SOIL MOISTURE RETRIEVAL FROM HUT-2D SYNTHETIC APERTURE RADIOMETER DATA

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1. ABSTRACT

Soil moisture is an important parameter in research of the Earth's hydrosphere, but so far no satellite data dedicated to global soil moisture are available. Soil Moisture and Ocean Salinity (SMOS), scheduled for launch in 2009, is the European Space Agency's Earth Explorer satellite for global monitoring of two important parameters, soil moisture and sea surface salinity. For both tasks it utilizes a single instrument: Microwave Imaging Radiometer by Aperture Synthesis (MIRAS) [1]. MIRAS is a passive instrument operating at a frequency of 1.4 GHz and using interferometry for producing two-dimensional brightness temperature images of the Earth.

A number of studies have shown the high potential of low-frequency passive microwaves for remote sensing of soil moisture [2, 3, 4, 5]. L-band radiometry is preferred over higher-frequency sensors because of its relatively low sensitivity to vegetation; however, the effects of vegetation are still significant and must be modelled appropriately [6].

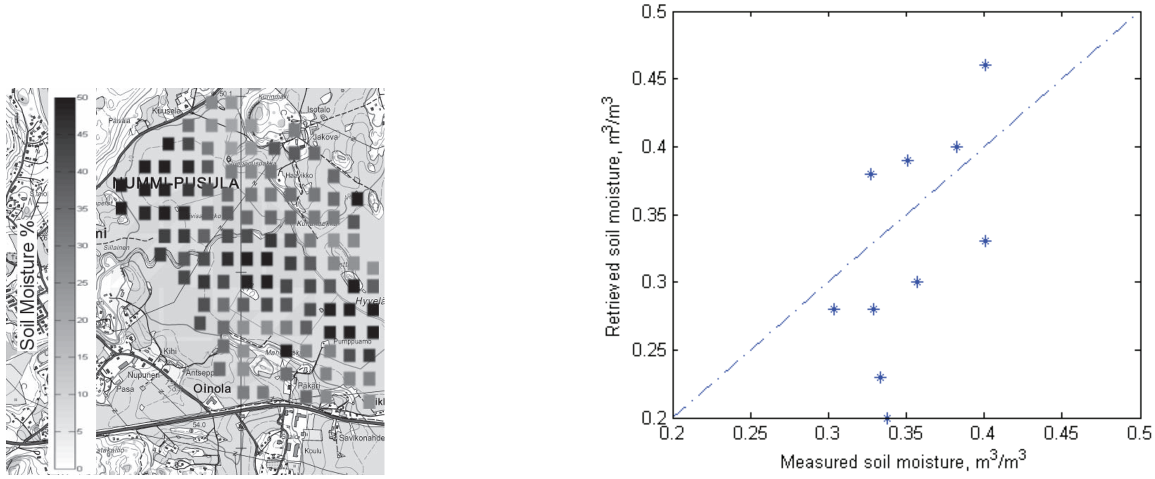
At L-band, a conventional spaceborne radiometer would need an unrealistically large antenna to achieve a satisfactory ground resolution. MIRAS employs interferometry, which is an established technology in radio astronomy, to achieve a spatial resolution of 30 to 50 km, while retaining a relatively small diameter of 8 m.[1]

HUT-2D is an airborne interferometric radiometer designed, manufactured and tested by Helsinki University of Technology and completed in spring 2006 [7]. HUT-2D has its major technical characteristics similar to those of MIRAS and can thus be used to collect datasets similar to SMOS products. In addition to the smaller Spanish MIRAS demonstrator AMIRAS it is the only airborne radiometer able to produce SMOS-like datasets.

To model the effect of various vegetation conditions to the brightness temperature of Earth land surfaces, a comprehensive model called L-MEB (L-band Microwave Emission of the Biosphere) has been created [8]. It is the key element in the SMOS L2 algorithm used to retrieve soil moisture from the measurements and also used in this paper to model the emission of the biosphere.

This paper describes the test campaign carried out in August 2007 in Finland with HUT-2D in order to demonstrate the capabilities of the radiometer to measure soil water content. During the campaign HUT-2D was used to collect a dataset over an extensive land area with variable vegetation conditions. During the three days of the campaign, almost 1000 km of soil was covered. Ground truth data for modelling of the soil and biosphere emission was gathered at various test sites ranging from bare and crop-covered agricultural fields to coniferous forests and bogs. A forward modelling method utilizing a biosphere emission model similar to L-MEB model was used to retrieve the water content of the soil and to create soil moisture maps of the test sites (Figure 1 (a)). Moisture retrieval was most successful for agricultural fields (Figure 1 (b)), where vegetation cover was easy to parameterize. For test sites with a more abundant and polymorphic vegetation cover reliable estimation of vegetation parameters proved more problematic and retrieval results were less satisfactory.

This paper presents the results of the soil moisture retrieval demonstrations made in August 2007 using the datasets measured with the HUT-2D radiometer. The accuracy of the measurements and the retrieval process is assessed and applicability of HUT-2D for retrieval purposes is discussed.



(a) (b)

Fig. 1. (a): A soil moisture map retrieved from datasets of HUT-2D. (b): Water content values of crop covered field retrieved from datasets of HUT-2D and measured on the ground.

2. REFERENCES

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