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Two satellite-based methodologies for the automated detection of the center of rotation in Mediterranean tropical-like cyclones

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Medicanes originate from extra-tropical cyclones undergoing tropical-like cyclone transition during their mature phase, showing characteristics typical of tropical cyclones (TC): a barotropic structure with an axi-symmetric warm core originating from diabatic processes, strong rotation winds, and spiraling rain bands around a nearly cloud-free eye. In analogy with TCs, the surface wind field is useful to characterize Medicanes, as it could give additional information on their evolution. In particular, the radius of maximum wind (RMW) is a key feature for the TC's intensification evaluation. Following the definition provided by the National Oceanic and Atmospheric Administration (NOAA) for the TCs, the RMW is defined as the distance between the band of the strongest winds and the Medicane's center of rotation. However, an accurate RMW computation is sensitive to the methodology used for the determination of the Medicanes' center of rotation.

In this work we use the near-surface wind field provided by the Advanced SCATterometer (ASCAT) real-aperture radar onboard MetOp satellites. Moreover, to increase the temporal coverage, the Wind Radar (WindRAD) onboard of Feng Yun FY-3E satellite series is also used. For both sensors the surface wind field estimation is related to the roughness of the sea surface through the back-scattered electromagnetic signal. The scatterometer wind field as well as ERA-5 mean sea level pressure (MSLP) field are used as an indication of the Medicanes' intensification.

The methodology developed to identify the center of rotation (which is often different from the position of the minimum MSLP) is based on the computation of the standard deviation of the horizontal surface wind direction also taking into account the wind speed field. The observations show that closer to the cyclone center the wind direction is highly variable due to the presence of the cyclonic vortex. This results in higher standard deviation's values and can be considered a reliable feature to identify the cyclone's center. Moreover, since Mediterranean cyclones often exhibit satellite-based phenomenological features typical of TCs we also investigate the applicability of the Automated Rotational Center Hurricane Eye Retrieval (ARCHER) algorithm, developed by the TC group at CIMSS/University of Wisconsin-Madison. ARCHER is widely used as an objective tool to locate the TC's center of rotation.

The purpose of our work is to compare the two methodologies to better understand their potentialities and limitations in the characterization of the RMW and to relate the evolution of the RMW to the Medicanes' intensification. Several cases of Medicanes that have occurred in the last 10 years are analysed. The results show that both methodologies are more reliable when the Medicane is more organized showing a closed cyclonic structure associated with strong near-surface winds with a quasi-calm area in its center (mature phase), and that in most cases the RMW decreases as the Medicanes intensify. This study indicates that satellite-based monitoring of the RMW could provide useful indication for tracking Medicanes evolution in near-real time. This work is carried out

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