



Multiangular L-band Datasets for Soil Moisture and Sea Surface Salinity Retrieval Measured by Airborne HUT-2D Synthetic Aperture Radiometer

J. Kainulainen, K. Rautiainen, J. Seppänen, and M. Hallikainen

Department of Radio Science and Engineering, Helsinki University of Technology, P.O.BOX 3000, FI-02015 TKK, Finland
(e-mail: juha.kainulainen@tkk.fi / fax: +358 9 451 2898)

SMOS is the European Space Agency's next Earth Explorer satellite due for launch in 2009. It aims for global monitoring of soil moisture and ocean salinity utilizing a new technology concept for remote sensing: two-dimensional aperture synthesis radiometry.

The payload of SMOS is Microwave Imaging Radiometer by Aperture Synthesis, or MIRAS. It is a passive instrument that uses 72 individual L-band receivers for measuring the brightness temperature of the Earth. From each acquisition, i.e. integration time or snapshot, MIRAS provides two-dimensional brightness temperature of the scene in the instrument's field of view. Thus, consecutive snapshots provide multiangular measurements of the target once the instrument passes over it. Depending on the position of the target in instrument's swath, the brightness temperature of the target at incidence angles from zero up to 50 degrees can be measured with one overpass.

To support the development MIRAS instrument, its calibration, and soil moisture and sea surface salinity retrieval algorithm development, Helsinki University of Technology (TKK) has designed, manufactured and tested a radiometer which operates at L-band and utilizes the same two-dimensional methodology of interferometry and aperture synthesis as MIRAS does. This airborne instrument, called HUT-2D, was designed to be used on board the University's research aircraft. It provides multiangular measurements of the target in its field of view, which spans up to 30 degrees off the boresight of the instrument, which is pointed to the nadir. The number of independent measurements of each target point depends on the flight speed and altitude. In addition to the Spanish Airborne MIRAS demonstrator (AMIRAS), HUT-2D is the only European airborne synthetic aperture radiometer.

This paper presents the datasets and measurement campaigns, which have been carried out using the HUT-2D radiometer and are available for the scientific community.

In April 2007 HUT-2D participated in to the first scientific measurement campaign. This campaign consisted of a single flight over the Gulf of Finland simultaneously with R/V Aranda's (Finnish Marine Research Institute) ground truth collection. The vessel measured e.g. sea surface salinity and sea temperature along the test lines measured with the radiometer system.

During the autumn of 2007 HUT-2D participated in the CoSMOS-2007 campaign, in which three datasets from the Finnish coastal area were measured in order to demonstrate sea salinity retrieval. The campaign consisted of two two-hour measurement flights over an expected salinity gradient with HUT-2D and the Danish conventional radiometer EMIRAD. For the reference data, sea surface temperature and salinity were measured along the gradient line from a vessel. The third flight included different maneuvers, such as wing-wags, circles, and clover leafs, over the Gulf of Finland.

During the same autumn, HUT-2D was used to measure datasets in northern Finland for soil moisture retrieval purposes. The flight consisted of measurement flights over test areas in Sodankylä, and Pallas. These test sites were equipped with weather stations of Finnish Meteorological Institute. Also soil moisture samples were collected at the sites. During the transition flights (approx. 800 km) from southern Finland to these test sites

HUT-2D measured continuously, however, ground reference data for soil moisture was not collected beyond a few weather stations overpassed. Land classification maps for the transit flights are available.

The most significant measurement campaign of HUT-2D so far was carried out during the spring of 2008. This 6-week campaign consisted of measurements of soil moisture test sites in Germany (Danube Catchment Area, DCA) and Spain (Valencia Anchor Station, VAS). The campaign at the DCA site consisted of four two-hour flights over the selected test lines in the Danube river catchment area, which is actively used for soil moisture studies. The VAC site consisted of 10 x 10 kilometers area also used for soil moisture studies. This area was mapped with HUT-2D in four different days.