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Passive microwave remote sensing of soil moisture and vegetation optical depth over the entire growing season of a winter wheat

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This study aims to provide a better understanding of the influence of the vegetation layer on L-band brightness temperature observations. The parameters of interest are the surface soil moisture and the vegetation optical depth. The surface soil moisture is a key variable in the global water cycle and the vegetation optical depth is of great interested to get information about the plant water status. In general, L-band radiometry is a promising tool to estimate soil moisture over vegetated areas because the vegetation can be assumed to be semi-transparent, the scattering inside the vegetation layer is low, and the effect of the soil surface roughness on the L-band radiations is reduced in comparison to higher microwave frequencies. Nevertheless, the vegetation layer still attenuates the emission originating from the soil and the vegetation canopy itself, which has to be accounted for. Moreover, it is still a major challenge to disentangle between the emissions originating from the soil and the vegetation in order to retrieve soil moisture and vegetation information from the L-band signal. To improve the soil moisture estimation retrieved from brightness temperature observations above footprints covered by vegetation and to advance the range of vegetation parameters which can be retrieved from the L-band brightness temperature signals, a field experiment was performed at the remote sensing field laboratory in Selhausen (Germany) over the entire growing season of a winter wheat. The ELBARA-II radiometer system operating at 1.4 GHz was used. The measurements took place over two footprints (natural and manipulated) using different observation angles in order to be able to disentangle between the radiation originating from the vegetation and from the soil. The manipulated footprints consisted of a wire grid (perfect reflector) covering the soil with wheat plants growing through, blocking any emission from the soil. The natural footprints on the other hand allowed the measurements of radiations coming from the soil and the vegetation. Additionally, soil and vegetation properties were monitored on regular intervals. The temporal evolution of the vegetation optical depth was retrieved from the manipulated plot measurements by inverting the tau-omega model, which is a zero-order solution of the radiative transfer equations. Afterwards, this information was used to estimate the soil moisture from the brightness temperature measurements over the natural plot also by inverting the tau-omega model. The results showed that the estimated values of the vegetation optical depth were lower at horizontal polarization compared to the estimated values obtained at vertical polarization. In addition, a clear angular dependency was detectable at vertical polarization. The in situ measurements of the vegetation, i.e. vegetation water content, vegetation biomass, vegetation height, and leaf area index, also showed a high correlation to the estimated vegetation optical depth throughout the growing season. Furthermore, the use of a time-, polarization-, and angle-dependent vegetation optical depth parameter significantly improved the retrieval of the soil moisture.