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Calibration of Cosmic Ray Neutron Probes in complex systems: open research issues

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Soil moisture is a key variable for environmental monitoring, hydrological and climate change research as it controls mass and energy fluxes in the soil-plant-atmosphere continuum. Actual soil moisture monitoring methods are capable of providing observations either at a very big spatial scale and timely spotty satellite observations or at a very small scale and timely continuous point measurements. In this framework, meso-scale timely continuous measurements appear of key relevance, thus, recently, Cosmic Ray Neutron Sensing (CRNS) is gaining more and more importance, because of its capacity to deliver long time-series of observations within a footprint of $\sim$500m of diameter. Even if during the last years a remarkable number of papers have been published, the calibration of Cosmic Ray Neutron Probes (CRPs) in heterogeneous ecosystems is still an open issue. The CRP is sensitive to all the Hydrogen species and their distribution within the footprint, thus in environments that can be assumed as homogeneous a good accordance between the CRNS data and observed soil moisture can be reached, but, where Hydrogen distributions are complex, different calibration campaigns lead to different results. In order to improve the efficiency of the method, a better understanding of the effects of combined spatial and temporal variability has to be reached. The aim of the actual work is to better understand the effects of multiple Hydrogen sources that vary in time and space and evaluate different approaches in calibration over complex terrain in a mountain area. We present different calibration approaches used for an alpine pasture, which is a research site of the LTER network in South-Tyrol (Italy). In the study site long-term soil moisture observations are present and are used for remote-sensing data validation. For this specific and highly heterogeneous site, the effects of heterogeneous land-cover and topography on CRP calibration are evaluated and some hypotheses on the major sources of uncertainty are formulated.