Name of research institute or organization:

Physikalisches Institut, Universität Bern

Title of project:

Neutron monitors - Study of solar and galactic cosmic rays

Project leader and team:

Dr. Rolf Bütikofer

Project description:

The Physikalisches Institut at the University of Bern, Switzerland, operates two standardized neutron monitors (NM) at Jungfraujoch: an 18-IGY NM (since 1958) and a 3-NM64 NM (since 1986). NMs provide key information about the interactions of galactic cosmic radiation (GCR) with the plasma and the magnetic fields in the heliosphere and about the production of energetic CRs at or near the Sun (solar cosmic rays, SCR), as well as about geomagnetic, atmospheric, and environmental effects. They ideally complement space observations. The NMs at Jungfraujoch are part of a worldwide network of standardized CR detectors. By using the Earth's magnetic field as a giant spectrometer, this network determines the energy dependence of primary CR intensity variations in the GeV range. Furthermore, the high altitude of Jungfraujoch provides good response to solar protons $\geq$ 3.6 GeV and to solar neutrons with energies as low as ~250 MeV. Neutron monitors play also an important role in the space weather domain.

In 2013, the operation of the two NMs at Jungfraujoch was pursued without major problems. No significant technical modifications were necessary. The recordings of the NM measurements are published in near-real time in the neutron monitor database NMDB (www.nmdb.eu). Figure 1 shows the relative monthly count rates of the IGY neutron monitor at Jungfraujoch (lower panel) since it was put into operation in 1958. The GCR are always present, and their intensity shows an 11-year variation in anti-correlation with the solar activity characterized by the smoothed sunspot number plotted in the upper panel of Figure 1.

The radioactivity measurements with a GammaTracer and a Liulin device inside the detector housing of the NM64 neutron monitor were continued. In 2013 the GammaTracer device had to be revised (change of battery and recalibration). As the detector is operated inside a housing with a connection for power supply, we rebuilt the GammaTracer in such a way that it is supplied via a power supply. With this modification we hope that the GammaTracer can be operated for a long time without any interruption of the measurements.

May 2013 was a period with strong precipitation in the Bernese Oberland. At Jungfraujoch the precipitation manifested itself in large snow accumulations. As the detector housing of the IGY neutron monitor is located at the roof of the Sphinx laboratories, i.e. exposed to the wind, the snow is strongly shifted by the wind, and it results mostly in only a thin layer of snow on the roof of the detector housing. In addition, the custodians remove the snow from the roof at least once per day (usually in the early morning). The situation is quite different at and around the detector housing of the NM64 neutron monitor which is located on the roof of the research station. The housing is in the wind shadow of the slope on the North side. As a result the snow can easily accumulate on the roof and around the detector housing. The custodians do not remove the snow from the roof and fully around the detector housing because of the danger of avalanches. The snow is removed completely around the detector housing in springtime. Mainly the snow accumulation on the roof attenuates the flux of secondary cosmic ray particles hitting the neutron monitor and as consequence the counting rate of the neutron monitor is decreasing. Figure 2 shows the ratio of the hourly count rates of the two neutron monitors at Jungfraujoch for the time interval 20-31 May 2013.

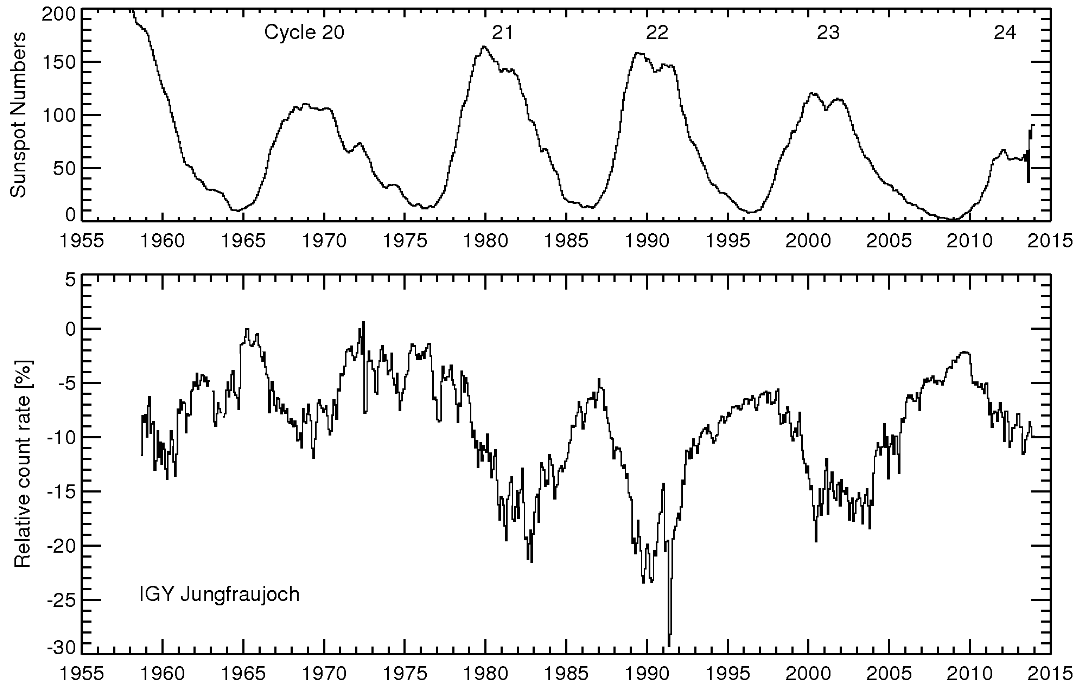

Figure 1. Smoothed sunspot numbers (top panel), pressure corrected monthly average counting rates of IGY neutron monitor at Jungfraujoch (bottom panel) for the years 1958-2013. The neutron monitor count rate is expressed in relative units with respect to May 1965.

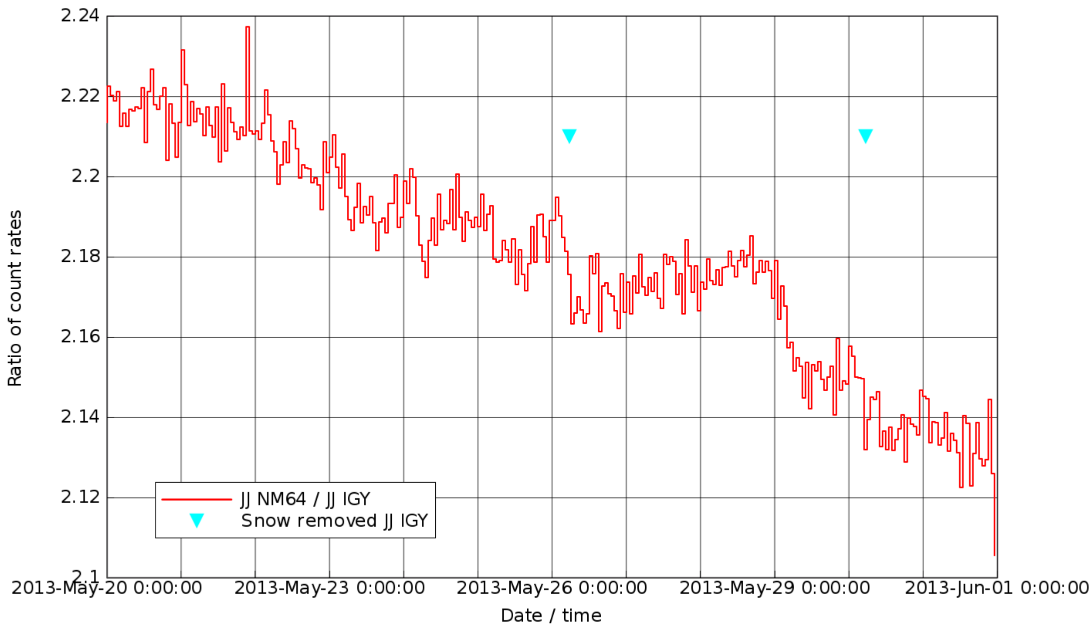

Figure 2. Ratio of hourly count rates of NM64 and IGY neutron monitors at Jungfraujoch for the time interval 20-31 May 2013. The blue triangles indicate times when large amounts of snow were removed from the roof of the IGY detector housing.

The ratio shows a clear trend that is produced by the effects described above. Periods with strong snow falls during the time interval under investigation are 22-25 May 2013 and on 29 May 2013. Large amounts of wet snow were removed from the detector housing of the IGY neutron monitor on 26 May 2013 at 0545 UT (30 cm) and on 30 May 2013 at 0535 UT (25 cm), indicated by the light blue triangles in Figure 2. Different operators of neutron monitor stations propose to correct the neutron monitor data for snow effects based on the measurements of a nearby neutron monitor station which is not influenced by the snow effect. The nearest neighbour neutron monitor stations of Jungfraujoch are Rome and Kiel. However, these two stations are located close to sea level and therefore have a different response. Figure 3 shows different ratios of the count rates of the neutron monitor stations Jungfraujoch IGY, Rome, and Kiel. From the plot it is evident that the correction of the neutron monitor count rate for the snow effect is not possible based on only the data of nearby neutron monitor stations. The approximate water equivalent of the snow layer and its spatial distribution on and around the detector housing versus time are also needed for a reliable correction of the neutron monitor count rate for the snow effect. As the routine recording of these data is very laborious we do not make any data correction for the snow effect on the data of the Jungfraujoch neutron monitors. However, we give the information about snow fall, about the removal of snow from the detector housing, and other circumstances that may influence the neutron monitor measurements in the meta data table of NMDB.

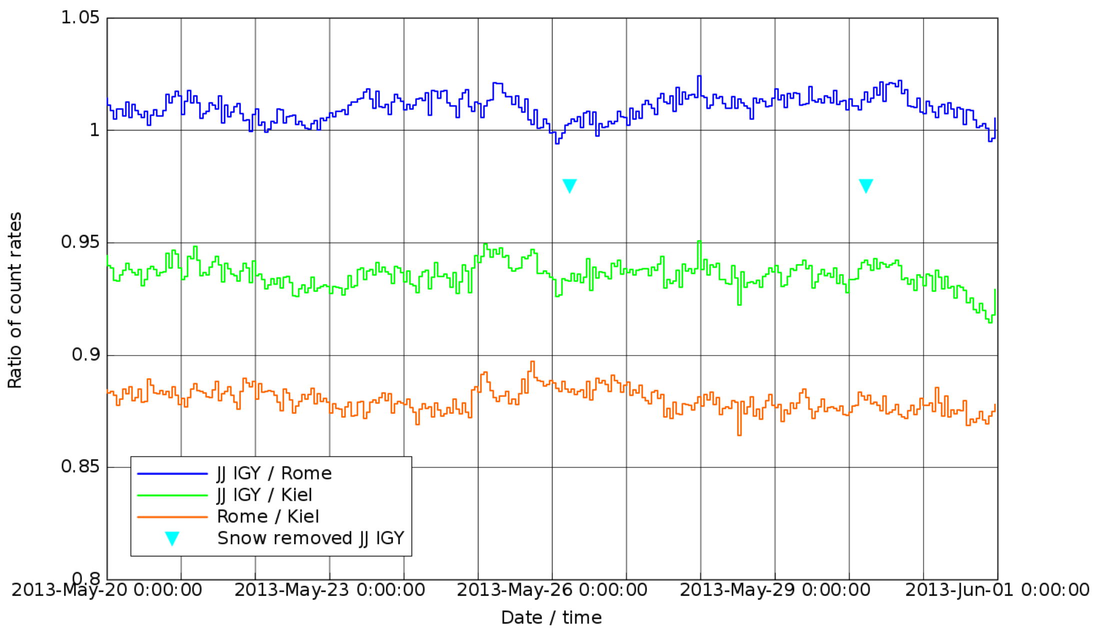

Figure 3. Different ratios of hourly count rates of Jungfraujoch IGY, Rome, and Kiel neutron monitor stations for the time interval 20-31 May 2013. The light blue triangles indicate times when large amounts of snow were removed from the roof of the Jungfraujoch IGY detector housing.

Key words:
Astrophysics, cosmic rays, neutron monitors, solar, heliospheric and magnetospheric phenomena

Internet data bases:
http://cosray.unibe.ch

Collaborating partners/networks:

International Council of the Scientific Union's (ICSU) Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)
World Data Centers A (Boulder), B (Moscow), C (Japan), International GLE database
European FP7 Project Real-Time Database for High Resolution Neutron Monitor Measurements (NMDB): http://www.nmbd.eu

Scientific publications and public outreach 2013:

Conference papers

Bütikofer, R., E.O. Flückiger, Y. Balabin and A. Belov, The reliability of GLE analysis based on neutron monitor data – a critical review, Conference Proceedings, 33rd International Cosmic Ray Conference, Rio de Janeiro, Brazil, 2013.

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