A PRE-OPERATIONAL ALGORITHM FOR THE RETRIEVAL OF SNOW WATER EQUIVALENT AND SOIL MOISTURE FROM AMSR-E DATA

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During the past decades, natural hazards such as floods, landslides and forest fires have caused major loss of human lives and the destruction of economic land social infrastructure, as well as environmental damages. The Italian National Project: PROSA (PRodotti di Osservazione Satellitari per l'Allerta Meteorologica) is a pilot project funded by the Italian Space Agency, which aims at contributing to civil protection from floods and landslides by developing a series of products derived from satellite sensors that can be useful in these dramatic events to permit immediate assessments of the areas at risk and/or aid decision-making on relief and clean-up operations. The products to be developed include two main groups: Precipitations and Land surface parameters (Soil moisture and Snow cover of bare and vegetated surfaces at different spatial scale and ground resolution). This work deals with mapping snow cover and water equivalent as well as soil moisture at low resolution from multifrequency microwave radiometers.

It has been established that optical sensors can monitor snow cover in cloud free conditions and several systems have been developed for operational monitoring of snow parameters from remote sensing data [e.g.. 1]. However, only microwave sensors are able to acquire data independently of day light and in adverse weather conditions. The potential of radar systems in mapping the extent of wet snow cover has been investigated by using both airborne and satellite systems. However, several studies have shown that the effect of dry snow on the backscattering of the presently available satellite SAR systems at C and X-band is too small to detect dry snow cover, and that higher frequencies are necessary for snow retrieval [2]. Instead, passive microwave sensors operating at higher frequencies such as the Special Sensor Microwave Imager (SSM/I) and Advanced Microwave Scanning Radiometer (AMSR-E), although limited by the poor spatial resolution, revealed a good sensitivity to snow depth and water equivalent. Several algorithms for the retrieval of SWE from multi-frequency radiometric systems have been developed based on empirical relationships [e.g. 3] or statistical approaches [e.g. 4]. On the other hand the capability of microwave radiometry in estimating soil moisture is well known [5]. For this target the best frequency has been found to be at L-band. However,

several experiments pointed out that C-band too has some potential in this task and retrieval algorithms for the AMSR-E have been developed [6],

The algorithm developed and implemented in this work produces the spatial distribution at regional scale of snow water equivalent (SWE) and of soil moisture (SMC) of snow free areas by using the brightness temperatures of the Advanced Microwave Scanning Radiometer (AMSR-E)

For the retrieval of SWE the algorithm uses the vertical polarization component of the brightness temperature at X, Ku and Ka bands and the related frequency and polarization indexes. It is based on experimental relationships obtained on an Alpine test site and inversion of model simulations.

The retrieval of soil moisture is basically obtained from the inversion of a radiative transfer model computed for the H polarized component of C-band brightness temperature. The polarization indexes at X and Ku bands are used to evaluate the vegetation cover and to correct for the effects of light vegetation while the surface temperature, necessary for estimating the emissivity is obtained from the Ka band channel. The evaluation of vegetation cover has been implemented by using an empirical relationship between polarization index and NDVI established by analyzing data collected over an extended area of Africa, ranging from the desert to the equatorial forest.

More specifically, inputs to the algorithm are:

a) Remote sensing data

- The brightness temperature at X, Ku, Ka bands (V and H pol.) for the SWE
- The brightness temperature at C, X, Ku, Ka bands (V and H pol.) for the SMC

b) Auxiliary data

- Land use maps including: water bodies, forests, urban areas.

Outputs of the algorithm are:

- Map of SWE in mm water equivalent at regional scale
- Map of volumetric SMC in % at regional scale.

Both retrieved SWE and SMC on maps are represented on a projected fixed gridded coordinate system. In these maps the urban areas, forests, and water bodies are masked by using land use and vegetation maps. The output maps are saved in Hierarchical Data Format (HDF)

The quality control performed on the final product. consists in checking AMSRE data (including detection of Radio Frequency Interferences - RFI), and in verifying that the output SMC and SWE values are in the working range of the algorithm.

Ground measurements have been taken into consideration partly to set up the input parameters of the algorithm and partly to validate the algorithm itself.The SWE algorithm has been developed and validated by using a large dataset of snow parameters collected over the Scandinavian by several meteo stations (http://meteo.infospace.ru/). The algorithm for estimating SMC has been instead developed and validated by using the AMSR-E/SMC match up dataset provided by JAXA/EORC along with ground data from the SMEX02 experiment. A final validation of both algorithms has been carried out with satisfactory results by using data taken on ground on wide test areas in North Italy.

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