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Framework for a near-surface soil sampling survey and C-band SAR-based soil moisture mapping in the Alento terrestrial observatory, South Italy

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Spatially explicit soil moisture information in a high temporal resolution plays an essential role in environmental modeling for improving risk assessment, for quantifying the effects of rainfall seasonality and climatic variability, and for addressing ecosystem services. In this context, remote sensing data, particularly from the Copernicus mission is highly acknowledged to serve as a fast and available supplier for the derivation of area wide and high-resolution spatial-temporal information. However, to reliably estimate near-surface soil moisture patterns based on remote sensing, robust ground-truthing for calibration and validation procedures is required.

Against this background, the present study will introduce into an in situ sampling framework that is optimized towards an eventual spatial-temporal SAR (Synthetic Aperture Radar)-based near-surface soil moisture mapping. The framework comprises a survey scheme, measurement sequence, and survey calendar in accordance to satellite overpasses. The spatial focus of the study lies on an experimental site (denoted by the acronym MFC2) close to Monteforte Cilento (Salerno province) in southern Italy. MFC2 is a pilot agricultural field belonging to the Alento terrestrial observatory within the TERENO (TERrestrial ENvironmental Observatories) network across the Mediterranean region. Ground-based sensors, namely a cosmic-ray probe and a wireless sensor network comprising 20 measurement nodes were installed in 2016 in MFC2 for real-time soil moisture monitoring.

During three weeks in November 2018 covering in total eight satellite overpasses at four days of satellite revisits, near-surface soil moisture (0-5 cm) was sampled each time at 20 different plots in MFC2. In addition, soil physical and chemical properties (i.e. soil texture, bulk density, and soil organic carbon content) and vegetation parameters (e.g., LAI) were sampled at times of satellite overpasses, supplemented by few UAV flights for the photogrammetric analysis of the soil surface roughness. To capture the fluctuation of near-surface soil moisture during the satellite overpasses and its dynamics for a longer period, namely from the wet period to the wet-to-dry transition period (November 2018 – March 2019), two further stationary soil moisture sensors were installed for high-temporal monitoring (1 min recording time). By doing so, acquisition lags between field measurements and overpass times will be addressed, too. The sensor locations were chosen to reflect real field conditions (i.e. non-bare soil plot in MFC2) and to act as a reference plot for calibration for SAR-based soil moisture mapping under non-vegetated conditions. Latter is represented by a 20 x 20 m square in close proximity to MFC2. The grass cover is frequently cut for keeping the bare soil conditions during the entire monitoring period.

Gathered ground-truth data and eventual validated SAR-based soil moisture mapping will support manifold further research activities such as the development of a local-specific transfer function to relate soil moisture patterns from remote sensing data to soil moisture ground-based sensors and vice versa. By assimilating those data into hydrological models, groundwater flow and surface flow under consideration of the climatic variability and in feedback with the vegetation can be simulated for different scenarios of water usage in a Mediterranean environment.