Exploring the performance of microwave radiometers in monitoring soil water surplus and deficit in the pampas plains of Argentina

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Introduction

The Argentine pampas is a wide plain with more than 40 million ha of lands suitable for cattle rearing and cropping. According to rainfall and soil quality patterns, the region was divided into five ecoregions: Mesopotamian, Rolling, Western, Flooding and Southern (Figure 1). Last decades have shown an increase in extreme conditions (droughts and floods) and the need for improving prediction models. In this regard, it is expected that satellite-derived soil moisture could contribute significantly in the predictive schemes. Over this area, the performance of both SMOS and AMSR-E signatures in monitoring events of soil water surplus and deficit are being investigated. To this aim, a sensitivity analysis based on temporal trends of L1 products (emissivity and polarization ratio) of both instruments is in progress. Also the retrieved soil moisture values of AMSR-E and SMOS are being compared using precipitation data and MODIS NDVI data as ancillary information. The final objective is to build a monitoring system based on current systems (AMSR-E and SMOS) and recently launched SAC-D/Aquarius.

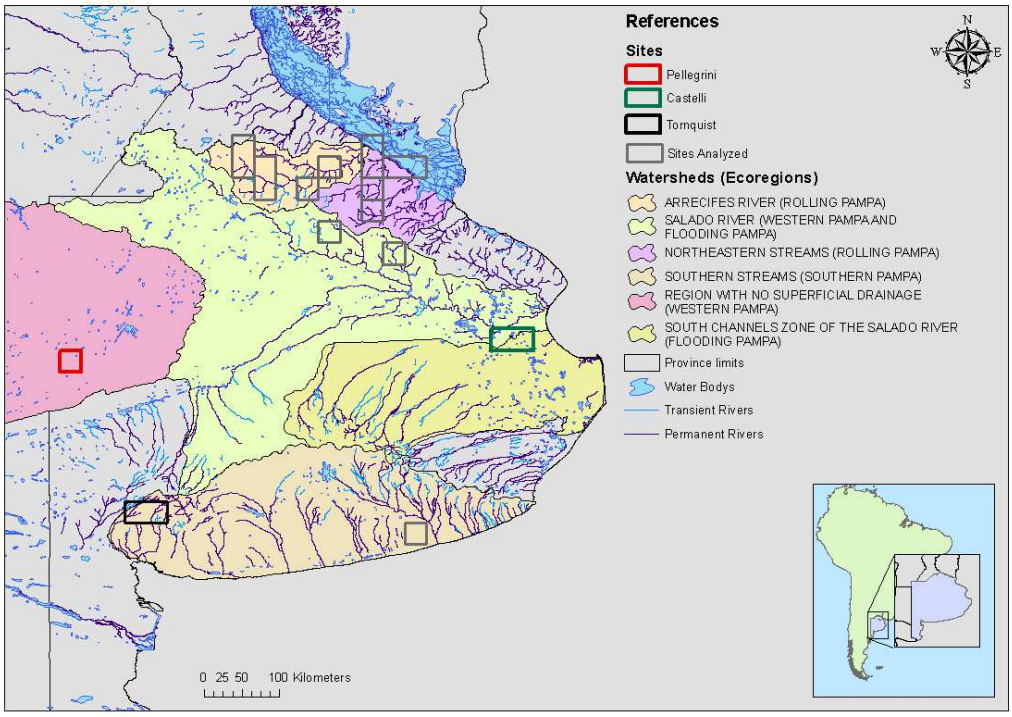

Figure 1: Study Area, located in Buenos Aires Region, Argentina, South America. Sub-basins areas, as well as rivers, are indicated. Color squares indicate sites where AMSR-E and SMOS data were compared. Gray squares indicate the different sites analyzed with AMSR-E and MODIS data.

This work is part of an ongoing project related to mapping and monitoring of flooding events in La Plata Basin. A GIS of the Pampas plains is being built, dividing the area into different watersheds located in the five agro ecological areas mentioned above. This presentation is based on the analysis of multitemporal AMSR-E and SMOS data acquired during 2010 in 15 sites of the pampas plains.

1. SMOS and AMSR-E soil moisture products dynamics

For the year 2010 and at three different locations (Castelli, Pelegrini and Tornquist) soil moisture products estimated by SMOS and AMSR-E were analyzed (Figure 2). In order to interpret the results, both MODIS NDVI (related to vegetation opacity) and precipitations data are shown (A in Figure 2). Radiometer measurements are shown as the polarization ratios [1] for both SMOS (L band) and AMSR-E PR (X and C band) (B in Figure 2). Finally, soil moisture products are shown for AMSR-E (SMA), SMOS (SMS) and estimated from ECMWF model (SME) (C in Figure 2).

Carefully analyzing the results, several comments are given below in order,

- Seasonal (Pelegrini), non-seasonal (Castelli) and complex (Tornquist) NDVI patterns are observed. Furthermore, most of rain events are in the Dec-Mar period. The three polarization ratio (PR) trends are similar and highly correlated. Moreover, SMOS PR is always higher than AMSR-E PR (C band) which is also higher than AMSR-E (X band), a result that is related to the increase of vegetation attenuation with frequency [2]. Finally, SMOS PR presents both higher sensitivity and higher dynamic range.
- SM estimations present high variance among them. In Castelli, SMS is strongly correlated to SMOS PR, a fact that is in agreement with the theory [1].
- SMA is mostly uncorrelated to AMSR-E PR, and presents low values and low variance. This could be related to the relatively high values of NDVI, which are related to higher vegetation opacities at C and X band [3]. SMA and SMS present little correlation.
- There is a good correlation between SMS and SME in Pellegrini and Torquist, but a systematic bias is observed. This bias could be related to (a) a known bias of ECMWF model for SM estimation and/or (b) an underestimation of SMS. Correlation with SME is generally low for SMA.
- In the areas where SMOS PR and SMS present a good correlation (Castelli), SMS estimations are higher than SMA values and present higher variance. It is interesting to remark that this area also presents the highest values of NDVI, which could explain the low correlation between SMA and AMSR-E PR.
- In the other two areas, where NDVI values are lower, SMS presents higher variance than SMA but lower mean values. However, SMS values of these areas are unrealistically low.

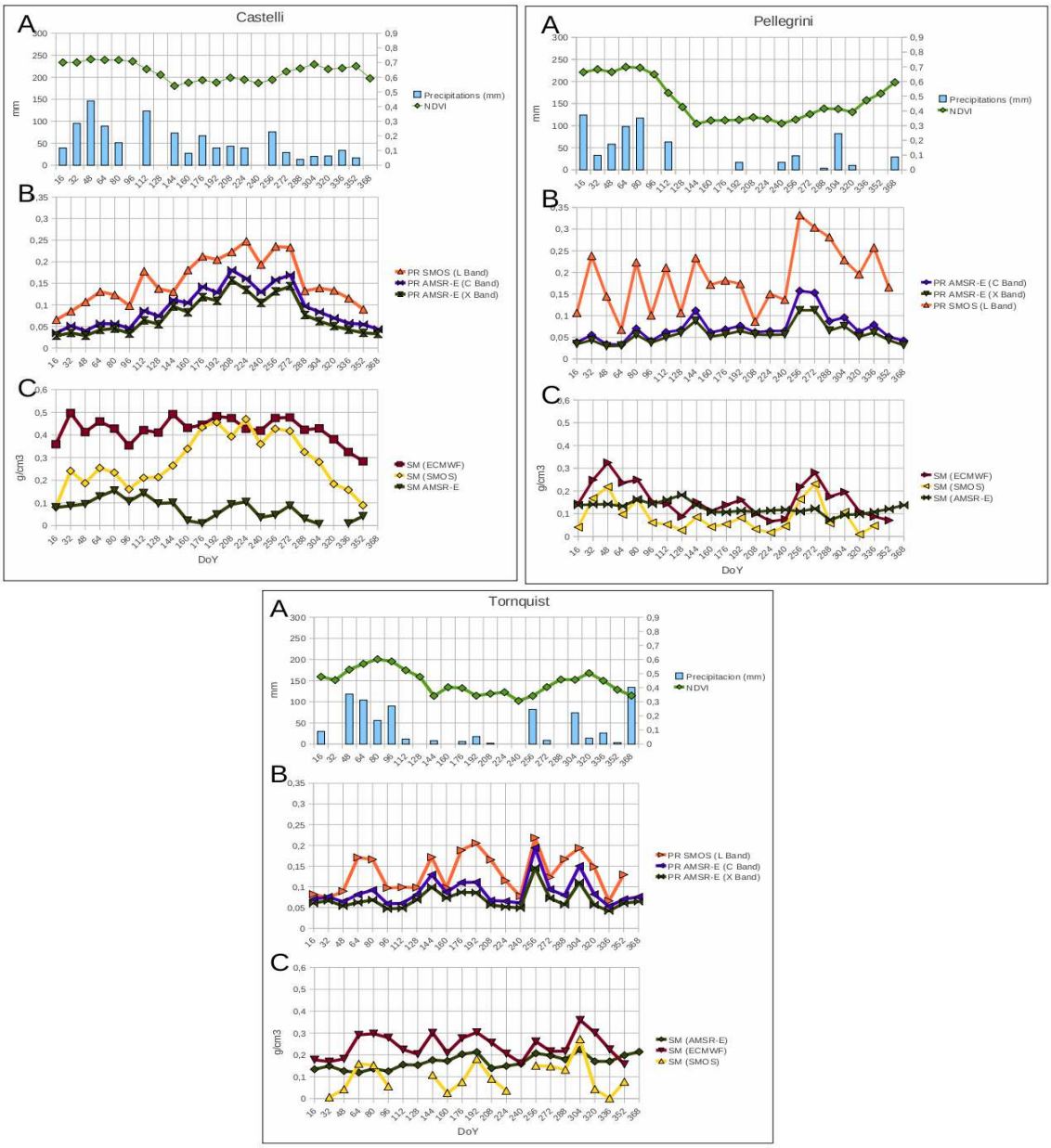

Figure 2: (A) Precipitations and NDVI; (B) PR SMOS (L Band) and AMSR-E (C and X Band); (C) SMA, SME and SMS, of Castelli (top left), Pellegrini (top right) and Tornquist (bottom).

2. AMSR-E soil moisture product under flooding conditions

As previously shown, AMSR-E soil moisture product in Pampas region presents low values and a low variance among different watershed and environmental conditions. However, when a major precipitation measured in several stations caused a flooding event in NE pampas between Jan-Feb 2010, SMA shows a significant increase for all the analyzed stations (Figure 3, A).

This differential sensitivity of SMA to this particular event needs to be analyzed. To this end, for San Antonio de Areco measuring station the precipitations and NDVI values were evaluated (Figure 3, B) along with the AMSR-E PR (polarization ratio) for both X

and C band (Figure 3, C). Unexpectedly, the increase in SMA does not correspond to an increase in measured PR at C or X band [1]. Furthermore, both T_{bV} and T_{bH} present high values for this event (not shown). This implies that SMA algorithm is able to produce high soil moisture values even when low PR are used as main input. This outcome could be explained due to the high values of NDVI, which are correlated with vegetation opacity [3]. Therefore, the large increase in SMA could be obtained in spite of a moderate increase in PR in a region with a large NDVI.

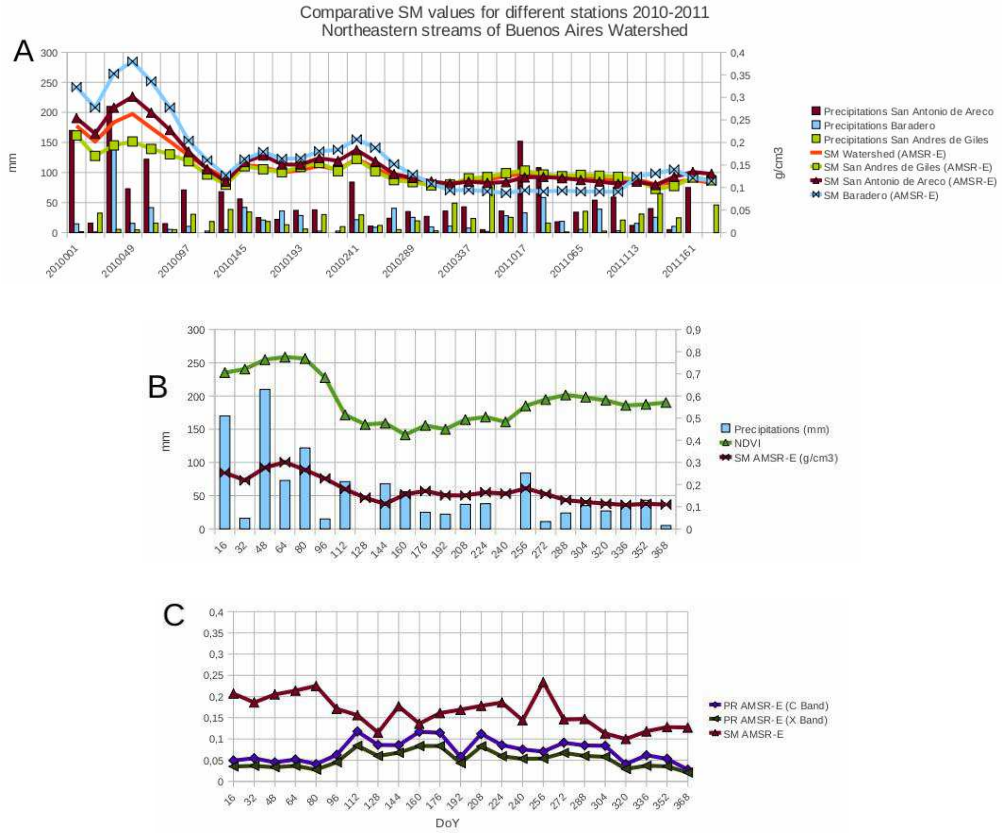

Figure 3. (A) Precipitations and soil moisture of different locations in the NE streams Watershed; (B) NDVI, SM (AMSR-E) and precipitations of San Antonio de Areco; (C) SM (AMSR-E) and PR (C and X Band) of San Antonio de Areco.

Conclusion

The AMSR-E and SMOS soil moisture product were analyzed for several locations on Pampa Humeda. Soil moisture product dynamics were compared, and interpretation based on ancillary data was provided when possible.

References

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