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Characterization and monitoring of heavy precipitation events in the Mediterranean area: role of the GPM mission

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The Mediterranean Sea is a unique meteorological environment and a weather forecasting challenge, where severe weather events of different nature often originate and develop to hit coastal regions, causing major damages and casualties. Conventional ground-based instruments (e.g., raingauges and weather radars) are often inadequate to monitor events during their offshore development. On the other hand, in spite of their irregular time sampling, Low Earth Orbit satellites, carrying passive and active microwave (MW) sensors, can be fully exploited for the characterization and monitoring of heavy precipitation systems over this area. In this respect, the NASA/JAXA Global Precipitation Measurement (GPM) Core Observatory (CO), equipped with the most advanced MW radiometer (GPM Microwave Imager, GMI) and the first spaceborne Dual-frequency Precipitation Radar (DPR), allows for the 3-D analysis of precipitation structures. Moreover the GPM constellation of MW radiometers ensures 1-3 hourly global coverage of precipitation.

In this presentation, we show the GPM mission role in the characterization and monitoring of precipitation associated to extreme events, that hit Italy in the last years. Moreover, we test the capabilities and limitations of advanced satellite precipitation products in the GPM era for quantification and monitoring of precipitation associated with very intense and localized convective cells. To this aim, we analyze the flash flood occurred in Livorno, on the coast of Tuscany, Italy, in the night between 9 and 10 Sept. 2017. In this case, the precipitation products based on the GPM constellation of MW radiometers offer a wide spectrum of results, showing that better performances come from algorithms tailored for the specific region, while algorithms designed for global application are less sensitive to such small-scale thunderstorms. An analogous study is carried out for Numa, a Mediterranean tropical-like cyclone occurred on 16-18 November 2017 over southern Italy. GPM-CO measurements are used, in conjunction with LINET (LIghtning NETwork) data, to show how the rain-band structure evolves as the storm develops into its mature phase. High-resolution simulations were carried out with the Regional Atmospheric Modeling System (RAMS) to analyze the key mechanisms leading to the formation and evolution of Numa. We also show the impact of the assimilation of DPR reflectivity on the precipitation forecast. Long data records of reliable satellite precipitation-related measurements and products are becoming available in the GPM era. Here we make a first attempt to exploit them for a preliminary analysis of occurrence and intensity of extreme events in the Mediterranean, where they can be recognized as climate change signatures.

This study evidences the need to fully exploit satellite data and products for studying and monitoring severe weather in the Mediterranean area, and to improve forecasting (and nowcasting) capabilities in this complex region. Thus efforts should be undertaken to develop satellite products tailored for these areas (working on algorithm calibration), and to provide the error structure of the products (working on validation). This would enable users to apply the most suitable product for a specific need, including hydrological applications, and for data assimilation of precipitation-related fields over the sea, where these systems often initiate.