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On the use of GPM constellation for monitoring heavy precipitation events over the Mediterranean region

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With the recent advent of the NASA/JAXA Global Precipitation Measurement (GPM) mission a new era has started for precipitation monitoring from space. The constellation of satellites carrying cross-track and conically scanning microwave radiometers has now reached an optimal configuration, ensuring a 3-hourly global coverage. Here we show how precipitation retrievals exploiting the available passive microwave (PMW) observations in the GPM mission era can be used to monitor and characterize heavy precipitation events. Specifically, our analysis focuses on specific features of three intense storms that occurred during the Fall 2014 over the Italian area. The goal is to evidence suitability and limitations of PMW precipitation retrievals from different radiometers to quantitatively estimate precipitation rate and to characterize extreme events. To this end, we apply and compare three different physically based PMW precipitation retrieval algorithms, which are used within international programs related to the GPM mission – i.e. our Cloud Dynamics and Radiation Database (CDRD) and Passive-microwave Neural-network Precipitation Retrieval (PNPR) algorithms, which are used operationally within the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Satellite Application Facility on support to Operational Hydrology and Water Management (H-SAF), and the National Aeronautics and Space Administration (NASA) Goddard PROFiling algorithm (GPROF), which is the reference algorithm for the GPM mission. Assessment of the accuracy of the satellite precipitation estimates has been carried out using the available polarimetric ground-based radar and/or raingauge measurements. The different characteristics of the radiometers (i.e. viewing geometry, spatial resolution, channel assortment) and of retrieval techniques (i.e. Bayesian vs. Neural Network), are taken into consideration in the evaluation of the accuracy and consistency of the retrievals. Results show that PMW precipitation retrievals from the GPM constellation of radiometers provide a reliable and quantitative description of precipitation (instantaneous and on the daily scale) throughout the evolution of the storms over the Mediterranean region. Notably, the relative errors among gauges, radar, and combination of radiometer overpasses are comparable, thus legitimizing the use of PMW estimates as a valuable and independent tool for monitoring precipitation – which is particularly relevant in the presence of complex orography in proximity of coastal areas, as for the analyzed cases. In particular, both CDRD and PNPR usually identify well the areas affected by the most intense precipitation, while showing some weaknesses in the PMW detection of light precipitation (the opposite is found for the GPROF products). Also, good consistency in CDRD and PNPR precipitation retrievals is found for (nearly) coincident overpasses of the different radiometers, with discrepancies that are comparable to the differences between ground-based instruments (i.e. raingauges and radar). In essence, in spite of their low spatial resolution and relatively poor temporal sampling, PMW precipitation retrievals from CDRD and PNPR, specifically designed for the Mediterranean area, provide good estimates of total precipitation amounts for the areas that are affected by the most intense precipitation, especially when the events are localized and persistent.