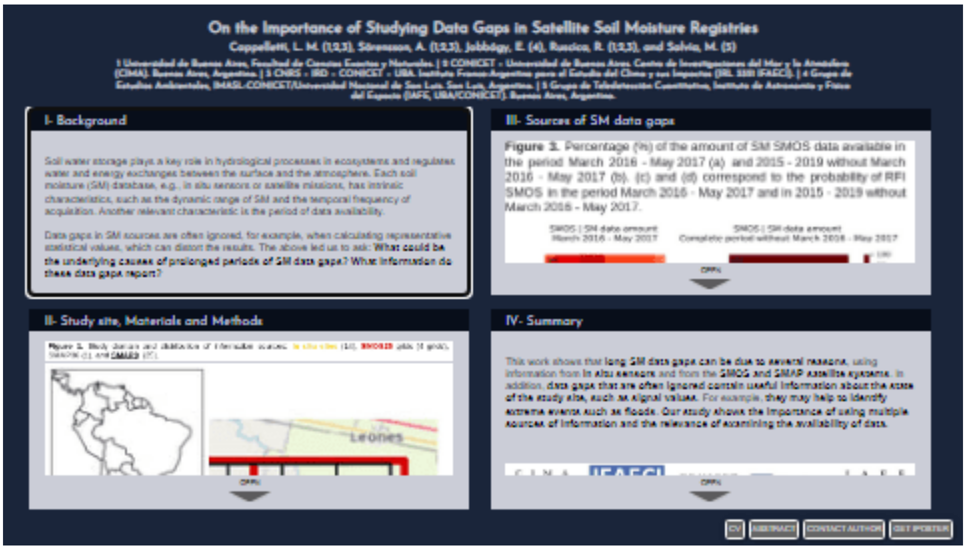
On the Importance of Studying Data Gaps in Satellite Soil Moisture Registries



Cappelletti, L. M. (1,2,3), Sörensson, A. (1,2,3), Jobbágy, E. (4), Ruscica, R. (1,2,3), and Salvia, M. (5)

1 Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales. | 2 CONICET – Universidad de Buenos Aires. Centro de Investigaciones del Mar y la Atmósfera (CIMA). Buenos Aires, Argentina. | 3 CNRS – IRD – CONICET – UBA. Instituto Franco-Argentino para el Estudio del Clima y sus Impactos (IRL 3351 IFAECI). | 4 Grupo de Estudios Ambientales, IMASL-CONICET/Universidad Nacional de San Luis. San Luis, Argentina. | 5 Grupo de Teledetección Cuantitativa, Instituto de Astronomía y Física del Espacio (IAFE, UBA/CONICET). Buenos Aires, Argentina.

PRESENTED AT:

Frontiers in Hydrology

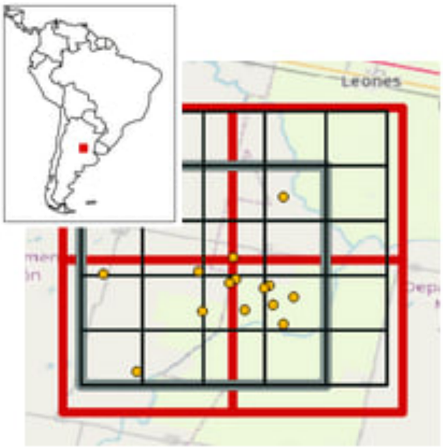
I- BACKGROUND

Soil water storage plays a key role in hydrological processes in ecosystems and regulates water and energy exchanges between the surface and the atmosphere. Each soil moisture (SM) database, e.g., in situ sensors or satellite missions, has intrinsic characteristics, such as the dynamic range of SM and the temporal frequency of acquisition. Another relevant characteristic is the period of data availability.

Data gaps in SM sources are often ignored, for example, when calculating representative statistical values, which can distort the results. The above led us to ask: What could be the underlying causes of prolonged periods of SM data gaps? What information do these data gaps report?

II- STUDY SITE, MATERIALS AND METHODS

Figure 1. Study domain and distribution of information sources: **in situ sites** (14), **SMOS25** grids (4 grids), SMAP36 (1), and **SMAP9** (25).



The study site is located in the southeast of the Córdoba province within the **Argentinean Pampean Plains** (Fig. 1). It is a flat sedimentary region with stagnant hydrological systems and shallow groundwater. It is also homogeneous in terms of land types and land use, without irrigation and drainage canals. The study period covers **April 2015–November 2019**.

This work focuses on **SM at the surface layer** (top ~5 cm). We examined **SM from in situ stations and satellite systems**. The satellite data is from the Soil Moisture and Ocean Salinity (**SMOS**, 25 km resolution) and the Soil Moisture Active Passive (**SMAP**, 9 and 36 km resolution) satellite missions. For each source of information, a SM time series was calculated through daily averages over the in situ sites and the satellite grids.

Figure 2. Daily time series of SM (m^3m^{-3}) from the analyzed information sources, after calculating the average of in situ stations or grids.

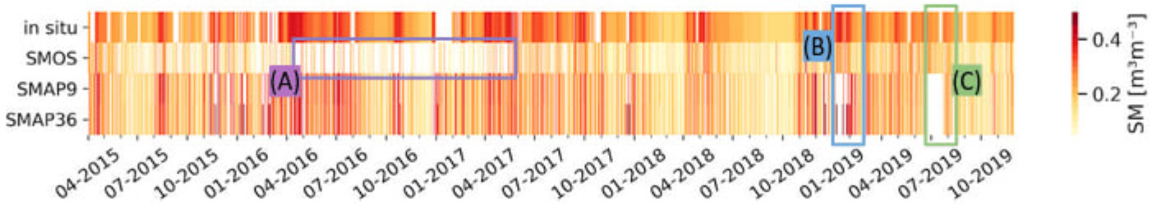


Fig. 2 shows that SMOS has a lower data frequency from March 2016 to May 2017 (A). SMAP has two long data gaps: one in January 2019 (B), followed by the period from 20 June 2019 to 23 July 2019 (C).

III- SOURCES OF SM DATA GAPS

Data frequency in SMOS is lower for over one year. SMOS is sensitive to radio-frequency interference (RFI), so we examined the RFI probability product. The amount of SMOS SM data for the data gap period is 71.75 % (Fig. 3a) and 94.54 % for the rest of the period (Fig. 3b). For these same intervals, the RFI probability is 0.33 and 0.07 (Figs. 3c and 3d). This indicates that **the low number of SM SMOS data during March 2016-May 2017 is due to RFI over the study area. This data gap can't be used as information, but since it occurs during a long-anomalously wet period** (see Fig. 2, in situ and SMAP data)**, it is relevant to take it into account when analyzing SMOS data for the full period.**

Figure 3. Percentage (%) of the amount of SM SMOS data available in the period March 2016 - May 2017 (a) and 2015 - 2019 without March 2016 - May 2017 (b). (c) and (d) correspond to the probability of RFI SMOS in the period March 2016 - May 2017 and in 2015 - 2019 without March 2016 - May 2017.

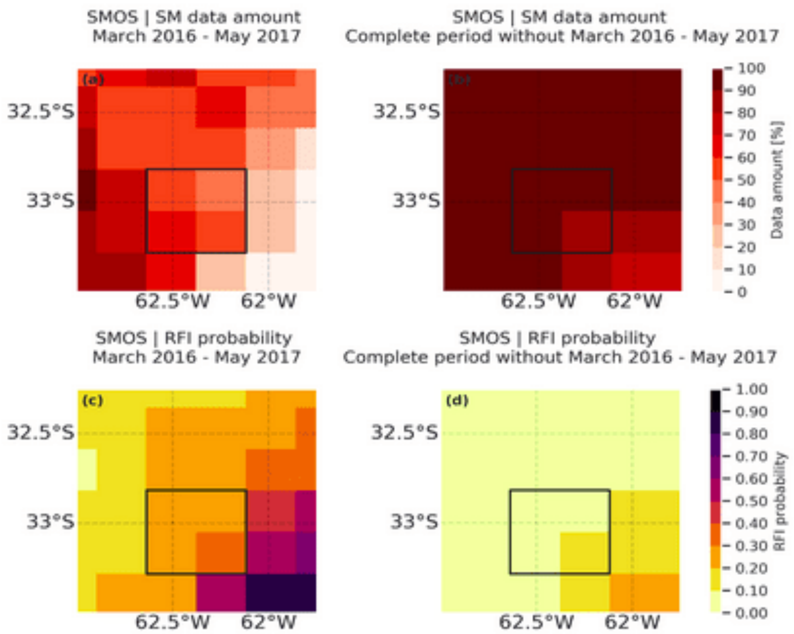
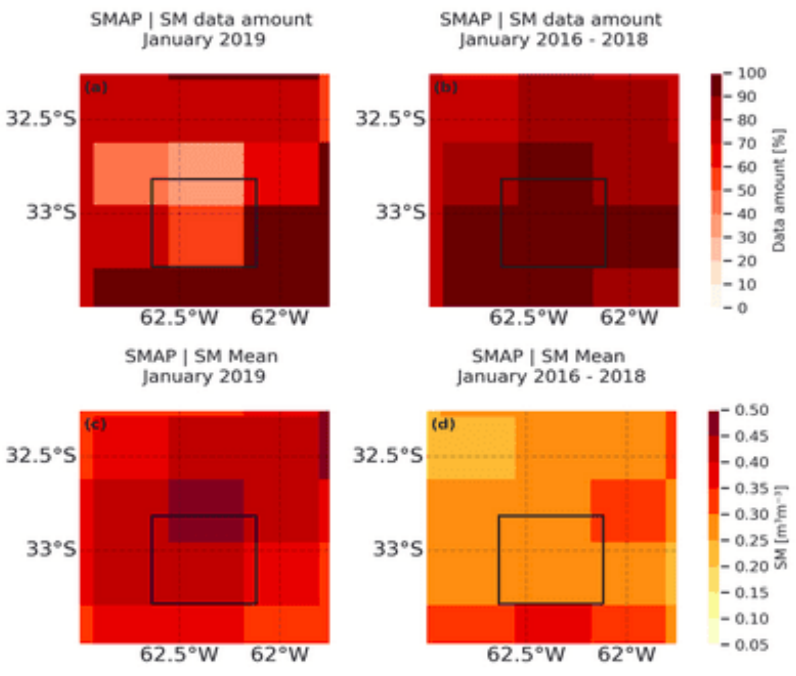


Fig. 4 shows the data gap of SMAP in January 2019. According to the metadata, the dynamic range of SMAP has a maximum of 0.50 m^3m^{-3}, so values greater than this threshold were removed. The analysis of unfiltered data reveals that there is no gap in January 2019. Examining **this case made it possible to identify the response of the SMAP36 system to high and long-lasting water content in soil, which generates values of SM that exceed the valid limits.** This SMAP data gap resulted from **the filtering of high SM signals that are not spurious but typical for this flood-prone region,** and it is an **example of a data gap that contains information about very wet soil**. The other SMAP data gap, 20 June 2019–23 July 2019, is due to a shutdown of all SMAP instruments during this period (https://nsidc.org/data/smap/news).

Figure 4. (a) and (b) show the percentage amount of SM SMAP36 data (%) available in the period January 2019 and January 2016 - 2018. (c) and (d) correspond to the mean field SM SMAP36 (m^3m^{-3}) in the period January 2019 and January 2016 - 2018.



IV- SUMMARY

This work shows that long SM data gaps can be due to several reasons, using information from in situ sensors and from the SMOS and SMAP satellite systems. In addition, data gaps that are often ignored contain useful information about the state of the study site, such as signal values. For example, they may help to identify extreme events such as floods. Our study shows the importance of using multiple sources of information and the relevance of examining the availability of data.

This research was supported by the Agencia Nacional de Promoción Científica y Tecnológica (ANPCyT), Argentina (PICTs 2017-1406, 2018-02511) and by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina (PIP 11220200102141CO).