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A Space-Based Perspective of Tropical Storms and Other Extremes in 2017 from GPM

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The Global Precipitation Measurement (GPM) mission collected unique, near-real-time 3-D satellite-based views of tropical cyclones and a variety of strong mid-latitude storms in 2017, together with estimated precipitation accumulation using merged satellite data for scientific studies and societal applications. Central to GPM is the NASA-JAXA GPM Core Observatory (CO). The GPM-CO carries an advanced dual-frequency precipitation radar (DPR) and a well-calibrated, multi-frequency passive microwave radiometer that together serve as an on orbit reference for precipitation measurements made by the international GPM satellite constellation.

GPM-CO overpasses of major tropical cyclones such as Harvey, Irma, Maria, and Ophelia (in the Atlantic basin), and Ava and Irving (in the Indian Ocean basin) revealed intense convective structures in DPR radar reflectivity together with deep ice-phase microphysics in both the eyewalls and outer rain bands. Of considerable scientific interest, and yet to be determined, will be DPR-diagnosed characteristics of the rain drop size distribution as a function of convective structure, intensity and microphysics. As well, rain/snow structures of mid-latitude storms are revealed across land/ocean boundaries.

The GPM-CO active/passive suite also provided important decision support information. For example, the National Hurricane Center used GPM-CO observations as a tool to inform track and intensity estimates in their forecast briefings. Near-real-time rainfall accumulation from the Integrated Multi-satellitE Retrievals for GPM (IMERG) was also provided via the NASA SPoRT team to Puerto Rico following Hurricane Maria when ground-based radar systems on the island failed. Comparisons between IMERG, NOAA Multi-Radar Multi-Sensor data, and rain gauge rainfall accumulations near Houston, Texas during Hurricane Harvey revealed spatial biases between ground and IMERG satellite estimates, and a general underestimation of IMERG rain accumulations associated with infrared observations, collectively illustrating the difficulty of measuring rainfall in hurricanes.

GPM data continue to advance scientific research on tropical cyclone intensification and structure, and contribute to societal and operational applications for improving storm forecasting.