

Neutron Monitor Data for Jungfrauoch and Bern during the Ground-Level Solar Cosmic Ray Event on 20 January 2005

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Abstract

This report includes information on the processing and use of the data for the solar cosmic ray ground-level event (GLE) on 20 January 2005 obtained by the IGY and NM64 neutron monitors at Jungfrauoch and the special neutron monitor in Bern, all of which are operated by the Cosmic Ray Group at the University of Bern, Switzerland.

Neutron Monitors

<http://cosray.unibe.ch>

IGY neutron monitor at Jungfrauoch

The standard IGY neutron monitor with 18 BF₃-counters is housed on top of the Sphinx Observatory of the High Altitude Research Station Jungfrauoch.

Geographic latitude:	46.55 N
Geographic longitude:	7.98 E
Effective vertical cutoff rigidity, Epoch 2005.0:	4.5 GV
Altitude	3570 m asl

This detector is an integral part of the worldwide network of neutron monitors, and data of this monitor have been published regularly since 1958 (Debrunner et al., 1987).

IQSY-NM64 neutron monitor at Jungfrauoch

The IQSY-NM64 neutron monitor with 3 counter tubes is housed on the roof of the High Altitude Research Station Jungfrauoch.

Geographic latitude:	46.55 N
Geographic longitude:	7.98 E
Effective vertical cutoff rigidity, Epoch 2005.0:	4.5 GV
Altitude	3475 m asl

This monitor has been in operation since 1986 (Debrunner et al., 1987; Schubnell, 1988).

Special neutron monitor at Bern

The special neutron monitor with 58 IGY-type counter tubes (Bütikofer, 1988) is housed on the roof of the Physikalisches Institut of the University of Bern.

Geographic latitude:	46.95 N
Geographic longitude:	7.456 E
Effective vertical cutoff rigidity, Epoch 2005.0:	4.4 GV
Altitude	570 m asl

This monitor has been in operation since 1977.

Preparation of GLE Data

The last full hour (in UT) before the onset of the particle increase at Earth was used as the baseline time interval, i.e. 20 January 2005, 0500 - 0600 UT.

The data given in the data files for the Jungfrauoch neutron monitors are listed in Table 1. For the Bern neutron monitor, the same data are given with the difference that the small-time data include 5- minute values only. All data are presented in the “Standard Format for Cosmic Ray Ground-Level Event Data” as suggested by Shea et al. (1987), and additions according to the document “STANDARD FORMAT FOR COSMIC RAY GROUND-LEVEL ENHANCEMENT DATA” at the GLE data base. The following names were used to identify the different monitors: JUNGFRAUJ for the 18-IGY and JUNGFRAU2 for the 3-NM64 neutron monitors at Jungfrauoch, BERN for the special neutron monitor in Bern.

Hourly data	19 January 2005	0000 - 2400 UT
	20 January 2005	0000 - 0500 UT
1-minute data	20 January 2005	0500 - 1900 UT
Hourly data	20 January 2005	1900 - 2400 UT
	21 January 2005	0000 - 2400 UT

Table 1: Data given in the data files for the Jungfrauoch neutron monitors.

All counting rates of the neutron monitors were normalized with the same correction factors as used for the publications on our website <http://cosray.unibe.ch> and for data sent to the world data centers. The factors for the time interval during the event are given in Table 2 for the different sections of the neutron monitors.

neutron monitor	section 1	section 2	section 3
IGY neutron monitor Jungfrauoch	0.885	0.908	0.792
NM64 neutron monitor Jungfrauoch	0.975	0.976	1.010
special neutron monitor Bern	1.067	1.000	1.060 / 1.000

Table 2: Correction factors used to normalize the counting rates of the neutron monitors during the event.

Pressure corrected hourly averages were obtained from pressure corrected 1-minute values. The hourly pressure values were obtained by averaging the 1-minute pressure readings.

Section 3 of the IGY neutron monitor at Jungfraujoch is the central section. Section 1 is west of section 3 (towards the building) and section 2 is east of section 3. In the NM64 neutron monitor Jungfraujoch section 1 is located toward the mountain, section 2 is the central section and section 3 is located toward the glacier. For the special neutron monitor in Bern section 1 is AL+AR+BL+BR and section 2 is CL+CR. In contrast to the data books where the count rates of the sections FL and FR are not taken into account, the data in this report include all sections of the special neutron monitor. Section 3 therefore is DL+DR+EL+ER+FL+FR. The correction factor for (DL+DR+EL+ER) is 1.060, whereas for (FL+FR) it is 1.000. For details see (Bütikofer, 1988).

In the special neutron monitor in Bern the counter tubes are placed at different positions relative to the absorbers. Therefore different barometric pressure coefficients were used for the pressure correction of the count rates of the different sections. The barometric pressure coefficients according to Bütikofer (1988) were used, see Table 3.

section	barometric coefficient in % / mmHg
AL, AR	-0.975
BL, BR	-0.961
CL, CR	-0.962
DL, DR	-0.920
EL, ER	-0.948
FL, FR	-0.928

Table 3: Barometric pressure coefficients for the special neutron monitor at Bern according to Bütikofer (1988)

The barometric pressure coefficient of -0.9557 % / mmHg given in line 3 of the header of the standard GLE format for the special neutron monitor in Bern corresponds to an average barometric pressure coefficient for the total count rate.

The pressure measurements at Jungfraujoch were disturbed by turbulent and high speed winds as can be seen from Figures 1-3. Figure 1 shows the maximum wind speed per hour at Jungfraujoch for the time interval 20-21 January 2005. In Figure 2 the atmospheric pressure measurements at the three locations of the neutron monitor stations: IGY and NM64 at Jungfraujoch (1-minute data) and special neutron monitor at Bern (5-minute data) are plotted for 20 January 2005, 0400-1200 UT. Figure 3 shows the difference between the 1-minute pressure measurements at the IGY and the N64 neutron monitor locations at Jungfraujoch, $\Delta p = p_{NM64} - p_{IGY}$, in function of time. No attempts have been made to correct the atmospheric pressure measurements (Bütikofer and Flückiger, 1999).

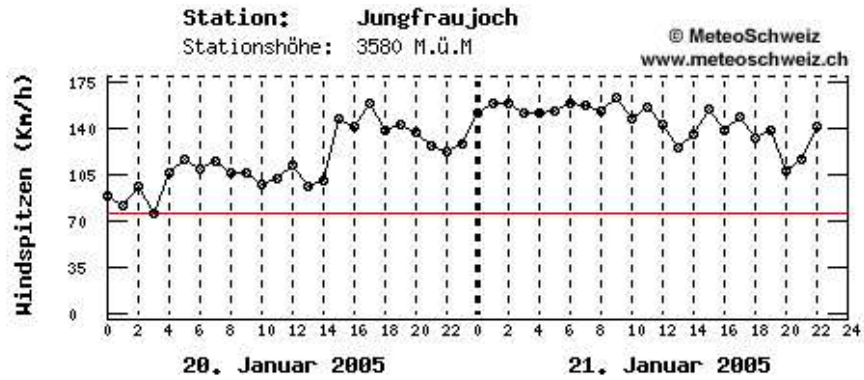


Figure 1: Maximum wind speed per hour at Jungfrauoch in the time interval 20-21 January 2005. Source: www.meteoschweiz.ch

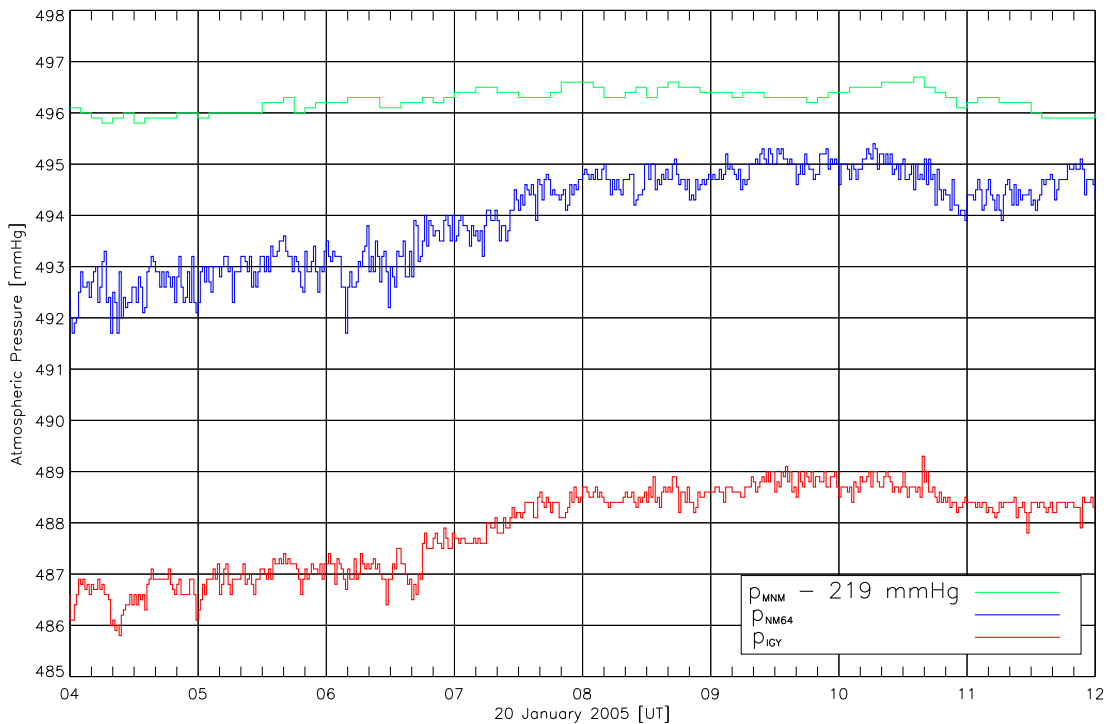


Figure 2: Atmospheric pressure measurements at the locations of the three Swiss neutron monitor stations: IGY and NM64 at Jungfrauoch (1-minute data) and special neutron monitor at Bern (5-minute data) on 20 January 2005, 0400-1200 UT.

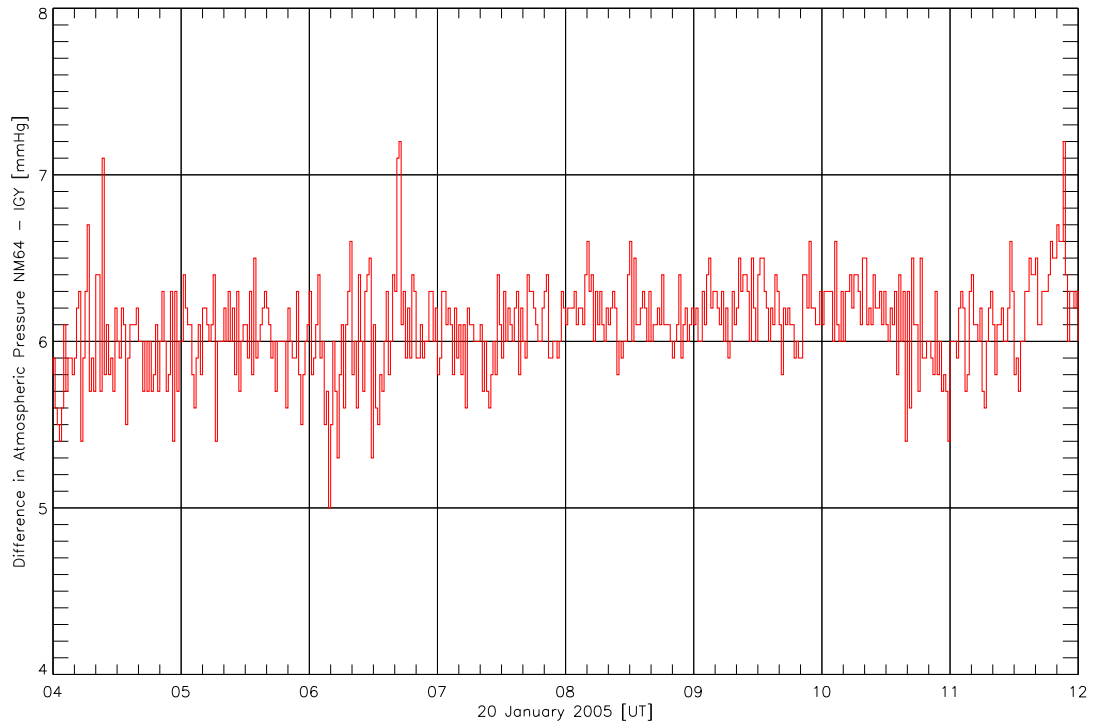


Figure 3: Difference of pressure measurements (1-minute data) between IGY and NM64 neutron monitor locations at Jungfrauoch in mmHg on 20 January 2005, 0400-1200 UT.

Measurements of Swiss neutron monitors

In the Figures 4-6 the relative pressure corrected counting rates of the Swiss neutron monitors are plotted for 20 January 2005, 0400-1200 UT.

To illustrate the influence of the pressure measurements affected by turbulent and high speed winds on the count rates of the neutron monitors the ratio (Not pressure corrected count rates)/(Pressure corrected count rates) are plotted in Figures 7-9.

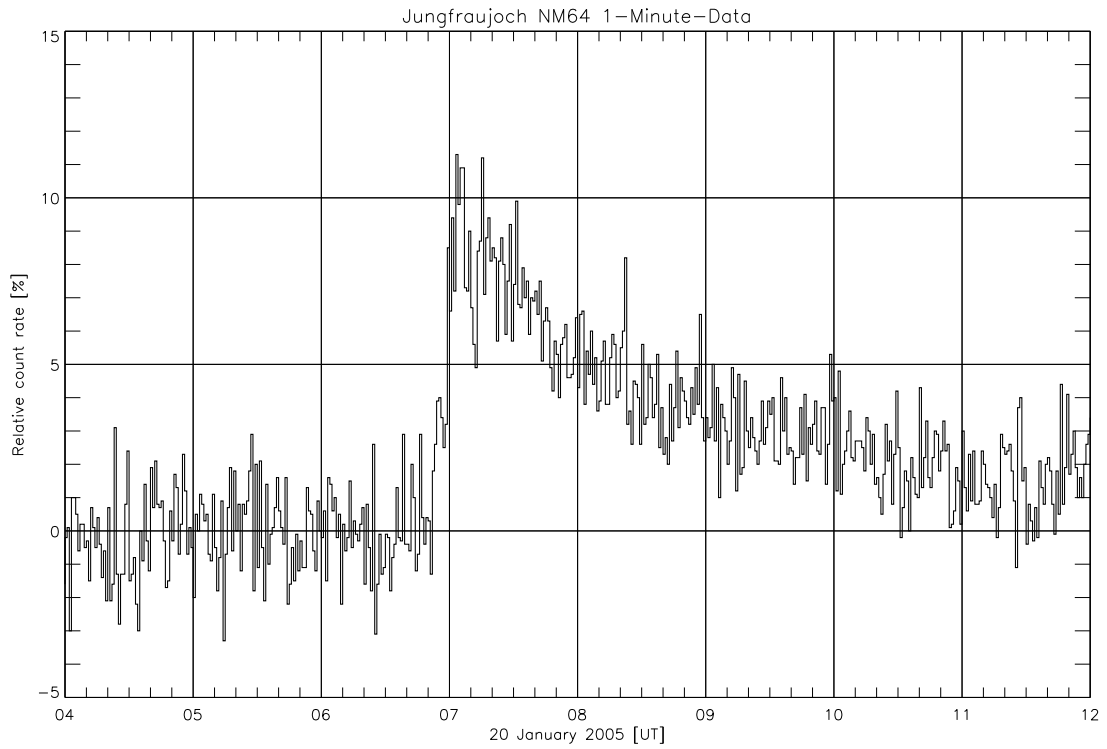


Figure 5: Relative pressure corrected 1-minute data of NM64 neutron monitor at Jungfrauoch on 20 January 2005, 0400-1200 UT.

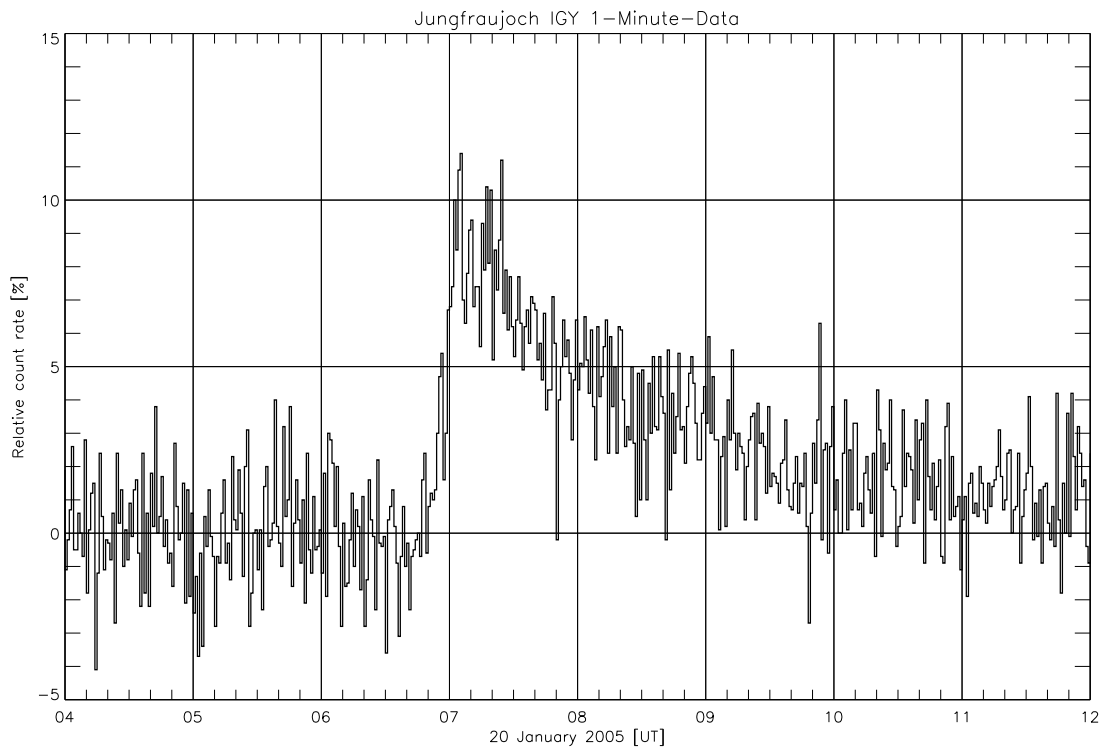


Figure 4: Relative pressure corrected 1-minute data of the IGY neutron monitor at Jungfrauoch on 20 January 2005, 0400-1200 UT.

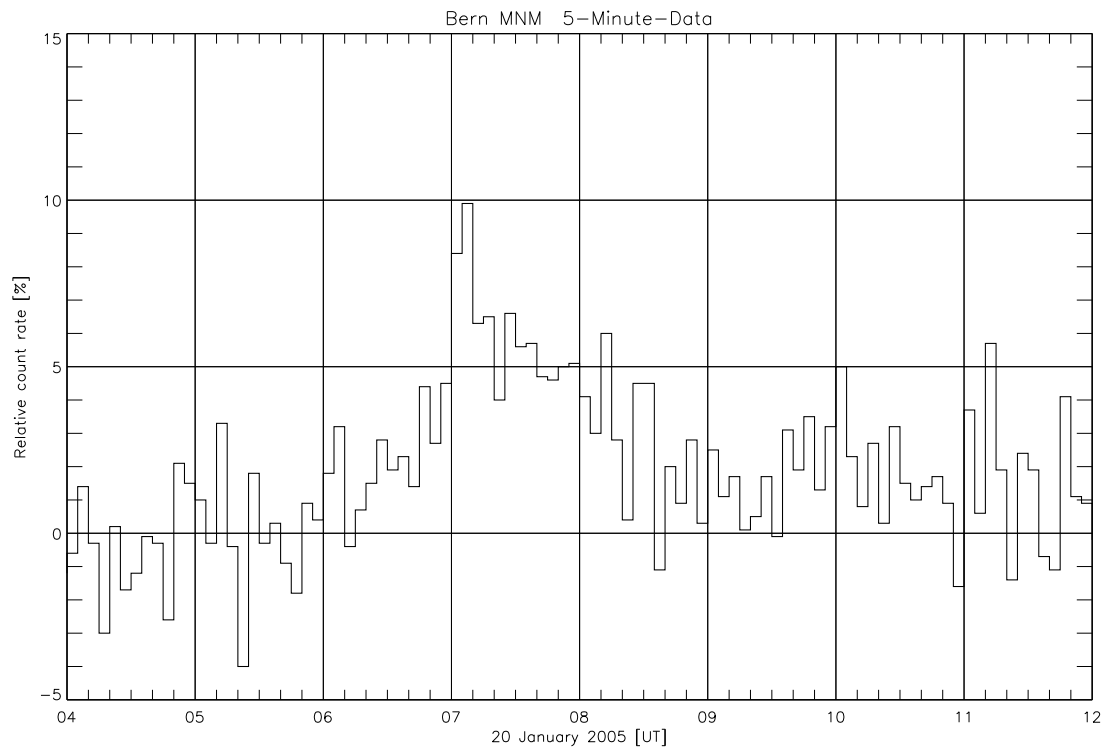


Figure 6: Relative pressure corrected 5-minute data of special neutron monitor at Bern on 20 January 2005, 0400-1200 UT.

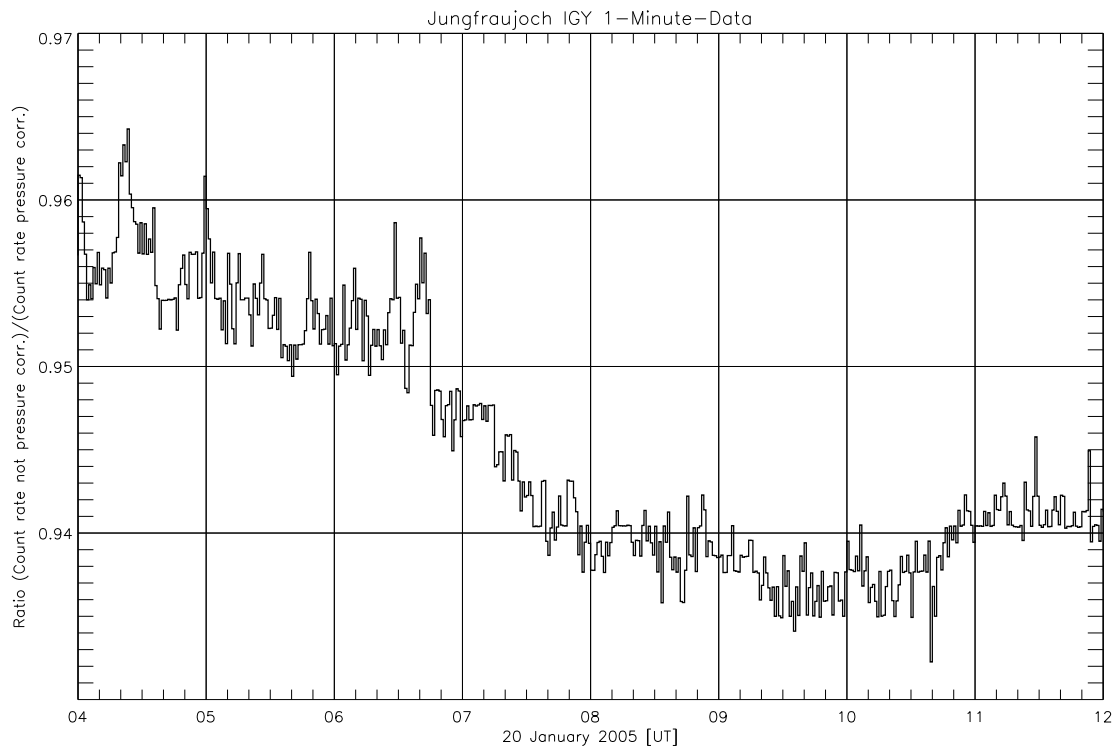


Figure 7: Ratio (Count rates not pressure corrected)/(Count rate pressure corrected) of 1-minute data of IGY neutron monitor at Jungfrauoch on 20 January 2005, 0400-1200 UT.

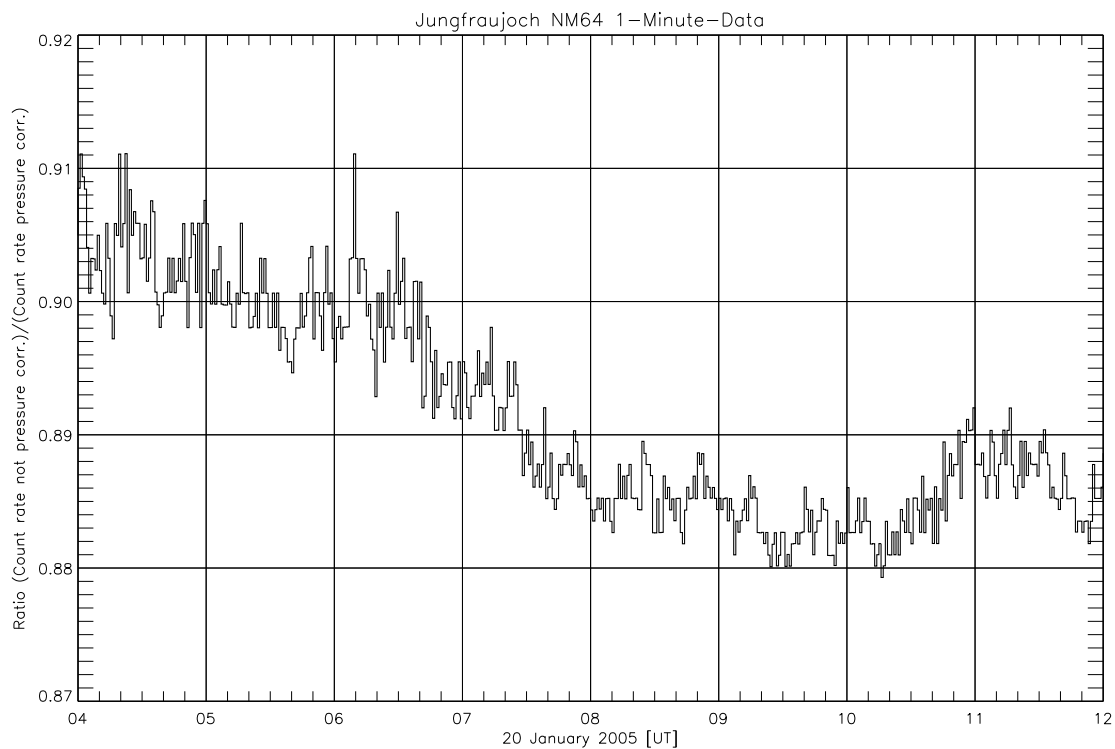


Figure 8: Ratio (Count rate not pressure corrected)/(Count rates pressure corrected) of 1-minute data of NM64 neutron monitor at Jungfraujoch on 20 January 2005, 0400-1200 UT.

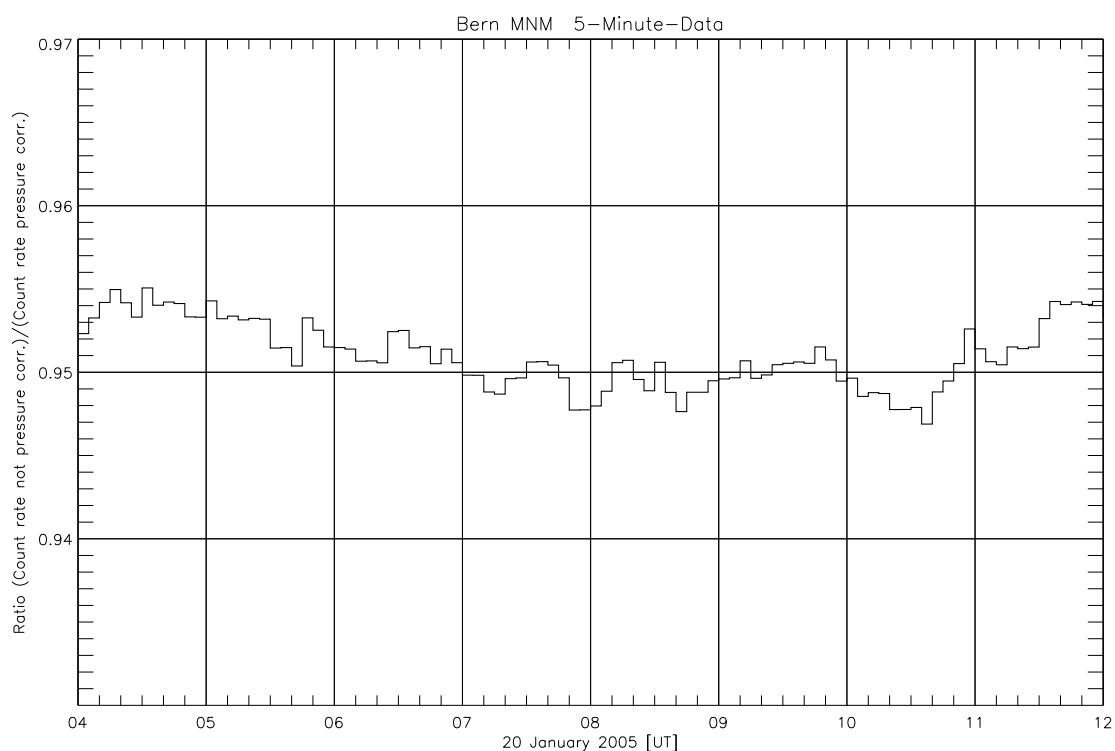


Figure 9: Ratio (Count rates not pressure corrected)/(Count rates pressure corrected) of 5-minute data of special neutron monitor at Bern on 20 January 2005, 0400-1200 UT.

In the following tables the characteristics (onset time, maximum) of the GLE data of the Swiss neutron monitors are listed.

IGY Jungfrauoch

1-minute values

Onset	0654 UT	
Pre-increase	0654-0657 UT	~4%
Max1	0705-0706 UT	11.4%
Max2	0724-0725 UT	11.2%

5-minute values

Onset	0650 UT	
Max1	0700-0705 UT	8.7%
Max2	0715-0720 UT	9.2%

NM64 Jungfrauoch

1-minute values

Onset	0652 UT	
Pre-increase	0652-0657 UT	~4%
Max1	0703-0704 UT	11.3%
Max2	0715-0716 UT	11.2%

5-minute values

Onset	0650 UT	
Max1	0705-0710 UT	9.1%
Max2	0715-0720 UT	8.9%

Special neutron monitor Bern

5-minute values

Onset	0645 UT	
Max1	0705-0710 UT	9.9%
Max2	0725-0730 UT	6.6%

Conditions for Use of Data

The Swiss neutron monitor data may be used under the following conditions:

1. You agree to acknowledge the source of the data in any published use. Example:
“Jungfrauoch neutron monitor data were kindly provided by the Cosmic Ray Group, Physikalisches Institut, University of Bern, University of Bern, Switzerland”
2. You agree to send a copy of any paper using these data to:
Erwin Flückiger
Physikalisches Institut
University of Bern
Sidlerstrasse 5
CH-3012 Bern / Switzerland
3. You may share these data with colleagues, provided you inform them of these conditions.

While the published data are accurate to the best of our knowledge, we reserve the right to correct errors without notifying users.

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References

- Bütikofer, R. (1988). *Zum Wiederaufbau des Multiplizitätsneutronenmonitors in Bern*. Master thesis, Physikalisches Institut, Universität Bern, Switzerland.
- Bütikofer, R. and E. Flückiger (1999). Pressure correction of neutron monitor measurements in turbulent winds (abstract). In *ISSI Workshop "Cosmic Rays and Earth, March 21-26, 1999*, Bern, Switzerland.
- Debrunner, H., E. Flückiger, and M. Schubnell (1987). Present and Future Activities of the Bern Cosmic Ray Group in the Field of Solar Neutrons. In *Workshop on Solar Neutrons; 20th International Cosmic Ray Conference*, Volume 9 of *Special Report of the A.F. Ioffe Physico-Technical Institute of the Academy of Sciences of the USSR*, Moscow.
- Schubnell, M. (1988). *Zum Nachweis solarer Neutronen auf Jungfrauoch*. Ph. D. thesis, Universität Bern, Switzerland.
- Shea, M., D. Smart, J. Humble, E. Flückiger, L. Gentile, and M. Nichol (1987). A revised standard format for cosmic ray ground-level event data. *20th ICRC, Moscow, Conference Papers 3*, 171.