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The precipitation structure of the Mediterranean tropical-like cyclone Numa: analysis of GPM-CO observations and NWP simulations

Giulia Panegrossi, Anna Cinzia Marra, Paolo Sanò, Leo Pio D'Adderio, Stefano Dietrich, Luca Baldini, Mario Montopoli, and Stefano Federico

Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR), Rome, Italy (g.panegrossi@isac.cnr.it)

The exploitation of the observational capacity of Low Earth Orbit (LEO) satellite systems equipped with passive and active microwave (MW) sensors can contribute significantly to the analysis, characterization, and monitoring of heavy precipitation systems over the Mediterranean region (Panegrossi et al., 2016). During their development offshore, where more conventional ground-based observations may not provide the needed coverage, LEO satellite MW measurements can be used in conjunction with high-resolution Numerical Weather Prediciton (NWP) simulations to improve our understanding of key mechanisms leading to the formation and intensification of such systems. The NASA/JAXA Global Precipitation Measurement Core Observatory (GPM-CO), equipped with the most advanced microwave radiometer (GPM Microwave Imager, GMI) and with the first spaceborne Dual-frequency Precipitation Radar (DPR), allows for the analysis of the 3-D structure of precipitation at all latitudes between 65°S-65°N. A previous study (Marra et al., 2017) has demonstrated the key role of the GPM-CO in the analysis and characterization of an extremely severe hailstorm occurred off the coast of Naples on September 5, 2015. In the present work, GMI and DPR are used, in conjunction with LINET (LIghtning NETwork) strokes data and high-resolution NWP simulations, to analyze the evolution and precipitation structure of the Mediterranean tropical-like cyclone Numa, occurred on 16-18 November 2017. Two GPM-CO overpasses captured the system: one on November 16 at 13:49 UTC, during its early development phase in the Ionian Sea, and one on November 18 at 03:59 UTC, during its mature phase, when the storm hit the southern coast of Puglia region for several hours, causing extensive floods. DPR measurements, available during the system development offshore, reveal a complex 3-D structure of the precipitation, with deep convection embedded in the shallower and stratiform precipitation in most part of the rain bands. The DPR measurements and products (e.g., rain band morphology, surface rainfall pattern and intensity, cloud-top height variability, size distribution parameters) are combined with coincident GMI measurements to analyze the passive MW radiometric response to the precipitation and to the microphysical structure of the storm. The comparison between GMI measurements at two different phases of the storm evolution shows how the structure of the rain bands evolves as the storm develops into its mature phase. It is worth noting that the storm was only partially covered by the Italian ground-based radar network, thus limiting its use in this study. High-resolution simulations are carried out with the Regional Atmospheric Modeling System (RAMS) to analyze the key mechanisms leading to the formation and evolution of Numa and to show the impact of the data assimilation of radar reflectivity and LINET strokes on the precipitation forecast.

References

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