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Water level within wetlands marshes using SAR instruments and Electromagnetic models

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Extended abstract

Key words: wetlands, radar, electromagnetic models

1. Background

The general goal of our current studies in radar remote sensing of wetlands is to better understand how variations in climate and anthropogenic factors influence the hydrologic condition of coastal wetland in Argentina and to develop tools to improve the capability to map and monitor these ecosystems through the use of C and L band spaceborne imaging radars. The final objective is to contribute with reliable information for hydrologic process modeling.

Imaging radars have distinct characteristics which make them of significant value for monitoring and mapping wetland conditions. The microwave energy transmitted by the radar penetrates the vegetation canopy, and the backscattered energy detected is mainly the result of electromagnetic interactions of a combination of vegetation structure and soil condition. The presence or absence of water in wetlands (which have a much higher dielectric constant than dry or wet soil) significantly alters the signal detected from these areas. The ability of radar observations to provide information about vegetation structure and soil condition (water level below the canopy) has driven the current research on the use of radar instruments and techniques for wetland mapping and monitoring (Grings *et al*., 2006, Wdowinski *et al*., 2006).

The present work addresses the lower delta of the Paraná river, a vast wetland macro-mosaic located at the terminal area of that river in Argentina. It stretches through the final 300 km of the Paraná basin, covering approximately 17,500 km^2, and is located between 32º05'S, 60º48'W, and 34º29'S, 58º30'W, close to Buenos Aires City. It has a complex hydrological regime determined by the influence of the Paraná and Uruguay rivers and the Del Plata estuary. The latter is primarily responsible for the regular flooding of the downstream portion of the region. The combined effects of wind and tide result in frequent but short (hours-long or day-long) floods. Two types of marshes, *junco* and *cortadera*, occupy 50% of the lower delta (Kandus *et al*., 2006). They are the main cause of the water buffer effect on this wetland, a key phenomenon for flood control and a key argument in wetlands conservation policies. In order to fully understand this buffer effect, water storage capacity needs to be monitored at regional scale.

This paper presents the analysis, interpretation and modeling of a multitemporal set of ENVISAT ASAR alternated polarization beam mode data acquired over the lower Paraná Delta. This presentation discusses whether it is possible to determine the amount of water below vegetation, and which environmental conditions and instrument characteristics (polarization and incidence angles) are required.

2. Methodology

The general strategy is based in the analysis of multitemporal SAR data supported by field work and an electromagnetic model developed by University of Tor Vergata and adapted for the type of marshes present in this area.

The major tasks are:

1) SAR data preprocessing: we have calibrated and geolocated over 50 radar scenes.

2) Field work: we have been doing field work for the last two years in a systematic way, collecting samples of different marsh types within the islands and obtaining biomass, plant density, height and diameter, dried biomass density, gravimetric moisture content, dried weight of floating and rooted plants, water level in main rives, channels and within the marsh (test area). We have been collecting weather data (precipitation and winds) and taking pictures with high resolution. From the photographs, we measured the *juncos* inclination's distribution.

3) Analysis of radar observations: we have systematically analyzed the field sites for different polarization, incidence angles, and environmental conditions for two types of marsh structures and for forest plantations of different ages.

4) Electromagnetic models: we have started with single scattering models, but now we are working with fully polarimetric models using vector radiative transfer algorithms.

3. Work in progress

The study area is part of a large freshwater watershed that is regularly subjected to mild flood events due to precipitation and tidal effects, but also to extreme floods due to El Niño phenomenon. SAR data have proven to be a useful tool for monitoring these events (Parmuchi et al., 2000; Karszenbaum et al., 1999; Kandus et al., 1999). The presentation shows several examples on this matter and discusses the usefulness of radar data for this purpose in terms of their characteristics (in this case: polarization and incidence angle).

Figure 1 shows two multitemporal images of different polarization (VV on the left and HH on the right) that combine three different environmental conditions: in red the October image (spring and normal water level in rivers), in green the November image (spring and a strong increase in water level) and in blue the March image (autumn starts). In VV polarization, the wetland radar response is quite uniform, and doesn't show temporal changes either. On the contrary, agricultural areas show a stronger response in the November image. In HH polarization, the wetland radar response shows important differences along the wetland area. On one hand, these are related to different vegetation covers. On the other, they are also due to temporal differences, which are related to distinct hydrological conditions at the acquisition time. These differences in the radar response can be attributed to the fact that the increase in water level reduces the amount of emerged biomass. In order to make estimates about this effect, the electromagnetic model that we use simulates marsh backscattering at HH and VV polarization under various flooding conditions. By comparing simulated backscattering coefficients with experimental ones, the water level inside marshes is estimated, and results are compared against ground truth. In this way, the combination of observations, models and field work allows us to develop and test an algorithm for flood condition within marshes. Possibilities and limitations of the scheme presented are also discussed.

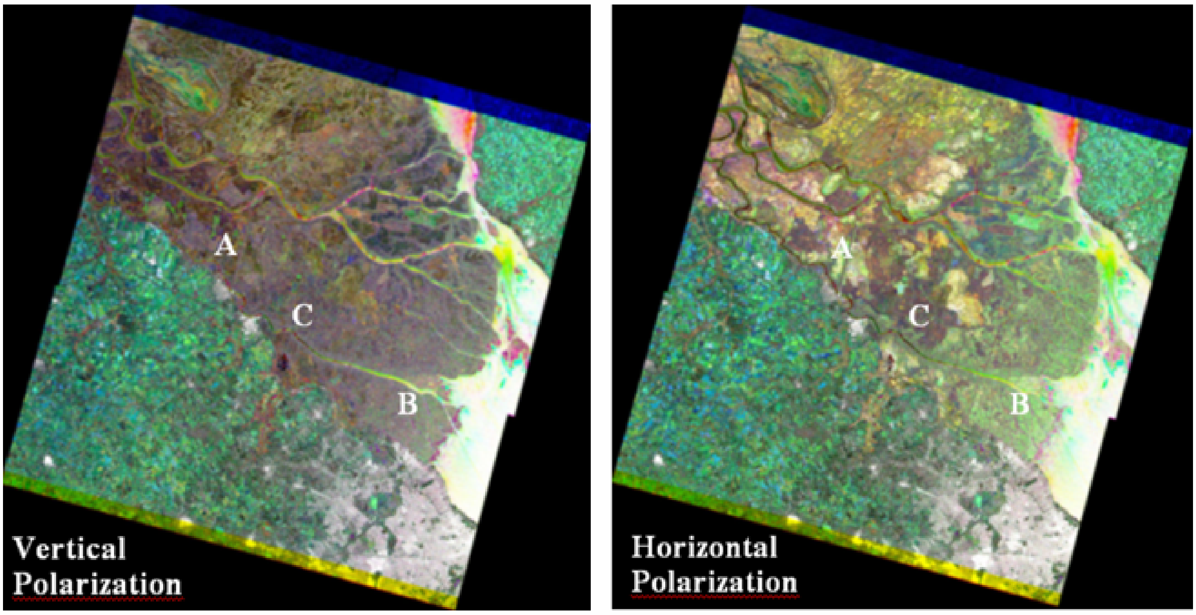

Figure 1: ASAR S1 APP mode: Multitemporal image (October, November, 2003, March 2004) (A: junco marshes, B: cortadera marshes, C: forest plantations)

4. References

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