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Exploring multi/full polarised SAR imagery for understanding surface soil moisture and roughness by using semi-empirical and theoretical models and field experiments

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Mediterranean countries are at high risk for an even pronounced susceptibility to water stress and drought, which is expected to have severe direct impact on agricultural productivity. Improved knowledge of the spatial and temporal patterns of near surface soil moisture, as monitored by remote sensing, can be used to better mitigate and adapt to severe drought situations by means of adjusted irrigation strategies. The presented project is aiming to conjointly employ field monitoring and spaceborne SAR to support adaptive water resources management and best agricultural practice. To make substantial progress in decision-making for an optimised irrigation strategy, a regular, e.g. weekly, monitoring of near surface soil moisture in various agricultural land-uses is anticipated. This becomes possible with current co-polarised ENVISAT/ASAR Alternating Polarisation (AP) Mode imagery (C-band).

However, since the backscattering signal is affected by several surface characteristics, a better measurement/estimation of surface roughness is crucial in retrieving near-surface soil moisture. The sensor PALSAR, on board ALOS, and the more recently launched satellite-Radarsat-2 provide new opportunities to retrieve information about surface roughness by means of full-polarised, high-resolution L-band and C-band radar data respectively. It is expected that these data sources can be utilised to better separate the dielectric from the surface roughness component in radar backscattering. For parameter retrieval and validation, intensive in-situ measurements are conducted in a fully equipped agricultural area in a Mediterranean environment in Sardinia, Italy, while ENVISAT/ASAR, ALOS/PALSAR and Radarsat-2 data are acquired. A close range digital photogrammetric technique is applied to monitor surface roughness.

This paper is aiming at exploring the capability of ENVISAT/ASAR AP Mode imagery and Radarsat-2 data for near surface soil moisture inversion using ALOS/PALSAR and close-range digital photogrammetry for surface roughness retrieval. A semi-empirical model is tested and a theoretical model AIEM is utilised for further understanding.

Results demonstrate that the semi-empirical soil moisture retrieval algorithm, which was developed in studies in humid climate conditions, must be carefully adapted to the drier Mediterranean environment. Modifying the approach by incorporating regional field data, led to a considerable improvement of the algorithms performance. In addition, it is found that the current representation of soil surface roughness in the AIEM is insufficient to account for the specific heterogeneities on the field scale.

The findings in this study indicate the necessity for future research, which must be extended to a more integrated combination of current sensors, e.g. ENVISAT/ASAR, ALOS/PALSAR and Radarsat-2 imagery and advanced development of soil moisture retrieval model for multi/full polarised radar imagery.