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Precipitation evidences on X-Band Synthetic Aperture Radar imagery: an approach for quantitative detection and estimation

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Spaceborne synthetic aperture radars (SARs) operating at L-band and above are nowadays a well-established tool for Earth remote sensing; among the numerous civil applications we can indicate flood areas detection and monitoring, earthquakes analysis, digital elevation model production, land use monitoring and classification. Appealing characteristics of this kind of instruments is the high spatial resolution ensured in almost all-weather conditions and with a reasonable duty cycle and coverage. This result has achieved by the by the most recent generation of SAR missions, which moreover allow polarimetric observation of the target. Nevertheless, atmospheric clouds, in particular the precipitating ones, can significantly affect the signal backscattered from the ground surface (e.g. Ferrazzoli and Schiavon, 1997), on both amplitude and phase, with effects increasing with the operating frequency. In this respect, proofs are given by several recent works (e.g. Marzano et al., 2010, Baldini et al., 2014) using X-Band SAR data by COSMO-SkyMed (CSK) and TerraSAR-X (TSX) missions. On the other hand, this sensitivity open interesting perspectives towards the SAR observation, and eventually quantification, of precipitations.

In this respect, a proposal approach for X-SARs precipitation maps production and cloud masking arise from our work. Cloud masking allows detection of precipitation compromised areas. Respect precipitation maps, satellite X-SARs offer the unique possibility to ingest within flood forecasting model precipitation data at the catchment scale. This aspect is particularly innovative, even if work has been done the late years, and some aspects need to still address.

Our developed processing framework allows, within the cloud masking stage, distinguishing flooded areas, precipitating clouds together with permanent water bodies, all appearing dark in the SAR image. The procedure is mainly based on image segmentation techniques and fuzzy logic (e.g. Pulvirenti et al. 2014 and Mori et al. 2012); ancillary data, such as local incident angle and land cover, are used. This stage is necessary to tune the precipitation map stage and to avoid severe misinterpretations on the precipitation map routines. The second stage consist of estimating the local cloud attenuation. Finally the precipitation map is estimated, using the the retrieval algorithm developed by Marzano et al. (2011), applied only to pixels where rain is known to be present.

Within the FP7 project EartH$_2$Observe we have applied this methodology to 14 study cases, acquired within TSX and CSK missions over Italy and United States. This choice allows analysing both hurricane-like intense events and continental mid-latitude precipitations, with the possibility to verify and validate the proposed methodology through the available weather radar networks. Moreover it allows in same extent analysing the contribution of orography and quality of ancillary data (i.e. landcover). In this work we will discuss the results obtained until now in terms of improved rain cell localization and precipitation quantification.