



Sentinel-1 and Metop ASCAT Driving Two New 1km Soil Moisture Products in Copernicus: First Data over Europe 2015-2018

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Two new 1km soil moisture (SM) products based on Sentinel-1 CSAR and Metop ASCAT radar observations expand the portfolio of geophysical variables of the Copernicus Global Land Service (CGLS). The CGLS provides freely accessible a large number of harmonised and co-formatted data products on energy, water and vegetation variables in Near-Real-Time (NRT).

Complementing the already operational 0.1° Metop-ASCAT Soil Water Index Version3 (SWIV3), the Surface Soil Moisture (SSM) from Sentinel-1 SAR data (named SSM1km) and a SWI product based on fused SSM data from ASCAT and Sentinel-1 observations (named SWI1km) enable continental and global monitoring of SM at a 1km sampling. They feature SM dynamics with much higher detail, allowing the analysis of local hydrological patterns, such as impacts from convective rains and irrigation activities, and thus meet the requirements of users in many fields.

The SSM1km gives in percent the relative soil moisture saturation of the upmost 5 cm, every 1.5-4 days over Europe, and globally every 3-6 days. The employed algorithm processes the CSAR observations at the initial 20m scale, at which a per-pixel signal analysis drives the algorithm parameter retrieval. Subsequent resampling of pre-processed SAR data to 1km suppresses artefacts stemming from the complex radar interactions at the 20m scale, and increases the sensitivity to soil moisture dynamics.

The SWI1km gives in percent the relative water content in 8 layers of the soil's upmost metre, with a daily full coverage over operated areas. ASCAT and Sentinel-1 SSM are combined per pixel with the aid of data fusion parameters. These are based on the full combined archive of Sentinel-1 and ASCAT (2015-2018) and account for the signals' differences in scaling, accuracy and spatial representativeness. Through combination of both, the high temporal resolution of ASCAT-SSM and the high spatial resolution of Sentinel-1-SSM, it is the first pre-operational dataset that allows resolving SM dynamics with a daily frequency and a 1km sampling.

We present results from the first released dataset from the SSM1km and SWI1km products, covering Europe over the period 2015-2018. We compare them against in-situ measurements, reference data from ASCAT SSM, 1km SM model data, and rainfall observations. Initial experiments on data over Italy found already comprehensively high agreement of the SWI1km with all reference datasets. While the Sentinel-1 signal appears to be attenuated, the ASCAT's signal dynamics are fully transferred to the SWI1km and benefit from the Sentinel-1 parametrisation. Moreover, the SWI1km shows excellent capability to reproduce rainfall observations. The SSM1km yields a consistent set of model parameters and product masks, unperturbed by Sentinel-1 coverage discontinuities. The SSM1km shows high agreement over plains and agricultural areas and low agreement over strong topography and forests, owing to wrongly attributed vegetation dynamics. While positive biases during the growing season are detected, excellent capability to capture small-scale soil moisture changes as such from convective rainfall or irrigation are evident, which are often missed by remotely sensed coarse-scale soil moisture products.

The SSM1km and SWI1km NRT-products are currently covering Europe from 2015 ongoing and are in preparation for dissemination with global coverage.