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Synergies and complementarities between ASCAT and SMOS soil moisture products

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Soil moisture is a critical variable in many kinds of applications including agriculture, water management, meteorology or climatology. This is especially true in the Mediterranean context, where soil moisture plays an important role in water resources management and hydrometeorological risks such as floods and droughts. Unfortunately, this variable is not widely observed in situ, so we lack data on its time evolution and spatial structure. Remote sensing has been used to estimate surface soil moisture because it provides comprehensive data over large surfaces.

In this study we compared two different surface soil moisture remote sensing products; one derived from active microwave data of the ASCAT scatterometer instrument onboard METOP and the other from passive microwave data of the SMOS mission the first dedicated to estimate soil moisture. SMOS measuring frequency (1.4 GHz) is theoretically more suited to measure soil moisture than ASCAT measuring frequency (5.255 GHz) because of its lower vegetation effects. On the other hand, ASCAT- like instruments have been providing measurements for more than 2 decades and have been a key input in building the CCI Soil Moisture Variable. In order to get the best global soil moisture products it is thus essential to understand their respective performances and restrictions.

The comparison has been carried out in Catalonia where we have implemented the SURFEX/ISBA land-surface model, which we forced with the SAFRAN meteorological analysis system. A downscaling algorithm has been also implemented and validated over the area to provide SMOS derived soil moisture fields at 1 km spatial resolution. Catalonia is located in the northeast of the Iberian Peninsula and its climate is typically Mediterranean, mild in winter and warm in summer. The Pyrenees and the neighbouring areas have a high-altitude climate, with minimum temperatures below 0º C, annual rainfall above 1000 mm and abundant snow during the winter. Along the coast, the climate is mild and temperate with temperatures increasing from north to south, while the rain behaves the opposite way. The hinterland, far from the sea, has a continental Mediterranean climate, with cold winters and very hot days in summer. Precipitation in Catalonia is very variable spatially and temporally. As a consequence, precipitation is very unevenly distributed within the year and it is also very variable from year to year. The range of altitudes covers over 3,000 metres and the major relief feature are the Pyrenees. Given its varied landscape, in which plains alternate with mountainous areas, Catalonia has a wide range of bioclimatic habitats.

The comparison concerns ASCAT soil moisture product and SMOS at its native and increased resolution versus the hydrological model outputs. The comparison shows in general good agreement for both ASCAT and SMOS on the temporal series simulated over flat, non irrigated areas which are not close to the sea. This result gives us confidence, as both methods of estimating the soil moisture (simulation and remote sensing) are very different. However, the comparison also shows the limitations of the different products. On the one hand, SMOS has difficulties in areas close to the sea and in areas with steep relief. On the other hand, the hydrological model is not able to simulate non natural processes such as irrigation. ASCAT, in its turn, shows some limitations over agriculture surfaces where it shows an increase of soil moisture from June to October clearly correlated with vegetation cycle but seems to show better performances in areas close to the sea.