ADVANCED MULTI-TEMPORAL PASSIVE MICROWAVE DATA ANALISYS FOR SOIL WETNESS MONITORING AND FLOOD RISK FORECAST

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ABSTRACT

Meteorological satellites provide frequent (from few hours to few minutes) observations that can be exploited to globally forecast weather conditions and, particularly, precipitation phenomena that are not rarely responsible of dangerous flooding events. Soil moisture is one of the variable involved in the hydrological cycle which plays a key role when an attempt of flood forecast have to be done in presence of adverse weather forecasts associated to different precipitation regimes. Depending on the pre-existing soil conditions the same raining event can result or not in a disastrous flooding event. Mainly for this reason particular importance is given to the estimates (e.g. on the base of antecedent precipitation regimes) or, if possible, to the direct measurement, of soil water content in order to formulate suitable flood forecast models at the basin scale. Ground measurements of soil moisture are not able to assure reliable information because of the extreme spatial variability of point measurements and the impracticality of obtaining a sufficient dense network of points to provide spatially continuous information. Satellite data, on the other side, could just help to fill these gaps. At this moment, although SAR data have been used for soil wetness estimation [1]-[6], the more suitable sensors for soil wetness observation are still passive radiometers, which assure global covertures with sufficiently short revisiting time. Scatterometers aboard ERS satellites and MetOp have been presently also used with promising results [7]-[9]. The potential of passive microwave remote sensing for measuring surface soil wetness has been largely demonstrated in the past [10]-[19] mostly using a statistical approach or a forward inversion model. Unfortunately both of them need ancillary data (mainly in order to model and discriminate contributes to the signal coming from soil roughness and vegetation from the one related to soil wetness) and, consequently, are highly conditioned from the availability and/or reliability of this kind of data [20]. Change detection methodologies have demonstrated to be a valid alternative in order to obtain reliable measurements of soil wetness. Their advantage lies in their simplicity and in their independence from auxiliary information, as they rely only on the information contained in the microwave signal at the sensor [21] [5] [22].

A new Soil Wetness Variation Index (SWVI) has been recently proposed [23] and applied with encouraging results to monitor soil wetness variation in the spatial-temporal domain during extreme flooding events occurred in Europe [24]-[27]. The proposed approach is based on the more general methodology for multi-temporal satellite data analysis named RST (Robust Satellite Techniques, [28]) already successfully applied to monitor different natural, environmental and technological risks ([29] and reference herein). SWVI is built on the base of a multi-temporal satellite data analysis devoted to characterize the expected signal, at each specific time and location. It gives, for each image pixels, a relative measurement of the soil emissivity variations which can be directly related to variations of soil water content. Such an approach allows to easily reduce the effects of the vegetation coverage and of soil roughness which affects traditional (single-image) methods devoted to soil wetness retrieval by satellite observations in the MW. In this work, SWVI is applied to the analysis of recent extreme flooding events affecting African countries by using data collected by the Advanced Microwave Sounding Unit (AMSU) which is the microwave radiometer aboard NOAA (National Oceanic and Atmosphere Administration) satellite since 1998. The low revisiting time offered by NOAA satellites (around six hours), together with the open access to data guaranteed by NOAA, could represent a unique opportunity to have access to information on soil wetness conditions particularly in those areas of the world where extensive ground-based observations systems are still lacking. Beside its importance for flood forecast it should be not neglected the contribute that SWVI long term analyses could offer to drought processes monitoring at large scale. Furthermore, because SWVI, like all the other RST-based index, is completely independent on the specific satellite platform, the same method could be easily exported to the new generation of satellite microwave sensors, which may guarantee improved performances, like AMSR-E presently aboard EOS-Aqua satellite platform.

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