

Name of research institute or organization:

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**Physikalisches Institut, Universität Bern**

Title of project:

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Study of solar and galactic cosmic rays

Part of this programme:

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NMDB

Project leader and team:

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Dr. Rolf Bütikofer

Project description:

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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  $\sim 250$  MeV. Neutron monitors play also an important role in the space weather domain.

In 2016, 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 ([www.nmdb.eu](http://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 a variation of about 11 years in anti-correlation with the solar activity characterized by the monthly mean total sunspot number plotted in the upper panel of Figure 1.

Figure 2 shows the superposition of the 13-month smoothed monthly total sunspot numbers over the solar activity cycles from cycle 20 through cycle 24. The starting point is each time the lowest smoothed monthly total sunspot number between two solar activity cycles. The duration of the last solar activity cycle (cycle 23, blue curve in Figure 2) was with more than 12 years longer than the typical length of around 11 years. In contrast, the length of the current activity solar cycle (cycle 24, red curve in Figure 2) will probably be shorter, maybe less than 10 years, although the gradient of the curve may still decrease significantly in the next months and the duration of cycle 24 become longer than expected. The maximum smoothed monthly sunspot number during cycle 24 was about 35% smaller than during cycle 23, i.e. the solar activity was not very high in the current solar activity cycle. In consequence, no large drops of the galactic cosmic ray intensity near Earth were observed by the worldwide network of neutron monitors. These so-called Forbush decreases are caused by traveling coronal mass ejections (CMEs) beyond the Earth's orbit. In addition, the neutron monitors so far only observed one clear solar energetic particle (SEP) event during the current solar activity cycle. This SEP event on 17 May 2012 was however only observed by high latitude neutron monitor stations, i.e. it was not seen by the two neutron monitors at Jungfraujoch.

The dosimetric measurements with a GammaTracer and a Liulin device inside the detector housing of the NM64 neutron monitor were continued in 2016.

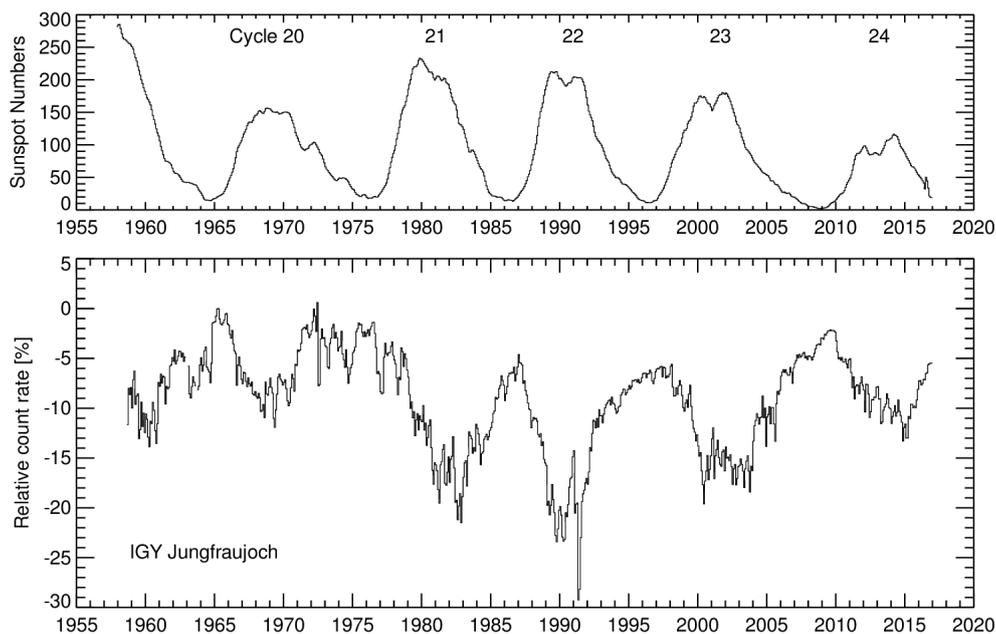


Figure 1. Smoothed monthly total sunspot numbers (Source: WDC-SILSO, Royal Observatory of Belgium, Brussels ([www.sidc.be/silso/datafiles](http://www.sidc.be/silso/datafiles)), top panel), relative pressure corrected monthly average counting rates of IGY neutron monitor at Jungfraujoch (bottom panel) for the years 1958-2016. The neutron monitor count rate is expressed in relative units with respect to May 1965.

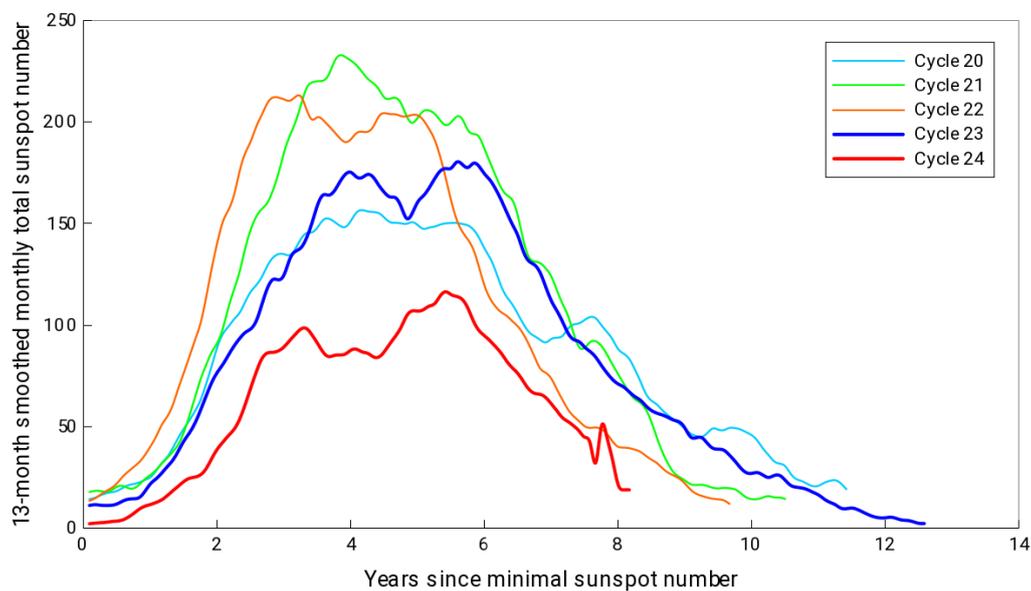


Figure 2. Superposition of the 13-month smoothed monthly total sunspot numbers of the solar activity cycles 20-24 where the starting point of each curve is the time of the lowest sunspot number.

Key words:

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

Internet data bases:

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<http://cosray.unibe.ch>

Collaborating partners/networks:

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

Address:

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