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Assessment of soil moisture dynamics on an irrigated maize field using cosmic ray neutron sensing

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In recent years cosmic ray neutron sensing (CRS) developed as a valuable, indirect and non-invasive method to estimate soil moisture at a scale of tens of hectares, covering the gap between point scale measurements and large scale remote sensing techniques. The method is particularly promising in cropped and irrigated fields where invasive installation of belowground measurement devices could conflict with the agricultural management. However, CRS is affected by all hydrogen pools in the measurement footprint and a fast growing biomass provides some challenges for the interpretation of the signal and application of the method for detecting soil moisture. For this aim, in this study a cosmic ray probe was installed on a field near Braunschweig (Germany) during one maize growing season (2014). The field was irrigated in stripes of 50 m width using sprinkler devices for a total of seven events. Three soil sampling campaigns were conducted throughout the growing season to assess the effect of different hydrogen pools on calibration results. Additionally, leaf area index and biomass measurements were collected to provide the relative contribution of the biomass on the CRS signal. Calibration results obtained with the different soil sampling campaigns showed some discrepancy well correlated with the biomass growth. However, after the calibration function was adjusted to account also for lattice water and soil organic carbon, thus representing an equivalent water content of the soil, the differences decreased. Soil moisture estimated with CRS responded well to precipitation and irrigation events, confirming also the effective footprint of the method (i.e. radius 300 m) and showing occurring water stress for the crop. Thus, the dynamics are in agreement with the soil moisture determined with point scale measurements but they are less affected by the heterogeneous moisture conditions within the field. For this reason, by applying a detailed calibration, CRS proves to be a valuable method for the application on agricultural sites to assess and improve irrigation management.