5+ years of fine-scale soil moisture estimates available!!

At Barcelona Expert Center (BEC) we are able to provide a Level 4 (L4) **Surface Soil Moisture (SSM) product with 1 km** spatial resolution that meets the requirements of **land hydrology applications**. To do so, we use a downscaling method that combines highly-accurate, but low-resolution, SMOS radiometric information with high resolution, but low sensitivity, visible-to-infrared imagery to SSM across spatial scales. A sample L4 SSM map from September 1, 2014 (6 AM) is shown in Figure 1.

Fig. 1. SMOS-BEC L4 product from September 1, 2014 (6 AM).

This downscaling approach was first presented in [1] along with results of its application to a set of SMOS images acquired during the commissioning phase over the Oznet network, South-East Australia. Using reprocessed SMOS data obtained with the latest L1 and L2 processors, we have further developed and validated this technique; **we now use SMOS polarimetric and multi-angular information in the downscaling method, which results in improved fine-scale soil moisture estimates** [2].

The temporal and spatial variability of two years of SMOS-BEC L4 fine-scale (1km) SSM estimates over the Iberian Peninsula has been evaluated through comparison with ground-based measurements acquired at the in situ soil moisture measurement network (REMEDHUS) located in the central part of the Duero basin, Spain [2]. Results show that **the downscaling method improves the spatial representation of SMOS coarse soil moisture estimates (SMOS L2) while maintaining temporal correlation and root mean squared differences with ground-**

based measurements. Figure 1 shows the temporal evolution of SSM time-series (i.e. SMOS L2, SMOS-BEC L4, in-situ) over REMEDHUS. It can be seen that area-averaged downscaled estimates match well with *in situ* data (circles are enclosed within the network's soil moisture variability in shaded green). Scatter plots of Fig. 2 display the agreement between remotely sensed and REMEDHUS *in situ* SSM time-series, with segments illustrating the linear fit of seasonal data. Results are shown for a representative station of rainfed cereals, the most common land-use in the area, for SMOS L2 (left plot) and for SMOS-BEC L4 (right column). It can be seen that **the slope of the linear correlation is significantly improved in the L4 maps** (it is closer to the 1:1 line) and **the dynamic range of *in situ* soil moisture measurements is reproduced in the high resolution maps**, including stations with different mean soil wetness conditions (see further results in [2]). This evaluation study supports the use of this downscaling approach to enhance the spatial resolution of SMOS observations over semi-arid regions such as the Iberian Peninsula.

Fig. 2. Temporal evolution of surface soil moisture time-series over REMEDHUS: ground-based mean (green solid line) and standard deviation (green shaded areas), SMOS L2 (black stars), 40-km aggregated SMOS/MODIS downscaled (blue circles). Daily mean rainfall on top.

Fig. 3. Results of the seasonal analysis for the hydrological year starting in September 2010 (afternoon passes) over station 07 (rainfed cereals). Left: scatter plots of SMOS L2 soil moisture versus point-scale measurements. Right: scatter plot of 1-km SMOS-MODIS disaggregated soil moisture versus point-scale measurements. Segments are linear fit of seasonal (3 months) data.

Fine-scale soil moisture maps over the Iberian Peninsula from years 2010 to present can be freely accessed through the SMOS-BEC data distribution and visualization service (cp34-bec.cmima.csic.es). Global SMOS data as well as MODIS data

over the Iberian Peninsula are received in NRT at SMOS-BEC facilities and, since June 2012 the downscaling algorithm is triggered twice a day, corresponding to SMOS ascending and descending passes to serve high-resolution soil moisture maps in **Near Real-Time NRT (delay of < 6h)**. As a prime NRT application, these maps are being used by local fire prevention services in their early warning system to detect extremely dry soil and vegetation conditions posing a risk of fire. BEC has recently been chosen as an **SMAP Early Adopter to foster the use of remotely sensed soil moisture data in forest fire risk prevention services**.

[1] Piles, M., A. Camps, M. Vall-llossera, I. Corbella, R. Panciera, C. Ruediger, Y. Kerr, J. Walker (2011) "Downscaling SMOS-derived soil moisture using MODIS Visible/Infrared data", IEEE Transactions on Geoscience and Remote Sensing, vol. 49, pp. 3156-3166.

[2] Piles, M., N. Sánchez, M. Vall-llossera, A. Camps, J. Martínez-Fernández, J. Martínez, V. González-Gambau (2014) "A Downscaling Approach for SMOS Land Observations: Evaluation of High-Resolution Soil Moisture Maps Over the Iberian Peninsula", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol.7, no.9, pp.3845-3857.