A novel approach to estimate surface soil moisture under vegetation cover using imaging spectroscopy

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ABSTRACT:

Surface soil moisture is an important key variable used for numerous applications in climatology, meteorology, hydrology and agriculture, to name but a few. Soil moisture estimation by means of remote sensing is intensively investigated and provides effective methodologies to map near surface soil water content over broad areas. Besides established methods using microwave remote sensing data, imaging spectroscopy has the potential for quantifying near surface soil water content too. Different indices like the Normalised Soil Moisture Index (NSMI, Haubrock et al. 2005, 2008) and the Soil Moisture Gaussian Modelling (SMGM, Whiting et al. 2004) have been developed. But the most disturbing factor affecting significantly the accuracy of soil moisture estimates derived from both microwave and optical data are the presence of vegetation.

In this study, a novel approach is presented minimising the influence of agricultural vegetation on soil moisture estimates by using canopy reflectance simulation to calibrate NSMI and SMGM. The approach consists of three processing and analysis steps. Firstly, imaging spectroscopy data are classified in terms of crop type and phenological growth stage automatically based on simulated training data. Secondly, based on these information specific canopy reflectance simulations are performed using the HySimCaR model (Kuester et al. 2014). This system enables the simulation of realistic bidirectional canopy reflectance spectra on the basis of high detailed virtual 3-D crop scenarios with ray-tracing techniques. Thereby, variations in the canopy structure (e.g. plant density and distribution) are combined with varying soil water content for the actual solar illumination and sensor viewing geometry of the recorded image data. the simulated canopy reflectance data are analysed for the impact of the varying vegetation cover on NSMI and SMGM to derive crop specific calibration functions, that are applied on the imaging spectroscopy data with the classified fields.The software has implemented models for winter rye, winter barley and winter wheat at the current stage of the development

The new approach is tested on simulated hyperspectral EnMAP data and also on data acquired by hyperspectral sensors like AISA/DUAL and HySpex at the DEMMIN test site in Germany. The results show significantly improved prediction accuracy compared to NSMI and SMGM indices for vegetation covers up to 70%. More dense canopies are dominated by the vegetation reflectance signal and thus the retrieval of surface soil water content is strongly limited. Future improvements will focus on integration of more soil types and more species.

Literature:

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