Quantitative Influence of Soil Properties on Mobile Cosmic-Ray Neutron Sensing

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Soil moisture is a key variable for meteorological and hydrological models. During the last years the Cosmic-Ray Neutron Sensing (CRNS) methodology has played an important role to estimate soil moisture non-invasively. The sensor's footprint provides an average soil moisture value for tens of hectares in area and tens of centimeters in depth. With the mobile CRNS we are able to provide a new quality of data describing the magnitude and spatial variability of soil moisture at the regional scale. However the mobile CRNS is sensitive to all kinds of hydrogen sources, like soil and surface water, lattice water, organic material, as well as to the soil bulk density. Soil maps provide key information about soil distribution and soil structures but can be fraught with considerable uncertainties arising from a number of factors. Usually little to no information about the extent and character of these uncertainties is provided. To learn more about the dependency of neutron counts to soil properties and saturation level, we performed several dedicated experiments and theoretical simulations. The neutron transport model URANOS (Ultra Rapid Neutron-Only Simulation) was used to simulate the reflection of neutrons above soils with various material properties. Furthermore we applied the CRNS Rover in field and lab experiments to test the theoretical results. The obtained analytical relationships between neutrons and soil properties will be used to improve the analysis and interpretation CRNS in heterogeneous terrain.