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Assessing the Contribution of the Arctic Weather Satellite to Improved Observation of Extreme Cyclonic Events: the hurricane Melissa Case Study

Andrea Camplani, Paolo Sanò, Daniele Casella, Leo Pio D'Adderio, Stefano Sebastianelli, Daniele D'Armiento, Laura Soncin, and **Giulia Panegrossi**
Institute of Atmospheric and Climatic Sciences (ISAC), National Research Council (CNR), Rome, Italy (andreacamplani@cnr.it)

The launch of the ESA Arctic Weather Satellite Path Finder Mission (AWS-PFM), forerunner of the EUMETSAT EPS-Sterna mission, equipped with a cross-track scanning radiometer (Microwave Radiometer, MWR) which covers frequency between 50 and 325 GHz, represents an important improvement in satellite meteorology. The MWR represents a significant innovation in microwave radiometry, due to its four channels in the 325.15 GHz band offering enhanced sensitivity to cloud ice, thus enabling precise cloud observation.Exploiting coincident overpasses over precipitation events between the AWS and spaceborne radars, such as the Dual-frequency Precipitation Radar (DPR) onboard the NASA/JAXA GPM-CO mission and the Cloud Profiling Radar (CPR) onboard the ESA/JAXA EarthCare mission, can improve our understanding on the relationship between the cloud structure and the signal observed by the radiometer.

This work presents a case study concerning a nearly coincident overpass of GPM-CO and AWS-PFM over Hurricane Melissa, a tropical cyclone that developed into a Category 5 during the 2025 Atlantic season. The observations took place on October 30, 2025, when Melissa had weakened to Category 2. The possibility to observe this type of event combining dual-polarization microwave (PMW) channels — available from the GPM Microwave Imager — with the sub-mm channels — available from the AWS-PFM MWR — as well as the measurements and precipitation profiles available from the DPR provides unprecedented potential for improving our understanding of the dynamics and microphysics processes in tropical cyclones. An analysis combining DPR observations and GMI brightness temperature (TB) is carried out based on our previous work regarding the analysis of Mediterranean tropical-like cyclonic events, such as Medicane Ianos, classified as category 1 hurricane at its peak of intensity. In addition, the combination of multi-channel measurements from AWS-PFM MWR reveal the added value of the sub-mm channels at 325.15 GHz to relate the cloud top structure with precipitation features. The comparison between Medicane Ianos and hurricane Melissa shows remarkable similarities at the time of the GPM-CO/AWS-PFM overpass. In both cases, very high Ku-band radar reflectivity values (around 50 dBZ) are associated with very intense precipitation (around 100 mm/h), which does not correspond to extreme TB features usually observed in the presence of strong updrafts sustaining large frozen hydrometeors at the upper levels. This indicates that, even during extremely intense cyclonic phenomena, the development of intense convective cores is limited.

This analysis is ancillary to the future launch of the EPS Sterna mission, a constellation of AWS-like small satellites, designed to improve weather forecasts by providing global measurements of atmospheric temperature, humidity profiles as well as cloud and precipitation features with frequent revisit times.