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How reliable are satellite precipitation estimates for driving hydrological models: a verification study over the Mediterranean area

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Floods are one of the most common and dangerous natural hazards, causing every year thousands of casualties and damages worldwide. The main tool for assessing flood risk and reducing damages is represented by hydrologic early warning systems that allow to forecast flood events by using real time data obtained through ground monitoring networks (e.g., raingauges and radars). However, the use of such data, mainly rainfall, presents some issues firstly related to the network density and to the limited spatial representativeness of local measurements. A way to overcome these issues may be the use of satellite-based rainfall products (SRPs) that nowadays are available on a global scale at ever increasing spatial/temporal resolution and accuracy. However, despite the large availability and increased accuracy of SRPs (e.g., the Tropical Rainfall Measurement Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA); the Satellite Application Facility on Support to Operational Hydrology and Water Management (H-SAF); and the recent Global Precipitation Measurement (GPM) mission), remotely sensed rainfall data are scarcely used in hydrological modeling and only a small number of studies have been carried out to outline some guidelines for using satellite data as input for hydrological modelling. Reasons may be related to: 1) the large bias characterizing satellite precipitation estimates, which is dependent on rainfall intensity and season, 2) the spatial/temporal resolution, 3) the timeliness, which is often insufficient for operational purposes, and 4) a general (often not justified) skepticism of the hydrological community in the use of satellite products for land applications.
The objective of this study is to explore the feasibility of using SRPs in a lumped hydrologic model (MISDc, "Modello Idrologico Semi-Distribuito in continuo", Masseroni et al., 2017) over 10 basins in the Mediterranean area with different sizes and physiographic characteristics. Specifically, TMPA 3B42-RT, CMORPH, PERSIANN and a new soil moisture-derived rainfall datasets obtained through the application of SM2RAIN algorithm (Brocca et al., 2014) to ASCAT (Advanced SCATterometer) soil moisture product are used in the analysis. The performances obtained with SRPs are compared with those obtained by using ground data during the 6-year period from 2010 to 2015. In addition, the performance obtained by an integration of the above mentioned SRPs is also investigated to see whether merged rainfall observations are able to improve flood simulation. Preliminary analysis were also carried out by using the IMERG early run product of GPM mission.
The results highlight that SRPs should be used with caution for rainfall-runoff modelling in the Mediterranean region. Bias correction and model recalibration are necessary steps, even though not always sufficient to achieve satisfactory performances. Indeed, some of the products provide unreliable outcomes, mainly in smaller basins (<500 km^2) that, however, represent the main target for flood modelling in the Mediterranean area. The better performances are obtained by integrating different SRPs, and particularly by merging TMPA 3B42-RT and SM2RAIN-ASCAT products. The promising results of the integrated product are expected to increase the confidence on the use of SRPs in hydrological modeling, even in challenging areas as the Mediterranean.

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