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CATALOG
of Solar Proton Events in the 24th Cycle of
Solar Activity (2009-2019)

Moscow – 2022

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edited by Yu.I. Logachev

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Editor's preface

The present “Catalog of solar proton events in the 24th cycle of solar activity (2009–2019)” is a continuation of the Catalogs of previous issues [Akinyan et al., 1982; Bazilevskaya et al., 1986, 1990a, 1990b; Sladkova et al., 1998; Logachev et al., 2016], starting from 1970* [http://www.wdcb.ru/stp/solar/solar_proton_events.ru.html].

The Catalog contains and systematizes data on solar events with the maximum flux of protons of energy $E_p > 10$ MeV exceeding the value $J_p = 1 \text{ cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$ (1 pfu). There were 100 such events in the 24th solar cycle. In addition, 14 events with J_p ($E > 10$ MeV) in the range $0.1 \div 1$ pfu with data on all accompanying phenomena, similarly to the main events were included. In the Catalog, these events are marked with an asterisk (*). Events with such small fluxes are not represented in other Catalogs.

Note that there were no proton events with the selected particle flux ($J_p > 1$ pfu) in 2009 and in the last two years of the 24th solar activity cycles (2018–2019); the last events presented in the Catalog refer to September 2017.

In addition to data on proton fluxes measured by several spacecraft, and by neutron monitors the Catalog contains information on particle sources and on the electromagnetic radiation associated with this event. For each event, the integral energy spectrum of protons at the maximum of the intensity-time profile is shown. Some events have a complex temporal profile of proton fluxes with two or more maxima. In these events, a separate energy spectrum is plotted for each of the maxima.

Based on the constructed energy spectrum of protons, we calculate the energy at which the flux of solar cosmic rays (SCR) is equal to 0.1 flux of galactic cosmic rays (GCR). We call this energy value the quasi maximal energy of SCR (E_{qm}) and consider it as some approach to the real maximal energy of protons (E_{max}) for a given increase in proton fluxes.

Each event is illustrated with overview graphs of X-ray radiation, electron and proton fluxes, solar wind speed, interplanetary magnetic field strength and Dst variation in near-Earth space, which makes it possible to estimate the Sun's activity in the time interval covering this event.

Among the authors of the Catalog are representatives of various institutes, experts on cosmic rays, solar-, radio-, geophysics, and physics of interplanetary space, which provided wide coverage of the phenomena associated with the generation of particles on the Sun and their propagation in space and the Earth's magnetosphere.

The experience of working with previously issued Catalogs has shown that they are useful for statistical studies of energetic solar particles, physical processes associated with their acceleration and propagation in interplanetary space.

Information on the fluxes and energy spectra of solar particles is necessary for studying and monitoring solar-terrestrial relations, primarily for assessing and predicting the radiation hazards in the inner heliosphere. The Catalog data will be useful in studying the penetration of particles into the Earth's magnetosphere and atmosphere, in the study of some geophysical phenomena, such as absorption of cosmic radio emission in the polar cap, as well as for predicting the conditions of radio wave propagation. The invasion of energetic solar particles into the Earth's atmosphere

initiates ion-molecular reactions that affect the change in the concentration of ozone, and, as a result, the temperature and circulation of air masses in the stratosphere and troposphere of the Earth.

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* Links are given in the list of references to the section "General Description of the Catalog".

General Description of the Catalog

Introduction

The Catalog contains data on the fluxes of energetic charged particles of solar origin in events of the 24th solar activity cycle (2009–2019), recorded on various spacecraft: at the Lagrange L1 point, in geostationary orbit, low-altitude satellites of the Earth, and on ground-based installations. In 2009 and at the minimum solar activity in 2018–2019 there were no events that met the conditions of the Catalog, therefore, the Catalog contains data only for 2010–2017.

A solar proton event (SPE) is defined as an increase in particle fluxes at 1 a.u., with the maximum flux of protons of energy $E_p > 10$ MeV being more than or equal to $1 \text{ cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1} = 1 \text{ pfu}$ (particle flux unit) i.e., $J_p(E > 10 \text{ MeV}) \geq 1 \text{ pfu}$. As a rule, an estimate of this fiducial value is based on the hourly means of the Energetic Particle Sensor (EPS) instrument of the NOAA geostationary satellites of the GOES series. If the data from these spacecraft are not available or the Earth's magnetosphere is strongly disturbed, the assessment of fiducial fluxes is carried out using the data of all spacecraft presented in the Catalog. The Catalog includes not only isolated increases in proton fluxes with a simple temporal profile with one maximum but also some events with a complex temporal profile with several enhancements, which were considered as one event with several maxima. In events with several maxima, the most prominent of them, no more than two, were selected to plot the energy spectra. For each selected maximum, the tables below provide the same information as for single maximum events.

A brief description of the spacecraft (SC) and the characteristics of the instruments are given in [Supplement 1](#).

One of the most important aspects of studying a solar proton event is the determination of its source – an explosive event on the Sun that generated energetic protons. We assume a solar event as

the entire spectrum of phenomena in all ranges of electromagnetic radiation with all dynamic phenomena accompanying the explosive release of energy in limited regions of the Sun's atmosphere. Depending on the strength of the magnetic field in which the solar events occur, these can be solar flares or/and ejections of solar filaments and coronal mass. If a solar event occurs in an invisible hemisphere, its manifestations are observed only in the upper layers of the Sun's atmosphere: coronal mass ejection (CME) and phenomena in the radio range. The problem of identifying proton flux enhancements recorded in the Earth's orbit with solar events has been topical since the beginning of the study of solar cosmic rays (SCR). The methodology and criteria used for the link the observation on the Earth's orbit to the Sun are described in all previous catalogs [[Akinyan et al., 1982](#); [Bazilevskaya et al., 1986, 1990a, 1990b](#); [Sladkova et al., 1998](#); [Logachev et al., 2016](#)], nevertheless, given the importance of this procedure, this Catalog also contains a description of the technique, albeit somewhat modified: **“Determination of proton sources in solar events”** (see [Supplement 2](#)).

The main source of information about relativistic SCRs are ground-based installations, neutron monitors (NM), which register solar events of very high energy, the secondary charged particles of which reach the Earth's surface. These increases are commonly referred to as GLE (Ground Level Enhancement) events. During the 24th solar activity cycle, two GLE events occurred (2012.05.17 – No. 71 and 2017.09.10 – No. 72).

The transition from NM readings to proton fluxes outside the Earth's magnetosphere is a complex process that includes taking into account the mechanisms of propagation of charged particles in the Earth's magnetic field and in its atmosphere, i.e. it becomes necessary to solve the inverse problem – to reconstruct the energy spectrum of relativistic solar protons in interplanetary space from the data of neutron monitors. To solve the problem under consideration, more advanced particle propagation models are used every year, which is taken into account in this Catalog. The problem is described in more detail in [Supplement 3](#) **“Determination of the relativistic solar proton fluxes and energy spectrum from the neutron monitor data”**.

Note that in 2006–2014 the measurement of relativistic particles was carried out by the PAMELA orbital spectrometer, which recorded fluxes of protons and nuclei with energies in the range from 80 MeV to several GeV in near-Earth space. The Catalog contains the available PAMELA data.

In this Catalog, in order to estimate the maximum energy of accelerated protons the parameter introduced in the Catalog of the 23rd SA cycle [[Logachev et al., 2016](#)] is used: the quasi maximal energy of protons in the event – E_{qm} , which characterizes the spectrum of the event in the region of the highest recorded proton energies. The E_{qm} parameter is the first approximation to the real maximal energy of the observed proton fluxes in a given solar event. The quasi maximal energy of protons in the event E_{qm} is defined as the energy at which the flux of solar protons in a given event is equal to 0.1 flux of galactic cosmic rays (GCR protons) of the same energy. The procedure for determining E_{qm} is described in [Supplement 4](#) and in [[Logachev et al., 2018](#)].

Description of the layout structure for an individual solar proton event

Each event begins with its name, which is the date of occurrence (beginning) of the event, indicated in two ways:

YYYY.MM.DD – (YYYY–DOY), for example, the first Catalog event that started on August 03, 2010 is referred to as 2010.08.03 – (2010–215). Mentioning the DOY value in an event name is often useful when comparing with other reference data. On the right side of this line, the number of

the event is given, the numbering of which has been carried out since the first event in 1970, included in the Catalog of solar proton events of 1970–1979 [Akinyan et al., 1982].

Next is the LEGEND of the event, which includes some general information about the event. Below is an example of a legend and an explanation of its each line.

Event 2012.03.07 – (2012-067)

506

Particle event: To(Ep>10 MeV) – 07d02^h

Tmax₁(Ep>10 MeV) – 07d17^h, Jmax₁ (Ep>10 MeV) – 1440 /cm²·s·sr

Tmax₂(Ep>10 MeV) – 08d13^h, Jmax₂ (Ep>10 MeV) – 4340 /cm²·s·sr

Duration of the event – 6 days, power-law index: $\gamma_1 = 2.9$, $\gamma_2 = 4.0$

Quasimaximal energy of protons in the event – Eqm₁ = 1200 MeV

– Eqm₂ = 650 MeV

Sources: • solar flare 07d00^h00^m, X5.4/3B, N17E27, AR11429

Ø solar flare 07d01^h05^m, X1.3/SF, N22E12, AR11430

Ø solar flare 09d03^h22^m, M6.3/SF, N15W02, AR11429

Ø solar flare 10d17^h15^m, M8.4/..., N17W24, AR11429

Main burst X-ray 1–8 Å: onset – 07d00^h02^m, max – 07d00^h40^m, $\Phi = 0.67 \text{ J/m}^2$

CME: 07d00^h24^m, V= 2684 km/s, $\Delta\phi = 360^\circ$, dA= 057°

▲ SC 07d 04^h 20^m; ▲ SC 12d 09^h 15^m;

Here:

Event 2012.03.07 – (2012-067) – event name and event number: № 506.

On the first line:

Particle event: To (Ep>10 MeV) – 07d02h – the day and time of the onset of the event, determined from the flux of protons with Ep>10 MeV according to the readings of the EPS instrument of the GOES geostationary spacecrafts or a combination of others presented in the Spacecraft Catalog. The accuracy of the start time of the event is within 1 hour.

The To value can be more accurately determined in the electronic version of the Catalog [http://swx.sinp.msu.ru/apps/sep_events_cat/index.php?gcm=1&lang=ru]. To do this, one needs to open the file of this event and find To using the cursor at the time profile of the GOES data.

An accurate determination of the start time of an event, even if using data with a higher temporal resolution, is difficult due to variations in the background counting rates of instruments and can lead to misinformation about the real time of the onset of an event in the proton component.

In the second (second-a and second-b) line

(a) Tmax₁(Ep>10 MeV) – 07d17^h, Jmax₁ (Ep>10 MeV) – 1440 /cm²·s·sr

(b) Tmax₂(Ep>10 MeV) – 08d13^h, Jmax₂ (Ep>10 MeV) – 4340 /cm²·s·sr

are given the day and time of the maximum (in this event at two maxima) of the flux of protons with energy >10 MeV in the event according to the data of the set of instruments presented in the Catalog that registered this event, and the value at the maximum (maxima) of the flux Jp (cm²·s·sr)⁻¹. In this example, the event had two maxima, and the legend has two lines (a and b).

All particle fluxes presented in the Catalogs are hourly means, time is UT everywhere. The accuracy of the time of the maximum proton flux, Tmax, is 1 hour. The accuracy of the proton flux

J_{\max} ($E_p > 10$ MeV) is no worse than $\pm 10\%$. The low accuracy of the time of the maximum proton flux is due to using hourly means of particle fluxes throughout the event. In addition, the time of the maximum flux of protons intends mainly for identifying a specific maximum of fluxes in complex events with several maxima, so that the flux values when constructing energy spectra from the data of different spacecraft relate to the same maximum.

The third line:

Duration of the event – 6 days, power-law index: $\gamma_1 = 2.9$, $\gamma_2 = 4.0$

shows the total duration of the event including all the noted maxima in complex events, and the index of the power-law spectrum of proton fluxes at the maximum (s) of the event – γ .

The last line:

Quasi maximal energy of protons in the event – $E_{qm_1} = 1200$ MeV
– $E_{qm_2} = 650$ MeV

shows the values of the quasi maximal proton energy in a given event, E_{qm} , determined for each maximum of this event. $E_{qm}(\max 1)$ and $E_{qm}(\max 2)$ are calculated using the integral energy spectrum of protons for each maximum in the event. The E_{qm} is determined with an accuracy of $\pm 15\%$.

The second section of the LEGEND refers to the solar sources of particles observed near the Earth. In the above example, the **Event 2012.03.07 – (2012-067)** is given:

Sources: • solar flare 07d00^h00^m, X5.4/3B, N17E27, AR11429

Ø solar flare 07d01^h05^m, X1.3/SF, N22E12, AR11430

Ø solar flare 09d03^h22^m, M6.3/SF, N15W02, AR11429

Ø solar flare 10d17^h15^m, M8.4/..., N17W24, AR11429

Main burst X-ray 1–8 Å: onset – 07d00^h02^m, max – 07d00^h40^m, $\Phi = 0.67$ J/m²

CME: 07d00^h24^m, $V = 2684$ km/s, $\Delta\phi = 360^\circ$, $dA = 057^\circ$

▲ SC 07d 04^h 20^m; ▲ SC 12d 09^h 15^m;

If the source of particles is a solar flare, then **the first line** contains its main characteristics: the time of the onset of the flare either in the H α line (6563 Å) or an X-ray burst: (07d00^h00^m – day, hours, minutes), depending on which range it began first. This determines the order of presentation of the X-ray class and optical flare importance of this event (X5.4/3B, in this case, the flare event earlier manifested itself in the soft X-ray range); the coordinates of the flare (N17E27), and the number of the active area where the flare event occurred (AR11429). If the reverse order is indicated for the X-ray class and optical flare importance (for example, in the event 2012.03.13 – 1B/M7.9), this means that the onset of the flare event in the optical range was recorded earlier than in the X-ray range.

At the beginning of this line, a conventional symbol is placed, indicative of confidence in the flare association to this solar event.

●, ■ – the flare is a certain source of the observed protons;

⊙, □ – the flare is most likely the source of the observed protons;

the symbols ■, □ are used when the source of a solar proton event occurs at near-limb and behind-limb for heliolongitudes W, $E \geq 80^\circ$;

- O – the flare is a possible but for some reason doubtful source of the observed protons;
- Ø – the flare is not the main source, but contributed, or might have contributed to the proton flux.

If the source of protons on the Sun is not identified, then the following symbols are used:

- – the flare (or flare associated activity) is behind the western or eastern limb of the Sun;
- ◇ – activity on the solar disk not associated with specific flare event, or modulation effects in interplanetary space

The procedure for identification of the solar proton sources for a given event is described in [Supplement 2](#). The characteristics of active regions where solar proton events have occurred are given in [Supplement 5](#).

Further, in the **Sources** section, information is given on a soft X-ray burst in the range of 1–8 Å (12.5–1 keV), according to the data of the GOES spacecraft: the times of onset and a maximum of the burst (in this example, 07d00^h02^m, and 07d00^h40^m), Φ is the integral energy flux, from the burst onset until the half of maximum level, J/m² ($\Phi = 0.67$ J/m²).

The following is information about the coronal mass ejection (CME) associated with the event under consideration if any. Shown are the time of the CME appearance in the field of view of the coronagraph – in this example – 07d00^h24^m, the CME velocity (2684 km/ s), the angular width of the CME near the Sun ($\Delta\phi = 360^\circ$), and the central position angle of the first appearance of the CME as observed by the LASCO-SOHO coronagraph – ($dA = 057^\circ$).

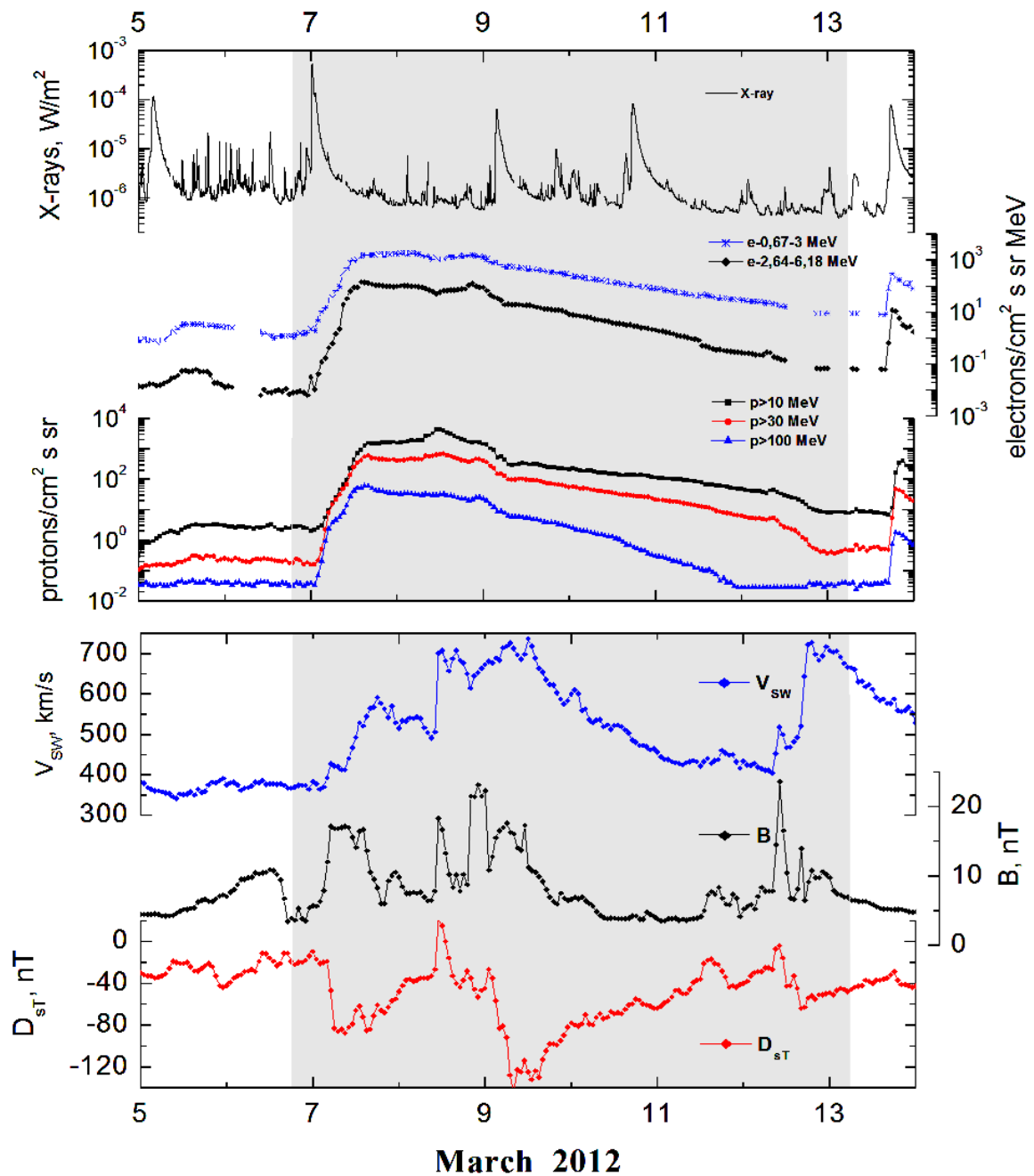
In the last line, in the presence of one or several storm sudden commencements (SC), after the symbols ▲ or Δ, the date and time of the SC are indicated: ▲ – SC associated with the shock wave that introduced changes in the particle fluxes, Δ – SC, associated with a shock wave not reflected on the profiles of particle fluxes.

After the legend, there are overview graphs showing the situation on the Sun and in near-Earth space for the events described.

Shown are (from top to bottom): soft X-ray emission of the Sun according to the data of the GOES spacecraft with a time resolution of 1 minute, the fluxes of solar electrons according to the data of the EPHIN SOHO instrument and protons with energies $E_p > 10$, > 30 and > 100 MeV according to the data of the GOES spacecraft (hourly means), solar wind speed, the interplanetary magnetic field (IMF) strength, and disturbance of the Earth's magnetosphere (Dst-index values).

These graphs cover a longer period of time than the duration of the event in question. The period related to this event is highlighted with slight shading.

The time profiles of protons and electrons in the survey graphs clearly demonstrate the situation on the Sun, the type of event (plain, composite, or complex), the number of maxima in a complex event, the contribution of shock waves to particle fluxes, Forbush decreases in solar particles. The accompanying soft X-ray bursts indicate a possible flare-source on the Sun and its power.



Description of the particle flux Tables

After the overview graphs, there are tables of proton fluxes for this event. The tables show the values of the fluxes of protons with different energies at the event maximum (in two maxima), recorded by all operating spacecraft. Common designations are used for spacecraft, NM – ground measurements by neutron monitors. A description of the devices is given in [Supplement 1](#).

All designations in particle flux tables are commonly accepted. Note that at the maximum on the same day as the beginning of the event, the day is not indicated. If the maximum occurred on the next day or later, in addition to the time, the day is also indicated (for example, 20 – if the maximum coincides with the day of the beginning of the event and 07d08 – if the maximum is the next day or later). If the event had two maxima, they are separated by a "slash" sign (for example,

11/21 – both maxima on one day or 21/07d08 – the second maximum on the next day or even later).

The proton fluxes at the maximum of events are given without any corrections of the original data, except for the subtraction of background values. The accuracy of the data in the tables is not worse than 10%. If two maxima are considered in an event, the flux values are separated by a "slash" sign, in accordance with the times of the maxima. The duration of an event is measured in days. Note that this parameter experiences the greatest variations both from instrument to instrument and for different proton energies. The measurement accuracy here is no worse than ± 1 day.

After the tables of proton fluxes, there are plots of the integral energy spectra of protons. The integral spectra were compiled from the maximum fluxes of protons of all energies recorded in a given event. Differential fluxes of protons recorded in separate energy intervals were recalculated into integral ones. If an event has two maxima, then the spectra were plotted for each maximum.

The high-energy part of the spectrum was fitted by a power-law function ($J_p \sim E^{-\gamma}$), shown on the graph for each spectrum, indicating the value of the exponent γ . This procedure, due to the significant scatter of points obtained by different instruments, gives γ with rather a low accuracy, not higher than $\pm 10\%$.

On each graph, in addition to the spectrum of solar protons in this event, the integral spectrum of galactic protons at the maximum of the solar cycle (0.1 part of the total flux) is shown, which makes it possible to see the intersection of the two spectra and evaluate Eqm.

Next are the time profiles of proton fluxes as measured from various spacecraft in the following sequence:

- fluxes of protons measured in space on the ACE and SOHO spacecraft located at the Lagrange point L1 at a distance of 1.5 million km from the Earth towards the Sun;
- fluxes of protons penetrated into the Earth's magnetosphere in the area of closed force lines of the geomagnetic field as measured on the geostationary spacecraft GOES and Electro;
- fluxes of protons entered the Earth's magnetosphere in the area of open lines of force of the geomagnetic field as measured on low-altitude polar spacecraft Meteor and POES.

Description of the solar phenomena Tables

The following are materials on the observed solar phenomena, the sources of this proton event. The parameters and characteristics of this solar event are summarized in a table and a graph (graphs) of the frequency spectrum. Since the conditions for their registration and results are different for different flare events, the tables for different events are also slightly different. Below is an explanation of all information in the events included in the Catalog.

All tables, as in all previous catalogs [Akinyan et al., 1982; Bazilevskaya et al., 1986, 1990a, 1990b; Sladkova et al., 1998; Logachev et al., 2016], begin with the title, where are indicated: date, degree of reliability of identification (\bullet , \odot , \square , \circ , \square or \emptyset) of a solar event – the source of the corresponding proton event, number of the active region (AR) according to the data of the Sun Service NOAA USA [<https://www.swpc.noaa.gov/>] and the ordinal number of the proton event (since the beginning of the release of our Catalogs).

If several episodes of solar activity contributed to the proton fluxes, each episode is described in a separate table.

All designations given in the parameter table are commonly accepted in solar physics, details can be found in the descriptive volumes of the monthly Solar Geophysical Data (SGD) Bulletin [Solar ...]. The data on the soft X-ray bursts are based on the GOES data. Basic data on hard X-ray radiation, gamma range for 2010–2017 are taken from catalogs of solar flares [https://hesperia.gsfc.nasa.gov/hessidata/dbase/hessi_flare_list.txt] and [https://hesperia.gsfc.nasa.gov/fermi/gbm/qlook/fermi_gbm_flare_list.txt]. CME data are available in the SOHO LASCO CME Catalog [http://cdaw.gsfc.nasa.gov/CME_list/].

The information in the Catalog tables is organized into blocks that include all actually observed electromagnetic radiation (optics, soft, hard X-rays, gamma and radio), dynamic phenomena observed in the H α line, and in the continuous spectrum (WL – in "white" light).

Each section of the table begins with a line of titles of the below columns and is separated from other sections by a narrow blank line. The absence of any data, whole lines, in the cells and columns of the Catalog tables indicates that there were no corresponding phenomena or observations in this event.

1. The block of observations in the optical and soft X-ray ranges is arranged in columns (1–8) as follows:

- Data in the optical range:

(1) – the wavelength of the spectral line of observation (H α – 6563 Å); (2) – the observed dynamic phenomenon in the optical wavelength range: in the H α line – FL, LPS, DSF (EPL), SPY, BSL, the characteristics of which may occupy several subsequent lines; (3–5) – time of the beginning, maximum and end of the event, (6) – helio coordinates, localization of the flare event on the visible disk of the Sun, (7) – optical class of the flare event, (8) – flare code characterizing the structure of the phenomenon according to Solar Geophysical Data [Solar ...].

- Soft X-ray burst data:

(1 and 2) – energy range, and measurement unit, (3–5) the times of start, maximum, and end (when the radiation intensity drops to 0.5 I_{max} of the burst; (6) – helio coordinates, localization of the X-ray burst on the visible disk of the Sun; (7) – the radiation flux at the maximum of the burst (burst class); (8) – fluence, i.e. the integral flux of soft X-ray radiation in joules per square meter, J/m².

2. Block of observations of the hard X-ray and γ -radiation:

(1 and 2) – the range of energies, or the maximum energy of the γ -burst and the unit of measurement, (3–5) – the times of the beginning, maximum, and end of the event, (6 – 7) – the count rates at the maximum and the total count rates, (8) – the spacecraft on which the measurements were made.

3. Block of observations of radio emission at fixed frequencies:

(1) – frequency, (2) – units of measurement, (3–5) – the times of start, maximum, and end of the radio event, (6) – code (see explanations below), (7) – logarithm of the flow in units of $10^{-22} \text{ W} \cdot \text{m}^{-2} \text{ Hz}^{-1}$ (for more details see descriptions of previous Catalogs).

4. Block of observations of the dynamic spectrum of radio bursts (DS for the Sun, DH for interplanetary):

Characteristics: (1) – type, the frequency range in MHz, (3 and 5) – start and end times, (6) – for DS II – estimated speed of propagation of the shock wave in the solar corona (if any), (7) – the spacecraft on which the measurements were made. Data on the DH Type II are taken from Wind/WAVES type II burst catalog [https://cdaw.gsfc.nasa.gov/CME_list/radio/waves_type2.html].

The type of dynamic spectrum (DS) of the meter component and the features of the radio burst are taken from the Solar Radio Burst: [<https://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/solar-radio/radio-bursts/reports/spectral-listings/docs/SPECTRAL.TXT>], and, for individual events, from [<https://www.solarmonitor.org/data/>].

5. Block of Coronal Mass Ejection (CME) Data:

(1) Observing instrument – LASCO/C2 coronagraph of SOHO unit; (2) – continuous spectrum (WL) (3) – time of the first appearance in the coronagraph's field of view, (4) – the value of the linear velocity V (km/s) of the radial propagation of CME when moving in the coronagraph's field of view. (5) – acceleration in km/s^2 , can be positive, negative, or close to zero, (6) – $\Delta\phi$ – angular width of CME near the Sun in degrees, (7) – dA – position angle of the first appearance of CME.

It should be noted that the absence of data on CME does not mean that it was absent in this solar event. It is possible that during this event, there were no observations on the coronagraph ("gap"), or the localization of the flare behind the solar limb did not contribute to the possibility of its registration. Immediately below the tables, there are, if necessary, notes (*) and http-addresses of the evolutionary development of this solar event in the UV range and magnetic fields (for especially interesting events). For example, for the event selected as an example on March 7, 2012, this is [https://sdowwww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_120306_165417_33724/www/].

After tables describing solar phenomena accompanying this SPE, graphs of radio emission spectra at decimeter and centimeter wavelengths are given. This spectrum makes it possible to evaluate and, possibly, reveal the patterns characteristic of flare events – sources of solar proton events. These characteristic patterns are indicated by the spectrum code indicative of the frequency spectrum shape (available in the table and in the upper right corner of the spectrum), and **Supplement 5** provides a brief description of these patterns and the associated possibilities of accelerating protons in an event.

A more detailed description of all symbols in the tables is given in **Supplement 6**.

The informational part of the material about the sources in this event is closed by a list of publications (not in every event and by no means complete). Detailed information on publications is contained in the general list of publications at the end of the description of the materials of the Catalog after the Supplements.

Conclusion

The Catalog contains data on 114 events (100 events with $J_p(E > 10 \text{ M}\text{\AA}B) \geq 1$ pfu and 14 events with $J_p(E > 10 \text{ M}\text{\AA}B) < 1$ pfu) in solar cosmic rays in the 24th solar cycle (2009–2019). The Catalog contains digital and graphic information on the fluxes and energy spectra of solar protons in the near-Earth space, time profiles of proton fluxes for all events included in the Catalog. Extensive data on the accompanying solar phenomena, radio and X-ray emissions, information on active regions with flares, and other additional information are given.

The Catalog is designed for a wide range of researchers working in the field of solar-terrestrial physics, solar physics, specialists in the radiation safety of space flights, and those interested in the problems of the impact of solar activity on the magnetosphere, atmosphere, and biosphere of the Earth.

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Supplement 1

Spacecraft and instruments with data for Catalog

The main information about the SPE is represented by the fluxes of protons recorded by different spacecraft in different orbits and having different instruments that use different methods of registering charged particles. These circumstances lead to slightly different measurement results, which have to keep in mind. No corrections of the obtained results were carried out. In some cases, instrument readings are absent or unreliable (a strong difference from the main group of instruments, failure in the information transmission system, in-flight instrument calibration processes, and other reasons), they were carefully considered, and these data were excluded from the Catalog. Below is the basic information about the instruments used in the Catalog.

GOES (Geostationary Operational Environmental Satellite system) – a series of artificial Earth satellites in geostationary orbit. **GOES** is a project of the National Oceanic and Atmospheric Administration – NOAA. The Catalog used the data of the EPS instrument complex from the GOES-15 apparatus: on the integral fluxes of protons with threshold energies >5 , >10 , >30 , >50 , >60 , >100 MeV (based on the readings of the EPEAD instrument as part of EPS) and fluxes of protons with energies in the ranges of 350–420, 420–510 and 510–700 and >700 MeV (HEPAD device as part of EPS). A detailed description of the GOES devices and the EPS instrument complex can be found on the sites: GOES Space Environment Monitor [<https://www.ngdc.noaa.gov/stp/satellite/goes/documentation.html>] and Goddard Space Flight Center [https://cdaweb.gsfc.nasa.gov/sp_phys/].

Electro – the general name of a series of Russian meteorological Earth satellites in geostationary orbit. The Catalog used the data of the SKL-E (SKL – Cosmic Ray Spectrometer) and GALS-E (GALS – Galactic Ray Spectrometer) instruments from the spacecraft Electro-L No. 1 and No. 2. The SKL-E instrument is a narrow-beam telescope, which consists of a semiconductor pass-through detector and two scintillation detectors. Registration is carried out in the direction perpendicular to the orbital plane to the south. The Catalog uses data from several differential channels of the SKL-E instrument in the energy range $\sim 1 \div 160$ MeV. The reading of the SKL instrument in each of the channels was a half-sum of the readings in two mutually perpendicular directions. The GALS-E instrument is a spectrometer based on a Cherenkov counter that detects protons with energies > 600 , > 800 , > 1100 MeV. The Catalog uses proton channels > 600 MeV. Basic information about the spacecraft Electro-L No. 1 and No. 2 and the instruments on them can be found on the sites of the Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University: [<https://ftp.sinp.msu.ru/>] and [http://smdc.sinp.msu.ru/index.py?nav=electro_11], [http://smdc.sinp.msu.ru/index.py?nav=electro_12].

Meteor is the general name for a series of Russian meteorological satellites of the Earth in a polar sun-synchronized orbit at altitudes of ~ 800 – 900 km. Polar satellites, in particular the Meteor series, register solar protons as they pass over the Earth's polar caps. The Catalog used data from the spectrometers of solar and galactic cosmic rays SKL-M and GALS-M from the spacecraft Meteor-M No. 1 and No. 2.

The SKL spectrometer is a telescope with a total viewing angle of 30° consisting of a pass-through semiconductor silicon detector and a scintillation detector based on a CsI (TI) crystal. The telescope axes are arranged in two mutually perpendicular directions – along the spacecraft velocity vector and radially from the Earth. The Catalog uses data from several differential channels in the energy range $\sim 1\div 160$ MeV. The data of the SKL instrument in each of the channels was a half-sum of the readings in two mutually perpendicular directions. The GALS instrument consists of two Geiger Müller gas-discharge counters measuring protons with energies >15 , >25 MeV and a spectrometer based on a Cherenkov counter for measuring protons with energies >600 , >800 and >1100 MeV. The Catalog uses proton channels >600 MeV. Basic information about spacecraft Meteor-M No. 1 and No. 2 and instruments onboard can be found on the sites of the Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University: [<https://ftp.sinp.msu.ru/>], [http://smdc.sinp.msu.ru/index.py?nav=meteor_m1], [http://smdc.sinp.msu.ru/index.py?nav=meteor_m2] and of the Fedorov Institute of Applied Geophysics [<http://ipg.geospace.ru/meteor-data.html>].

POES (Polar Orbiting Environmental Satellites) – a series of Earth satellites in a polar circular orbit with solar synchronization at altitudes from 700 to 850 kilometers, the duration of the orbital period from 98 to 103 minutes [Evans and Greer, 2000]. **POES** is a project of the National Oceanic and Atmospheric Administration – NOAA. The Catalog used the data of measurements of proton fluxes from the MEPED instrument on the satellite POES-19. A detailed description of the POES apparatus and the MEPED instrument complex can be found on the sites: NOAA [<https://www.ngdc.noaa.gov/stp/satellite/poes/>] and Goddard Space Flight Center [https://cdaweb.gsfc.nasa.gov/sp_phys/].

ACE (Advanced Composition Explorer) – a spacecraft located at the Lagrange point L1 at a distance of 1.5 million km from the Earth. For a description of the apparatus and the set of experiments, see site of the Caltech ACE Science Center [<http://www.srl.caltech.edu/ACE/>]. The Catalog uses data from the SIS (Solar Isotope Spectrometer) instrument on proton fluxes with energies >10 MeV and >30 MeV. Particle flux data and a description of the ACE apparatus and SIS instrument can be found at: Caltech ACE Science Center [http://www.srl.caltech.edu/ACE/CRIS_SIS/] and Goddard Space Flight Center [https://cdaweb.gsfc.nasa.gov/sp_phys/].

SOHO (Solar & Heliospheric Observatory) – a spacecraft located at the Lagrange point L1 at a distance of 1.5 million km from the Earth. The Catalog uses data from two instruments:

- **LION (Low Energy ION and Electron Instrument)** is designed to measure proton spectra in the energy range 44 keV–6 MeV. The Catalog uses proton channels 0.75–2 MeV and 2–6 MeV.

- **EPHIN (Electron Proton Helium INstrument)**. For the Catalog, channels are used that register protons with energies: 4–8; 8–25; 25–41 and 41–53 MeV (after a year of flight, the last two channels merged into one 25–53 MeV), as well as the INTEGRAL channel: >10 MeV (electrons) + >50 MeV (protons). Particle flux data and a description of the **SOHO** apparatus and the **LION** and **EPHIN** instruments can be found on the websites: NASA [<https://sohowww.nascom.nasa.gov/>], COSTEP [<http://www.ieap.uni-kiel.de/et/ag-heber/costep/>] and Goddard Space Flight Center [http://cdaweb.gsfc.nasa.gov/sp_phys/].

PAMELA (Payload for Antimatter-Matter Exploration and Light Nuclei Astrophysics), the telescope-spectrometer operated in the Earth's orbit from June 2006 to January 2016. The RESURS

DK-1 satellite with the **PAMELA** instrument onboard had a quasi-polar orbit with an inclination of 70.4 deg. and an altitude of 300–600 km, the orbital period of the satellite was 90 minutes. The main objectives of the **PAMELA** experiment were to study galactic cosmic rays. Telescope-spectrometer **PAMELA** allows one to reliably determine the energy, momentum, sign, and value of the particle charge. An additional task was to study the high-energy component of solar proton events (from 80 MeV to several GeV). The background count of the **PAMELA** instrument is determined by the flux of galactic cosmic rays. The details of the experiment are described in: [[Adriani et al., 2011](#); [Bruno et al., 2018](#)].

Neutron monitors (NM) are instruments that register a high-energy part of the energy spectrum of protons in a solar event by ground-based means. Due to the geomagnetic cutoff and absorption of protons by the Earth's atmosphere (all NMs are located on the Earth's surface), the minimum proton energy recorded by the NM is about 500 MeV. NM have a very large geometric factor, which makes it possible to distinguish even small increases in solar proton fluxes. Since NM register secondary neutrons created in the Earth's atmosphere and NM counter screens, it becomes necessary to recalculate the registered increase in the count rate of a particular NM to proton fluxes outside the Earth's magnetosphere. This problem was solved according to the readings of the world network of NM stations for all solar events called Ground Level Enhancement (GLE), and the Catalog contains proton fluxes already outside the Earth's magnetosphere. The recalculation procedure is described in detail in [Supplement 3](#).

Spacecraft and instruments

Spacecraft	Instrument	E, ΔE, MeV	G, cm ² ·sr, or effective area and direction (nominal values)	Work period in the SC 24th, years
GOES – 15	EPS/EPEAD	>5		2010-2017
	EPS/EPEAD	>10		
	EPS/EPEAD	>30		
	EPS/EPEAD	>50		
	EPS/EPEAD	>60		
	EPS/EPEAD	>100		
	EPS/HEPAD	350-420		
	EPS/HEPAD	420-510		
	EPS/HEPAD	510-700		
	EPS/HEPAD	>700		
Electro-L No.1	SCR-E	13.7-23	0.1	2011-2016
	SCR-E	23-42	0.1	
	SCR-E	42-112	0.1	
Electro-L No.2	SCR-E	9-20	0.1	2014-2017
	SCR-E	20-40	0.1	
	SCR-E	40-110	0.1	
Electro-L No.1, No.2	GALS – E	>600	40 cm ² , 3π	2011-2017
Meteor – M No.1 and No.2	SCR-M	1-100	0.1	2010-2017
	SCR-M	3-10	0.1	
	GALS – M	>15	0.8 cm ² , 2π for SCR,	
	GALS - M	>25	2.3 cm ² , 2π for GCR	
	GAL S– M	>600	40 sm ² , 3π	
POES - 19	MEPED	0.24-0.8	0.01	2010-2014
	MEPED	0.8-2.5	0.01	
	MEPED	2.5-6.9	0.01	
	MEPED	>6.9	0.01	
	MEPED	>16		
	MEPED	>35		
	MEPED	>70		
	MEPED	>140		
	MEPED	16-36		2015-2017
	MEPED	36-70		
	MEPED	70-140		
	MEPED			
ACE	SIS	>10	≈40	2010-2017
	SIS	>30	≈40	
SOHO	LION	0.75-2	0.32	2010-2017
	LION	2-6	0.32	
	EPHIN	4-8	5.1	
	EPHIN	8-25	5.1	
	EPHIN	25-53	5.1	
	EPHIN	>50	5.1	
PAMELA	PAMELA	>80	20	2010-2014

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Supplement 2

Determination of proton sources in solar events

An event in solar cosmic rays (SCR), in the Catalog – solar proton event – SPE, is defined as a population of energetic particles observed in the interplanetary medium after explosive energy release on the Sun, the most striking causes of which are solar flares accompanied by a certain set of electromagnetic radiation, and coronal mass ejections. The question on the relative role of the processes associated with flares and coronal mass ejections in the acceleration of charged particles has been central to the SCR problem for many years. To advance in this area, it is necessary to determine as accurately as possible the flare and coronal mass ejection – the main sources of energetic particles in most SCR events.

Since solar protons can enter near-Earth space even from distant flare events behind the limb, it is not always possible to find the actual optical flare as a source of SPE.

Unfortunately, in many cases, the identification of the particle source remains subjective. In the described Catalog, this subjectivity is minimized due to the complex accounting of reliable and verified statistical regularities, none of which, however, was given decisive importance.

Three types of data were considered:

- fluxes of charged particles, their time profiles, and energy spectra;
- electromagnetic radiations in the X-ray, optical, and radio ranges, their spectral characteristics, dynamics, and other parameters;
- the structure of the magnetic field and the evolution of active regions, their flare activity [Laurenza et al., 2007].

The first type of data made it possible to preliminarily estimate the localization and time interval of a solar event, which, with a certain degree of probability, could be the source of a given proton event. A fast (hours) increase in the $E > 10$ MeV proton flux to a maximum and a hard spectrum in the energy range of 10–100 MeV (integral power-law spectrum index $\gamma \leq 3$), with a high probability, indicates that the solar event occurred in the western hemisphere of the visible disk of the Sun. Slow rise (> 10 hours), wide maximum and usually softer spectrum ($\gamma \geq 3$) most

likely indicate a source (flare event) in the eastern hemisphere of the Sun's visible disk [e.g., [Lario, 2005](#); [Laurenza et al., 2007](#)].

If grounds were found to consider a solar flare event located in the western hemisphere of the Sun as a source of SPE, then all flare preceding the onset of particle growth within 1–10 hours were considered to determine a specific source. In the case of an eastern flare event, the indicated interval expanded to 2–3 days.

In the present SPE Catalog for the 24th SA cycle, it became possible to include data on dynamic phenomena such as solar fiber ejections, limb emission, and other phenomena in the optical range accompanying solar flare events. The most informative of them are coronal mass ejections (CME), the main characteristics of which are given in the Catalog. If a proton flare event occurs far enough behind the limb (usually behind the western one), then its only evidence will be CME of the "halo" or "partial halo of types I–III" [[Park and Moon, 2012](#)].

When analyzing the electromagnetic radiation of a solar event, attention was primarily paid to the X-ray class of the burst (1–8 Å, $E_x = 12.5\text{--}1\text{ keV}$), which for flares on the visible solar disk in the range of longitudes E70 ÷ W70 should exceed M1, and the flares the average class ($M < 5$) should usually be of long duration (> 1 hour) and the integral radiation flux in this X-ray range should be $\geq 5 \cdot 10^{-2}\text{ J/m}^2$. If solar flares of a small X-ray class are located on the visible disk of the Sun, then they are accompanied by the entire spectrum of dynamic phenomena, both in optics and in the radio range. The data in the optical range in the H α hydrogen line ($\lambda = 6563\text{ Å}$), which give the exact localization of the flare, indirectly indicate the energetics and temporal structure of the flare process itself.

A significant diagnostic factor is the radio emission of a flare event: proton flares, as a rule, are accompanied by dynamic radio bursts of type II and/or IV with the presence of sufficiently intense radio emission at centimeter (~ 9 and 15.4 GHz) and meter ($\sim 245\text{ MHz}$) waves with a relatively low-density flow in the decimeter range. The duration of the rise of the microwave burst is usually ≥ 5 minutes and has a U-shaped frequency spectrum [[Akinyan et al., 1980](#)].

An essential additional factor in identifying an increase in the proton flux with one or another flare event is the characteristics of active regions (AR) or a complex of active regions (CAR), which are considered as sources of particles of this event. Proton flare events occur in AR, in which a fast emerging of a new magnetic flux of large magnitude is observed, transforming a simple group of sunspots into a complex one. In such ARs, the flare energy release usually occurs in the form of a series of flares of high and medium power in a limited time interval [[Ishkov, 2003](#)]. It is especially necessary to note the flare activity of CAO, which consists of two or more neighboring groups of spots connected by a common magnetic field. A large flare event usually covers the main components of the CAO, and its magnetic structure most likely facilitates the release of large fluxes of protons.

A special class is made up of increases in the proton flux caused by behind-limb flare events. The main signs indicating a connection between this increase with the flare behind the limb are:

- the presence of CME and/or meter type II and/or type IV radio bursts in the absence of pertinent flare events in the visible hemisphere;
- recent (up to 4 days) leaving the western limb of a flare AR of a complex magnetic configuration with a high probability of a quick emergence of a new magnetic flux or being in the period of realization of large flare events;

– the expected appearance from behind the eastern limb of the Sun (up to 3 days) on the visible solar disk of the AR, which in the last rotation was highly flare-active and departed behind the western limb in full development.

If these signs are present, it is concluded that the source of the particle increase, is located on the invisible hemisphere of the Sun.

When in some SPEs, mostly of low power, the increase in protons is not identified with any manifestations of flare or CME activity then one has to conclude that its source is unknown.

For all events in the Catalogs, the reliability of the source of this SPE is indicated, based on the above approaches. The degree of confidence with which the link of the proton event to the source has been carried out is indicated by the corresponding symbols given in the description of the materials in the Catalog, which coincide with the scheme developed by [Dodson and Hederman, 1975].

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Supplement 3

Determination of the relativistic solar proton fluxes and energy spectrum from the neutron monitor data

Until recently, the source of information on the intensity of relativistic SCRs were ground-based installations, mainly neutron monitors (NM), which register Ground Level Enhancements (GLE). In the 24th cycle, orbital spectrometers appeared that allow direct measurement of energetic SCR in near-Earth space: PAMELA, with a threshold for protons and nuclei above 80 MeV/n [Adriani et al., 2011; Bazilevskaya et al., 2013; Bruno et al., 2018], and AMS-2 with a detection threshold above hundreds of MeV [Bindi, 2015]. Nevertheless, NMs remain unsurpassed in

efficiency instruments for measuring SCR up to energies of tens of GeV, due to the large geometric factor and the use of a global network of stations.

Ground-based installations register secondary cosmic rays, and the transition from an increase in the counting rate of a ground-based instrument to SCR fluxes at the atmospheric boundary requires knowledge of the response functions of the instrument. In recent years, the technique for obtaining SCR spectra from neutron monitor data has been improved by a group of physicists from Oulu (Finland) based on detailed Monte Carlo calculations of SCR propagation in the Earth's magnetosphere and atmosphere in [Mishev et al., 2014, 2018].

The formula for determining the SCR fluxes from the NM data is as follows:

$$\frac{\Delta N(R_{c,t})}{N(t)} = \frac{\int_{R_c}^{R_{max}} J_{\parallel sep}(R, t) Y(R) G(\alpha(R), t) dR}{\int_{R_c}^{\infty} J_{GCR}(R, t) Y(R) dR},$$

where $N(t)$ is the count rate of NM for GCR; $\Delta N(R_{c,t})$ is an increase in the counting rate caused by the arrival of SCR at the point with the geomagnetic cutoff rigidity R_c ; $J_{\parallel sep}(R, t)$ and $J_{GCR}(R, t)$ are the SCR and GCR spectra, respectively; $Y(R)$ is the multiplicity of the generation of secondary particles in the atmosphere by one primary particle with rigidity R , $G(\alpha(R, t))$ is the pitch-angle distribution of SCR particles; R_{max} is the maximum SCR rigidity, taken equal to 20 GV. In the new technique, the multiplicity values are significantly refined and the pitch-angle distribution of SCRs, which changes with time, is taken into account.

In the 24th solar cycle, only two events were recorded that caused an increase in the particle flux on ground-based neutron monitors (GLE 71 and GLE 72). In [Mishev et al., 2014, 2018], an approximation of the differential spectra in rigidity is given in the form

$$J_{\parallel sep}(R) = J_0 R^{-(\gamma + \delta\gamma(R-1))},$$

where $J_{\parallel sep}(R)$ is the flux of particles with rigidity R , γ is the spectrum index in the power-law representation, $\delta\gamma$ is the spectrum steepening coefficient. The angular distribution function of arriving particles (in these papers, it does not depend on energy) is given in the form of a superposition of two Gaussians:

$$G \sim \exp(-\alpha^2/\sigma_1^2) + B \exp(-(\alpha - \alpha_1)^2/\sigma_2^2),$$

where α is the pitch angle, σ_1 and σ_2 characterize the width of the pitch-angular distribution, B and α_1 are the parameters of a possible direction other than the direction to the Sun. For the anti-solar direction, $\alpha_1 = \pi$. The fitting parameters for different points in time are available in the articles [Mishev et al., 2014, 2018]. The Catalog contains the integral fluxes of particles at the event maximum.

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Supplement 4

Determination of the quasi maximal energy of solar protons in an event

One of the parameters of an event, characterizing its power, can be the maximum energy of the particles registered in the event. However, a direct estimate of the maximum energy is practically not possible; there is no guarantee that there were no particles with an energy higher than the registered one in this event. Any accepted maximum energy value will be conventional. It is necessary to accept (assign) some critical value of the proton flux J_{crit} . The energy of protons, at which the flux J_{crit} is observed in a given event, can be conventionally considered as maximum, and it can be called quasi maximal with the designation E_{qm} .

Galactic cosmic rays constantly present in space can serve as a natural critical flux measure. The energy spectrum of GCR protons is very stable; flux variations in the energy range below 10 GeV, associated with solar activity, are well studied. The use of GCR fluxes makes it possible to determine the "maximal" (in fact, E_{qm}) energy of particles accelerated on the Sun. This definition is very clear, the spectra in SCR events can be easily compared with the usual spectrum of GCR protons and approximately estimate the capabilities of the Sun in accelerating protons in each event.

It turned out that the instruments used for registering solar protons are capable of measuring proton fluxes much smaller than the fluxes of GCR protons of the corresponding energies, and in order to approach the real "maximal" energies, not the full flux of GCR particles, but only 10% of this flux, is included in the method for determining E_{qm} . Since GCRs with energies < 500–1000 MeV in the 11-year solar cycle experience almost a twofold variation, in this definition, the starting point of comparison is the GCR flux at the maximum of solar activity. Thus, the quasi maximal energy E_{qm} in this event is determined in comparison with 10% of the GCR flux or $0.1 J_{\text{p}}(E_{\text{gcr}})$. It follows that the method for determining E_{qm} is reduced to finding the point of intersection of two integral energy spectra: the spectrum $0.1 J_{\text{p}}(E_{\text{gcr}})$ and the spectrum of a given solar event. At this point, the equality $J_{\text{p}}(E_{\text{scr}}) = 0.1 J_{\text{p}}(E_{\text{gcr}}) = J_{\text{p}}(E_{\text{qm}})$ is observed. Energy, which is designated as E_{qm} , is given for each event included in the Catalog.

Let us note some features of the determination of the energy E_{qm} in solar proton events presented in the Catalog. For most events, the energy spectrum of protons in the energy range of 10–100 MeV is well described by the power function $J(>E) \sim E^{-\gamma}$. For more powerful events, the power-law spectrum extends to higher energies, but, naturally, with a further increase in energy, the spectrum becomes steeper, described by another dependence, for example, $J(>E) \sim E^{-\gamma} \exp(-E/E_0)$.

In cases of ground-based SCR enhancements (GLE), when the event was observed not only by high-latitude NMs with a geomagnetic cutoff rigidity of 1 GV, the best approximation to the real maximal energy should be considered the geomagnetic cutoff energy of the lowest-latitude station that registered this event (see tables in the Catalog), which more than E_{qm} .

The E_{qm} values presented in the Catalog give an idea of the power of solar events, i.e. one more unified parameter in SCR events, which allows comparisons with other characteristics of events.

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Supplement 5

Characteristics of active regions where solar proton events occurred

For the evolutionary and flare characteristics of active regions (AR), it is convenient to use a short notation (code, formula) [Ishkov, 2006]. It contains the ordinal number of the AR in the United States NOAA (National Oceanic and Atmospheric Administration) Solar Service system; its absolute heliocoordinates; the date of the solar central meridian passage; the area of the sunspot group at the maximum development in millionths of solar hemisphere; the evolutionary characteristics of the AR: the modified Zurich class of sunspot group which reflects the stage of its development and contains information on the type of penumbra and distribution of sunspots in the group, the magnetic class according to the Mount-Wilson magnetic classification, which reflects the configuration of the magnetic field of the AR, the lifetime of the sunspot group in units of the Sun's rotation period, if possible.

The following lines reflect the flare characteristics of the considered AR: the X-ray flare index (XRI) of the sunspot group, introduced by P. McIntosh, calculated as the sum of the X and M classes flares, where the flares of the X class give unity (X1.9 gives 1.9), and flares of M class give tenths (M7.4 gives 0.74). The flare potential of an AR includes the number of solar flares in terms of X-ray and optical importance, with the subscript showing the number of flare events of this class or importance (for Ha-flares) that occurred in the AR during the entire time of its passage through the visible disk of the Sun, and the upper index of the X-ray class shows the intensity of the largest burst in the range of soft X-ray radiation:

AR11302 (N13L280, CMP 28,7.09.2011
Sp=1300 msh; EKC, BGD, R2)

$$\begin{aligned} \text{XRI} &= 8.73; X_2^{1.9} + M_{16}^{7.4} + C_{32} - 2_6 + 1_9 + S_{72} \\ \text{PFR1 } 21\text{--}22.09 \text{ (22}^{\text{h}}) & X_1^{1.4} + M_2^{1.8} \\ \text{PFR2 } 24\text{--}26.09 \text{ (52}^{\text{h}}) & X_1^{1.9} + M_{11}^{7.4} \end{aligned}$$

Above is the record for AR11302 on September, 2011 – with heliocoordinates (**N13L280**), which passed the central meridian (**CMP**) of the solar visible disk on 28,7 September 2011, had the maximum area of the sunspot group (**Sp**) of 1300 millionth of solar hemisphere (**msh**), evolutionary class (**EKC**), magnetic class (**BGD** – beta-gamma delta), and existed on the visible disk of the Sun 2 rotations (**R2**). Flare index **XRI**=8.73. In this AR, 2 flares of X-ray class X took place, the largest of which was of class X1.9, 16 – of class M (M7.4), and 32 – of class C. In the system of optical importance in this AR, there was 6 flares of importance 2, 9 flares – importance s 1, and 72 – importance S. For this AR, two time intervals **PFR** (Period of Flare Realization) were noted when the concentration of flare events of large and medium classes was observed. The first period (**PFR1 21–22.09**), which lasted 22 hours from 21 to 22.09 and included 1 flare event of the class X and 2 – class M. The second period (**PFR2 24–26.09**) lasted 52 hours from 24 to 26.09 and included 1 flare event of class X and 11 – class M.

It is pertinent to recall here that the GOES series geostationary satellites, which have been used to determine the X-ray magnitude of solar flare events since 1970, have repeatedly changed the threshold of the maximum measurable intensity of soft X-ray radiation in the energy range 1–8 Å (12.5–1 keV). Until 1976, the saturation threshold of the instruments related to the X-ray class of X5, and therefore the famous flares on 4 and 7 August 1972 had a formal class of $X > 5$. Before the start of the GOES-9 geostationary satellite, the threshold corresponded to the X-ray class X12.5, and after that, in the 23rd solar cycle, the threshold increased to X17.5. Accordingly, for the most powerful flare events, for which the flux intensity exceeded the specified threshold, the X-ray class was determined conventionally: in proportion to the time when the instrument was turned off. Therefore, it would be more objective to characterize the X-ray class of such flare events with saturation not only by the saturation threshold of the instrument but also by the duration of the time interval of the device shutdown (τ). Any extrapolation, for example, linear, for very strong flares with long saturation can hardly be justified. With this estimate, the most intense X-ray bursts for the entire observation period were on 1 and 6 June 1991 ($\tau = 26^{\text{m}}$), and in three more flares of the same AR, $\tau \geq 17^{\text{m}}$. This was well understood by the researchers who were the first to receive information about these bursts, and all of them were given a class of $X > 12.5$ with the indication of the X-ray photometer cut-off time [[Preliminary ..., 1991](#)], although later this circumstance was forgotten and these flares now have an X-ray class of X12. Unfortunately, not for every powerful flare can be found in the literature, and in most cases, for such flares, an estimated X-ray class is indicated (for example, for November 4, 2003, $X_{28} \rightarrow X > 17.5$, $\tau = 11$ min). The largest XRI index for the entire time of observation of the Sun in this range of electromagnetic radiation (from 1970 to May 2005) was obtained by three ARs: AR6659 June 1991 (>86.5), AR 10486 October 2003 (>62.56), and AR5395 March 1989 (>55.5).

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List of symbols and abbreviations on the phenomena and events used in the Catalog

1. Designations in the legend of the event, overview graphs and tables of proton fluxes

To – the beginning of the event;

Tmax – event maximum time;

Ep – the energy of protons;

Eqm – quasi maximal energy of protons in the event;

Jmax – maximum proton flux;

Φ – the integral flux of energy in the X-ray range from the beginning of the burst to the moment when it flux level decays to a point halfway (1/2 peak) between the maximum flux and the pre-flare background level; in J/m^2 ;

pfu – proton flux unit ($1 \text{ pfu} = 1 \text{ cm}^{-2}\text{s}^{-1}\text{sr}^{-1}$) – particle flux units;

●, ■ – the flare is a certain source of the observed protons;

⊙, ☐ – the flare is most likely the source of the observed protons;

symbols ■, ☐ are used when the source of a solar proton event occurs at near-limb and behind-limb for heliolongitudes W , $E \geq 80^\circ$;

○ – the flare is a possible but for some reason doubtful source of the observed protons;

∅ – the flare is not the main source, but contributed, or might have contributed to the proton flux.

□ – a flare (or flare associated activity) behind the western or eastern limb of the Sun;

◇ – activity on the solar disk not associated with specific flare event, modulation effects in interplanetary space.

SC – sudden commencement of a magnetic storm, the arrival of an interplanetary shock wave to the Earth;

▲ – SC, which introduced changes in particle fluxes;

Δ – SC, not reflected in the profiles of particle fluxes;

CME – coronal mass ejection;

V – the linear CME velocity in km/s ;

a – CME acceleration (km/s^2);

Δφ – the angular width of the CME near the Sun;

dA – position angle of the first appearance of CME;

gap – lack of observations;

Vsw – the solar wind speed;

B – the magnitude of the magnetic field in the solar wind (nT);

Dst – the index of geomagnetic activity;

S/C – spacecraft;

SCR, SKL – solar cosmic rays;

GLE – solar proton event recorded by ground-based instruments;

Location – heliocoordinates of the event;

WL – emission in the continuous spectrum (white light);

UT – Universal Time (Greenwich Time)

2. Designations in the optical and X-ray regions of radiation

H α -flare code according to the Solar Geophysical Data system as a set of Latin letters indicating the following:

- A** – eruptive prominence at a distance of $<90^\circ$ from the central meridian;
- B** – probably the end of a more important flare;
- D** – bright point;
- E** – two or more bright points;
- F** – several eruptive centers;
- G** – no visible spots in the flare neighborhood;
- H** – the flare is accompanied by high-speed disturbances of the dark (in absorption) filament;
- K** – several intensity maxima;
- L** – existing filaments show signs of sudden activity;
- M** – white-light flare t;
- N** – continuous spectrum shows effects of polarization;
- O** – observations have been made in Calcium II lines H or K;
- P** – flare shows emission in the line Helium D₃;
- Q** – flare shows the emission of Balmer continuum;
- R** – marked asymmetry in H α line suggests ejection of high velocity material;
- S** – brightness follows disappearance of the filament in the same position;
- U** – two bright flare ribbons, parallel or converging;
- V** – occurrence of an explosive phase: important and abrupt expansion in about a minute with or without important intensity increase;;
- W** – great increase in area after time of maximum intensity);
- X** – unusually wide H α line;
- Y** – arched flare filament systems (loop-type prominences) were observed;
- Z** – major sunspot umbra covered by flare emission.

X-ray class of burst (importance) in the range 1-8 Å (12.5-1 keV)

[<http://legacy-www.swpc.noaa.gov/weekly/index.html>];

[<https://www.sws.bom.gov.au/Educational/2/1/3>]:

Classification	Peak Flux Range (0.1-0.8 nm)	
	mks system (W m ²)	cgs system (erg cm ⁻² s ⁻¹)
A	$\Phi < 10^{-7}$	$\Phi < 10^{-4}$
B	$10^{-7} \leq \Phi < 10^{-6}$	$10^{-4} \leq \Phi < 10^{-3}$
C	$10^{-6} \leq \Phi < 10^{-5}$	$10^{-3} \leq \Phi < 10^{-2}$
M	$10^{-5} \leq \Phi < 10^{-4}$	$10^{-2} \leq \Phi < 10^{-1}$
X	$10^{-4} \leq \Phi$	$10^{-1} \leq \Phi$

The optical importance of a solar flare observed in the H α line is determined by the corrected flare area at the center of the line in heliographic square degrees at maximum brightness (by SGD):

- S** – subflare - (area ≤ 2.0 sq. deg.)
- 1** – importance 1 ($2.1 \leq \text{area} \leq 5.1$ sq. deg.)
- 2** – importance 2 ($5.2 \leq \text{area} \leq 12.4$ sq. deg.)
- 3** – importance 3 ($12.5 \leq \text{area} \leq 24.7$ sq. deg.)
- 4** – importance 4 (area ≤ 24.8 sq. deg.)

Brightness – the relative brightness at the maximum of the flare:

F – weak; **N** – normal; **B** – bright.

Dynamic phenomena observed in the H α line (6563 Å):

EPL – eruptive prominence at the limb;

LPS – Loop Prominence System = Arched Flare Filament System;

DSF – ejection (disappearance) of solar filament;

SPY – flare spray (giant ejection on the limb in the place of the flare realization);

BSL – bright emission at the limb.

3. Designations in the field of radio emission

Type of solar dynamic spectrum (DS) of the meter radio burst component [Illustrated Glossary for Solar and Solar-Terrestrial Physics. Eds. A.Bruzek and C.J.Durrant. Springer. 1977] and [<https://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-features/solar-radio/radio-bursts/reports/spectral-listings/docs/SPECTRAL.TXT>];

DS I – noise storm;

DS II – slowly drifting bursts;

DS III – fast drifting bursts;

DS IV – long-term radio burst occupying a wide frequency band;

DS V – broadband continuous radiation at long meter waves (associated with a type III radio burst);

DS cont – broadband radiation of type IV bursts;

DH II – slowly drifting bursts observed in the interplanetary space of the WIND spacecraft (Wind/WAVES type II bursts)

The encoded spectral type of radio bursts in the decimeter and centimeter wavelength range:

P5 – means that the spectrum shows a peak at 5 GHz. P5(2,3) means that log of the maximum flux at 5 GHz is 2.3 (the maximum density of the flux is $200 \cdot 10^{-22} \cdot \text{W} \cdot \text{m}^{-2} \cdot \text{Hz}^{-1}$);

1/9 – means that the flux density is lowest at 1 GHz and rises up to 9 GHz; no information is available at frequencies below 0.6 GHz and above 9 GHz);

0.6\9 – means that the flux density rises toward high frequencies (from 0.6 GHz to 9 GHz);

0.6/9 – means that the flux density falls toward high frequencies from 0.6 GHz to 9 GHz;

U2 P7 – means that the flux density is minimal at 2 GHz and probably peaks at 7 GHz;

3–9 – means a flat frequency spectrum between 3 and 9 GHz;

If a designation element is indicated in square brackets (for example, [P5]), this means that this parameter is not determined reliably enough due to incompleteness or inconsistency of the initial data.

In many cases, different combinations of these designations have to be used to describe the spectrum of a radio burst.

4. Designation of sources of information used in the Catalog

SGD – Solar Geophysical Data, explanation of data reports. 1987. No. 515 (Supplement):

https://www.ngdc.noaa.gov/stp/space-weather/online-publications/stp_sgd/docs/SGDDescText1987.pdf

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Events in 2010

			Page
1	Event 2010.08.03 – (2010-215)	№ 477	51
2	Event 2010.08.14 – (2010-226)	№ 478	59
3	Event 2010.08.18 – (2010-230)	№ 479	66

Particle event: To($E_p > 10$ MeV) – 03d10^h

Tmax₁($E_p > 10$ MeV) – 03d19^h, Jmax₁($E_p > 10$ MeV) – 2.7 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma = 3.1$

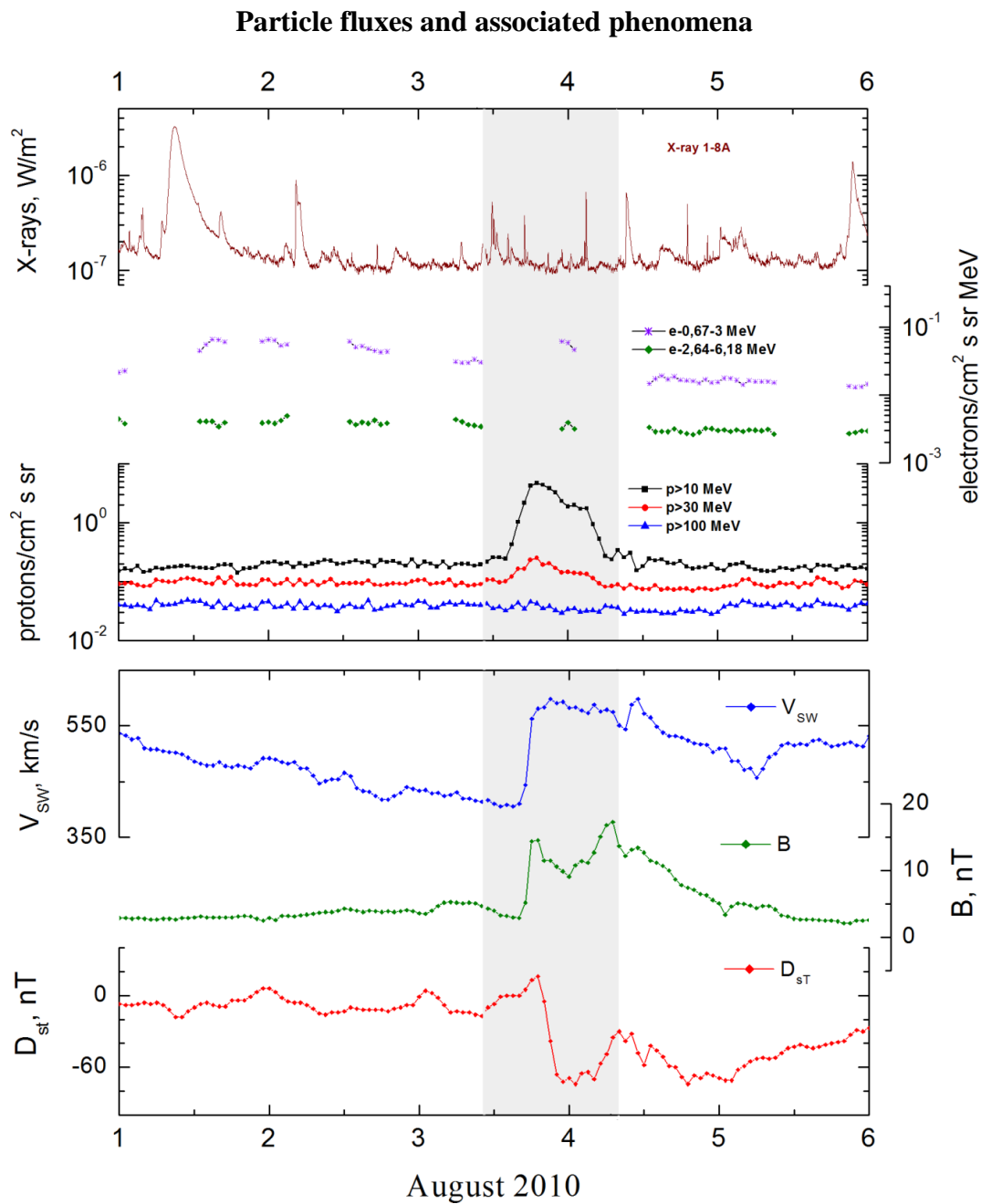
Quasimaximal energy of protons in the event – Eqm = 60 MeV

Sources: ● DSF* 01d 07^h50^m, N37W32 42°

CME: 01d13^h42^m, V = 850 km/s, $\Delta\phi = 360^\circ$; dA = 84°

▲ SC 03d 17^h40^m; ▲ SC 04d 10^h19^m

*<https://aia.cfa.harvard.edu/filament/index.html?search=0073>

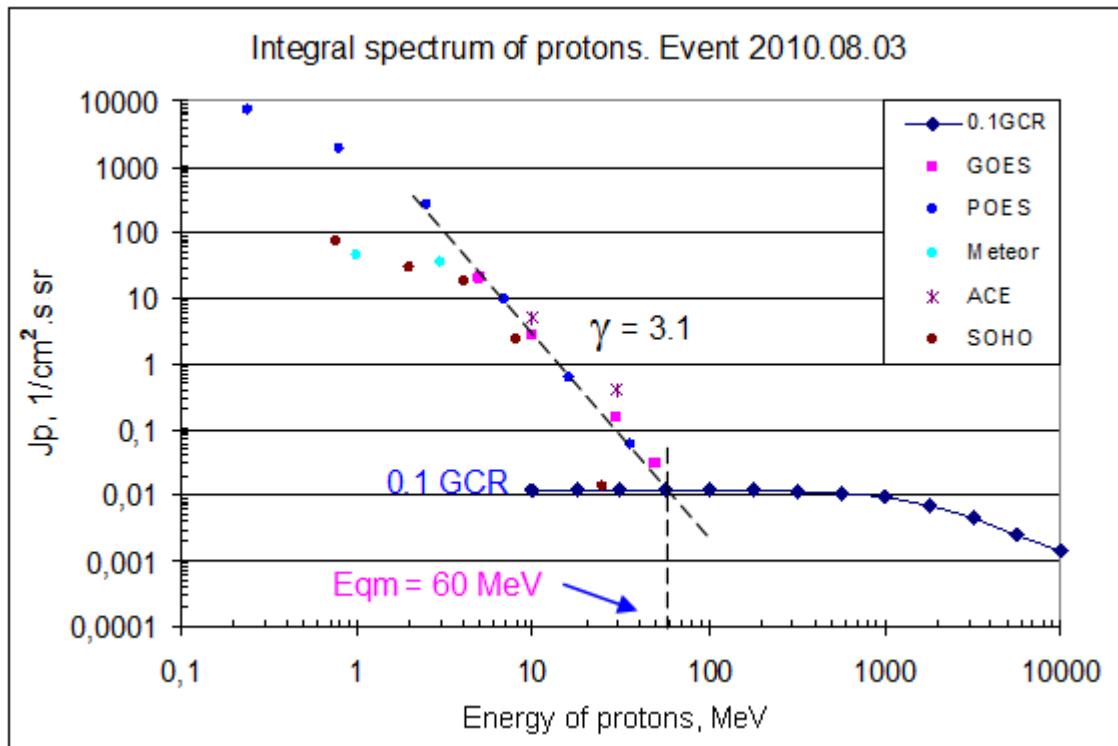


Integral fluxes of protons for the event of 2010 August 03

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	10	20	20.7	1.3	0.3	
EPS	>10	10	19	2.7	1	0.2	
EPS	>30	12	18	0.15	0.7	0.1	
EPS	>50	-	18	0.03	0.3	0.08	
EPS	>60	-	-	-	-	0.07	
EPS	>100	-	-	-	-	0.05	
POES							
MEPED	>0.24	9	18	7450	2.5	110	
MEPED	>0.8	11	18	1880	2	85	
MEPED	>2.5	13	19	270	1	65	
MEPED	>6.9	13	19	10	0.5	55	
MEPED	>16	-	18	0.6	0.5	0.9	
MEPED	>36	-	18	0.06	0.5	1.1	
MEPED	>70	-	-	-	-	1.2	
MEPED	>140	-	-	-	-	1.4	
Meteor-1							
SCR	>1	13	20	44	1	3.6	
SCR	>3	13	20	35	1	3.2	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	1.7	
GALS-M	>25	-	-	-	-	1.7	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	11	18	5	1	1.9	
SIS	>30	11	17	0.4	0.7	1.4	
SOHO							
EPHIN	>50	-	-	-	-	0.35	

Differential fluxes of protons for the event of 2010 August 03

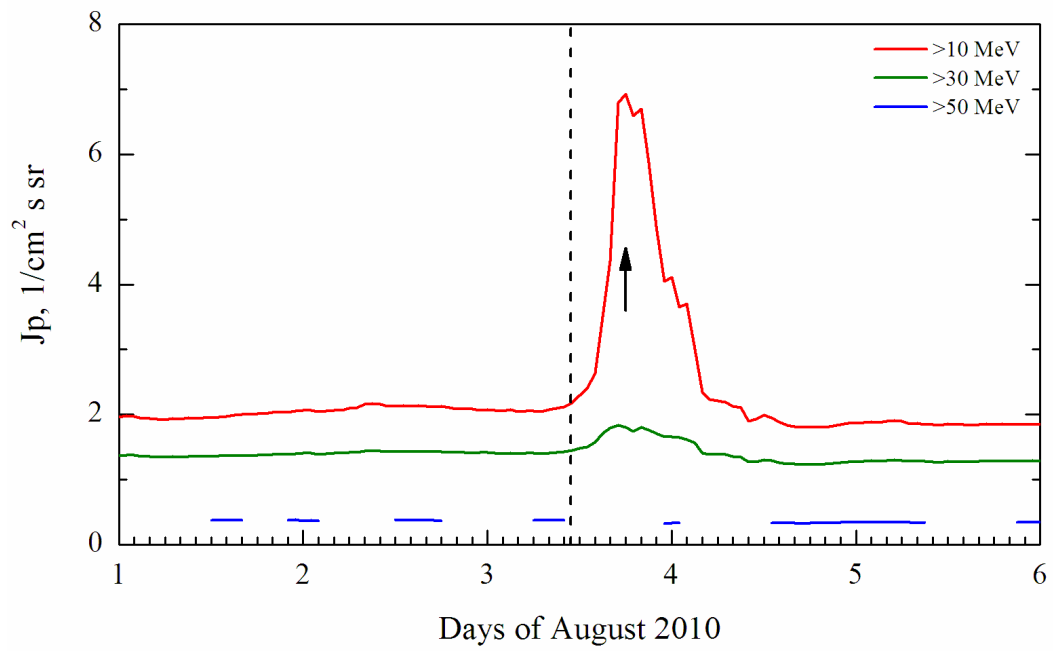
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75-2	-	23	36	1	-	
LION	2-6	-	23	3.9	1	-	
EPHIN	4-8	-	23	4	1	-	
EPHIN	8-25	-	22	0.14	1	-	
EPHIN	25-53	-	22	0.0005	1	0.0001	



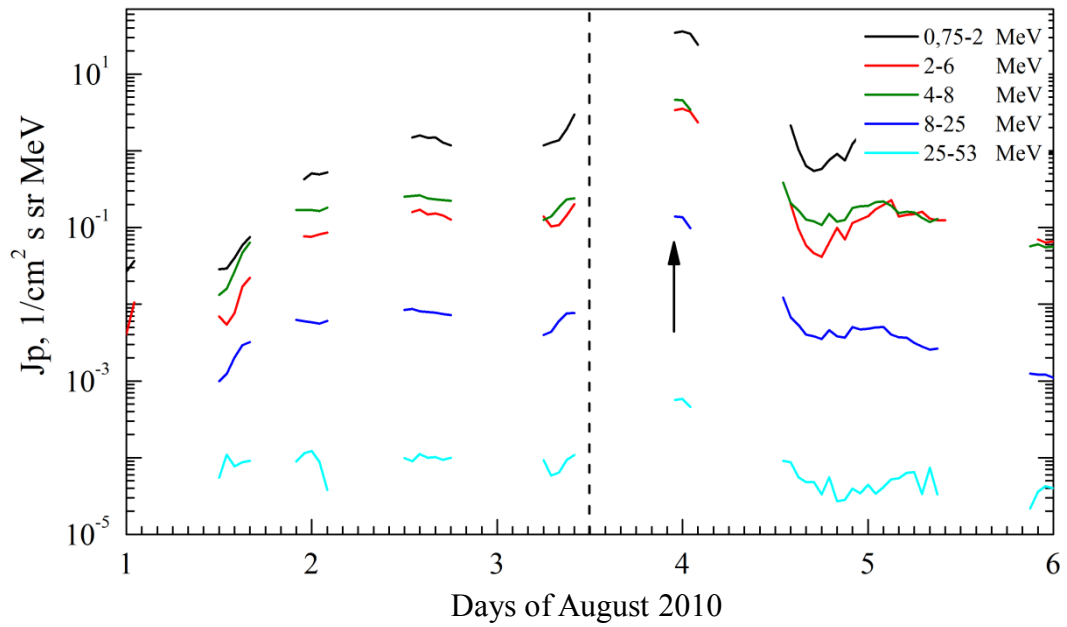
Time profiles of proton fluxes in the event 2010.08.03

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2010.08.03

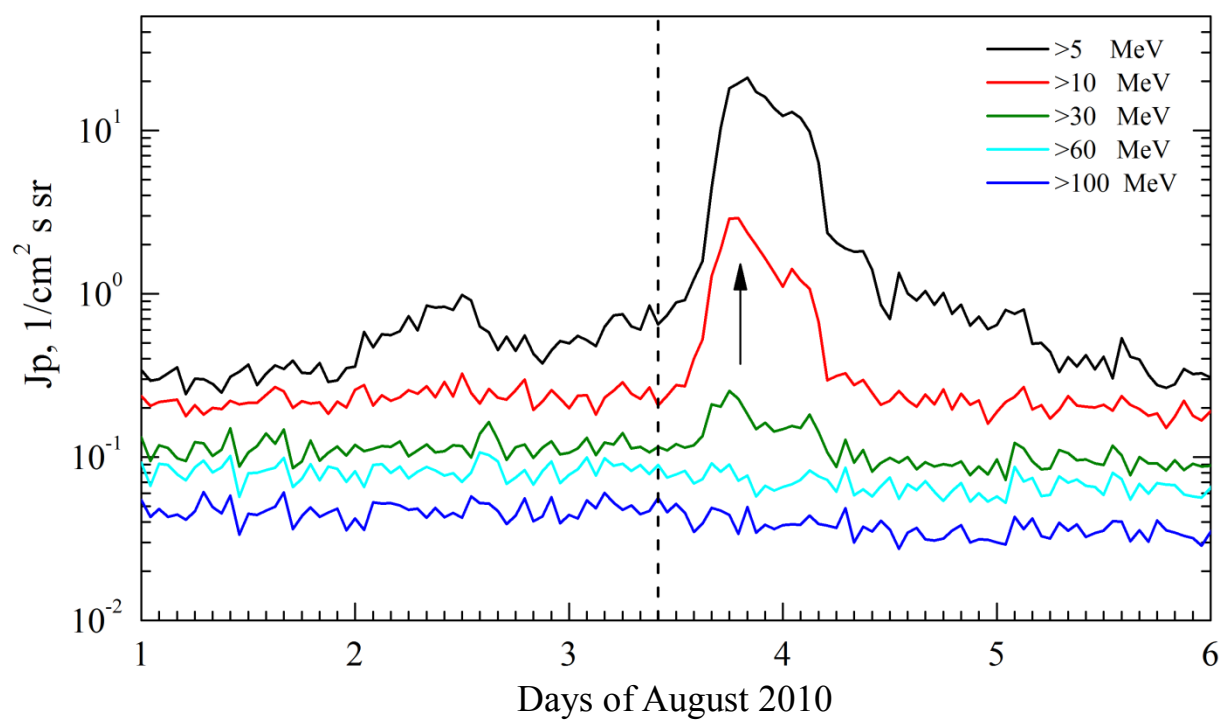


SOHO. Event 2010.08.03



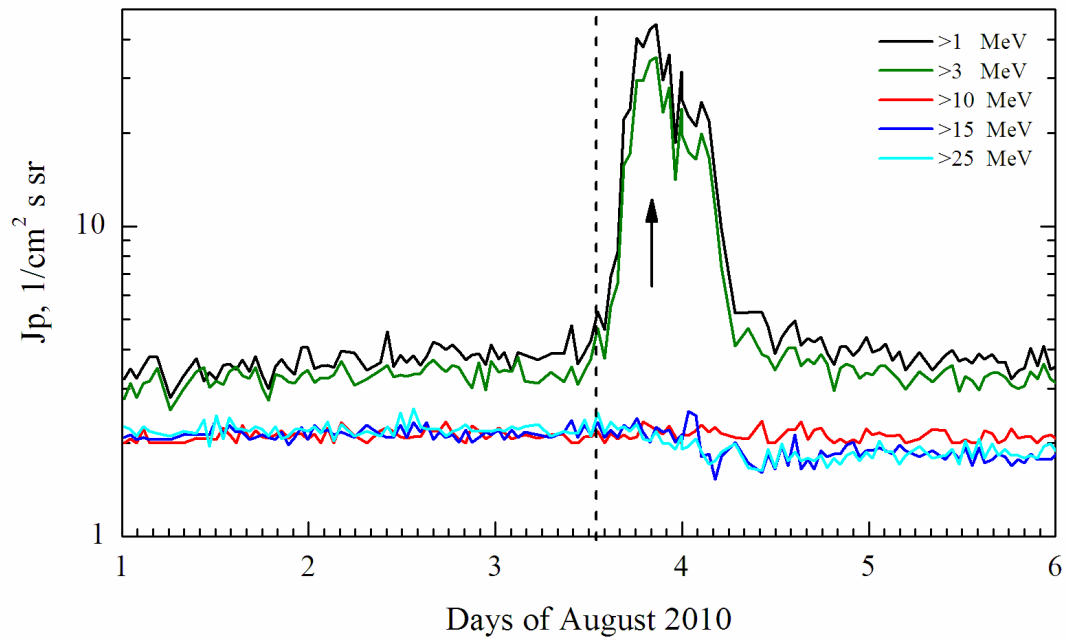
Earth satellites in geostationary orbit. $R \approx 6.6$ Re: GOES

GOES. Event 2010.08.03

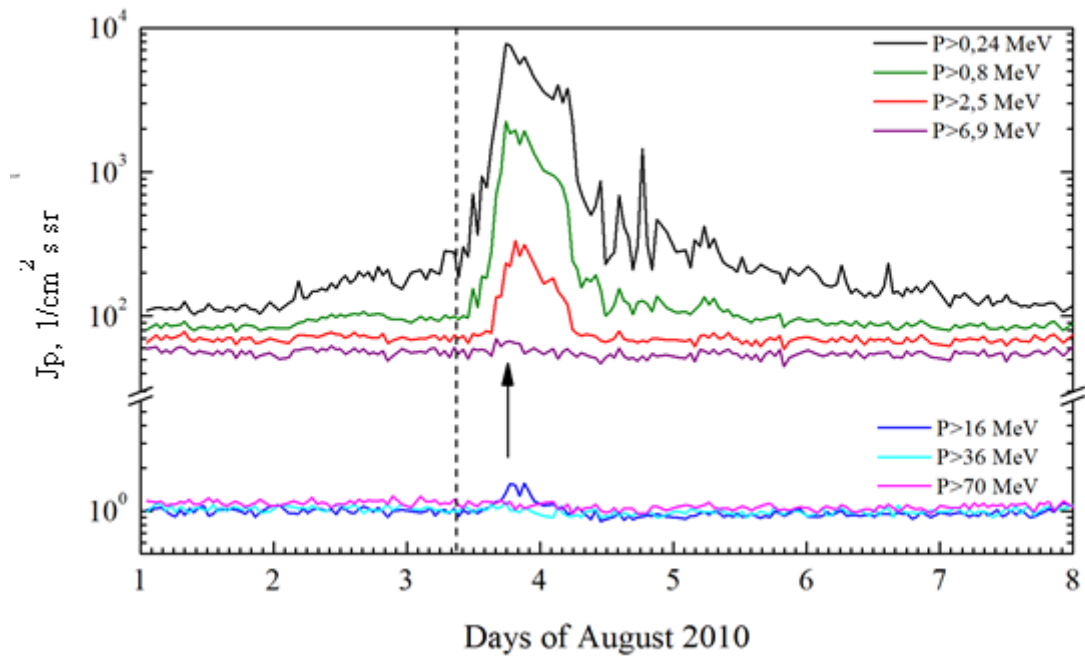


Earth satellites in polar orbit. $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2010.08.03



POES. Event 2010.08.03



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2010 August 03**

2010

August 01

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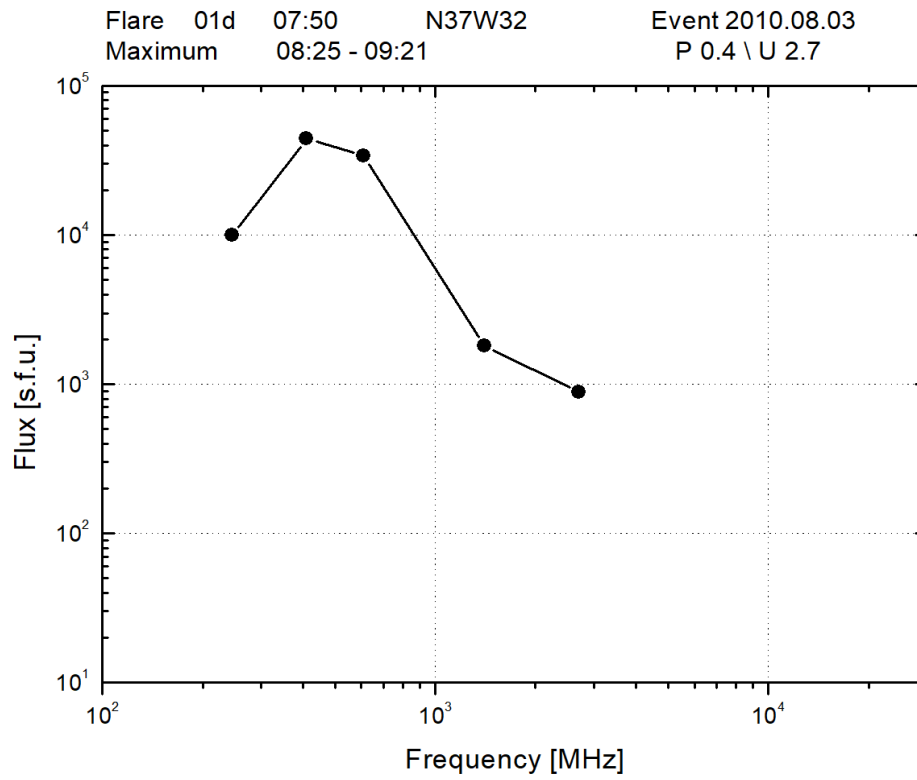
AR XXXX

To event 477

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563Å 1 – 12	DSF* keV	0750	0811	1121	N37W32	42°	
		No X-ray event at this time					
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0820:22	0820:26	0853:24	2019	577623	FERMI
12-25	keV	0918:24	0919:06	0952:40	688	4678344	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
2.7	GHz	0811	0913	1052		2.95	
1.4	GHz	0812	0921	1040	P0.4 \ 2.7	3.26	
610	MHz	0801	0825	0946		4.53	
410	MHz	0755	0907	1052		4.64	
245	MHz	0754	0908	1035		4.00	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	025-180	0808		1136		2	
DS III	025-142	0806		0814		1	
DH II	0.7-2	0920		1730			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1342	850	-22.1	360°	84°	SOHO

*<https://aia.cfa.harvard.edu/filament/index.html?search=0073>

Radio burst frequency spectrum



References:

- Ameri D., E. Valtonen, [2019](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Luhmann J.G., M.L. Mays, D. Odstrcil et al., [2017](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zou Z., X. Xue, W. Yi et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 14d11^h

Tmax ($E_p > 10$ MeV) – 14d12^h, Jmax₁ ($E_p > 10$ MeV) – 9.4 /cm²·s·sr

Duration of the event – 1.3 days, power-law index: $\gamma = 2.25$

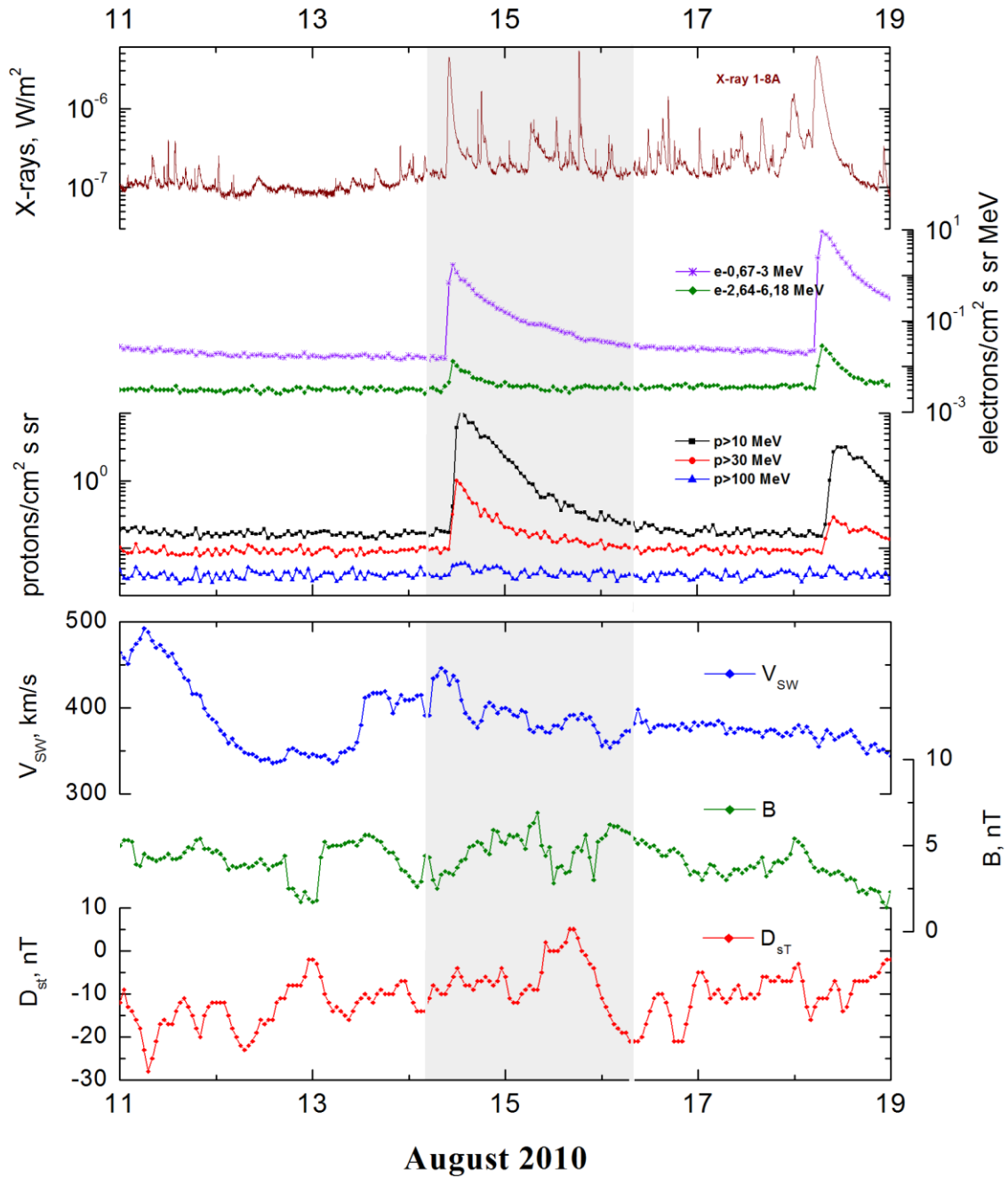
Quasimaximal energy of protons in the event – E_{qm} = 200 MeV

Sources: ☐ solar flare 14d10^h05^m, C4.4/SF, N17W52, AR11099

Main X-ray burst 1-8 Å: onset – 14d09^h38^m, max – 14d10^h05^m, $\Phi = 0.0099$ J/m²

CME: 14d 10^h12^m, V = 1205 km/s, $\Delta\phi = 360^\circ$, dA = 224°

Particle fluxes and associated phenomena

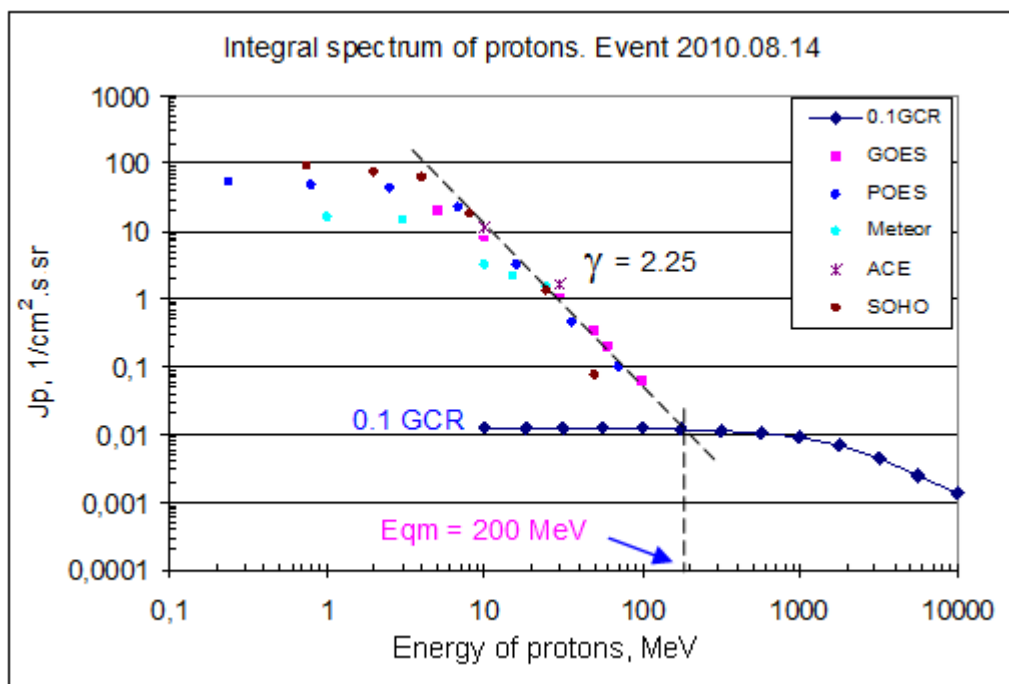


Integral fluxes of protons for the event of 2010 August 14

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	11	13	19.7	1.3	0.3	
EPS	>10	11	12	9.4	1.3	0.2	
EPS	>30	11	12	1.2	1	0.12	
EPS	>50	11	12	0.34	0.5	0.09	
EPS	>60	11	12	0.2	0.3	0.09	
EPS	>100	10	12	0.06	0.2	0.05	
EPS	>700	-	-	-	-		
POES							
MEPED	>0.24	11	13	53	1.5	110	
MEPED	>0.8	11	13	48	1	85	
MEPED	>2.5	11	13	43	1	70	
MEPED	>6.9	11	13	23	0.5	55	
MEPED	>16	11	13	3.2	0.5	0.9	
MEPED	>36	11	13	0.45	0.5	1	
MEPED	>70	11	13	0.12	0.5	1.1	
MEPED	>140	-	-	-	-	1.4	
Meteor-1							
SCR	>1	11	13	16.1	1	3.5	
SCR	>3	11	13	14.6	1	3.2	
SCR	>10	11	12	3.25	0.5	2.1	
GALS-M	>15	11	12	2.2	0.25	1.6	
GALS-M	>25	11	12	1.5	0.25	1.7	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	11	13	10.7	1	1.9	
SIS	>30	11	12	1.7	0.7	1.3	
SOHO							
EPHIN	>50	9	11	0.075	0.3	0.4	

Differential fluxes of protons for the event of 2010 August 14

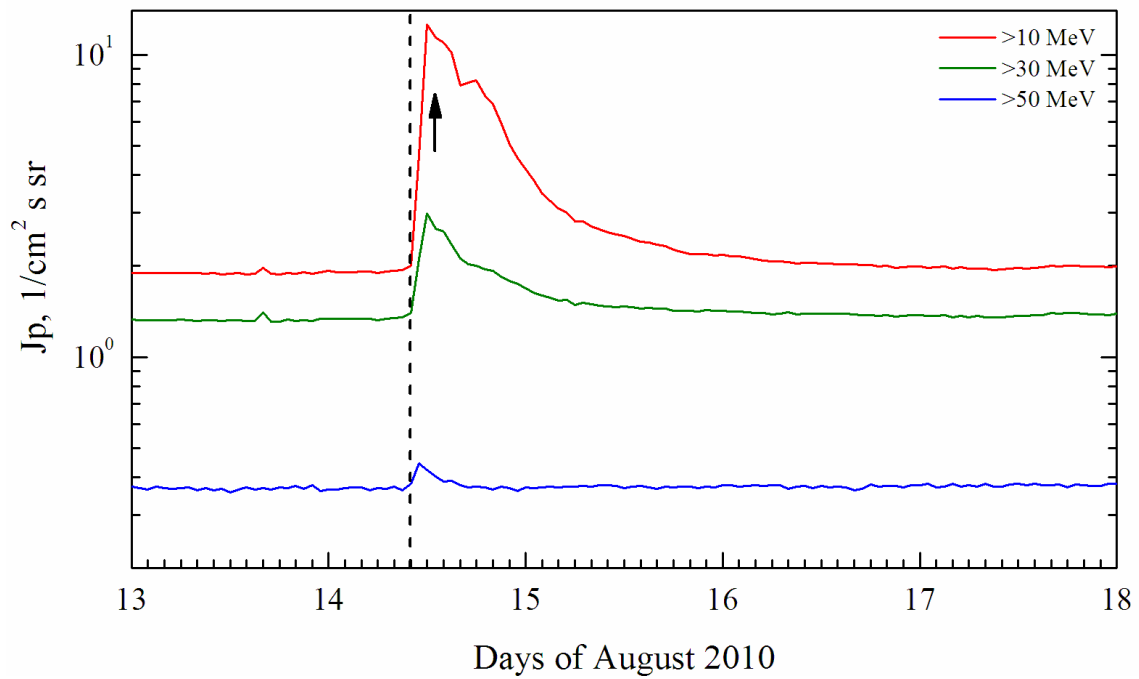
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75-2	9	14	14	3	0.02	
LION	2-6	9	12	3.6	3	0.003	
EPHIN	4-8	9	13	11	2.5	0.003	
EPHIN	8-25	9	12	1	2.5	0.0002	
EPHIN	25-53	9	11	0.045	2	0.00005	



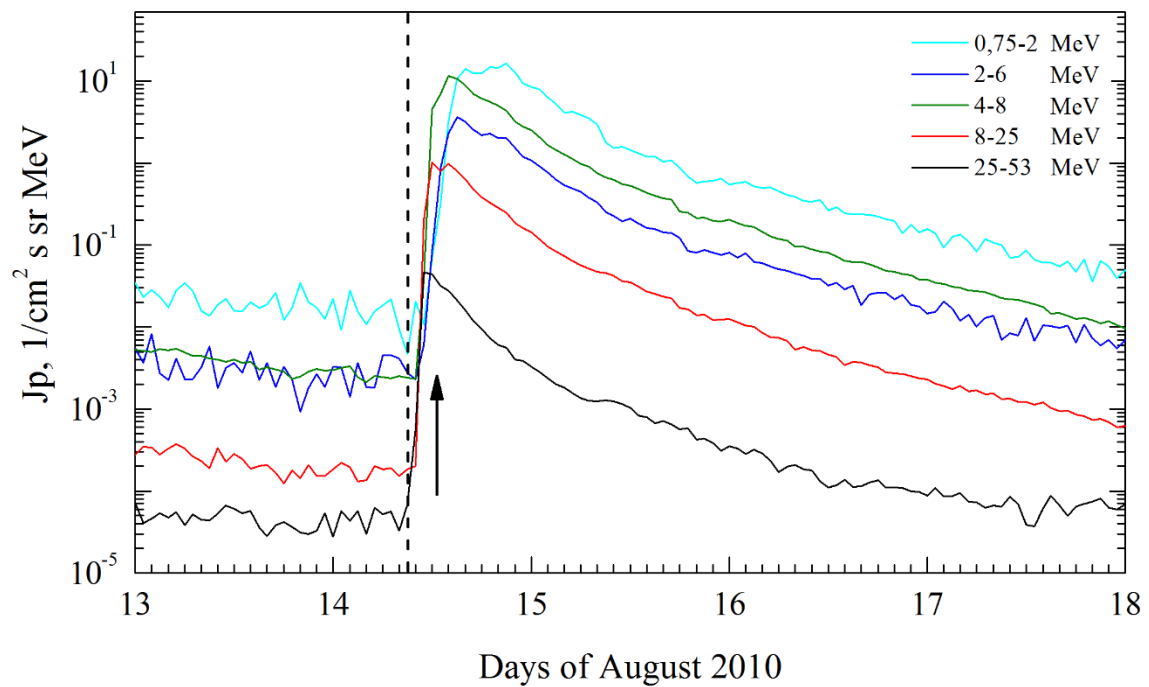
Time profiles of proton fluxes in the event 2010.08.14

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.08.14

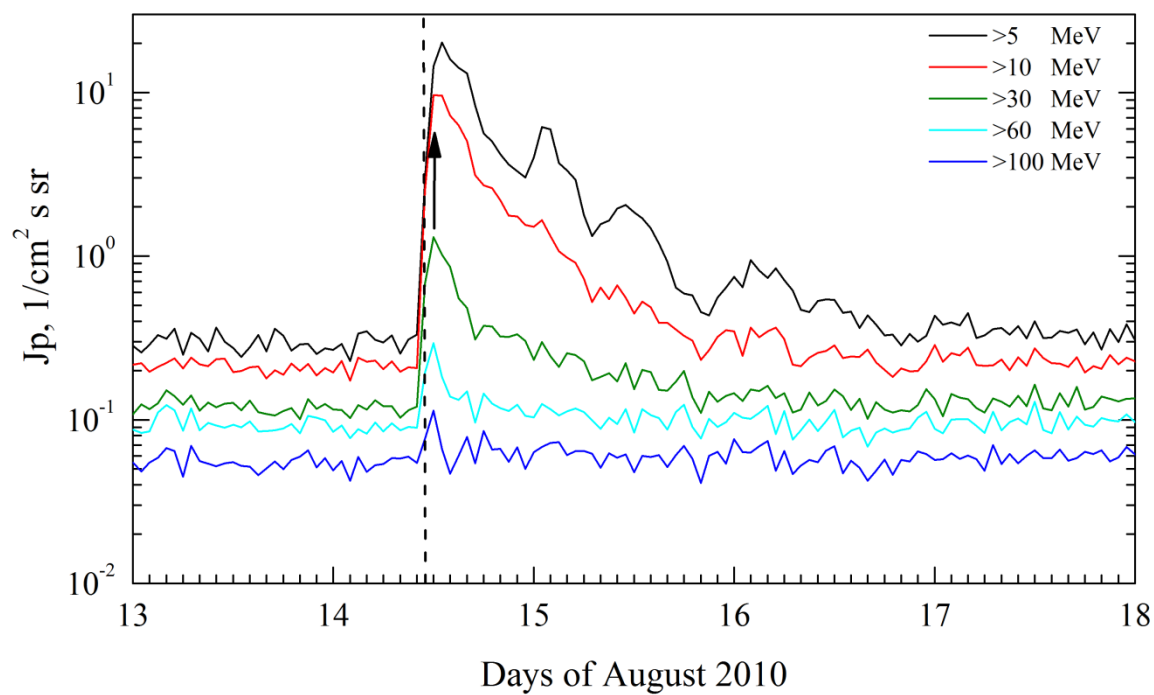


SOHO. Event 2010.08.14



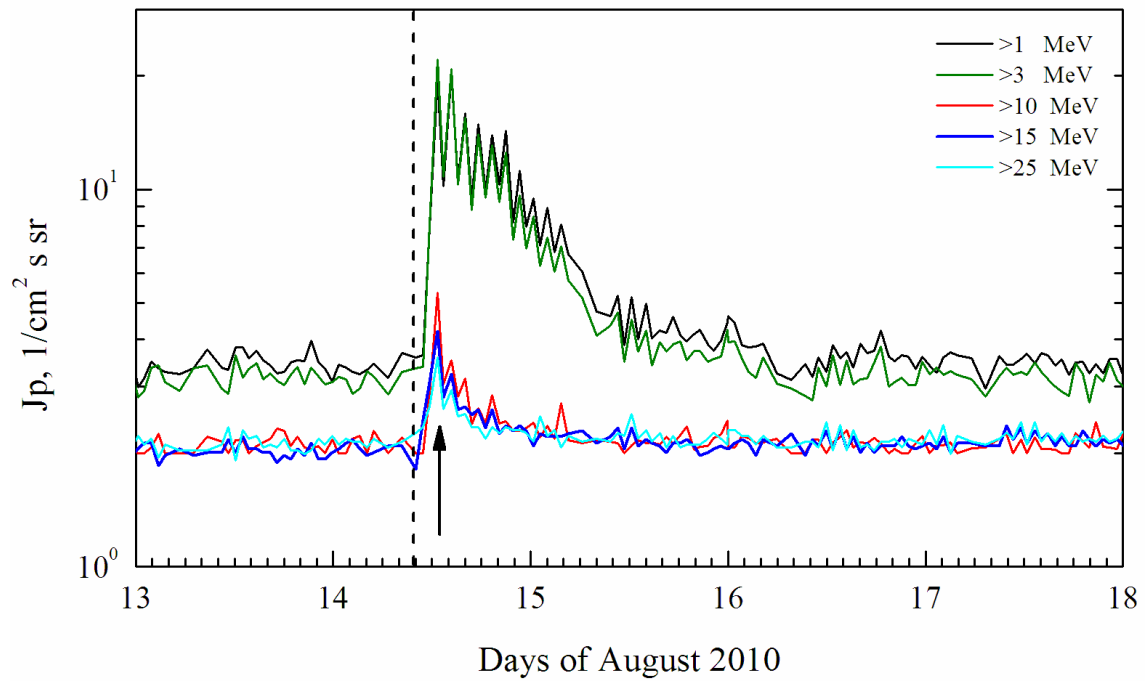
Earth satellites in geostationary orbit. $R \approx 6.6$ Re: GOES

GOES. Event 2010.08.14

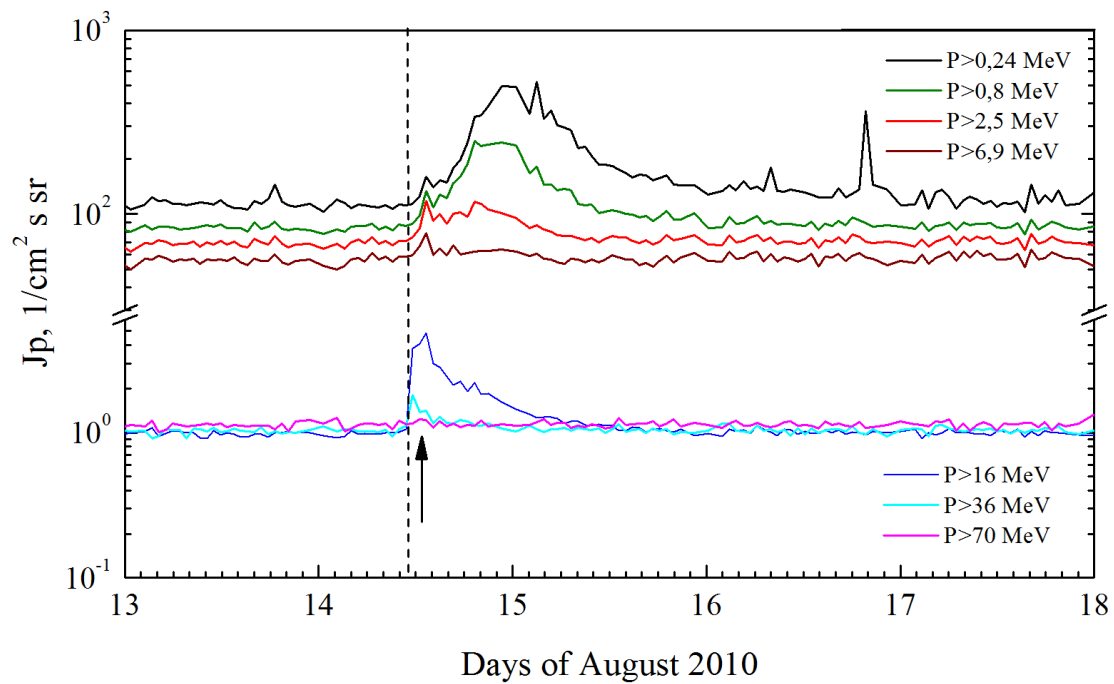


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2010.08.14



POES. Event 2010.08.14



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2010 August 14**

2010 August 14



AR 11099

To event 478

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	0941	0959	1110	N17W52	SF	ERU
1 – 12	keV	0938	1005	>1031	*	C4.4	0.0099
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0925:40	0952:46	0955:28	56	178453	HESSI
12-25	keV	1001:34	1003:13	1031:49	1218	376079	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
610	MHz	1038	1039	1040		2.23	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	0952		1009	406	1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1012	1205	- 43.0	360°	224°	SOHO

* – data gap 20.05.2010 – 20.01.2011

Proton Active Region:

AR11099 (N17L347, CMP 10,5.08.2010,
Sp=090 msh, CRO, B, R1)
XRI=0 C₅ S₉

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Bruno A., I.G. Richardson, [2021](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
Kahler S.W., D. Brown, [2021](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
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Luhmann J.G., M.L. Mays, D. Odstrcil et al., [2017](#).
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Núñez M., T. Nieves-Chinchilla, and A. Pulkkinen, [2019](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C. St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 18d07^h

Tmax₁($E_p > 10$ MeV) – 18d11^h, Jmax₁($E_p > 10$ MeV) – 2.2 /cm²·s·sr

Duration of the event – 1.3 days, power-law index: $\gamma = 2.25$

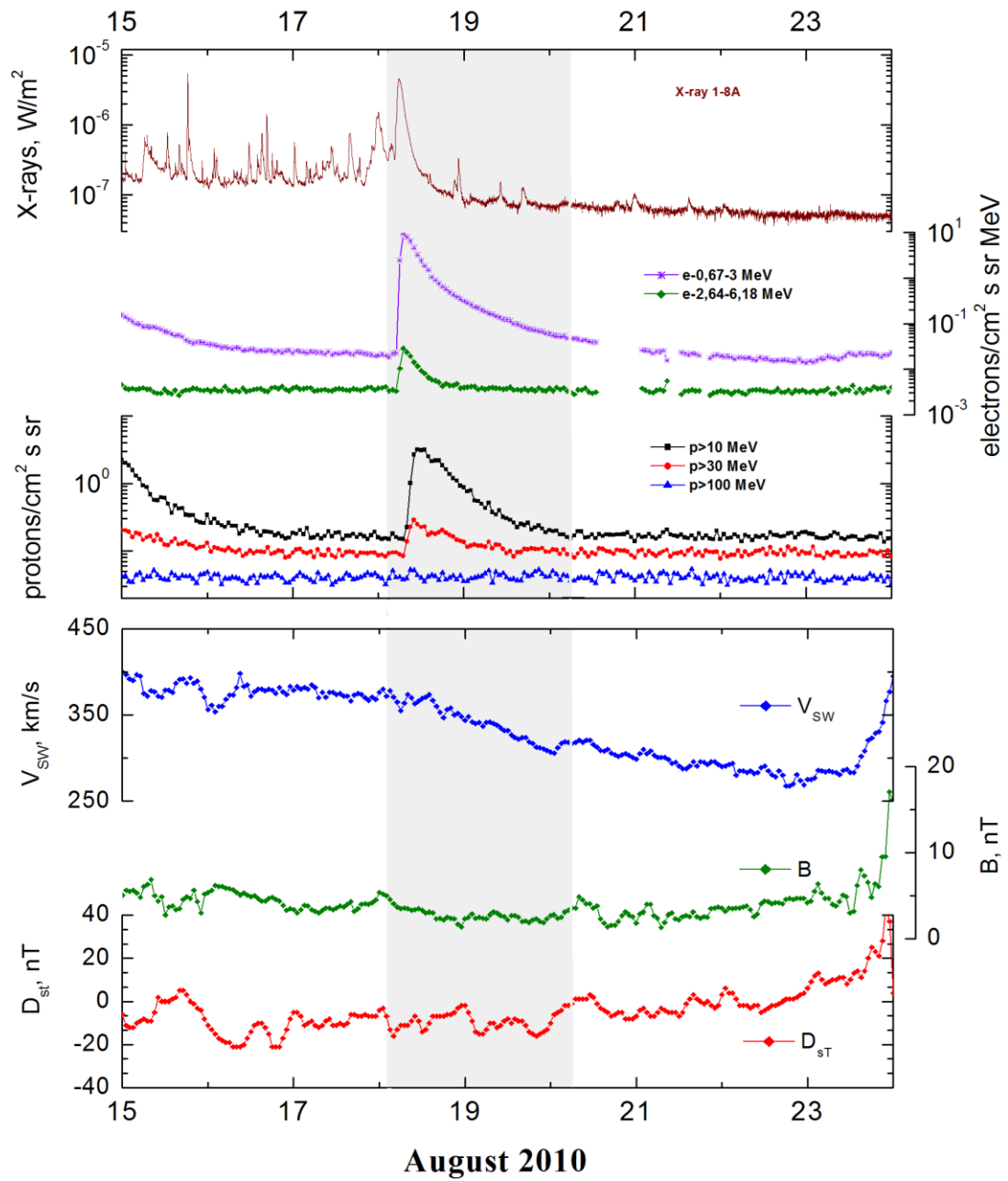
Quasimaximal energy of protons in the event – E_{qm} = 95 MeV

Sources: ☐ solar flare 18d04^h45^m, C4.5/, N18W88, AR11099, 1.5 days behind W_L

Main: X-ray burst 1-8 Å: onset – 18d04^h45^m, max – 18d05^h48^m, $\Phi = 0.023$ J/m²

CME: 18d05^h48^m, V = 1471 km/s, $\Delta\phi = 184^\circ$, dA = 230°

Particle fluxes and associated phenomena

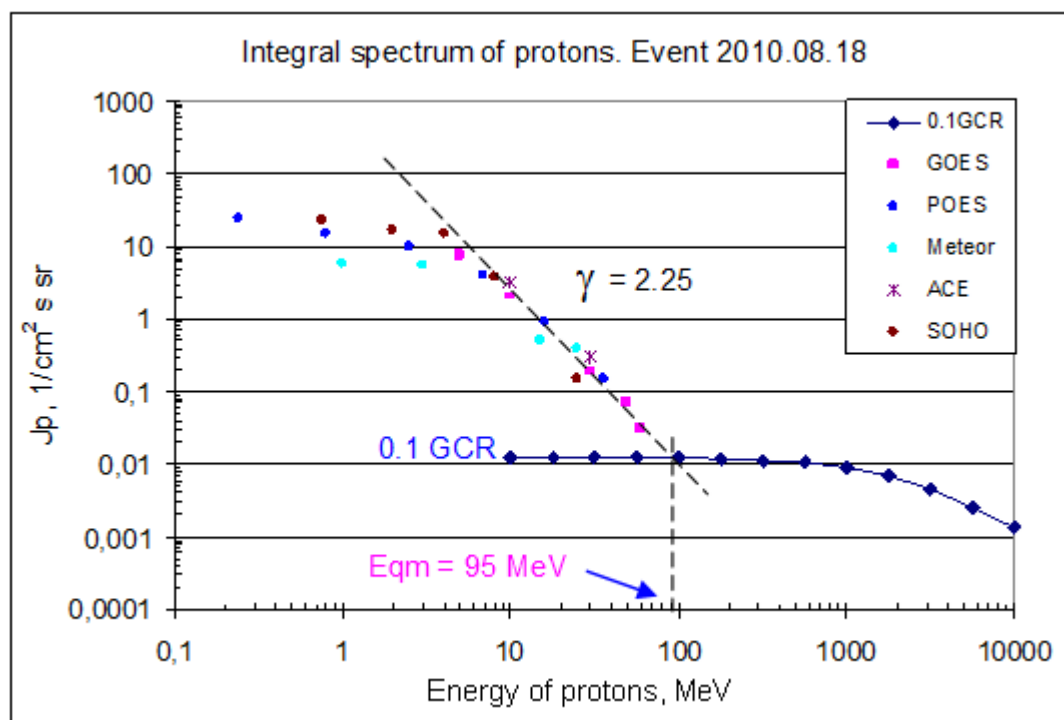


Integral fluxes of protons for the event of 2010 August 18

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	12	7.7	1.5	0.3	
EPS	>10	7	11	2.2	1.3	0.25	
EPS	>30	7	10	0.25	0.5	0.11	
EPS	>50	7	10	0.07	0.3	0.09	
EPS	>60	7	10	0.03	0.3	0.09	
EPS	>100	-	-	-	-	0.06	
POES							
MEPED	>0.24	7	11	25	1.5	110	
MEPED	>0.8	7	12	15	1	85	
MEPED	>2.5	7	12	10	1	70	
MEPED	>6.9	7	12	4	0.5	55	
MEPED	>16	7	11	0.9	0.5	1	
MEPED	>36	7	11	0.15	-	1	
MEPED	>70	-	-	-	-	1.1	
MEPED	>140	-	-	-	-	1.4	
Meteor-1							
SCR	>1	6	14	5.94	1.5	3.5	
SCR	>3	6	14	5.62	1.5	3.2	
SCR	>10	6	-	-	1	2.1	
GALS-M	>15	6	10	0.52	0.5	1.6	
GALS-M	>25	6	10	0.4	0.5	1.7	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	7	12	2.9	1.5	2	
SIS	>30	7	12	0.3	1	1.4	
SOHO							
EPHIN	>50	-	-	-	-	0.35	

Differential fluxes of protons for the event of 2010 August 18

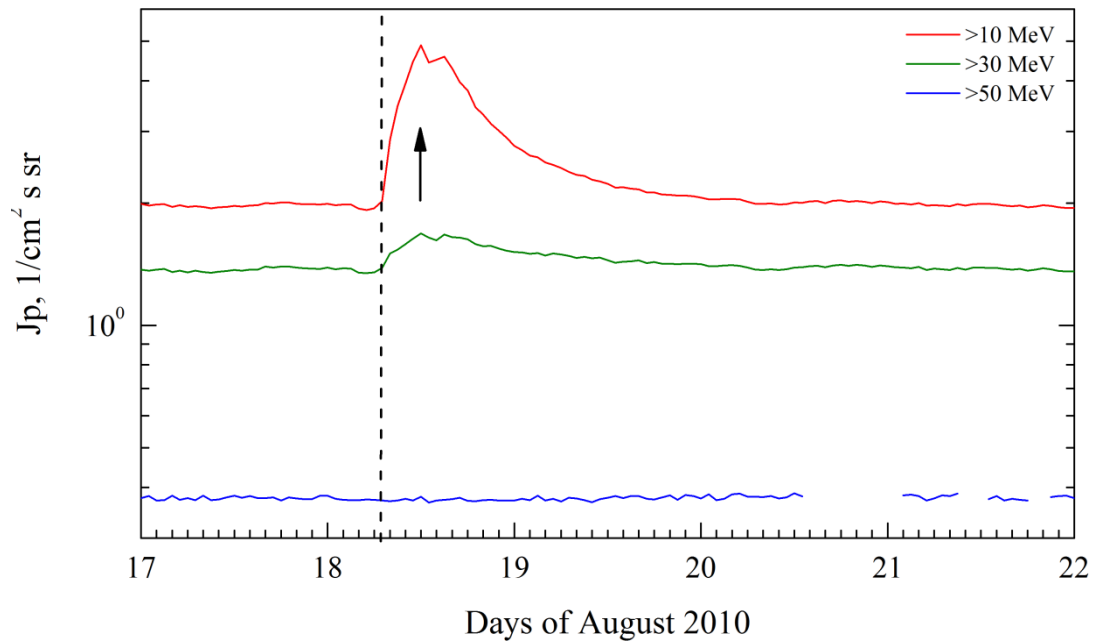
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0,75-2	6	16	4.3	3	0.02	
LION	2-6	6	15	0.7	3	0.003	
EPHIN	4-8	6	13	2.8	2	0,005	
EPHIN	8-25	6	12	0.22	2	0,0005	
EPHIN	25-53	6	10	0.0055	1,5	0,00005	



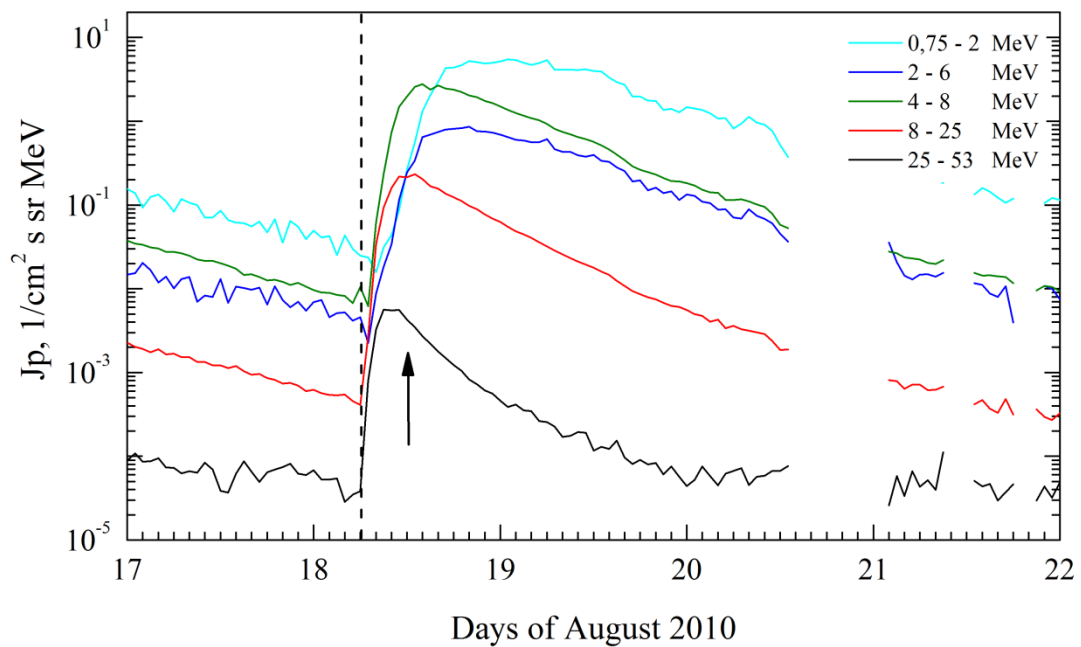
Time profiles of proton fluxes in the event 2010.08.18

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2010.08.18

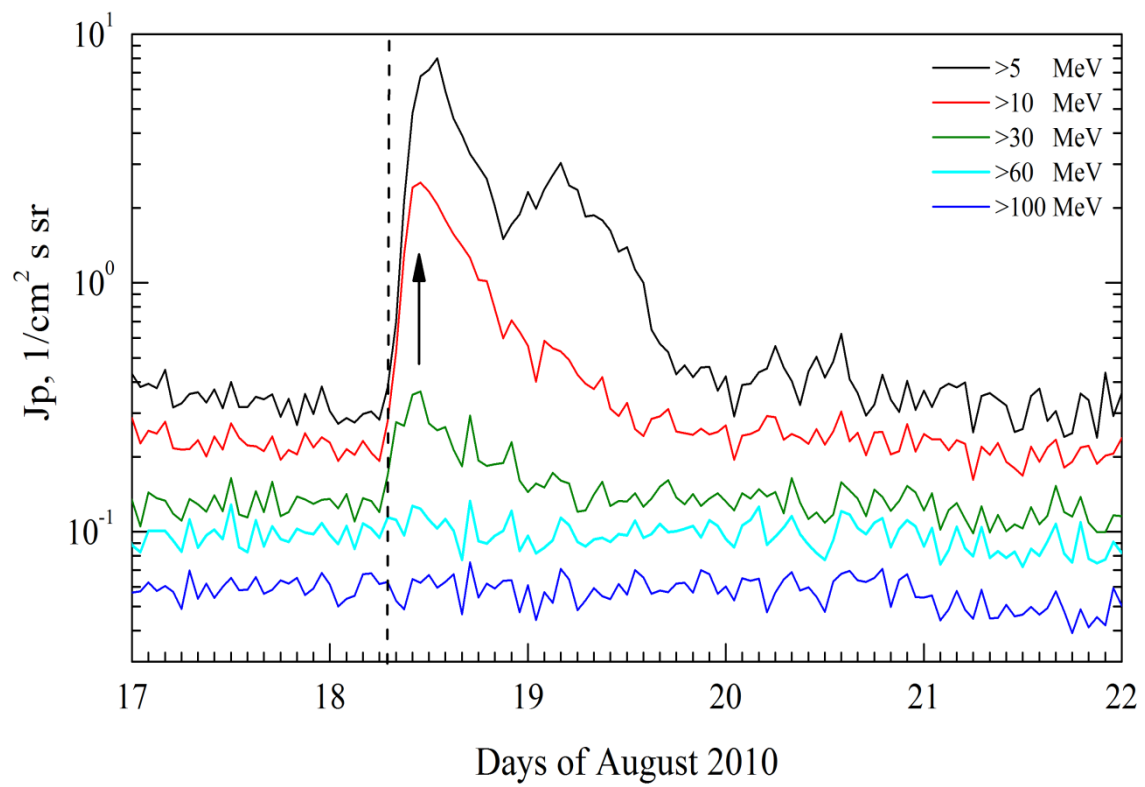


SOHO. Event 2010.08.18



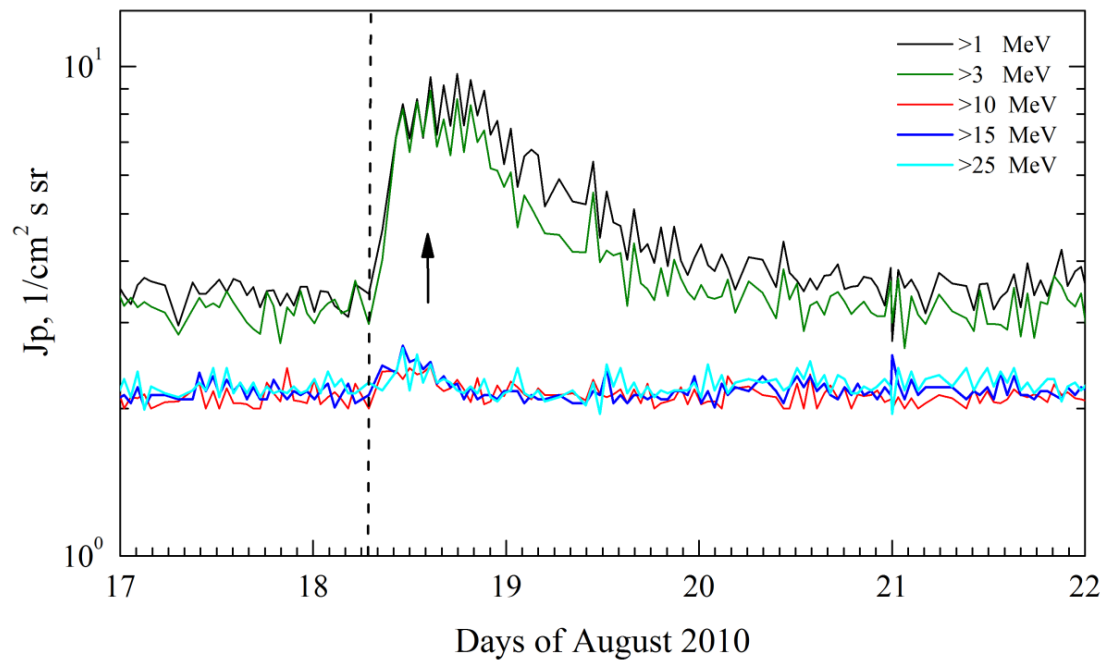
Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES

GOES. Event 2010.08.18

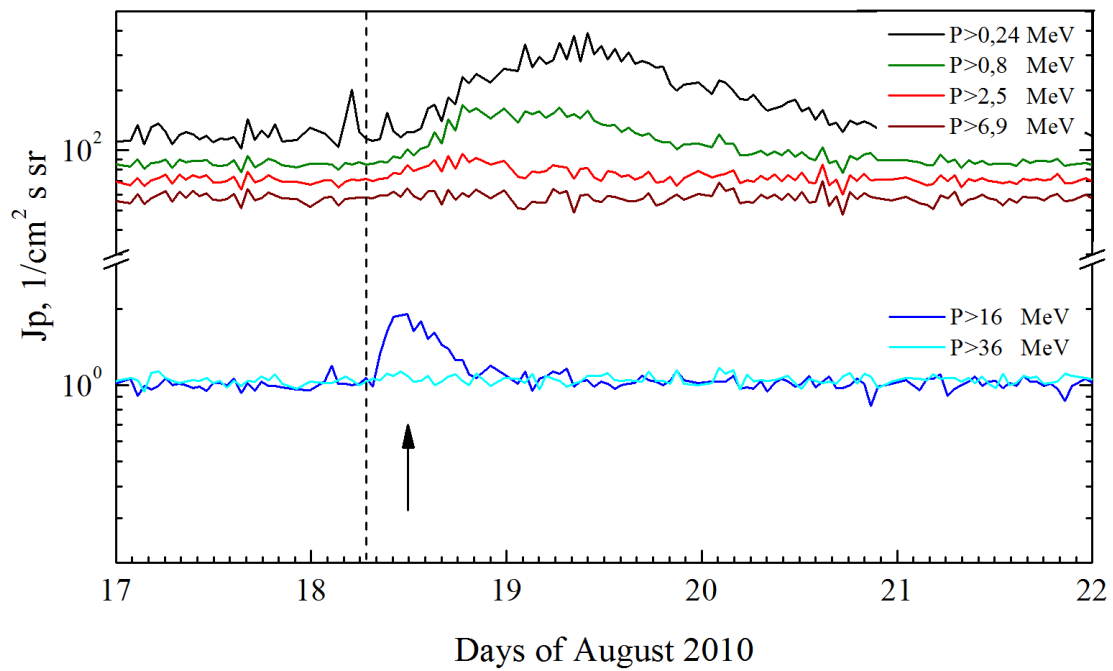


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2010.08.18



POES. Event 2010.08.18



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2010 August 18**

2010 August 18 ☐ AR 11099 To event 479

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	0445	0548	>0651	N18W88	C4.5	0.023
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0436:28	0449:46	0454:40	1092	2452632	HESSI
6-12	keV	0606:20	0606:26	0607:00	49	10949	HESSI
12-25	keV	0506:46	0534:16	0549:38	3105	1057898	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
610	MHz	1038	1039	1040		2.23	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-55	0551		0555	545	1	
DH II	0.7-13	0605		0745			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0548	1471	20.2	184°	230°	SOHO

Proton Active Region:

AR11099 (N17L347, CMP 10,5.08.2010,
Sp=090 msh, CRO, B, R1)
XRI=0 C₅ S₉

References:

Bruno A., I.G. Richardson, [2021](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
Leske R.A., C.M.S. Cohen, R.A. Mewaldt et al., [2012](#).
Luhmann J.G., M.L. Mays, D. Odstrcil et al., [2017](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).

Events in 2011

			Page
1	Event 2011.01.28 – (2011-028)	№ 480	74
2	Event 2011.02.15 – (2011-046)	№ 481	81
3	Event 2011.03.07 – (2011-066)	№ 482	89
4	Event 2011.03.21 – (2011-080)	№ 483	98
5	Event 2011.06.05 – (2011-156)	№ 484	107
6	Event 2011.06.07 – (2011-158)	№ 485	114
7	Event 2011.06.11 – (2011-162)	№ 486	124
8	*Event 2011.06.15 – (2011-166)	№ 487	131
9	Event 2011.06.17 – (2011-168)	№ 488	138
10	Event 2011.08.02 – (2011-214)	№ 489	145
11	Event 2011.08.04 – (2011-216)	№ 490	154
12	Event 2011.08.08 – (2011-220)	№ 491	163
13	Event 2011.08.09 – (2011-221)	№ 492	171
14	Event 2011.09.06 – (2011-249)	№ 493	180
15	Event 2011.09.07 – (2011-250)	№ 494	188
16	Event 2011.09.22 – (2011-265)	№ 495	196
17	Event 2011.10.22 – (2011-295)	№ 496	204
18	Event 2011.11.04 – (2011-308)	№ 497	211
19	Event 2011.11.26 – (2011-330)	№ 498	219
20	Event 2011.12.25 – (2011-359)	№ 499	226

* Here and below in the lists of events, an asterisk (*) marks weak events with Jp ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To($E_p > 10$ MeV) – 28d01^h

Tmax₁($E_p > 10$ MeV) – 28d07^h, Jmax₁($E_p > 10$ MeV) – 1.6 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 28d16^h, Jmax₂($E_p > 10$ MeV) – 2.1 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 1.8$, $\gamma_2 = 1.8$

Quasimaximal energy of protons in the event – Eqm₁ = 200 MeV

– Eqm₂ = 140 MeV

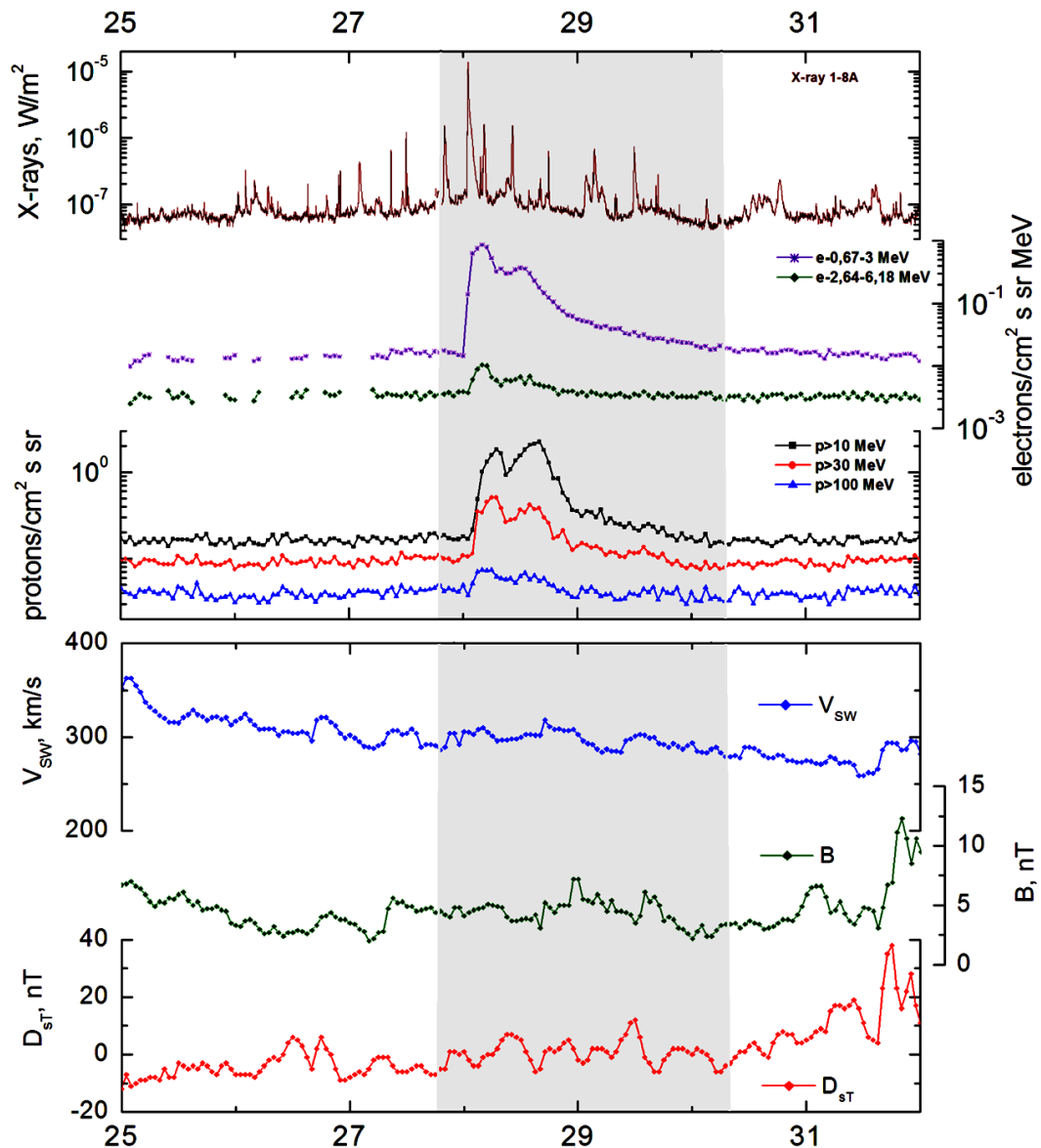
Sources: ☐ solar flare event 28d<00^h44^m, M1.3*, N16W88, AR11149, 1d behind W_L

Main X-ray burst 1-8 Å: onset – 28d00^h44^m, max – 28d01^h03^m, $\Phi = 0.0095$ J/m²

CME: 28d01^h26^m, V = 606 km/s, $\Delta\phi = 119^\circ$, dA = 290°

*Large solar flare event behind W_L

Particle fluxes and associated phenomena



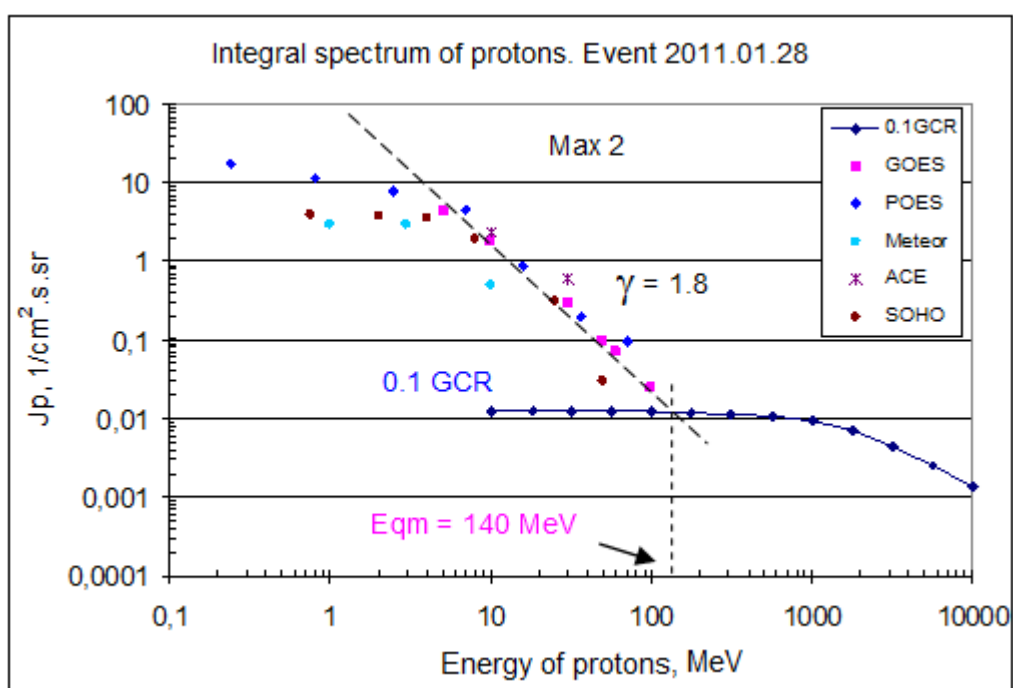
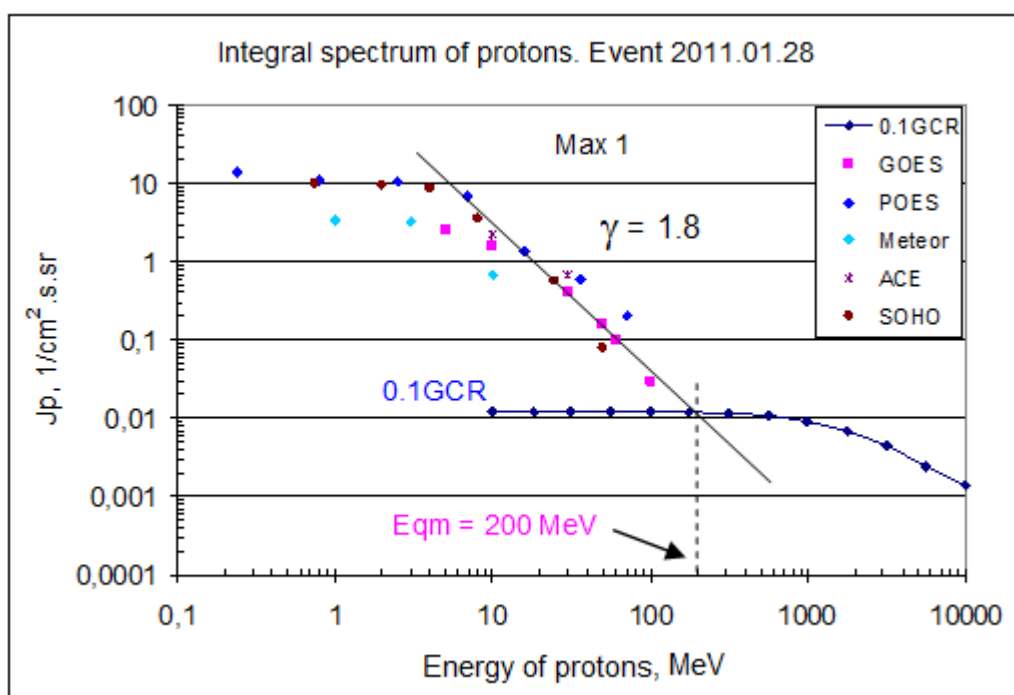
January 2011

Integral fluxes of protons for the event of 2011 January 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	01	08/16	2.6/4.3	2	0.2	
EPS	>10	01	07/16	1.6/2.1	1.5	0.17	
EPS	>30	01	06/14	0.4/0.3	1	0.1	
EPS	>50	01	06/14	0.16/0.1	1	0.07	
EPS	>60	01	05/14	0.1/0.05	1	0.06	
EPS	>100	01	04/13	0.03/0.025	1	0.04	
EPS	>700	-	-	-	-	-	
POES							
MEPED	>0.24	3h	5/18.5	14/18	0.5	110	
MEPED	>0.8	4h	5/18.5	11/11.5	0.5	85	
MEPED	>2.5	4h	5/18.5	10.5/8	0.5	70	
MEPED	>6.9	4h	5/18.5	7/4.5	0.5	55	
MEPED	>16	2h	6/14	1.5/0.9	0.7	0.9	
MEPED	>36	2h	6/14	0.6/0.2	0.7	1	
MEPED	>70	2h	6/14	0.2/0.1	0.7	1.1	
MEPED	>140	2h	-	-	-	1.4	
Meteor-1							
SCR	>1	3	08/ 15	3.4/3	1	3.4	
SCR	>3	3	08/ 16	3.2/3	1	2.7	
SCR	>10	3	04/14	0.7/1	1	2.1	
GALS-M	>15	-	-	-	-	4.7	
GALS-M	>25	-	-	-	-	4.8	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	01	05/13	2.2/2.35	1	1.9	
SIS	>30	01	04/12	0.7/0.6	1	1.3	
SOHO							
EPHIN	>50	02	04/11	0.08/ 0.03	0.5	0.36	

Differential fluxes of protons for the event of 2011 January 28

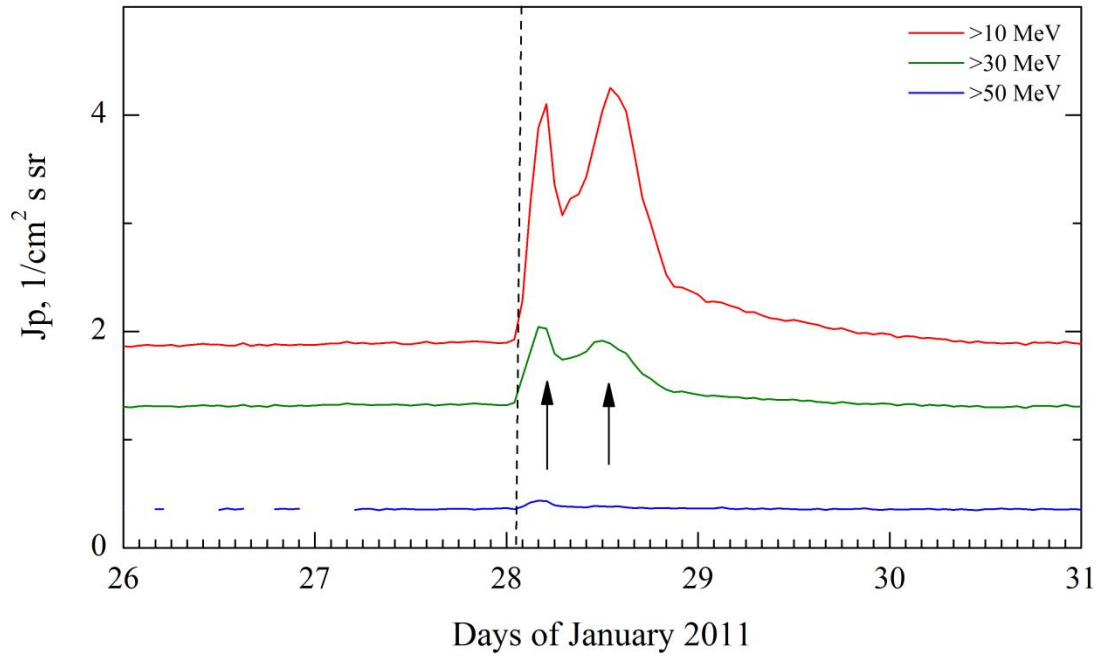
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	01	8/12	0.24/0.17	4.5	0.01	
LION	2 – 6	01	6/12	0.25/0.07	4.	0.0025	
EPHIN	4 – 8	01	5/11	1.3/0.4	4	0.0004	
EPHIN	8 – 25	01	5/13	0.18/0.1	3	0.00003	
EPHIN	25 – 53	02	5/12	0.018/0.01	2.55	0.00003	



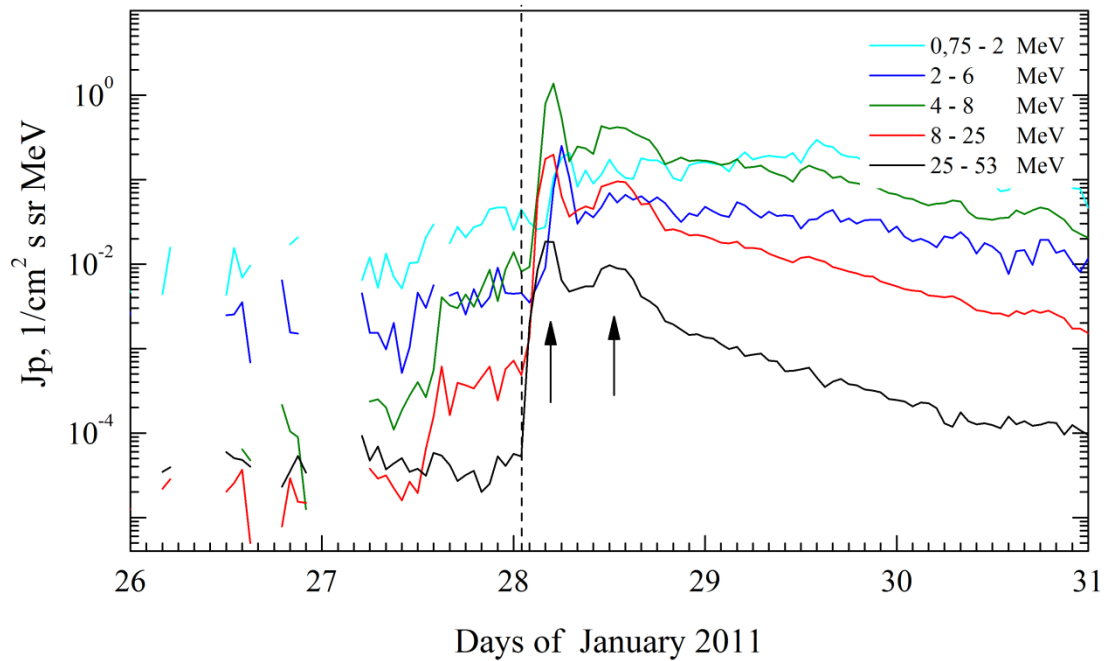
Time profiles of proton fluxes in the event 2011.01.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.01.28

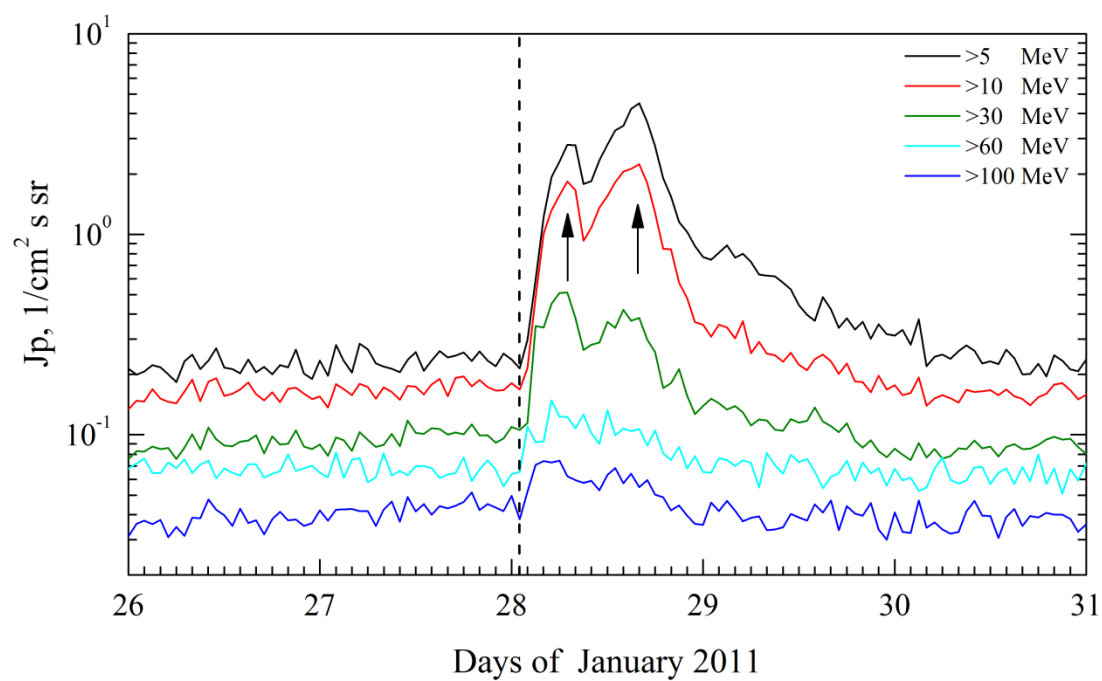


SOHO. Event 2011.01.28



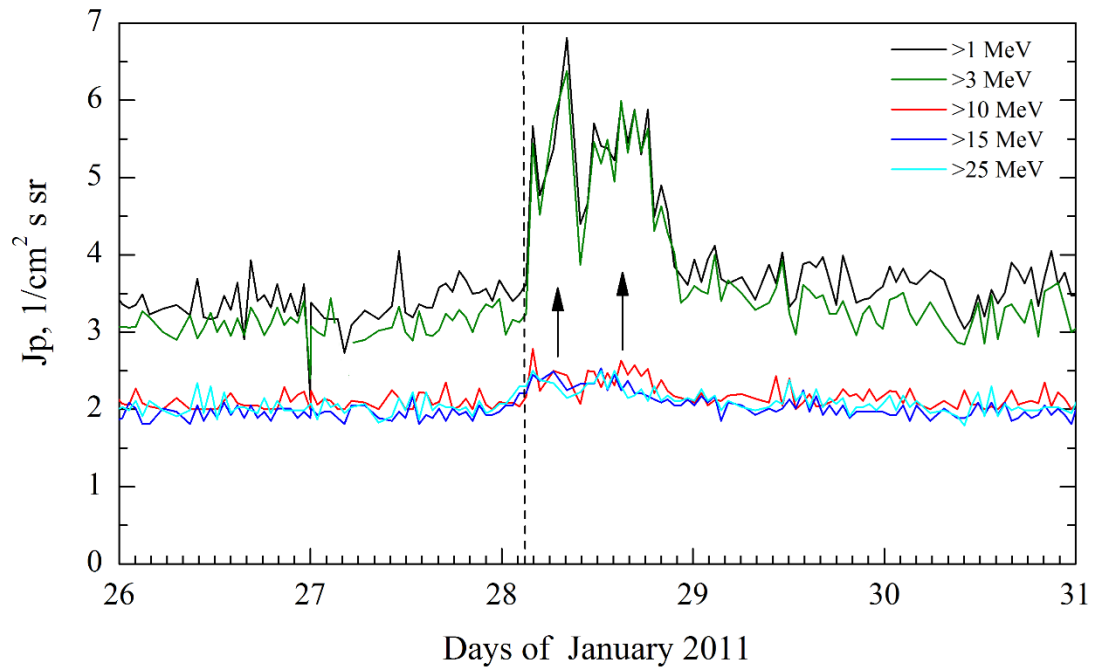
Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES

GOES. Event 2011.01.28

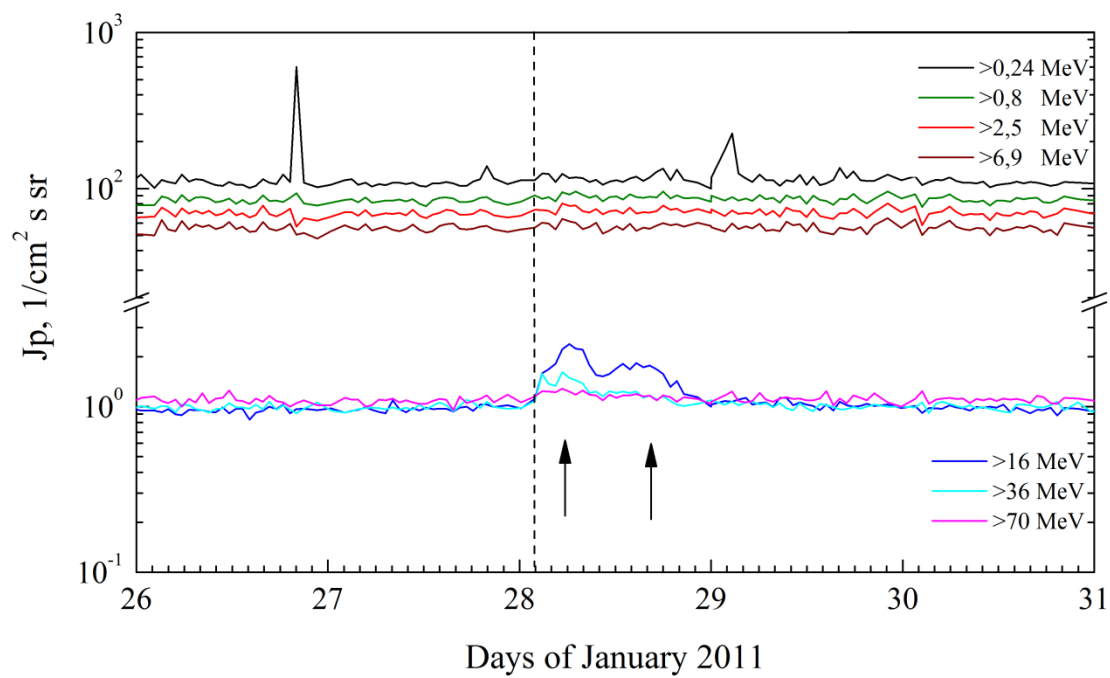


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.01.28



POES. Event 2011.01.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event
of 2011 January 28**

2011

January 28



AR 11149

To event 480

Ha, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	0044	0103	0245	N16W88	M1.3*	0.0095
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25 – 50	keV	0046:20	0056:10	0115:40	1968	4826051	HESSI
6-12	keV	0115:40	0118:14	0122:48	30	60707	HESSI
12-25	keV	0048:23	0049:32	0052:29	2386	62231	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
2.8	GHz	0056.5	0108.4	0109		1	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-130	0101		0112	732	1	
DS III	57-200	0057		0059		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0126	606	-20.9	119°	290°	SOHO

*Large solar flare behind W_L

Proton Active Region:

AR11149 (N17L343, CMP 21.01.2011,

Sp=250 msh BG; R1)

XRI= 0.13; M₁^{1.3}+C₈; S₄;

PFR 28.01 – M₁^{1.3}

References:

Bučík R., S.M. Mulay, G.M. Mason et al., [2021](#).

Koleva K., M. Dechev, P. Duchlev, [2021](#).

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Winter L.M., and K. Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 15d05^h

Tmax₁($E_p > 10$ MeV) – 15d12^h, Jmax₁ ($E_p > 10$ MeV) – 1.9 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 15d18^h, Jmax₂ ($E_p > 10$ MeV) – 1.4 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma_1 = 2.2$, $\gamma_2 = 2.2$

Quasimaximal energy of protons in the event – Eqm₁ = 80 MeV

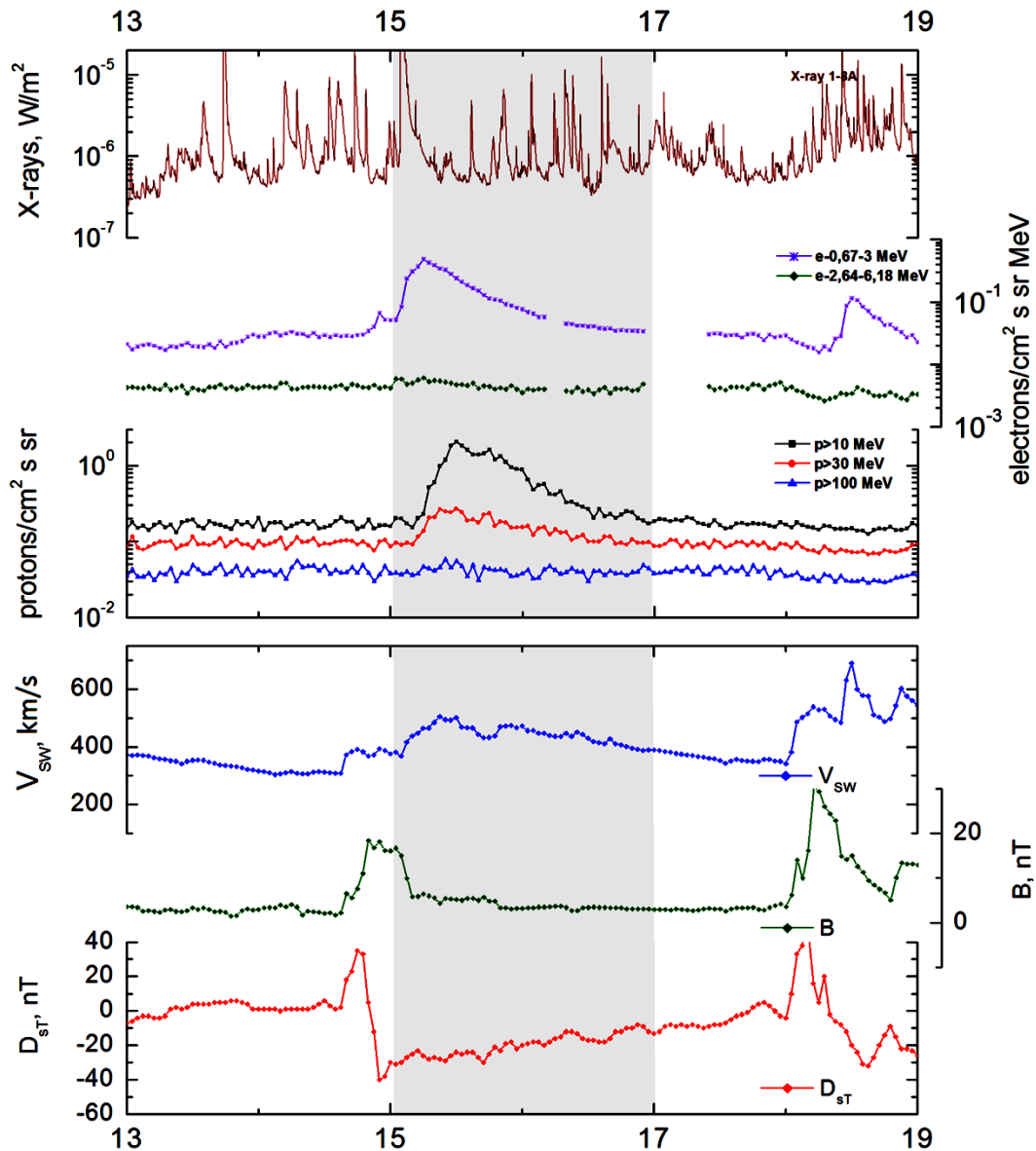
– Eqm₂ = 80 MeV

Sources: ● solar flare 15d01^h44^m, X2.2/2B, S20W15, AR11158

Main burst X-ray 1–8 Å: onset – 15d01^h44^m, max – 15d01^h56^m, $\Phi = 0.16$ J/m²

CME: 15d02^h24^m, V = 669 km/s, $\Delta\phi = 360^\circ$, dA = 189°

Particle fluxes and associated phenomena



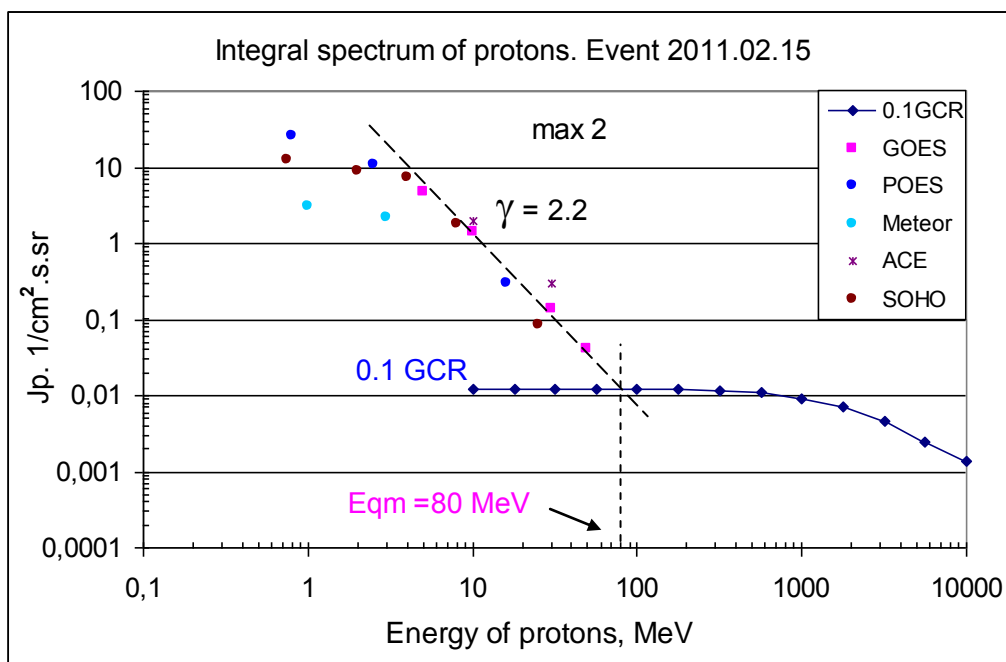
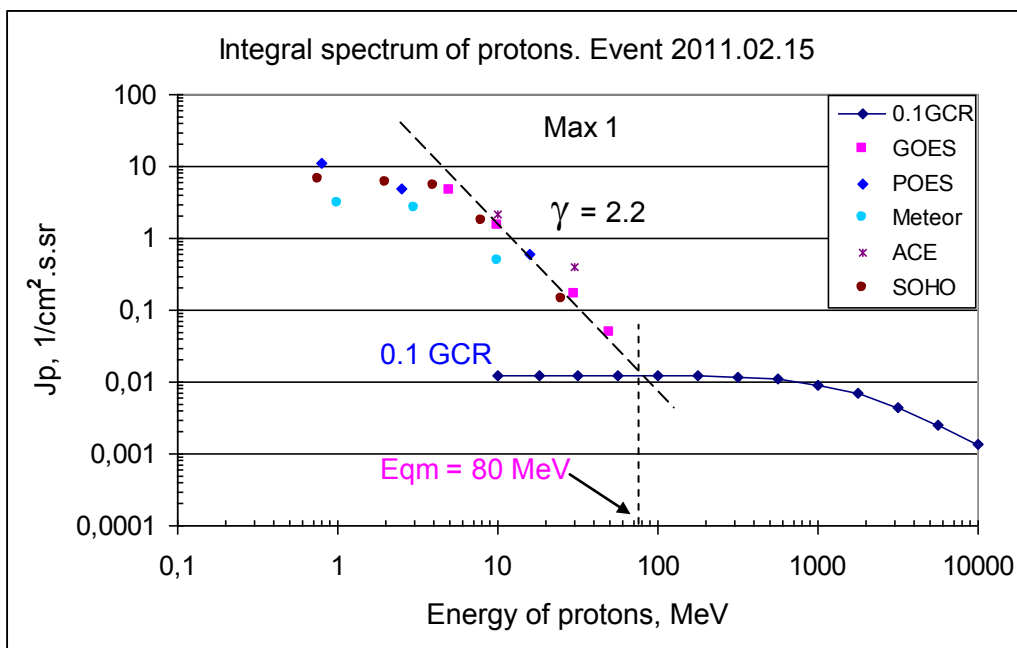
February 2011

Integral fluxes of protons for the event of 2011 February 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	05	12/18	4.75/4.7	2.5	0.25	
EPS	>10	05	12/18	1.9/1.4	2	0.18	
EPS	>30	05	12/18	0.17/0.14	1.5	0.1	
EPS	>50	05	12/18	0.05/0.04	0.7	0.07	
EPS	>60	05	-	-		0.06	
EPS	>100	05	-	-		0.04	
POES							
MEPED	>0.24	-	-	-	-	110	
MEPED	>0.8	4	12/19	11/26	0.5	85	
MEPED	>2.5	4	12/19	5/11	0.5	70	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	4	12/20	0.6/0.3	0.3	1	
MEPED	>36	-	-	-	-	1	
MEPED	>70	-	-	-	-	1.1	
MEPED	>140	-	-	-	-	1.4	
Meteor-1							
SCR	>1	03	13/20	3.1/3	2	3.4	
SCR	>3	03	13/20	2.7/2.4	2	3	
SCR	>10	0.3	13/-	0.5/-	1	2.1	
GALS-M	>15	-	-	-	-	0.8	
GALS-M	>25	-	-	-	-	0.8	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	04	10/16	2.3/2	1	1.9	
SIS	>30	04	10/16	0.4/0.3	1	1.3	
SOHO							
EPHIN	>50	-	-	-	-	0.35	

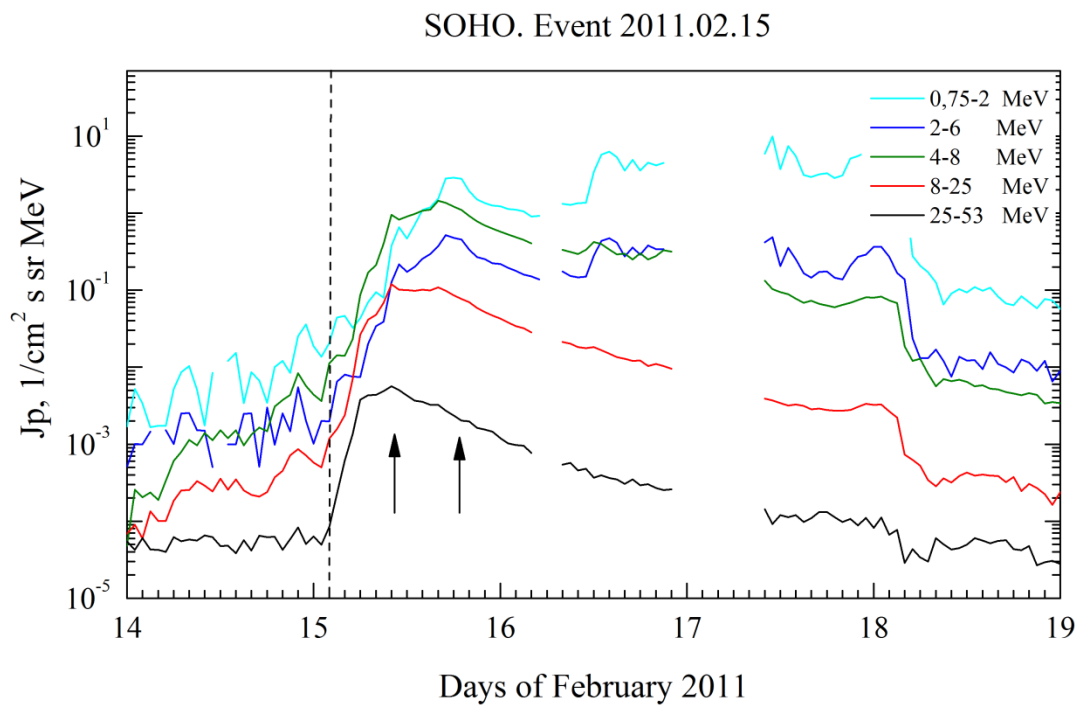
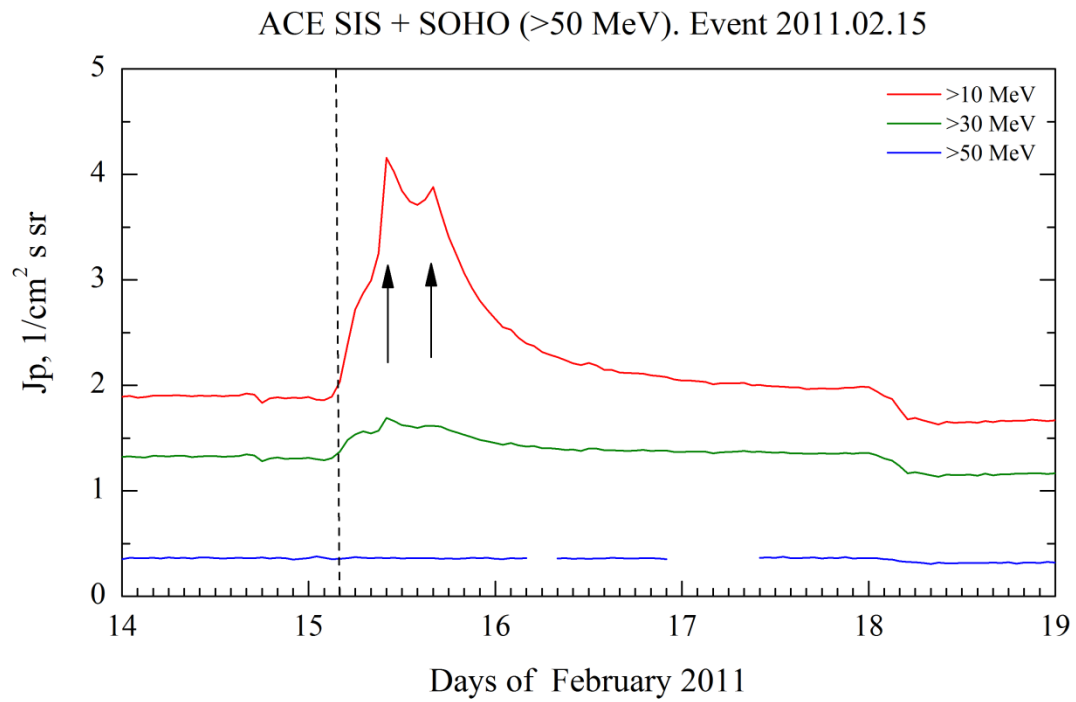
Differential fluxes of protons for the event of 2011 February 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	02	10/18	0.6/2.8	3.5	0.01	
LION	2 – 6	03	10/18	0.2/0.5	3.5	0.001	
EPHIN	4 – 8	02	10/18	0.9/1.4	3.5	0.0002	
EPHIN	8 – 25	02	10/18	0.1/0.1	3.5	0.0001	
EPHIN	25 – 53	03	10/18	0.005/0.003	3	0.00005	

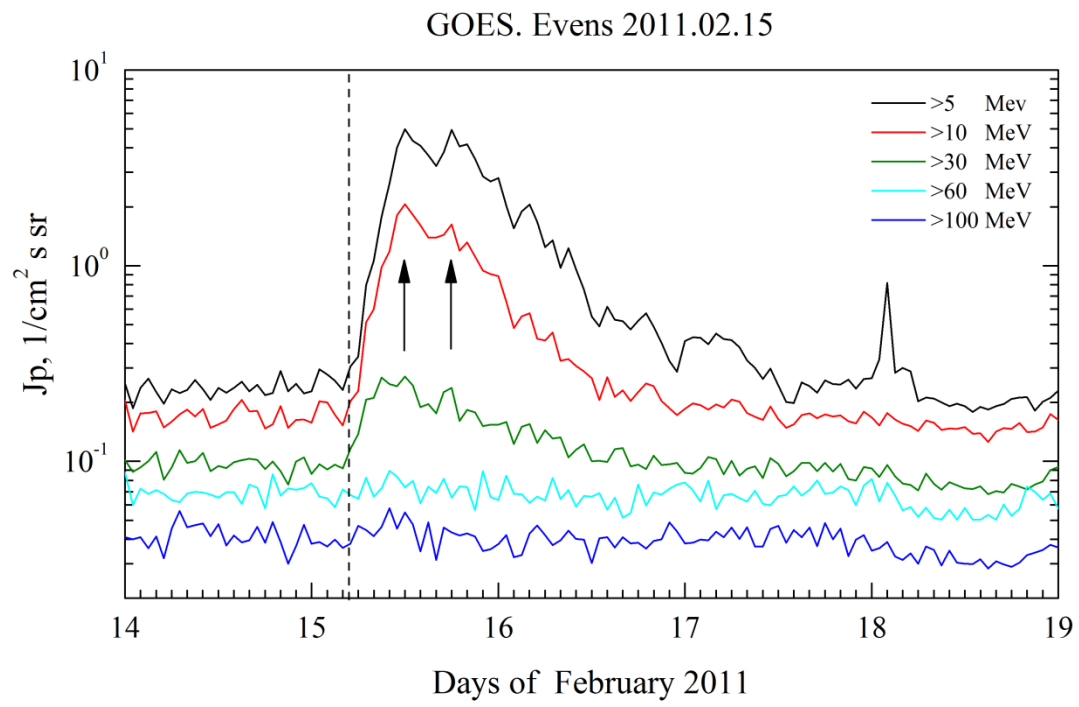


Time profiles of proton fluxes in the event 2011.02.15

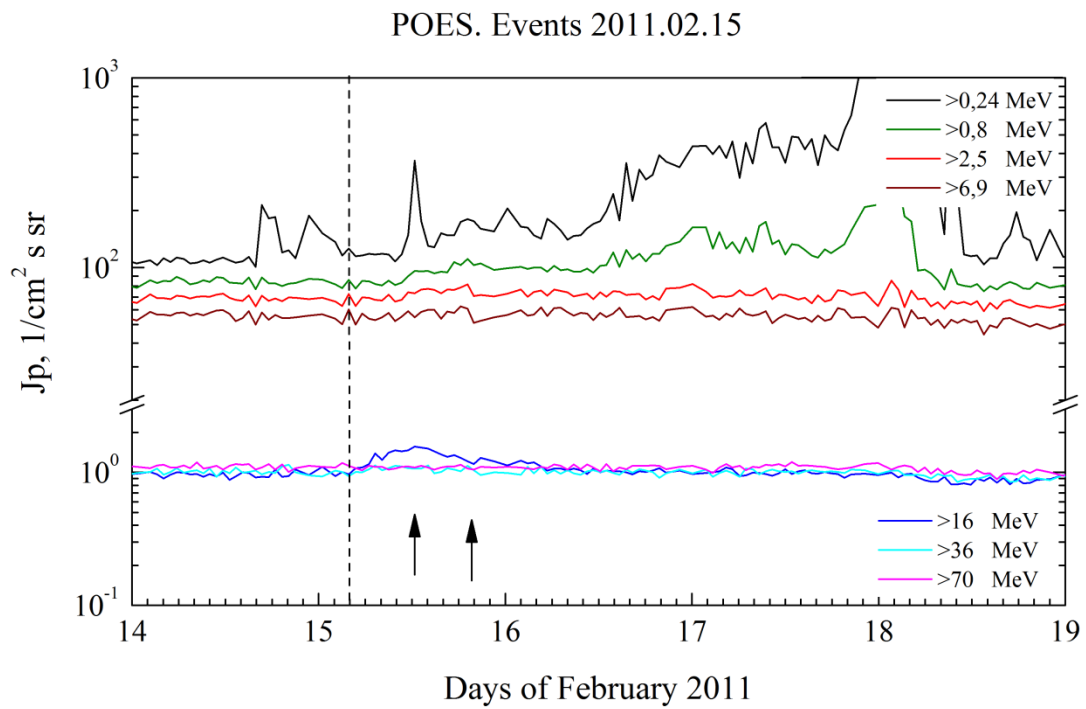
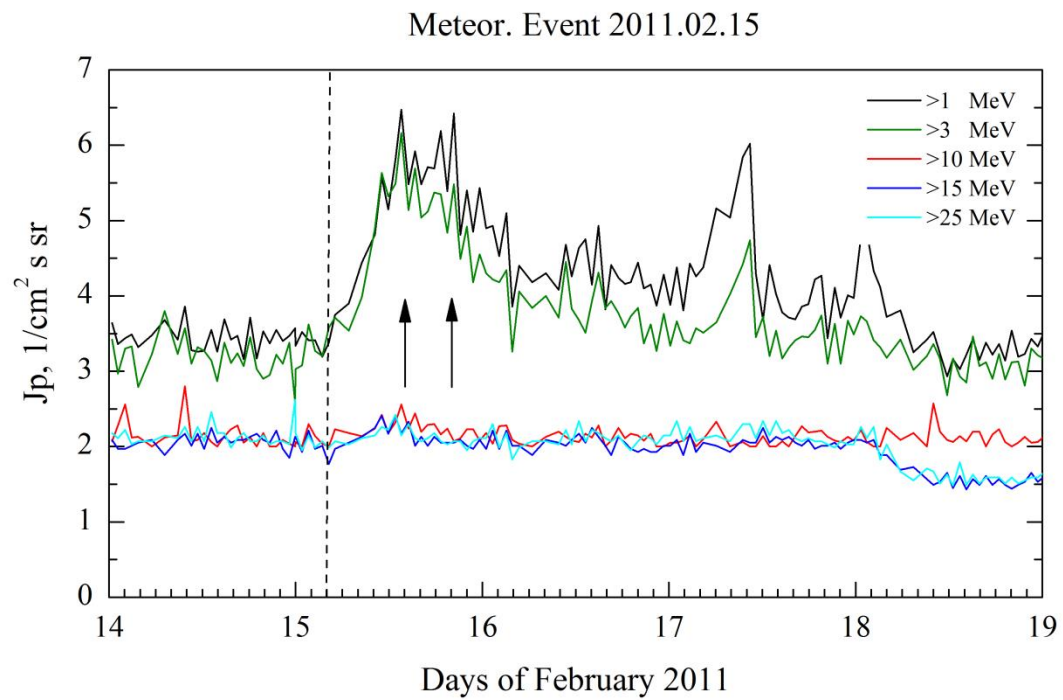
Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO



Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 February 15**

2011

February 15

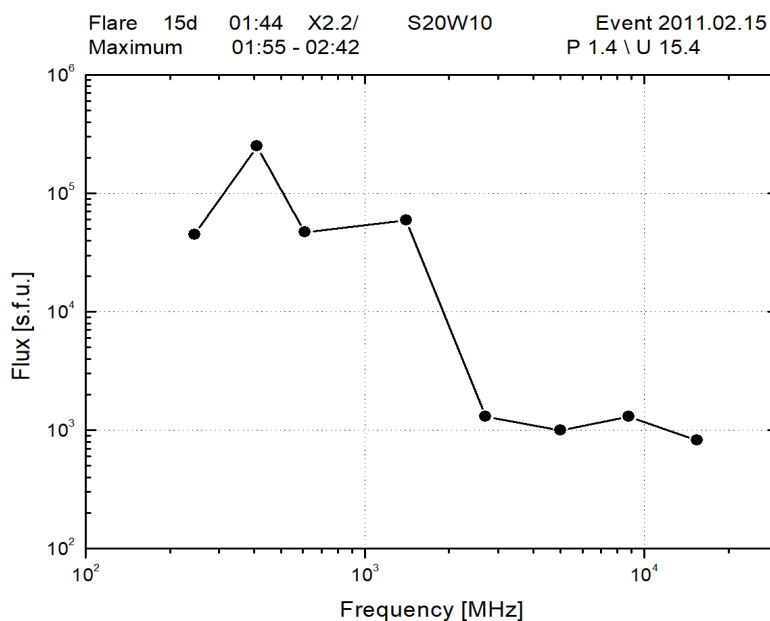
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AR 11158

To event 481

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL				S20W15	2B	FH
1 – 12	keV	0144	0156	>0206	S20W10	X2.2	0.16
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50-100	keV	0143:44	0155:30	0227:32	26868	97891880	HESSI
12-25	keV	0145:26	0159:47	0221:50	877741	403589952	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0148	0155	0211	P1.4 \ U15.4	2.91	
8.8	GHz	0148	0155	0209		3.11	
5	GHz	0149	0155	0209		3.00	
2.7	GHz	0149	0159	0235		3.11	
1.4	GHz	0148	0234	0312		4.77	
610	MHz	0151	0242	0418		4.67	
410	MHz	0152	0224	0418		5.4	
245	MHz	0151	0222	0351		4.65	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	057-260	0152		0200		2	
DS IV	025-180	0155		0158		2	
DS III	057-130	0155		0200	G	3	
DH II	0.4-16	0210		0700			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0224	669	-18.3	360°	189°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR11158 (S19L034, CMP 13.8.02.2011,

Sp=620, EKC, BGD; R1)

XRI=3.59; $X_1^{2.2} + M_6^{6.6}$; $1_4 + S_{25}$

PFR1 13.02 $M_1^{6.6}$

PFR2 14.02 $X_1^{2.2} + M_3^{2.2}$

PFR3 18.02 $M_2^{6.6}$

References:

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

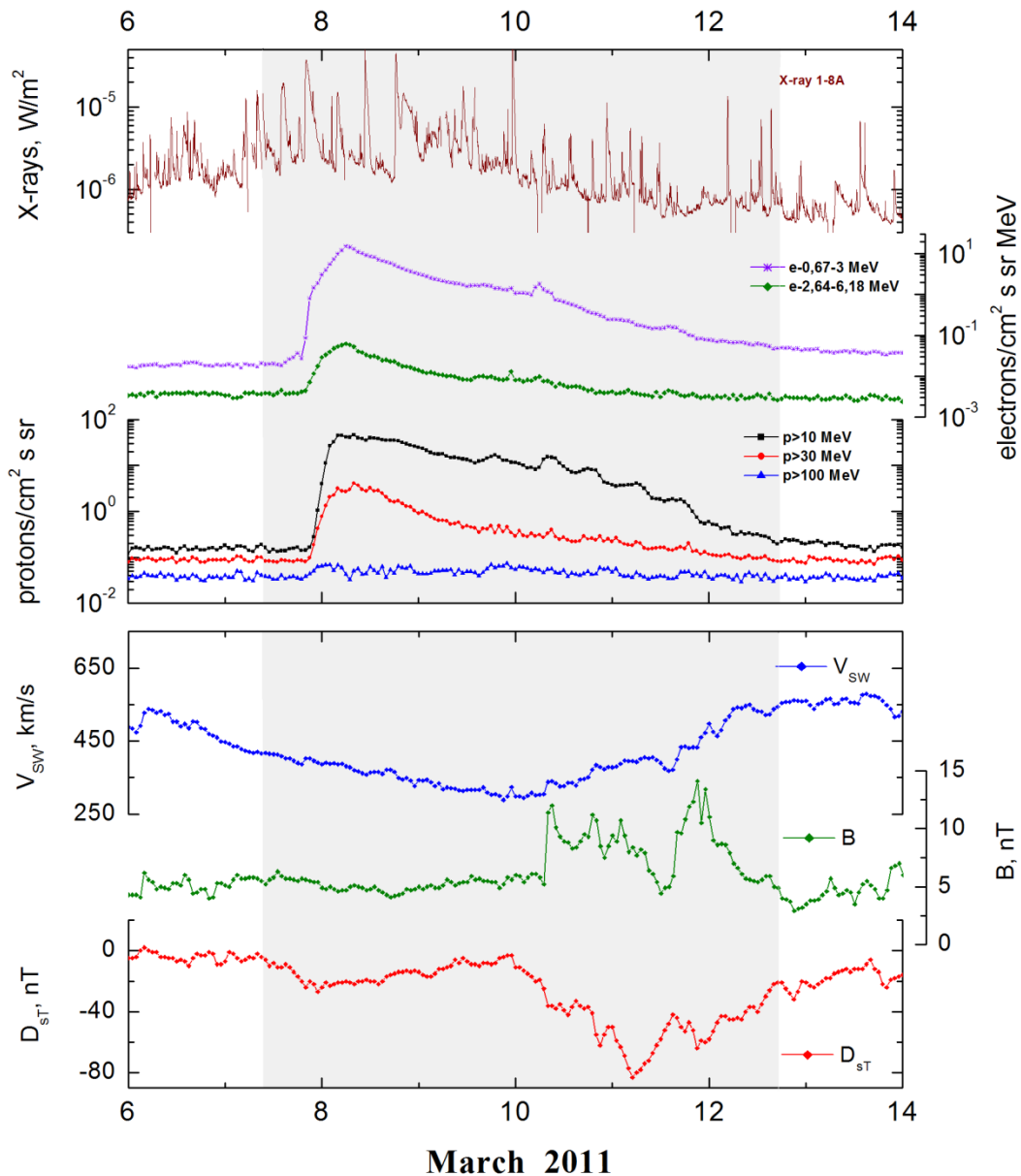
Winter L. M., and K. Ledbetter, [2015](#).

Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 07d22^h
 Tmax ($E_p > 10$ MeV) – 08d05^h, Jmax ($E_p > 10$ MeV) – 45 /cm²·s·sr
 Duration of the event – 5 days, power-law index: $\gamma = 3.1$
 Quasimaximal energy of protons in the event – $E_{qm} = 140$ MeV

Sources: ● solar flare 07d19^h43^m, M3.7/, S22W67, AR11164
 Main burst X-ray 1–8 Å: onset – 07d19^h43^m, max – 07d20^h12^m, $\Phi = 0.12$ J/m²
 CME: 07d20^h00^m, $V = 2125$ km/s, $\Delta\phi = 360^\circ$, $dA = 313^\circ$
 ▲ SC 10d 06^h 32^m

Particle fluxes and associated phenomena

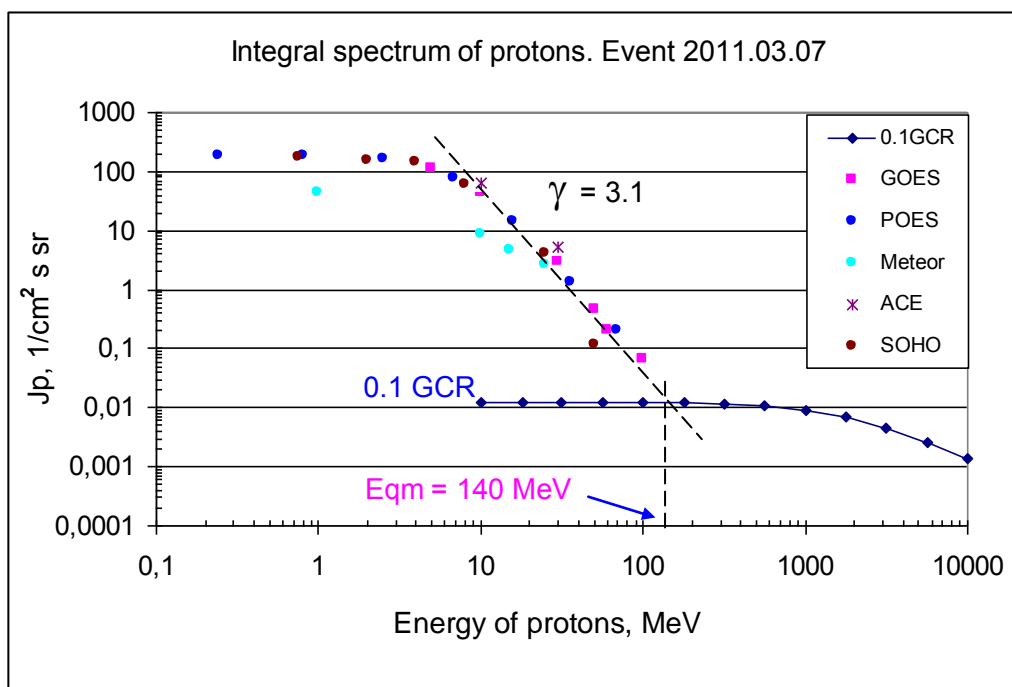


Integral fluxes of protons for the event of 2011 March 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	22	08d05	110	5	0.2	
EPS	>10	22	08d05	45	5	0.16	
EPS	>30	22	08d04	3	3	0.09	
EPS	>50	22	08d04	0.45	2	0.07	
EPS	>60	22	08d03	0.2	1	0.07	
EPS	>100	22	08d04	0.065	0.5	0.04	
EPS	>700						
POES							
MEPED	>0.24	23	08d03	190	5	110	
MEPED	>0.8	23	08d03	185	5	85	
MEPED	>2.5	23	08d03	165	5	65	
MEPED	>6.9	23	08d03	75	2	55	
MEPED	>16	22	08d03	14	3	1	
MEPED	>36	22	08d03	1.3	1	1	
MEPED	>70	22	08d03	0.2	0.5	1.1	
MEPED	>140	22	-	-	-	1.4	
Meteor-1							
SCR	>1	21	08d08	44	5	3.4	
SCR	>3	21	-	-	5	3.2	
SCR	>10	21	08d08	8.7	3	2.1	
GALS-M	>15	21	08d08	4.6	3	1.6	
GALS-M	>25	21	08d08	2.6	2	1.6	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	22	08d04	58.4	4	1.8	
SIS	>30	22	08d04	5.3	3	1.2	
SOHO							
EPHIN	>50	22	8d01	0.12	0.7	0.35	

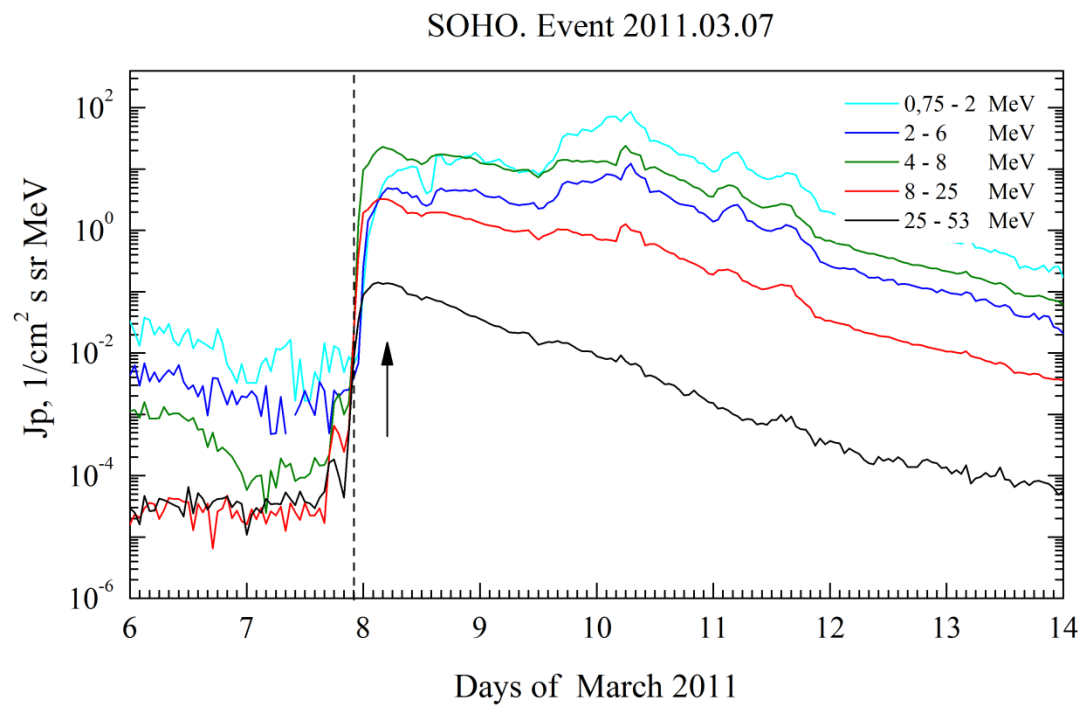
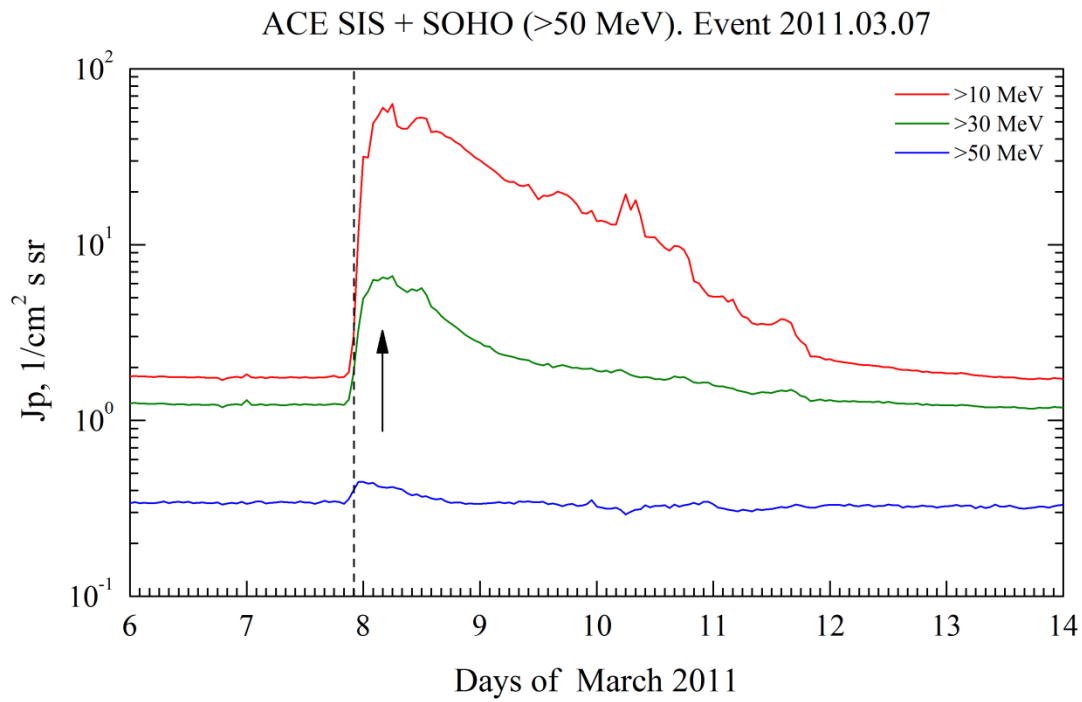
Differential fluxes of protons for the event of 2011 March 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75– 2	22	8d10	11.1	9	0.01	
LION	2 – 6	22	8d07	4.9	7	0.003	
EPHIN	4 – 8	22	8d05	20.7	7	0.0001	
EPHIN	8 – 25	22	8d05	3.25	6	0.00003	
EPHIN	25 – 53	22	8d05	0.14	5	0.00003	



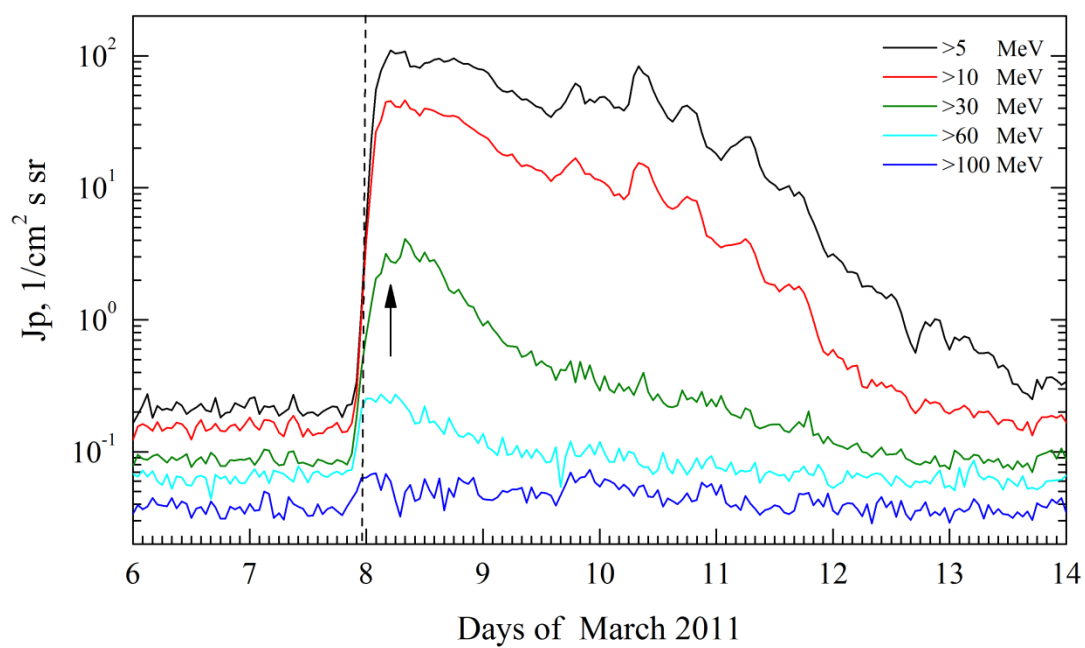
Time profiles of proton fluxes in the event 2011.03.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

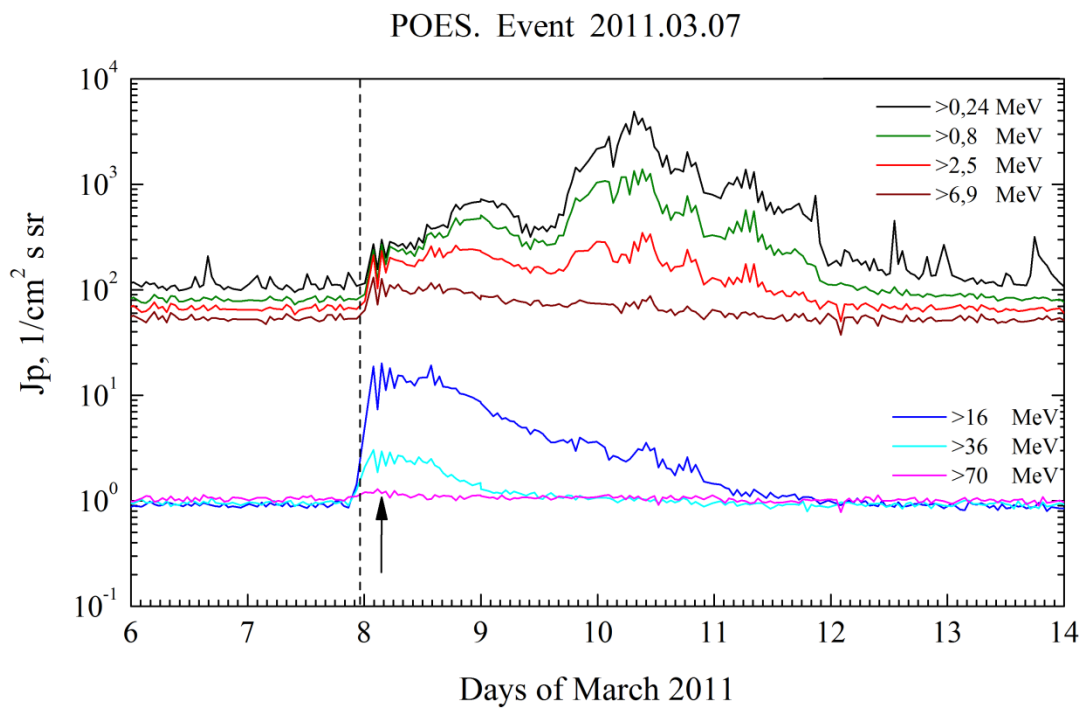
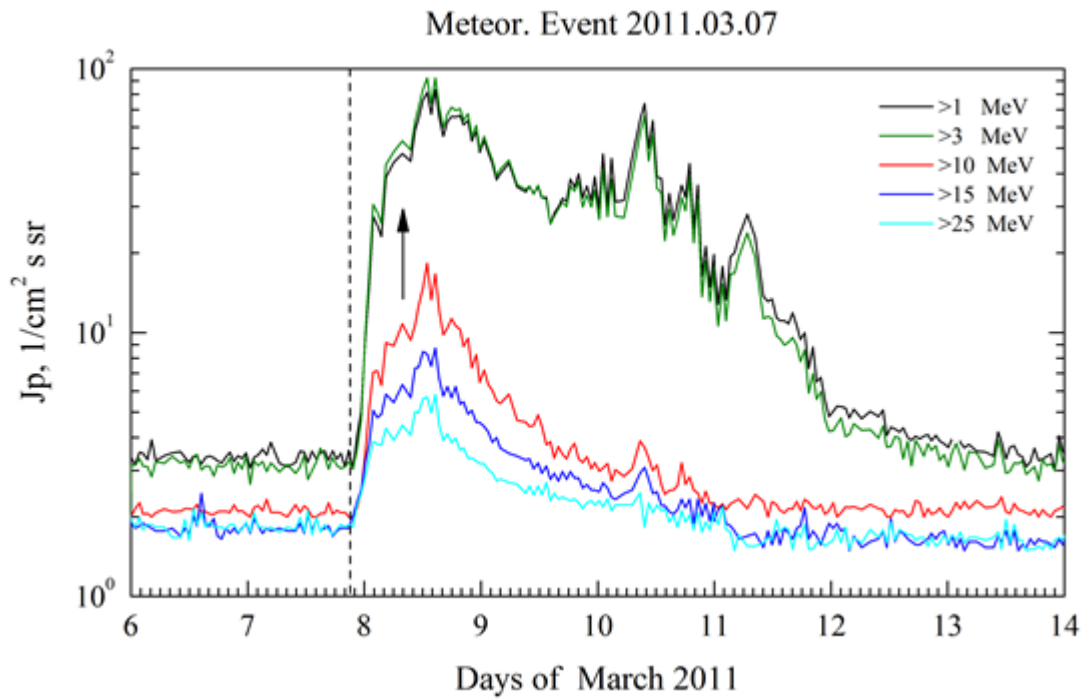


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES

GOES. Event 2011.03.07



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 March 07**

2011

March 07

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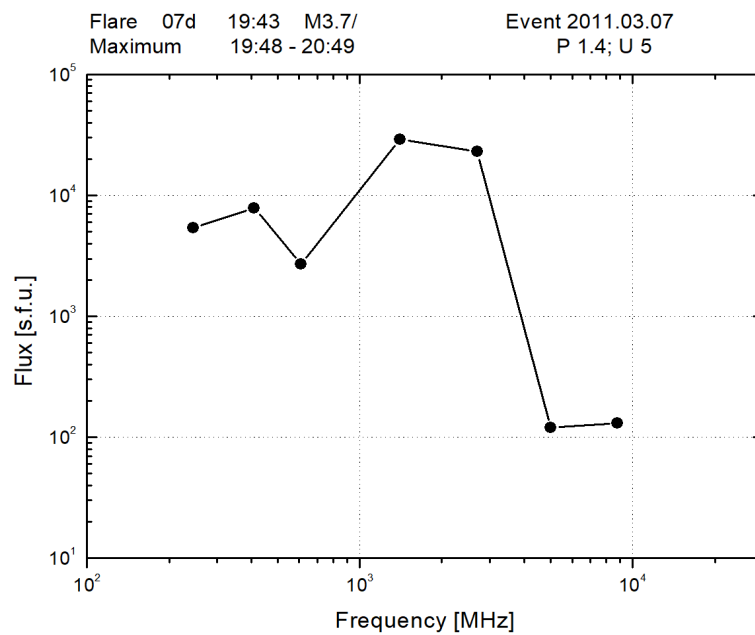
AR 11164

To event 482

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å		No data about optical flare					
1 – 12	keV	1943	2012	2058		M3.7	0.12
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	1939:24	2004:54	2007:48	1328	5286911	HESSI
12-25	keV	2023:28	2023:30	2032:40	720	1461296	HESSI
>100	MeV	2010:30		20:40:30		2.23E-05*	FERMI
12-25	keV	2002:19	2002:30	21:02:07	116627	78543160	FERMI
12-25	keV	2054:04	2054:12	2102:07	6990	481566	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	1947.0	1948.0	1948.0		2.11	
5	GHz	1948.0	1948.0	1948.0		2.08	
2.7	GHz	1953.0	2035.0	2118.0		4.36	
1.4	GHz	1953.0	2016.0	2118.0	P1.4 \ U5	4.46	
610	MHz	1956.0	2038.0	2109.0		4.43	
410	MHz	1950.0	2039.0	2111.0		3.89	
245	MHz	1951.0	2049.0	2112.0		3.73	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-180	1954		2015	1133	3	
DH II	0.2-16	2000		8/0830			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2000	2125	-63.1	360°	313°	SOHO

*cm⁻² s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR11164 (N25L164, CMP02,06.03.2011,

Sp=770 mhs, EKC, BGD, R)

XRI=0.92 $M_5^{3.7} + C_{38}$ $1_3 + S_{24}$

PFR 07.03 (15^h) $M_4^{3.7}$

References:

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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 21d04^h

Tmax₁($E_p > 10$ MeV) – 21d11^h, Jmax₁($E_p > 10$ MeV) – 6.8 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 21d20^h, Jmax₂($E_p > 10$ MeV) – 11.1 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 2.4$, $\gamma_2 = 2.8$

Quasimaximal energy of protons in the event – Eqm₁ = 250 MeV

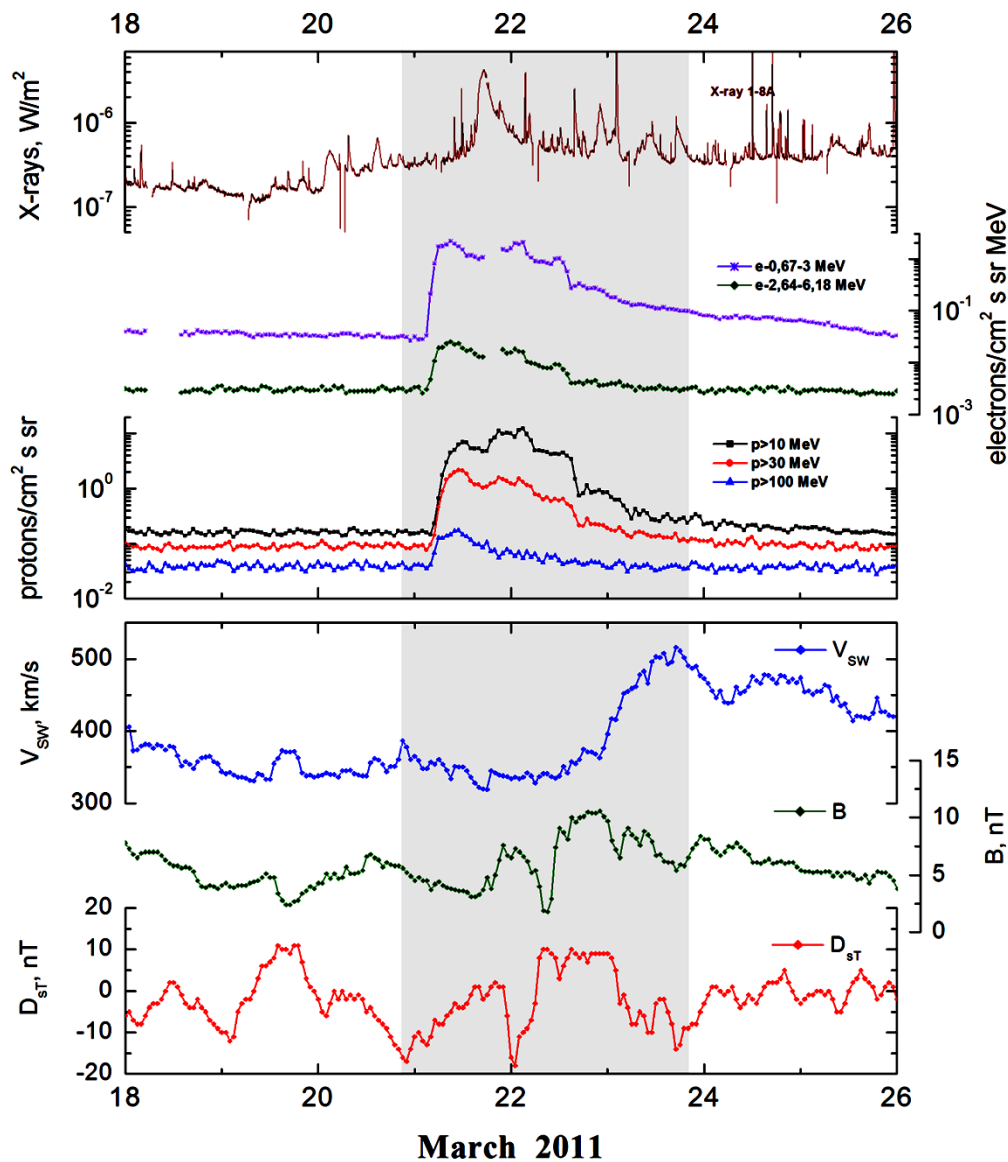
– Eqm₂ = 140 MeV

Sources: ☐ back side solar flare event 21d<02^h24^m, AR unknown, behind W_L

Ø solar flare event 21d 15^h31^m, C4.2/, S20E87, AR 11176

CME 21d02^h24^m, V = 1341 km/s, $\Delta\phi = 360^\circ$, dA = 274°

Particle fluxes and associated phenomena

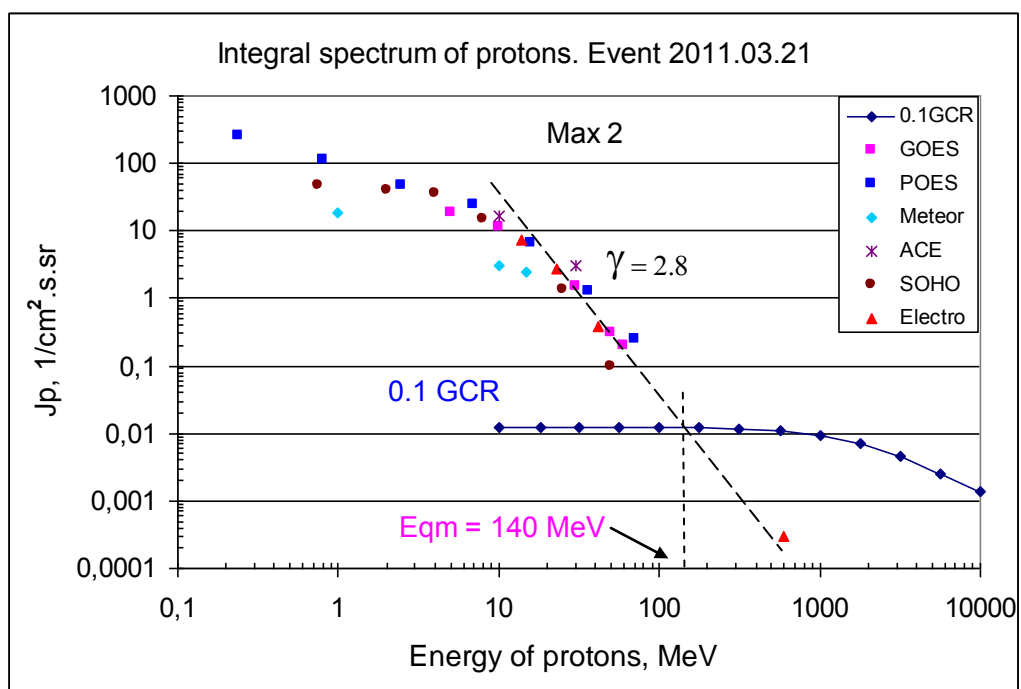
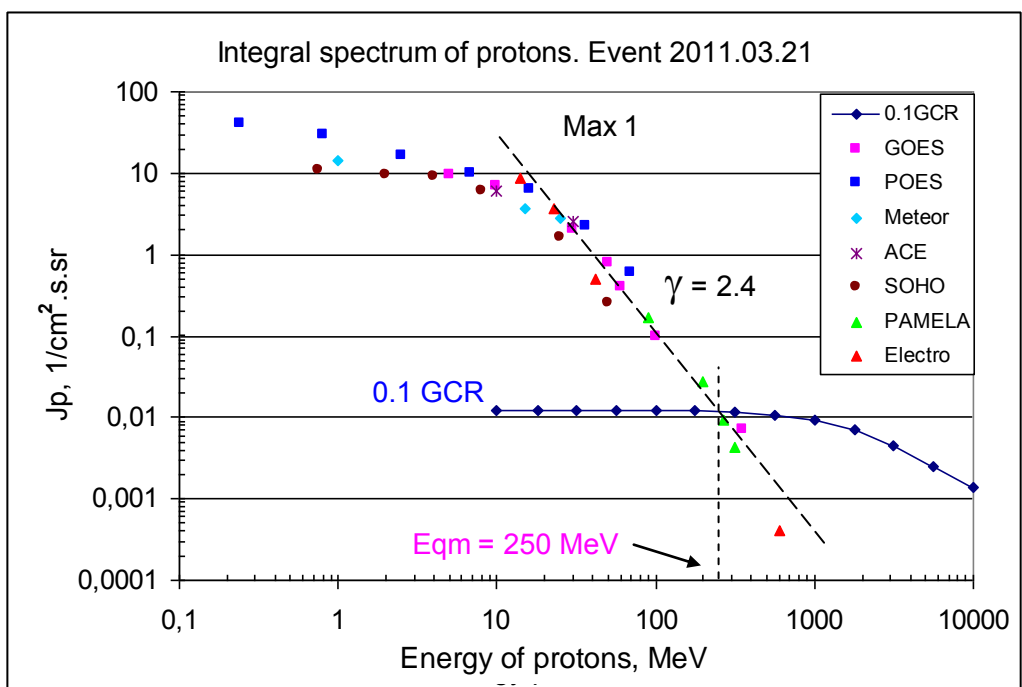


Integral fluxes of protons for the event of 2011 March 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	04	12/20	9.3/18.7	3	0.2	
EPS	>10	04	11/20	6.8/11.1	3	0.16	
EPS	>30	04	10/20	2/1.5	2.5	0.09	
EPS	>50	04	10/20	0.8/0.3	2	0.07	
EPS	>60	04	10/20	0.4/0.2	1.5	0.06	
EPS	>100	04	10/ -	0.1/ -	1	0.04	
Electro-1							
GALS-E	>600	4	10/19	0.0004/0.0003	1	0.001	
POES5							
MEPED	>0.24	5	12/20	40/250	1.5	110	
MEPED	>0.8	4	12/20	30/110	1.5	85	
MEPED	>2.5	3	10/20	16/46	1.5	65	
MEPED	>6.9	3	11/20	10/25	1.5	55	
MEPED	>16	3	10/20	6.2/6.7	1.5	1	
MEPED	>36	3	10/20	2.2/1.3	1.2	0.9	
MEPED	>70	4	10/20	0.6/0.25	1	1.1	
MEPED	>140	4	-	-	-	1.4	
Meteor-1							
SCR	>1	5	11/22d00	14/19	2	3.4	
SCR	>3	5	-	-	2	3.1	
SCR	>10	5	- /22	- /3.1	2	2.1	
GALS-M	>15	3	11/22	3.7/2.4	1.5	0.8	
ACE							
SIS	>10	04	10/21	6.1/16.5	2	1.8	
SIS	>30	04	09/21	2.5/3	1.5	1.2	
SOHO							
EPHIN	>50	03	07/22d00	0.25/0.1	1.5	0.35	
PAMELA							
TRACKER	>90	03	04÷10/ -	0.17/ -	2	-	
TRACKER	>200	03	04÷10/ -	0.027/ -	2	-	
TRACKER	>265	03	04÷10/ -	0.0094/ -	2	-	
TRACKER	>312	03	04÷10/ -	0.0043/ -	2	-	

Differential fluxes of protons for the event of 2011 March 21

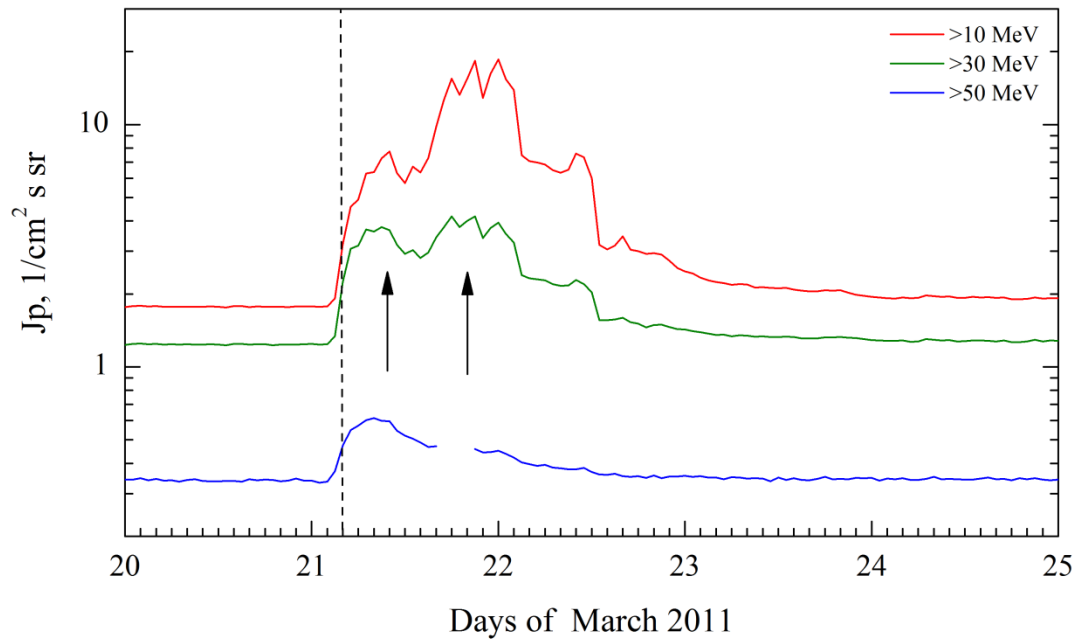
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	04	11/22d00	1.2/5.6	3	0.02	
LION	2 – 6	04	11/22d01	0.18/1.25	3	0.005	
EPHIN	4 – 8	04	11/22d00	0.75/5.2	3	0.009	
EPHIN	8 – 25	03	11/22d00	0.25/0.8	2	0.0004	
EPHIN	25 – 53	03	11/22d00	0.05/0.045	1	0.00005	
Electro-1							
SCR-E	13.7 – 23	4	10/20'	0.54/0.51	1.5	0.06	
SCR-E	23 – 42	4	10/20'	0.17/0.12	1.5	0.03	
SCR-E	42 – 112	4	10/19'	0.007/0.0055	1.5	0.005	
GOES							
EPS	350–420	-	06/ -	0.0001/ -	0.3	0.0021	
EPS	420–510	-	-	-	-	0.0012	



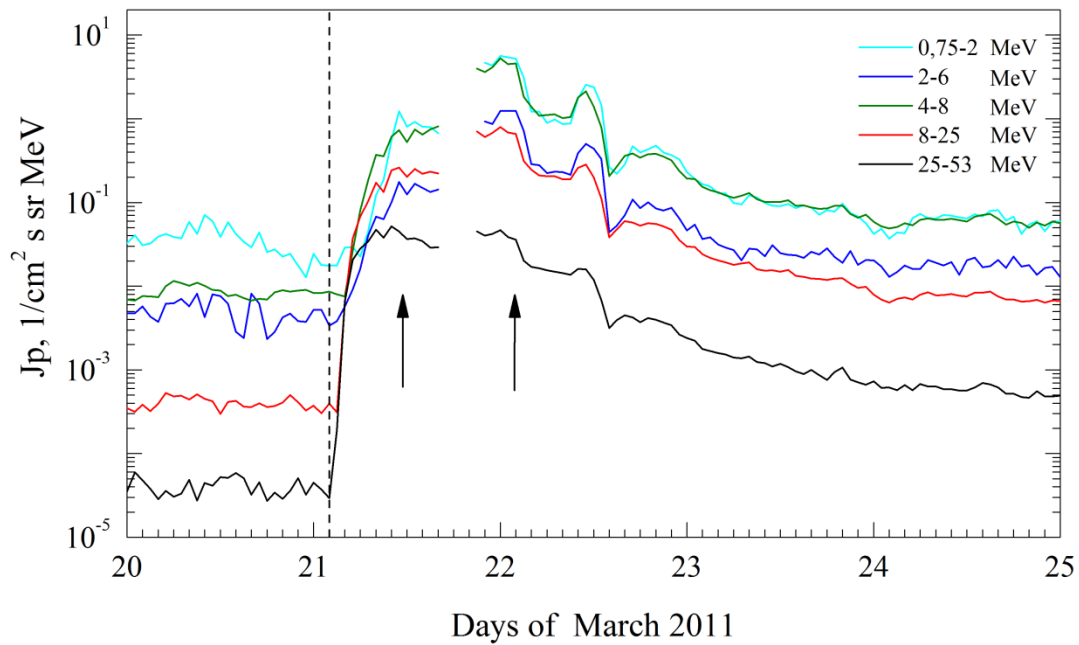
Time profiles of proton fluxes in the event 2011.03.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS +SOHO (>50 MeV). Event 2011.03.21

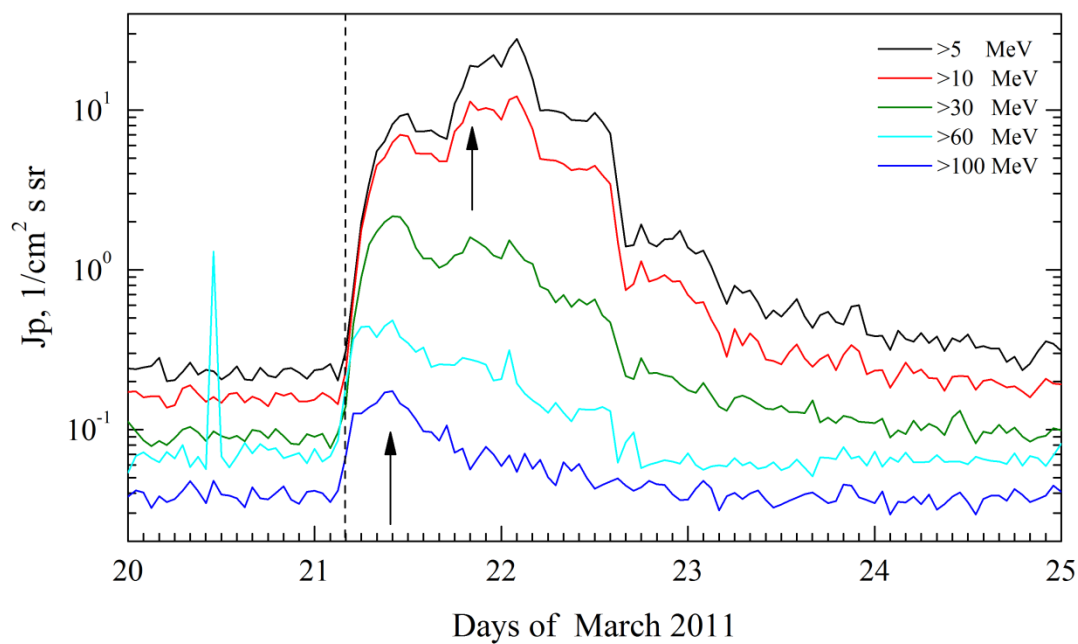


SOHO. Event 2011.03.21

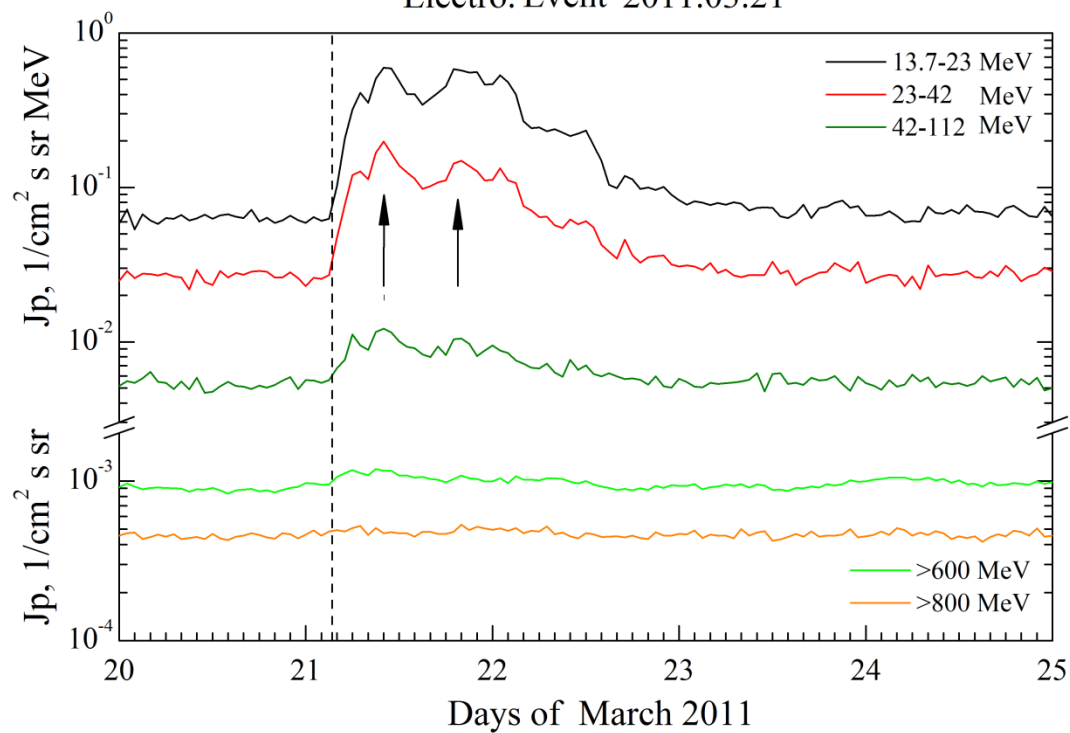


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2011.03.21

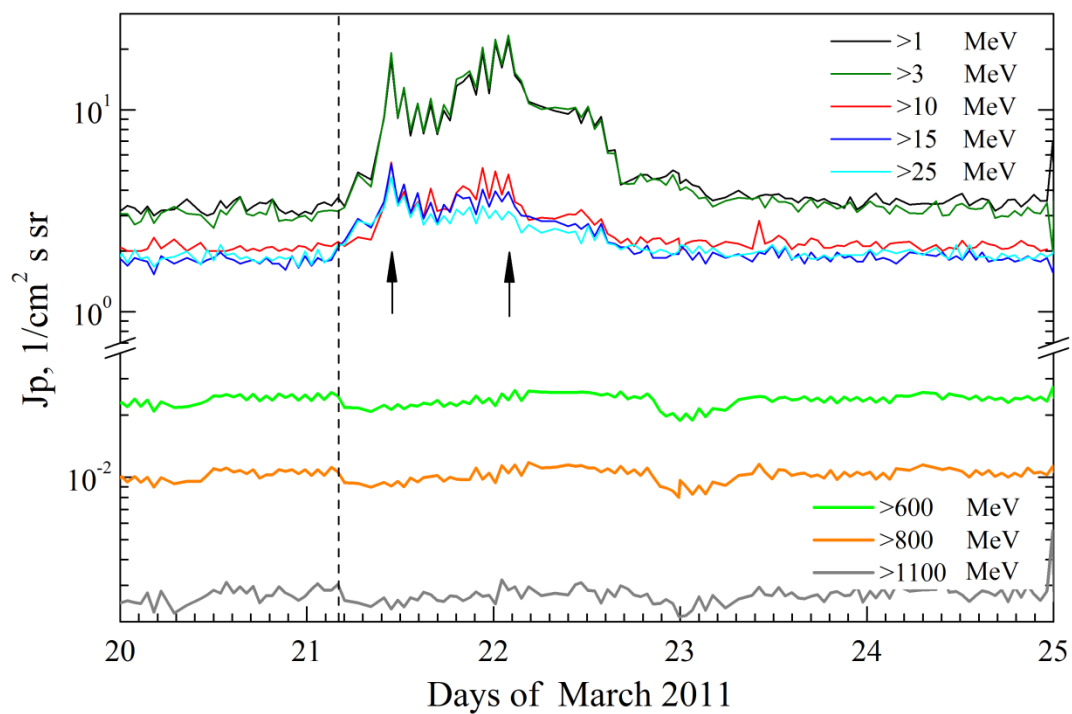


Electro. Event 2011.03.21

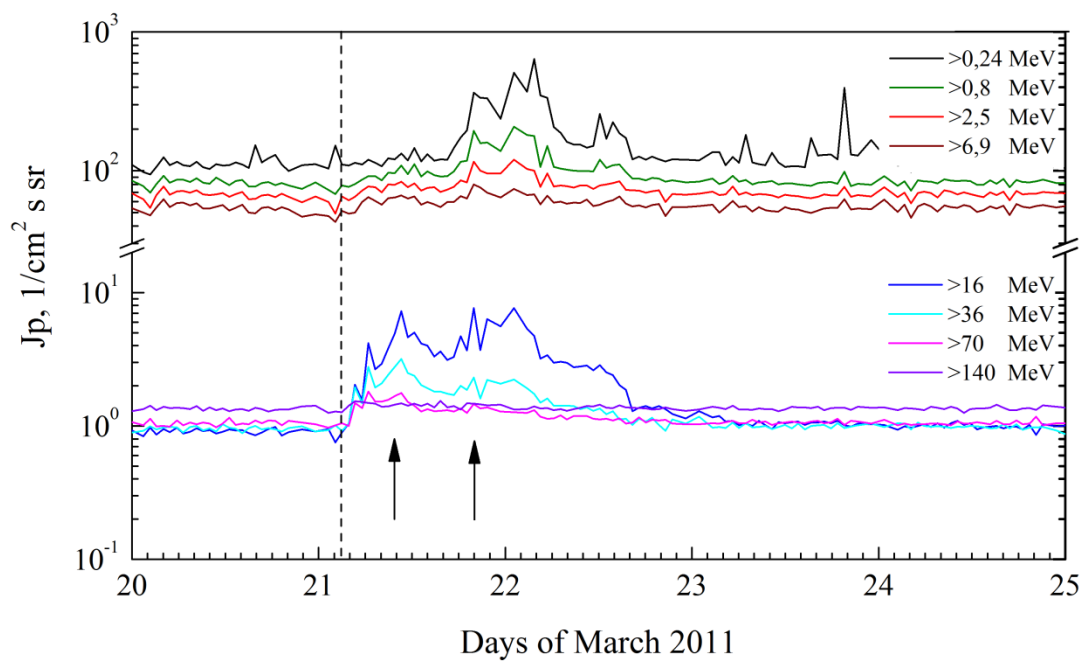


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.03.21



POES. Event 2011.03.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 March 21**

**2011 March 21 ☐ AR XXXXX To event
483**

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	No optical event on visible solar disc					
1 – 12	keV	No X-ray event at this time					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0224	1341	8.0	360°	274°	SOHO

**2011 March 21 Ø AR 11176 To event
483**

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	No optical event on visible solar disc					
1 – 12	keV	1531	1719	1830	S20E87	C4.2	0.033
X-ray		To	Tmax	Te	N _{peak} , counts/s	Total counts	Sp/c
12-25	keV	1533:24	1550:34	1551:20	1648	6075408	HESSI
12-25	keV	1551:20	1607:10	1622:52	2833	24630992	HESSI
12-25	keV	1622:52	1623:42	1629:40	2197	4695201	HESSI
12-25	keV	1629:40	1631:42	1633:32	2091	2347680	HESSI
12-25	keV	1709:08	1709:46	1728:52	93	454339	HESSI
12-25	keV	1745:24	1749:30	1804:56	33	96919	HESSI
12-25	keV	1539:58	1550:57	1625:26	2479	914221	FERMI
12-25	keV	1701:57	1708:22	1711:47	996	51110	FERMI
12-25	keV	1713:42	1730:58	1744:49	1812	245338	FERMI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS VI	25-147	1502		1552		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1536	963	67.7	019°	092°	SOHO
LASCO	WL	1612	608	31.3	084°	108°	SOHO

Proton Active Region:

AR 11176 (S16L200, CMP 28,02.03 2011,
Sp=440 msh, EKI, BG, R)
XRI=0.34 $M_3^{1.4} + C_{16}^{1.4} + S_{15}$
PFR 23-25.03 (69^h) $M_3^{1.4}$

References:

Базилевская Г.А., Майоров А.Г., Малахов В.В. и др., [2013](#).
Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
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Bruno A., I.G. Richardson, [2021](#).
Cliver E.W., [2016](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
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Rouillard A.P., N.R. Sheeley, Jr., A. Tylka et al., [2012](#).
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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
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Particle event: To($E_p > 10$ MeV) – 05d18^h

Tmax ($E_p > 10$ MeV) – 06d04^h, Jmax ($E_p > 10$ MeV) – 3.6 /cm²·s·sr

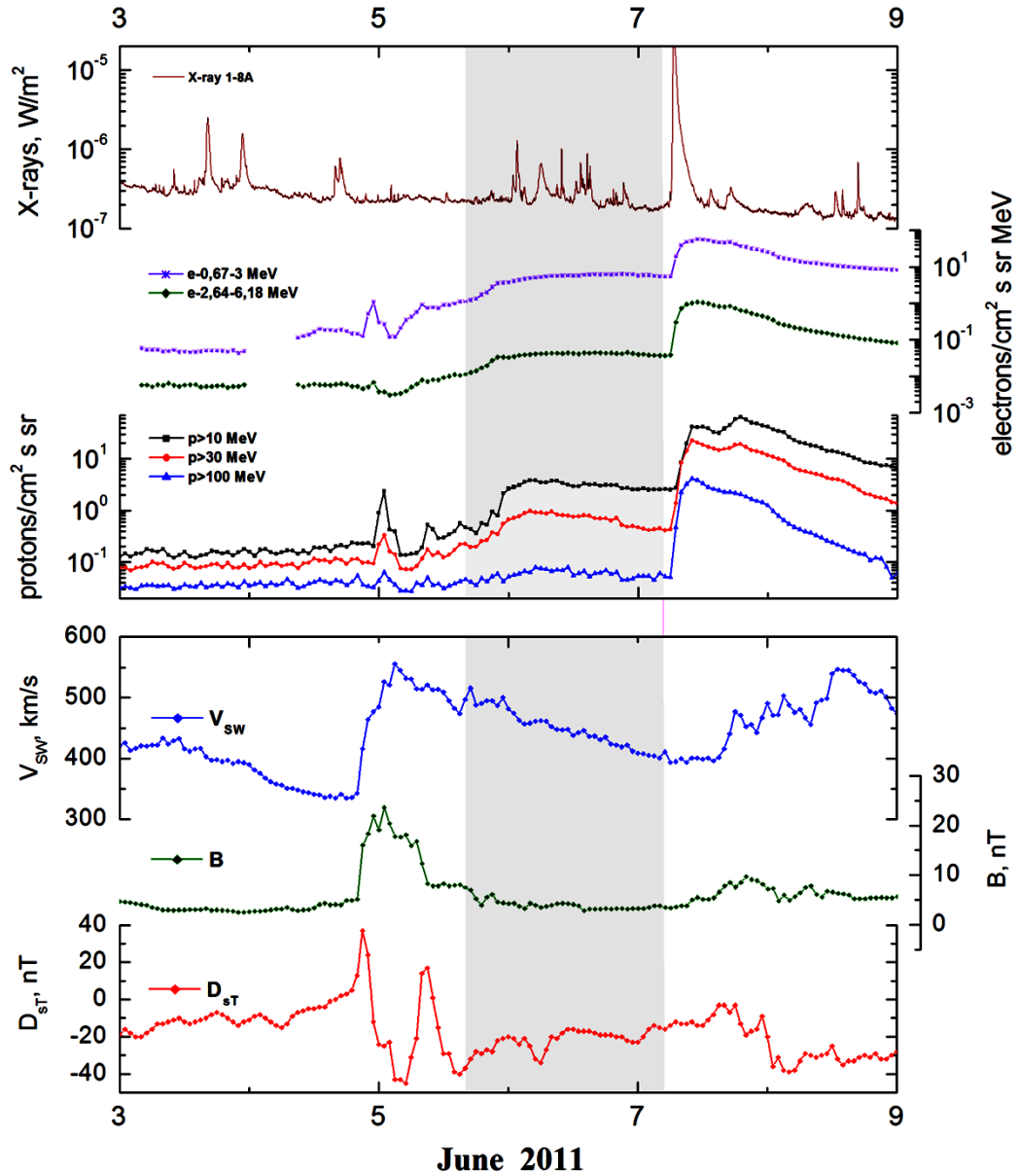
Duration of the event – 1.5 days, power-law index: $\gamma = 3.25$

Quasimaximal energy of protons in the event – $E_{qm} = 160$ MeV

Sources: ☒ back side solar flare event 04d<22^h05^m, AR 11222, 3d behind W_L

☒ CME 04d22^h05^m, $V = 2425$ km/s, $\Delta\phi = 360^\circ$, $dA = 300^\circ$

Particle fluxes and associated phenomena

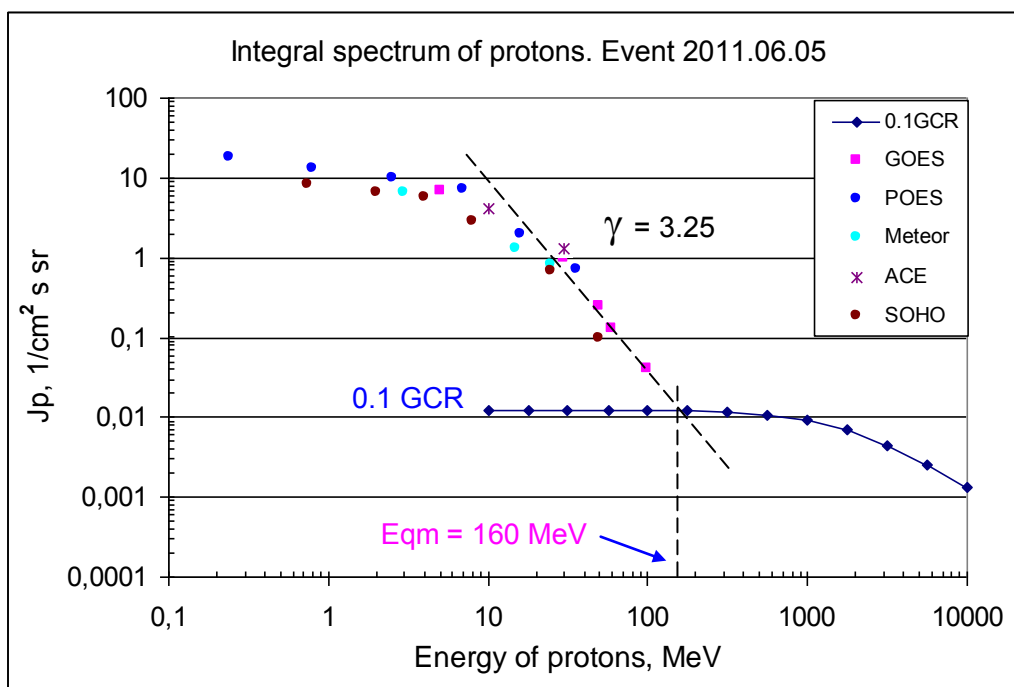


Integral fluxes of protons for the event of 2011 June 05

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	06d04	7	1.5	0.2	
EPS	>10	18	06d04	3.6	1.5	0.17	
EPS	>30	18	06d04	0.97	1.5	0.1	
EPS	>50	18	06d05	0.25	1.5	0.07	
EPS	>60	18	06d02	0.13	1	0.07	
EPS	>100	18	06d05	0.04	1	0.04	
EPS	>700	-	-	-	-	-	
POES							
MEPED	>0.24	18	6d05	18	1.5	190	
MEPED	>0.8	18	6d06	13	1.5	95	
MEPED	>2.5	18	6d06	10	1.5	65	
MEPED	>6.9	18	6d06	7.3	1.5	50	
MEPED	>16	18	6d05	2	1.5	1	
MEPED	>36	18	6d05	0.7	1.5	1	
MEPED	>70	18	-	-	-	1.1	
MEPED	>140	18	-	-	-	1.4	
Meteor-1							
SCR	>1	20	-	-	1.5	3.2	
SCR	>3	20	6d03	6.5	1.5	3	
SCR	>10	20	-	-	1.5	2.1	
GALS-M	>15	20	6d03	1.27	1.5	0.75	
GALS-M	>25	20	6d03	0.8	1.5	0.8	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	17	06d02	4.1	2	2.3	
SIS	>30	17	06d02	1.3	1.5	1.4	
SOHO							
EPHIN	>50	5	06d00	0.1	2.3	0.3	

Differential fluxes of protons for the event of 2011 June 05

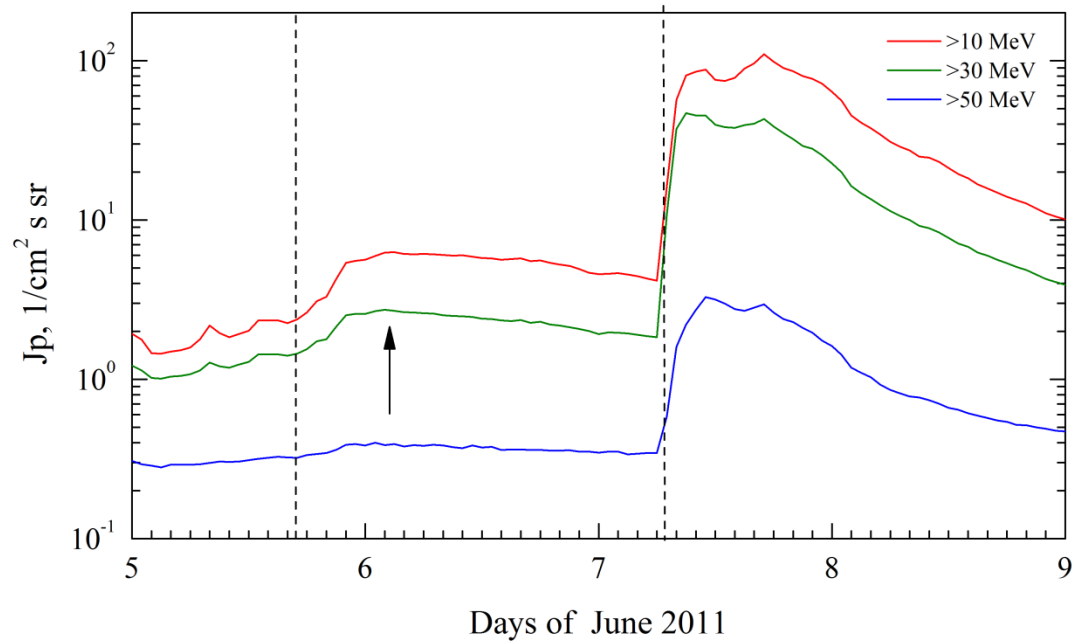
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	14	6d04	1.5	2	0.1	
LION	2 – 6	13	6d03	0.28	2	0.01	
EPHIN	4 – 8	4.5	6d02	0.71	2	0.02	
EPHIN	8 – 25	4.5	6d03	0.125	2	0.0002	
EPHIN	25 – 53	4.5	6d03	0.021	2	0.00008	
Electro-1							
GALS-E	13.7 – 23	-	-	-	-	0.061	
GALS-E	23 – 42	-	-	-	-	0.025	
GALS-E	42 – 112	-	-	-	-	0.005	



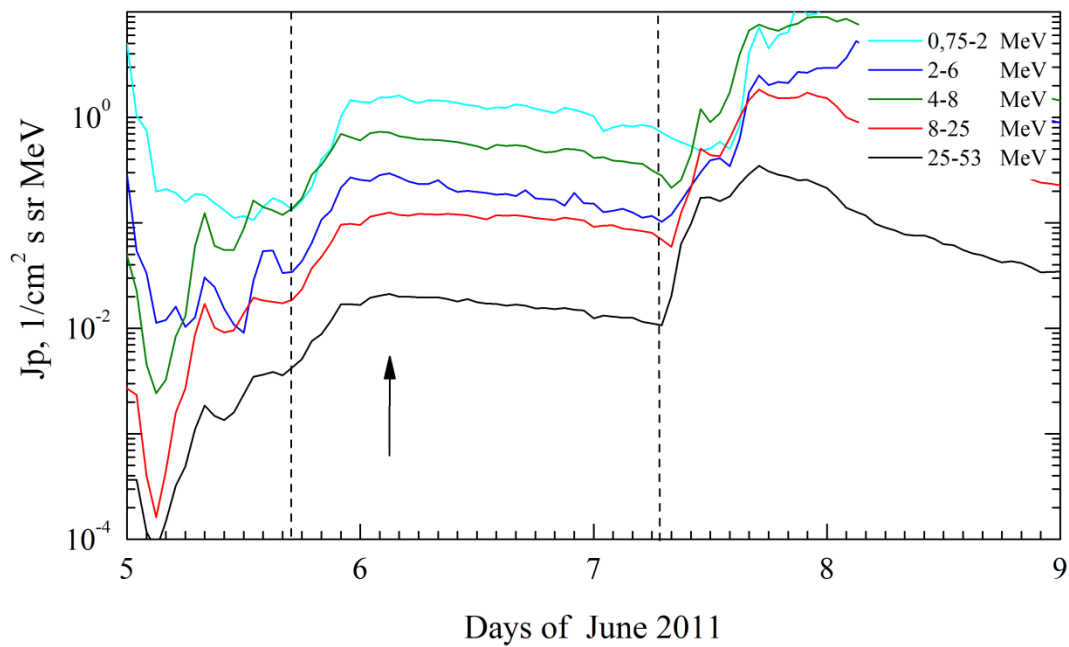
Time profiles of proton fluxes in the event 2011.06.05

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.06.05

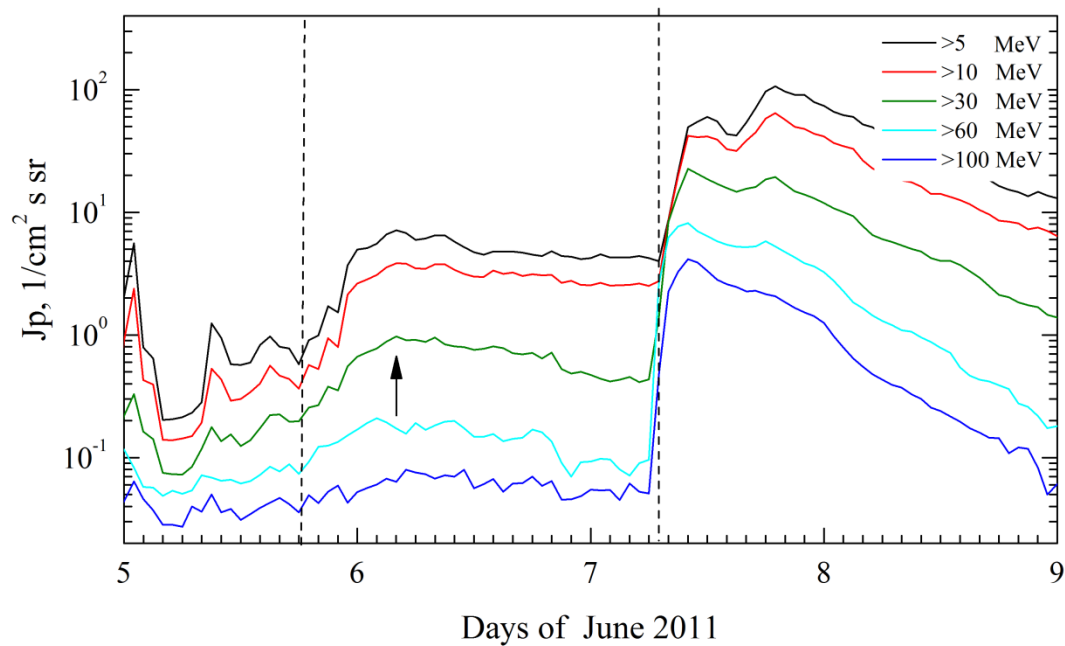


SOHO. Event 2011.06.05

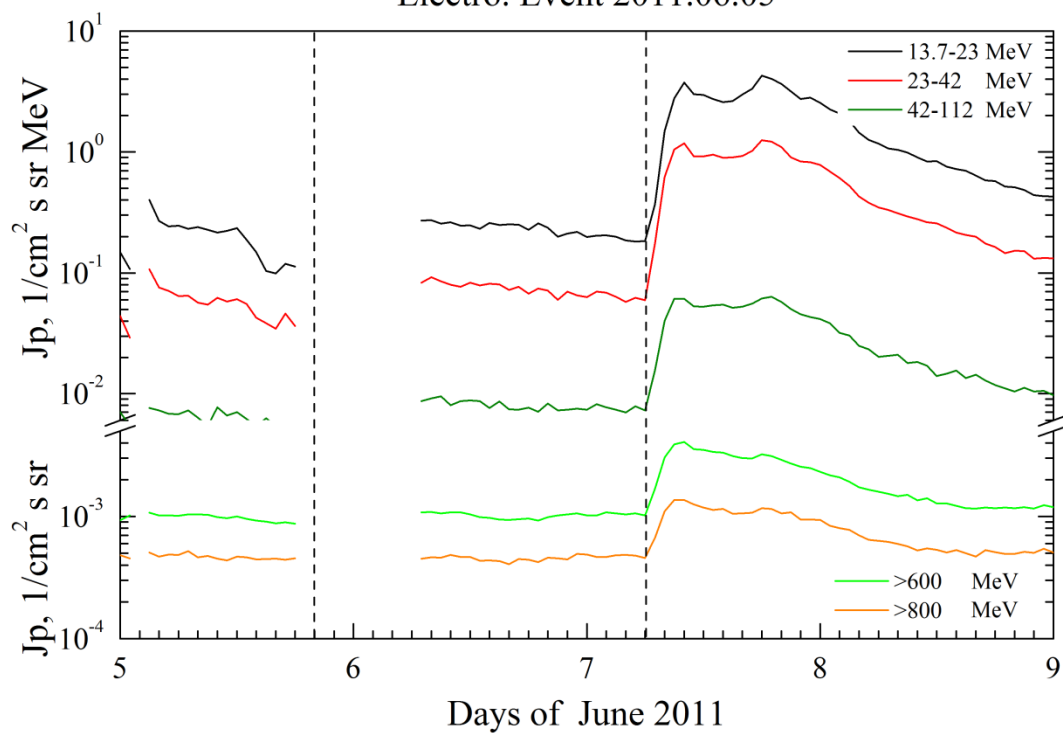


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2011.06.05

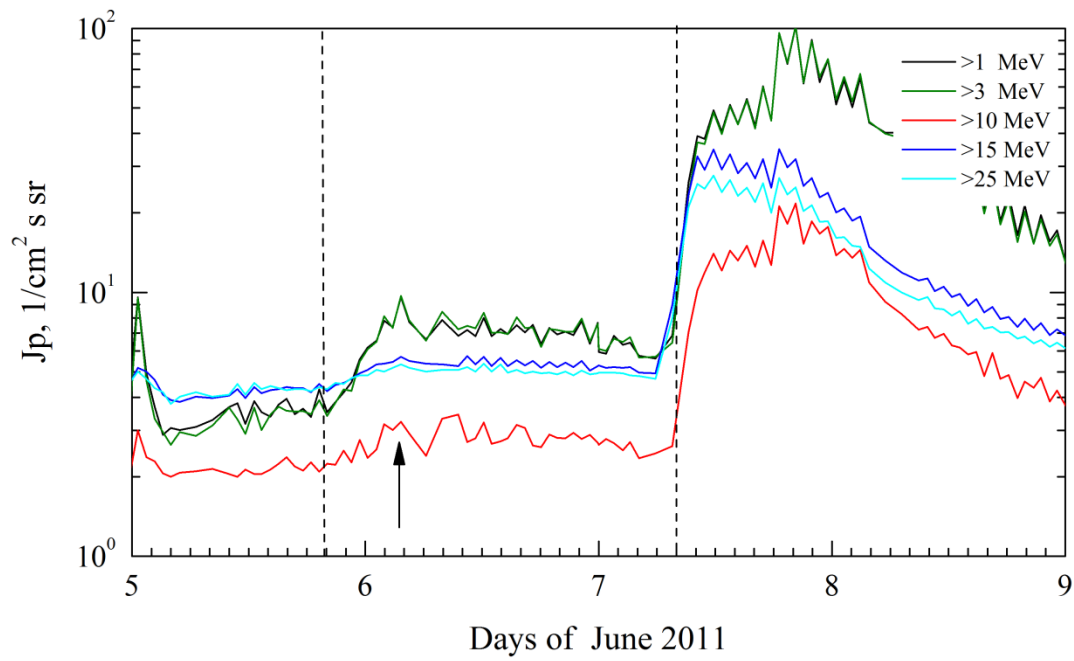


Electro. Event 2011.06.05

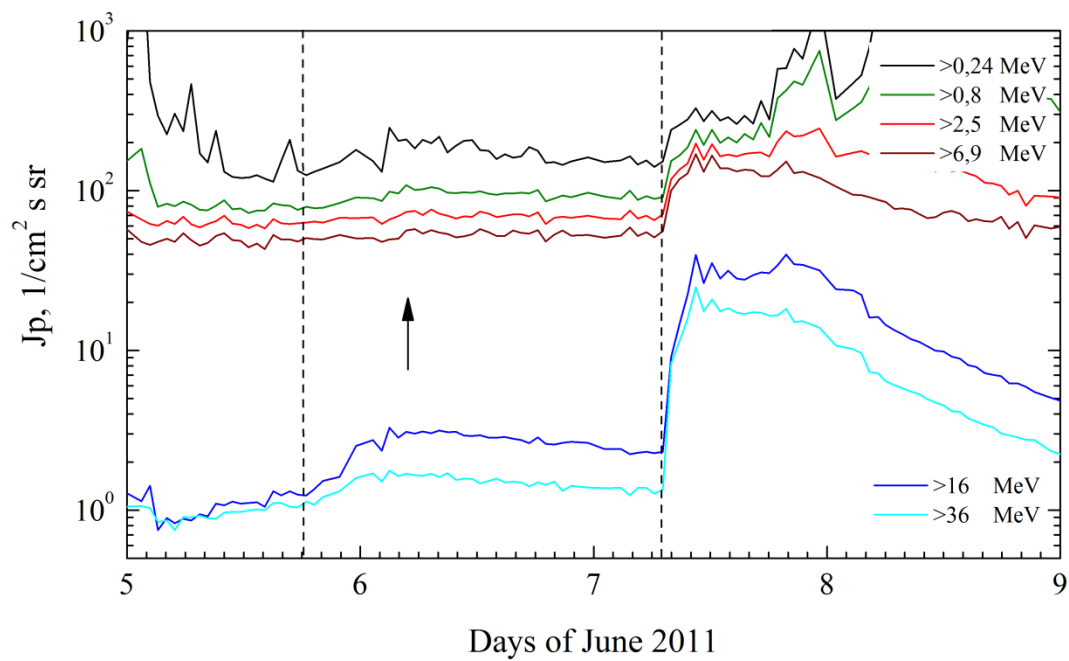


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.06.05



POES. Event 2011.06.05



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 June 05**

2011

June 04



AR 11222

484

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc at this time					
1 – 12	keV	No X-ray event at this time					
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DH II	0.025-16	2200		7/0130			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2205	2425	- 140.2	360°	300°	SOHO

Proton Active Region:

AR11222 (N16L166, CMP* 23,5.06.2011,
Sp=150 msh, DSO, B, R1)
* appearance at 25.05 on W24

References:

Cohen C.M.S., R.A. Mewaldt, [2018](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Lario D., A. Aran, R. Gomez-Herrero et al., [2013](#).
Oka M., T. Obara, N.V. Nitta et al., [2021](#).
Winter L.M., and K. Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 07d07^h

Tmax₁($E_p > 10$ MeV) – 07d12^h, Jmax₁ ($E_p > 10$ MeV) – 40 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 07d19^h, Jmax₂ ($E_p > 10$ MeV) – 62.5 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 2.8$, $\gamma_2 = 2.5$

Quasimaximal energy of protons in the event – Eqm₁ = 650 MeV

– Eqm₂ = 650 MeV

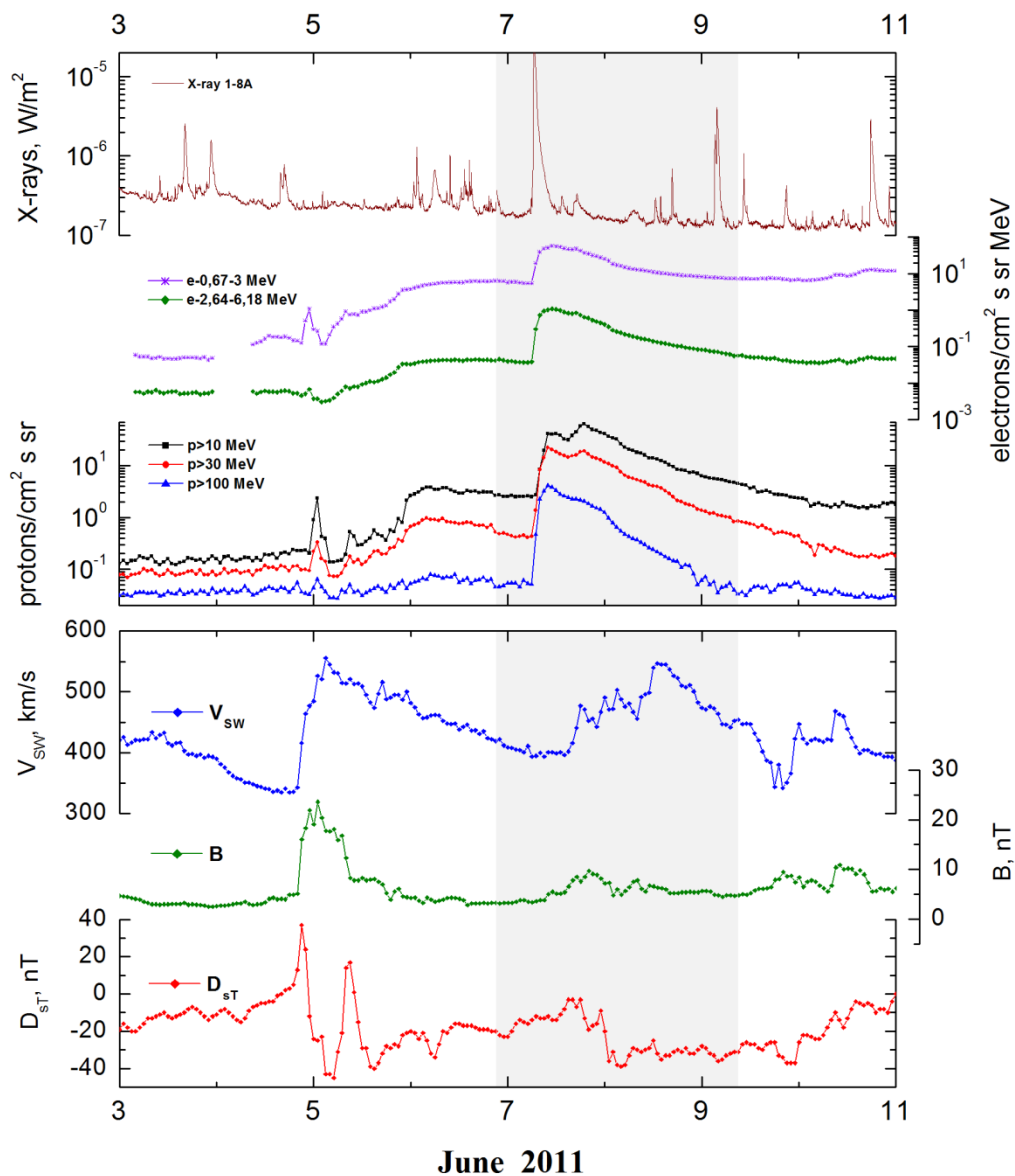
Sources: ● solar flare 07d06^h16^m, M2.5/2N, S21W54, AR11226

Main burst X-ray 1–8 Å: onset – 07d06^h16^m, max – 07d06^h41^m, $\Phi = 0.044$ J/m²

CME: 07d06^h49^m, V = 1255 km/s, $\Delta\phi = 360^\circ$, dA = 250°

▲ SC 10d08^h47^m

Particle fluxes and associated phenomena

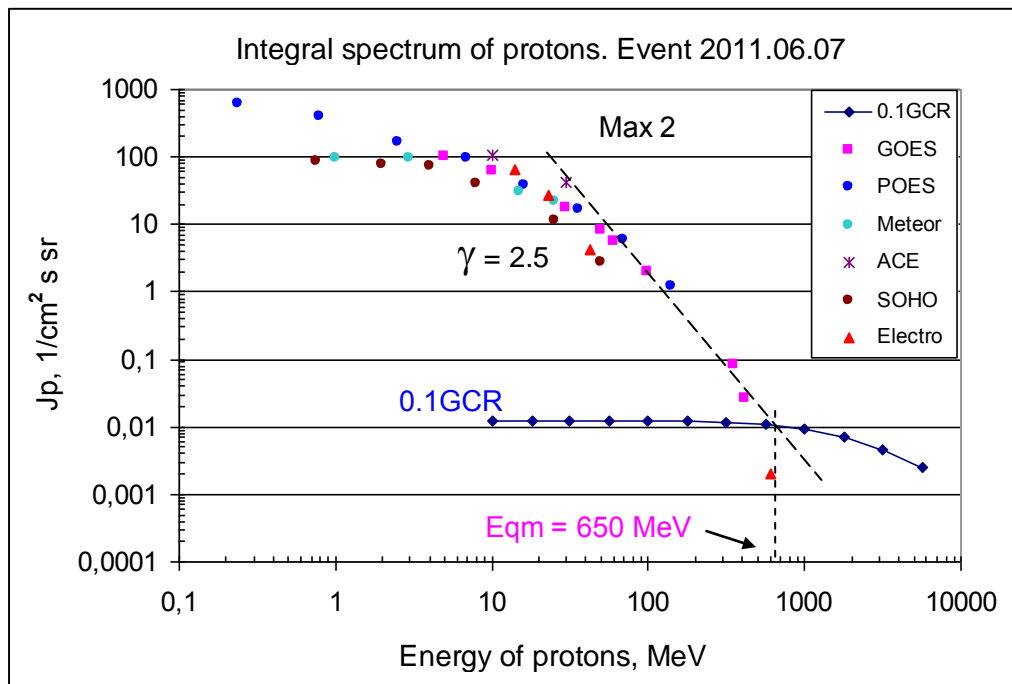
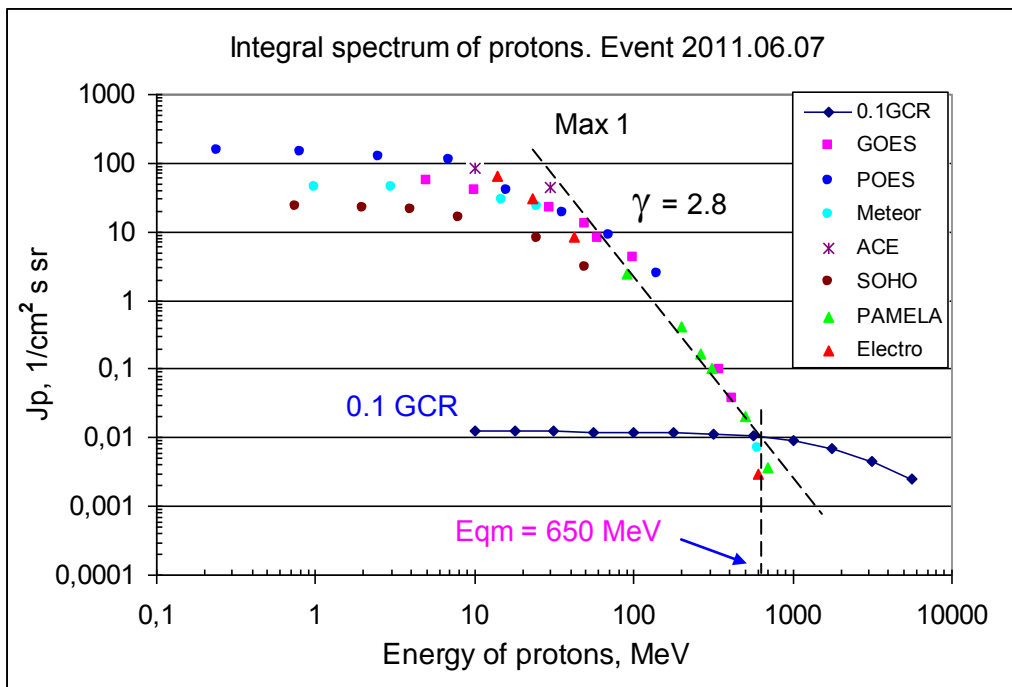


Integral fluxes of protons for the event of 2011 June 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	12/19	56/103	3	4	
EPS	>10	7	12/19	40/62.5	3	2	
EPS	>30	7	10/19	22/17.5	3	0.4	
EPS	>50	7	10/19	12.7/8	2.5	0.15	
EPS	>60	7	10/19	8.1/5.7	2.5	0.09	
EPS	>100	7	10/19	4.1/2	2	0.05	
Electro-1							
GALS-E	>600	7	10/19	0.003/0.002	1	0.001	
POES							
MEPED	>0.24	7	12/20	155/610	3	160	
MEPED	>0.8	7	12/20	145/385	3	95	
MEPED	>2.5	7	12/20	125/165	3	70	
MEPED	>6.9	7	12/20	110/97	3	55	
MEPED	>16	7	12/20	38/38	3	2.3	
MEPED	>36	7	12/20	19.5/17	3	1.4	
MEPED	>70	7	12/20	9/6	2	1.1	
MEPED	>140	7	12/20	2.4/1.2	1.5	1.2	
Meteor-1							
SCR	>1	6	11/19	45/98	3	3.2	
SCR	>3	6	12/19	45/97	3	3	
SCR	>10	6	-	-	3	2.1	
GALS-M	>15	6	10/18	28.3/30.3	3	0.75	
GALS-M	>25	6	10/18	22.8/22.4	3	0.8	
GALS-M	>600	6	11/-	0.007/-	1	0.02	
ACE							
SIS	>10	07	11/17	84/106	3	4.3	
SIS	>30	07	08/17	45/42	2.5	1.6	
SOHO							
EPHIN	>50	07	11/17	3/2.7	3	0.3	
PAMELA							
TRACKER	>90	07	12÷14/ -	2.5/ -	3	-	
TRACKER	>200	07	12÷14/ -	0.41/ -	3	-	
TRACKER	>265	07	12÷14/ -	0.17/ -	3	-	
TRACKER	>312	07	12÷14/ -	0.1/ -	3	-	
TRACKER	>500	07	12÷14/ -	0.02/ -	3	-	
TRACKER	>700	07	12÷14/ -	0.0037/ -	3	-	

Differential fluxes of protons for the event of 2011 June 07

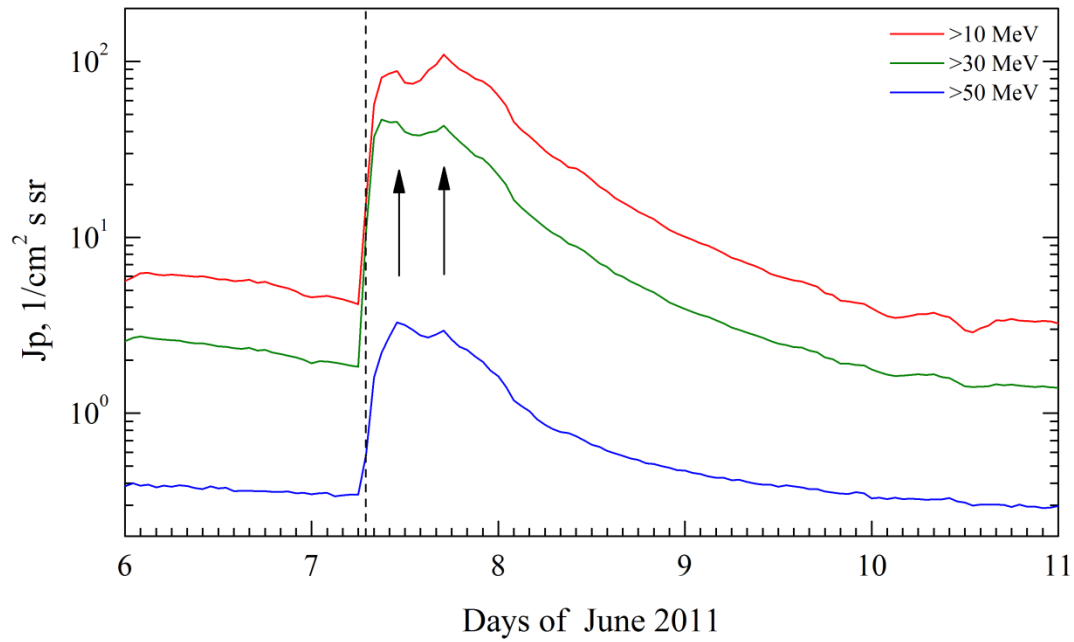
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	15	18/08d07	0.5 /7	4	0.53	
LION	2 – 6	15	17/08d07	0.4 /2.5	3	0.1	
EPHIN	4 – 8	07	16/21	1.2/7.7	3	0.00001	
EPHIN	8 – 25	03	17/23	0.5/1.7	3	0.00003	
EPHIN	25 – 53	05	18/ -	0.17/ 0.3	3	0.00003	
Electro-1							
SCR-E	13.7 – 23	7	10/19'	3.5/4.1	1	0.2	
SCR-E	23 – 42	7	10/19'	1.1/1.2	1	0.06	
SCR-E	42 – 112	7	10/19'	0.054/0.058	1	0.007	
GOES							
EPS	350 – 420	-	10/18	0.00085/0.0005	1	0.0018	
EPS	420 – 510	-	9/17	0.0004/0.0003	1	0.001	
EPS	510 – 700	-	-	-	-		



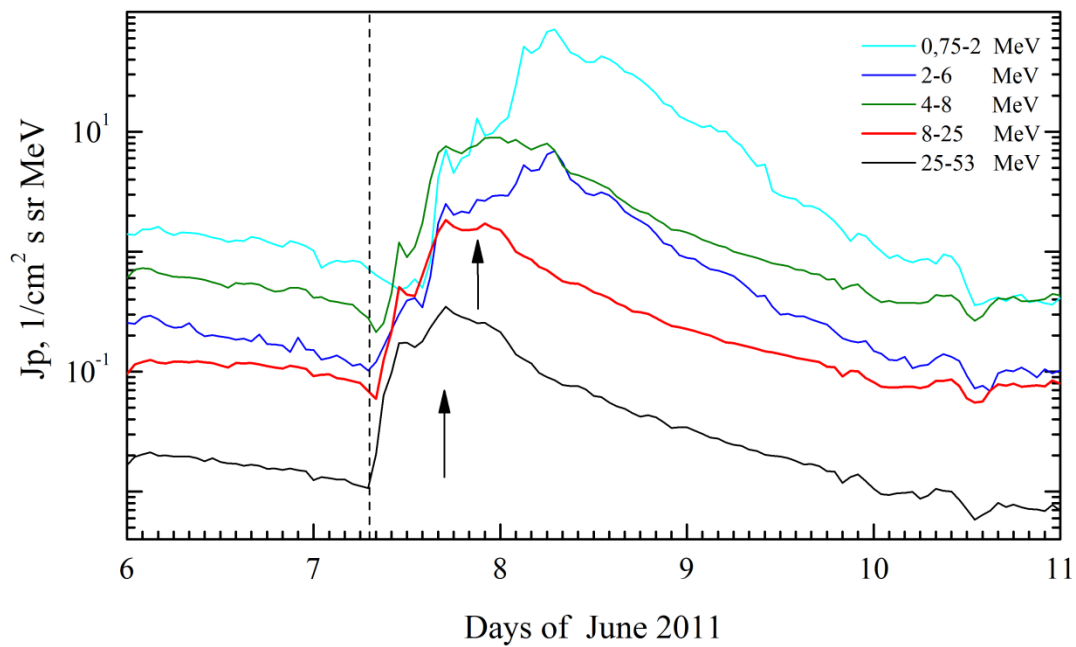
Time profiles of proton fluxes in the event 2011.06.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.06.07

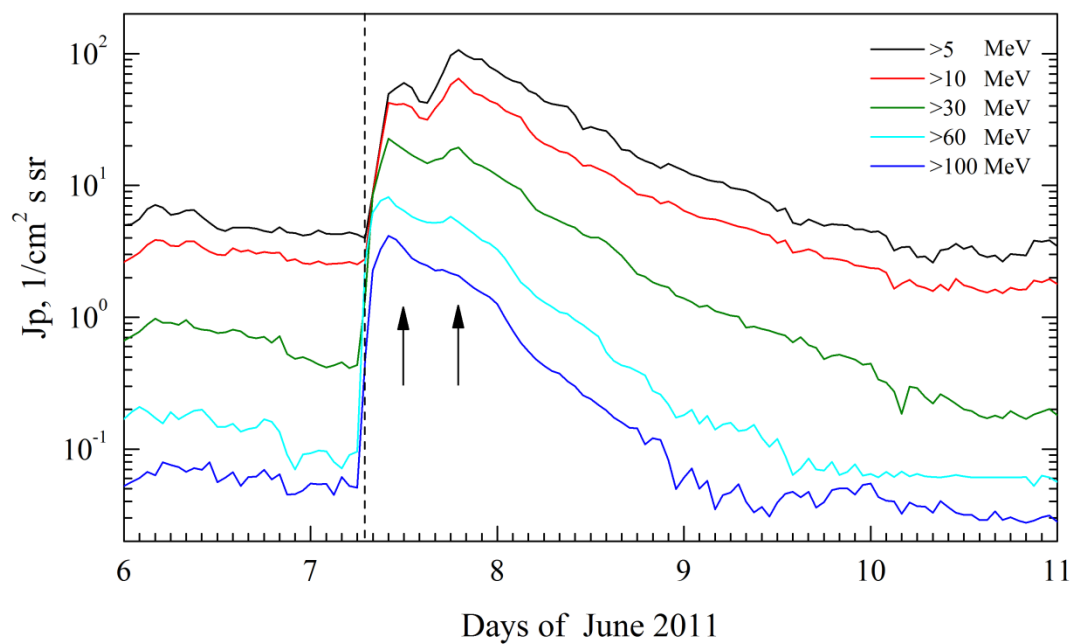


SOHO. Event 2011.06.07

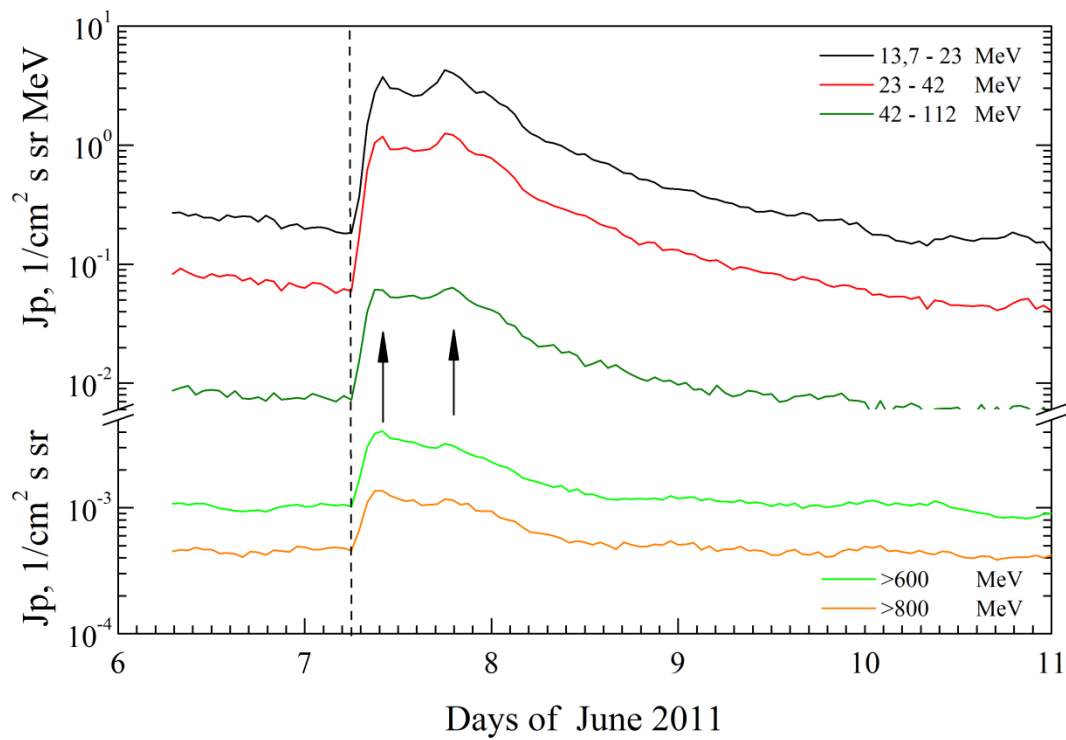


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2011.06.07

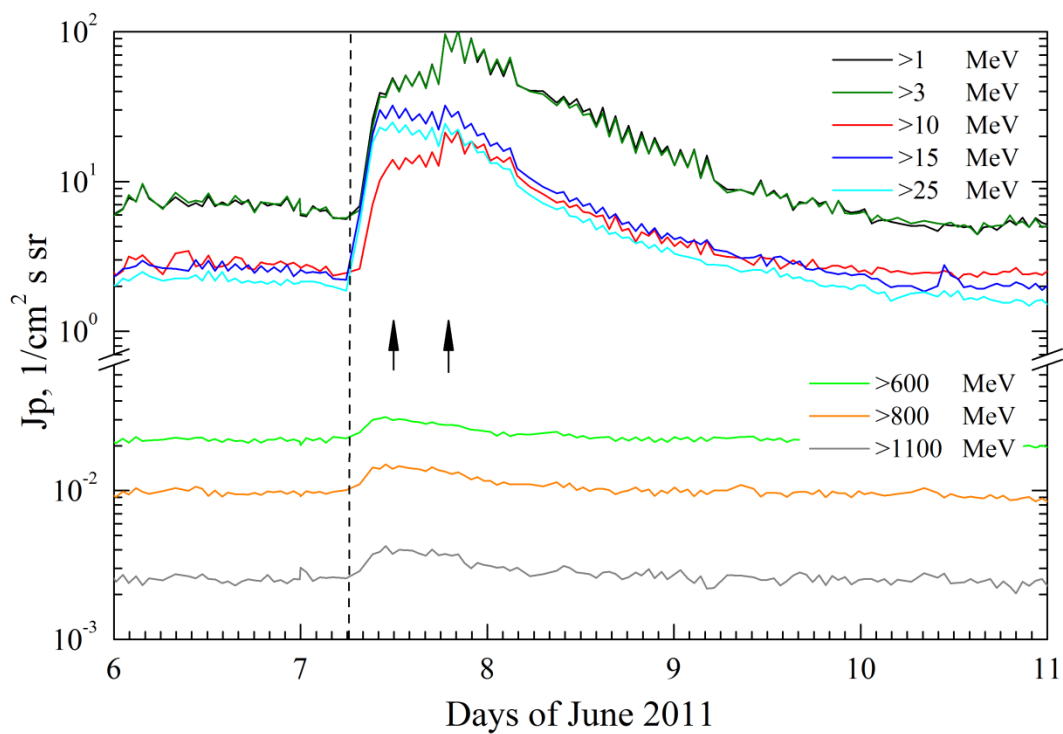


Electro. Event 2011.06.07

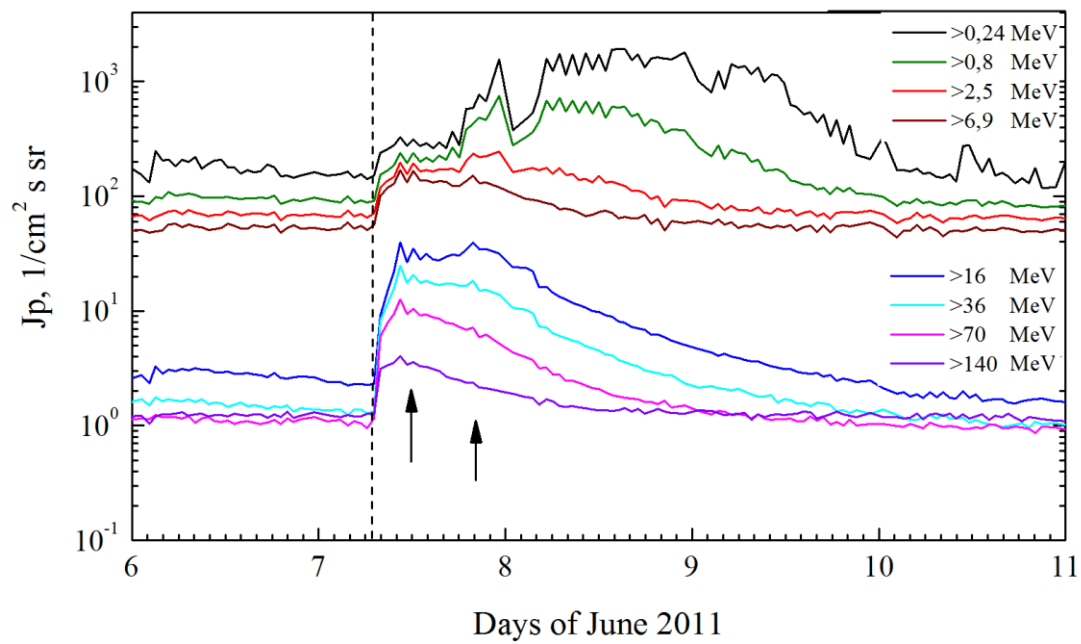


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.06.07



POES. Event 2011.06.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 June 07**

2011

June 07

•

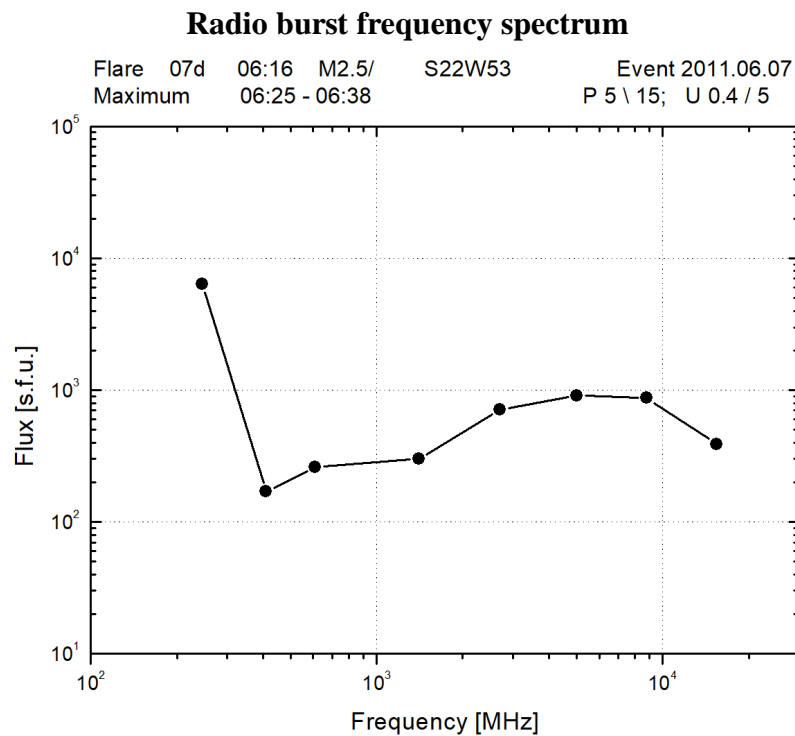
AR 11226

To event 485

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	0616	0641	0809	S21W54	2N	
1 – 12	keV	0616	0641	0659	S22W53	M2.5*	0.044
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	0616:32	0637:54	0716:40	944	5147401	HESSI
12 – 25	keV	0751:28	0752:14	08:38:16	616	3770088	HESSI
12-25	keV	0619:39	0625:33	0655:40	69214	44915560	FERMI
100	keV	0747:30		0824:30		4.35E-05**	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0625	0625	0642		2.59	
8.8	GHz	0624	0625	0643		2.94	
5	GHz	0623	0625	0645	P5 \ 15	2.96	
2.7	GHz	0623	0638	0645		2.85	
1.4	GHz	0624	0637	0645		2.48	
610	MHz	0629	0634	0639		2.42	
410	MHz	0624	0625	0625	U0.4 / 5	2.23	
245	MHz	0625	0633	0644		3.81	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-120	0625		0650		2	
DS IV	25-180	0626		0658		2	
DH II	0.25-16	0645		1800			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0649	1255	0.3	360°	250°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/ssw_client/data/ssw_service_110606_235609_98013/www/

** cm⁻²·s⁻¹



Proton Active Region:

AR11226 (S21L037 CMP 03,0.06.2011,
Sp=360msh, EKI, BD)
XRI= 0.5 $M_3^{2.5} + C_{36}$ $2_1 + 1_3 + S_{32}$
PFR1 28-29.05 - $M_2^{1.4}$
PFR2 7.06 - $M_1^{2.5}$

References:

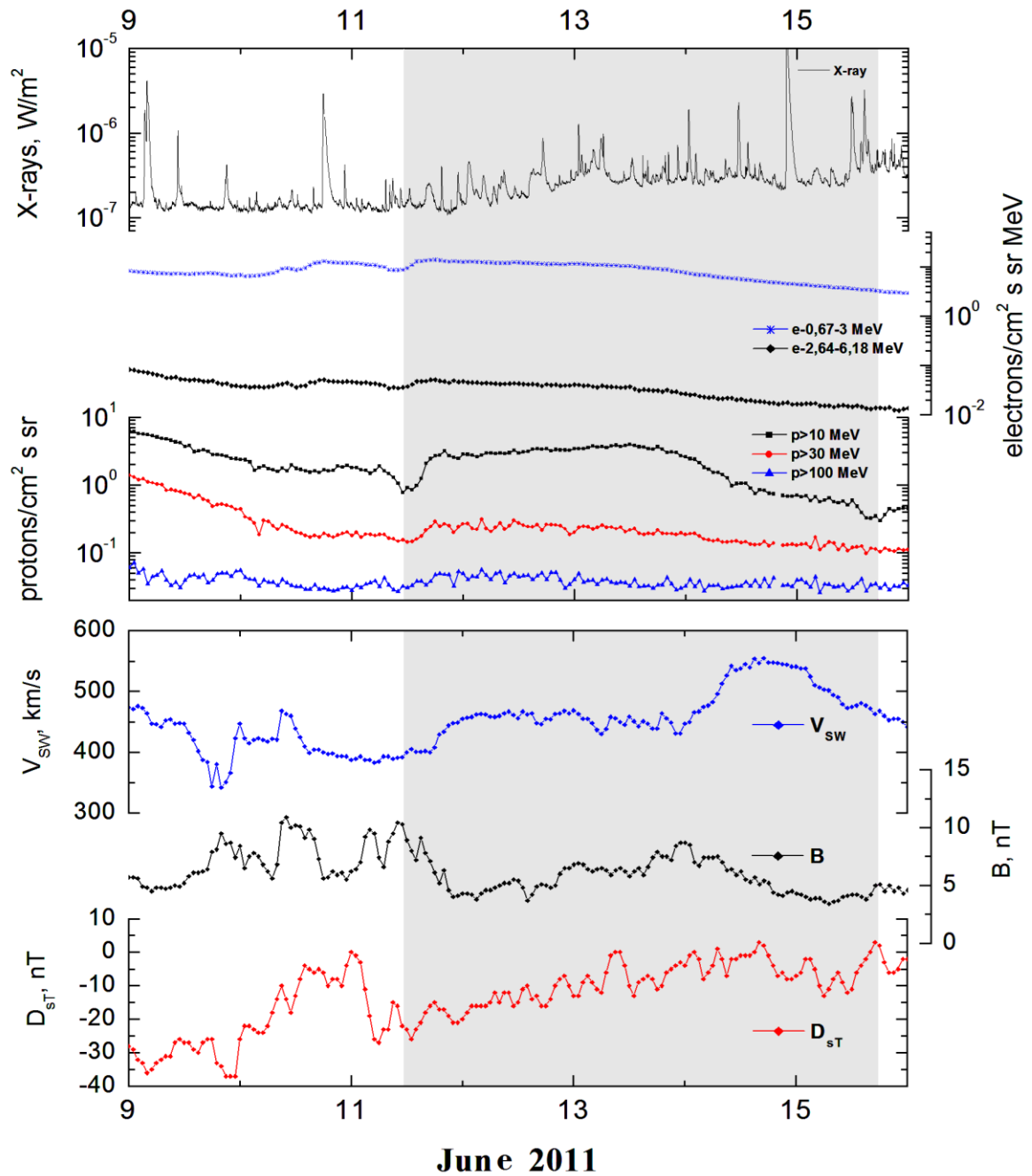
- Базилевская Г.А., Майоров А.Г., Малахов В.В. и др., [2013](#).
Богомолов Э.А., Адриани О., Базилевская Г.А. и др., [2017](#).
Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Bazilevskaya G.A., A.G. Mayorov, V.V. Malakhov, V.V. Mikhailov, [2013](#).
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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 11d13^h
 Tmax ($E_p > 10$ MeV) – 11d20^h, Jmax ($E_p > 10$ MeV) – 2.4 /cm²·s·sr
 Duration of the event – 4 days, power-law index: $\gamma = 2.8$
 Quasimaximal energy of protons in the event – $E_{qm} = 75$ MeV

Sources: ○ source unknown

Particle fluxes and associated phenomena

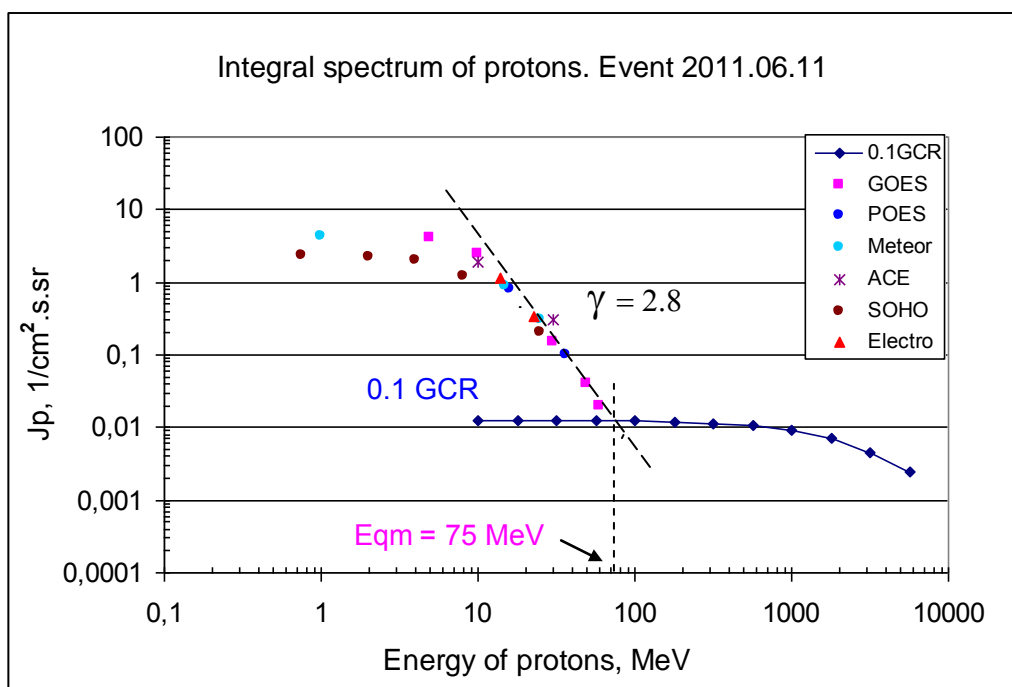


Integral fluxes of protons for the event of 2011 June 11

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	13	20	4	4	1.7	
EPS	>10	13	20	2.4	4	0.8	
EPS	>30	13	20	0.15	3	0.15	
EPS	>50	12	18	0.04	2	0.07	
EPS	>60	12	18	0.02	1.5	0.06	
EPS	>100	12	-	-	-	0.03	
POES							
MEPED	>0.24	12	-	-	-	-	
MEPED	>0.8	12	-	-	-	85	
MEPED	>2.5	12	-	-	-	65	
MEPED	>6.9	12	-	-	-	50	
MEPED	>16	12	21	0.8	3	1.6	
MEPED	>36	12	21	0.1	3	1	
MEPED	>70	12	-	-	-	0.9	
MEPED	>140	12	-	-	-	1.3	
Meteor-1							
SCR	>1	14	20	4.3	3.5	3.2	
SCR	>3	14	-	-	3.5	3	
SCR	>10	14	-	-	3	2.1	
GALS-M	>15	14	19	0.91	2.5	0.75	
GALS-M	>25	14	19	0.31	2.5	0.8	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	12	18	1.9	2	2.6	
SIS	>30	12	18	0.3	1.5	1.3	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2011 June 11

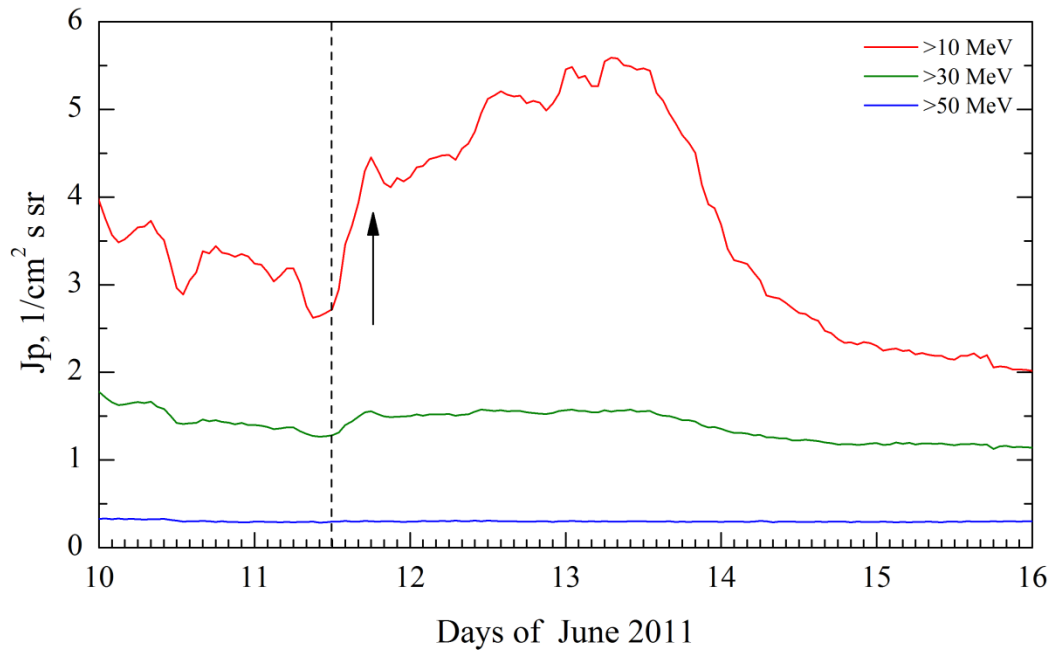
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	10	19	0.1	4	0.1	
LION	2 – 6	10	19	0.05	4	0.07	
EPHIN	4 – 8	10	19	0.2	4	0.3	
EPHIN	8 – 25	10	19	0.06	4	0.05	
EPHIN	25 – 53	10	19	0.007	4	0.003	
Electro-1							
SCR-E	13.7–23	12	20	0.09	0.5	0.1	
SCR-E	23–42	12	19	0.014	0.5	0.035	
SCR-E	42–112	-	-	-	-	0.005	



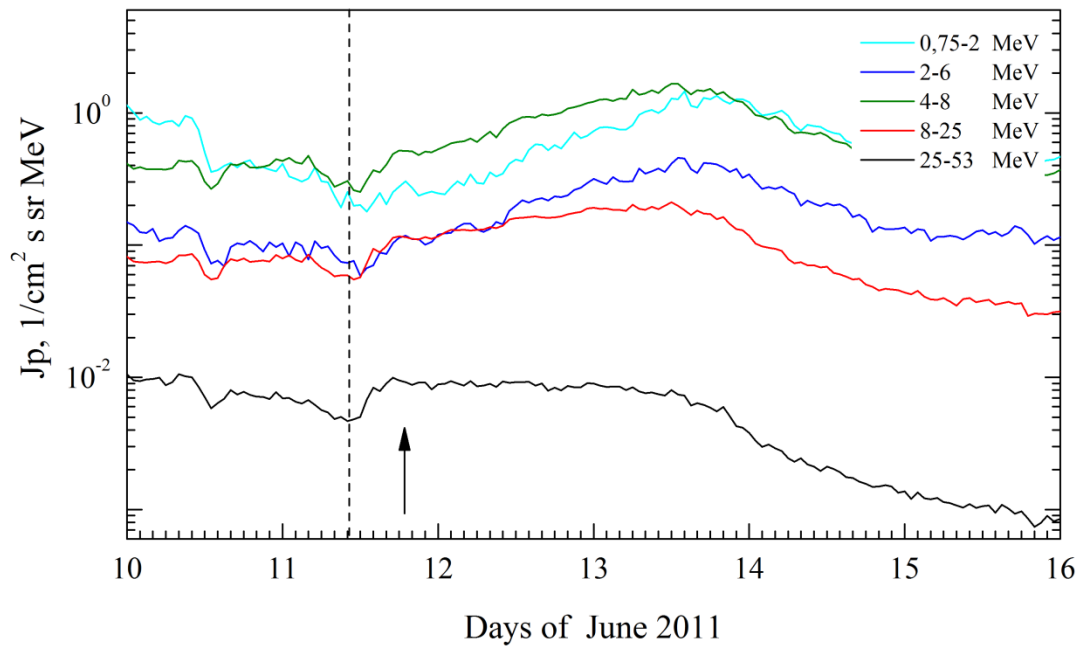
Time profiles of proton fluxes in the event 2011.06.11

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.06.11

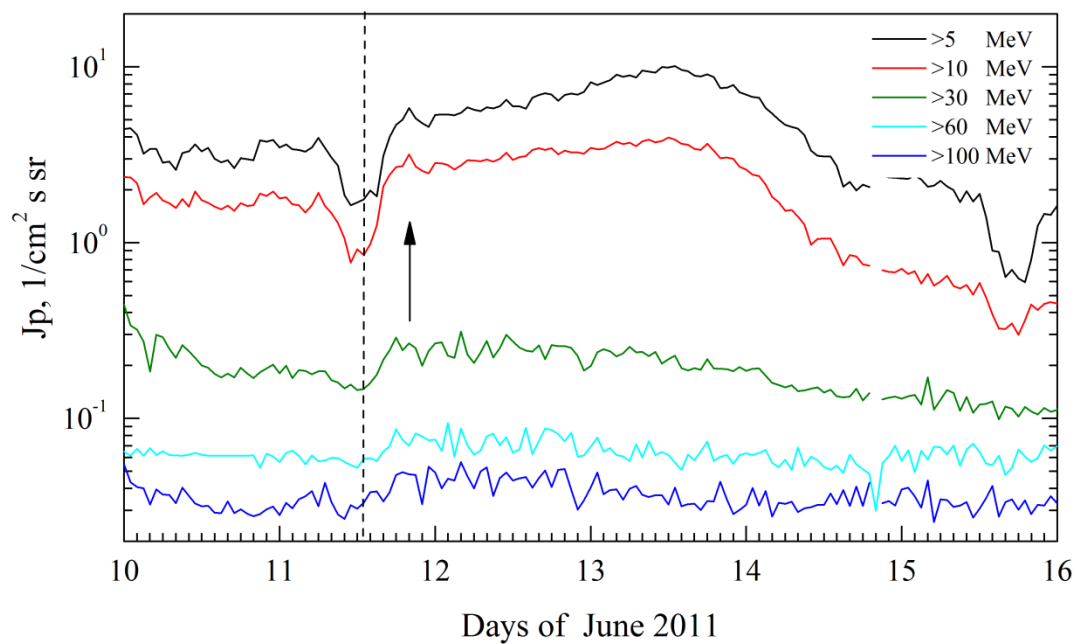


SOHO. Event 2011.06.11

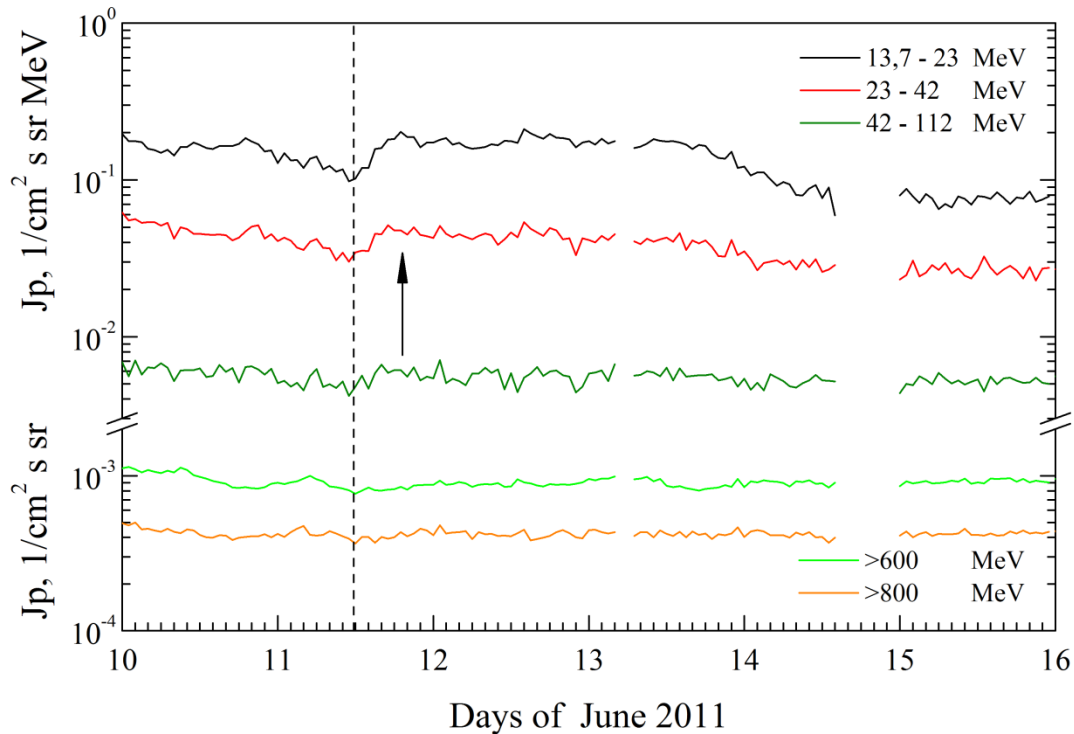


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2011.06.11

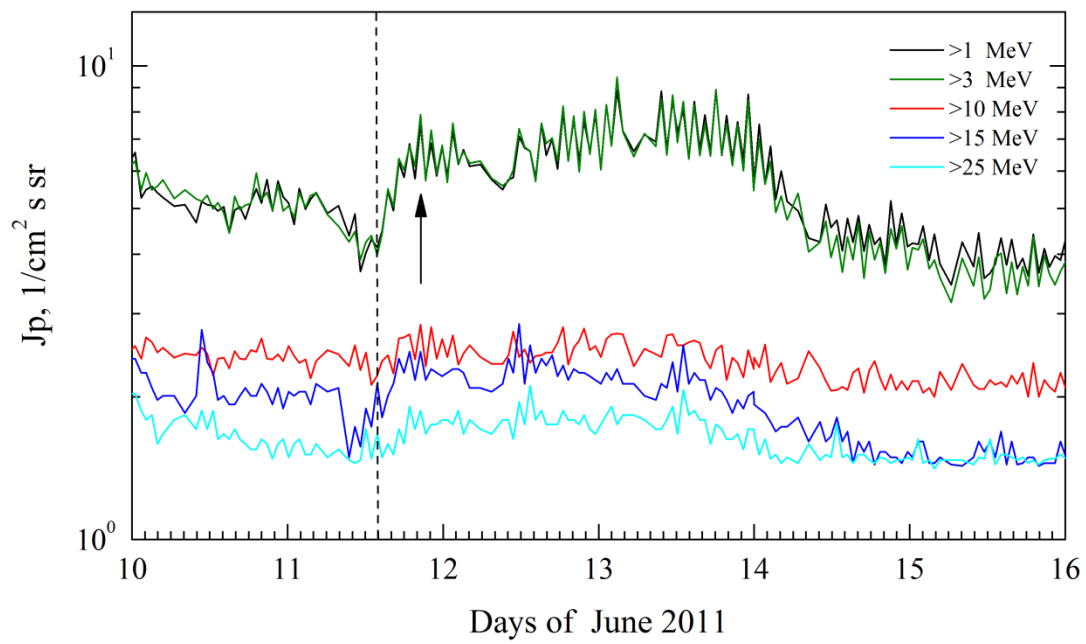


Electro. Event 2011.06.11

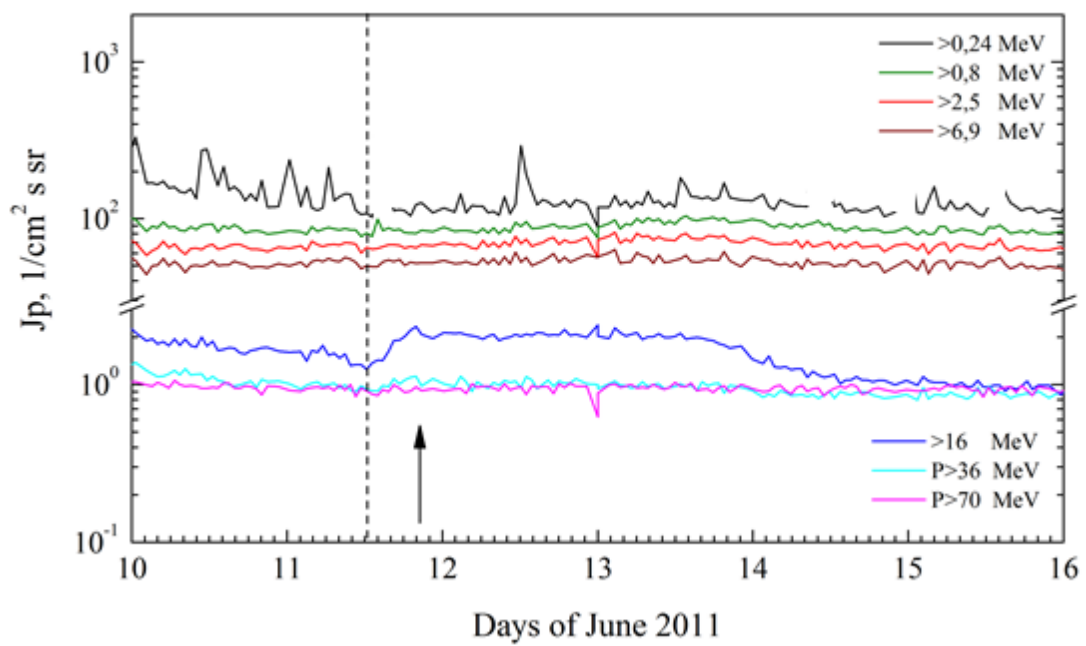


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.06.11



POES. Event 2011.06.11



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 June 11**

2011	June 11	source unknown	To event 486
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References:

Tsvetkov Ts., R. Miteva, N. Petrova, [2018](#).

Particle event: To($E_p > 10$ MeV) – 15d18^h

Tmax($E_p > 10$ MeV) – 16d20^h, Jmax($E_p > 10$ MeV) – $0.9 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1.5 days, power-law index: $\gamma = 2.1$

Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

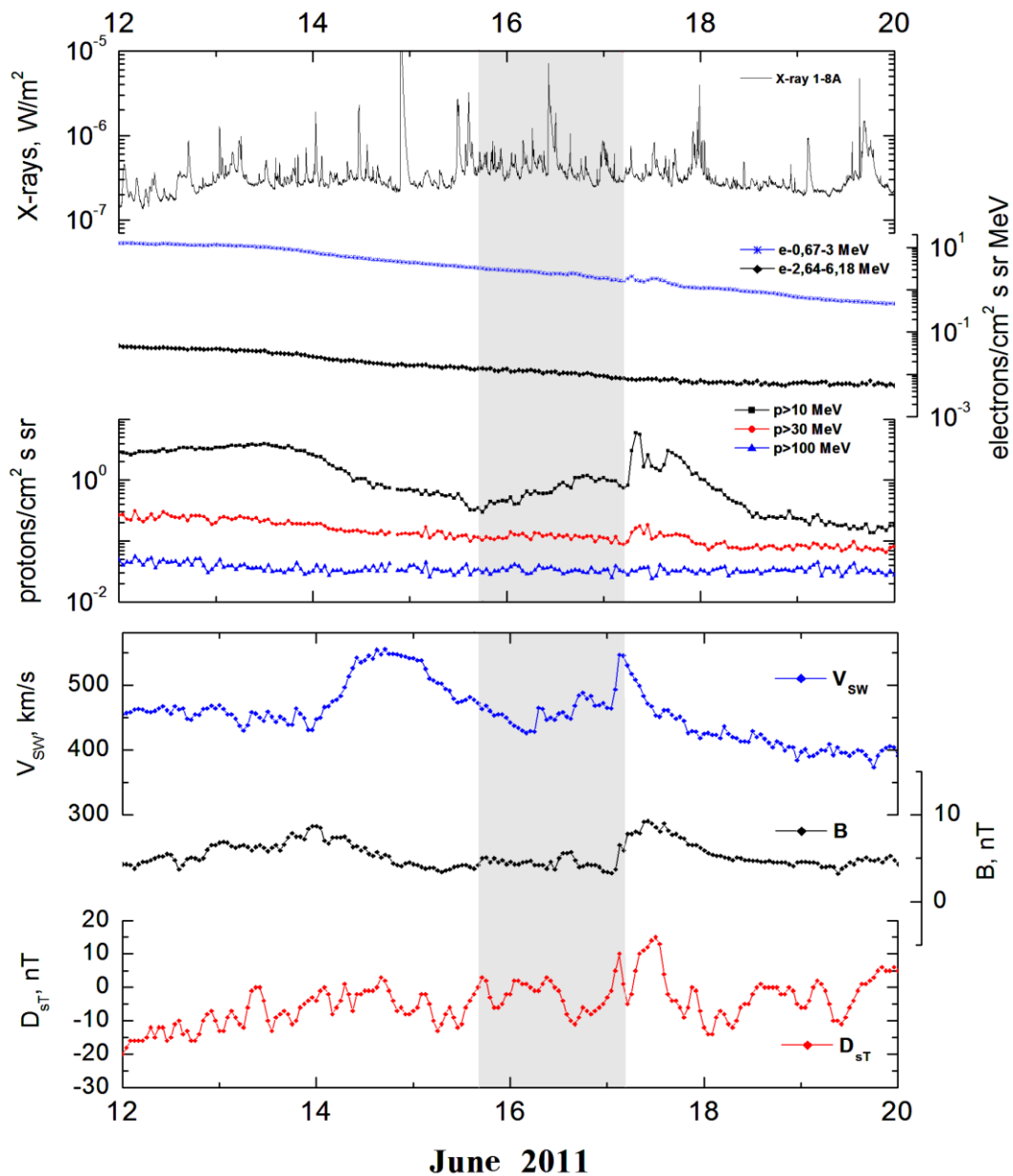
Sources: ☉ solar flare 14d21^h36^m, M1.3/SF, N15E77, AR11236

Main X-ray burst 1-8 Å: onset – 14d21^h36^m, max – 14d21^h47^m, $\Phi = 0.018 \text{ J/m}^2$

CME: 14d22^h36^m, $V = 0441 \text{ km/s}$, $\Delta\phi = 028^\circ$, $dA = 135^\circ$

▲ SC 17d02^h39^m

Particle fluxes and associated phenomena

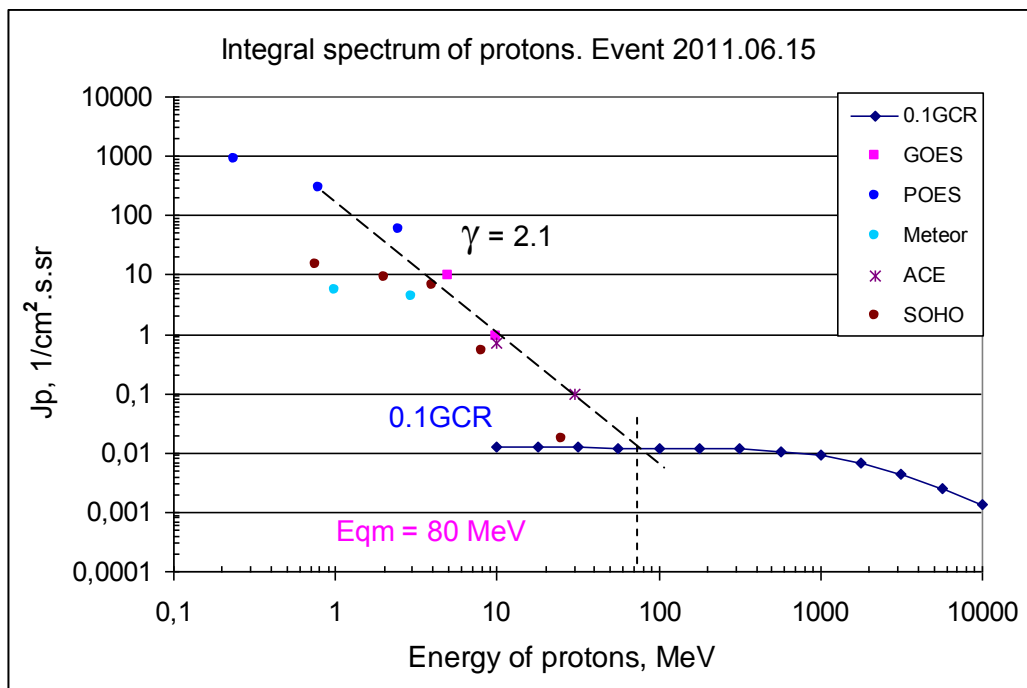


Integral fluxes of protons for the event of 2011 June 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	16d19	9.5	1.5	0.6	
EPS	>10	18	16d20	0.9	1.5	0.3	
EPS	>30	-	-	-	-	0.1	
EPS	>50	-	-	-	-	0.07	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
POES							
MEPED	>0.24	16d06	16d20	900	1	110	
MEPED	>0.8	16d06	16d20	300	1	85	
MEPED	>2.5	16d06	16d20	57	1	65	
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	-	-	-	-	1.6	
MEPED	>36	-	-	-	-	1	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.3	
Meteor-1							
SCR	>1	16d07	16d13	5.6	1	3.2	
SCR	>3	16d07	16d13	4.3	1	3	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	1.5	
GALS-M	>25	-	-	-	-	1.5	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	23	16d10	0.7	1.3	2	
SIS	>30	23	16d10	0.1	1.3	1.2	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2011 June 15

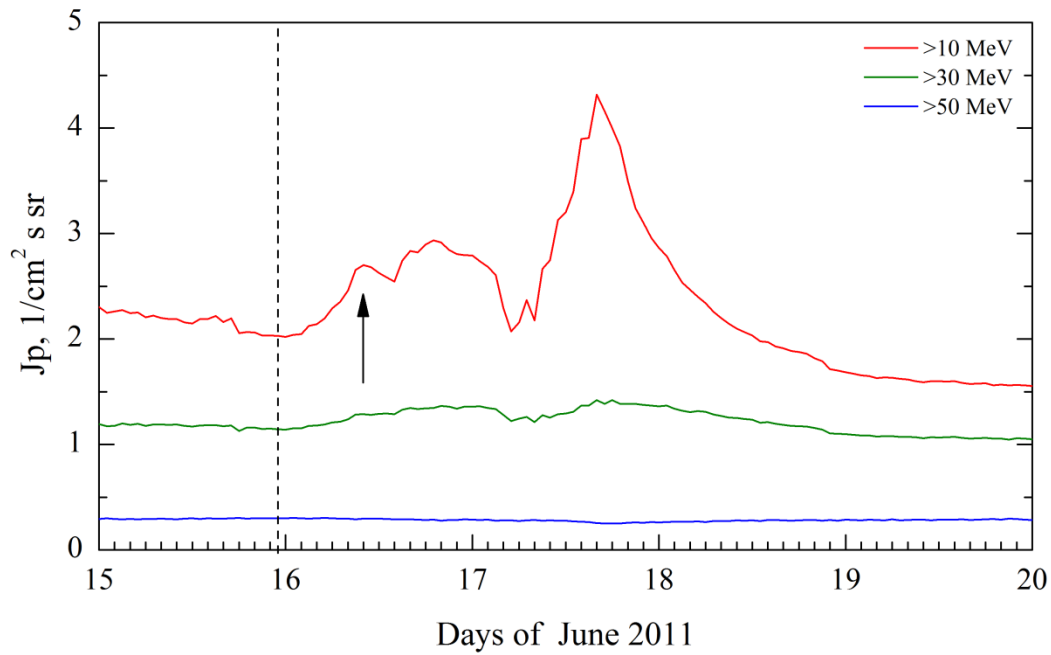
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	23	16d10	4.6	1	0.05	
LION	2 – 6	24	16d10	0.8	1	0.01	
EPHIN	4 – 8	16d01	16d10	1.5	1	0.04	
EPHIN	8 – 25	16d02	16d10	0.03	1	0.0004	
EPHIN	25 – 53	16d03	16d10	0.0006	1	0.00005	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.07	
SCR-E	23–42	-	-	-	-	0.03	
SCR-E	42–112	-	-	-	-	0.005	



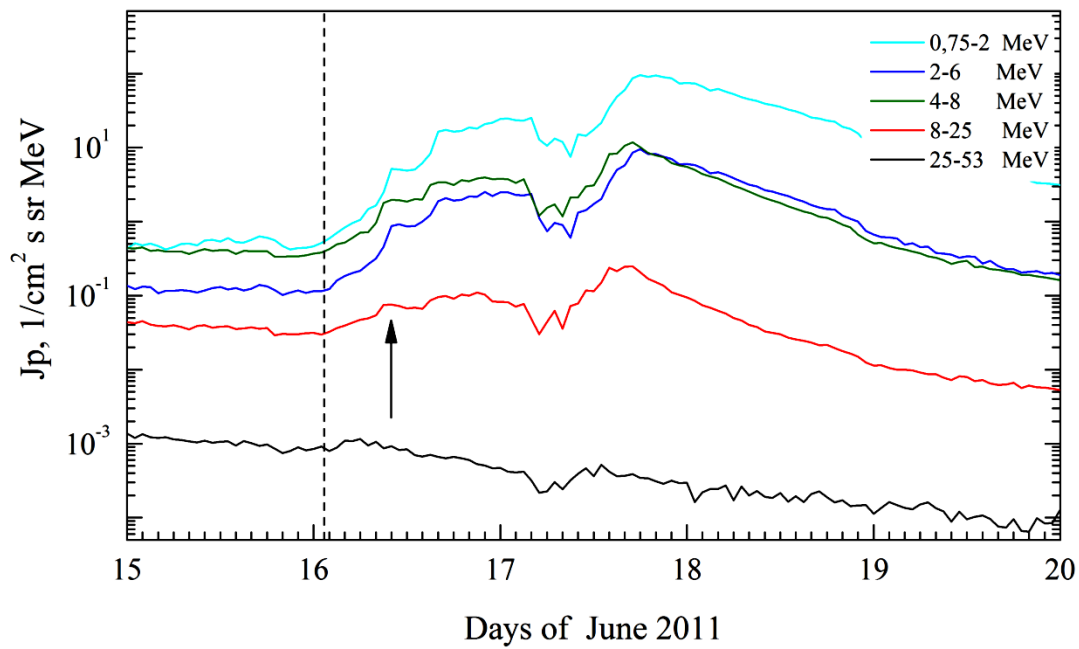
Time profiles of proton fluxes in the event 2011.06.15

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.06.15

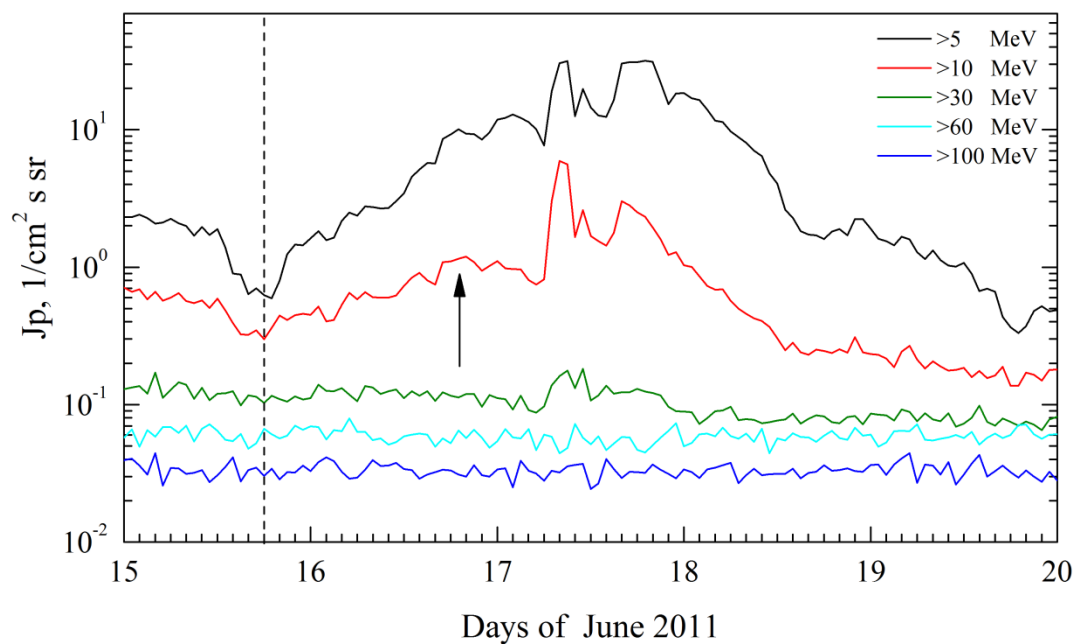


SOHO. Event 2011.06.15

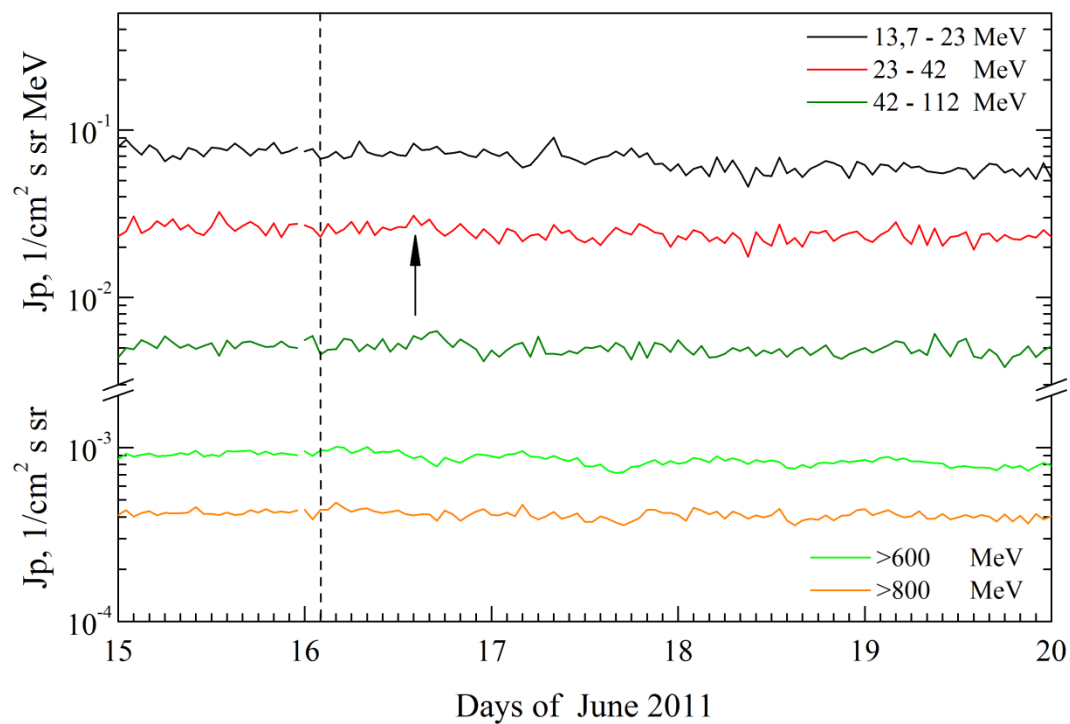


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

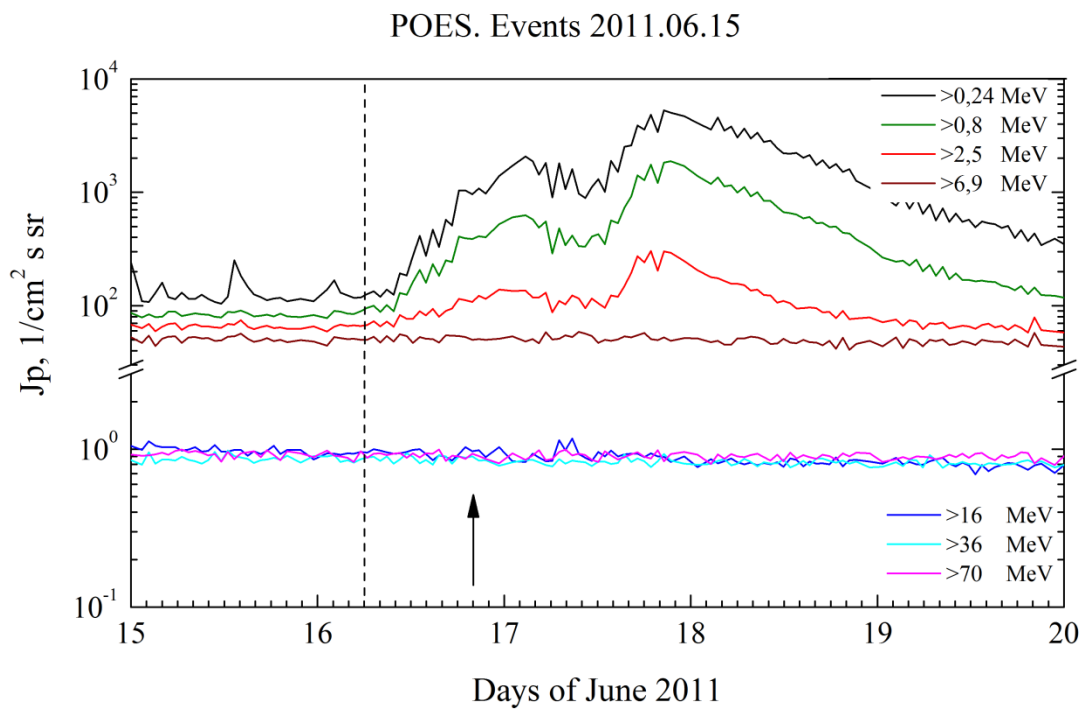
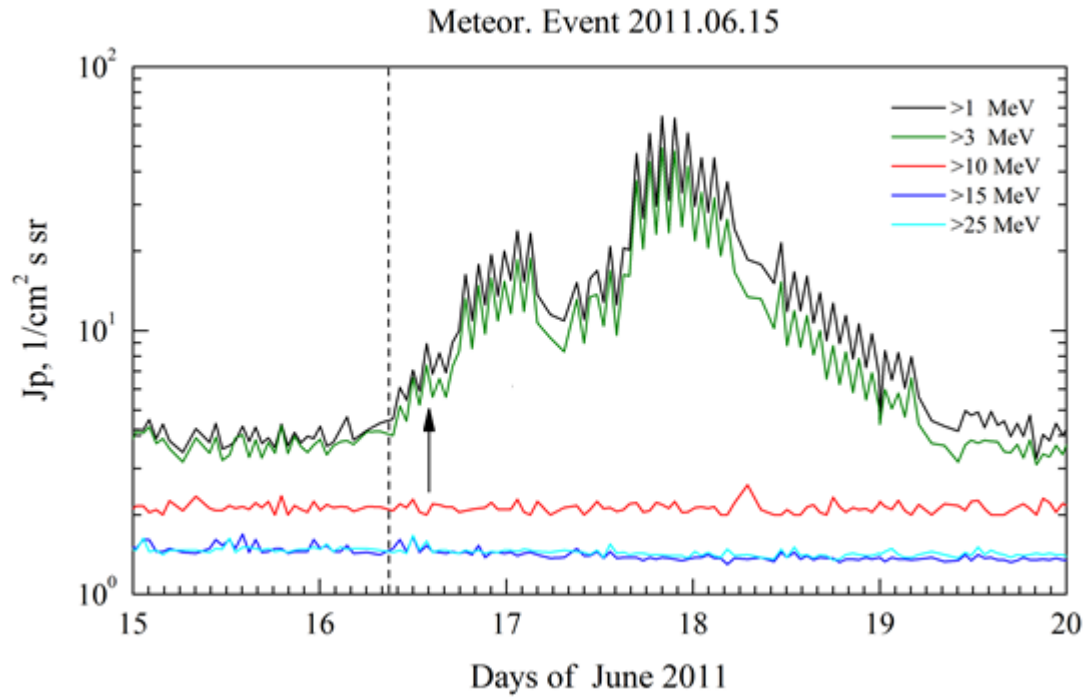
GOES. Event 2011.06.15



Electro. Event 2011.06.15



Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES



Electromagnetic and other phenomena that are sources and/or accompanying for the event of

2011 June 15

2011

June 14

☉

AR11236

To event 487

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	2142	2142	2201	N15E77	SF	ERU
1 – 12	keV	2136	2147	2210	N14E78	M1.3	0.018
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	2143:24	2146:14	2222:40	688	1703393	HESSI
12-25	keV	2139:15	2146:11	2207:15	155628	47393372	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2141	2141	2142		2.45	
5	GHz	2145.0	2146.0	2146.0		2.12	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2236	441	5.2	028°	135°	SOHO

Proton Active Region

AR11236 (N17L165, CMP 20,5.06.2011,

Sp=350 msh, ESI, BD)

XRI=0.13 $M_1^{1.3}+C_7$ 1_1+S_{11}

PFR 14.06 $-M_1^{1.3}$

Particle event: To($E_p > 10$ MeV) – 17d06^h

Tmax₁($E_p > 10$ MeV) – 17d08^h, Jmax₁($E_p > 10$ MeV) – 5.6 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 17d16^h, Jmax₂($E_p > 10$ MeV) – 2.7 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 2.8$, $\gamma_2 = 2.7$

Quasimaximal energy of protons in the event – Eqm₁ = 70 MeV

– Eqm₂ = 75 MeV

Sources: ● flare event 14d21^h36^m, M1.3/SF, N15E77, AR11236 (**Event 2011.06.15**)

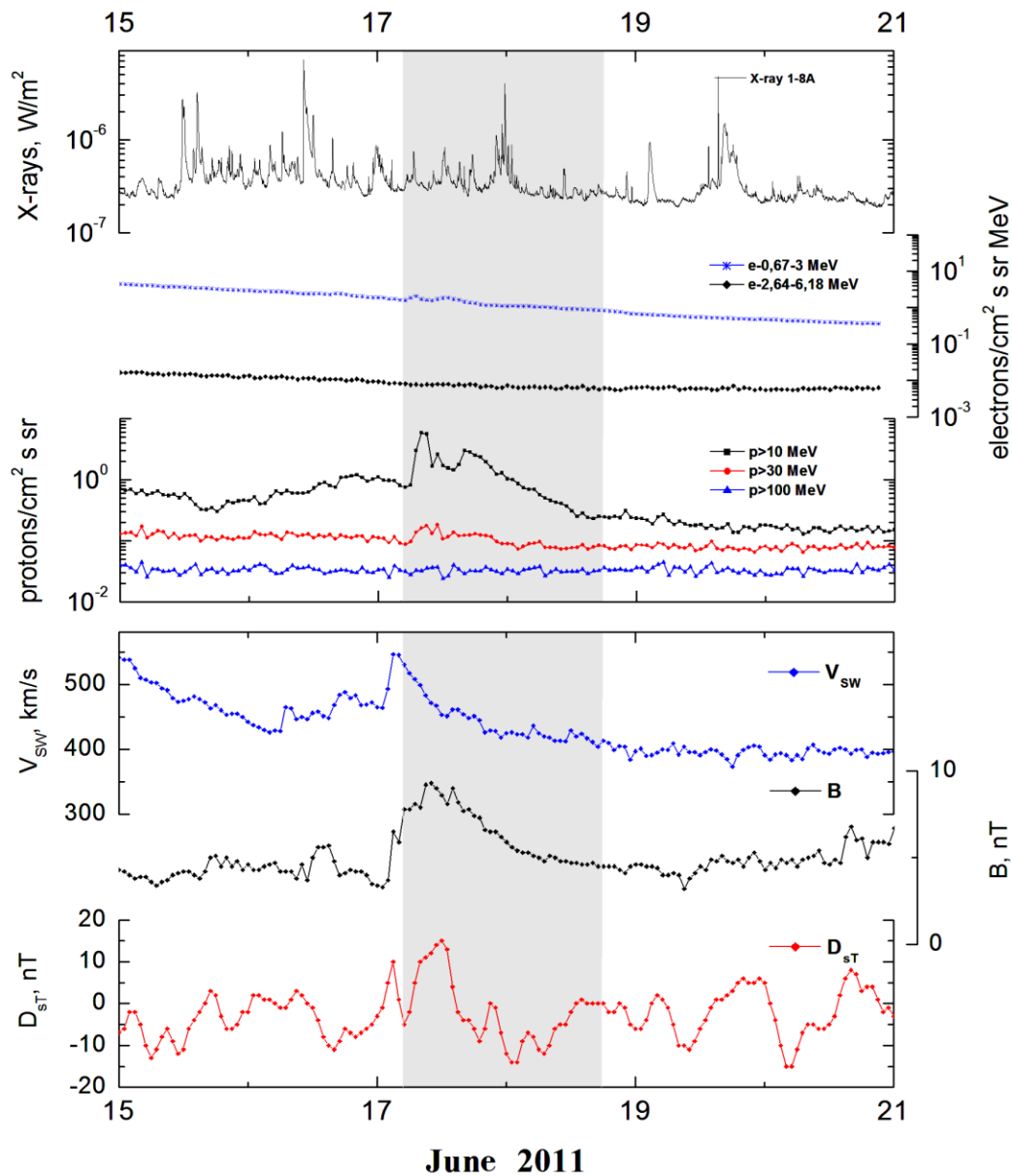
Main X-ray burst 1-8 Å: onset – 14d21^h36^m, max – 14d21^h47^m, $\Phi = 0.018$ J/m²

CME: 14d22^h36^m, V = 441 km/s, $\Delta\phi = 028^\circ$, dA = 135°

▲ SC* 17d02^h39^m

* **Source:** ▲ SC 17d02^h39^m – from flare of **Event 2011.06.15**

Particle fluxes and associated phenomena

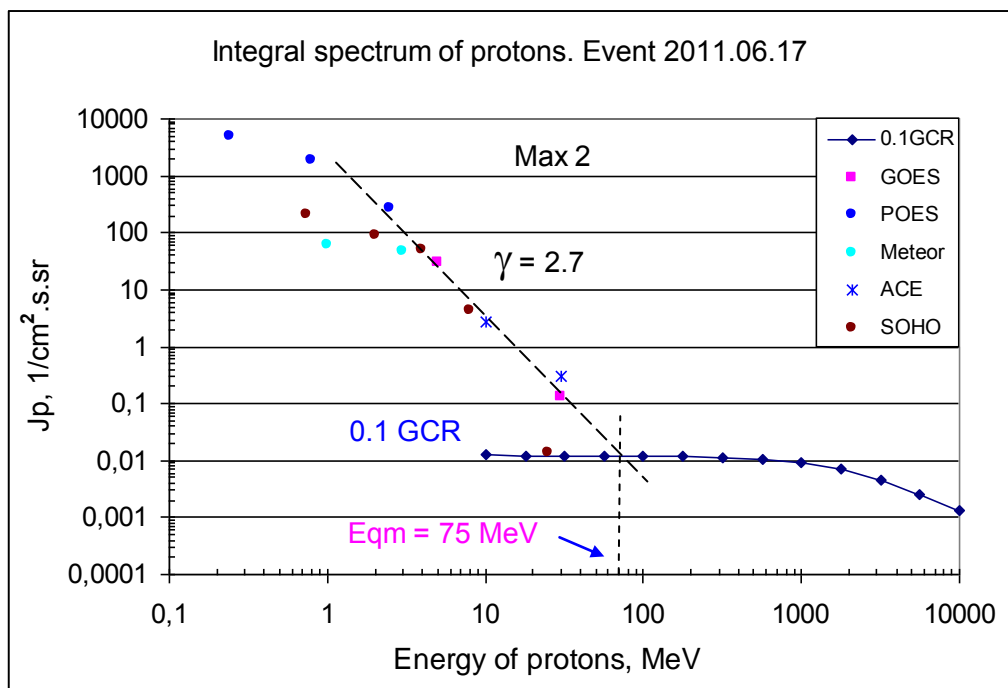
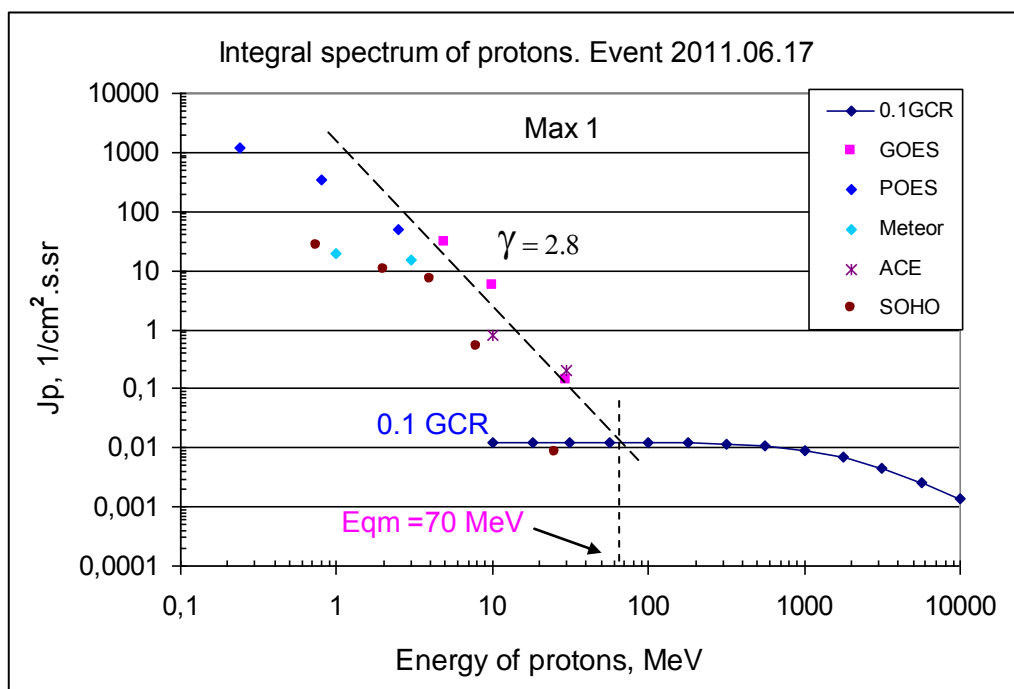


Integral fluxes of protons for the event of 2011 June 17

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	06	09/17	29.9/30.5	2.5	0.6	
EPS	>10	06	08/16	5.6/2.7	1.5	0.3	
EPS	>30	06	09/14	0.17/0.13	0.7	0.1	
EPS	>50	-	-	-	-	0.07	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
POES							
MEPED	>0.24	7	12/20	1200/5300	3	110	
MEPED	>0.8	7	12/20	340/1800	3	85	
MEPED	>2.5	7	11/20	50/237	1.5	65	
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	-	-	-	-	1.6	
MEPED	>36	-	-	-	-	1	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.3	
Meteor-1							
SCR	>1	7	10/20	20/61	2	4	
SCR	>3	7	10/20	15/46	2	3.2	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	0.75	
GALS-M	>25	-	-	-	-	0.75	
GALS-M	>600	-	-	-	-	0.01	
ACE							
SIS	>10	06	08/16	0.8/2.7	1.5	2	
SIS	>30	06	08/16	0.2/0.3	1	1.2	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2011 June 17

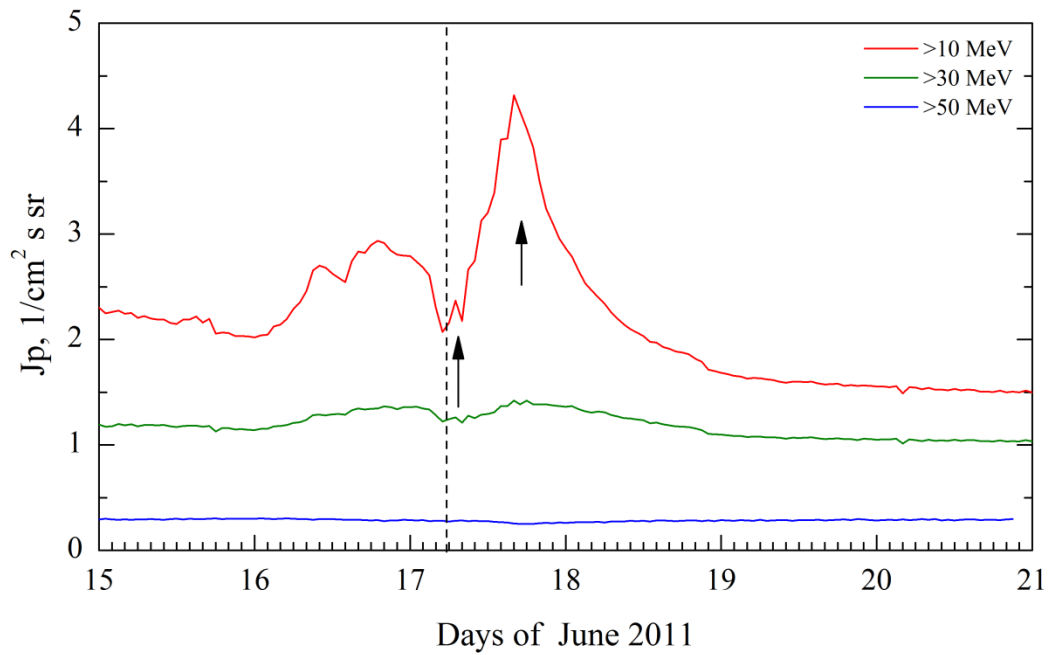
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	6	8/18	13.3/95	5	0.05	
LION	2 – 6	5	8/18	1.1/12	5	0.01	
EPHIN	4 – 8	5	7/18	1.7/11.8	4	0.04	
EPHIN	8 – 25	5	7/17	0.06/0.25	4	0.0004	
EPHIN	25–53	5	7/17	0.0003/0.0005	3	0.00005	
Electro							
SCR-E	13.7–23	-	-	-	-	0.07	
SCR-E	23–42	-	-	-	-	0.03	
SCR-E	42–112	-	-	-	-	0.005	



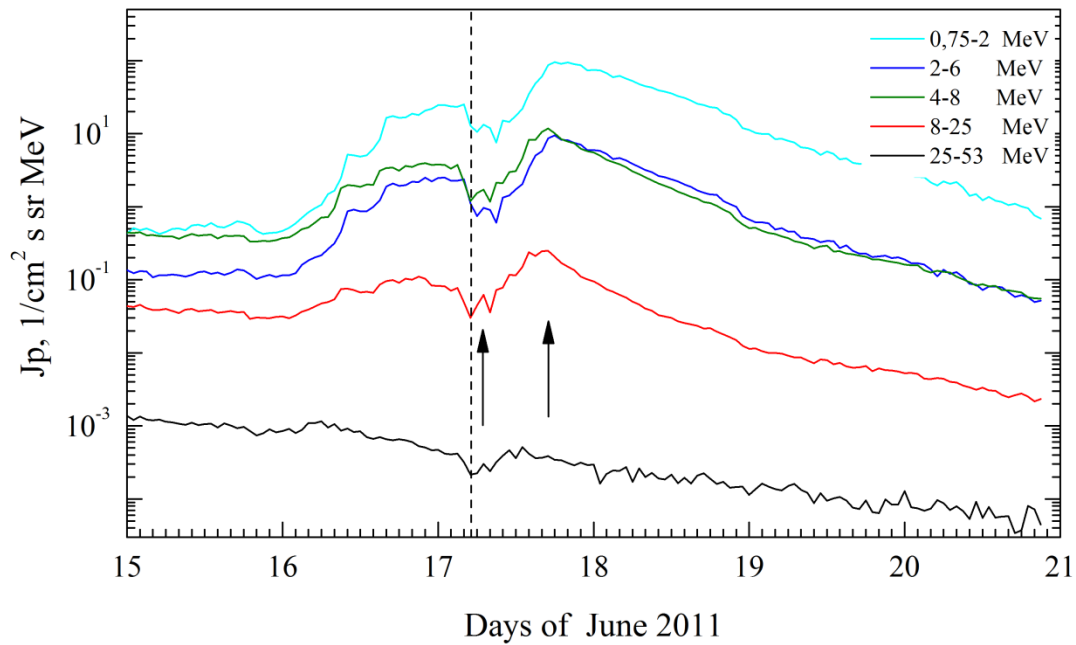
Time profiles of proton fluxes in the event 2011.06.17

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.06.17

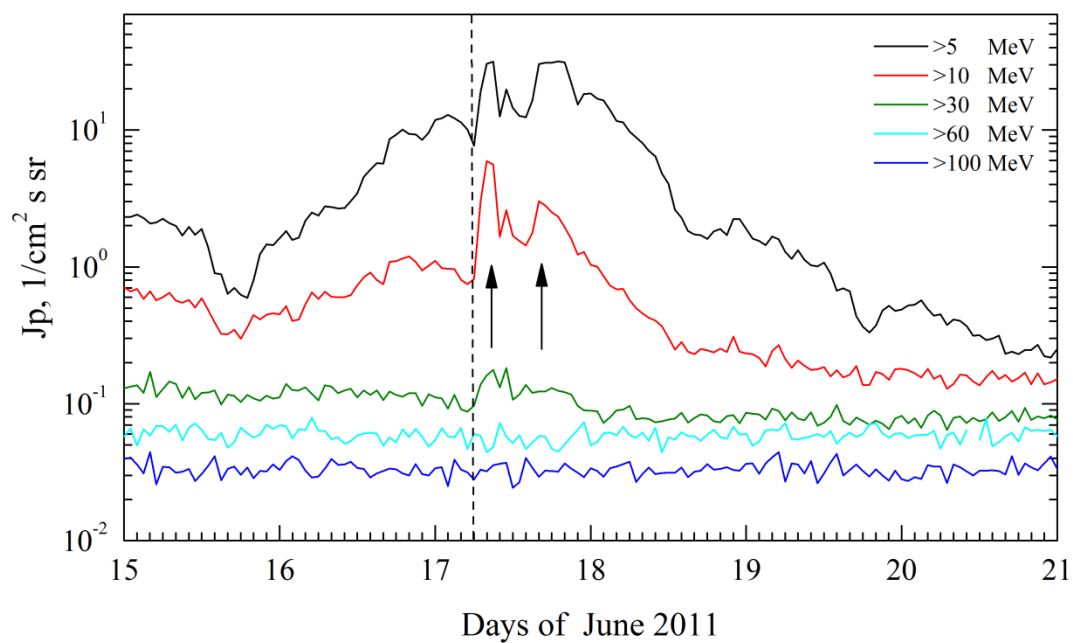


SOHO. Event 2011.06.17

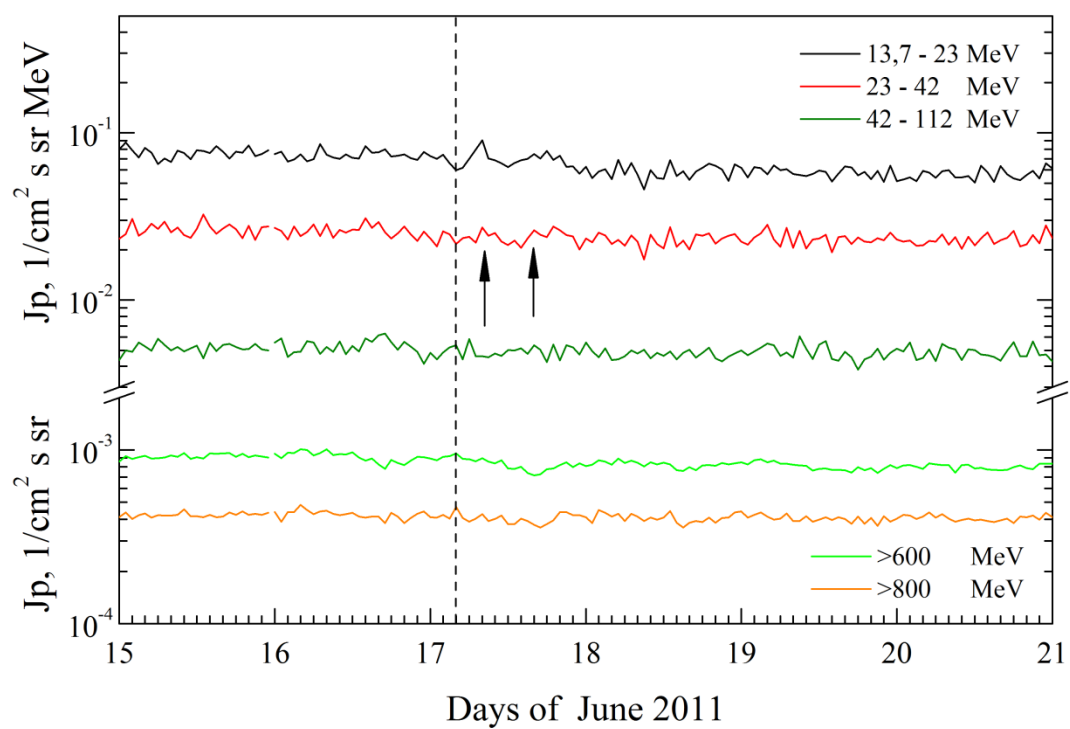


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

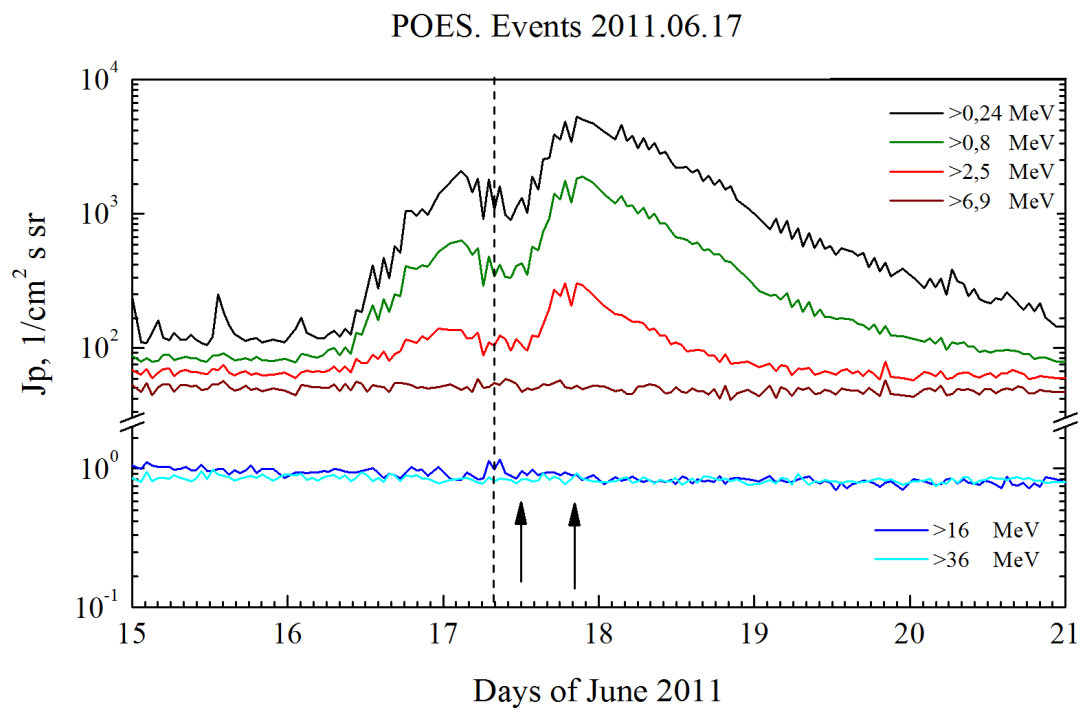
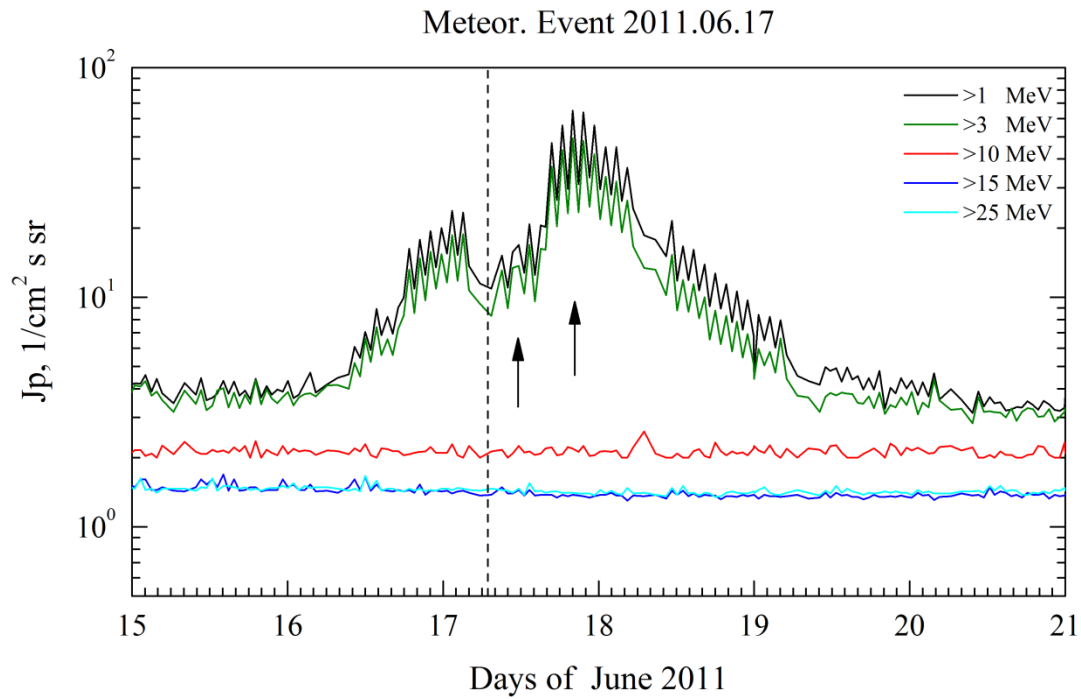
GOES. Event 2011.06.17



Electro. Event 2011.06.17



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources* and/or accompanying for the event
of 2011 June 17**

2011

June 14

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AR11236

To event 488

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	H α	2142	2142	2201	N15E77	SF	ERU
1 – 12	keV	2136	2147	2210		M1.3	0.018
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50-100	keV	214324	214614	222240	688	1703393	HESSI
12-25	keV	2139:15	2146:11	2207:15	155628	47393372	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2141	2141	2142		2.43	
5	GHz	2145.0	2146.0	2146.0		2.08	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2236	441	5.2	028°	135°	SOHO

*SC 17d02^h39^m from flare event 14.06

Proton Active Region

AR11236 (N17L165, CMP 20,5.06.2011,

Sp=350 msh, ESI, BD)

XRI=0.13 M₁^{1.3}+C₇ 1₁+S₁₁

PFR 14.06 – M₁^{1.3}

Particle event: To($E_p > 10$ MeV) – 02d07^h

Tmax₁($E_p > 10$ MeV) – 02d11^h, Jmax₁($E_p > 10$ MeV) – $2.2 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Tmax₂($E_p > 10$ MeV) – 03d17^h, Jmax₂($E_p > 10$ MeV) – $0.55 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma_1 = 2.2$, $\gamma_2 = 2.1$

Quasimaximal energy of protons in the event – Eqm₁ = 120 MeV

– Eqm₂ = 70 MeV

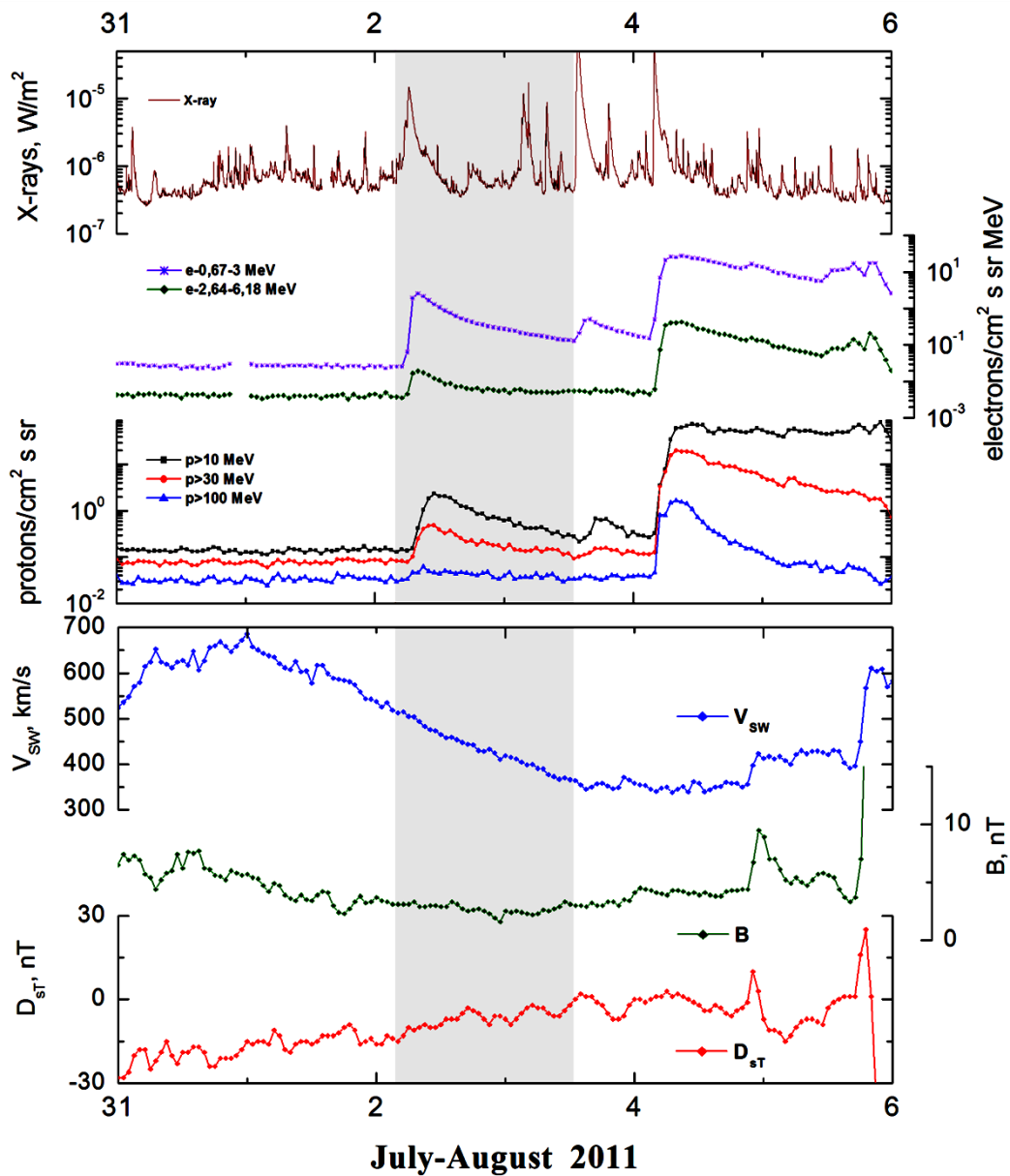
Sources: ☉ solar flare 02d05^h19^m, M1.4/1N, N14W15, AR11261

☽ solar flare 03d13^h17^m; M6.0/2B, N16W30; AR11261

Main X-ray burst 1-8 Å: onset – 02d05^h19^m, max – 02d06^h19^m, $\Phi = 0.039 \text{ J/m}^2$

CME: 02d06^h36^m, $V = 0852 \text{ km/s}$, $\Delta\phi = 268^\circ$, $dA = 285^\circ$

Particle fluxes and associated phenomena

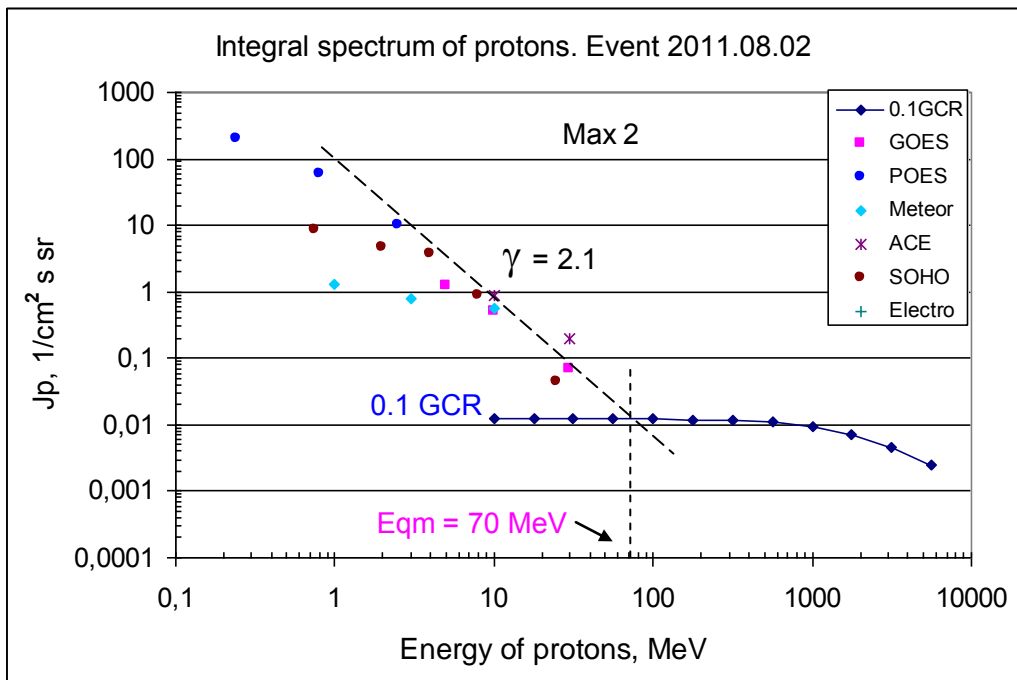
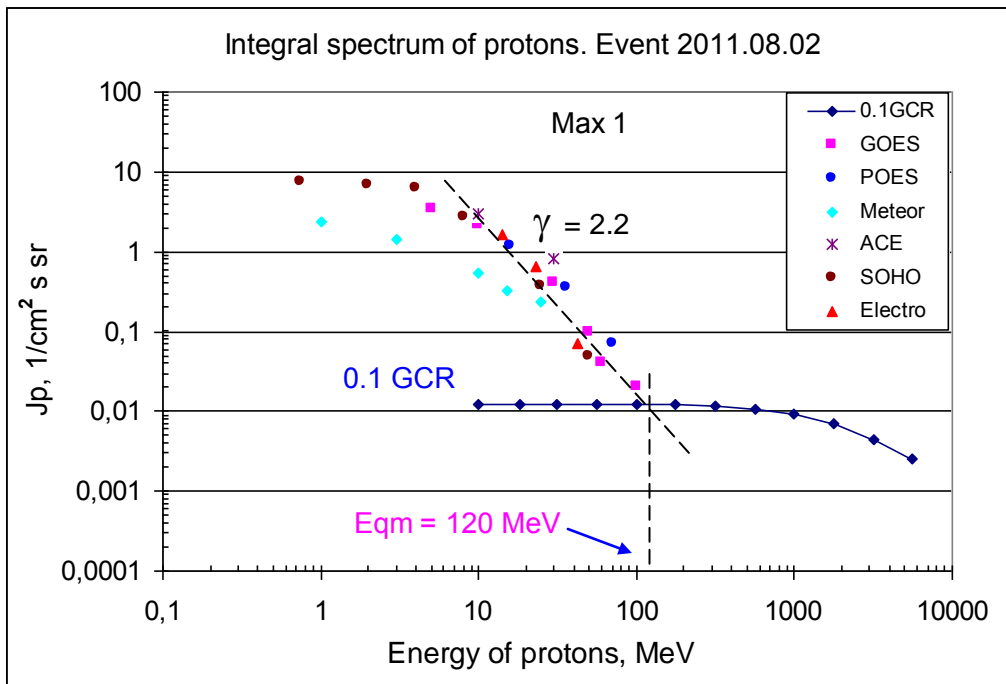


Integral fluxes of protons for the event of 2011 August 02

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	07	11/3d18	3.5/1.2	2	0.2	
EPS	>10	07	11/3d17	2.2/0.55	2	0.15	
EPS	>30	07	10/3d18	0.4/0.07	1.5	0.08	
EPS	>50	07	09/ -	0.1/ -	1.5	0.07	
EPS	>60	07	09/ -	0.04/ -	1	0.06	
EPS	>100	07	09/ -	0.02/ -	1	0.04	
EPS	>700	-	-	-	-	-	
POES							
MEPED	>0.24	-	- /3d18	-/200	-	95	С графика
MEPED	>0.8	-	- /3d18	-/60	-	80	С графика
MEPED	>2.5	-	- /3d18	-/10	-	65	С графика
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	6	11/ -	1.2/ -	0.5	0.8	
MEPED	>36	6	9/ -	0.35/ -	0.5	0.8	
MEPED	>70	6	10/ -	0.07/ -	0.5	0.95	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	06	12/ 03d10	2.4/1.3	1.5	3.1	
SCR	>3	06	12/ 03d10	1.4/0.8	1.5	3	
SCR	>10	06	12/ 03d10	0.54/0.57	0.5	2.1	
GALS-M	>15	06	12/ -	0.32/-	0.5	0.7	
GALS-M	>25	06	12/ -	0.24/-	0.5	0.75	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	06	09/03d18	3/0.9	2	1.5	
SIS	>30	06	09/03d18	0.8/0.2	2	1	
SOHO							
EPHIN	>50	06	08/ -	0.05/ -	0.5	0.3	

Differential fluxes of protons for the event of 2011 August 02

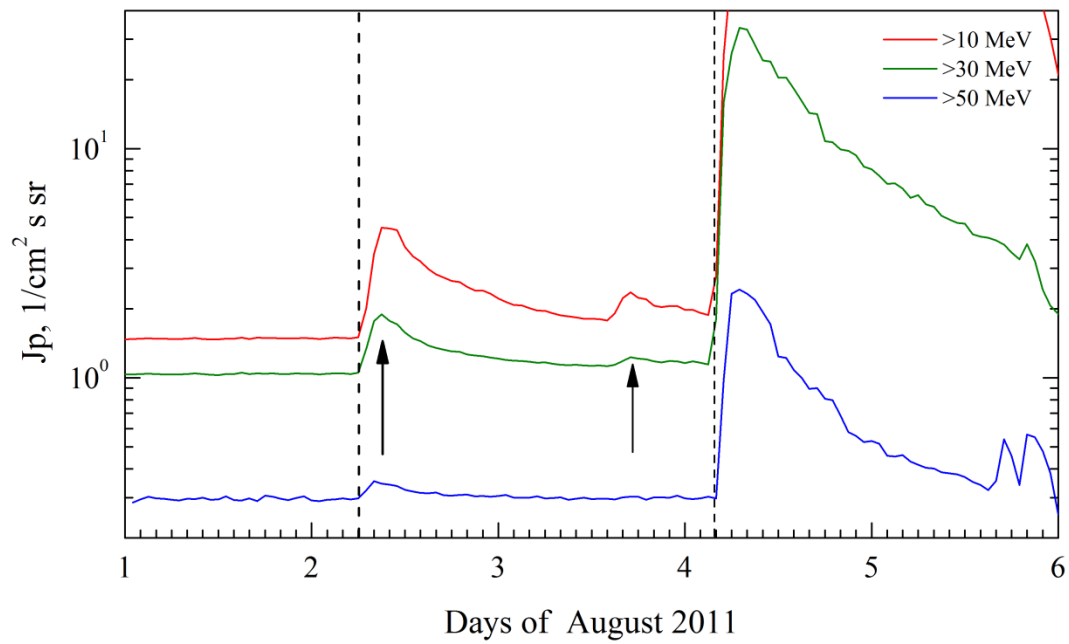
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	7	14/3d16	0.5/3.1	2	0.018	
LION	2 – 6	6	12/3d18	0.22/0.32	2	0.0035	
EPHIN	4 – 8	6	12/3d17	0.9/0.7	2	0.0003	
EPHIN	8 – 25	6	11/3d16	0.14/0.05	2	0.00004	
EPHIN	25 – 53	6	10/3d16	0.011/0.0016	2	0.00004	
Electro-1							
SCR-E	13.7–23	7	10/ -	0.11/ -	1.5	0.07	
SCR-E	23–42	7	10/ -	0.03/ -	1.5	0.03	
SCR-E	42–112	7	10/ -	0.001/ -	0.5	0.005	



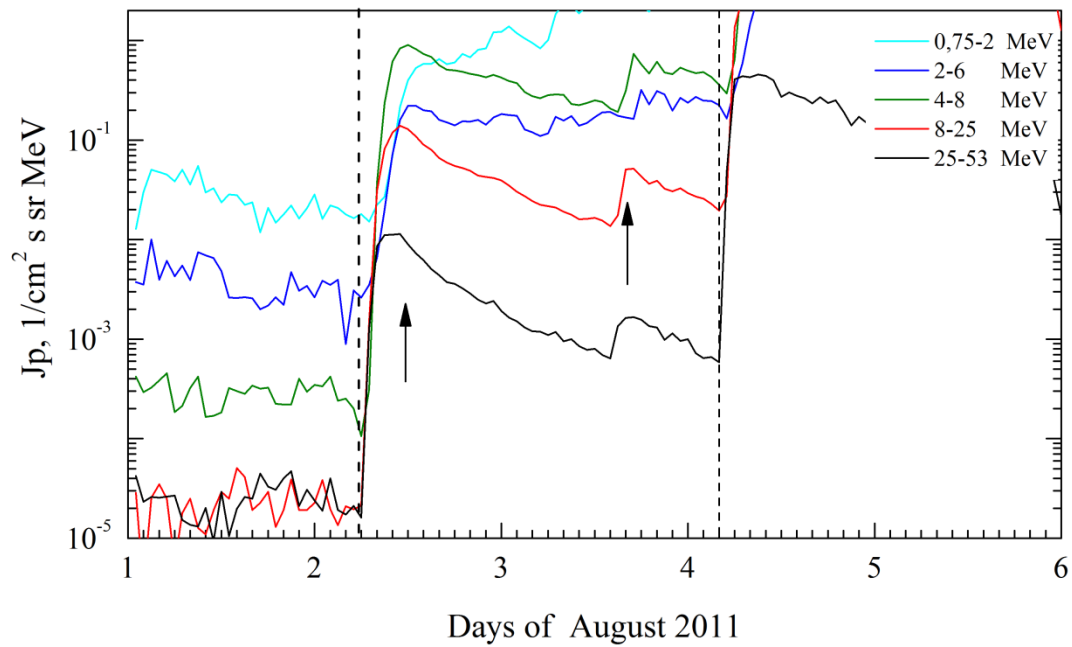
Time profiles of proton fluxes in the event 2011.08.02

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

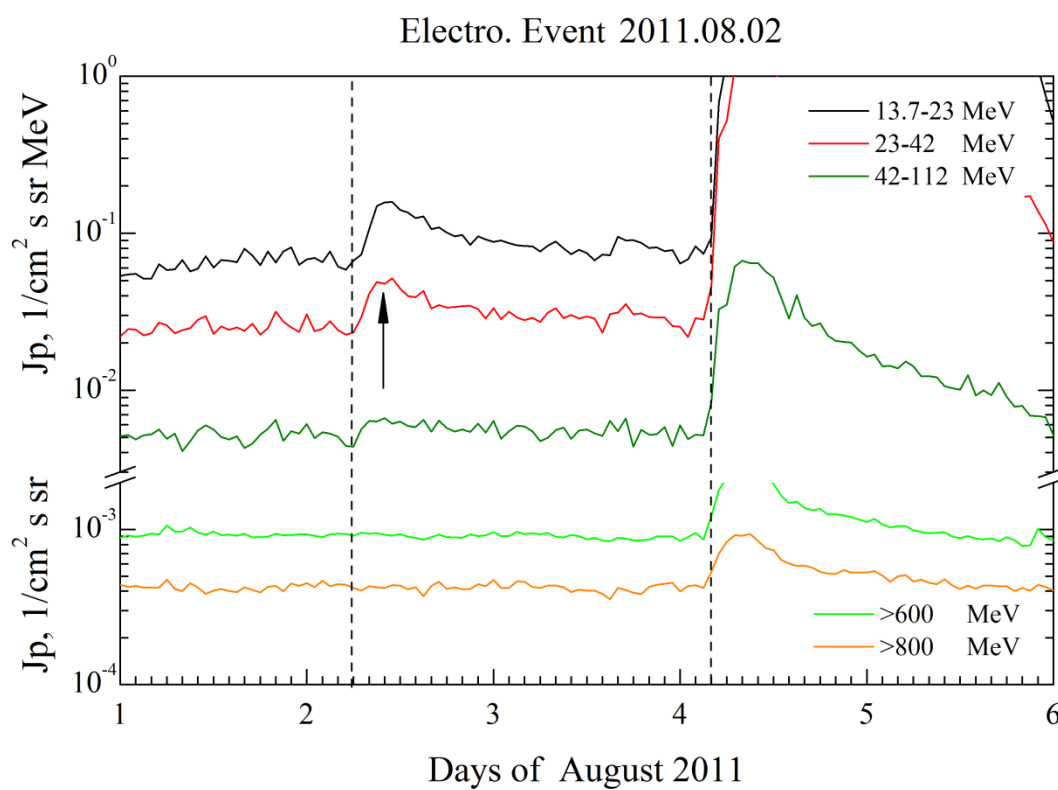
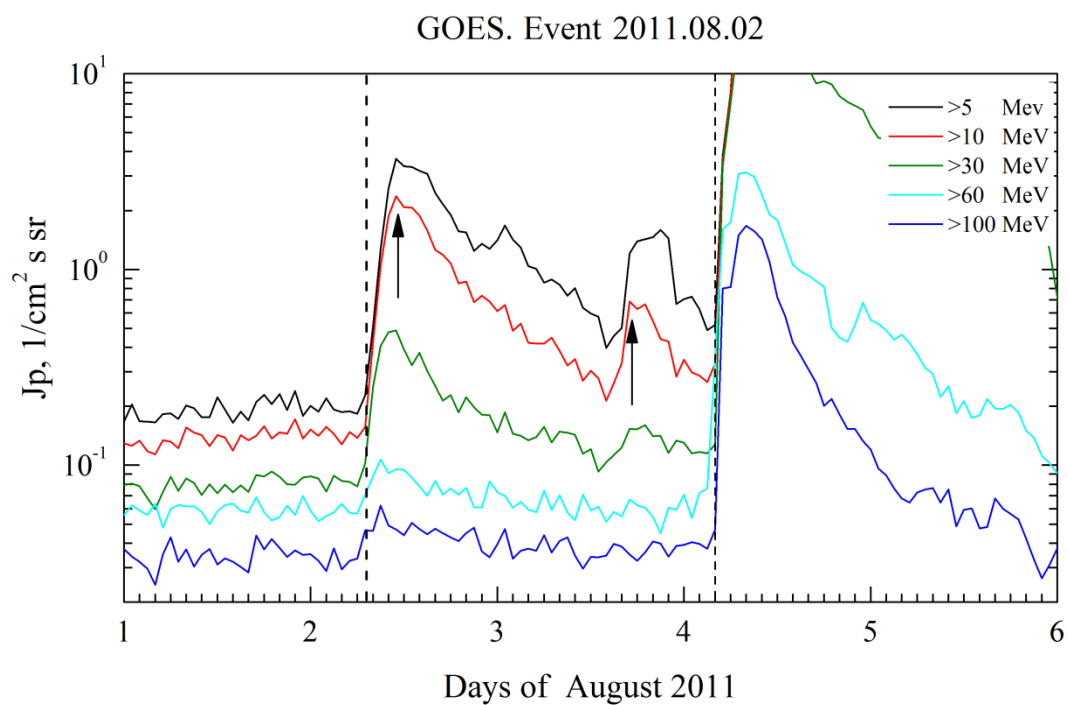
ACE SIS + SOHO (>50 MeV). Event 2011.08.02



SOHO. Event 2011.08.02

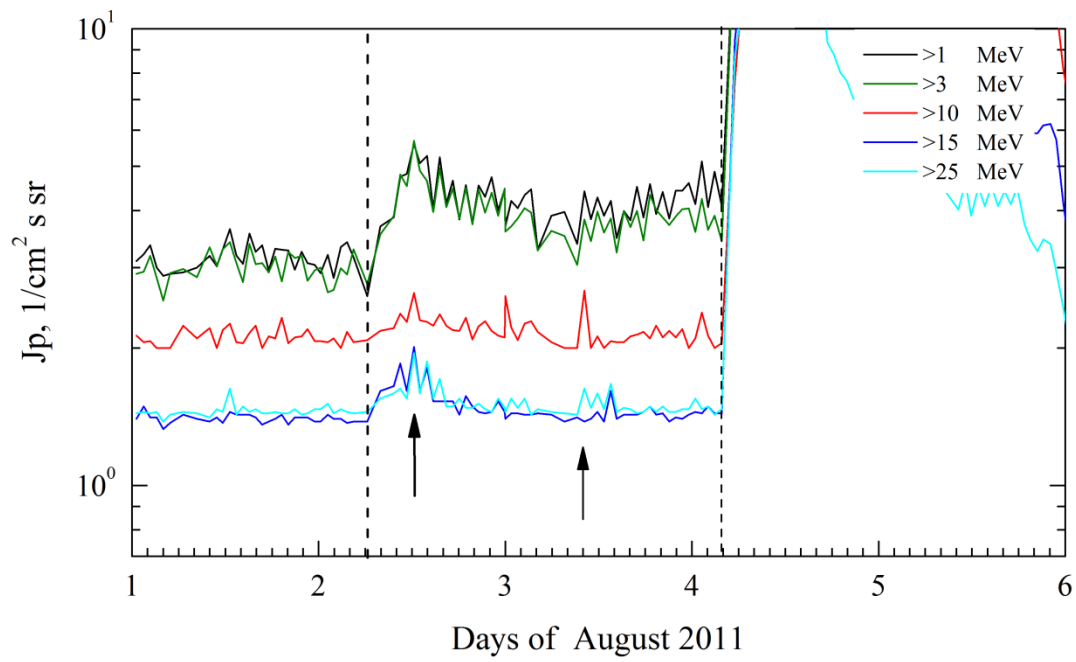


Earth satellites in geostationary orbit, $R \approx 6.6 \text{ Re}$: GOES and Electro

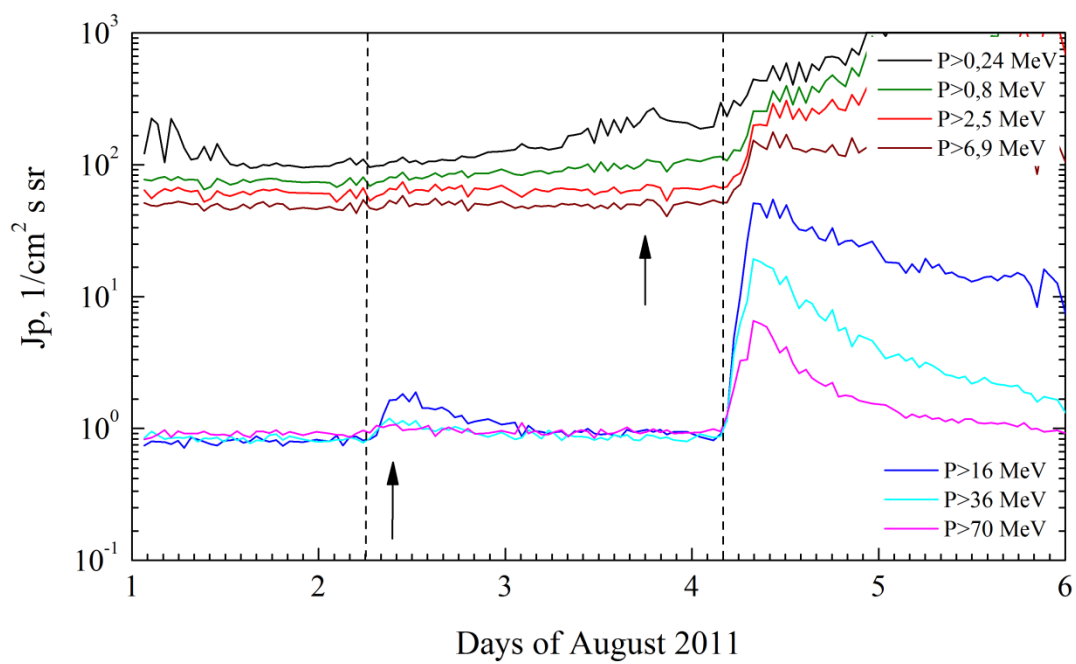


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.08.02



POES. Events 2011.08.02



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 August 02**

2011

August 02

☉

AR11261

To event 489

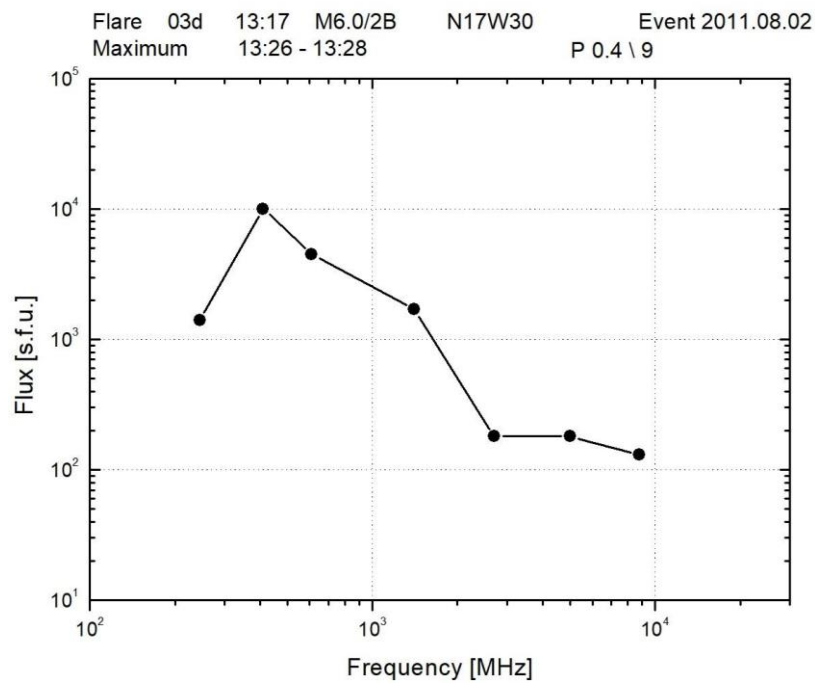
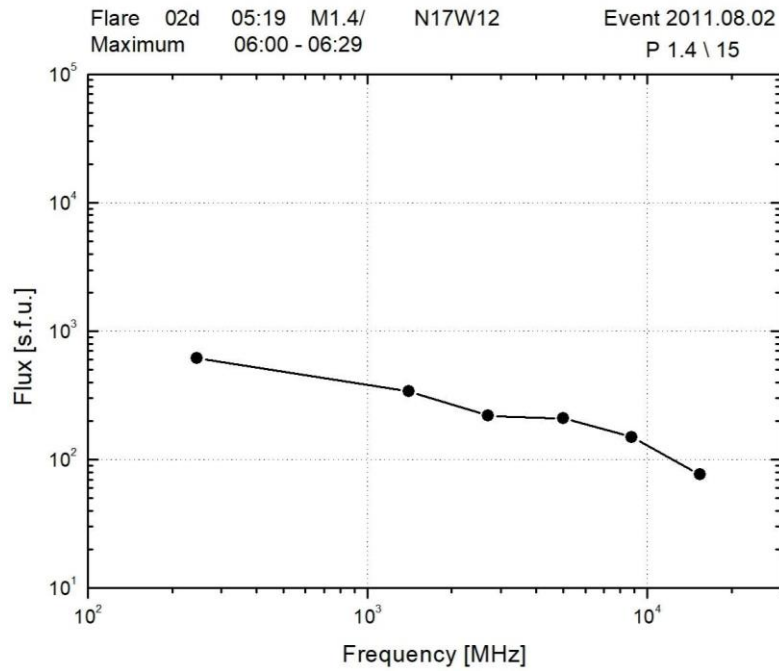
Ha, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	0525	0615	0710	N14W15	1N	
1 – 12	keV	0519	0619	0648	N17W12	M1.4	0.039
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	0456:44	0507:26	0517:12	14	48176	HESSI
12 – 25	keV	0517:12	0528:38	0530:00	104	146234	HESSI
12 – 25	keV	0603:12	0603:34	0605:20	1895	209736	HESSI
25 – 50	keV	0605:20	0612:22	0647:16	496	2707179	HESSI
6 – 12	keV	0647:16	0648:06	0700:40	76	239880	HESSI
12 – 25	keV	0520:01	0540:05	0558:47	7795	1977947	FERMI
12 – 25	keV	0646:30	0649:13	0722:00	1942	588619	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0608	0608	0609		1.89	
8.8	GHz	0600	0608	0610		2.18	
5	GHz	0600	0600	0625		2.32	
2.7	GHz	0600	0600	0625		2.34	
1.4	GHz	0559	0629	0630.0	P1.4 / 15	2.53	
245	MHz	0559	0609	~ 0649		2.79	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	023-090	0608		0622		2	
DS II	018-057	0617		0628		2	
DS IV	025-200	0612		0946		2	
DS III	100-900	0609		0609		1	
DS III	018-050	0625		0627		2	
DH II	06-15			0730			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0636	852	-15.5	268°	285°	SOHO

**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 August 02**

2011 August 03 Ø AR11261 To event 489

H α , X-ray		To	Tmax	Te	Location	Importance Class	FI Code Φ , J/m ²
6563 Å	LPS	1320	1350	1538	N16W30	2B	ERU
1 – 12	keV	1317	1348	1410	N17W30	M6.0	0.12
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1315:00	1324:46	1325:36	320	213669	HESSI
12-25	keV	1357:40	1358:14	1425:08	1904	4593157	HESSI
6-12	keV	1455:08	1455:26	1501:00	60	89182	HESSI
12-25	keV	1533:24	1534:02	1543:40	1200	2826040	HESSI
12-25	keV	1318:34	1335:06	1350:08	539198	333410368	FERMI
12-25	keV	1425:52	1426:04	1438:54	5207	71401	FERMI
12-25	keV	1456:37	1456:49	1514:13	1611	201501	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	1327	1328	1335		2.11	
5	GHz	1326	1332	1335		2.26	
2.7	GHz	1332	1332	1335		2.26	
1.4	GHz	1332	1326	1335		3.23	
610	MHz	1323	1333	1339		3.65	
410	MHz	1321	1338	1348	P0.4 \ 9	4.0	
245	MHz	1331	1334	1335		3.15	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-081	1352		1344		1	
DS IV	030-080	1330		>2359		2	
DS III	025-180	1341		1341		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1400	610	-12.2	360°	307°	SOHO

Radio bursts frequency spectrum



Proton Active Region

AR11261 (N16L330, CMP 01.4.08.2011,
Sp=390 msh; Fkc; BGD)
XRI=2.71; $M_5^{9.3} + C_{36}$ $2_2 + 1_6 + S_{82}$
PFR 2-4.08 (47^h) $M_4^{9.3}$

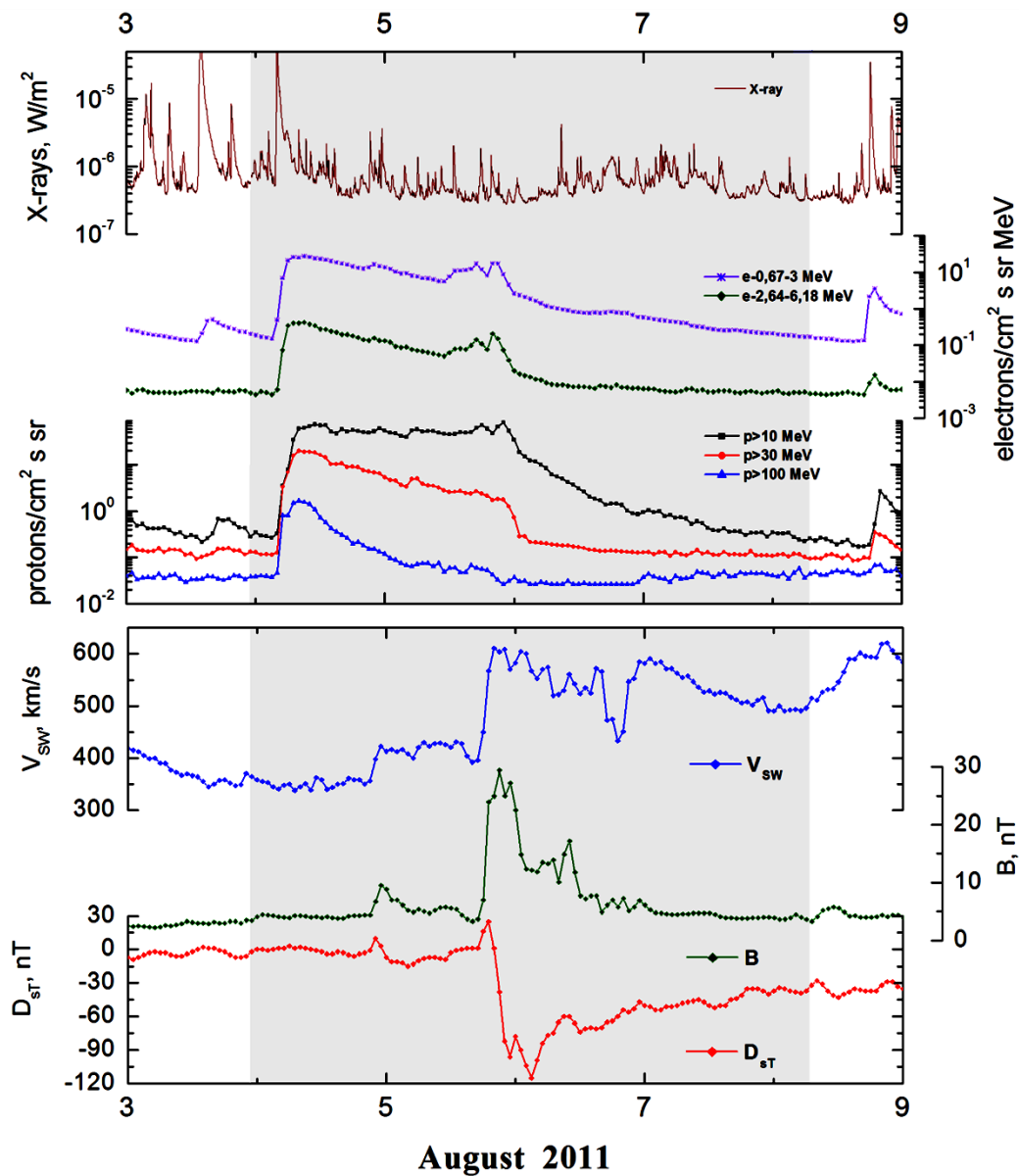
References:

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 04d04^h
 Tmax ($E_p > 10$ MeV) – 04d08^h, Jmax ($E_p > 10$ MeV) – $60 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$
 Duration of the event – 4 days, power-law index: $\gamma = 2.5$
 Quasimaximal energy of protons in the event – $E_{qm} = 500$ MeV

Sources: ● solar flare 04d03^h41^m, M9.3/2B, N19W36, AR11261
 Main burst X-ray 1–8 Å: onset – 04d03^h41^m, max – 04d03^h57^m, $\Phi = 0.056 \text{ J/m}^2$
 CME: 04d04^h12^m, $V = 1315 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 298^\circ$
 ▲ SC04d21^h54^m; ▲ SC 05d 17^h51^m

Particle fluxes and associated phenomena

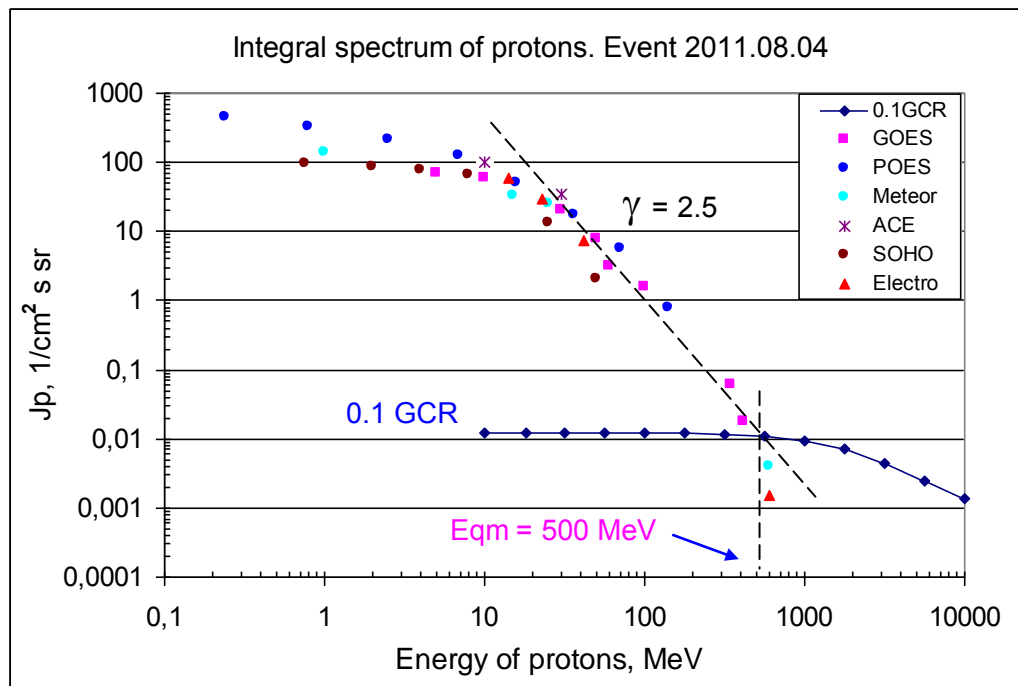


Integral fluxes of protons for the event of 2011 August 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	04	08	69	4	0.2	
EPS	>10	04	08	60	4	0.15	
EPS	>30	04	08	19.8	2	0.08	
EPS	>50	04	08	7.8	2	0.07	
EPS	>60	04	08	3.1	2	0.06	
EPS	>100	04	08	1.6	2	0.04	
Electro-1							
GALS-E	>600	4	8	0.0015	1	0.001	
POES-15							
MEPED	>0.24	4	8	455	4	105	
MEPED	>0.8	4	8	320	4	80	
MEPED	>2.5	4	8	210	3	65	
MEPED	>6.9	4	8	125	3	50	
MEPED	>16	4	8	50	2	0.9	
MEPED	>36	4	8	17.5	2	0.9	
MEPED	>70	4	8	5.6	1	0.95	
MEPED	>140	4	8	0.8	1	1.3	
Meteor-1							
SCR	>1	04	10	138	3	3.1	
SCR	>3	04	-	-	3	2.55	
SCR	>10	04	-	-	2	2.1	
GALS-M	>15	04	10	33	2	4.1	
GALS-M	>25	04	10	25	2	4.3	
GALS-M	>600	04	07	0.004	0.3	0.02	
ACE							
SIS	>10	04	08	102	3	1.9	
SIS	>30	04	07	35.5	2.5	1.1	
SOHO							
EPHIN	>50	05	07	2.1	2	0.3	

Differential fluxes of protons for the event of 2011 August 04

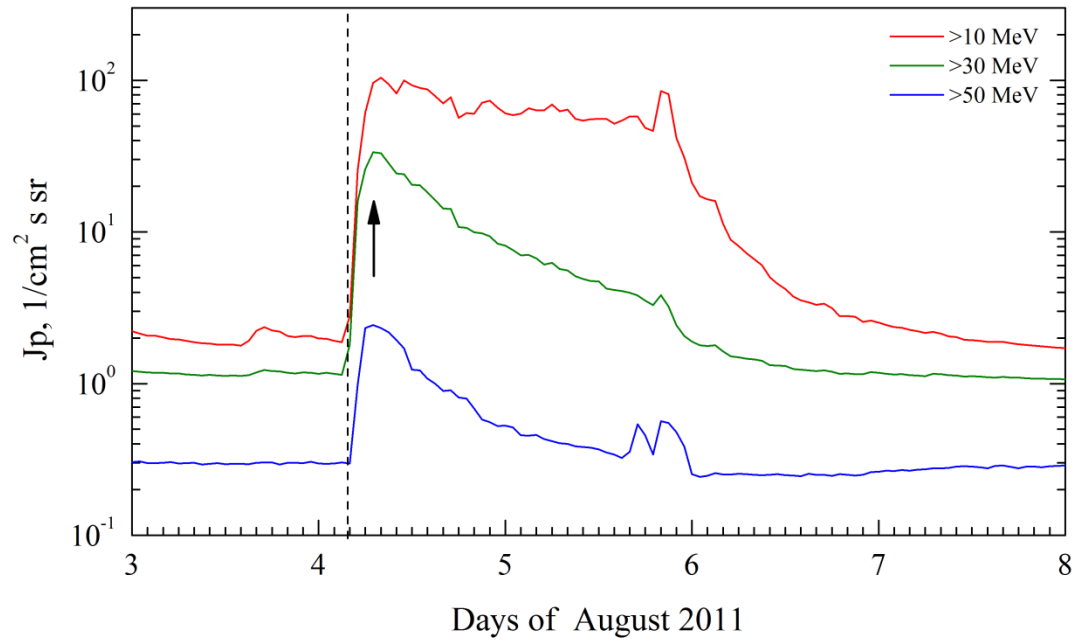
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax,. (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	5	10	5.3	5	0.018	
LION	2 – 6	5	10	3.4	5	0.0035	
EPHIN	4 – 8	5	9	3.3	5	0.0003	
EPHIN	8 – 25	5	8	3	4	0.00003	
EPHIN	25 – 53	5	7	0.4	3	0.00003	
GOES							
EPS	350–420	5	9	0.0006	1.5	0.0016	
EPS	420–510	-	9	0.00018	-	0.001	
EPS	510–700	-	-	-	-	-	
Electro-1							
SCR-E	13.7–23	4	8	3.2	3	0.1	
SCR-E	23–42	4	8	1.2	3	0.03	
SCR-E	42–112	4	8	0.06	2	0.0055	



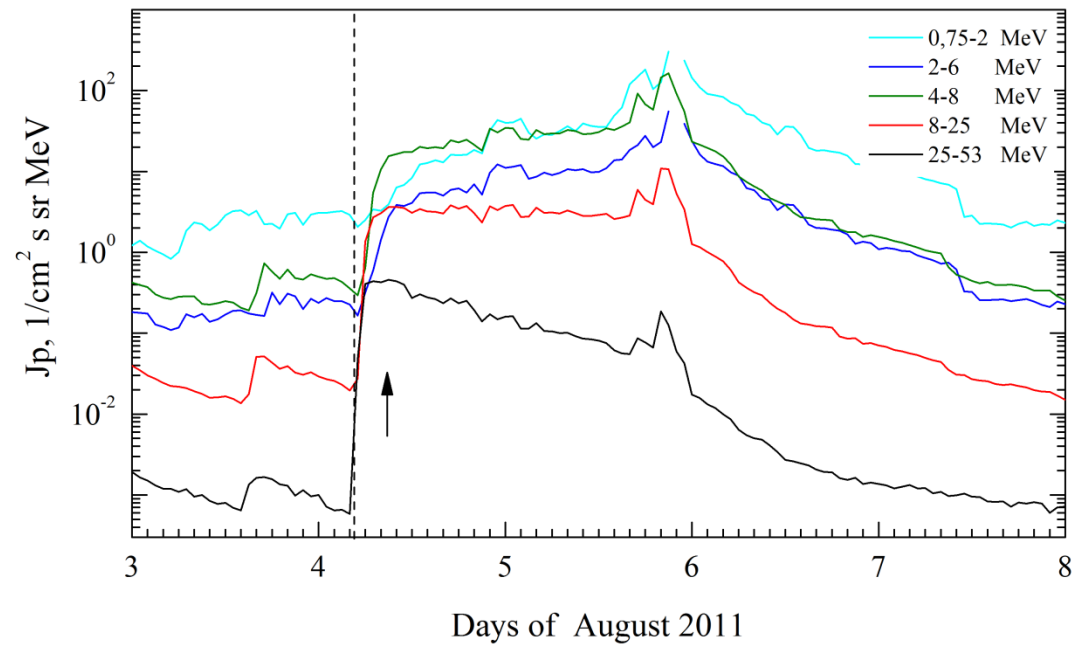
Time profiles of proton fluxes in the event 2011.08.04

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.08.04

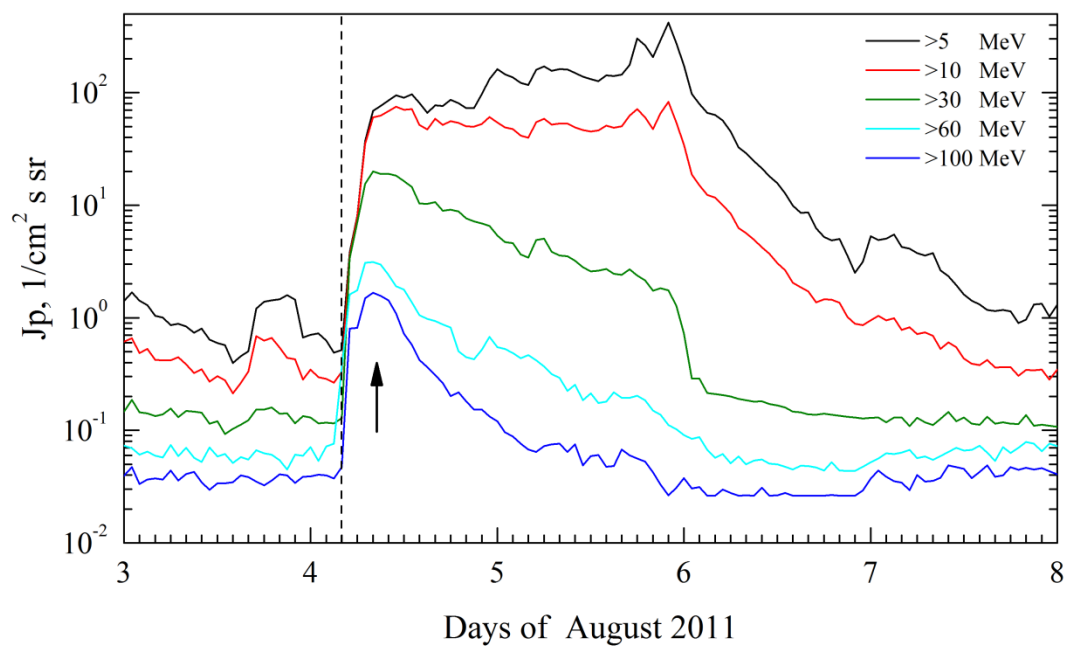


SOHO. Event 2011.08.04

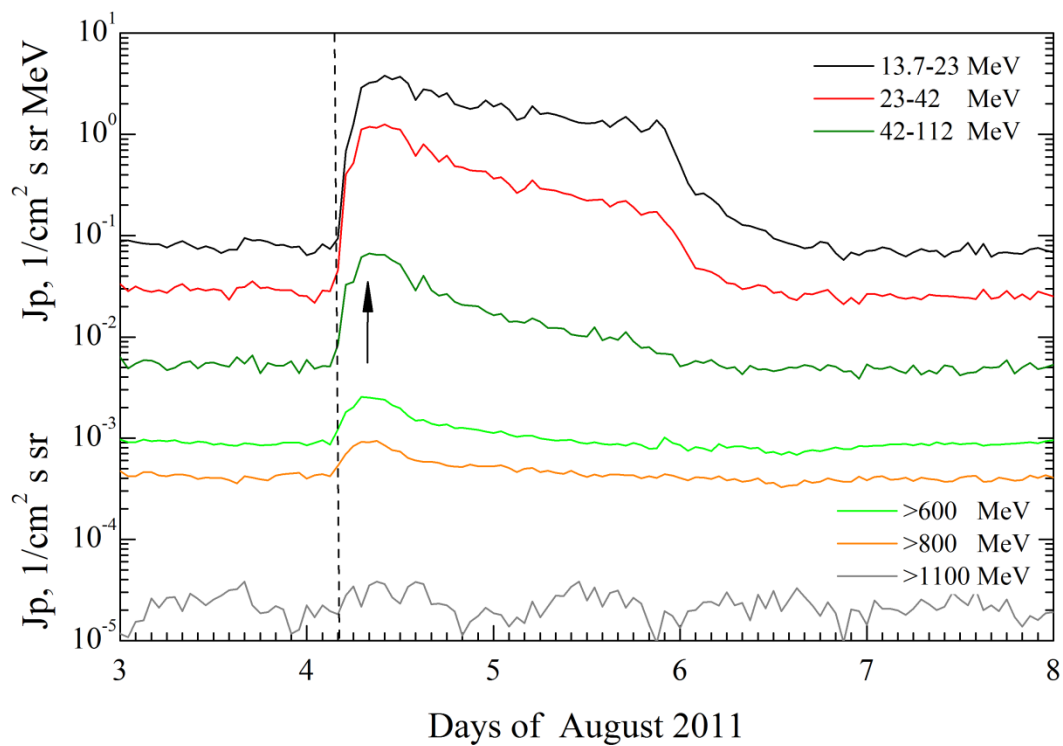


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2011.08.04

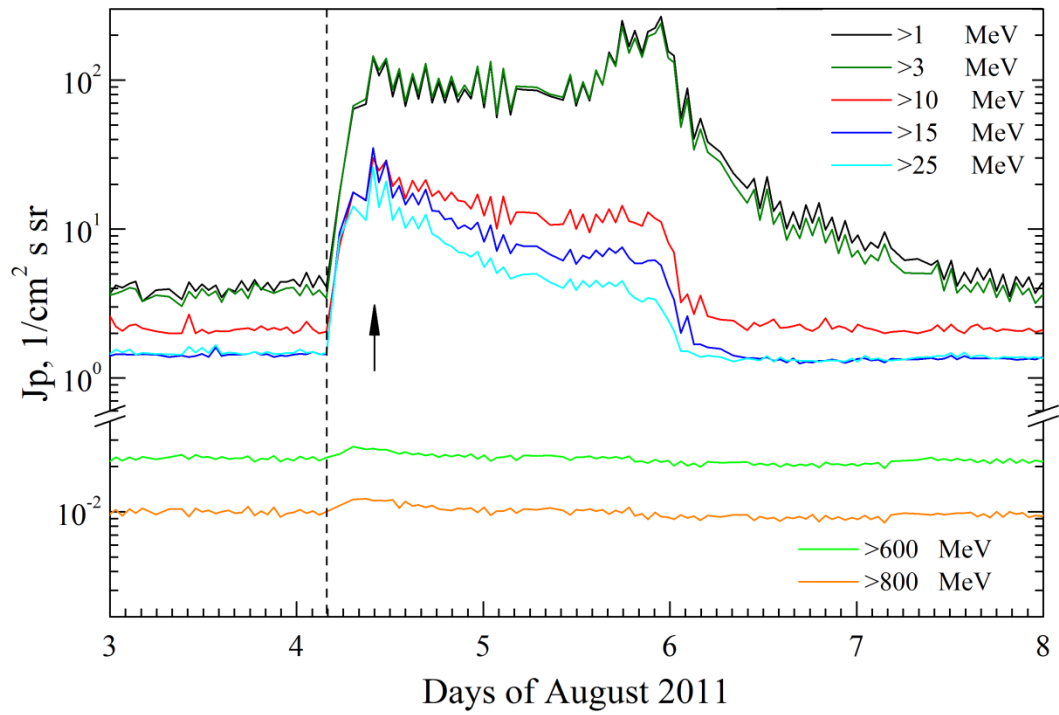


Electro. Event 2011.08.04

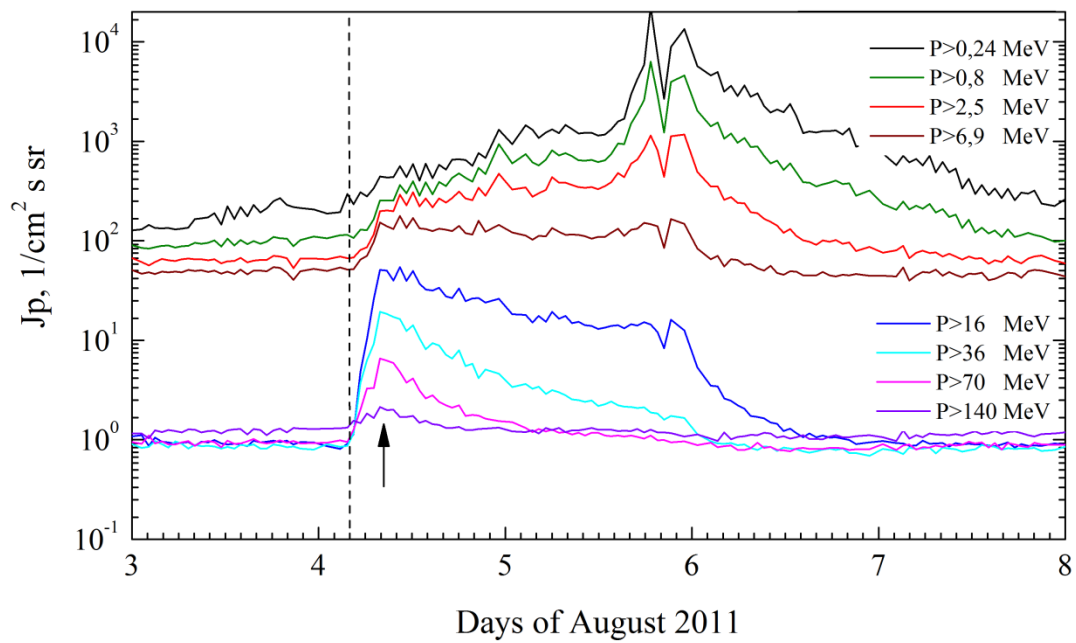


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.08.04



POES. Events 2011.08.04



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 August 04**

2011

August 04

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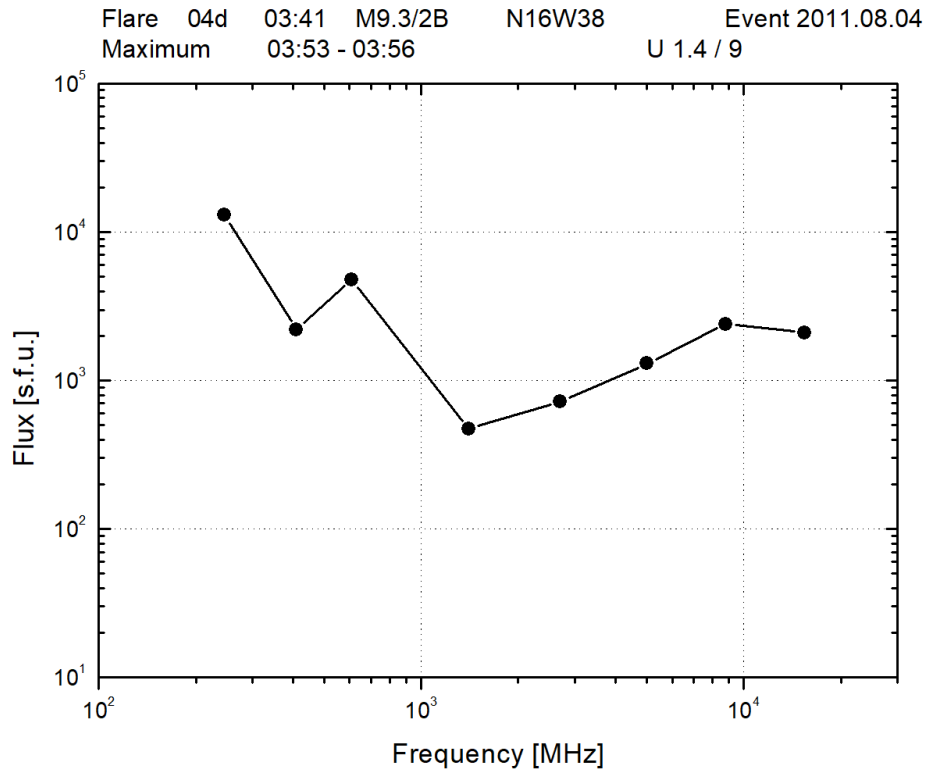
AR11261

To event 490

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	0344	0355	0505	N19W36	2B	PRB
6563 Å	DSF						
1 – 12	keV	0341	0357	0404	N16W38	M9.3	0.056
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50-100	keV	0336:20	0346:58	0347:40	184	90790	HESSI
6-12	keV	0419:12	0419:38	0450:20	1923	901803	HESSI
6-12	keV	0450:20	0451:58	0456:40	36	52280	HESSI
12-25	keV	0343:52	0354:25	0410:09	585570	181062176	FERMI
12-25	keV	0451:31	0452:04	0513:01	1043	180752	FERMI
300	keV	0455:30		0537:30		2.57E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0349	0353	0402		3.32	
8.8	GHz	0349	0353	0402	U1.4 / P8.8	3.38	
5	GHz	0349	0353	0402		3.11	
2.7	GHz	0349	0351	0401		2.86	
1.4	GHz	0349	0351	0400		2.67	
610	MHz	0351	0356	0422		3.68	
410	MHz	0350	1155	0423		3.34	
245	MHz	0351	1153	1220		4.11	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	066-180	0354		0403	750	2	
DS IV	035-180	0400		1750		1	
DS III	018-600	0350		0353		3	
DS V	025-180	0358		0401	G	3	
DS VI	025-180	0429		0947		2	
DH II	0.06-13	0415		1700			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0412	1315	-41.1	360°	298°	SOHO

*cm⁻²s⁻¹

Radio burst frequency spectrum



Proton Active Region

AR11261 (N16L330, CMP 01.4.08.2011,
Sp=390 msh; Fkc; BGD)
XRI=2.71; $M_5^{9.3} + C_{36} \quad 2_2 + 1_6 + S_{82}$
PFR 2-4.08 (47^h) $M_4^{9.3}$

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Particle event: To($E_p > 10$ MeV) – 08d19^h

Tmax($E_p > 10$ MeV) – 08d20^h, Jmax($E_p > 10$ MeV) – $2.6 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 0.5 days, power-law index: $\gamma = 2.3$

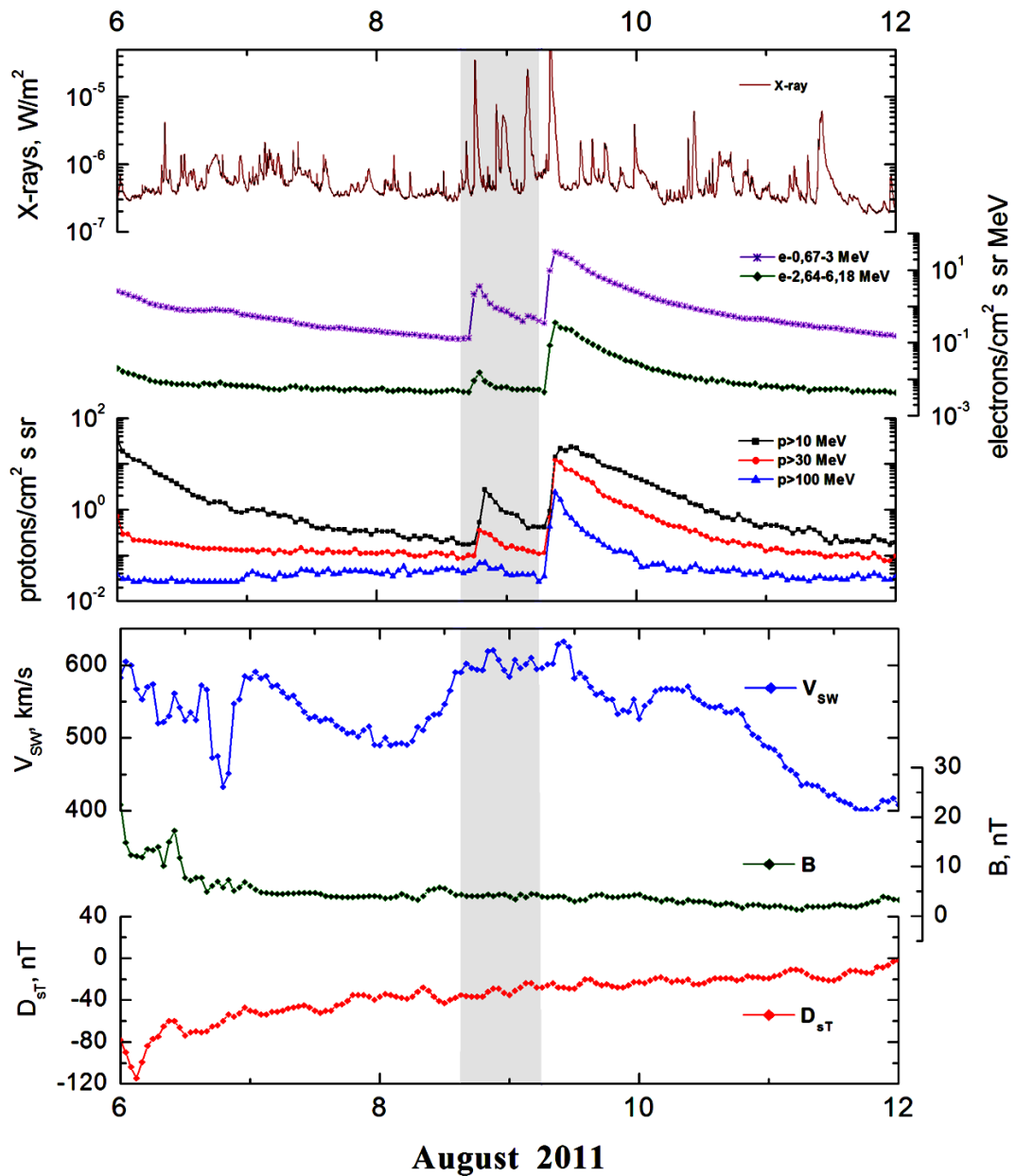
Quasimaximal energy of protons in the event – $E_{qm} = 100$ MeV

Sources: • solar flare 08d18^h00^m, M3.5/1B, N16W61, AR11263

Main burst X-ray 1–8 Å: onset – 08d18^h00^m, max – 08d18^h10^m, $\Phi = 0.022 \text{ J/m}^2$

CME: 18d18^h12^m, $V = 1343 \text{ km/s}$, $\Delta\phi = 237^\circ$, $dA = 281^\circ$

Particle fluxes and associated phenomena

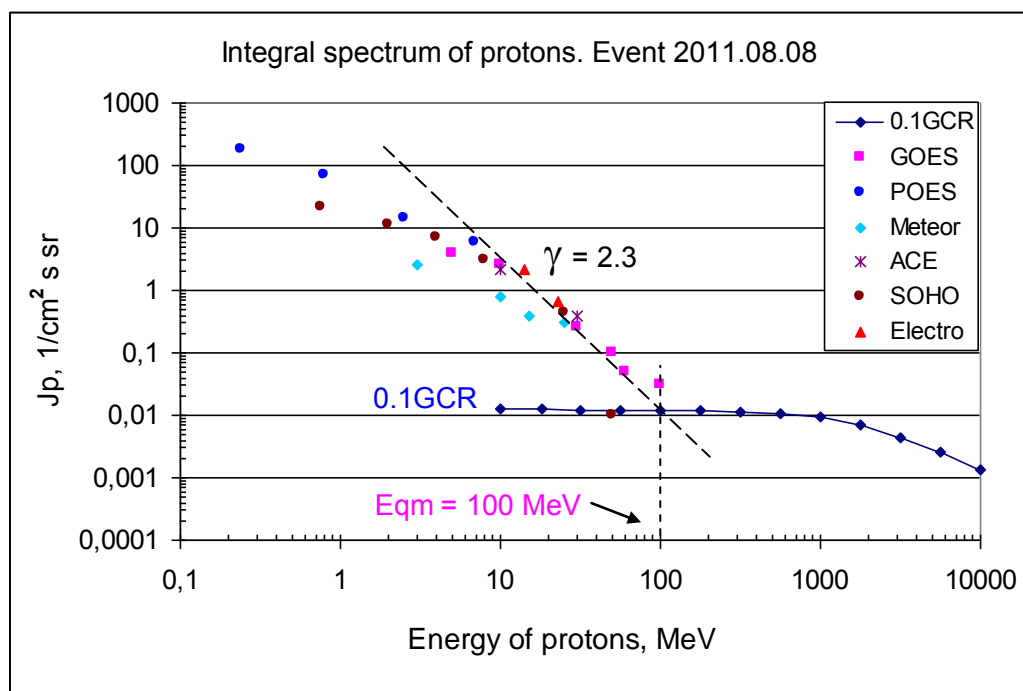


Integral fluxes of protons for the event of 2011 August 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	19	21	4	0.5	0.2	
EPS	>10	19	20	2.6	0.5	0.15	
EPS	>30	19	19	0.25	0.5	0.08	
EPS	>50	19	19	0.1	0.5	0.07	
EPS	>60	19	19	0.05	0.5	0.06	
EPS	>100	19	19	0.03	0.5	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	23	9d03	180	0.5	150	
MEPED	>0.8	23	9d03	70	0.5	80	
MEPED	>2.5	23	9d02	14	0.5	60	
MEPED	>6.9	-	9d02	6	0.5	45	
MEPED	>16	-	-	-	-	0.9	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	18	-	-	0.5	3.1	
SCR	>3	18	19	2.6	0.5	3	
SCR	>10	18	19	0.8	0.5	2.1	
GALS-M	>15	18	19	0.4	0.5	0.7	
GALS-M	>25	18	19	0.3	0.5	0.7	
GALS-M	>600	-	-	-	0.25	0.02	
ACE							
SIS	>10	17	19	2.1	0.5	1.6	
SIS	>30	17	19	0.4	0.5	1.1	
SOHO							
EPHIN	>50	18	19	0.01	06	0.3	

Differential fluxes of protons for the event of 2011 August 08

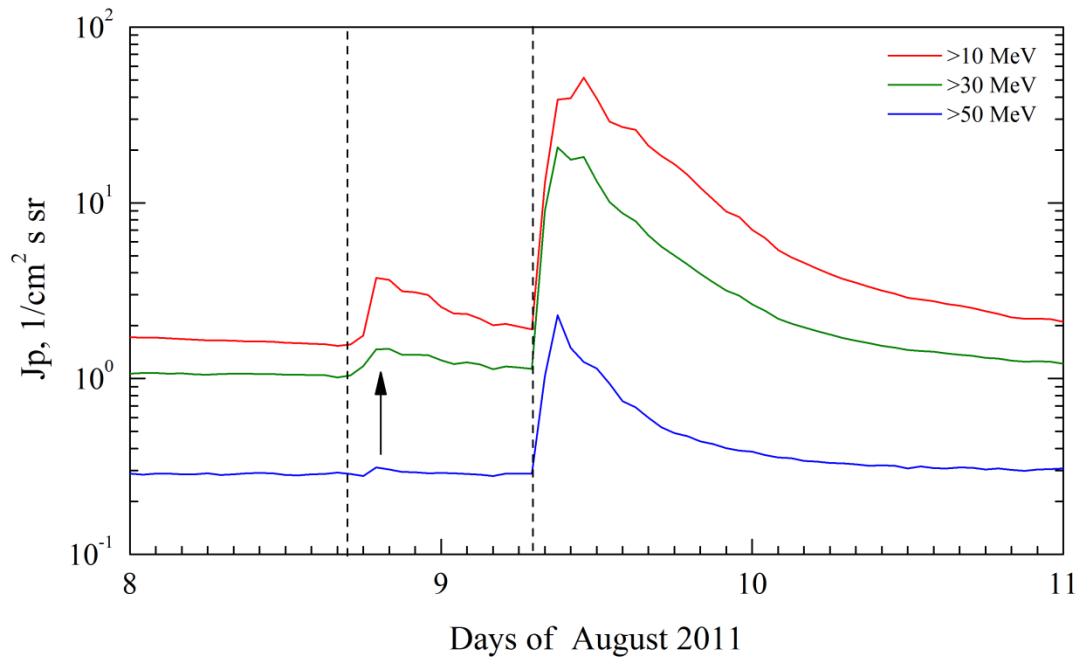
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	21	9d08	7.9	0.6	0.02	
LION	2 – 6	21	9d00	1.27	0.6	0.0035	
EPHIN	4 – 8	19	23	1.0	0.6	0.0003	
EPHIN	8 – 25	19	19	0.16	0.6	0.00003	
EPHIN	25 – 53	18	20	0.015	0.6	0.00003	
Electro-1							
SCR-E	13.7–23	18	19	0.15	0.25	0.025	
SCR-E	23–42	18	19	0.035	0.25	0.05	
SCR-E	42–112	-	-	-	-	0.001	



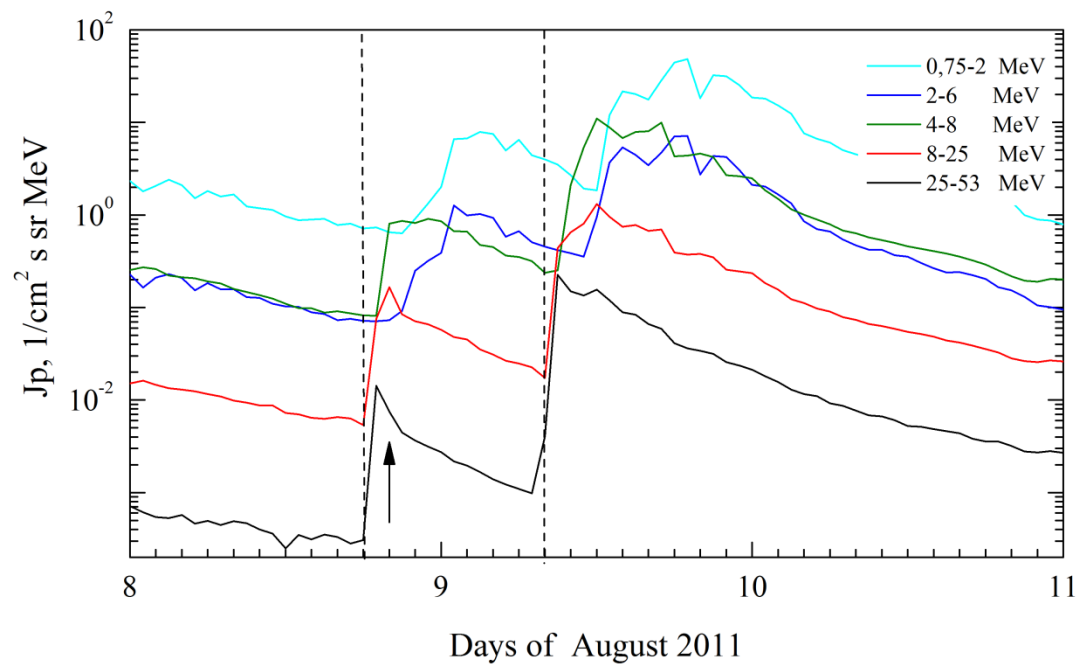
Time profiles of proton fluxes in the event 2011.08.08

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

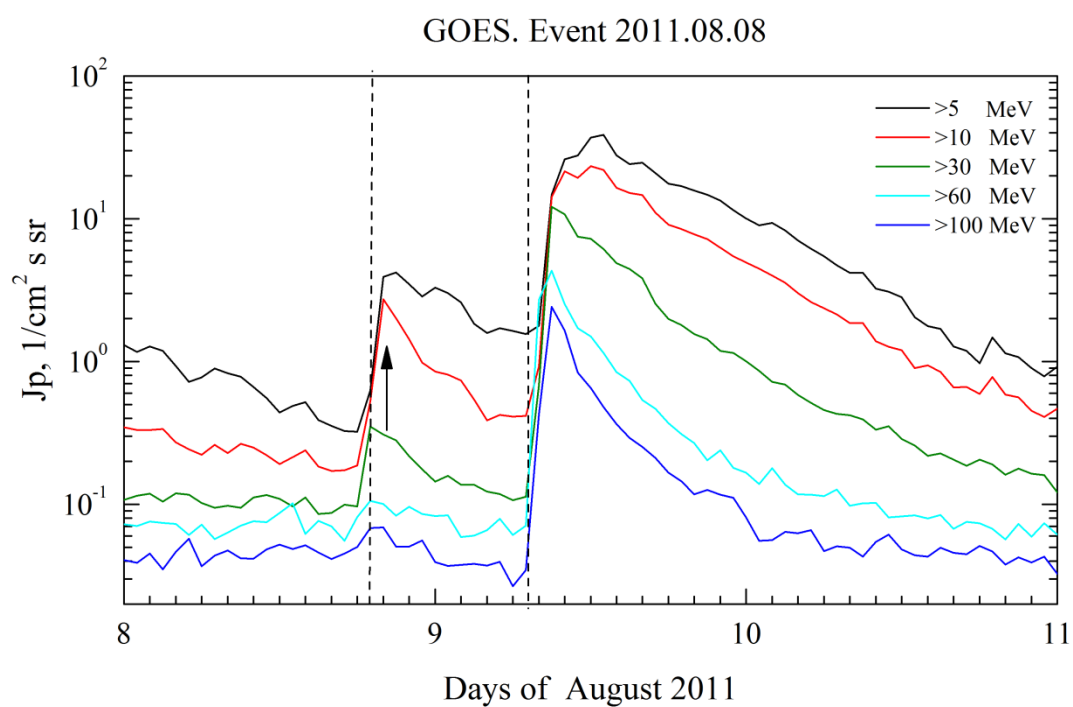
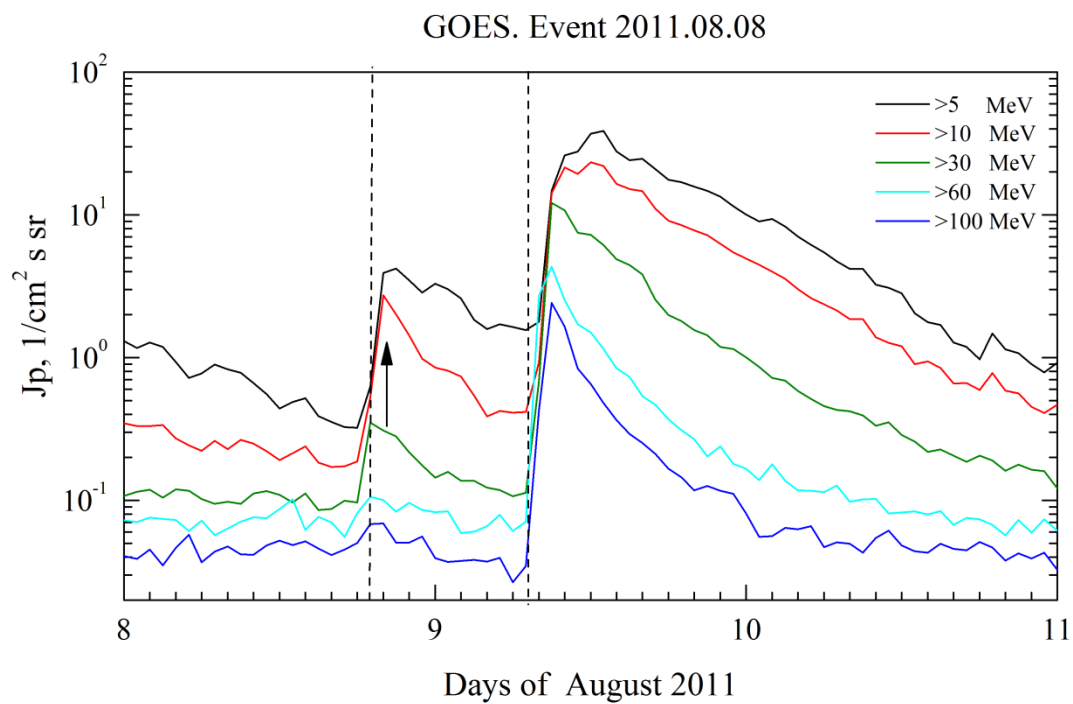
ACE SIS + SOHO (>50 MeV). Event 2011.08.08



SOHO. Event 2011.08.08

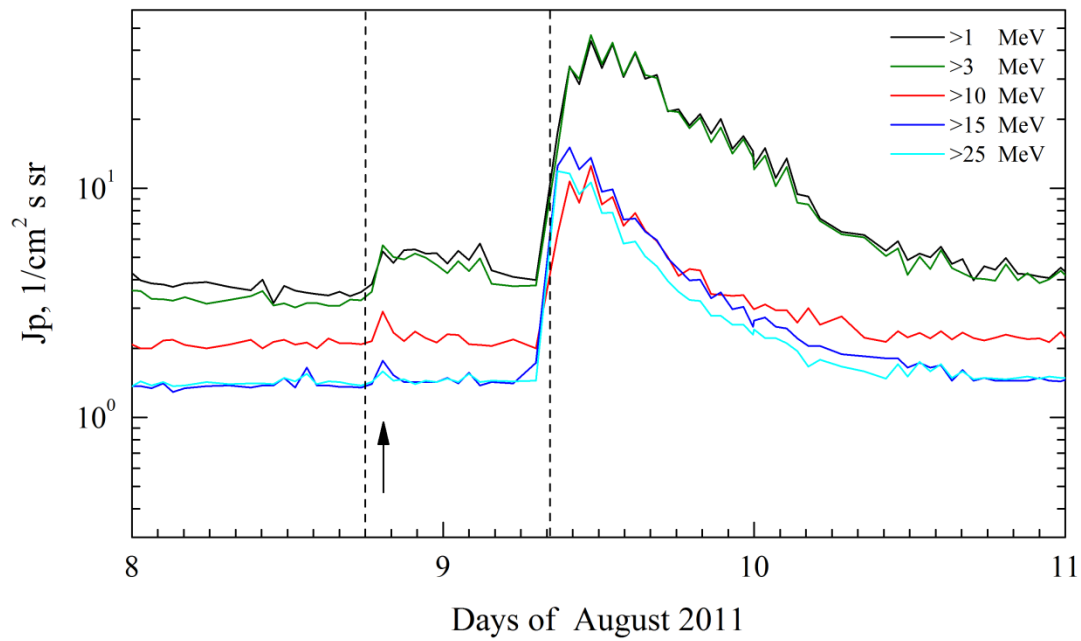


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

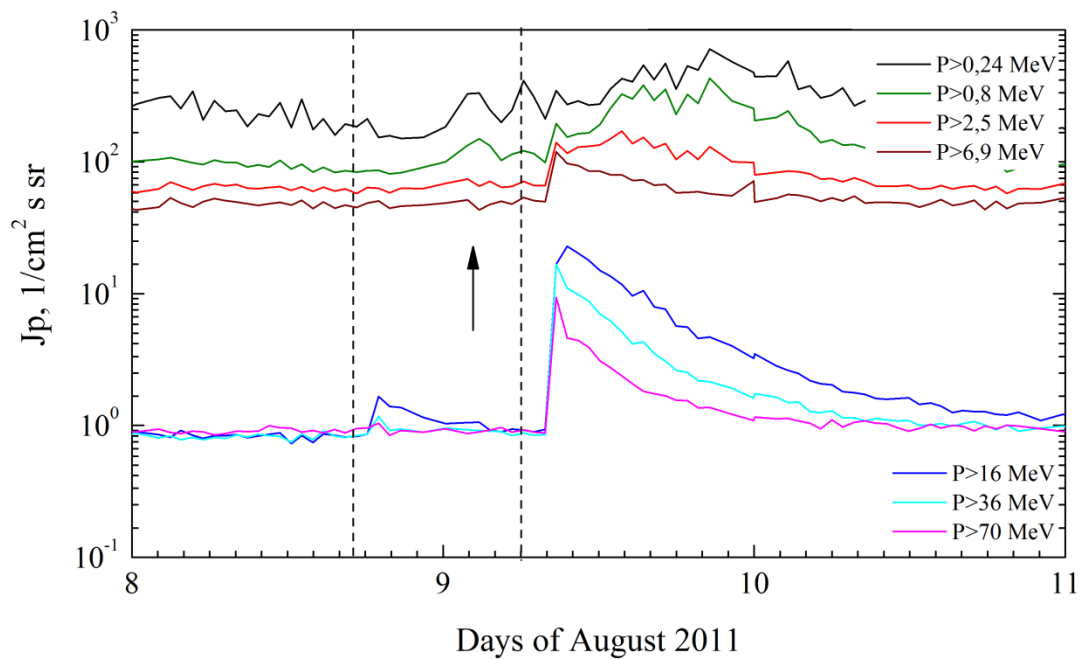


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.08.08



POES. Events 2011.08.08



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 August 08**

2011

August 08

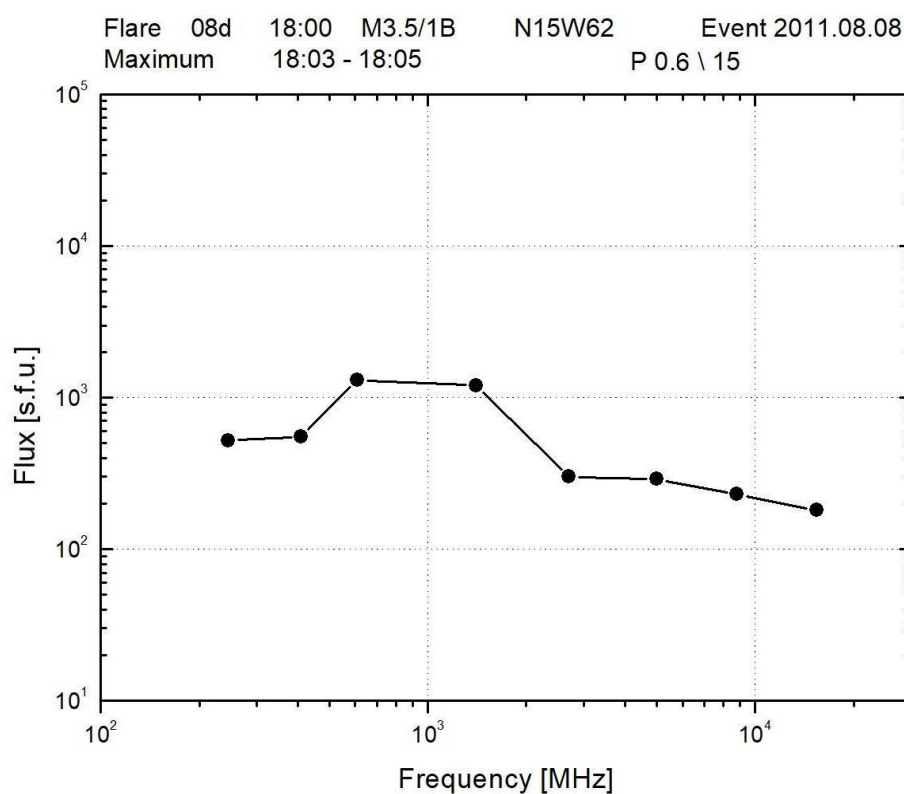
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AR 11263

To event 491

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	1804	1810	1855	N16W61	1B	ERU
1 – 12	keV	1800	1810	1818	N15W62	M3.5	0.022
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1826:40	1827:34	1907:12	46	123972	HESSI
12-25	keV	1802:34	1803:48	1804:05	45033	1401419	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1803	1803	1805		2.25	
8.8	GHz	1803	1803	1805		2.36	
5	GHz	1803	1803	1818		2.46	
2.7	GHz	1803	1805	1818		2.48	
1.4	GHz	1803	1804	1817		3.08	
610	MHz	1803	1805	1812	P0.6 \ 15	3.11	
410	MHz	1803	1804	1808		2.74	
245	MHz	1803	1804	1826		2.72	
410	MHz	1846	1847	1849		2.25	
245	MHz	1832	1833	1849		2.20	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-135	1803		1816		1	
DS IV	025-180	1803		2111		2	
DS VI	025-180	1800		1752		2	
DH II	0.4-6	1810		2010			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1812	1343	-42.3	237°	281°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR11263 (N17L301, CMP 03.5.08.2011,
Sp=720 msh; Ekc; BGD)
XRI=7.67, $X_1^{6.9} + M_3^{3.5} + C_{33}$; $2_1 + 1_3 + S_{96}$)
PFR 8-9.08 (14^h) $X_1^{6.9} + M_2^{3.5}$

References:

Bruevich E.A., G.V. Yakunina, [2017](#).
Kahler S.W., D. Brown, [2021](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 09d08^h

Tmax($E_p > 10$ MeV) – 09d10^h, Jmax($E_p > 10$ MeV) – 21.3 /cm²·s·sr

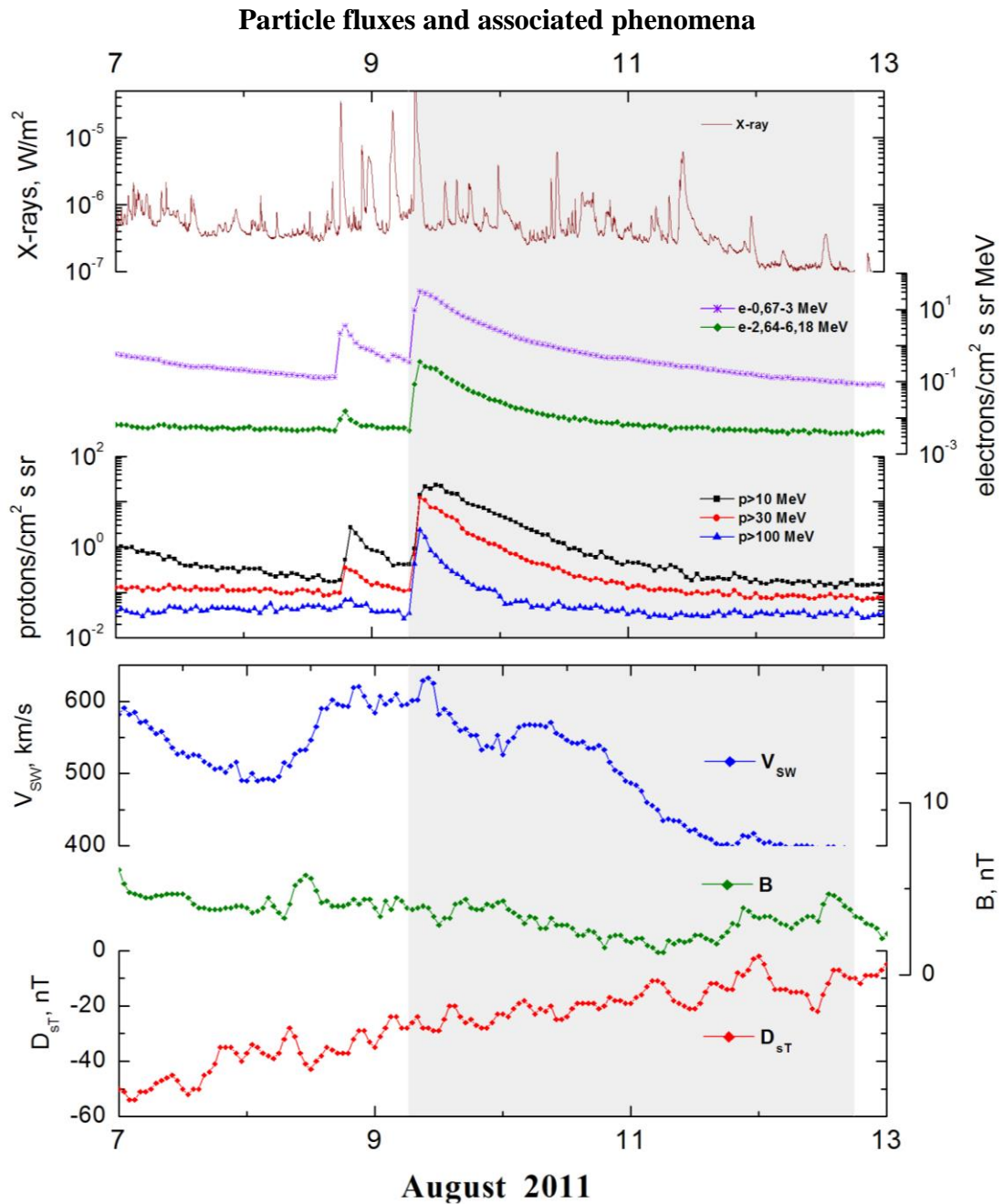
Duration of the event – 2.5 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 650$ MeV

Sources: ● solar flare 09d07^h48^m, X6.9/2B, N17W69, AR11263

Main burst X-ray 1–8 Å: onset – 09d07^h48^m, max – 09d08^h05^m, $\Phi = 0.190$ J/m²

CME: 09d08^h12^m, $V = 1610$ km/s, $\Delta\phi = 360^\circ$, $dA = 279^\circ$

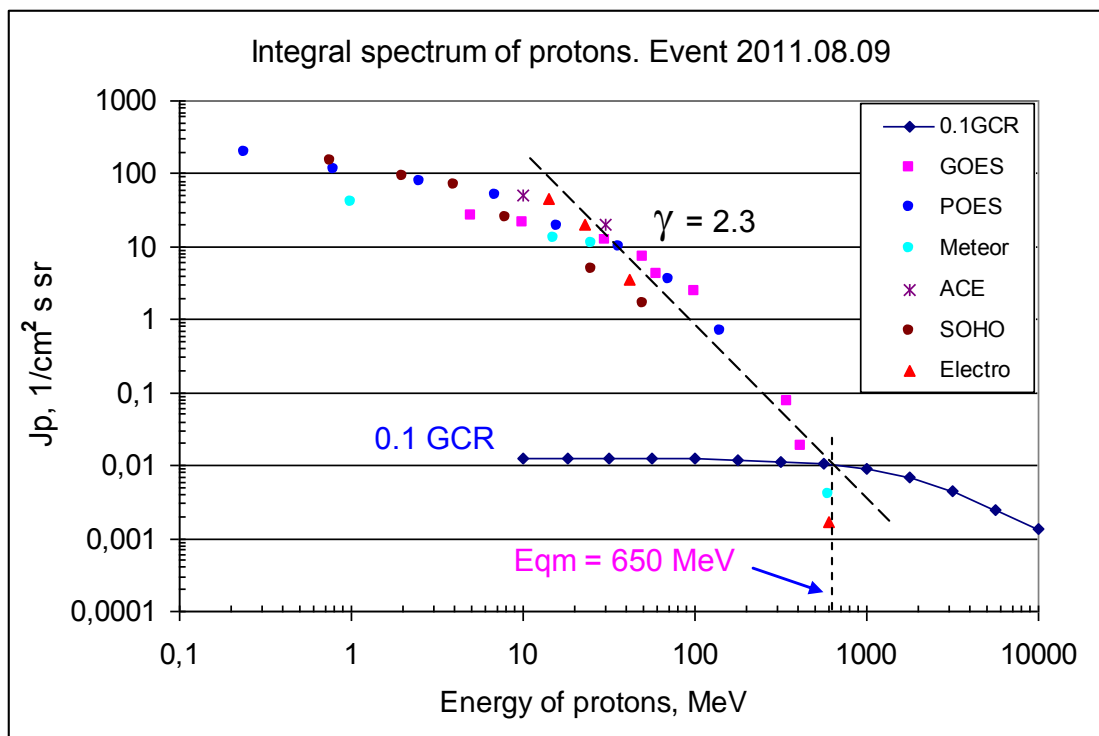


Integral fluxes of protons for the event of 2011 August 09

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	08	10	26	2.5	0.2	
EPS	>10	08	10	21.3	2.5	0.15	
EPS	>30	08	09	12.1	2	0.08	
EPS	>50	08	09	7.2	2	0.07	
EPS	>60	08	09	4.25	1.5	0.06	
EPS	>100	08	09	2.4	1.5	0.04	
Electro-1							
GALS-E	>600	8	9	0.0017	0.5	0.001	
POES							
MEPED	>0.24	6	10	195	2.5	150	
MEPED	>0.8	6	10	115	2	80	
MEPED	>2.5	6	10	80	2	60	
MEPED	>6.9	6	10	50	1.5	45	
MEPED	>16	6	10	19	1.5	0.9	
MEPED	>36	6	10	10	1	0.9	
MEPED	>70	6	10	3.5	0.5	0.9	
MEPED	>140	6	10	0.7	5	1.2	
Meteor-1							
SCR	>1	6	11	40	2	3.1	
SCR	>3	6	-	-	2	2.55	
SCR	>10	6	-	-	1	2.1	
GALS-M	>15	6	9	13	1	0.7	
GALS-M	>25	6	8	11	1	0.75	
GALS-M	>600	6	8	0.004	0.25	0.02	
ACE							
SIS	>10	08	11	50	2.5	1.6	
SIS	>30	08	09	19.6	2	1.1	
SOHO							
EPHIN	>50	06	09	1.7	1	0.3	

Differential fluxes of protons for the event of 2011 August 09

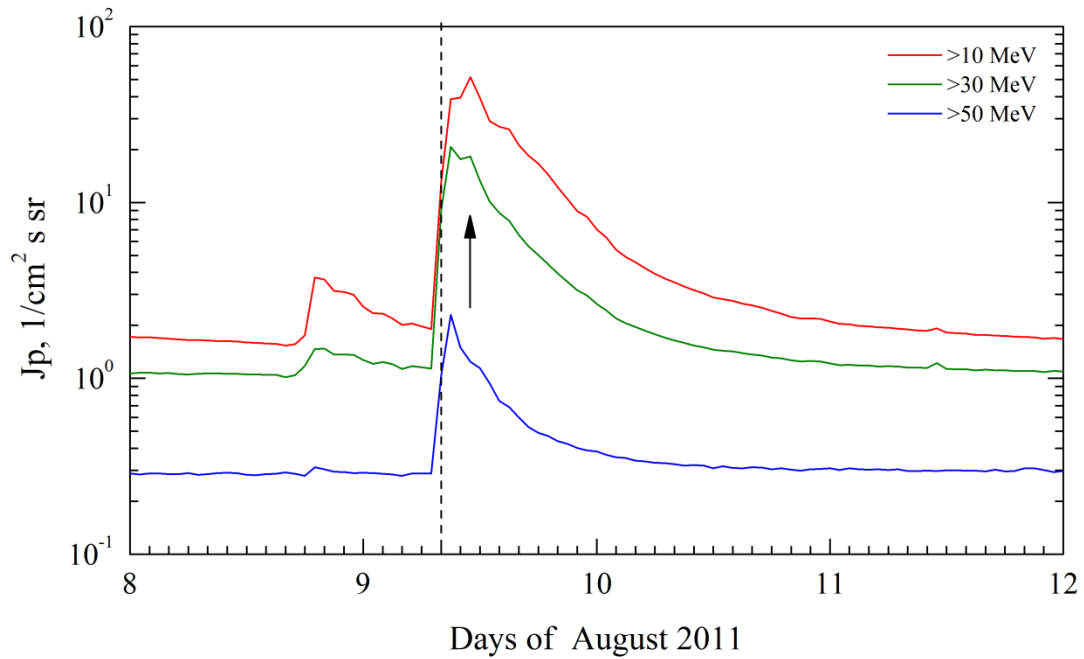
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	12	18	48.4	5	0.018	
LION	2 – 6	11	18	7.15	5	0.0035	
EPHIN	4 – 8	09	12	10.9	7	0.0003	
EPHIN	8 – 25	08	12	1.2	7	0.00003	
EPHIN	25 – 53	08	11	0.11	5	0.00003	
GOES							
EPS	350–420	8	9	0.0008	0.5	0.0016	
EPS	420–510	7	9	0.0002	0.3	0.001	
EPS	510–700	-	-	-	-	0.0001	
Electro-1							
SCR-E	13.7–23	8	9	2.8	1.5	0.068	
SCR-E	23–42	8	9	0.87	1.5	0.026	
SCR-E	42–112	8	9	0.05	1	0.005	



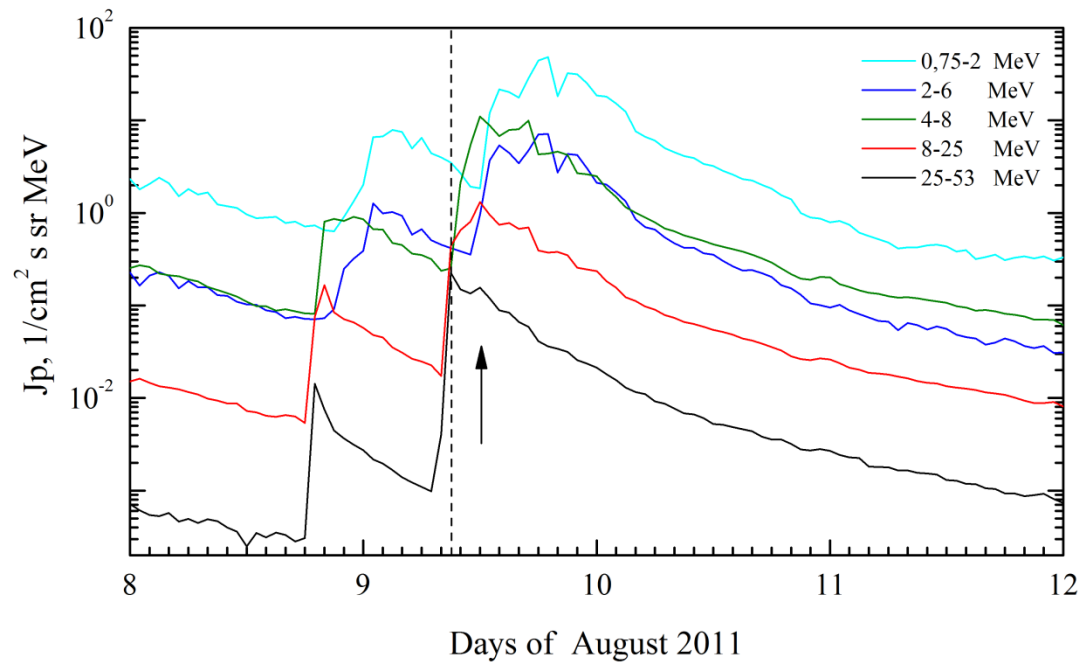
Time profiles of proton fluxes in the event 2011.08.09

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50MeV). Event 2011.08.09

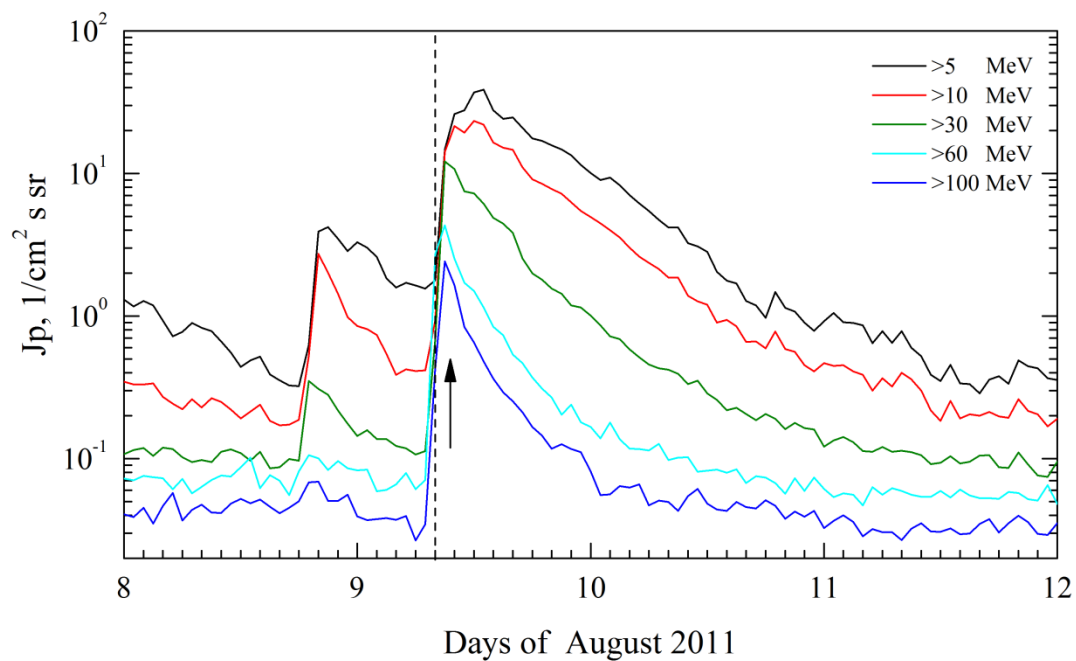


SOHO. Event 2011.08.09

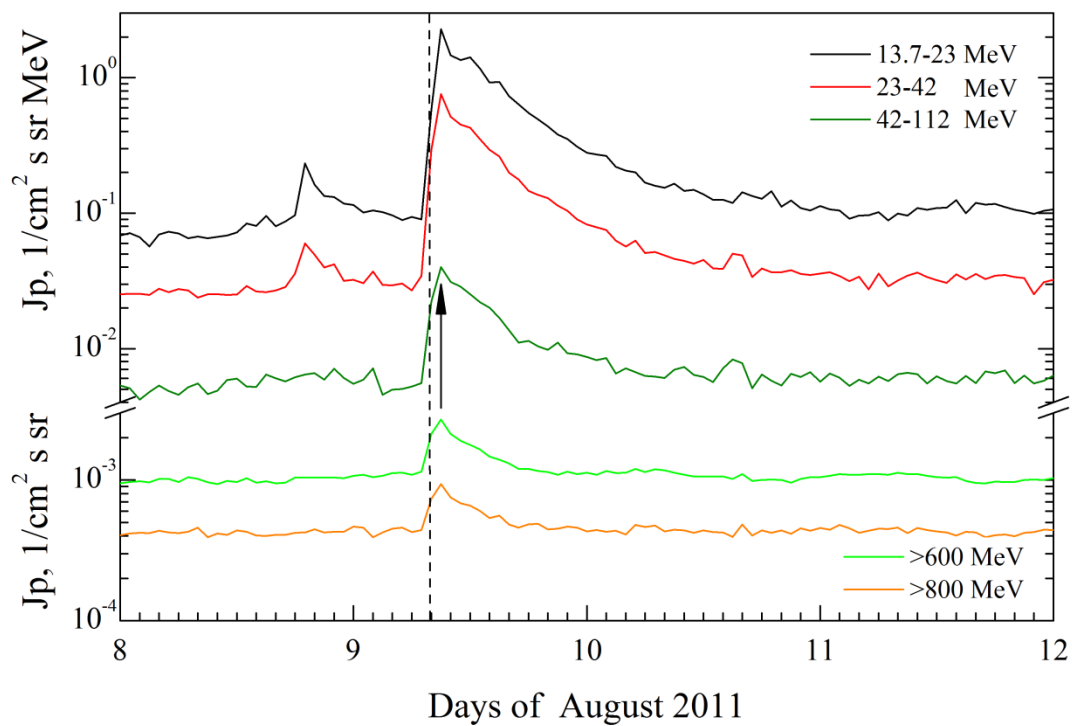


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2011.08.09

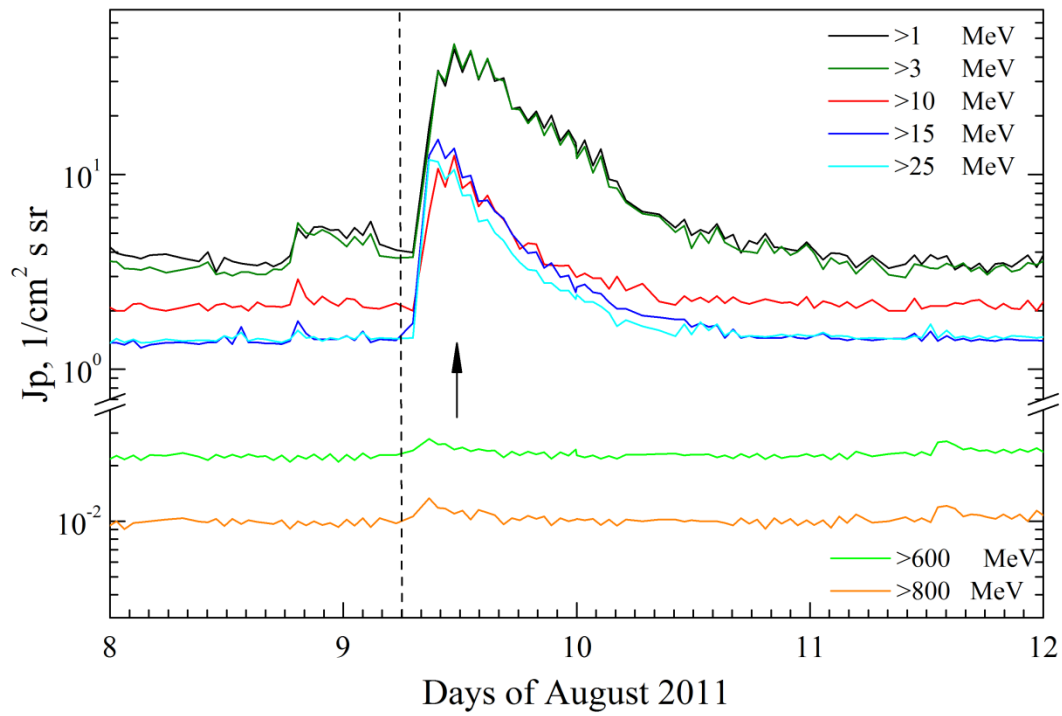


Electro. Event 2011.08.09

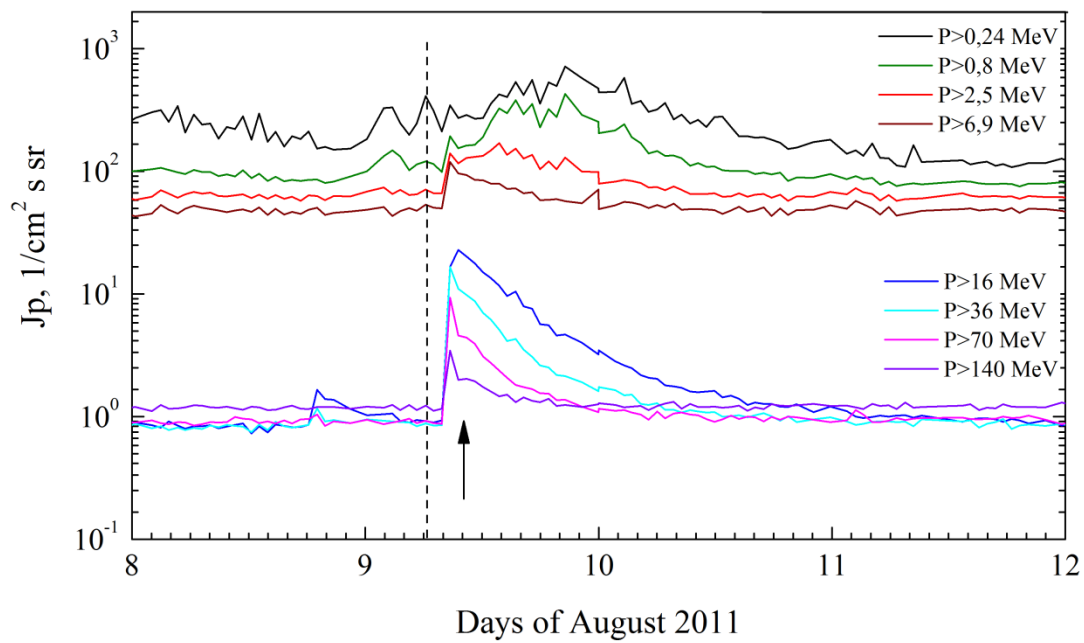


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.08.09



POES. Events 2011.08.09



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 August 09**

2011

August 09

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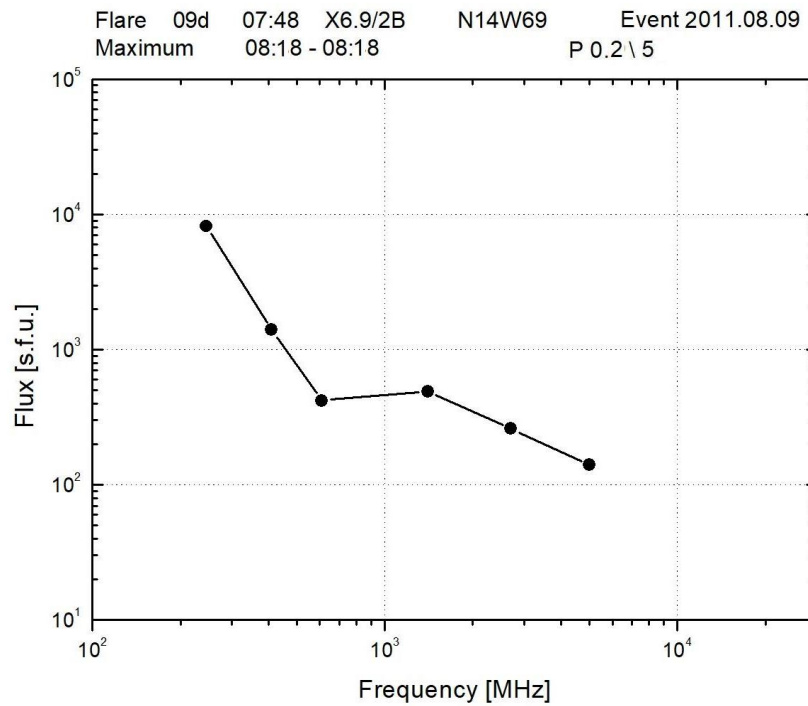
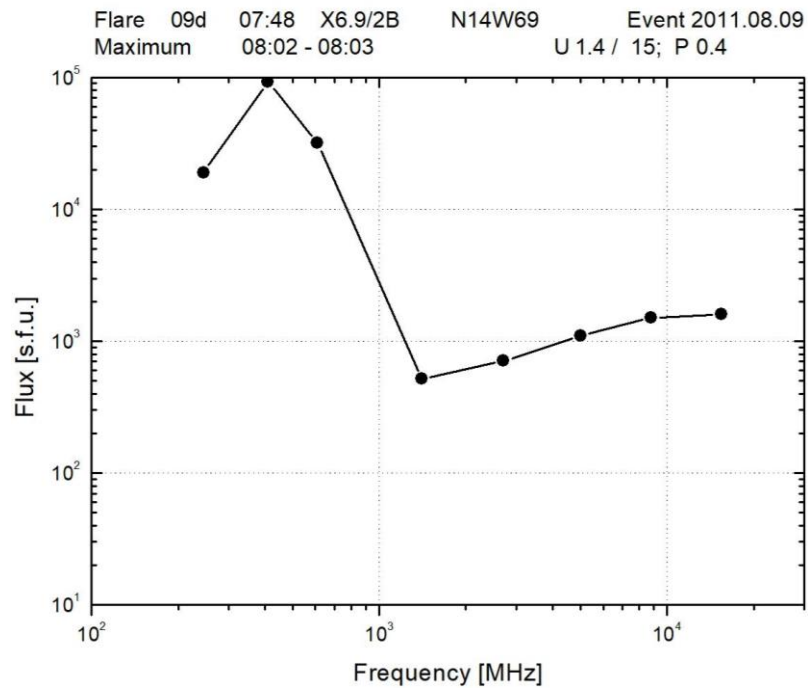
AR 11263

To event 492

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	0754	0806	0904	N17W69	2B	ERU
1 – 12	keV	0748	0805	0808	N14W69	X6.9	0.19
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0744:36	0804:34	0822:12	53158	73353352	HESSI
12-25	keV	0848:56	0849:42	0900:16	100	188364	HESSI
6-12	keV	0900:16	0901:54	0902:00	40	17440	HESSI
12-25	keV	0749:53	0807:46	0824:10	1192144	454029280	FERMI
300	keV	0748		0808			FERMI*
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0801	0803	0807		3.2	
8.8	GHz	0801	0803	0807		3.18	
5	GHz	0801	0802	0807		3.04	
2.7	GHz	0801	0802	0806		2.85	
1.4	GHz	0801	0802	0806	U1.4 / 15	2.72	
610	MHz	0759	0802	0806		4.51	
410	MHz	0800	0802	0808	P 0.4	4.97	
245	MHz	0800	0802	0809		4.28	
5	GHz	0818	0818	0818		2.15	
2.7	GHz	0817	0818	0819		2.41	
1.4	GHz	0817	0818	0819	P0.2 \ 5	2.69	
610	MHz	0818	0818	0819		2.62	
410	MHz	0817	0818	0819		3.15	
245	MHz	0817	0818	0820		3.91	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-180	0801		0816		1	
DS IV	025-084	0820		0840		1	
DS III	025-180	0817		0819	G	1	
DS VI	025-151	0838		0920	G	1	
DH II	4-16	0820		0835			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0812	1610	-40.6	360°	279°	SOHO

*Share et al., 2018

Radio bursts frequency spectrum



Proton Active Region

AR11263 (N17L301, CMP 03.5.08.2011,
Sp=720 msh; Ekc; BGD)
XRI=7.67, $X_1^{6.9}+M_3^{3.5}+C_{33}; 2_1+1_3+S_{96}$)
PFR 8-9.08 (14^h) $X_1^{6.9}+M_2^{3.5}$

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Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 06d02^h

Tmax ($E_p > 10$ MeV) – 06d09^h, Jmax ($E_p > 10$ MeV) – $1.4 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1 day, power-law index: $\gamma = 2.2$

Quasimaximal energy of protons in the event – $E_{qm} = 200$ MeV

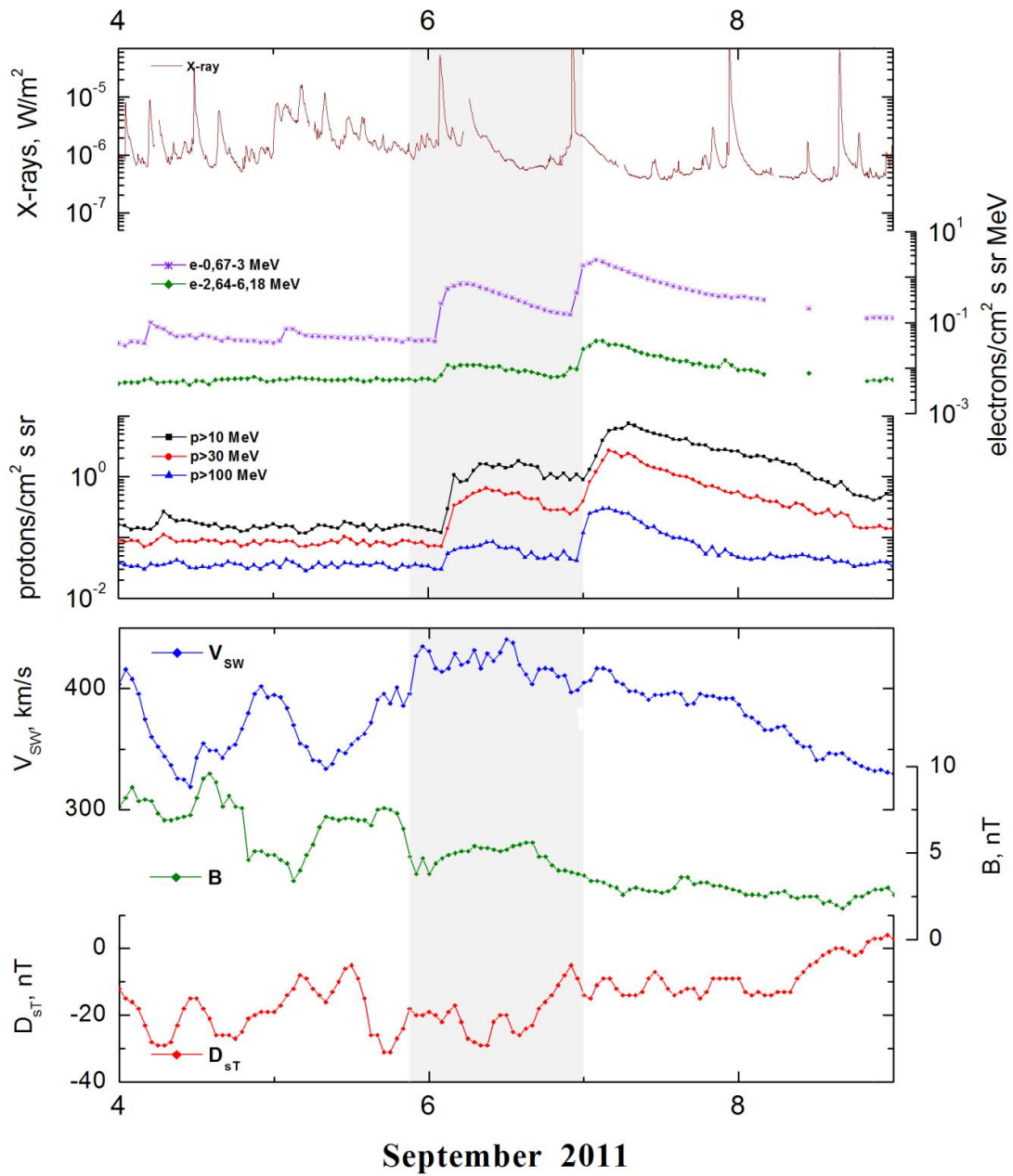
Sources: ● solar flare 06d01^h35^m, M5.3/1B, N14W07, AR11283

Main burst X-ray 1–8 Å: onset – 06d01^h35^m, max – 06d01^h50^m, $\Phi = 0.54 \text{ J/m}^2$

CME: 06d02^h24^m, $V = 782 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 70^\circ$

▲ SC 09d12^h42^m; ▲ SC 09d13^h18^m

Particle fluxes and associated phenomena

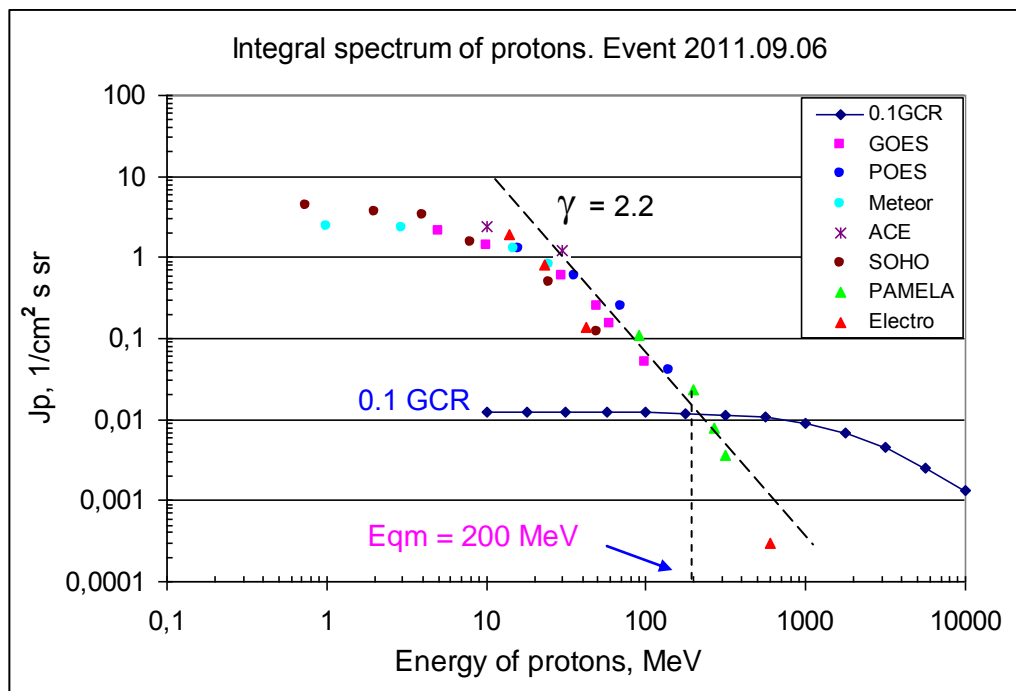


Integral fluxes of protons for the event of 2011 September 06

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	9	2.1	1	0.2	
EPS	>10	2	9	1.4	1	0.15	
EPS	>30	2	9	0.6	1	0.08	
EPS	>50	2	9	0.25	1	0.06	
EPS	>60	2	9	0.15	1	0.05	
EPS	>100	2	9	0.05	1	0.04	
Electro-1							
GALS-E	>600	2	11	0.0003	0.5	0.0008	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	80	
MEPED	>2.5	-	-	-	-	60	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	2	11	1.3	1	0.9	
MEPED	>36	2	11	0.6	1	0.9	
MEPED	>70	2	11	0.25	1	1	
MEPED	>140	2	11	0.04	0.5	1.3	
Meteor-1							
SCR	>1	2	12	2.4	1	3.2	
SCR	>3	2	10	2.3	1	3	
SCR	>10	2	-	-	1	2.1	
GALS-M	>15	2	09	1.3	1	1.45	
GALS-M	>25	2	09	0.8	1	1.5	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	01	08	2.4	1	1.6	
SIS	>30	01	08	1.2	1	1.1	
SOHO							
EPHIN	>50	02	04	0.12	1	03	
PAMELA							
TRACKER	>90	02	05	0.11	1		
TRACKER	>200	02	05	0.023	1		
TRACKER	>265	02	05	0.0078	1		
TRACKER	>312	02	05	0.0036	1		

Differential fluxes of protons for the event of 2011 September 06

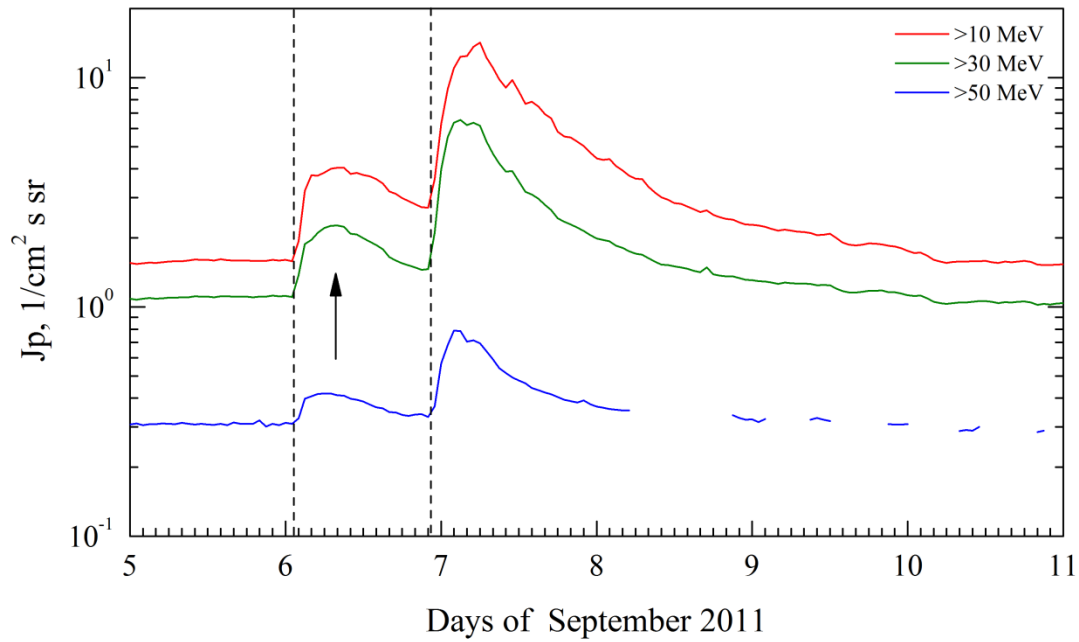
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	3	07	0.53	1	0.01	
LION	2 – 6	3	05	0.12	1	0.002	
EPHIN	4 – 8	3	05	0.45	1	0.0006	
EPHIN	8 – 25	2	04	0.063	1	0.00003	
EPHIN	25 – 53	2	10	0.012	1	0.00003	
Electro-1							
SCR-E	13.7–23	2	12	0.12	1	0.07	
SCR-E	23–42	2	12	0.04	1	0.025	
SCR-E	42–112	2	12	0.002	1	0.005	



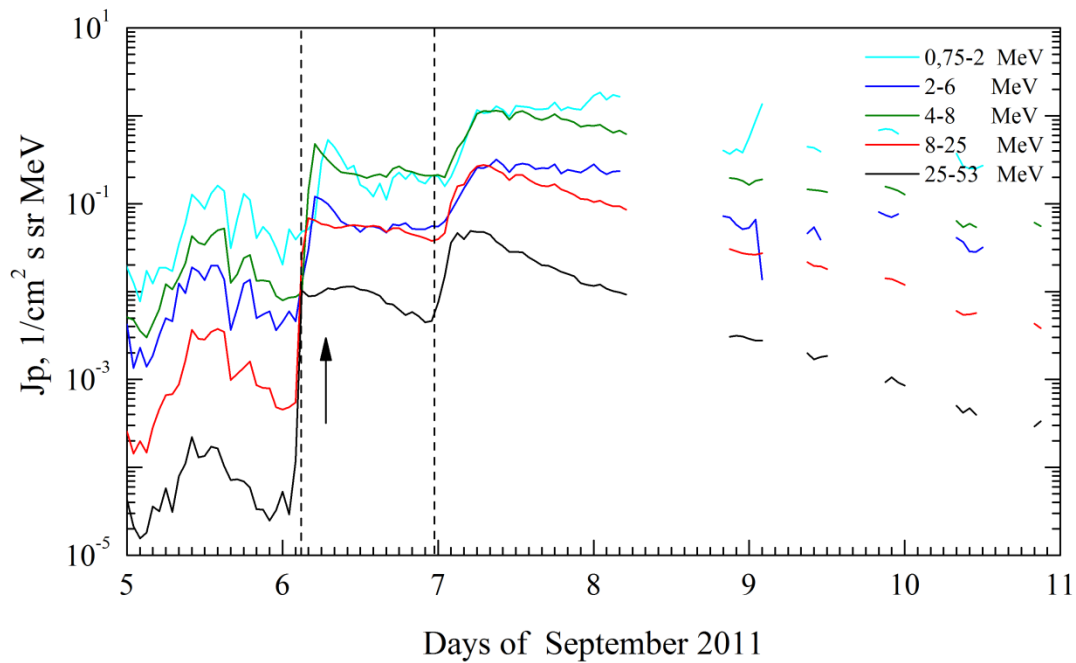
Time profiles of proton fluxes in the event 2011.09.06

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.09.06

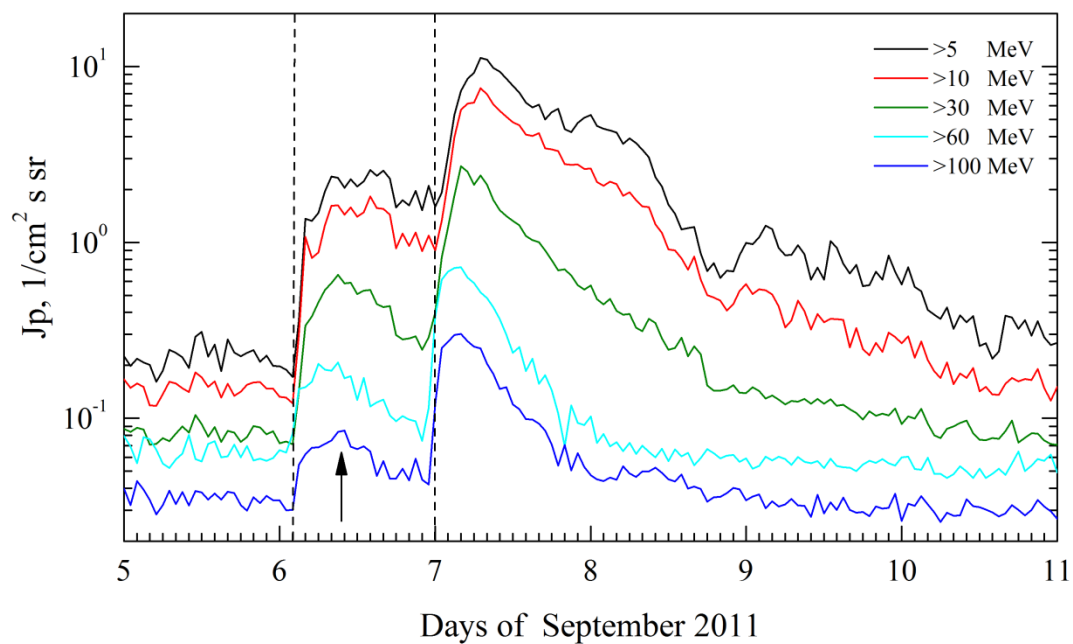


SOHO. Event 2011.09.06

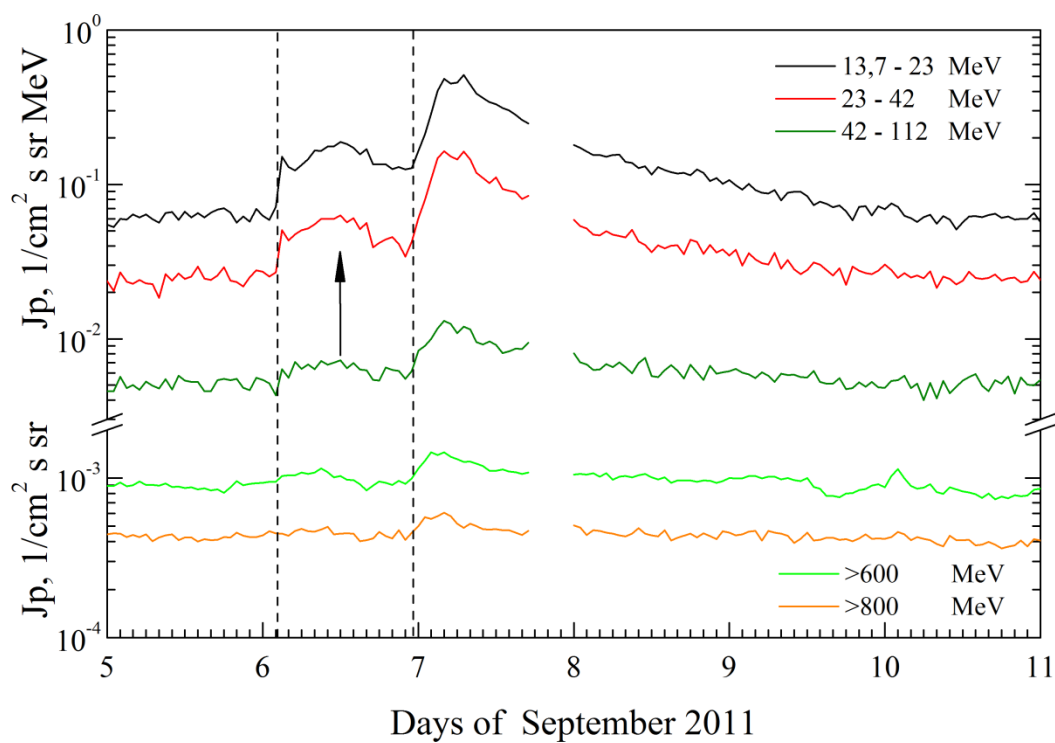


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro.

GOES. Event 2011.09.06

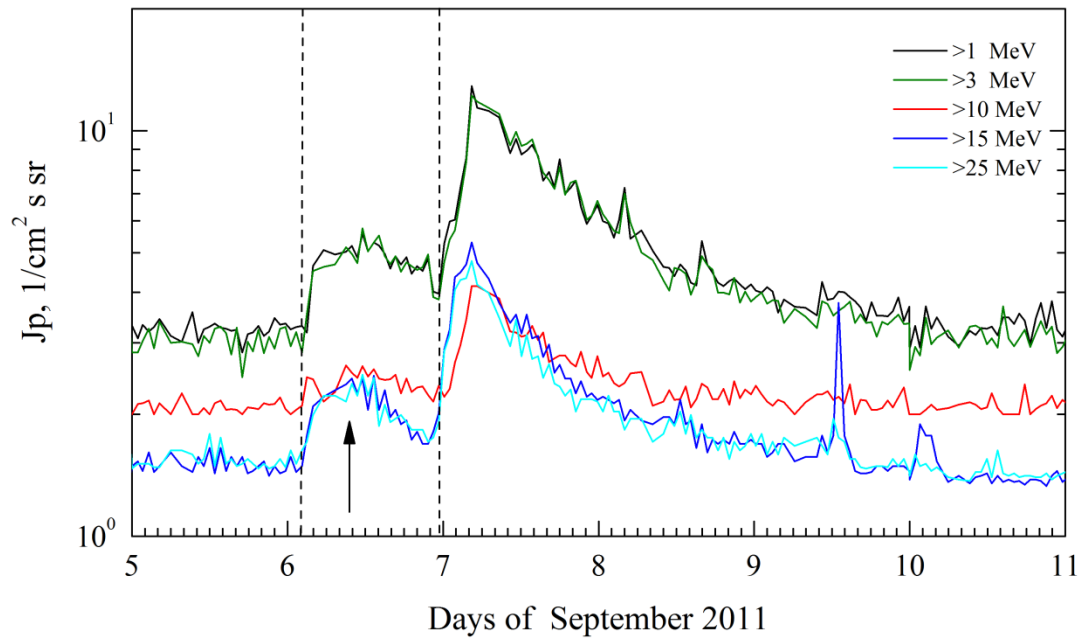


Electro. Event 2011.09.06

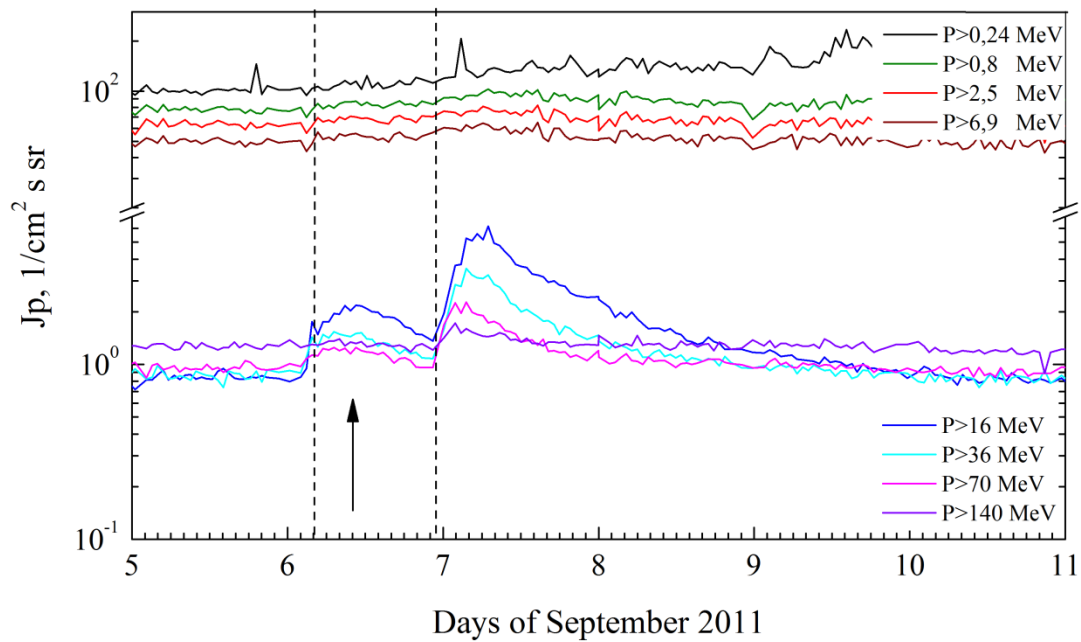


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.09.06



POES. Events 2011.09.06



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 September 06**

2011

September 06

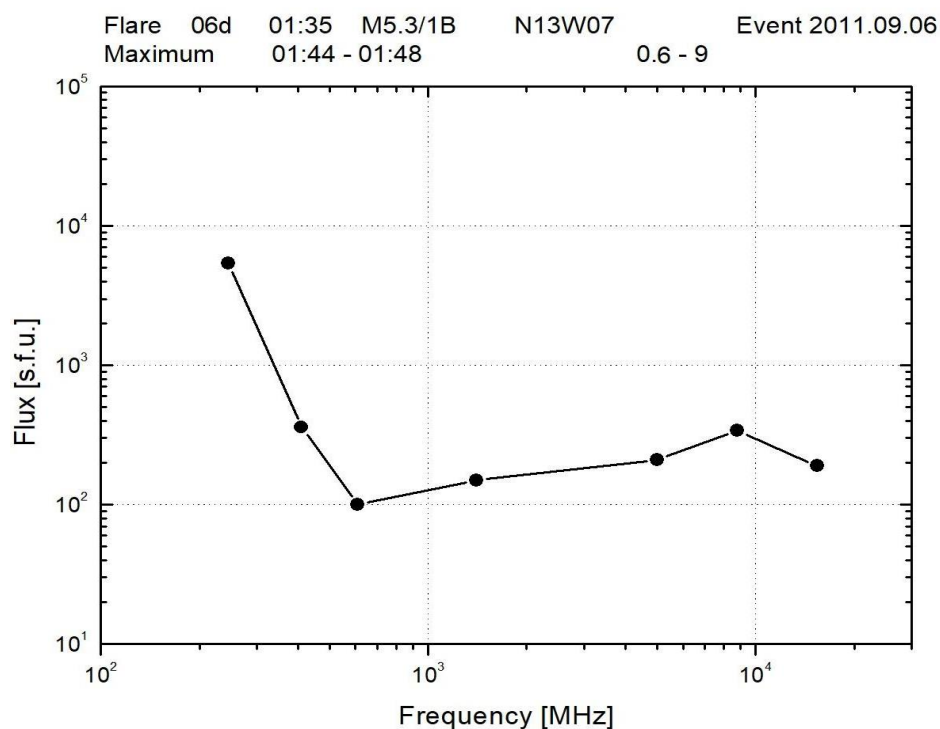
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AR 11283

To event 493

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	0143	0149	0236	N14W07	1B	ERU
1 – 12	keV	0135	0150	0205	N13W07	M5.3	0.54
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0135:44	0146:06	0147:16	4724	3853820	HESSI
12-25	keV	0136:39	0147:37	0217:58	664560	327615040	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0144	0144	0146		2.28	
8.8	GHz	0143	0144	0149		2.53	
5	GHz	0144	0144	0148		2.32	
1.4	GHz	0144	0144	0144		2.18	
610	MHz	0148	0148	0148	0.6 – 9	2.0	
410	MHz	0143	0144	0149		2.56	
245	MHz	0142	0146	0149		4.73	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	050-300	0146		0153		3	
DS IV	034-102	0232		0410		1	
DS III	018-550	0144		0146		1	
DS III	025-119	0224		0229		1	
DS V	025-180	0143		0153		1	
DH II	0.2-14	0200		2340			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0224	782	105.6	360°	70°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR11283 (N14L224,CMP 5,7.09.2011,
Sp=230 msh, DAI, BGD)
XRI= 5.60 $X2^{2.1}+M5^{6.7}+C13$ $2_1+1_1+S_{27}$
PFR 6-8.09 - 61^h $X2^{2.1}+M2^{6.7}$

References:

- Bruno A., I.G. Richardson, [2021](#).
Gopalswamy N., S. Yashiro, P. Mäkelä et al., [2021](#).
Grechnev V., V. Kiselev, N. Meshalkina, I. Chertok, [2017](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
de Nolfo G.A., A. Bruno, J.M. Ryan et al., [2019](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Wang Y., D. Lyu, B. Xiao et al., [2021](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zuccarello F., I. Ermolli, M.B. Korsos et al., [2021](#).

Particle event: To($E_p > 10$ MeV) – 07d02^h

Tmax ($E_p > 10$ MeV) – 07d05^h, Jmax ($E_p > 10$ MeV) – 6 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 2.1$

Quasimaximal energy of protons in the event – $E_{qm} = 420$ MeV

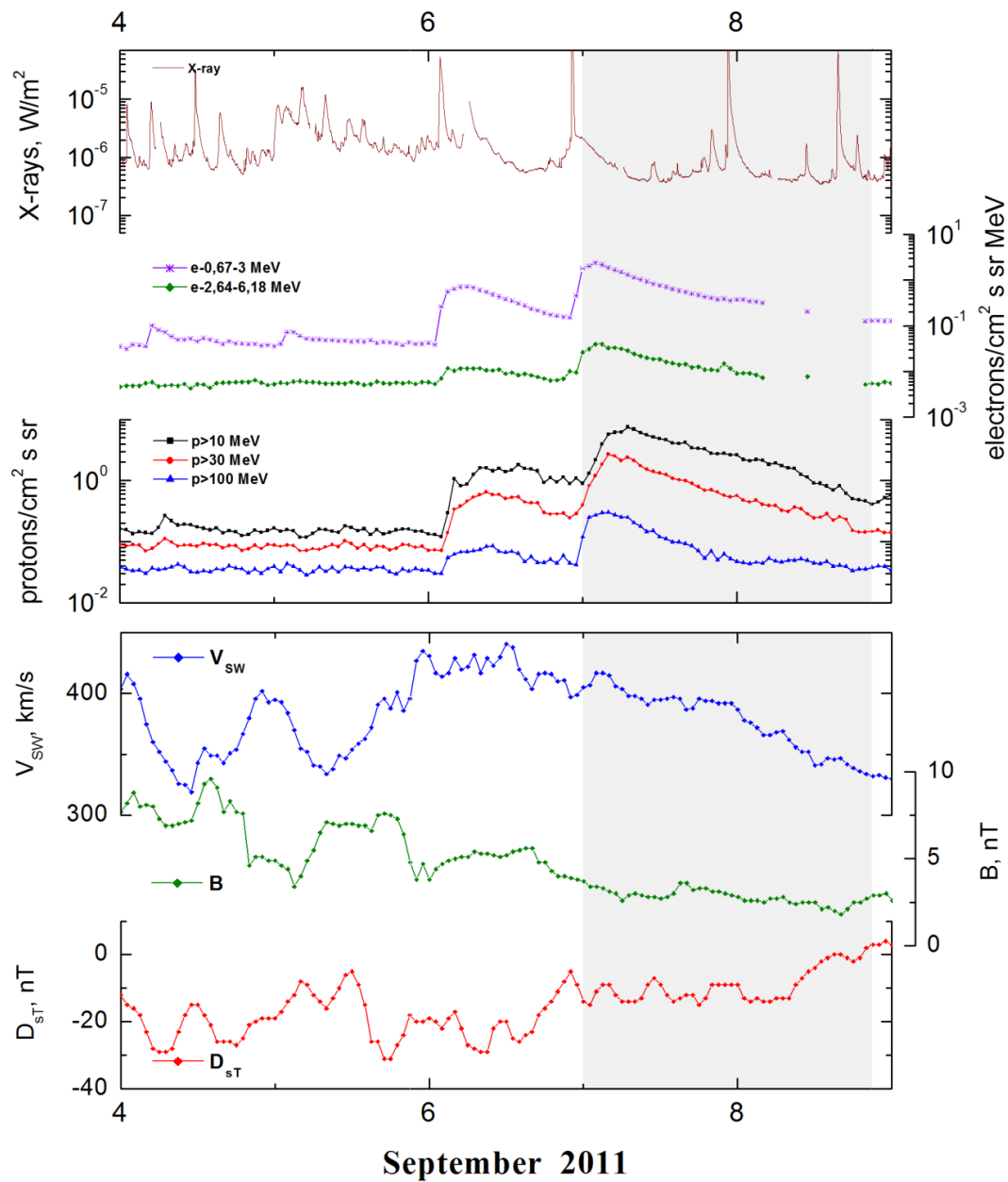
Sources: ● solar flare 06d22^h12^m, X2.1/2B, N14W18, AR11283

Main burst X-ray 1–8 Å: onset – 06d22^h12^m, max – 06d22^h20^m, $\Phi = 0.58$ J/m²

CME: 06d23^h05^m, $V = 0575$ km/s, $\Delta\phi = 360^\circ$, $dA = 300^\circ$

▲ SC 09d12^h42^m; ▲ SC 09d13^h18^m

Particle fluxes and associated phenomena

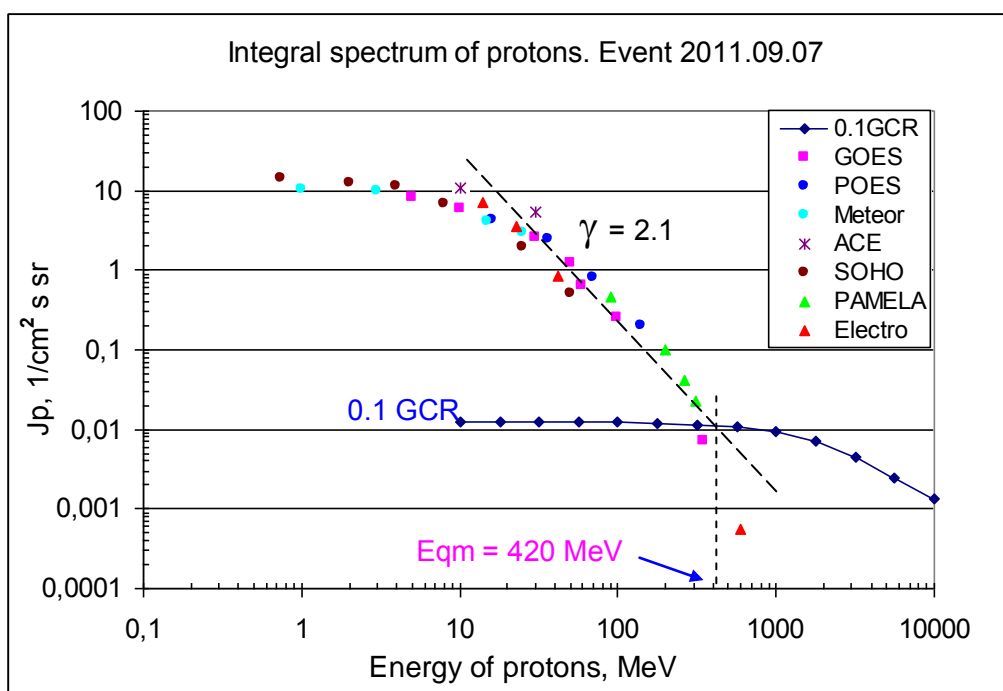


Integral fluxes of protons for the event of 2011 September 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	05	8.3	2	0.2	
EPS	>10	2	05	6	2	0.15	
EPS	>30	2	05	2.6	1.5	0.08	
EPS	>50	2	05	1.2	1.5	0.06	
EPS	>60	2	05	0.65	1	0.05	
EPS	>100	2	04	0.25	1	0.04	
Electro-1							
GALS-E	>600	6d22	3	0.00055	1	0.0009	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	80	
MEPED	>2.5	-	-	-	-	60	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	6d23	3	4.2	2	0.9	
MEPED	>36	6d23	3	2.5	1.5	0.9	
MEPED	>70	6d23	3	0.8	1	1.2	
MEPED	>140	6d23	2	0.2	1	1.3	
Meteor-1							
SCR	>1	00	05	10.2	2	3.2	
SCR	>3	00	05	10	2	2.6	
SCR	>10	00	-	-	1.5	2.1	
GALS-M	>15	00	04	4	1.5	1.4	
GALS-M	>25	00	04	3	1.5	1.5	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	1	04	10.8	2	1.6	
SIS	>30	1	03	5.4	1.5	1.1	
SOHO							
EPHIN	>50	2	02	0.5	1	03	
PAMELA							
TRACKER	>90	2	02	0.46	3		
TRACKER	>200	2	02	0.099	3		
TRACKER	>265	2	02	0.041	3		
TRACKER	>312	2	02	0.023	3		

Differential fluxes of protons for the event of 2011 September 07

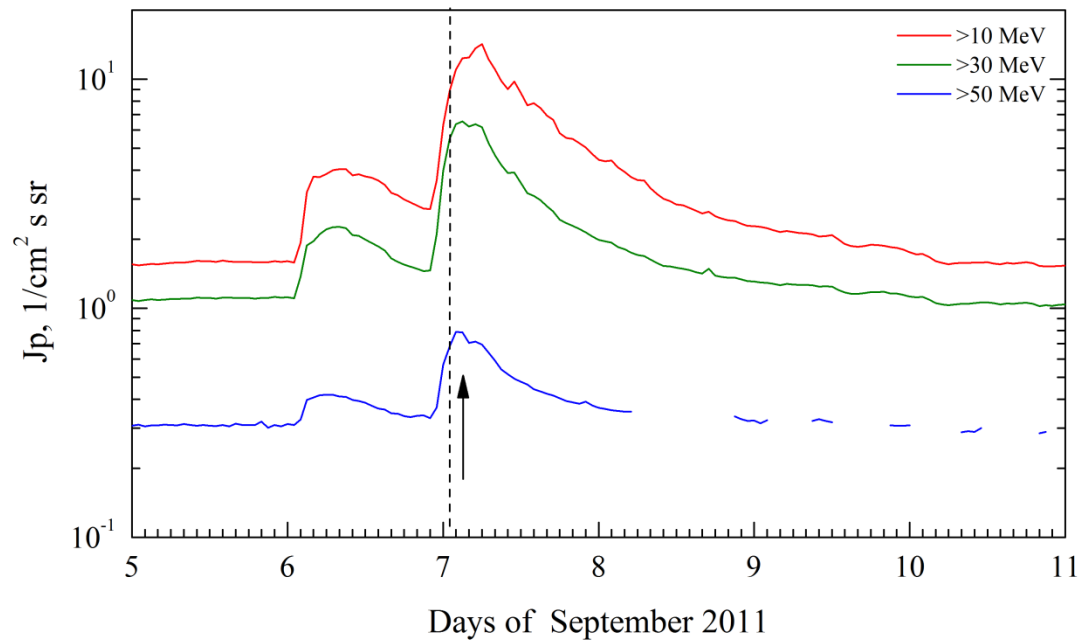
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	2	09	1.3	6	0.01	
LION	2 – 6	2	09	0.32	5	0.002	
EPHIN	4 – 8	2	06	1.2	4	0.0006	
EPHIN	8 – 25	2	06	0.285	4	0.00003	
EPHIN	25 – 53	2	05	0.049	4	0.00003	
GOES							
EPS	350–420	-	16	0.0001	-	0.002	
EPS	420–510	-	-	-	-	0.001	
Electro-1							
SCR-E	13.7–23	6d22	5	0.38	4	0.07	
SCR-E	23–42	6d22	4	0.14	4	0.025	
SCR-E	42–112	6d22	4	0.012	3	0.005	



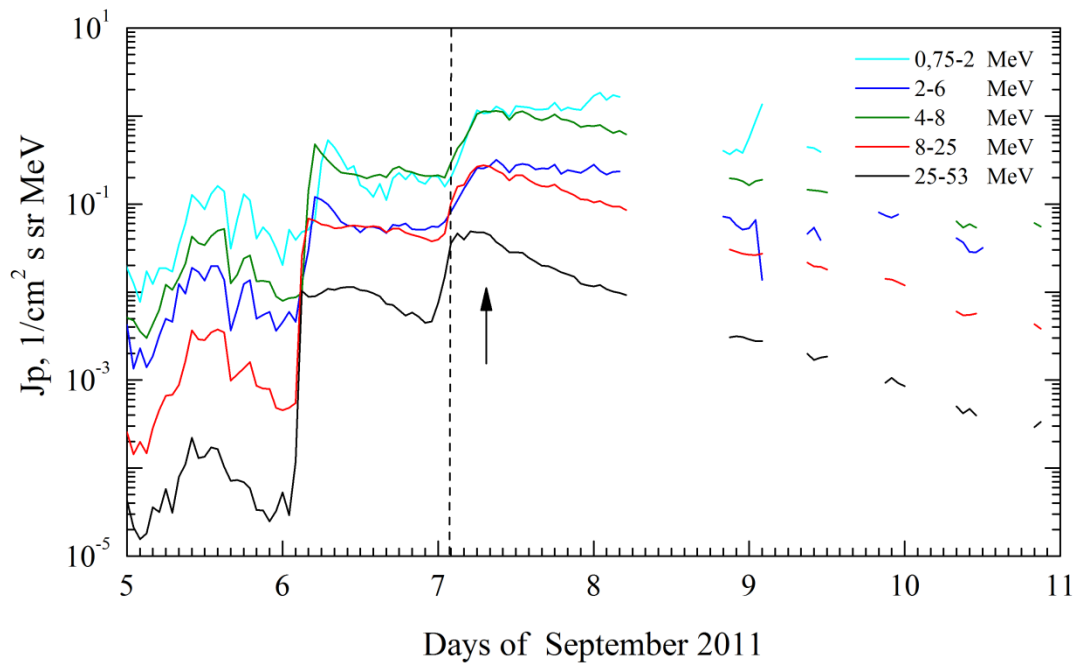
Time profiles of proton fluxes in the event 2011.09.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.09.07

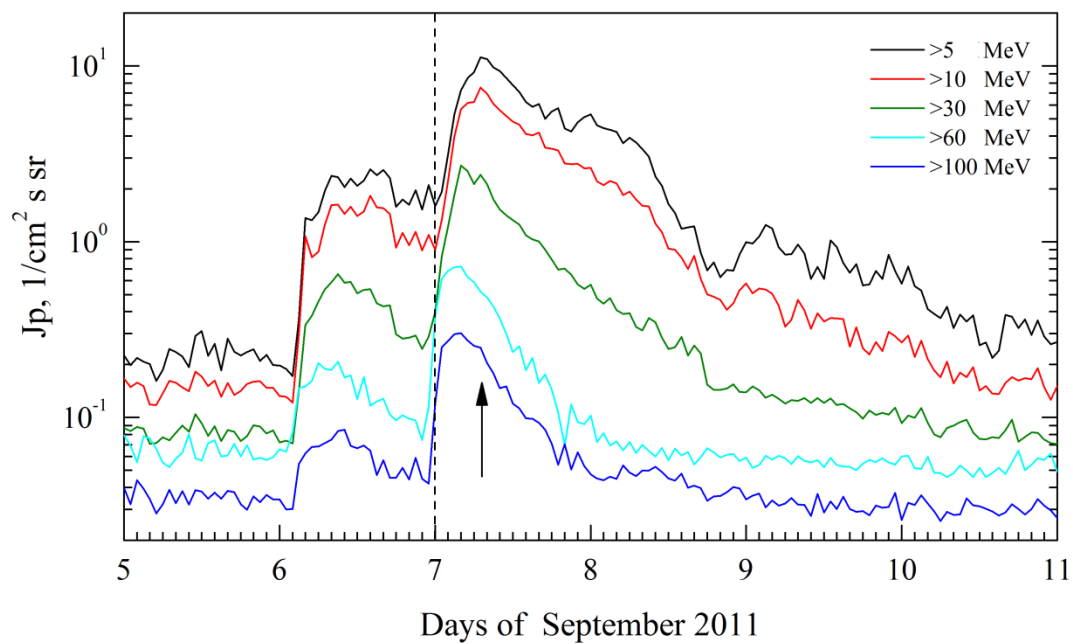


SOHO. Event 2011.09.07

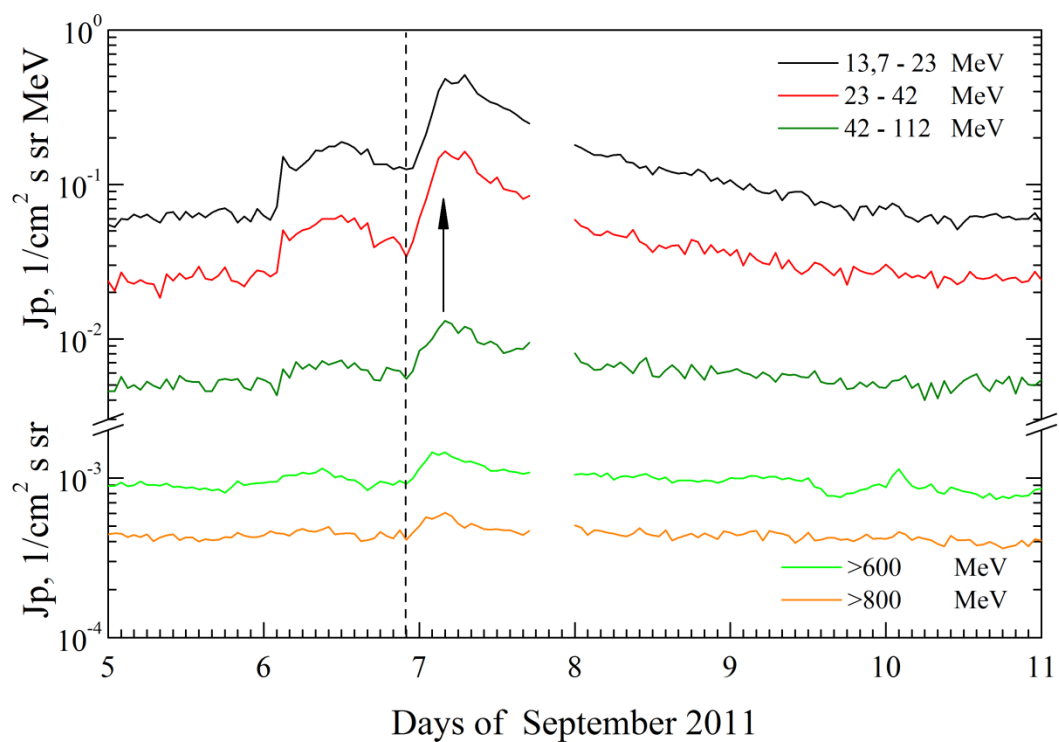


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2011.09.07

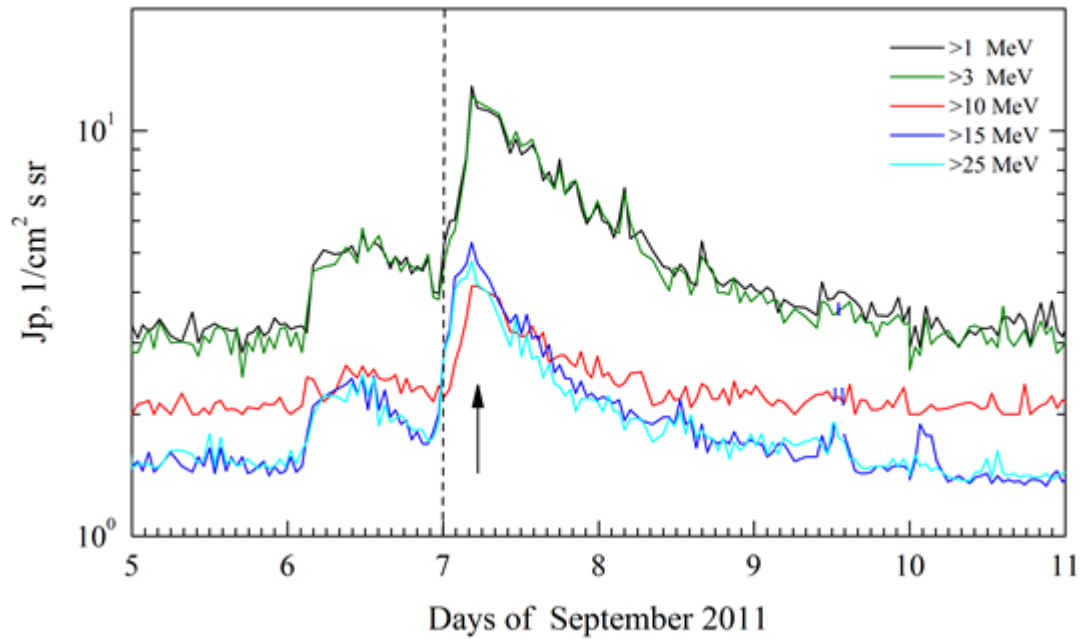


Electro. Event 2011.09.07

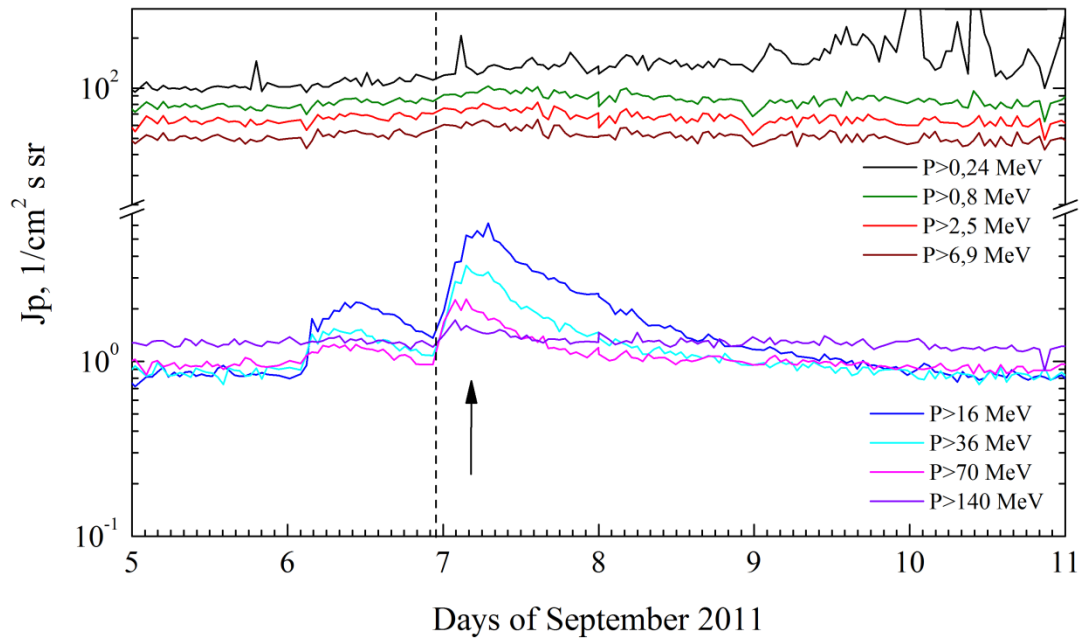


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.09.07



POES. Events 2011.09.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 September 07**

2011

September 06

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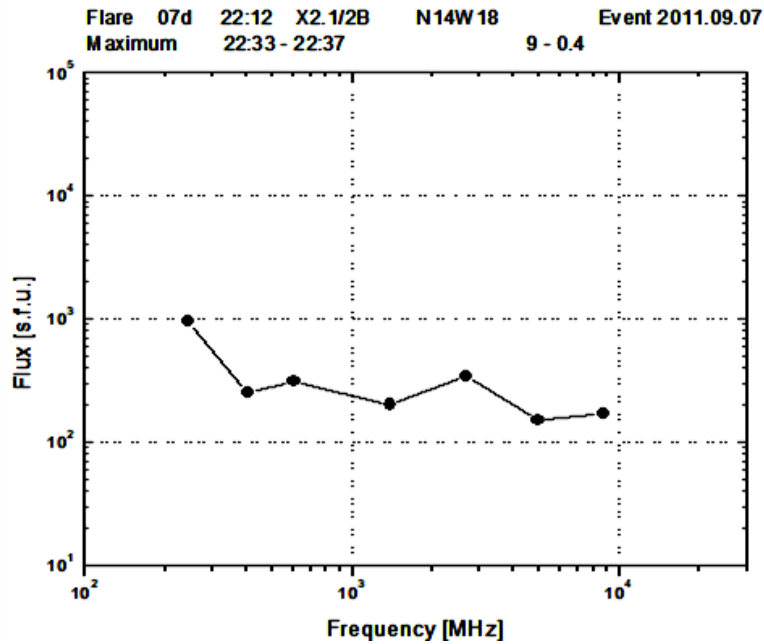
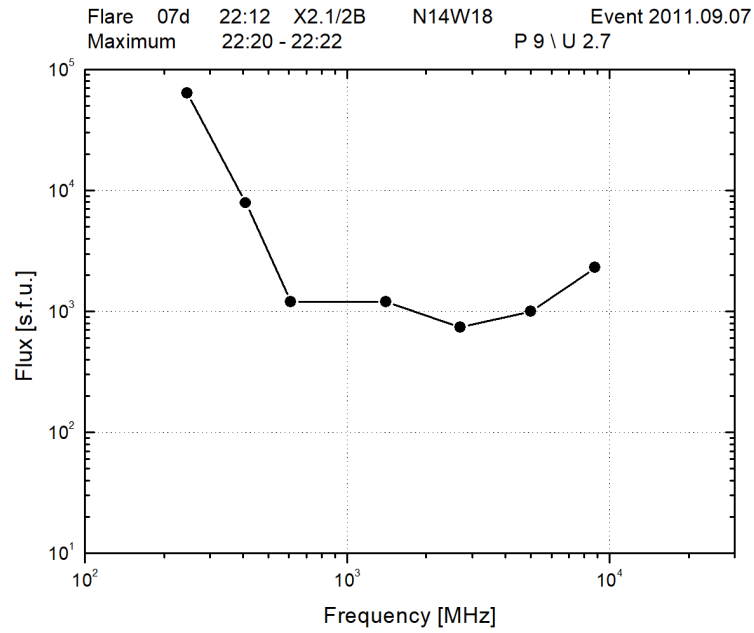
AR 11283

To event 494

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	2213	2221	>0029	N14W18	2B	ERU
1 – 12	keV	2212	2220	2224	N14W18	X2.1	0.58
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	2208:00	2219:46	2225:04	21072	23000110	HESSI
1000	keV	2212		2224		1.42E-04*	FERMI
12-25	keV	2159:48	2220:19	2244:34	865439	495946144	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2220	2220	2226	P9 \ U2.7	3.36	
5	GHz	2220	2220	2225		3.0	
2.7	GHz	2220	2220	2225		2.87	
1.4	GHz	2220	2221	2225		2.91	
610	MHz	2220	2220	2225		3.08	
410	MHz	2220	2221	2226		3.9	
245	MHz	2220	2222	2225		4.81	
8.8	GHz	2231	2236	2237	P9 – 0.4	2.23	
5	GHz	2231	2236	2237		2.18	
2.7	GHz	2236	2236	2237		2.53	
1.4	GHz	2236	2237	2238		2.3	
610	MHz	2236	2237	2239		2.49	
410	MHz	2233	2236	2240		2.4	
245	MHz	2231	2233	2240		2.97	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	040-300	2219		2234		2	
DS II	030-045	2236		2238		1	
DS IV	025-086	2228		2359		3	
DS III	018-800	2222		2222		3	
DS III	025-180	2303		2305		1	
DS III	025-086	2229		2232		1	
DH II	0.15-16	2230		07/1540			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2305	575	1.1	360°	300°	SOHO

*cm⁻²s⁻¹

Radio bursts frequency spectrum



Proton Active Region

AR11283 (N14L224,CMP 5,7.09.2011,
Sp=230 msh, DAI, BGD)
XRI= 5.60 $X2^{2.1}+M5^{6.7}+C_{13}$ $2_1+1_1+S_{27}$
PFR 6-8.09 (61^h) $X2^{2.1}+M2^{6.7}$

References:

Grechnev V., V. Kiselev, N. Meshalkina, I. Chertok, [2017](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K.Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 22d13^h

Tmax₁($E_p > 10$ MeV) – 23d09^h, Jmax₁($E_p > 10$ MeV) – 5.4 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 23d21^h, Jmax₂($E_p > 10$ MeV) – 9.7 /cm²·s·sr

Duration of the event – 6 days, power-law index: $\gamma_1 = 2.2$, $\gamma_2 = 3.2$

Quasimaximal energy of protons in the event – Eqm₁ = 200 MeV

– Eqm₂ = 140 MeV

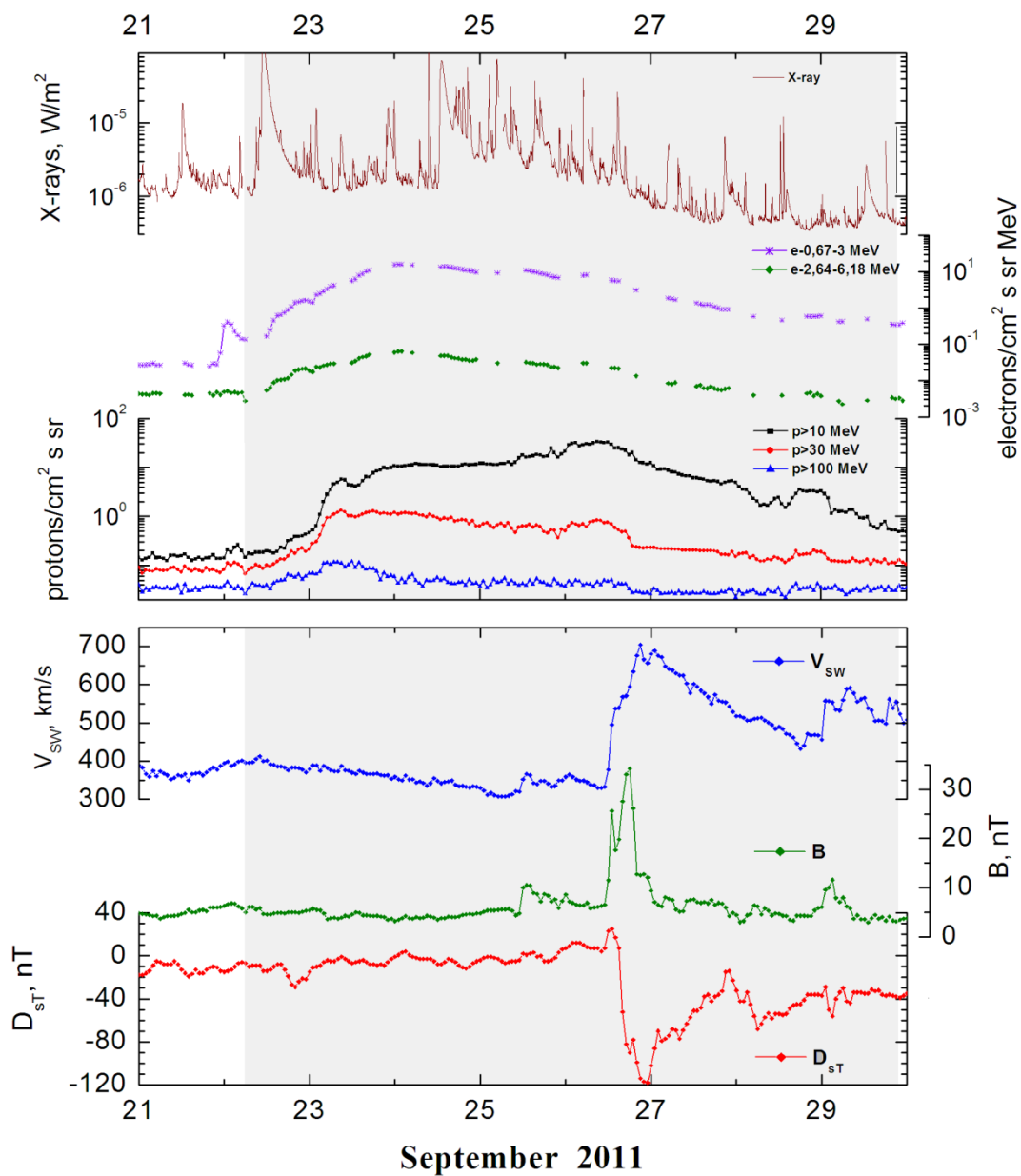
Sources: ● solar flare 22d10^h29^m, X1.4/2N, N13E78, AR11302

Main burst X-ray 1–8 Å: onset – 22d10^h29^m, max – 22d11^h01^m, $\Phi = 0.450$ J/m²

CME: 22d10^h48^m, V = 1905 km/s, $\Delta\phi = 360^\circ$, dA = 72°

▲ SC 25d11^h45^m; ▲ SC 26d12^h35^m

Particle fluxes and associated phenomena

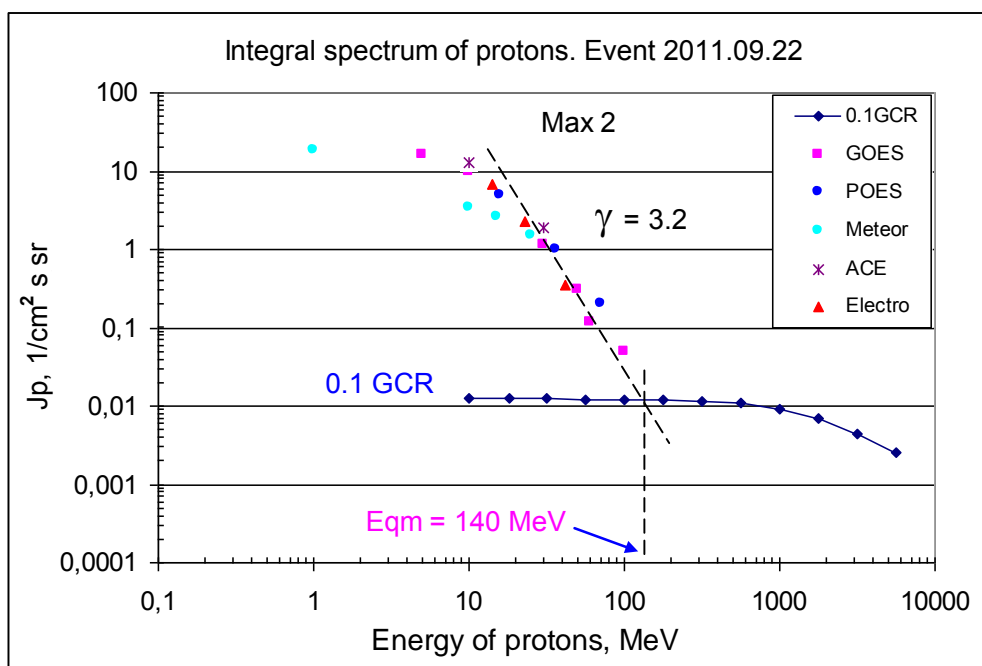
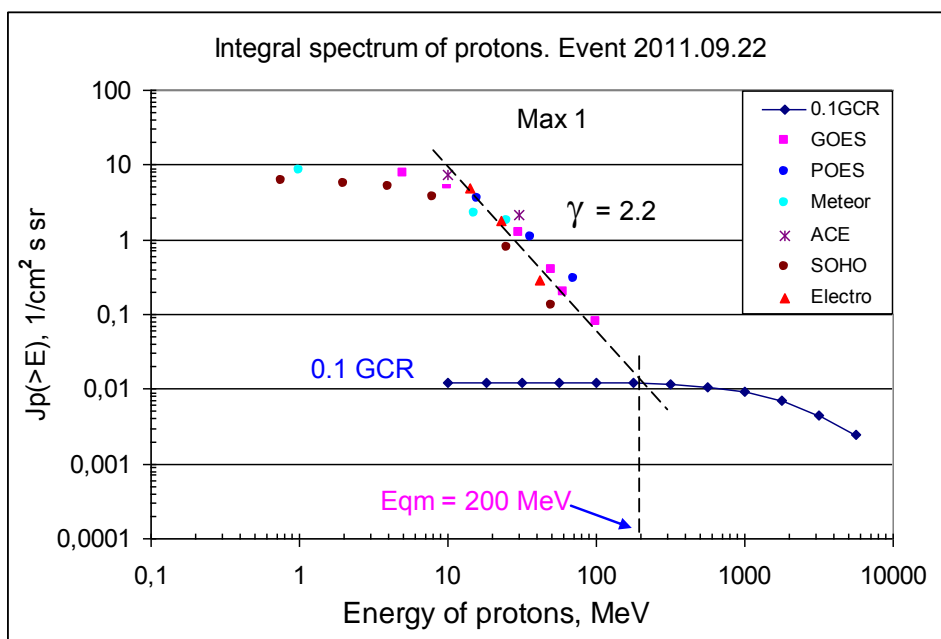


Integral fluxes of protons for the event of 2011 September 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	13	23d09/21	7.7/16	6	0.2	
EPS	>10	13	23d09/21	5.4/9.7	6	0.15	
EPS	>30	13	23d09/18	1.25/1.15	6	0.08	
EPS	>50	13	23d09/18	0.4/0.3	4	0.06	
EPS	>60	13	23d09/18	0.2/0.12	4	0.05	
EPS	>100	13	23d09/18	0.08/0.05	4	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	80	
MEPED	>2.5	-	-	-	-	60	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	15	23d09/23	3.6/5	5	0.9	
MEPED	>36	15	23d09/23	1.1/1	4	0.9	
MEPED	>70	15	23d09/23	0.3/0.2	4	1	
MEPED	>140	-	-	-	-	1.3	
Meteor-1							
SCR	>1	23	23d10/24d06	8.3/18.8	8	3	
SCR	>3	23	-	-	8	2.9	
SCR	>10	23	-/24d03	-/3.5	5	2.1	
GALS-M	>15	11	23d10/24d03	2.2/2.6	5	1.3	
GALS-M	>25	11	23d10/24d02	1.8/1.5	4	1.35	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	12	23d07/20	7.4/12.8	6	1.5	
SIS	>30	12	23d07/19	2.1/1.9	6	1.1	
SOHO							
EPHIN (INT)	>50	14	23d07/ -	0.13/ -	4	0.3	

Differential fluxes of protons for the event of 2011 September 22

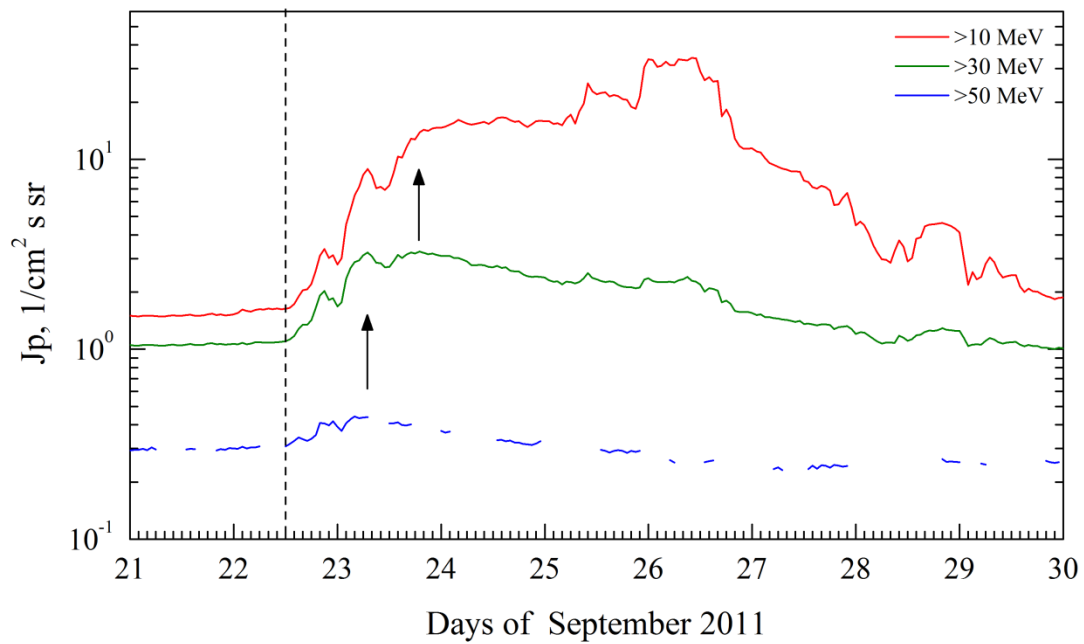
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	14	23d06/ -	0.46/ -	9	0.008	
LION	2 – 6	14	23d07/ -	0.14/ -	9	0.001	
EPHIN	4 – 8	14	23d06/ -	0.37/ -	8	0.0001	
EPHIN	8 – 25	14	23d06/ -	0.17/ -	7	0.00003	
EPHIN	25 – 53	14	23d07/ -	0.024/ -	6	0.00001	
Electro-1							
SCR-E	13.7–23	15	23d09/21	0.32/0.49	7	0.06	
SCR-E	23–42	15	23d09/20	0.08/0.10	6	0.025	
SCR-E	42–112	15	23d07/21	0.004/0.005	5	0.005	



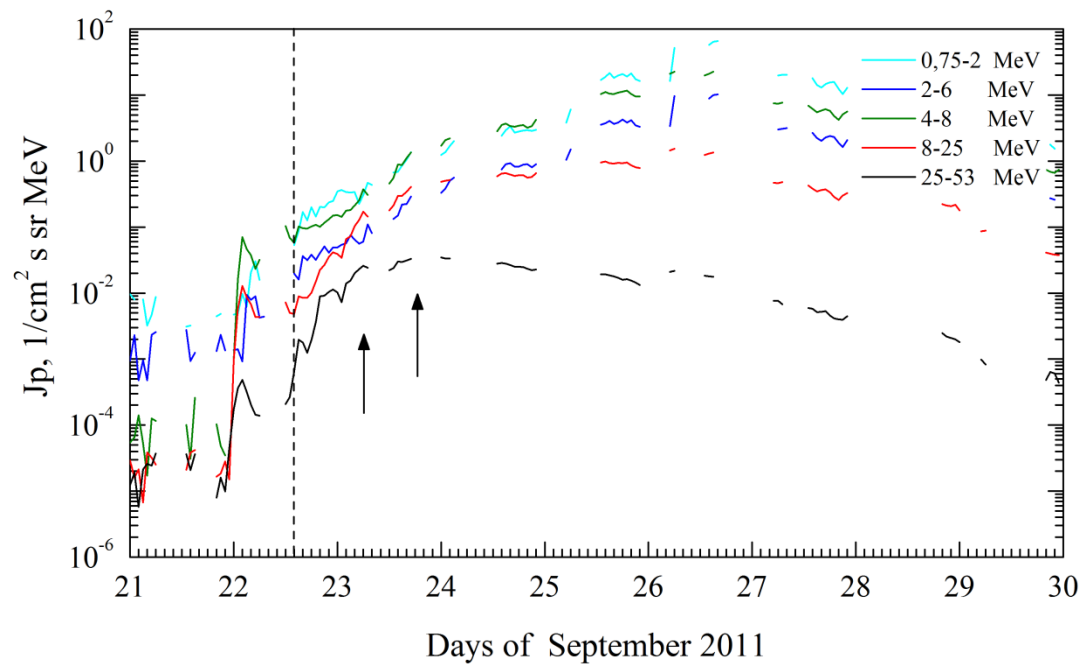
Time profiles of proton fluxes in the event 2011.09.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.09.22

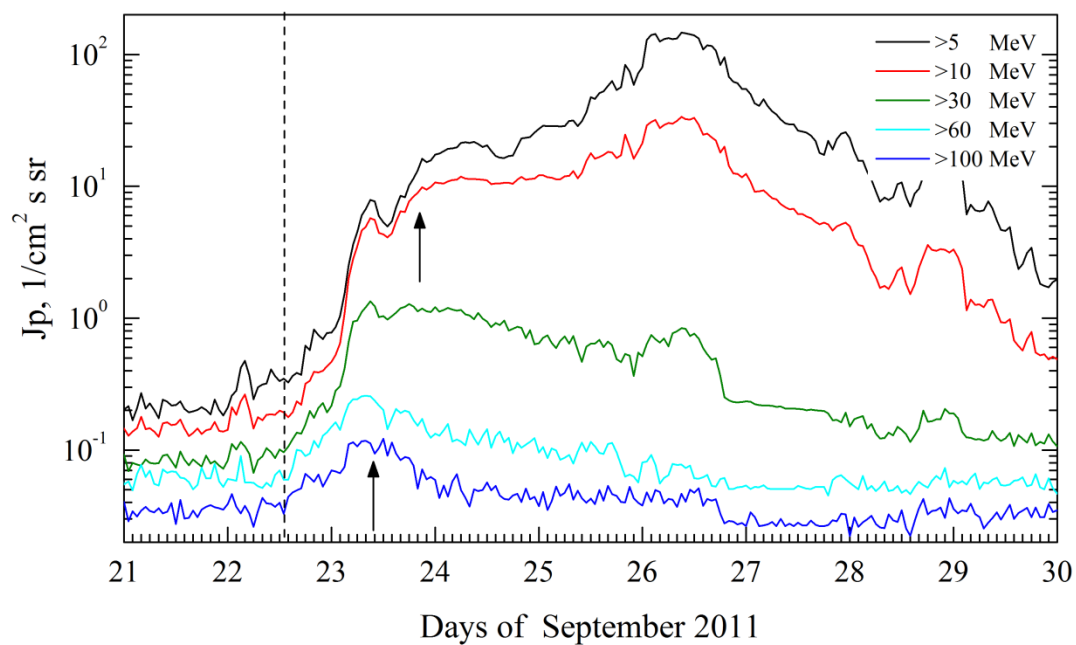


SOHO. Event 2011.09.22

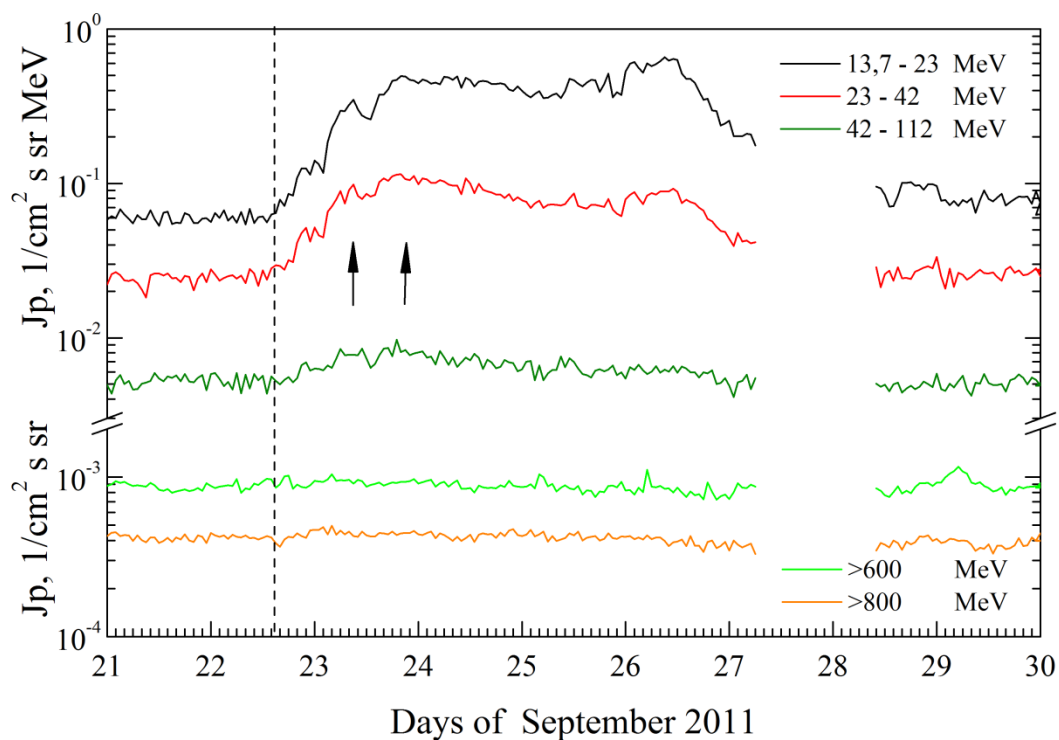


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

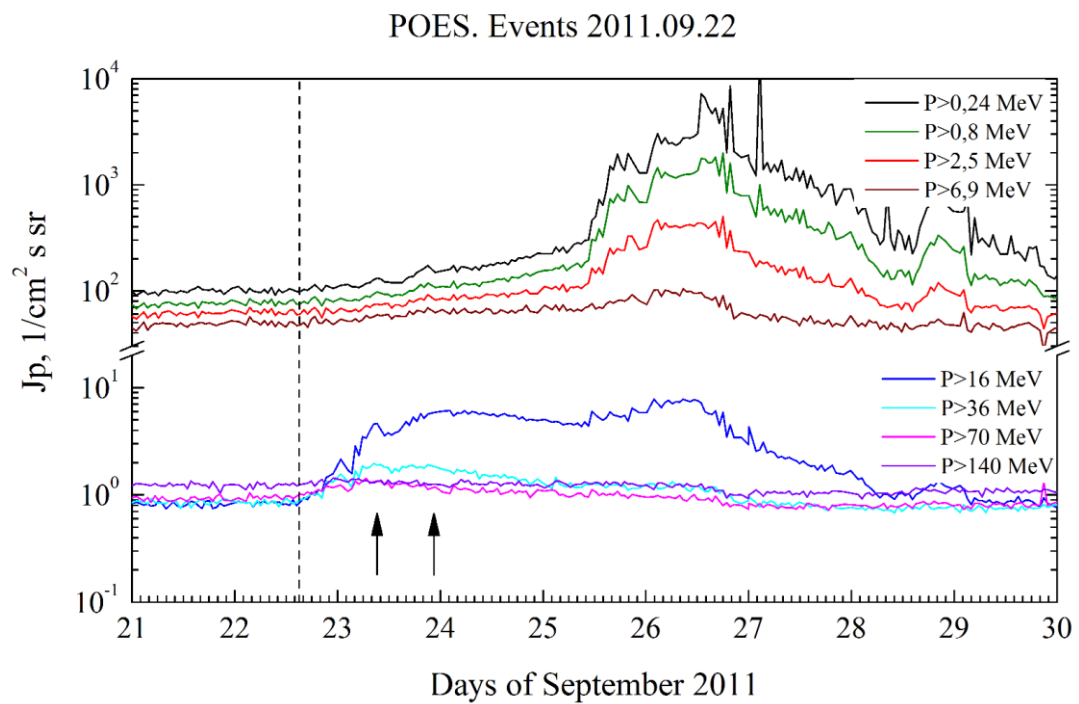
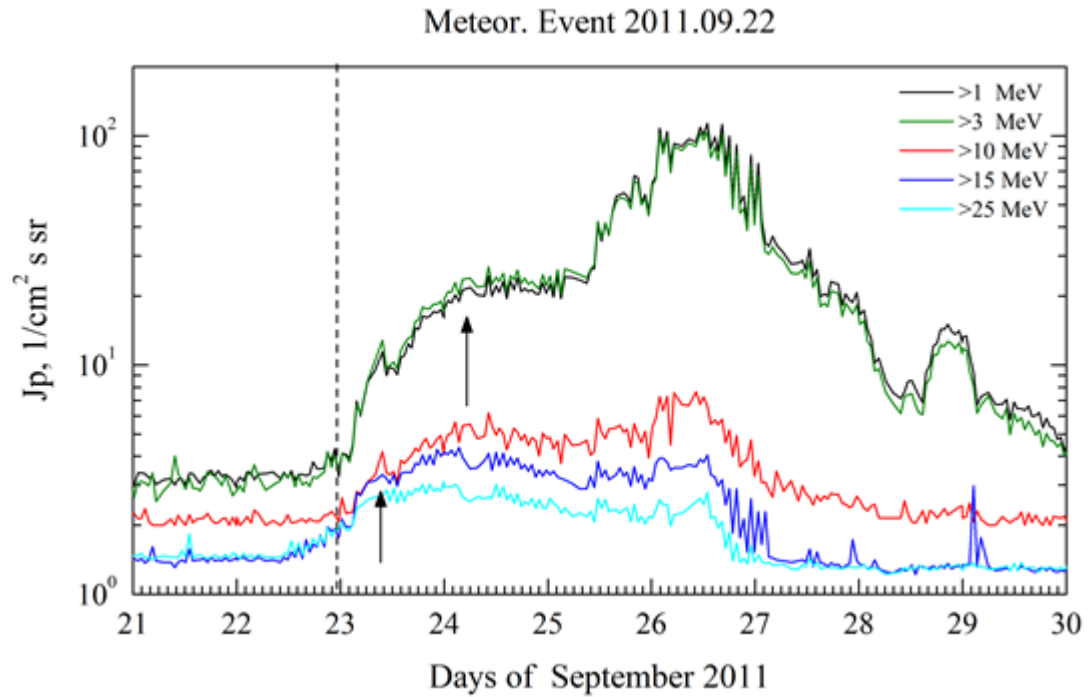
GOES. Event 2011.09.22



Electro. Event 2011.09.22



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 September 22**

2011

September 22

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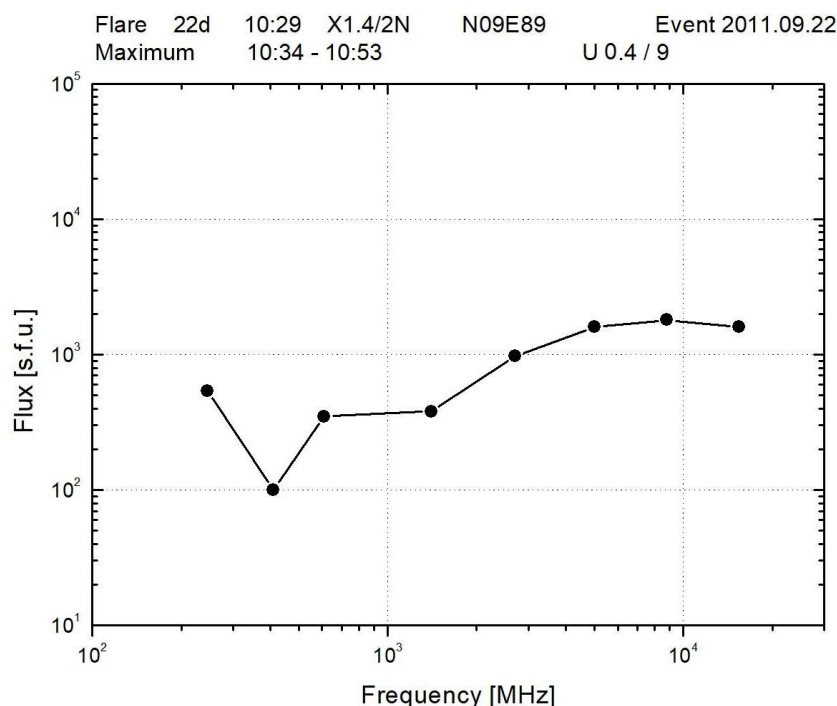
AR 11302

To event 495

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	1041	1057	1227	N13E78	2N	ERU
1 – 12	keV	1029	1101	1144	N09E89	X1.4*	0.45
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1053:16	1053:38	1106:40	9200	24755012	HESSI
12-25	keV	1106:40	1108:58	1128:56	7068	25138412	HESSI
12-25	keV	1136:04	1136:10	1153:24	1712	6101970	HESSI
12-25	keV	1047:21	1049:16	1049:22	780009	83675024	FERMI
12-25	keV	1109:49	1109:57	1146:32	692210	179296864	FERMI
12-25	keV	1223:00	1230:30	1230:47	11684	1241732	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1034	1042	1302	U0.4 / 9	3.2	
8.8	GHz	1032	1047	1242		3.26	
5	GHz	1031	1047	1143		3.2	
2.7	GHz	1034	1053	1115		2.99	
1.4	GHz	1032	1034	1106		2.58	
610	MHz	1043	1043	1045		2.54	
410	MHz	1043	1043	1043		2.0	
245	MHz	1040	1049	1056		2.73	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-086	1039		1045		2	
DS IV	025-180	1041		1333		3	
DH II	0.07-14	1105		2400			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1048	1905	-68.3	360°	072°	SOHO

*https://sdowwww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_110922_045634_11316/www/

Radio burst frequency spectrum



Proton Active Region

AR11302 (N13L280, CMP 28,7.09.2011,
Sp=1300 msh; EKC, BGD, R2)
XRI=8.73; $X_2^{1.9} + M_{16}^{7.4} + C_{32} \quad 2_6 + 1_9 + S_{72}$
PFR1 21-22.09 (22^h) $X_1^{1.4} + M_2^{1.8}$
PFR2 24-26.09 (52^h) $X_1^{1.9} + M_{11}^{7.4}$

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Bruno A., I.G. Richardson, [2021](#).
Cohen C.M.S., R.A. Mewaldt, [2018](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Kalaivani P.P., O. Prakash, A. Shanmugaraju et al., [2021](#).
NOAA SPE, [2019](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Wang Y., D. Lyu, B. Xiao et al., [2021](#).
Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 22d12^h

Tmax ($E_p > 10$ MeV) – 22d23^h, Jmax₁ ($E_p > 10$ MeV) – 3.3 /cm²·s·sr

Duration of the event – 3.5 days, power-law index: $\gamma = 2.8$

Quasimaximal energy of protons in the event – E_{qm} = 75 MeV

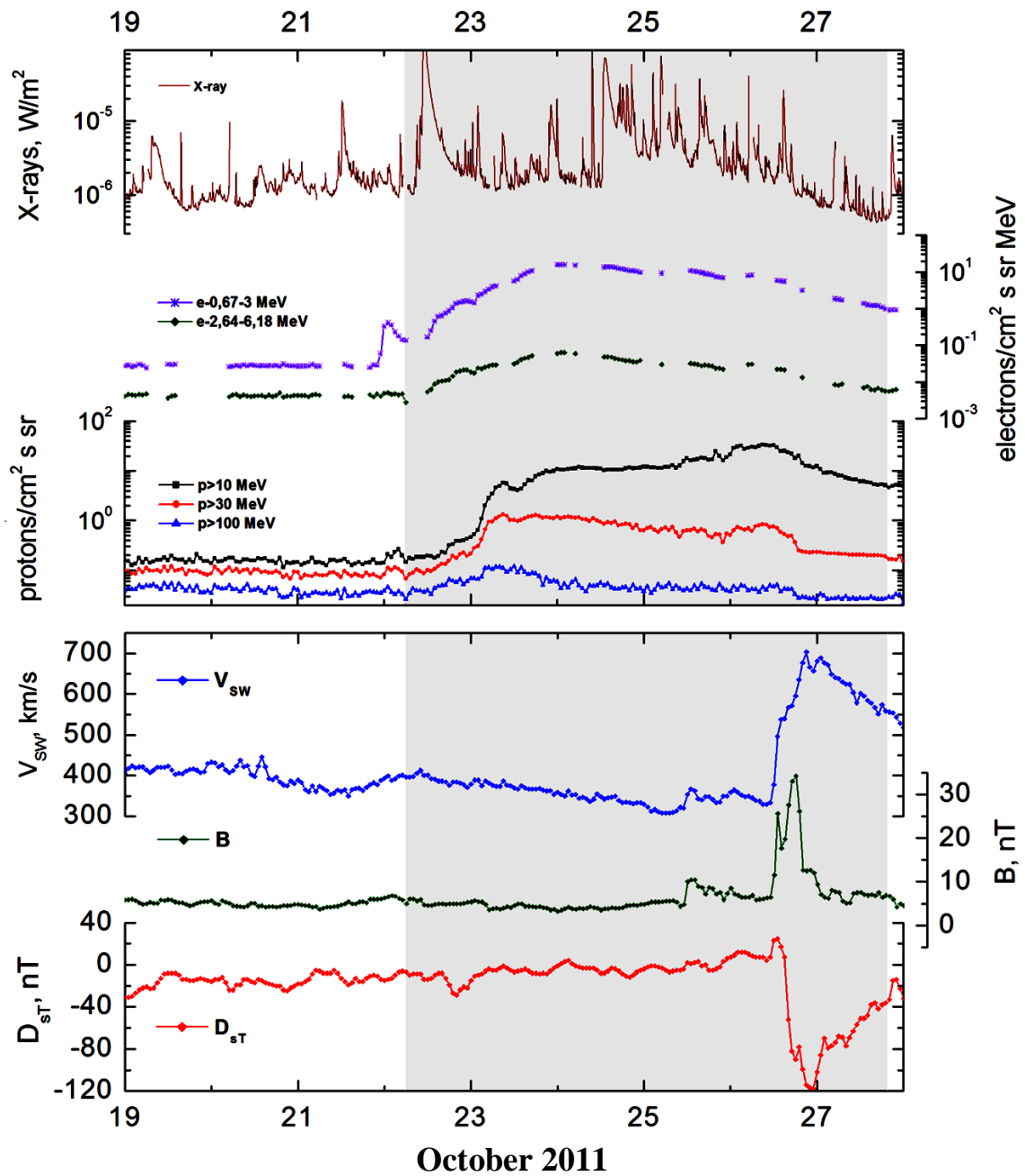
Sources: ● solar flare 22d10^h00^m, M1.3/SF, N25W77, AR11314

Main burst X-ray 1–8 Å: onset – 22d10^h00^m, max – 22d11^h10^m, $\Phi = 0.11$ J/m²

CME: 22d10^h24^m, V = 1005 km/s, $\Delta\phi = 360^\circ$, dA = 311°

▲ SC 24d18^h31^m

Particle fluxes and associated phenomena

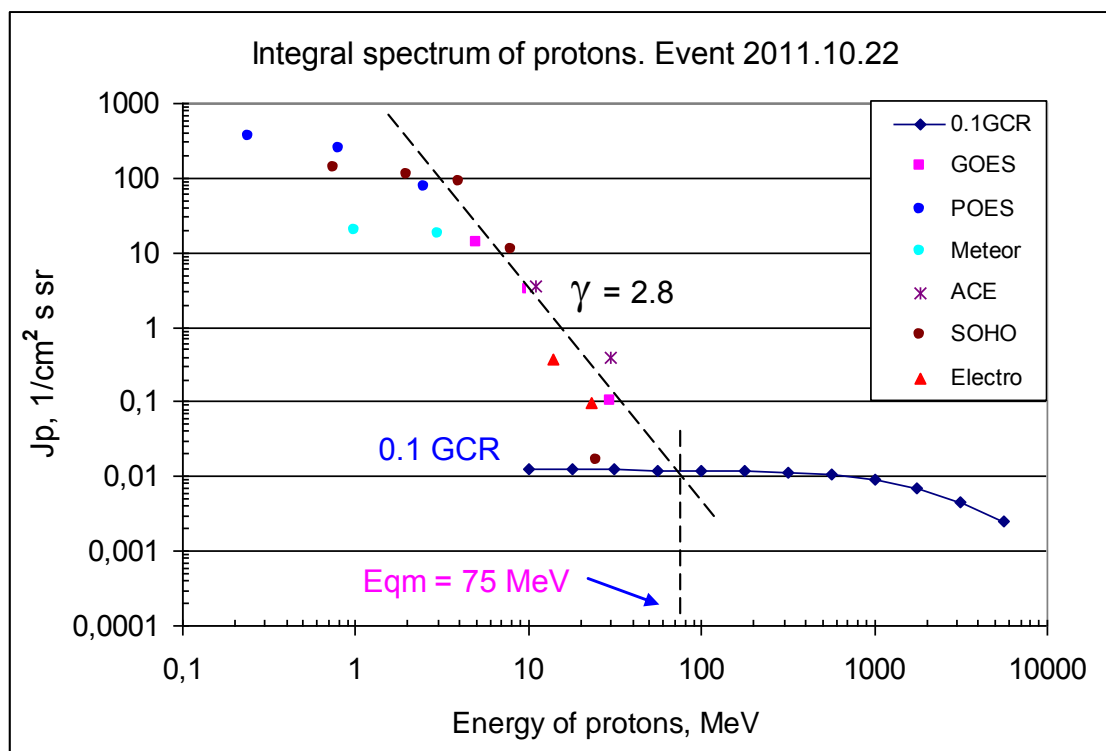


Integral fluxes of protons for the event of 2011 October 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	12	23d00	13.3	3.5	0.2	
EPS	>10	12	23	3.3	3.5	0.15	
EPS	>30	12	23	0.1	2.5	0.08	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	18	23	360	4	100	
MEPED	>0.8	18	23	250	4	80	
MEPED	>2.5	18	23	75	3	60	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	-	-	-	-	0.9	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.3	
Meteor-1							
SCR	>1	15	23d00	17.4	5	3	
SCR	>3	15	23d00	15.1	5	3	
SCR	>10	-	-	-	-	2.	
GALS-M	>15	-	-	-	-	1.35	
GALS-M	>25	-	-	-	-	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	14	23d02	3.4	2	1.5	
SIS	>30	14	23	0.4	2	1.1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2011 October 22

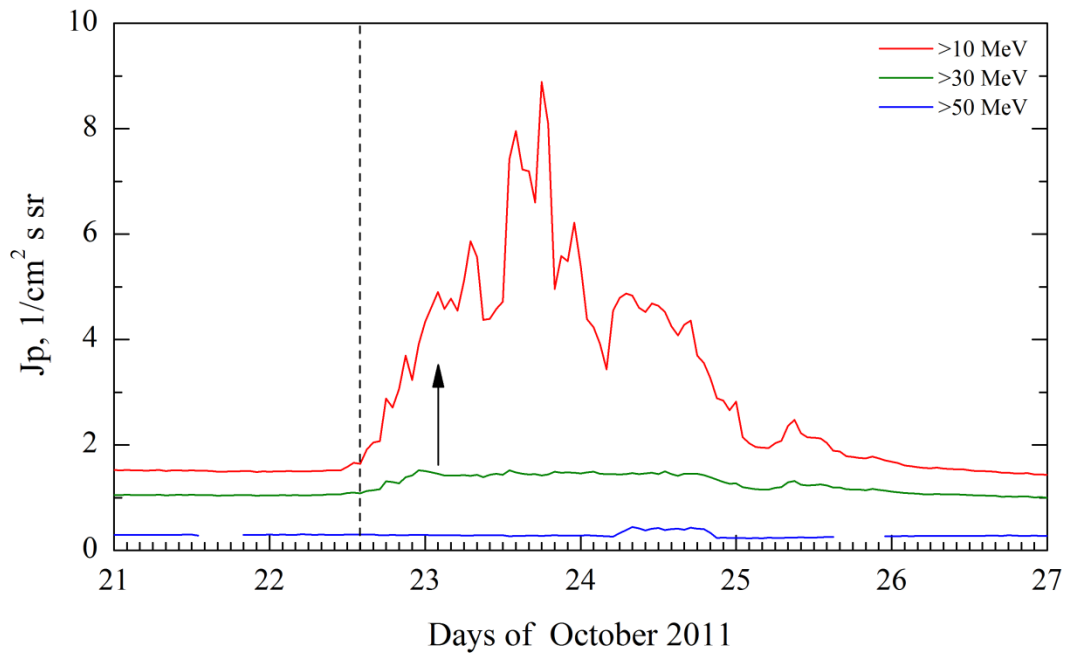
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	12	23d07	23	6	0.03	
LION	2 – 6	12	23d07	6.9	6	0.004	
EPHIN	4 – 8	12	23d07	19	5	0.006	
EPHIN	8 – 25	12	23d07	0.65	5	0.0005	
EPHIN	25–53	12	23d05	0.0006	4	0.00005	
Electro-1							
SCR-E	13.7–23	11	20	0.03	0.5	0.06	
SCR-E	23–42	11	20	0.005	0.5	0.025	
SCR-E	42–112	-	-	-	-	0.005	



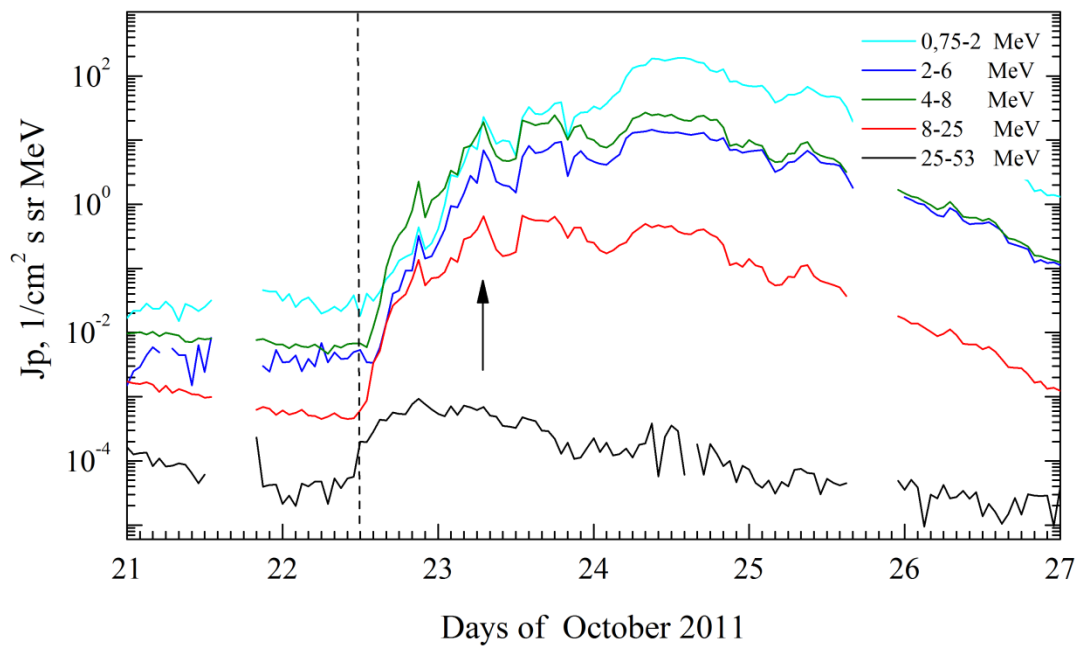
Time profiles of proton fluxes in the event 2011.10.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.10.22

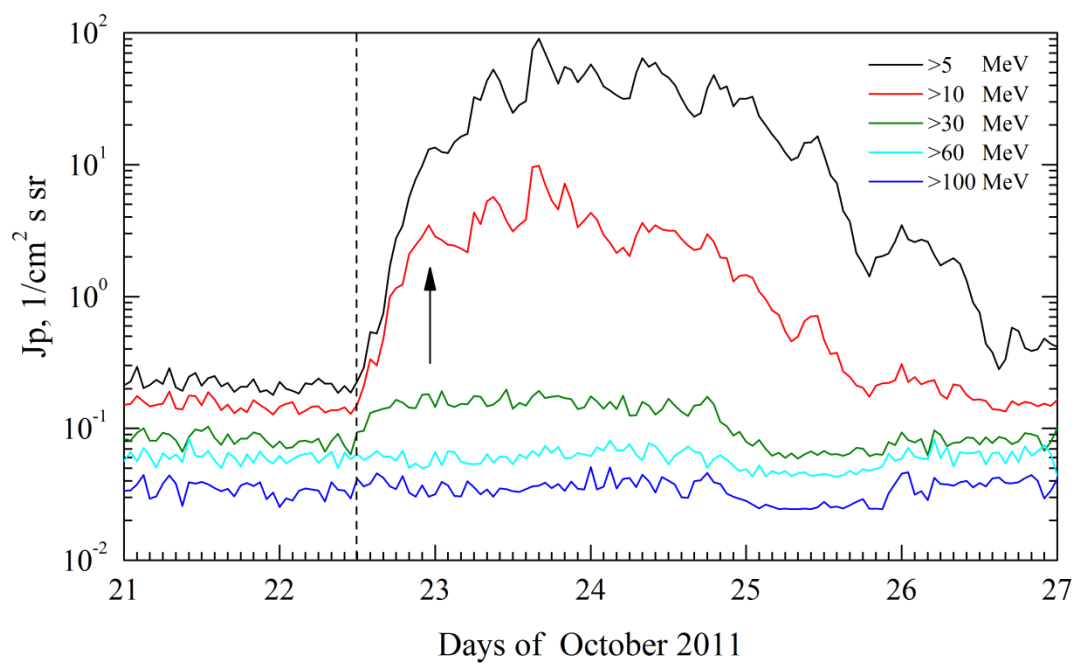


SOHO. Event 2011.10.22

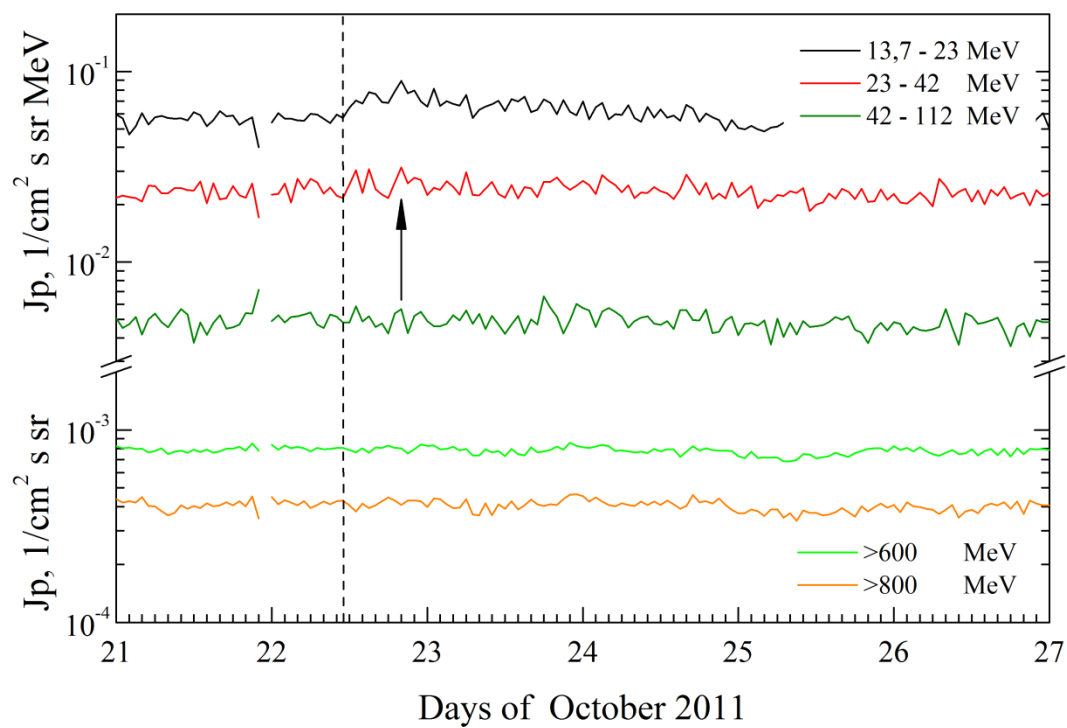


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2011.10.22

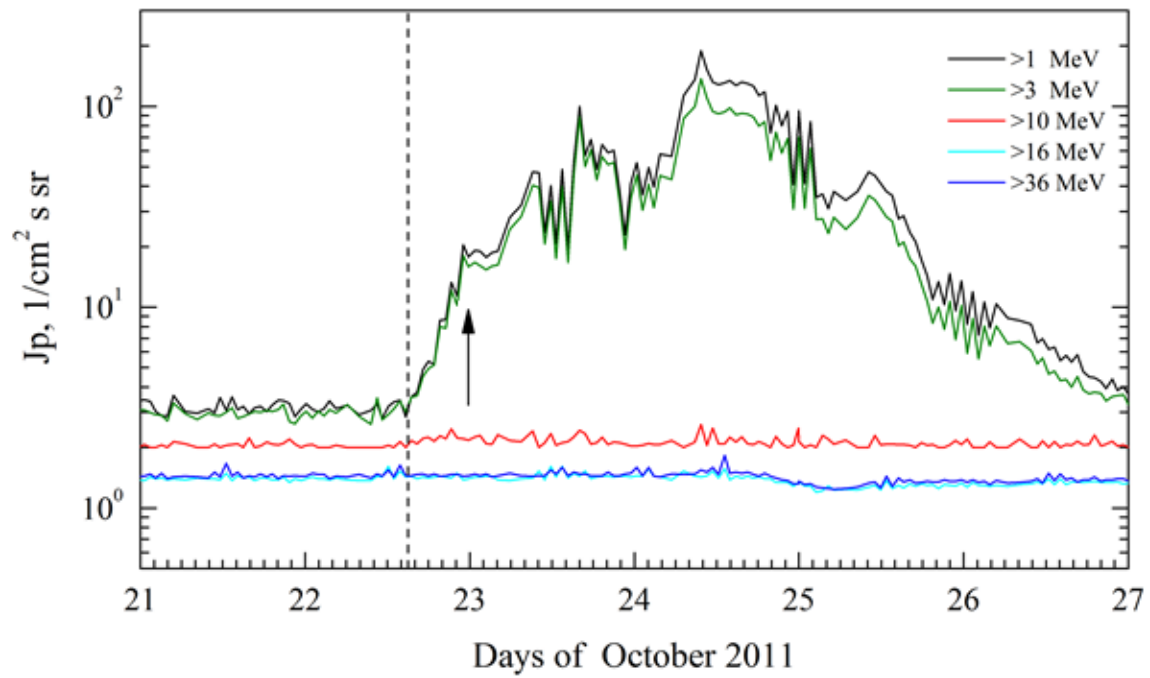


Electro. Event 2011.10.22

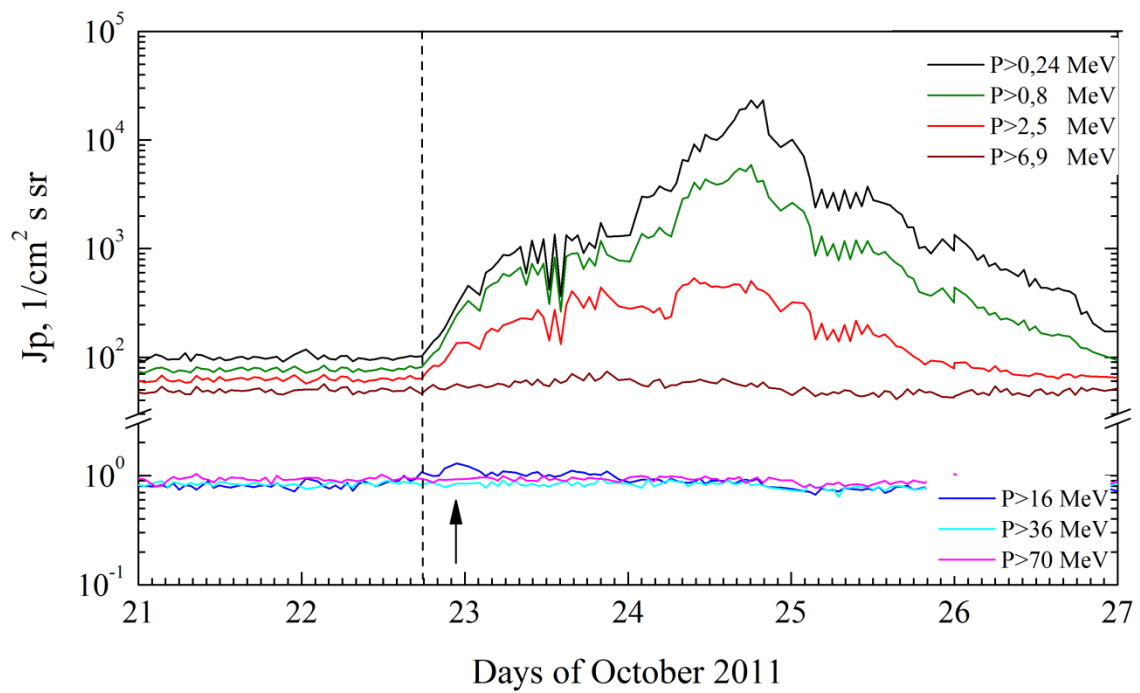


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2011.10.22



POES. Events 2011.10.22



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 October 22**

2011

October 22

•

AR 11314

To event 496

Hα, X-ray		To	Tmax	Te	Location	Importance class	Fl Code Φ, J/m²
6563 Å	FL	1041	1057	1227	N25W77	SF	ERU
1 – 12	keV	1000	1110	1340	N27W87	M1.3	0.11
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1023:16	1029:18	1029:28	92	143441	HESSI
6-12	keV	1104:12	1104:34	1113:48	90	187858	HESSI
6-12	keV	1158:40	1159:14	1204:40	600	96366	HESSI
6-12	keV	1204:40	1204:50	1206:16	42	17800	HESSI
12-25	keV	1206:16	1208:02	1209:04	41	30818	HESSI
6-12	keV	1209:04	1210:22	1210:28	46	16000	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS cont	069-180	1026		1049		1	
DS III	034-149	1117		1123		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1024	1005	17.7	360°	311°	SOHO

Proton Active Region

AR11314 (N27L056, CMP 15,3.10.2011,
Sp=370 msh, HSX, A)
XRI=0.13 M₁^{1.3}+C₉ 1₁+S₁₁
PFR 22.10 M₁^{1.3}

References:

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Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 04d00^h

Tmax ($E_p > 10$ MeV) – 04d09^h, $J_{\max 1}$ ($E_p > 10$ MeV) – $2.6 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 3 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{\text{qm}} = 190$ MeV

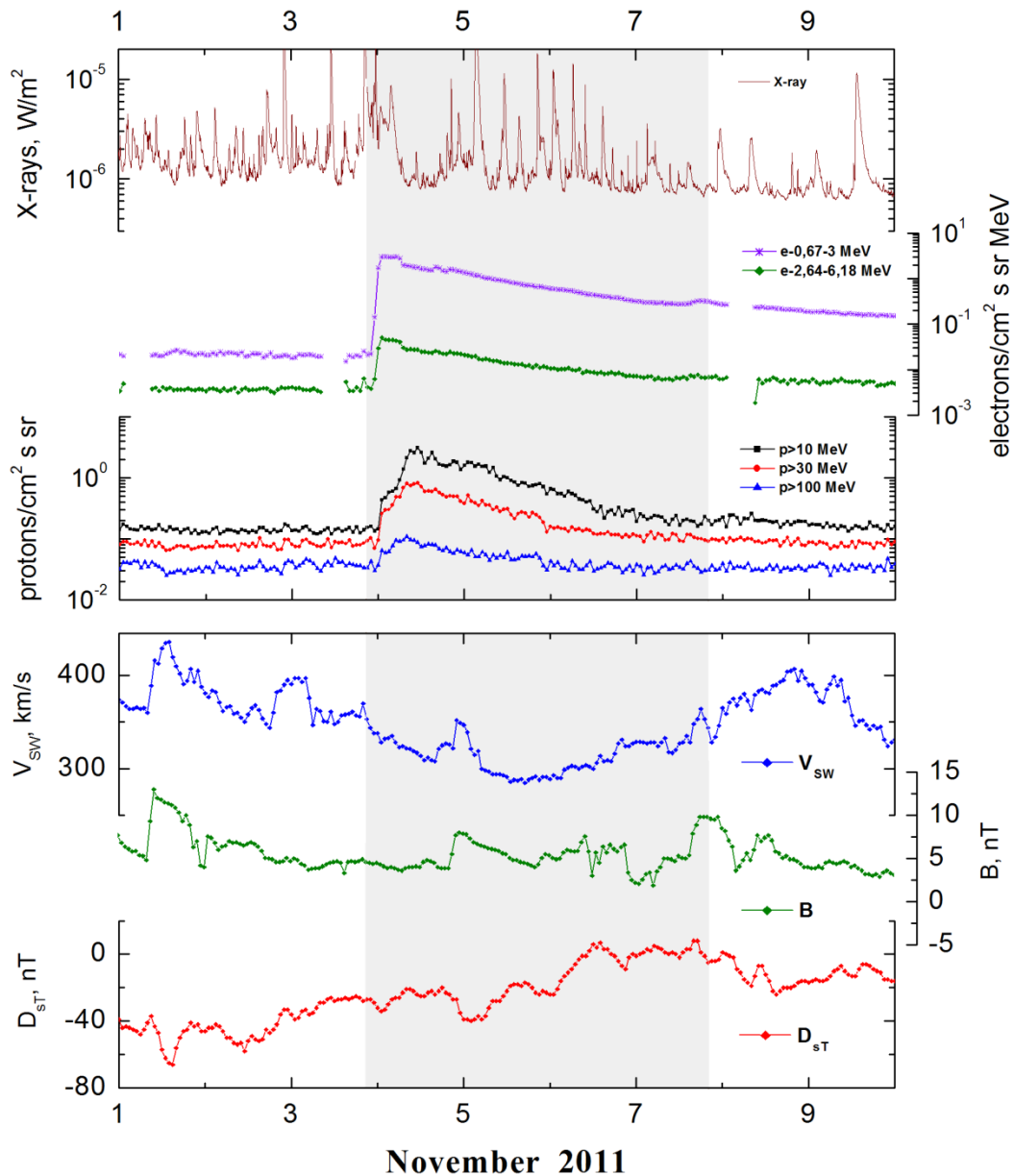
Sources: • solar flare 03d20^h16^m, X1.9/2B, N22E63, AR11339

Ø solar flare 03d23^h28^m, M2.1/, N22E63, AR11339

Main burst X-ray 1–8 Å: onset – 03d20^h16^m, max – 03d20^h27^m, $\Phi = 0.1 \text{ J/m}^2$

CME: 03d23^h10^m, $V = 991 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 90^\circ$

Particle fluxes and associated phenomena

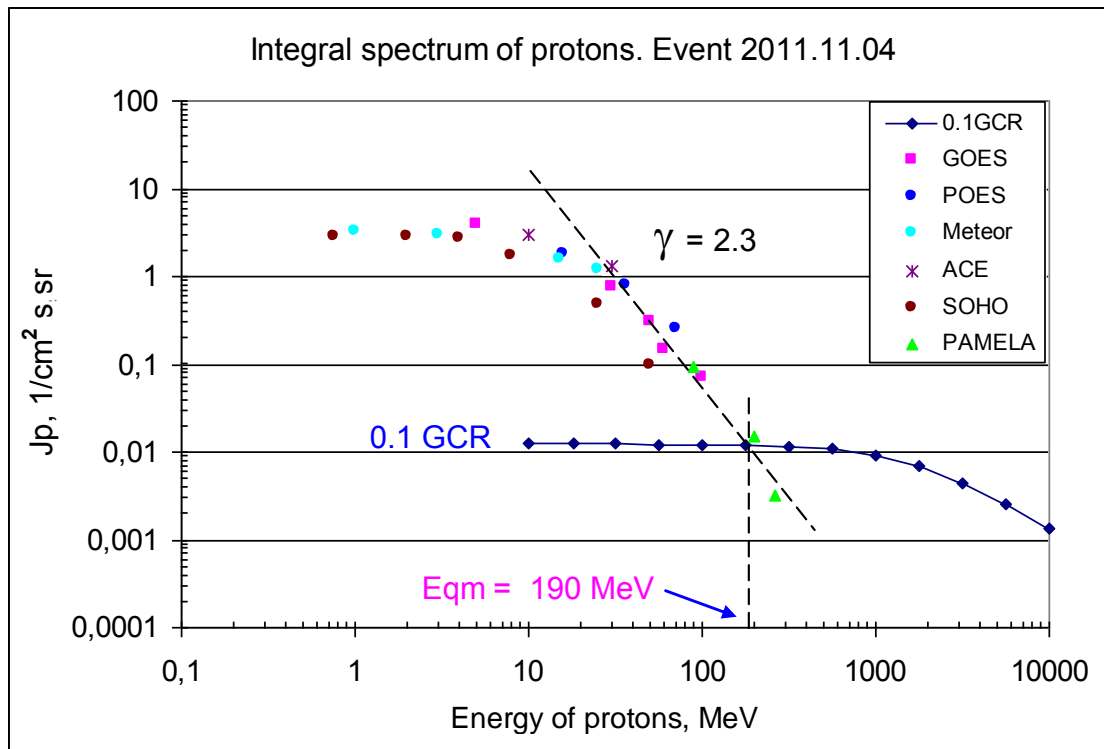


Integral fluxes of protons for the event of 2011 November 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	00	09	4	3.5	0.2	
EPS	>10	00	09	2.6	3	0.15	
EPS	>30	00	08	0.75	2.5	0.08	
EPS	>50	00	08	0.3	2	0.07	
EPS	>60	03d23	07	0.15	2	0.06	
EPS	>100	03d23	08	0.07	2	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	80	
MEPED	>2.5	-	-	-	-	60	
MEPED	>6.9	-	-	-	-	55	
MEPED	>16	3d23	10	1.8	2	0.85	
MEPED	>36	3d23	10	0.8	2	0.8	
MEPED	>70	3d23	10	0.35	1	0.9	
MEPED	>140	3d23	-	-	-	1.2	
Meteor-1							
SCR	>1	03d23	12	3.3	4	3.1	
SCR	>3	03d23	12	3.0	4	3.05	
SCR	>10	03d23	-	-	4	2.1	
GALS-M	>15	03d23	11	1.6	3	1.35	
GALS-M	>25	03d23	11	1.2	3	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	03d23	03	3	2	1.5	
SIS	>30	03d23	03	1.3	2	1.1	
SOHO							
EPHIN	>50	0	4	0.1	2	0.3	
PAMELA							
TRECKER	>90	0	07-10	0.095	2	-	
TRECKER	>200	0	07-10	0.015	2	-	
TRECKER	>265	0	07-10	0.0032	2	-	

Differential fluxes of protons for the event of 2011 November 04

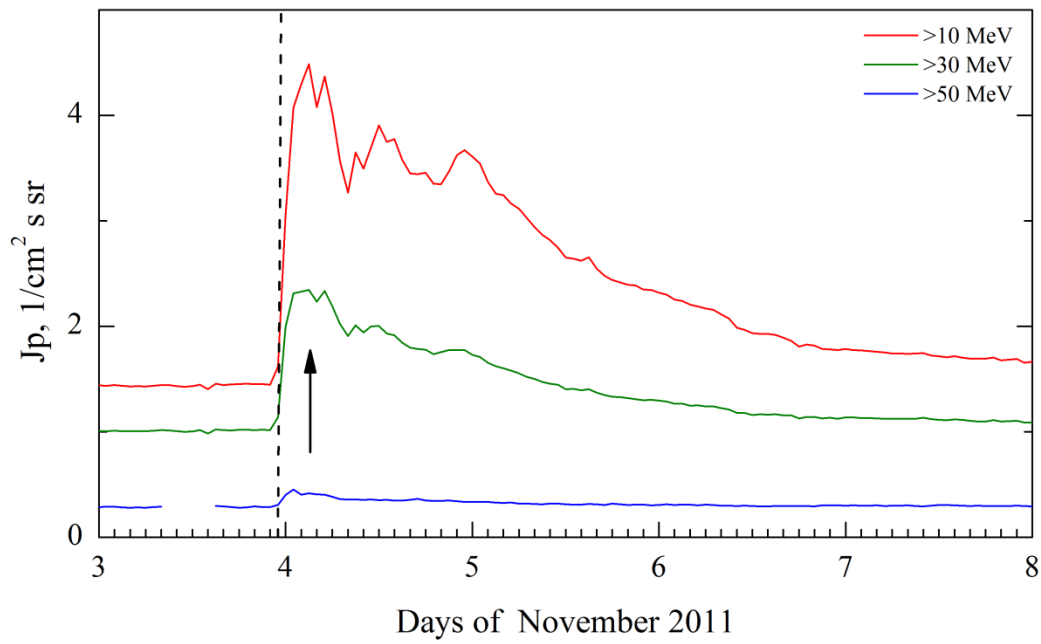
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	0	5	0.04	7	0.01	
LION	2 – 6	0	4	0.046	7	0.001	
EPHIN	4 – 8	0	4	0.25	5	0.0003	
EPHIN	8 – 25	0	4	0.07	5	0.00001	
EPHIN	25–53	0	4	0.014	4	0.00002	
Electro-1							
SCR-E	13.7–23	03d23	-	-	3	0.06	
SCR-E	23–42	03d23	-	-	2	0.025	
SCR-E	42–112	03d23	-	-	1	0.005	



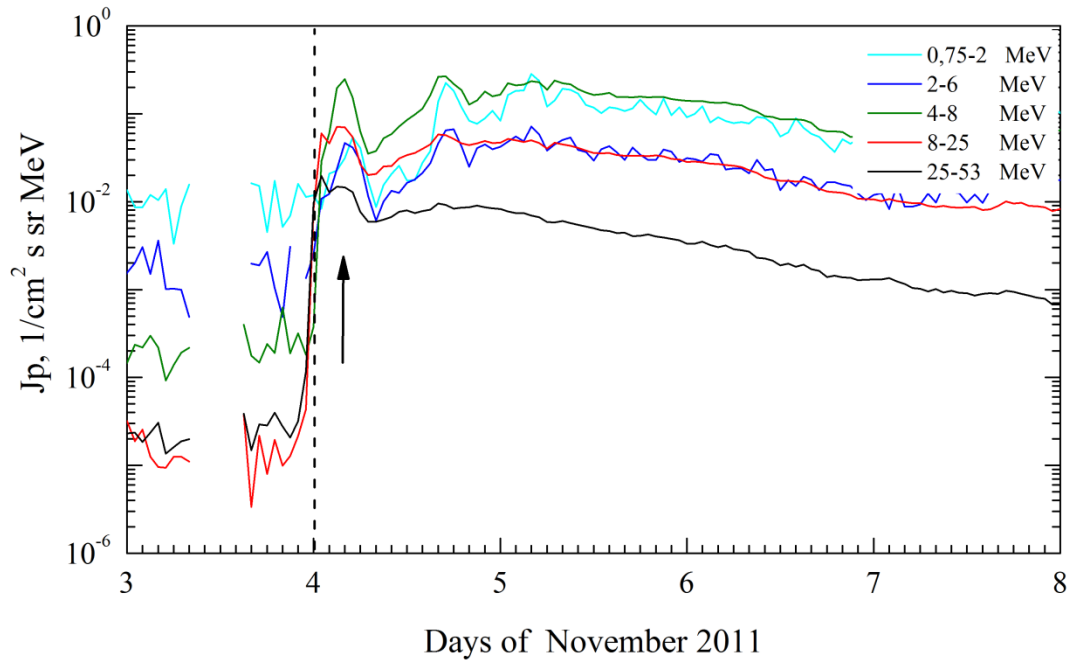
Time profiles of proton fluxes in the event 2011.11.04

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2011.11.04

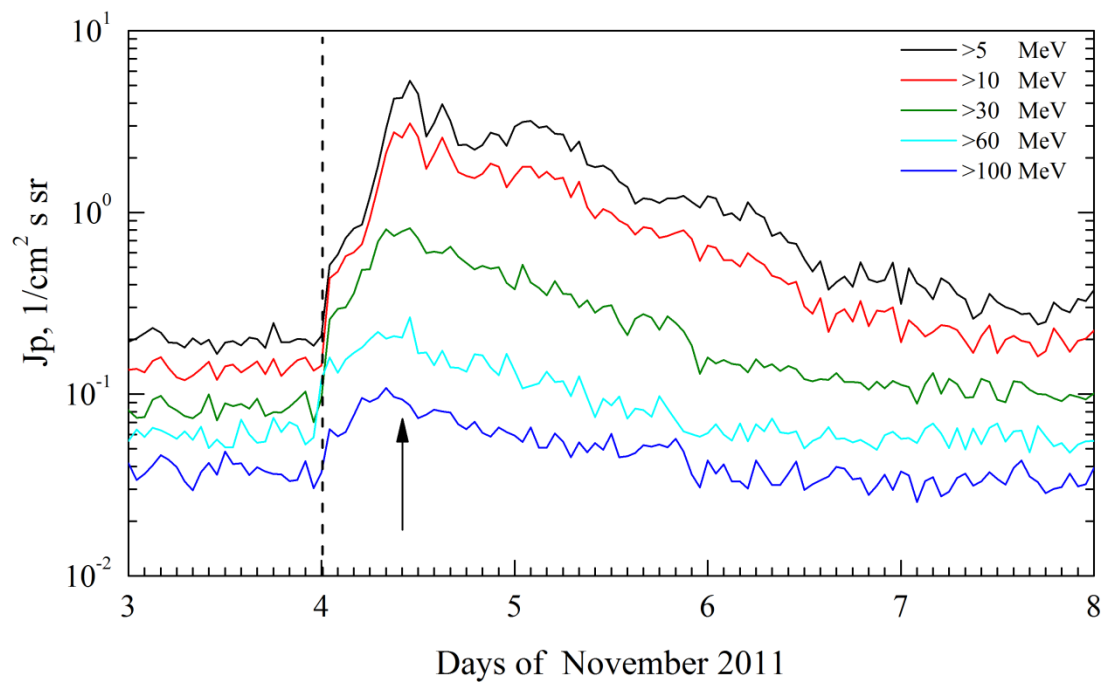


SOHO. Event 2011.11.04

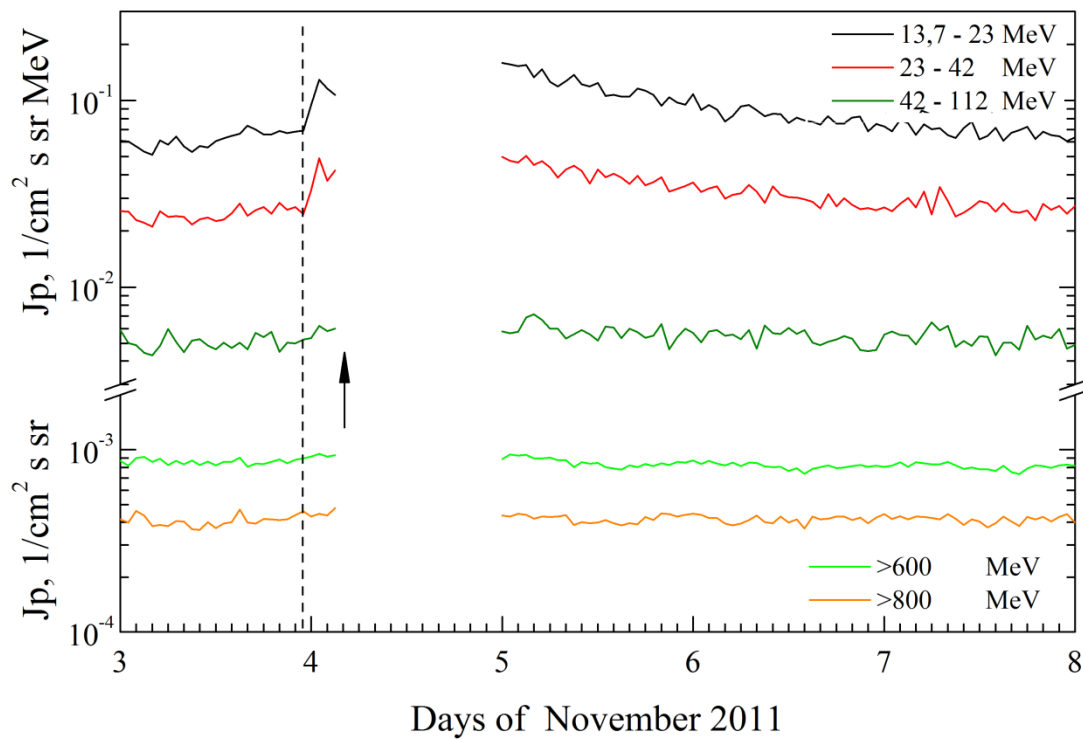


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2011.11.04

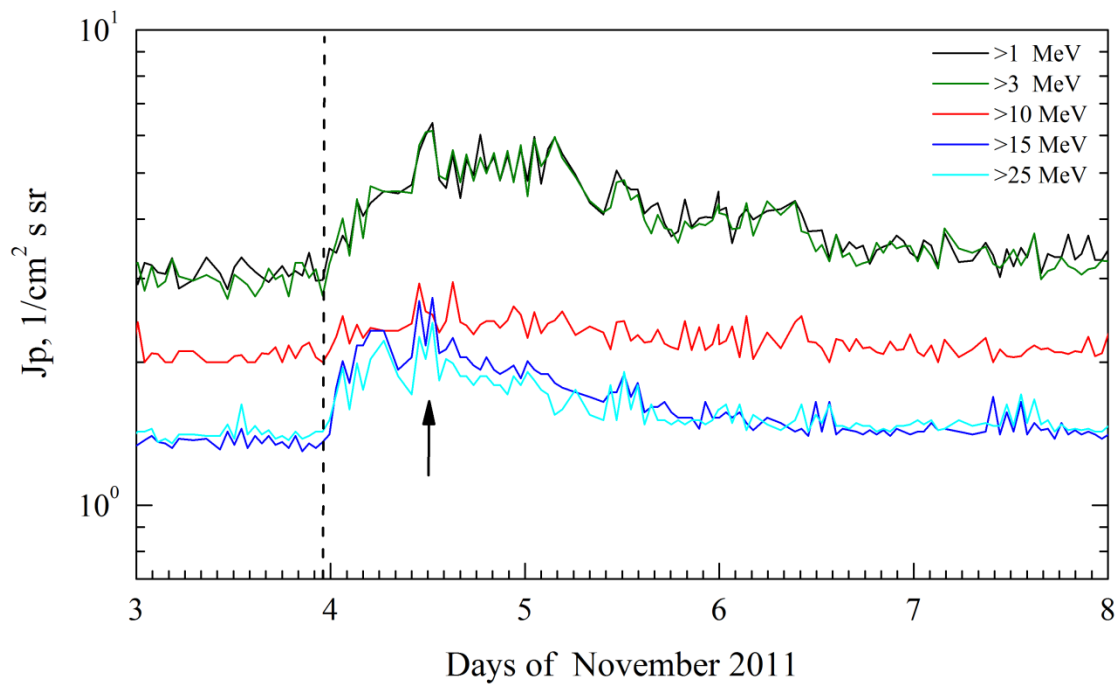


Electro. Event 2011.11.04

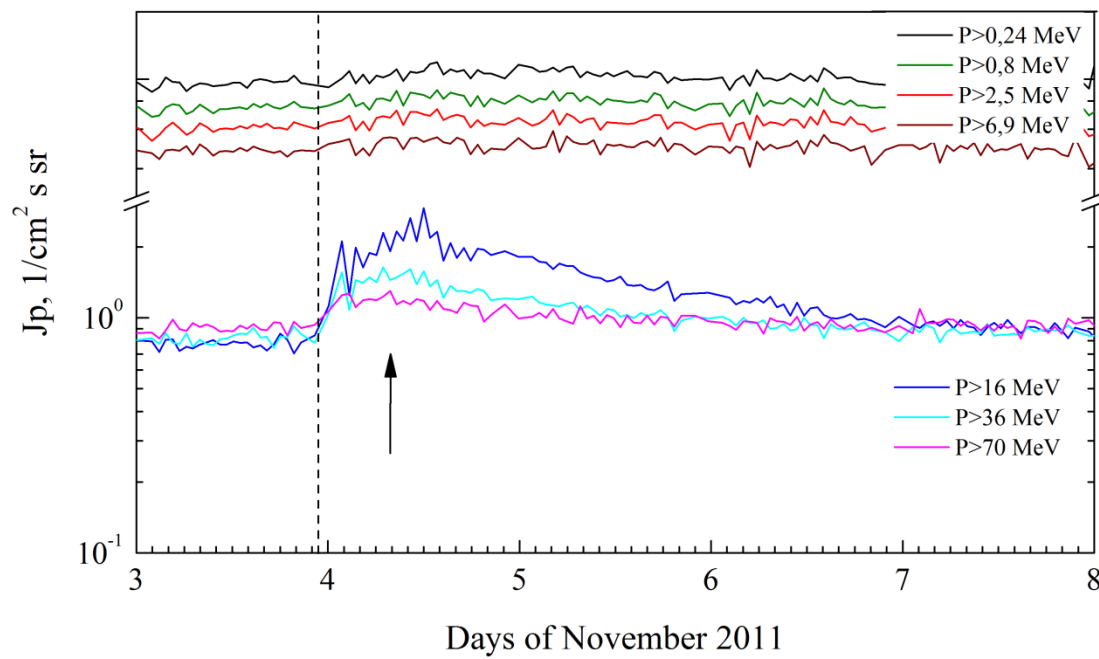


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2011.11.04



POES. Events 2011.11.04



**Electromagnetic and other phenomena that are sources and/or accompanying for the event
of 2011 November 04**

2011 November 03 • AR 11339 To event 497

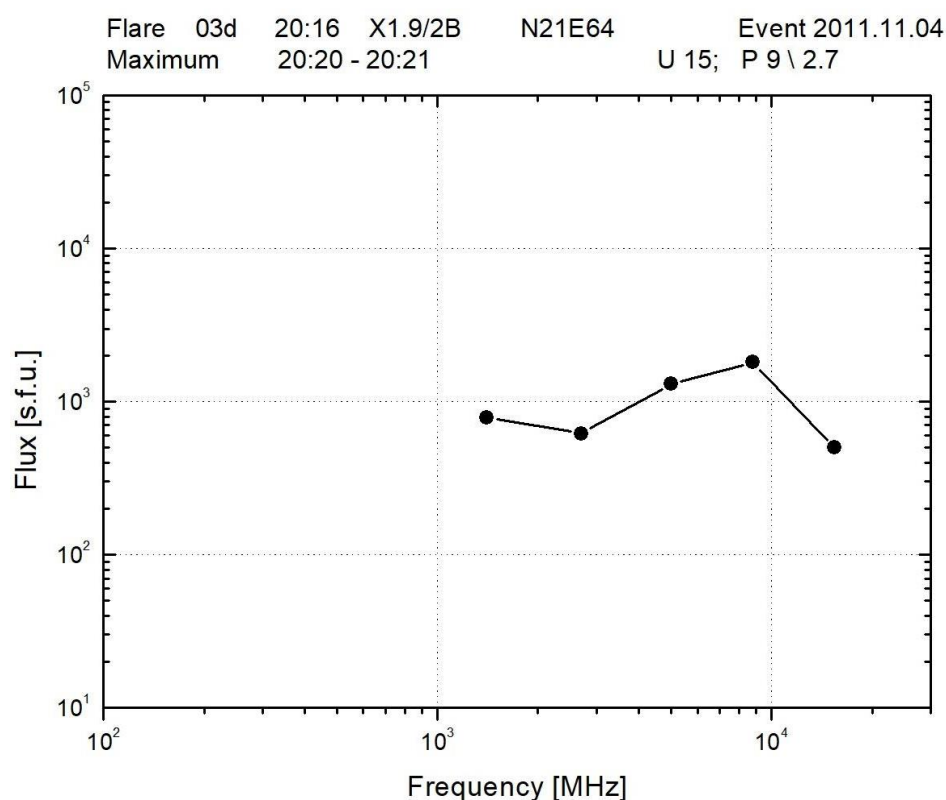
H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	2019	2023	2140	N22E63	2B	UMB
1 – 12	keV	2016	2027	2032	N21W64	X1.9	0.10
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	2116:00	2117:38	2119:56	32	28680	HESSI
12-25	keV	2119:56	2123:38	2127:24	38	56160	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	2020	~2020	2021	U15	2.7	
8.8	GHz	2019	2021	2027	P9 \ 2.7	3.26	
5	GHz	2020	2021	2027		3.11	
2.7	GHz	2020	2021	2024		2.79	
1.4	GHz	2020	2020	2023		2.89	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	025-180	2034		2038		1	
DS III	025-087	2053		2100		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2310	991	-40.5	360°	090°	SOHO

2011 November 03 • AR 11339 To event 497

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å		No flare event on visible solar disc					
1 – 12	keV	2328	2336	2344	N20E62	M2.1*	0.014
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS cont	031-180	4d0000		1019		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	04d0125	756	- 8.0	360°	084°	SOHO

* for second maxima

Radio burst frequency spectrum



Proton Active Region

AR11339 (N19L103, CMP 08.11.2011,
Sp=1540 msh, EKC, BGD)
XRI=4.18; $X_1^{1.9} + M_9^{4.3} + C_{38}$; $2_1 + 1_4 + C_{30}$
PFR 2-3.11 (25^h) $X_1^{1.9} + M_3^{4.3}$

References:

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Particle event: To($E_p > 10$ MeV) – 26d08^h

Tmax ($E_p > 10$ MeV) – 26d17^h, Jmax($E_p > 10$ MeV) – 40 /cm²·s·sr

Duration of the event – 3.5 days, power-law index: $\gamma = 3.2$

Quasimaximal energy of protons in the event – $E_{qm} = 120$ MeV

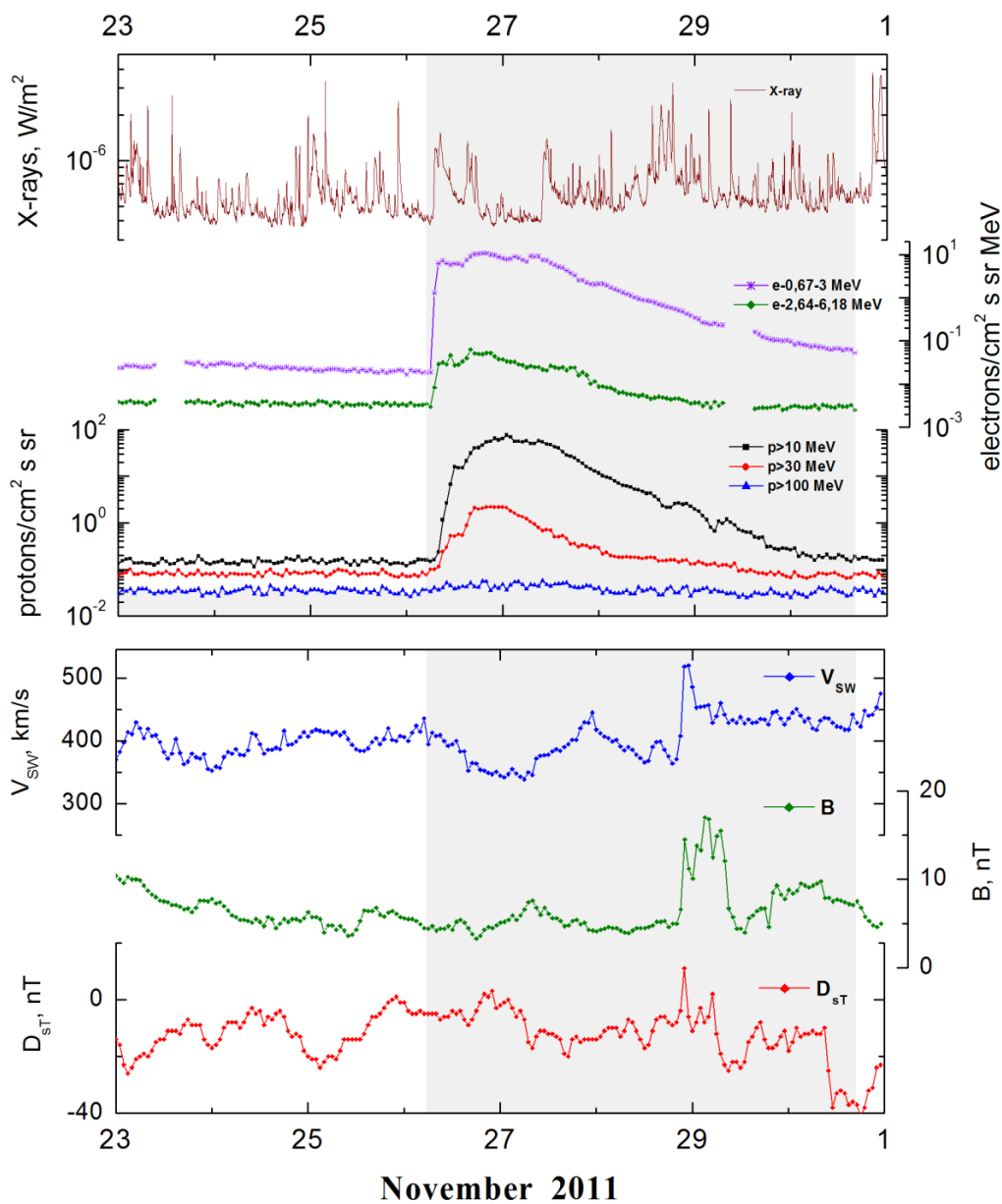
Sources: ☉ solar flare 26d06^h09^m, C1.2/DSF, N08W49, AR11353

Main burst X-ray 1–8 Å: onset – 26d06^h09^m, max – 26d07^h10^m, $\Phi = 0.0053$ J/m²

CME: 26d07^h12^m, V = 0933 km/s, $\Delta\phi = 360^\circ$, dA = 327°

▲ SC 28d21^h50^m

Particle fluxes and associated phenomena

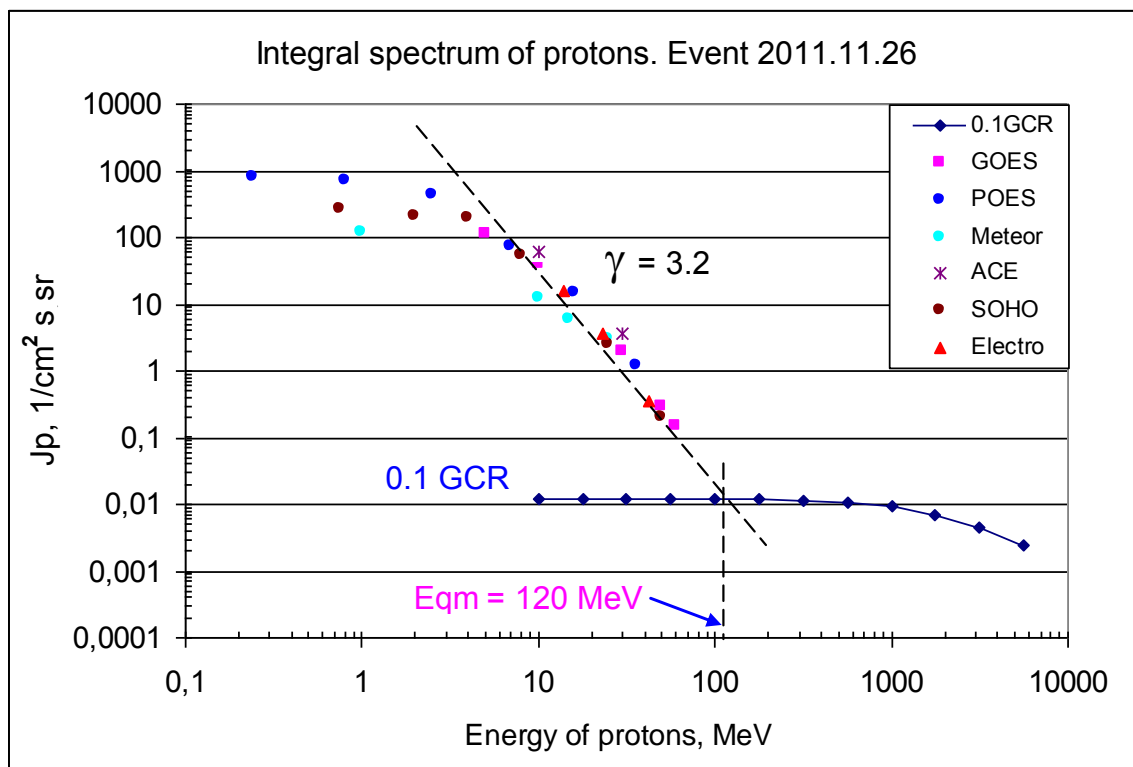


Integral fluxes of protons for the event of 2011 November 26

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	17	115	4d	0.2	
EPS	>10	8	17	40	3.5d	0.15	
EPS	>30	8	17	2	3d	0.08	
EPS	>50	8	17	0.3	2d	0.07	
EPS	>60	8	17	0.15	1d	0.06	
EPS	>100	8	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	8	23	800	4	100	
MEPED	>0.8	8	23	700	4	80	
MEPED	>2.5	8	23	440	3	60	
MEPED	>6.9	8	23	75	2	50	
MEPED	>16	8	23	15.3	2	0.85	
MEPED	>36	8	23	1.2	1	0.8	
MEPED	>70	8	-	-	-	0.9	
MEPED	>140	8	-	-	-	1.2	
Meteor-1							
SCR	>1	7	22	123	4	3.2	
SCR	>3	7	-	-	4	3	
SCR	>10	7	22	12.7	2	2.1	
GALS-M	>15	7	21	6	2	1.4	
GALS-M	>25	7	21	3	2	1.45	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	8	18	62	2.5	1.5	
SIS	>30	8	17	3.6	2.5	1.1	
SOHO							
EPHIN	>50	14	17	0.2	2	0.3	

Differential fluxes of protons for the event of 2011 November 26

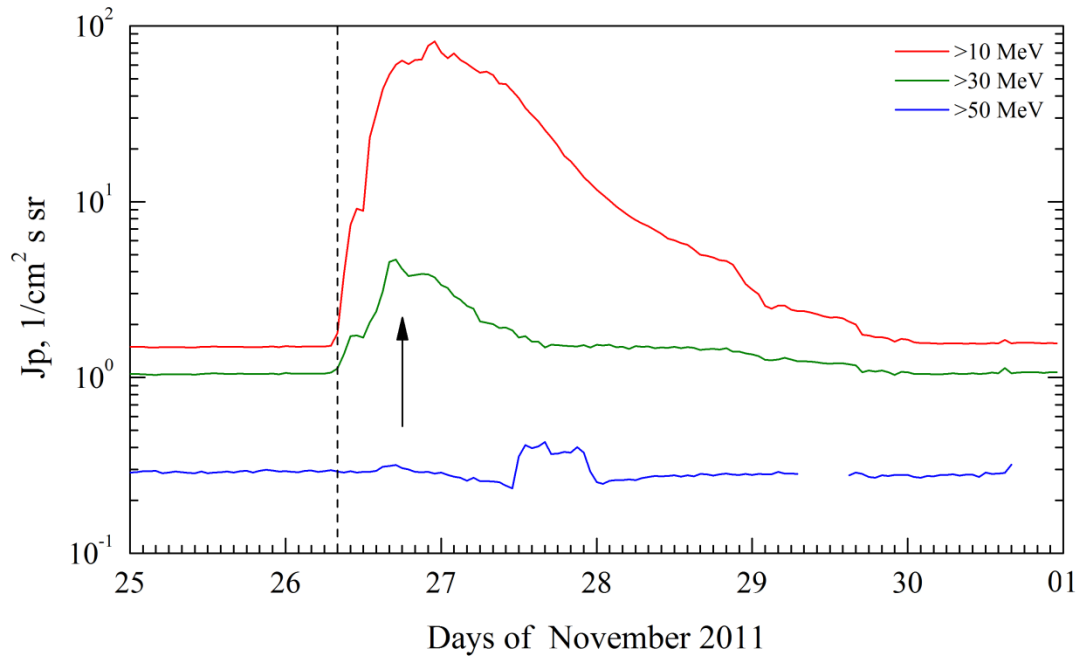
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	8	16	31	4	0.01	
LION	2 – 6	8	17	10	4	0.005	
EPHIN	4 – 8	8	17	34	4	0.003	
EPHIN	8 – 25	8	18	3.1	4	0.0001	
EPHIN	25–53	8	18	0.08	4	0.00002	
Electro-1							
SCR-E	13.7–23	7	21	1.3	2	0.06	
SCR-E	23–42	7	20	0.17	2	0.025	
SCR-E	42–112	7	16	0.005	1.25	0.005	



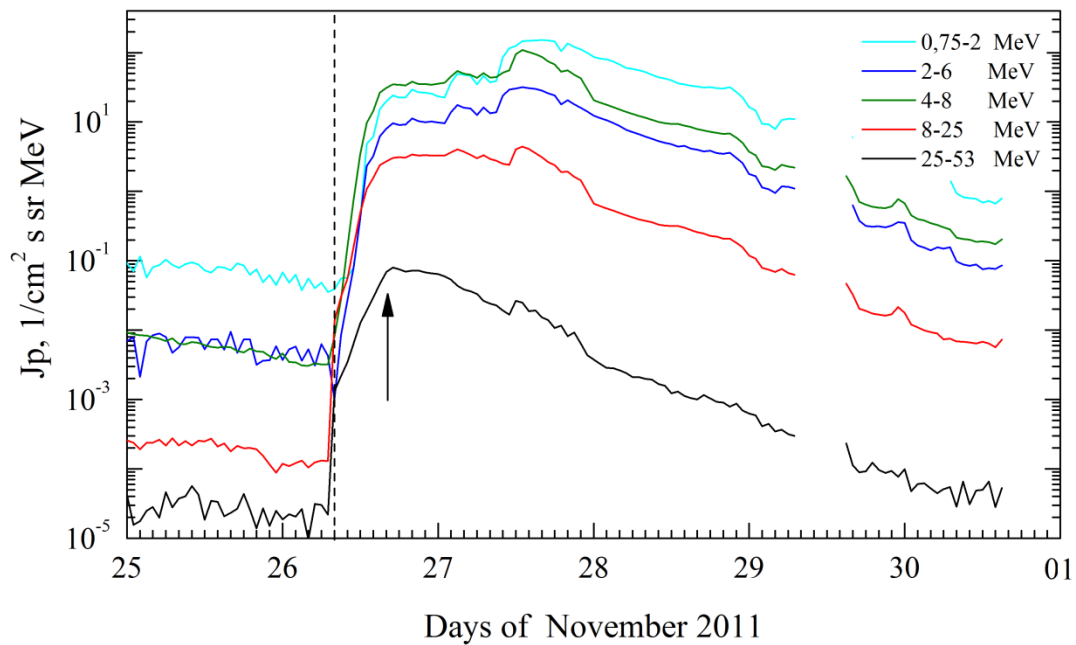
Time profiles of proton fluxes in the event 2011.11.26

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (50>MeV). Event 2011.11.26

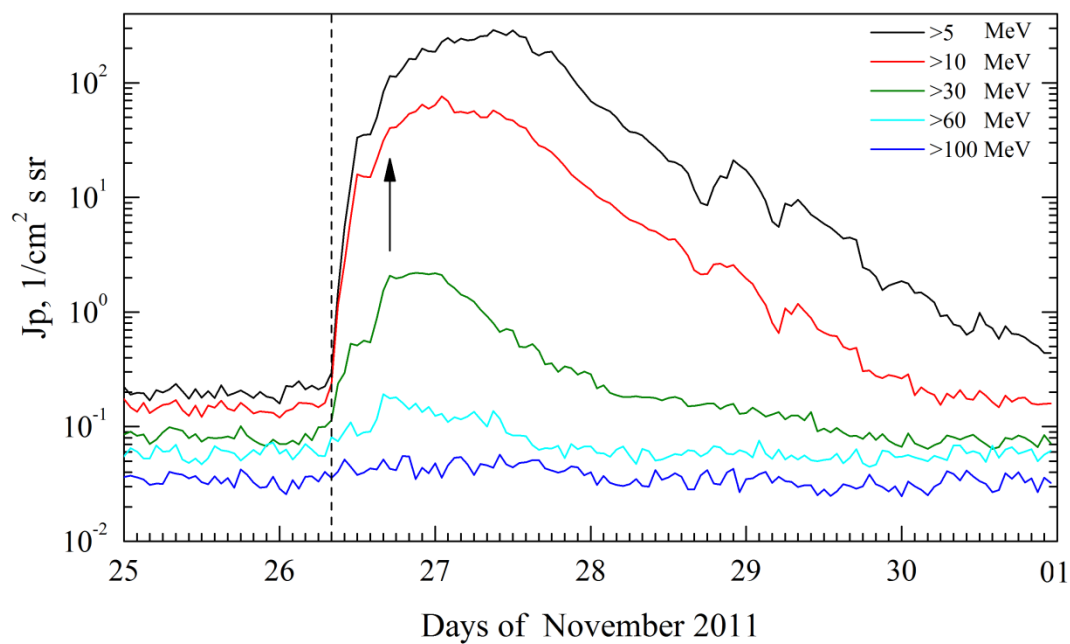


SOHO. Event 2011.11.26

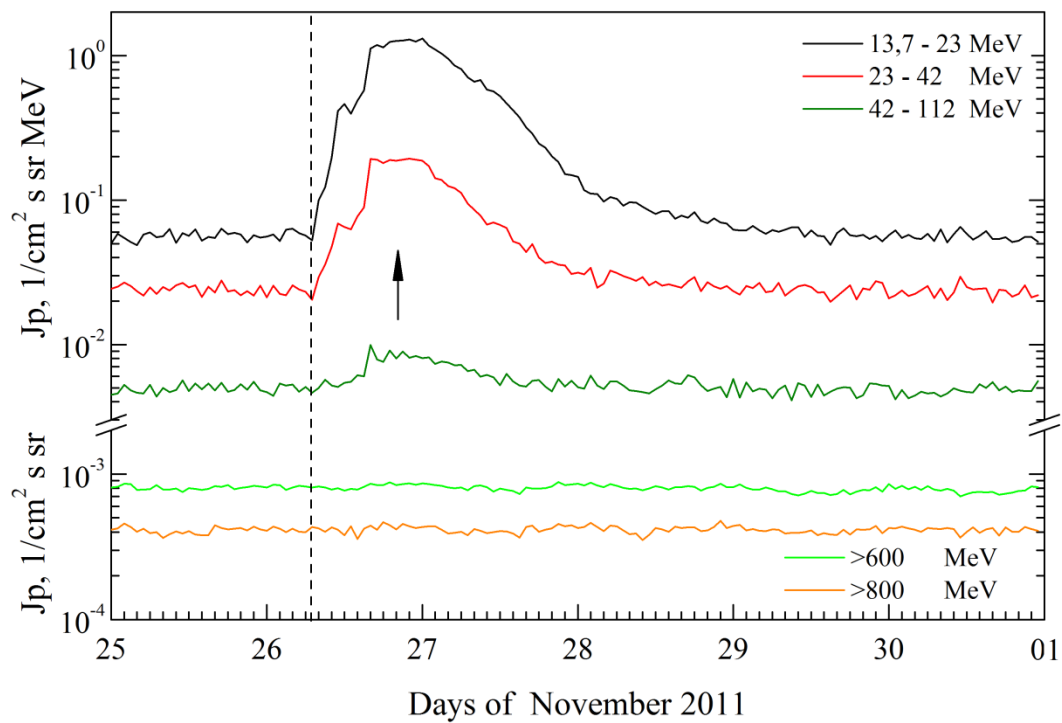


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2011.11.26

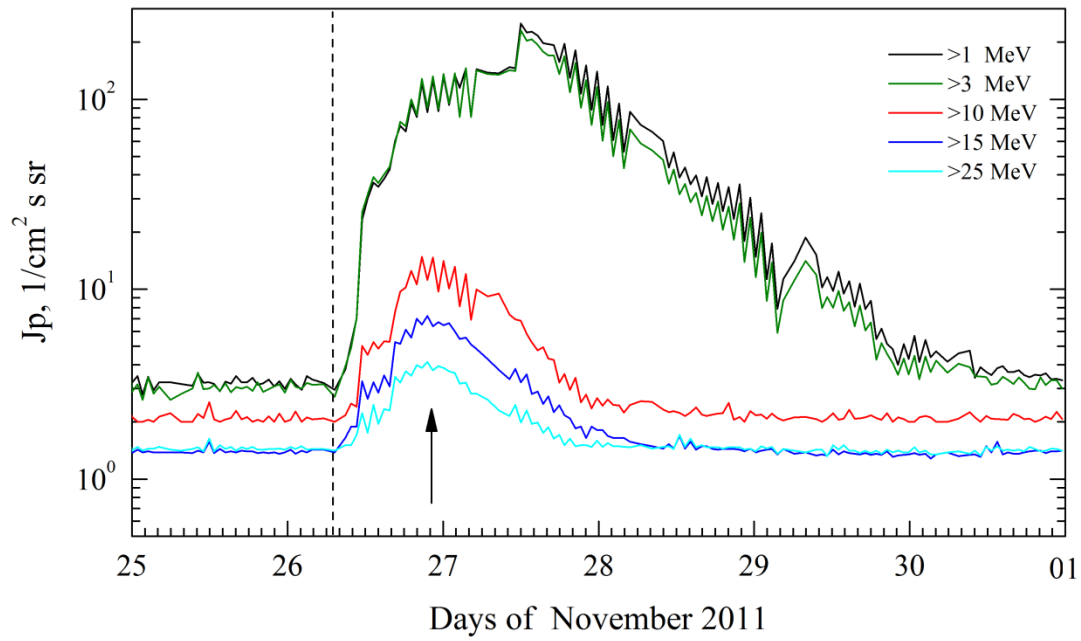


Electro. Event 2011.11.26

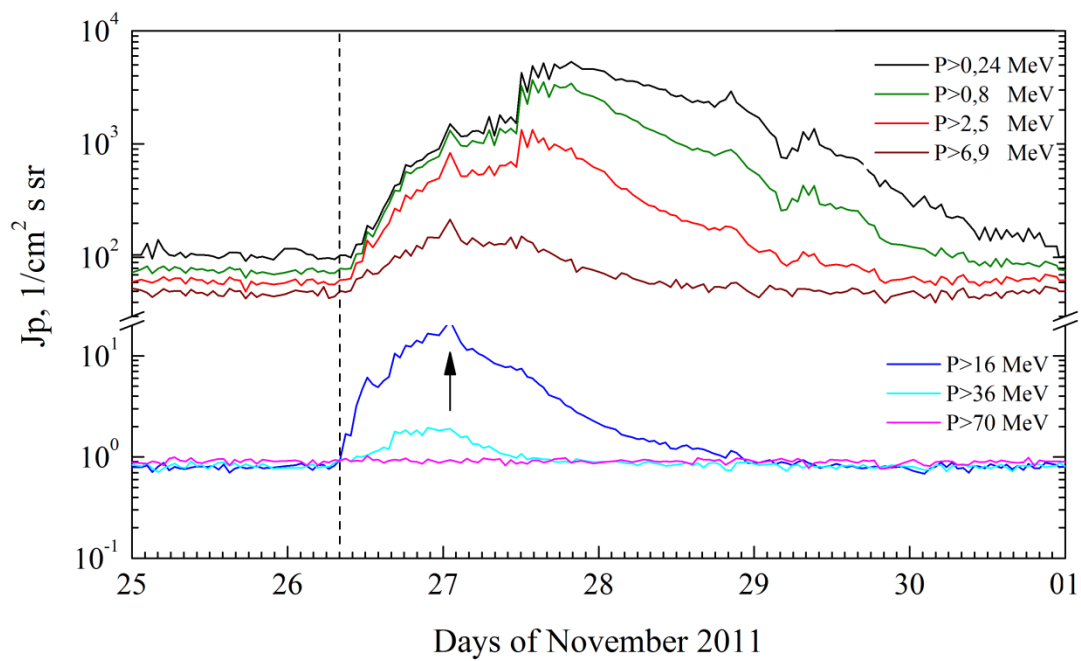


Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES

Meteor. Event 2011.11.26



POES. Events 2011.11.26



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 November 26**

2011 November 26 ☉ AR 11353 To event 498

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	DSF	0530		~0830	N11W49	>10°	
1 – 12	keV	0609	0710	0756	N08W47	C1.2	0.0053
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	0646	0646:34	0648:32	38	22400	HESSI
6-12	keV	0648:32	0700:10	0715:28	84	449120	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	025-180	0703		0704		1	
DH II	0.05-10	0715		27/2400			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0712	933	9.0	360°	327°	SOHO

Proton Active Region

AR11353 (N08L267, CMP 23,7.12.2011,
Sp=0490 msh, CRO, B)
XRI=0 C₂ S₂

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 Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
 Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 25d19^h

Tmax ($E_p > 10$ MeV) – 26d01^h, Jmax₁ ($E_p > 10$ MeV) – 2.5 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 2.3$.

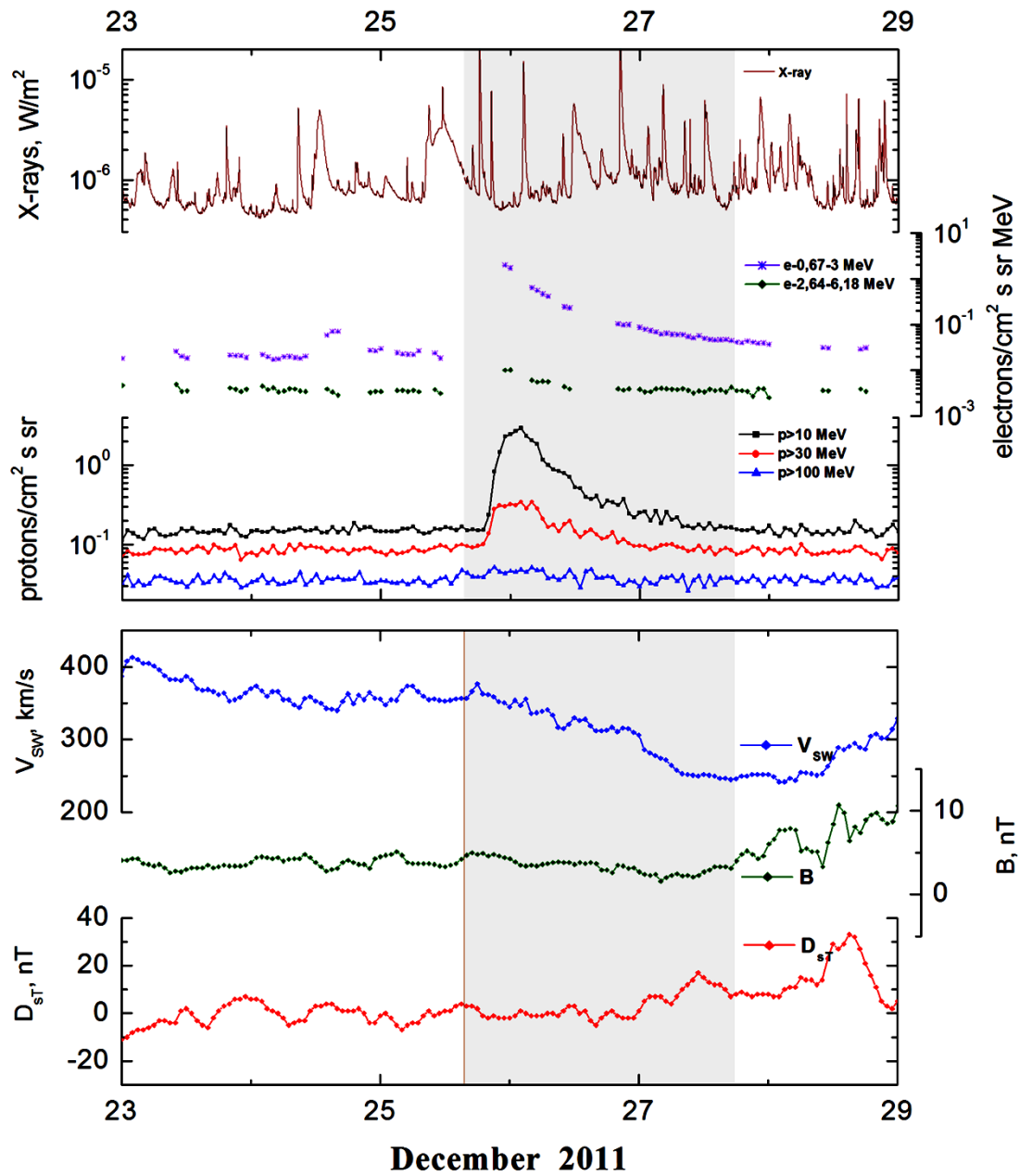
Quasimaximal energy of protons in the event – E_{qm} = 100 MeV

Sources: • solar flare 25d18^h11^m, M4.0/1N, S22W26, AR11387

Main burst X-ray 1–8 Å: onset – 25d18^h11^m, max – 25d18^h16^m, $\Phi = 0.011$ J/m²

CME: 25d18^h48^m, V = 366 km/s, $\Delta\phi = 125^\circ$, dA = 235°

Particle fluxes and associated phenomena

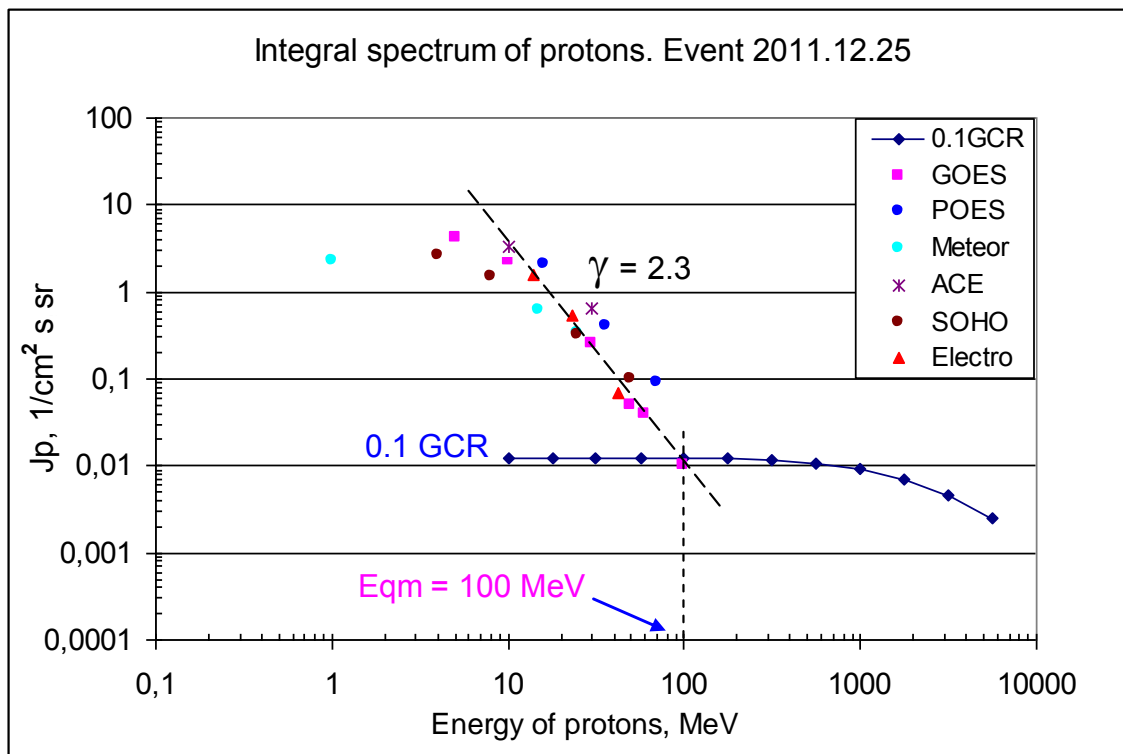


Integral fluxes of protons for the event of 2011 December 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	19	26d01	4.1	2	0.2	
EPS	>10	19	26d01	2.5	2	0.15	
EPS	>30	19	26d00	0.25	1	0.08	
EPS	>50	19	26d00	0.05	0.5	0.07	
EPS	>60	19	26d00	0.04	0.5	0.06	
EPS	>100	19	26d00	0.01	0.5	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	80	
MEPED	>2.5	-	-	-	-	60	
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	20	23	2.1	0.5	0.85	
MEPED	>36	20	23	0.4	0.5	0.9	
MEPED	>70	20	21	0.09	0.2	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	19	22	2.27	1.5	3.3	
SCR	>3	19	-	-	1.5	3	
SCR	>10	19	-	-	1	2.05	
GALS-M	>15	19	22	0.61	0.5	1.45	
GALS-M	>25	19	22	0.34	0.5	1.5	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	19	26d00	3.2	1	1.6	
SIS	>30	19	23	0.65	0.5	1.1	
SOHO							
EPHIN	>50	-	23	0.01	-	0.3	

Differential fluxes of protons for the event of 2011 December 25

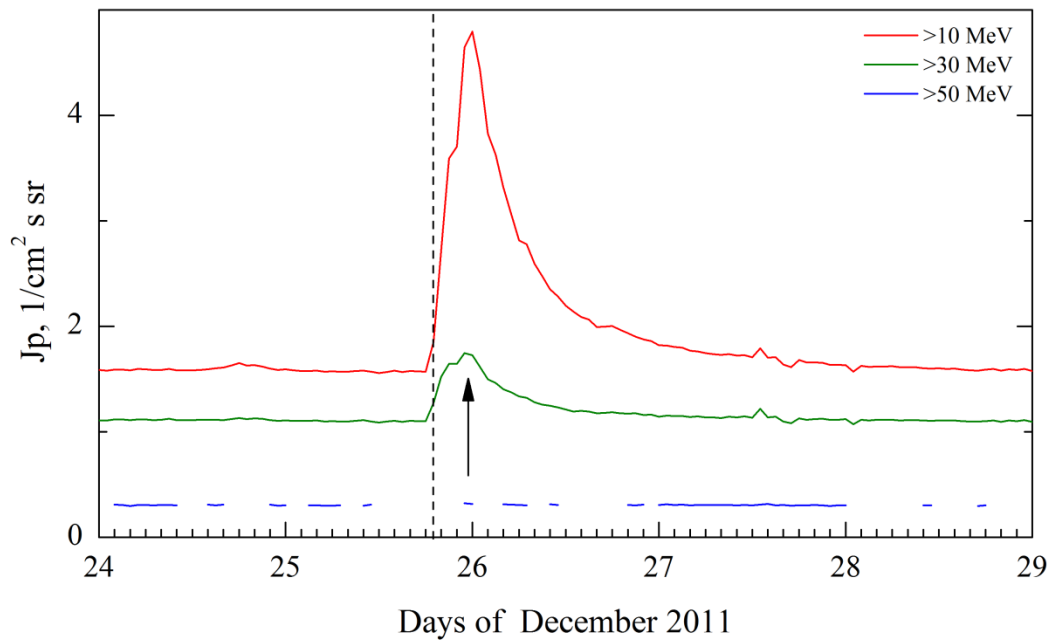
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	3	0.01	
LION	2 – 6	-	-	-	3	0.005	
EPHIN	4 – 8	-	23	0.27	3	0.0003	
EPHIN	8 – 25	-	23	0.07	3	0.00005	
EPHIN	25 – 53	-	23	0.008	3	0.00002	
GOES							
EPS	350–420	14	23	0.0002	1	0.002	
Electro-1							
SCR-E	13.7–23	19	23	0.126	1	0.057	
SCR-E	23–42	19	22	0.034	1	0.024	
SCR-E	42–112	-	-	-	-	0.01	



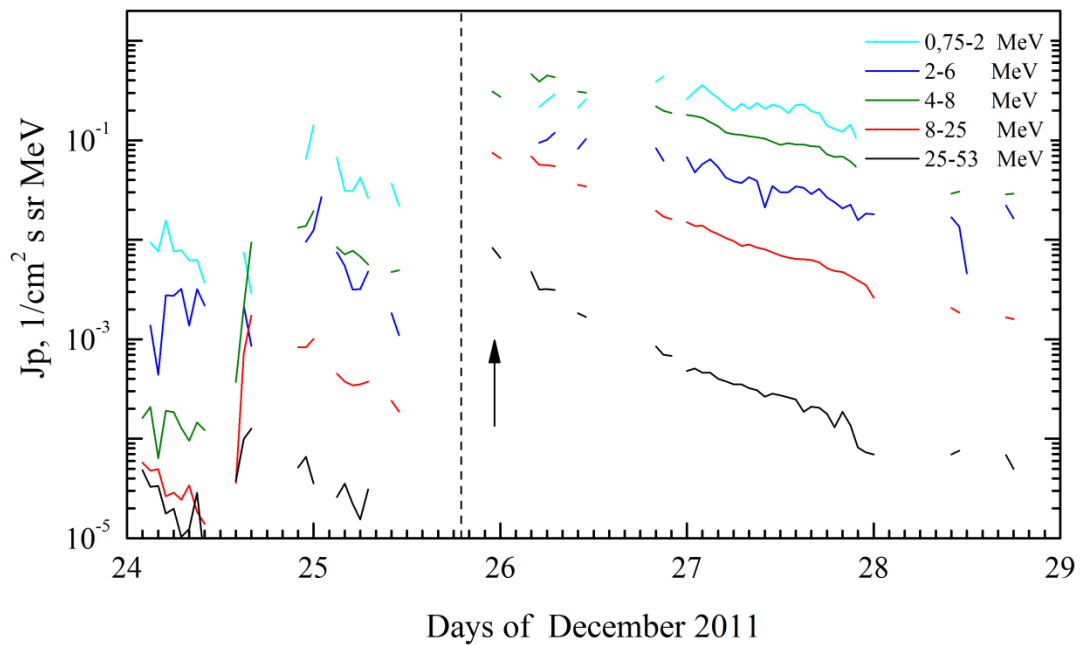
Time profiles of proton fluxes in the event 2011.12.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

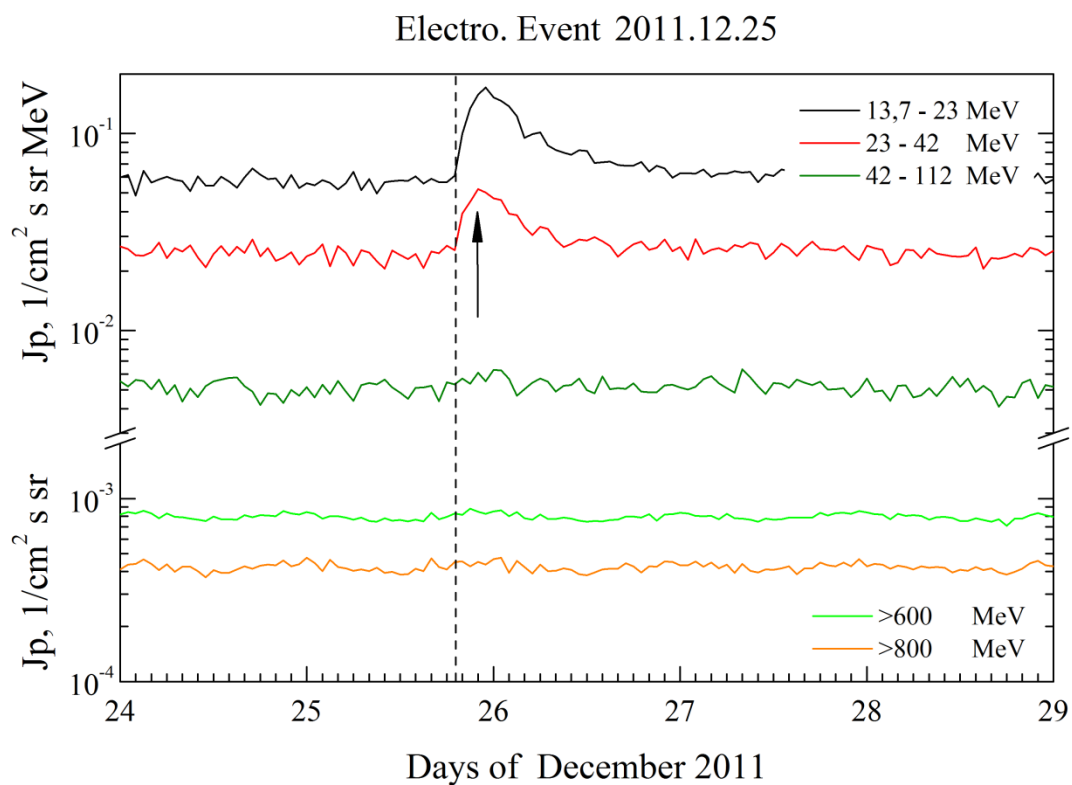
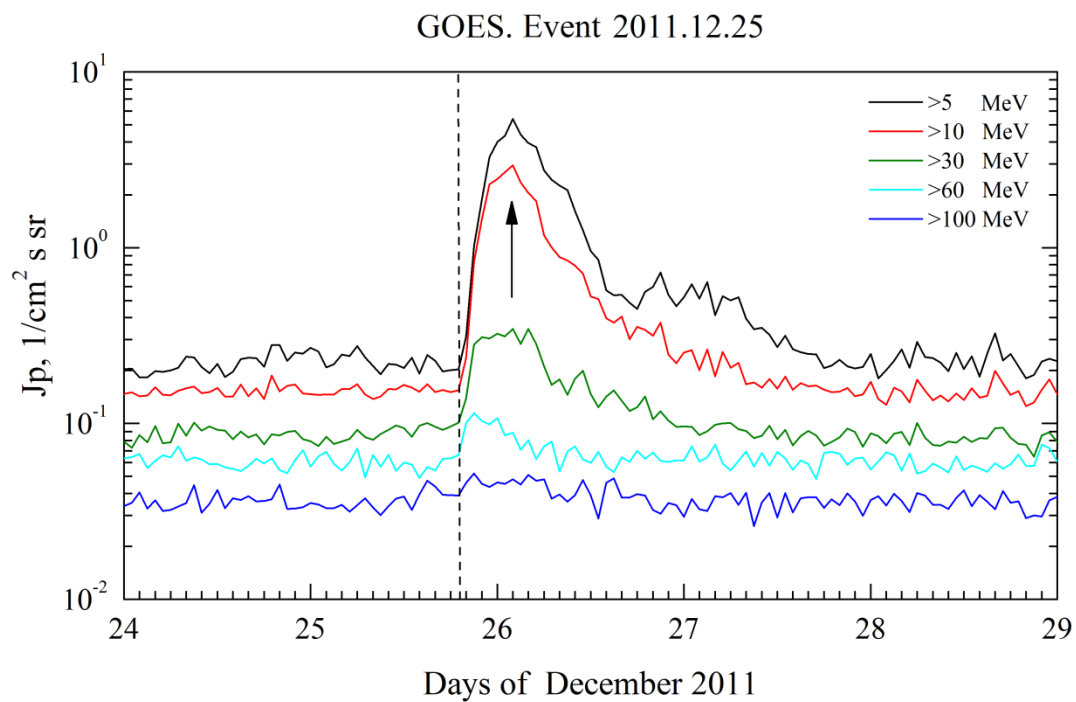
ACE SIS + SOHO (>50 MeV). Event 2011.12.25



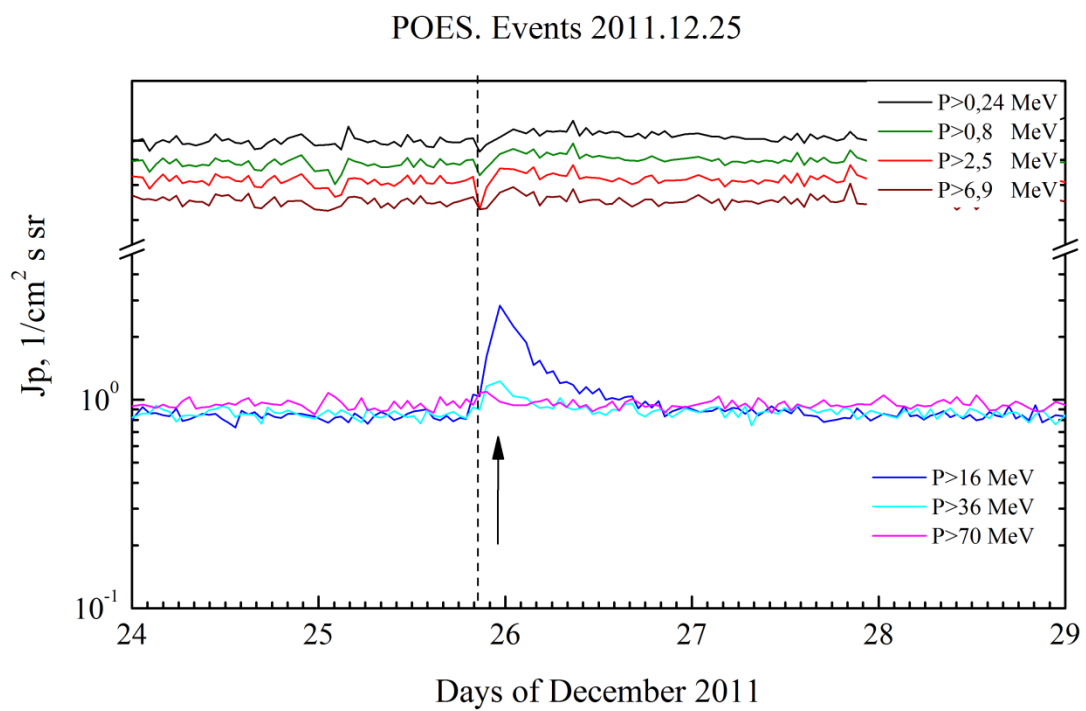
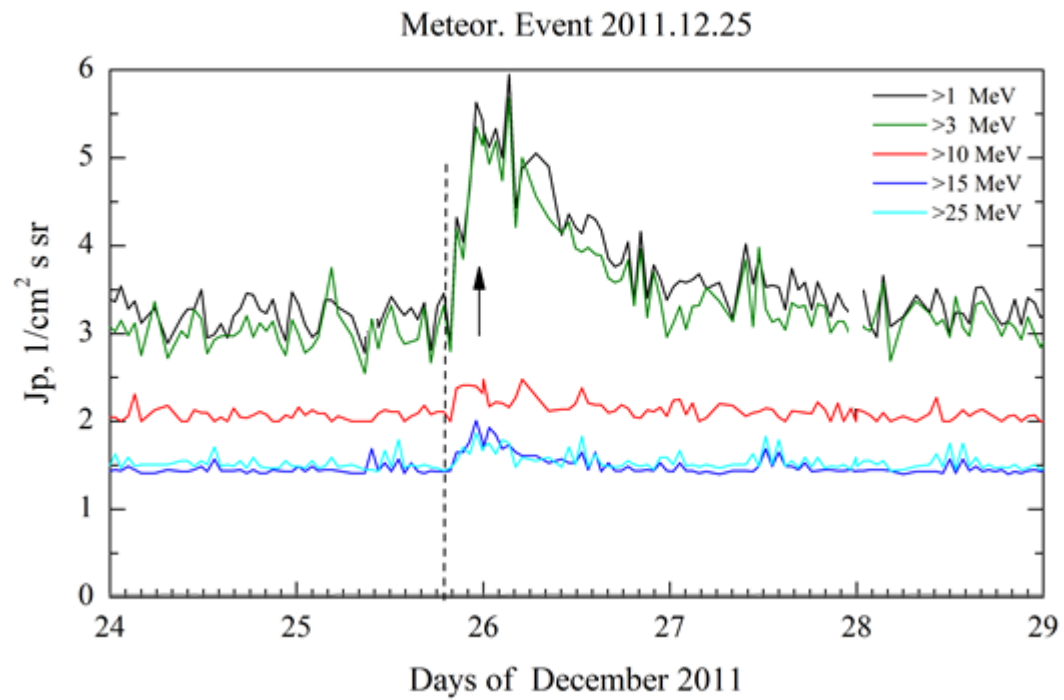
SOHO. Event 2011.12.25



Earth satellites in geostationary orbit, $R \approx 6,6$ Re: GOES and Electro.



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2011 December 25**

2011

December 25

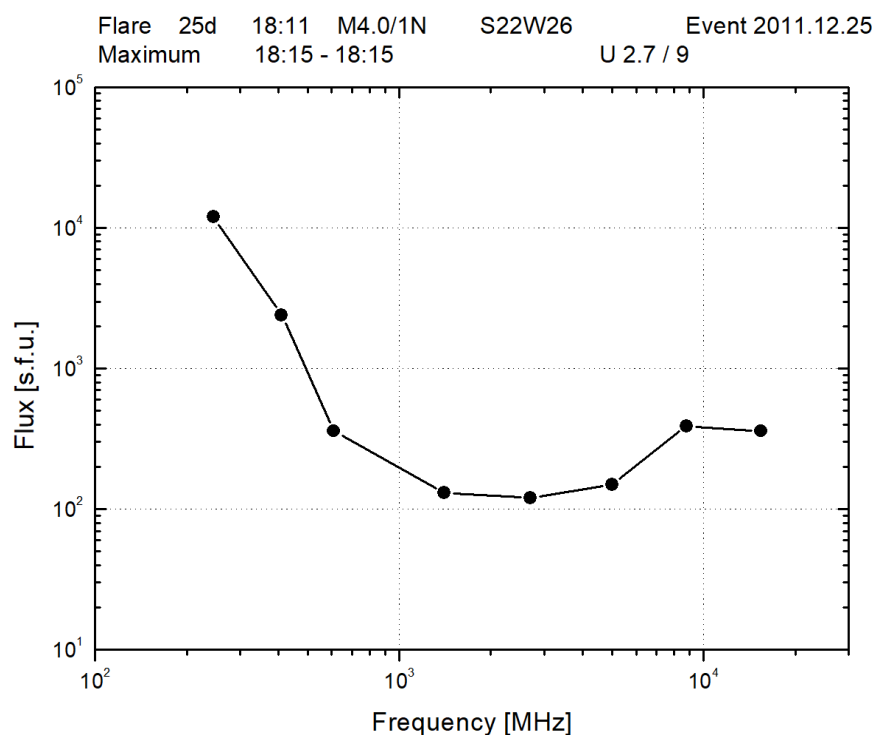
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AR 11387

To event 499

Hα, X-ray		To	Tmax	Te	Location	Importance Class	FI Code Φ, J/m²
6563 Å	FL	1814	1819	1911	S22W26	1N	ERU
1 – 12	keV	1811	1816	1820	S22W26	M4.0	0.011
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1817:12	1818:22	1838:16	784	1235920	HESSI
12-25	keV	1838:16	1838:46	1851:40	4	10017	HESSI
12-25	keV	1812:59	1815:37	1838:39	277312	53683156	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1814	1815	1815	U2.7 / 9	2.56	
8.8	GHz	1814	1815	1816		2.59	
5	GHz	1814	1815	1816		2.18	
2.7	GHz	1814	1815	1815		2.08	
1.4	GHz	1814	1815	1815		2.11	
610	MHz	1814	1815	1816		2.56	
410	MHz	1815	1815	1820		3.38	
245	MHz	1815	1815	1824		4.08	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-062	1820		1831		2	
DS IV	025-180	1817		1857		3	
DS VI	025-180	1817		1847		2	
DH II	7-14	1845		1855			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1848	366	- 4.7	125°	235°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR11339 (N19L103, CMP 08.11.2011,
Sp=1540 msh, EKC, BGD)
XRI=4.18; $X_1^{1.9} + M_9^{4.3} + C_{38}$; $2_1 + 1_4 + C_{30}$
PFR 2-3.11 (25^h) $X_1^{1.9} + M_3^{4.3}$

References:

Bazilevskaya G.A., A.G. Mayorov, V.V. Malakhov, V.V. Mikhailov, [2013](#).
Bučik R., S.M. Mulay, G.M. Mason et al., [2021](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).

Events in 2012

			Page
1	*Event 2012.01.02 – (2012-002)	№ 500	235
2	Event 2012.01.20 – (2012-020)	№ 501	242
3	Event 2012.01.21 – (2012-021)	№ 502	250
4	Event 2012.01.22 – (2012-022)	№ 503	256
5	Event 2012.01.23 – (2012-023)	№ 504	263
6	Event 2012.01.27 – (2012-027)	№ 505	273
7	Event 2012.02.24 – (2012-055)	№ 506	283
8	Event 2012.03.04 – (2012-064)	№ 507	290
9	Event 2012.03.07 – (2012-067)	№ 508	298
10	Event 2012.03.13 – (2012-073)	№ 509	311
11	Event 2012.05.17 – (2012-138)	№ 510	320
12	Event 2012.05.26 – (2012-147)	№ 511	330
13	Event 2012.06.14 – (2012-166)	№ 512	337
14	Event 2012.07.06 – (2012-188)	№ 513	345
15	Event 2012.07.08 – (2012-190)	№ 514	353
16	Event 2012.07.12 – (2012-194)	№ 515	361
17	Event 2012.07.17 – (2012-199)	№ 516	369
18	Event 2012.07.19 – (2012-201)	№ 517	377
19	Event 2012.07.23 – (2012-205)	№ 518	386
20	*Event 2012.08.02 – (2012-215)	№ 519	394
21	Event 2012.09.01 – (2012-245)	№ 520	401
22	Event 2012.09.28 – (2012-272)	№ 521	409
23	Event 2012.11.08 – (2012-313)	№ 522	416
23	Event 2012.12.14 – (2012-349)	№ 523	424

An asterisk (*) marks weak events with Jp ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To($E_p > 10$ MeV) – 02d19^h

Tmax₁($E_p > 10$ MeV) – 02d22^h, Jmax₁($E_p > 10$ MeV) – 0.4/cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 03d06^h, Jmax₂($E_p > 10$ MeV) – 0.5 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma_1 = 1.6$, $\gamma_2 = 1.6$

Quasimaximal energy of protons in the event – Eqm₁ = 120 MeV

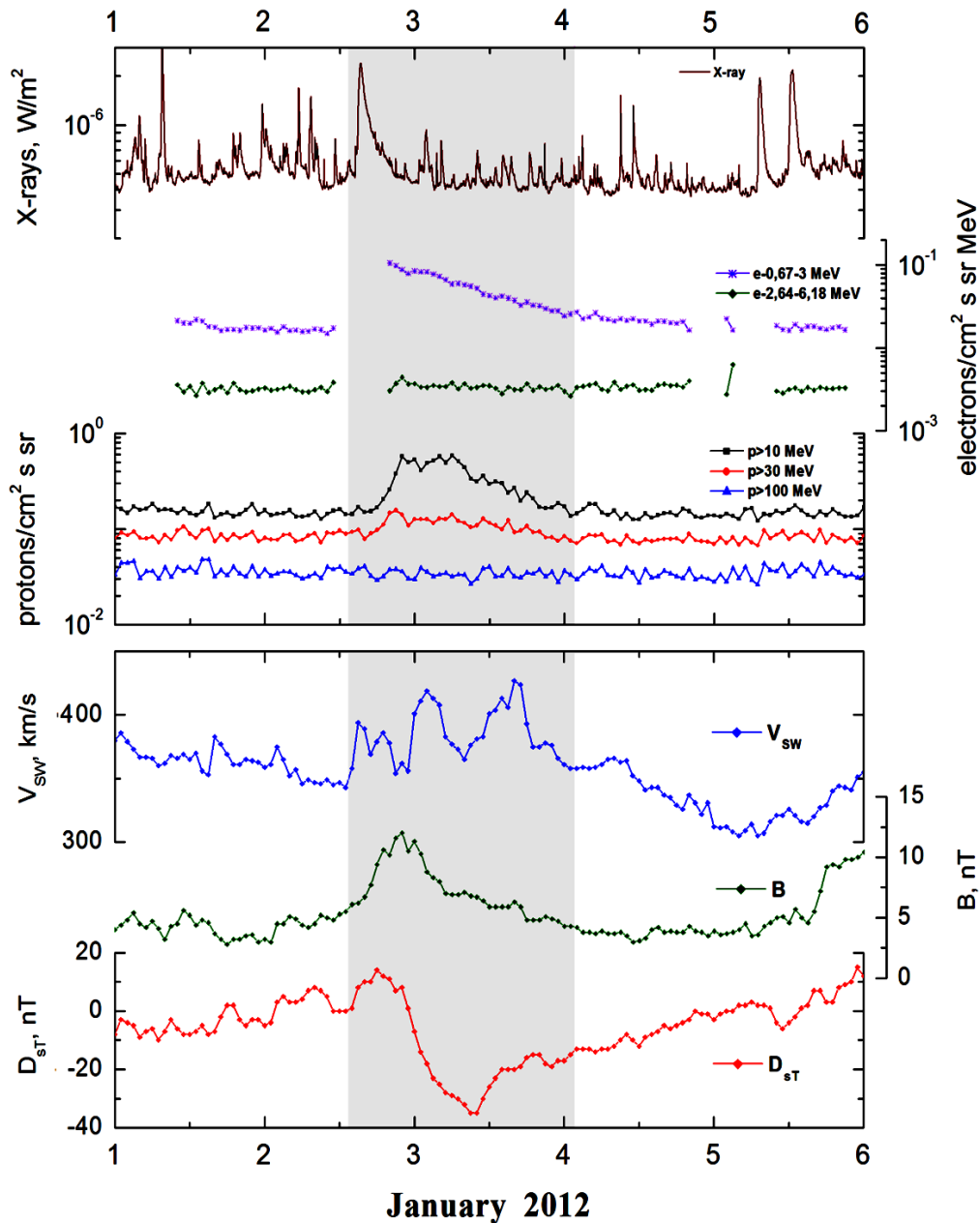
– Eqm₂ = 90 MeV

Sources: ☐ solar flare 02d14^h31^m, C2.4/EPL, N07W89, AR11384, 1.5d behind W_L

Main X-ray burst 1-8 Å: onset – 02d14^h31^m, max – 02d15^h24^m, $\Phi = 0.0087$ J/m²

CME: 02d15^h13^m, V = 1138 km/s, $\Delta\phi = 360^\circ$; dA=244°

Particle fluxes and associated phenomena

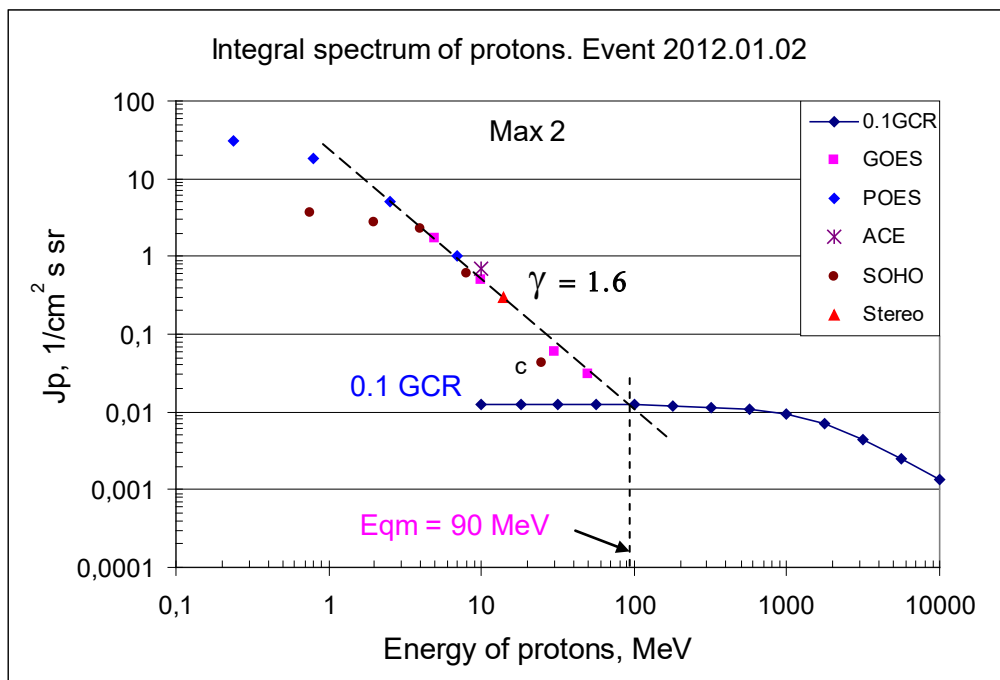
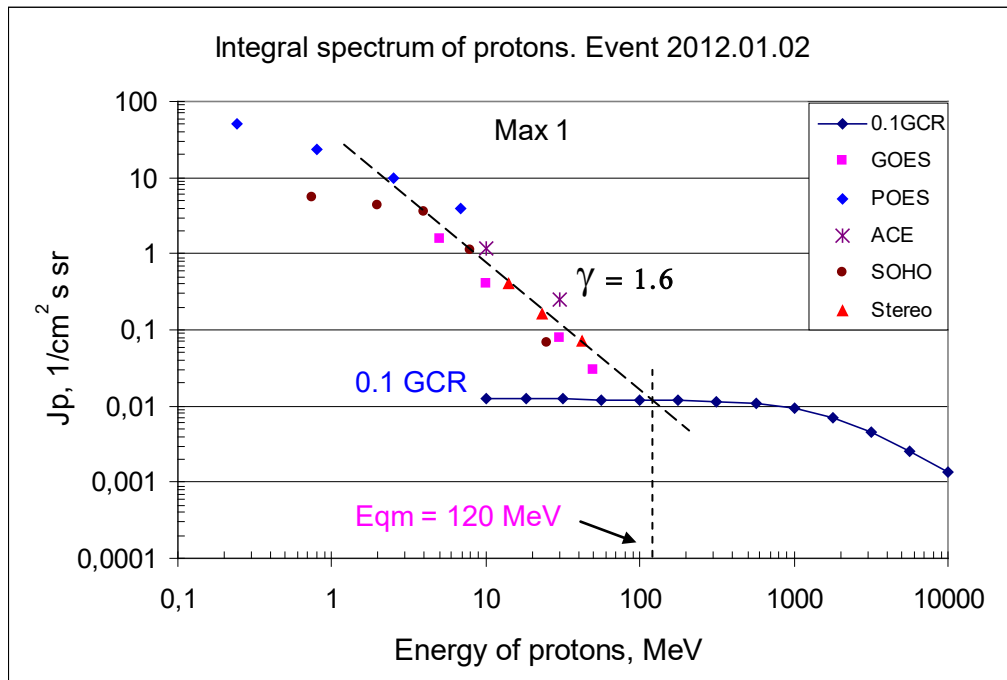


Integral fluxes of protons for the event of 2012 January 02

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	19	23/3d06	1.6/1.7	1	0.2	
EPS	>10	19	22/3d06	0.4/0.5	1	0.16	
EPS	>30	19	21/3d06	0.08/0.06	1	0.08	
EPS	>50	19	21/3d06	0.03/0.015	1	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	23	3d02/3d06	50/40	0.5	100	
MEPED	>0.8	23	3d02/3d06	23/18	0.2	75	
MEPED	>2.5	23	3d02/3d06	10/5	-	60	
MEPED	>6.9	23	3d02/3d06	4/1	-	50	
MEPED	>16	-	-	-	-	0.85	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
ACE							
SIS	>10	17	21/3d03	1.2/ 0.7	1	1.5	
SIS	>30	17	21/ -	0.25/ -	1	1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2012 January 02

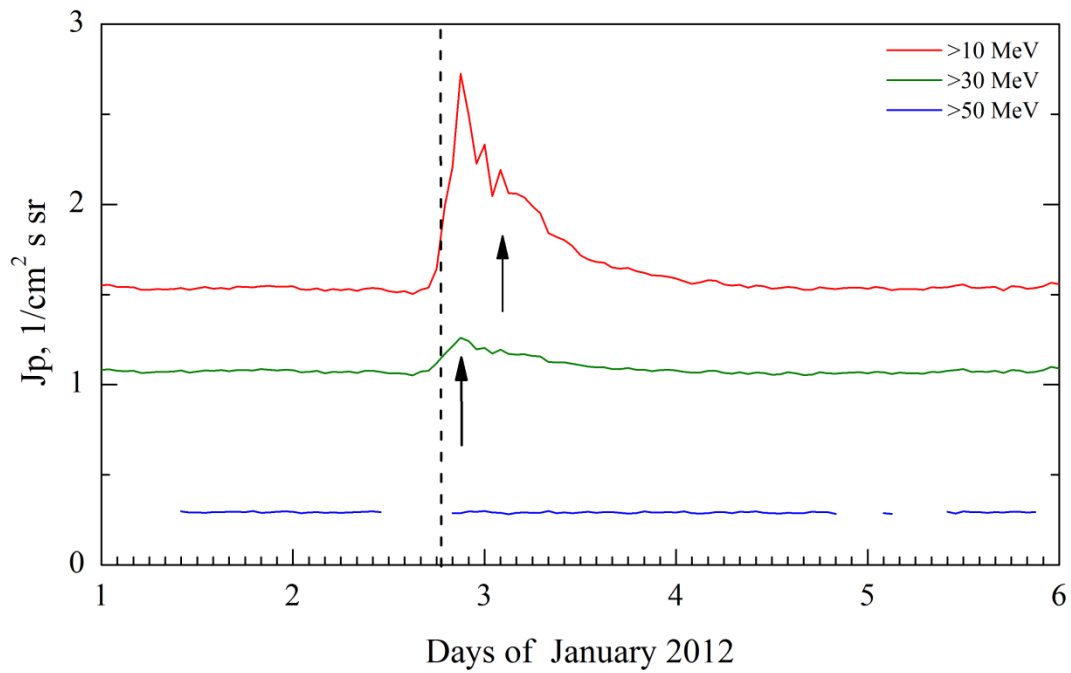
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	22/3d04	1/0.8	1	0.14	
LION	2 – 6	-	22/3d03	0.216/0.14	1	0.017	
EPHIN	4 – 8	-	22/3d03	0.64/0.42	1.7	0.0066	
EPHIN	8 – 25	-	22/3d03	0.06/0.033	3	0.00006	
EPHIN	25 – 53	-	21/3d03	0.0024/0.0015	2.5	0.00002	
Electro-1							
SCR-E	13.7–23	17	23/3d03	0.025/ 0.033	0.5	0.055	
SCR-E	23–42	17	23/ -	0.005/ -	0.5	0.025	
SCR-E	42–112	19	22/ -	0.001/-	0.5	0.005	



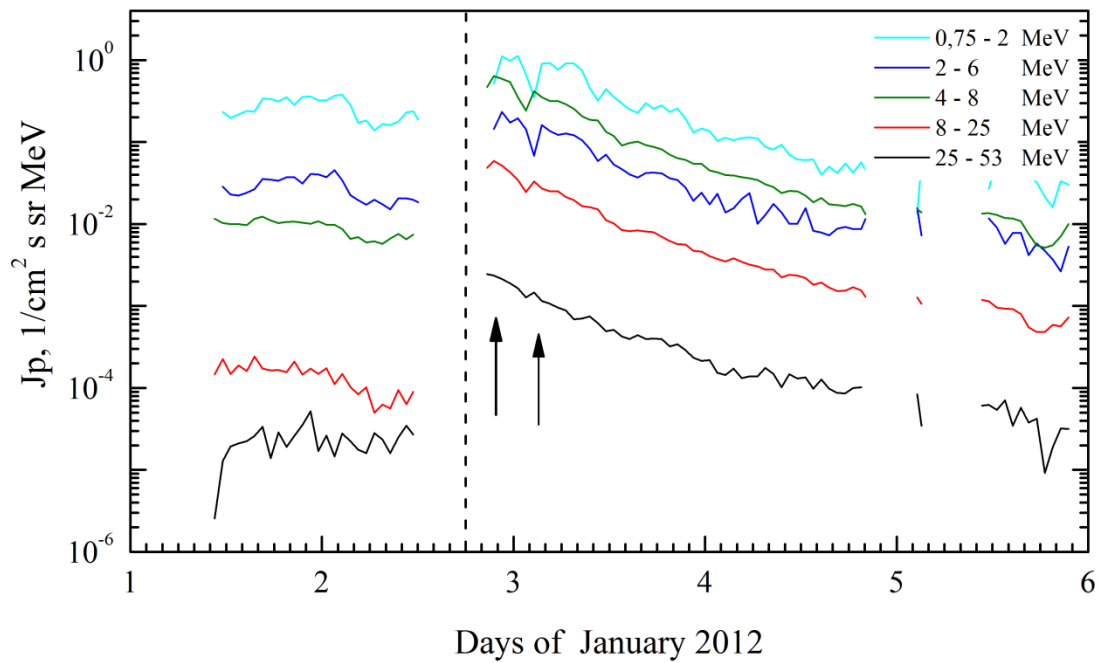
Time profiles of proton fluxes in the event 2012.01.02

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

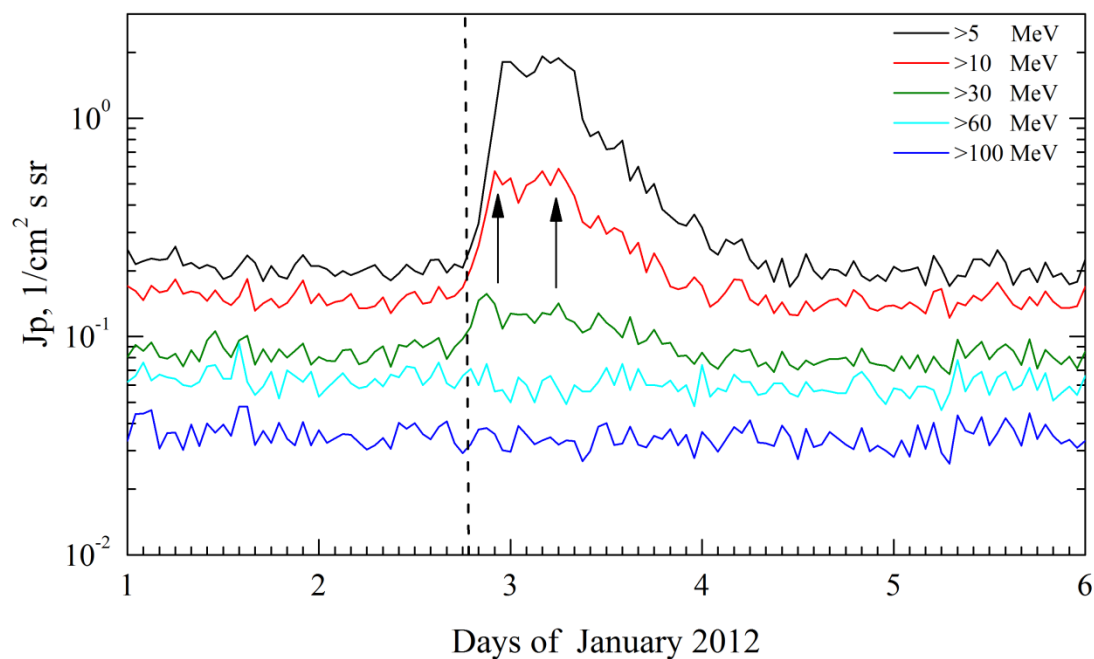
ACE SIS + SOHO (>50 MeV). Event 2012.01.02



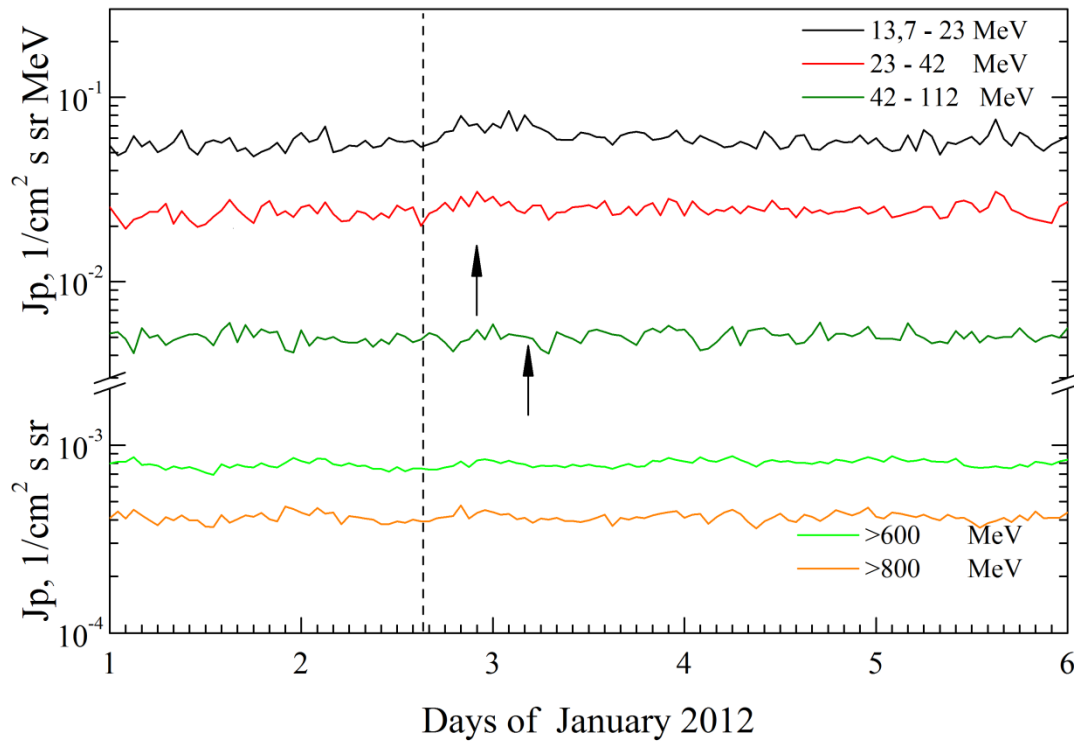
SOHO. Event 2012.01.02



Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro
GOES. Event 2012.01.02

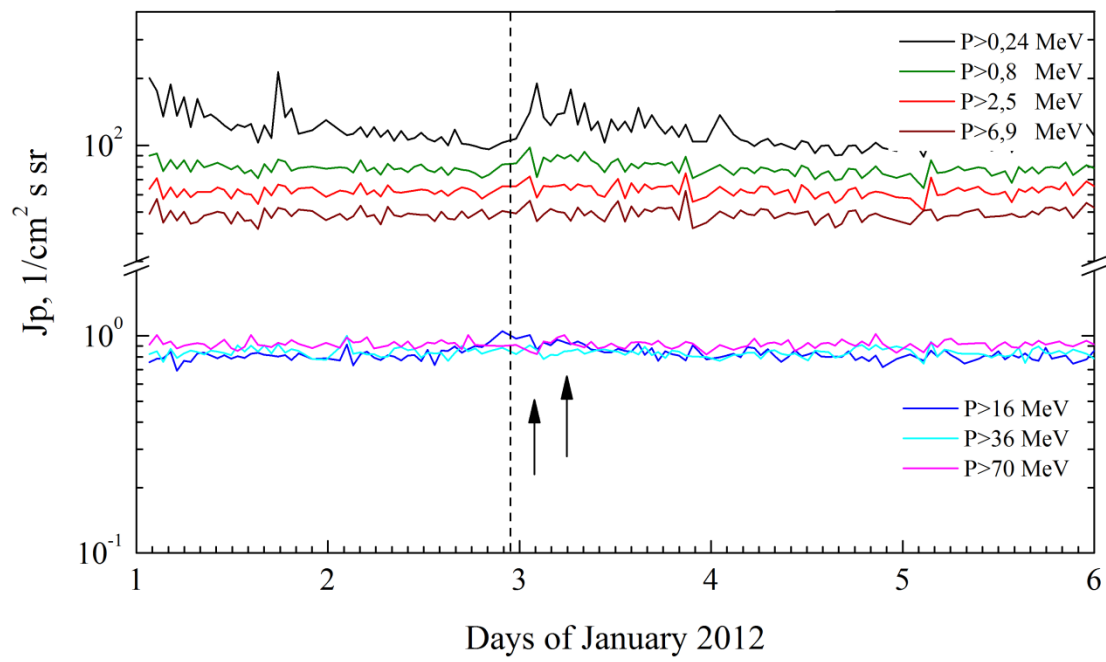


Electro. Event 2012.01.02



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

POES. Event 2012.01.02



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 02**

2012 January 02



AR 11384

To event 500

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical event on visible solar disc					
6563 Å	EPL	1452		1506	S17W90	0.28	
1– 12	keV	1431	1524	>1604	N07W89*	C2.4	0.0087
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1429:36	1434:54	1442:00	624	1086040	HESSI
12 – 25	keV	1517:56	1518:14	1526:24	1584	2937400	HESSI
12-25	keV	1452:07	1500:02	1511:18	2034	289570	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	1456	1457	1457		2.2	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DH II	4-16	1500		1545			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1513	1138	-8.4	360°	244°	SOHO

*1.5d behind W_L

Proton Active Region

AR 11384 (N12L197, CMP 25,9.12.2012,

Sp=500 msh, CKO, B, R)

XRI=0 C₈ S₈

Particle event: To($E_p > 10$ MeV) – 20d01^h

Tmax₁($E_p > 10$ MeV) – 20d20^h, Jmax₁ ($E_p > 10$ MeV) – 2.4 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 21d01^h, Jmax₂ ($E_p > 10$ MeV) – 1.9 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 2.2$, $\gamma_2 = 2.2$

Quasimaximal energy of protons in the event – E_{qm} = 100 MeV

– E_{qm} = 80 MeV

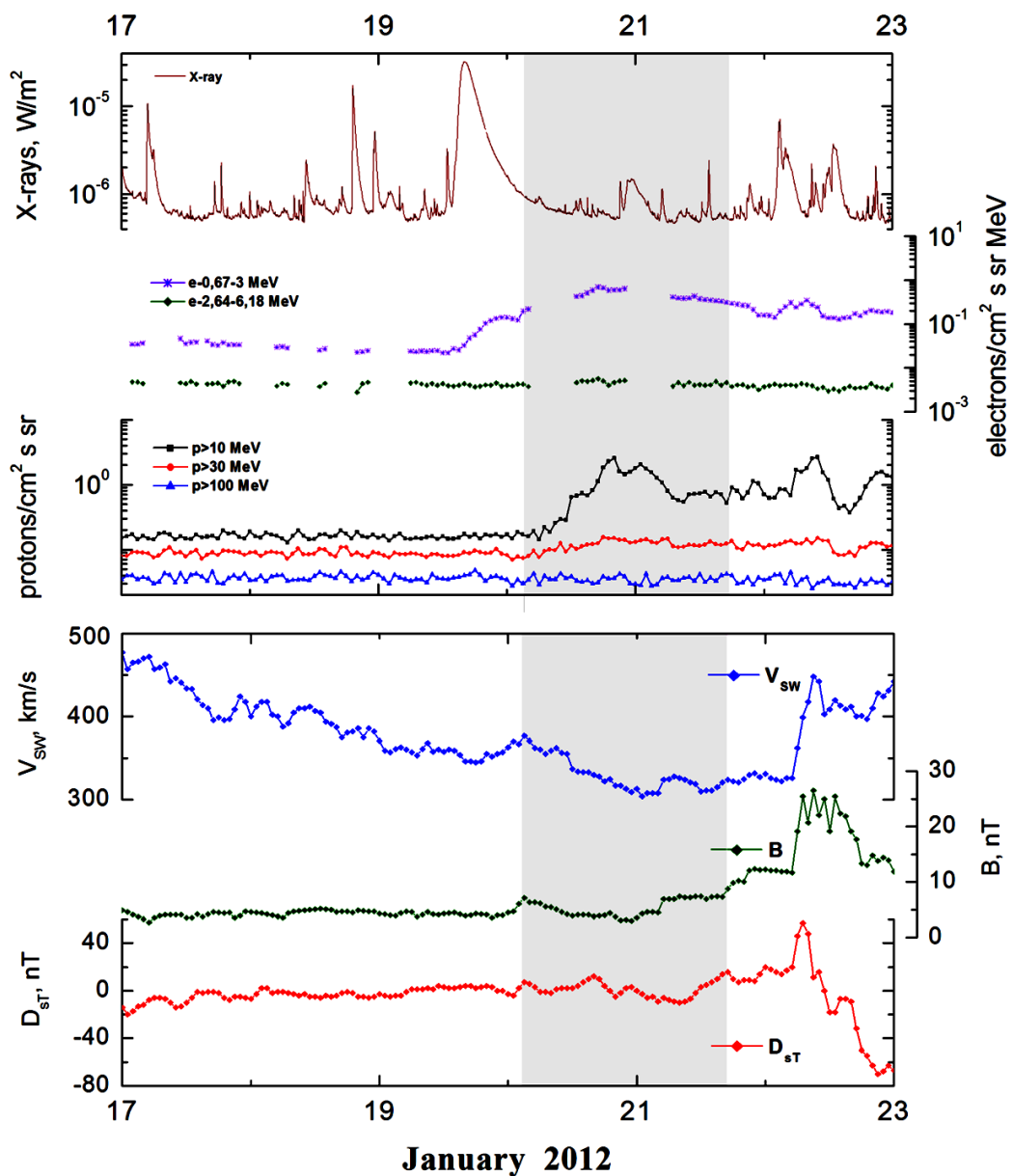
Sources: ● solar flare 19d13^h44^m, M3.2/SF, N30E30, AR11402

Main burst X-ray 1–8 Å: onset – 19d13^h44^m, max – 19d16^h05^m, $\Phi = 0.27$ J/m²

CME: 19d14^h36^m, V = 1120 km/s, $\Delta\phi = 360^\circ$, dA = 020°

▲ SC 22d06^h12^m

Particle fluxes and associated phenomena

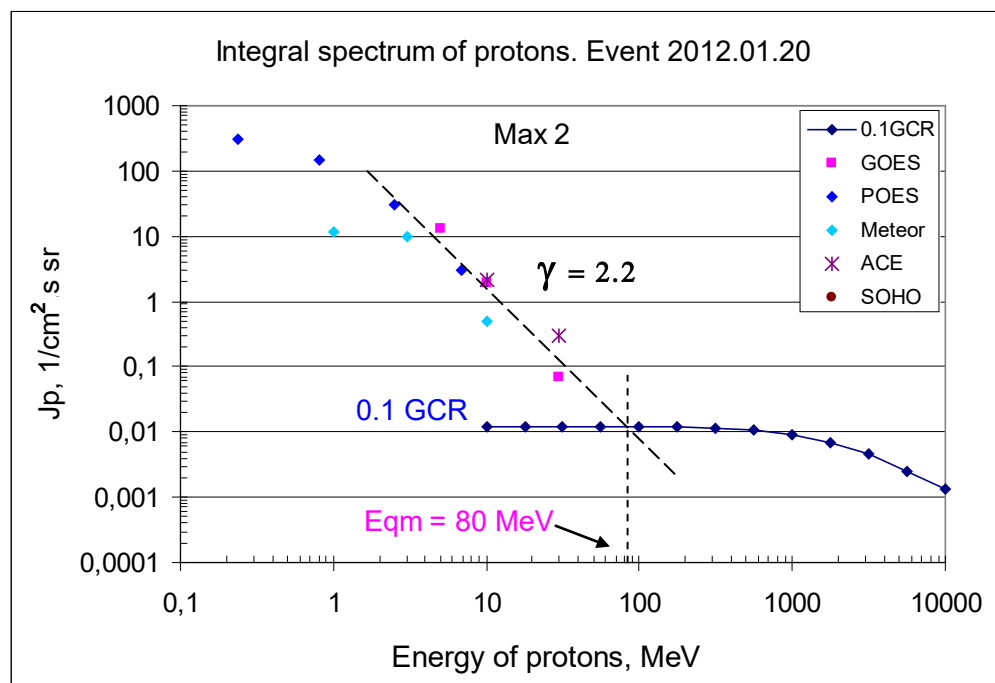
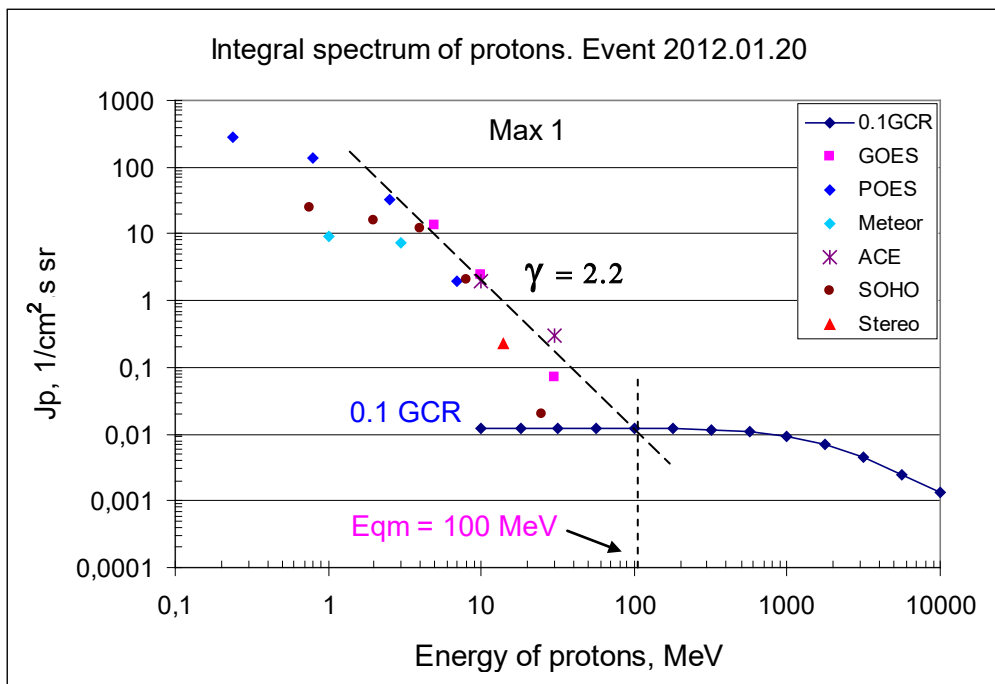


Integral fluxes of protons for the event of 2012 January 20

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	01	20/21d01	13.7/13.3	1.5	0.2	
EPS	>10	01	20/21d01	2.4/1.9	1.5	0.16	
EPS	>30	01	20/21d01	0.07/0.07	1.5	0.08	
EPS	>50	01	-	-	-	0.06	
EPS	>60	01	-	-	-	0.05	
EPS	>100	01	-	-	-	0.04	
POES							
MEPED	>0.24	1	20/21d02	280/310	2	120	
MEPED	>0.8	1	20/21d02	140/145	2	85	
MEPED	>2.5	1	20/21d02	33/31	1.5	60	
MEPED	>6.9	1	20/21d02	44257	-	50	
MEPED	>16	-	-	-	-	0.85	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	00	17/21d00	9.4/11.6	1.5	3.8	
SCR	>3	00	17/21d00	7.3/9.6	1.5	3.8	
SCR	>10	-	-/23	-/0.5	0.2	2.3	
GALS-M	>15	-	-	-	-	1.4	
GALS-M	>25	-	-	-	-	1.4	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	9	17/23	2.2/2.1	1.5	1.6	
SIS	>30	9	17/23	0.3/0.3	1	1.1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2012 January 20

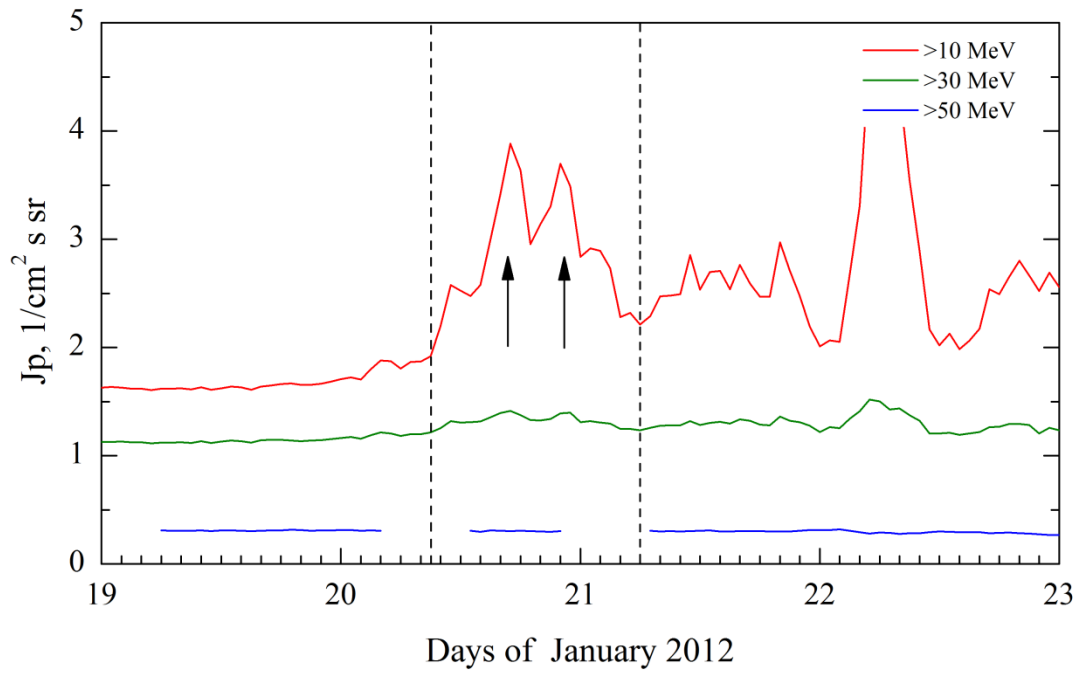
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	3	18/-	7.1/-	1.5	0.2	
LION	2 – 6	3	18/-	1.2/-	1.5	0.02	
EPHIN	4 – 8	3	18/-	2.5/-	1.5	0.035	
EPHIN	8 – 25	3	18/-	0.125/-	1.5	0.0012	
EPHIN	25 – 53	3	18/-	0.0007/-	1.5	0.0004	
Electro-1							
SCR-E	13.7–23	2	19/ -	0.025/-	0.5	0.055	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0.005	



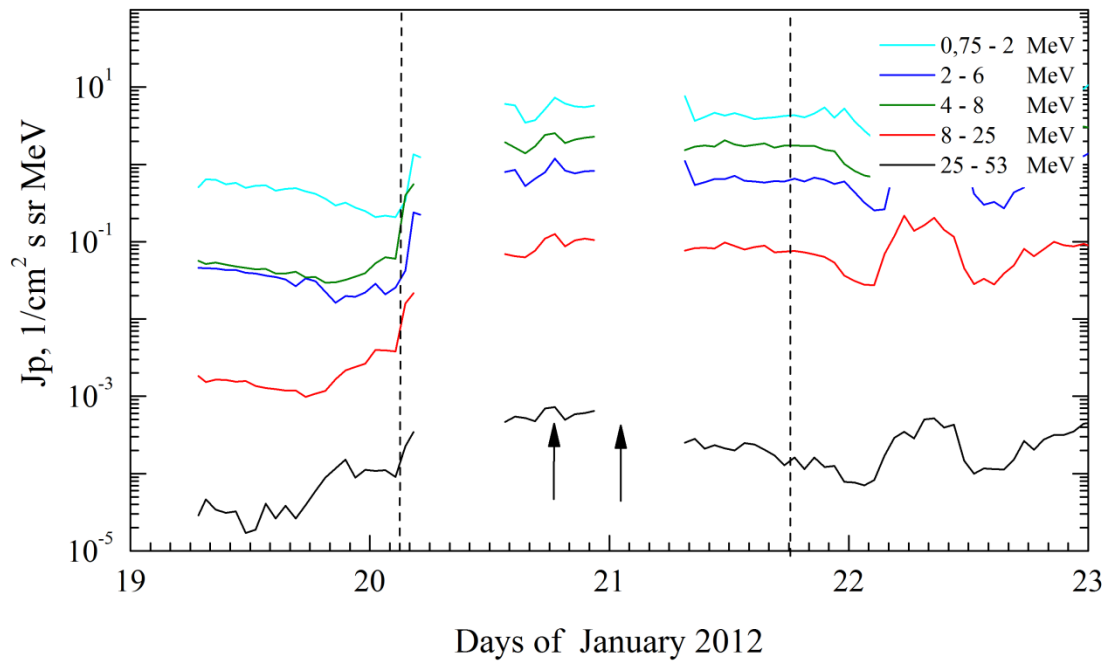
Time profiles of proton fluxes in the event 2012.01.20

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.01.20

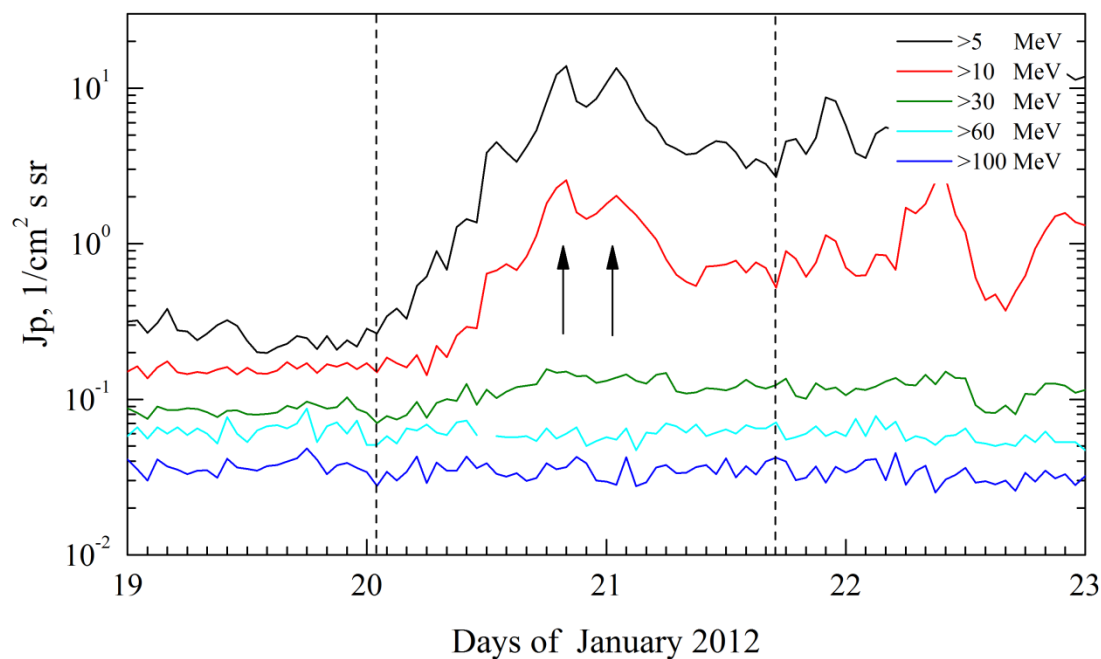


SOHO. Event 2012.01.20

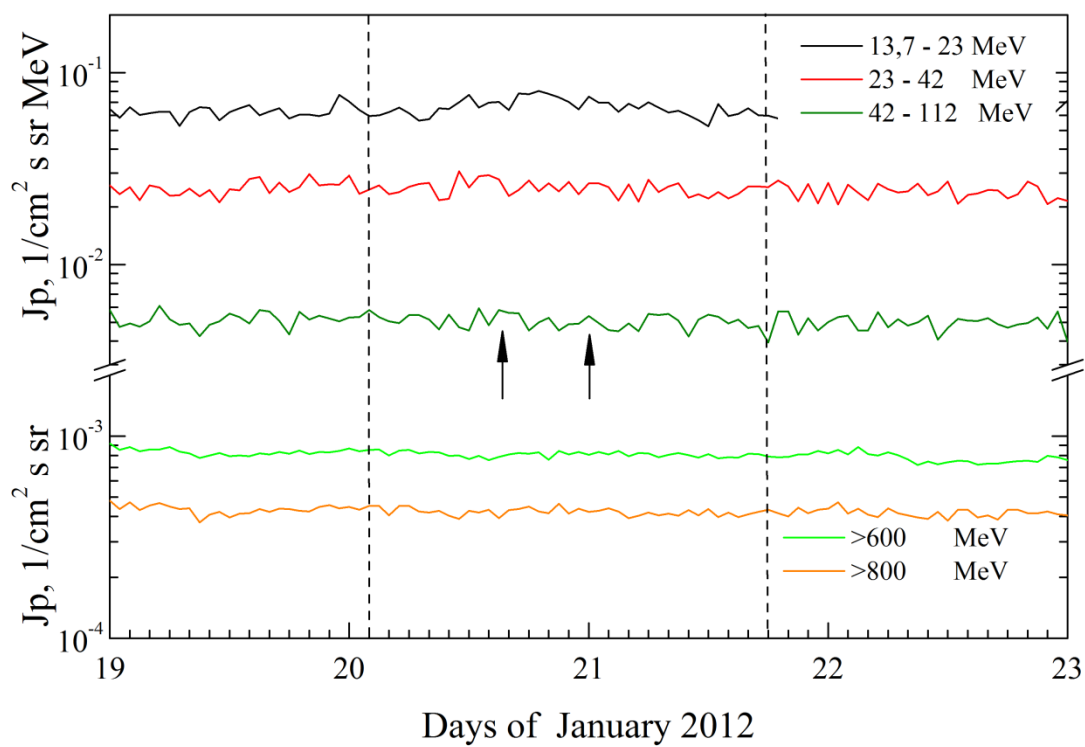


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2012.01.20

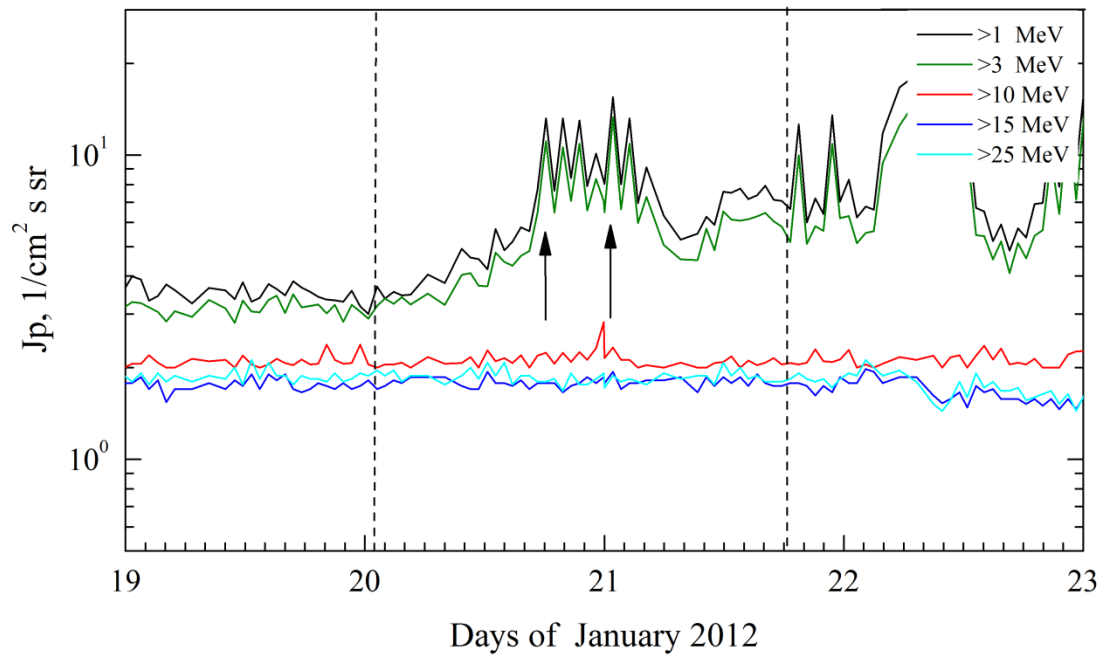


Electro. Event 2012.01.20

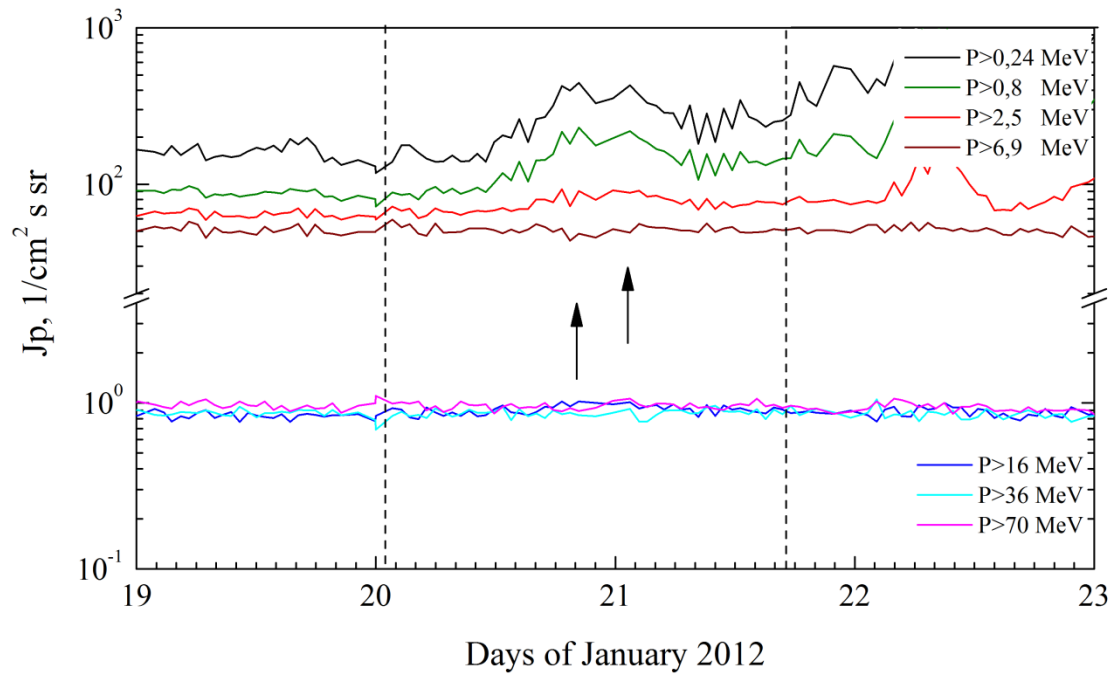


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.01.20



POES. Event 2012.01.20



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 20**

2012

January 19

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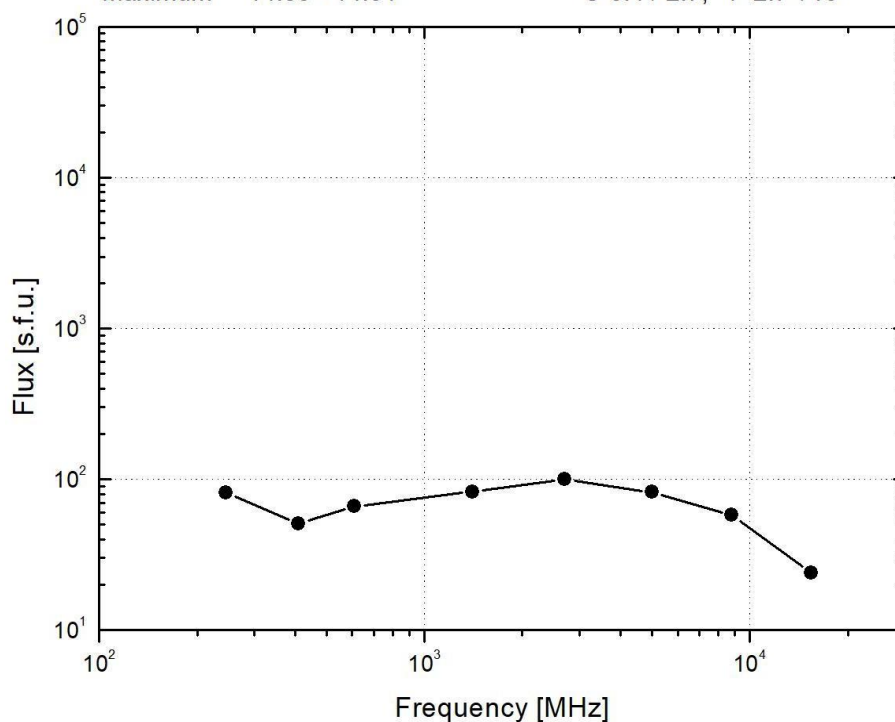
AR 11402

To event 501

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1413	1417	1420	N32E22	SF	
6563 Å	FL	1524	1607	2001	N30E30	2N	UMB
1 – 12	keV	1344	1605	1750	N32E27	M3.2	0.27
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1437:50	1446:55	1452:35	21468	3421389	FERMI
12-25	keV	1529:10	1549:59	1550:40	50957	14672738	FERMI
12-25	keV	1618:11	1618:15	1628:09	29020	3129106	FERMI
12-25	keV	1704:44	1713:53	1730:24	6413	2086401	FERMI
12-25	keV	1757:51	1758:08	1803:35	1189	66853	FERMI
12-25	keV	1840:15	1908:27	1912:49	1398	531102	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1440	1451	1451		1.38	
8.8	GHz	1438	1445	1451		1.76	
5	GHz	1437	1441	1451		1.91	
2.7	GHz	1440	1441	1446	P2.7 \ 15	2.0	
1.4	GHz	1437	1440	1451		1.92	
610	MHz	1438	1445	1451		1.82	
410	MHz	1437	1443	1451	U0.4 / 2.7	1.71	
245	MHz	1437	1439	1451		1.91	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS IV	25-180	1438		2127		1	
DS IV	36-180	1746		2359		1	
DS CONT	75-180	1438		1538		1	
DH II	0.1-16	1500		20/0245			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1436	1120	54.1	360°	020°	SOHO

Radio burst frequency spectrum

Flare 19d 13:44 M3.2/ N32E27 Event 2012.01.20
Maximum 14:39 - 14:51 U 0.4 / 2.7; P 2.7 \ 15



Proton Active Region:

AR11402 (N28L211, CMP 21,3.01.2012,
Sp= 630 msh, DKI, BG, R)
XRI=2.89; $X_1^{1.7} + M_2^{8.7} + C_9$; $2_2 + 1_3 + C_{20}$;
PFR1 23.11 $M_1^{8.7}/2B$
PFR2 27.11 $X_1^{1.7}/2F$

References:

Ameri D., E. Valtonen, [2019](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
Le G.-M., X-F. Zhang, [2017](#).
Rodenko S.A., I.K. Troitskaya, A.G. Mayorov, V.V. Malakhov, [2018](#).

Particle event: To($E_p > 10$ MeV) – 21d18^h

Tmax ($E_p > 10$ MeV) – 21d22^h, Jmax ($E_p > 10$ MeV) – $1.4 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$ (ACE)

Duration of the event – 0.5 days, power-law index: $\gamma = 1.8$

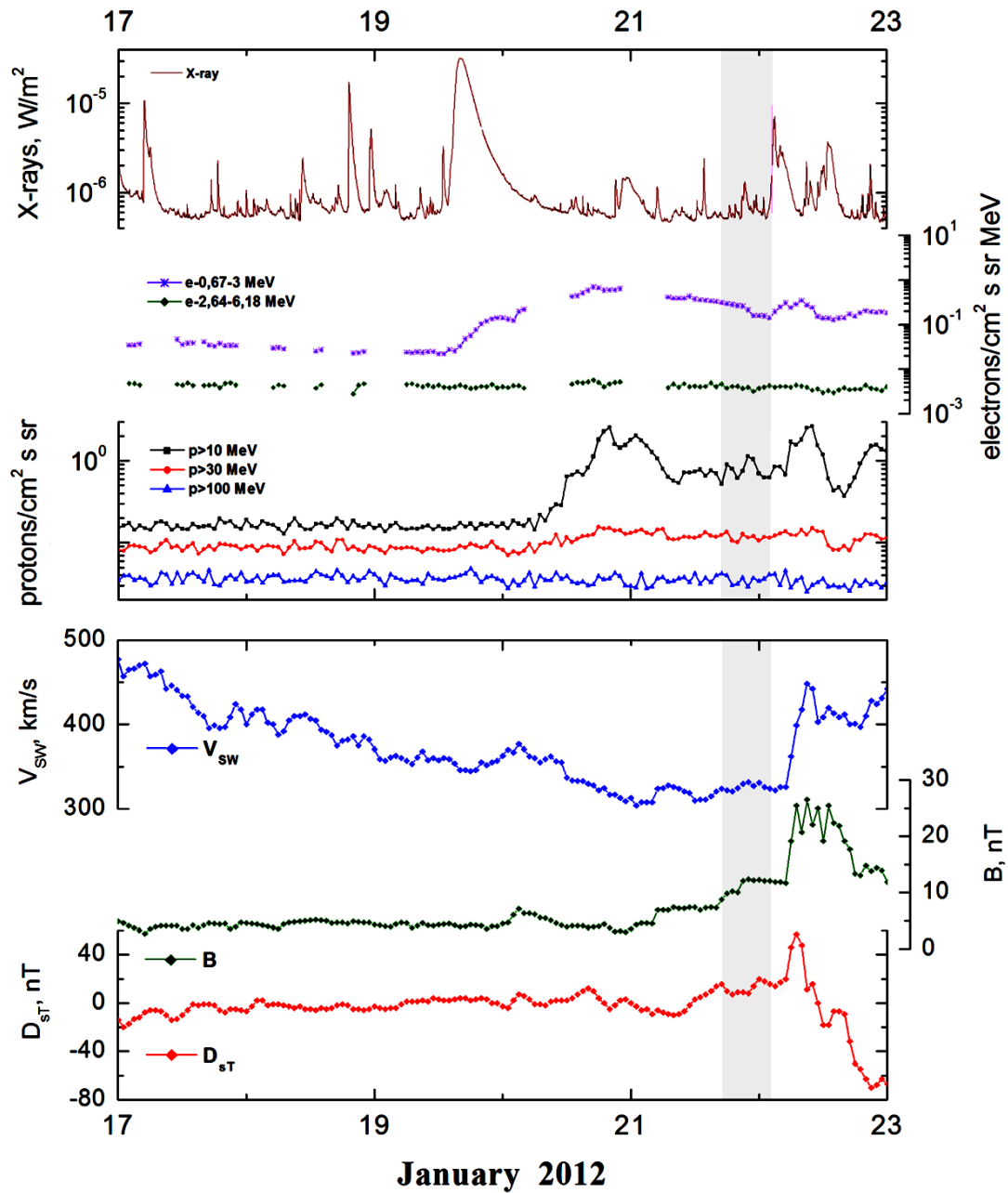
Quasimaximal energy of protons in the event – $E_{qm} = 140$ MeV

Sources: ☐ solar flare 21d13^h35^m, C2.4/BSL, N25W82, AR11396

Main burst X-ray 1–8 Å: onset – 21d13^h35^m, max – 21d13^h42^m, $\Phi = 0.0012 \text{ J/m}^2$

CME: 21d14^h00^m, $V = 0377 \text{ km/s}$, $\Delta\phi = 048^\circ$, $dA = 266^\circ$

Particle fluxes and associated phenomena

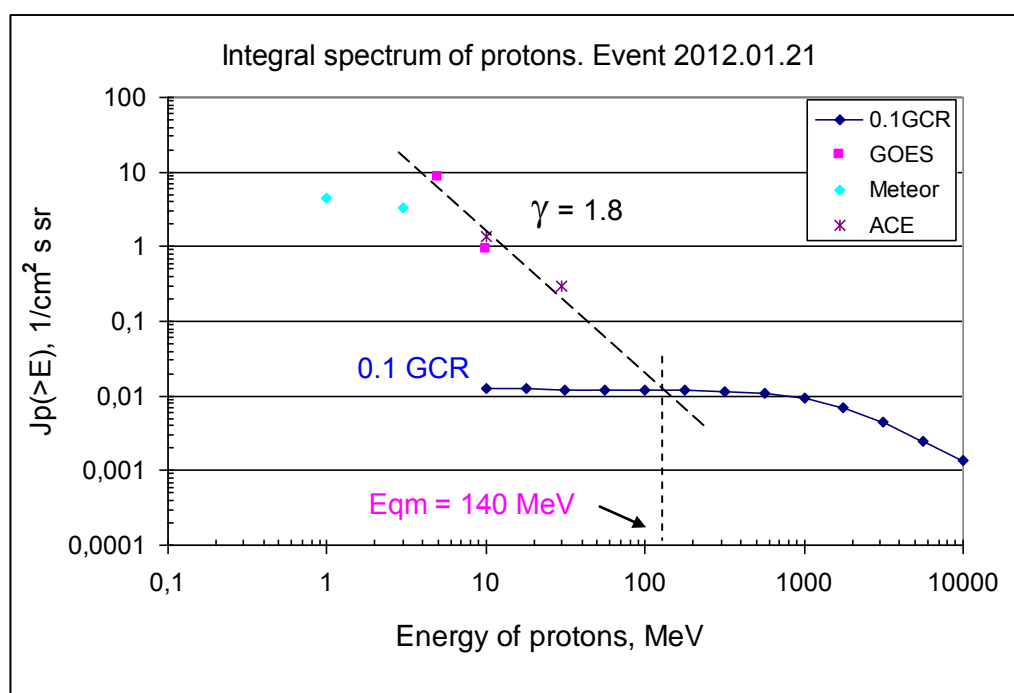


Integral fluxes of protons for the event of 2012 January 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	22	8.5	0.5	0.2	
EPS	>10	18	22	0.9	0.5	0.16	
EPS	>30	-	-	-	-	0.1	
EPS	>50	-	-	-	-	0.07	
EPS	>60	-	-	-	-	0.06	
EPS	>100	-	-	-	-	0.04	
Meteor-1							
SCR	>1	18	22	4.35	0.5	3.1	
SCR	>3	18	22	3.4	0.5	3.1	
SCR	>10	-	-	-	-	1.9	
GALS-M	>15	-	-	-	-	1.4	
GALS-M	>25	-	-	-	-	1.45	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	6	22	1.4	0.5	1.6	
SIS	>30	6	22	0.3	0.5	1.1	

Differential fluxes of protons for the event of 2012 January 21

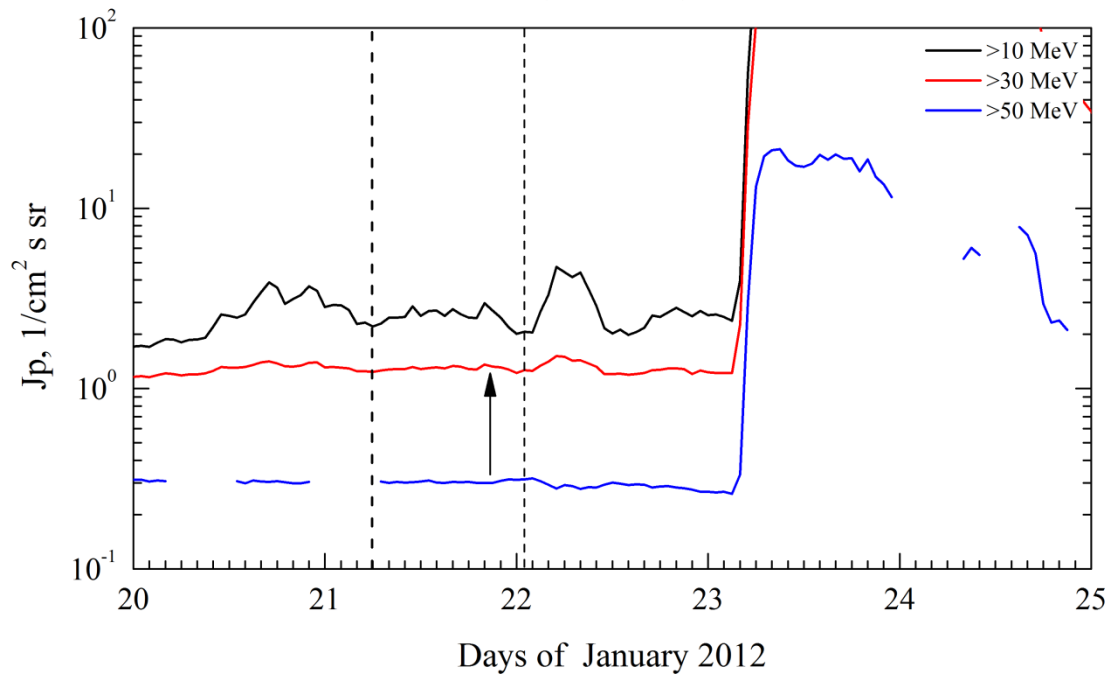
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
Electro-1							
SCR-E	13.7-23	-	-	-	-	0.06	
SCR-E	23-42	-	-	-	-	0.025	
SCR-E	42-112	-	-	-	-	0.005	



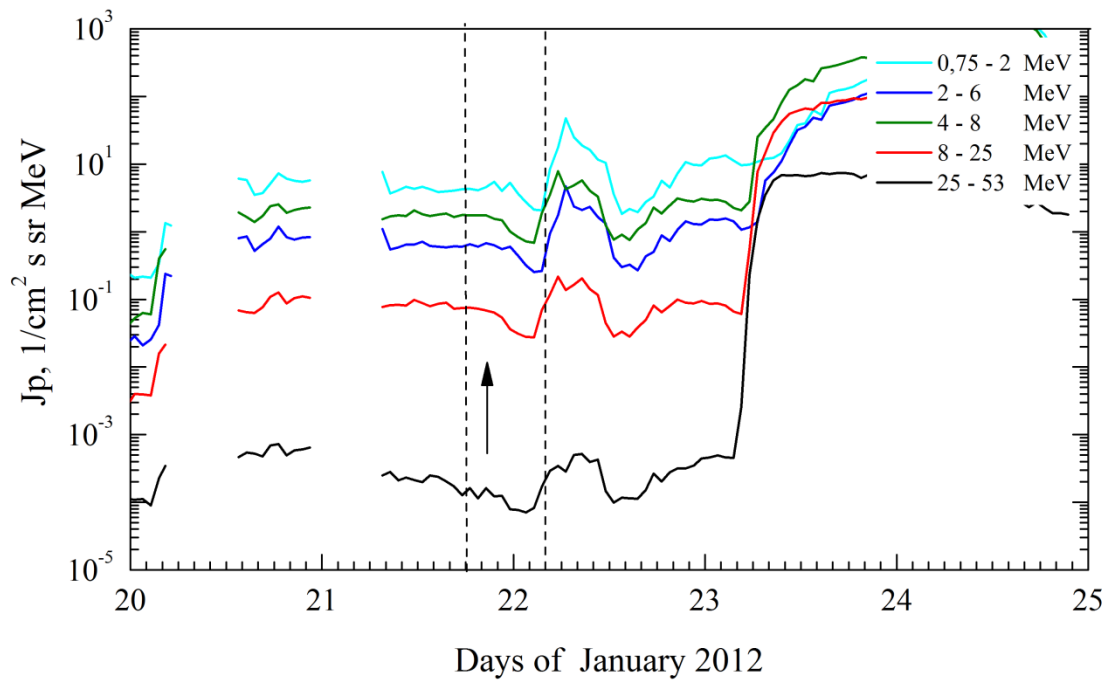
Time profiles of proton fluxes in the event 2012.01.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.01.21

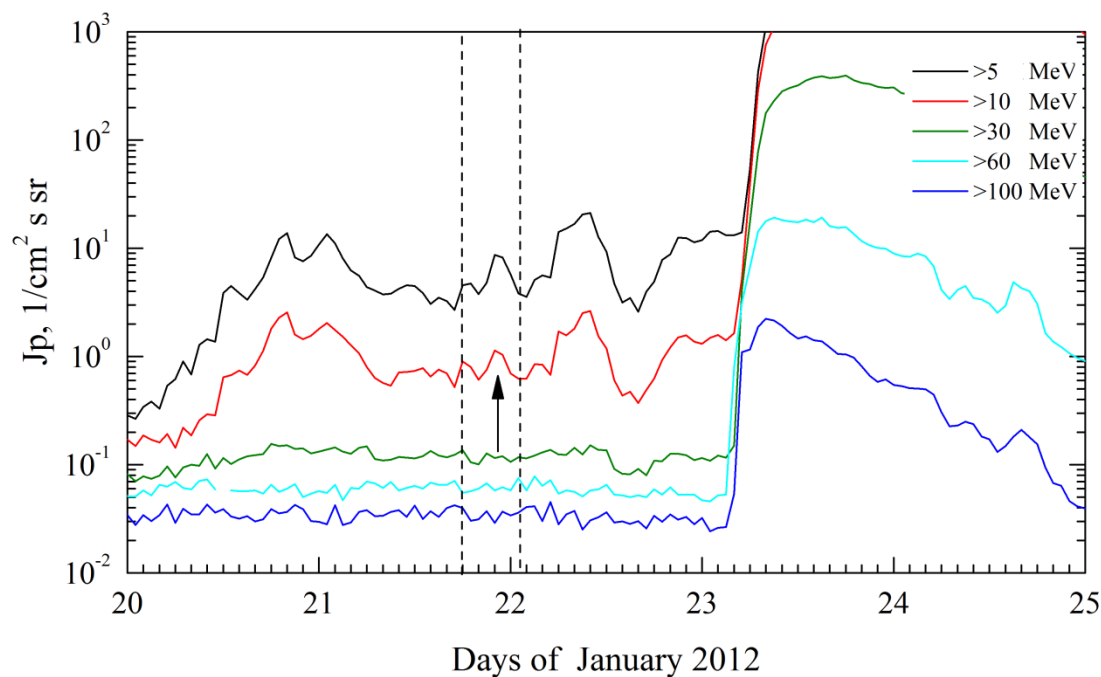


SOHO. Event 2012.01.21

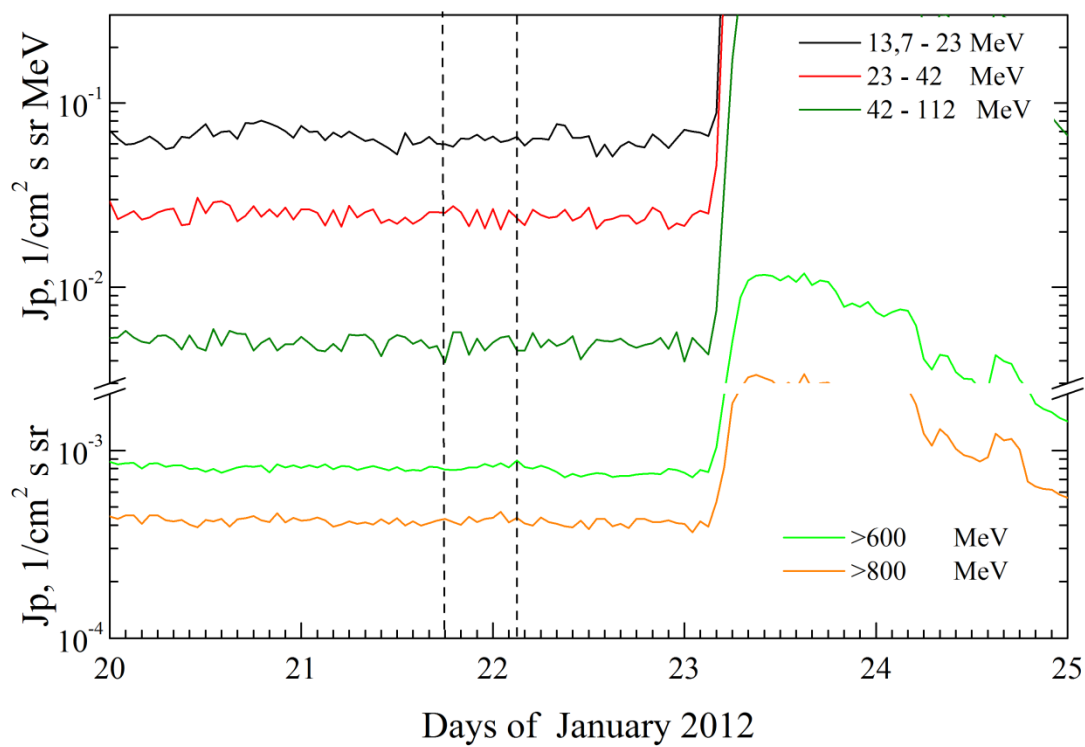


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

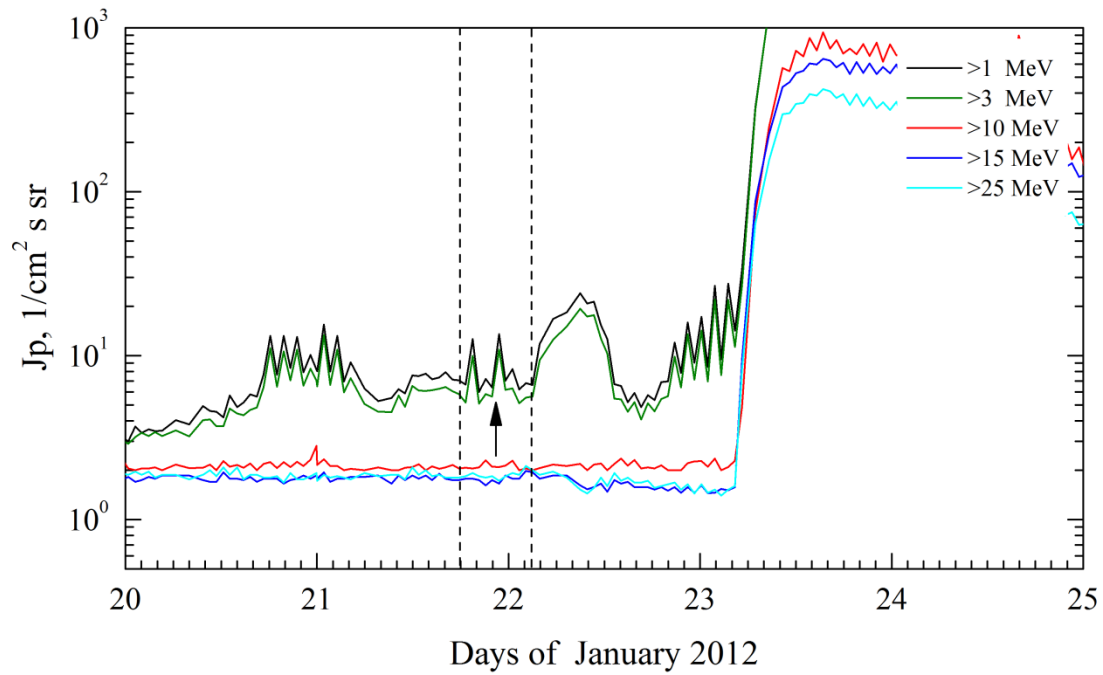
GOES. Event 2012.01.21



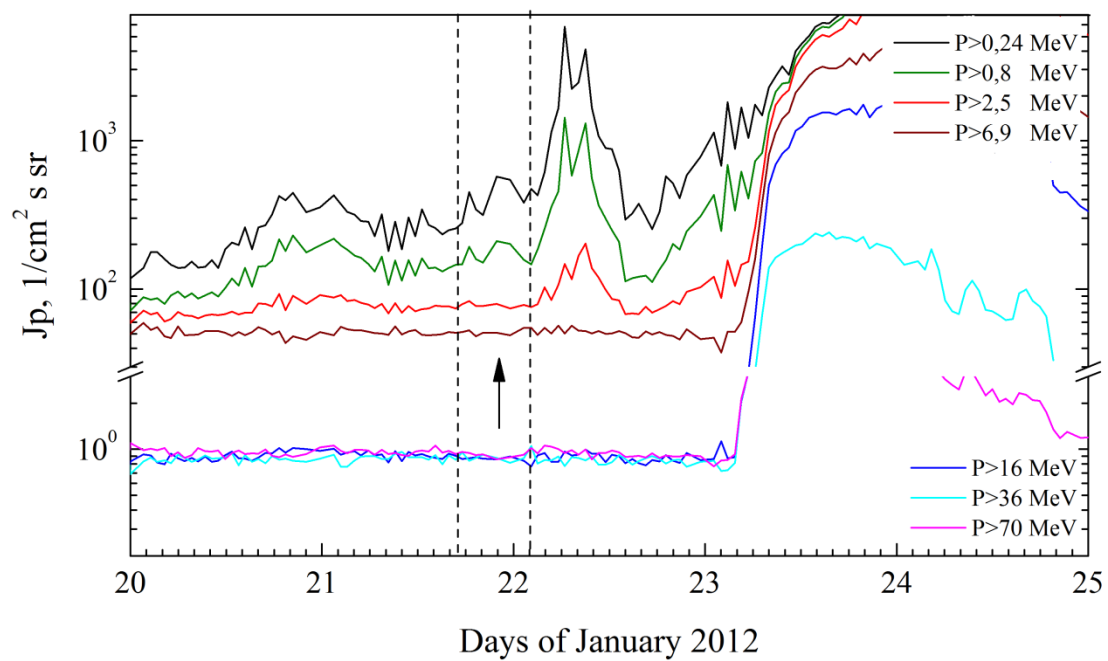
Electro. Event 2012.01.21



Meteor. Event 2012.01.21



POES. Event 2012.01.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 21**

2012 January 21 ☐ AR 11396 To event 502

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible solar disc					
6563 Å	BSL	1353		1401	0.18	B.9A	
1 – 12	keV	1335	1342	1347	N25W82	C2.4	0.0012
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1400	377	-3.5	048°	266°	SOHO

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Particle event: To($E_p > 10$ MeV) – 22d01^h

Tmax ($E_p > 10$ MeV) – 22d10^h, Jmax ($E_p > 10$ MeV) – $2.5 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1 day, power-law index: $\gamma = 2.4$

Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

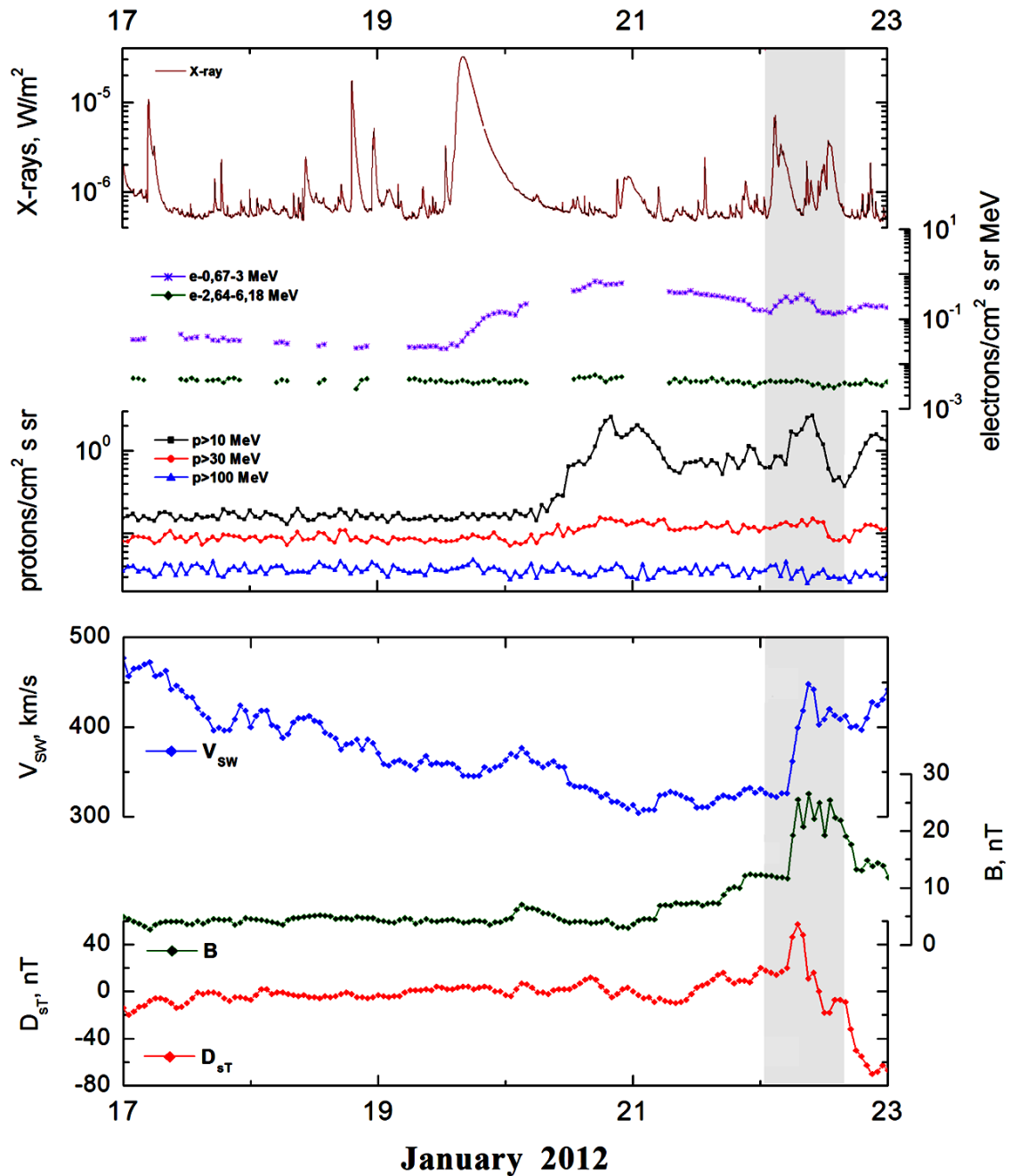
Sources: ☉ solar flare 22d02^h32^m, C7.1/, N17W13, AR11401

Main burst X-ray 1–8 Å: onset – 22d02^h32^m, max – 22d02^h57^m, $\Phi = 0.01 \text{ J/m}^2$

CME: 22d06^h00^m, $V = 0367 \text{ km/s}$, $\Delta\phi = 085^\circ$, $dA = 248^\circ$

▲ SC 22d06^h12^m

Particle fluxes and associated phenomena

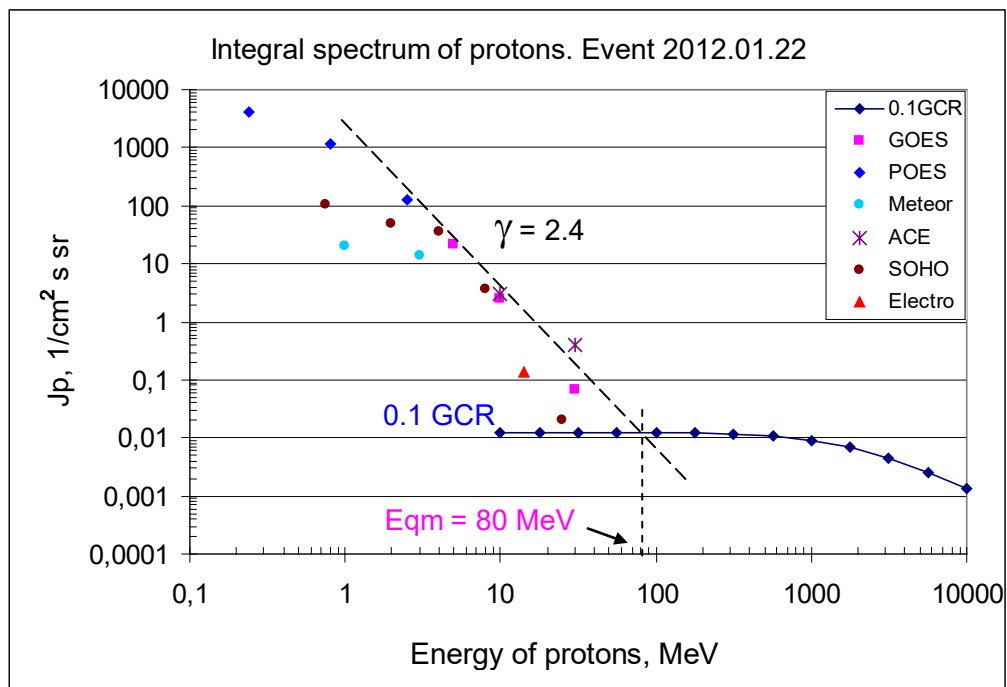


Integral fluxes of protons for the event of 2012 January 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	01	10	21	1.5	0.2	
EPS	>10	01	10	2.5	1.5	0.17	
EPS	>30	01	11	0.07	1.5	0.1	
EPS	>50	01	-	-	-	0.07	
EPS	>60	01	-	-	-	0.06	
EPS	>100	01	-	-	-	0.04	
POES							
MEPED	>0.24	02	9	4000	1	120	
MEPED	>0.8	02	9	1180	1	90	
MEPED	>2.5	02	9	130	1	70	
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	-	-	-	-	0.85	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	03	09	20	0.5	3.8	
SCR	>3	03	09	14.1	0.5	3.8	
SCR	>10	-	-	-	-	2.3	
GALS-M	>15	-	-	-	-	1.4	
GALS-M	>25	-	-	-	-	1.4	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	01	05	3.1	1.5	1.6	
SIS	>30	01	05	0.4	1.5	1.1	
SOHO							
EPHIN (INT)	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2012 January 22

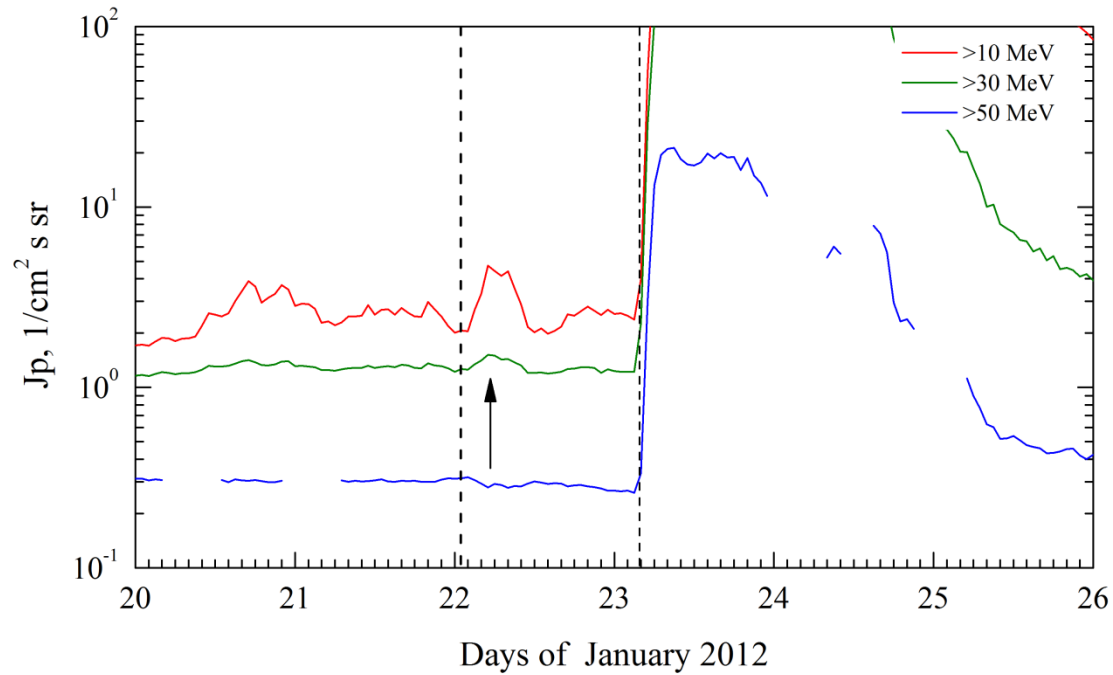
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	04	06	47.3	1	0.2	
LION	2 – 6	04	06	4.7	1	0.02	
EPHIN	4 – 8	04	06	7.8	1	0.035	
EPHIN	8 – 25	04	06	0.22	1	0.0012	
EPHIN	25 – 53	04	09	0.0007	1	0.00004	
Electro-1							
SCR-E	13.7–23	02	9	0.015	1	0.06	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0,005	



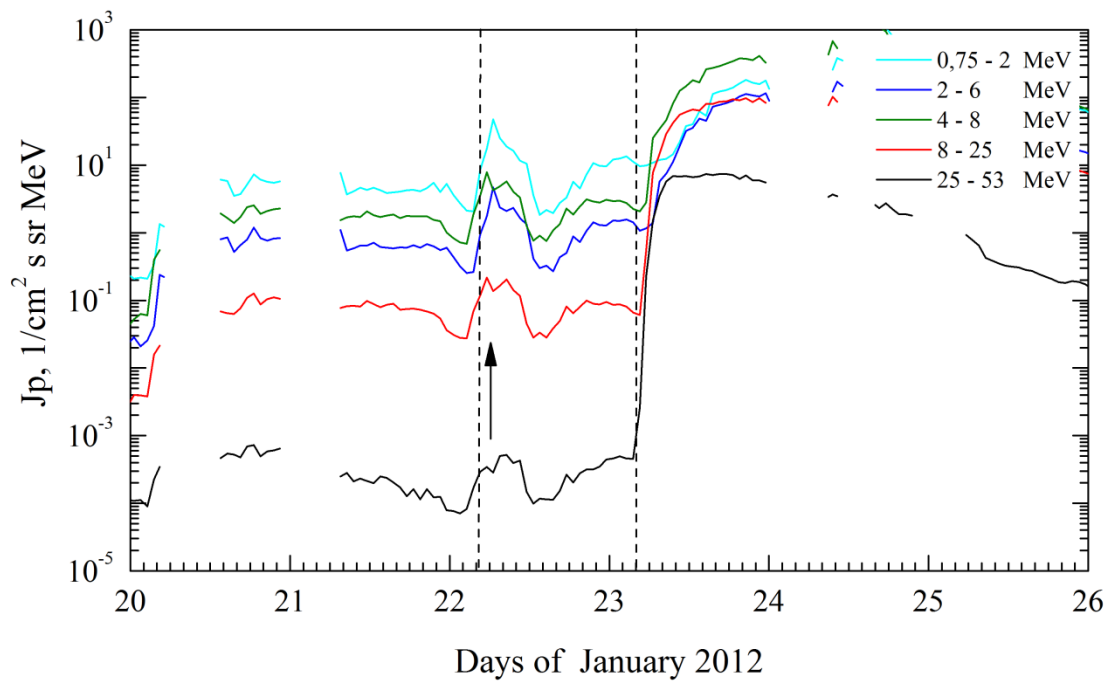
Time profiles of proton fluxes in the event 2012.01.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

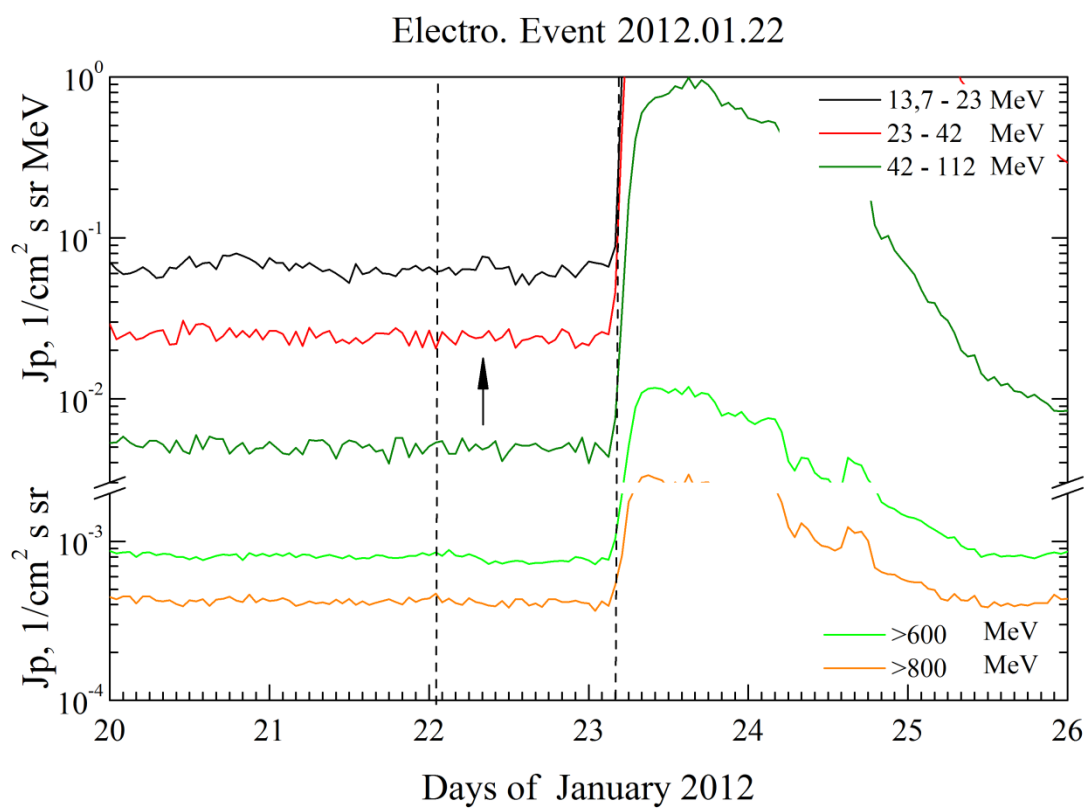
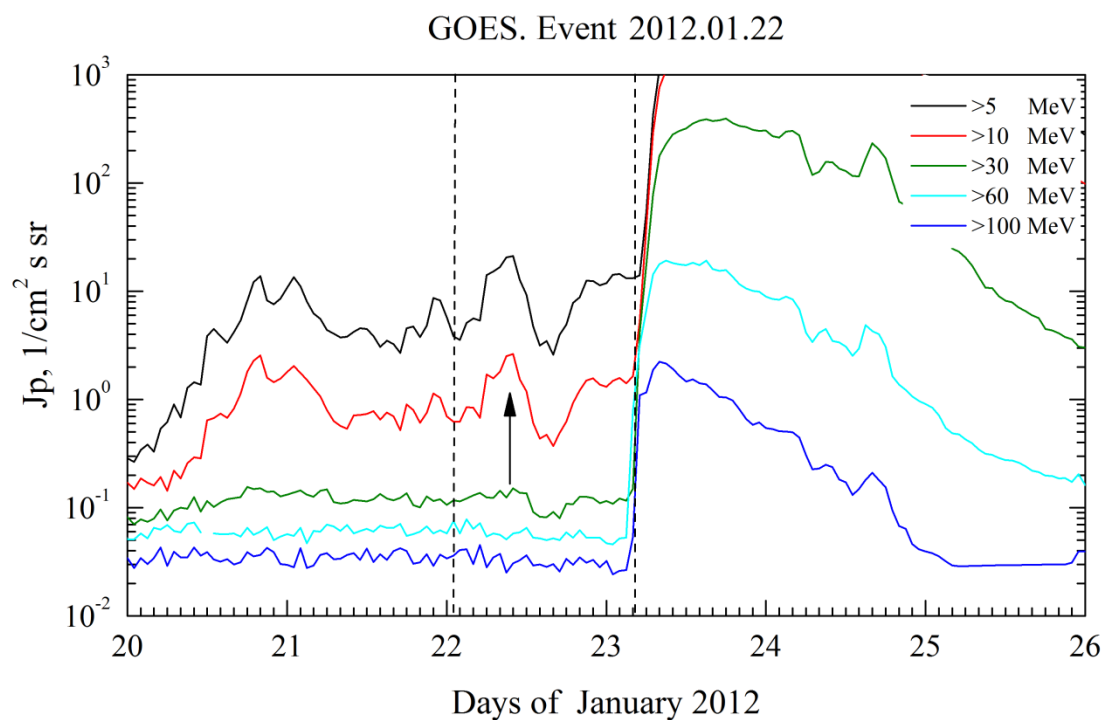
ACE SIS + SOHO (>50 MeV). Event 2012.01.22



SOHO. Event 2012.01.22

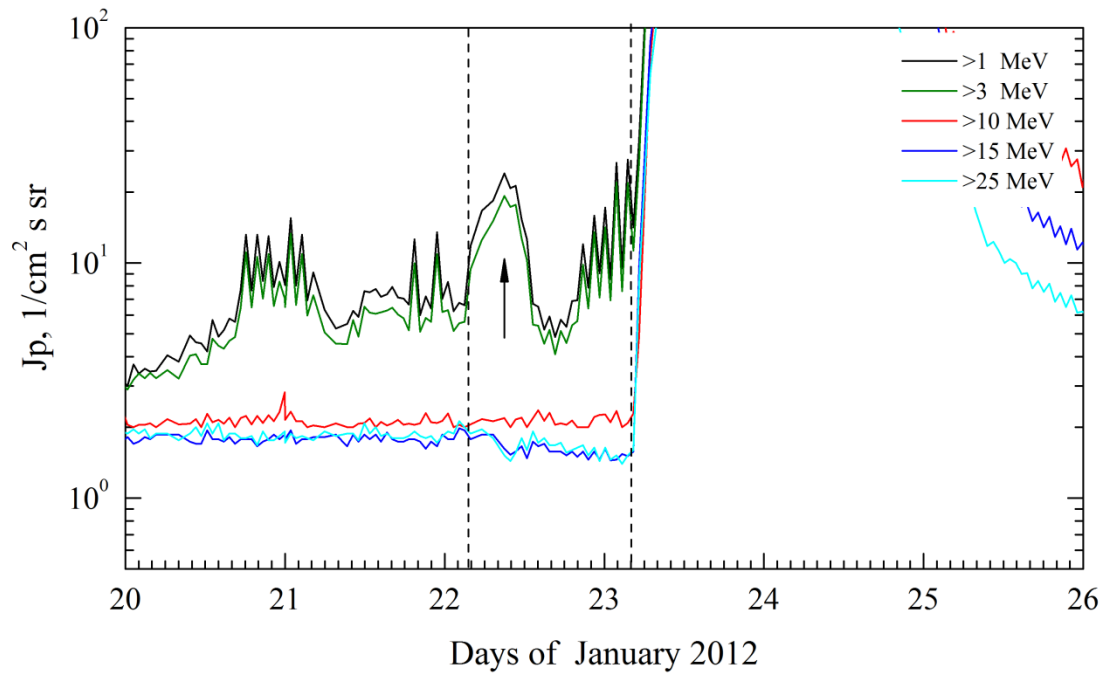


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro.

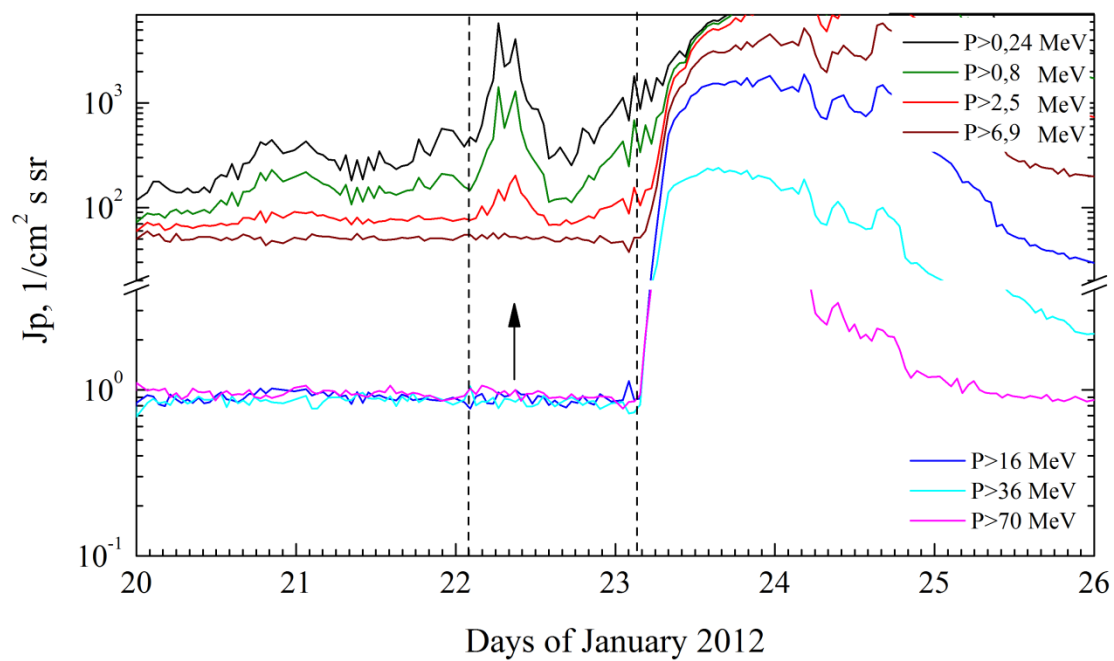


Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES

Meteor. Event 2012.01.22



POES. Event 2012.01.22



Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 22
2012 January 22 ☉ AR 11401 To event 503

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	No optical event on visible solar disc					
1 – 12	keV	0232	0257	0306	N17W13	C7.1	0.01
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0224:09	0242:49	0310:02	51937	6772818	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
5	GHz	0242	0242	0243		2.15	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0600	0367	10.0	85°	248°	SOHO

Proton Active Region:

AR11401* (N16L213, CMP 21,0.01.2012,
 Sp=540 msh, EKC, BG, R)
 XRI=0.41 $M_3^{1.7} + C_{19}$ $1_4 + S_{16}$
 PFR 17-18: (39^h) $M_2^{1.7}$
 *Complex of active regions together AR11402

References:

Bardeen C.G., D.R. Marsh, C.H. Jackman et al., [2016](#).
 Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
 Paassilta M., O. Raukunen, R. Vainio et al., [2017](#).
 Roldugin A.V., S.V. Pilgaev, V.C. Roldugin, [2014](#).
 Winter L.M. and K. Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 23d04^h

Tmax₁($E_p > 10$ MeV) – 23d14^h, Jmax₁($E_p > 10$ MeV) – 2700 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 24d17^h, Jmax₂($E_p > 10$ MeV) – 3900 /cm²·s·sr

Duration of the event – 5 days, power-law index: $\gamma_1 = 3.55$, $\gamma_2 = 4.1$

Quasimaximal energy of protons in the event – Eqm₁ = 450 MeV

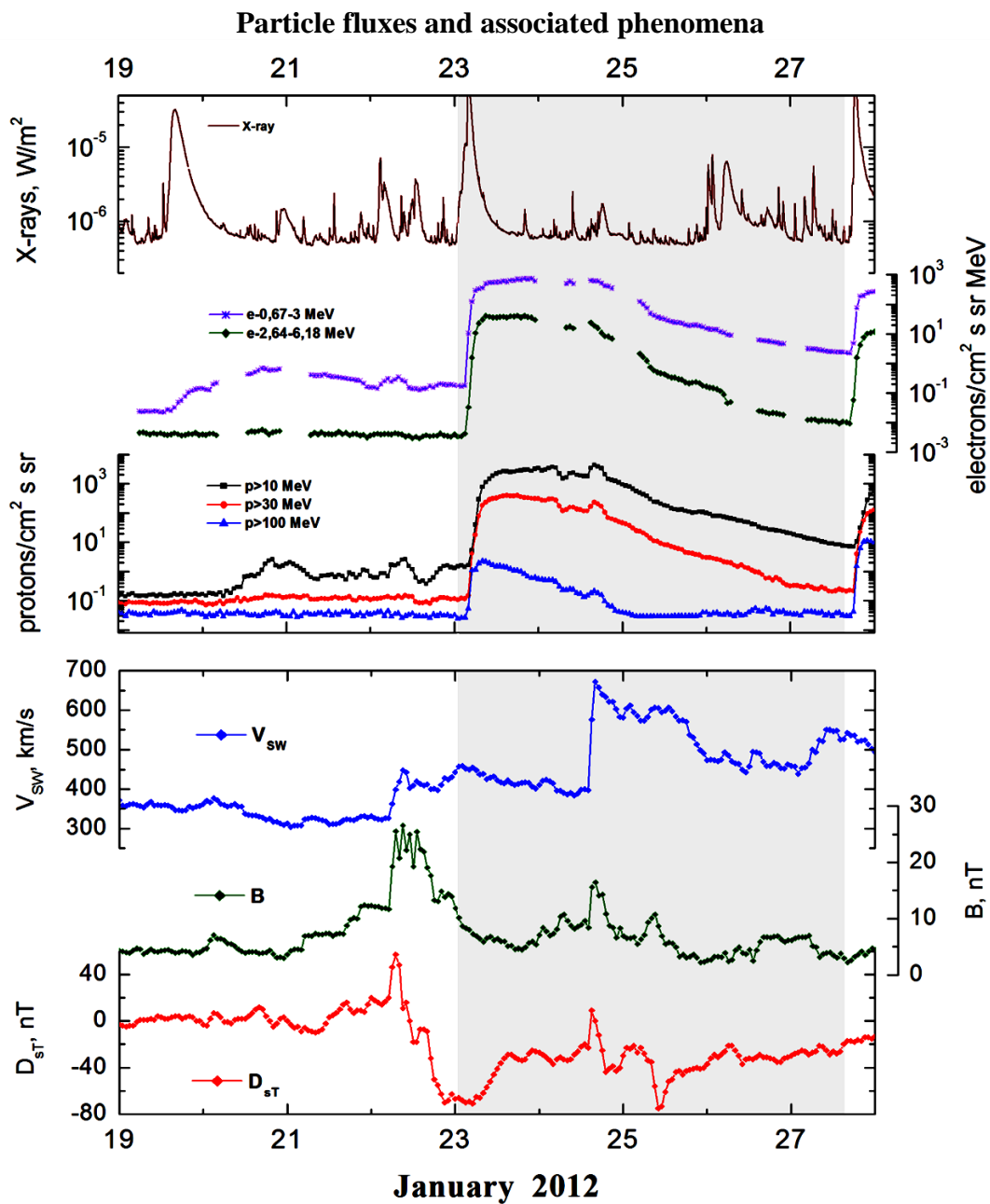
– Eqm₂ = 250 MeV

Sources: ● solar flare 23d03^h38^m, M8.7/2B, N28W21, AR11402

Main burst X-ray 1–8 Å: onset – 23d03^h38^m, max – 23d03^h59^m, $\Phi = 0.2$ J/m²

CME: 23d04^h00^m, V = 2175 km/s, $\Delta\phi = 360^\circ$, dA = 326°

▲ SC 24d15^h03^m

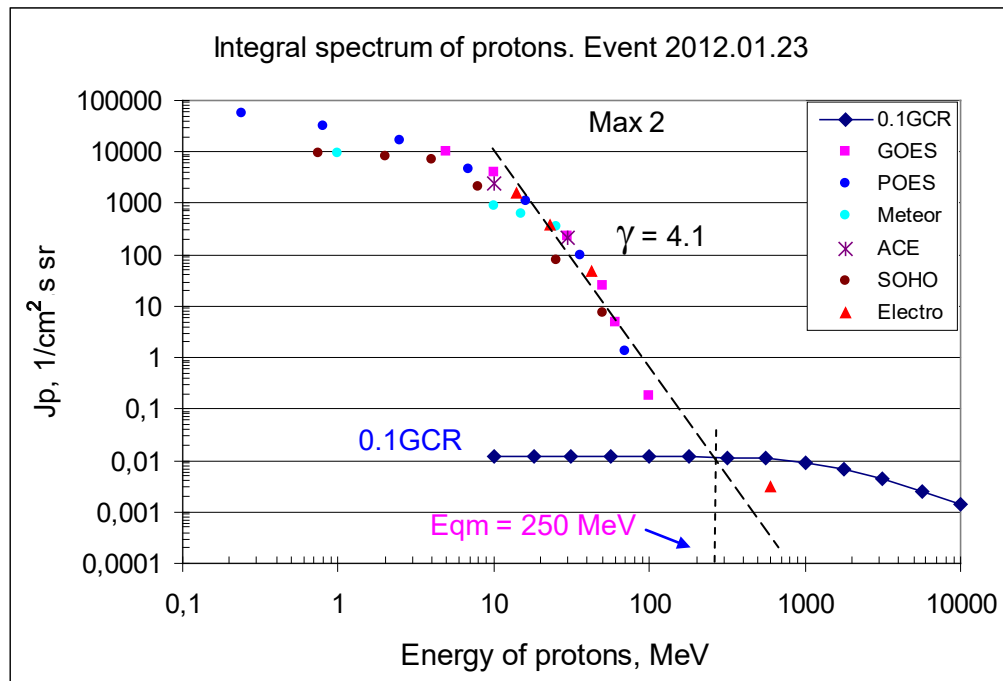
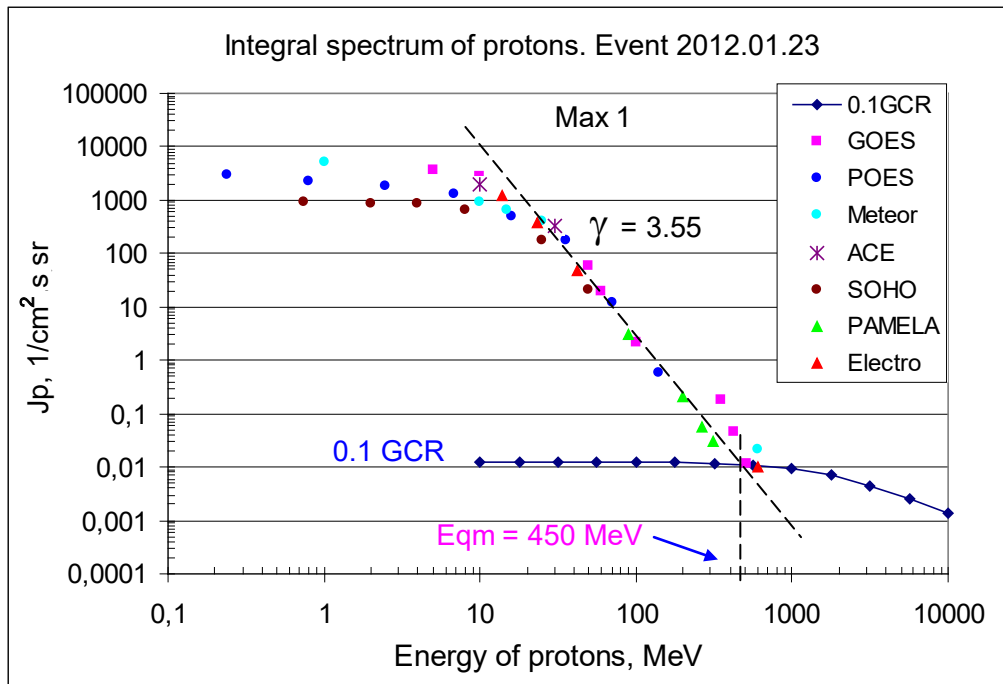


Integral fluxes of protons for the event of 2012 January 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	6	14/24d17	3570/10300	5	0.2	
EPS	>10	4	13/24d17	2700/3900	5	0.17	
EPS	>30	4	12/24d17	300/230	5	0.1	
EPS	>50	3	10/24d17	57/24.5	4	0.07	
EPS	>60	3	10/24d17	19.2/4.8	3	0.06	
EPS	>100	3	09/24d17	2.2/0.18	2	0.04	
Electro-1							
GALS-E	>600	4	9/24d16	0.01/0.003	2.5	0.001	
POES							
MEPED	>0.24	3	9/24d16	3000/56400	5	120	
MEPED	>0.8	3	9/24d16	2300/32000	5	90	
MEPED	>2.5	3	9/24d16	1800/17000	5	70	
MEPED	>6.9	3	9/24d16	1300/4700	5	50	
MEPED	>16	3	9/24d16	490/1100	5	0.85	
MEPED	>36	3	9/24d16	175/98	4	0.9	
MEPED	>70	3	9/24d16	12.4/1.3	2	1	
MEPED	>140	3	9/ -	0.6/ -	2	1.2	
Meteor-1							
SCR	>1	4	15/24d16	5300/9130	4	3.2	
SCR	>3	4	-	-	4	2.6	
SCR	>10	4	15/24d16	920/900	3.5	2.1	
GALS-M	>15	4	15/24d16	644/630	2.5	4.2	
GALS-M	>25	4	15/24d16	415/357	2.5	4.3	
GALS-M	>600	4	15/ -	0.022/ -	1	0.03	
ACE							
SIS	>10	4	11/24d15	2000/2450	5	2.5	
SIS	>30	4	10/24d15	330/210	5	1.2	
SOHO							
EPHIN	>50	4	10/24d16	20.7/7.6	3	0.3	
PAMELA							
TRACKER	>90	4	05-10/ -	3/ -	3	-	
TRACKER	>200	4	05-10/ -	0.21/ -	3	-	
TRACKER	>265	4	05-10/ -	0.056/ -	3	-	
TRACKER	>312	4	05-10/ -	0.03/ -	3		

Differential fluxes of protons for the event of 2012 January 23

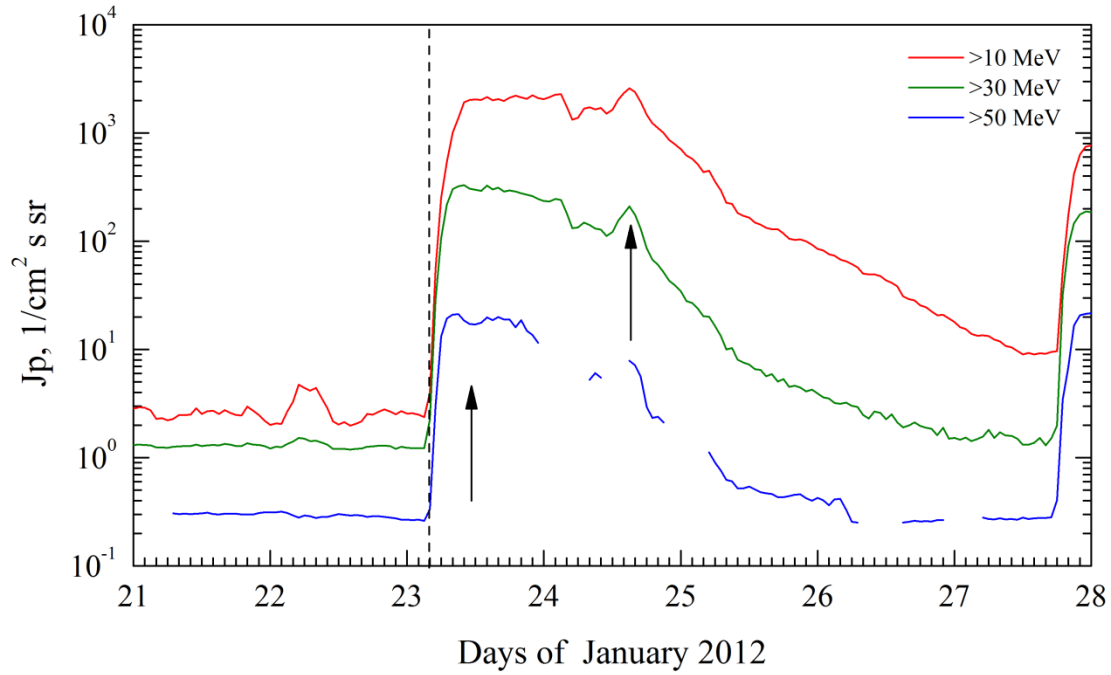
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	03	09/24d16	14.3/1200	5	0. 2	
LION	2 – 6	06	09/24d16	11/370	5	0.02	
EPHIN	4 – 8		09/24d16	47/1200	5	0.035	
EPHIN	8 – 25		09/24d16	29/120	5	0.0012	
EPHIN	25 – 53		09/24d16	5.7/2.6	5	0.00004	
Electro-1							
SCR-E	13.7–23	4	9/24d16	90/130	5	0.065	
SCR-E	23–42	4	9/24d16	17/16.5	5	0.025	
SCR-E	42–112	4	9/24d16	0.7/0.32	4	0.005	
GOES							
EPS	350–420	7	14/ -	0.0019/ -	1.5	0.0016	
EPS	420–510	8	17/ -	0.0004/ -	1.5	0.001	
EPS	510–700	7	18/-	0.00006/ -	1	0.0005	
EPS	>700	-	-	-	-		



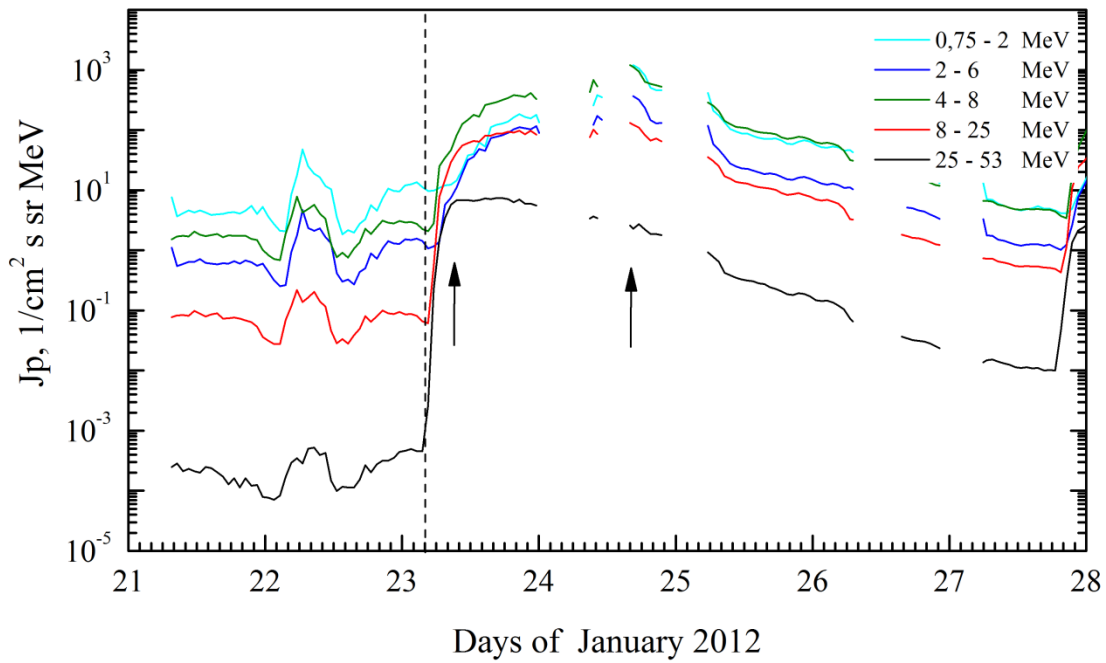
Time profiles of proton fluxes in the event 2012.01.23

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.01.23

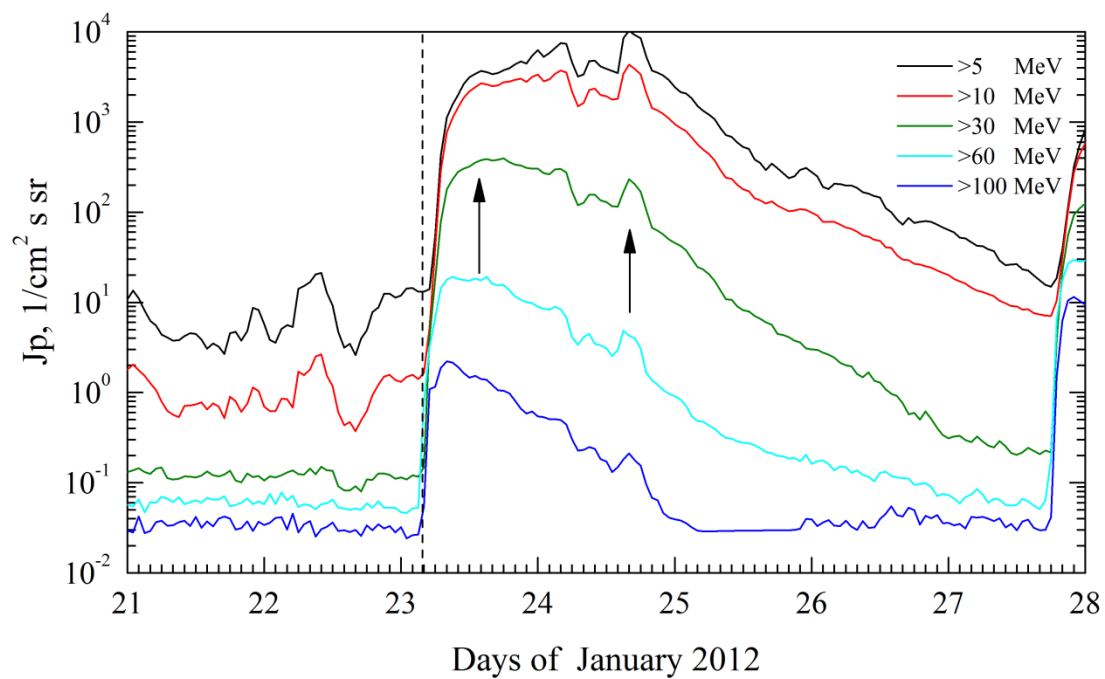


SOHO. Event 2012.01.23

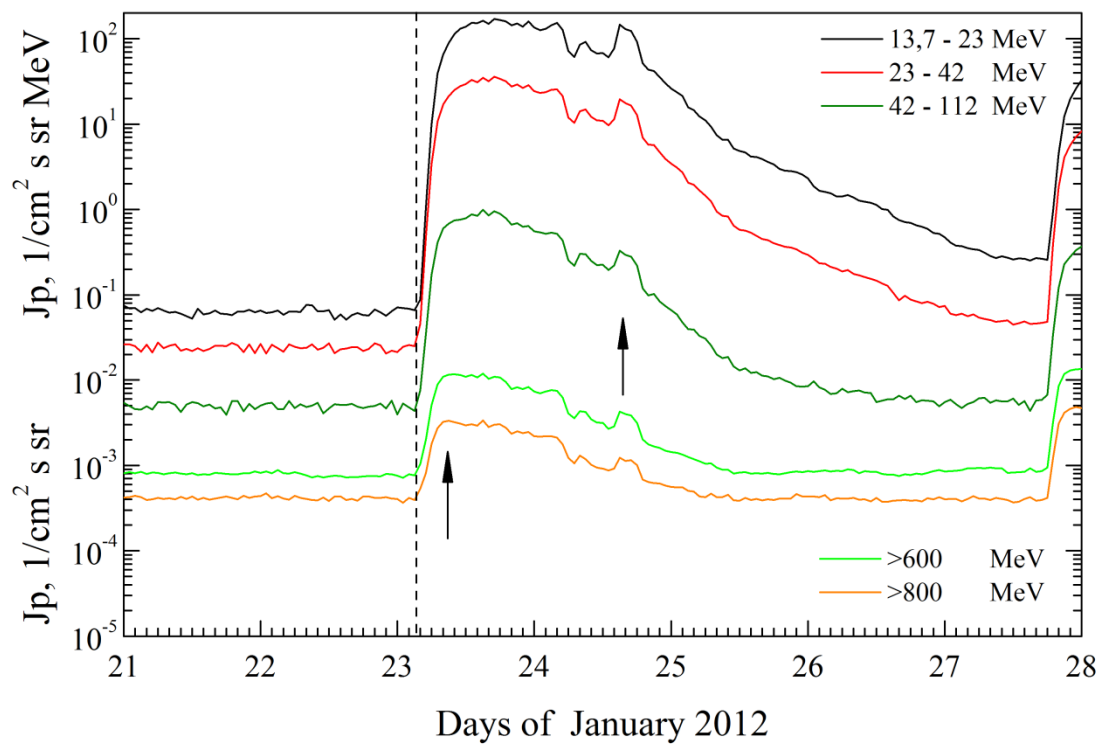


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

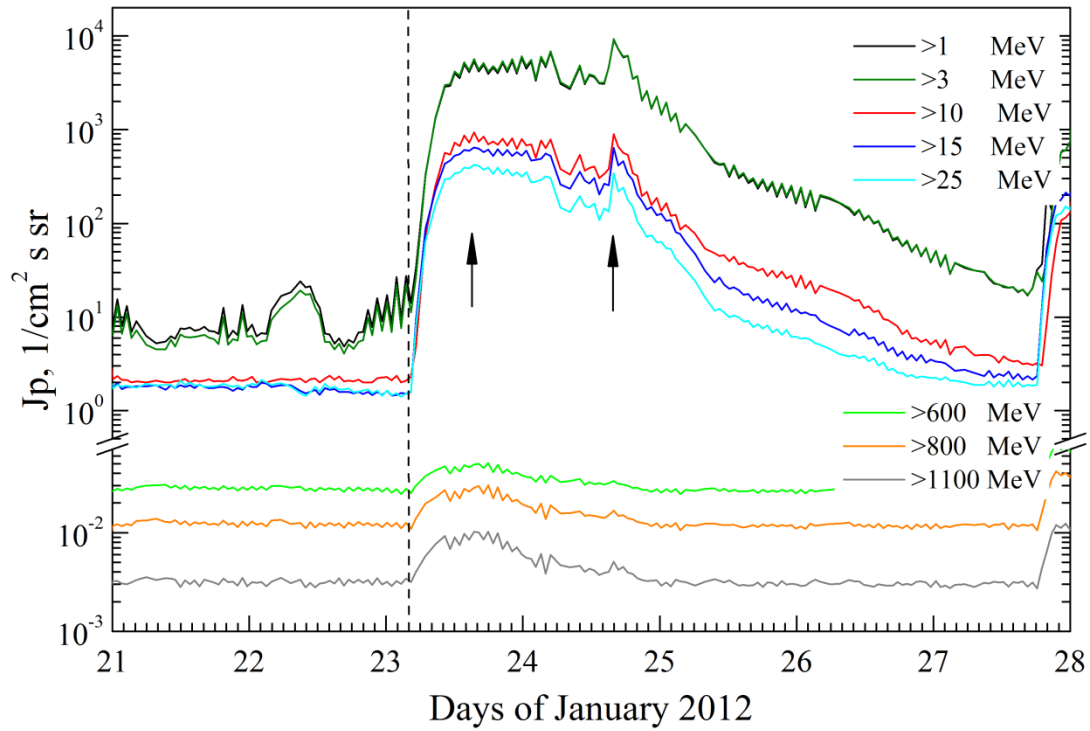
GOES. Event 2012.01.23



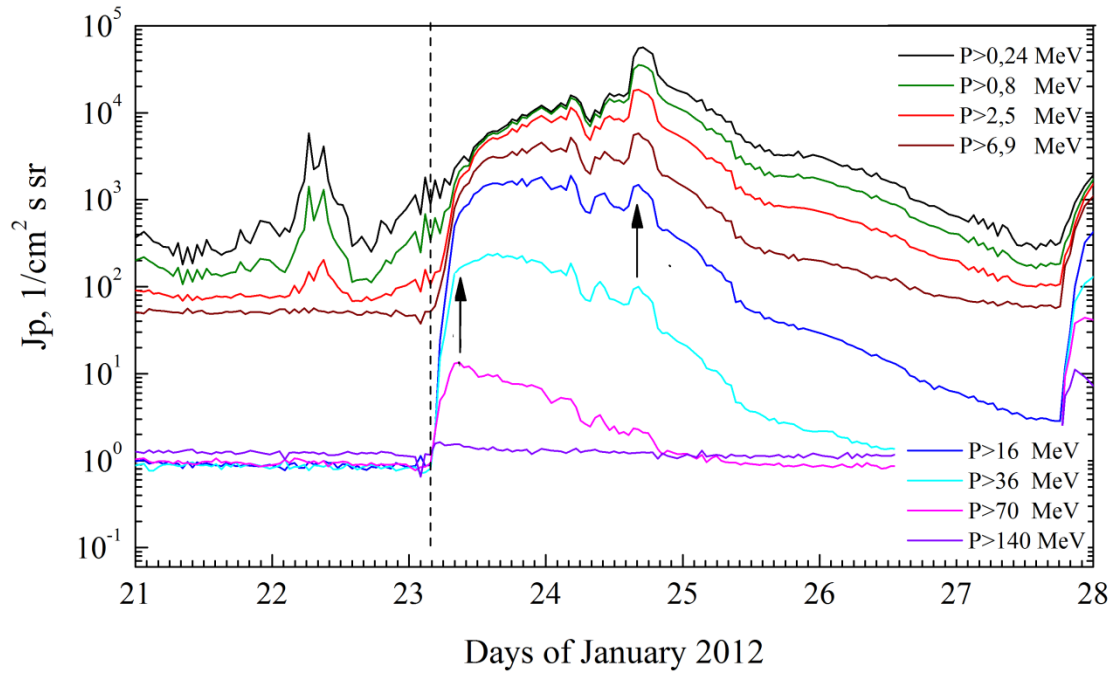
Electro. Event 2012.01.23



Meteor. Event 2012.01.23



POES. Event 2012.01.23



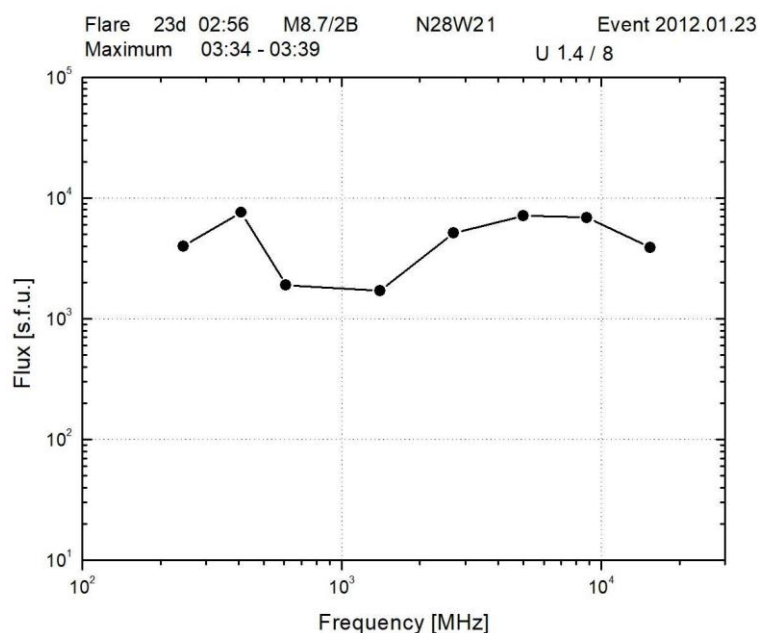
**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 23**

**2012 January 23 • AR 11402 To event
504**

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	0256	0404	0553	N28W21	2B	
1 – 12	keV	0338	0359	0434		M8.7	0.2
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
>100	keV	0406:30		0447:30		1.70E-05*	FERMI
>100	keV	0534:30		0623:30		2.40E-05*	FERMI
>100	keV	0719:30		0747:30		2.29E-05*	FERMI
>100	keV	0858:30		0926:30		2.62E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0339	0350	0425		3.59	
8.8	GHz	0339	0350	0428		3.84	
5	GHz	0339	0350	0430		3.85	
2.7	GHz	0339	0352	0426		3.71	
1.4	GHz	0339	0405	0426	U1.4 / 8	3.23	
610	MHz	0339	0404	0417		3.28	
410	MHz	0339	0401	0413		3.88	
245	MHz	0334	0341	0408		3.6	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS IV	25-180	0339		0901		2	
DS VII	25-180	0333		0405		2	
DH II	0.04-16	0400		24/1500			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0400	2175	28.0	360°	326°	SOHO

*cm⁻² s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR11402 (N28L211, CMP 21,3.01.2012,

Sp= 630 msh, DKI, BG, R)

XRI=2.89; $X_1^{1.7} + M_2^{8.7} + C_9$; $2_2 + 1_3 + C_{20}$;

PFR1 23.11 $M_1^{8.7}/2B$

PFR2 27.11 $X_1^{1.7}/2F$

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Particle event: To($E_p > 10$ MeV) – 27d18^h

Tmax₁($E_p > 10$ MeV) – 28d02^h, Jmax₁($E_p > 10$ MeV) – 740 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 28d12^h, Jmax₂($E_p > 10$ MeV) – 680 /cm²·s·sr

Duration of the event – 5 days, power-law index: $\gamma_1 = 3.1$, $\gamma_2 = 2.9$

Quasimaximal energy of protons in the event – Eqm₁ = 900 MeV

– Eqm₂ = 600 MeV

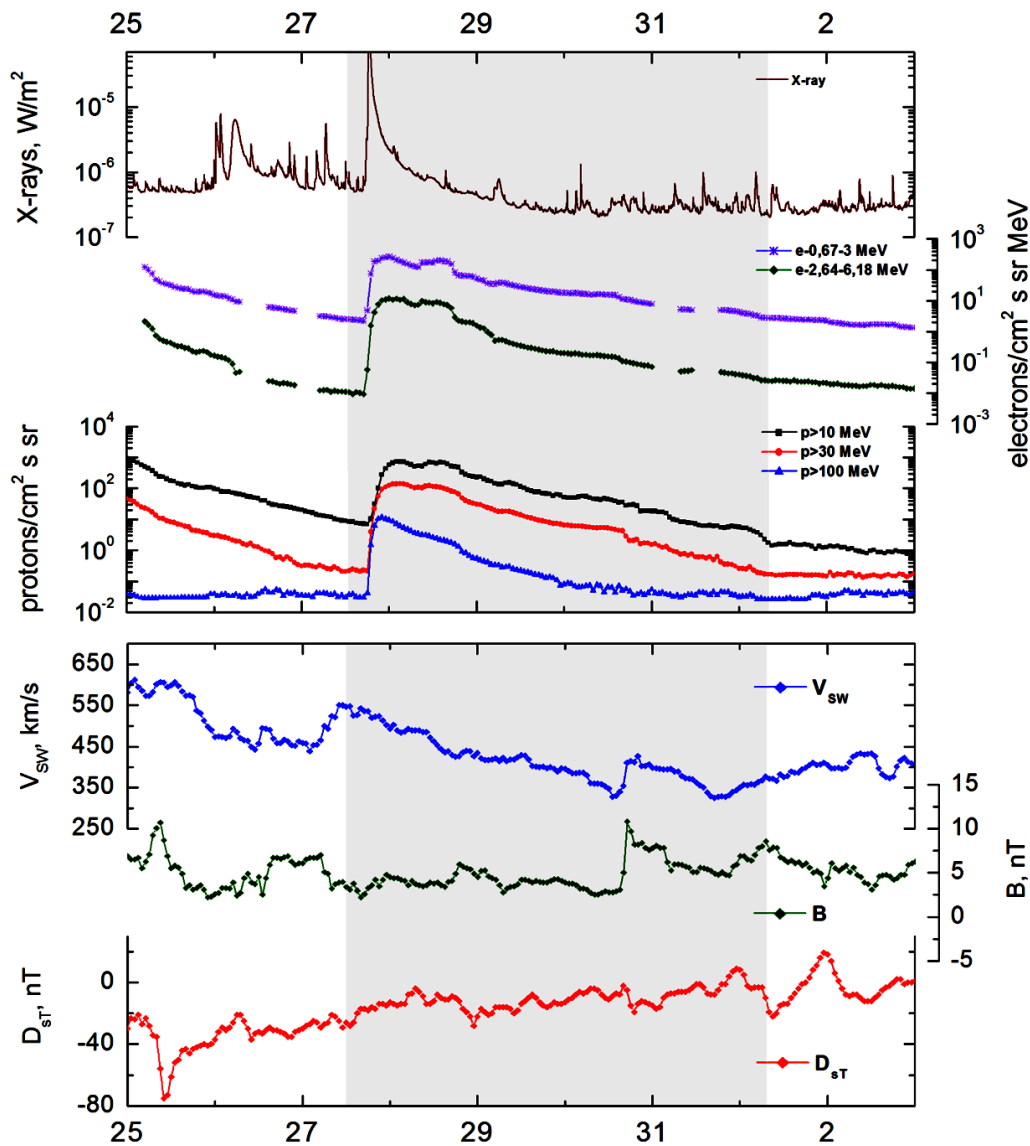
Sources: ● solar flare 27d17^h37^m, X1.7/1F, N27W71, AR11402

Main burst X-ray 1–8 Å: onset – 27d17^h37^m, max – 27d18^h37^m, $\Phi = 0.32$ J/m²

CME: 27d18^h28^m, V = 2508 km/s, $\Delta\phi = 360^\circ$, dA = 296°

▲ SC 30d16^h24^m

Particle fluxes and associated phenomena



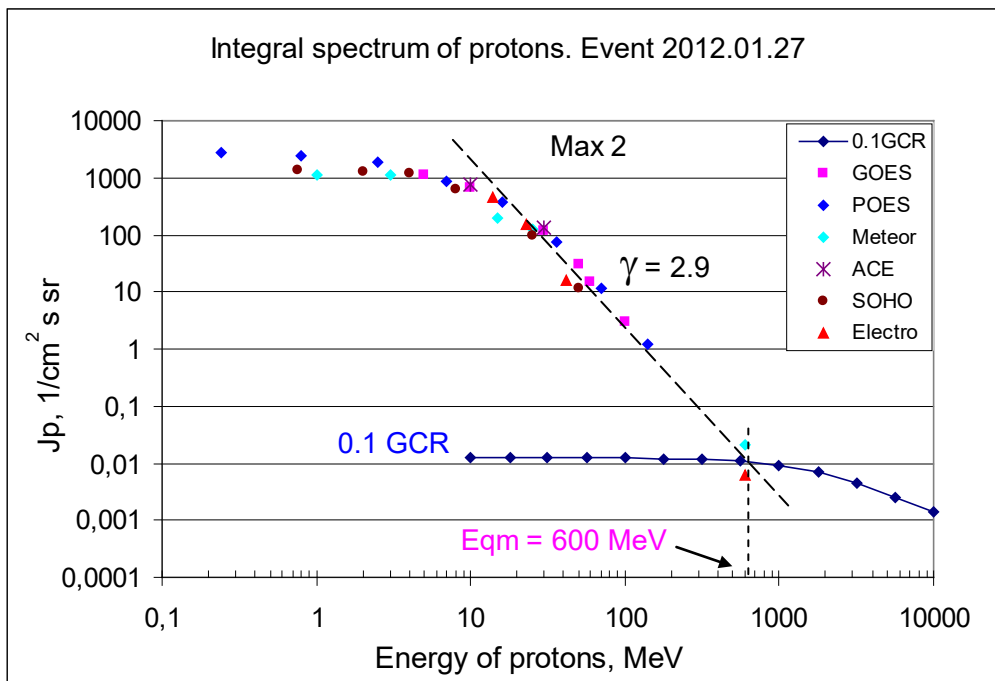
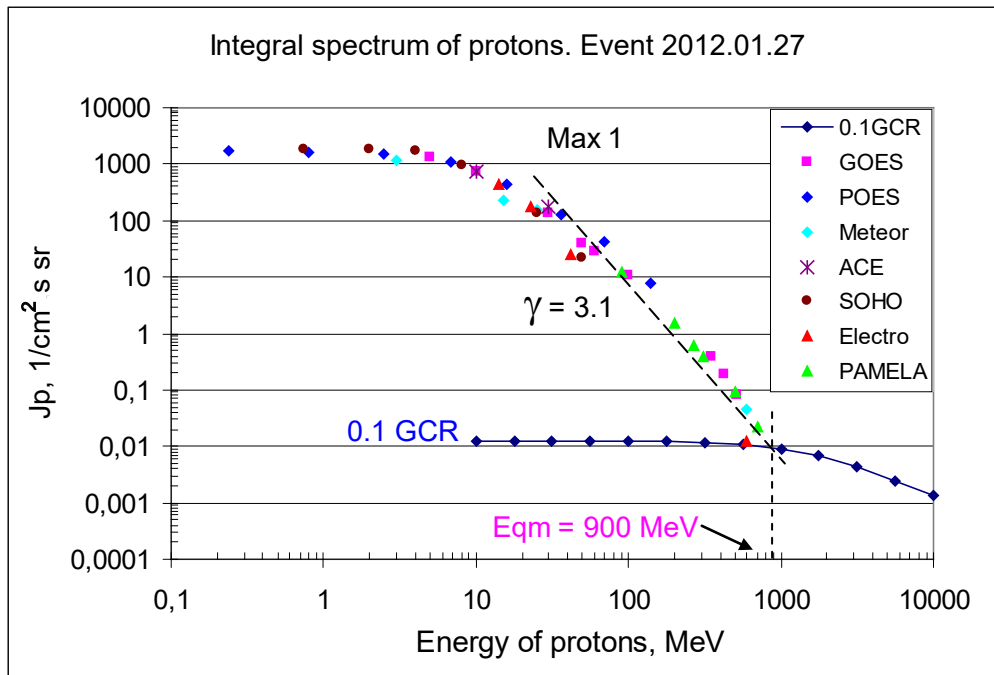
January-February 2012

Integral fluxes of protons for the event of 2012 January 27

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	20	28d02/28d12	1300/1150	5	0.2	
EPS	>10	18	28d02/28d12	740/680	5	0.17	
EPS	>30	18	28d01/28d11	135/120	4	0.1	
EPS	>50	18	22/28d10	40/31	4	0.07	
EPS	>60	18	22/28d10	29/15	3	0.06	
EPS	>100	18	22/28d10	11.5/3	3	0.04	
Electro-1							
GALS-E	>600	18	22/28d10	0.012/0.006	2	0.001	
POES							
MEPED	>0.24	18	28d00/14	1730/2680	4	290	
MEPED	>0.8	18	28d00/14	1610/2460	4	180	
MEPED	>2.5	18	28d00/14	1490/1840	4	100	
MEPED	>6.9	18	28d00/14	1070/840	3	60	
MEPED	>16	18	28d00/14	435/385	3	2.9	
MEPED	>36	18	28d00/14	131/75.5	3	0.9	
MEPED	>70	18	23/28d10	43/11.5	2	1	
MEPED	>140	18	23/28d10	8/1.2	1.5	1.2	
Meteor-1							
SCR	>1	17	- /28d11	- /1110	4.5	3.2	
SCR	>3	17	28d02/28d11	1160/1100	4.5	3	
SCR	>10	17	-	-	3.5	2.1	
GALS-M	>15	17	28d00/28d11	226/192	3	1.5	
GALS-M	>25	17	28d00/28d11	160/128	3	1.5	
GALS-M	>600	17	21/28d05	0.045/0.021	1	0.03	
ACE							
SIS	>10	18	23/28d13	740/740	4	10	
SIS	>30	18	23/28d13	175/135	4	1.2	
SOHO							
EPHIN	>50	18	28d00/28d11	21.4/11.2	4	0.3	
PAMELA							
TRACKER	>90	19	19-28d01	12/ -	5	-	
TRACKER	>200	19	19-28d01	1.5/ -	4	-	
TRACKER	>265	19	19-28d01	0.61/ -	4	-	
TRACKER	>312	19	19-28d01	0.39/ -	3		
TRACKER	>500	19	19-28d01	0.09/ -	2		
TRACKER	>700	19	19-28d01	0.022/ -	2		

Differential fluxes of protons for the event of 2012 January 27

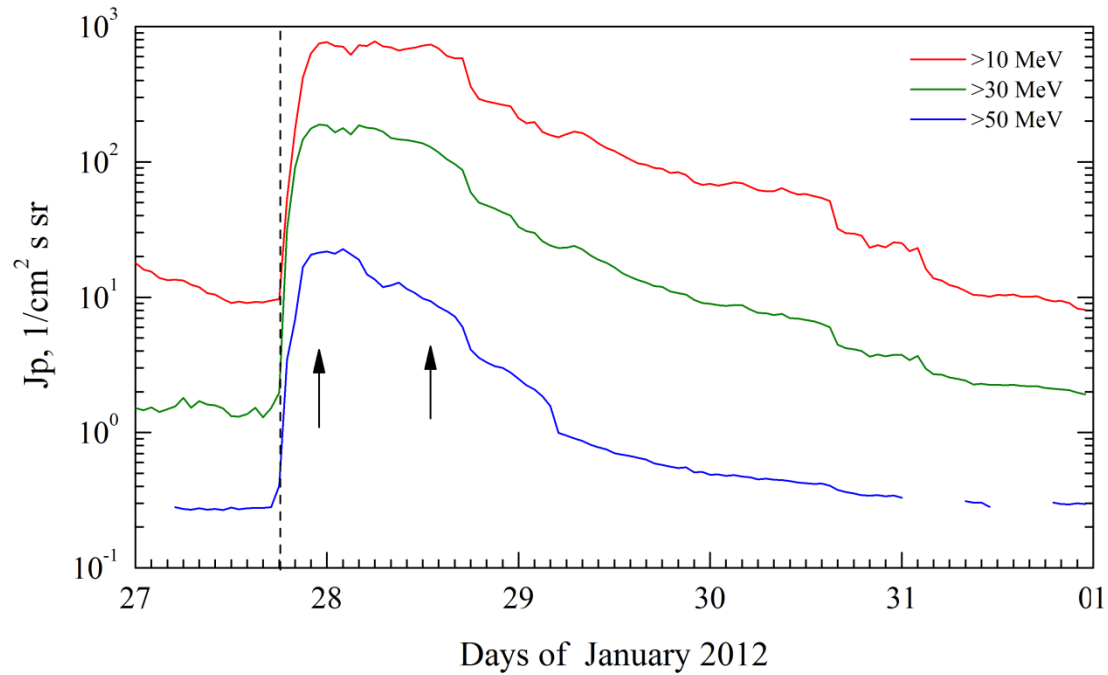
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	20	28d02/28d11	63.4/62.4	7	0. 2	
LION	2 – 6	20	28d02/28d11	34.5/29.4	7	0.02	
EPHIN	4 – 8	22	28d02/28d11	188/145	7	0.035	
EPHIN	8 – 25	22	28d02/28d11	47.6/32.3	7	0.0012	
EPHIN	25 – 53	20	28d04/28d11	4.1/3	7	0.00004	
Electro-1							
SCR-E	13.7–23	18	22/28d10	26.7/38.3	4	0.25	
SCR-E	23–42	18	22/28d10	8/9.2	4	0.05	
SCR-E	42–112	18	22/28d10	0.37/0.27	4	0.005	
GOES							
EPS	350–420	18	21/ -	0.0029/ -	0.5	0.0016	
EPS	420–510	17	20/ -	0.0012/ -	0.5	0.001	
EPS	510–700	17	20/ -	0.00043/ -	0.5	0.0005	
EPS	>700	-	-	-	-		



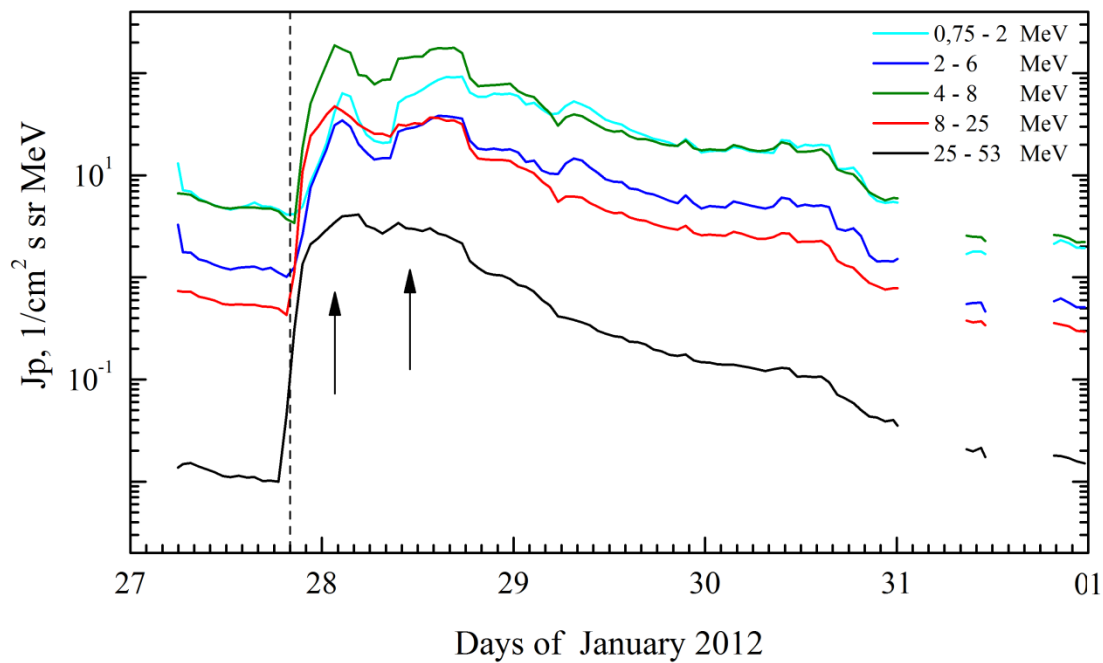
Time profiles of proton fluxes in the event 2012.01.27

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.01.27

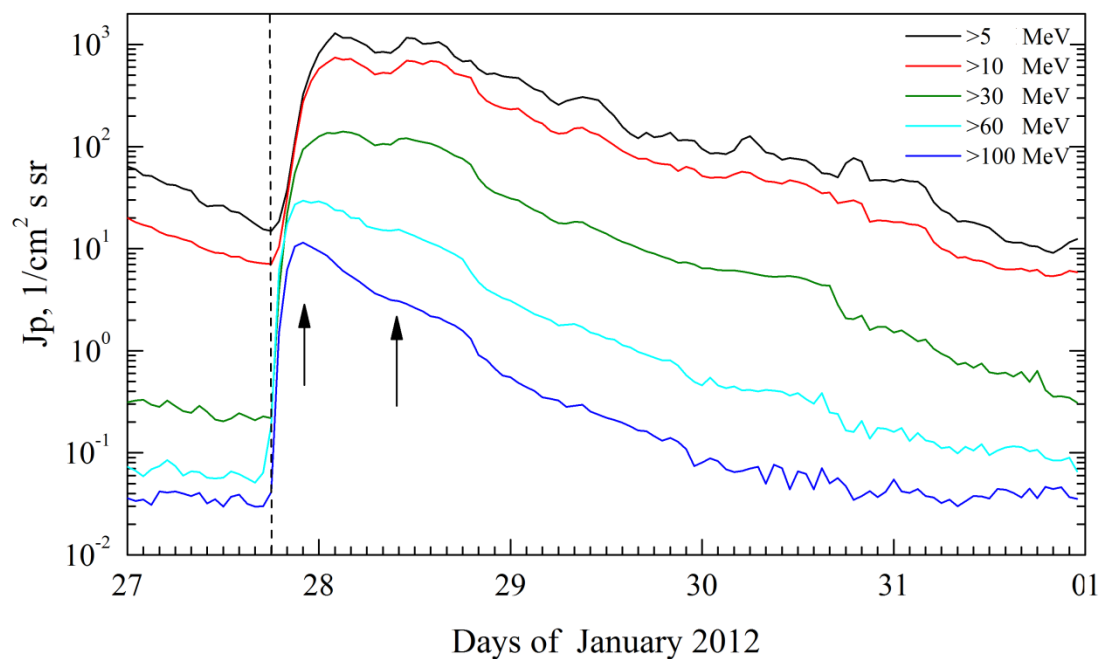


SOHO. Event 2012.01.27

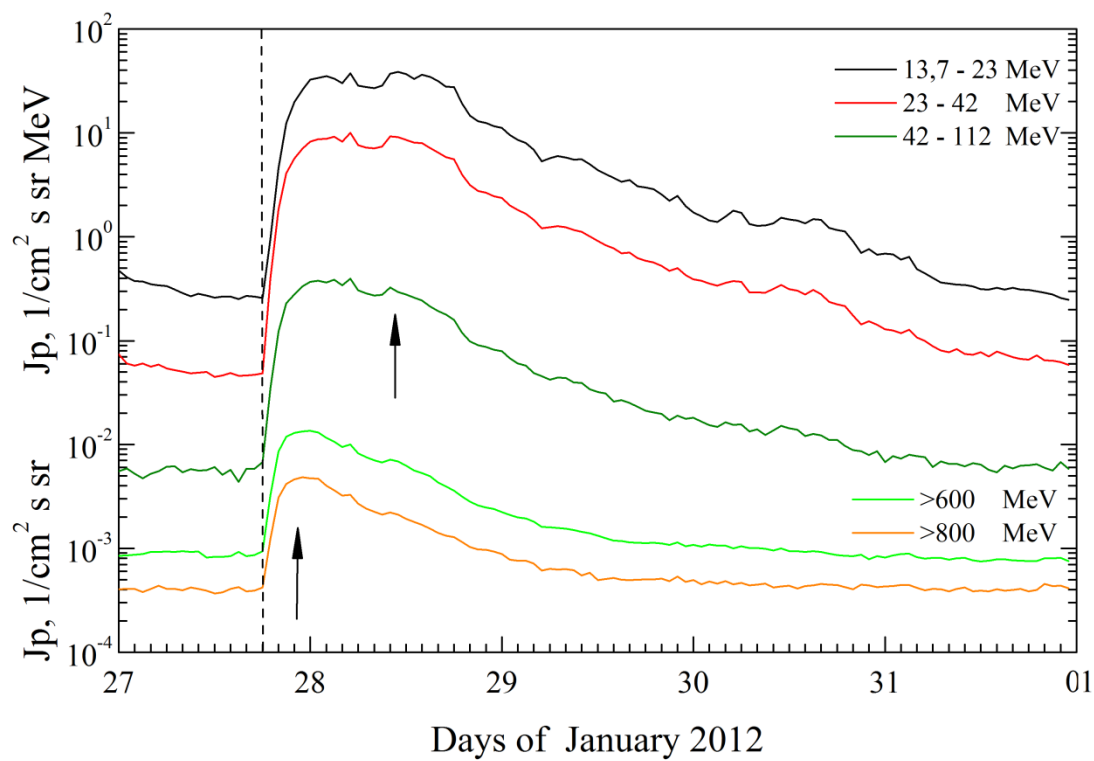


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro

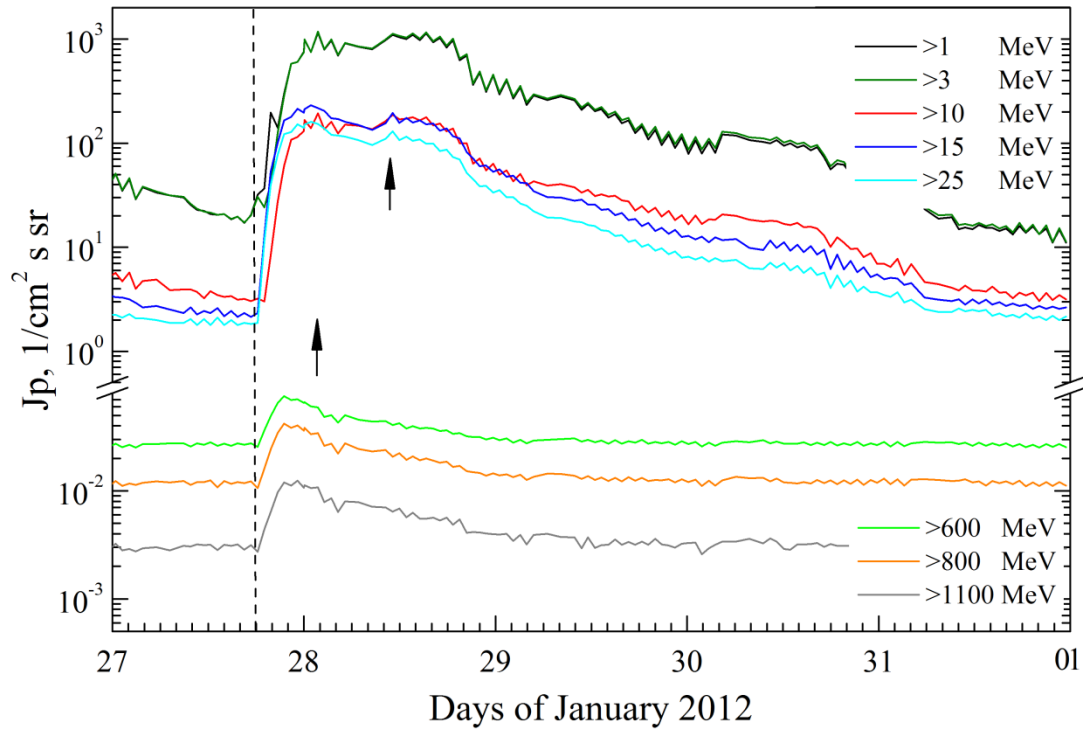
GOES. Event 2012.01.27



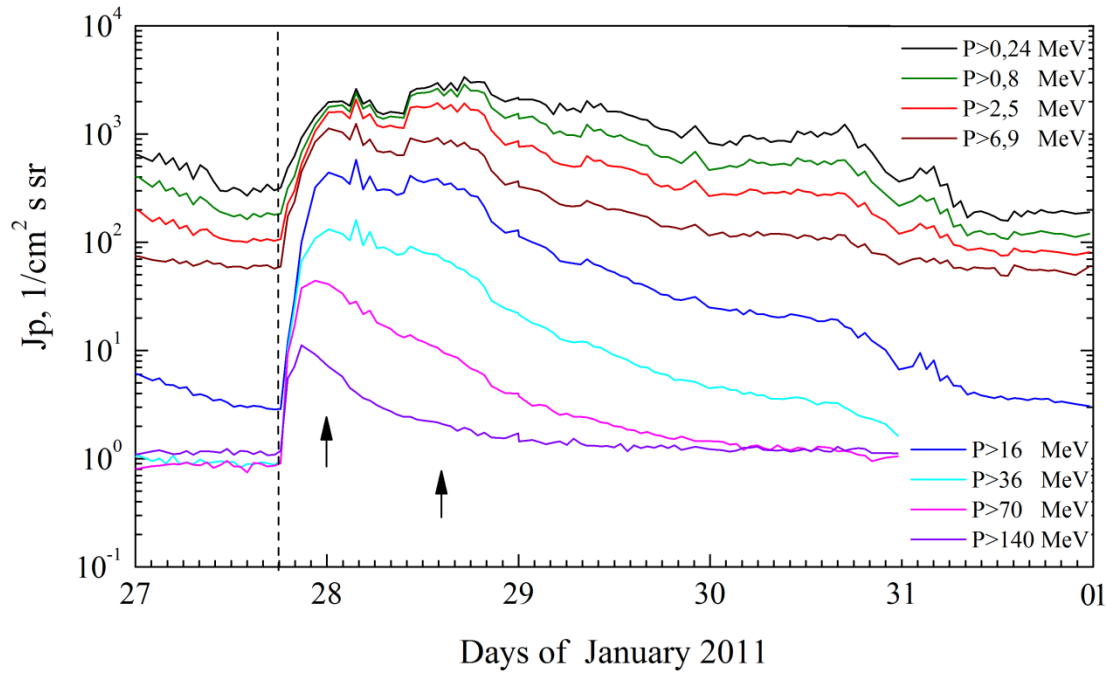
Electro. Event 2012.01.27



Meteor. Event 2012.01.27



POES. Event 2012.01.27



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 January 27**

2012 January 27

●

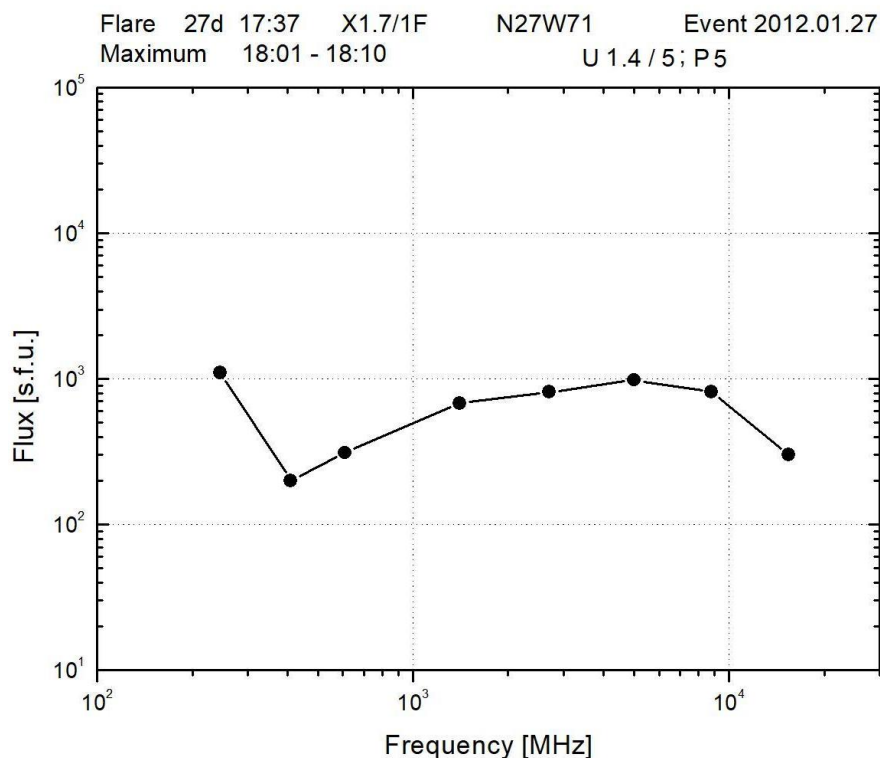
AR 11402

To event 505

Hα, X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ, J/m²
6563 Å	FL	1813	1851	1913	N27W71	1F	
6563 Å	LPS	1846		1952	0.03	B9.A	
1 – 12	keV	1737	1837	1856	N33W85	X1.7	0.32
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1834:05	1834:09	1844:27	691027	57144256	FERMI
12-25	keV	1921:03	1922:13	1956:12	6650	2805725	FERMI
>100	MeV	1937:30		1956:30		3.02E-05*	FERMI
>100	MeV	2108:30		2137:30		1.29E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1801	1816	1914		2.48	
8.8	GHz	1810	1815	1850	P 5	2.91	
5	GHz	1809	1824	1913		2.99	
2.7	GHz	1808	1824	1854		2.91	
1.4	GHz	1808	1811	1849	U0.4 / 5	2.83	
610	MHz	1809	1810	1817		2.49	
410	MHz	1809	1813	1820		2.3	
245	MHz	1810	1819	1823		3.04	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-180	1810		1825		3	
DS IV	25-180	1814		1844		2	
DH II	0.15-16	1830		28/0445			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1828	2508	165.9	360°	296°	SOHO

*cm⁻² s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR11402 (N28L211, CMP 21,3.01.2012,
Sp= 630 msh, DKI, BG, R)
XRI=2.89; $X_1^{1.7} + M_2^{8.7} + C_9$; $2_2 + 1_3 + C_{20}$;
PFR1 23.11 $M_1^{8.7}/2B$
PFR2 27.11 $X_1^{1.7}/2F$

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Particle event: To($E_p > 10$ MeV) – 24d23^h

Tmax₁($E_p > 10$ MeV) – 26d01^h, Jmax₁($E_p > 10$ MeV) – 3.5 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 27d00^h, Jmax₂($E_p > 10$ MeV) – 2.3 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 3.5$, $\gamma_2 = 4.0$

Quasimaximal energy of protons in the event – Eqm₁ = 55 MeV

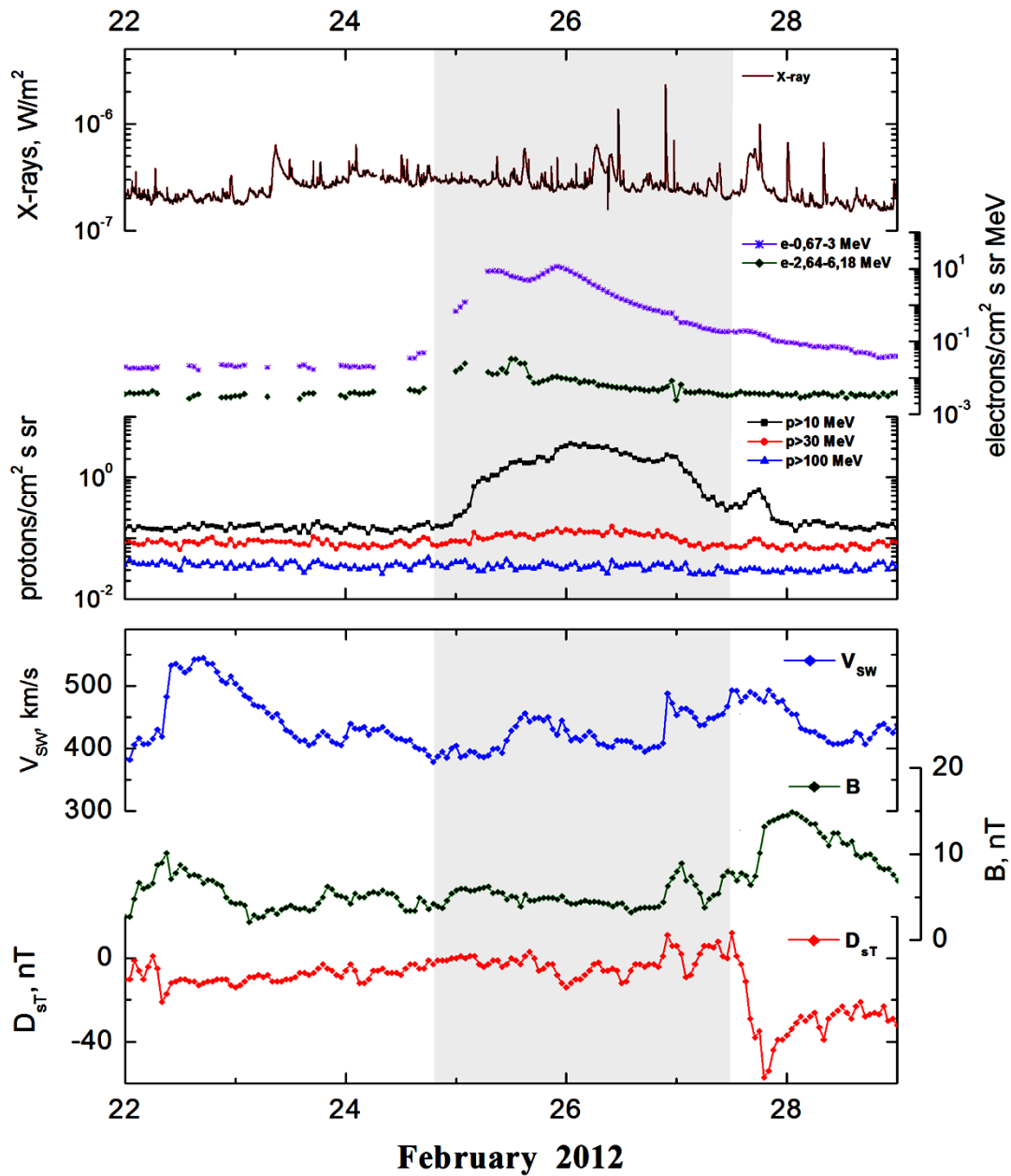
– Eqm₂ = 45 MeV

Sources: ☉ DSF 24d02^h25^m, N32E38, 26°

CME 24d 03^h46^m, V = 0800 km/s, $\Delta\phi = 189^\circ$, dA = 001°

▲ SC 26d21^h40^m

Particle fluxes and associated phenomena

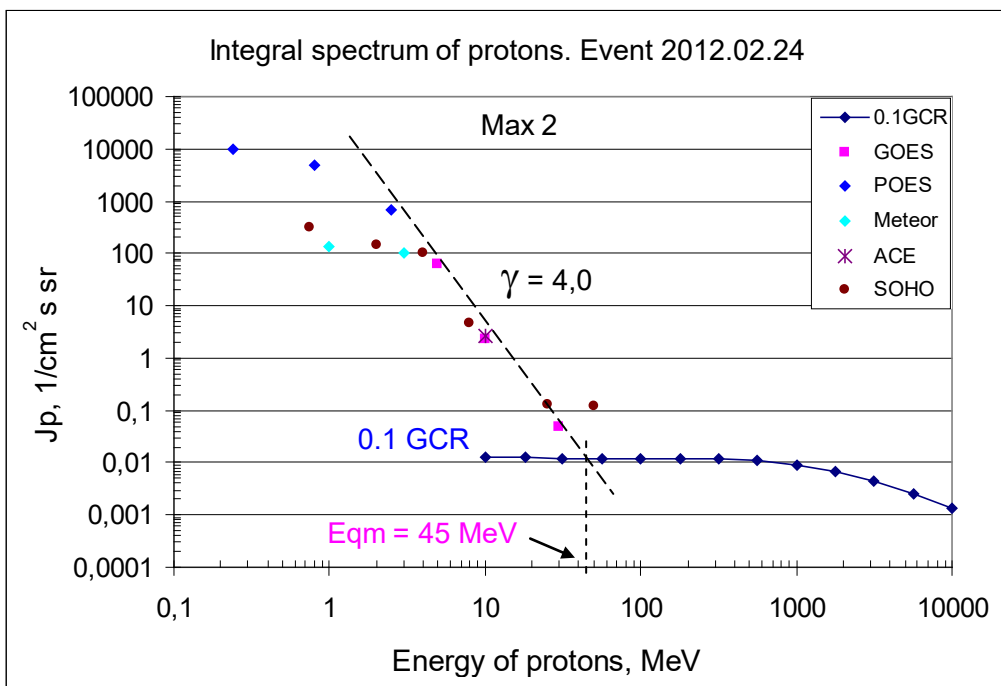
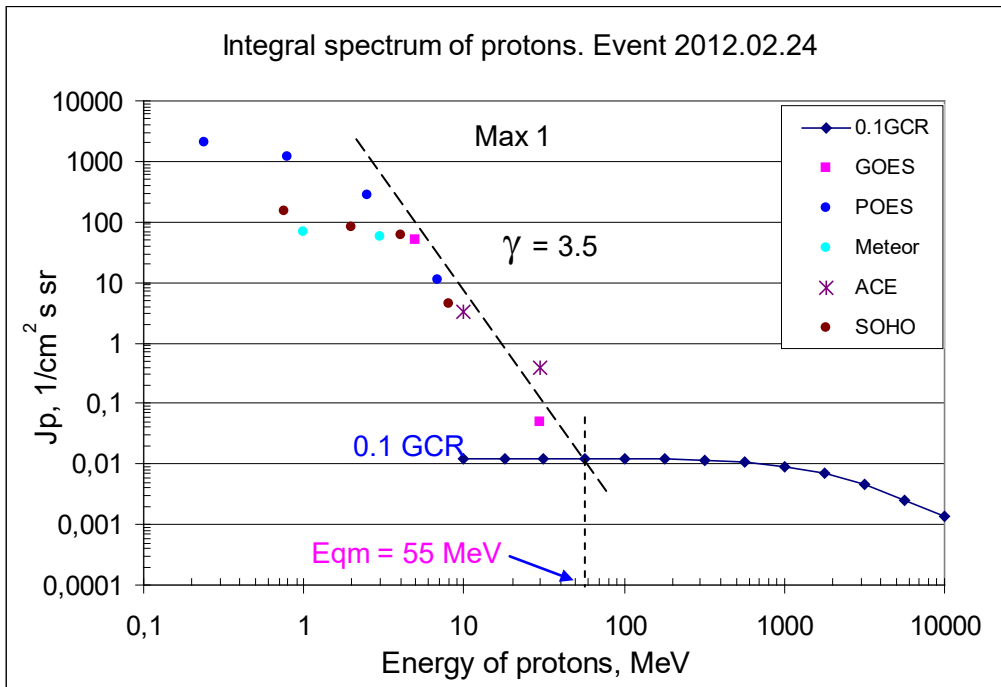


Integral fluxes of protons for the event of 2012 February 24

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	26d01/27d00	50/62	4	0.2	
EPS	>10	23	26d01/26d23	3.5/2.3	3	0.17	
EPS	>30	-	26d01/26d22	0.05/0.05	2	0.1	
EPS	>50	-	-	-	-	0.07	
EPS	>60	-	-	-	-	0.06	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	22	25d23/27d00	2010/9800	4	110	
MEPED	>0.8	22	25d23/27d00	1190/4790	4	80	
MEPED	>2.5	22	26d01/27d02	273/683	3	60	
MEPED	>6.9	-	26d01/ -	11/ -	-	50	
MEPED	>16	-	-	-	-	0.9	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	18	26d07/27d01	70/132	3	2.8	
SCR	>3	18	26d07/27d00	57/100	3	2.5	
SCR	>10	-	-	-	-	1.6	
GALS-M	>15	-	-	-	-	1.4	
GALS-M	>25	-	-	-	-	1.45	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	23	25d23/26d20	3.3/2.6	3	1.5	
SIS	>30	23	25d23/ -	0.4/ -	3	1.1	
SOHO							
EPHIN	>50	-	- /26d22	- /0.12	0.2	0.3	

Differential fluxes of protons for the event of 2012 February 24

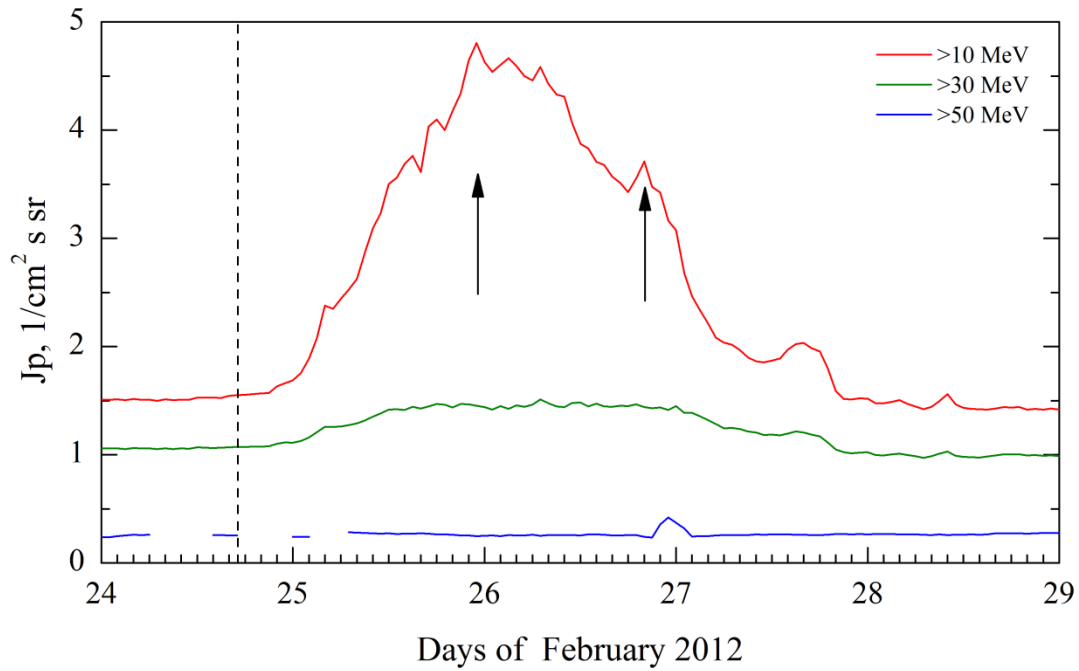
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	-	25d23/26d23	54.6/130	4	0.01	
LION	2 – 6	-	25d23/26d23	8.2/13.3	4	0.0025	
EPHIN	4 – 8	-	25d23/27d00	13.6/25	4	0.0004	
EPHIN	8 – 25	-	25d23/27d00	0.26/0.27	4	0.00003	
EPHIN	25–53	-	- /27d00	- /0.0002	-	0.00002	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.06	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0.005	



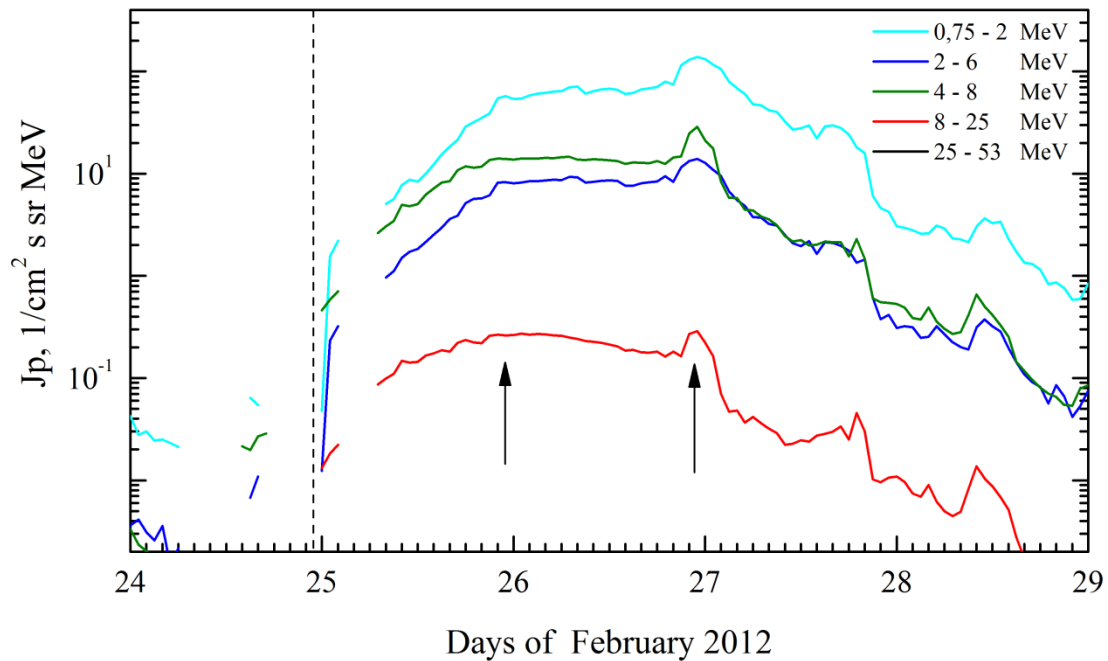
Time profiles of proton fluxes in the event 2012.02.24

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

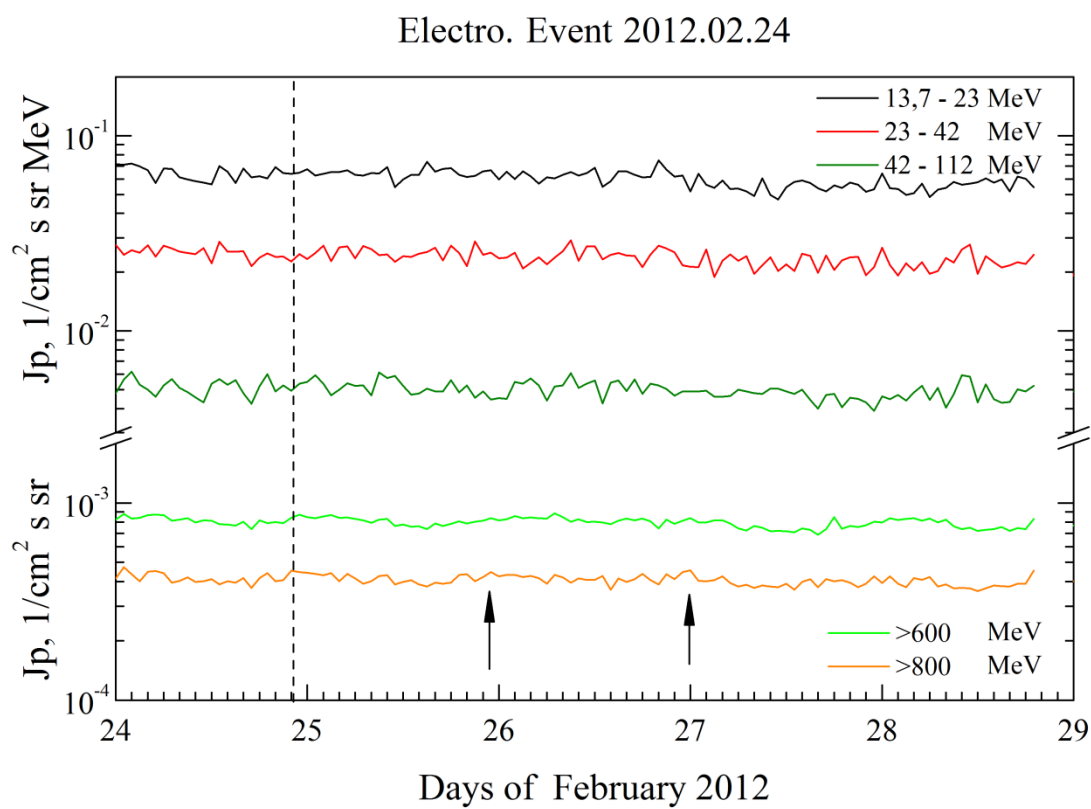
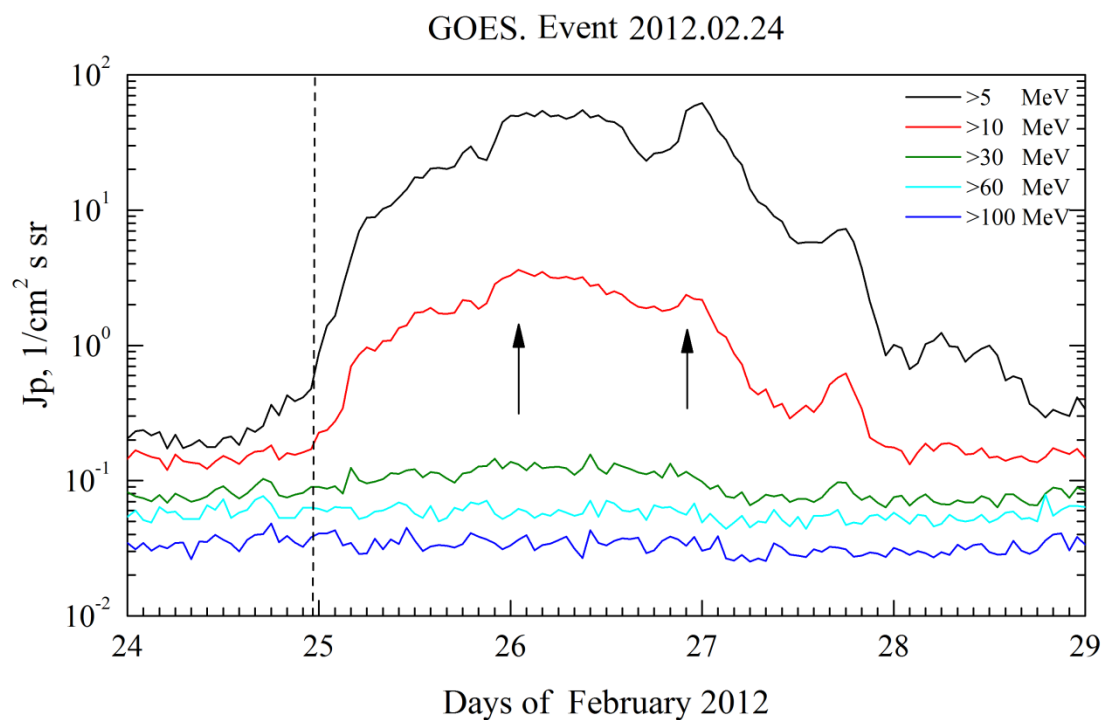
ACE SIS + SOHO (>50 MeV). Event 2012.02.24



SOHO. Event 2012.02.24

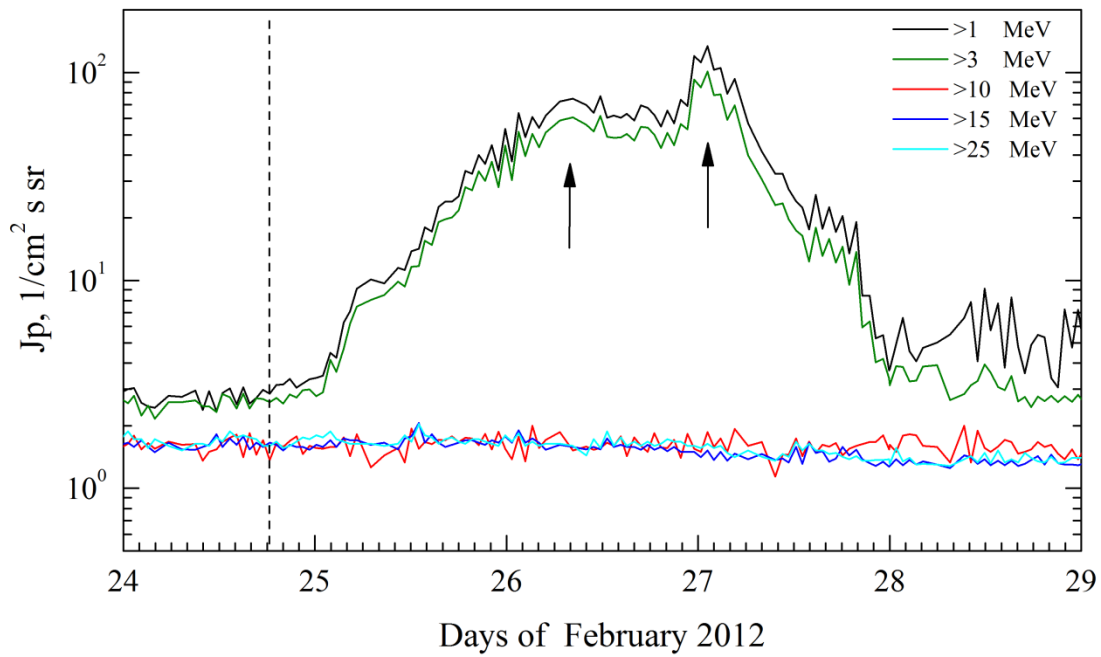


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

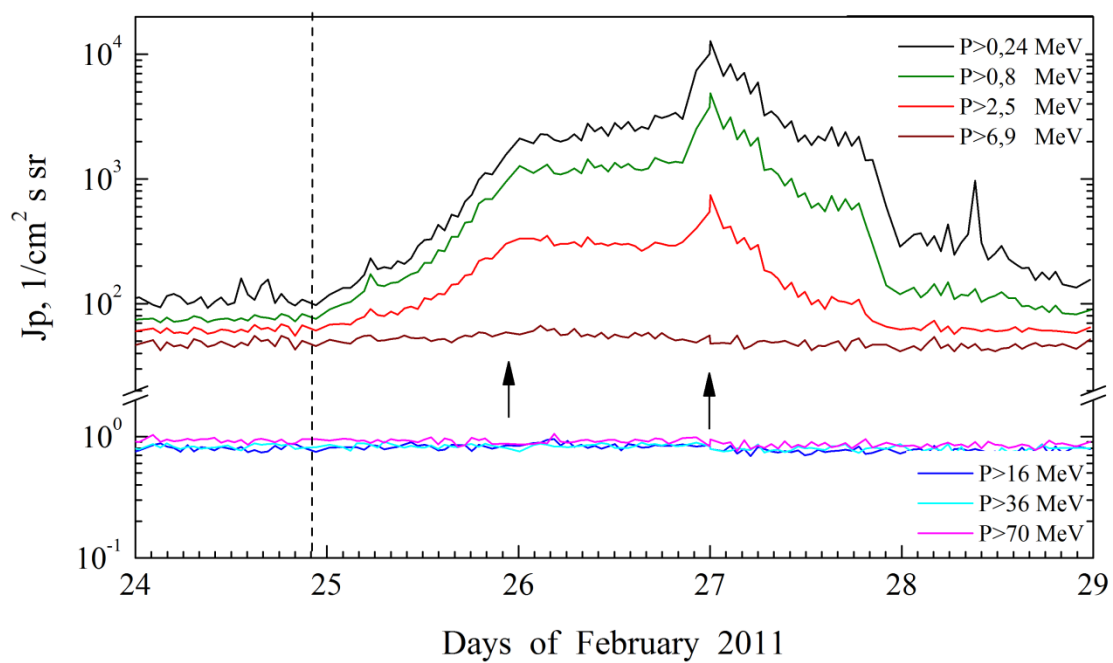


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.02.24



POES. Event 2012.02.24



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 February 24**

2012

February 24

☉

AR

To event 506

Hα, X-ray		To	Tmax	Te	Location	Importance Class	FI Code Φ, J/m²
6563 Å	DSF	0225		0348	N32E38	26°	
1 – 12	keV	No X-ray event at this time \geq B1					
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0346	800	13.3	189°	1°	SOHO

References:

Ameri D., E. Valtonen, [2019](#).

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Winter L.M., and K. Ledbetter, [2015](#).

Particle event: To($E_p > 10$ MeV) – 04d21^h

Tmax ($E_p > 10$ MeV) – 05d16^h, Jmax ($E_p > 10$ MeV) – $3.2 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

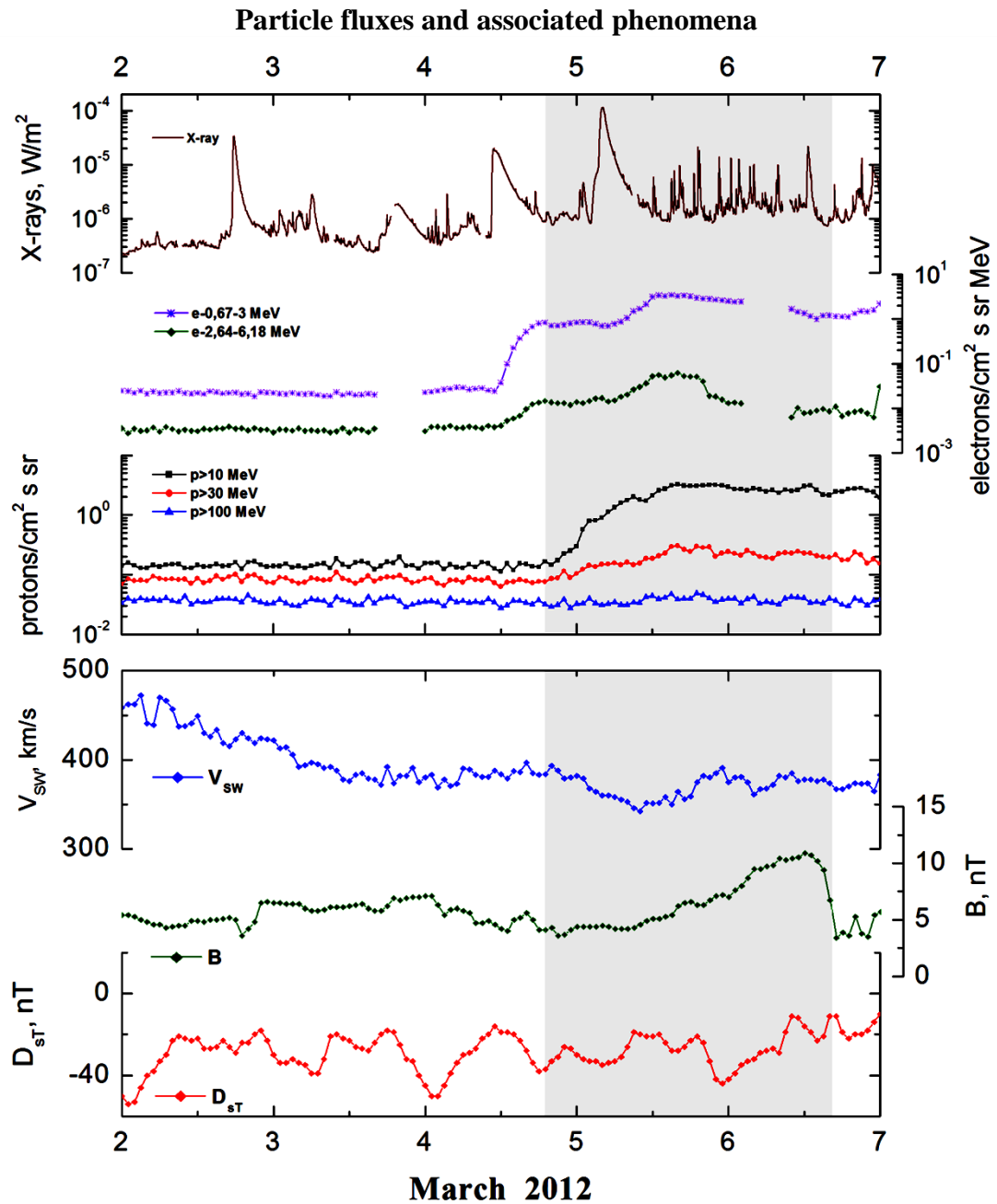
Duration of the event – 2 days, power-law index: $\gamma = 2.25$

Quasimaximal energy of protons in the event – $E_{qm} = 90$ MeV

Sources: ● solar flare 04d10^h29^m, M2.0/1N, N19E61, AR11429

Main burst X-ray 1–8 Å: onset – 04d10^h29^m, max – 04d10^h52^m, $\Phi = 0.092 \text{ J/m}^2$

CME: 04d11^h00^m, $V = 1306 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 052^\circ$

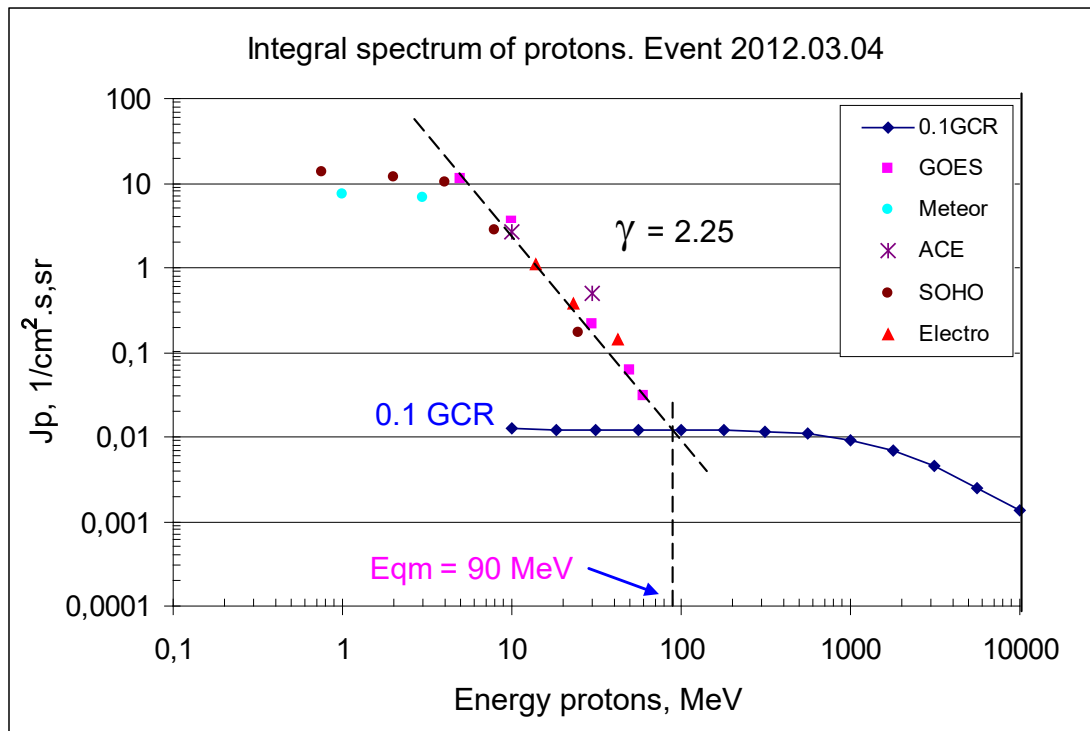


Integral fluxes of protons for the event of 2012 March 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	24	5d16	11	2	0.2	
EPS	>10	21	5d16	3,2	2	0.17	
EPS	>30	23	5d16	0,22	2	0.1	
EPS	>50	-	5d15	0,06	2	0.07	
EPS	>60	-	5d1	0,03	2	0.06	
EPS	>100	-	-	-	-	0.04	
Meteor-1							
SCR	>1	20	05d18	7.3	2	2.55	
SCR	>3	20	05d18	6.7	2	2.55	
SCR	>10	-	-	-	-	1.6	
GALS-M	>15	-	-	-	-	1.4	
GALS-M	>25	-	-	-	-	1.4	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	23	5d13	3	2	1.5	
SIS	>30	23	5d13	0.5	2	1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

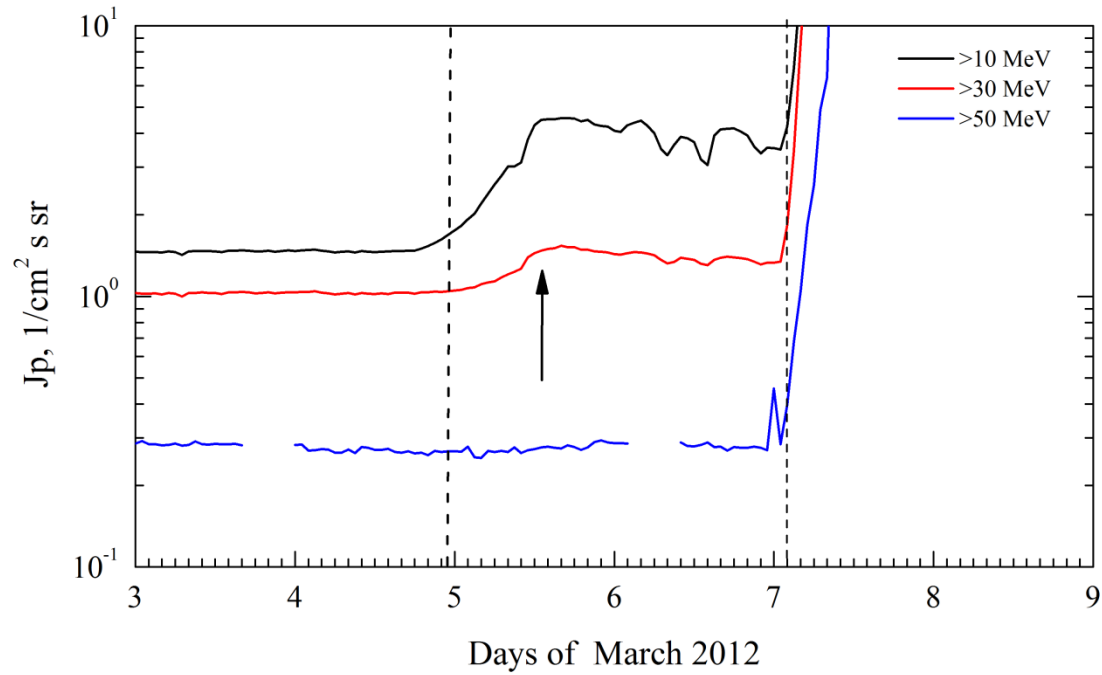
Differential fluxes of protons for the event of 2012 March 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	11	5d15	1.23	3	0.017	
LION	2 – 6	11	5d15	0.46	3	0.0025	
EPHIN	4 – 8	05	5d16	1.89	3	0.001	
EPHIN	8 – 25	05	5d16	0.155	3	0.00003	
EPHIN	25 – 53	17	5d16	0.006	3	0.00003	
Electro-1							
SCR-E	13.7–23	21	5d18	0.08	1	0.06	
SCR-E	23–42	-	5d18	0.012	1	0.025	
SCR-E	42–112	-	5d18	0.002	0.5	0.005	

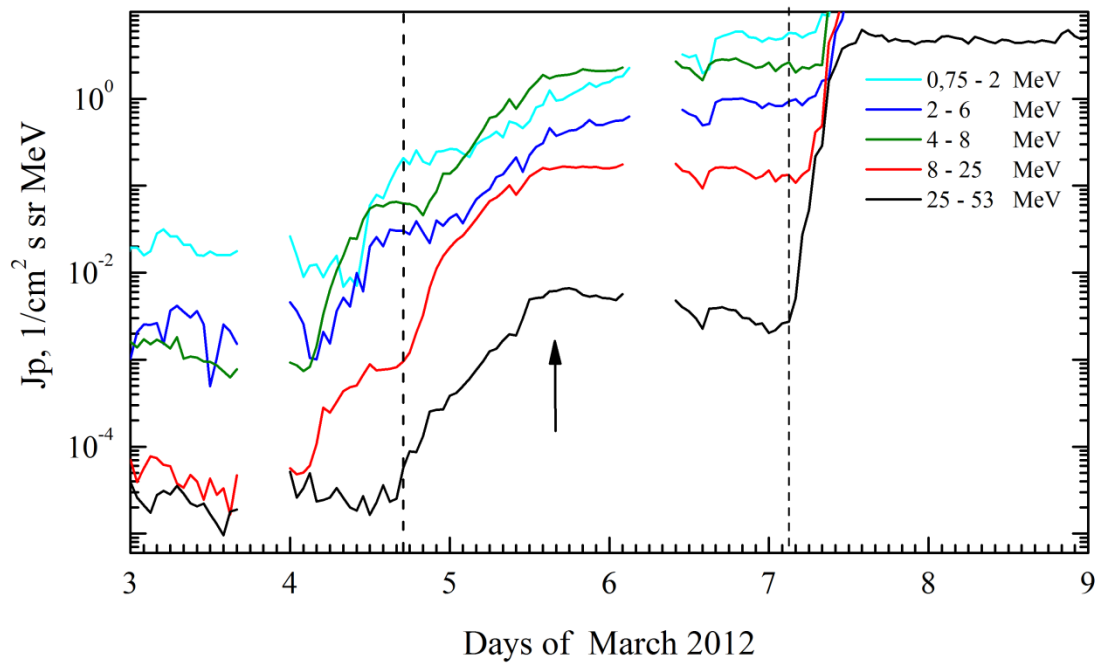


Time profiles of proton fluxes in the event 2012.03.04

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO
ACE SIS + SOHO (>50 MeV). Event 2012.03.04

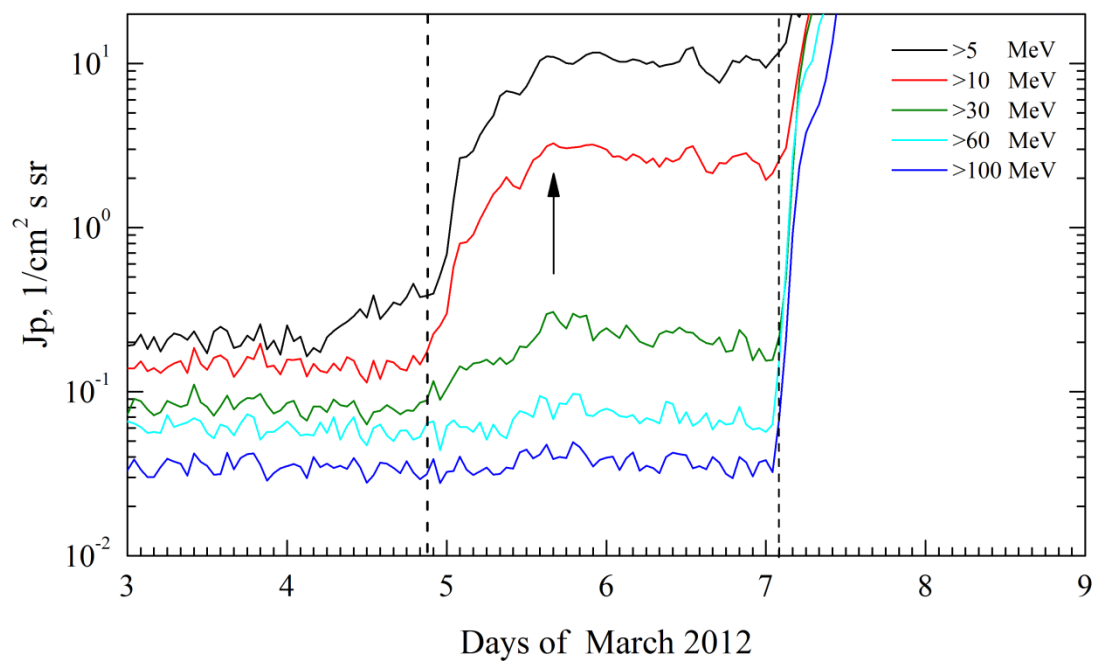


SOHO. Event 2012.03.04

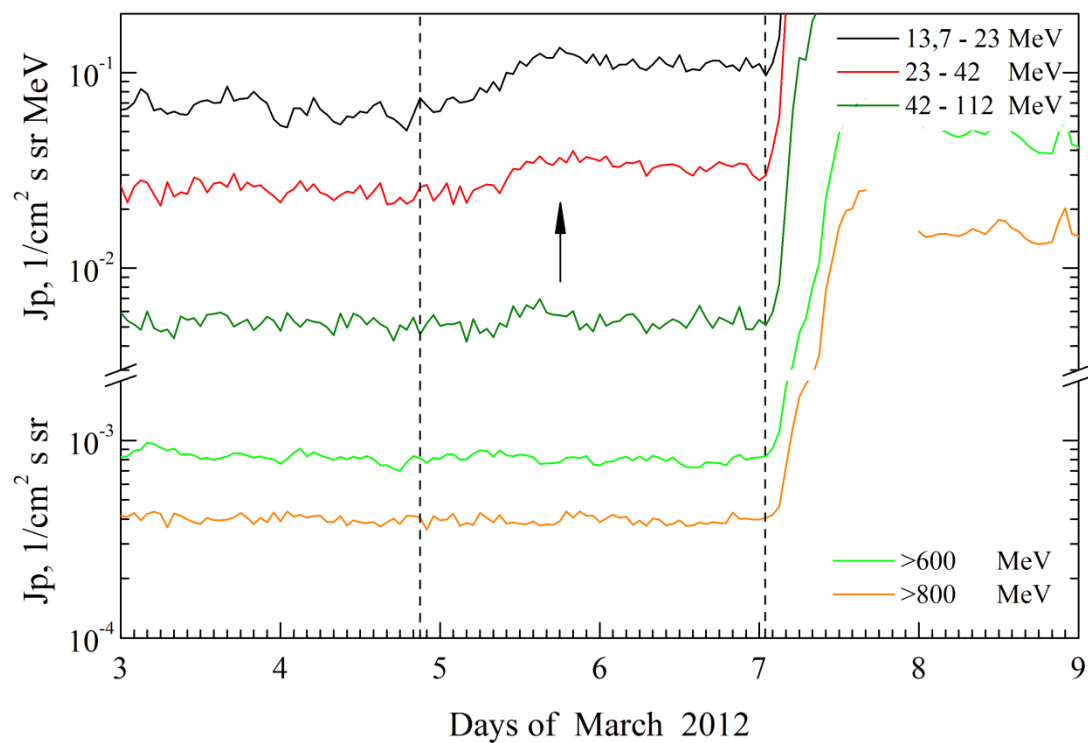


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

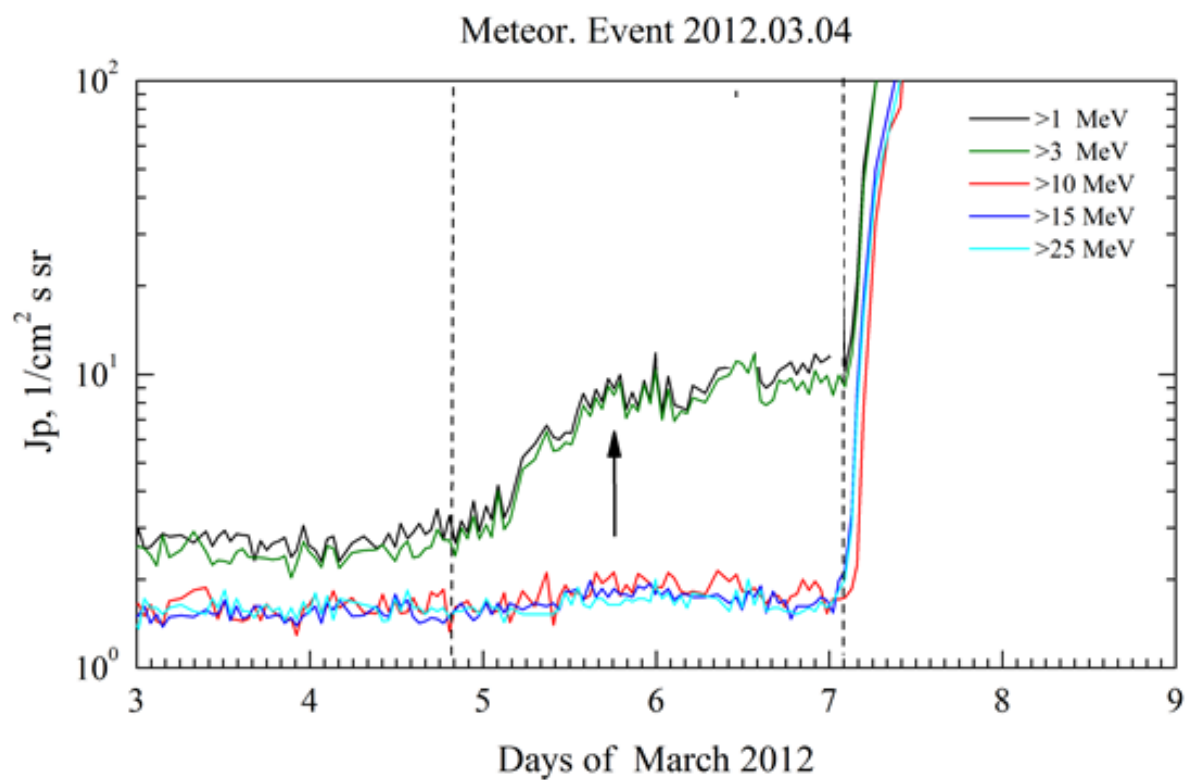
GOES. Event 2012.03.04



Electro. Event 2012.03.04



Earth satellites in polar orbit, $R = 800 \div 1000$ km: Meteor



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 March 04**

2012 March 04

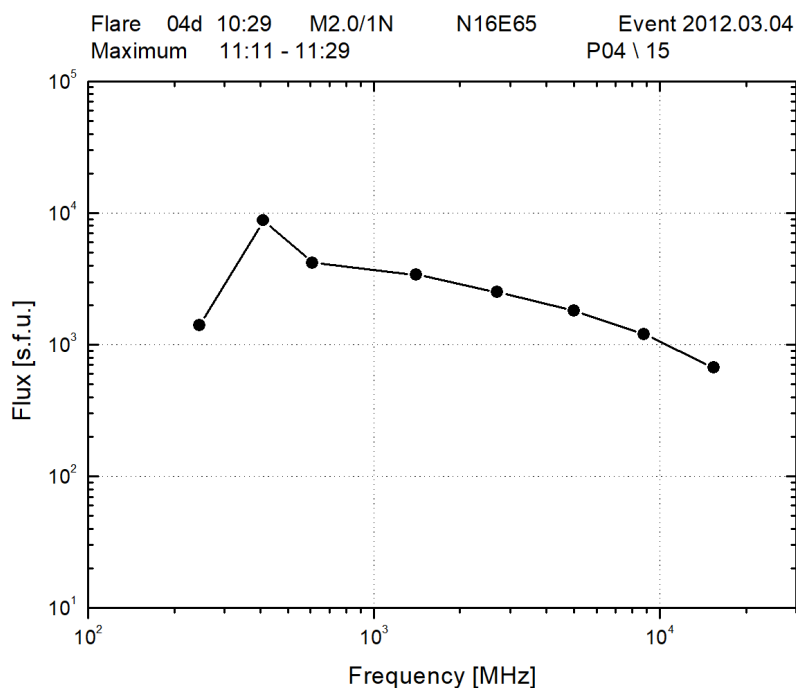
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AR 11429

To event 507

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å	FL	1032	1110	1324	N19E61	1N	ERU
1 – 12	keV	1029	1052	1216	N16E65	M2.0	0.092
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25 – 50	keV	1024:36	1034:18	1034:24	2032	1235760	HESSI
100-300	keV	1103:32	1104:06	1106:52	20464	18825600	HESSI
100-300	keV	1106:52	1107:30	1110:44	20464	21729824	HESSI
100-300	keV	1110:44	1118:38	11:20:4 4	20629	56560792	HESSI
12-25	keV	1031:59	1042:31	1124:01	194292	158384560	FERMI
12-25	keV	1200:24	1211:07	1225:27	5167	1681211	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	11039	1112	1205		2.83	
8.8	GHz	1037	1111	1218		3.08	
5	GHz	1036	1111	1229		3.26	
2.7	GHz	1035	1111	1236		3.4	
1.4	GHz	1035	1116	1225		3.53	
610	MHz	1125	1129	1205		3.62	
410	MHz	1035	1119	1206	P0.4 \ 15	3.94	
245	MHz	1038	1119	1204		3.15	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	25-180	1040		1728		3	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1100	1306	28.3	360°	52°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11429 (N18L301,CMP 09,1.03.2012,
Sp=1270 мдп, ЕКС, ВGD, R)
XRI=11.92 $X_2^{5.4}+M_{14}^{8.4}+C_{32}$ $3_1+2_1+1_7+S_{51}$
PFR1 5-7.03 (46^h) $X_2^{5.4}+M_{10}$
PFR2 9-10.03 (38^h) $M_2^{8.4}$

References:

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Tsvetkov Ts., R. Miteva, N. Petrova, [2018](#).
Winter L.M. and K.Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 07d02^h

Tmax₁($E_p > 10$ MeV) – 07d17^h, Jmax₁ ($E_p > 10$ MeV) – 1440 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 08d13^h, Jmax₂ ($E_p > 10$ MeV) – 4340 /cm²·s·sr

Duration of the event – 6 days, power-law index: $\gamma_1 = 2.9$, $\gamma_2 = 4.0$

Quasimaximal energy of protons in the event – Eqm₁ = 1200 MeV

– Eqm₂ = 650 MeV

Sources: ● solar flare 07d00^h00^m, X5.4/3B, N17E27, AR11429

Ø solar flare 07d01^h05^m, X1.3/SF, N22E12, AR11430

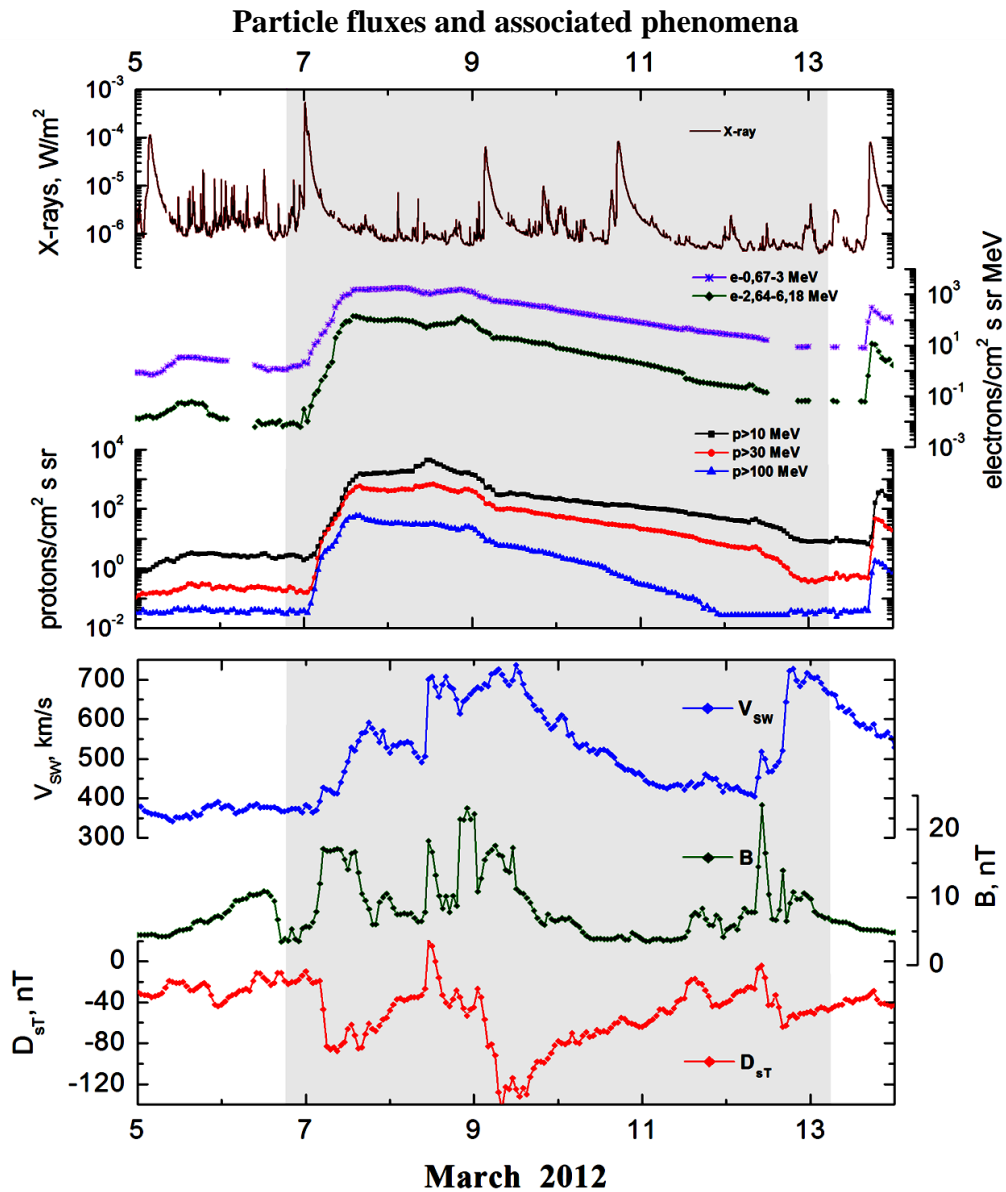
Ø solar flare 09d03^h22^m, M6.3/SF, N15W03, AR11429

Ø solar flare 10d17^h15^m, M8.4/..., N17W24, AR11429

Main burst X-ray 1–8 Å: onset – 07d00^h02^m, max – 07d00^h24^m, $\Phi = 0.67$ J/m²

CME: 07d00^h24^m, V = 2684 km/s, $\Delta\phi = 360^\circ$, dA = 057°

▲ SC 07d04^h20^m; ▲ SC 12d09^h15^m

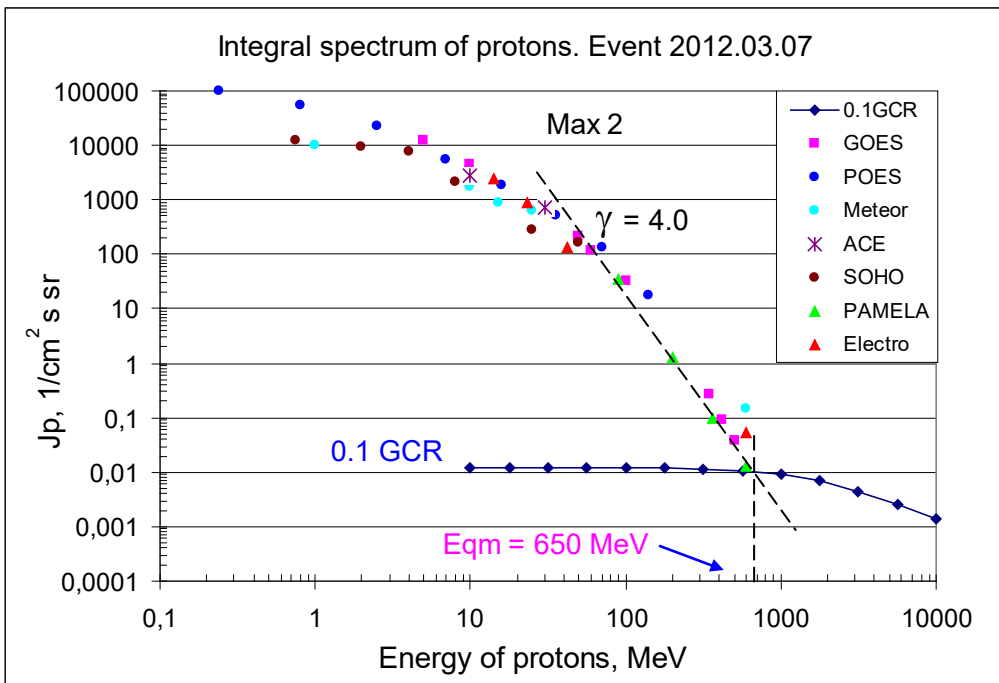
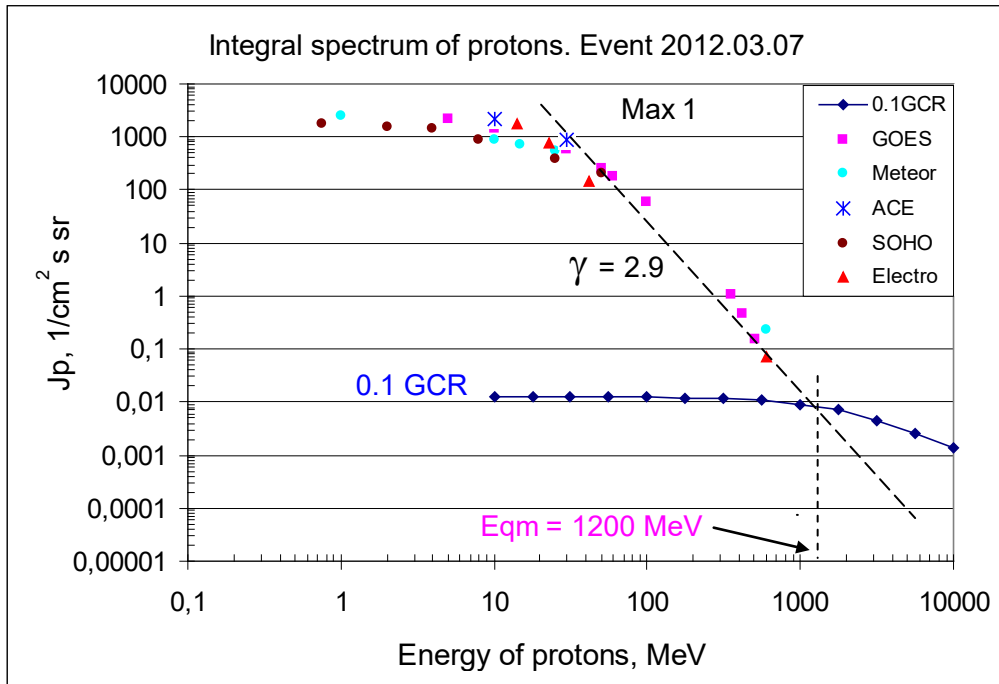


Integral fluxes of protons for the event of 2012 March 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	17/08d13	2170/12000	7	0.2	
EPS	>10	2	17/08d13	1440/4340	6	0.17	
EPS	>30	2	16/08d13	580/670	6	0.1	
EPS	>50	2	16/08d13	255/208	6	0.07	
EPS	>60	2	16/08d13	180/115	6	0.06	
EPS	>100	2	16/08d13	58.5/32.5	6	0.04	
Electro-1							
GALS-E	>600	1	16/8d13	0.073/0.055	6	0.0008	
POES							
MEPED	>0.24	-	- / 8d13	- /99800	5	110	
MEPED	>0.8	-	- / 8d13	- /55100	5	80	
MEPED	>2.5	-	- / 8d13	- /23200	5	60	
MEPED	>6.9	-	- / 8d13	- /5500	5	50	
MEPED	>16	-	- / 8d13	- /1860	5	0.9	
MEPED	>36	-	- / 8d13	- /530	5	0.9	
MEPED	>70	-	- / 8d13	- /138	5	1	
MEPED	>140	-	- / 8d13	- /17.4	4	1.2	
Meteor-1							
SCR	>1	2	17/08d12	2500/10200	7	2.7	
SCR1	>3	2	17/08d12	-	7	2.4	
SCR1	>10	2	17/08d12	880/1730	6	1.6	
GALS-M	>15	2	17/08d12	708/890	6	1.4	
GALS-M	>25	2	17/08d12	530/620	6	1.4	
GALS-M	>600	2	17/08d12	0.23/0.15	2.5	0.03	
ACE							
SIS	>10	2	14/08d12	2210/2760	6	4	
SIS	>30	2	14/08d11	890/710	6	1.4	
SOHO							
EPHIN	>50	2	14/08d12	211/163	5	0.3	
PAMELA							
TRACKER	>90	4	- /8d08-9d01	- /34	7		
TRACKER	>200	4	- /8d08-9d01	- /1.3	5		
TRACKER	>360	4	- /8d08-9d01	- /0.095	4		
TRACKER	>600	4	- /8d08-9d01	- /0.013	4		

Differential fluxes of protons for the event of 2012 March 07

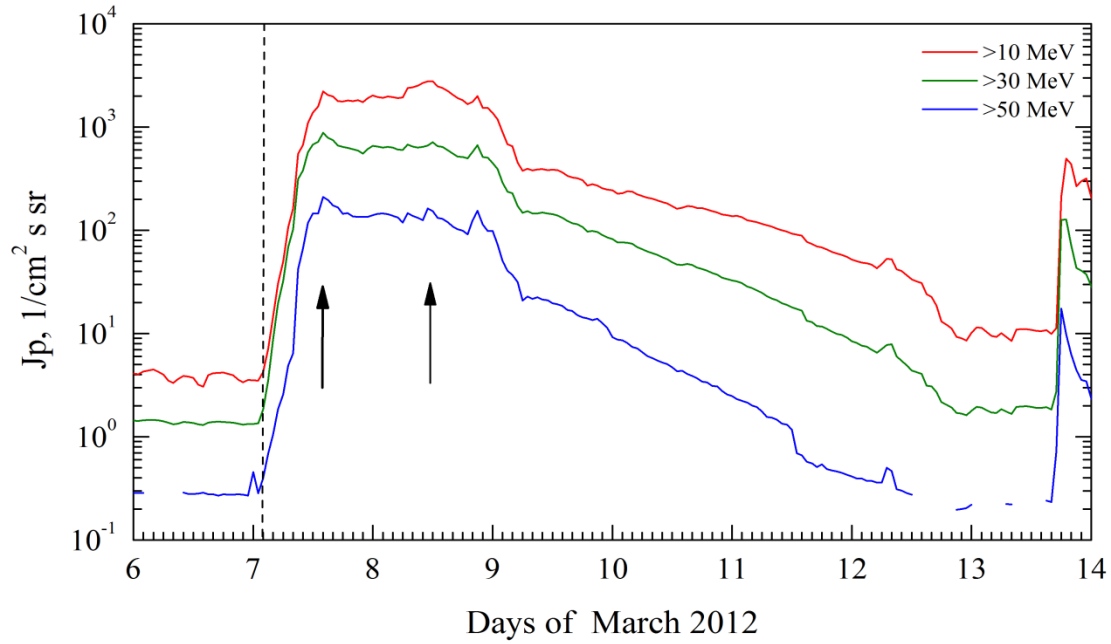
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	8	15/08d12	151/2120	5	0.017	
LION	2 – 6	8	15/08d12	56.5/593	5	0.0025	
EPHIN	4 – 8	9	14/08d12	134/1430	5	0.001	
EPHIN	8 – 25	8	14/08d12	29.5/112	5	0.00003	
EPHIN	25 – 53	5	14/08d12	6.27/4.73	5	0.00003	
Electro-1							
SCR-E	13.7-23	1	16/8d13	103/160	6	0.11	
SCR-E	23-42	1	16/8d13	34/40	6	0.03	
SCR-E	42-112	1	16/8d13	2.1/1.9	6	0.005	
GOES							
EPS	350-420	3	15/8d22	0.0084/0.0026	0.5	0.0016	
EPS	420-510	3	16/8d22	0.0033/0.0006	-	0.001	
EPS	510-700	3	15/8d22	0.0008/0.0002	2	0.00043	
EPS	>700	-	-	-	-	0.00013	



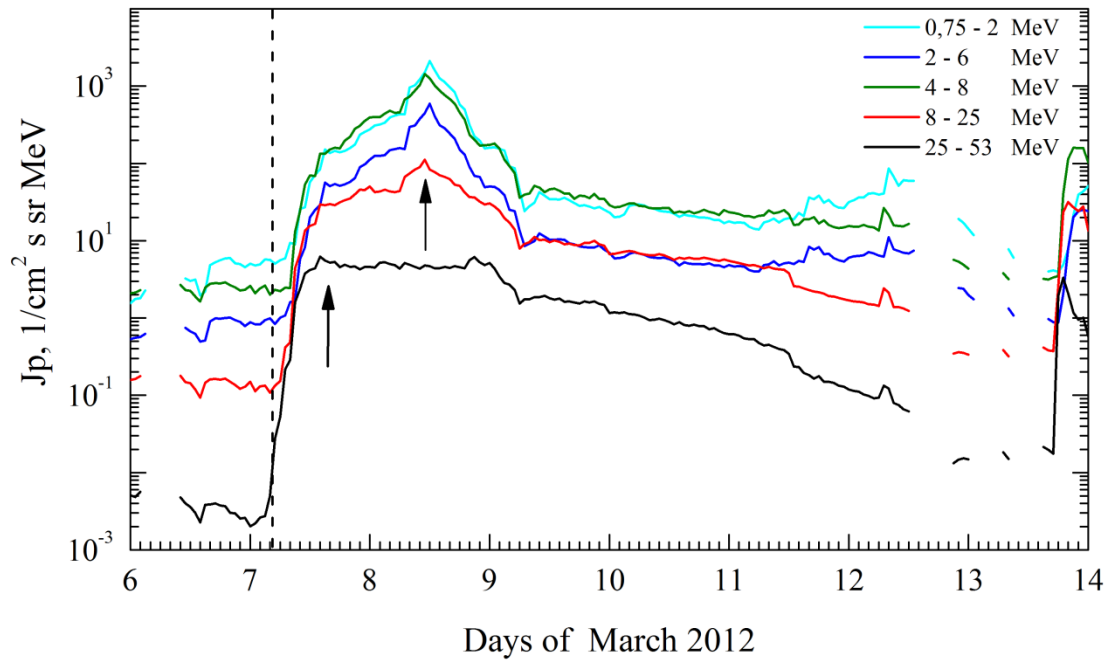
Time profiles of proton fluxes in the event 2012.03.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.03.07

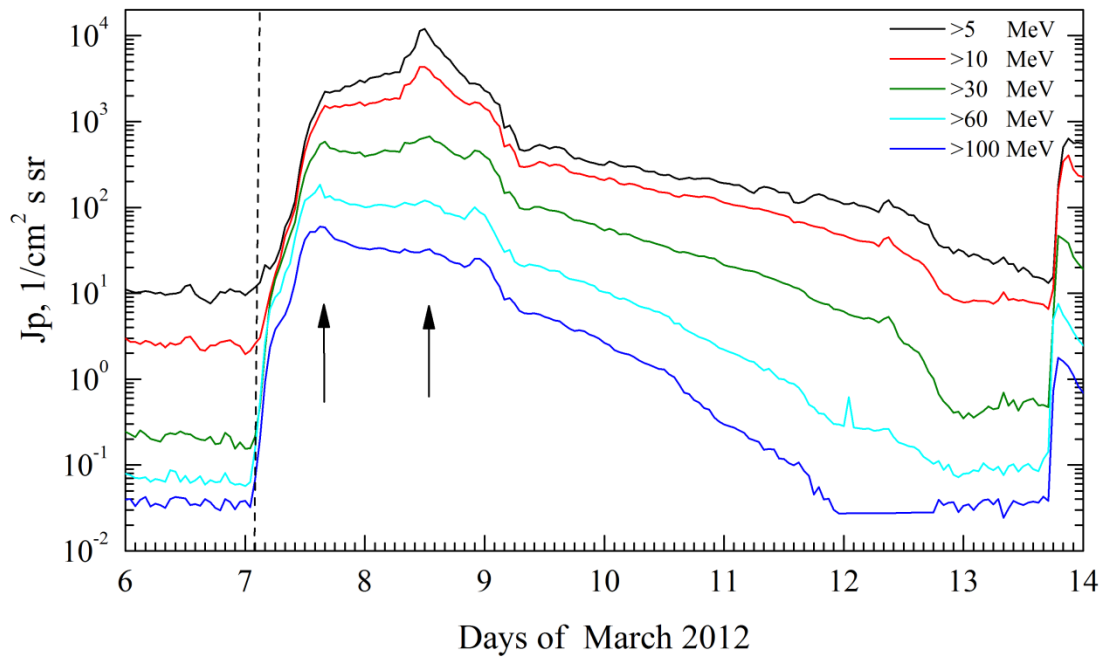


SOHO. Event 2012.03.07

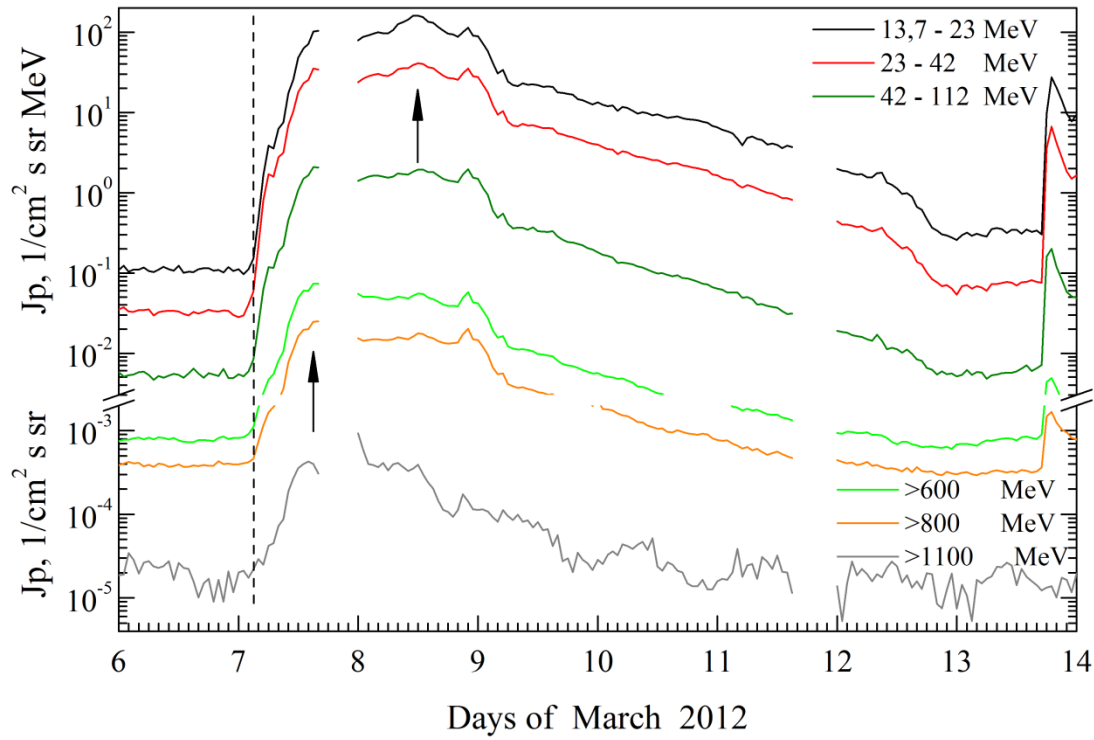


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

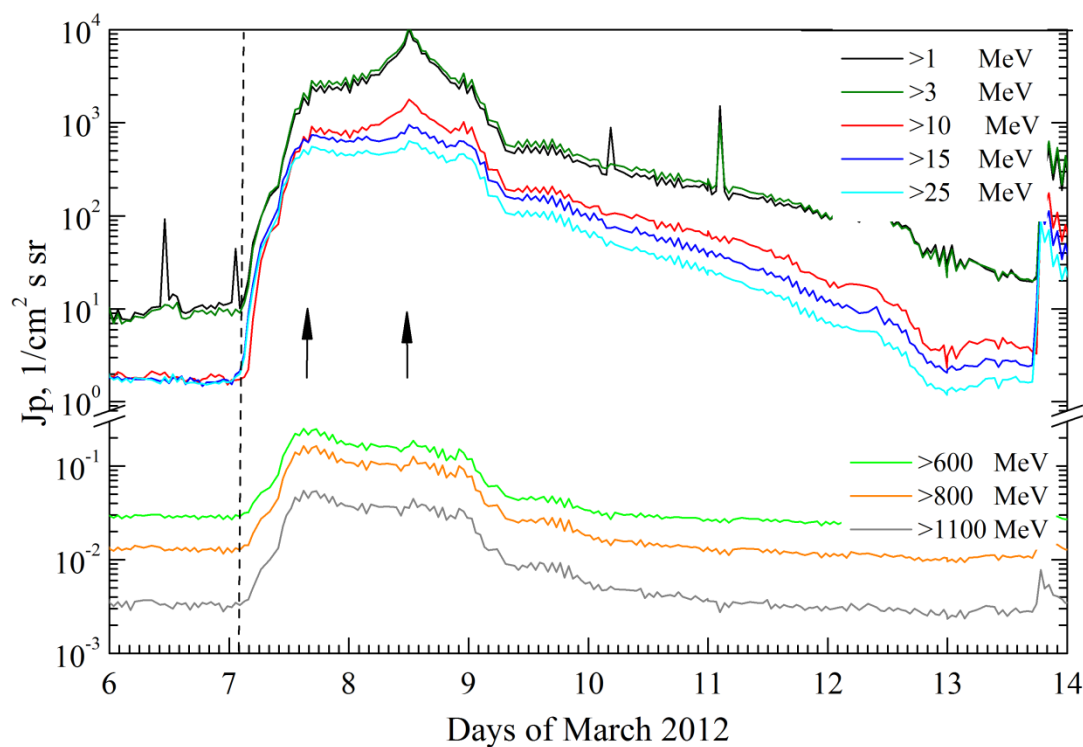
GOES. Event 2012.03.07



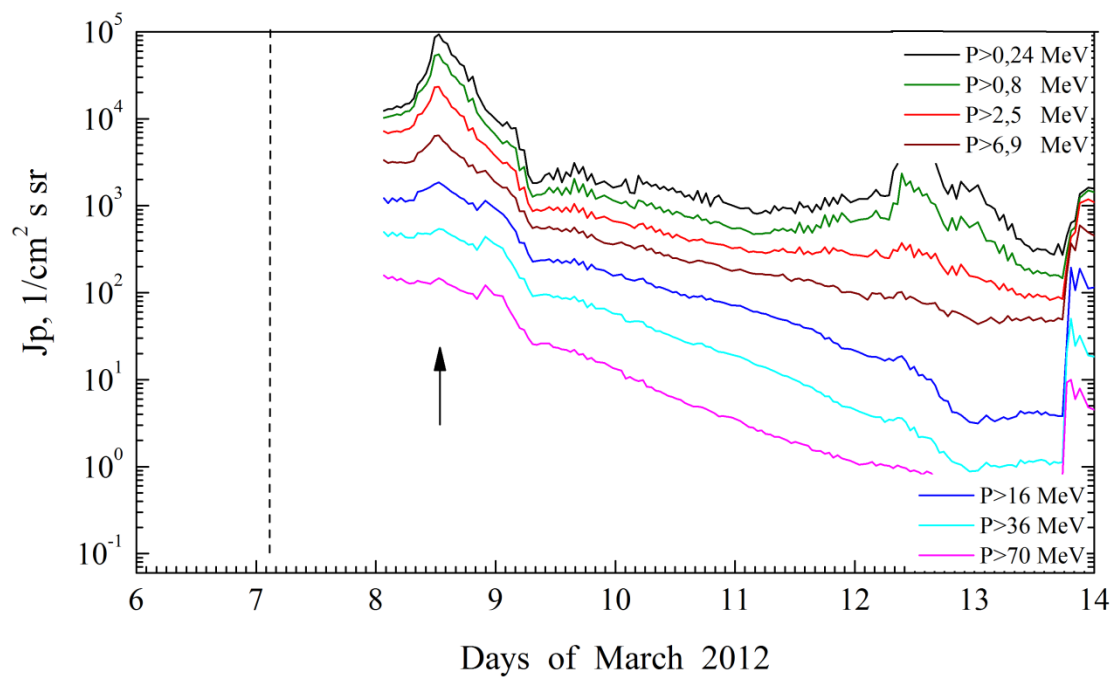
Electro. Event 2012.03.07



Meteor. Event 2012.03.07



POES. Event 2012.03.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 March 07**

2012

March 07

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AR 11429

To event 508

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL*	<0000	0017	0349	N17E27	3B	PRB
1 – 12	keV	0002	0024	0040	N18E31	X5.4	0.67
1 – 12	keV	0105	0114	0123	N15E26	X1.3	1.5E-01
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0030:40	0039:29	0128:24	942049	1449281024	FERMI
12-25	keV	0206:11	0206:36	0305:31	15270	11328235	FERMI
12-25	keV	0341:46	0438:25	0441:05	13144	1302889	FERMI
>1000	keV	0226:30		0245:30		6.67E-04	INTEGRAL
>1000	keV	0351:30		0432:30		9.14E-04	INTEGRAL
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	0006	0021	0222	9 \ 1.4	4.3	
5	GHz	0006	0114	0227		4.11	
2.7	GHz	0007	0117	0210		3.86	
1.4	GHz	0012	0129	0209		3.72	
610	MHz	0014	0112	0207		5.63	
410	MHz	0015	0113	0204	P 0.4	5.97	
245	MHz	0015	0126	0203		5.51	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-180	0017		0031		2	
DS IV	025-075	0017		1030		2	
DS V	025-180	0017		0019		2	
DS II	025-180	0109		0129		2	
DS IV	025-075	0017		1030		2	
DS V	025-180	0017		0019		2	
DH II	1.9-16	0100		08d1900			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0024	2684	-88.2	360°	057°	SOHO
LASCO	WL	0130	1825	-160.9	360°	082°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_120306_165417_33724/www/

2012

March 09

Ø

AR 11429

To event 508

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible disk					
1 – 12	keV	0322	0353	0418	N15W03	M6.3*	0.13
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0334:52	0344:50	0418:40	5616	34474328	HESSI
25-50	keV	0418:40	0420:50	0424:36	944	1312320	HESSI
100-300	keV	0424:36	0427:54	0437:12	848	2338460	HESSI
12-25	keV	0327:57	0338:48	0427:33	1276491	835321472	FERMI
>100	keV	0400		1000			FERMI**
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
610	MHz	0342	0440	0538		3.62	
410	MHz	0342	0423	0529		3.57	
245	MHz	0343	0423	0541		3.79	
DS-type	Frequency, MHz	To	Tmax	Te	VII, km/s	Importance	Sp/c
DS II	025-180	0343		0345		2	
DS III	025-180	0341		0428		1	
DS V	056-180	0343		0345		2	
DH II	1-14	0410		9d0605			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0426	1032	-13.5	360°	029°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_120308_202250_7222/www/

** The first Fermi-LAT solar flare catalog [Ajello et al., 2021]

2012

March 10

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AR 11429

To event

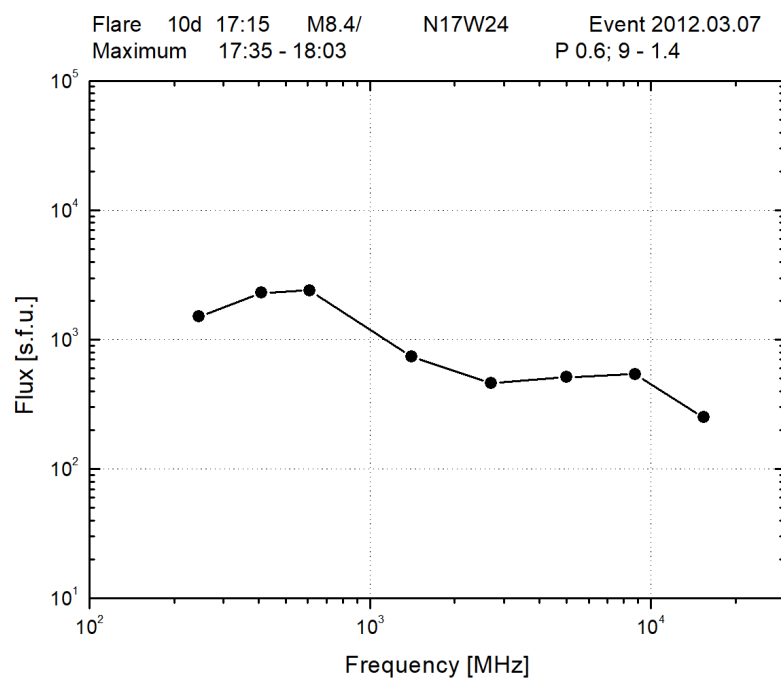
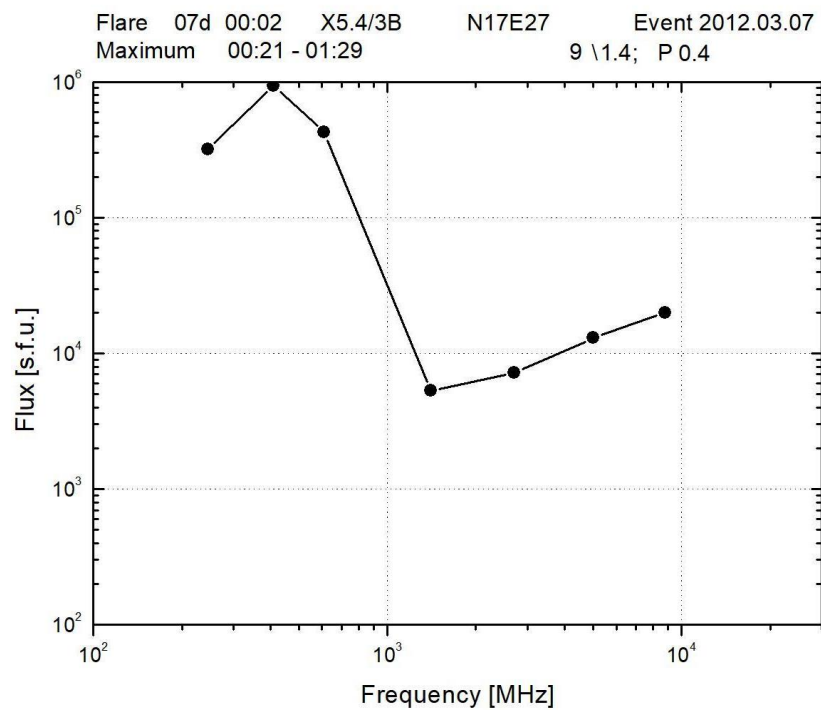
508

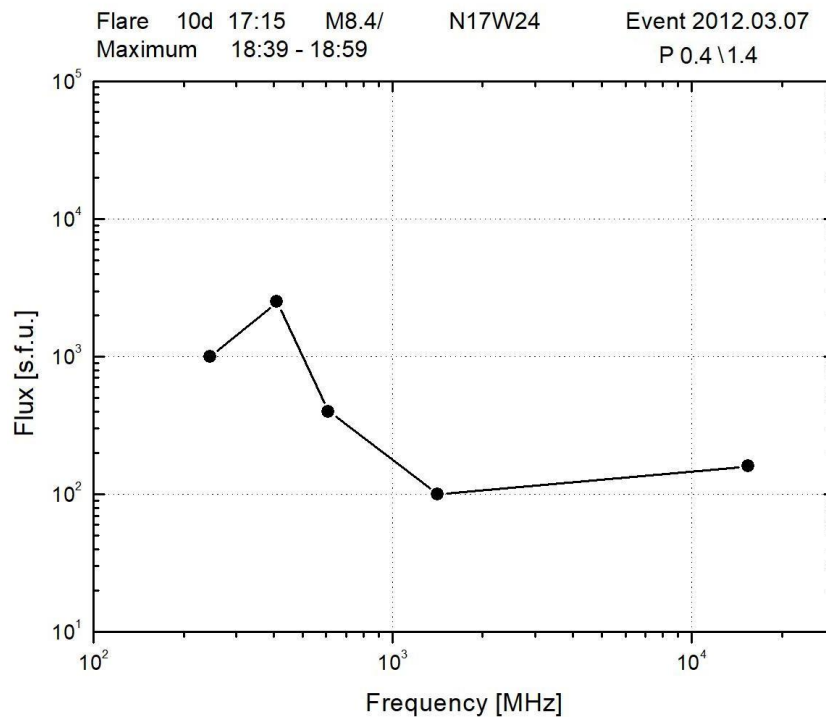
H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible disk					
1 – 12	keV	1715	1744	1830	N17W24	M8.4*	0.26
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1713:00	1715:34	1716:00	28	19833	HESSI
25-50	keV	1750:28	1753:06	1819:20	6102	26697758	HESSI
12-25	keV	1840:28	1840:38	1852:08	496	1205369	HESSI
12-25	keV	1741:02	1742:37	1811:49	653988	480259936	FERMI
12-25	keV	1833:38	1833:46	1840:48	39902	3023805	FERMI
100-300	keV						FERMI**
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1722	1735	1828		2.4	
8.8	GHz	1721	1735	1828	9 – 1.4	2.73	
5	GHz	1721	1735	1828		2.71	
2.7	GHz	1722	1802	1822		2.66	
1.4	GHz	1730	1803	1820		2.87	
610	MHz	1731	1736	1828	P0.6	3.38	
410	MHz	1731	1755	1828		3.36	
245	MHz	1732	1758	1828		3.18	
15.4	MHz	1855	1859	1859		2.2	
1.4	MHz	1842	1842	1843		2.0	
610	MHz	1834	1842	1847		2.6	
410	MHz	1834	1839	1905	P0.4\ 1.4	3.40	
245	MHz	1834	1842	1906		3.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	025-180	1910		1910		1	
DH II	0.03-14	1755		11d1230			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1800	1296	-10.9	360°	005°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_120310_095354_4989/www/

** The first Fermi-LAT solar flare catalog [Ajello et al., 2021].

Radio bursts frequency spectrum





Proton Active Region:

AR11429 (N18L301, CMP 09, 1.03.2012,
Sp=1270 msh, EKC, BGD, R)
XRI=11.92 $X_2^{5.4} + M_{14}^{8.4} + C_{32}$ $3_1 + 2_1 + 1_7 + S_{51}$
PFR1 5-7.03 (46^h) $X_2^{5.4} + M_{10}$
PFR2 9-10.03 (38^h) $M_2^{8.4}$

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Particle event: To($E_p > 10$ MeV) – 13d17^h

Tmax ($E_p > 10$ MeV) – 17d21^h, Jmax ($E_p > 10$ MeV) = 390 /cm²·s·sr

Duration of the event – 3.5 days, power-law index: $\gamma = 2.8$

Quasimaximal energy of protons in the event – E_{qm} = 650 MeV

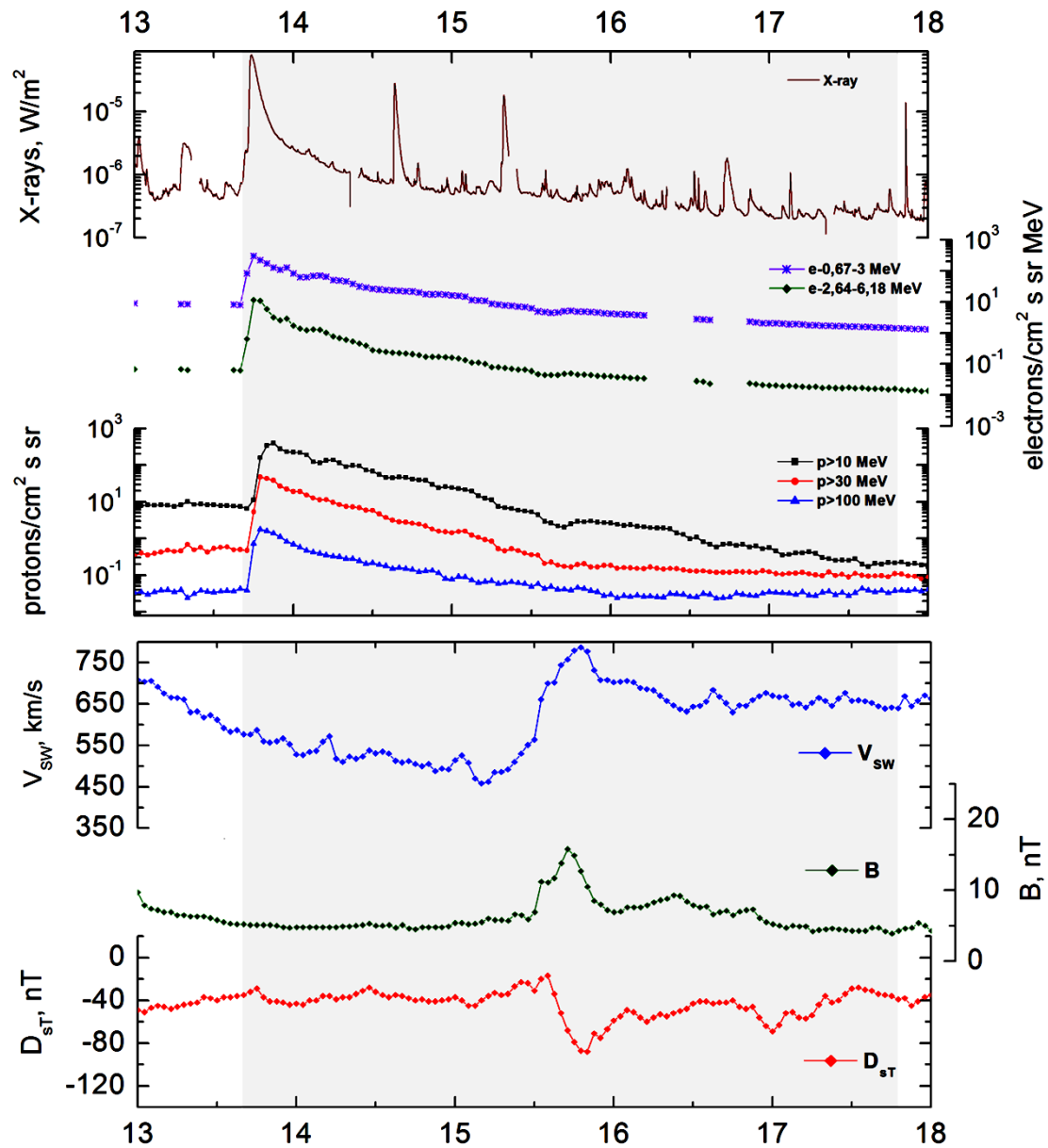
Sources: ● solar flare 13d16^h35^m, 1B/M7.9, N19W59, AR11429

Main burst X-ray 1–8 Å: onset – 13d17^h12^m, max – 13d17^h41^m, $\Phi = 0.24$ J/m²

CME: 13d17^h36^m, V = 1884 km/s, $\Delta\phi = 360^\circ$, dA = 286°

▲ SC 15d13^h07^m

Particle fluxes and associated phenomena



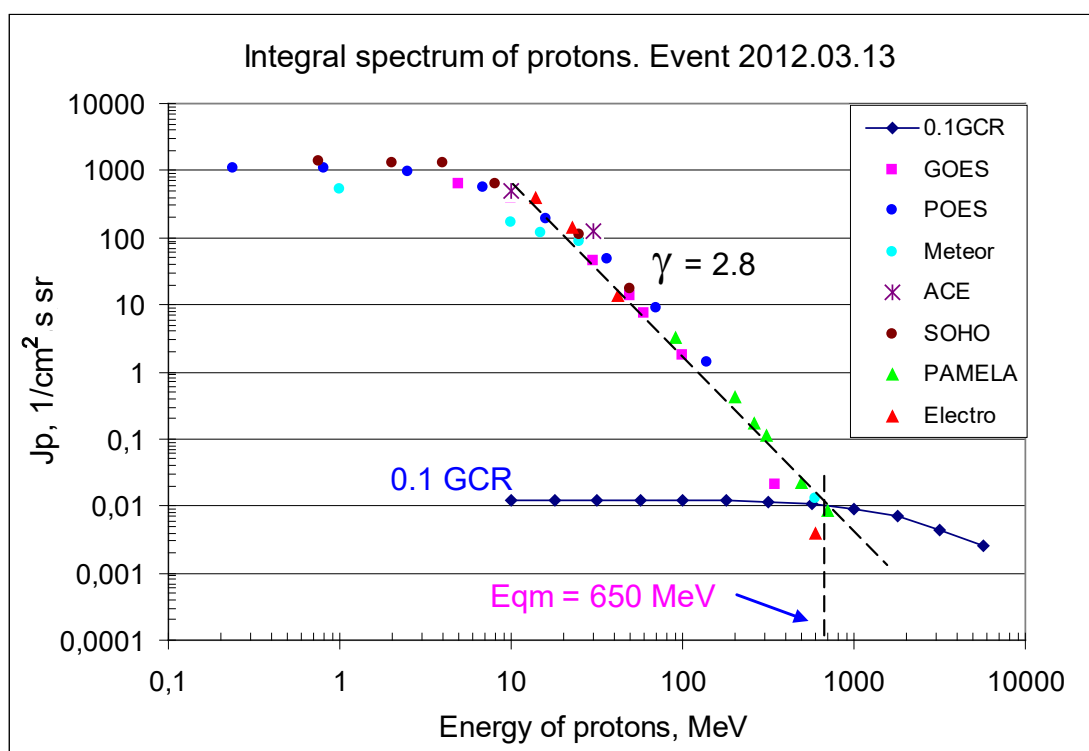
March 2012

Integral fluxes of protons for the event of 2012 March 13

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	17	21	620	4	15	
EPS	>10	17	21	390	3.5	7	
EPS	>30	17	19	46	2	0.6	
EPS	>50	17	19	14	2	0.1	
EPS	>60	17	19	7.5	2	0.05	
EPS	>100	17	19	1.75	2	0.04	
Electro-1							
GALS-E	>600	17	19	0.004	1	0.001	
POES							
MEPED	>0.24	18	21	1080	2	280	
MEPED	>0.8	18	21	1070	2	160	
MEPED	>2.5	18	21	985	2	85	
MEPED	>6.9	18	21	545	1.5	50	
MEPED	>16	18	21	185	1.5	4	
MEPED	>36	18	20	49	1	1.2	
MEPED	>70	18	20	9	1	0.9	
MEPED	>140	18	20	1.4	1	1	
Meteor-1							
SCR	>1	17	20	524	3	2.7	
SCR	>3	17	-	-	3	2.4	
SCR	>10	17	20	173	2	1.6	
GALS-M	>15	17	18	116	2	1.4	
GALS-M	>25	17	18	85	2	1.4	
GALS-M	>600	17	18	0.013	0.25	0.03	
ACE							
SIS	>10	17	19	485	3	10	
SIS	>30	17	19	125	3	2	
SOHO							
EPHIN	>50	18	19	17.4	3	0.2	
PAMELA							
TRACKER	>90	17	18-21	3.2	2	-	
TRACKER	>200	17	18-21	0.43	1	-	
TRACKER	>265	17	18-21	0.17	1	-	
TRACKER	>312	17	18-21	0.11	1	-	
TRACKER	>500	17	18-21	0.022	1	-	
TRACKER	>700	17	18-21	0.0084	1	-	

Differential fluxes of protons for the event of 2012 March 13

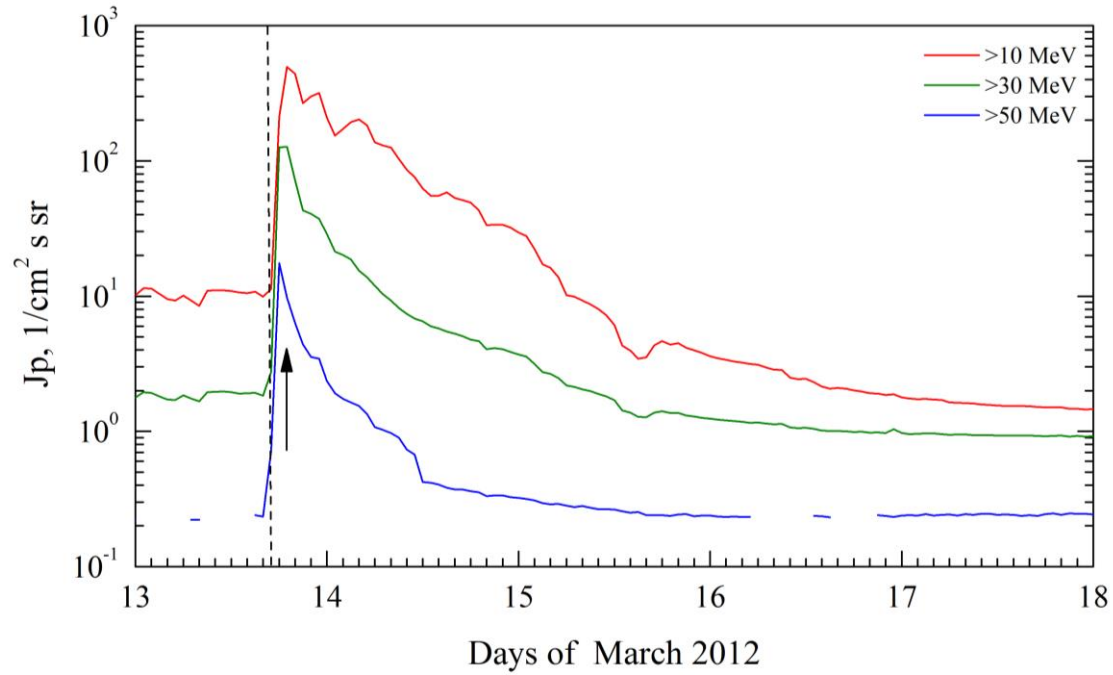
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	19	21	70	4	4	
LION	2 – 6	19	21	26	4	1	
EPHIN	4 – 8	19	21	157	4	3	
EPHIN	8 – 25	19	21	31.3	4	0.4	
EPHIN	25 – 53	19	19	3.26	4	0.03	
Electro-1							
SCR-E	13.7–23	17	19	27	2	0.35	
SCR-E	23–42	17	19	6.6	2	0.07	
SCR-E	42–112	17	19	0.2	1.5	0.005	
GOES							
EPS	350–420	18	19	0.0003	0.3	0.0016	
EPS	420–510	-	-	-	-	0.001	



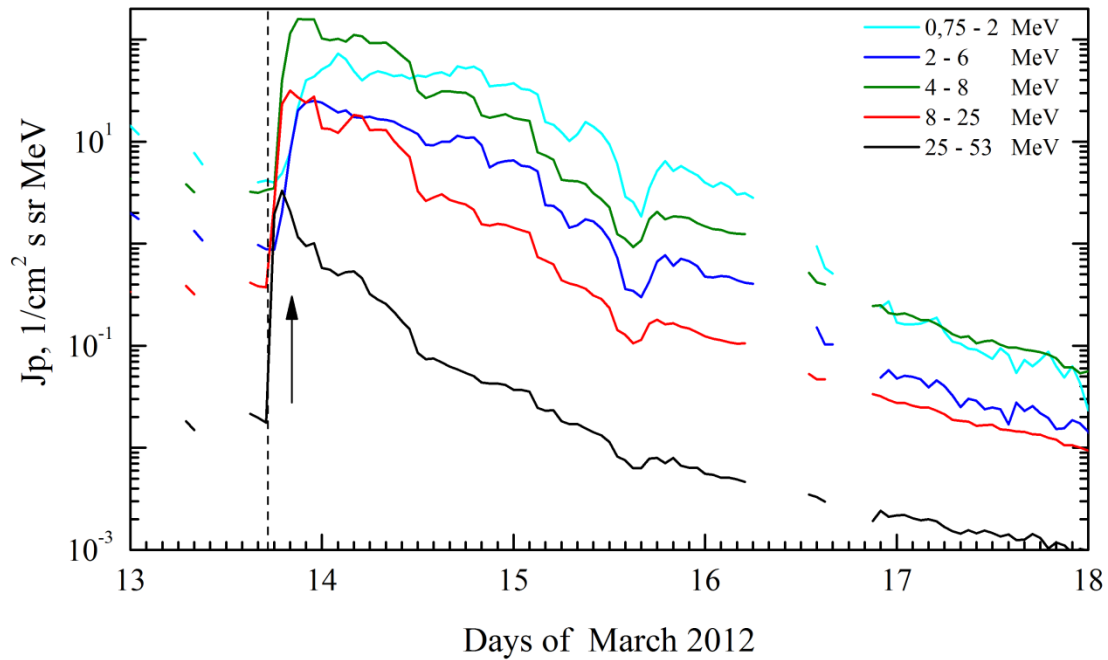
Time profiles of proton fluxes in the event 2012.03.13

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.03.13

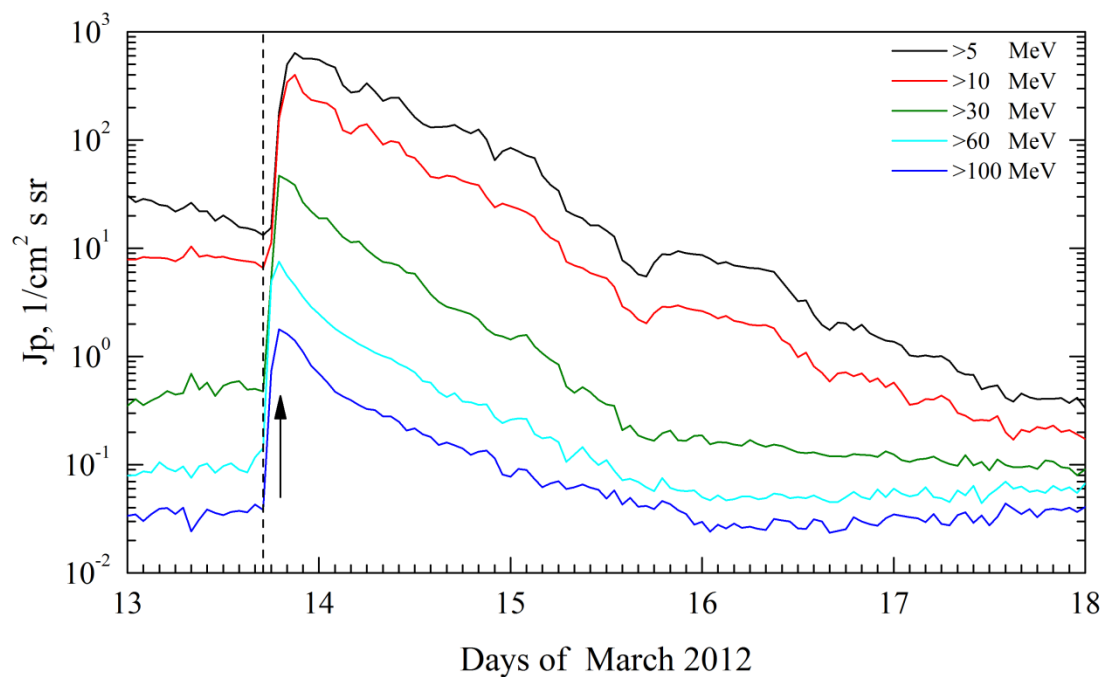


SOHO. Event 2012.03.13

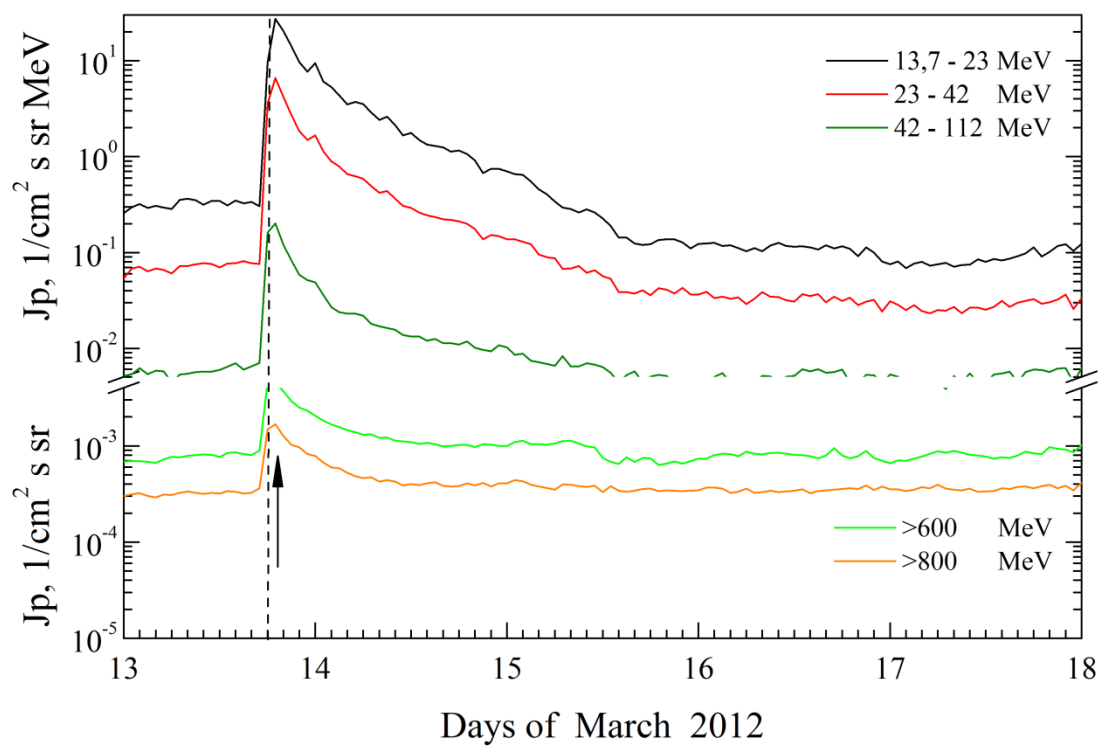


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2012.03.13

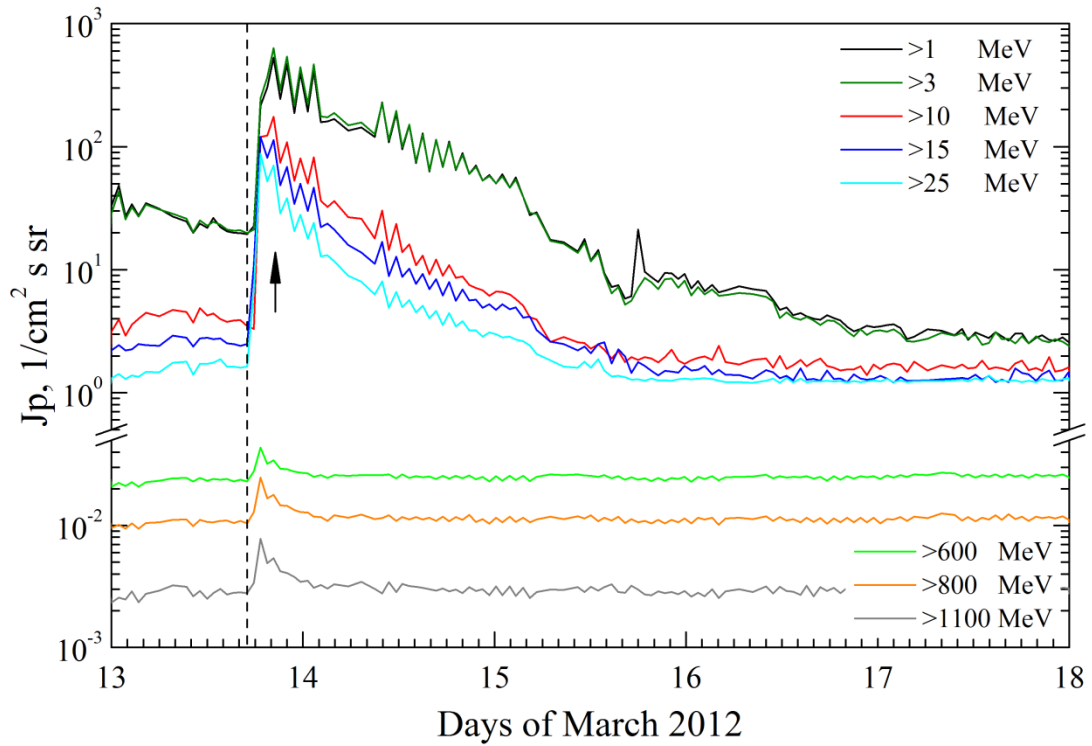


Electro. Event 2012.03.13

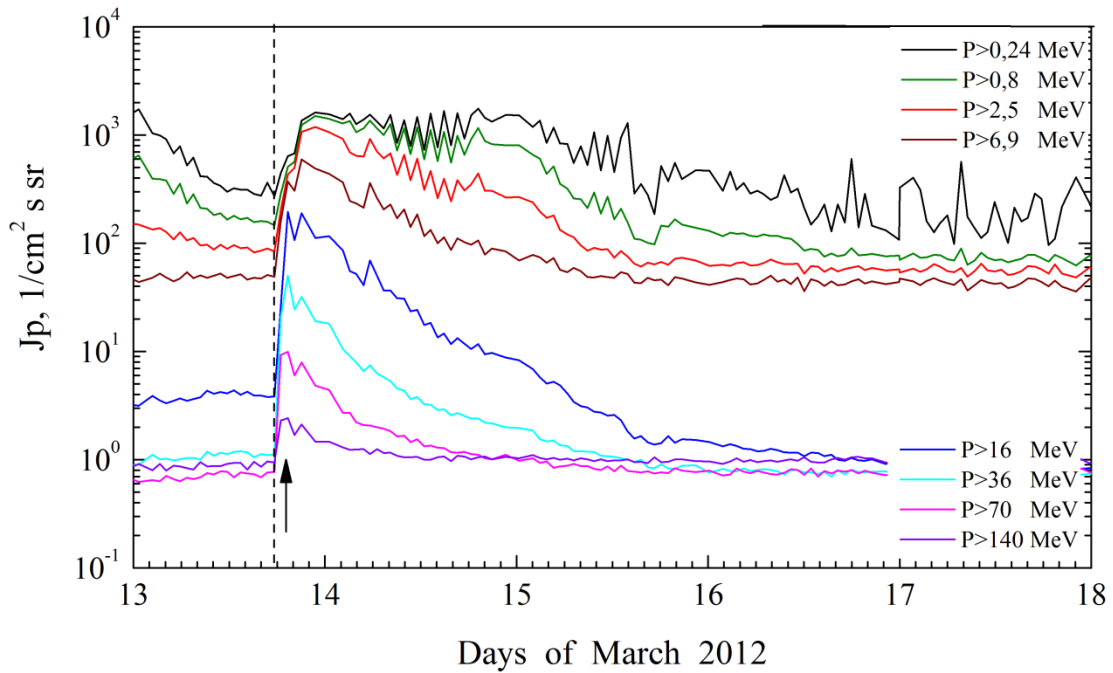


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2012.03.13



POES. Event 2012.03.13



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 March 13**

2012

March 13

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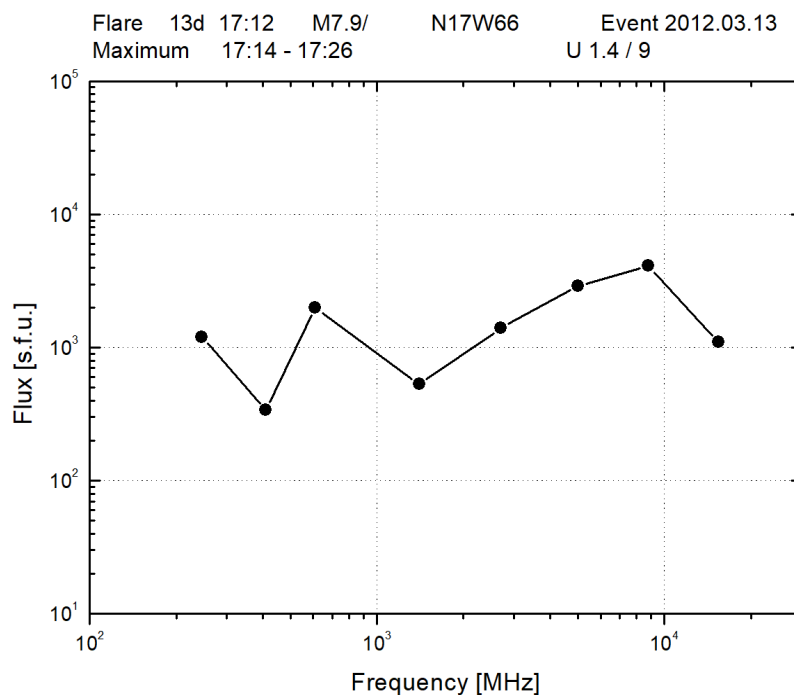
AR 11429

To event 509

Ha, X-ray		To	Tmax	Te	Location	Importance Class	FI Code Φ , J/m ²
6563 Å	FL*	1635	1724	2046	N19W59	1B	UMB
1 – 12	keV	1712	1741	1825	N17W66	M7.9*	0.24
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1641:32	1644:50	1655:44	2800	8418880	HESSI
12-25	keV	1655:44	1657:46	1659:44	1648	1440000	HESSI
12-25	keV	1818:04	1818:34	1835:00	816	2355762	HESSI
12-25	keV	1720:56	1727:09	1749:39	560520	579008256	FERMI
12-25	keV	1809:38	1809:42	1820:54	58935	5351244	FERMI
12-25	keV	1856:32	1918:10	1930:56	3949	1402667	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1726	1726	1732		3.04	
8.8	GHz	1714	1722	1814	U1.4 / 9	3.61	
5	GHz	1713	1724	1804		3.46	
2.7	GHz	1711	1725	1805		3.15	
1.4	GHz	1712	1722	1805		2.72	
610	MHz	1712	1722	1803		3.3	
410	MHz	1707	1721	1748		2.53	
245	MHz	1714	1714	1747		3.08	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-180	1715		1736	1366	3	
DS IV	025-180	1717		1814		3	
DS IV	025-180	1729		1814			
DS III	050-180	1703		1704		1	
DS III	025-180	1728		1728		1	
DS VI	025-180	1718		2172		3	
DS VI	25 - 180	1756		1908			
DH II	0.2-16	1735		2400			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1736	1884	45.6	360°	286°	SOHO

*https://sdowwww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_120313_105302_91045/www/

Radio burst frequency spectrum



Proton Active Region:

AR11429 (N18L301,CMP 09,1.03.2012,
Sp=1270 msh, EKC, BGD, R)
XRI=11.92 $X_2^{5.4}+M_{14}^{8.4}+C_{32}$ $3_1+2_1+1_7+S_{51}$
PFR1 5-7.03 (46^h) $X_2^{5.4}+M_{10}$
PFR2 9-10.03 (38^h) $M_2^{8.4}$

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Particle event: To($E_p > 10$ MeV) – 17d01^h

Tmax₁($E_p > 10$ MeV) – 17d04^h, Jmax₁($E_p > 10$ MeV) – 180 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 18d02^h, Jmax₂($E_p > 10$ MeV) – 30 /cm²·s·sr

Duration of the event – 5 days, power-law index: $\gamma_1 = 2.15$ (4.2), $\gamma_2 = 2.05$

Quasimaximal energy of protons in the event – Eqm₁ = 5000 (1800) MeV

– Eqm₂ = 650 MeV

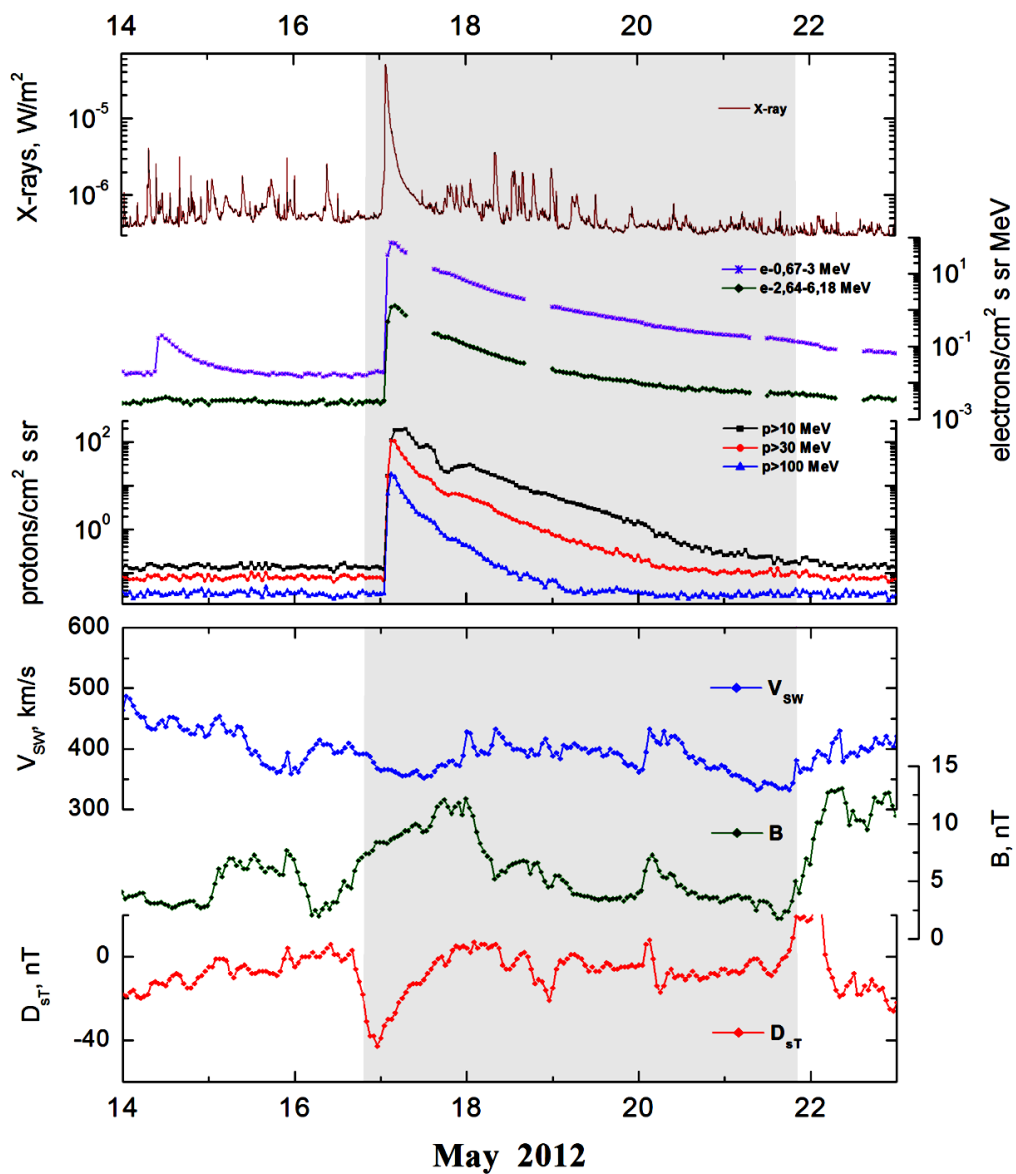
Sources: ● solar flare 17d01^h25^m, M5.1/1F, N11W76, 11476

Main burst X-ray 1–8 Å: onset – 17d01^h25^m, max – 17d01^h47^m, $\Phi = 0.099$ J/m²

CME: 17d01^h48^m, V = 1582 km/s, $\Delta\phi = 360^\circ$, dA = 261°

▲ SC 21d19^h37^m

Particle fluxes and associated phenomena

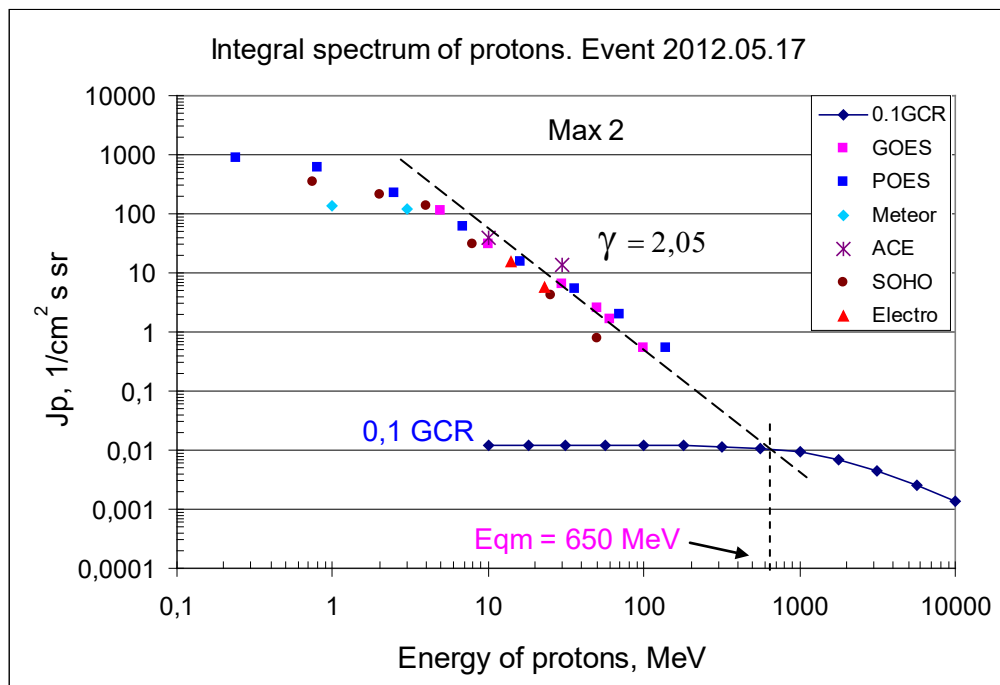
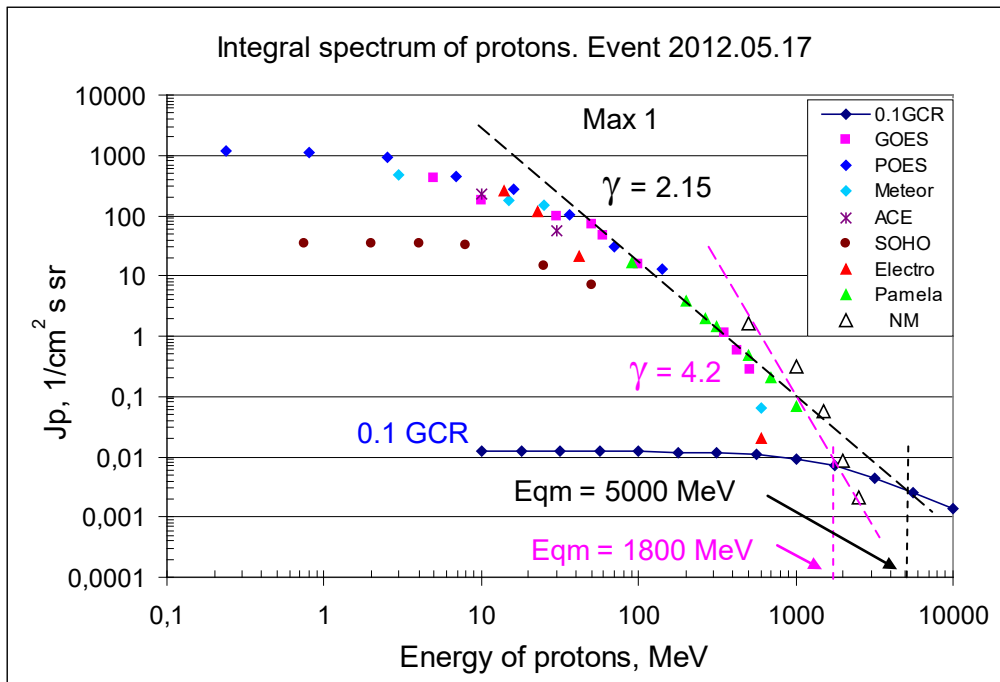


Integral fluxes of protons for the event of 2012 May 17

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	J max, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	1	7/18d02	410/110	5	0.2	
EPS	>10	1	4/18d02	180/30	5	0.14	
EPS	>30	1	3/20	100/6.5	4	0.09	
EPS	>50	1	3/20	69.4/2.5	3	0.06	
EPS	>60	1	3/20	47/1.6	2.5	0.05	
EPS	>100	1	3/20	16/0.55	2.5	0.04	
EPS	>700	1	3/ -	0.000165/ -	0.5	0.00013	
Electro-1							
GALS-E	>600	1	3/ -	0.02/ -	1	0.001	
POES							
MEPED	>0.24	2	17d04/21	1200/900	4	100	
MEPED	>0.8	2	17d04/21	1090/610	4	80	
MEPED	>2.5	2	17d04/21	940/220	3	60	
MEPED	>6.9	2	17d04/21	450/60	3	50	
MEPED	>16	2	17d04/21	271/15.9	3	0.9	
MEPED	>36	2	17d04/21	101/5.5	2.5	0.9	
MEPED	>70	2	17d04/21	30.5/2	2	1	
MEPED	>140	2	17d04/21	13.2/0.55	1.5	1.2	
Meteor-1							
SCR	>1	1	- /18d 2	- /140	4	2.7	
SCR	>3	1	4/18d02	482/119	4	2.45	
SCR	>10	1	-	-	3	1.6	
GALS-M	>15	1	4/ -	181/ -	3	1.35	
GALS-M	>25	1	4/ -	151/ -	3	1.4	
GALS-M	>600	1	4/ -	0.064/ -	1	0.03	
ACE							
SIS	>10	2	8/20	227/40	4	1.4	
SIS	>30	2	7/19	57/14	3	1	
SOHO							
EPHIN	>50	1	2/19	6.85/0.8	2	0.3	
PAMELA							
TRACKER	>90	2	4/ -	17/ -	3	-	
TRACKER	>200	2	4/ -	3.8/ -	2	-	
TRACKER	>265	2	4/ -	2/ -	2	-	
TRACKER	>312	2	4/ -	1.4/ -	2	-	
TRACKER	>500	2	4/ -	0.49/ -	1	-	
TRACKER	>700	2	4/ -	0.21/ -	1	-	
TRACKER	>1000	2	4/ -	0.068/ -	1	-	
NM							
Network	>500	2	3	1.6/ -	-	-	
Network	>1000	2	3	0.32/ -	-	-	
Network	>1500	2	3	0.056/ -	-	-	
Network	>2000	2	3	0.00842/ -	-	-	
Network	>2500	2	3	0.00205/ -	-	-	

Differential fluxes of protons for the event of 2012 May 17

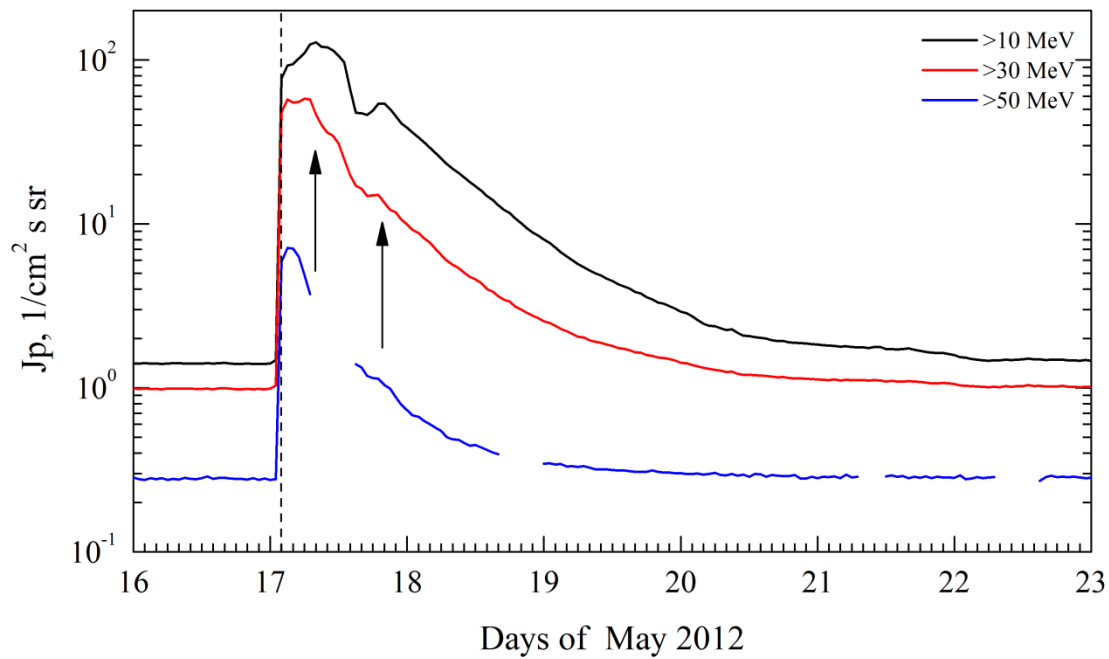
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	02	5/18d02	0.8/117	5	0.01	
LION	2 – 6	02	7/18d02	0.25/24	5	0.0025	
EPHIN	4 – 8	05	- /18d01	0.3/26.3	5	0.0004	
EPHIN	8 – 25	03	7/23	1/1.5	5	0.00003	
EPHIN	25 – 53	03	6/21	0.3/0.12	5	0.00003	
Electro-1							
SCR-E	13.7–23	1	3/21	15.2/1	3	0.06	
SCR-E	23–42	1	3/21	5/0.3	3	0.025	
SCR-E	42–112	1	3/ -	0.3/ -	2	0.005	
GOES							
EPS	350–420	2	3/ -	0.0076/ -	1	0.0017	
EPS	420–510	2	3/ -	0.0033/ -	1	0.00105	
EPS	510–700	2	3/ -	0.0015/ -	1	0.00042	
EPS	>700	1	3/ -	0.000165/ -	0.5	0.00013	



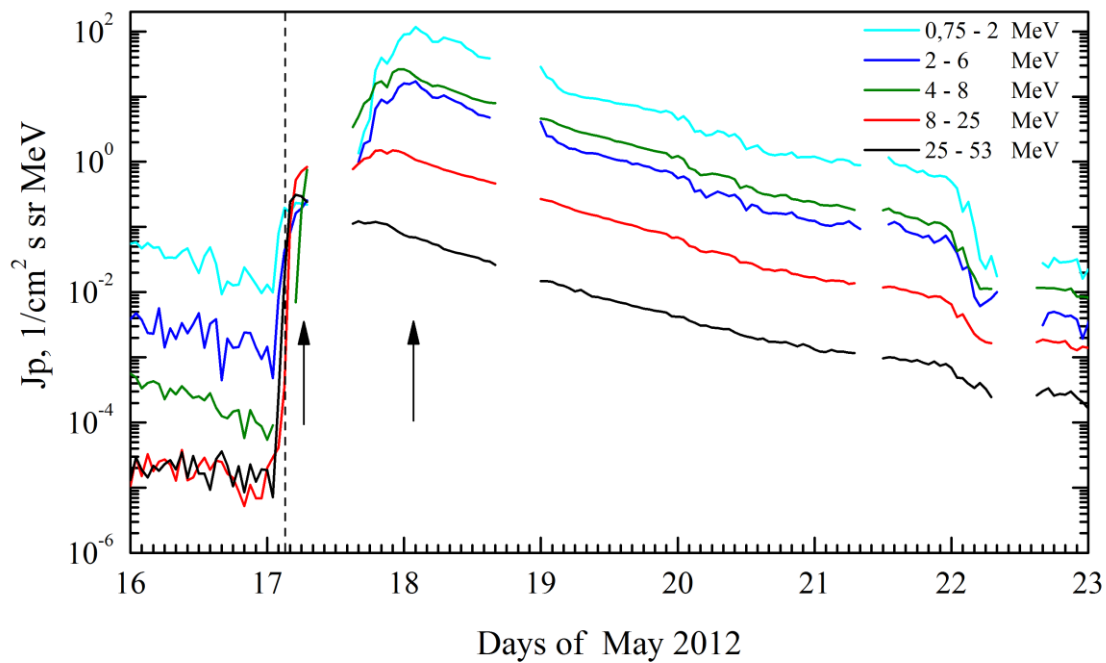
Time profiles of proton fluxes in the event 2012.05.17

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.05.17

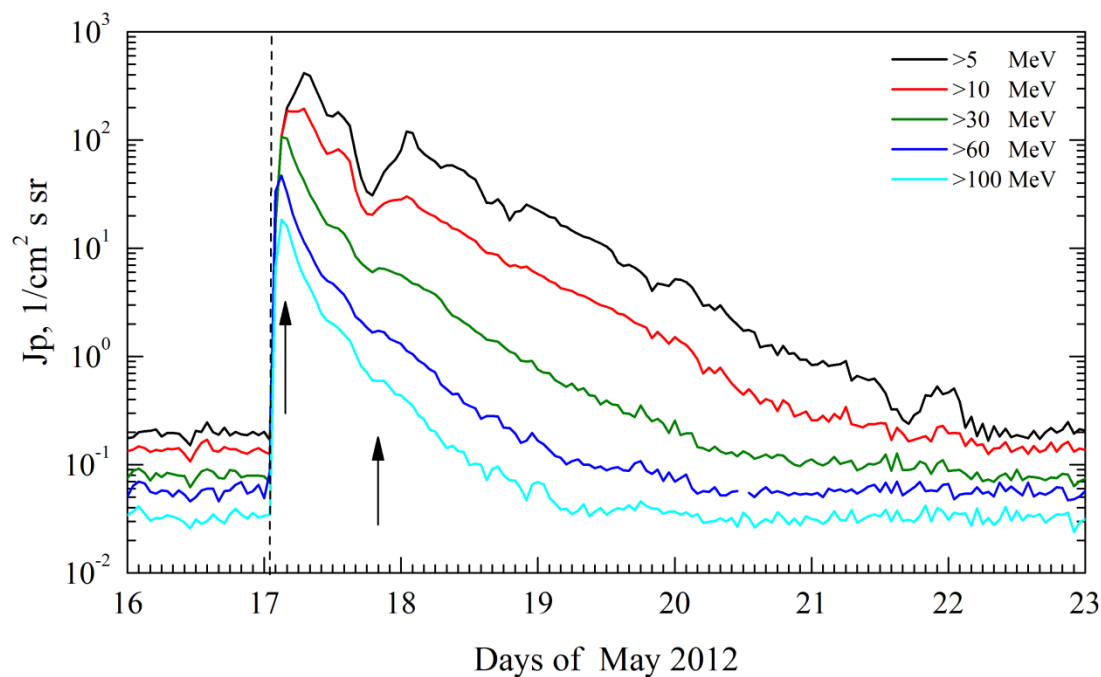


SOHO. Event 2012.05.17

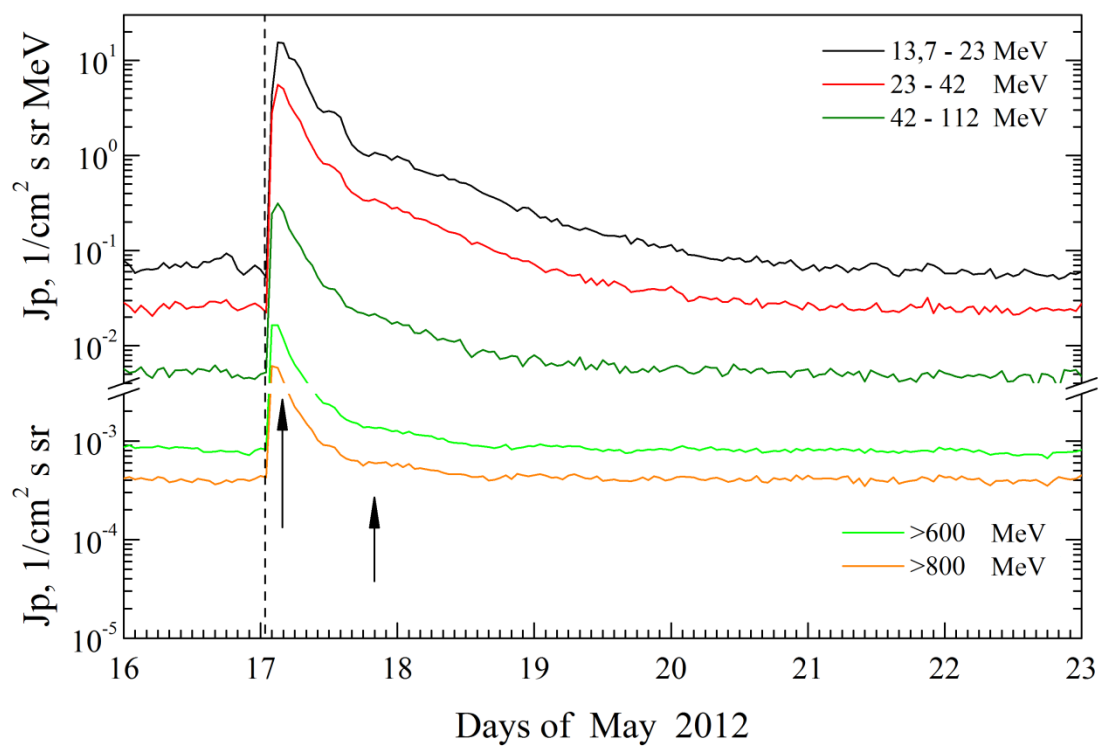


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

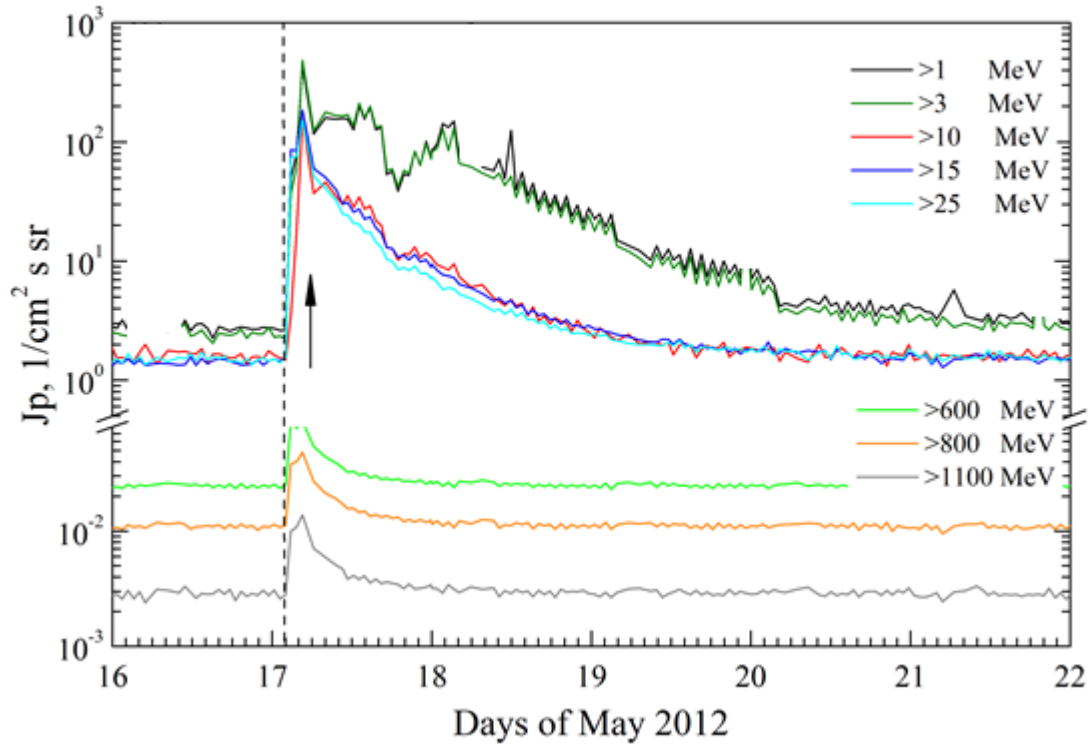
GOES. Event 2012.05.17



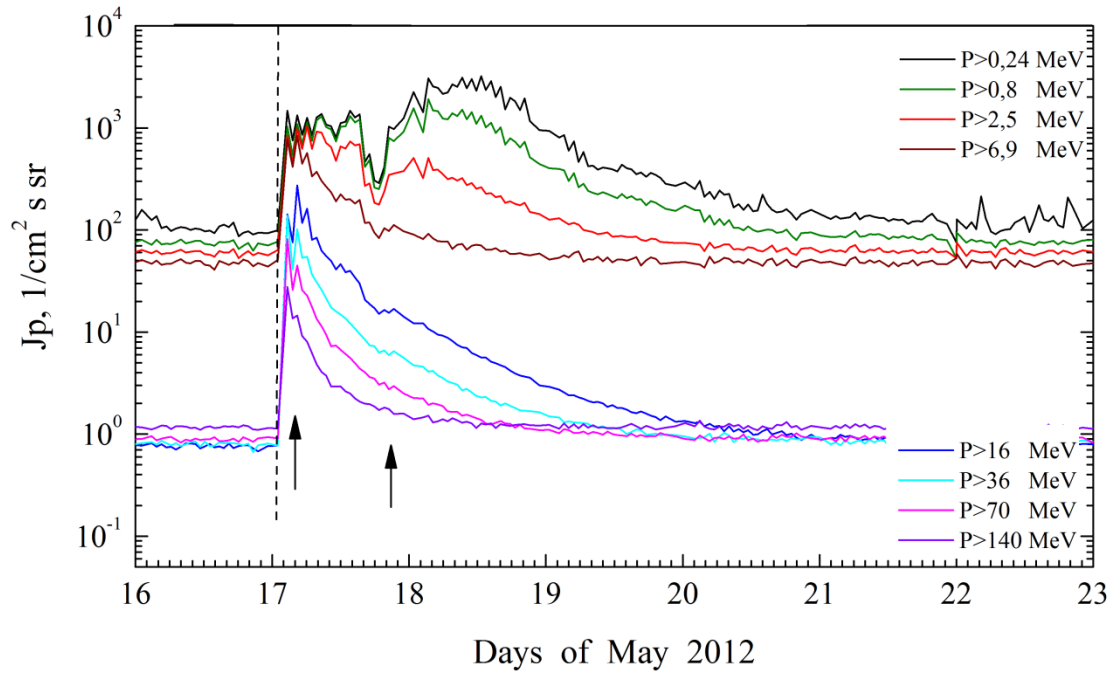
Electro. Event 2012.05.17



Meteor. Event 2012.05.17



POES. Event 2012.05.17



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 May 17**

2012

May 17

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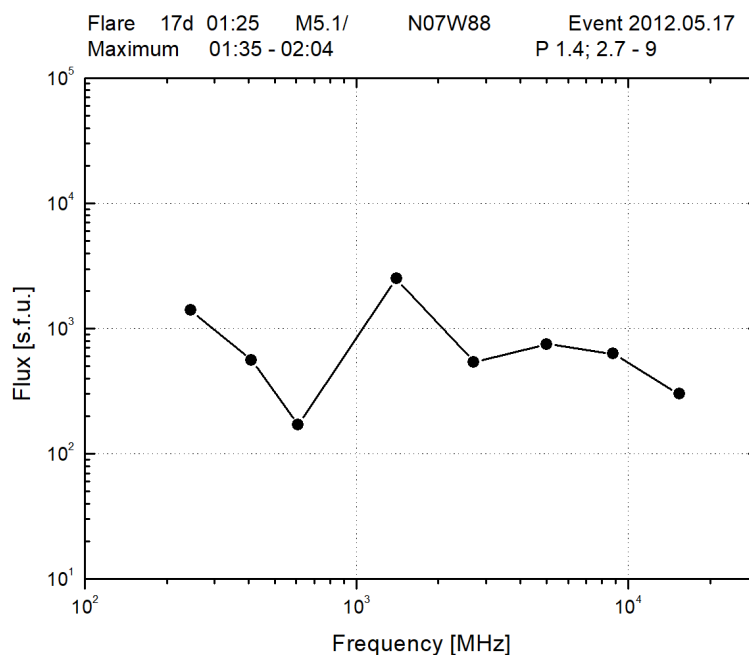
AR11476

To event 510

H α , X-ray		To	Tmax	Te	Location	Importance Class	FI Code Φ , J/m ²
6563 Å	FL	0128	0134	0308	N11W76	1F	BPT
1 – 12	keV	0125	0147	0211	N07W88	M5.1	0.099
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	0138:32	0140:38	0223:40	2416	12687325	HESSI
12-25	keV	0158:45	0158:54	0257:32	39931	11434505	FERMI
>100	keV	0212:30		0244:30		1.91E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0130	0136	0144		2.48	
8.8	GHz	0129	0135	0149	2.7 – 9	2.8	
5	GHz	0129	0142	01155		2.88	
2.7	GHz	0129	0142	0158		2.73	
1.4	GHz	0203	0204	0204	P1.4	3.4	
610	MHz	0135	0142	0144		2.23	
410	MHz	0134	0142	0150		2.75	
245	MHz	0129	0153	0220		3.15	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-180	0131		01411216		2	
DS IV	025-180	0132		1728		3	
DS III	40-325	1134		1141		3	
DS III	020-140	0244		0250		1	
DH II	0.3-16	0141		0620			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0148	1582	-51.8	360°	261°	SOHO

*cm⁻²s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR11476 (N11L182, CMP 11,6.05.2012

Sp=1050 msh, FKC, BGD, R)

XRI=2.91; $M_{11}^{5.7} + C_{87}; 2_1 + 1_7 + S_{88}$

PFR1 8-10.05 (39^h) $M_5^{5.7}$

PFR2 17.05 $M_1^{5.1}$ (W-limb)

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Particle event: To($E_p > 10$ MeV) – 26d23^h

Tmax₁($E_p > 10$ MeV) – 27d06^h, Jmax₁($E_p > 10$ MeV) – 11.9 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 27d11^h, Jmax₂($E_p > 10$ MeV) – 12.5 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 3.2$, $\gamma_2 = 3.2$

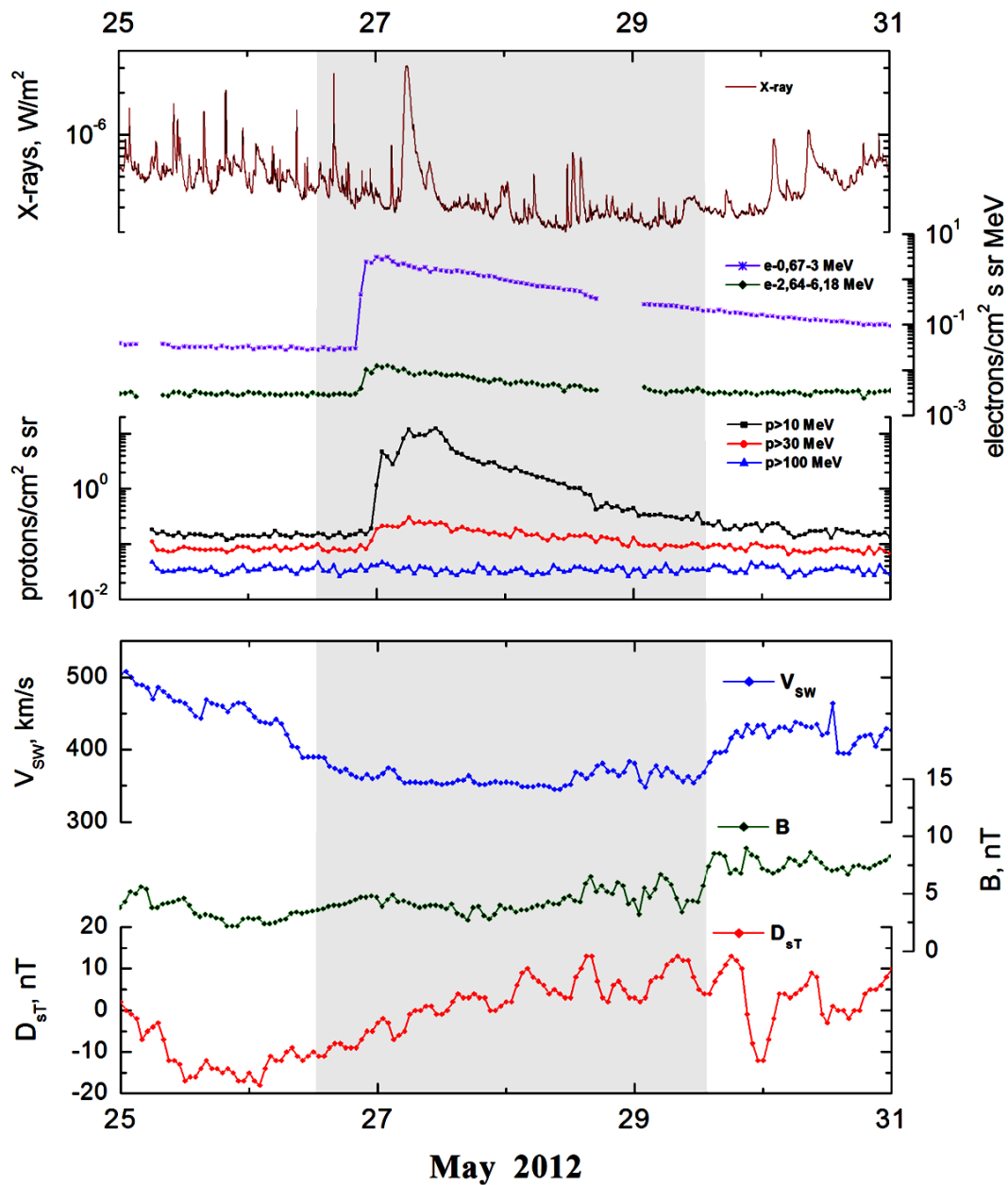
Quasimaximal energy of protons in the event – Eqm₁ = 70 MeV

– Eqm₂ = 70 MeV

Sources: ☐ back side solar flare 26d<20^h57^m, AR unknown, behind W_L;

CME: 26d20^h57^m, V = 1966 km/s, $\Delta\phi = 360^\circ$, dA = 291°

Particle fluxes and associated phenomena

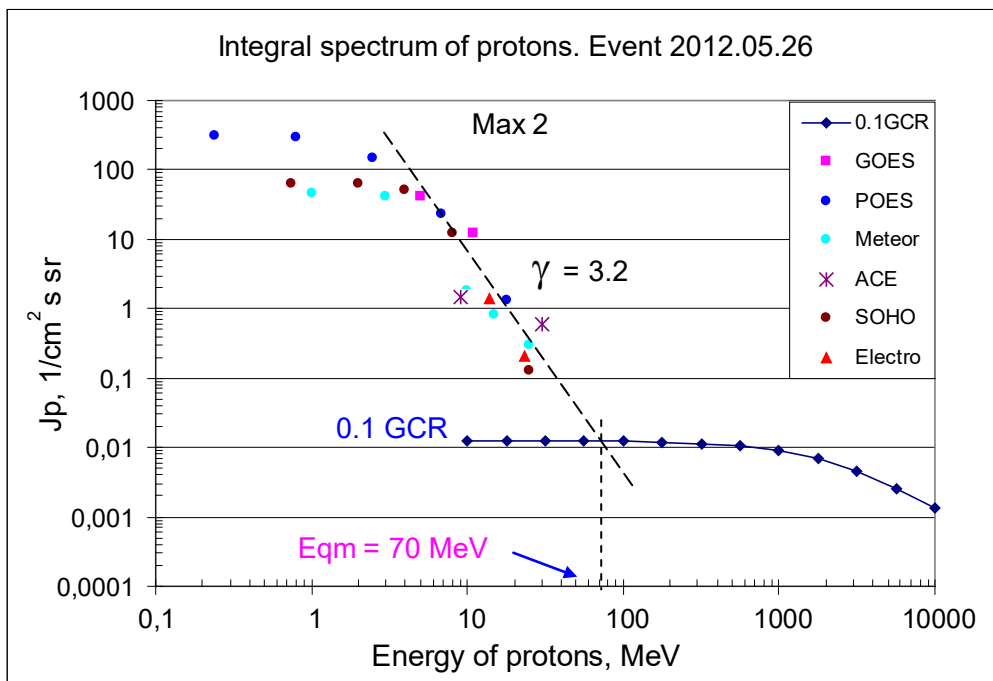
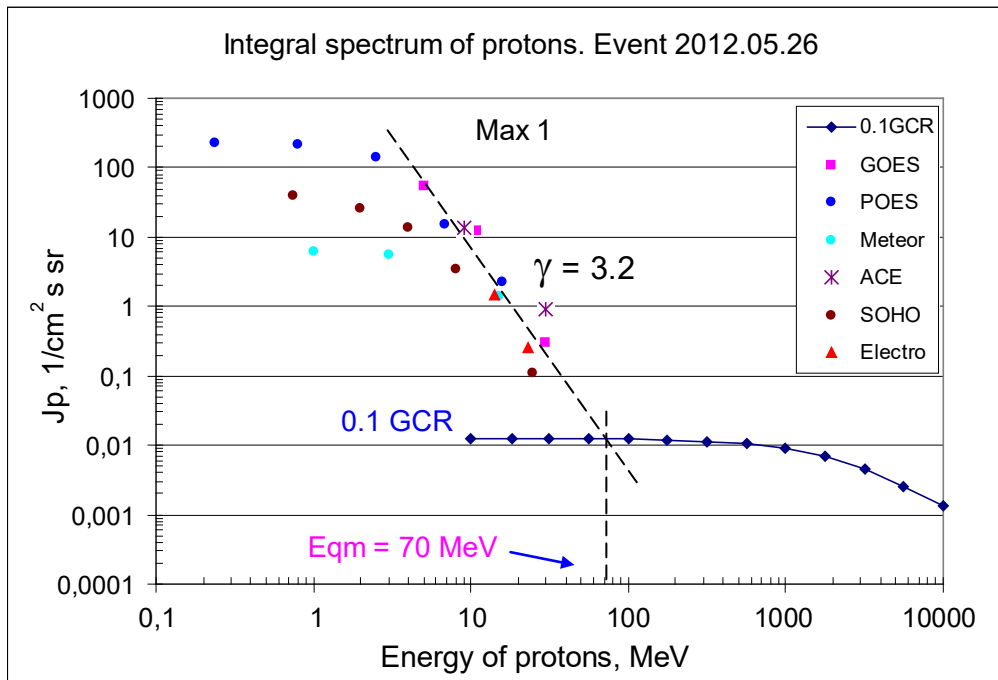


Integral fluxes of protons for the event of 2012 May 26

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	23	27d06/27d11	52.7/41.6	4	0.2	
EPS	>10	23	27d06/27d11	11.9/12.5	3	0.14	
EPS	>30	23	27d06/ -	0.3/ -	2	0.09	
EPS	>50	23	-	-	-	0.06	
EPS	>60	23	-	-	-	0.05	
EPS	>100	23	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	23	27d06/27d13	227/307	2	100	
MEPED	>0.8	23	27d06/27d13	220/295	2	80	
MEPED	>2.5	23	27d06/27d13	137/148	2	60	
MEPED	>6.9	23	27d06/27d12	15.4/22.8	1	50	
MEPED	>16	23	27d06/27d12	2.2/1.3	1	0.9	
MEPED	>36	23	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	23	27d04/27d11	6/45	3	2.7	
SCR	>3	23	27d04/27d11	5.6/42	3	2.4	
SCR	>10	23	- /27d11	- /1.8	0.5	1.6	
GALS-M	>15	23	27d04/27d11	1.41/0.8	0.5	1.35	
GALS-M	>25	23	- /27d11	-/0.3	0.25	1.4	
GALS-M	>600	-	-	-	-	0.03	
ACE							
SIS	>10	21	27d04/27d09	11.5/15	2	1.5	
SIS	>30	21	27d04/27d09	0.9/0.6	1.5	1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2012 May 26

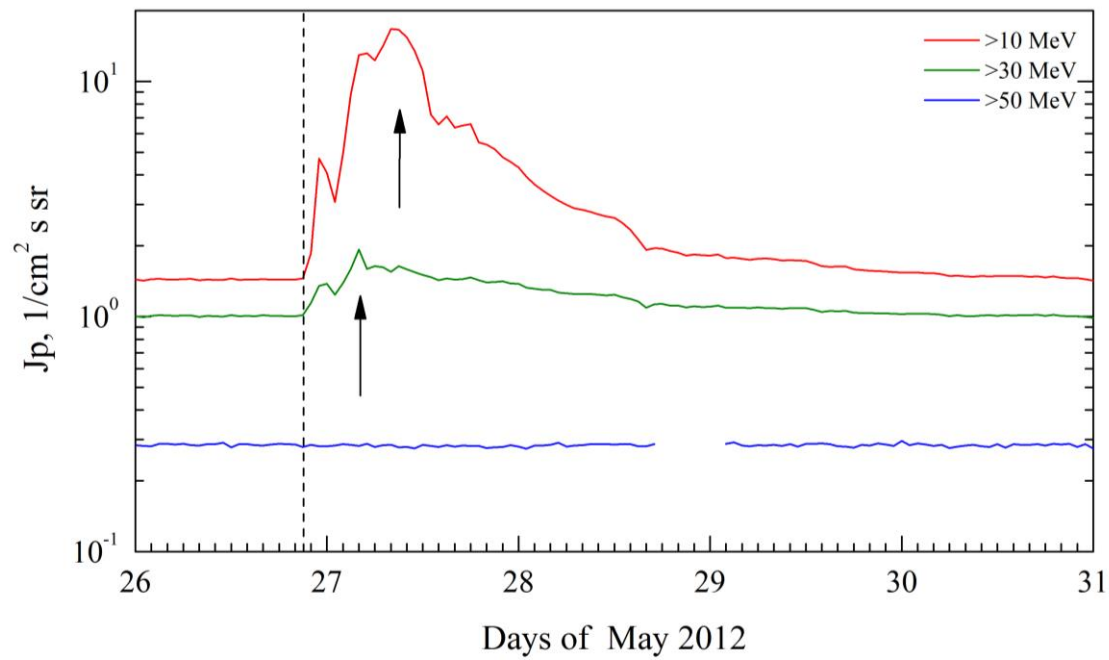
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	27d00	27d10/27d16	11/15.7	5	0.01	
LION	2 – 6	23	27d10/27d16	3.9/3.6	5	0.0025	
EPHIN	4 – 8	23	27d02/27d09	2.6/10	5	0.0004	
EPHIN	8 – 25	23	27d02/27d09	0.2/0.7	5	0.00003	
EPHIN	25 – 53	23	27d02/27d09	0.004/0.0046	5	0.00003	
Electro-1							
SCR-E	13.7–23	23	27d05/27d10	0.13/0.125	1	0.08	
SCR-E	23–42	23	27d05/27d09	0.013/0.011	1	0.025	
SCR-E	42–112			-	-	0.005	



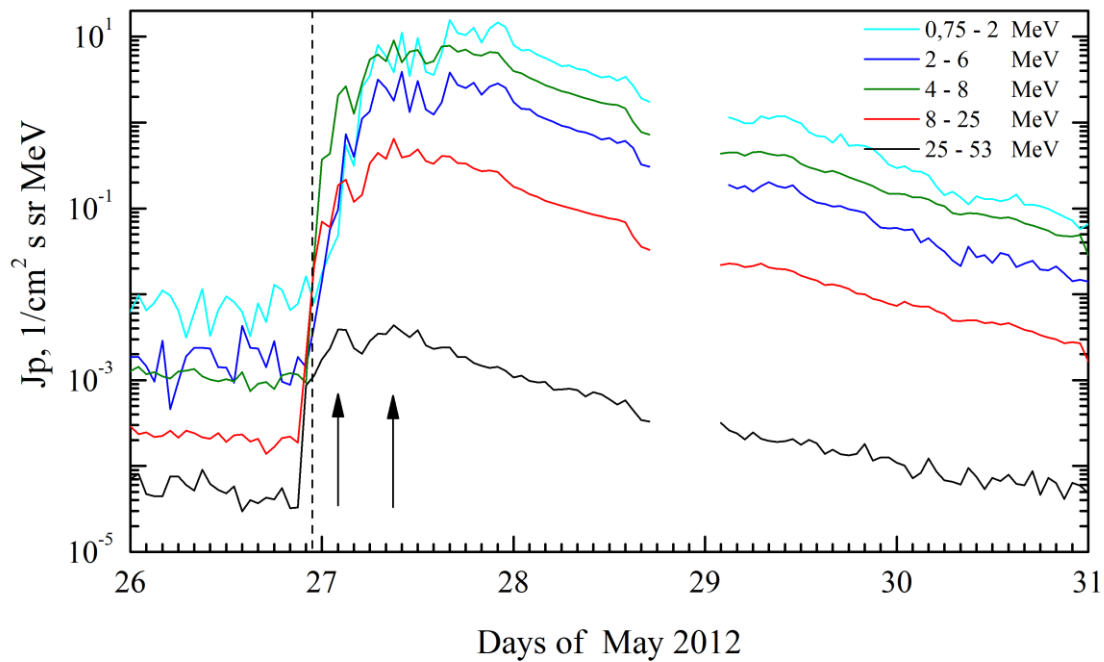
Time profiles of proton fluxes in the event 2012.05.26

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.05.26

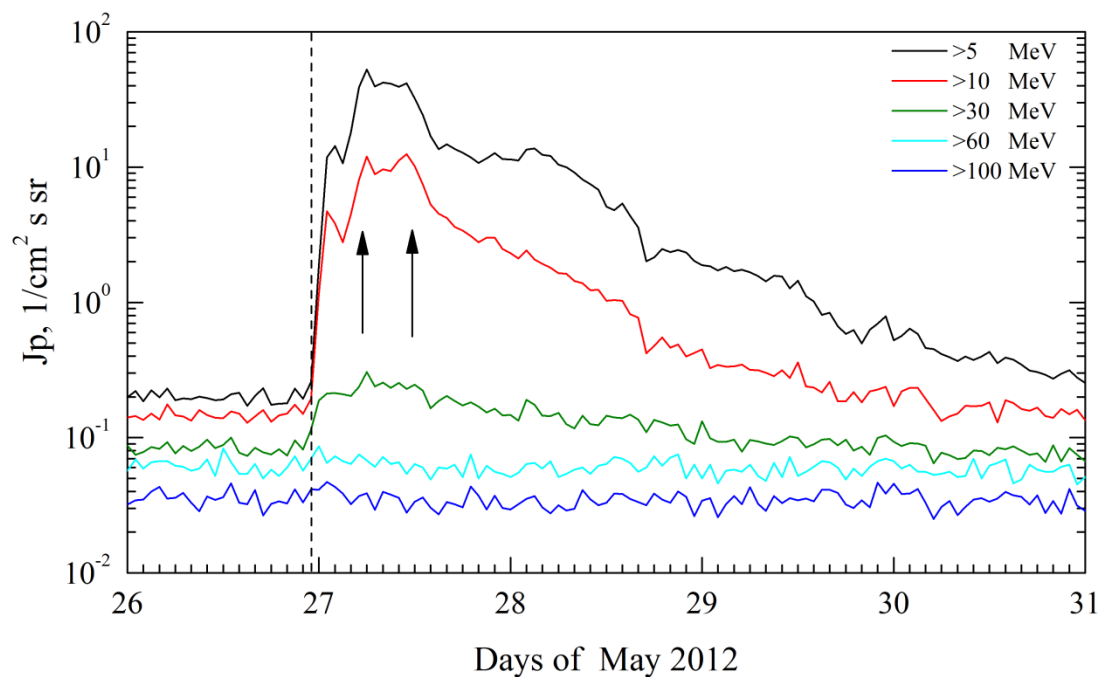


SOHO. Event 2012.05.26

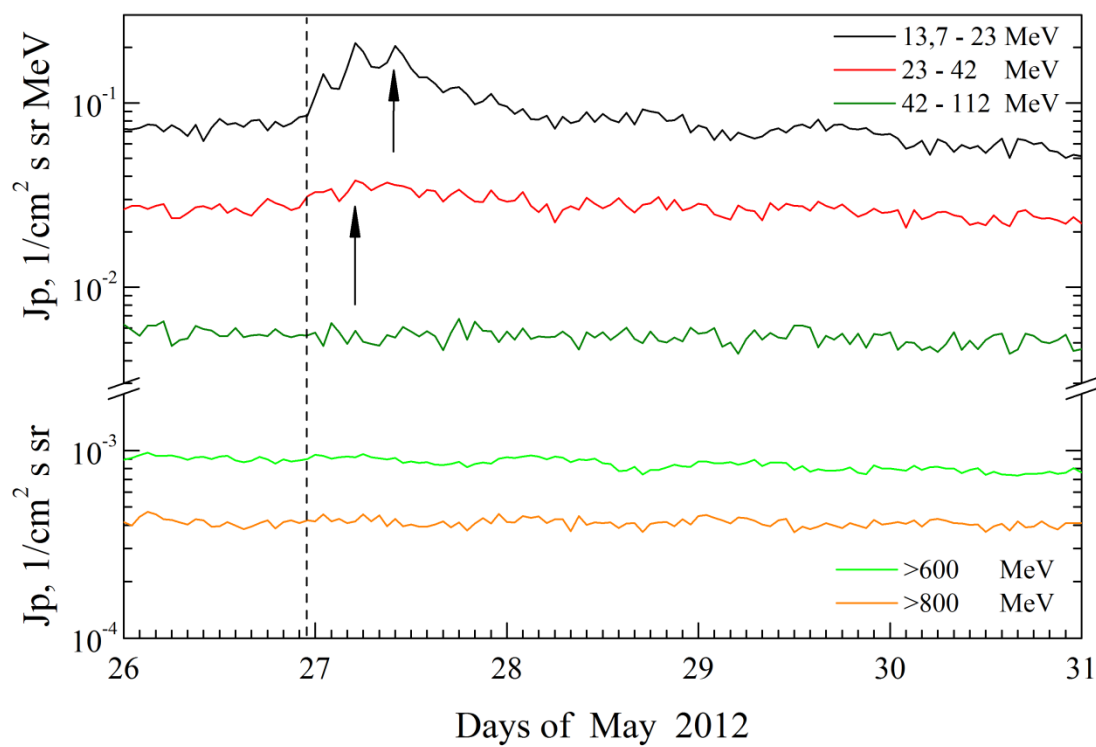


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

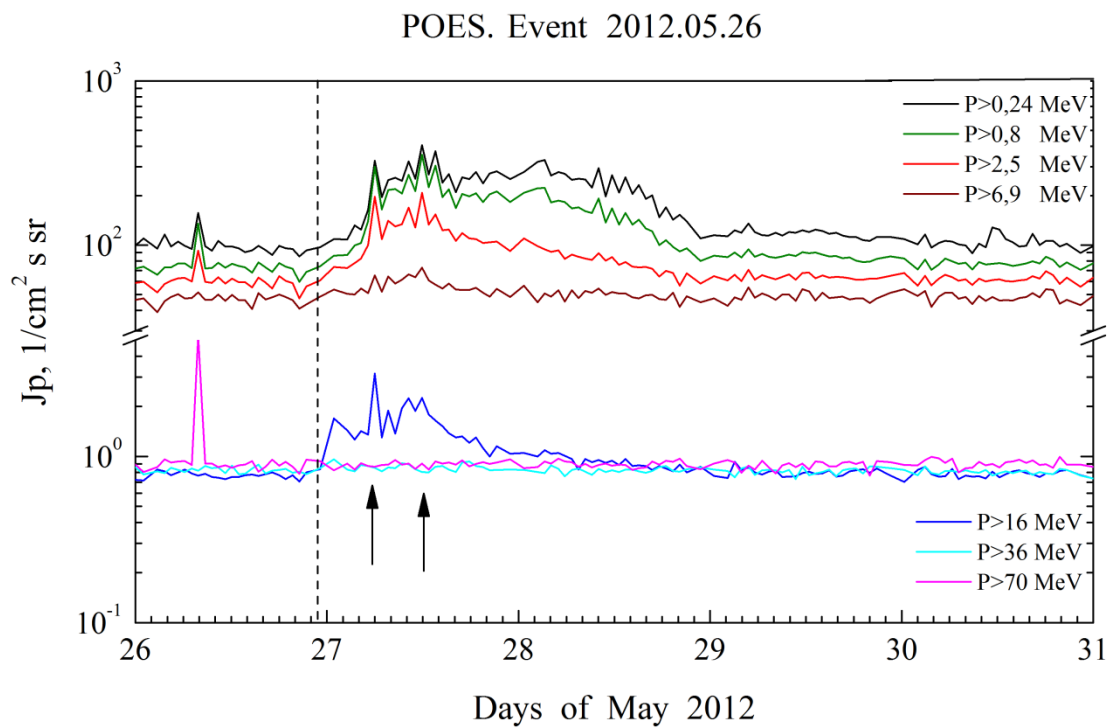
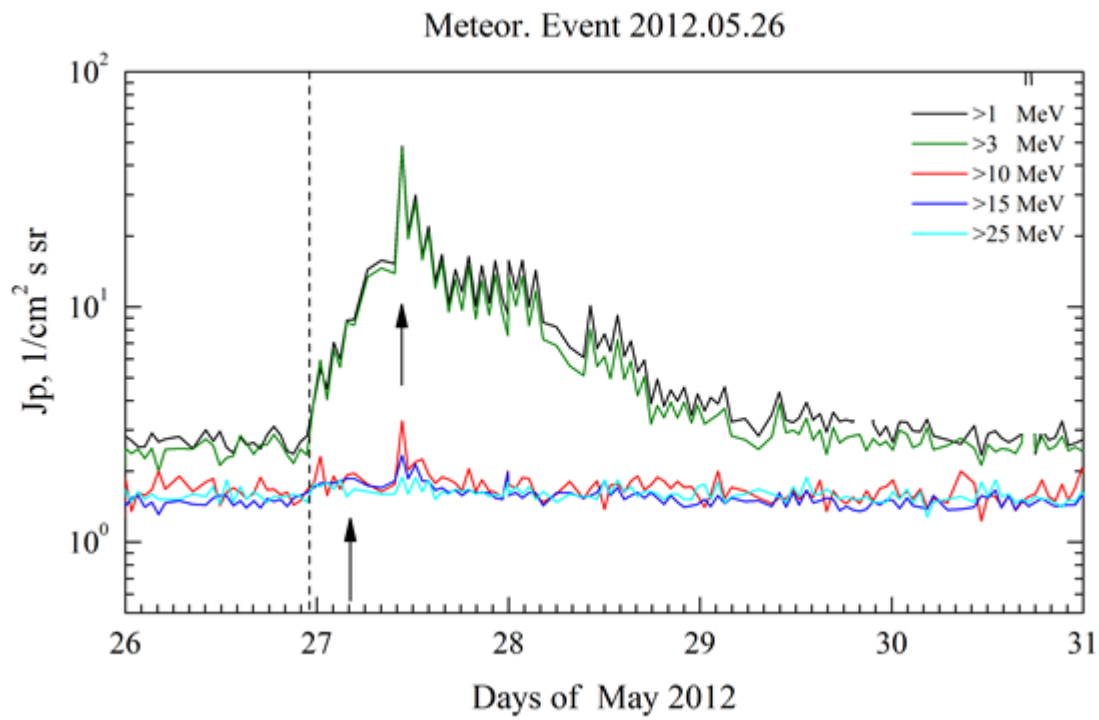
GOES. Event 2012.05.26



Electro. Event 2012.05.26



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 May 26**

2012 May 26 ☐ ARXXXXX To event 511

H α , X-ray		To	Tmax	Te	Location	Importance Class	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2057	1966	-159.2	360°	291°	SOHO

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 Wang Y., D. Lyu, B. Xiao et al., [2021](#).
 Winter L.M., and K. Ledbetter, [2015](#).
 Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
 Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 14d18^h

Tmax ($E_p > 10$ MeV) – 16d21^h, Jmax ($E_p > 10$ MeV) – 11 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma = 3.0$

Quasimaximal energy of protons in the event – $E_{qm} = 90$ MeV

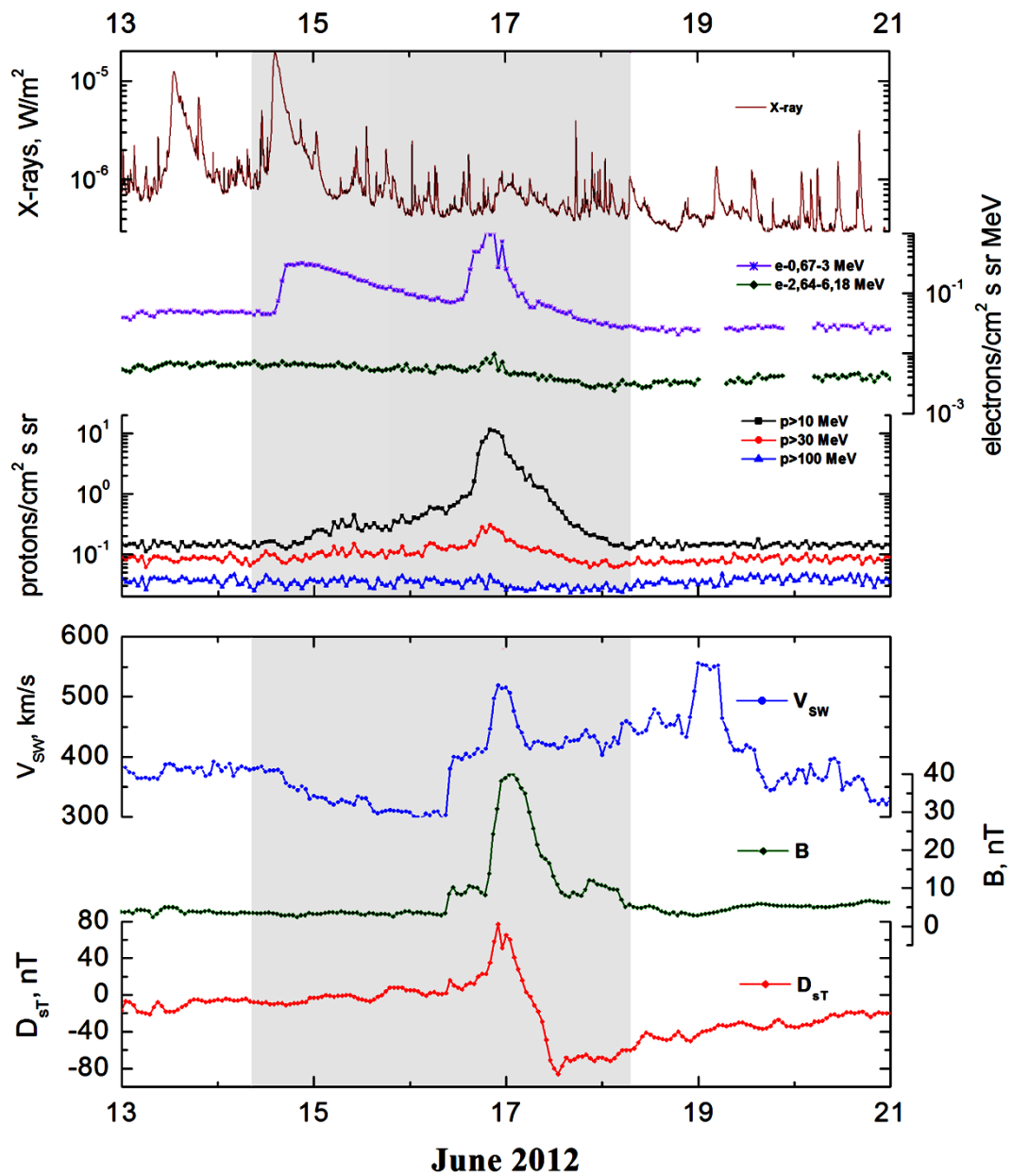
Sources: ● solar flare 14d12^h52^m, M1.9/1N, S17E06, AR11504

Main burst X-ray 1–8 Å: onset – 14d12^h52^m, max – 14d14h35^m, $\Phi = 0.12$ J/m²

CME: 14d14^h12^m, $V = 987$ km/s, $\Delta\phi = 360^\circ$, $dA = 144^\circ$

▲ SC 16d09^h56^m; ▲ SC 16d20^h20^m; ▲ SC 16d21^h15^m

Particle fluxes and associated phenomena

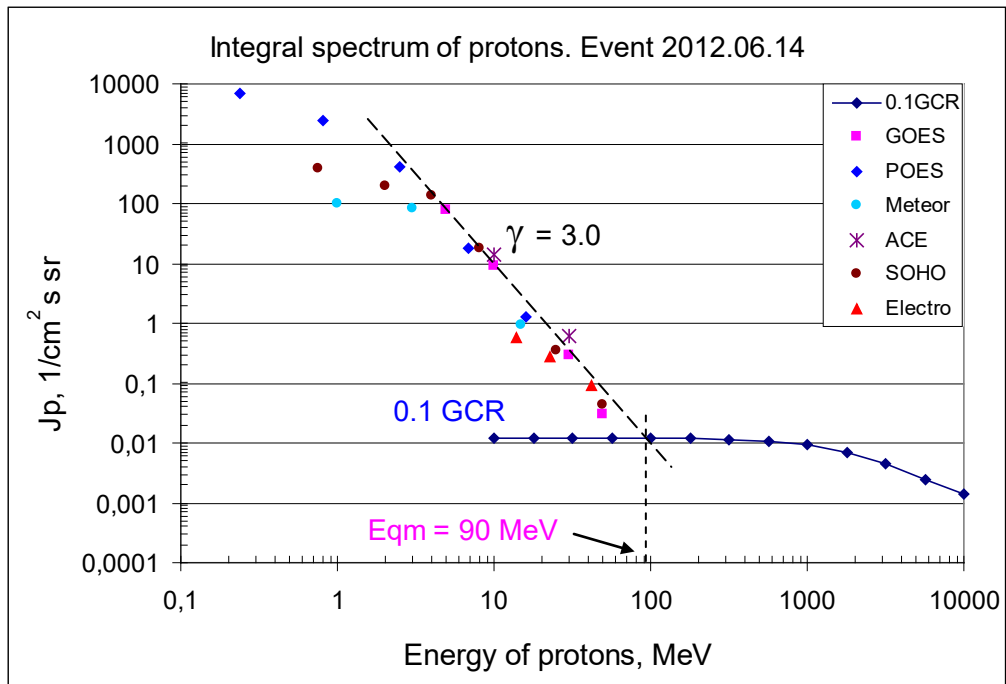


Integral fluxes of protons for the event of 2012 June 14

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	16d21	77.5	3	0.2	
EPS	>10	18	16d21	11	2	0.15	
EPS	>30	18	16d20	0.3	1	0.09	
EPS	>50	18	16d20	0.03	0.5	0.07	
EPS	>60	18	-	-	-	0.05	
EPS	>100	18	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	22	16d20	6800	3	95	
MEPED	>0.8	22	16d20	2430	3	75	
MEPED	>2.5	22	16d20	405	2	60	
MEPED	>6.9	22	16d20	17.8	1	50	
MEPED	>16	-	16d20	1.3	0.5	0.9	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.2	
Meteor-1							
SCR	>1	22	16d22	102	3	2.4	
SCR	>3	22	16d22	82	3	2.4	
SCR	>10	22	-	-	0.5	1.5	
GALS-M	>15	22	16d22	0.92	0.5	1.3	
GALS-M	>25	-	-	-	-	1.3	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	18	16d18	14	2	1.4	
SIS	>30	18	16d18	0.6	2	1	
SOHO							
EPHIN	>50	-	16d21	0.05	-	0.3	

Differential fluxes of protons for the event of 2012 June 14

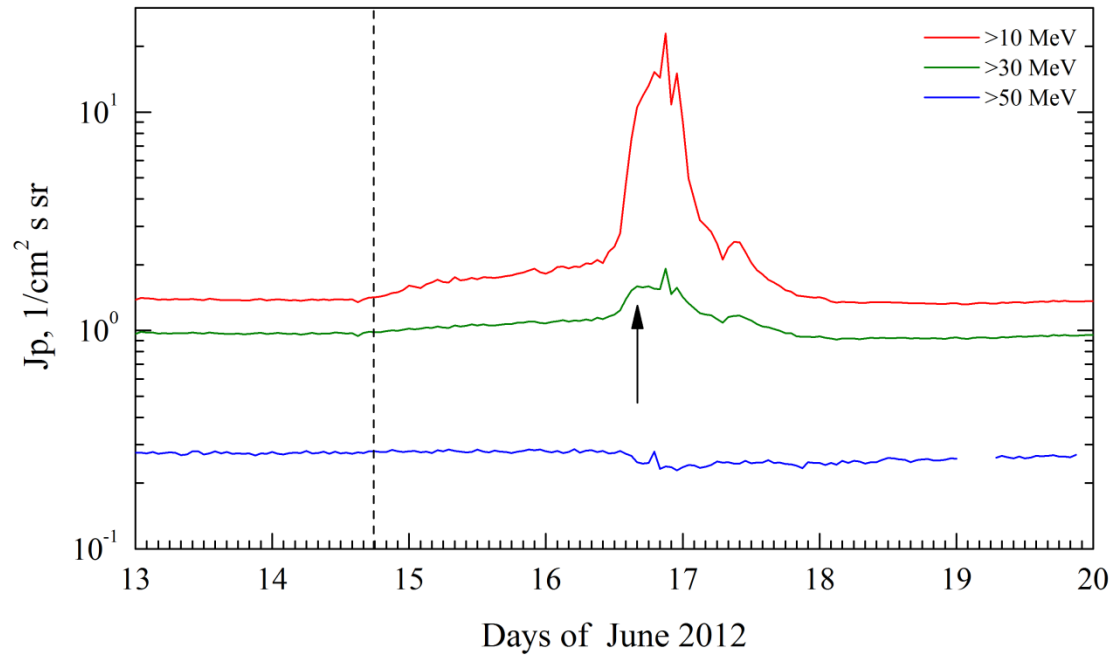
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	16	16d21	154	8	0.01	
LION	2 – 6	16	16d21	19.4	8	0.002	
EPHIN	4 – 8	16	16d20	28.7	8	0.0004	
EPHIN	8 – 25	16	16d20	1.05	8	0.00003	
EPHIN	25 – 53	16	16d21	0.013	3	0.00002	
Electro-1							
SCR-E	13.7–23	-	16d19	0.031	0.5	0.004	
SCR-E	23–42	-	16d19	0.01	0.5	0.025	
SCR-E	42–112	-	16d19	0.0014	0.5	0.005	



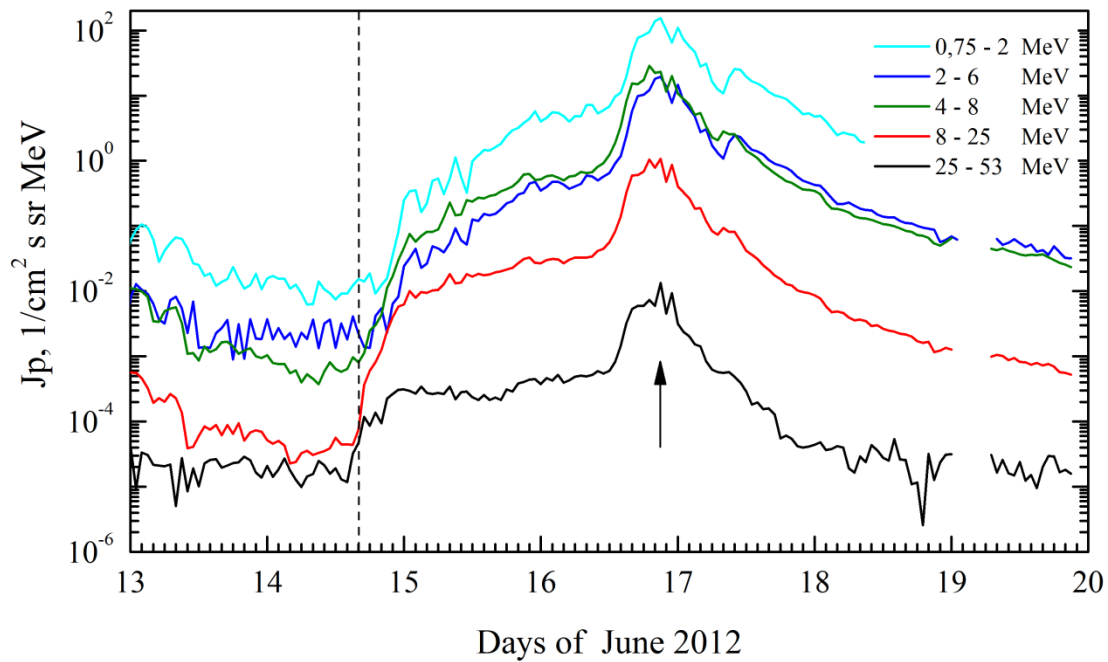
Time profiles of proton fluxes in the event 2012.06.14

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.06.14

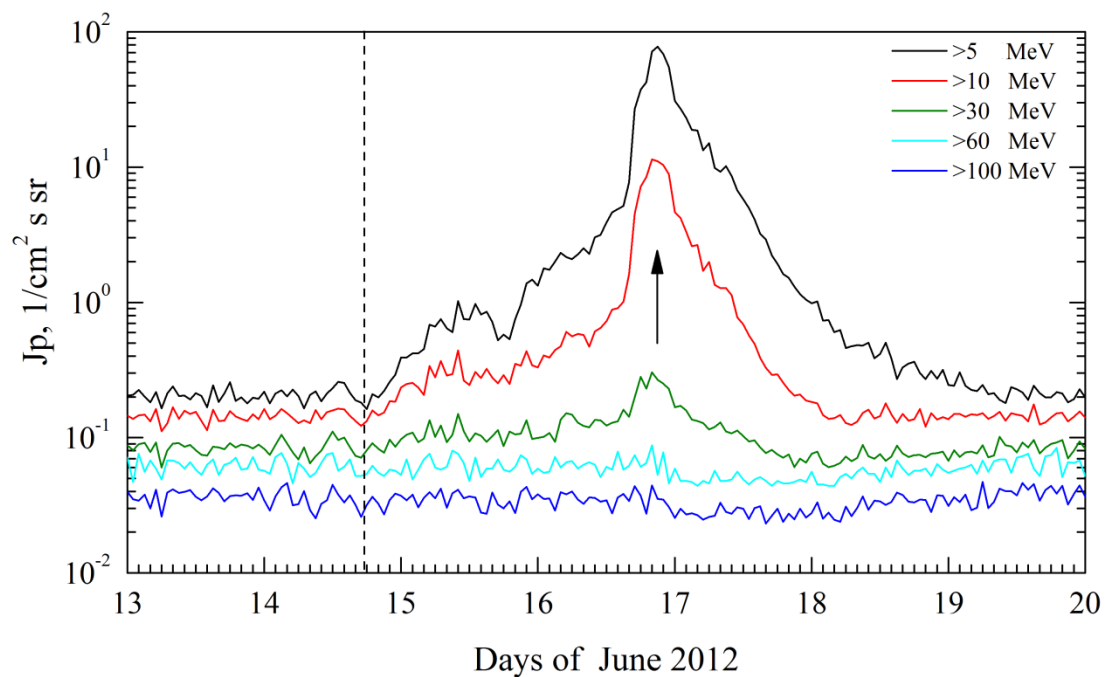


SOHO. Event 2012.06.14

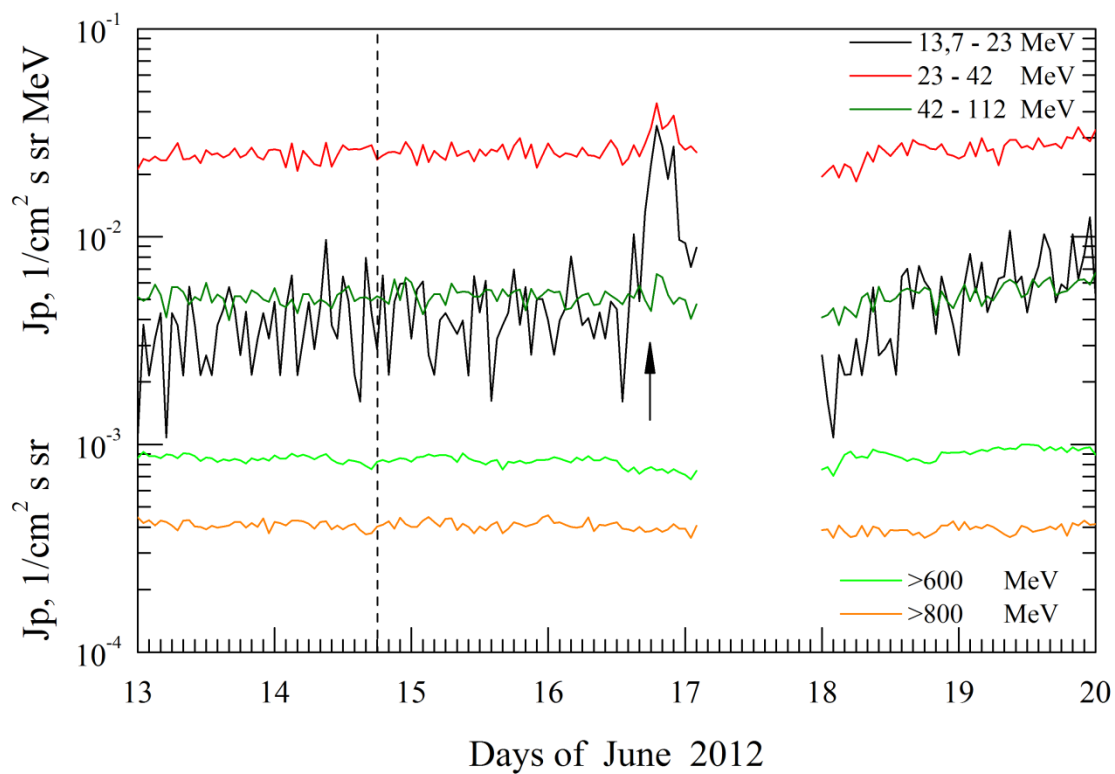


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

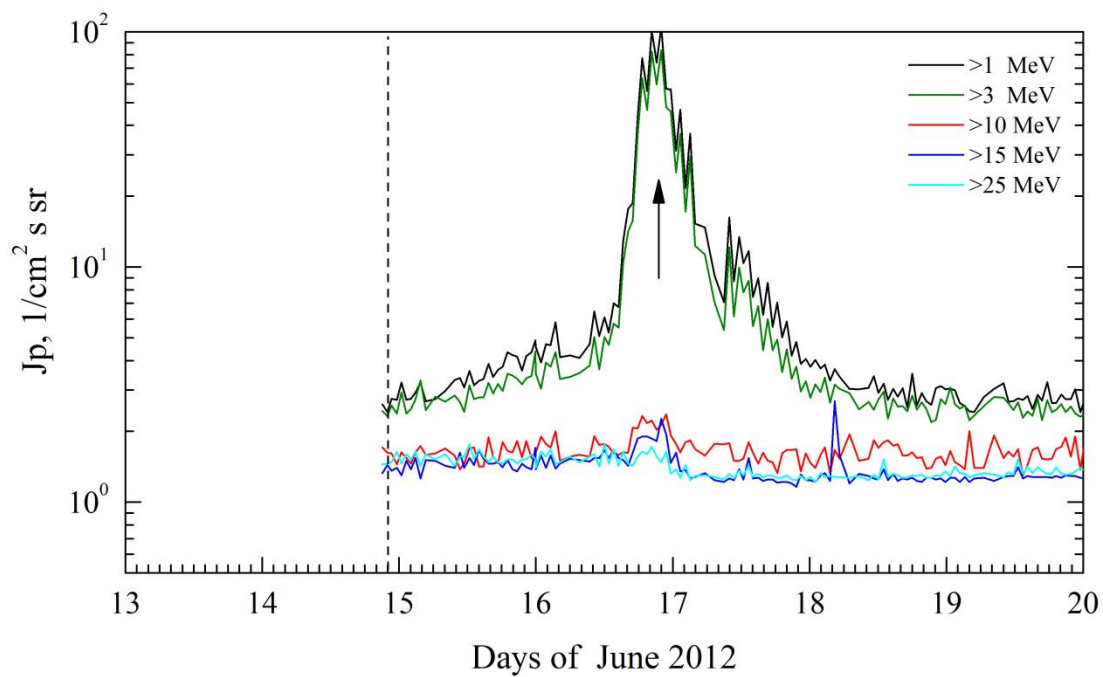
GOES. Event 2012.06.14



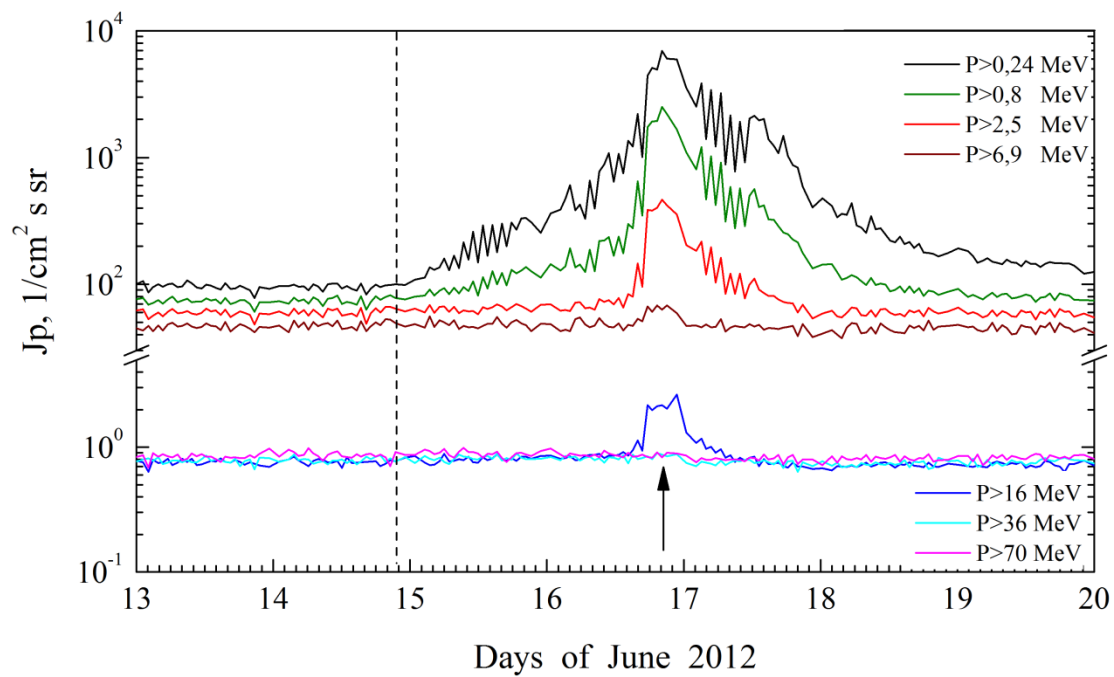
Electro. Event 2012.06.14



Meteor. Event 2012.06.14



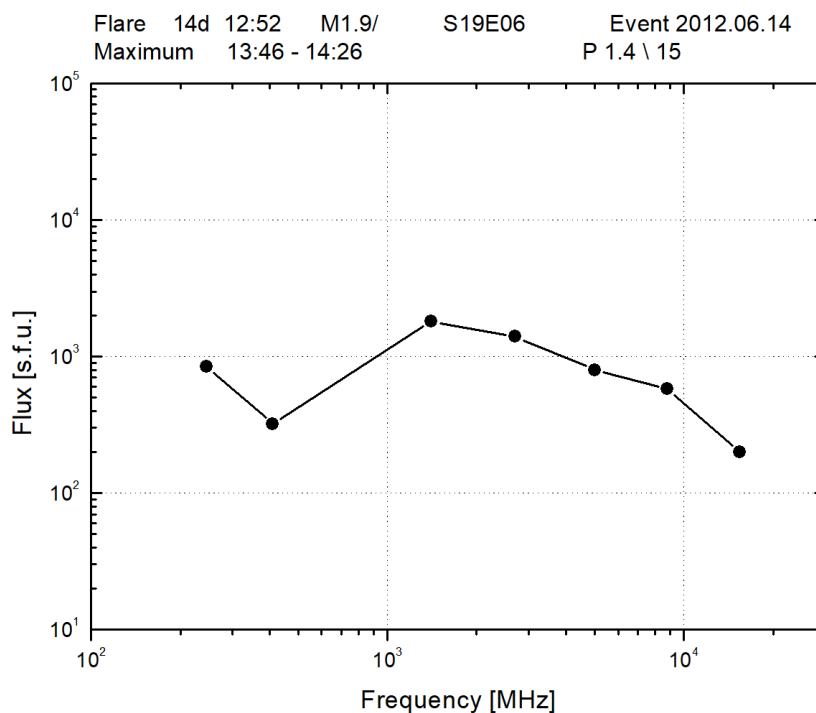
POES. Event 2012.06.14



Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 June 14
2012 June 14 • AR 11504 To event 512

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1331	1402	>1724	S17E06	1N	ERU
1 – 12	keV	1252	1435	1556	S19E06	M1.9	0.12
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1343:00	1354:08	1406:41	31309	72309998	FERMI
12-25	keV	1436:56	1448:16	1456:35	13194	2451640	FERMI
12-25	keV	1522:23	1529:00	1542:11	7645	1002322	FERMI
12-25	keV	1622:03	1639:32	1639:48	787	124775	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1353	1426	1452	P1.4 \ 15	2.3	
8.8	GHz	1348	1424	1518		2.76	
5	GHz	1151	1424	1210		2.9	
2.7	GHz	1151	1424	1216		3.15	
1.4	GHz	1341	1409	1510		3.26	
410	MHz	1339	1346	1527		2.5	
245	MHz	1342	1421	1512		2.92	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	025-180	1349		1810		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1412	987	-1.2	360°	144°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR 11504 (S17L086, CMP 15,1.06.1.2012,
Sp=750 msh, EKC, BGD, R)
XRI=0.81 $M_5^{1.9} + C_{39} 1_5 + S_{42}$
PFR1 9-10.06 (19^h) $M_3^{1.9}$
PFR2 13-14.06 (25^h) M_2^{19}

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Temmer M., [2021](#).
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Particle event: To($E_p > 10$ MeV) – 06d23^h

Tmax ($E_p > 10$ MeV) – 07d08^h, Jmax ($E_p > 10$ MeV) – 23 /cm²·s·sr

Duration of the event – 1.7 days, power-law index: $\gamma = 3.0$

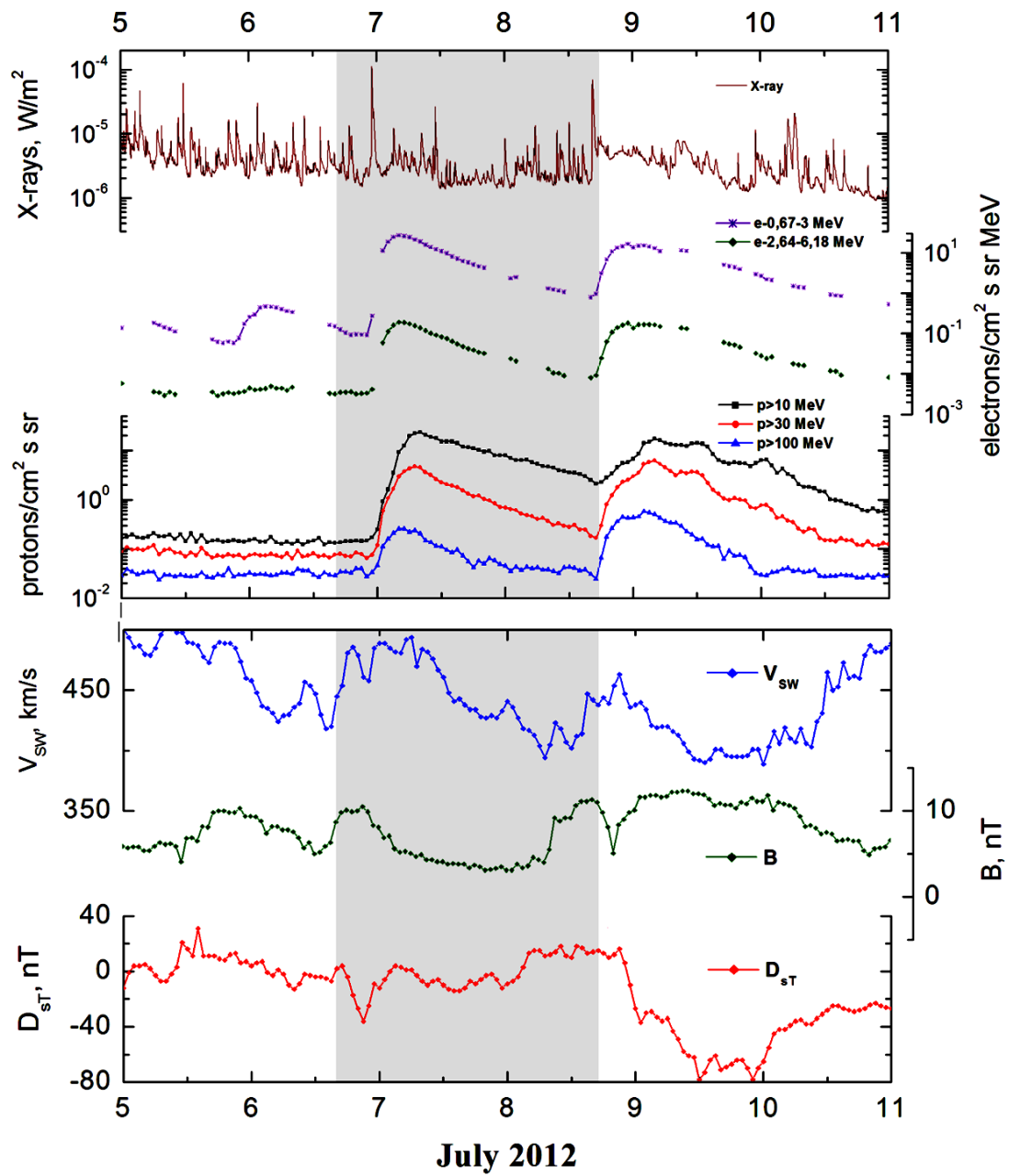
Quasimaximal energy of protons in the event – $E_{qm} = 220$ MeV

Sources: ● solar flare 06d23^h01^m, X1.1/, S13W59, AR11515

Main burst X-ray 1–8 Å: onset – 06d23^h01^m, max – 06d23^h08^m, $\Phi = 0.043$ J/m²

CME: 06d23^h24^m, $V = 1828$ km/s, $\Delta\phi = 360^\circ$, $dA = 233^\circ$

Particle fluxes and associated phenomena

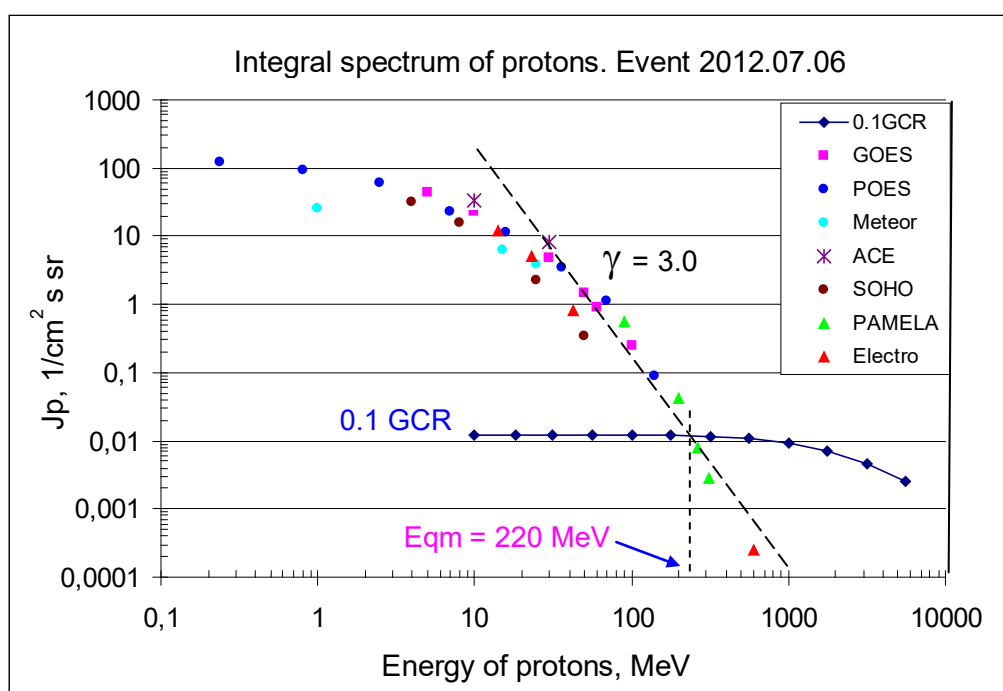


Integral fluxes of protons for the event of 2012 July 06

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	23	07d08	43.5	1.7	0.2	
EPS	>10	23	07d08	23	1.7	0.15	
EPS	>30	23	07d07	4.7	1.7	0.09	
EPS	>50	23	07d07	1.5	1.7	0.07	
EPS	>60	23	07d07	0.9	1.7	0.05	
EPS	>100	23	07d05	0.25	1.7	0.04	
Electro-1							
GALS-E	>600	23	07d04	0.00025	1	0.0009	
POES							
MEPED	>0.24	23	07d08	121	1.5	100	
MEPED	>0.8	23	07d08	94	1.5	75	
MEPED	>2.5	23	07d08	62	1.5	55	
MEPED	>6.9	23	07d08	22.8	1.5	50	
MEPED	>16	23	07d07	11.6	1.5	0.9	
MEPED	>36	23	07d07	3.54	1	0.8	
MEPED	>70	23	07d07	1.1	1	0.8	
MEPED	>140	-	07d07	0.09	0.5	1.1	
Meteor-1							
SCR1	>1	23	07d07	26	1.5	2.7	
SCR1	>3	23	-	-	1.5	2.5	
SCR1	>10	23	-	-	1.5	1.6	
GALS-M	>15	23	07d04	6.2	1.5	1.3	
GALS-M	>25	23	07d04	3.8	1.5	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	23	07d07	33.5	2	1.4	
SIS	>30	23	07d06	8.2	2	1	
SOHO							
EPHIN	>50	07d01	07d06	0.34	2	0.25	
PAMELA							
TRACKER	>90	23	23-7d01	0.57	1	-	
TRACKER	>200	23	23-7d02	0.041	1	-	
TRACKER	>265	23	23-7d03	0.0078	1	-	
TRACKER	>312	23	23-7d04	0.0029	1		

Differential fluxes of protons for the event of 2012 July 06

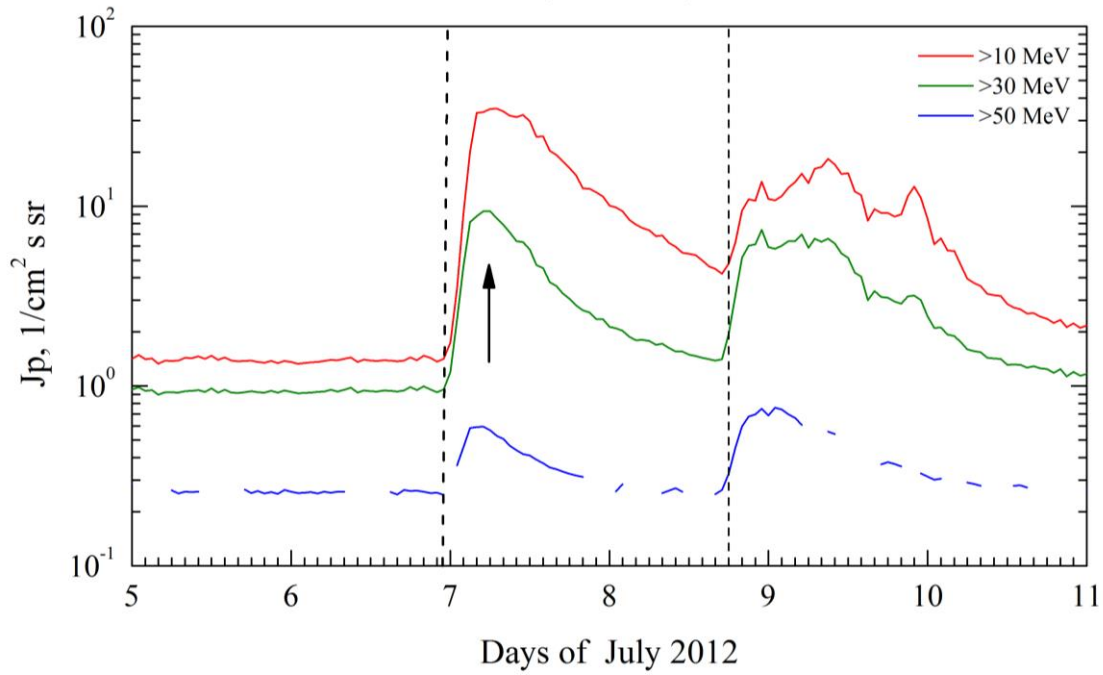
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	16	-	-	2	0.1	
LION	2 – 6	15	-	-	2	0.01	
EPHIN	4 – 8	24	07d05	4.1	2	0.03	
EPHIN	8 – 25	24	07d05	0.8	2	0.003	
EPHIN	25 – 53	07d01	07d07	0.07	2	0.00008	
Electro-1							
SCR-E	13.7–23	23	07d04	0.77	1.5	0.06	
SCR-E	23–42	23	07d04	0.22	1.5	0.025	
SCR-E	42–112	23	07d04	0.0117	1.5	0.005	



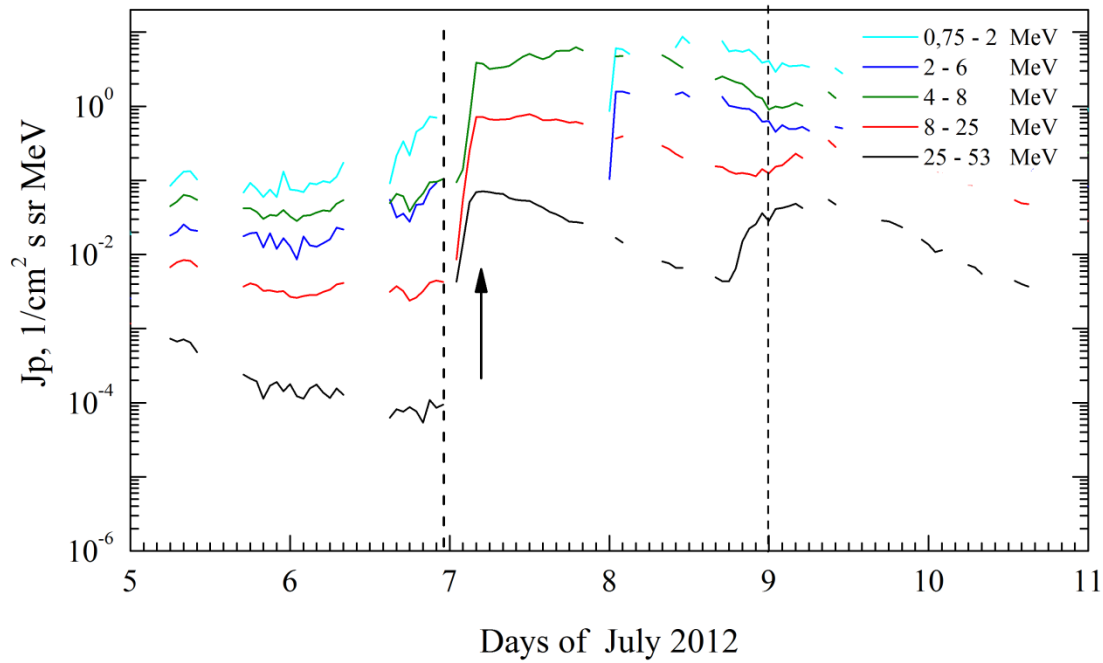
Time profiles of proton fluxes in the event 2012.07.06

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.07.06

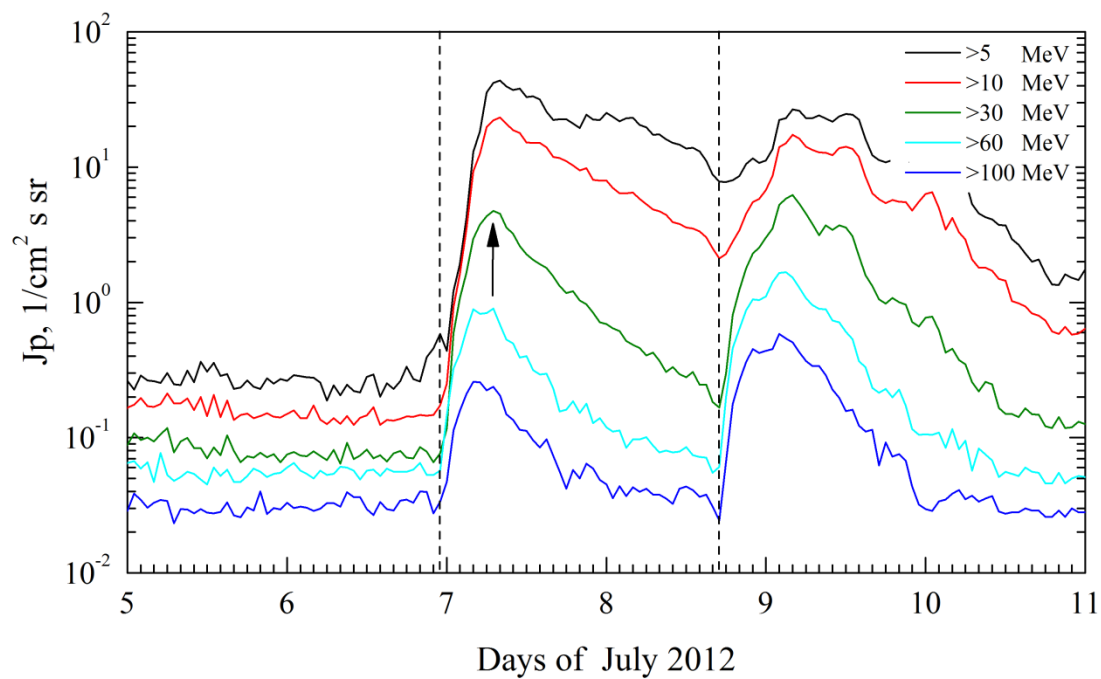


SOHO. Event 2012.07.06

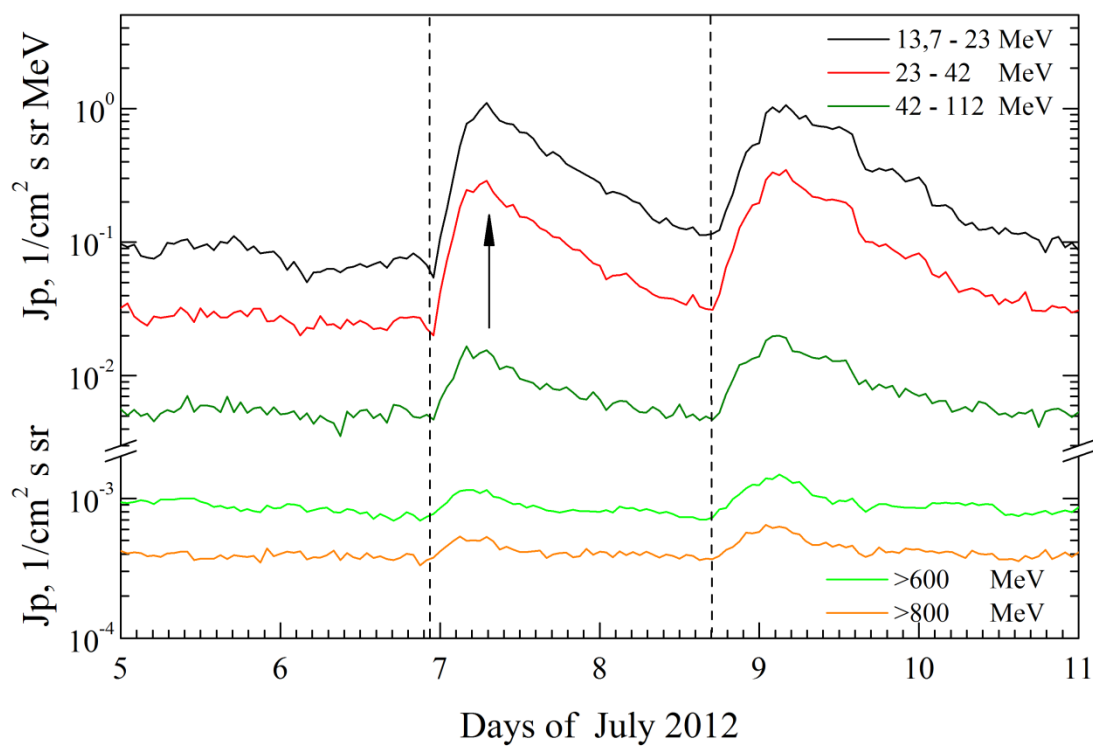


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

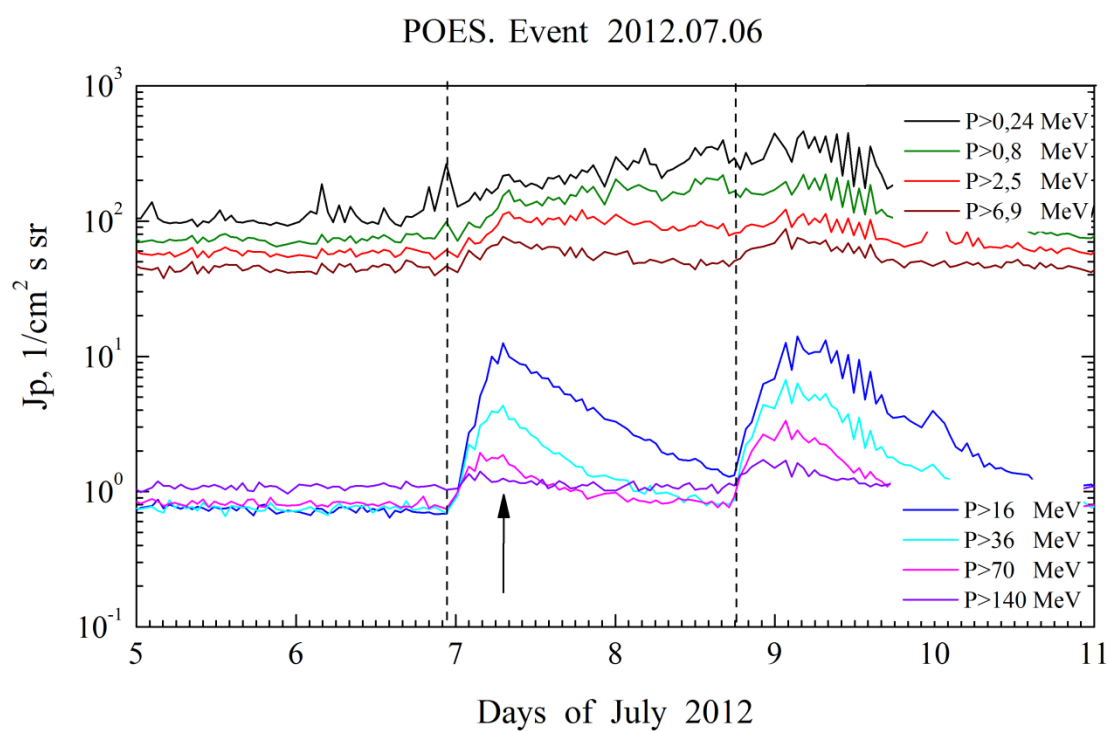
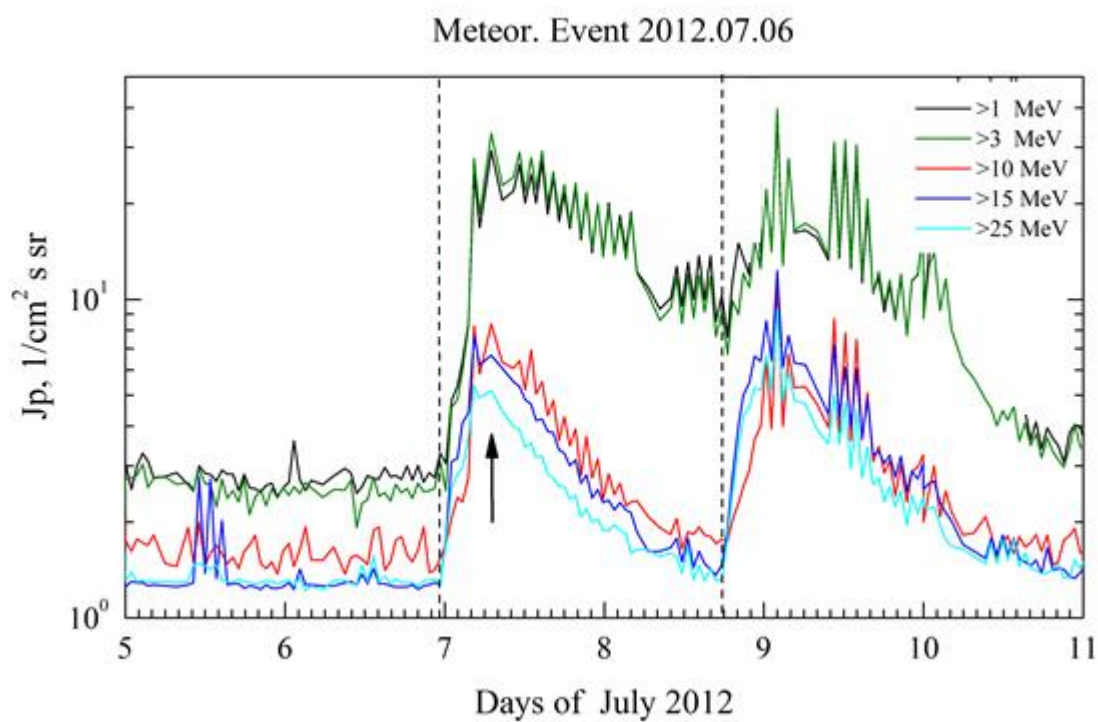
GOES. Event 2012.07.06



Electro. Event 2012.07.06



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 July 06**

2012

July 06

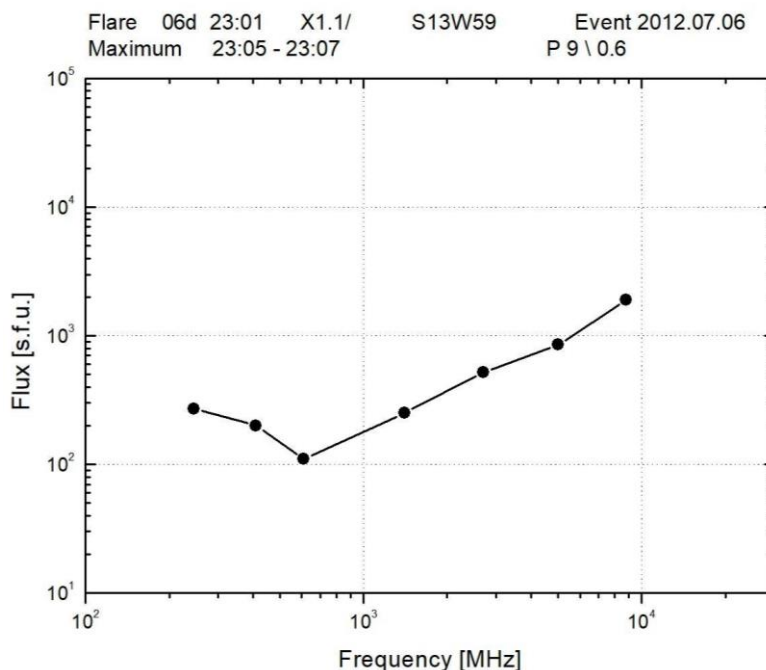
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AR 11515

To event 513

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	2301	2308	2314	S13W59	X1.1	0.043
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	2330:52	2331:30	2341:04	336	320339	HESSI
12-25	keV	2341:04	2342:46	2355:32	34	66041	HESSI
12-25	keV	2315:30	2328:53	2349:40	134932	2210129	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2303	2306	2323	P9 \ 0.6	3.28	
5	GHz	2304	2305	2311		2.93	
2.7	GHz	2304	2305	2309		2.72	
1.4	GHz	2304	2305	2309		2.4	
610	MHz	2305	2306	2307		2.04	
410	MHz	2306	2307	2307		2.3	
245	MHz	2305	2306	2307		2.43	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-180	2309		2321	1771	3	
DS IV	052-180	2322		2338		1	
DS III	025-180	2304		2307		2	
DS V	025-180	2304		2309		3	
DH II	0.3-16	2310		07d2314			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2324	1828	-56.1	360°	233°	SOHO

Radio burst frequency spectrum



Proton Active Region:

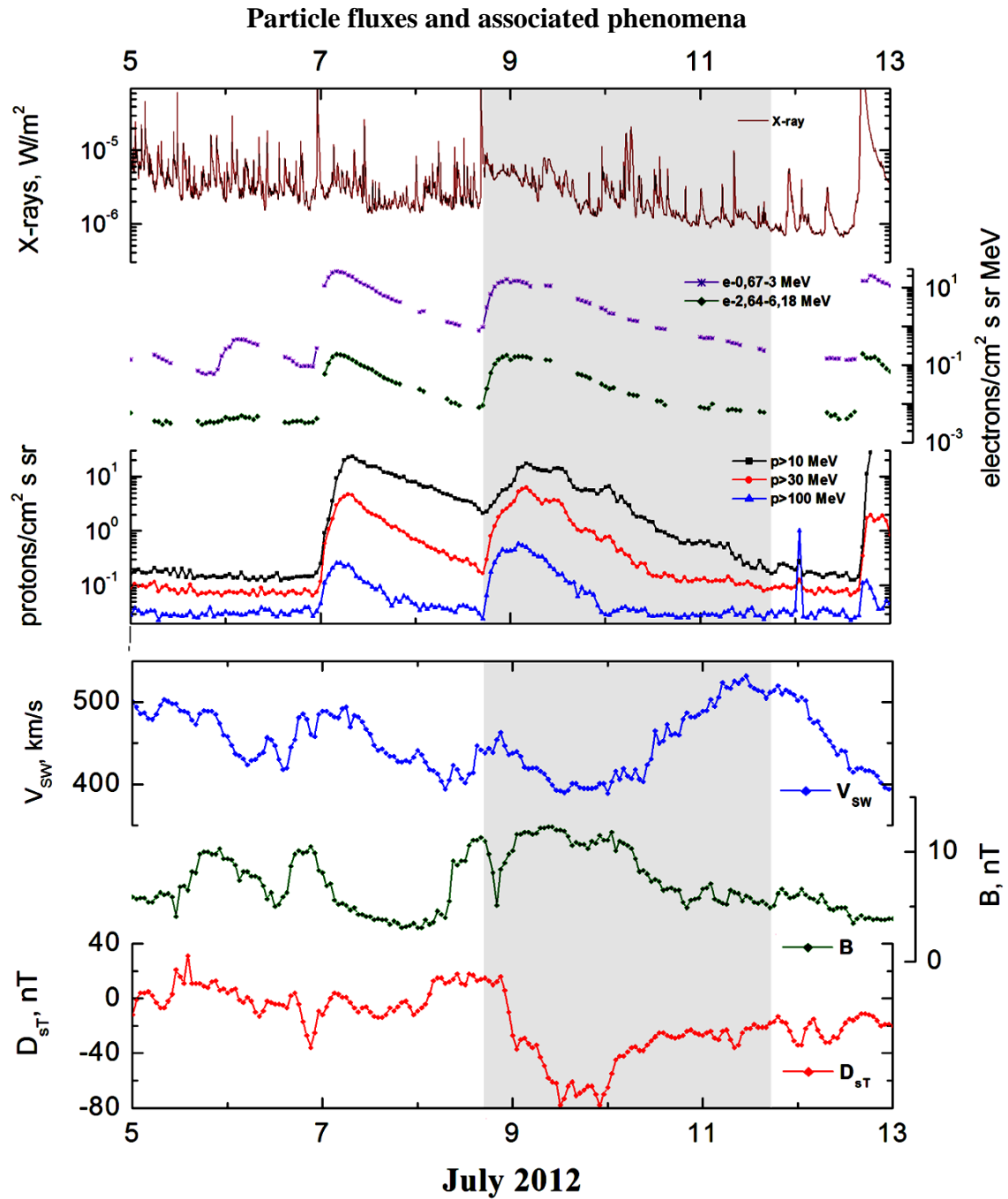
AR11515 (S16L205, CMP 3.3.07.2012,
Sp= 900 msh, FKC, BGD, R)
XRI=8.5; $X_1^{1.1}+M_{30}^{6.9}+C_{72}^{3.1}+2.5+1_{21}+S_{165}$
PFR1 2-5.07 (73^h) $M_{16}^{6.2}$;
PFR2 6-8.07 (9^h) $X_1^{1.1}+M_5^{6.9}$

References:

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Winter L.M., and K. Ledbetter, 2015.
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, 2019.
Zhuang B., N. Lugaz, T. Gou et al., 2020.
Zuccarello F., I. Ermolli, M.B. Korsos et al., 2021.

Particle event: To($E_p > 10$ MeV) – 08d16^h
 Tmax ($E_p > 10$ MeV) – 09d05^h, Jmax ($E_p > 10$ MeV) – $17 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$
 Duration of the event – 3 days, power-law index: $\gamma = 2.2$
 Quasimaximal energy of protons in the event – $E_{qm} = 550$ MeV

Sources: ■ solar flare 08d16^h23^m, M6.9/1N, S14W83, AR11515
 Main burst X-ray 1–8 Å: onset – 08d16^h23^m, max – 08d16^h32^m, $\Phi = 0.045 \text{ J/m}^2$
 CME: 08d16^h54^m, $V = 1495 \text{ km/s}$, $\Delta\phi = 157^\circ$, $dA = 234^\circ$

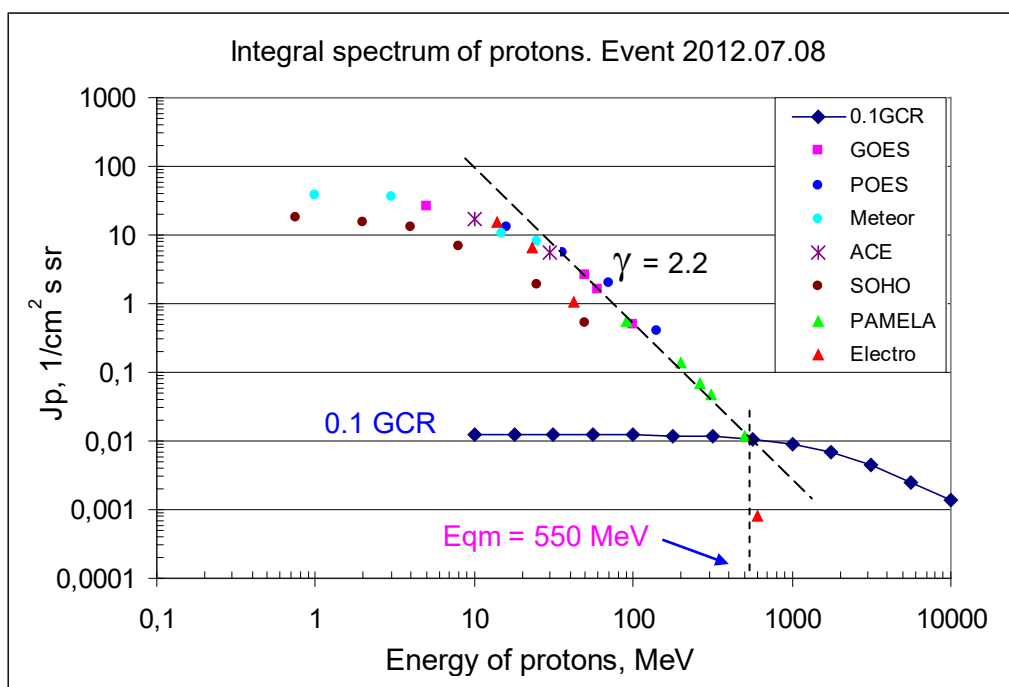


Integral fluxes of protons for the event of 2012 July 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	16	09d05	26.8	3	0.2	
EPS	>10	16	09d05	17	3	0.15	
EPS	>30	16	09d05	6.2	2	0.09	
EPS	>50	16	09d04	2.6	2	0.07	
EPS	>60	16	09d04	1.6	2	0.05	
EPS	>100	16	09d02	0.50	1.5	0.04	
Electro-1							
GALS-E	>600	18	09d06	0.0008	1	0.0009	
POES							
MEPED	>0.24	-	-	-	-	100	
MEPED	>0.8	-	-	-	-	75	
MEPED	>2.5	-	-	-	-	55	
MEPED	>6.9	-	-	-	-	50	
MEPED	>16	18	09d03	13.1	1.5	0.9	
MEPED	>36	18	09d03	5.54	1.5	0.8	
MEPED	>70	18	09d03	2.05	1	0.8	
MEPED	>140	18	09d03	0.4	0.5	1.1	
Meteor-1							
SCR	>1	18	09d02	38.9	2	2.7	
SCR	>3	18	09d02	36.7	2	2.5	
SCR	>10	18	-	-	1.5	1.6	
GALS-M	>15	18	09d02	10.5	1.5	1.3	
GALS-M	>25	18	09d02	8.0	1.5	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	18	09d09	17	2	1.4	
SIS	>30	18	09d09	5.5	2	1	
SOHO							
EPHIN	>50	18	09d02	0.54	2	0.25	
PAMELA							
TRACKER	>90	18	18-9d01	0.56	3	-	
TRACKER	>200	18	18-9d02	0.14	2	-	
TRACKER	>265	18	18-9d03	0.069	1	-	
TRACKER	>312	18	18-9d04	0.048	1		
TRACKER	>500	18	18-9d05	0.012	1		

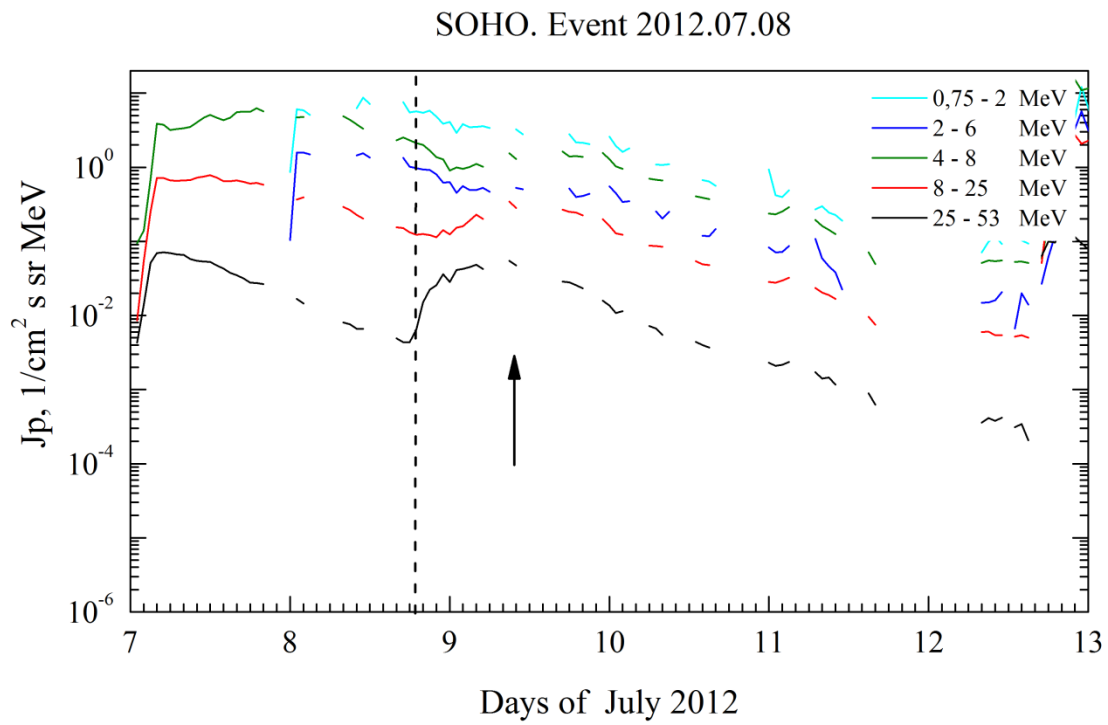
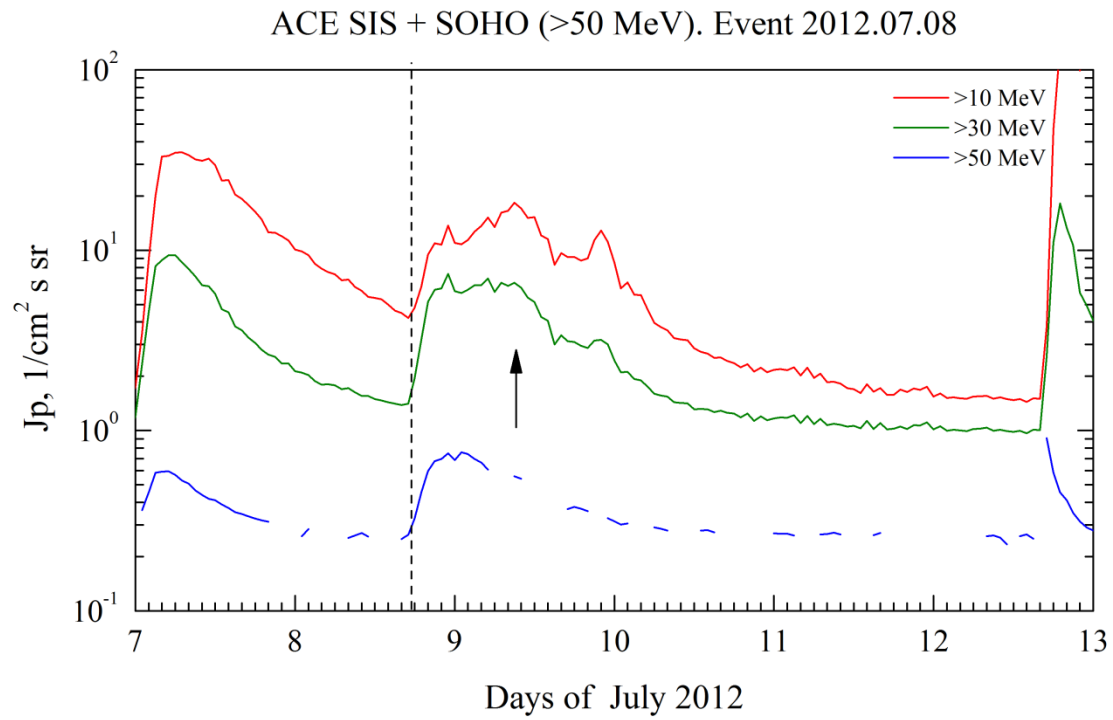
Differential fluxes of protons for the event of 2012 July 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	09d18	2.7	3	0.1	
LION	2 – 6	-	09d18	0.5	3	0.01	
EPHIN	4 – 8	-	09d18	1.55	3	0.03	
EPHIN	8 – 25	23	09d10	0.3	3	0.003	
EPHIN	25 – 53	18	09d02	0.05	3	0.00008	
Electro-1							
SCR-E	13.7–23	18	09d06	0.96	1.5	0.06	
SCR-E	23–42	18	09d06	0.29	1.5	0.025	
SCR-E	42–112	18	09d06	0.015	1.5	0.005	



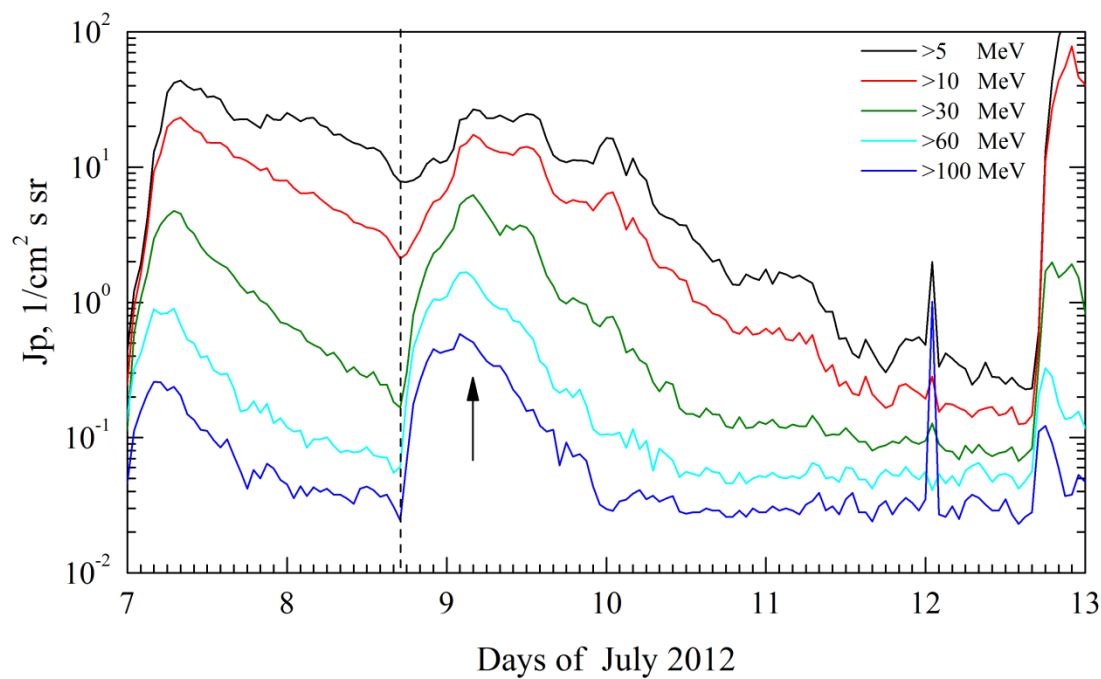
Time profiles of proton fluxes in the event 2012.07.08

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

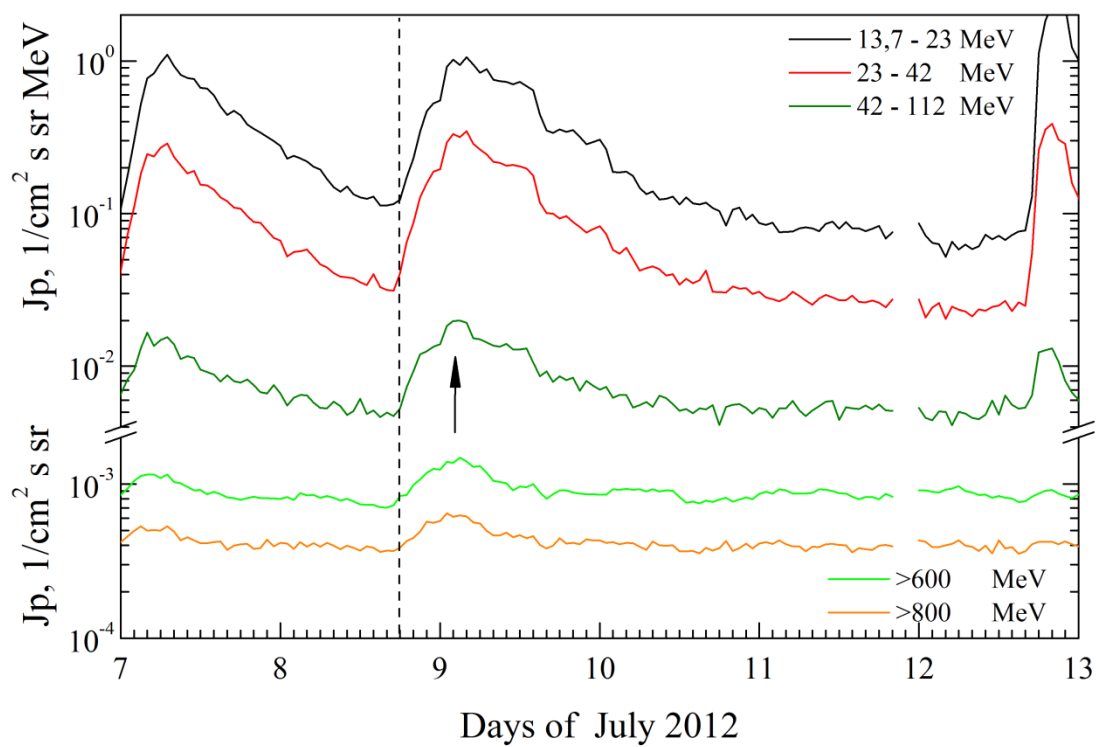


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

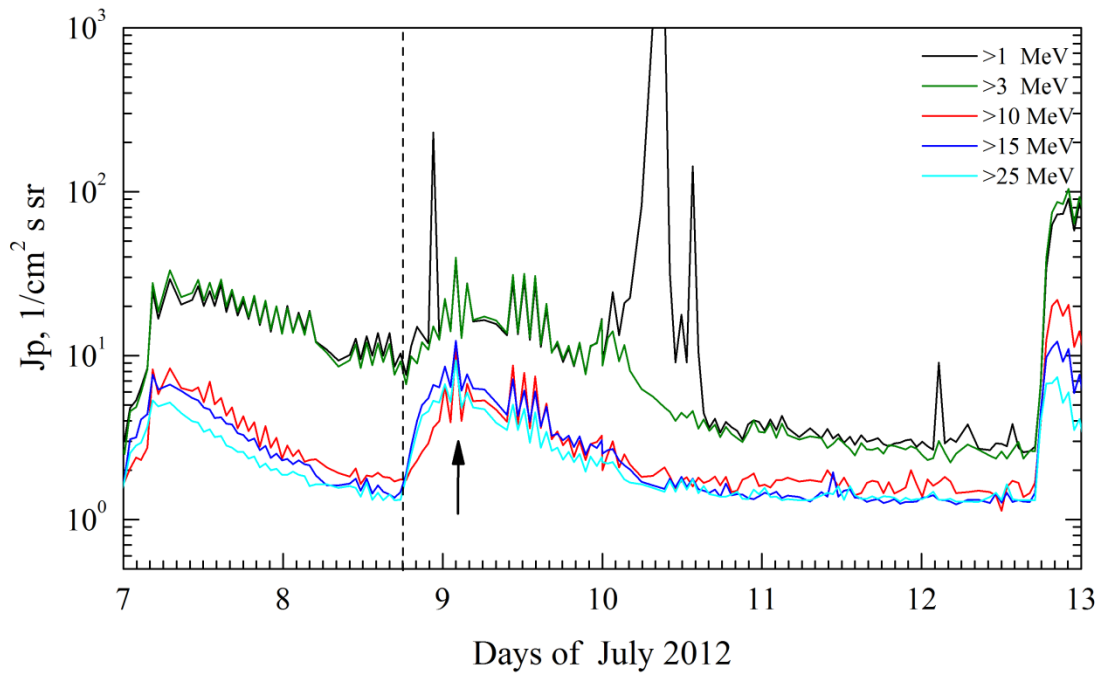
GOES. Event 2012.07.08



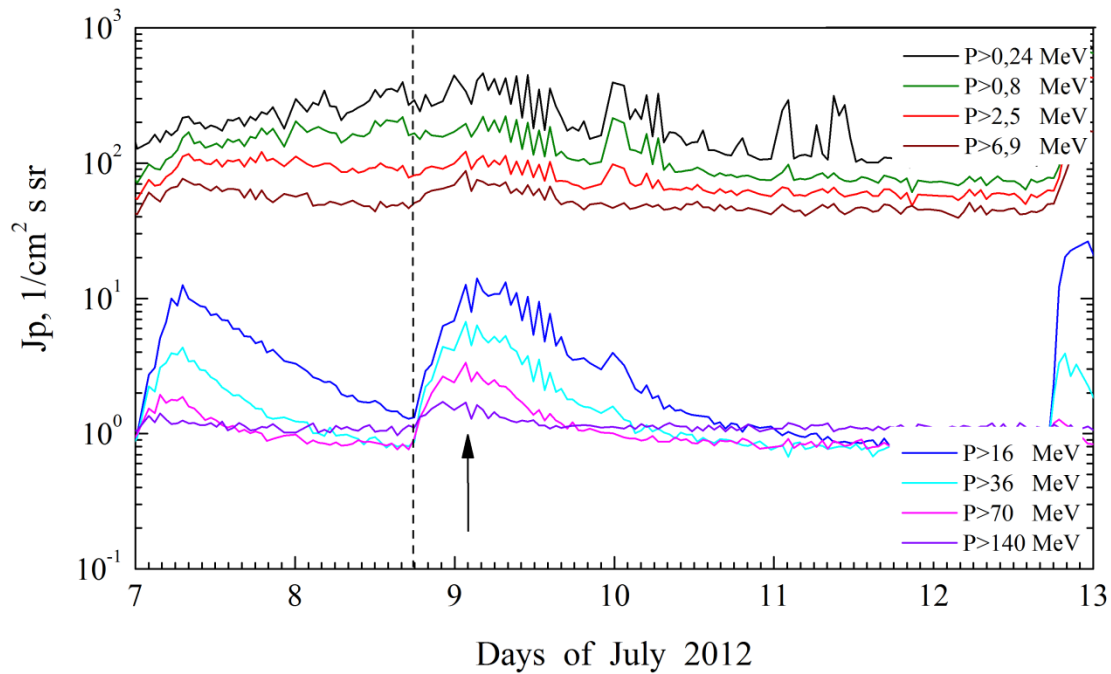
Electro. Event 2012.07.08



Meteor. Event 2012.07.08



POES. Event 2012.07.08



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 July 08**

2012

July 08

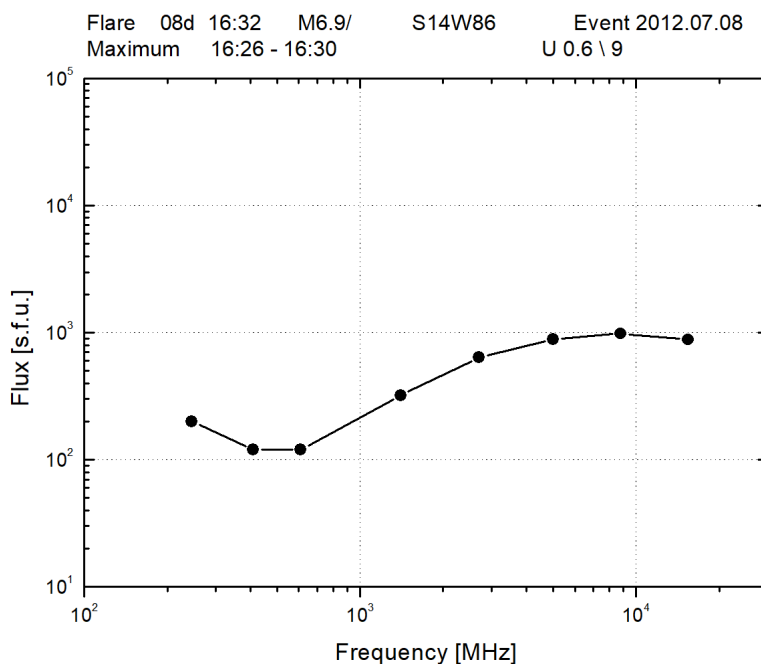


AR 11515

To event 514

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1623	1632	1646	S14W83	1N	ERU
1 – 12	keV	1623	1632	1642	S14W86	M6.9	0.045
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1639:08	1640:24	1724:07	47563	12755956	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1625	1630	1634	U1.4 / 15	2.94	
8.8	GHz	1624	1627	1638		2.99	
5	GHz	1624	1627	1631		2.95	
2.7	GHz	1624	1627	1631		2.81	
1.4	GHz	1624	1627	1633		2.51	
610	MHz	1625	1627	1632		2.08	
410	MHz	1624	1627	1633		2.08	
245	MHz	1626	1626	1632		2.3	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1630		1643	2711	2	
DH II	0.3-16	1635		2200			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1654	1495	-85.3	157°	234°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11515 (S16L205, CMP 3.3.07.2012,
Sp= 900 msh, FKC, BGD, R)
XRI=8.5; $X_1^{1.1} + M_{30}^{6.9} + C_{72}$ $3_1 + 2_5 + 1_{21} + S_{165}$
PFR1 2-5.07 (73^h) $M_{16}^{6.2}$;
PFR2 6-8.07 (9^h) $X_1^{1.1} + M_5^{6.9}$

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Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
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Particle event: To($E_p > 10$ MeV) – 12d16^h

Tmax ($E_p > 10$ MeV) – 12d22^h, Jmax ($E_p > 10$ MeV) – 80 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma = 3.7$

Quasimaximal energy of protons in the event – $E_{qm} = 110$ MeV

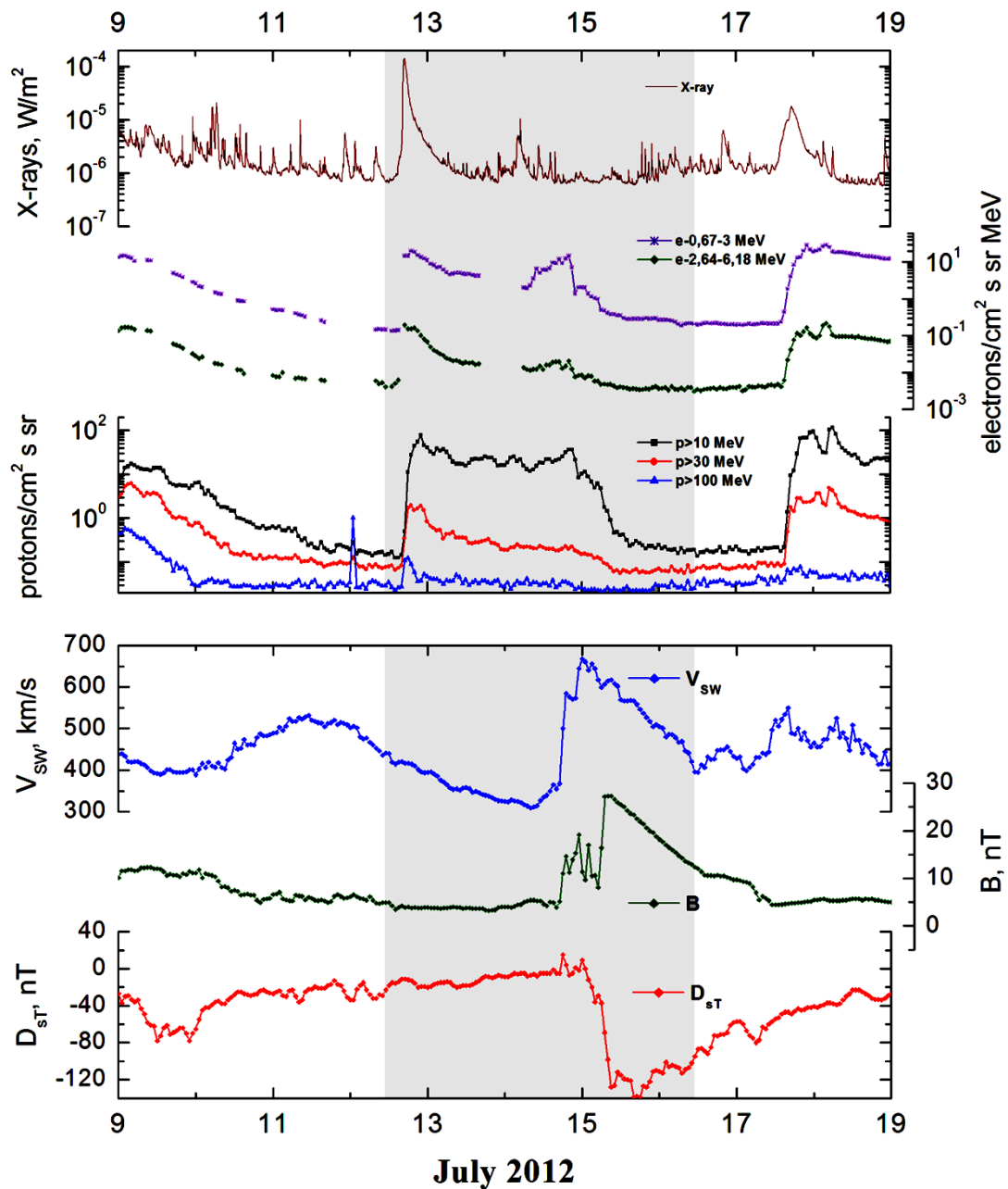
Sources: ● solar flare 12d15^h18^m, 2B/X1.4, S14W01, AR11520

Main burst X-ray 1–8 Å: onset – 12d15^h37^m, max – 12d16^h49^m, $\Phi = 0.46$ J/m²

CME: 12d16^h48^m, $V = 0885$ km/s, $\Delta\phi = 360^\circ$, $dA = 158^\circ$

▲ SC 14d18^h09^m

Particle fluxes and associated phenomena

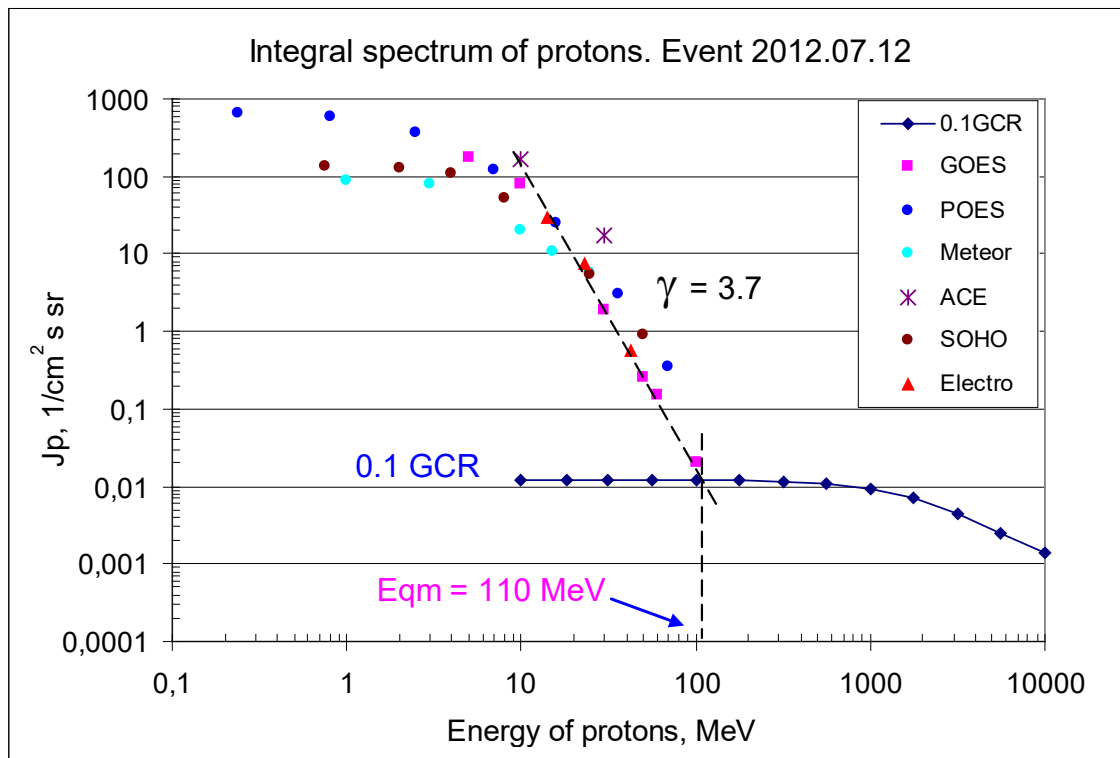


Integral fluxes of protons for the event of 2012 July 12

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	16	22	180	4	0.2	
EPS	>10	16	22	80	3	0.15	
EPS	>30	16	22	1.9	2.5	0.09	
EPS	>50	16	22	0.25	1	0.07	
EPS	>60	16	23	0.2	1	0.05	
EPS	>100	16	23	0.02	1	0.04	
Electro-1							
GALS-MP	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	18	23	640	3	100	
MEPED	>0.8	18	23	595	3	75	
MEPED	>2.5	18	23	375	3	55	
MEPED	>6.9	18	23	122	3	50	
MEPED	>16	18	23	25.5	2	0.9	
MEPED	>36	18	21	3.1	0.5	0.8	
MEPED	>70	18	20	0.36	0.3	0.8	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	17	22	88	1.5	2.7	
SCR	>3	17	22	81	1.5	2.1	
SCR	>10	17	20	20	1	1.6	
GALS-M	>15	17	20	10.6	1	1.3	
GALS-M	>25	17	20	5.8	1	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	16	21	167	2.5	1.4	
SIS	>30	16	19	17	2.5	1	
SOHO							
EPHIN	>50	16	19	0.9	2.5	0.2	

Differential fluxes of protons for the event of 2012 July 12

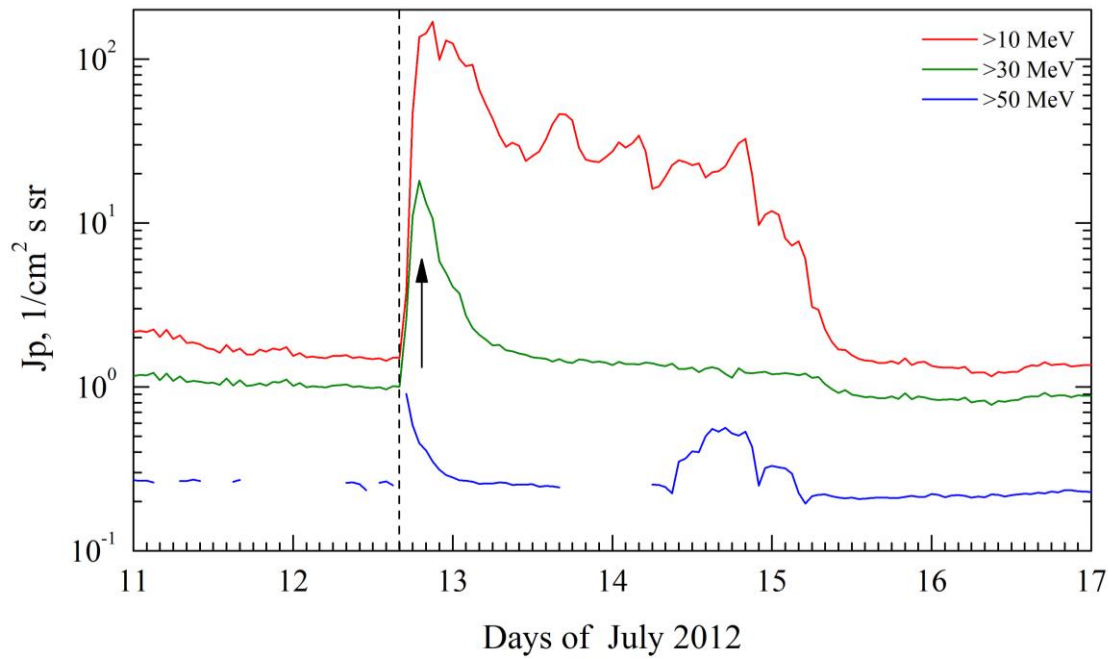
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	16	23	7	3.5	0.1	
LION	2 – 6	16	23	6	3.5	0.015	
EPHIN	4 – 8	16	22	15	3.50	0.05	
EPHIN	8 – 25	16	22	2.7	3.5	0.005	
EPHIN	25 – 53	16	21	0.16	2.5	0.0004	
Electro-1							
SCR-E	13.7–23	16	20	2.3	0.5	0.06	
SCR-E	23–42	16	20	0.36	0.5	0.025	
SCR-E	42–112	16	20	0.008	0.3	0.005	



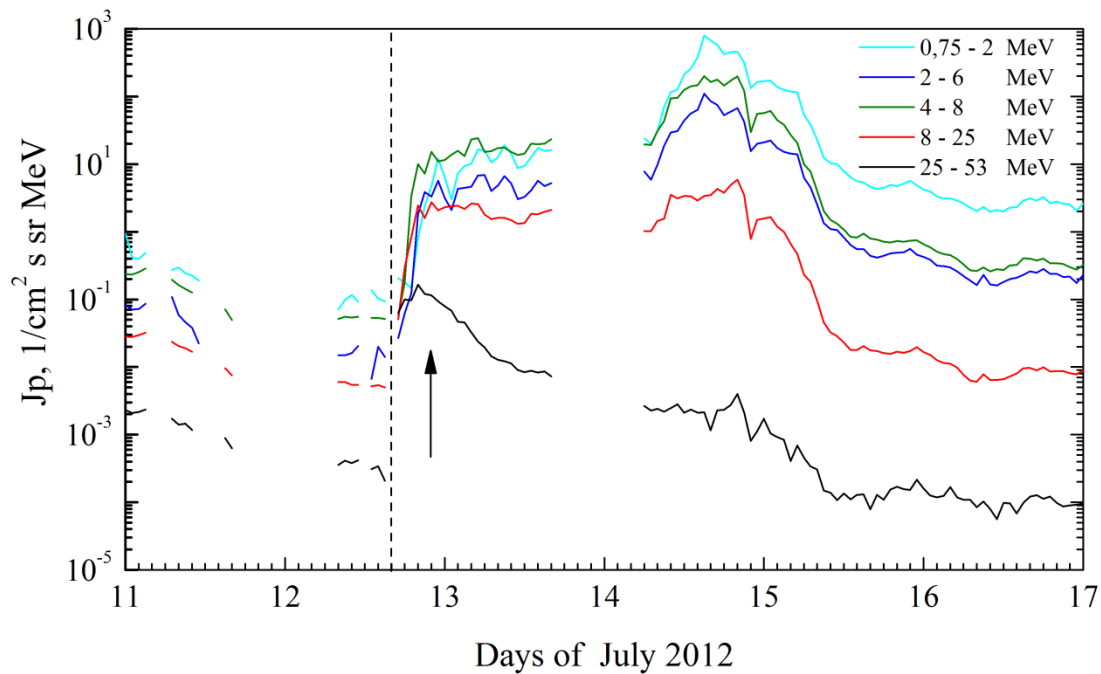
Time profiles of proton fluxes in the event 2012.07.12

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

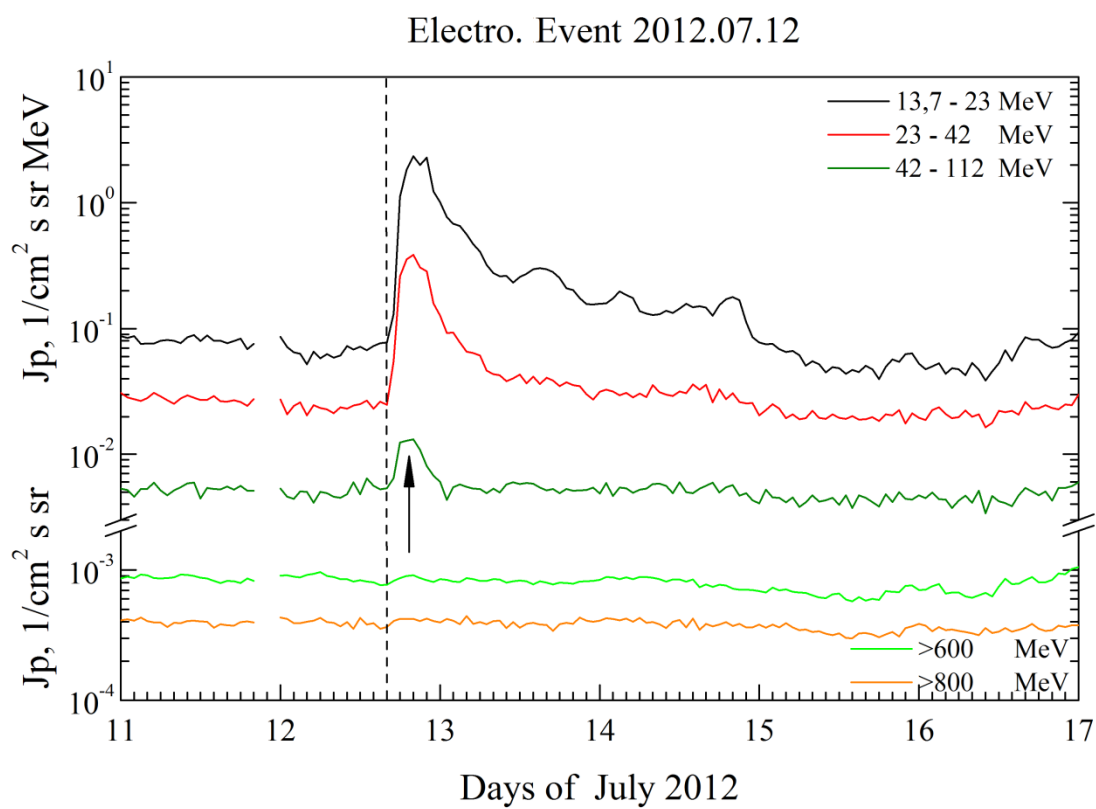
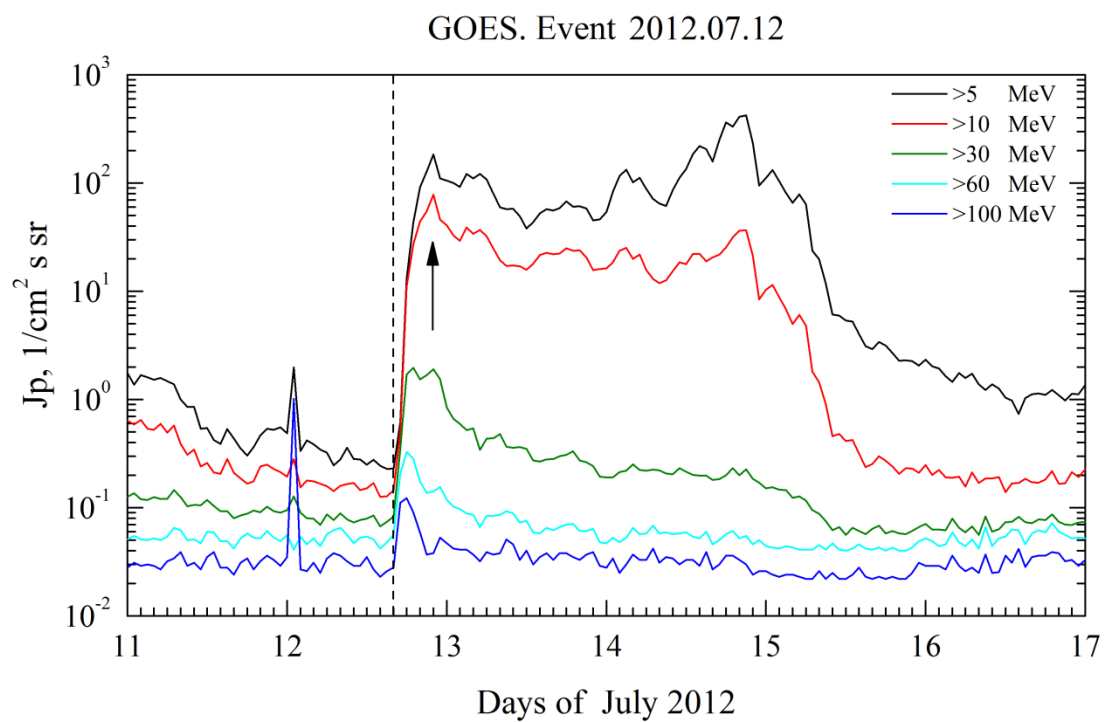
ACE SIS + SOHO (>50 MeV). Event 2012.07.12



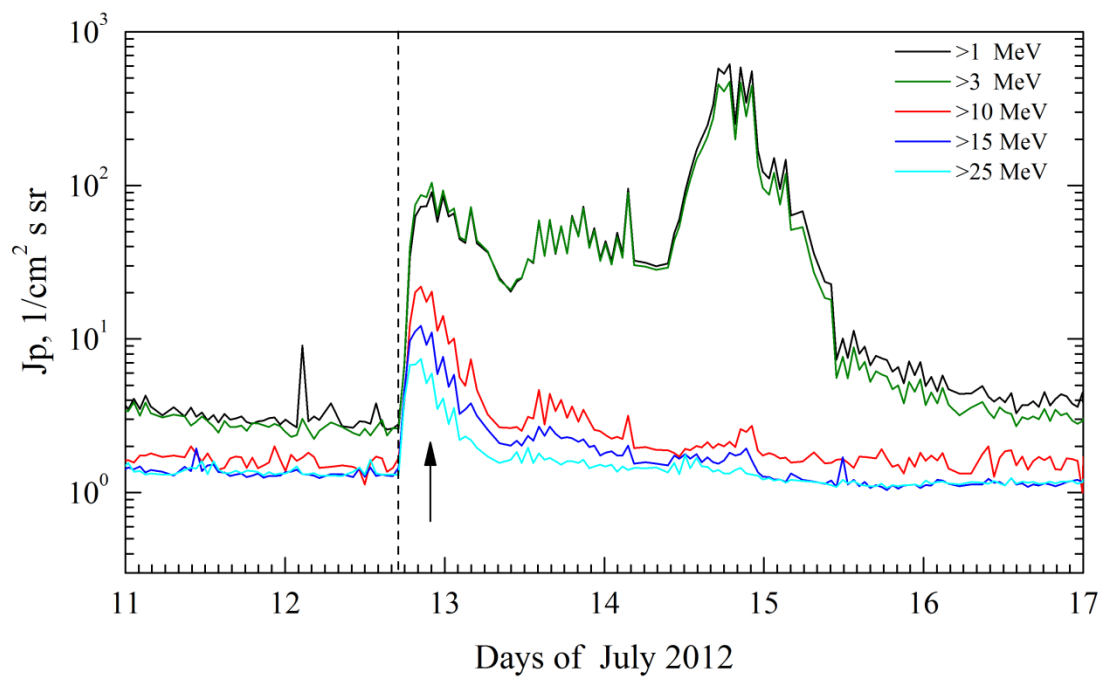
SOHO. Event 2012.07.12



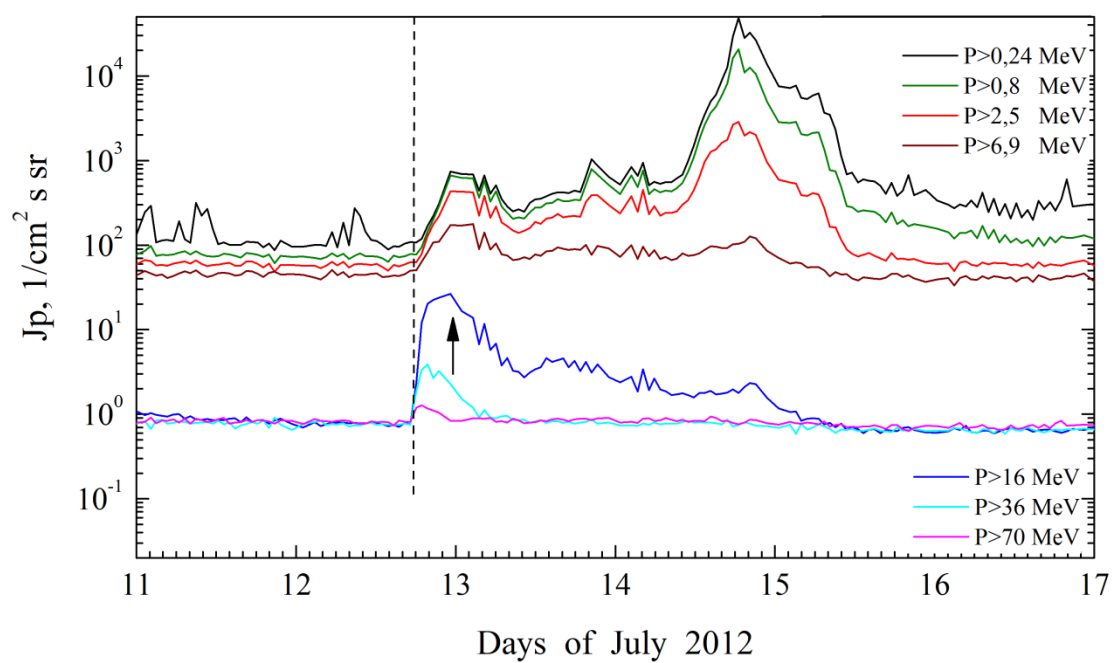
Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro



Meteor. Event 2012.07.12



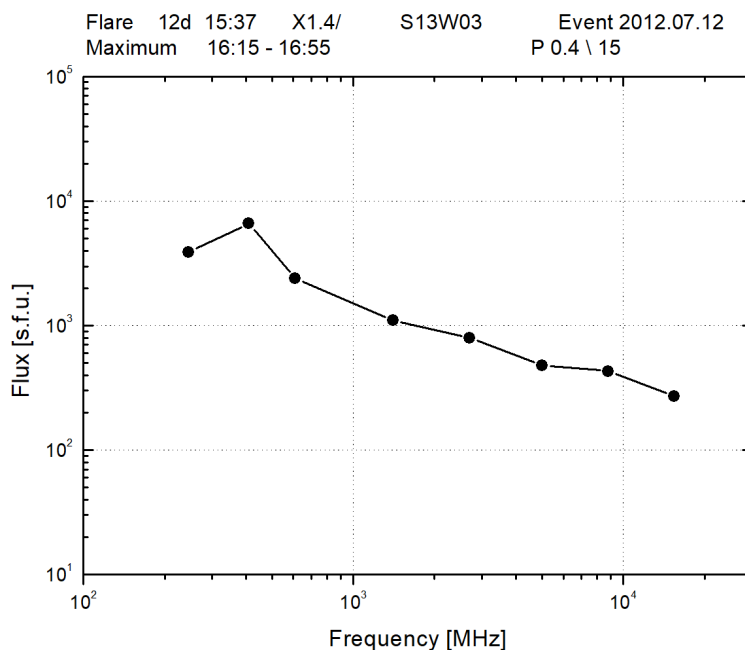
POES. Event 2012.07.12



Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 July 12
2012 July 12 • AR 11520 To event 515

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1539	1625	2041	S15W01	2B	
1 – 12	keV	1537	1649	1730	S13W03	X1.4	0.46
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1534:12	1550:46	1552:40	1225	4600876	HESSI
25-50	keV	1628:08	16:36:22	1649:52	14335	76898024	HESSI
50-100	keV	1649:52	1650:54	1728:08	9712	81983696	HESSI
12-25	keV	1610:27	1647:06	1709:21	966663	970299008	FERMI
12-25	keV	1745:57	1813:54	1828:06	23993	12127359	FERMI
12-25	keV	1921:29	1946:41	2001:13	3953	1528422	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1621	1654	1815	P0.4 \ 15	2.43	
8.8	GHz	1615	1615	1824		2.63	
5	GHz	1614	1653	1714		2.68	
2.7	GHz	1614	1653	1705		2.9	
1.4	GHz	1614	1652	1706		3.04	
610	MHz	1620	1655	1814		3.38	
410	MHz	1614	1649	1732		3.82	
245	MHz	1615	1652	2010		3.59	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-082	1625		1653		2	
DS IV	025-180	1638		2359		2	
DS VI	025-180	1856		2359		1	
DS CTM	108-180	1610		1638		1	
DH II	0.25-14	1645		13d0900			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1648	885	195.6	360°	158°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11520 (S16L084, CMP 12.3.07.2012,
Sp=1460 msh, FKC, BGD, R)
XRI=2.82 $X_2^{1.4} + M_5^{7.7} + C_{26}$ $2_1 + 1_7 + S_{64}$
PFR1 12.07 X1.4/2B
PFR2 19.07 $M_1^{7.7}$

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Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
Zuccarello F., I. Ermolli, M.B. Korsos et al., [2021](#).

Particle event: To($E_p > 10$ MeV) – 17d15^h

Tmax₁($E_p > 10$ MeV) – 18d00^h, Jmax₁($E_p > 10$ MeV) – 93 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 18d06^h, Jmax₂($E_p > 10$ MeV) – 116 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 3.2$, $\gamma_2 = 3.2$

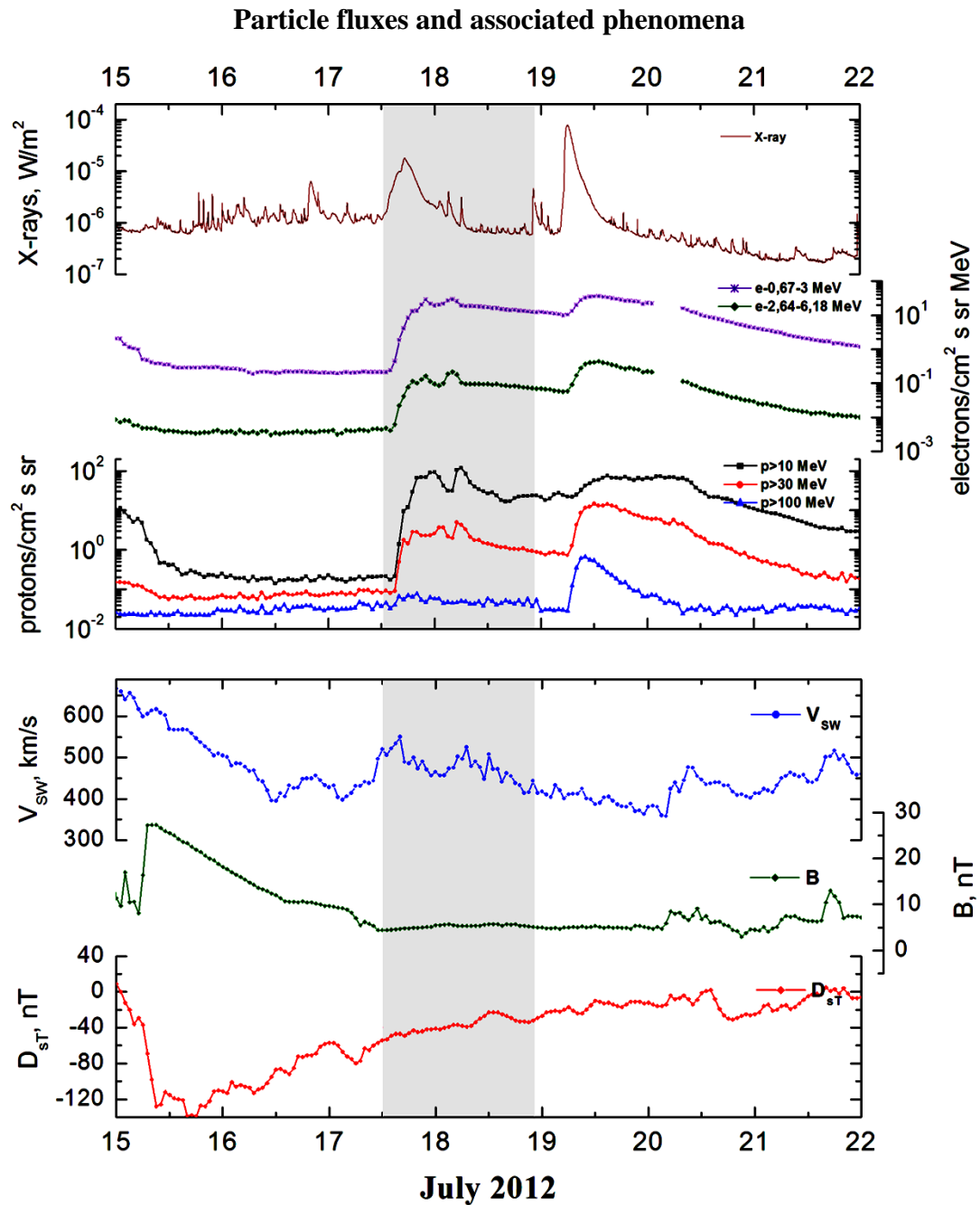
Quasimaximal energy of protons in the event – Eqm₁ = 150 MeV

– Eqm₂ = 140 MeV

Sources: • solar flare 17d12^h03^m, M1.7/1F, S28W75, AR11520

Main burst X-ray 1–8 Å: onset – 17d12^h03^m, max – 17d17^h15^m, $\Phi = 0.21$ J/m²

CME: 17d13^h48^m, V = 958 km/s, $\Delta\phi = 176^\circ$, dA = 241°

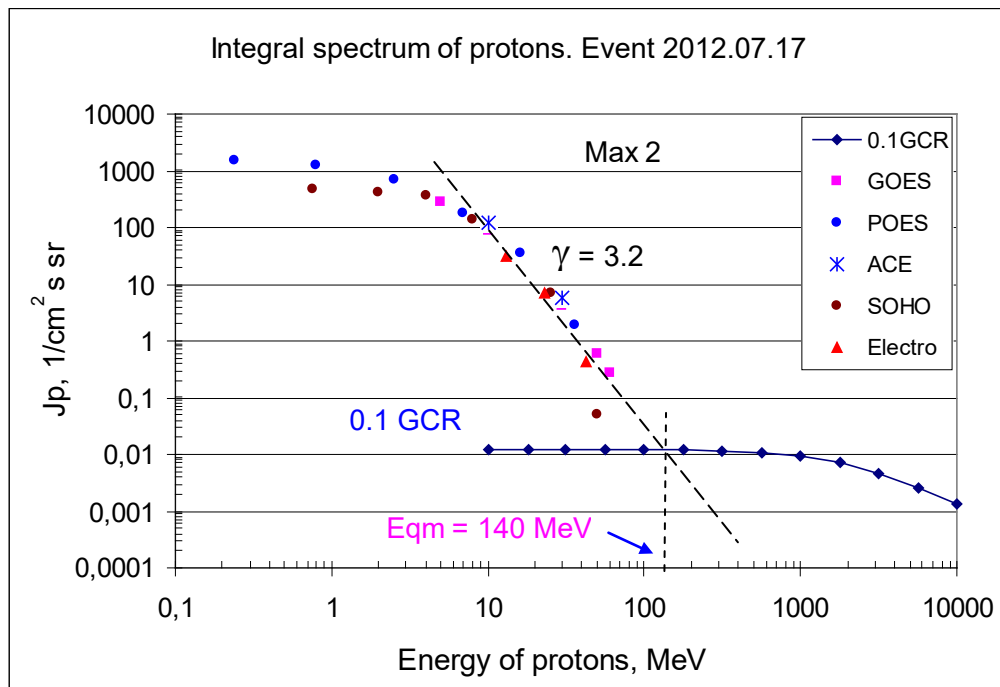
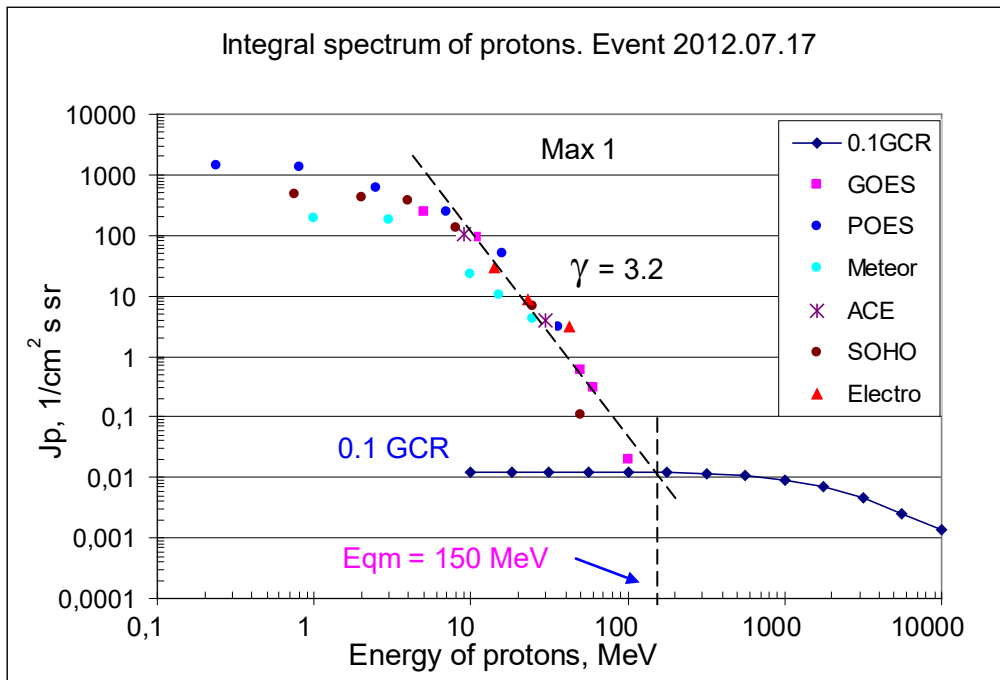


Integral fluxes of protons for the event of 2012 July 17

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	15	18d00/18d06	240/290	1.5	0.2	
EPS	>10	15	18d00/18d06	93/116	1.5	0.15	
EPS	>30	15	18d01/18d06	3.7/4.3	1.5	0.09	
EPS	>50	15	18d02/18d05	0.6/0.6	1.5	0.07	
EPS	>60	15	18d01/18d06	0.3/0.27	1	0.05	
EPS	>100	15	23/ -	0.02/ -	1	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	16	18d00/18d05	1430/1500	2	100	
MEPED	>0.8	16	18d00/18d05	1310/1225	2	75	
MEPED	>2.5	16	18d00/18d05	595/700	2	55	
MEPED	>6.9	16	18d00/18d05	240/180	1	50	
MEPED	>16	16	18d00/18d05	50.3/35.8	1	0.9	
MEPED	>36	16	18d00/18d05	3.1/1.9	0.5	0.8	
MEPED	>70	16	-	-	-	0.8	
MEPED	>140	18	-	-	-	1.1	
Meteor-1							
SCR	>1	15	18d00/ -	196/-	1.5	2.7	
SCR	>3	15	18d00/ -	180/-	1.5	2.1	
SCR	>10	15	18d00/ -	23/-	1.5	1.65	
GALS-M	>15	15	18d00/ -	10.1/-	1.5	1.3	
GALS-M	>25	15	18d00/ -	4.3/-	1.5	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	15	22/18d04	102/120	1.5	1.4	
SIS	>30	15	22/18d04	3.9/5.9	1.5	1	
SOHO							
EPHIN	>50	16	17/18d04	0.11/0.05	0.6	0.25	

Differential fluxes of protons for the event of 2012 July 17

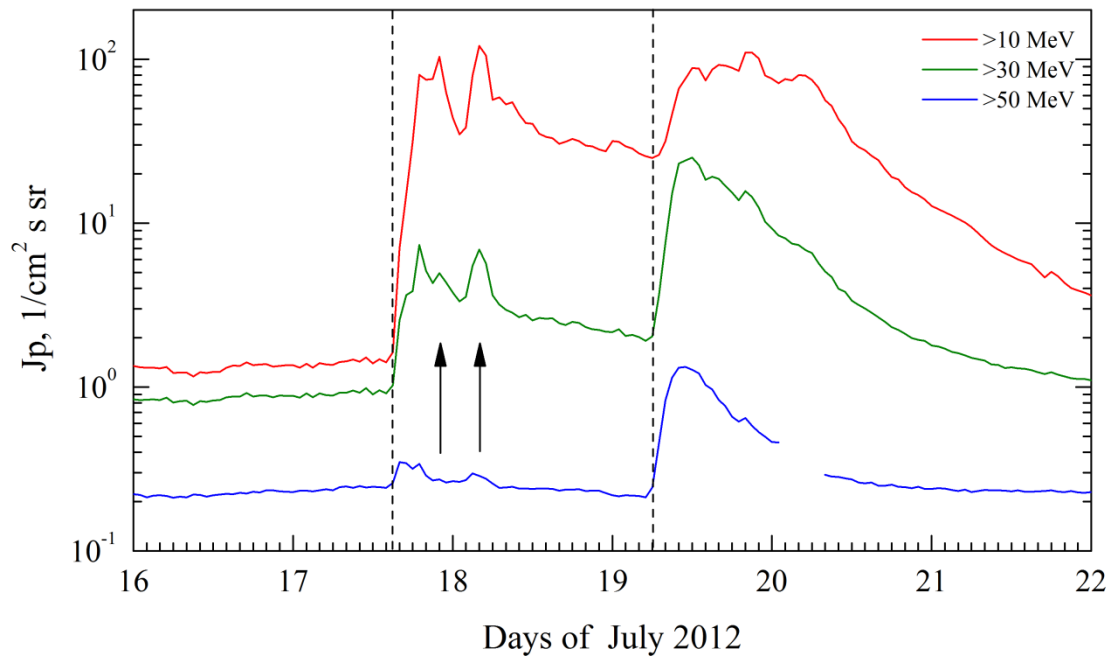
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	18	22/18d04	38/51.8	2	0.1	
LION	2 – 6	18	22/18d04	18/18.3	2	0.01	
EPHIN	4 – 8	17	22/18d05	62/55.7	2	0.03	
EPHIN	8 – 25	16	22/18d05	7.35/7.6	2	0.003	
EPHIN	25 – 53	16	20/18d05	0.24/0.24	2	0.0001	
Electro-1							
SCR-E	13.7–23	16	20/18d05	2.31/2.63	1.5	0.04	
SCR-E	23–42	16	20/18d05	0.3/0.34	1.5	0.02	
SCR-E	42–112	16	20/18d05	0.0043/0.006	1.5	0.005	



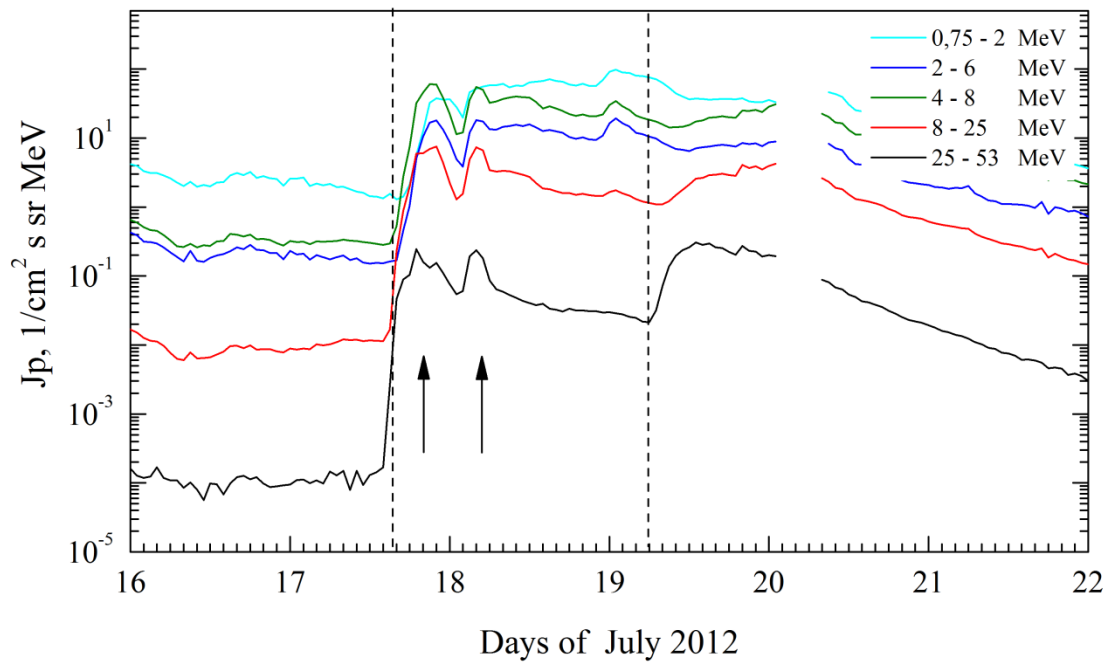
Time profiles of proton fluxes in the event 2012.07.17

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.07.17

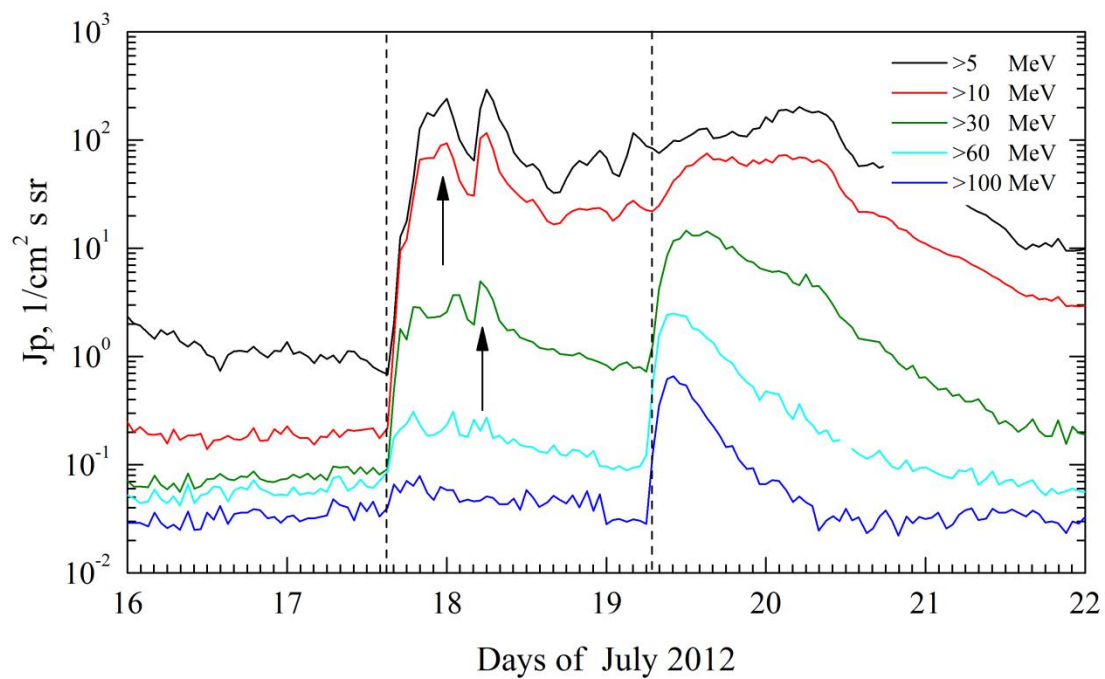


SOHO. Event 2012.07.17

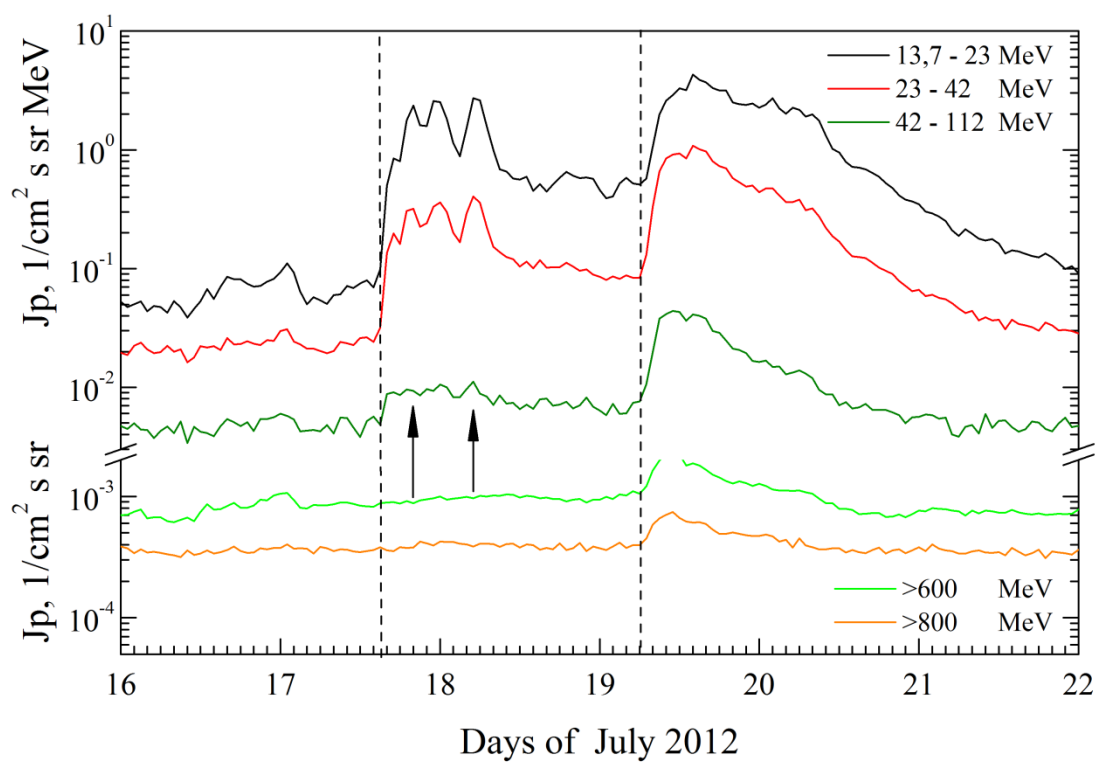


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2012.07.17

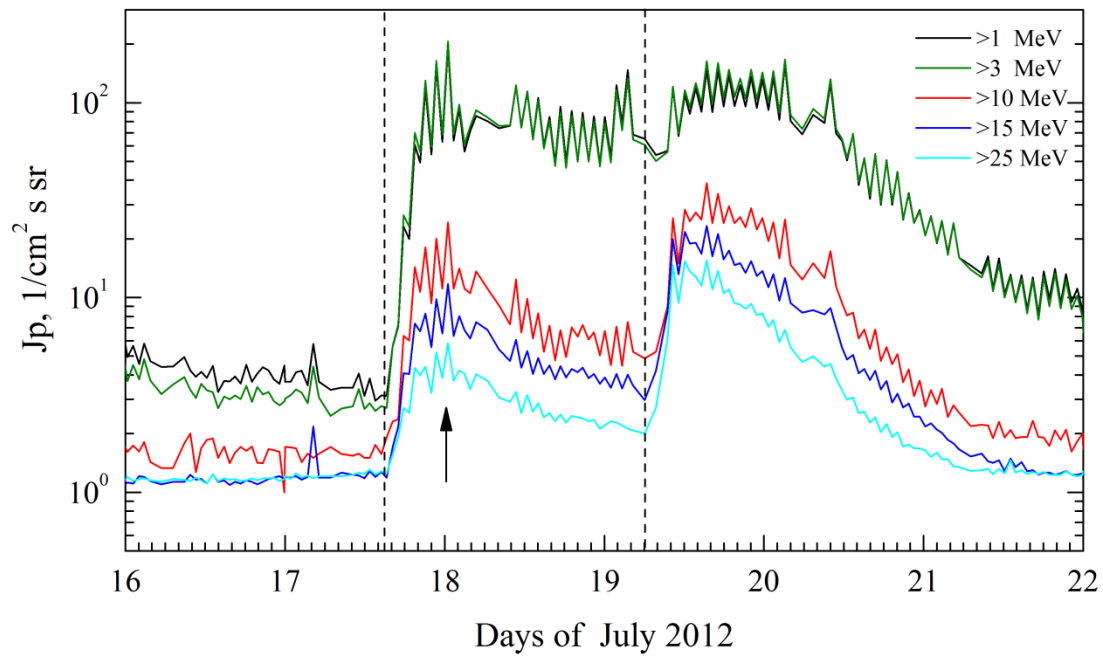


Electro. Event 2012.07.17

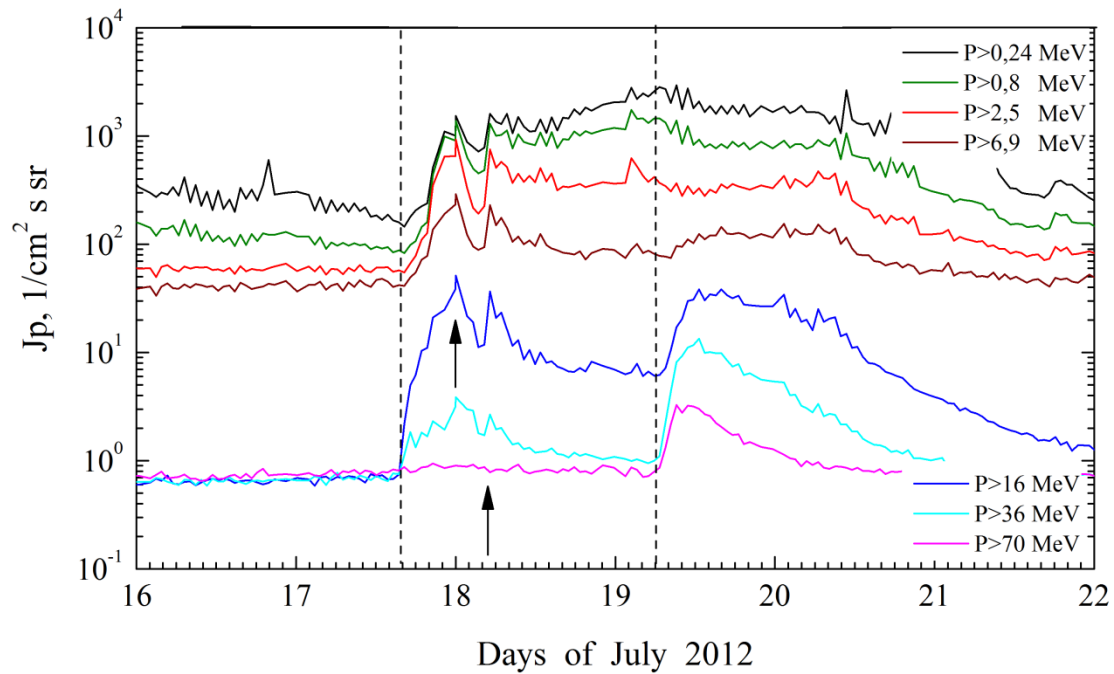


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.07.17



POES. Event 2012.07.17



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 July 17**

2012 July 17 • AR 11520 To event 516

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1328	1643	1753	S28W75	1F	
1 – 12	keV	1203	1715	>1904	S15W88	M1.7	0.21
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1244:56	1244:58	1246:32	3	1348	HESSI
6-12	keV	1246:32	1250:10	1253:08	4	6246	HESSI
6-12	keV	1305:08	1305:46	1309:36	3	4073	HESSI
12-25	keV	1309:36	1342:26	1344:24	31	154884	HESSI
6-12	keV	1424:52	1431:30	1433:20	38	90958	HESSI
6-12	keV	1447:52	1458:10	1459:28	64	206736	HESSI
6-12	keV	1509:56	1517:18	1519:40	80	225432	HESSI
12-25	keV	1555:24	1556:42	1608:12	84	287736	HESSI
6-12	keV	1608:12	1612:38	1615:48	74	153250	HESSI
6-12	keV	1615:48	1616:46	1623:04	60	137952	HESSI
12-25	keV	1623:04	1644:50	1647:24	240	1061184	HESSI
12-25	keV	1647:24	1652:14	1655:24	288	604536	HESSI
25-50	keV	1730:52	1731:38	1734:36	184	187816	HESSI
12-25	keV	1734:36	1736:14	1753:48	216	1213498	HESSI
12-25	keV	1753:48	1755:02	1804:40	208	707136	HESSI
12-25	keV	1804:40	1810:30	1830:36	208	1486800	HESSI
12-25	keV	1538:35	1557:29	1607:36	1265	426949	FERMI
12-25	keV	1630:04	1632:35	1633:12	2846	95520	FERMI
12-25	keV	1709:31	1742:4	1745:0	6260	2169032	FERMI
12-25	keV	1844:59	1855:01	1923:21	1833	786621	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	1328	1348	1356		2.41	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS CTM	099-148	1307		1952		1	
DS III	027-041	1607		1608		1	
DS III	025-050	1732		1733		1	
DS III	025-038	1809		1810		1	
DS III	025-068	1821		1822		1	
DS VI	025-117	1716		1955		2	
DS VI	025-112	1716		1733		1	
DS CTM	099-148	1700		1805		1	
DH II	0.15-12	1440		18d0500			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1348	958	63.5	176°	241°	SOHO

Proton Active Region:

AR11520 (S16L084, CMP 12.3.07.2012,
Sp=1460 msh, FKC, BGD, R)
XRI=2.82 $X_2^{1.4}+M_5^{7.7}+C_{26}$ 2₁+1₇+S₆₄
PFR1 12.07 $X_2^{1.4}$
PFR2 19.07 $M_1^{7.7}$

References:

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Winter L.M., and K. Ledbetter, [2015](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 19d06^h

Tmax₁($E_p > 10$ MeV) – 19d15^h, Jmax₁ ($E_p > 10$ MeV) – 75 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 20d03^h, Jmax₂ ($E_p > 10$ MeV) – 72 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma_1 = 3.5$, $\gamma_2 = 4.4$

Quasimaximal energy of protons in the event – Eqm₁ = 280 MeV

– Eqm₂ = 120 MeV

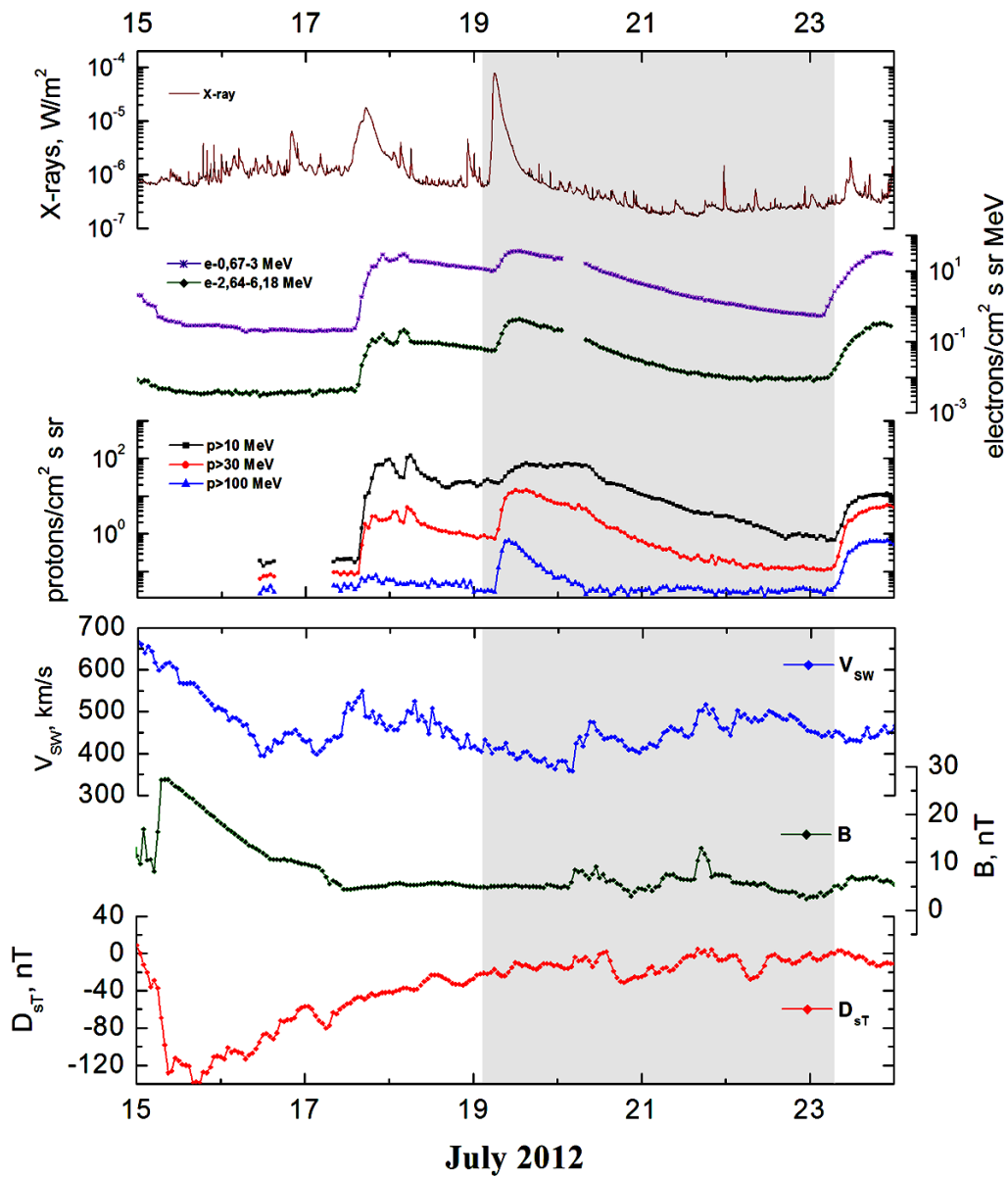
Sources: ■ solar flare 19d04^h17^m, M7.7/, S16W90, AR11520, 0.5d behind W_L;

Main burst X-ray 1–8 Å: onset – 19d04^h17^m, max – 19d05^h58^m, $\Phi = 0.36$ J/m²

CME: 19d05^h24^m, V = 1631 km/s, $\Delta\phi = 360^\circ$, dA = 275°

▲ SC 20d04^h49^m; ▲ SC 21d16^h12^m

Particle fluxes and associated phenomena

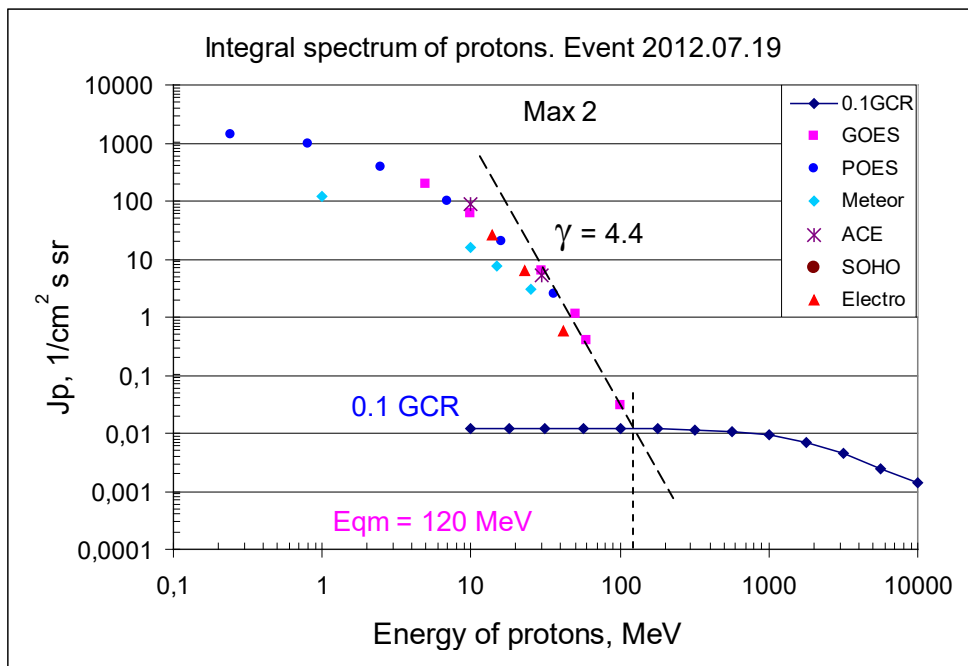
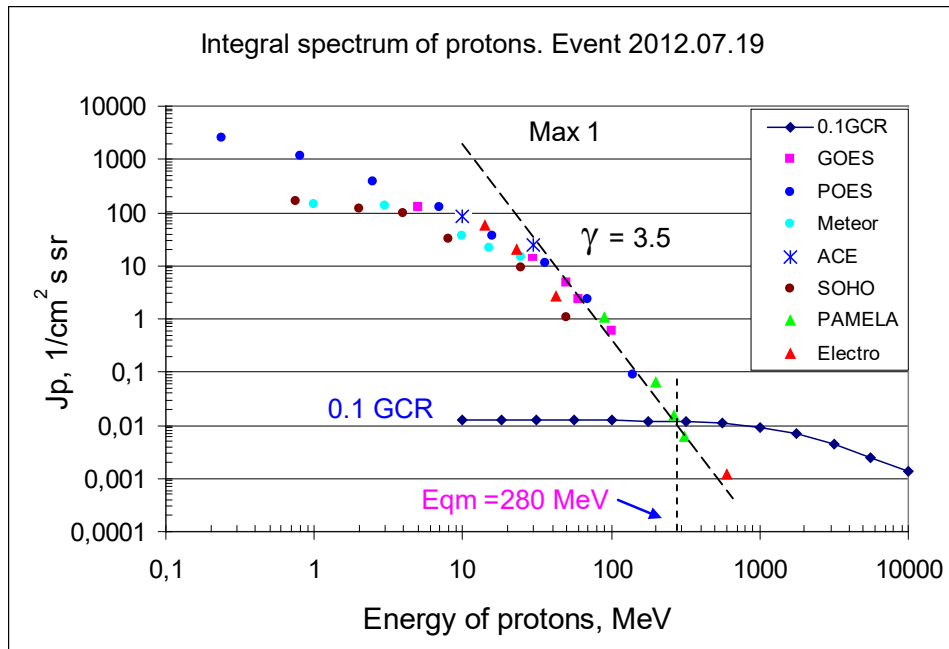


Integral fluxes of protons for the event of 2012 July 19

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	15/20d04	125/200	4	0.2	
EPS	>10	6	15/20d03	75/72	4	0.15	
EPS	>30	6	15/20d03	14.5/5.8	3	0.09	
EPS	>50	6	12/20d02	4.8/1.1	3	0.07	
EPS	>60	6	12/20d02	2.4/0.4	3	0.05	
EPS	>100	6	10/20d02	0.6/0.03	1	0.04	
Electro-1							
GALS-E	>600	18	15/20d06	0.0012/0.0003	1.5	0.0009	
POES							
MEPED	>0.24	-	11/20d07	2610/1390	4	150	
MEPED	>0.8	-	11/20d07	1130/970	4	95	
MEPED	>2.5	-	11/20d07	390/395	3	55	
MEPED	>6.9	6	11/20d07	122/100	3	40	
MEPED	>16	6	12/20d07	37.4/20.2	3	0.9	
MEPED	>36	6	12/20d07	10.9/2.55	2	0.8	
MEPED	>70	6	11/ -	2.4/ -	1	0.8	
MEPED	>140	6	11/ -	0.09/ -	-	1.1	
Meteor-1							
SCR	>1	6	15/20d10	144/123	4	2.7	
SCR	>3	6	15/ -	131/ -	4	2.1	
SCR	>10	6	15/20d10	37/16	2	1.65	
GALS-M	>15	6	15/20d10	22/7.5	2	1.3	
GALS-M	>25	6	15/20d10	14.1/3.1	2	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	6	13/20d04	86/79	4	1.4	
SIS	>30	6	12/20d04	24/6.4	3	1	
SOHO							
EPHIN	>50	6	11/ -	1.1/ -	2	0.25	
PAMELA							
TRACKER	>90	06	06-12/ -	1.1/ -	1.5	-	
TRACKER	>200	06	06-12/ -	0.063/ -	1	-	
TRACKER	>265	06	06-12/ -	0.015/ -	1	-	
TRACKER	>312	06	06-12/ -	0.006/ -	1		

Differential fluxes of protons for the event of 2012 July 19

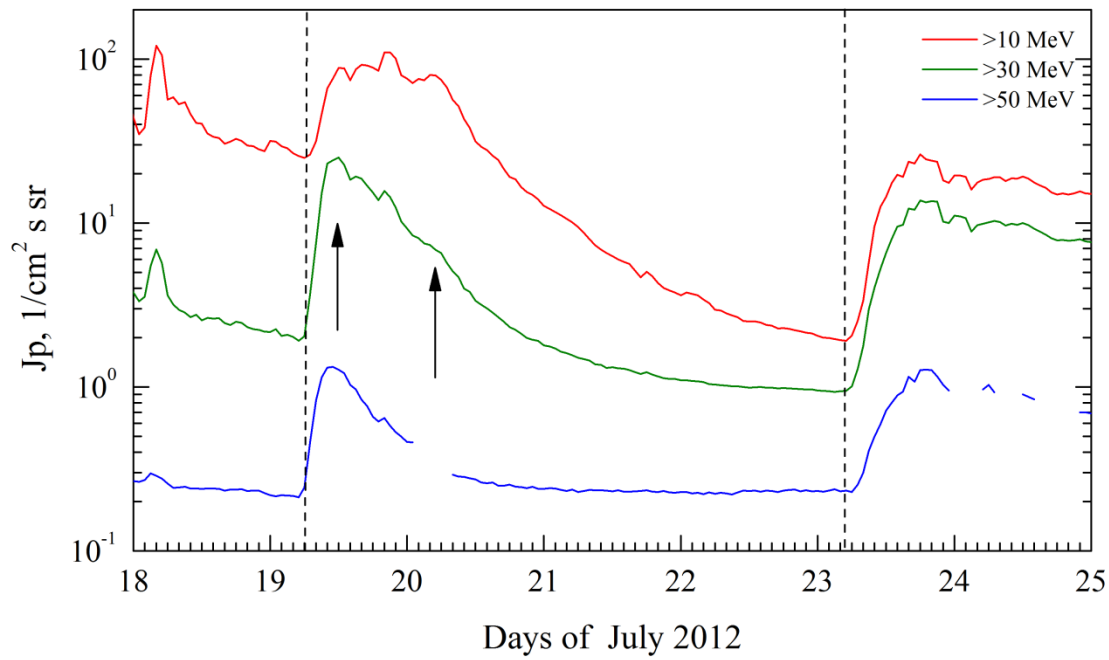
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	13	20/ -	37.7/-	4	0.1	
LION	2 – 6	13	20/ -	8.5/-	4	0.01	
EPHIN	4 – 8	12	13/ -	16.1/-	4	0.03	
EPHIN	8 – 25	12	13/ -	2.26/-	4	0.003	
EPHIN	25 – 53	07	13/ -	0.29/-	4	0.0001	
Electro-1							
SCR-E	13.7–23	18	15/20d06	3.83/2.12	3	0.05	
SCR-E	23–42	18	15/20d06	0.93/0.3	3	0.08	
SCR-E	42–112	18	15/20d06	0.039/0.008	2	0.005	



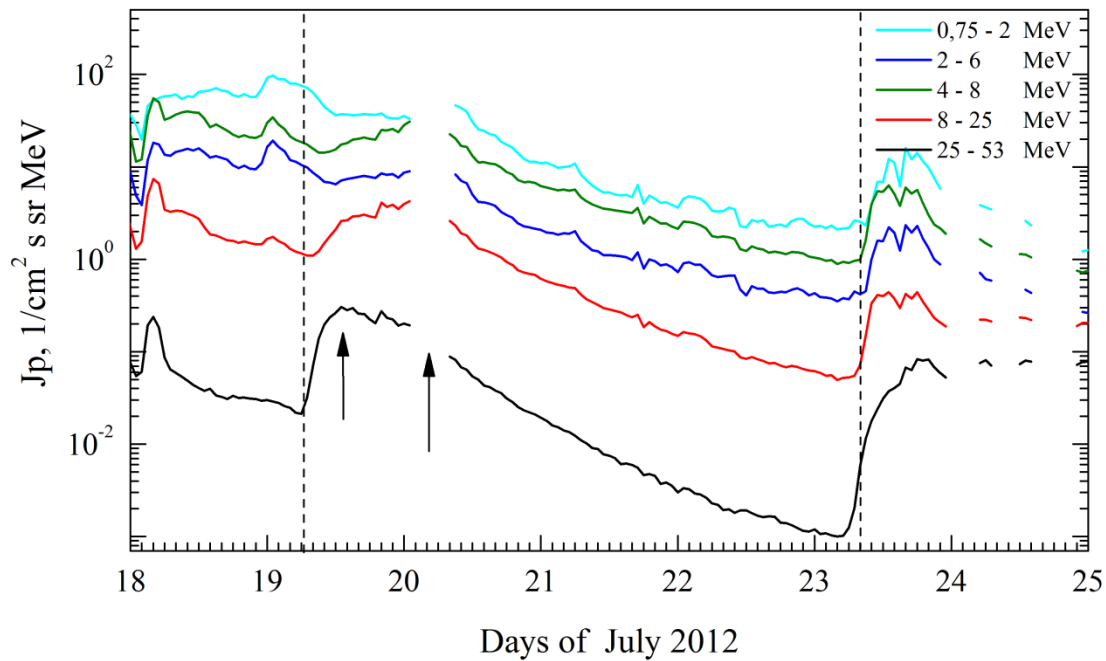
Time profiles of proton fluxes in the event 2012.07.19

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.07.19

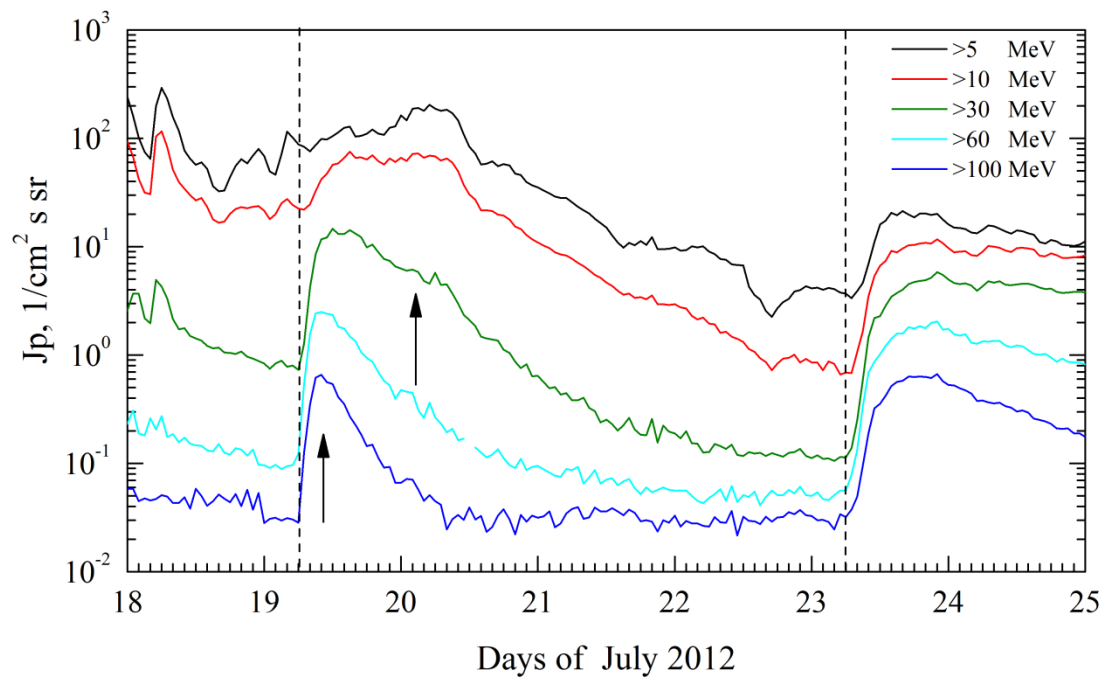


SOHO. Event 2012.07.19

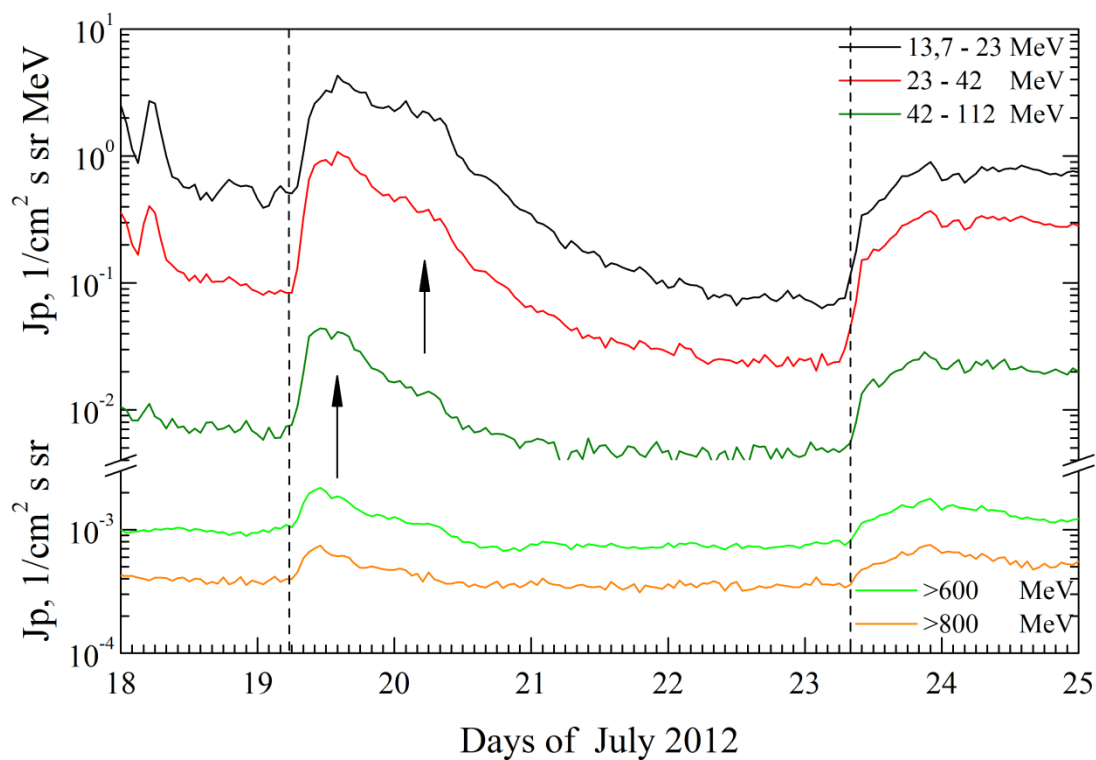


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2012.07.19

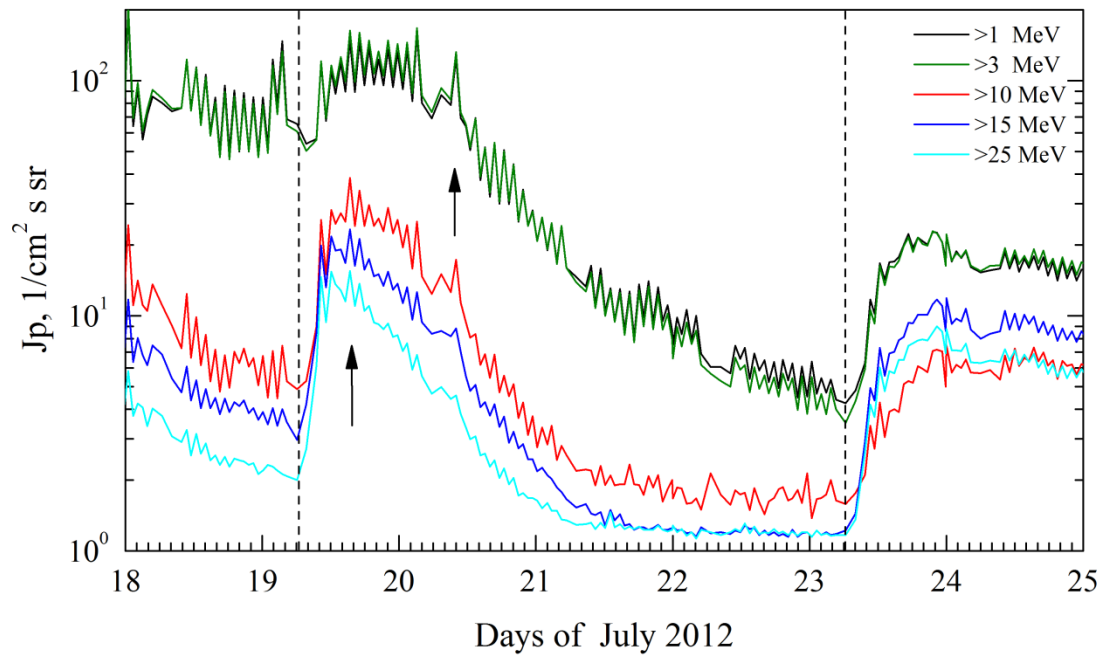


Electro. Event 2012.07.19

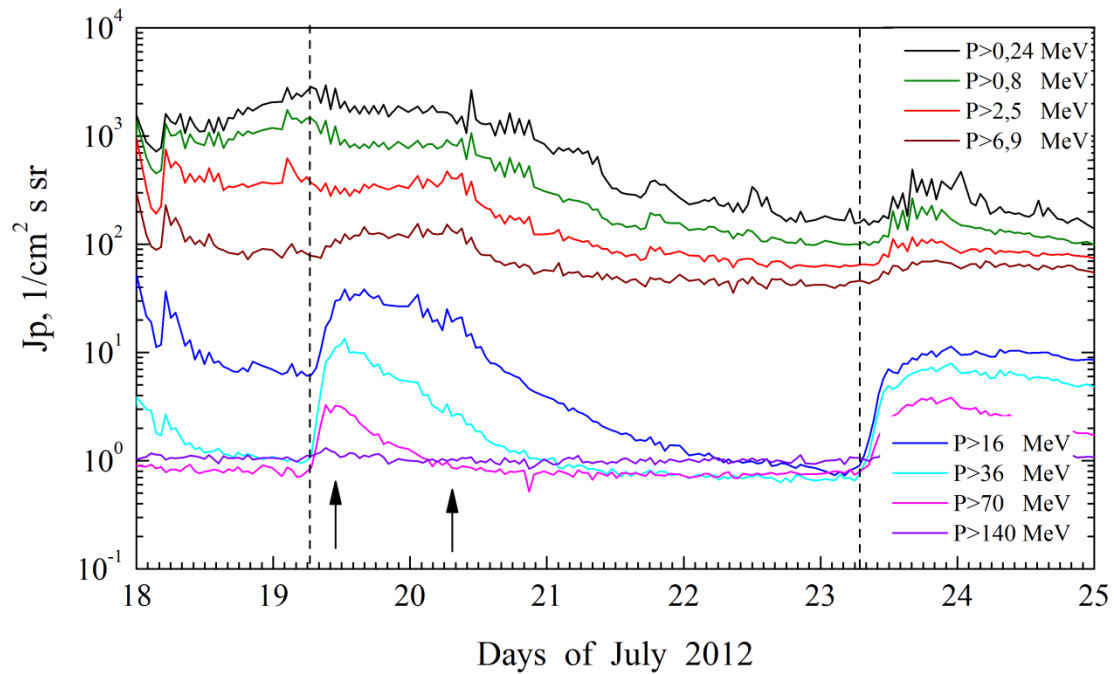


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.07.19



POES. Event 2012.07.19



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 July 19**

2012

July 19

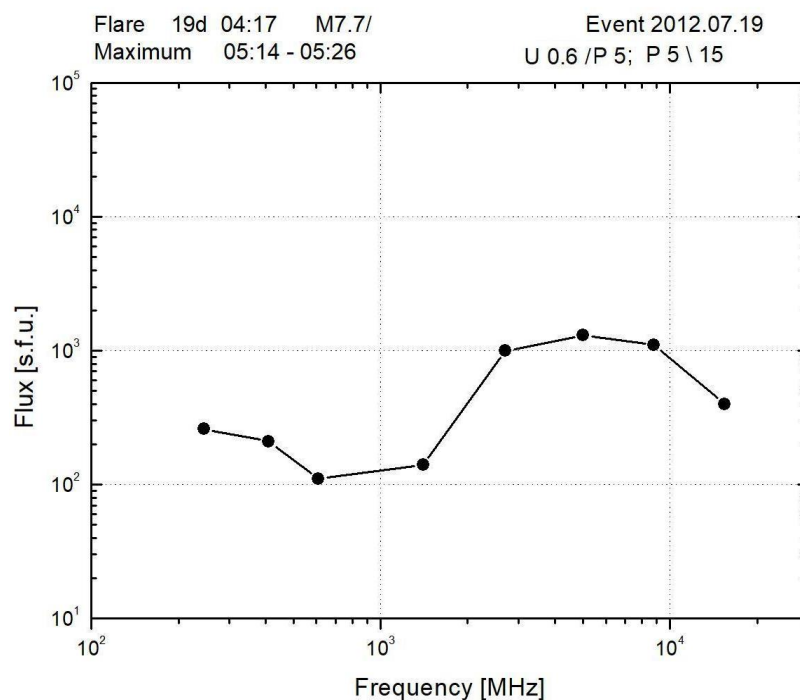


AR 11520

To event 517

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
6563 Å	LPS	0557		0928	0.12		0557
1 – 12	keV	0417	0558	0656	S13W88	M7.7	0.36
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0434:08	0443:18	0444:52	21	54535	HESSI
12-25	keV	0444:52	0455:22	0458:16	60	169840	HESSI
50-100	keV	0458:16	0529:30	0533:28	3696	13453050	HESSI
6-12	keV	0654:40	0654:46	0655:00	219	23852	HESSI
6-12	keV	0655:08	0655:50	0656:20	248	88601	HESSI
12-25	keV	0451:20	0454:41	0456:39	3057	155950	FERMI
12-25	keV	0504:51	0509:05	0510:14	3774	181865	FERMI
12-25	keV	0546:13	0552:18	0645:49	215053	6704178	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0520	0526	0538	P5 \ 15	2.6	
8.8	GHz	0518	0526	0602		3.04	
5	GHz	0517	0526	0601		3.11	
2.7	GHz	0517	0521	0601		3.0	
1.4	GHz	0513	0514	0514		2.15	
610	MHz	0516	0516	0517	U0.6 / P5	2.04	
410	MHz	0518	0519	0522		2.32	
245	MHz	0522	0524	0527		2.41	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-100	0524		0538		1	
DS IV	020-750	0523		0630		1	
DS III	020-120	0613		0617		1	
DS III	027-120	0643		0654		1	
DH II	0.6-5	0530		0620			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0524	1631	-8.0	360°	275°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11520 (S16L084, CMP 12.3.07.2012,
Sp=1460 msh, FKC, BGD, R)
XRI=2.82 $X_2^{1.4} + M_5^{7.7} + C_{26}$ $2_1 + 1_7 + S_{64}$
PFR1 12.07 $X_2^{1.4}$
PFR2 19.07 $M_1^{7.7}$

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Zhuang B., N. Lugaz, T. Gou et al., 2020.

Particle event: To($E_p > 10$ MeV) – 23d06^h

Tmax ($E_p > 10$ MeV) – 23d22^h, Jmax ($E_p > 10$ MeV) – 11/cm²·s·sr

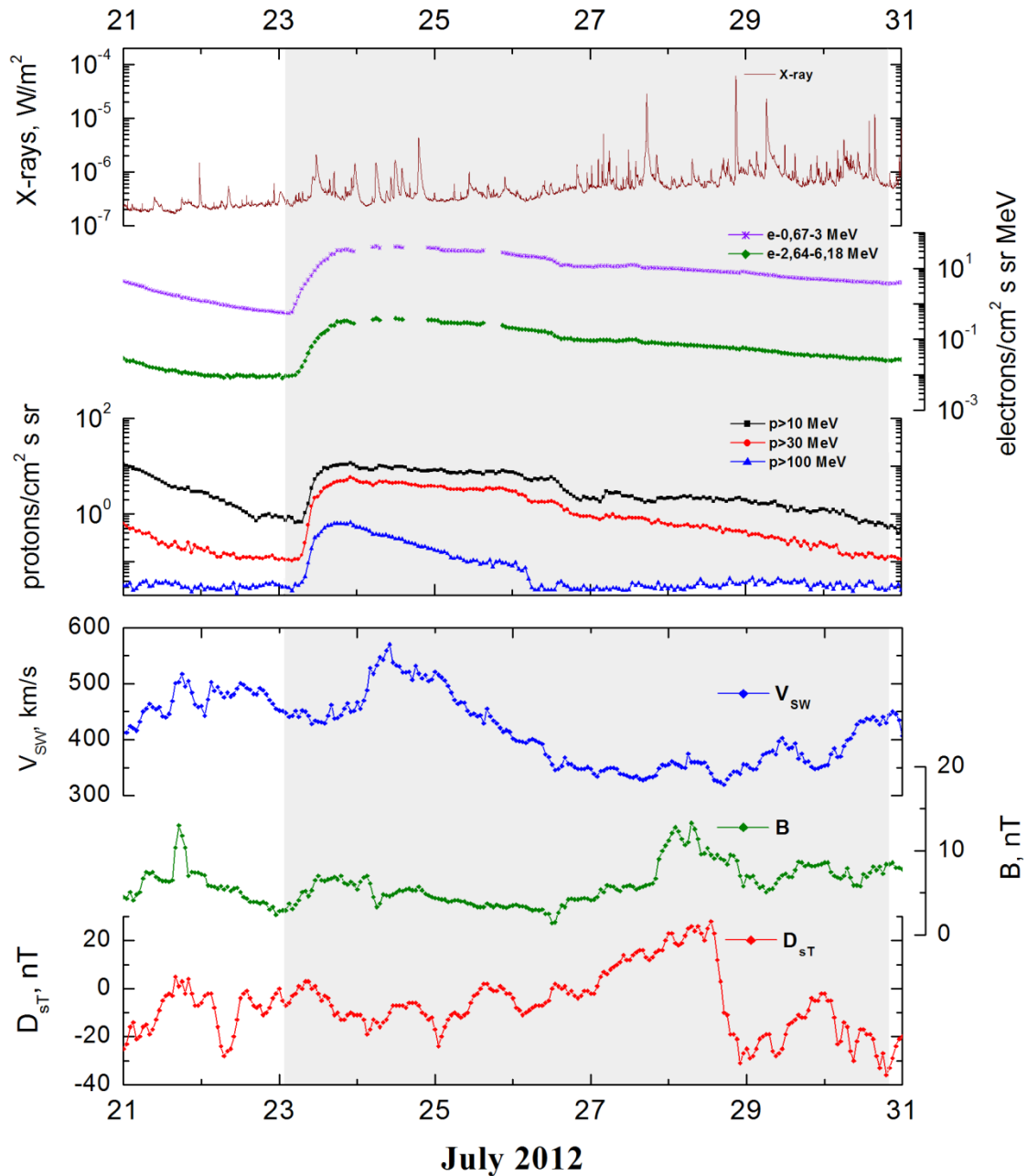
Duration of the event – 8 days, power-law index: $\gamma = 3.6$

Quasimaximal energy of protons in the event – $E_{qm} = 250$ MeV

Sources: \square back side solar flare 23d<02^h36^m, AR11520, 4d behind W_L

CME: 23d02^h36^m, $V = 2003$ km/s, $\Delta\phi = 360^\circ$, $dA = 286^\circ$

Particle fluxes and associated phenomena

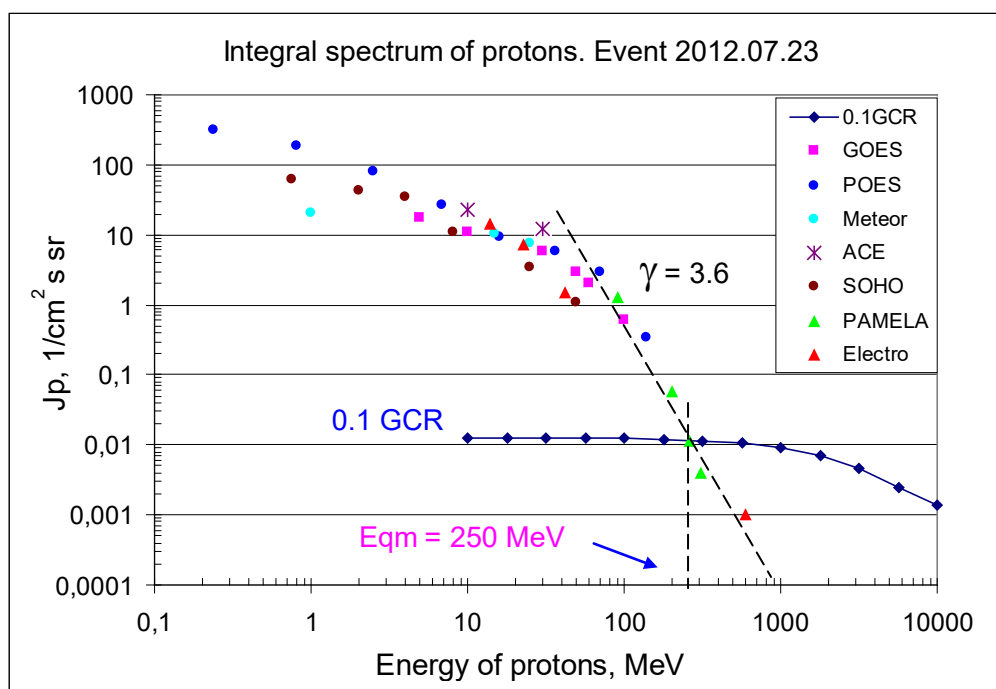


Integral fluxes of protons for the event of 2012 July 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	23	17,9	8	0.2	
EPS	>10	6	22	11	8	0.15	
EPS	>30	6	22	5,8	7	0.09	
EPS	>50	6	22	3	7	0.07	
EPS	>60	6	22	2,0	7	0,05	
EPS	>100	6	20	0.6	3	0,04	
Electro-1							
GALS-E	>600	7	22	0,001	3	0,001	
POES							
MEPED	>0.24	9	20	310	4	95	
MEPED	>0.8	9	20	190	4	75	
MEPED	>2.5	9	20	80	4	55	
MEPED	>6.9	9	20	27	4	45	
MEPED	>16	7	20	9.2	4	0.8	
MEPED	>36	7	20	5.8	4	0.8	
MEPED	>70	7	20	2.9	3	0.8	
MEPED	>140	7	20	0.35	1	1	
Meteor-1							
SCR	>1	6	22	20.3	7	2.7	
SCR	>3	6	-	-	7	2.1	
SCR	>10	6	-	-	7	1.65	
GALS-M	>15	6	22	10.4	7	1.3	
GALS-M	>25	6	22	7.5	6	1.4	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	5	19	23	8	1.4	
SIS	>30	5	19	12	7	1	
SOHO							
EPHIN	>50	08	19	1.08	4.5	0.22	
PAMELA							
TRACKER	>90	07	07-17	1.3	>1	-	
TRACKER	>200	07	07-17	0.058	>1	-	
TRACKER	>265	07	07-17	0.011	>1	-	
TRACKER	>312	07	07-17	0.004	>1		

Differential fluxes of protons for the event of 2012 July 23

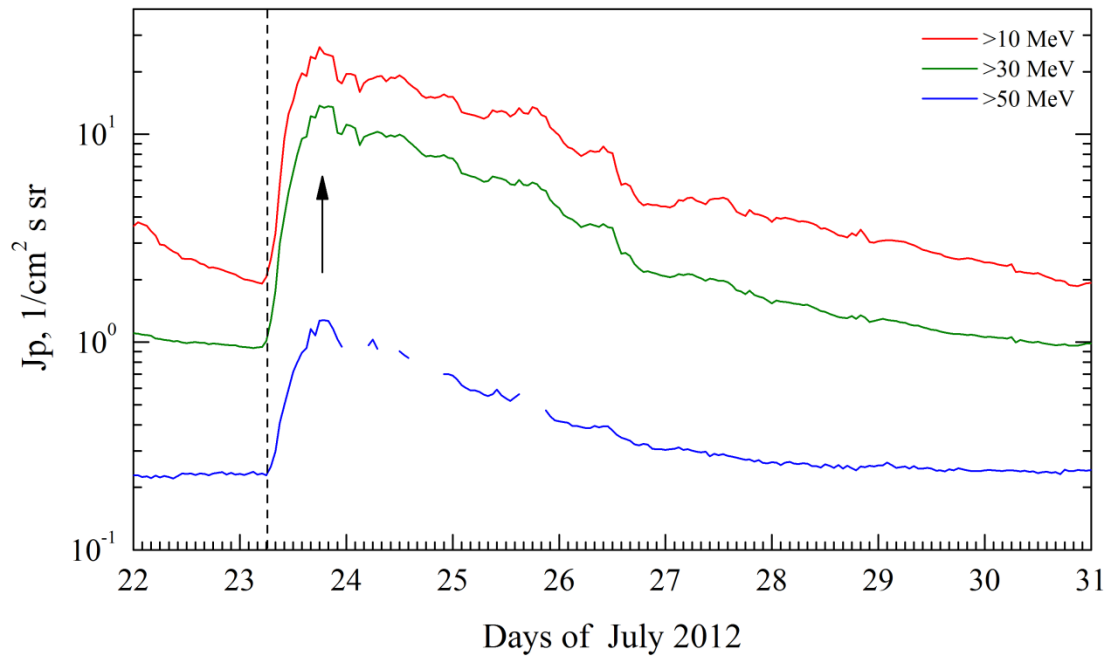
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	08	16	15.9	3.5	0.1	
LION	2 – 6	08	16	2.33	3.5	0.01	
EPHIN	4 – 8	01	18	6	3.5	0.03	
EPHIN	8 – 25	01	18	0.44	10	0.003	
EPHIN	25 – 53	02	18	0.085	10	0.00008	
Electro-1							
SCR-E	13.7–3	7	22	0.72	8	0.06	
SCR-E	23–42	7	22	0.31	8	0.025	
SCR-E	42–12	7	22	0.021	6	0.005	



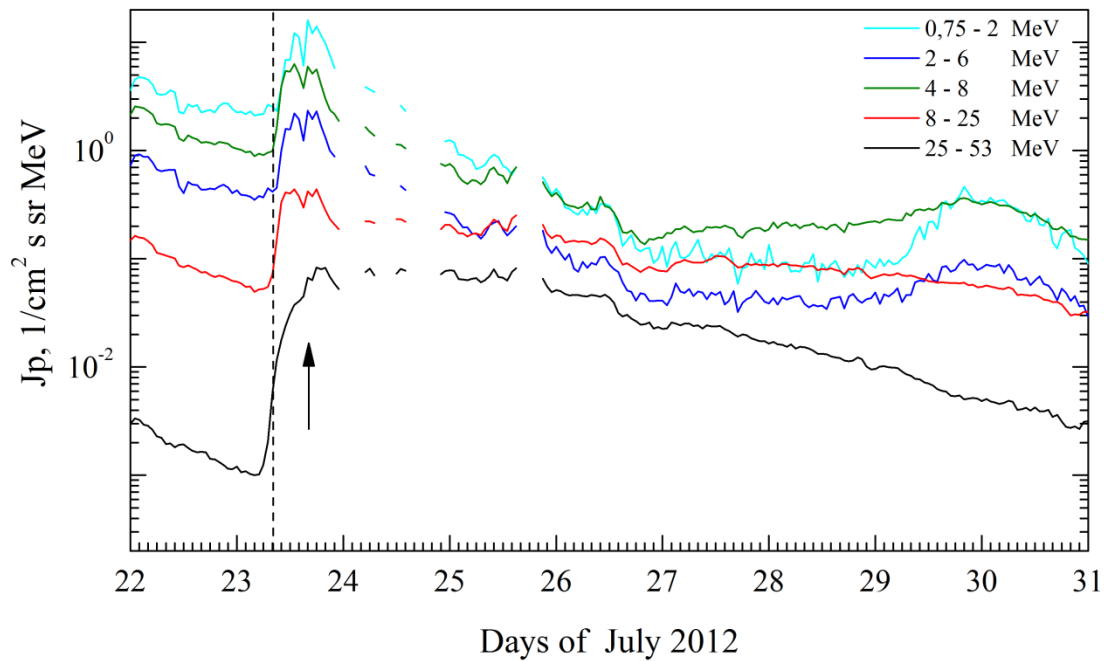
Time profiles of proton fluxes in the event 2012.07.23

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.07.23

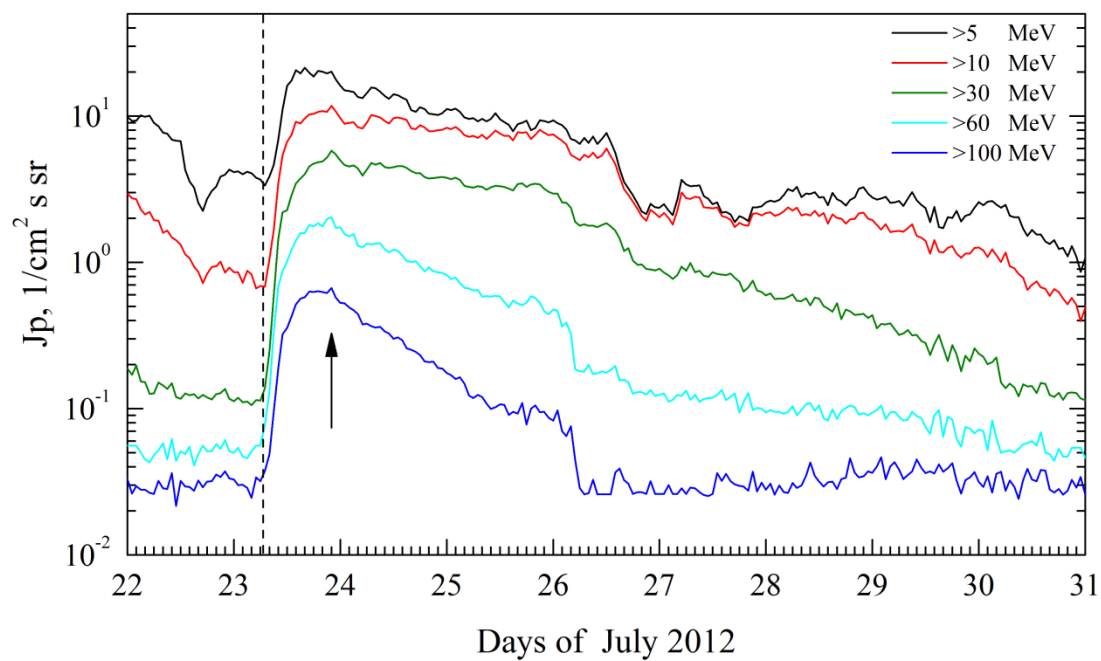


SOHO. Event 2012.07.23

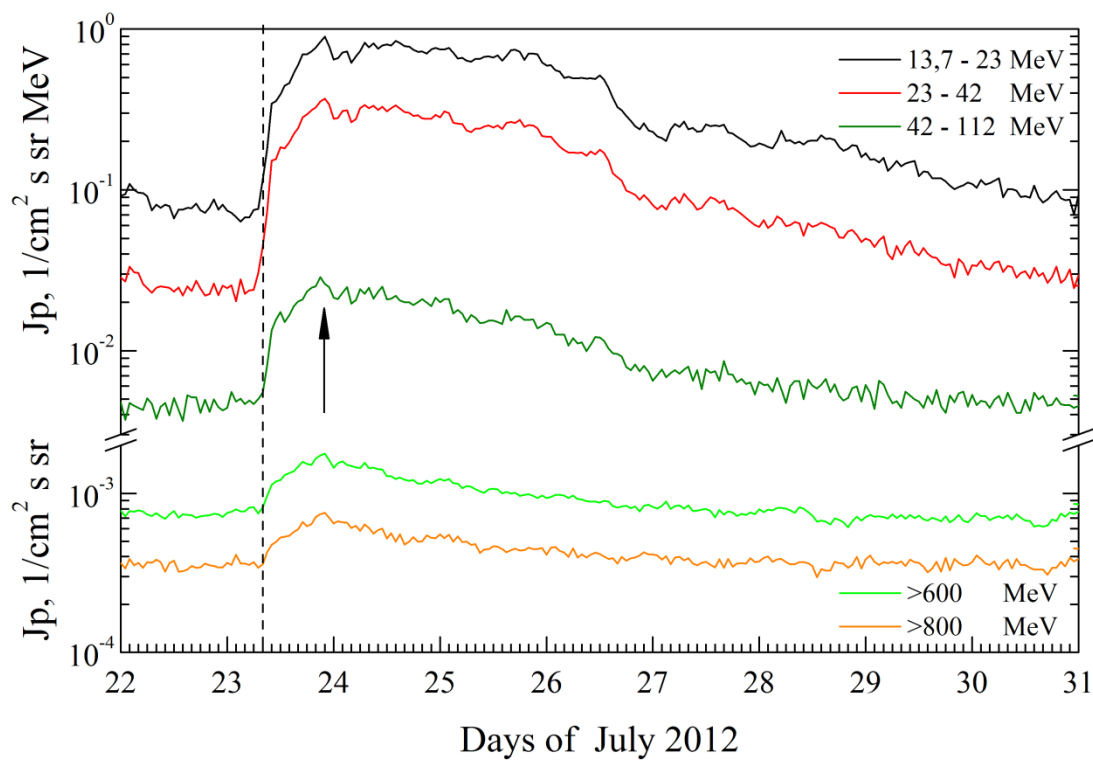


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2012.07.23

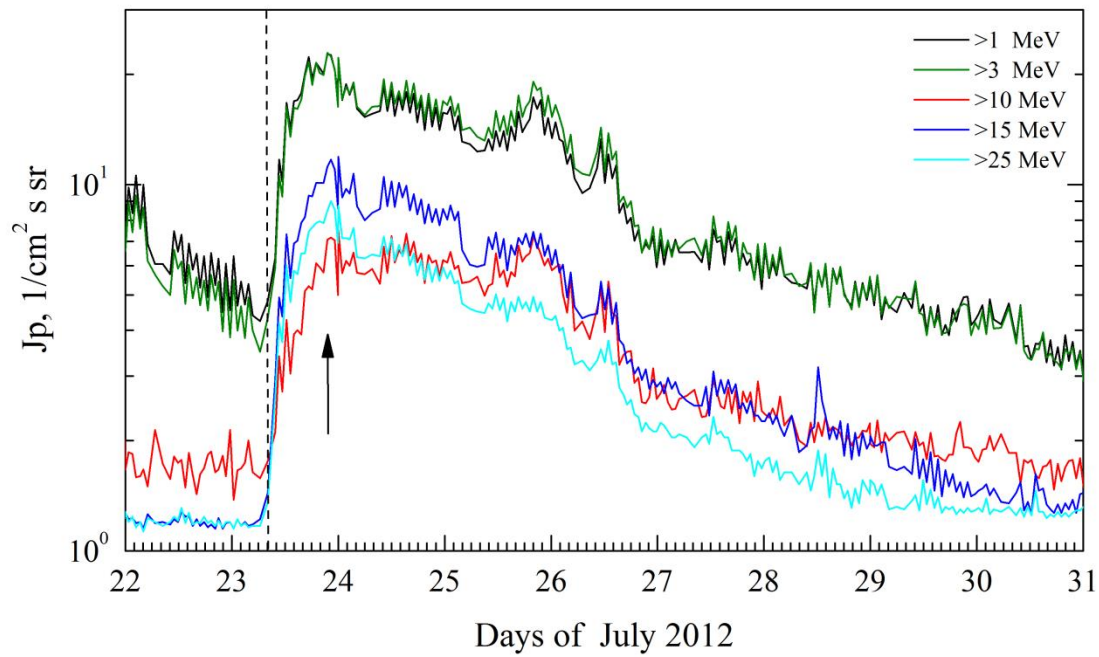


Electro. Event 2012.07.23

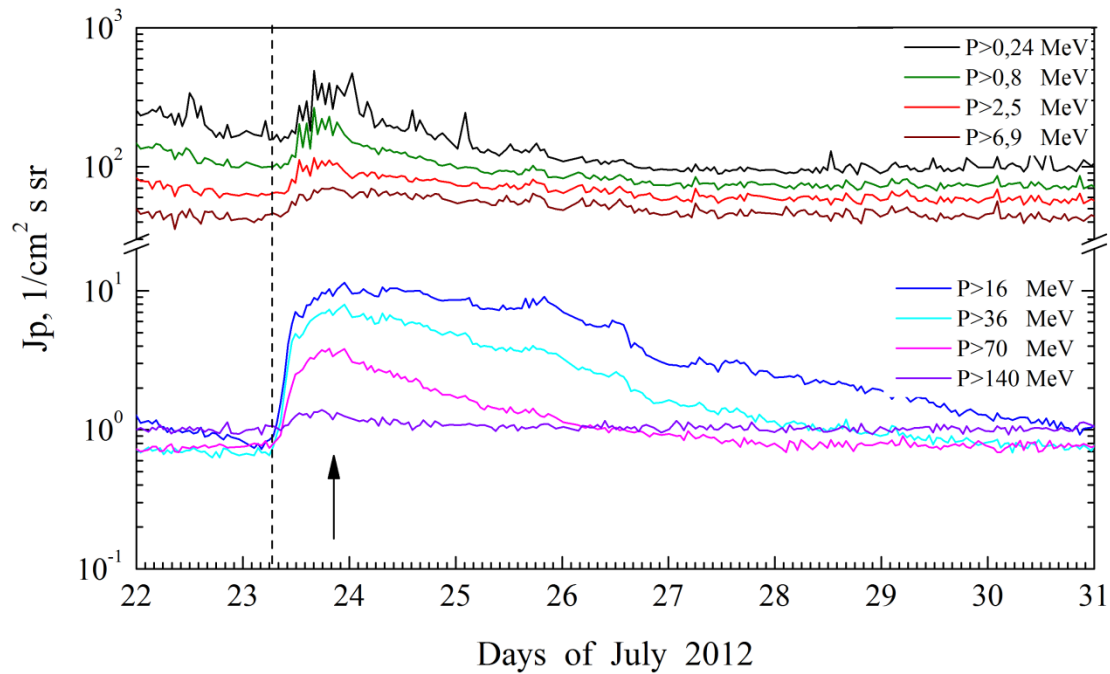


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2012.07.23



POES. Event 2012.07.23



**Electromagnetic and other phenomena that are sources and/or accompanying for the event
of 2012 July 23**

2012

July 23



AR 11520

To event 518

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
410	MHz	0220	0220	0220		2.0	
245	MHz	0225	0225	0225		2.41	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	020-045	0231		0237		1	
DS III	020-730	0218		0226		1	
DS CTM	075-180	0217		0235		1	
DH II	0.02-16	0230		2140			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0236	2003	- 24.6	360°	286°	SOHO

Proton Active Region:

AR11520 (S16L084, CMP 12.3.07.2012,

Sp=1460 msh, FKC, BGD, R)

XRI=2.82 X₂^{1.4}+M₅^{7.7}+C₂₆ 2₁+1₇+S₆₄

PFR1 12.07 X₂^{1.4}

PFR2 19.07 M₁^{7.7}

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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhu B., Y.D Liu, J.G. Luhmann et al., [2016](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 02d10^h

Tmax ($E_p > 10$ MeV) – 02d21^h, Jmax ($E_p > 10$ MeV) – 0.6 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma = 2.2$

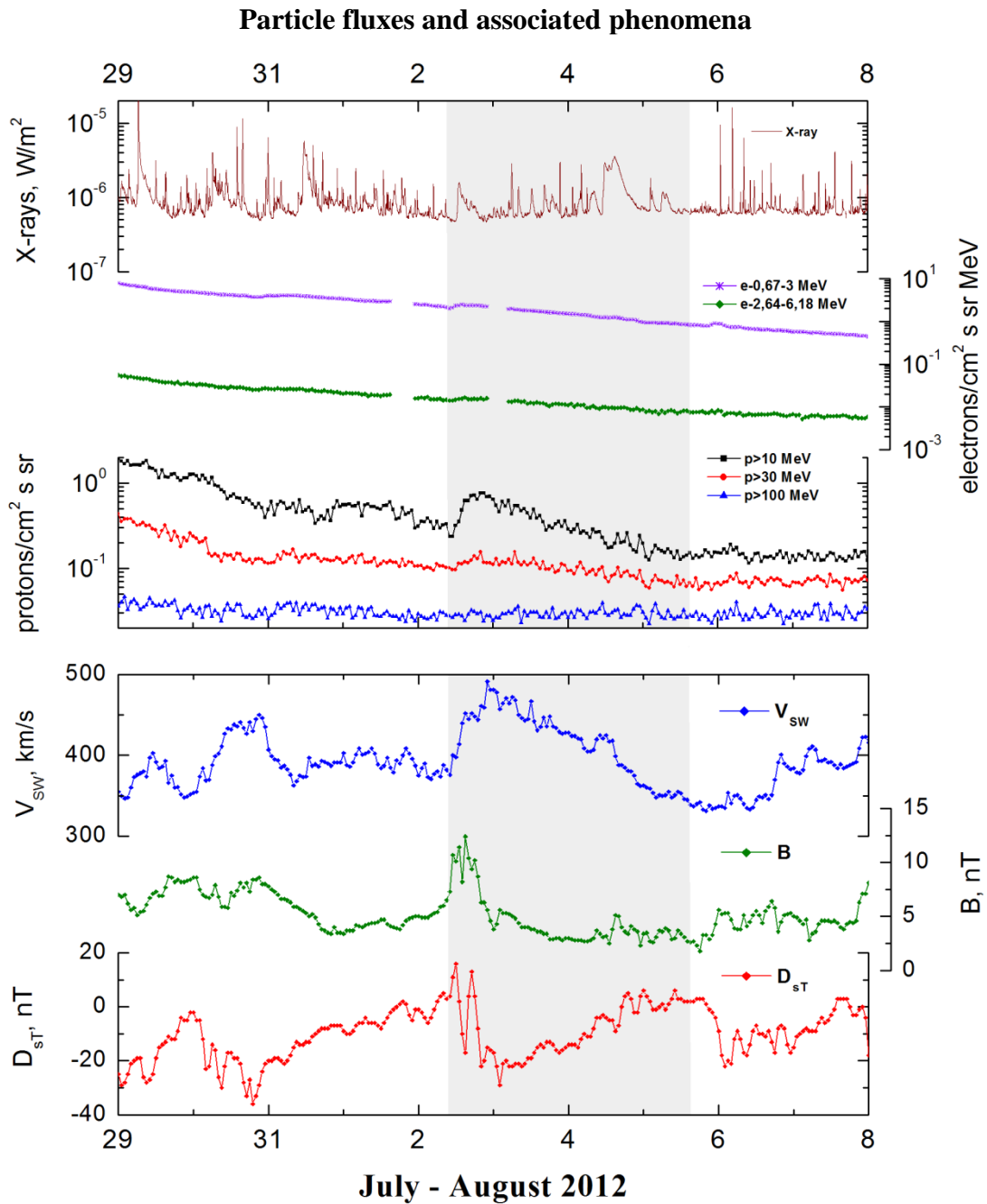
Quasimaximal energy of protons in the event – $E_{qm} = 50$ MeV

Sources: ☐ solar flare 02d12^h10^m, C1.5/, S20W87, AR11529

Main burst X-ray 1–8 Å: onset – 02d12^h10^m, max – 02d13^h10^m, $\Phi = 0.0057$ J/m²

CME: 02d13^h26^m, $V = 563$ km/s, $\Delta\phi = 108^\circ$, $dA = 234^\circ$

▲ SC 02d10^h50^m

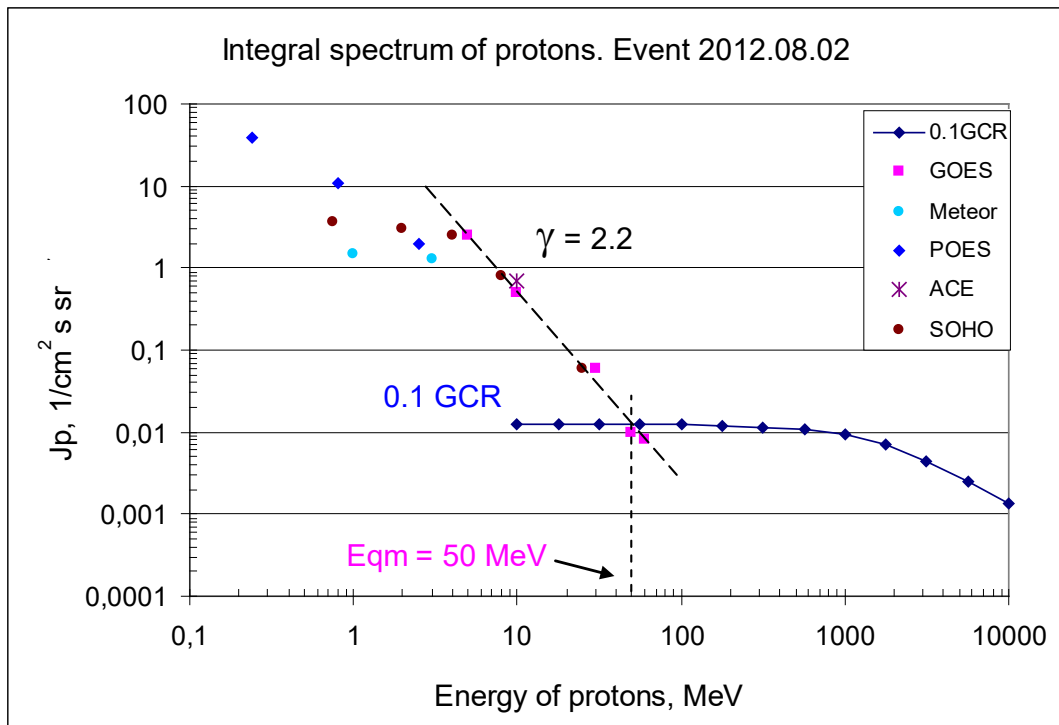


Integral fluxes of protons for the event of 2012 August 02

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	10	21	2.5	3	0.2	
EPS	>10	10	21	0.6	3	0.15	
EPS	>30	10	20	0.06	2	0.09	
EPS	>50	-	20	0.01	-	0.07	
EPS	>60	-	19	0.008	-	0.05	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	10	16	69	1	100	
MEPED	>0.8	-	16	6	-	75	
MEPED	>2.5	-	16	2	-	60	
MEPED	>6.9	-	-	-	-	45	
MEPED	>16	-	-	-	-	0.9	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	1	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	12	20	1.5	3	2.5	
SCR	>3	12	20	1	3	2.5	
SCR	>10	-	-	-	-	-	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	-	
GALS-M	>600	-	-	-	-	-	
ACE							
SIS	>10	10	17	0.7	2.5	1.4	
SIS	>30	10	-	-	-	1	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2012 August 02

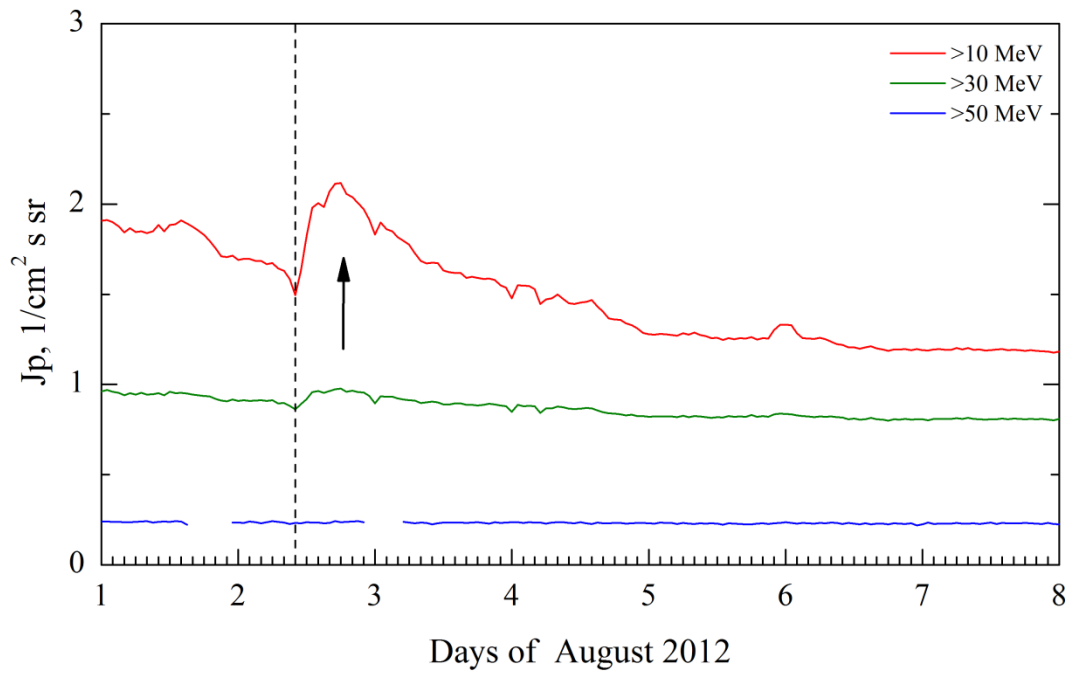
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	12	18	0.6	5	0.1	
LION	2 – 6	12	18	0.14	5	0.01	
EPHIN	4 – 8	12	19	0.43	8	0.03	
EPHIN	8 – 25	12	19	0.045	8	0.003	
EPHIN	25 – 53	12	19	0.002	8	0.00008	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.06	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0.005	



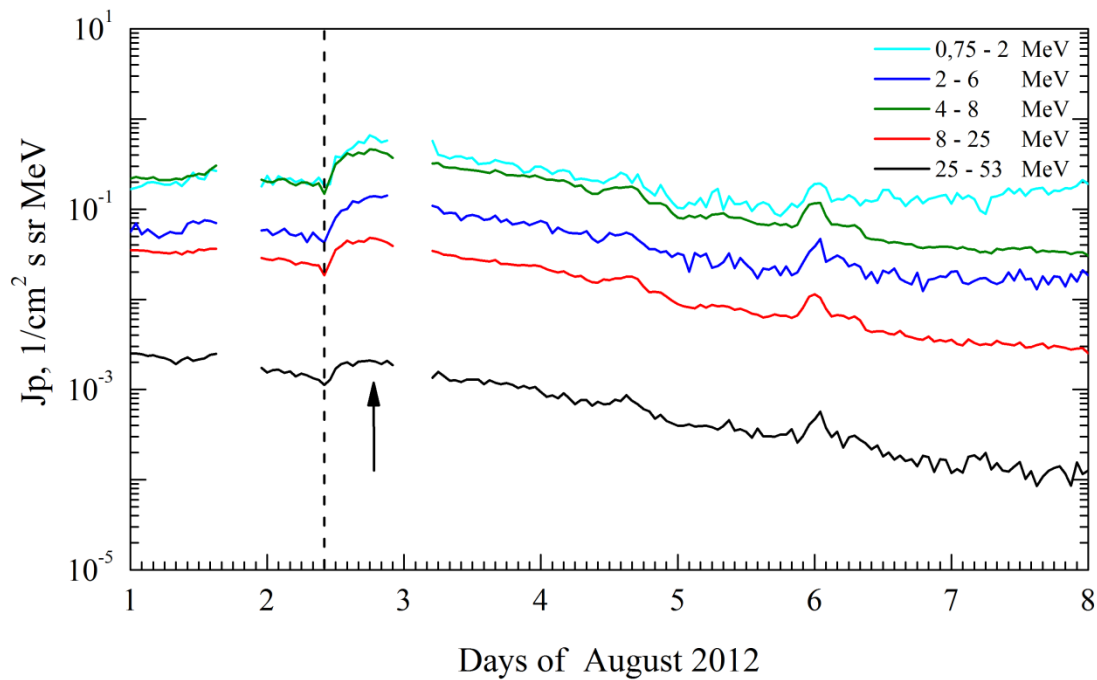
Time profiles of proton fluxes in the event 2012.08.02

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.08.02

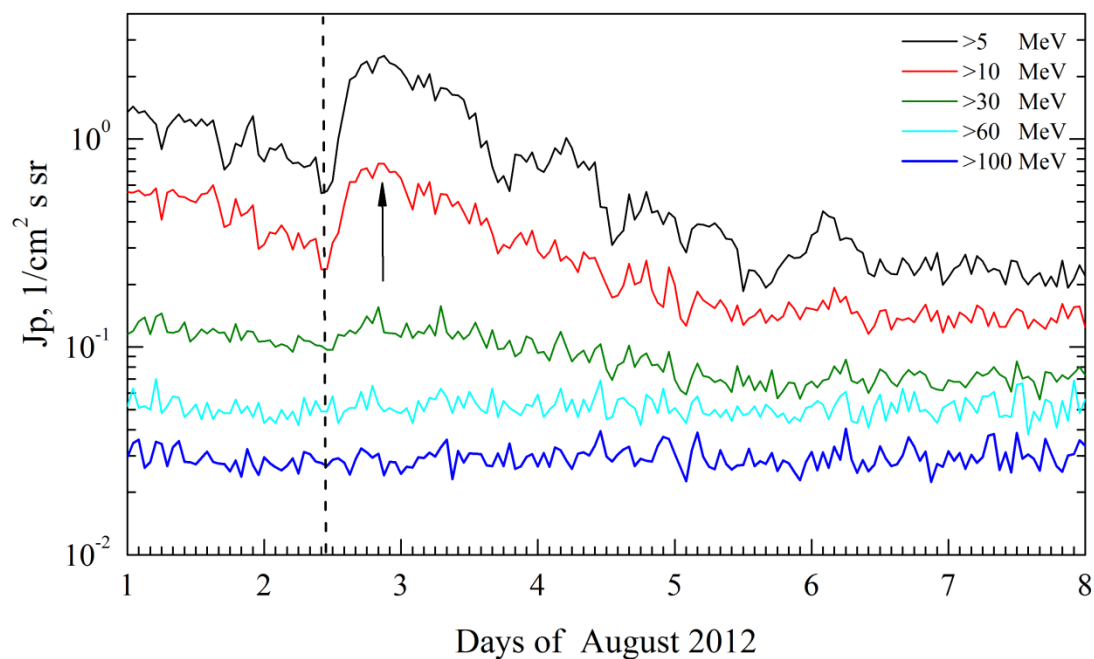


SOHO. Event 2012.08.02

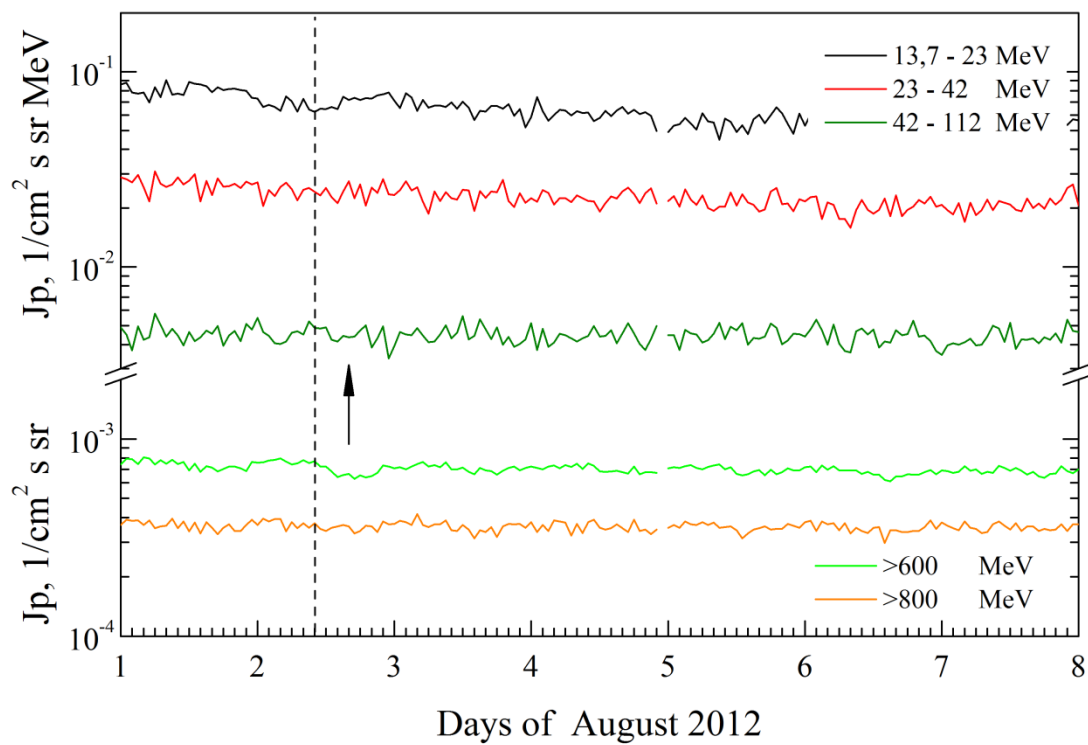


Earth satellites in geostationary orbit, $R \approx 6.6 \text{ Re}$: GOES and Electro.

GOES. Event 2012.08.02

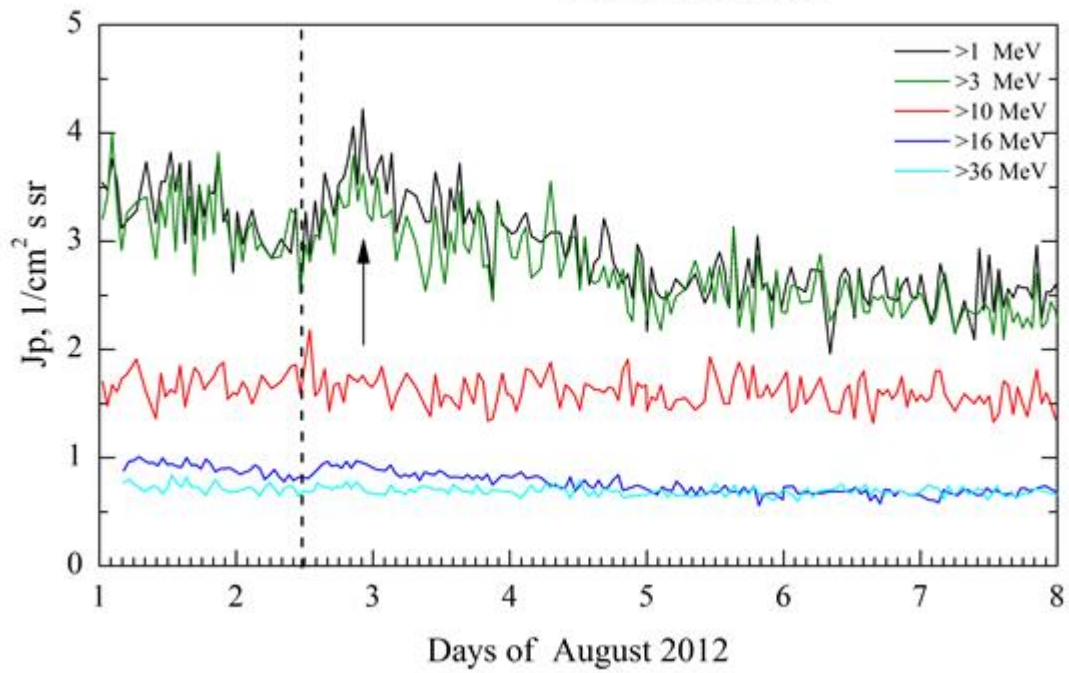


Electro. Event 2012.08.02

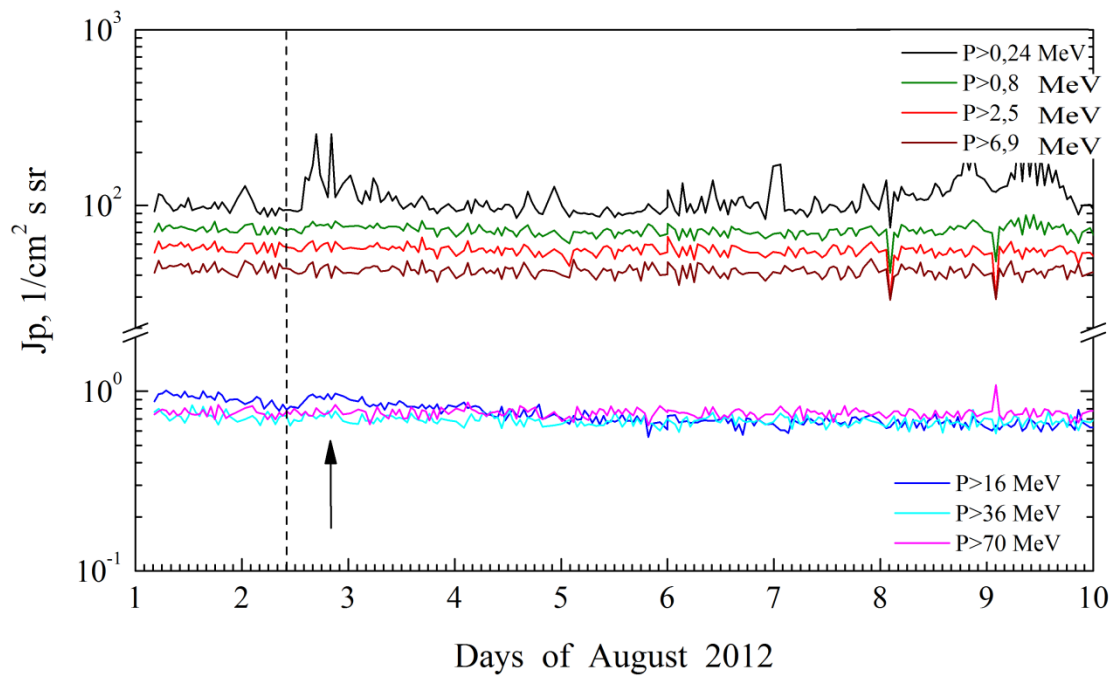


Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES

Meteor . Event 2012.08.02



POES. Event 2012.08.02



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 August 02**

2012 August 02



AR 11529

To event 519

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	1210	1310	1335	S20W87	C1.5	0.0057
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6 – 12	keV	1230:08	1251:50	1256:48	560	2631768	HESSI
6 – 12	keV	1323:08	1324:18	1331:40	208	468960	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS VI	025-128	1214		1526		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1326	563	-0.9	108°	234°	SOHO

Particle event: To($E_p > 10$ MeV) – 01d01^h

Tmax₁($E_p > 10$ MeV) – 01d15^h, Jmax₁($E_p > 10$ MeV) – 24 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 02d10^h, Jmax₂($E_p > 10$ MeV) – 47 /cm²·s·sr

Duration of the event – 5 days, power-law index: $\gamma_1 = 3.4$, $\gamma_2 = 4.1$

Quasimaximal energy of protons in the event – Eqm₁ = 80 MeV

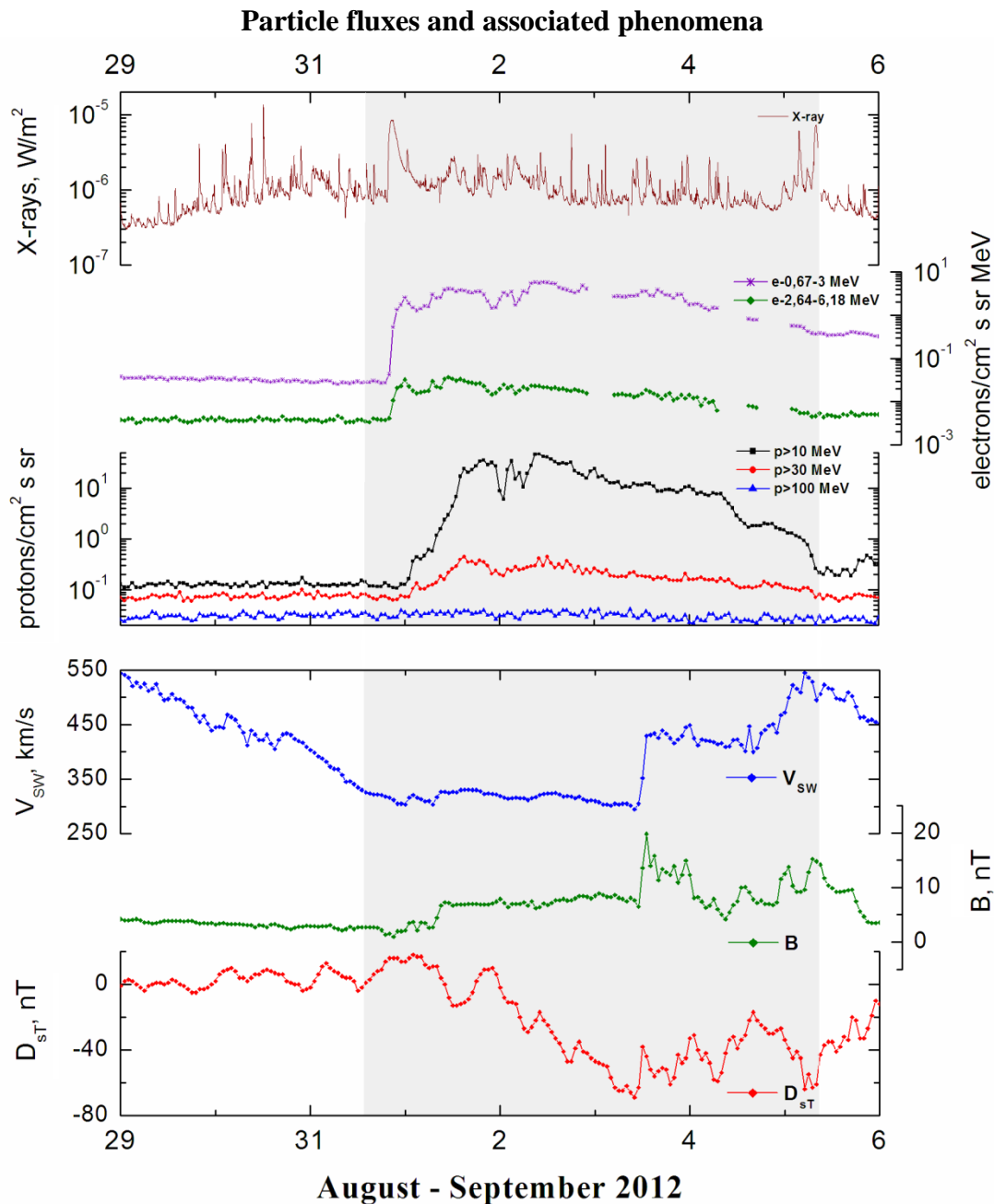
– Eqm₂ = 65 MeV

Sources: ● solar flare 31d19^h45^m, C8.4/2F, S19E42, AR11562

Main burst X-ray 1–8 Å: onset – 31d19^h45^m, max – 31d20^h43^m, $\Phi = 0.051$ J/m²

CME: 31d20^h00^m, V = 1442 km/s, $\Delta\phi = 360^\circ$, dA = 090°

▲ SC 03d12^h13^m

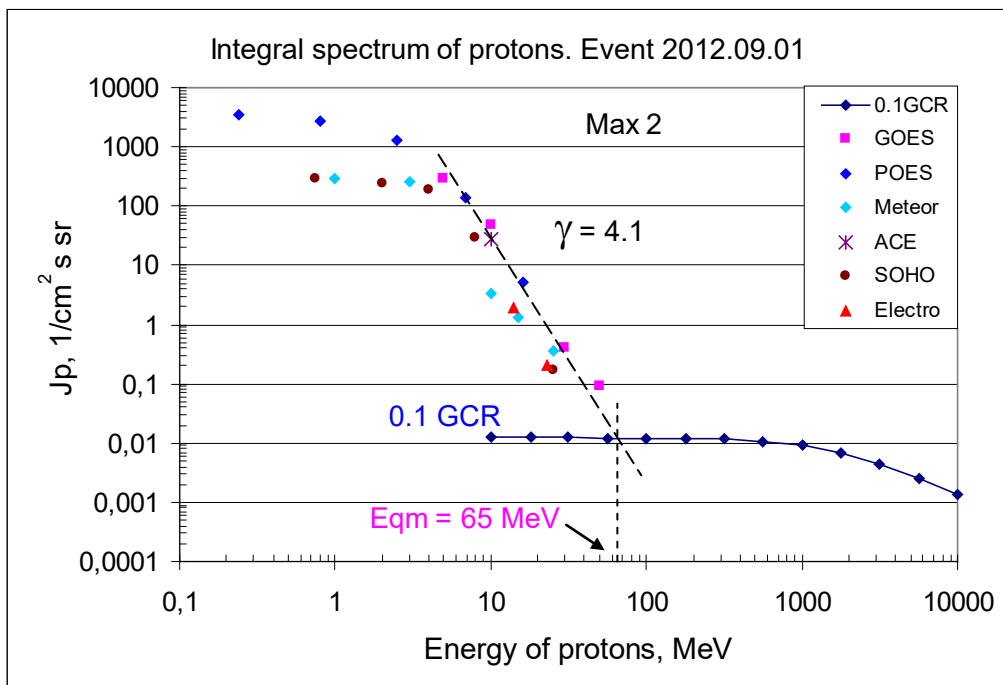
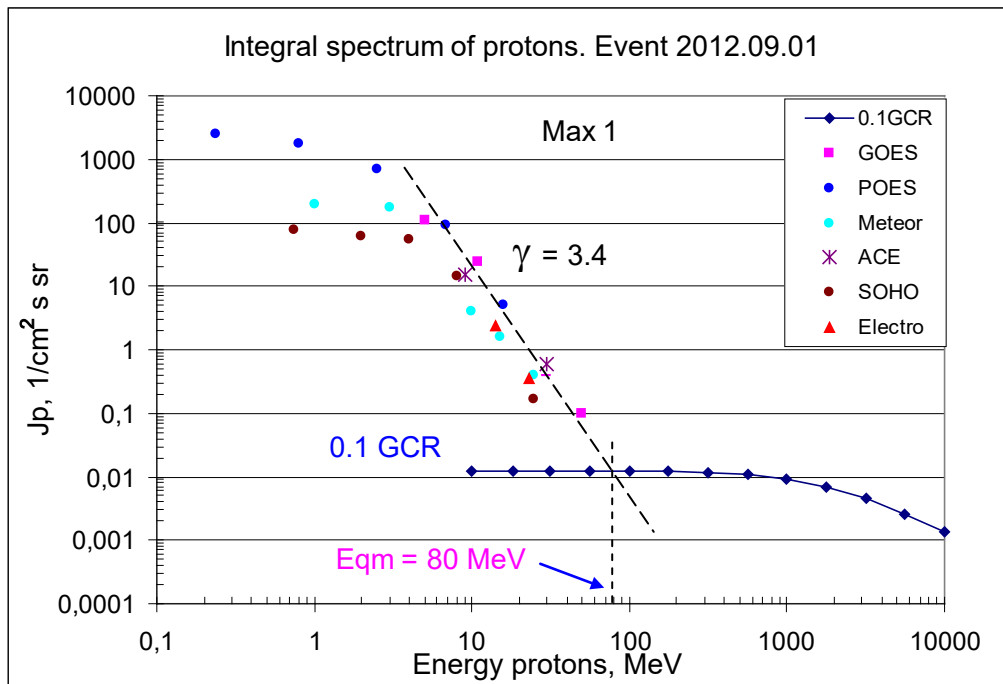


Integral fluxes of protons for the event of 2012 September 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	1	15/02d09	110/300	5	0.2	
EPS	>10	1	15/02d10	24/47	5	0.15	
EPS	>30	1	15/02d10	0.45/0.4	4	0.09	
EPS	>50	1	15/02d12	0.1/0.09	4	0.07	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	10	20/2d11	2480/3480	5	100	
MEPED	>0.8	10	20/2d11	1800/2700	5	75	
MEPED	>2.5	10	20/2d11	710/1280	5	60	
MEPED	>6.9	10	20/2d11	90/140	3	45	
MEPED	>16	10	20/2d11	5.1/5.3	2	0.8	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	2	21/02d13	190/285	5	2.56	
SCR	>3	2	21/02d13	173/254	5	1.99	
SCR	>10	2	21/02d13	4.1/3.4	2.5	1.57	
GALS-M	>15	2	21/02d13	1.6/1.31	2.5	1.20	
GALS-M	>25	2	20/02d12	0.4/0.35	2	1.24	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	2	17/02d09	15/28	4	1.4	
SIS	>30	2	11/ -	0.5/ -	4	1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2012 September 01

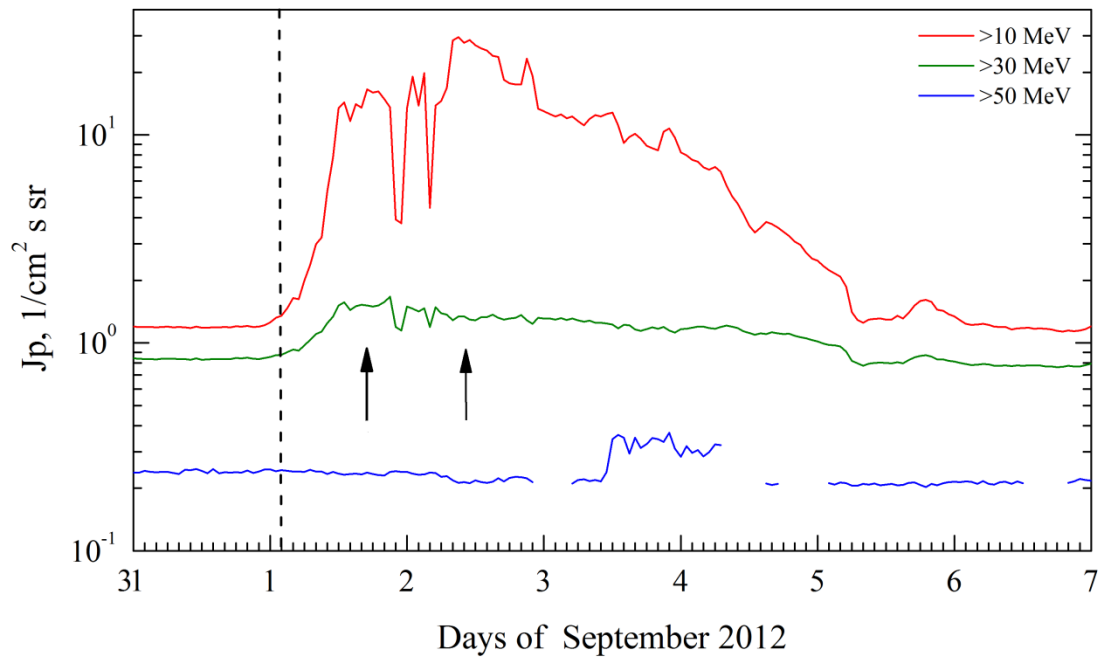
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	03	17/2d12	11/52	5.5	0.03	
LION	2 – 6	01	17/2d09	2.9/15	5.5	0.003	
EPHIN	4 – 8	00	18/2d14	10/40	5.5	0.001	
EPHIN	8 – 25	00	15/2d11	0.8/1.73	5.5	0.00003	
EPHIN	25 – 53	00	14/2d11	0.006/0.006	5.5	0.00002	
Electro-1							
SCR-E	13.7–23	6	14/2d08	0.22/0.18	2	0.06	
SCR-E	23–42	6	14/2d08	0.019/0.011	2	0.025	
SCR-E	42–112	-	-	-	-	0.005	



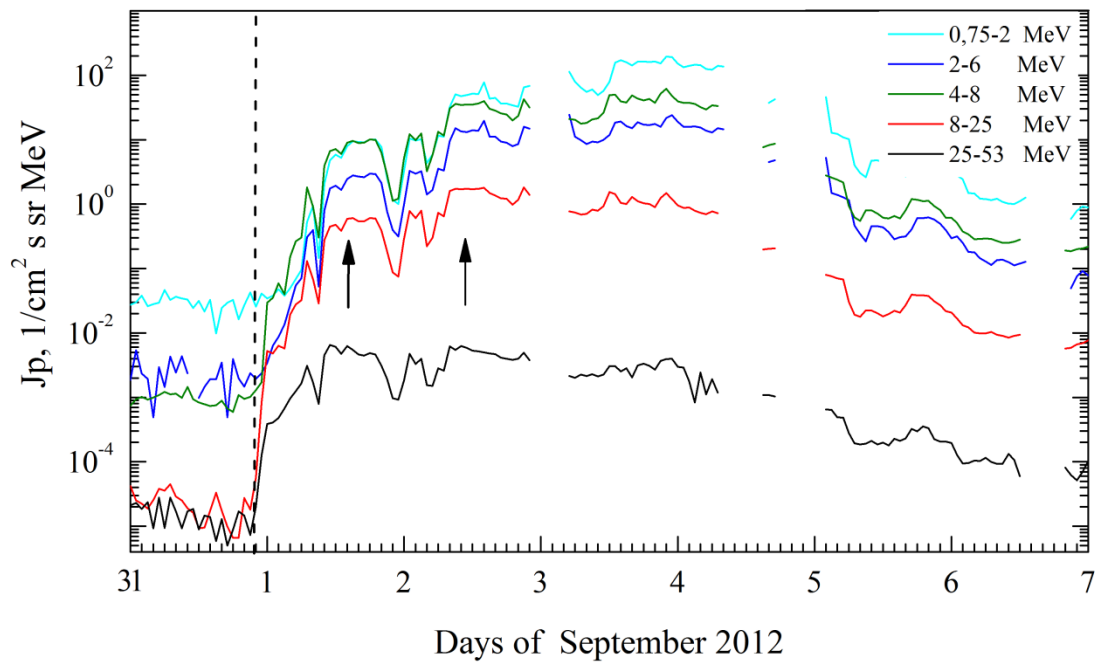
Time profiles of proton fluxes in the event 2012.09.01

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

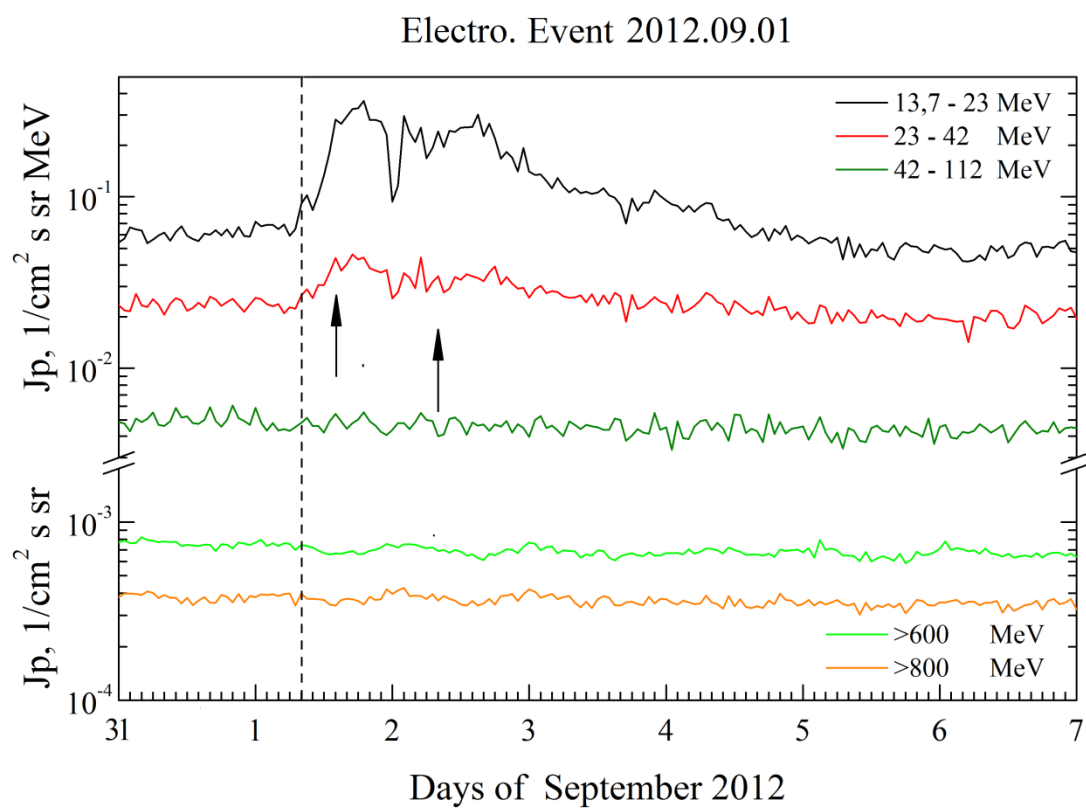
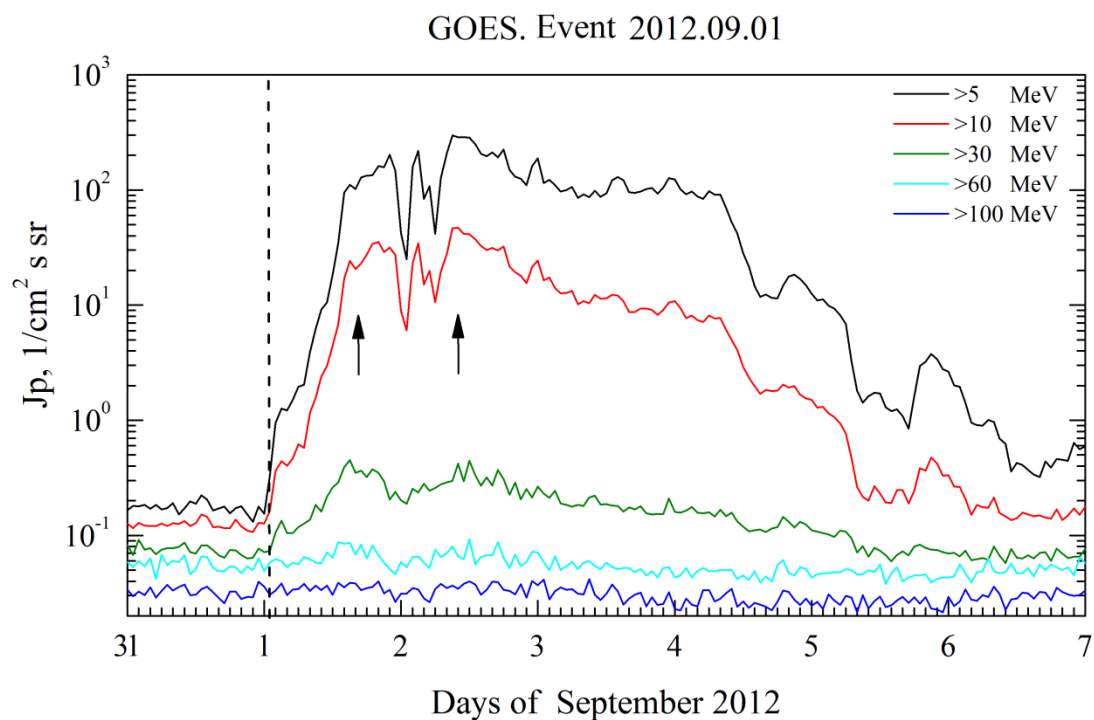
ACE SIS + SOHO (>50 MeV). Event 2012.09.01



SOHO. Event 2012.09.01

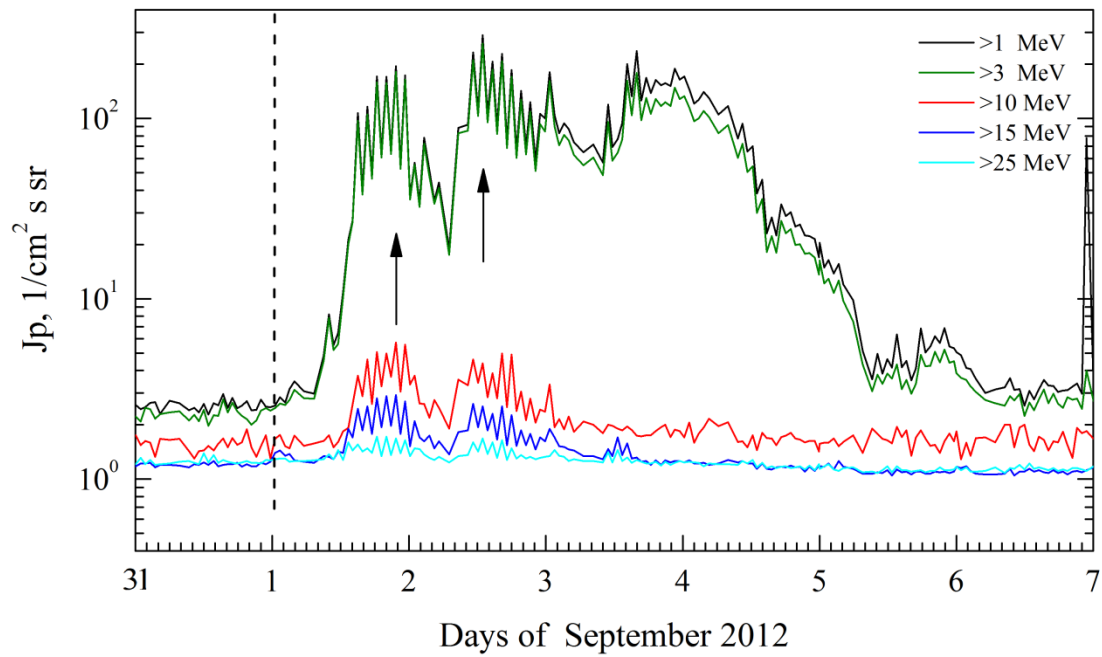


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro.

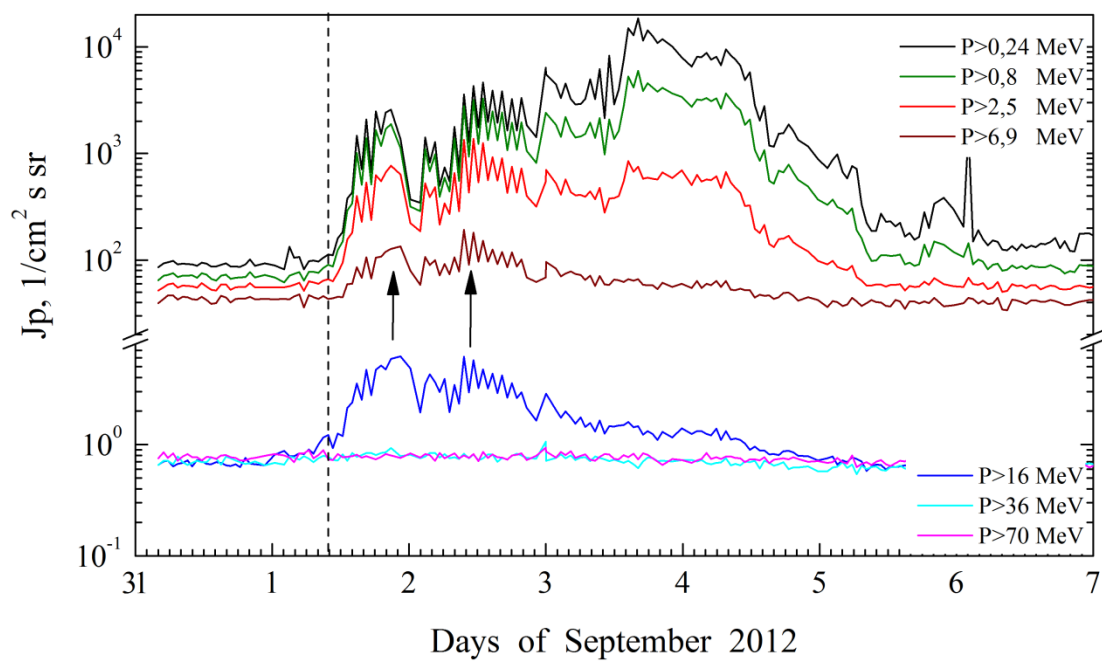


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.09.01



POES. Event 2012.09.01



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 September 01**

2012

August 31

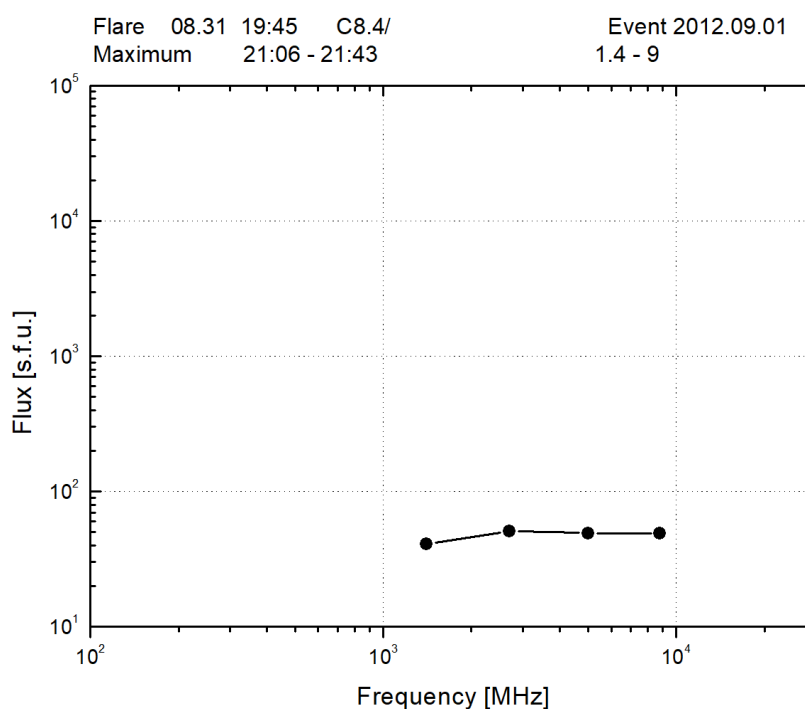
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AR 11562

To event 520

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1952	2043	2122	S19E42	2F	ERU
6563 Å	DSF	1700	2043	2218	S17E50	>15°	
1 – 12	keV	1945	2043	>2151		C8.4	0.051
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1935:20	1953:38	1955:04	1456	3713448	HESSI
12 – 25	keV	2001:06	2026:59	2032:22	1457	248562	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2029	2107	2245		1.69	
5	GHz	2026	2108	2300		1.69	
2.7	GHz	2028	2106	2300		1.71	
1.4	GHz	2054	2143	2300	1.4 – 9	1.61	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-131	1942		2000	515	2	
DS IV	025-087	2002		2019		3	
DH II	0.4-16	2000		2345			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2000	1442	2.0	360°	90°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR 11562 (S19L103, CMP 03,5.09.2012,
Sp=340 msh, DAO, B, R1)
XRI=0.1, $C_3^{8.4}$ 2_1+S_3
PFR DSF 31.08 $C_1^{8.4}$

References:

Кичигин Г.Н., Мирошниченко Л.И., Сидоров В.И., Язев С.А., [2016](#).
Bruno A., I.G. Richardson, [2021](#).
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Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Kalaivani P.P., O. Prakash, A. Shanmugaraju et al., [2021](#).
Maričić D., B. Vršnak, A.M. Veronig et al., [2020](#).
NOAA SPE, [2019](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zelina P., S. Dalla, C.M.S. Cohen, R.A. Mewaldt, [2017](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 28d00^h

Tmax ($E_p > 10$ MeV) – 28d05^h, Jmax ($E_p > 10$ MeV) – $23.8 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 3 days, power-law index: $\gamma = 3.0$

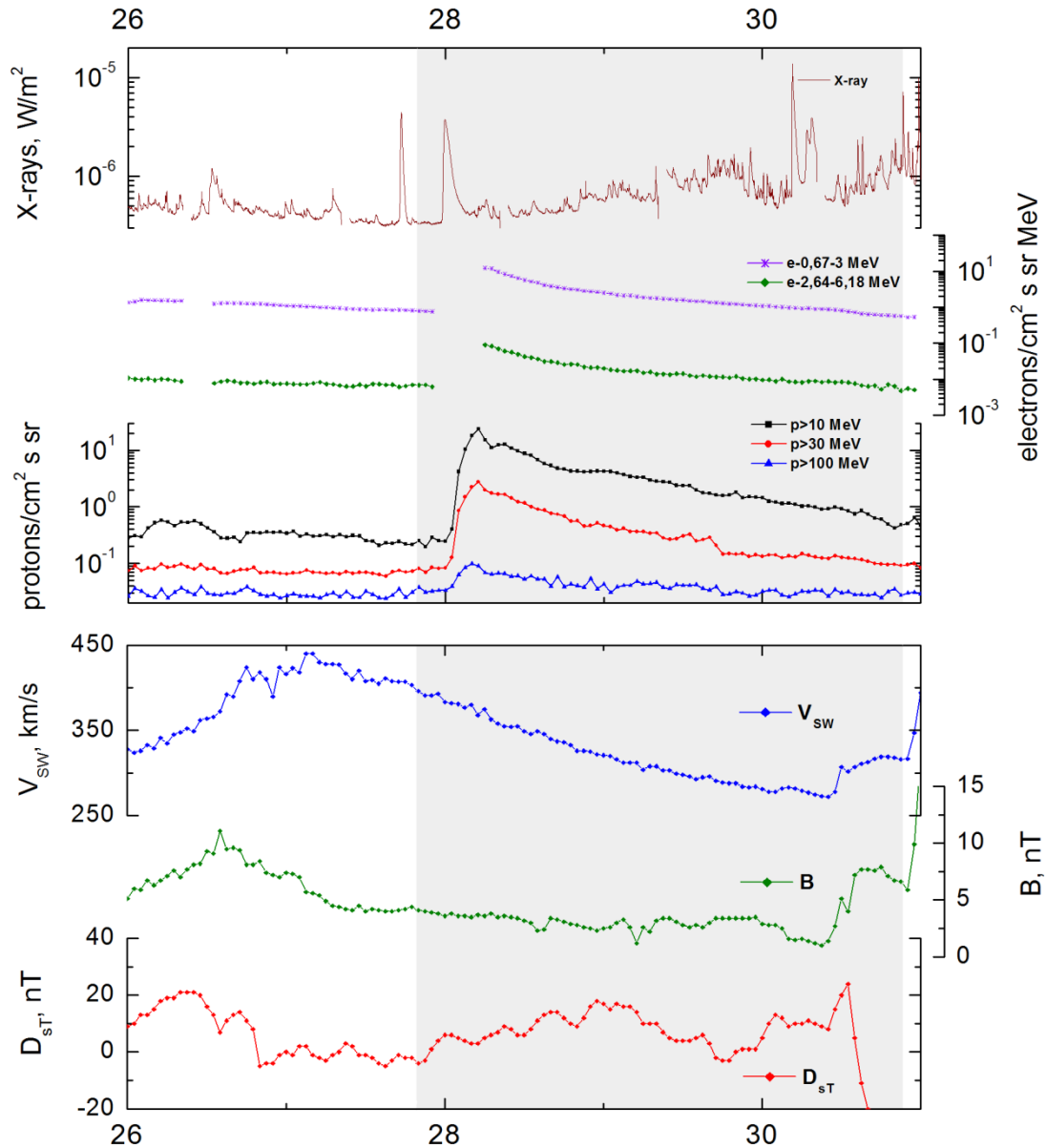
Quasimaximal energy of protons in the event – $E_{qm} = 200$ MeV

Sources: • solar flare 27d23^h36^m, C3.7/1F, N06W34, AR11577

Main burst X-ray 1–8 Å: onset 27d23^h36^m, max – 27d23^h57^m, $\Phi = 0.0094 \text{ J/m}^2$

CME: 28d00^h12^m, $V = 947 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 251^\circ$

Particle fluxes and associated phenomena



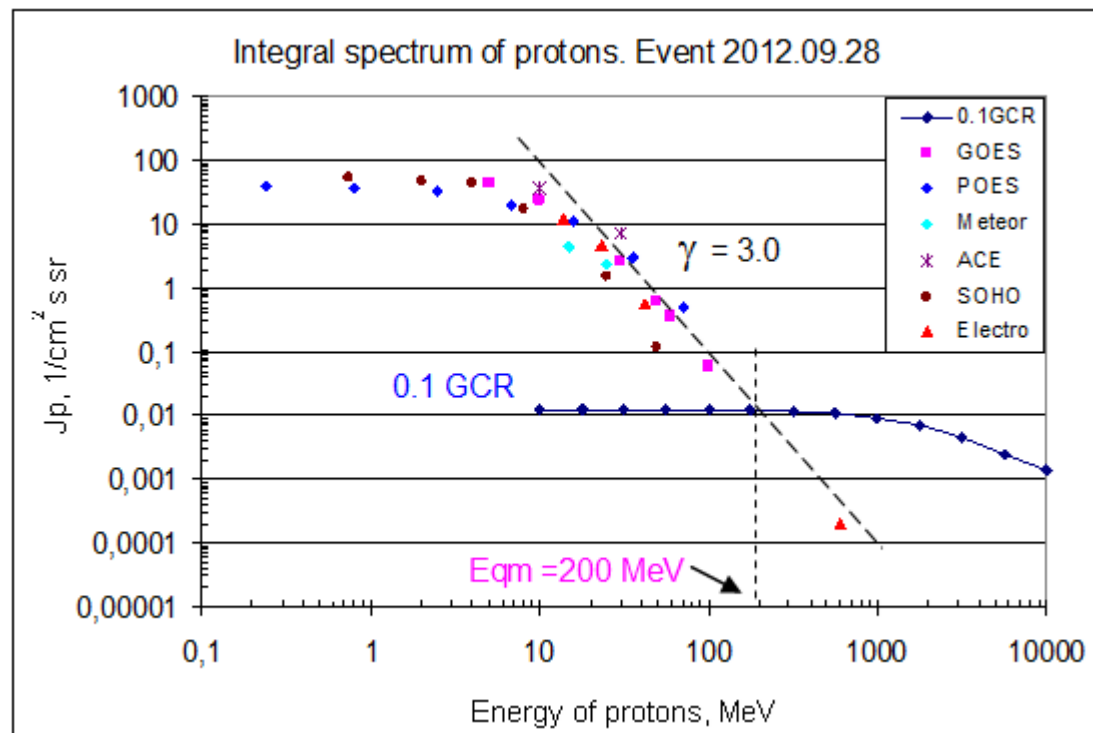
September 2012

Integral fluxes of protons for the event of 2012 September 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	0	5	42.3	3	0.2	
EPS	>10	0	5	23.8	3	0.15	
EPS	>30	0	5	2.7	2	0.09	
EPS	>50	0	5	0.64	2	0.07	
EPS	>60	0	4	0.36	2	0.05	
EPS	>100	0	4	0.06	2	0.04	
Electro-1							
GALS-E	>600	1	3	0.0002	0.5	0.0007	
POES							
MEPED	>0.24	1	4	40	5	135	
MEPED	>0.8	1	4	36	5	100	
MEPED	>2.5	1	4	33	5	65	
MEPED	>6.9	1	4	20	3	45	
MEPED	>16	1	2	11	2	0.8	
MEPED	>36	1	2	3	1	0.9	
MEPED	>70	1	2	0.5	0.3	0.9	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	-	-	-	-	2.7	
SCR	>3	-	-	-	-	2.5	
SCR	>10	-	-	-	-	1.6	
GALS-M	>15	0	03	4.5	1	1.25	
GALS-M	>25	0	03	2.4	1	1.3	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	0	3	36.6	3	1.4	
SIS	>30	0	3	7.4	2	1	
SOHO							
EPHIN	>50	-	6	0.12	1	0.24	

Differential fluxes of protons for the event of 2012 September 28

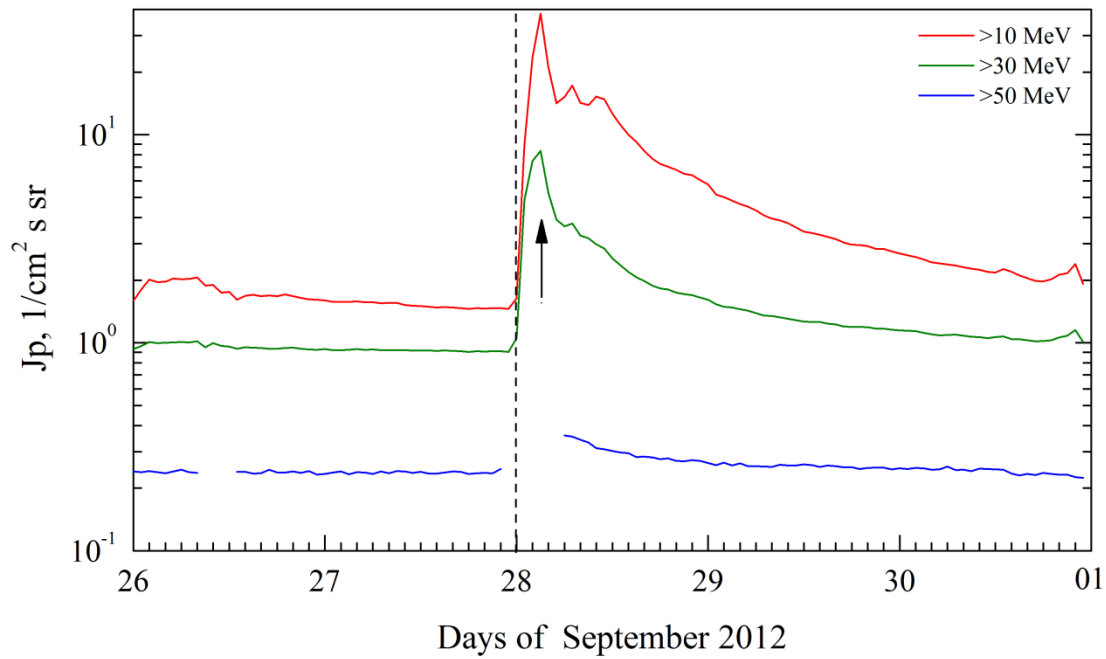
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	11	5	-	1	
LION	2 – 6	-	11	1	-	0.15	
EPHIN	4 – 8	-	9	6.5	3	0.38	
EPHIN	8 – 25	-	8	0.9	3	0.017	
EPHIN	25 – 53	-	7	0.05	3	0.0002	
Electro-1							
SCR-E	13.7–23	01	4	0.82	2	0.06	
SCR-E	23–42	01	4	0.21	2	0.025	
SCR-E	42–112	01	4	0.008	1	0.005	



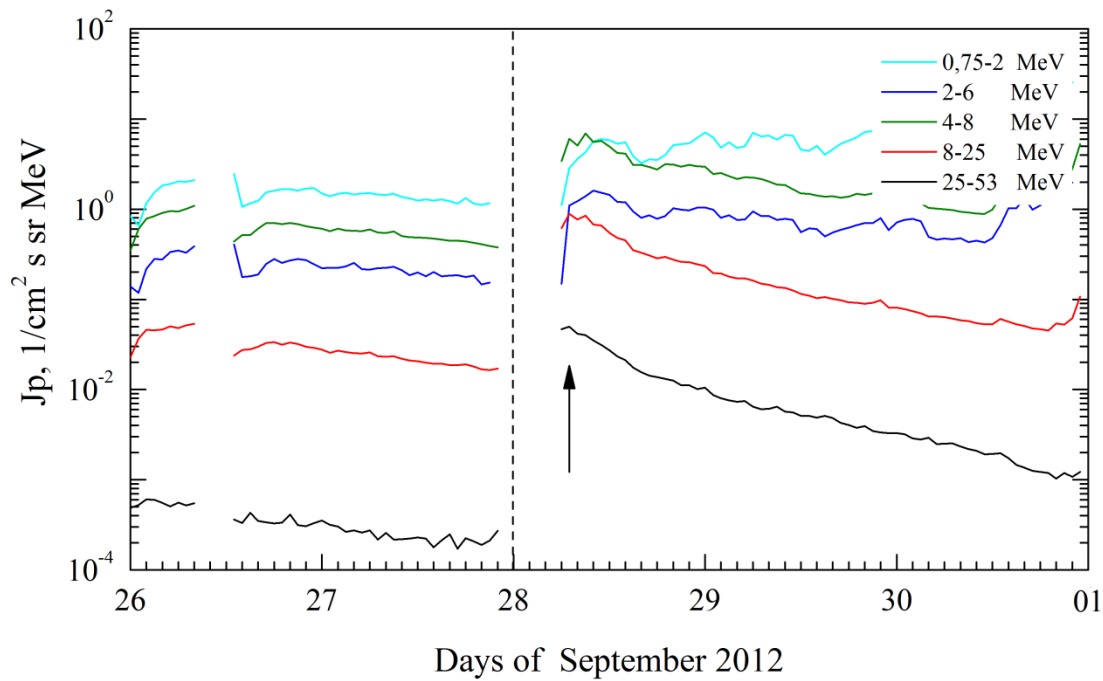
Time profiles of proton fluxes in the event 2012.09.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

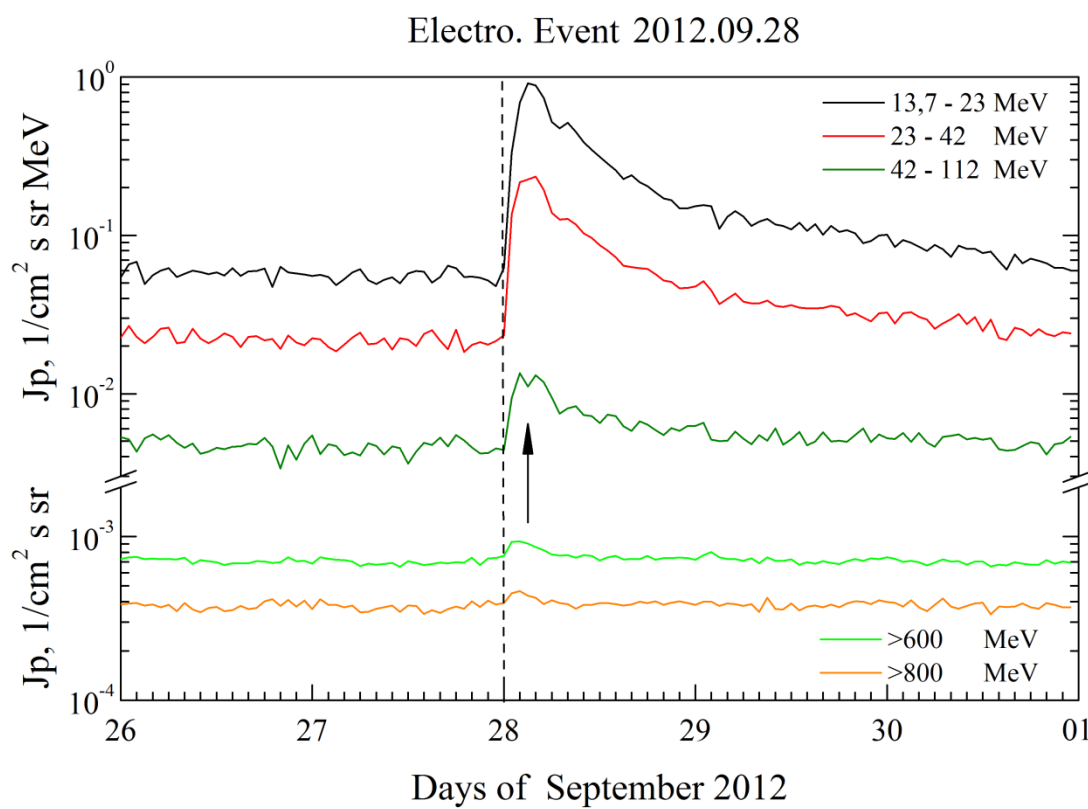
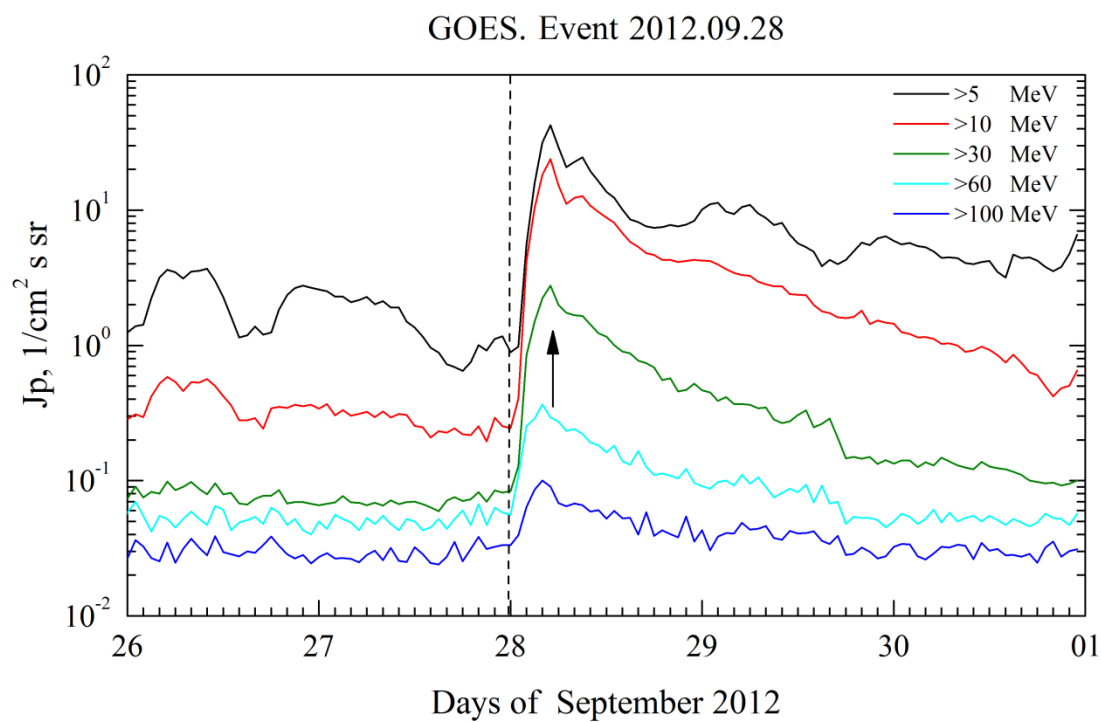
ACE SIS + SOHO (>50 MeV). Event 2012.09.28



SOHO. Event 2012.09.28

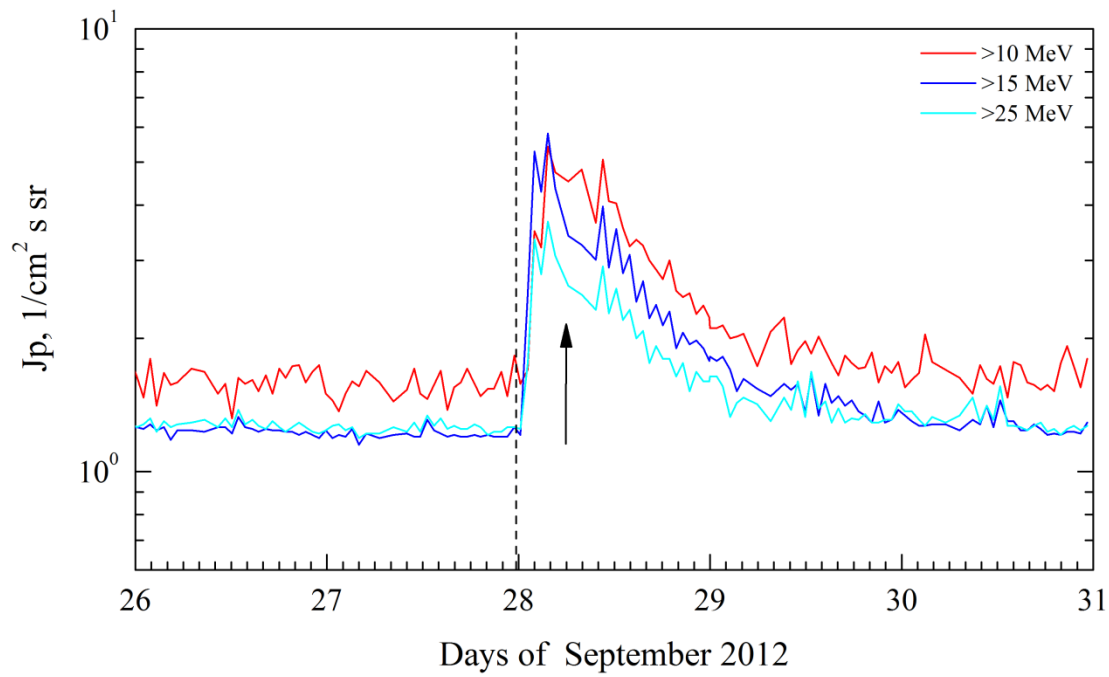


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro.

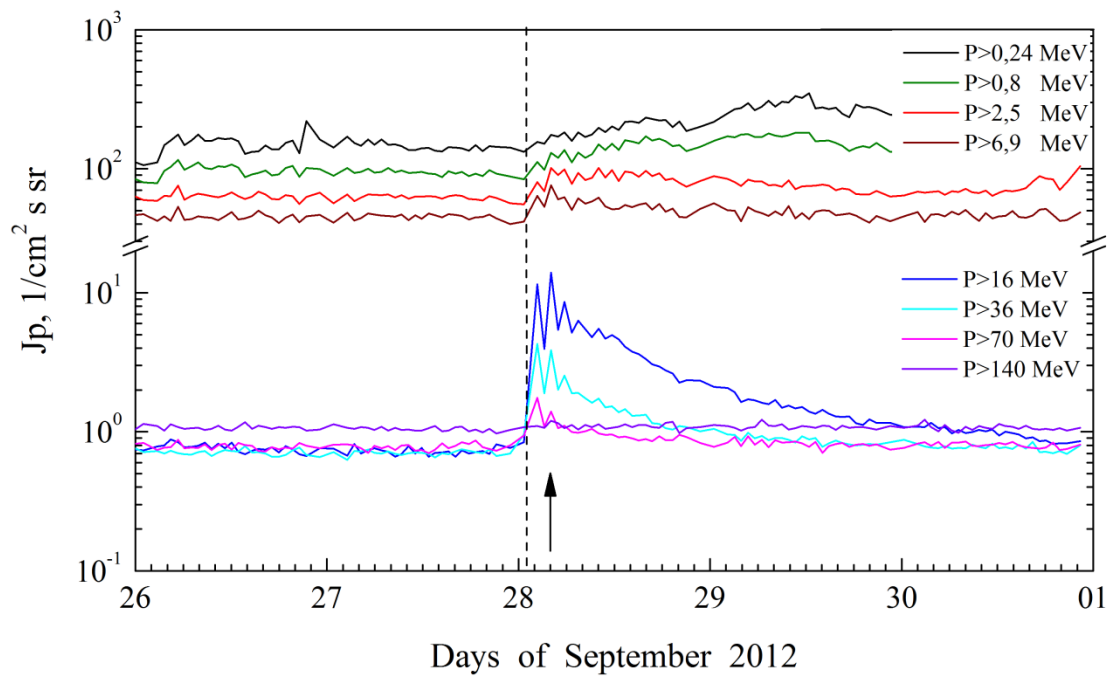


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2012.09.28



POES. Event 2012.09.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 September 28**

2012 September 27

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AR 11577

To event 521

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	2339	2348	0034	N06W34	1F	PRB
6563 Å	DSF	2336		28d0256	N03W28	14	
1 – 12	keV	2336	2357	0034	N09W32	C3.7	0.0094
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	2345:04	2352:26	0041:48	2800	21547104	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	027-060	2344		2354		1	
DS III	018-060	0006		0007		3	
DS VI	025-180	0000		0018		2	
DS CTM	025-120	0000		0013		1	
DH II	0.25-16	0255		28d1015			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	28d0012	947	3.7	360°	251°	SOHO

Proton Active Region:

AR11577 (N09, L163, CMP 26, 1.09.2012,
Sp=100 msh, CSO, B, R1)
XRI<0.2 C₉ 1₁+S₅
PFR DSF 27.09 C₁

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
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Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Wang Y., D. Lyu, B. Xiao et al., [2021](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 08d12^h

Tmax ($E_p > 10$ MeV) – 09d04^h, Jmax ($E_p > 10$ MeV) – 1.4 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma = 2.0$

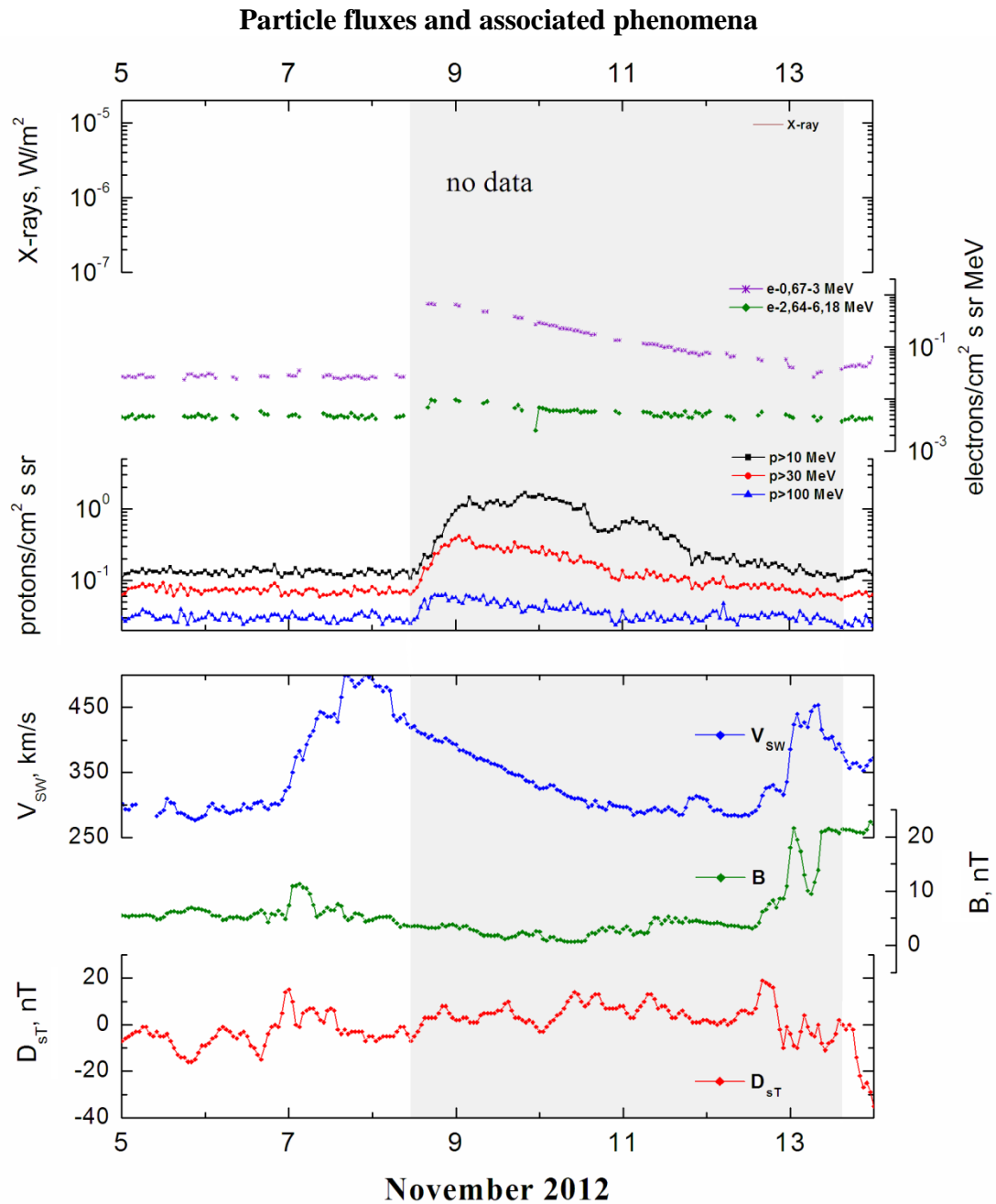
Quasimaximal energy of protons in the event – $E_{qm} = 170$ MeV

Sources: ■ solar flare 08d02^h08^m, M1.7/, N13E89, AR11611

Main burst X-ray 1–8 Å: onset – 08d02^h08^m, max – 28d02^h23^m, $\Phi = 0.03$ J/m²

CME: 28d02^h36^m, $V = 855$ km/s, $\Delta\phi = 360^\circ$, dA = 046°

▲ SC 12d23^h12^m

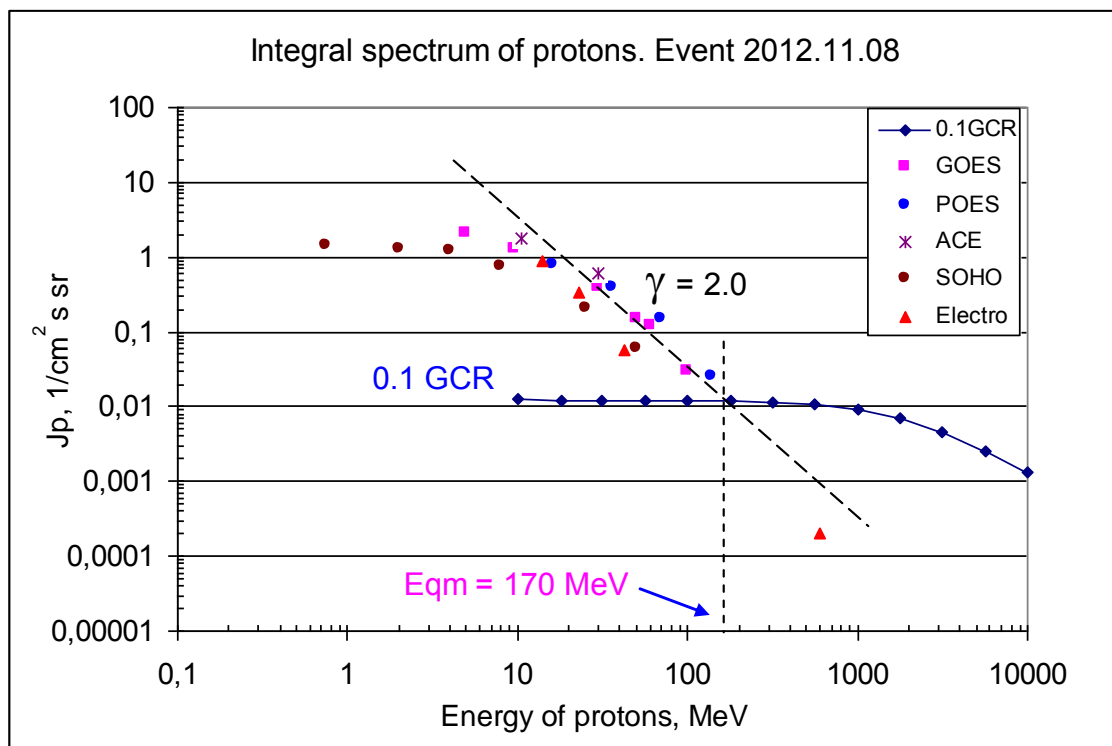


Integral fluxes of protons for the event of 2012 November 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	13	09d04	2.1	4	0.2	
EPS	>10	12	09d04	1.4	4	0.15	
EPS	>30	12	09d01	0.4	3	0.09	
EPS	>50	12	09d01	0.15	3	0.07	
EPS	>60	12	09d00	0.12	3	0.05	
EPS	>100	12	09d00	0.03	2	0.03	
Electro-1							
GALS-E	>600	14	23	0.0002	1	0.0007	
POES							
MEPED	>0.24	-	-	-	-	90	
MEPED	>0.8	-	-	-	-	75	
MEPED	>2.5	-	-	-	-	50	
MEPED	>6.9	-	-	-	-	45	
MEPED	>16	12	20	0.8	2	0.7	
MEPED	>36	12	20	0.4	1	0.8	
MEPED	>70	12	20	0.15	0.5	0.9	
MEPED	>140	-	20	0.025	-	1.1	
ACE							
SIS	>10	12	09d01	1.5	3	1.2	
SIS	>30	12	09d01	0.6	2	0.85	
SOHO							
EPHIN	>50	14	09d00	0.06	0.7	0.23	

Differential fluxes of protons for the event of 2012 November 08

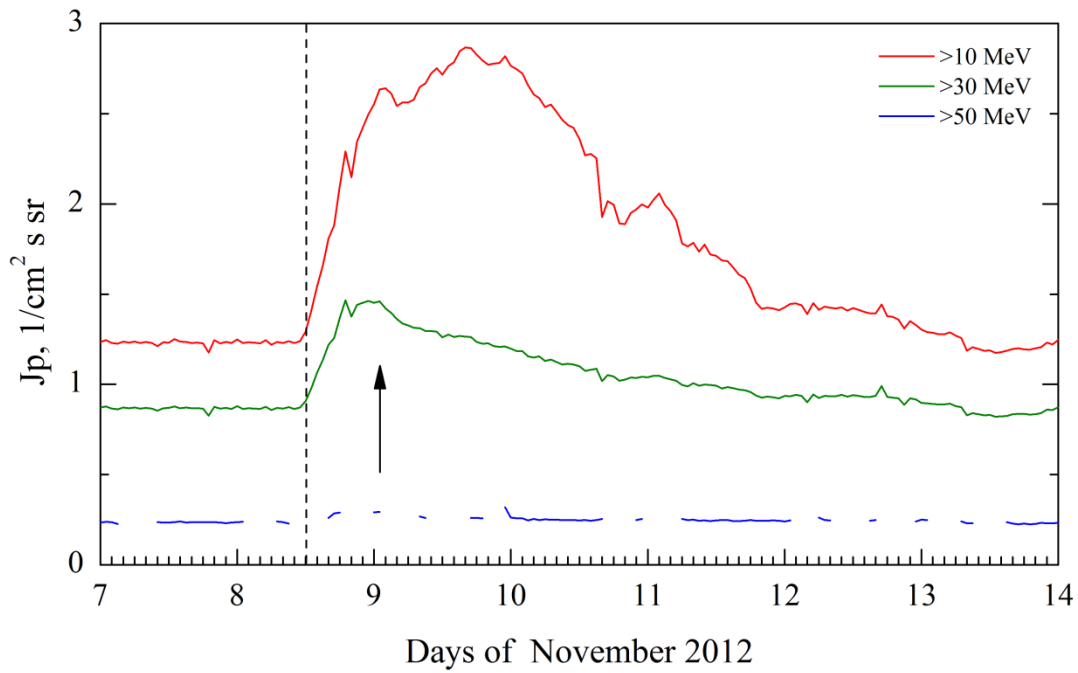
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	14	09d01	0.056	6	0.005	
LION	2 – 6	14	09d01	0.022	6	0.002	
EPHIN	4 – 8	14	09d01	0.124	6	0.00002	
EPHIN	8 – 25	14	09d01	0.032	6	0.00002	
EPHIN	25 – 53	14	09d01	0.0054	6	0.00001	
Electro-1							
SCR-E	13.7–23	14	23	0.06	3	0.06	
SCR-E	23–42	14	23	0.015	3	0.025	
SCR-E	42–112	14	23	0.0008	2	0.005	



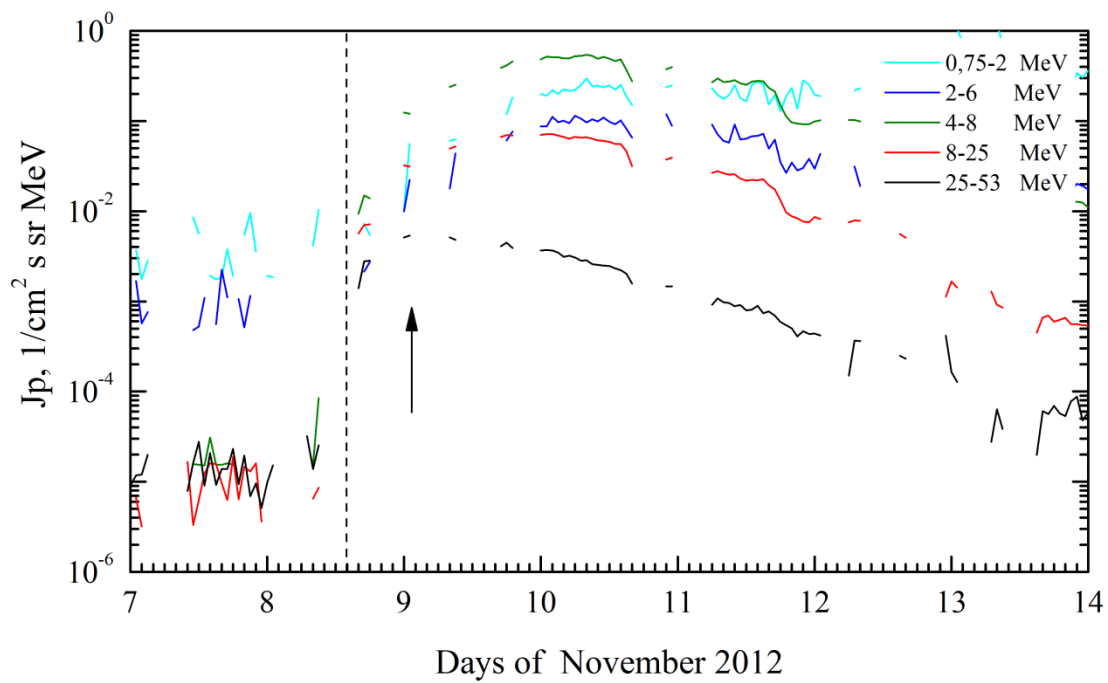
Time profiles of proton fluxes in the event 2012.11.08

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.11.08

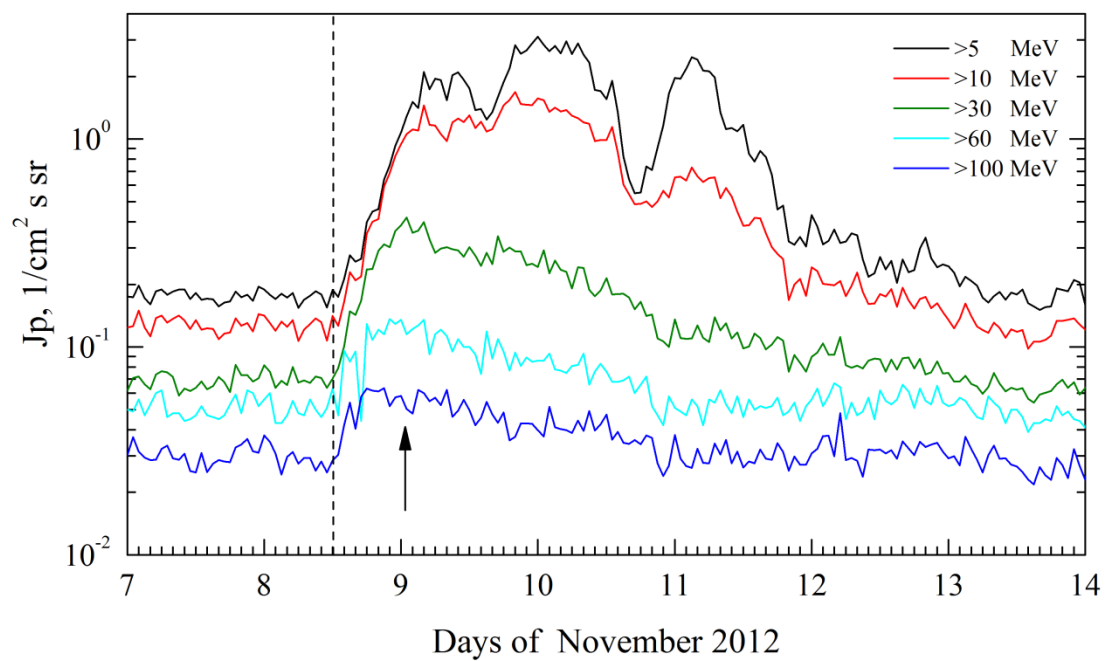


SOHO. Event 2012.11.08

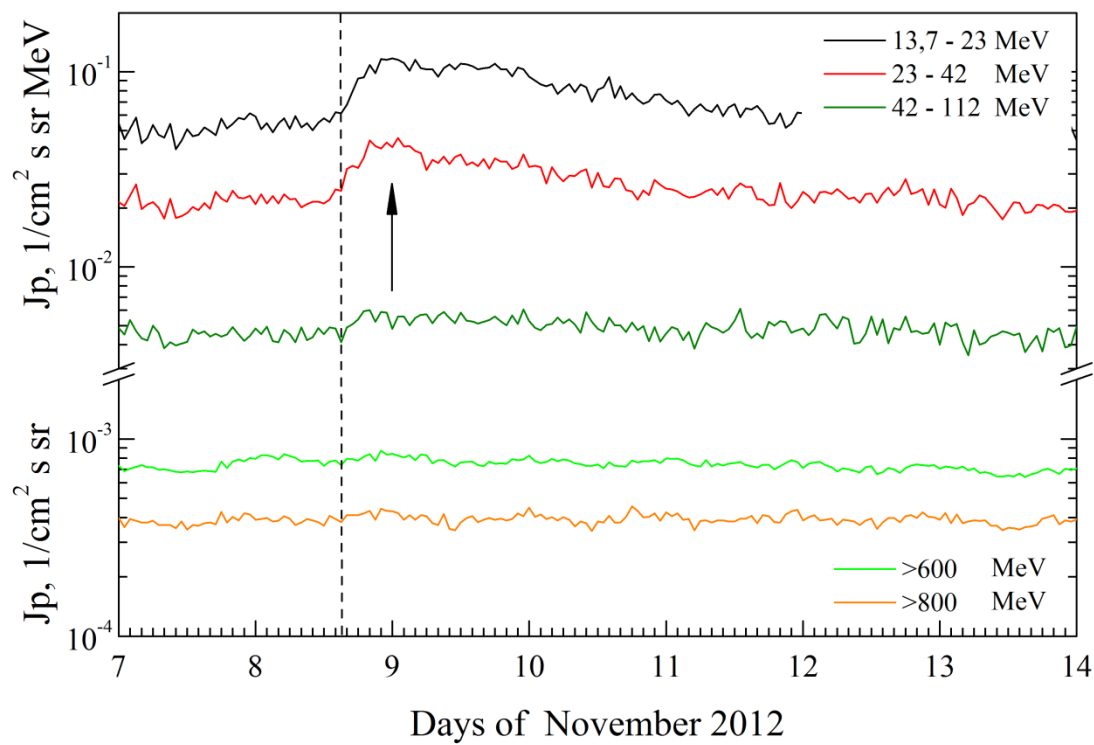


Earth satellites in geostationary orbit, $R \approx 6.6 \text{ Re}$: GOES and Electro.

GOES. Event 2012.11.08

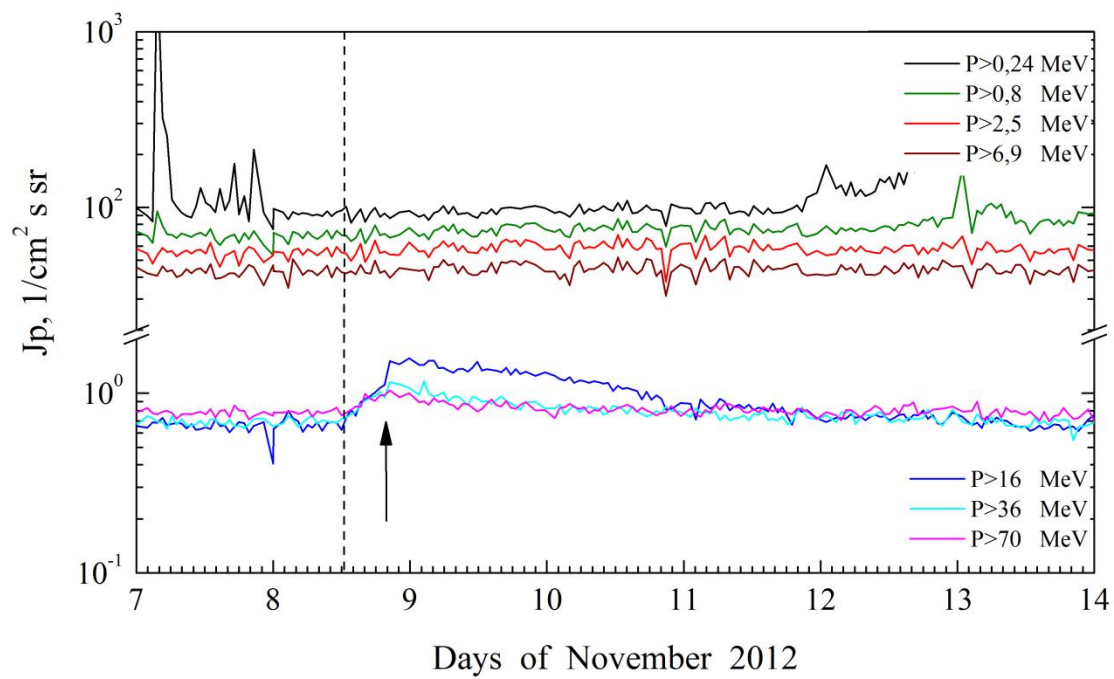


Electro. Event 2012.11.08



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

POES. Event 2012.11.08



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2012 November 08**

2012

November 08

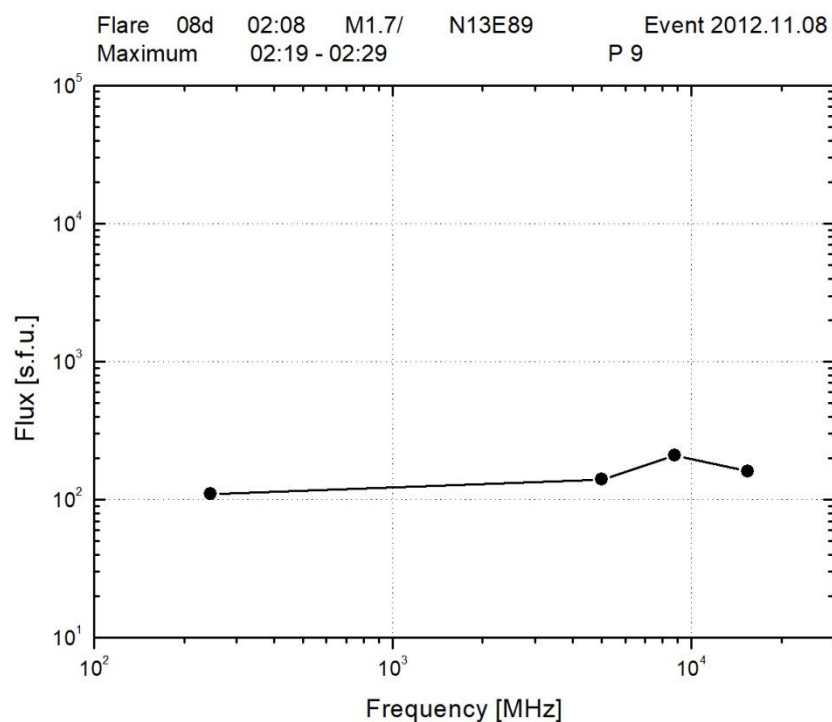


AR 11611

To event 522

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	0208	0223	>0255	N13E89	M1.7	0.03
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0206:12	0217:02	02 0217:12	128	76169	HESSI
12-25	keV	0252:08	0252:38	0316:48	95	359360	HESSI
12-25	keV	0211:03	0219:39	0300:15	65908	17448744	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0219	0219	0222		2.2	
8.8	GHz	0219	0219	0223	P9	2.32	
5	GHz	0219	0222	0222		2.15	
245	MHz	0229	0229	0229		2.04	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	30-120	0221		0242		3	
DS III	18-090	0219		0222		3	
DS V	25-180	0219		0221		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0236	855	- 15.2	360°	46°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11611 (N12L239, CMP 14,0.11.2012,
Sp=270 msh, DSO, BG, R)
XRI=0.17 $M_1^{1.7}+C_1$ 1_1+S_2
PFR 08.11 $M_1^{1.7}$

References:

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Wang Y., D. Lyu, B. Xiao et al., [2021](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).

Particle event: To($E_p > 10$ MeV) – 14d08^h

Tmax ($E_p > 10$ MeV) – 15d02^h, Jmax ($E_p > 10$ MeV) – 6.5 /cm²·s·sr

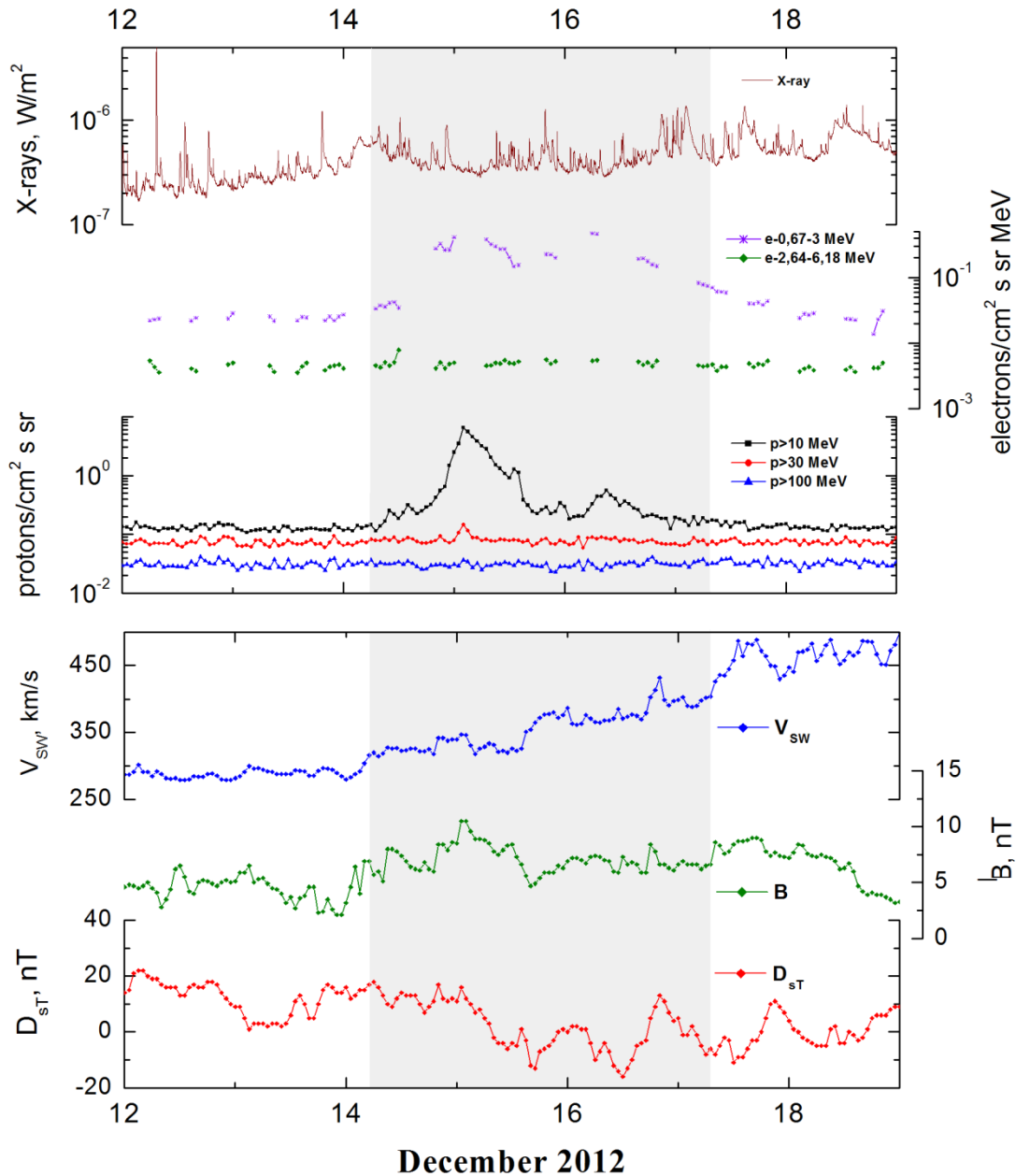
Duration of the event – 3 days, power-law index: $\gamma = 4.1$

Quasimaximal energy of protons in the event – $E_{qm} = 50$ MeV

Sources: ☐ solar flare event 14d<02^h00^m, AR unknown, behind W_L

CME: 14d02^h00^m, $V = 763$ km/s, $\Delta\phi = 149^\circ$, $dA = 232^\circ$

Particle fluxes and associated phenomena

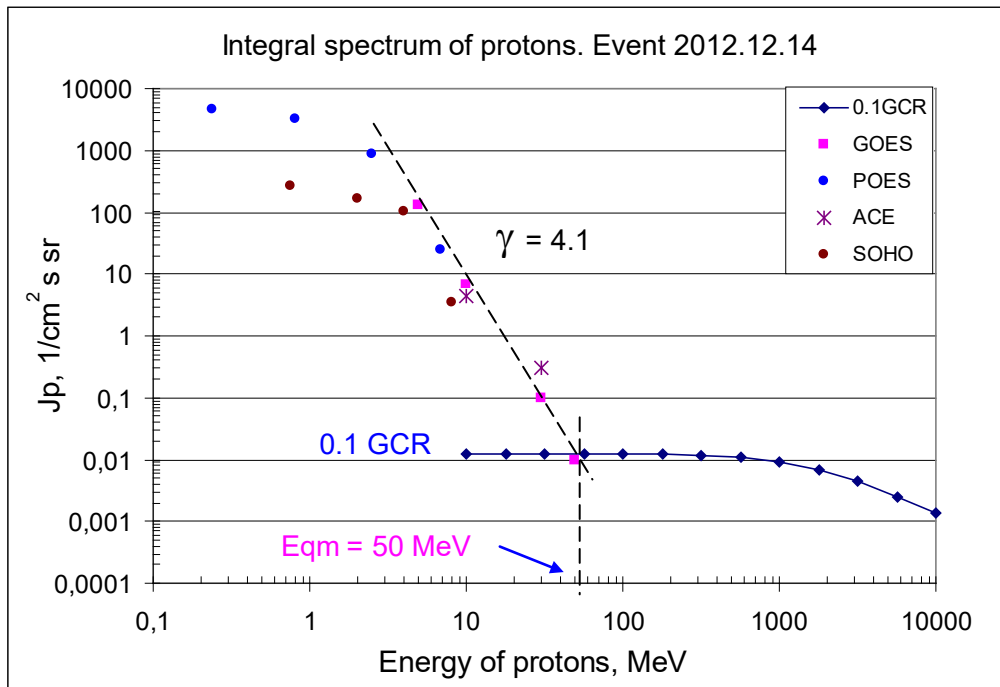


Integral fluxes of protons for the event of 2012 December 14

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	15d03	130	4	0.2	
EPS	>10	8	15d02	6.5	3	0.15	
EPS	>30	-	15d02	0.1	0.1	0.09	
EPS	>50	-	15d02	0.01	0.1	0.07	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.04	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	13	15d02	4700	2.5	90	
MEPED	>0.8	13	15d02	3160	2.5	75	
MEPED	>2.5	13	15d02	865	1.5	50	
MEPED	>6.9	-	15d02	25.4	0.5	45	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.8	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.1	
ACE							
SIS	>10	12	15d03	4.5	2	1.4	
SIS	>30	12	15d01	0.3	1	1	
SOHO							
EPHIN	>50	-	-	-	-	0.24	

Differential fluxes of protons for the event of 2012 December 14

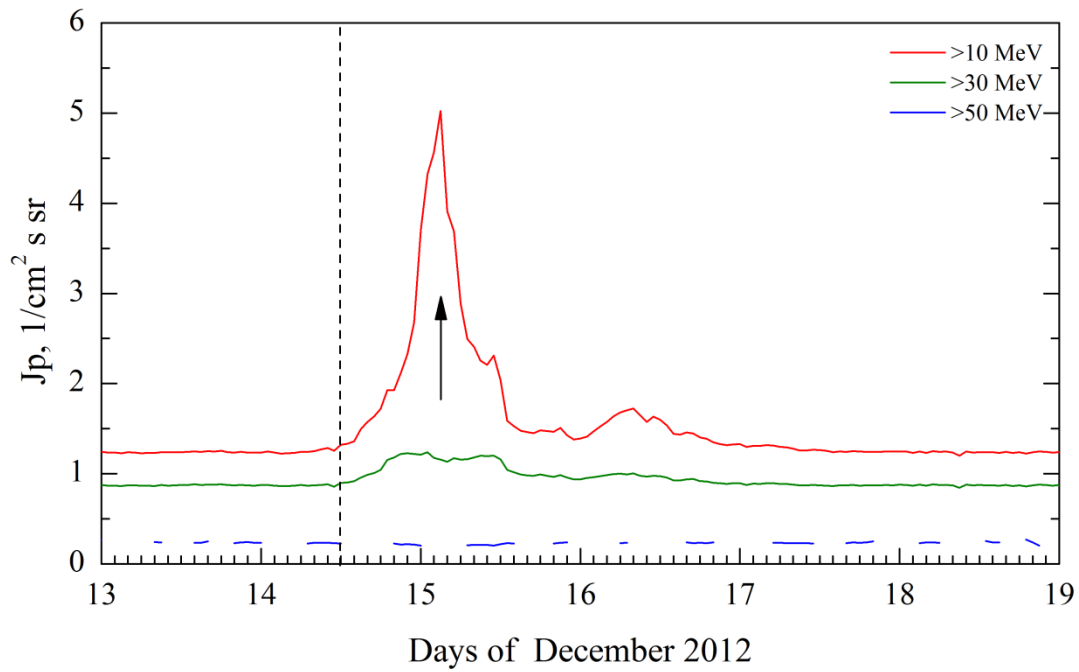
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	01	15d03	80	4	0.01	
LION	2 – 6	01	15d03	20	4	0.002	
EPHIN	4 – 8	01	15d03	25	5	0.00001	
EPHIN	8 – 25	01	15d03	0.2	5	0.00001	
EPHIN	25 – 53	02	15d03	-	5	0.00001	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.06	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0.005	



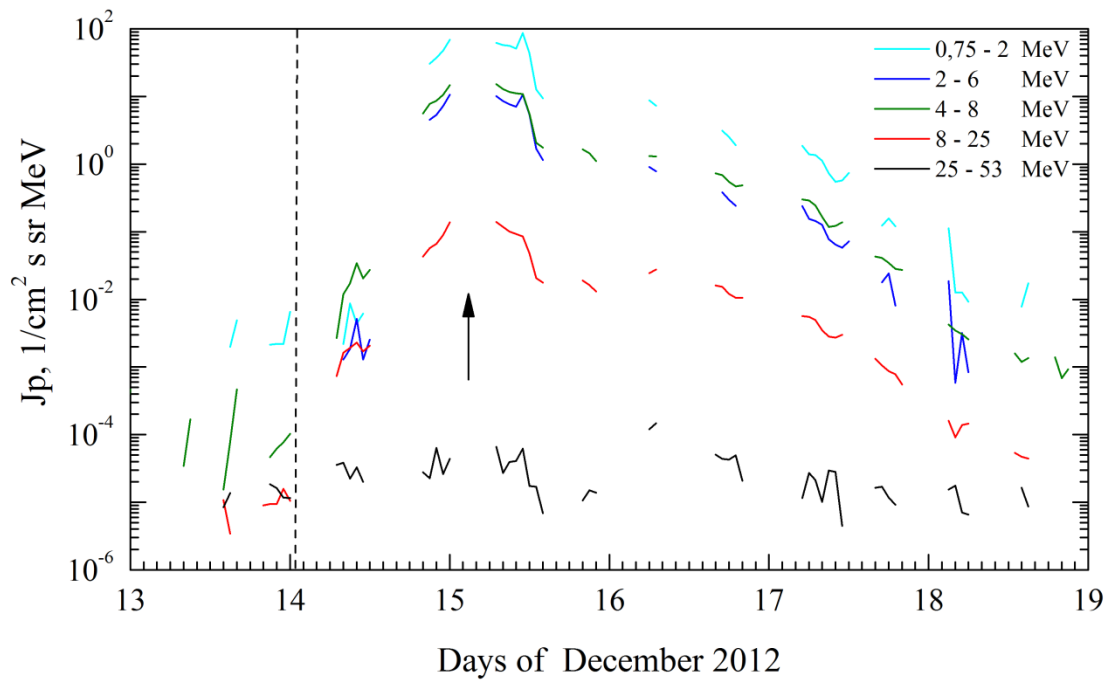
Time profiles of proton fluxes in the event 2012.12.14

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2012.12.14

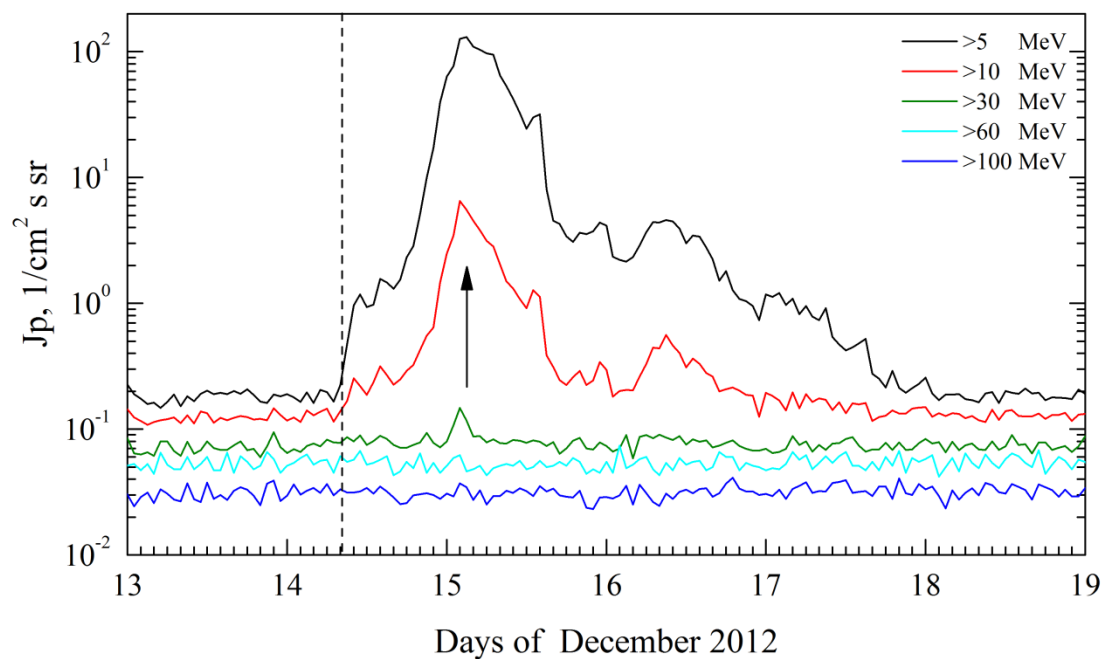


SOHO. Event 2012.12.14

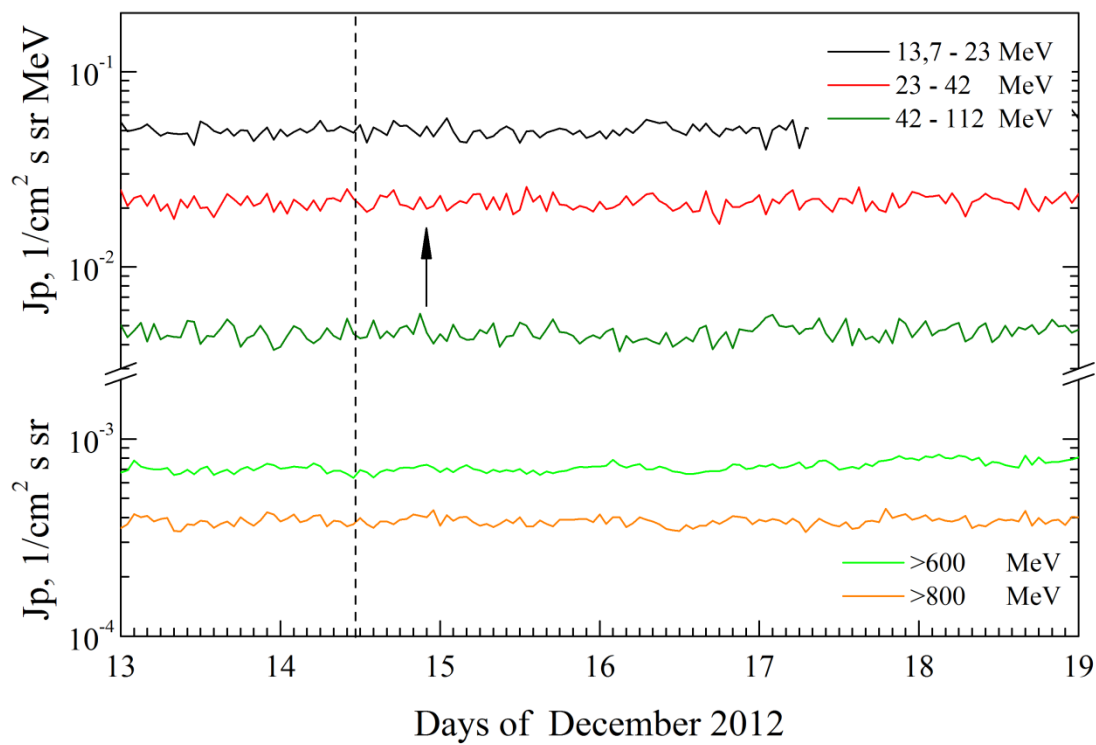


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro.

GOES. Event 2012.12.14

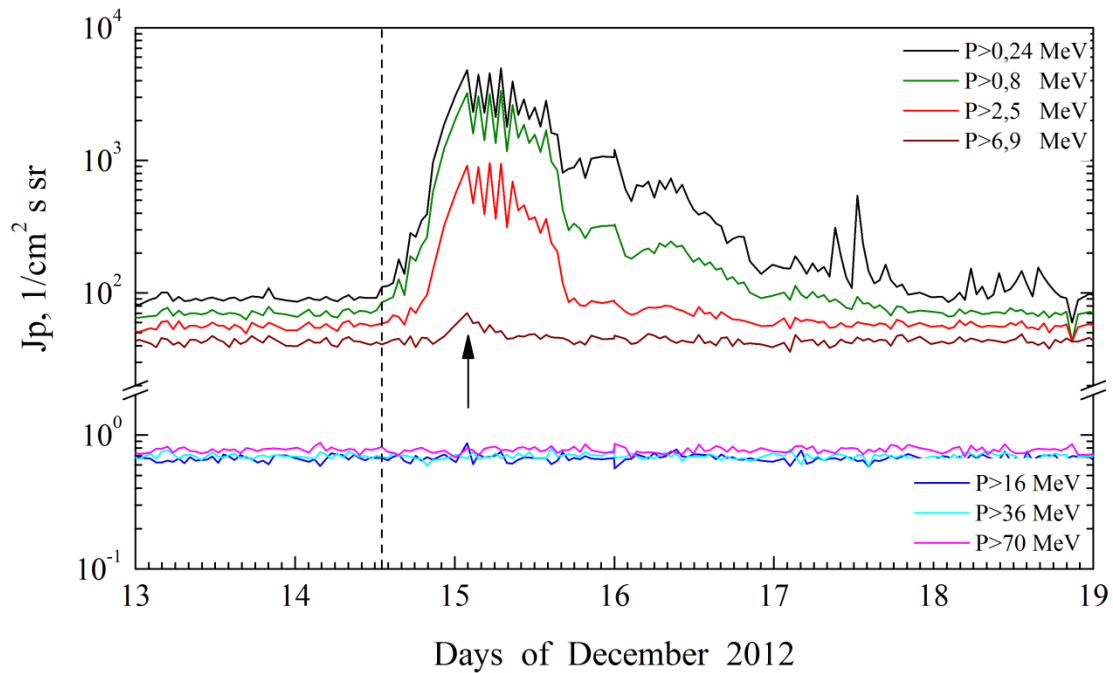


Electro. Event 2012.12.14



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

POES. Event 2012.12.14



Electromagnetic and other phenomena that are sources and/or accompanying for the event of 2012 December 14

2012 December 14 ☐ AR XXXXX To event 523

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
6563 Å	EPL	<0025		<0145		0.19	
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0200	763	20.9	149°	232°	SOHO

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Events in 2013

			Page
1	Event 2013.01.16 – (2013-016)	№ 524	431
2	Event 2013.03.15 – (2013-074)	№ 525	438
3	Event 2013.04.11 – (2013-101)	№ 526	446
4	Event 2013.04.21 – (2013-111)	№ 527	454
5	Event 2013.04.24 – (2013-114)	№ 528	461
6	Event 2013.05.13 – (2013-133)	№ 529	468
7	Event 2013.05.15 – (2013-135)	№ 530	478
8	Event 2013.05.22 – (2013-142)	№ 531	486
9	Event 2013.06.21 – (2013-172)	№ 532	495
10	Event 2013.06.23 – (2013-174)	№ 533	503
11	*Event 2013.08.17 – (2013-229)	№ 534	511
12	Event 2013.08.20 – (2013-232)	№ 535	519
13	Event 2013.09.30 – (2013-273)	№ 536	526
14	Event 2013.10.28 – (2013-301)	№ 537	533
15	Event 2013.10.30 – (2013-303)	№ 538	545
16	Event 2013.11.02 – (2013-306)	№ 539	553
17	Event 2013.11.07 – (2013-311)	№ 540	561
18	*Event 2013.11.08 – (2013-312)	№ 541	568
19	*Event 2013.11.10 – (2013-314)	№ 542	577
20	Event 2013.11.19 – (2013-323)	№ 543	585
21	Event 2013.12.14 – (2013-348)	№ 544	593
22	Event 2013.12.26 – (2013-360)	№ 545	600
23	Event 2013.12.28 – (2013-362)	№ 546	607

An asterisk (*) marks weak events with Jp ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To($E_p > 10$ MeV) – 16d22^h

Tmax₁($E_p > 10$ MeV) – 17d07^h, Jmax₁($E_p > 10$ MeV) – 1.1/cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 17d13^h, Jmax₂($E_p > 10$ MeV) – 1.25 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma_1 = 2.2$, $\gamma_2 = 2.8$

Quasimaximal energy of protons in the event – Eqm₁ = 70 MeV

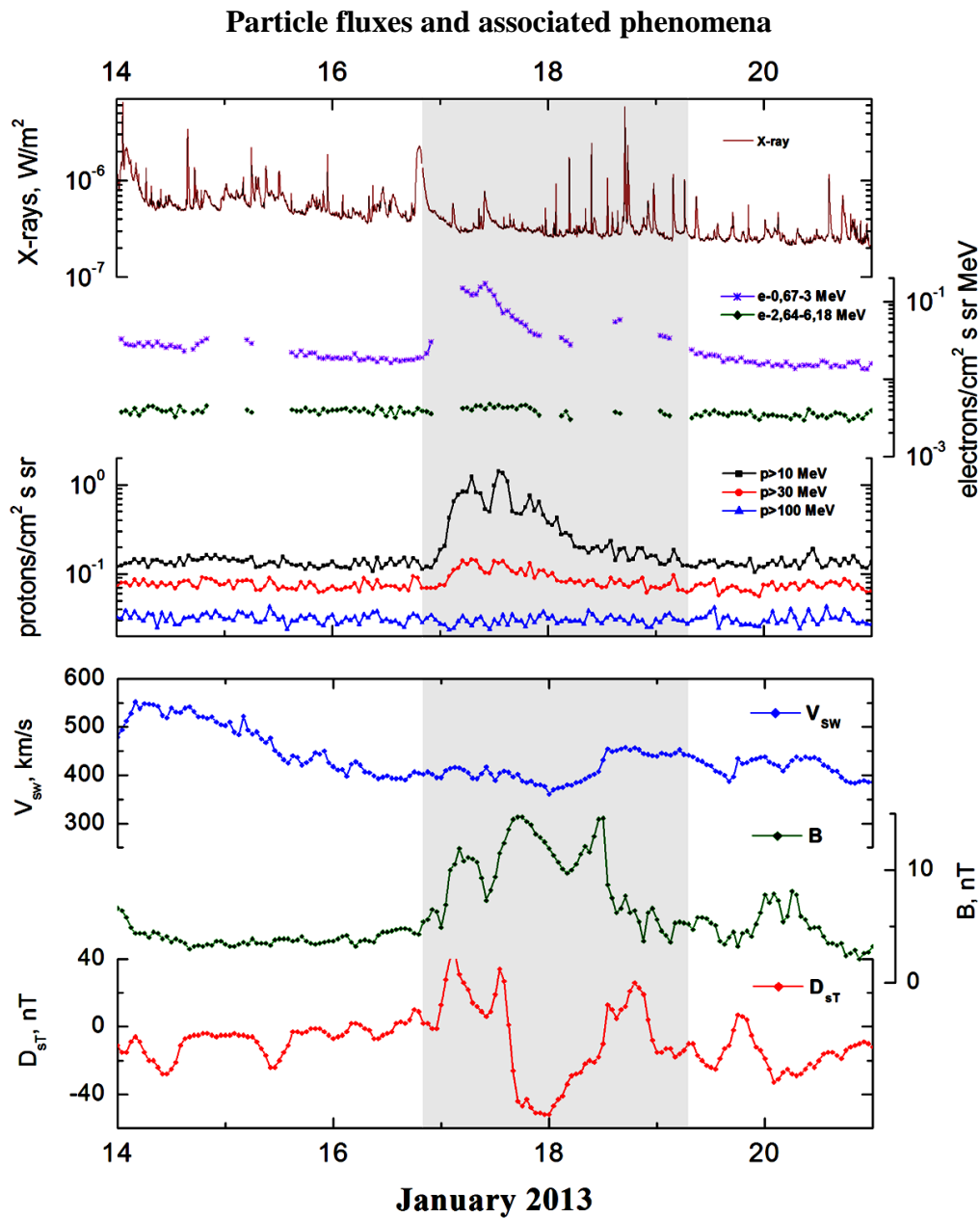
– Eqm₂ = 50 MeV

Sources: ■ solar flare 16d19^h18^m C2.2/, S32W87, AR 11650

Main X-ray burst 1-8 Å: onset – 16d19^h18^m, max – 16d19^h23^m, $\Phi = 0.011$ J/m²

CME: 16d19^h00^m, V = 648 km/s, $\Delta\phi = 250^\circ$; dA=236°

▲ SC 19d17^h32^m

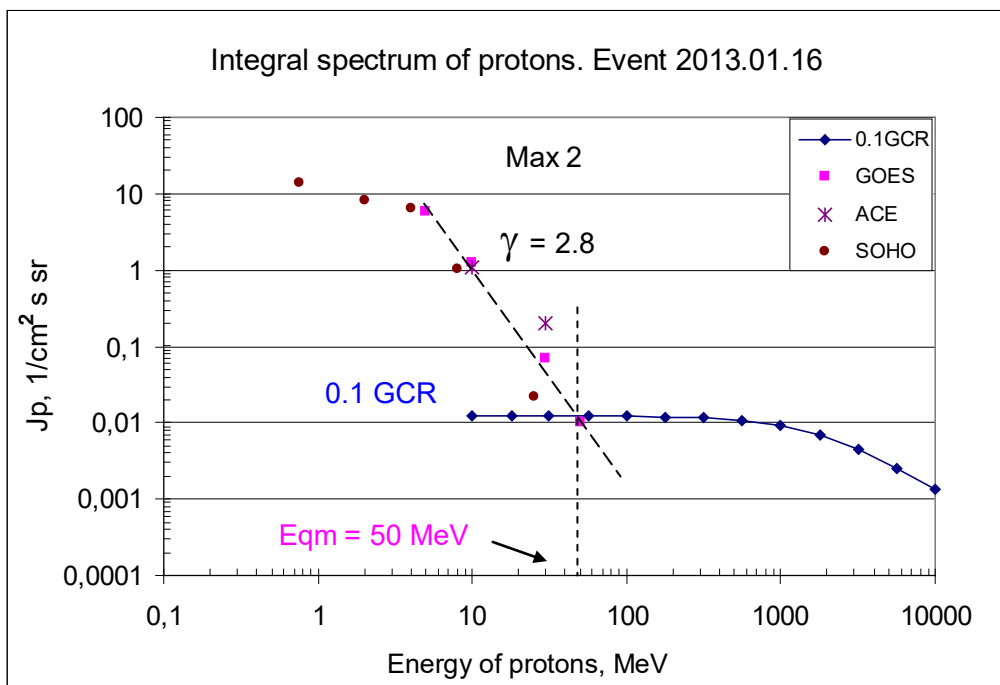
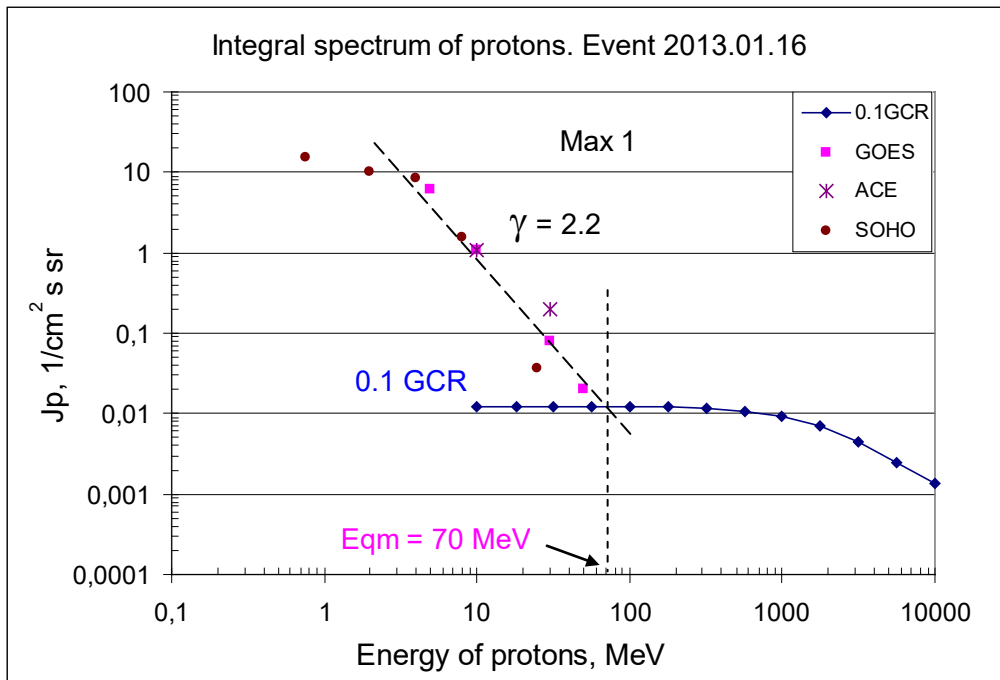


Integral fluxes of protons for the event of 2013 January 16

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	22	17d07/17d13	6/5.8	2.5	0.2	
EPS	>10	22	17d07/17d13	1.1/1.25	2	0.15	
EPS	>30	22	17d07/17d14	0.8/0.7	1.5	0.07	
EPS	>50	22	17d08/17d14	0.02/0.01	1	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	-	-	-	-	95	
MEPED	>0.8	-	-	-	-	75	
MEPED	>2.5	-	-	-	-	50	
MEPED	>6.9	-	-	-	-	45	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.9	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.1	
ACE							
SIS	>10	23	17d13/17d18	1.1/1.1	1.5	1.3	
SIS	>30	23	17d13/17d18	0.2/0.2	1.5	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 January 16

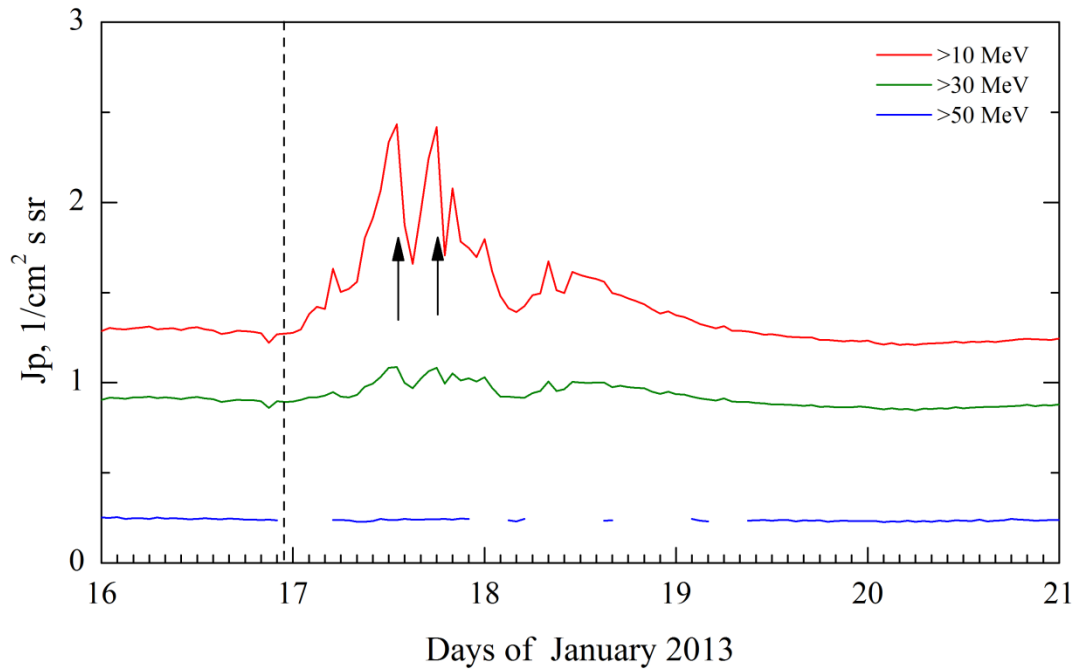
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	17d06	17d13/17d18	3.9/4.68	>0.55	0.01	
LION	2 – 6	17d06	17d12/17d18	0.6/0.6	>0.55	0.001	
EPHIN	4 – 8	17d05	17d12/17d16	1.7/1.33	>0.55	0.001	
EPHIN	8 – 25	17d05	17d12/17d16	0.09/0.06	>0.55	0.00002	
EPHIN	25 – 53	17d05	17d12/17d16	0.0013/0.0008	>0.55	0.00001	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.06	
SCR-E	23–42	-	-	-	-	0.025	
SCR-E	42–112	-	-	-	-	0.005	



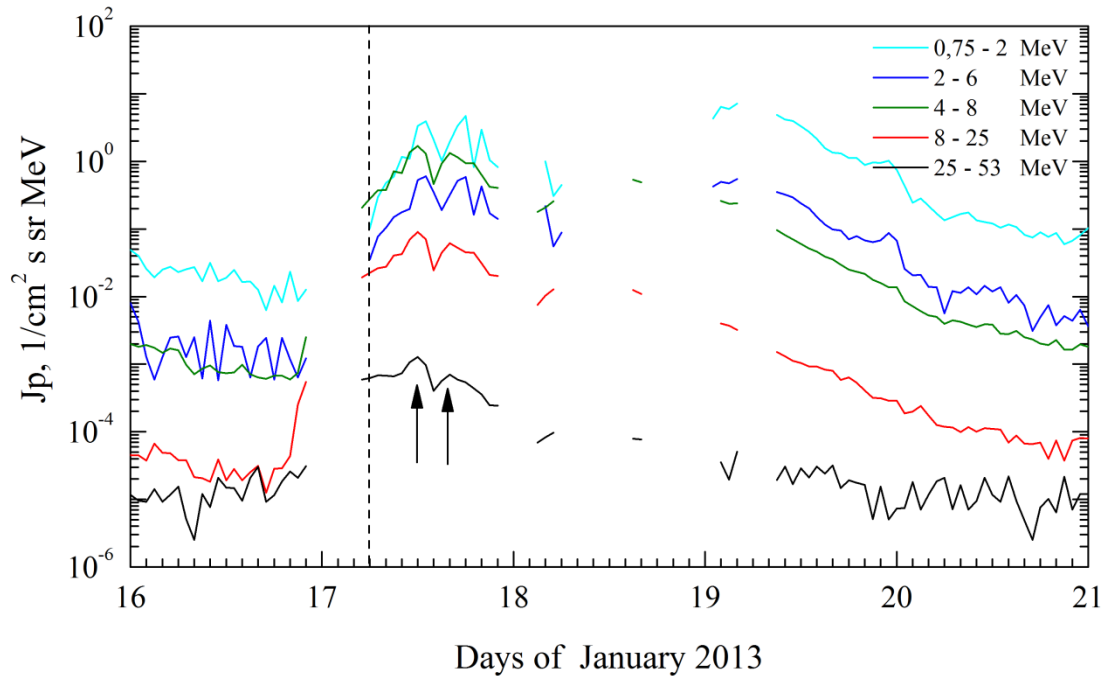
Time profiles of proton fluxes in the event 2013.01.16

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.01.16

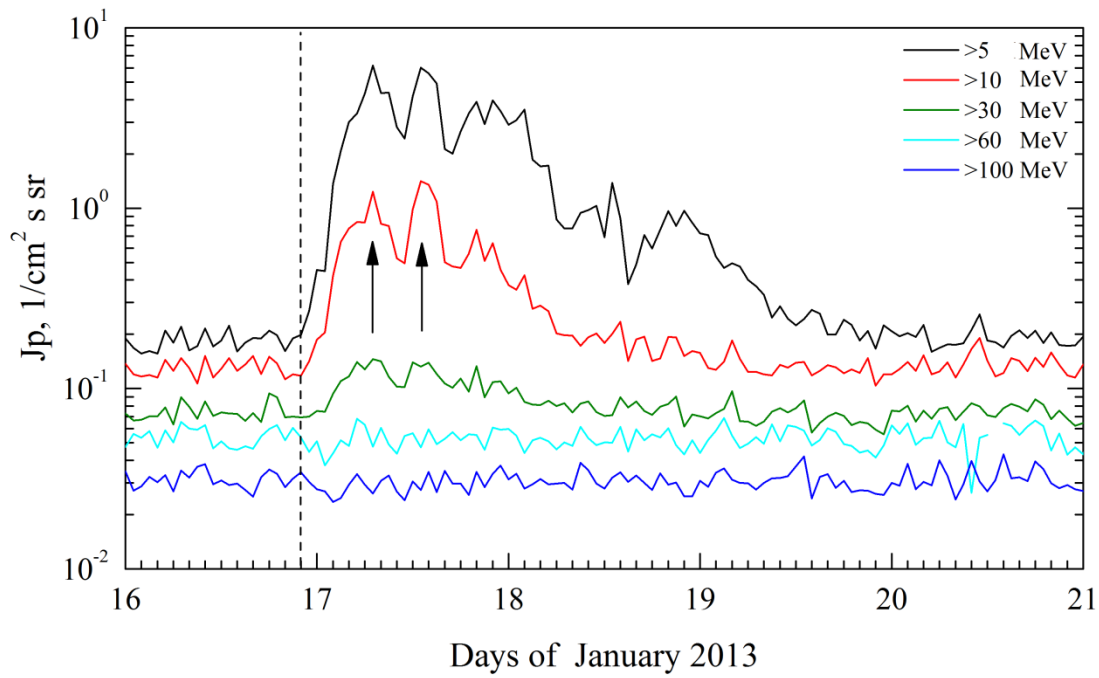


SOHO. Event 2013.01.16

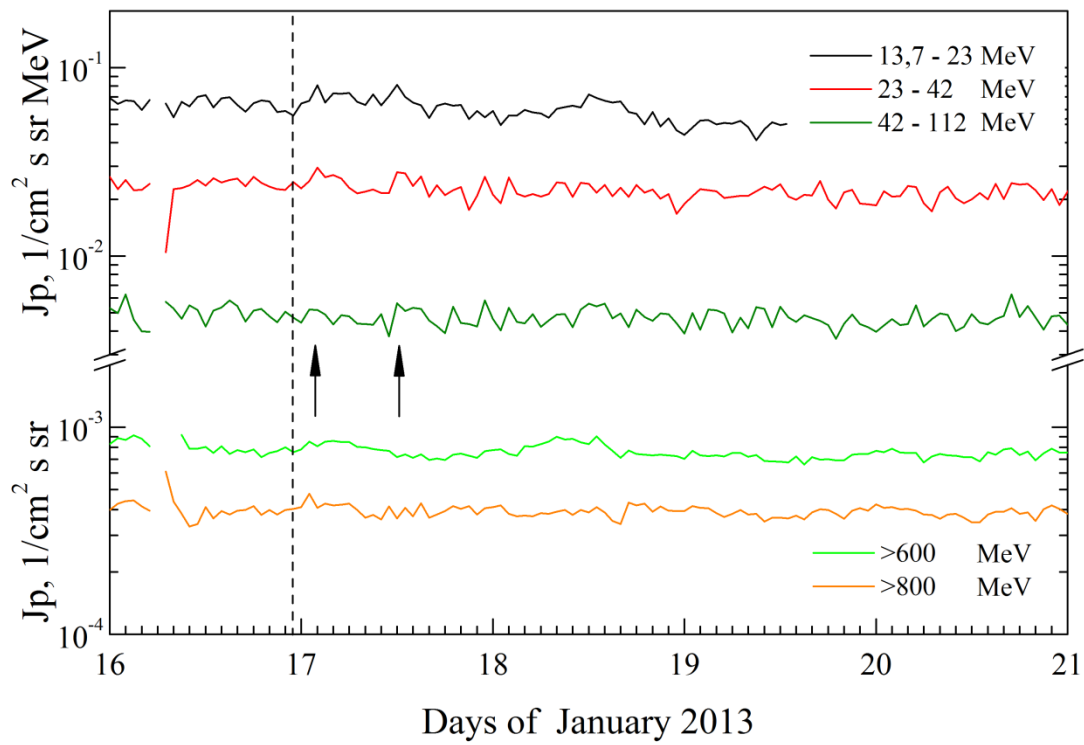


Earth satellites in geostationary orbit, $R \approx 6.6 \text{ Re}$: GOES and Electro.

GOES. Event 2013.01.16

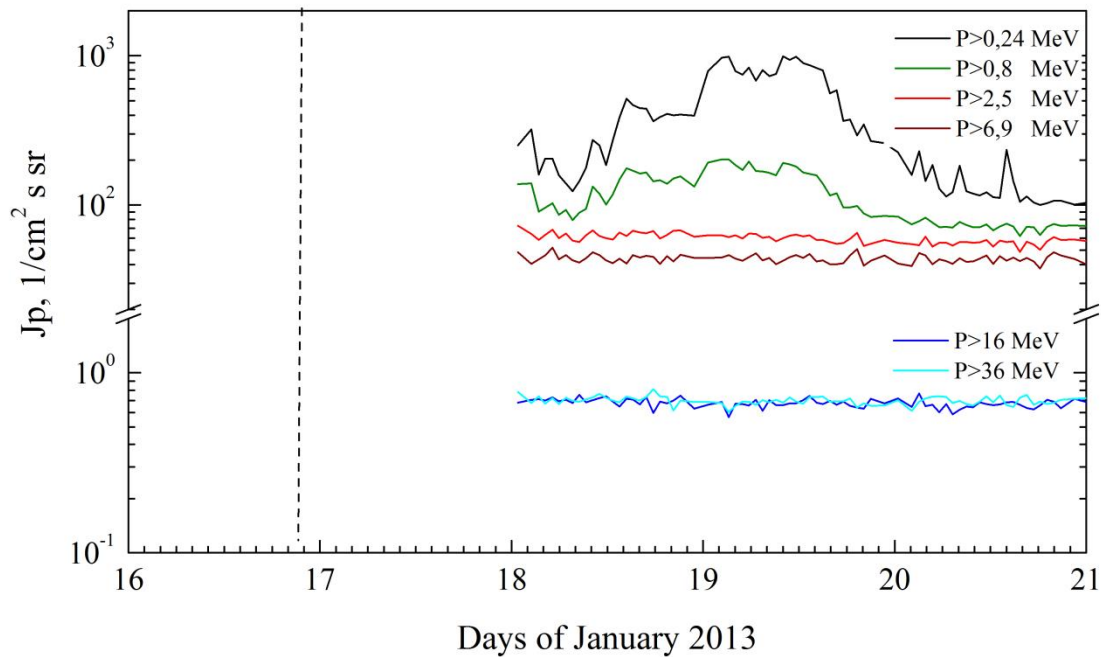


Electro. Event 2013.01.16



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

POES. Event 2013.01.16



Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 January 16

2013 January 16 ■ AR 11650 To event 524

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m^2
6563 Å		No event on visible solar disc					
1 – 12	keV	1918	1923	>2020	S32W87	C2.2	0.011
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1925:04	1926:34	20:00:24	816	4022616	HESSI
6-12	keV	2019:00	2019:38	20:24:44	52	83232	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II} , km/s	Importance	Sp/c
DH II	1000-200	2200		17/0130		2	WIND
CME		UT	V, km/s	a, km/s^2	$\Delta\phi$	dA	Sp/c
LASCO	WL	1900	648	- 4.9	250°	236°	SOHO

Proton Active Region:

AR 11650 (S29L194, CMP 11.1.01.2013,
Sp=250 msh, EHO, A, R1)
XRI= 0; C₉; S₂

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 15d18^h

Tmax₁($E_p > 10$ MeV) – 15d22^h, Jmax₁($E_p > 10$ MeV) – 0.9/cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 16d12^h, Jmax₂($E_p > 10$ MeV) – 6.2 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 2.3$, $\gamma_2 = 2.5$

Quasimaximal energy of protons in the event – Eqm₁ = 70 MeV

– Eqm₂ = 75 MeV

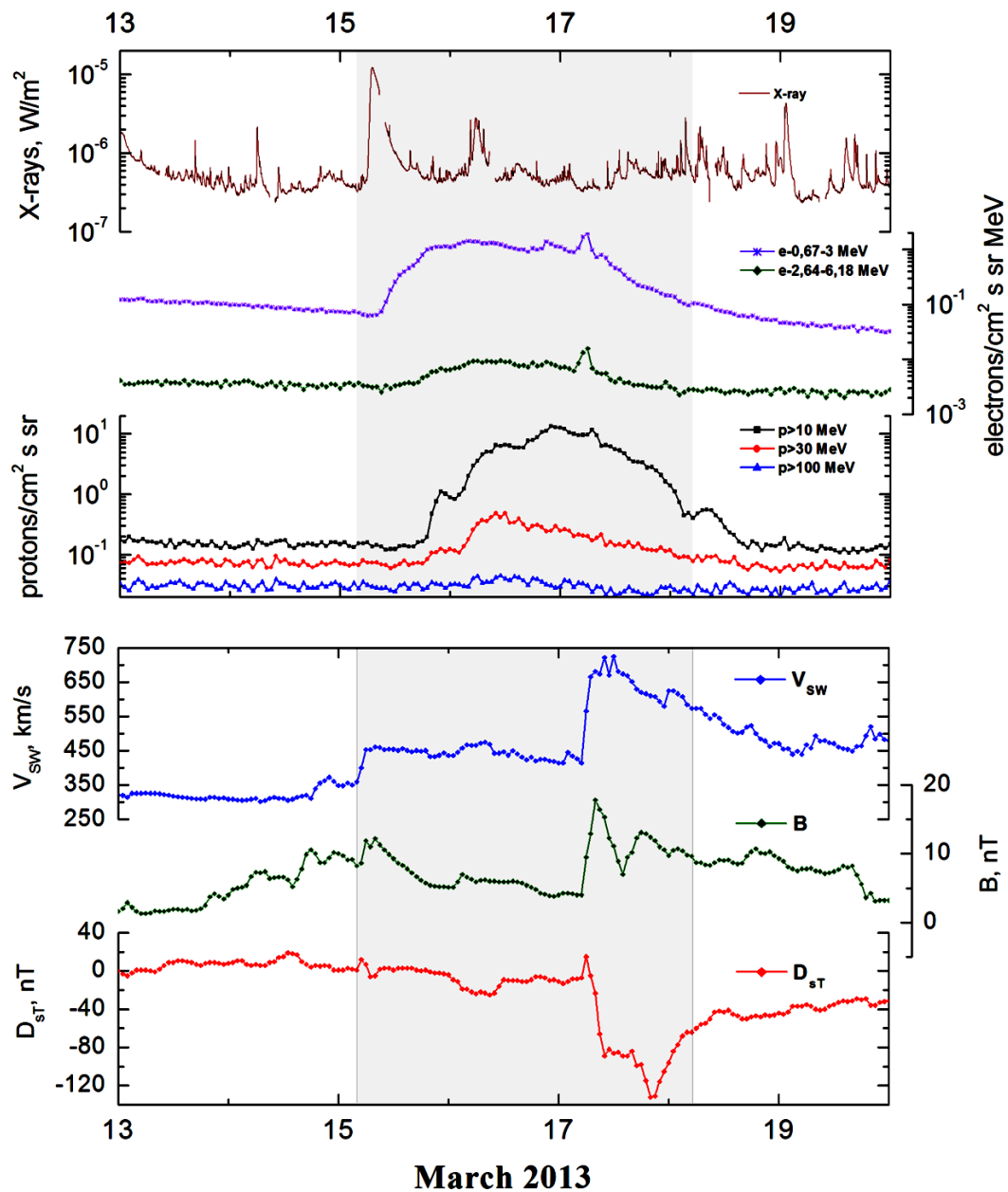
Sources: ● solar flare 15d05^h46^m, M1.1/1F, N09E06, AR11692

Main burst X-ray 1–8 Å: onset – 15d05^h46^m, max – 15d06^h58^m, $\Phi = 0.073$ J/m²

CME: 15d07^h12^m, V = 1063 km/s, $\Delta\phi = 360^\circ$, dA = 112°

▲ SC 17d06^h00^m

Particle fluxes and associated phenomena

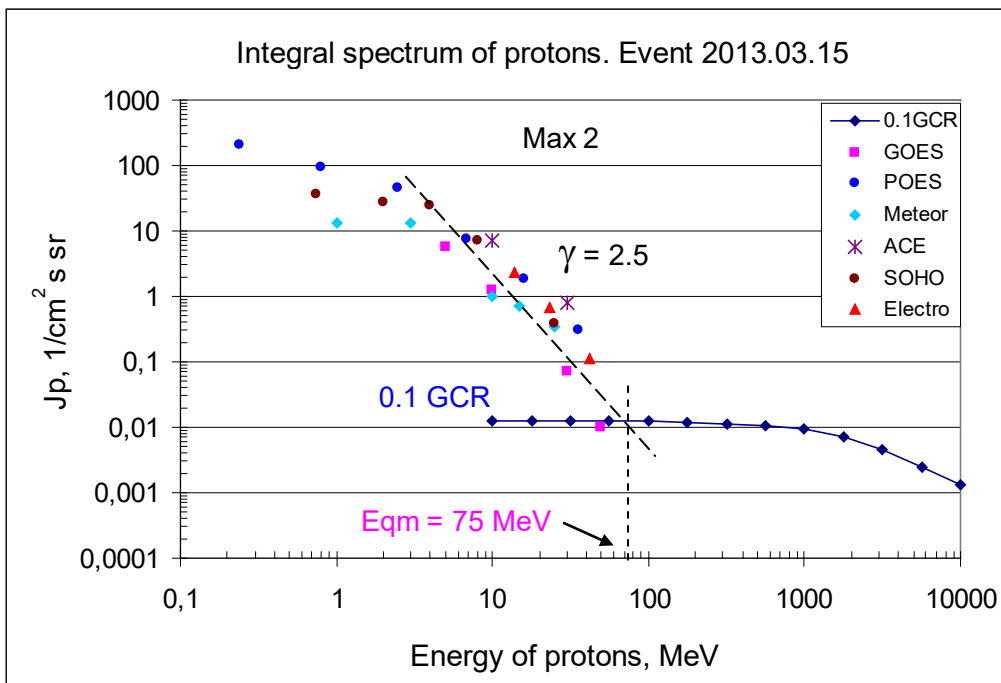
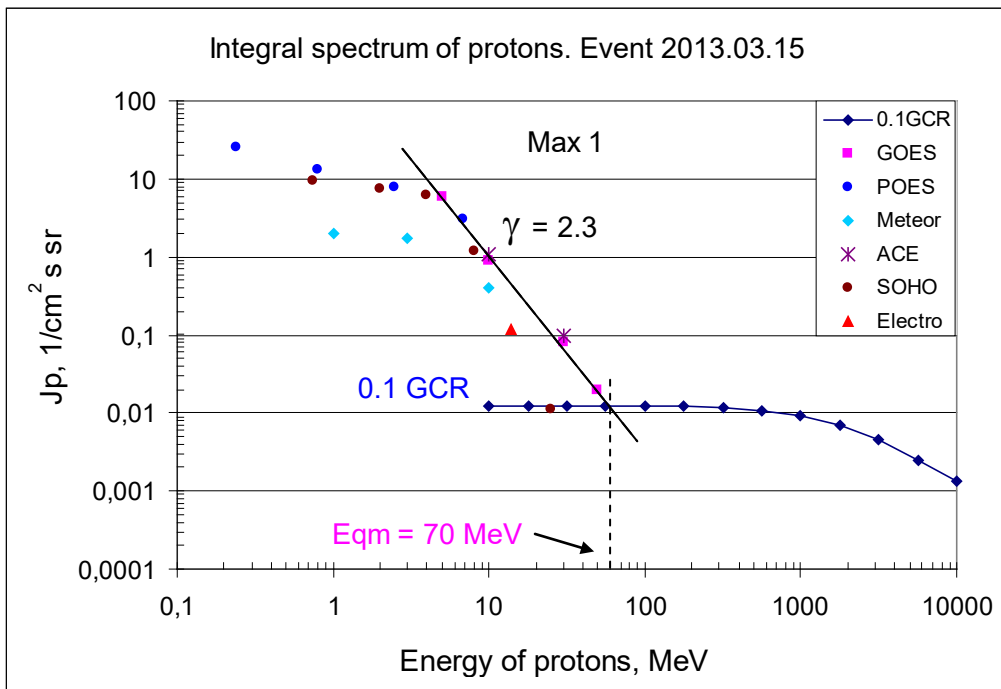


Integral fluxes of protons for the event of 2013 March 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	22/16d13	4.2/21	3	0.2	
EPS	>10	18	22/16d12	0.9/6.2	3	0.15	
EPS	>30	18	22/16d12	0.05/0.33	3	0.07	
EPS	>50	18	- /16d10	- /0.08	2	0.06	
EPS	>60	18	- /16d10	- ./0.05	2	0.05	
EPS	>100	18	- /16d12	- /0.01	2	0.03	
EPS	>700	-	-	-	-	-	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	18	23/16d09	25/205	3	110	
MEPED	>0.8	18	23/16d09	13/95	3	80	
MEPED	>2.5	18	23/16d09	8/46.5	2	55	
MEPED	>6.9	18	23/16d09	3/7.5	2	45	
MEPED	>16	16d03	- /16d11	- /1.9	2	0.7	
MEPED	>36	16d03	- /16d11	- /0.3	-	0.8	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	22	23/16d10	2/13.5	4	2.6	
SCR	>3	22	23/16d10	1.7 /13	4	2.4	
SCR	>10	22	23/16d10	0.4/1	2	1.6	
GALS-M	>15	22	- /16d10	- ./0.7	1	1.2	
GALS-M	>25	22	- /16d10	- /0.4	1	1.3	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	18	22/16d10	0.8/7.3	2	1.4	
SIS	>30	18	22/16d10	0.1/0.8	2	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 March 15

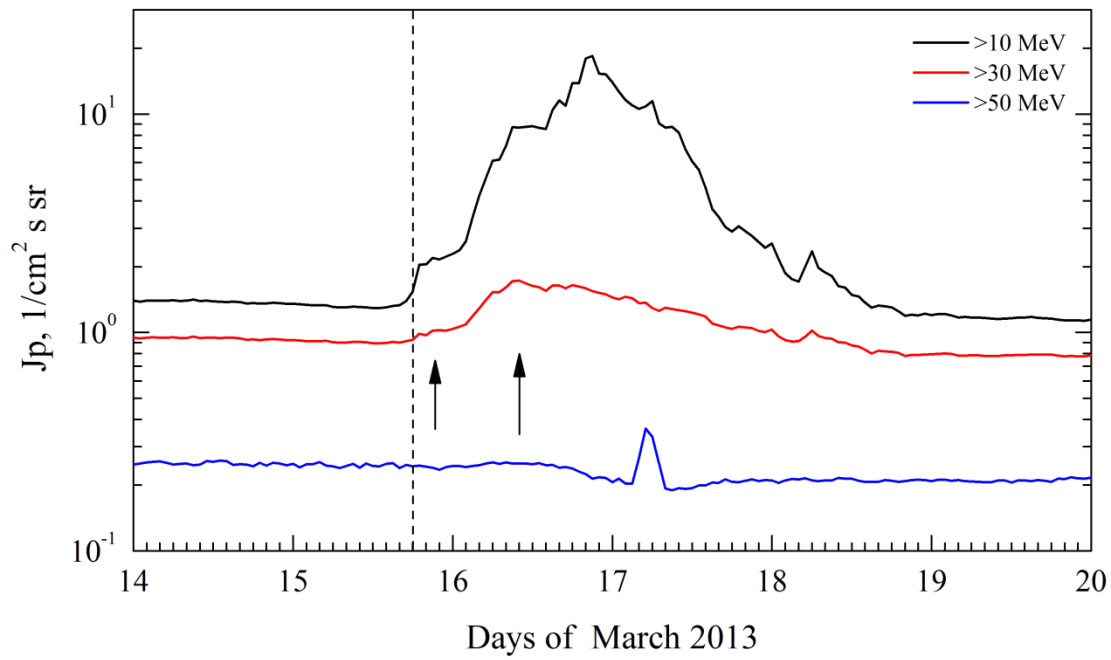
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	18	22/16d10	1.8/6.25	3	0.3	
LION	2 – 6	18	22/16d10	0.4/1.2	3	0.03	
EPHIN	4 – 8	14	22/16d10	1.25/4.3	3	0.04	
EPHIN	8 – 25	14	22/16d10	0.07/0.39	3	0.002	
EPHIN	25 – 53	16	21/16d10	0.0004/0.014	3	0.0001	
Electro-1							
SCR-E	13.7–23	18	23/16d10	0.013/0.18	2	0.05	
SCR-E	23–42	18	23/16d10	- /0,03	2	0,025	
SCR-E	42–112	18	23/16d10	- /0,0016	-	0,005	



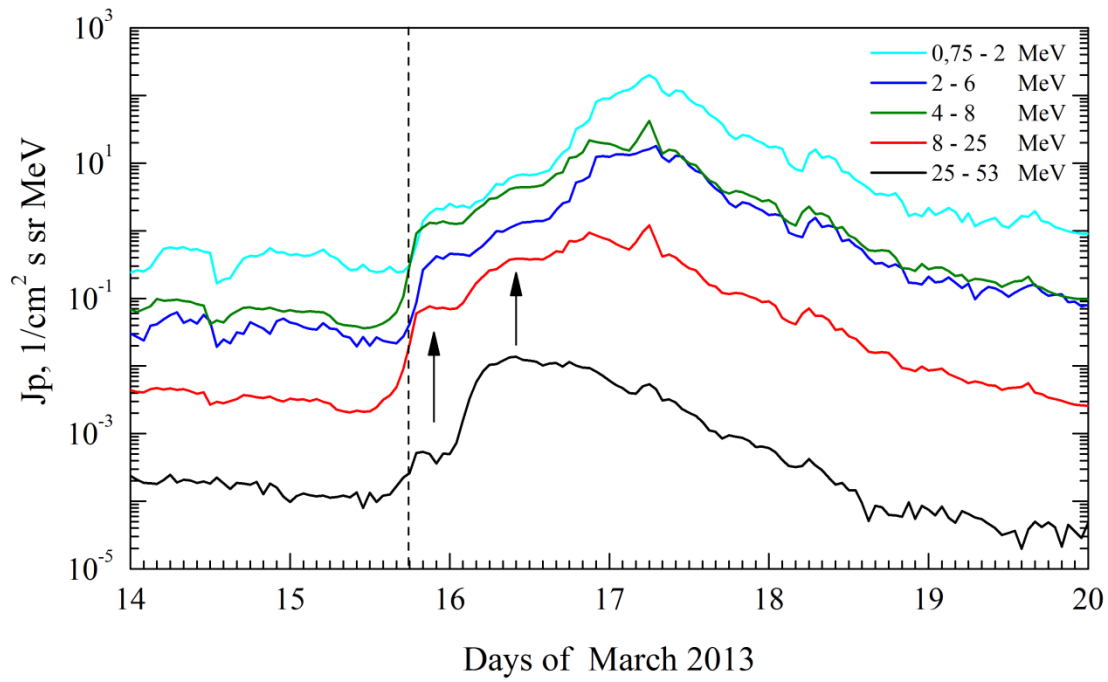
Time profiles of proton fluxes in the event 2013.03.15

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

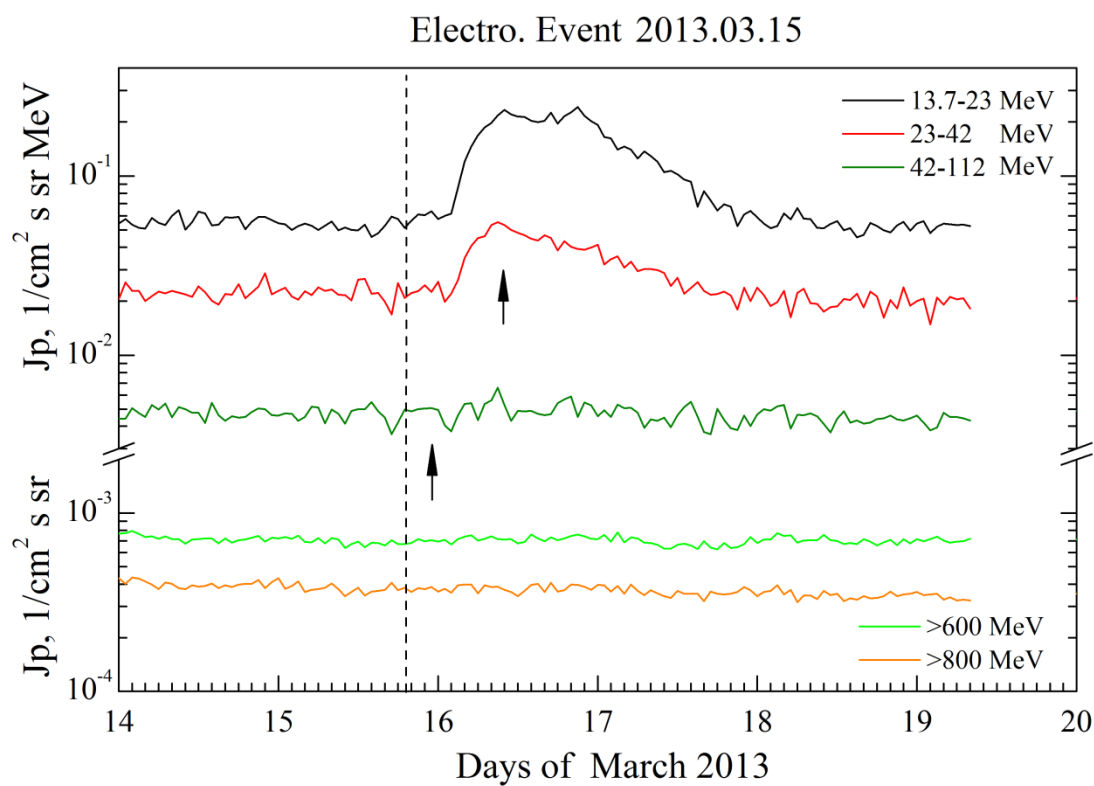
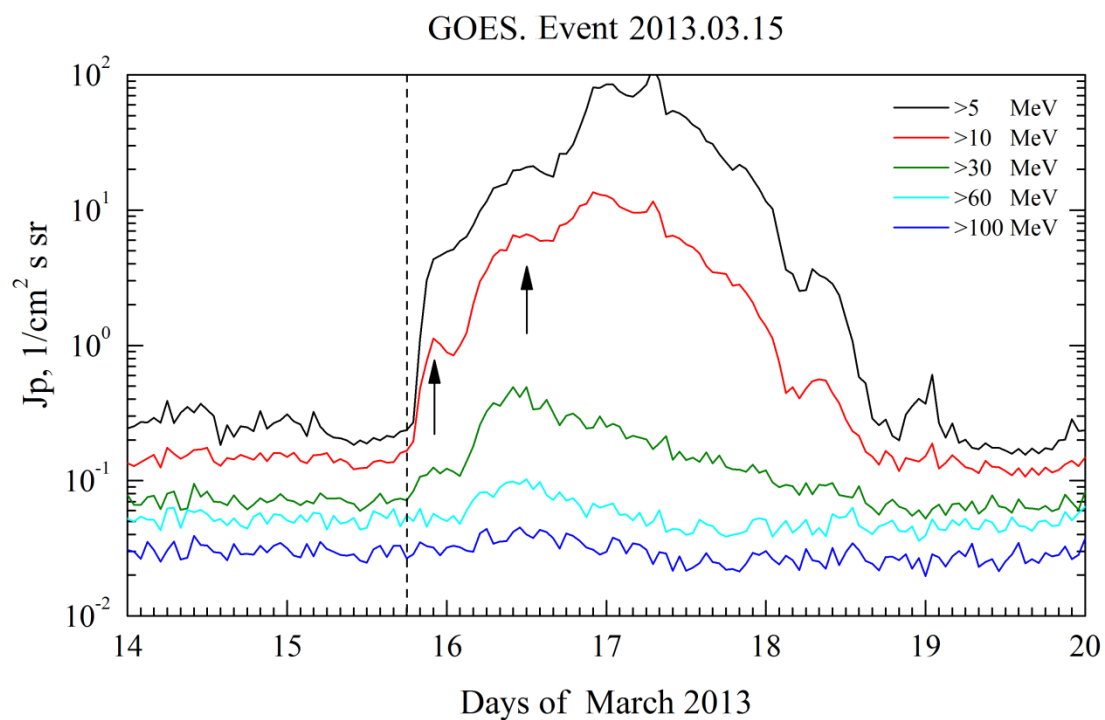
ACE SIS + SOHO (>50 MeV). Event 2013.03.15



SOHO. Event 2013.03.15

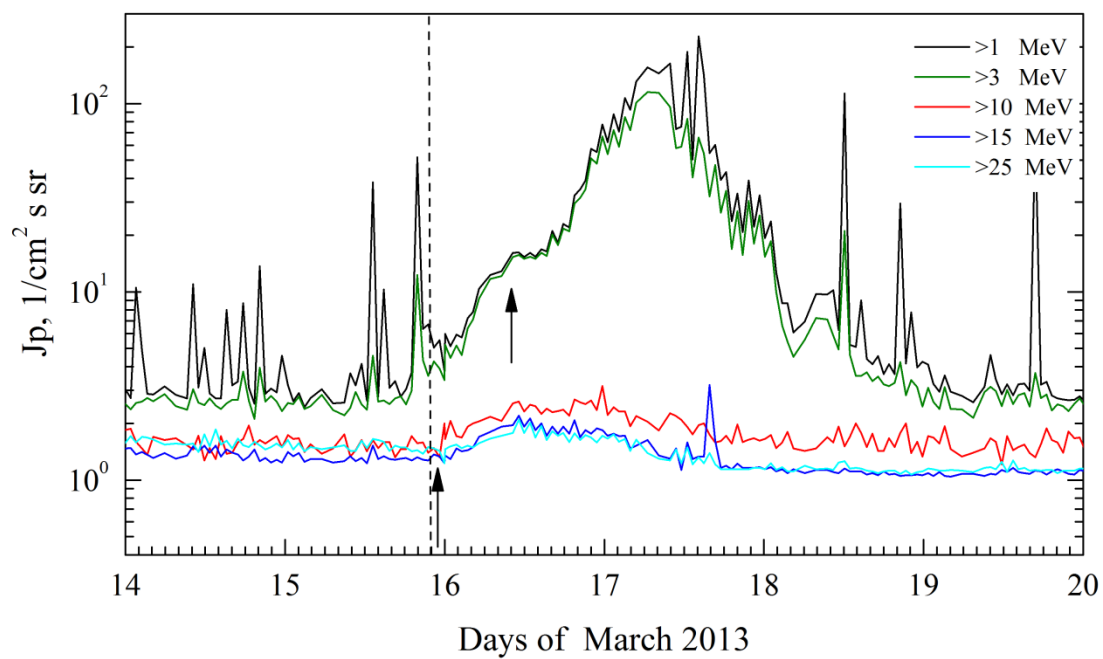


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro.

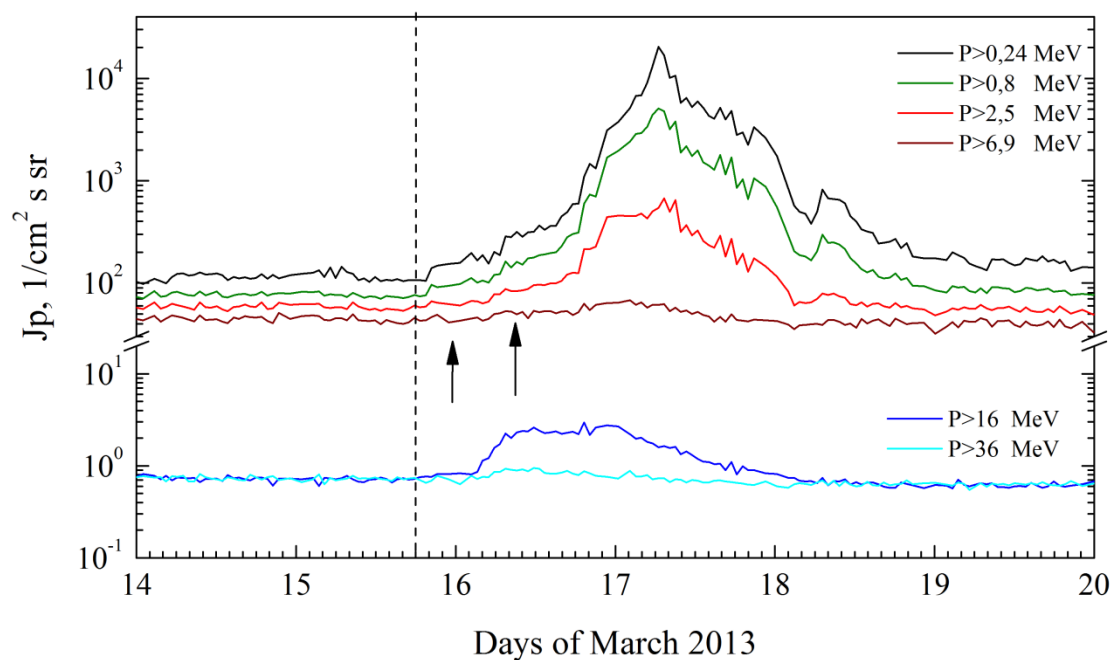


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.03.15



POES. Event 2013.03.15



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 March 15**

2013

March 15

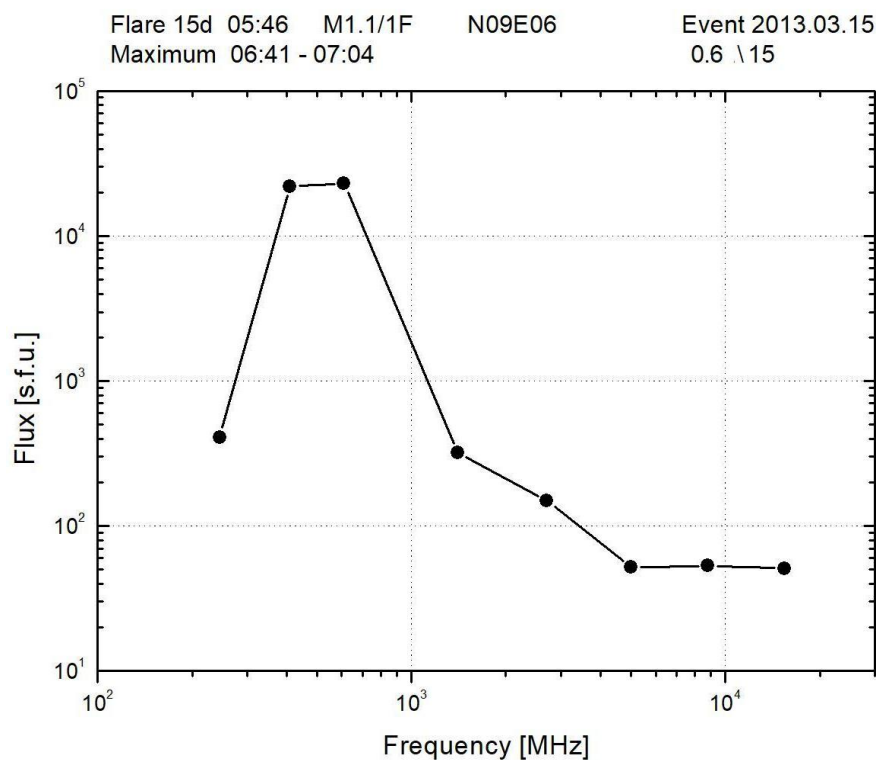
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AR 11692

To event 525

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0613	0637	0833	N11E12	1F	ERU
1 – 12	keV	0546	0658	0835	N09E06	M1.1	0.073
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	0551:52	0611:10	0612:20	1008	2204784	HESSI
12-25	keV	0707:36	0709:22	0728:48	120	697607	HESSI
6-12	keV	0728:48	0729:46	0744:44	84	372167	HESSI
12-25	keV	0615:24	0621:53	0625:38	1313	114548	FERMI
12-25	keV	0701:37	0712:04	0755:57	1577	732825	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0658	0704	0705	0.6 \ 15	1.71	
8.8	GHz	0646	0647	0651		1.72	
5	GHz	0644	0647	0651		1.72	
2.7	GHz	0631	0649	0651		2.18	
1.4	GHz	0627	0652	0704		2.51	
610	MHz	0620	0641	0732		4.36	
410	MHz	0622	0644	0743		4.34	
245	MHz	0620	0647	0732		2.61	
DS-type	Frequency, MHz	To	Tmax	Te	V _n , km/s	Importance	Sp/c
DS IV	25-180	0620		1023		2	
DS IV		0632		0800D		3	
DS III		0632		0800D		1	
DS III		0641		0644		3	
DH II	14-0.1	0700		2130			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0712	1063	-25.8	360°	112°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR 11692(N09L075, CMP 15,7.03.2013,
Sp=340 msh, DKI, B, R)
XRI=0.27, $M_2^{1.6} + C_9$ $1_2 + S_1$
PFR1 15.03 M_1
PFR2 21.03 M_1

References:

- Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 11d07^h

Tmax ($E_p > 10$ MeV) – 11d17^h, Jmax ($E_p > 10$ MeV) – 100 /cm²·s·sr

Duration of the event – 5 days, power-law index: $\gamma = 3.2$

Quasimaximal energy of protons in the event – $E_{qm} = 500$ MeV

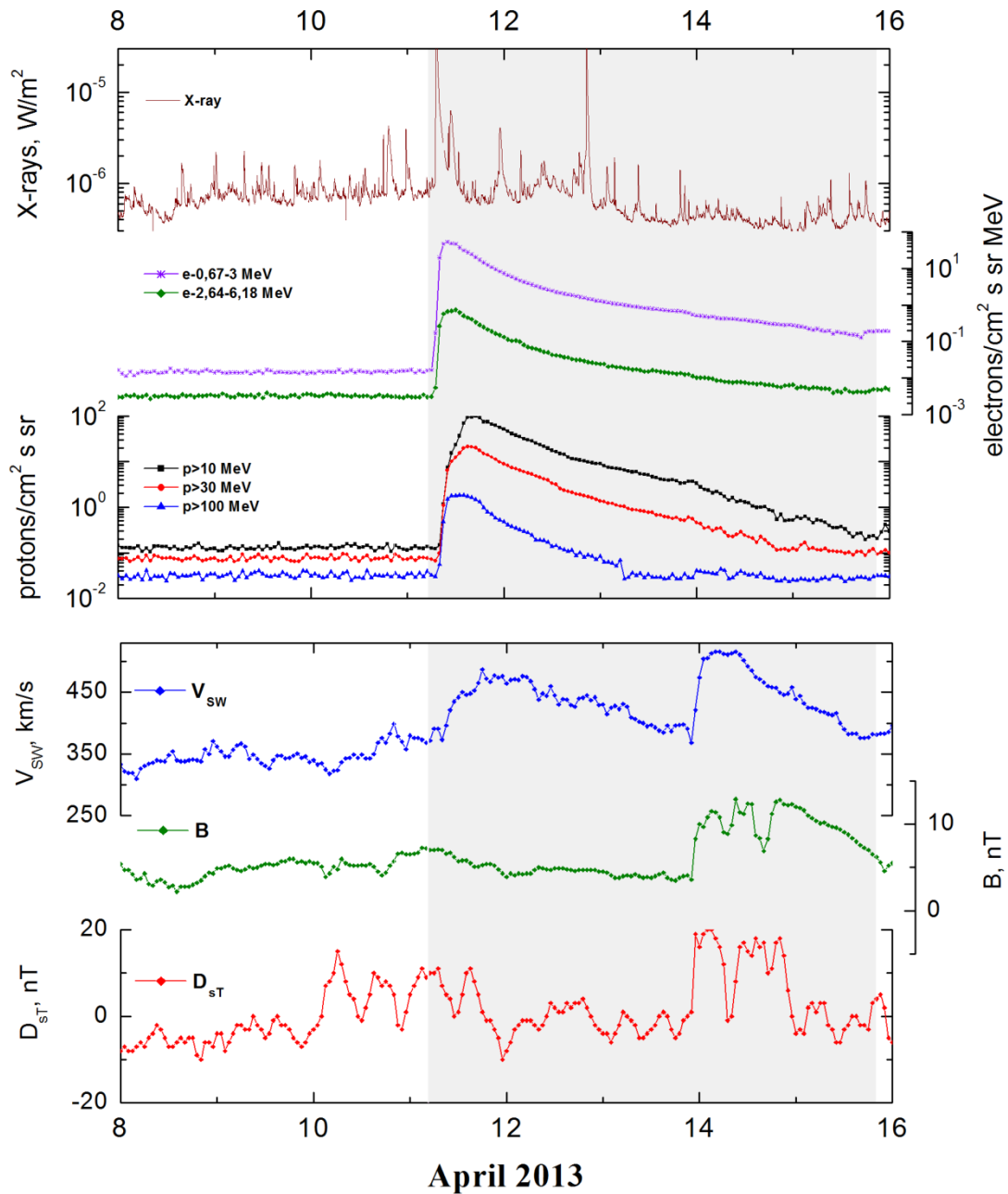
Sources: ● solar flare 11d06^h55^m, M6.5/3B, N09E12, AR11719

Main burst X-ray 1–8 Å: onset – 11d06^h55^m, max – 11d07^h16^m, $\Phi = 0.074$ J/m²

CME 11d07^h24^m, $V = 861$ km/s, $\Delta\phi = 360^\circ$, $dA = 085^\circ$

▲ SC 13d22^h54^m

Particle fluxes and associated phenomena

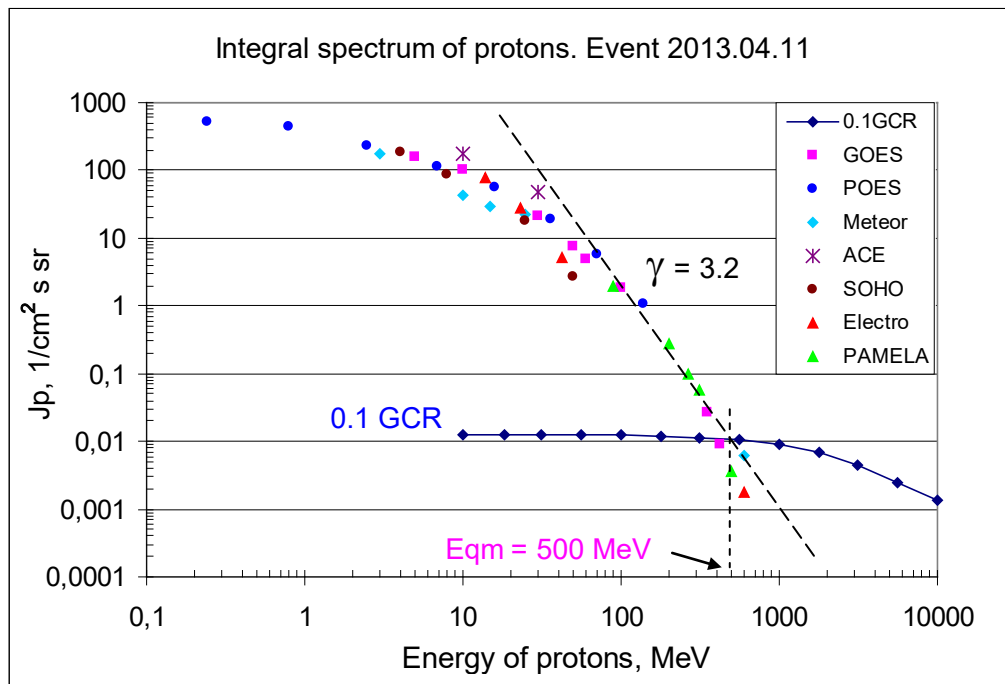


Integral fluxes of protons for the event of 2013 April 11

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	18	158	5	0.2	
EPS	>10	7	17	100	5	0.15	
EPS	>30	7	16	21	4	0.07	
EPS	>50	7	15	7.5	3	0.06	
EPS	>60	7	15	5	2	0.05	
EPS	>100	7	14	1.8	2	0.03	
Electro-1							
GALS-E	>600	7	16	0.0018	2	0.001	
POES							
MEPED	>0.24	8	17	530	4	100	
MEPED	>0.8	8	16	440	3.5	80	
MEPED	>2.5	8	15	225	3	55	
MEPED	>6.9	8	14	117	3	45	
MEPED	>16	8	14	55.5	3	0.7	
MEPED	>36	8	14	19.3	2	0.8	
MEPED	>70	8	14	5.7	1	0.9	
MEPED	>140	8	14	1.1	1	1.1	
Meteor-1							
SCR	>1	7	-	-	5	2.6	
SCR	>3	7	16	173	5	2.35	
SCR	>10	7	16	42	4	1.6	
GALS-M	>15	7	15	30	3	1.2	
GALS-M	>25	7	15	22	3	1.3	
GALS-M	>600	7	12	0.0063	0.5	0.02	
ACE							
SIS	>10	7	13	174	3	1.3	
SIS	>30	7	13	47.5	3	0.9	
PAMELA							
TRACKER	>90	8	08-11	2	>2	-	
TRACKER	>200	8	08-12	0.28	>2	-	
TRACKER	>265	8	08-13	0.1	>1	-	
TRACKER	>312	8	08-14	0.057	>1	-	
TRACKER	>500	8	08-15	0.0035	1	-	
SOHO							
EPHIN	>50	8	12	2.7	3	0.25	

Differential fluxes of protons for the event of 2013 April 11

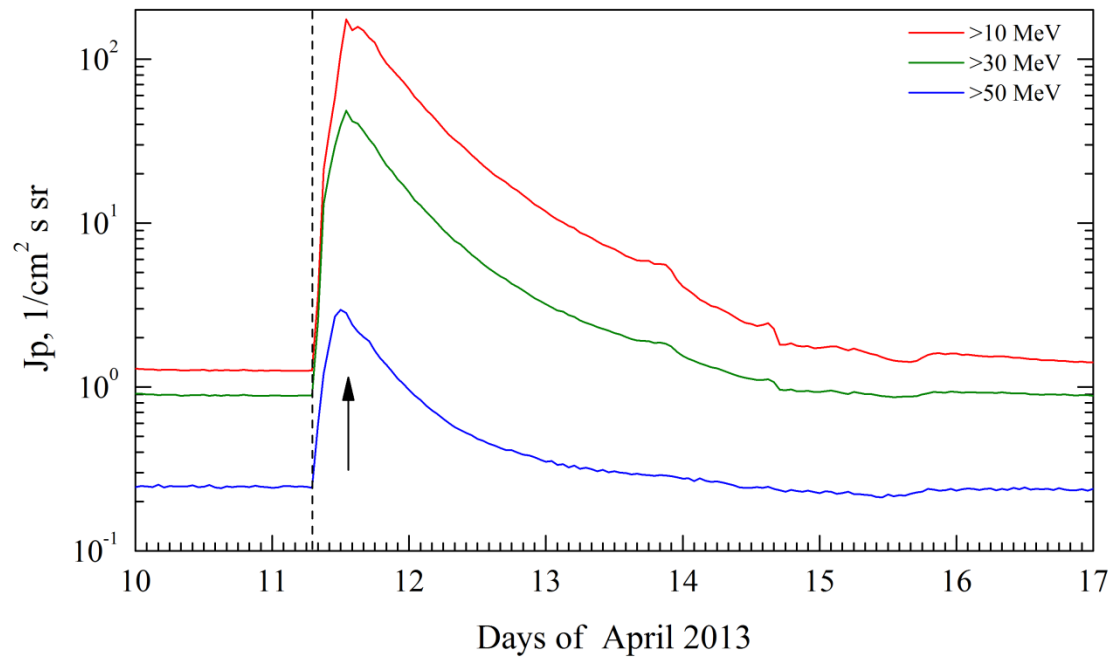
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	8	16	25.1	4	0.00002	
EPHIN	8 – 25	8	14	4.09	4	0.00002	
EPHIN	25 – 53	8	12	0.56	4	0.00002	
Electro-1							
SCR-E	13.7–23	7	15	5.6	5	0.05	
SCR-E	23–42	7	15	1.2	4	0.025	
SCR-E	42–112	7	15	0.058	3	0.005	
GOES							
EPS	350–420	8	14	0.00026	1	0.0017	
EPS	420–510	8	12	0.0001	1	0.001	
EPS	510–700	-	-	-	-	0.0004	



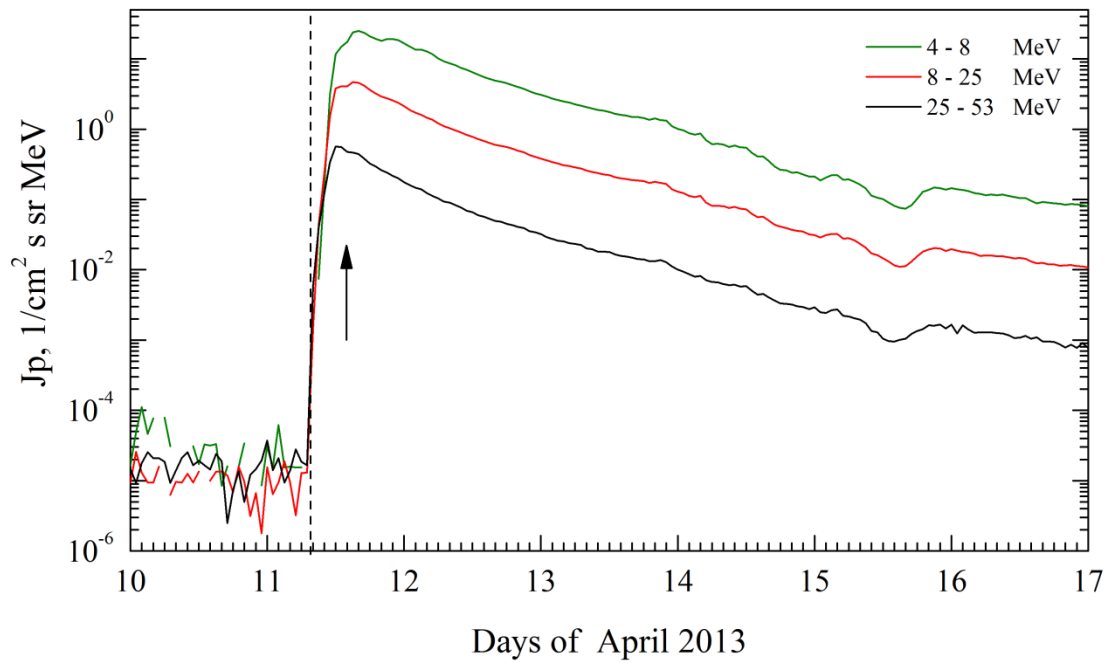
Time profiles of proton fluxes in the event 2013.04.11

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.04.11

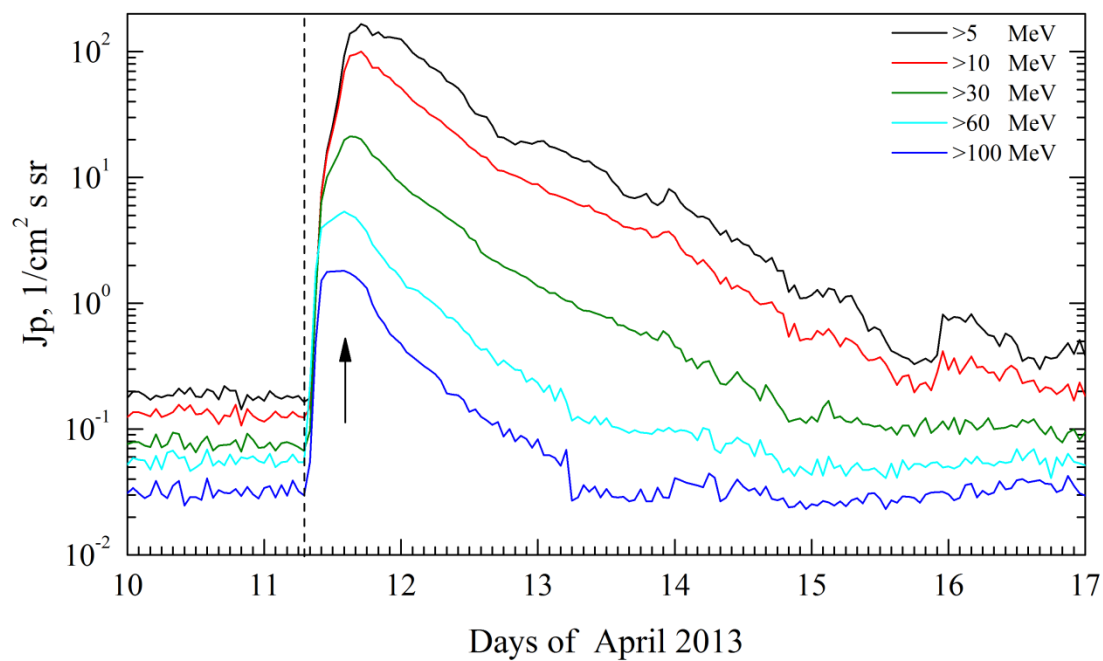


SOHO. Event 2013.04.11

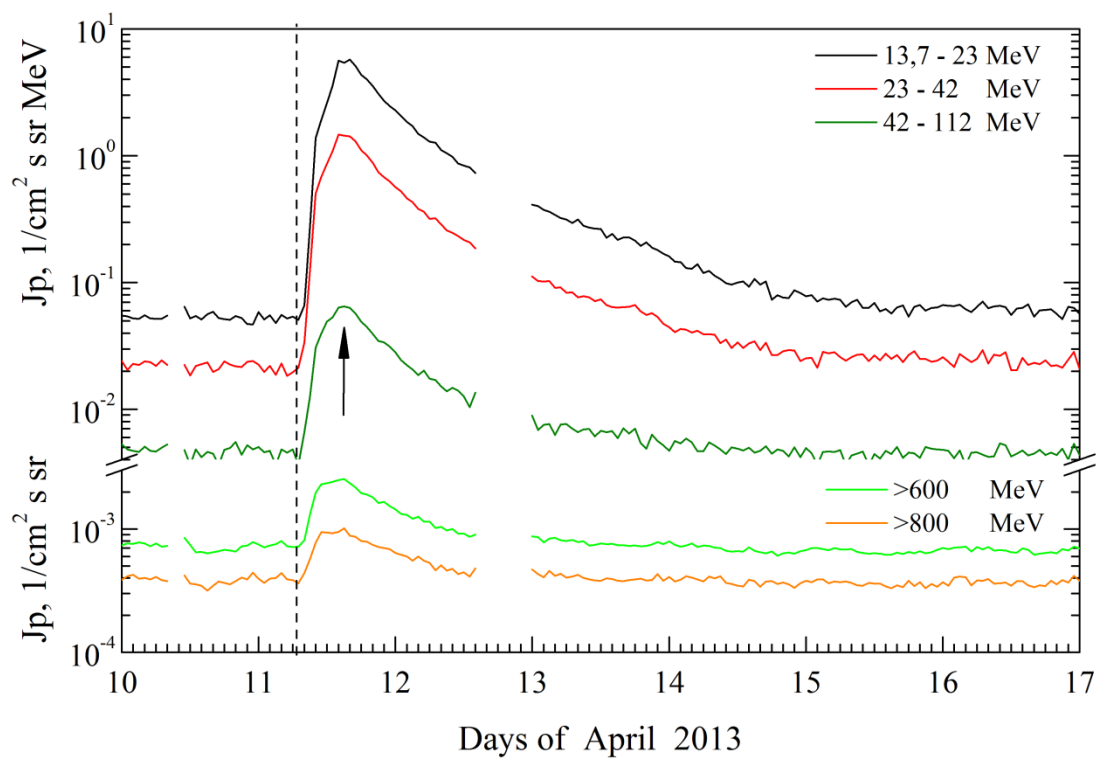


Earth satellites in geostationary orbit. $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.04.11

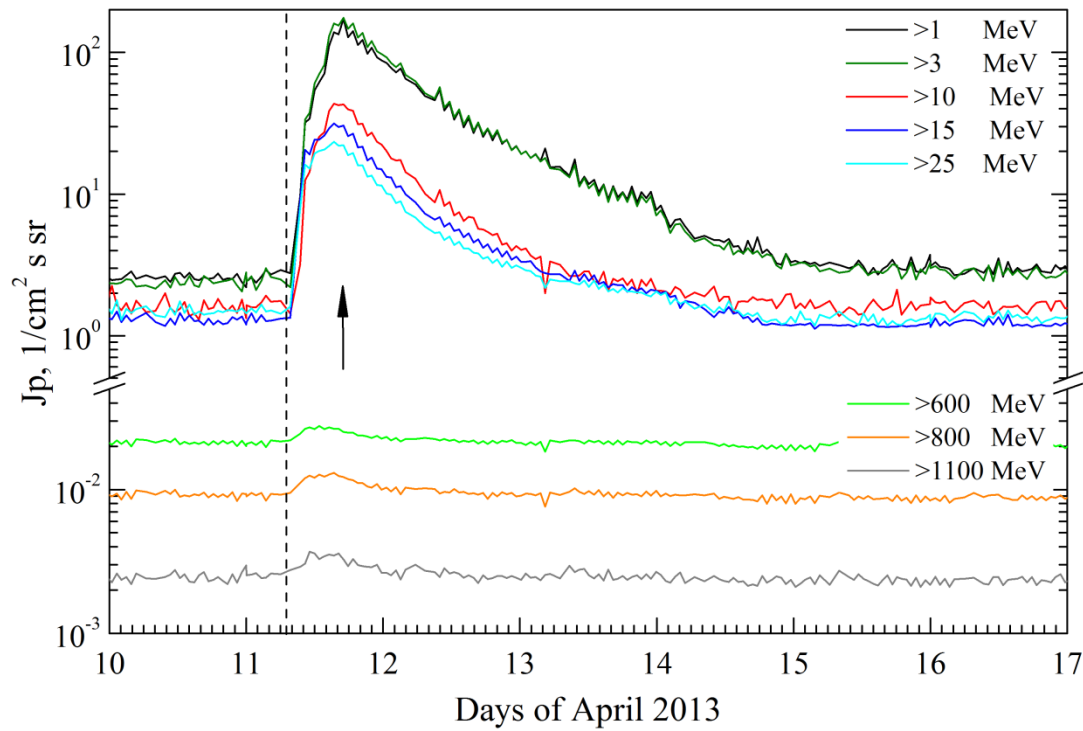


Electro. Event 2013.04.11

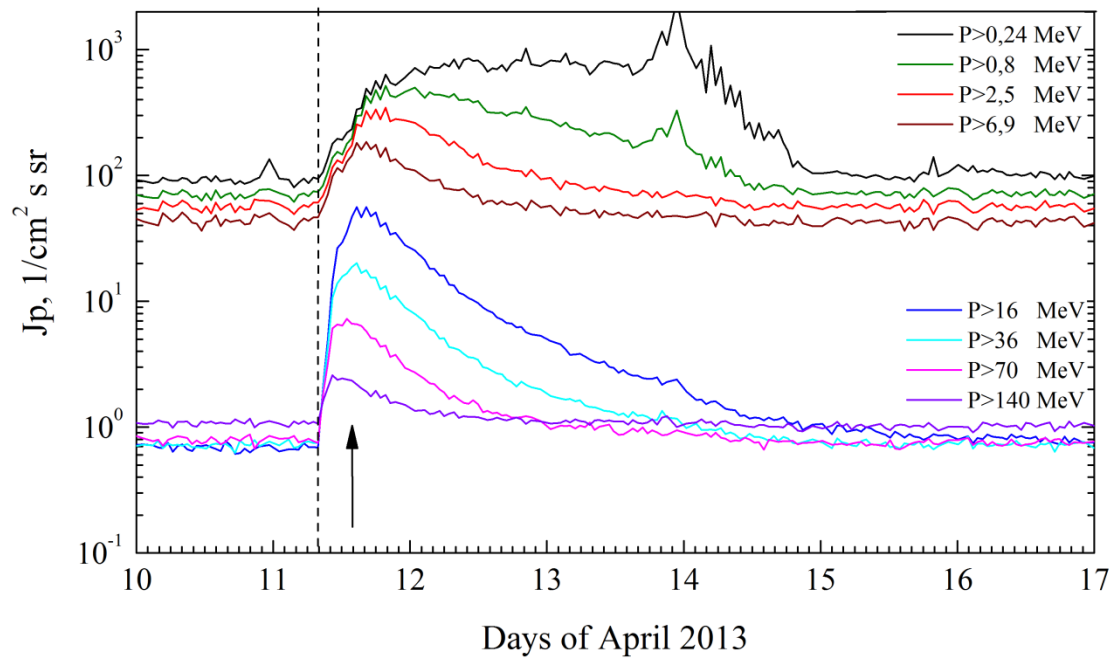


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.04.11



POES. Event 2013.04.11



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 April 11**

2013

April 11

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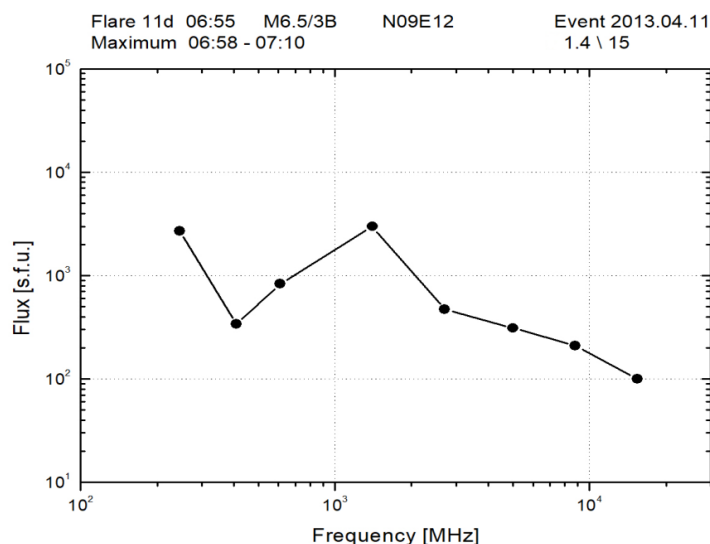
AR 11719

To event 526

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0656	0710	0906	N09E12	3B	UMB
1 – 12	keV	0655	0716	0729	N07E13	M6.5	0.074
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0650:44	0707:38	07:08:40	2160	2815919	HESSI
6-12	keV	0803:12	0807:50	0810:52	34	76941	HESSI
12-25	keV	0656:44	0709:45	0746:41	205369	113465544	FERMI
>100	MeV	0720:30		0739:30		4.03E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0710	0710	0710		2.00	
8.8	GHz	0702	0710	0723		2.32	
5	GHz	0658	0710	0716		2.49	
2.7	GHz	0658	0702	0718		2.67	
1.4	GHz	0656	0658	0811	1.4 \ 15	3.48	
610	MHz	0658	0702	0830		2.92	
410	MHz	0657	0707	0845		2.53	
245	MHz	0657	0658	0859		3.43	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	45-160	0702		0709		3	
DS IV	25-180	0702		0712		3	
DS III	25-90	0703		0720		3	
DS VI	25-180	0657		0846		1	
DH II	10-0.2	0710		1500			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0724	861	- 8.1	360°	85°	SOHO

* cm⁻² s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR 11719 (N10L076; CMP 12,0.04.2013;

Sp=290 msh; EKI; BGD)

XRI=0.87; $M_2^{6.5} + C_{15}$

PFR1 05.04 $M_1^{2.2}$

PFR2 11.04 $M_1^{6.5}$

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Particle event: To($E_p > 10$ MeV) – 21d09^h

Tmax₁($E_p > 10$ MeV) – 21d12^h, Jmax₁($E_p > 10$ MeV) – 2 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 22d02^h, Jmax₂($E_p > 10$ MeV) – 1.2 /cm²·s·sr

Duration of the event – 3.5 days, power-law index: $\gamma_1 = 2.3$, $\gamma_2 = 2.2$

Quasimaximal energy of protons in the event – Eqm₁ = 110 MeV

– Eqm₂ = 70 MeV

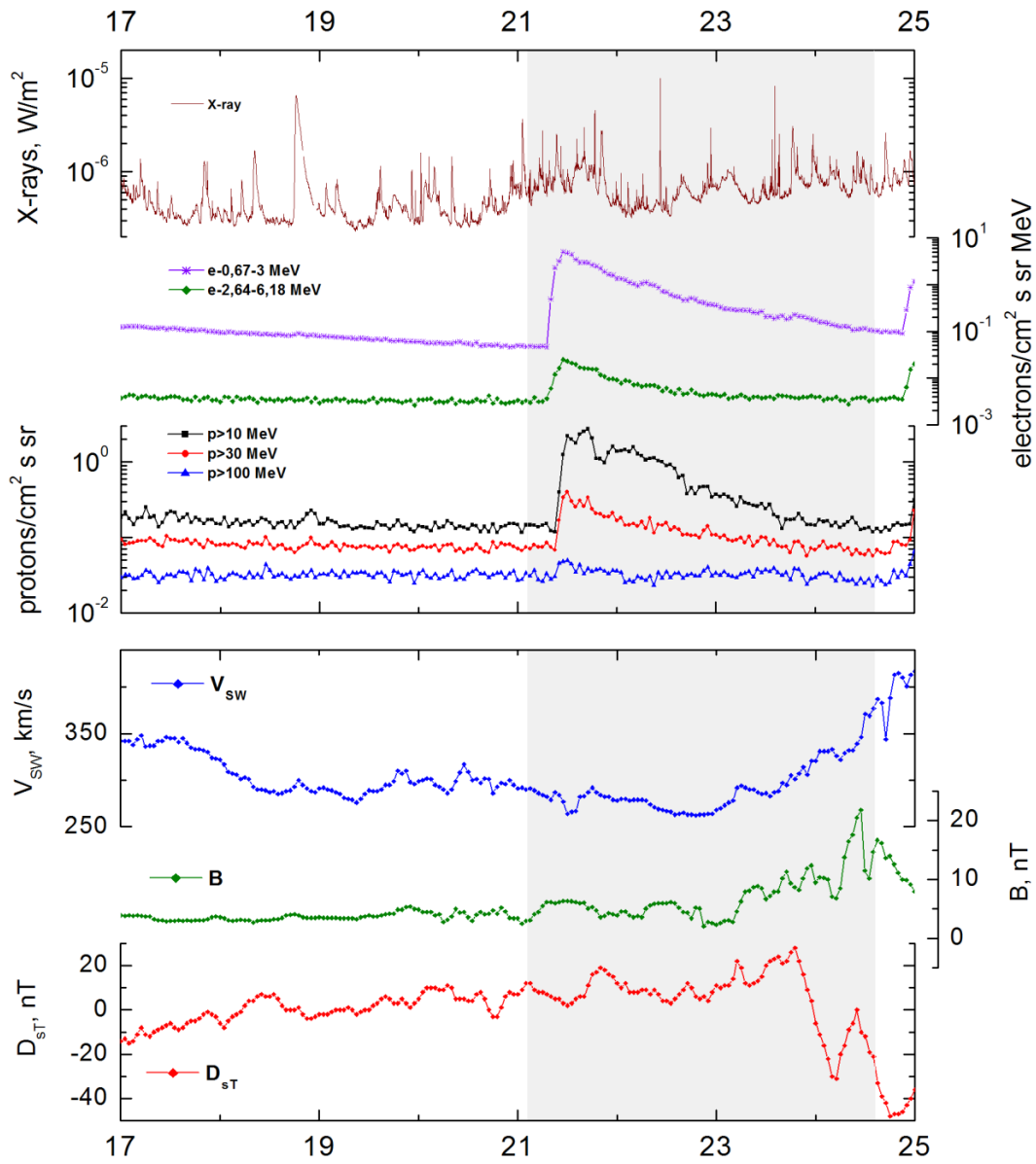
Sources: ☐ back side solar flare event 21d<07^h24^m, AR11719, 2d behind W_L

Ø back side solar flare event 21d<20^h36^m, AR11719, 2d behind W_L

CME 21d07^h24^m, V = 919 km/s, $\Delta\phi = 360^\circ$, dA = 269°

CME 21d20^h36^m, V = 561 km/s, $\Delta\phi = 212^\circ$, dA = 260°

Particle fluxes and associated phenomena



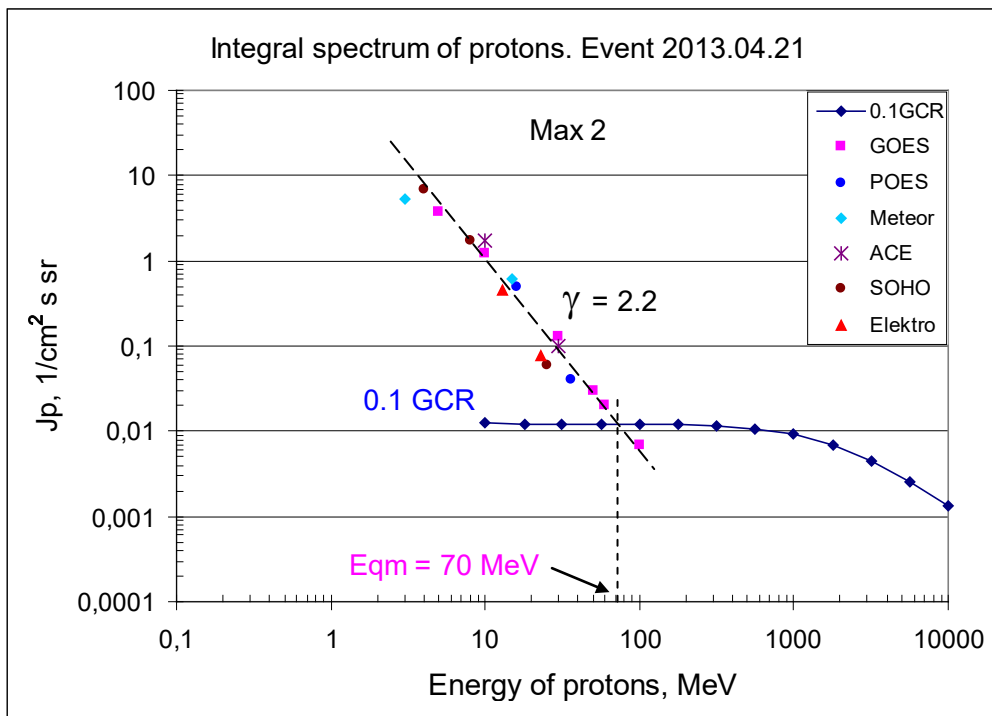
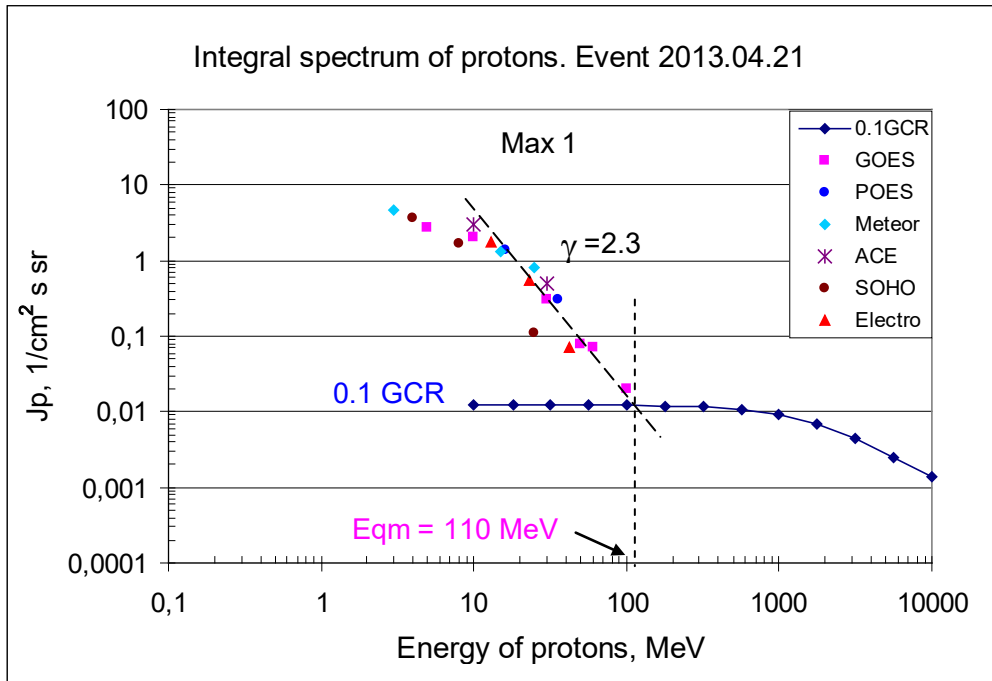
April 2013

Integral fluxes of protons for the event of 2013 April 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	9	12/22d03	2.8/3.7	3.5	0.25	
EPS	>10	9	12/22d02	2/1.2	3.5	0.15	
EPS	>30	9	12/22d01	0.3/0.13	3	0.07	
EPS	>50	9	12/23	0.08/0.03	1	0.06	
EPS	>60	9	12/23	0.07/0.02	1	0.05	
EPS	>100	9	12/23	0.02/0.007	1	0.03	
EPS	>700						
Electro-1							
GALS-MP	>600	-	-	-	-	0,0007	
POES-15							
MEPED	>0.24	5	-	-	-	100	
MEPED	>0.8	5	-	-	-	80	
MEPED	>2.5	5	-	-	-	55	
MEPED	>6.9	5	-	-	-	45	
MEPED	>16	5	12/23	1,4/0,5	1	0,7	
MEPED	>36	5	12/23	0,3/0,04	0,5	0,75	
MEPED	>70	-	-	-	-	0,9	
MEPED	>140	-	-	-	-	1,1	
Meteor -1							
SCR-1	>1	9	-	-	2	2.75	
SCR-1	>3	9	12/17	4.7/5.3	2	2.6	
SCR-1	>10	9	-	-	1	1.6	
GALS-MP	>15	9	12/17	1.3/0.6	1	1.2	
GALS-MP	>25	9	12/-	0.8/-	1	1.25	
GALS-MP	>600	-	-	-	-	0.02	
ACE							
SIS	>10	8	13/22d07	3/1,7	2	1,3	
SIS	>30	8	13/22d07	0,5/0,1	1	0,9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 April 21

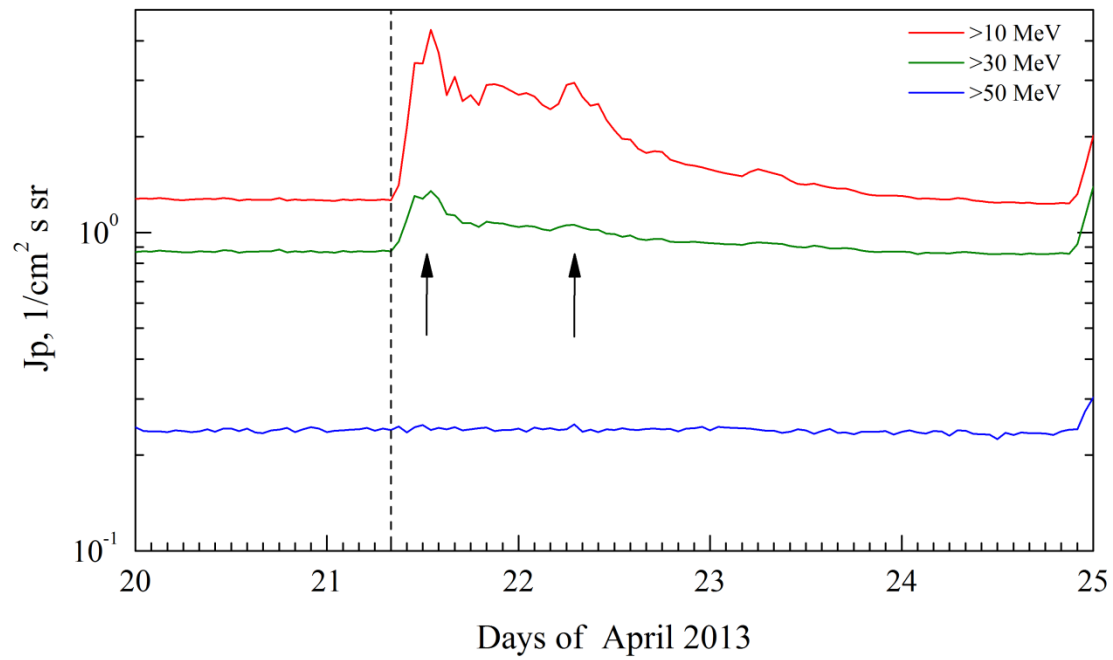
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0,75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	13	20/22d07	0,51/1,3	3,5	0,02	
EPHIN	8 – 25	13	20/22d06	0,09/0,1	3,5	0,002	
EPHIN	25 – 53	13	20/22d06	0,0039/0,0021	3,5	0,0004	
Electro-1							
SCR-E	13.7–23	8	12/22d00	0,13/0,04	5	0,05	
SCR-E	23–42	8	12/22d00	0,025/0,004	4	0,025	
SCR-E	42–112	8	12/22d00	0,001/ -	3	0,005	



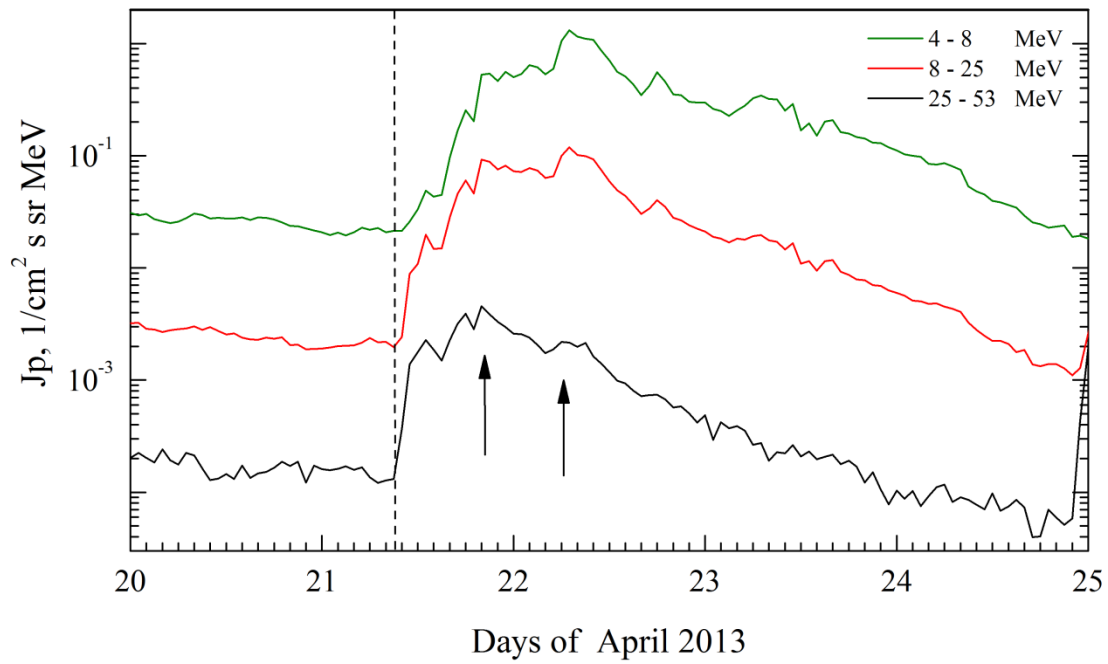
Time profiles of proton fluxes in the event 2013.04.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.04.21

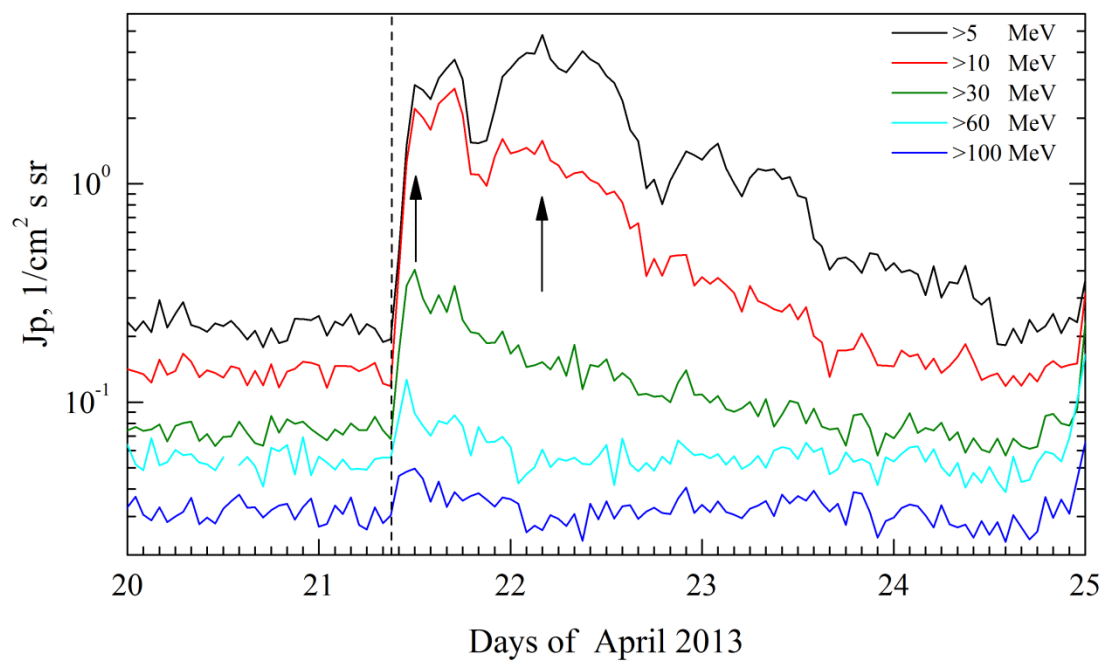


SOHO. Event 2013.04.21

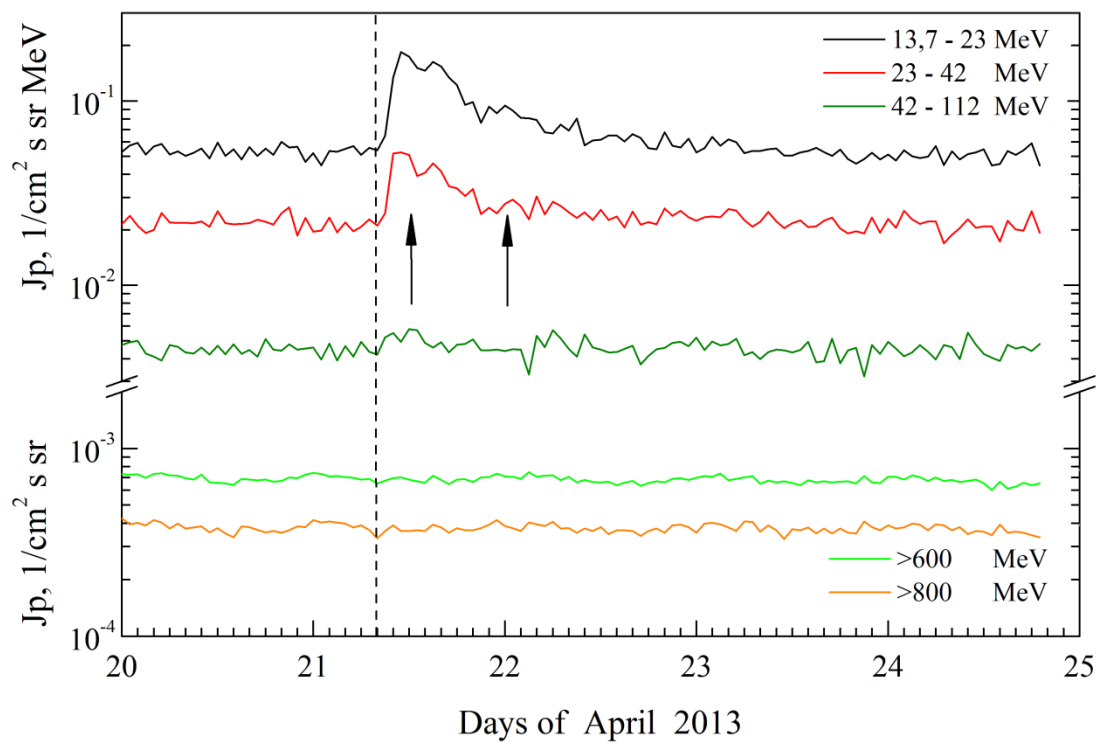


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.04.21

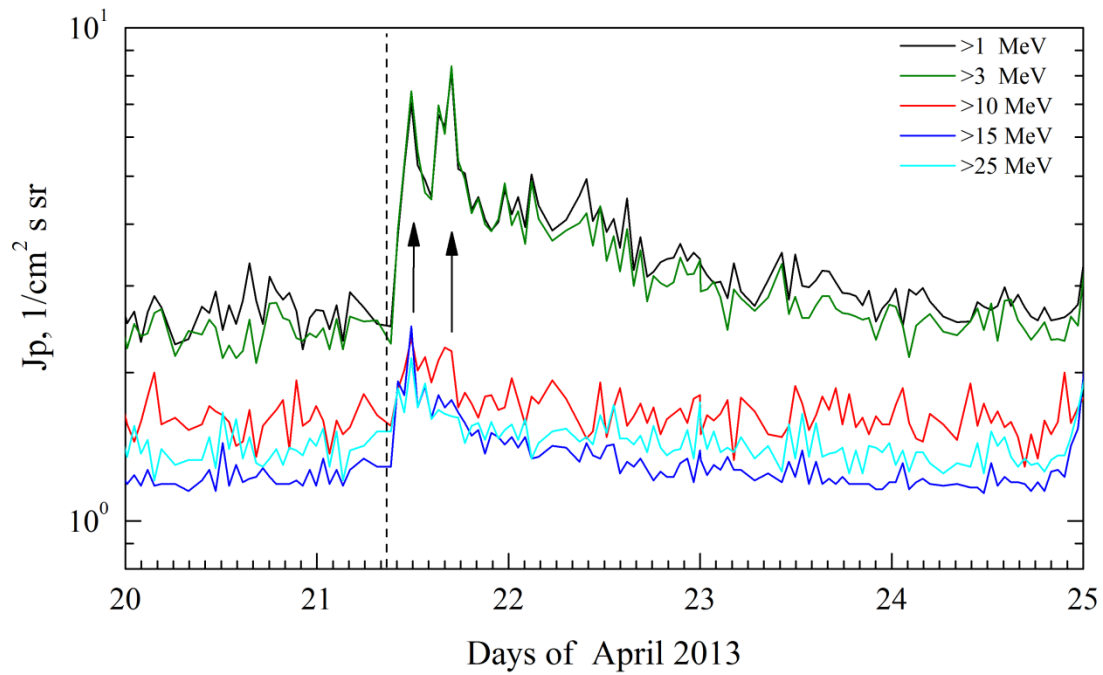


Electro. Event 2013.04.21

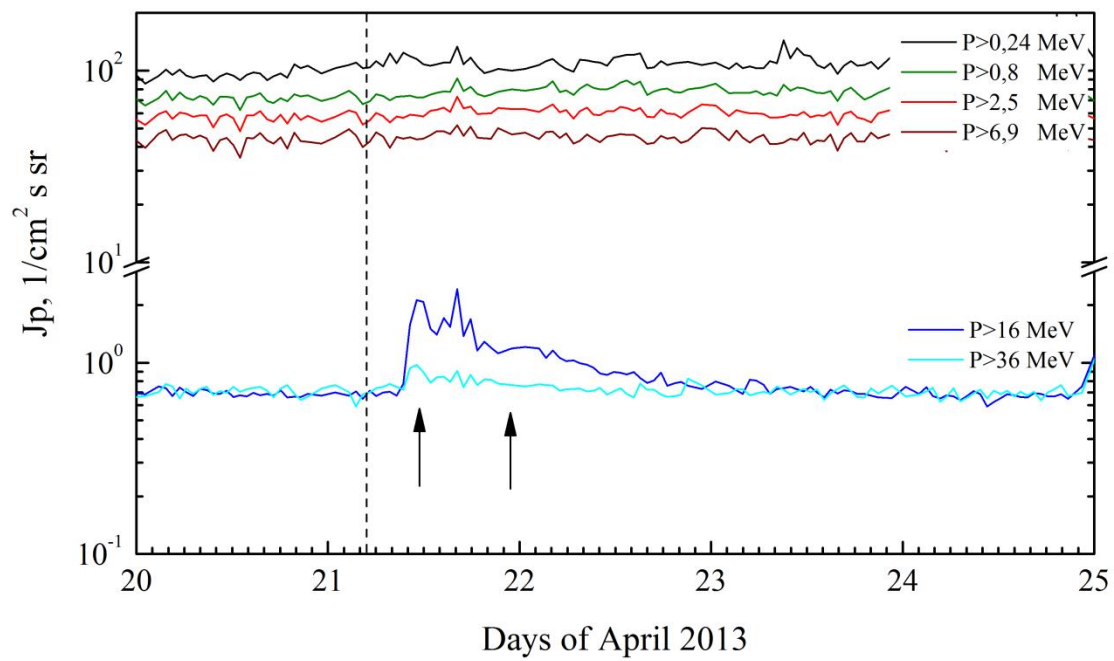


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2013.04.21



POES. Event 2013.04.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 April 21**

2013 April 21 ☐ AR 11719 To event 527

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event at this time					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0724	919	- 4.2	360°	269°	SOHO

2013 April 21 Ø AR 11719 To event 527

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event at this time					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2036	561	- 8.3	212°	260°	SOHO

Proton Active Region:

AR 11719 (N10L076; CMP 12,0.04.2013;
Sp=290 msh; EKI; BGD)
XRI=0.87; M₂^{6.5}+C₁₅
PFR1 05.04 M₁^{2.2}
PFR2 11.04 M₁^{6.5}

References:

Kalaivani P.P., O.Prakash, A. Shanmugaraju et al., [2021](#).
Luhmann J.G., M.L. Mays, D. Odstrci et al., [2017](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 24d23^h

Tmax ($E_p > 10$ MeV) – 25d05^h, Jmax ($E_p > 10$ MeV) – $1.3/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$ (ACE)

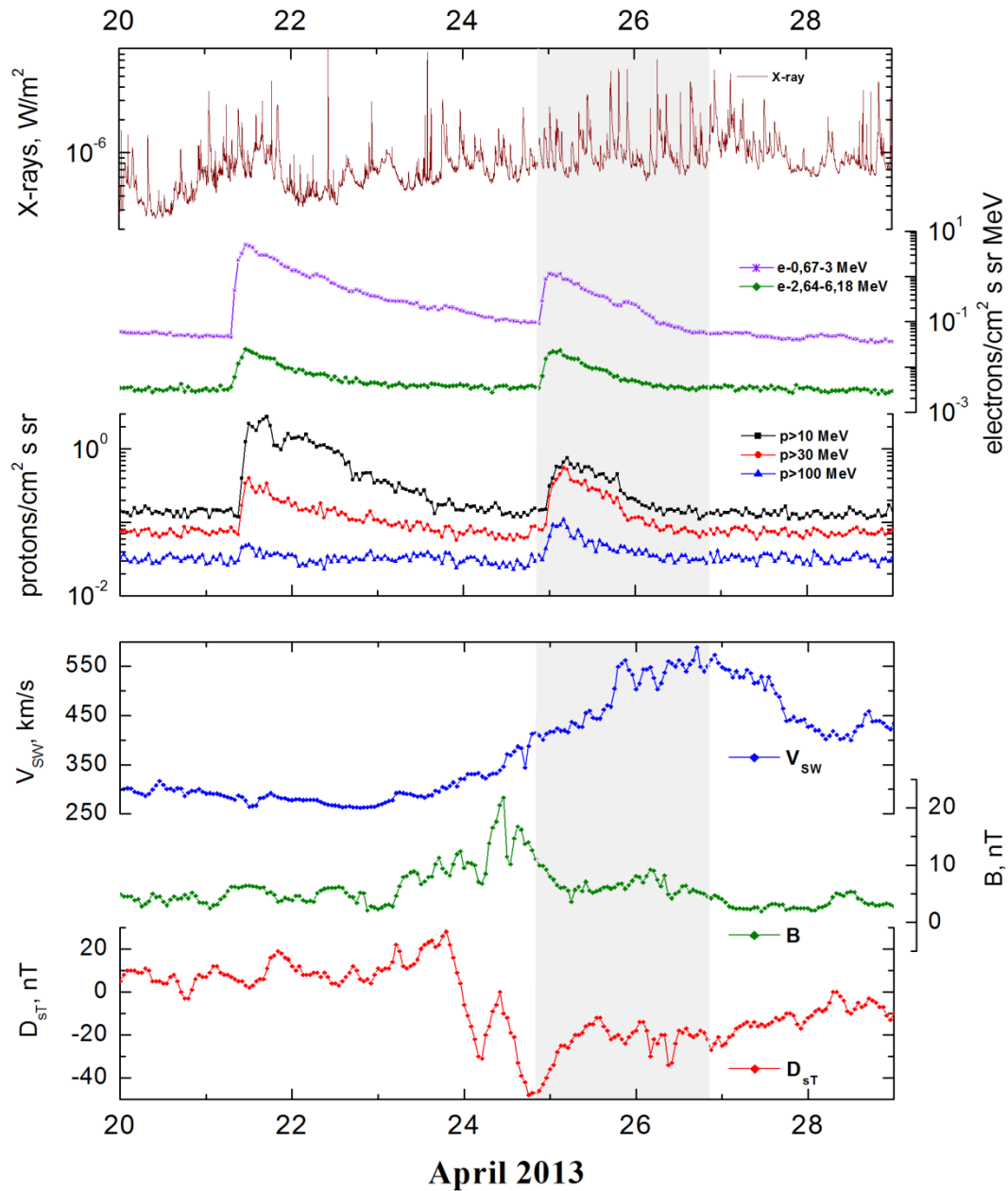
Duration of the event – 1.5 days, power-law index: $\gamma = 2.6$

Quasimaximal energy of protons in the event – $E_{qm} = 140$ MeV

Sources: \square back side solar flare 24d<22^h12^m, AR 11719, 6d behind W_L

CME: 24d22^h12^m, $V = 784$ km/s, $\Delta\phi = 360^\circ$, $dA = 241^\circ$

Particle fluxes and associated phenomena

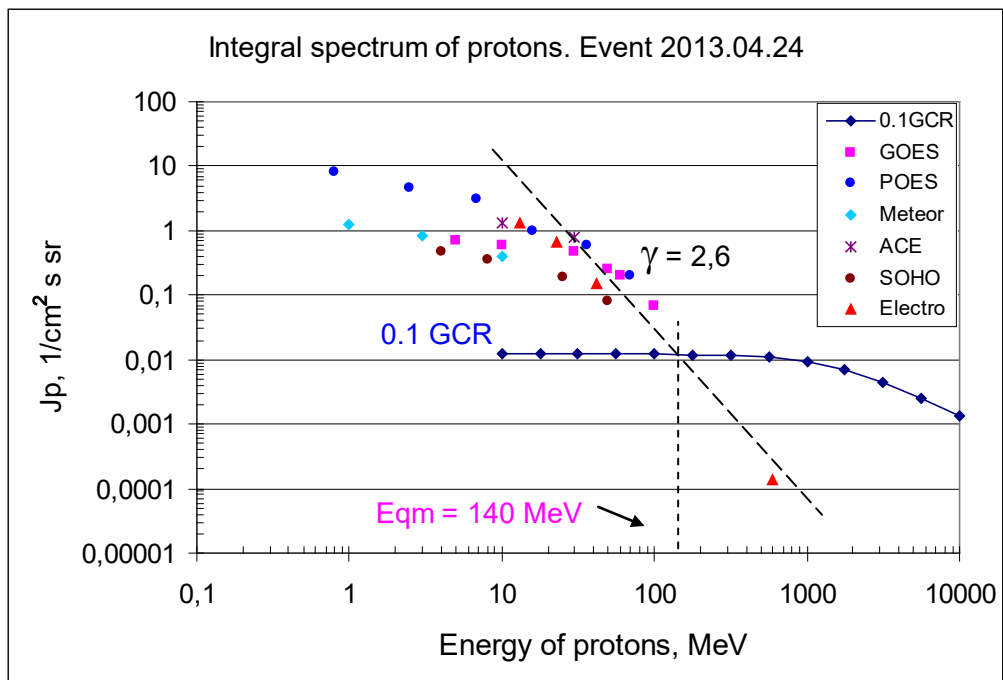


Integral fluxes of protons for the event of 2013 April 24

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	23	25d05	0.7	1.5	0.2	
EPS	>10	23	25d05	0.6	1.5	0.15	
EPS	>30	23	25d04	0.48	1.5	0.07	
EPS	>50	23	25d04	0.25	1.5	0.06	
EPS	>60	23	25d03	0.2	1.5	0.05	
EPS	>100	23	25d04	0.07	1.5	0.03	
Electro-1							
GALS-E	>600	23	25d02	0.00014	-	0.0007	
POES							
MEPED	>0.24	-	-	-	0.5	100	
MEPED	>0.8	-	25d05	8	0.5	70	
MEPED	>2.5	-	25d05	4.7	0.5	55	
MEPED	>6.9	-	25d05	3.1	0.5	45	
MEPED	>16	22	25d05	1	0.5	0.7	
MEPED	>36	22	25d05	0.6	0.5	0.75	
MEPED	>70	22	25d05	0.2	-	0.9	
MEPED	>140	-	-	-	-	1.1	
Meteor-1							
SCR	>1	22	25d03	1.25	1.5	2.7	
SCR	>3	22	25d03	0.83	1.5	2.75	
SCR	>10	22	25d03	0.39	1.5	1.6	
GALS-M	>15	22	-	-	0.5	1.2	
GALS-M	>25	22	-	-	0.5	1.25	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	23	25d03	1.3	1	1.3	
SIS	>30	23	25d03	0.8	1	0.9	
SOHO							
EPHIN	>50	22	25d03	0.08	1	0.25	

Differential fluxes of protons for the event of 2013 April 24

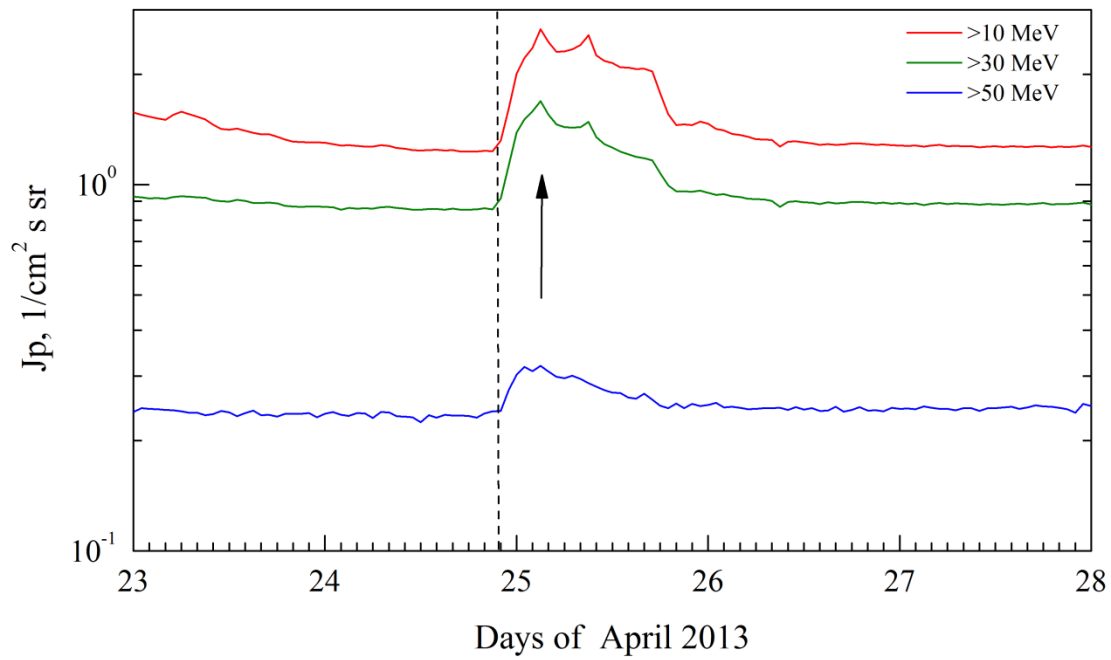
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	22	25d04	0.03	1	0.001	
EPHIN	8 – 25	22	25d03	0.01	1	0.0005	
EPHIN	25 – 53	22	25d03	0.004	1	0.00006	
Electro-1							
SCR-E	13.7–23	23	25d04	0.07	2	0.05	
SCR-E	23–42	23	25d04	0.027	2	0.025	
SCR-E	42–112	23	25d04	0.0022	1	0.0045	



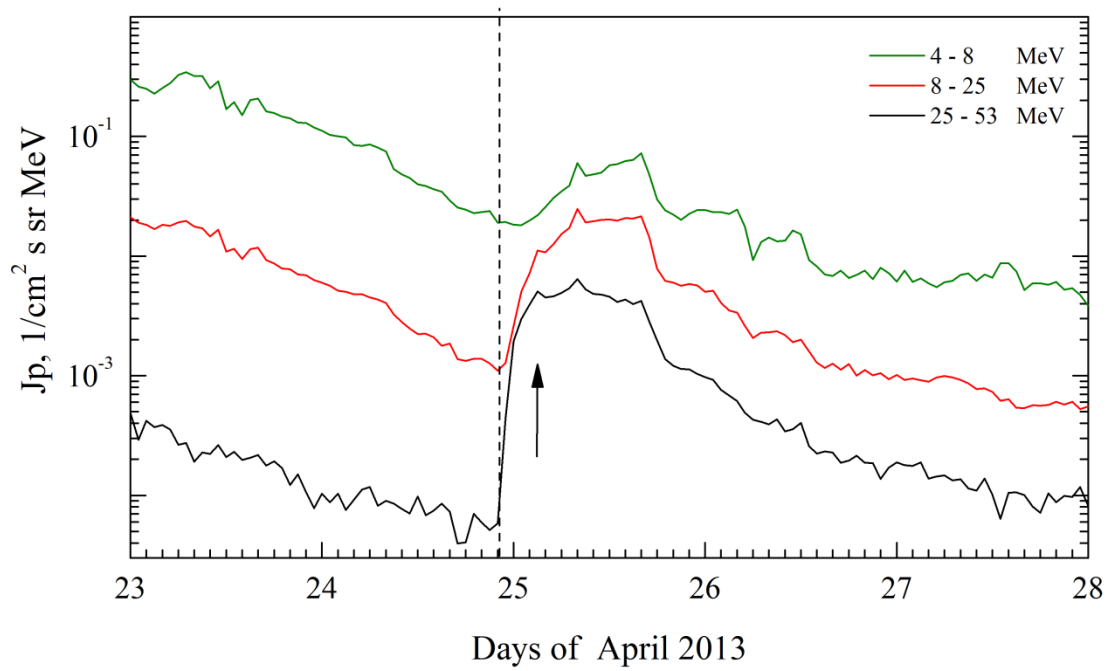
Time profiles of proton fluxes in the event 2013.04.24

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.04.24

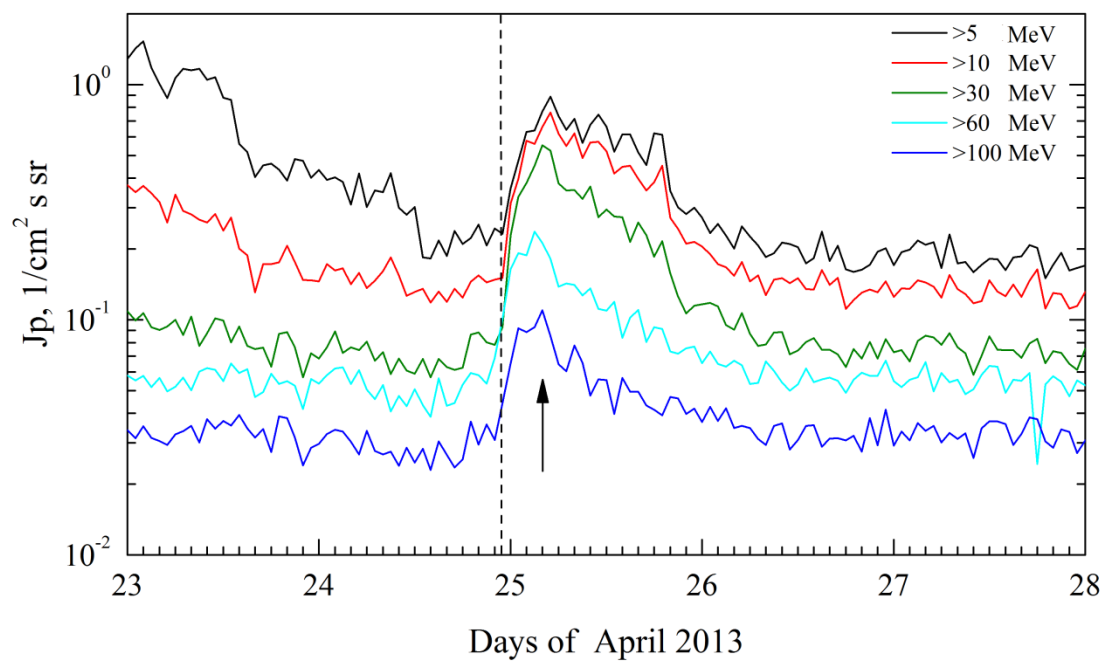


SOHO. Event 2013.04.24

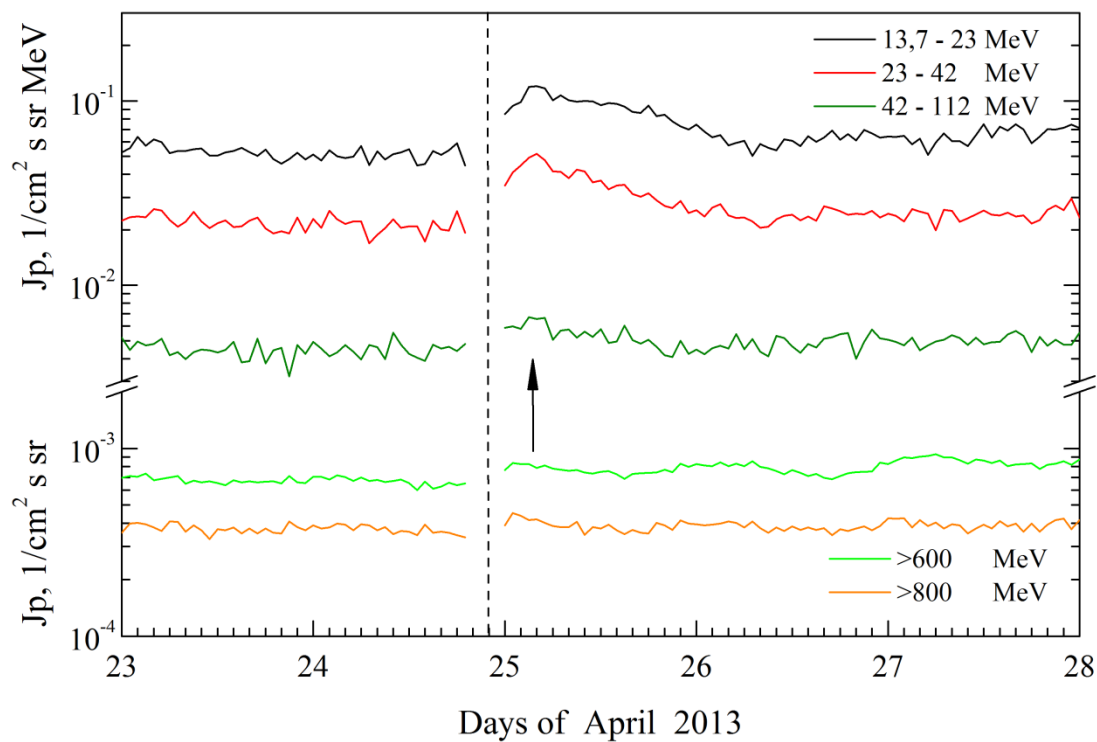


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.04.24

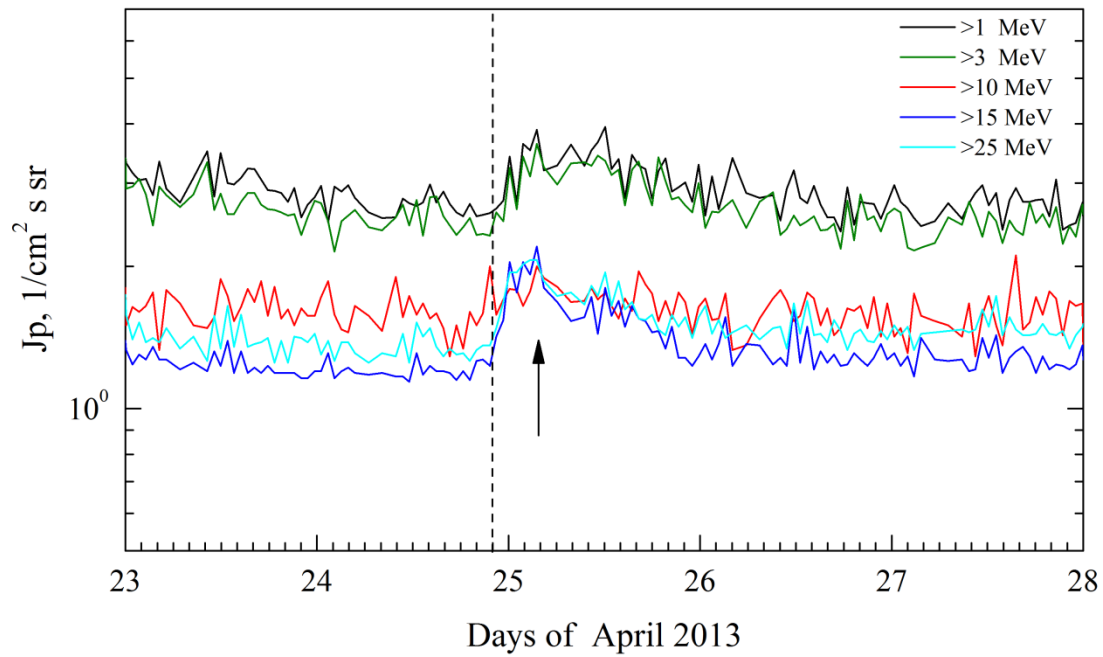


Electro. Event 2013.04.24

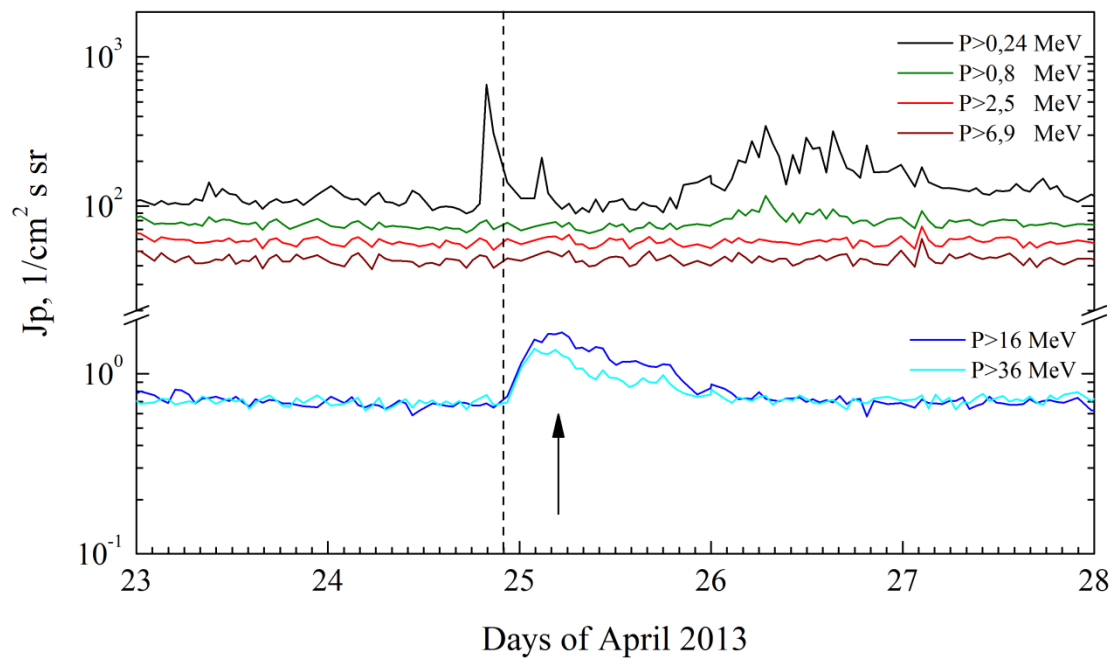


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.04.24



POES. Event 2013.04.24



Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 April 24 ☐ AR 11719 To event 528

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event at this time					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2212	784	- 34.7	360°	241°	SOHO

Proton Active Region:

AR 11719 (N10L076; CMP 12,0.04.2013;

Sp=290 msh; EKI; BGD)

XRI=0.87; M₂^{6.5}+C₁₅

PFR1 05.04 M₁^{2.2}

PFR2 11.04 M₁^{6.5}

Particle event: To($E_p > 10$ MeV) – 13d18^h

Tmax ($E_p > 10$ MeV) – 14d09^h, Jmax₁ ($E_p > 10$ MeV) – $1/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$ (ACE)

Duration of the event – 1.5 days, power-law index: $\gamma = 2.2$,

Quasimaximal energy of protons in the event – $E_{qm1} = 70$ MeV

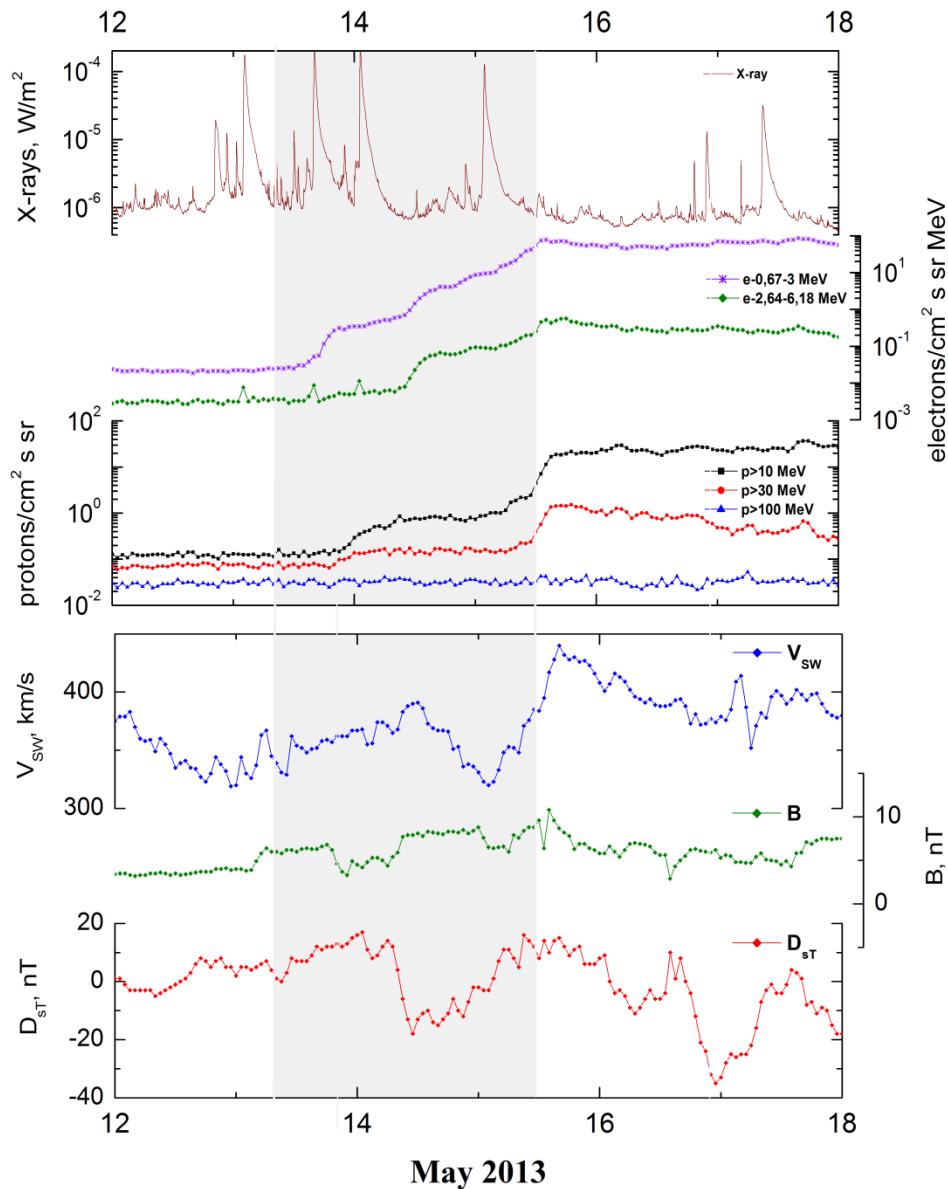
Sources: ■ solar flare 13d15^h48^m, X2.8/1N, N14E85, AR11748

○ solar flare 13d23^h59^m, X3.2/2B, N12E77, AR11748

Main burst X-ray 1–8 Å: onset – 13d15^h48^m, max – 13d16^h05^m, $\Phi = 0.23 \text{ J/m}^2$

CME: 13d16^h08^m, $V = 1850 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 063^\circ$

Particle fluxes and associated phenomena

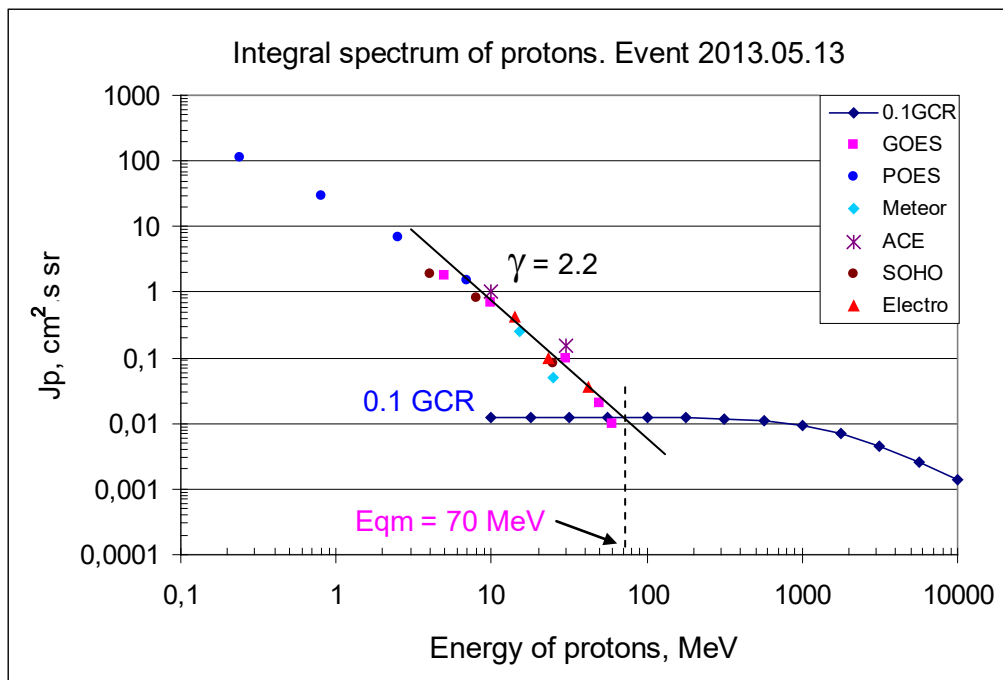


Integral fluxes of protons for the event of 2013 May 13

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	14d09	1.8	1.5	0.2	
EPS	>10	18	14d09	0.7	1.5	0.13	
EPS	>30	18	14d09	0.1	1.5	0.07	
EPS	>50	18	14d09	0.02	0.5	0.06	
EPS	>60	18	14d09	0.01	0.5	0.055	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	14	14d10	110	7	90	
MEPED	>0.8	14	14d10	30	7	65	
MEPED	>2.5	-	14d10	7	6	50	
MEPED	>6.9	-	14d10	1	5	45	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	-	-	-	-	2.7	
SCR	>3	-	-	-	-	2.5	
SCR	>10	-	-	-	-	1.6	
GALS-M	>15	14	14d12	0.25	1	1.2	
GALS-M	>25	14	14d12	0.05	1	1.2	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	18	14d11	1	1.5	1.2	
SIS	>30	18	14d11	0.15	1.5	0.85	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

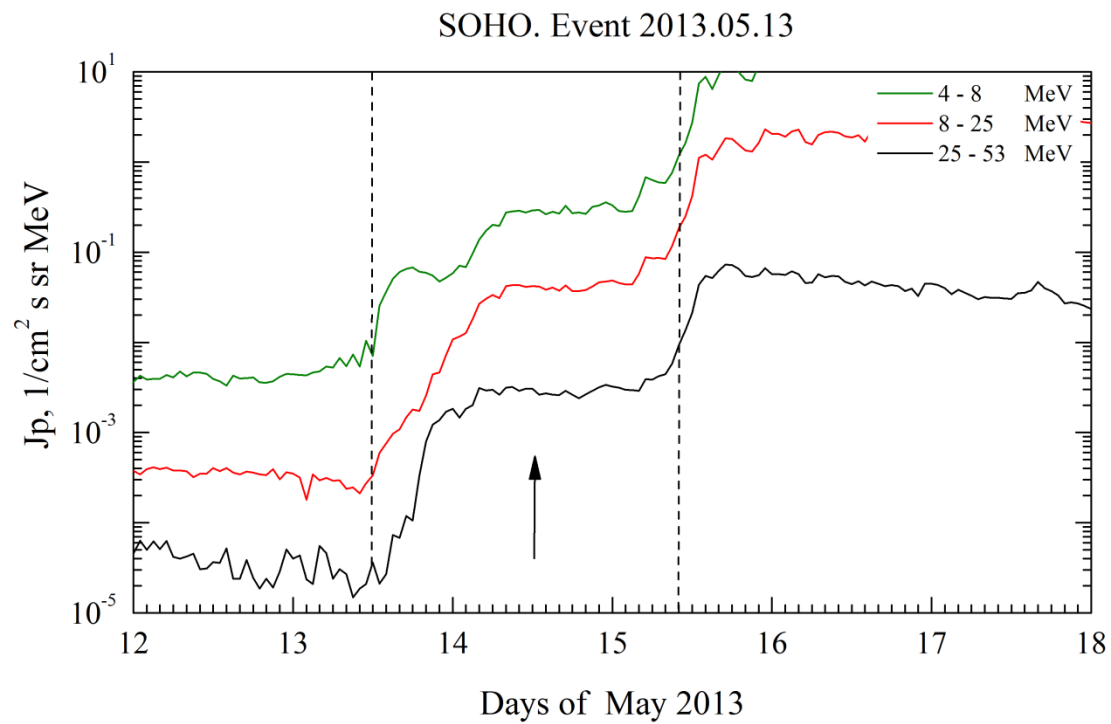
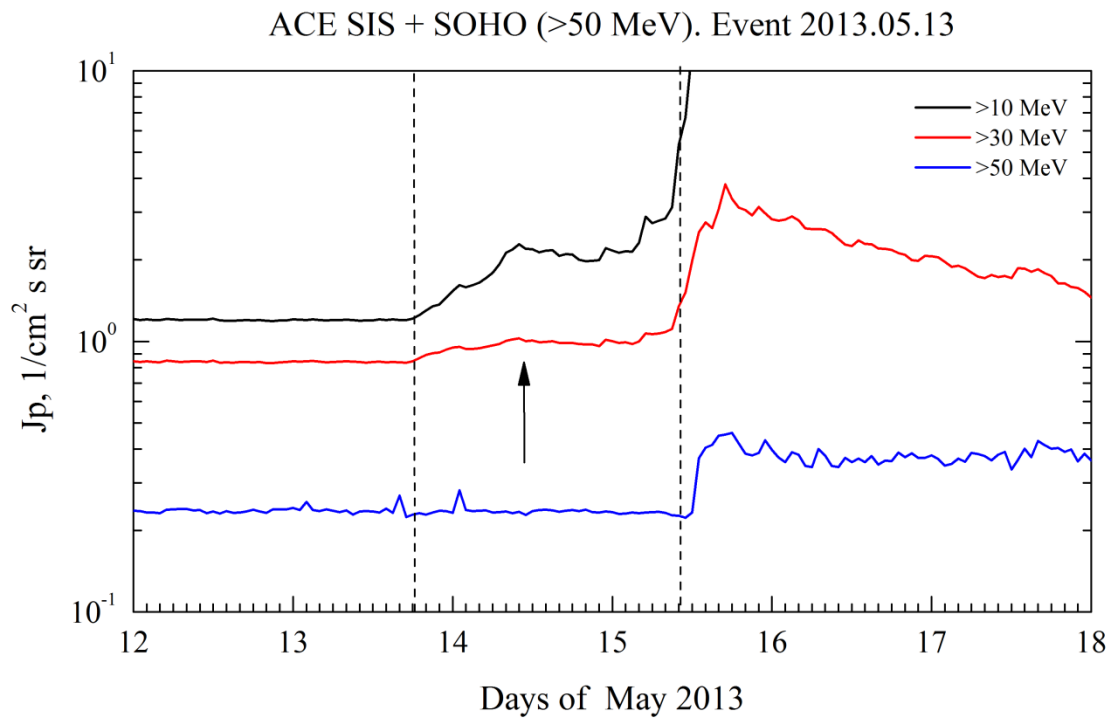
Differential fluxes of protons for the event of 2013 May 13

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	12	14d12	0.27	2	0.004	
EPHIN	8 – 25	12	14d12	0.042	2	0.0004	
EPHIN	25 – 53	12	14d12	0.003	2	0.000025	
Electro-1							
SCR-E	13.7–23	20	14d13	0.035	1,5	0.05	
SCR-E	23–42	20	14d13	0.0035	1,5	0.025	
SCR-E	42–112	20	14d13	0.0005	1,5	0.005	



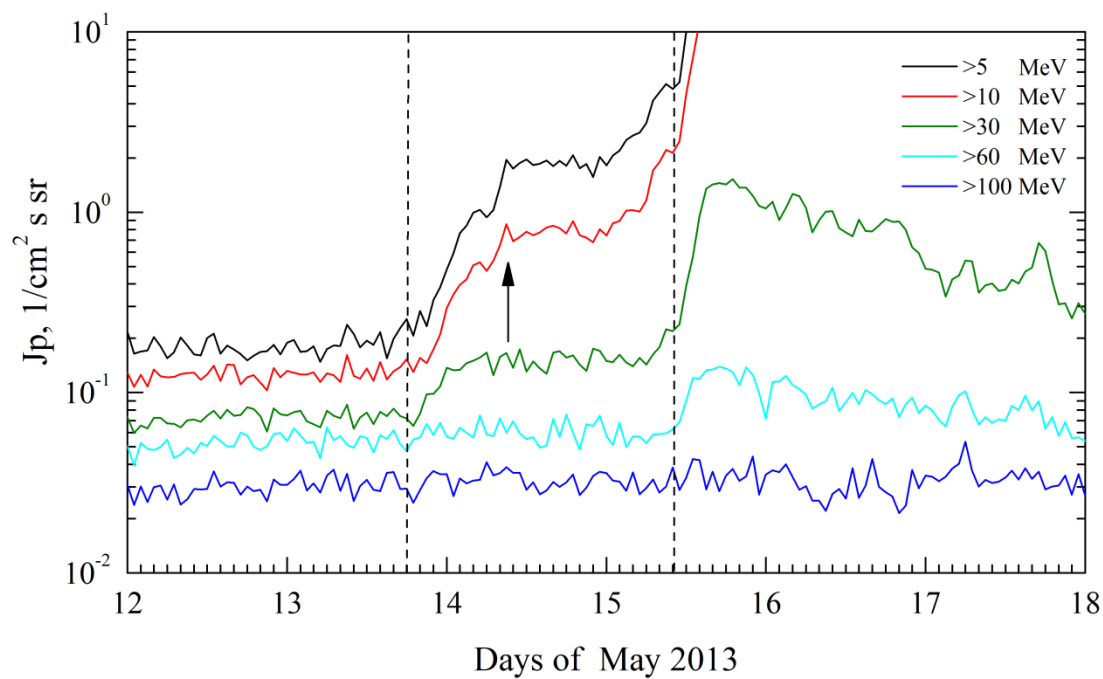
Time profiles of proton fluxes in the event 2013.05.13

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

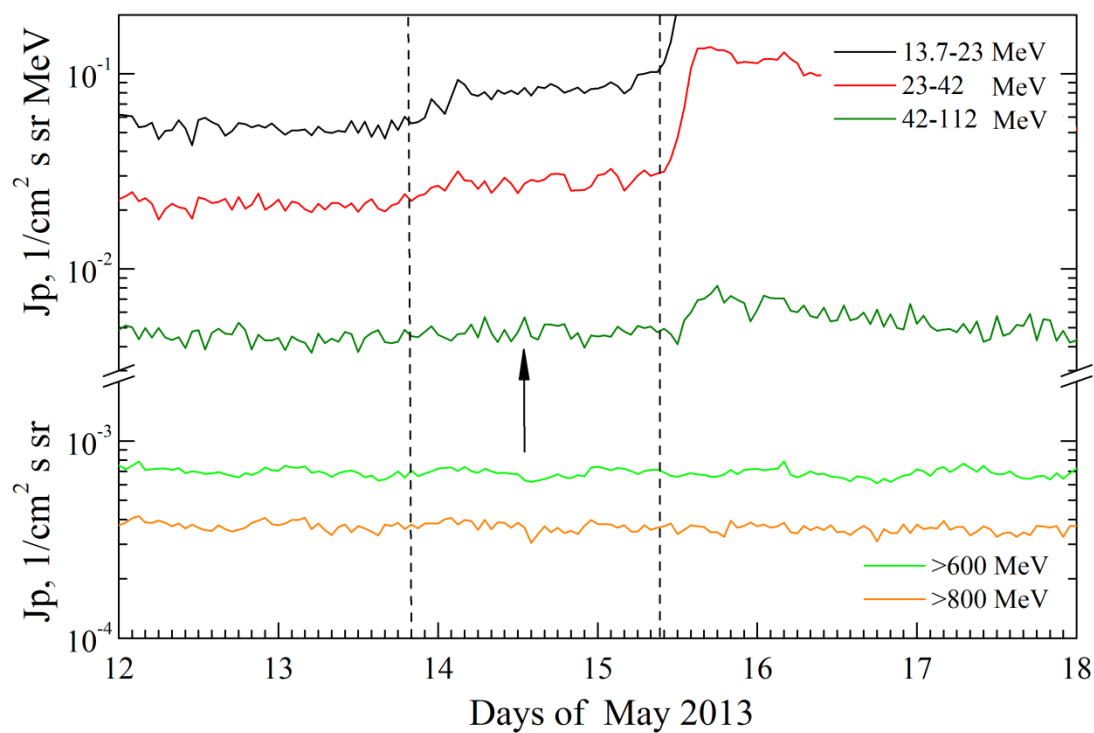


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

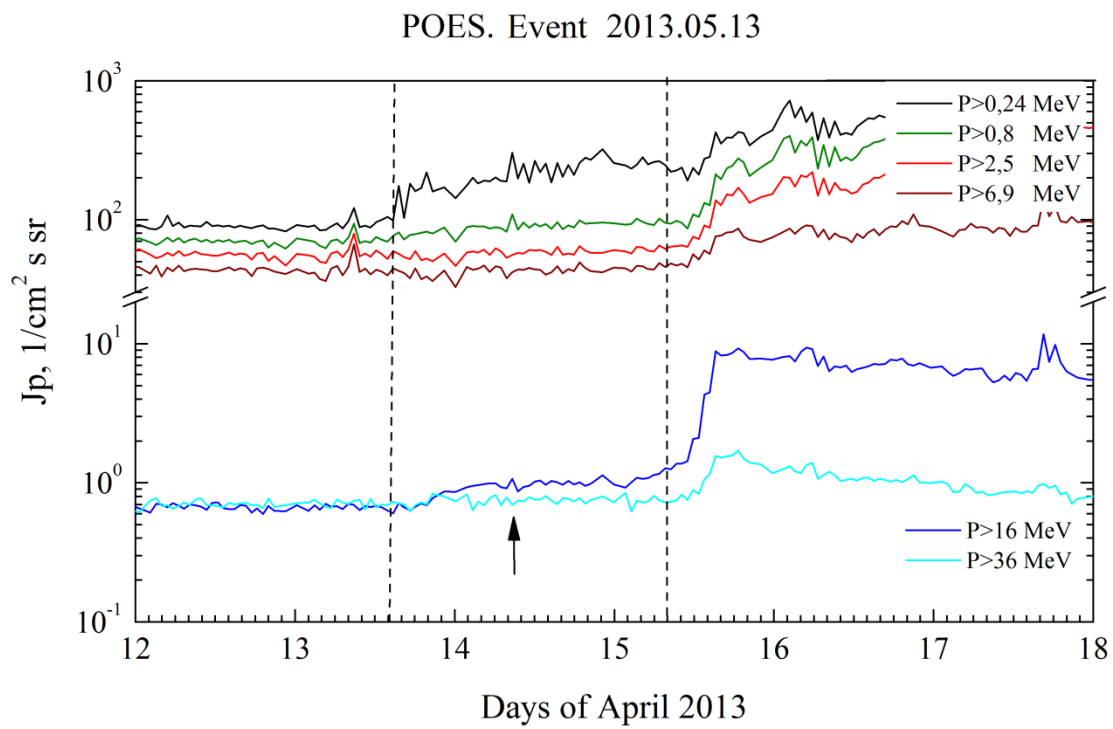
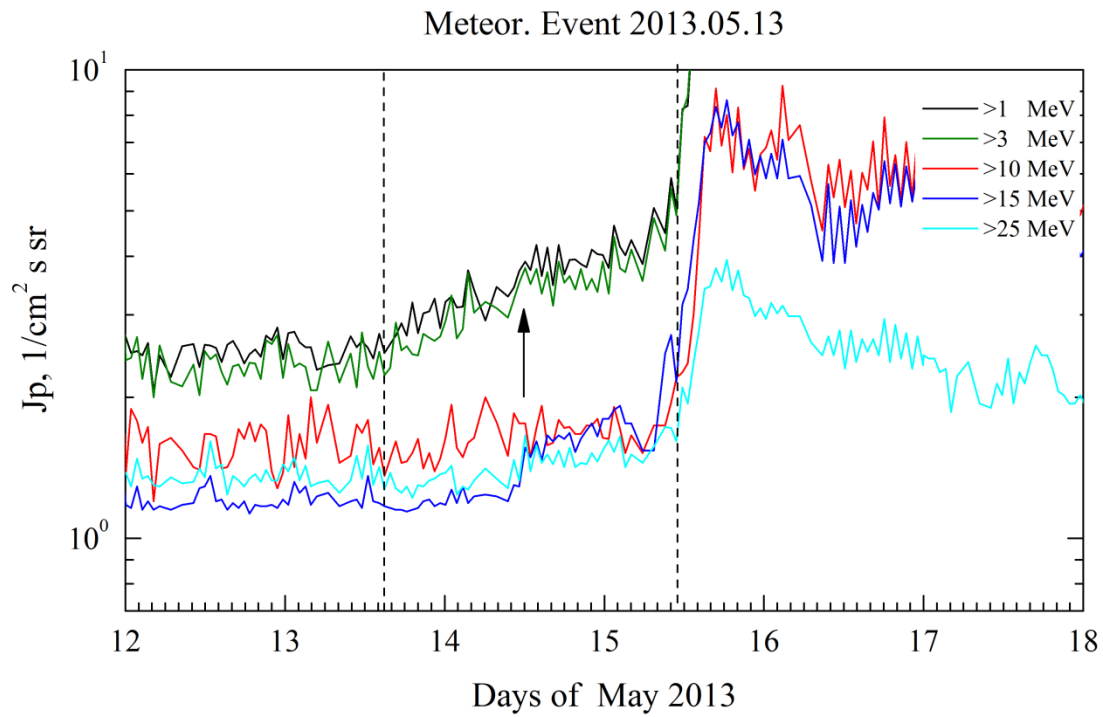
GOES. Event 2013.05.13



Electro. Event 2013.05.13



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 May 13**

2013

May 13



AR 11748

To event 529

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1548	1601	1637	N14E85	1N	
6563 Å	FL	1554		1749		0.3	EPL
6563 Å	FL	1614		2340	0.08	B.9A	LPS
1 – 12	keV	1548	1605	1616		X2.8	0.23
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
300-800	keV	1550:24	1604:26	1607:36	33601	73108112	HESSI
100-300	keV	1615:20	1615:42	1650:24	6487	24453486	HESSI
12-25	keV	1544:58	1546:24	1546:44	858	19256	FERMI
12-25	keV	1604:08	1606:44	1629:31	780890	449654272	FERMI
12-25	keV	1704:24	1713:28	1728:01	7544	1623983	FERMI
12-25	keV	1738:52	1739:54	1804:53	3492	776591	FERMI
>1000	keV	1715:30		1728:30		2.14E-05*	FERMI
>100	keV	1740:30		1758:30		3.20E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1551	1603	1625	1.4/15	3.73	
8.8	GHz	1551	1603	1624		3.56	
5	GHz	1551	1559	1620		3.20	
2.7	GHz	1553	1601	1618		2.72	
1.4	GHz	1554	1603	1606		2.00	
245	MHz	1603	1604	1604		1.73	
DS-type	Frequeny, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1557		1620	990	2	
DS IV	25-180	1557		1636		2	
DH II	16-0.3	1615		1910			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1608	1850	- 76.6	360°	63°	SOHO

* cm⁻²·s⁻¹

2013

May 13-14

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AR 11748

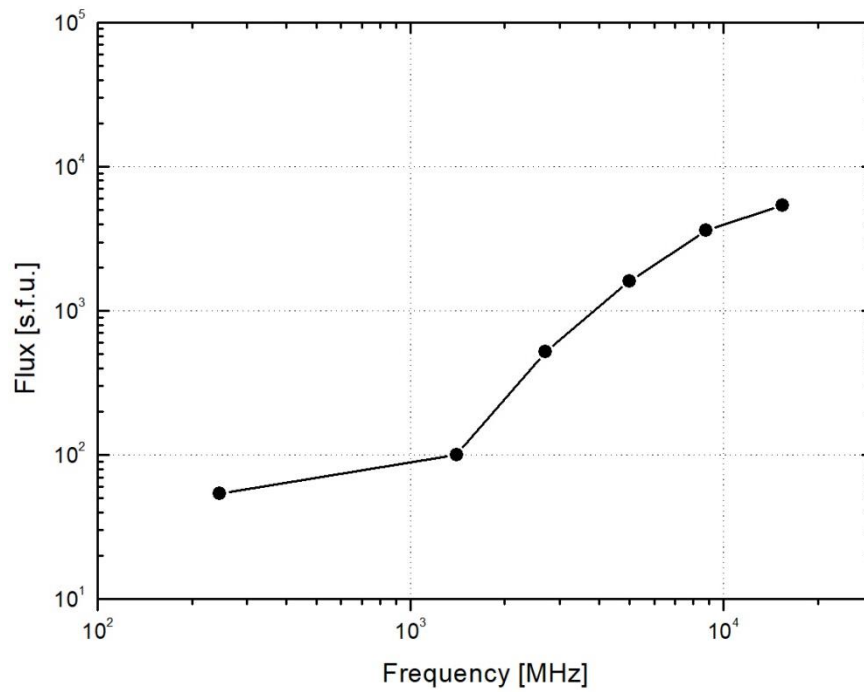
To event 529

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical event on visible solar disc					
1 – 12	keV	2359	0111	0120	N08E77	X3.2	0.22
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	2358:00	2358:30	0000:32	6	3822	HESSI
12-25	keV	0000:32	0003:06	0006:04	128	84167	HESSI
12-25	keV	0006:04	0017:46	0047:16	120	929913	HESSI
50-100	keV	0122:44	0124:14	0222:40	4915	26928144	HESSI
12-25	keV	0001:59	0002:57	0026:42	18002	1077621	FERMI
12-25	keV	0101:52	0112:36	0202:20	935633	770058240	FERMI
12-25	keV	0237:20	0237:57	0336:19	3051	952821	FERMI
>100	MeV	0129:30	0237:57	0157:30		1.23E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0103	0107	0127	0.6 / 9	3.32	
8.8	GHz	0103	0107	0126		3.32	
5	GHz	0103	0114	0126		3.11	
2.7	GHz	0104	0114	0127		2.81	
1.4	GHz	0105	0108	0118		2.52	
610	MHz	0106	0108	0126		2.08	
410	MHz	0106	0107	0126		3.00	
245	MHz	0106	0107	0107		3.34	
15.4	GHz	0125	0125	0126	5 \ 15	2.15	
8.8	GHz	0125	0125	0126		2.50	
5	GHz	0125	0125	0126		2.54	
2.7	GHz	0125	0125	0126		2.04	
610	MHz	0125	0126	0126		2.66	
15.4	GHz	0141	0141	0143	5 \ 15	2.08	
8.8	GHz	0136	0141	0143		2.34	
5	GHz	0135	0141	0143		2.46	
2.7	GHz	0134	0141	0143		2.08	
15.4	GHz	0202	0206	0209	P1.4 \ 15	2.25	
8.8	GHz	0201	0203	0210		2.53	
5	GHz	0201	0203	0210		2.60	
2.7	GHz	0200	0203	0210		2.57	
1.4	GHz	0202	0210	0210		2.94	
610	MHz	0202	0208	0210		2.41	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	35-270	0107		0116		1	
DS IV	70-180	0113		0126		1	
DS III	18-70	0116		0121		3	
DS III	330-750	0126		0126		2	
DS VI	025-097	0152		0216		1	
DH II	16-0.7	0116		0235			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0126	2625	- 51.0	360°	89°	SOHO

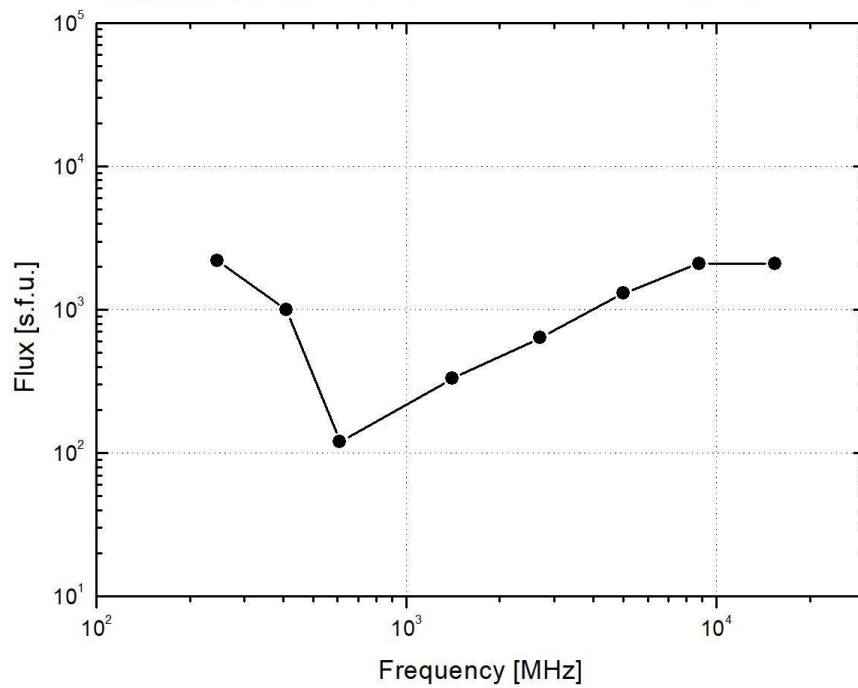
* cm⁻²·s⁻¹

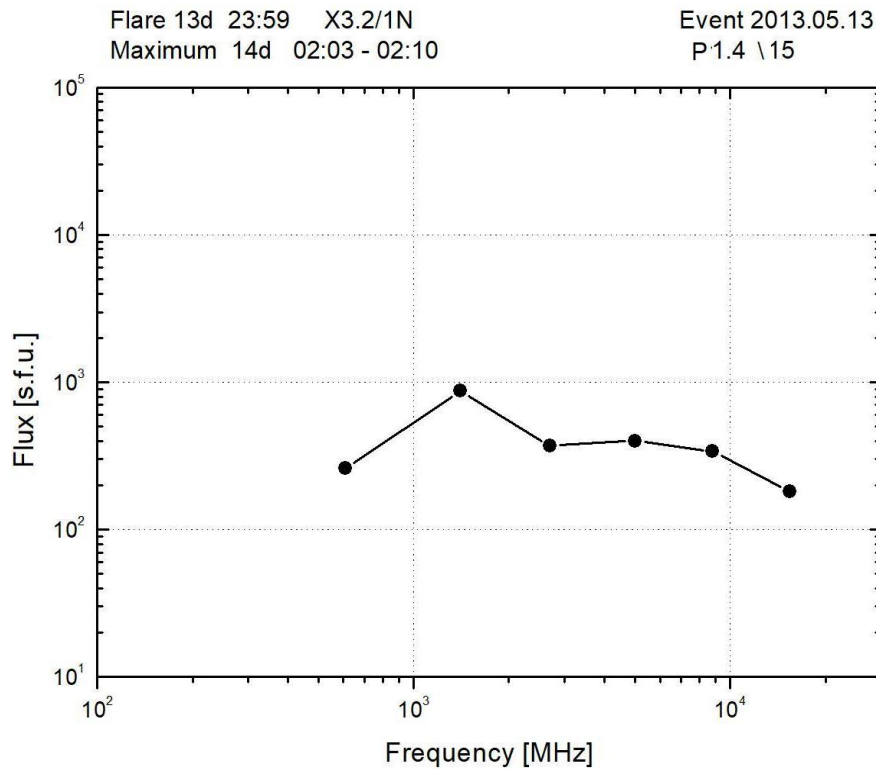
Radio bursts frequency spectrum

Flare 13d 15:48 X2.8/1N N14E85 Event 2013.05.13
Maximum 15:59 - 16:04 U1.4 / 15



Flare 13d 23:59 X3.2/1N Event 2013.05.13
Maximum 14d 01:07 - 01:14 0.6 / 9





Proton Active Region:

AR11748 (N12L294, CMP 20.0.05.2013,
Sp=310 msh, DKI, BGD, R)
XRI=9.96; $X_4^{3.2} + M_5^{3.2} + C_{19}^{2.2} + I_3^{1.9} + S_{56}^{1.9}$
PFR1 12-13.05; (52^h) $X_3^{3.2} + M_3^{1.9}$
PFR2 15-17.05 (57^h) $X_1^{1.2} + M_2^{3.2}$

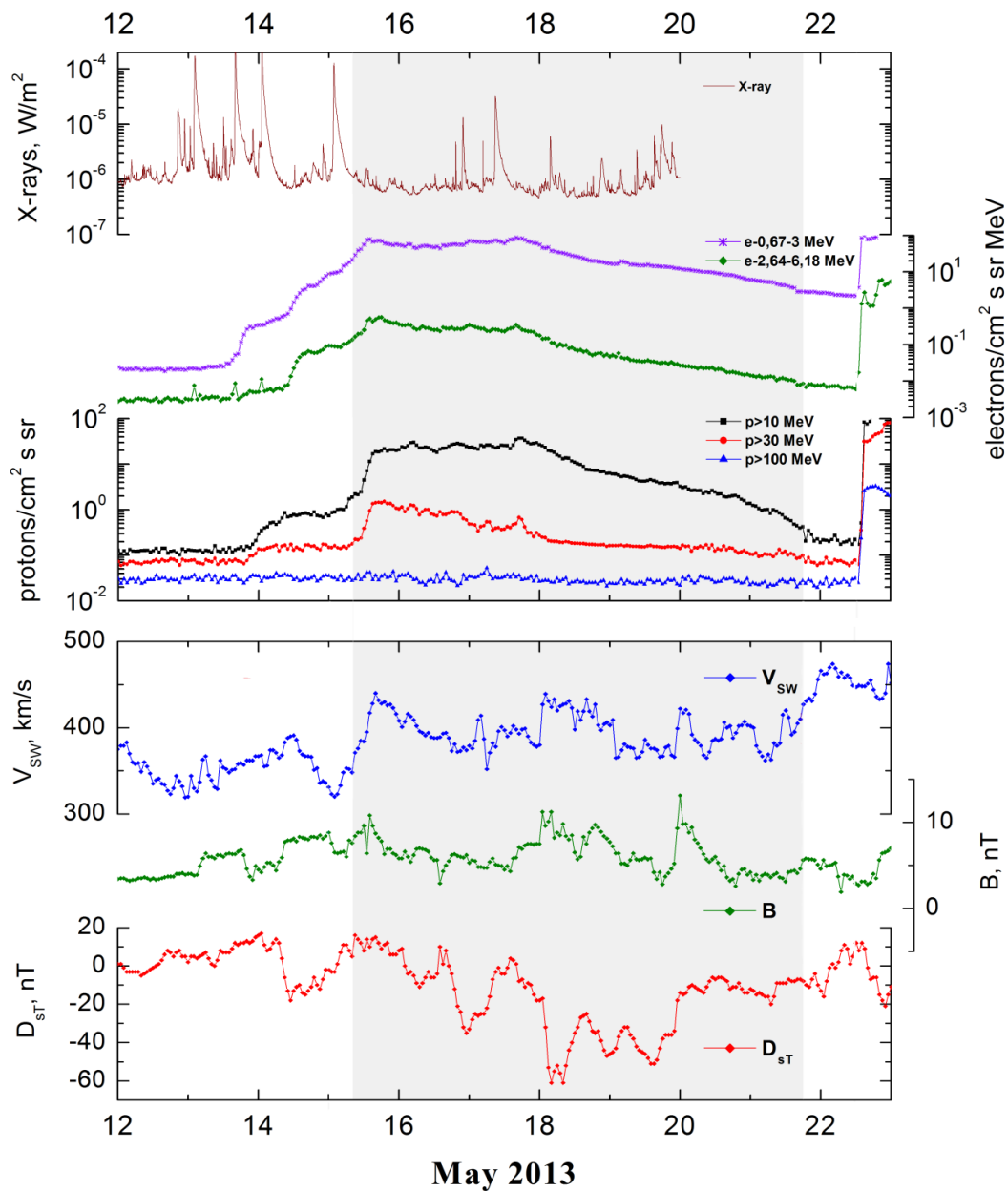
References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Bruno A., I.G. Richardson, [2021](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Grechnev V., V. Kiselev, N. Meshalkina, I. Chertok, [2017](#).
NOAA SPE, [2019](#).
de Nolfo G.A., A. Bruno, J.M. Ryan et al., [2019](#).
Paassilta M., O. Raukunen, R. Vainio et al., [2017](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 15d10^h
 Tmax ($E_p > 10$ MeV) – 15d21^h, Jmax₂ ($E_p > 10$ MeV) – 20.5 /cm²·s·sr
 Duration of the event – 6 days, power-law index: $\gamma = 3.5$
 Quasimaximal energy of protons in the event – Eqm = 110 MeV

Sources: ● solar flare 15d01^h24^m, 2N/X1.2, N12E64, AR11748
 Main burst X-ray 1–8 Å: onset – 15d01^h24^m, max – 15d01^h48^m, $\Phi = 0.12$ J/m²
 CME: 15d01^h48^m, V = 1366 km/s, $\Delta\phi = 360^\circ$, dA = 093°
 ▲ SC 15d14^h13^m; ▲ SC 18d01^h10^m; ▲ SC 19d23^h08^m

Particle fluxes and associated phenomena

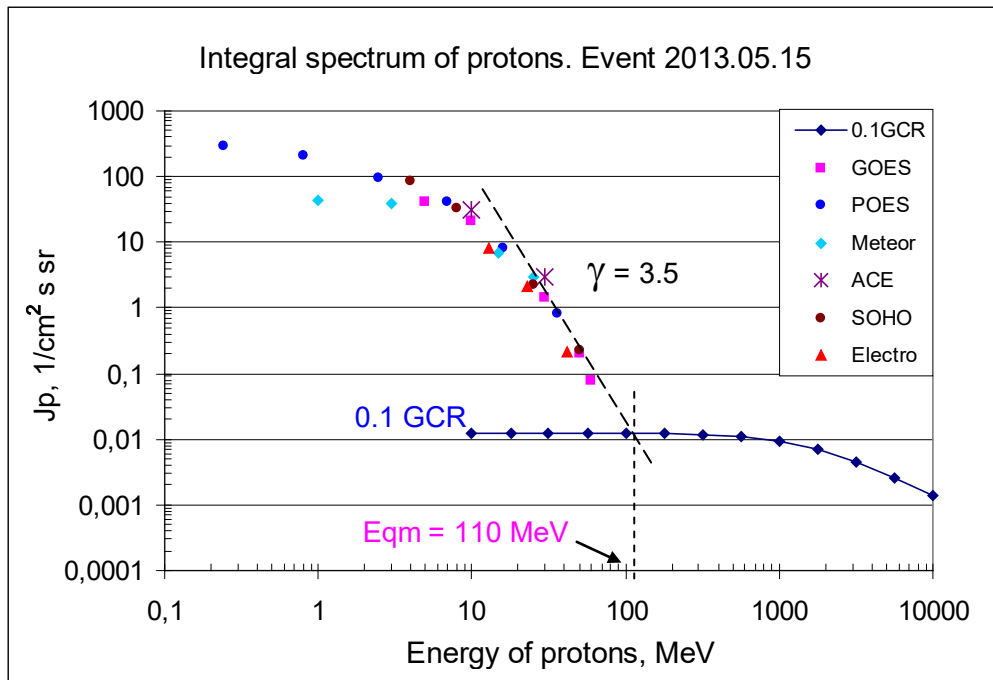


Integral fluxes of protons for the event of 2013 May 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	10	21	41	6	0.2	
EPS	>10	10	21	20.5	6	0.15	
EPS	>30	10	20	1.35	4	0.07	
EPS	>50	10	20	0.2	3	0.06	
EPS	>60	10	20	0.08	3	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>0.24	8	19	300	6	90	
MEPED	>0.8	8	19	210	6	65	
MEPED	>2.5	8	19	98	5	55	
MEPED	>6.9	8	19	41	3.5	45	
MEPED	>16	8	19	7.9	3	0.7	
MEPED	>36	8	19	0.81	1	0.75	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	11	17	44	7	2.7	
SCR	>3	11	17	40	7	2.5	
SCR	>10	9	-	-	4	1.6	
GALS-M	>15	7	17	7	4	1.2	
GALS-M	>25	7	17	3	3	1.2	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	10	19	31	6	1.2	
SIS	>30	10	19	3	4	0.85	
SOHO							
EPHIN	>50	10	16	0.22	2	0.25	

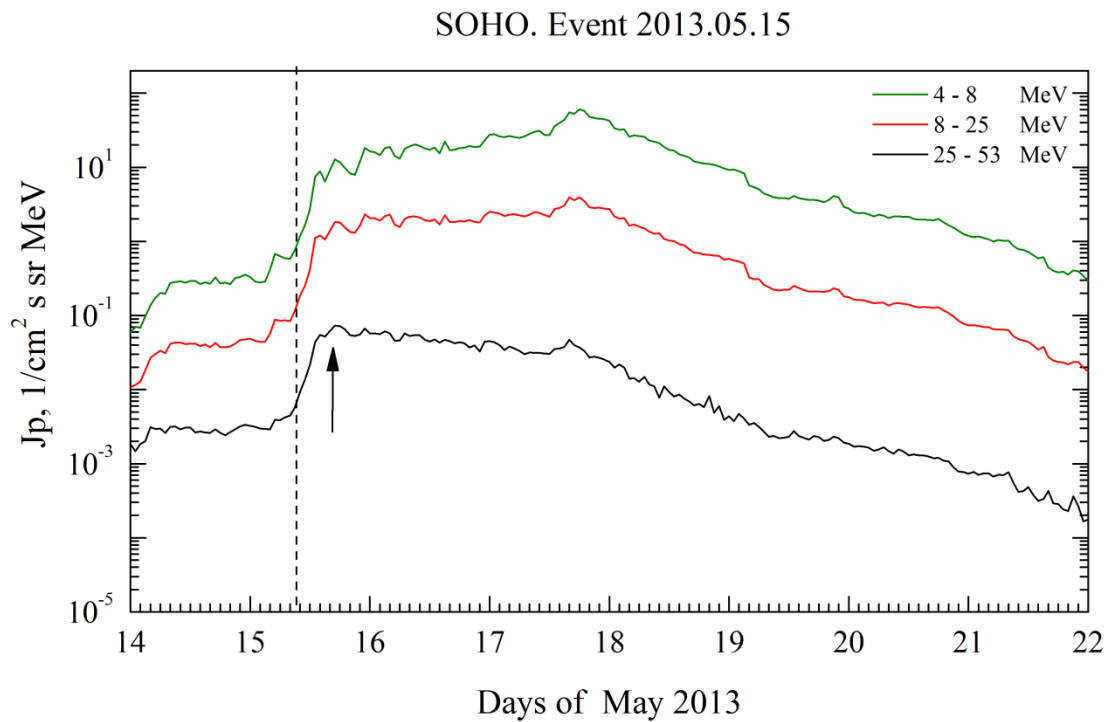
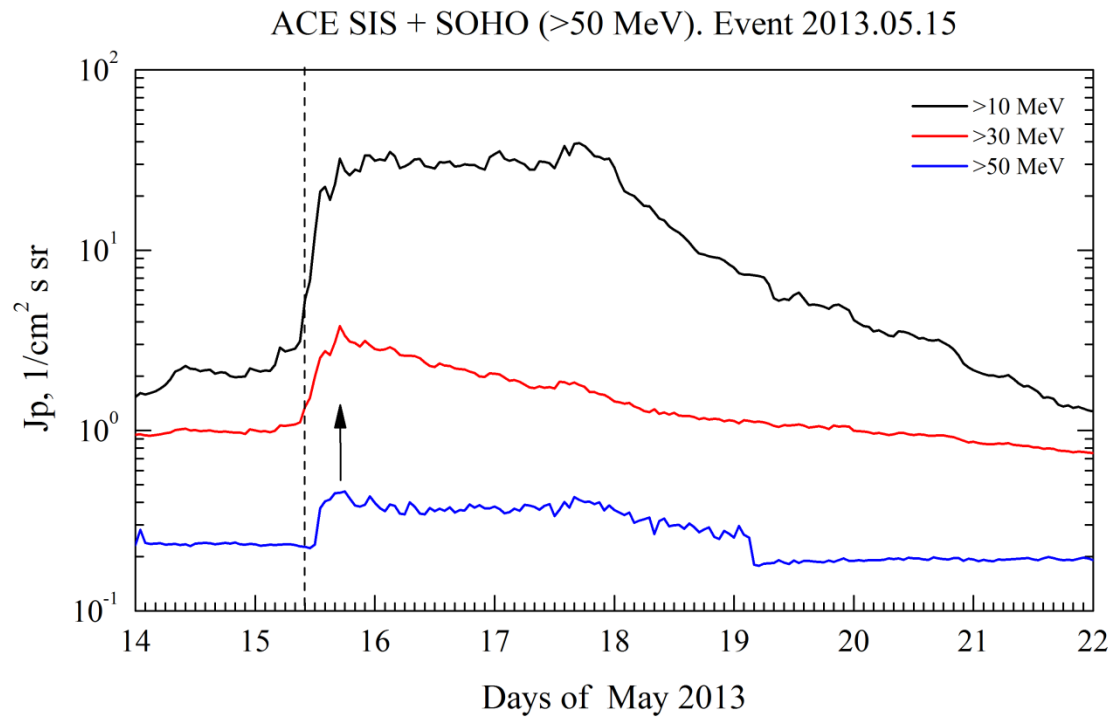
Differential fluxes of protons for the event of 2013 May 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	10	17	12.8	6	0.005	
EPHIN	8 – 25	10	17	1.83	6	0.0003	
EPHIN	25 – 53	10	17	0.073	6	0.00005	
Electro							
SCR-E	13.7–23	10	18	0.67	5	0.08	
SCR-E	23–42	10	18	0.1	4	0.03	
SCR-E	42–112	10	18	0.003	3	0.005	



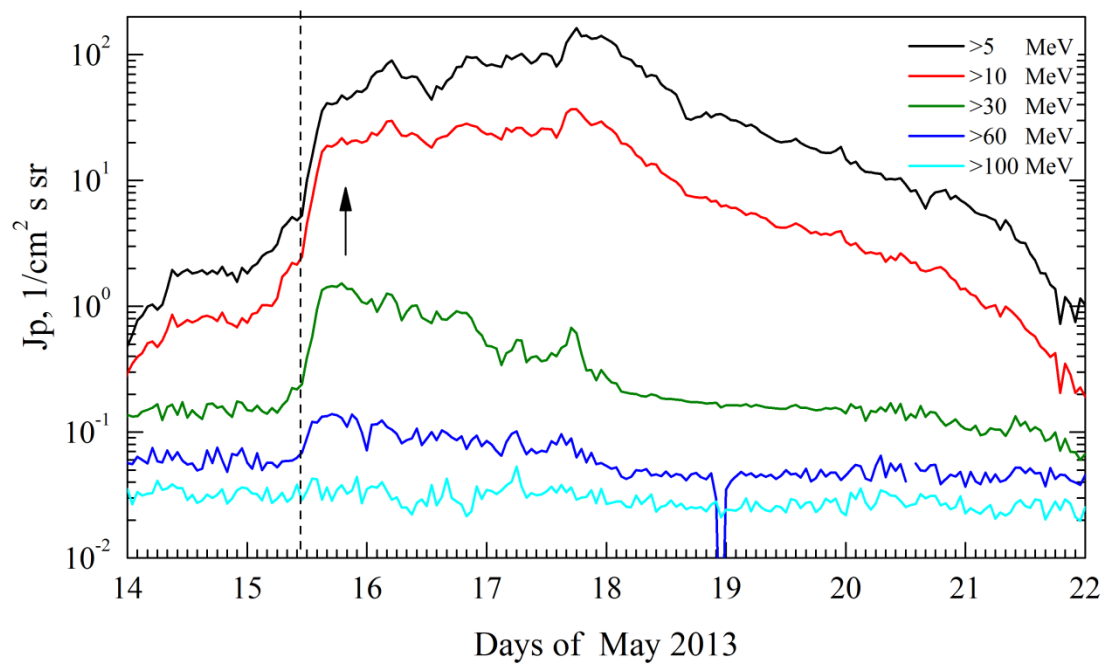
Time profiles of proton fluxes in the event 2013.05.15

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

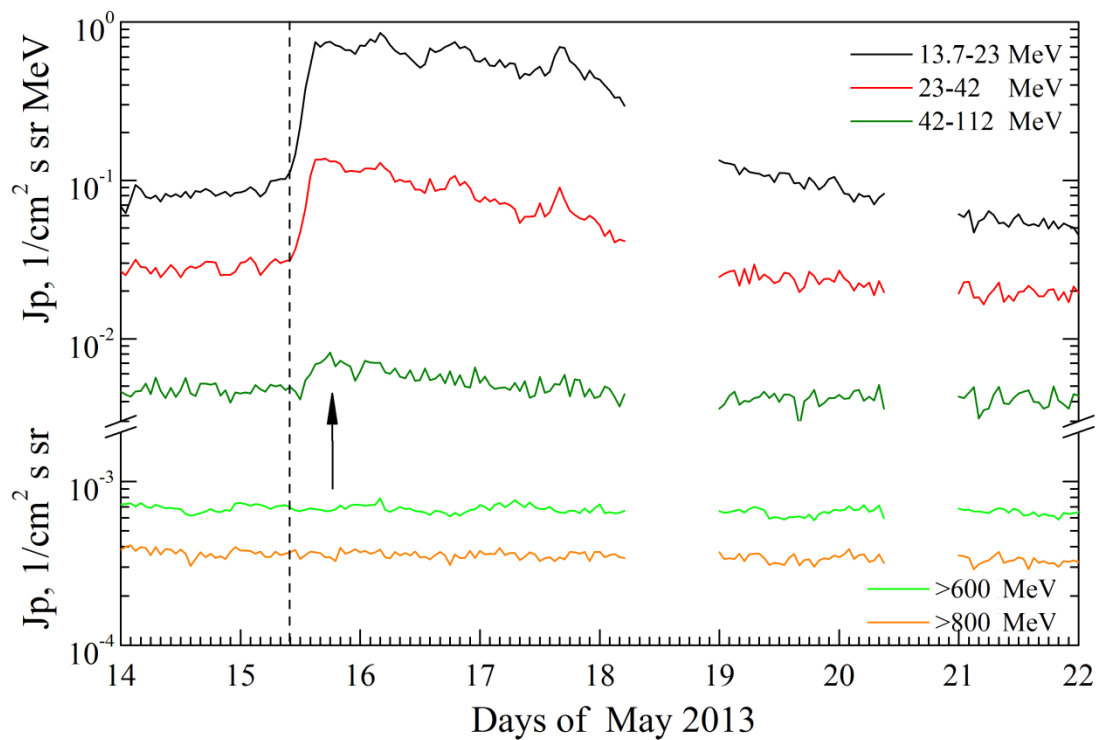


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.05.15

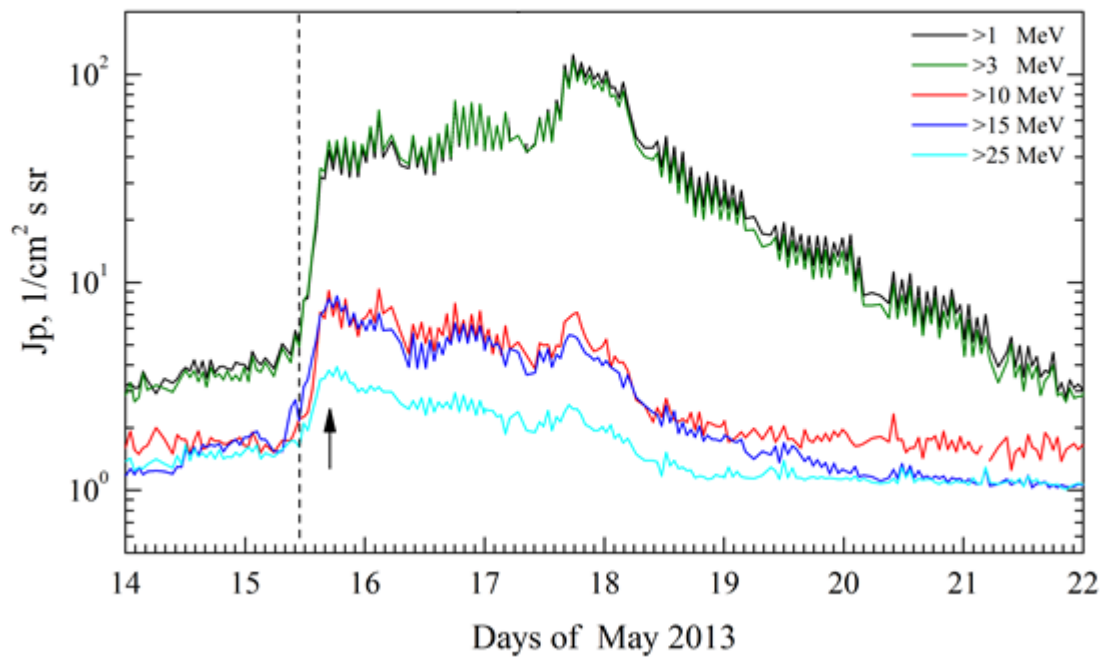


Electro. Event 2013.05.15

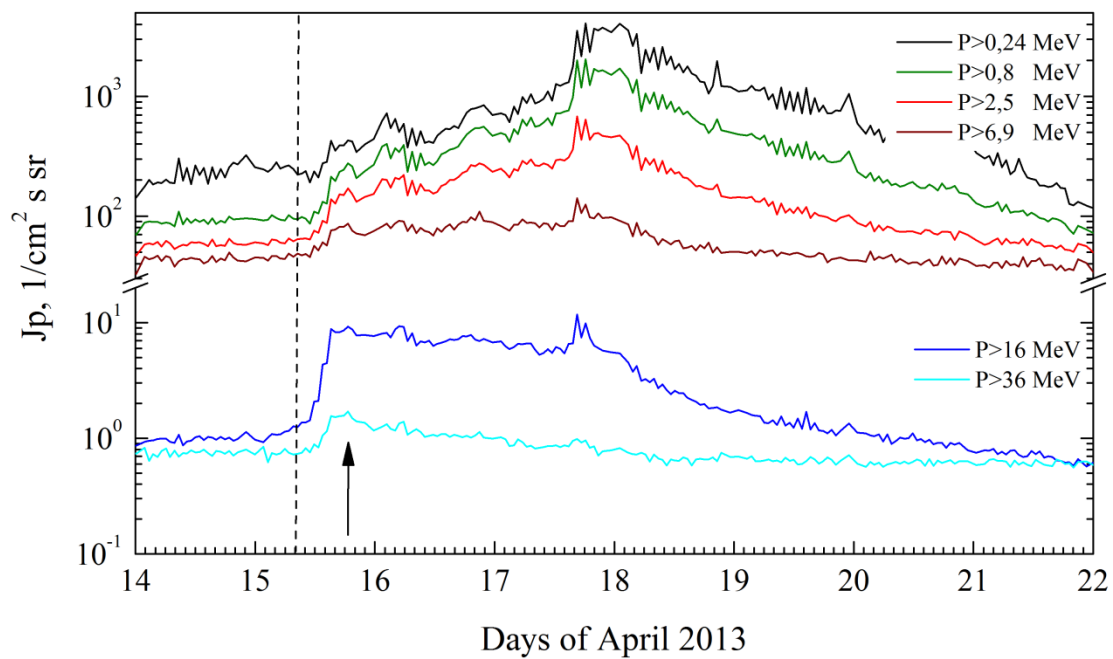


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.05.15



POES. Event 2013.05.15



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 May 15**

2013

May 15

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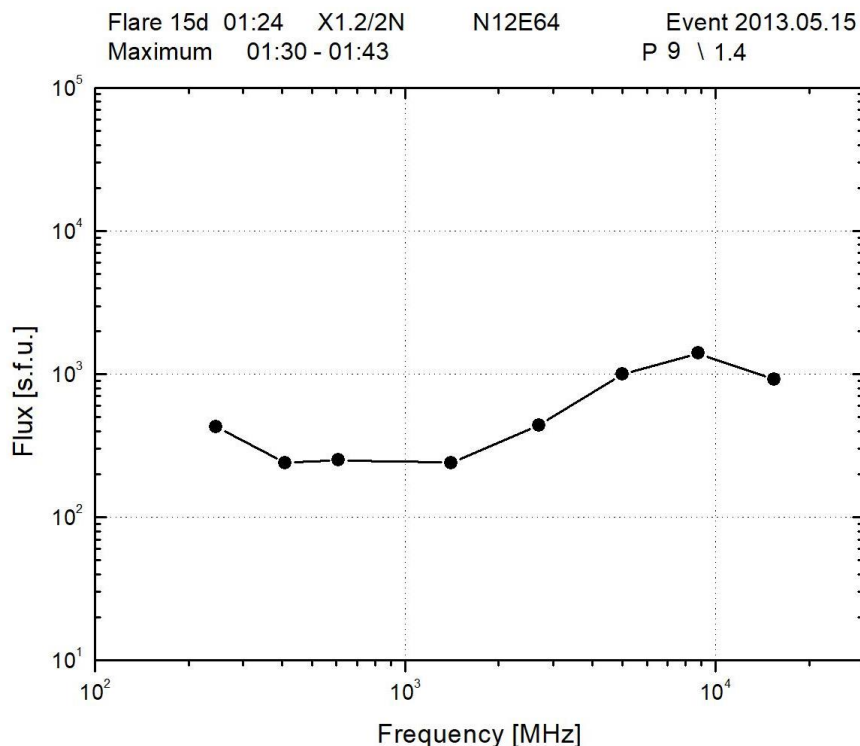
AR 11748

To event

530

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0124	0140	0230	N12E64	2N	ERU
1 – 12	keV	0125	0148	0158		X1.2	0.12
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0118:44	0143:18	0154:20	680871	408274784	FERMI
12-25	keV	0229:43	0230:24	0230:24	6415	2062607	FERMI
50-100	keV	0114:32	0143:34	02:13:16	8656	38809072	HESSI
12-25	keV	1541:18	1621:46	1640:09		805600768	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0136	0141	0154		2.96	
8.8	GHz	0135	0141	0153	P9 \ 1.4	3.15	
5	GHz	0136	0143	0151		3.00	
2.7	GHz	0133	0142	0150		2.64	
1.4	GHz	0129	0134	0146		2.38	
610	MHz	0130	0136	0142		2.40	
410	MHz	0127	0130	0142		2.38	
245	MHz	0133	0133	0146		2.63	
Ds-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	073-180	0137		0145		1	
DS IV	073-180	0127		0148		2	
DH II	16-0.25	0149		0730		2	WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0148	1366	- 52.1	360°	93°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11748 (N12L294, CMP 20.0.05.2013,
Sp=310 msh, DKI, BGD, R)
XRI=9.96; $X_4^{3.2} + M_5^{3.2} + C_{19}^{2.2} + I_3 + S_{56}$
PFR1 12-13.05; (52^h) $X_3^{3.2} + M_3^{1.9}$
PFR2 15-17.05 (57^h) $X_1^{1.2} + M_2^{3.2}$

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
Grechnev V., V. Kiselev, N. Meshalkina, I. Chertok, [2017](#).
NOAA SPE, [2019](#).
de Nolfo G.A., A. Bruno, J.M. Ryan et al., [2019](#).
Paassilta M., O. Raukunen, R. Vainio et al., [2017](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Winter L.M., and K. Ledbetter, [2015](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 22d13^h

Tmax ($E_p > 10$ MeV) – 22d15^h, Jmax ($E_p > 10$ MeV) – $83.5/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 4 days, power-law index: $\gamma = 3.0$

Quasimaximal energy of protons in the event – $E_{qm} = 500$ MeV

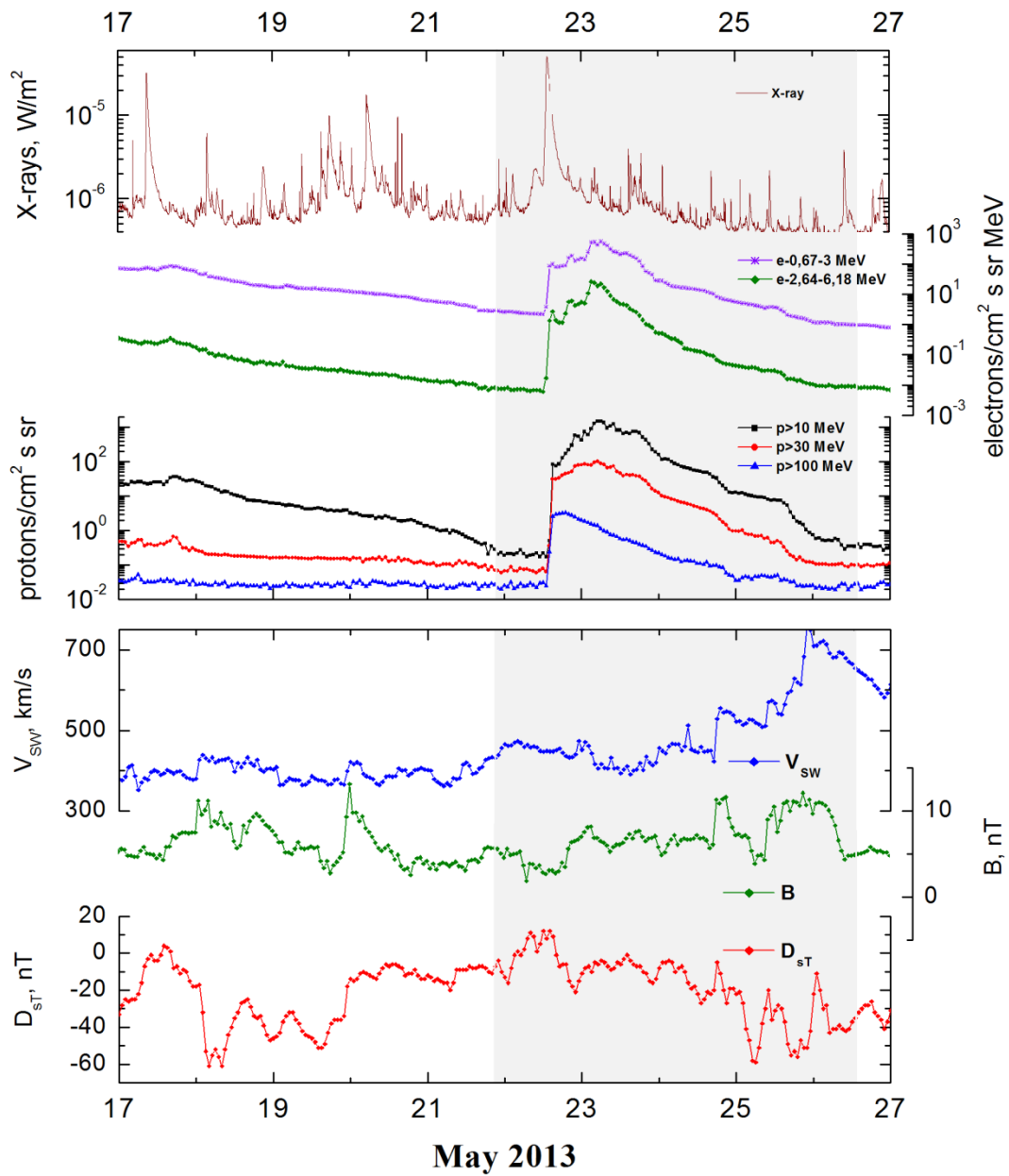
Sources: ● solar flare 22d12^h35^m, 3N/M5.0, N15W70, AR11745

Main burst X-ray 1–8 Å: onset – 22d13^h08^m, max – 22d13^h32^m, $\Phi = 0.14 \text{ J/m}^2$

CME: 22d13^h26^m, $V = 1466 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 287^\circ$

▲ SC 24d18^h10^m; ▲ SC 25d 09^h48^m

Particle fluxes and associated phenomena

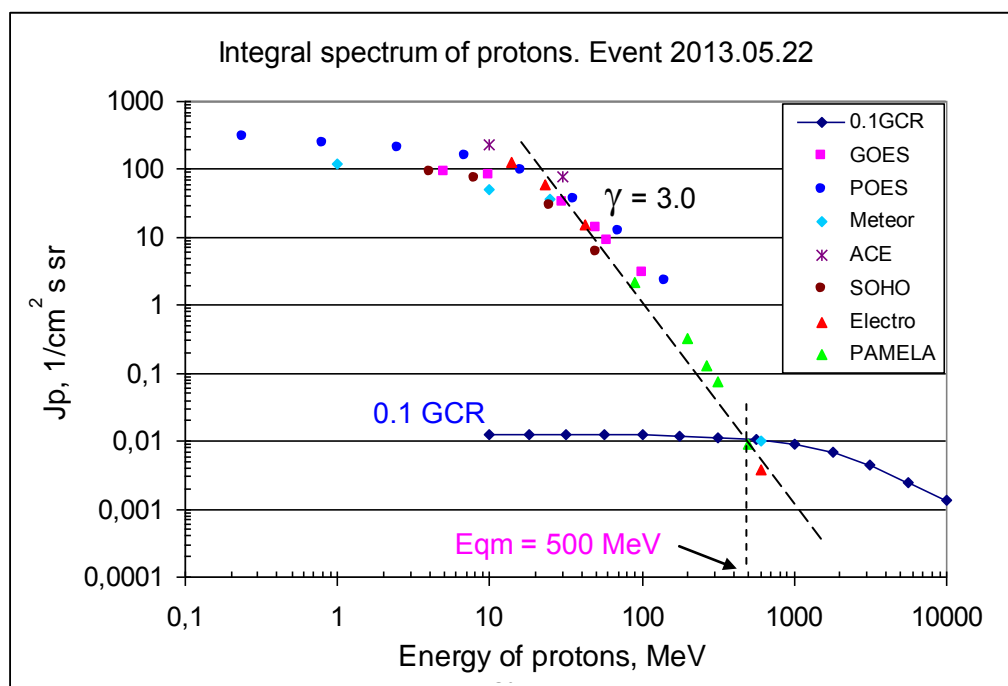


Integral fluxes of protons for the event of 2013 May 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	13	15	92	4	1	
EPS	>10	13	15	83.5	4	0.2	
EPS	>30	13	15	31.3	3.5	0.07	
EPS	>50	13	15	14	3.5	0.06	
EPS	>60	13	15	9	3.5	0.05	
EPS	>100	13	15	3.3	3	0.03	
Electro-1							
GALS-E	>600	12	17	0.0037	1.5	0.0007	
POES							
MEPED	>0.24	12	18	300	4	90	
MEPED	>0.8	12	18	250	3.5	80	
MEPED	>2.5	12	18	205	3.5	55	
MEPED	>6.9	12	18	155	3	45	
MEPED	>16	12	18	95	3	0.8	
MEPED	>36	12	18	36.2	2.5	0.8	
MEPED	>70	12	18	12.6	2	0.85	
MEPED	>140	12	18	2.3	1.5	0.9	
Meteor-1							
SCR	>1	13	16	121	3.5	2.5	
SCR	>3	13	-	-	3.5	2.35	
SCR	>10	13	16	50	3	1.6	
GALS-M	>15	12	-	-	3	1.2	
GALS-M	>25	12	16	36	3	1.2	
GALS-M	>600	13	16	0.01	1	0.02	
ACE							
SIS	>10	12	18	227	3.5	1.3	
SIS	>30	12	17	78	3.5	0.8	
PAMELA							
TRACKER	>90	14	19-23d04	2.2	>3		
TRACKER	>200	14	19-23d04	0.32	>2		
TRACKER	>265	14	19-23d04	0.13	>1		
TRACKER	>312	14	19-23d04	0.075	1		
TRACKER	>500	14	19-23d04	0.0089	1		
SOHO							
EPHIN	>50	12	15	6.1	3	0.2	

Differential fluxes of protons for the event of 2013 May 22

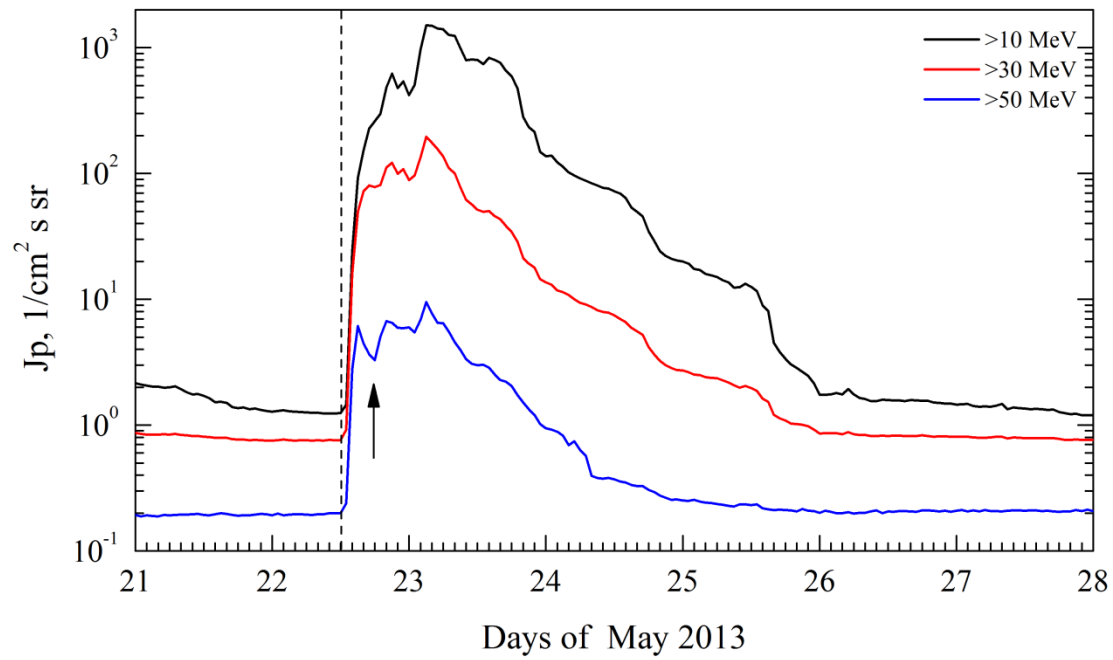
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	13	15	5.1	4	0.3	
EPHIN	8 – 25	13	15	2.6	4	0.015	
EPHIN	25 – 53	12	15	0.84	4	0.0004	
Electro							
SCR-E	13.7–23	12	17	7.1	3.5	0.05	
SCR-E	23–42	12	17	2.35	3.5	0.02	
SCR-E	42–112	12	17	0.135	2.5	0.005	



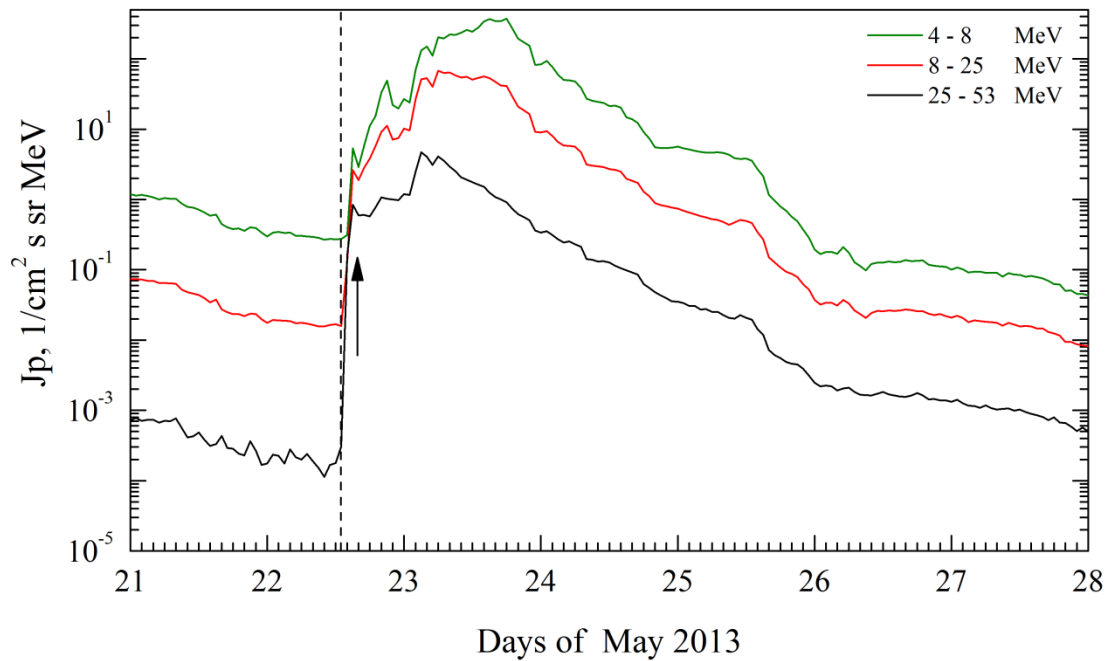
Time profiles of proton fluxes in the event 2013.05.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.05.22

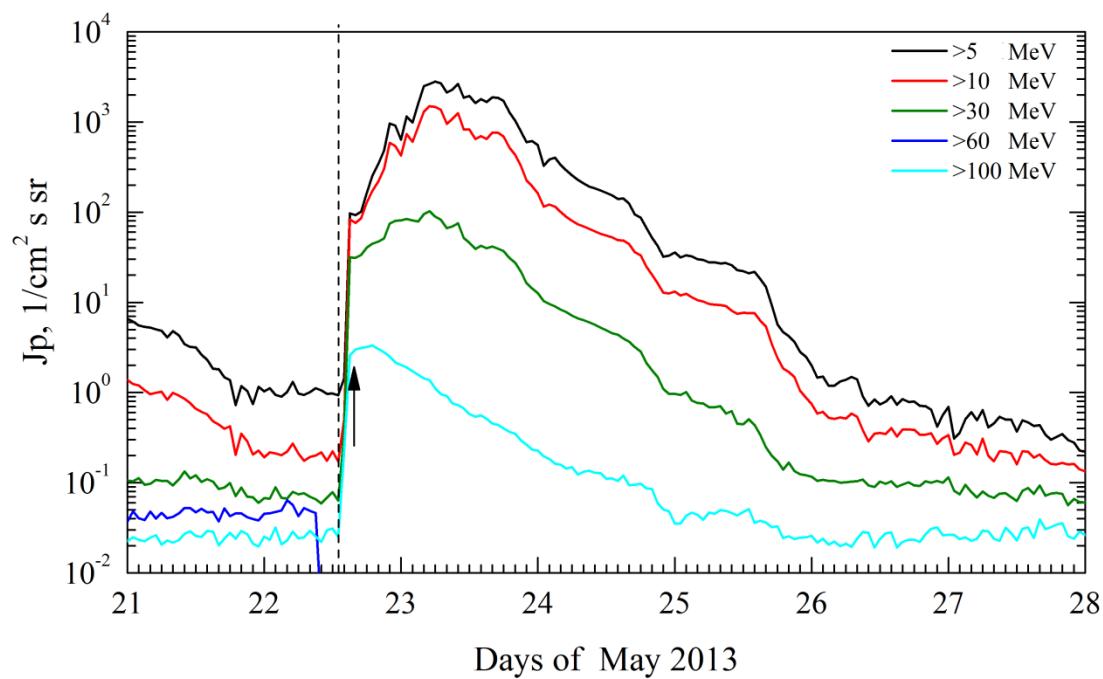


SOHO. Event 2013.05.22

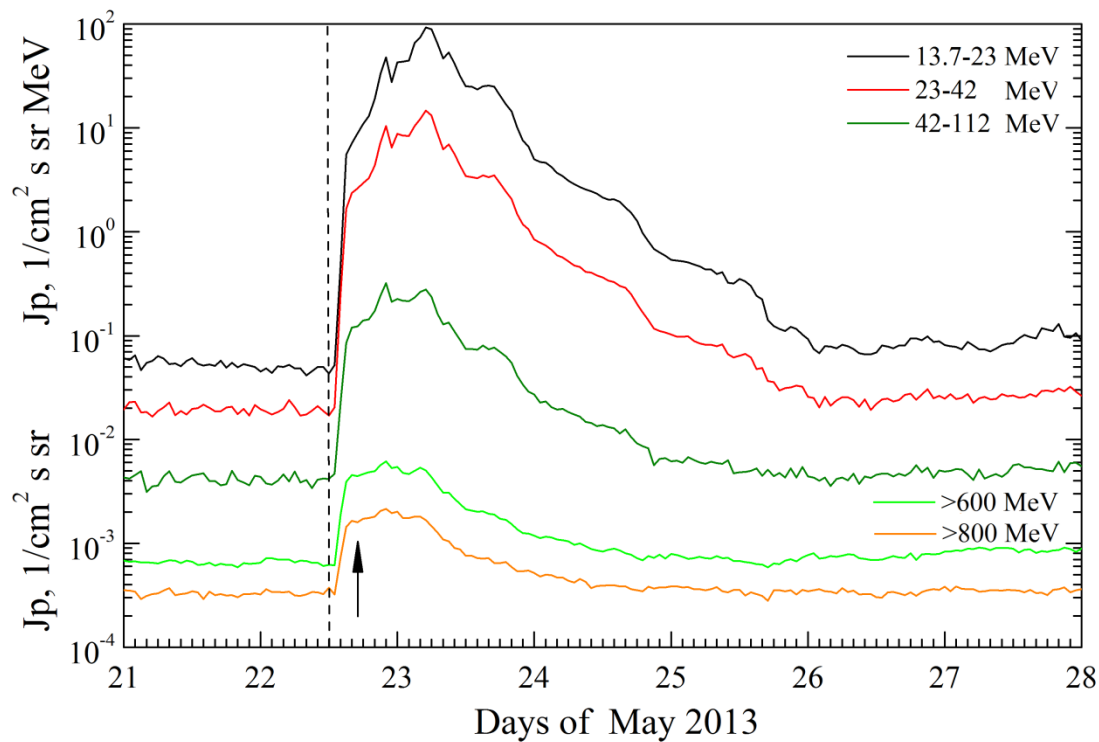


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.05.22

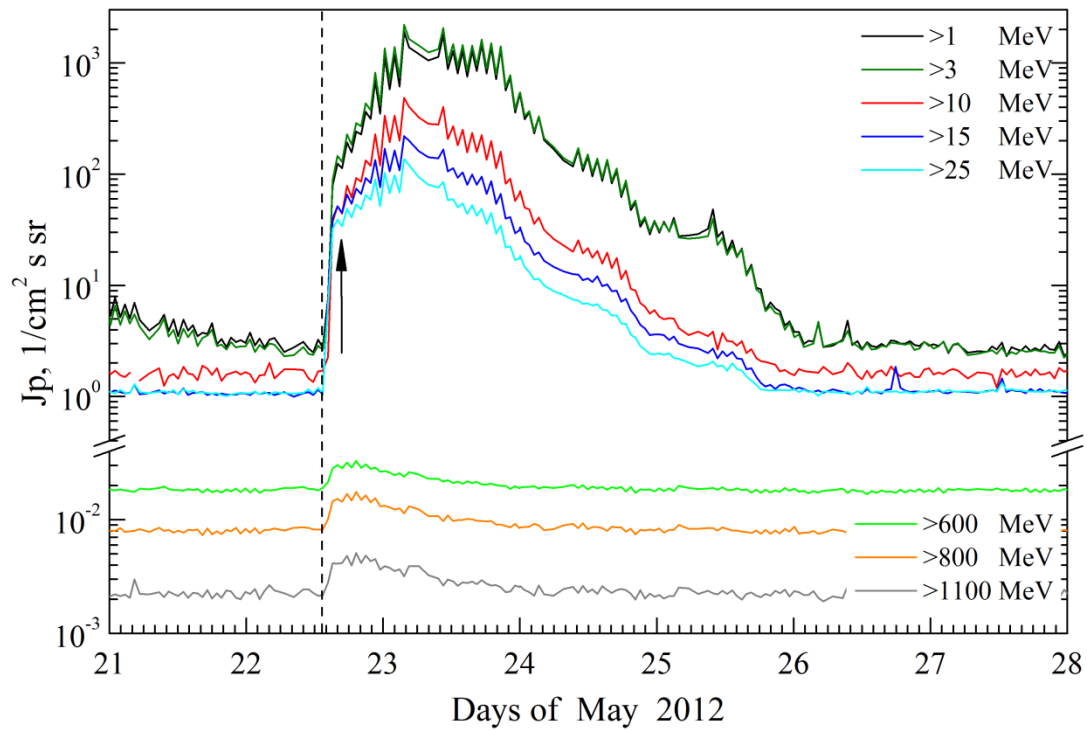


Electro. Event 2013.05.22

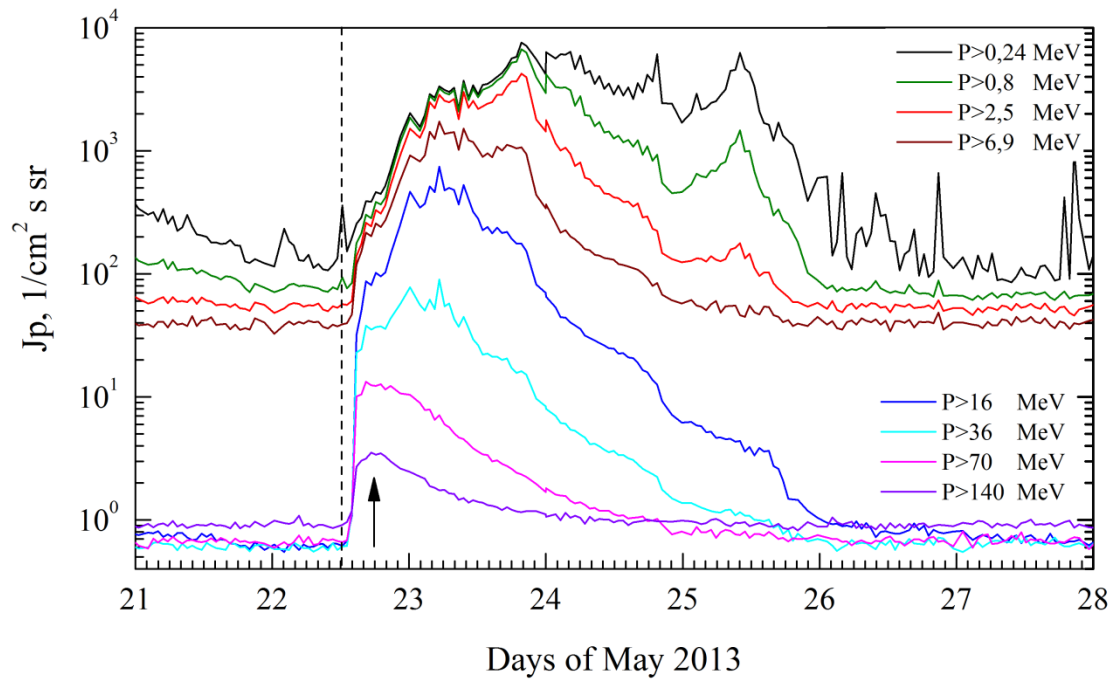


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.05.22



POES. Event 2013.05.22



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 May 22**

2013

May 22

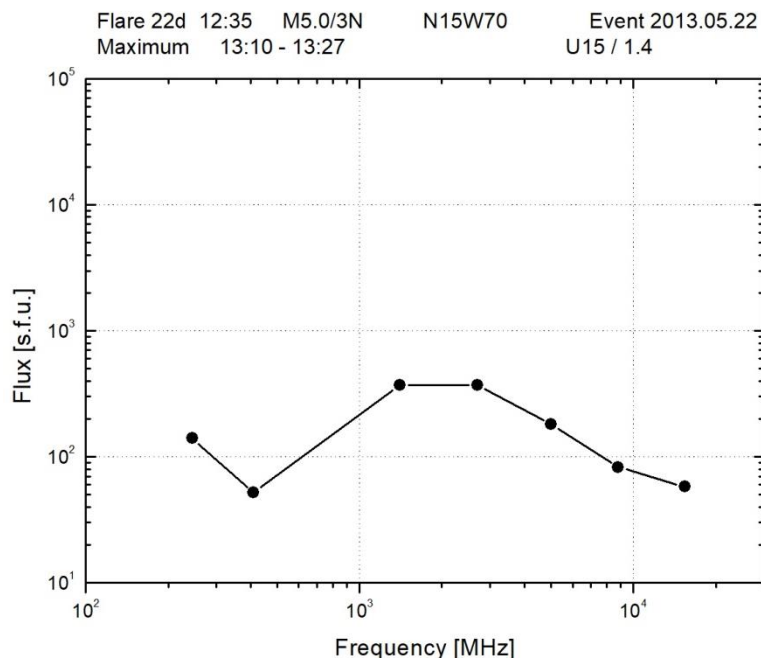
•

AR 11745

To event 531

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	<1235	1322	1555	N15W70	3N	PRB
1 – 12	keV	1308	1332	1408	N14W87	M5.0	0.14
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1245:20	1249:05	1249:09	1413	43623	FERMI
12-25	keV	1252:20	1252:46	1257:52	76	115901	HESSI
50-100	keV	1257:52	1319:58	1352:00	1328	11354487	HESSI
12-25	keV	1429:59	1441:39	1505:00	640	224436	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1319	1327	1331	U15 / 1.4	1.76	
8.8	GHz	1312	1315	1338		1.91	
5	GHz	1310	1313	1338		2.25	
2.7	GHz	1309	1313	1338		2.57	
1.4	GHz	1309	1314	1338		2.57	
410	MHz	1312	1312	1312		1.72	
245	MHz	1310	1310	1310		2.15	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-41	1259		1305	1962	2	
DS IV	25-143	1303		1350		1	
DH II	16-0.15	1310		24/0600		2	WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1326	1466	-13.2	360°	287°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR 11745 (N13L334, CMP 16,8.05.2013,
Sp=600 mvh, DKC, BG, R)
XRI= 1.2; $M_3^{5.0} + C_{15}$; $3_1 + S_{19}$.
PFR1 10.05 (12^h) – $M_2^{3.9}$.
PFR2 22.05 $M_1^{5.0}$

References:

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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).
Zou Z., X. Xue, Ch. Shen et al., [2018](#).

Particle event: To($E_p > 10$ MeV) – 21d14^h

Tmax₁($E_p > 10$ MeV) – 22d10^h, Jmax₁($E_p > 10$ MeV) – 6 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 2.3$,

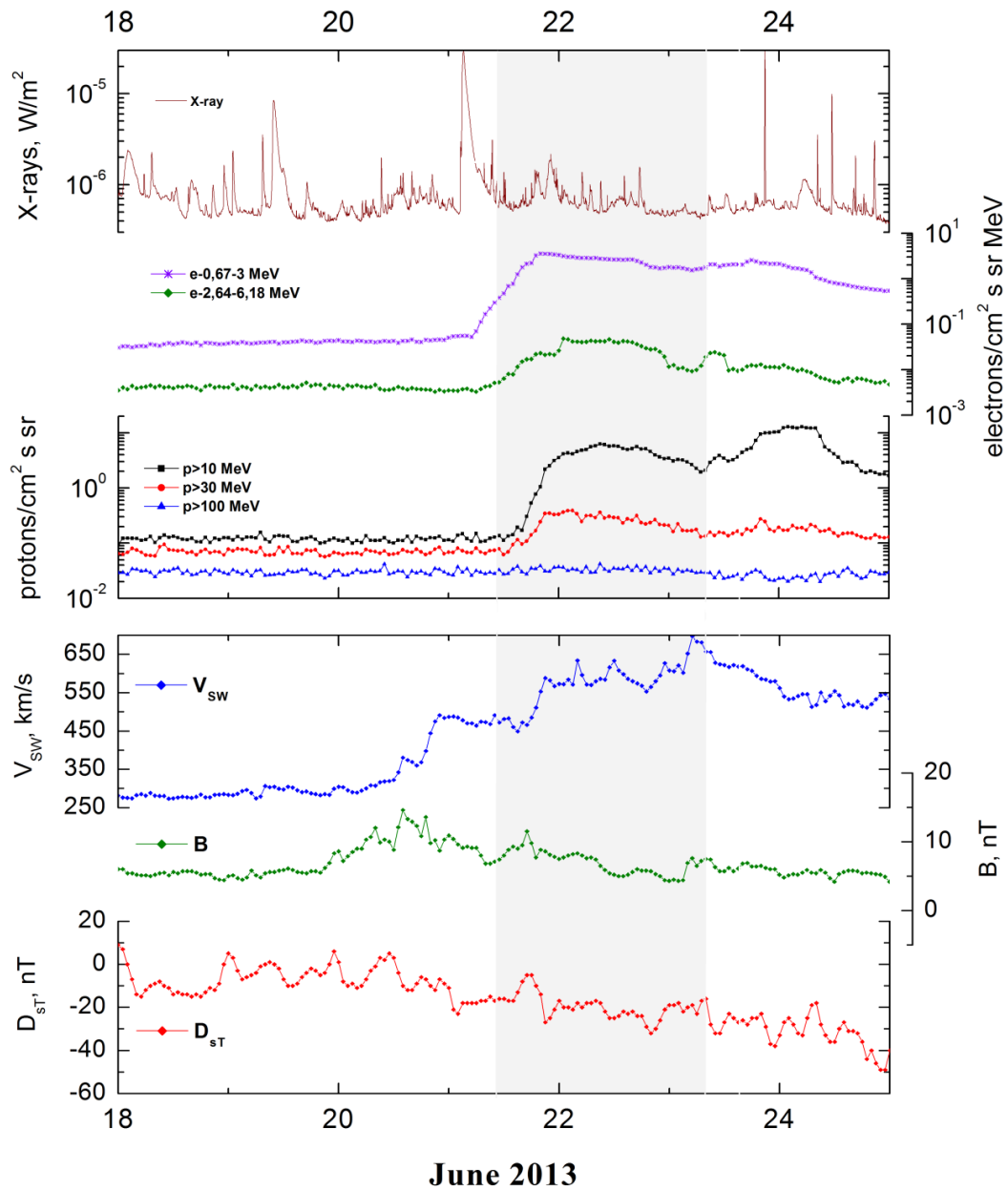
Quasimaximal energy of protons in the event – E_{qm} = 100 MeV

Sources: • solar flare 21d02^h30^m, M2.9/1F, S16E73, AR11777

Main burst X-ray 1–8 Å: onset – 21d02^h30^m, max – 21d03^h14^m, $\Phi = 0.069$ J/m²

CME: 21d03^h12^m, V = 1900 km/s, $\Delta\phi = 207^\circ$, dA = 107°

Particle fluxes and associated phenomena

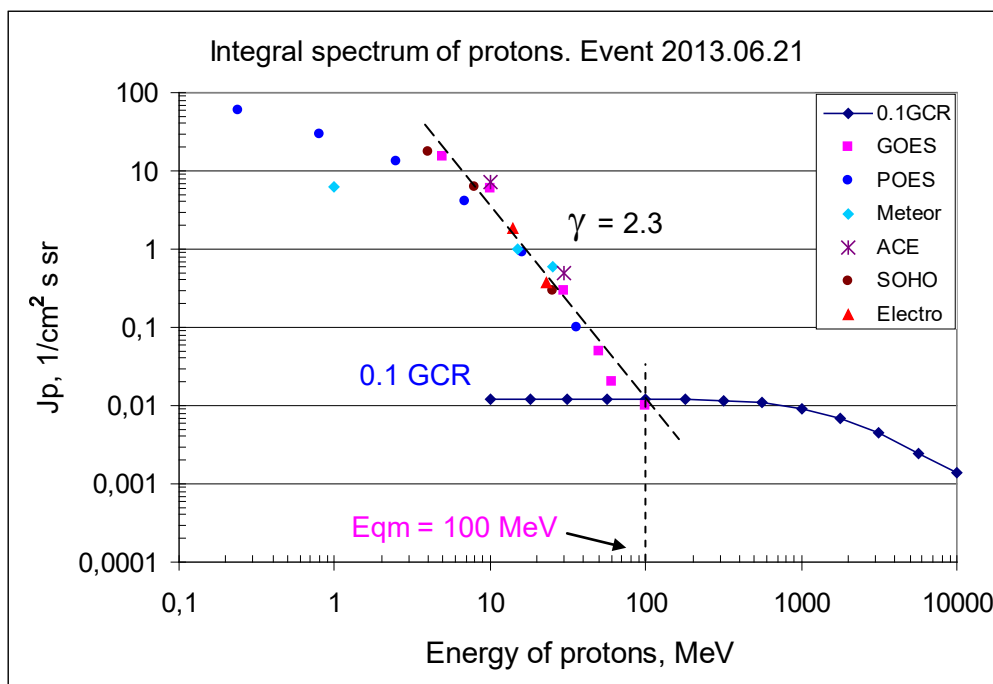


Integral fluxes of protons for the event of 2013 June 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	14	22d11	15	2	0.2	
EPS	>10	14	22d10	6	2	0.15	
EPS	>30	14	22d09	0.3	2	0.07	
EPS	>50	14	22d09	0.05	2	0.06	
EPS	>60	14	22d09	0.02	2	0.05	
EPS	>100	-	22d09	0.01	2	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	18	22d10	60	1.5	90	
MEPED	>0.8	18	22d10	30	1.5	70	
MEPED	>2.5	18	22d10	13	1.5	50	
MEPED	>6.9	18	22d10	4	1	40	
MEPED	>16	18	22d13	0.9	1	0.7	
MEPED	>36	18	22d13	0.1	0.5	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	16	22d03	6.3	1.5	2.4	
SCR	>3	16	-	-	1.5	2.3	
SCR	>10	16	-	-	1.5	1.6	
GALS-M	>15	16	22d01	1.0	1.5	1.1	
GALS-M	>25	16	22d01	0.6	1.5	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	14	22d09	7.3	2	1.1	
SIS	>30	14	22d09	0.5	2	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 June 21

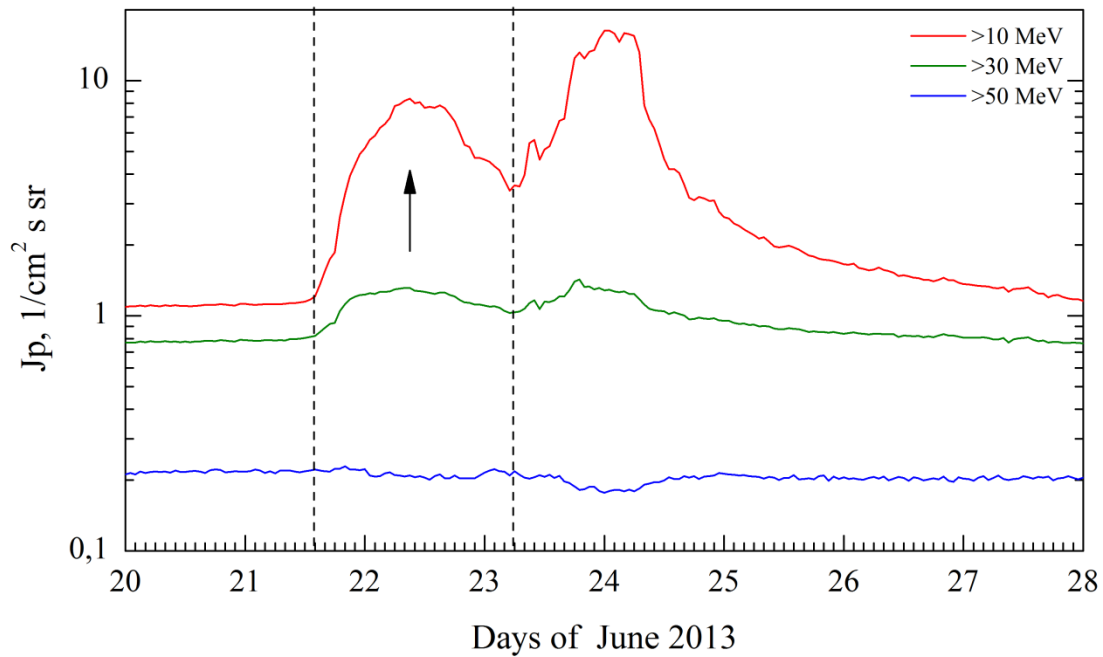
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- round	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	09	22d15	2.88	2	0.002	
EPHIN	8 – 25	09	22d15	0.34	2	0.0001	
EPHIN	25 – 53	09	22d08	0.013	2	0.00001	
Electro-1							
SCR-E	13.7–23	12	22d07	0.16	2	0.05	
SCR-E	23–42	12	22d07	0.024	2	0.02	
SCR-E	42–112	12	-	-	-	0.005	



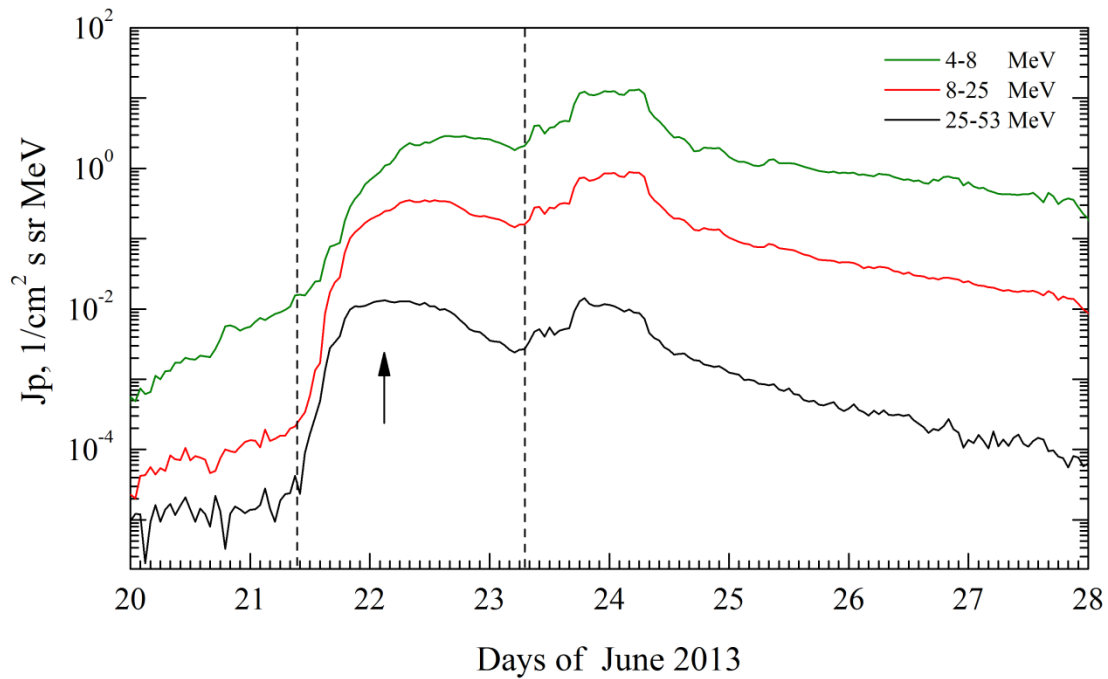
Time profiles of proton fluxes in the event 2013.06.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.06.21

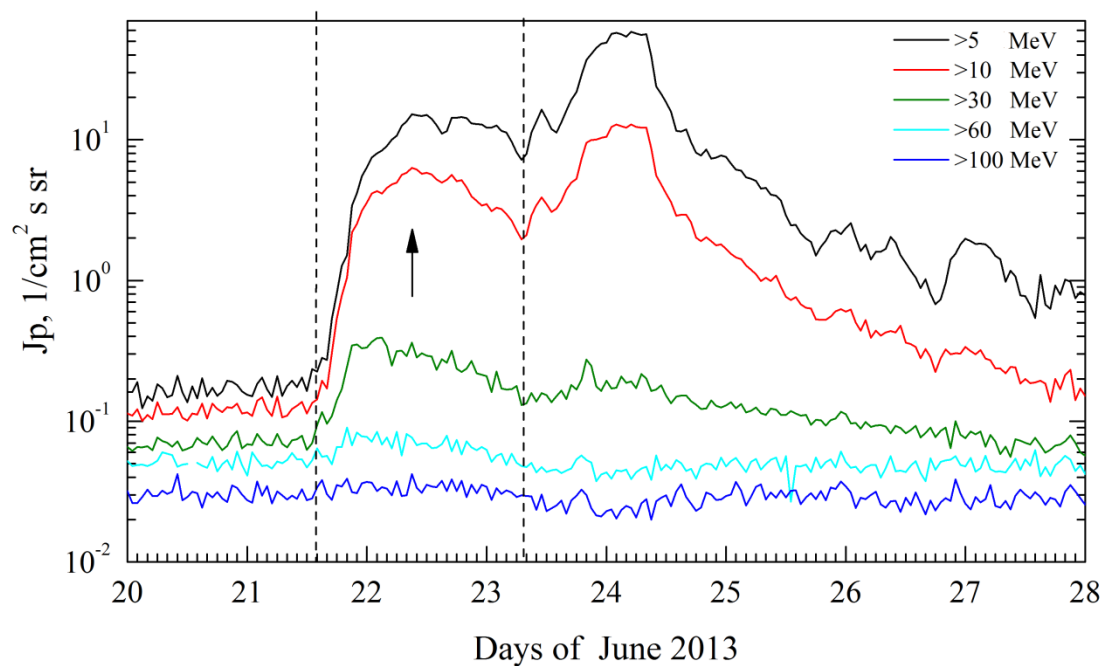


SOHO. Event 2013.06.21

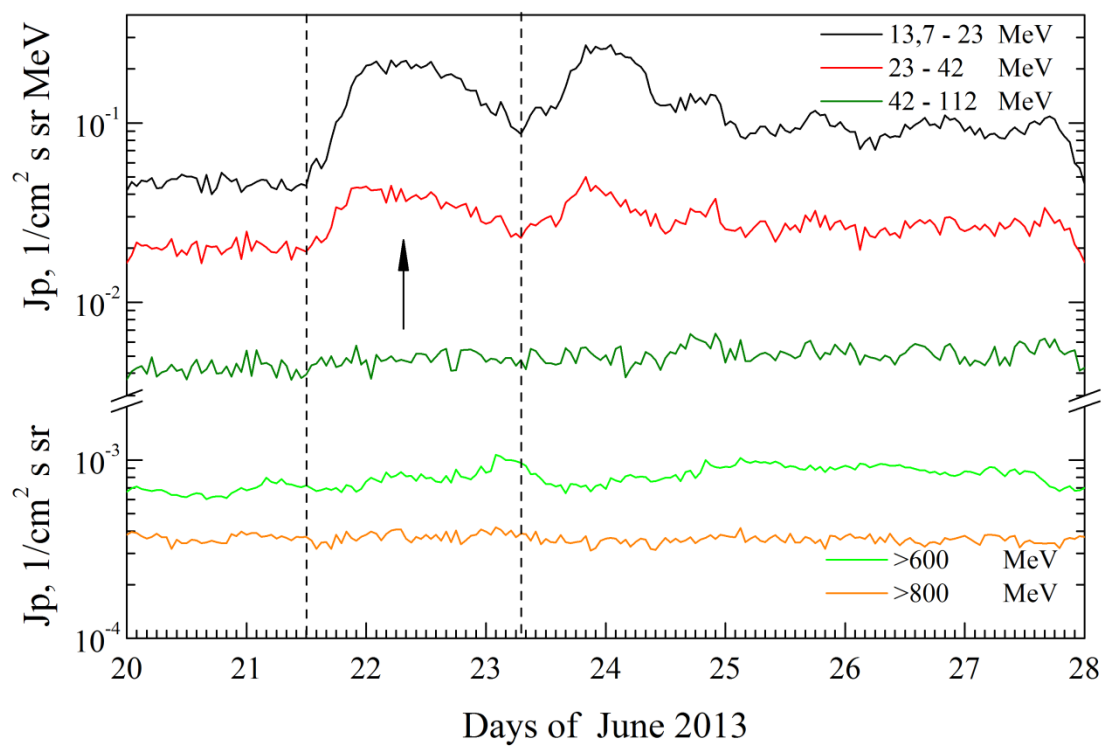


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.06.21

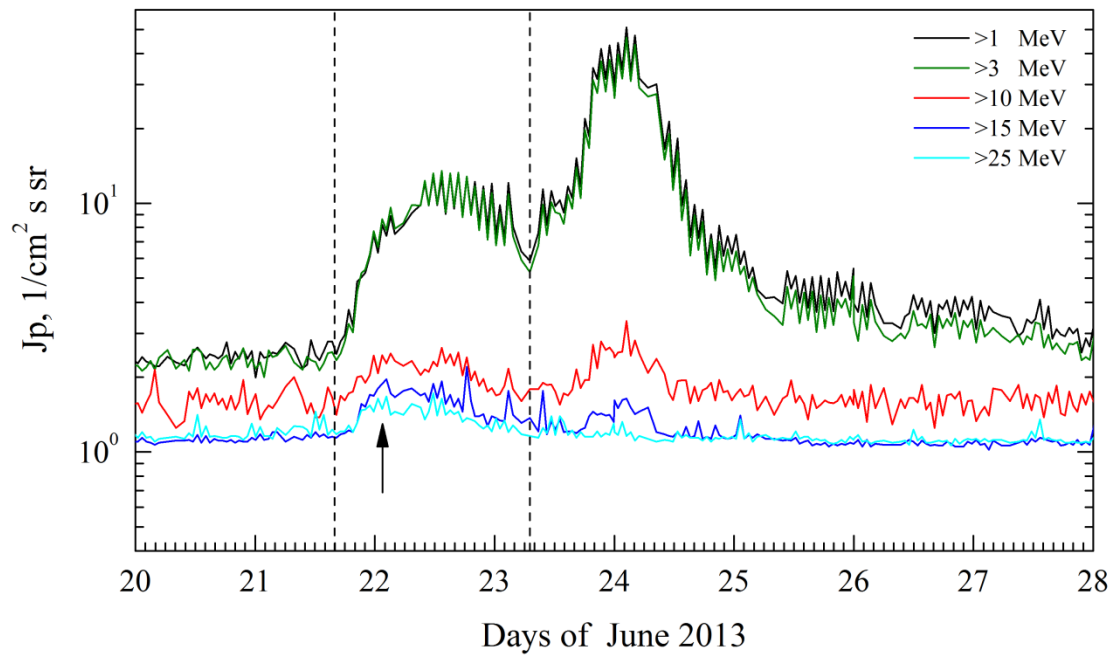


Electro. Event 2013.06.21

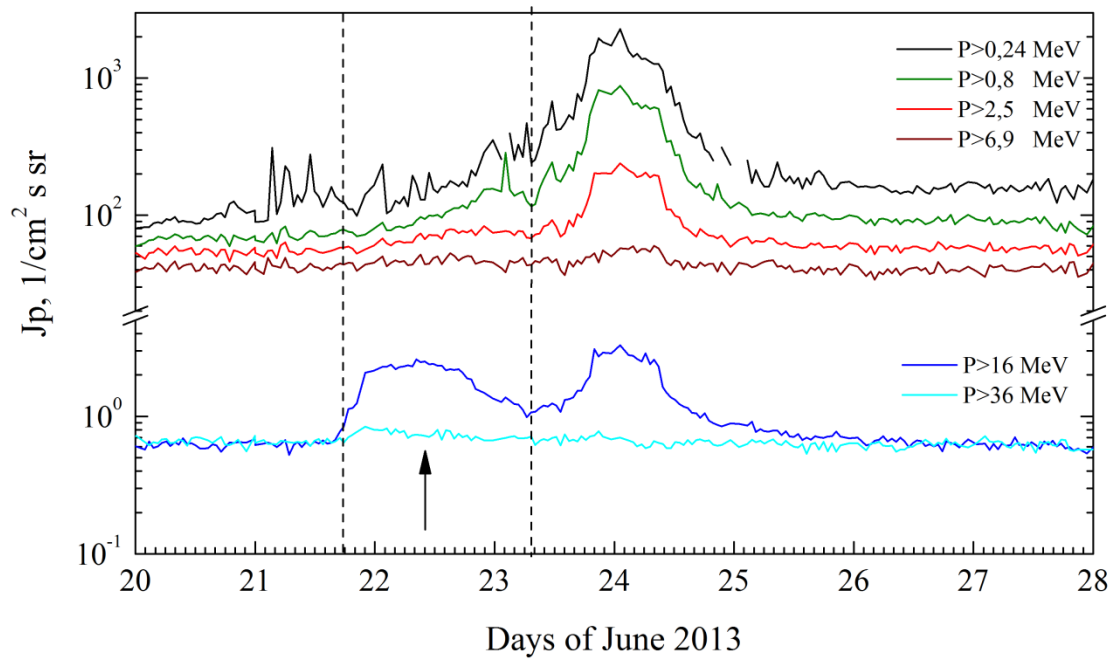


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.06.21



POES. Event 2013.06.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 June 21**

2013

June 21

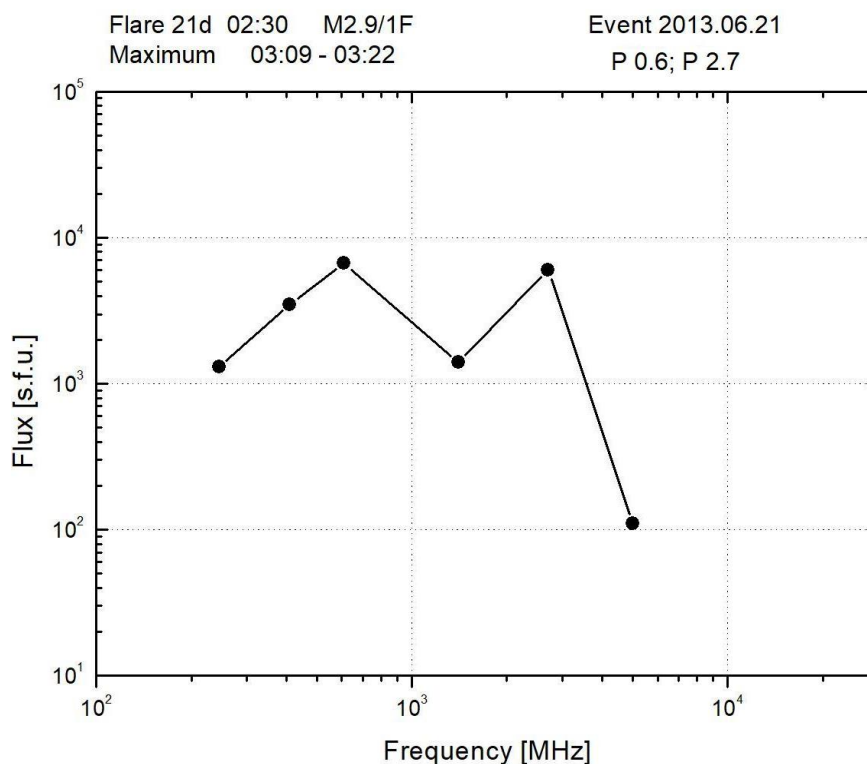
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AR 11777

To event 532

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0233	0301	0357	S16E73	1F	ERU
6563 Å	EPL	0252		0310		0.17	
1 – 12	keV	0230	0314	0343	S14E73	M2.9	0.069
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0230:32	0237:26	0245:04	72	123453	HESSI
25-50	keV	0245:04	0303:26	0305:40	912	2347025	HESSI
12-25	keV	0325:24	0327:22	0355:00	256	1250448	HESSI
12-25	keV	0234:28	0237:12	0240:20	4403	211179	FERMI
12-25	keV	0244:38	0303:21	0329:34	33854	8469234	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
5	GHz	0308	0309	0310		2.04	
2.7	GHz	0308	0322	0330	P2.7	3.78	
1.4	GHz	0305	0322	0329		3.15	
610	MHz	0308	0319	0332	P0.6	3.83	
410	MHz	0308	0319	0331		3.54	
245	MHz	0308	0321	0328		3.11	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/
DS IV	25-180	0256		0336		1	
DS III	18-060	0309		0311		3	
DS VI	25-180	0254		0321		1	
DH II	14-2	0335		0515			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0312	1900	-1.5	207°	107°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11777 (S16L161, CMP 26,3.06.2013,
Sp=200 msh, HSX, A, R)
XRI= 0.29 $M_2^{2.9}+C_2$ 1_1+S_1
PFR 21.06 $M_1^{2.9}$

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Bruno A., I.G. Richardson, [2021](#).
Maričić D., B. Vršnak, A.M. Veronig et al., [2020](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 23d07^h

Tmax₁($E_p > 10$ MeV) – 23d11^h, Jmax₁ ($E_p > 10$ MeV) – 3.7 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 23d20^h, Jmax₂ ($E_p > 10$ MeV) – 9.7 /cm²·s·sr

Duration of the event – 2.5 days, power-law index: $\gamma_1 = 2.6$, $\gamma_2 = 4.0$

Quasimaximal energy of protons in the event – Eqm₁ = 70 MeV

– Eqm₂ = 60 MeV

Sources: • solar flare 21d02^h30^m, M2.9/1F, S16E73, AR11777 (**Event 2013.06.21**)

Ø solar flare 23d20^h48^m, M2.9/1N, S15E66, AR11778

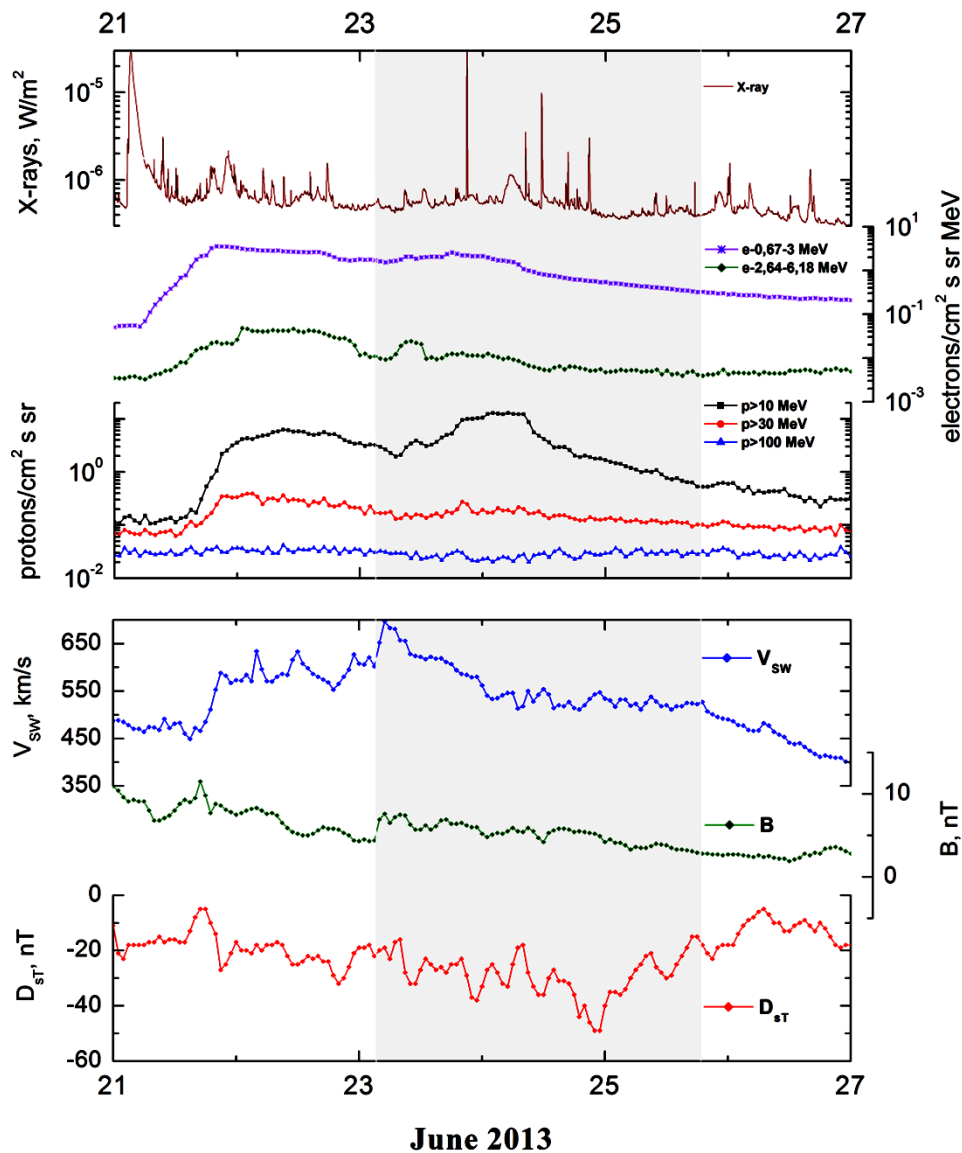
Main burst X-ray 1–8 Å: onset – 23d20^h48^m, max – 23d20^h56^m, $\Phi = 0.0025$ J/m²

CME: 23d21^h24^m, V = 339 km/s, $\Delta\phi = 101^\circ$, dA = 133°

• SC* 23d04^h26^m

* **Source:** • SC 23d04^h26^m – from flare of **Event 2013.06.21**

Particle fluxes and associated phenomena

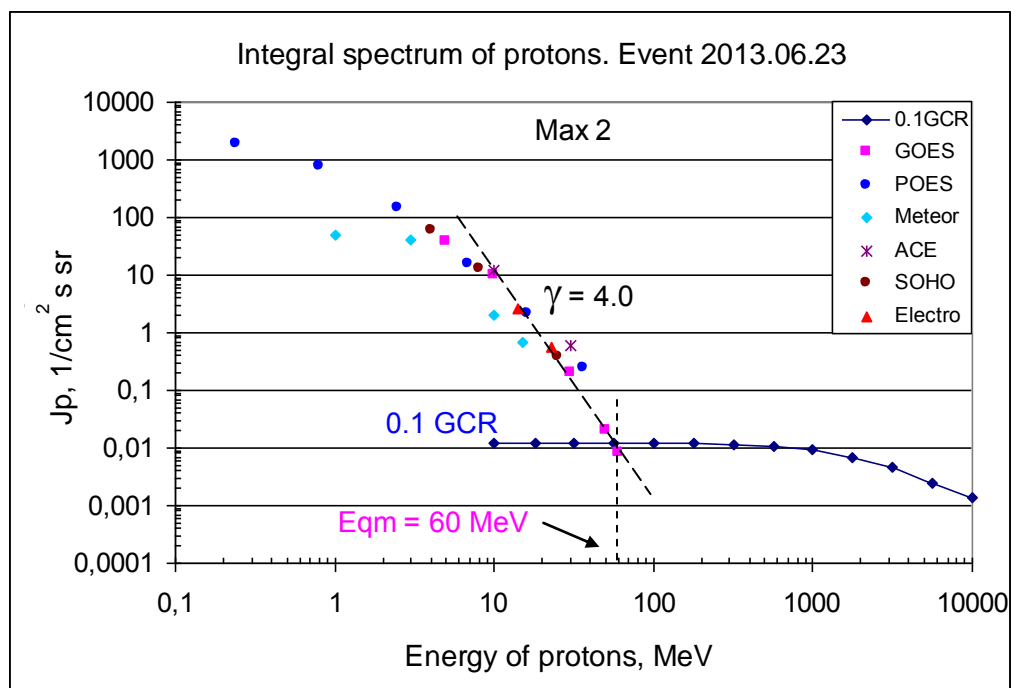
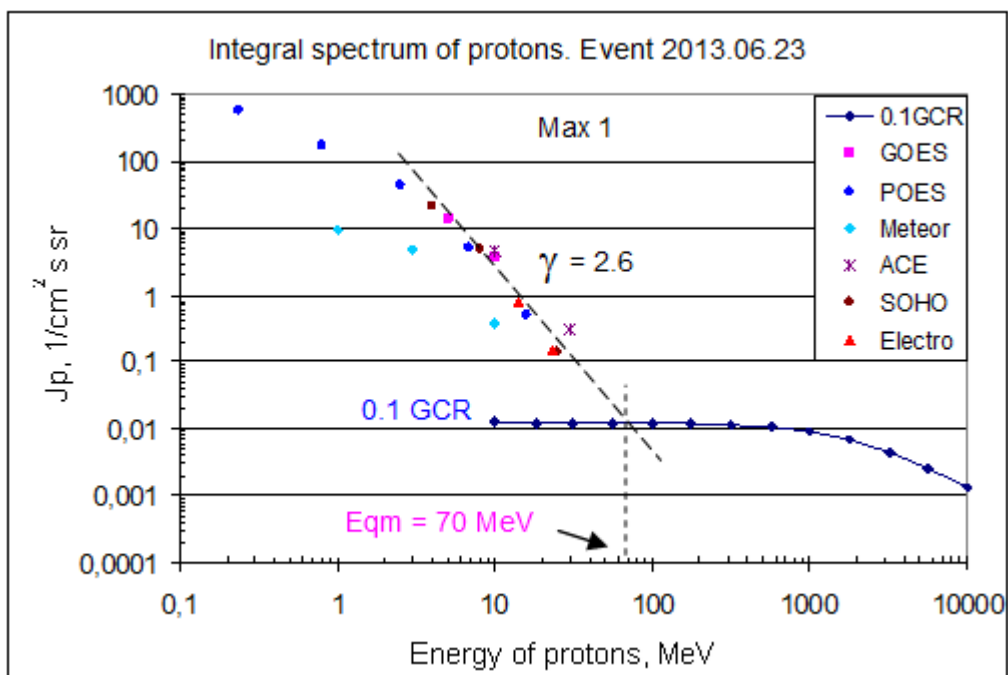


Integral fluxes of protons for the event of 2013 June 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	11/20	14/39	2.5	0.2	
EPS	>10	7	11/20	3.7/9.7	2.5	0.15	
EPS	>30	7	- /20	- /0.2	1.5	0.07	
EPS	>50	-	- /20	- /0.02	-	0.06	
EPS	>60	-	-	- /0.008	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	7	11/21	590/1900	2	90	
MEPED	>0.8	7	11/21	170/750	2	70	
MEPED	>2.5	7	11/21	42.5/150	2	50	
MEPED	>6.9	7	11/21	5.2/15.5	2	40	
MEPED	>16	7	11 /21	0.5/2.2	2	0.7	
MEPED	>36	7	- /21	- /0.25	0.5	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	8	09/24d02	9.1/49	2	2.4	
SCR	>3	8	09/24d02	4.8/42	2	2.3	
SCR	>10	8	09/24d02	0.38/2	1	1.6	
GALS-M	>15	8	-/24d01	-/0.7	1	1.1	
GALS-M	>25	-	-	-	-	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	6	10/19	4.5/12	1.5	1.3	
SIS	>30	6	10/19	0.3/0.6	1	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 June 23

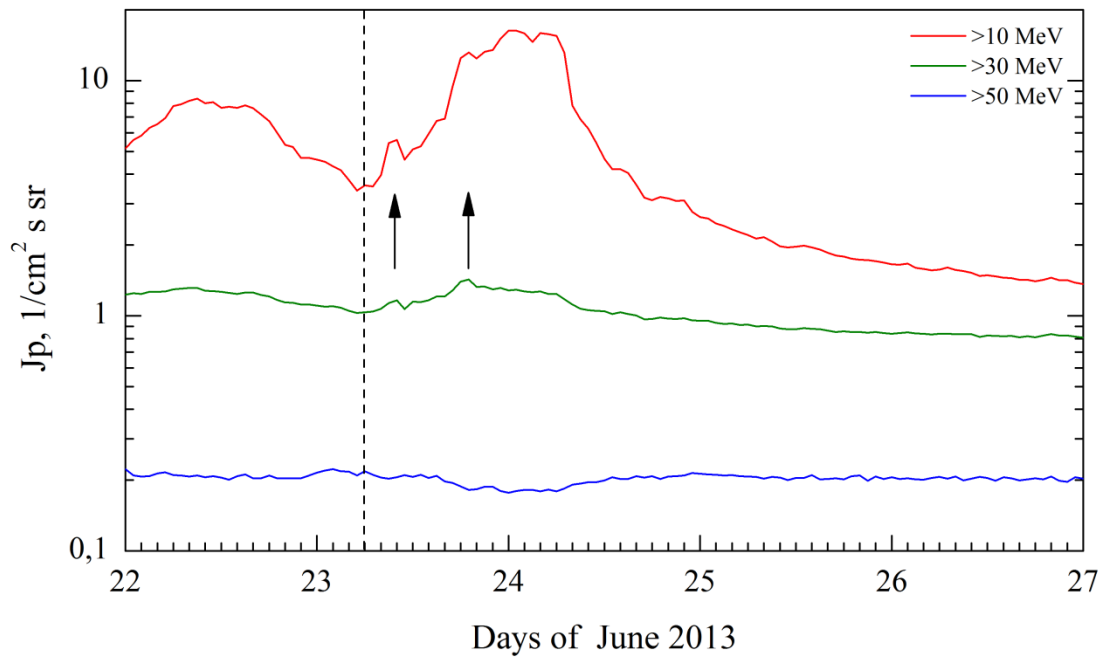
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	03	09/18	4.02/11.6	3.5	0.002	
EPHIN	8 – 25	05	09/18	0.28/0.73	3.5	0.0001	
EPHIN	25 – 53	08	09/18	0.005/0.014	3.5	0.00001	
Electro-1							
SCR-E	13.7–23	7	11/20	0.07/0.22	2	0.05	
SCR-E	23–42	7	11/20	0.008/0.03	2	0.02	
SCR-E	42–112	-	-	-	-	0.005	



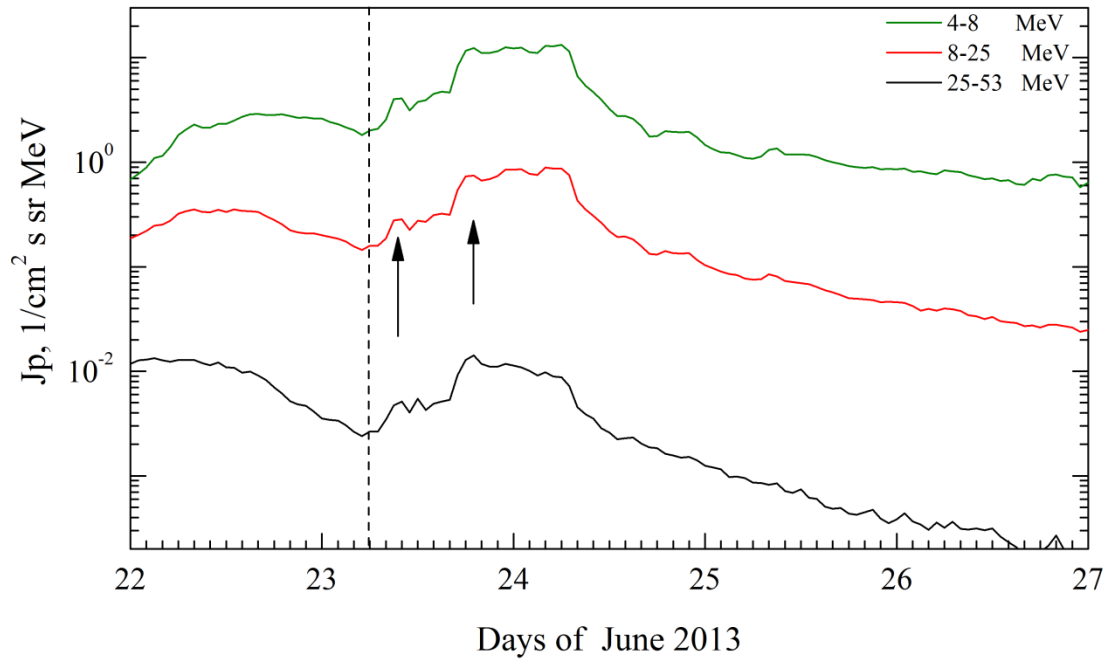
Time profiles of proton fluxes in the event 2013.06.23

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.06.23

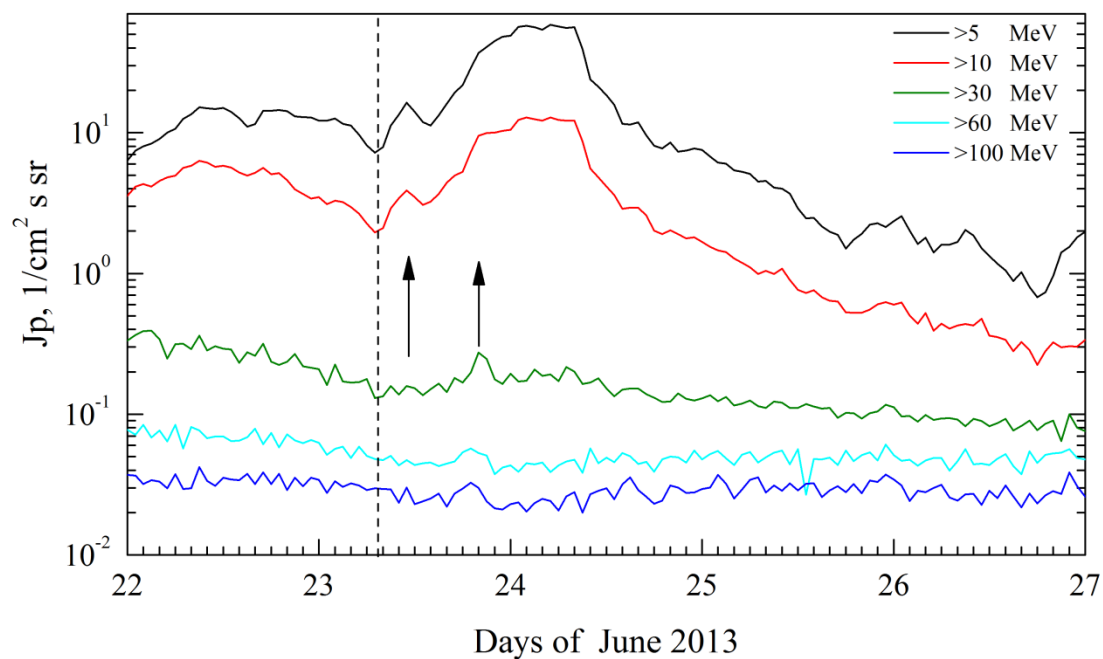


SOHO. Event 2013.06.23

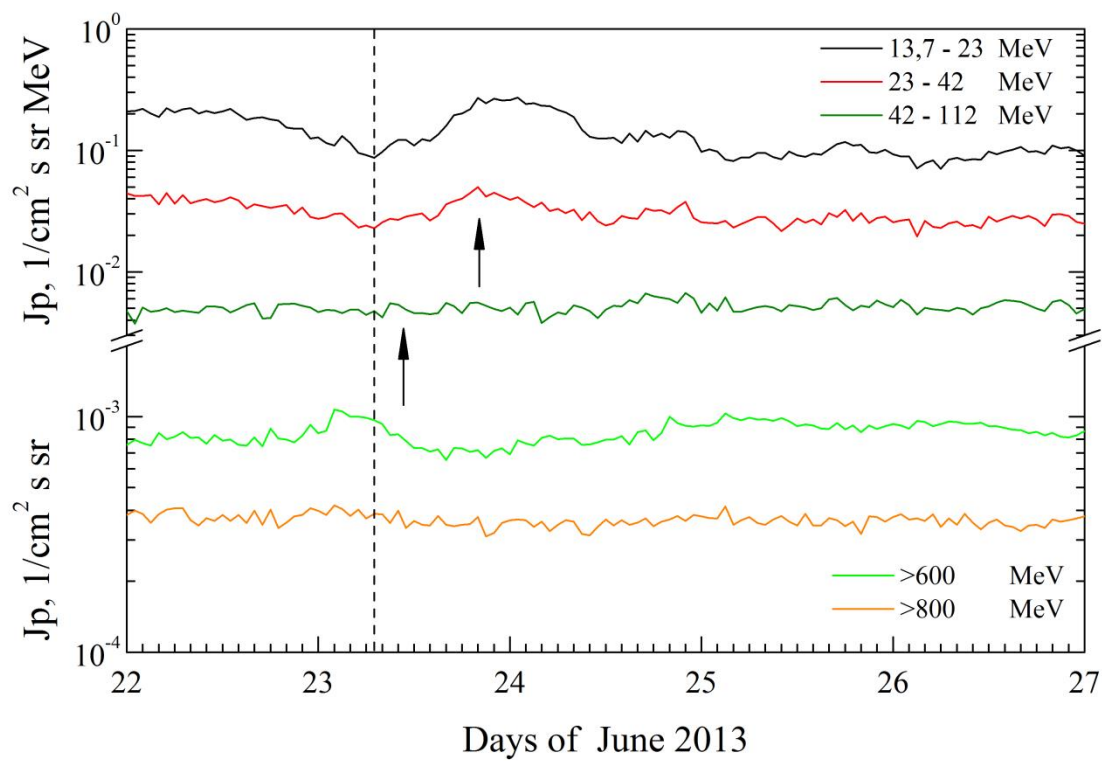


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.06.23

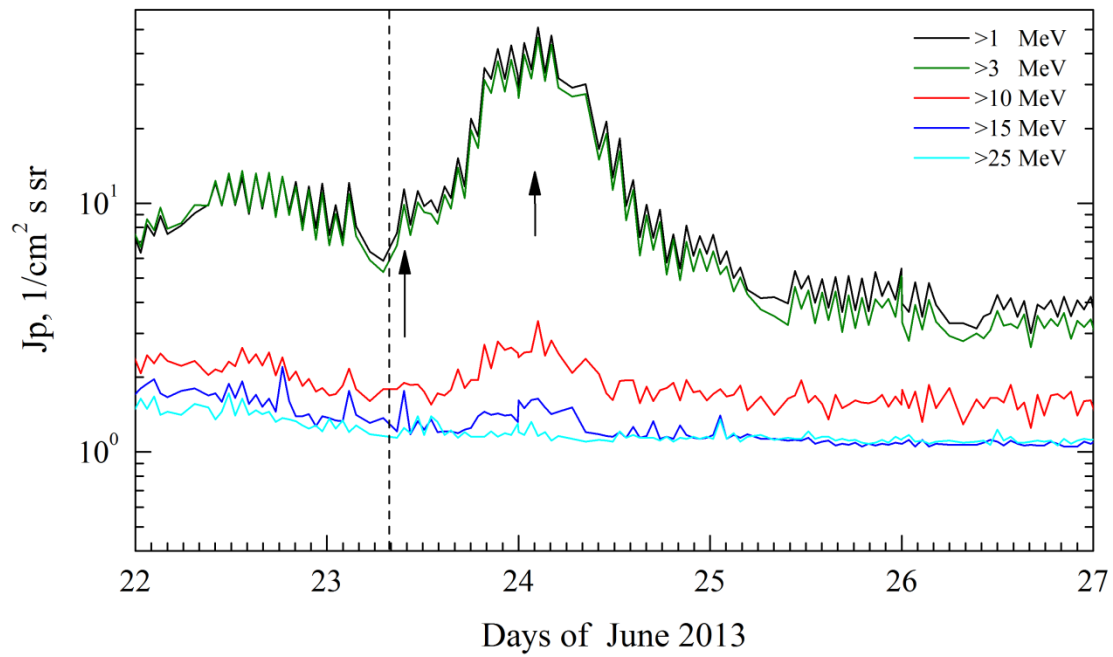


Electro. Event 2013.06.23

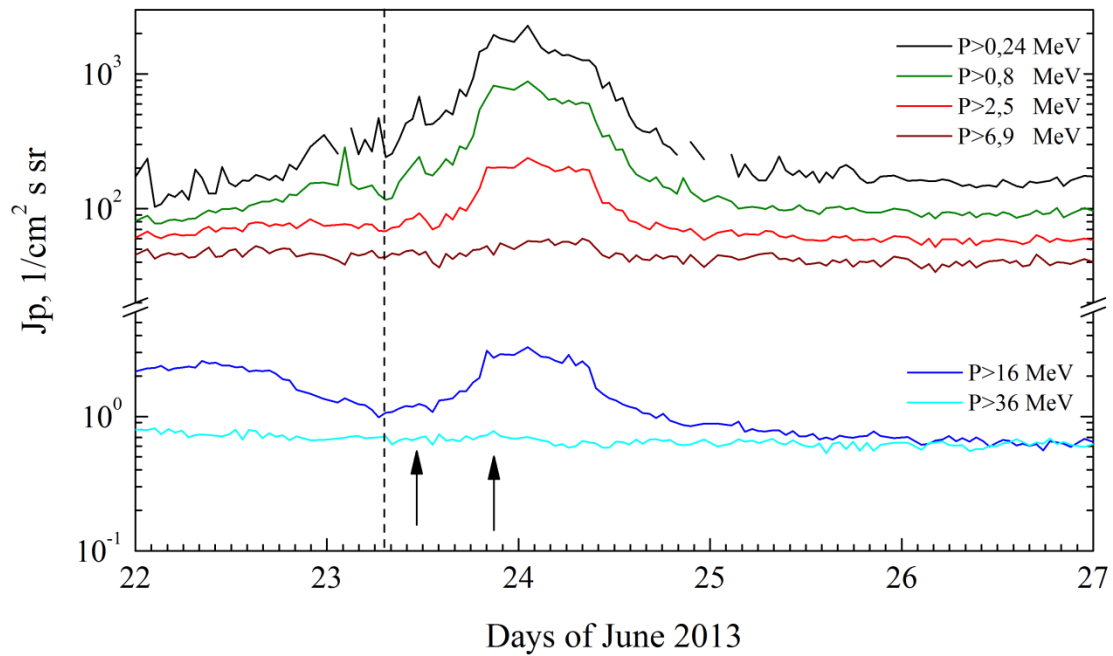


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2013.06.23



POES. Event 2013.06.23



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 June 23**

2013

June 23

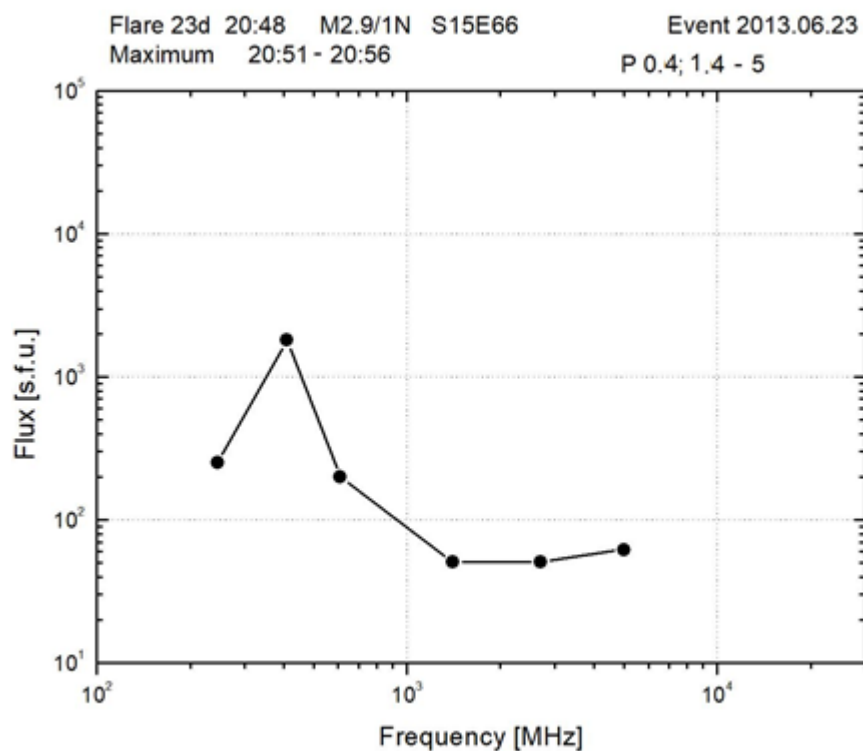
Ø

AR 11778

To event 533

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	2051	2056	2059	S15E66	1N	BPT
1 – 12	keV	2048	2056	2058	S18E63	M2.9	0.0025
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	2050:16	2053:50	2109:08	2160	2663900	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
5	GHz	2053	2053	2053		1.8	
2.7	GHz	2053	2053	2053	1.4 – 5	1.71	
1.4	GHz	2053	2053	2053		1.71	
610	MHz	2051	2051	2053		2.3	
410	MHz	2051	2053	2055	P0.4	3.26	
245	MHz	2052	2056	2056		2.4	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS III	25-180	2052		2054		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2124	339	-3.8	101°	133°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11778 (S17L125, CMP 28,9.06.2013,
Sp=110 msh, CAO, B)
XRI= 0.29 $M_1^{2.9} + C_8$ $I_2 + S_{18}$
PFR 23.06 $M_1^{2.9}$

References:

Maričić D., B. Vršnak, A.M. Veronig et al., [2020](#).
NOAA SPE, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 17d20^h

Tmax ($E_p > 10$ MeV) – 18d06^h, Jmax ($E_p > 10$ MeV) – $0.3/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma = 1.8$

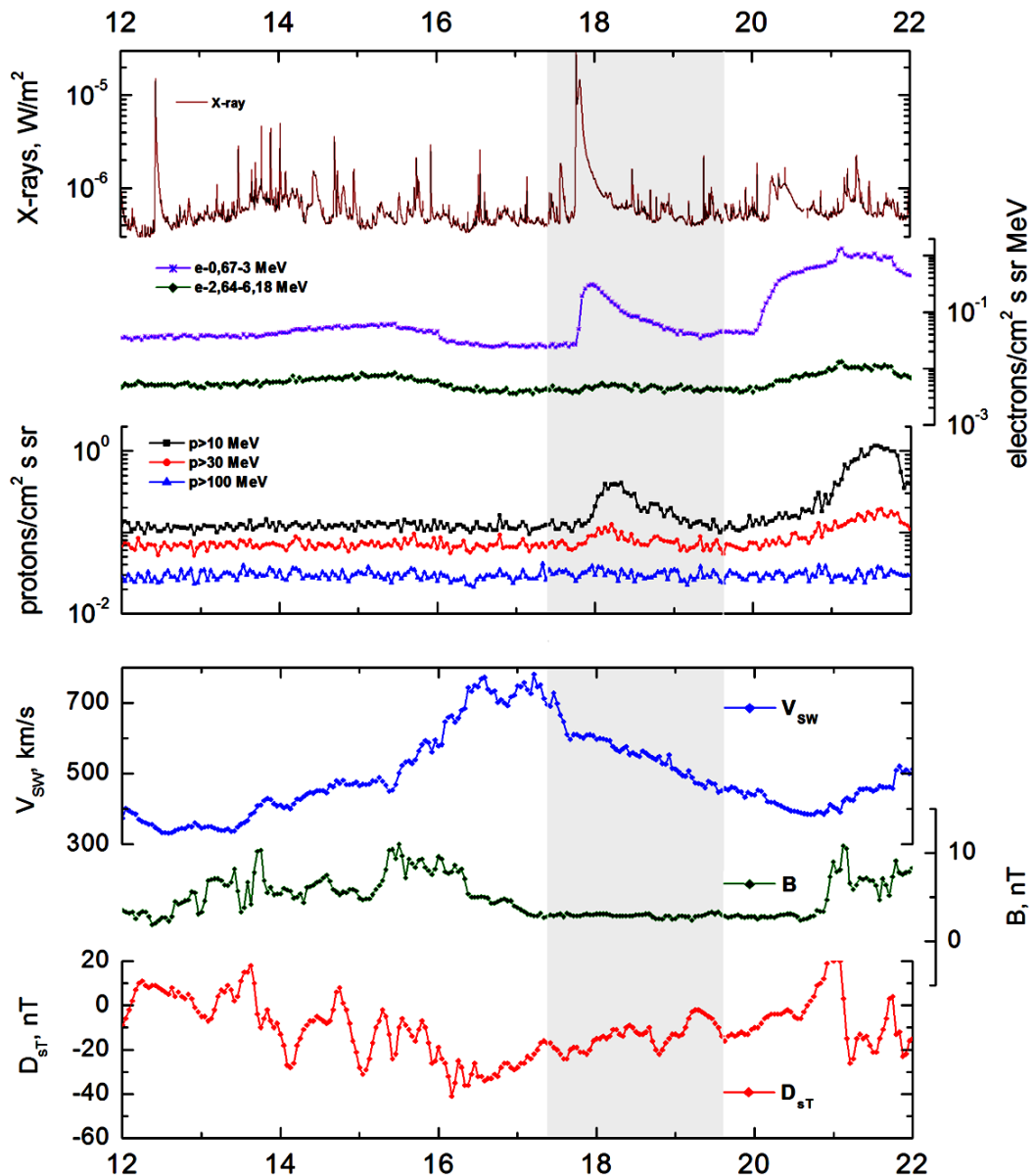
Quasimaximal energy of protons in the event – $E_{qm} = 60$ MeV

Sources: • solar flare 17d18^h16^m, 2B/M3.3, M1.4, S07W30, AR11818

Main burst X-ray 1–8 Å: onset – 17d18^h16^m, max – 17d18^h24^m, $\Phi = 0.021 \text{ J/m}^2$

CME: 17d19^h12^m, $V = 1202 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 274^\circ$

Particle fluxes and associated phenomena



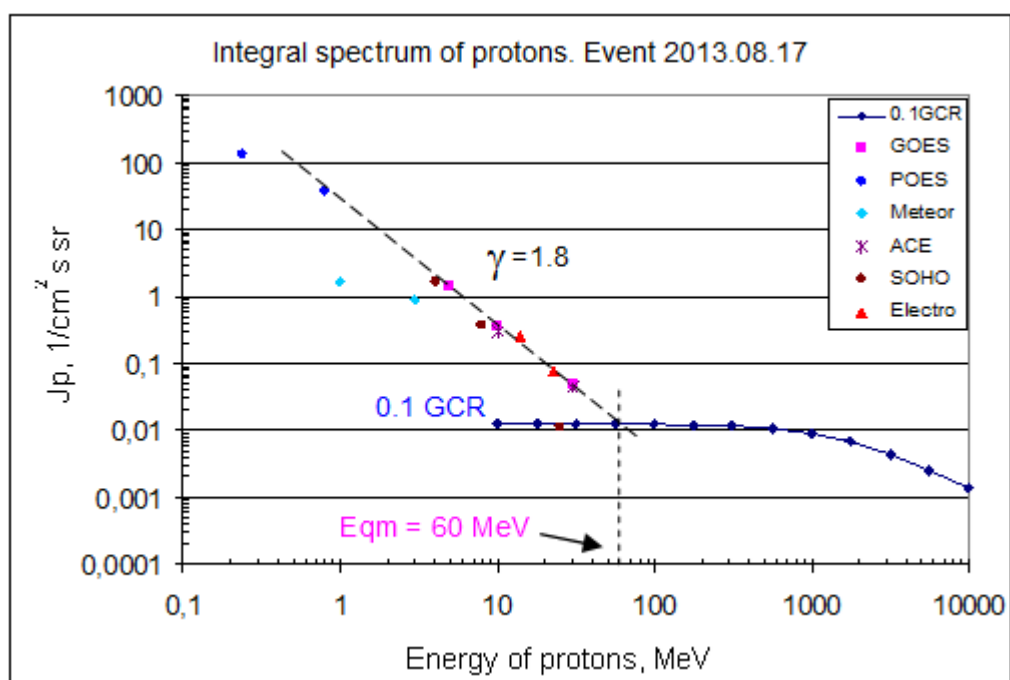
August 2013

Integral fluxes of protons for the event of 2013 August 17

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	21	18d06	1.4	2	0.2	
EPS	>10	20	18d05	0.3	2	0.12	
EPS	>30	20	18d05	0.052	1	0.07	
EPS	>50	20	-	-	-	0.06	
EPS	>60	20	-	-	-	0.05	
EPS	>100	20	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	18d02	18d11	130	1	90	
MEPED	>0.8	18d02	18d11	38	1	70	
MEPED	>2.5	-	-	-	-	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	23	18d10	1.6	1.5	2.4	
SCR	>3	23	18d10	0.9	1.5	2.3	
SCR	>10	-	-	-	-	1.6	
GALS-M	>15	-	-	-	-	1.1	
GALS-M	>25	-	-	-	-	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	20	18d04	0.3	1	1.1	
SIS	>30	21	18d04	0.05	1	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2013 August 17

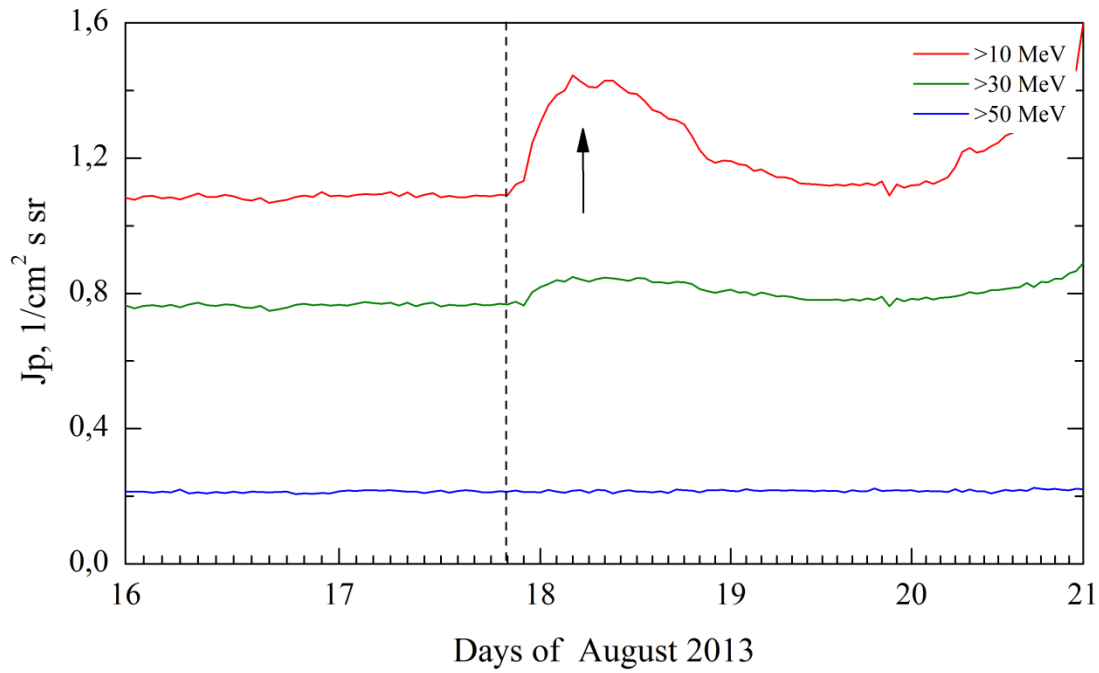
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	21	18d02	0.32	1.5	0.0006	
EPHIN	8 – 25	21	18d05	0.021	1.5	0.00001	
EPHIN	25 – 53	21	18d05	0.0004	1	0.00001	
Electro-1							
SCR-E	13.7–23	18d01	18d05	0.02	0.5	0.05	
SCR-E	23–42	18d01	18d04	0.004	0.5	0.02	
SCR-E	42–112	-	-	-	-	0.005	



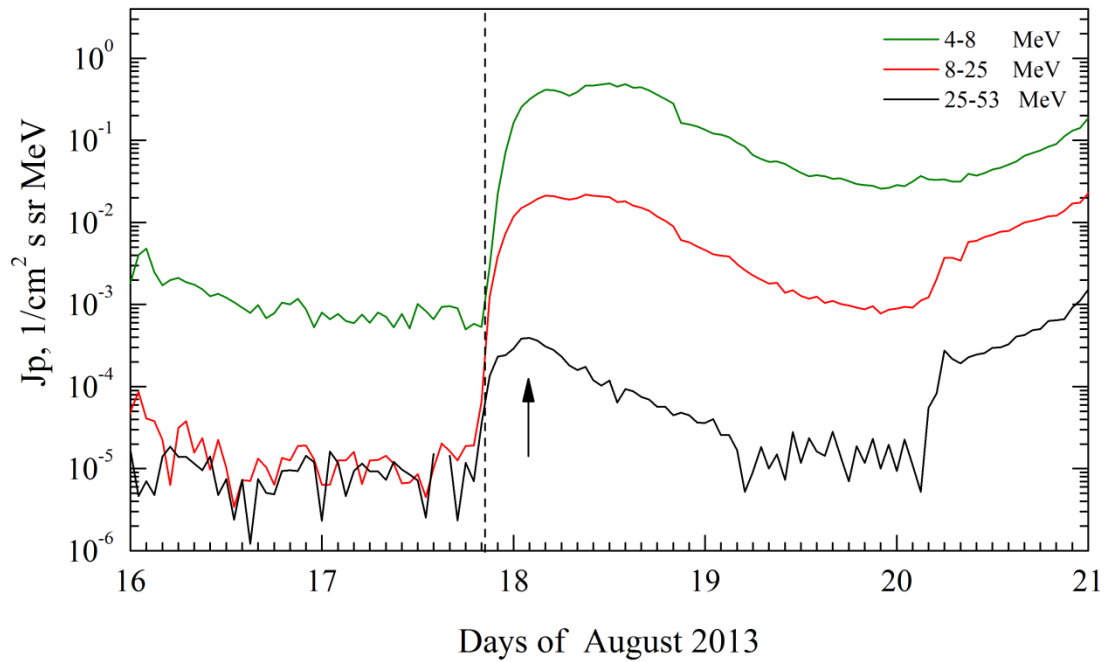
Time profiles of proton fluxes in the event 2013.08.17

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.08.17

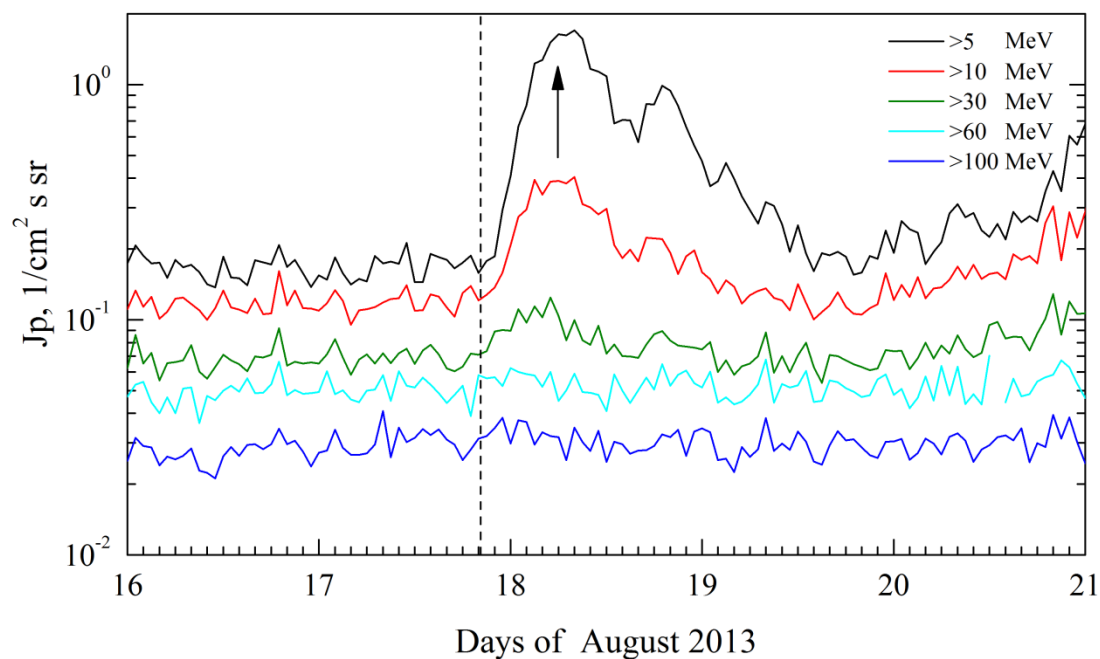


SOHO. Event 2013.08.17

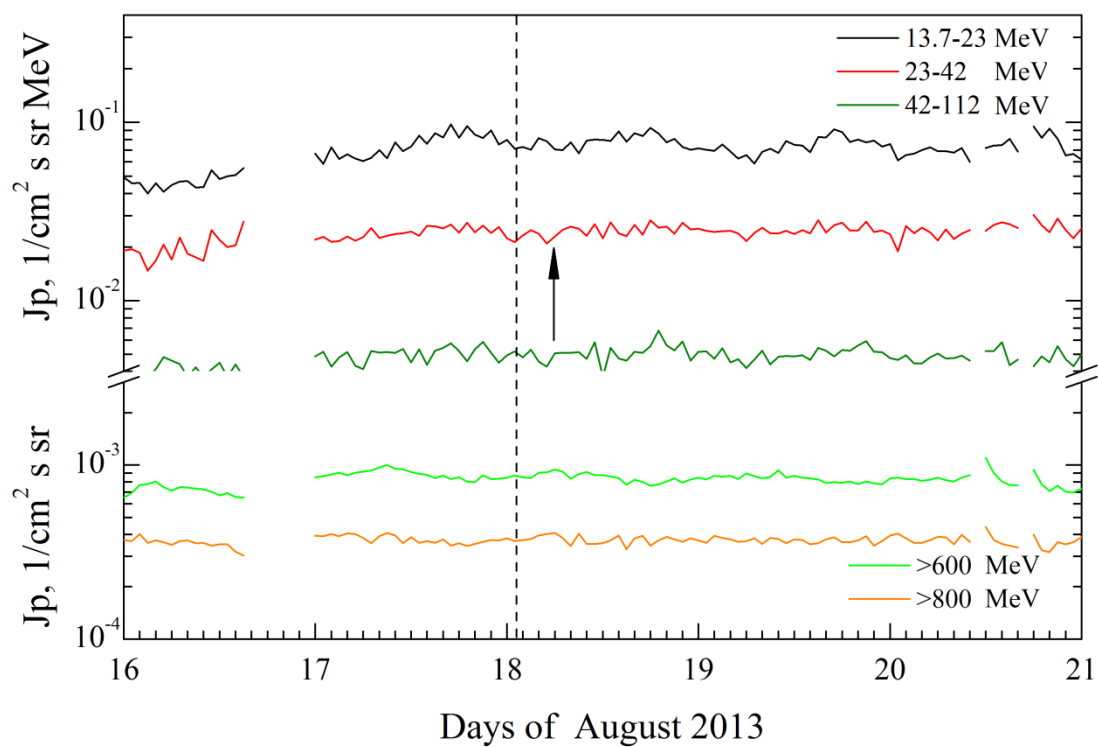


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.08.17

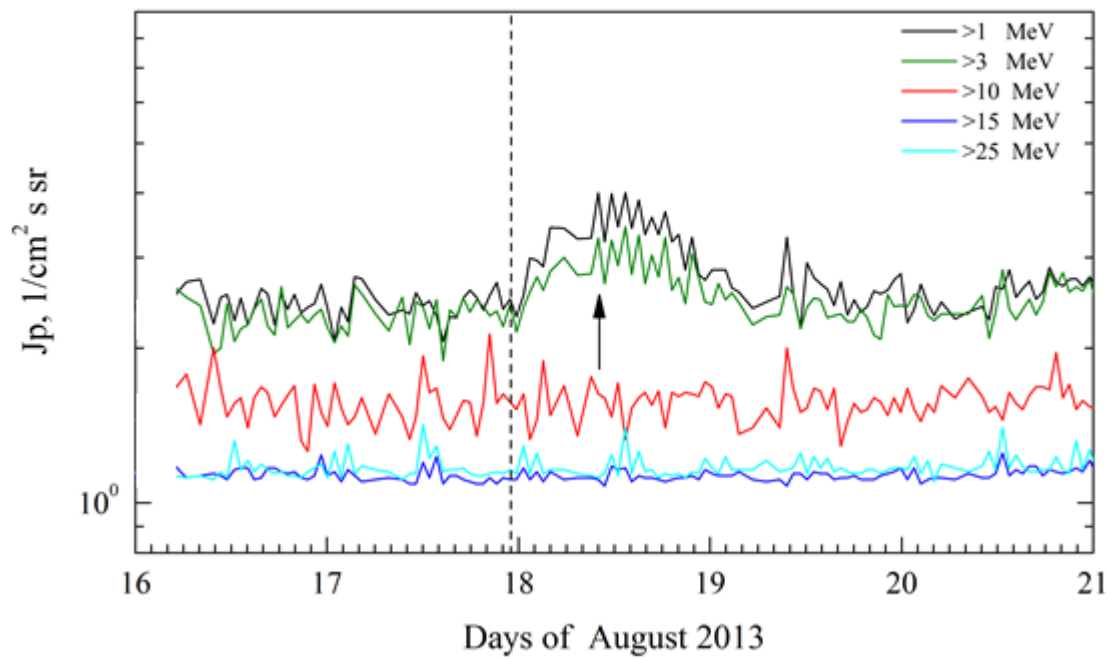


Electro. Event 2013.08.17

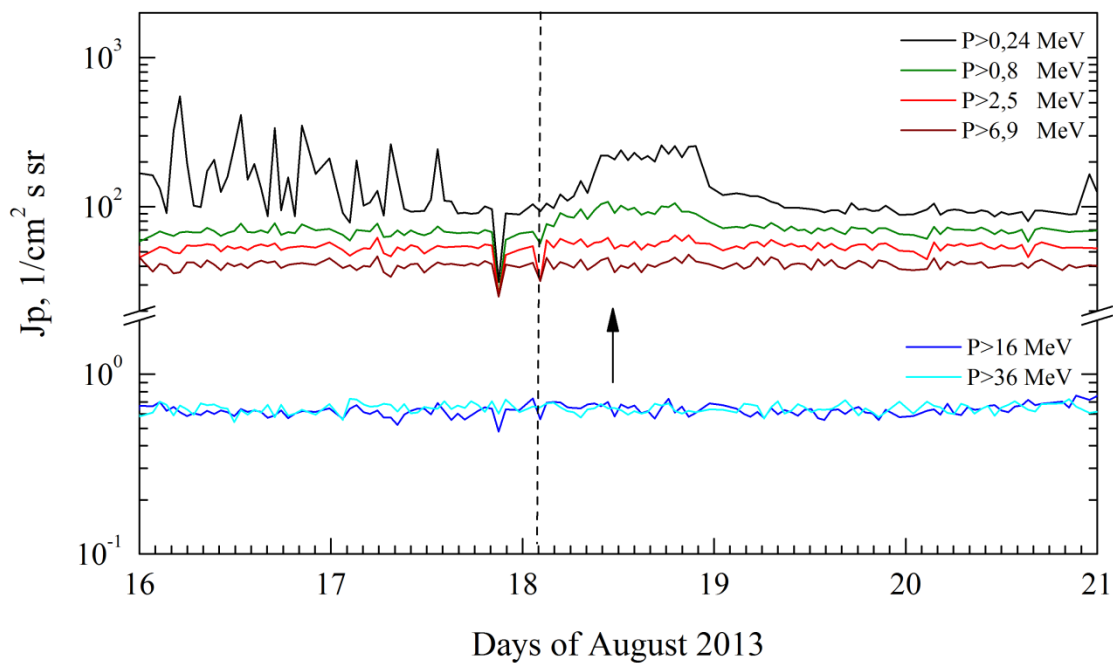


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.08.17



POES. Event 2013.08.17



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 August 17**

2013

August 17

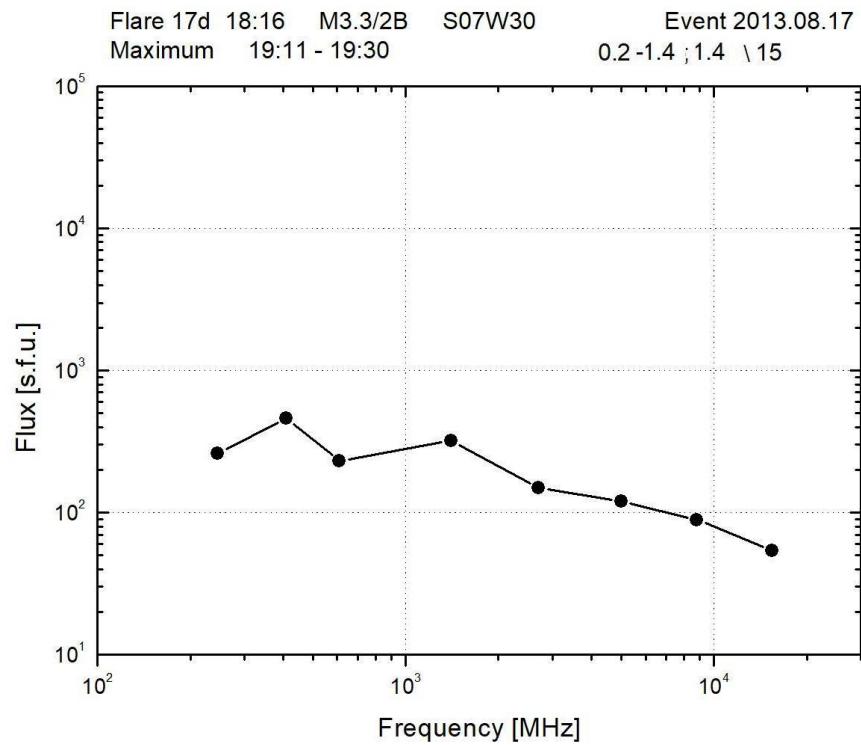
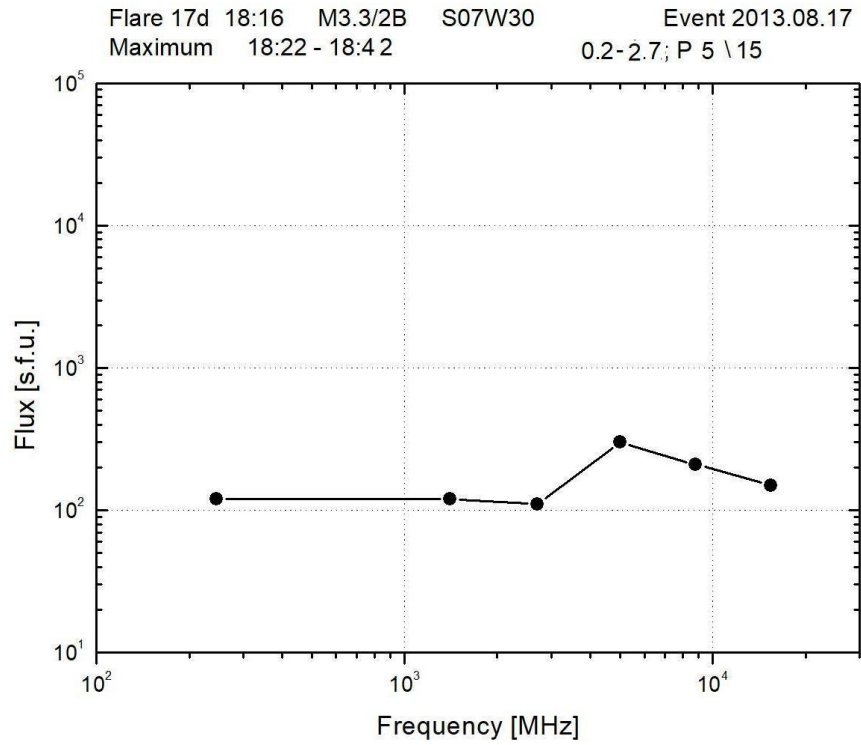
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AR 11818

To event 534

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1816	1824	2141	S07W30	2B	YSR
1 – 12	keV	1816	1824	1835		M3.3	0.021
1 – 12	keV	1849	1933	1954		M1.4	0.046
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1938:48	1938:48	1952:40	2327	202999	FERMI
6-12	keV	2026:20	2026:30	2027:00	21	4603	HESSI
6-12	keV	2140:32	2141:14	2144:52	288	373272	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1821	1822	1823	P5 \ 15	2.17	
8.8	GHz	1821	1822	1824		2.32	
5	GHz	1821	1822	1824		2.48	
2.7	GHz	1821	1822	1823	0.2 - 2.7	2.04	
1.4	GHz	1823	1823	1823		2.08	
245	MHz	1842	1842	1842		2.08	
15.4	GHz	1915	1915	1929	1.4 \ 15	1.73	
8.8	GHz	1908	1916	1937		1.95	
5	GHz	1908	1911	1932		2.08	
2.7	GHz	1908	1915	1933		2.17	
1.4	GHz	1909	1930	1936	0.2 - 1.4	2.50	
610	MHz	1853	1930	1935		2.36	
410	MHz	1852	1915	1934		2.66	
245	MHz	1850	1914	1932		2.41	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-55	1856		1902	1399	2	
DS IV	25-180	1904		1928		2	
DS IV	25-180	1909		1941		1	
DH II	18-0.15	2025		18/0305			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1912	1202	1.7	360°	274°	SOHO

Radio bursts frequency spectrum



Proton Active Region:

AR1-1818 (S07L214, CMP15, 5.08.2013,
Sp=340 msh; DKI; BGD; R)
XRI=0.47 $M_2^{3.3} + C_{12}$ $2_1 + S_{23}$
PFR 17.08 $M_2^{3.3;1.4}$

Particle event: To($E_p > 10$ MeV) – 20d16^h

Tmax ($E_p > 10$ MeV) – 21d14^h, Jmax ($E_p > 10$ MeV) – 1 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 2.15$

Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

Sources: ☐ solar flare 20d04^h54^m, (C1.3;C1.1)*, S18W87, AR11817, 1d behind W_L

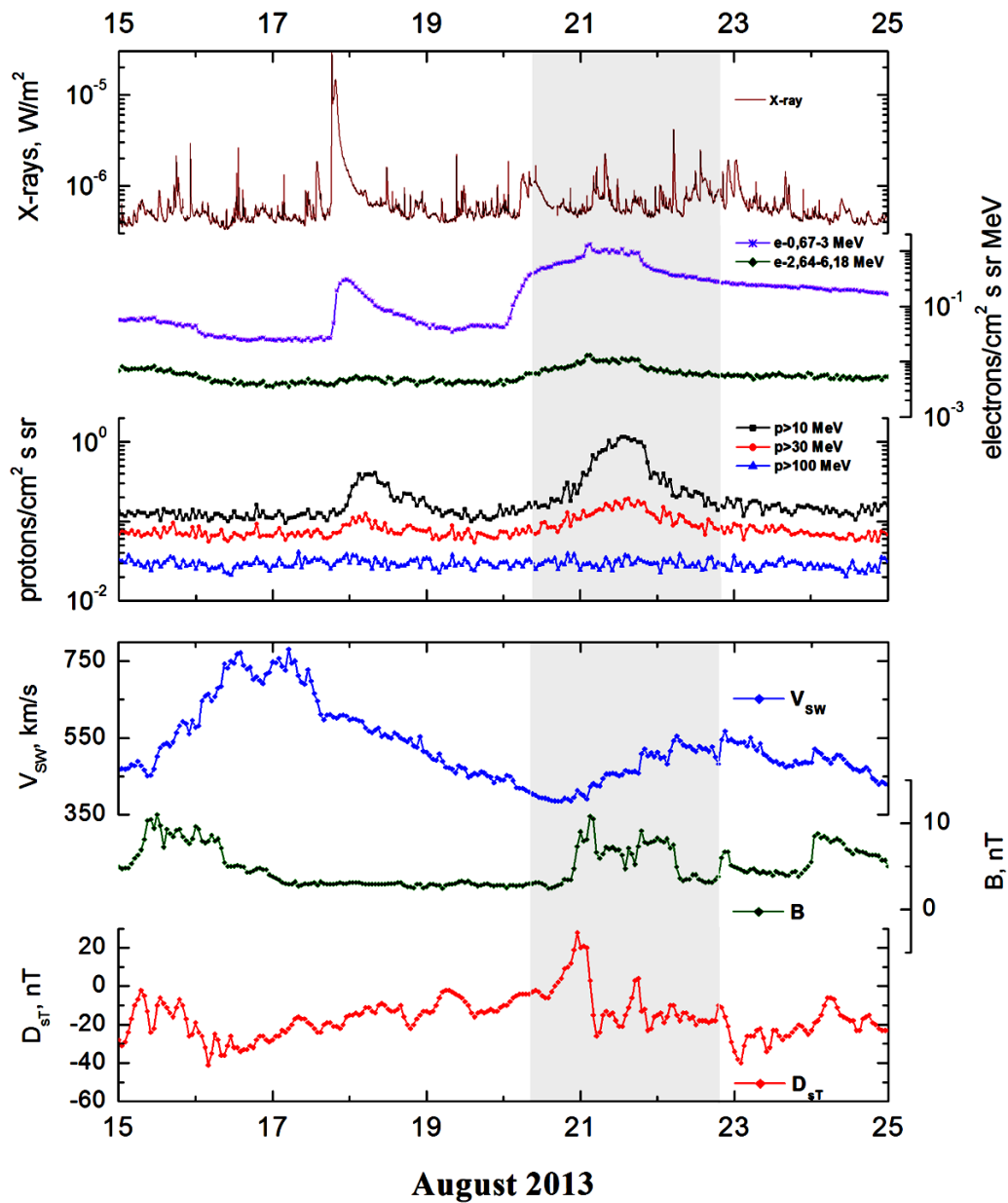
Main X-ray burst 1-8 Å: onset – 20d04^h54^m, max – 20d06^h08^m, $\Phi = 0.0055$ J/m²

CME: 20d08^h12^m, $V = 784$ km/s, $\Delta\phi = 360^\circ$, $dA = 210^\circ$

▲ SC 20d22^h29^m; ▲ SC 22d19^h26^m

* Large flare with double X-ray burst behind W_L .

Particle fluxes and associated phenomena

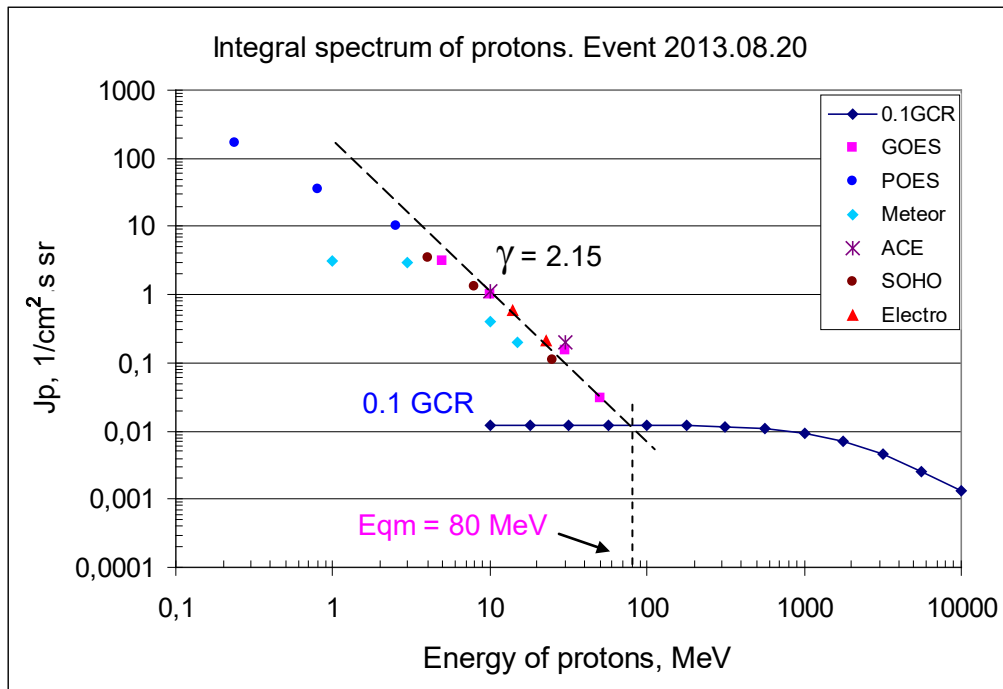


Integral fluxes of protons for the event of 2013 August 20

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	17	21d14	3.2	2	0.2	
EPS	>10	17	21d14	1	2	0.12	
EPS	>30	17	21d15	0.15	2	0.07	
EPS	>50	17	21d15	0.03	1	0.06	
EPS	>60	17	-	-	-	0.05	
EPS	>100	17	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	21d02	21d15	170	1	90	
MEPED	>0.8	21d02	21d15	35	1	70	
MEPED	>2.5	21d02	21d15	10	1	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	21d00	21d12	3.14	1.5	2.4	
SCR	>3	21d00	21d12	3.0	1.5	2.3	
SCR	>10	21d09	21d16	0.4	0.5	1.6	
GALS-M	>15	21d09	21d15	0.2	0.5	1.2	
GALS-M	>25	-	-	-	-	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	5	21d14	1.1	2	1.1	
SIS	>30	-	21d14	0.2	2	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2013 August 20

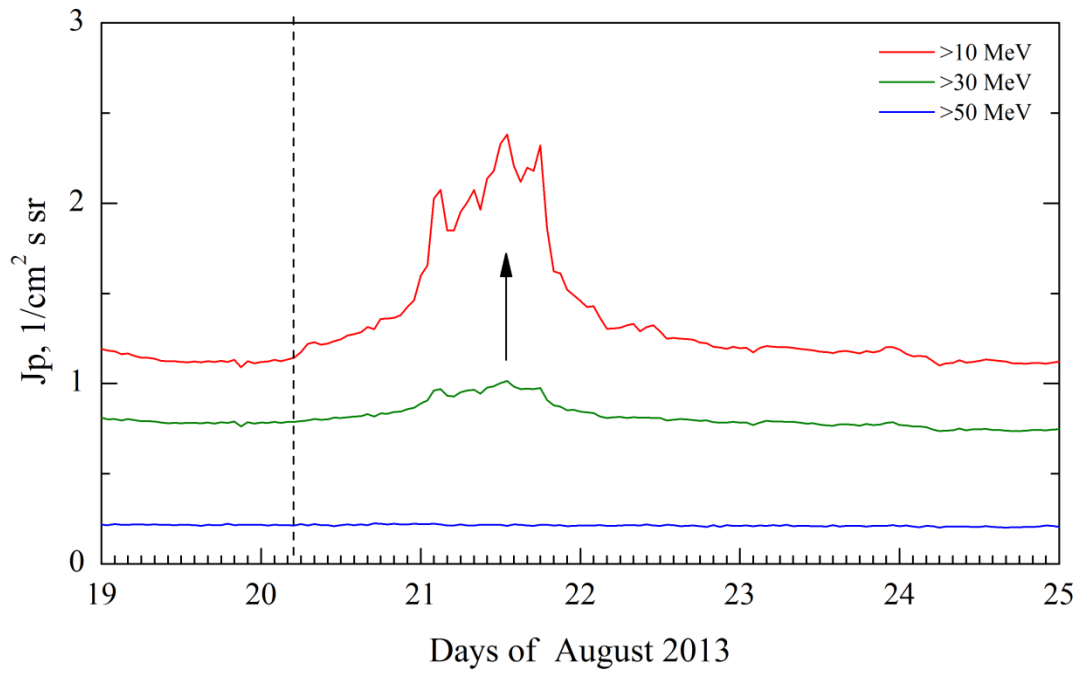
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	05	21d13	0.54	2	0.04	
EPHIN	8 – 25	05	21d13	0.07	2	0.001	
EPHIN	25 – 53	04	21d13	0.004	2	0.00001	
Electro-1							
SCR-E	13.7–23	23	21d16	0.04	1	0.07	
SCR-E	23–42	23	21d16	0.011	1	0.02	
SCR-E	42–112	-	-	-	-	0.005	



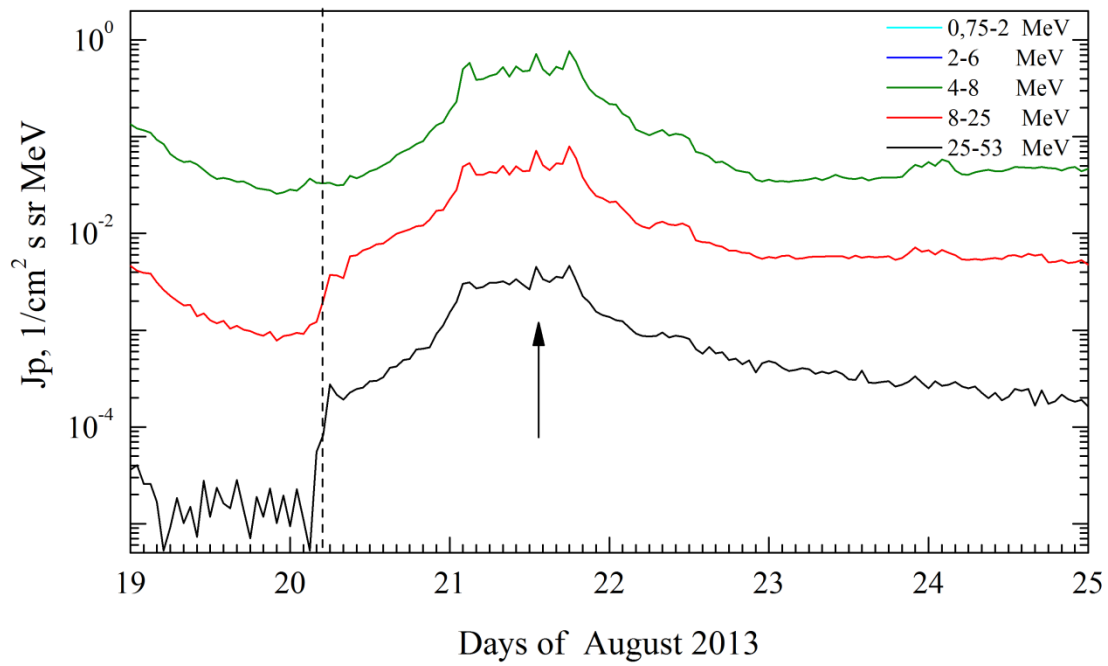
Time profiles of proton fluxes in the event 2013.08.20

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.08.20

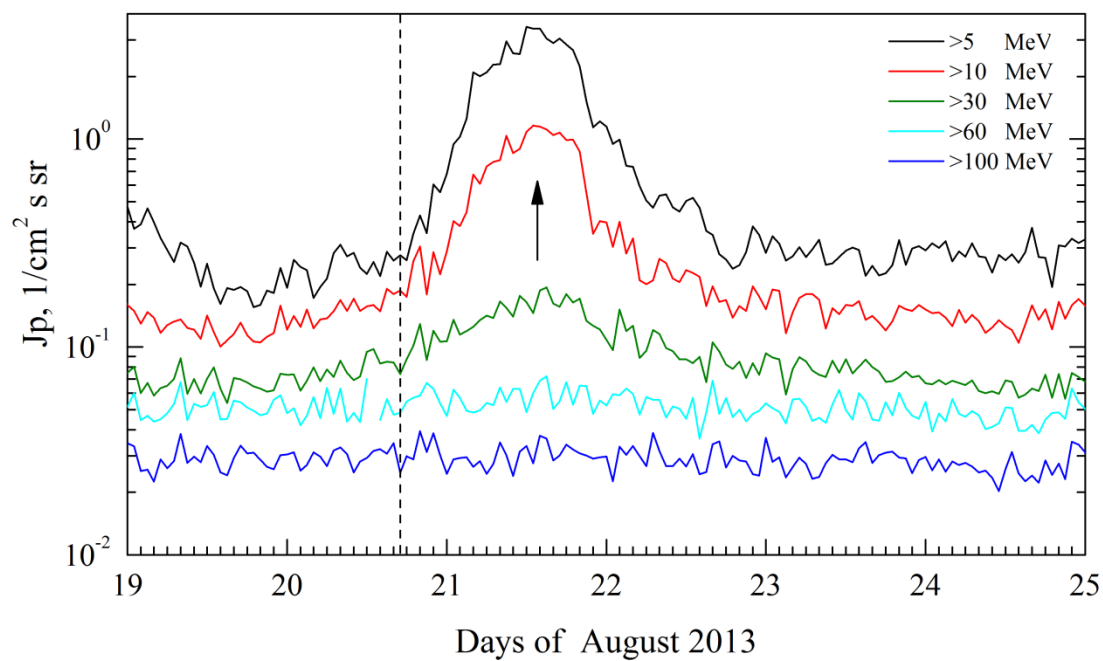


SOHO. Event 2013.08.20

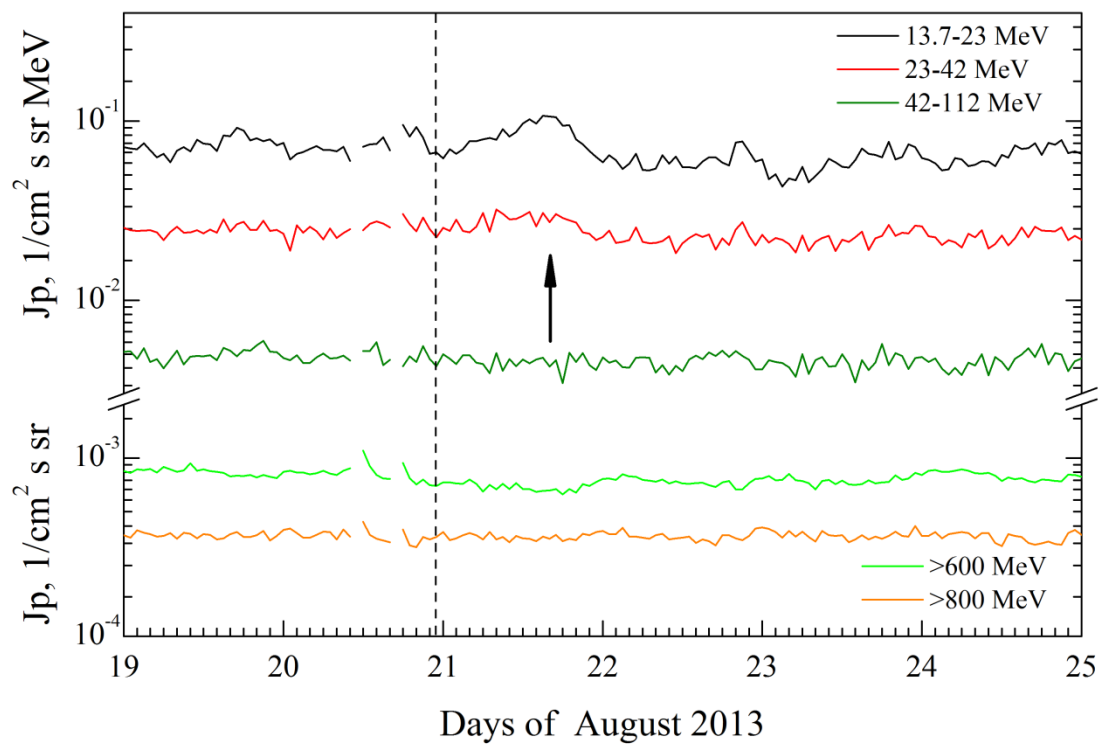


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.08.20

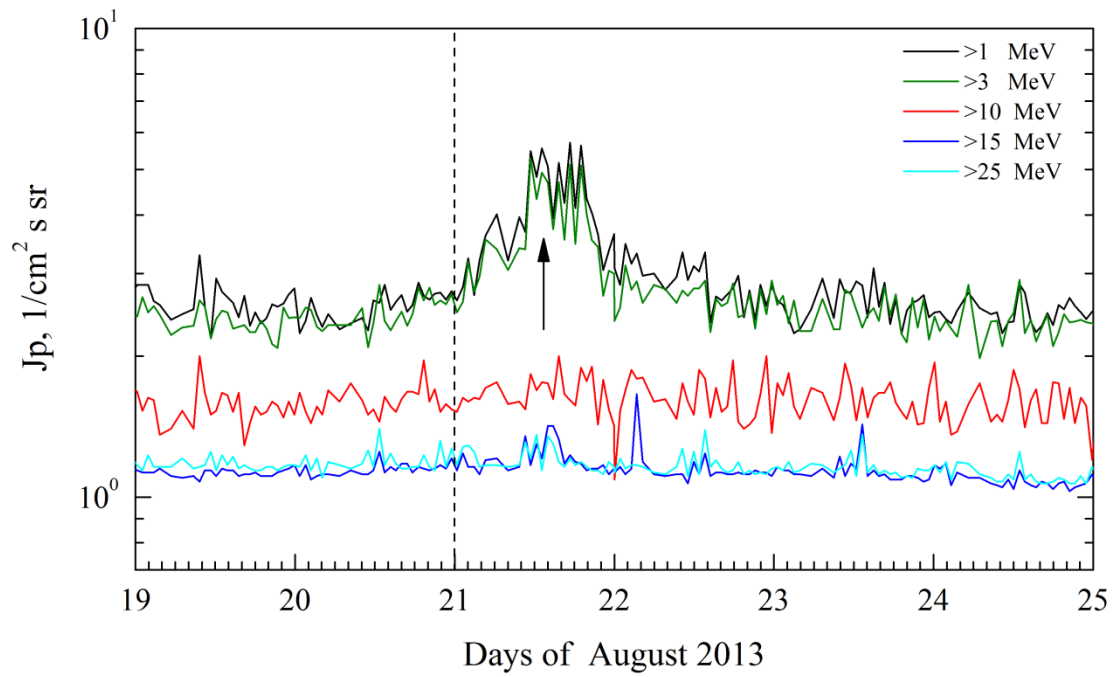


Electro. Event 2013.08.20

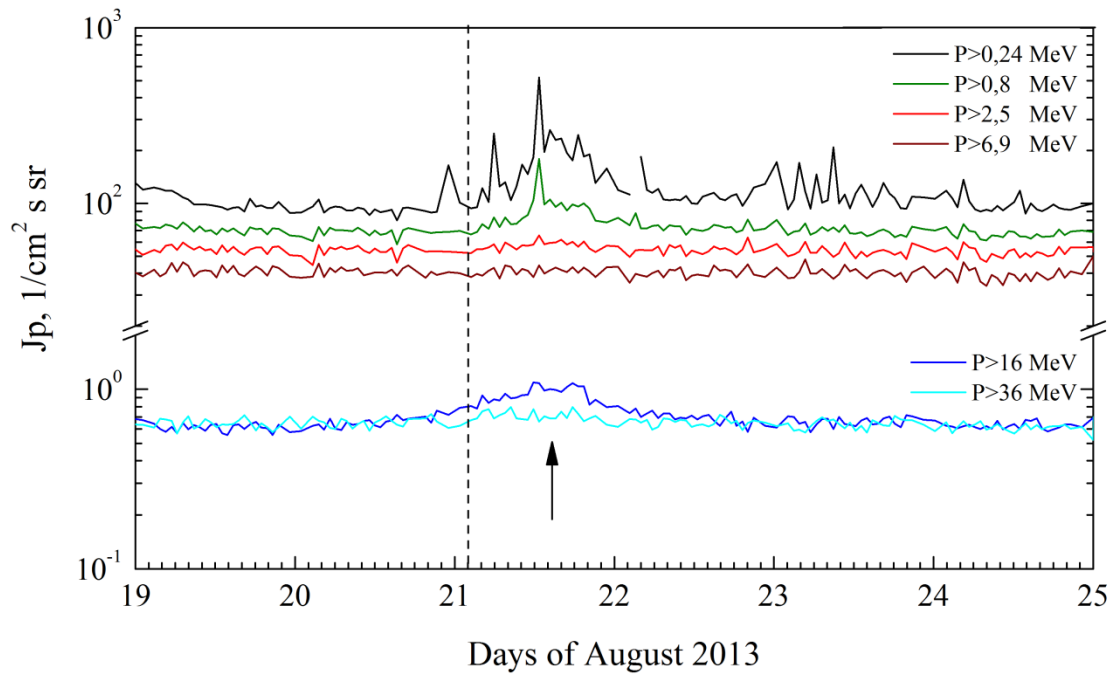


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.08.20



POES. Event 2013.08.20



**Electromagnetic and other phenomena that are sources and/or accompanying for the event
of 2013 August 20**

2013 August 20 ☐ AR 11817 To event 535

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å		No flare event on visible disk					
LPS	6563 Å	0619		1000	S18W90	0.1	
1 – 12	keV	0454	0608	0623	S18W87	C1.3*	0.0055
1 – 12	keV	0458	0530	0620		C1.1*	
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	0532:32	0534:46	0537:32	160	246720	HESSI
6-12	keV	0537:32	0538:26	0545:12	144	344448	HESSI
6-12	keV	0545:12	0557:14	0602:08	160	728928	HESSI
6-12	keV	0602:08	0605:14	0619:56	176	662520	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS III	059-180	0551		0551		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0812	784	- 0.6	360°	210°	SOHO

*Large flare with double X-ray burst behind W_L.

Proton Active Region:

AR11817(S21L240, CMP 13,7.08.2013,

Sp=260 msh; EKC; BGD; R)

XRI=0.15 M₁^{1.5}+C₁₅ 1₁+S₁₆

PFR1 12.08 M₁^{1.5}

PFR2 20.08 1d behind W-limb

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Rodríguez-García L., R. Gómez-Herrero, I. Zouganelis et al., [2021](#).

Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).

Particle event: To($E_p > 10$ MeV) – 30d00^h

Tmax($E_p > 10$ MeV) – 30d17^h, Jmax($E_p > 10$ MeV) – 102/cm²·s·sr

Duration of the event – 6 days, power-law index: $\gamma = 3.0$

Quasimaximal energy of protons in the event – $E_{qm} = 220$ MeV

Sources: • DSF 29d21^h45^m N15W40; extent of 35°

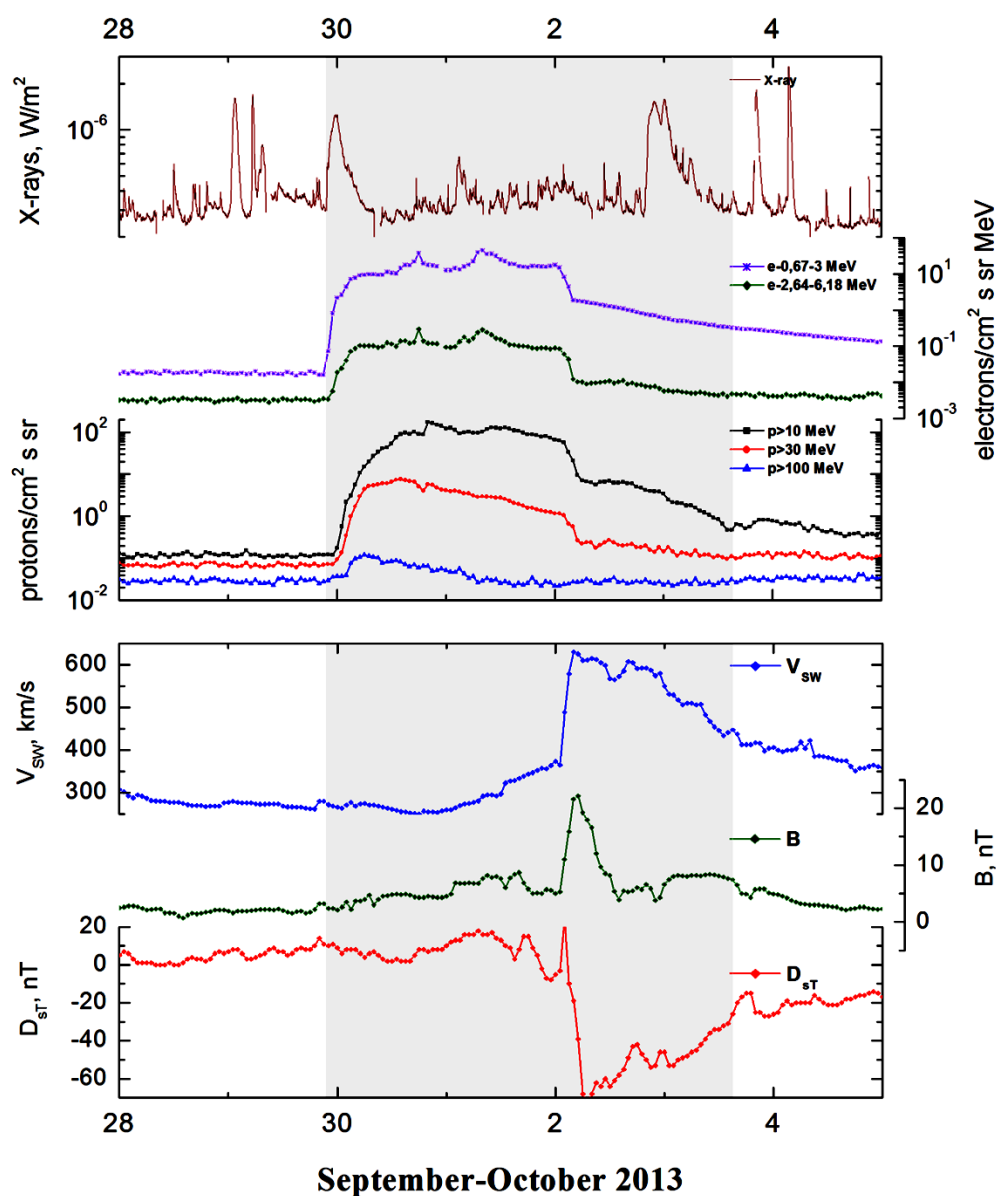
• solar flare 29d21^h43^m, C1.2/, N15W33, DSF

Main burst X-ray 1–8 Å: onset – 29d21^h43^m, max – 29d23^h39^m, $\Phi = 0.011$ J/m²

CME: 29d22^h12^m, $V = 1179$ km/s, $\Delta\phi = 360^\circ$, $dA = 343^\circ$

▲ SC 02d01^h55^m

Particle fluxes and associated phenomena

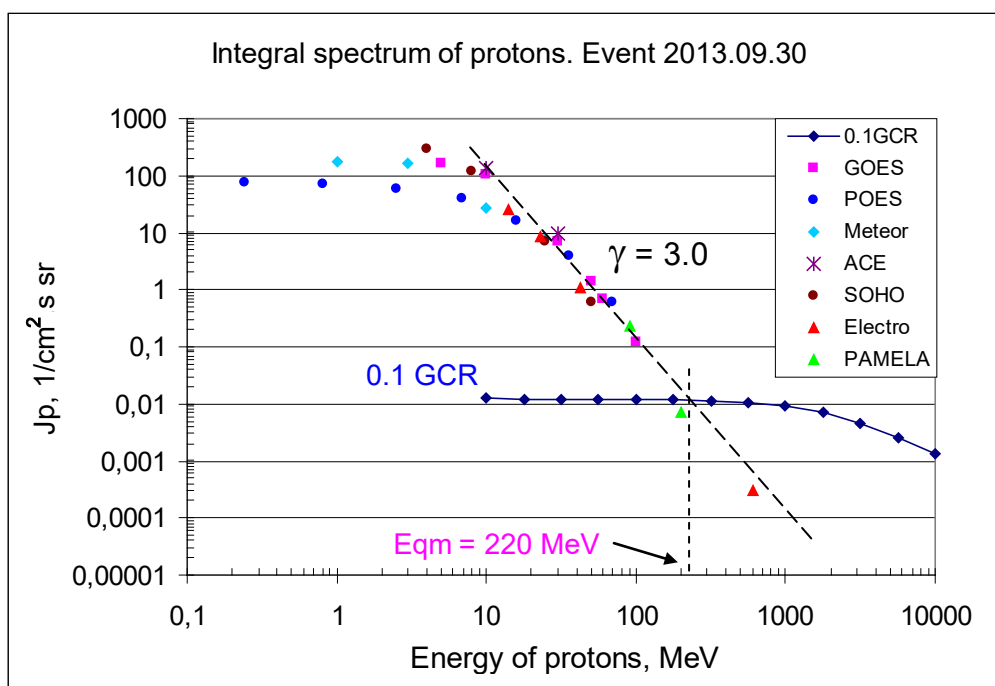


Integral fluxes of protons for the event of 2013 September 30

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	0	18	165	6	0.2	
EPS	>10	0	17	102	6	0.12	
EPS	>30	0	15	7.1	4	0.07	
EPS	>50	0	8	1.4	2	0.06	
EPS	>60	0	7	0.7	2	0.05	
EPS	>100	0	6	0.12	1.5	0.03	
Electro-1							
GALS-E	>600	0	8	0.0003	0.5	0.0007	
POES							
MEPED	>0.24	2	8	75	5	90	
MEPED	>0.8	2	8	71	5	70	
MEPED	>2.5	2	8	58	4	50	
MEPED	>6.9	2	8	39.2	3	40	
MEPED	>16	2	8	16.7	3	0.7	
MEPED	>36	2	8	3.85	2	0.7	
MEPED	>70	2	8	0.6	1	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	1	13	179	6	2.5	
SCR	>3	1	13	170	6	1.9	
SCR	>10	1	13	28	2.5	1.9	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	1	13	8	2.5	1.9	
GALS-M	>600	-	-	-	-	0.01	
ACE							
SIS	>10	0	12	135	4	1.1	
SIS	>30	0	12	10	2	0.8	
PAMELA							
TRACKER	>90	2	6	0.23	<2	-	
TRACKER	>200	2	6	0.0073	<2	-	
SOHO							
EPHIN	>50	0	5	0.6	2	0.2	

Differential fluxes of protons for the event of 2013 September 30

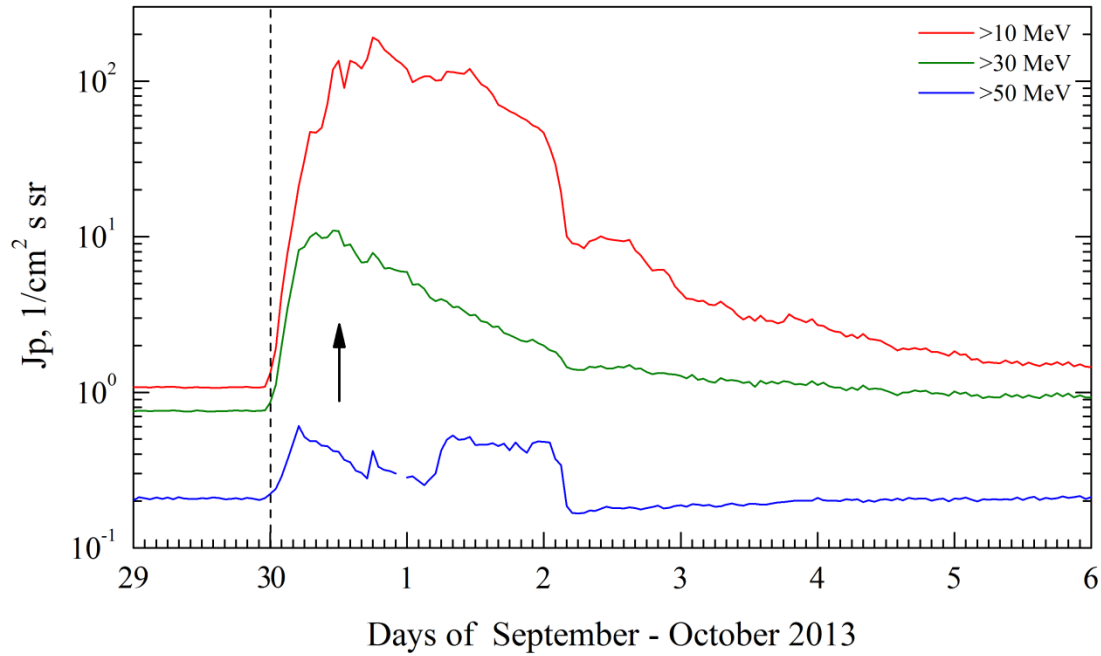
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	00	18	43	6	0.0005	
EPHIN	8 – 25	00	18	6.7	6	0.00003	
EPHIN	25 – 53	00	11	0.22	4.5	0.00003	
Electro-1							
SCR-E	13.7–23	0	8	1.85	3	0.05	
SCR-E	23–42	0	8	0.38	3	0.02	
SCR-E	42–112	0	8	0.015	2	0.005	



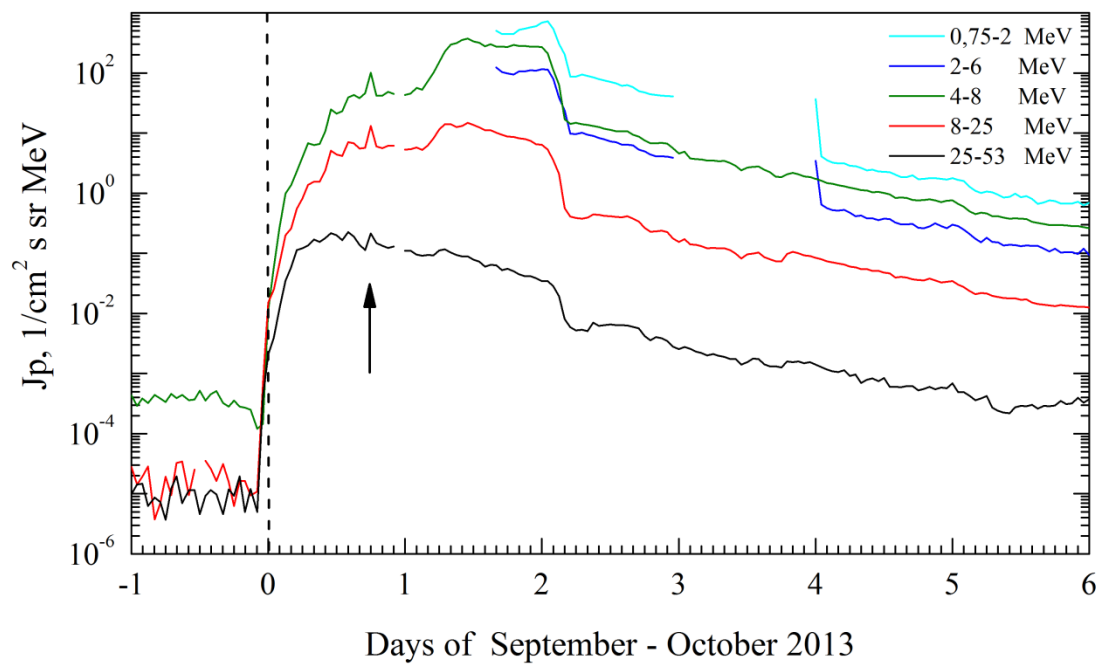
Time profiles of proton fluxes in the event 2013.09.30

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.09.30

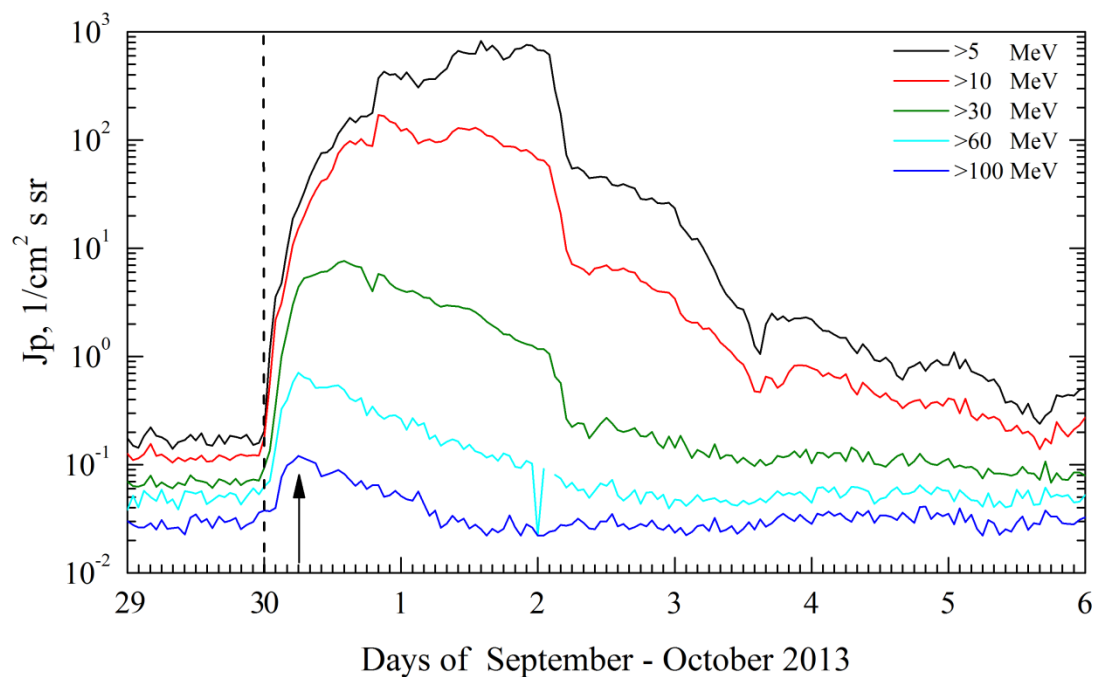


SOHO. Event 2013.09.30

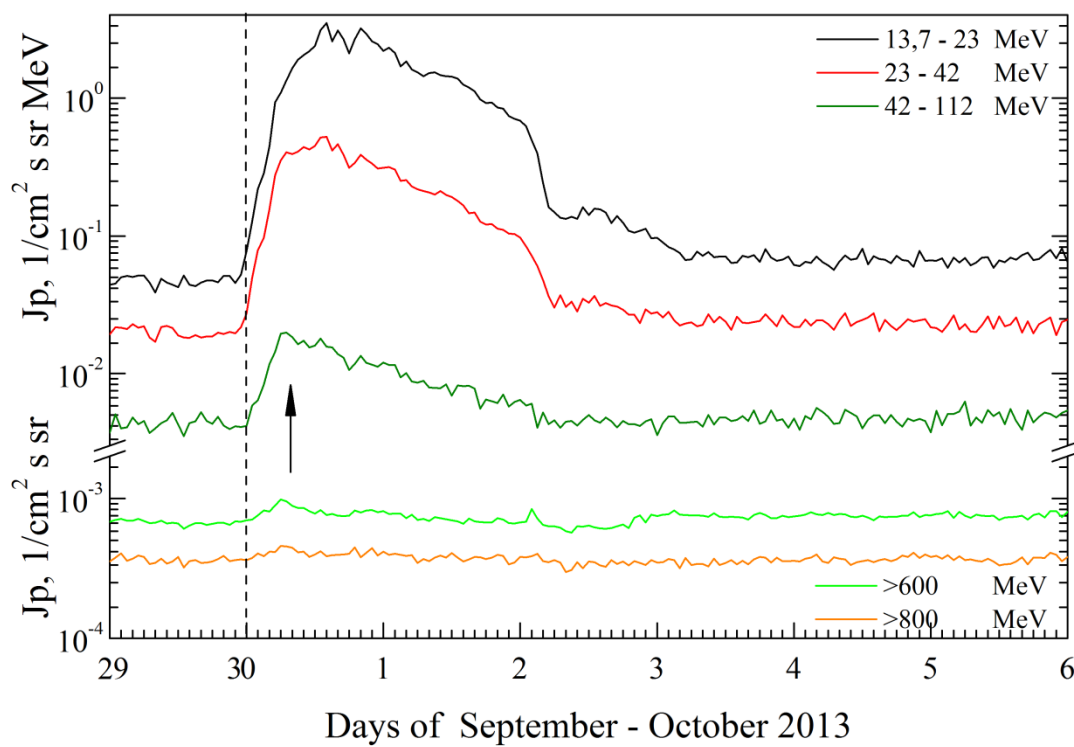


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

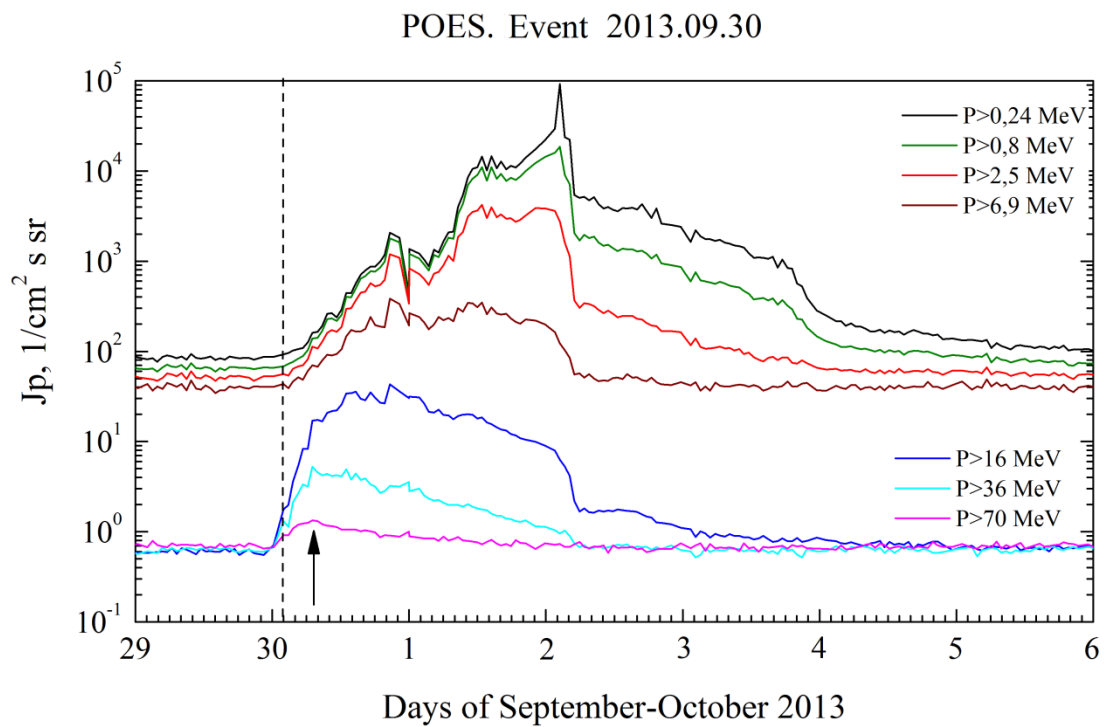
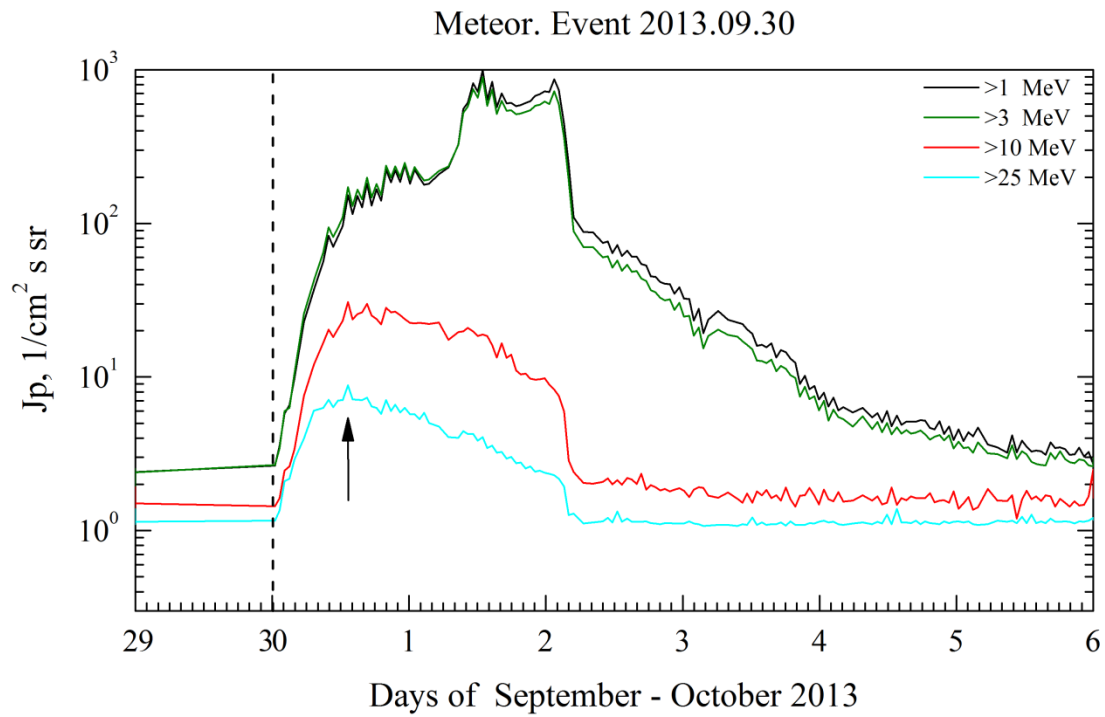
GOES. Event 2013.09.30



Electro. Event 2013.09.30



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



Electromagnetic and other phenomena that are sources and/or accompanying for the event of 2013 September 30

2013

September 29

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DSF

To event 536

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare event on visible solar disc					
303 Å	DSF	2145			N15W40	35°	
1 – 12	keV	2143	2339	0103	N10W33	C1.2	0.011
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	2207	2207	2207		2.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	0952		1009	406	1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2212	1179	- 5.3	360°	343°	SOHO

References:

- Гецелев И.В., Подзолко М.В., Охлопков В.П., [2013](#).
Григорьева И.Ю., Струминский А.Б., Шаховская А.Н., [2020](#).
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Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
Ameri D., E. Valtonen, [2019](#).
Cliver E.W., S.W. Kahler, M. Kazachenko, M. Shimojo, [2019](#).
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Particle event: To($E_p > 10$ MeV) – 28d06^h

Tmax₁($E_p > 10$ MeV) – 28d11^h, Jmax₁($E_p > 10$ MeV) – $2.3/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Tmax₂($E_p > 10$ MeV) – 29d02^h, Jmax₂($E_p > 10$ MeV) – $3.5/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 4 days, power-law index: $\gamma_1 = 2.35$, $\gamma_2 = 1.7$

Quasimaximal energy of protons in the event – Eqm₁ = 100 MeV

– Eqm₂ = 300 MeV

Sources: • solar flare 28d01^h41^m, X1.0/2N, N04W66, AR11875,

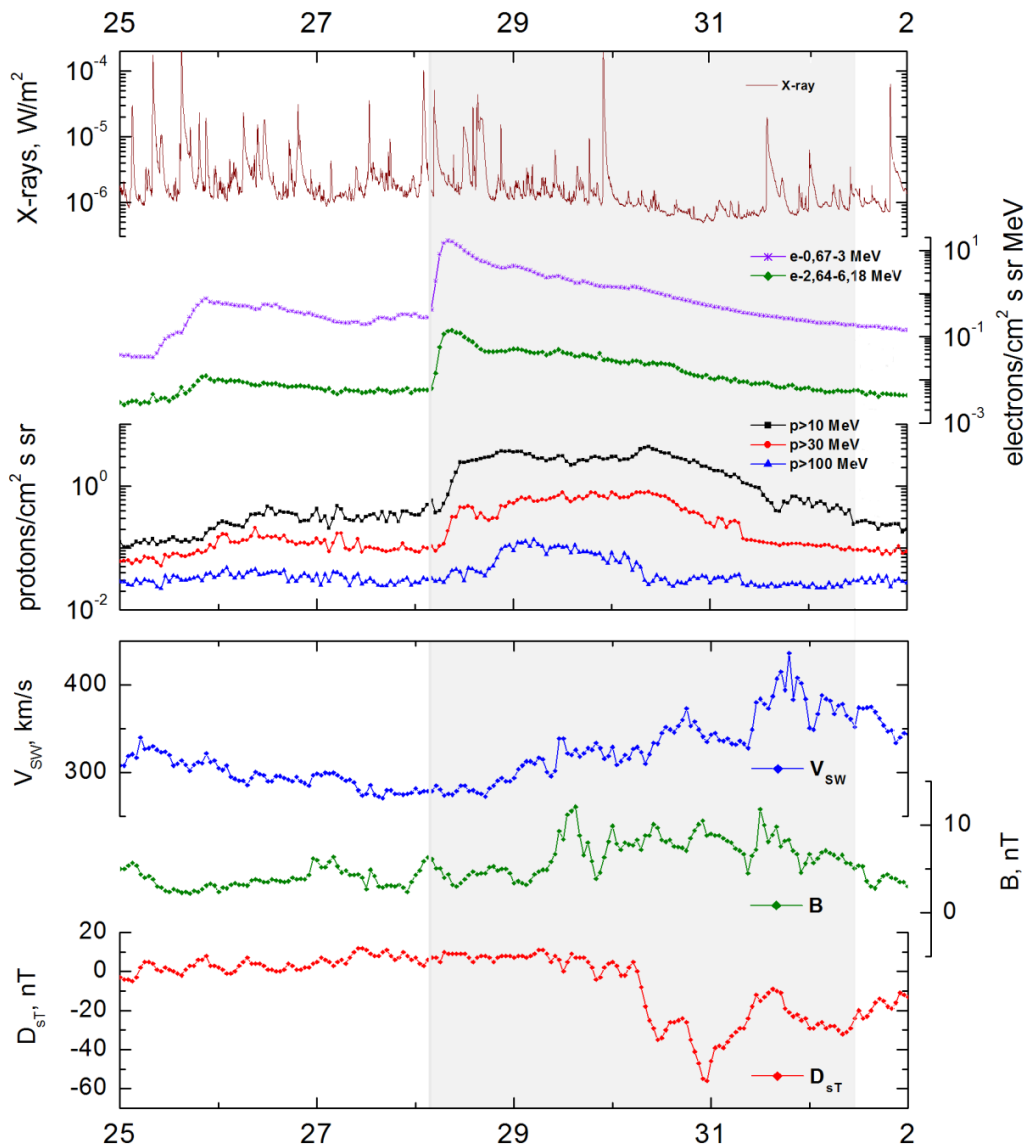
Ø solar flare 28d04^h32^m, M5.1/2B, N08W71, AR11875

Ø solar flare 28d14^h45^m, 1N/M2.7, M4.4, S06E28; AR11882

Main burst X-ray 1–8 Å: onset – 28d01^h41^m, max – 28d02^h03^m, $\Phi = 0.084 \text{ J/m}^2$

CME: 28d02^h24^m, V = 695 km/s, $\Delta\phi = 360^\circ$, dA = 296°

Particle fluxes and associated phenomena



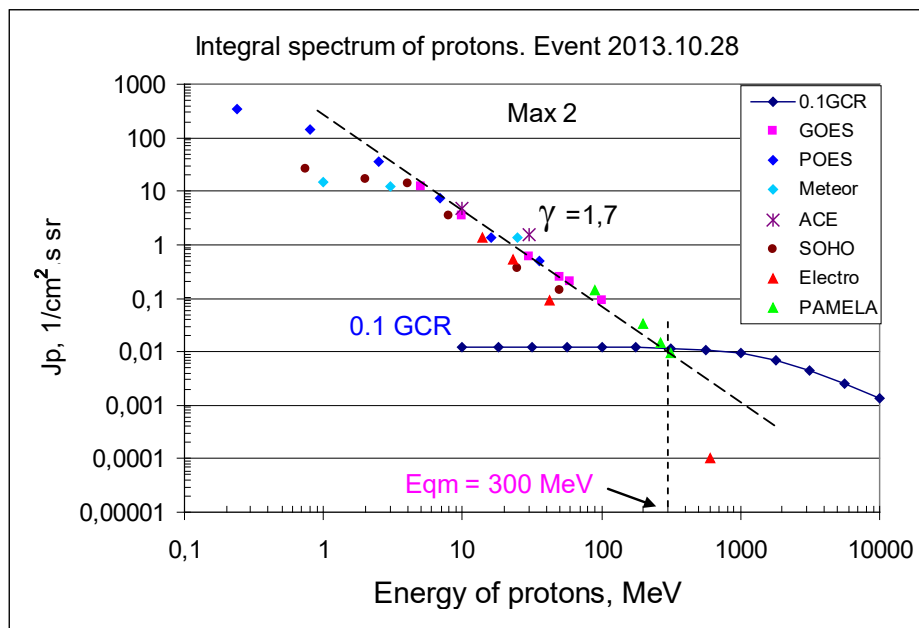
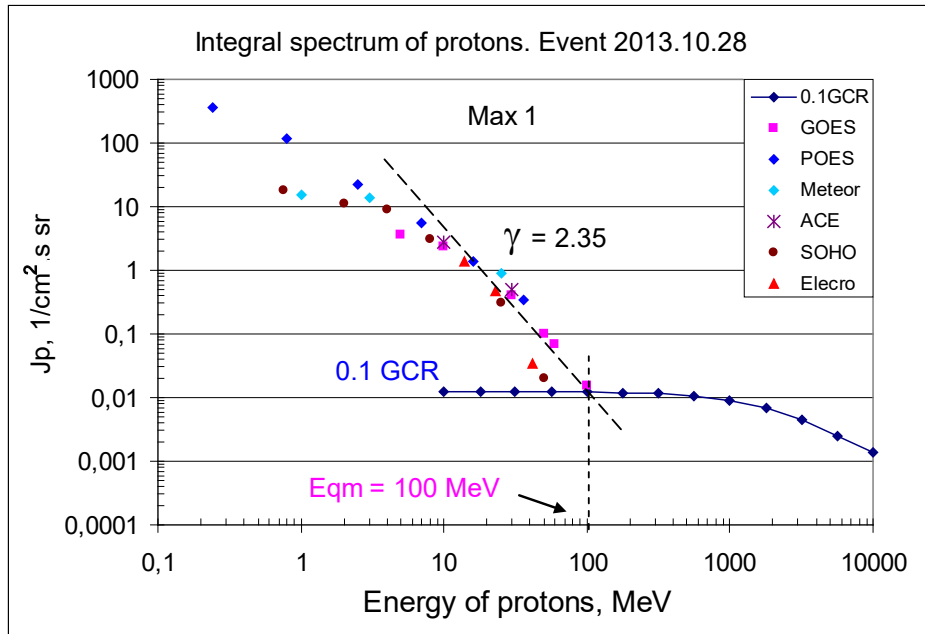
October - November 2013

Integral fluxes of protons for the event of 2013 October 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	6	11/29d02	3.7/12.2	4	0.2	
EPS	>10	6	11/29d02	2.3/3.5	4	0.12	
EPS	>30	6	11/29d02	0.4/0.6	3	0.07	
EPS	>50	6	11/29d02	0.1/0.25	3	0.06	
EPS	>60	6	10/29d02	0.07/0.2	3	0.05	
EPS	>100	6	10/29d02	0.015/0.09	2	0.03	
Electro-1							
GALS-E	>600	-	- /29d01	- /0.0001	1	0.0007	
GALS-E	>800	-	- /29d01	- /0.00003	1	0.0004	
GALS-E	>1100	-	-	-	-	0.00002	
POES							
MEPED	>0.24	5	12/29d03	360/345	4	90	
MEPED	>0.8	5	12/29d03	115/145	4	70	
MEPED	>2.5	5	12/29d03	22/36	4	50	
MEPED	>6.9	5	12/29d03	5.5/7.2	3	40	
MEPED	>16	5	12/29d03	1.4/1.4	3	0.7	
MEPED	>36	5	12/29d03	0.35/0.5	3	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	7	22/29d11	15.4/15	4	2.62	
SCR	>3	7	22/29d11	14/12.4	4	2.50	
SCR	>10	7	-	-	-	1.67	
GALS-M	>15	-	-	-	-	0.00	
GALS-M	>25	5	12/29d11	0.9/1.4	3	1.16	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	6	13/23	2.7/4.7	3	1.4	
SIS	>30	6	13/29d01	0.5/1.5	3	1	
PAMELA							
TRACKER	>90	18	- /17-29d08	- /0.14	>2		
TRACKER	>200	18	- /17-29d08	- /0.034	2		
TRACKER	>265	18	- /17-29d08	- /0.015	<2		
TRACKER	>312	18	- /17-29d08	- /0.0097	1		
SOHO							
EPHIN	>50	3	12/29d01	0.02/0.14	2	0.2	

Differential fluxes of protons for the event of 2013 October 28

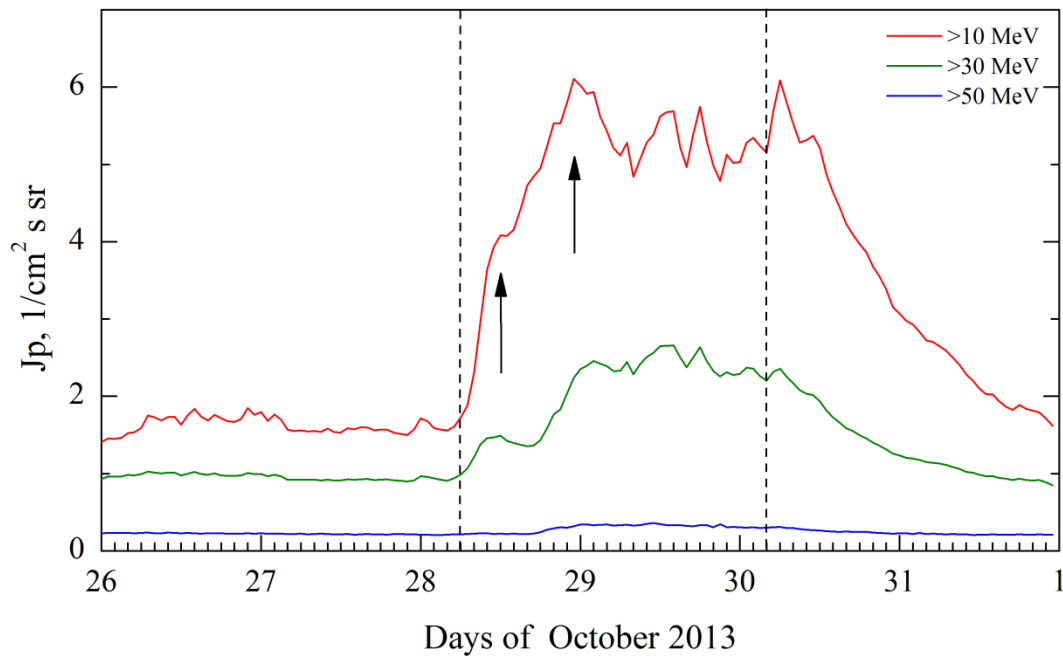
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	7	14/29d01	5.48/7.5	5	0.01	
LION	2 – 6	7	14/29d01	0.55/1.08	5	0.01	
EPHIN	4 – 8	7	14/29d01	1.55/2.65	4	0.01	
EPHIN	8 – 25	7	14/29d01	0.16/0.18	4	0.005	
EPHIN	25 – 53	5	13/29d01	0.01/0.008	4	0.006	
Electro-1							
SCR-E	13.7–23	6	13/29d02	0.1/0.09	3	0.06	
SCR-E	23–42	6	13/29d02	0.023/0.023	3	0.025	
SCR-E	42–112	8	13/29d02	0.0005/0.0013	2	0.005	



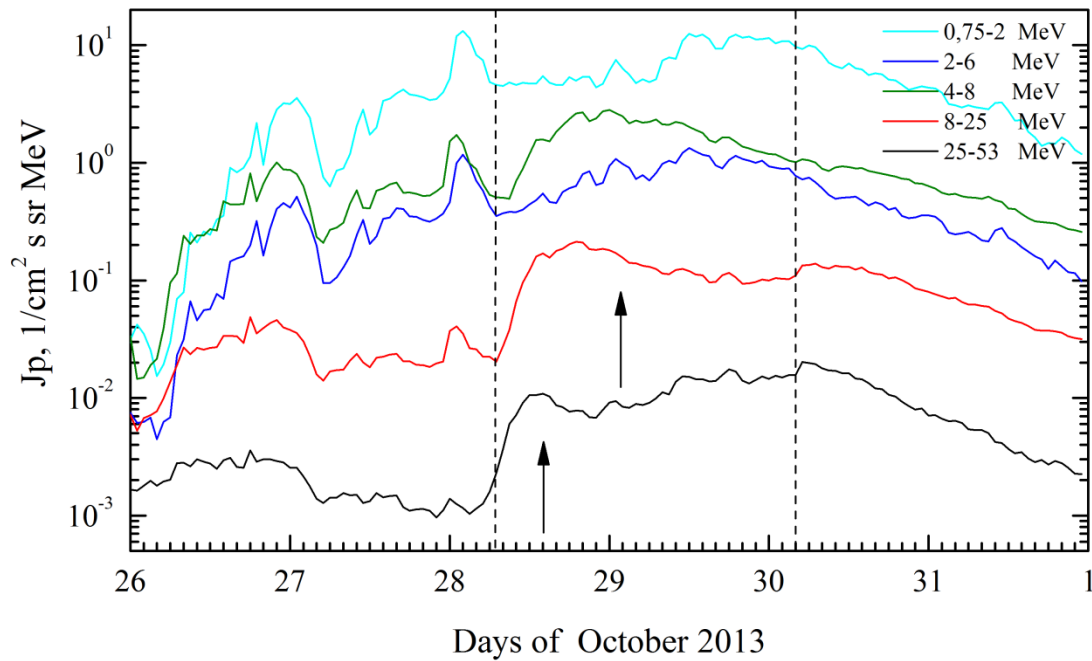
Time profiles of proton fluxes in the event 2013.10.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.10.28

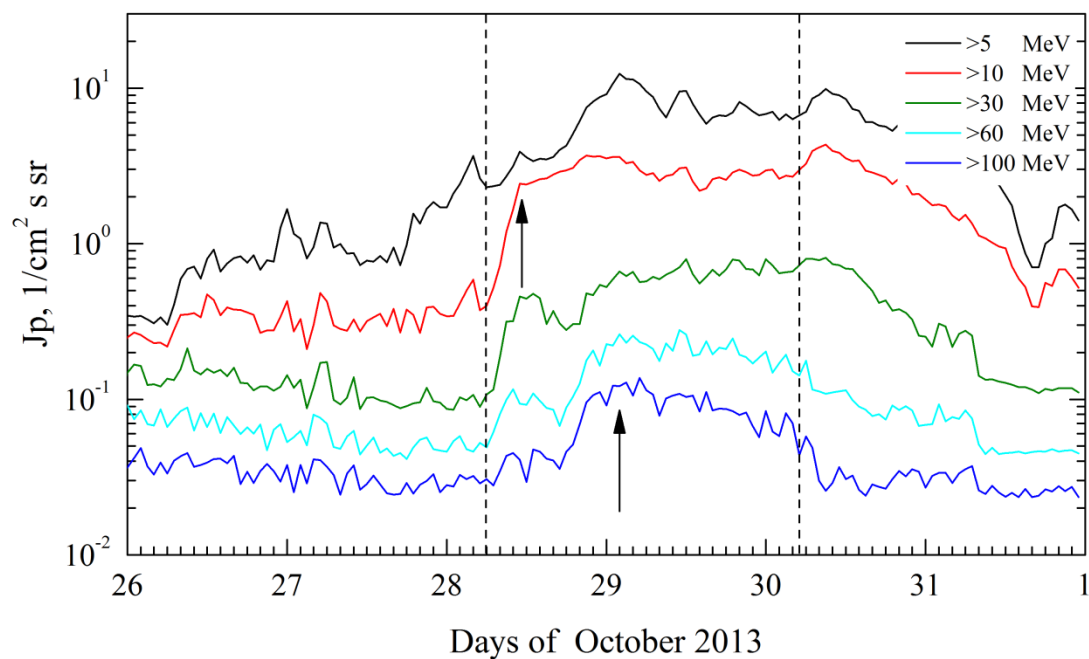


SOHO. Event 2013.10.28

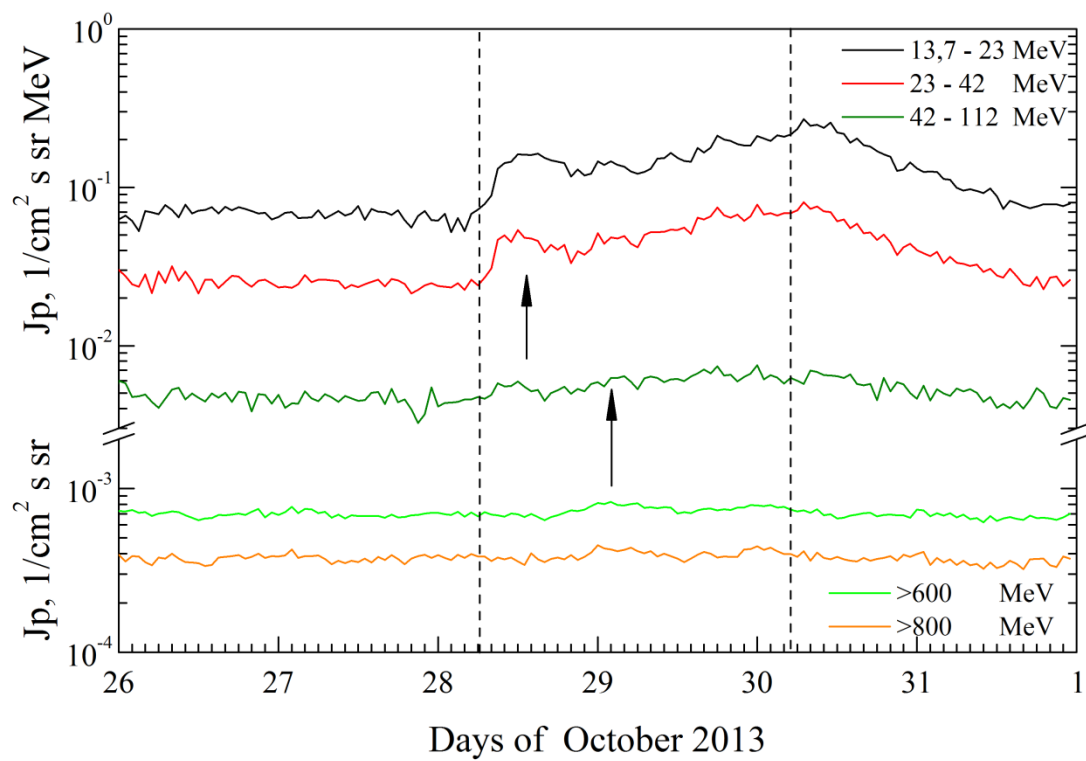


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.10.28

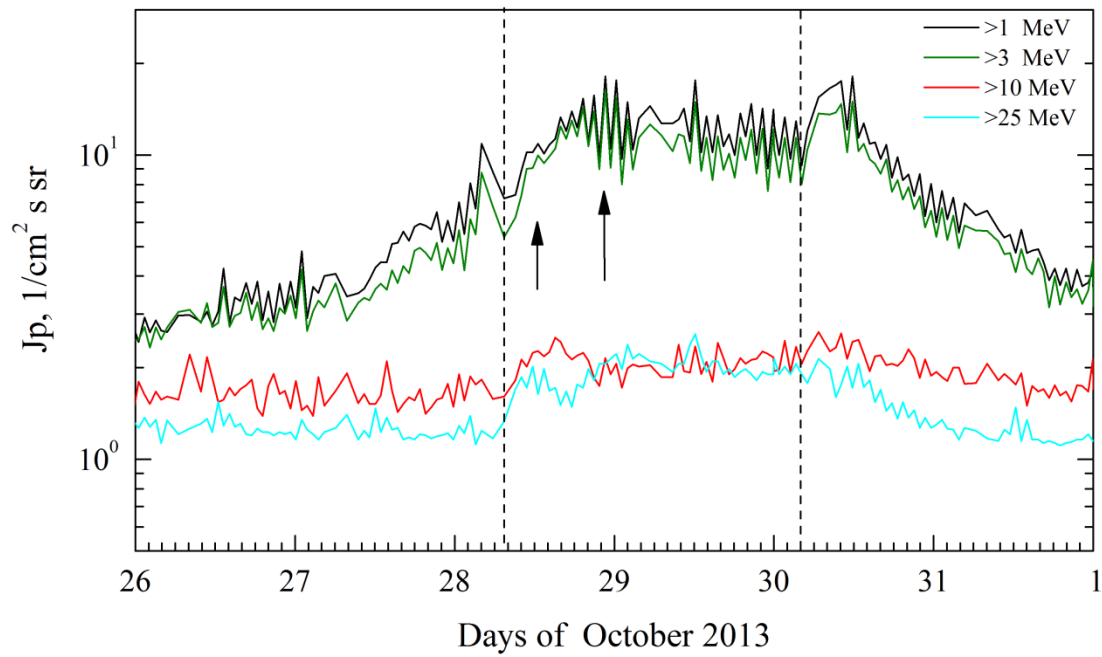


Electro. Event 2013.10.28

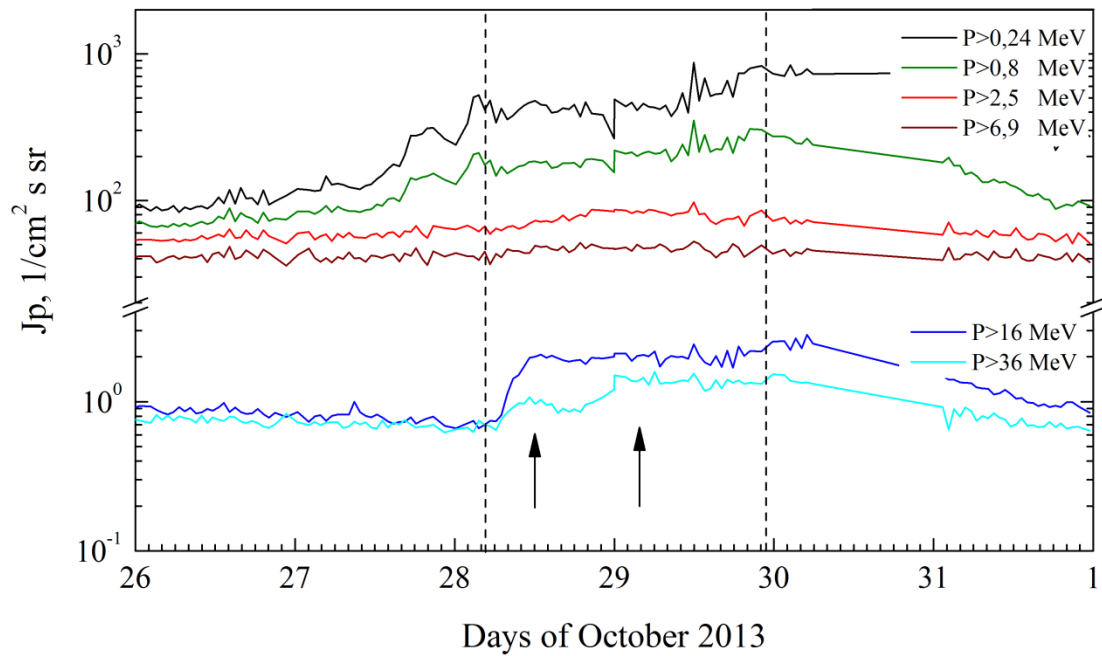


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.10.28



POES. Event 2013.10.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 October 28**

2013 October 28 • AR 11875 To event 537

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0149	0156	0231	N04W66	2N	PRB
1–12	keV	0141	0203	0212	N05W72	X1.0	0.084
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0137:55	02:00:34	02:19:36	538262	289584192	FERMI
100–300	keV	0151:44	0200:34	02:25:00	9863	30720740	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0155	0159	0208	U2.7 / 15	3.52	
8.8	GHz	0155	0159	0205		3.41	
5	GHz	0155	0159	0202		2.92	
2.7	GHz	0157	0157	0159	0.2 – 2.7	2.08	
1.4	GHz	0158	0158	0158		2.3	
410	MHz	0207	0207	0207		2.08	
245	MHz	0211	0211	0211		2.08	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	80-180	0200		0204		2	
DS III	18-270	0155		0200		2	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0224	695	- 12.1	360°	296°	SOHO

**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 October 28**

2013 October 28 Ø AR 11875 To event 537

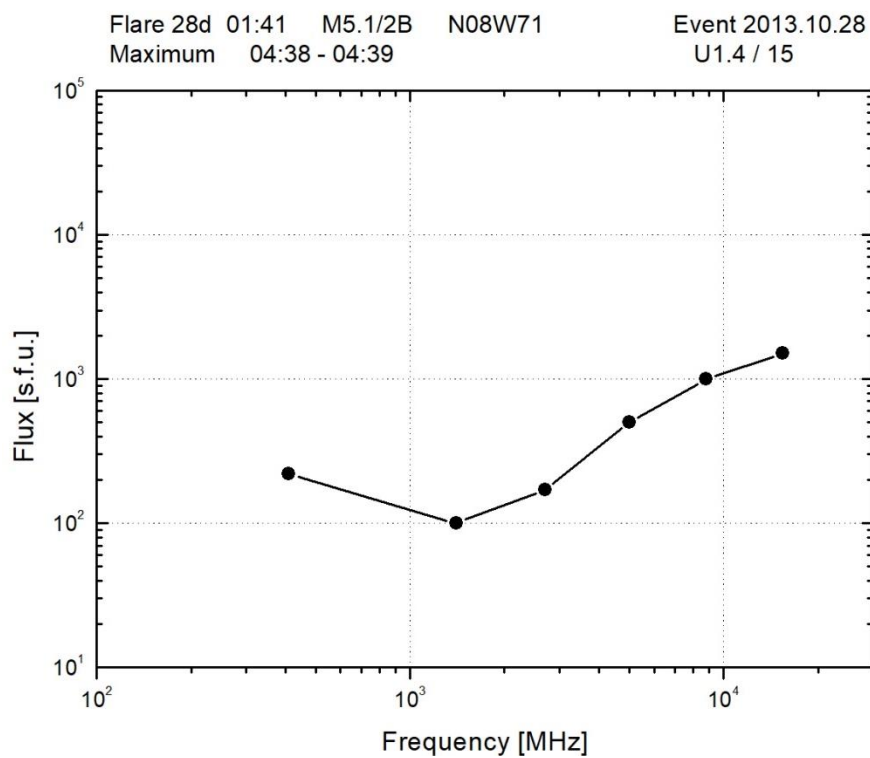
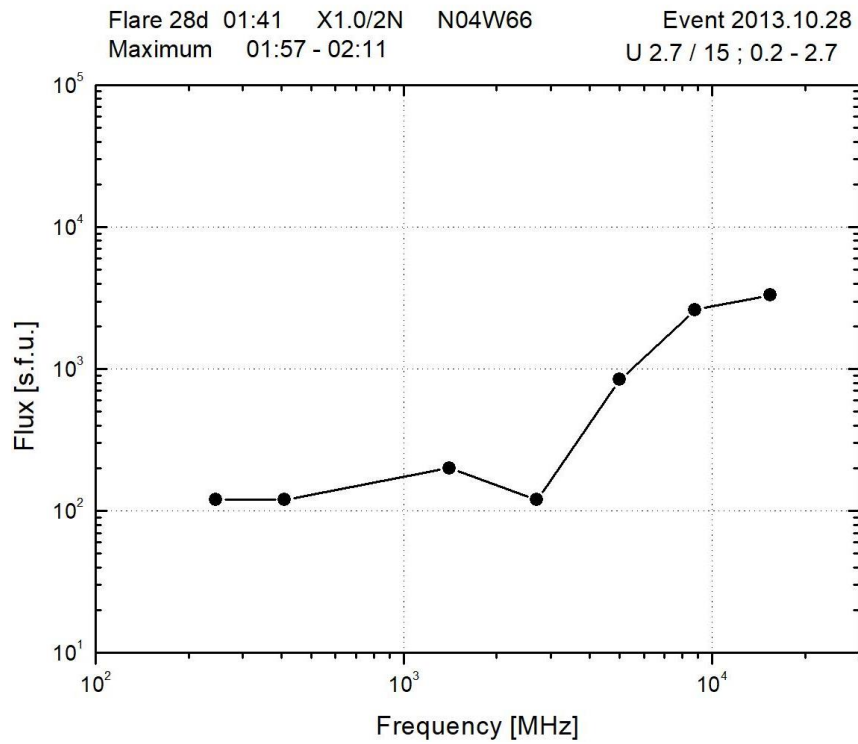
Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0432	0439	0453	N08W71	2B	ERU
1 – 12	keV	0432	0441	0446	N08W72	M5.1	0.021
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12–25	keV	0434:54	0440:15	0527:45	334322	88715960	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0436	0438	0440	U1.4 / 9	3.18	
8.8	GHz	0437	0438	0440		3.00	
5	GHz	0437	0438	0440		2.7	
2.7	GHz	0438	0438	0439		2.23	
1.4	GHz	0439	0439	0439		2.00	
410	MHz	0438	0438	0438		2.34	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-117	0437		0441		2	
DS IV	58-180	0437		1016		1	
DS III	18-500	0437		0441		3	
DS V	20-80	0439		0443		3	
DH II	14-0.2	0441		1151			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0448	1202	- 45.2	156°	313°	SOHO

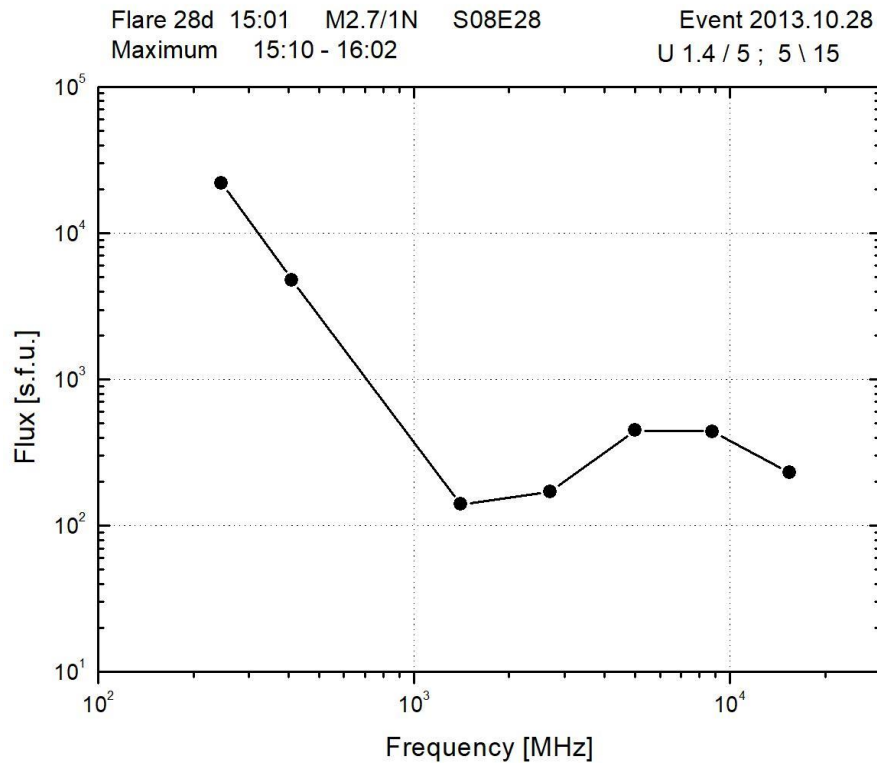
Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 October 28
2013 October 28 Ø AR 11882 To event 537

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	<1450	~1515	>1520	S08E28	1N	ERU
1 – 12	keV	1446	1501	1504	S08E27	M2.7	0.0098
1 – 12	keV	1507	1515	1521	S06E28	M4.4	0.026
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	1445:28	1512:06	1528:48	2288	8849536	HESSI
12-25	keV	1451:24	1459:11	1503:13	155038	26128808	FERMI
12-25	keV	1539:36	1551:09	16:06:26	42072	10449810	FERMI
>100	MeV	1545:30		1606:30		1.44E-05*	FERMI
100–300	keV	1545:30		1606:30		8849536	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1509	1510	1512		2.36	
8.8	GHz	1508	1510	1514		2.64	
5	GHz	1508	1510	1514	5 \ 15	2.65	
2.7	GHz	1508	1510	1514		2.23	
1.4	GHz	1508	1514	1516	U1.4 / 5	2.15	
410	MHz	1509	1602	1609		3.68	
245	MHz	1506	1511	1613		4.34	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1510		1529		2	
DS IV	50-180	1515		2129		1	
DS III	25-180	1510		1510	G	1	
CME		UT	V, km/s	a, km/s ²	$\Delta\varphi$	dA	Sp/c
LASCO	WL	1536	812	- 17.7	360°	086°	SOHO

* cm⁻²·s⁻¹

Radio bursts frequency spectrum





Proton Active Region:

AR11882 (S09L291, CMP 30.5.10.2013,
Sp=390, DKC, BGD, R)
XRI=9.96; $X_2^{2.1} + M_{11}^{4.4} + C_9$,
PFR1 25.10 (18^h) $X_2^{2.1} + M_9^{2.9}$
PFR2 28.10 (1.5^h) $M_2^{4.4}$

AR11875 (N07L027, CMP 22.10.2013,
Sp=420 msh, DKC, BGD, R)
XRI=6.53; $X_2^{2.3} + M_{11}^{5.1} + C_{57}$; $2_3 + 1_8 + S_{72}$;
PFR1 22-24.10 (58^h) - $M_8^{4.2}$;
PFR2 27-29.10, (57^h) $X_2^{2.3} + M_4^{5.1}$

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Gopalswamy N., S. Yashiro, P. Mäkelä et al., [2021](#).
Grechnev V., V. Kiselev, N. Meshalkina, I. Chertok, [2017](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
de Nolfo G.A., A. Bruno, J.M. Ryan et al., [2019](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 30d02^h

Tmax ($E_p > 10$ MeV) – 30d05^h, Jmax ($E_p > 10$ MeV) – $4.2 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma = 2.4$

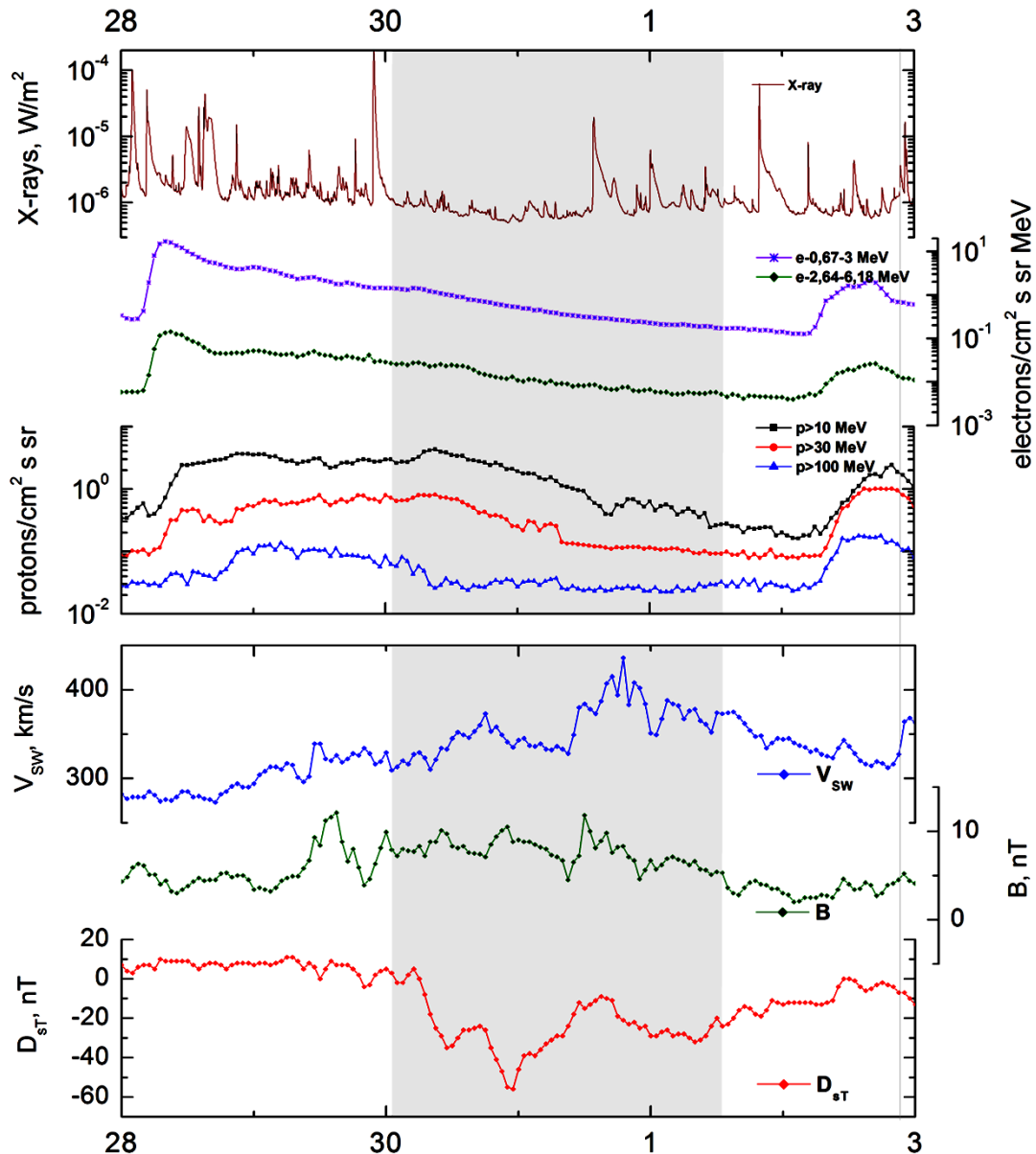
Quasimaximal energy of protons in the event – $E_{qm} = 130$ MeV

Sources: ■ solar flare 29d21^h42^m X2.3/, N05W89 AR11875

Main burst X-ray 1–8 Å: onset – 29d21^h42^m, max – 29d21^h54^m, $\Phi = 0.14 \text{ J/m}^2$

CME: 29d22^h00^m, $V = 1001 \text{ km/s}$, $\Delta\phi = 360$, $dA = 249^\circ$

Particle fluxes and associated phenomena



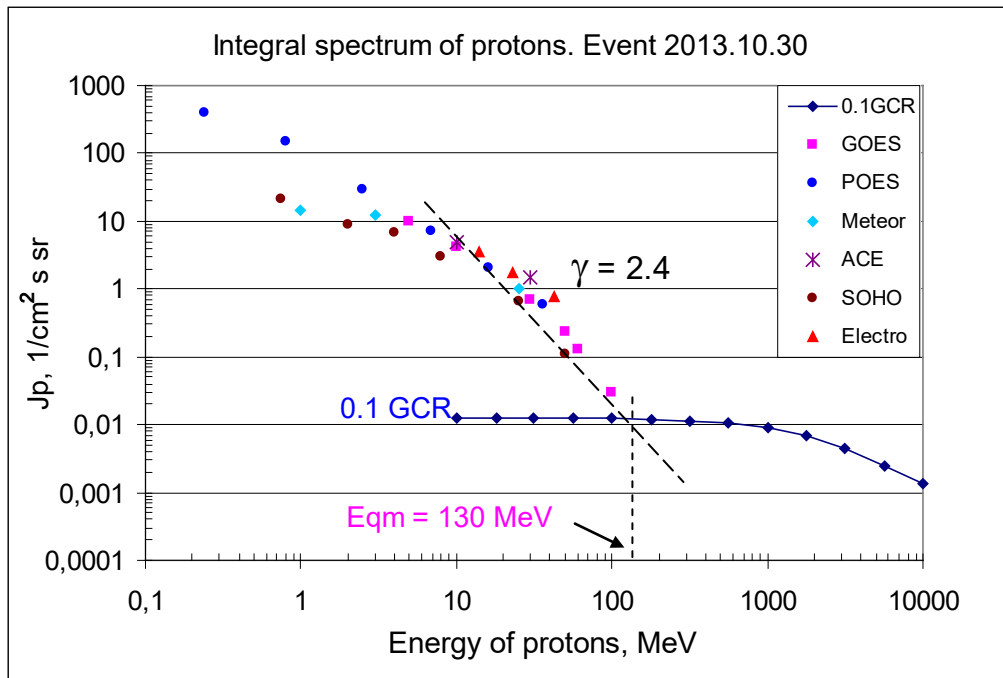
October - November 2013

Integral fluxes of protons for the event of 2013 October 30

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	5	10	9.7	1.5	0.2	
EPS	>10	5	10	4.2	1.5	0.12	
EPS	>30	5	10	0.7	1	0.1	
EPS	>50	5	8	0.23	1	0.06	
EPS	>60	5	7	0.13	1	0.05	
EPS	>100	5	7	0.03	1	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	-	2	400	2	400	
MEPED	>0.8	-	2	150	2	120	
MEPED	>2.5	-	2	30	2	50	
MEPED	>6.9	-	2	7	2	40	
MEPED	>16	29d23	2	2.1	2	0.7	
MEPED	>36	29d23	2	0.6	2	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	4	10	14.7	3	2.6	
SCR	>3	4	10	12.2	3	2.5	
SCR	>10	4	-	-	1	1.7	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	1	?	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	4	6	5	3	1.1	
SIS	>30	4	6	1.5	3	0.8	
SOHO							
EPHIN	>50	4	6	0.11	1	0.2	

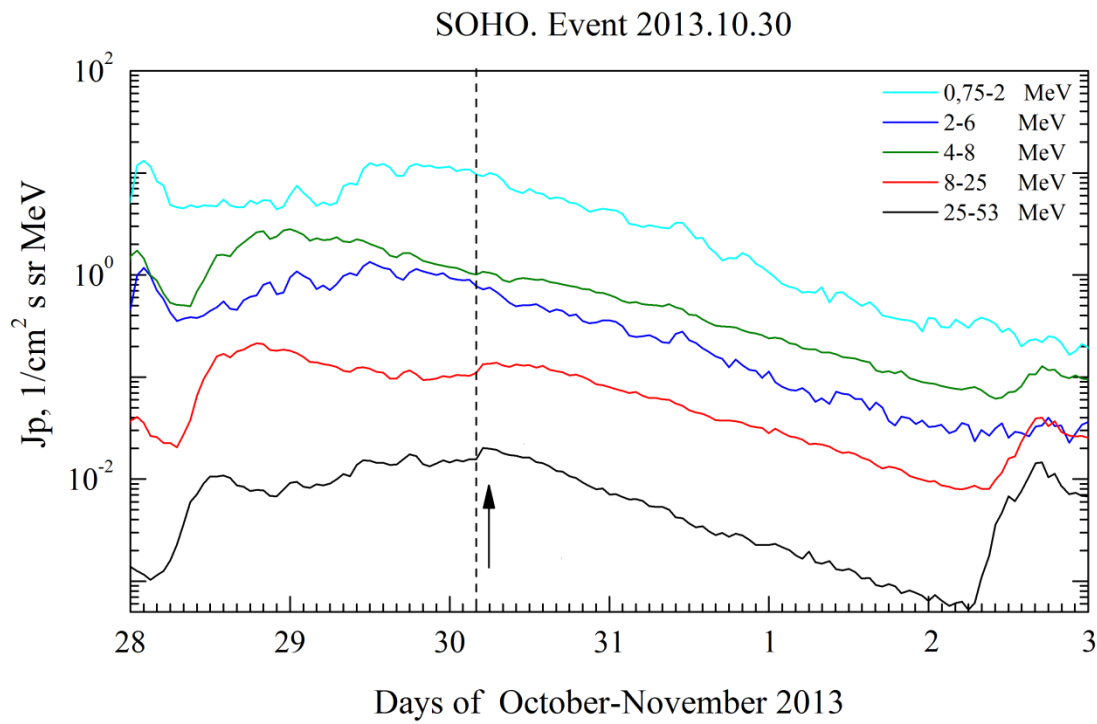
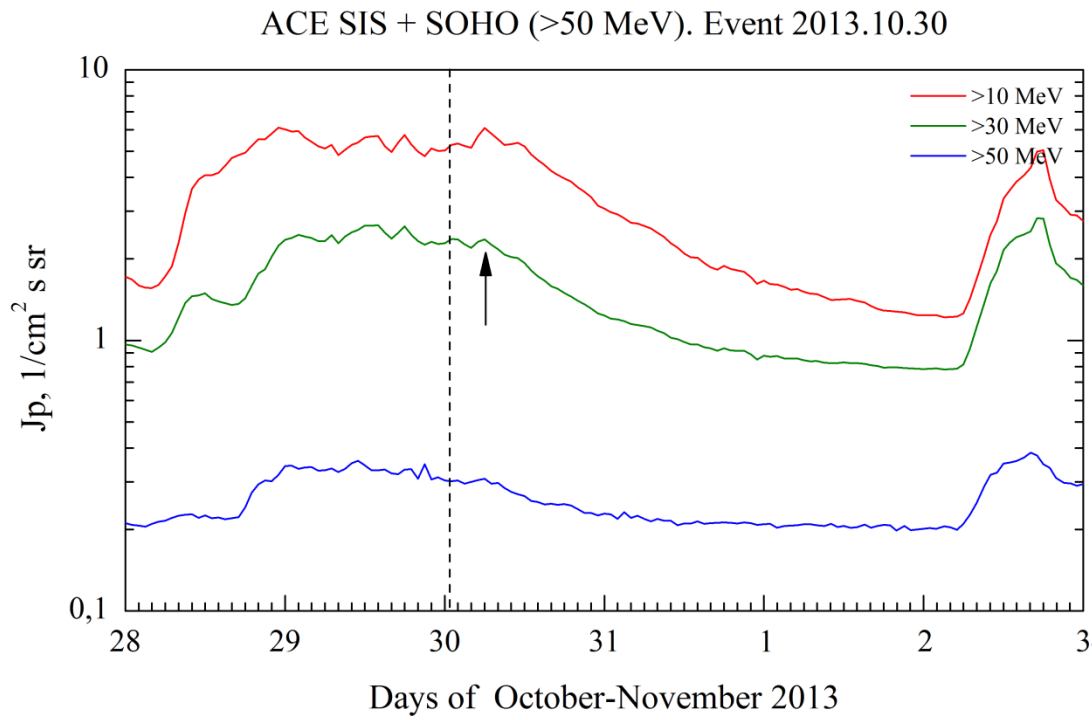
Differential fluxes of protons for the event of 2013 October 30

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	4	6	9.5	2.5	0.06	
LION	2 – 6	4	6	0.75	2.5	0.01	
EPHIN	4 – 8	4	6	0.9	2.5	0.01	
EPHIN	8 – 25	4	6	0.14	2.5	0.003	
EPHIN	25 – 53	4	6	0.02	2.5	0.0004	
Electro-1							
SCR-E	13.7–23	5	7	0.2	2	0.06	
SCR-E	23–42	5	7	0.05	2	0.025	
SCR-E	42–112	5	7	0.002	2	0.005	



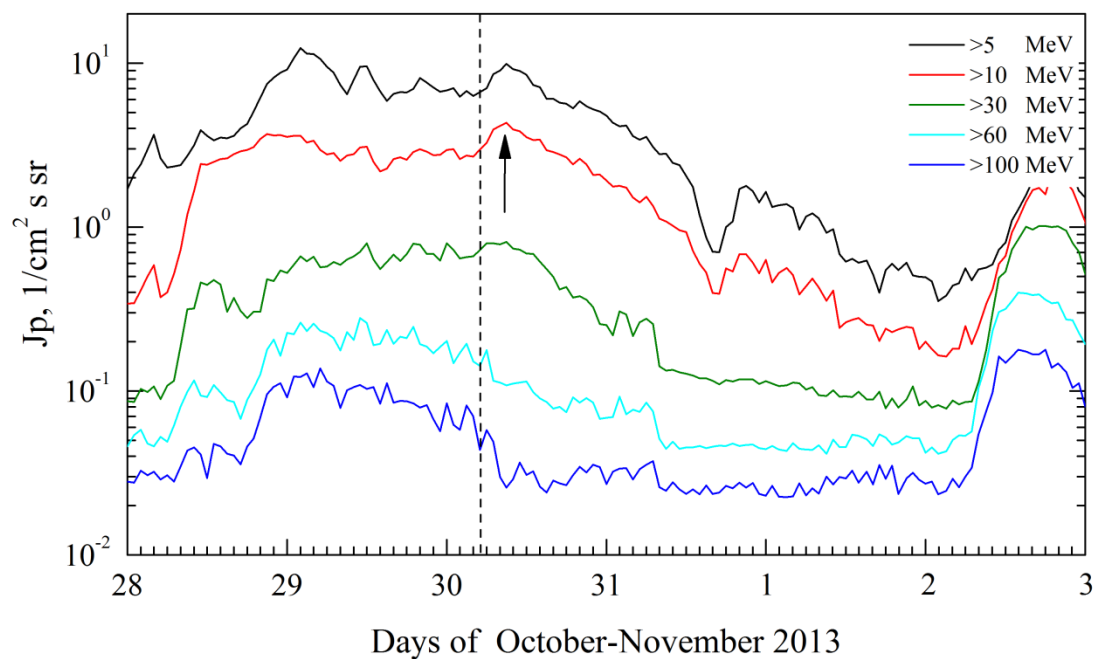
Time profiles of proton fluxes in the event 2013.10.30

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

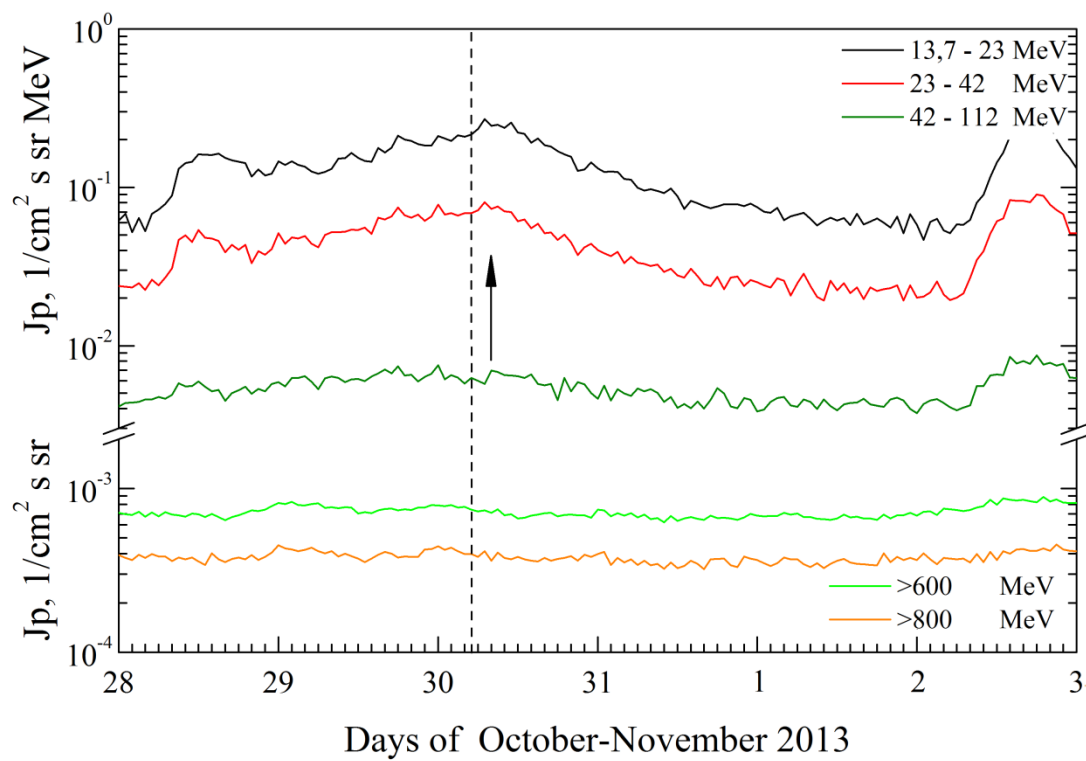


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro

GOES. Event 2013.10.30

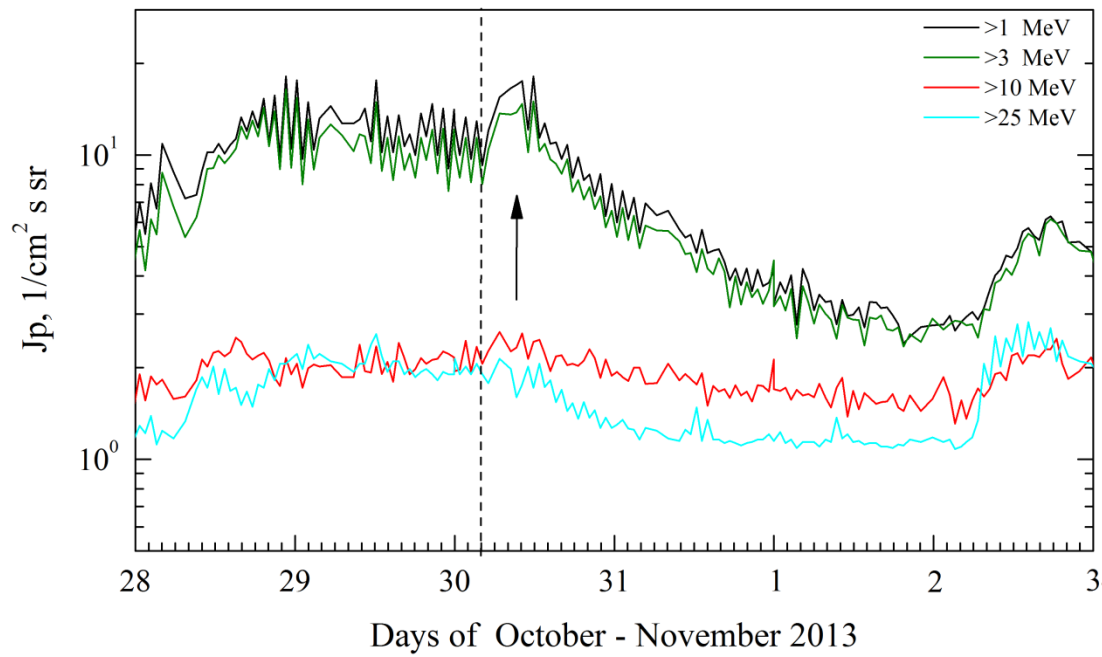


Electro. Event 2013.10.30

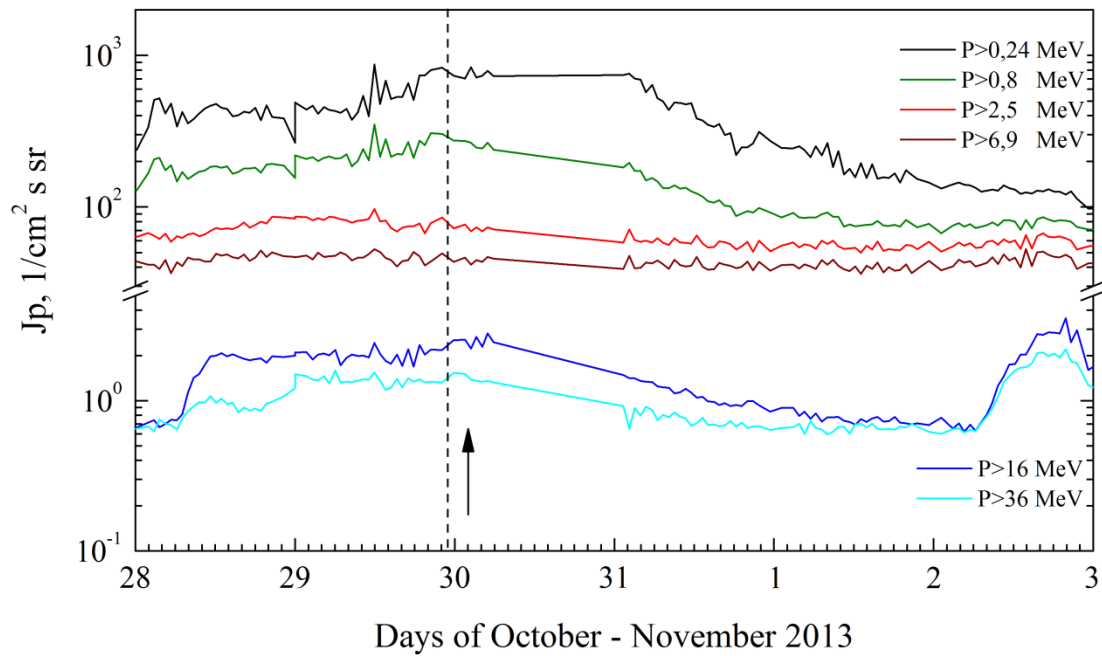


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2013.10.30



POES. Event 2013.10.30



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 October 30**

2013

October 29

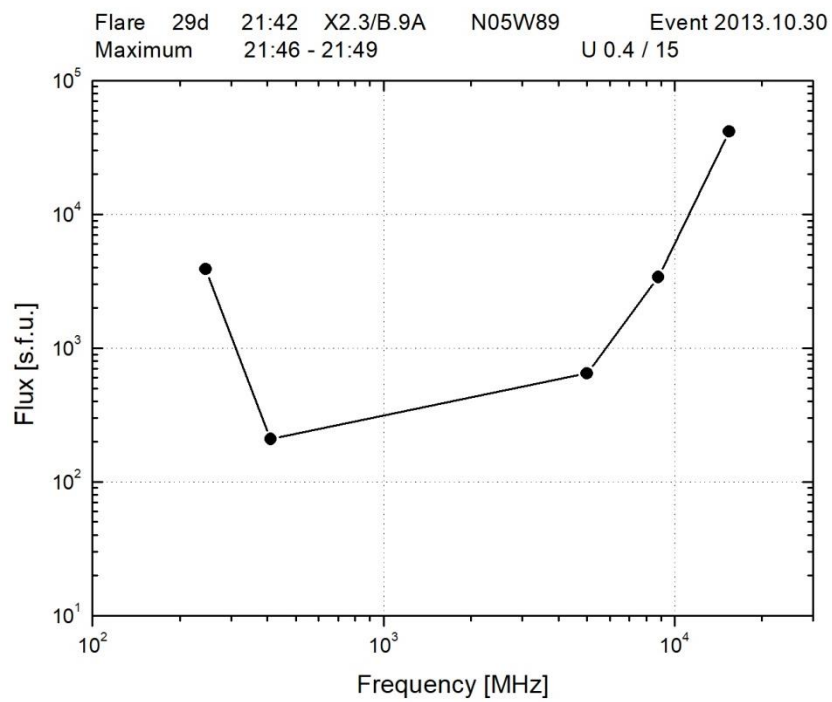


AR 11875

To event 538

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å		No optical flare on visible disk					
6563 Å	LPS	2300	0049	0049	N05W90	B.9A	
1 – 12	keV	2142	2154	2201	N05W89	X2.3	0.14
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	2146	2148	2157	U0.4 / 15	4.62	
8.8	GHz	2146	2148	2157		3.53	
5	GHz	2148	2148	2155		2.81	
410	MHz	2146	2149	2149		2.32	
245	MHz	2146	2146	2151		3.59	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-300	2148		2210		1	
DS IV	25-180	2158		2359		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2200	1001	- 29.7	360°	249°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11875 (N07L027, CMP 22.10.2013

Sp=420 msh, DKC, BGD, R)

XRI=6.53; $X_2^{2.3} + M_{11}^{5.1} + C_{57}; 2_3 + 1_8 + S_{72}$

PFR1 22-24.10 (58^h) - $M_8^{4.2}$

PFR2 27-29.10 (57^h) $X_2^{2.3} + M_4^{5.1}$

Particle event: To($E_p > 10$ MeV) – 02d07^h

Tmax($E_p > 10$ MeV) – 02d16^h, Jmax($E_p > 10$ MeV) – 1.6 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 2.2$

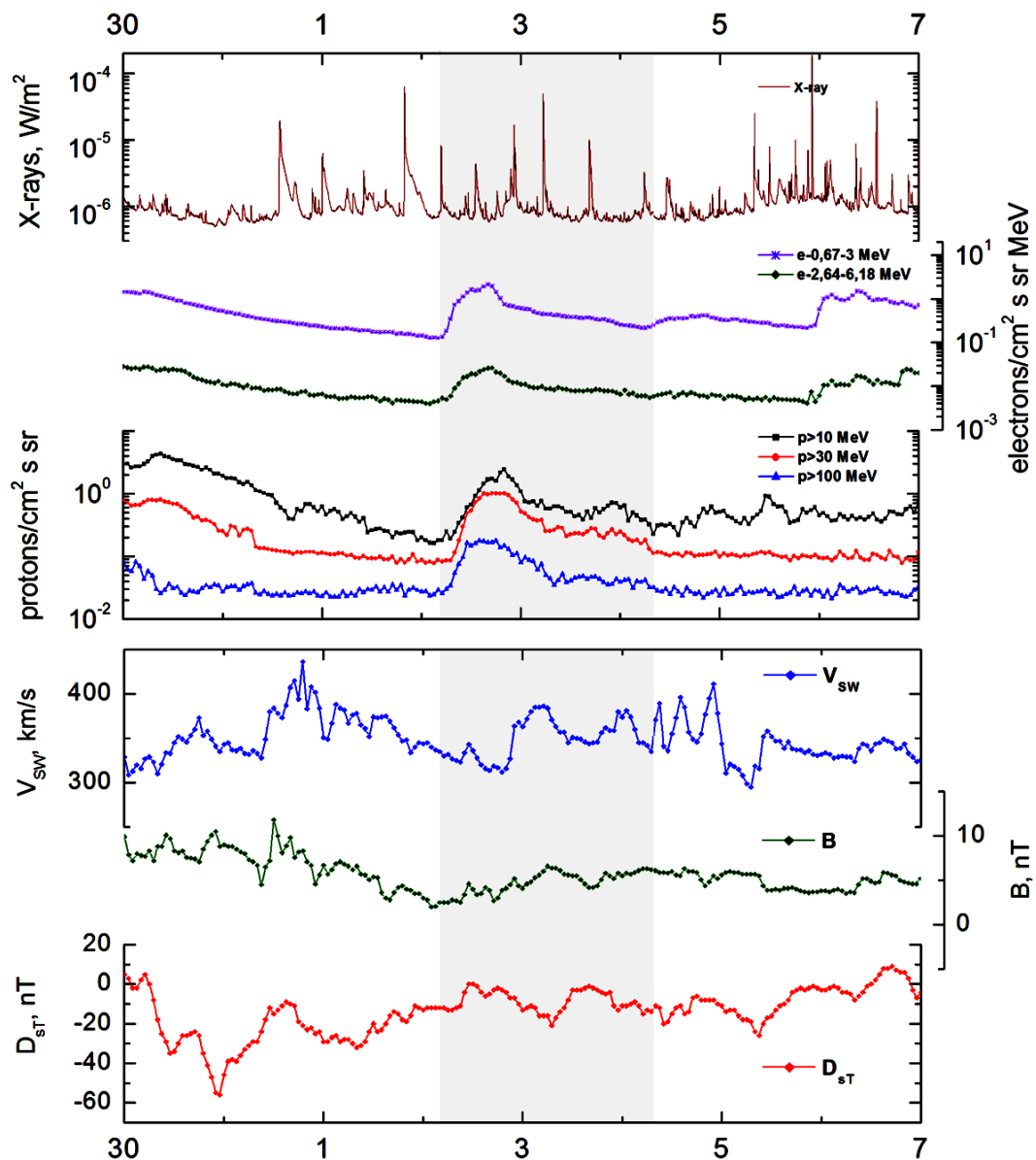
Quasimaximal energy of protons in the event – $E_{qm} = 300$ MeV

Sources: \square solar flare event 02d<04^h48^m, AR11875, 3d behind W_L

\emptyset solar flare 01d19^h46^m, M6.3/1B, S11E01, AR11884

CME: 02d04^h48^m, $V = 828$ km/s, $\Delta\phi = 360^\circ$, $dA = 239^\circ$

Particle fluxes and associated phenomena



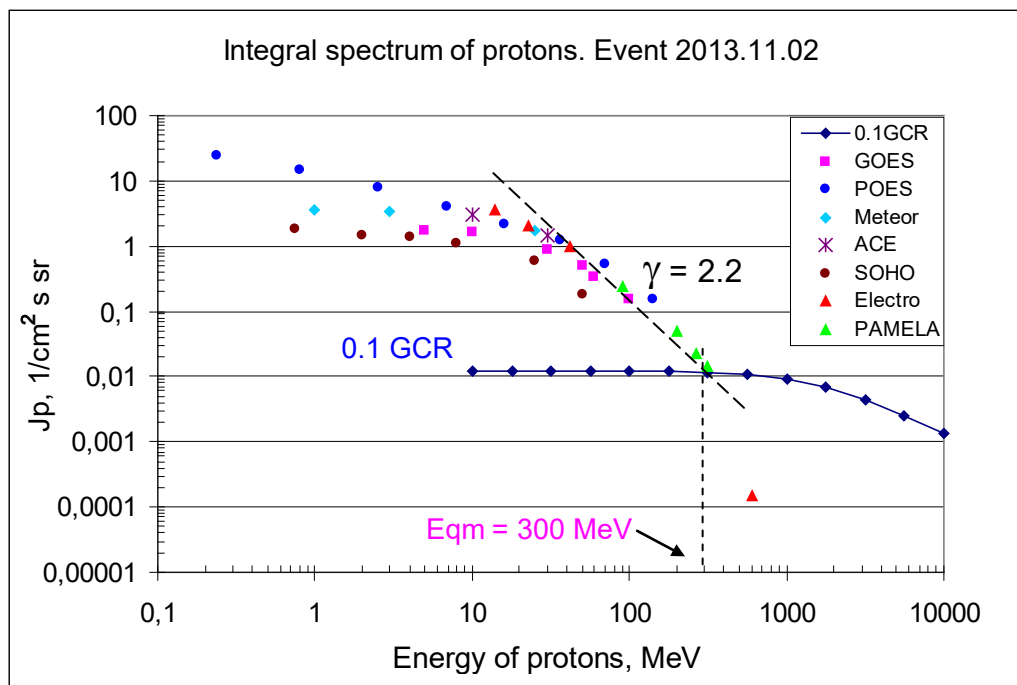
October-November 2013

Integral fluxes of protons for the event of 2013 November 02

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	10	16	1.7	2	0.2	
EPS	>10	7	16	1.6	2	0.12	
EPS	>30	7	15	0.9	2	0.07	
EPS	>50	7	15	0.5	2	0.06	
EPS	>60	7	15	0.34	2	0.05	
EPS	>100	7	15	0.15	1	0.03	
Electro-1							
GALS-E	>600	7	15	0.00015	0.5	0.0007	
POES-							
MEPED	>0.24	-	17	25	-	95	
MEPED	>0.8	6	17	15	-	70	
MEPED	>2.5	6	17	8	-	55	
MEPED	>6.9	6	17	4	-	45	
MEPED	>16	6	18	2.15	2	0.7	
MEPED	>36	6	18	1.25	1	0.75	
MEPED	>70	6	18	0.53	1	0.8	
MEPED	>140	6	14	0.15	0.5	1	
Meteor-1							
SCR	>1	7	20	3.6	1.5	2.6	
SCR1	>3	7	20	3.6	1	2.5	
SCR1	>10	7	-	-	1	1.7	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	7	17	1.7	1	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	6	15	3	2	1.2	
SIS	>30	6	15	1.5	2	0.8	
PAMELA							
TRACKER	>90	7	0726-0813	0.24	<2	-	
TRACKER	>200	7	0726-0813	0.051	<2	-	
TRACKER	>265	7	0726-0813	0.022	<2	-	
TRACKER	>312	7	0726-0813	0.014	<2	-	
SOHO							
EPHIN	>50	7	16	0.184	2	0.2	

Differential fluxes of protons for the event of 2013 November 02

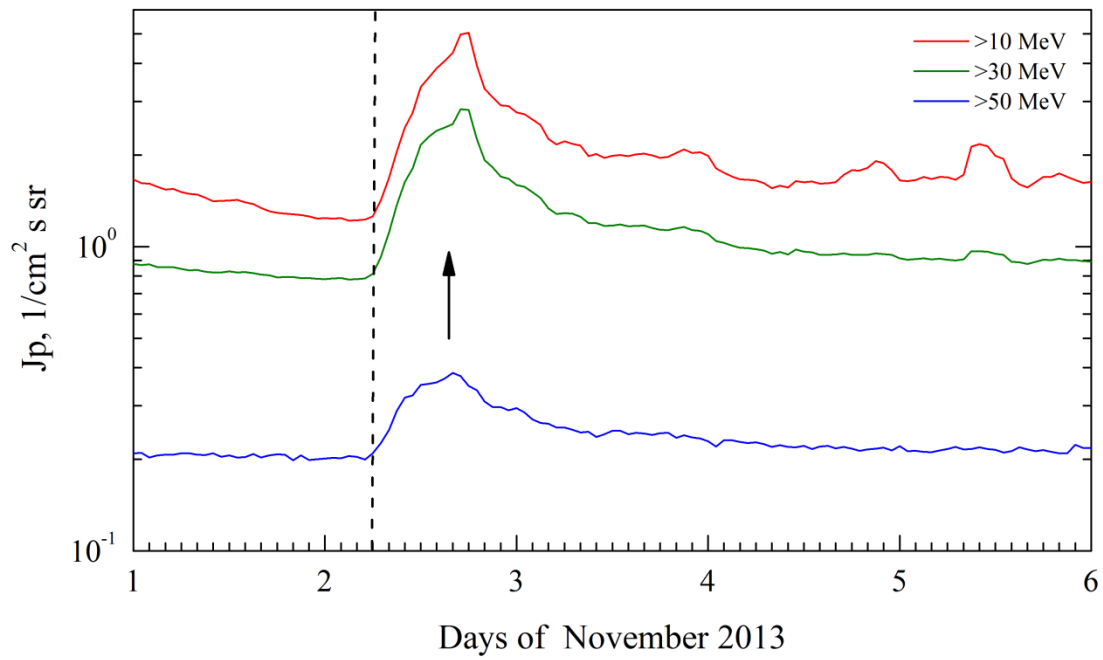
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	12	17	0.245	2	0.06	
LION	2 – 6	12	17	0.033	2	0.007	
EPHIN	4 – 8	12	17	0.07	2	0.06	
EPHIN	8 – 25	11	16	0.03	2	0.008	
EPHIN	25 – 53	8	16	0.0014	2	0.0006	
Electro-1							
SCR-E	13.7–23	7	15	0.16	1	0.06	
SCR-E	23–42	7	15	0.06	1	0.025	
SCR-E	42–112	7	15	0.005	1	0.004	



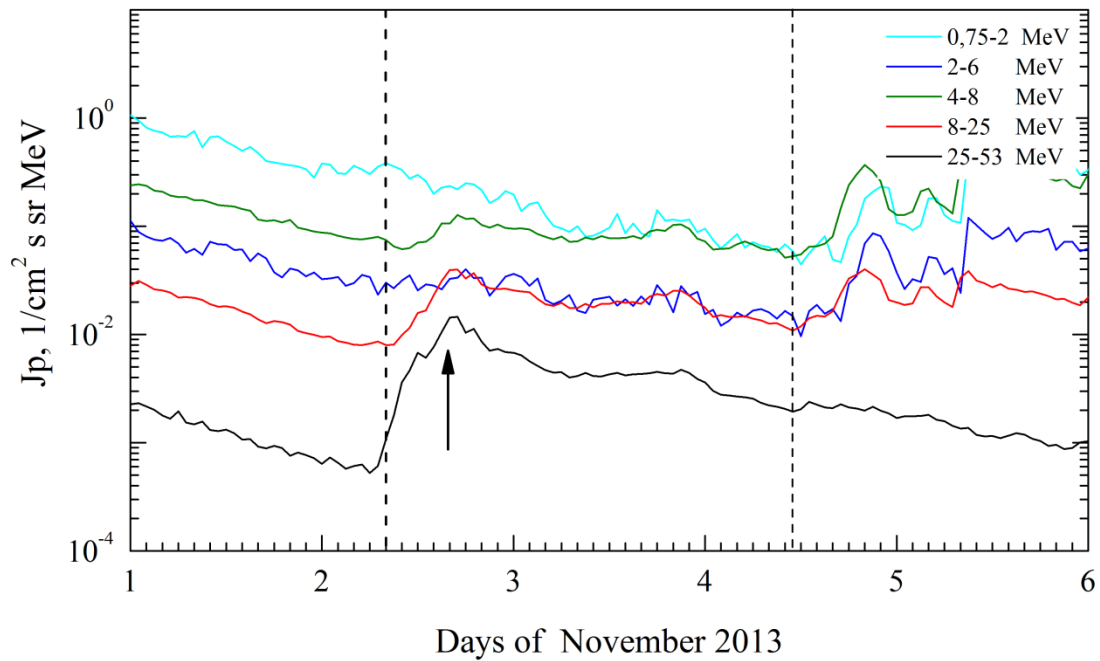
Time profiles of proton fluxes in the event 2013.11.02

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.11.02

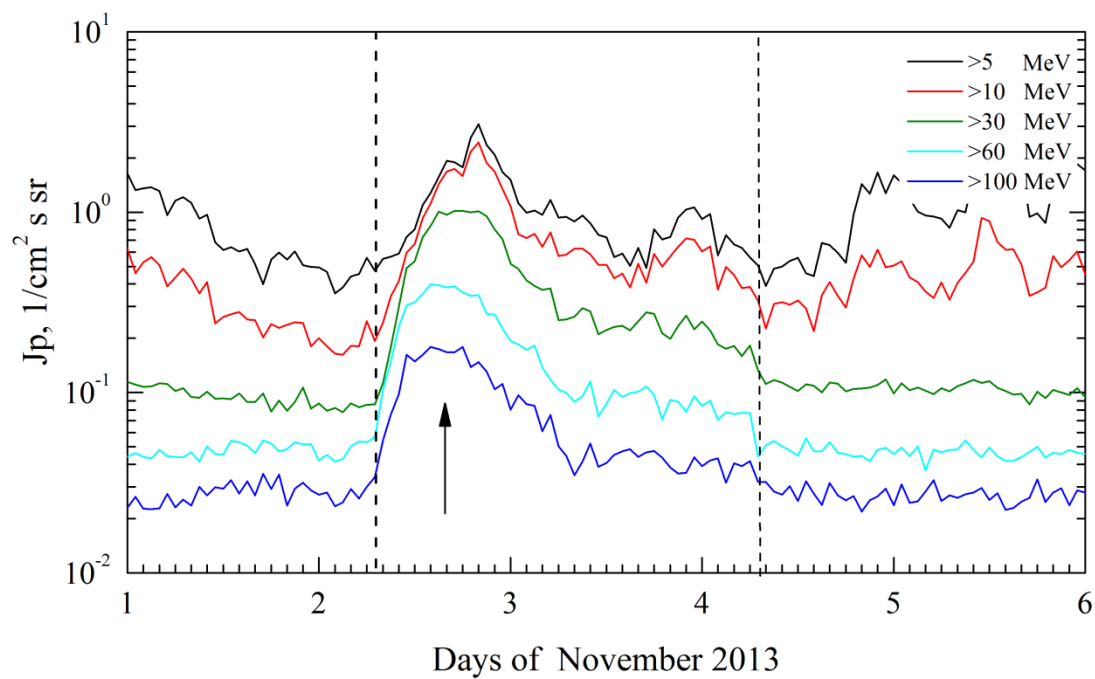


SOHO. Event 2013.11.02

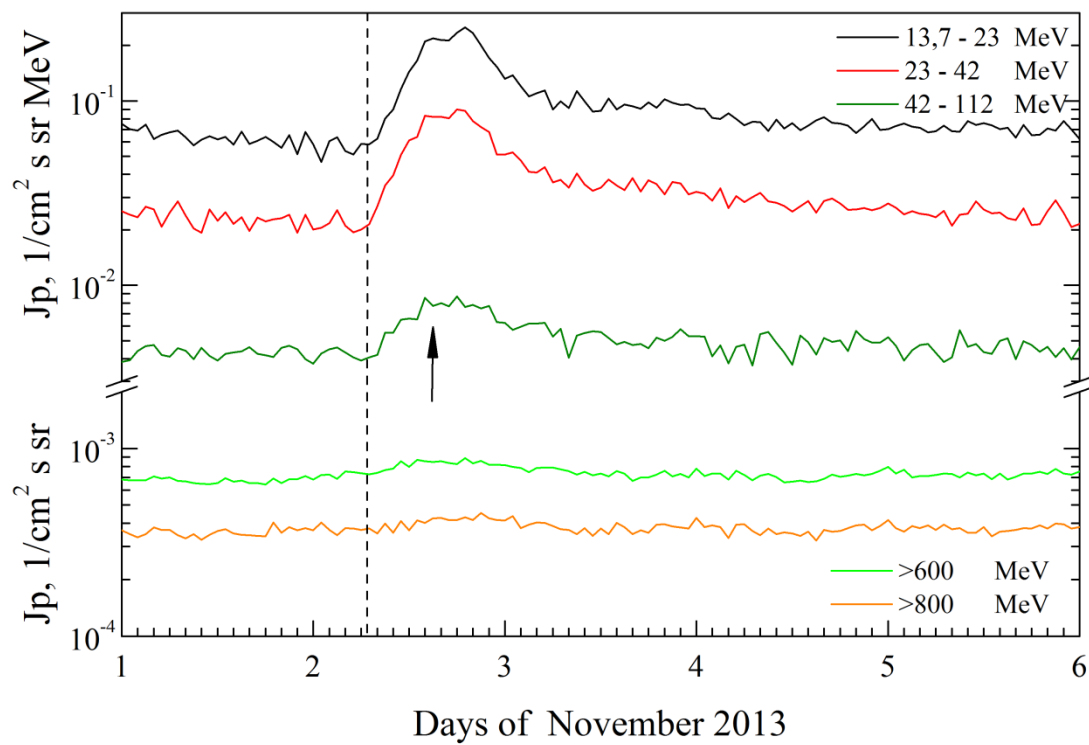


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.11.02

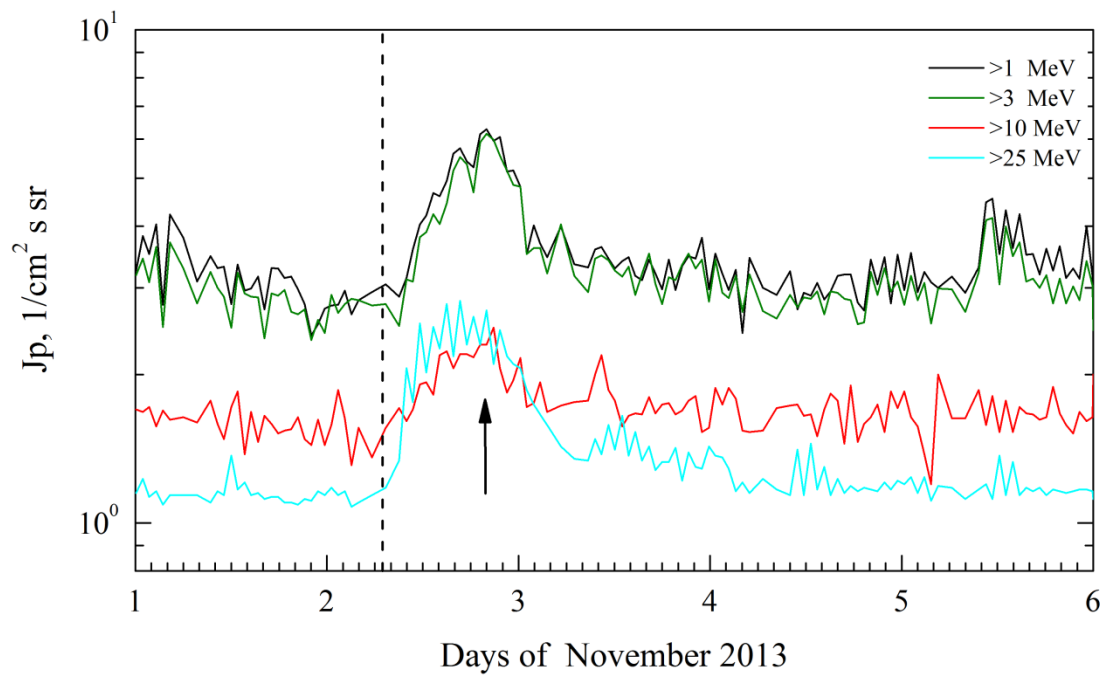


Electro. Event 2013.11.02

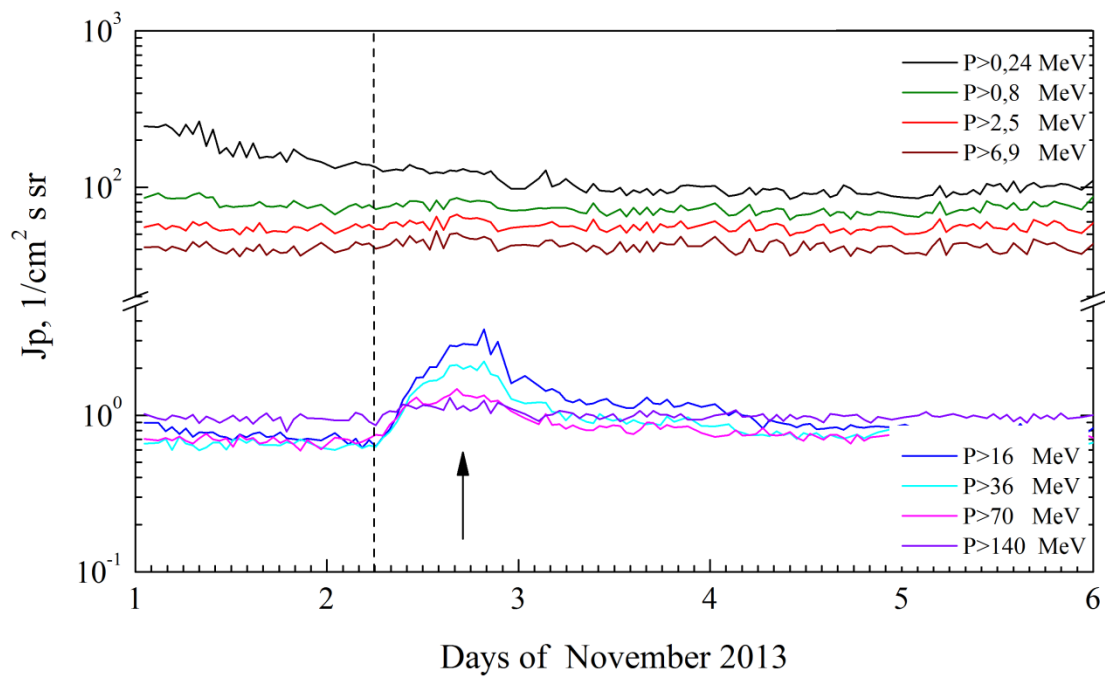


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2013.11.02



POES. Event 2013.11.02



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 November 02**

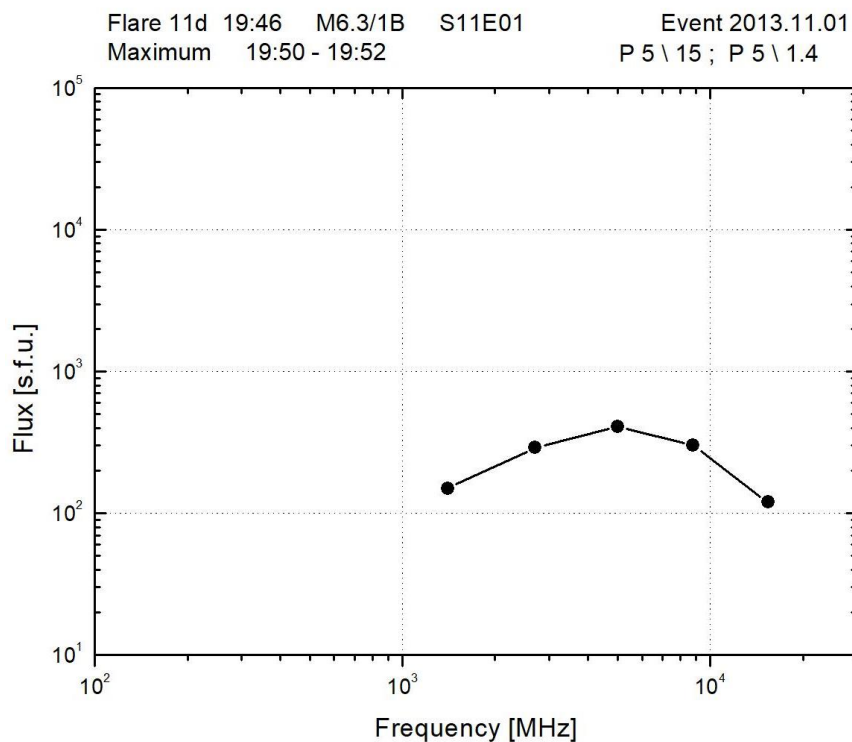
2013 November 02 ☐ AR 11875 To event 539

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0448	828	- 26.4	360°	239°	SOHO

2013 November 01 Ø AR 11884 To event 539

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1949	1952	2055	S11E01	1B	ERU
1 – 12	keV	1946	1952	1958	S12E01	M6.3	0.023
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1952:58	1953:08	2033:17	289647	44193300	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1950	1952	1953	P5 \ 15	2.08	
8.8	GHz	1949	1950	1953		2.48	
5	GHz	1949	1950	1953	P5 \ 1.4	2.61	
2.7	GHz	1949	1950	1953		2.46	
1.4	GHz	1952	1952	1953		2.18	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	58-180	2000		2007		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2024	268	3.7	42°	168°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR11875 (N07L027, CMP 22.10.2013,
Sp=420 msh, DKC, BGD)
XRI=6.53; $X_2^{2.3} + M_{11}^{5.1} + C_{57}$; $2_3 + 1_8 + S_{72}$
PFR1 22-24.10 (58^h) - $M_8^{4.2}$
PFR2 27-29.10 (57^h) $X_2^{2.3} + M_4^{5.1}$

AR11884 (S12L260; CMP 01,9.11.2013;
Sp=460 msh; EKI; BGD)
XRI=1.6 $M_4^{6.3} + C_{15}$ $2_1 + 1_3 + S_{18}$
PFR1 26.11 M_1
PFR2 1-3.11 (34^h); $M_3^{6.3}$

References:

Bruno A., I. G. Richardson, [2021](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 07d01^h

Tmax ($E_p > 10$ MeV) – 07d05^h, Jmax ($E_p > 10$ MeV) – 5.5 /cm²·s·sr

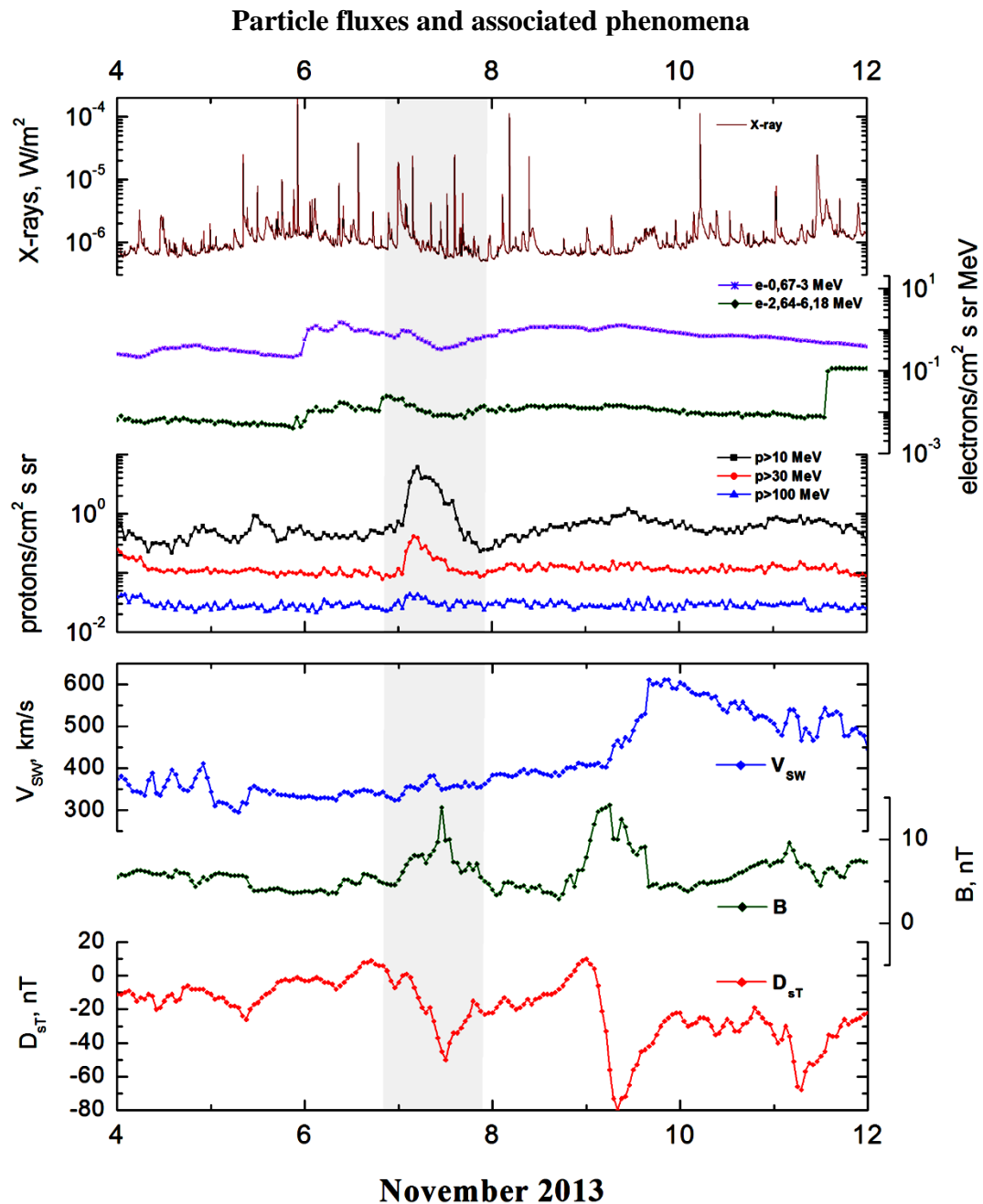
Duration of the event – 1 day, power-law index: $\gamma_1 = 3.0$

Quasimaximal energy of protons in the event – Eqm = 90 MeV

Sources: ■ solar flare 06d23^h35^m, M1.9, M1.8/SPY, S11W88, AR11882, 1d behind W_L

Main burst X-ray 1–8 Å: onset – 06d23^h35^m, max – 07d00^h02^m, $\Phi = 0.021$ J/m²

CME: 07d00^h00^m, $V = 1033$ km/s, $\Delta\phi = 360^\circ$, $dA = 233^\circ$

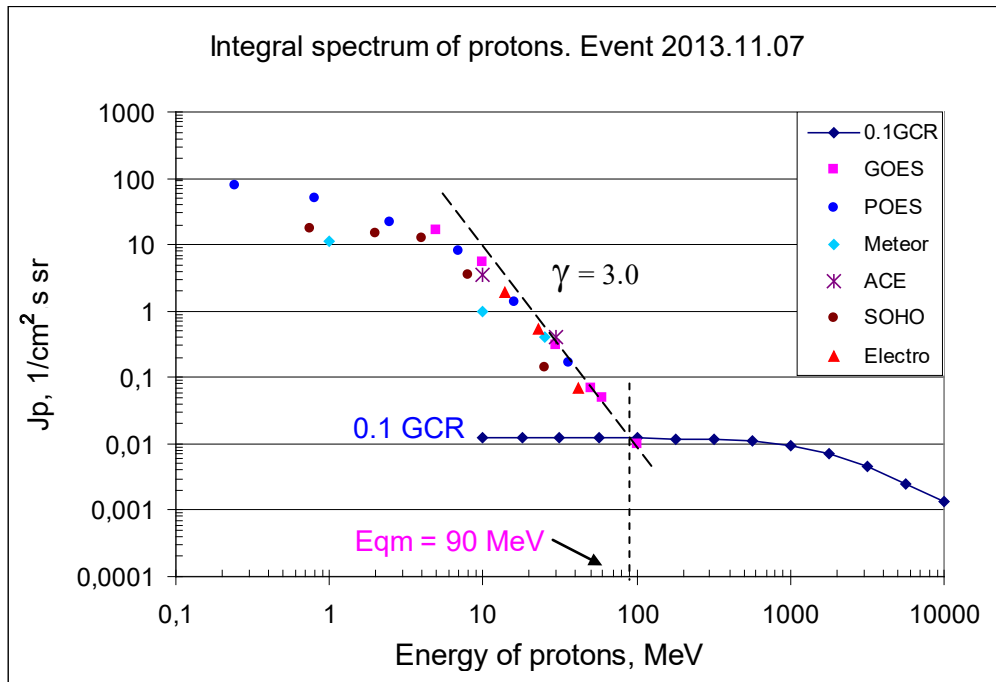


Integral fluxes of protons for the event of 2013 November 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	1	5	16.4	1	1	
EPS	>10	1	5	5.5	1	0.4	
EPS	>30	1	4	0.3	1	0.1	
EPS	>50	1	4	0.07	1	0.06	
EPS	>60	1	4	0.05	1	0.05	
EPS	>100	1	3	0.01	1	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	-	6	80	1	100	
MEPED	>0.8	1	6	50	1	70	
MEPED	>2.5	1	6	22	1	60	
MEPED	>6.9	1	6	8	0.5	40	
MEPED	>16	1	6	1.4	0.5	0.7	
MEPED	>36	1	6	0.17	0.5	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	1	5	11.4	1	2.6	
SCR	>3	1	-	-	1	2.5	
SCR	>10	1	5	1	0.5	1.7	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	1	2	0.4	0.5	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	0	6	3.5	1	1.5	
SIS	>30	0	6	0.4	1	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

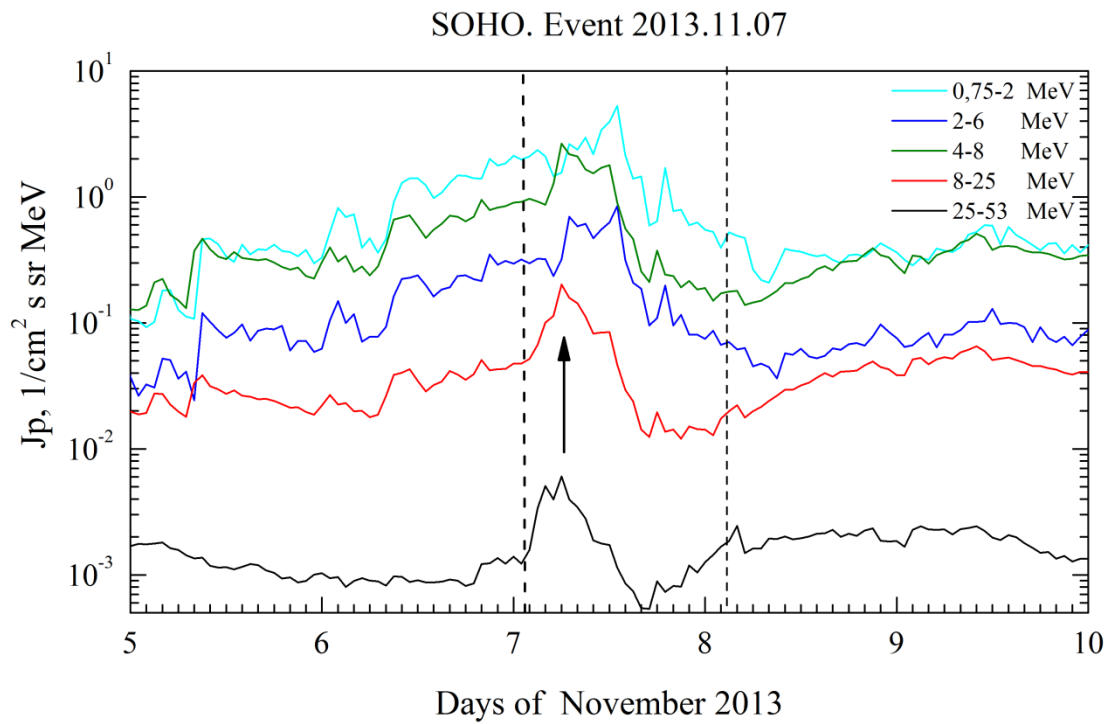
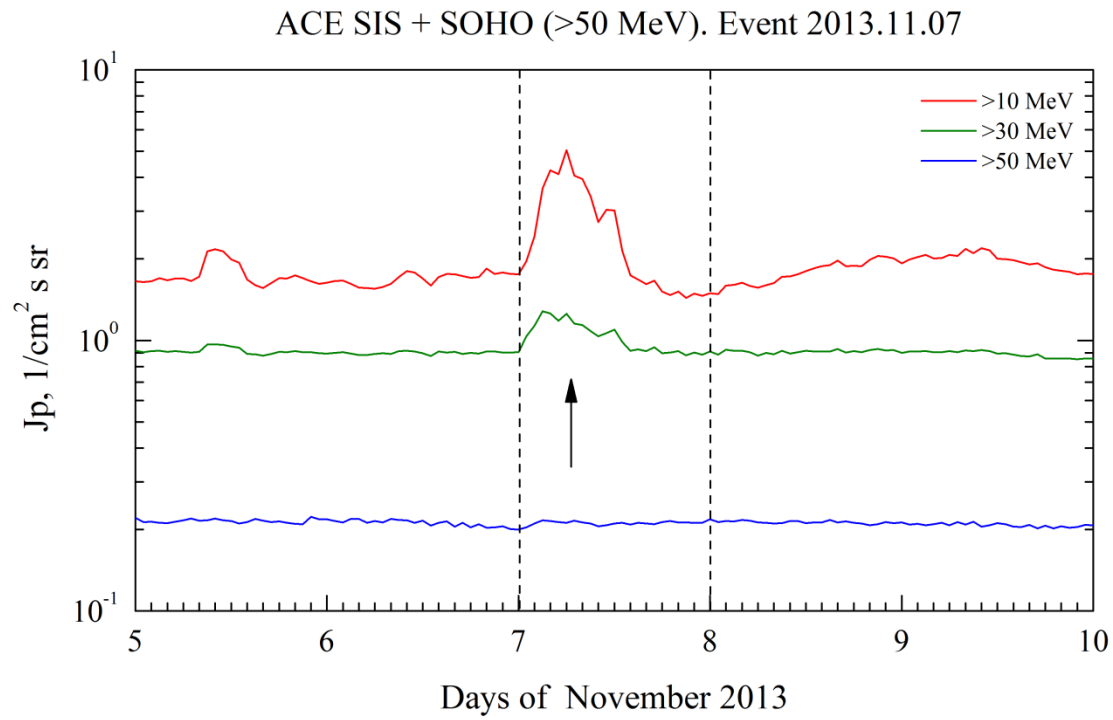
Differential fluxes of protons for the event of 2013 November 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	6	7	2.6	1	0.37	
LION	2 – 6	6	7	0.6	1	0.09	
EPHIN	4 – 8	3	6	2.3	1	0.3	
EPHIN	8 – 25	3	6	0.2	1	0.02	
EPHIN	25 – 53	3	6	0.005	1	0.001	
Electro-1							
SCR-E	13.7–23	7d00	4	0.15	0.5	0.06	
SCR-E	23–42	7d00	4	0.025	0.5	0.025	
SCR-E	42–112	7d00	3	0.001	0.5	0.005	

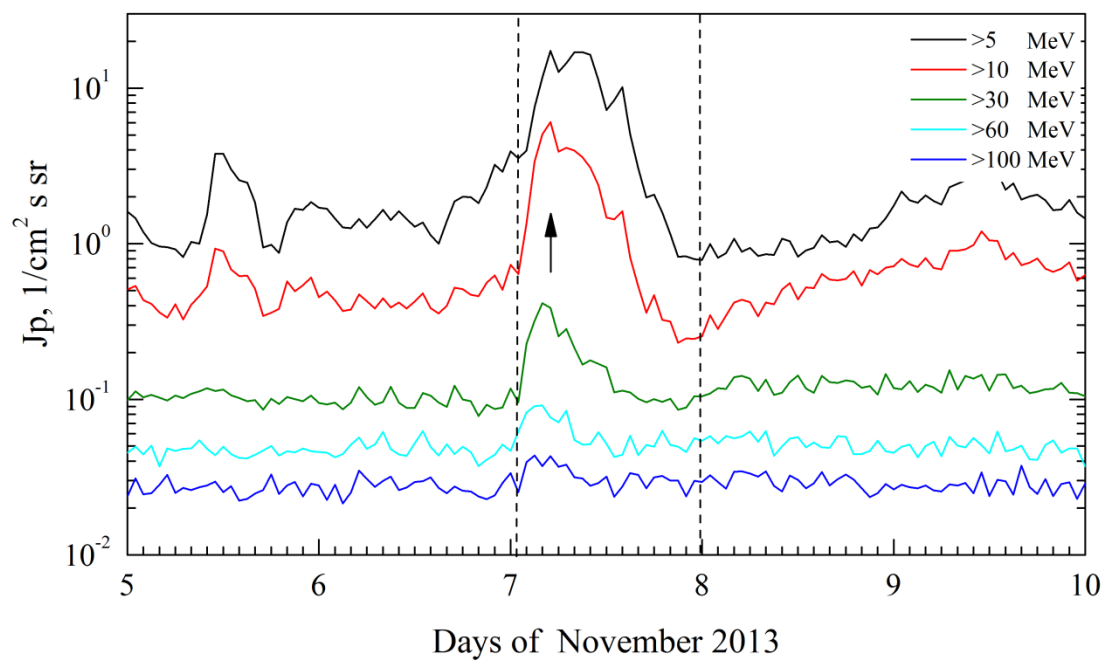


Time profiles of proton fluxes in the event 2013.11.07

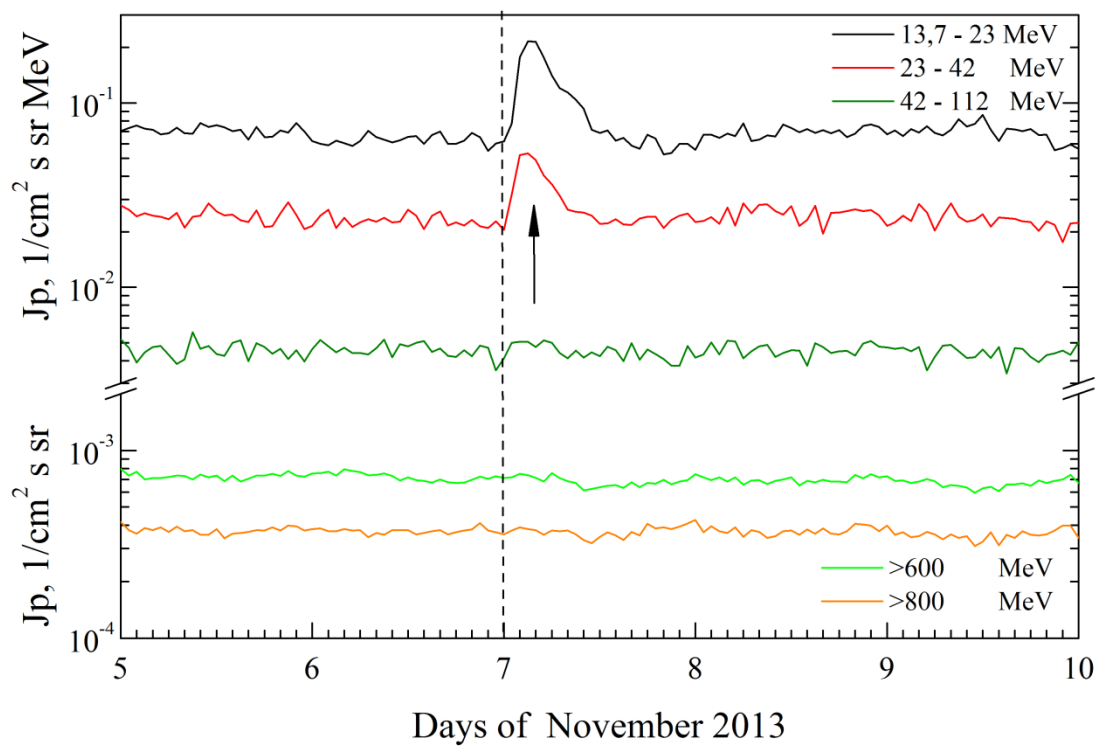
Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO



GOES. Event 2013.11.07

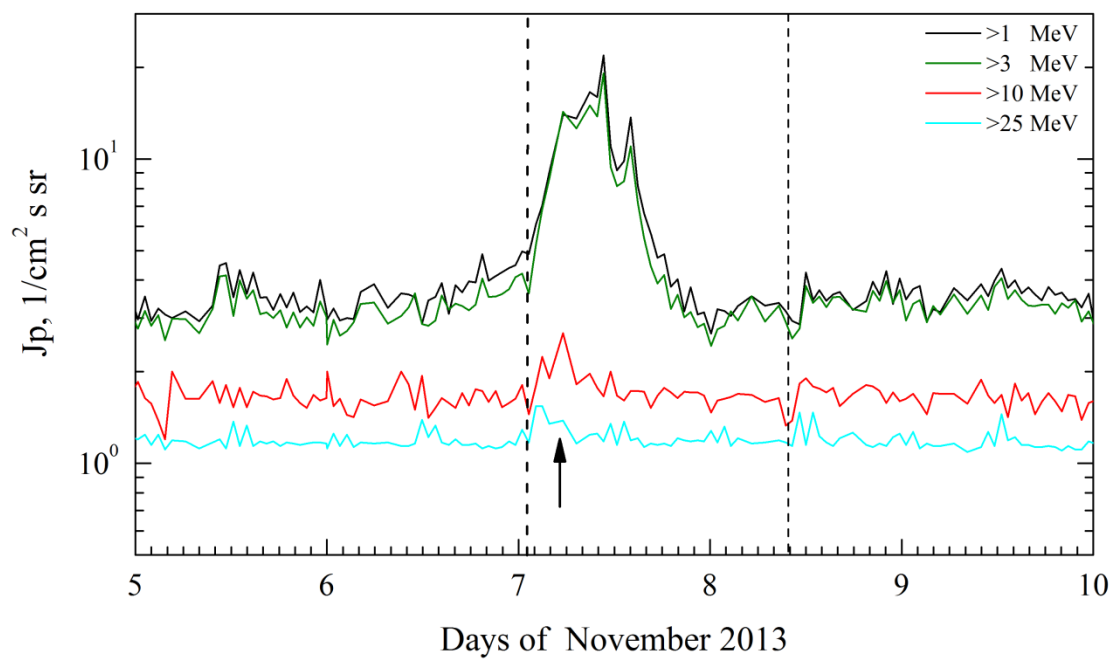


Electro. Event 2013.11.07

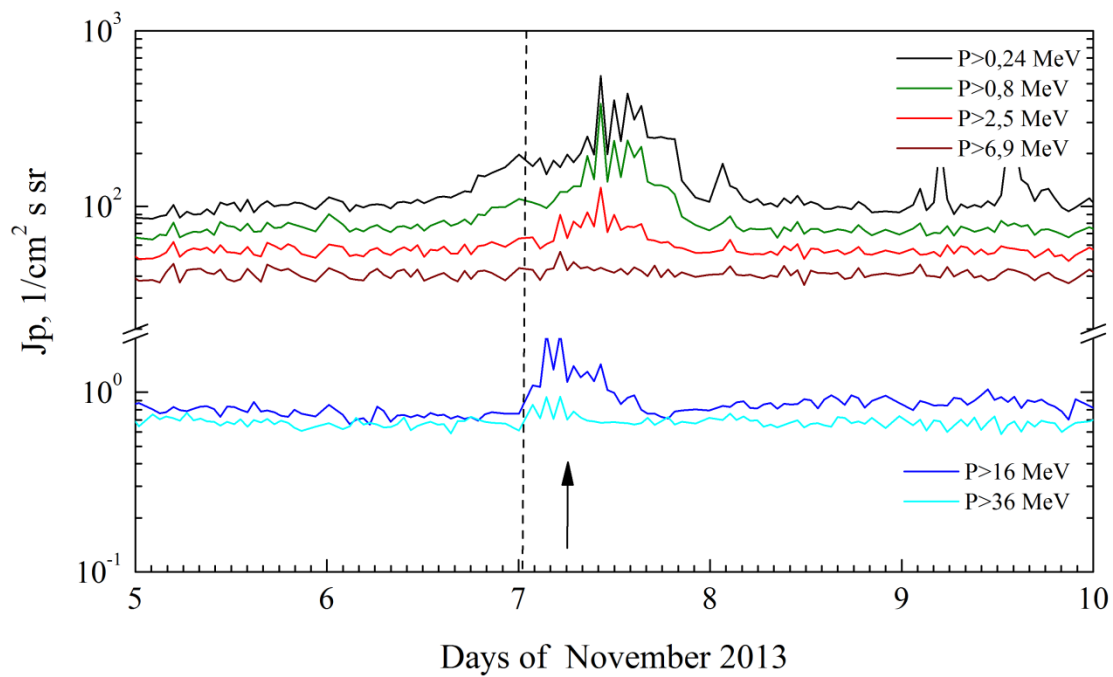


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.11.07



POES. Event 2013.11.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 November 07**

2013 November 06 ■ AR 11882 To event 540

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible disk					
6563 Å	SPY	2345		2351	S17W90		
1 – 12	keV	2335	0002	0050	S11W88	M1.9*	0.021*
1 – 12	keV	2344	0002	0014	S11W88	M1.8*	
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	2358:24	0009:38	0025:56	6070	969474	FERMI
12 – 25	keV	0008:48	0009:38	0025:56	80	250807	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS CTM	054-168	0000		0012		1	
DS III	025-041	0000		0000		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	7d0000	1033	- 45.5	360°	233°	SOHO

*Total Φ for both X-ray bursts

Proton Active Region:

AR11882 (S09L291, CMP 30.5.10.2013,
Sp=390, DKC, BGD, R)
XRI=9.96; X₂^{2.1}+M₁₁^{4.4}+ C₉
PFR1 25.10 (18^h) X₂^{2.1}+M₉^{2.9}
PFR2 28.10 (1.5^h) M₂^{4.4}

References:

Cohen C.M.S., R.A. Mewaldt, [2018](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 08d02^h

Tmax($E_p > 10$ MeV) – 09d11^h, Jmax($E_p > 10$ MeV) – $0.6 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma = 2.7$

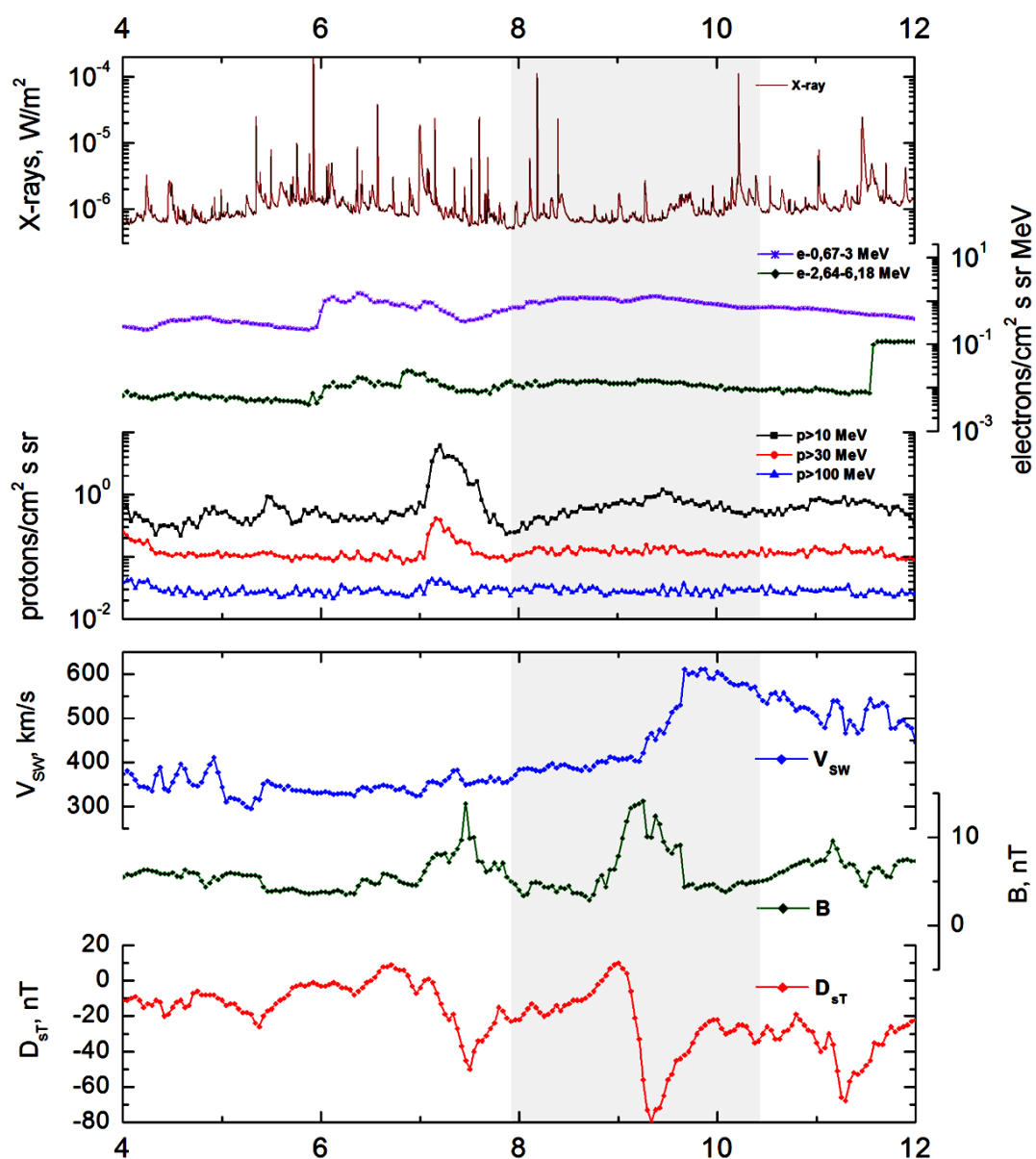
Quasimaximal energy of protons in the event – $E_{qm} = 40$ MeV

Sources: ☉ solar flare 08d04^h20^m, X1.1/2B, S14E15, AR11890

☾ solar flare 07d14^h15^m, M2.4/1N, S13E23, AR11890

Main burst X-ray 1–8 Å: onset – 08d04^h20^m, max – 08d04^h26^m, $\Phi = 0.028 \text{ J/m}^2$

Particle fluxes and associated phenomena



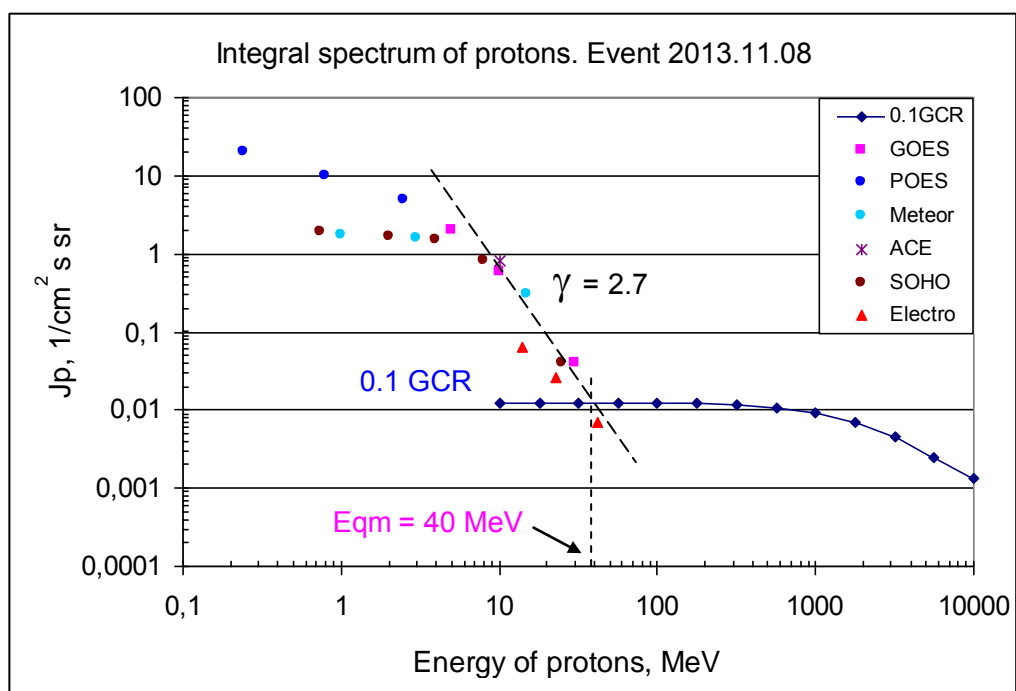
November 2013

Integral fluxes of protons for the event of 2013 November 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	09d12	2	2	1	
EPS	>10	2	09d11	0.6	2	0.4	
EPS	>30	2	09d11	0.04	2	0.1	
EPS	>50	2	-	-	-	0.06	
EPS	>60	2	-	-	-	0.05	
EPS	>100	2	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	24	9d12	20	0.5	100	
MEPED	>0.8	24	9d12	10	0.5	70	
MEPED	>2.5	24	9d12	5	0.5	55	
MEPED	>6.9	24	9d12	4	0.5	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	10	9d13	1.74	2	2.6	
SCR	>3	10	9d13	1.56	2	2.5	
SCR	>10	10	-	-	2	1.7	
GALS-M	>15	-	9d13	0.3	2	1.7	
GALS-M	>25	-	-	-	-	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	10	09d11	0.8	2	1.2	
SIS	>30	-	-	-	-	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

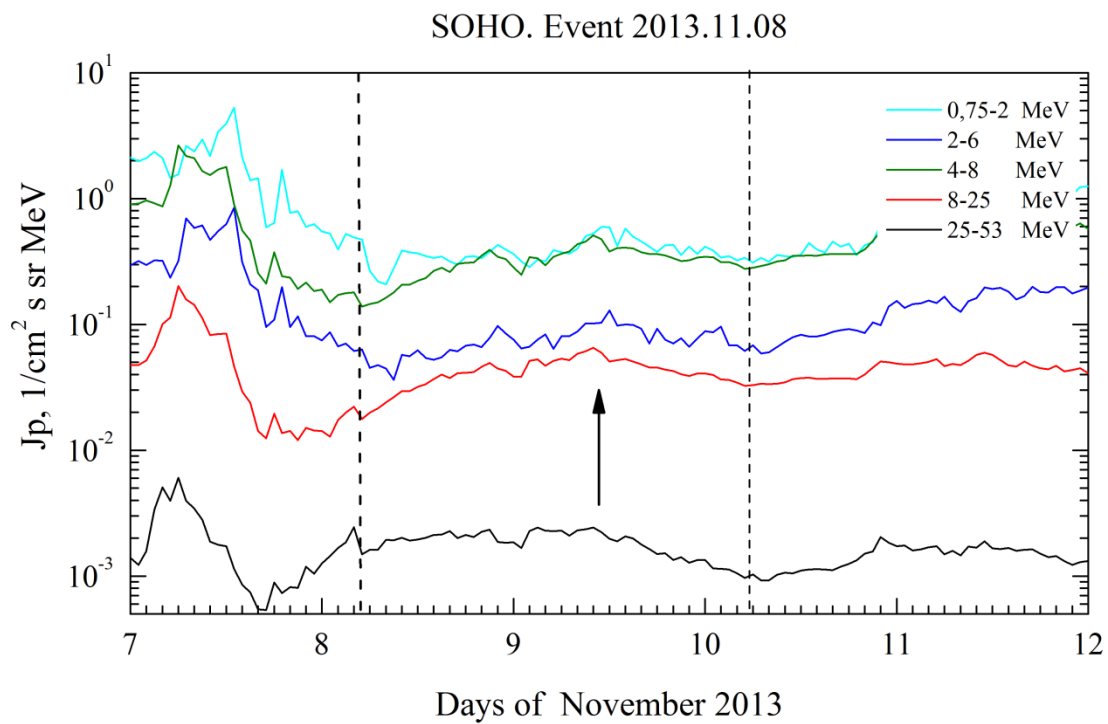
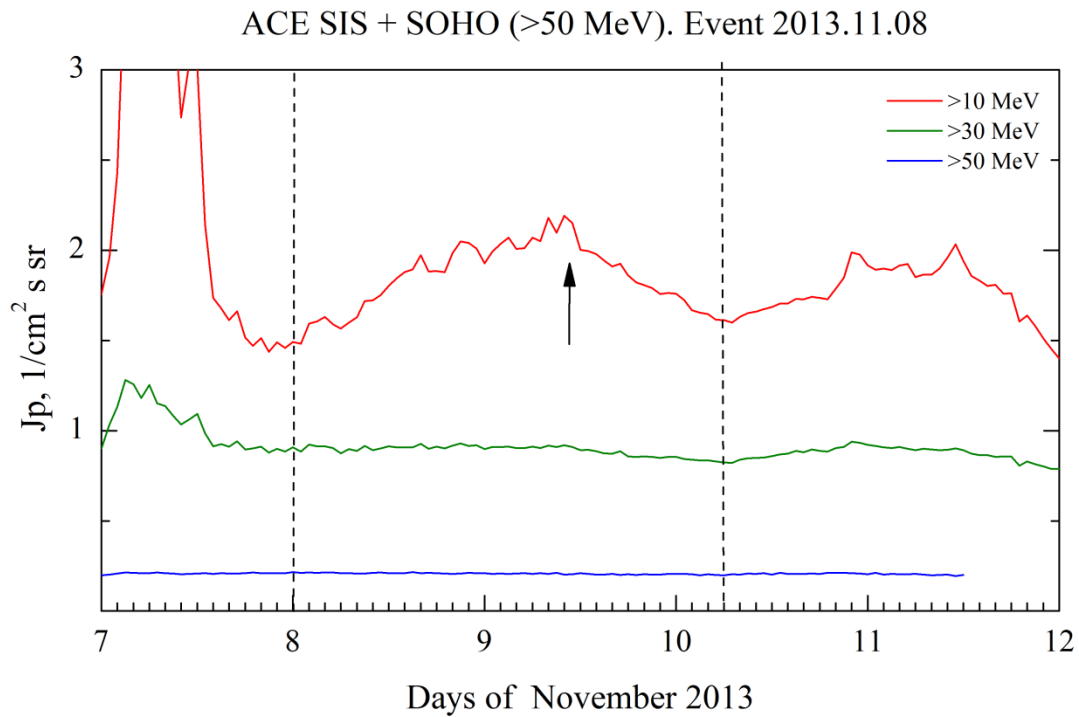
Differential fluxes of protons for the event of 2013 November 08

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	9	9d12	0.22	2	0.37	
LION	2 – 6	10	9d12	0.04	2	0.09	
EPHIN	4 – 8	7	9d11	0.18	2	0.3	
EPHIN	8 – 25	2	9d10	0.045	2.5	0.02	
EPHIN	25 – 53	07d21	9d10	0.0014	2.5	0.001	
Electro-1							
SCR-E	13.7 – 23	5	9d10	0.004	0.5	0.07	
SCR-E	23 – 42	5	9d10	0.001	0.5	0.025	
SCR-E	42 – 112	5	9d10	0.0002	0.5	0.005	



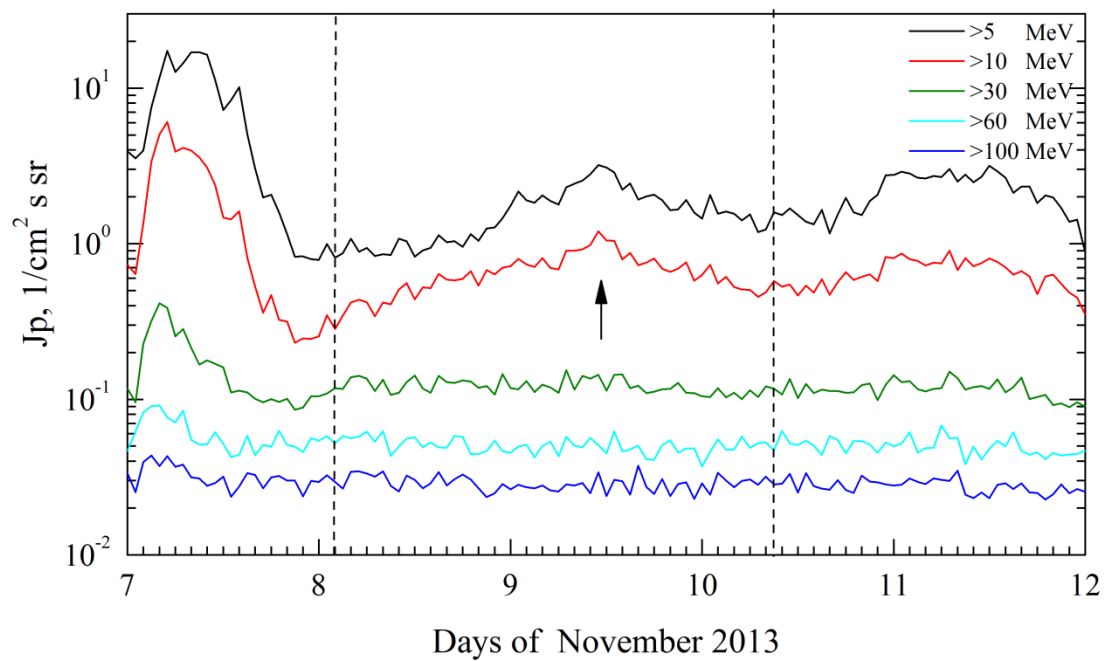
Time profiles of proton fluxes in the event 2013.11.08

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

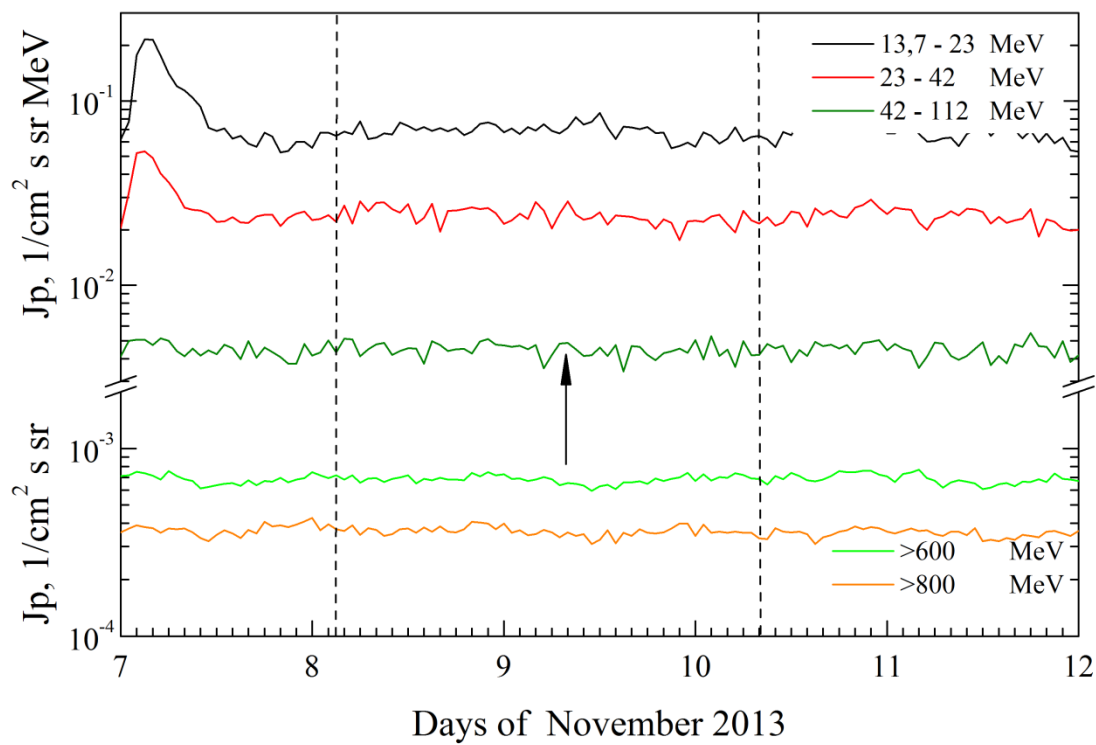


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

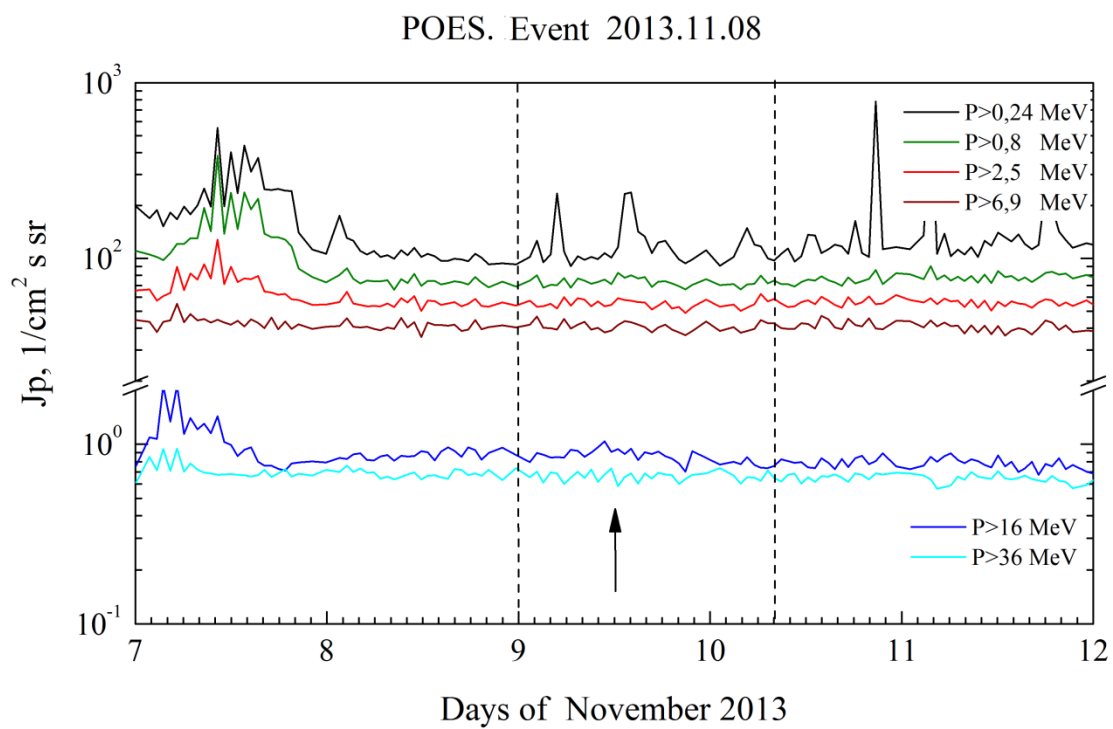
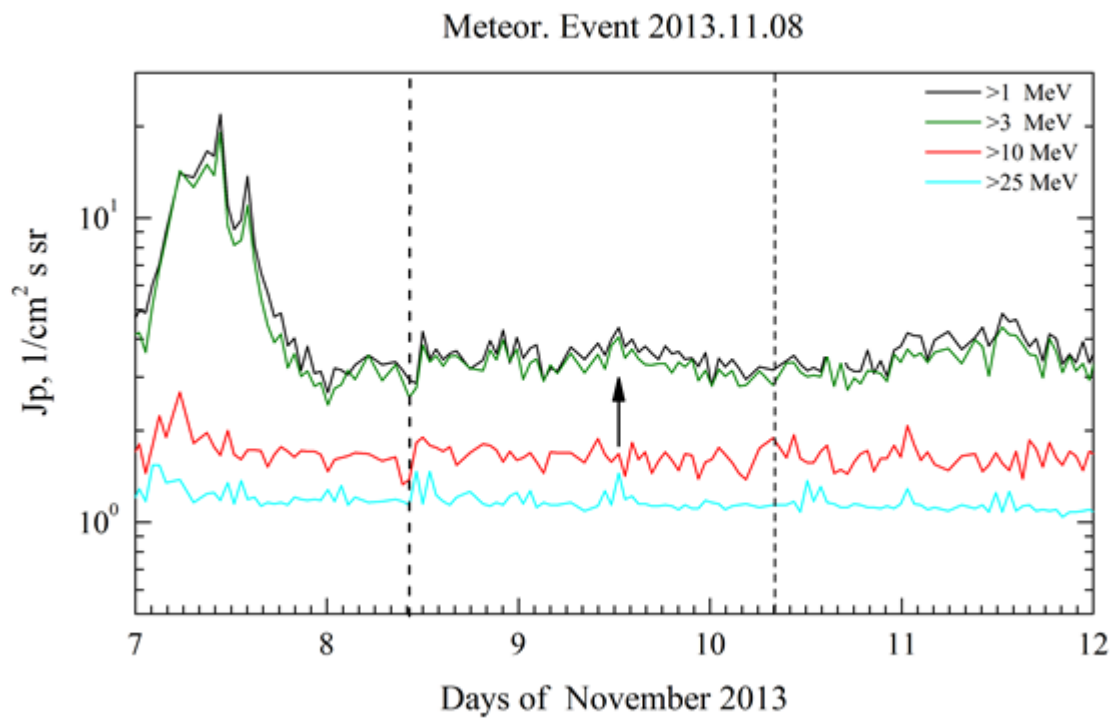
GOES. Event 2013.11.08



Electro. Event 2013.11.08



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 November 08**

2013 November 08

☉

AR 11890

To event 541

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0424	0425	0442	S14E15	2B	ERU
1 – 12	keV	0420	0426	0429		X1.1	0.028
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12–25	keV	0436:33	0436:42	0439:21	2827	49297	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0423	0424	0427	U1.4 / 15	3.58	
8.8	GHz	0423	0424	0427		3,34	
5	GHz	0423	0424	0428		3.18	
2.7	GHz	0424	0425	0429		3.00	
1.4	GHz	0424	0425	0430		2.95	
610	MHz	0424	0425	0431		3.15	
410	MHz	0423	0422	0429		4.11	
245	MHz	0424	0424	0430		4.81	
Ds-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	30-80	0424		0436	834	1	
DS IV	30-80	0424		2359		2	
DS III	40-600	0424		0426		3	

2013

November 07

Ø

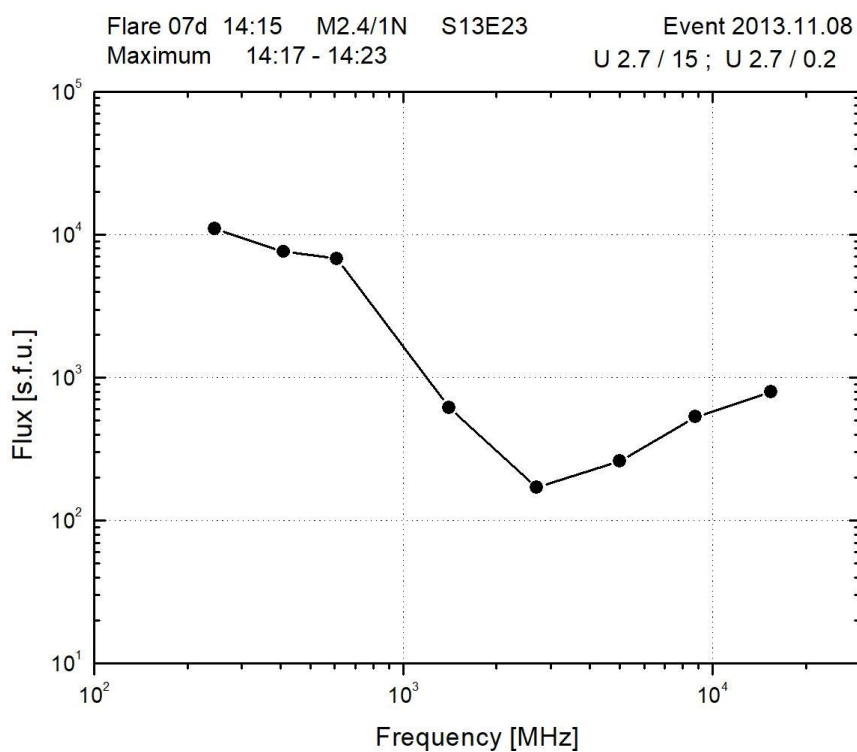
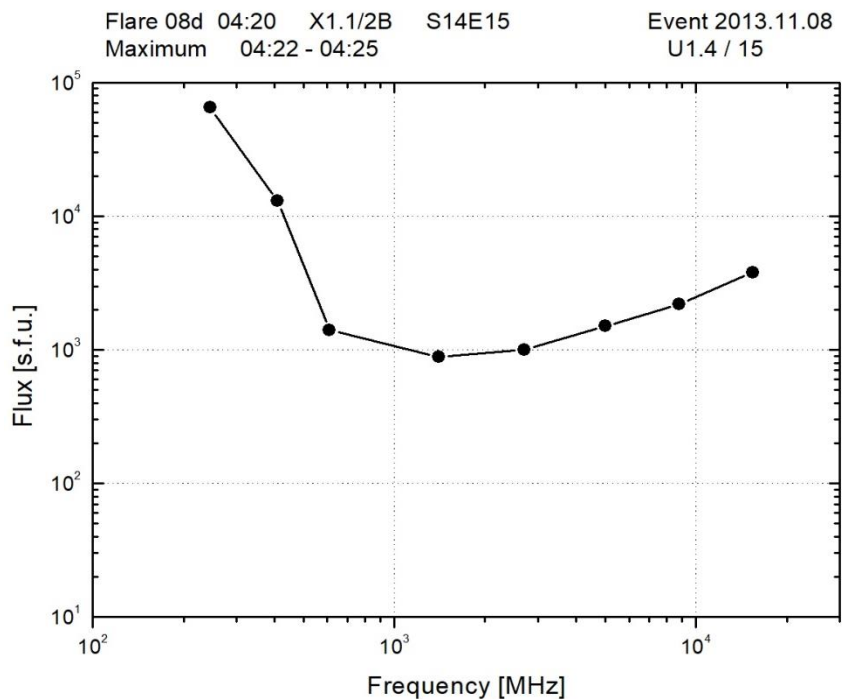
AR 11890

To event 541

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1418	1429	1441	S13E23	1N	ERU
1 – 12	keV	1415	1425	1431		M2.4*	0.012
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12–25	keV	1417:31	1424:29	1433:56	290119	64490320	FERMI
50-100	keV	1426:44	1428:22	1436:00	976	777094	HESSI
6-12	keV	1436:00	1439:06	1454:52	112	364728	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1417	1423	1429	U2.7 / 15	2.90	
8.8	GHz	1417	1423	1430		2.72	
5	GHz	1418	1423	1430		2.41	
2.7	GHz	1418	1419	1430	U2.7 / 0.2	2.23	
1.4	GHz	1417	1418	1430		2.79	
610	MHz	1418	1419	1430		3.83	
410	MHz	1417	1417	1430		3.88	
245	MHz	1417	1417	1429		4.04	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1417		1435	633	1	
DS IV	75-180	1435		1527		1	
DS III	25-180	1417		1420		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1512	411	- 4.9	360°	130°	SOHO

*contribution to the beginning

Radio burst frequency spectrum



Proton Active Region:

AR11890 (S10L113, CMP 8,7.11.2013
Sp=420 msh; EKC; BGD; R)
XRI=7.38; $X_3^{3.3} + M_5^{3.8} + C_{46}^{2.2} + I_5 + S_{36}$
PFR1 5-8.11 (54^h) $X_2^{3.3} + M_3^{3.8}$
PFR2 10 $X_1^{1.1}$

Particle event: To($E_p > 10$ MeV) – 10d08^h

Tmax($E_p > 10$ MeV) – 11d02^h, Jmax($E_p > 10$ MeV) – 0.5 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma = 2.0$

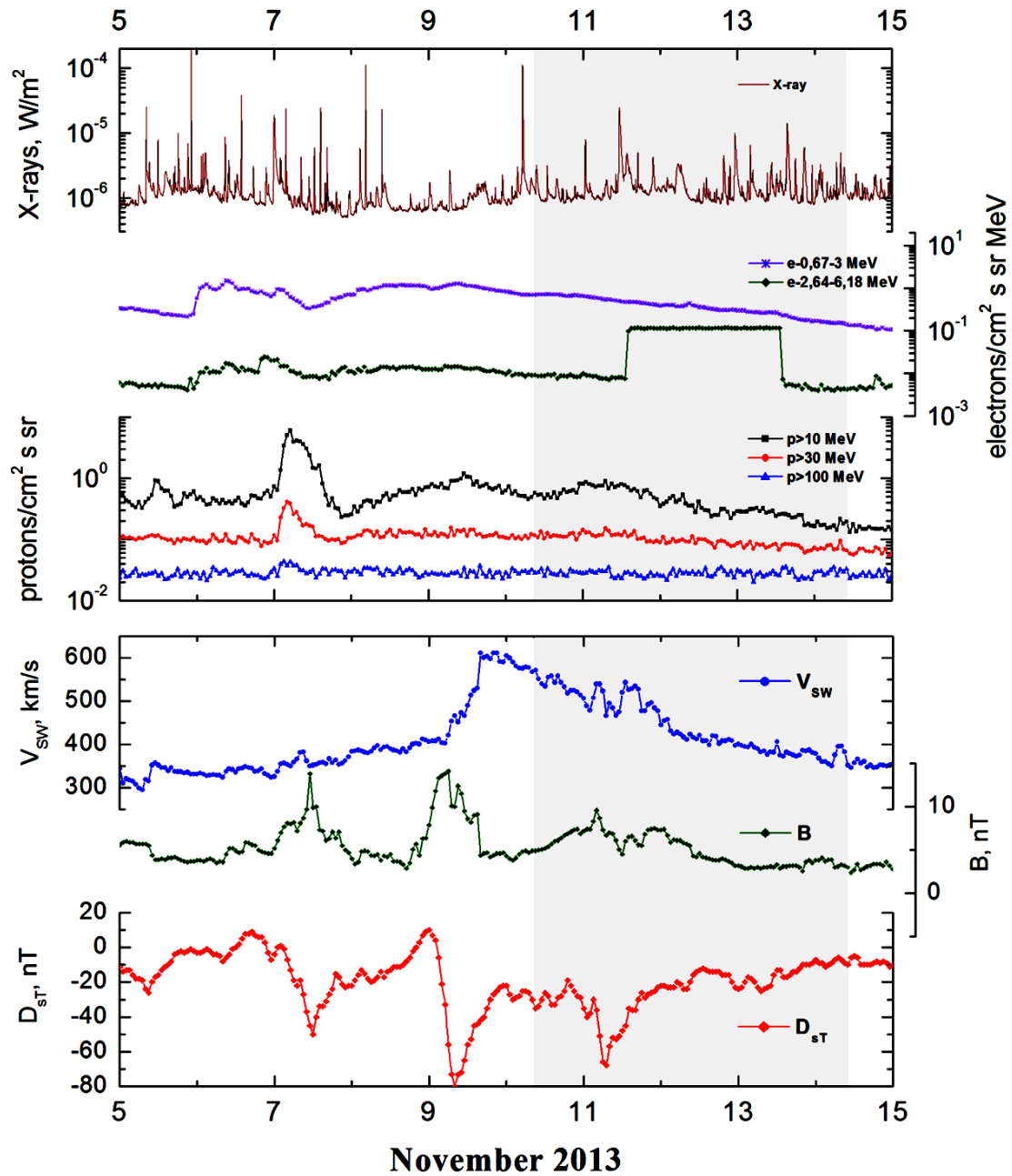
Quasimaximal energy of protons in the event – $E_{qm} = 60$ MeV

Sources: ● solar flare 10d05^h08^m, X1.1/2B, S14W13, AR11890

Main burst X-ray 1–8 Å: onset – 10d05^h08^m, max – 10d05^h14^m, $\Phi = 0.035$ J/m²

CME: 10d05^h36^m, $V = 682$ km/s, $\Delta\phi = 262^\circ$, $dA = 198^\circ$

Particle fluxes and associated phenomena

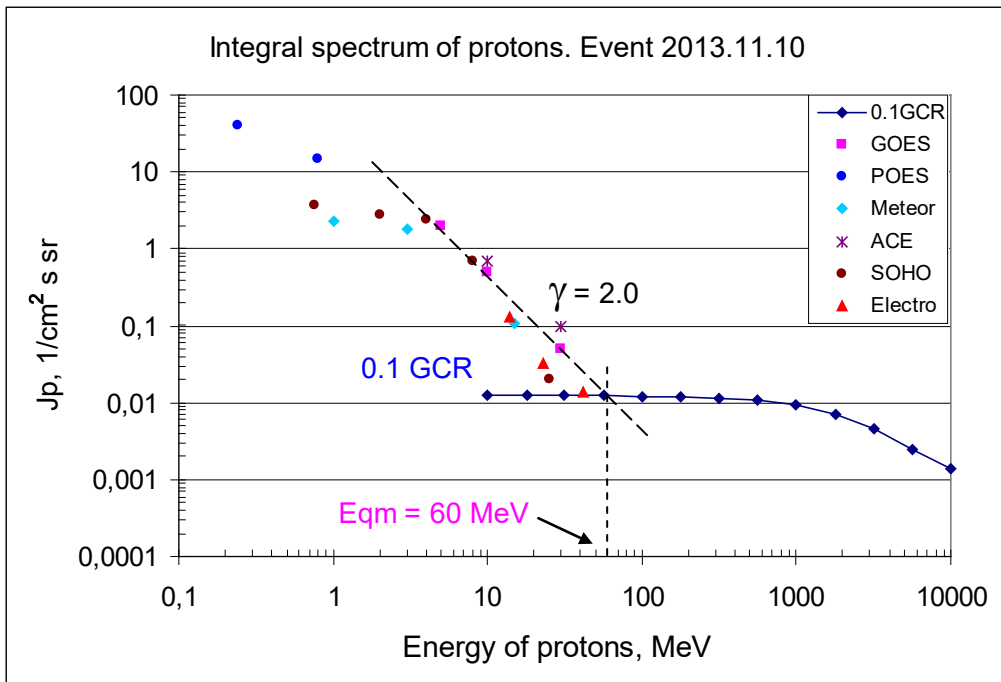


Integral fluxes of protons for the event of 2013 November 10

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	11d02	2	4	1	
EPS	>10	8	11d02	0.5	4	0.4	
EPS	>30	8	11d02	0.05	4	0.1	
EPS	>50	8	-	-	-	0.06	
EPS	>60	8	-	-	-	0.05	
EPS	>100	8	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	20	11d12	40	1.5	100	
MEPED	>0.8	20	11d12	15	1.5	70	
MEPED	>2.5	-	-	-	-	55	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	22	11d12	2.26	1	2.6	
SCR	>3	22	11d12	1.83	1	2.5	
SCR	>10	-	-	-	-	-	
GALS-M	>15	22	11d13	0.11	0.5	1.7	
GALS-M	>25	-	-	-	-	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	4	11d07	0.7	4	1.2	
SIS	>30	4	11d07	0.1	4	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2013 November 10

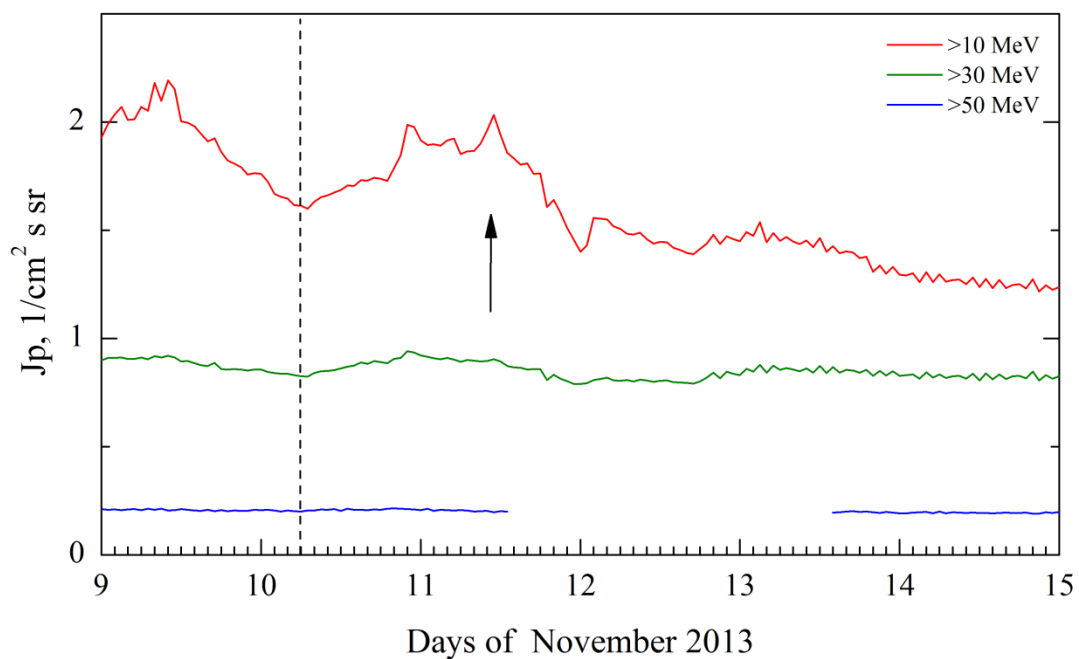
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	05	11d12	0.8	4	0.37	
LION	2 – 6	05	11d11	0.11	4	0.09	
EPHIN	4 – 8	05	11d11	0.43	4	0.3	
EPHIN	8 – 25	05	11d11	0.04	4	0.02	
EPHIN	25 – 53	05	11d11	0.0007	4	0.001	
Electro-1							
SCR-E	13.7–23	18	11 d11	0.01	0.5	0.07	
SCR-E	23–42	18	11d11	0.001	0.5	0.025	
SCR-E	42–112	18	11d11	0.0002	0.5	0.0045	



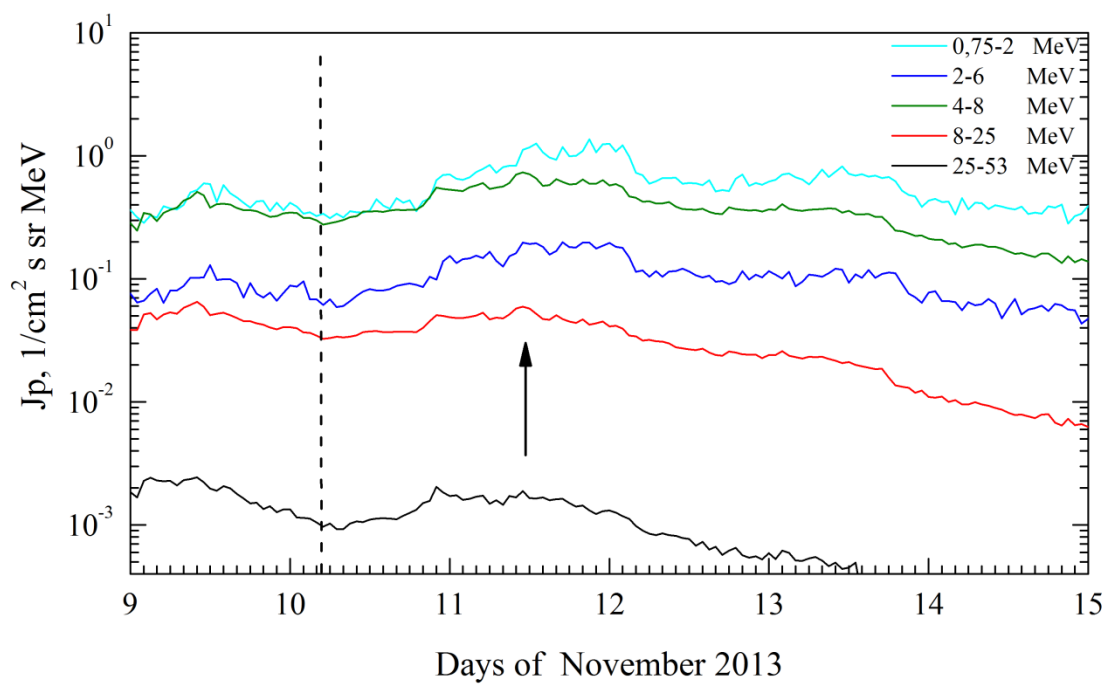
Time profiles of proton fluxes in the event 2013.11.10

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.11.10

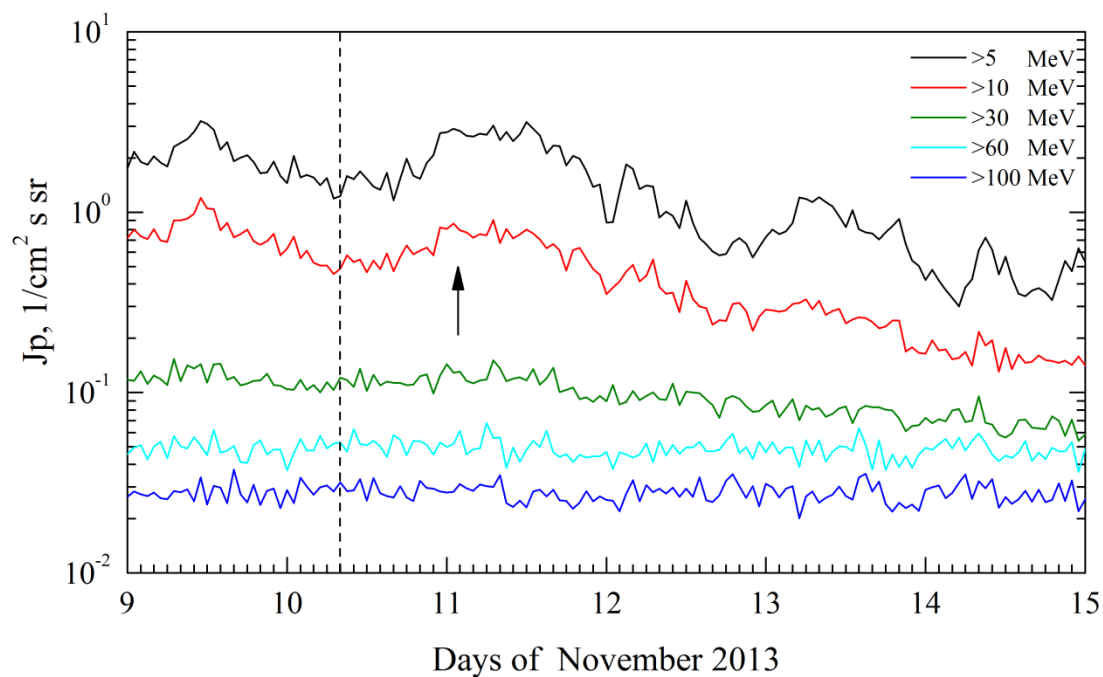


SOHO. Event 2013.11.10

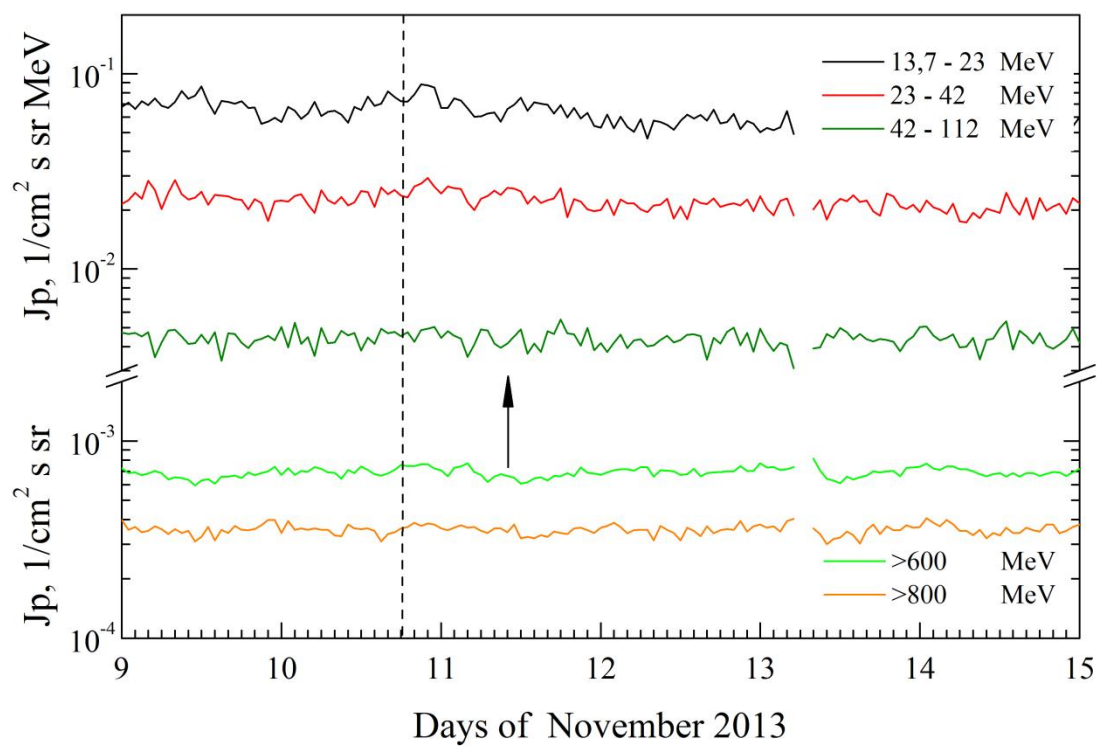


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

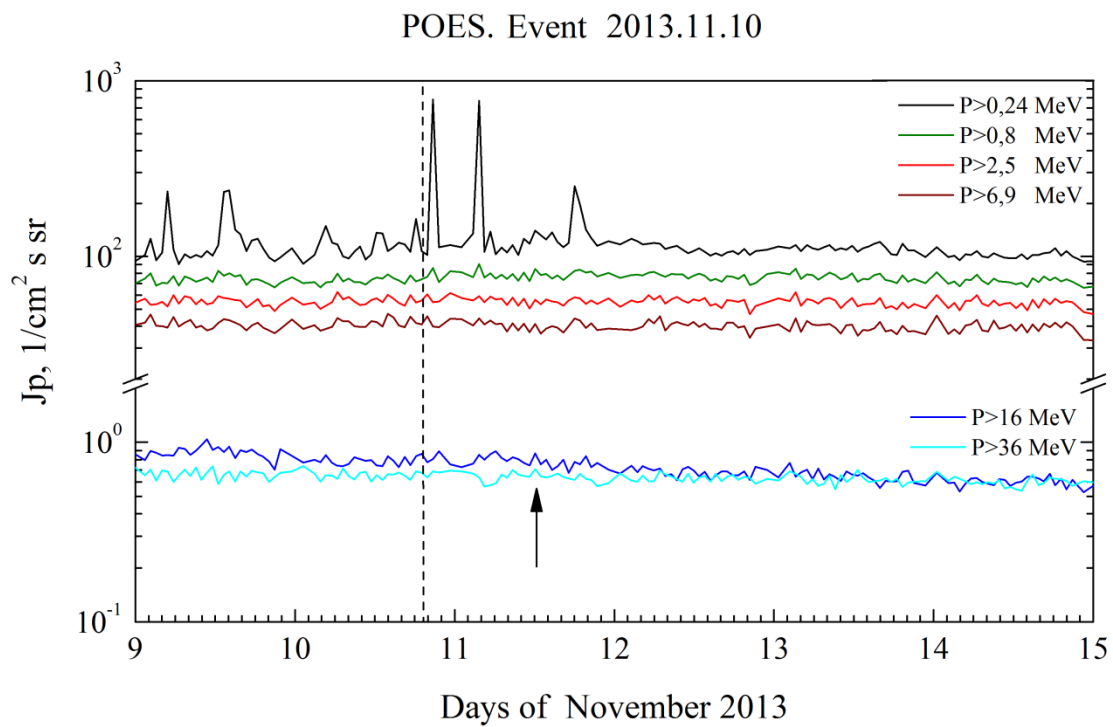
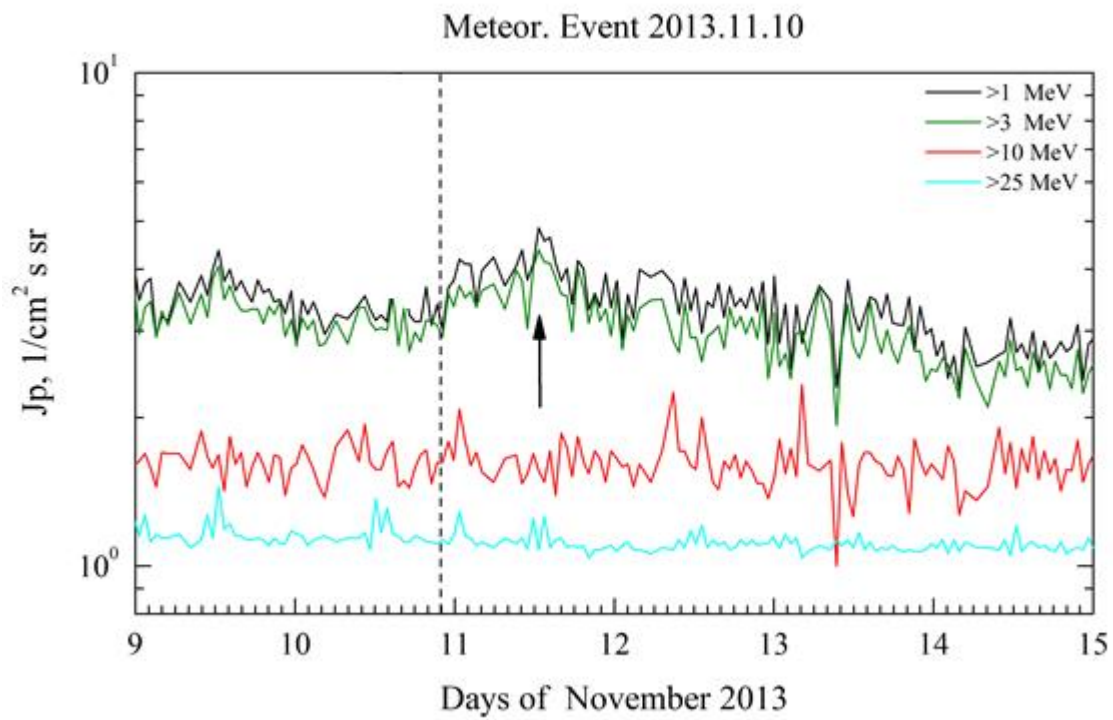
GOES. Event 2013.11.10



Electro. Event 2013.11.10



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 November 10**

2013

November 10

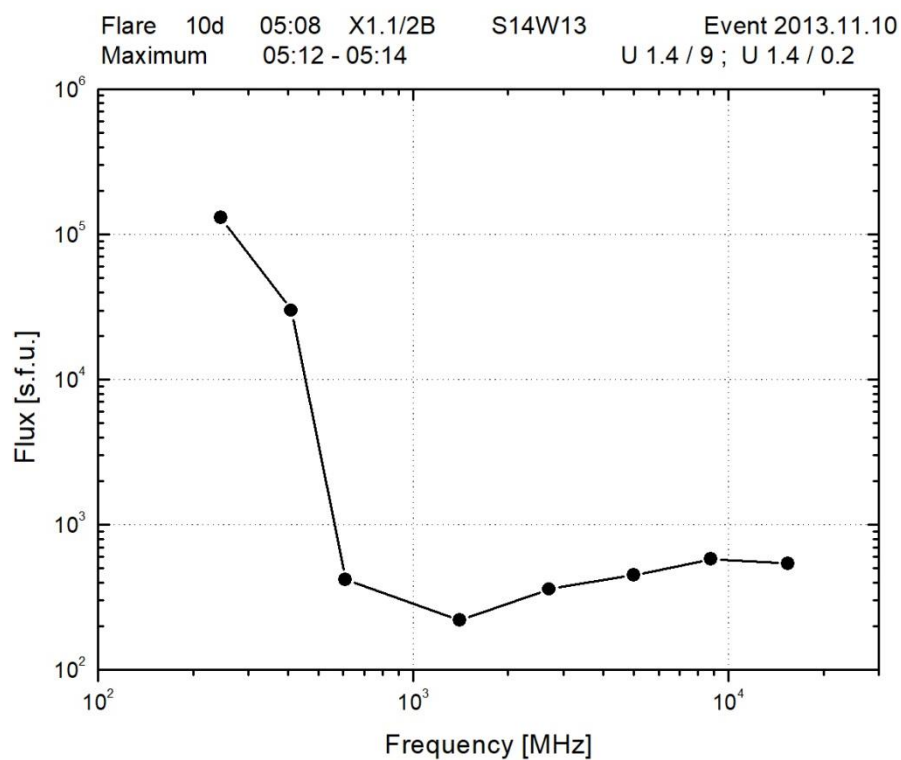
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AR 11890

To event 542

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0510	0514	0536	S14W13	2B	ERU
1 – 12	keV	0508	05145	0518		X1.1	0.035
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0507:16	0513:46	0524:00	9303	12815907	HESSI
12-25	keV	0508:34	0513:07	0519:16	750040	173204480	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0510	0512	0514	U1.4 / 9	2.73	
8.8	GHz	0509	0513	0515		2.76	
5	GHz	0509	0513	0514		2.65	
2.7	GHz	0512	0513	0514		2.56	
1.4	GHz	0512	0513	0514	U1.4 / 0.2	2.34	
610	MHz	0513	0514	0514		2.62	
410	MHz	0512	0513	0514		4.48	
245	MHz	0513	0514	0516		5.11	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-180	0513		0525	1012	2	
DS IV	75-169	0534		1010		1	
DS III	130-00?	0513		0515		3	
DS III	20-160	0520		0523		2	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0536	682	- 41.8	262°	198°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11890 (S10L113, CMP 8,7.11.2013,
Sp=420 msh; EKC; BGD; R)
XRI=7.38; $X_3^{3.3} + M_5^{3.8} + C_{46}^{2.2+1.5} + S_{36}$
PFR1 5-8.11 (54^h) $X_2^{3.3} + M_3^{3.8}$;
PFR2 10 $X_1^{1.1}$

Particle event: To($E_p > 10$ MeV) – 19d12^h

Tmax($E_p > 10$ MeV) – 19d19^h, Jmax($E_p > 10$ MeV) – $3.4 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

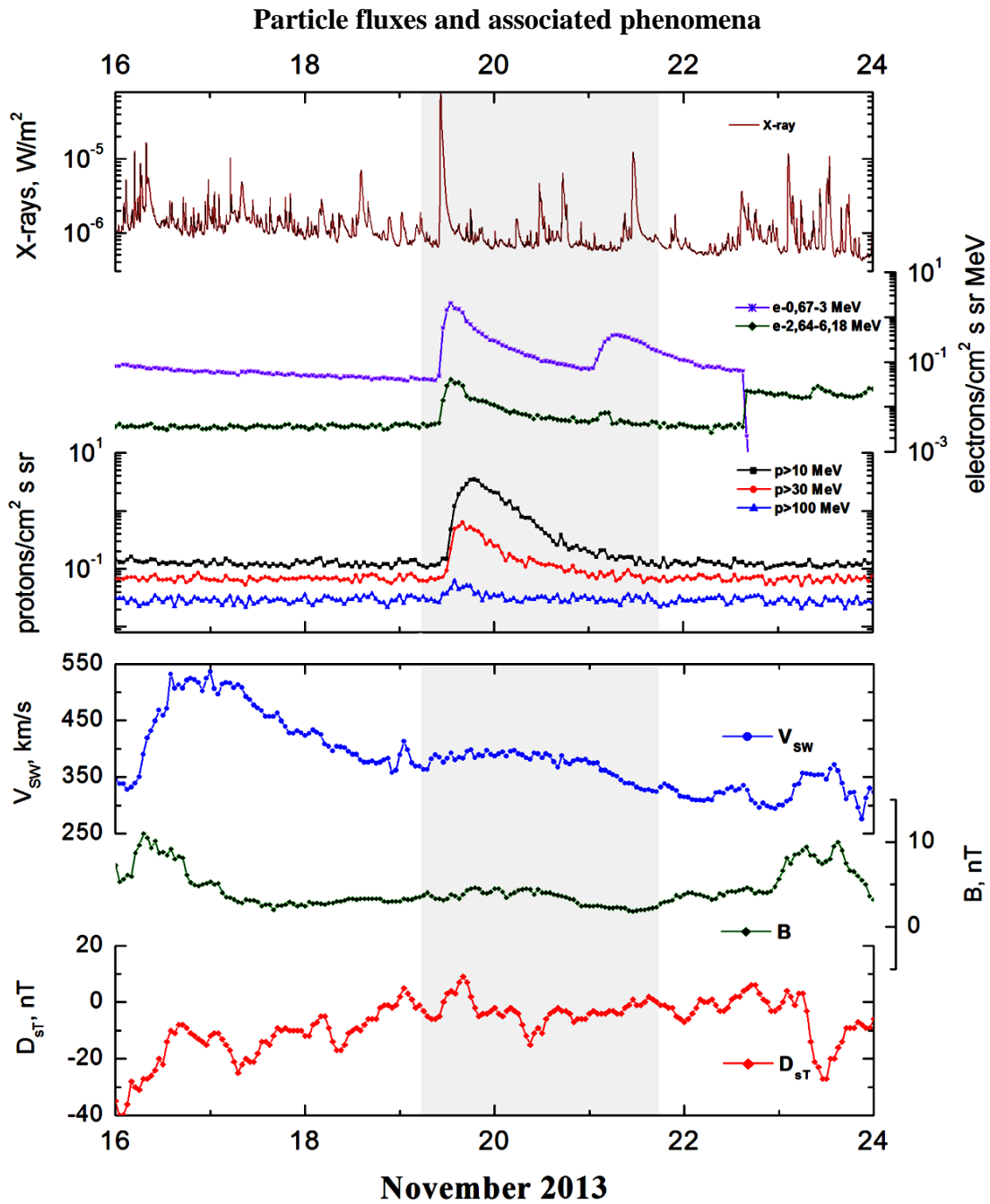
Duration of the event – 2 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 130$ MeV

Sources: • solar flare 19d10^h14^m, X1.0/SF, S13W69, AR11893

Main burst X-ray 1–8 Å: onset – 19d10^h14^m, max – 19d10^h26^m, $\Phi = 0.066 \text{ J/m}^2$

CME: 19d10^h36^m, $V = 740 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 222^\circ$

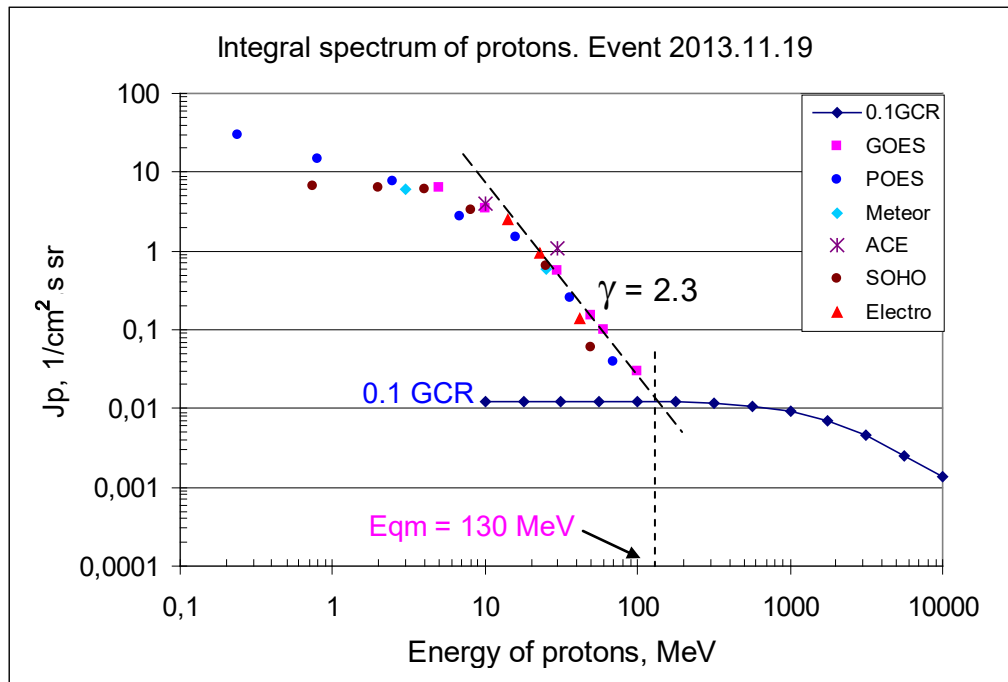


Integral fluxes of protons for the event of 2013 November 19

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	12	20	6.5	2	0.2	
EPS	>10	12	19	3.4	2	0.12	
EPS	>30	12	16	0.55	1.5	0.07	
EPS	>50	12	16	0.15	1.5	0.06	
EPS	>60	12	16	0.1	1	0.05	
EPS	>100	12	14	0.03	0.5	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	15	20	30	1.5	90	
MEPED	>0.8	15	20	15	1.5	70	
MEPED	>2.5	14	20	7.8	15	50	
MEPED	>6.9	13	20	2.8	1	40	
MEPED	>16	12	18	1.5	1	0.7	
MEPED	>36	12	18	0.25	0.5	0.75	
MEPED	>70	12	17	0.04	0.5	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	11	-	-	2	2.6	
SCR	>3	11	19	6	2	2.5	
SCR	>10	11	-	-	1	1.65	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	11	14	0.6	1	1.15	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	10	16	4	1	1.2	
SIS	>30	10	16	1.1	1	0.8	
SOHO							
EPHIN	>50	11	15	0.06	0.5	0.2	

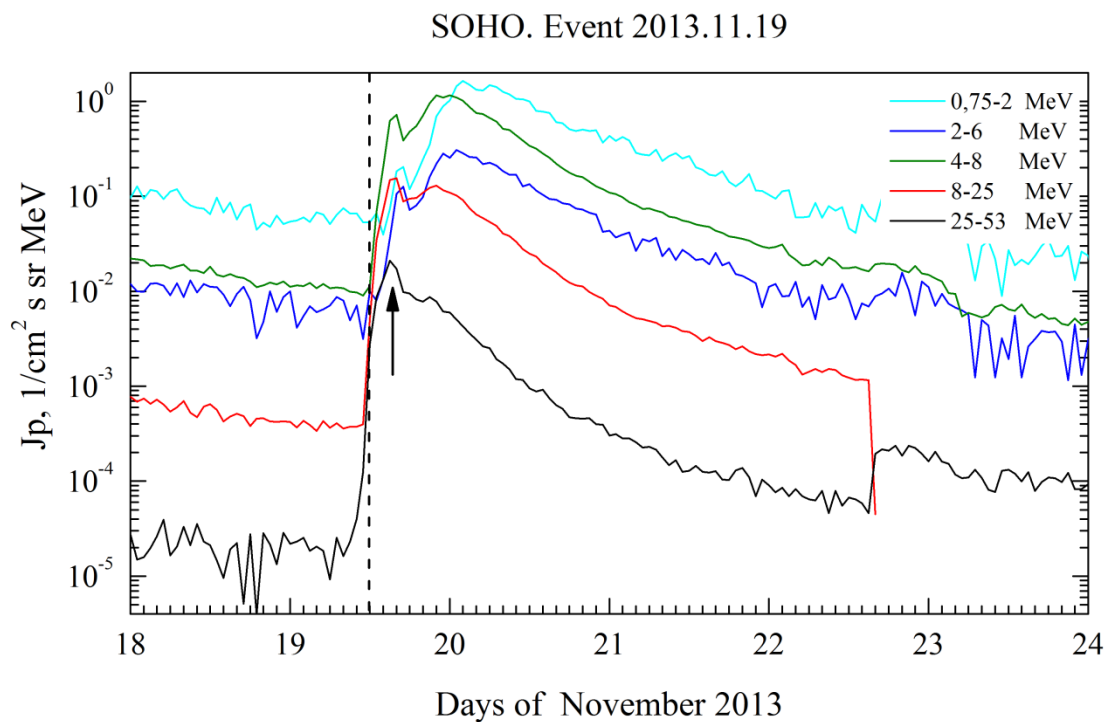
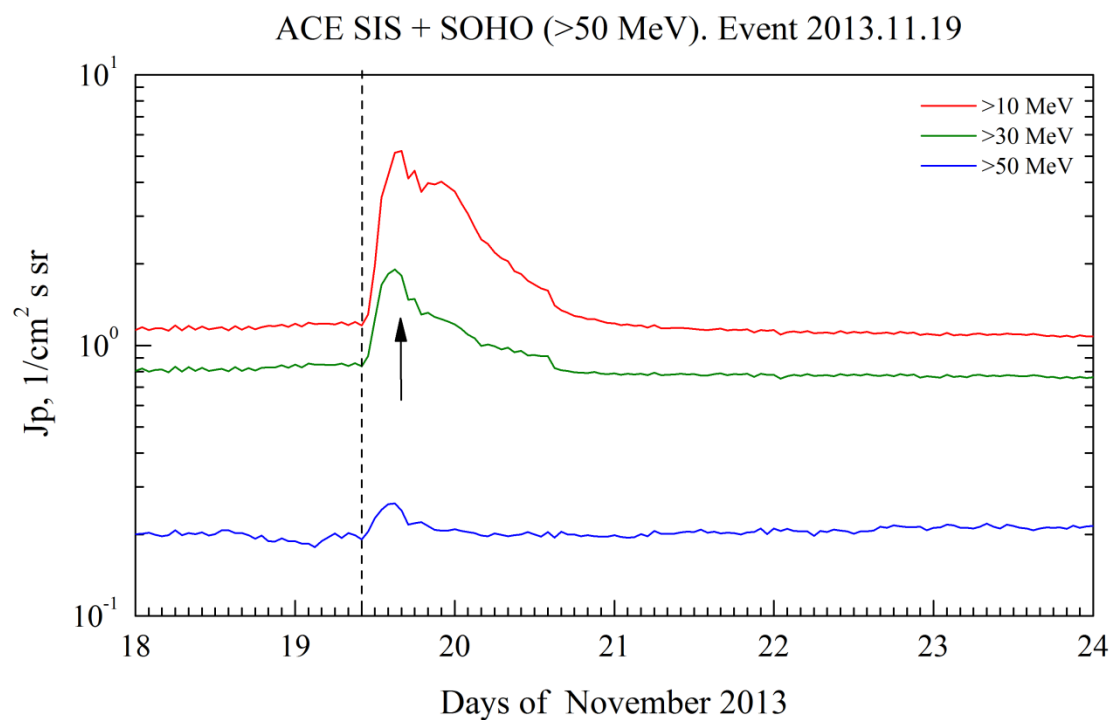
Differential fluxes of protons for the event of 2013 November 19

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	15	17	0.14	2.5	0.06	
LION	2 – 6	14	17	0.12	2.5	0.007	
EPHIN	4 – 8	14	16	0.7	2.5	0.01	
EPHIN	8 – 25	12	16	0.155	2.5	0.0003	
EPHIN	25 – 53	11	15	0.021	2.5	0.00002	
Electro-1							
SCR-E	13.7–23	9	16	0.17	1	0.05	
SCR-E	23–42	9	16	0.042	1	0.02	
SCR-E	42–112	-	16	0.002	0.5	0.004	



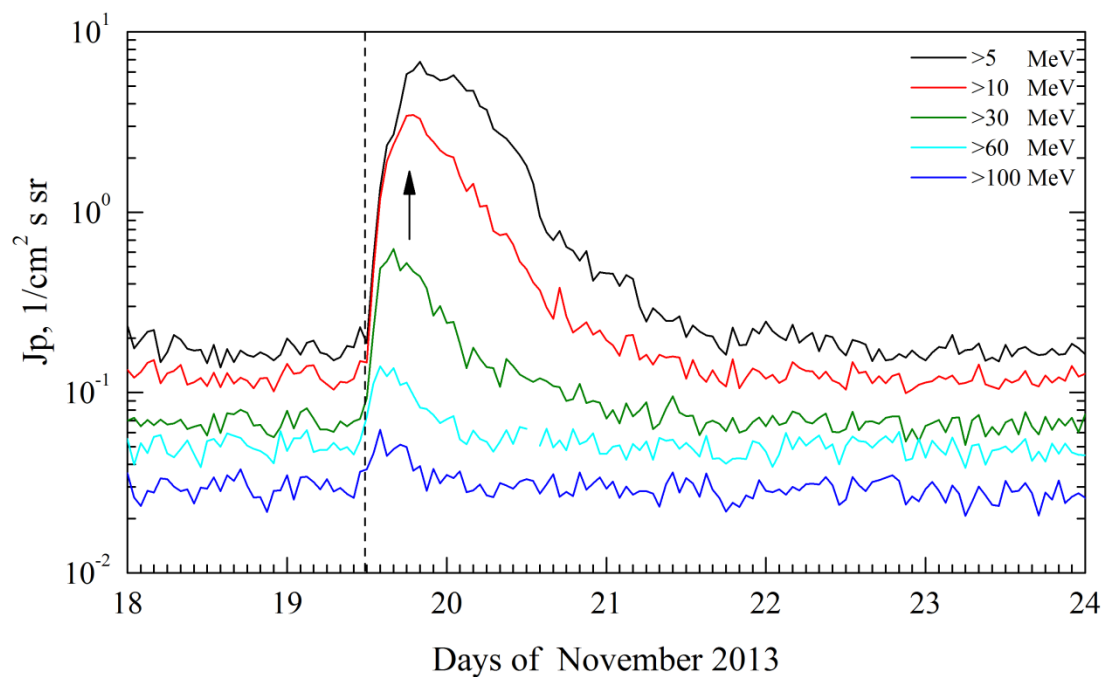
Time profiles of proton fluxes in the event 2013.11.19

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

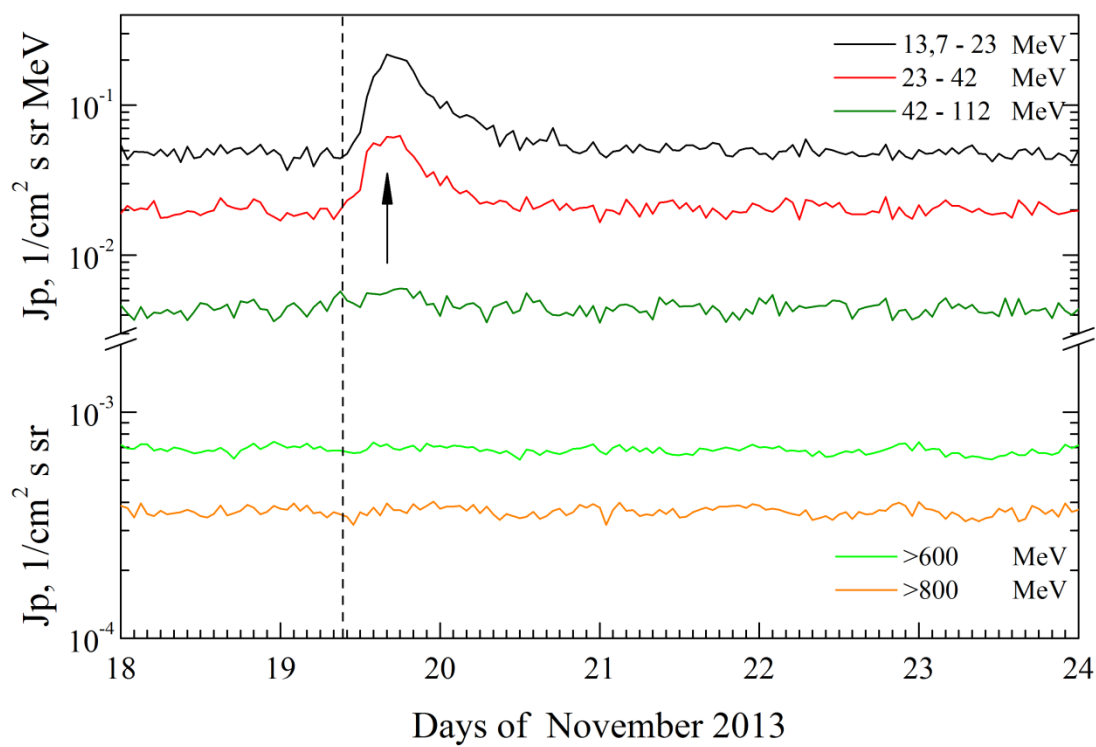


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.11.19

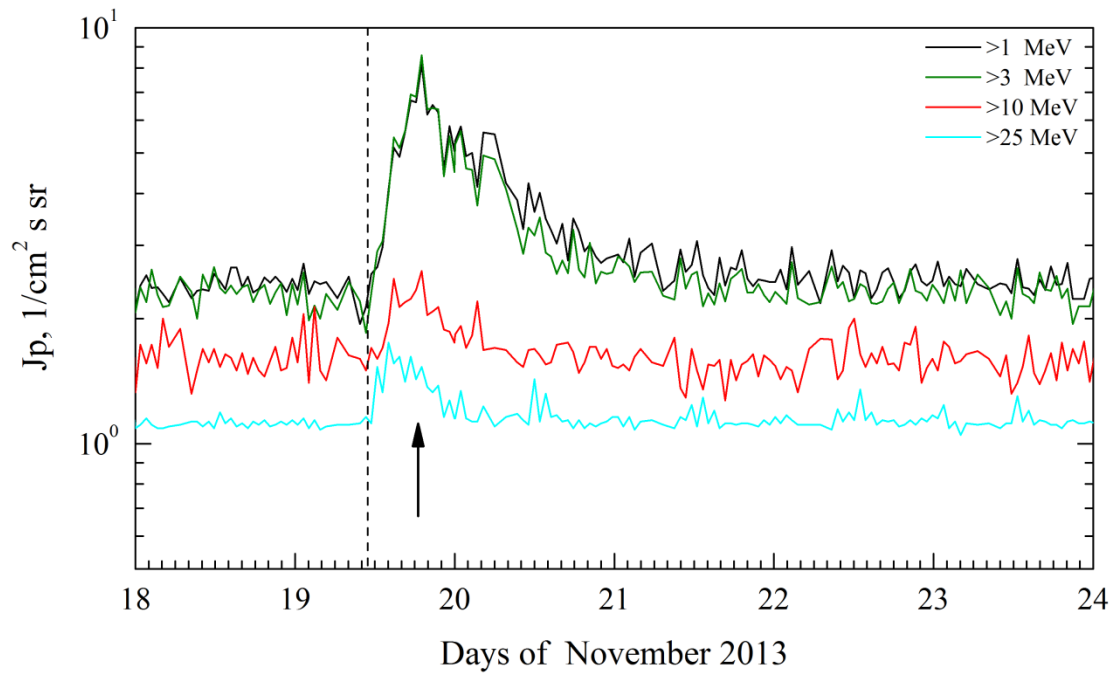


Electro. Event 2013.11.19

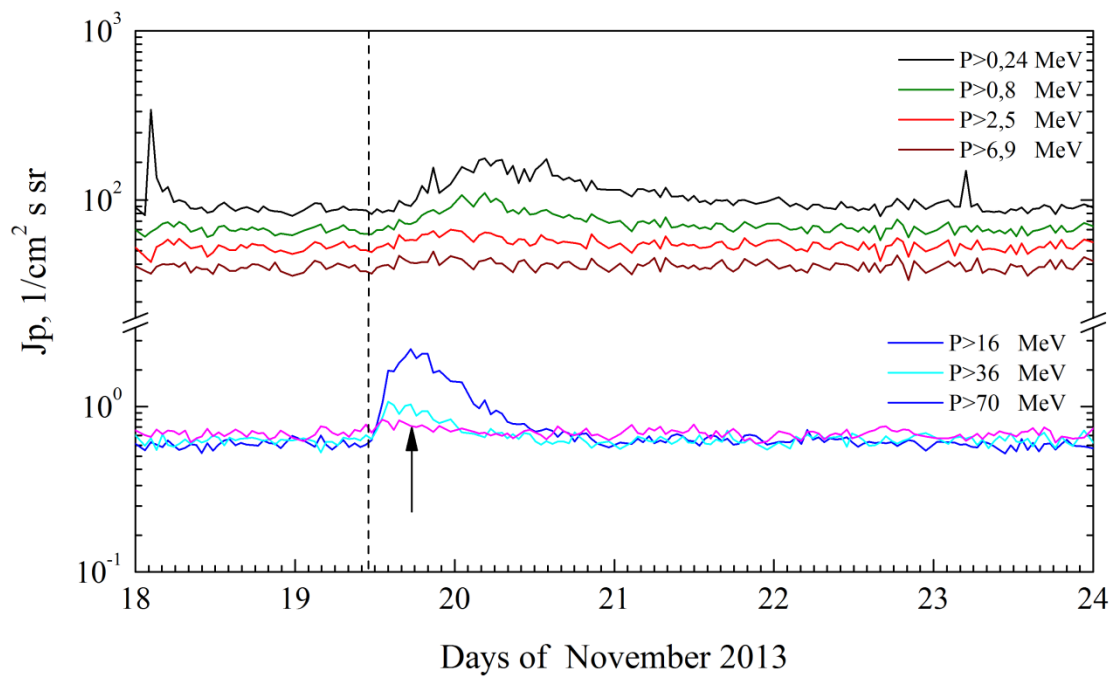


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.11.19



POES. Event 2013.11.19



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 November 19**

2013

November 19

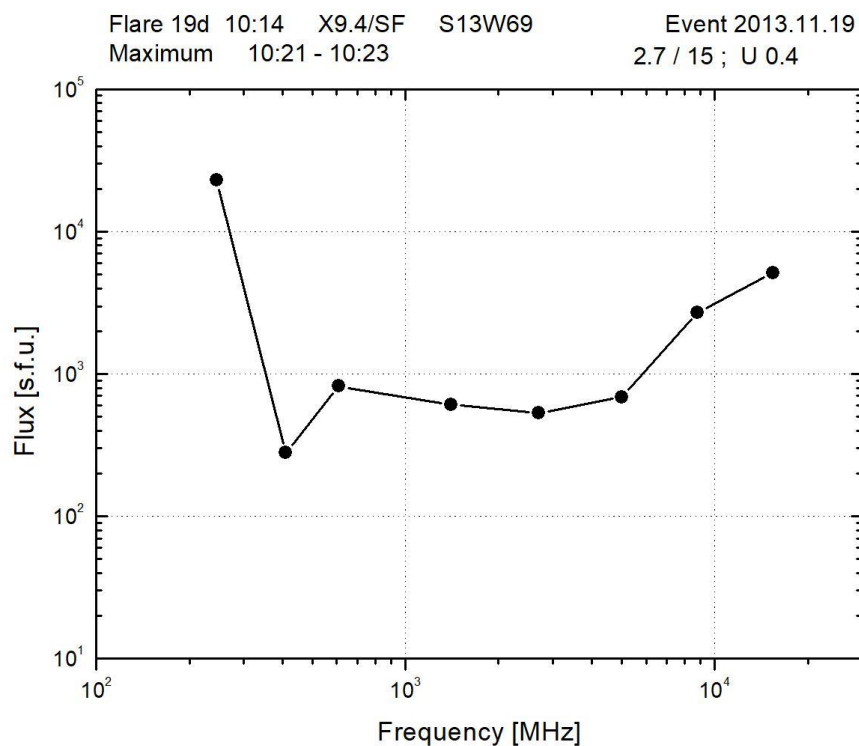
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AR 11893

To event 543

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1024	1024	1035	S14W70	SF	
1 – 12	keV	1014	1026	1034	S13W69	X1.0	0.066
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1042:28	1043:02	1055:56	656	1988690	HESSI
6-12	keV	1123:12	1123:26	1138:52	30	106456	HESSI
6-12	keV	1140:20	1138:52	1140:36	11	1040	HESSI
12-25	keV	1008:14	1023:07	1025:56	779248	209146912	FERMI
12-25	keV	1101:45	1101:57	1107:49	2516	176309	FERMI
12-25	keV	1128:45	1132:59	1137:53	979	120510	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1017	1022	1029	2.7 / 15	3.71	
8.8	GHz	1018	1023	1029		3.43	
5	GHz	1020	1023	1029		2.84	
2.7	GHz	1020	1021	1027		2.72	
1.4	GHz	1020	1022	1024		2.78	
610	MHz	1020	1021	1024		2.91	
410	MHz	1022	1023	1024	U0.4	2.45	
245	MHz	1022	1023	1025		4.36	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	36-180	1024		1029	1049	1	
DH II	14-0.1	1039		2020			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1036	740	- 2.0	360°	222°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11893 (S13L098, CMP14, 2.11.2013;
Sp=480 msh; EKI; BGD; R)
XRI=1.12 $X_1^{1.0} + M_1^{1.2} + C_{11}$
PFR 19.11 $X_1^{1.0}$

References:

Махмутов В.С., Базилевская Г.А., Стожков Ю.И. и др., [2015](#).
Мирошниченко Л.И., Ли Ч., Янке В.Г., [2020](#).
Bruno A., I.G. Richardson, [2021](#).
Miroshnichenko L.I., C. Li, V.G. Yanke, [2020](#).
Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 14d06^h

Tmax ($E_p > 10$ MeV) – 15d01^h, Jmax ($E_p > 10$ MeV) – 1.1 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 60$ MeV

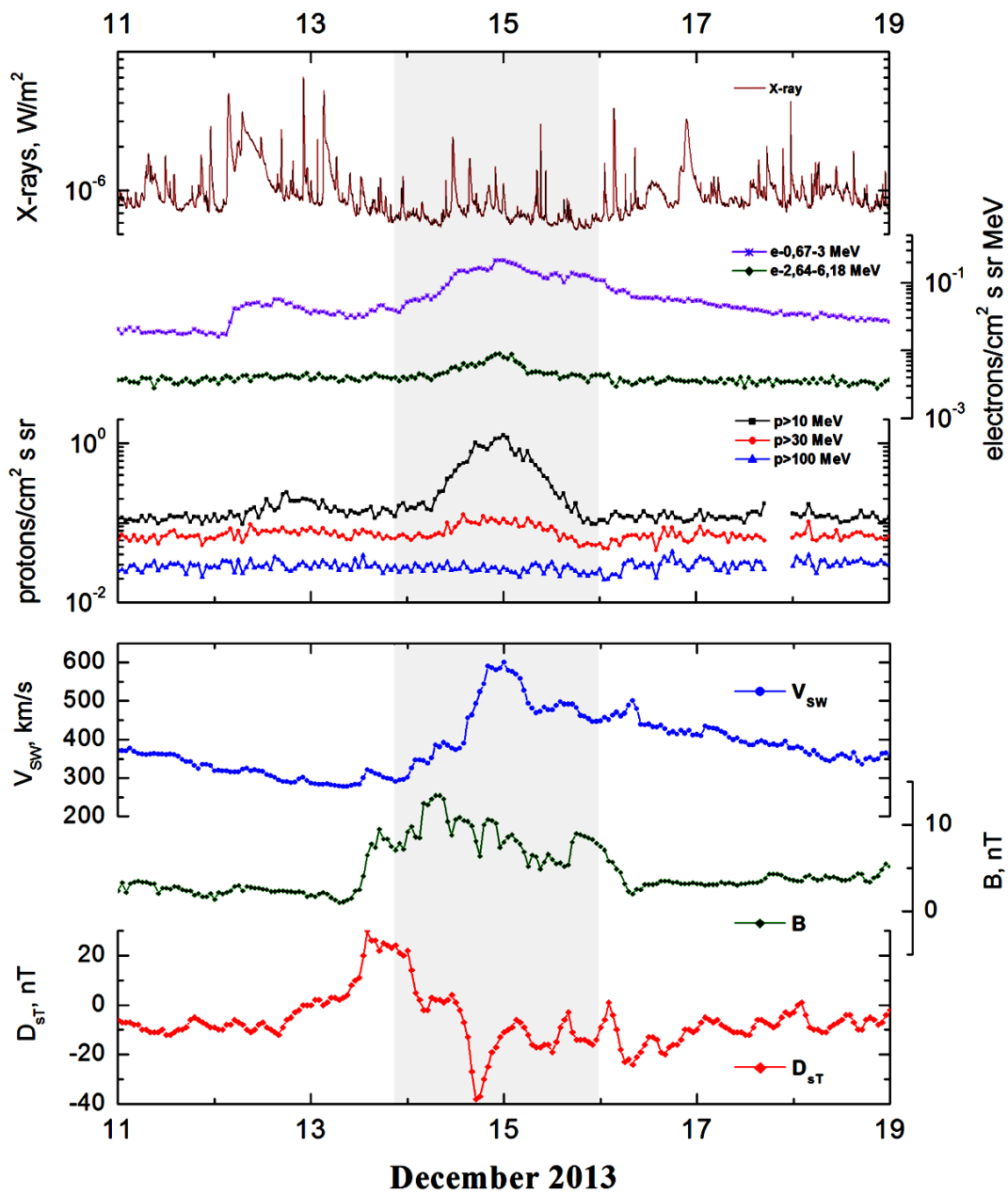
Sources: \square back side solar flare 14d<06^h36^m, AR unknown, behind E_L

CME: 14d06^h36^m, $V=611$ km/s, $\Delta\phi=121^\circ$, $dA=112^\circ$

\emptyset CME: 14d21^h24^m, $V=611$ km/s, $\Delta\phi=360^\circ$, $dA=169^\circ$

\blacktriangle SC 15d17^h27^m

Particle fluxes and associated phenomena

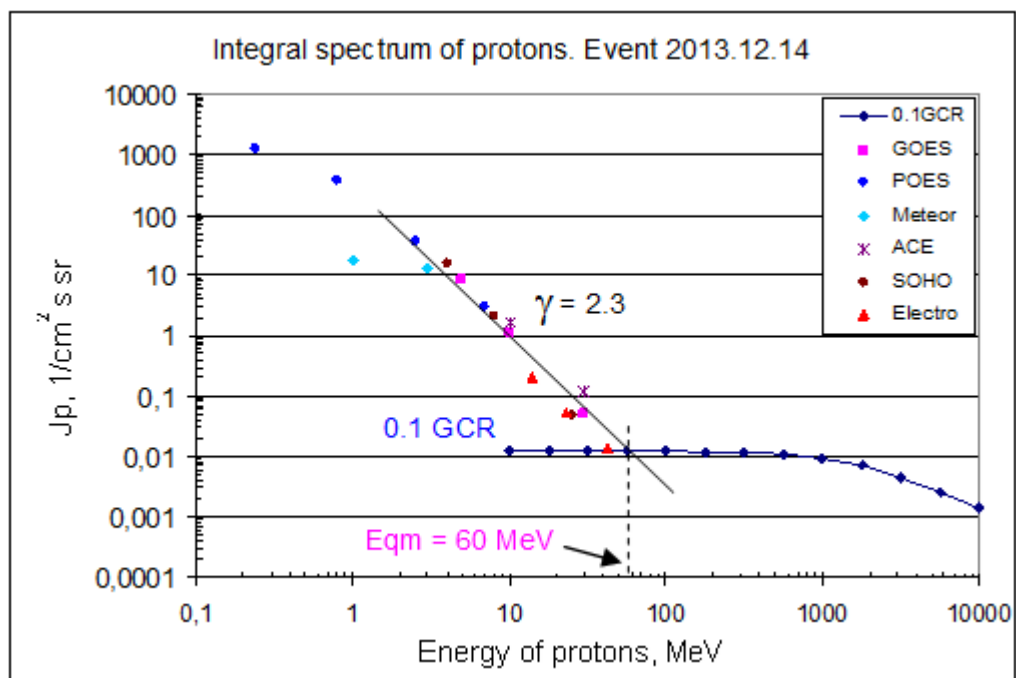


Integral fluxes of protons for the event of 2013 December 14

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	6	15d00	8.5	1.5	0.2	
EPS	>10	6	15d01	1.1	1.5	0.12	
EPS	>30	10	15d00	0.05	1.5	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	6	24	1230	2	90	
MEPED	>0.8	6	24	375	2	70	
MEPED	>2.5	6	24	37	2	50	
MEPED	>6.9	-	24	3	1	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	6	15d00	18	1.5	3	
SCR	>3	6	15d00	13.3	1.5	3.1	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	4	23	1.6	1.5	1.2	
SIS	>30	4	23	0.12	1.5	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2013 December 14

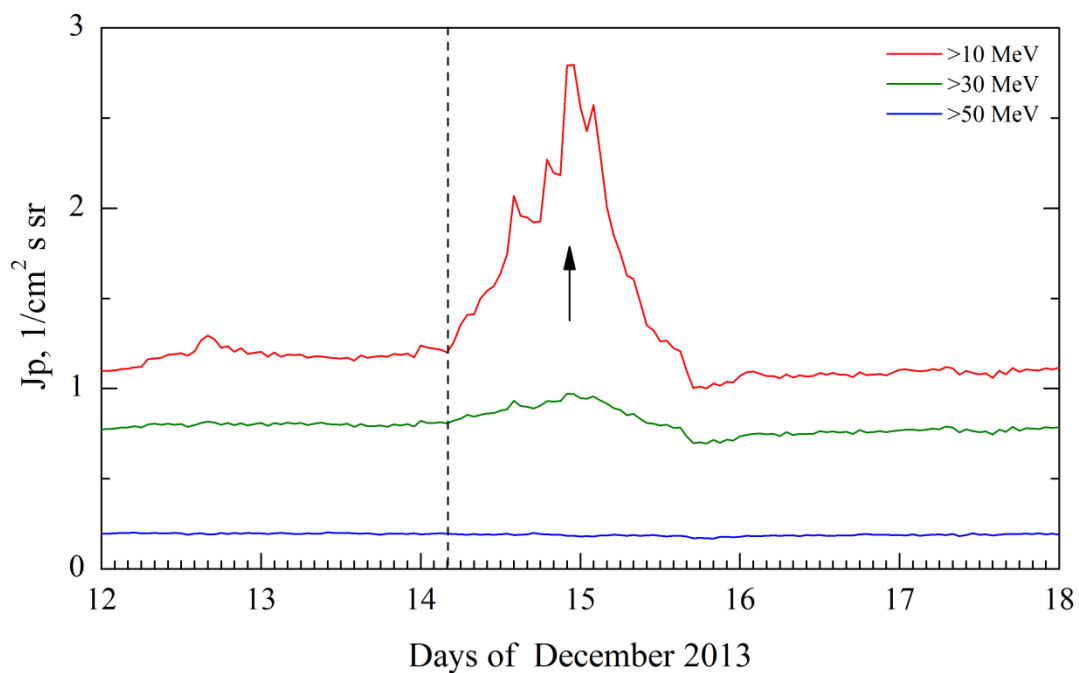
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	5	14d23	3.35	2	0.0003	
EPHIN	8 – 25	5	14d23	0.12	2	0.000006	
EPHIN	25 – 53	5	14d23	0.0017	2	0.000002	
Electro-1							
SCR-E	13.7–23	4	18	0.016	1.5	0.05	
SCR-E	23–42	4	18	0.002	1	0.02	
SCR-E	42–112	-	18	0.0007	-	0.004	



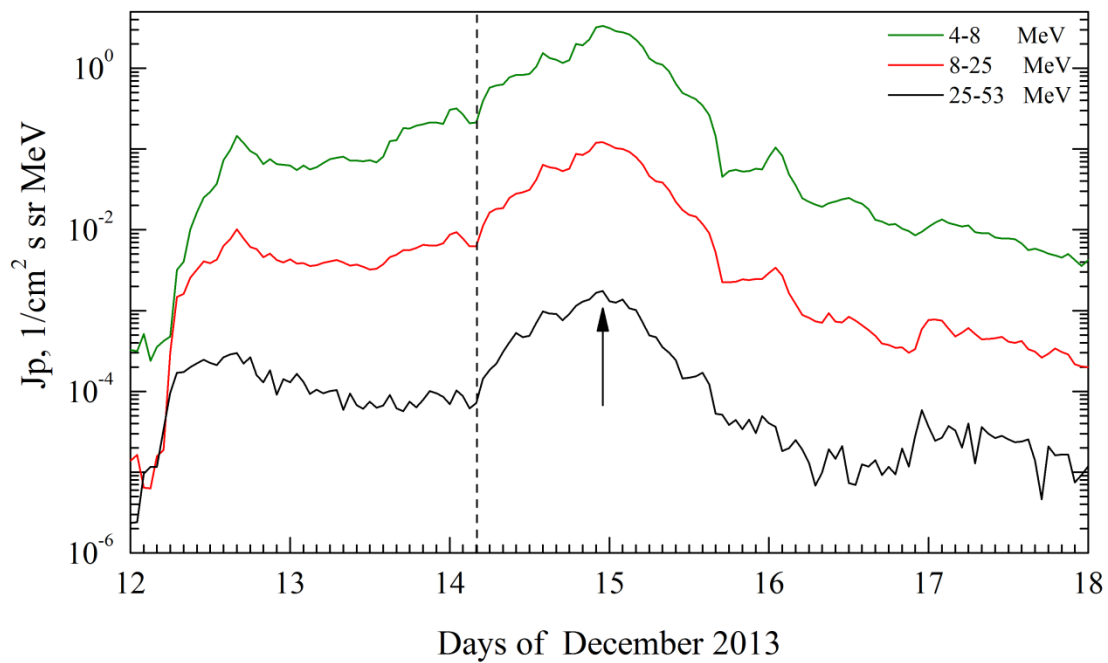
Time profiles of proton fluxes in the event 2013.12.14

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2013.12.14

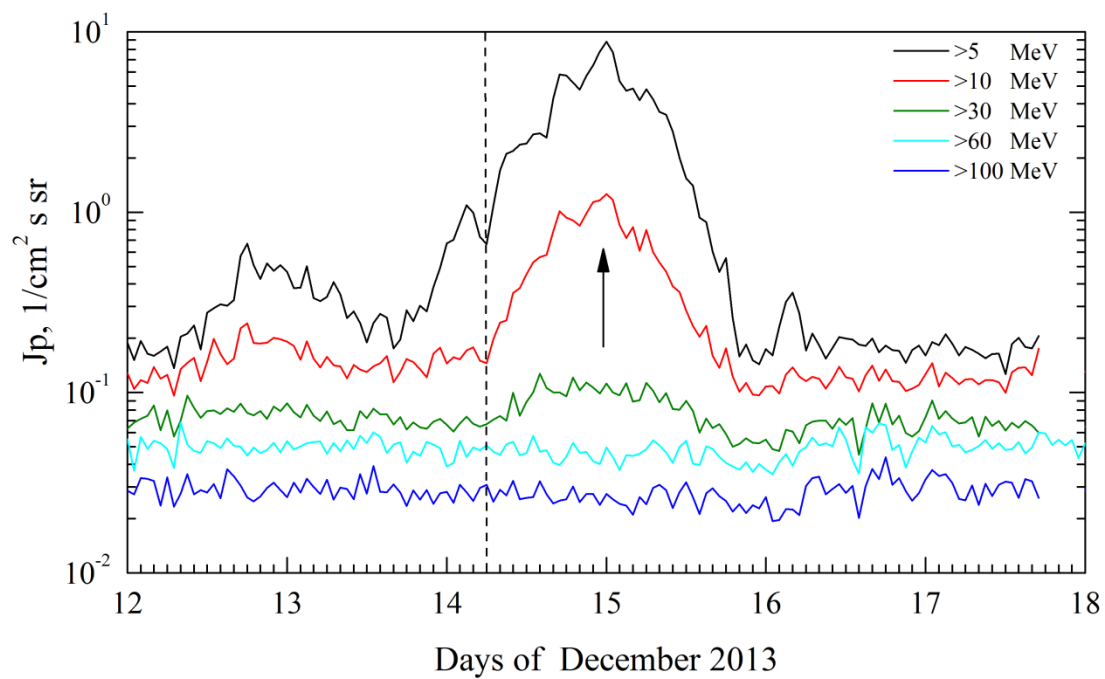


SOHO. Event 2013.12.14

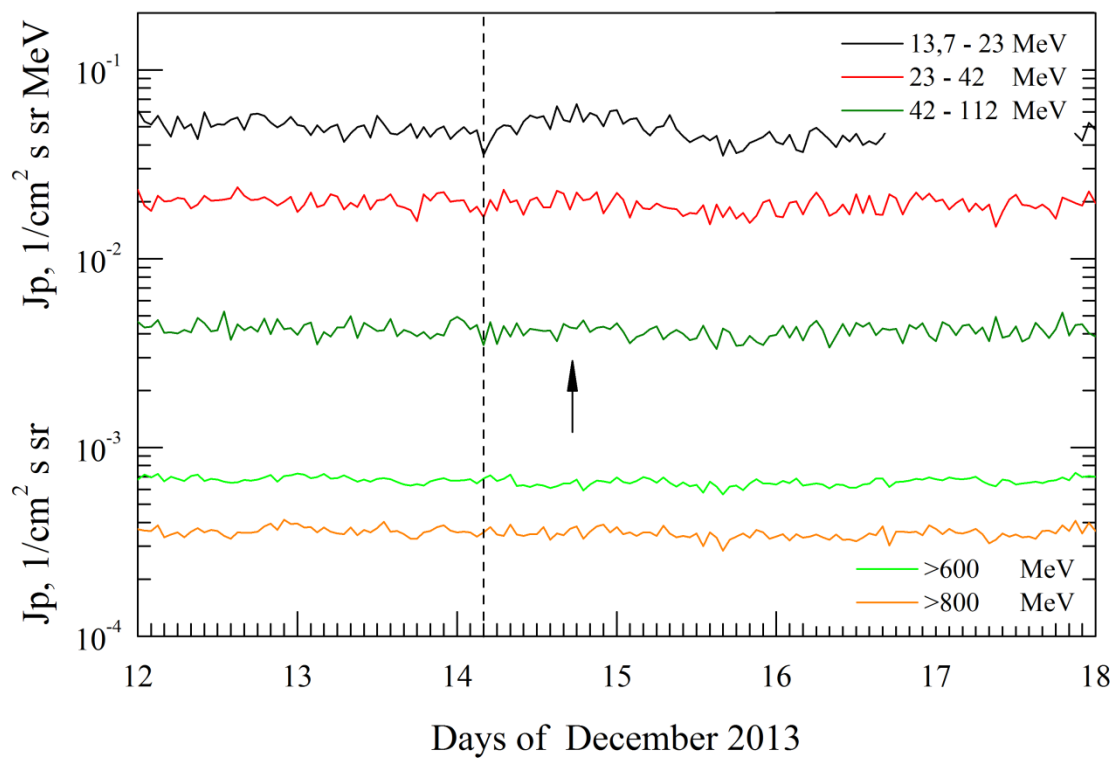


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2013.12.14

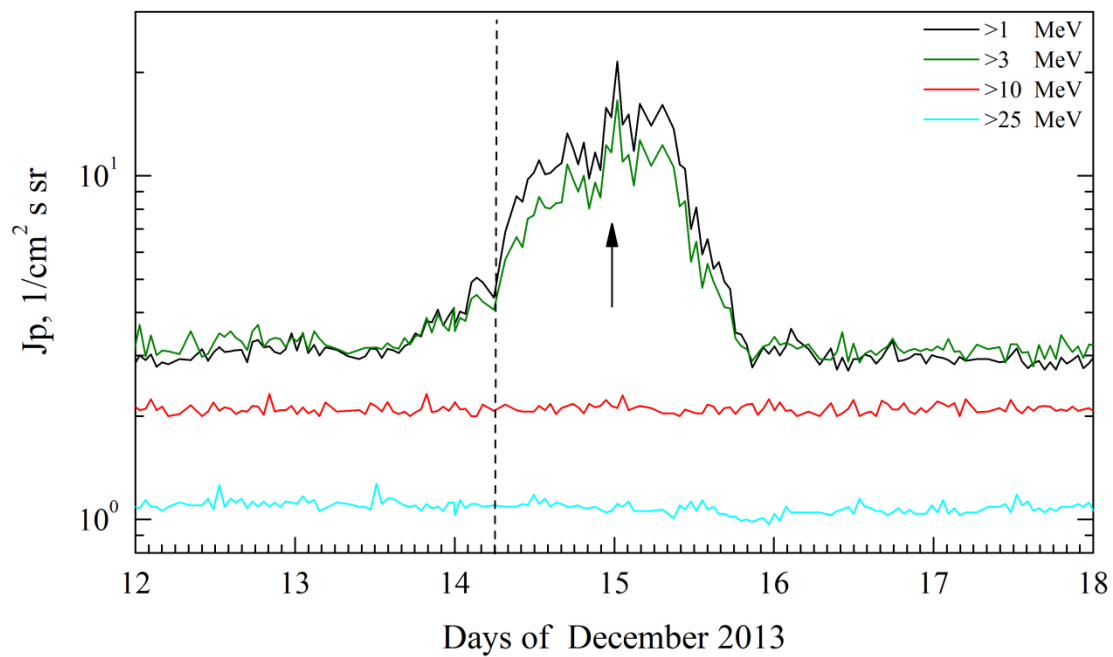


Electro. Event 2013.12.14

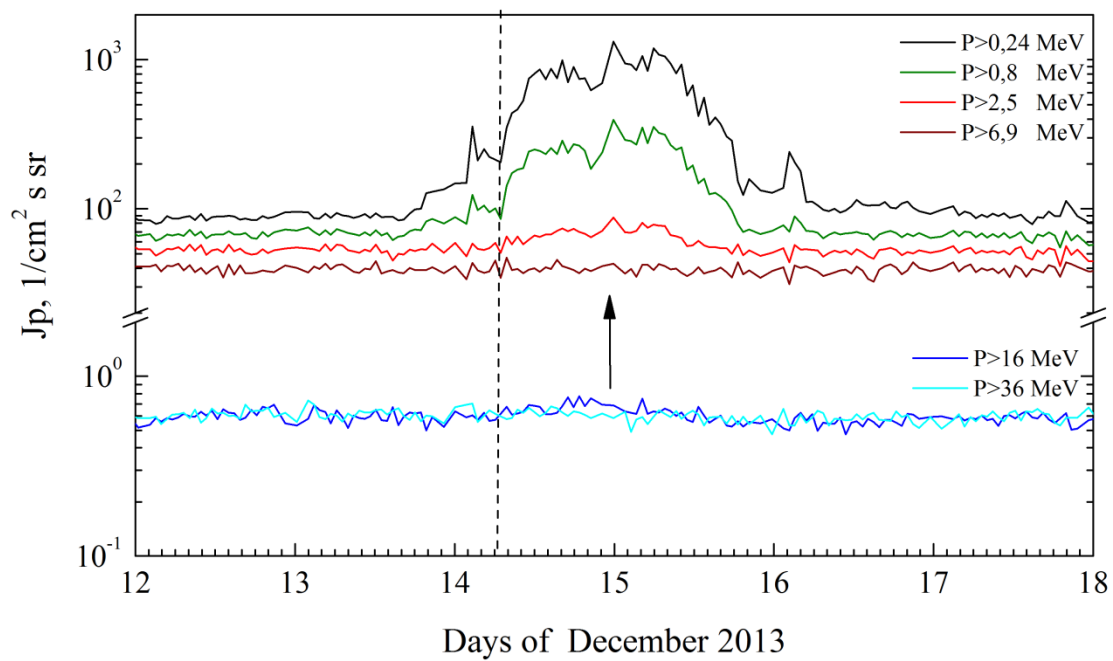


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.12.14



POES. Event 2013.12.14



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 December 14**

2013 December 14 ☐ AR XXXXX To event 544

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-180	0640		0641	500	1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0636	611	- 21.1	121°	112°	SOHO

2013 December 14 Ø AR XXXXX To event 544

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2124	611	- 2.5	360°	169°	SOHO

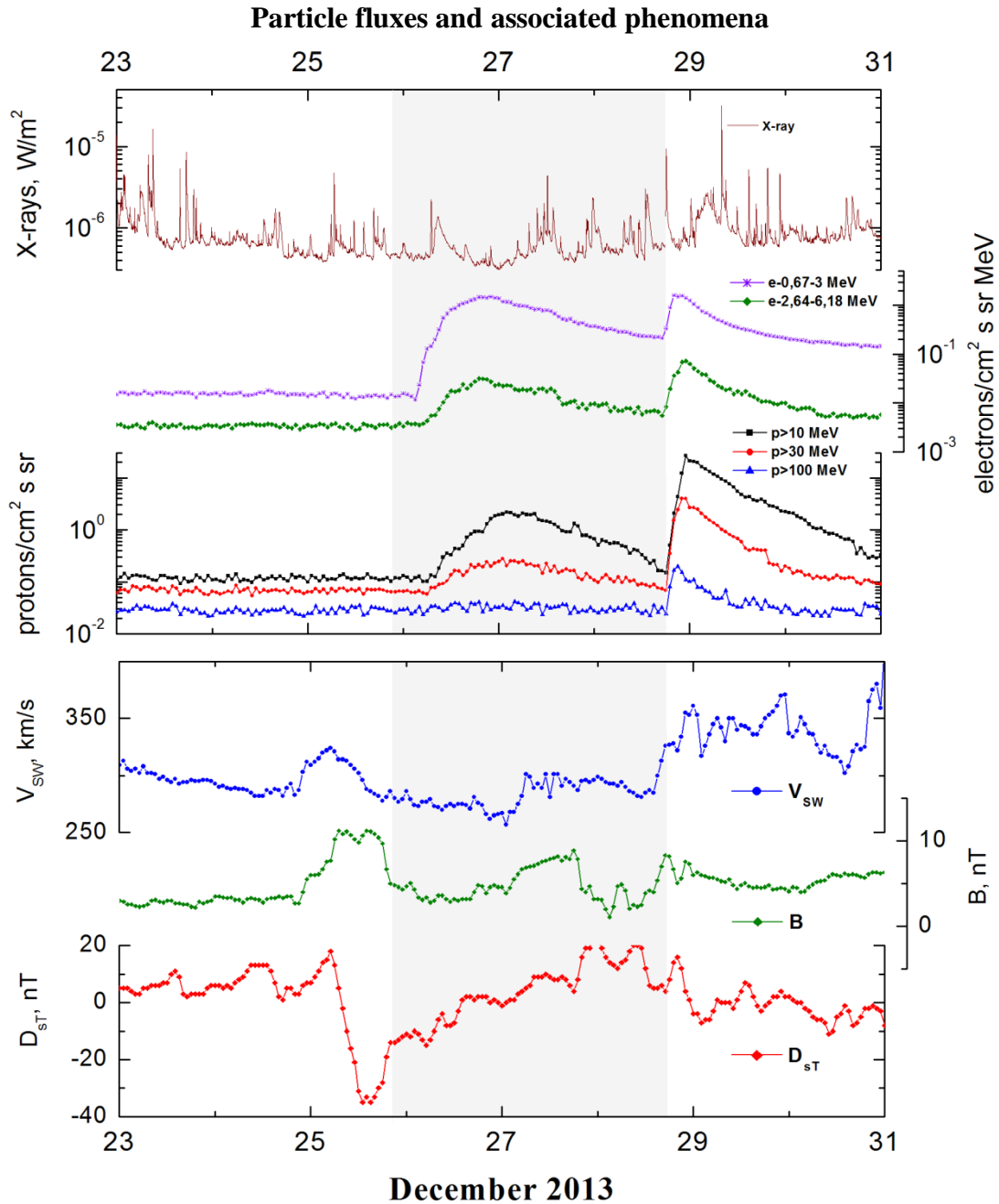
References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).

Particle event: To($E_p > 10$ MeV) – 26d08^h
 Tmax ($E_p > 10$ MeV) – 27d03^h, Jmax ($E_p > 10$ MeV) – 2 /cm²·s·sr
 Duration of the event – 2.5 days, power-law index: $\gamma = 2.3$
 Quasimaximal energy of protons in the event – $E_{qm} = 90$ MeV

Sources: ☐ solar flare 26d<03^h24^m, AR unknown, behind E_L
 CME 26d03^h24^m, $V = 1336$ km/s, $\Delta\phi = 360^\circ$, $dA = 36^\circ$

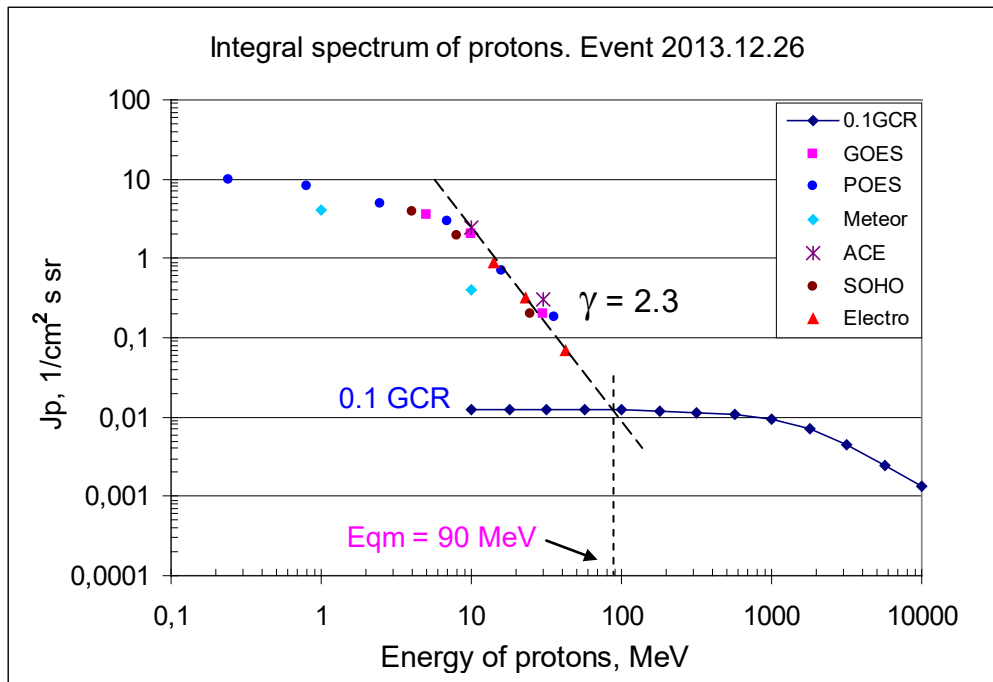


Integral fluxes of protons for the event of 2013 December 26

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	27d03	3.5	2.5	0.2	
EPS	>10	8	27d03	2	2.5	0.12	
EPS	>30	6	27d01	0.2	2.5	0.07	
EPS	>50	6	-	-	2	0.06	
EPS	>60	6	-	-	2	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	-	27d06	10	-	90	
MEPED	>0.8	-	27d06	8	-	70	
MEPED	>2.5	-	27d06	5	-	55	
MEPED	>6.9	-	27d06	3	-	42	
MEPED	>16	12	14	0.7	1.5	0.7	
MEPED	>36	12	15	0.18	1	0.75	
MEPED	>70	-	-	-	-	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	9	27d06	4	2	2.9	
SCR	>3	9	-	-	2	2.4	
SCR	>10	9	27d06	0.4	2	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	8	23	2.5	2	1.2	
SIS	>30	8	23	0.3	2	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

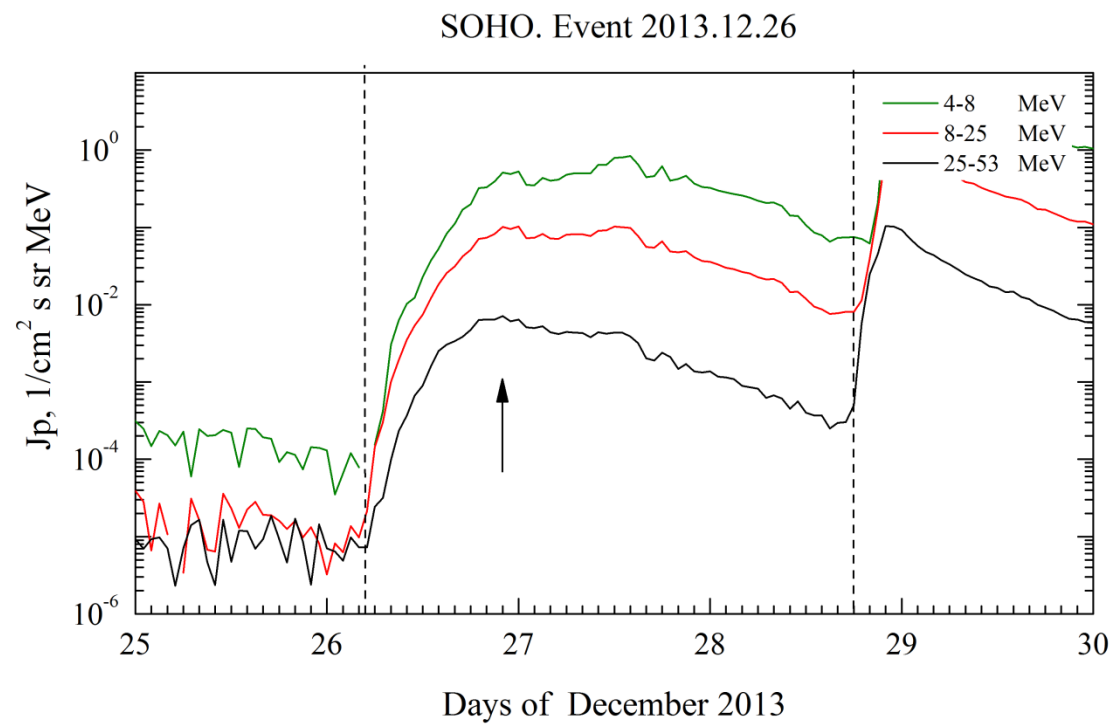
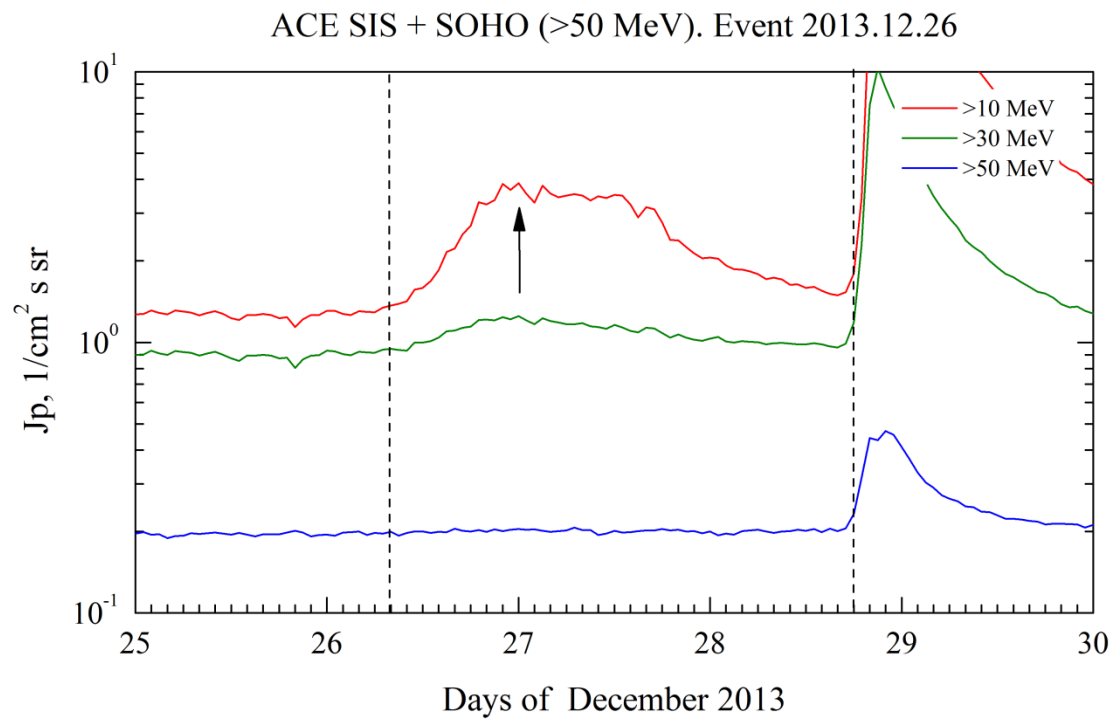
Differential fluxes of protons for the event of 2013 December 26

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	06	22	0.51	2.5	0.0001	
EPHIN	8 – 25	05	22	0.1	2.5	0.00001	
EPHIN	25 – 53	06	22	0.007	2.5	0.00001	
Electro-1							
SCR-E	13.7–23	8	22	0.06	2	0.05	
SCR-E	23–42	8	22	0.013	2	0.02	
SCR-E	42–112	8	21	0.001	-	0.004	



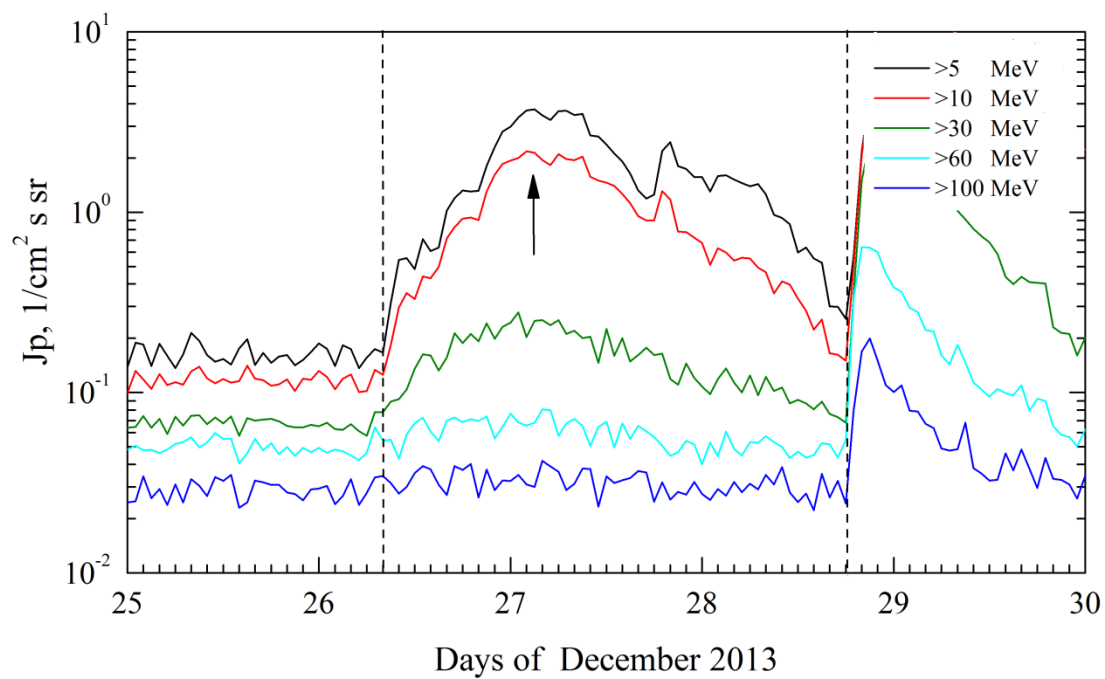
Time profiles of proton fluxes in the event 2013.12.26

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

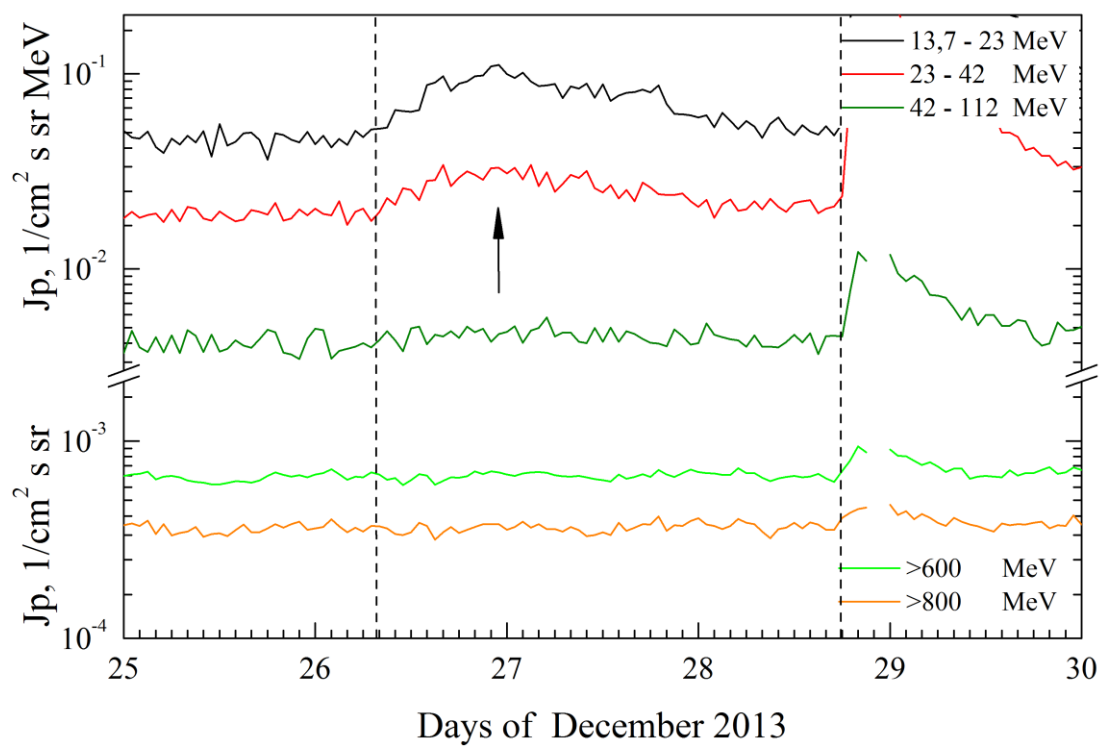


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.12.26

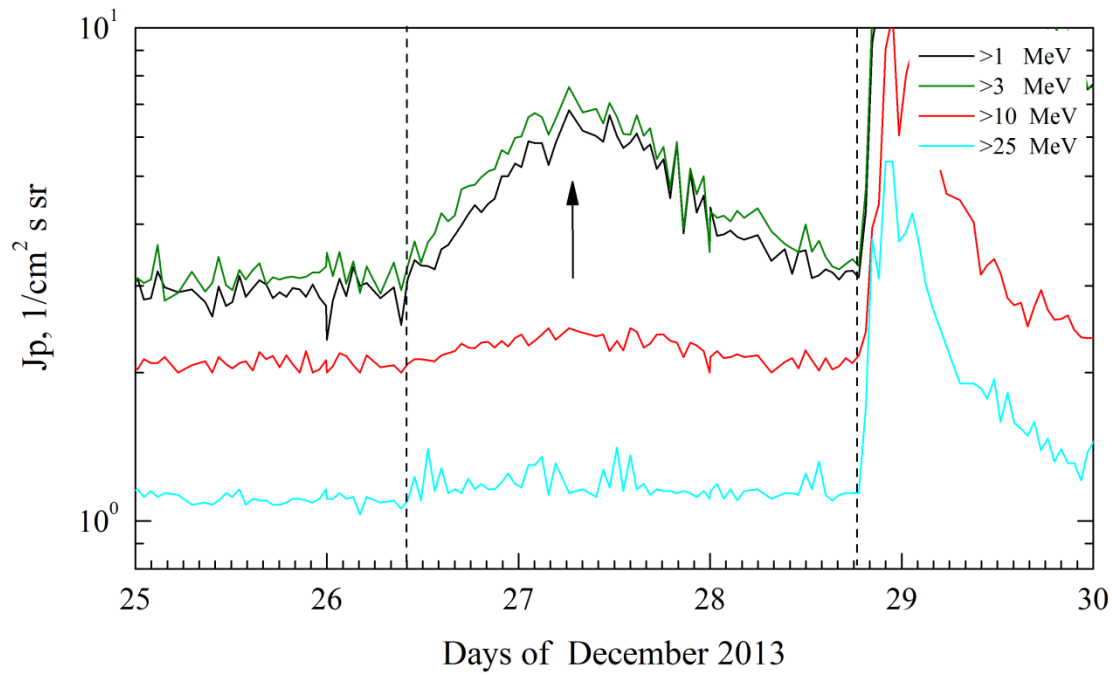


Electro. Evens 2013.12.26

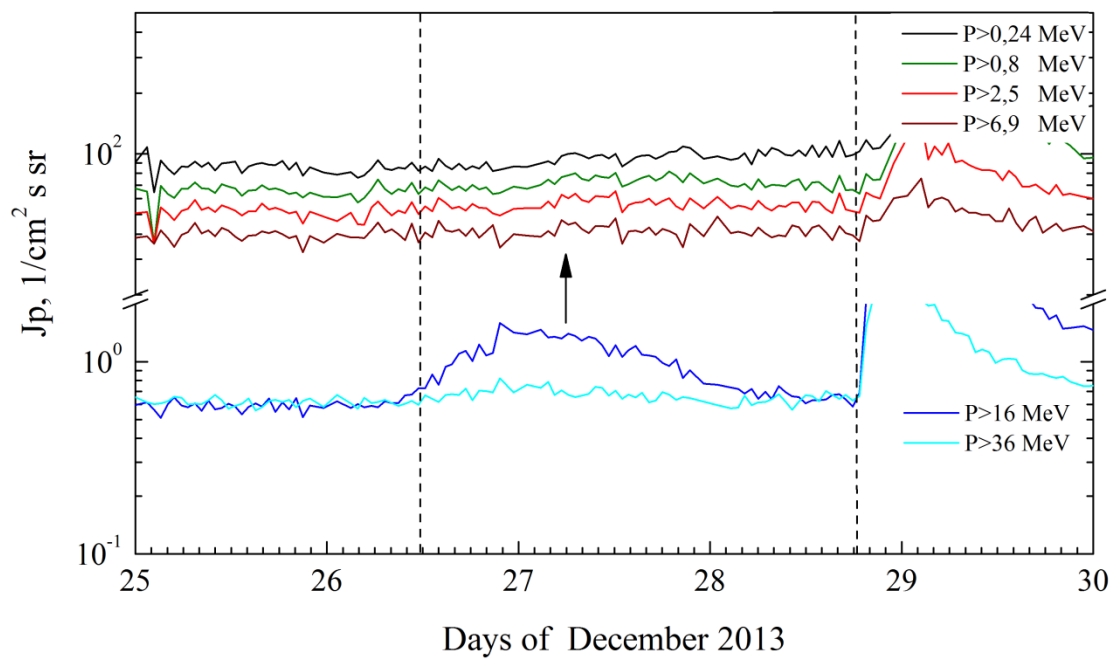


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2013.12.26



POES. Event 2013.12.26



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 December 26**

2013 December 26 ☐ AR XXXXX To event 545

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0324	1336	- 47.9	360°	36°	SOHO

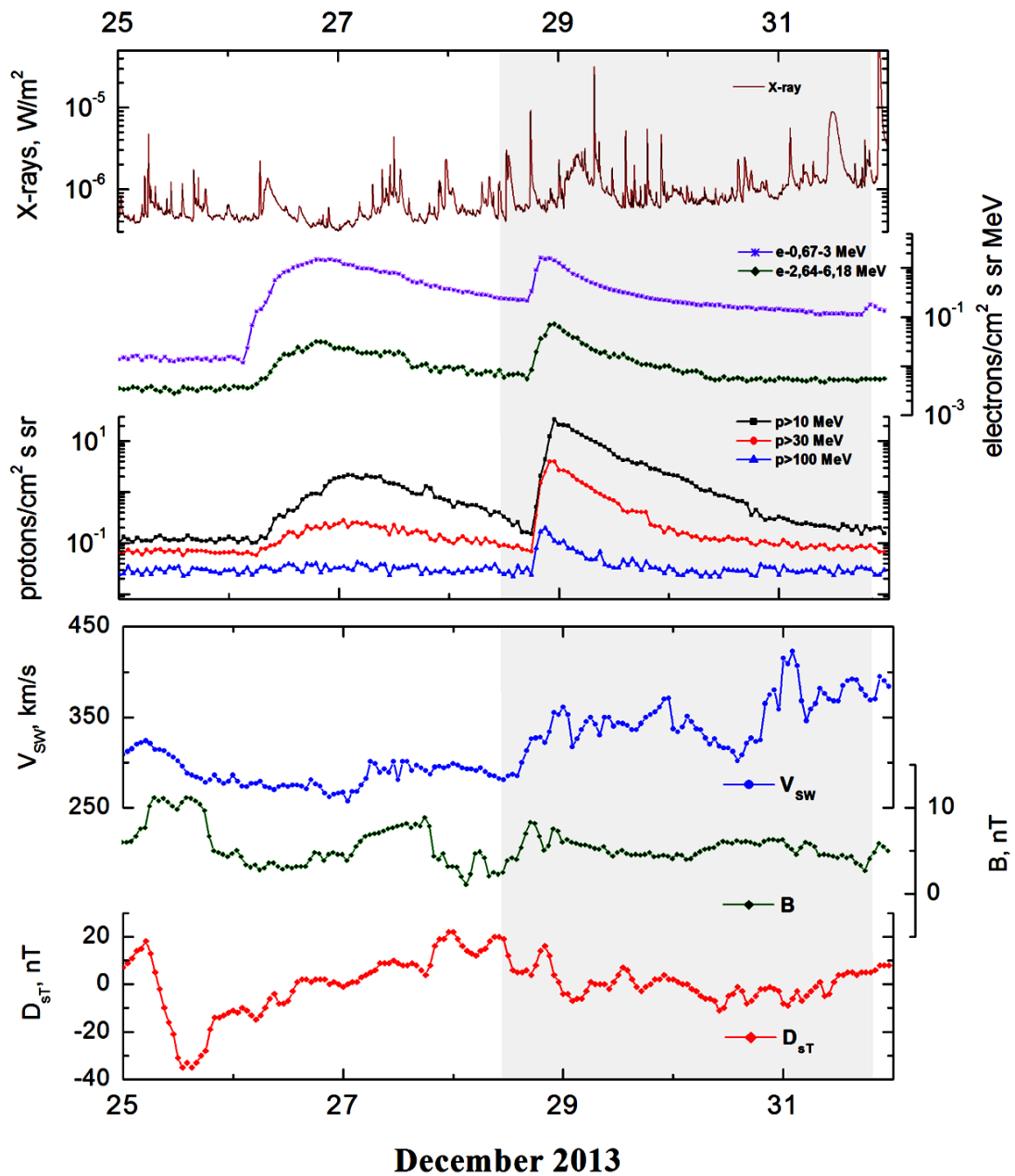
References:

Bruno A., I.G. Richardson, [2021](#).
 Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
 Wang Y., D. Lyu, B. Xiao et al., [2021](#).
 Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).

Particle event: To($E_p > 10$ MeV) – 28d18^h
 Tmax($E_p > 10$ MeV) – 28d23^h, Jmax($E_p > 10$ MeV) – 26.5 /cm²·s·sr
 Duration of the event – 3 days, power-law index: $\gamma = 2.6$
 Quasimaximal energy of protons in the event – Eqm = 240 MeV

Sources: ☐ solar flare 28d<17^h36^m, AR unknown, behind W_L
 CME: 28d17^h36^m, V = 1118 km/s, $\Delta\phi = 360^\circ$, dA = 284°

Particle fluxes and associated phenomena

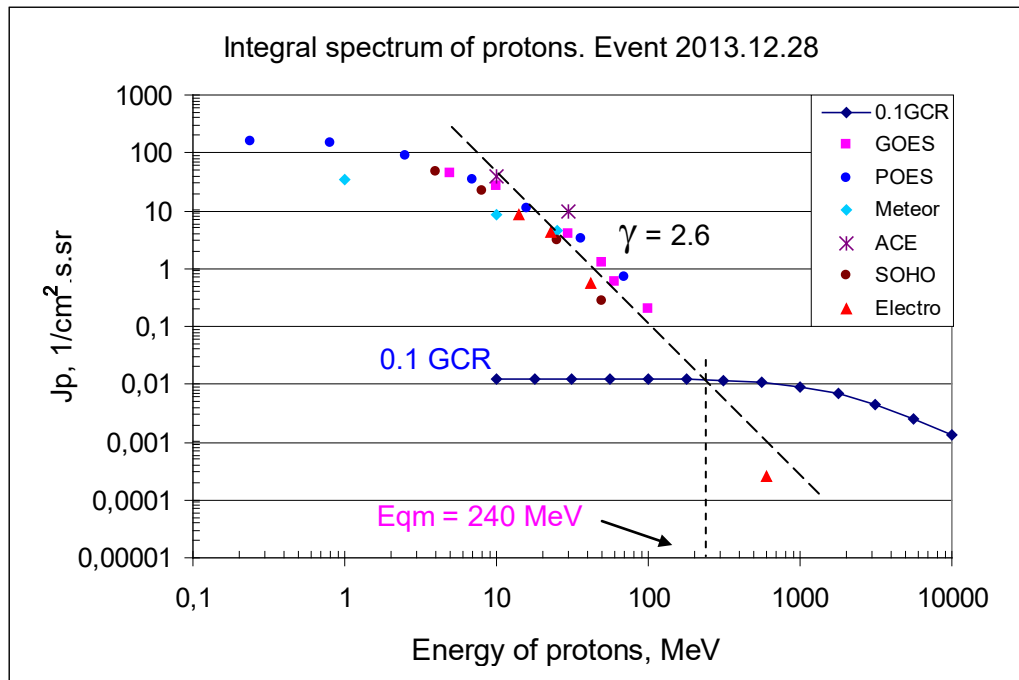


Integral fluxes of protons for the event of 2013 December 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	29d01	44.8	3	0.2	
EPS	>10	18	23	26.5	3	0.12	
EPS	>30	18	23	3.9	1.5	0.07	
EPS	>50	18	22	1.3	1	0.06	
EPS	>60	18	21	0.6	1	0.05	
EPS	>100	18	21	0.2	1	0.03	
Electro-1							
GALS-E	>600	18	29d00	0.00025	1	0.00065	
POES							
MEPED	>0.24	18	23	155	2	95	
MEPED	>0.8	18	23	145	2	70	
MEPED	>2.5	18	23	90	2	55	
MEPED	>6.9	18	23	35.5	1.5	40	
MEPED	>16	18	23	11.2	1.5	0.7	
MEPED	>36	18	23	3.35	1.5	0.75	
MEPED	>70	18	23	0.72	1	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	18	23	34.5	2	2.9	
SCR	>3	18	-	-	2	2.4	
SCR	>10	18	23	8.5	1	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	18	23	4.4	0.5	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	17	22	38.4	2	1.2	
SIS	>30	17	21	9.6	2	0.9	
SOHO							
EPHIN	>50	18	22	0.27	1	0.2	

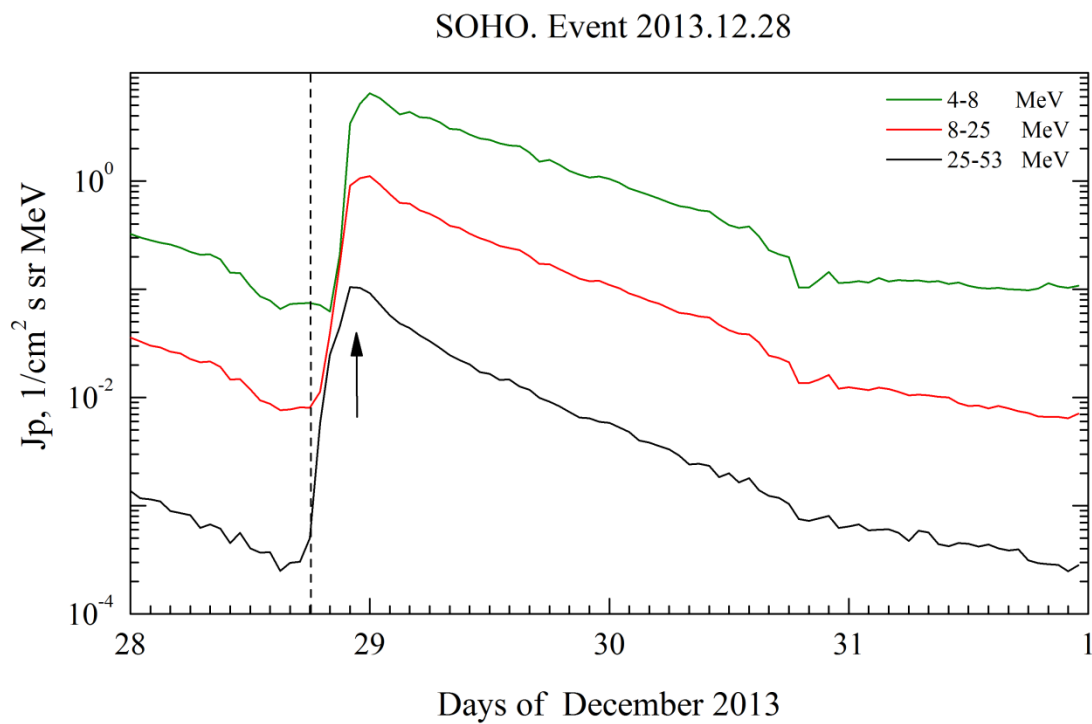
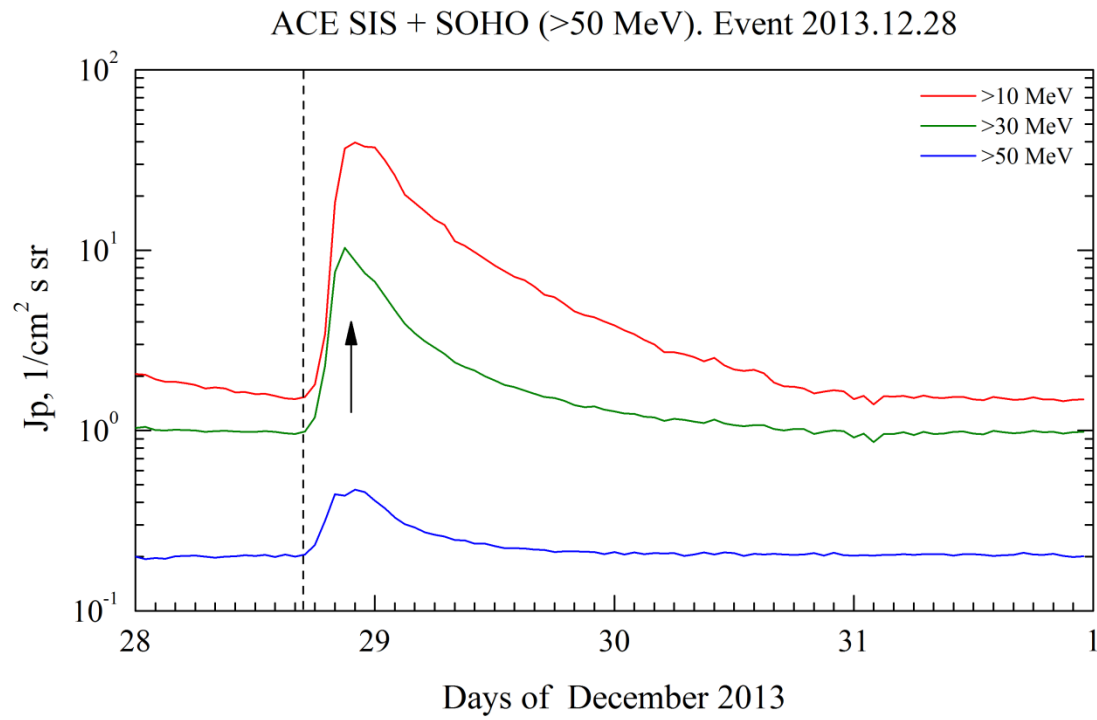
Differential fluxes of protons for the event of 2013 December 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	21	29d00	6.47	2	0.0001	
EPHIN	8 – 25	20	29d00	1.11	2	0.00001	
EPHIN	25 – 53	18	22	0.1	2	0.00001	
Electro-1							
SCR-E	13.7–23	18	29d00	0.42	2	0.055	
SCR-E	23–42	18	29d00	0.2	2	0.02	
SCR-E	42–112	18	29d00	0.008	1	0.004	



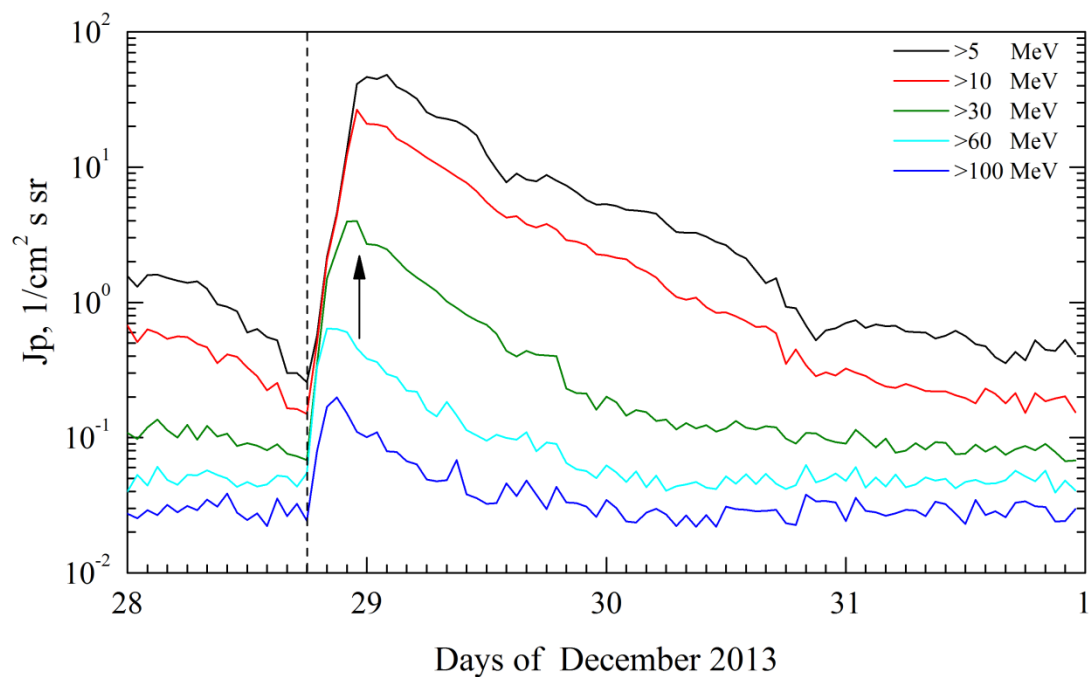
Time profiles of proton fluxes in the event 2013.12.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

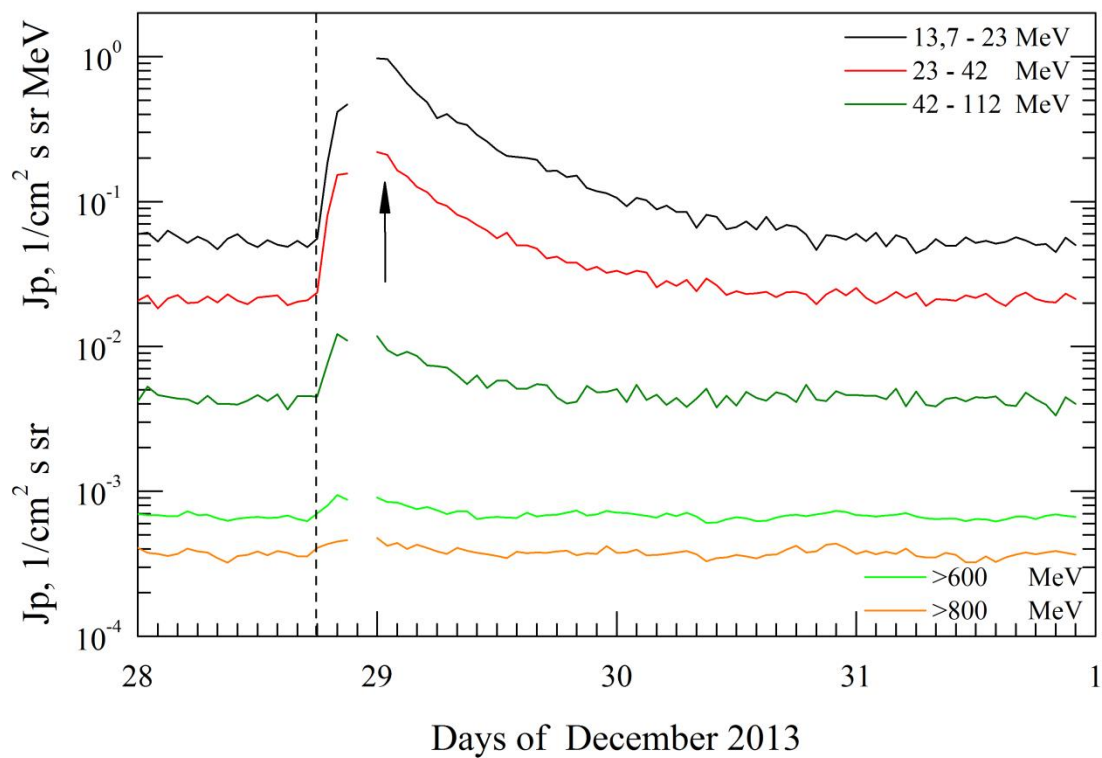


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2013.12.28

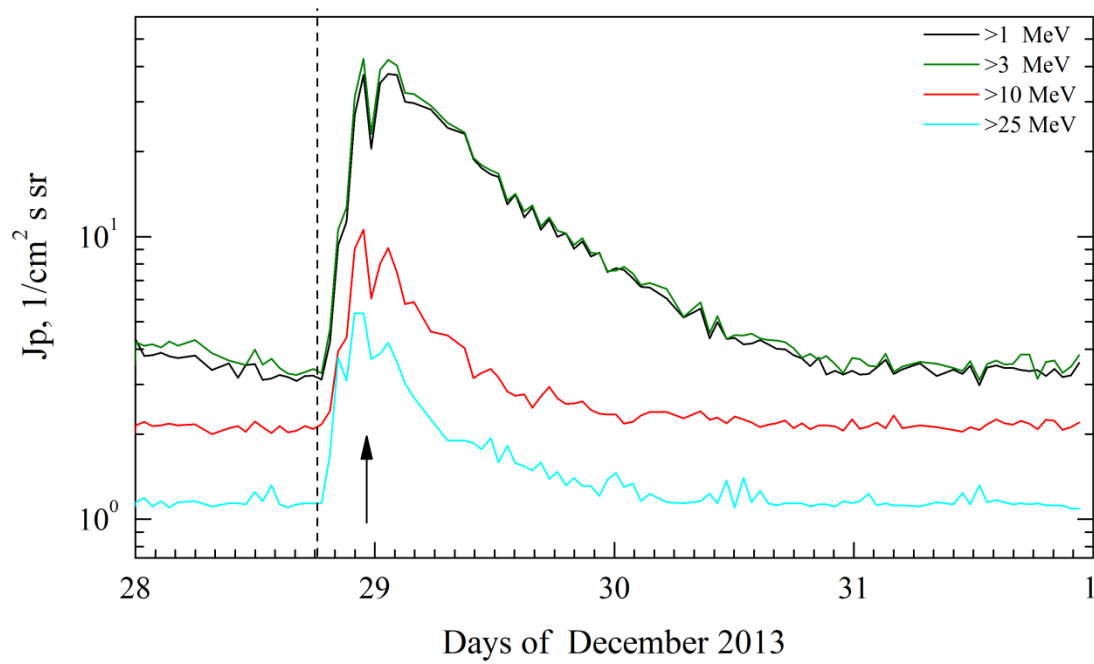


Electro. Evens 2013.12.28

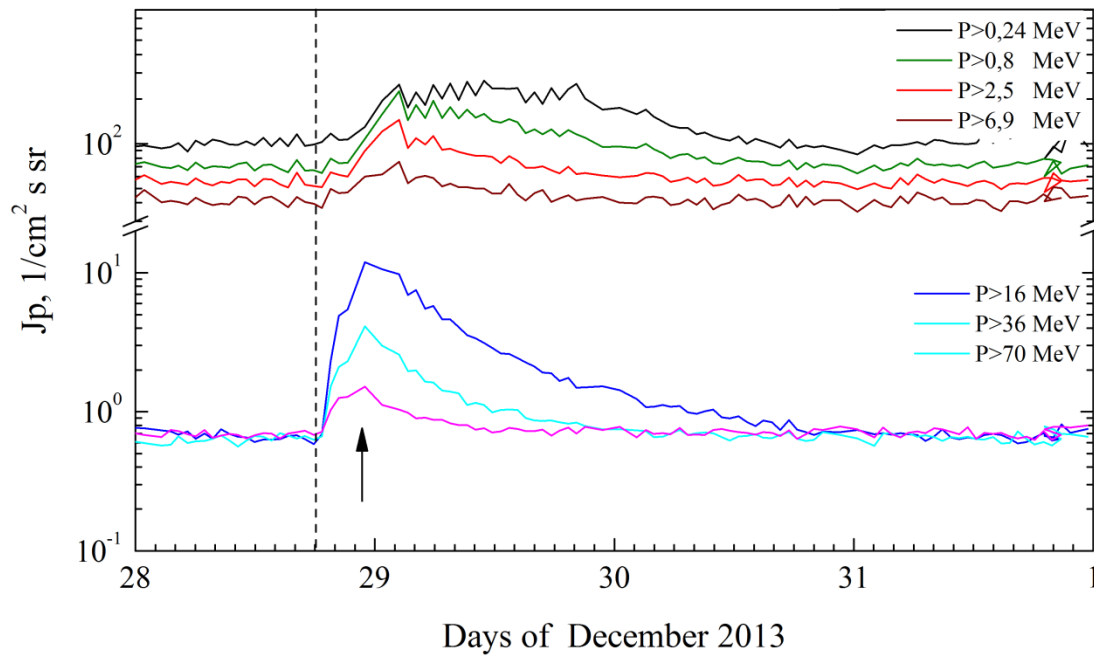


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2013.12.28



POES. Event 2013.12.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2013 December 28**

2013 December 28 ☐ AR XXXX To event 546

H α , X-ray		To	Tmax	Te	Location	Importance	FI Code Φ , J/m ²
6563 Å		No flare event o the visible disk					
1 – 12	keV	No X-ray durst in the visible disk					
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1758:16	1801:26	1832:36	352	635063	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DH II	16-0.5	1731		1805			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1736	1118	- 26.7	360°	284°	SOHO

References:

Alberti T., M. Laurenza, E.W. Cliver et al., [2017](#).
 Cliver E.W., [2016](#).
 Gopalswamy N., H. Xie, S. Akiyama et al., [2014](#).
 Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
 NOAA SPE, [2019](#).
 Núñez M., T. Nieves-Chinchilla, and A. Pulkkinen, [2019](#).
 Richardson I.G., T.T. von Rosenvinge, H.V. Cane et al., [2014](#).
 Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
 Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Events in 2014

			Page
1	Event 2014.01.16 – (2014-006)	№ 547	615
2	Event 2014.01.07 – (2014-007)	№ 548	623
3	*Event 2014.02.18 – (2014-049)	№ 549	633
4	Event 2014.02.19 – (2014-050)	№ 550	640
5	Event 2014.02.20 – (2014-051)	№ 551	647
6	Event 2014.02.25 – (2014-056)	№ 552	655
7	Event 2014.02.28 – (2014-059)	№ 553	663
8	*Event 2014.03.25 – (2014-084)	№ 554	670
9	Event 2014.03.29 – (2014-088)	№ 555	677
10	Event 2014.04.18 – (2014-108)	№ 556	685
11	Event 2014.08.25 – (2014-237)	№ 557	693
12	Event 2014.09.01 – (2014-244)	№ 558	701
13	Event 2014.09.10 – (2014-253)	№ 559	709
14	Event 2014.11.01 – (2014-305)	№ 560	719
15	Event 2014.12.13 – (2014-347)	№ 561	726
16	Event 2014.12.21 – (2014-355)	№ 562	733
17	Event 2014.12.23 – (2014-357)	№ 563	742

An asterisk (*) marks weak events with J_p ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To($E_p > 10$ MeV) – 06d07^h

Tmax($E_p > 10$ MeV) – 06d14^h, Jmax($E_p > 10$ MeV) – $38/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1.5 days, power-law index: $\gamma = 2.1$

Quasimaximal energy of protons in the event – $E_{qm} = 1350$ MeV

Sources: ■ solar flare 06d07^h30^m, C2.1*/EPL, S15W89, AR11936, ~1.5d behind W_L

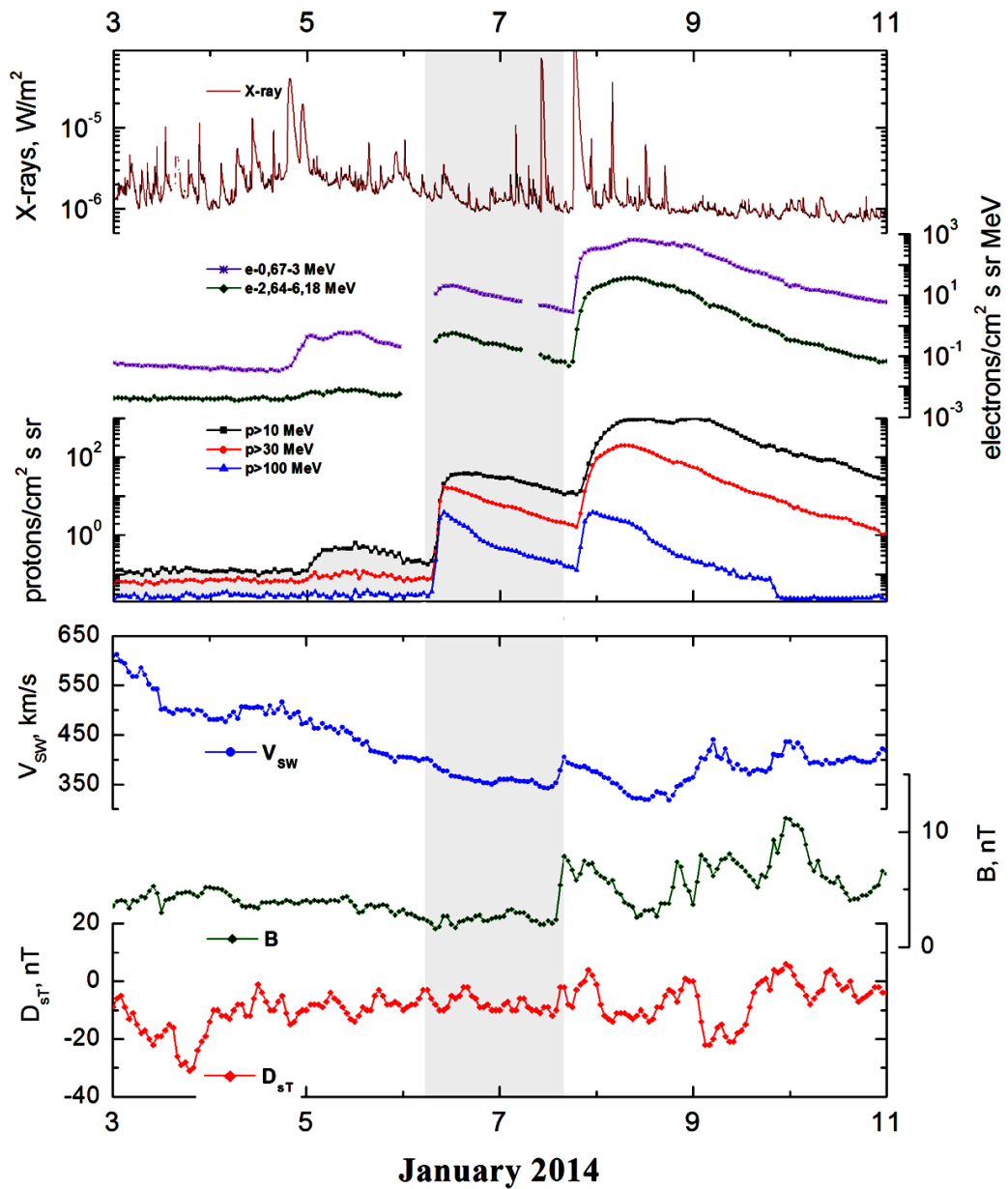
Main burst X-ray 1–8 Å: onset – 06d07^h30^m, max – 06d07^h45^m, $\Phi = 0.056 \text{ J/m}^2$

CME: 06d08^h00^m, $V = 1402 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 274^\circ$

▲ SC 07d15^h14^m

* echo of mostly large flare event

Particle fluxes and associated phenomena

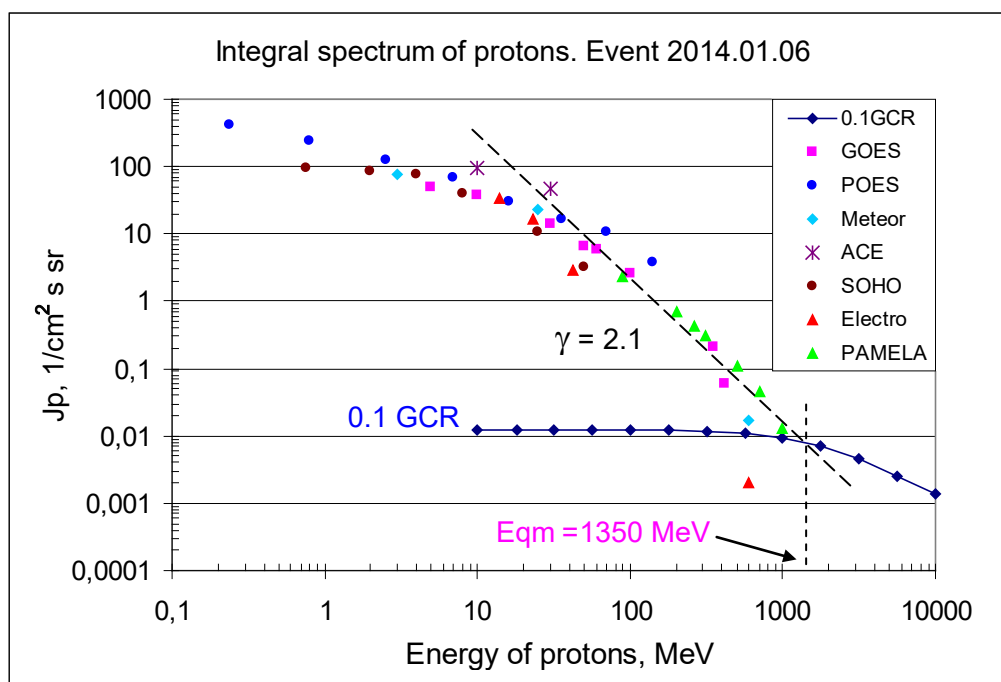


Integral fluxes of protons for the event of 2014 January 06

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	15	49	1.5	0.2	
EPS	>10	7	14	38	1.5	0.15	
EPS	>30	7	13	13.8	1.5	0.07	
EPS	>50	7	12	6.7	1.5	0.06	
EPS	>60	7	12	6	1.5	0.05	
EPS	>100	7	11	2.6	-	0.03	
Electro-1							
GALS-E	>600	7	11	0.0017	1.5	0.0007	
POES							
MEPED	>0.24	8	11	410	1.5	90	
MEPED	>0.8	8	11	245	1.5	65	
MEPED	>2.5	8	11	125	1.5	50	
MEPED	>6.9	8	11	70	1.5	40	
MEPED	>16	8	11	30	1.5	0.7	
MEPED	>36	8	11	16.5	1.5	0.75	
MEPED	>70	8	11	10.6	1.5	0.9	
MEPED	>140	8	11	3.7	1.5	1	
Meteor-1							
SCR	>1	8	-	-	1.7	3	
SCR	>3	8	16	78	1.7	3.2	
SCR	>10	8	-	-	1.7	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	8	10	23	1.7	1.1	
GALS-M	>600	8	10	0.017	0.5	0.02	
ACE							
SIS	>10	7	11	95	1.5	1.1	
SIS	>30	7	9	46	1.5	0.75	
SOHO							
EPHIN	>50	8	9	3.3	1.5	0.2	
PAMELA							
TRACKER	>90	8	9-13	2.3	1.5	-	
TRACKER	>200	8	9-13	0.71	1.5	-	
TRACKER	>265	8	9-13	0.42	1.5	-	
TRACKER	>312	8	9-13	0.31	1.5	-	
TRACKER	>500	8	9-13	0.11	1.5	-	
TRACKER	>700	8	9-13	0.046	1.5	-	
TRACKER	>1000	8	9-13	0.013	1.5	-	

Differential fluxes of protons for the event of 2014 January 06

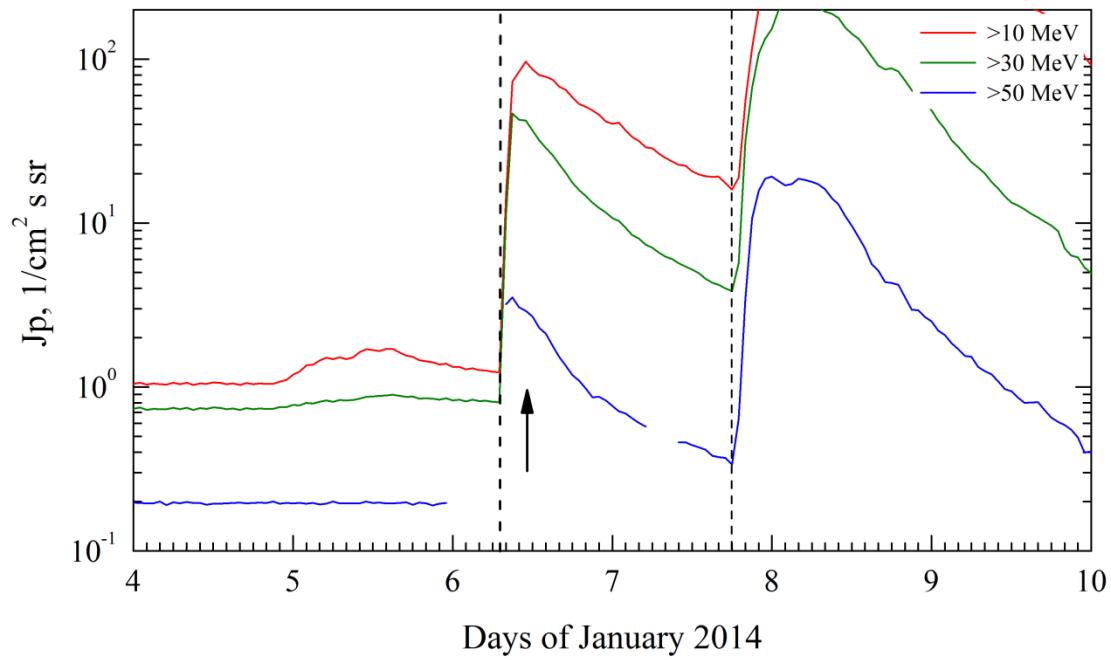
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	8	17	8.7	1.5	0.02	
LION	2 – 6	8	17	2.87	1.5	0.002	
EPHIN	4 – 8	8	17	9	1.5	0.004	
EPHIN	8 – 25	8	15	1.67	1.5	0.0003	
EPHIN	25 – 53	8	12	0.26	1.5	0.00003	
Electro-1							
SCR-E	13.7–23	7	11	1.75	1.5	0.05	
SCR-E	23–42	7	11	0.735	1.5	0.025	
SCR-E	42–112	7	11	0.042	1.5	0.0045	
GOES							
EPS	350–420	9	10	0.0021	1	0.0016	
EPS	420–510	7	9	0.00068	1	0.0009	
EPS	510–700	-	-	-	-	0.0003	



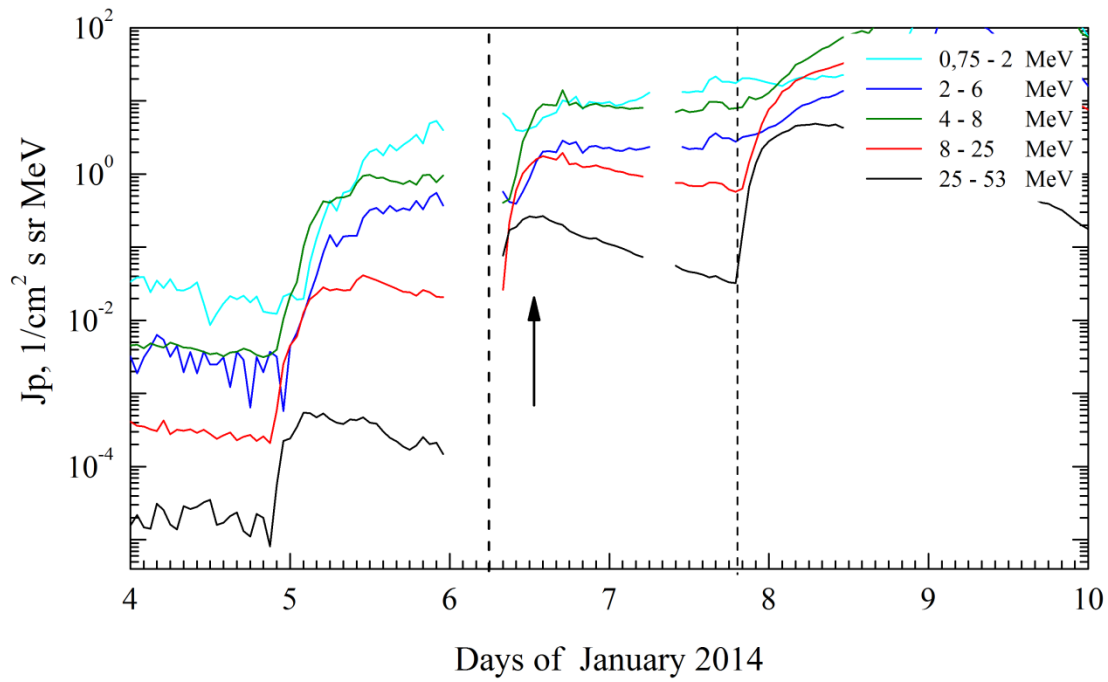
Time profiles of proton fluxes in the event 2014.01.06

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.01.06

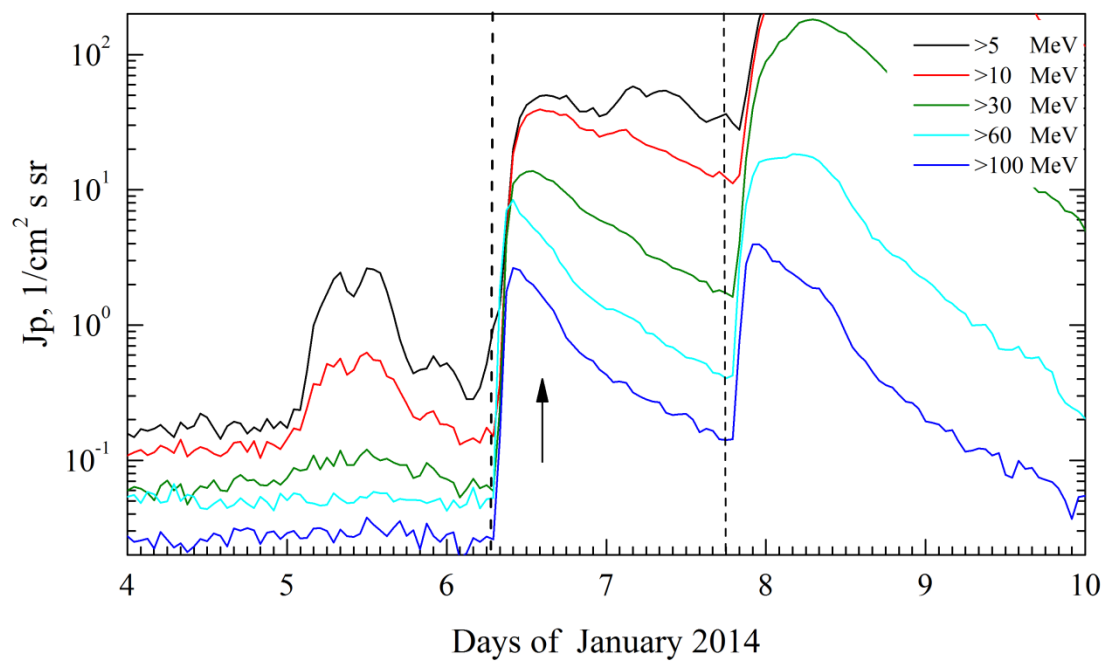


SOHO. Event 2014.01.06

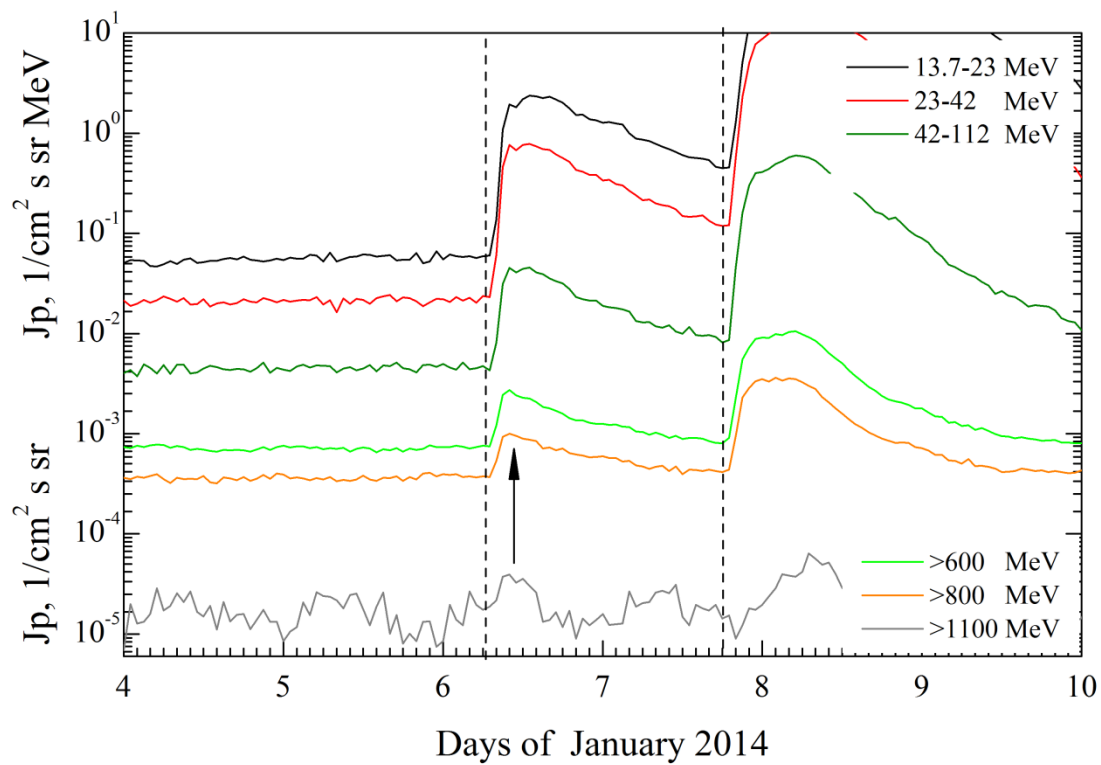


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

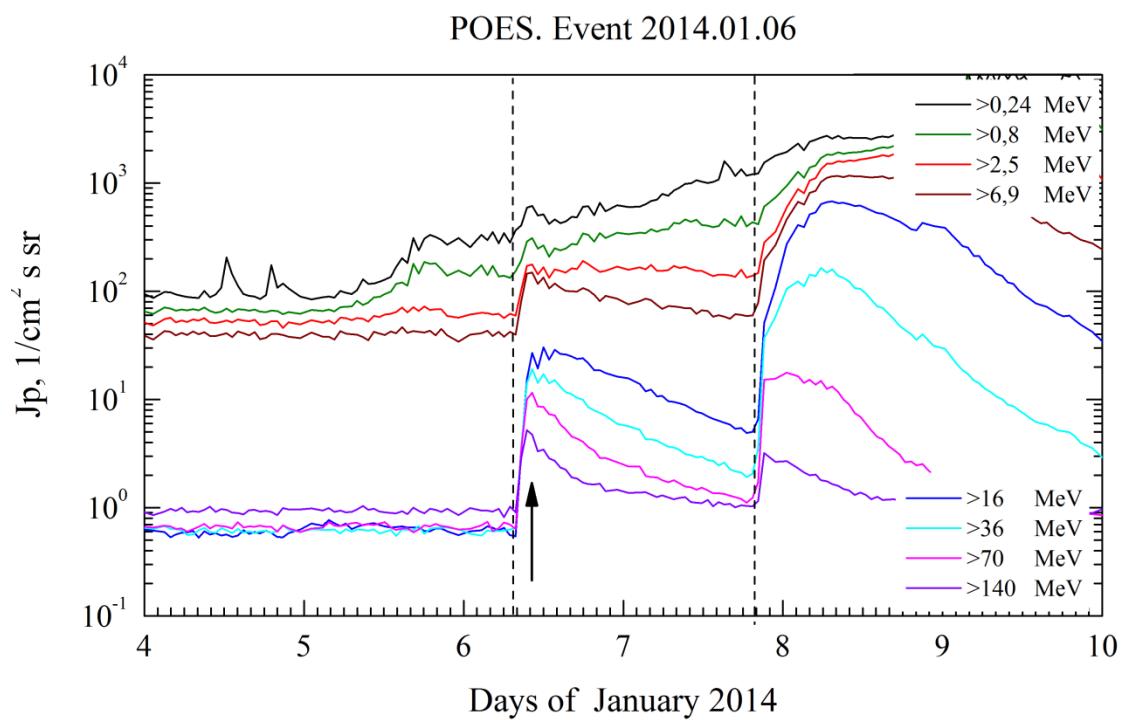
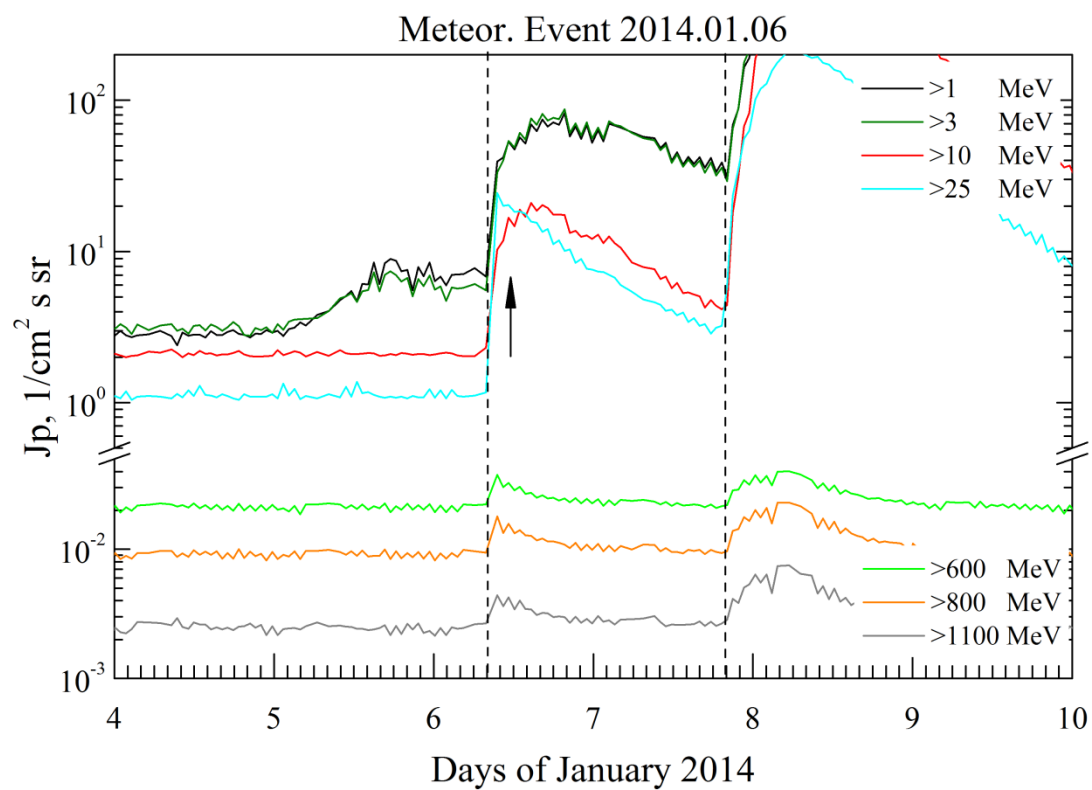
GOES. Event 2014.01.06



Electro. Event 2014.01.06



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



Electromagnetic and other phenomena that are sources and/or accompanying for the event of 2014 January 06

2014

January 06



AR 11936

To event 547

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	EPL*	<0755		<0810	S15W90		
1 – 12	keV	0730	0745	0900	S15W89	C2.1**	0.056
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
410	MHz	0744	0744	0744		2.04	
245	MHz	0747	0747	0747		2.08	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s;	Importance	Sp/c
DS II	25-180	0745		0808		2	
DS IV	27-180	0653		1525		2	
DH II	0.8-14	0757		2230			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0800	1402	- 7.1	360°	274°	SOHO

*https://lmsal.com/hek/her?cmd=view-voevent&ivorn=ivo://helio-informatics.org/FE304_halocme_20140106_153743

** echo of mostly large flare event

Proton Active Region:

AR11936 (S17L223, CMP 29,4.12.2013;

Sp=280 msh EAC; BGD; R)

XRI= 2.13 M₄^{9.9}+C₂₉ 2₂+1₁+S₃₁

PFR 31-01.01 (21^h) M₂^{9.9}

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Particle event: To($E_p > 10$ MeV) – 07d18^h

Tmax($E_p > 10$ MeV) – 08d12^h, Jmax($E_p > 10$ MeV) – 1000 /cm²·s·sr

Duration of the event – 7 days, power-law index: $\gamma = 3.8$

Quasimaximal energy of protons in the event – $E_{qm} = 400$ MeV

Sources: ● solar flare 07d18^h04^m, X1.2/2N, S15W11, AR11944

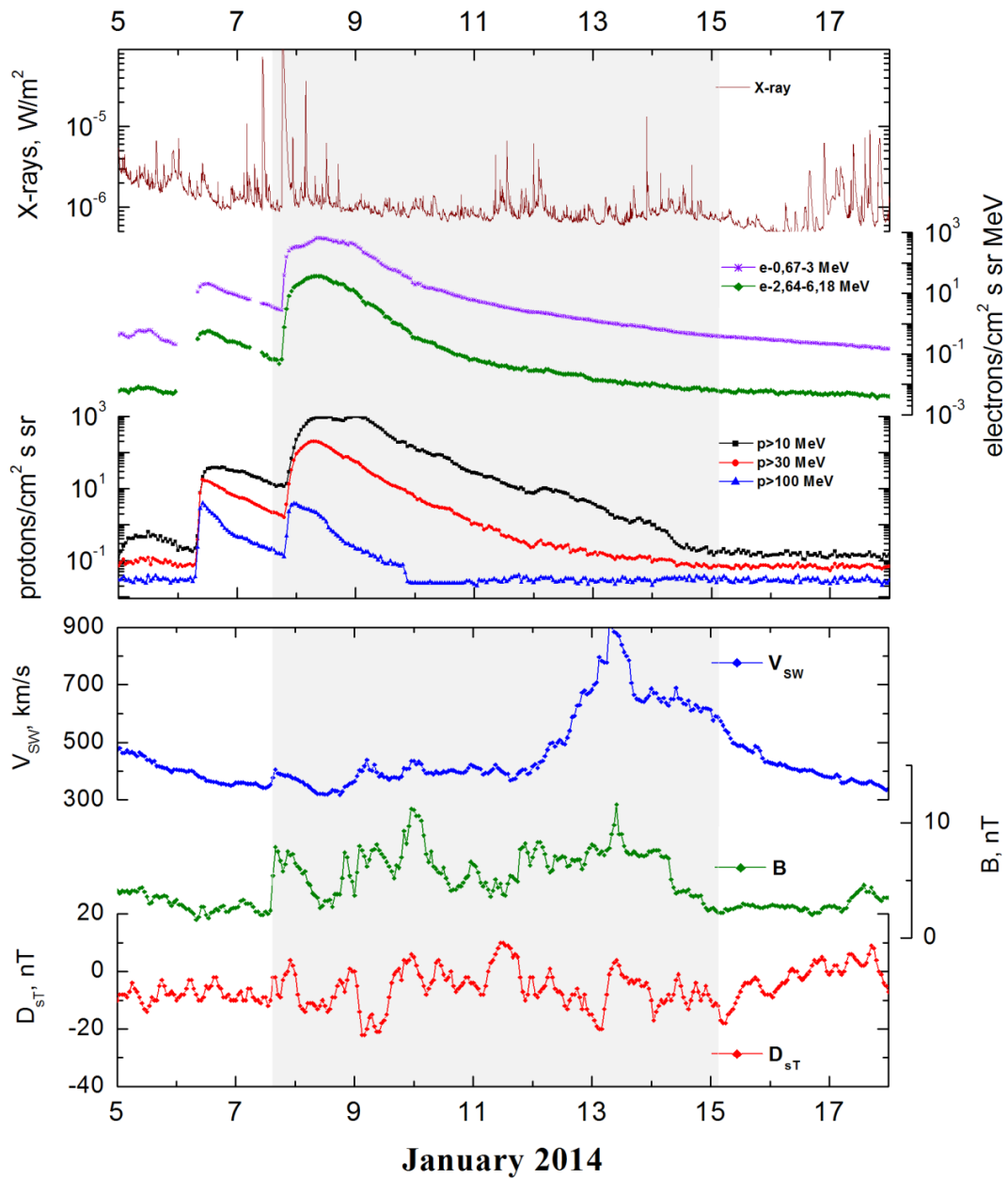
○ solar flare 07d10^h07^m, M7.2/2B, S13E11, AR11944

Main burst X-ray 1–8 Å: onset – 07d18^h04^m, max – 07d18^h32^m, $\Phi = 0.25$ J/m²

CME: 07d18^h24^m, $V = 1830$ km/s, $\Delta\phi = 360^\circ$, dA = 231°

▲ SC 01d15^h14^m, ▲ SC 09d20^h10^m

Particle fluxes and associated phenomena

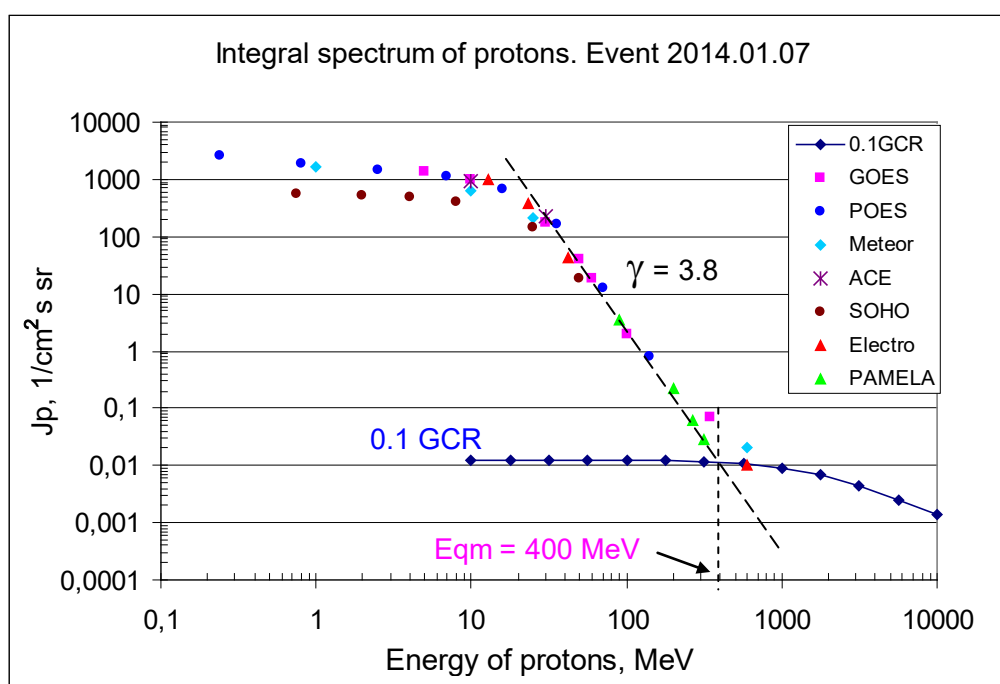


Integral fluxes of protons for the event of 2014 January 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	8d12	1400	7	0.2	
EPS	>10	18	8d12	1000	7	0.15	
EPS	>30	18	8d8	180	4	0.07	
EPS	>50	18	8d8	41	4	0.06	
EPS	>60	18	8d7	18	3	0.05	
EPS	>100	18	8d8	1.9	2	0.03	
Electro-1							
GALS-E	>600	18	8d06	0.01	3	0.0007	
POES							
MEPED	>0.24	20	8d08	2540	5	90	
MEPED	>0.8	20	8d08	1920	5	65	
MEPED	>2.5	20	8d08	1460	4	50	
MEPED	>6.9	20	8d08	1120	4	40	
MEPED	>16	20	8d08	675	4	0.7	
MEPED	>36	20	8d08	160	3	0.75	
MEPED	>70	20	8d08	12.5	1.5	0.9	
MEPED	>140	20	8d08	0.8	1	1	
Meteor-1							
SCR	>1	20	8d08	1700	7	3	
SCR	>3	20	-	-	7	3.2	
SCR	>10	20	8d05	646	4	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	20	8d05	212	3	1.1	
GALS-M	>600	20	8d05	0.02	1	0.02	
ACE							
SIS	>10	18	08d05	910	6	1.1	
SIS	>30	18	08d02	220	5	0.75	
SOHO							
EPHIN	>50	19	08d03	18.5	2.5	0.2	
PAMELA							
TRACKER	>90	19	20-8d04	3.5	>4	-	
TRACKER	>200	19	20-8d04	0.22	>4	-	
TRACKER	>265	19	20-8d04	0.062	>4	-	
TRACKER	>312	19	20-8d04	0.028	>4	-	

Differential fluxes of protons for the event of 2014 January 07

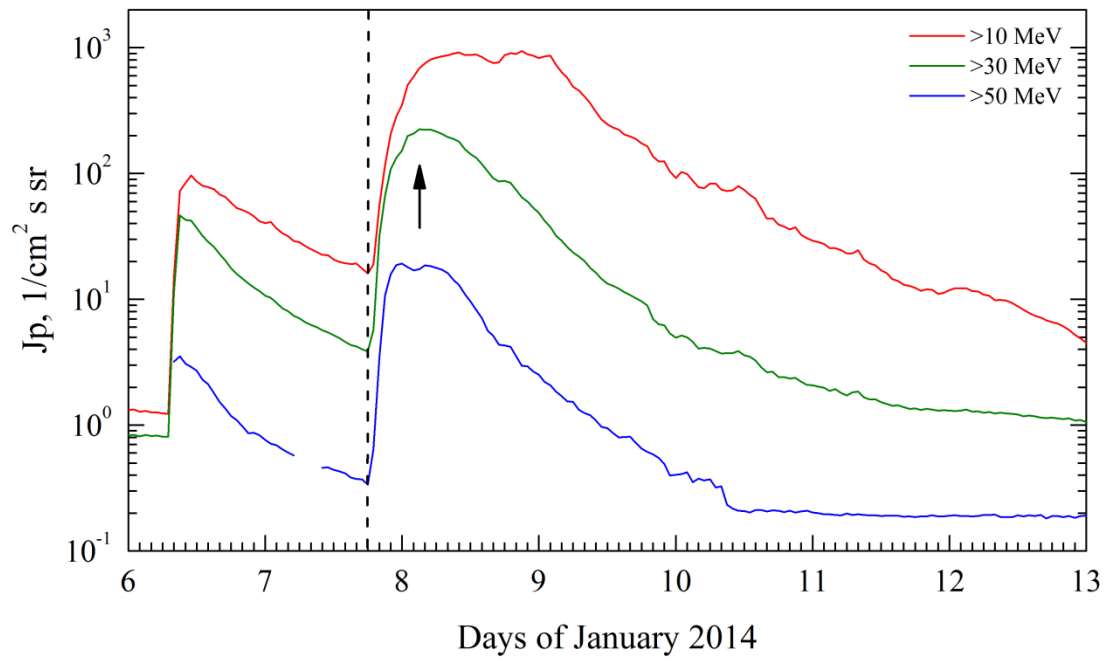
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	19	8d03	17.4	7	0.02	
LION	2 – 6	19	8d03	6.33	7	0.002	
EPHIN	4 – 8	19	8d03	23.4	7	0.004	
EPHIN	8 – 25	19	8d03	15.1	7	0.0003	
EPHIN	25 – 53	19	8d04	4.57	7	0.00003	
Electro-1							
SCR-E	13.7–23	18	8d06	67.8	5	0.05	
SCR-E	23–42	18	8d06	17.2	5	0.025	
SCR-E	42–112	18	8d06	0.6	4	0.0045	
GOES							
EPS	350–420	19	08d03	0.001	1.5	0.0016	
EPS	420–510	-	-	-	-	0.0009	



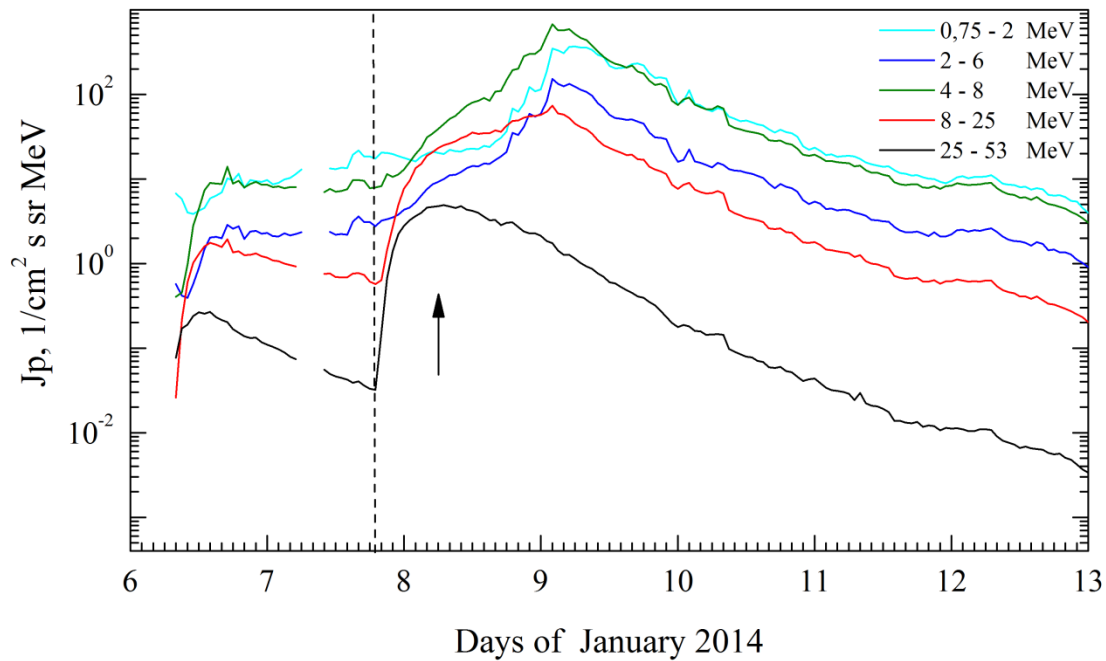
Time profiles of proton fluxes in the event 2014.01.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.01.07

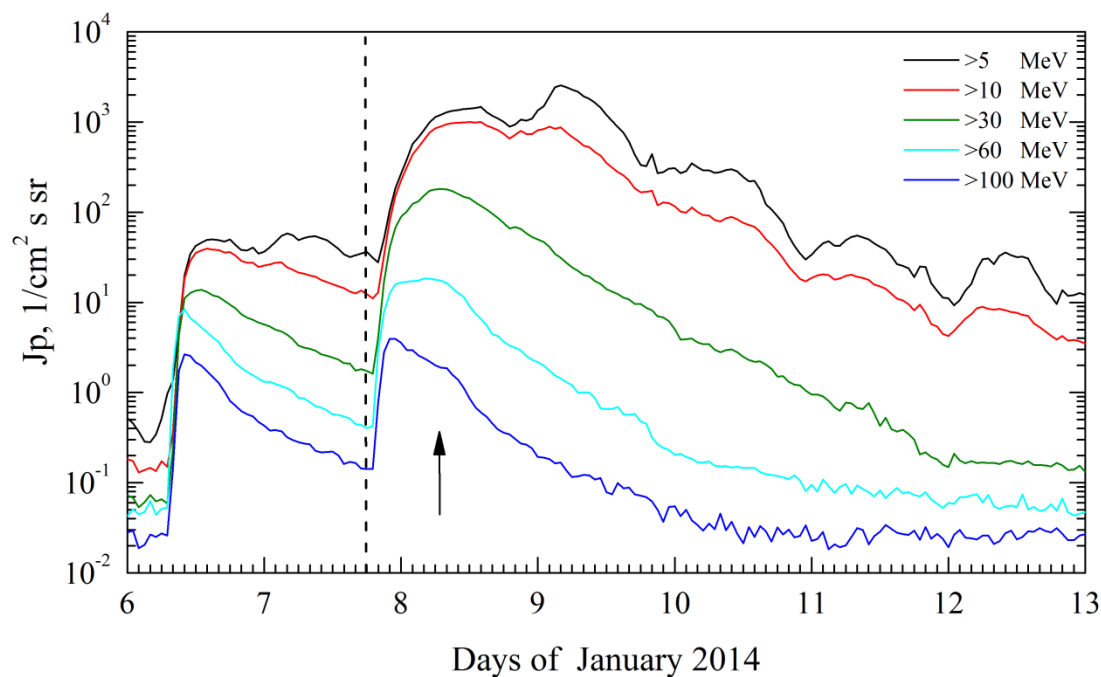


SOHO. Event 2014.01.07

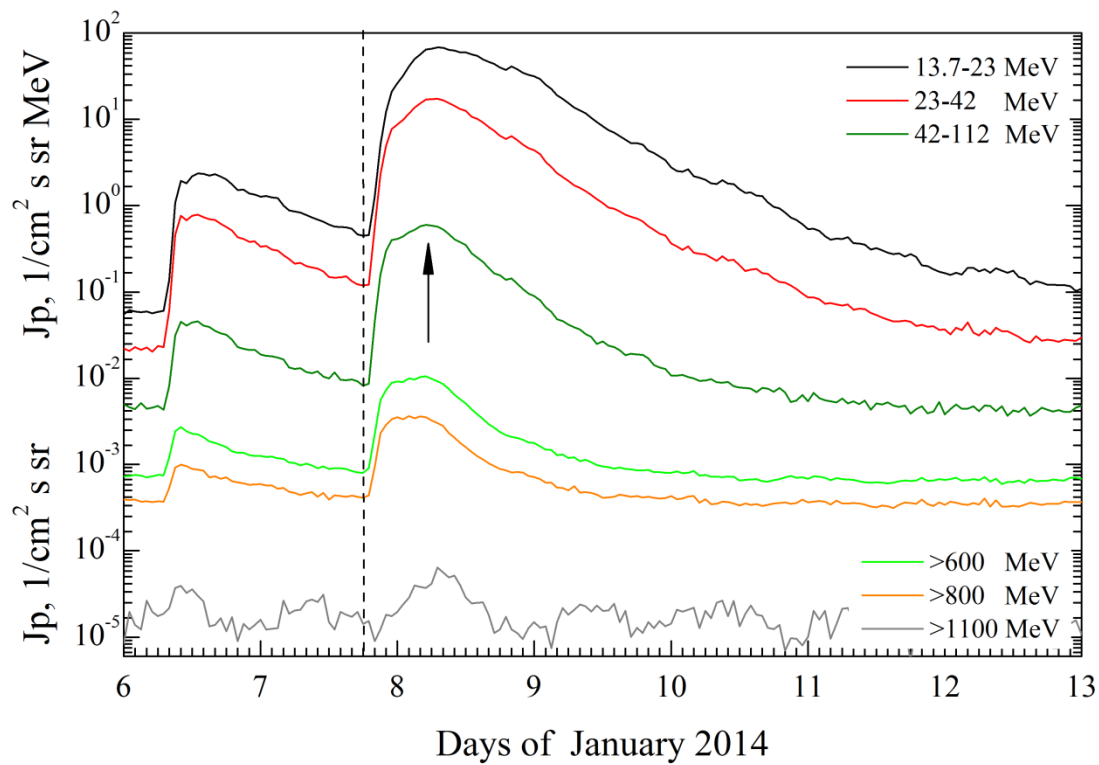


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.01.07

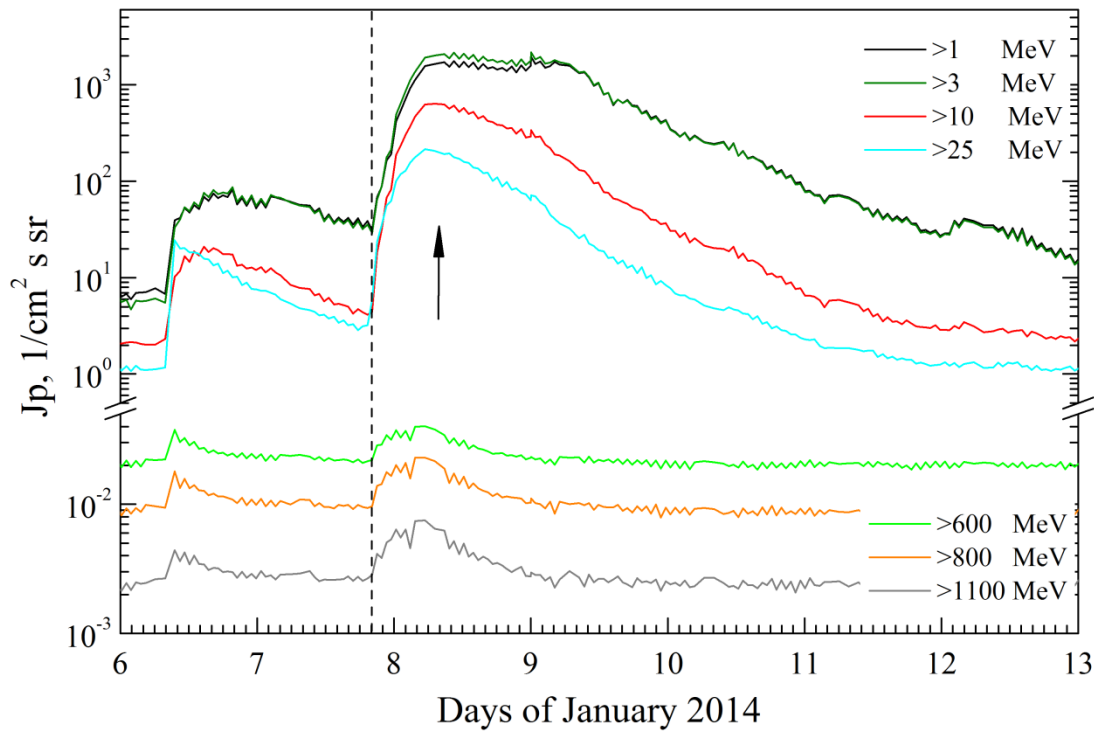


Electro. Event 2014.01.07

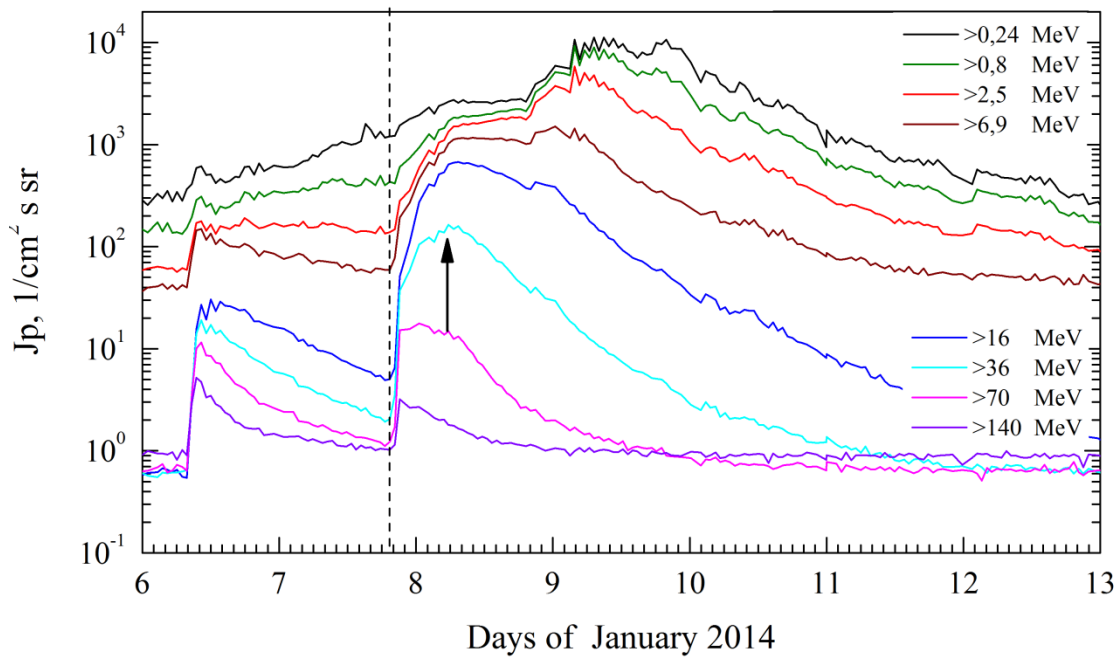


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2014.01.07



POES. Event 2014.01.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 January 07**

2014

January 07

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AR 11944

To event

548

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	<1825	1857	2054	S15W11	2N	
1 – 12	keV	1804	1832	1858	S12W08	X1.2	0.25
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1835:13	1841:09	1934:03	81605	16973540	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1805	1814	1926	P2.7 \ 15	3.0	
8.8	GHz	18051	1814	1928		3.26	
5	GHz	1806	1815	1919		3.34	
2.7	GHz	1806	1813	1856		3.92	
1.4	GHz	1806	1817	1856		2.99	
610	MHz	1806	1852	1919		3.43	
410	MHz	1807	1857	1900		2.86	
245	MHz	1805	1826	1833		3.86	
245	MHz	1948	1948	1948		3.08	
410	MHz	1954	1954	1954		2.20	
245	MHz	1958	1958	1958		2.32	
410	MHz	2005	2005	2005		2.20	
610	MHz	2011	2011	2013		2.40	
610	MHz	2016	2016	2016		2.20	
245	MHz	2053	2053	2053		2.66	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-67	1817		1848	1064	2	
DH II	0.06-14	1833	08/2100	1624		2	WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1824	1830	- 60.8	360°	231	SOHO

2014

January 07

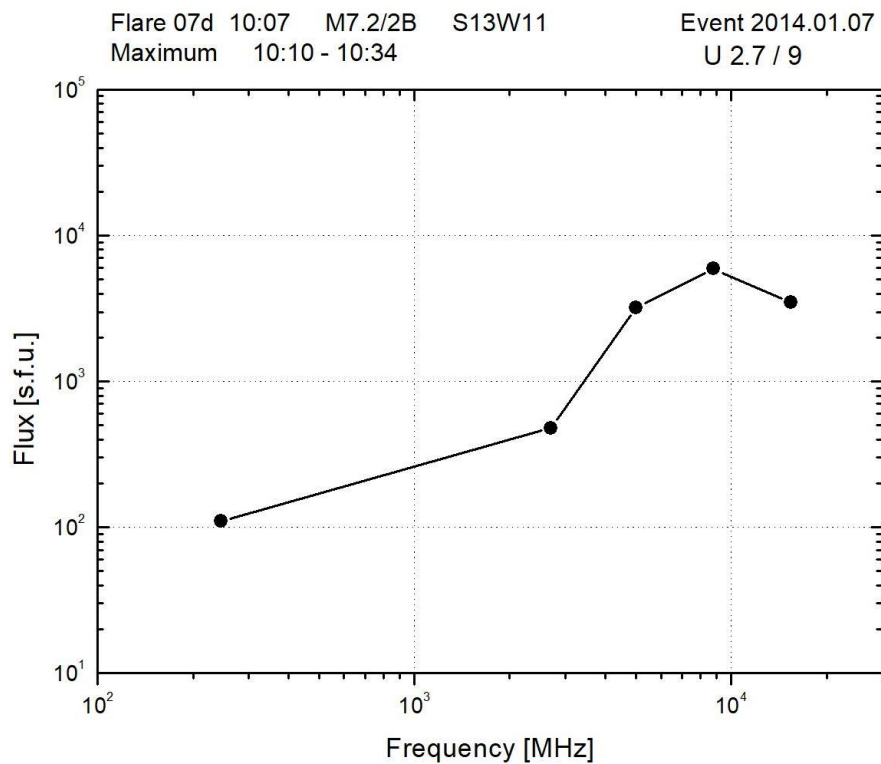
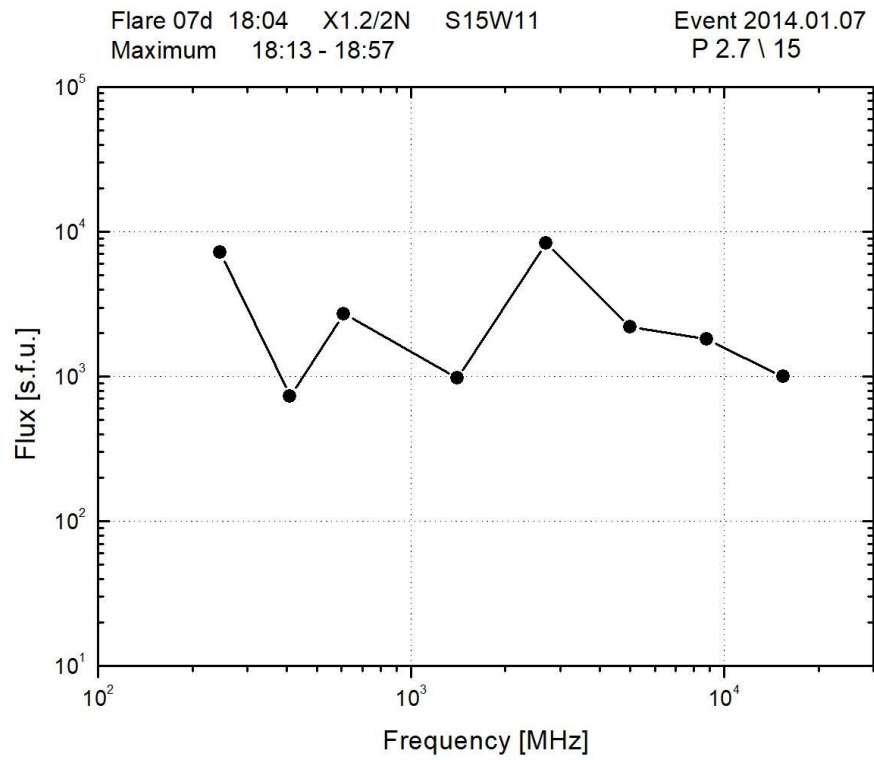
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AR 11944

To event 548

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1010	~1011	1124	S13E11	2B	ERU
1 – 12	keV	1007	1013	1037	S13E13	M7.2	0.092
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	1008:24	1016:14	1041:44	7967	28294588	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1010	1011	1048	U2.7 / 9	3.54	
8.8	GHz	1010	1011	1058		3.77	
5	GHz	1010	1012	1050		3.5	
2.7	GHz	1011	1012	1021		2.68	
245	MHz	1034	1034	1034		2.04	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	58-180	2000		2007		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1036	451	6.9	71°	148°	SOHO

Radio bursts frequency spectrum



Proton Active Region:

AR11944 (S09L100, CMP 4.8.01.2014;
Sp=1560 msh, FKC, BGD, R)
XRI= 3.08 $X_1^{1.2}+M_7^{7.2}+C_{44}$ $2_3+1_2+S_{52}$
PFR1 2-4.01 (68^h) $M_7^{4.0},:$
PFR2 7.01 (8^h) $X_1^{1.2}+M_1^{7.2}$

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Particle event: To($E_p > 10$ MeV) – 18d08^h

Tmax($E_p > 10$ MeV) – 18d14^h, Jmax($E_p > 10$ MeV) – 0.4 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma = 3.1$

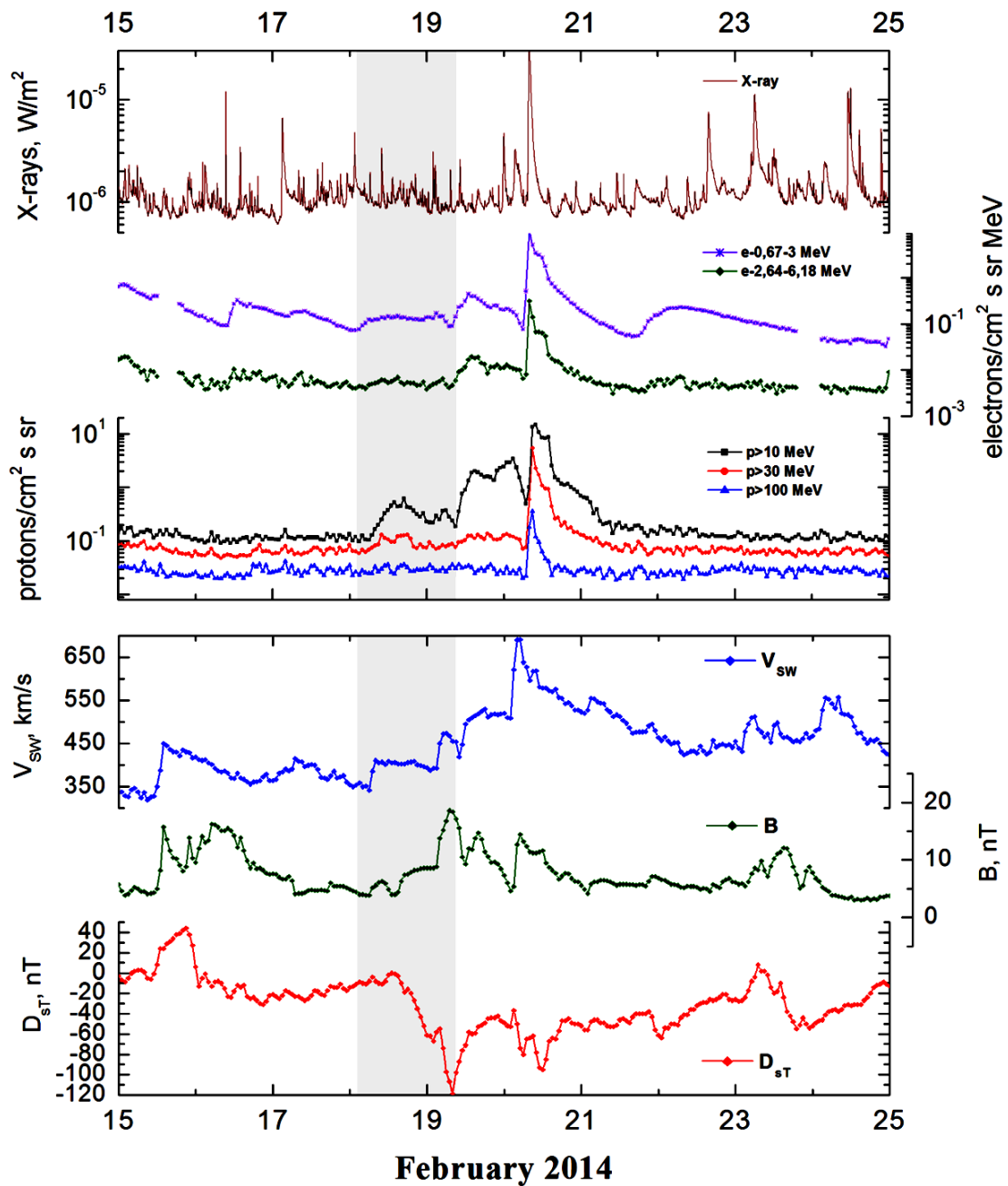
Quasimaximal energy of protons in the event – $E_{qm} = 50$ MeV

Sources: ☉ solar flare 18d01^h27^m, C4.7/SF, S16W42, AR11976,

Main burst X-ray 1–8 Å: onset – 18d01^h27^m, max – 18d01^h34^m, $\Phi = 0.0025$ J/m²

CME: 18d01^h36^m, $V = 779$ km/s, $\Delta\phi = 360^\circ$, $dA = 044^\circ$

Particle fluxes and associated phenomena

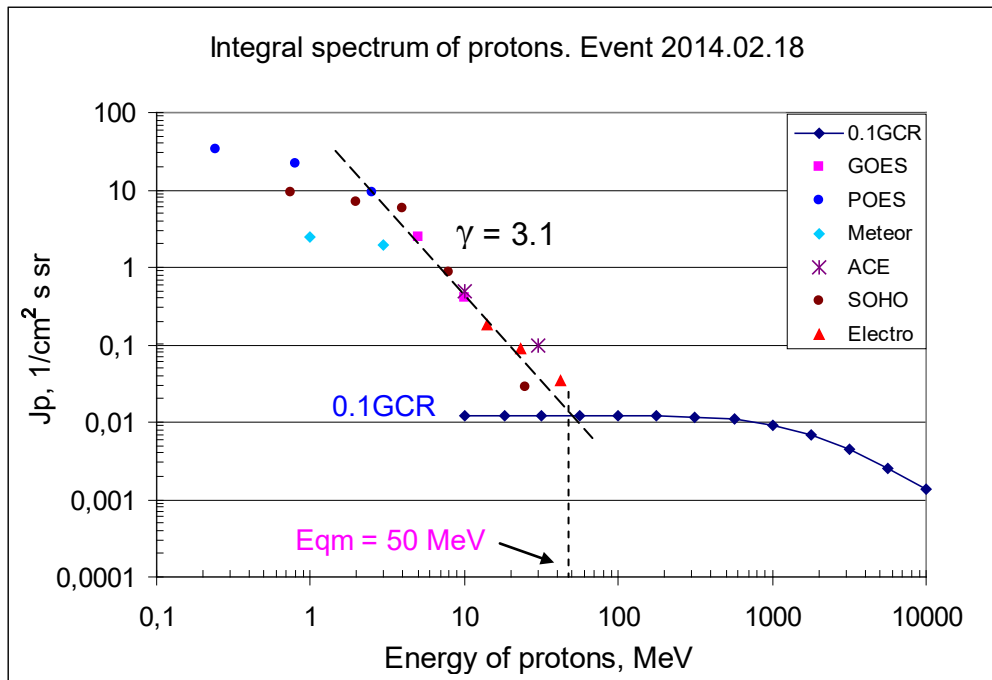


Integral fluxes of protons for the event of 2014 February 18

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	14	2.5	1	0.2	
EPS	>10	8	14	0.4	1	0.12	
EPS	>30	8	-	-	-	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	8	16	33	0.5	90	
MEPED	>0.8	8	16	22	0.5	65	
MEPED	>2.5	8	16	9.3	0.5	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	10	16	2.51	1	2.9	
SCR	>3	10	16	1.96	1	3.15	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	6	12	0.6	1	1	
SIS	>30	6	12	0.1	1	0.7	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2014 February 18

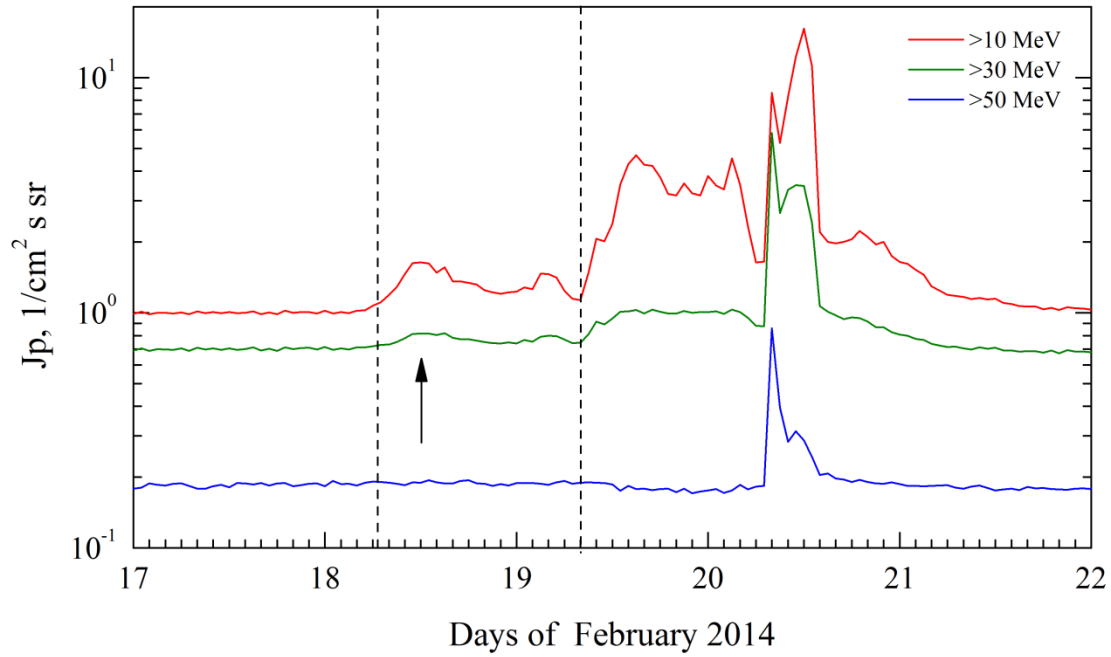
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	09	15	2.07	1.2	0.04	
LION	2 – 6	09	15	0.37	1.2	0.005	
EPHIN	4 – 8	08	15	1.23	1.2	0.004	
EPHIN	8 – 25	08	15	0.05	1.2	0.0004	
EPHIN	25 – 53	07	15	0.001	1.2	0.00004	
Electro-1							
SCR-E	13.7–23	8	15	0.01	0.5	0.045	
SCR-E	23–42	8	15	0.003	0.5	0.02	
SCR-E	42–112	8	15	0.0005	0.5	0.004	



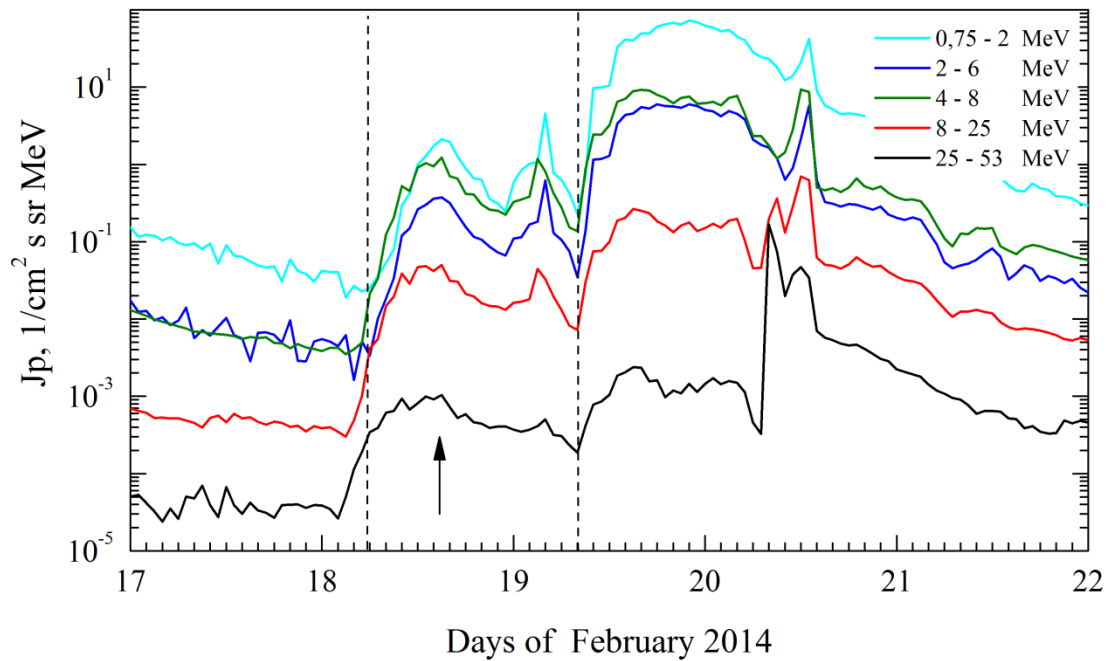
Time profiles of proton fluxes in the event 2014.02.18

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.02.18

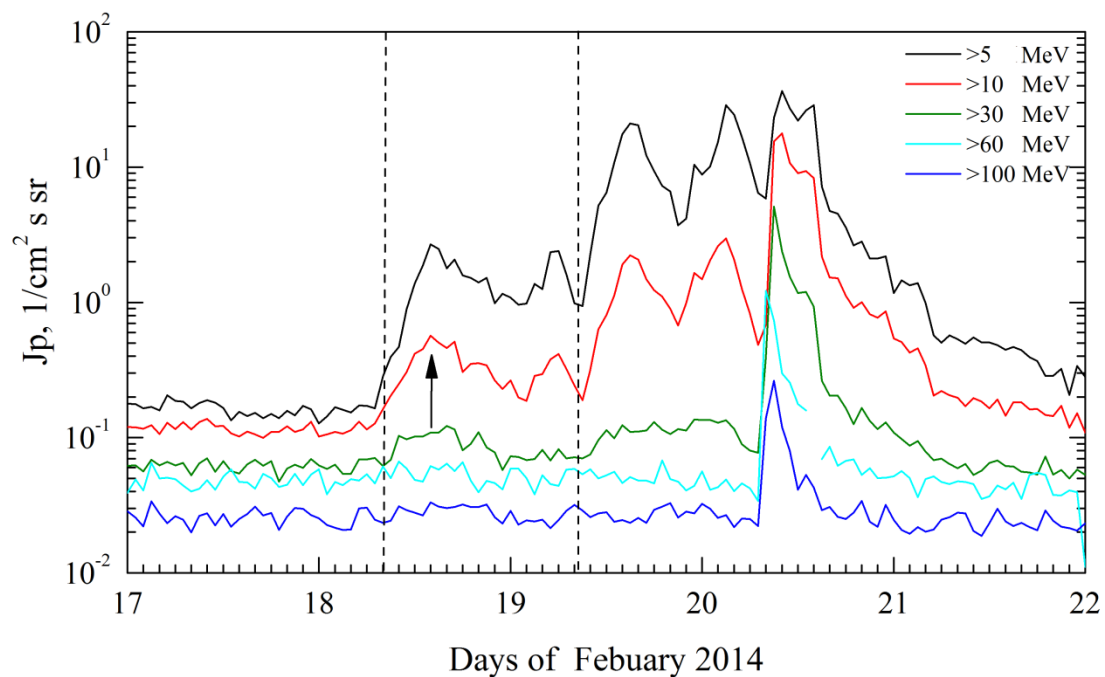


SOHO. Event 2014.02.18

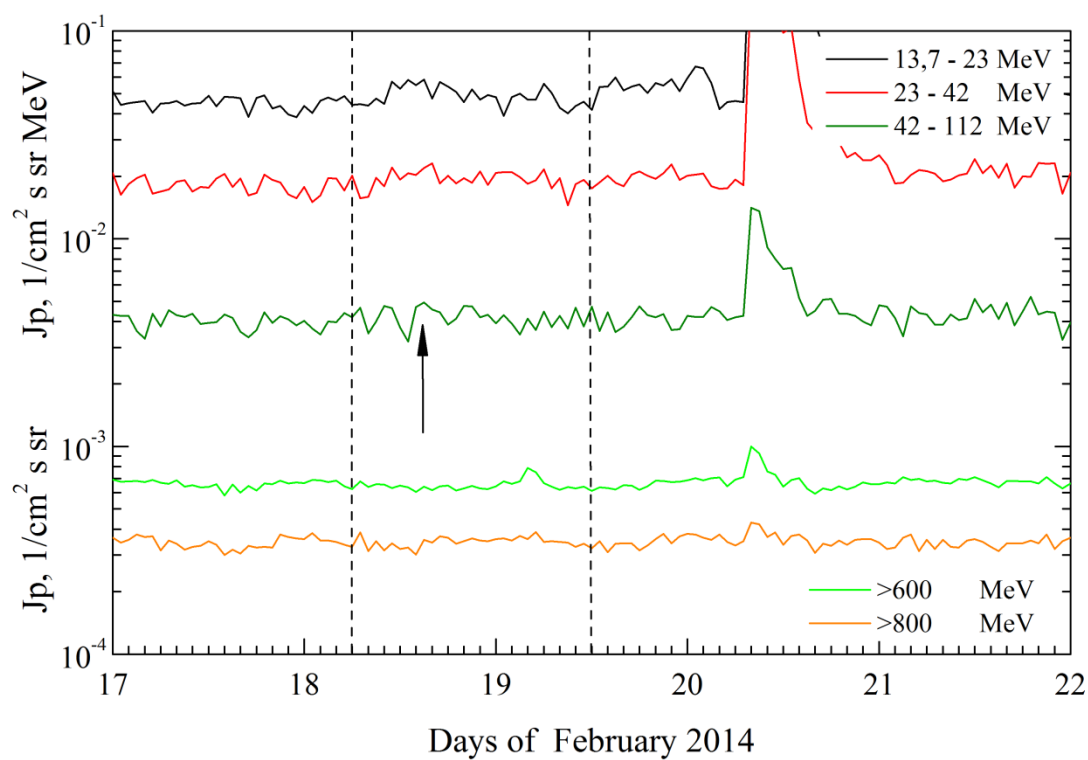


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro

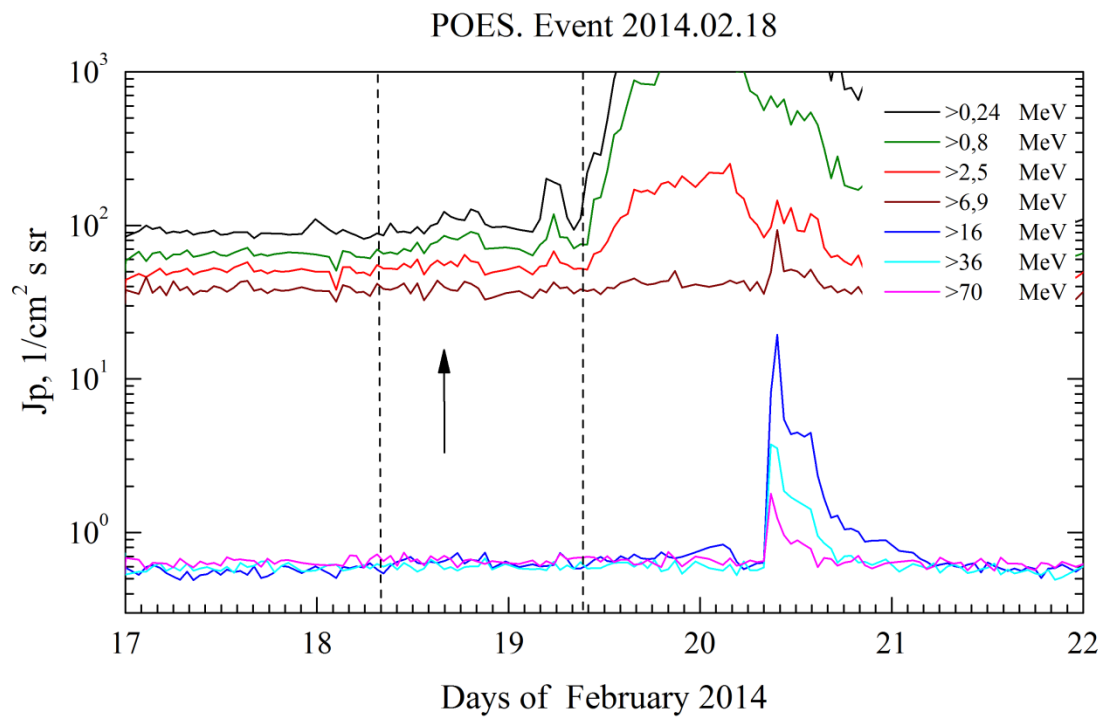
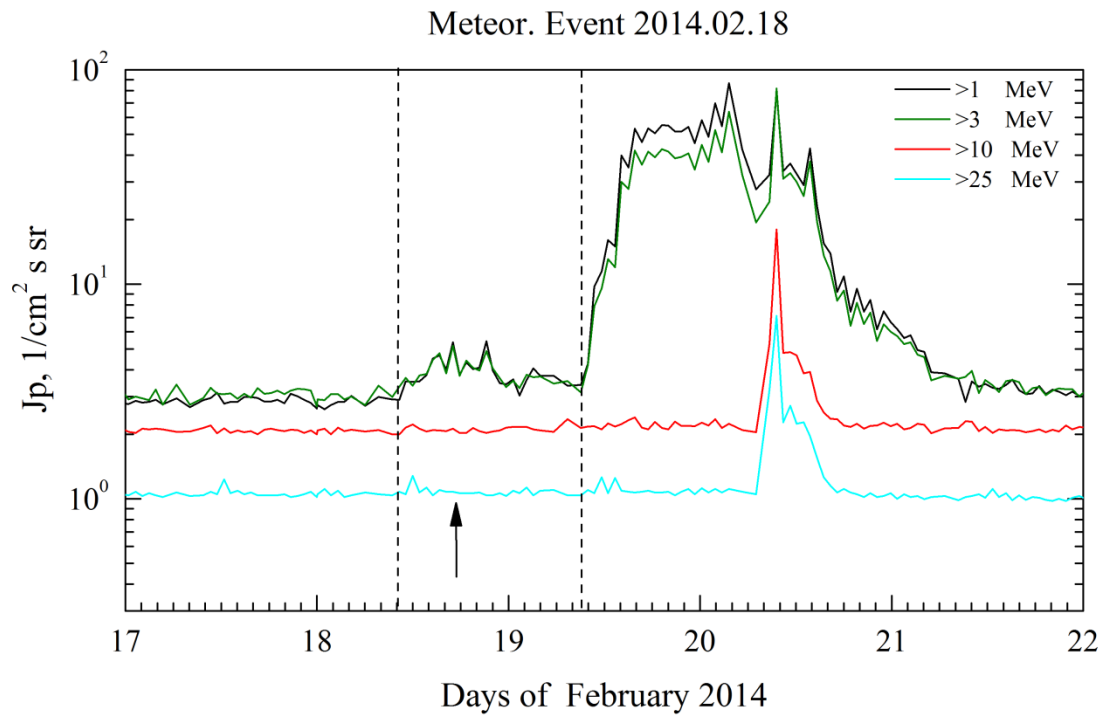
GOES. Event 2014.02.18



Electro. Event 2014.02.18



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 February 18**

2014 February 18 ☉ AR 11976 To event 549

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0134	0134	0145	S16W42	SF	ERU
1 – 12	keV	0127	0134	0140	S17W42	C4.7	0.0025
X-ray		To	Tmax	Te	N _{peak} , counts/s	Total counts	Sp/c
12-25	keV	0135:20	0136:06	0149:32	2288	2672952	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DH II	2-0.9	0216		0251			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0136	779	- 11.3	360°	044°	SOHO

Proton Active Region:

AR11976 (S14L320, CMP 14,8.02.2014,
Sp=390 msh, EKI, BG, R)
XRI=0.3, M₁^{3.0}+C₈, S₈
PFR 20.02: M₁^{3.0}

Particle event: To($E_p > 10$ MeV) – 19d09^h

Tmax₁($E_p > 10$ MeV) – 19d15^h, Jmax₁($E_p > 10$ MeV) – 2 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 20d03^h, Jmax₂($E_p > 10$ MeV) – 2.8 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma_1 = 3.3$, $\gamma_2 = 2.4$

Quasimaximal energy of protons in the event – Eqm₁ = 45 MeV

– Eqm₂ = 90 MeV

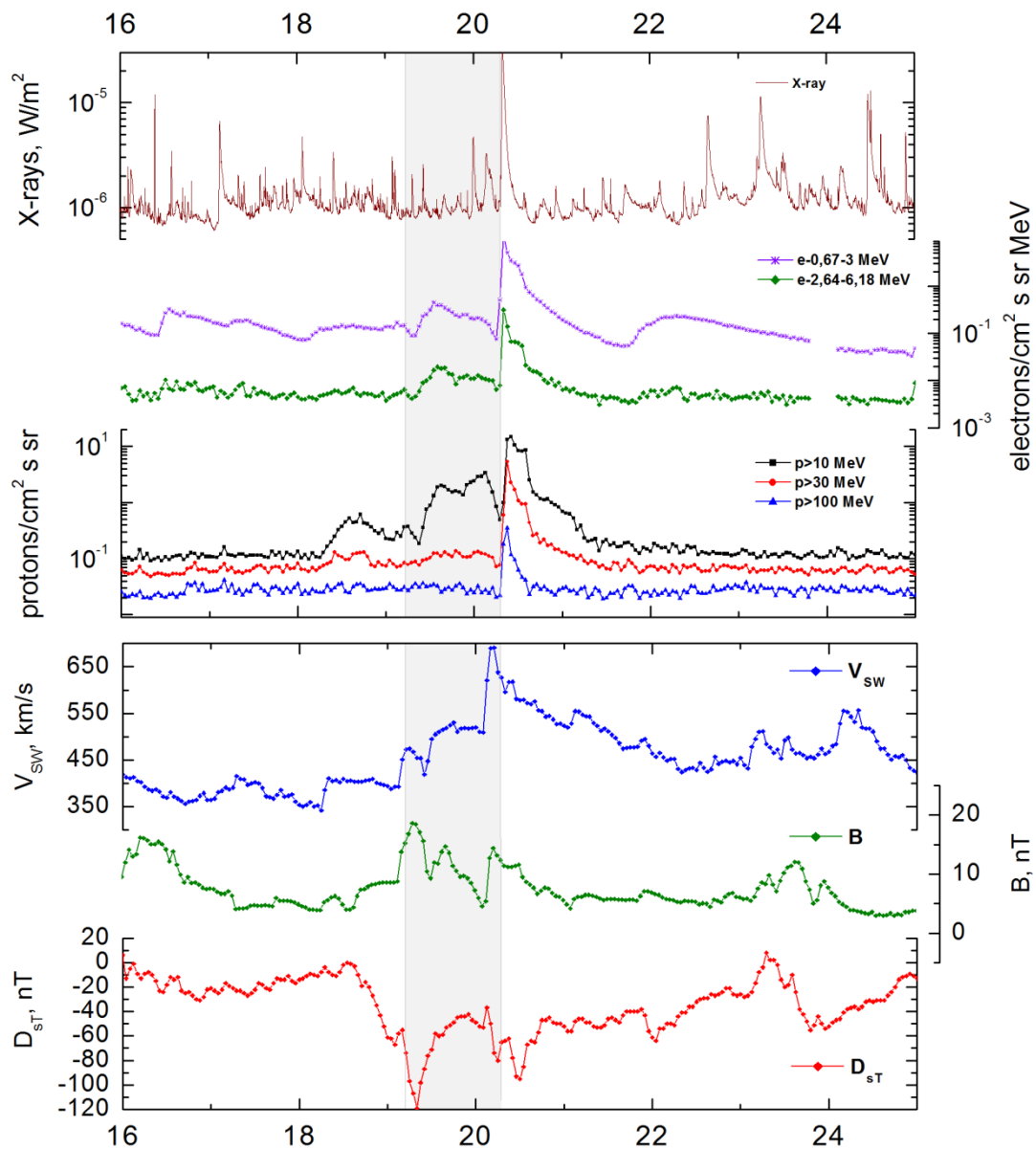
Sources: ☐ solar flare 19d<04^h48^m, AR11990, 3d behind E_L

CME 19d04^h48^m, V = 612 km/s, $\Delta\phi = 360^\circ$, dA = 090°

CME 20d03^h12^m, V = 993 km/s, $\Delta\phi = 360^\circ$, dA = 089°

▲ SC 20d03^h20^m

Particle fluxes and associated phenomena



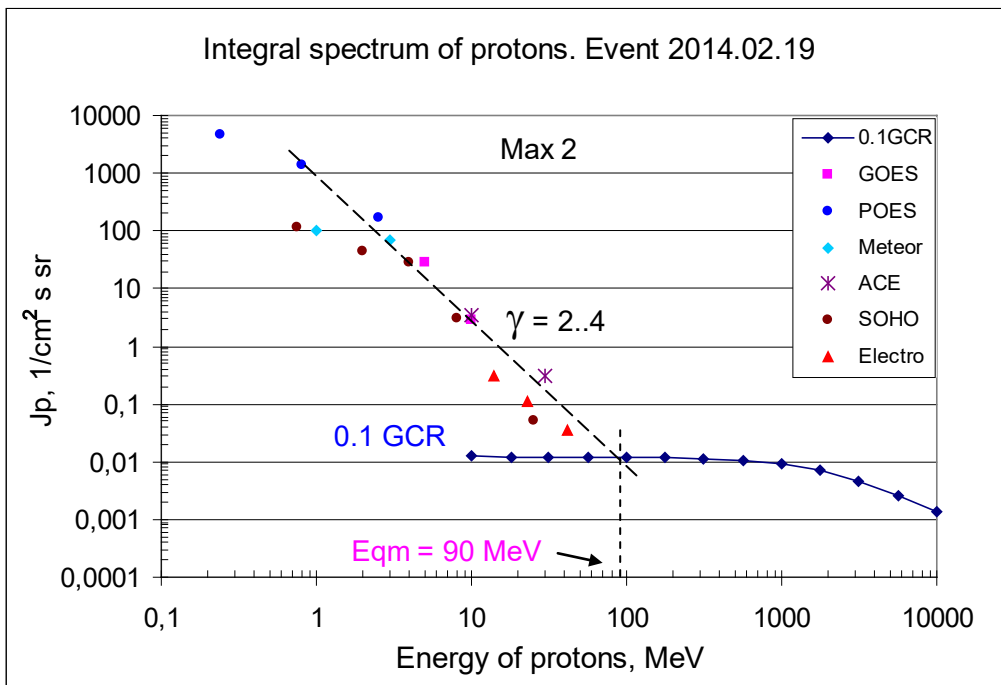
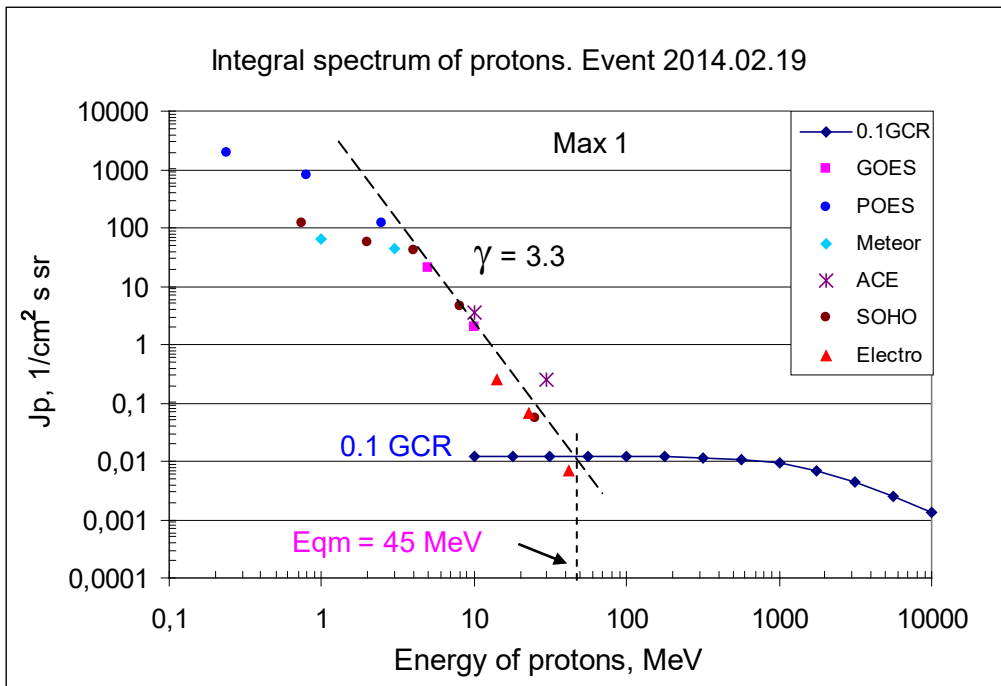
February 2014

Integral fluxes of protons for the event of 2014 February 19

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	9	15/20d03	21/28.5	1	0.2	
EPS	>10	9	15/20d03	2/2.8	1	0.12	
EPS	>30	9	-	-	-	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	10	16/20d03	1950/4700	0.5	90	
MEPED	>0.8	10	16/20d03	815/1350	0.5	65	
MEPED	>2.5	10	16/20d03	120/170	0.5	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.75	
MEPED	>70	-	-	-	-	0.9	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	9	15/20d03	65/100	0.5	2.9	
SCR	>3	9	15/20d03	45/70	0	3.2	
SCR	>10	-	-	-	-	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	7	15/20d03	3.6/3.5	1	1.1	
SIS	>30	7	15/20d03	0.25/0.3	1	0.7	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2014 February 19

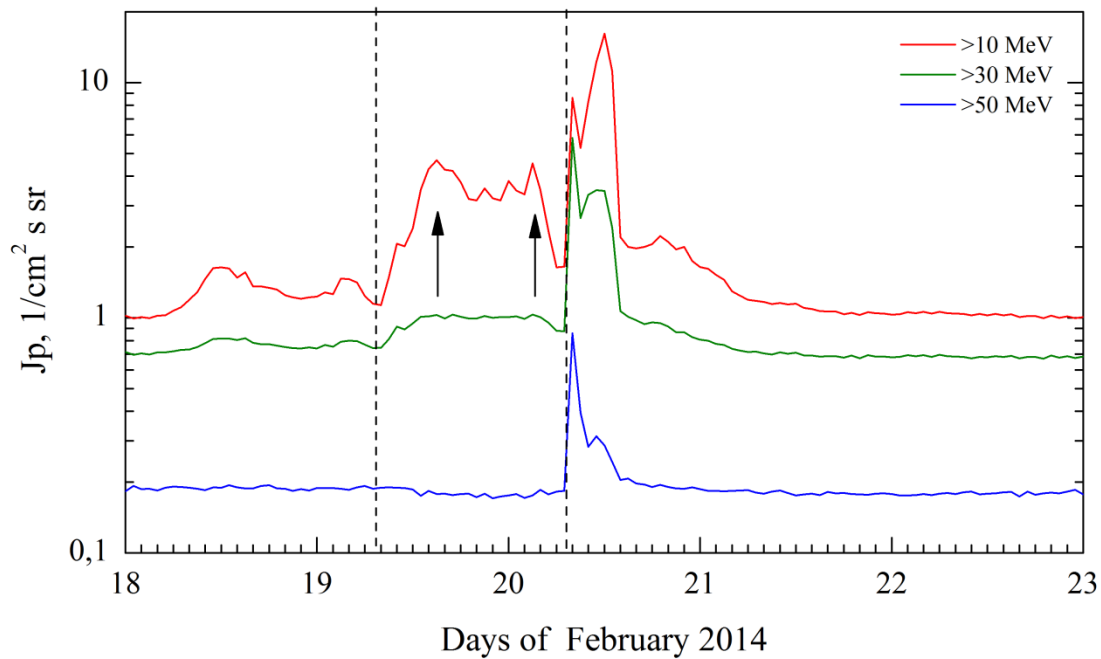
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	9	16/20d01	49.6/59	1	0.04	
LION	2 – 6	9	16/20d01	5.5/4.9	1	0.005	
EPHIN	4 – 8	9	16/20d01	9.2/6.5	1	0.004	
EPHIN	8 – 25	9	15/20d01	0.264/0.17	1	0.0004	
EPHIN	25 – 53	9	15/20d01	0.002/0.0017	1	0.00004	
Electro-1							
SCR-E	13.7–23	11	14/20d01	0.02/0.02	0.5	0.045	
SCR-E	23–42	11	14/20d01	0.003/0.004	0.5	0.02	
SCR-E	42–112	-	14/20d01	0.0001/0.0005	0.5	0.004	



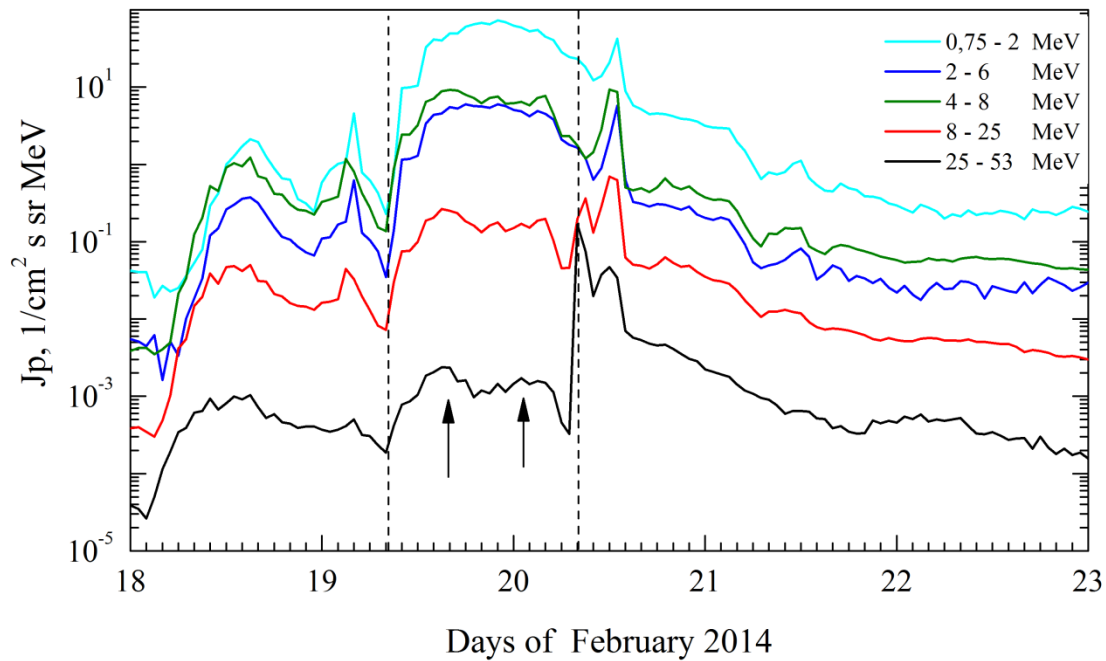
Time profiles of proton fluxes in the event 2014.02.19

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.02.19

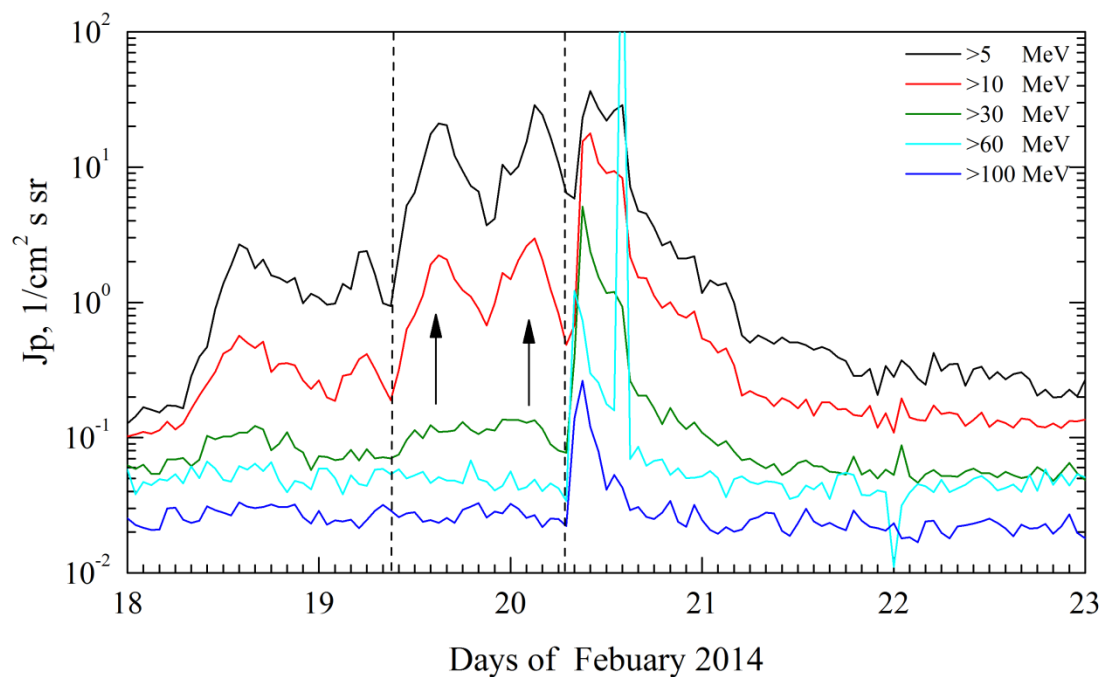


SOHO. Event 2014.02.19

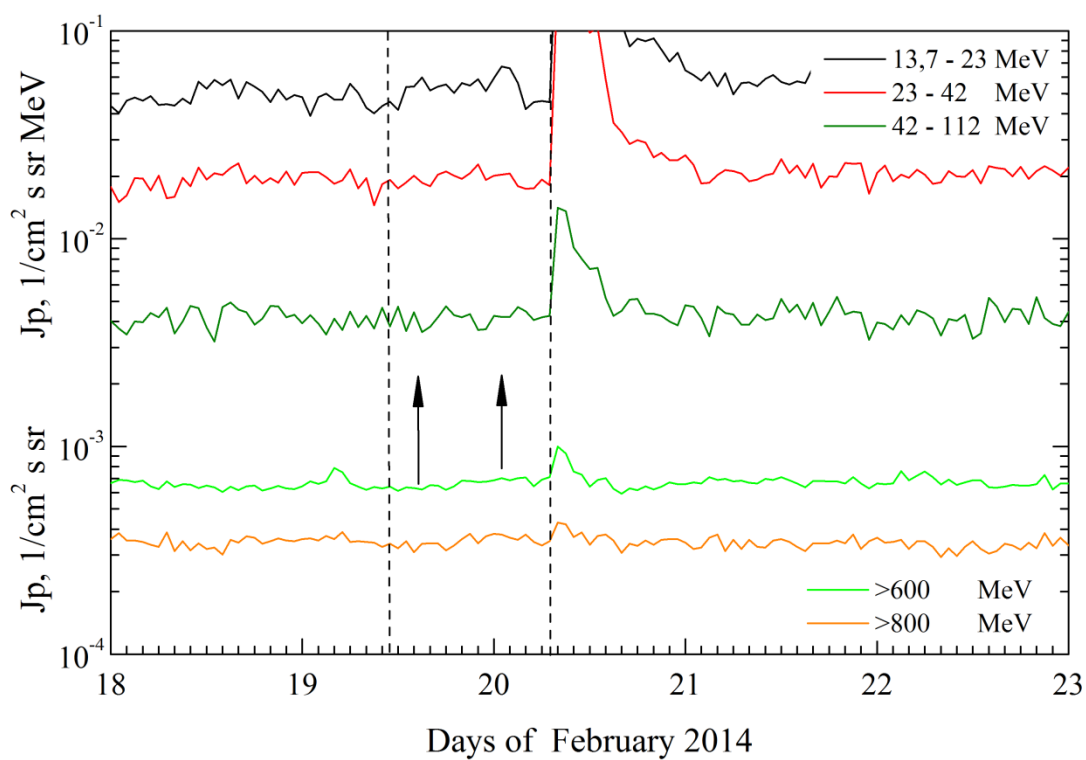


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

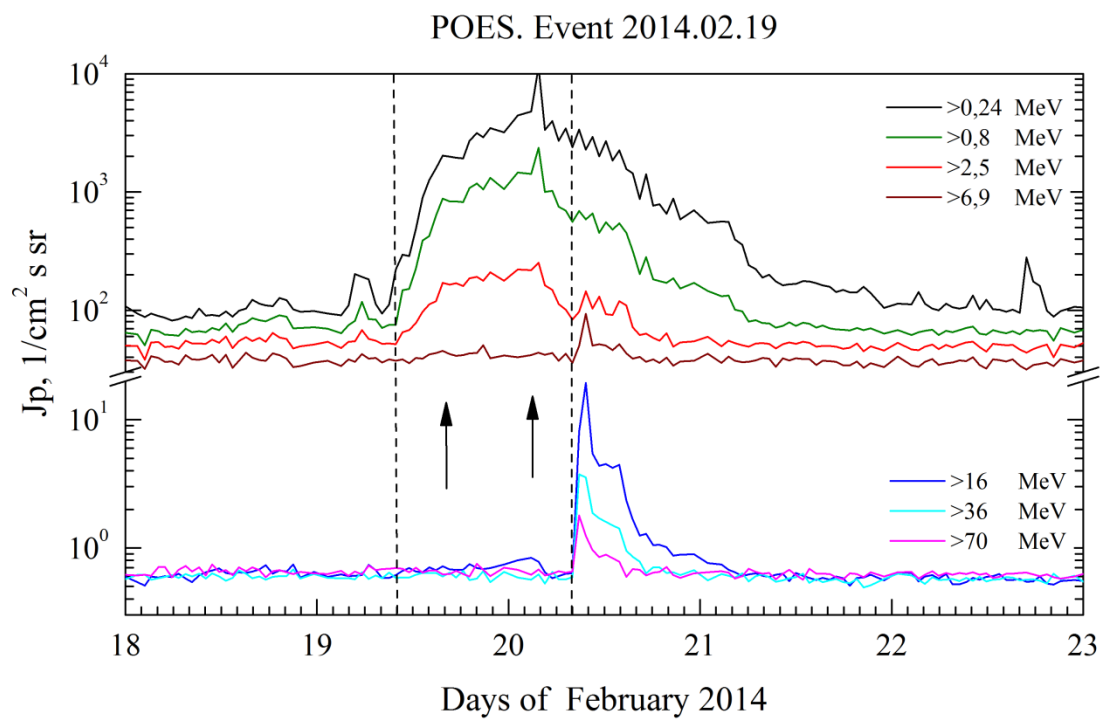
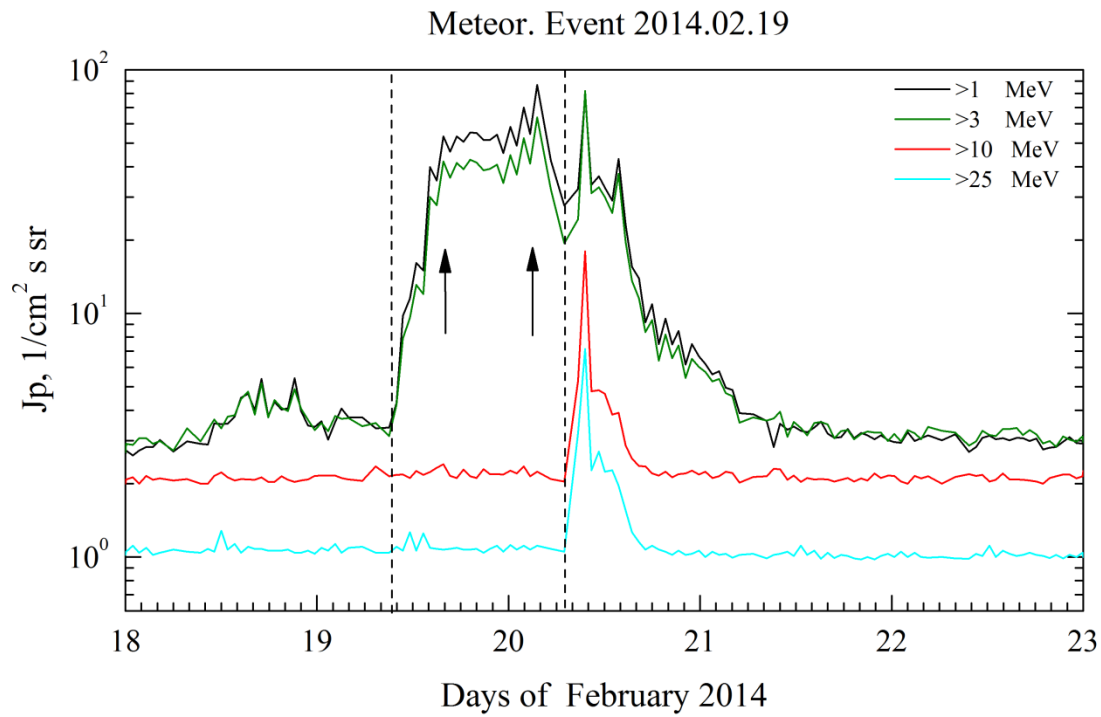
GOES. Event 2014.02.19



Electro. Event 2014.02.19



Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 February 19**

2014 February 19 ☐ AR 11990 To event 550

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0448	612	-30.8	360°	090°	SOHO

2014 February 20 Ø AR 11990 To event 550

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No event on visible solar disc					
1 – 12	keV	No X-ray event on visible solar disc					
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0312	993	- 48.8	360°	089°	SOHO

Proton Active Region:

AR11990 (S13L110, CMP 03.03.2014,
Sp=420 msh, DKC, BD, R)
XRI= 5.13 X₁^{4.9}+M₃^{1.3}+C₆ 2₁+S₆
PFR 23-25.02 (42^h) X₁^{4.9}+M₃

References:

Ameri D., E. Valtonen, [2019](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
Kalegaev V., M. Panasyuk, I. Myagkova et al., [2019](#).

Particle event: To($E_p > 10$ MeV) – 20d08^h

Tmax₁($E_p > 10$ MeV) – 20d10^h, Jmax₁($E_p > 10$ MeV) – 17.7 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 20d13^h, Jmax₂($E_p > 10$ MeV) – 9.2 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 2.7$, $\gamma_2 = 3.2$

Quasimaximal energy of protons in the event – Eqm₁ = 250 MeV

– Eqm₂ = 110 MeV

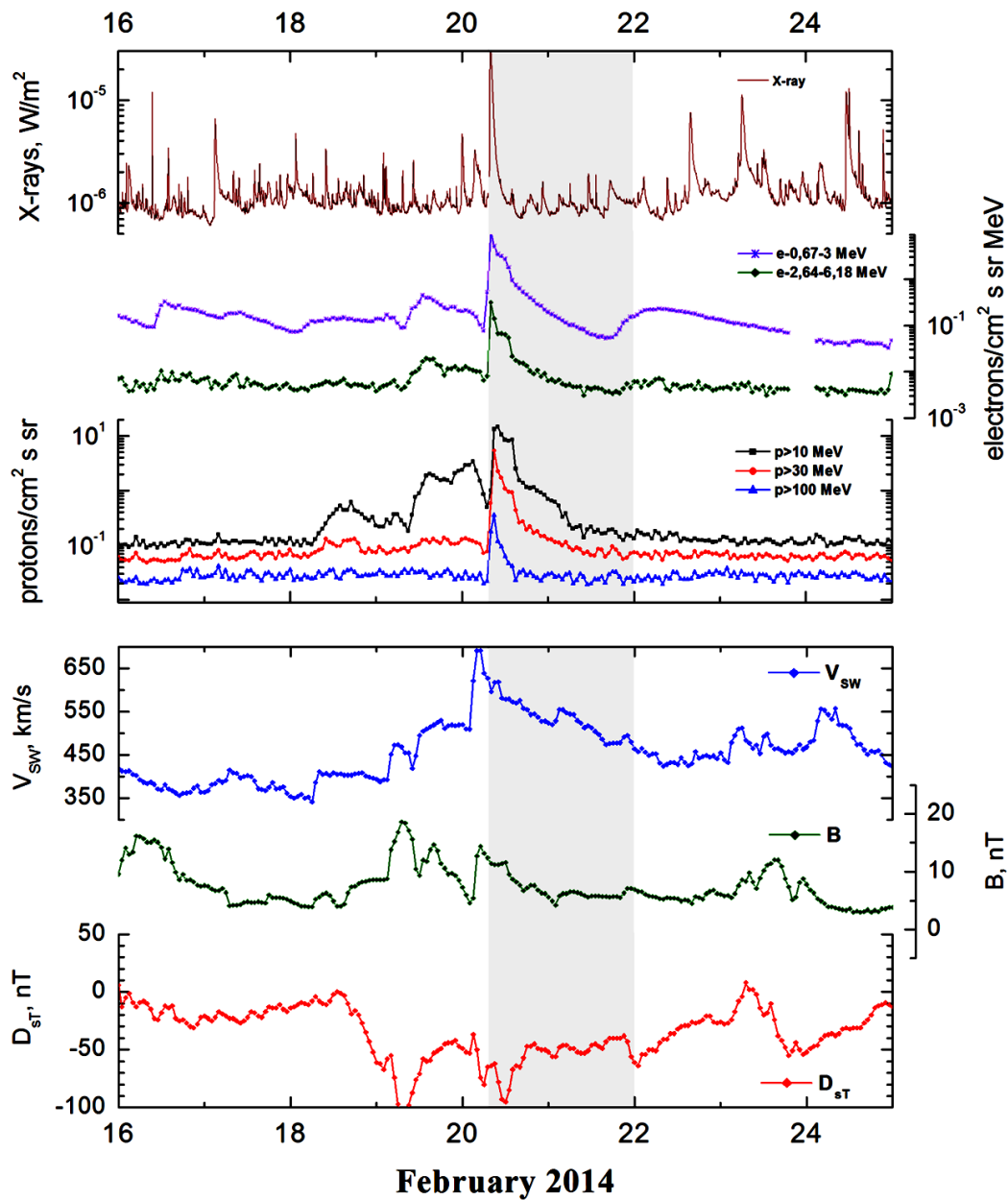
Sources: ● solar flare 20d07^h26^m, M3.0/SN, S15W73, AR11976

Main burst X-ray 1–8 Å: onset – 20d07^h26^m, max – 20d07^h56^m, $\Phi = 0.063$ J/m²

CME: 20d08^h00^m, $V = 948$ km/s, $\Delta\varphi = 360^\circ$, dA = 268°

Δ SC 20d03^h18^m

Particle fluxes and associated phenomena

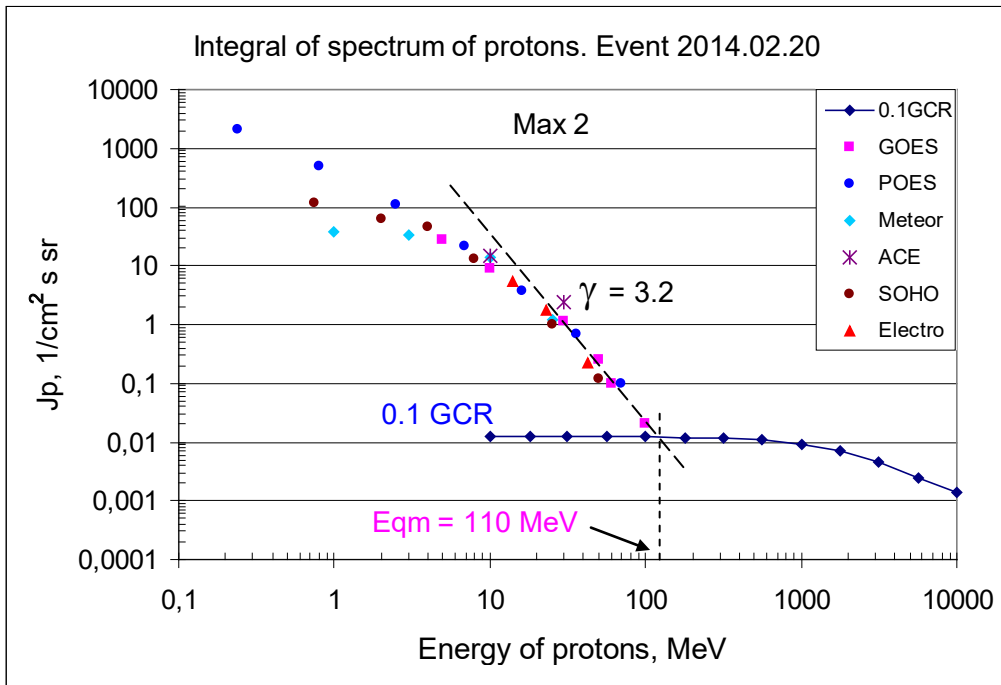
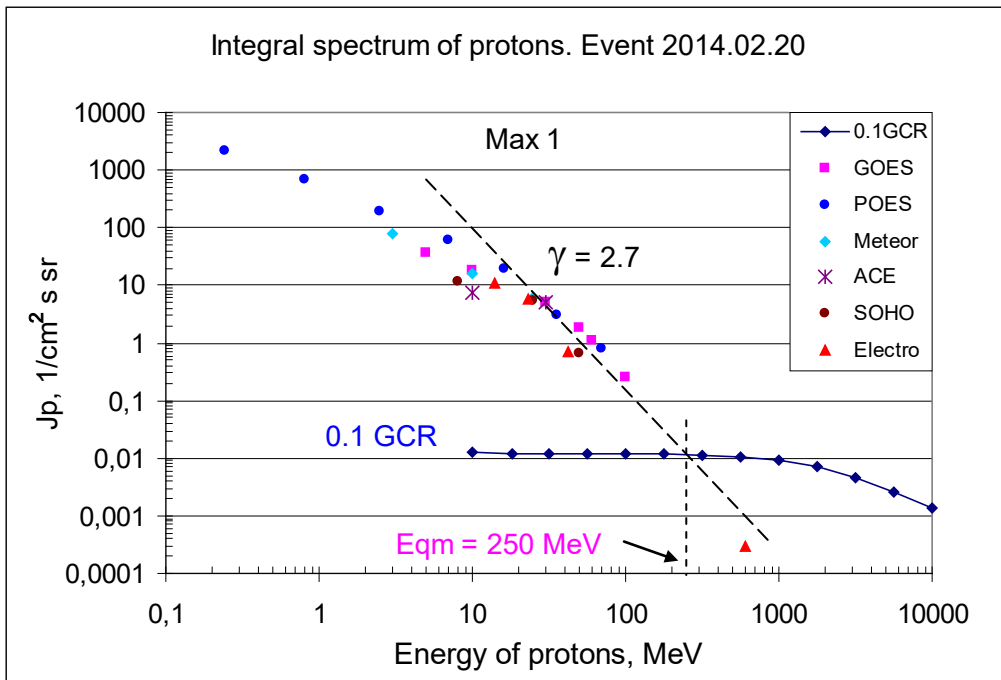


Integral fluxes of protons for the event of 2014 February 20

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	10/14	36/28.5	1.5	0.2	
EPS	>10	7	10/13	17.7/9.2	1.5	0.12	
EPS	>30	7	9/13	5/1.1	1	0.07	
EPS	>50	7	9/13	1.8/0.25	1	0.06	
EPS	>60	7	9/13	1.1/0.1	1	0.05	
EPS	>100	7	9/13	0.25/0.02	0.5	0.03	
Electro-1							
GALS-E	>600	7	9/13	0.0003/ -	0.5	0.0007	
POES							
MEPED	>0.24	8	10/14	2200/2160	2	90	
MEPED	>0.8	8	10/14	690/480	1.5	60	
MEPED	>2.5	8	10/14	95/70	1	50	
MEPED	>6.9	8	10/14	60/11.5	0.5	40	
MEPED	>16	8	10/14	18.7/3.8	0.5	0.7	
MEPED	>36	8	10/14	3/0.7	0.5	0.75	
MEPED	>70	8	10/14	0.9/0.1	0.5	0.8	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	6	- /13	- / 39	1	2.9	
SCR	>3	6	9/ 13	78/34	1	3.15	
SCR	>10	6	10/13	16/14	0.5	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	6	10/12	6.1/1.2	0.5	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	7	8/12	7.5/15	1	1.1	
SIS	>30	7	8/11	5/2.8	1	0.7	
SOHO							
EPHIN	>50	7	8/11	0.65/0.12	0.5	0.2	

Differential fluxes of protons for the event of 2014 February 20

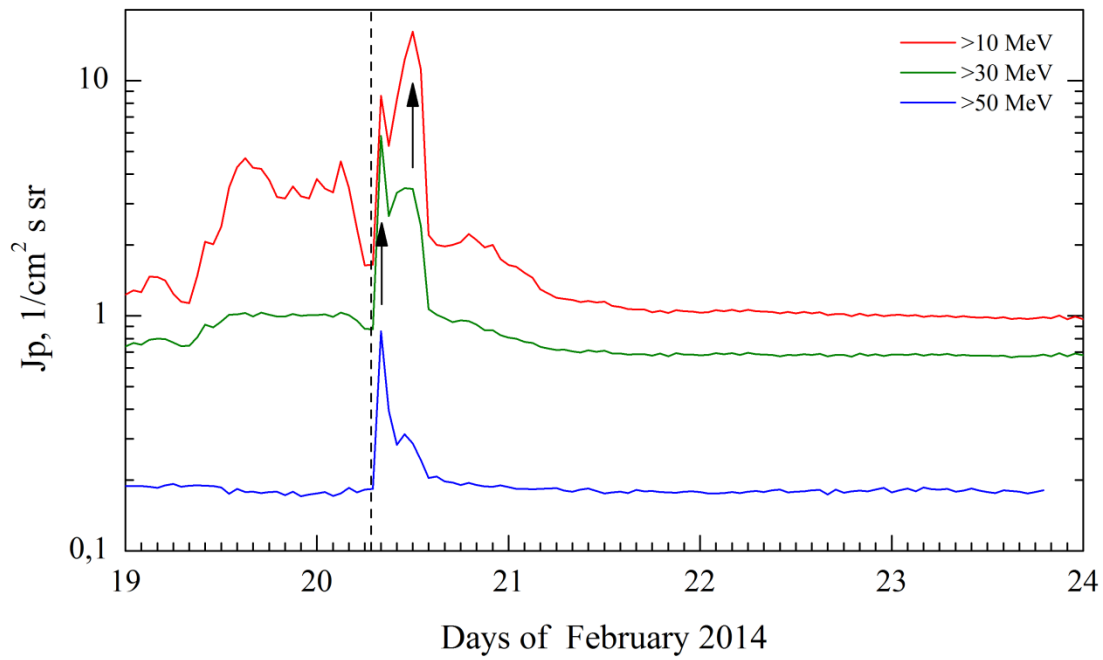
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	7	- /13	- /42	2	0.03	
LION	2 – 6	7	- /13	- /5.7	2	0.005	
EPHIN	4 – 8	7	- /13	- /8.6	2	0.005	
EPHIN	8 – 25	7	9/12	0.36/0.69	2	0.0003	
EPHIN	25 – 53	7	8/12	0.165/0.03	1.5	0.00003	
Electro-1							
SCR-E	13.7–23	7	9/13	0.6/0.4	1	0.045	
SCR-E	23–42	7	9/13	0.26/0.08	1	0.02	
SCR-E	42–112	7	9/13	0.01/0.0032	0.5	0.004	



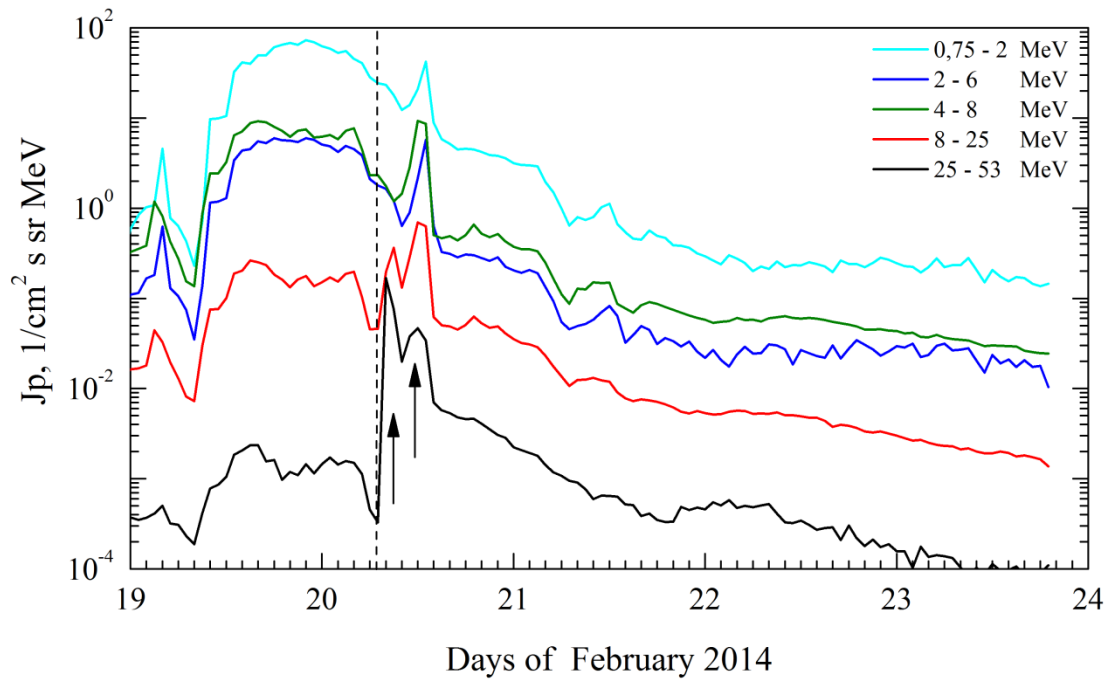
Time profiles of proton fluxes in the event 2014.02.20

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.02.20

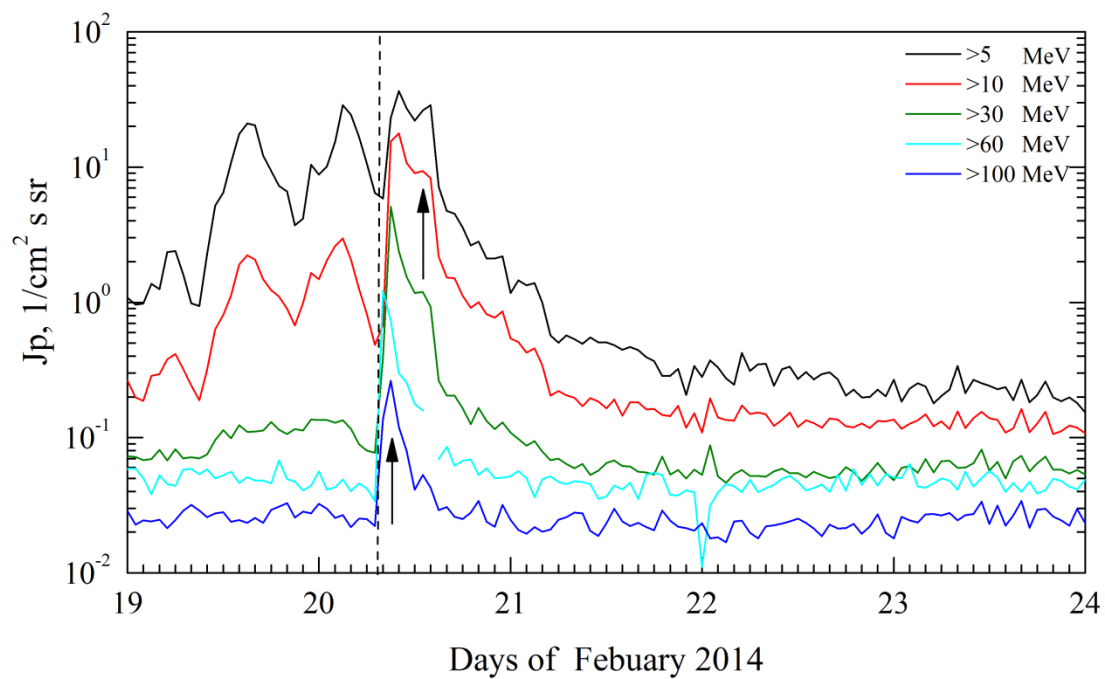


SOHO. Event 2014.02.20

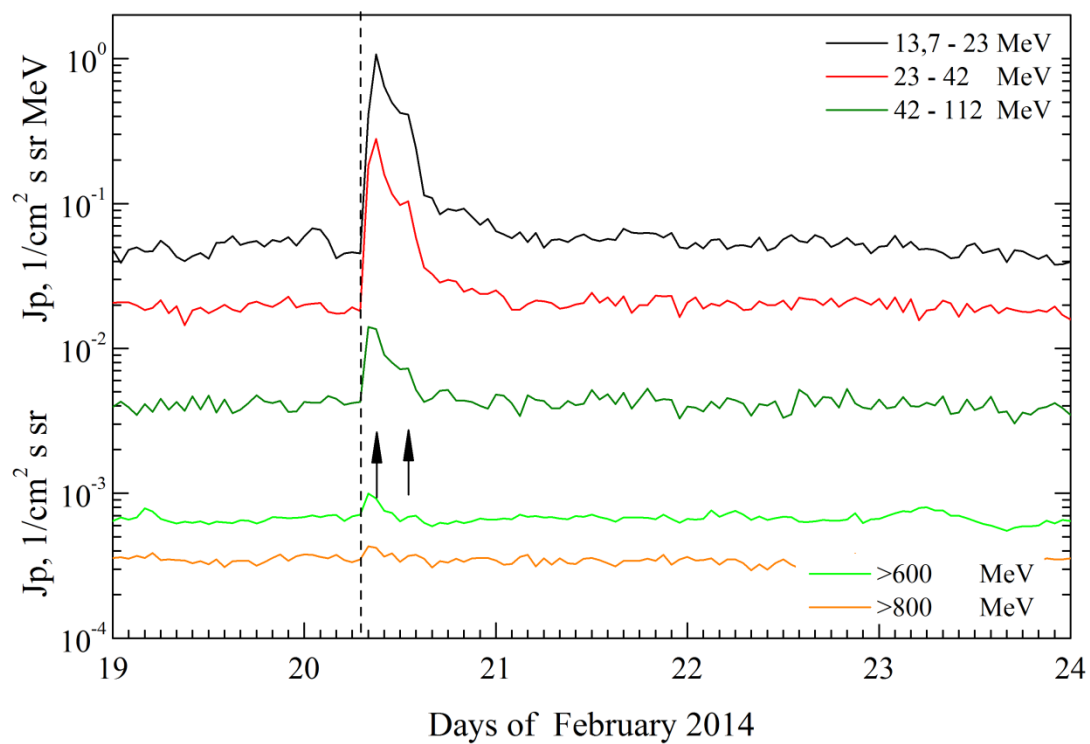


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

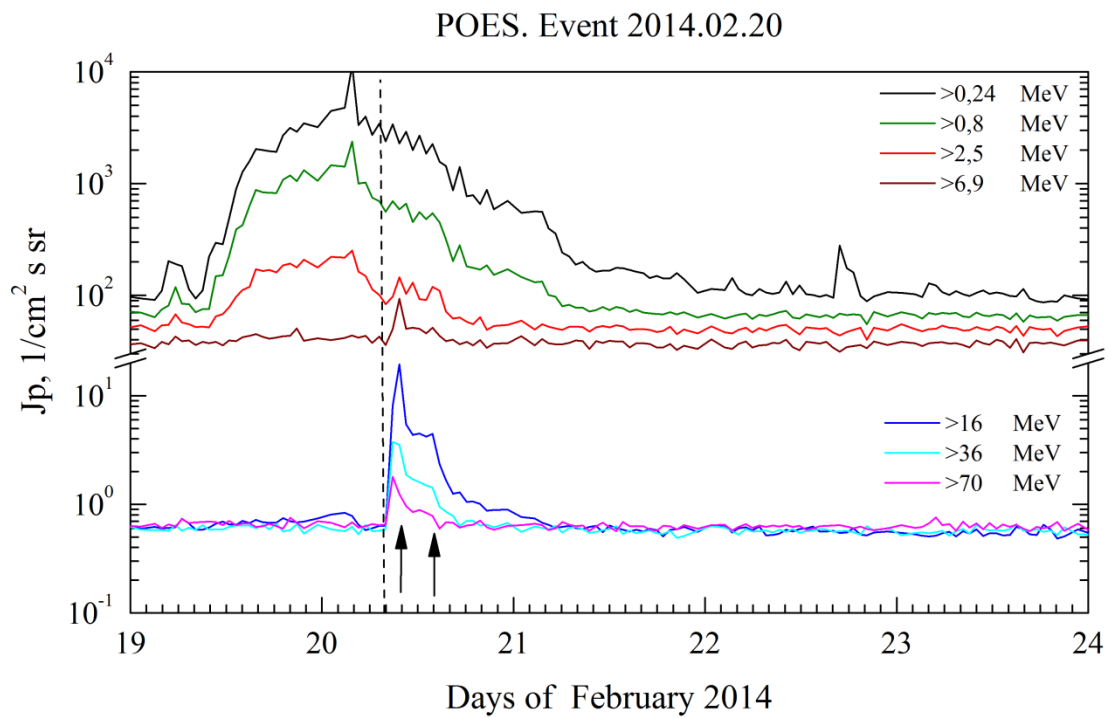
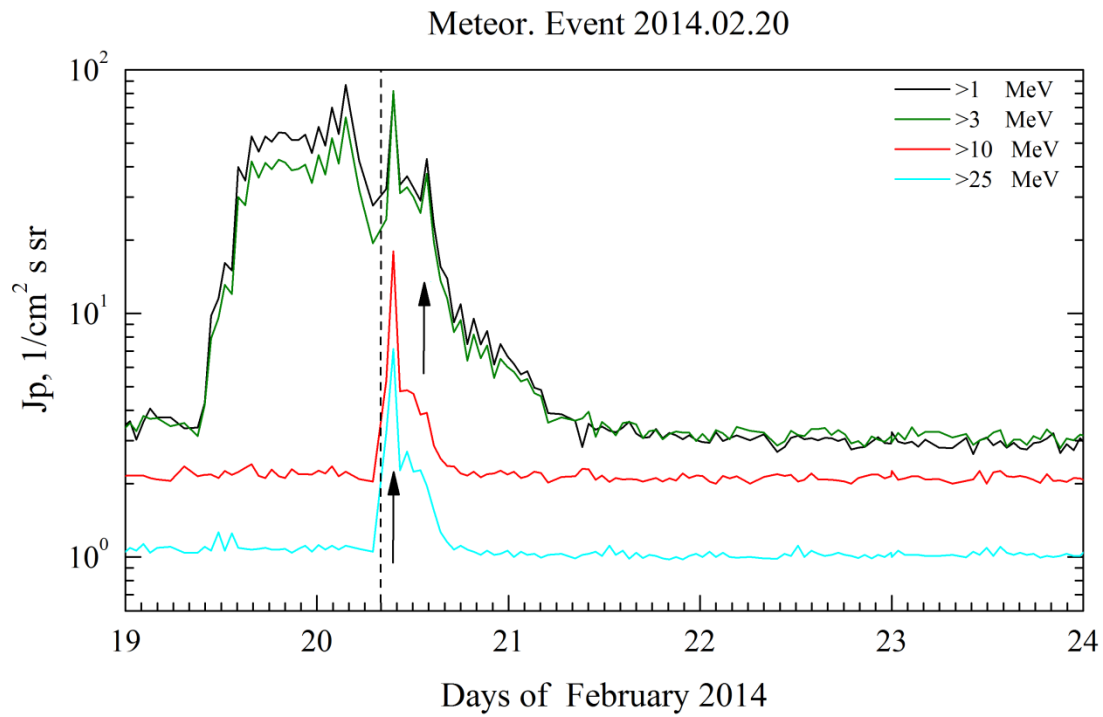
GOES. Event 2014.02.20



Electro. Event 2014.02.20



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 February 20**

2014

February 20

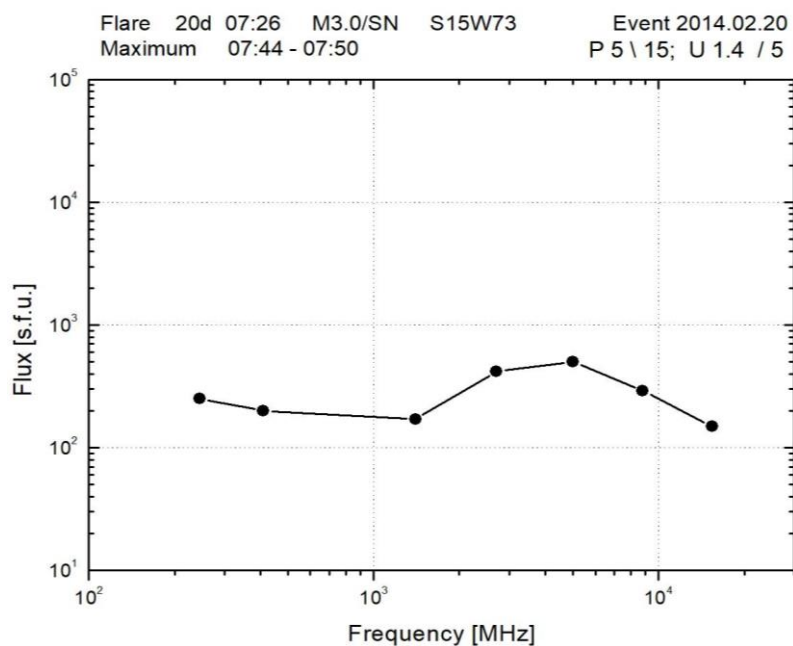
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AR11976

To event 551

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0728	0744	0832	S15W73	SN	ERU
1 – 12	keV	0726	0756	0825	S15W75	M3.0	0.063
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0732:32	0733:26	0736:12	19	18428	HESSI
25-50	keV	0736:56	0748:50	0832:16	976	6686966	HESSI
12-25	keV	0756:57	0757:05	0837:21	26418	3108770	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0745	0745	0747	P5 \ 15	2.18	
8.8	GHz	0744	0745	0755		2.46	
5	GHz	0743	0745	0756		2.7	
2.7	GHz	0741	0745	0756		2.62	
1.4	GHz	0744	0750	0756	U1.4 / 5	2.23	
410	MHz	0743	0745	0746		2.3	
245	MHz	0744	0744	0751		2.4	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	26-180	0745		0757		2	
DS III	29-176	0739		0739		2	
DS V	26-80	0730		0731		1	
DH II	7.7-12	0805		0829			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0800	948	- 9.5	360°	268°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR11976 (S14L320, CMP 14,8.02.2014,
Sp=390 msh, EKI, BG, R)
XRI=0.3, $M_1^{3.0}+C_8$, S₈
PFR 20.02: $M_1^{3.0}$

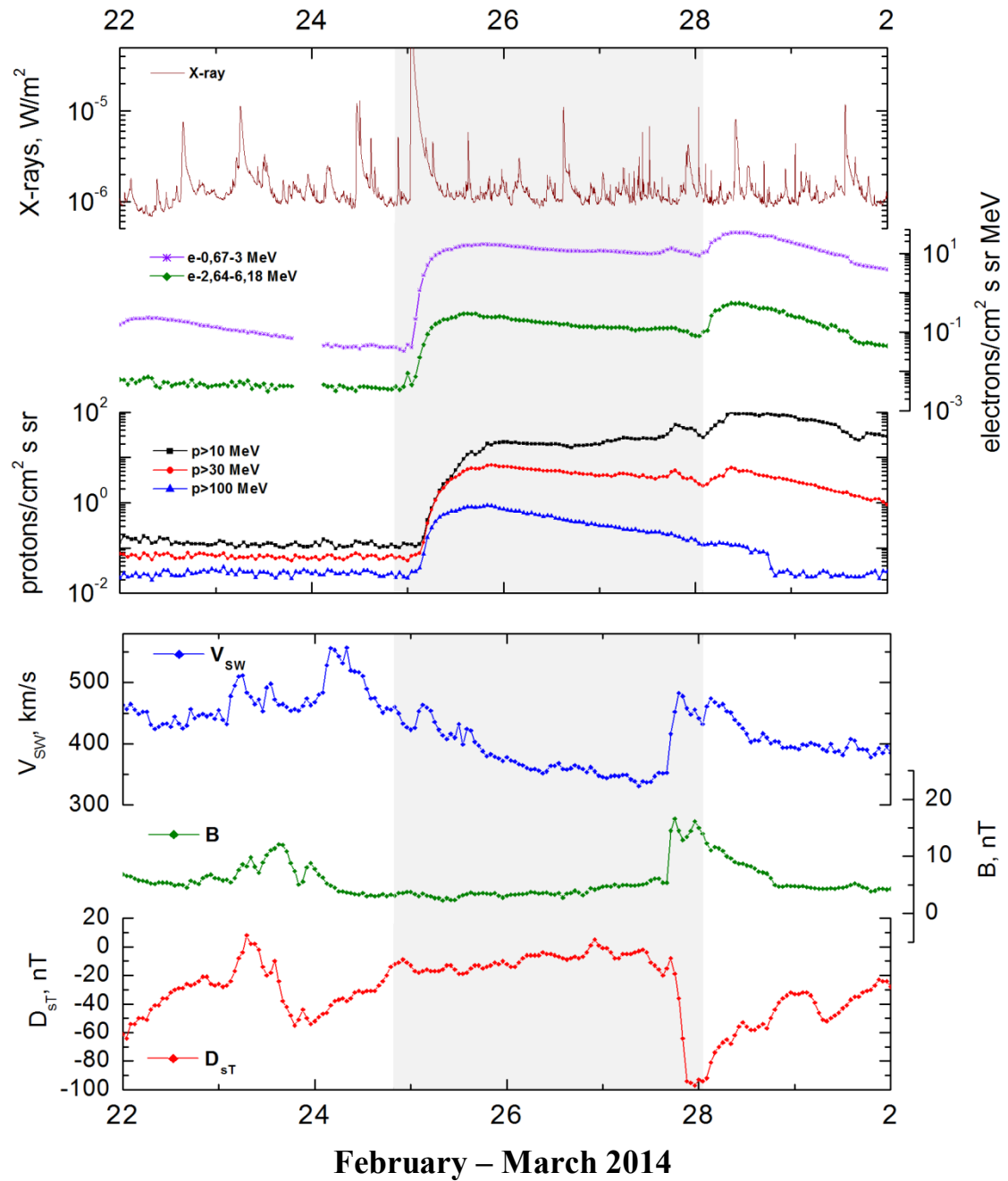
References:

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Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
Kalaivani P.P., O. Prakash, A. Shanmugaraju et al., [2021](#).
Kalegaev V., Kaportseva K., Nikolaeva N. et al., [2021](#).
Kalegaev V., M. Panasyuk, I. Myagkova et al., [2019](#).
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Le G.-M., X-F. Zhang, [2017](#).
NOAA SPE, [2019](#).
Núñez M., T. Nieves-Chinchilla, and A. Pulkkinen, [2019](#).
Vlasova N.A., V.I. Tulupov, V.V. Kalegaev, [2021](#).
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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 25d04^h
 Tmax($E_p > 10$ MeV) – 25d16^h, Jmax($E_p > 10$ MeV) – 13.6 /cm²·s·sr
 Duration of the event – 3 days, power-law index: $\gamma = 2.3$
 Quasimaximal energy of protons in the event – $E_{qm} = 500$ MeV

Sources: ● solar flare 25d00^h39^m, X4.9/2B, S12E82, AR11990
 Main burst X-ray 1–8 Å: onset – 25d00^h39^m, max – 25d00^h49^m, $\Phi = 0.43$ J/m²
 CME: 25d01^h25^m, $V = 2147$ km/s, $\Delta\phi = 360^\circ$, $dA = 073^\circ$

Particle fluxes and associated phenomena

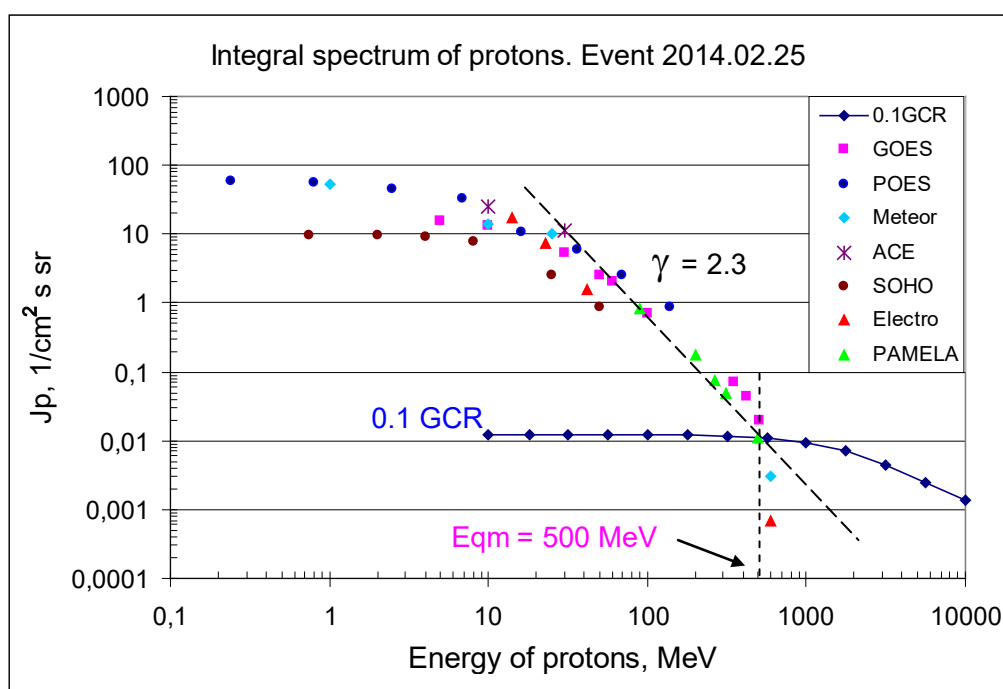


Integral fluxes of protons for the event of 2014 February 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	4	16	15.7	3	0.2	
EPS	>10	4	16	13.6	3	0.12	
EPS	>30	4	16	5.4	3	0.07	
EPS	>50	4	16	2.5	3	0.06	
EPS	>60	4	16	2	3	0.05	
EPS	>100	4	16	0.7	3	0.03	
Electro-1							
GALS-E	>600	4	20	0.0007	3	0.0007	
POES							
MEPED	>0.24	4	16	60	3	90	
MEPED	>0.8	4	16	55	3	60	
MEPED	>2.5	4	16	45	3	50	
MEPED	>6.9	4	16	33	3	40	
MEPED	>16	4	16	10.5	3	0.65	
MEPED	>36	4	16	5.8	3	0.7	
MEPED	>70	4	16	2.6	3	0.8	
MEPED	>140	4	16	0.85	3	0.9	
Meteor-1							
SCR	>1	3	21	52	3	2.94	
SCR	>3	3	-	-	3	3.15	
SCR	>10	3	21	14	3	2.09	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	3	21	10	3	1.09	
GALS-M	>600	3	15	0.003	>1	0.02	
ACE							
SIS	>10	2	15	25	6	1.1	
SIS	>30	2	15	11	6	0.7	
PAMELA							
TRACKER	>90	3	12-23	0.83	6	-	
TRACKER	>200	3	12-23	0.18	6	-	
TRACKER	>265	3	12-23	0.075	6	-	
TRACKER	>312	3	12-23	0.05	6	-	
TRACKER	>500	3	12-23	0.011	6	-	
SOHO							
EPHIN	>50	03	14	0.85	3	0.18	

Differential fluxes of protons for the event of 2014 February 25

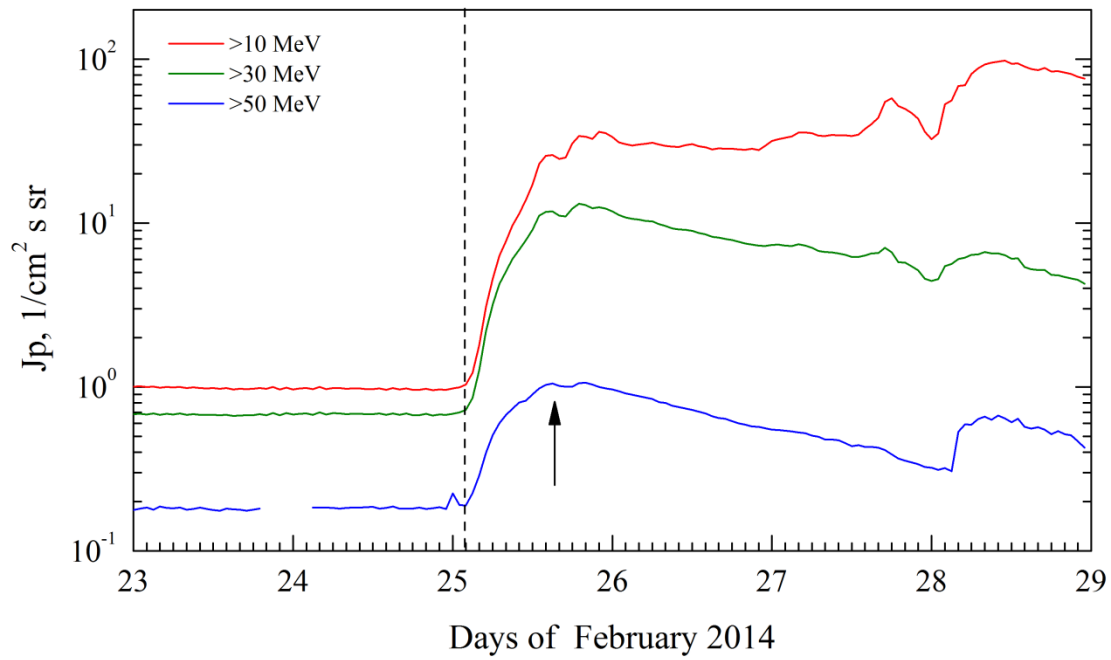
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	3	14	0.07	3	0.04	
LION	2 – 6	3	14	0.081	3	0.002	
EPHIN	4 – 8	3	14	0.404	3	0.008	
EPHIN	8 – 25	3	14	0.28	3	0.0005	
EPHIN	25 – 53	3	14	0.07	3	0.00003	
Electro-1							
SCR-E	13.7–23	4	20	1.1	3	0.045	
SCR-E	23–42	4	20	0.3	3	0.02	
SCR-E	42–112	4	20	0.022	3	0.004	
GOES							
EPS	350–420	2	10	0.0004	2	0.0016	
EPS	42–510	2	10	0.00025	2	0.0008	
EPS	510–700	5	12	0.00011	1.5	0.0003	
EPS	>700	-	-	-	-		



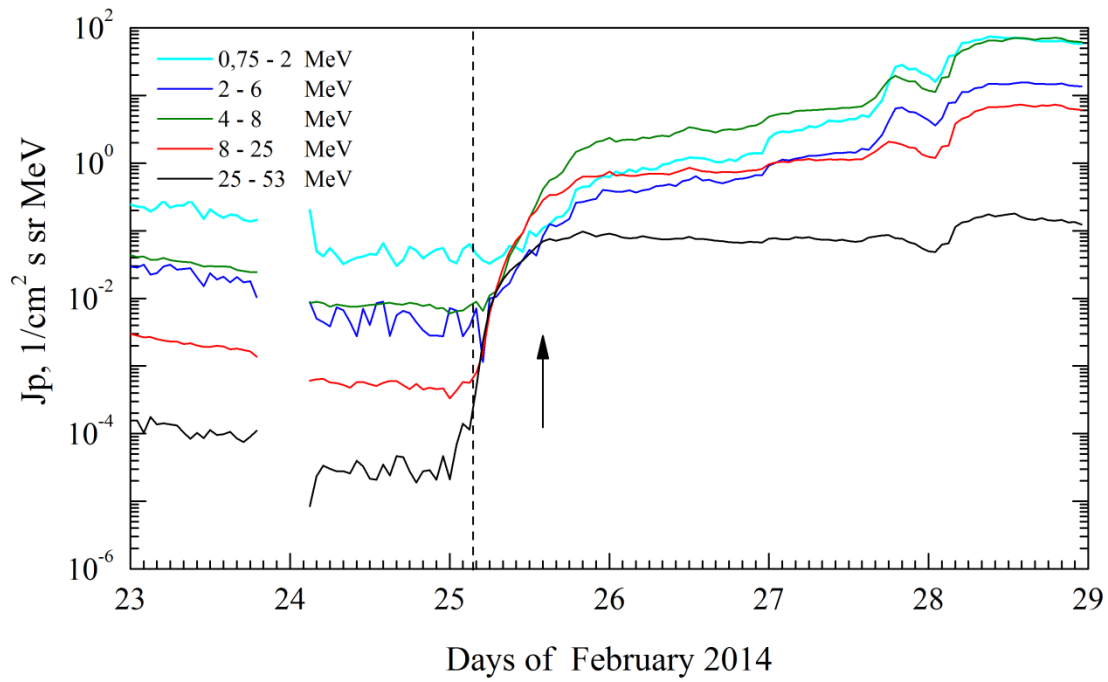
Time profiles of proton fluxes in the event 2014.02.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50MeV). Event 2014.02.25

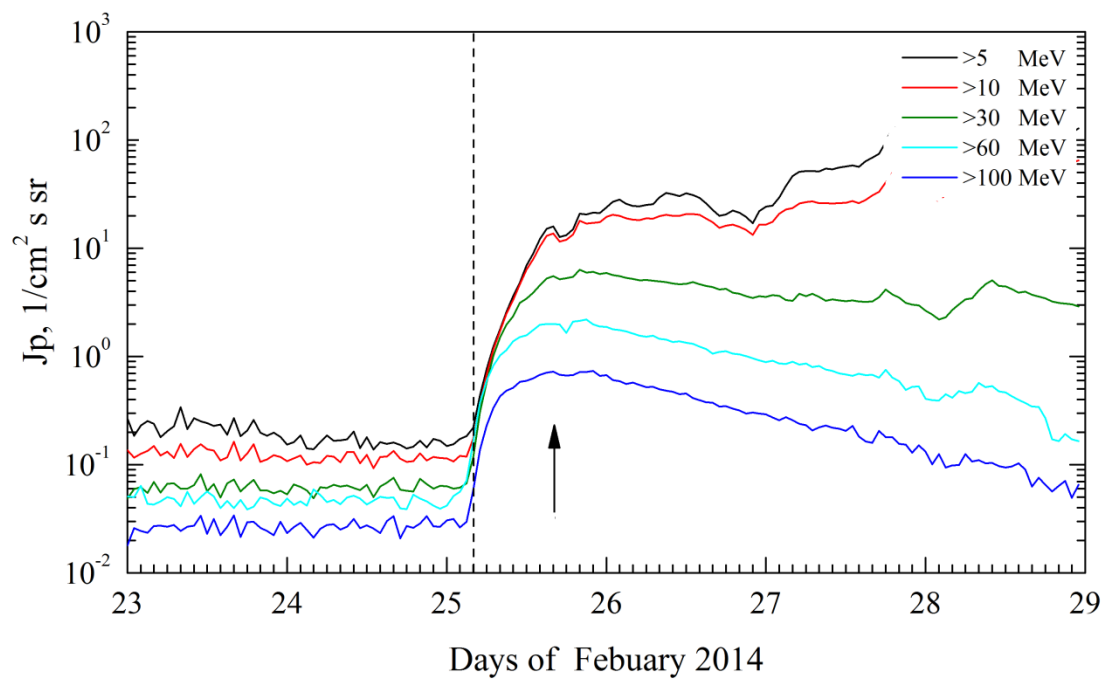


SOHO. Event 2014.02.25

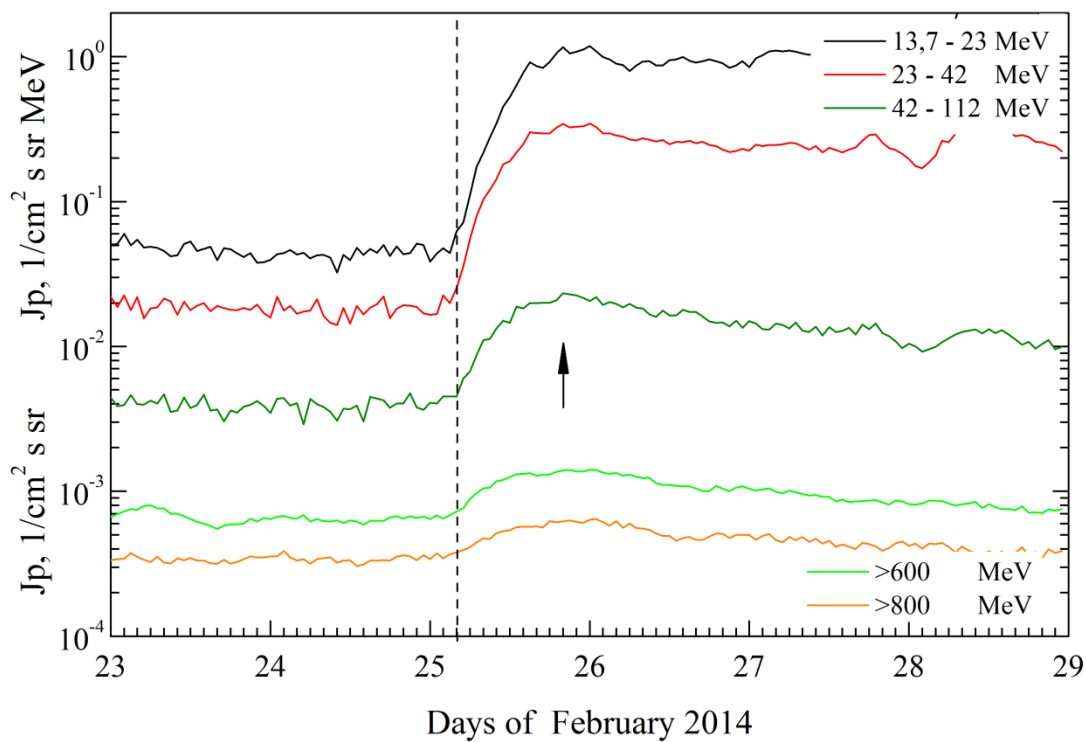


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2014.02.25

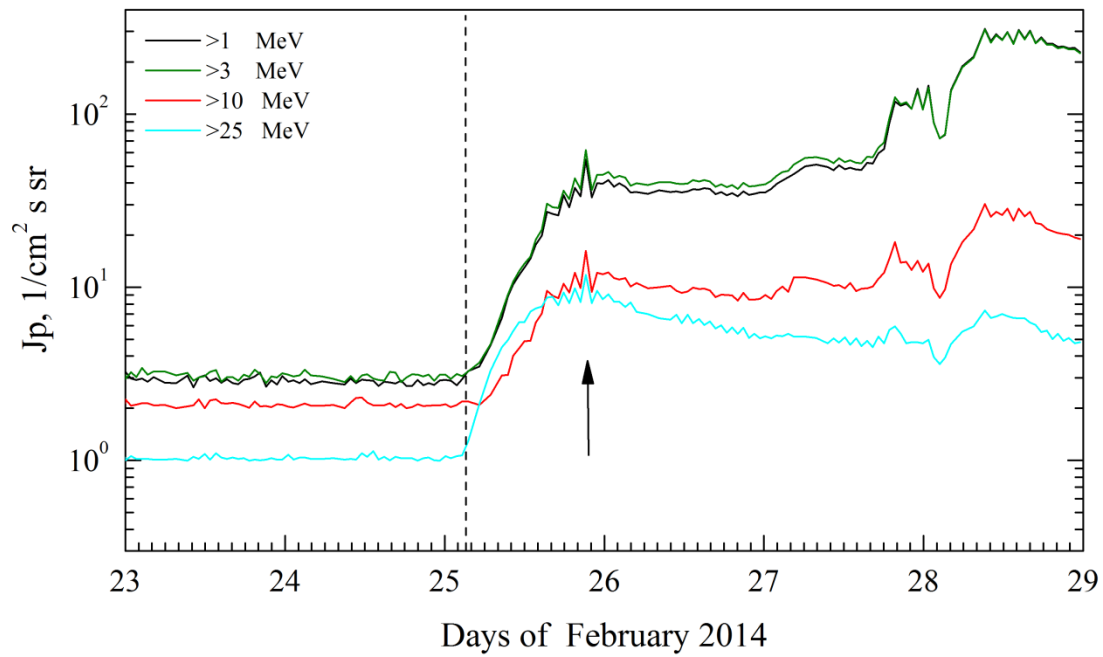


Electro. Event 2014.02.25

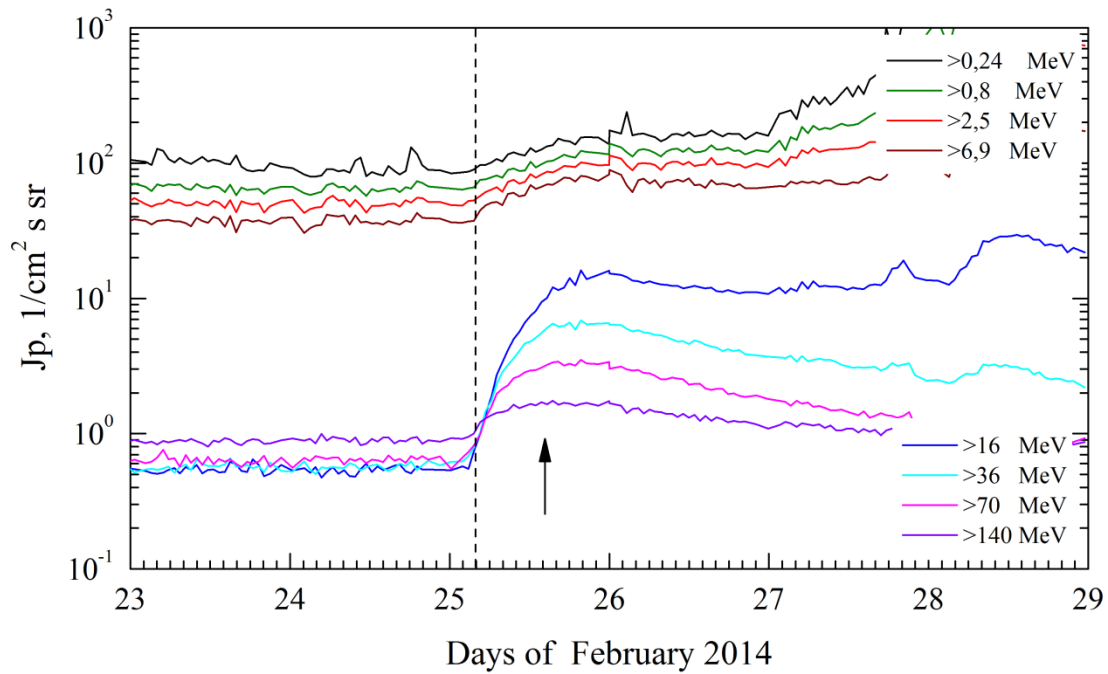


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2014.02.25



POES. Event 2014.02.25



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of 2014
February 25**

2014

February 25

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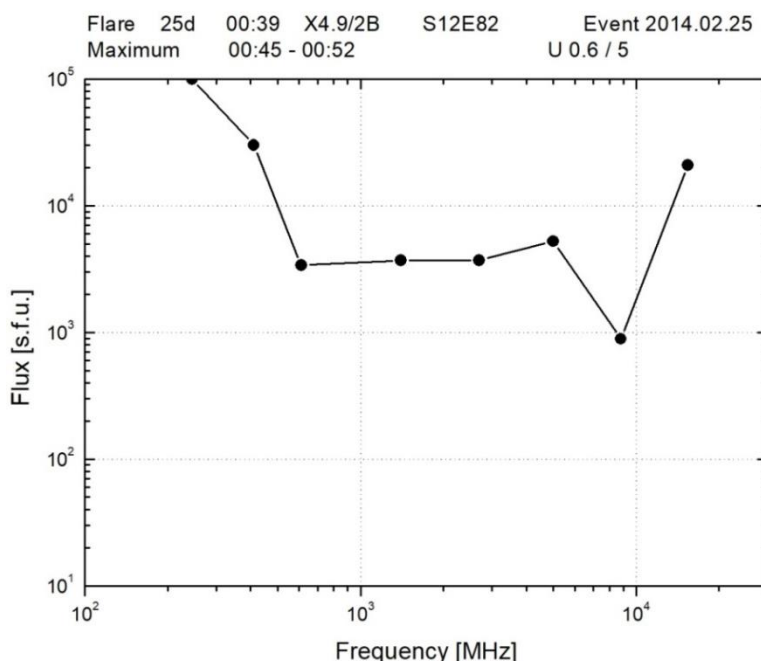
AR 11990

To event 552

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0043	0047	0210	S12E82	2B	ERU
6563 Å	LPS	0231		0621		0.03	
1 – 12	keV	0039	0049	0103	S12E77	X4.9	0.43
X-ray, gamma ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
300-800	keV	0037:04	0046:54	0104:28	24508	97224896	HESSI
12 – 25	keV	0040:57	0052:58	0136:06	812309	457523104	FERMI
>100	MeV	0110:30		0130:30		1.62E-03*	FERMI
12 – 25	keV	0144:28	0145:02	0153:36	4447	1153703	HESSI
12 – 25	keV	0153:36	0154:46	0231:48	256	1697598	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0041	0049	0118		4.32	
8.8	GHz	0041	0049	0114		2.95	
5	GHz	0042	0052	0110	U0.6 / 5	3.72	
2.7	GHz	0042	0045	0107		3.57	
1.4	GHz	0043	0045	01103		3.57	
610	MHz	0044	0047	0053		3.53	
410	MHz	0045	0046	0053		4.48	
245	MHz	0045	0046	0054		5.0	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	18-57	0056		0102		3	
DS IV	25-180	0045		0134		2	
DS III	18-480	0045		0050		1	
DS III	18-40	0125		0125		1	
DH II	0.1-14	0056		1128			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0125	2147	- 158.1	360°	073°	SOHO

*cm⁻²s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR11990 (S13L110, CMP 03.03.2014,
Sp=420 msh, DKC, BD, R)
XRI= 5.13 $X_1^{4.9}+M_3^{1.3}+C_6$ 2_1+S_6
PFR 23-25.02 (42^h) $X_1^{4.9}+M_3$

References:

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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zelina P., S. Dalla, C.M.S. Cohen, R.A. Mewaldt, [2017](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 28d02^h

Tmax($E_p > 10$ MeV) – 28d10^h, Jmax($E_p > 10$ MeV) – 97 /cm²·s·sr

Duration of the event – 7 days, power-law index: $\gamma = 3.2$

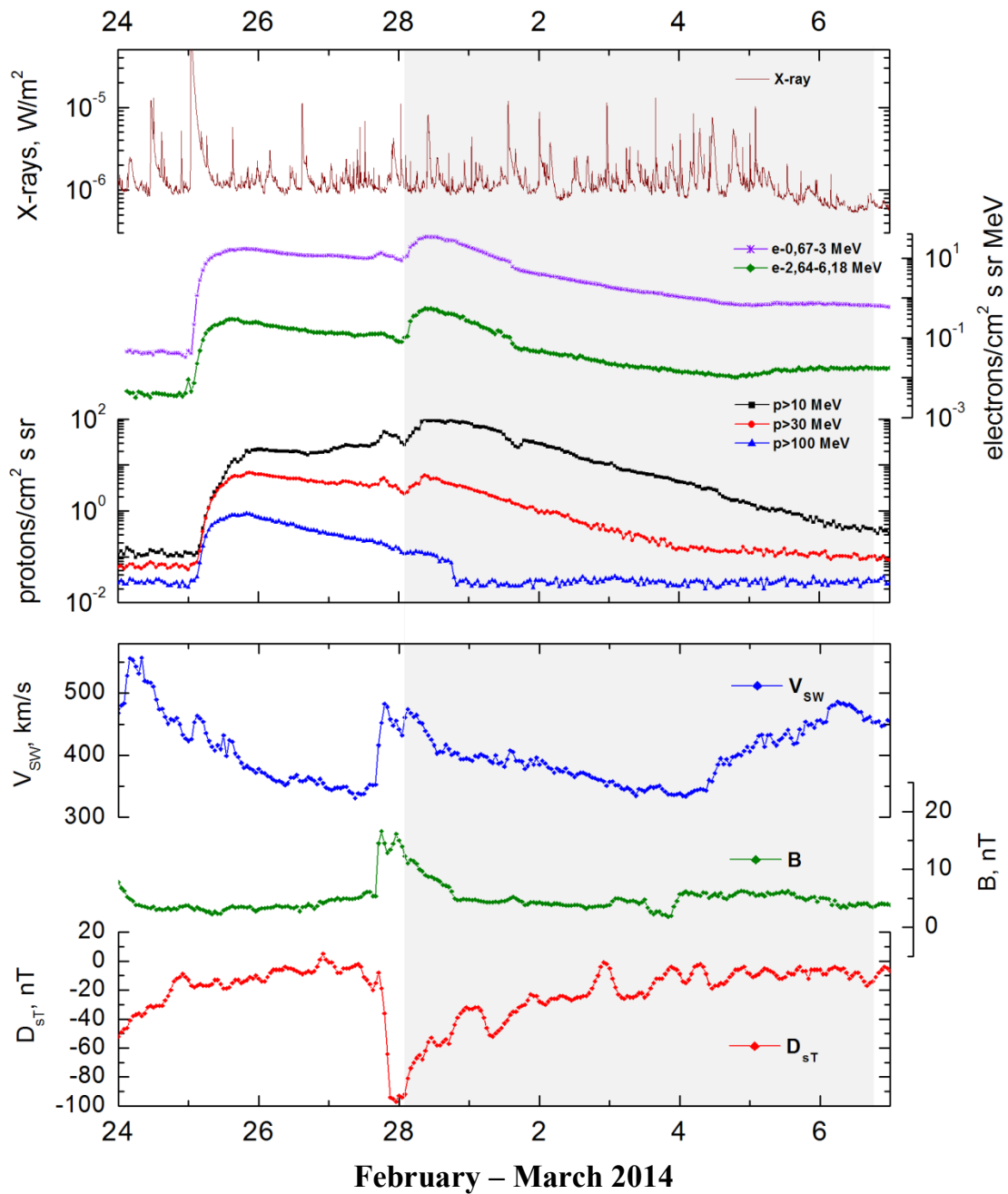
Quasimaximal energy of protons in the event – $E_{qm} = 180$ MeV

Sources: ☉ solar flare 27d21^h33^m, C4.2/SF, S11W63, AR11982

☾ solar flare 28d00^h44^m, M1.1/SN, S24E53, AR11991

Main X-ray burst 1-8 Å: onset – 27d21^h33^m, max – 27d22^h12^m, $\Phi = 0.012$ J/m²

Particle fluxes and associated phenomena

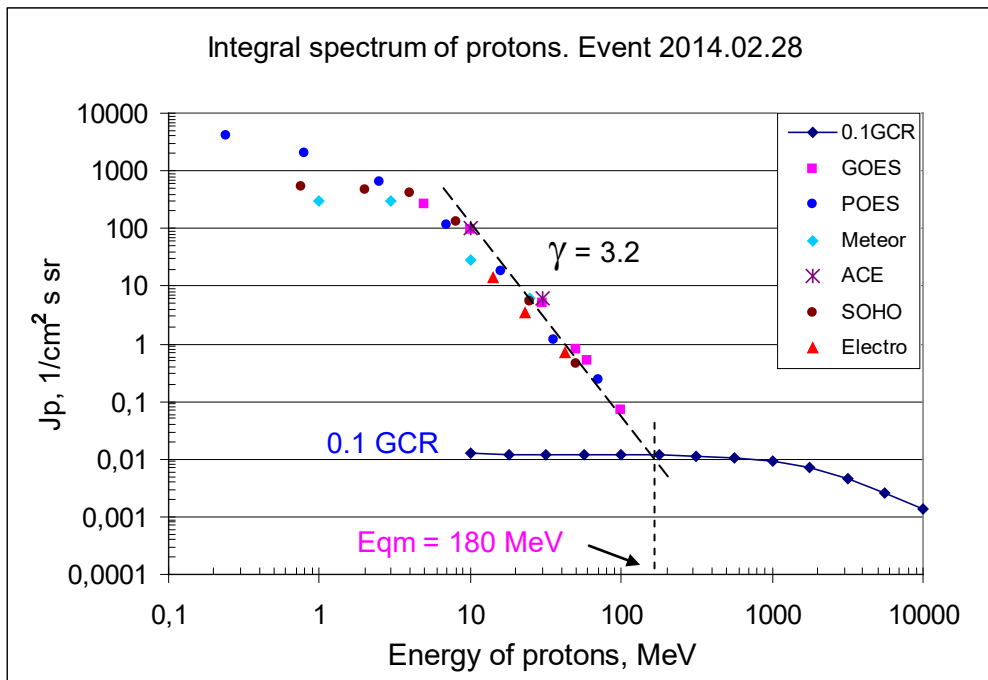


Integral fluxes of protons for the event of 2014 February 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	10	270	8	0.2	
EPS	>10	2	10	97	7	0.12	
EPS	>30	2	10	5	5	0.07	
EPS	>50	2	10	0.8	4	0.06	
EPS	>60	2	10	0.5	4	0.05	
EPS	>100	2	10	0.07	2	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	2	11	4040	4	160	
MEPED	>0.8	2	11	2070	4	130	
MEPED	>2.5	2	11	635	4	100	
MEPED	>6.9	2	11	115	4	65	
MEPED	>16	2	11	18.5	3	10	
MEPED	>36	2	11	1.2	2	2	
MEPED	>70	2	11	0.24	0.5	1	
MEPED	>140	-	-	-	-	1	
Meteor-1							
SCR	>1	2	9	307	7	2.95	
SCR	>3	2	9	304	7	3.15	
SCR	>10	2	9	28	4	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	2	9	6.3	3	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	1	10	100	7	1.1	
SIS	>30	1	10	6	5	0.7	
SOHO							
EPHIN	>50	4	10	0.45	1.7	0.2	

Differential fluxes of protons for the event of 2014 February 28

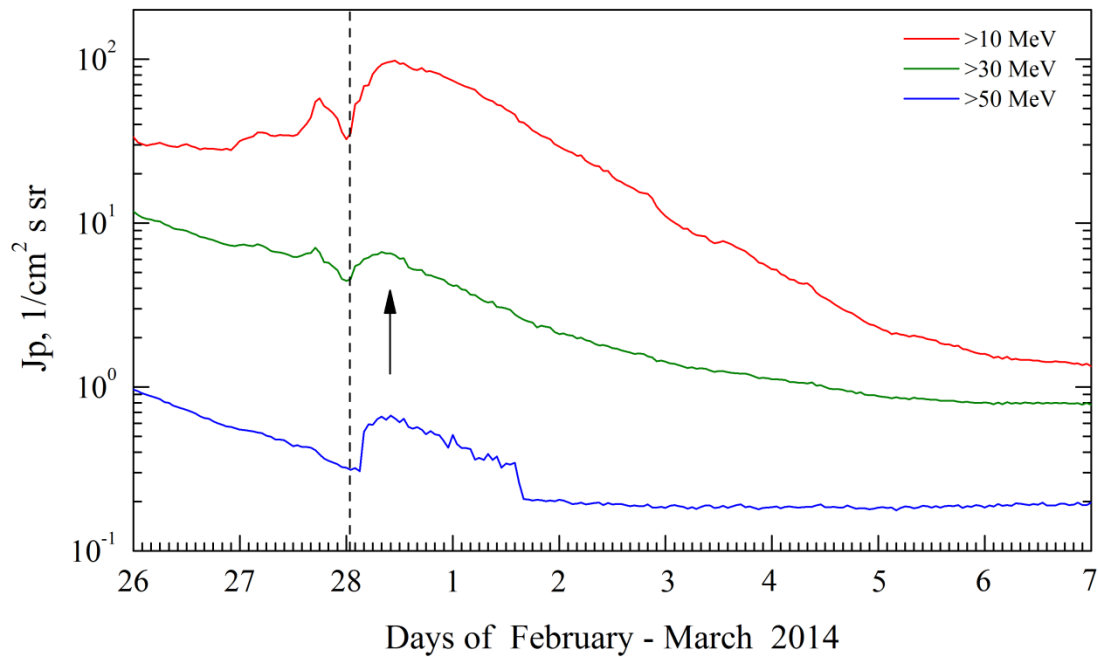
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	2	9	74.1	7	0.04	
LION	2 – 6	2	14	15.6	7	0.002	
EPHIN	4 – 8	2	14	70.4	7	0.008	
EPHIN	8 – 25	2	14	7.29	7	0.0005	
EPHIN	25 – 53	2	13	0.18	7	0.00003	
Electro-1							
SCR-E	13.7–23	2	10	1.2	3	1	
SCR-E	23–42	2	10	0.14	3	0.2	
SCR-E	42–112	2	10	0.01	1	0.004	



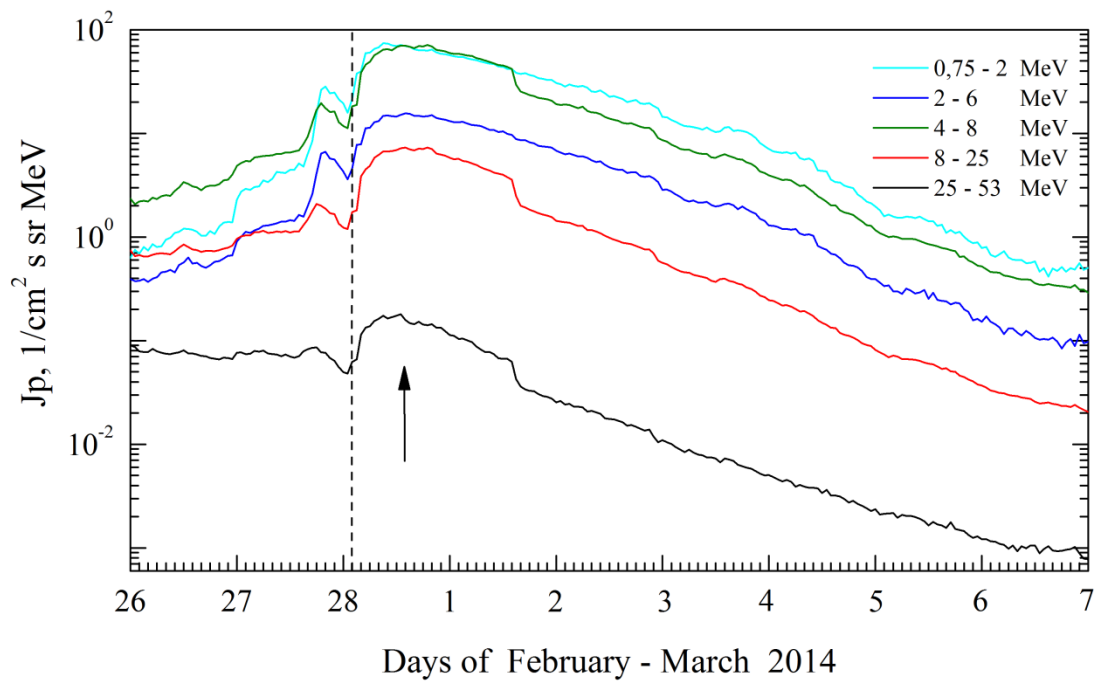
Time profiles of proton fluxes in the event 2014.02.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.02.28

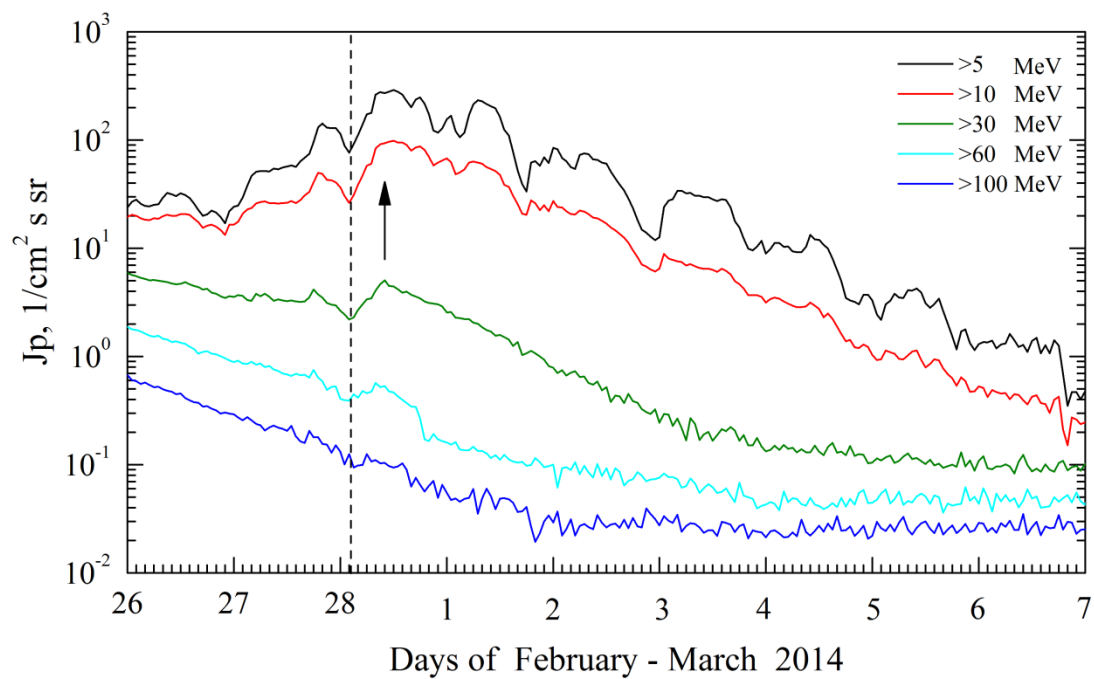


SOHO. Event 2014.02.28

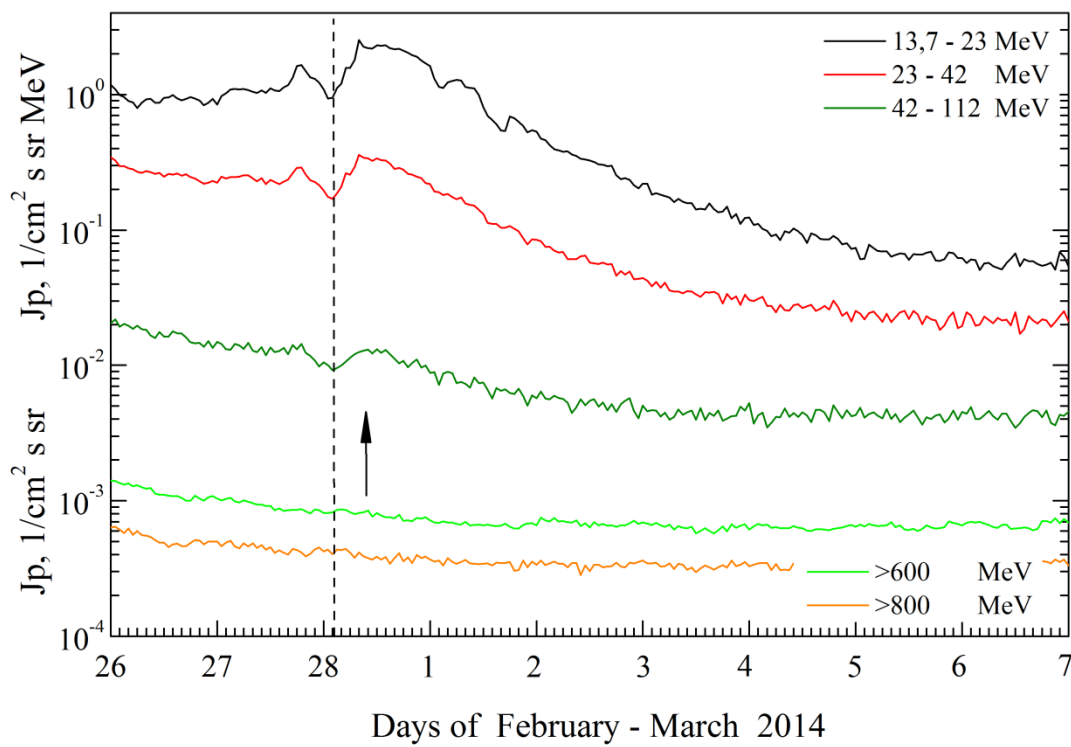


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.02.28

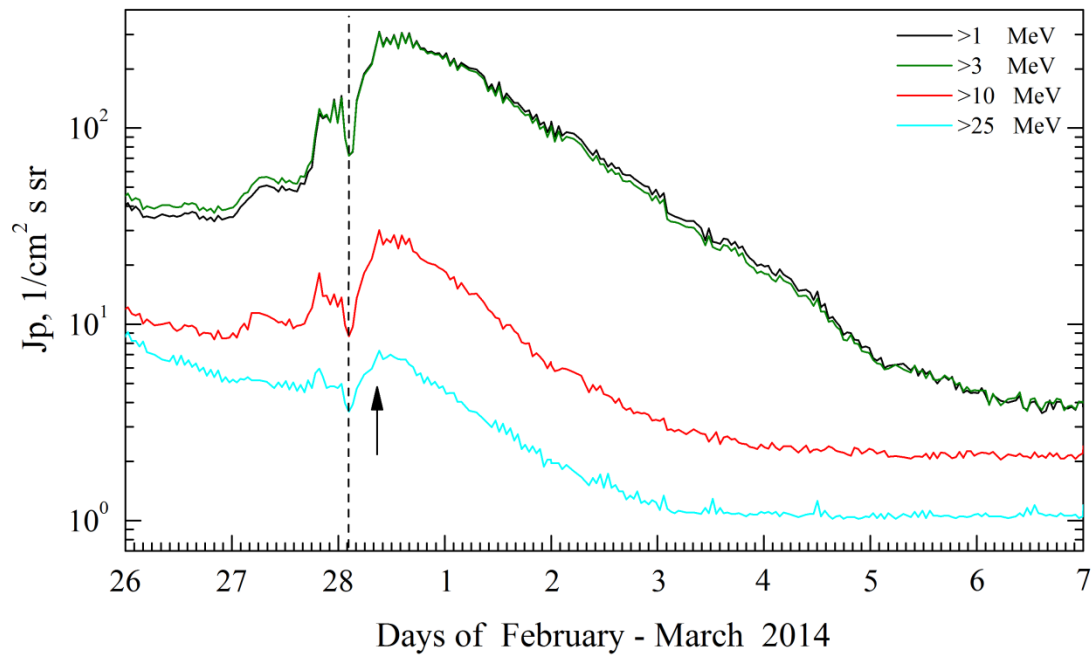


Electro. Event 2014.02.28

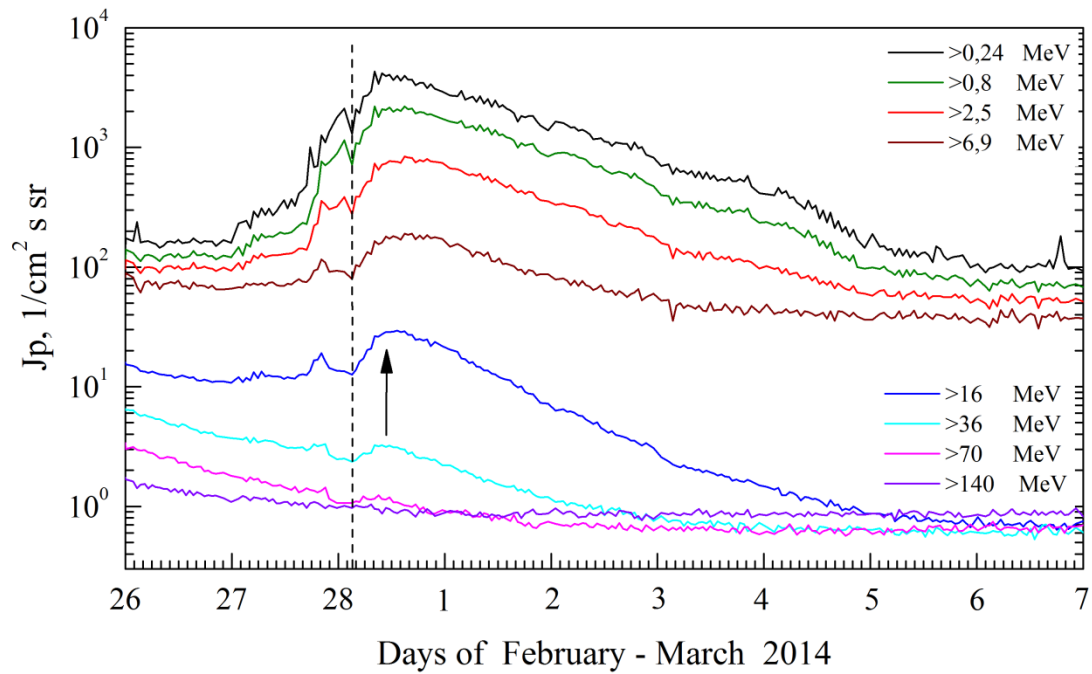


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.02.28



POES. Event 2014.02.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 February 28**

2014 February 27

⊙

AR 11982

To event 553

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	2134	2135	2152	S11W63	SF	DSD
1 – 12	keV	2133	2212	2237	S11W64	C4.2	0.012
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	2156:28	2205:18	2244:12	2160	12287760	HESSI
12-25	keV	2134:41	2135:35	2138:19	3615	99431	FERMI
12-25	keV	2140:30	2140:50	2141:56	749	12198	FERMI
12-25	keV	2147:07	2147:52	2150:03	1610	34648	FERMI
12-25	keV	2152:26	2152:43	2153:32	544	6189	FERMI

2014 February 28

Ø

AR 11991

To event 553

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0047	0048	0056	S24E53	SN	BPT
1 – 12	keV	0044	0048	0050	S22E52	M1.1	0.0019
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12– 25	keV	0046:38	0048:14	0052:13	58598	3434795	FERMI

Proton Active Region:

AR11982 (S11L207, CMP 23,3.02 2014,
Sp=570 msh, EKC, BGD)

XRI=0.35, $M_3^{1.3}+C_{21}$ $2_1+1_2+S_{39}$

AR1 1991 (S25L093, CMP 03,0.03.2014,
Sp= 370 msh EKO, BG)

XRI=0.38, $M_3^{1.7}+C_{17}$ 1_2+S_{24}

References:

Kalegaev V., M. Panasyuk, I. Myagkova et al., [2019](#).

Podgorny I.M., A.I. Podgorny, [2018](#).

Particle event: To($E_p > 10$ MeV) – 25d04^h

Tmax₁($E_p > 10$ MeV) – 25d11^h, Jmax₁($E_p > 10$ MeV) – 0.4 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 26d00^h, Jmax₂($E_p > 10$ MeV) – 0.2 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 3.2$ $\gamma_2 = 4.0$

Quasimaximal energy of protons in the event – Eqm₁ = 35 MeV

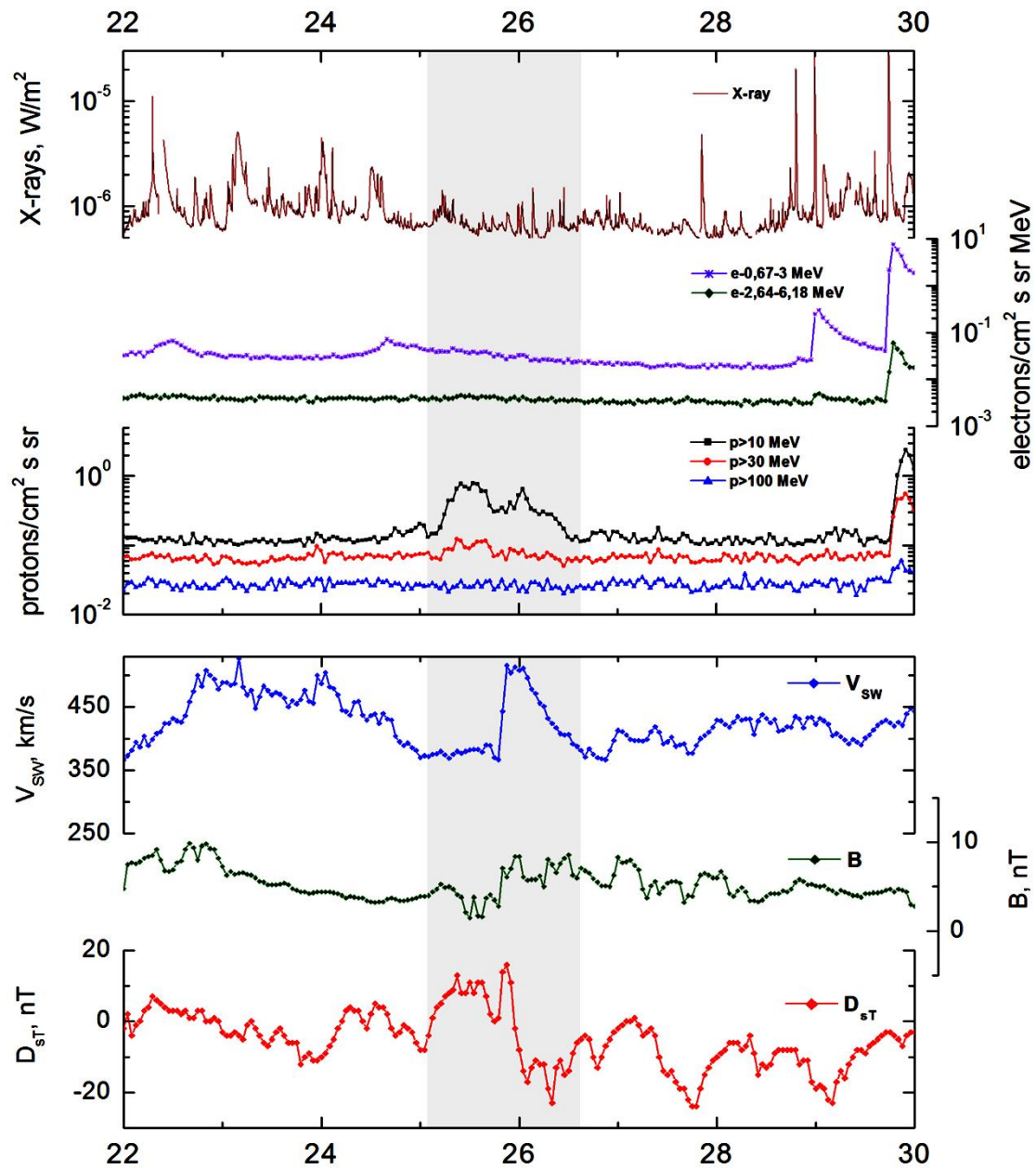
– Eqm₂ = 25 MeV

Sources: ☐ solar flare 25d<05^h36^m, AR unknown, behind W_L

CME: 25d05^h36^m, V = 651 km/s, $\Delta\phi = 223^\circ$, dA = 269°

▲ SC 25d20^h04^m

Particle fluxes and associated phenomena



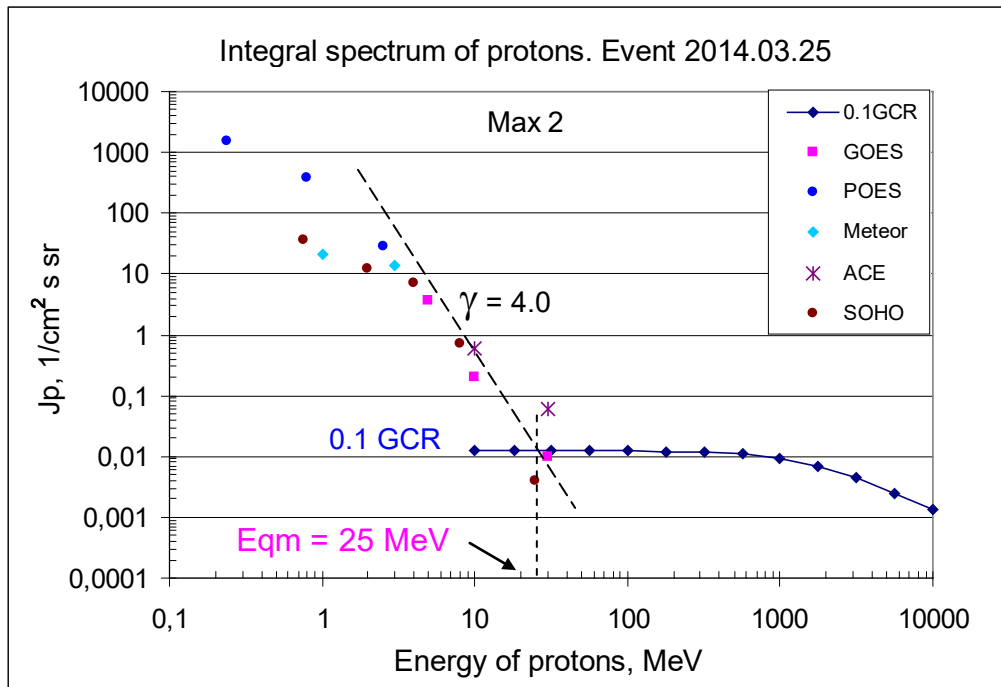
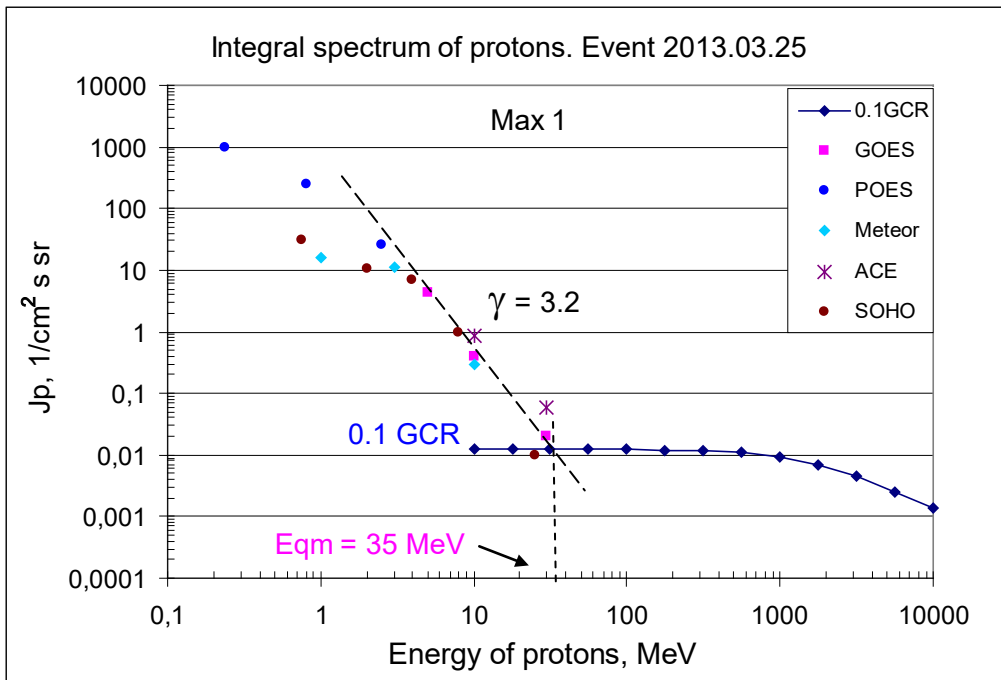
March 2014

Integral fluxes of protons for the event of 2014 March 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	4	11/26d01	4.3/3.7	1.5	0.2	
EPS	>10	4	11/26d00	0.4/0.2	1.5	0.12	
EPS	>30	6	11/26d00	0.02/0.01	1	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.007	
POES							
MEPED	>0.24	6	12/26d02	990/1500	2	90	
MEPED	>0.8	6	12/26d02	250/390	2	65	
MEPED	>2.5	6	12/26d02	26/28	2	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.7	
MEPED	>36	-	-	-	-	0.8	
MEPED	>70	-	-	-	-	0.85	
MEPED	>140	-	-	-	-	0.9	
Meteor-1							
SCR	>1	1	16/26d01	16/21	2	2.9	
SCR	>3	1	16/26d01	11/14	2	3.1	
SCR	>10	9	16/-	0.3/-	0.25	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	4	9/26d01	0.85/0.6	1.5	1	
SIS	>30	4	9/26d00	0.06/0.06	1.5	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

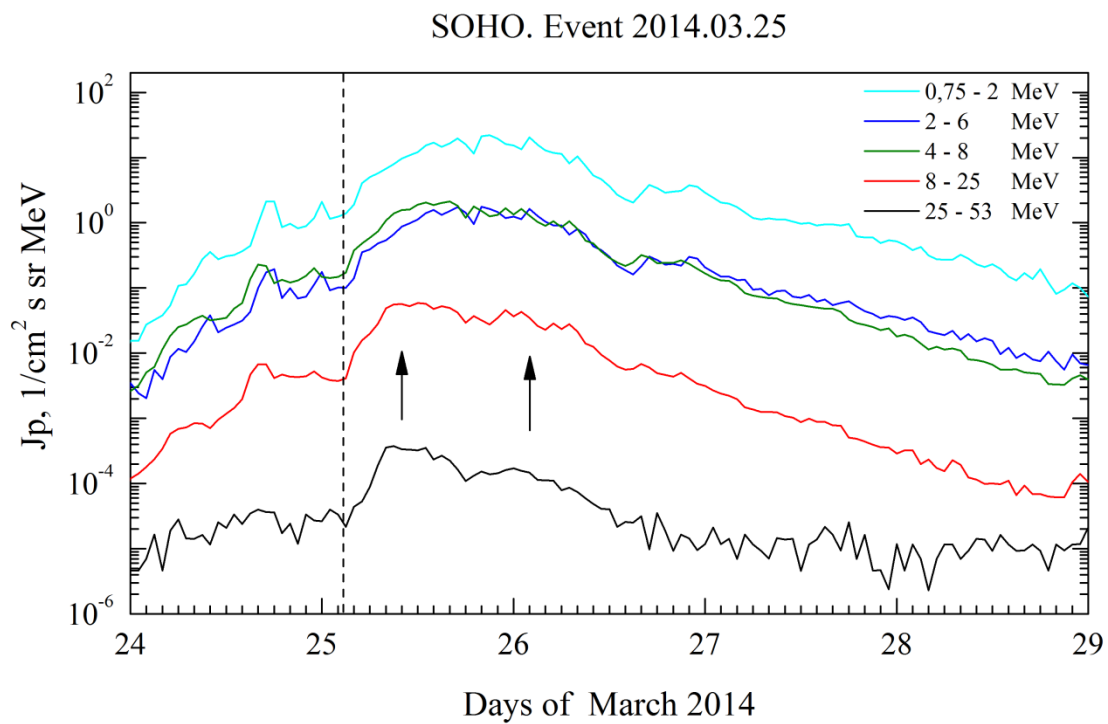
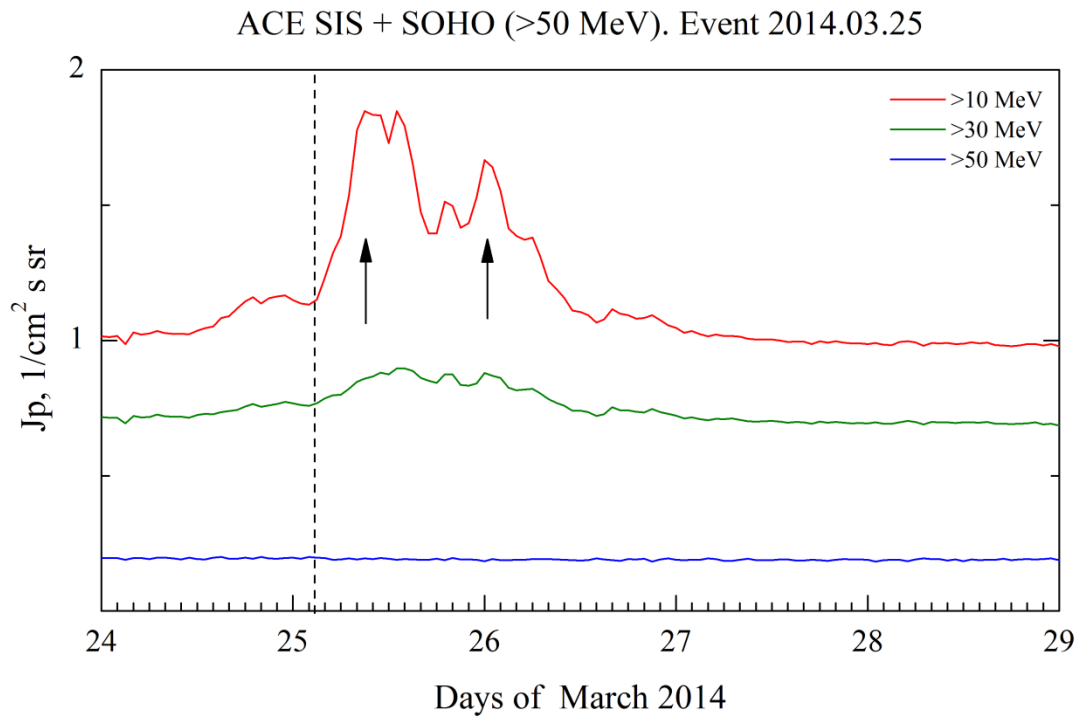
Differential fluxes of protons for the event of 2014 March 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	3	11/26d02	16.9/20.1	4	0.015	
LION	2 – 6	3	10/26d01	1.1/1.6	4	0.003	
EPHIN	4 – 8	3	10/26d91	1.5/1.6	4	0.003	
EPHIN	8 – 25	3	10/26d01	0.056/0.043	3	0.00012	
EPHIN	25 – 53	3	10/26d00	0.00035/0.00015	2	0.000014	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0.045	
SCR-E	23–42	-	-	-	-	0.02	
SCR-E	42–112	-	-	-	-	0.004	



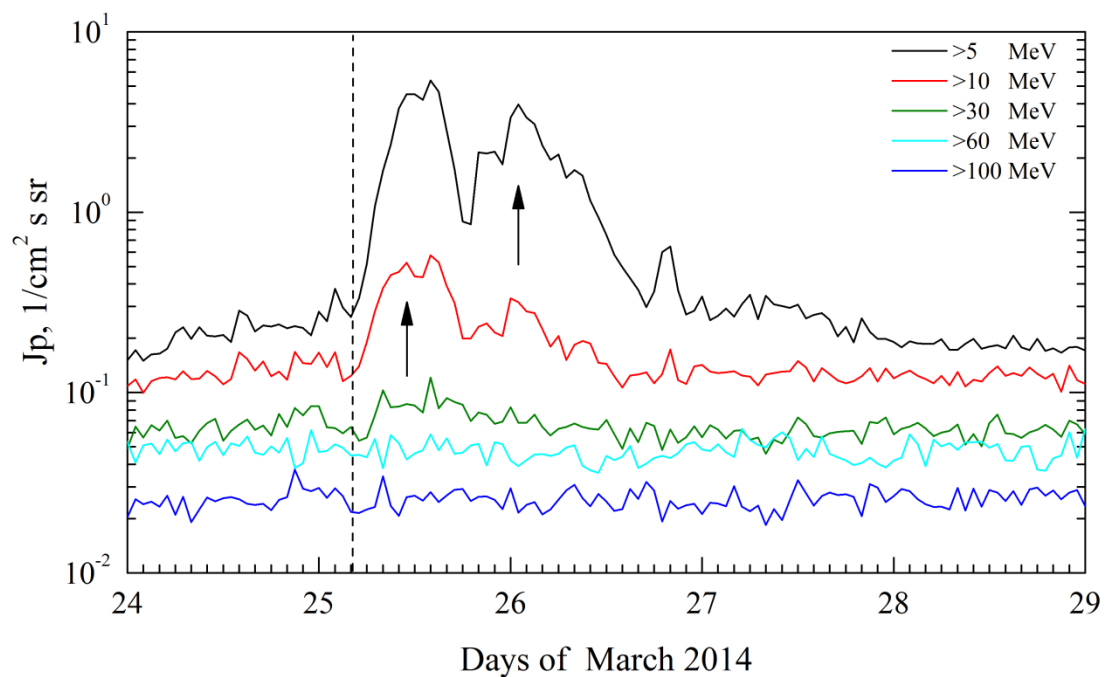
Time profiles of proton fluxes in the event 2014.03.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

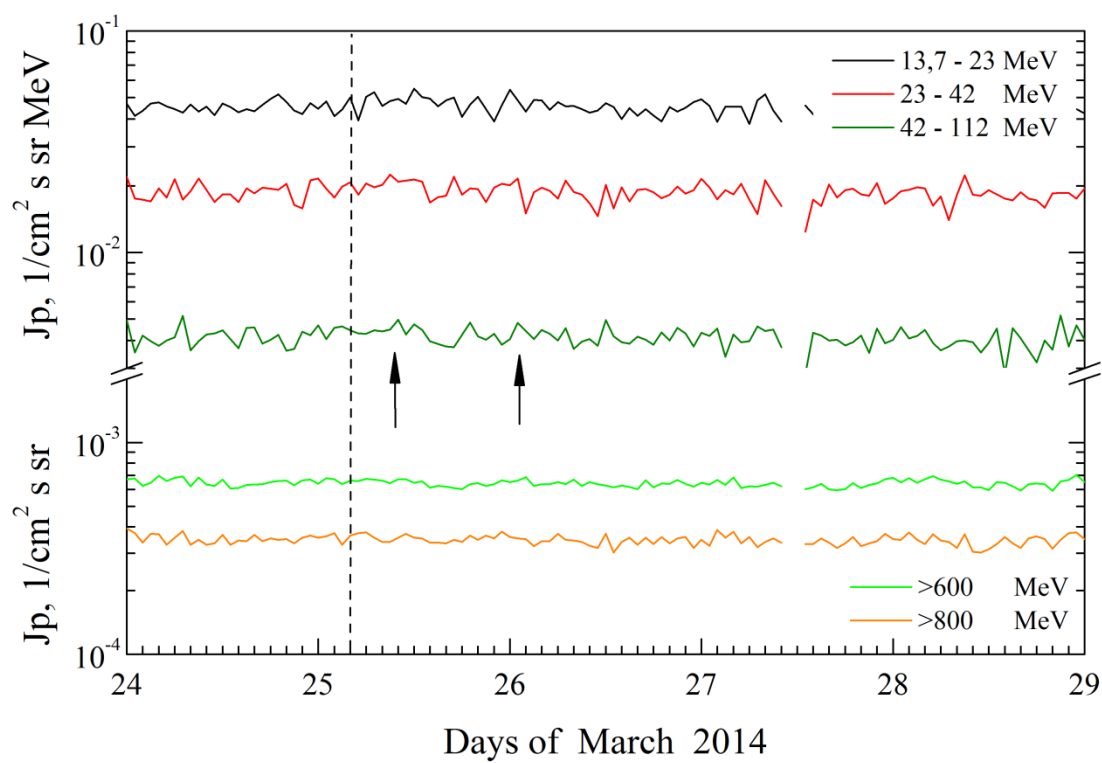


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.03.25

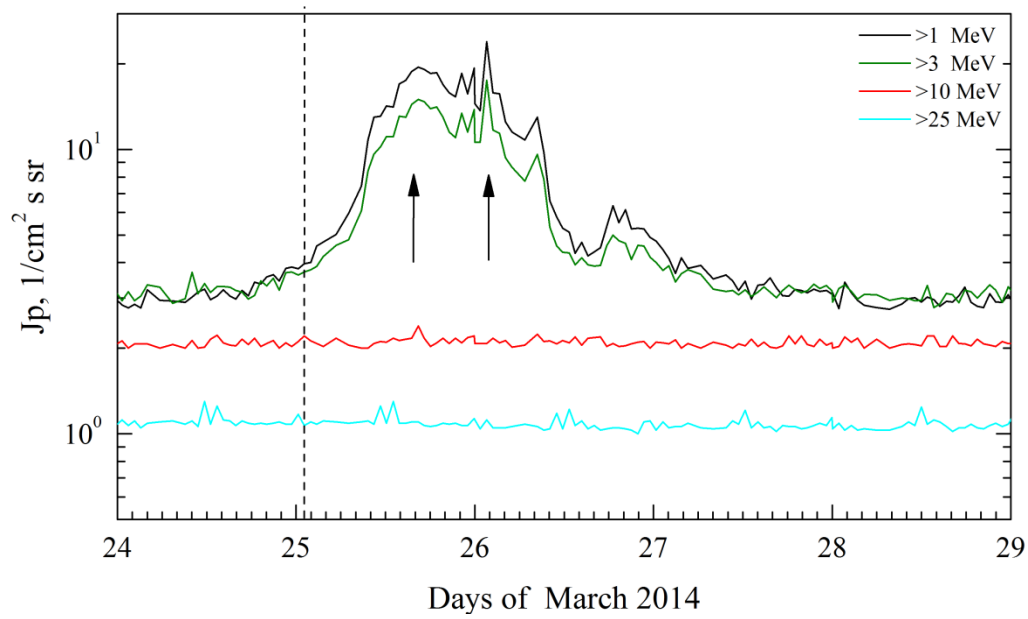


Electro. Event 2014.03.25

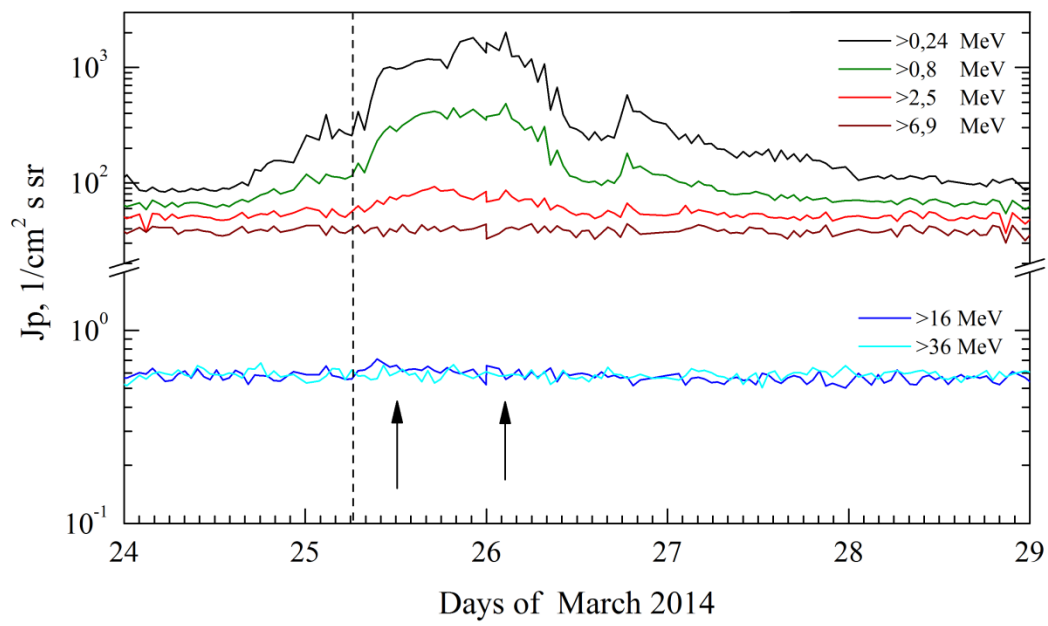


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.03.25



POES. Event 2014.03.25



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 March 25**

2014

March 25



AR XXXX

To event 554

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	No optical flare on visible solar disc						
1 – 12	No soft X-ray event on visible solar disc						
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III		0207		0207		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0536	651	3.4	223°	269°	SOHO

Particle event: To($E_p > 10$ MeV) – 29d18^h

Tmax($E_p > 10$ MeV) – 29d22^h. Jmax($E_p > 10$ MeV) – $1.4 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1 day. power-law index: $\gamma = 2.3$

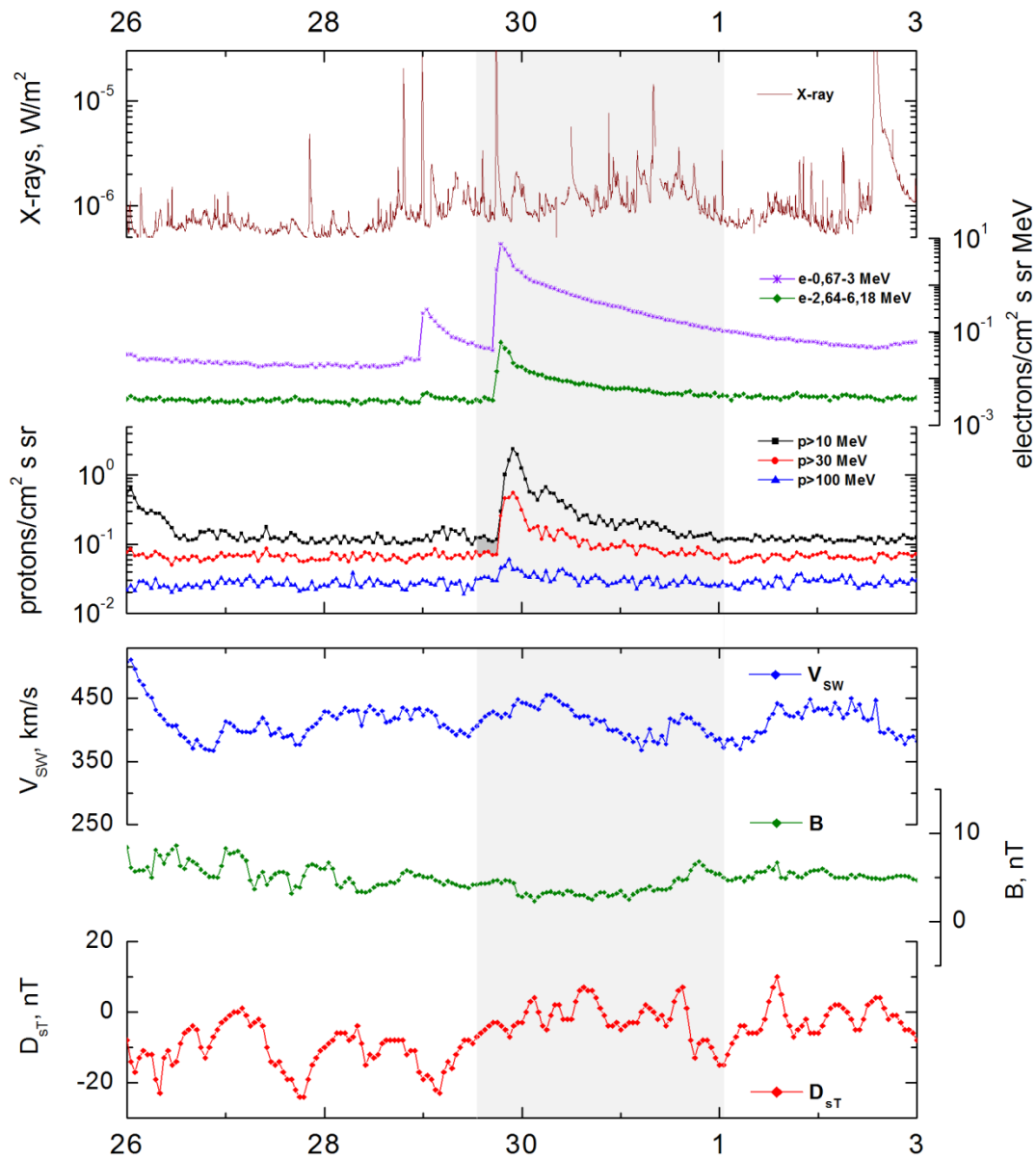
Quasimaximal energy of protons in the event – $E_{qm} = 130$ MeV

Sources: • solar flare 29d17^h35^m, X1.0/2B, N11W32, AR12017

Main burst X-ray 1–8 Å: onset – 29d17^h35^m, max – 29d17^h48^m, $\Phi = 0.042 \text{ J/m}^2$

CME 29d18^h12^m, $V = 528 \text{ km/s}$, $\Delta\varphi = 360^\circ$, $dA = 325^\circ$

Particle fluxes and associated phenomena



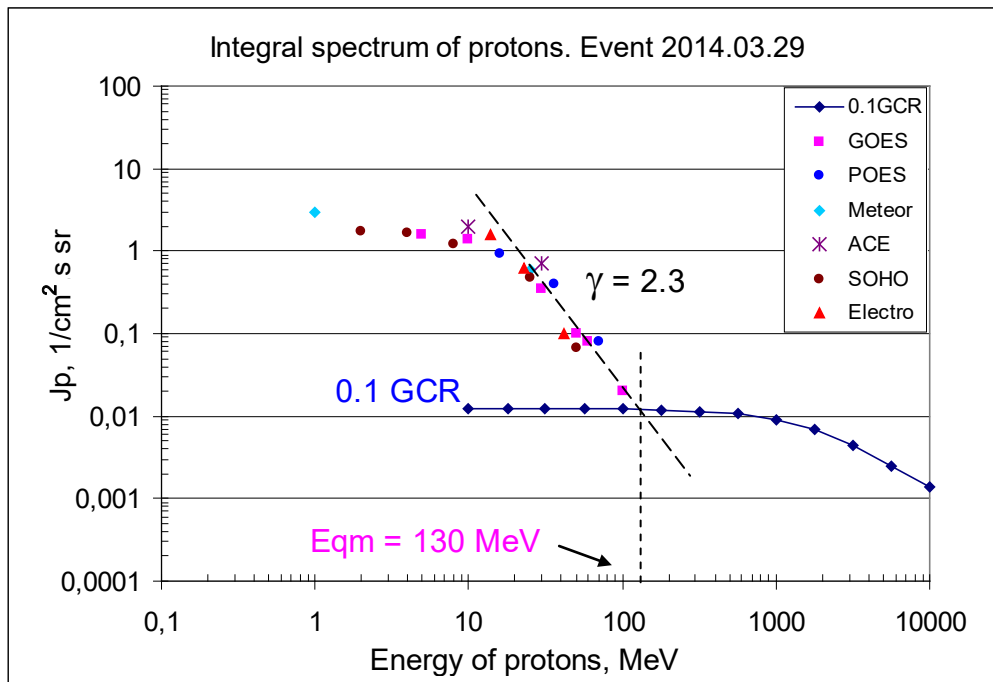
March 2014

Integral fluxes of protons for the event of 2014 March 29

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	23	1.6	1	0.2	
EPS	>10	18	22	1.4	1	0.12	
EPS	>30	18	22	0.35	1	0.07	
EPS	>50	18	22	0.1	1	0.06	
EPS	>60	18	22	0.08	1	0.05	
EPS	>100	18	21	0.02	1	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES-15							
MEPED	>0.24	-	-	-	-	90	
MEPED	>0.8	-	-	-	-	70	
MEPED	>2.5	-	-	-	-	50	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	18	21	0.92	0.5	0.6	
MEPED	>36	18	21	0.4	0.5	0.65	
MEPED	>70	18	21	0.08	0.5	0.75	
MEPED	>140	-	-	-	-	0.9	
Meteor-1							
SCR	>1	18	21	2.9	1	2.9	
SCR	>3	18	-	-	1	3.1	
SCR	>10	18	-	-	0.5	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	18	21	0.6	0.5	1.1	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	18	20	2	1	1	
SIS	>30	18	20	0.7	1	0.7	
SOHO							
EPHIN	>50	18	19	0.066	3	0.2	

Differential fluxes of protons for the event of 2014 March 29

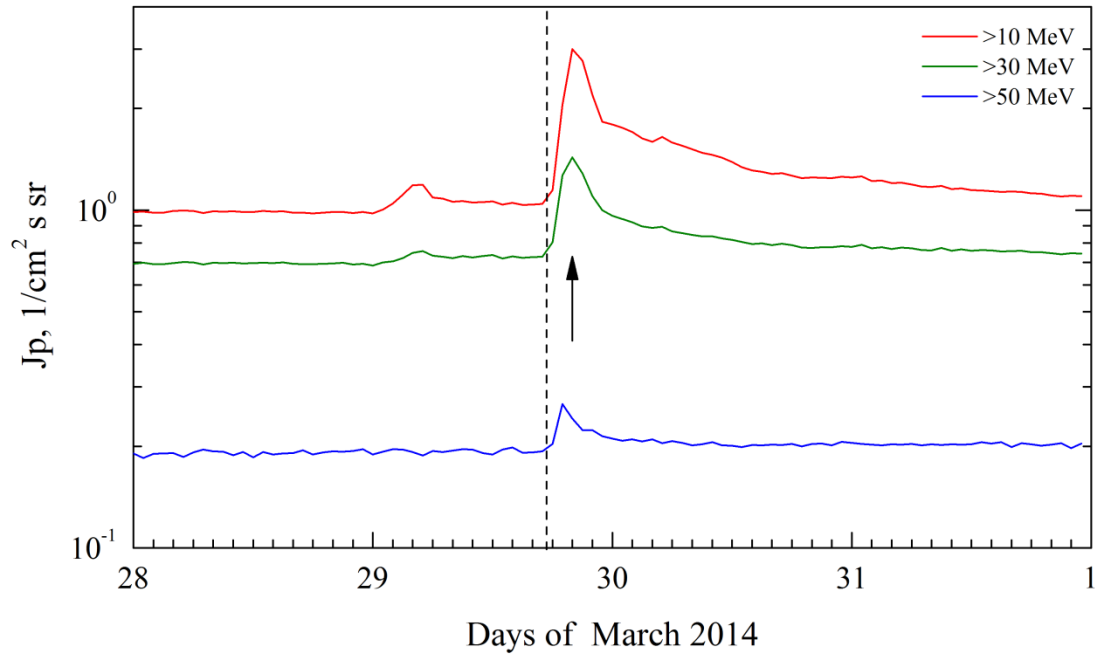
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	0.015	
LION	2 – 6	17	18	0.018	-	0.003	
EPHIN	4 – 8	19	21	0.116	2.3	0.003	
EPHIN	8 – 25	18	19	0.0435	2.3	0.00012	
EPHIN	25 – 53	17	19	0.0146	2.3	0.000014	
Electro-1							
SCR-E	13.7–23	18	21	0.1	0.5	0.045	
SCR-E	23–42	18	21	0.028	0.5	0.02	
SCR-E	42–112	18	21	0.0014	0.5	0.004	



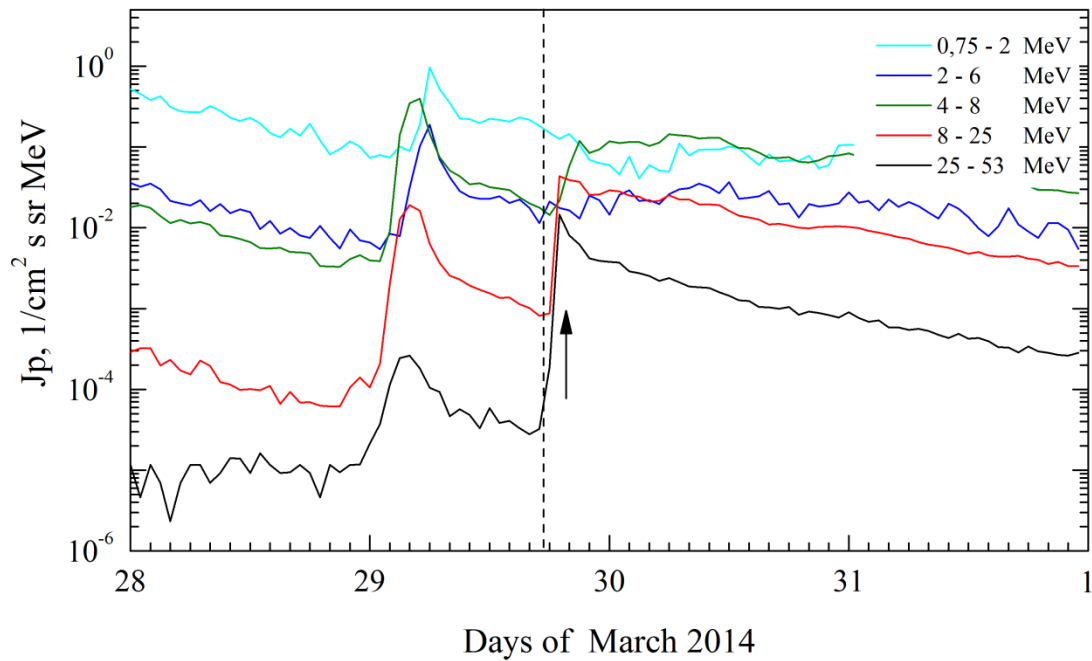
Time profiles of proton fluxes in the event 2014.03.29

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.03.29

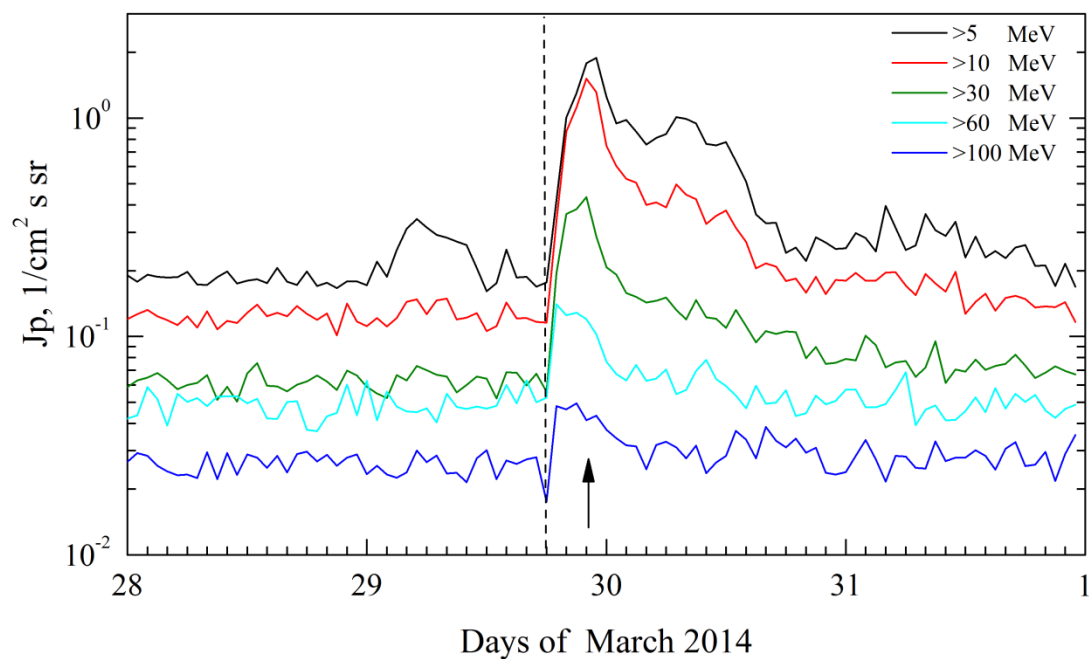


SOHO. Event 2014.03.29

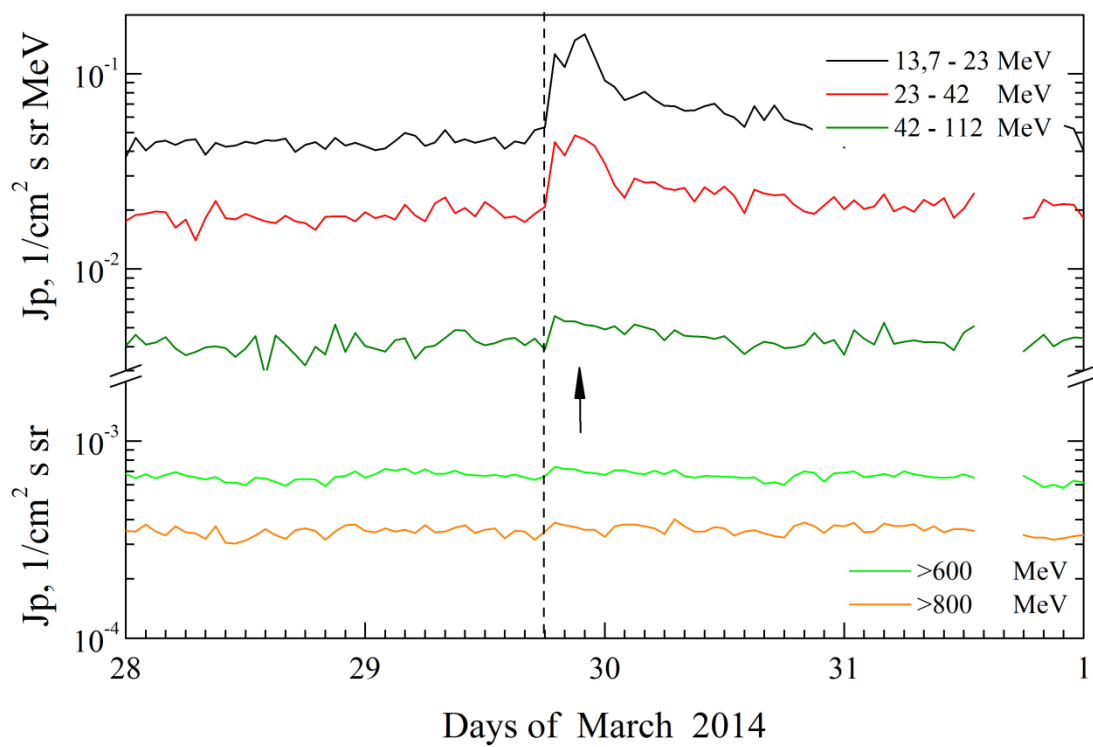


Earth satellites in geostationary orbit. $R \approx 6.6 R_e$: GOES and Electro

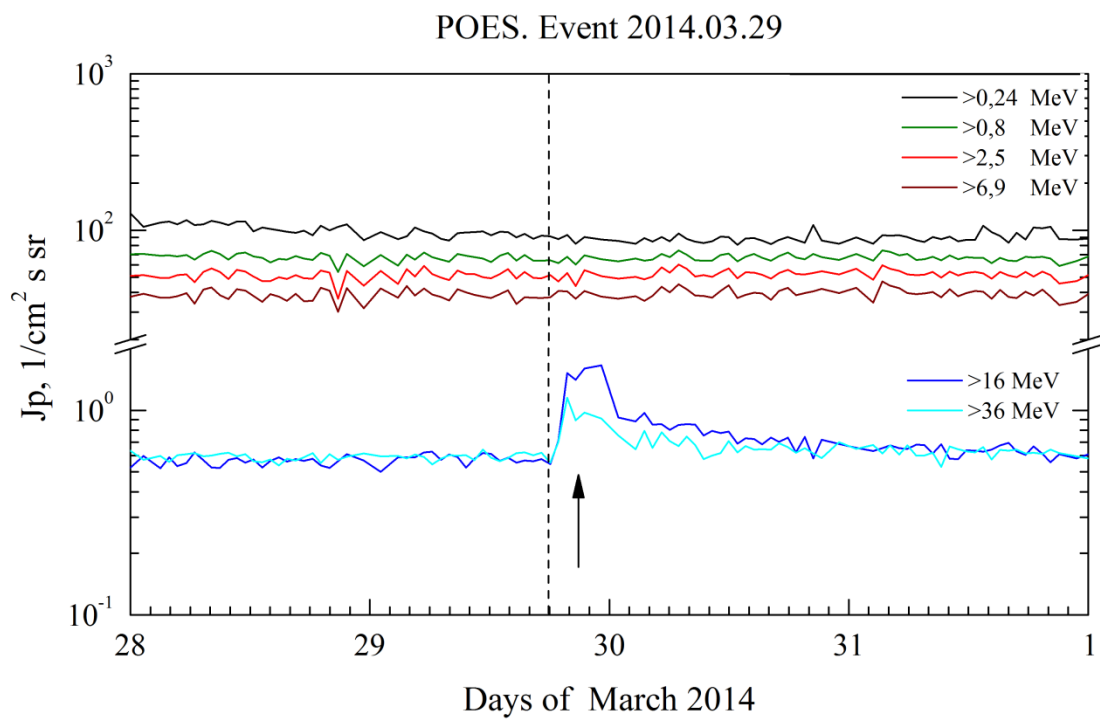
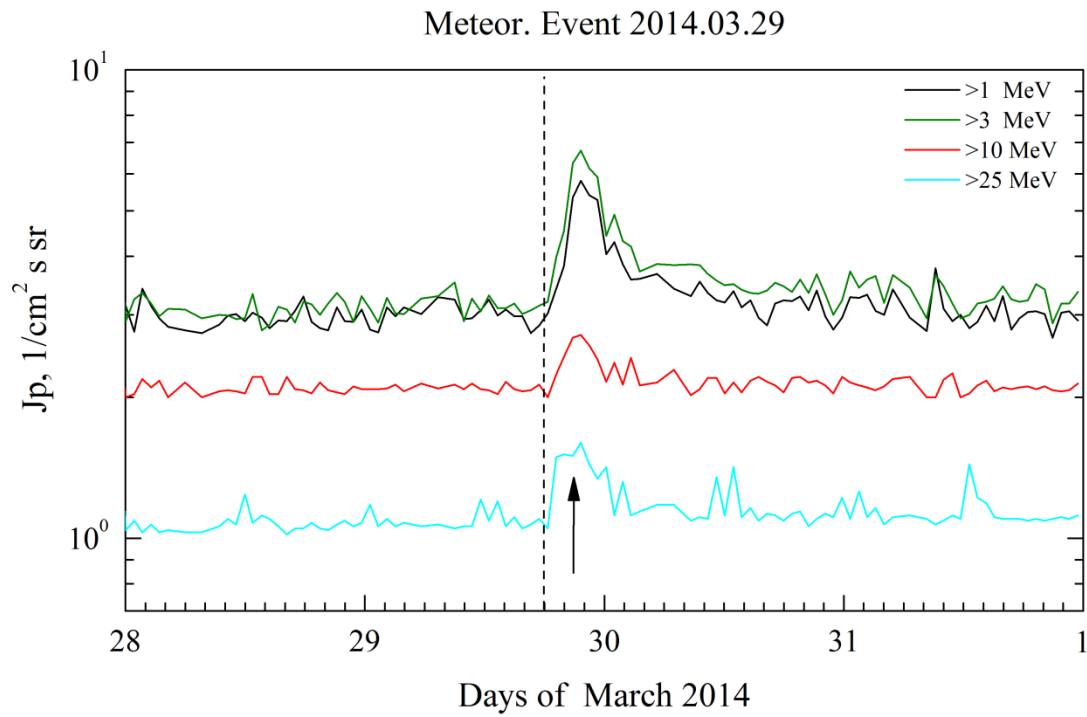
GOES. Event 2014.03.29



Electro. Event 2014.03.29



Earth satellites in polar orbit. $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 March 29**

2014

March 29

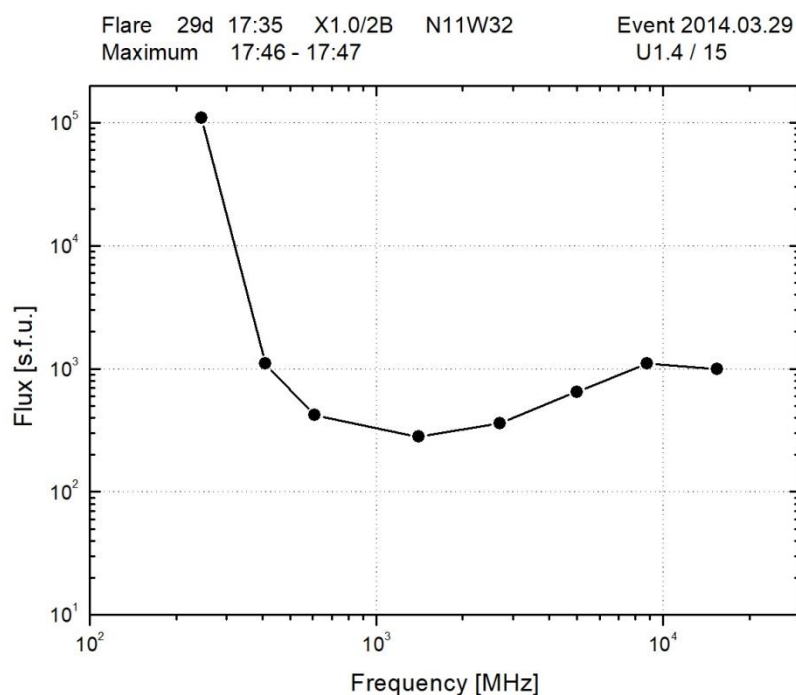
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AR 12017

To event 555

Ha. X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1738	1746	1816	N11W32	2B	ERU
1 – 12	keV	1735	1748	1754	N10W32	X1.0	0.042
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1739:06	1739:43	1741:01	2087	25410	FERMI
100-300	keV	1735:28	1747:18	1814:36	7017	13089182	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1745	1746	1748	U1.4 / 15	3.0	
8.8	GHz	1745	1746	1749		3.04	
5	GHz	1745	1747	1748		2.81	
2.7	GHz	1745	1746	1748		2.56	
1.4	GHz	1745	1746	1219		2.45	
610	MHz	1745	1746	1748		2.62	
410	MHz	1745	1747	1749		3.04	
245	MHz	1745	1747	1751		5.04	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1753		1801		3	
DS III	25-180	1745		1749		3	
DH II	0.2-14	1759		30d/0958			WIND
CME		UT	V, km/s	A, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1812	528	- 4.1	360°	325°	SOHO

Radio burst frequency spectrum



Proton Active Region

AR12017* (N11L142; CMP 27.05.2014;

Sp=160 msh; DAO; BGD; R1)

XRI= 1.68 $X_1^{1.0} + M_3^{2.6} + C_{19} \quad 2_1 + 1_2 + S_{18}$

PFR 28-30.03 (40^h) $X_1^{1.0} + M_3^{2.6}$

*Sunspot 22.03 – 1.04. 2014 only

References:

Богомолов Э.А., Адриани О., Базилевская Г.А. и др., [2017](#).

Bučík R., S.M. Mulay, G.M. Mason et al., [2021](#).

Particle event: To($E_p > 10$ MeV) – 18d14^h

Tmax($E_p > 10$ MeV) – 18d16^h, Jmax($E_p > 10$ MeV) – 11.8 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 500$ MeV

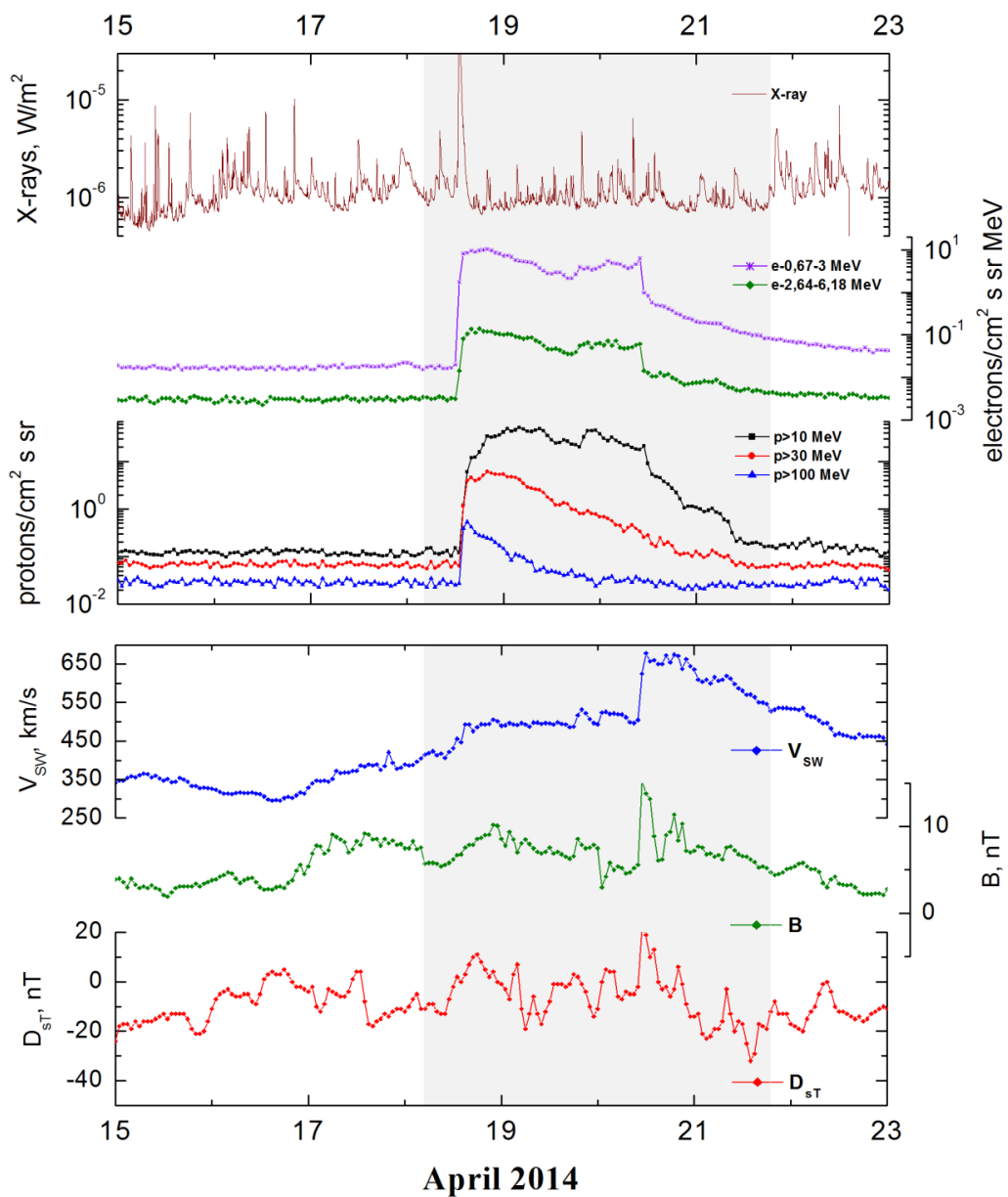
Sources: ● solar flare 18d12^h31^m, M7.3/, S20W34, AR12036

Main burst X-ray 1–8 Å: onset – 18d12^h31^m, max – 18d13^h03^m, $\Phi = 0.11$ J/m²

CME: 18d13^h25^m, $V = 1203$ km/s, $\Delta\phi = 360^\circ$, $dA = 238^\circ$

▲ SC 19d18^h36^m; ▲ SC 20d10^h56^m

Particle fluxes and associated phenomena

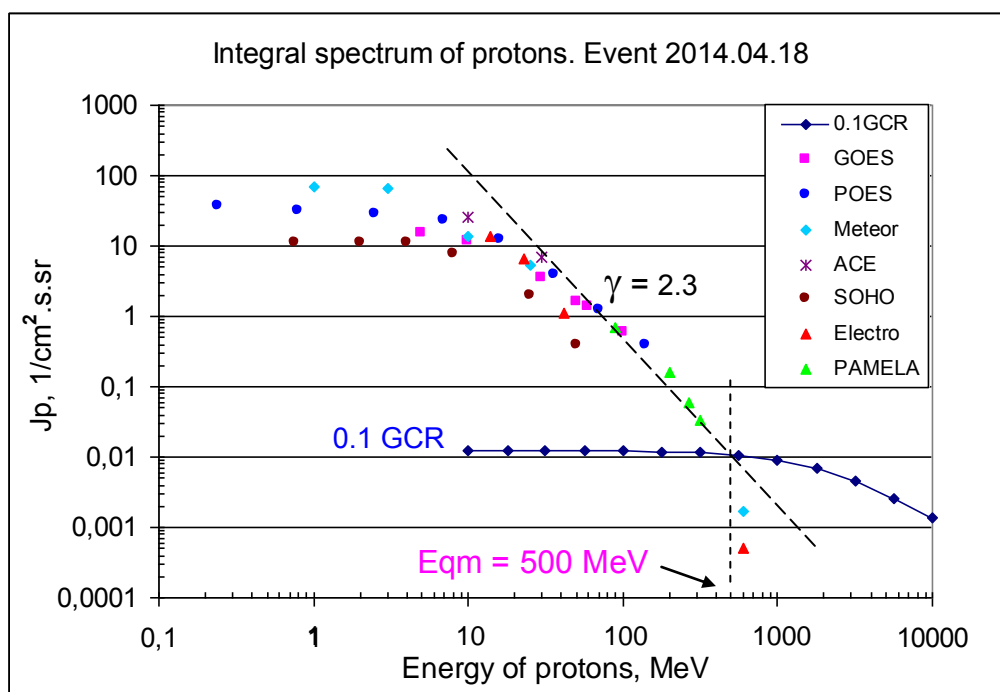


Integral fluxes of protons for the event of 2014 April 18

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration days	Back- ground	Comments
GOES							
EPS	>5	14	16	15	3.5	0.2	
EPS	>10	14	16	11.8	3	0.12	
EPS	>30	14	16	3.5	2	0.07	
EPS	>50	14	15	1.6	1.5	0.06	
EPS	>60	14	15	1.4	1.5	0.05	
EPS	>100	14	15	0.6	1	0.03	
Electro-1							
GALS-E	>600	13	15	0.0005	1	0.0007	
GALS-E	>800	13	15	0.00014	1	0.0004	
GALS-E	>1100	-	-	-	-	0.00002	
POES							
MEPED	>0.24	14	16	37	3	90	
MEPED	>0.8	14	16	32	3	70	
MEPED	>2.5	14	16	29	2	55	
MEPED	>6.9	14	16	22.7	2	40	
MEPED	>16	14	16	12.5	2	0.6	
MEPED	>36	14	16	3.8	1.5	0.65	
MEPED	>70	14	16	1.25	1	0.75	
MEPED	>140	14	16	0.4	0.5	0.9	
Meteor-1							
SCR	>1	13	20	70	3.5	2.9	
SCR	>3	13	20	66	3	3.1	
SCR	>10	13	20	14	2	2.1	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	13	14	5.3	2	1.1	
GALS-M	>600	3	14	0.0017	0.25	0.02	
ACE							
SIS	>10	13	18	26	2.5	1	
SIS	>30	13	17	7	2.5	0.7	
PAMELA							
TRACKER	>90	13	14	0.69	>2	-	
TRACKER	>200	13	14	0.16	>2	-	
TRACKER	>265	13	14	0.06	>2	-	
TRACKER	>312	13	14	0.033	>2	-	
SOHO							
EPHIN	>50	15	16	0.4	2	0.2	

Differential fluxes of protons for the event of 2014 April 18

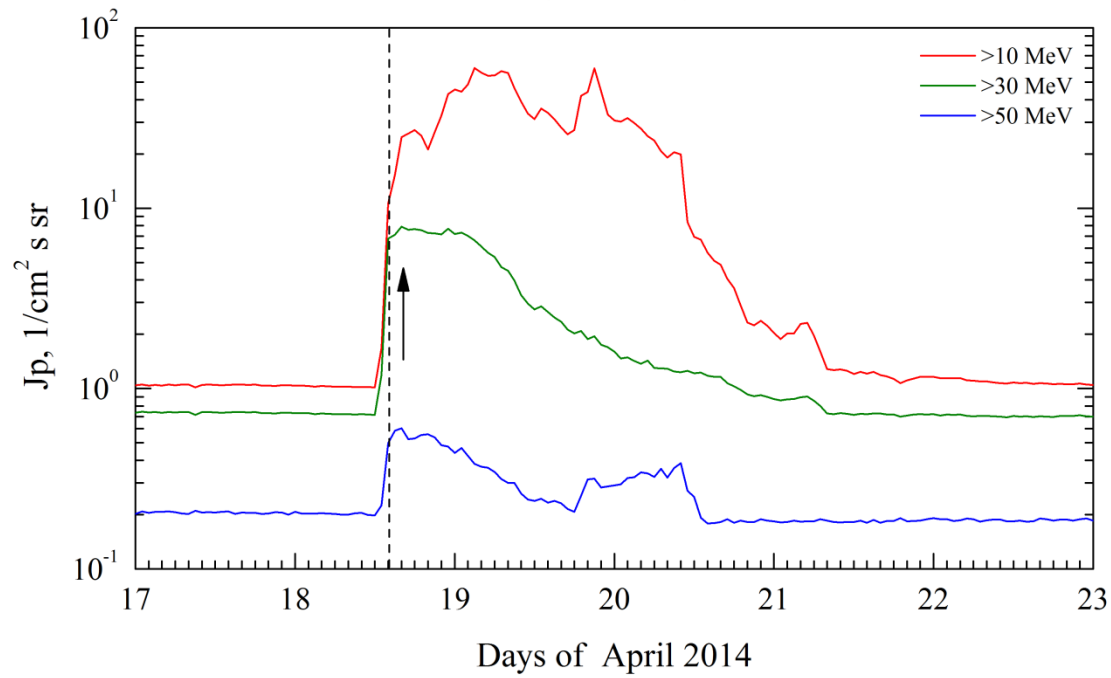
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	14	16	0.04	4	0.03	
LION	2 – 6	14	16	0.005	4	0.005	
EPHIN	4 – 8	14	16	0.8	4	0.005	
EPHIN	8 – 25	14	16	0.34	3	0.0003	
EPHIN	25 – 53	14	16	0.055	3	0.00003	
Electro-1							
SCR-E	13.7–23	13	15	0.75	2.5	0.05	
SCR-E	23–42	13	15	0.28	2	0.02	
SCR-E	42–112	13	15	0.016	1	0.004	



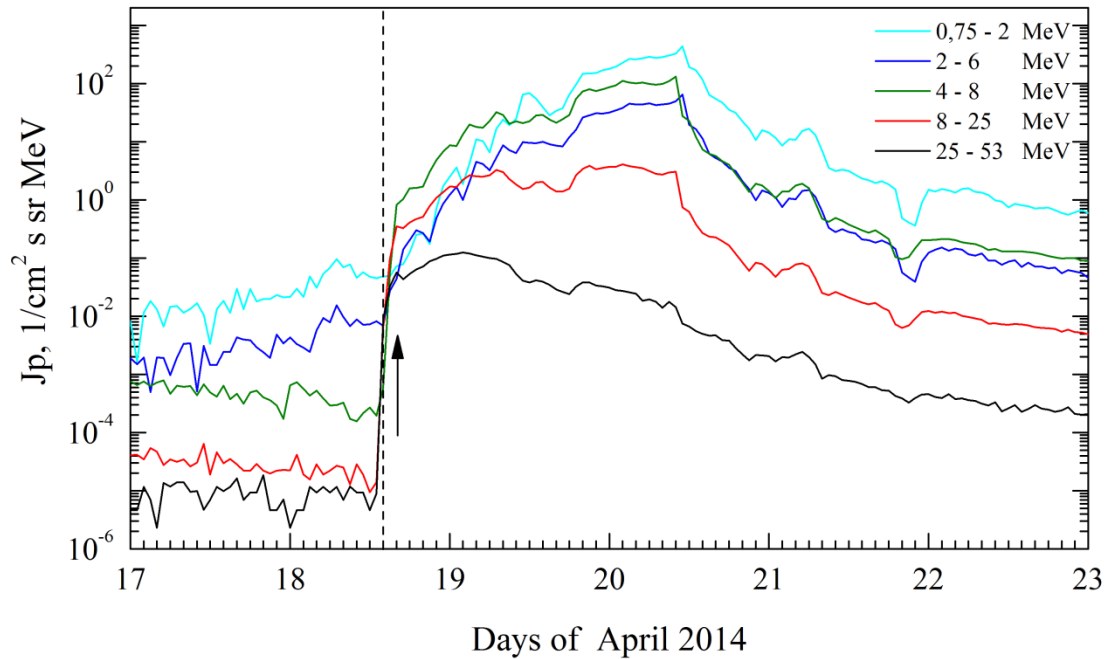
Time profiles of proton fluxes in the event 2014.04.18

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.04.18

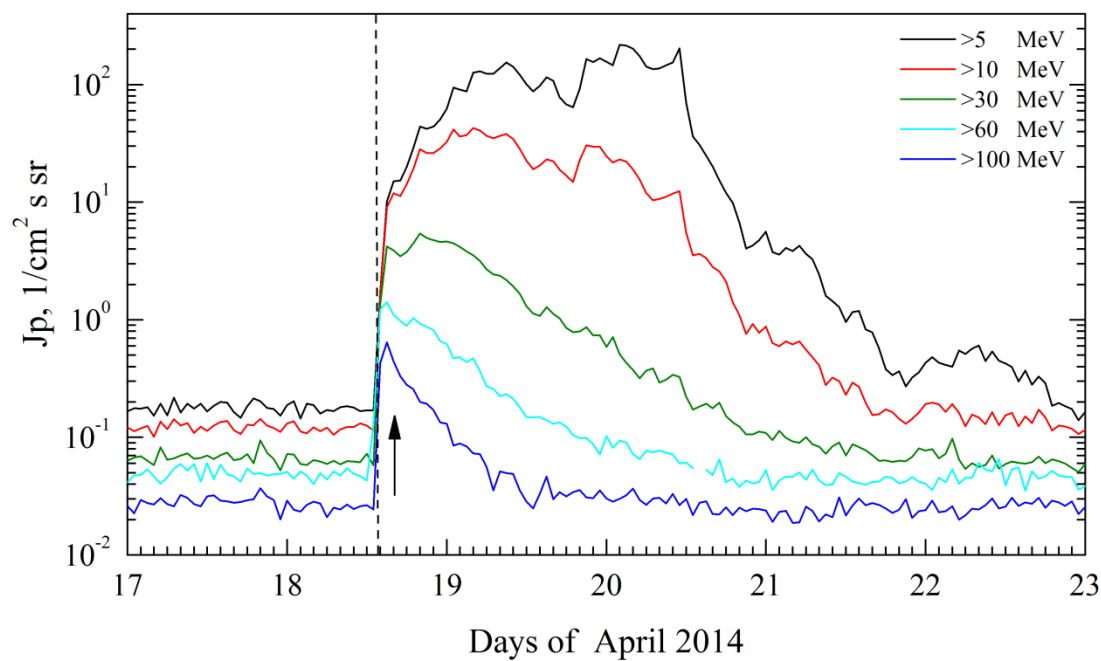


SOHO. Event 2014.04.18

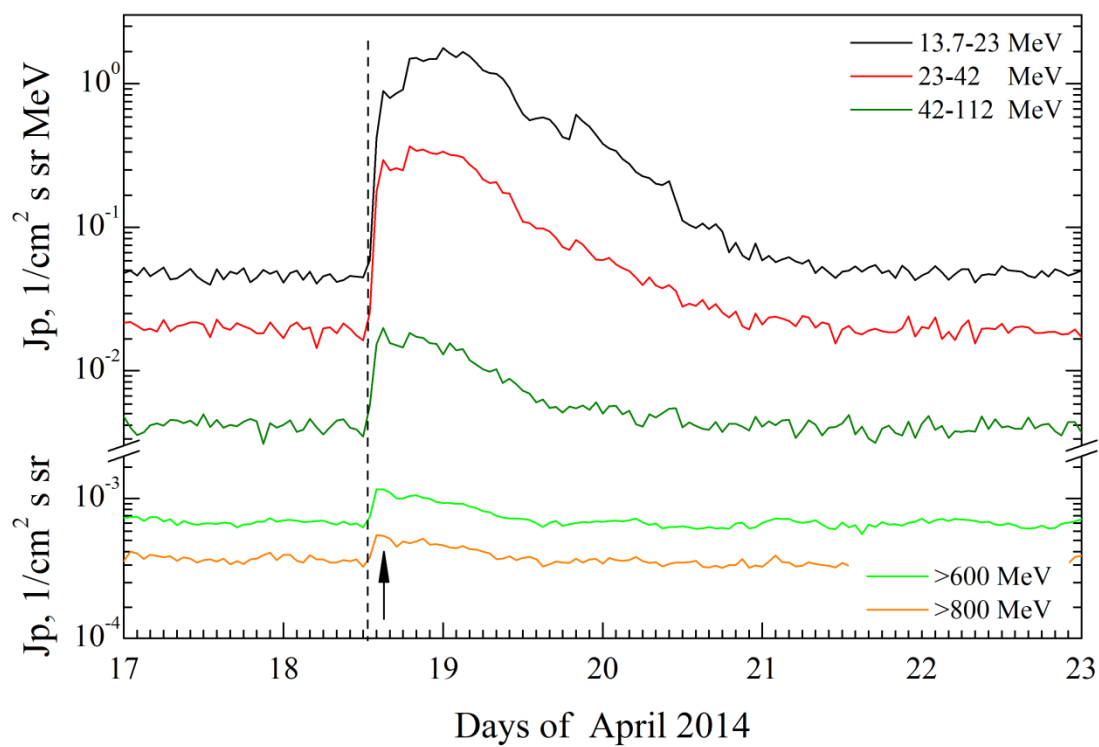


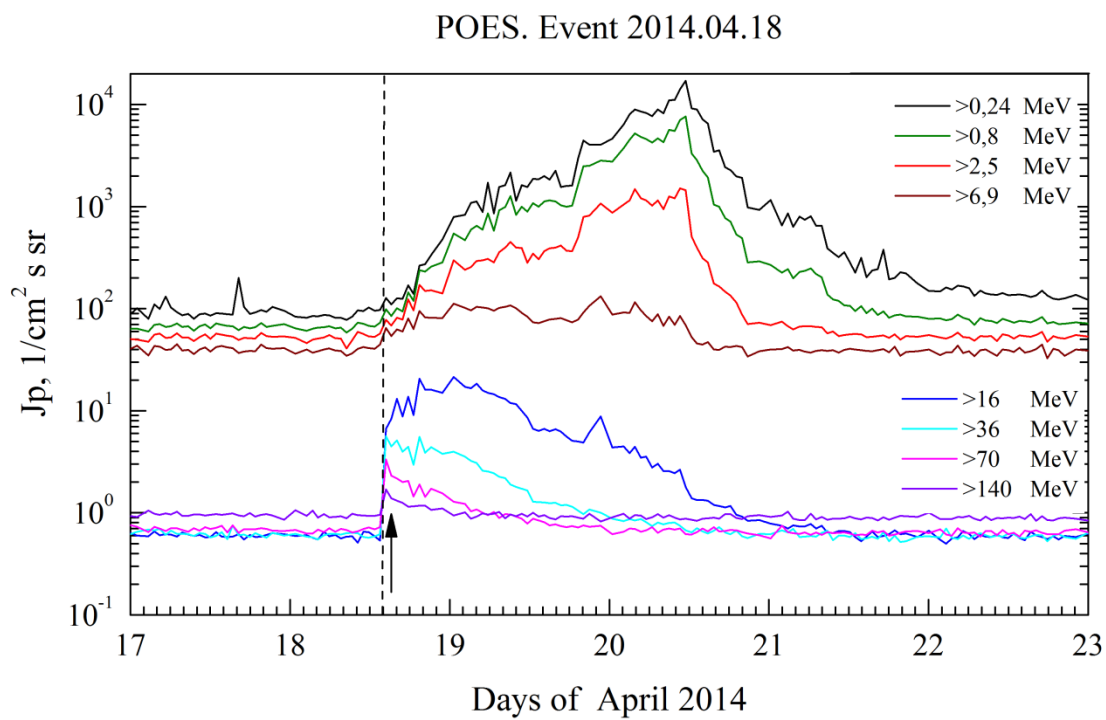
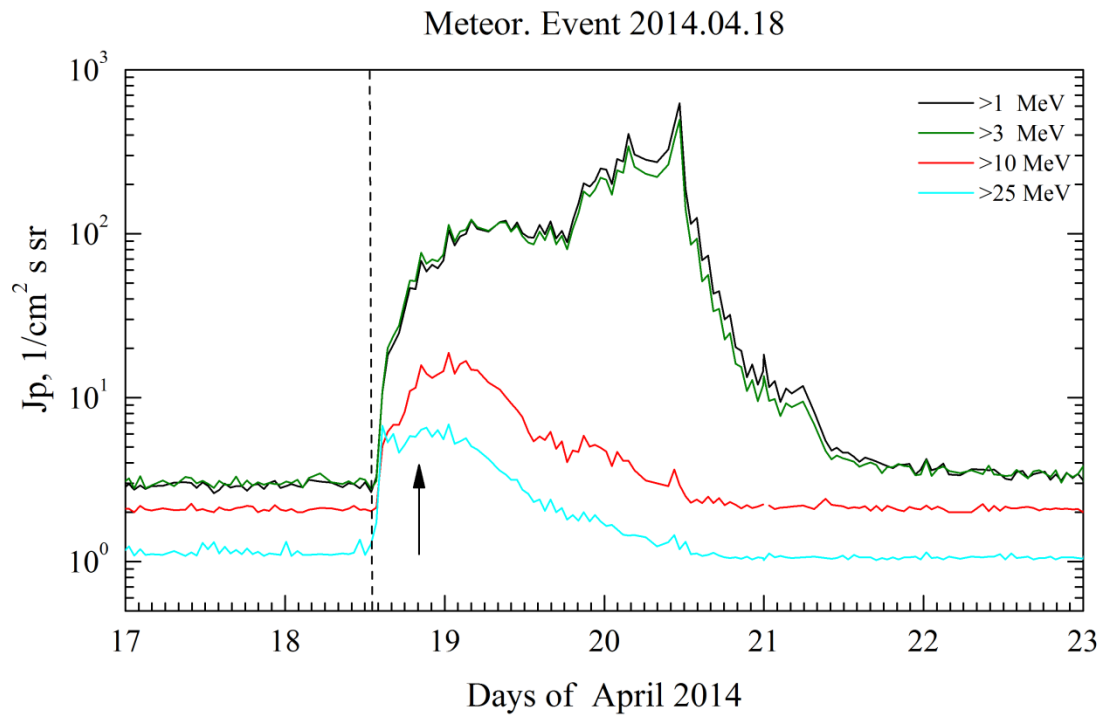
Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2014.04.18



Electro. Event 2014.04.18





**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 April 18**

2014

April 18

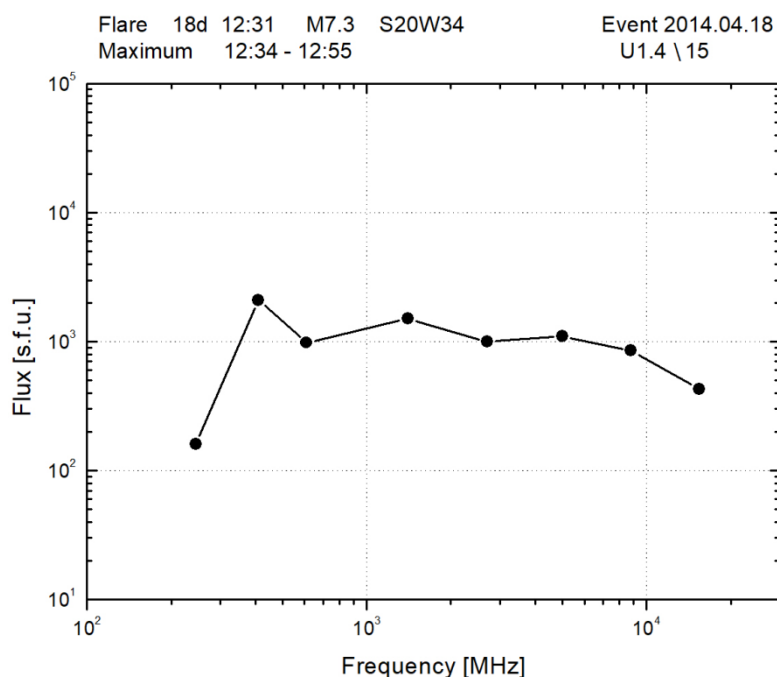
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AR12036

To event 556

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	1231	1303	1320	S20W34	M7.3	0.11
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1234:04	1234:29	1235:5	1896	27508	FERMI
12-25	keV	1236:07	1255:24	1307:50	268408	132936416	FERMI
50-100	keV	1250:08	1255:50	1313:40	2416	13137984	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1249	1255	1310	U1.4 \ 15	2.63	
8.8	GHz	1245	1254	1316		2.93	
5	GHz	1246	1254	1310		3.04	
2.7	GHz	1243	1255	1307		3.0	
1.4	GHz	1244	1248	1306		3.18	
610	MHz	1245	1250	1300		2.99	
410	MHz	1246	1255	1301		3.22	
245	MHz	1234	1234	1234		2.2	
DS-type	Frequency, MHz	To	Tmax	Te	V_n, km/s	Importance	Sp/c
DS II	25-172	1255		1314	769	2	
DS IV	25-180	1242		2014		2	
DS III	25-81	1227		1232		1	
DS V	25-180	1234		1236		2	
DS VI	25-180	1243		1257		2	
DS CTM	74-129	1142		1243		1	
DH II	4-14	1520		1602			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1325	1203	13.5	360°	238°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR12036 (S17L246, CMP 15,9.04.2014,

Sp=510 msh, DKC, BG, R)

XRI=0.73 $M_1^{7.3} + C_{28}$ $1_1 + S^{26}$

PFR 18.04 $M_1^{7.3}$

References:

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 Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
 Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 25d18^h

Tmax($E_p > 10$ MeV) – 26d00^h, Jmax($E_p > 10$ MeV) – $1.3 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$ (ACE)

Duration of the event – 1.5 days, power-law index: $\gamma = 2.3$

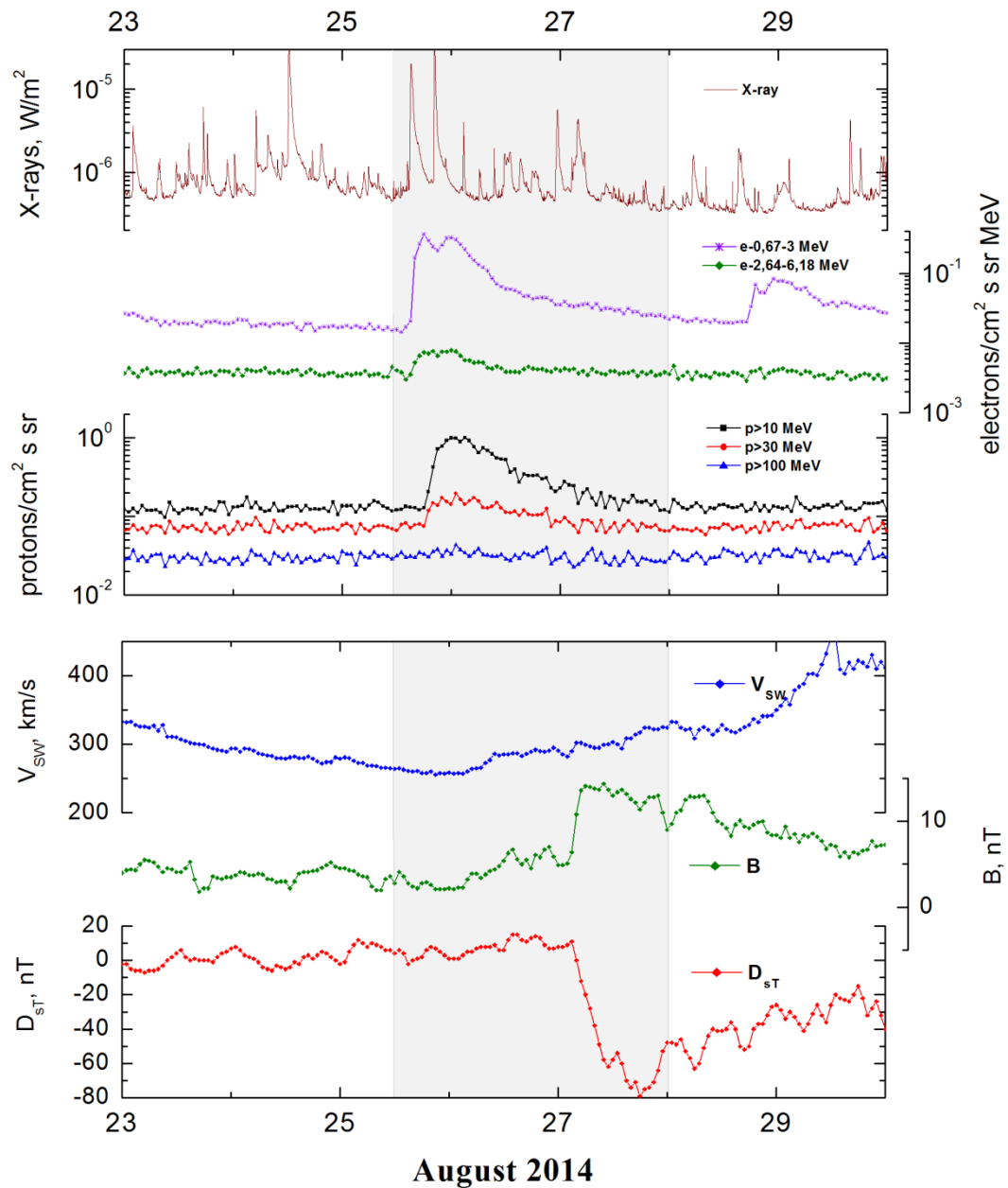
Quasimaximal energy of protons in the event – $E_{qm} = 75$ MeV

Sources: ● solar flare 25d14^h46^m, M2.0/1B, N05W36, AR12146

Main burst X-ray 1–8 Å: onset – 25d14^h46^m, max – 25d15^h11^m, $\Phi = 0.032 \text{ J/m}^2$

CME: 25d15^h36^m, $V = 555 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 270^\circ$

Particle fluxes and associated phenomena

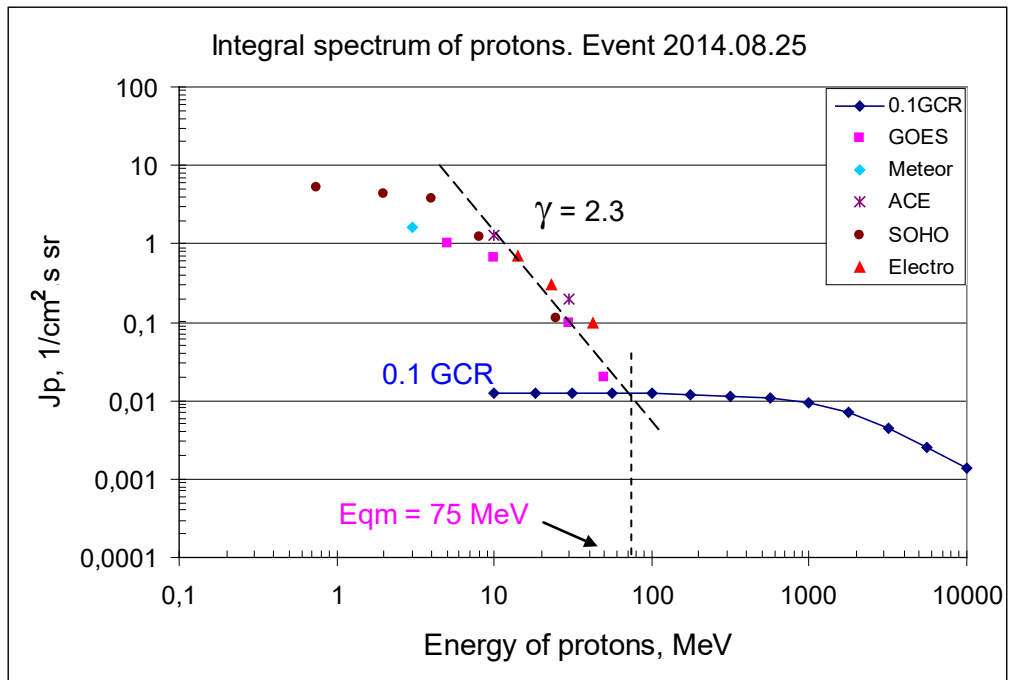


Integral fluxes of protons for the event of 2014 August 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	26d01	1	2	0.2	
EPS	>10	18	26d00	0.7	1.5	0.12	
EPS	>30	18	26d00	0.1	1	0.07	
EPS	>50	18	26d00	0.02	1	0.06	
EPS	>60	18	-	-	-	0.05	
EPS	>100	18	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
Meteor-1							
SCR	>1	18	-	-	2	2.75	
SCR	>3	18	26d02	1.65	2	2.85	
SCR	>10	-	-	-	-	1.85	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	-	-	-	-	1.2	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	16	22	1.3	1	1	
SIS	>30	16	22	0.2	1	0.7	
SOHO							
EPHIN	>50						

Differential fluxes of protons for the event of 2014 August 25

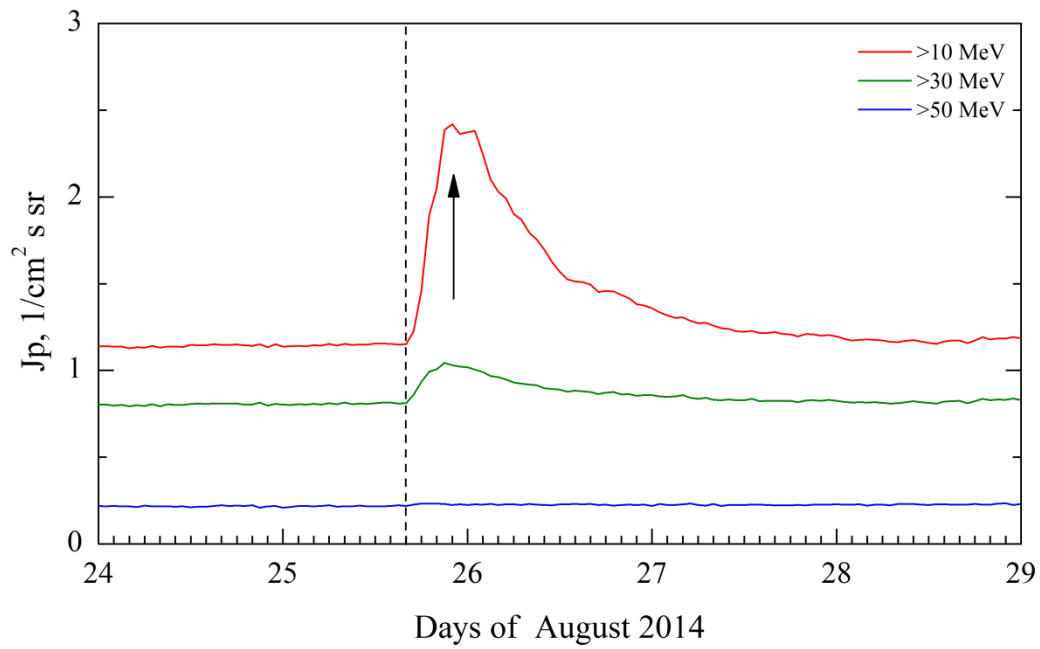
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	20	26d02	0.65	3	0.02	
LION	2 – 6	19	26d02	0.18	3	0.002	
EPHIN	4 – 8	18	26d02	0.65	3	0.0015	
EPHIN	8 – 25	17	26d01	0.065	3	0.0001	
EPHIN	25 – 53	16	21	0.004	3	0.00001	
Electro							
SCR-E	13.7–23	17	21	0.04	0.5	0.05	
SCR-E	23–42	17	21	0.01	0.5	0.02	
SCR-E	42–112	18	21	0.0015	0.5	0.004	



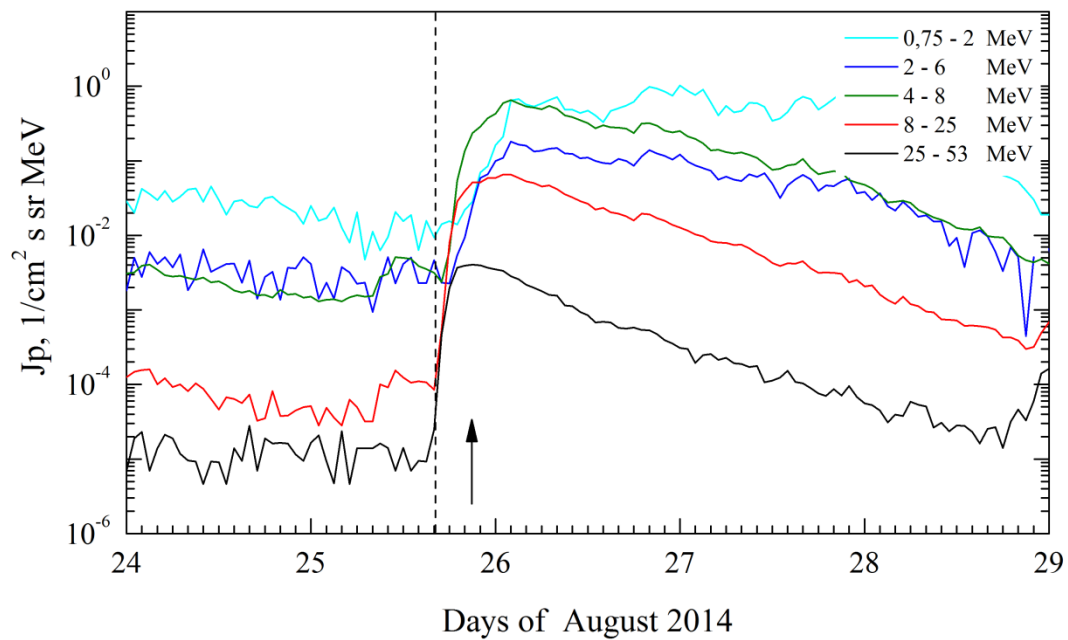
Time profiles of proton fluxes in the event 2014.08.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.08.25

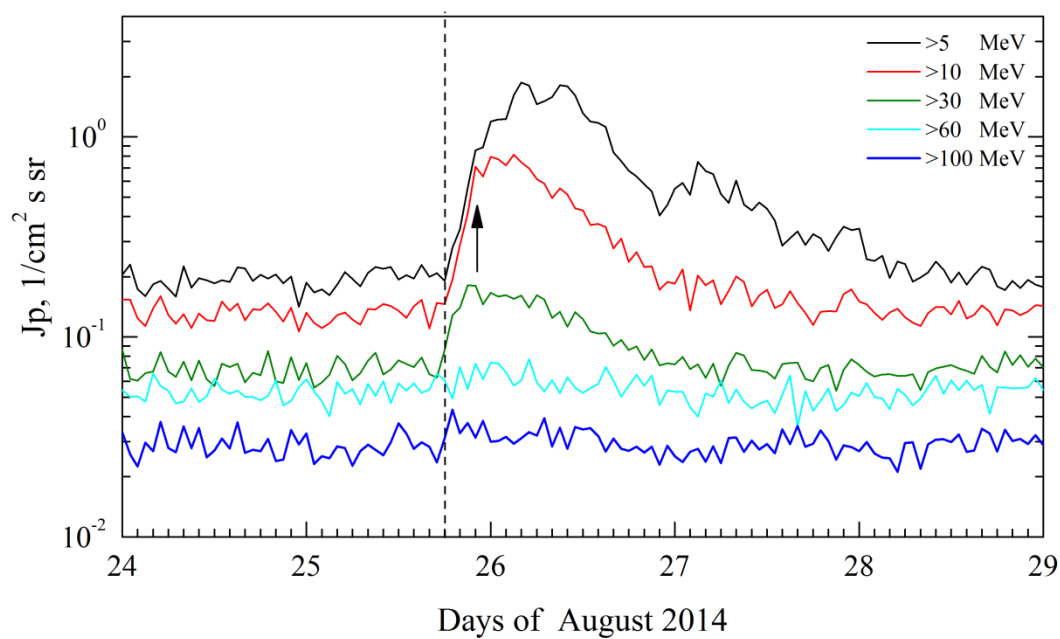


SOHO. Event 2014.08.25

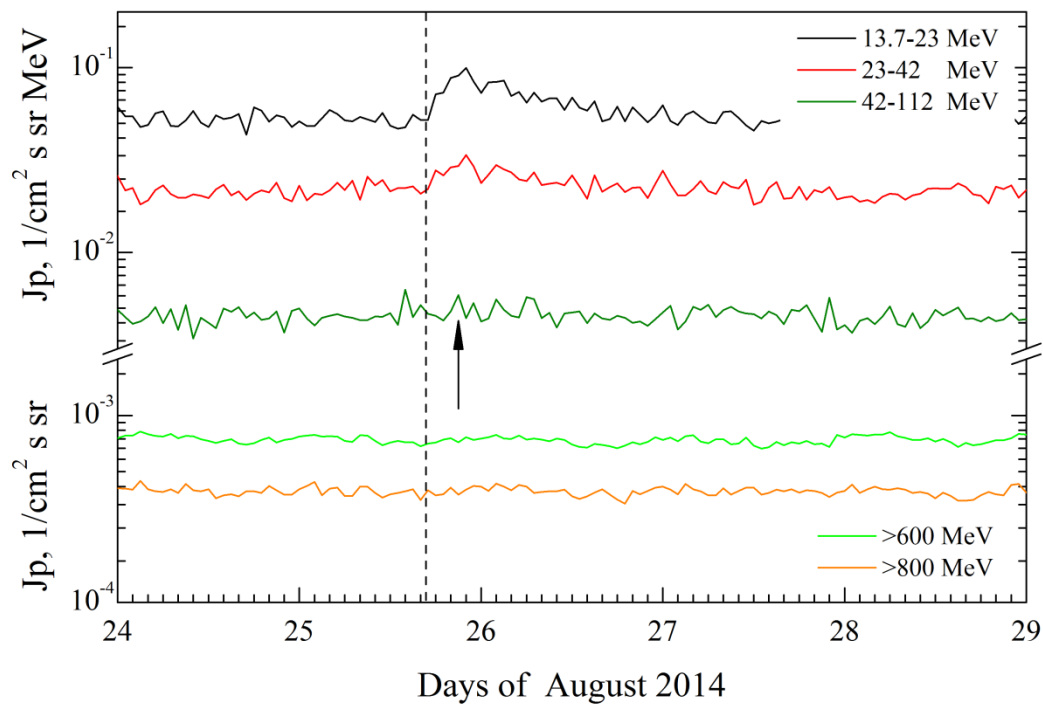


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

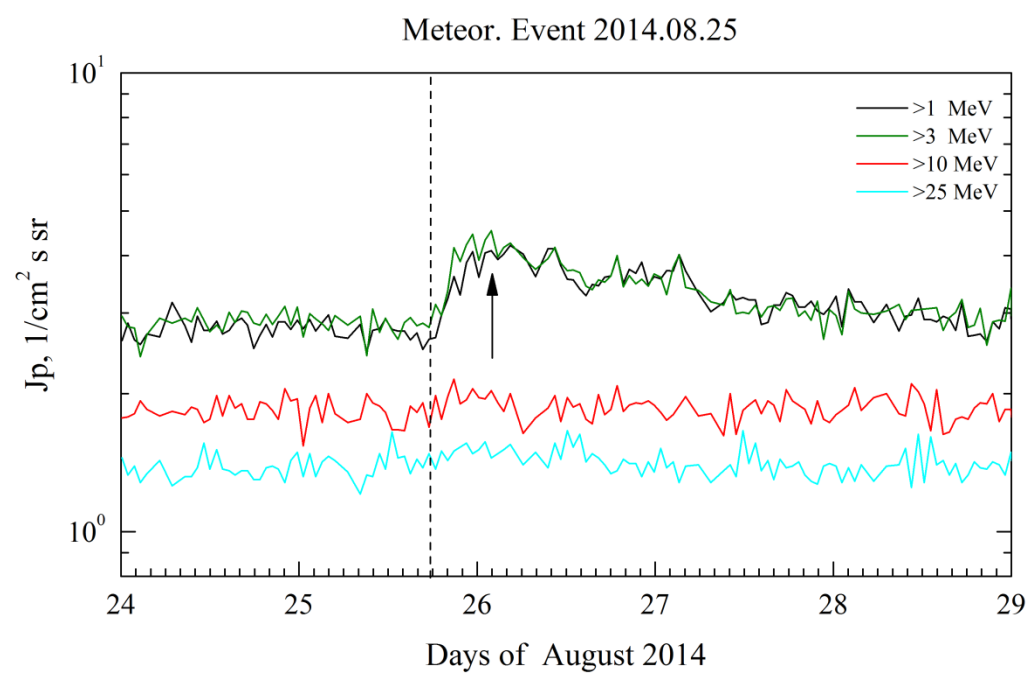
GOES. Event 2014.08.25



Electro. Event 2014.08.25



Earth satellites in polar orbit, R = 800÷1000 km: Meteor



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 August 25**

2014

August 25

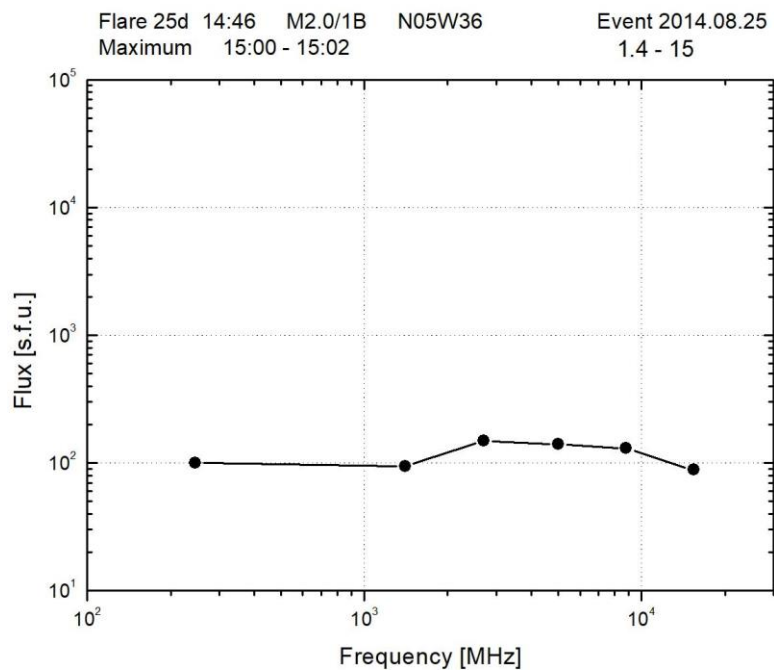
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AR 12146

To event 557

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1452	1504	1639	N05W36	1B	ERU
1 – 12	keV	1446	1511	1531	N06W39	M2.0	0.032
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1456:53	1505:26	1512:16	37277	17642164	FERMI
12-25	keV	1521:32	1521:41	1545:38	6479	551944	FERMI
25-50	keV	1443:28	1504:54	1513:08	1008	255625	HESSI
25-50	keV	1548:56	1549:38	1633:52	135	70141	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1500	1502	1209	1.4 – 15	1.94	
8.8	GHz	1500	1501	1212		2.11	
5	GHz	1500	1501	1210		2.15	
2.7	GHz	1500	1501	1216		2.18	
1.4	GHz	1500	1501	1219		1.97	
245	MHz	1500	1500	1220		2.0	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS VI		1437		1504		1	
DS II	25-82	1508		1527	707	2	
DS IV	30-80	1518		1721		1	
DH II	4-14	1520		1602			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1536	555	- 12.2	360°	270°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR12146 (N09L344, CMP 22,5.08.2014,

Sp=300 msh, DKI, BGD, R)

XRI=0.59, $M_2^{3.9} + C_{14}$ $1_1 + S_{30}$

PFR 25.08 (6^h) $M_2^{3.9}$

Particle event: To($E_p > 10$ MeV) – 01d18^h

Tmax($E_p > 10$ MeV) – 03d08^h, Jmax($E_p > 10$ MeV) – $2.5 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 9 days, power-law index: $\gamma = 2.2$

Quasimaximal energy of protons in the event – $E_{qm} = 700$ MeV

Sources: ■ solar flare 01d10^h55^m, B6.2($\sim X2.4^*$), N14E126*, AR12158, 3d behind E_L

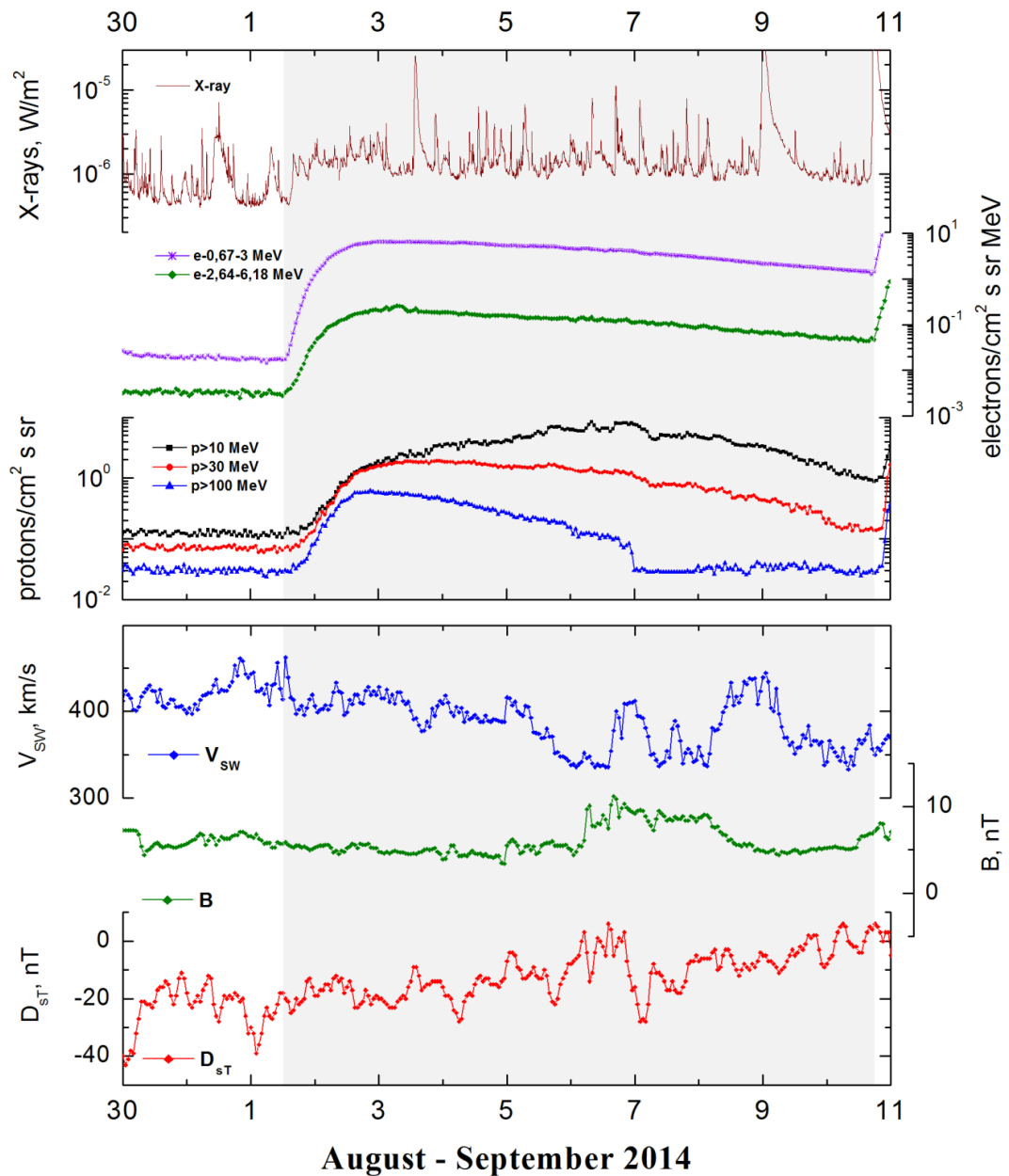
Main burst X-ray 1–8 Å: onset – 01d10^h55^m, max – 01d~11^h05^m

CME: 01d11^h12^m, $V = 1901$ km/s, $\Delta\phi = 360^\circ$, $dA = 065^\circ$

▲ SC 06d15^h24^m

*restored data

Particle fluxes and associated phenomena

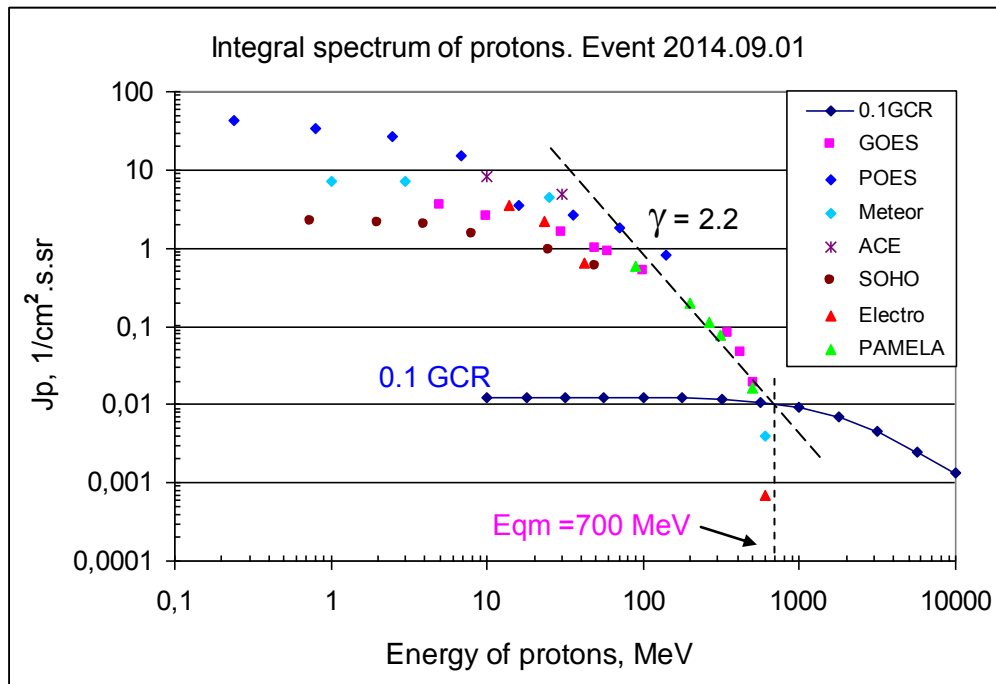


Integral fluxes of protons for the event of 2014 September 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	03d12	3.6	9	0.2	
EPS	>10	18	03d08	2.5	9	0.15	
EPS	>30	18	03d06	1.6	9	0.07	
EPS	>50	18	03d03	1	9	0.06	
EPS	>60	18	03d00	0.9	8	0.05	
EPS	>100	18	02d18	0.5	6	0.03	
Electro-1							
GALS-E	>600	22	02d23	0.0007	9	0.0007	
POES							
MEPED	>0.24	20	02d23	43	9	90	
MEPED	>0.8	20	02d23	34	9	70	
MEPED	>2.5	20	02d23	27	8	60	
MEPED	>6.9	20	02d23	15	8	50	
MEPED	>16	20	03d10	3.6	7	0.65	
MEPED	>36	20	03d10	2.7	7	0.7	
MEPED	>70	20	03d06	1.8	7	0.75	
MEPED	>140	20	03d04	0.8	6	1	
Meteor-1							
SCR	>1	18	03d02	7.1	9	2.75	
SCR	>3	18	03d02	7.0	9	2.85	
SCR	>10	18	-	-	7	1.85	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	18	03d02	4.4	7	1.2	
GALS-M	>600	02d02	02d24	0.004	8	0.02	
ACE							
SIS	>10	19	3d12	8.2	9	1.2	
SIS	>30	19	3d06	5	9	0.8	
PAMELA							
TRACKER	>90	17	2d10-3d17	0.58	9	-	
TRACKER	>200	17	2d10-3d17	0.2	9	-	
TRACKER	>265	17	2d10-3d17	0.11	9	-	
TRACKER	>312	17	2d10-3d17	0.076	9	-	
TRACKER	>500	17	2d10-3d17	0.016	9	-	
SOHO							
EPHIN	>50	21	03d01	0.6	8	0.2	

Differential fluxes of protons for the event of 2014 September 01

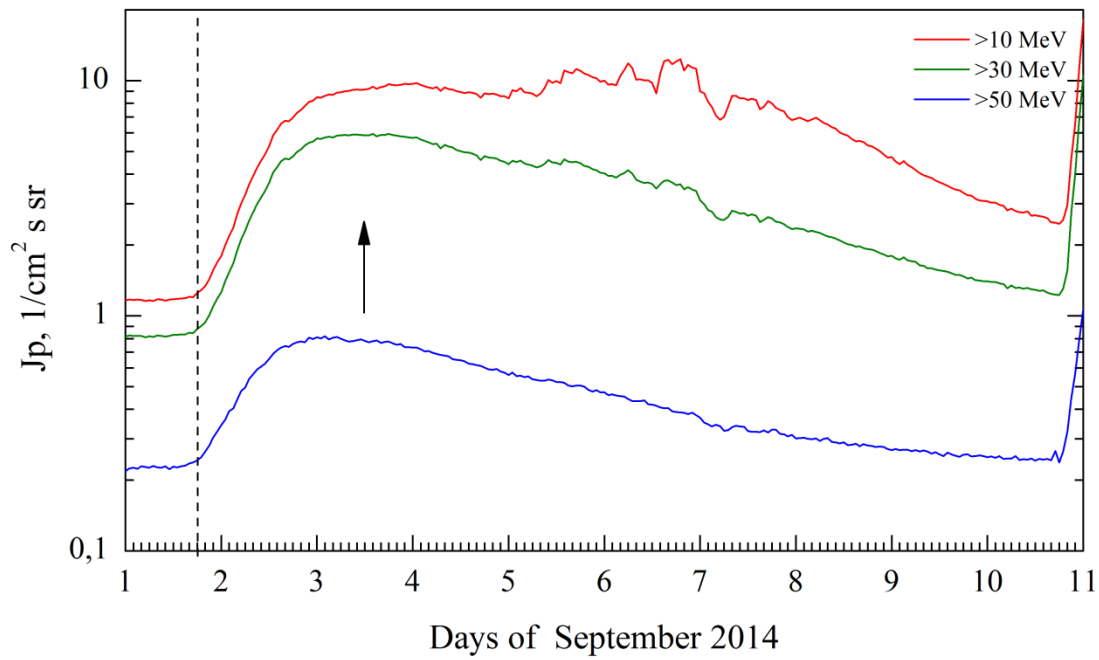
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	21	03d08	0.06	9	0.006	
LION	2 – 6	21	03d08	0.05	9	0.002	
EPHIN	4 – 8	21	03d05	0.12	9	0.001	
EPHIN	8 – 25	21	03d03	0.032	9	0.0002	
EPHIN	25 – 53	21	03d02	0.012	9	0.00003	
Electro-1							
SCR-E	13.7–23	22	02d23	0.15	9	0.05	
SCR-E	23–42	22	02d23	0.08	9	0.02	
SCR-E	42–112	22	02d23	0.009	9	0.004	
GOES							
EPS	350–420	22	02d09	0.0005	1.5	0.0016	
EPS	420–510	22	02d21	0.0003	1.5	0.0009	
EPS	510–700	-	02d20	0.0001	-	0.0004	
EPS	>700	-	-	-	-	0.0001	



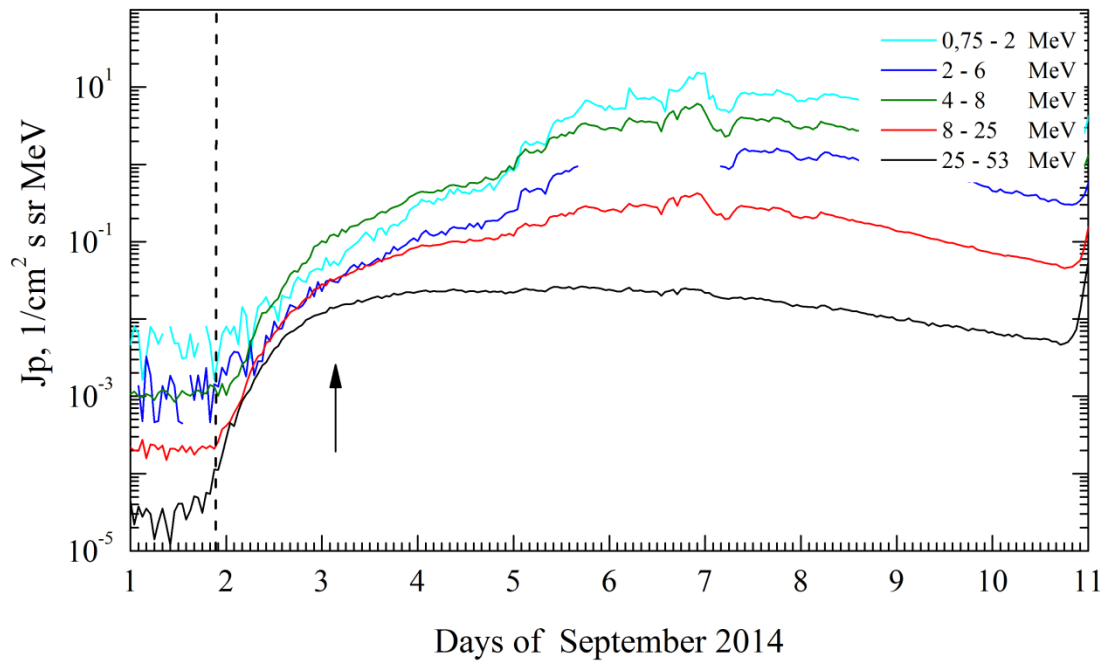
Time profiles of proton fluxes in the event 2014.09.01

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.09.01

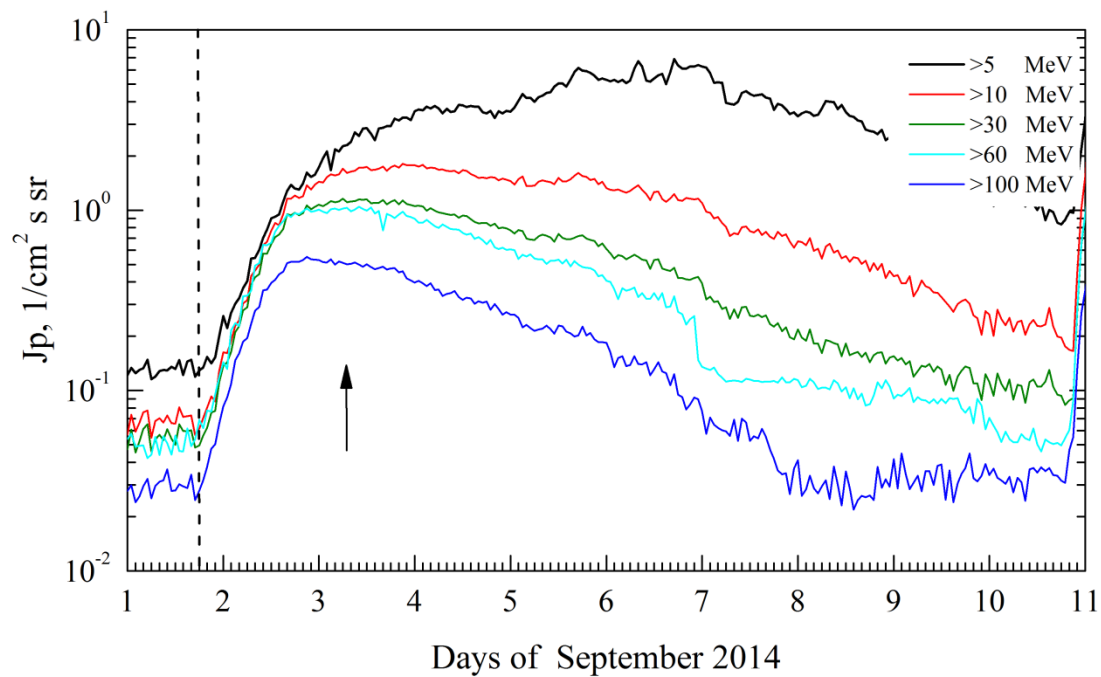


SOHO. Event 2014.09.01

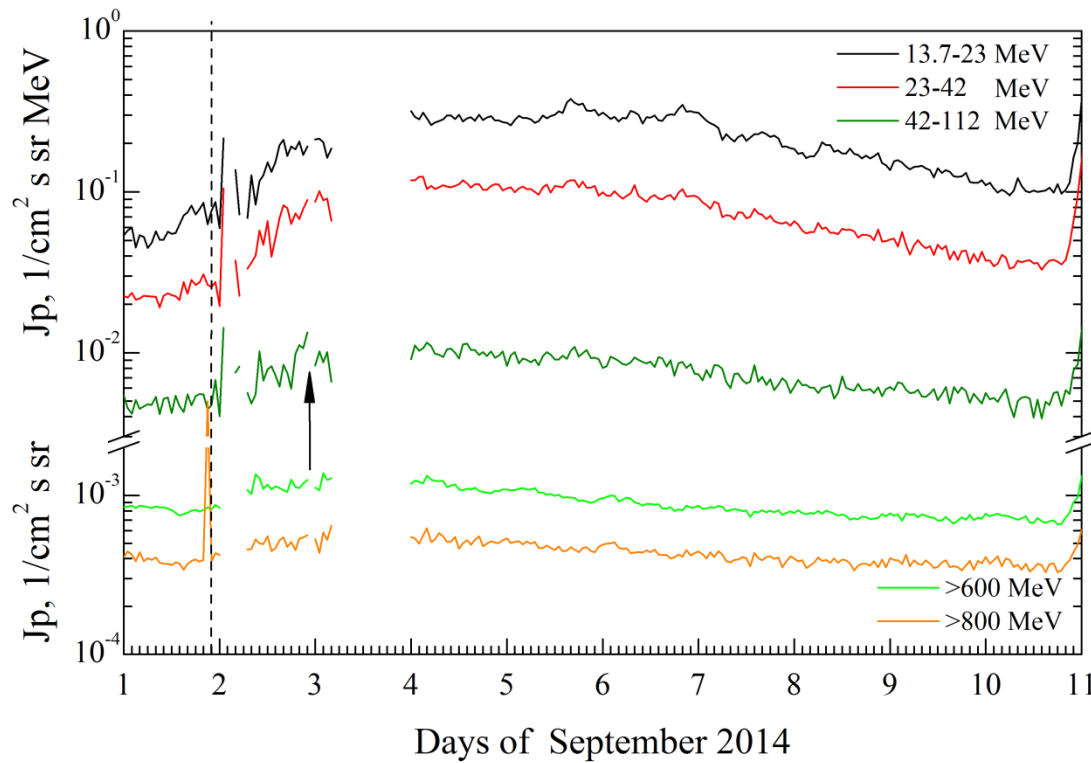


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.09.01

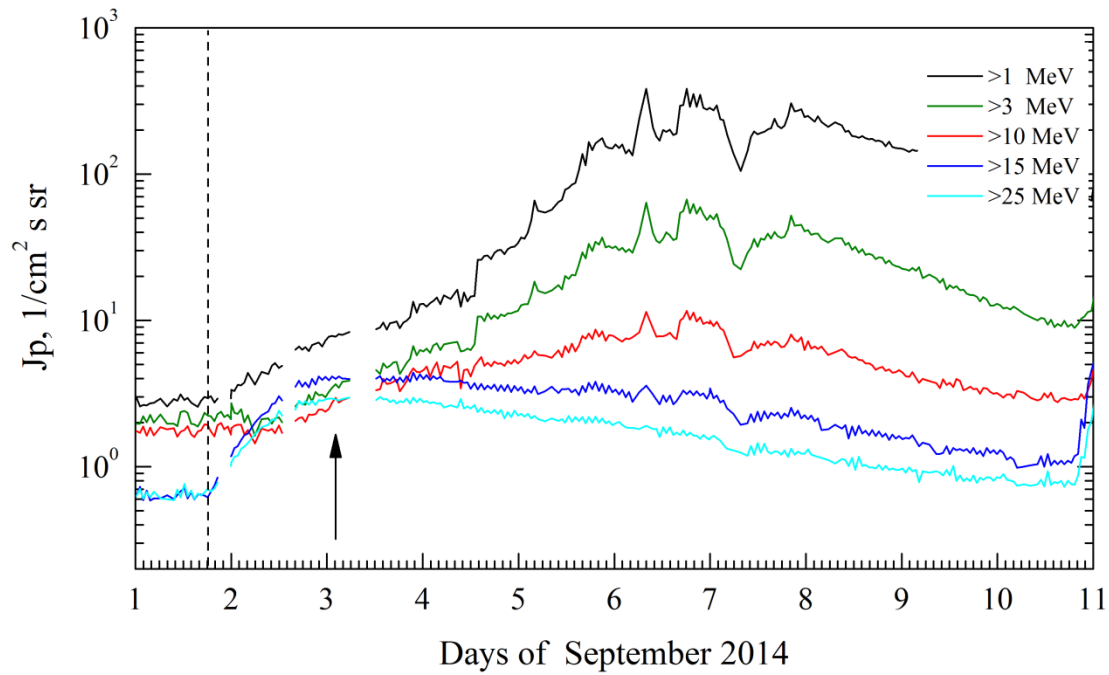


Electro. Event 2014.09.01

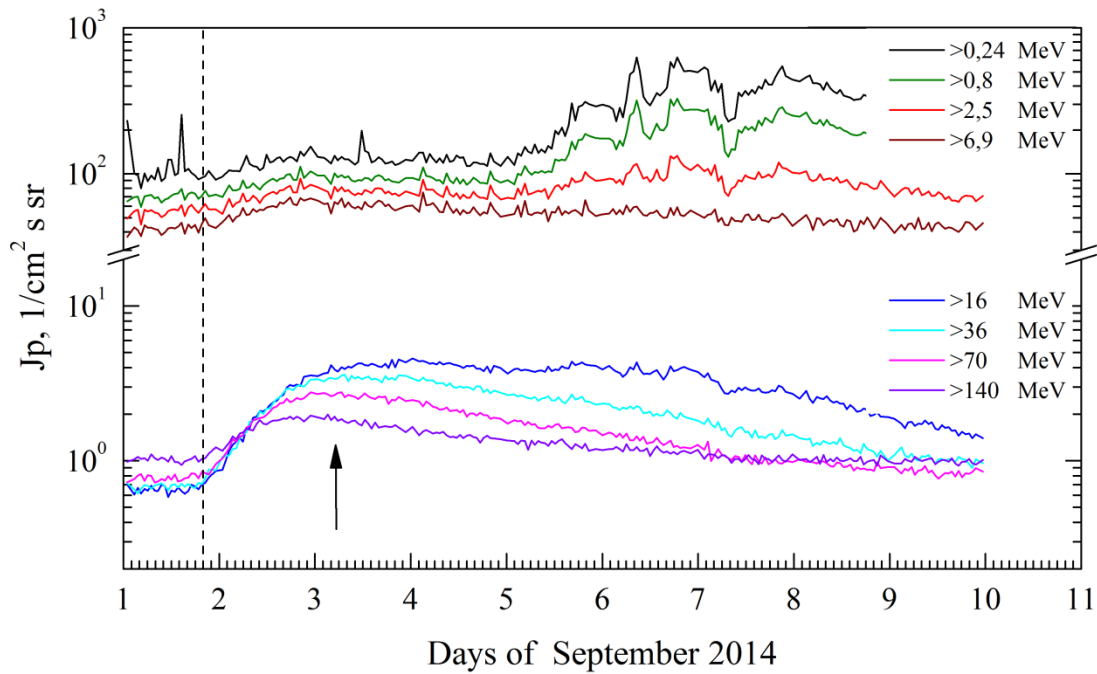


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.09.01



POES. Event 2014.09.01



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 September 01**

2014 September 01



AR 12158

To event 558

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No flare on visible disc					
1 – 12	keV	1055	1139	1200	N16W88	B6.2	
1 – 12	keV	1056*	~1101*	~1319*	N14E126*	X2.4*	
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
>100	MeV	1101:30		1118:30		3.17E-03**	FERMI
>100	MeV	1225:30		1257:30		3.04E-05**	FERMI
800-7000	keV	1110:48	1114:06	1122:00	60	105248	HESSI
800-7000	keV	1122:00	1124:02	1133:36	42	79936	HESSI
800-7000	keV	1133:36	1138:42	1145:12	320	200208	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
2.7	GHz	1106	1153	1216		1.76	
1.4	GHz	1102	1117	1126		2.46	
245	MHz	1101	1102	1106		2.56	
DS-type	Frequency, MHz	To	Tmax	Te	V _H , km/s	Importance	Sp/c
DS II	25-53	1113		1124		2	
DS V	25-180	1100		1103		2	
DS VI	25-180	1100		2133		2	
DS VI	25-180	1104		1710		2	
DH II	0.6-16	1112		2235			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1112	1901	- 240.1	360°	065°	SOHO

* restored data: [M. Ackermann, A. Allafort, L. Baldini et al., 2017](#)

** cm⁻²s⁻¹

Proton Active Region:

AR12158 (N14L089, CMP 10.09.2014,
Sp=440 msh, DKC, BGD, R)
XRI*= 2.05 $X_1^{1.6}+M_1^{4.5}+C_{11}$; $2_1+1_1+S_{29}$
PFR 8-10.09 (41^h) $X_1^{1.6}+M_1^{4.5}$
* excluding the "restored" X2.4 flare

References:

Ackermann M., A. Allafort, L. Baldini et al., [2017](#).
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Wu Y., A.P. Rouillard, A. Kouloumvakos et al., [2021](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zelina P., S. Dalla, C.M.S. Cohen, R.A. Mewaldt, [2017](#).

Particle event: To($E_p > 10$ MeV) – 10d21^h

Tmax₁($E_p > 10$ MeV) – 11d07^h, Jmax₁($E_p > 10$ MeV) – 25 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 12d16^h, Jmax₂($E_p > 10$ MeV) – 67.5 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma_1 = 2.8$, $\gamma_2 = 3.1$

Quasimaximal energy of protons in the event – Eqm₁ = 400 MeV

– Eqm₂ = 160 MeV

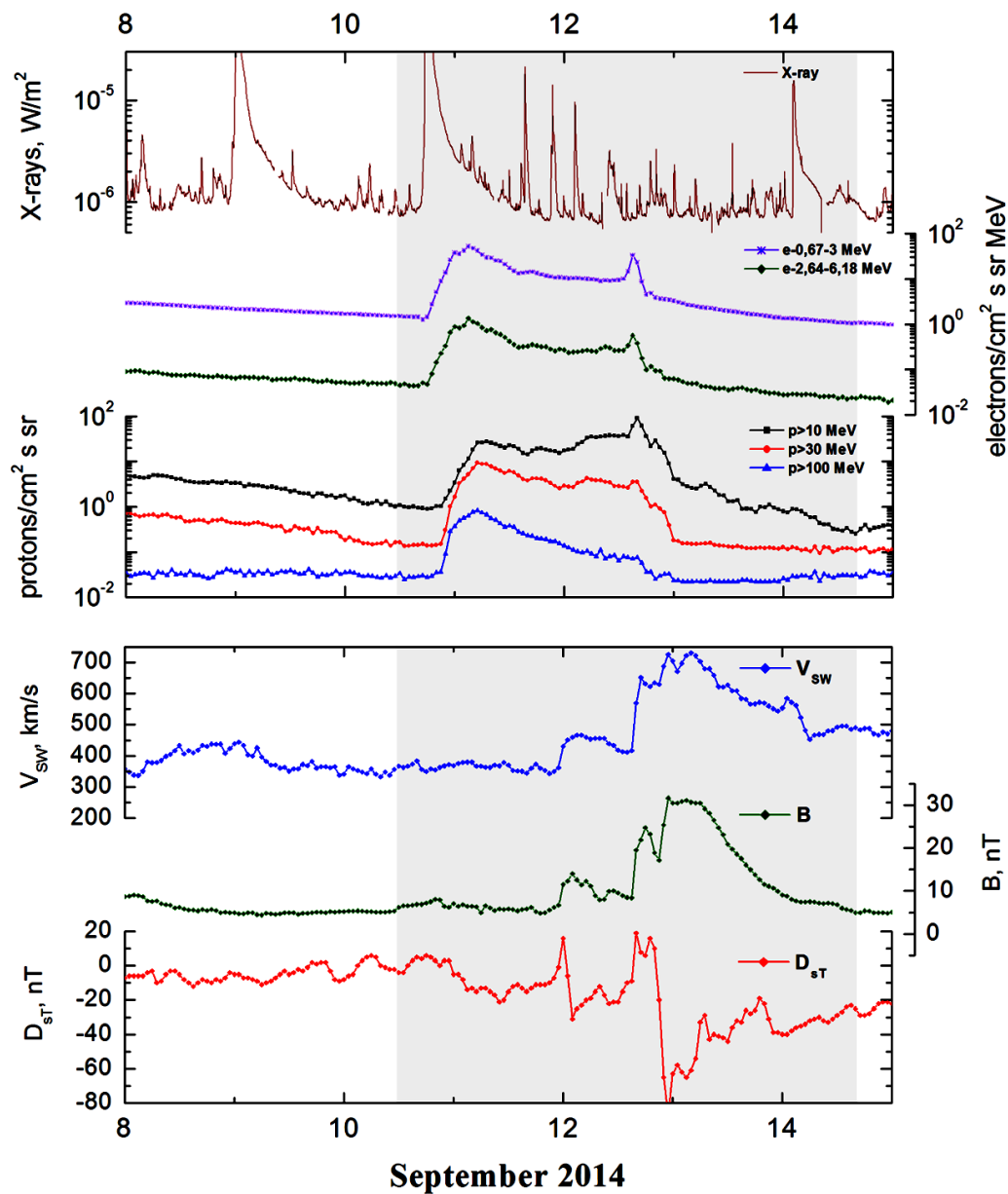
Sources: ● solar flare 10d16^h59^m, 2B/X1.6, N14E02, AR12158

Main burst X-ray 1–8 Å: onset – 10d17^h21^m, max – 10d17^h45^m, $\Phi = 0.38$ J/m²

CME: 10d18^h00^m, $V = 1267$ km/s, $\Delta\phi = 360^\circ$, dA = 175°

▲ SC 11d23^h45^m; ▲ SC 12d15^h53^m

Particle fluxes and associated phenomena

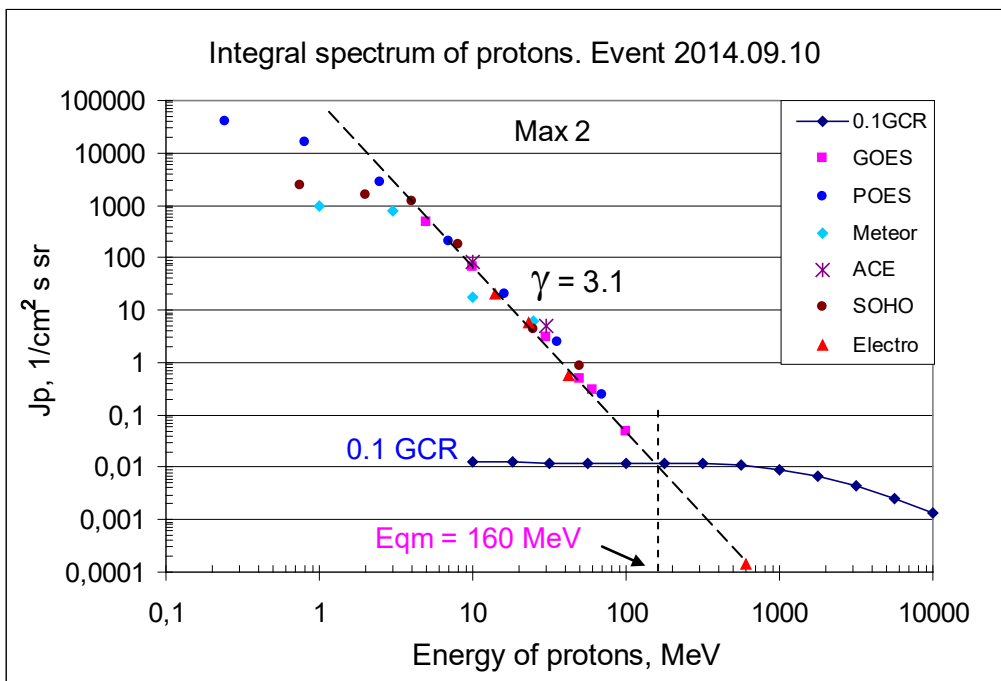
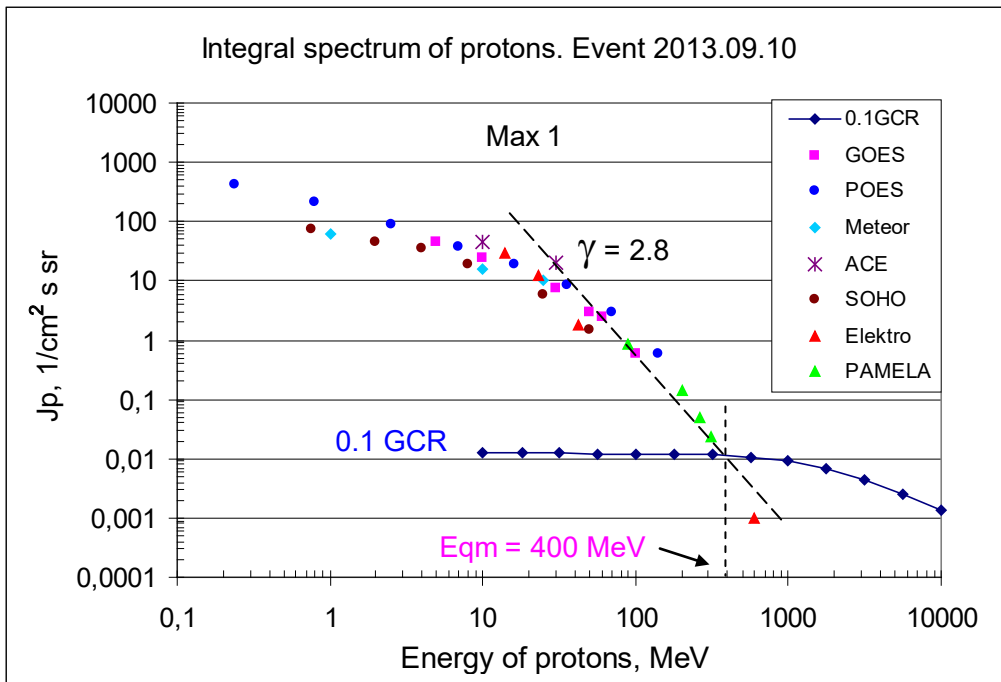


Integral fluxes of protons for the event of 2014 September 10

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	19	11d07/12d16	45.5/475	4	0.2	
EPS	>10	21	11d07/12d16	25/67.5	4	0.12	
EPS	>30	21	11d07/12d16	7.3/3	2	0.07	
EPS	>50	21	11d06/12d16	2.9/0.5	2	0.06	
EPS	>60	21	11d06/12d16	2.4/0.3	2	0.05	
EPS	>100	19	11d05/12d16	0.6/0.05	2	0.03	
Electro-1							
GALS-E	>600	20	11d05/12d15	0.001/0.00014	2	0.0007	
POES							
MEPED	>0.24	-	11d06/12d18	415/40400	2	90	
MEPED	>0.8	-	11d06/12d18	210/15600	2	70	
MEPED	>2.5	-	11d06/12d18	90/2700	2	55	
MEPED	>6.9	-	11d06/12d18	37.5/200	2	50	
MEPED	>16	-	11d06/12d18	19.2/20	2	0.65	
MEPED	>36	-	11d06/12d18	8.6/2.5	2	0.7	
MEPED	>70	-	11d06/12d18	2.9/0.25	1.5	0.75	
MEPED	>140	-	11d06/ -	0.6/ -	1.5	1	
Meteor-1							
SCR	>1	23	11d06/12d17	60/980	2.5	2.75	
SCR	>3	23	- /12d17	- /790	2.5	2.85	
SCR	>10	23	11d06/12d16	16/18	2	1.85	
GALS-M	>15	-	-	-	-	-	
GALS-M	>25	21	11d05/12d16	10/5	2	1.2	
GALS-M	>600	-	-	-	-	0.02	
ACE							
SIS	>10	19	11d03/12d15	44/83	3	1.2	
SIS	>30	19	11d03/12d15	20/5	3	0.8	
PAMELA							
TRACKER	>90	20	11d01-07/ -	0.84/ -	>3		
TRACKER	>200	20	11d01-07/ -	0.14/ -	>3		
TRACKER	>265	20	11d01-07/ -	0.048/ -	>3		
TRACKER	>312	20	11d01-07/ -	0.023/ -	>3		
SOHO							
EPHIN	>50	20	11d03/12d15	1.51/0.84	2	0.2	

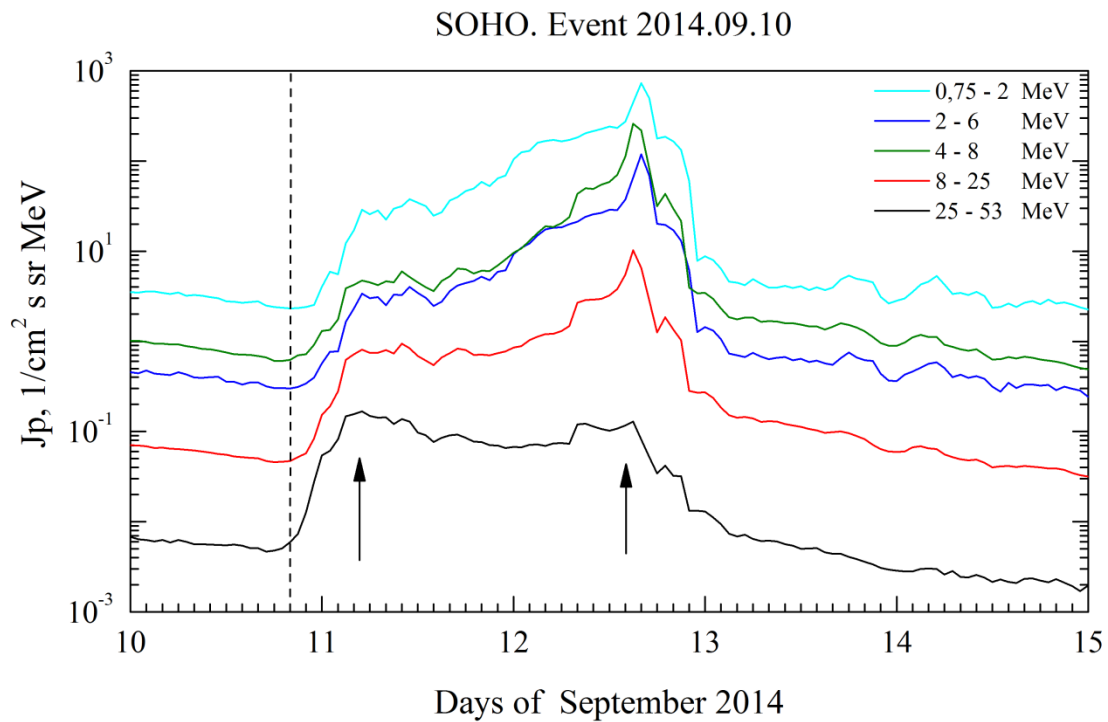
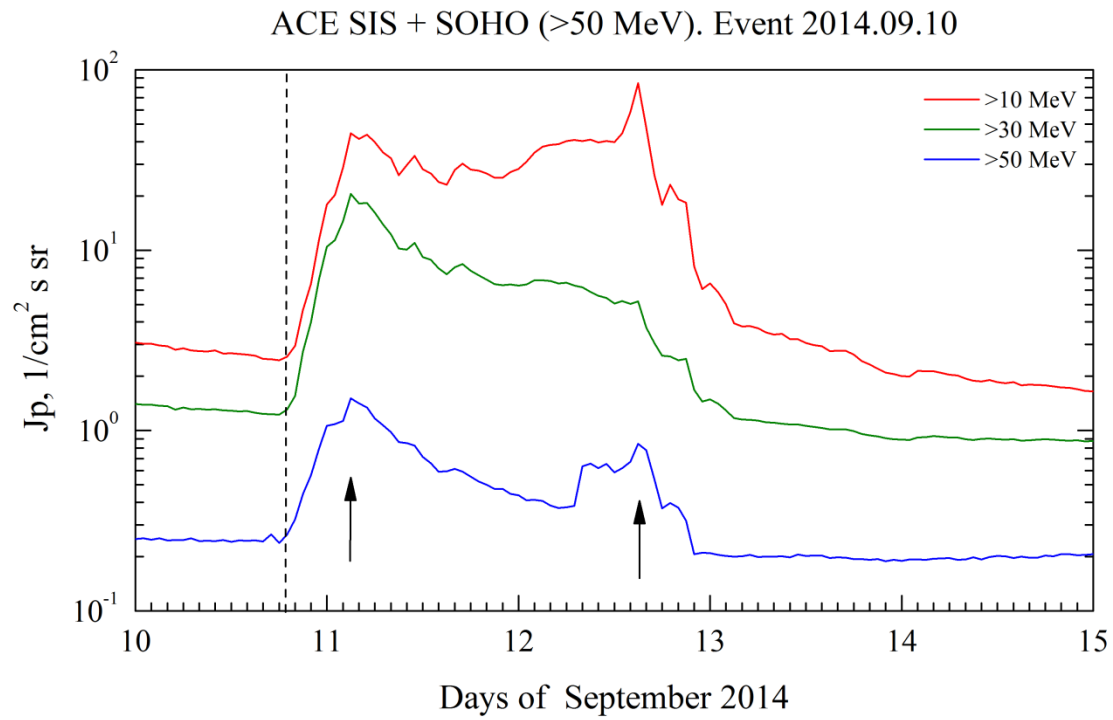
Differential fluxes of protons for the event of 2014 September 10

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75-2	22	11d05/12d16	26.4/730	2	2.5	
LION	2-6	21	11d05/12d16	3.1/120	2	0.3	
EPHIN	4-8	21	11d05/12d15	4/260	2	0.6	
EPHIN	8-25	20	11d05/12d15	0.75/10.3	2	0.05	
EPHIN	25-53	20	11d05/12d15	0.162/0.125	2	0.005	
Electro-1							
SCR-E	13.7-23	20	11d05/12d15	1.75/1.65	3	0.1	
SCR-E	23-42	20	11d05/12d15	0.55/0.27	3	0.035	
SCR-E	42-112	20	11d05/12d15	0.025/0.008	2	0.005	



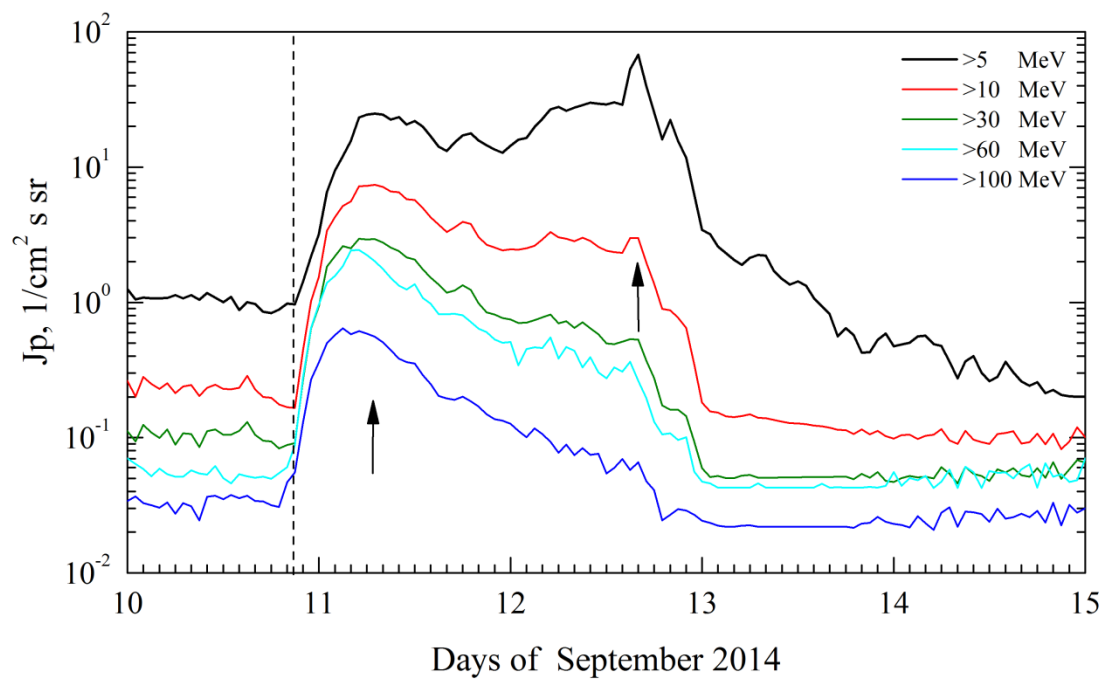
Time profiles of proton fluxes in the event 2014.09.10

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

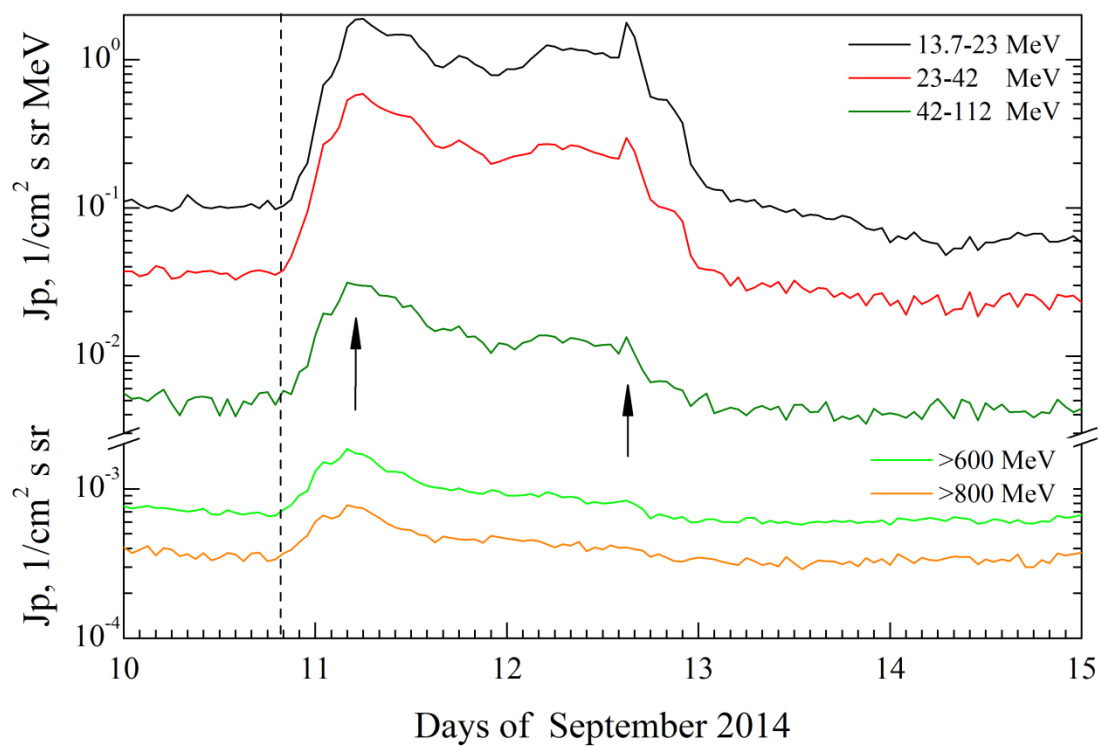


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.09.10

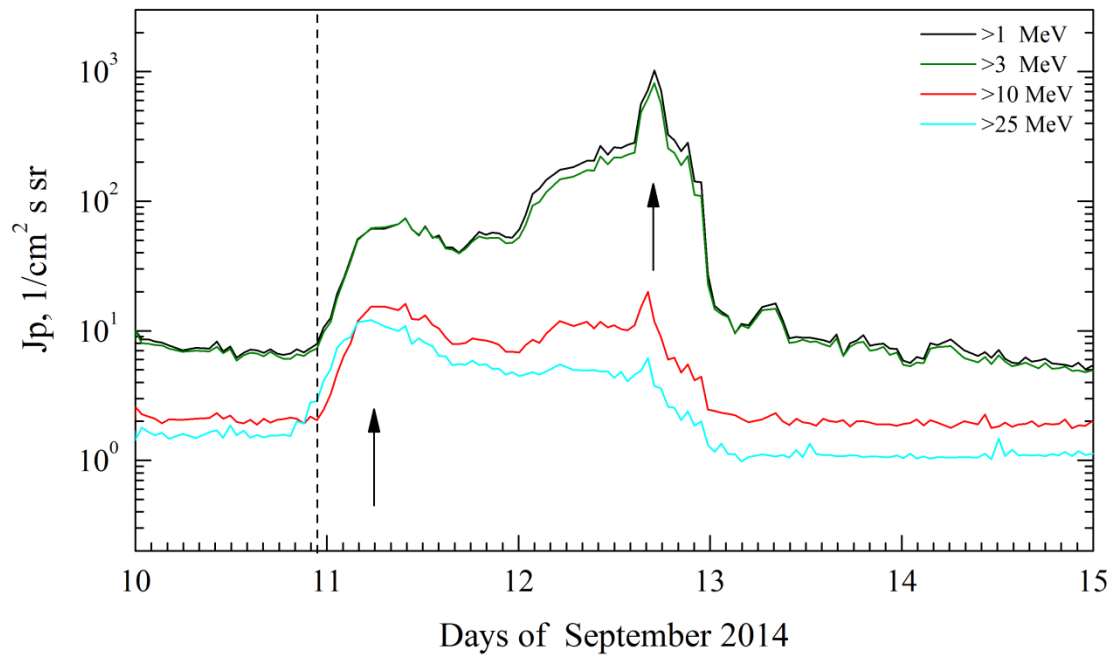


Electro. Event 2014.09.10

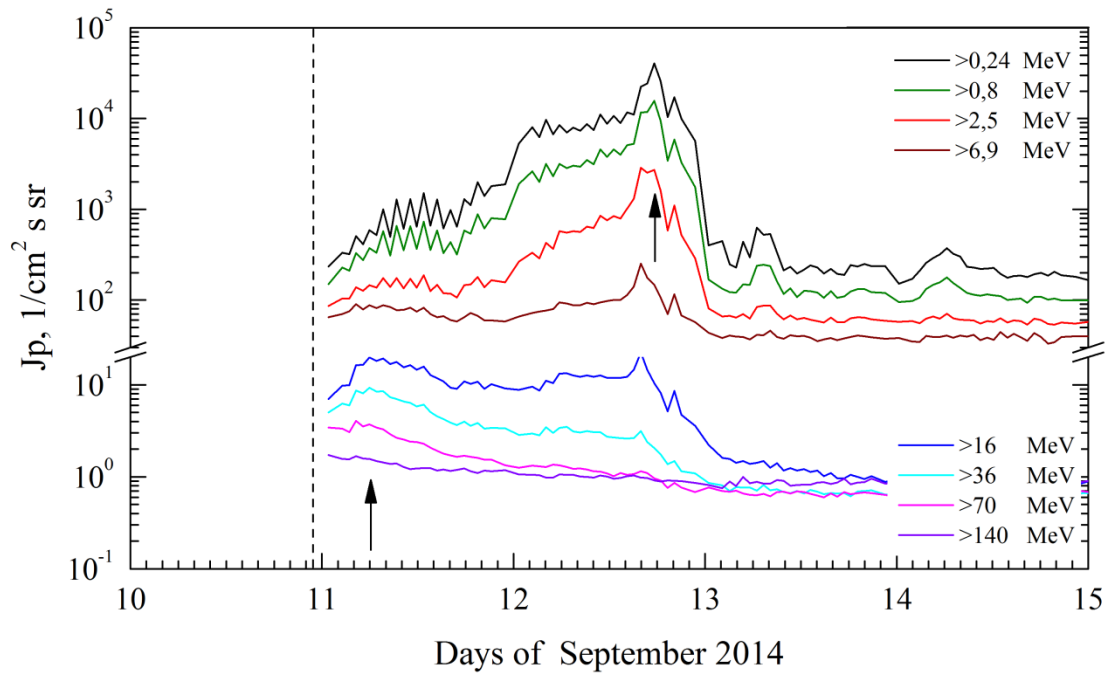


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.09.10



POES. Event 2014.09.10



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 September 10**

2014

September 10

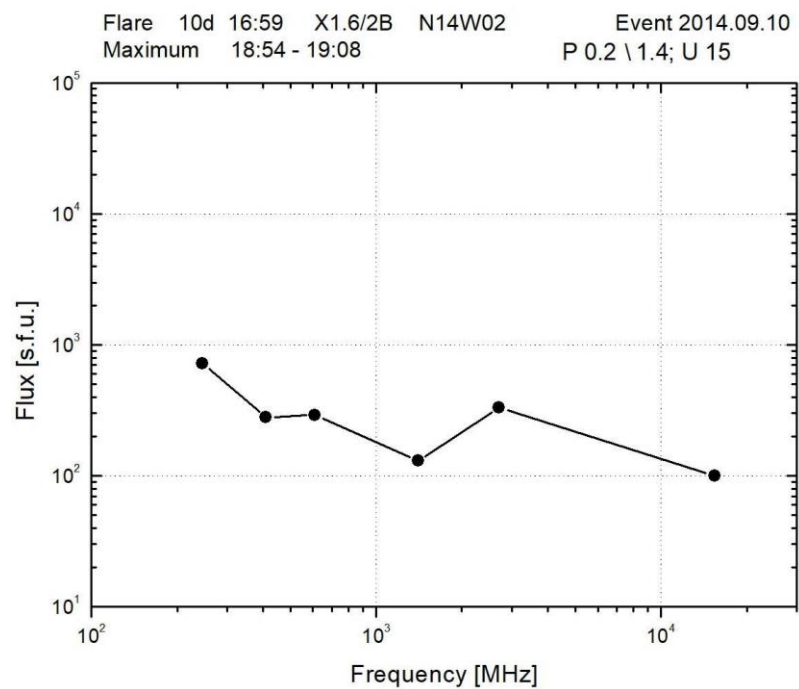
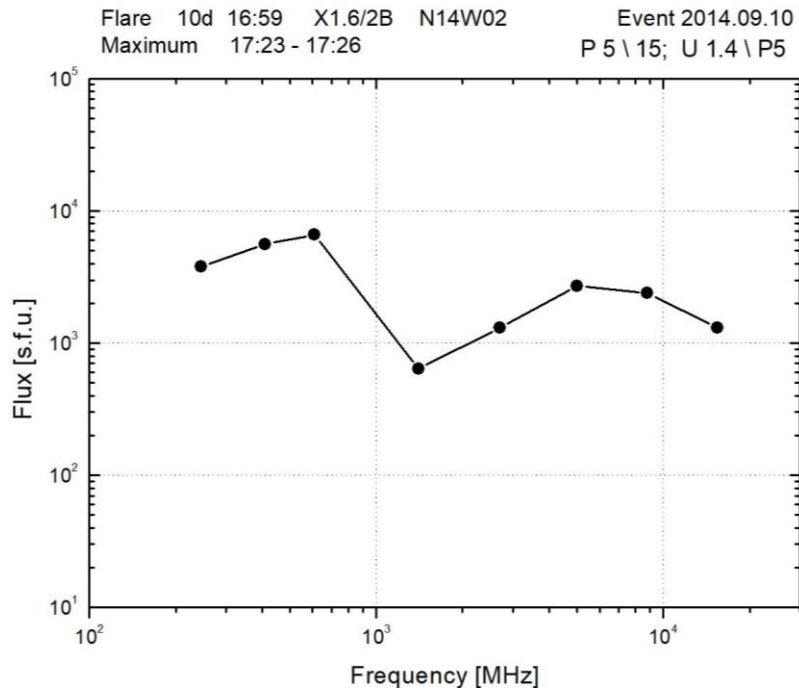
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AR 12158

To event 559

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1659	1733	2240	N14E02	2B	UMB
1 – 12	keV	1721	1745	1820	N11E05	X1.6	0.38
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1850:04	1850:57	1931:39	22135	7013644	FERMI
12-25	keV	2025:29	2047:52	2109:35	1875	951345	FERMI
12-25	keV	2201:23	2241:23	2249:10	958	376540	FERMI
300-800	keV	1645:08	1719:14	1719:44	108	253482	HESSI
50-100	keV	1811:16	1812:38	1825:36	4080	8975020	HESSI
800-7000	keV	1825:36	1827:34	1854:32	2416	8879104	HESSI
25-50	keV	1946:2	1949:40	1949:40	4756	406641	HESSI
25-50	keV	1949:40	1949:54	2016:44	272	1082910	HESSI
800-7000	keV	2016:44	2017:38	2023:32	144	197632	HESSI
7000-20000	keV	2023:32	2025:06	2031:40	136	20000	HESSI
12-25	keV	2121:20	2121:54	2124:44	1988	138747	HESSI
12-25	keV	2124:44	2126:18	2132:40	79	104999	HESSI
12-25	keV	2132:4	2132:46	2146:56	64	154636	HESSI
12-25	keV	2146:56	2147:10	2150:48	46	36064	HESSI
6-12	keV	2155:52	2157:06	2158:20	48	22016	HESSI
6-12	keV	2158:20	2200:06	2204:56	46	56352	HESSI
50-100	keV	2256:20	2258:34	2315:28	2619	9212287	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1724	1733	1847	P5 \ 15	3.11	
8.8	GHz	1723	1732	1842		3.38	
5	GHz	1723	1733	1827		3.43	
2.7	GHz	1723	1733	1855		3.11	
1.4	GHz	1724	1746	1855	U1.4 / P5	2.81	
610	MHz	1724	1747	1910		3.82	
410	MHz	1723	1747	1916		3.75	
245	MHz	1726	1747	1922		3.6	
15.4	GHz	1848	1858	1858	U15	2.0	
2.7	GHz	1854	1854	1855		2.52	
1.4	GHz	1854	1854	1855		2.11	
610	MHz	1853	1855	1910		2.46	
410	MHz	1851	1854	1916		2.45	
245	MHz	1849	1908	1922	P0.2 \ 1.4	2.86	
610	MHz	1943	1943	1943		1.71	
410	MHz	1941	1946	1957		2.3	
245	MHz	1939	1945	2006		2.91	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	25-180	1728		2359		2	
DH II	01-14	1745		11d1200			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1800	1267	- 51.6	360°	175°	SOHO

Radio bursts frequency spectrum



Proton Active Region:

AR12158 (N14L089, CMP 10.09.2014,
Sp=440 msh, DKC, BGD, R)
XRI*= 2.05 $X_1^{1.6} + M_1^{4.5} + C_{11}; 2_1 + 1_1 + S_{29}$
PFR 8-10.09 (41^h) $X_1^{1.6} + M_1^{4.5}$
* excluding the "restored" X2.4 flare

References:

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Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 01d14^h

Tmax₁($E_p > 10$ MeV) – 01d20^h, Jmax₁($E_p > 10$ MeV) – 3.2 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 02d22^h, Jmax₂($E_p > 10$ MeV) – 7 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma_1 = 3.7$, $\gamma_2 = 2.7$

Quasimaximal energy of protons in the event – Eqm₁ = 50 MeV

– Eqm₂ = 120 MeV

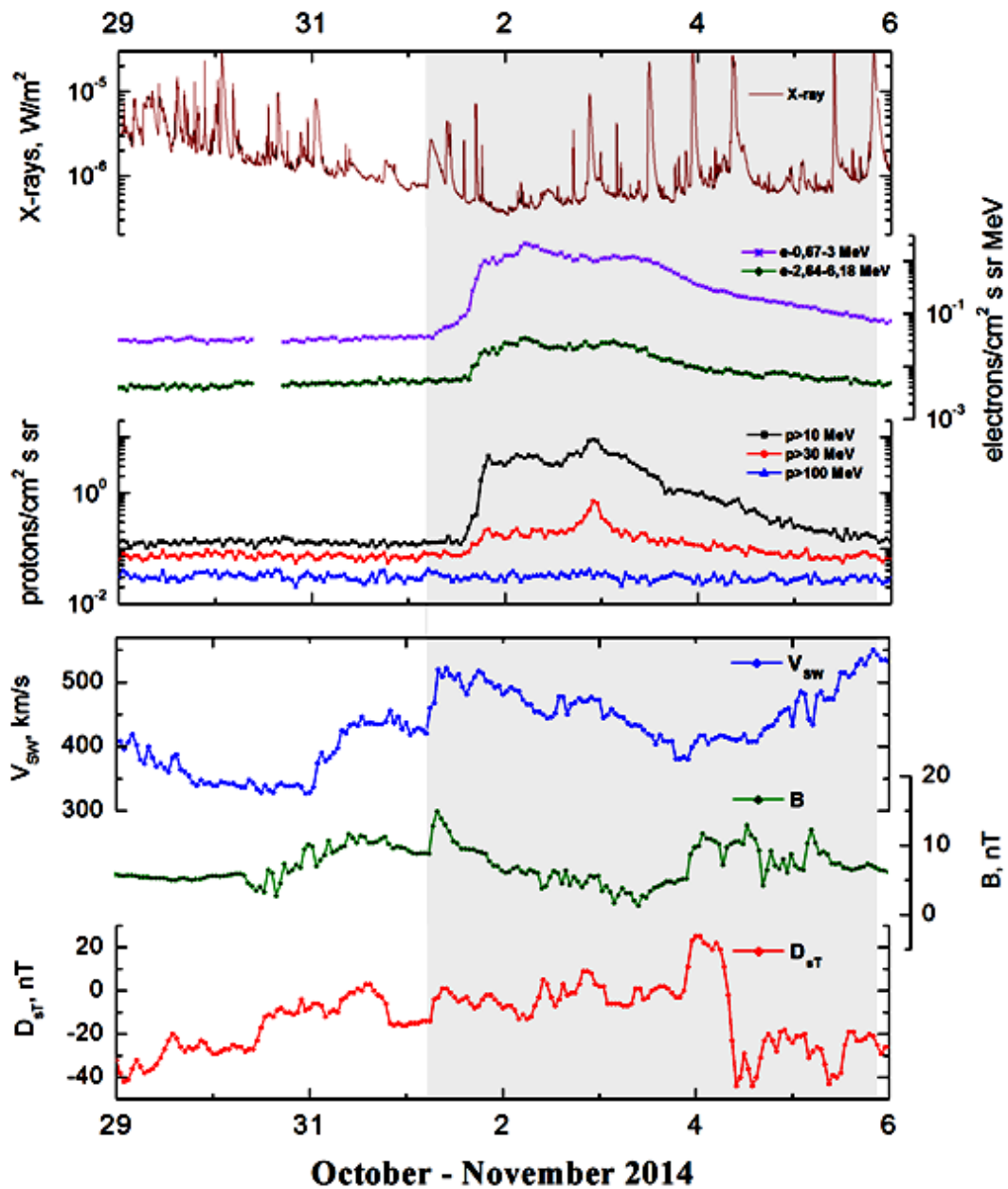
Sources: ● solar flare 01d04^h44^m, C2.7/DSF, S08E52, Spotless AR

Main burst X-ray 1–8 Å: onset – 01d04^h44^m, max – 04d05^h34^m, $\Phi = 0.017$ J/m²

CME: 01d05^h00^m, $V = 1628$ km/s, $\Delta\phi = 159^\circ$, $dA = 125^\circ$

▲ SC 01d07^h05^m

Particle fluxes and associated phenomena

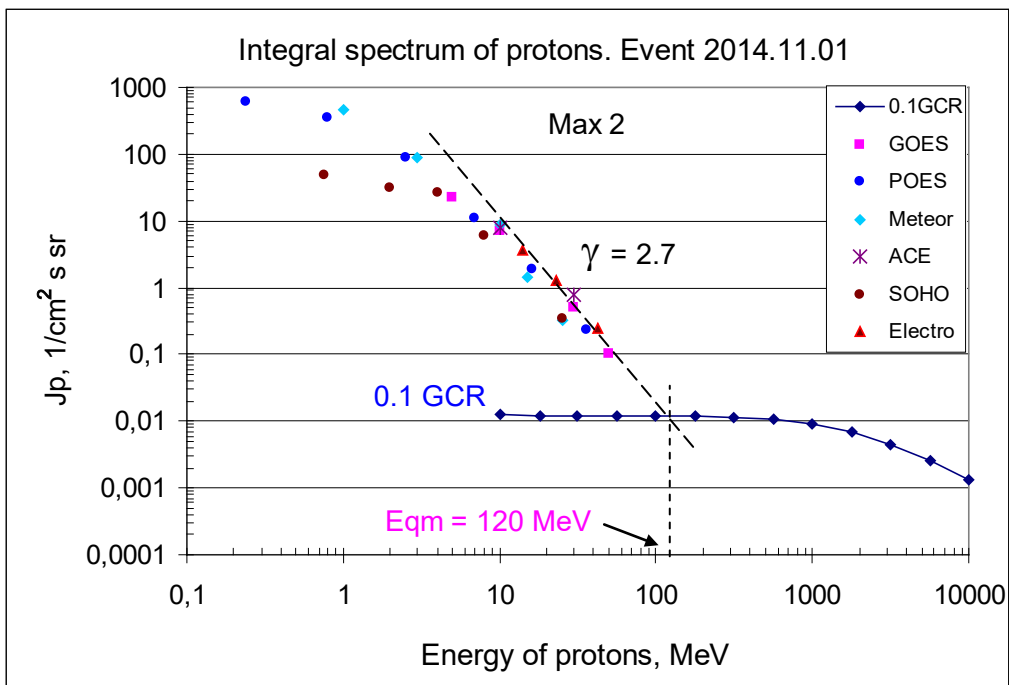
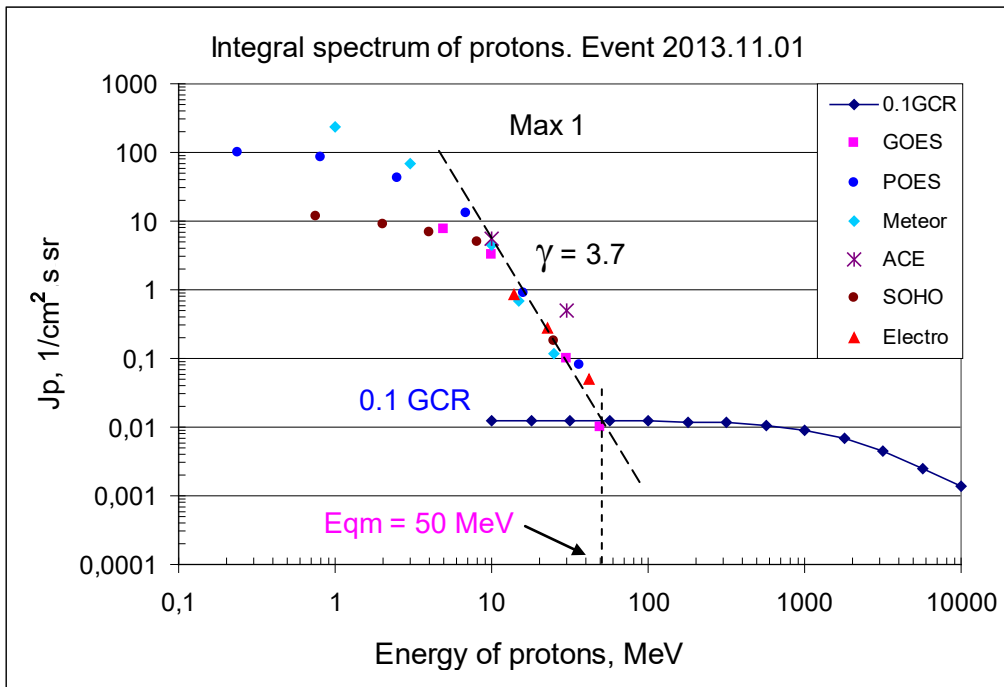


Integral fluxes of protons for the event of 2014 November 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration days	Back- ground	Comments
GOES							
EPS	>5	14	20/02d21	7.6/22	4	0.2	
EPS	>10	14	20/02d22	3.2/7	4	0.12	
EPS	>30	14	21/02d22	0.1/0.5	2	0.07	
EPS	>50	14	21/02d22	0.01/0.1	2	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	17	21/02d22	98/625	4	90	
MEPED	>0.8	17	21/02d22	84/350	4	70	
MEPED	>2.5	17	21/02d22	43/90	3	55	
MEPED	>6.9	17	21/02d22	13/11	2	40	
MEPED	>16	17	21/02d22	0.9/1.9	2	0.65	
MEPED	>36	-	21/02d22	0.08/0.24	2	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-2							
SCR	>1	17	20/02d22	241/466	6	3.9	
SCR	>3	17	20/02d22	70/88	4	2.4	
SCR	>10	17	20/02d22	4.5/9	3	1.9	
GALS-M	>15	17	20/02d22	0.7/1.4	2	0.6	
GALS-M	>25	17	20/02d22	0.12/0.32	2	0.6	
GALS-M	>600	-	-	-		0.2	
ACE							
SIS	>10	20	19/02d20	5.5/8	2.5	1.2	
SIS	>30	20	19/02d20	0.5/0.8	2	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

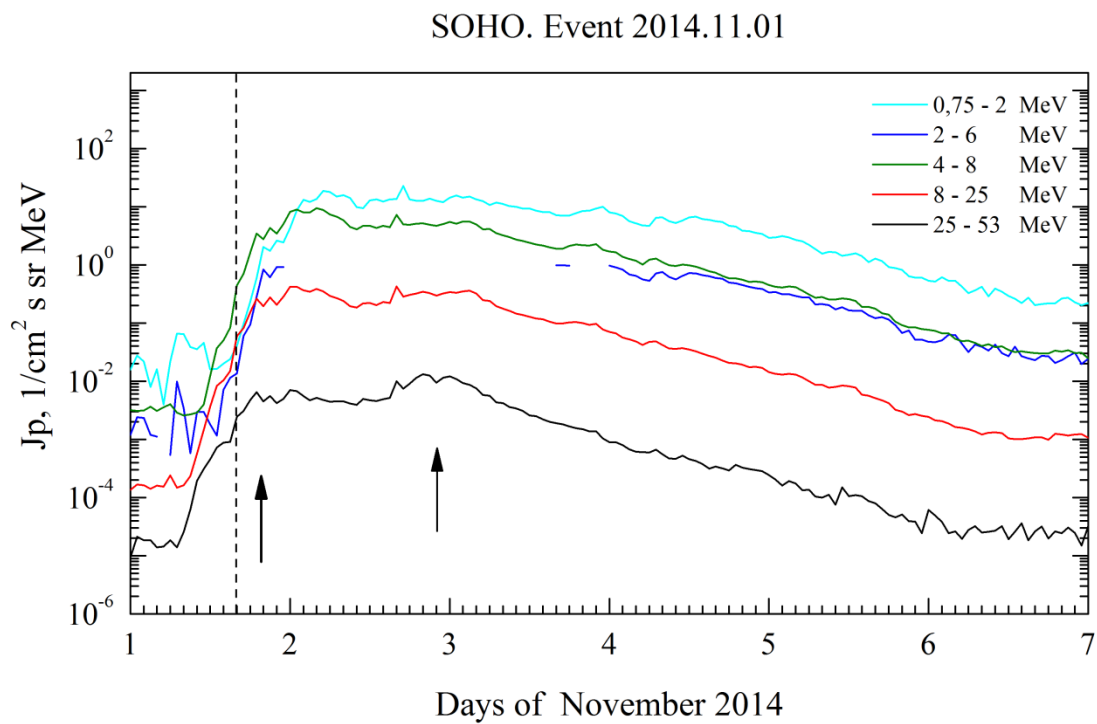
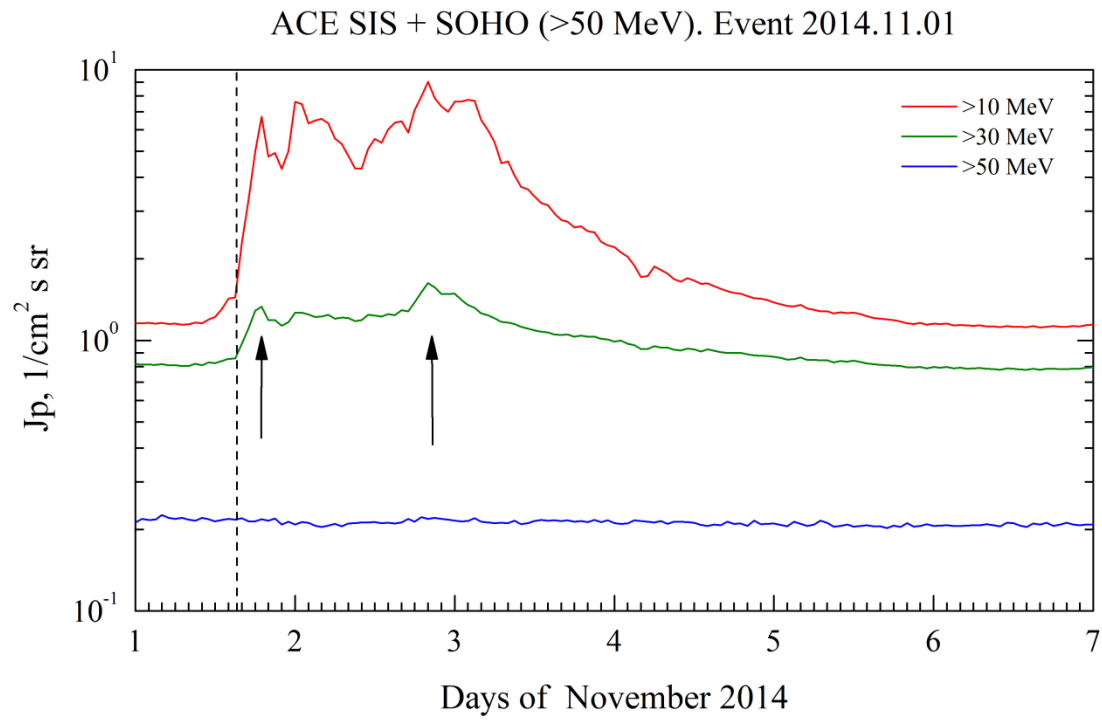
Differential fluxes of protons for the event of 2014 November 01

S/c, instruments	Ep, MeV	To, ours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	16	20/02d19	2/13.8	6	0.04	
LION	2 – 6	17	20/02d20	0.82/2.2	6	0.003	
EPHIN	4 – 8	16	21/02d20	0.43/4.9	6	0.003	
EPHIN	8 – 25	16	21/02d20	0.28/0.34	5.5	0.0001	
EPHIN	25 – 53	16	19/02d20	0.0064/0.0125	4.5	0.00001	
Electro-1							
SCR-E	13.7–23	14	20/02d22	0.06/0.25	2	0.045	
SCR-E	23–42	14	20/02d22	0.012/0.057	2	0.02	
SCR-E	42–112	14	20/02d22	0.001/0.0036	2	0.004	



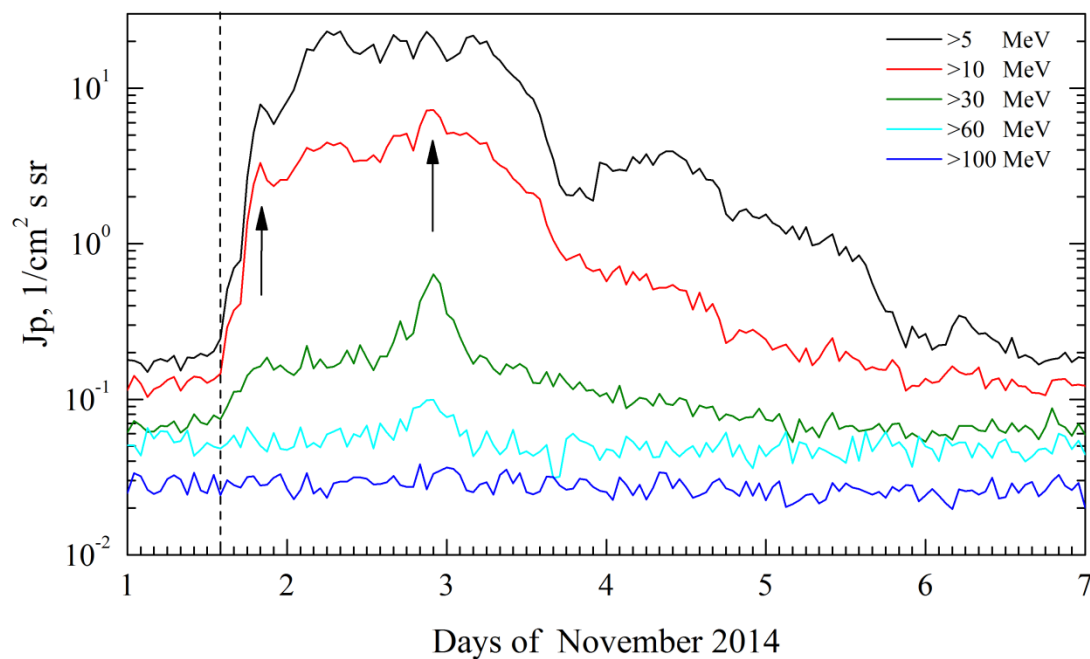
Time profiles of proton fluxes in the event 2014.11.01

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

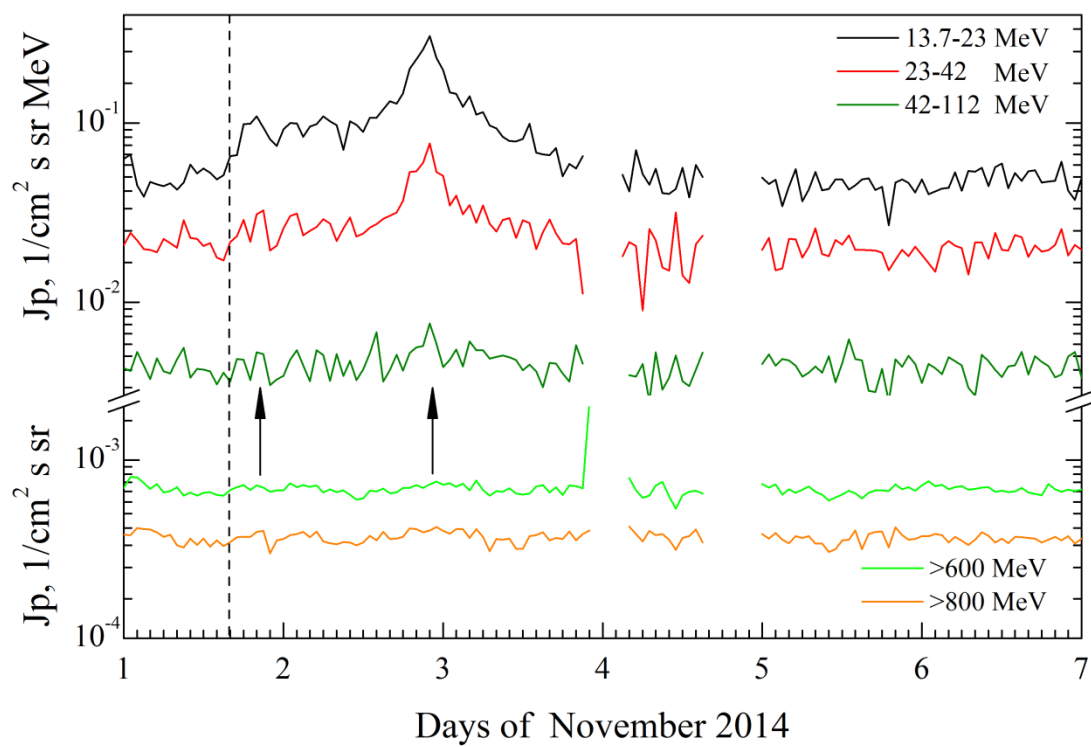


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2014.11.01

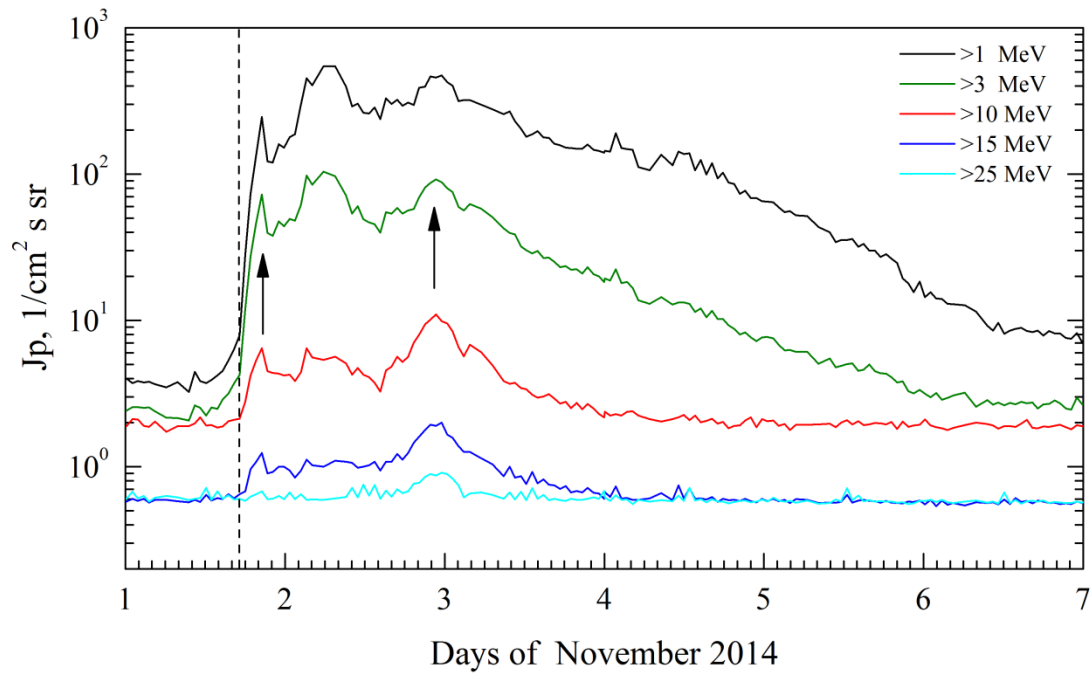


Electro. Event 2014.11.01

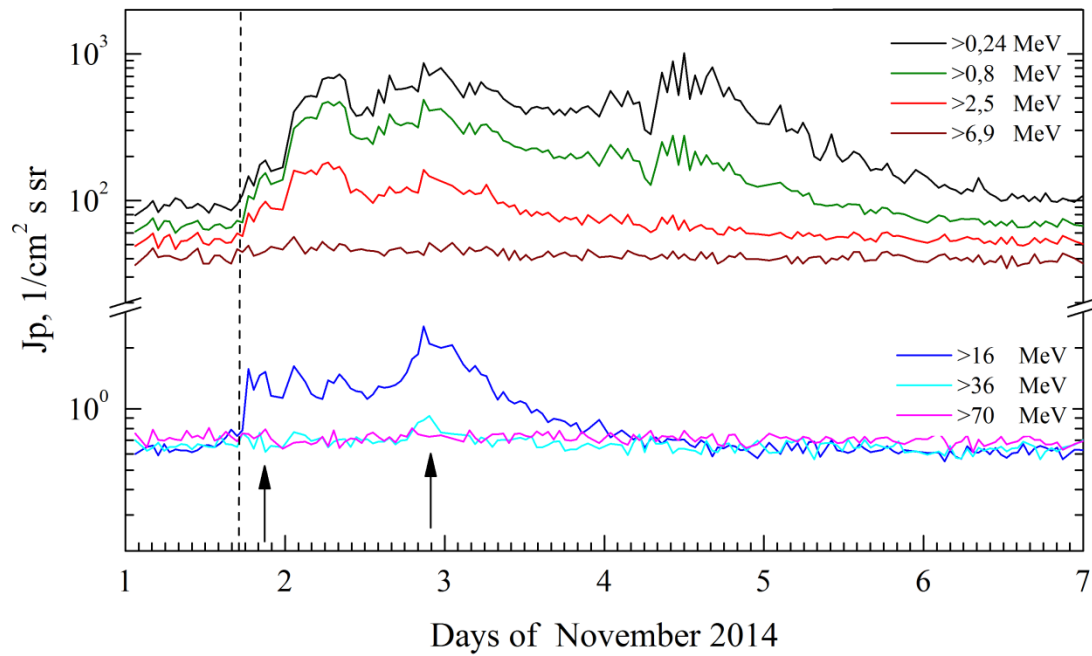


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.11.01



POES. Event 2014.11.01



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 November 01**

2014 November 01



AR XXXXX*

To event 560

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	DSF*	0403		0500	S30E54	16°	
6563 Å	EPL	0405		0515	E90	0.21	
6563 Å	FL	< 0507	0507	0512	S28E54	SF	PRB
6563 Å	FL	0534	0534	0539	S08E50	SF	
1 – 12	keV	0444	0534	0705	S22E52	C2.7	0.017
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS VI	61-180	0648		1007		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0500	1628	7.3	159°	125°	SOHO

*Spotless AR on SE-quadrant

https://sdowwww.lmsal.com/sdomedia/ssw/ssw_client/data/ssw_service_141101_005621_975/www/

References:

Gopalswamy N., S. Yashiro, N. Thakur et al., 2016.

Paassilta M., O. Raukunen, R. Vainio et al., 2017.

Richardson, I.G., T.T., von Rosenvinge, H.V. Cane, 2016.

Particle event: To($E_p > 10$ MeV) – 13d16^h

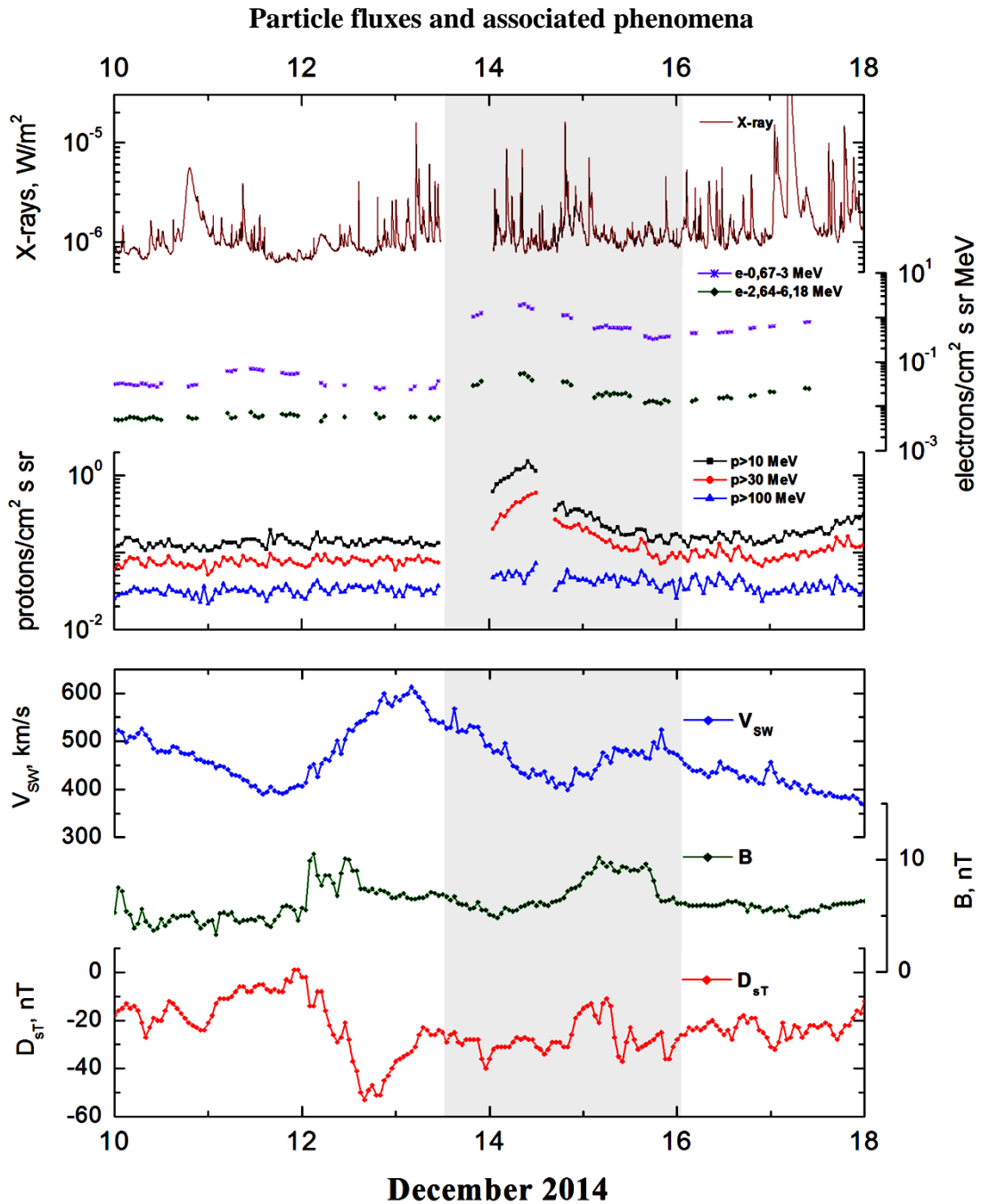
Tmax($E_p > 10$ MeV) – 14d11^h, Jmax($E_p > 10$ MeV) – 1.7 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 130$ MeV

Sources: ☐ solar flare 13d<14^h24^m, AR 12222, 3d behind W_L

CME: 13d14^h24^m, $V = 2222$ km/s, $\Delta\phi = 360^\circ$, $dA = 265^\circ$

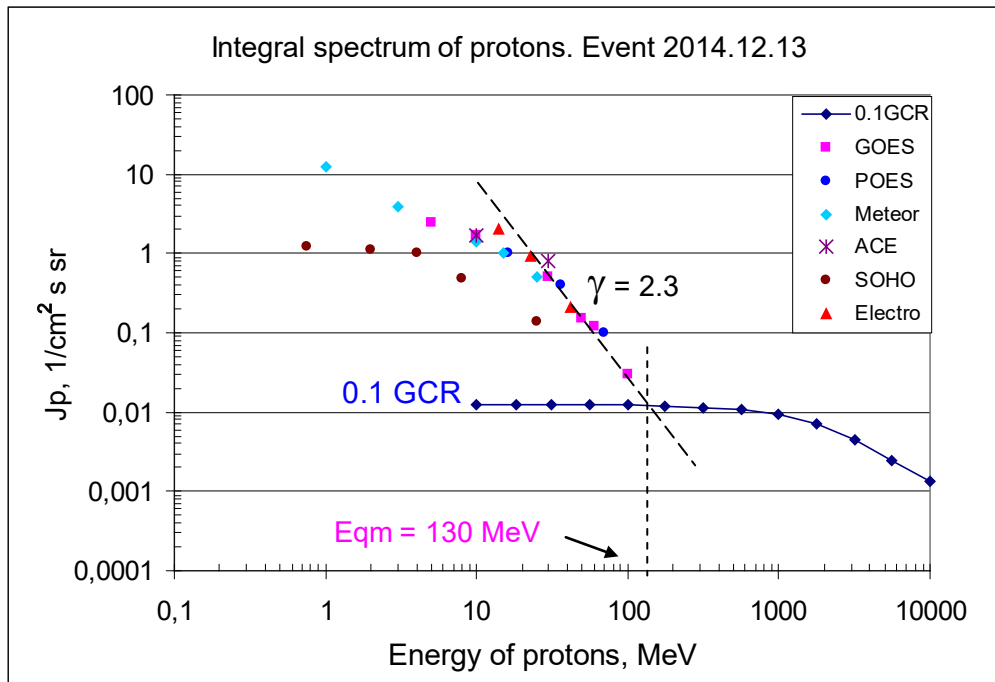


Integral fluxes of protons for the event of 2014 December 13

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	-	14d11	2.5	1.5	0.2	
EPS	>10	-	14d11	1.7	1.5	0.12	
EPS	>30	-	14d11	0.5	1.5	0.07	
EPS	>50	-	14d11	0.15	1.5	0.06	
EPS	>60	-	14d11	0.12	1.5	0.05	
EPS	>100	-	14d11	0.03	1.5	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	-	-	-	-	90	
MEPED	>0.8	-	-	-	-	70	
MEPED	>2.5	-	-	-	-	55	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	22	14d09	1	1	0.65	
MEPED	>36	22	14d09	0.4	1	0.7	
MEPED	>70	22	14d09	0.1	1	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-2							
SCR	>1	16	14d09	12.6	1.5	3.7	
SCR	>3	16	14d11	3.9	1.5	2.5	
SCR	>10	16	14d11	1.4	1.5	1.9	
GALS-M	>15	16	14d11	1	1.5	0.6	
GALS-M	>25	16	14d11	0.5	1.5	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	16	14d10	1.7	1.5	1.2	
SIS	>30	16	14d10	0.8	1.5	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2014 December 13

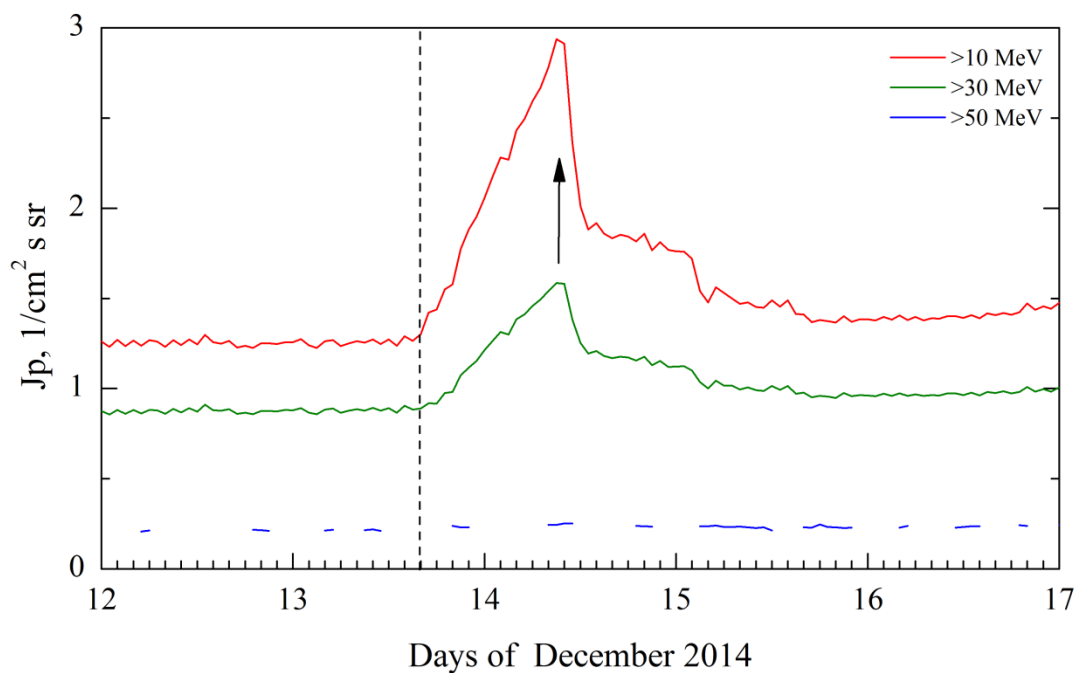
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	14d08	0.086	2	0.002	
LION	2 – 6	21	14d09	0.035	2	0.001	
EPHIN	4 – 8	21	14d10	0.13	2	0.001	
EPHIN	8 – 25	20	14d10	0.02	2	0.0003	
EPHIN	25 – 53	20	14d10	0.005	2	0.00002	
Electro-1							
SCR-E	13.7–23	14	14d10	0.11	2	0.05	
SCR-E	23–42	14	14d10	0.038	2	0.02	
SCR-E	42–112	14	14d10	0.003	1.5	0.004	



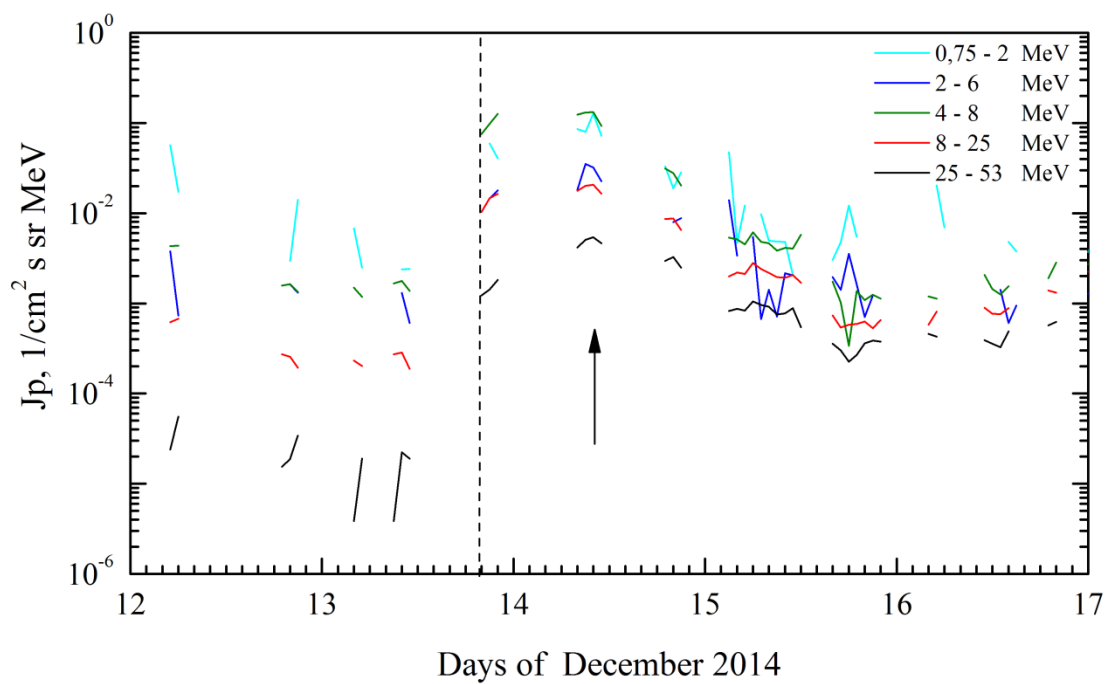
Time profiles of proton fluxes in the event 2014.12.13

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS + SOHO (>50 MeV). Event 2014.12.13

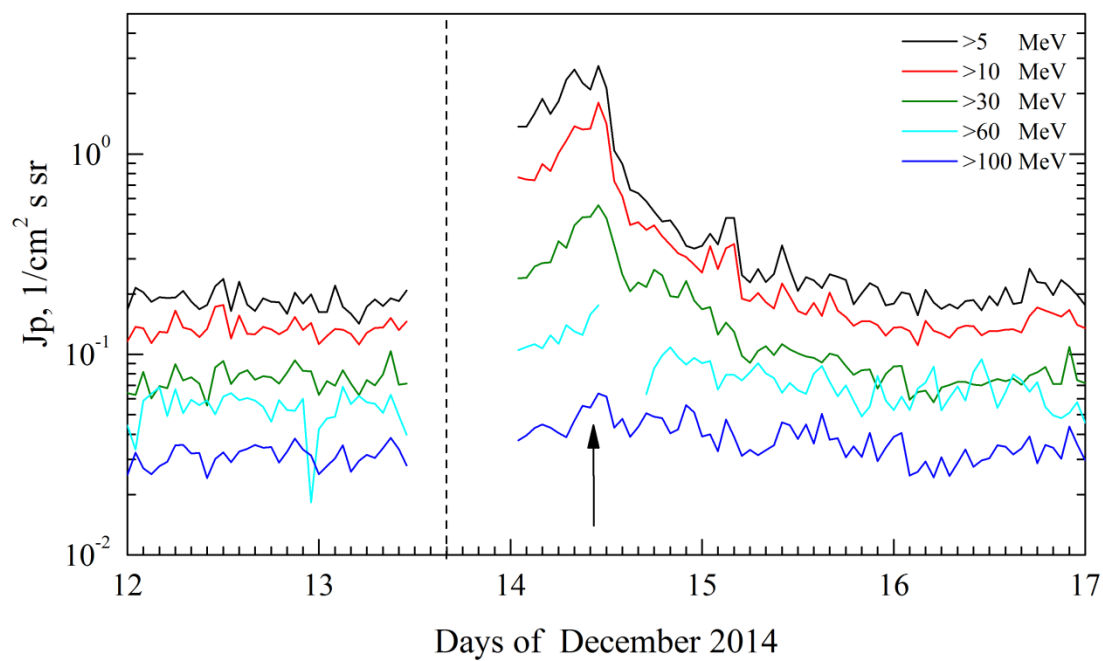


SOHO. Event 2014.12.13

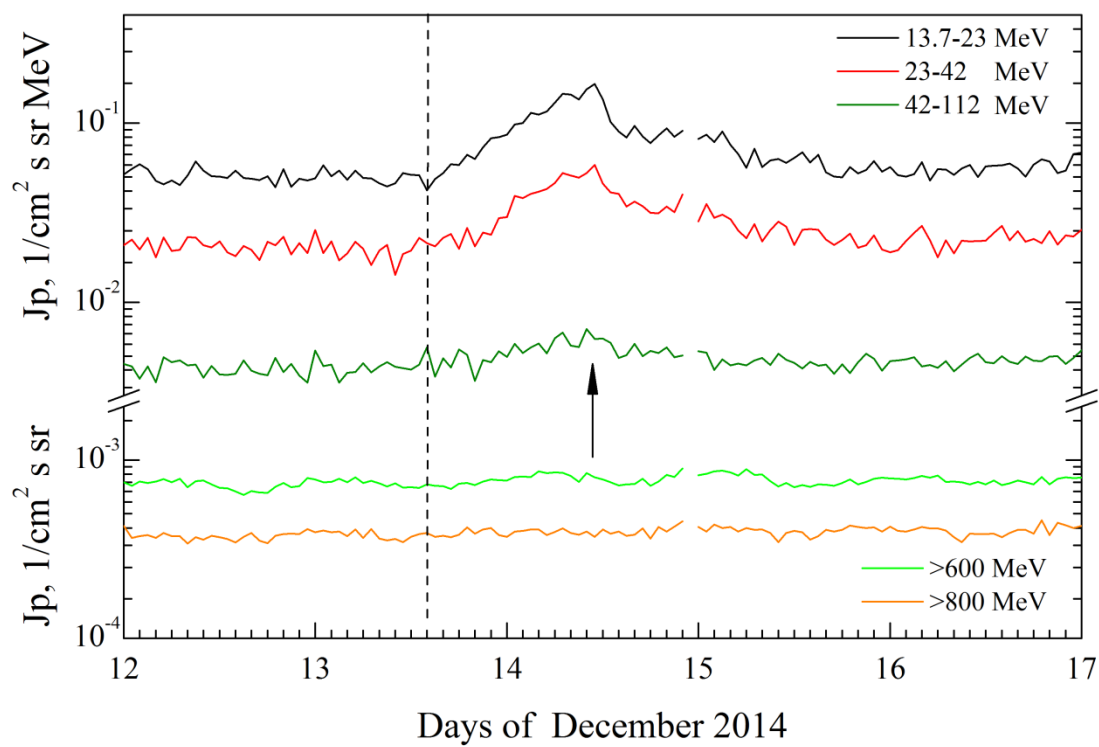


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.12.13

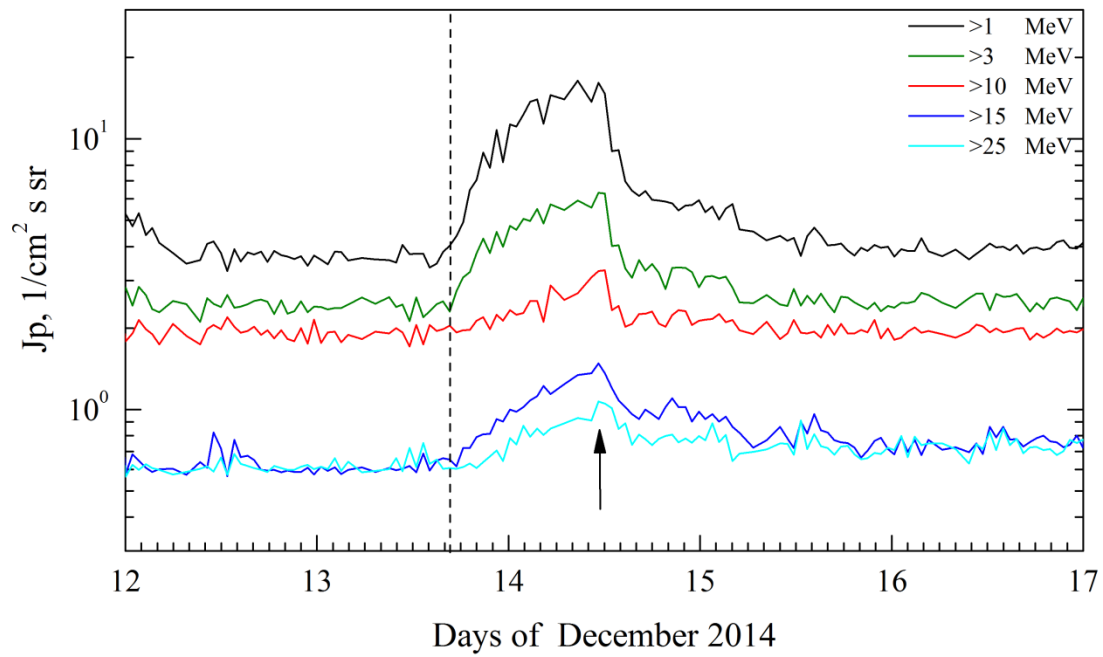


Electro. Event 2014.12.13

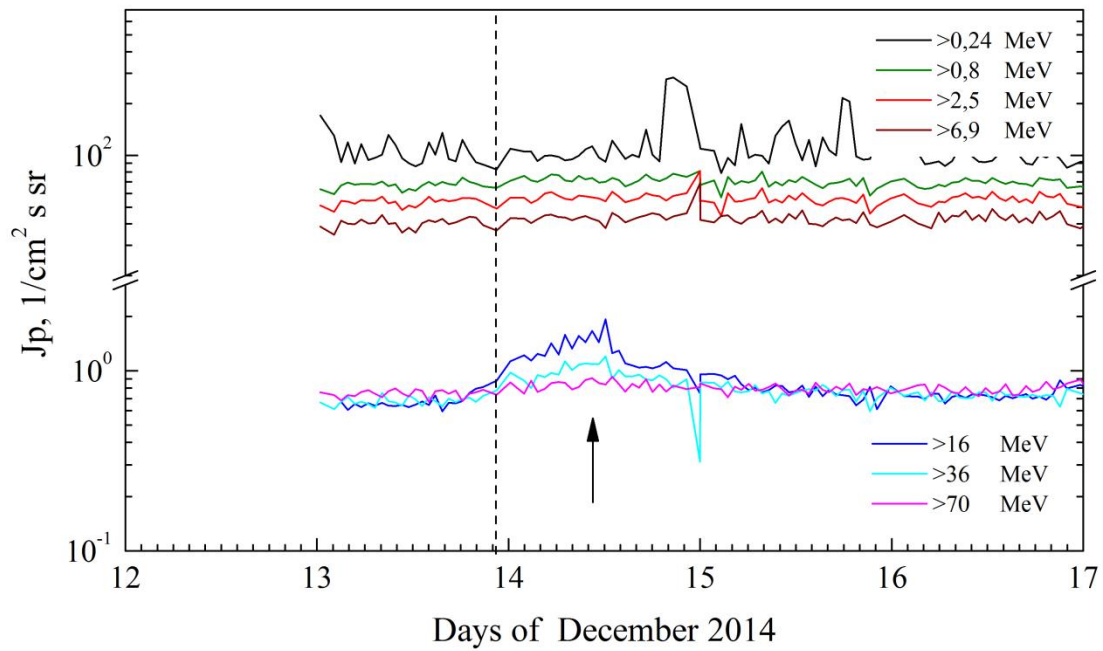


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.12.13



POES. Event 2014.12.13



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 December 13**

2014 December 13 ☐ AR 12222 To event 561

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	No optical event on visible solar disc						
1 – 12	No soft X-ray event on visible solar disc						
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1421:20	1433:14	1440:20	1179	2353513	HESSI
12-25	keV	1507:56	1509:26	1543:16	42	64884	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	107-180	1448		1451	955	2	
DH II	3.9-14	1427		1451			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1424	2222	- 84.4	360°	265°	SOHO

Proton Active Regions:

AR 12222 (S20L084, CMP 02,3.11.2014,
Sp=680 msh, EKC, BG)
XRI=1.07 M₅^{6.1}+C₅₅ 2₁+1₇+S₁₀₀
PFR 4-5.12 (30^h) M₃^{6.1}

References:

Richardson I.G., T.T. von Rosenvinge, H.V. Cane, [2016](#).

Particle event: To($E_p > 10$ MeV) – 21d08^h

Tmax($E_p > 10$ MeV) – 21d21^h, Jmax($E_p > 10$ MeV) – $2.4 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 1.5 days, power-law index: $\gamma = 3.1$

Quasimaximal energy of protons in the event – $E_{qm} = 55$ MeV

Sources: ● solar flare 21d11^h24^m, M1.0/, S13W25, AR12241

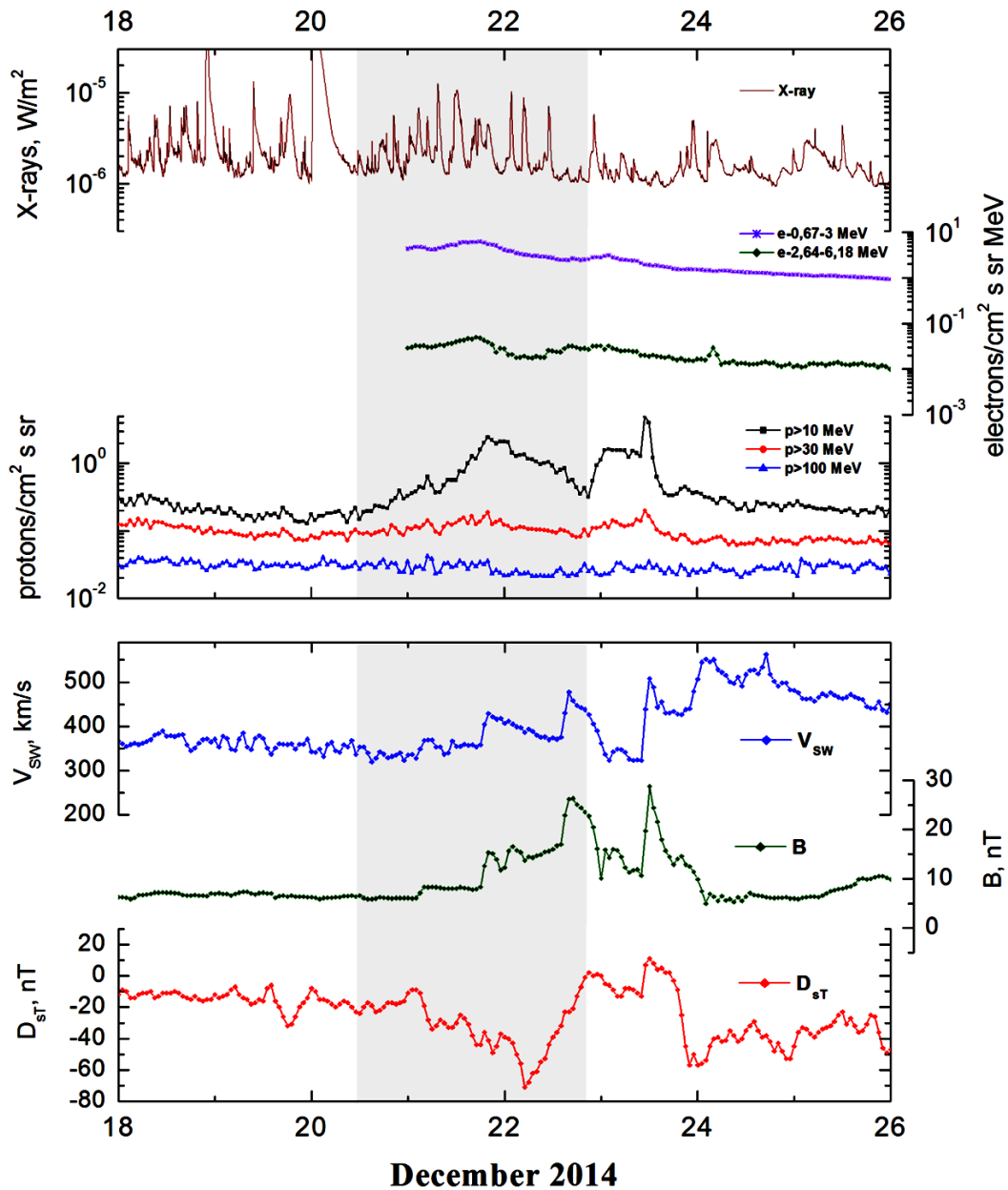
○ solar flare 20d00^h11^m, X1.8/3B, S21W24, AR12242

Main burst X-ray 1–8 Å: onset – 21d11^h24^m, max – 21d12^h17^m, $\Phi = 0.046 \text{ J/m}^2$

CME: 21d12^h12^m, $V = 669 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 189^\circ$

▲ SC 21d19^h11^m, ▲ SC 22d15^h11^m

Particle fluxes and associated phenomena

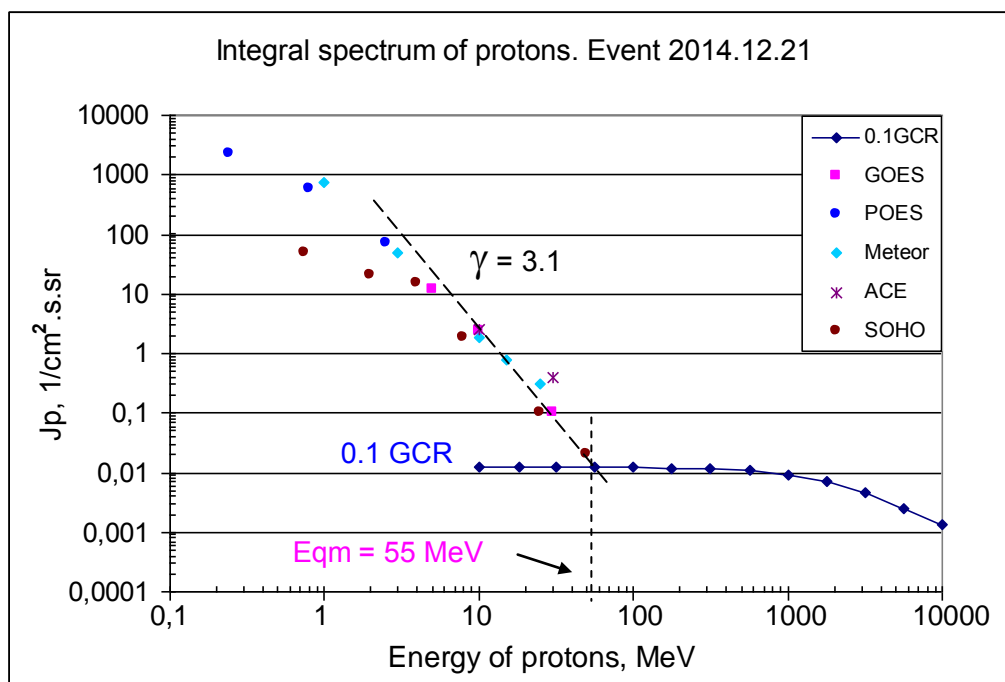


Integral fluxes of protons for the event of 2014 December 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	8	22	12	1.5	0.2	
EPS	>10	8	21	2.4	1.5	0.12	
EPS	>30	8	20	0.1	1.5	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	14	22d04	2200	1	90	
MEPED	>0.8	14	22d04	600	1	70	
MEPED	>2.5	14	22d04	70	1	55	
MEPED	>6.9	-	-	-	-	40	
MEPED	>16	-	-	-	-	0.65	
MEPED	>36	-	-	-	-	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-2							
SCR	>1	9	22d01	755	2.5	3.7	
SCR	>3	9	22d01	50	2.5	2.5	
SCR	>10	9	22	1.9	1.5	1.9	
GALS-M	>15	9	21	0.8	1.5	0.6	
GALS-M	>25	9	21	0.3	1	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	8	20	2.5	1.5	1.2	
SIS	>30	8	19	0.4	1.5	1	
SOHO							
EPHIN	>50	-	17	0.02	-	0.2	

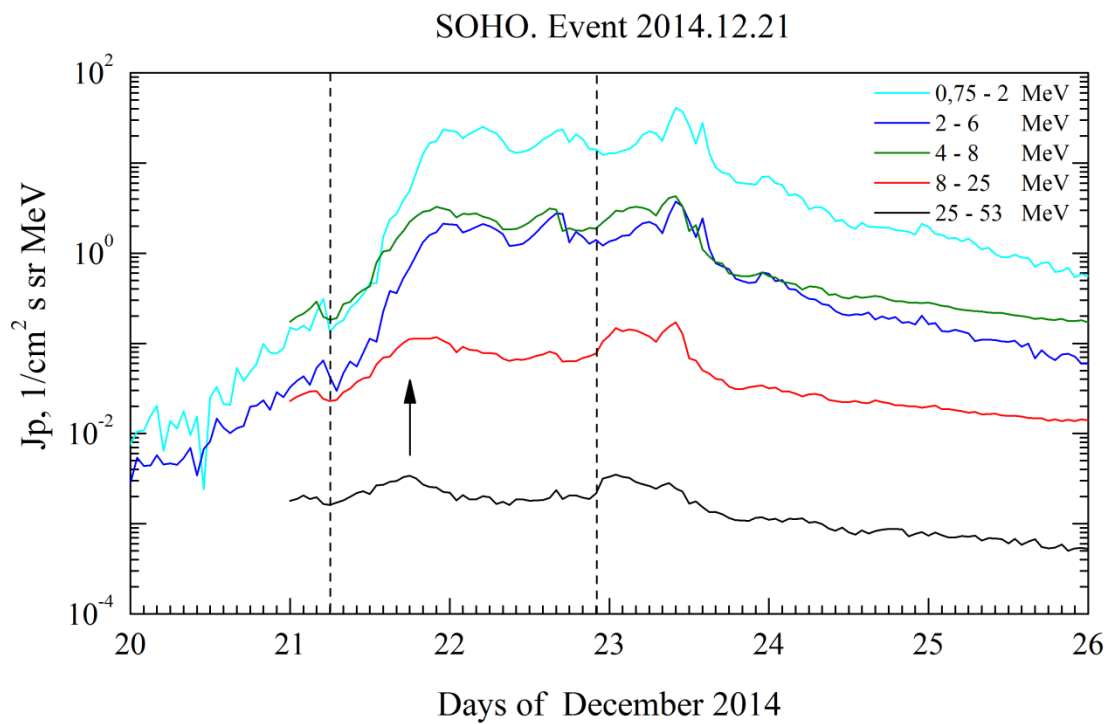
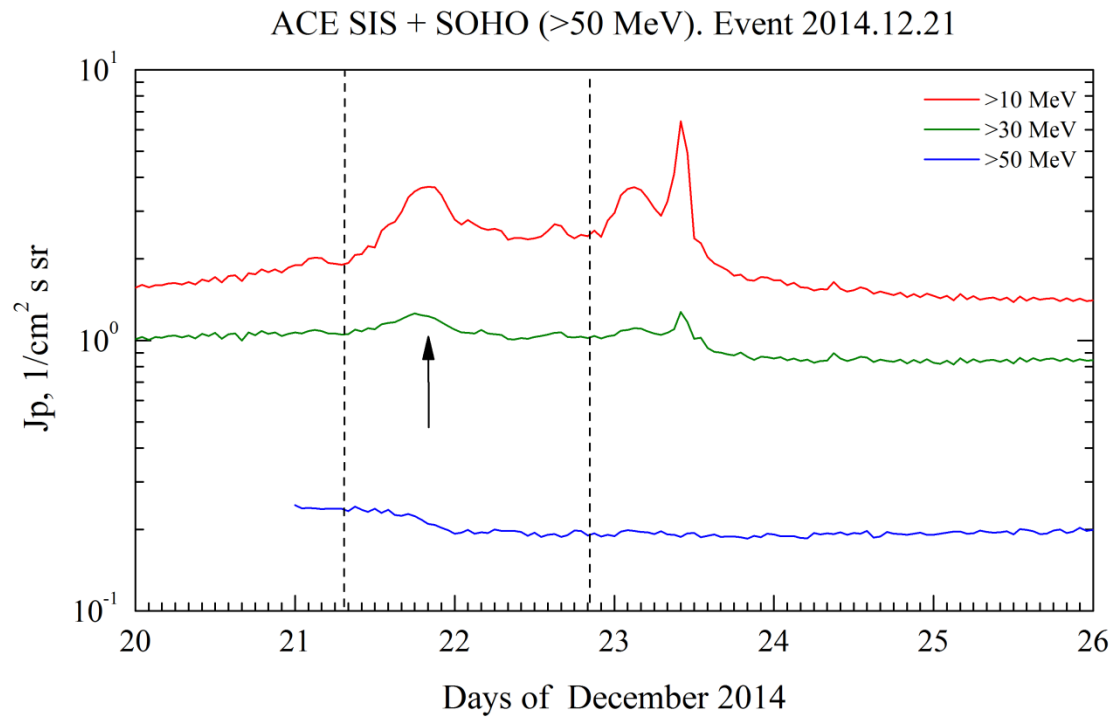
Differential fluxes of protons for the event of 2014 December 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	20d00	23	23.5	1.5	0.002	
LION	2 – 6	20d00	23	2.12	1.5	0.001	
EPHIN	4 – 8	<21d00	22	3.27	1.5	0.001	
EPHIN	8 – 25	<21d00	17	0.1	1.5	0.0003	
EPHIN	25 – 53	<21d00	17	0.003	1.5	0.00002	
Electro-1							
SCR-E	13.7–23	12	-	-	1	0.05	
SCR-E	23–42	12	-	-	1	0.02	
SCR-E	42–112	12	-	-	1	0.004	



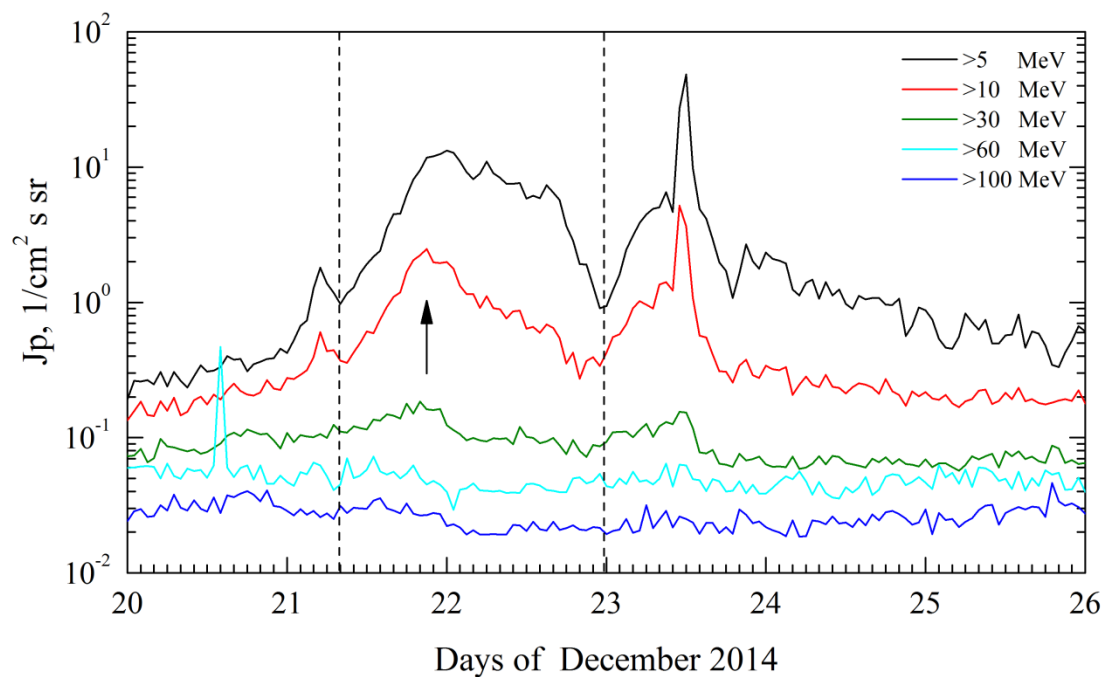
Time profiles of proton fluxes in the event 2014.12.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

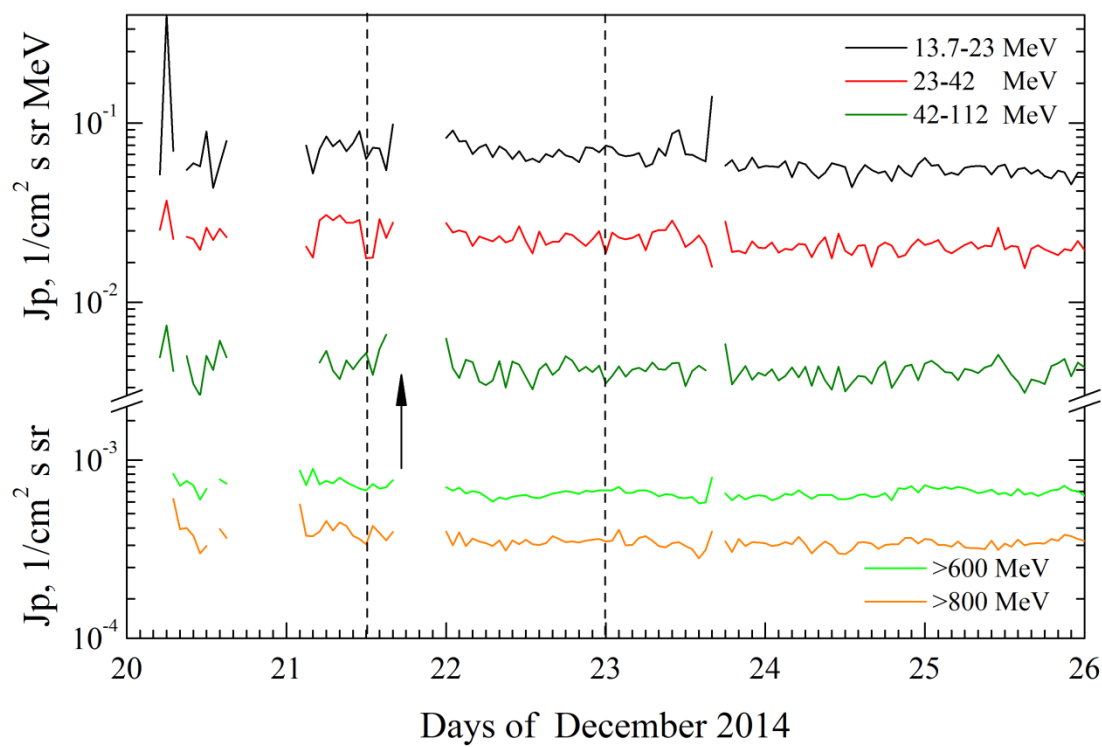


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2014.12.21

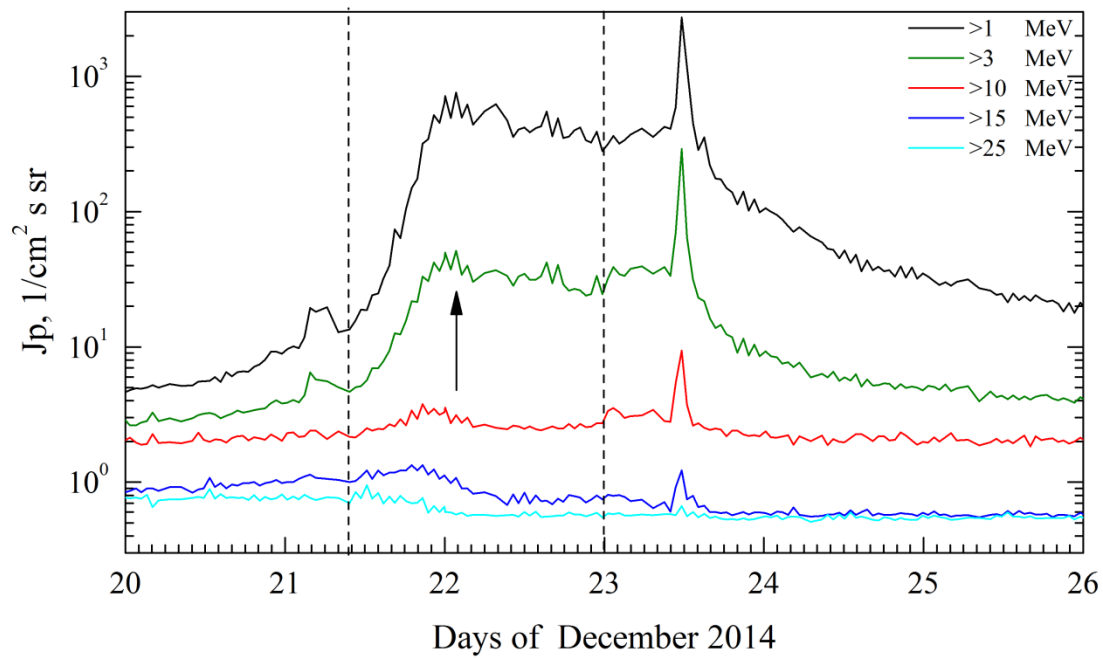


Electro. Event 2014.12.21

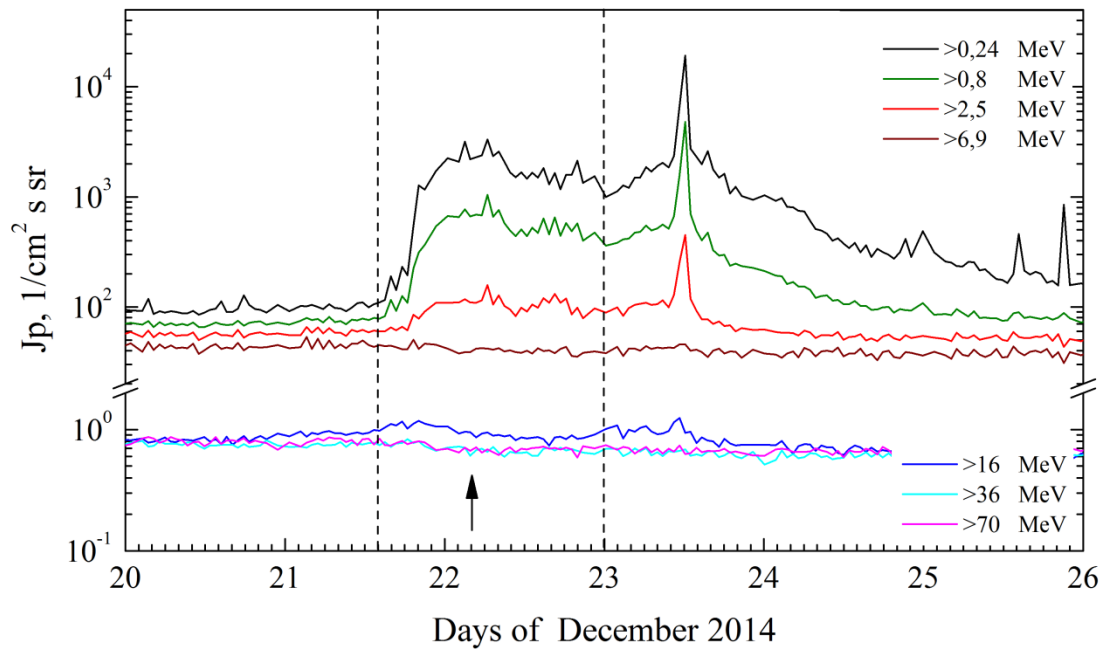


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2014.12.21



POES. Event 2014.12.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 December 21**

2014 December 21

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AR 12241

To event 562

WL, X-ray		To	Tmax	Te	Location	Importance	Class; Φ , J/m ²
6563 Å	FL	No optical flare on visible solar disk					
1 – 12	keV	1124	1217	1257	S13W25	M1.0	0.046
X-ray		To	Tmax	Te	Npeak, counts	Total counts	Sp/c
25-50	keV	1151:12	1139:54	1149:28	48	17101	HESSI
25-50	keV	1149:28	1200:10	1233:56	53	406328	HESSI
12-25	keV	11:21:21	1136:10	1139:27	7631	935065	FERMI
12-25	keV	12:15:54	12:24:22	12:35:09	2138	443580	FERMI
12-25	keV	1252:18	1259:44	1307:48	7228	250349	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
1.4	GHz	1209	1209	1210		2.0	
410	MHz	1154	1155	1157		2.52	
245	MHz	1154	1155	1202		2.73	
SP-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS VI	25-180	1121		1202		2	
DS CTM	46-180	1226		2101		2	
DH II	7.4-14	1205		1228			WIHD
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1212	669	- 13.0	360°	189°	SOHO

2014

December 20

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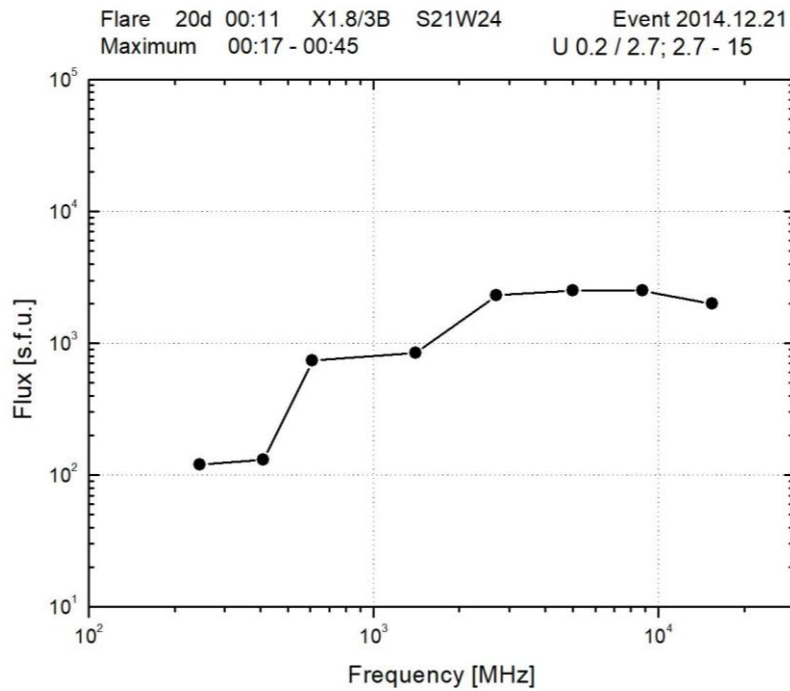
AR 12242

To event 562

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0012	0026	0241	S21W24	3B*	UMB
1 – 12	keV	0011	0028	0055	S19W29	X1.8	0.27
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0013:526	0025:22	0036:02	902259	740384704	FERMI
12-25	keV	0118:31	0118:39	0216:53	49897	11627386	FERMI
100-300	keV	0034:44	0042:42	0052:40	8656	29856568	HESSI
100-300	keV	0052:40	0054:34	0140:56	7390	11842462	HESSI
100-300	keV	0210:12	0211:50	0246:48	80	388094	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0017	0022	0222		3.3	
8.8	GHz	0017	0021	0159		3.4	
5	GHz	0017	0022	0109		3.4	
2.7	GHz	0018	0024	0100	2.7 – 15	3.36	
1.4	GHz	0022	0038	0038		2.92	
610	MHz	0027	0030	0039		2.87	
410	MHz	0038	0038	0041		2.11	
245	MHz	0045	0045	0045	U 0.2 / 2.7	2.08	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-75	0050		0107		1	
DS III	25-150	0035		0200		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0126	830	- 8.5	257°	197°	SOHO

*Contribution to the beginning of the event

Radio burst frequency spectrum



Proton Active Region:

AR12241 (S09L217, CMP 19,6.12.2014,
Sp=720 msh, EKC, BGD, R)
XRI=1.19 $M_5^{6.9}+C_{20}$ $2_2+1_3+S_{49}$
PFR 17-18.12 (27^h) $M_2^{6.9}$

AR 12242 (S18L237, CMP 17,9.12.2014,
Sp=1080 msh, EKC, BGD, R)
XRI=3.39 $X_1^{1.8}+M_6^{8.7}+C_{51}$ $3_1+2_1+1_{11}+S_{91}$
PFR1 17.12 (3^h) $M_2^{8.7}$
PFR2 19-20.12 (14^h) $X_1^{1.8}+M_1$
Complex of active regions: AR12241+ AR 12242

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Particle event: To($E_p > 10$ MeV) – 23d00^h

Tmax($E_p > 10$ MeV) – 23d12^h, Jmax($E_p > 10$ MeV) – 5 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma = 3.4$

Quasimaximal energy of protons in the event – $E_{qm} = 50$ MeV

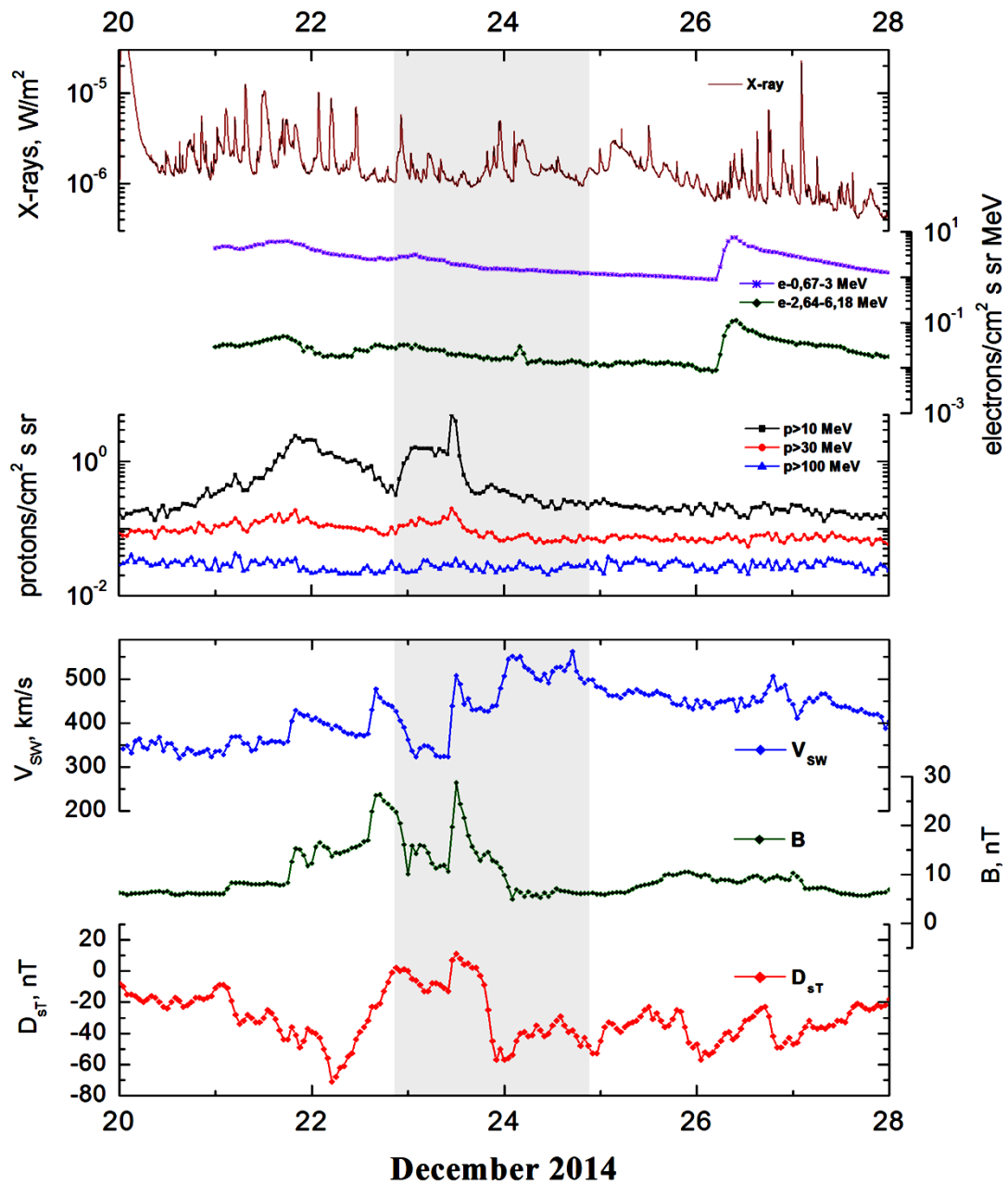
Sources: ☉ solar flare 22d21^h15^m, C5.7*, S19W71, AR12242

Main X-ray burst 1-8 Å: onset – 22d21^h15^m, max – 22d22^h25^m, $\Phi = 0.015$ J/m²

▲ SC 22d15^h11^m, ▲ SC 23d11^h15^m

* Long duration flare ($> 3^h$)

Particle fluxes and associated phenomena

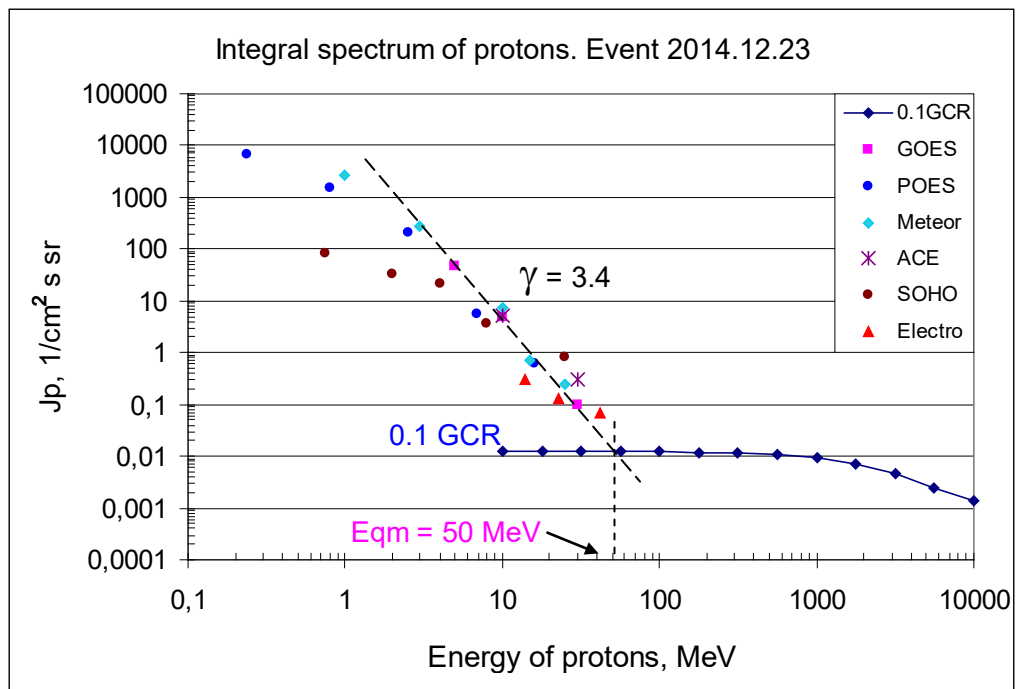


Integral fluxes of protons for the event of 2014 December 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	0	12	48	2	0.2	
EPS	>10	0	12	5	2	0.12	
EPS	>30	0	12	0.1	2	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>0.24	1	11	6550	3	120	
MEPED	>0.8	1	11	1500	2	80	
MEPED	>2.5	1	11	210	1	50	
MEPED	>6.9	1	11	5.6	-	40	
MEPED	>16	1	11	0.6	-	0.65	
MEPED	>36	-	-	-	-	0.7	
MEPED	>70	-	-	-	-	0.75	
MEPED	>140	-	-	-	-	1	
Meteor-2							
SCR	>1	24	12	2640	1	3.7	
SCR	>3	24	12	280	1	2.5	
SCR	>10	24	12	7.4	0.5	1.9	
GALS-M	>15	24	11	0.7	0.5	0.6	
GALS-M	>25	24	11	0.25	0.25	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	22d22	10	5.2	1.5	1.2	
SIS	>30	22d22	10	0.3	1	1	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

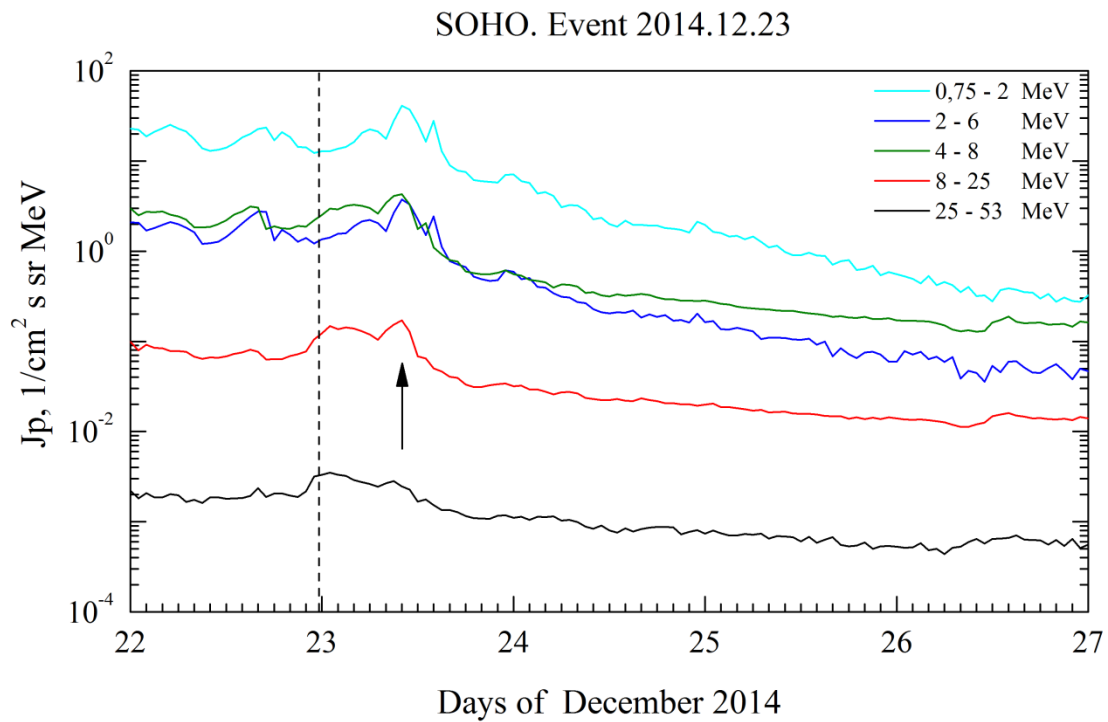
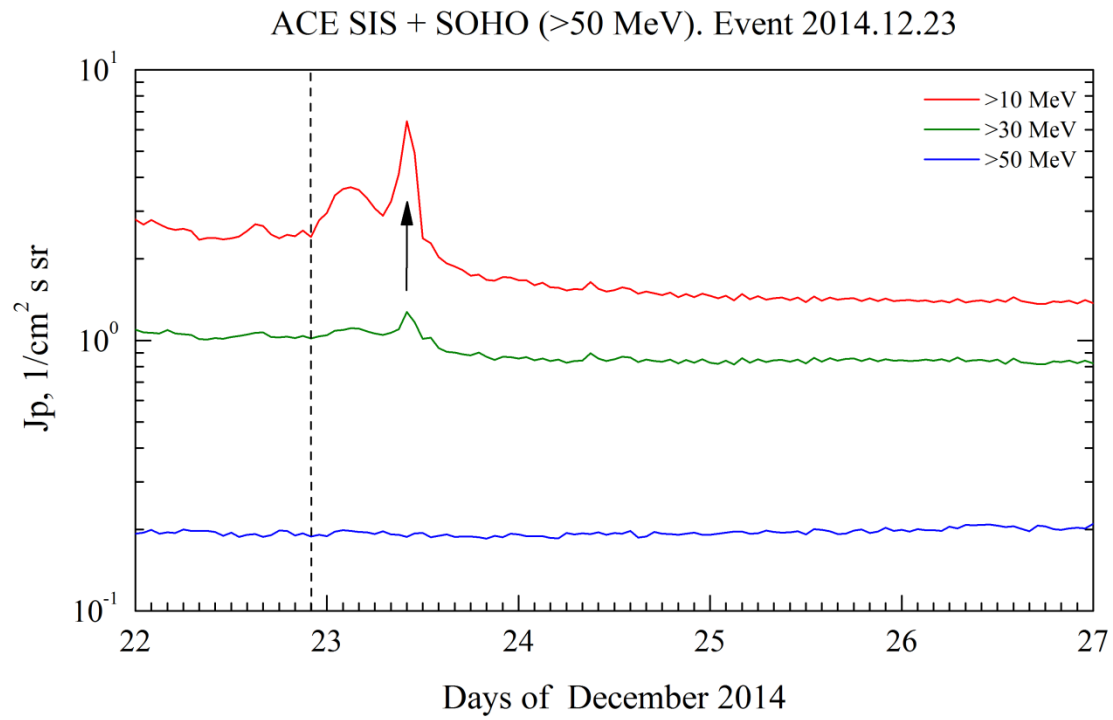
Differential fluxes of protons for the event of 2014 December 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	00	10	41.2	1	0.002	
LION	2 – 6	00	10	3.74	1	0.001	
EPHIN	4 – 8	00	10	4.28	1	0.001	
EPHIN	8 – 25	00	10	0.17	1	0.0003	
EPHIN	25 – 53	00	09	0.028	1	0.00002	
Electro-1							
SCR-E	13.7–23	5	11	0.02	1	0.07	
SCR-E	23–42	5	11	0.003	1	0.025	
SCR-E	42–112	-	11	0.001	-	0.004	



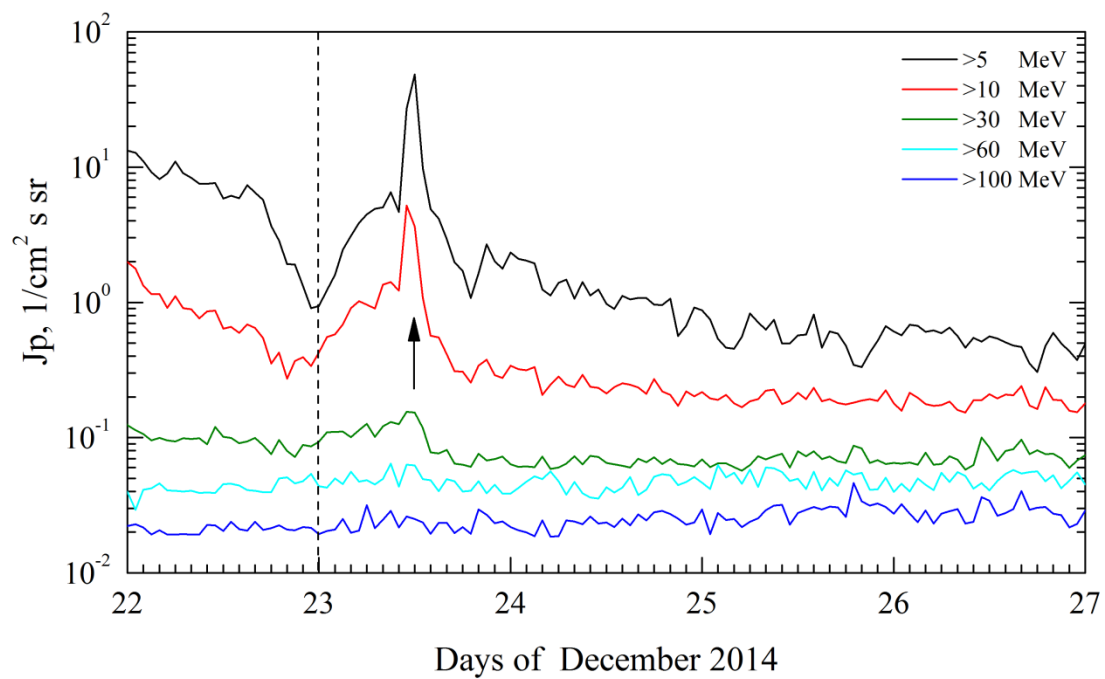
Time profiles of proton fluxes in the event 2014.12.23

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

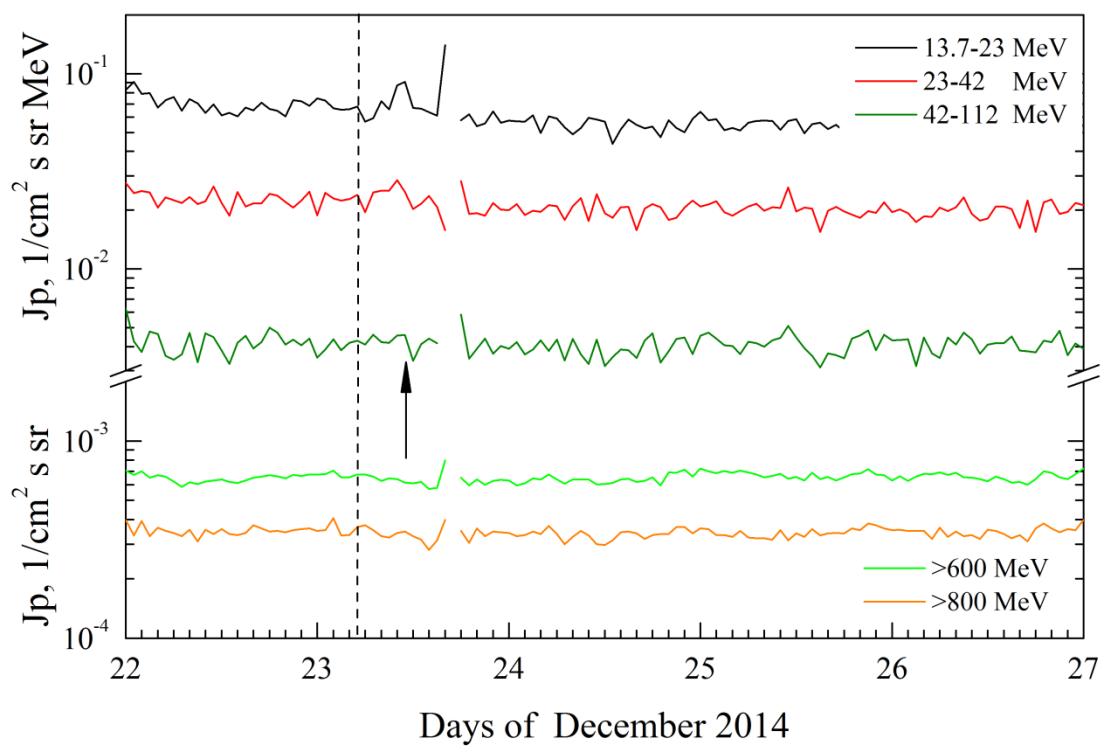


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2014.12.23

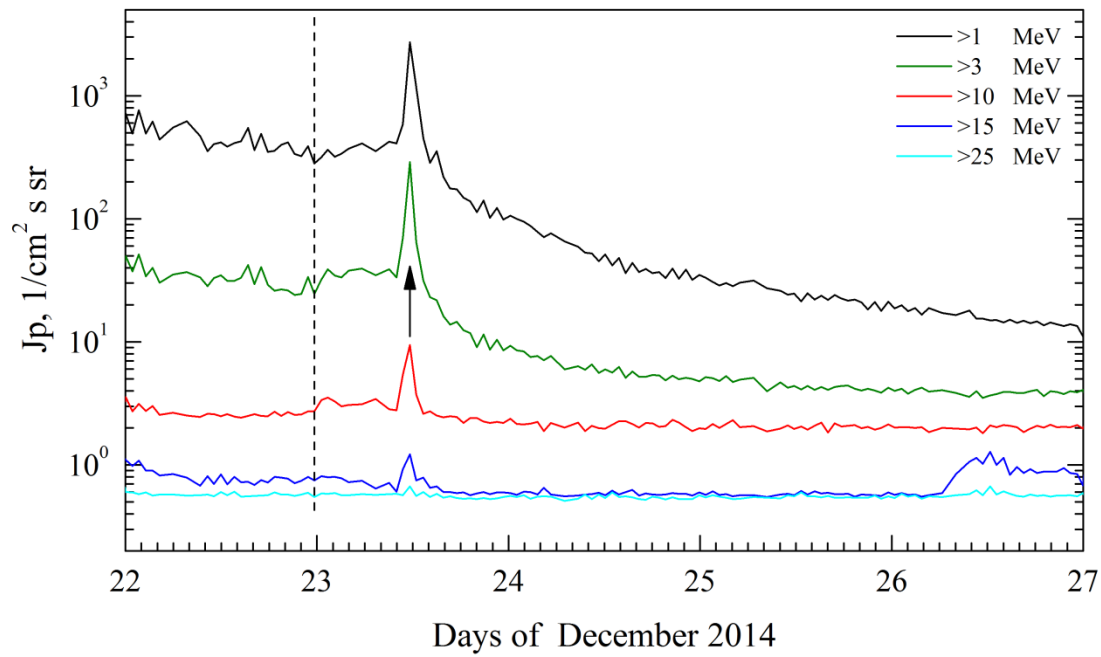


Electro. Event 2014.12.23

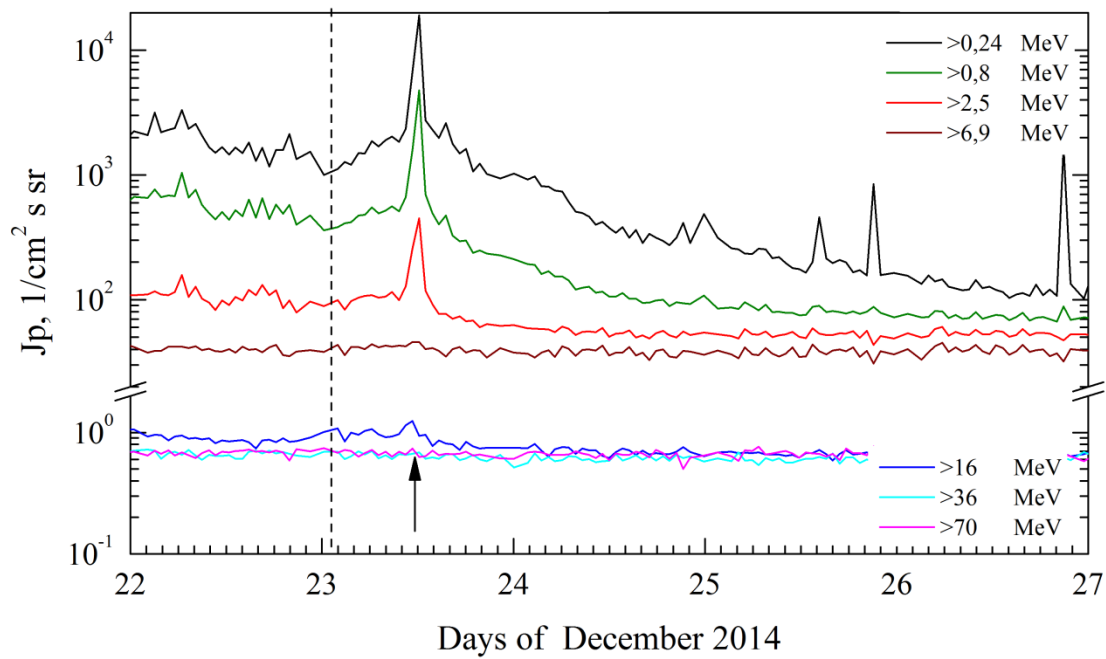


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2014.12.23



POES. Event 2014.12.23



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2014 December 23**

2014 December 22 ☉ AR 12242 To event 563

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No flare on visible disk					
1 – 12	keV	2115	2225	2239	S17W71	C5.7	0.015
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	2110:40	2120:38	2123:48	256	458960	HESSI
25 – 50	keV	2213:32	2217:54	2244:04	152	424362	HESSI
12 – 25	keV	2210:03	2218:07	2223:06	6761	678448	FERMI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS CTM	72-180	2156		2359		1	

Proton Active Region:

AR 12242 (S18L237, CMP 17,9.12.2014,
 Sp=1080 msh, EKC, BGD, R)
 XRI=3.39 X₁^{1.8}+M₆^{8.7}+C₅₁ 3₁+2₁+1₁₁+S₉₁
 PFR1 17.12 (3^h) M₂^{8.7}
 PFR2 19-20.12 (14^h) X₁^{1.8}+M₁

Events in 2015

			Page
1	*Event 2015.01.27 – (2015-027)	№ 564	750
2	Event 2015.02.21 – (2015-052)	№ 565	758
3	Event 2015.03.15 – (2015-074)	№ 566	765
4	Event 2015.03.16 – (2015-075)	№ 567	772
5	*Event 2015.04.22 – (2015-112)	№ 568	780
6	Event 2015.05.12 – (2015-132)	№ 569	787
7	Event 2015.06.18 – (2015-169)	№ 570	794
8	Event 2015.06.21 – (2015-172)	№ 571	801
9	Event 2015.06.25 – (2015-176)	№ 572	811
10	Event 2015.07.01 – (2015-182)	№ 573	820
11	Event 2015.09.20 – (2015-263)	№ 574	827
12	*Event 2015.09.30 – (2015-273)	№ 575	835
13	*Event 2015.10.22 – (2015-295)	№ 576	843
14	Event 2015.10.29 – (2015-302)	№ 577	850
15	Event 2015.11.09 – (2015-313)	№ 578	857
16	Event 2015.12.28 – (2015-362)	№ 579	865

An asterisk (*) marks weak events with Jp ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To(Ep>10 MeV) – 27d19^h

Tmax₁(Ep>10 MeV) – 29d01^h, Jmax₁(Ep>10 MeV) – 0.5 /cm²·s·sr (ACE)

Tmax₂(Ep>10 MeV) – 30d19^h, Jmax₂(Ep>10 MeV) – 1.0 /cm²·s·sr (ACE)

Duration of the event – 4 days, power-law index: $\gamma_1 = 4.8$, $\gamma_2 = 2.4$

Quasimaximal energy of protons in the event – Eqm₁ = 20 MeV

– Eqm₂ = 60 MeV

Sources: ☐ solar flare 27d07^h13^m, C2.1/, N07E89, AR12277, 1d behind E_L

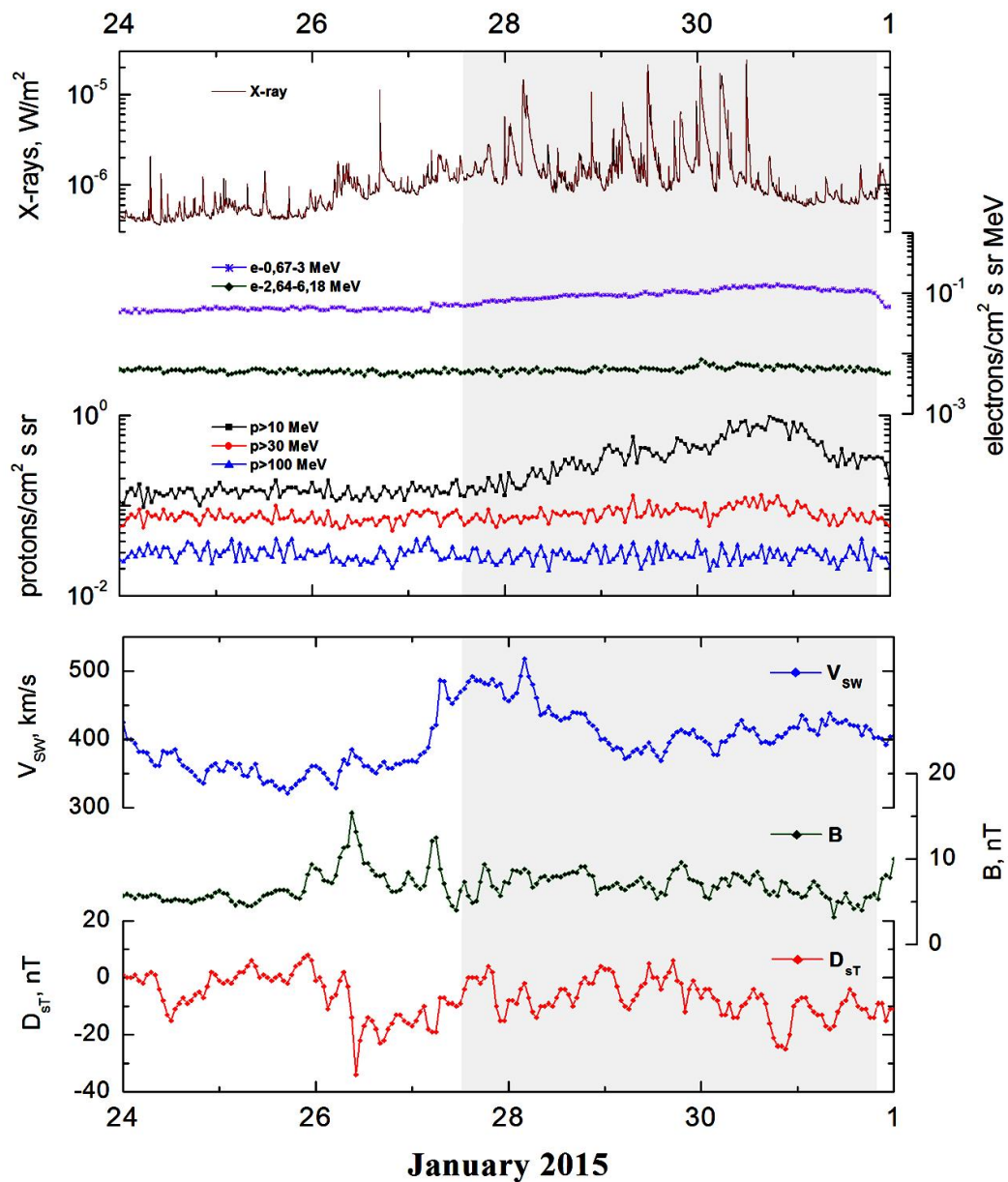
Ø solar flare 28d21^h32^m, M1.0/SF, N08E73, AR12277

Ø solar flare 30d12^h10^m, M2.4/, N07E52, AR12277

Main burst X-ray 1–8 Å: onset – 27d07^h13^m, max – 27d07^h33^m, $\Phi = 0.0086$ J/m²

CME: 27d08^h23^m, V = 332 km/s, $\Delta\phi = 009^\circ$, dA = 119°

Particle fluxes and associated phenomena

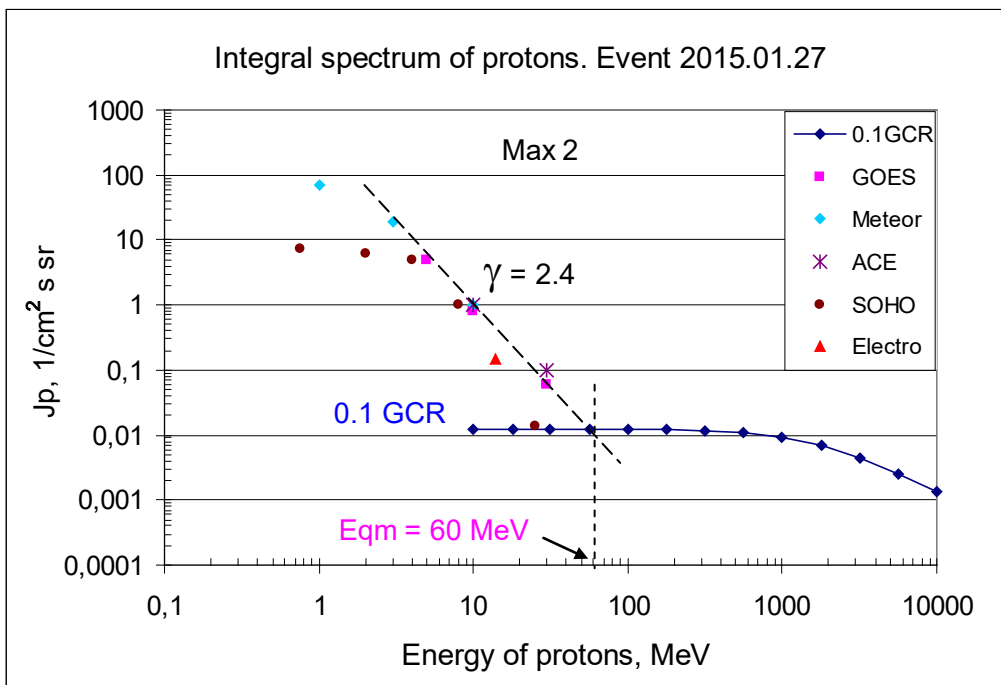
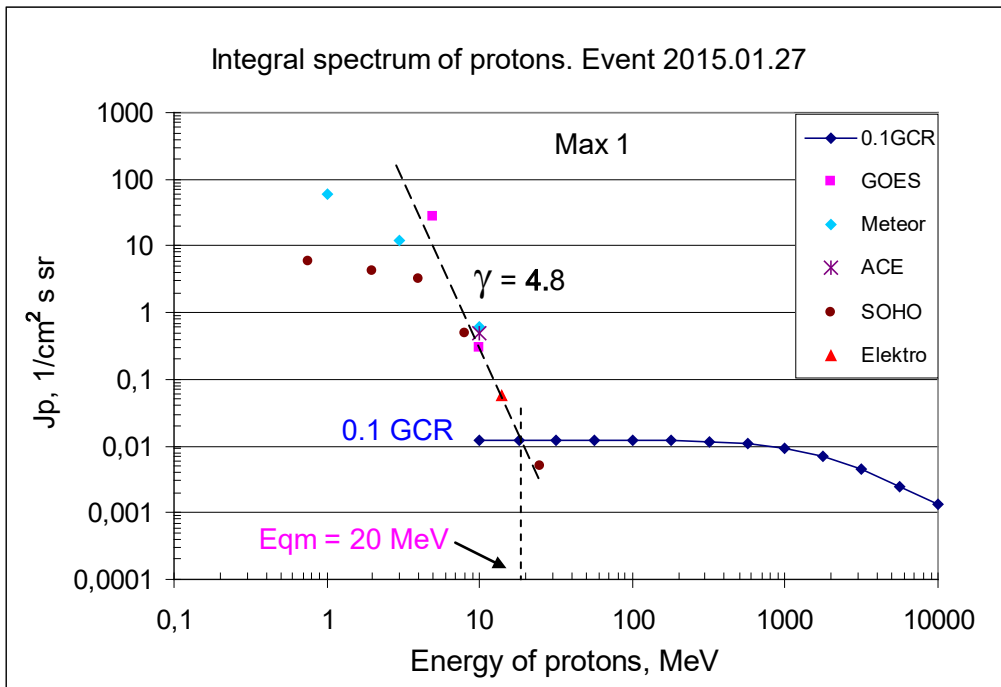


Integral fluxes of protons for the event of 2015 January 27

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	19	29d01/30d19	2.7/5	4	0.2	
EPS	>10	19	29d01/30d19	0.3/0.8	4	0.12	
EPS	>30	-	- /30d18	- /0.06	4	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR	>1	18	29d03/30d16	60/71	5	3.9	
SCR	>3	18	29d03/30d16	11/19	4.5	2.4	
SCR	>10	-	28d23 /30d18	0.6/1.04	-	1.9	
GALS-M	>15	-	-	-	-	0.6	
GALS-M	>25	-	-	-	-	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	17	29d17/30d19	0.5/1	4	1.2	
SIS	>30	17	- /30d19	- /0.1	4	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2015 January 27

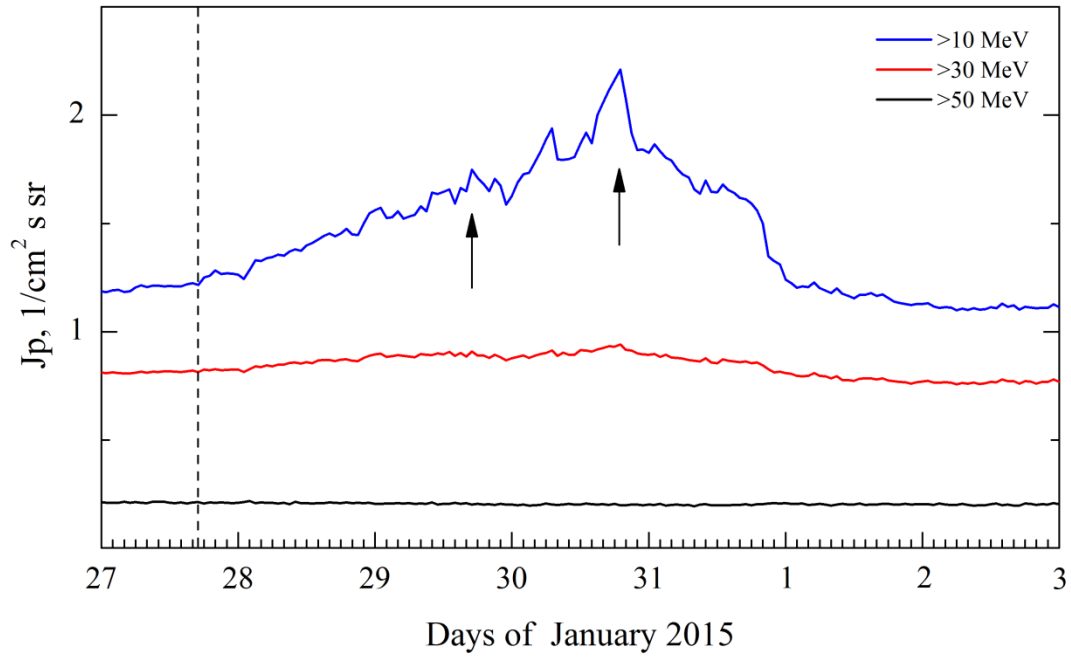
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	17	29d11/30d21	1.5/1.1	4	0.1	
LION	2 – 6	17	29d11/30d21	0.3/0.32	4	0.02	
EPHIN	4 – 8	17	29d12/30d21	0.7/1.02	4	0.05	
EPHIN	8 – 25	17	29d12/30d21	0.031/0.061	4	0.003	
EPHIN	25 – 53	17	29d13/30d11	0.00016/0.0005	4	0.00004	
Electro-1							
SCR-E	13.7-23	16	29d02/ -	0.01/ 0.016	-	0.045	
SCR-E	23-42	-	-	-	-	0.02	
SCR-E	42-112	-	-	-	-	0.004	
POES							
MEPED	16-36	-	-	-	-	0.033	
MEPED	36-70	-	-	-	-	0.005	
MEPED	70-140	-	-	-	-	0.0008	



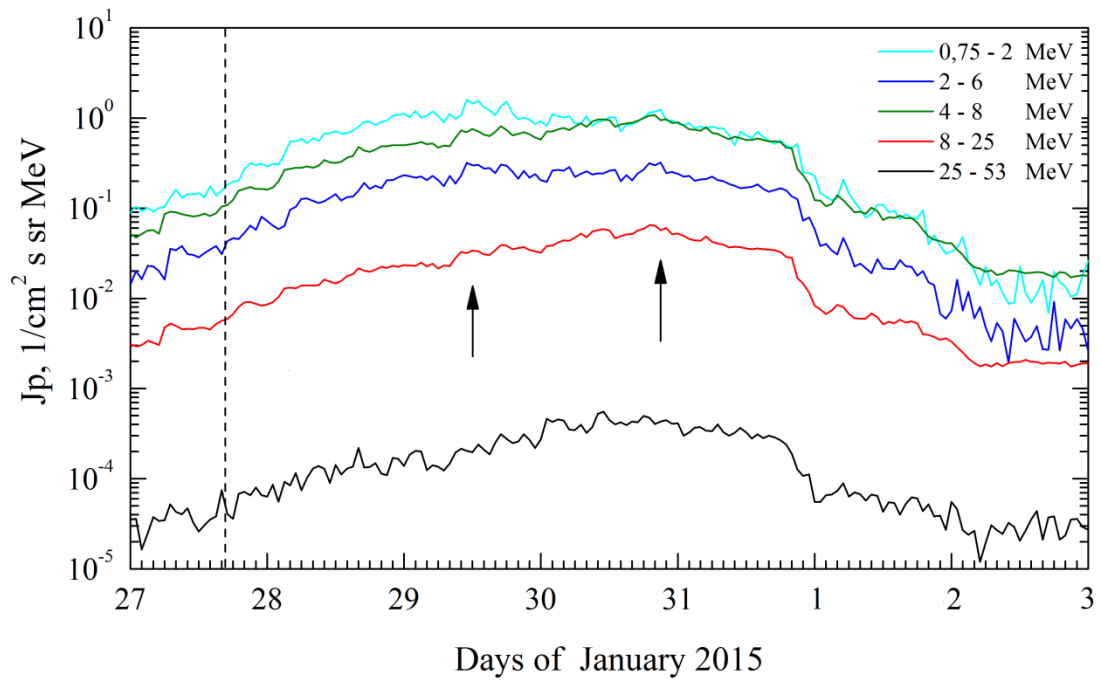
Time profiles of proton fluxes in the event 2015.01.27

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.01.27

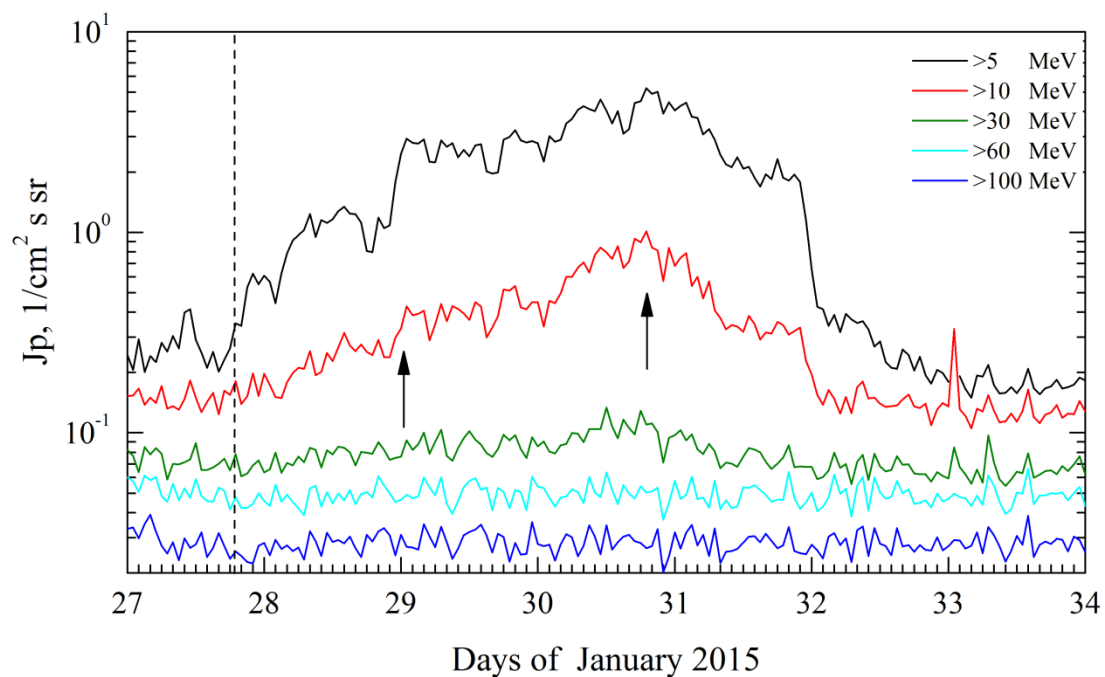


SOHO. Event 2015.01.27

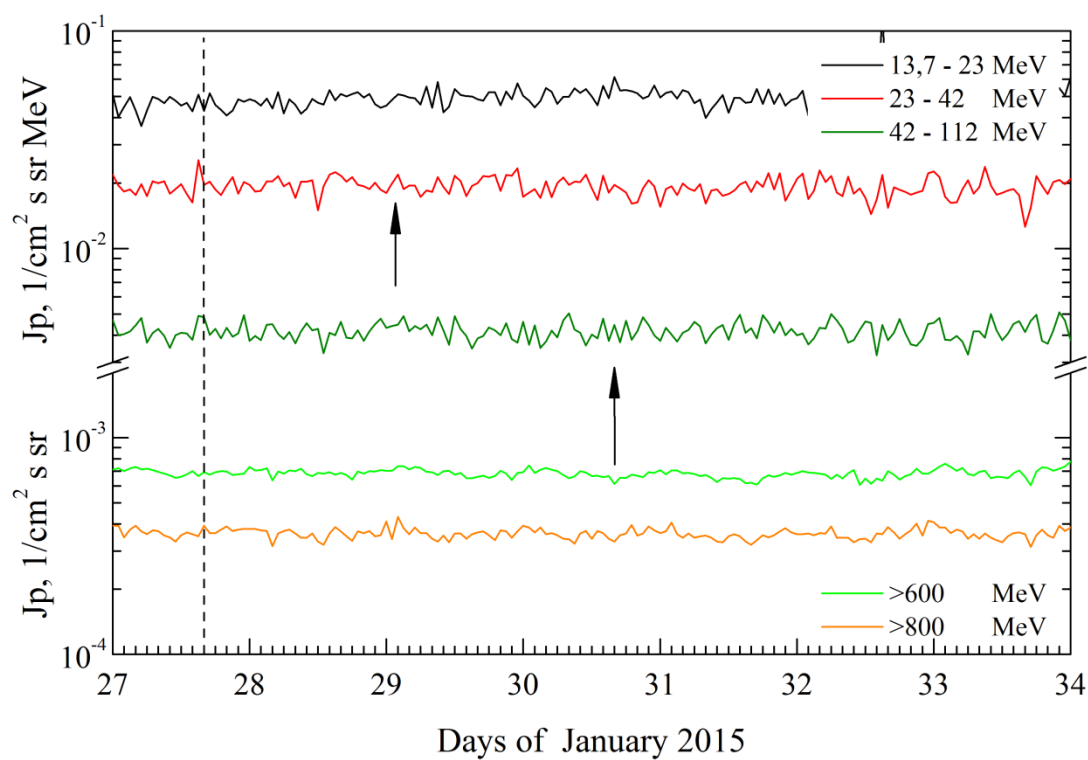


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2015.01.27

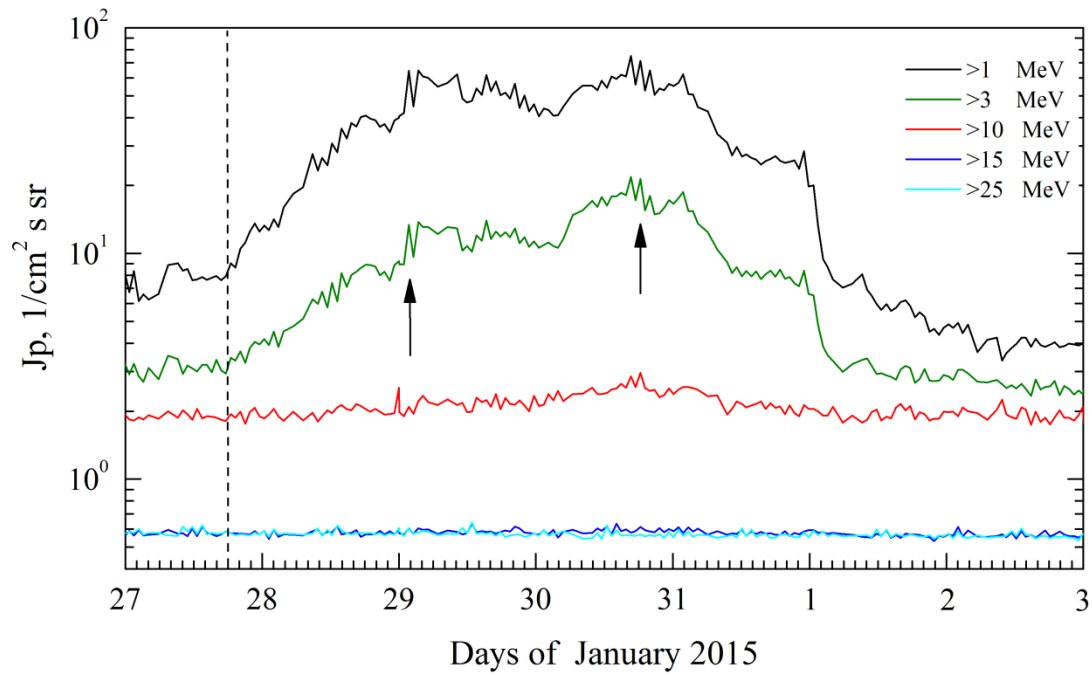


Electro. Event 2015.01.27

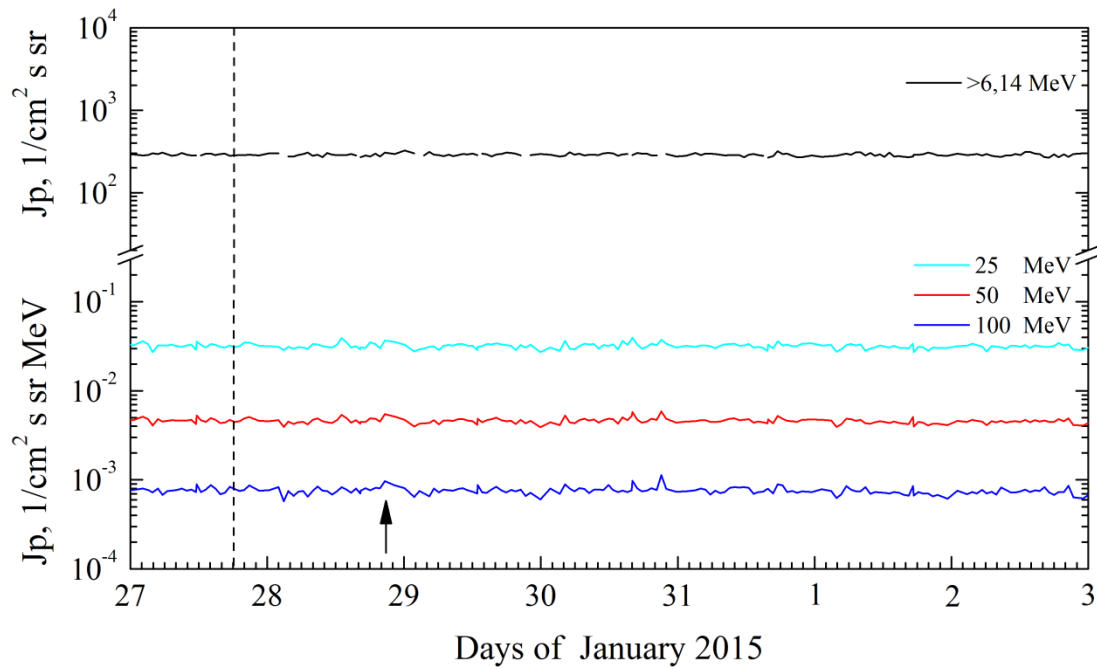


Earth satellites in polar orbit, $R = 800\div1000$ km: Meteor and POES

Meteor. Event 2015.01.27



POES. Event 2015.01.27



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 January 27**

2015 January 27 ☐ AR 12277 To event 564

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optic flare on the solar disk					
1 – 12	keV	0713	0733	0827	N07E89	C2.1	0.0086
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100 – 300	keV	0710:40	0717:38	0724:28		4159872	HESSI
12 – 25	keV	0724:28	0727:34	0742:44	1328	4663248	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	0823	0823	0823		2.04	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	75-171	0752		0755		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0823	332	- 15.7	9°	119°	SOHO

2015 January 28 Ø AR 12277 To event 564

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	2136	2138	2141	N08E73	SF	
1 – 12	keV	2132	2137	2140	N07E74	M1.0	0.0024
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
3 – 6	keV	2131:56	2136:54	2137:52	816	265183	HESSI
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2200	817	- 19.1	054°	120°	SOHO

2015

January 30

Ø

AR 12277

To event 564

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optic flare on the solar disk					
1 – 12	keV	1210	1216	1221	N07E52	M2.4	0.0087
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	1206:24	1215:30	12:15:36	C	704060	HESSI
12 – 25	keV	1212:37	1214:41	1232:49	123232	18927150	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
5	GHz	1213	1214	1214		2.08	
2.7	GHz	1213	1214	1214		2.04	
CME		UT	V, km/s	a km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1326	575	- 15.7	17°	117°	SOHO

Proton Active Region:

AR 12277 (N08L331, CMP 03,5.02.2015,

Sp=510 msh, FKC, BG, R1)

XRI=0.46 M₃^{2.4}+C₃₅ 2₁+1₃+S₅₈

PFR 28-30.01 (39^h) M₂^{2.4};

Particle event: To(Ep>10 MeV) – 21d10^h

Tmax₁(Ep>10 MeV) – 21d19^h, Jmax₁(Ep>10 MeV) – 1.2 /cm²·s·sr (ACE)

Tmax₂(Ep>10 MeV) – 22d07^h, Jmax₂(Ep>10 MeV) – 0.7 /cm²·s·sr (ACE)

Duration of the event – 2 days, power-law index: $\gamma_1 = 2.3$, $\gamma_2 = 2.5$

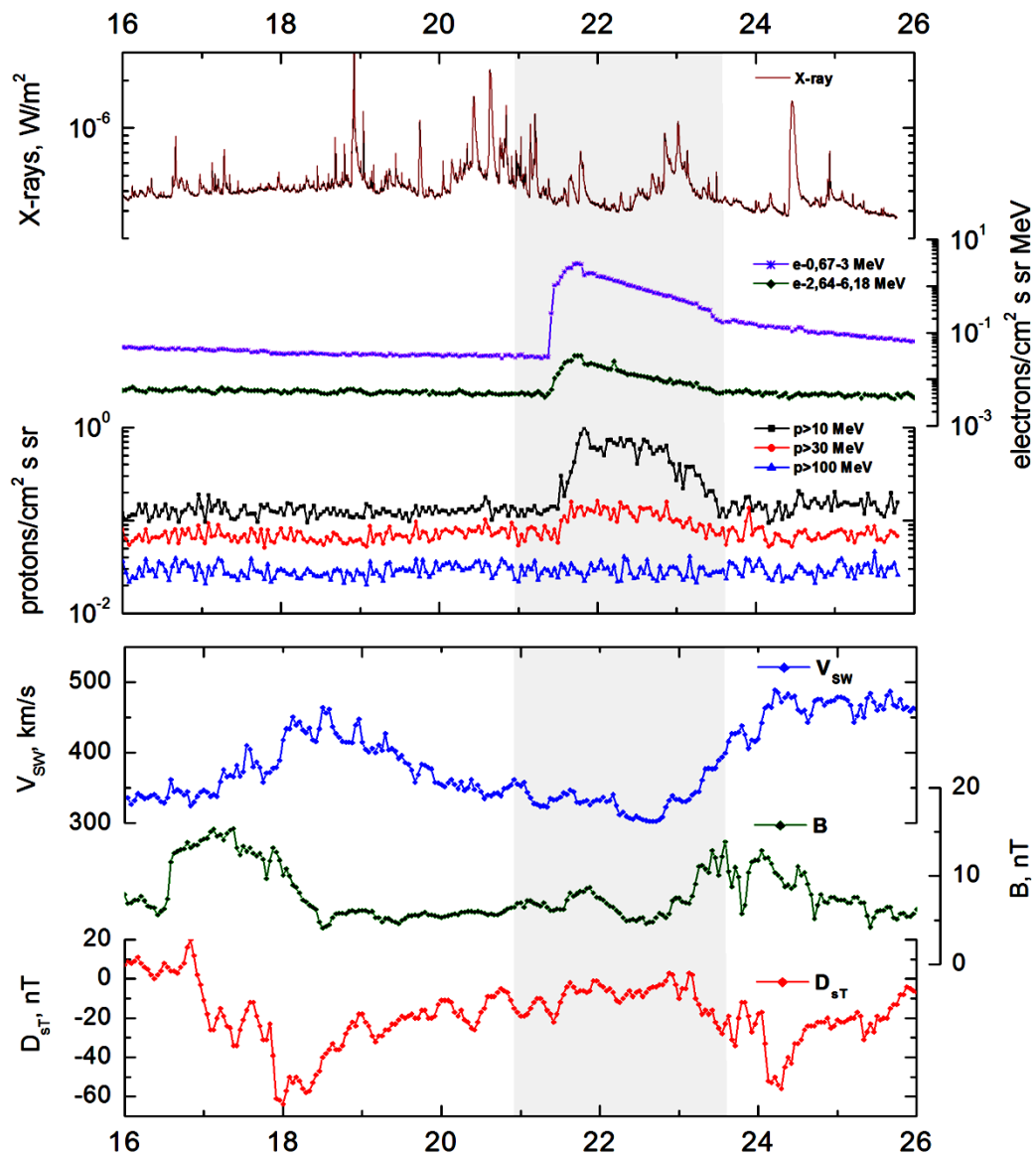
Quasimaximal energy of protons in the event – Eqm₁ = 60 MeV

– Eqm₂ = 70 MeV

Sources: ☐ DSF, 21d<09^h24^m – backside event on SW_L

CME: 21d09^h24^m, V = 1120 km/s, $\Delta\phi = 360^\circ$, dA = 215°

Particle fluxes and associated phenomena



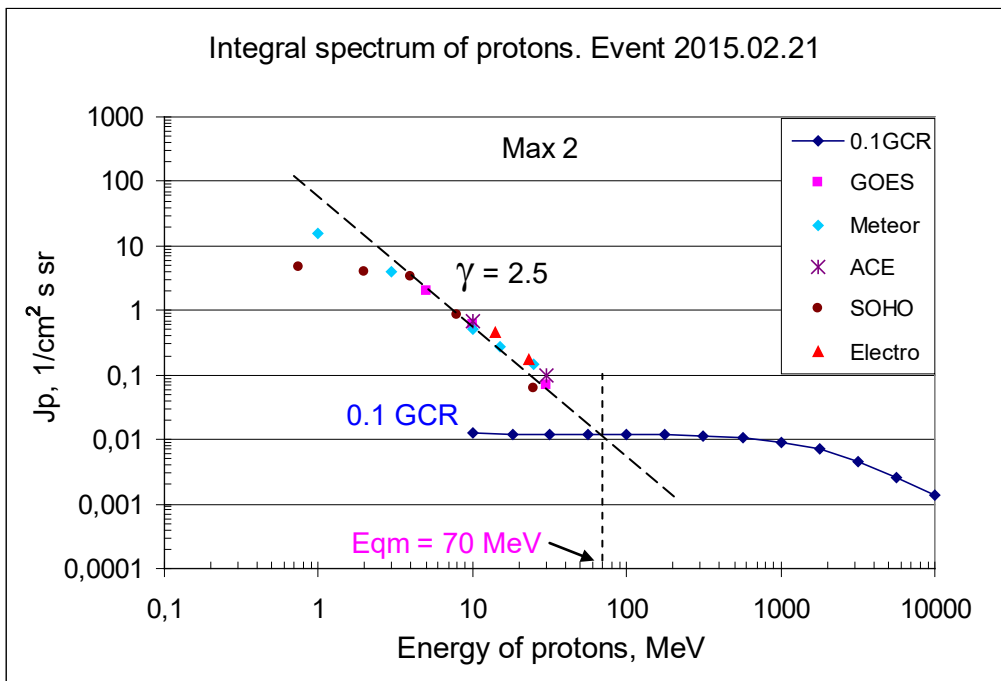
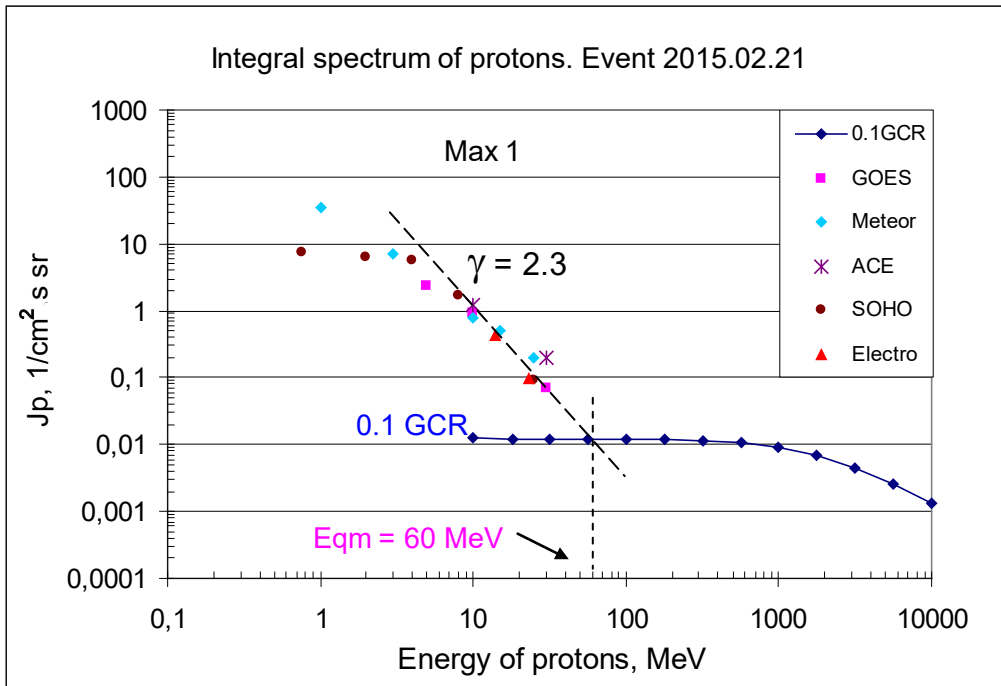
February 2015

Integral fluxes of protons for the event of 2015 February 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	10	20/22d07	2.4/2	2	0.2	
EPS	>10	10	19/22d07	0.9/0.6	2	0.12	
EPS	>30	10	18/22d07	0.07/0.07	2	0.07	
EPS	>50	-	-	-	-	0.06	
EPS	>60	-	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	310	
Meteor-2							
SCR	>1	12	21d24/22d10	35/16	2.5	3.7	
SCR	>3	12	21d24/22d10	7/4	2	2.4	
SCR	>10	12	23/22d10	0.8/0.5	1	1.9	
GALS-M	>15	12	13/22d10	0.5/0.27	1	0.6	
GALS-M	>25	12	13/22d10	0.2/0.15	0.5	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	12	18/22d08	1.2/0.7	2	1.2	
SIS	>30	12	18/22d07	0.2/0.1	2	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2015 February 21

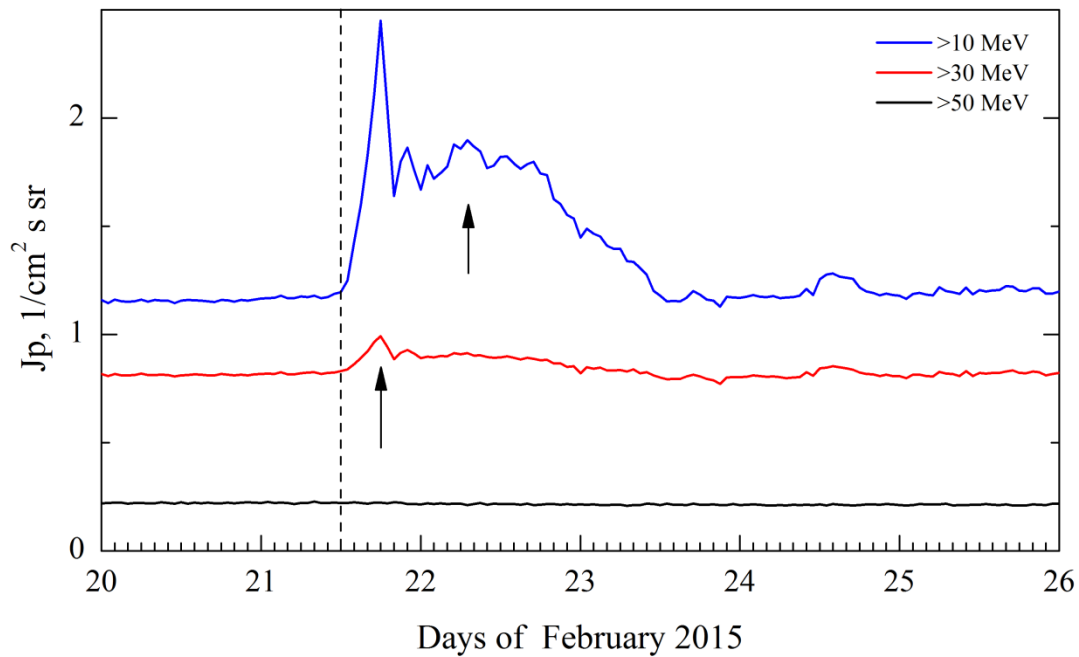
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	14	19/22d07	0.8/0.74	2	0.02	
LION	2 – 6	14	19/22d07	0.27/0.17	2	0.004	
EPHIN	4 – 8	13	19/22d07	1.01/0.62	2	0.003	
EPHIN	8 – 25	11	19/22d07	0.093/0.048	2	0.0001	
EPHIN	25 – 53	11	19/22d07	0.0033/0.0022	2	0.00002	
Electro-1							
SCR-E	13.7–23	10	20/25d06	0.035/ 0.03	2	0.05	
SCR-E	23–42	10	20/25d06	0.005/0.009	2	0.02	
SCR-E	42–112	-	-	-	-	0.0045	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.03	25
MEPED	36–70	-	-	-	-	0.005	50
MEPED	70–140	-	-	-	-	0.0008	100



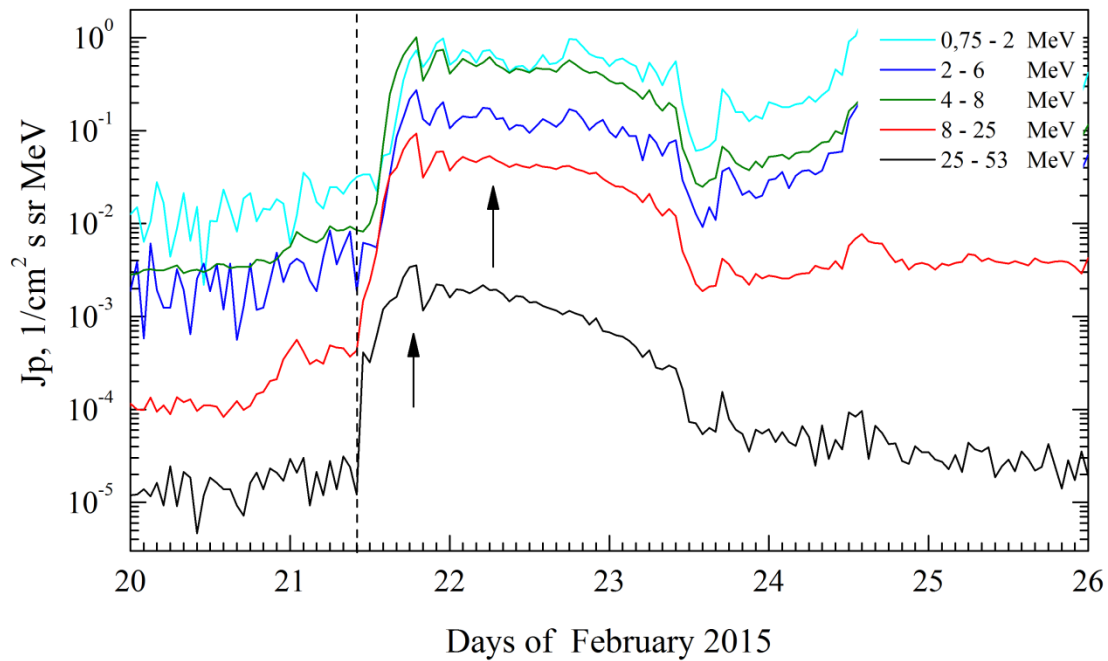
Time profiles of proton fluxes in the event 2015.02.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.02.21

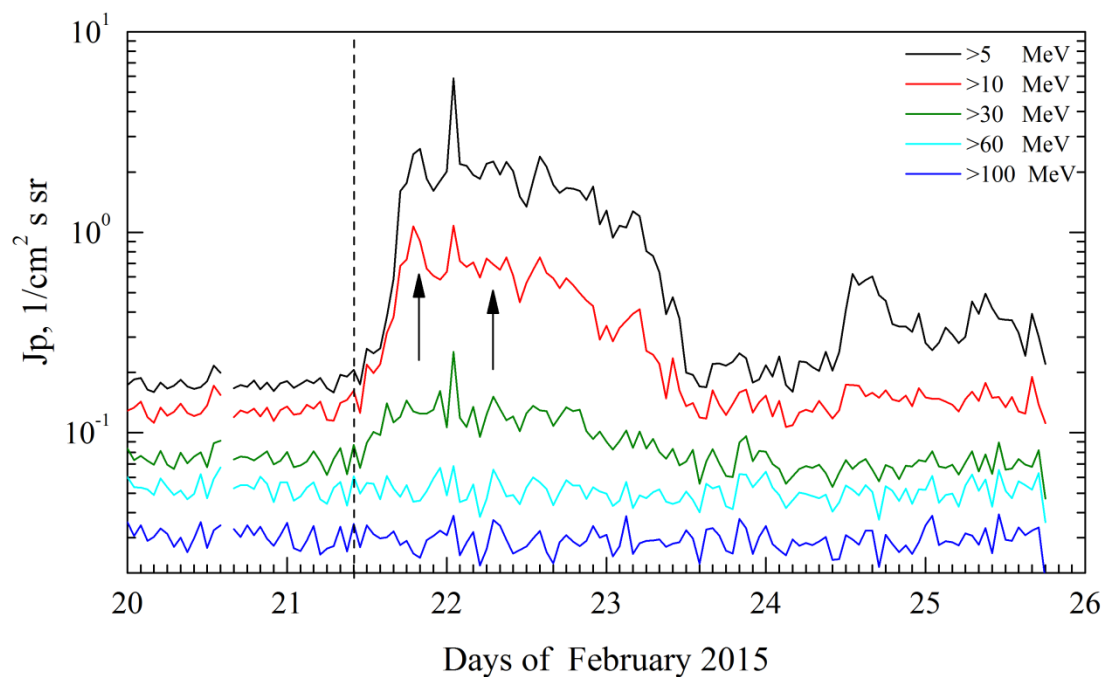


SOHO. Event 2015.02.21

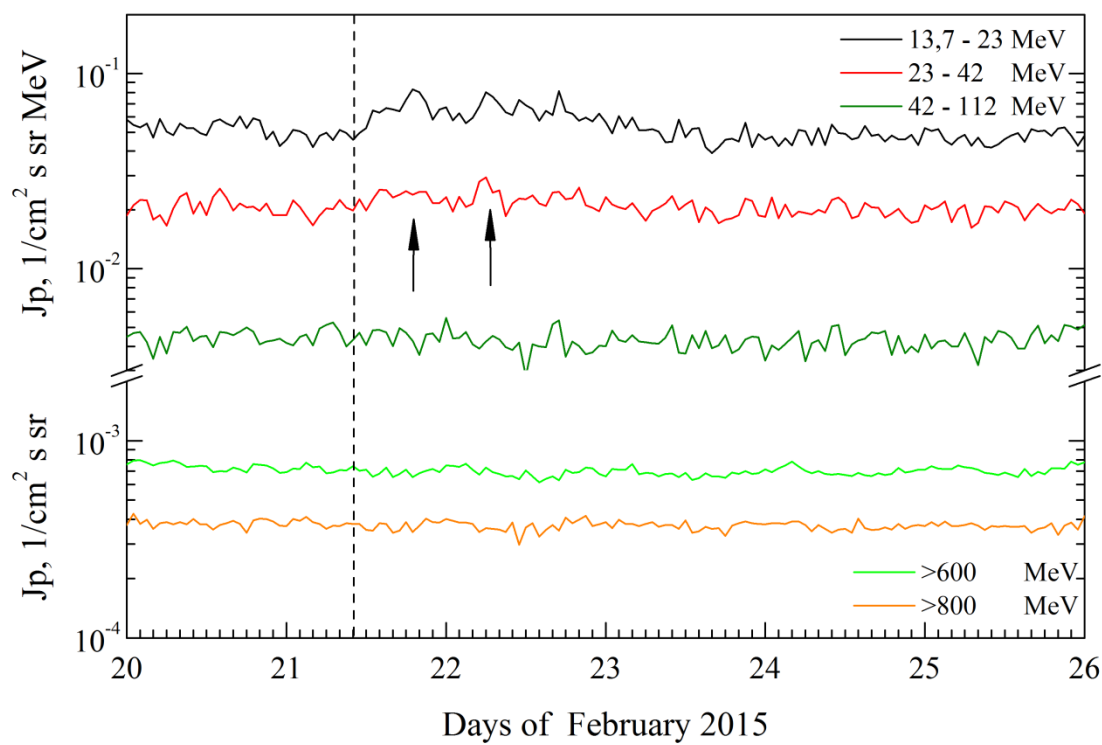


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro

GOES. Event 2015.02.21

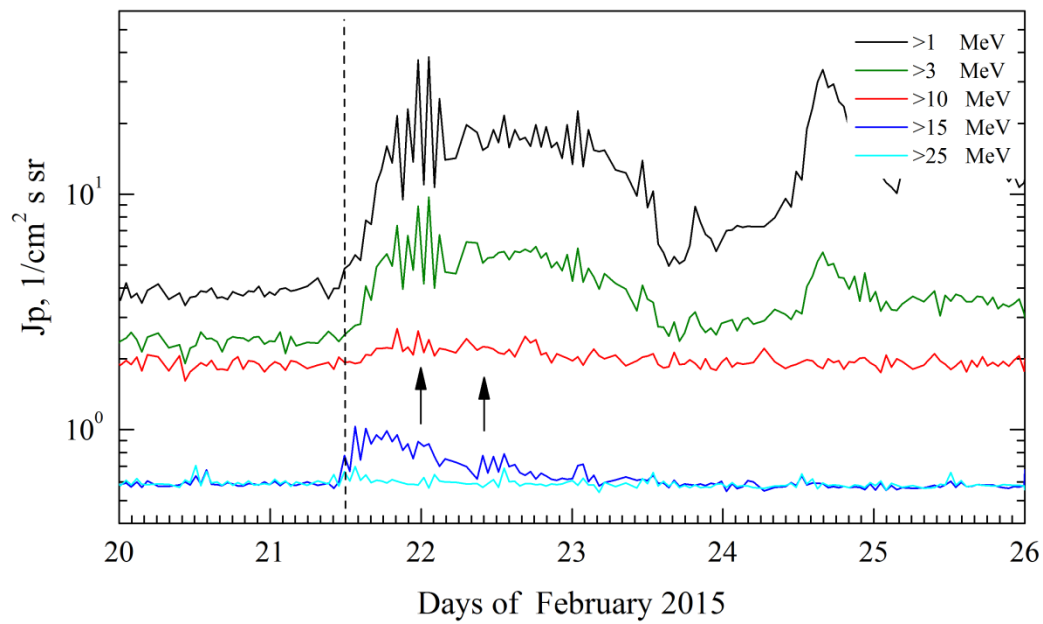


Electro. Event 2015.02.21

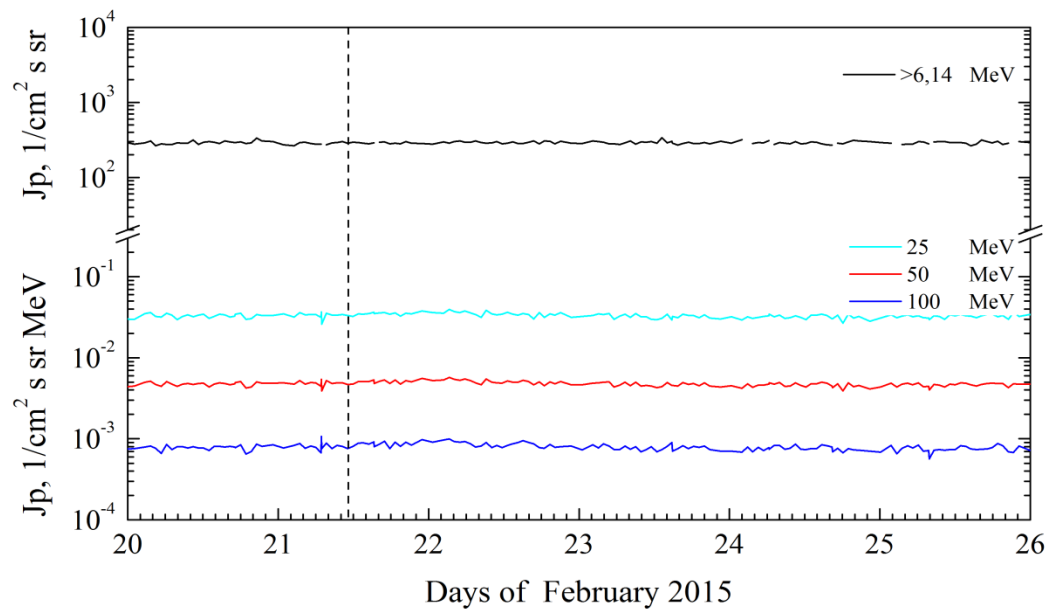


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.02.21



POES. Event 2015.02.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 February 21**

2015 February 21 ☐ AR XXXX To event 565

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	DSF*	<0924			SW _L	>15°	
6563 Å		No flare event on visible solar disk					
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
1 – 12	keV	No X-ray event on visible solar disk					
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0924	1120	5.5	360°	215°	SOHO

Particle event: To($E_p > 10$ MeV) – 15d02^h

Tmax($E_p > 10$ MeV) – 15d10^h, Jmax($E_p > 10$ MeV) – 2 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma = 2.2$

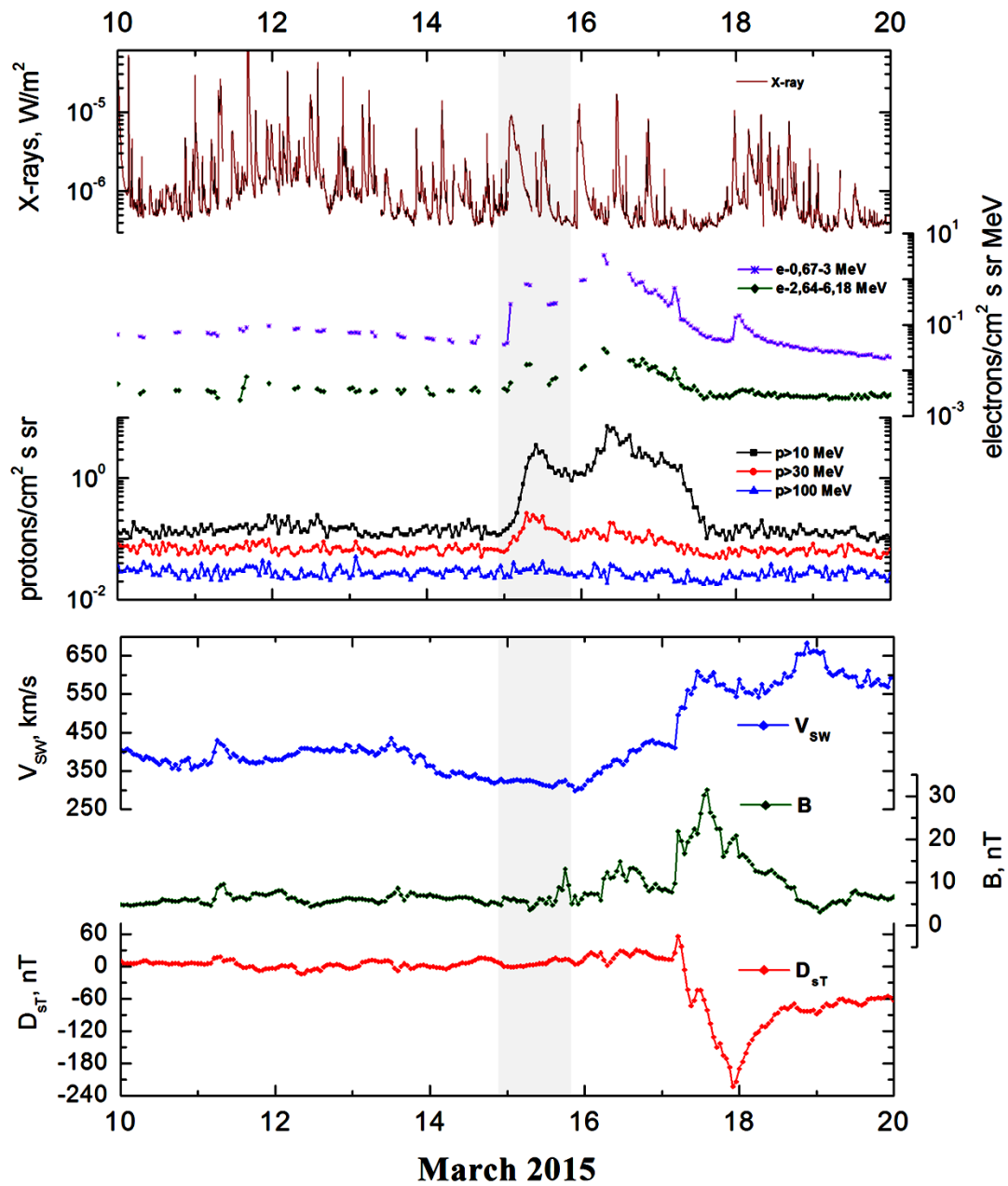
Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

Sources: ☉ solar flare 15d01^h15^m, C9.1/1F, S22W25, AR12297

Main burst X-ray 1–8 Å: onset – 15d01^h15^m, max – 15d02^h13^m, $\Phi = 0.048$ J/m²

CME: 15d01^h48^m, $V = 719$ km/s, $\Delta\phi = 360^\circ$, $dA = 240^\circ$

Particle fluxes and associated phenomena

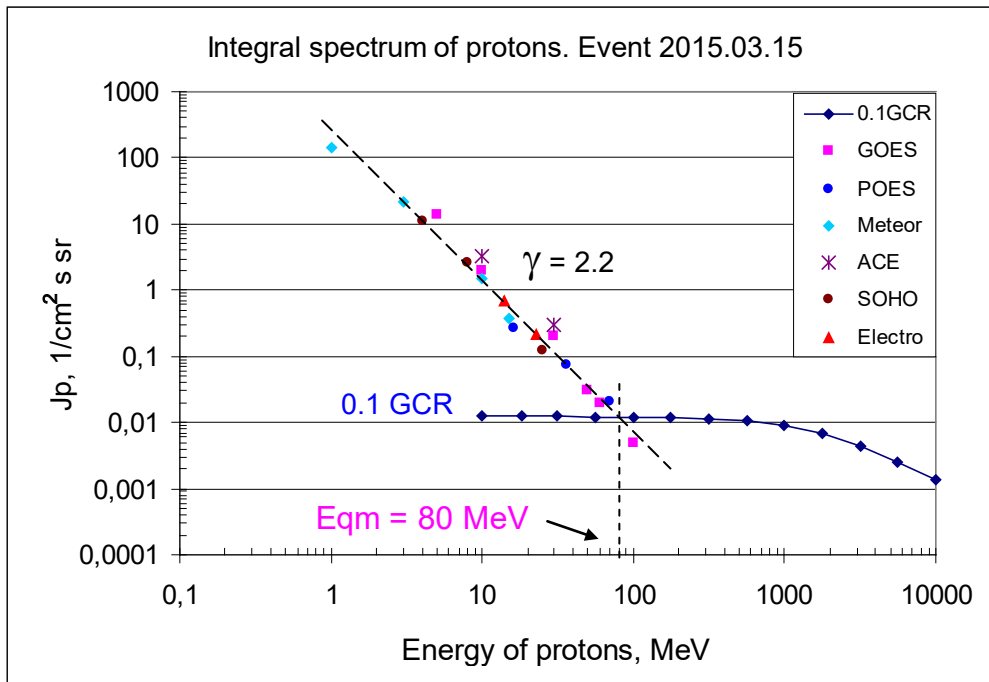


Integral fluxes of protons for the event of 2015 March 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	10	13.5	1	0.2	
EPS	>10	2	10	2	1	0.12	
EPS	>30	2	9	0.2	1	0.07	
EPS	>50	2	9	0.03	1	0.06	
EPS	>60	2	9	0.02	-	0.05	
EPS	>100	-	9	0.05	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	285	
Meteor-2							
SCR	>1	4	11	141	1	3.8	
SCR	>3	4	12	22	1	2.4	
SCR	>10	4	8	1.5	1	1.9	
GALS-M	>15	2	8	0.38	1	0.6	
GALS-M	>25	-	-	-	-	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	2	9	3.2	1	1.1	
SIS	>30	2	9	0.3	1	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

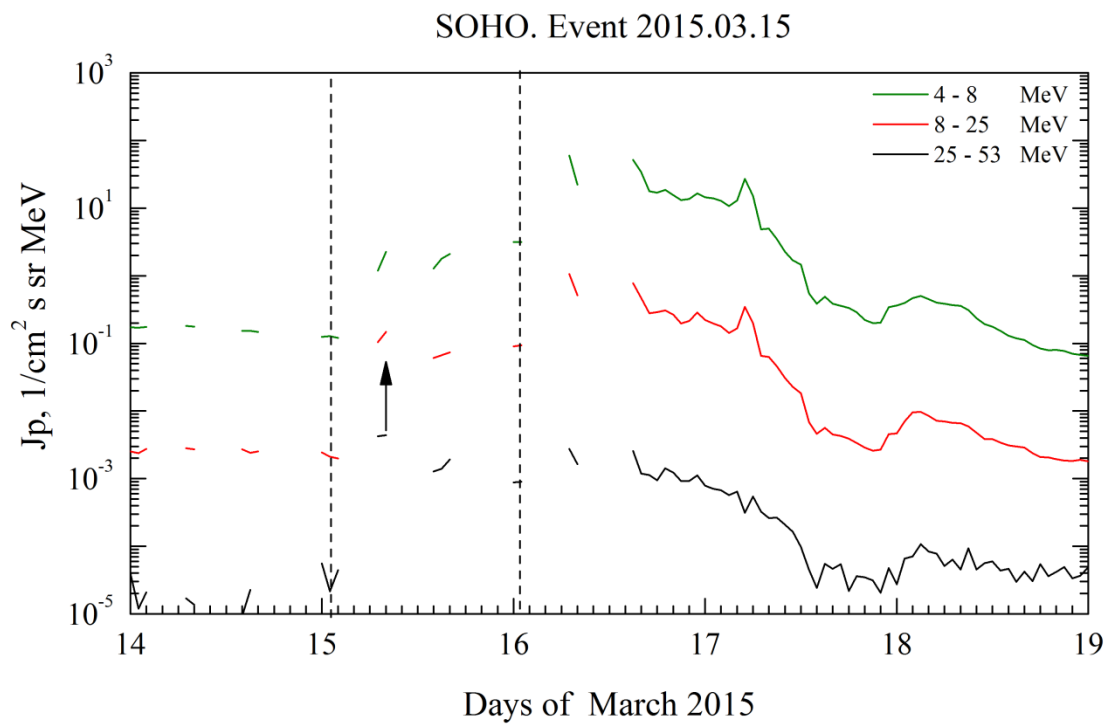
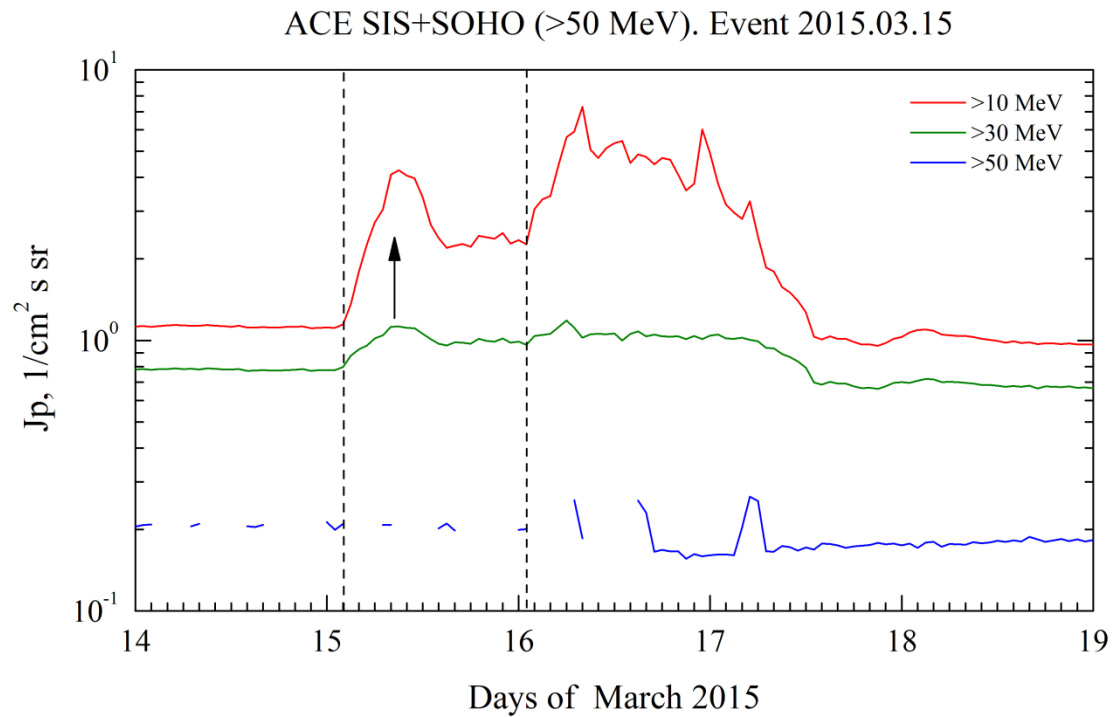
Differential fluxes of protons for the event of 2015 March 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	-	-	-	-	-	
LION	2 – 6	-	-	-	-	-	
EPHIN	4 – 8	-	8	2.12	1	0.13	
EPHIN	8 – 25	-	8	0.146	1	0.002	
EPHIN	25 – 53	-	8	0.0044	1	0.00001	
Electro-1							
SCR-E	13.7–23	1	8	0.05	1	0.05	
SCR-E	23–42	1	8	0.011	1	0.02	
SCR-E	42–112	-	-	-	-	0.0045	
POES							<E>, MeV
MEPED	16–36	03	11	0.0094	1	0.032	25
MEPED	36–70	03	11	0.0016	1	0.0047	50
MEPED	70–140	03	07	0.0003	1	0.0008	100



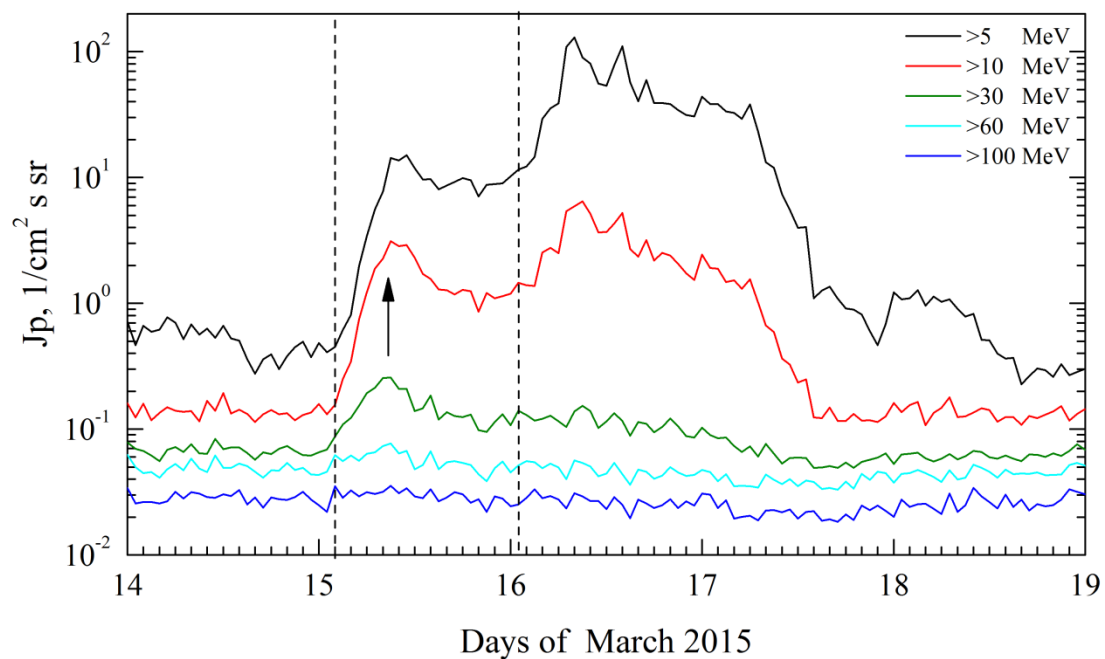
Time profiles of proton fluxes in the event 2015.03.15

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

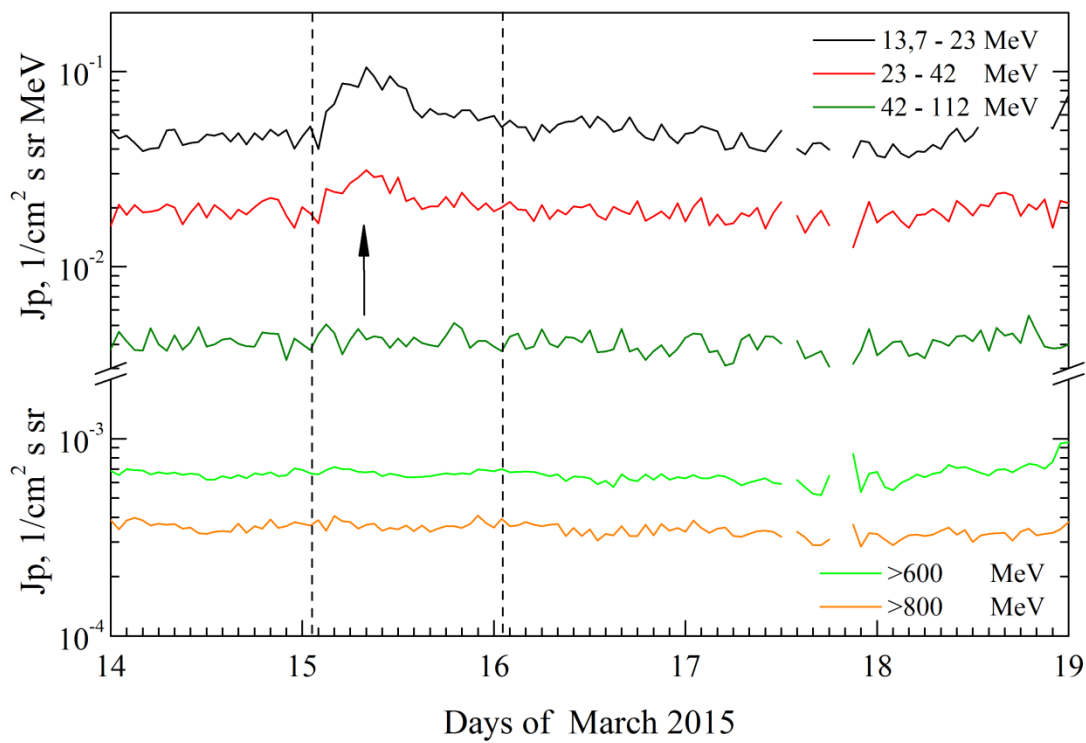


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

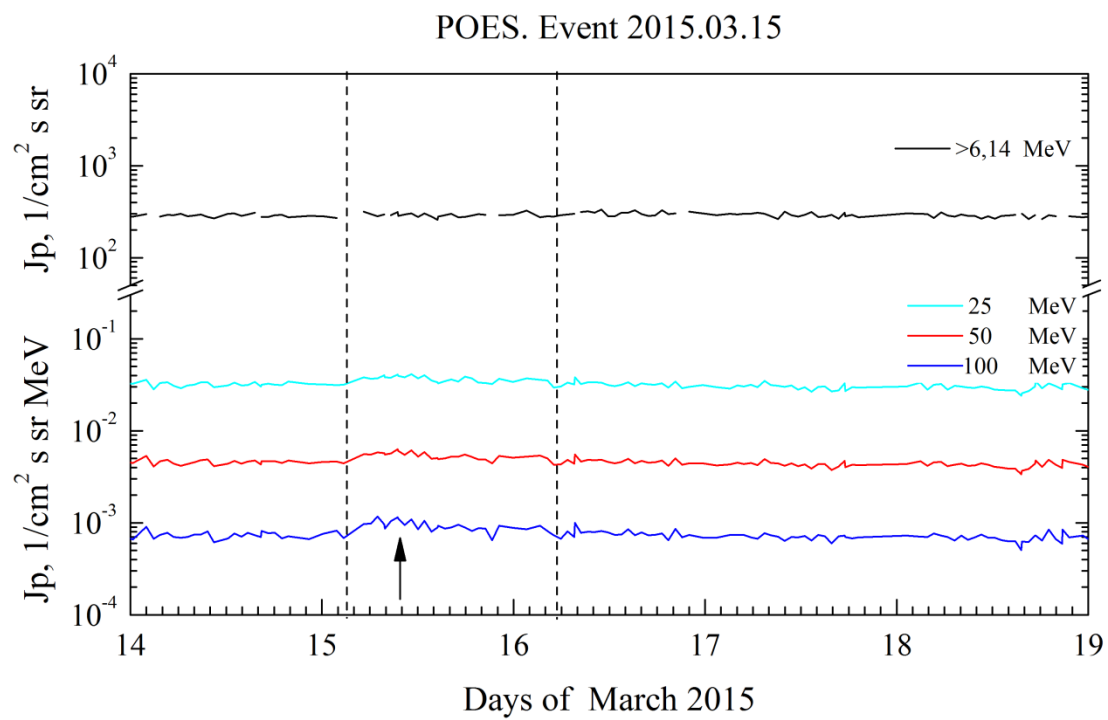
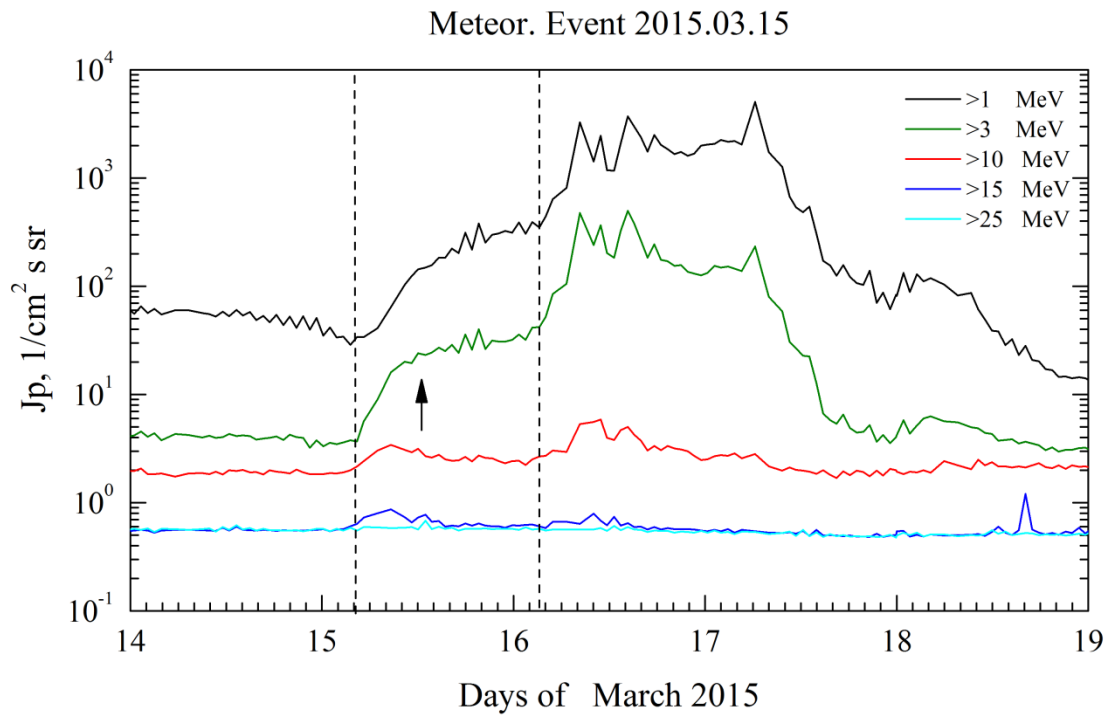
GOES. Event 2015.03.15



Electro. Event 2015.03.15



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 March 15**

2015

March 15

☉

AR 12297

To event 566

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0118	0213	0328	S22W25	1F	DSD
	DSF*						
1 – 12	keV	0115	0213	0320	S22W29	C9.1	0.048
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0141:48	0143:18	0207:16	68	441320	HESSI
12-25	keV	0207:16	0207:34	0210:08	38	36720	HESSI
12-25	keV	0210:08	0213:14	0217:16	68	91646	HESSI
12-25	keV	0217:16	0217:22	0236:00	32	169326	HESSI
6-12	keV	0236:00	0237:38	0239:32	24	26880	HESSI
12-25	keV	0130:09	0213:17	0221:40	6979	731327	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
610	MHz	0212	0213	0213		2.38	
410	MHz	0115	0225	0238		2.15	
245	MHz	0137	0200	0244		2.26	
SP-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	27-54	0127		0137	745	2	
DS IV	50-500	0115		0136		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0148	719	- 9.0	360°	240°	SOHO

*https://www.lmsal.com/solarsoft/latest_events_archive/events_summary/2015/03/15/gev_20150315_0115/index.html

Proton Active Region:

AR12297 (S17L197, CMP13,0.03.2015.

Sp=420 msh, DKC, BGD, R)

XRI=8.28 X₁^{2.1}+M₂₃^{9.2}+C₉₇ 2₇+1₁₇+S₁₀₀

PFR1 06-07.03: (41^h) – M₃^{9.2}

PFR2 09-11.03: (52^h) – X₁^{2.1}+M₇^{5.8}

PFR3 12-13.03: (25^h) – M₇^{4.2}

References:

Ameri D., E. Valtonen, [2019](#).

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Luhmann J.G., M.L. Mays, D. Odstrcil et al., [2017](#).

Particle event: To($E_p > 10$ MeV) – 16d01^h

Tmax₁($E_p > 10$ MeV) – 16d09^h, Jmax₁($E_p > 10$ MeV) – 5.2 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 16d14^h, Jmax₂($E_p > 10$ MeV) – 4 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma_1 = 3.5$, $\gamma_2 = 4.2$

Quasimaximal energy of protons in the event – Eqm₁ = 50 MeV

– Eqm₂ = 35 MeV

Sources: ☉ solar flare 15d22^h42^m, M1.2/, S19W32, AR12297

☉ solar flare 16d10^h39^m, M1.6/2N, S17W39, AR12297

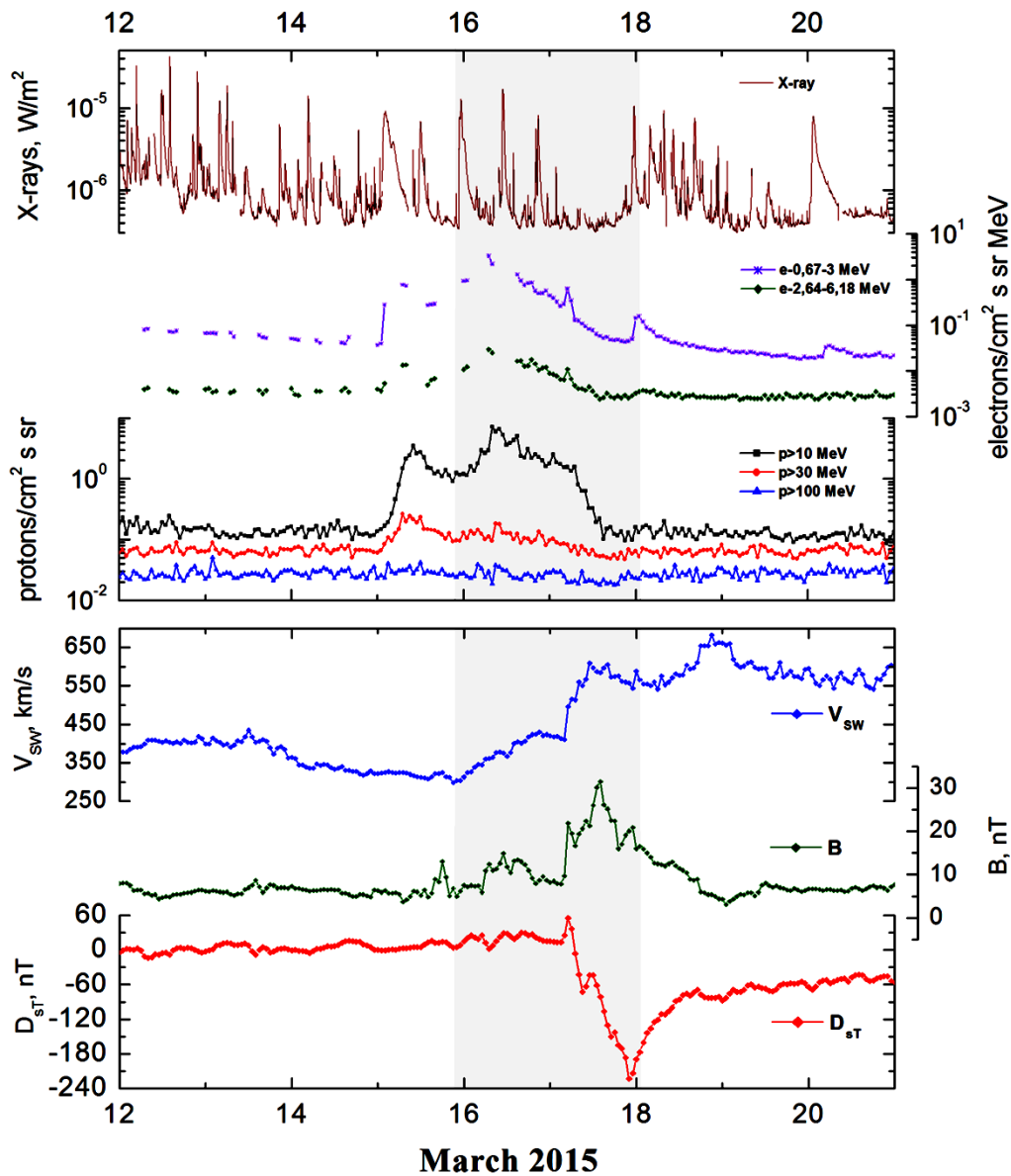
☉ solar flare 16d20^h38^m, C8.1/1N, S22W48, AR12297

Main burst X-ray 1–8 Å: onset – 15d22^h42^m, max – 15d23^h22^m, $\Phi = 0.027$ J/m²

CME: 15d23^h24^m, V = 284 km/s, $\Delta\phi = 15^\circ$, dA = 290°

▲ SC 17d04^h45^m

Particle fluxes and associated phenomena

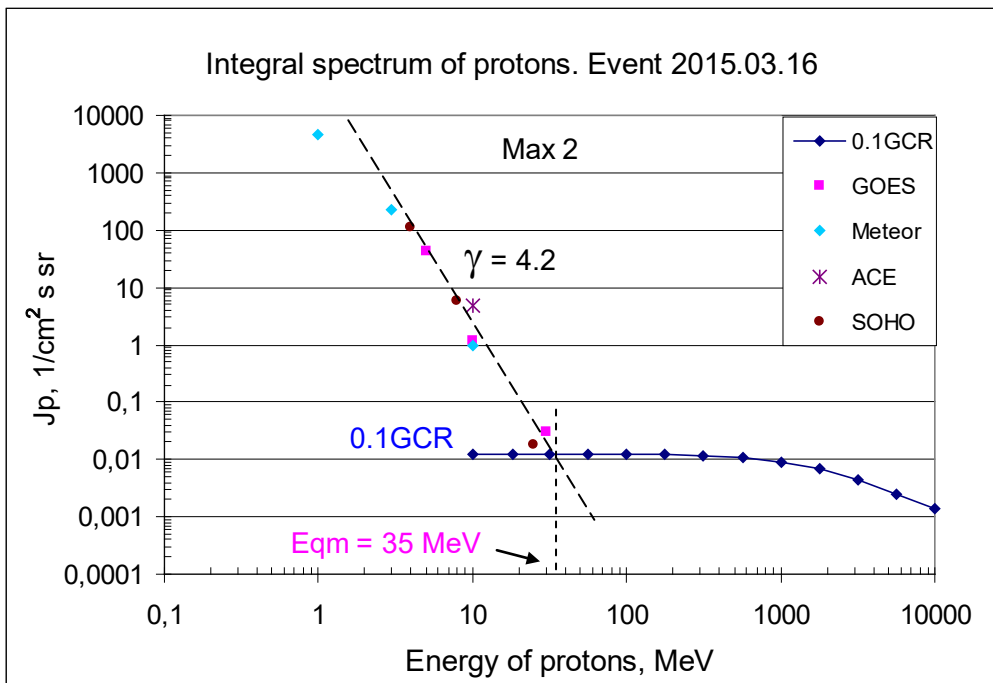
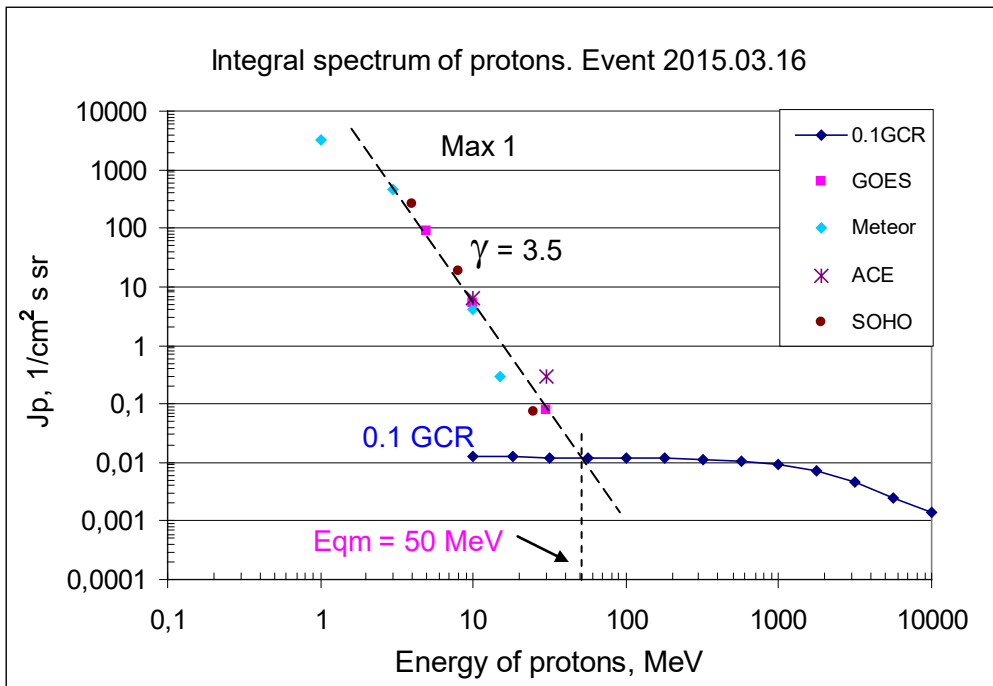


Integral fluxes of protons for the event of 2015 March 16

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	1	9/17d00	89/43.7	2	0.2	
EPS	>10	1	9/17d00	5.2/1.2	2	0.12	
EPS	>30	1	9/17d00	0.08/0.03	2	0.07	
EPS	>50	1	-	-	-	0.06	
EPS	>60	1	-	-	-	0.05	
EPS	>100	1	-	-	-	0.03	
Electro-1							
GALS-MP	>600	-	-	-	-	0.0007	
POES-19							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR-1	>1	3	08/17d06	3200/4500	2	3.8	
SCR-1	>3	3	08/17d06	460/225	2	2.4	
SCR-1	>10	3	08/17d06	4/1	1	1.9	
GALS-MP	>15	2	08/-	0.3/-	0.5	0.6	
GALS-MP	>25	-	-	-	-	0.6	
GALS-MP	>600	-	-	-	-	0.2	
ACE							
SIS	>10	1	8/23	6,2/4,8	1,5	1,1	
SIS	>30	1	6/ -	0,3/ -	1,5	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0,21	

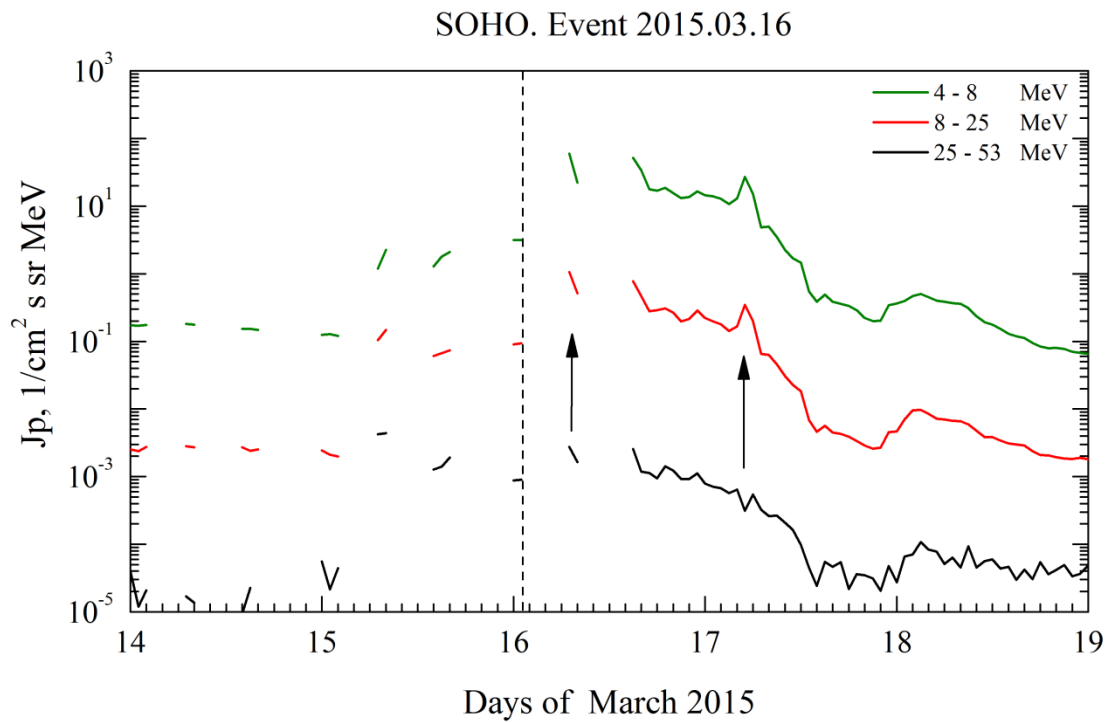
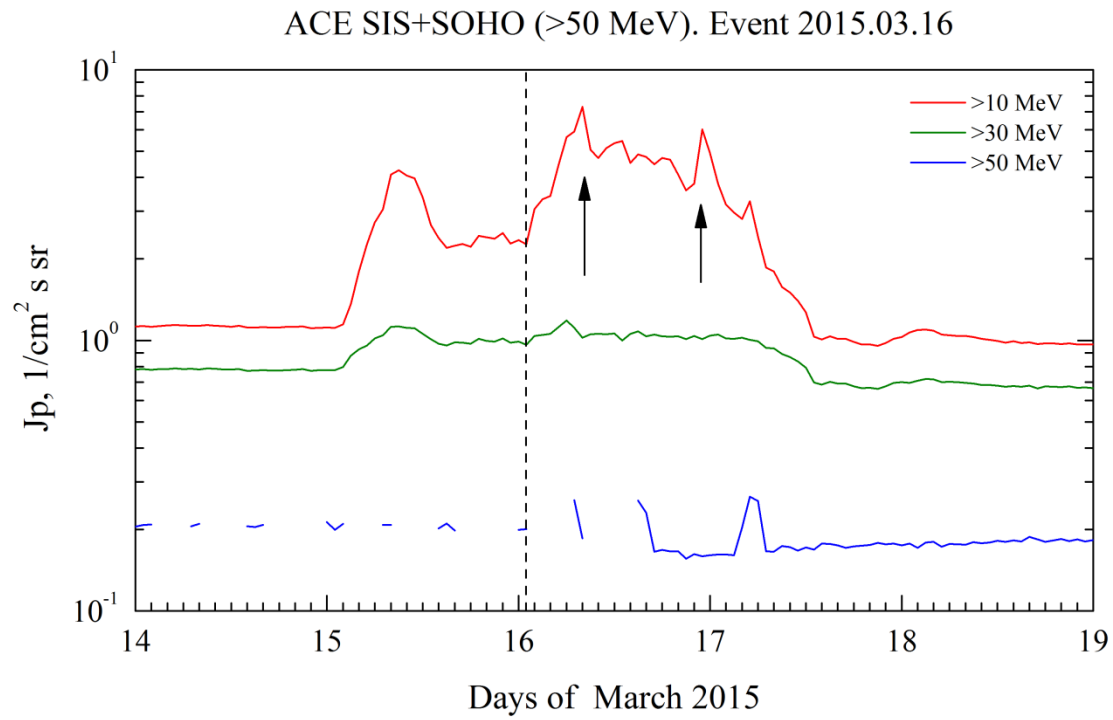
Differential fluxes of protons for the event of 2015 March 16

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0,75 – 2						
LION	2 – 6						
EPHIN	4 – 8	1	7/17d05	59,3/26.9	2	0,13	
EPHIN	8 – 25	1	7/17d05	1,06/0,344	2	0,002	
EPHIN	25 – 53	1	7/17d04	0,0027/0,00065	2	0,00001	
Electro-1							
SCR-E	13.7–23	-	-	-	-	0,05	
SCR-E	23–42	-	-	-	-	0,020	
SCR-E	42–112	-	-	-	-	0,004	
POES-19							<E>, MeV
MEPED	16–36	-	-	-	-	0.03	25
MEPED	36–70	-	-	-	-	0.005	50
MEPED	70–140	-	-	-	-	0.0008	100



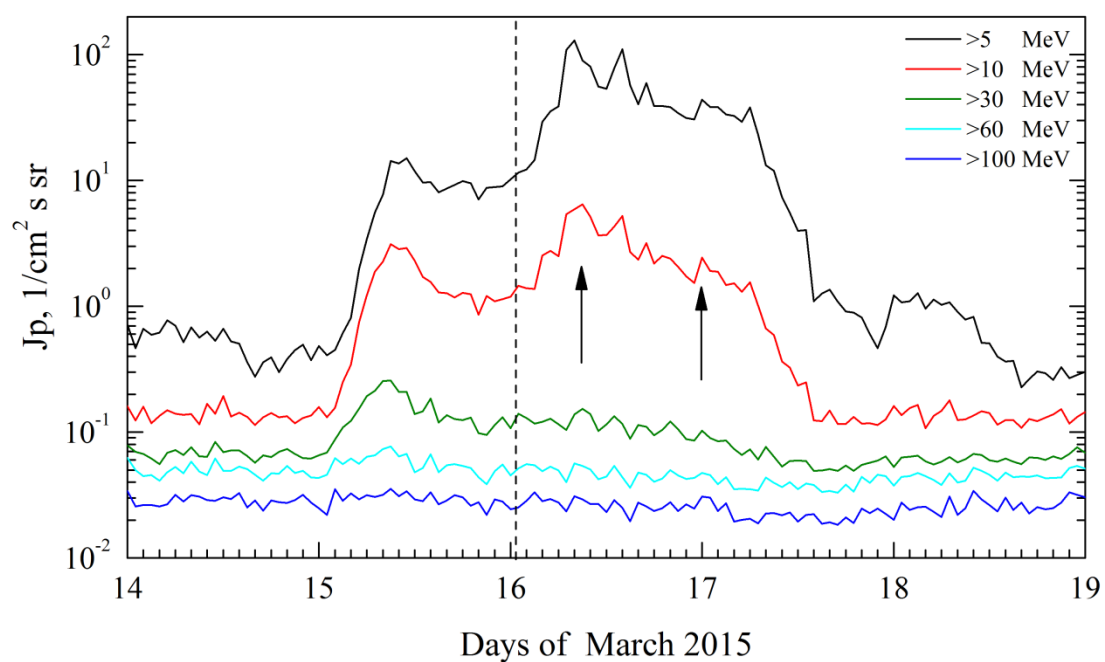
Time profiles of proton fluxes in the event 2015.03.16

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

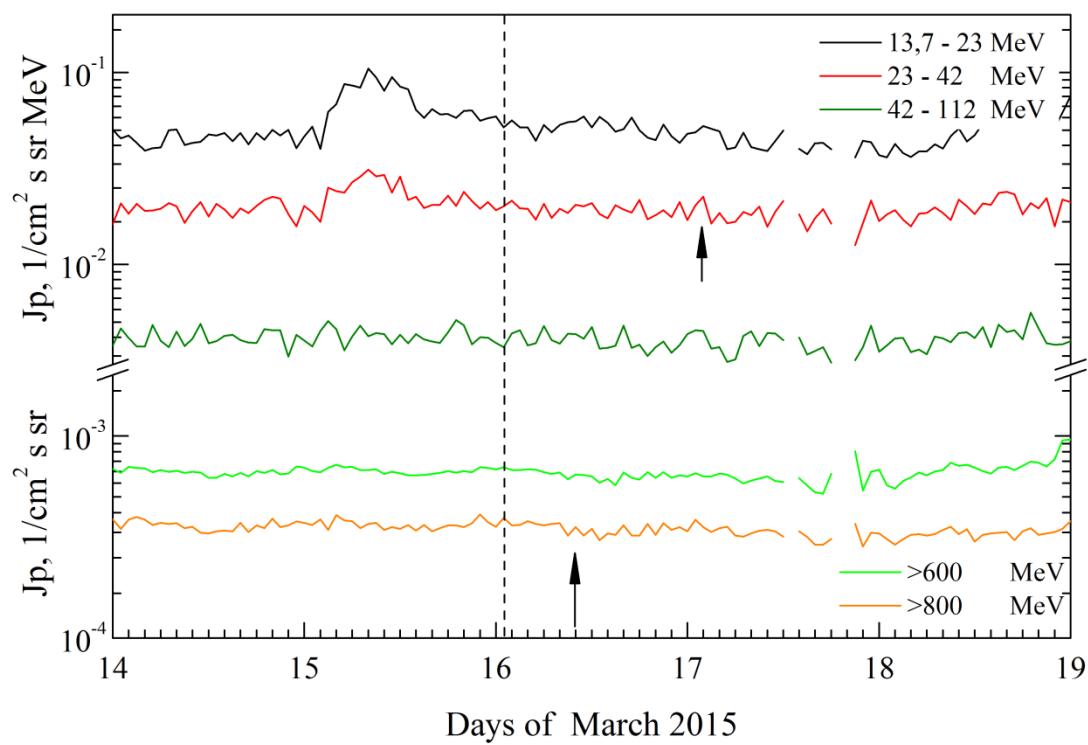


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

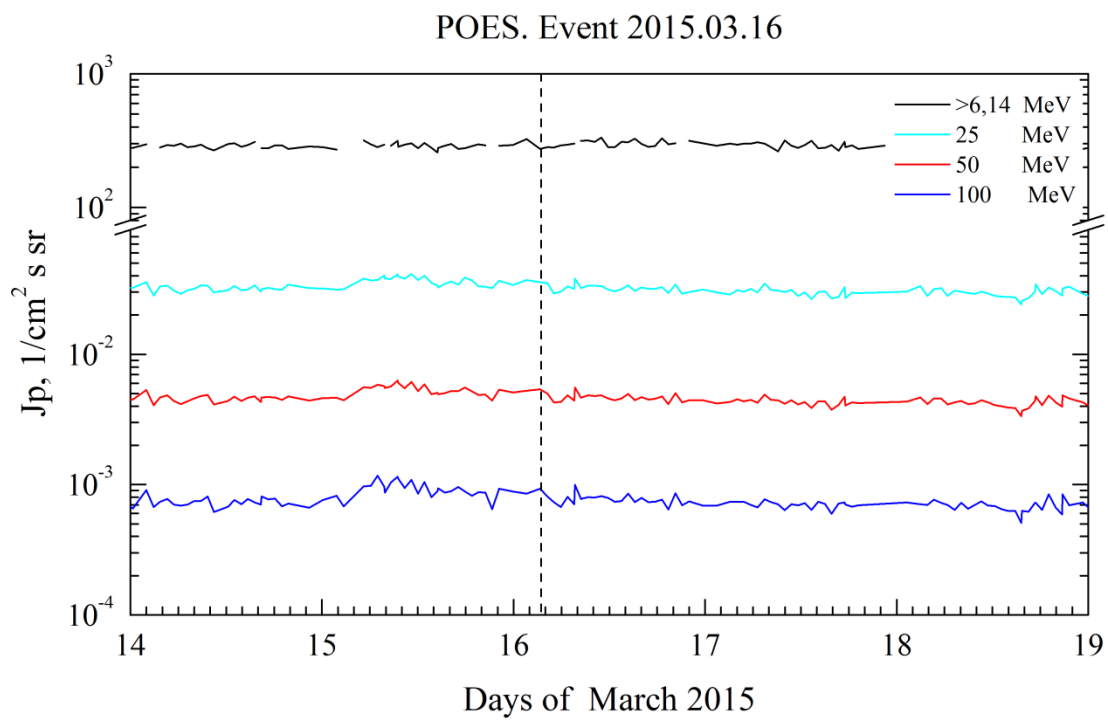
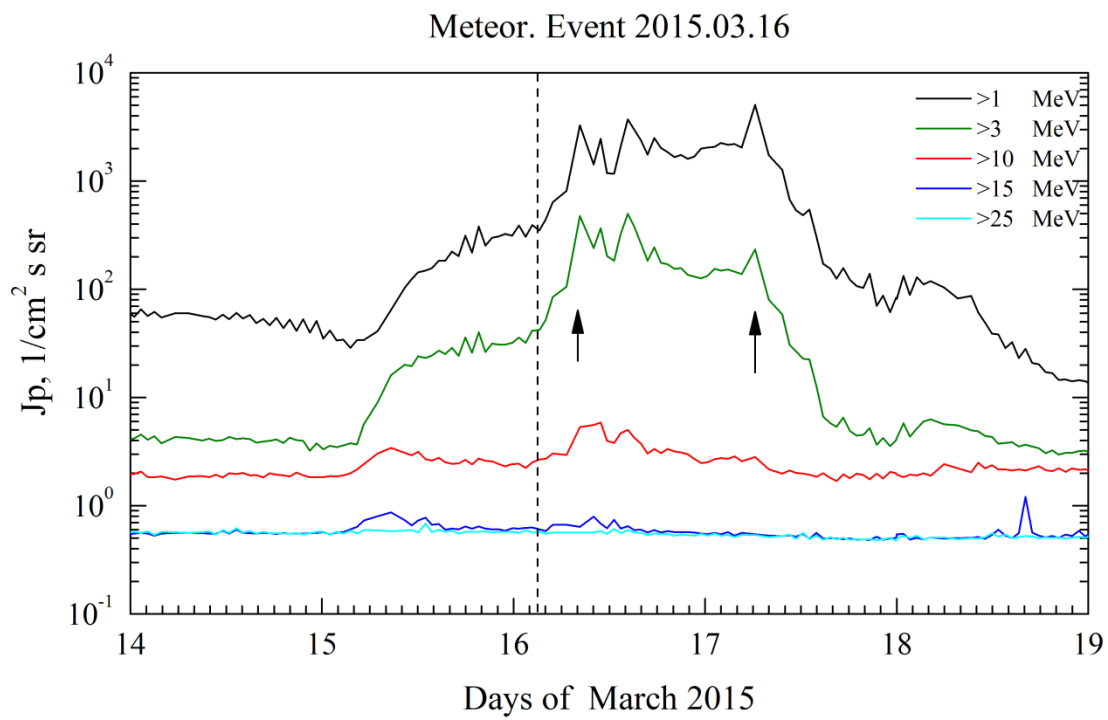
GOES. Evens 2015.03.16



Electro. Evens 2015.03.16



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 March 16**

2015 March 16 ☉ AR 12297 To event 567

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical event on visible solar disc					
1 – 12	keV	2242	2322	2338	S19W32	M1.2	0.027
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50-100	keV	2242:04	2254:18	2302:16	496	1412787	HESSI
25-50	keV	2302:16	2311:02	2311:44	336	791259	HESSI
12-25	keV	2347:28	0000:58	0042:52	68	626978	HESSI
12-25	keV	2244:53	2254:12	2256:33	49889	10399639	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	2245	2245	r/spectrum	U1.4 / 15	2.32	
8.8	GHz	2245	2245	Code of		2.11	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	40-60	2259		2259		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2324	284	3.3	15°	290°	SOHO

2015 March 16 Ø AR 12297 To event 567

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1039	~1057	>1151	S17W39	2N	ERU
1 – 12	keV	1039	1058	1117	S17W38	M1.6	0.025
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1050:24	1052:02	1052:40	624	332194	HESSI
12-25	keV	1051:53	1059:03	1126:54	31972	5683322	FERMI
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1124	441	31.6	019°	225°	SOHO

2015

March 16

Ø

AR 12297

To event 567

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	2039	2044	2118	S22W48	1N	PRB
1 – 12	keV	2038	2049	2100	S21W48	C8.1	0.0071
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	2037:28	2045:02	2109:20	432	975928	HESSI
12-25	keV	2039:12	2043:13	2059:23	72682	11870305	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	2042	2043	2044	U1.4 / 15	2.0	
8.8	GHz	2042	2043	2043		1.93	
5	GHz	2043	2043	2043		1.85	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	gap					SOHO

Proton Active Region:

AR12297 (S17L197, CMP13,0.03.2015,
 Sp=420 msh, DKC, BGD, R)
 XRI=8.28 $X_1^{2.1}+M_{23}^{9.2}+C_{97}^{2.7}+1_{17}+S_{100}$
 PFR1 06-07.03: (41^h) – $M_3^{9.2}$
 PFR2 09-11.03: (52^h) – $X_1^{2.1}+M_7^{5.8}$
 PFR3 12-13.03: (25^h) – $M_7^{4.2}$

References:

Лукьянова Р.Ю., [2020](#).
 Eroglu E., [2019](#).
 Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
 Luhmann J.G., M.L. Mays, D. Odstrcil et al., [2017](#).

Particle event: To($E_p > 10$ MeV) – 22d06^h

Tmax₁($E_p > 10$ MeV) – 23d07^h, Jmax₁($E_p > 10$ MeV) – 0.55 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 23d21^h, Jmax₂($E_p > 10$ MeV) – 0.6 /cm²·s·sr

Duration of the event – 8 days, power-law index: $\gamma_1 = 1.6$, $\gamma_2 = 2.0$

Quasimaximal energy of protons in the event – Eqm₁ = 80 MeV

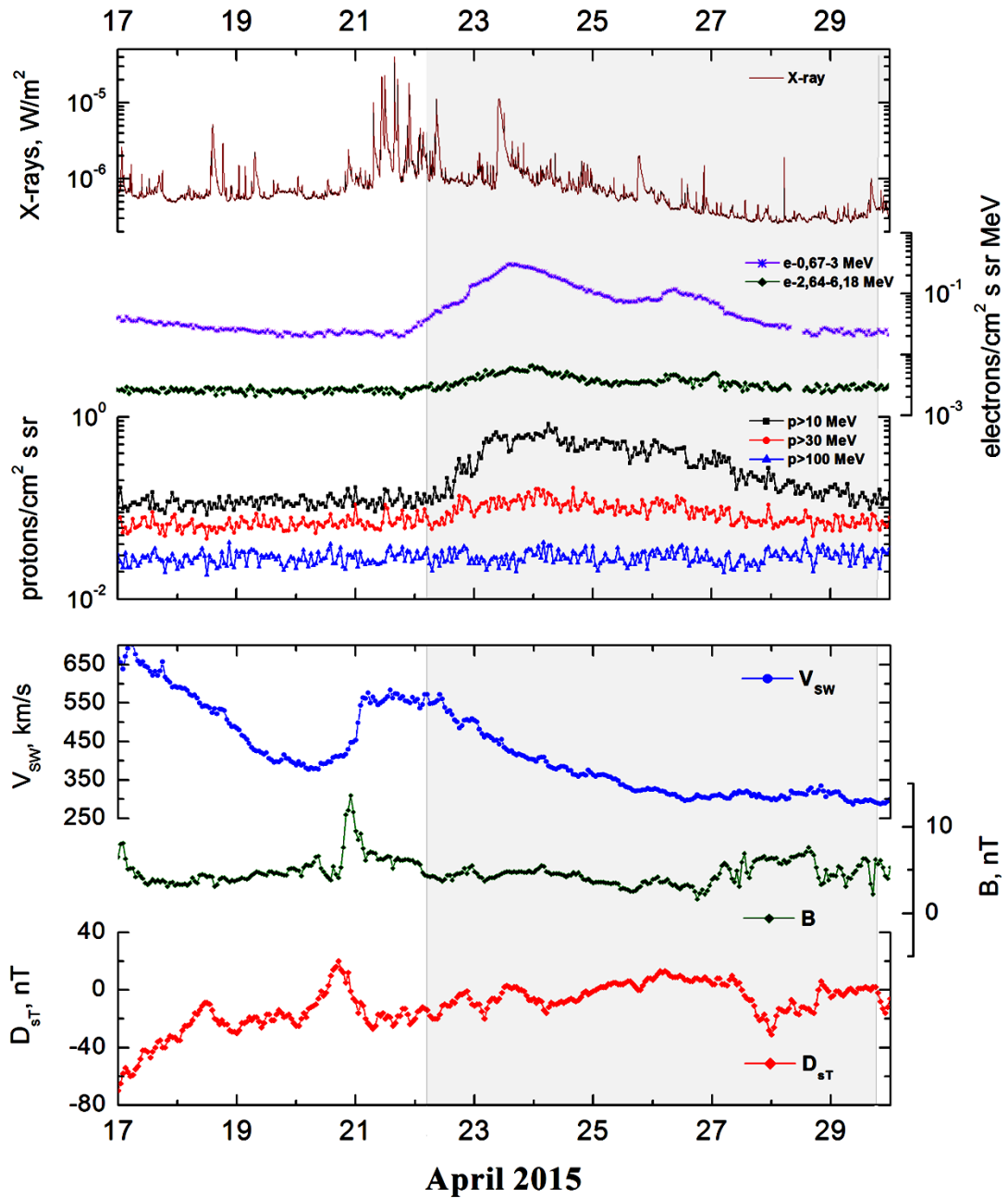
– Eqm₂ = 75 MeV

Sources: ☐ solar flare 21d21^h39^m, M1.8, M1.2/, N10W80, AR12322

Main burst X-ray 1–8 Å: onset – 21d21^h39^m, max – 21d21^h45^m, $\Phi = 0.011$ J/m²

onset – 21d21^h58^m, max – 21d22^h01^m, $\Phi = 0.0028$ J/m²

Particle fluxes and associated phenomena

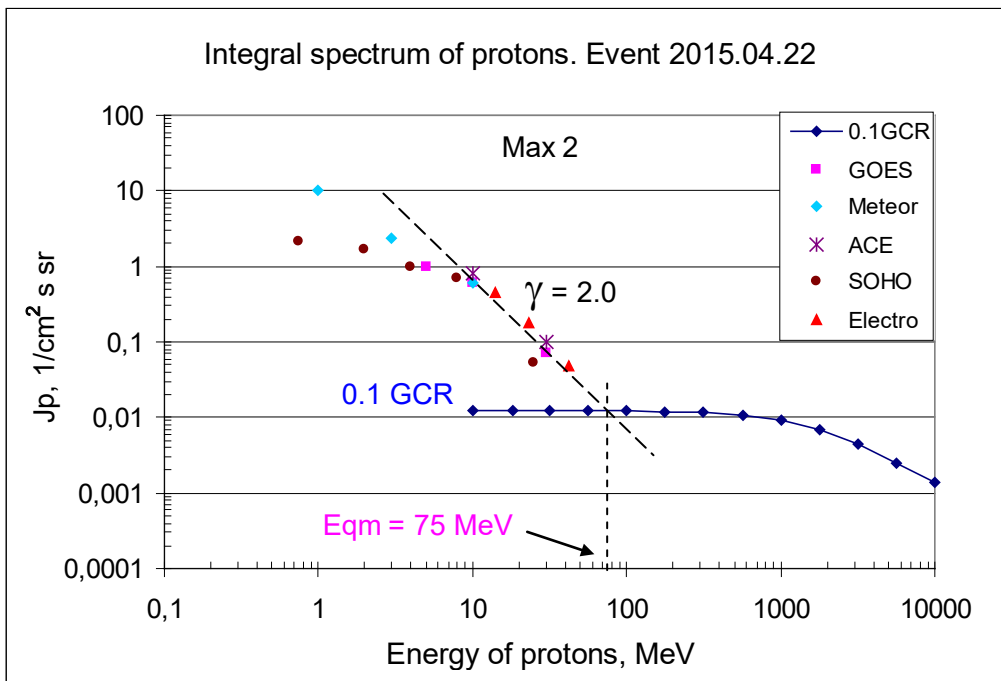
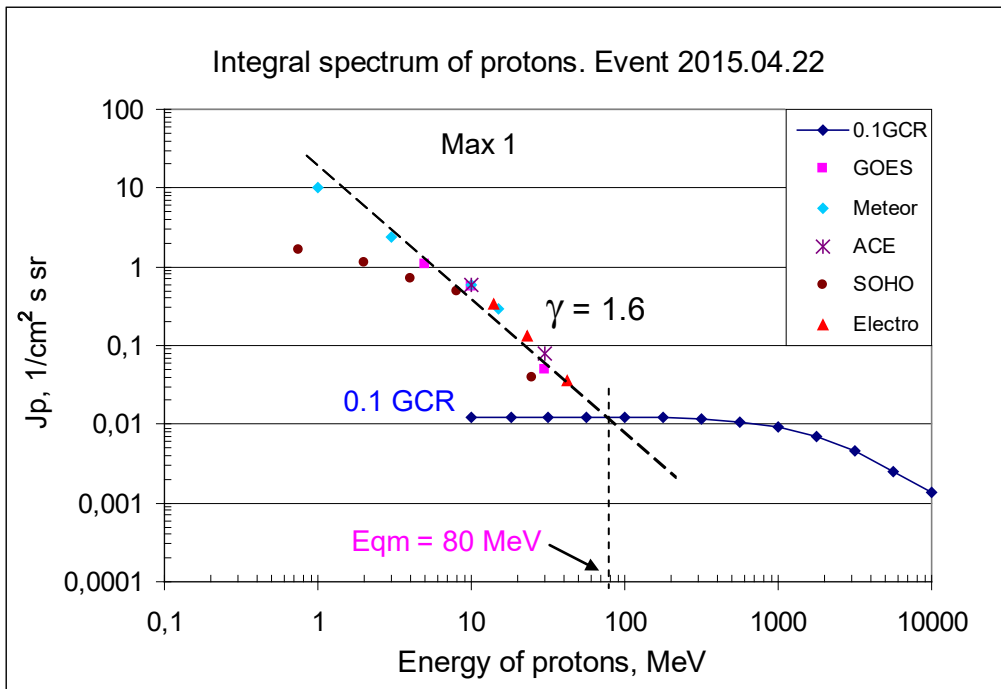


Integral fluxes of protons for the event of 2015 April 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	6	23d08/23d22	1.1/1	8	0.2	
EPS	>10	6	23d07/23d21	0.55/0.6	8	0.12	
EPS	>30	7	23d07/23d21	0.05/0.07	5	0.07	
EPS	>50	8	-	-	-	0.06	
EPS	>60	8	-	-	-	0.05	
EPS	>100	8	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0006	
POES							
MEPED	>6.14	-	-	-	-	285	
Meteor-2							
SCR	>1	8	23d05/23d22	10/10	11	3.9	
SCR	>3	8	23d09/23d22	2.34/2.35	7	2.3	
SCR	>10	8	23d09/23d22	0.58/0.6	1	1.9	
GALS-M	>15	23d03	23d05/-	0.29/-	0.25	0.6	
GALS-M	>25	-	-	-	-	0.5	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	6	23d03/23d22	0.6/0.8	6	1	
SIS	>30	6	23d03/23d22	0.08/0.1	6	0.7	
SOHO							
EPHIN (INT)	>50	-	-	-	-	0.2	

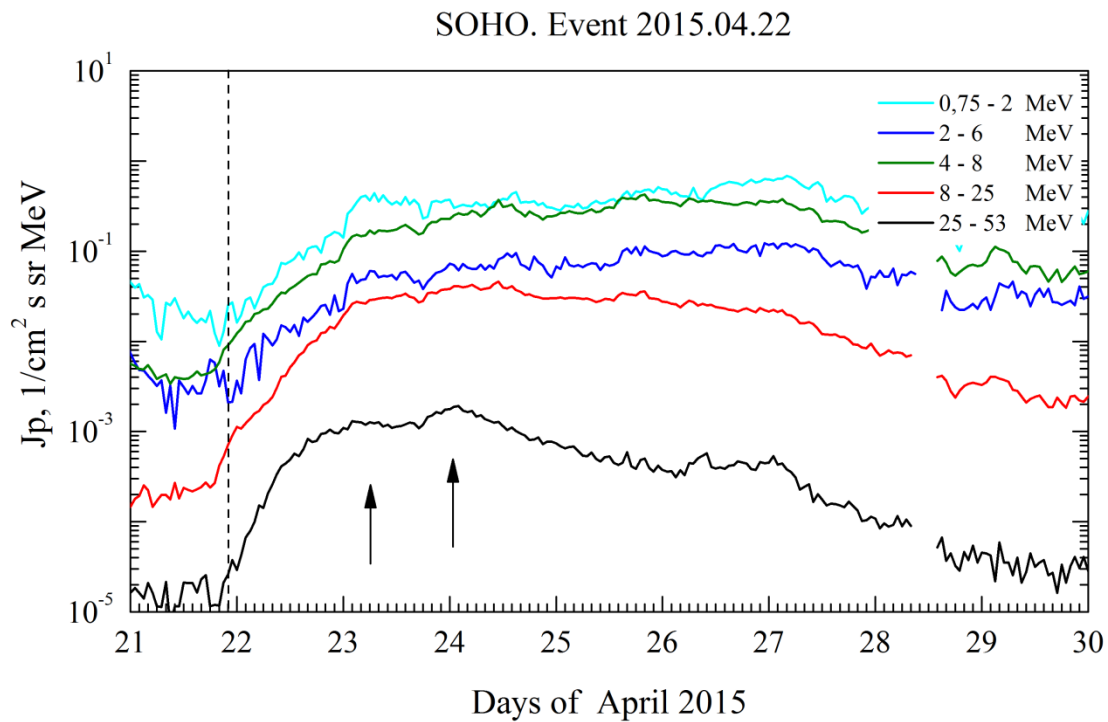
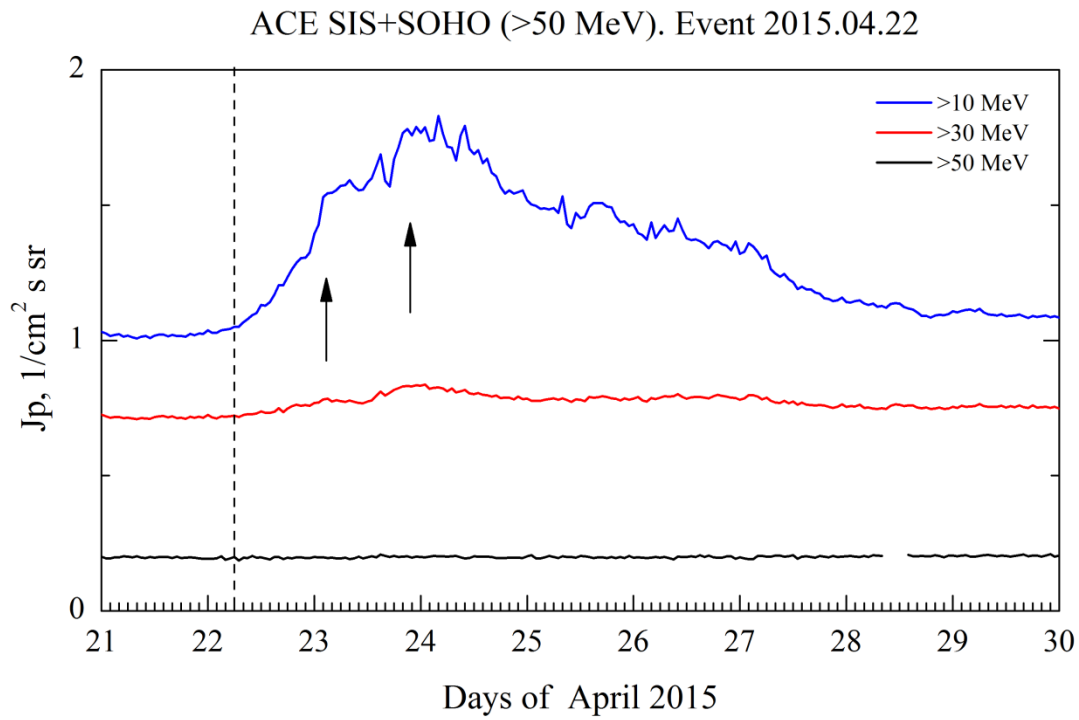
Differential fluxes of protons for the event of 2015 April 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	21d23	23d04/23d23	0.4/0.37	7	0.02	
LION	2 – 6	21d23	23d06/23d24	0.15/0.224	7	0.003	
EPHIN	4 – 8	21d23	23d06/23d24	0.052/0.07	7	0.004	
EPHIN	8 – 25	21d23	23d04/23d24	0.026/0.038	7	0.0002	
EPHIN	25 – 53	21d23	23d04/24d02	0.0013/0.0019	7	0.00002	
Electro-1							
SCR-E	13.7–23	4	23d03/24d06	0.023/0.029	3	0.05	
SCR-E	23–42	4	23d03/24d06	0.005/0.007	3	0.02	
SCR-E	42–112	4	23d03/24d06	0.0005/0.0007	-	0.004	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.032	25
MEPED	36–70	-	-	-	-	0.0046	50
MEPED	70–140	-	-	-	-	0.0007	100



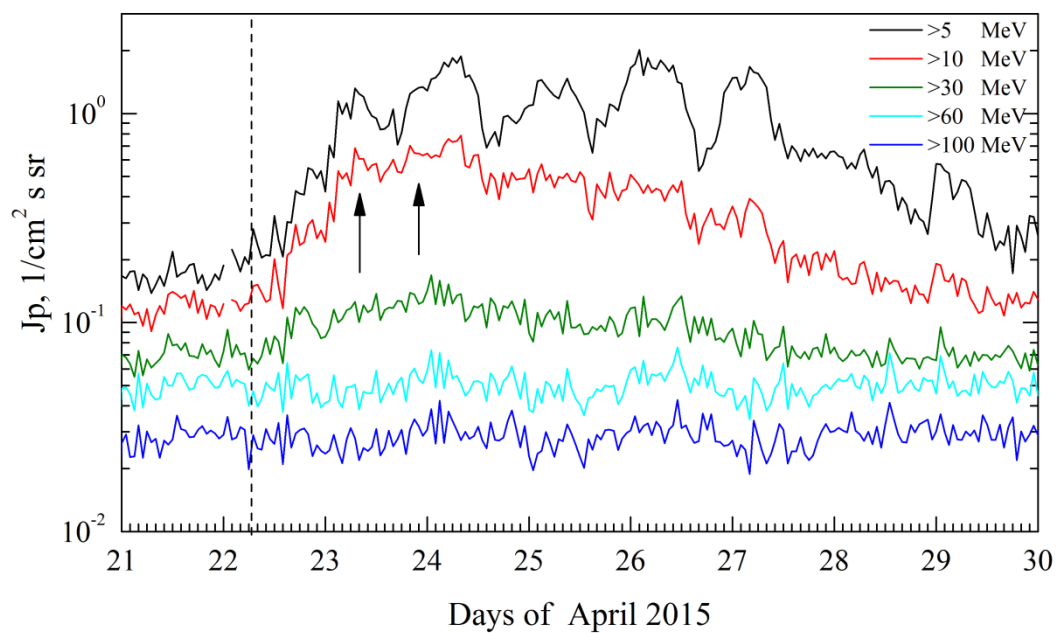
Time profiles of proton fluxes in the event 2015.04.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

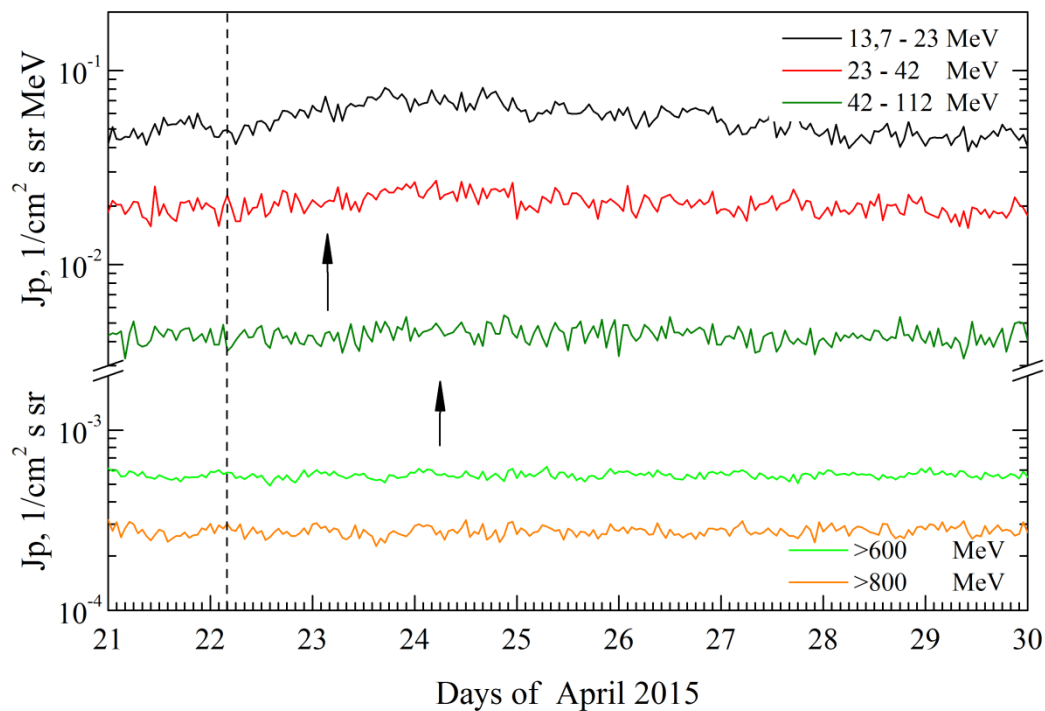


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.04.22

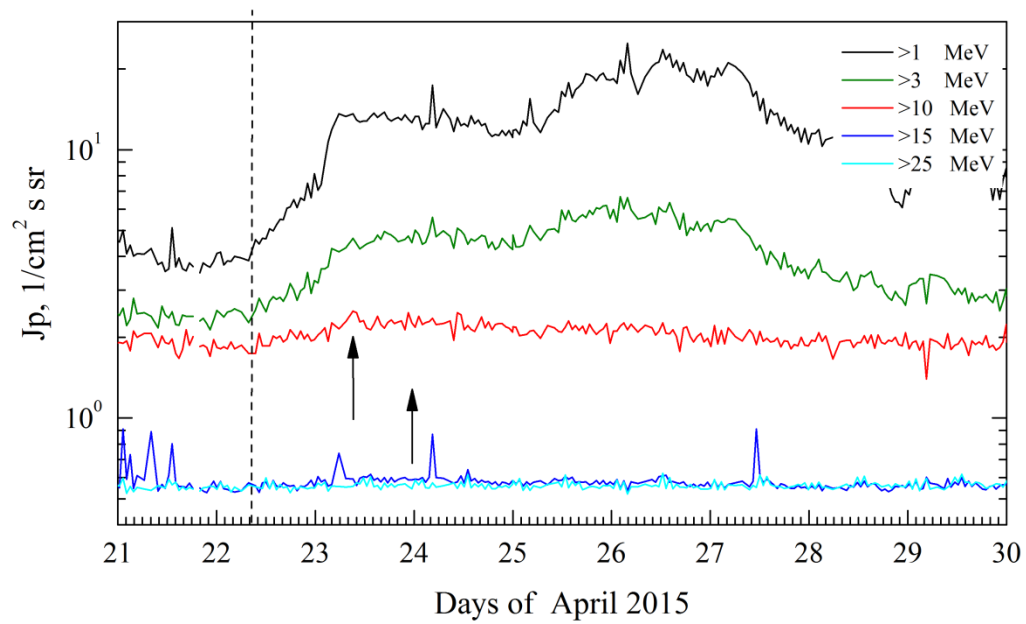


Electro. Event 2015.04.22

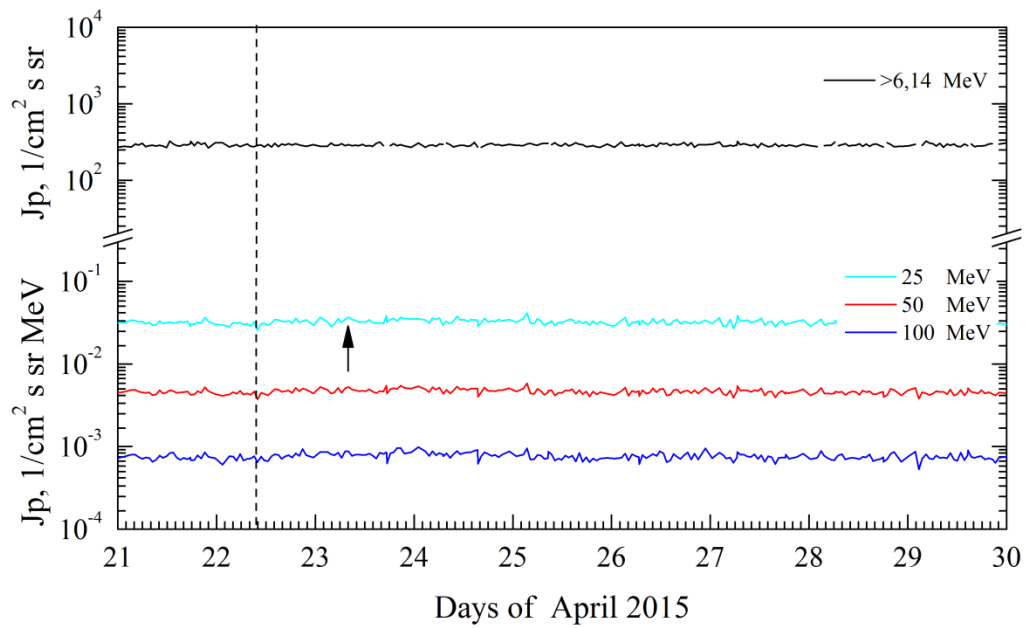


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.04.22



POES. Event 2015.04.22



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 April 22**

2015

April 22



AR 12322

To event 568

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optic flare on the visible disk					
1 – 12	keV	2139	2145	2155	N10W80	M1.8*	0.011
1 – 12	keV	2158	2201	2204	N09W80	M1.2*	0.0028
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	2135:04	2137:30	2139:12	6	5261	HESSI
100-300	keV	2139:12	2143:14	2154:56	1904	3255020	HESSI

*double X-ray burst

Particle event: To($E_p > 10$ MeV) – 12d04^h

Tmax($E_p > 10$ MeV) – 12d07^h, Jmax($E_p > 10$ MeV) – $5.4 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

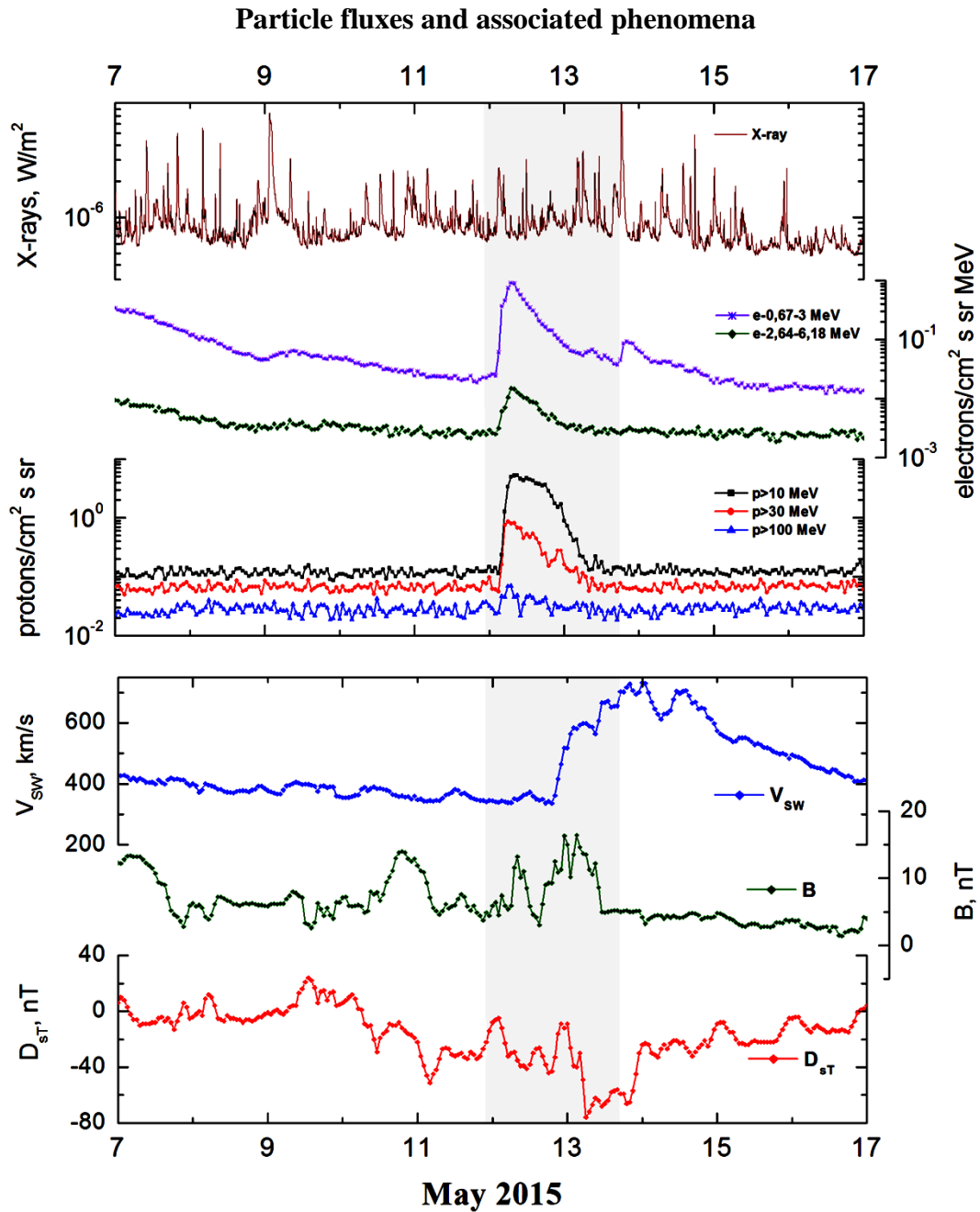
Duration of the event – 1.5 days, power-law index: $\gamma = 2.4$

Quasimaximal energy of protons in the event – $E_{qm} = 120$ MeV

Sources: ■ solar flare 12d02^h15^m, C2.6/DSF, S21W83, AR12335

Main burst X-ray 1–8 Å: onset – 12d02^h15^m, max – 12d03^h02^m, $\Phi = 0.0094 \text{ J/m}^2$

CME: 12d02^h48^m, $V = 772 \text{ km/s}$, $\Delta\phi = 250^\circ$, $dA = 283^\circ$

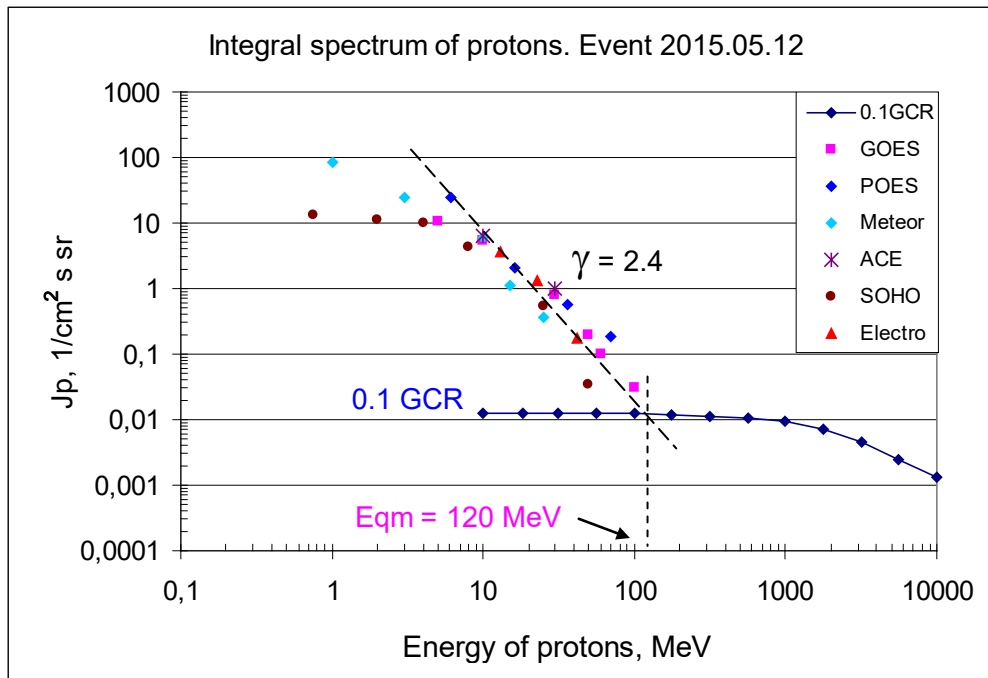


Integral fluxes of protons for the event of 2015 May 12

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	4	7	10.5	1.5	0.2	
EPS	>10	4	7	5.4	1.5	0.12	
EPS	>30	3	7	0.8	1.5	0.07	
EPS	>50	3	7	0.2	1	0.06	
EPS	>60	2	7	0.1	1	0.05	
EPS	>100	2	6	0.03	1	0.03	
Electro-1							
GALS-E	>600	4	6	0.0001	0.5	0.0006	
GALS-E	>800	-	-	-	-	0.0003	
POES							
MEPED	>6.14	-	9	24.4	0.4	280	
Meteor-2							
SCR	>1	4	10	86	1.5	3.8	
SCR	>3	4	10	25	1	2.4	
SCR	>10	4	10	6.3	1	1.9	
GALS-M	>15	3	10	1.1	0.75	0.6	
GALS-M	>25	3	11	0.4	0.75	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	3	8	6.3	1	1	
SIS	>30	3	8	1	1	0.7	
SOHO							
EPHIN	>50	3	8	0.035	1	9.2	

Differential fluxes of protons for the event of 2015 May 12

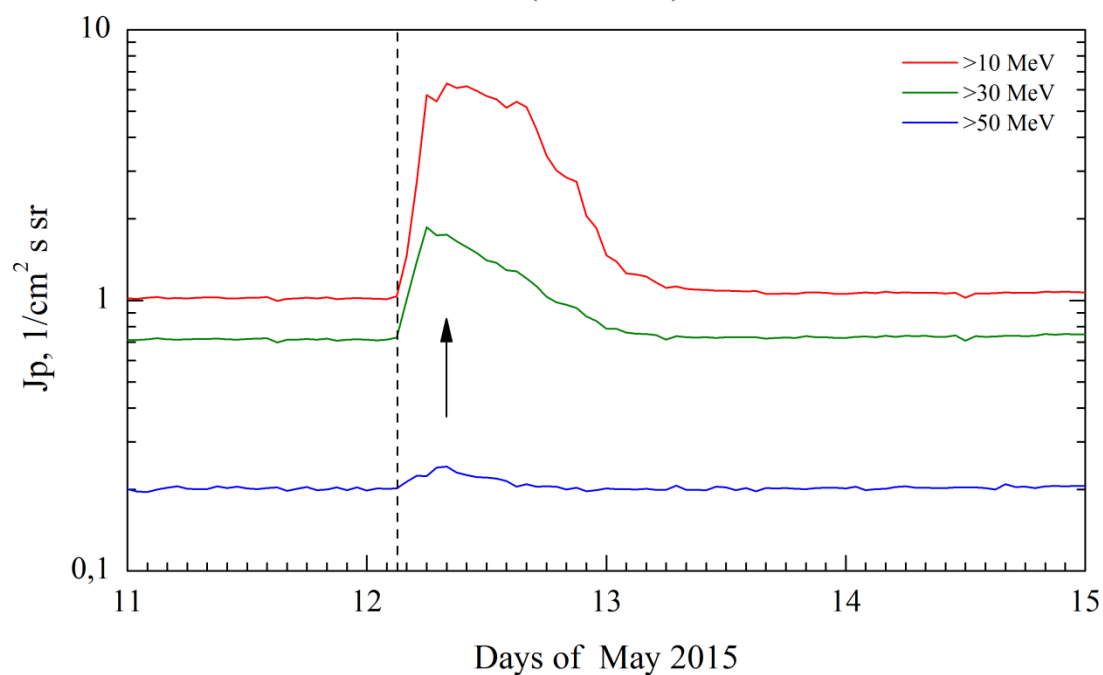
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	5	8	1.9	3	0.01	Logachev
LION	2 – 6	5	8	0.46	3	0.001	
EPHIN	4 – 8	3	8	1.42	3	0.001	
EPHIN	8 – 25	3	8	0.216	3	0.0001	
EPHIN	25 – 53	3	8	0.0183	3	0.00001	
Electro-1							
SCR-E	13.7–23	4	7	0.25	1	0.05	
SCR-E	23–42	4	6	0.06	1	0.02	
SCR-E	42–112	4	6	0.0025	1	0.004	
POES							<E>, MeV
MEPED	16–36	04	6	0.073	0.8	0.032	25
MEPED	36–70	04	5	0.0116	0.8	0.0046	50
MEPED	70–140	04	5	0.0027	0.7	0.00072	100



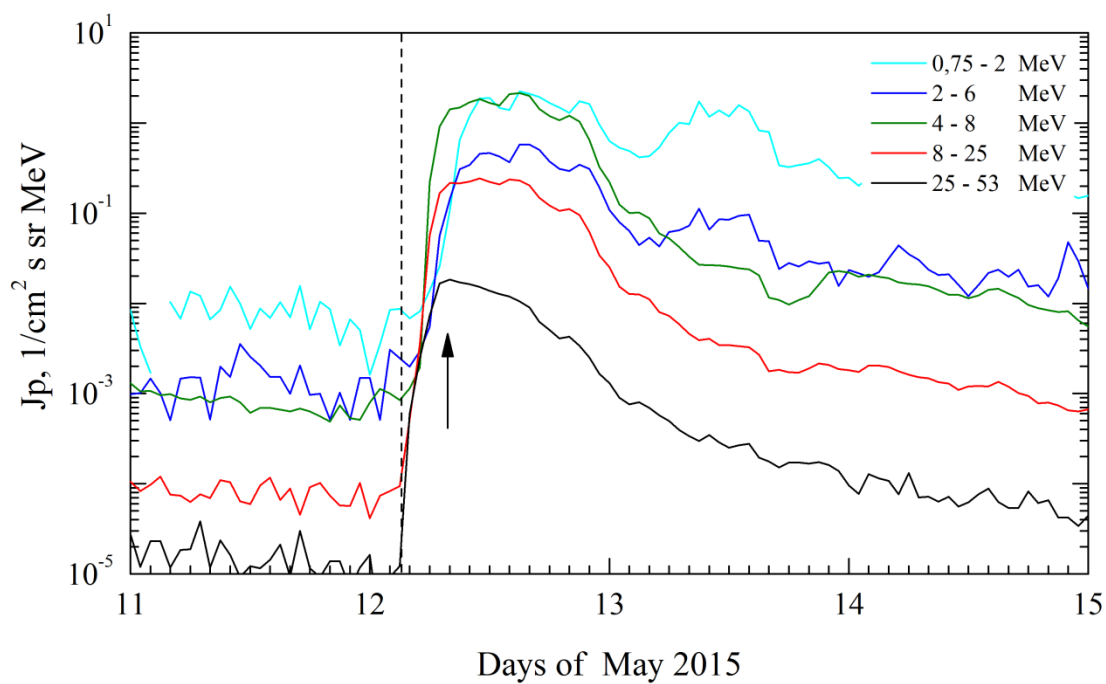
Time profiles of proton fluxes in the event 2015.05.12

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.05.12

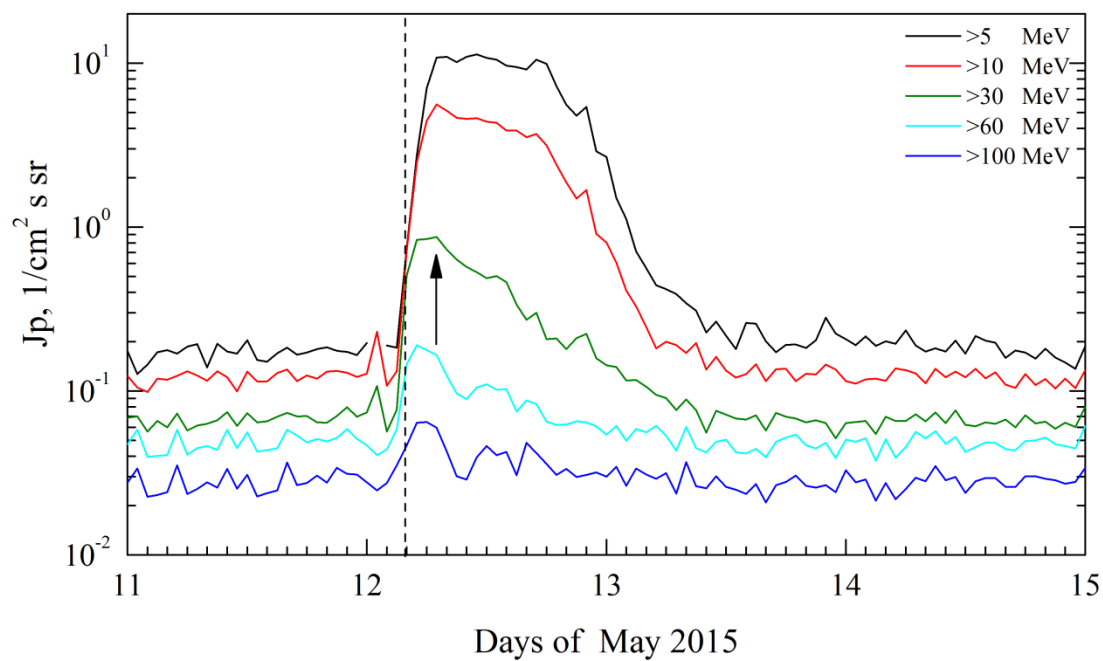


SOHO. Event 2015.05.12

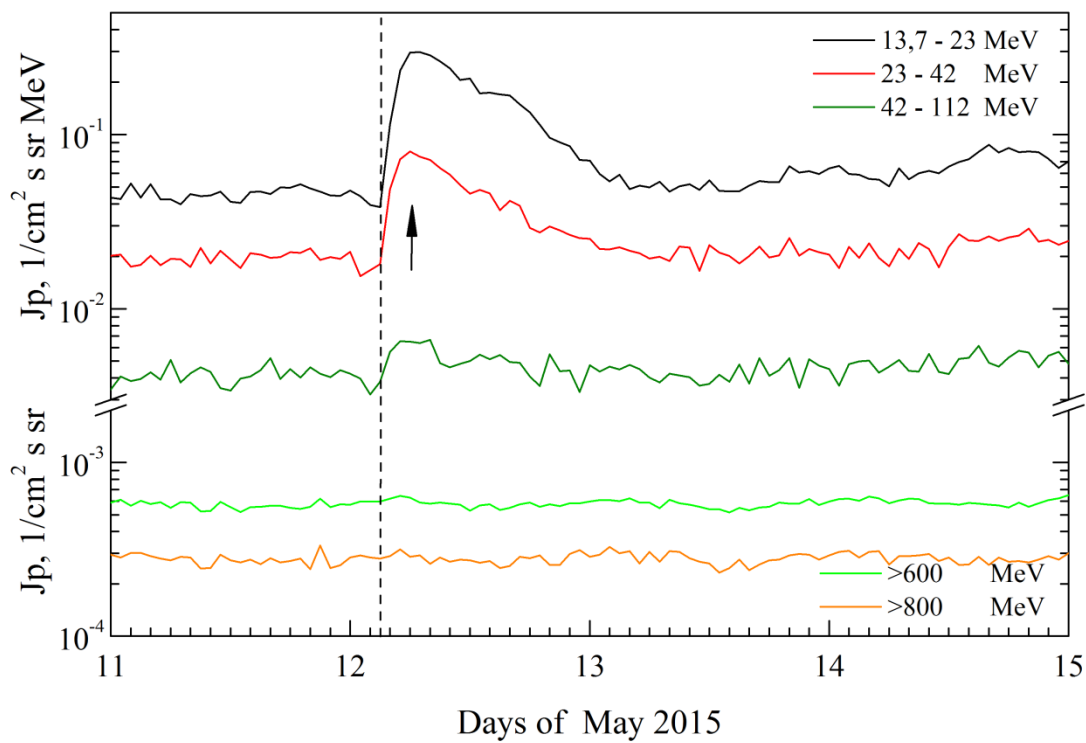


Earth satellites in geostationary orbit, $R \approx 66 R_E$: GOES and Electro

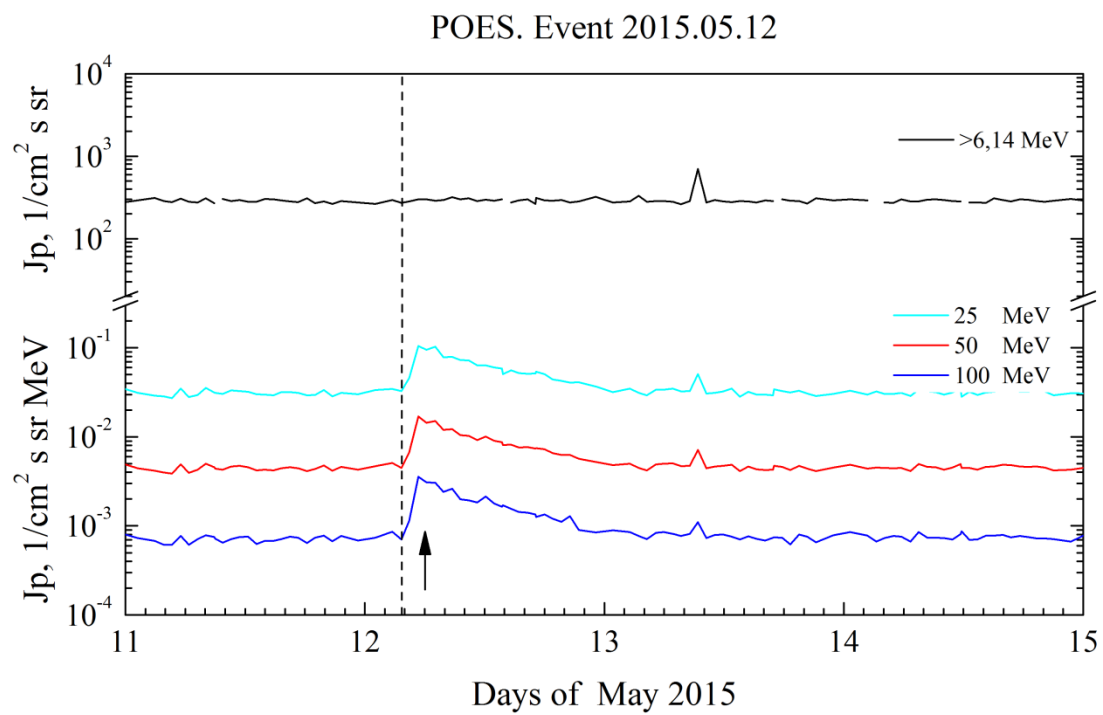
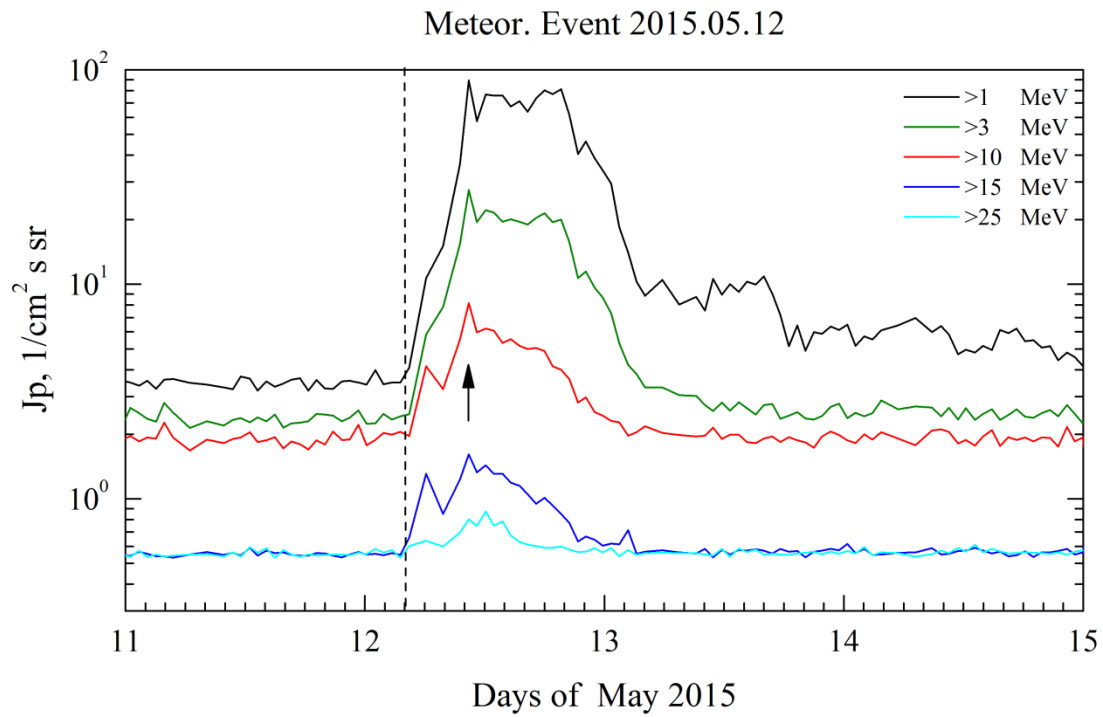
GOES. Event 2015.05.12



Electro. Event 2015.05.12



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 May 12**

2015

May 12



AR 12335

To event 569

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	DSF*	0226		0248	S21W83	22°	
1 – 12	keV	0215	0302	0342	S21W83	C2.6	0.0094
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	30-45	0247		0252		1	
DS III	75-117	0252		0252		1	
DH II	6.4-14	0300		0304			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0248	772	- 5.9	250°	283°	SOHO

*https://sdowwww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_150512_123609_1775_1/www/

Proton Active Region:

AR12335 (S15L193, CMP 06,9.05.2015,
Sp=310 msh, EKC, BG, R)
XRI=0.39 $M_2^{2.6}+C_{23}$ $2_1+1_2+S_{53}$
PFR 5.05: (4^h) $M_2^{2.6}$

References:

Koleva K., M. Dechev, P. Duchlev, [2021](#).
Richardson, I.G., T.T., von Roseninge, H.V. Cane, [2016](#).
Tsvetkov Ts., R. Miteva, N. Petrova, [2018](#).

Particle event: To($E_p > 10$ MeV) – 18d02^h

Tmax($E_p > 10$ MeV) – 18d14^h, Jmax($E_p > 10$ MeV) – 15.4 /cm²·s·sr

Duration of the event – 2.5 days, power-law index: $\gamma = 3.2$

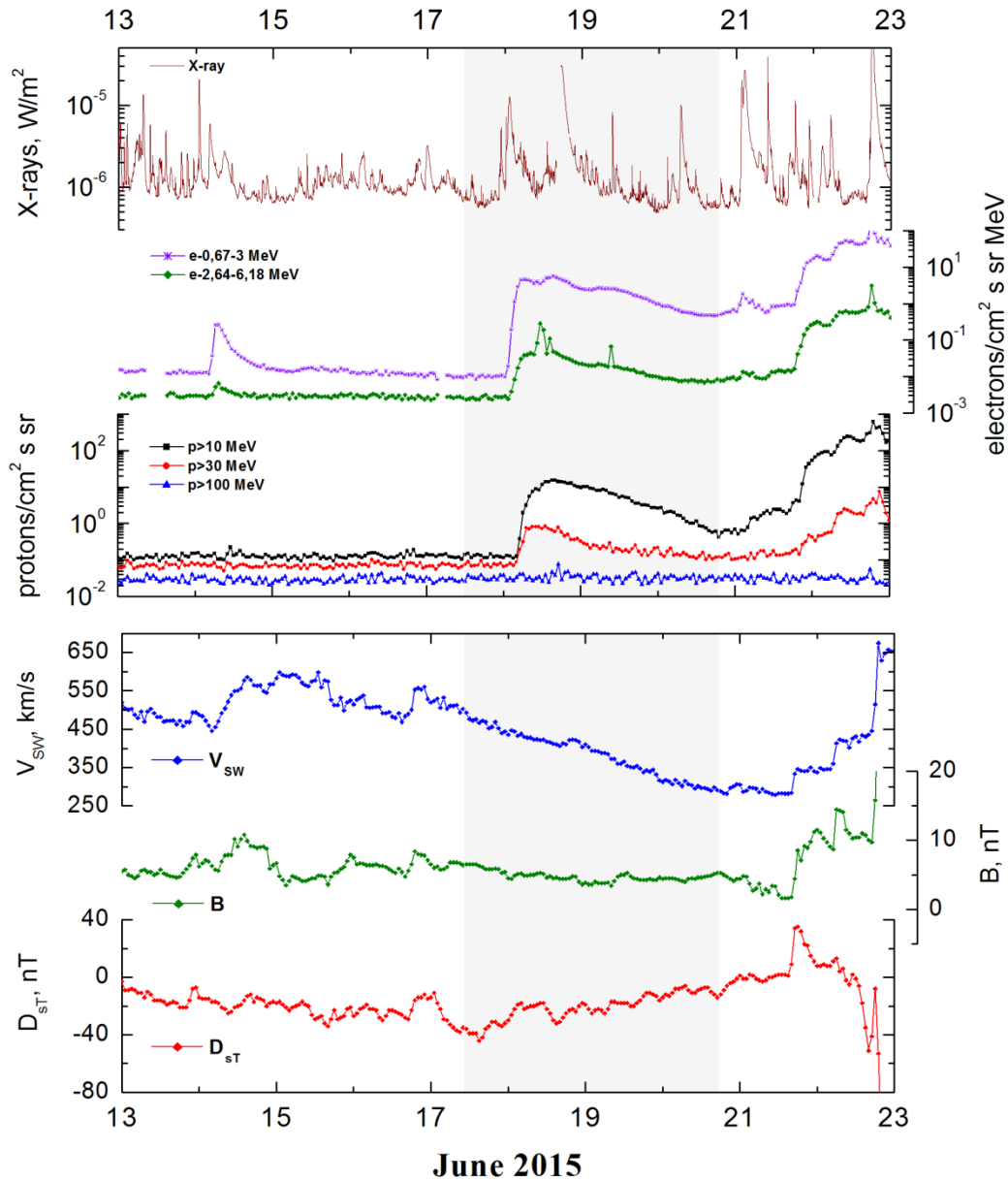
Quasimaximal energy of protons in the event – $E_{qm} = 100$ MeV

Sources: ■ solar flare 18d00^h33^m, M1.3, S16W81, AR12365

Main burst X-ray 1–8 Å: onset – 18d00^h33^m, max – 18d01^h27^m, $\Phi = 0.04$ J/m²

CME: 18d01^h26^m, $V = 1714$ km/s, $\Delta\phi = 195^\circ$, $dA = 270^\circ$

Particle fluxes and associated phenomena

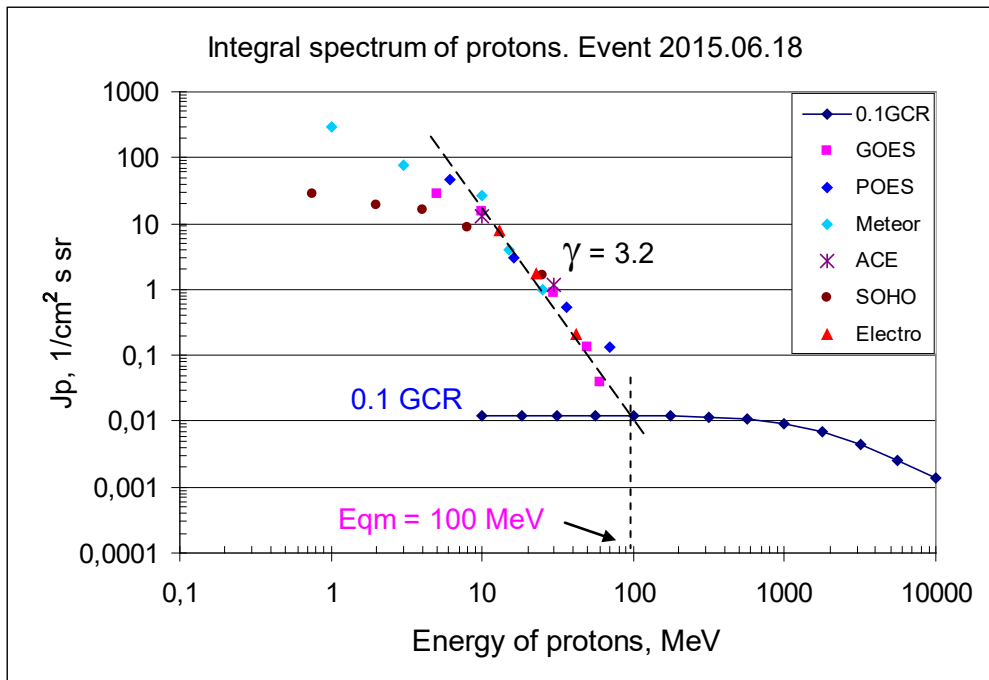


Integral fluxes of protons for the event of 2015 June 18

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	15	28.5	2.5	0.2	
EPS	>10	2	14	15.4	2.5	0.12	
EPS	>30	2	12	0.9	1.5	0.07	
EPS	>50	2	12	0.13	1	0.06	
EPS	>60	2	12	0.04	1	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0006	
POES							
MEPED	>6.14	04	23	45.6	2	290	
Meteor-2							
SCR	>1	4	21	300	3	3.9	
SCR	>3	4	18	76	3	2.3	
SCR	>10	4	17	26	2	1.9	
GALS-M	>15	4	17	4	1.5	0.6	
GALS-M	>25	4	13	1	1	0.5	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	3	12	13	3	1.1	
SIS	>30	3	12	1.2	3	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2015 June 18

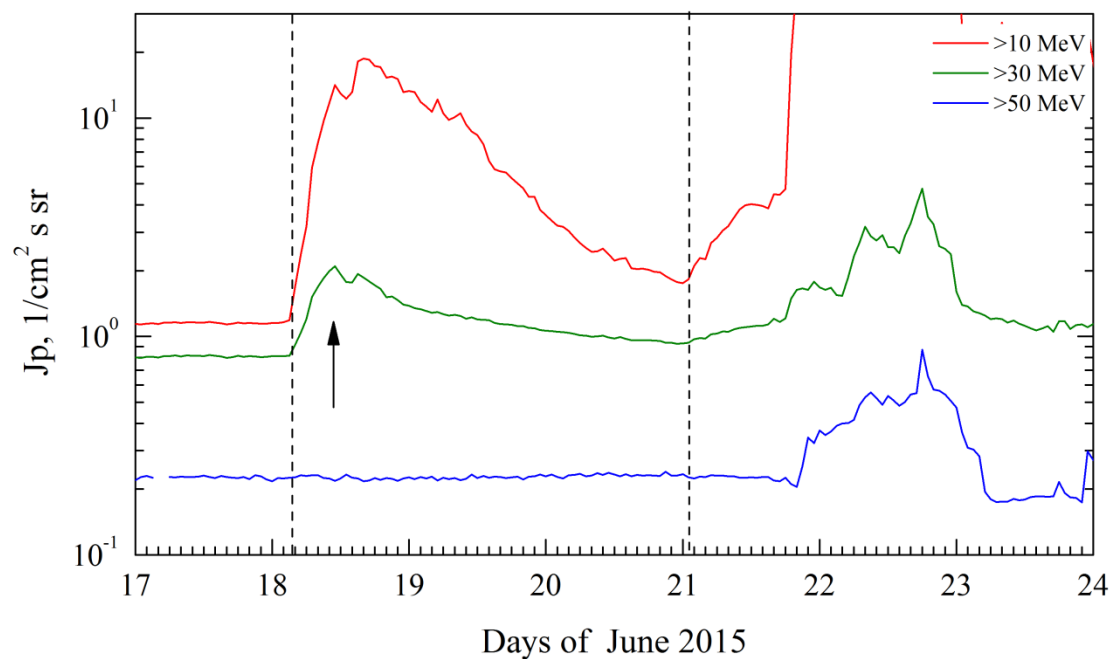
S/c. instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	4	12	6.98	3	0.01	
LION	2 – 6	4	12	0.926	3	0.001	
EPHIN	4 – 8	4	12	1.93	3	0.0001	
EPHIN	8 – 25	4	12	0.43	3	0.00001	
EPHIN	25 – 53	4	11	0.0556	3	0.00001	
Electro-1							
SCR-E	13.7–23	4	11	0.68	1.5	0.05	
SCR-E	23–42	4	11	0.08	1.5	0.02	
SCR-E	42–112	4	9	0.003	0.5	0.004	
POES							<E>, MeV
MEPED	16–36	04	10	0.123	3	0.033	25
MEPED	36–70	04	10	0.0123	3	0.0048	50
MEPED	70–140	04	7	0.0019	3	0.0008	100



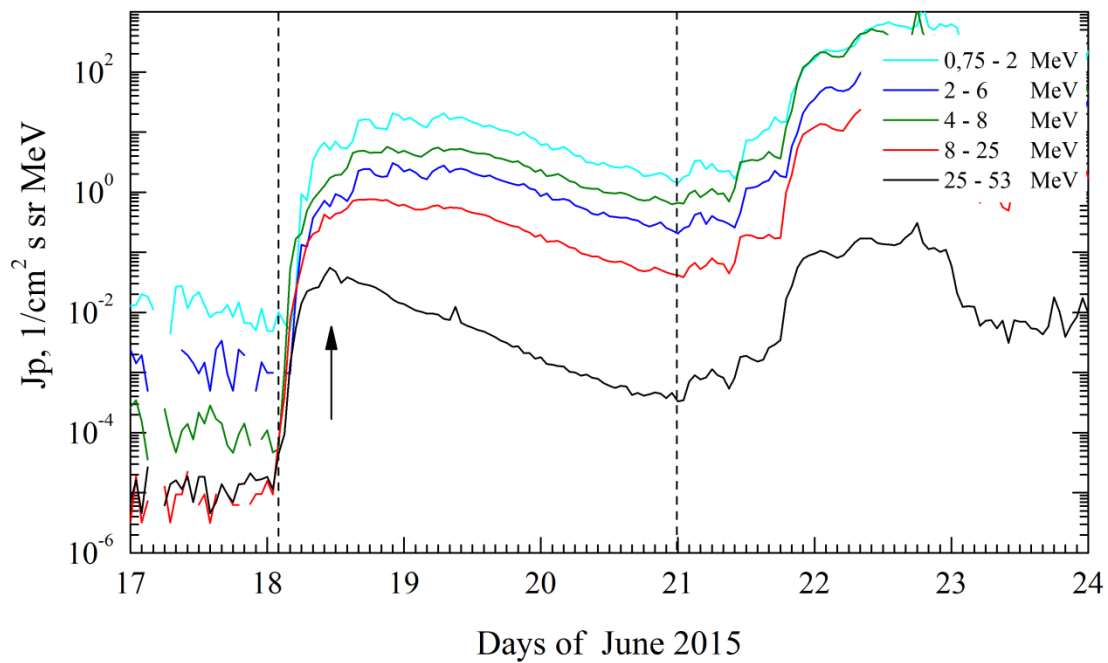
Time profiles of proton fluxes in the event 2015.06.18

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.06.18

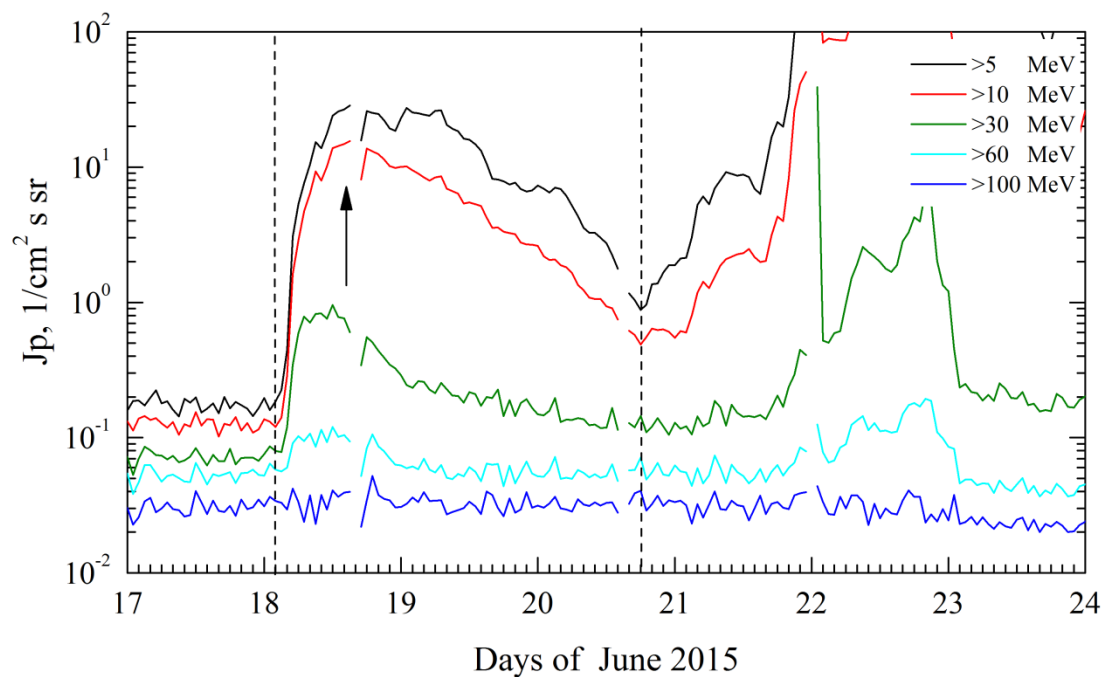


SOHO. Event 2015.06.18

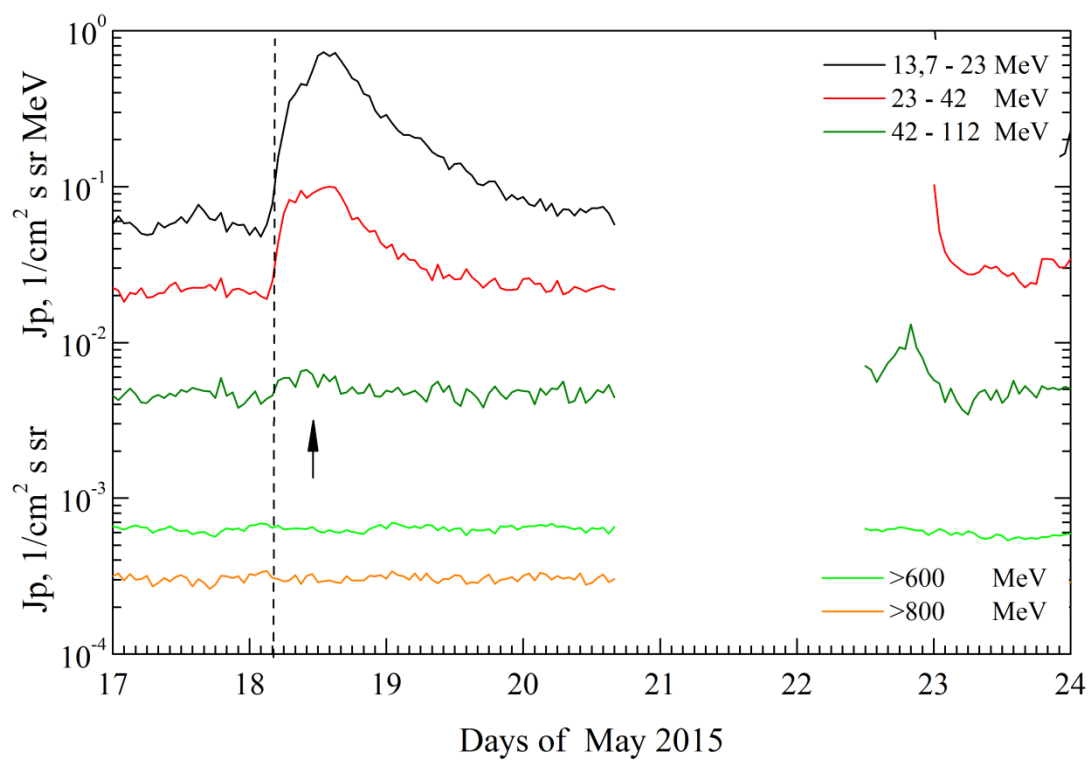


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2015.06.18

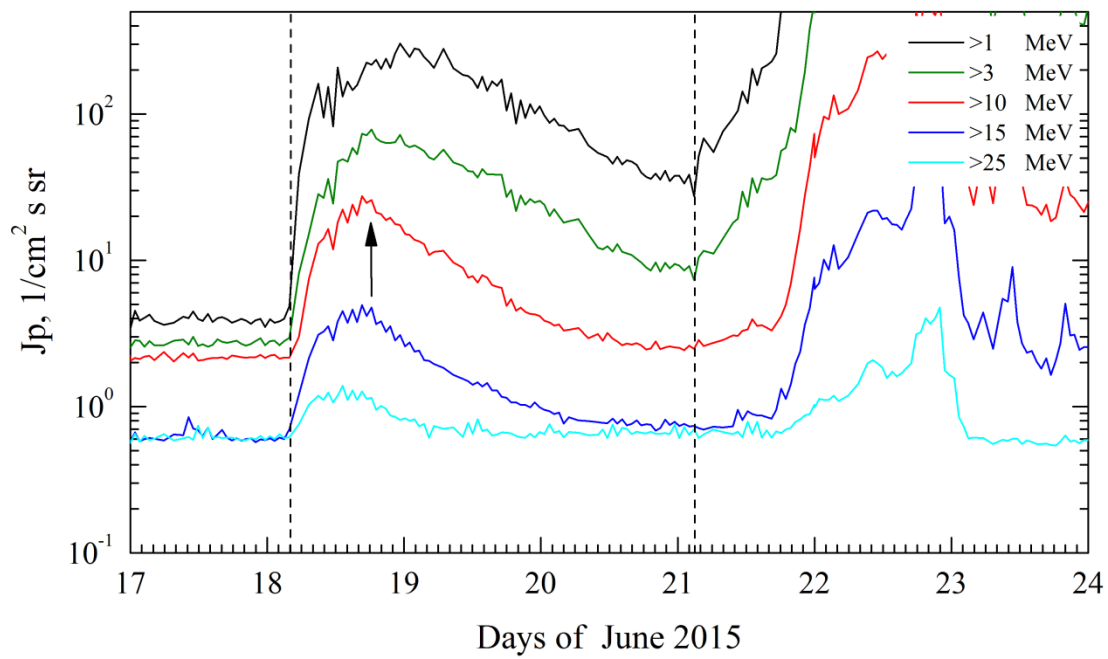


Electro. Event 2015.06.18

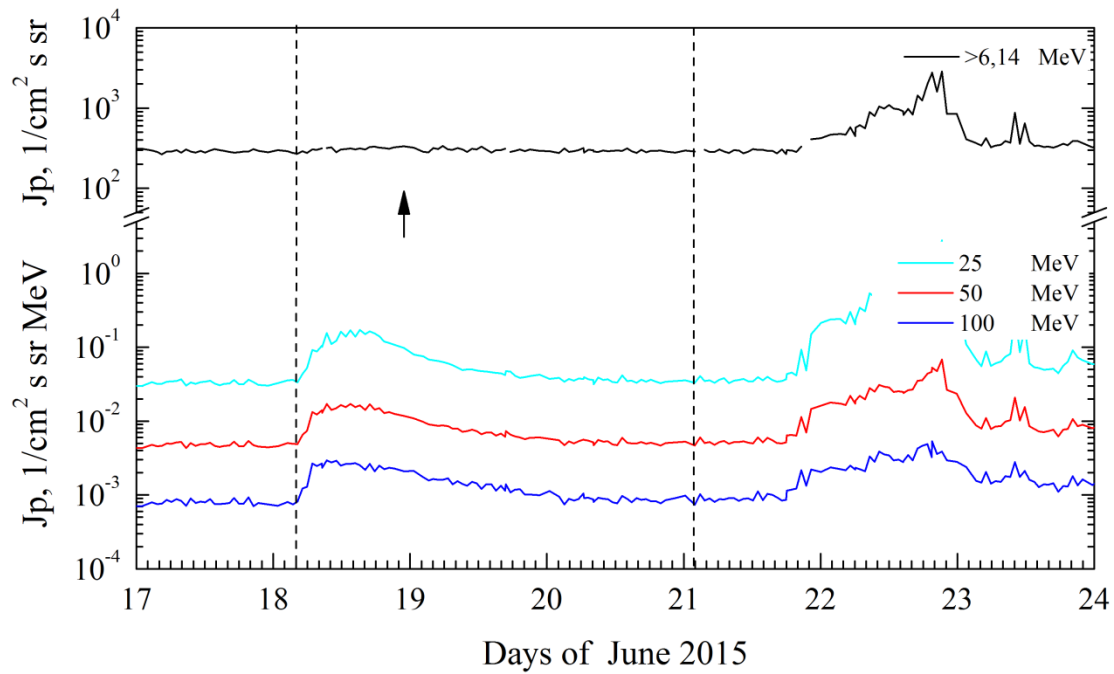


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2015.06.18



POES. Event 2015.06.18



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 June 18**

2015

June 18



AR 12365

To event 570

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on the visible disk					
1 – 12	keV	0033	0127	0155	S16W81	M1.3	0.04
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0102:01	0110:29	0146:48		836307	FERMI
12-25	keV	0121:16	0127:10	0137:20	108	353908	HESSI
12-25	keV	0137:20	0141:54	0216:00	56	306206	HESSI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	0147	0147	0147		2.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS VI	25-180	0055		0505		1	
DS III	27-80	0104		0111		1	
DS III	70-140	0139		0139		1	
DS III	25-180	0147		0148		1	
DS III	18-250	0148		0149		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0126	1714	27.7	195°	270°	SOHO

Proton Active Region:

AR 12365 (S13L1080, CMP 11,4.06.2021,
Sp=140 msh, HSX, B, R)
XRI=0.12 M₁^{1.2}+C₄ S₂
PFR 18.06 M₁^{1.2}

References:

Кичигин Г.Н., Кравцова М.В., Сдобнов В.Е., [2018](#).
Матюгов С.С., Яковлев О.И., Павельев А.А. , [2021](#).
Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
Koleva K., M. Dechev, P. Duchlev, [2021](#).
NOAA SPE, [2019](#).
Núñez M., T. Nieves-Chinchilla and A. Pulkkinen, [2019](#).
Tsvetkov Ts., R. Miteva, N. Petrova, [2018](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 21d16^h

Tmax₁($E_p > 10$ MeV) – 22d10^h, Jmax₁($E_p > 10$ MeV) – 230 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 22d19^h, Jmax₂($E_p > 10$ MeV) – 600 /cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma_1 = 4.15$, $\gamma_2 = 4.3$

Quasimaximal energy of protons in the event – Eqm₁ = 100 MeV

– Eqm₂ = 110 MeV

Sources: ● solar flare 21d01^h02^m, M2.0, M2.7/1N, N12E13, AR12371

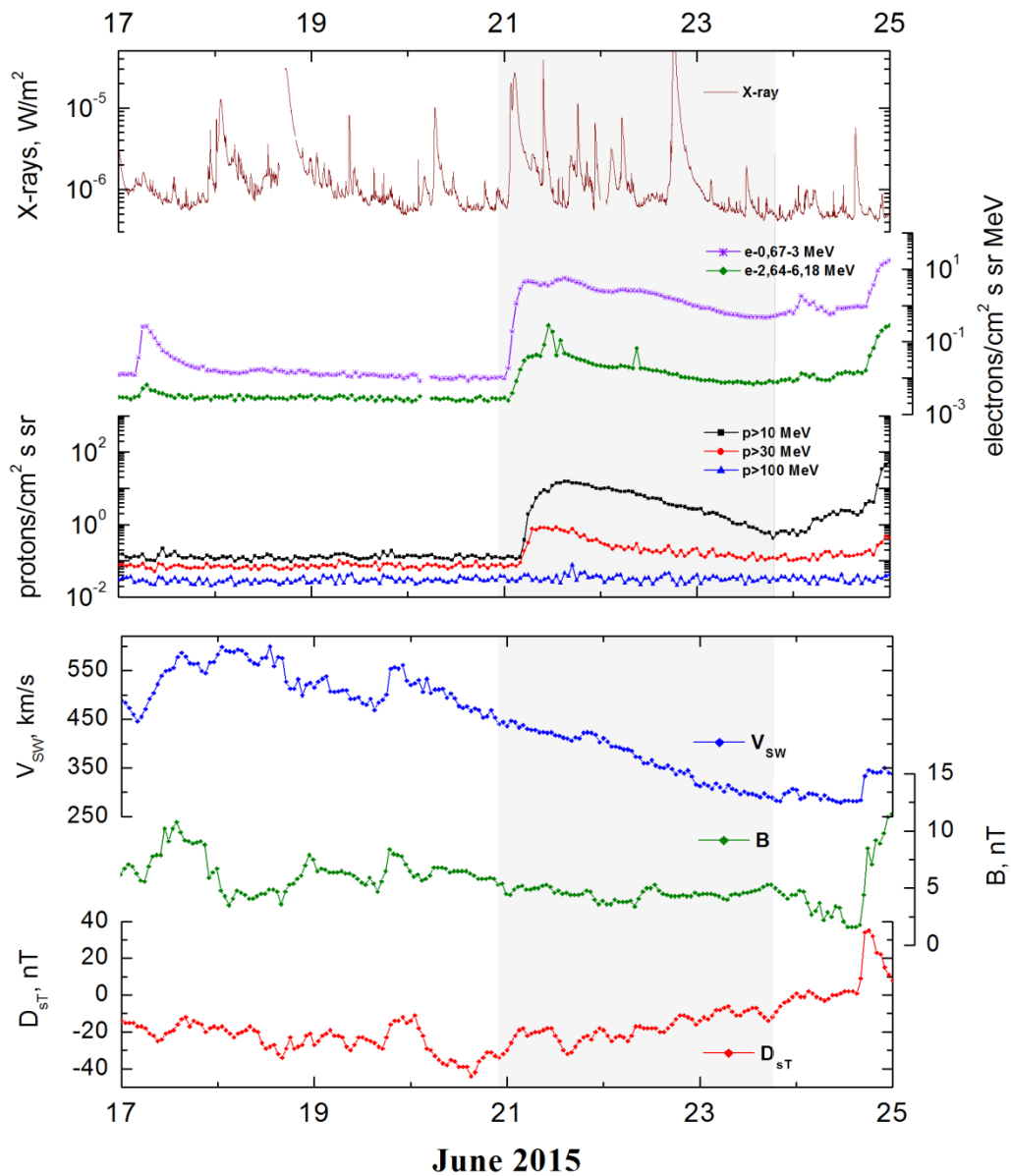
○ solar flare 22d17^h23^m, 2B/M6.5; N12W08, AR12371

Main burst X-ray 1–8 Å: onset – 21d01^h02^m, max – 21d01^h42^m, $\Phi = 0.032$ J/m²

CME: 21d02^h36^m, $V = 1366$ km/s, $\Delta\phi = 360^\circ$, dA = 72°

▲ SC 21d16^h43^m, ▲ SC 22d05^h45^m, ▲ SC 22d18^h33^m

Particle fluxes and associated phenomena

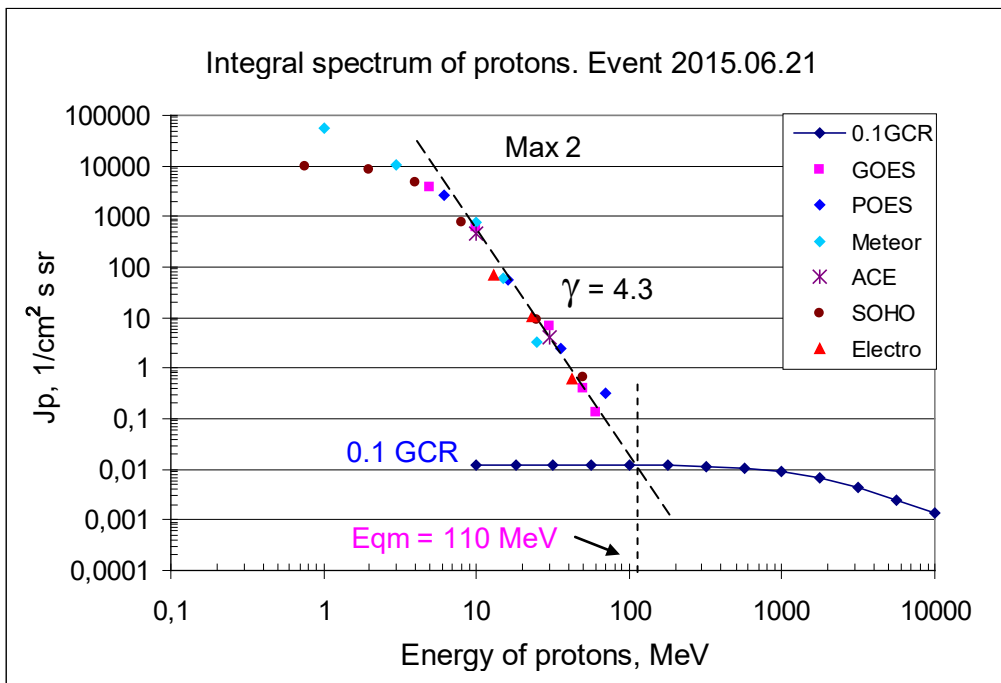
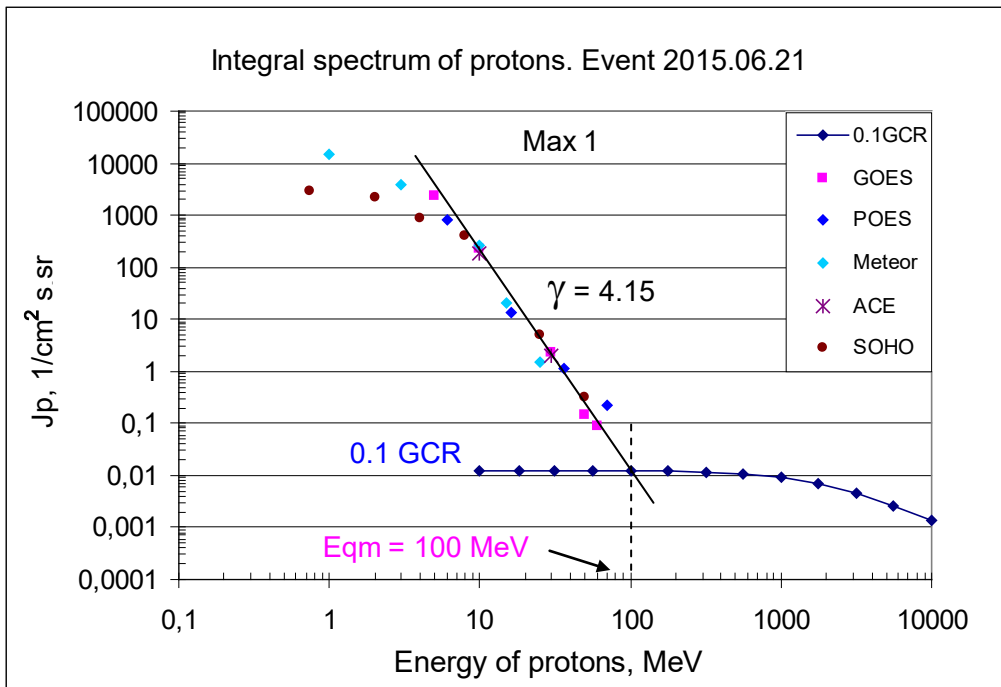


Integral fluxes of protons for the event of 2015 June 21

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	16	22d10/22d19	2290/3930	4	0.2	
EPS	>10	16	22d10/22d19	230/600	4	0.15	
EPS	>30	16	22d10/22d20	2.3/6.7	1.5	0.07	
EPS	>50	16	22d10/22d20	0.15/0.4	1.5	0.06	
EPS	>60	16	22d10/22d20	0.09/0.13	1.5	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	20	22d12/22d22	800/2570	2	290	
Meteor-2							
SCR	>1	3	22d10/22d19	14400/56200	4.5	3.8	
SCR	>3	3	22d10/22d19	3890/10200	4.5	2.7	
SCR	>10	16	22d10/22d19	267/746	4	2.2	
GALS-M	>15	18	22d10/22d19	21/59	2.5	0.6	
GALS-M	>25	22	22d10/22d19	1.5/3.4	2	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	18	22d11/22d18	190/470	4	1.1	
SIS	>30	18	22d09/22d18	2.5/4	4	0.7	
SOHO							
EPHIN	>50	21	22d09/22d18	0.32/0.64	1.5	0.23	

Differential fluxes of protons for the event of 2015 June 21

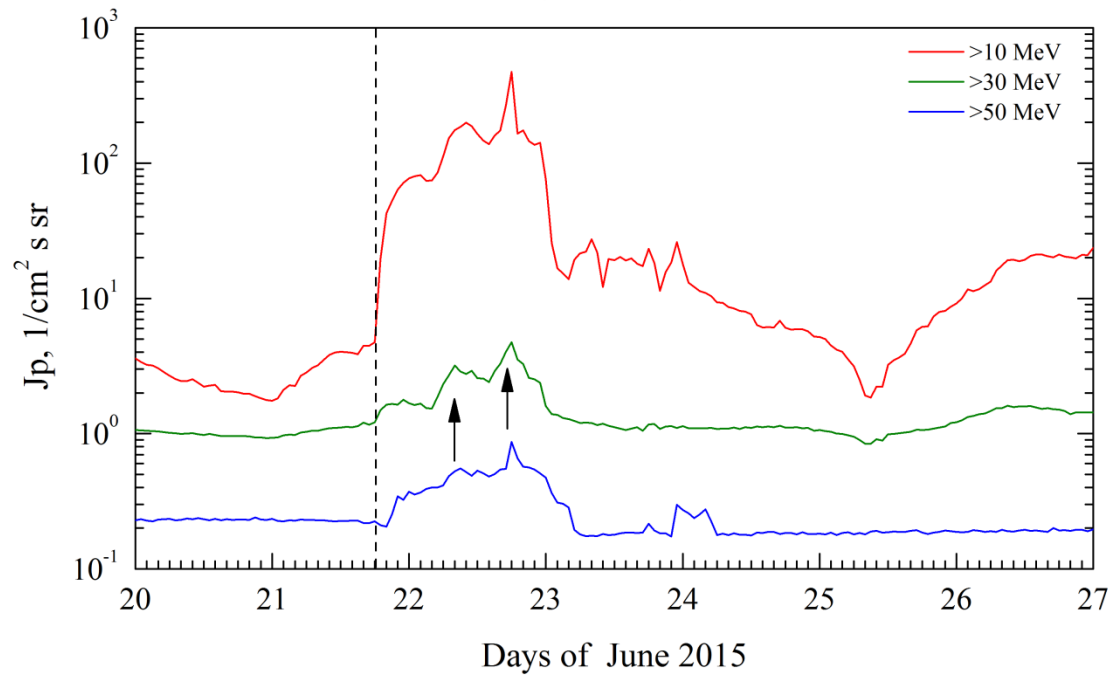
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	11	22d08/22d18	498/1300	4	0.01	
LION	2 – 6	11	22d08/22d18	446/1130	4	0.001	
EPHIN	4 – 8	11	22d08/22d18	123/1000	4	0.0001	
EPHIN	8 – 25	11	22d08/22d18	23.4/44.2	4	0.00001	
EPHIN	25 – 53	11	22d08/22d18	0.17/0.31	4	0.00001	
Electro-1							
SCR-E	13.7–23	-	- /22d19	- /6.2	1	0.07	
SCR-E	23–42	-	- /22d19	- /0.52	1	0.02	
SCR-E	42–112	-	- /22d19	- /0.009	1	0.004	
POES							<E>, MeV
MEPED	16–36	18	22d12/22d22	0.62/2.76	2	0.033	25
MEPED	36–70	18	22d12/22d22	0.026/0.064	2	0.0048	50
MEPED	70–140	18	22d12/22d20	0.0031/0.0045	2	0.0008	100



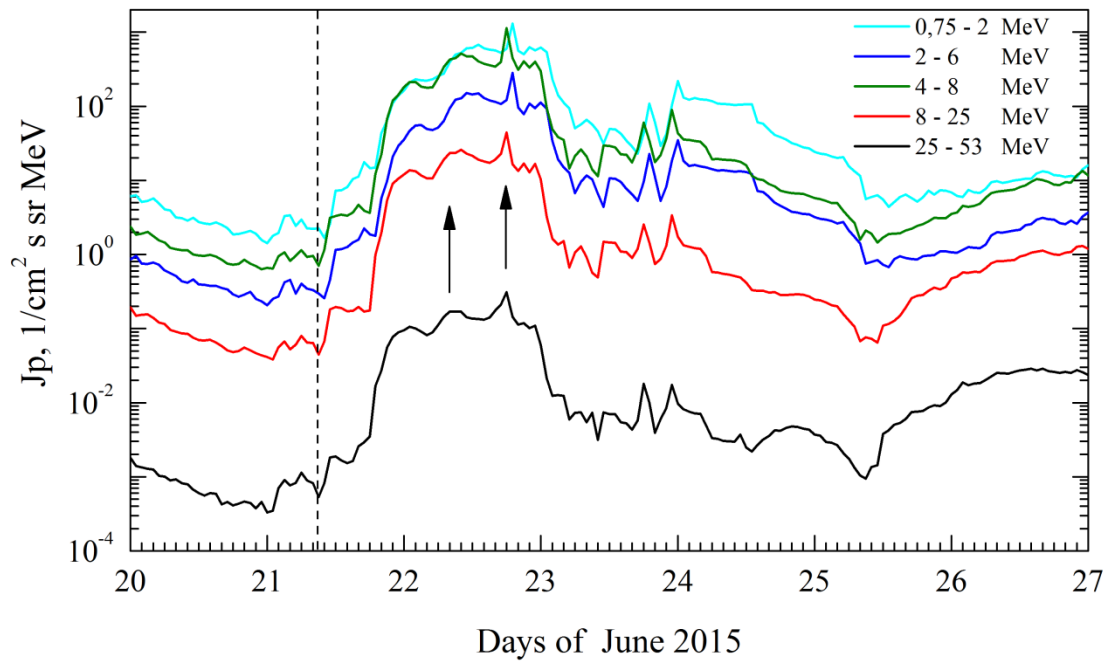
Time profiles of proton fluxes in the event 2015.06.21

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.06.21

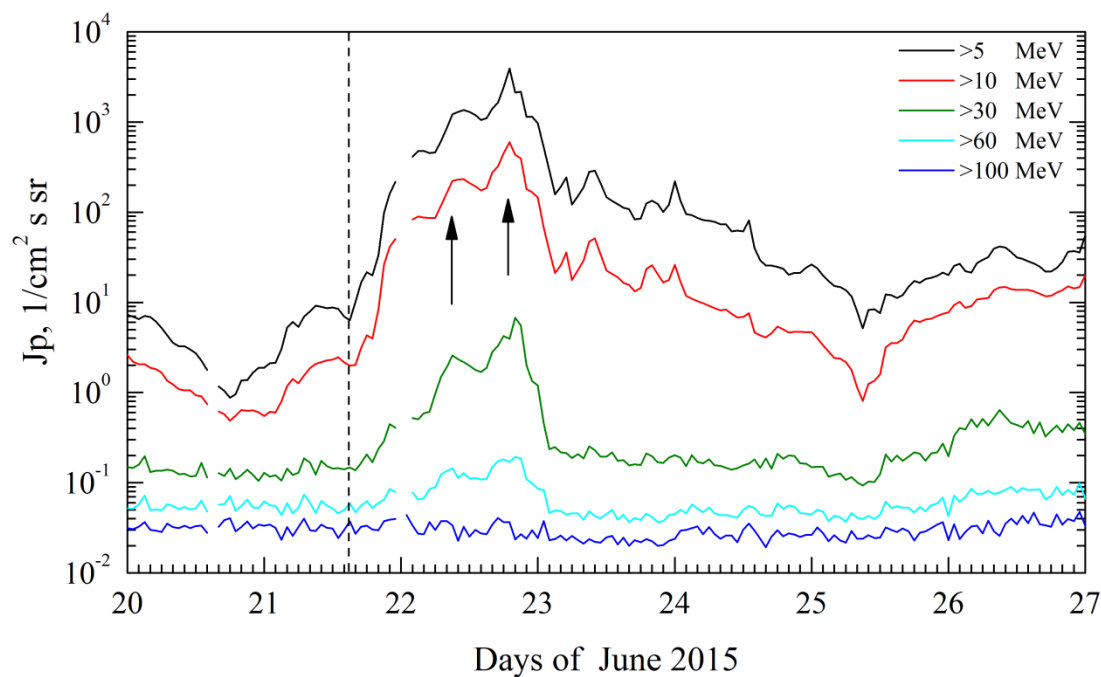


SOHO. Event 2015.06.21

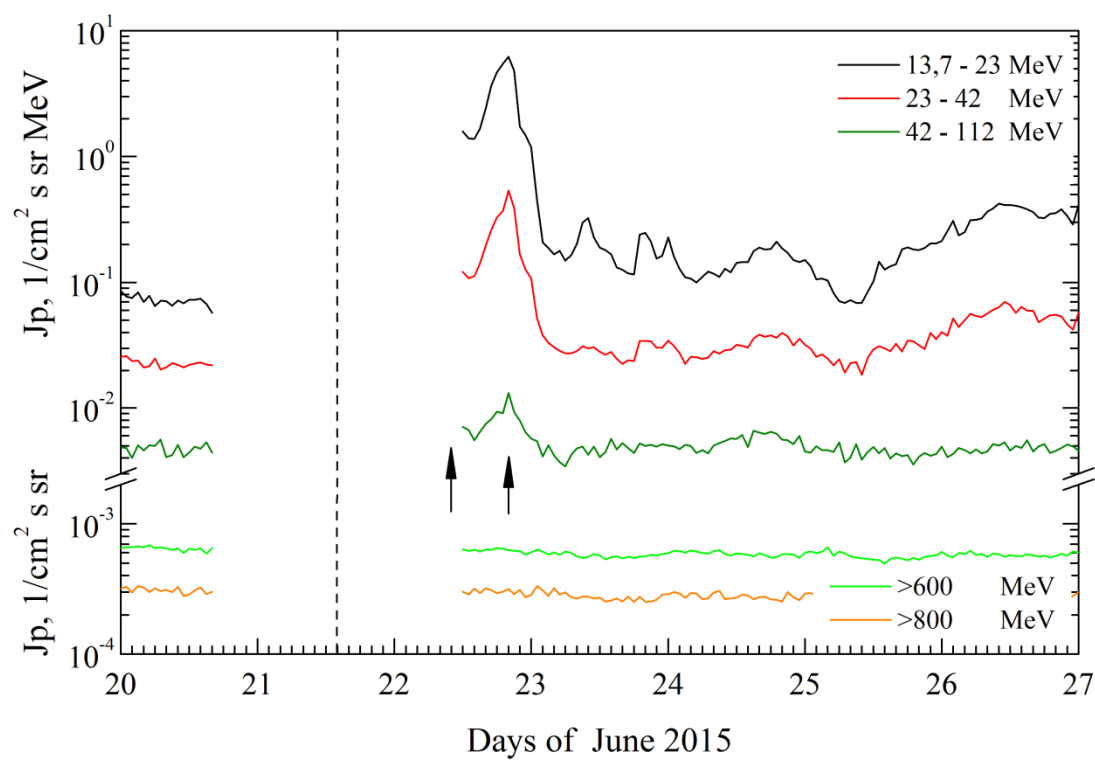


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.06.21

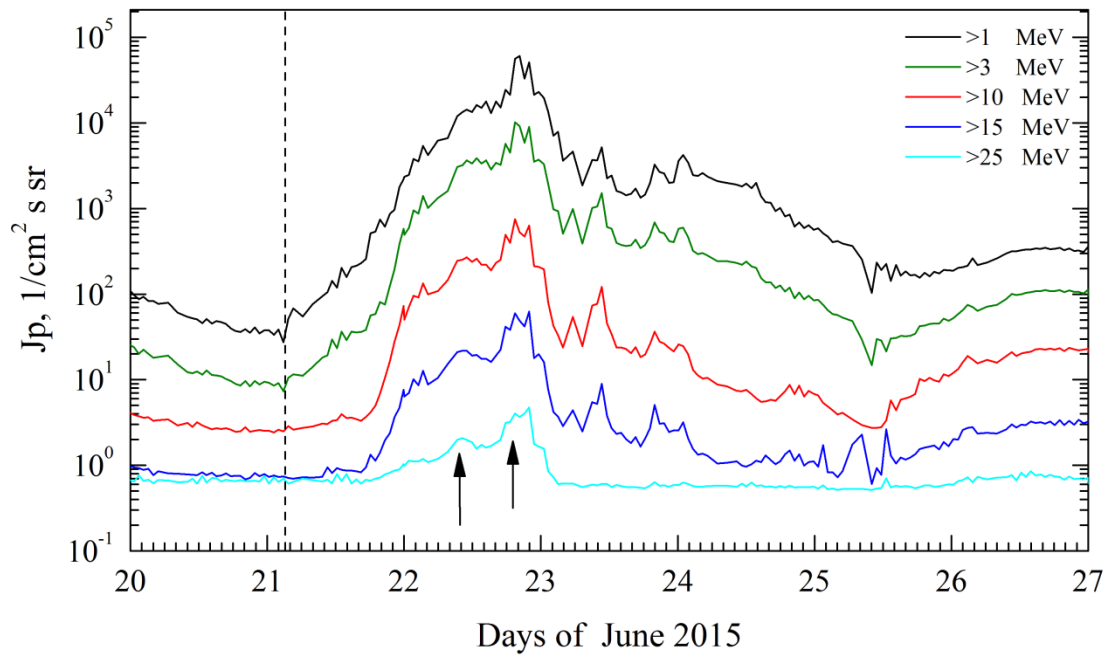


Electro. Event 2015.06.21

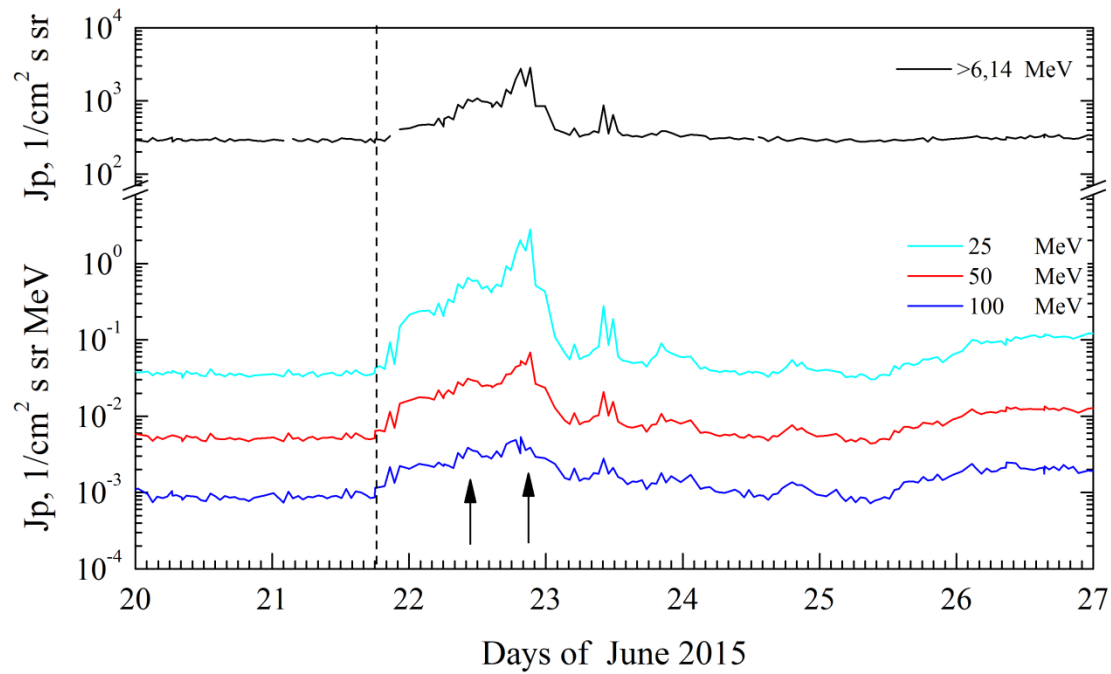


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.06.21



POES. Event 2015.06.21



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 June 21 • AR12371 To event 571**

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0107	0140	0434	N12E13	1N	UMB
1 – 12	keV	0102	0142	0200		M2.0	0.032
1 – 12	keV	0206	0236	0302		M2.7	
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0108:00	0113:46	0118:56	23	45946	HESSI
25-50	keV	0118:56	0127:42	0129:00	368	390275	HESSI
100-300	keV	0158:04	0228:14	0303:08	1264	12931743	HESSI
12-25	keV	0332:44	0333:18	0345:16	339	143652	HESSI
12-25	keV	0345:16	0345:42	0349:20	28	37013	HESSI
12-25	keV	0349:20	0351:02	0401:04	27	92524	HESSI
6-12	keV	0401:04	0401:06	0410:08	20	56736	HESSI
6-12	keV	0410:08	0411:02	0423:44	18	73416	HESSI
12-25	keV	0121:50	0125:15	0125:51	7981	222287	HESSI
12-25	keV	0201:42	0221:09	0301:06	58948	58948	FERMI
12-25	keV	0348:24	0406:42	0413:15	769	212221	FERMI
>100	MeV	0519:30		0553:30		2.66E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0135	0136	0140		2.89	
8.8	GHz	0129	0129	0130		2.11	
5	GHz	0134	0136	0143		2.95	
2.7	GHz	0152	0152	0152		2.0	
1.4	GHz	0203	0249	0315		2.81	
610	MHz	0136	0137	0137		2.18	
410	MHz	0136	0136	0136	0.4 / 1.4	2.08	
245	MHz	0152	0152	0152		2.56	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS VI	25-180	0151		0425		2	
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0222	0238	0255		2.08	
8.8	GHz	0207	0225	0315		2.48	
5	GHz	0207	0226	0317	P5 \ 15	2.95	
2.7	GHz	0204	0226	0320		2.69	
1.4	GHz	0203	0249	0315		2.81	
610	MHz	0204	0240	0329		2.72	
410	MHz	0205	0205	0326	0.4 / 1.4	2.6	
245	MHz	0233	0250	0329		3.0	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	45-245	1153		1216		2	
DS IV	30-80	1152		1728		3	
DS IV	35-85	1152		1446		3	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0236	1366	21.2	360°	72°	SOHO

*cm⁻²s⁻¹

2015

June 22

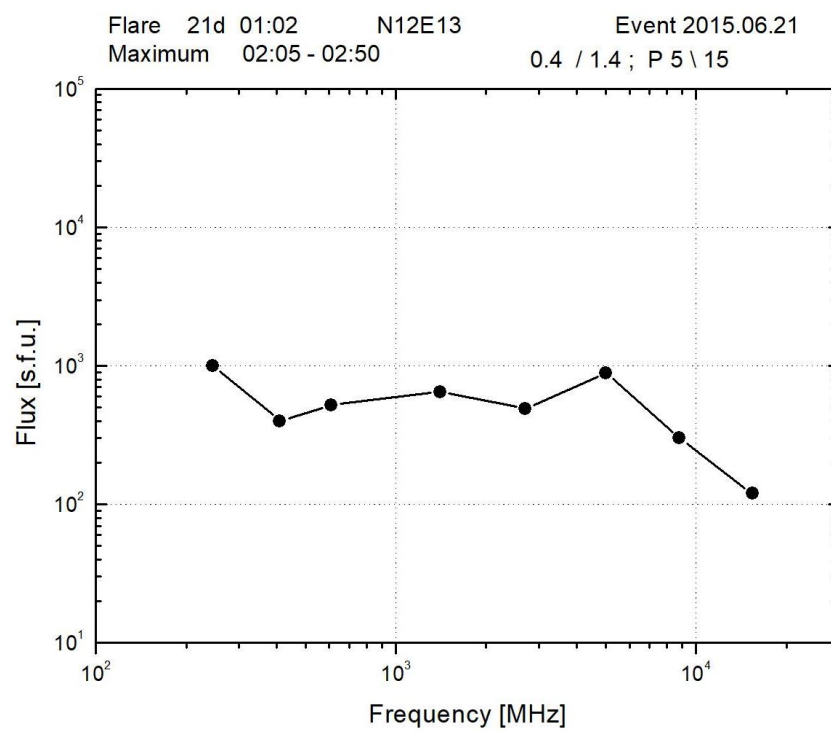
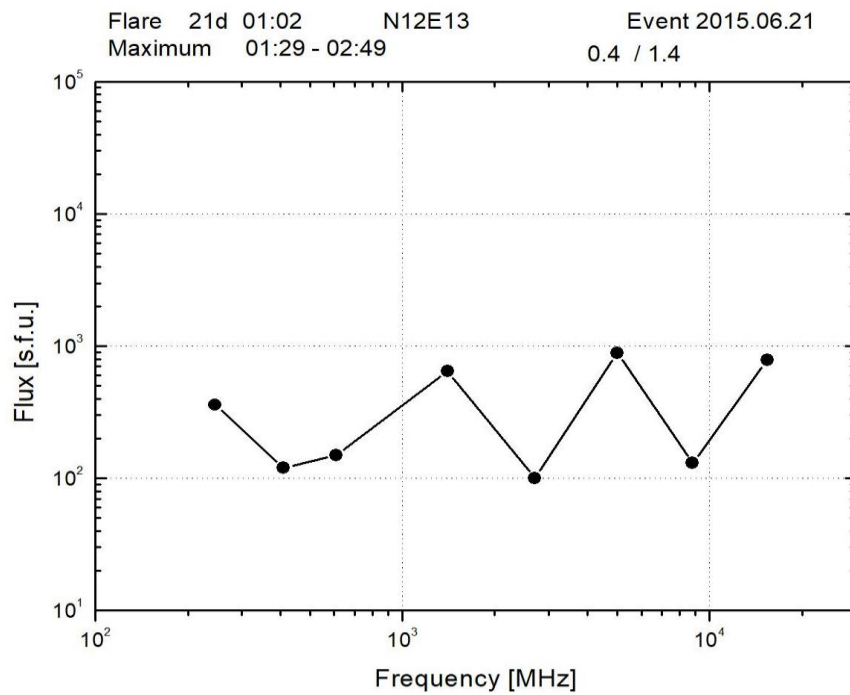
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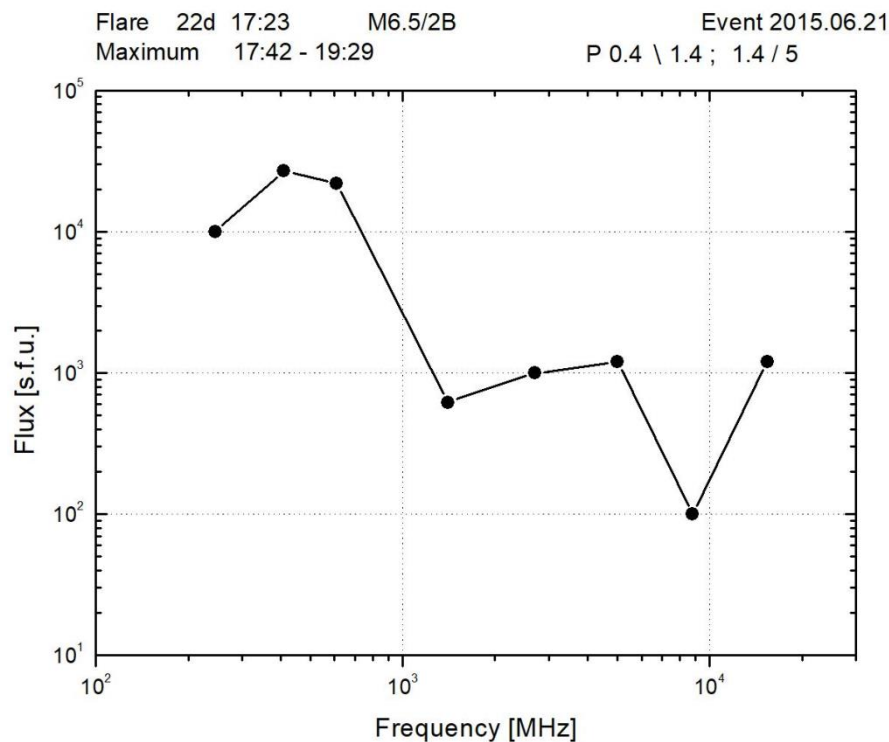
AR12371

To event 571

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1723	1810	2053	N12W08	2B	UMB
6563 Å	LPS	>1754		>0412	N31W32	6°	
1 – 12	keV	1739	1823	1851		M6.5	0.19
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1724:28	1725:30	1735:00	108	139480	HESSI
25-50	keV	1736:00	1743:18	1746:0	432	466635	HESSI
100-300	keV	1803:16	1804:46	1806:56	4609	5439385	HESSI
100-300	keV	1806:56	1815:30	1827:44	6527	35508716	HESSI
12-25	keV	1859:00	1859:30	1927:48	905	1680316	HESSI
100-300	keV	2033:28	2034:34	2052:48	599	2794909	HESSI
100-300	keV	2052:48	2053:38	2108:08	225	505522	HESSI
12-25	keV	1743:34	1759:25	1818:39	458242	487982592	FERMI
12-25	keV	1918:49	1923:23	1959:26	1938	472384	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1752	1752	1849		3.08	
8.8	GHz	1742	1742	1742		2.0	
5	GHz	1752	1804	1938		3.08	
2.7	GHz	1753	1825	1946		3.0	
1.4	GHz	1755	1810	1950	1.4 / 5	2.79	
610	MHz	1803	1929	1955		4.34	
410	MHz	1755	1928	1959	P0.4 \ 1.4	4.43	
245	MHz	1807	1929	2032		4.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _H , km/s	Importance	Sp/c
DS II	25-180	1805		1826	1480	1	
DS VI	25-180	1907		2335		2	
DH II	0.3-14	1820		2155			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1836	1209	- 25.1	360°	358°	SOHO

Radio bursts frequency spectrum





Proton Active Region:

AR12371 (N12L302; CMP 22,0.06.2015;
Sp=1180 msh; FKC; BGD, R)
XRI=2.0; $M_6^{7.9} + C_{39} \quad 3_1 + 2_2 + 1_7 + S_{88}$
PFR1 20-22.06: $(59^h) - M_4^{6.5}$
PFR2 25.06: $M_1^{7.9}$

References:

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 Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
 Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).
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Particle event: To($E_p > 10$ MeV) – 25d09^h

Tmax($E_p > 10$ MeV) – 26d10^h, Jmax($E_p > 10$ MeV) – $13.5 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

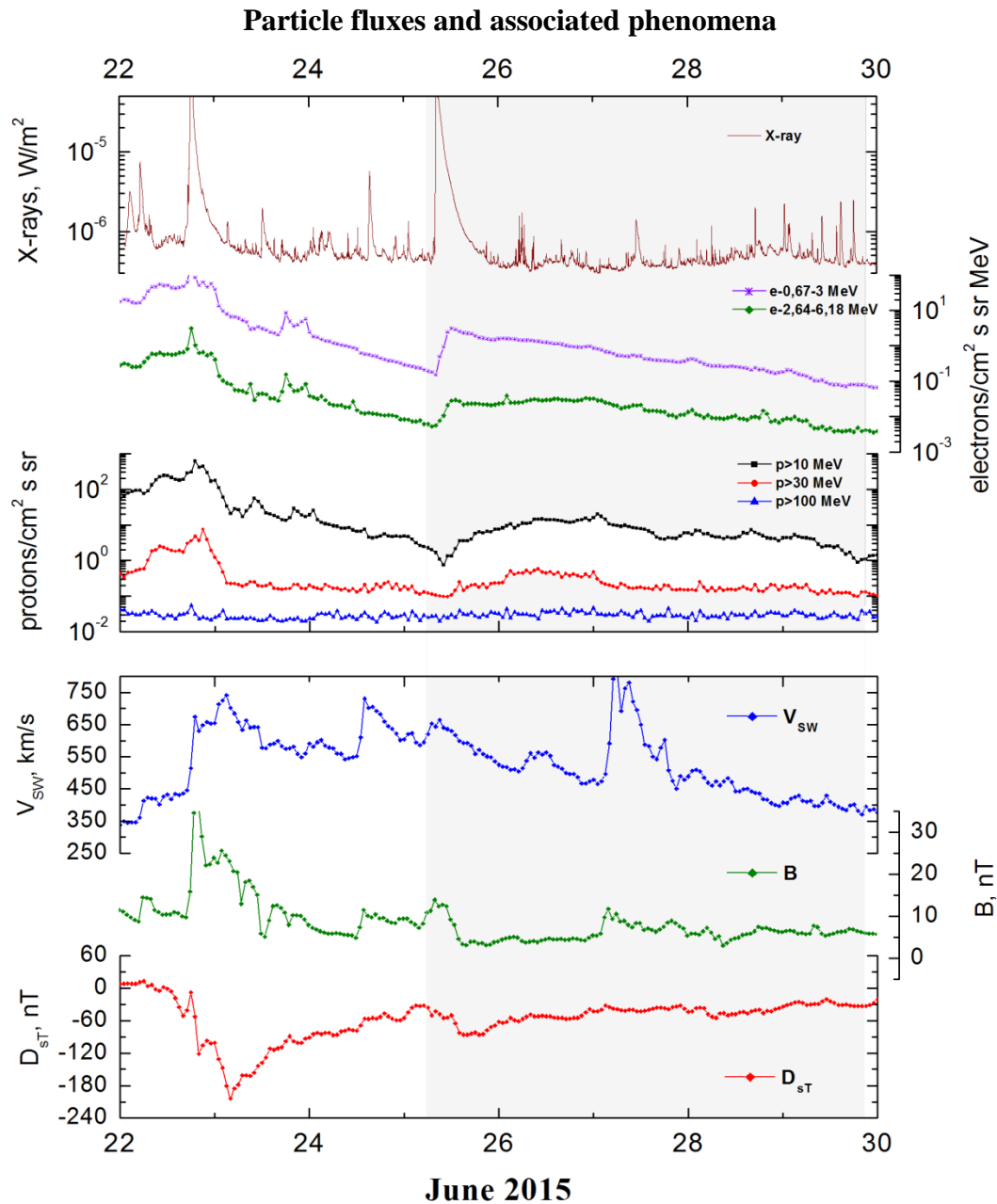
Duration of the event – 5 days, power-law index: $\gamma = 3.3$

Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

Sources: • solar flare 25d08^h02^m, M7.9/3B, N09W42, AR12371

Main burst X-ray 1–8 Å: onset – 25d08^h02^m, max – 25d08^h16^m, $\Phi = 0.17 \text{ J/m}^2$

CME: 25d08^h36^m, $V = 1627 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 330^\circ$

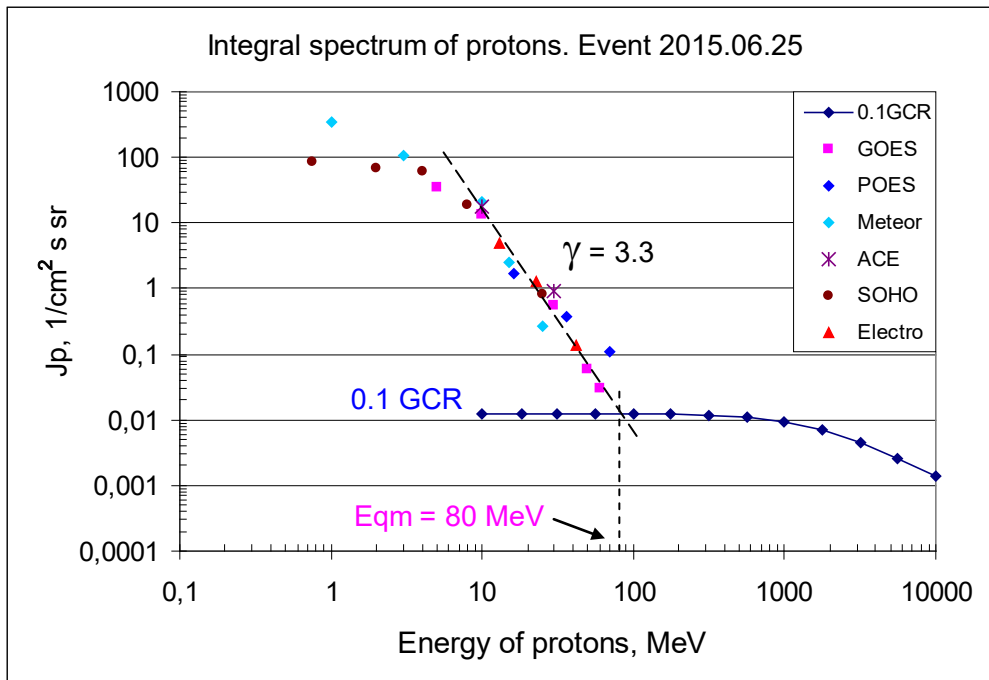


Integral fluxes of protons for the event of 2015 June 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	9	26d10	35	5	0.2	
EPS	>10	9	26d10	13.5	5	0.12	
EPS	>30	9	26d10	0.55	4	0.07	
EPS	>50	9	26d10	0.06	2	0.06	
EPS	>60	9	26d10	0.03	2	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR	>1	11	26d17	347	5	3.9	
SCR	>3	11	26d17	109	5	2.7	
SCR	>10	11	26d17	21.3	4	2.2	
GALS-M	>15	11	26d17	2.5	5	0.6	
GALS-M	>25	11	26d17	0.26	2	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	8	26d10	18	5	1.1	
SIS	>30	8	26d10	0.9	5	0.7	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

Differential fluxes of protons for the event of 2015 June 25

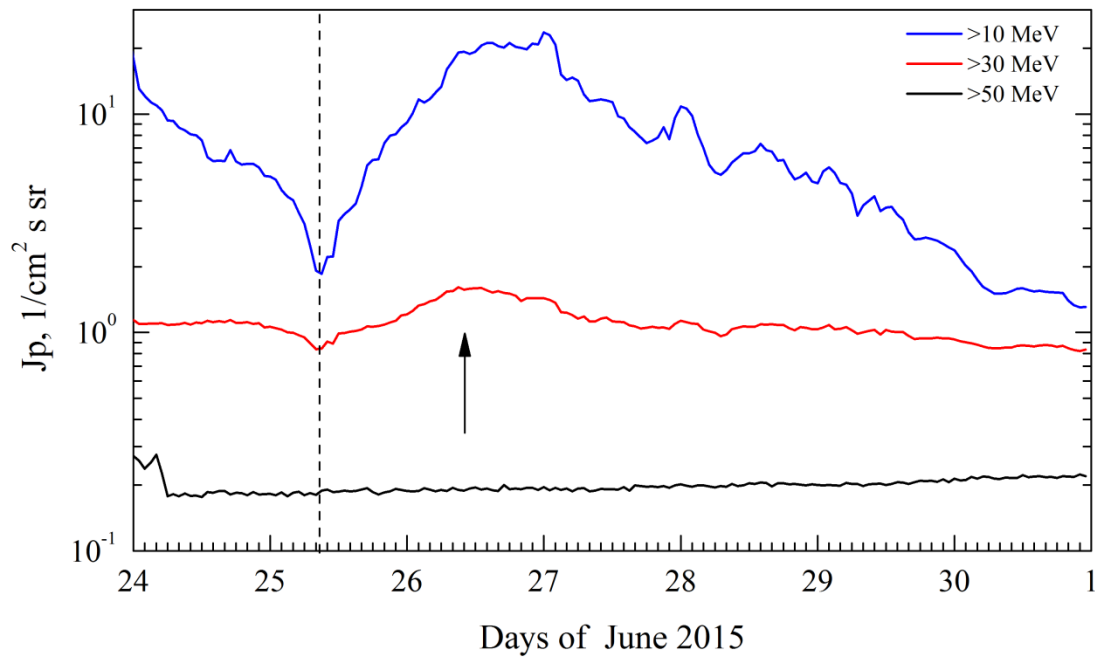
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	13	26d14	13.3	7	0.01	
LION	2 – 6	12	26d14	2.57	7	0.001	
EPHIN	4 – 8	14	26d14	10.52	7	0.0001	
EPHIN	8 – 25	13	26d14	1.06	7	0.00001	
EPHIN	25 – 53	11	26d14	0.0287	7	0.00001	
Electro-1							
SCR-E	13.7–23	10	26d11	0.4	-	0.07	
SCR-E	23–42	10	26d11	0.06	-	0.02	
SCR-E	42–112	10	26d11	0.002	-	0.004	
POES							<E>, MeV
MEPED	16–36	12	26d03	0.067	2	0.033	25
MEPED	36–70	12	26d03	0.0075	2	0.0048	50
MEPED	70–140	12	26d03	0.0016	2	0.0008	100



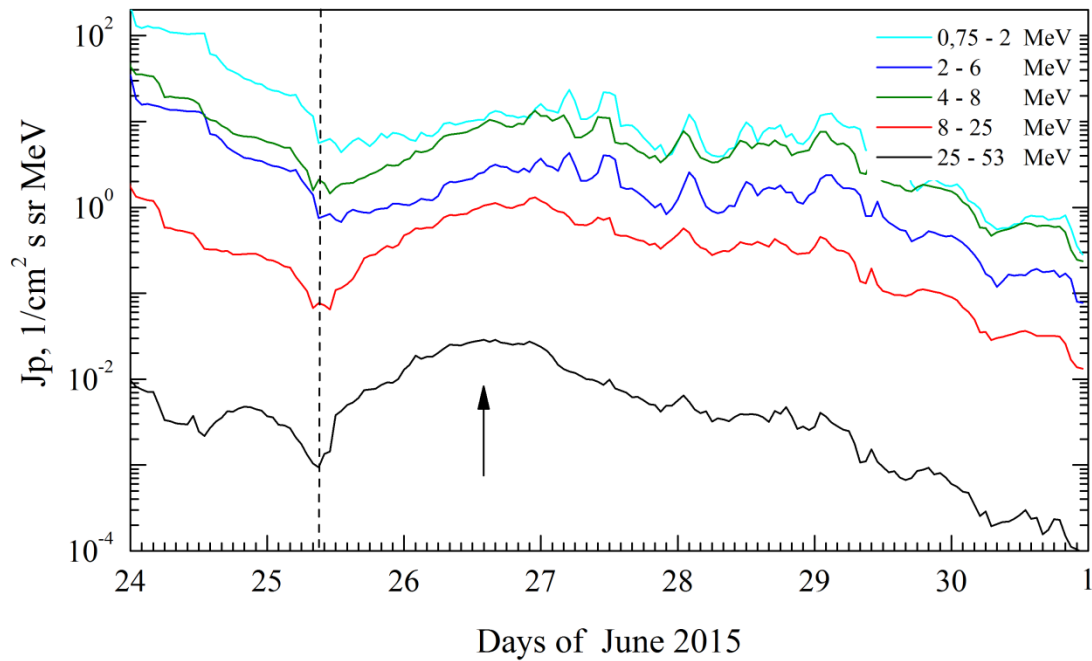
Time profiles of proton fluxes in the event 2015.06.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.06.25

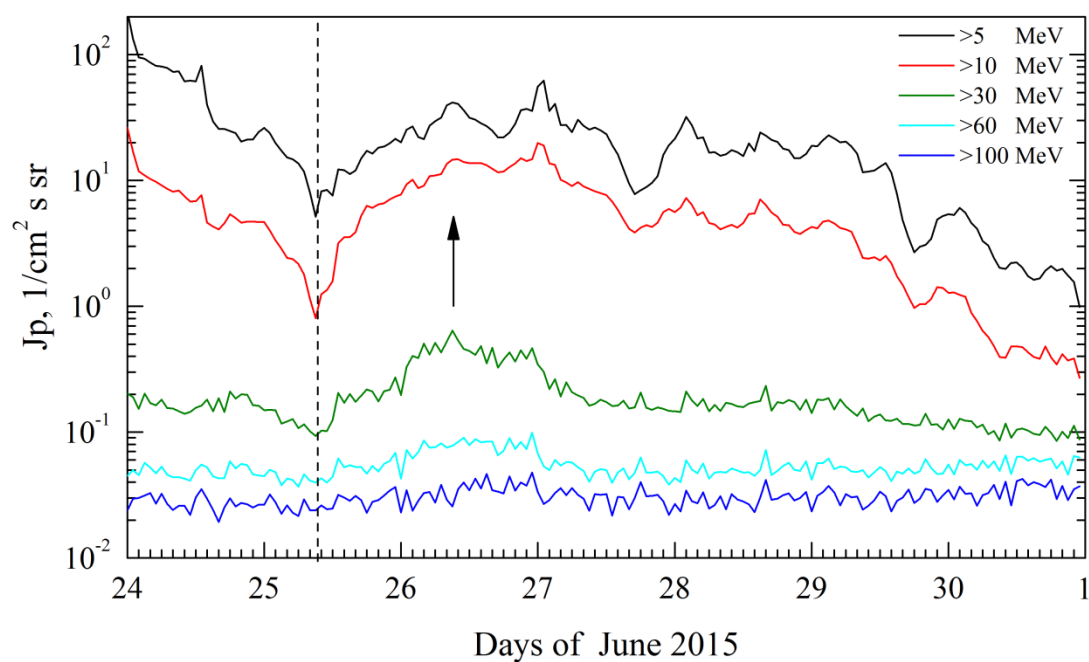


SOHO. Event 2015.06.25

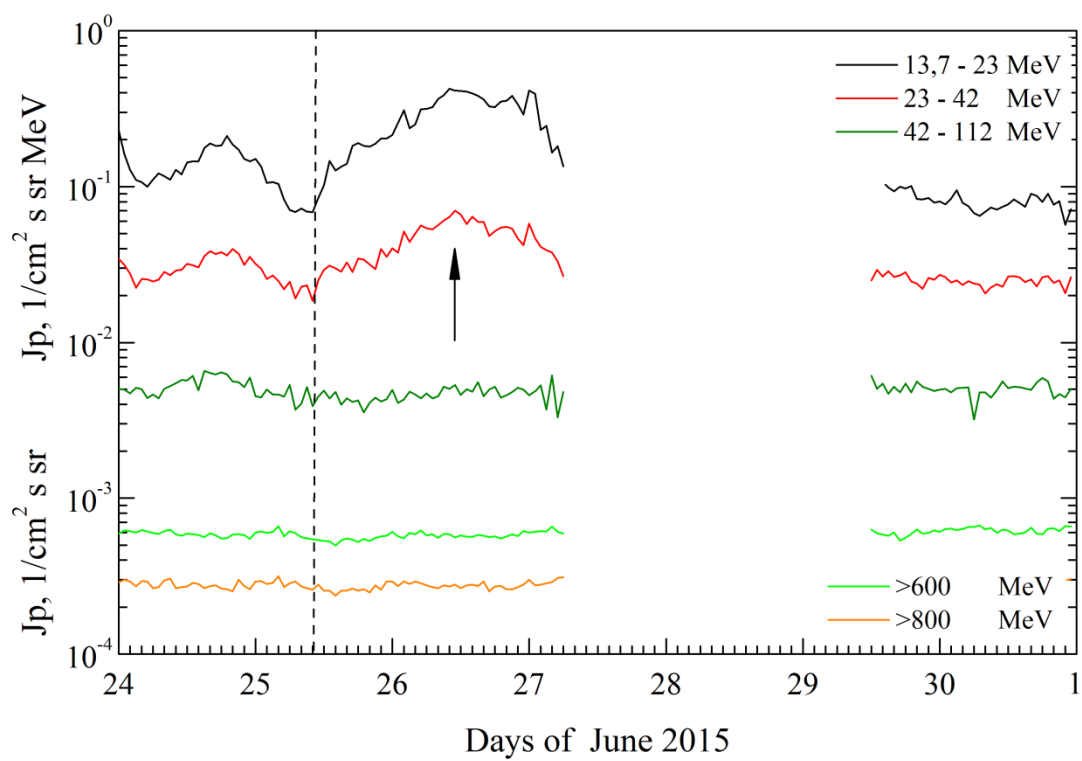


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.06.25

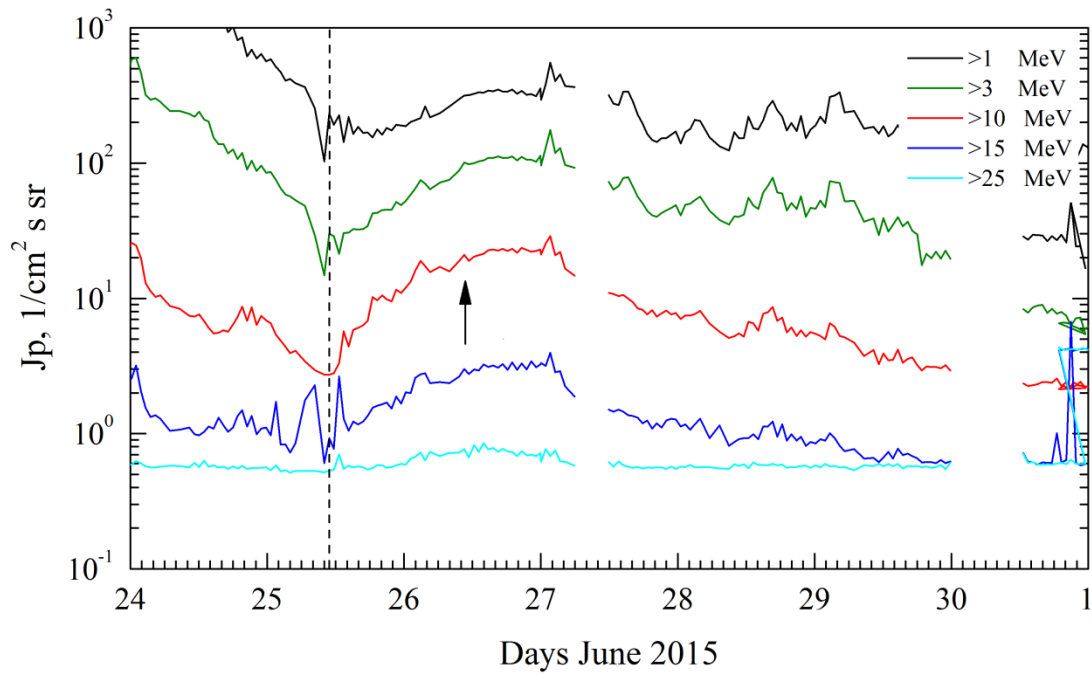


Electro. Event 2015.06.25

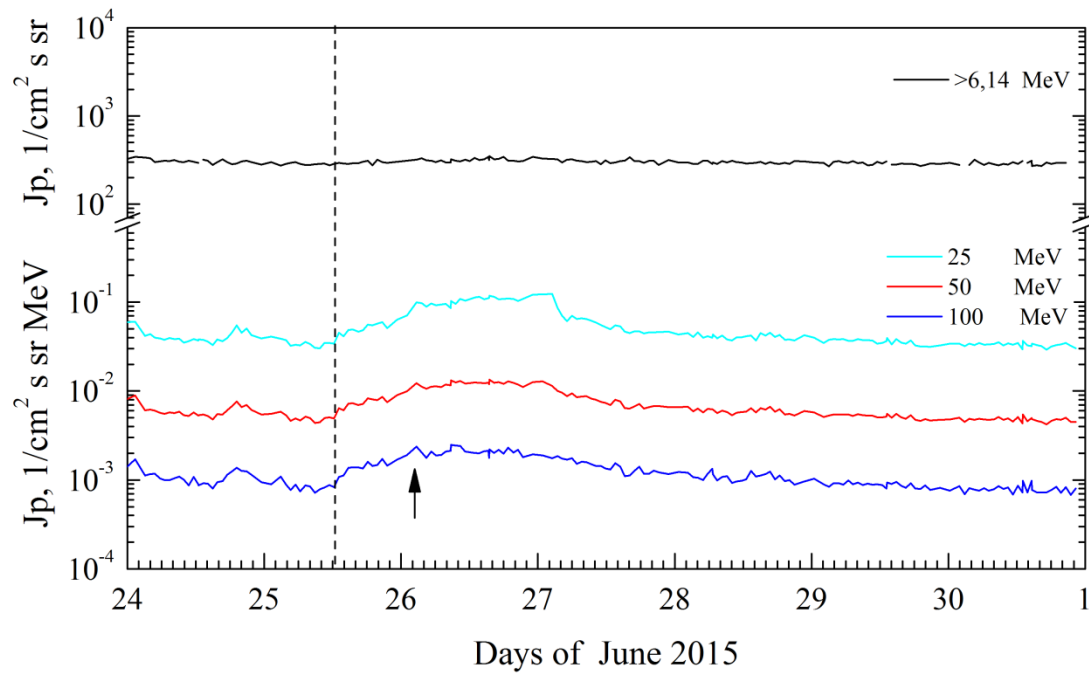


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2015.06.25



POES. Event 2015.06.25



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 June 25**

2015

June 25

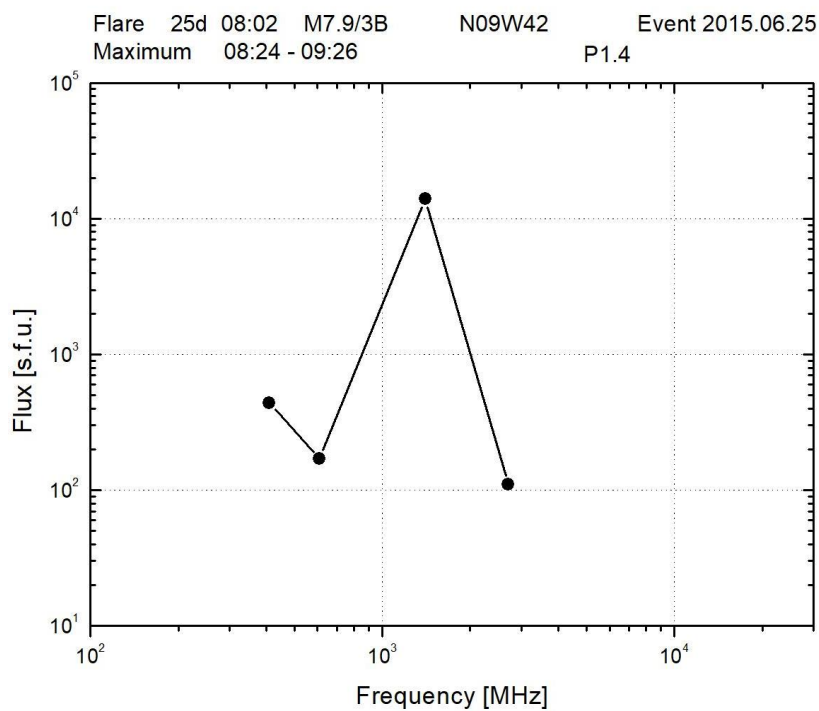
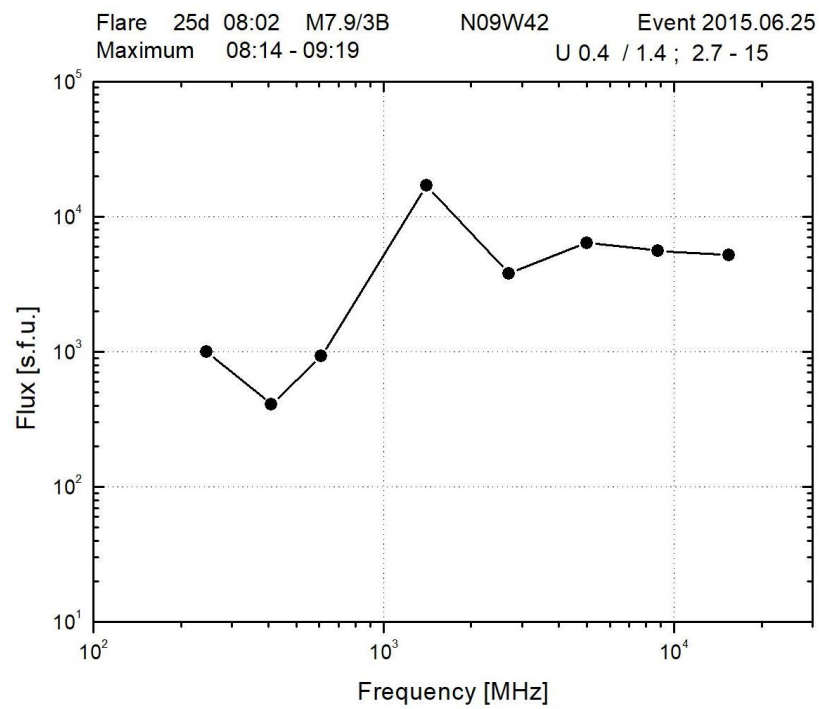
•

AR12371

To event 572

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0802	0814	1235	N09W42	3B	UMB
1 – 12	keV	0802	0816	0905	N12W40	M7.9	0.17
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	0847:40	0847:58	0929:44	2283	14190195	HESSI
50-100	keV	1026:48	1026:50	1043:32	52	253987	HESSI
100-300	keV	1043:32	1045:22	1103:28	40	226468	HESSI
12-25	keV	1138:08	1139:06	1139:52	1136	404784	HESSI
12-25	keV	0804:28	0815:36	0840:49	620639	342993408	FERMI
12-25	keV	0914:42	0923:23	1011:58	5768	4358847	FERMI
12-25	keV	1100:02	1120:06	1127:32	751	204914	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0812	0814	0903		3.72	
8.8	GHz	0811	0814	0910		3.75	
5	GHz	0810	0814	0920		3.81	
2.7	GHz	0812	0815	0903	2.7 – 15	3.58	
1.4	GHz	0812	0919	0936		4.23	
610	MHz	0814	0824	0900		2.97	
410	MHz	0814	0824	0902	U 0.4 / 1.4	2.61	
245	MHz	0824	0829	0851		3.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-79	0816		0833	2056	1	
DS IV	25-180	0821		1124		1	
DH II	0.15-14	0835		1630			WIND
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
2.7	GHz	0926	0926	0926		2.04	
1.4	GHz	0909	0919	0929	P1.4	4.15	
610	MHz	0814	0824	0900		2.23	
410	MHz	0814	0824	0902		2.64	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	25-180	1027		1125		1	
DS VI	25-78	0907		1000		1	
DS VI	25-105	1027		1054		1	
DS III	25-74	1215		1216		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0836	1627	- 24.8	360°	330°	SOHO

Radio bursts frequency spectrum



Proton Active Region:

AR12371 (N12L302; CMP 22,0.06.2015;
Sp=1180 msh; FKC; BGD, R)
XRI=2.0; $M_6^{7.9} + C_{39} \quad 3_1 + 2_2 + 1_7 + S_{88}$
PFR1 20-22.06: $(59^h) - M_4^{6.5}$
PFR2 25.06 : $M_1^{7.9}$

References:

Кичигин Г.Н., Кравцова М.В., Сдобнов В.Е., [2018](#).
Матюгов С.С., Яковлев О.И., Павельев А.А., [2021](#).
Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).
de Nolfo G.A., A. Bruno, J.M. Ryan et al., [2019](#).
Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).
Zhdanov D., L.K. Kashapova, R. Miteva, [2018](#).

Particle event: To($E_p > 10$ MeV) – 01d18^h

Tmax₁($E_p > 10$ MeV) – 01d20^h, Jmax₁($E_p > 10$ MeV) – 2.8 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 02d01^h, Jmax₂($E_p > 10$ MeV) – 4.5 /cm²·s·sr

Duration of the event – 2 days, power-law index: $\gamma_1 = 2.0$, $\gamma_2 = 2.3$

Quasimaximal energy of protons in the event – Eqm₁ = 130 MeV

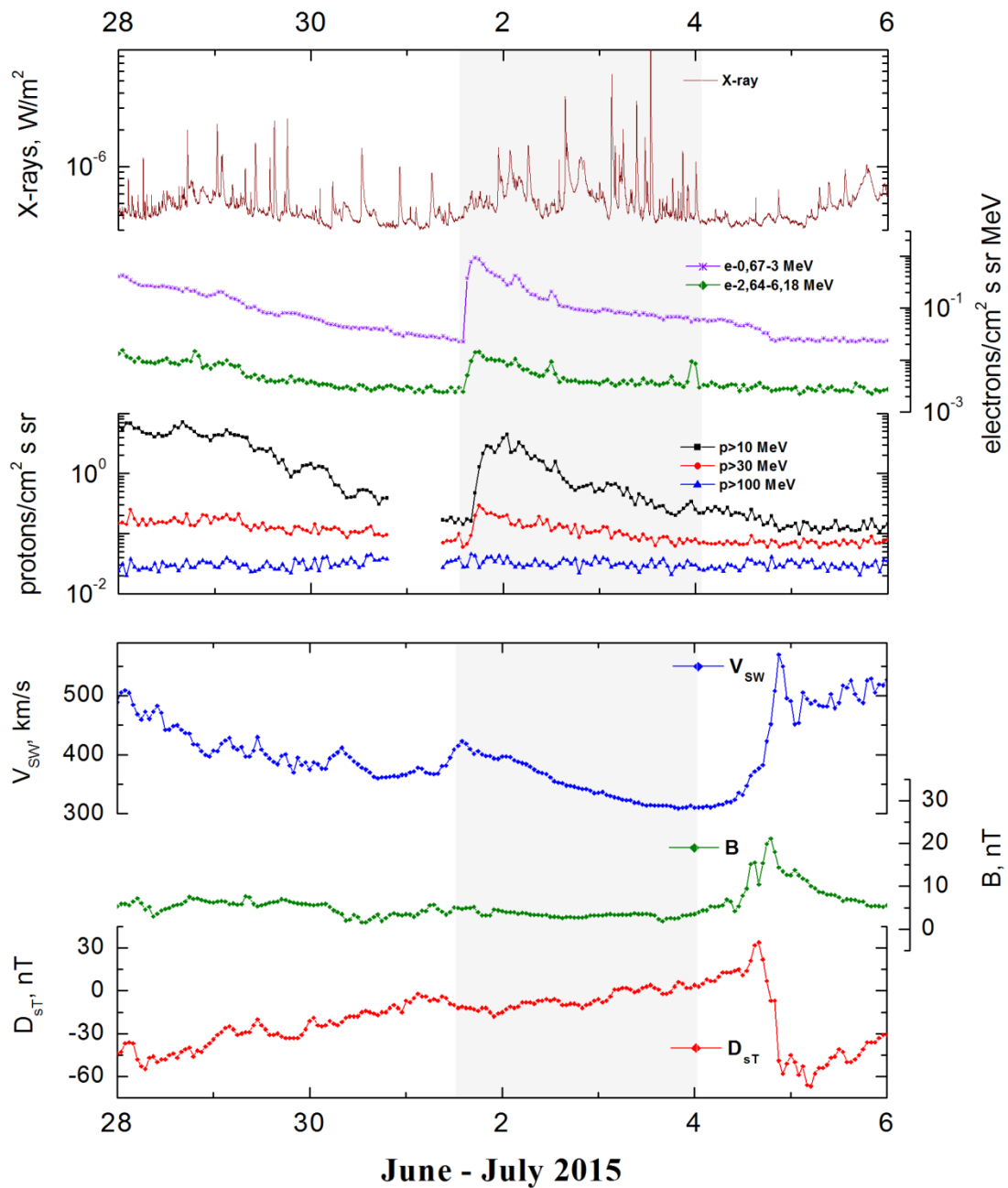
– Eqm₂ = 90 MeV

Sources: \diamond Flare activity behind W_L

\square solar flare 01d<14^h36^m, AR12731, 2.5d behind W_L

CME: 01d14^h36^m, V = 1435 km/s, $\Delta\phi = 360^\circ$, dA = 311°

Particle fluxes and associated phenomena

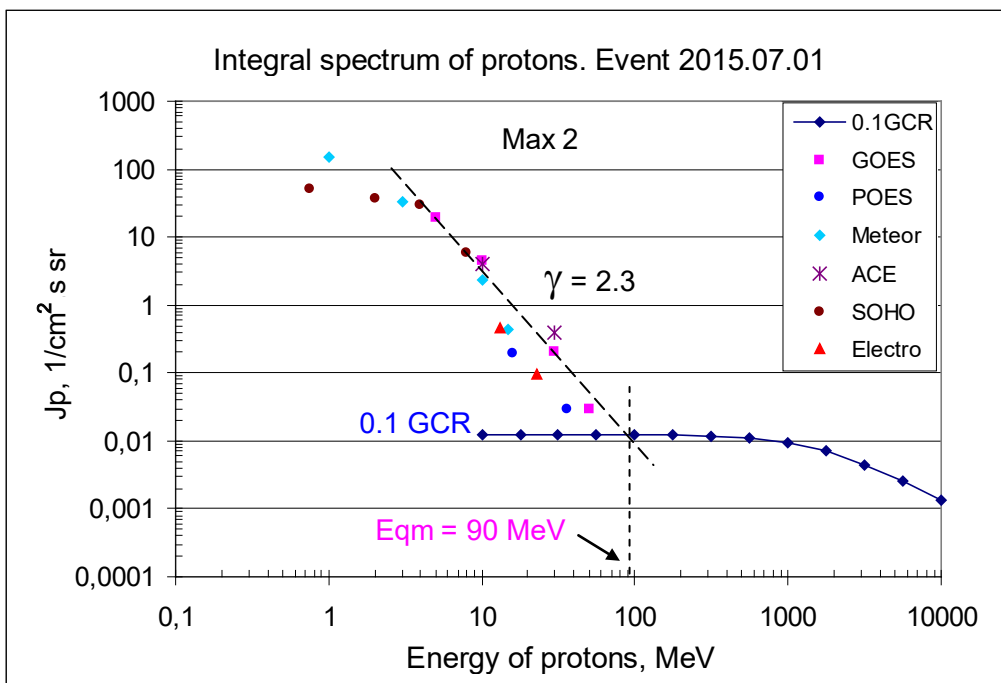
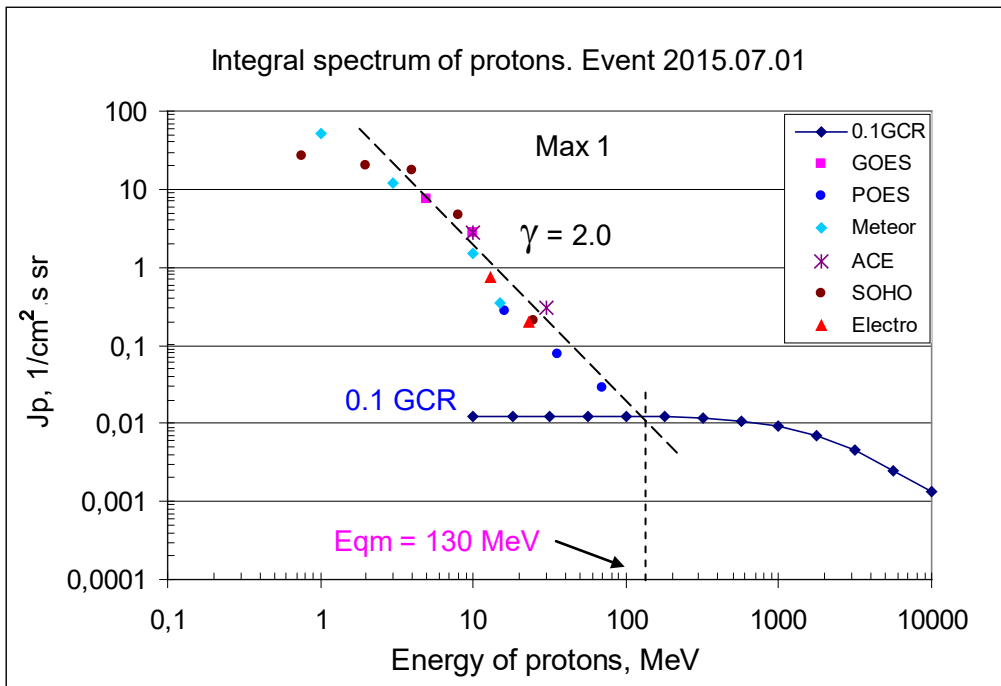


Integral fluxes of protons for the event of 2015 July 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	20/02d01	7.5/19.5	2	0.2	
EPS	>10	18	20/02d01	2.8/4.5	2	0.12	
EPS	>30	18	- /02d01	- /0.2	1	0.07	
EPS	>50	18	- /02d01	- /0.03	1	0.06	
EPS	>60	18	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR	>1	15	20/02d00	52/151	3	3.9	
SCR	>3	15	20/02d00	12/34	3	2.7	
SCR	>10	15	20/02d00	1.5/2.3	2	2.2	
GALS-M	>15	15	18/02d00	0.35/0.44	1	0.7	
GALS-M	>25	-	-	-	-	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	15	18/22	2.8/4	2	1.2	
SIS	>30	15	18/22	0.3/0.4	1	0.8	
SOHO							
EPHIN	>50	-	-	-	-	0.2	

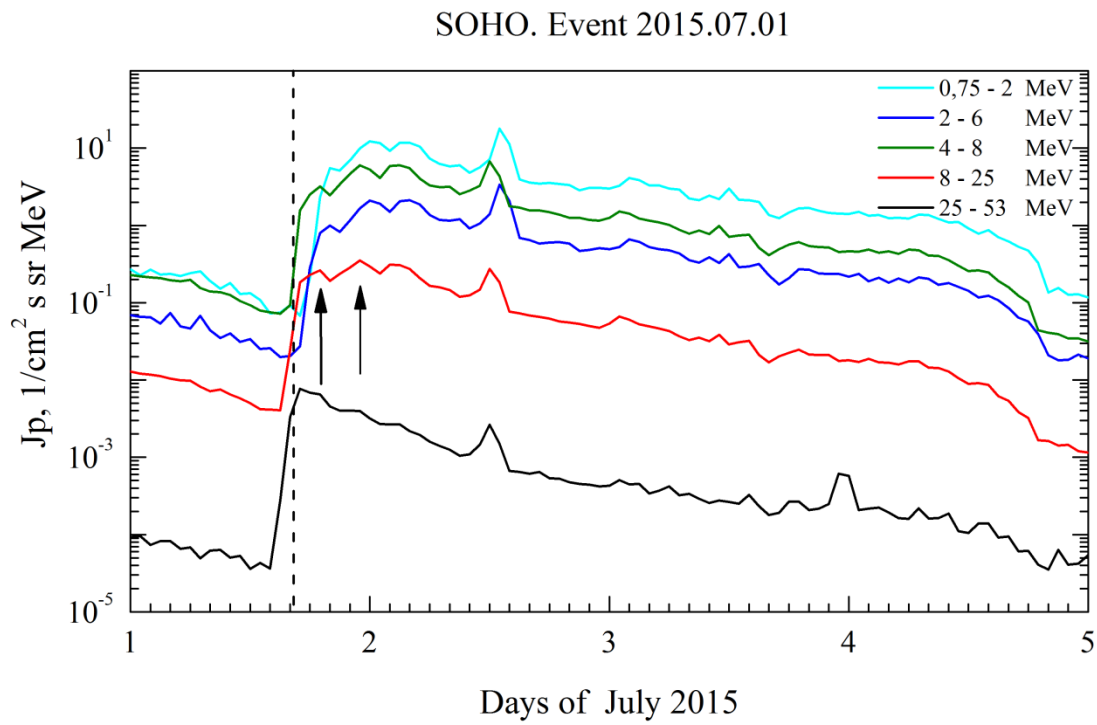
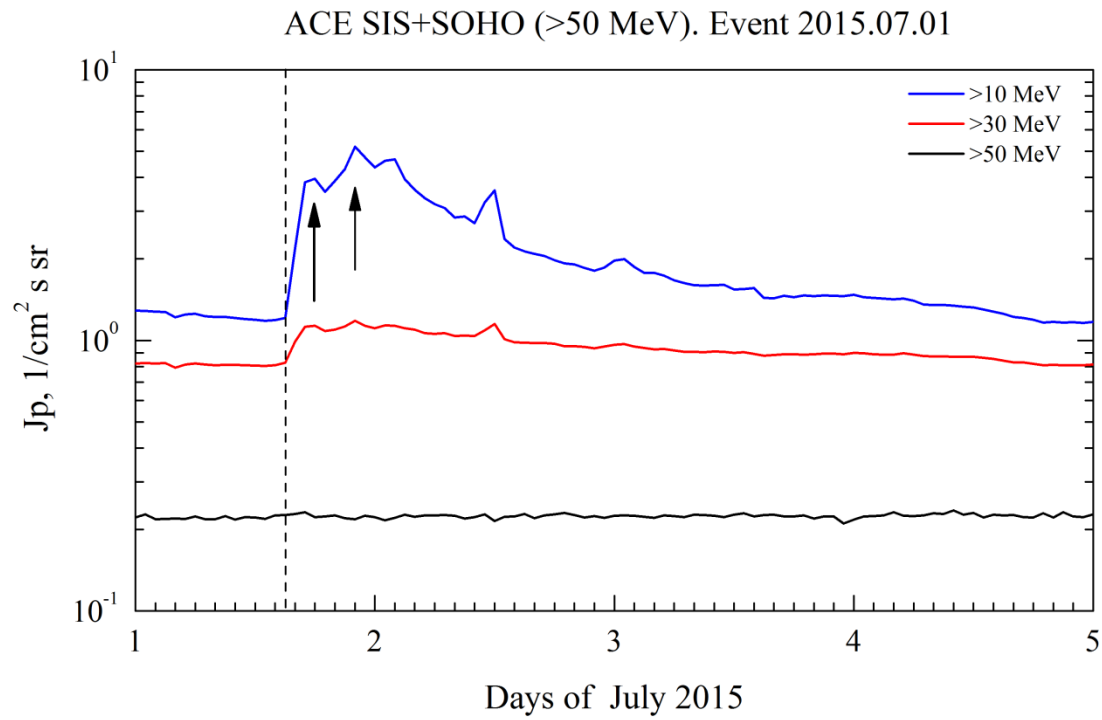
Differential fluxes of protons for the event of 2015 July 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	18	20/02d00	5.47/12.2	3.3?	0.07	
LION	2 – 6	18	20/02d00	0.98/2.07	3.3?	0.02	
EPHIN	4 – 8	17	19/23	3.12/5.96	3.3?	0.07	
EPHIN	8 – 25	16	19/23	0.26/0.347	3.3?	0.004	
EPHIN	25 – 53	15	17/23	0.0077/ -	3.3?	0.00004	
Electro-1							
SCR-E	13.7–23	15	19/02d00	0,06/0,04	0,5	0,07	
SCR-E	23–42	15	19/02d00	0,01/0,005	0,5	0,02	
SCR-E	42–112	-	-	-	-	0,004	
POES9							<E>, MeV
MEPED	16–36	16	19/2d02	0.0097/0,008	0.5	0.033	25
MEPED	36–70	16	19/2d02	0.0014/0,0009	0.5	0.0048	50
MEPED	70–140	16	22/ -	0.0004/ -	0.5	0.0008	100



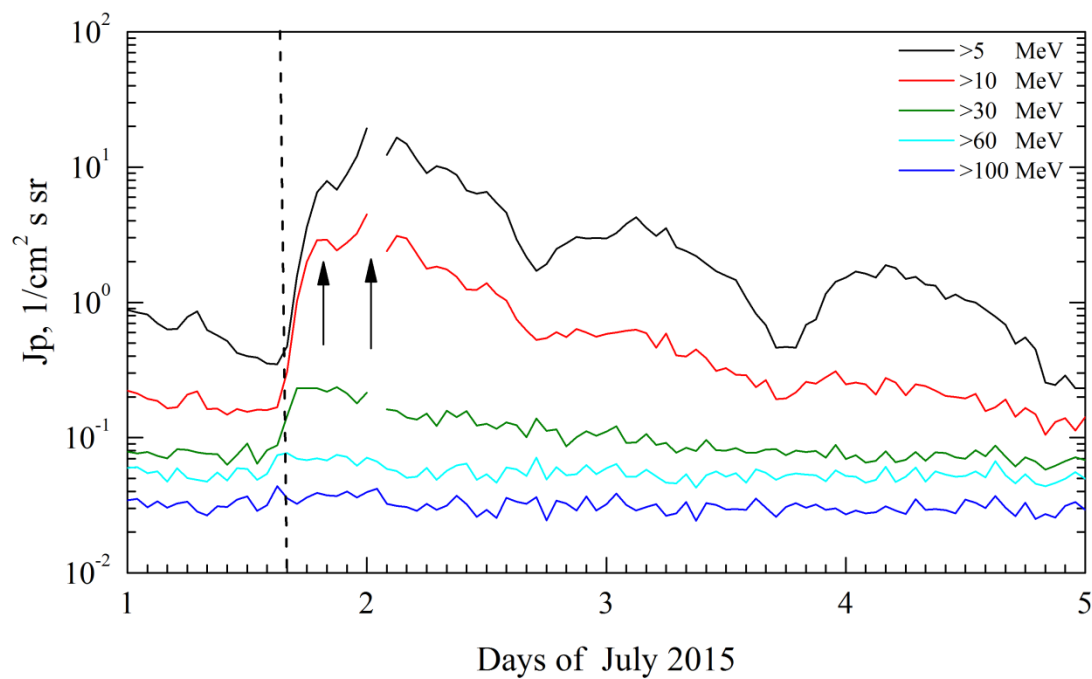
Time profiles of proton fluxes in the event 2015.07.01

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

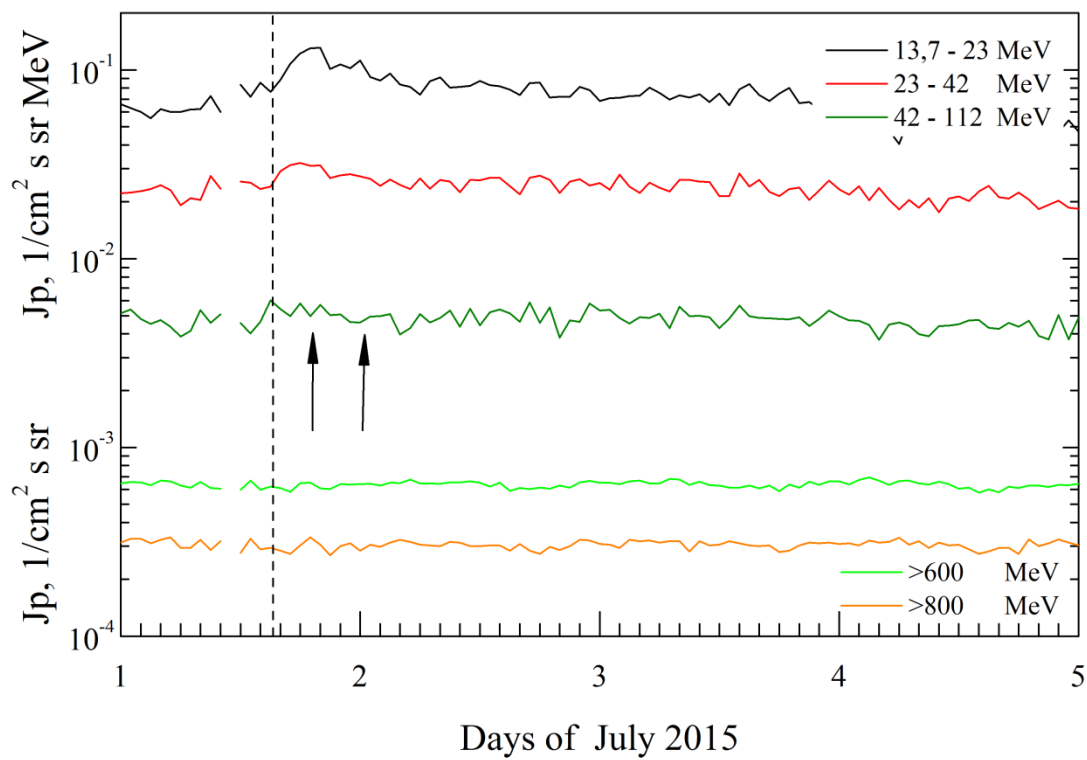


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2015.07.01

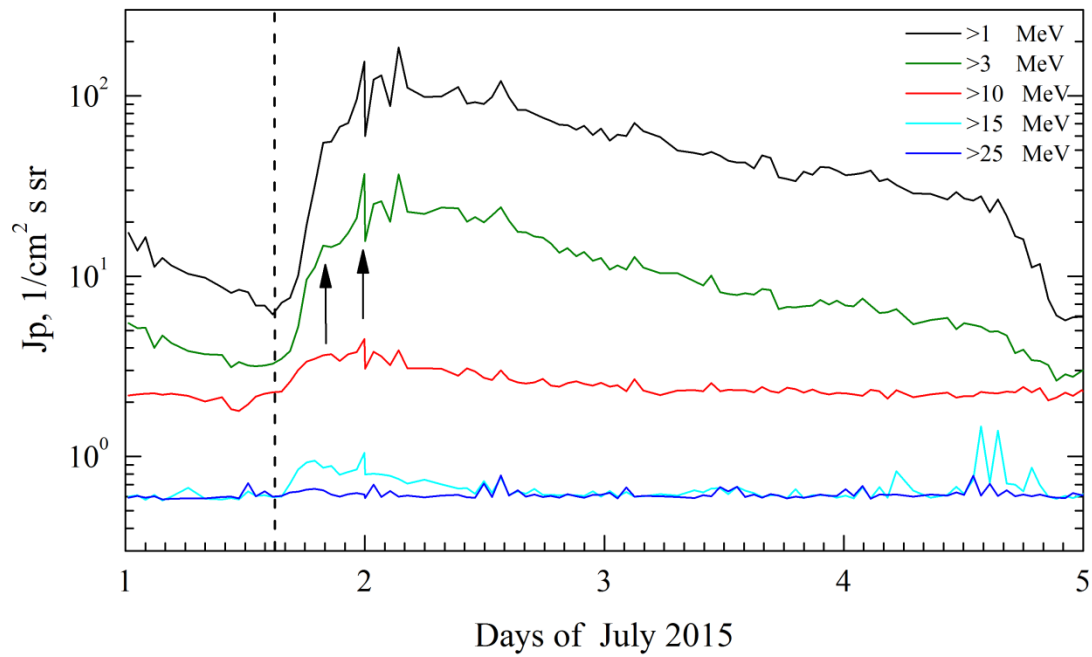


Electro. Event 2015.07.01

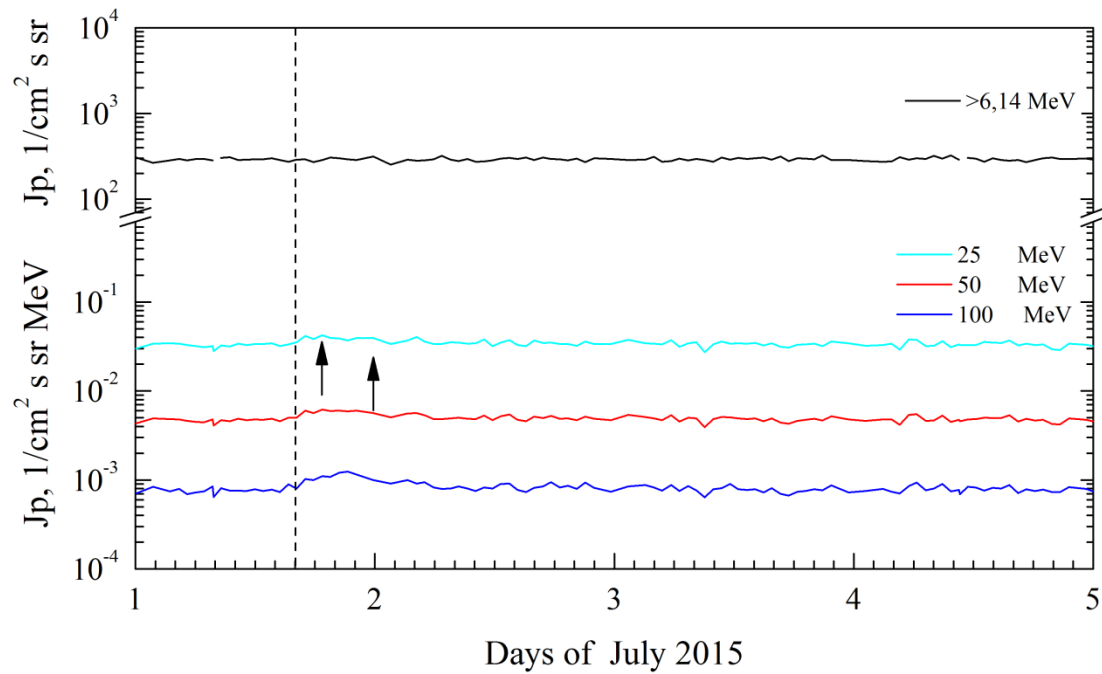


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.07.01



POES. Event 2015.07.01



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 July 01**

2015

July 01



AR 12731

To event 573

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical and X-ray flare on visible disk					
1 – 12	keV						
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1414:20	1423:18	1423:32	32	67440	HESSI
6-12	keV	1436:12	1439:34	1447:24	24	64488	HESSI
6-12	keV	1447:24	1447:26	1449:36	12	8040	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS VI	25-75	1438		1505		1	
DH II	0.15-1	1608		2047			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1436	1435	- 19.8	360°	311°	SOHO

Proton Active Region:

AR12371 (N12L302; CMP 22,0.06.2015;

Sp=1180 msh; FKC; BGD, R)

XRI=2.0; M₆^{7.9}+C₃₉ 3₁+2₂+1₇+S₈₈

PFR1 20-22.06: (59^h) – M₄^{6.5}

PFR2 25.06 : M₁^{7.9}

Particle event: To($E_p > 10$ MeV) – 20d18^h

Tmax ($E_p > 10$ MeV) – 20d22^h, Jmax($E_p > 10$ MeV) – $2.2 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma = 2.2$

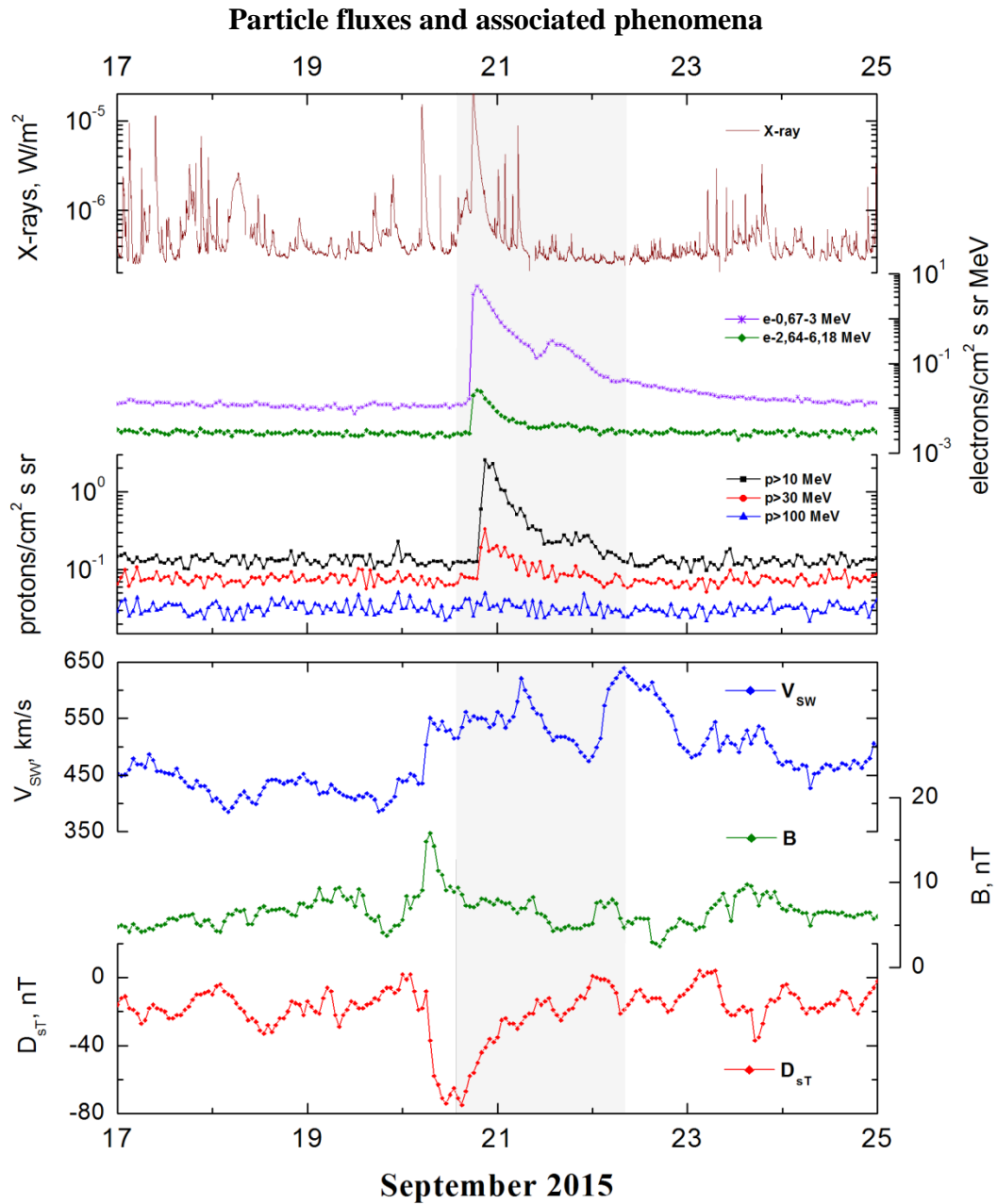
Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

Sources: ● solar flare 20d17^h30^m, 2N/M2.1, S20W24, AR12415

Main burst X-ray 1–8 Å: onset – 20d17^h32^m, max – 20d18^h03^m, $\Phi = 0.045 \text{ J/m}^2$

CME: 20d18^h12^m, $V = 1239 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 219^\circ$

▲ SC 20d06^h03^m

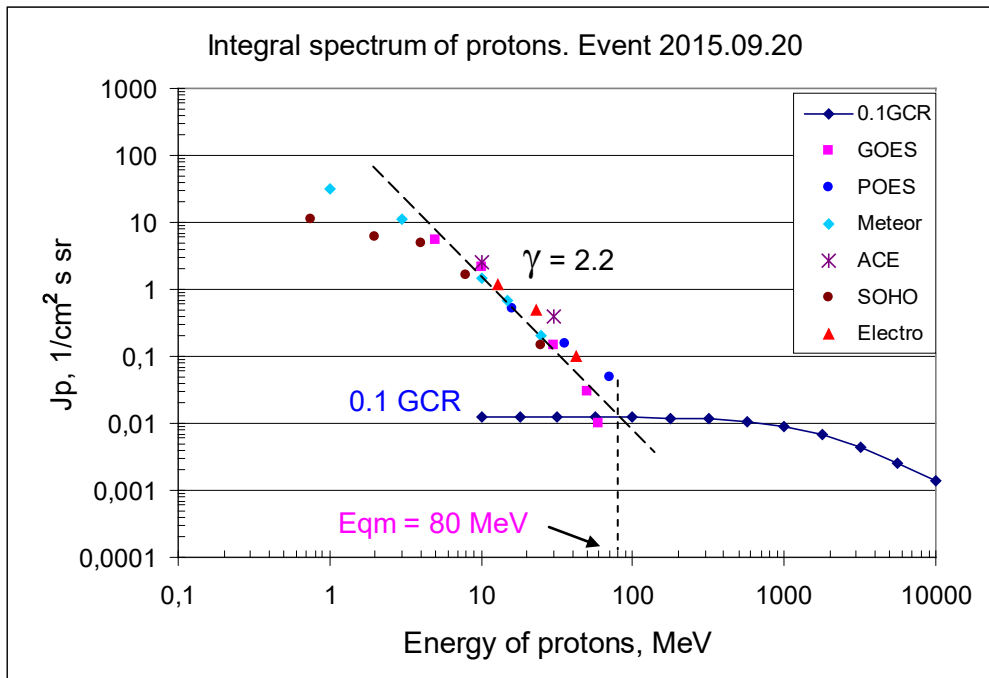


Integral fluxes of protons for the event of 2015 September 20

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	18	22	5.6	2	0.2	
EPS	>10	18	22	2.2	2	0.12	
EPS	>30	18	22	0.15	1	0.07	
EPS	>50	18	23	0.08	1	0.06	
EPS	>60	18	23	0.01	1	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.001	
POES							
MEPED	>6.14	-	-	-	-	300	
Meteor-2							
SCR	>1	19	22	32	2	3.9	
SCR	>3	19	22	11	1.5	2.7	
SCR	>10	19	21	1.5	0.25	2.2	
GALS-M	>15	18	20	0.7	0.25	0.6	
GALS-M	>25	18	20	0.2	0.25	0.6	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	18	20	2.5	2	1.25	
SIS	>30	18	20	0.4	1	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.24	

Differential fluxes of protons for the event of 2015 September 20

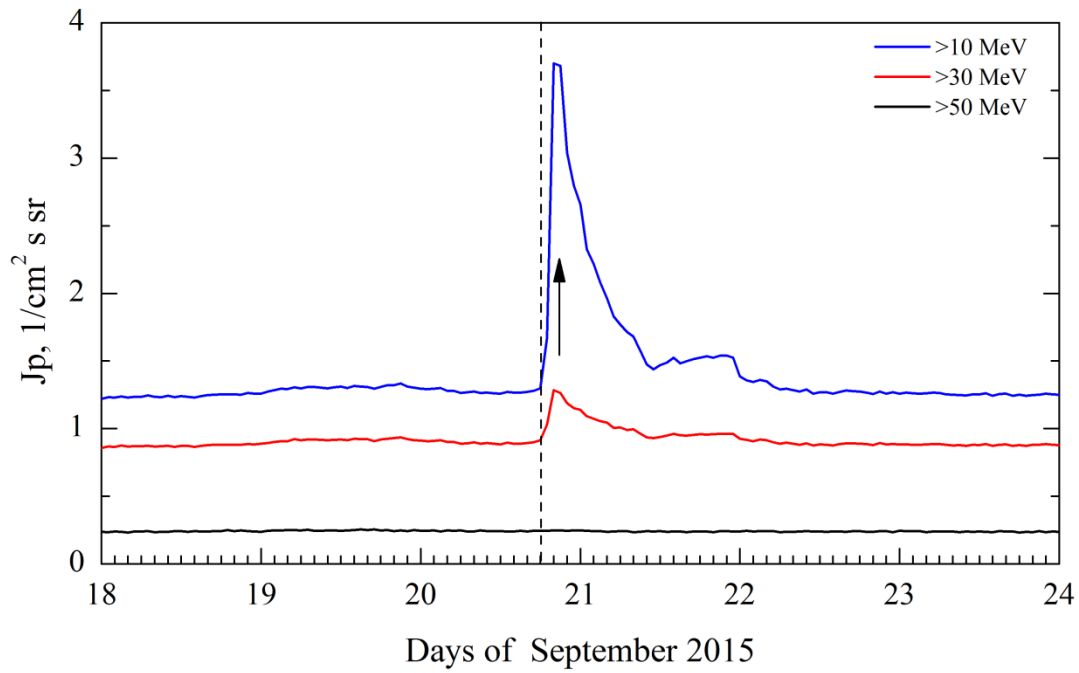
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	21	21d05	4.24	3	0.009	
LION	2 – 6	20	21d05	0.423	3	0.001	
EPHIN	4 – 8	19	21d01	0.797	3	0.0003	
EPHIN	8 – 25	19	22	0.084	3	0.00002	
EPHIN	25 – 53	18	20	0.00528	2	0.00002	
Electro-1							
SCR-E	13.7–23	16	21	0.075	0.5	0.05	
SCR-E	23–42	16	20	0.02	0.5	0.02	
SCR-E	42–112	16	21	0.0015	0.5	0.004	
POES							<E>, MeV
MEPED	16–36	19	20	0.019	0,5	0.032	25
MEPED	36–70	19	19	0.003	0,5	0.0047	50
MEPED	70–140	19	22	0.0007	0,5	0.0008	100



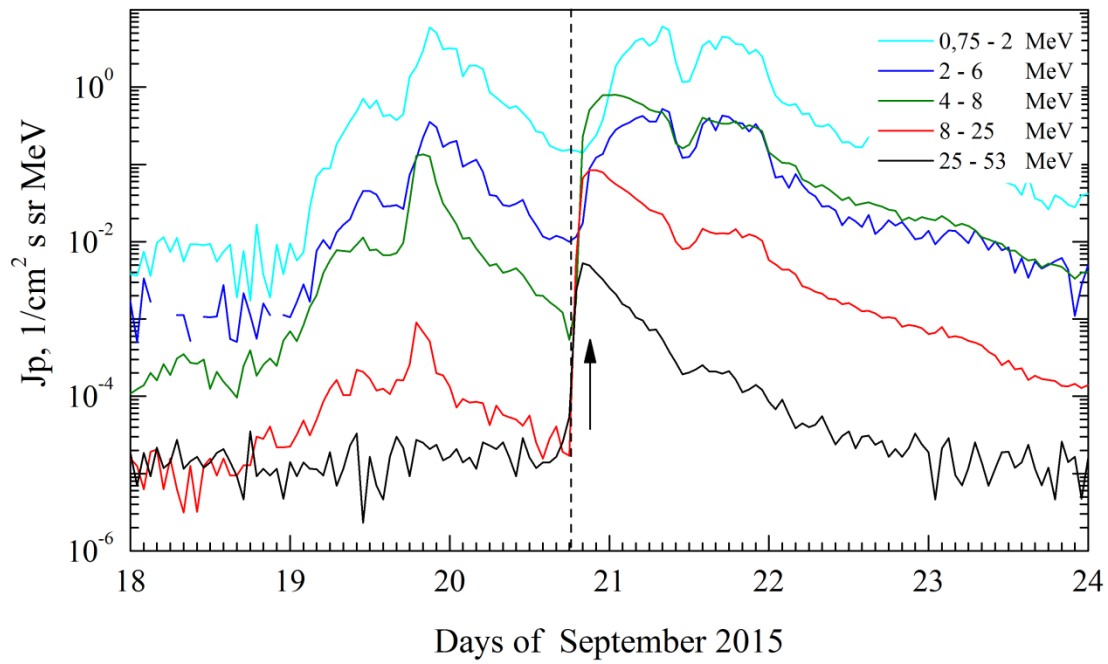
Time profiles of proton fluxes in the event 2015.09.20

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.09.20

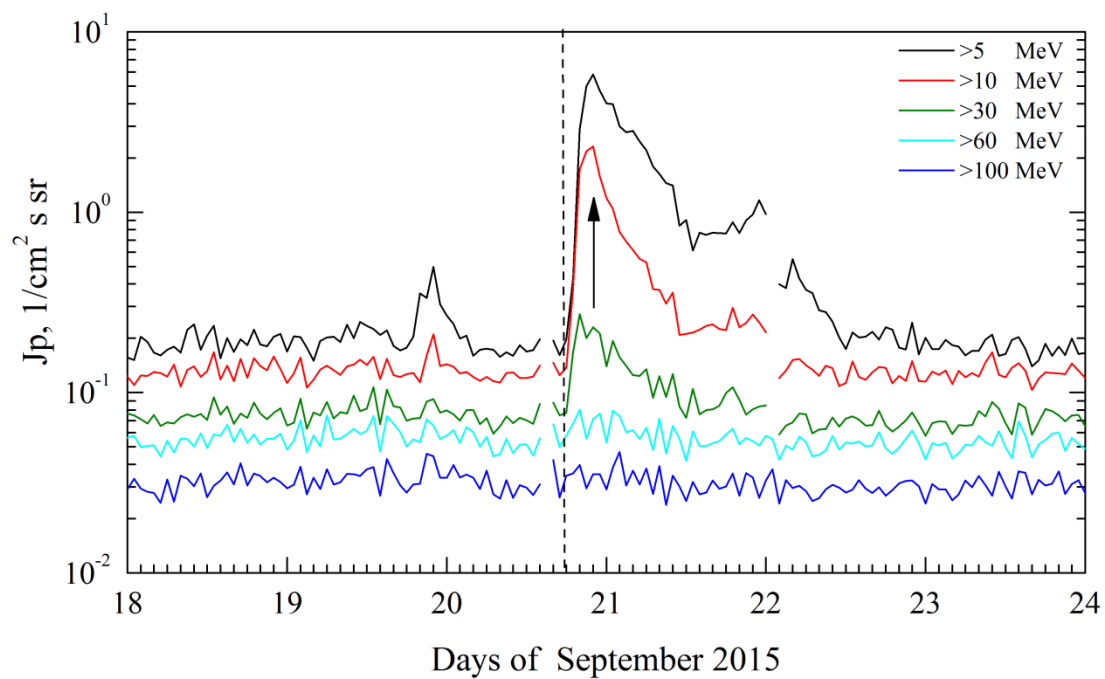


SOHO. Event 2015.09.20

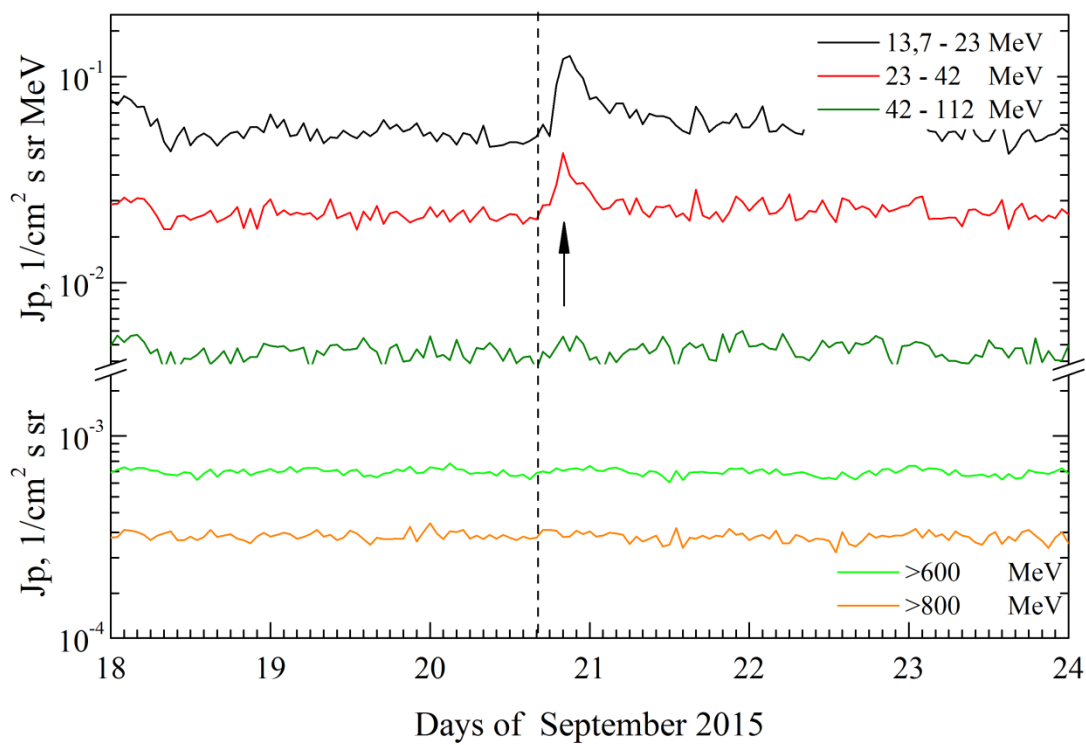


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

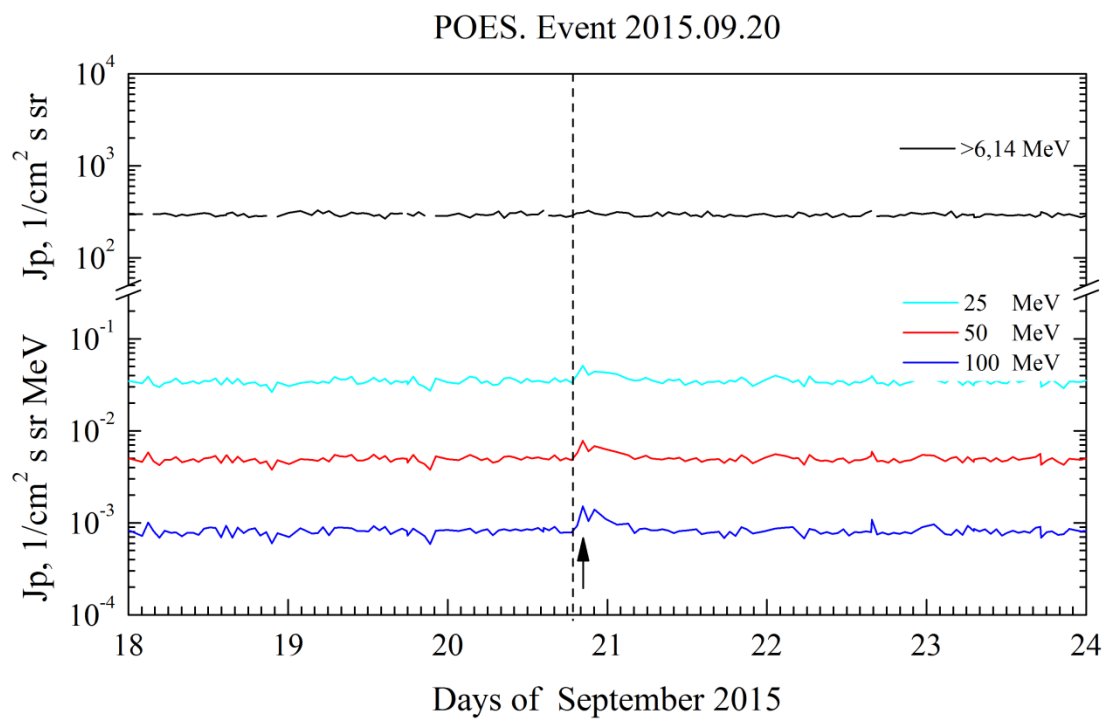
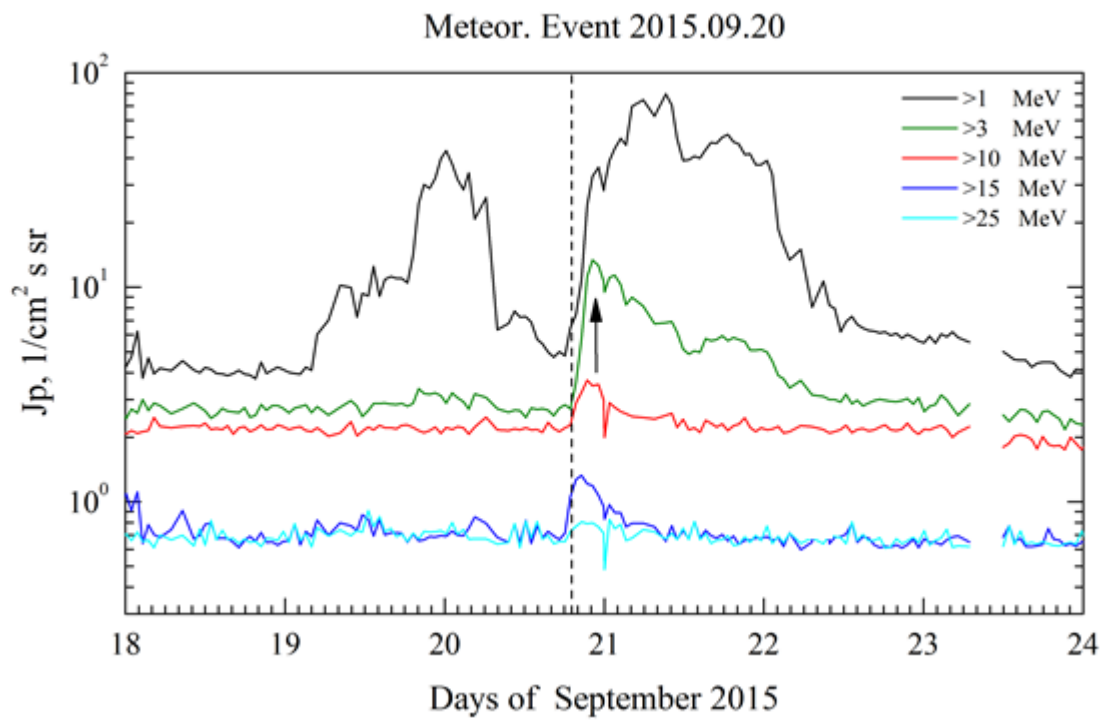
GOES. Event 2015.09.20



Electro. Event 2015.09.20



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 September 20**

2015 September 20

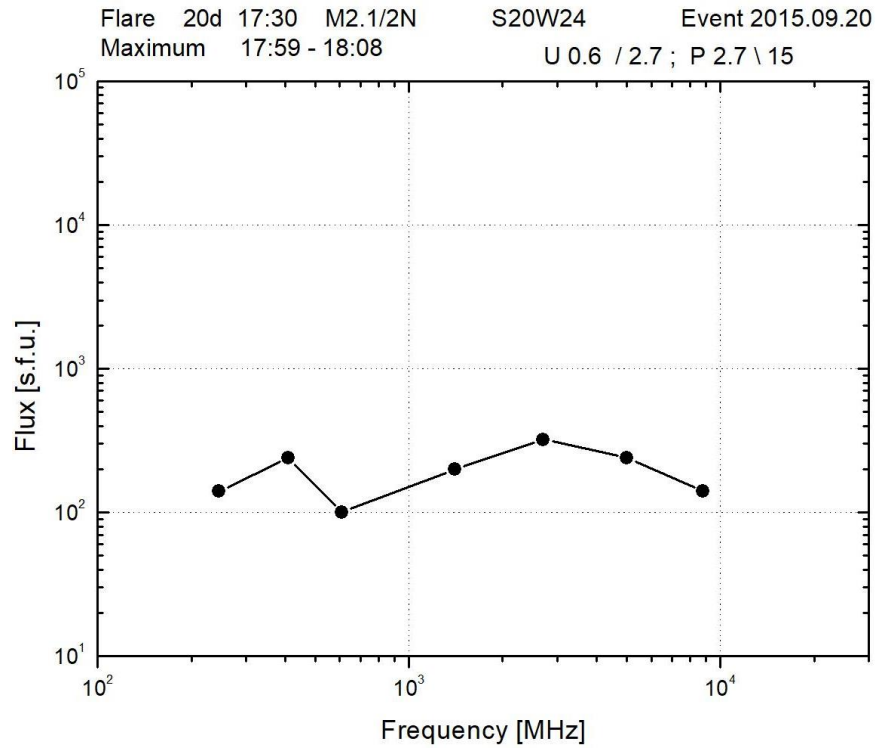
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AR 12415

To event 574

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1730	1757	1959	S20W24	2N	PRB
1 – 12	keV	1732	1803	1829	S22W50	M2.1	0.045
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1814:44	1815:26	1852:28	168	766180	HESSI
12-25	keV	1749:25	1756:10	1823:45	25656	6476539	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	1756	1804	1811		2.15	
5	GHz	1754	1804	1815		2.38	
2.7	GHz	1754	1804	1817	P2.7 \ 15	2.51	
1.4	GHz	1801	1804	1813		2.30	
610	MHz	1807	1808	1808	U0.6 / 2.7	2.0	
410	MHz	1807	1808	1813		2.38	
245	MHz	1758	1759	1800		2.15	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-39	1816		1822	1304	1	
DS VI	25-180	1756		1845		2	
DS III	25-180	1800		1809		1	
DS III	25-135	1925		1926		13	
DH II	0.3-14	1823		09/0146			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1812	1239	0.2	360°	219°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR12415 (S20L234, CMP 16,9.09.2021,
Sp=240 msh, EAC, BG, R)
XRI=0.32, $M_2^{2.1} + C_{34}$ $2_1 + 1_2 + S_{55}$
PFR 20.09 $M_1^{2.1}$

References:

Gopalswamy N., S. Yashiro, H. Xie et al., [2015](#).

Particle event: To($E_p > 10$ MeV) – 30d20^h

Tmax₁($E_p > 10$ MeV) – 30d23^h, Jmax₁($E_p > 10$ MeV) – 0.9 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 01d02^h, Jmax₂($E_p > 10$ MeV) – 0.6 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma_1 = 3.0$, $\gamma_2 = 3.1$

Quasimaximal energy of protons in the event – Eqm₁ = 40 MeV

– Eqm₂ = 35 MeV

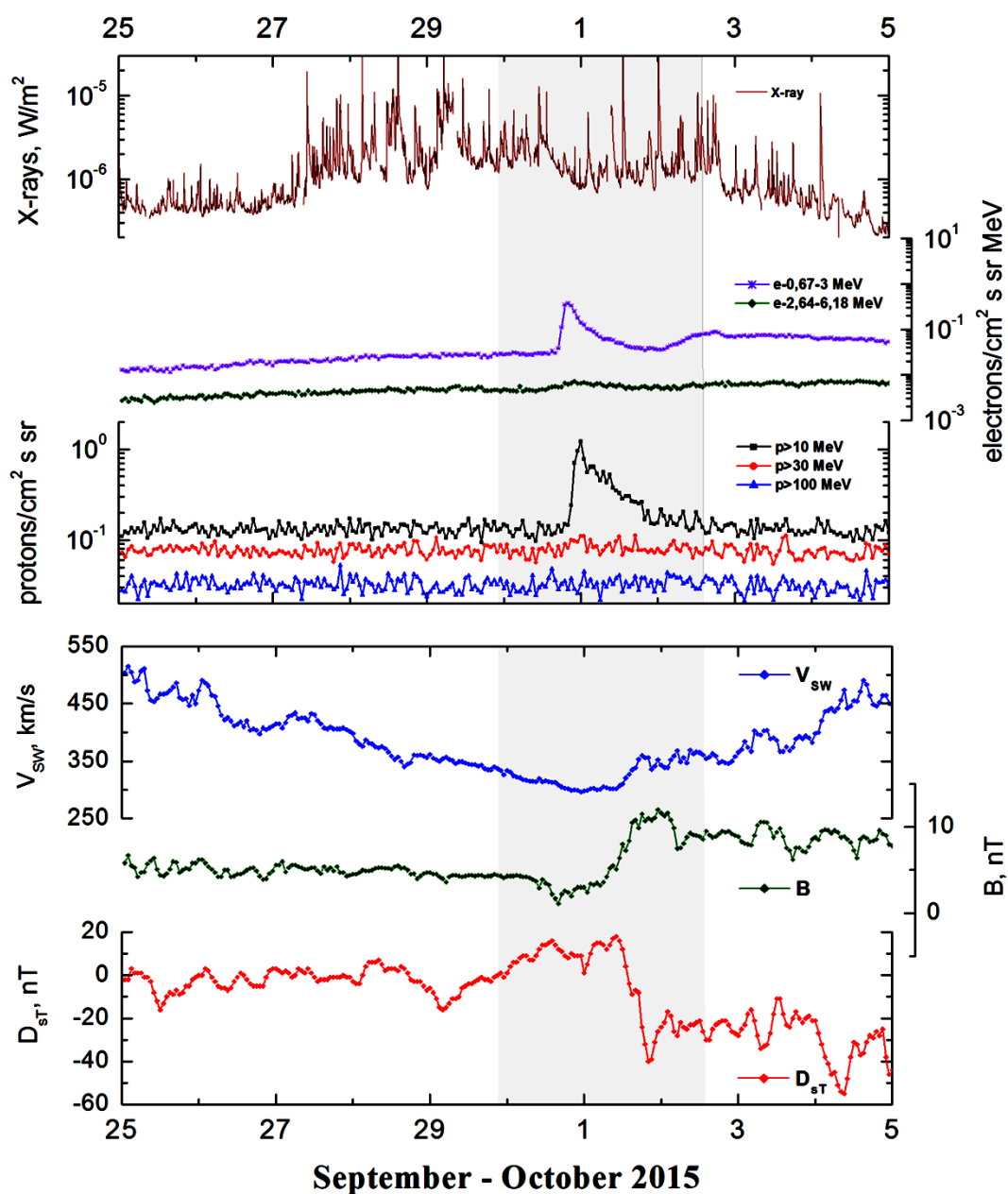
Sources: ☉ solar flare 30d07^h36^m, 1N/M1.3, S22W46, AR12422

☉ solar flare 30d13^h18^m, 1N/M1.1, S23W59, AR12422

Main burst X-ray 1–8 Å: onset – 30d10^h49^m, max – 30d10^h59^m, $\Phi = 0.014$ J/m²

CME: 30d10^h00^m, V = 602 km/s, $\Delta\phi = 128^\circ$; dA=304°

Particle fluxes and associated phenomena

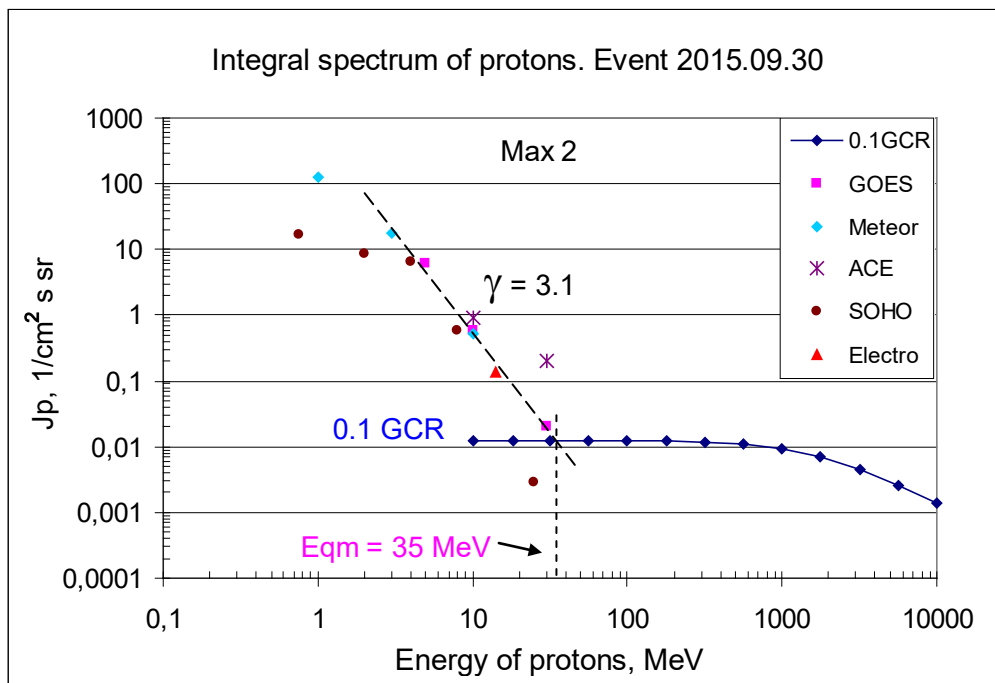
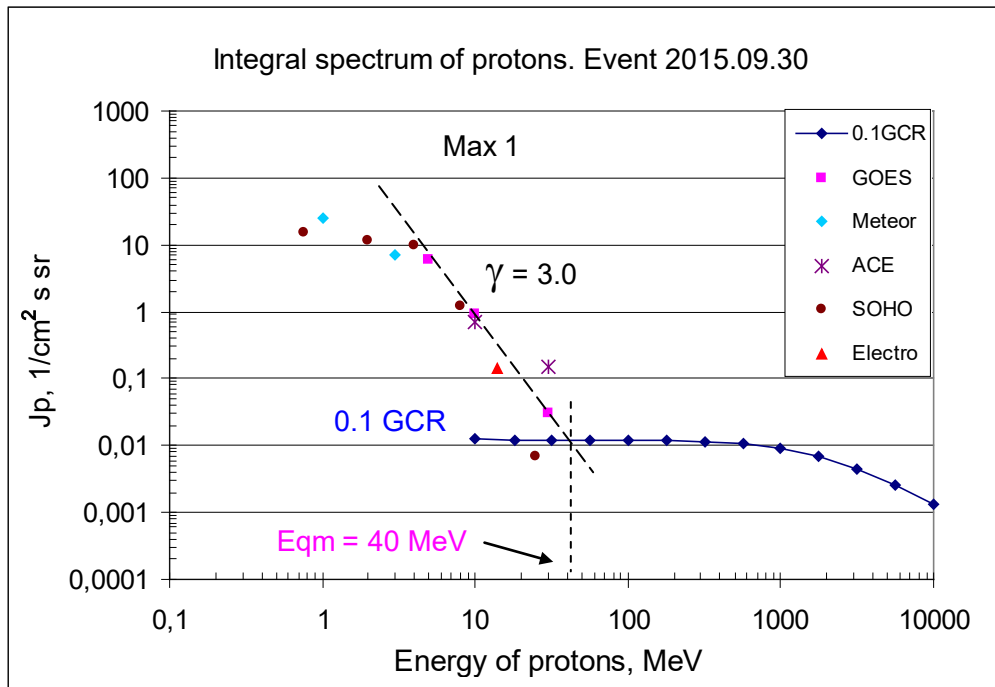


Integral fluxes of protons for the event of 2015 September 30

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	20	23/01d02	6.1/6.2	2	0.2	
EPS	>10	20	23/01d02	0.9/0.6	1	0.12	
EPS	>30	20	23/01d03	0.03/0.02	1	0.07	
EPS	>50	20	-	-	-	0.06	
EPS	>60	20	-	-	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	296	
Meteor-2							
SCR	>1	19	23/01d07	25/125	2.5	3.8	
SCR	>3	19	23/01d04	7/18	2	2.4	
SCR	>10	19	- /01d03	- /0.53	0.5	1.9	
GALS-M	>15	-	-	-	-	0.65	
GALS-M	>25	-	-	-	-	0.65	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	18	20/01d01	0.7/0.9	1	1.25	
SIS	>30	18	20/01d01	0.15/0.2	1	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2015 September 30

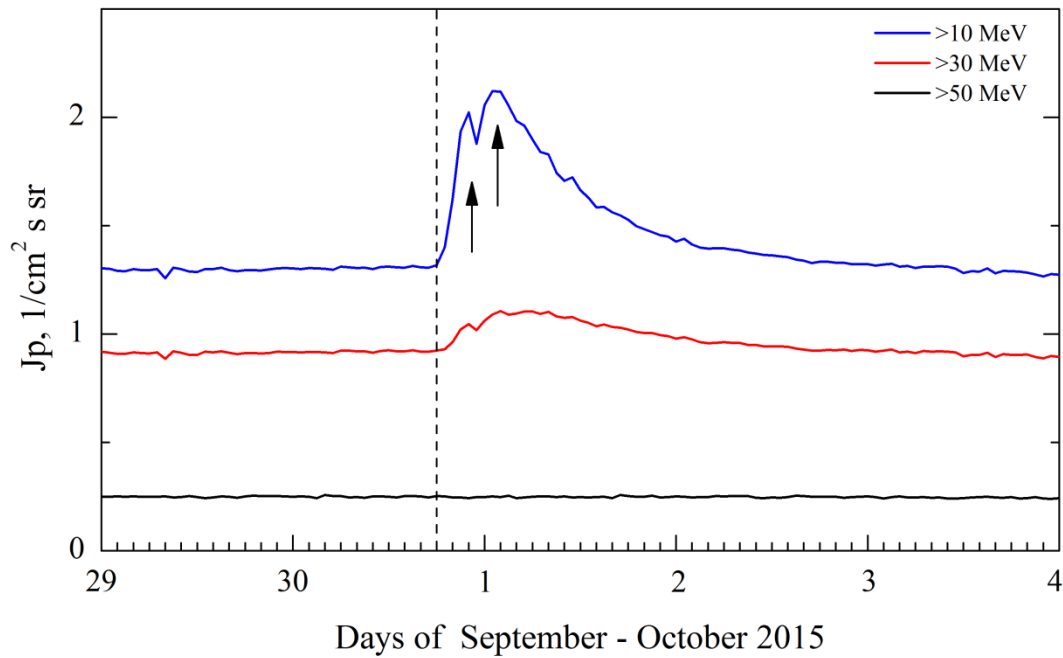
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	20	01d05/01d09	3.3/6.35	3	0.01	
LION	2 – 6	18	01d05/01d09	0.65/0.7	3	0.0017	
EPHIN	4 – 8	16	01d03/01d08	2.1/1.46	3	0.00005	
EPHIN	8 – 25	17	01d03/01d08	0.068/0.035	3	0.00001	
EPHIN	25 – 53	19	23/01d08	0.00025/0.0001	3	0.00002	
Electro-1							
SCR-E	13.7–23	-	01d02/01d06	0.015/0.015	0.2	0.05	
SCR-E	23–42	-	-	-	-	0.02	
SCR-E	42–112	-	-	-	-	0.004	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.032	25
MEPED	36–70	-	-	-	-	0.0047	50
MEPED	70–140	-	-	-	-	0.00084	100



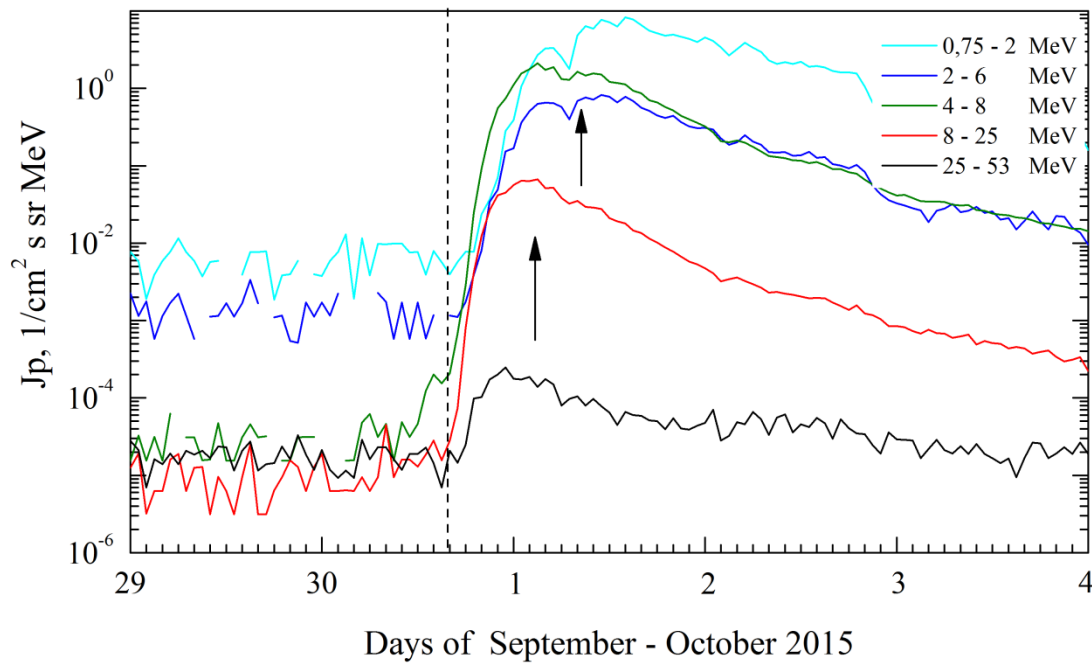
Time profiles of proton fluxes in the event 2015.09.30

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.09.30

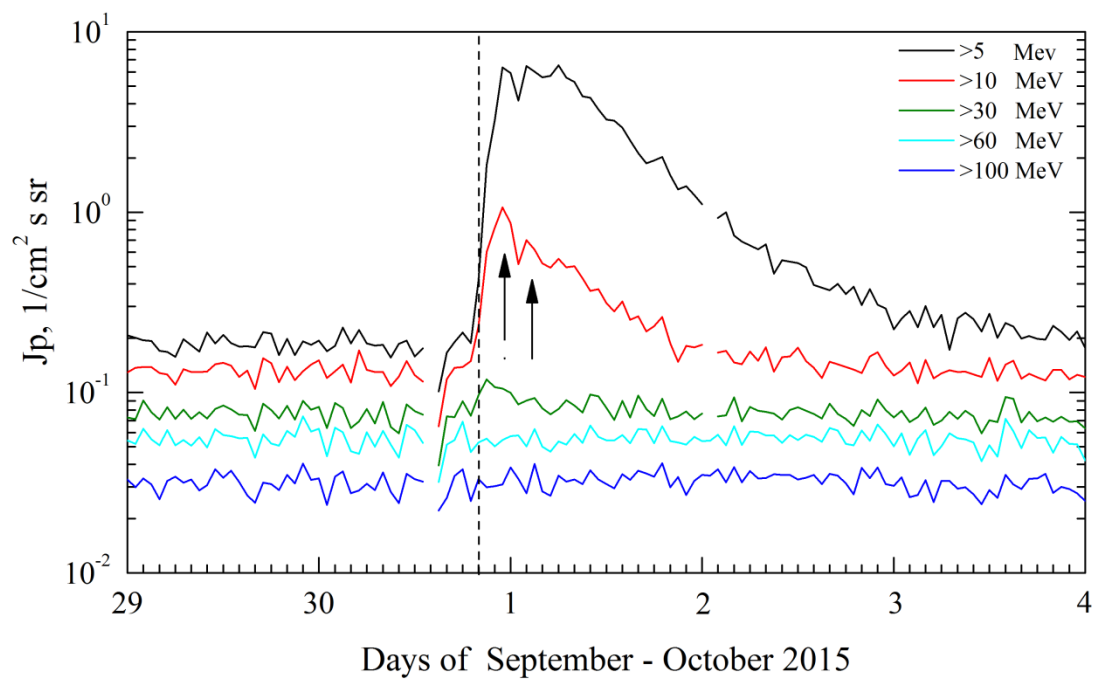


SOHO. Event 2015.09.30

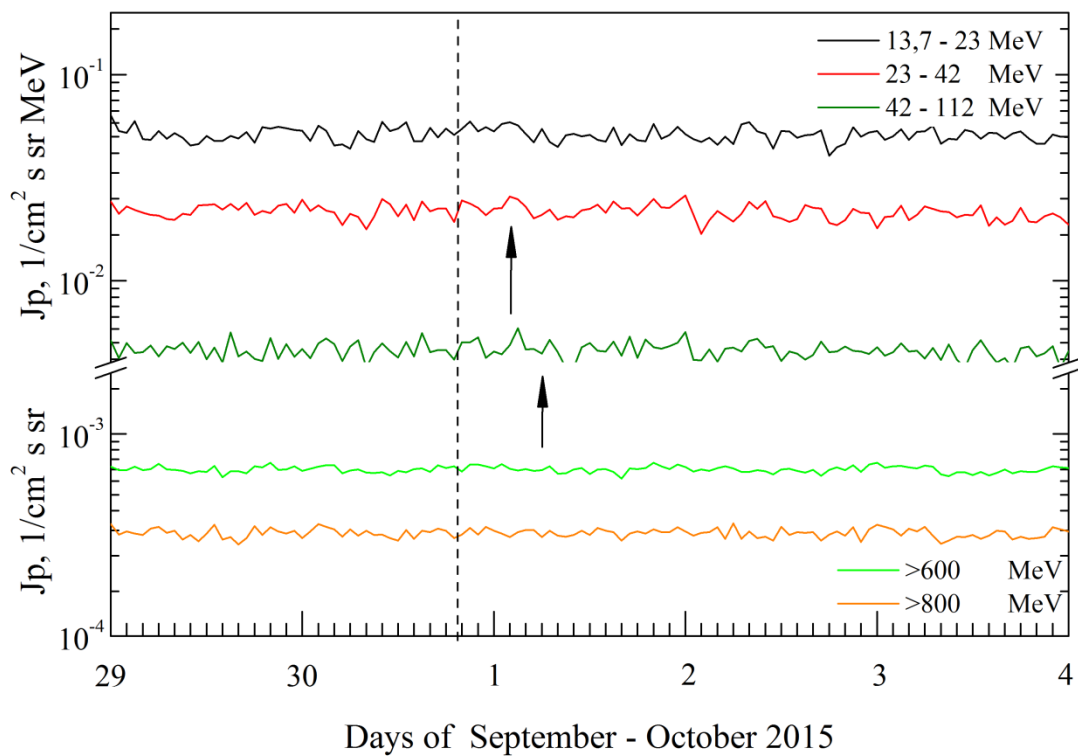


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.09.30

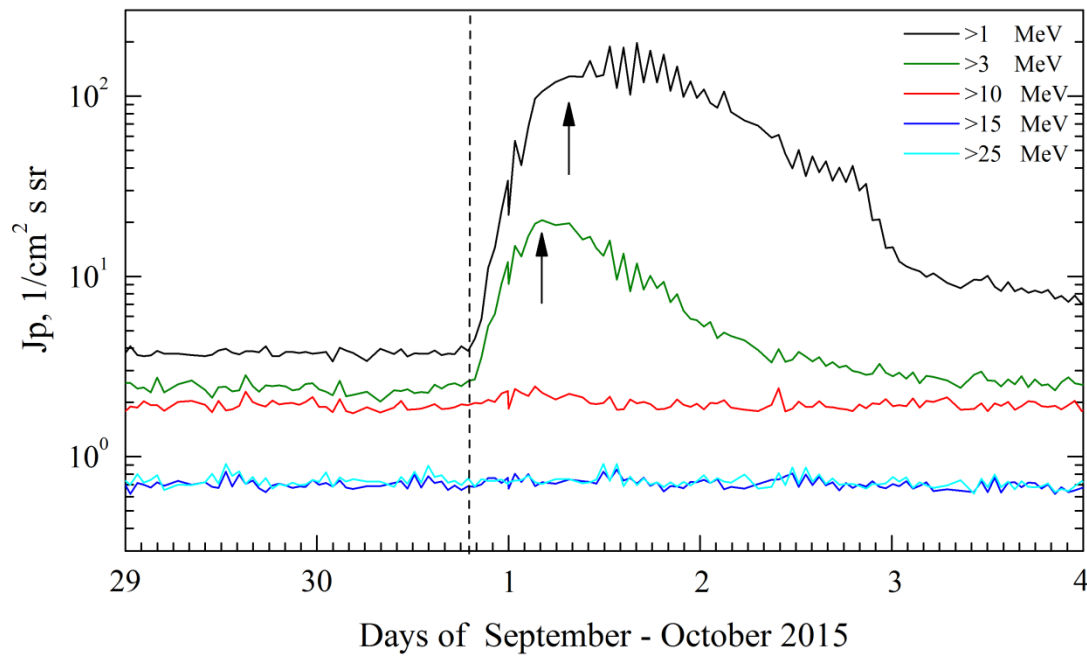


Electro. Event 2015.09.30

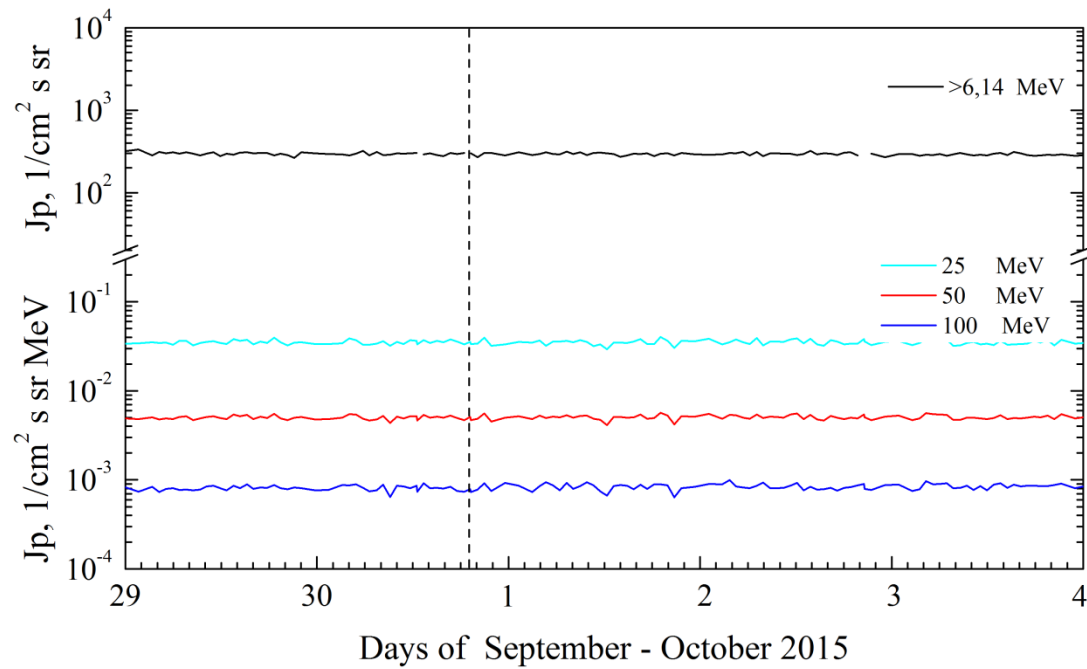


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.09.30



POES. Event 2015.09.30



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 September 30**

2015 September 30 ☉ AR 12422 To event 575

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	<0736	~1054	>1102	S22W46	1N	ERU
6563 Å	FL	0743	0744	0752	S19W49	SF	
6563 Å	FL	0811	0815	0842	S19W47	SF	
1 – 12	keV	1049	1059	1113		M1.3	0.014
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	0852:48	0855:22	0909:08	40	43787	HESSI
6-12	keV	1026:36	1026:50	1028:32	16	4500	HESSI
6-12	keV	1038:00	1040:58	1042:44	20	8863	HESSI
6-12	keV	1042:44	1043:46	1045:00	13	4003	HESSI
50-100	keV	1048:56	1054:02	1055:20	348	471438	HESSI
12 – 25	keV	0814:55	0815:08	0815:36	1013	7870	FERMI
12-25	keV	0948:35	0949:04	0949:37	3524	14253	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	0811	0811	0811		2.88	
245	MHz	0905	0905	0905		2.76	
SP-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-043	1608		1612	928	1	
DS IV	025-180	1553		1624		2	
DS III	025-180	1554		1604		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1000	602	21.3	128°	304°	SOHO
LASCO	WL	0936	586	27.0	102°	240°	SOHO

**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 September 30**

2015 September 30 Ø AR 12422 To event 575

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1314	~1320	1328	S23W59	1N	ERU
1 – 12	keV	1318	1320	1321		M1.1	0.0016
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	1313:52	1315:06	1316:28	42	11699	HESSI

Proton Active Region:

AR 12422 (S20L102, CMP 26,8.09.2015,

Sp=950 msh, FRC, BGD, R1?)

XRI= 3.72 $M_{17}^{7.6} + C_{62}$ $2_1 + 1_{17} + S_{113}$

PFR1 28-29.09: (23^h) $M_9^{7.6}$

PFR2 1-2.10: (11^h) $M_2^{5.5}$

Particle event: To($E_p > 10$ MeV) – 22d13^h

Tmax₁($E_p > 10$ MeV) – 22d23^h, Jmax₁($E_p > 10$ MeV) – 0.5 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 23d05^h, Jmax₂($E_p > 10$ MeV) – 0.2 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma_1 = 3.0$, $\gamma_2 = 3.0$,

Quasimaximal energy of protons in the event – Eqm₁ = 40 MeV

– Eqm₂ = 40 MeV

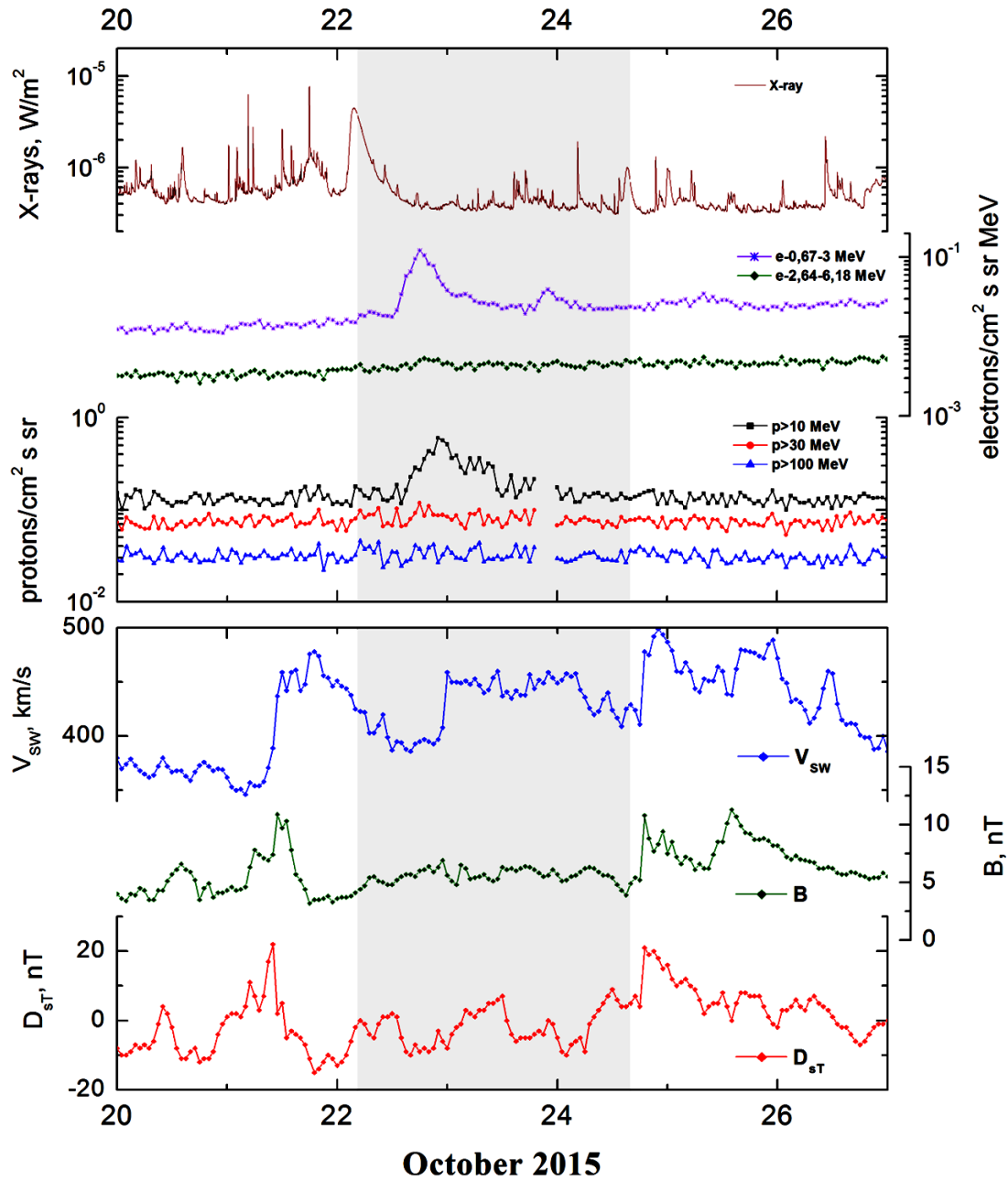
Sources: ● solar flare 22d02^h13^m, C4.4/SF, S11W27, AR12434

Main burst X-ray 1–8 Å: onset – 22d02^h13^m, max – 22d03^h40^m, $\Phi = 0.036$ J/m²

CME: 22d03^h12^m, $V = 817$ km/s, $\Delta\phi = 360^\circ$, $dA = 206^\circ$

▲ SC 24d18^h55^m

Particle fluxes and associated phenomena

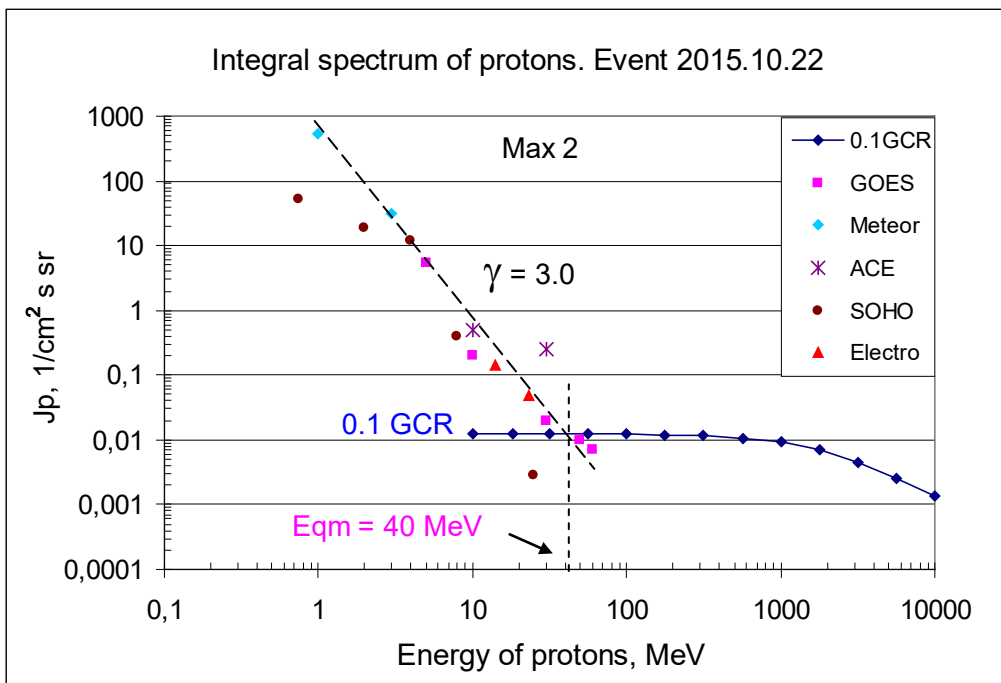
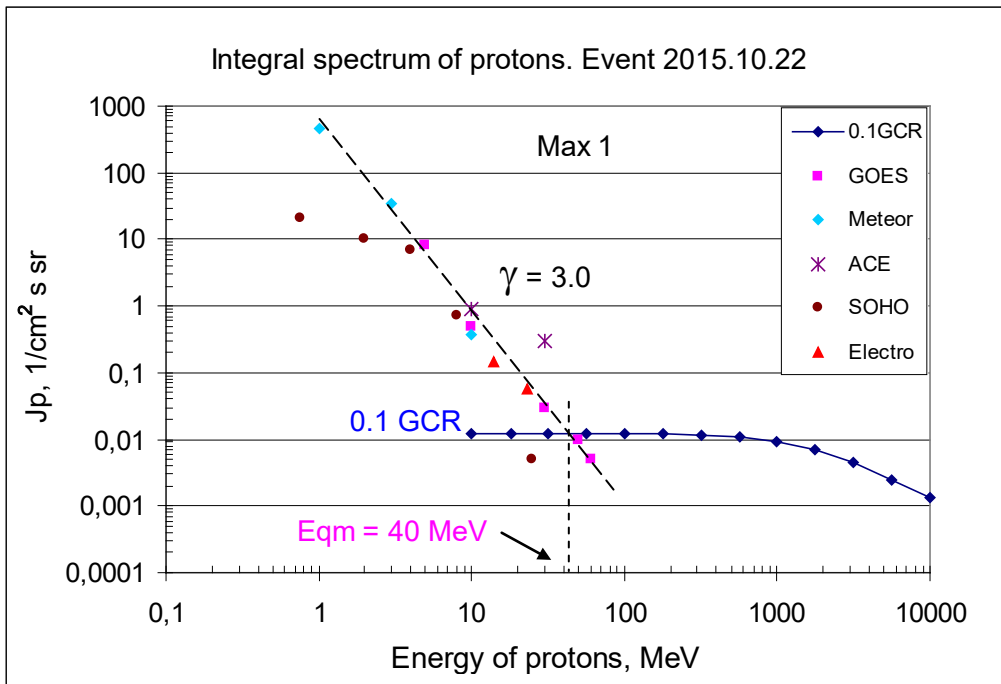


Integral fluxes of protons for the event of 2015 October 22

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	13	23/23dd05	8/5.5	2	0.2	
EPS	>10	13	22/23dd05	0.5/0.2	1	0.12	
EPS	>30	13	22/23dd05	0.03/0.02	-	0.07	
EPS	>50	13	22/23dd05	0.01/0.01	-	0.06	
EPS	>60	13	22/23dd05	0.005/0.007	-	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	295	
Meteor-2							
SCR	>1	12	23d01/23d07	460/526	3.5	3.8	
SCR	>3	12	23d01/23d07	35/31	2	2.4	
SCR	>10	16?	21/-	0.37/-	0.3	1.9	
GALS-M	>15	-	-	-	-	0.65	
GALS-M	>25	-	-	-	-	0.65	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	12	21/23d05	0.9/0.5	1.5	1.25	
SIS	>30	12	21/23d05	0.3/0.25	1.5	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

Differential fluxes of protons for the event of 2015 October 22

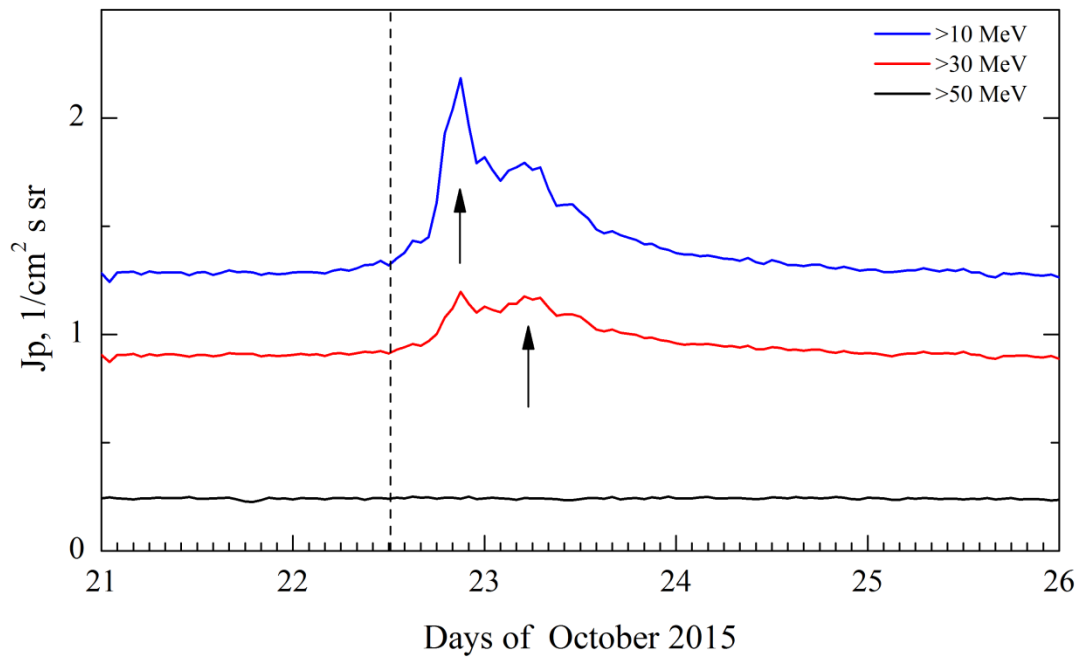
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	8	22/23d04	9/25.4	3.7	0.004	
LION	2 – 6	8	22/23d05	1.1/2.53	3.7	0.001	
EPHIN	4 – 8	7	22/23d04	1.54/2.83	3.7	0.00005	
EPHIN	8 – 25	6	20/23d04	0.042/0.0233	3.7	0.00002	
EPHIN	25 – 53	6	20/23d04	0.00017/0.0001	1.5	0.00002	
Electro-1							
SCR-E	13.7–23	12	23/23d04	0.01/0.01	0.2	0.05	
SCR-E	23–42	12	23/23d04	0.003/0.0025	0.2	0.02	
SCR-E	42–112	-	-	-	-	0.004	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.033	25
MEPED	36–70	-	-	-	-	0.0047	50
MEPED	70–140	-	-	-	-	0.0008	100



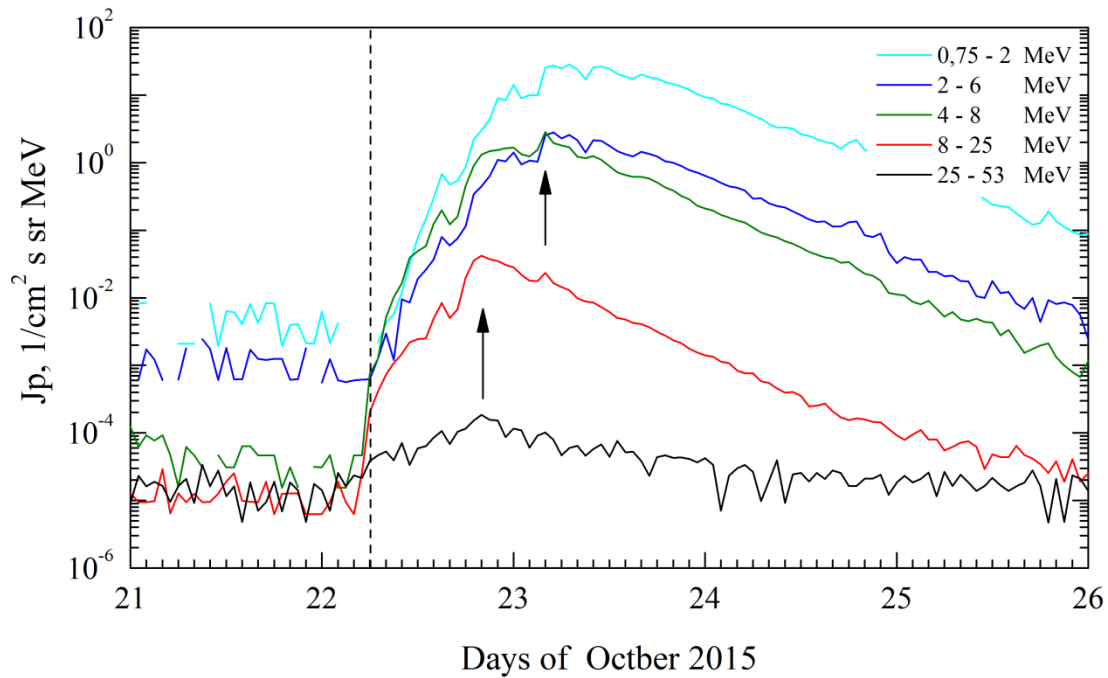
Time profiles of proton fluxes in the event 2015.10.22

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

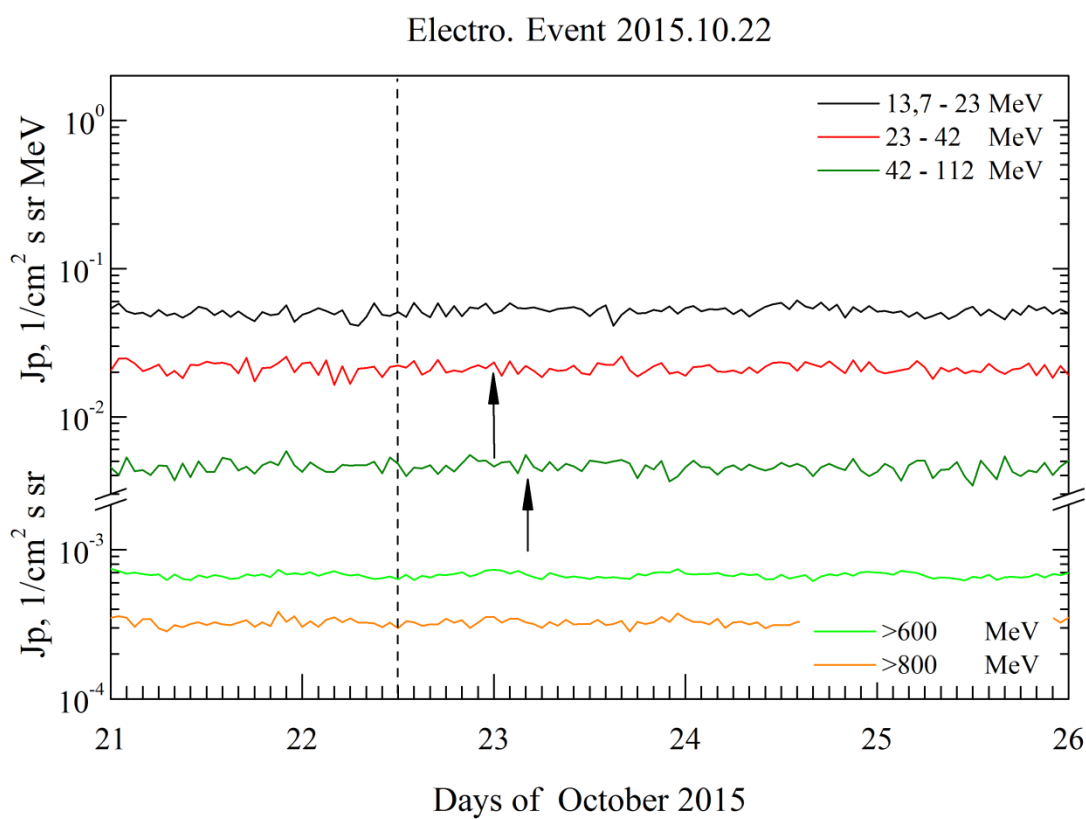
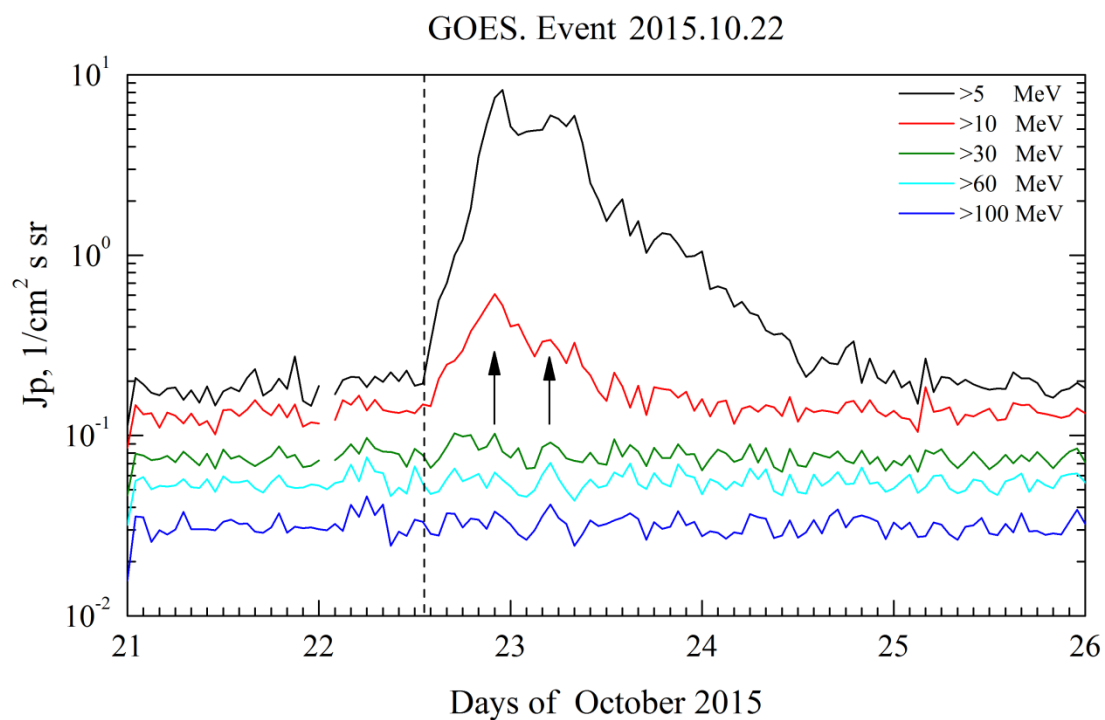
ACE SIS+SOHO (>50 MeV). Event 2015.10.22



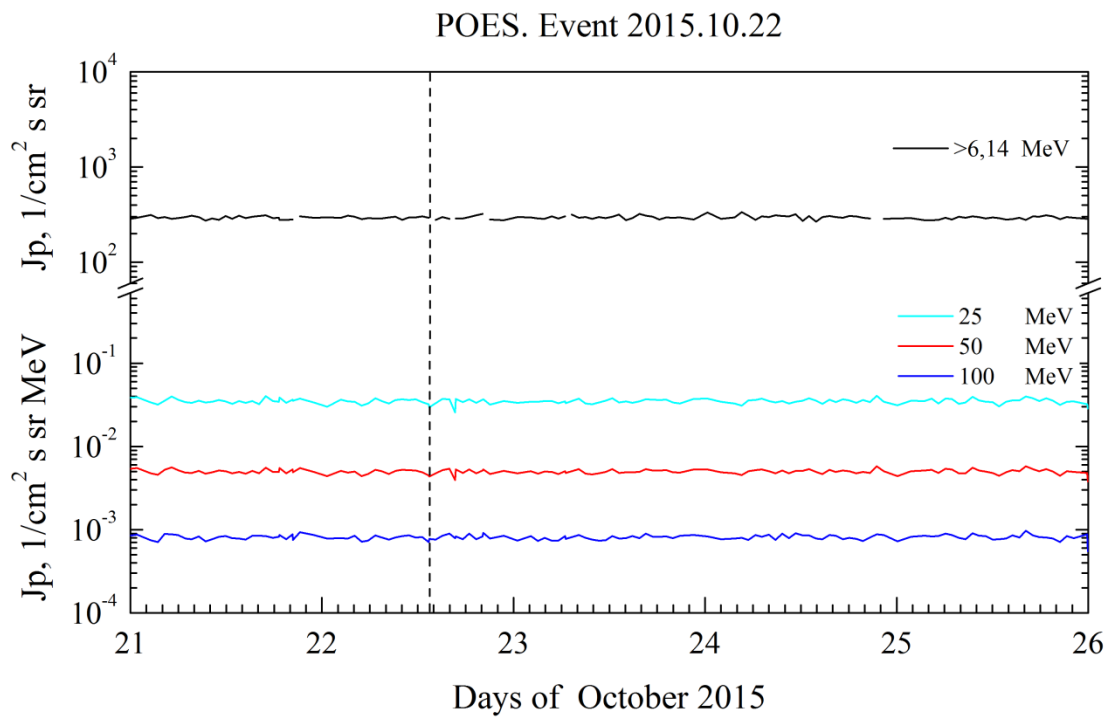
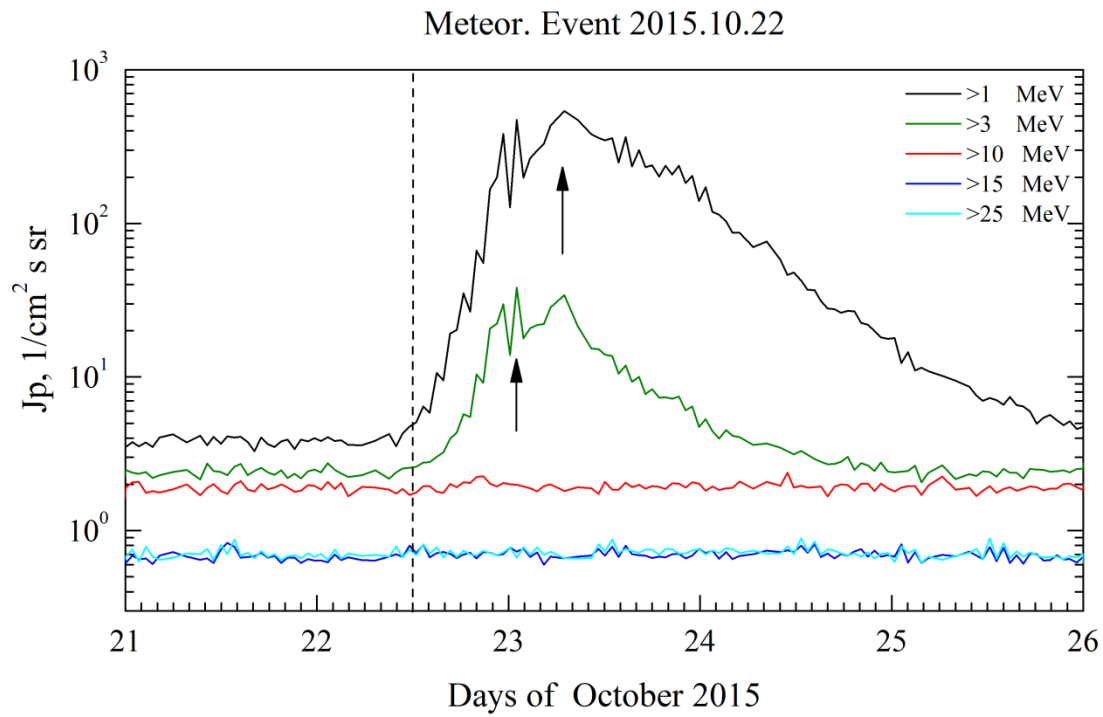
SOHO. Event 2015.10.22



Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro



Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 October 22**

2015

October 22

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AR12434

To event 576

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0239	0303	0515	S11W27	SF	UMB
6563 Å	DSF	0244			S15W40	16°	
1 – 12	keV	0213	0340	0515	S10W34	C4.4*	0.036
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	0220:56	0246:42	0248:32	1584	4178976	HESSI
12-25	keV	0321:24	0321:30	0422:56	2288	15451236	HESSI
6-12	keV	0458:28	0459:02	0517:00	336	851466	HESSI
12-25	keV	0248:44	0307:01	0327:55	999	436093	FERMI
12-25	keV	0425:37	0426:41	0429:27		324670	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
245	MHz	0230	0231	0232		2.46	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	25-180	0230		0240		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0312	817	6.0	360°	206°	SOHO

*https://sdownwww.lmsal.com/sdomedia/ssw/ssw_client/data/ssw_service_151022_000245_57422/ww/

Proton Active Region:

AR12434 (S10L164, CMP 19,4.10.2015,
Sp=260 msh, DKI, BGD, R)
XRI=0.22 $M_2^{1.1} + C_{41} \quad 1_1 + S_{25}$
PFR 15-16.10: (7^h) $M_2^{1.1}$

Particle event: To($E_p > 10$ MeV) – 29d02^h

Tmax ($E_p > 10$ MeV) – 29d07^h, Jmax($E_p > 10$ MeV) – 19 /cm²·s·sr

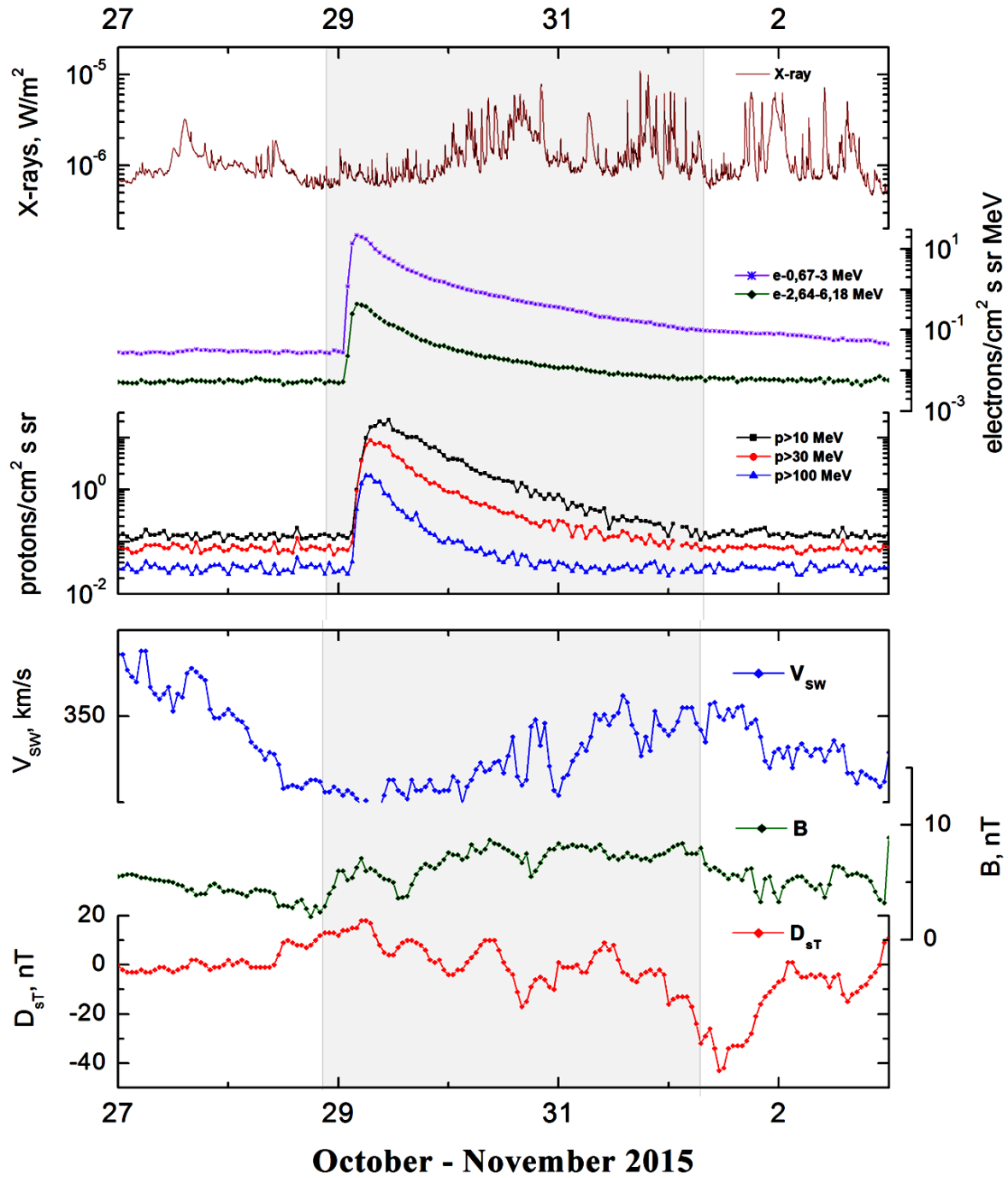
Duration of the event – 3 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 900$ MeV

Sources: \square solar flare 29d<02^h36^m, AR12434 – 2d behind W_L

CME: 29d02^h36^m, $V = 530$ km/s, $\Delta\phi = 202^\circ$, $dA = 251^\circ$

Particle fluxes and associated phenomena

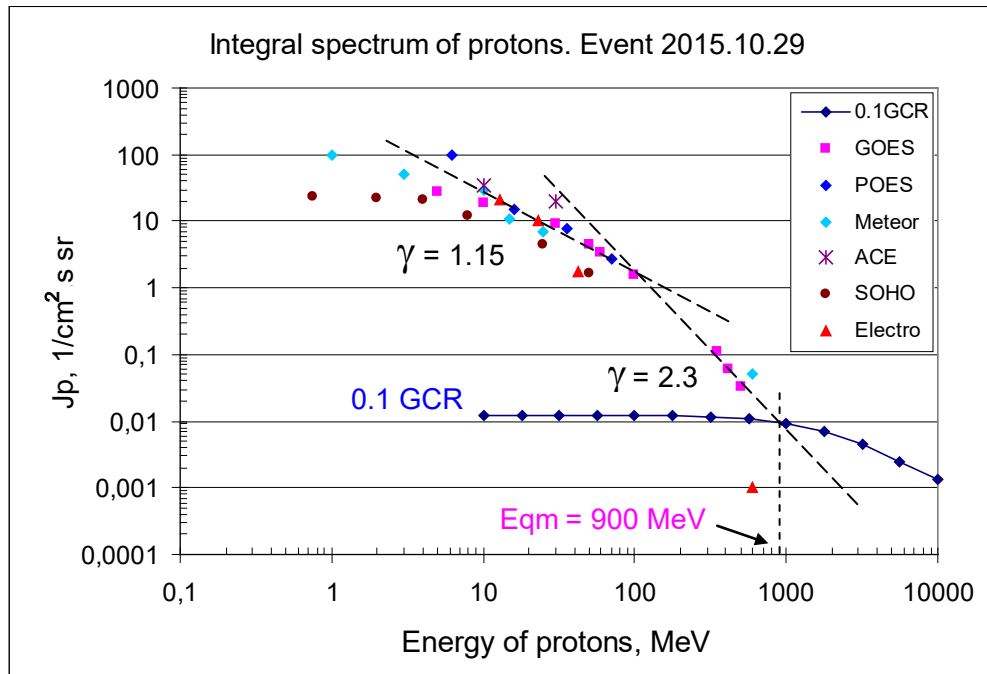


Integral fluxes of protons for the event of 2015 October 29

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	2	8	27.2	3	0.2	
EPS	>10	2	7	19	3	0.12	
EPS	>30	2	6	9	3	0.07	
EPS	>50	2	6	4.5	2	0.06	
EPS	>60	2	6	3.4	2	0.05	
EPS	>100	2	6	1.6	2	0.03	
EPS	>700	-	-	-	-	0.001	
Electro-1							
GALS-E	>600	2	6	0.001	0.5	0.0007	
POES							
MEPED	>6.14	03	06	97	0.4	295	
Meteor-2							
SCR	>1	2	8	100	3	3.8	
SCR	>3	2	8	50	3	1.8	
SCR	>10	2	8	29.5	1.5	1.9	
GALS-M	>15	2	8	10.7	1	0.6	
GALS-M	>25	2	7	6.9	1	0.6	
GALS-M	>600	2	6	0.05	0.5	0.2	
ACE							
SIS	>10	3	5	35	1.5	1.3	
SIS	>30	3	5	20	1.5	0.9	
SOHO							
EPHIN	>50	3	6	1.64	1	0.24	

Differential fluxes of protons for the event of 2015 October 29

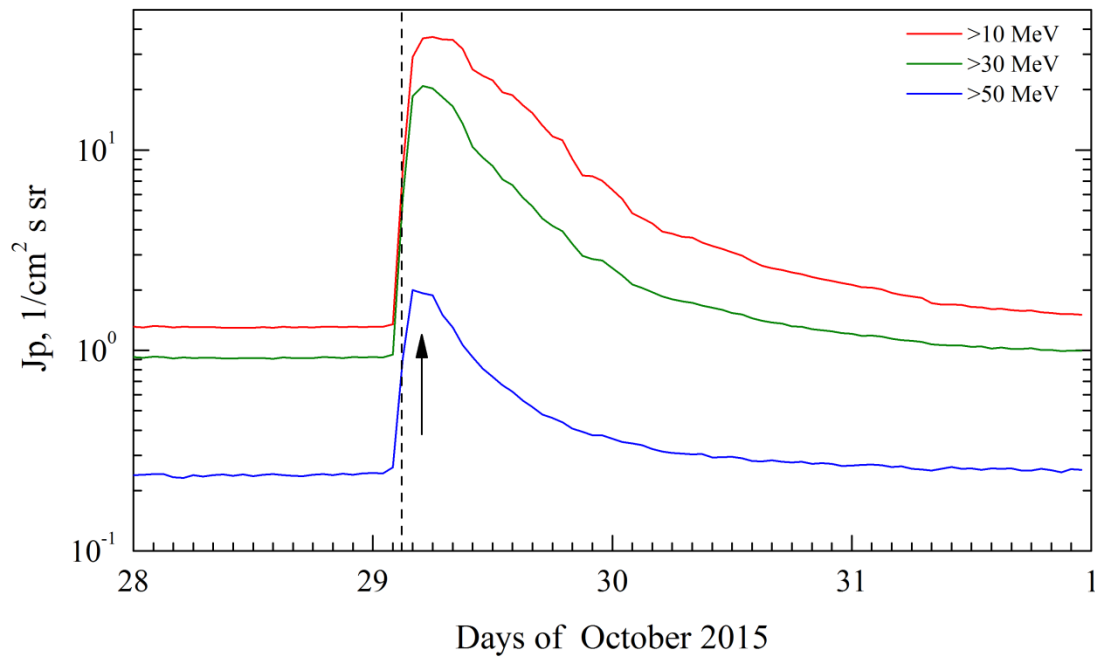
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	4	17	1.34	>3	0.015	
LION	2 – 6	4	17	0.455	>3	0.0023	
EPHIN	4 – 8	3	16	2.1	>3	0.001	
EPHIN	8 – 25	3	12	0.45	>3	0.00003	
EPHIN	25 – 53	3	6	0.1	>3	0.00002	
Electro-1							
SCR-E	13.7–23	2	6	1.2	1	0.05	
SCR-E	23–42	2	6	0.45	1	0.02	
SCR-E	42–112	2	6	0.025	1	0.004	
POES							<E>, MeV
MEPED	16–36	03	06	0.357	2	0.034	25
MEPED	36–70	03	06	0.147	1.5	0.005	50
MEPED	70–140	03	06	0.04	1.5	0.0008	100
GOES							
EPS	350–420	4	6	0.0007	1	0.0016	
EPS	420–510	3	6	0,0003	1	0.001	
EPS	510–700	3	6	0,00017	1	0,0005	



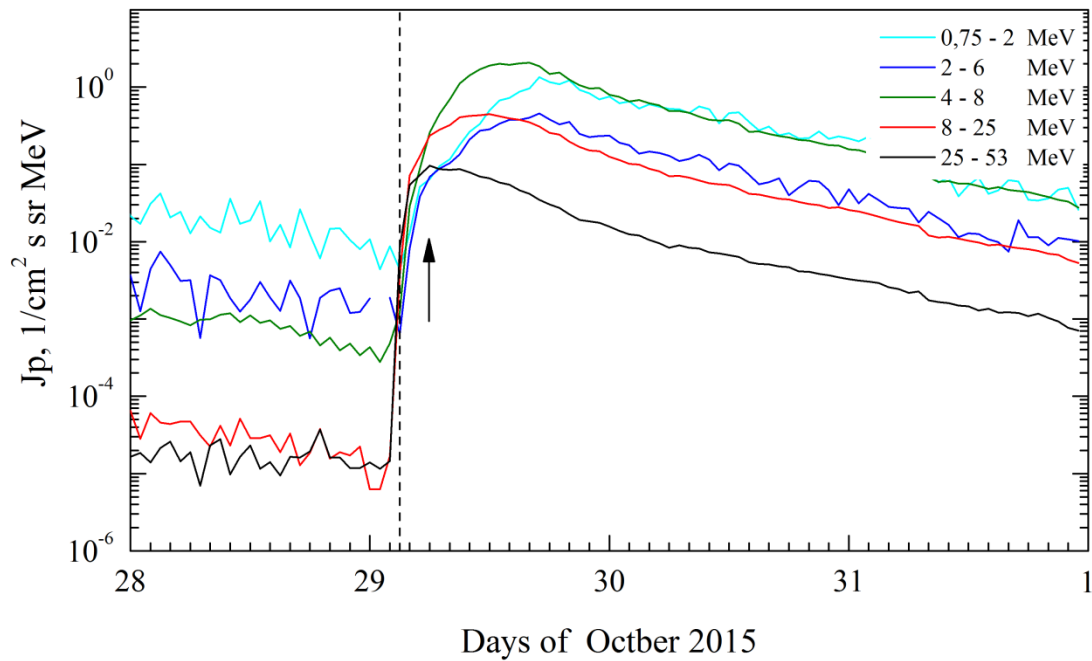
Time profiles of proton fluxes in the event 2015.10.29

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.10.29

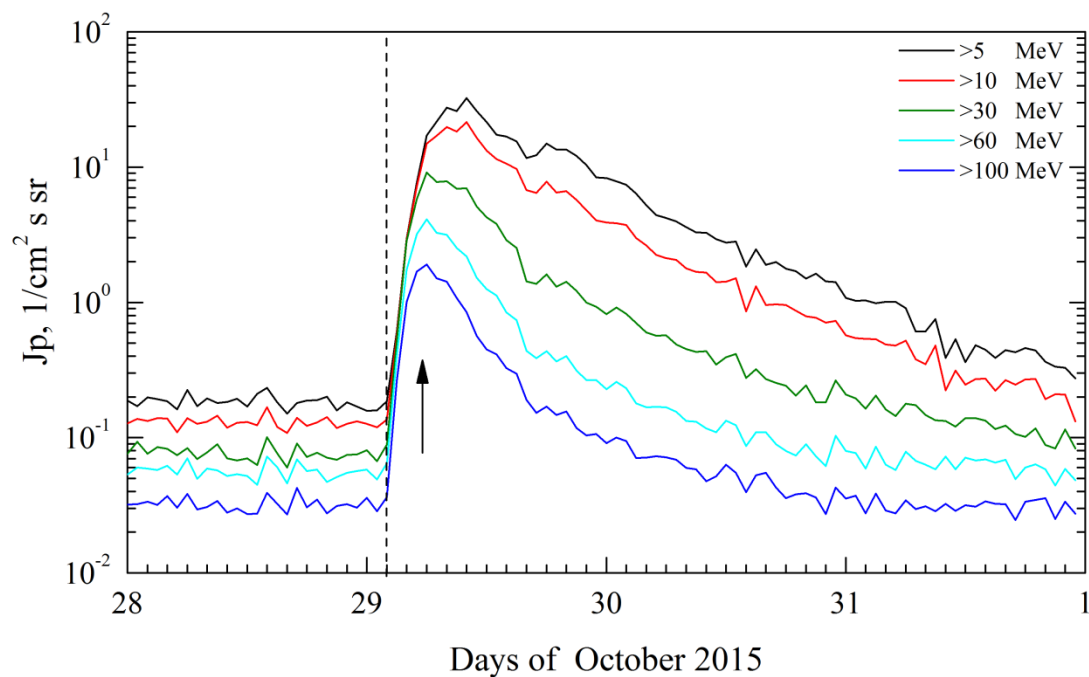


SOHO. Event 2015.10.29

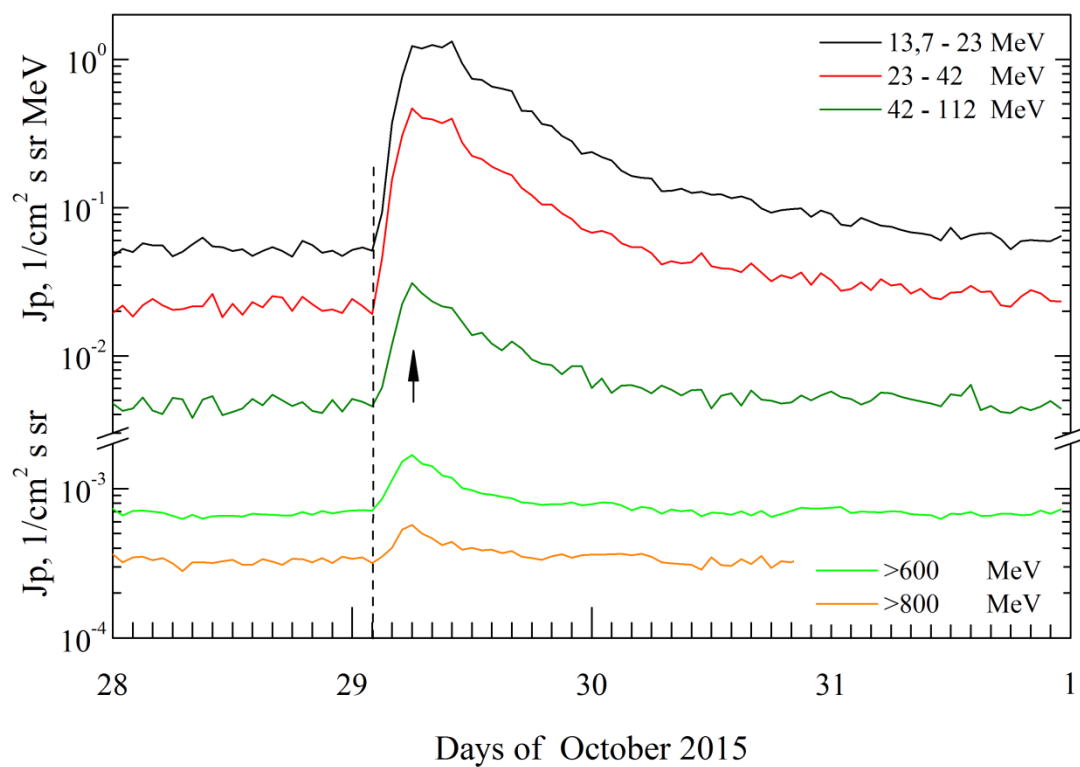


Earth satellites in geostationary orbit, $R \approx 6.6 R_e$: GOES and Electro

GOES. Event 2015.10.29

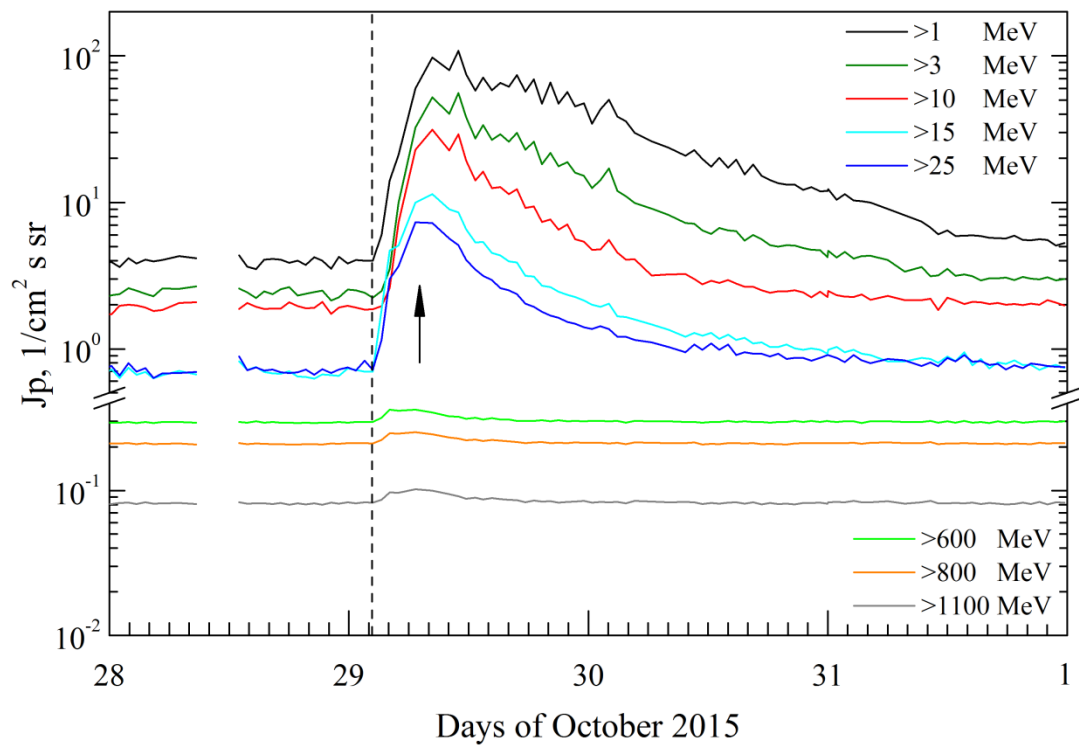


Electro. Event 2015.10.29

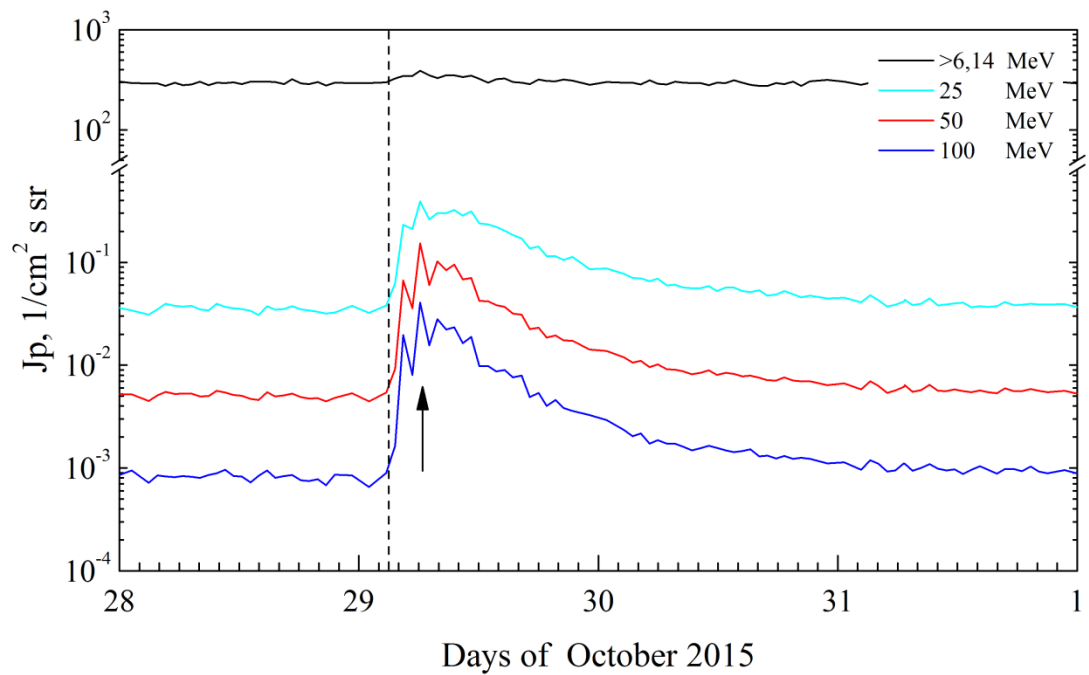


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.10.29



POES. Event 2015.10.29



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 October 29**

2015 October 29 ☐ AR 12434 To event 577

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical and X-ray flare on visible disc					
1 – 12	keV						
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6 – 12	keV	0241:52	0244:34	0253:24	104	129072	HESSI
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	35-400	0219		0232		1	
DS II	25-180	0219		0230	972	1	
DS II	30-57	0219		0246		1	
DS IV	30-135	0230		0247		1	
DS III	18-75	0227		0231		3	
DS III	43-64	0240		0241		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0236	530	- 7.5	202°	251°	SOHO

Proton Active Region:

AR12434* (S10L164, CMP 19,4.10.2015,

Sp=260 msh, DKI, BGD)

XRI=0.22 M₂^{1.1}+C₄₁ 1₁+S₂₅

PFR 15-16.10: (7^h) M₂^{1.1}

*2d behind W_L

References:

Мирошниченко Л.И., Ли Ч., Янке В.Г., [2020](#).

Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).

Kahler S.W., D. Brown, [2021](#).

Miroshnichenko L.I., C. Li, V.G. Yanke, [2020](#).

NOAA SPE, [2019](#).

Xie H., O.C.St. Cyr, P. Mäkelä, N. Gopalswamy, [2019](#).

Particle event: To($E_p > 10$ MeV) – 09d16^h

Tmax ($E_p > 10$ MeV) – 10d02^h, Jmax($E_p > 10$ MeV) – $2.7 \text{ /cm}^2 \cdot \text{s} \cdot \text{sr}$

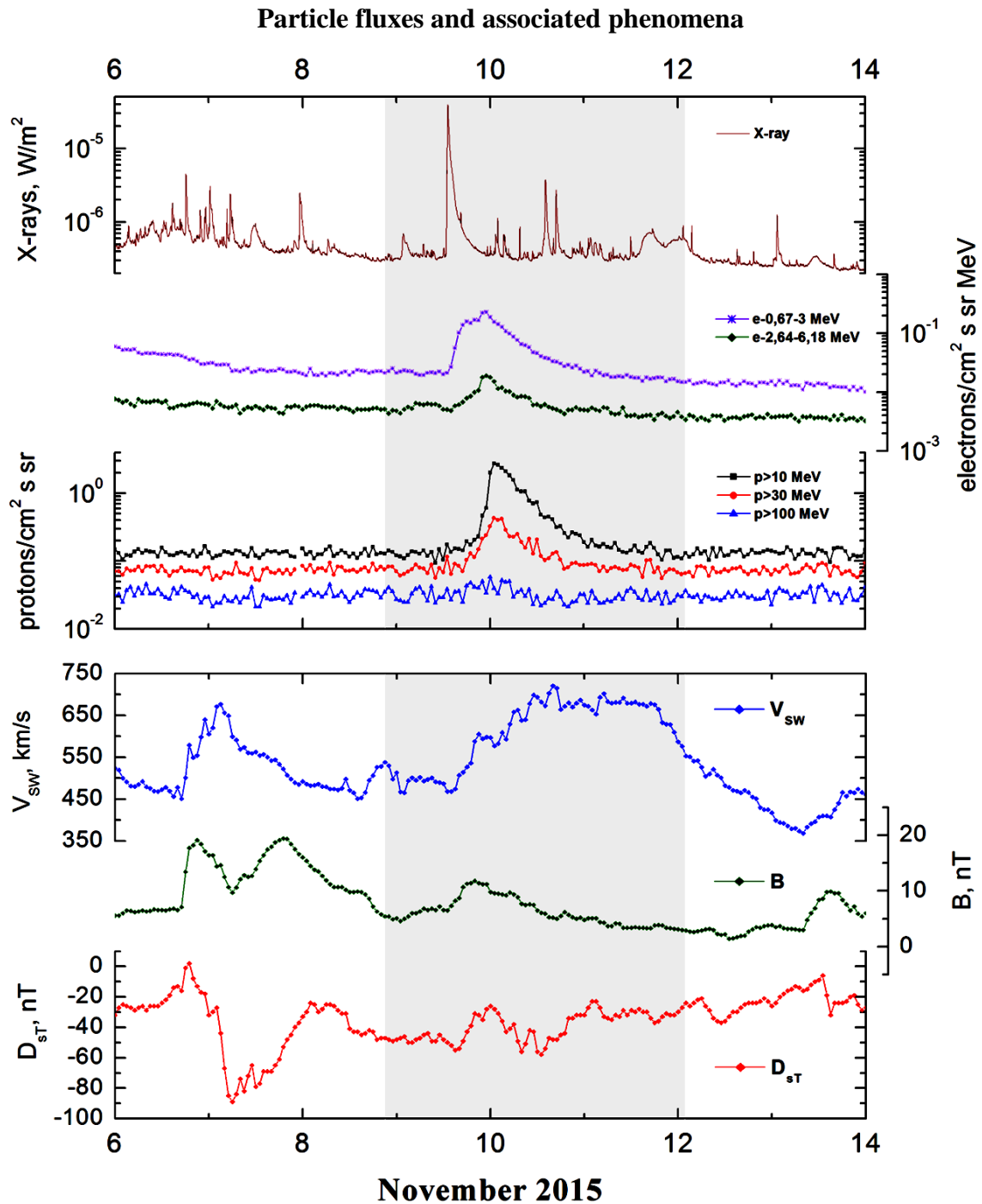
Duration of the event – 1.5 days, power-law index: $\gamma = 2.2$

Quasimaximal energy of protons in the event – $E_{qm} = 120$ MeV

Sources: • solar flare 09d12^h49^m, M3.9/2B, 1F, S11E41, AR12449

Main burst X-ray 1–8 Å: onset – 09d12^h49^m, max – 09d13^h12^m, $\Phi = 0.047 \text{ J/m}^2$

CME: 09d13^h25^m, $V = 1041 \text{ km/s}$, $\Delta\phi = 273^\circ$, $dA = 137^\circ$

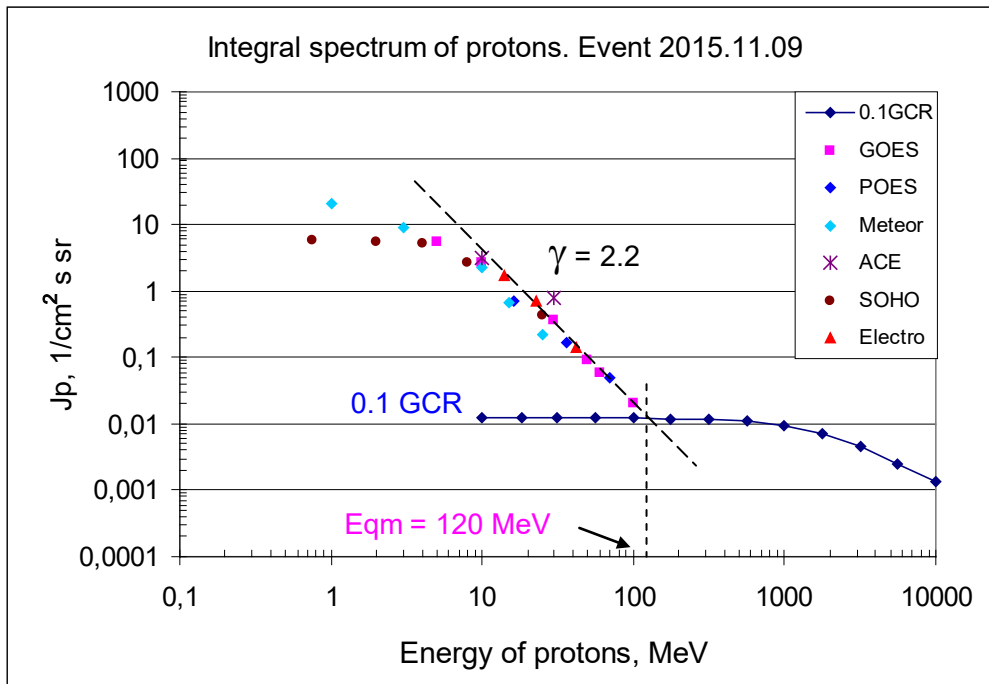


Integral fluxes of protons for the event of 2015 November 09

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	16	10d01	5.6	1.5	0.2	
EPS	>10	16	10d02	2.7	1.5	0.12	
EPS	>30	16	10d03	0.37	1	0.07	
EPS	>50	16	10d00	0.09	1	0.06	
EPS	>60	16	10d00	0.06	1	0.05	
EPS	>100	16	22	0.02	0.5	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	295	
Meteor-2							
SCR	>1	22	10d02	20.5	1.5	3.8	
SCR	>3	22	10d02	9.21	1	1.8	
SCR	>10	22	10d02	2.23	1	1.9	
GALS-M	>15	22	10d02	0.66	0.5	0.7	
GALS-M	>25	22	10d01	0.22	0.4	0.7	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	15	23	3.2	1.5	1.3	
SIS	>30	15	23	0.8	1.5	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.24	

Differential fluxes of protons for the event of 2015 November 09

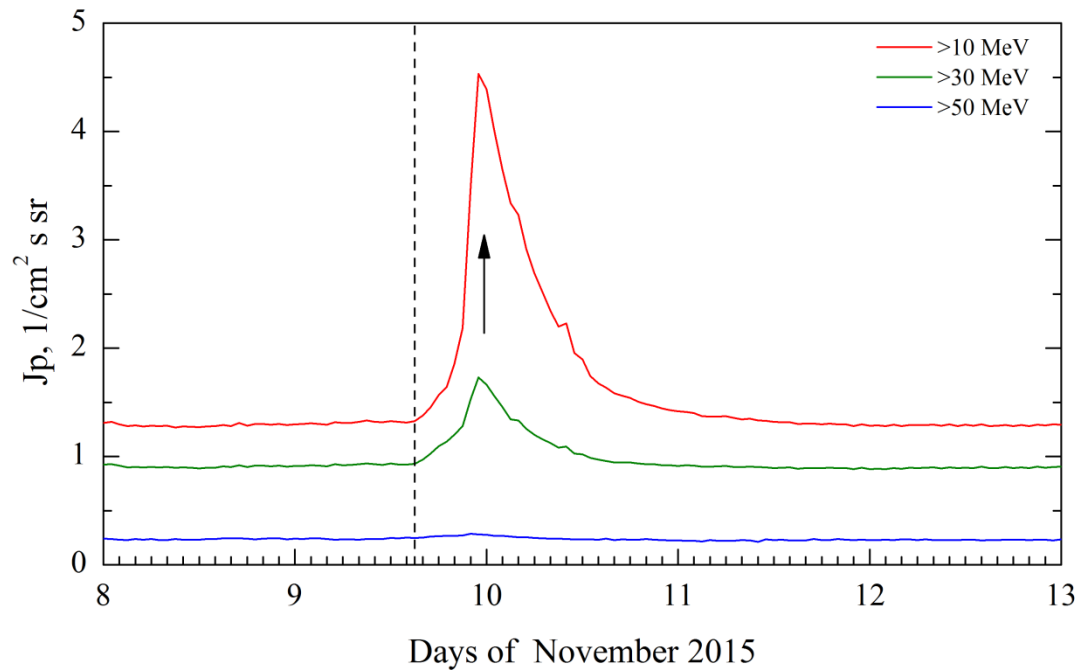
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	18	10d05	0.19	1.5	0.01	
LION	2 – 6	20	10d05	0.093	2.5	0.002	
EPHIN	4 – 8	20	10d00	0.639	5.5	0.0007	
EPHIN	8 – 25	17	23	0.132	5.5	0.00004	
EPHIN	25 – 53	16	23	0.0147	4.5	0.00002	
Electro-1							
SCR-E	13.7–23	16	10d01	0.11	1	0.05	
SCR-E	23–42	16	10d01	0.03	1	0.02	
SCR-E	42–112	16	10d01	0.002	1	0.004	
POES							<E>, MeV
MEPED	16–36	17	10d03	0.027	1	0.034	25
MEPED	36–70	17	10d03	0.0035	1	0.005	50
MEPED	70–140	17	10d01	0.0007	1	0.0008	100



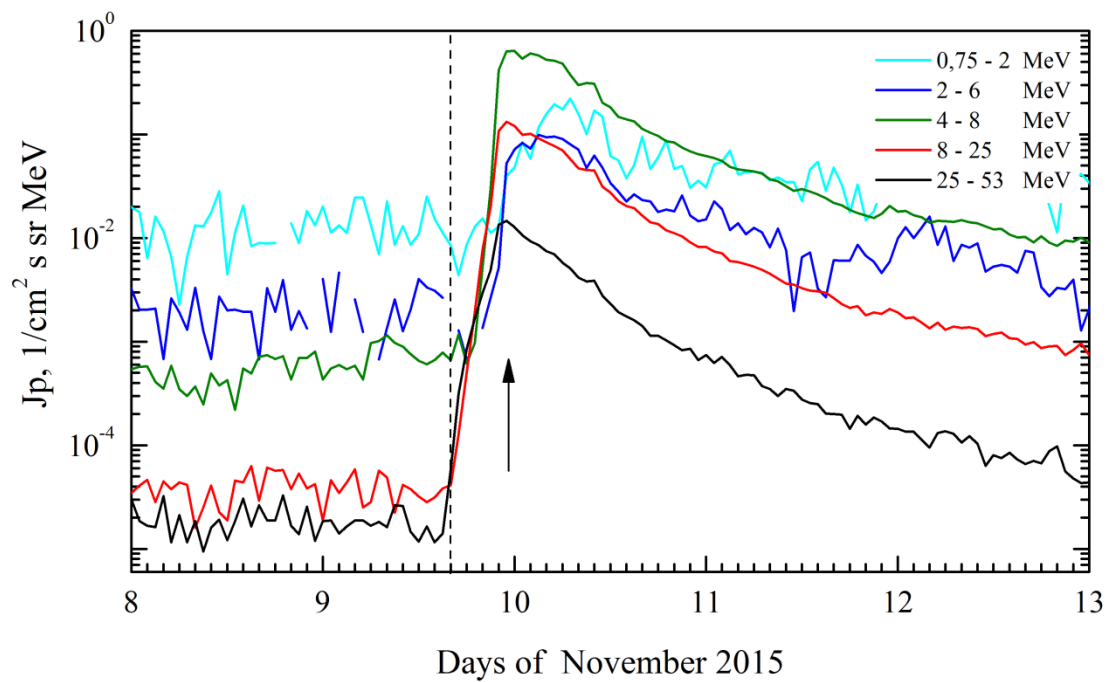
Time profiles of proton fluxes in the event 2015.11.09

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.11.09

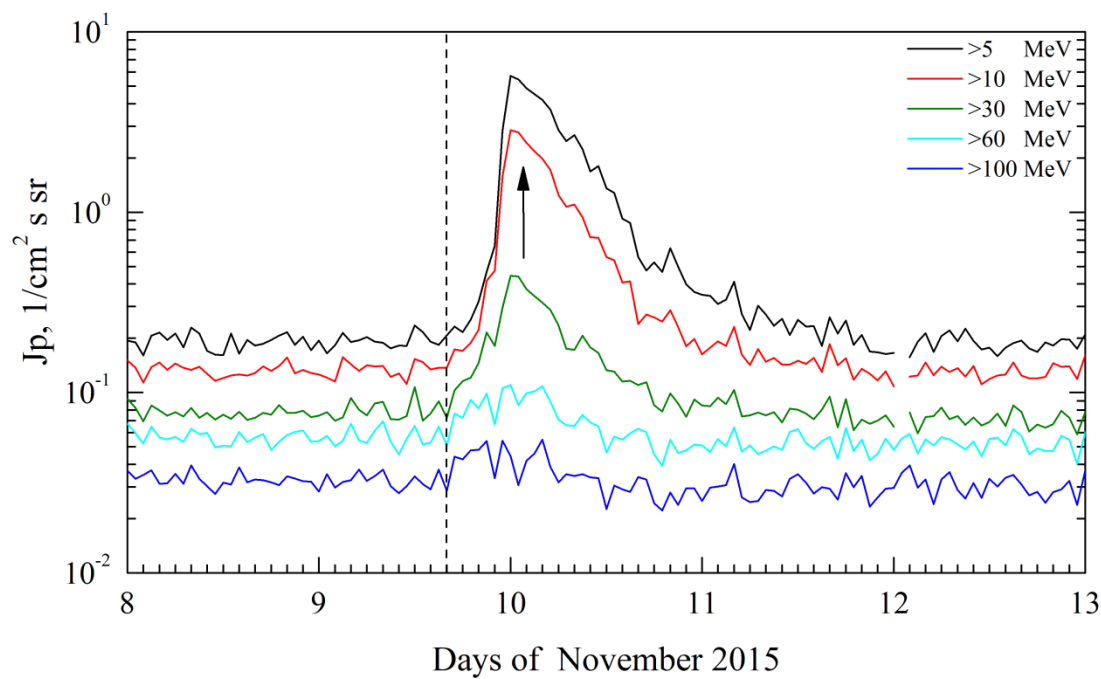


SOHO. Event 2015.11.09

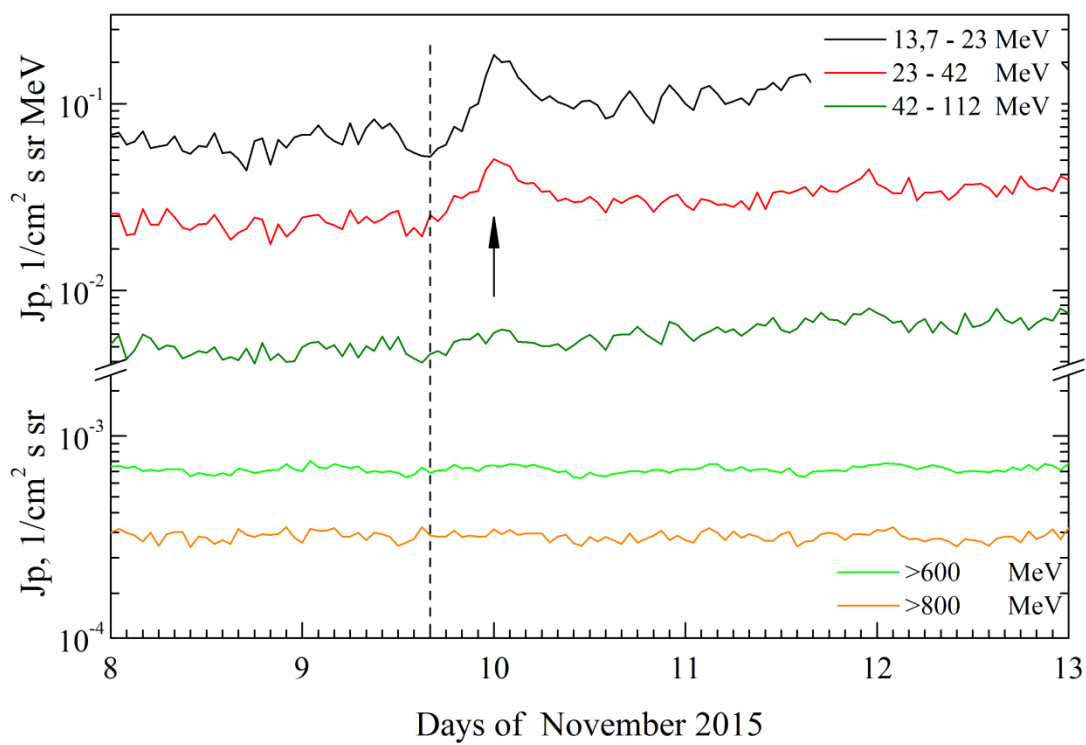


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.11.09

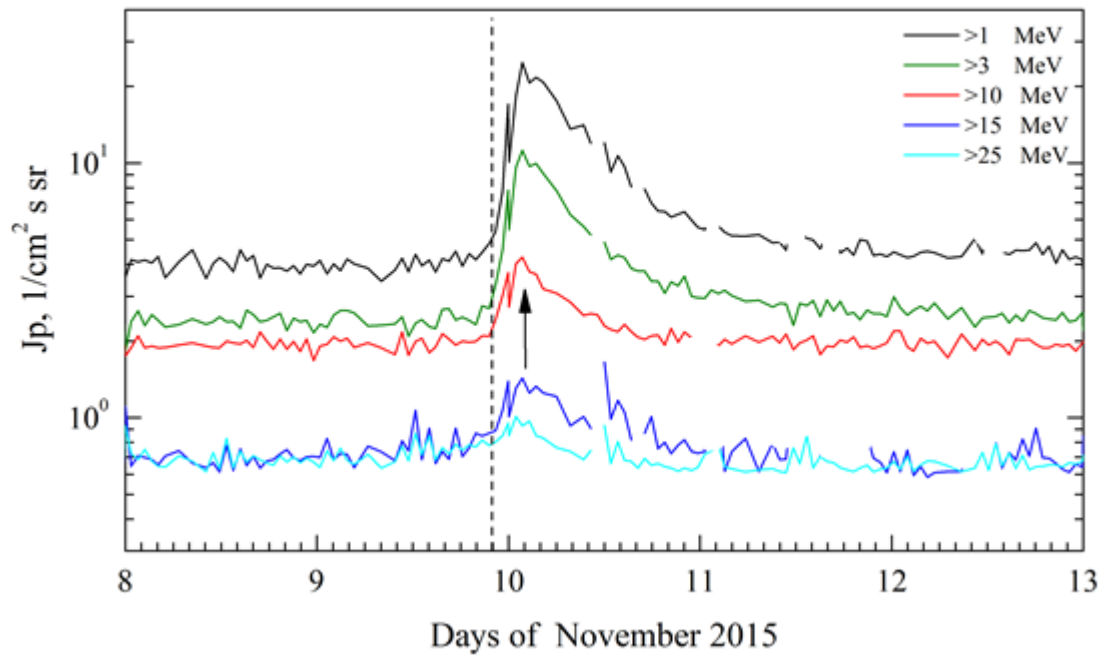


Electro. Event 2015.11.09

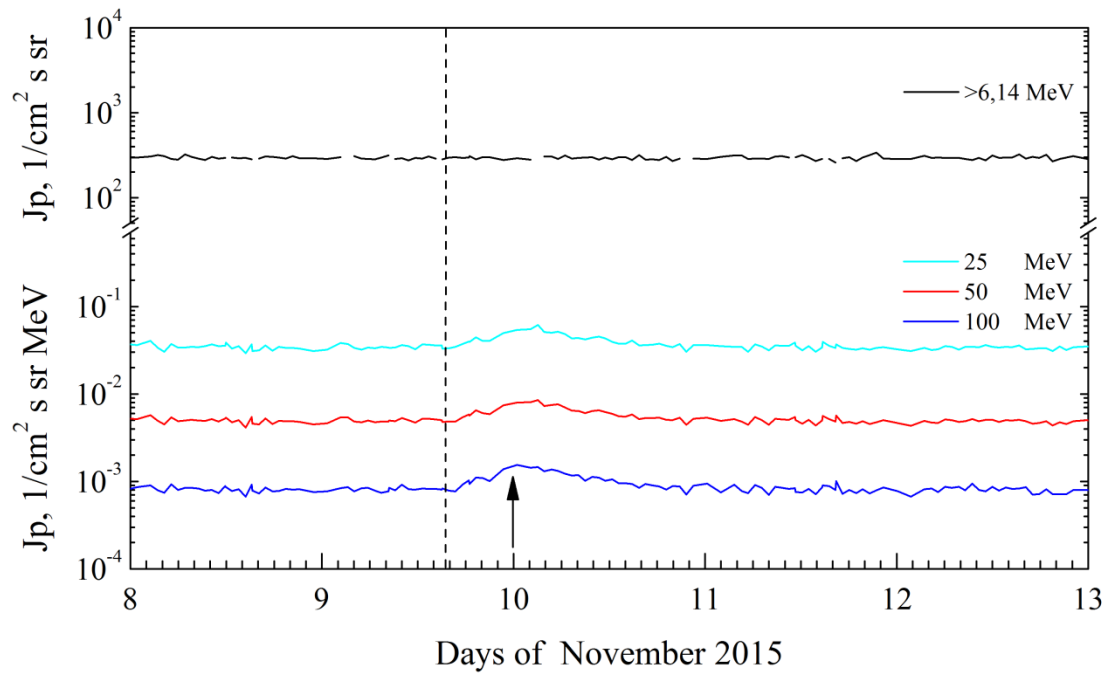


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.11.09



POES. Event 2015.11.09



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 November 09**

2015 November 09

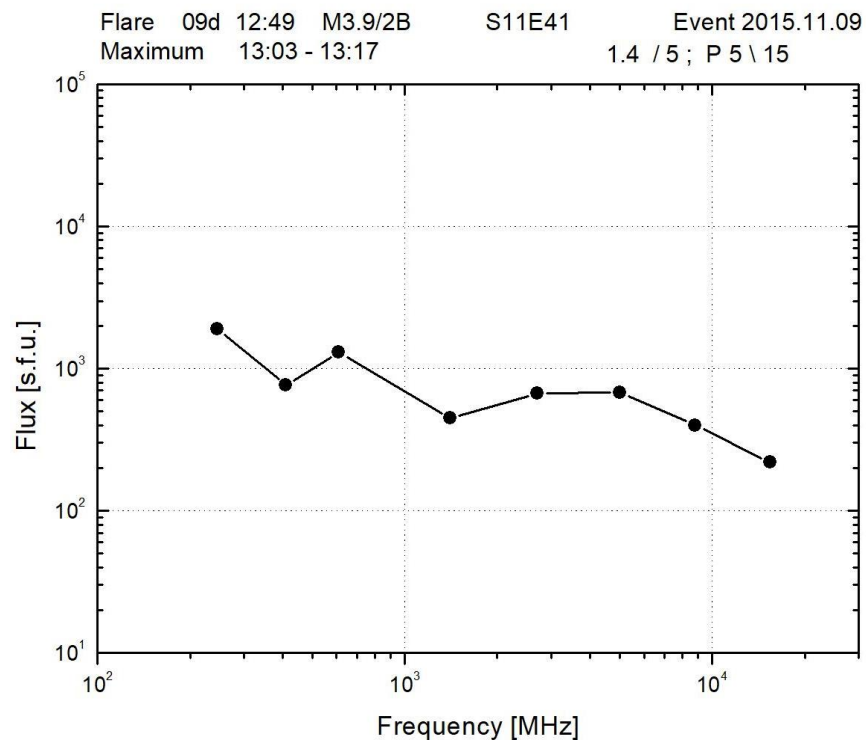
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AR 12449

To event 578

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1252	1304	1510	S11E41	2B	ERU
6563 Å	FL	1346	1350	1538	S12E39	1F	ERU
1 – 12	keV	1249	1312	1328	S13E39	M3.9	0.047
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1311:00	1311:06	1323:24	1584	1720464	HESSI
6-12	keV	1359:16	1359:46	1418:52	52	135864	HESSI
12-25	keV	1251:27	1302:23	1305:19	46546	13406465	FERMI
12-25	keV	1341:43	1359:57	1404:39	1147	248323	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1301	1303	1311		2.34	
8.8	GHz	1300	1303	1328		2.6	
5	GHz	1259	1303	1315	P5 \ 15	2.83	
2.7	GHz	1300	1306	1311		2.83	
1.4	GHz	1300	1306	1317		2.65	
610	MHz	1259	1307	1323	1.4 / 5	3.11	
410	MHz	1259	1307	1328		2.88	
245	MHz	1303	1317	1330		3.28	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	25-180	1305		1319	957	2	
DS IV	100-180	1305		1325		1	
DS III	25-130	1300		1303		2	
DH II	9-14	1321		1327			WIND
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
410	MHz	1349	1352	1353		2.43	
245	MHz	1349	1349	1351		2.08	
610	MHz	1442	1446	1447		2.15	
410	MHz	1441	1446	1449		2.49	
245	MHz	1442	1446	1450		2.23	
610	MHz	1500	1511	1515		2.54	
410	MHz	1455	1512	1516		2.63	
245	MHz	1455	1507	1519		2.52	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	74-180	1459		1538		1	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1325	1041	- 10.2	273°	137°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR 12449 (S11L206, CMP 12,3.11.2015,
Sp=150 msh, DAI, B, R)
XRI=0.39 $M_1^{3.9} + C_5$ $2_1 + 1_1 + S_{12}$
PFR 09.11 $M_1^{3.9}$

References:

Paasilta M., O. Raukunen, R. Vainio et al., [2017](#).

Particle event: To($E_p > 10$ MeV) – 28d14^h

Tmax ($E_p > 10$ MeV) – 29d02^h, Jmax($E_p > 10$ MeV) – $1.4 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

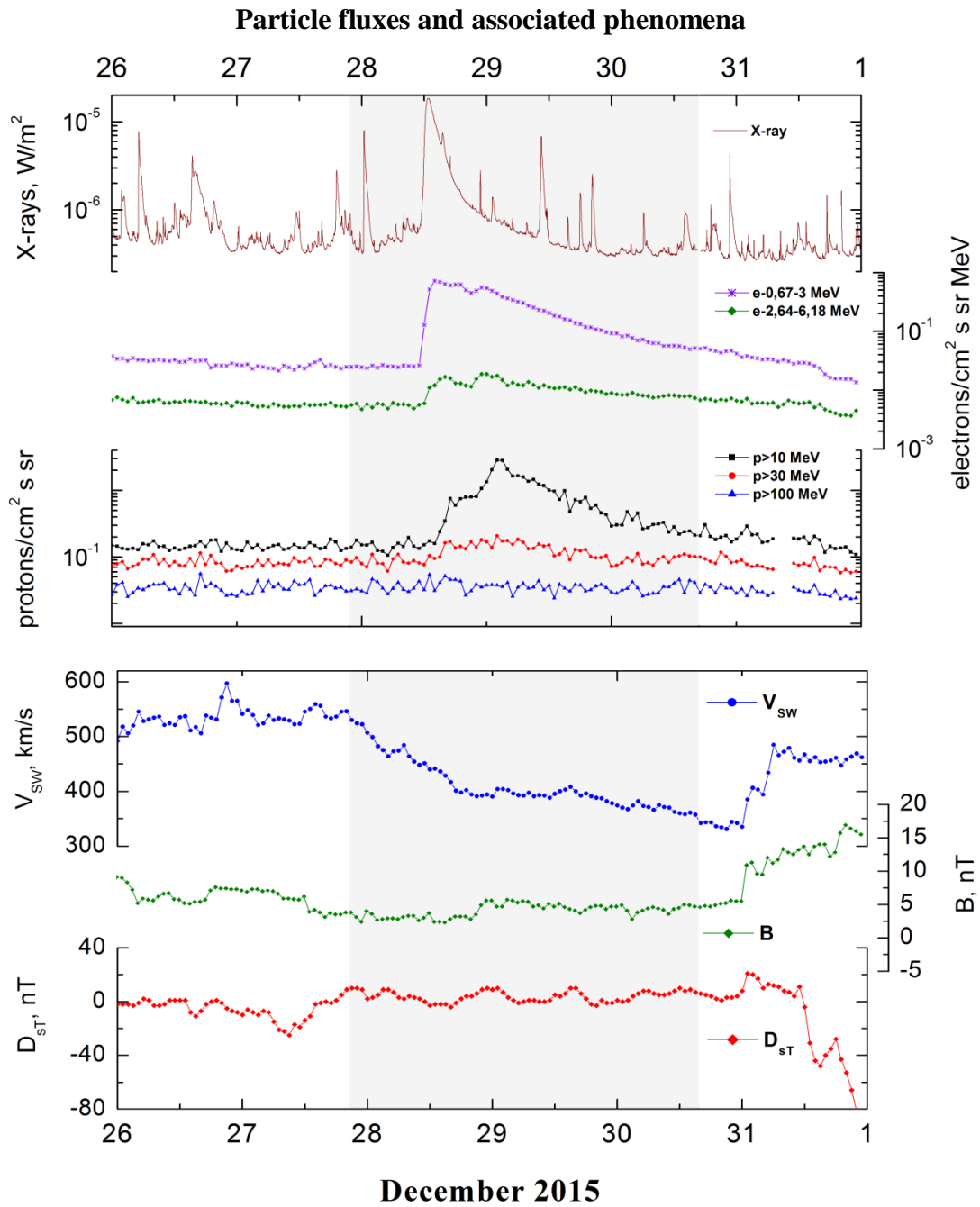
Duration of the event – 2 days, power-law index: $\gamma = 2.3$

Quasimaximal energy of protons in the event – $E_{qm} = 80$ MeV

Sources: ● solar flare 28d11^h20^m, M1.8/, S23W11, AR12473

Main burst X-ray 1–8 Å: onset – 28d11^h20^m, max – 28d12^h45^m, $\Phi = 0.11 \text{ J/m}^2$

CME: 28d12^h12^m, $V = 1212 \text{ km/s}$, $\Delta\phi = 360^\circ$, $dA = 163^\circ$

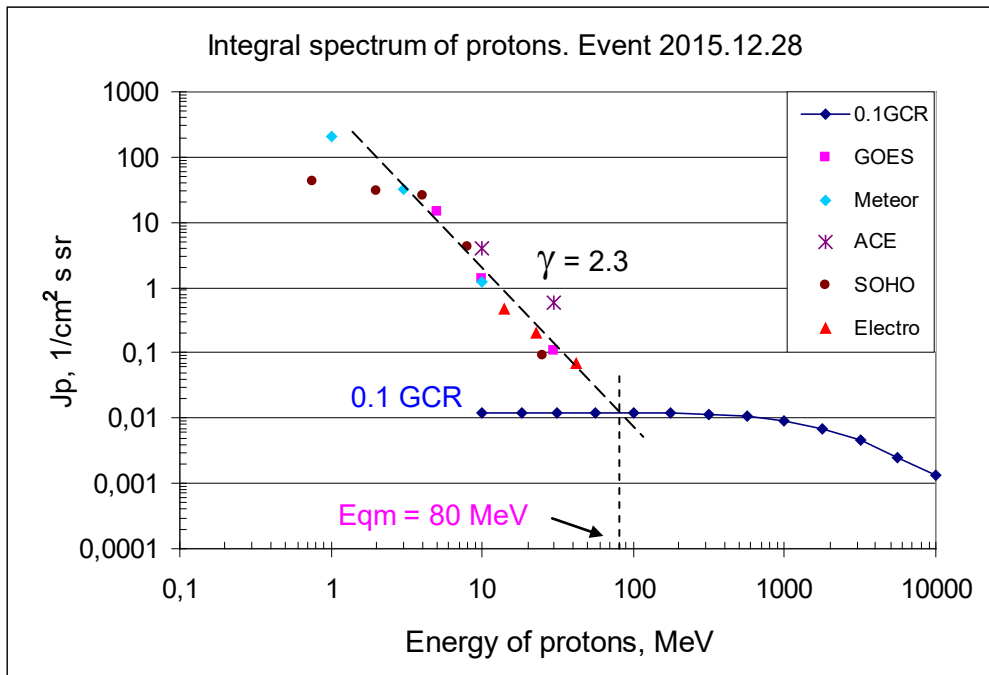


Integral fluxes of protons for the event of 2015 December 28

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	14	29d02	14.7	2	0.2	
EPS	>10	14	29d02	1.4	2	0.12	
EPS	>30	14	29d01	0.11	1	0.07	
EPS	>50	14	-	-	-	0.06	
EPS	>60	14	-	-	-	0.05	
EPS	>100	14	-	-	-	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	-	-	-	295	
METEOR-2							
SCR	>1	14	29d09	205	3.5	4.2	
SCR	>3	14	29d08	32	3	1.8	
SCR	>10	14	29d03	1.2	1	1.95	
GALS-M	>15	-	-	-	-	0.7	
GALS-M	>25	-	-	-	-	0.7	
GALS-M	>600	-	-	-	-	0.24	
ACE							
SIS	>10	13	29d00	3.9	1.5	1.3	
SIS	>30	13	29d01	0.6	1.5	0.9	
SOHO							
EPHIN	>50	-	-	-	-	0.28	

Differential fluxes of protons for the event of 2015 December 28

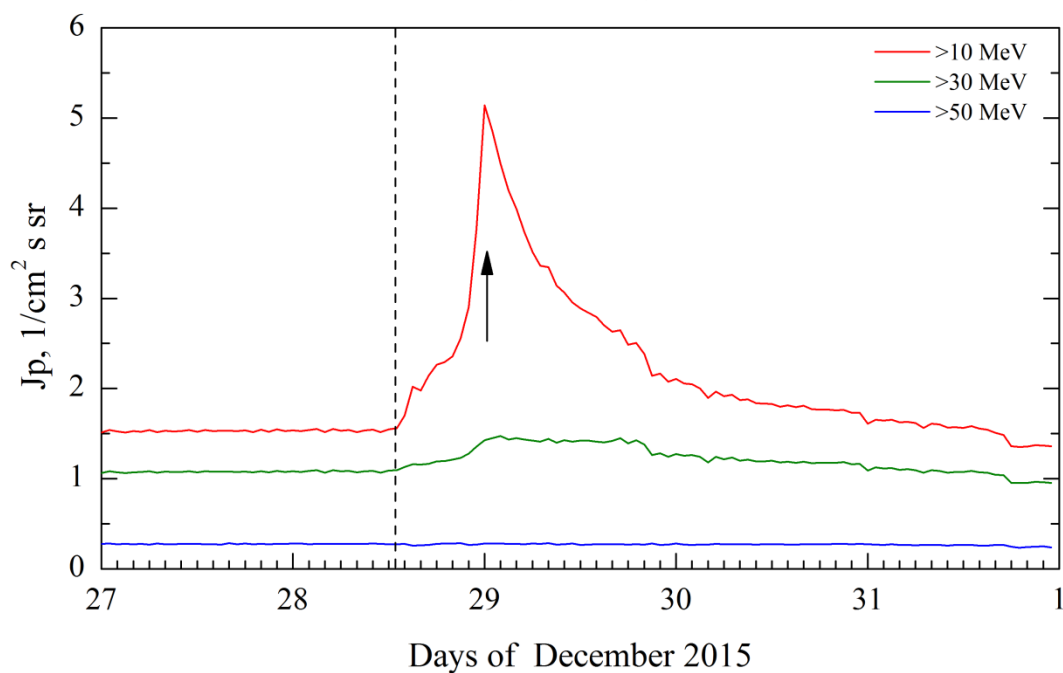
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	16	29d00	9.0	3.2	0.2	
LION	2 – 6	16	29d00	1.86	3.2	0.02	
EPHIN	4 – 8	14	29d00	5.23	3.2	0.003	
EPHIN	8 – 25	13	29d00	0.242	3.2	0.00004	
EPHIN	25 – 53	13	29d00	0.0033	3.2	0.00002	
Electro-1							
SCR-E	13.7–23	12	29d01	0.03	1	0.06	
SCR-E	23–42	12	29d01	0.007	1	0.025	
SCR-E	42–112	12	29d01	0.001	0.5	0.005	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.034	25
MEPED	36–70	-	-	-	-	0.005	50
MEPED	70–140	-	-	-	-	0.0008	100



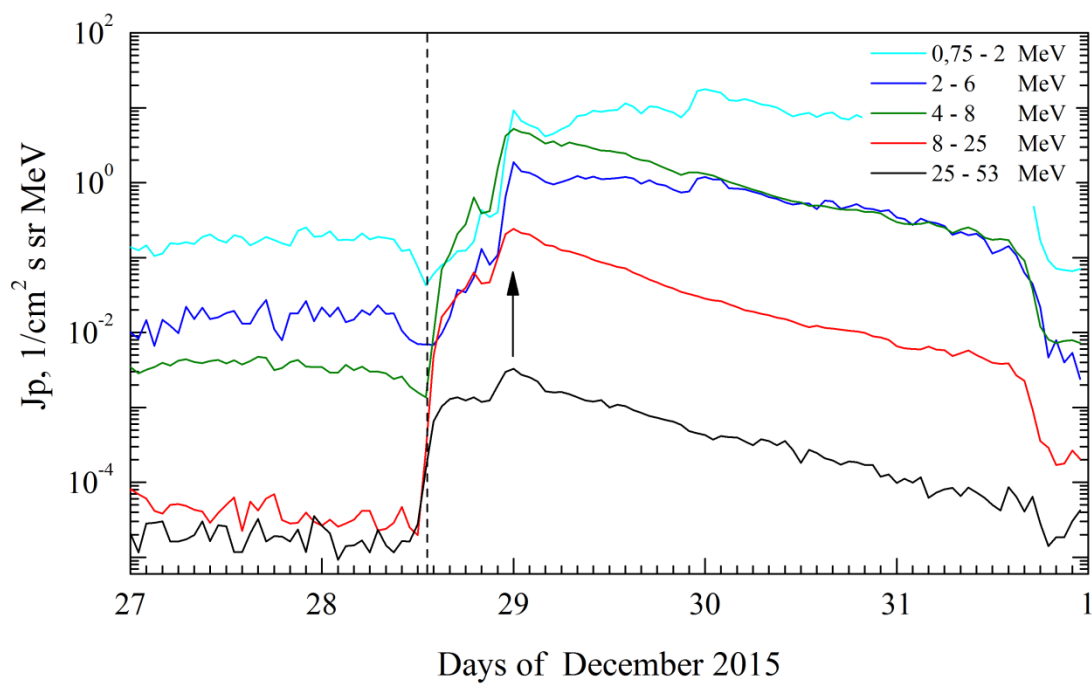
Time profiles of proton fluxes in the event 2015.12.28

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+SOHO (>50 MeV). Event 2015.12.28

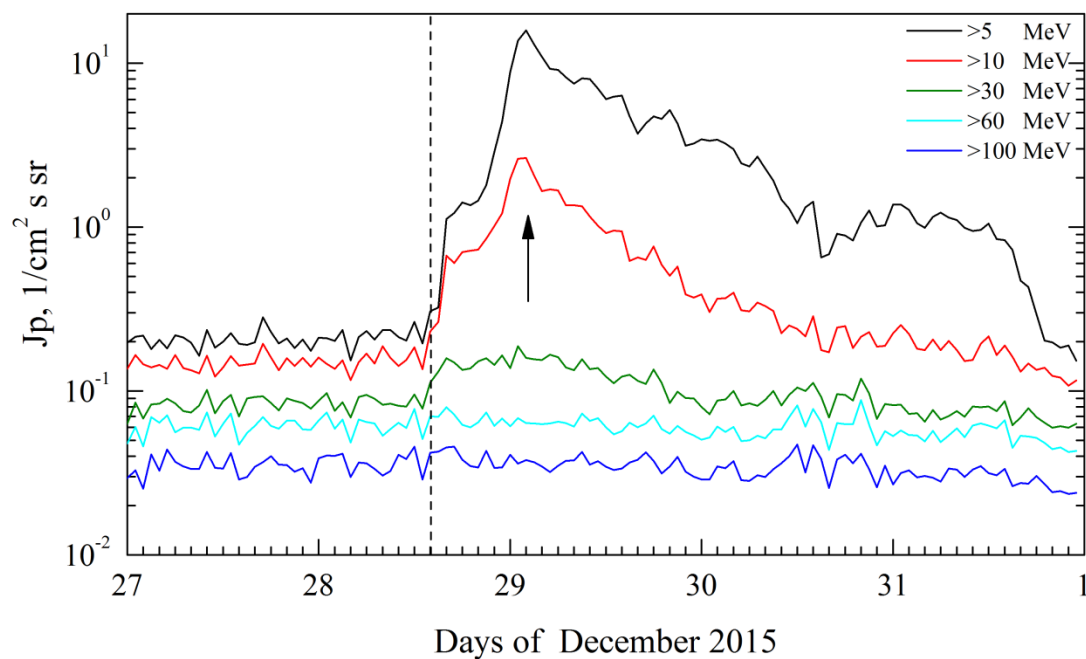


SOHO. Event 2015.12.28

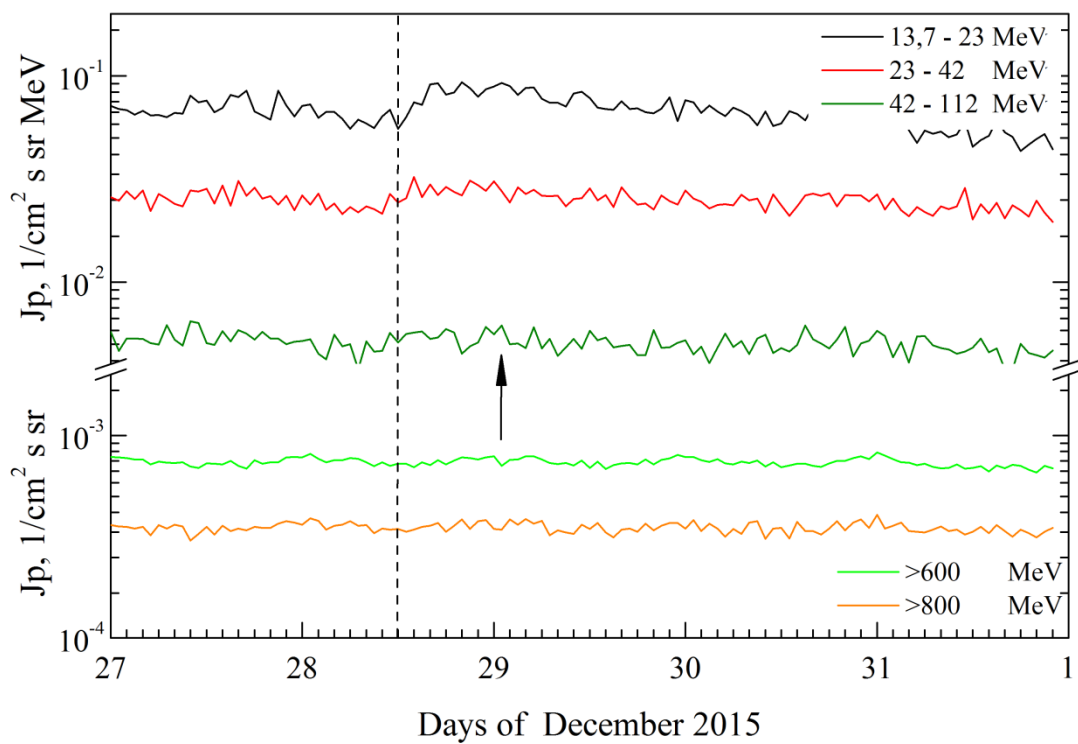


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2015.12.28

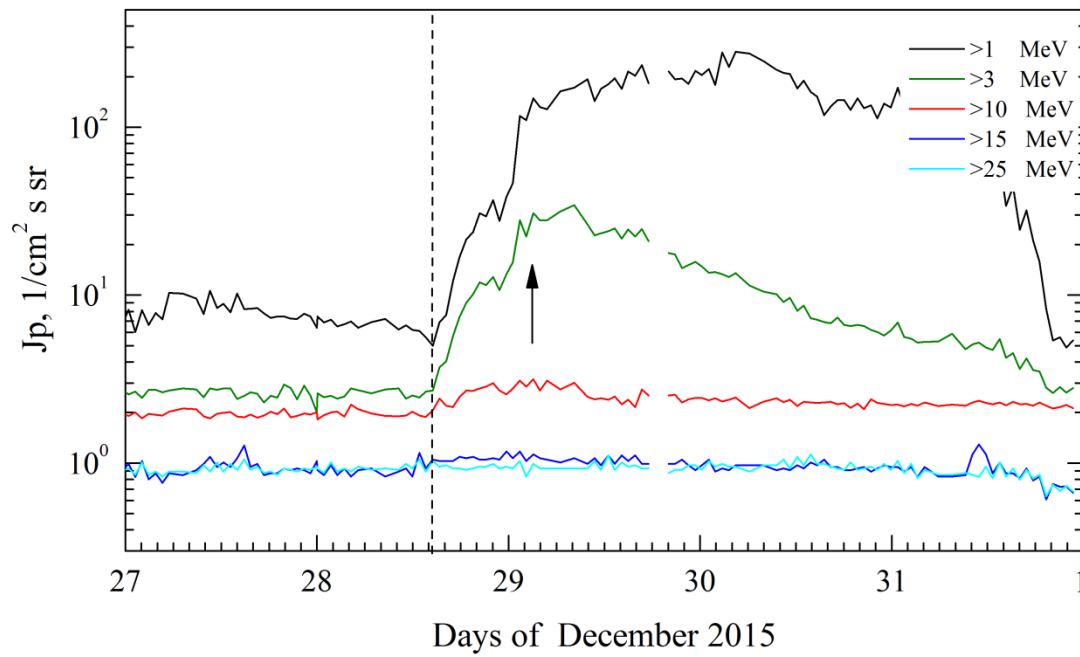


Electro. Event 2015.12.28

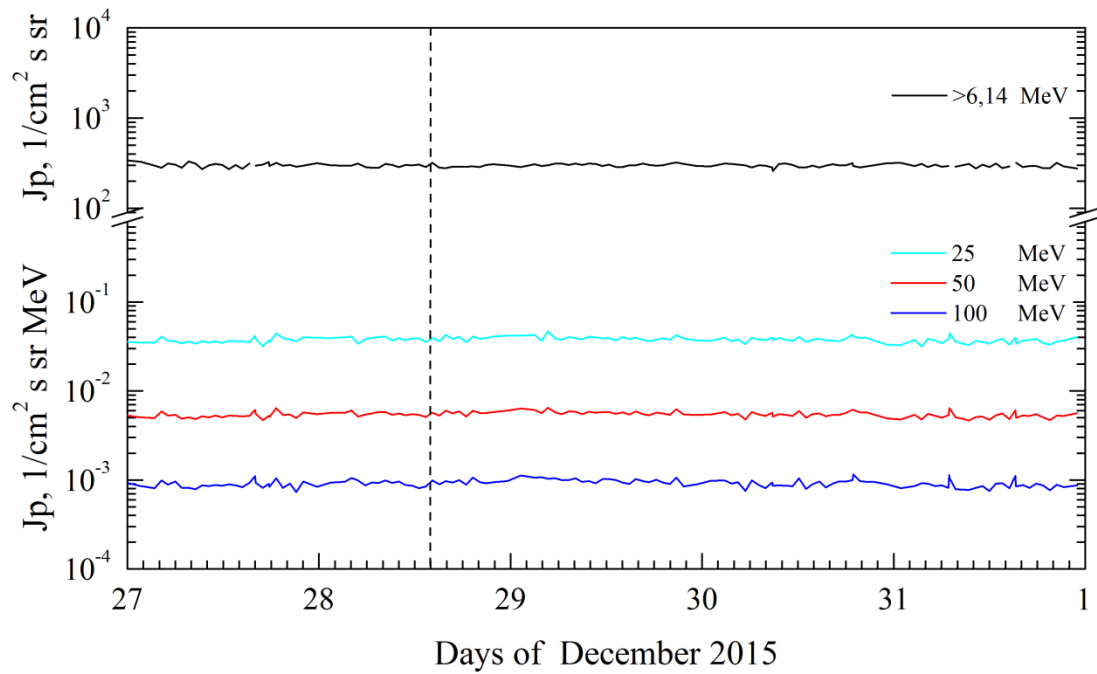


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2015.12.28



POES. Event 2015.12.28



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2015 December 28**

2015 December 28

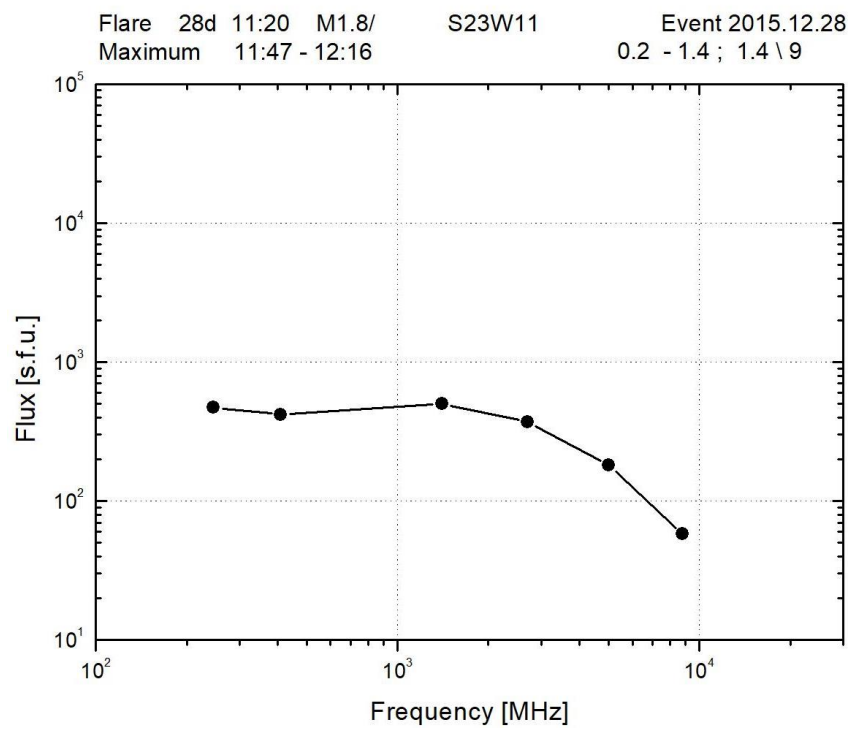
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AR12473

To event 579

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	1120	1245	1409	S23W11	M1.8	0.11
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	1123:20	1129:58	1131:16	87	92644	HESSI
12-25	keV	1141:56	1201:02	1201:44	200	367851	HESSI
6-12	keV	1237:40	1238:30	1255:16	3952	624088	HESSI
6-12	keV	1322:44	1322:58	1336:00	76	147948	HESSI
12-25	keV	1146:03	1151:31	1213:09	20715	3652437	FERMI
12-25	keV	1249:49	1301:17	1306:41	1922	369943	FERMI
12-25	keV	1330:13	1330:42	1346:45	1088	148816	FERMI
12-25	keV	1426:12	1443:41	1444:05	834	148867	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	1151	1153	1155	1.4 \ 9	1.76	
5	GHz	1148	1206	1222		2.56	
2.7	GHz	1146	1206	1231		2.57	
1.4	GHz	1146	1206	1226		2.7	
410	MHz	1145	1147	1221		2.62	
245	MHz	1145	1216	1223	0.2 – 1.4	2.67	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	25-180	1146		1334		1	
DS CTM	25-180	1123		1146		1	
DH II	0.18-14	1150		2145			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1212	1212	4.6	360°	163°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR12473 (S22L332, CMP 27,7.12.2015,
Sp=590 msh, EKC, BGD, R)
XRI=0,83 $M_4^{4.7} + C_{30}$ $1_4 + S_{59}$
PFR1 22-24.12: (47^h) $M_3^{4.7}$
PFR2 28.12 $M_1^{1.8}$

References:

Núñez M., T. Nieves-Chinchilla and A. Pulkkinen, [2019](#).

Events in 2016

			Page
1	Event 2016.01.01 – (2016-001)	№ 580	874
2	Event 2016.03.16 – (2016-076)	№ 581	882
3	*Event 2016.04.18 – (2016-109)	№ 582	889
4	Event 2016.05.15 – (2016-136)	№ 583	897
5	*Event 2016.07.23 – (2016-205)	№ 584	904

An asterisk (*) marks weak events with J_p ($E > 10$ MeV) in the interval $0.1 \div 1$ pfu

Particle event: To($E_p > 10$ MeV) – 01d23^h

Tmax₁($E_p > 10$ MeV) – 02d01^h, Jmax₁($E_p > 10$ MeV) – 4.7 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 02d04^h, Jmax₂($E_p > 10$ MeV) – 12.4 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 2.6$, $\gamma_2 = 2.5$

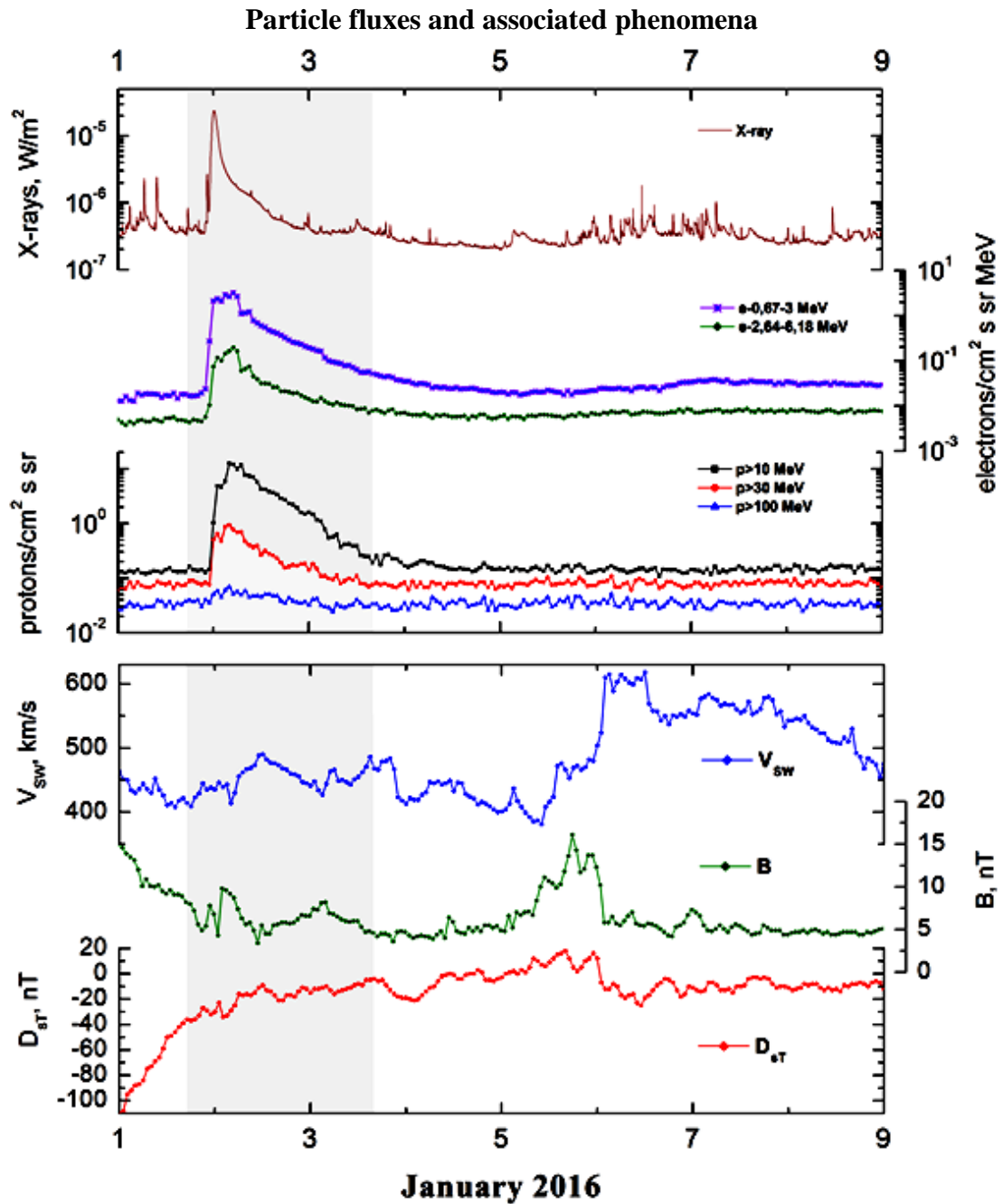
Quasimaximal energy of protons in the event – Eqm₁ = 120 MeV

– Eqm₂ = 140 MeV

Sources: ■ solar flare 01d23^h10^m, M2.3/, S25W82, AR12473

Main burst X-ray 1–8 Å: onset – 01d23^h10^m, max – 02d00^h11^m, $\Phi = 0.11$ J/m²

CME: 01d23^h24^m, V = 1730 km/s, $\Delta\phi = 360^\circ$, dA = 227°

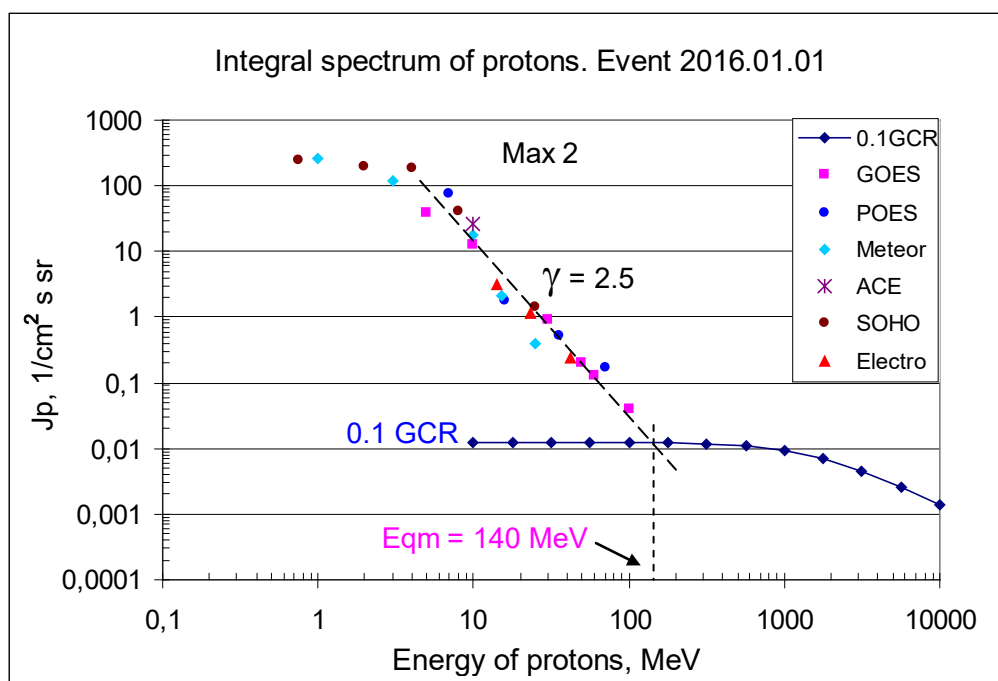
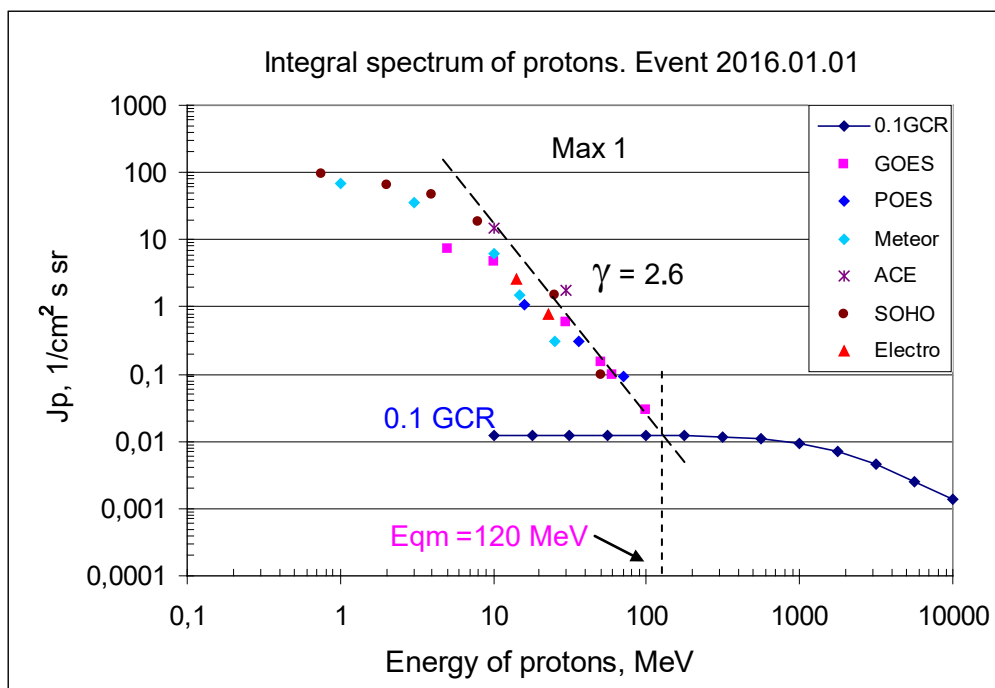


Integral fluxes of protons for the event of 2016 January 01

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	23	02d01/02d05	7.2/38.7	2	0.2	
EPS	>10	23	02d01/02d04	4.7/12.4	1.5	0.12	
EPS	>30	23	02d01/02d04	0.6/0.9	1	0.07	
EPS	>50	23	02d01/02d04	0.15/0.2	0.7	0.06	
EPS	>60	23	02d00/02d04	0.1/0.13	0.7	0.05	
EPS	>100	23	02d01/02d04	0.03/0.04	0.7	0.03	
Electro-1							
GALS-E	>600	-	-	-	-	0.0007	
POES							
MEPED	>6.14	-	- /02d07	- /80	0.5	290	
Meteor-2							
SCR	>1	24	02d02/02d04	70/260	4	4.2	
SCR	>3	24	02d02/02d04	35/120	2.5	2.5	
SCR	>10	24	02d02/02d04	6.3/17	1.5	1.9	
GALS-M	>15	24	02d01/02d04	1.5/2.1	1	0.7	
GALS-M	>25	24	02d01/02d03	0.3/0.4	1	0.7	
GALS-M	>600	-	-	-	-	0.2	
ACE							
SIS	>10	23	02d01/02d04	15.1/26.6	1	1.4	
SIS	>30	23	02d02/ -	1.8/ -	0.5	1	
SOHO							
EPHIN	>50	02d00	02.01	0.1/ -	0.5	0.25	

Differential fluxes of protons for the event of 2016 January 01

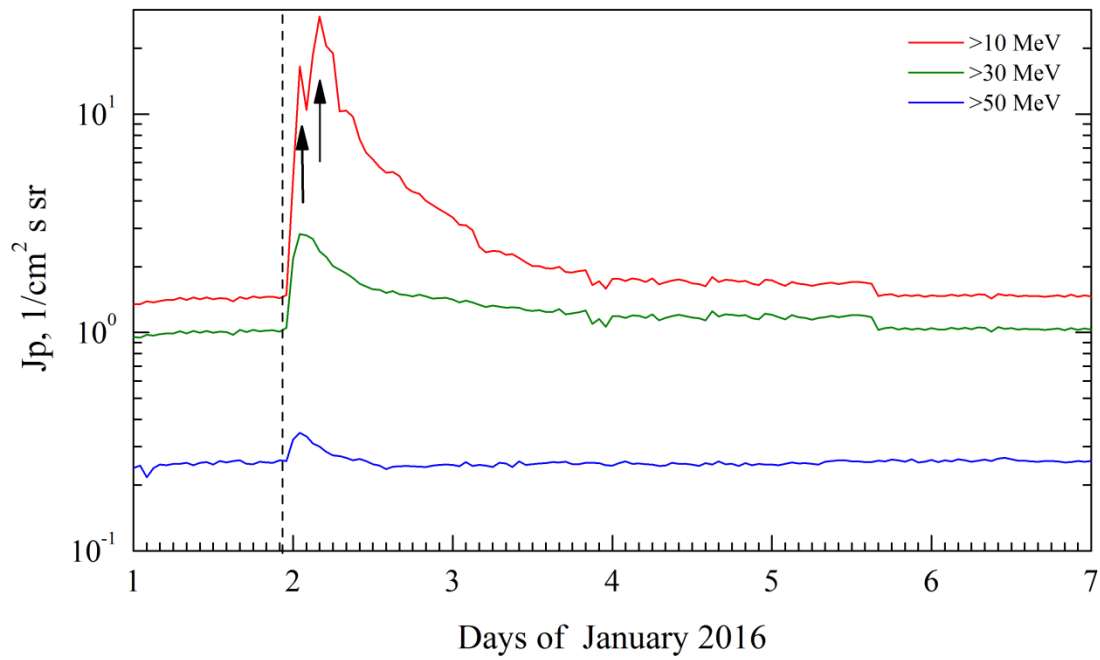
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	02d01	02d06/02d10	22.5/43.1	3.5	0.01	
LION	2 – 6	02d01	02d06/02d10	6.27/5.94	3.5	0.001	
EPHIN	4 – 8	02d00	02d01/02d05	7/35.2	4	0.0004	
EPHIN	8 – 25	02d00	02d01/02d05	1/2.42	4	0.00003	
EPHIN	25 – 53	02d00	02d01/02d03	0.05/0.046	4	0.00002	
Electro-1							
SCR-E	13.7–23	23	02d01/02d04	0.2/0.21	1.5	0.05	
SCR-E	23–42	23	02d01/02d04	0.04/0.053	1.5	0.02	
SCR-E	42–112	23	- /02d03	- /0.003	1	0.0045	
POES							<Δ>, MeV
MEPED	16–36	23	02d01/02d04	0.0394/0.066	1	0.034	25
MEPED	36–70	23	02d01/02d04	0.0065/0.01	1	0.005	50
MEPED	70–140	23	02d01/02d04	0.0013/0.0025	1	0.0008	100



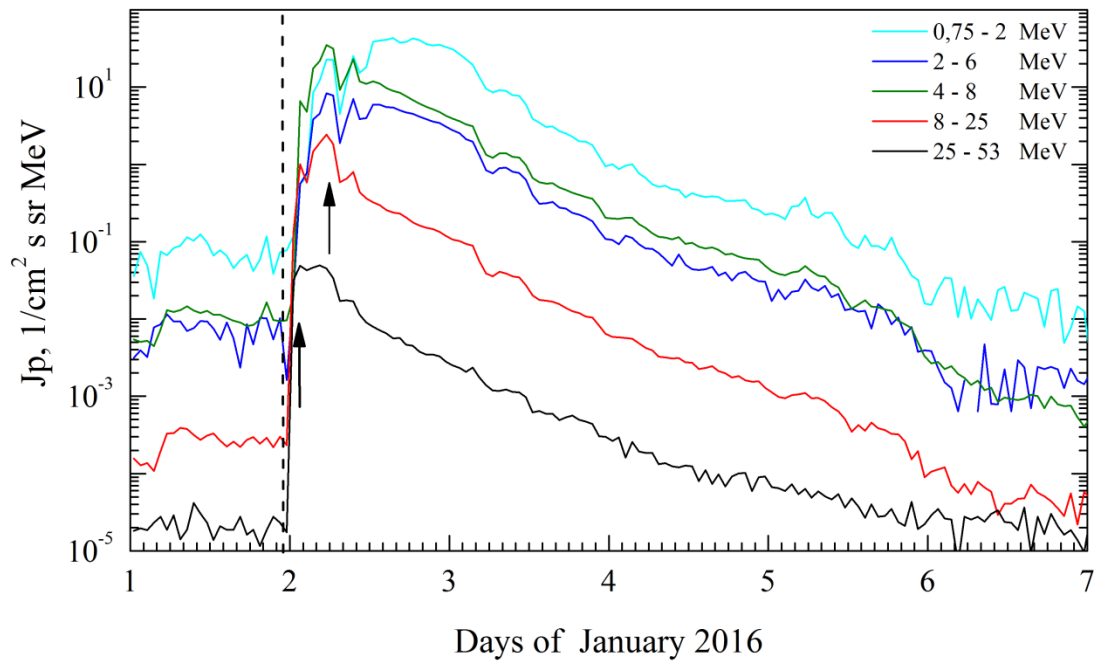
Time profiles of proton fluxes in the event 2016.01.01

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2016.01.01

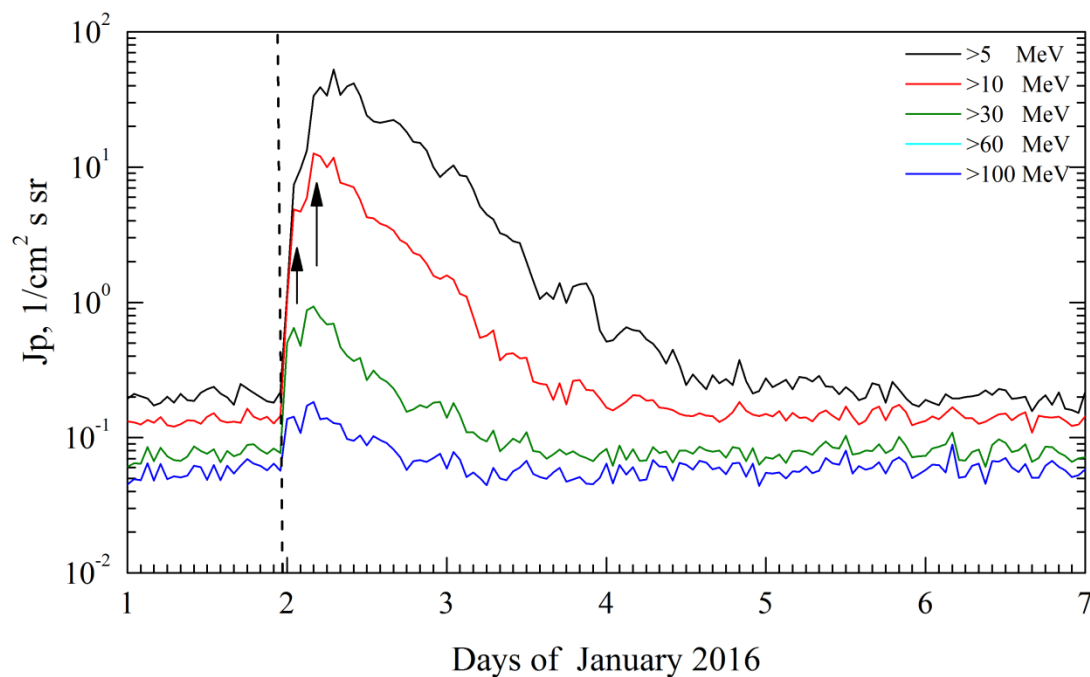


SOHO. Event 2016.01.01

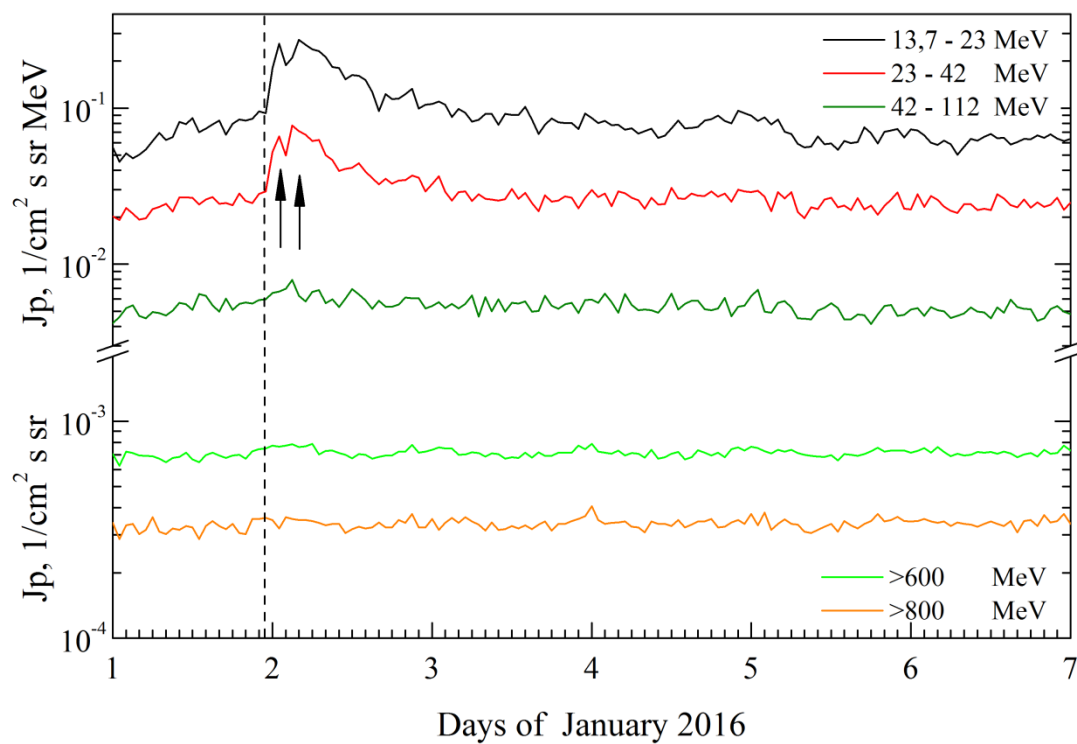


Earth satellites in geostationary orbit, $R \approx 6.6$ Re: GOES and Electro

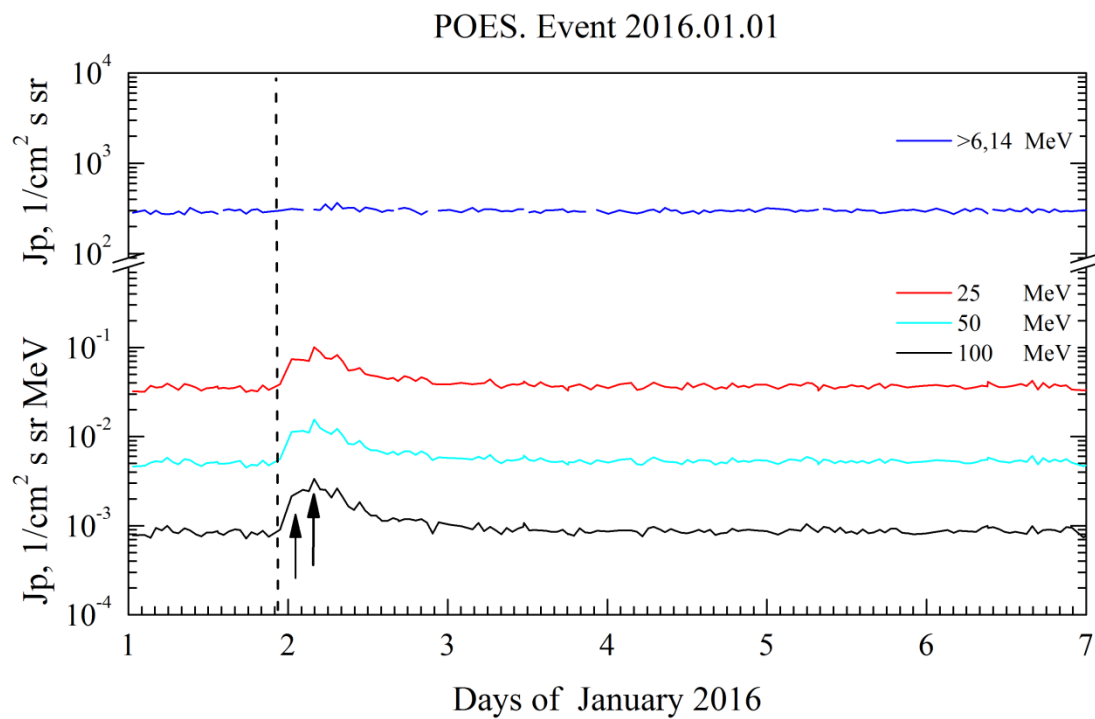
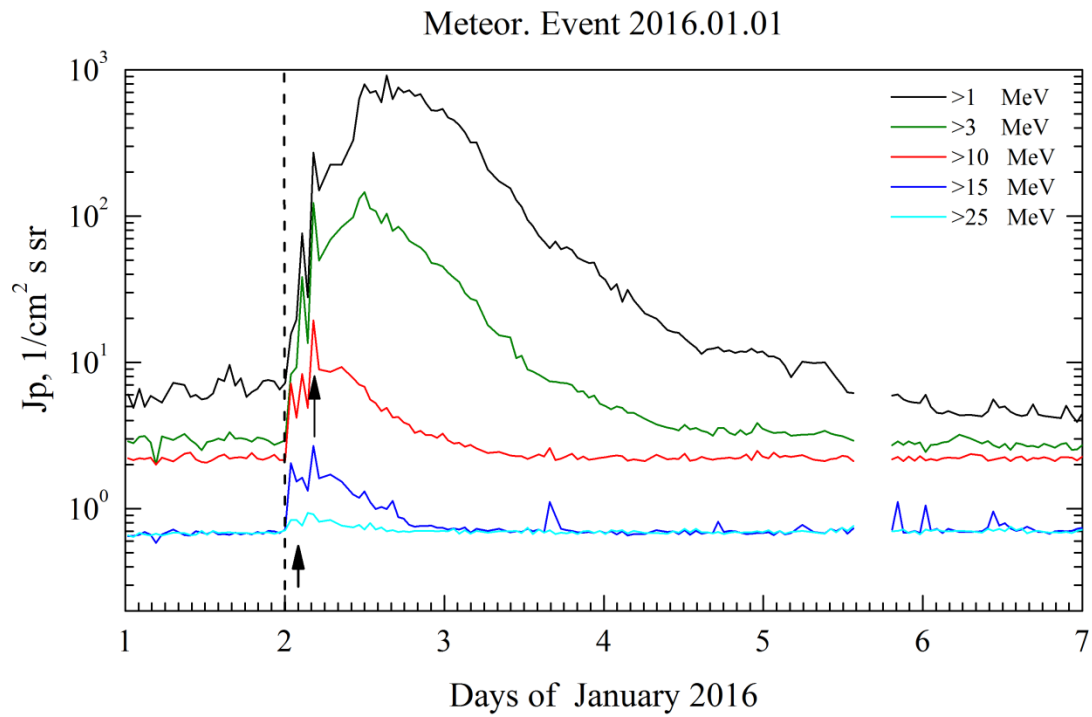
GOES. Event 2016.01.01



Electro. Event 2016.01.01



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2016 January 01**

2016

January 01



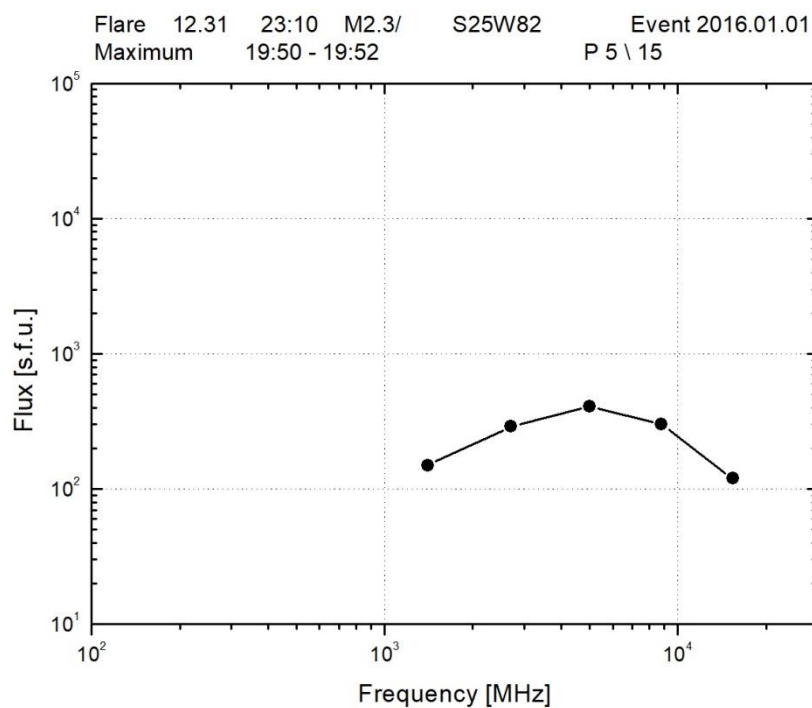
AR 12473

To event 580

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible disk					
6563 Å	LPS	0226		0655	0.04		
1 – 12	keV	2310	0011	0101	S25W82	M2.3*	0.11
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	23:38:40	23:39:14	23:40:48	128	255121	HESSI
25-50	keV	23:40:48	23:43:22	00:30:28	10869	3267284	HESSI
25-50	keV	23:12:29	23:42:19	00:10:59	12045	5304185	FERMI
25-50	keV	00:47:47	01:22:56	01:36:44	1071	565736	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1950	1952	1953	P5 \ 15	2.01	
8.8	GHz	1949	1950	1953		2.48	
5	GHz	1949	1950	1953		2.61	
2.7	GHz	1949	1950	1953		2.46	
1.4	GHz	1952	1952	1953		2.18	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	030-039	2321		2326	1095	1	
DS IV	036-180	2324		2359		1	
DH II	0.3-1.1	2d/0055		2d/0308			
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	2324	1730	12.7	360°	227°	SOHO

*https://sdowwww.lmsal.com/sdomedia/ssw/ssw_client/data/ssw_service_160101_163431_7362/ww/

Radio burst frequency spectrum



Proton Active Region:

AR12473 (S22L332, CMP 27,7.12.2015,
Sp=590 msh, EKC, BGD, R)
XRI=0,83 $M_4^{4.7} + C_{30}$ $1_4 + S_{59}$
PFR1 22-24.12: (47^h) $M_3^{4.7}$
PFR2 28.12 $M_1^{1.8}$

References:

Gopalswamy N., S. Yashiro, N. Thakur et al., [2016](#).
NOAA SPE, [2019](#).
Temmer M., [2021](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 16d07^h

Tmax₁($E_p > 10$ MeV) – 16d11^h, J max₁($E_p > 10$ MeV) – 1,1 /cm²·s·sr (ACE)

Tmax₂($E_p > 10$ MeV) – 16d17^h, J max₂($E_p > 10$ MeV) – 0.8 /cm²·s·sr (ACE)

Duration of the event – 0.5 days, power-law index: $\gamma_1 = 1.5$, $\gamma_2 = 1.7$

Quasimaximal energy of protons in the event – Eqm₁ = 120 MeV

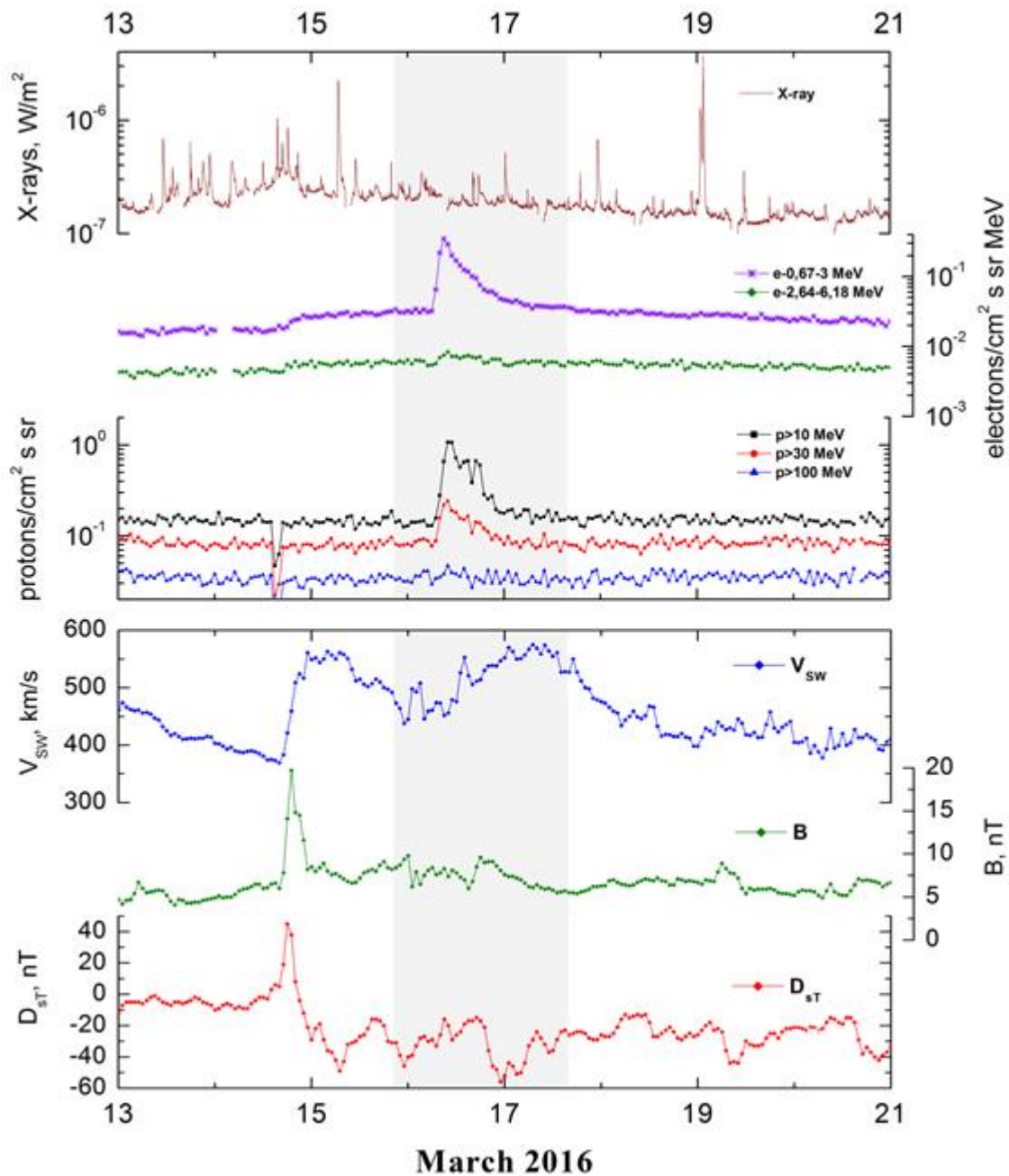
– Eqm₂ = 80 MeV

Sources: ■ solar flare 16d06^h34^m, C2.2/DSF, N12W88, AR12522

Main burst X-ray 1–8 Å: onset – 16d06^h34^m, max – 16d06^h45^m, $\Phi = 0.0022$ J/m²

CME: 16d07^h00^m, V = 592 km/s, $\Delta\phi = 154^\circ$, dA = 265°

Particle fluxes and associated phenomena

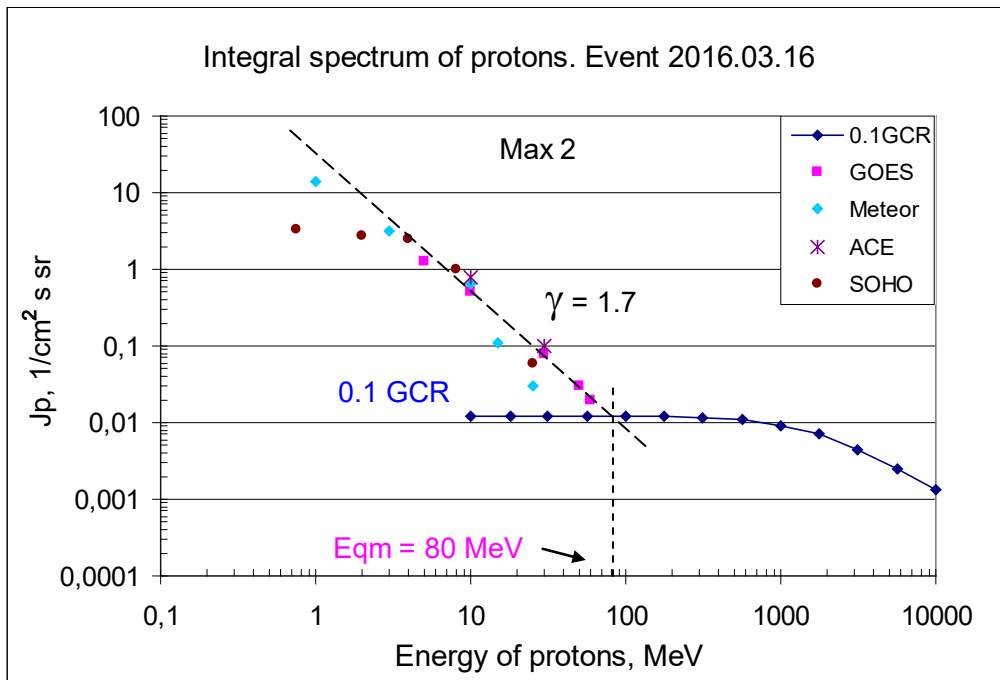
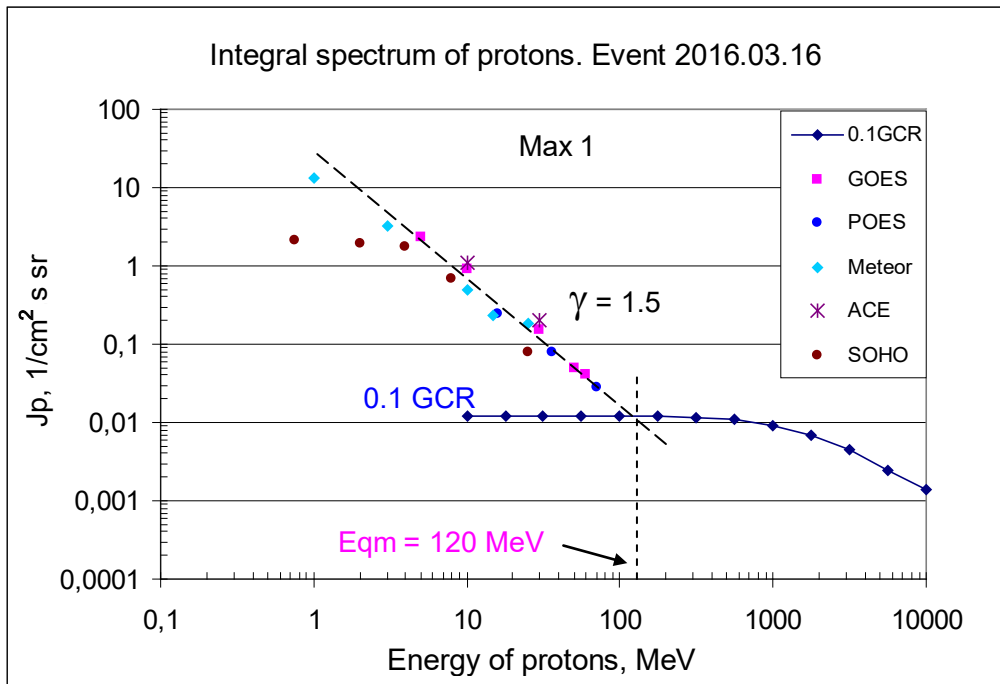


Integral fluxes of protons for the event of 2016 March 16

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	11/18	2.3/1.3	0.5	0.2	
EPS	>10	7	11/17	0.9/0.5	0.5	0.14	
EPS	>30	7	10/17	0.15/0.08	0.5	0.08	
EPS	>50	7	10/18	0.05/0.03	0.3	0.06	
EPS	>60	7	10/18	0.04/0.02	0.3	0.05	
EPS	>100	-	-	-	-	0.03	
Electro-1,-2							
GALS-E	>600	-	-	-	-	-	
POES							
MEPED	>6.14	-	-	-	-	285	
Meteor-2							
SCR	>1	9	12/18	13/14	1	4.3	
SCR	>3	9	11/18	3.3/3.1	1	2.5	
SCR	>10	9	11/18	0.5/0.64	1	1.9	
GALS-M	>15	9	11/16	0.23/0.11	0.5	0.7	
GALS-M	>25	9	11/16	0.18/0.03	0.5	0.8	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	7	10/17	1.1/0.8	0.7	1.5	
SIS	>30	7	10/17	0.2/0.1	0.5	1.1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2016 March 16

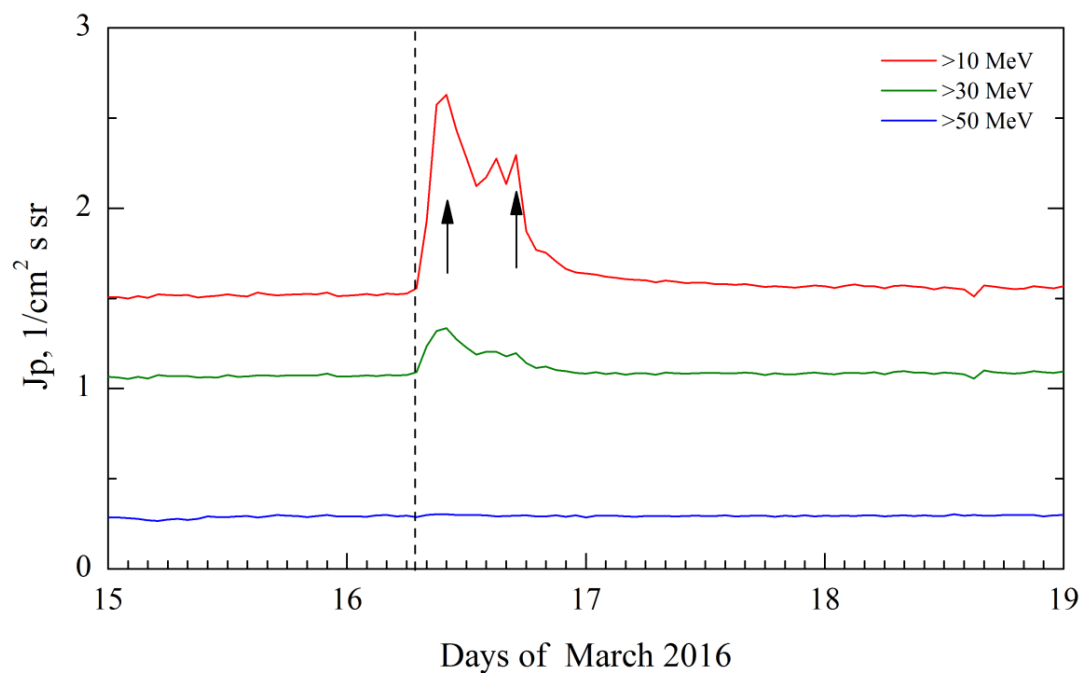
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	10	11/17	0.158/0.433	1	0.004	
LION	2 – 6	09	12/17	0.056/0.117	1	0.001	
EPHIN	4 – 8	07	10/17	0.262/0.358	3	0.0001	
EPHIN	8 – 25	07	10/17	0.0357/0.057	2	0.00003	
EPHIN	25 – 53	08	10/16	0.0027/0.0021	1	0.00003	
POES							<E>, MeV
MEPED	16–36	07	11	0.0085/ -	0.5	0.039	25
MEPED	36–70	07	10	0.0015/ -	0.5	0.0054	50
MEPED	70–140	07	10	0.0004/ -	0.5	0.0009	100



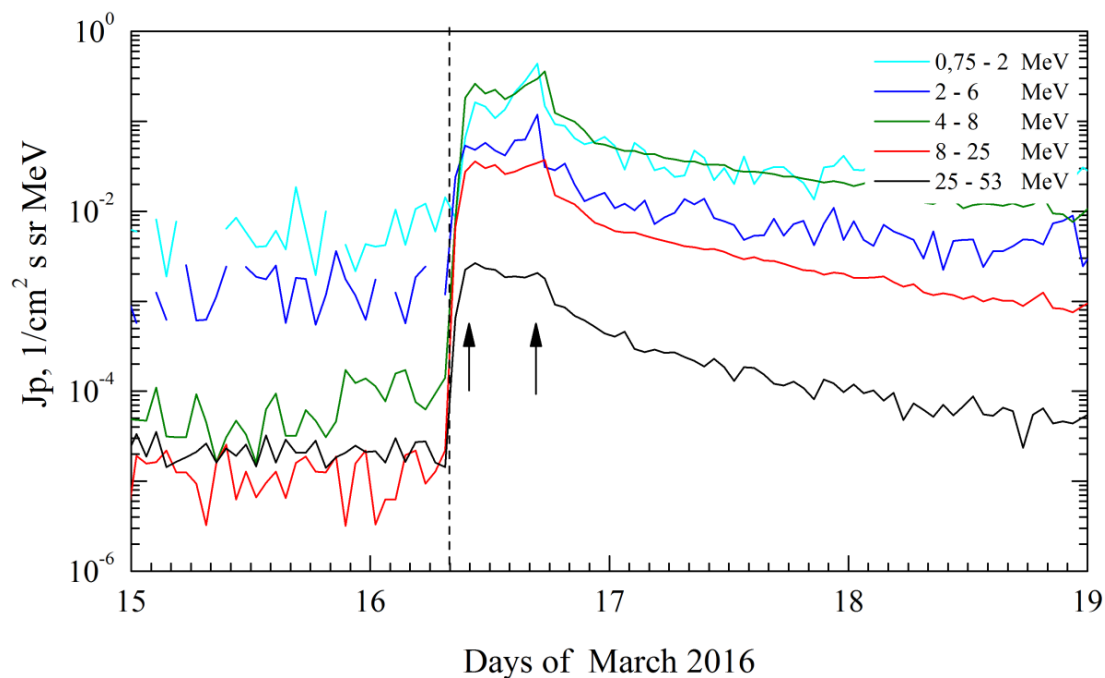
Time profiles of proton fluxes in the event 2016.03.16

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2016.03.16

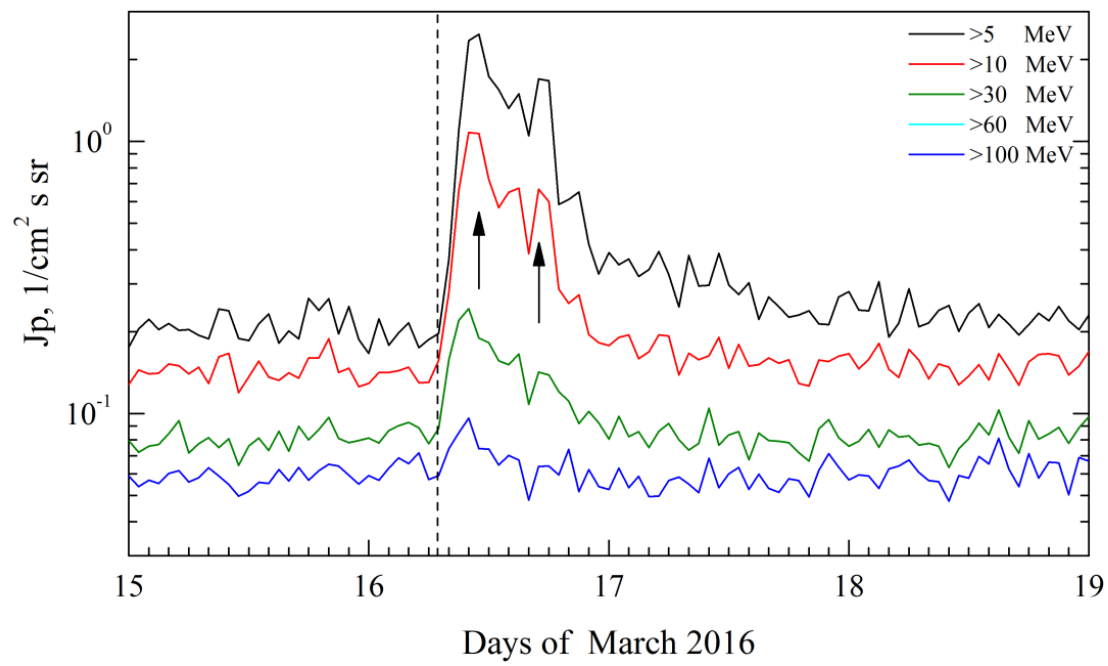


SOHO. Event 2016.03.16



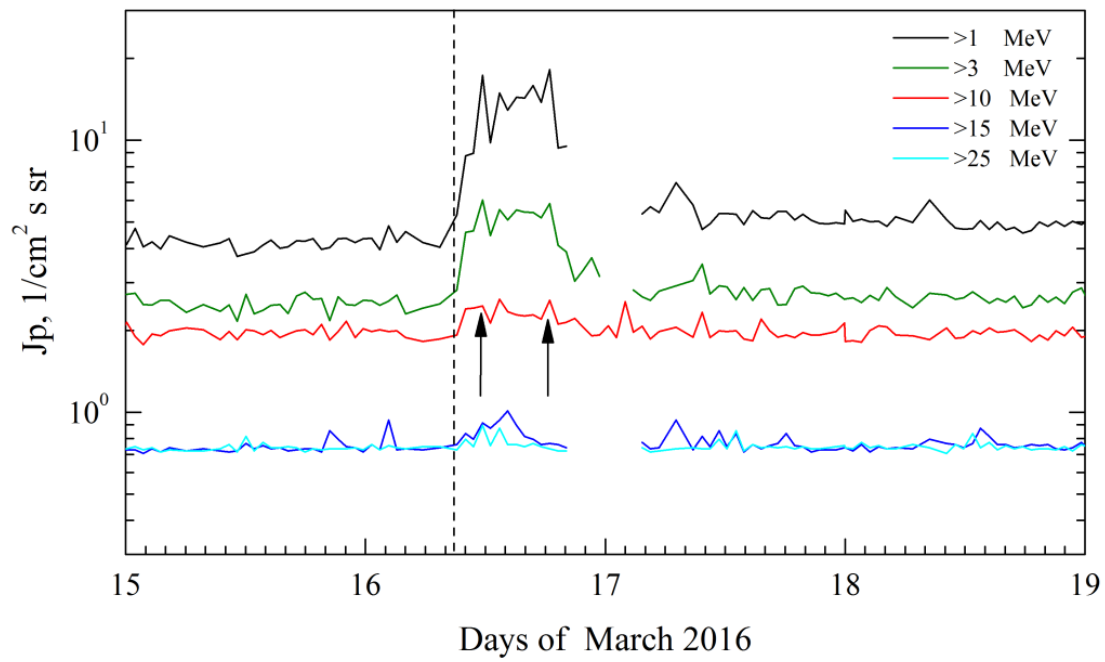
Earth satellite in geostationary orbit, $R \approx 6.6$ Re: GOES

GOES. Event 2016.03.16

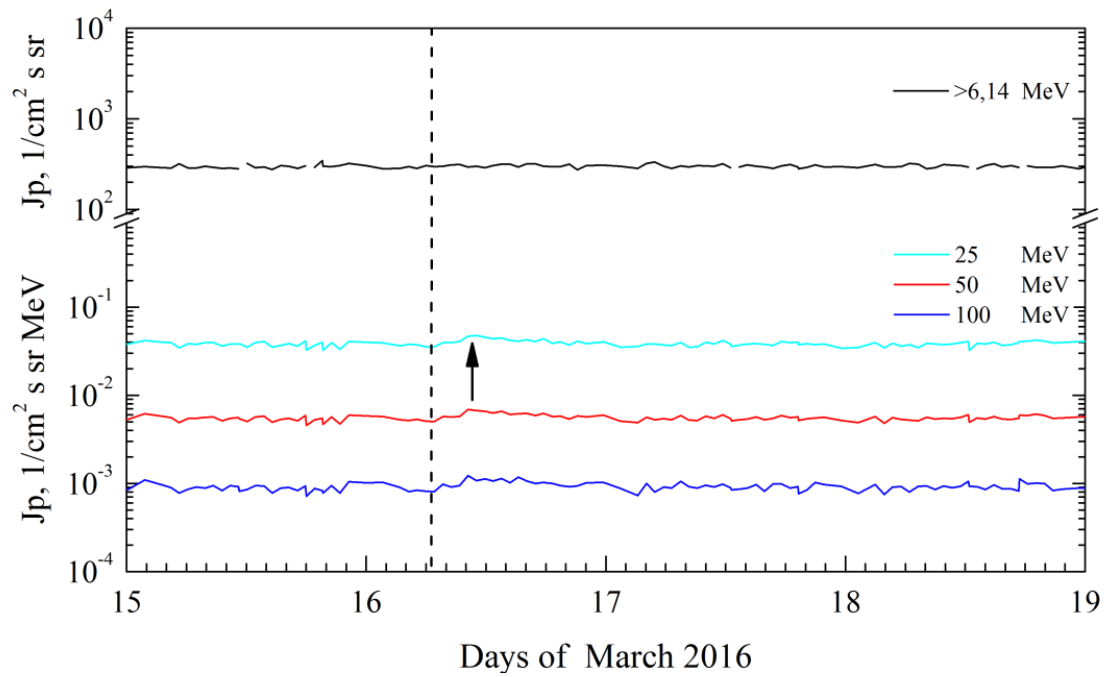


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2016.03.16



POES. Event 2016.03.16



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2016 March 16**

2016

March 16



AR 12522

To event 581

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	DSF	0634		> 0647	N20 W86	~10°	
1 – 12	keV	0634	0645	0657	N12W88	C2.2	0.0022
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	0637:45	0637:45	0640:05	4274	244986	FERMI
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-132	0645		0711	853	2	
DS V	25-180	0636		0640		3	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0700	592	- 22.4	154°	265°	SOHO

Proton Active Region

AR 12522 (N14L076, CMP no,

Sp= 040, CAO, B, R1)

XRI=<0.1 C₁ S₂

AR appearance at 14.03.2016 on W56

Particle event: To($E_p > 10$ MeV) – 18d07^h

Tmax ($E_p > 10$ MeV) – 18d15^h, Jmax ($E_p > 10$ MeV) – 0.3 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma = 2.1$

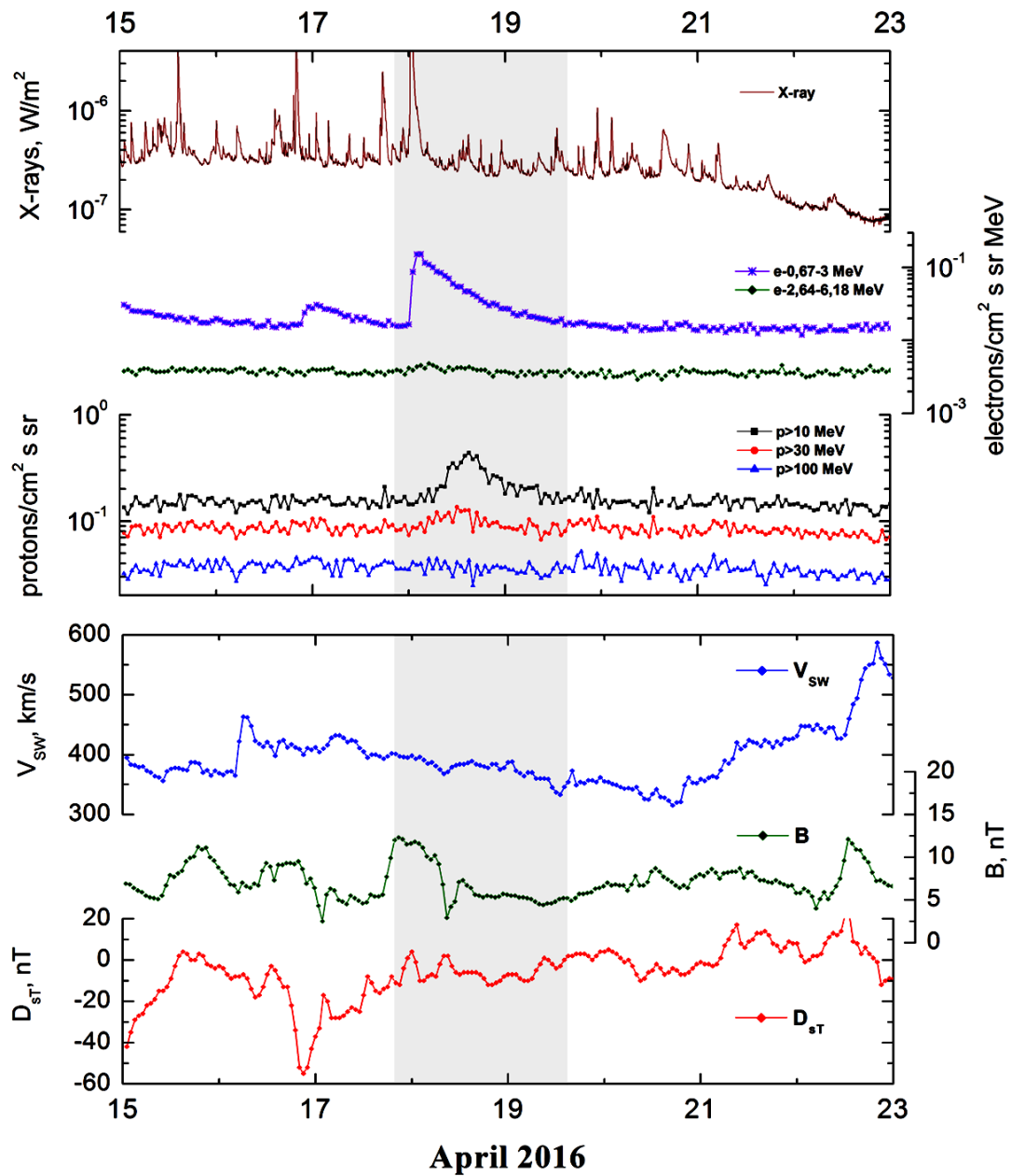
Quasimaximal energy of protons in the event – $E_{qm1} = 55$ MeV

Sources: ● solar flare 18d00^h14^m, M6.7/1F, N12W62, AR12529

Main burst X-ray 1–8 Å: onset – 18d00^h14^m, max – 18d00^h29^m, $\Phi = 0.049$ J/m²

CME: 18d00^h48^m, $V = 1084$ km/s, $\Delta\phi = 162^\circ$, $dA = 291^\circ$

Particle fluxes and associated phenomena

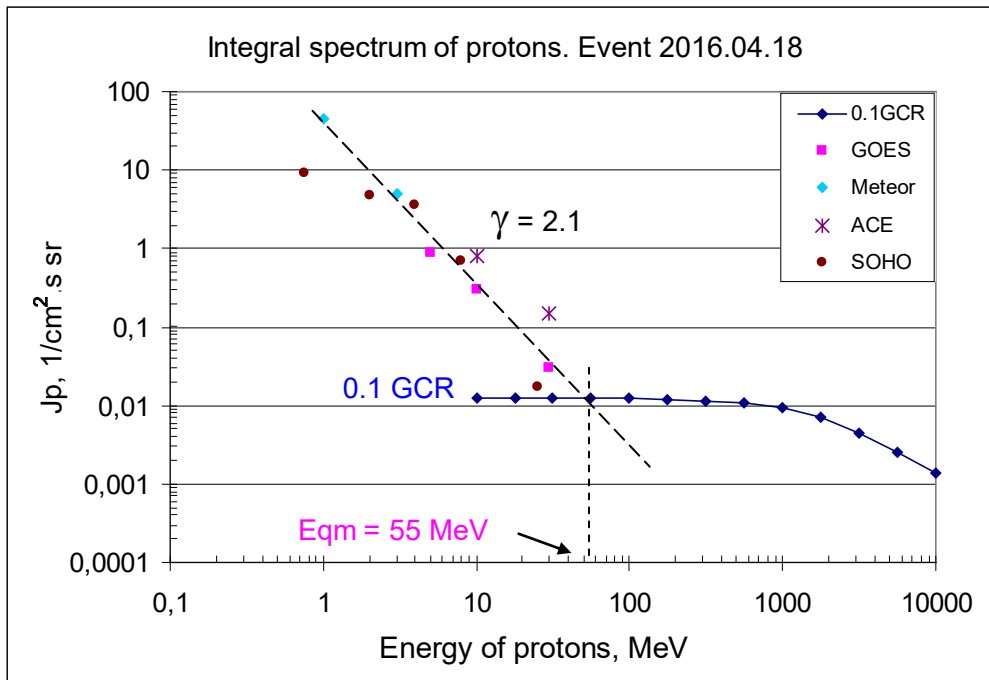


Integral fluxes of protons for the event of 2016 April 18

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	7	14	0.9	1	0.2	
EPS	>10	7	15	0.3	1	0.15	
EPS	>30	7	15	0.03	0.5	0.09	
EPS	>50	7	-	-	-	0.07	
EPS	>60	7	-	-	-	0.06	
EPS	>100	7	-	-	-	0.035	
POES							
MEPED	>6.14	-	-	-	-	300	
Meteor-2							
SCR	>1	2	17	45	2.5	4.4	
SCR	>3	2	16	5	2	2.8	
SCR	>10	-	-	-	-	2.2	
GALS-M	>15	-	-	-	-	0.7	
GALS-M	>25	-	-	-	-	0.8	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	2	13	0.8	1	1.5	
SIS	>30	2	13	0.15	1	1.1	
SOHO							
EPHIN	>50	-	-	-	-	-	

Differential fluxes of protons for the event of 2016 April 18

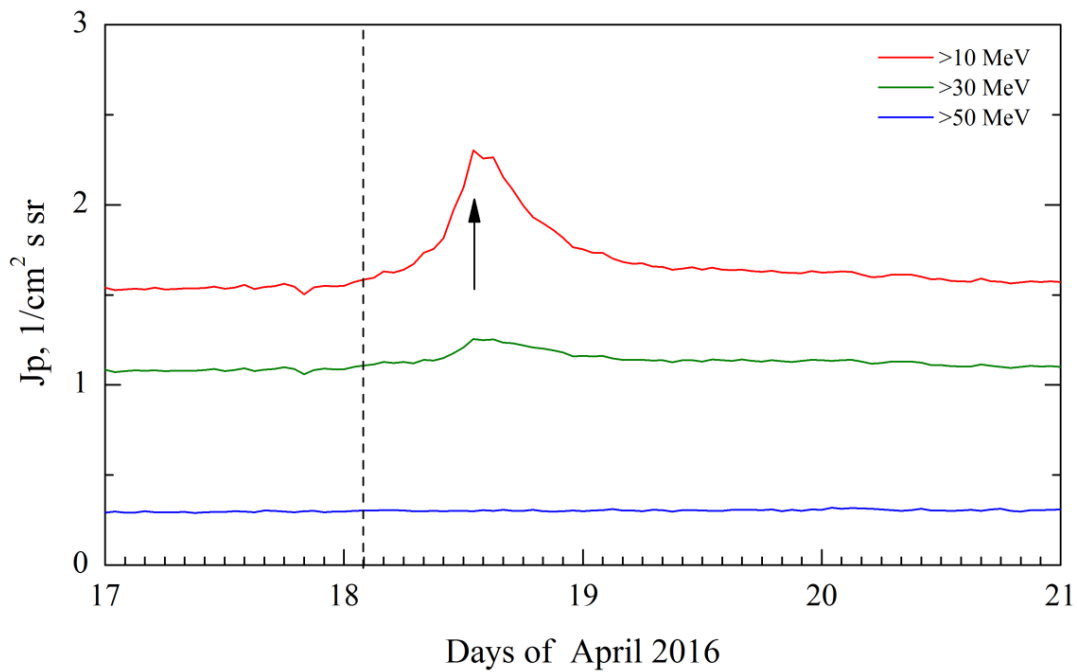
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	09	19	3.65	3.5	0.07	
LION	2 – 6	09	19	0.4	2	0.015	
EPHIN	4 – 8	0	16	0.724	4	0.001	
EPHIN	8 – 25	0	15	0.0414	3	0.00004	
EPHIN	25 – 53	01	15	0.00062	1.5	0.00004	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.038	25
MEPED	36–70	-	-	-	-	0.0053	50
MEPED	70–140	-	-	-	-	0.0009	100



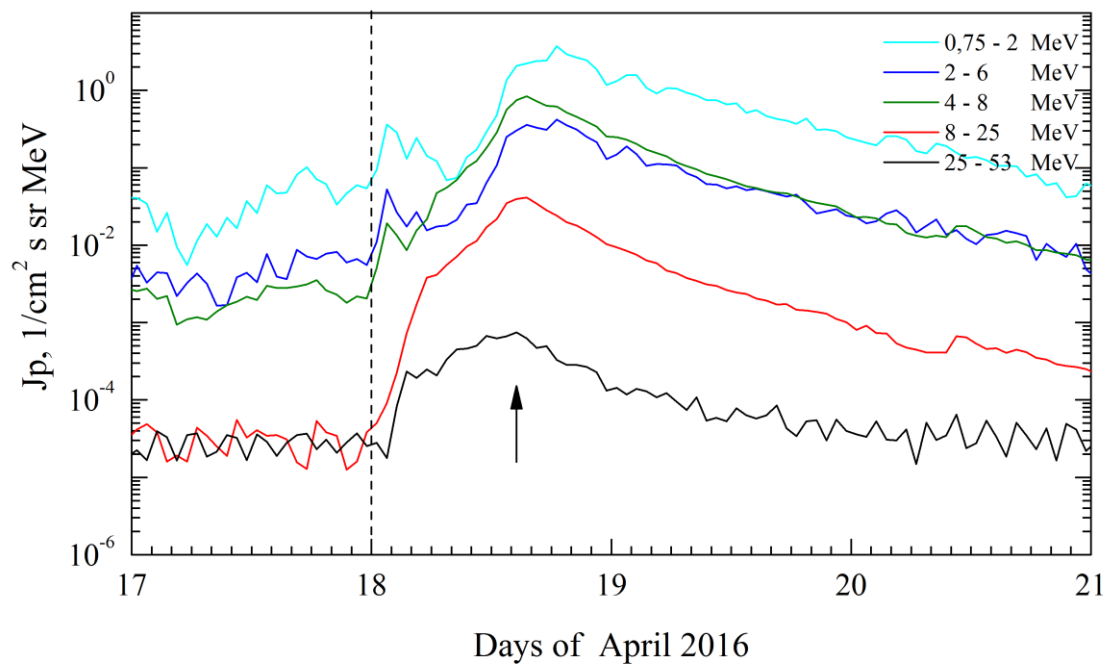
Time profiles of proton fluxes in the event 2016.04.18

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2016.04.18

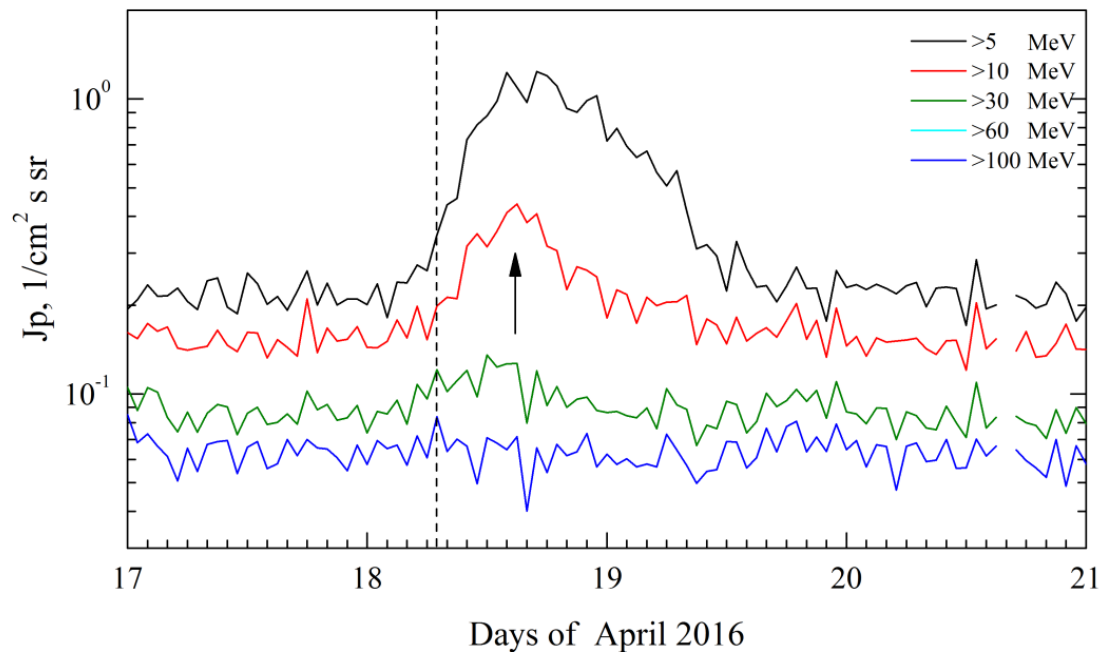


SOHO. Event 2016.04.18



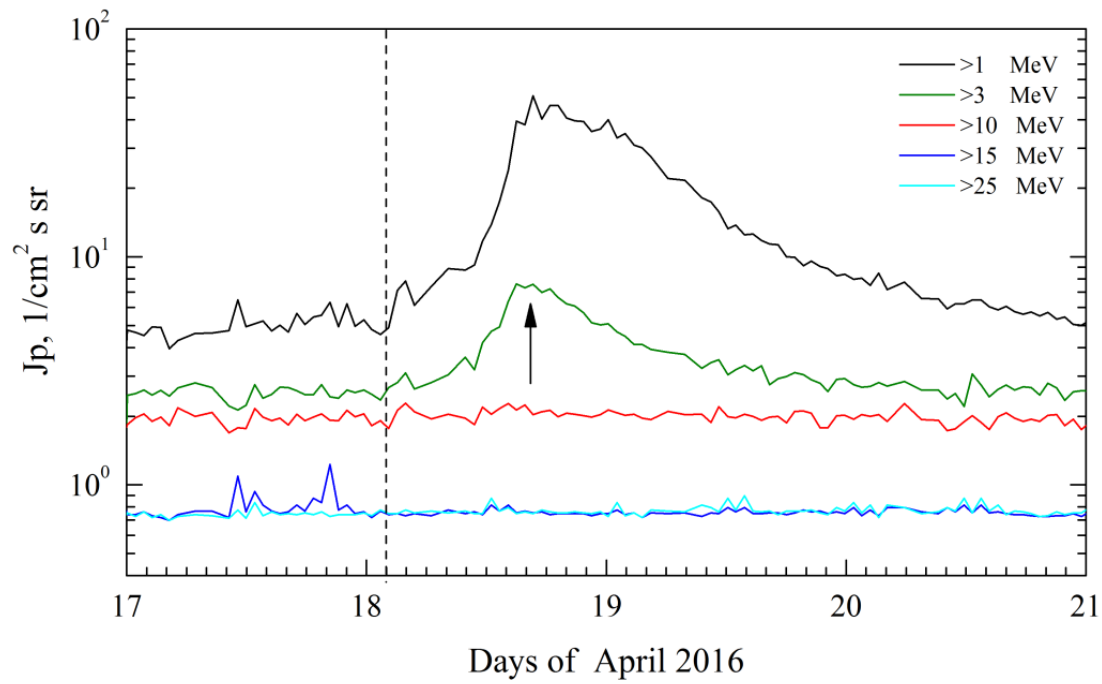
Earth satellite in geostationary orbit, $R \approx 6.6 R_E$: GOES

GOES. Event 2016.04.18

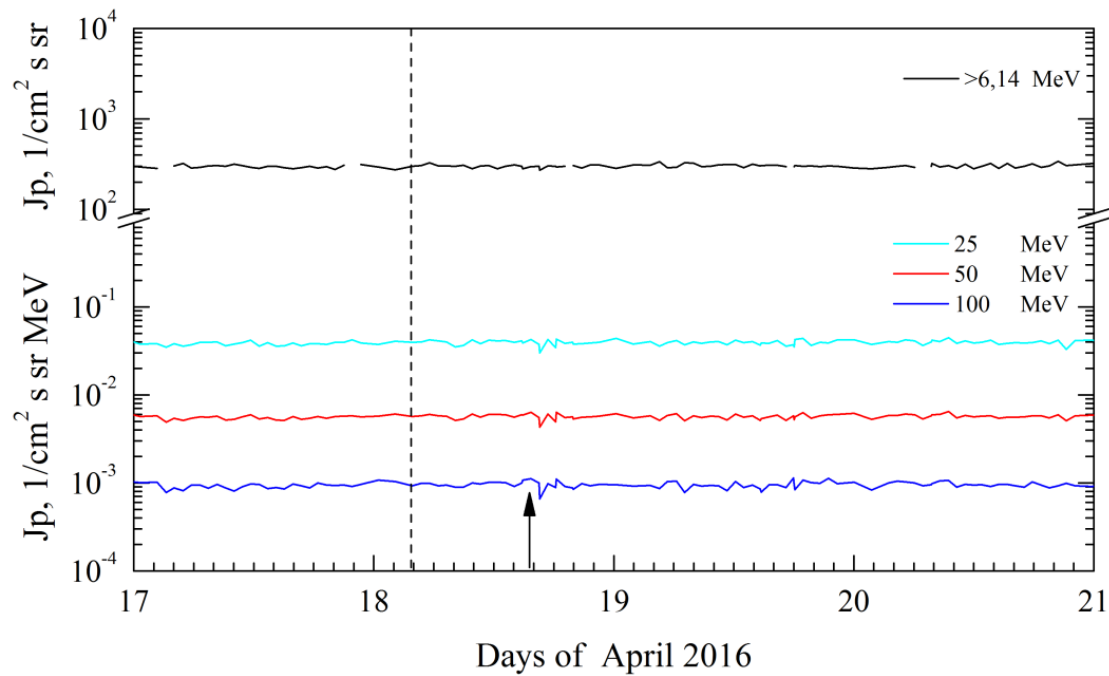


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2016.04.18



POES. Event 2016.04.18



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2016 April 18**

2016

April 18

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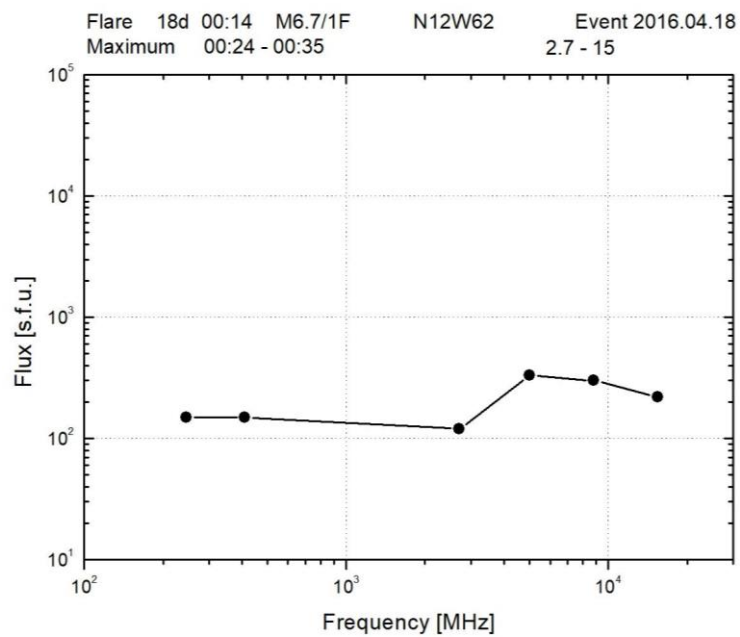
AR 12529

To event 582

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	0022	0043	0102	N12W62	1F	EUR
1 – 12	keV	0014	0029	0039	N11W60	M6.7*	0.049
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12 – 25	keV	0018:27	0026:55	0058:09	510292	196352768	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0022	0025	0034		2.34	
8.8	GHz	0023	0025	0027		2.48	
5	GHz	0022	0024	0027		2.52	
2.7	GHz	0023	0024	0024	2.7 – 15	2.08	
410	MHz	0026	0026	0026		2.18	
245	MHz	0035	0035	0035		2.18	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	25-152	0030		0033	1869	2	
DS IV	25-180	0034		0244		2	
DS III	25-82	0024		0027		3	
DS CTM	30-180	0000		0029		1	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0048	1084	- 24.6	162°	291°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/ssw_client/data/ssw_service_160417_210618_58234/ww/

Radio burst frequency spectrum



Proton Active Region:

AR 12529 (N10L344, CMP 14,0.04.2016,
Sp=850 msh, EKI, BG, R)
XRI=0.67 $M_1^{6.7}$
PFR 18.04 $M_1^{6.7}$

Particle event: To($E_p > 10$ MeV) – 15d17^h

Tmax ($E_p > 10$ MeV) – 17d21^h, Jmax($E_p > 10$ MeV) – $1.6 / \text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 2 days, power-law index: $\gamma = 2.1$

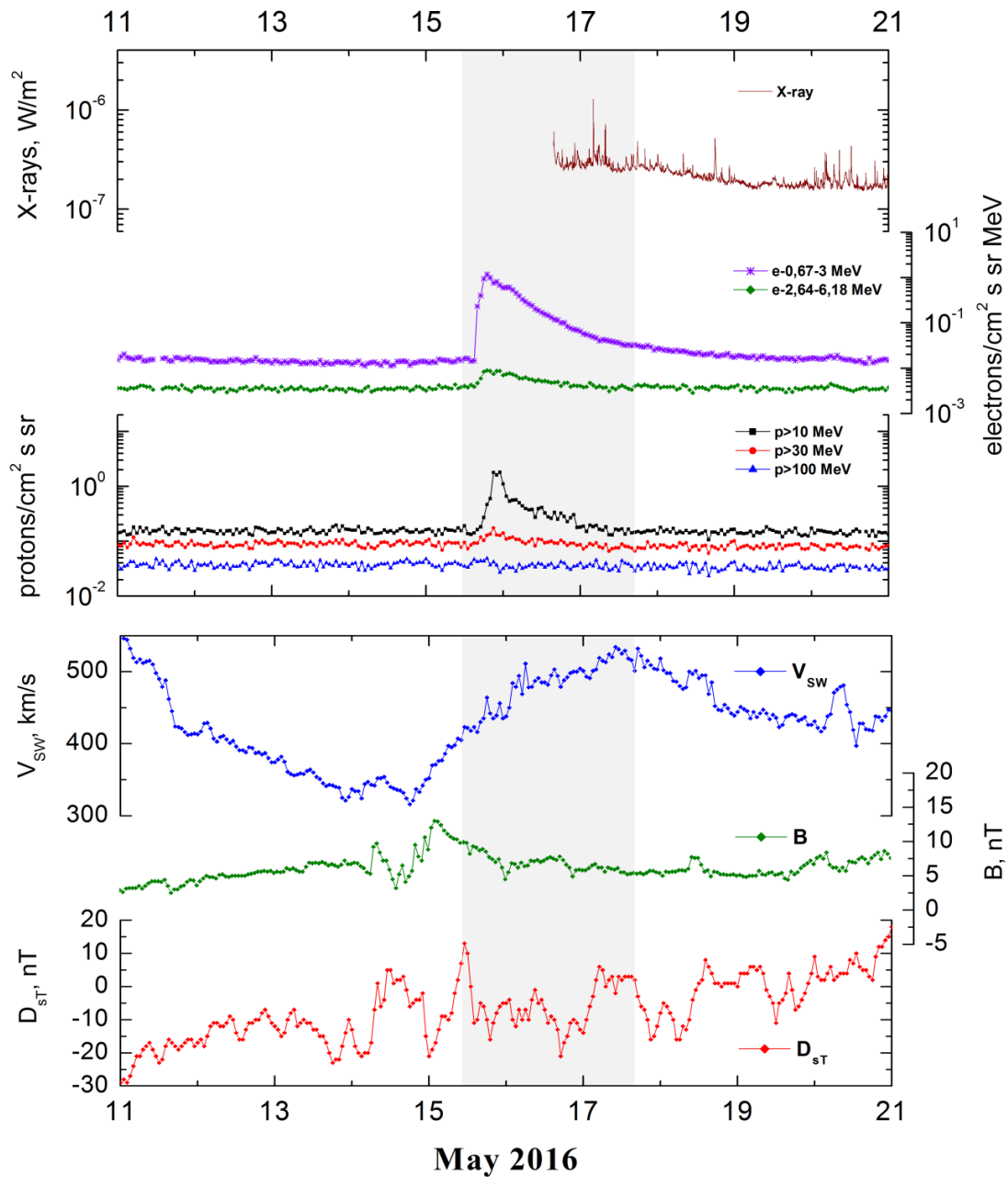
Quasimaximal energy of protons in the event – $E_{qm} = 90$ MeV

Sources: • solar flare 15d15^h00^m, DSF/ C3.2, N10W62, AR12542

Main burst X-ray 1–8 Å: onset – 15d15^h19^m, max – 15d16^h03^m, $\Phi = 0.018 \text{ J/m}^2$

CME: 15d15^h12^m, $V = 1118 \text{ km/s}$, $\Delta\phi = 176^\circ$, $dA = 309^\circ$

Particle fluxes and associated phenomena

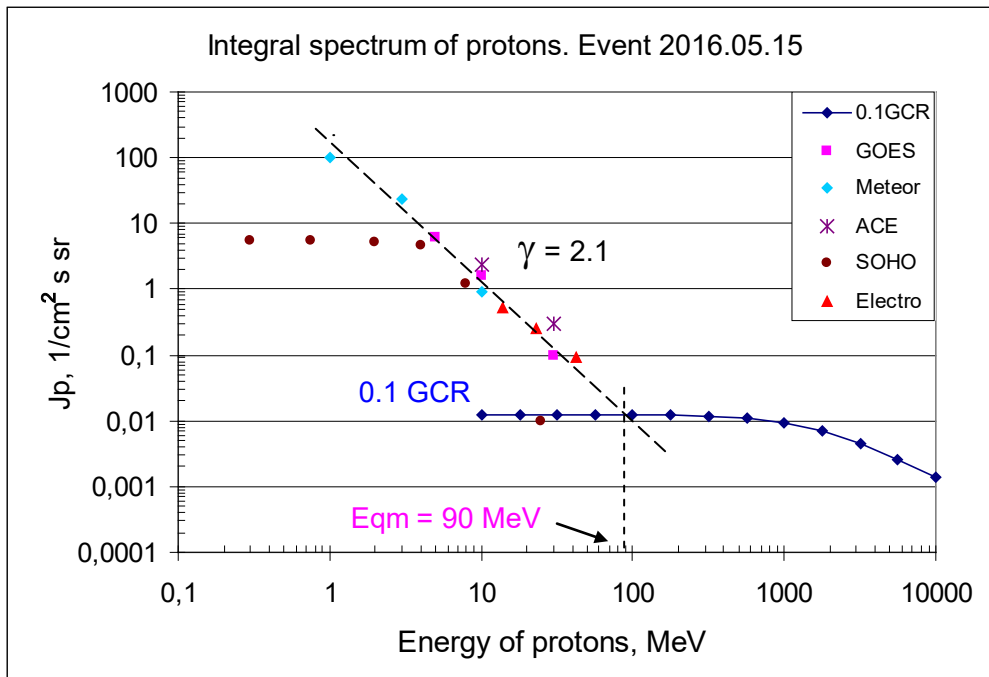


Integral fluxes of protons for the event of 2016 May 15

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	17	21	6	2	0.2	
EPS	>10	17	21	1.6	2	0.15	
EPS	>30	17	21	0.1	1	0.1	
EPS	>50	-	-	-	-	0.08	
EPS	>60	-	-	-	-	0.07	
EPS	>100	-	-	-	-	0.04	
Electro-2							
GALS-E	>600	-	-	-	-	0.0008	
POES							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR	>1	18	16d00	99	2	4.6	
SCR	>3	18	16d00	24	1.5	2.8	
SCR	>10	18	16d00	0.9	0.5	2.2	
GALS-M	>15	-	-	-	-	0.8	
GALS-M	>25	-	-	-	-	0.8	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	17	21	2.4	1	1.5	
SIS	>30	17	21	0.3	0.3	1.1	
SOHO							
EPHIN	>50	-	-	-	-	0.3	

Differential fluxes of protons for the event of 2016 May 15

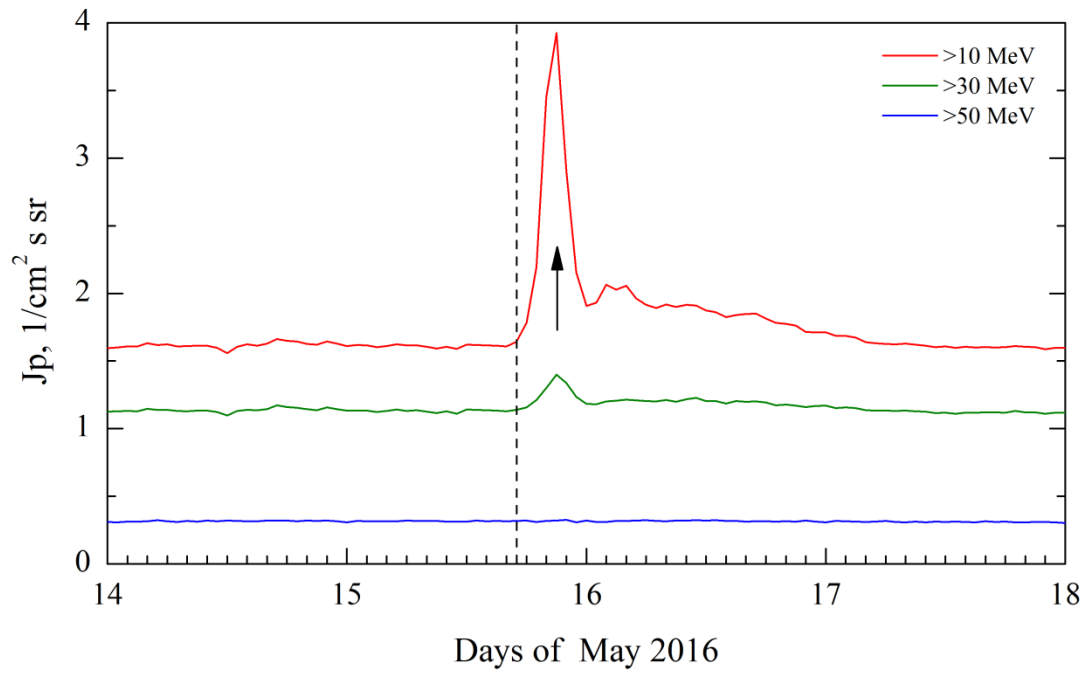
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	19	23	0.25	1.5	0.01	
LION	2 – 6	19	23	0.175	1.5	0.002	
EPHIN	4 – 8	17	22	0.85	1.5	0.0001	
EPHIN	8 – 25	17	22	0.068	1.5	0.00002	
EPHIN	25 – 53	17	22	0.0004	1.5	0.00003	
Electro-2							
SCR-E	13.7–23	18	20	0.03	0.5	0.05	
SCR-E	23–42	18	20	0.008	0.5	0.02	
SCR-E	42–112	18	20	0.001	0.5	0.004	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.04	25
MEPED	36–70	-	-	-	-	0.006	50
MEPED	70–140	-	-	-	-	0.0009	100



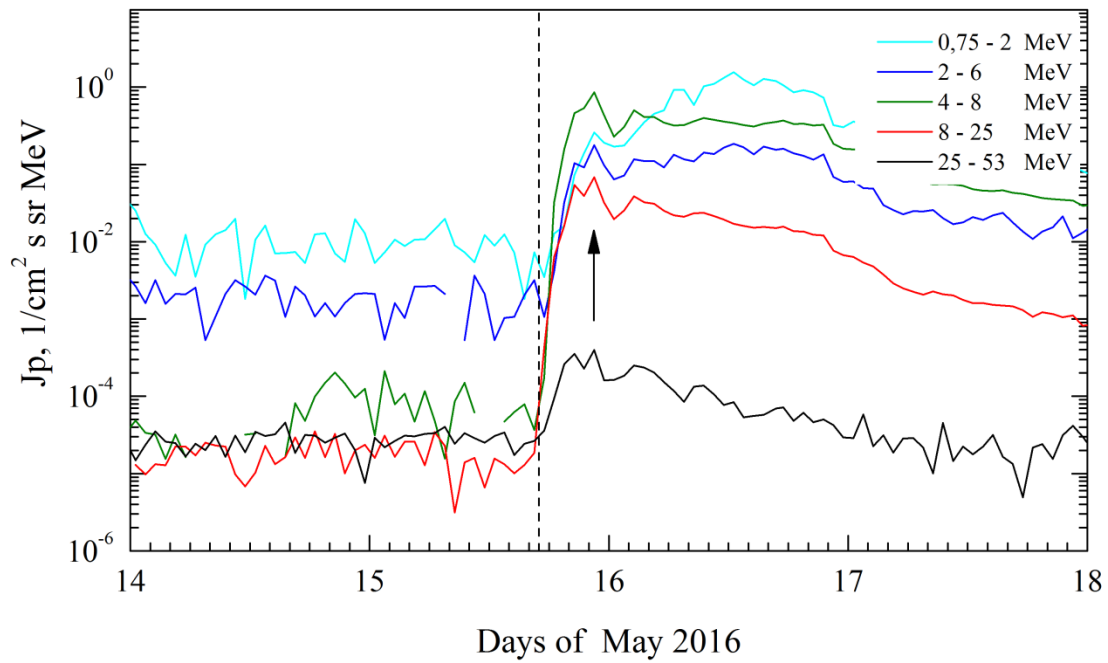
Time profiles of proton fluxes in the event 2016.05.15

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2016.05.15

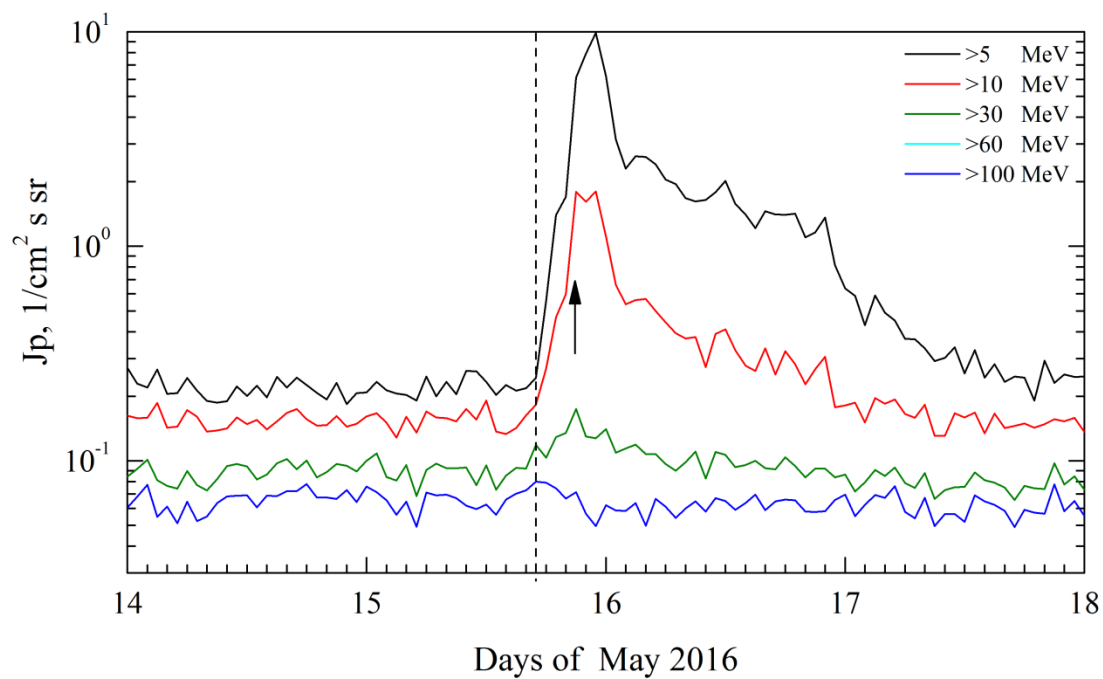


SOHO. Event 2016.05.15

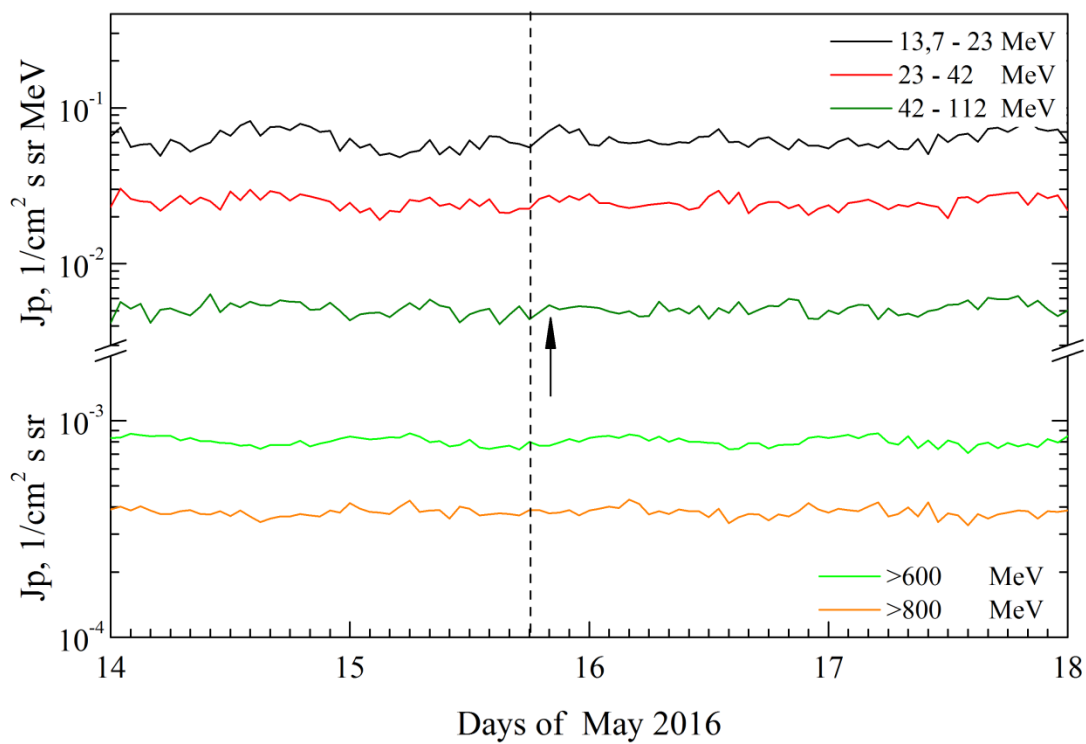


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2016.05.15

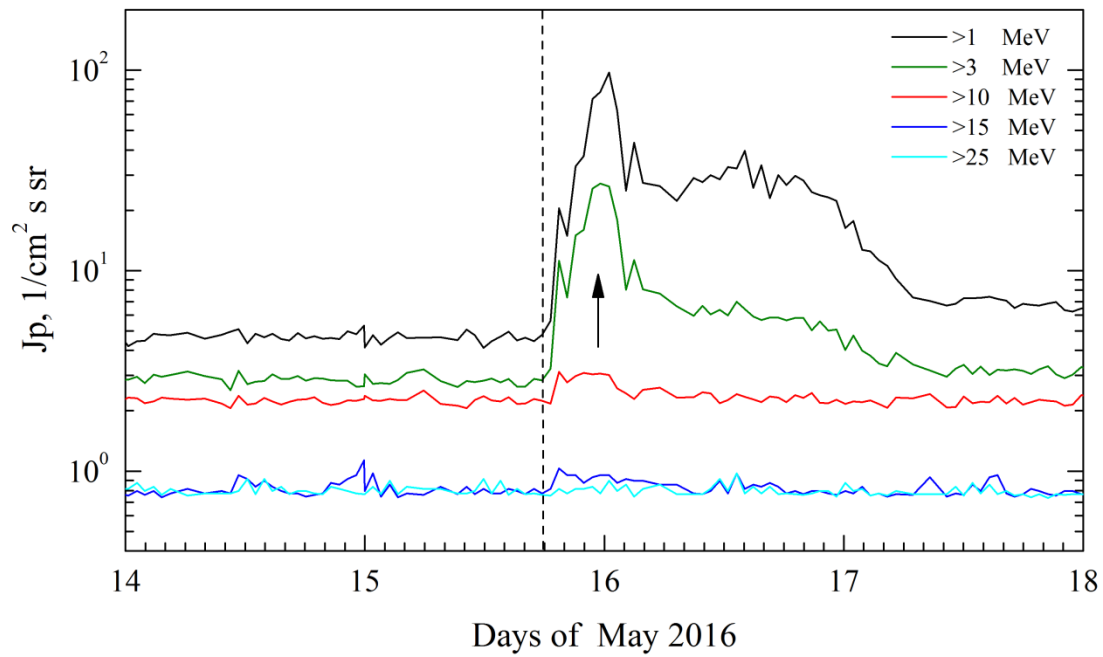


Electro. Event 2016.05.15

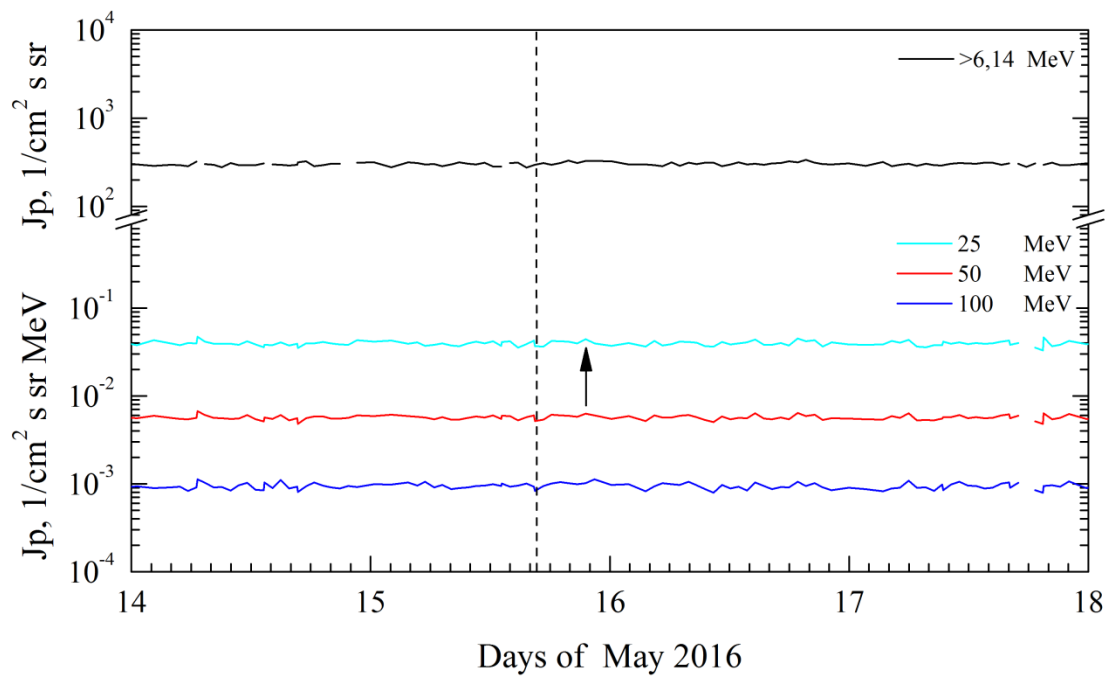


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2016.05.15



POES. Event 2016.05.15



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2016 May 15**

2016 May 15 • AR 12542 To event 583

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	DSF	~1500		~1745	NW (n10 w70)*	>10°	
6563 Å	FL	<1532	~1548	>1633	N10W62	SF	PRB
1 – 12	keV	1519	1603	1733	N10W62	C3.2*	1.8E-02
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6 – 12	keV	1502:08	1507:54	1513:44		91872	HESSI
6 – 12	keV	1513:44	1514:54	1521:52		45096	HESSI
6 – 12	keV	1624:32	1625:26	1630:12		25008	HESSI
6 – 12	keV	1632:52	1633:46	1638:20		27168	HESSI
12-25	keV	1602:17	1602:46	1603:14	57	7384	FERMI
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1512	1118	35.1	176°	309°	SOHO

*https://sdowwww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_160515_103023_15238_1/www/

Proton Active Region:

AR12542 (N11L357, CMP 10,2.05. 2016,
Sp=250 msh, DAI, BG, R)
XRI=0 C₂ S₆

Particle event: To($E_p > 10$ MeV) – 23d04^h

Tmax ($E_p > 10$ MeV) – 23d07^h, Jmax ($E_p > 10$ MeV) – $0.4/\text{cm}^2 \cdot \text{s} \cdot \text{sr}$

Duration of the event – 0.5 days, power-law index: $\gamma = 1.5$

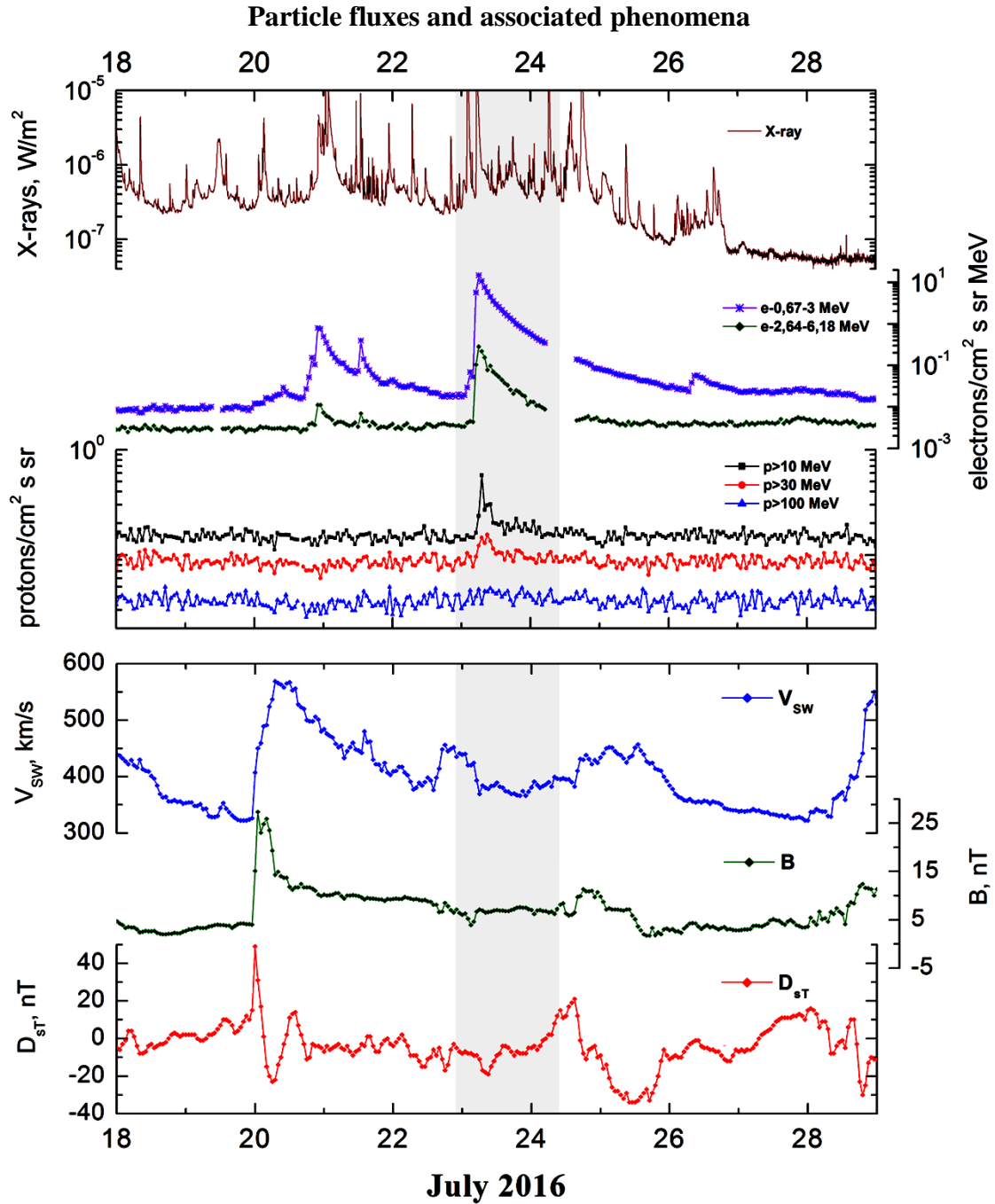
Quasimaximal energy of protons in the event – $E_{qm} = 100$ MeV

Sources: ● solar flare 23d05^h00^m, M7.6, M5.5/3B, N02W74, AR12567

Main burst X-ray 1–8 Å: onset 23d05^h00^m, max – 23d05^h16^m, $\Phi = 0.046 \text{ J/m}^2$

CME: 23d05^h24^m, $V = 835 \text{ km/s}$, $\Delta\phi = 117^\circ$, $dA = 271^\circ$

▲ SC 24d15^h25^m

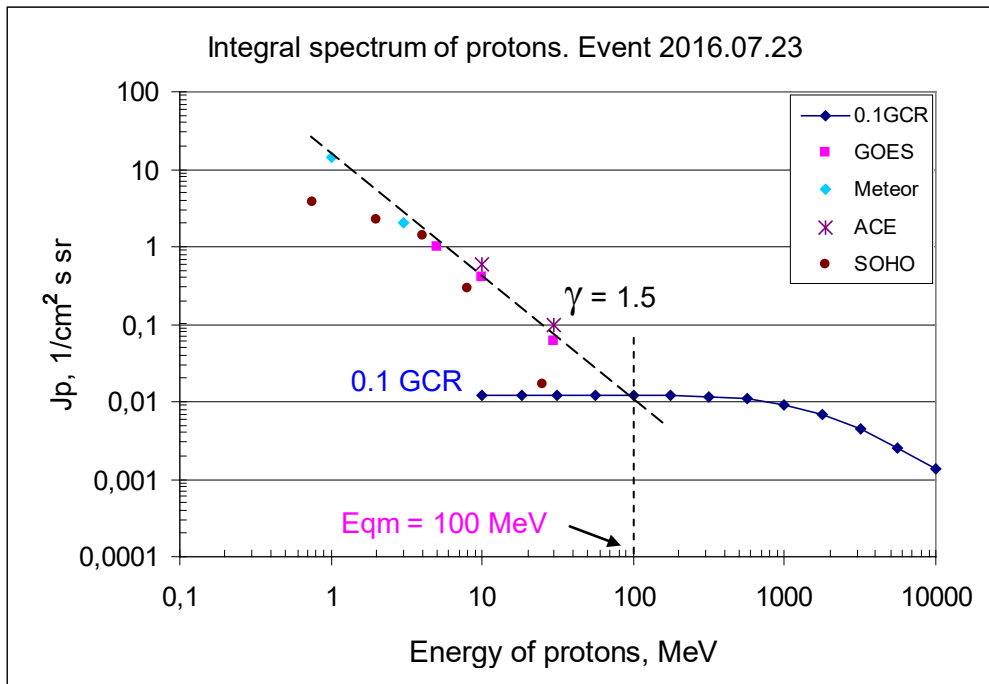


Integral fluxes of protons for the event of 2016 July 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	4	7	1	0.5	0.2	
EPS	>10	4	7	0.4	0.5	0.13	
EPS	>30	4	7	0.06	0.5	0.08	
EPS	>50	–	–	–	–	0.07	
EPS	>60	–	–	–	–	0.06	
EPS	>100	–	–	–	–	0.04	
POES							
MEPED	>6.14	-	-	-	-	290	
Meteor-2							
SCR	>1	5	10	14	2	4.5	
SCR	>3	5	10	2	1.5	2.8	
SCR	>10	-	-	-	-	2.2	
GALS-M	>15	-	-	-	-	0.8	
GALS-M	>25	-	-	-	-	0.8	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	4	8	0.6	5	1.5	
SIS	>30	4	8	0.1	0.3	1.1	
SOHO							
EPHIN	>50	-	-	-	-	0.25	

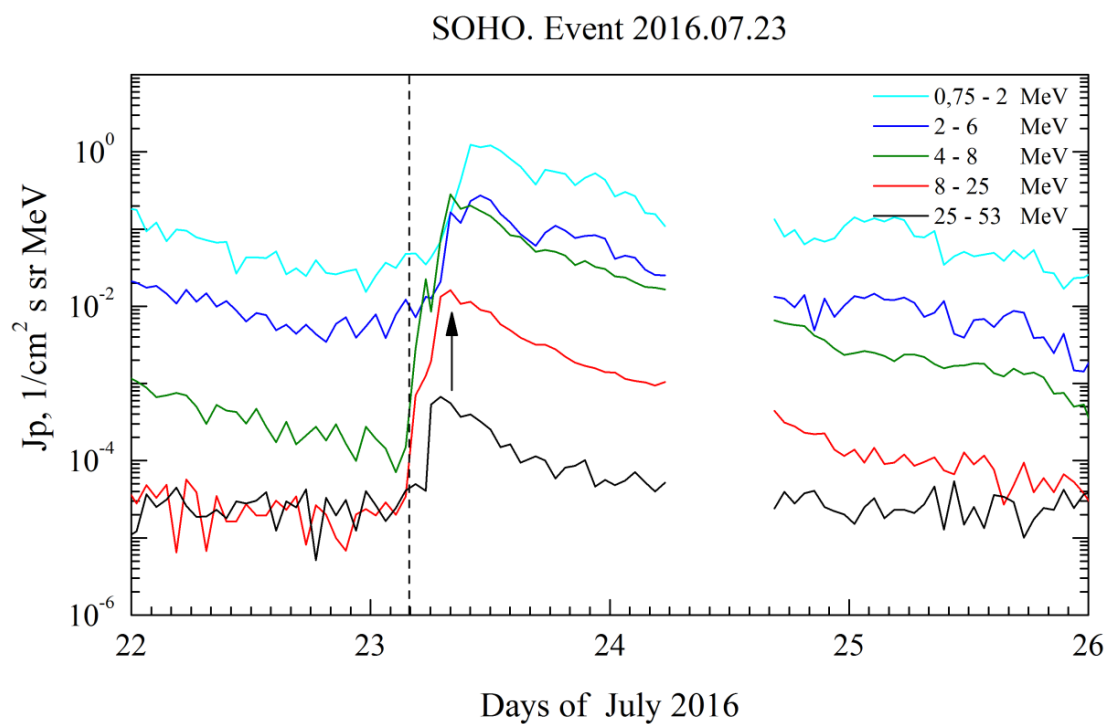
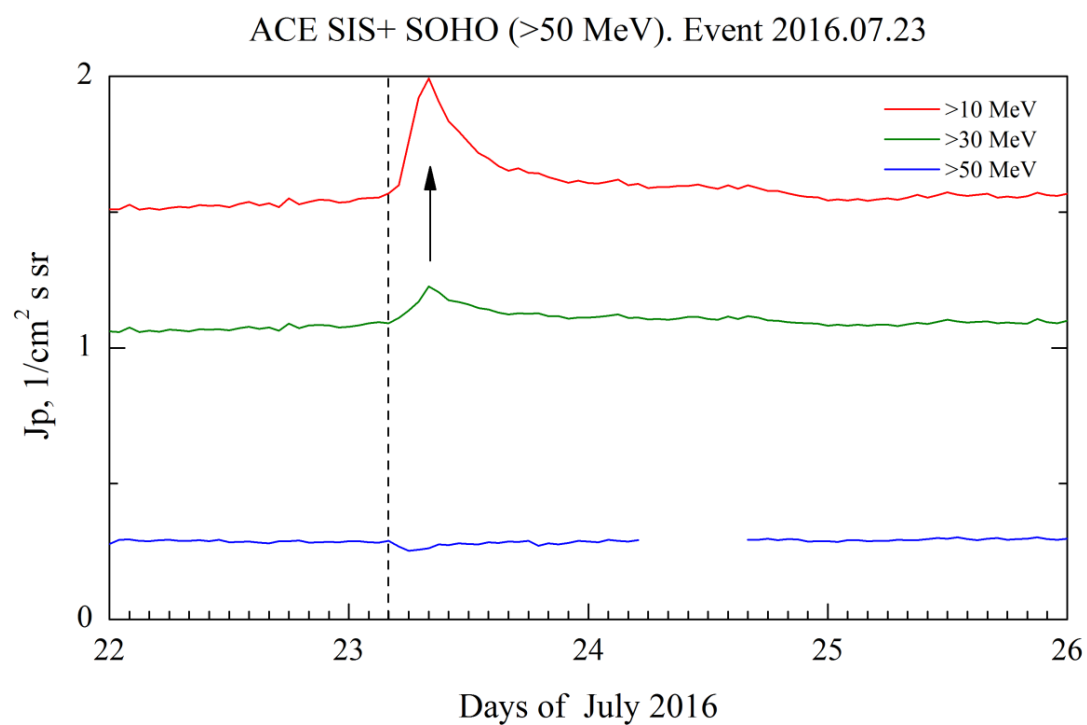
Differential fluxes of protons for the event of 2016 July 23

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	08	11	1.21	1	0.026	
LION	2 – 6	08	11	0.26	1	0.01	
EPHIN	4 – 8	04	08	0.281	3	0.0001	
EPHIN	8 – 25	04	08	0.0162	2	0.00003	
EPHIN	25 – 53	04	07	0.00064	1.5	0.00003	
POES-19							<E>, MeV
MEPED	16–36	-	-	-	-	0.04	25
MEPED	36–70	-	-	-	-	0.006	50
MEPED	70–140	-	-	-	-	0.0009	100



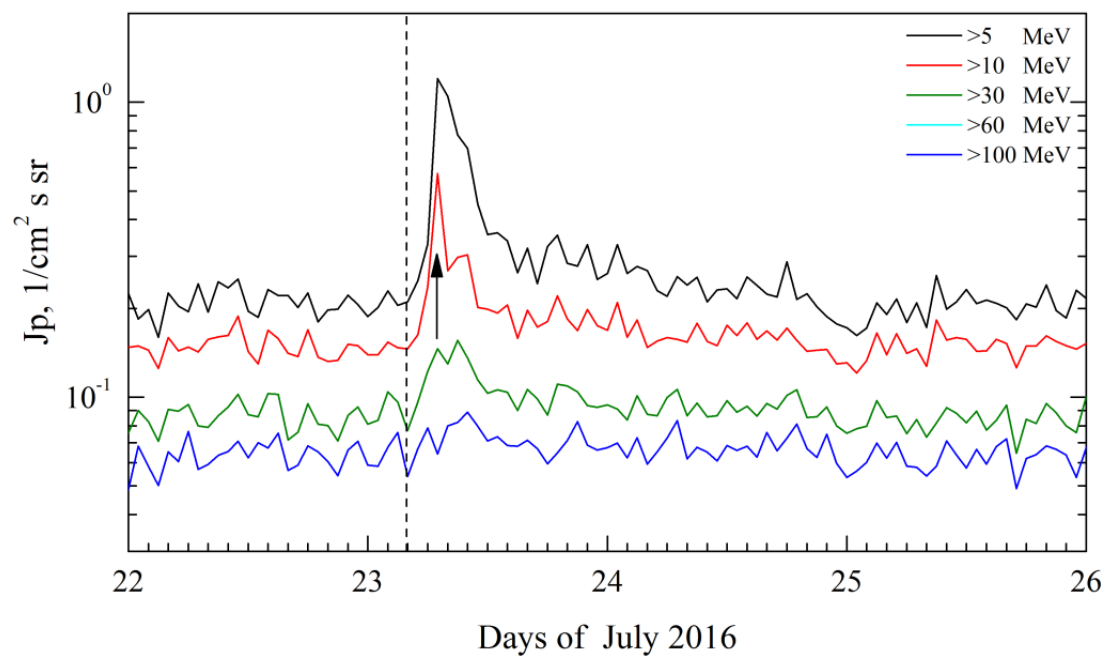
Time profiles of proton fluxes in the event 2016.07.23

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO



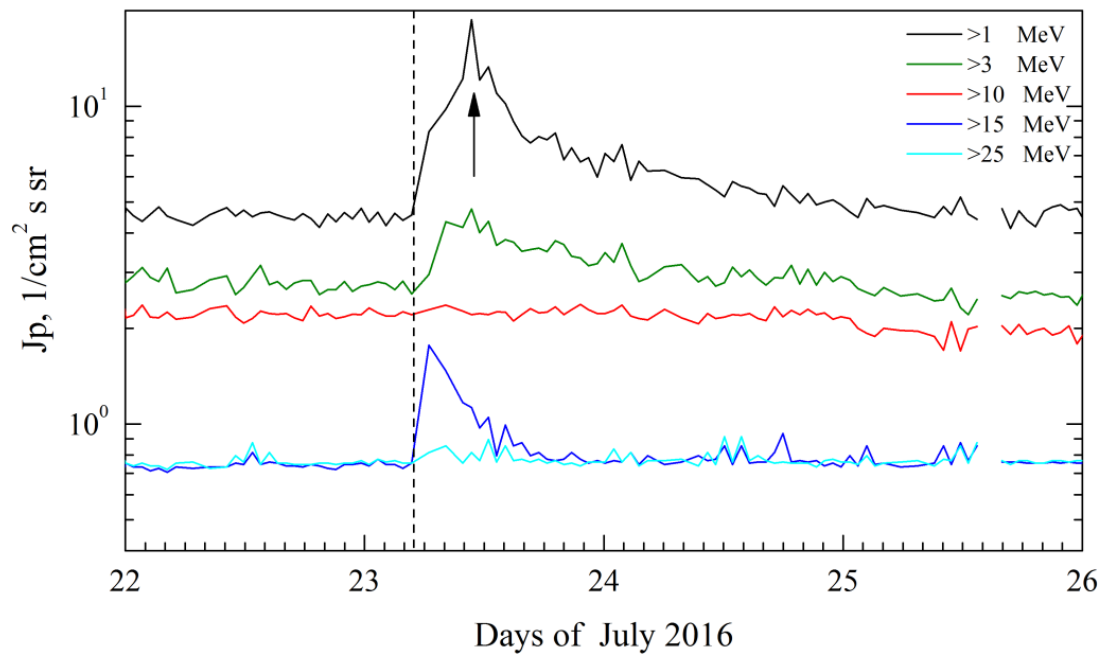
Earth satellite in geostationary orbit, $R \approx 6.6 \text{ Re}$: GOES

GOES. Event 2016.07.23

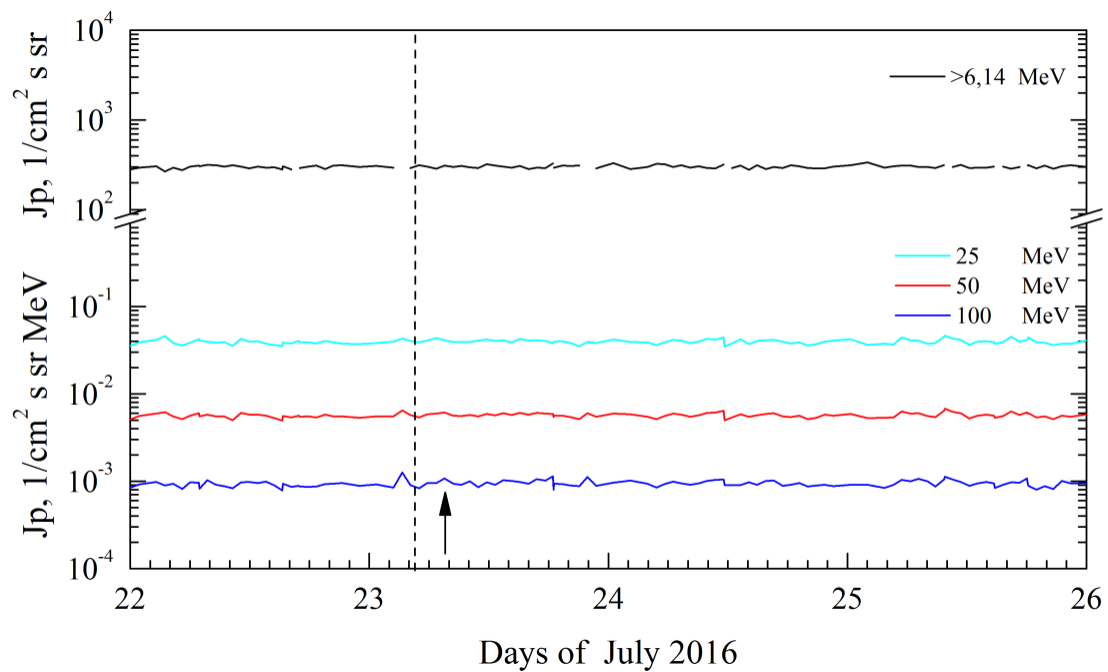


Earth satellites in polar orbit, $R = 800 \div 1000$ km: Meteor and POES

Meteor. Event 2016.07.23



POES. Event 2016.07.23



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2016 July 23**

2016

July 23

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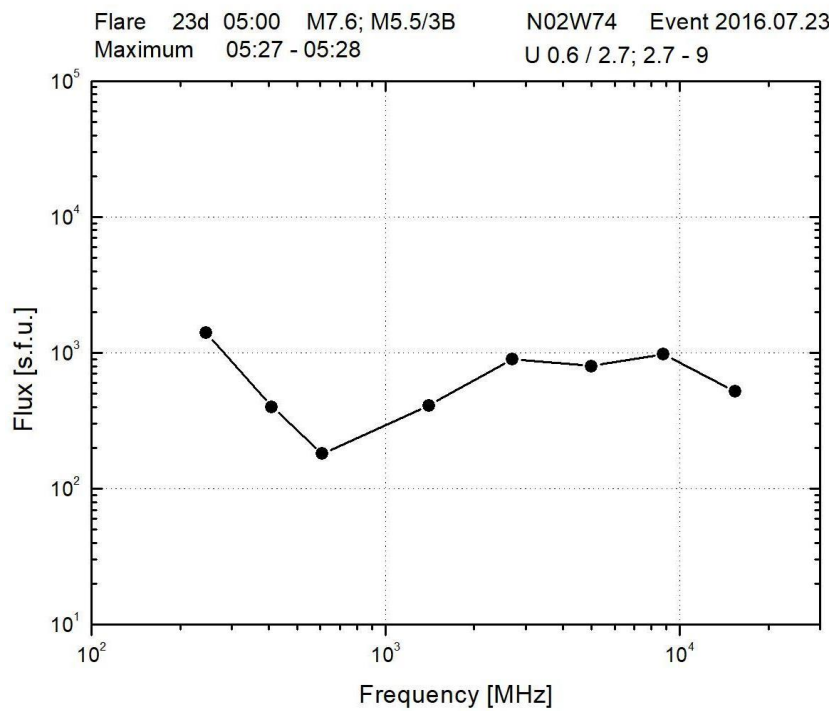
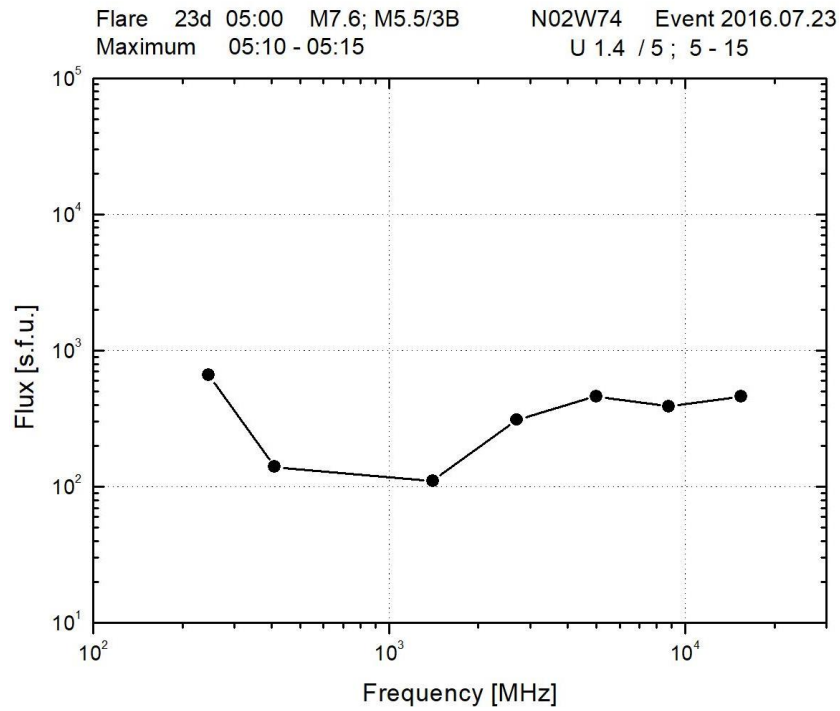
AR 12567

To event 584

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0509	0531	0633	N02W74	3B	ERU
1 – 12	keV	0500	0516	0524	N05W73	M7.6*	0.046
1 – 12	keV	0527	05:31	05:33	N02W75	M5.5	0.011
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
50 – 100	keV	0503:20	0504:30	0509:12	317	111394	HESSI
100-300	keV	0509:12	0515:14	0526:32	2527	2191325	HESSI
100-300	keV	0526:32	0531:06	0606:01	1584	697816	HESSI
12-25	keV	0506:27	0514:10	0544:13	523357	211931392	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0510	0515	0518	5 – 15	460	
8.8	GHz	0510	0515	0516		390	
5	GHz	0508	0510	0515		460	
2.7	GHz	0510	0510	0515		310	
1.4	GHz	0510	0510	0511	U1.4 / 5	110	
410	MHz	0510	0510	0510		140	
245	MHz	0506	0510	0511		660	
15.4	GHz	0527	0528	0528		520	
8.8	GHz	0527	0528	0530	2.7 – 9	970	
5	GHz	0527	0528	0530		800	
2.7	GHz	0527	0528	0530		900	
1.4	GHz	0527	0528	0530		410	
610	MHz	0528	0528	0530	U0.6 / 2.7	180	
410	MHz	0526	0527	0531		400	
245	MHz	0527	0528	0530		1400	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS III	25-180	0506		0515		2	
DS II	25-52	0529		0535	729	2	
DS IV	44-180	0529		0942		2	
DS V	25-180	0527		0530		3	
DS VI	25-172	0532		0558		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0524	835	- 15.2	117°	271°	SOHO

*https://sdowww.lmsal.com/sdomedia/ssw/media/ssw/ssw_client/data/ssw_service_160723_043108_18113_1/www/

Radio bursts frequency spectrum



Proton Active Region:

AR 12567 (N05L165, CMP 18, 1.07.2016,
Sp=510 msh, DKI, BG, R1)
XRI=2.43: $M_7^{7.6} + C_{45}$ $3_1 + 1_1 + S_{55}$
PFR 23.07: (4^h) $M_3^{7.6}$

Events in 2017

			Page
1	Event 2017.07.14 – (2017-195)	№ 585	913
2	Event 2017.07.25 – (2017-206)	№ 586	921
3	Event 2017.09.04 – (2017-247)	№ 587	928
4	Event 2017.09.06 – (2017-249)	№ 588	936
5	Event 2017.09.07 – (2017-250)	№ 589	946
6	Event 2017.09.10 – (2017-253)	№ 590	955

Particle event: To($E_p > 10$ MeV) – 14d03^h

Tmax₁($E_p > 10$ MeV) – 14d10^h, Jmax₁($E_p > 10$ MeV) – 11.2 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 14d23^h, Jmax₂($E_p > 10$ MeV) – 20.4 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 2.6$, $\gamma_2 = 2.7$

Quasimaximal energy of protons in the event – Eqm₁ = 120 MeV

– Eqm₂ = 130 MeV

Sources: ● solar flare 14d01^h07^m, M2.4/1N, S06W29, AR12665

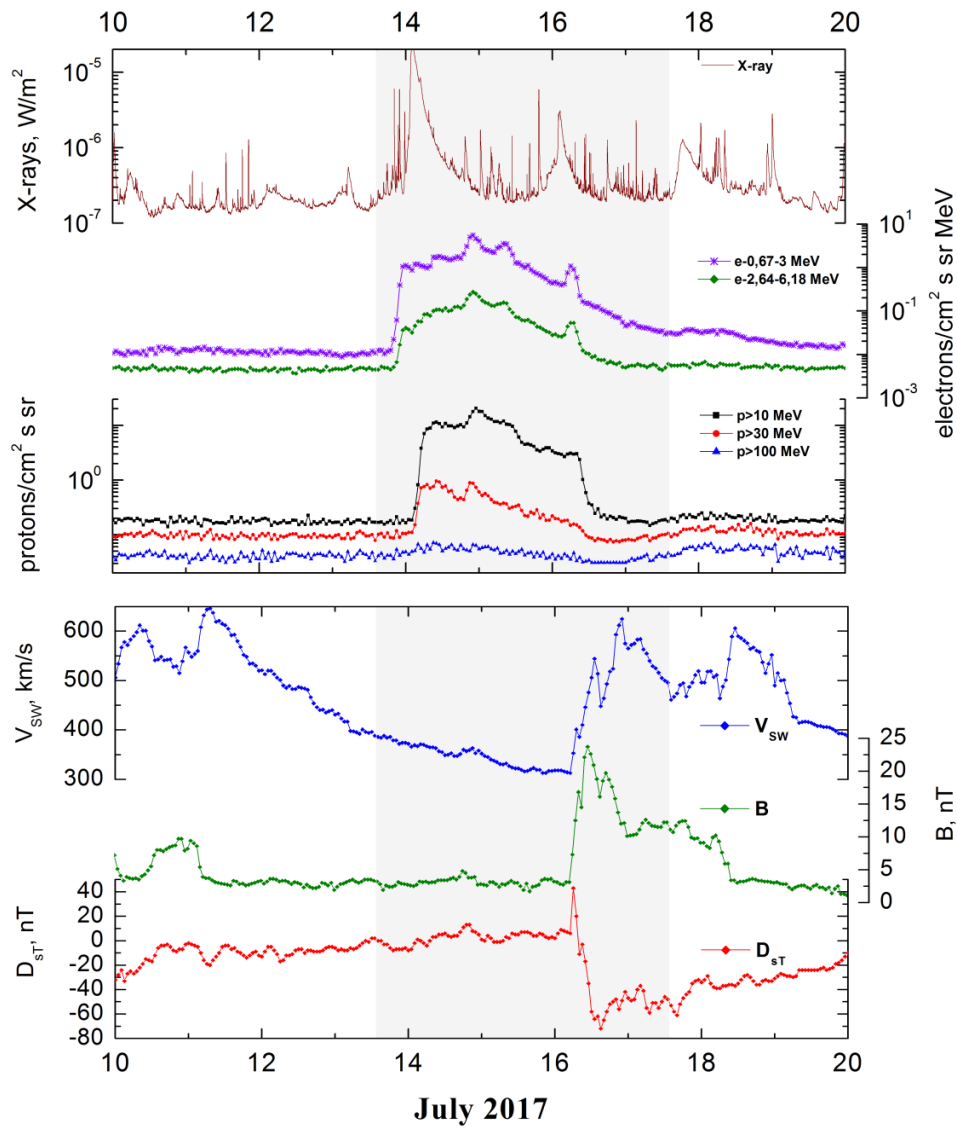
Ø solar flare 14d19^h18^m, C1.4/1N, S07W44, AR12665

Main burst X-ray 1–8 Å: onset – 14d01^h07^m, max – 14d02^h09^m, $\Phi = 0.13$ J/m²

CME: 14d01^h26^m, V = 1200 km/s, $\Delta\phi = 360^\circ$, dA = 230°

▲ SC 16d05^h59^m

Particle fluxes and associated phenomena

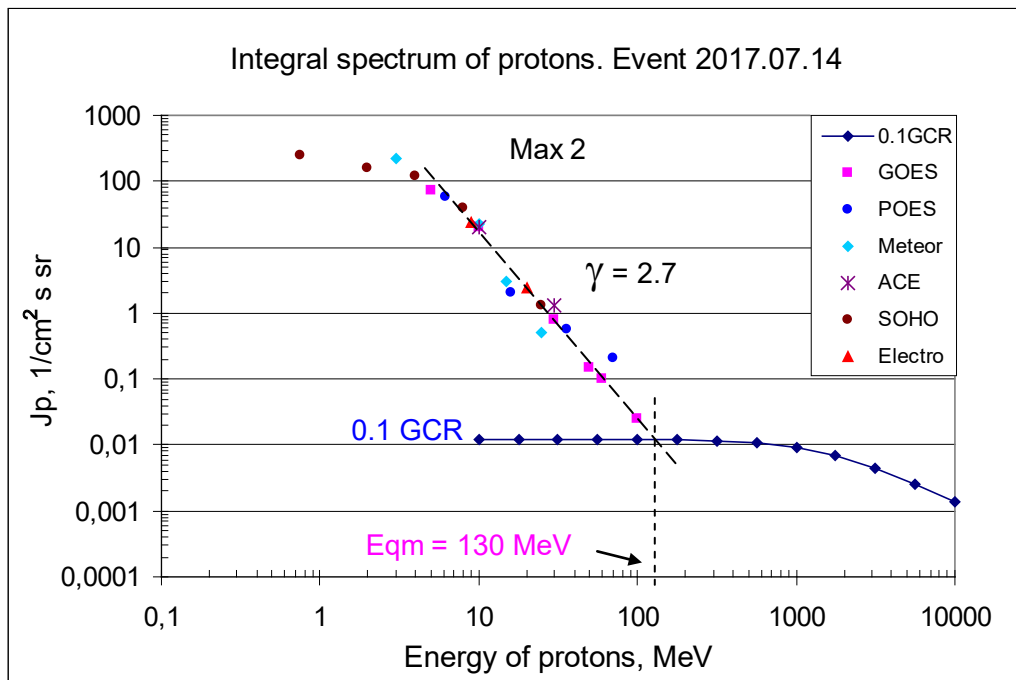
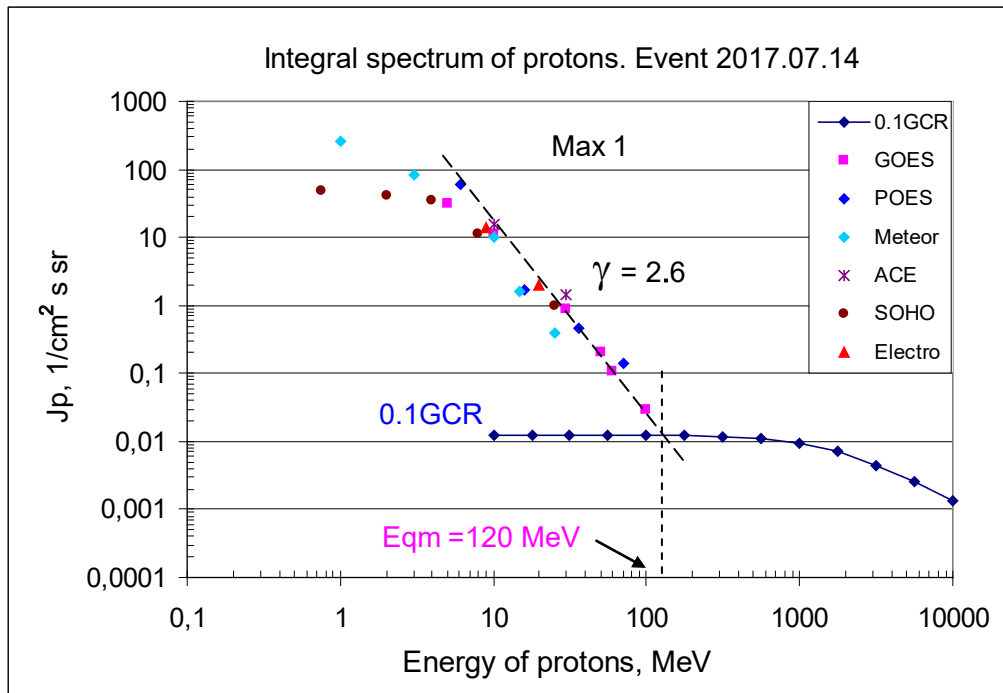


Integral fluxes of protons for the event of 2017 July 14

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	3	10/24	32.2/74.5	3	0.25	
EPS	>10	3	10/23	11.2/20.4	3	0.17	
EPS	>30	3	10/22	0.9/0.8	3	0.08	
EPS	>50	3	10/22	0.2/0.15	2.5	0.07	
EPS	>60	3	10/22	0.11/0.1	2.5	0.06	
EPS	>100	–	10/23	0.03/0.025	2.5	0.04	
Electro-2							
GALS-E	>600	-	-	-	-	0.11	
POES							
MEPED	>6.14	04	8/24	61/57	2	310	
Meteor-2							
SCR	>1	3	09/24	254/1050	6	5.3	
SCR	>3	3	06/23	81/226	2.5	2.9	
SCR	>10	3	07/23	10/23	2.5	2.2	
GALS-M	>15	3	07/23	1.6/3.0	2	0.9	
GALS-M	>25	33	07/23	0.4/0.5	1.5	0.9	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	4	13/22	15.3/20	2	2	
SIS	>30	4	10/22	1.4/1.3	2	1.4	
SOHO							
EPHIN	>50	-	-	-	-	0.35	

Differential fluxes of protons for the event of 2017 July 14

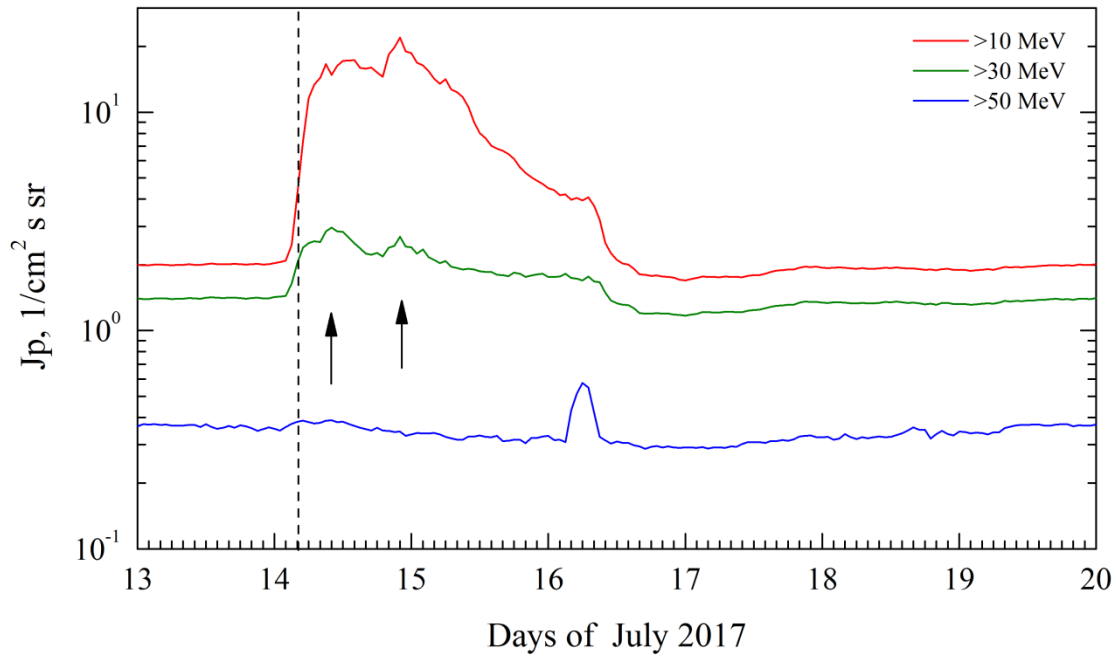
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	4	8/23	2.4/75	3	0.02	
LION	2 – 6	2	8/23	2.2/13.2	3	0.003	
EPHIN	4 – 8	0	8/23	4.6/20.6	3	0.0001	
EPHIN	8 – 25	0	8/23	0.59/2.25	3	0.00005	
EPHIN	25 – 53	0	8/23	0.035/0.047	3	0.00003	
Electro-2							
SCR-E	9–20	3	10/23	1.1/2	2.5	0.08	
SCR-E	20–40	3	10/23	0.1/0.12	2.5	0.03	
SCR-E	40–110	-	-	-	-	0.01	
POES							<E>, MeV
MEPED	16–36	04	8/22	0.063/0.075	2	0.044	25
MEPED	36–70	04	8/22	0.009/0.011	2	0.0063	50
MEPED	70–140	04	8/22	0.002/0.003	2	0.0011	100



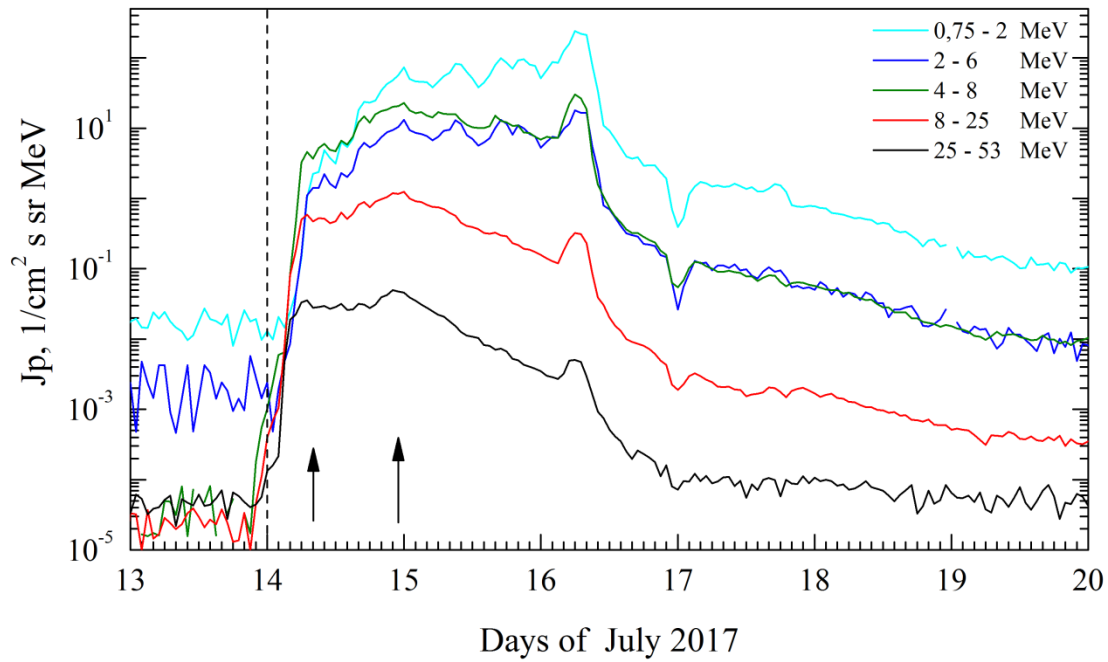
Time profiles of proton fluxes in the event 2017.07.14

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2017.07.14

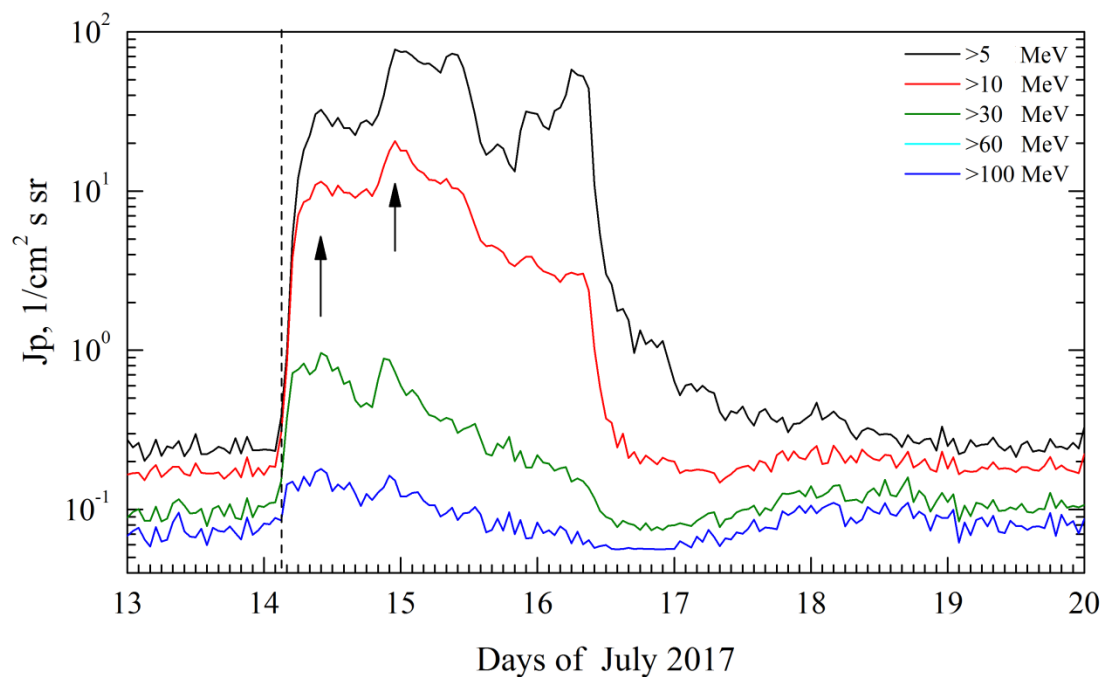


SOHO. Event 2017.07.14

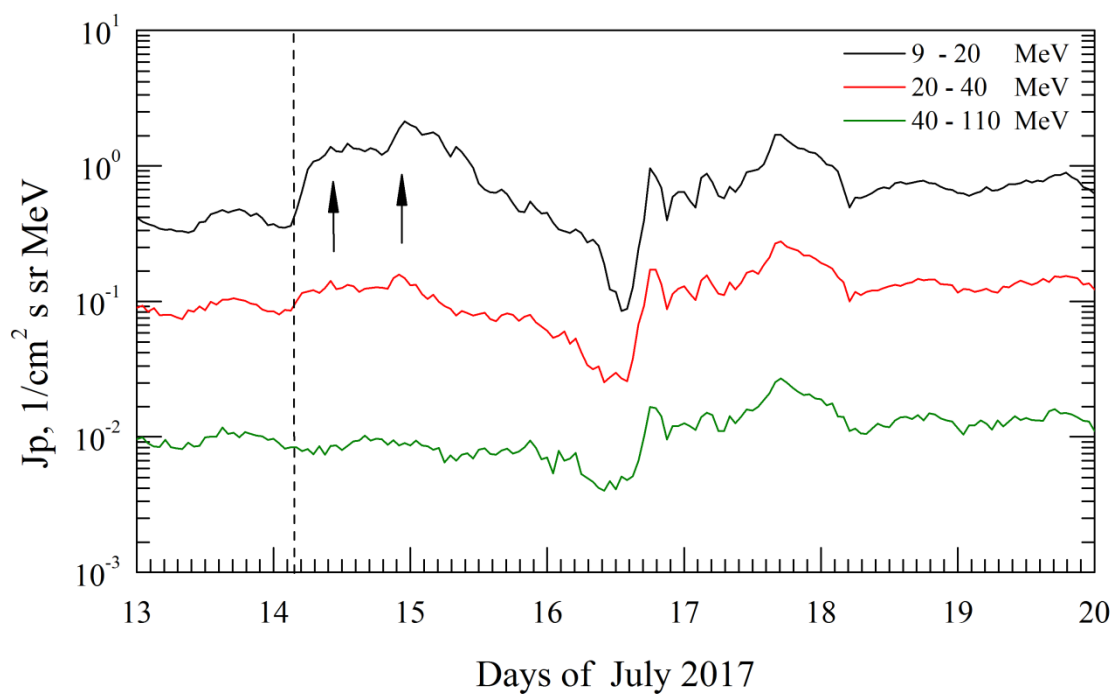


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

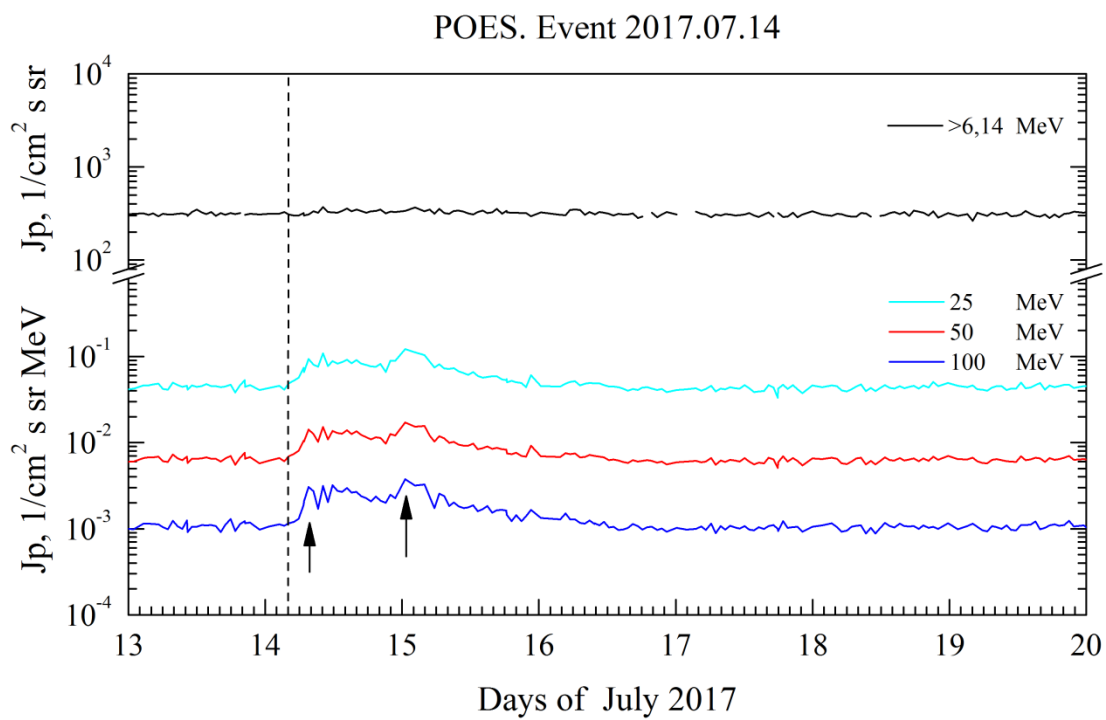
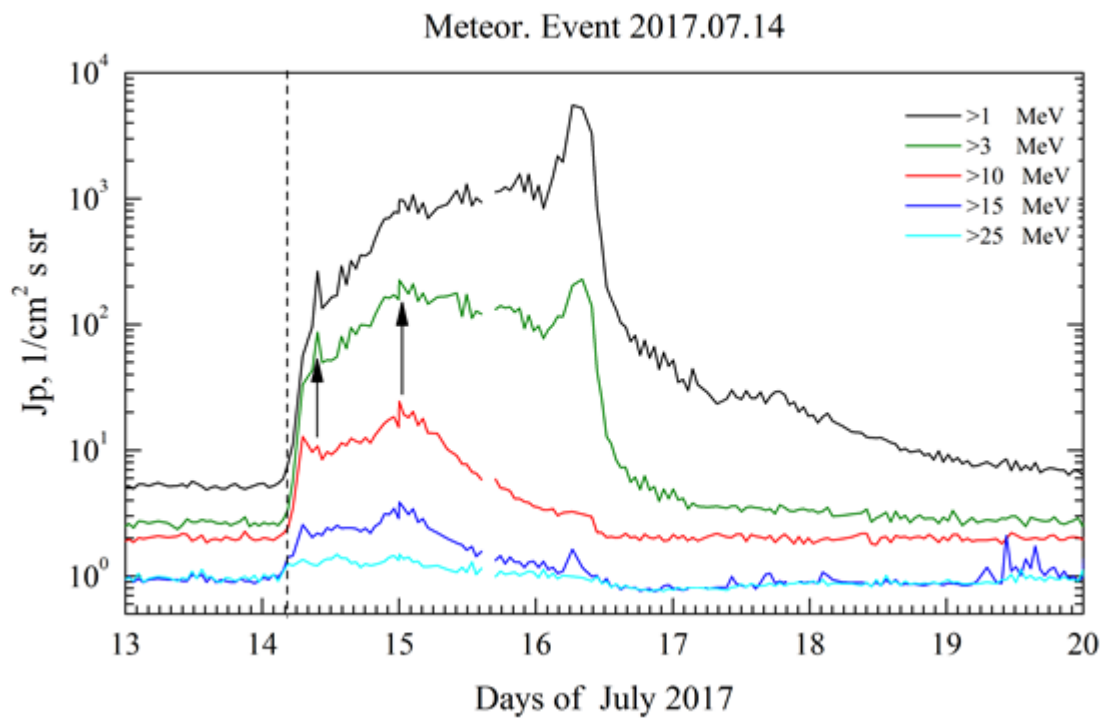
GOES. Event 2017.07.14



Electro. Event 2017.07.14



Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2017 July 14**

2017

July 14

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AR 12665

To event 585

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	LPS	0110	0215	0455	S06W29	1N	UMB
1 – 12	keV	0107	0209	0324	S09W33	M2.4	0.13
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	0121:36	0140:14	0224:36	848	5439907	HESSI
100-300	keV	0255:24	0300:10	0314:20	8827	26473368	HESSI
100-300	keV	0314:20	0314:34	0345:24	7889	32019516	HESSI
50-100	keV	0345:24	0345:38	0359:16	4078	9088848	HESSI
12-25	keV	0429:44	0438:42	0519:24	2032	504	HESSI
12-25	keV	0119:24	0140:40	0222:40	22695	19438122	FERMI
12-25	keV	0254:41	0315:06	0340:09	1074	342950	FERMI
12-25	keV	0430:20	0430:45	0432:11	1139	12646	FERMI
12-25	keV	0432:35	0433:08	0433:24	195	1474	FERMI
12-25	keV	0435:56	0441:32	0459:05	636	177874	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0123	0126	0138		2.15	
8.8	GHz	0114	0126	0131	U9	2.04	
5	GHz	0110	0126	0145		2.51	
2.7	GHz	0110	0151	0154		2.11	
1.4	GHz	0109	0128	0155		2.64	
610	MHz	0107	0113	0218		3.22	
410	MHz	0104	0114	0218		3.22	
245	MHz	0153	0214	0626	P0.2 \ 2.7	3.52	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	037-171	0353		0745		1	
DH II	0.7-14	0118		2130			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	0126	1200	- 0.1	360°	230°	SOHO

2017

July 14

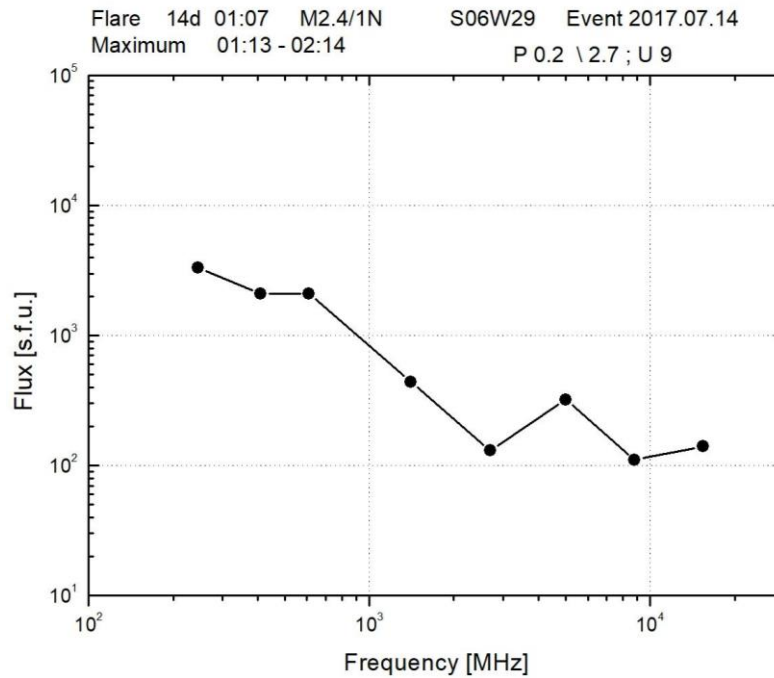
Ø

AR 12665

To event 585

H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	No optical flare on visible disk					
1 – 12	keV	1918	1944	1925	S07W44	C1.4	0.0017
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1919:08	1920:42	1921:08	136	24264	HESSI

Radio burst frequency spectrum



Proton Active Region:

AR 12665 (S06L111, CMP 11,8.07.2017,
Sp=710 msh, EKC, BG, R)
XRI=0.37 $M_2^{2.4} + C_{22}$ $2_3 + 1_4 + S_{83}$
PFR1 9.07 $M_1^{1.3}$
PFR2 14.07 $M_1^{2.4}$

References:

Ameri D., E. Valtonen, [2019](#).
Núñez M., T. Nieves-Chinchilla and A. Pulkkinen, [2019](#).

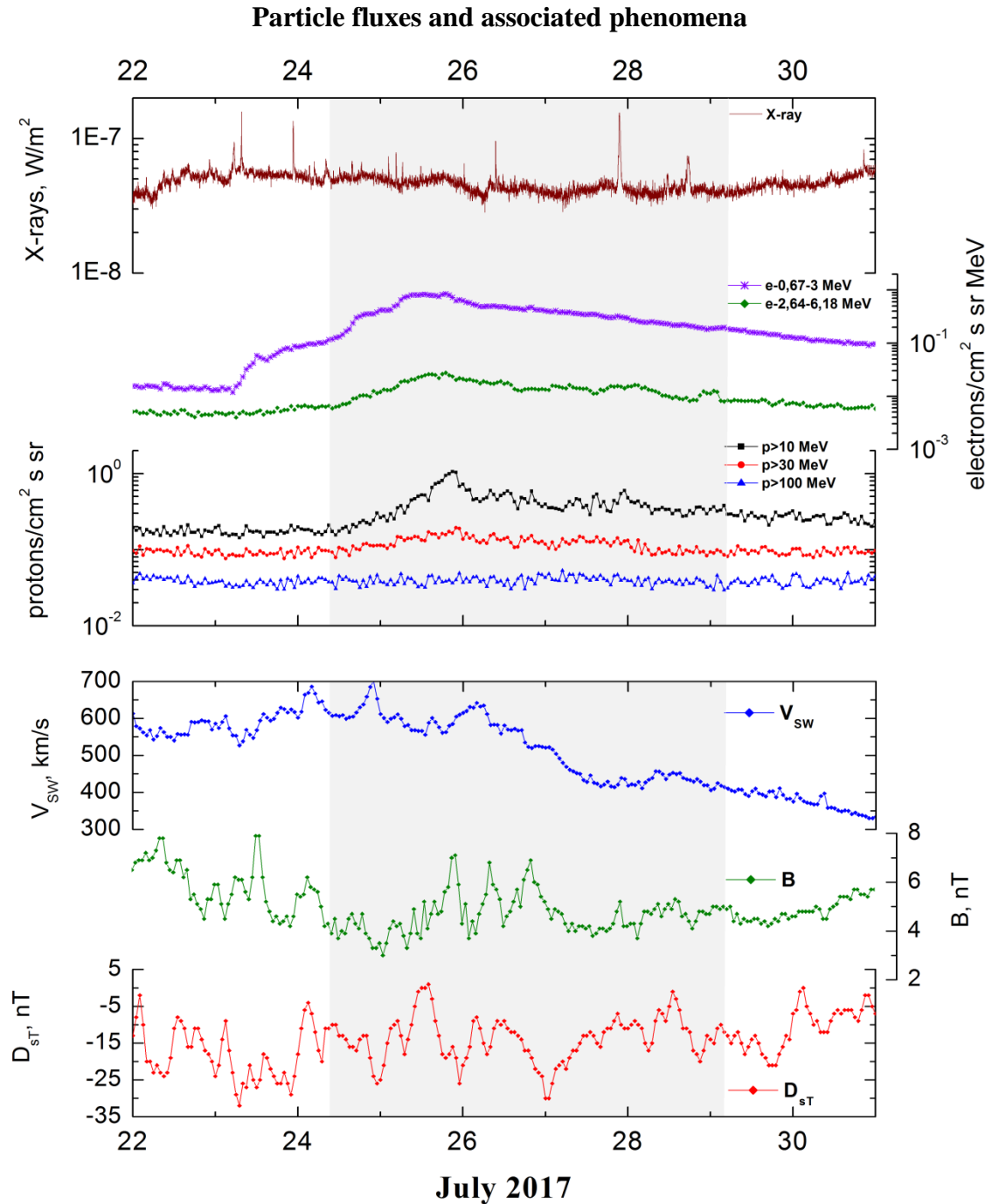
Particle event: To($E_p > 10$ MeV) – 25d03^h

Tmax ($E_p > 10$ MeV) – 25d20, Jmax ($E_p > 10$ MeV) – 1.0 /cm²·s·sr (ACE)

Duration of the event – 4 days, power-law index: $\gamma = 1.8$

Quasimaximal energy of protons in the event – $E_{qm} = 9$ MeV

Sources: unknown

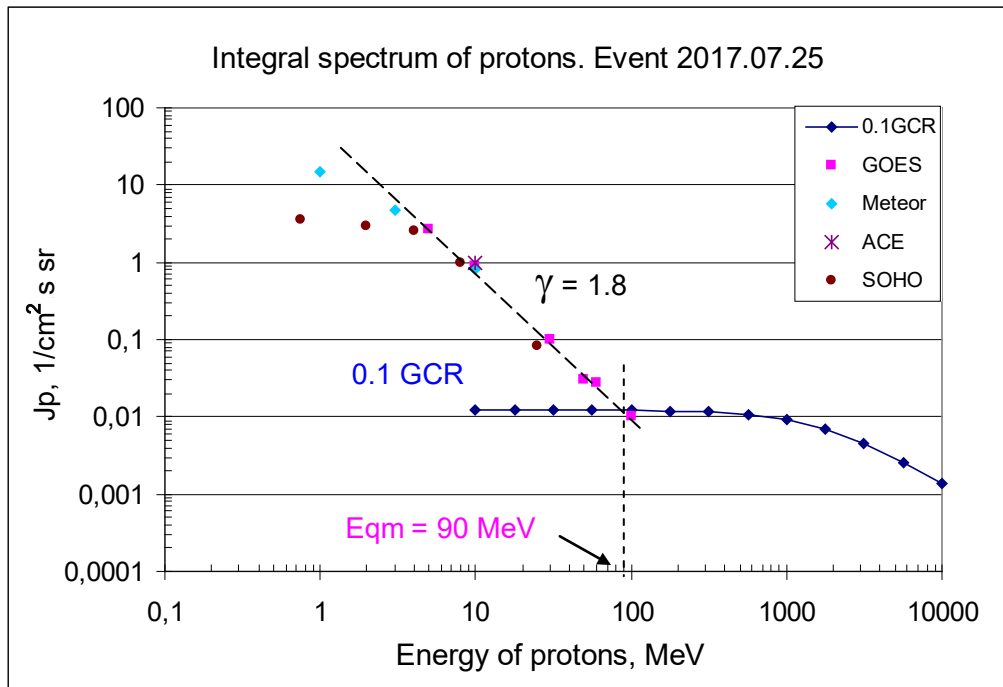


Integral fluxes of protons for the event of 2017 July 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	3	21	2.7	5	0.25	
EPS	>10	3	21	0.9	4	0.17	
EPS	>30	3	22	0.1	3	0.1	
EPS	>50	3	23	0.03	–	0.07	
EPS	>60	3	23	0.027	–	0.06	
EPS	>100	3	23	0.01	–	0.04	
EPS	>350	-	-	-	-	-	
Electro-2							
GALS-E	>600	-	-	-	-	0.11	
POES							
MEPED	>6.14	-	-	-	-	310	
Meteor-2							
SCR	>1	5	21	15.1	9	5	
SCR	>3	5	21	4.7	7	3	
SCR	>10	5	23	/0.8	2	2	
GALS-M	>15	6	-	-	1.5	0.9	
GALS-M	>25	6	-	-	0.5	0.9	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	3	20	1	4	1.9	
SIS	>30	-	-	-	-	1.3	
SOHO							
EPHIN	>50	-	-	-	-	0.35	

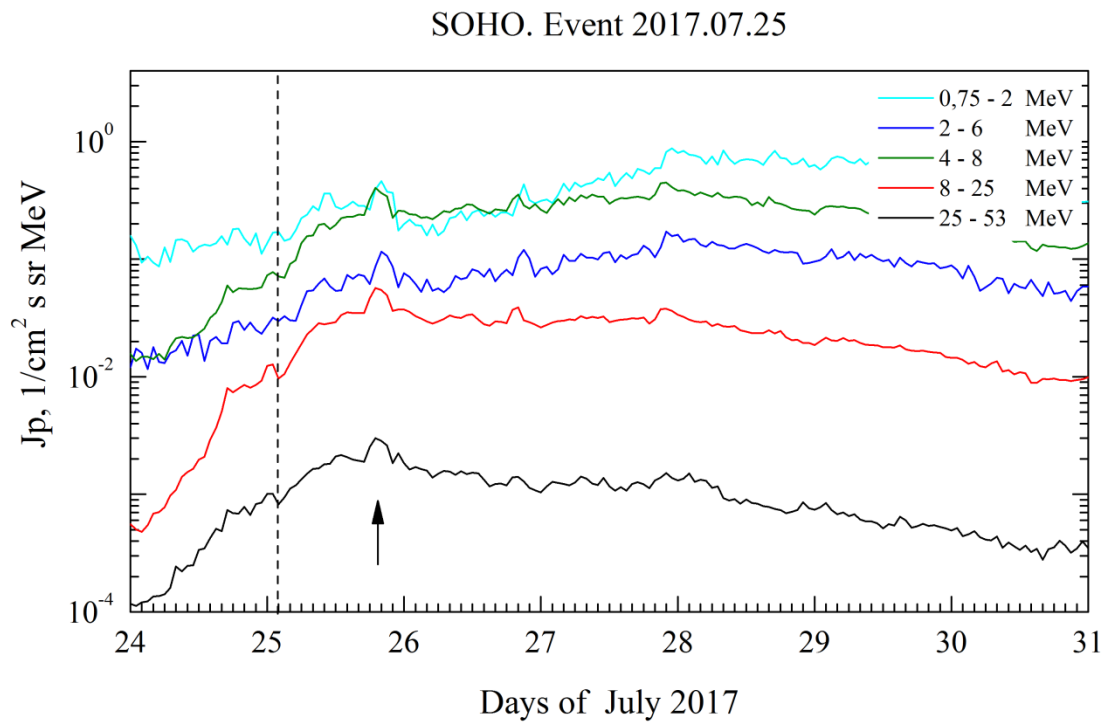
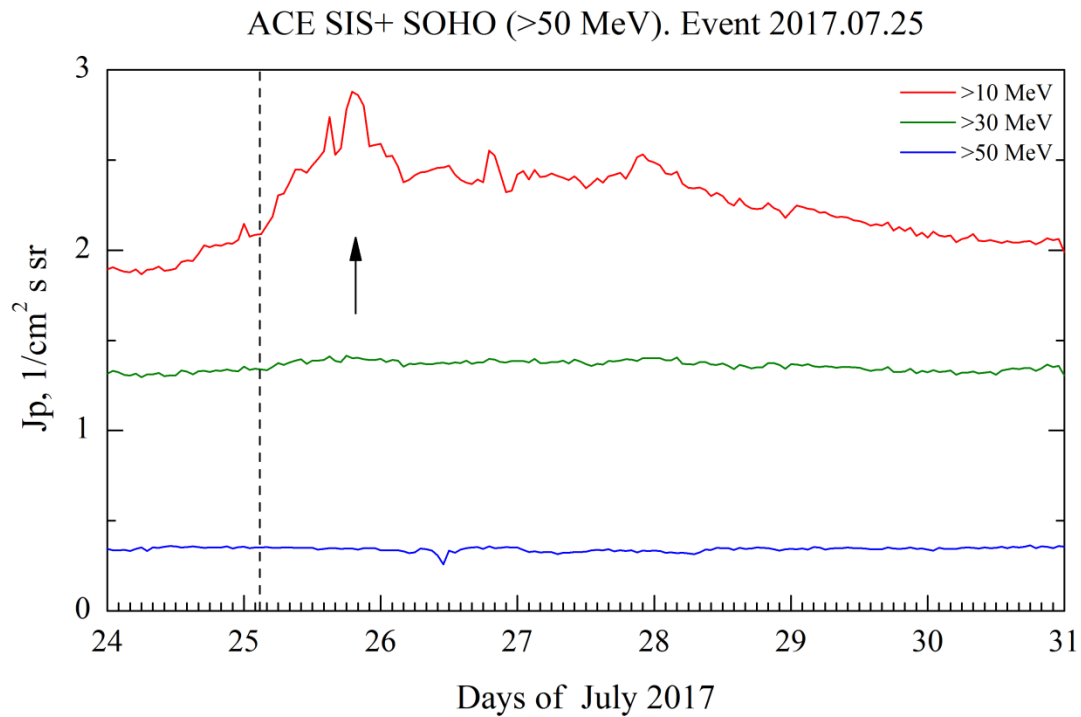
Differential fluxes of protons for the event of 2017 July 25

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	2	20	0.46	4	0.02	
LION	2 – 6	2	20	0.12	4	0.003	
EPHIN	4 – 8	2	20	0.4	5	0.0001	
EPHIN	8 – 25	2	20	0.055	5	0.0005	
EPHIN	25 – 53	2	20	0.003	5	0.0001	
Electro-2							
SCR-E	9 – 20	-	-	-	-	0.07	
SCR-E	20 – 40	-	-	-	-	0.03	
SCR-E	40 – 110	-	-	-	-	0.01	
POES							<E>, MeV
MEPED	16–36	-	-	-	-	0.044	25
MEPED	36–70	-	-	-	-	0.0063	50
MEPED	70–140	-	-	-	-	0.0011	100



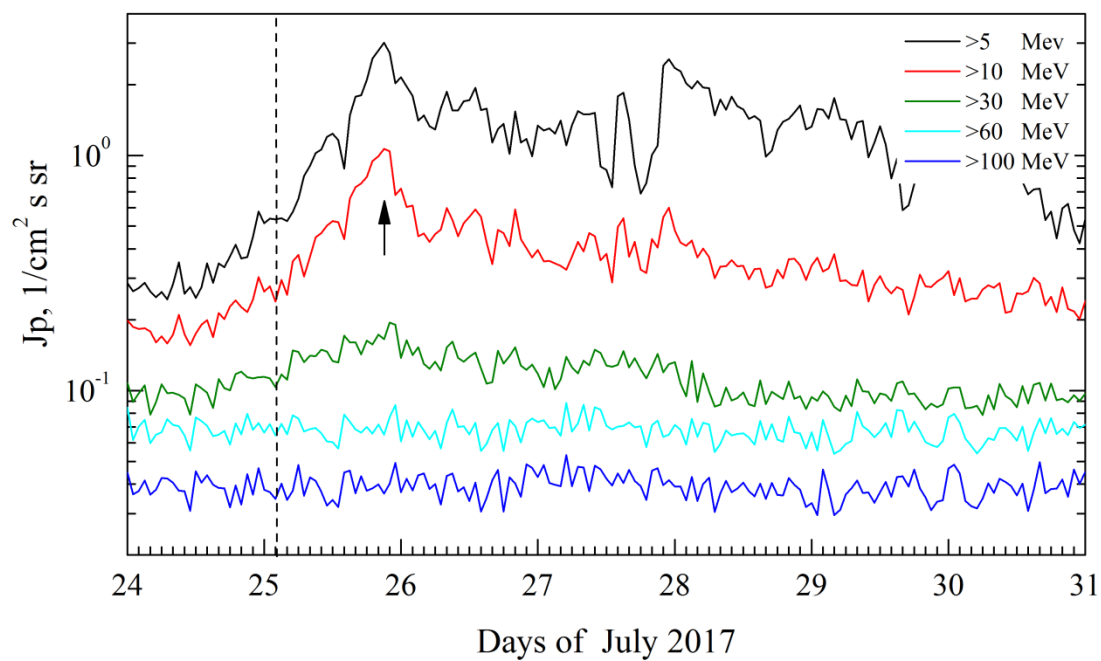
Time profiles of proton fluxes in the event 2016.07.25

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

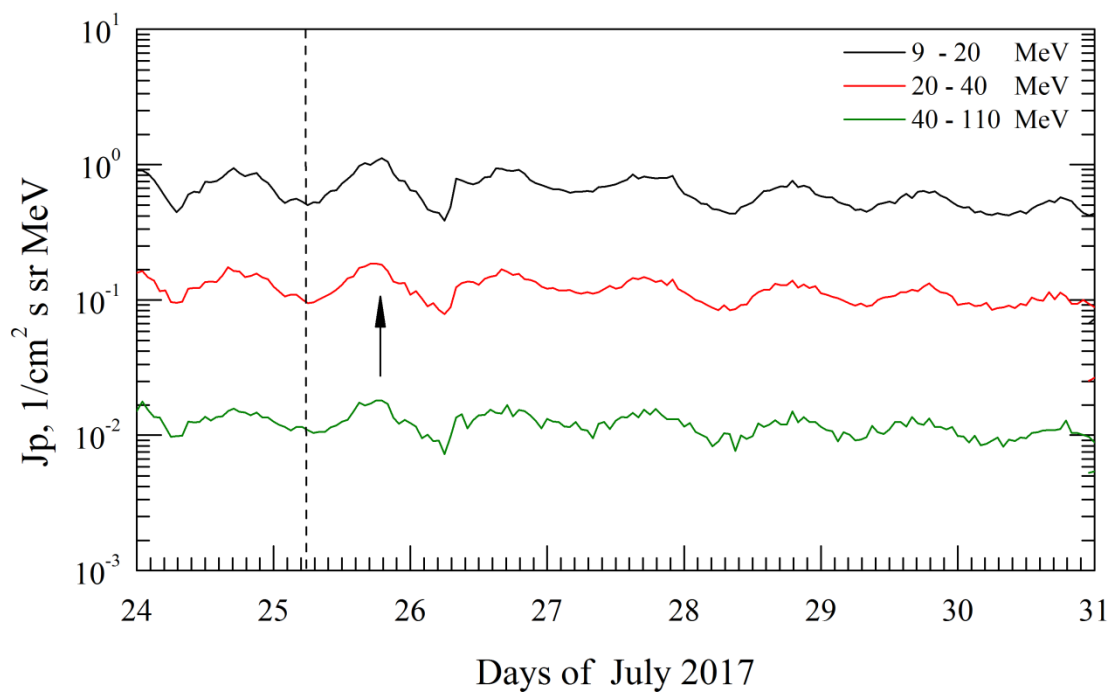


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2017.07.25

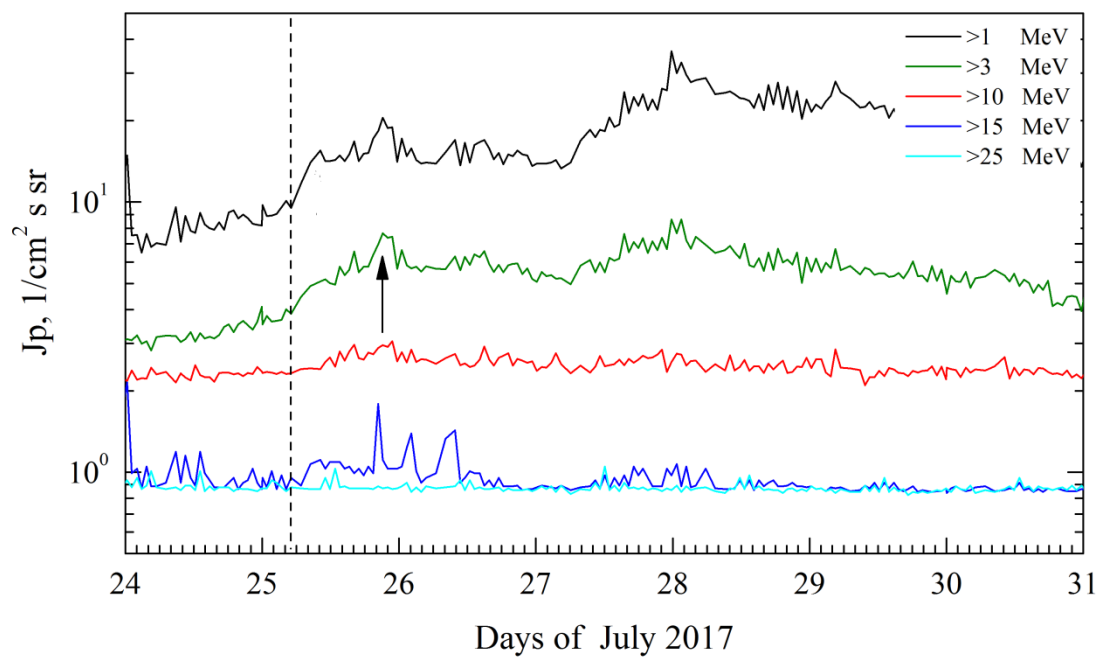


Electro. Event 2017.07.25

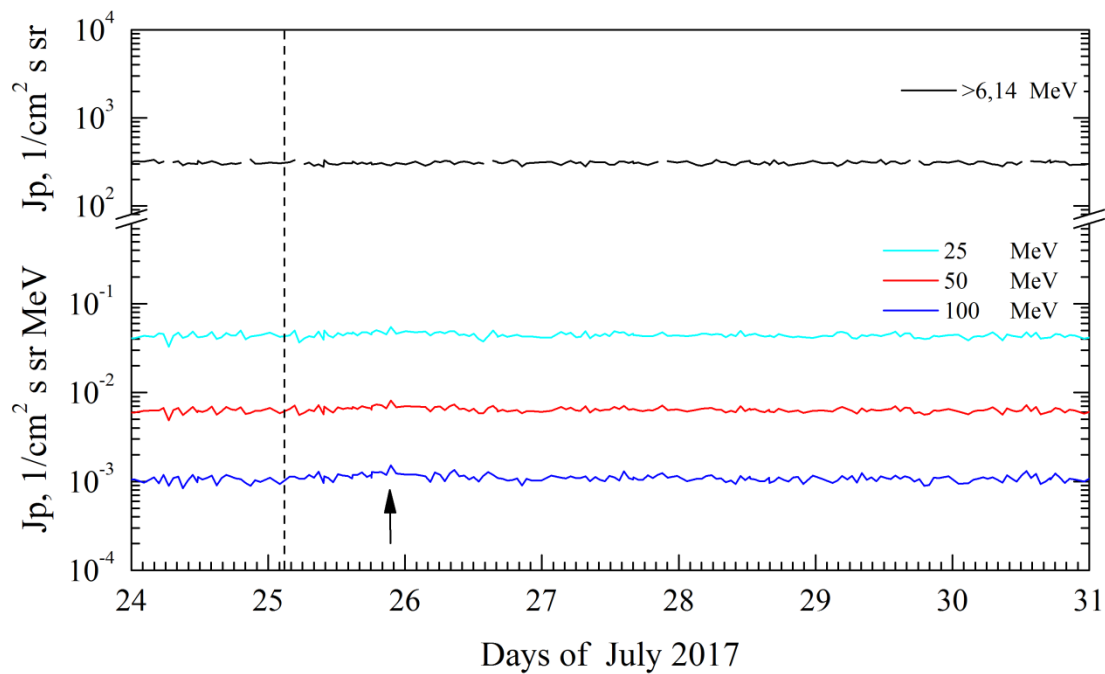


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2017.07.25



POES. Event 2017.07.25



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2017 July 25**

2017	July 25	Sources unknown	AR XXXXX	To event 586
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References:

<http://newserver.stil.bas.bg/SEPcatalog/index.html>

Particle event: To($E_p > 10$ MeV) – 04d21^h

Tmax₁($E_p > 10$ MeV) – 05d07^h, Jmax₁($E_p > 10$ MeV) – 99 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 05d19^h, Jmax₂($E_p > 10$ MeV) – 167 /cm²·s·sr

Duration of the event – 1.5 days, power-law index: $\gamma_1 = 3.5$, $\gamma_2 = 4.1$

Quasimaximal energy of protons in the event – Eqm₁ = 100 MeV

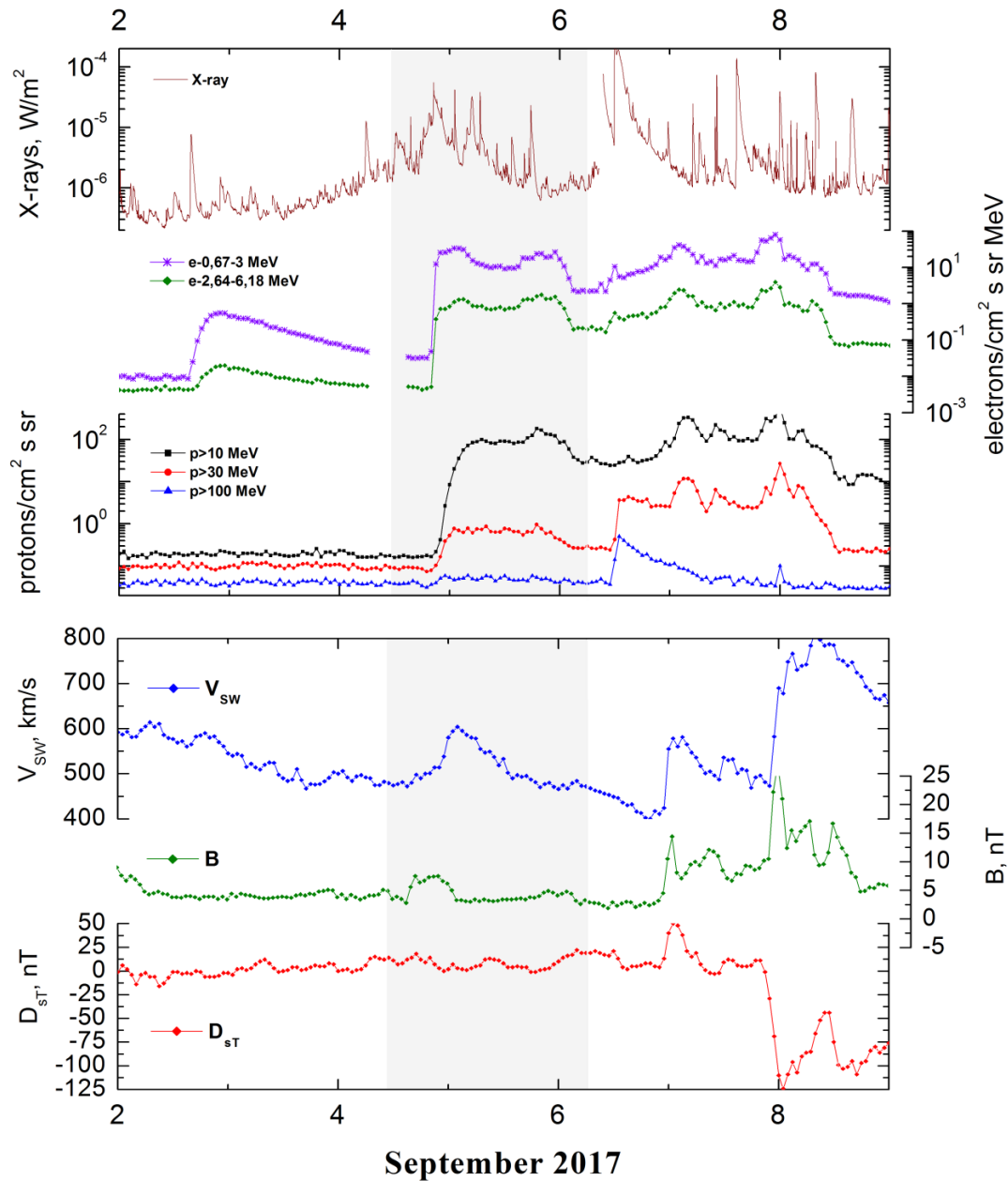
– Eqm₂ = 90 MeV

Sources: ● solar flare 04d13^h45^m, 3B/M1.5; M1.0; M1.7; M1.5; M5.5; M2.1/, S11W16, AR12673

Main burst X-ray 1–8 Å: onset – 04d20^h28^m, max – 04d20^h33^m, $\Phi = 0.018$ J/m²

CME: 04d20^h12^m, V = 1418 km/s, $\Delta\phi = 360^\circ$, dA = 184°

Particle fluxes and associated phenomena

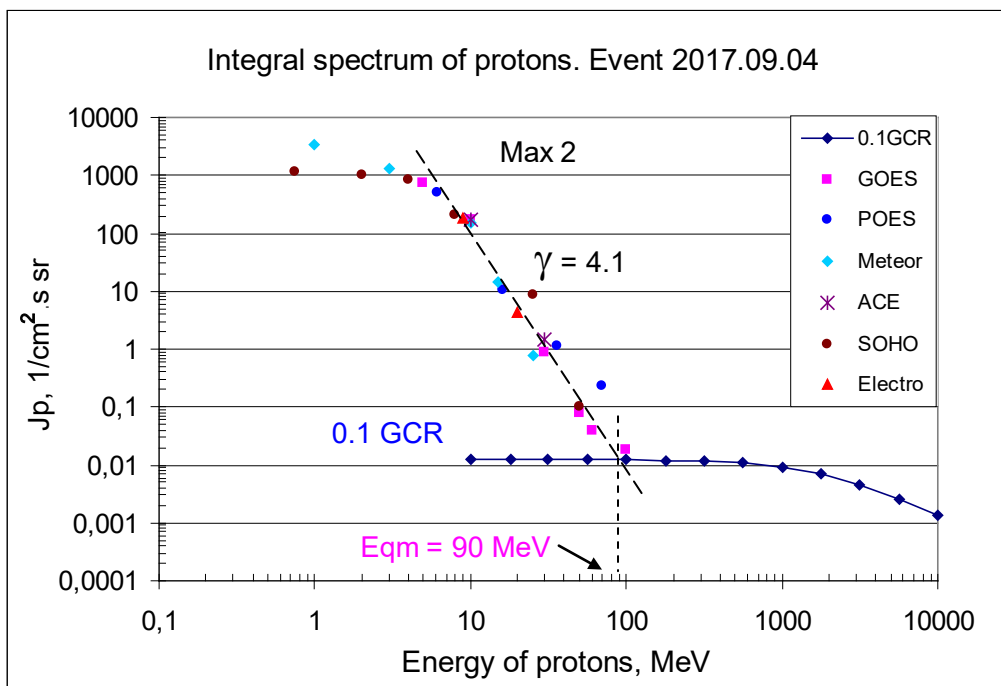
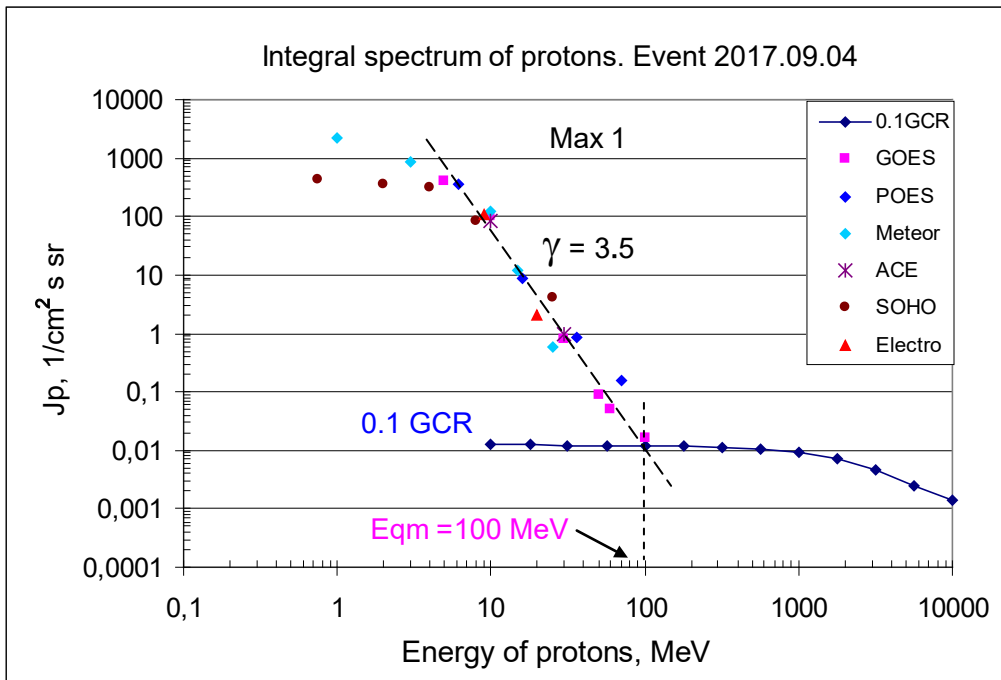


Integral fluxes of protons for the event of 2017 September 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	21	5d07/5d20	397/725	1.5	0.25	
EPS	>10	21	5d07/5d19	99/167	1.5	0.2	
EPS	>30	21	5d08/5d19	0.8/0.9	1.5	0.1	
EPS	>50	21	5d08/5d19	0.09/0.08	1	0.08	
EPS	>60	21	5d08/5d19	0.05/0.04	1	0.06	
EPS	>100	21	5d08/5d19	0.016/0.018	1	0.04	
Electro-2							
GALS-E	>600	-	-	-	-	0.11	
POES							
MEPED	>6.14	-	05d08/05d22	354/515	1.5	300	
Meteor-2							
SCR	>1	20	05d8/05d21	2215/3500	1.5	5.0	
SCR	>3	22	05d8/05d21	860/1330	1.5	2.7	
SCR	>10	22	05d6/05d20	125/ 150	1.5	2.0	
GALS-M	>15	20	05d3/05d20	12/14	1.5	0.9	
GALS-M	>25	22	05d1/05d20	0.6/0.76	1.5	0.9	
GALS-M	>600	-	-	-	1.5	0.3	
ACE							
SIS	>10	22	5d08/5d20	86.6/173	1.5	1.9	
SIS	>30	22	5d07/5d20	1/1.5	1.5	1.3	
SOHO							
EPHIN (INT)	>50	-	- /5d21	- /0.1	1.5	0.35	

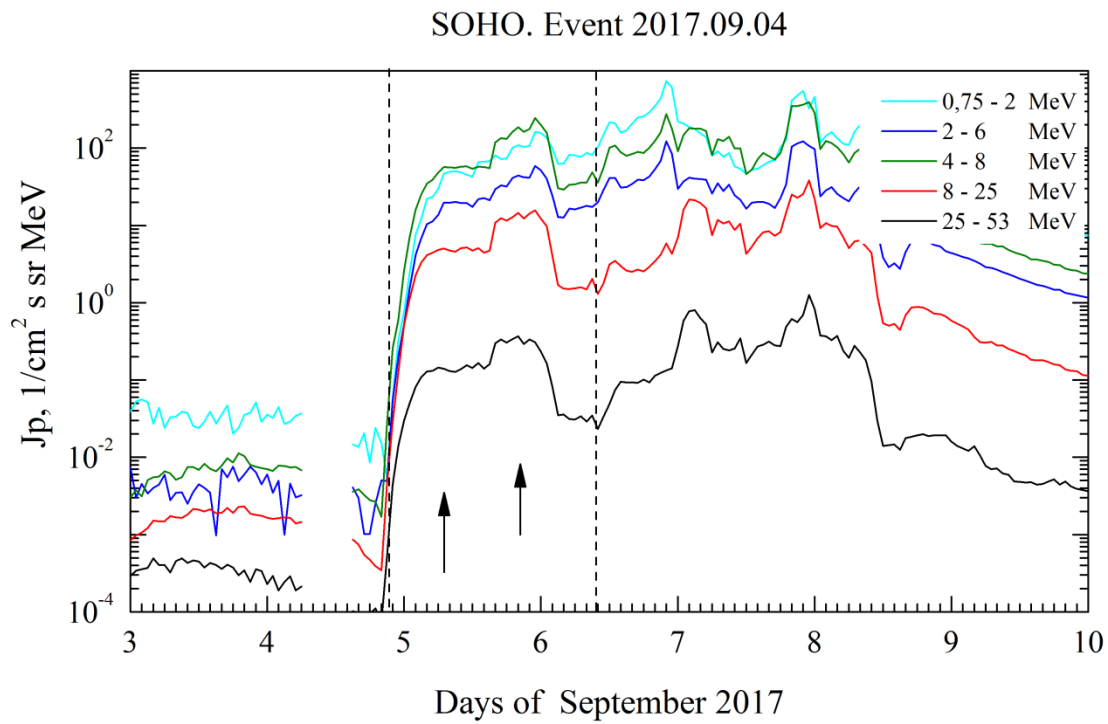
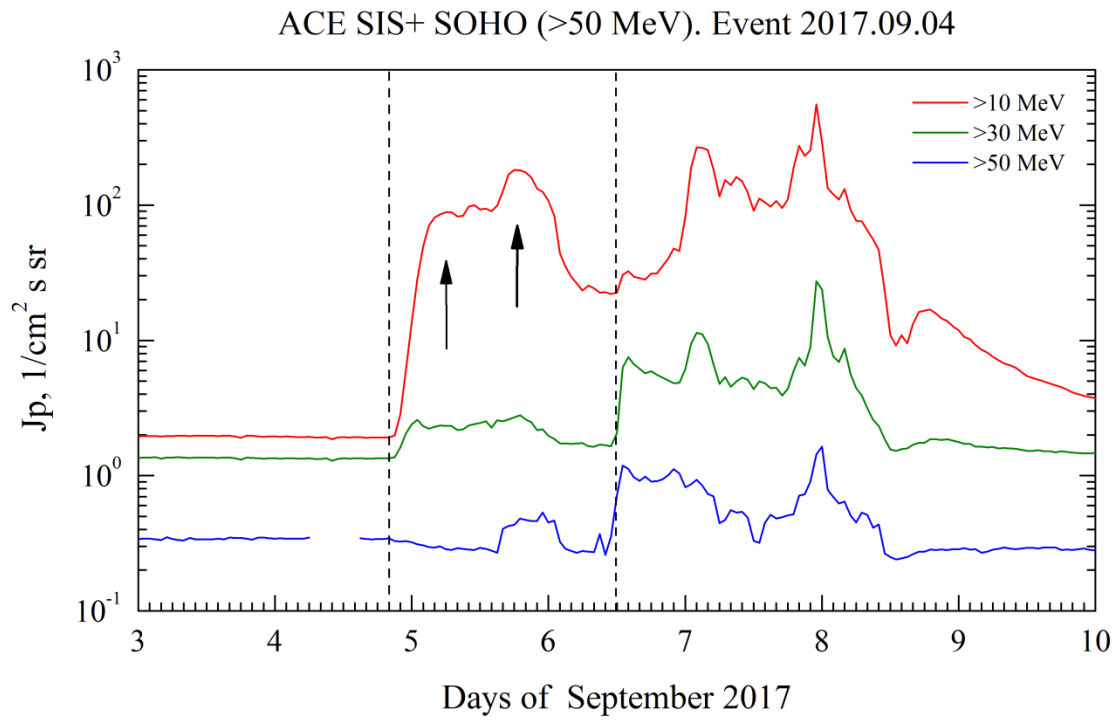
Differential fluxes of protons for the event of 2017 September 04

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75-2	20	5d07/5d20	50/110	1.5	0.03	
LION	2 – 6	20	5d07/5d20	19/44	1.5	0.003	
EPHIN	4 – 8	20	5d07/5d20	56/162	1.5	0.0002	
EPHIN	8 – 25	20	5d07/5d20	4.6/12	1.5	0.00005	
EPHIN	25 – 53	20	5d07/5d20	0.15/0.3	1.5	0.00002	
Electro-2							
SCR-1	9–20	21	5d06/5d19	9.6/16.7	1.5	0.3	
SCR-1	20–40	21	5d07/5d19	0.1/0.21	1.5	0.08	
SCR-1	40–110	-	-	-	-	-	
POES							<E>, MeV
MEPED	16–36	22	05d08/05d22	0.36/0.475	1.5	0.043	25
MEPED	36–70	22	05d08/05d22	0.021/0.026	1.5	0.0059	50
MEPED	70–140	22	05d08/05d22	0.0022/0.0033	1.5	0.0011	100



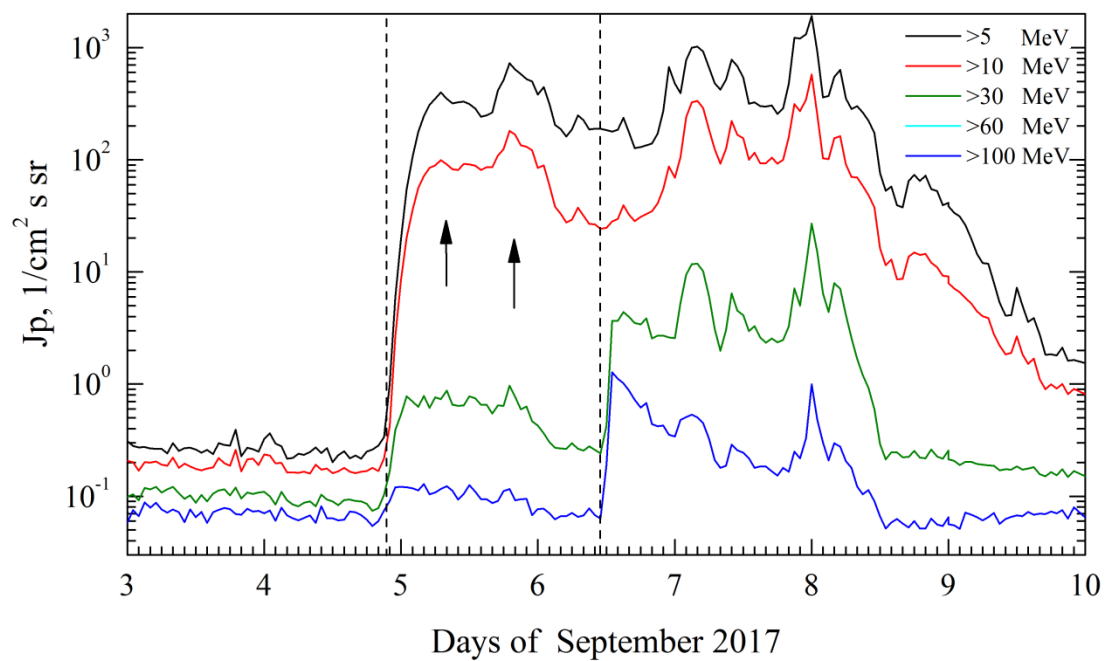
Time profiles of proton fluxes in the event 2017.09.04

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

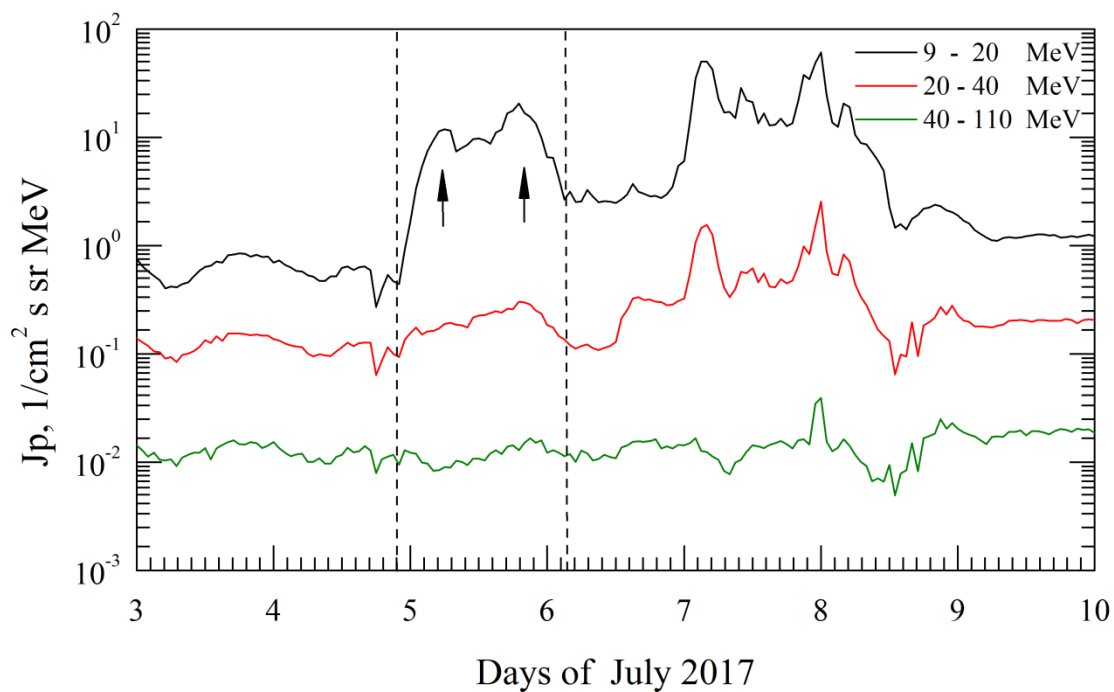


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2017.09.04

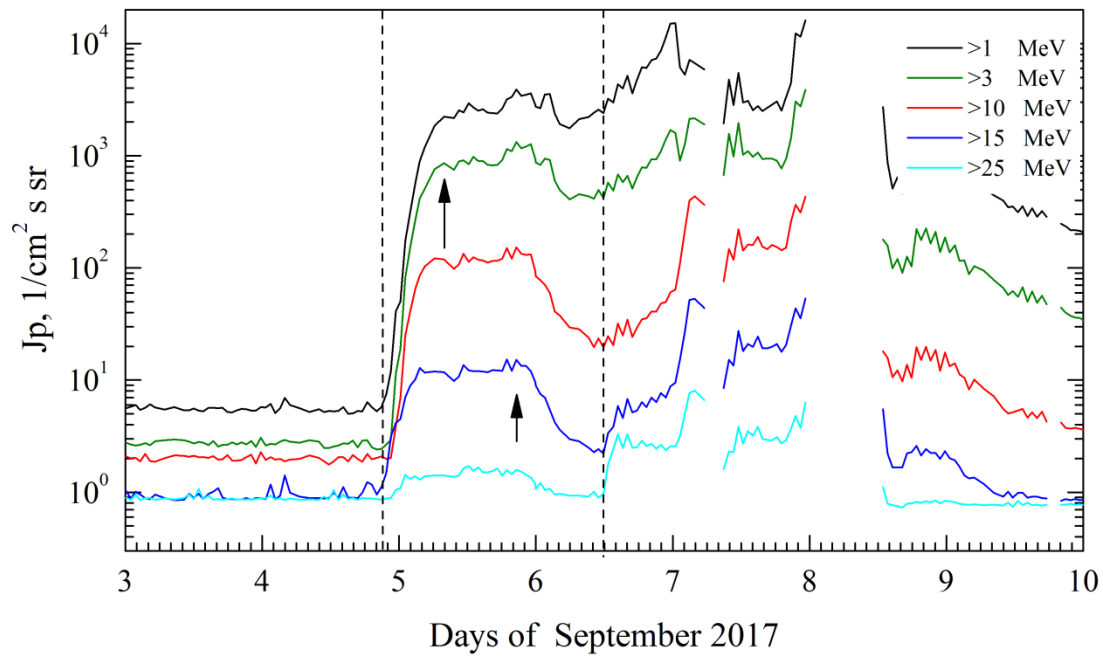


Electro. Event 2017.09.04

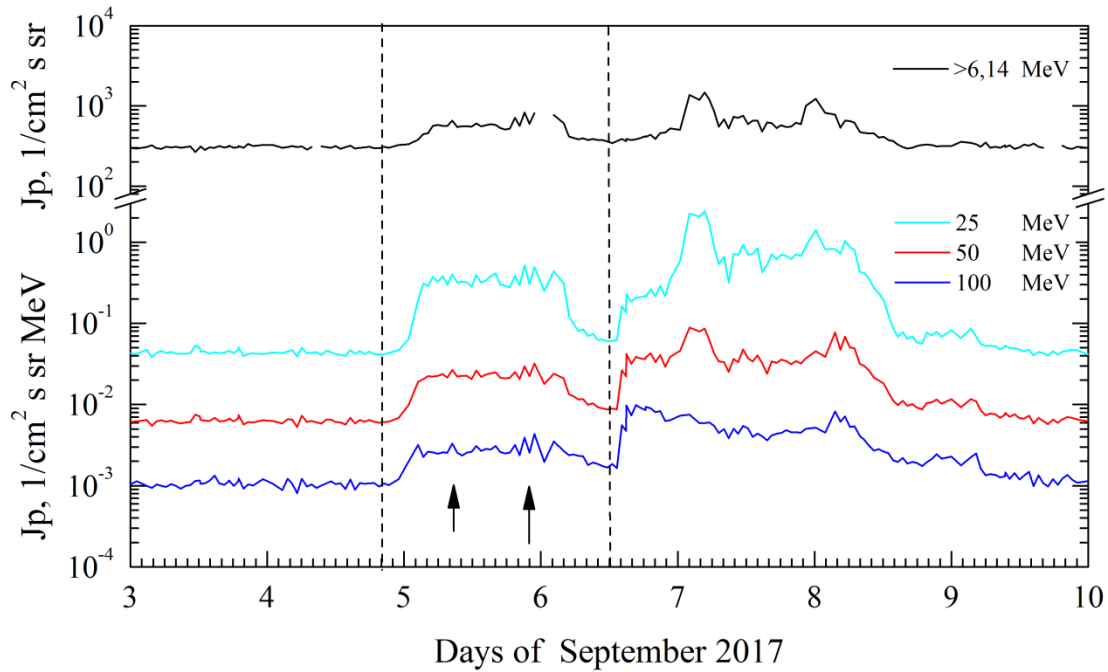


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2017.09.04



POES. Event 2017.09.04



**Electromagnetic and other phenomena that are sources and/or accompanying for the event
of 2017 September 04**

2017 September 04

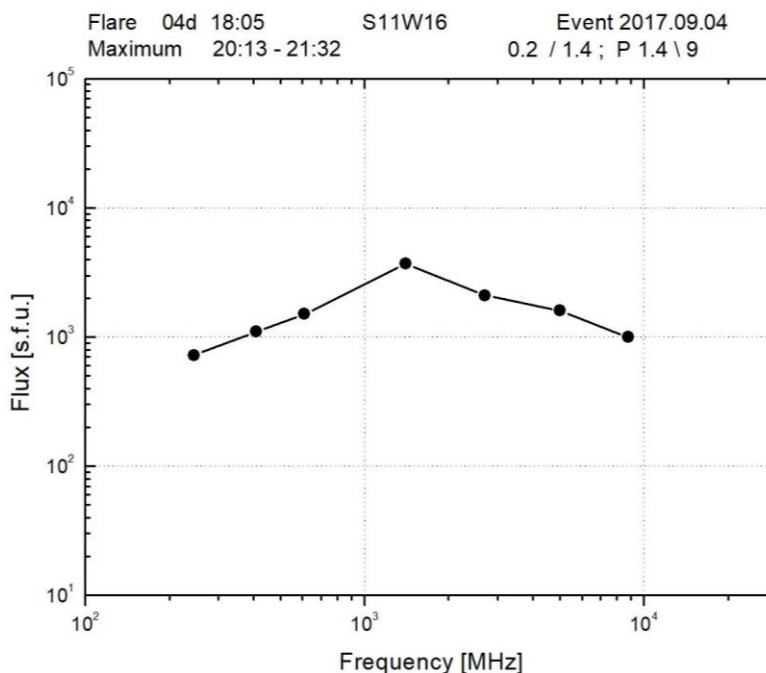
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AR 12673

To event 587

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1343	2033	>2359	S11W16	3B	ERU
1 – 12	keV	1511	1530	1533	S10W08	M1.5	0.0064
1 – 12	keV	1805	1822	1831	S07W11	M1.0	0.011
1 – 12	keV	1846	1937	1952	S09W11	M1.7	0.045
1 – 12	keV	1959	2002	2006	S10W11	M1.5	0.0042
1 – 12	keV	2028	2033	2037	S10W11	M5.5	0.018
1 – 12	keV	2210	2214	2219	S09W12	M2.1	0.0084
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	1526:00	1530:02	1546:12	160	91391	HESSI
50-100	keV	1713:44	1728:18	1733:32	1136	2108352	HESSI
12-25	keV	1844:12	1852:58	1902:40	1840	5259840	HESSI
25-50	keV	1902:40	1912:50	1913:28	1904	3298944	HESSI
6-12	keV	2009:20	2032:14	2052:40	848	1314863	HESSI
12-25	keV	1412:19	1413:08	1415:44	24851	248743	FERMI
12-25	keV	1515:57	1515:57	1517:35	654	10262	FERMI
12-25	keV	1525:26	1529:54	1533:23	96559	10276245	FERMI
12-25	keV	1613:39	1614:16	1614:49	5695	25751	FERMI
12-25	keV	1657:20	1657:29	1658:01	1362	7753	FERMI
12-25	keV	1723:51	1738:31	1748:54	6244	581960	FERMI
12-25	keV	1826:23	1858:56	1925:17	3279	1378001	FERMI
12-25	keV	2001:37	2032:20	2100:41	509993	109992256	FERMI
12-25	keV	2136:52	2214:33	2231:37	43135	3154991	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
8.8	GHz	2011	2048	2142		3.0	
5	GHz	2013	2050	2122		3.2	
2.7	GHz	2011	2050	2119		3.32	
1.4	GHz	2026	2044	2120	P1.4 \ 9	3.57	
610	MHz	2008	2013	2136		3.18	
410	MHz	2011	2132	2135		3.04	
245	MHz	2009	2009	2009	0.2 / 1.4	2.86	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-056	2042		2050	1472	1	
DS IV	025-108	1908		2126		1	
DS III	025-180	1719		1720		2	
DS V	025-180	0017		0019		2	
DS VI	025-048	1649		2221		1	
DH II	0.21-14	2027		5d/0454			WIND
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1900	597	52.9	205°	240°	SOHO
LASCO	WL	2012	1418	47.5	360°	184°	SOHO

Radio burst frequency spectrum



Proton Active Region:

AR12673 (S08L117, CMP 04.09.2017,
Sp=1060 msh, EKC, BGD, R3),
XRI=18.97, $X_5^{9.3}+M_{26}^{8.1}+C_{54}$, $3_2+2_4+1_{13}+S_{84}$
PFR1 4–5.09 (12^h): $M_8^{5.5}$;
PFR2 6–8.09 (12^h): $X_3^{9.3}+M_{15}^{8.1}$;
PFR3 9–10.09 (17^h): $X_1^{8.2}+M_1$

References:

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Pandya, M., V. Bhaskara, [2021](#).
Struminsky A.B., I.Yu. Grigorieva, Yu. I.Logachev, A.M. Sadovskii, [2020](#).
Temmer M., [2021](#).
Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
Zhuang B., N. Lugaz, T. Gou, L. Ding, [2021](#).

Particle event: To($E_p > 10$ MeV) – 06d11^h

Tmax₁($E_p > 10$ MeV) – 06d15^h, Jmax₁($E_p > 10$ MeV) – 39 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 07d04^h, Jmax₂($E_p > 10$ MeV) – 334 /cm²·s·sr

Duration of the event – 1 day, power-law index: $\gamma_1 = 2.1$, $\gamma_2 = 3.8$,

Quasimaximal energy of protons in the event – Eqm₁ = 450 MeV

– Eqm₂ = 140 MeV

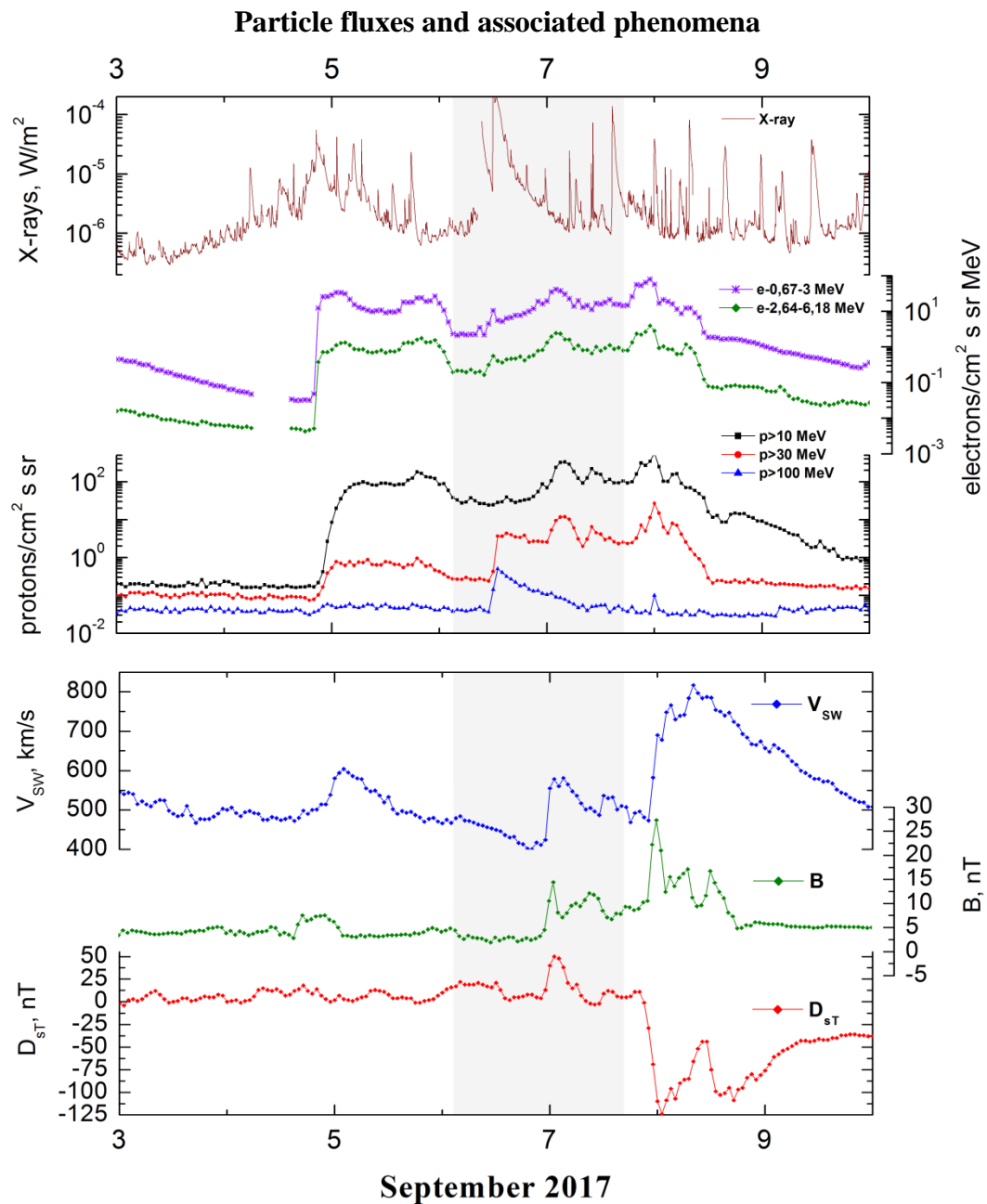
Sources: ● solar flare 06d08^h52^m, 2B/X2.2, X9.3, S07W33, AR12673

○ solar flare 06d13^h54^m, 3N/M2.5, S08W38, AR12673

Main burst X-ray 1–8 Å: onset – 06d11^h53^m, max – 06d12^h02^m, $\Phi = 0.57$ J/m²

CME 06d 12^h24^m, V = 1571 km/s, $\Delta\phi = 360^\circ$, dA = 201°

▲ SC 06d 23^h44^m

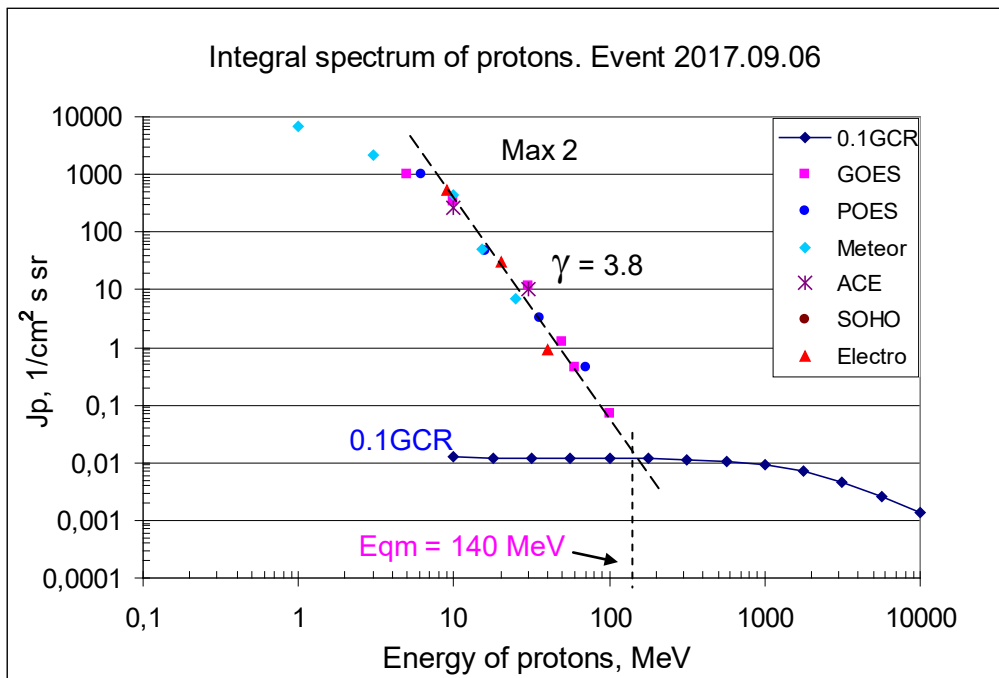
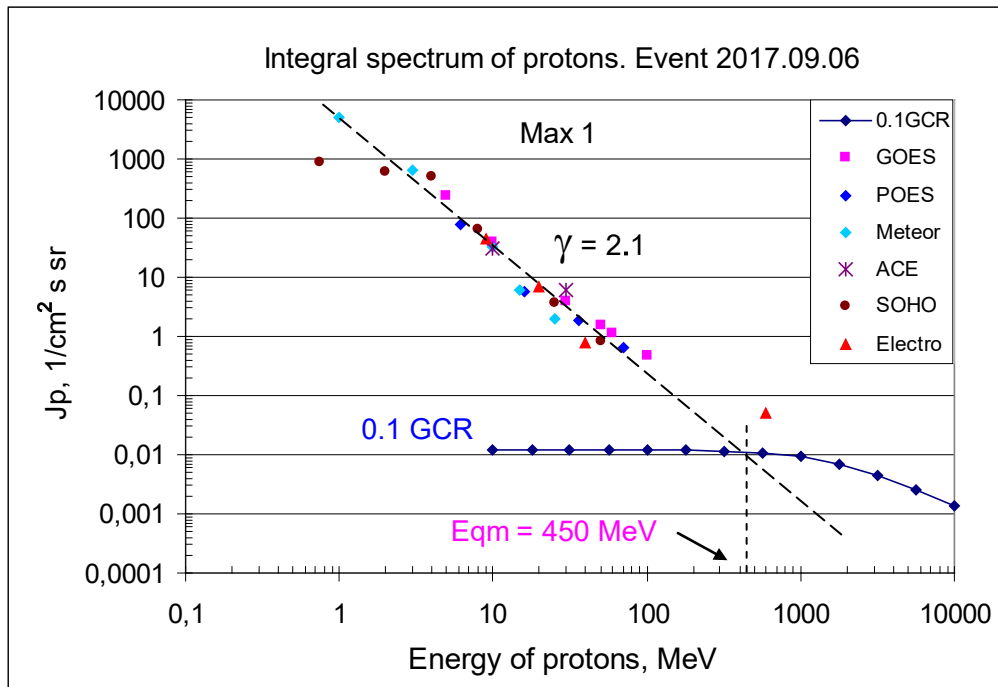


Integral fluxes of protons for the event of 2017 September 06

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	11	15/07d04	237/1020	1	0.25	
EPS	>10	11	15/07d04	39/334	1	0.18	
EPS	>30	11	15/07d04	3.9/11.7	1	0.1	
EPS	>50	11	14/07d04	1.55/1.23	1	0.08	
EPS	>60	11	14/07d04	1.1/0.45	1	0.06	
EPS	>100	11	13/07d04	0.46/0.07	1	0.04	
EPS	>350	-	-	-	-	-	
Electro-2							
GALS-E	>600	12	13/ -	0.05/ -	0.25	0.11	
POES							
MEPED	>6.14	13	15/07d03	80/1040	2	310	
Meteor-2							
SCR	>1	12	16/07d03	5080/6860	4	5.0	
SCR	>3	12	16/07d03	648/2200	4	2.7	
SCR	>10	12	16/07d03	32/440	4	2.0	
GALS-M	>15	12	16/07d03	6/50	3	0.9	
GALS-M	>25	12	16/07d03	2/7	3	0.9	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	12	14/7d06	30.6/265	1.25	1.9	
SIS	>30	12	14/7d06	6.2/10.1	1.25	1.3	
SOHO							
EPHIN (INT)	>50	11	13/7d03	0.8/0.6	1.5	0.3	

Differential fluxes of protons for the event of 2017 September 06

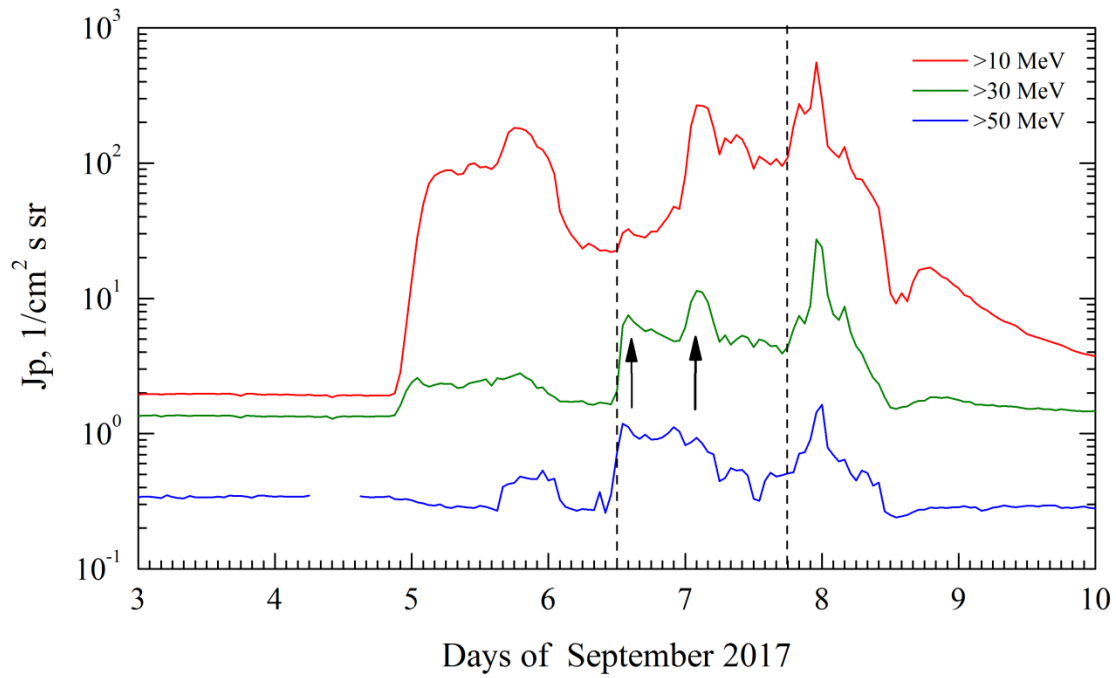
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	11	13/7d03	210/180	1.5	0.03	
LION	2 – 6	11	13/7d03	41/40	1.5	0.003	
EPHIN	4 – 8	11	13/7d03	110/180	1.5	0.0002	
EPHIN	8 – 25	11	13/7d03	3.5/21.3	1.5	0.00005	
EPHIN	25 – 53	11	13/7d03	0.1/0.3	1.5	0.00002	
Electro-2							
SCR-1	9–20	12	15/07d04	3.4/46.5	1	0.04	
SCR-1	20–40	12	15/07d04	0.3/1.5	1	0.02	
SCR-1	40–110	12	15/07d04	0.011/0.013	1	0.004	
POES							<E>, MeV
MEPED	16–36	13	15/7d03	0.187/2.2	2.6	0.043	25
MEPED	36–70	13	15/7d03	0.036/0.083	2.7	0.006	50
MEPED	70–140	13	15/7d03	0.009/0.0064	2.8	0.001	100



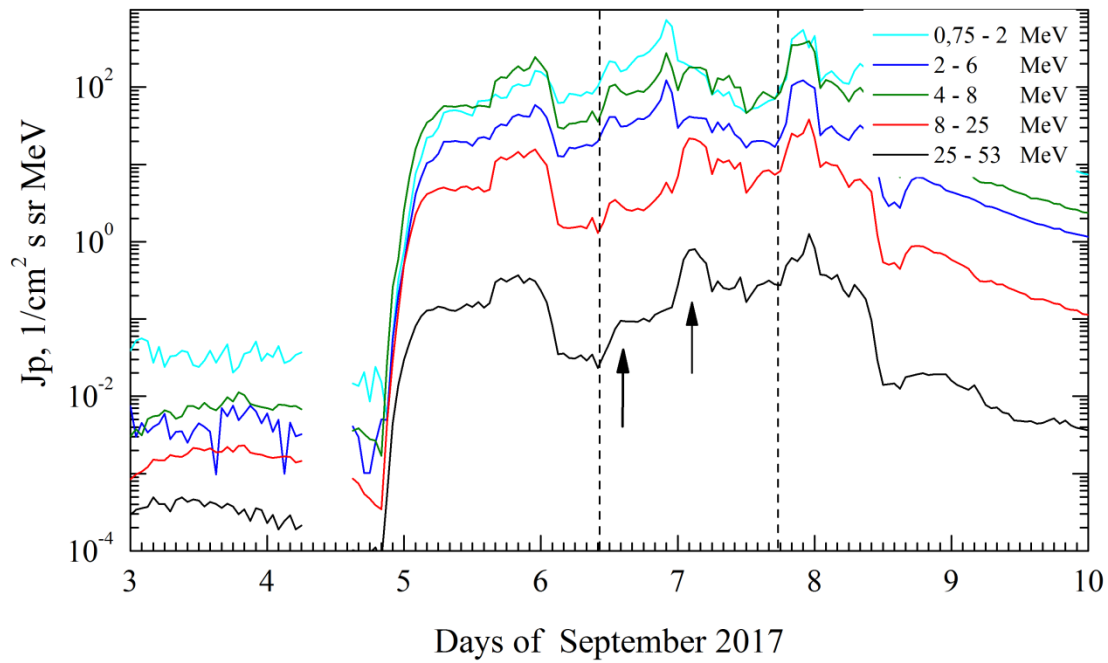
Time profiles of proton fluxes in the event 2017.09.06

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2017.09.06

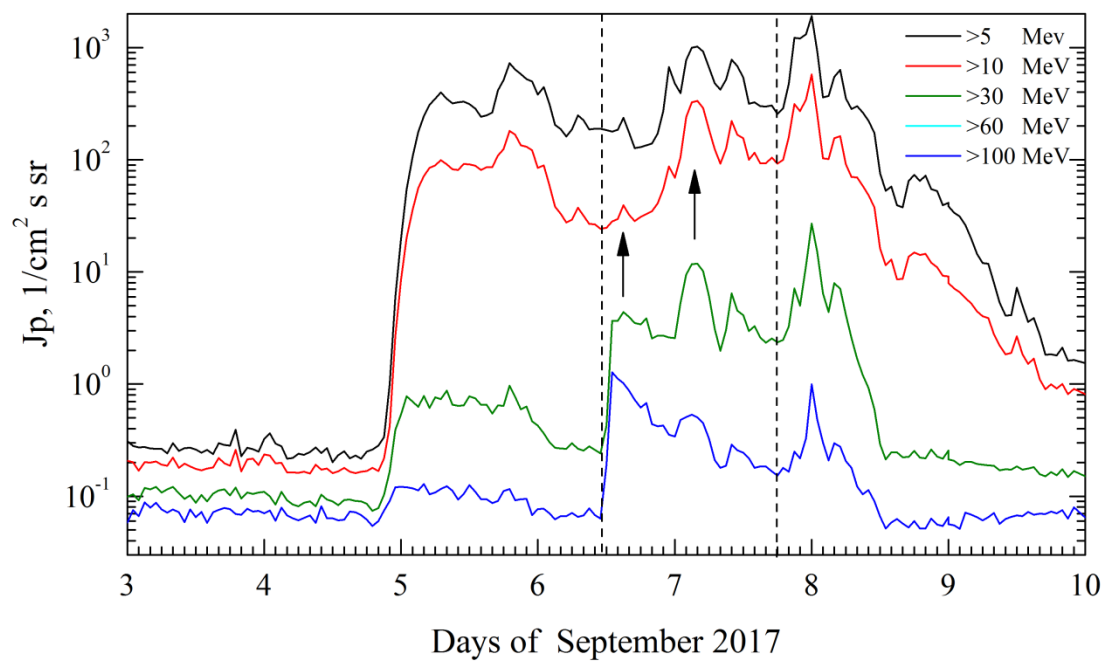


SOHO. Event 2017.09.06

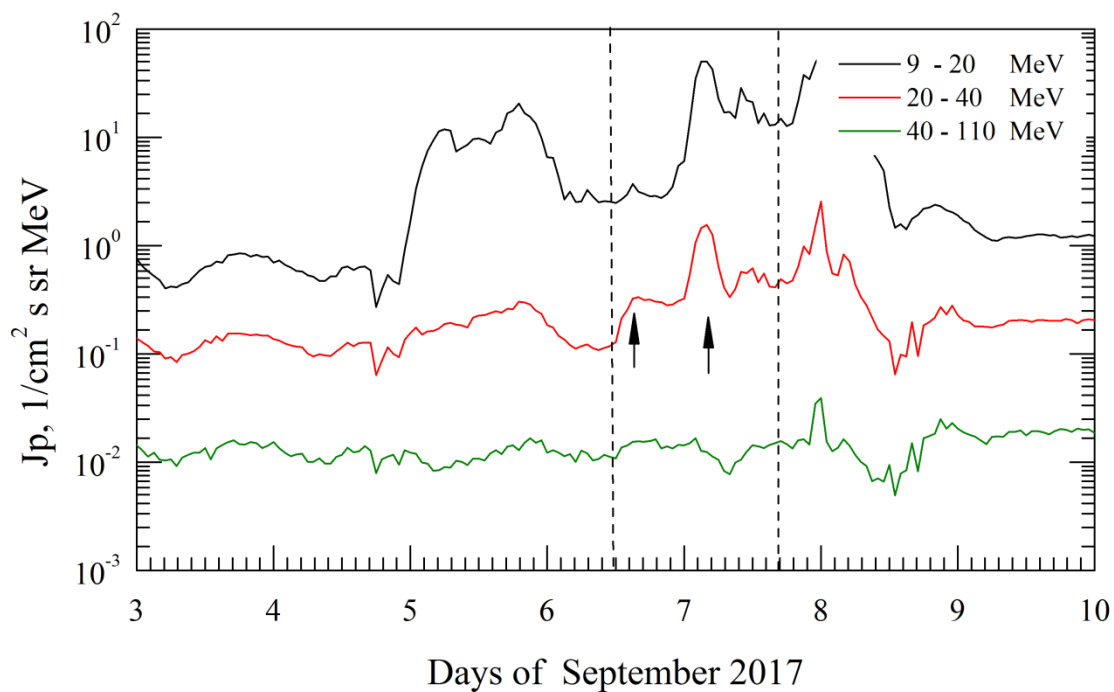


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2017.09.06

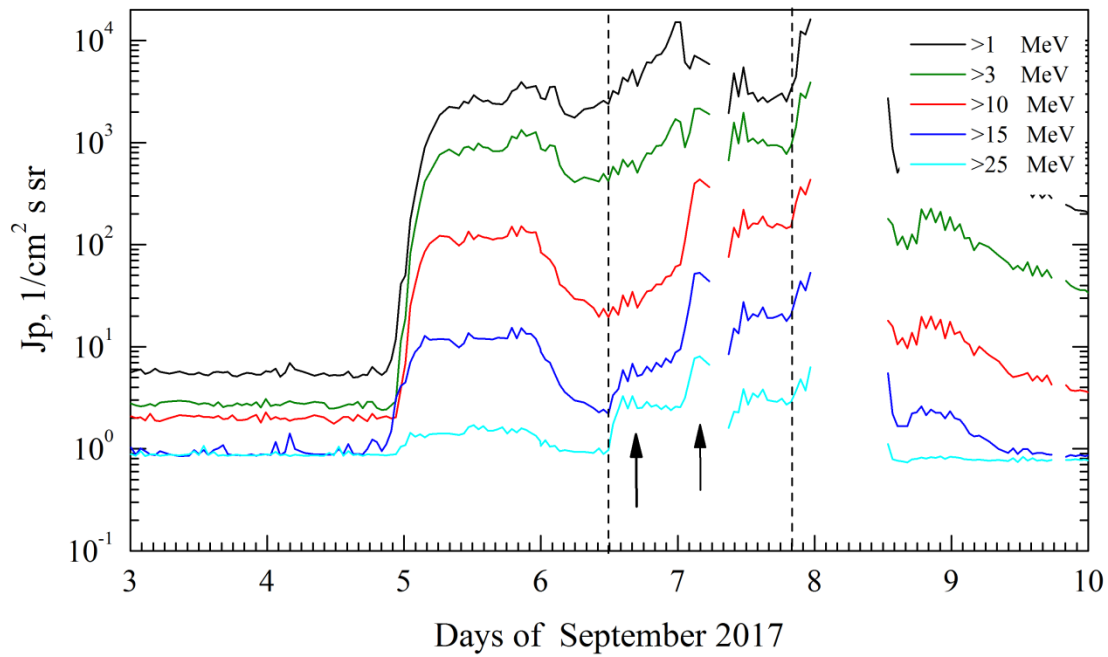


Electro. Event 2017.09.06

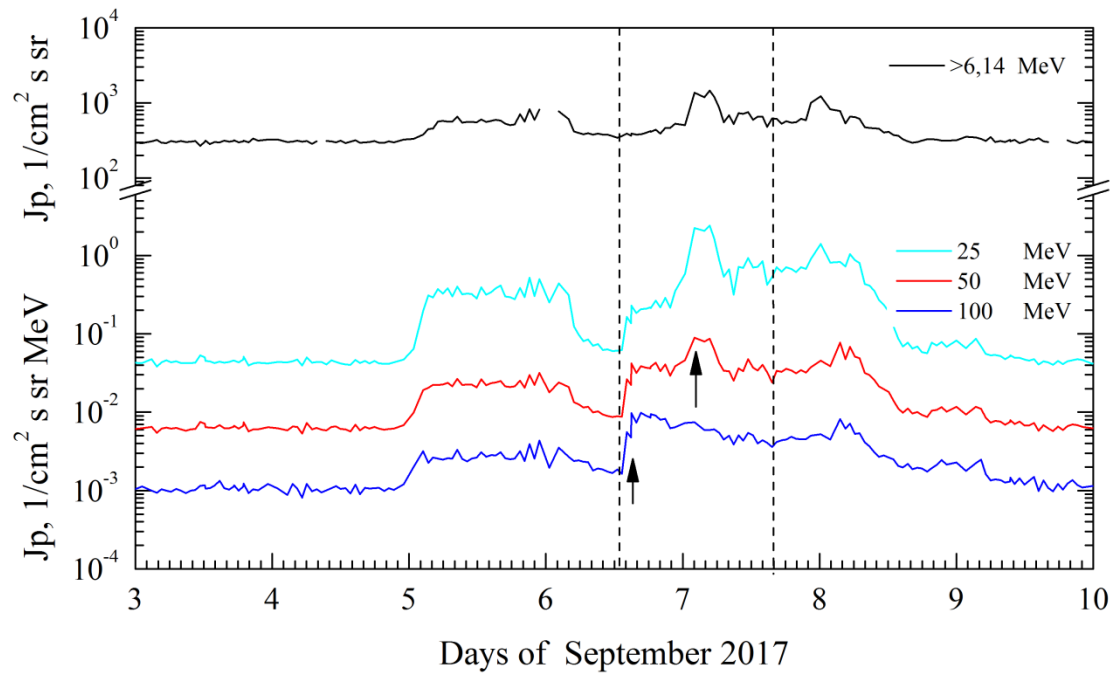


Earth satellites in polar orbit, R = 800÷1000 km: Meteor and POES

Meteor. Event 2017.09.06



POES. Event 2017.09.06



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2017 September 06**

2017

September 06

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AR 12673

To event 588

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	0852	~1159	>1553	S07W33	2B	ERU
1 – 12	keV	0857	0910	0917	S08W32	X2.2	0.13
1 – 12	keV	1153	1202	1210	S09W34	X9.3	0.57
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
6-12	keV	0848:12	0908:58	0917:08	3171	5491588	HESSI
12-25	keV	0949:08	0949:46	1000:44	144	220019	HESSI
6-12	keV	1028:28	1030:30	1036:44	20	21888	HESSI
50-100	keV	1123:20	1128:38	1137:08	560	1097436	HESSI
50-100	keV	1207:44	1216:18	1225:12	1778	3902514	HESSI
50-100	keV	1257:16	1259:14	13:12:44	976	2173851	HESSI
12-25	keV	1344:44	1345:06	1359:16	192	378470	HESSI
25-50	keV	1431:48	1440:54	1450:04	256	413074	HESSI
12-25	keV	1450:04	1451:42	1454:12	72	46512	HESSI
12-25	keV	0925:11	0925:15	0930:38	711534	155488256	FERMI
12-25	keV	1028:34	1103:56	1105:47	10468	746583	FERMI
12-25	keV	1452:46	1506:23	1508:29	33874	3128196	FERMI
>100	MeV	1349:30		1412:30		2.70E-05*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	0900	0909	1050	P15	3.15	
8.8	GHz	0901	0903	1034		2.88	
5	GHz	0902	0904	0936		2.93	
2.7	GHz	0903	0903	0931		2.61	
1.4	GHz	0903	0928	0928	1.4 – 9	2.95	
410	MHz	0922	0922	0922		2.28	
245	MHz	1122	1136	1148		3.04	
15.4	GHz	1154	1156	1351		3.91	
8.8	GHz	1155	1156	1356		3.81	
5	GHz	1156	1157	1405		3.77	
2.7	GHz	1154	1156	1432		4.15	
1.4	GHz	1156	1202	1424	P1.4 \ 5	4.28	
610	MHz	1158	1202	1232		3.97	
410	MHz	1155	1202	1232		3.8	
245	MHz	1202	1203	1411	0.2 / 1.4	3.5	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-081	1202		1221	1765	2	
DS IV	025-180	1201		1515		2	
DS III	025-170	1157		1202		2	
DS VI	025-061	1202		1208		1	
DH II	16-0.07	1205		09d/0708			WIND
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1224	1571	25	360°	201°	SOHO

*cm⁻²s⁻¹

2017

September 06

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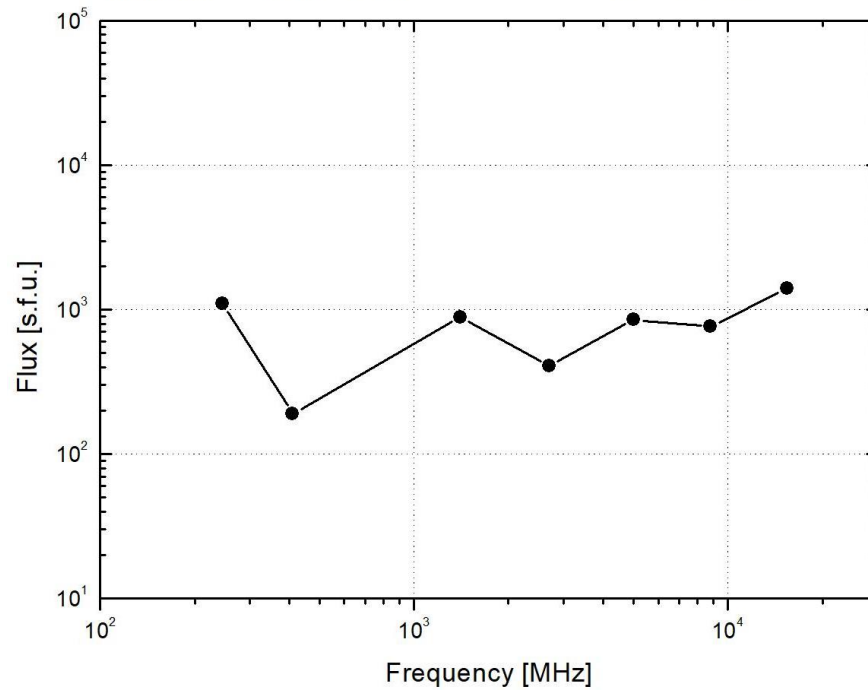
AR 12673

To event 588

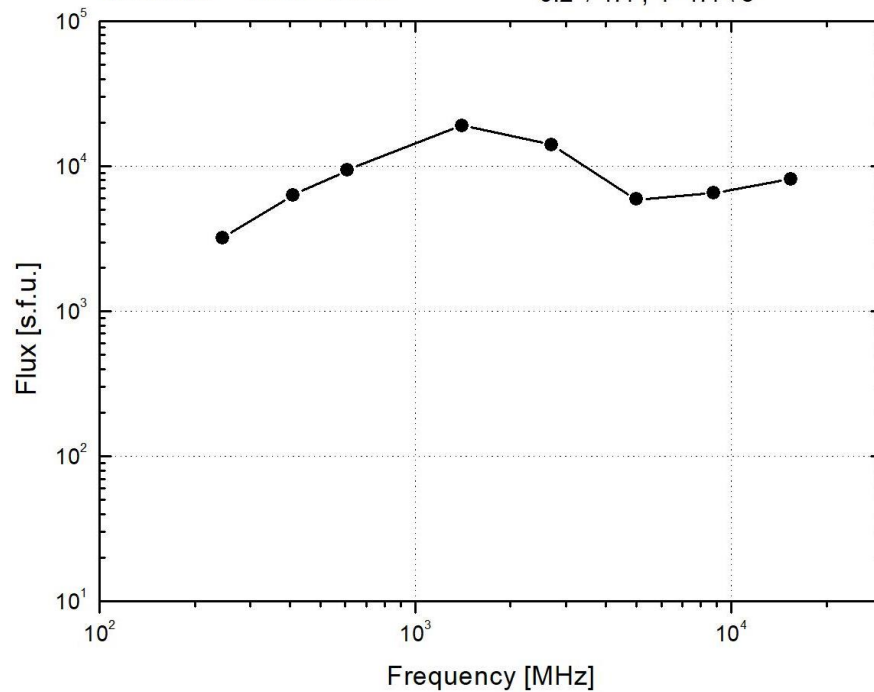
H α , X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å	FL	1354	1554	1752	S08W38	3N	UMB
1 – 12	keV	1551	1556	1603	S08W36	M2.5	0.014
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
25-50	keV	1431:48	1440:54	1450:04	256	413074	HESSI
12-25	keV	1450:04	1451:42	1454:12	72	46512	HESSI
25-50	keV	1605:40	1606:38	1615:08	202	245174	HESSI
50-100	keV	1615:08	1617:06	1633:12	133	245742	HESSI
50-100	keV	1739:52	1742:06	1754:40	587	1388233	HESSI
12-25	keV	1452:46	1506:23	1508:29	33874	3128196	FERM
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
410	MHz	1648	1648	1649		2.43	
245	MHz	1648	1648	1650		3.0	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS IV	104-180	1733		2157		1	
DS CTM	103-171	1604		1701		1	
DS III	48-079	1653		1653		1	
DS V	25-180	1732		1733		2	
DS VI	25-180	1735		2256		1	

Radio bursts frequency spectrum

Flare 06d 08:52 X2.2/2B S07W33 Event 2017.09.06
Maximum 09:03 - 09:36 1.4 - 9; P 15



Flare 06d 08:52 S09W34 Event 2017.09.06
Maximum 11:56 - 12:03 0.2 / 1.4; P 1.4 \ 5



Proton Active Region:

AR12673 (S08L117, CMP 04.09.2017,
Sp=1060 msh, EKC, BGD, R3)
XRI=18.97, $X_5^{9.3}+M_{26}^{8.1}+C_{54}$, $3_2+2_4+1_{13}+S_{84}$
PFR1 4–5.09 (12^h): $M_8^{5.5}$;
PFR2 6–8.09 (12^h): $X_3^{9.3}+M_{15}^{8.1}$
PFR3 9–10.09 (17^h): $X_1^{8.2}+M_1$

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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).

Particle event: To($E_p > 10$ MeV) – 07d20^h

Tmax₁($E_p > 10$ MeV) – 08d00^h, Jmax₁($E_p > 10$ MeV) – 575 /cm²·s·sr

Tmax₂($E_p > 10$ MeV) – 08d20^h, Jmax₂($E_p > 10$ MeV) – 14.3 /cm²·s·sr

Duration of the event – 3 days, power-law index: $\gamma_1 = 4.0$, $\gamma_2 = 2.5$

Quasimaximal energy of protons in the event – Eqm₁ = 150 MeV

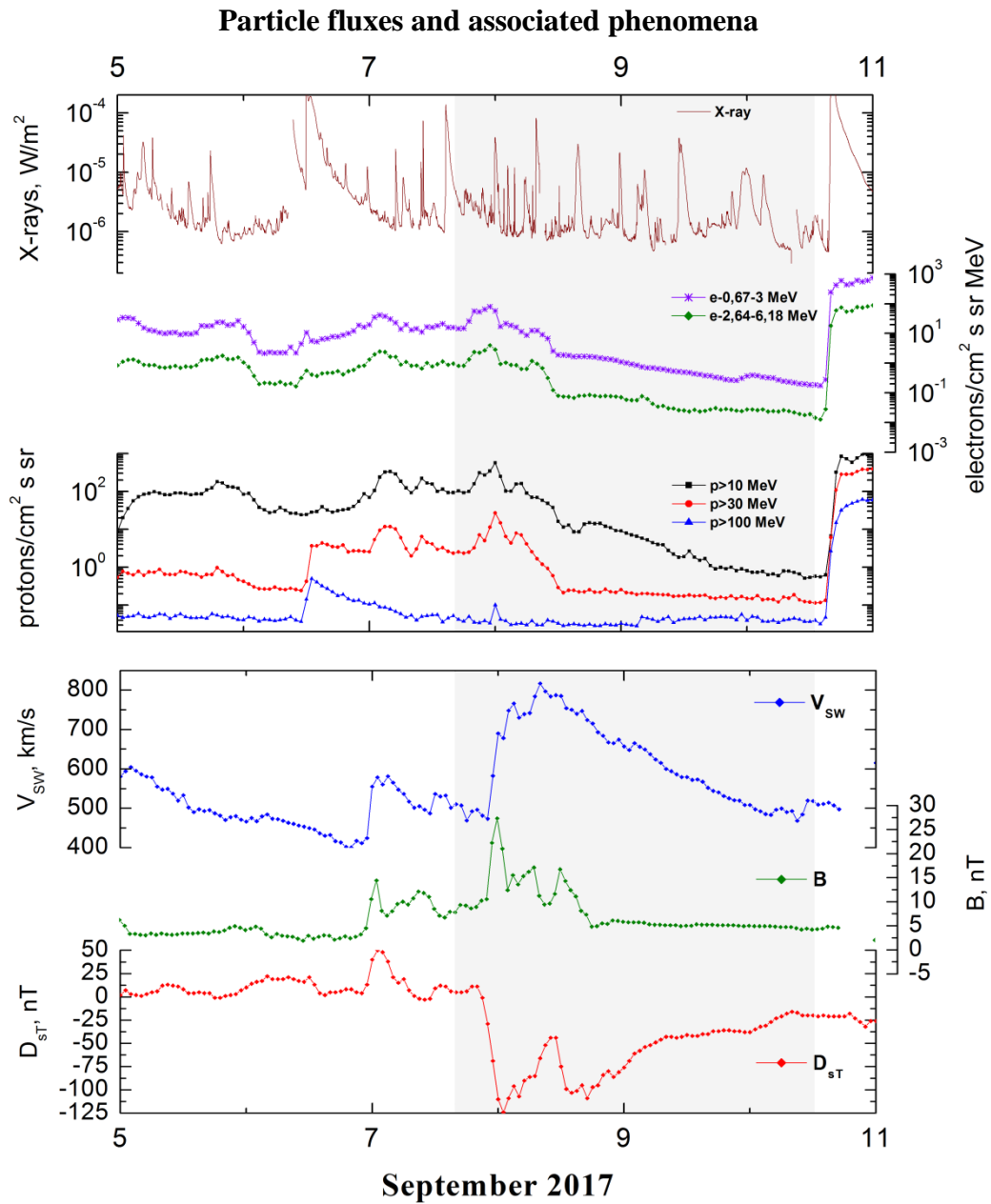
– Eqm₂ = 130 MeV

Sources: ● solar flare 07d14^h20^m, X1.3/2B, S11W49, AR12673

Main burst X-ray 1–8 Å: onset – 07d14^h20^m, max – 07d14^h36^m, $\Phi = 0.12$ J/m²

CME: 07d15^h12^m, $V = 433$ km/s, $\Delta\phi = 058^\circ$, dA = 246°

▲ SC 7d23^h00^m

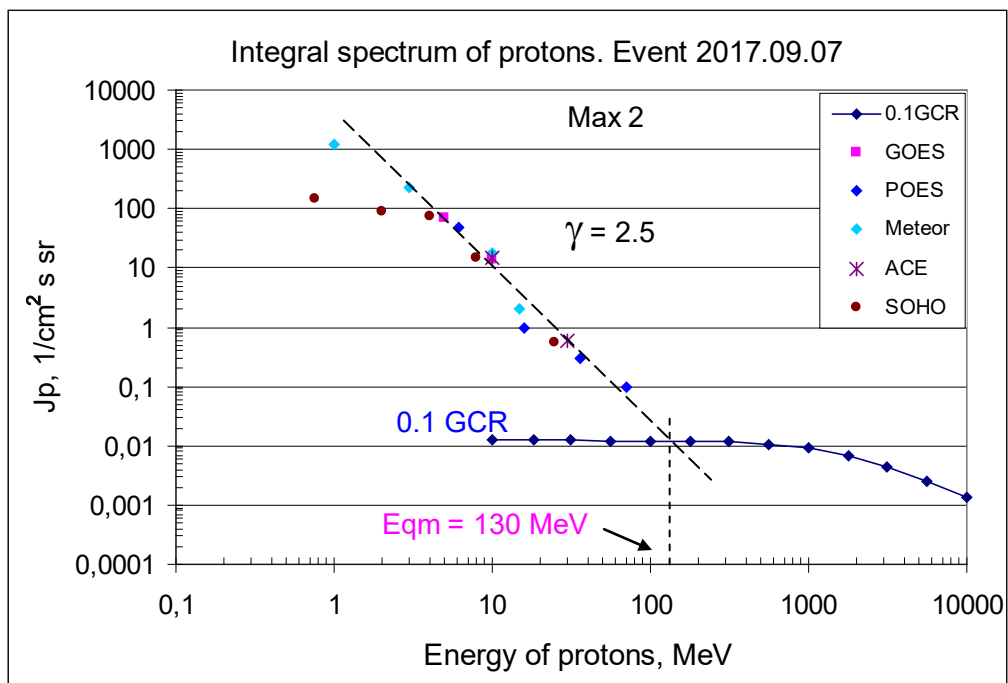
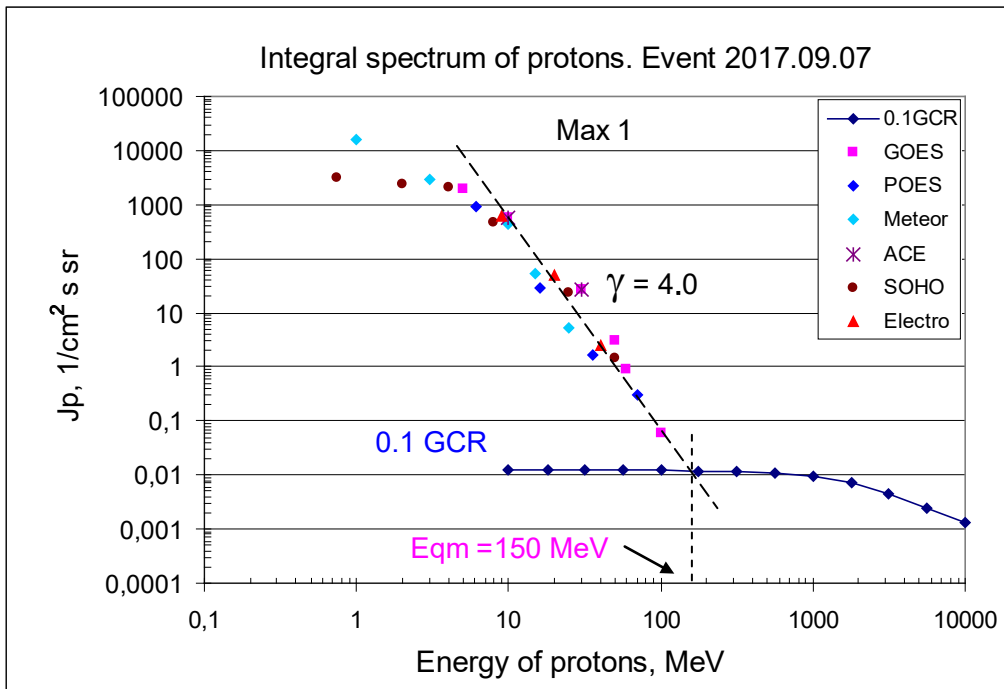


Integral fluxes of protons for the event of 2017 September 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	20	8d00/8d20	1920/72	3	0.25	
EPS	>10	20	8d00/8d20	575/14.3	3	0.18	
EPS	>30	20	8d00/ -	27/ -	1	0.1	
EPS	>50	20	8d00/ -	3.15/ -	1	0.08	
EPS	>60	20	8d00/ -	0.93/ -	1	0.06	
EPS	>100	-	8d00/ -	0.06/ -	-	0.04	
Electro-2							
GALS-E	>600	-	-	-	-	0.11	
POES							
MEPED	>6.14	20	23/08d05	920/352	0.75	310	
Meteor-2							
SCR	>1	19	23/08d20	16100/1225	2.5	5.0	
SCR	>3	19	23/08d20	3877/223	2.5	2.7	
SCR	>10	19	23/08d20	430/18	2.5	2.0	
GALS-M	>15	19	23/08d20	52/2	2	0.9	
GALS-M	>25	19	23/ -	5.4/ -	1	0.9	
GALS-M	>600	-	-	-	-	0.3	
ACE							
SIS	>10	18	23/8d19	553/15	3	1.9	
SIS	>30	18	23/8d20	26/0.6	2	1.3	
SOHO							
EPHIN	>50	18	23/ -	1.4/ -	3	0.25	

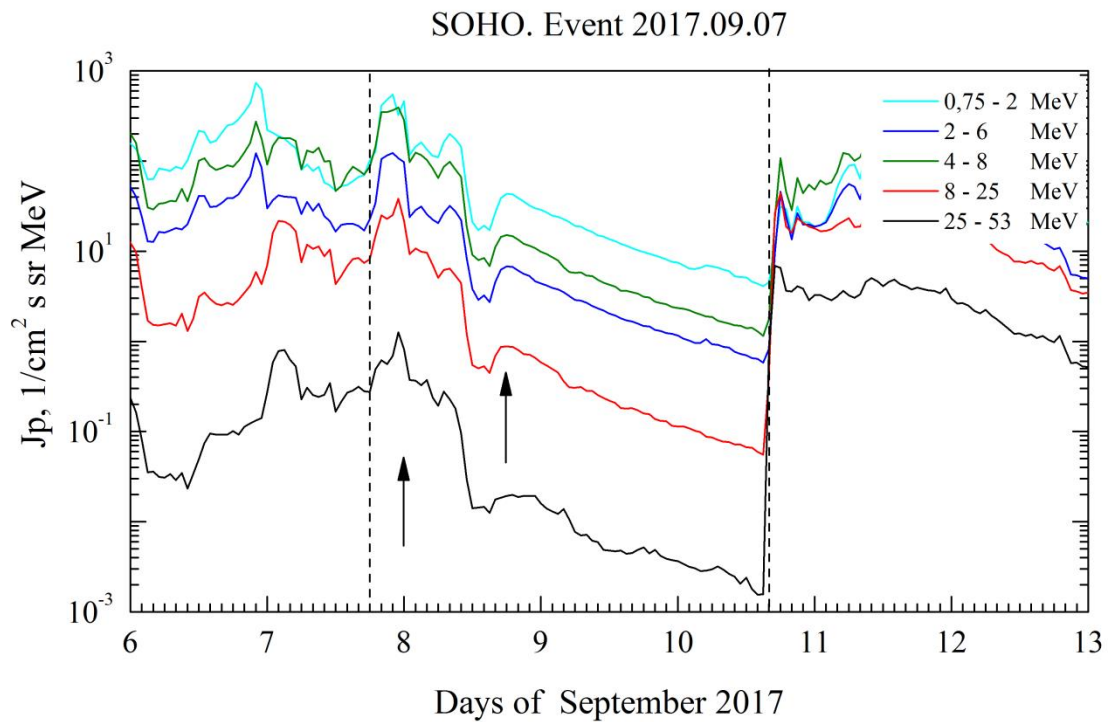
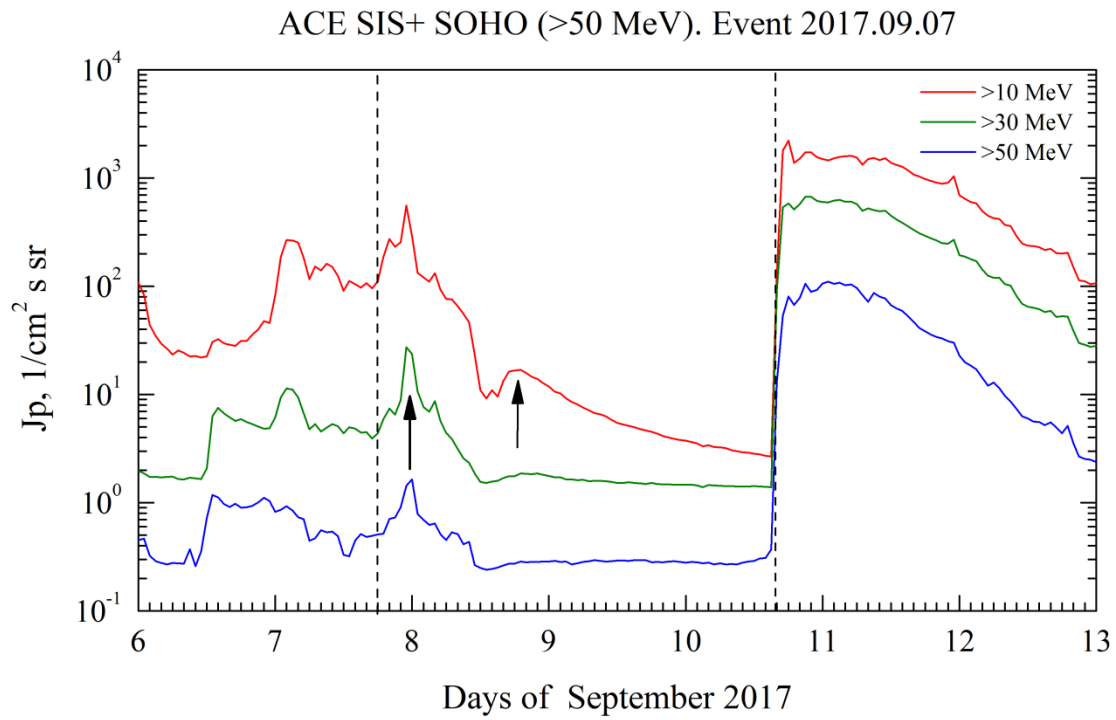
Differential fluxes of protons for the event of 2017 September 07

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75 – 2	18	22/8d19	550/42.5	3	0.03	
LION	2 – 6	18	22/8d19	120/6.5	3	0.003	
EPHIN	4 – 8	18	22/8d19	400/14.5	3	0.0002	
EPHIN	8 – 25	18	22/8d19	25.5/0.85	3	0.00005	
EPHIN	25 – 53	18	22/8d19	0.8/002	3	0.00002	
Electro-2							
SCR-1	9–20	19	08d00/ -	51/ -	1.5	0.3	
SCR-1	20–40	19	08d00/ -	2.4/ -	1.5	0.1	
SCR-1	40–110	19	08d00/ -	0.035/ -	1.5	0.01	
POES							<E>, MeV
MEPED	16–36	20	23/8d20	1.36/0.036	1.25	0.043	25
MEPED	36–70	20	8d01/8d20	0.04/0.0056	1.25	0.006	50
MEPED	70–140	20	8d01/8d20	0.0042/0.0015	1.25	0.001	100



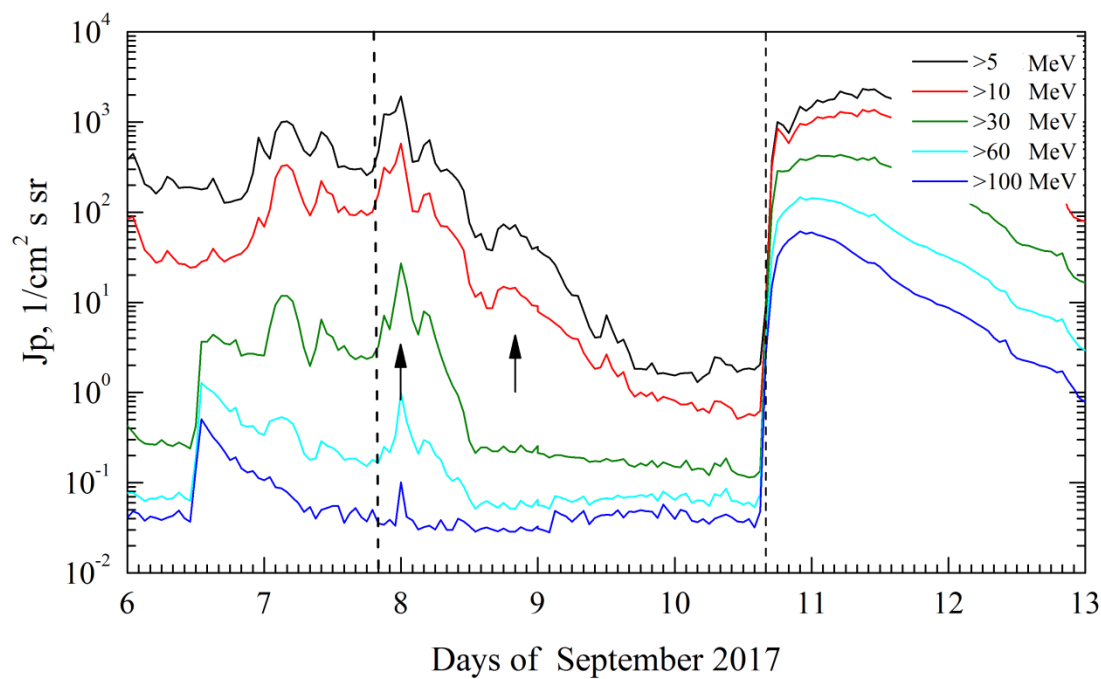
Time profiles of proton fluxes in the event 2017.09.07

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

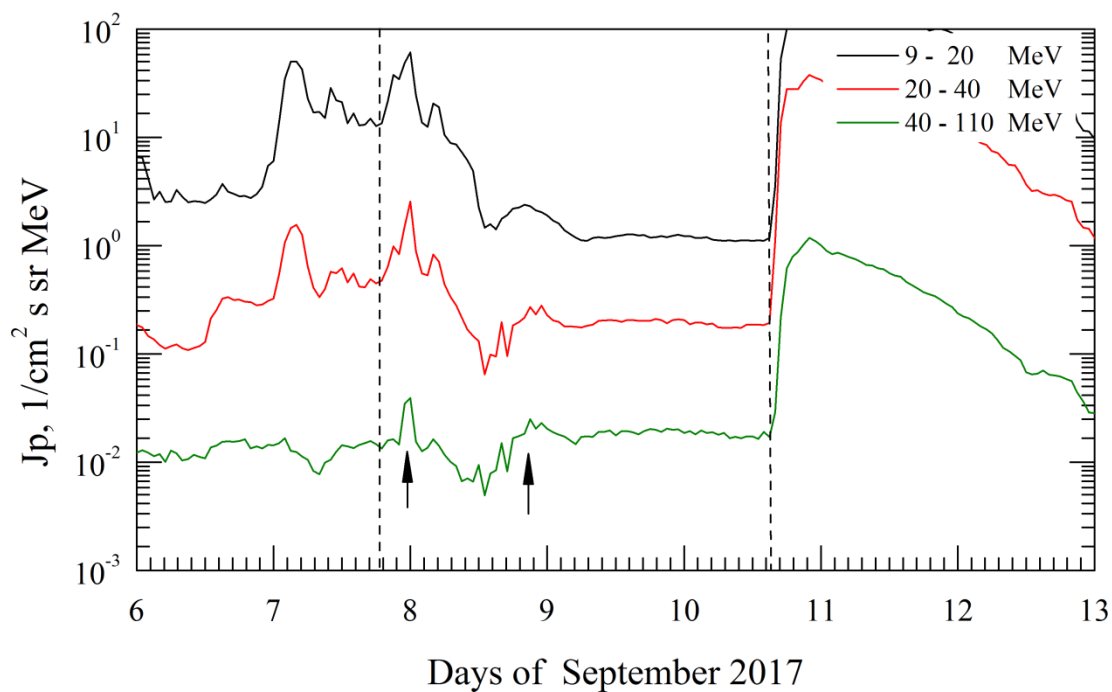


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2017.09.07

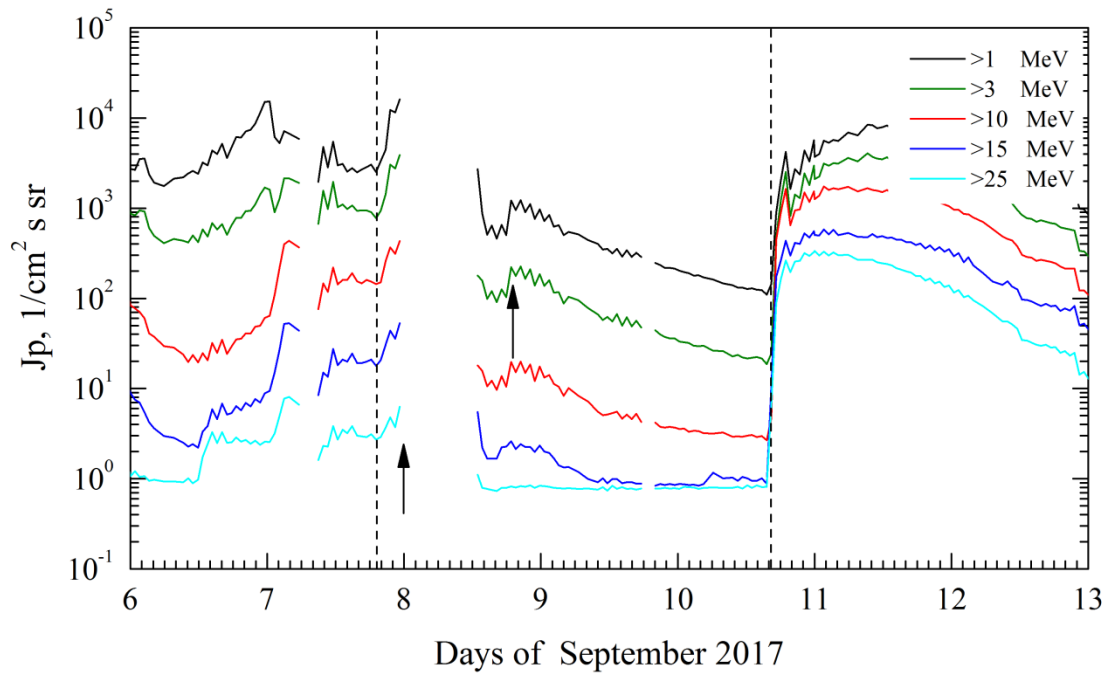


Electro. Event 2017.09.07

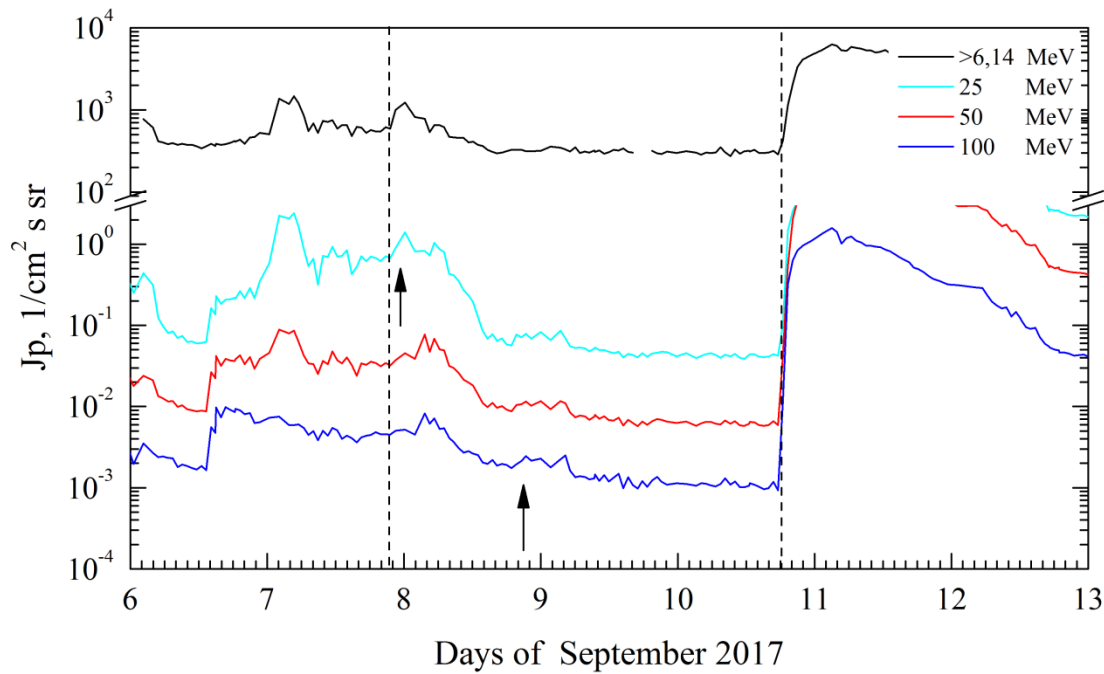


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2017.09.07



POES. Event 2017.09.07



**Electromagnetic and other phenomena that are sources and/or accompanying for the event of
2017 September 07**

2017 September 07

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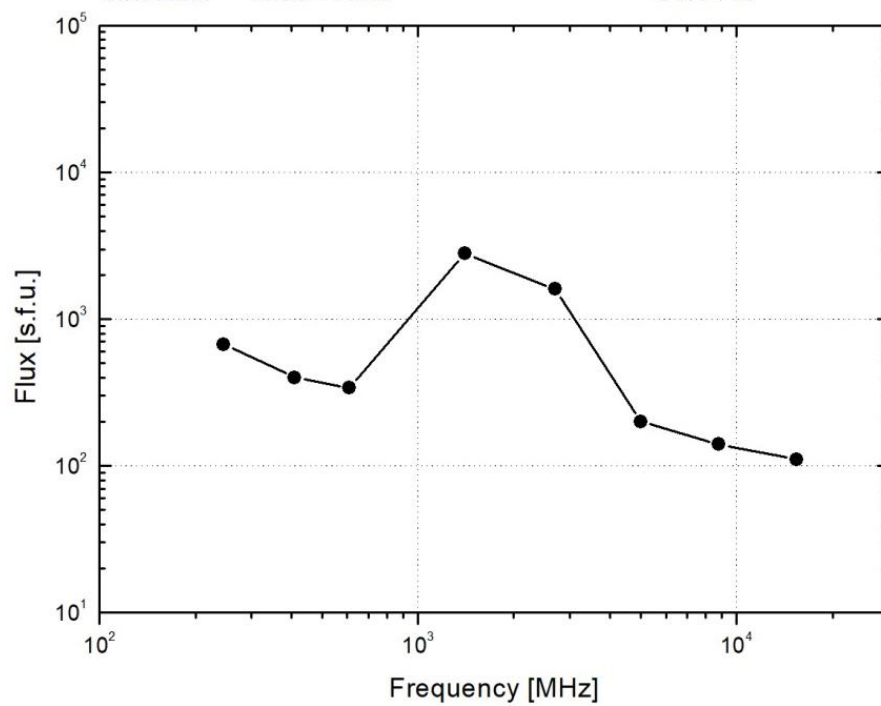
AR12673

To event 589

Hα, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ, J/m²
6563 Å	FL	1423	1423	1426	S11W49	2B	ERU
1–12	keV	1420	1436	1455	S08W48	X1.3	0.12
X-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
12-25	keV	1417:04	1422:50	1500:04	594	158970	HESSI
25–50	keV	1455:00	1455:22	1500:04	656	431217	HESSI
25–50	keV	1500:04	1500:06	1506:44	374	264926	HESSI
6-12	keV	1538:44	1539:46	1605:24	1008	2531280	HESSI
12-25	keV	1441:06	1448:48	14:56:02	514599	226376992	FERMI
12-25	keV	1509:44	1509:52	1539:38	12503	1044038	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15.4	GHz	1448	1448	1452	P1.4 \ U15	2.04	
8.8	GHz	1448	1448	1449		2.15	
5	GHz	1448	1448	1449		2.3	
2.7	GHz	1434	1435	1441		3.2	
1.4	GHz	1446	1448	1456		3.45	
610	MHz	1448	1448	1448		2.53	
410	MHz	1448	1448	1453		2.6	
245	MHz	1448	1448	1448		2.83	
DS-type	Frequency, MHz	To	Tmax	Te	V_{II}, km/s	Importance	Sp/c
DS II	025-043	1608		1612	928	1	
DS IV	025-180	1553		1624		2	
DS III	025-180	1554		1604		2	
CME		UT	V, km/s	a, km/s²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1512	433	- 9.9	058°	246°	SOHO

Radio burst frequency spectrum

Flare 07d 14:20 X1.3/2B S11W49 Event 2017.09.07
Maximum 14:35 - 14:48 U1.4 \ 15



Proton Active Region:

AR12673 (S08L117, CMP 04.09.2017,
Sp=1060 msh, EKC, BGD, R3),
XRI=18.97, $X_5^{9.3}+M_{26}^{8.1}+C_{54}$), $3_2+2_4+1_{13}+S_{84}$
PFR1 4–5.09 (12^h): $M_8^{5.5}$;
PFR2 6–8.09 (12^h): $X_3^{9.3}+M_{15}^{8.1}$;
PFR3 9–10.09 (17^h): $X_1^{8.2}+M_1$

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Zhuang B., N. Lugaz, T. Gou et al., [2020](#).
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Particle event: To($E_p > 10$ MeV) – 10d16^h

Tmax ($E_p > 10$ MeV) – 10d19^h, Jmax ($E_p > 10$ MeV) – 850/cm²·s·sr

Duration of the event – 4 days, power-law index: $\gamma = 2.1$ (4.2)

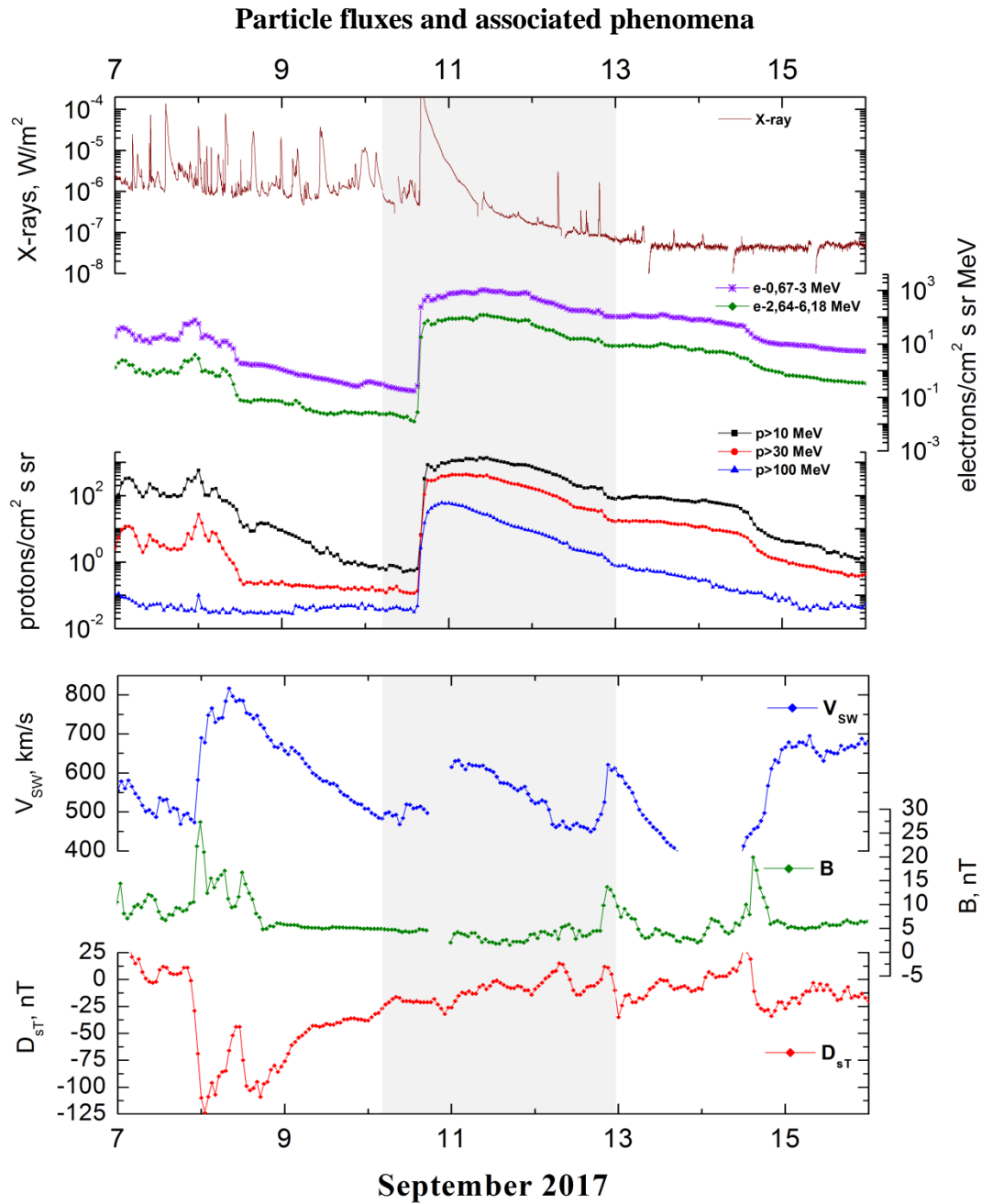
Quasimaximal energy of protons in the event – $E_{qm} = 1200$ MeV

Sources: ■ solar flare 10d15^h35^m, X8.2/, S08W88, AR12673

Main burst X-ray 1–8 Å: onset – 10d15^h35^m, max – 10d16^h06^m, $\Phi = 1.4$ J/m²

CME: 10d16^h00^m, $V = 3163$ km/s, $\Delta\phi = 360^\circ$, $dA = 262^\circ$

▲ SC 12d 20^h04^m; ▲ SC 14d 11^h16^m

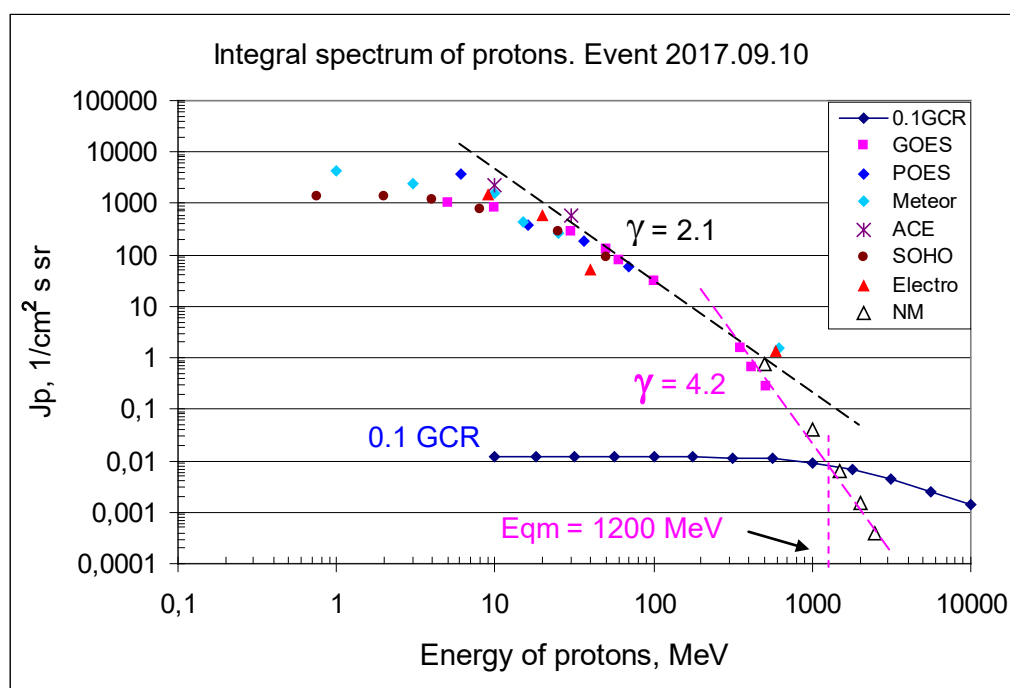


Integral fluxes of protons for the event of 2017 September 10

S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr) ⁻¹	Duration, days	Back- ground	Comments
GOES							
EPS	>5	16	19	1000	5	1.5	
EPS	>10	16	19	850	5	0.5	
EPS	>30	16	19	283	5	0.1	
EPS	>50	16	19	132	4	0.08	
EPS	>60	16	18	80	4	0.06	
EPS	>100	16	18	32	4	0.04	
EPS	>700	-	-	-	-	0.0002	
Electro-2							
GALS-E	>600	15	18	1.3	2.5	0.11	
POES							
MEPED	>6.14	16	20	3790	4	310	
Meteor-2							
SCR	>1	15	18	4200	5	5.0	
SCR	>3	15	18	2520	5	2.7	
SCR	>10	15	18	1627	5	2.0	
GALS-M	>15	15	18	433	4	0.9	
GALS-M	>25	15	18	262	4	0.9	
GALS-M	>600	15	18	1.5	2	0.3	
ACE							
SIS	>10	16	18	2220	5	1.9	
SIS	>30	16	18	585	5	1.3	
NM							
Network	>500	16	18	0.768	-	-	
Network	>1000	16	18	0.041	-	-	
Network	>1500	16	18	0.00627	-	-	
Network	>2000	16	18	0.00146	-	-	
Network	>2500	16	18	0.00039	-	-	
SOHO							
EPHIN	>50	16	19	90	4	0.3	

Differential fluxes of protons for the event of 2017 September 10

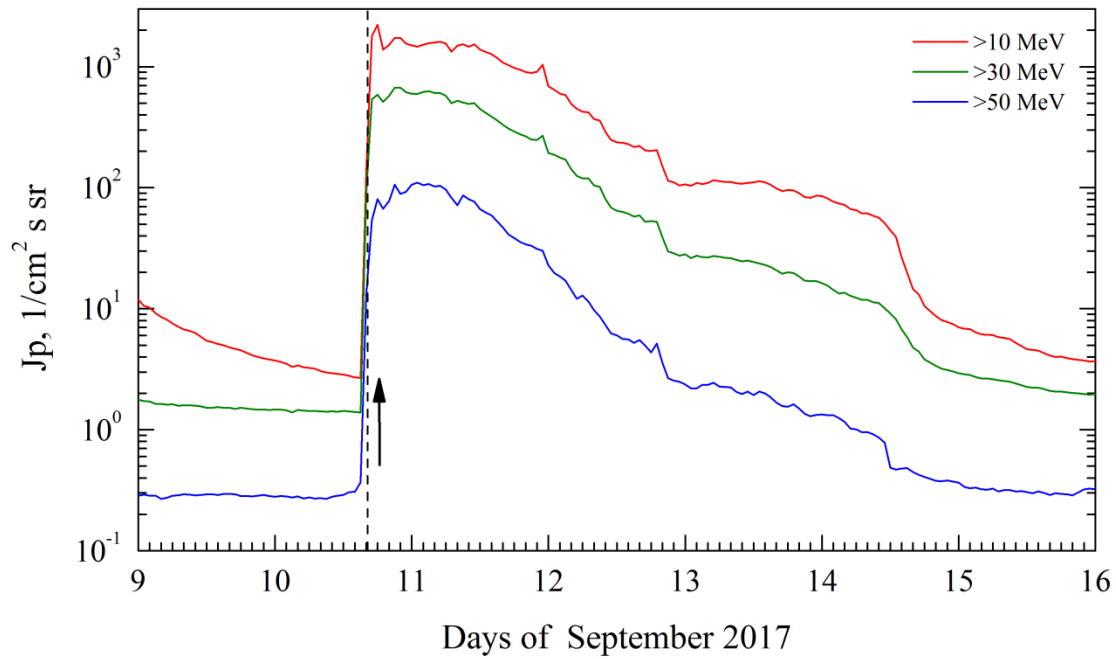
S/c, instruments	Ep, MeV	To, hours	Tmax, hours	Jmax, (cm ² ·s·sr·MeV) ⁻¹	Duration, days	Back- ground	Comments
SOHO							
LION	0.75–2	16	19	28.5	4	0.03	
LION	2–6	16	19	43.8	4	0.003	
EPHIN	4–8	16	19	110	4	0.0002	
EPHIN	8–25	16	19	28	4	0.00005	
EPHIN	25–53	16	19	6.5	4	0.00002	
Electro-2							
SCR-1	9–20	15	18	84	4	0.3	
SCR-1	20–40	15	18	27	4	0.1	
SCR-1	40–110	15	18	0.7	2.5	0.01	
GOES							
EPS	350–420	16	21	0.013	2	0.002	
EPS	420–510	16	21	0.0044	2	0.0012	
EPS	510–700	16	21	0.0015	1.5	0.0005	
POES							<E>, MeV
MEPED	16–36	16	19	9.46	5.5	0.043	25
MEPED	36–70	16	19	3.72	5.5	0.006	50
MEPED	70–140	16	19	0.85	5.5	0.001	100



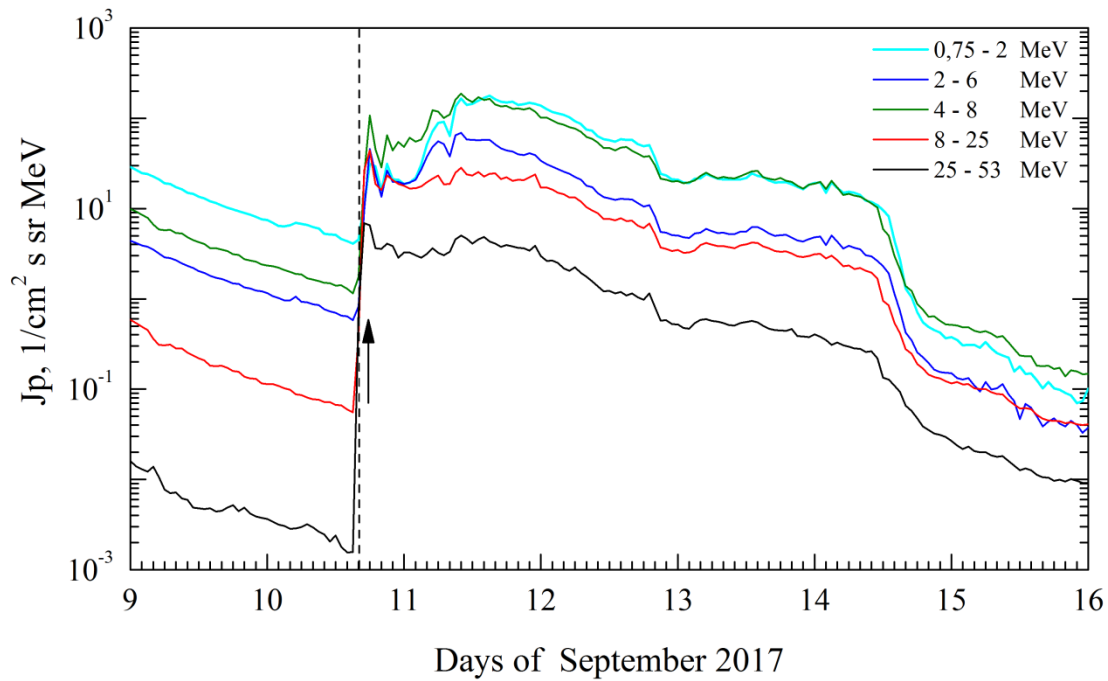
Time profiles of proton fluxes in the event 2017.09.10

Spacecrafts at point L1: ACE + SOHO (> 50 MeV) and SOHO

ACE SIS+ SOHO (>50 MeV). Event 2017.09.10

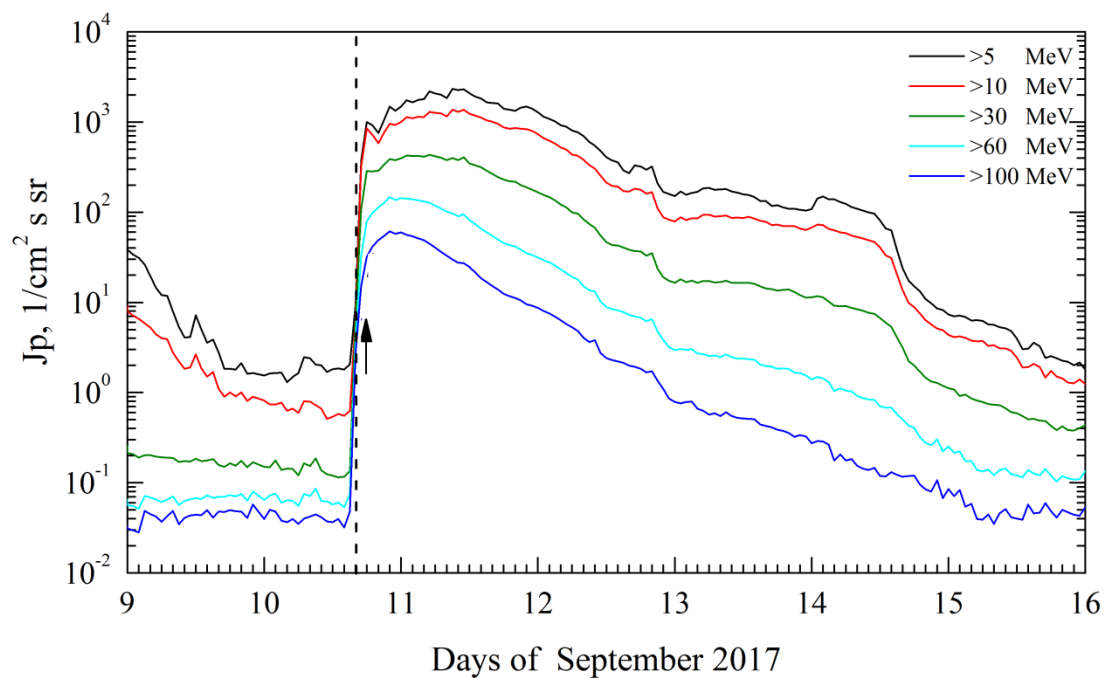


SOHO. Event 2017.09.10

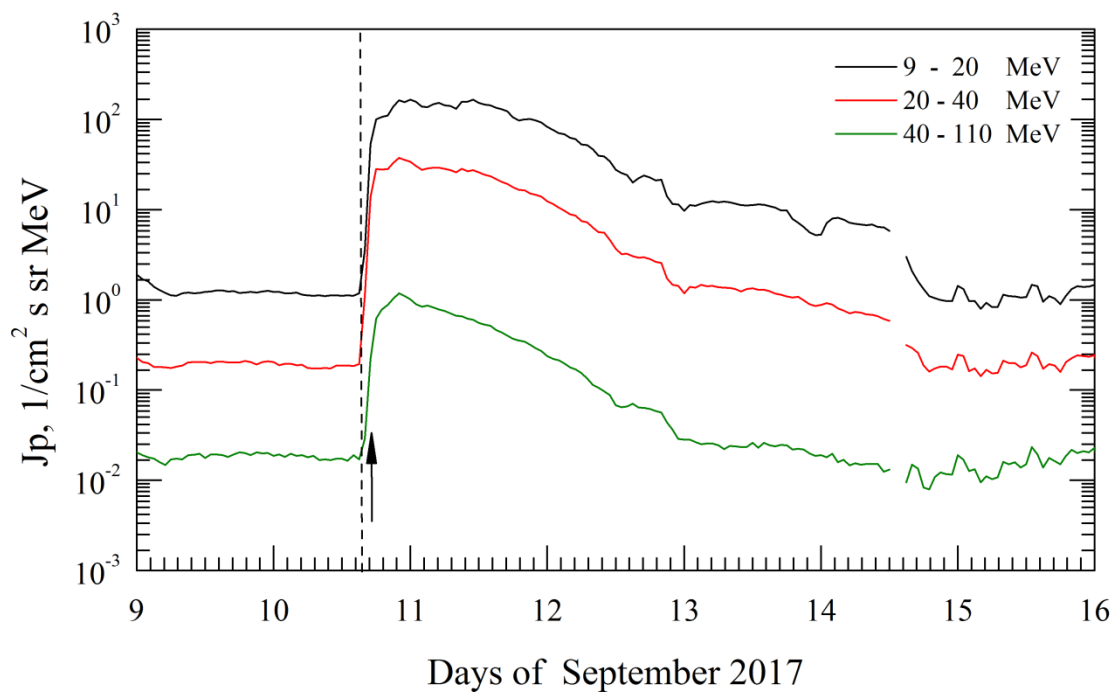


Earth satellites in geostationary orbit, $R \approx 6.6 R_E$: GOES and Electro

GOES. Event 2017.09.10

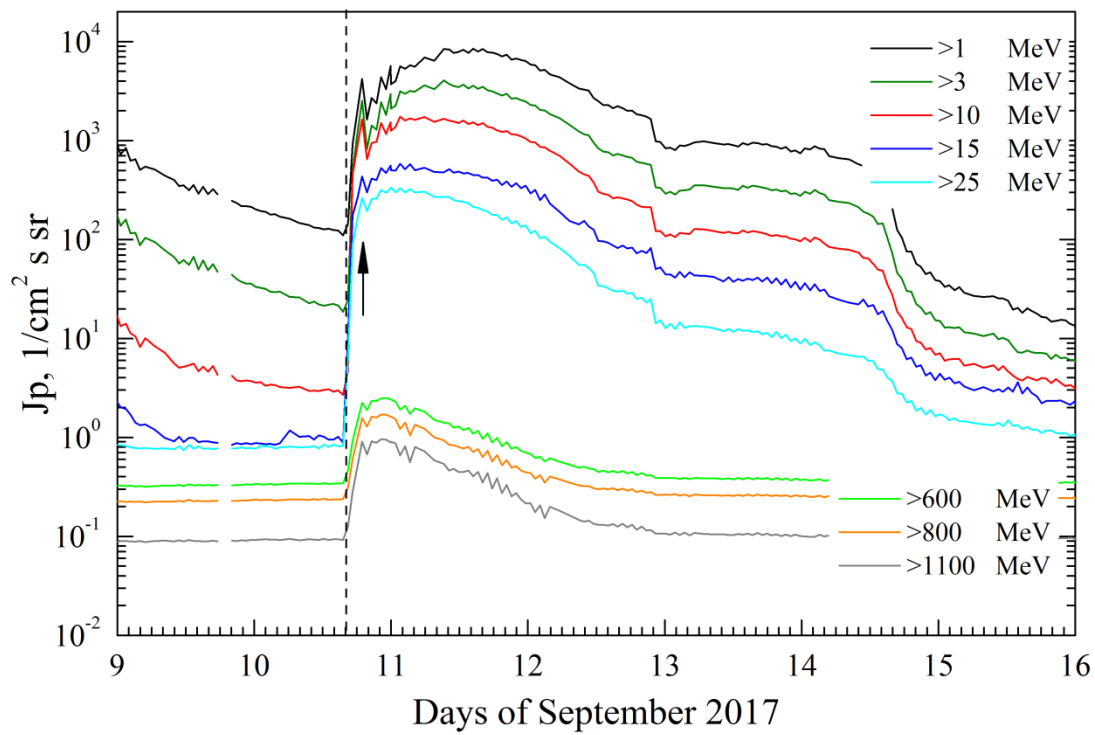


Electro. Event 2017.09.10

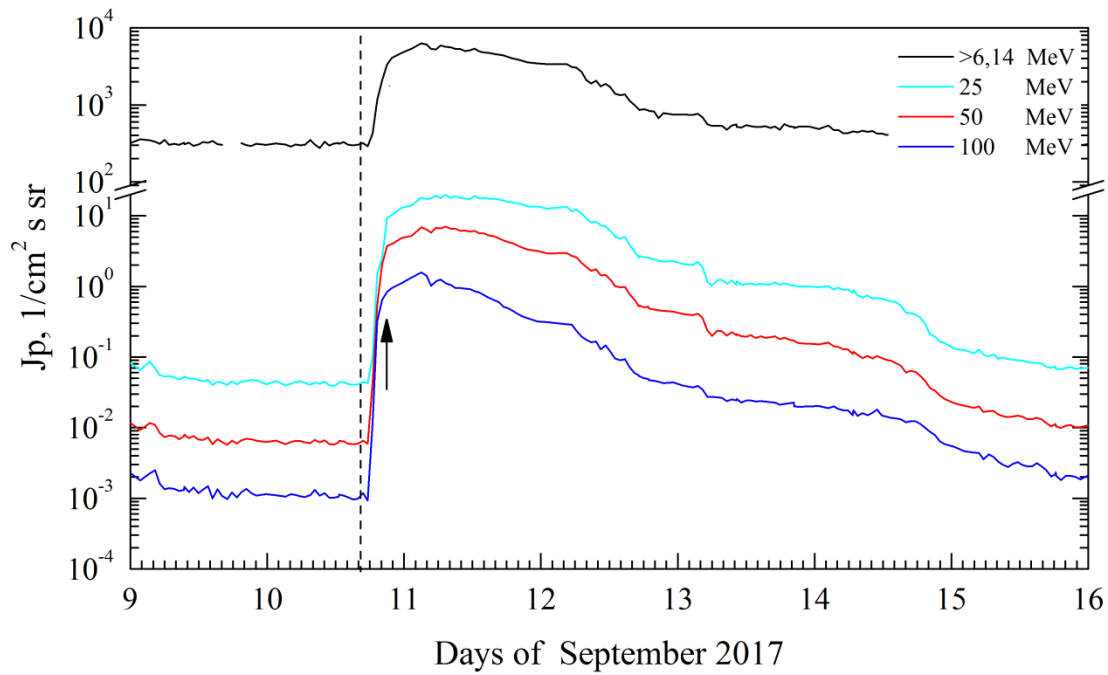


Earth satellites in polar orbit, $R = 800\div 1000$ km: Meteor and POES

Meteor. Event 2017.09.10



POES. Event 2017.09.10



**Electromagnetic and other phenomena that are sources and/or accompanying
for the event of 2017 September 10**

2017 September 10



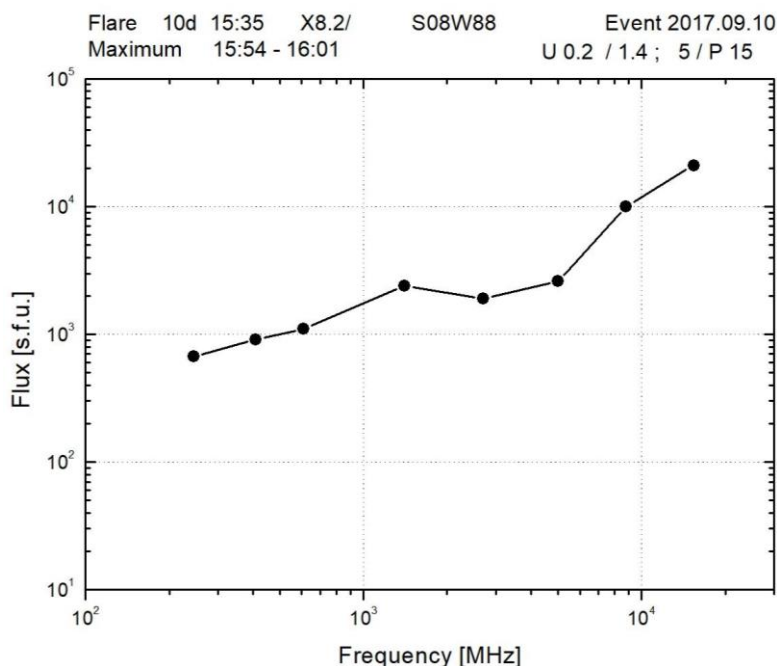
AR 12673

To event 590

Ha, X-ray		To	Tmax	Te	Location	Importance	Fl Code Φ , J/m ²
6563 Å		No optical flare on visible disk					
6563 Å	LPS	1756		2359		0.07	
1 – 12	keV	1535	1606	1631	S08W88	X8.2	1.4
X-ray, gamma-ray		To	Tmax	Te	Npeak, counts/s	Total counts	Sp/c
100-300	keV	1552:36	1557:50	1617:28	4806	10273221	HESSI
100-300	keV	1639:36	1640:30	1648:44	1698	2196080	HESSI
50-100	keV	1648:44	1649:18	1654:48	1200	1042140	HESSI
25-50	keV	1726:48	1756:28	1756:28	624	2719924	HESSI
12-25	keV	1541:18	1621:46	1640:09	996883	805600768	FERMI
>100	MeV	1733:30		1758:30		7.62E-04*	FERMI
Radio burst frequency		To	Tmax	Te	Code of r/spectrum	lg F, sfu	
15400	GHz	1552	1558	1706	5 / P15	4.32	
8.8	GHz	1552	1559	1706		4.00	
5	GHz	1551	1601	1706		3.41	
2.7	GHz	1550	1554	1706		3.28	
1.4	GHz	1550	1554	1608		3.38	
610	MHz	1553	1555	1606		3.04	
410	MHz	1554	1556	1607		2.96	
245	MHz	1553	1558	1604	U0.2 / 1.4	2.83	
DS-type	Frequency, MHz	To	Tmax	Te	V _{II} , km/s	Importance	Sp/c
DS II	025-043	1608		1612	928	1	
DS IV	025-180	1553		1624		2	
DS III	025-180	1554		1604		2	
CME		UT	V, km/s	a, km/s ²	$\Delta\phi$	dA	Sp/c
LASCO	WL	1600	3163	- 232	360°	262°	SOHO

*cm⁻²s⁻¹

Radio burst frequency spectrum



Proton Active Region:

AR12673 (S08L117, CMP 04.09.2017,
Sp=1060 msh, EKC, BGD, R3),
XRI=18.97, $X_5^{9.3} + M_{26}^{8.1} + C_{54}$, $3_2 + 2_4 + 1_{13} + S_{84}$
PFR1 4–5.09 (12^h): $M_8^{5.5}$;
PFR2 6–8.09 (12^h): $X_3^{9.3} + M_{15}^{8.1}$;
PFR3 9–10.09 (17^h): $X_1^{8.2} + M_1$

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Summary Table of Solar Proton Events in the 24 Cycle of Solar Activity (2009 – 2019)

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Legend:

N – is the sequence number of the event; * – sign highlighting "the small event"

Event name-(yyyymmdd-doy-year month day-day of the year);

To – the hour of the event beginning (UT), the event date coincides with the date in the event name;

Tmax – time of the first (second and third if any) peak intensity, UT;

Jmax – the flux of protons with energy ≥ 10 MeV in the first (second and third if any) maximum;

γ – power-law index of the integral spectrum ($J(>E) \sim E^{-\gamma}$);

Eqm – quasimaximal energy of proton in this event;

Legend for solar flares is commonly accepted;

CME – set to "Source" if CME is the only manifestation of a flare event-source of SPE (outlimb event), and isn't set, if CME is a constituent part of a flare event;

CME data – median velocity (km/s), angular width (degrees) principal angle, counterclockwise from North (degrees);

A symbol is placed indicative of confidence of the flare association to this event.

●, ■ – the flare event is a certain source of the observed protons: ● – on visible solar disk; ■ – near or beyond solar limb;

⊙, □ – the flare event is a probable source of the observed protons: ⊙ – on visible solar disk; □ – near or beyond solar limb;

○ – the flare event is a possible but for some reason doubtful source of the observed protons;

∅ – the flare event is not the main source of the observed protons but contributed, or might have contributed to the proton flux.

The following symbols are used in the case when a flare was not identified:

□ – the flare event (or flare associated activity) beyond the western or eastern limb of the Sun

▲ SC – a particle flux change associated with a the sudden commencement of geomagnetic disturbance, coincides with the arrival of an interplanetary shock wave to the Earth, which can bring charged particles from the solar flare event into near-Earth space; b/s – back side flare event;

W_L (E_L) -1d – 1 day behind the W (E)-limb;

DSF– Disappearance of solar filament = Solar filament ejection; (the length of the rejected filament in the degrees for class event);

AR – active region (NOAA SWPC number of active region)

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
1	2010.08.03- 215	10 ^h	19 ^h	2.7	3.1	60	DSF	●01d07 ^h 50 ^m 01d13 ^h 42 ^m	42°	N37W32 0850/360/084	
2	2010.08.14- 226	11 ^h	12 ^h	9.4	2.25	200	FL	☐14d10 ^h 05 ^m 14d10 ^h 12 ^m	C4.4/SF	N17W52 1205/360/224	11099
3	2010.08.18- 230	07 ^h	11 ^h	2.2	2.25	95	FL	☐18d04 ^h 45 ^m 18d05 ^h 48 ^m	C4.5/	N18W88 1471/184/230	11099, 1.5d behind W _L
4	2011.01.28- 028	01 ^h	07 ^h 16 ^h	1.6 2.1	1.8 1.8	200 140	FL	☐28d<00 ^h 44 ^m 28d01 ^h 26 ^m	M1.3/	N16W88 0606/119/290	11149, 1d behind W _L
5	2011.02.15- 046	05 ^h	12 ^h 18 ^h	1.9 1.4	2.2 2.2	80 80	FL	●15d01 ^h 44 ^m 15d02 ^h 24 ^m	X2.2/2B	S20W15 0669/360/189	11158
6	2011.03.07- 066	22 ^h	08d05 ^h	45	3.1	140	FL	●07d19 ^h 43 ^m 07d20 ^h 00 ^m	M3.7	S22W67 2125/360/313	11164
7	2011.03.21- 080	04 ^h	11 ^h 20 ^h	6.8 11.1	2.4 2.8	250 140	FL CME FL	☐21d<02 ^h 24 ^m 21d02 ^h 24 ^m 021d15 ^h 31 ^m	C4.2/	1341/360/274 S20E87	unknown, behind W _L 11176
8	2011.06.05- 156	18 ^h	06d04 ^h	3.6	3.25	160	FL CME	☐04d<22 ^h 05 ^m 04d22 ^h 05 ^m		2425/360/300	11222, 3d behind W _L
9	2011.06.07- 158	07 ^h	12 ^h 19 ^h	40 62.5	2.8 2.5	650 650	FL	●07d06 ^h 16 ^m 07d06 ^h 49 ^m	M2.5/2N	S21W54 1255/360/250	11226
10	2011.06.11- 162	13 ^h	20 ^h	2.4	2.8	75	Unkn own				
☐11	2011.06.15- 166	18 ^h	16d20 ^h	0.9	2.1	80	FL	☉14d21 ^h 36 ^m 14d22 ^h 36 ^m	M1.3/SF	N15E77 0441/028/135	11236
12	2011.06.17- 168	06 ^h	08 ^h 16 ^h	5.6 2.7	2.8 2.7	70 75	SC (FL 486)	17d02 ^h 39 ^m ●14d21 ^h 36 ^m 14d22 ^h 36 ^m	M1.3/SF	N15E77 0441/028/135	11236
13	2011.08.02- 214	07 ^h	02d11 ^h 03d17 ^h	2.2 0.55	2.2 2.1	120 70	FL FL	☉02d05 ^h 19 ^m 02d06 ^h 36 ^m 003d13 ^h 17 ^m 02d14 ^h 00 ^m	M1.4/1N M6.0/2B	N14W15 0852/268/285 N16W30 0610/360/307	11261 11261
14	2011.08.04- 216	04 ^h	08 ^h	60	2.5	500	FL	●04d03 ^h 41 ^m 04d04 ^h 12 ^m	M9.3/2B	N19W36 1315/360/298	11261
15	2011.08.08- 220	19 ^h	20 ^h	2.6	2.3	100	FL	●08d18 ^h 00 ^m 18d18 ^h 12 ^m	M3.5/1B	N16W61 1343/237/281	11263
16	2011.08.09- 221	08 ^h	10 ^h	21.3	2.3	650	FL	●09d07 ^h 48 ^m 09d08 ^h 12 ^m	X6.9/2B	N17W69 1610/360/279	11263
17	2011.09.06- 249	02 ^h	09 ^h	1.4	2.2	200	FL	●06d01 ^h 35 ^m 06d02 ^h 24 ^m	M5.3/1B	N14W07 0782/360/070	11283
18	2011.09.07- 250	02 ^h	05 ^h	6	2.1	420	FL	●06d22 ^h 12 ^m 06d23 ^h 05 ^m	X2.1/2B	N14W18 0575/360/300	11283
19	2011.09.22- 265	13 ^h	23d09 ^h 23d21 ^h	5.4 9.7	2.2 3.2	200 140	FL	●22d10 ^h 29 ^m 22d10 ^h 48 ^m	X1.4/2N	N13E78 1905/360/072	11302
20	2011.10.22- 295	12 ^h	23 ^h	3.3	2.8	75	FL	●22d10 ^h 00 ^m 22d10 ^h 24 ^m	M1.3/SF	N25W77 1005/360/311	11314
21	2011.11.04- 308	00 ^h	09 ^h	2.6	2.3	190	FL	●03d20 ^h 16 ^m 03d23 ^h 10 ^m	X1.9/2B	N22E63 0991/360/090	11339
22	2011.11.26- 330	08 ^h	17 ^h	40	3.2	120	FL	☉26d06 ^h 09 ^m 26d07 ^h 12 ^m	C1.2/DSF	N08W49 0933/360/327	11353
23	2011.12.25- 359	19 ^h	26d01 ^h	2.5	2.3	100	FL	●25d18 ^h 11 ^m 25d18 ^h 48 ^m	M4.0/1N	S22W26 0366/125/235	11387

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
□24	2012.01.02-002	19 ^h	22 ^h 03d06 ^h	0.4 0.5	1.6 1.6	120 90	FL	☐02d14 ^h 31 ^m 02d15 ^h 13 ^m	C2.4/EPL	N07W89 1138/360/244	11384, 1.5d behind W _L
25	2012.01.20-020	01 ^h	20 ^h 21d01 ^h	2.4 1.9	2.2 2.2	100 80	FL	●19d13 ^h 44 ^m 19d14 ^h 36 ^m	M3.2/SF	N30E30 1120/360/020	11402
26	2012.01.21-021	18 ^h	22 ^h	1.4	1.8	140	FL	☐21d13 ^h 35 ^m 21d14 ^h 00 ^m	C2.4/BSL	N25W82 0377/048/266	11396
27	2012.01.22-022	01 ^h	10 ^h	2.5	2.4	80	FL	☉22d02 ^h 32 ^m 22d06 ^h 00 ^m	C7.1/	N17W13 0367/085/248	11401
28	2012.01.23-023	04 ^h	14 ^h 24d17 ^h	2700 3900	3.55 4.1	450 250	FL SC	●23d03 ^h 38 ^m 23d04 ^h 00 ^m 24d15 ^h 03 ^m	M8.7/2B	N28W21 2175/360/326	11402
29	2012.01.27-027	18 ^h	28d02 ^h 28d12 ^h	740 680	3.1 2.9	900 600	FL	●27d17 ^h 37 ^m 27d18 ^h 28 ^m	X1.7/1F	N27W71 2508/360/296	11402
30	2012.02.24-055	23 ^h	26d01 ^h 27d00 ^h	3.5 2.3	3.5 4.0	55 45	DFS SC	☉24d02 ^h 25 ^m 24d03 ^h 46 ^m ▲26d21 ^h 40 ^m	26°	N32E38 0800/189/001	
31	2012.03.04-064	21 ^h	05d16 ^h	3.2	2.25	90	FL	●04d10 ^h 29 ^m 04d11 ^h 00 ^m	M2.0/1N	N19E61 1306/360/052	11429
32	2012.03.07-067	02 ^h	17 ^h 08d13 ^h	1440 4340	2.9 4.0	1200 650	FL FL	●07d00 ^h 00 ^m 07d00 ^h 24 ^m 007d01 ^h 05 ^m	X5.4/3B X1.3/SF	N17E27 2684/360/057 N22E12	11429 11430
33	2012.03.13-073	17 ^h	21 ^h	390	2.8	650	FL	●13d16 ^h 35 ^m 13d17 ^h 36 ^m	1B/M7.9	N19W59 1884/360/286	11429
34	2012.05.17-138	01 ^h	04 ^h 18d02 ^h	180 30	2.15 (4.2) 2.05	5000 (1800) 650	FL	●17d01 ^h 25 ^m 17d01 ^h 48 ^m	M5.1/1F	N11W76 1582/360/261	11476
35	2012.05.26-147	23 ^h	27d06 ^h 27d11 ^h	11.9 12.5	3.2 3.2	70 70	FL CME	☐26d<20 ^h 57 ^m 26d20 ^h 57 ^m		1966/360/291	Flare activity behind W _L
36	2012.06.14-166	18 ^h	16d21 ^h	11	3.0	90	FL SC SC	●14d12 ^h 52 ^m 14d14 ^h 12 ^m ▲16d20 ^h 20 ^m ▲16d21 ^h 15 ^m	M1.9/1N	S17E06 0987/360/144	11504
37	2012.07.06-188	23 ^h	07d08 ^h	23	3.0	220	FL	●06d23 ^h 01 ^m 06d23 ^h 24 ^m	X1.1/	S13W59 1828/360/233	11515
38	2012.07.08-190	16 ^h	09d05 ^h	17	2.2	550	FL	■08d16 ^h 23 ^m 08d16 ^h 54 ^m	M6.9/1N	S14W83 1495/157/234	11515
39	2012.07.12-194	16 ^h	22 ^h	80	3.7	110	FL	●12d15 ^h 18 ^m 12d16 ^h 48 ^m	X1.4/2B	S14W01 0885/360/158	11520
40	2012.07.17-199	15 ^h	18d00 ^h 18d06 ^h	93 116	3.2 3.2	150 140	FL	●17d12 ^h 03 ^m 17d13 ^h 48 ^m	M1.7/1F	S28W75 0958/176/241	11520
41	2012.07.19-201	06 ^h	15 ^h 20d03 ^h	75 72	3.5 4.4	280 120	FL SC	■19d04 ^h 17 ^m 19d05 ^h 24 ^m ▲20d04 ^h 49 ^m	M7.7/	S16W90 1631/360/275	11520, 0.5d behind W _L
42	2012.07.23-205	06 ^h	22 ^h	11	3.6	250	FL CME	☐23d<02 ^h 36 ^m 23d02 ^h 36 ^m		2003/360/286	11520, 4d behind W _L
□43	2012.08.02-215	10 ^h	21 ^h	0.6	2.2	50	FL SC	☐02d12 ^h 10 ^m 02d13 ^h 26 ^m ▲02d10 ^h 50 ^m	C1.5/	S20W87 0563/108/234	11529

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
44	2012.09.01- 245	01 ^h	15 ^h 02d10 ^h	24 47	3.4 4.1	80 65	FL	●31d19 ^h 45 ^m 31d20 ^h 00 ^m	C8.4/2F	S19E42 1442/360/090	11562
45	2012.09.28- 272	00 ^h	05 ^h	23.8	3.0	200	FL	●27d23 ^h 36 ^m 28d00 ^h 12 ^m	C3.7/1F	N06W34 0947/360/251	11577
46	2012.11.08- 313	12 ^h	09d04 ^h	1.4	2.0	170	FL	■08d02 ^h 08 ^m 28d02 ^h 36 ^m	M1.7/	N13E89 0855/360/046	11611
47	2012.12.14- 349	08 ^h	15d02 ^h	6.5	4.1	50	FL CME	▣14d<02 ^h 00 ^m 14d02 ^h 00 ^m		0763/149/232	unknown, behind W _L
48	2013.01.16- 016	22 ^h	17d07 ^h 17d13 ^h	1.1 1.25	2.2 2.8	70 50	FL	■16d19 ^h 18 ^m 16d19 ^h 00 ^m	C2.2/	S32W87 0648/250/236	11650
49	2013.03.15- 074	18 ^h	22 ^h 16d12 ^h	0.9 6.2	2.3 2.5	70 75	FL	●15d05 ^h 46 ^m 15d07 ^h 12 ^m	M1.1/1F	N09E06 1063/360/112	11692
50	2013.04.11- 101	07 ^h	17 ^h	100	3.2	500	FL	●11d06 ^h 55 ^m 11d07 ^h 24 ^m	M6.5/3B	N09E12 0861/360/085	11719
51	2013.04.21- 111	09 ^h	12 ^h 22d02	2 1.2	2.3 2.2	110 70	FL CME FL CME	▣21d<07 ^h 24 ^m 21d07 ^h 24 ^m Ø 21d<20 ^h 36 ^m 21d20 ^h 36 ^m		0919/360/269 0561/212/260	11719, 2d behind W _L
52	2013.04.24- 114	23 ^h	25d05 ^h	1.3	2.6	140	FL CME	▣24d<22 ^h 12 ^m 24d22 ^h 12 ^m		0784/360/241	11719, 6d behind W _L
53	2013.05.13- 133	18 ^h	14d09 ^h	1	2.2	70	FL	■13d15 ^h 48 ^m 13d16 ^h 08 ^m	X2.8/1N	N14E85 1850/360/063	11748
54	2013.05.15- 135	10 ^h	21 ^h	20.5	3.5	110	FL	●15d01 ^h 24 ^m 15d01 ^h 48 ^m	2N/X1.2	N12E64 1366/360/093	11748
55	2013.05.22- 142	13 ^h	15 ^h	83.5	3.0	500	FL	●22d12 ^h 35 ^m 22d13 ^h 26 ^m	3N/M5.0	N15W70 1466/360/287	11745
56	2013.06.21- 172	14 ^h	22d10 ^h	6	2.3	100	FL	●21d02 ^h 30 ^m 21d03 ^h 12 ^m	M2.9/1F	S16E73 1900/207/107	11777
57	2013.06.23- 174	07 ^h	11 ^h 20 ^h	3.7 9.7	2.6 4.0	70 60	FL SC FL	●21d02 ^h 30 ^m ●23d04 ^h 26 ^m Ø23d20 ^h 48 ^m 23d21 ^h 24 ^m	M2.9/1F M2.9/1N	S16E73 S15E66 0339/101/133	11777 11778
▣58	2013.08.17- 229	20 ^h	18d06 ^h	0.3	1.8	60	FL	●17d18 ^h 16 ^m 17d19 ^h 12 ^m	2B/ M3.3,M1.4	S07W30 1202/360/274	11818
59	2013.08.20- 232	16 ^h	21d14 ^h	1	2.15	80	FL	▣20d04 ^h 54 ^m 20d08 ^h 12 ^m	C1.3,C1.1/	S18W87 0784/360/210	11817, 1d behind W _L
60	2013.09.30- 273	00 ^h	17 ^h	102	3.0	220	DSF FL	●29d21 ^h 45 ^m ●29d21 ^h 43 ^m 29d22 ^h 12 ^m	35° C1.2/	N15W40 N15W33 1179/360/343	spotless AR
61	2013.10.28- 301	06 ^h	11 ^h 29d02 ^h	2.3 3.5	2.35 1.7	100 300	FL	●28d01 ^h 41 ^m 28d02 ^h 24 ^m	X1.0/2N	N04W66 0695/360/296	11875
62	2013.10.30- 303	02 ^h	05 ^h	4.2	2.4	130	FL	■29d21 ^h 42 ^m 29d22 ^h 00 ^m	X2.3/	N05W89 1001/360/249	11875
63	2013.11.02- 306	07 ^h	16 ^h	1.6	2.2	300	FL CME	▣02d<04 ^h 48 ^m 02d04 ^h 48 ^m		0828/360/239	11875, 3d behind W _L
64	2013.11.07- 311	01 ^h	05 ^h	5.5	3.0	90	FL	■06d23 ^h 35 ^m 07d00 ^h 00 ^m	M1.9,M1.8/ SPY	S11W88 1033/360/233	11882, 1d behind W _L
▣65	2013.11.08- 312	02 ^h	09d11 ^h	0.6	2.7	40	FL FL	⊙08d04 ^h 20 ^m Ø07d14h15m	X1.1/2B M2.4/1N	S14E15 S13E23	11890 11890
▣66	2013.11.10- 314	08 ^h	11d02 ^h	0.5	2.0	60	FL	●10d05 ^h 08 ^m 10d05 ^h 36 ^m	X1.1/2B	S14W13 0682/262/198	11890

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
67	2013.11.19-323	12 ^h	19 ^h	3.4	2.3	130	FL	●19d10 ^h 14 ^m 19d10 ^h 36 ^m	X1.0/SF	S13W69 0740/360/222	11893
68	2013.12.14-348	06 ^h	15d01 ^h	1.1	2.3	60	FL CME CME	▣14d<06 ^h 36 ^m 14d06 ^h 36 ^m Ø14d21 ^h 24 ^m		0611/121/112 0611/360/169	Flare activity behind E _L
69	2013.12.26-360	08 ^h	27d03 ^h	2	2.3	90	FL CME	▣26d<03 ^h 24 ^m 26d03 ^h 24 ^m		1336/360/036	Flare activity behind E _L
70	2013.12.28-362	18 ^h	23 ^h	26.5	2.6	240	FL CME	▣28d<17 ^h 36 ^m 28d17 ^h 36 ^m		1118/360/284	Flare activity behind W _L
71*	2014.01.06-006	07 ^h	14 ^h	38	2.1	1350	FL	■06d07 ^h 30 ^m 06d08 ^h 00 ^m	C2.1/EPL	S15W89 1402/360/274	11936, ~1.5d behind W _L
72	2014.01.07-007	18 ^h	08d12 ^h	1000	3.8	400	FL	●07d18 ^h 04 ^m 07d18 ^h 24 ^m	X1.2/2N	S15W11 1830/360/231	11944
▣73	2014.02.18-049	08 ^h	14 ^h	0.4	3.1	50	FL	⊙18d01 ^h 27 ^m 18d01 ^h 36 ^m	C4.7/SF	S16W42 0779/360/044	11976
74	2014.02.19-050	09 ^h	15 ^h 20d03 ^h	2 2.8	3.3 2.4	45 90	FL CME SC	▣19d<04 ^h 48 ^m 19d04 ^h 48 ^m ▲20d03 ^h 20 ^m		0612/360/090	11990, 3d behind E _L
75	2014.02.20-051	08 ^h	10 ^h 13 ^h	17.7 9.2	2.7 3.2	250 110	FL	●20d07 ^h 26 ^m 20d08 ^h 00 ^m	M3.0/SN	S15W73 0948/360/268	11976
76	2014.02.25-056	04 ^h	16 ^h	13.6	2.3	500	FL	●25d00 ^h 39 ^m 25d01 ^h 25 ^m	X4.9/2B	S12E82 2147/360/073	11990
77	2014.02.28-059	02 ^h	10 ^h	97	3.2	180	FL	⊙27d21 ^h 33 ^m	C4.2/SF	S11W63	11982
▣78	2014.03.25-084	04 ^h	11 ^h 26d00 ^h	0.4 0.2	3.2 4.0	35 25	FL CME	▣25d<05 ^h 36 ^m 25d05 ^h 36 ^m		0651/223/269	Flare activity behind W _L
79	2014.03.29-088	18 ^h	22 ^h	1.4	2.3	130	FL	●29d17 ^h 35 ^m 29d18 ^h 12 ^m	X1.0/2B	N11W32 0528/360/325	12017
80	2014.04.18-108	14 ^h	16 ^h	11.8	2.3	500	FL	●18d12 ^h 31 ^m 18d13 ^h 25 ^m	M7.3/	S20W34 1203/360/238	12036
81	2014.08.25-237	18 ^h	26d00 ^h	1.3	2.3	75	FL	●25d14 ^h 46 ^m 25d15 ^h 36 ^m	M2.0/1B	N05W36 0555/360/270	12146
82 **	2014.09.01-244	18 ^h	03d08 ^h	2.5	2.2	700	FL	■01d10 ^h 55 ^m 01d11 ^h 12 ^m	B6.2/(~X2.4)	N14E126 1901/360/065	12158, 3d behind E _L
83	2014.09.10-253	21 ^h	11d07 ^h 12d16 ^h	25 67.5	2.8 3.1	400 160	FL SC	●10d16 ^h 59 ^m 10d18 ^h 00 ^m ▲12d15 ^h 53 ^m	2B/X1.6	N14E02 1267/360/175	12158
84	2014.11.01-305	14 ^h	20 ^h 02d22 ^h	3.2 7	3.7 2.7	50 120	FL	●01d04 ^h 44 ^m 01d05 ^h 00 ^m	C2.7/DSF	S08E52 1628/159/125	Spotless AR***
85	2014.12.13-347	16 ^h	14d11 ^h	1.7	2.3	130	FL CME	▣13d<14 ^h 24 ^m 13d14 ^h 24 ^m		2222/360/265	12222, 3d behind W _L
86	2014.12.21-355	08 ^h	21 ^h	2.4	3.1	55	FL	●21d11 ^h 24 ^m 21d12 ^h 12 ^m	M1.0/	S13W25 0669/360/189	12241
87	2014.12.23-357	00 ^h	12 ^h	5	3.4	50	FL	⊙22d21 ^h 15 ^m	C5.7	S19W71	12242
▣88	2015.01.27-027	19 ^h	29d01 ^h 30d19 ^h	0.5 1.0	4.8 2.4	20 60	FL	▣27d07 ^h 13 ^m 27d08 ^h 23 ^m	C2.1/	N07E89 0332/009/119	12277, 1d behind E _L

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
89	2015.02.21-052	10 ^h	19 ^h 22d07 ^h	1.2 0.7	2.3 2.5	60 70	DSF CME	☐21d<09 ^h 24 ^m 21d09 ^h 24 ^m	>15°	1120/360/215	backside event on SW _L
90	2015.03.15-074	02 ^h	10 ^h	2	2.2	80	FL	☉15d01 ^h 15 ^m 15d01 ^h 48 ^m	C9.1/1F	S22W25 0719/360/240	12297
91	2015.03.16-075	01 ^h	09 ^h 14 ^h	5.2 4	3.5 4.2	50 35	FL	☉15d22 ^h 42 ^m 15d23 ^h 24 ^m	M1.2/	S19W32 0284/015/290	12297
☐92	2015.04.22-112	06 ^h	23d07 ^h 23d21 ^h	0.55 0.6	1.6 2.0	80 75	FL	☐21d21 ^h 39 ^m	M1.8, M1.2/	N10W80	12322
93	2015.05.12-132	04 ^h	07 ^h	5.4	2.4	120	FL DSF	■12d02 ^h 15 ^m 12d02 ^h 48 ^m 12d02 ^h 26 ^m	C2.6/DSF 22°	S21W83 772/250/283 S21W83	12335
94	2015.06.18-169	02 ^h	14 ^h	15.4	3.2	100	FL	■18d00 ^h 33 ^m 18d01 ^h 26 ^m	M1.3/	S16W81 1714/195/270	12365
95	2015.06.21 - 172	16 ^h	22d10 ^h 22d19 ^h	230 600	4.15 4.3	100 110	FL SC	●21d01 ^h 02 ^m 21d02 ^h 36 ^m ▲22d18 ^h 33 ^m	M2.0,M2.7/ 1N	N12E13 1366/360/072	12371
96	2015.06.25-176	09 ^h	26d10 ^h	13.5	3.3	80	FL	●25d08 ^h 02 ^m 25d08 ^h 36 ^m	M7.9/3B	N09W42 1627/360/330	12371
97	2015.07.01-182	18 ^h	20 ^h 02d01 ^h	2.8 4.5	2.0 2.3	130 90	FL CME	☐01d<14 ^h 36 ^m 01d14 ^h 36 ^m		1435/360/311	12731, 2.5d behind W _L
98	2015.09.20-263	18 ^h	22 ^h	2.2	2.2	80	FL	●20d17 ^h 30 ^m 20d18 ^h 12 ^m	2N/M2.1	S20W24 1239/360/219	12415
☐99	2015.09.30-273	20 ^h	23 ^h 01d02 ^h	0.9 0.6	3.0 3.1	40 35	FL	☉30d07 ^h 36 ^m 30d10 ^h 00 ^m	1N/M1.3	S22W46 0602/128/304	12422
☐ 100	2015.10.22-295	13 ^h	23 ^h 23d05 ^h	0.5 0.2	3.0 3.0	40 40	FL	●22d02 ^h 13 ^m 22d03 ^h 12 ^m	C4.4/SF	S11W27 0817/360/206	12434
101	2015.10.29-302	02 ^h	07 ^h	19	2.3	900	FL CME	☐29d<02 ^h 36 ^m 29d02 ^h 36 ^m		0530/202/251	12434, 2d behind W _L
102	2015.11.09-313	16 ^h	10d02 ^h	2.7	2.2	120	FL	●09d12 ^h 49 ^m 09d13 ^h 25 ^m	M3.9/2B, 1F	S11E41 1041/273/137	12449
103	2015.12.28-362	14 ^h	29d02 ^h	1.4	2.3	80	FL	●28d11 ^h 20 ^m 28d12 ^h 12 ^m	M1.8/	S23W11 1212/360/163	12473
104	2016.01.01-001	23 ^h	02d01 ^h 02d04 ^h	4.7 12.4	2.6 2.5	120 140	FL	■01d23 ^h 10 ^m 01d23 ^h 24 ^m	M2.3/	S25W82 1730/360/227	12473
105	2016.03.16-076	07 ^h	11 ^h 17 ^h	1.1 0.8	1.5 1.7	120 80	DSF FL	■16d06 ^h 34 ^m ■16d06 ^h 34 ^m 16d07 ^h 00 ^m	10° C2.2/DSF	N20W86 N12W88 0592/154/265	12522
☐ 106	2016.04.18-109	07 ^h	15 ^h	0.3	2.1	55	FL	●18d00 ^h 14 ^m 18d00 ^h 48 ^m	M6.7/1F	N12W62 1084/162/291	12529
107	2016.05.15-136	17 ^h	17d21 ^h	1.6	2.1	90	DSF FL	●15d15 ^h 00 ^m ●15d15 ^h 19 ^m 15d15 ^h 12 ^m	>10° C3.2/SF	NW N10W62 1118/176/309	12542
☐ 108	2016.07.23-205	04 ^h	07 ^h	0.4	1.5	100	FL	●23d05 ^h 00 ^m 23d05 ^h 24 ^m	M7.6,M5.5/ 3B	N02W74 0835/117/271	12567
109	2017.07.14-195	03 ^h	10 ^h 23 ^h	11.2 20.4	2.6 2.7	120 130	FL	●14d01 ^h 07 ^m 14d01 ^h 26 ^m	M2.4/1N	S06W29 1200/360/230	12665
110	2017.07.25-206	03 ^h	20 ^h	1.0	1.8	9	unkn own				

N	Particles enhancements						Solar flares or CME – the particle sources				
	Event name	To	Tmax	Jmax, pfu	γ	Eqm, MeV	Sour- ce	To (UT) To (CME)	X-ray class, importance	Localization, CME data	AR
111	2017.09.04- 247	21 ^h	05d07 ^h 05d19 ^h	99 167	3.5 4.1	100 90	FL	●04d13 ^h 45 ^m 04d20 ^h 12 ^m	3B/M1.5; M1.0; M1.7; M1.5; M5.5; M2.1/	S11W16 1418/360/184	12673
112	2017.09.06- 249	11 ^h	15 ^h 07d04 ^h	39 334	2.1 3.8	450 140	FL	●06d08 ^h 52 ^m 06d12 ^h 24 ^m	2B/X2.2, X9.3	S07W33 1571/360/201	12673
113	2017.09.07- 250	20 ^h	08d00 ^h 08d20 ^h	575 14.3	4.0 2.5	150 130	FL	●07d14 ^h 20 ^m 07d15 ^h 12 ^m	X1.3/2B	S11W49 0433/058/246	12673
114	2017.09.10- 253	16 ^h	19 ^h	850	2.1 (4.2)	1200	FL	■10d15 ^h 35 ^m 10d16 ^h 00 ^m	X8.2/	S08W88 3163/360/262	12673

* – C2.1 perhaps an echo solar flare X~3.5 on AR11936 located S8W110, 1.5^d behind E_L

** – the likely source of a class X2.1 solar flare in an AR12158 located N14E126, 2.5^d behind E_L

*** – Spotless AR on SE-quadrant according [Pesce-Rollins, M, Omodei, N. Petrosian, V at al. Fermi Large Area Telescope observations of high-energy gamma-ray emission from behind-the-limb solar flare, The 34th International Cosmic Ray Conference, 30 July- 6 August, 2015 The Hague, The Netherlands, <https://arxiv.org/pdf/1507.04303v2.pdf>].

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