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Quantification of seasonal biomass effects on cosmic-ray soil water content determination

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Cosmic-ray soil moisture probes (CRS) utilize the fact that high-energy cosmic-ray neutrons are moderated (slowed to lower energies) as they most effective collide with terrestrial hydrogen atoms contained in water molecules. Low-energy cosmic-ray neutron intensity near the ground is therefore a measure of the water content of nearby soils and any water on the ground.
In this study we present calibration results of a cosmic-ray soil moisture network in the Rur catchment, Germany. We propose a method to correct for above ground biomass vegetation effects on neutron flux density to improve soil water content estimates from cosmic-ray measurements. The correction for above ground water equivalents aims to remove biases in soil water content measurements on sites with high seasonal vegetation dynamics such as agricultural fields. Above ground biomass is estimated as function of the normalized difference vegetation index using regression equations. The regression equations were obtained from literature information, ground-based control measurements, a crop growth model and globally available data from the Moderate Resolution Imaging Spectrometer (MODIS). The results show that above ground biomass could be well estimated during the first half of the year. Seasonal changes in vegetation water content yielded biases in soil water content of $\sim$0.05 cm^3/cm^3 that could be corrected for with the vegetation correction. The vegetation correction has particularly high potential when applied at long term cosmic-ray monitoring sites and the cosmic-ray rover.