Geophysical Research Abstracts
Vol. 15, EGU2013-1089, 2013
EGU General Assembly 2013

Ground Albedo Neutron Sensing (GANS) method for measurements of soil moisture in cropped fields

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Measurement of soil moisture at the plot or hill-slope scale is an important link between local vadose zone hydrology and catchment hydrology. However, so far only few methods are on the way to close this gap between point measurements and remote sensing. This study evaluates the applicability of the Ground Albedo Neutron Sensing (GANS) for integral quantification of seasonal soil moisture in the root zone at the scale of a field or small watershed, making use of the crucial role of hydrogen as neutron moderator relative to other landscape materials.

GANS measurements were performed at two locations in Germany under different vegetative situations and seasonal conditions. Ground albedo neutrons were measured at (i) a lowland Bornim farmland (Brandenburg) cropped with sunflower in 2011 and winter rye in 2012, and (ii) a mountainous farmland catchment (Schaefertal, Harz Mountains) since middle 2011. At both sites depth profiles of soil moisture were measured at several locations in parallel by frequency domain reflectometry (FDR) for comparison and calibration.

Initially, calibration parameters derived from a previous study with corn cover were tested under sunflower and winter rye periods at the same farmland. GANS soil moisture based on these parameters showed a large discrepancy compared to classical soil moisture measurements. Therefore, two new calibration approaches and four different ways of integration the soil moisture profile to an integral value for GANS were evaluated in this study. This included different sets of calibration parameters based on different growing periods of sunflower. New calibration parameters showed a good agreement with FDR network during sunflower period (RMSE = 0.023 m^3 m^{-3}), but they underestimated soil moisture in the winter rye period. The GANS approach resulted to be highly affected by temporal changes of biomass and crop types which suggest the need of neutron corrections for long-term observations with crop rotation. Finally, Bornim sunflower parameters were transferred to Schaefertal catchment for further evaluation. This study proves GANS potential to close the measurement gap between point scale and remote sensing scale; however, its calibration needs to be adapted for vegetation in cropped fields.