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Correction of near-surface neutron measurements using incoming cosmic-ray fluxes from neutron monitors

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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 consulted to serve as a reference for the correction of the local detectors for environmental purposes. The correction approach assumes a proportional relationship between the local low-energy flux at the measurement location and the high-energy flux at a distant neutron monitor location. Observations have shown that this approach is unreliable because it does not account for geographical displacement, different energy windows of the detectors, or potential influence of meteorological conditions on the referenced neutron monitor. The performance during solar activity events is particularly poor.

The neutron monitor stations are sparse on Earth and signals from different locations appear to be inconsistent. Various stations show significant differences in terms amplitude, time lag, and other subtle features even if their local cutoff rigidities are similar. The signals also show different behaviour on daily time scales.

The corresponding uncertainties of the scaling of incoming neutron radiation directly propagate to the performance of local neutron detectors. 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 cosmic-ray neutron sensing.