COMPARING DATA OF TWO AIRBORNE L-BAND RADIOMETERS WITH DIFFERENT SPATIAL RESOLUTION OVER A HETEROGENEOUS LAND SURFACE

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1. INTRODUCTION

In the context of the calibration and validation activities for the Soil Moisture and Ocean Salinity (SMOS) mission, which has been launched by the European Space Agency (ESA) in November 2009, the SMOS Validation Rehearsal Campaign was conducted in April 2008. Two L-band radiometers, EMIRAD and HUT-2D, were flown simultaneously in the same aircraft over ESA's two major test sites for soil moisture in Europe. While there are several studies analyzing EMIRAD data, e.g. [1], HUT-2D is a novel instrument which was flown over land surfaces together with EMIRAD for the very first time during this campaign. As the two radiometers both measure at the same frequency but with different measurement principles and different spatial resolution, a comparison of contemporaneous measurements has two major objectives. One of them is to validate the new and more complex instrument against the simpler but better understood instrument; the other objective is to gain a better understanding of sub-pixel variability of brightness temperature. The latter is an important task for scientists dealing with SMOS data, as the radiometer carried on board the satellite (MIRAS) has a spatial ground resolution in the order of 40 km [2] and therefore can be expected to contain large sub-pixel variability stemming from a heterogeneous land surface within the footprint.

2. STUDY AREA

The Upper Danube catchment, situated mostly in Southern Germany, has an area of 77.000 km² and is one of ESA's two major test sites in Europe for the calibration and validation of SMOS level 2 soil moisture products. Within that catchment, best soil moisture retrieval performance of SMOS data is expected in the smaller catchment of the river Vils, situated in the Northeast of the city of Munich [3]. This area, whose size roughly matches that of a SMOS pixel, was chosen as a reference test site for calibration and validation purposes as it is

quite homogeneous in terms of soil texture and topography and mainly used for intensive agriculture. For the SMOS Validation Rehearsal Campaign 2008, six focus areas were selected within the Vils test site where ground measurements were taken and land cover was mapped. In the course of three weeks, four two-hour flights took place before sunrise. No open water bodies or large urban areas considerably affect the passive microwave signal in that area and radio frequency interference (RFI) is expected to be low.

3. EMIRAD

EMIRAD [4], owned by the Technical University of Denmark, is a fully polarized radiometer with a nadir antenna and a 40° aft antenna. The antenna opening angle is 36°. The diameter of the nadir footprint roughly matches the flight height above ground, which is about 3 km in our case. In the post-processing, all RFI flagged data is removed and the measurements obtained with a sampling rate of 1 ns are integrated by a factor 1000.

4. HUT-2D

The interferometric radiometer HUT-2D [5], owned by the Helsinki University of Technology, consists of 36 receivers on a U-shaped platform, measuring at incidence angles in the range from 0° to about 40°. Spatial ground resolution is about ten times higher than that of EMIRAD with a pixel size of about 300 m and a swath width across track of about 1 km. X and Y polarization alternate every second with an integration time of 250 ms.

5. METHODOLOGY

For the comparison, the First Stokes Parameter, which is the sum of vertically and horizontally polarized brightness temperatures (i.e. the total amount of emitted energy at that wavelength), is considered so that the data is independent of polarization rotation. For each of the four overflight days, nine footprints of the EMIRAD nadir antenna were selected which cover the focus areas in the Vils test site. As for the HUT-2D data, all measurements of less than 20° incidence angle that fall into an EMIRAD footprint were selected in order to roughly match the EMIRAD incidence angles. For each EMIRAD footprint, all HUT-2D measurements were averaged using a weighted mean according to the EMIRAD antenna gain pattern.

6. RESULTS

The comparison of the First Stokes parameter as measured by EMIRAD and HUT-2D gives mixed results. While in some areas the agreement of the measured brightness temperatures is within 10 K on all of the overflight days, in other areas the offset improves considerably in the course of the campaign. Further processing steps are undertaken in order to analyse the influence of calibration and temperature effects.

7. CONCLUSIONS

In this study, a first attempt of comparing EMIRAD and HUT-2D data over land surface is made, using the radiometric measurements collected during the SMOS Validation Rehearsal Campaign 2008 in the Upper Danube Catchment. Measurements of the two instruments may differ due to various factors, concerning the instruments (e.g. frequency of calibrations) as well as the environmental conditions (e.g. air and soil temperature) both of which changed significantly from one overflight day to the other. These issues will be further analysed using the data of the SMOS Validation Campaign in spring and early summer 2010.

8. REFERENCES

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