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Monitoring Environmental Water with Ground Albedo Neutrons from Cosmic Rays

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Neutron monitors on Earth are usually used to track the dynamics of incoming cosmic-ray particles under the assumption that local environmental conditions do not influence the highly shielded signal. Oppositely, in a young research field the local dynamics of environmental water is monitored by detecting less moderated cosmic-ray neutrons. Water in soil, air, snow and vegetation determines the amount of ground albedo neutrons in the sensitive energy range from 1 eV to 100 keV. Plenty of small neutron detectors have been installed on natural or agricultural sites throughout the USA (>50), Europe (>30), Africa (>4), Asia (>2), and Australia (>5), and more to follow. Climate research, hydrologic models and irrigation management rely on the data, which represents area-average water content within tens of hectares due to the fast diffusion of neutrons in air. A major issue is the modulation of the count rate by the dynamics of incoming cosmic-ray neutrons. Conventionally, independent data from neutron monitors are consulted to serve as a reference for the correction of the local detectors. However, the performance of this comparative correction approach is unreliable, because it does not account for displacement (cutoff rigidity, altitude), different energy window, or potential influence of atmospheric conditions on the referenced neutron monitor. In addition, neutron monitor stations are sparse on Earth, and occasionally signals from different locations appear to be significantly inconsistent. The presentation shows how ground albedo neutrons from cosmic-rays are applied to environmental research, and emphasizes the need for a reliable correction for the incoming flux. Being part of a young adjacent community, we like to learn from the experience of cosmic-ray scientists and to discuss correction approaches that account for spatio-temporal variations of incoming cosmic rays at any place on Earth.

Collaboration

– not specified –

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Author: Mr SCHRÖN, Martin (Helmholtz Centre for Environmental Research - UFZ)

Co-authors: Mr WEIMAR, Jannis (Helmholtz Centre for Environmental Research - UFZ); Mr KÖHLI, Markus (Physics Institute, University of Heidelberg); Mr DIETRICH, Peter (Helmholtz Centre for Environmental Research - UFZ); Mr ZACHARIAS, Steffen (Helmholtz Centre for Environmental Research - UFZ)

Presenter: Mr SCHRÖN, Martin (Helmholtz Centre for Environmental Research - UFZ)

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