Geophysical Research Abstracts,
Vol. 11, EGU2009-7369-1, 2009
EGU General Assembly 2009

Soil moisture retrieval from passive microwave data: A sensitivity study using a coupled SVAT-radiative transfer model at the Upper Danube anchor site

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The surface soil moisture content, which is highly variable in space and time, is an important parameter for all water and energy fluxes occurring at the interface between land surfaces and the atmosphere. As passive microwave remote sensing data is sensitive to the surface soil moisture, recent satellite mission concepts to measure the surface soil moisture content with L-band passive microwave sensors will provide global soil moisture information with a high temporal resolution. The Soil Moisture and Ocean Salinity (SMOS) mission, to be launched in 2009 will provide frequent coverage of the globe. Although the temporal resolution of the expected images is within 1-3 days, the spatial resolution used for the retrieval of the soil moisture from SMOS images will be rather coarse, in the order of tens of kilometres. The provided soil moisture information is therefore integrated over a large area that may be composed of different land covers and soils.

For the soil moisture retrieval from passive microwave data ancillary data like land cover and soil information is necessary. Uncertainties of the soil moisture retrieval depend, among others, on the accuracy and spatial resolution of that data. Since the land cover and soil data used for the SMOS retrieval have to be available on a global scale, the spatial resolution lies in the order of kilometers.

To quantify the trade off using coarse scale ancillary information for the soil moisture retrieval from passive microwave data, the sensitivity of the retrieval to land cover and soil data stes with different spatial resolutions is investigated.

A coupled SVAT-radiative transfer model is developed to simulate the major water and energy fluxes including soil moisture fields and the resulting microwave emmissions as brightness temperatures for a multiyear period. The SVAT model PROMET, which is used to model the hydrological processes, is based on high resolution GIS and meteorological forcing data as input for the calculations and simulates the land surface state for a large area at hourly resolution The radiative transfer model L-MEB, which is also part of ESA's SMOS processor, is used to simulate high resolution microwave emissions as brightness temperatures using, among other things, the soil moisture fields, LAI, and temperatures coming from PROMET.

To simulate SMOS-like images the high resolution brightness temperature maps are aggregated to a coarse scale. L-MEB is then used to retrieve the corresponding soil moisture fields using an iterative inversion approach based on brightness temperature observations from multiple angles and different ancillary data sets. The different soil moisture products are compared to evaluate the impact of the ancillary information used. Soil moisture inversion results, obtained using high resolution ancillary soil and land cover information are contrasted against retrievals based on the standard data sets used within the SMOS Level 2 soil moisture processor, which are the ECOCLIMAP land cover and FAO soil map.
Investigations are made for the hydrological catchment of the Upper Danube in Southern Germany and parts of Austria and Switzerland. The test site is an anchor test site for the calibration and validation of SMOS data products.