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Validation potential for Remote Sensing soil moisture products using Cosmic-Ray Neutron Sensing

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Soil moisture is a key variable to our understanding of heat and water fluxes at the land-atmosphere interface. Satellite-based remote sensing instruments offer soil moisture data sets with global coverage that help advancing climate modeling and weather forecast models. However, the development of algorithms to estimate soil moisture from these satellite missions is complex and depends on several other parameters such as vegetation cover and surface roughness.

This demands for comprehensive reference data sets to validate and calibrate satellite products against but faces a challenge in spatial resolution: Traditional in situ methods measure on a representative horizontal scale of few meters while satellite instrumentation offers a much coarser resolution of hundreds of meters to tens of kilometers. Cosmic-ray neutron sensing (CRNS) fills this measurement gap by averaging over the moisture content of the upper soil layers within a footprint of approximately ten hectares. Mobile applications of CRNS extend the method's coverage to up to a square kilometer. In the recent years the interest was set to understanding neutron transport by Monte-Carlo simulations for complex environmental topographies. As a conclusion, its remarkable performance in signal interpretation allows for a promising prospect of more comprehensive data quality.

With snapshot measurements of soil moisture with a spatial resolution of 50 m and a coverage of up to 1 km^2 using mobile CRNS, high-quality data sets can be obtained as ground truthing for remote sensing products. These on demand campaigns can cover different land types and may be combined with existing sensor networks in order to improve soil moisture retrieval algorithms for satellite-based instruments.