Heavy Precipitation Systems in the Mediterranean: The Role of the GPM

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Introduction

Examples of typical precipitation systems occurring in the Mediterranean area, that often devastate the coastal regions, are described and analyzed here by exploiting active and passive microwave measurements and state of the art precipitation products available in the GPM mission era. They are 1) a small-scale, and rapidly evolving, intense self-regenerating thunderstorm causing flashfloods; 2) a MCS leading to an exceptionally intense hailstorm; 3) a Mediterranean Tropical-Like Cyclone (or Mediterranean). The GPM key role in integrating observational ground-based and satellite-borne tools not only for precipitation monitoring, but also for understanding and characterizing severe weather in the Mediterranean, is described.

Isolated Deep-convection Systems: Livorno Flood

In the right between 8 and 10 Sept. 2017 a flash flood hit the coastal city of Livorno (it 43.45° N, 10.50° E), Tuscany, causing extensive damages in the city centre and along the coast. The area around the city (Fig. 1b), three raingauges registered over 230 mm of cumulated precipitation between 00 and 06 UTC of 10 Sept., with peaks of about 75 mm in 10 minutes (550 mm) registered (Fig. 2a). Overwhelmed the GPM constellation MW radiometers (6 AMSU/IR, 2 G, 2 SMAP, 1 AMS, 1 ATMS), captured the complex structure of the event. Precipitation patterns (Fig. 1c) do not explain the fact that the GPM-CDO observers, uniformly distributed over the city of Livorno (Fig. 2c), did not detect the storm, but GPM brightness temperatures (TB) provided unique multiscale images of the mature core over the city of Livorno (Fig. 3).

MCS: The Naples hailstorm

Marra et al. (2017) analyzed one hailstorm that developed over the Tyrrhenian Sea and hit the Gulf and the city of Naples, in Italy, on 9 Sep 2017 (hereafter referred to as the Naples hailstorm). The storm was detected on 10 and 11 September by the three GPM-CDO observers, uniformly distributed in the area. An GPM Core-Observer (GCO) 10 GHz in the core of the storm did not cover the storm, but GPM brightness temperatures (TB) provided unique multiscale images of the mature core over the city of Naples (Fig. 3).

The 24-h cumulated precipitation on 01/07 00 UTC (Fig. 3) was obtained from:

- Raingages (from the Italian Civil Protection - DPC), by cumulating half-hourly rainfall maps.
- Ground-based Italian radar network mosaic (from the DPC), by integrating the surface rainfall maps available every 10 min.
- PMW-only products (SIF and GPM GPROF V05), by registering RTR retrievals available in the 24 h.
- Combined products (SIF, SAF H3 and IMERG V05) by integrating the (mean) instantaneous RTR estimates available every 10 and 30 min, respectively.

We noted that during rainbands and radians, especially in the region affected by the flood (black box in Fig. 1a and Fig. 3), with a significant (~50%) overestimation by the radar.

At significant difference between the 24-h precipitation maps obtained from SIF and GPM products. The SIF 24-h product seems to either follow or anticipate the peaks, in better agreement with the radar. On the other hand, despite the relatively poor performance of some products, the mean cumulative precipitation estimated by the radar is roughly ~50% higher than the raingages.

The temporal evolution of the mean instantaneous precipitation (Fig. 4, top panel) shows that:

- The mean cumulated precipitation obtained by the radar is much larger (~50%) than the instantaneous precipitation. In particular, the highest precipitation events (at 10 UTC) are underestimated by the raingages and overestimated by the radar.

The precipitation pattern (Fig. 4, bottom panel) shows a general agreement in terms of occurrence and spatial distribution. The radar images show a broad area of precipitation, with the highest rainfall intensity. Instead, the raingages images show a more confined area of precipitation, with the highest rainfall intensity. The GPM products show an overall agreement in terms of occurrence and spatial distribution. The GPM products show a general agreement in terms of occurrence and spatial distribution. The GPM products show a general agreement in terms of occurrence and spatial distribution.

Conclusion

We presented three events that have recently challenged observational and forecasting capabilities in the Mediterranean, and caused damages at the ground. Making use of ground-based and satellite-borne instruments, we addressed the problem of estimating precipitation of a small-scale and short-living intense Mediterranean, the capability to render the 3D structure of a convective system, and the key role of satellite and radar in the classification and monitoring of a Mediterranean. Measurements and precipitation products available in the GPM era can be successfully exploited with the aim to increase the knowledge of severe systems in the Mediterranean area and to support operational forecasting activities in this complex region in a climate change perspective.

To fully achieve this purpose, efforts should be undertaken to provide products tailored for these regions (working on algorithm calibration), and error the problem of products (working on validation). This would enable users to properly apply the more valuable product for the specific need, including data assimilation of precipitation-related fields over the sea where heavy precipitation systems affecting the Mediterranean coastal regions often indicate. Moreover, long-data records of precipitation-related measurements and reliable products would help assessing climate change signatures in the Mediterranean area, where such severe events are becoming more and more frequent.

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References


