Geophysical Research Abstracts, Vol. 8, 01413, 2006
SRef-ID: 1607-7962/gra/EGU06-A-01413
© European Geosciences Union 2006

# Soil moisture maps from ENVISAT/ASAR images in a Finland area obtained by using an algorithm based on Neural Networks

S. Paloscia (1), S. Pettinato (1), E. Santi (1), M. Huttunen (2), J. Silander (2), B. Vehvilainen (2)

(1) CNR-IFAC, Firenze, Italy, (S.Paloscia@ifac.cnr.it), (2) Finnish Environment Institute, Helsinki, Finland

Soil moisture is a key state variable that influences the redistribution of the radiant energy and the runoff generation and percolation of water in soil. The possibility of measuring soil moisture on a large scale from satellite sensors, with complete and frequent coverage of the Earth's surface, is, therefore, extremely attractive. However, up to now, the only available frequency from space is C band, operational on ERS-2, RADARSAT, and ENVISAT satellites, which is not the optimal for this aim. The retrieval of soil moisture maps at C-band is, in fact, still challenging, since the effects of soil surface roughness and vegetation cover on the backscattering coefficient at this frequency is high, and needs the use of correcting procedures.

In spite of these problems, multi-temporal soil moisture maps have been already produced in two Italian sites starting from ENVISAT/ASAR images, collected in 2003 and 2004, by using a Neural Network algorithm. In this case several SAR images were analyzed for a flat agricultural area, which is the watershed of Scrivia river, located close to Alessandria in North-west Italy, and a mountainous site on the Cordevole watershed (Arabba) on the Italian Alps. This watershed, located at the foothill of Mount Sella in Northern Italy was selected because of its relatively smooth topography and availability of historical and topographic data. All the SAR images acquired at different dates over the Cordevole test site were geocoded by using a DEM of the area and the orbital parameters. Direct measurements of soil moisture (with a TDR probe) and fresh biomass of vegetation were carried out during the ENVISAT overpasses.

The soil moisture maps were obtained by using a feed-forward neural network having some hidden layers of neurons between the input and output, and trained by using the back-propagation learning rule. The available backscattering dataset was divided in two parts: the first portion was used to generate a training set and the second one to test the ANN performances. Furthermore, the experimental training set was increased by simulating radar backscattering through the Integral Equation Model, which was driven with soil data taken from ground measurements. Once the training set was generated, several configurations of hidden layers/neurons were tested to optimise the performances of the ANN. The obtained results, compared with ground data, showed a satisfactory agreement with ground truth data and meteorological conditions, and enabled us to generate maps with 4-5 levels of soil moisture of both the test sites from the available ENVISAT ASAR images.

A further validation of the retrieval algorithm was carried out by using two ENVISAT images collected on the Kemjoki area in Finland, on May 7, 2004 and July 27, 2005. Unfortunately, due to the well-known user conflicts, one of the ENVISAT ASAR image was in HH polarization and the other one in VV polarization, at 23˚ incidence angle. Since actual ground measurements of soil moisture were not available, the results were compared with a hydrological model outputs. In spite of the problems related to the difference in polarization configuration, the wideness and non-homogeneity of the area, and the lack of detailed ground measurements, the results obtained by using the Artificial Neural Network were satisfactory. Although with some discrepancies, the maps of SMC obtained both from the ENVISAT images and from the hydrological model are, in fact, rather similar. From the comparison of the histograms of SMC values it can be noted that in the SMC map obtained from SAR data, about 60% of pixels correspond to an average SMC of 15-16%, whereas in the SMC map obtained from the hydrological model beside the peak at 15% there are two other small groups of pixels at 10% and 20%. An additional check was carried out by using the data of a meteorogical station, Naruska (67˚08’N-29˚17’E), which measured a local SMC value of 11%. The corresponding value estimated from the inversion algorithm was 13%.