Geophysical Research Abstracts
Vol. 17, EGU2015-10363, 2015
EGU General Assembly 2015


# Soil moisture sensing with cosmic ray neutron probes: Do forests and other low-count locations call for additional calibration?

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Cosmic ray neutron sensors are bridging the scale gap between point measurements and remotely sensed data of soil moisture. We present a best practice for the calibration of cosmic ray neutron sensors in areas with low count rates (<1000 counts/hour). These areas can include low altitude and high latitude regions as well as forested areas where the sensor is situated below the canopy. After calibrating a sensor ten times within a single year it became clear that individual calibrations at different points in time yield a soil moisture-neutron count relationship that cannot be described by the Desilets et al. (2010) calibration function. Neither can it be explained by the dynamics in canopy biomass (we analyzed the influence of growing and falling leaves and water redistribution within the vegetation surrounding the instrument). Our empirically determined function appears to be flatter, i.e. a decrease in soil moisture causes a smaller increase in neutron counts than would be expected from the Desilets calibration function. Therefore we cannot assume that the calibration function has a constant shape irrespective of the measurement location. In order to yield consistent soil moisture measurements we thus recommend a two-point calibration with one of the calibrations being performed during high soil moisture conditions and a second one during low soil moisture conditions.