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Satellite soil moisture assimilation in operational hydrology: preliminary assessment of the Sentinel 1 potentialities within a flood risk management framework

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As a first-order control of the partitioning of precipitation into infiltration and runoff, soil moisture (SM) has a key role in hydrological sciences. Its accurate estimation allows for a better prediction of river discharge and this, in turn, allows for a more effective mitigation of flood risk. SM data can be obtained by in-situ measurements and by satellite observations. Because of an apparent lack of dense and uniform monitoring networks, microwave satellite observations offer an alternative for obtaining synoptic Satellite Soil Moisture (SSM) maps representative of the first centimetres of the soil. SSM maps generated using Synthetic Aperture Radar (SAR) systems are characterised by a comparatively high spatial resolution (in the order of tenths of meters). However, SSM retrievals are known to be often affected by inaccuracies in terms of backscattering signal modelling, especially due to approximations in the parameterization of the vegetation and the surface roughness. In order to obtain more reliable SM estimates, Data Assimilation (DA) techniques were adapted to the specific needs of hydrological models.

The objective of this research is to assess the potentialities of Sentinel-1 (S1) in operational hydrology. S1 carries a C-Band, SAR sensor and it has a spatial resolution of 5x20 m (single look) in Interferometric Wide Swath mode and a temporal resolution of 12 days (that will become 6 after the launch of the Sentinel 1-B scheduled for 2016). As part of the Copernicus Programme, it represents a unique monitoring tool whose potentialities in flood risk management still need to be evaluated. To this aim, SSM maps are extracted from S1-A images and assimilated into a time-continuous, spatially distributed, physically-based hydrological model (i.e. Continuum) with the specific objective to evaluate the impact on discharge predictions. The SM retrievals are performed by adopting a multitemporal algorithm. Before their assimilation into the model, SSM maps are pre-processed in order to be comparable with the SM variable modelled by Continuum. The latter is representative of the root zone saturation degree. The assimilation algorithm used is a simplified version of the Ensemble Kalman Filter that has been developed with the aim to reduce the high computational demand of the ensemble reanalysis. Results are evaluated on the Orba River catchment (Italy) by comparing the observed discharges with the modelled ones, obtained with and without the assimilation.