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Surface Soil Moisture retrieval via change detection using SAOCOM L-band data over the Po Valley (Italy)

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Synthetic Aperture Radar (SAR) has a high potential for measuring superficial soil moisture (SSM) dynamics over regional and global scales. Taking advantage of the continuous supply of Sentinel-1 C-band acquisitions, soil moisture is operationally mapped at kilometer-scale resolution using a change detection method (https://land.copernicus.eu/global/). However, the superimposed effect of the vegetation layer causes significant biases in the retrieval over densely vegetated areas or crop fields characterized by seasonal variations. L-band SAR data, due to their penetration capabilities through the canopy, are sensitive to SSM even where higher-frequency signal gets strongly attenuated. However, data availability has remained limited to a few space missions, e.g. ALOS and ALOS-2. Accordingly, limited applications have investigated the use of change detection models using L-band SAR satellite data.

In the context of the current development of new active L-band satellites, such as SAOCOM (2018), ALOS-4 (2023), NISAR (2024), Tandem-L (2024), and Rose-L (2028) this work aims to explore the potential of SAOCOM data, which has become available since July 2022 over the European territory, to track soil moisture variations underneath crops and natural vegetation. L-band backscattering responses have been jointly evaluated in respect of Sentinel-1 data.

A preprocessing workflow for SAOCOM Single Look Complex (SLC) acquisitions is developed to produce a 1 km co-polarized backscattering time series. The topics addressed are i) the improvement of coregistration between the different SAR sensors; ii) the use of radiometric terrain corrected gamma nought compared to the standard ground range detected (sigma nought) data; iii) the effect of SAOCOM acquisition strategies, such as incidence angle variation and inhomogeneous coverage, on the backscattering trends; iv) the optimization of the dynamic masking procedure to exclude low sensitivity pixel. Subsequently, the preprocessed scenes are ingested into an EO data cube (TUW-GEO/yeoda) and the well-established change detection method is implemented. The methodology is tested over the Po Valley (Italy), where the constellation achieves the highest revisit frequency. The resulting SSM product is compared to Sentinel-1 gamma nought retrievals and to modeled SSM from ERA5-Land reanalysis.

Preliminary results show the potential of SAOCOM data for soil moisture mapping below the vegetation layer, which is essential for studying the effect of SSM climate-linked variations on

vegetation growth, and could serve as a foundation for the development of multifrequency approaches.