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Exploitation of polarimetric RADARSAT2 images for spatial and temporal estimation of soil moisture in an alpine catchment

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The knowledge of spatial and temporal distribution of soil moisture has important implications in many application domains, such as hydrological modeling for flood and landslide prediction or climate change analysis. To this aim, microwave space-borne remote sensing imagery could provide useful information, thanks to the sensitivity of microwave signals to the amount of water within the soil. In the last years the scientific community has shown a rising interest in the direction of the new generation Synthetic Aperture Radars (SARs) systems, such as RADARSAT2, thanks to the good geometrical resolution and the possibility to acquire even more complete information, such as the polarimetric features, from the scene of interest. However, full-polarimetric estimation approaches have not been fully exploited yet, due to the only recent availability of full-polarimetric orbiting SAR systems.
The estimation of soil parameters in mountain areas, such as the Alps, becomes even more important for the applications seen previously, but at the same time complex. The reasons are: i) the effect of topography, which determines the variability of the local incidence angle and of the distance between target and sensor. One may expect a residual contribution of the topographic effects even after a proper calibration of the signal; and ii) the heterogeneity and variability of the land coverage, which may affect the soil moisture retrieval process, in particular when medium-high geometrical resolution imagery is considered. Up to now, very limited effort has been devoted to the retrieval of soil parameters in these challenging conditions, thus suggesting the necessity of further research effort in this direction.
In the context of the SOFIA project (ESA AO-6280), supported by the Province of Bolzano in the framework of the IRKIS project, 15 full-polarimetric RADARSAT2 SAR images were acquired over the South-Tyrol area, northern Italy, during summer 2010. The aim was to investigate the capability of the new generation satellite SAR system to provide useful and reliable information on the soil moisture status in the Alpine environment. A preliminary analysis of the data (in combination with ground measurements and ancillary data), pointed out from the one side the potentiality of the new generation SAR data for the retrieval of soil moisture, but on the other side the necessity of further analysis for handling the complexity of the mountain environment.
This work inserts in this context and has three main objectives:
- the improvement of the estimation system developed during the preliminary study by further exploiting the polarimetric capability of the RADARSAT2 SAR system and the ancillary data to try to reduce the ambiguity due to the heterogeneity and variability of the land coverage;
- the extension of the analysis on the whole set of SAR images acquired, in order to assess the capability of the proposed estimation system to provide spatial and temporal distributed information on the moisture content status of soils in the mountain environment.
- the comparison of the estimates derived from RADARSAT2 images with the simulation of the GEOTop hydrological model, in order to provide spatially distributed soil moisture products for model calibration. In a long term perspective, satellite soil moisture products might be combined with hydrological models for flood and landslide prevention.