Geophysical Research Abstracts
Vol. 21, EGU2019-17590-1, 2019
EGU General Assembly 2019

Correcting near-surface neutron measurements for incoming cosmic-ray fluxes

Kalindi Shah (1), Steffen Zacharias (2), Markus Köhli (3,7), Tatsuhiko Sato (4), Jannis Weimar (3), Roland Baatz (5), Konstantin Herbst (6), and Martin Schrön (2)

(1) SVNIT, Ichchhanath, Surat 395007, Gujarat, India, (2) UFZ Helmholtz Centre for Environ. Res., Monitoring and Exploration Technologies, Leipzig, Germany, (3) Physikalisches Institut, Heidelberg University, Germany, (7) Physikalisches Institut, University of Bonn, Germany, (4) Nuclear Science and Engineering Center , Japan Atomic Energy Agency (JAEA), (5) Forschungszentrum Jülich, Germany, (6) Institute of Experimental and Applied Physics, University of Kiel, Germany

Neutron monitors on the Earth's surface are usually used to track the dynamics of incoming, high-energy cosmic-ray neutrons under the assumption that local environmental conditions are not influencing the signal. Oppositely, in a recently established research field the local environmental conditions are monitored by detecting low-energy albedo neutrons. In order to relate the local neutron flux to water storage dynamics, the modulation by incoming cosmic-ray neutrons needs to be removed from the signal.

Neutron monitors on the Earth's surface are usually used to track the dynamics of incoming, high-energy cosmic-ray neutrons under the assumption that local environmental conditions are not influencing the signal. Oppositely, in a recently established research field the local environmental conditions are monitored by detecting low-energy albedo neutrons. In order to relate the local neutron flux to water storage dynamics, the modulation by incoming cosmic-ray neutrons needs to be removed from the signal.

By convention, data from neutron monitors are served as a reference for the correction of the
local CRNS (Cosmic Ray Neutron Sensors) detectors. The correction approach assumes a proportional relationship between
the local low-energy flux at the measurement location and the high-energy flux measured at a distant neutron monitor
location. Observations have shown that this approach is unreliable because it does not account for geomagnetic displacement, specific energy windows of the detectors, or potential influence of different meteorological conditions at both locations. The performance during extrema of solar activity events is particularly poor and signals from different locations appear to be inconsistent.

To overcome the issues of sparse and inconsistent neutron monitor data, we suggest to use data from the PARMA/PHITS model (Sato et al., 2018). It is capable of simulating cosmic-ray neutrons everywhere and anytime on Earth. The model uses data from several different neutron monitors and regionalizes the obtained fluxes in a consistent and parameterized way across time and space. With the help of this model, we can exactly specify the right location, altitude, energy range, and point in time where the correction of incoming fluxes is needed.

We found that the method improved the performance of cosmic-ray neutron sensors to detect soil water changes, particularly in periods of high cosmic-ray variability. As the demand for accurate observations and predictions of environmental states and fluxes is globally increasing, the correction for incoming radiation and meteorological effects should
become a key challenge in the research field of terrestrial cosmic-ray neutron sensing.