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Satellite-based characterization of Medicanes in the GPM era

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Mediterranean hurricanes (Medicanes) are meso-scale cyclones typical of the Mediterranean area which during their lifetime may show some dynamical features with tropical cyclones: the presence of a quasi-cloud-free calm eye, spiral-like cloud bands elongated from the center, strong winds close to the vortex centre and a warm core. They are often associated to heavy rainfall and flooding, intense wind, and high waves and storm surge, and can be serious threats to human life and infrastructure. Recent studies highlighted that extra-tropical and tropical-like cyclone (TLC) characteristics can alternate or even coexist in the same cyclonic system, and that only in some cases strong diabatic forcing leads to tropical-like transition (i.e., purely barotropic structure) associated to shallow or deep warm core. In this study a comparative analysis among the Medicanes occurred during the Global Precipitation Measurement (GPM) era (i.e. since March 2014), is carried out. The goal is to extract common features from passive MW measurements to identify and characterize the transition to TLC phase during the Medicane evolution. Passive microwave measurements from the GPM constellation radiometers are used to characterize the precipitation structure and warm core properties throughout the Medicane evolution. In particular, the NASA/JAXA GPM Core Observatory (GPM-CO) active and passive microwave (MW) sensors are used in conjunction with ground-based LIghtning NETwork (LINET) measurements to analyse the rainband structure and infer microphysics processes and convection strength. On the other hand, MW temperature sounding channels available from AMSU-A and ATMS radiometers are used to identify the warm core and infer its properties (e.g., depth and symmetry) around the cyclone center. The most intense Medicane on record, named Ianos, which swept across the Ionian Sea between 14 and 18 September 2020, is anlaysed in detail. The GPM-CO Dual-frequency Precipitation Radar (DPR) overpass, available for the first time during a medicane TLC phase, provides key measurements and products to analyze the 3D precipitation structure in the rainbands, offering further evidence of the main precipitation microphysics processes inferred from the passive MW measurement analysis. Moreover, the GPM-CO overpasses highlight a significant change in deep convection features between Ianos development and mature phases, which explain the substantial drop in lightning activity during Ianos TLC phase. The study demonstrates the value of satellite MW measurements in the GPM era to provide evidence of Medicanes' transition to TLC phase and to characterize its precipitation structure and microphysics processes.