Geophysical Research Abstracts
Vol. 20, EGU2018-3100, 2018
EGU General Assembly 2018

Vegetation influence on cosmic-ray neutrons at ground level

Heye Bogena, Jannis Jakobi, Johan A. Huisman, and Harry Vereecken
Forschungszentrum Juelich, Institute Agrosphere (IBG-3), Juelich, Germany (h.bogena@fz-juelich.de)

Cosmic radiation produces neutrons with kinetic energies ranging from <1 eV (thermal) to >1 MeV at ground level. In the fast neutron energy range (1 eV - 100 keV), neutrons are strongly moderated by collisions with hydrogen nuclei. Soil moisture is the most important pool of hydrogen for the moderation of fast neutron intensity in most terrestrial environments, and this enables non-invasive soil moisture measurements at the field scale. However, many other hydrogen pools also affect neutron intensity at ground level, most notably vegetation biomass, soil organic matter, snow cover and canopy interception. Several studies proposed linear and non-linear relationships between aboveground biomass and the calibration parameter in the standard relation between neutrons and soil moisture, which allow straightforward correction in case of static biomass. However, in case of growing vegetation continuous information on biomass is needed for meaningful correction. Recently, it was found that the ratio between thermal and fast neutron intensity contains information on vegetation biomass. This opens up the possibility to use cosmic-ray neutron measurements for continuous and non-invasive monitoring of biomass development at the field scale. To test the possibility for simultaneous measurement of soil moisture and biomass dynamics, we instrumented an arable field cropped with sugar beet with cosmic-ray neutron probes and a wireless sensor network with 156 in-situ soil moisture sensors as reference. Below- and aboveground biomass were sampled in-situ in monthly intervals. We found a close linear relationship between the thermal to fast neutron intensity ratio and the aboveground biomass. Using this relationship, we were able to continuously quantify the aboveground biomass development throughout the growing season with an RMSE of 0.17 kg/m^2. This information together with in-situ measured belowground biomass was used to correct for the effect of biomass on soil moisture determination. This reduced the RMSE from 0.048 to 0.013 m^3/m^3. We anticipate that future research on thermal to fast neutron intensity ratios can both improve the accuracy of the soil moisture estimates and extend the application of cosmic-ray neutron sensing to include biomass, canopy interception, and snow water equivalent estimation for both stationary and roving systems.