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Multi-frequency SAR data for soil surface moisture estimation over agricultural fields

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Soil moisture plays a crucial role in the continental water cycle, in particular through its influence on the distribution of precipitation between surface runoff and infiltration, which is the main driver behind most hydrological and geomorphologic processes. Although there is now a good understanding of soil hydrodynamics and water transfer in porous media, the development of reliable techniques allowing field heterogeneities to be fully analyzed in space and time remains a key issue. In recent decades, various inversion models have been proposed for the retrieval of surface parameters (mainly soil moisture and surface roughness) from Synthetic Aperture Radar (SAR) high resolution measurements. The proposed techniques depend particularly on two instrumental parameters: the radar system's spatial resolution and the number of configurations measured during satellite acquisitions (mainly incidence angle and polarization). In this paper, our objective is to illustrate different applications of SAR data to estimate soil moisture over bare soil and vegetation cover areas (wheat, olive groves, meadows ...). Potential of very high resolution data, with the availability of TerraSAR-X and COSMO-SkyMed constellations is also discussed.

This study is based on different experimental campaigns organized over different sites in humid and semi-arid regions. Ground measurements (soil moisture, soil roughness, vegetation description) over test fields were carried out simultaneously to SAR measurements. Effect of vegetation attenuation on radar signal is considered through a synergy with optical remote sensing. Soil moisture precision for all proposed applications is generally ranged between 3 and 5% of volumetric moisture. These methodologies are developed in the context of the preparation for having a high soil moisture operational product, with SENTINEL and/or the other planned constellations. After an analysis of radar data sensitivity (C and X bands) to surface parameters, different inversion approaches are developed to estimate soil moisture (change detection, neural network, and physical or semi-empirical model inversion).