MONITORING RAIN AND FLOODING EVENTS IN DE LA PLATA BASIN USING AMSR-E SIGNATURES

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1. INTRODUCTION

Monitoring extreme variations of soil moisture, eventually associated to flooding, is important for several applications. Long term studies about the water cycle use soil moisture information as an important element. Moreover, severe rainstorms and increases in the water flow of rivers need to be timely monitored, in order to aid the development of an effective protection. It is recognized that passive microwave instruments, operating at the lower frequencies, are very effective for soil moisture monitoring. In these systems, soil moisture is the dominant factor influencing the surface emissivity. Other elements, such as soil roughness and vegetation biomass must be considered in the algorithms but, in most of the cases, are less important than the main effect of soil moisture. For this reason space missions, such as forthcoming SMOS and future SMAP, use L band instruments. Presently available spaceborne radiometers, such as AMSR-E, operate at higher frequencies which are not the most effective ones for soil moisture monitoring. However, some studies aimed at exploiting the use of higher frequency radiometers for this application have been carried out. Results indicate that there is some potential, especially when strong events, associated to flooding or severe rainstorms, are being monitored. Various algorithms have been proposed. In spite of differences in the implementation, the algorithms are based on the same basic properties, confirmed by models and previous experiments. In a soil covered by vegetation, an increase of soil moisture produces a decrease of emissivity which is more evident at the lower frequencies and at horizontal polarization. An increase in vegetation biomass reduces the sensitivity to soil moisture and makes the emissivity less dependent on frequency and polarization.
This paper shows the results of a sensitivity study about the effects of flooding and rainstorms on AMSR-E signatures. The study site is the La Plata Basin, covering about 3.6 million km^2. In terms of geographical extent, it is the fifth largest basin in the world. The principal sub-basins are those of the Paraná, Paraguay and Uruguay Rivers. The annual mean total precipitation in the De La Plata Basin is about 1,100mm, of which only about 20% reaches the sea as surface water. The other 80% is evaporated and infiltrated into the ground. In particular, we have considered a flooding event which occurred in the middle and low sub-basins of Parana river in February and March 2007, and a severe rainstorm which occurred in the southern side of the Chaco forest in September 2006.

2. STUDIES AND RESULTS

In the middle and low basins of Parana river, four sample points were monitored during the flooding of February-March 2007. Information about the water level in the river was made available by hydrometric stations in these points. AMSR-E multitemporal signatures were collected in areas along the river close to the samples, and converted into normalized indexes. In particular, we considered polarization indexes at the lower frequencies and a frequency index based on the combination between C band and Ka band signatures. The correlations between indexes and water level measured in the river were investigated. A clear increase of all indexes with increasing water level was observed. In normal conditions, this increase is related to an increase of soil moisture. After saturation of soil capacity, there is a flooding effect with a consequent reduction

of the height of emerged vegetation, and this leads to a further increase of the indexes. A cross-correlation study indicates that the trends are shifted in time and the shift proceeds in the sense of river flow. Time lags observed in AMSR-E signatures are in agreement with the ones measured using hydrometric measurements.

In the lower part of Chaco forest, a heavy rainstorm was observed on September 3, 2006. The event occurred after a long dry period, so that produced a strong variation of soil moisture. Maps of polarization index at C band collected in the area, before and after the rain event, show an increase of polarization index in the lower part of the area, and also in zones in which the forest is more dense and homogeneous. More specifically, two forest pixels were considered, characterized by homogeneous forest cover and a biomass of about 100 t/ha. The polarization indexes show a clear increase associated to the rainstorm and decrease when the soil becomes again dry. As expected, the effect is more evident at C band than at X band, and is more evident for the sample located closer to the area mostly affected by the rainstorm. The increase is moderate, but appreciable, although the forest cover was uniform. The effect is investigated by means of model simulations.