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Analysis of ASAR Wide Swath Mode time series for the retrieval of soil moisture in mountainous areas

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Soil moisture is a key element in the global cycles of water, energy, and carbon. Knowledge on the spatial and temporal distribution of the soil moisture content (SMC) is therefore essential for a number of hydrological applications as well as earth sciences like meteorology or climatology (Heathman et al., 2003). In the last few years there has been an increasing interest towards the estimation of SMC at local scales using active microwave sensors (Barret et al., 2009). Compared to passive microwave sensors, SAR offers the potential to provide data at high spatial resolution (modern sensors can acquire images with up to approximately 1 m), which is particularly important in mountainous areas. So far, these areas have been considered only marginally in research and only pioneer studies can be found in the literature (Brocca et al., 2012; Bertoldi et al. 2013).
In this work we analyzed the temporal and spatial dynamics of the surface SMC (0 - 5 cm depth) on the basis of ground data collected by fixed meteorological stations located in the emerging Long-Term Ecological Research (LTER) site Mazia Valley (Province of Bolzano, South Tyrol, Italy), SAR data from ENVISATs ASAR sensor, wide swath (WS) mode (acquired between 2005 and 2012), and SMC estimates from the hydrological model GEOtop (Endrizzi et al., 2013). The SMC retrieval process was based on the support vector regression (SVR) method introduced by Pasolli et al. (2011). The training of the algorithm was based on data acquired in 2010. Furthermore, the SAR backscatter and derived SMC have been compared with time-series derived from the distributed hydrological model GEOtop. The differences in terms of temporal and spatial dynamic have been analyzed. The main goal of this work is to evaluate the spatial and temporal patterns of SAR derived SMC at field scale and to correlate them with ground information. This is a preparatory study to establish a methodology for the retrieval of SMC with high spatial and temporal sampling and to improve retrieval accuracies by integrating temporal information from different sources of ancillary data and from SAR time-series.
It was found that the dynamics of both, temporal and spatial SMC patterns obtained from various data sources (ASAR, GEOtop and meteorological stations), show a similar general temporal behaviour that indicates the robustness of the retrieval algorithm with ASAR WS. However, depending on land cover, soil type and local topographic conditions different spatial patters can be found between SMC estimations coming from ASAR and from the GEOtop model. Introducing information on the temporal behaviour of the SAR signal proves to be a promising method for increasing the confidence and accuracy in estimating SMC, complementing hydrological model predictions. Following steps were identified as critical for the retrieval process: the topographic correction and geocoding of SAR data and the calibration of the meteorological stations. Both factors can have significant influence on the quality of SMC estimation. The accuracy of meteorological input and soil parameterization were identified as the most crucial challenges for SMC derived from hydrological modeling.

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