Name of research institute or organization:

Physikalisches Institut, Universität Bern

Title of project:

Study of solar and galactic cosmic rays

Part of this programme:

NMDB

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 energy range ~500 MeV to ~20GeV. Furthermore, the high altitude of Jungfraujoch provides a good response to solar protons ≥ 3.6 GeV and to solar neutrons with energies as low as ~250 MeV. Neutron monitors also play an important role in the space weather domain.

In 2017, operation of the two NMs at Jungfraujoch was pursued without major problems. No technical modifications were necessary. The recordings of the NM measurements are published in near real-time in the neutron monitor database NMDB (http://www.nmdb.eu).

The dosimetric measurements with a GammaTracer device inside the detector housing of the NM64 neutron monitor were continued in 2017.

The first days in September 2017 were characterized by intense solar activity. On 06.09.2017 the solar active region 2673 produced an X9.3 flare and was about to rotate across the western solar limb. Activity seemed to be decreasing on 9/10 September 2017, i.e. no major flare was expected. However, on 10.09.2017 the active region 2673 produced an X8.2 flare with starting time 1535 UT and peak time at 1606 UT. The active region was located at S08 W88 on the Sun, i.e. close to the foot points of the interplanetary magnetic field lines that connect the Sun with the Earth. Indeed on 10.09.2017 the neutron monitor station Fort Smith (60.02°N, 248.07°E, sea level) observed a clear onset of increased count rate after 1610 UT whereas other neutron monitor stations of the worldwide network measured a gradual increase in the counting rate that probably started at about the same time as the station at Fort Smith or a few minutes later (Inuvik, South Pole, Yakutsk). Figure 1 shows the relative 5-minute count rate increase of the stations Fort Smith, Inuvik, South Pole as well as of the two neutron monitors at Jungfraujoch. The maximum increase was observed by the neutron monitor station Fort Smith with only about 6% in the time interval 1650-1655 UT, i.e. about 40 minutes after the onset. Neutron monitor stations at mid-latitudes, as e.g. the stations at Jungfraujoch, did not detect SEPs during this ground level enhancement (GLE), as can be seen from Figure 1. The event on 10.09.2017 was only the second GLE in the current solar cycle after the event on 17.05.2012 and has the number GLE72. The first observed GLE, i.e. GLE1, occurred on 28.02.1942. Between 1942 and 2017, i.e. in 75 years, 72 GLEs were observed, thus about one GLE per year. It became apparent that the probability of GLE occurrence is higher during the solar activity maximum and during the initial phase of the

decrease after the solar activity maximum. As we reported in the Activity Report 2016, the current solar activity cycle (solar cycle 24) is not very active. The smoothed monthly total sunspot number was maximal only at about 100 sunspots, whereas it was typically between about 150 and 230 during the past solar cycles. This low solar activity may be the reason that the GLE frequency was very low during solar cycle 24, only two GLEs since the start of this solar cycle in December 2008. GLE72 in September 2017 occurred about 3.4 years after the solar activity maximum when the monthly mean total sunspot number was only 43.7.

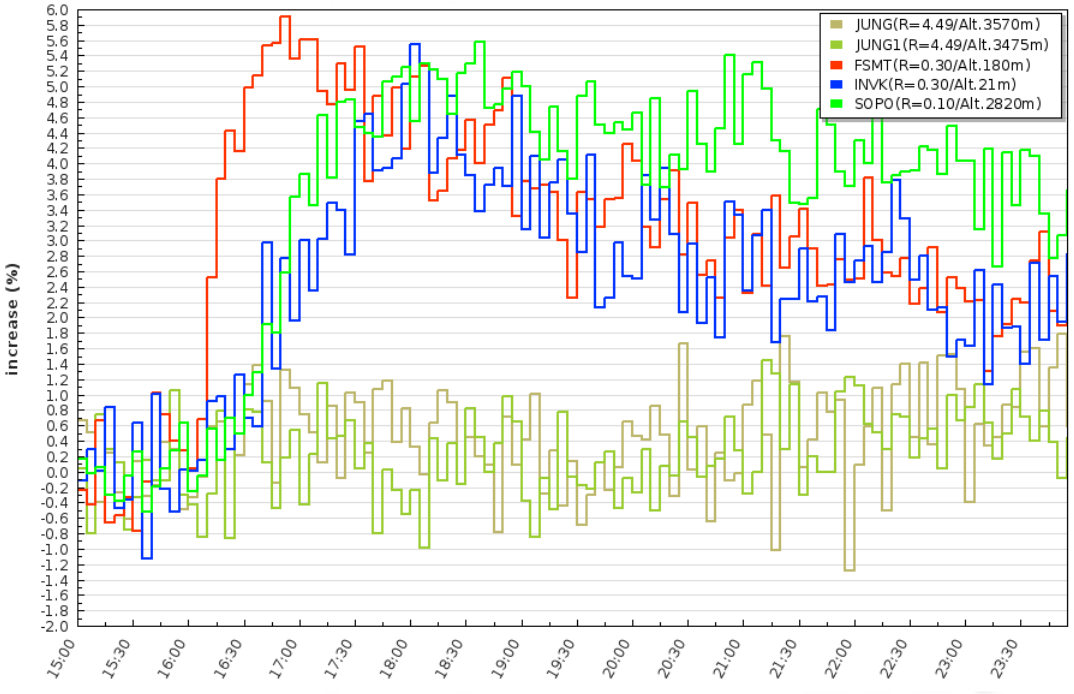

Figure 1. Relative pressure corrected 5-minute values of the neutron monitor stations Fort Smith, Inuvik, South Pole, Jungfraujoch IGY and NM64 during the GLE on 10 September 2017 for the time interval 2017-09-10, 1500 UT until 2017-09-10, 2400 UT. Plotted with NEST (http://www.nmdb.eu).

Key words:

Astrophysics, cosmic rays, neutron monitors; solar, heliospheric and magnetospheric phenomena

Internet data bases:

http://cosray.unibe.ch

Collaborating partners/networks:

European FP7 Project Real-Time Database for High Resolution Neutron Monitor Measurements (NMDB): http://www.nmdb.eu

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