Toward quality-controlled soil moisture products for climate studies using data assimilation of multiple satellite datasets

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1. Background:

Satellite observations provide information on soil moisture spatio-temporal variability, key to understanding processes linking land surface and atmosphere, and their impact on climate change (*Seneviratne et al., 2010*). This is a key motivation behind the setting up by the European Space Agency (ESA) of the climate change initiative (CCI) project for soil moisture (http://www.esa-soilmoisture-cci.org/). The ESA CCI for soil moisture will produce a multi-year soil moisture dataset from various satellite datasets – see Fig. 1.

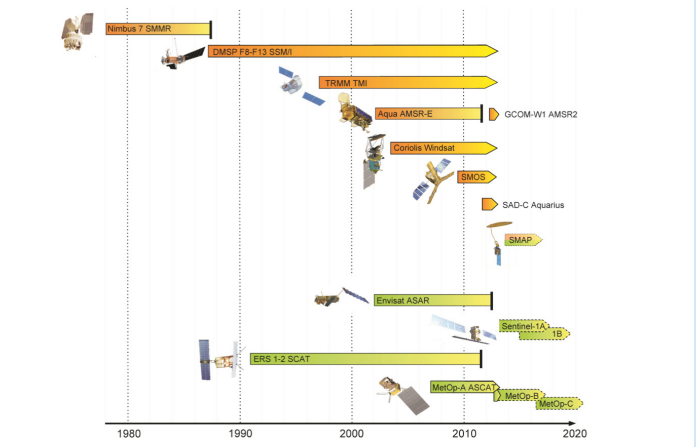

Fig. 1. Satellite datasets used in ESA CCI for soil moisture. *From ESA CCI Soil Moisture website.*

2. Adding value:

To add value to the ESA CCI soil moisture dataset, we perform land data assimilation (DA) – *Lahoz and De Lannoy (2014)* – experiments using multiple satellite datasets with a variant of the Ensemble Kalman Filter, in the first instance over the European domain. Initially, satellite datasets are from the ASCAT, AMSR-E and SMOS platforms; later, we will include ESA CCI soil moisture datasets (Fig. 2).

DA data forms a key part of the validation activities for Phase 2 (2015-2017) of the ESA CCI for soil moisture.

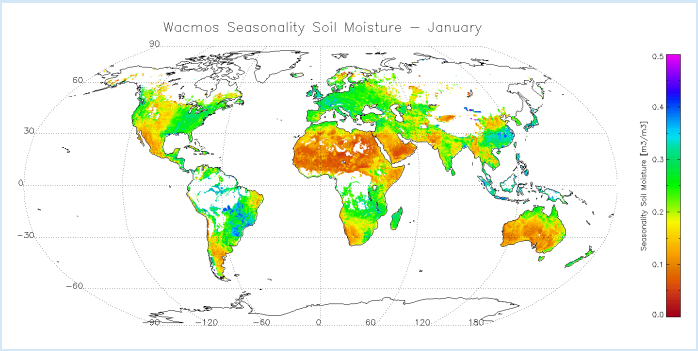

Fig. 2. Soil moisture climatology derived from combination of six active & passive sensors over the period 1979 to 2010 – January shown. *Source: TUW & ESA CCI Soil Moisture website.*

3. Results:

DA set-up tests involve 1-month long runs; 1-year run (July 2010-June 2011) is ongoing. We evaluate DA results by comparison vs independent in situ soil moisture data from the International Soil Moisture Network (Fig. 3).

DA provides:

- Information on observational error, quality of ESA CCI product & impact of satellite observations;
- Extension of ESA CCI product in horizontal (gridding data) & vertical (root zone soil moisture).

Figure 4 shows sample results for open loop run & analysis.

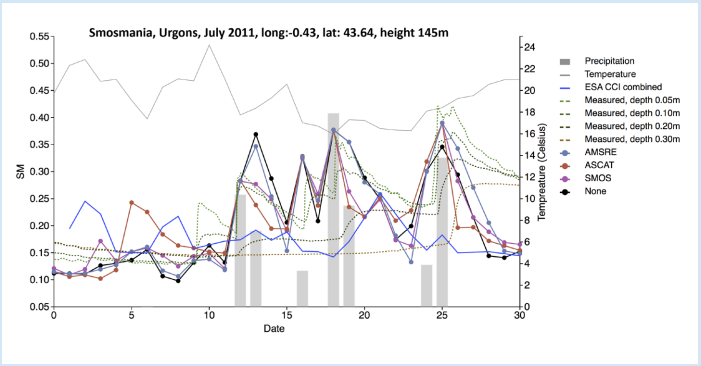

Fig. 3. Time series (July 2011), various soil moisture datasets (m^3m^{-3}), temperature (K) and precipitation (see legend)

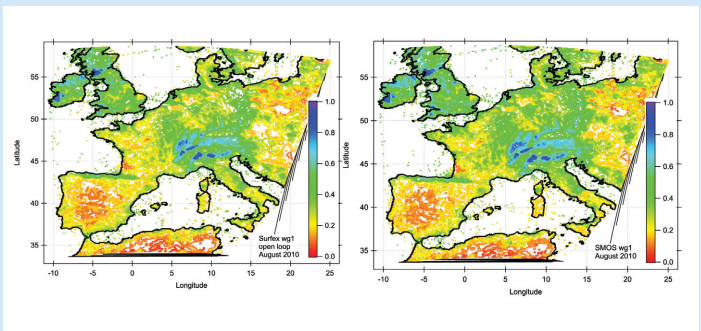

Fig. 4. Monthly averages (Aug 2010) for soil moisture fields (m^3m^{-3}). Left: open loop; right: analyses.

4. Way forward:

We will use DA to validate ESA CCI soil moisture products & extend & complement it. By helping validate and improve the ECV soil moisture product, DA contributes to provision of an evaluated long-term time series of soil moisture for climate studies.

References

Lahoz, W. A., and De Lannoy, G. J. M. (2014). Closing the gaps in our knowledge of the hydrological cycle over land: conceptual problems. *Surv. Geophys.* 35, 623–660. doi:10.1007/s10712-013-9221-7

Seneviratne, S. I., et al. (2010). Investigating soil moisture-climate interactions in a changing climate: a review. *Earth Sci. Rev.* 99, 125–161. doi:10.1016/j.earscirev.2010.02.004

NFR project 202315/V30; ESA CCI Soil Moisture