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Improved regionalization of soil surface properties using multi-frequency remote sensing data and geo-statistics at field scale

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Land Surface Models (LSM) have become indispensable tools to quantify the most important physical, chemical and biological processes to determine water and nutrient fluxes in support of land management strategies or the prediction of climate change impacts. However, the utilization of LSM requires numerous soil and vegetation parameters, which are seldom available in spatial distribution or an appropriate temporal frequency. The quality of these model input parameters, especially the spatial heterogeneity and temporal variability of soil parameters, has a strong effect on LSM simulations. Conventional measurements of soil characteristics (texture, bulk density, moisture) remain time consuming and non-cost effective and are therefore continuously reduced.

Thus, the presentation focuses on the regionalization of soil physical properties such as surface texture, bulk density, soil roughness and soil moisture using microwave airborne SAR data at different frequencies and polarisations, calculated terrain attributes from a Digital Elevation Model (DEM) and geo-statistical approaches.

Stochastic and deterministic approaches comprised different prediction methods, such as IDW, linear- and multiple linear regressions, Simple Kriging and Ordinary Kriging as well as hybrid approaches such as Regression Kriging. Different co- variables were integrated in the spatial prediction process using the Regression-Kriging Models A, B and C first introduced by Odeh et al. (1995).

Co-variables were derived using:
a.) An interferometric high resolution DEM and its quantified first and second order terrain attributes.
b.) Spatially distributed dielectric properties of the soil surface derived from SAR imagery following a semi empirical approach (Oh et al. 1992) and a physically based approach (Hajnsek et al. 2003).

The developed approach was validated against in-situ data from different field campaigns carried out over a test site located in the young moraine area in northern Mecklenburg-Western Pomerania, Germany. Results of the prediction show a RMSE of 0.4 for sand and 0.9 for silt. In comparison to the predicted soil maps resulting from the Ordinary Kriging approach, the Regression-Kriging B model with additional SAR information and secondary terrain attributes showed a significant relative improvement of 70% (sand) and 18% (silt) respectively.

The presentation highlights the potential of the proposed approach for the derivation and regionalization of spatial distributed soil physical properties at field scale.