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Cosmic Ray Neutron sensing in complex systems

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Soil moisture is a key variable in environmental monitoring and modelling: being located at the soil-atmosphere boundary, it is a driving force for water, energy and carbon fluxes. Nevertheless its importance, soil moisture observations lack of long time-series at high acquisition frequency in spatial meso-scale resolutions: traditional measurements deliver either long time series with high measurement frequency at spatial point scale or large scale and low frequency acquisitions. The Cosmic Ray Neutron Sensing (CRNS) technique fills this gap because it supplies information from a footprint of ∼240m of diameter and 15 to 83 cm of depth at a temporal resolution varying between 15 minutes and 24 hours. In addition, being a passive sensing technique, it is non-invasive.
For these reasons, CRNS is gaining more and more attention from the scientific community. Nevertheless, the application of this technique in complex systems is still an open issue: where different Hydrogen pools are present and where their distributions vary appreciably with space and time, the traditional calibration method shows some limits. In order to obtain a better understanding of the data and to compare them with remote sensing products and spatially distributed traditional measurements (i.e. Wireless Sensors Network), the complexity of the surrounding environment has to be taken into account.
In the current work we assessed the effects of spatial-temporal variability of soil moisture within the footprint, in a steep, heterogeneous mountain grassland area. Measurement were performed with a Cosmic Ray Neutron Probe (CRNP) and a mobile Wireless Sensors Network. We performed an in-deep sensitivity analysis of the effects of varying distributions of soil moisture on the calibration of the CRNP and our preliminary results show how the footprint shape varies depending on these dynamics. The results are then compared with remote sensing data (Sentinel 1 and 2). The current work is an assessment of different calibration procedures and their effect on the measurement outcome. We found that the response of the CRNP follows quite well the punctual measurement performed by a TDR installed on the site, but discrepancies could be explained by using the Wireless Sensors Network to perform a spatially weighted calibration and to introduce temporal dynamics.