SMOS Soil Moisture Validation in Australia

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Abstract: For the validation of the European Space Agency-led Soil Moisture and Ocean Salinity (SMOS) Level 2 soil moisture product two extensive field campaigns were conducted in the Australian summer (18 January to 21 February) and winter (8-23 September) periods of 2010. Such extensive field campaigns including detailed in-situ and airborne observations are required due to the new design of the SMOS satellite as a 2-dimensional interferometric radiometer and its use of a previously underused microwave frequency band (L-band at 1.4GHz).

The Australian Airborne Cal/val Experiments for SMOS (AACES) were undertaken in south-western Australia, across the catchment of the Murrumbidgee River, a tributary of the Murray-Darling basin. The climatological and hydrological conditions throughout the catchment range from flat, semi-arid regions in the west to alpine and temperate in the central and eastern reaches. This variety makes the Murrumbidgee River catchment particularly well suited for such large scale studies. The study area covered a total area of 50,000km2 with 20 focus farms distributed across the catchment in which high-resolution in-situ measurements were taken. Furthermore, the OzNet monitoring network consisting of over 60 stations, including soil temperature and soil moisture sensors, is located within the catchment, complementing the data collection efforts by providing long-term observations.

During the campaigns extensive brightness temperature data sets were collected using an airborne L-band radiometer, while ground teams were deployed to the focus farms to collect in-situ data. Those data sets are used in the present study to produce large scale soil moisture maps, using the standard parameterization of the L-band Microwave Emission of the Biosphere (L-MEB) model, which forms part of the operational soil moisture retrieval system of SMOS. The subsequent comparison of those large scale maps, as well as the station time series show a systematic dry bias in the SMOS retrieval. The magnitude of this bias varies between the regions and is likely related to the varying surface conditions.

As the spatial resolution of SMOS is too low for the agricultural purposes, SMOS soil moisture data were also disaggregated, applying an approach based on the a semi-empirical soil evaporative efficiency model, and a first order Taylor series expansion around the field-mean soil moisture. While the bias is well preserved, promising results are obtained when comparing the disaggregated product with aggregated in-situ measurements of the focus farms, with retrieval errors from 0.02 to 0.1 m3 m-3, which is similar to the errors found in the large scale products.

The two studies performed highlight the value SMOS can have in various applications. In particular, a further expected improvement of the retrieval algorithm should allow a soil moisture product close to the design accuracy of SMOS of 0.04 m3 m-3.