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Cosmic-Ray neutron sensing for - but not only - field soil moisture measurements.

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Cosmic-ray neutron sensing (CRS) is a valuable non-invasive method to estimate soil moisture at field scale and depths down to about 40 cm. Thus, it provides to be a unique approach for several applications in hydrology and water related sectors. However, some studies showed that the CRS signal is affected not only by soil moisture but all other hydrogen pools could also play an important role (e.g., biomass, canopy interception etc.). For this reason, the functional equation used to relate CRS signal directly to soil moisture found some limitations and several corrections had to be introduced e.g., accounting for lattice water, organic carbon and water vapor. Overall, the studies showed that it is important to understand the relative importance of several hydrogen contributions on the CRS signal for the proper application of the method.
In the present study CRS was used in an experimental cropped field close to Berlin (Germany). Data were collected during three years and compared with direct soil samples as well as point soil moisture measurements. A soil moisture scaling approach is proposed and used to evaluate the contribution of the different time-varying hydrogen pools on the CRS signal. The results confirm that the main contribution on CRS is soil moisture, as expected. Thus, CRS is able to reproduce field soil moisture measurements with a good accuracy. However, the scaling approach applied also shows how biomass water equivalent and rainfall interception play an important role at different temporal scales. Overall, the study on one hand underlines that additional corrections should be introduced. On the other hand, it shows how CRS could be applied to estimate these additional quantities given measurements of the other pools. In conclusion, the results suggest that using a functional relation between CRS signal and equivalent water storage (mm) would facilitate the calibration, the interpretation of the signal and the application of this method.