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Validation of Distributed Soil Moisture: Airborne Polarimetric SAR vs. Ground-based Sensor Networks

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The knowledge of spatially distributed soil moisture is highly desirable for an enhanced hydrological modeling in terms of flood prevention and for yield optimization in combination with precision farming. Especially in mid-latitudes, the growing agricultural vegetation results in an increasing soil coverage along the crop cycle. For a remote sensing approach, this vegetation influence has to be separated from the soil contribution within the resolution cell to extract the actual soil moisture.

Therefore a hybrid decomposition was developed for estimation of soil moisture under vegetation cover using fully polarimetric SAR data. The novel polarimetric decomposition combines a model-based decomposition, separating the volume component from the ground components, with an eigen-based decomposition of the two ground components into a surface and a dihedral scattering contribution. Hence, this hybrid decomposition, which is based on [1,2], establishes an innovative way to retrieve soil moisture under vegetation.

The developed inversion algorithm for soil moisture under vegetation cover is applied on fully polarimetric data of the TERENO campaign, conducted in May and June 2011 for the Rur catchment within the Eifel/Lower Rhine Valley Observatory. The fully polarimetric SAR data were acquired in high spatial resolution (range: 1.92m, azimuth: 0.6m) by DLR's novel F-SAR sensor at L-band. The inverted soil moisture product from the airborne SAR data is validated with corresponding distributed ground measurements for a quality assessment of the developed algorithm. The in situ measurements were obtained on the one hand by mobile FDR probes from agricultural fields near the towns of Merzenhausen and Selhausen incorporating different crop types and on the other hand by distributed wireless sensor networks (SoilNet clusters) from a grassland test site (near the town of Rollesbroich) and from a forest stand (within the Wüstebach sub-catchment). Each SoilNet cluster incorporates around 150 wireless measuring devices on a grid of approximately 30ha for distributed soil moisture sensing. Finally, the comparison of both distributed soil moisture products results in a discussion on potentials and limitations for obtaining soil moisture under vegetation cover with high resolution fully polarimetric SAR.

[1] S.R. Cloude, Polarisation: applications in remote sensing. Oxford, Oxford University Press, 2010.
[2] Jagdhuber, T., Hajnsek, I., Papathanassiou, K.P. and Bronstert, A.: A Hybrid Decomposition for Soil Moisture Estimation under Vegetation Cover Using Polarimetric SAR. Proc. of the 5th International Workshop on Science and Applications of SAR Polarimetry and Polarimetric Interferometry, ESA-ESRIN, Frascati, Italy, January 24-28, 2011, p.1-6.