

Editorial

# Mediterranean Tropical-Like Cyclones (Medicanes)

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## 1. Background

Due to its peculiar morphology, the Mediterranean Basin is one of the main cyclogenetic areas in the world. Most of these cyclones are synoptic-scale events and baroclinic in origin. However, intense mesoscale vortices have sometimes been observed, showing features and a development mechanism similar to tropical cyclones, although they are weaker and smaller in size. Thus, they are generally called Medicanes, a short name for “Mediterranean hurricanes”, or Mediterranean tropical-like cyclones (TLC).

In recent years, a renewed interest in this topic has emerged due both to the important social impact of these vortices, which may affect coasts with intense winds and heavy precipitation, and the implications of climate change for their intensity and location. While a number of papers have shed some light on the mechanisms of formation and intensification, several questions are still subject of debate in the scientific community, ranging from the criteria for a reliable definition of Medicanes to their classification, either as a peculiar category or as member of an extensive category that also includes polar lows and subtropical cyclones.

## 2. Development Mechanisms

Numerical simulations have shown that the latent heat release associated with convection and air–sea interaction processes are fundamental for the intensification of Medicanes, while baroclinic instability is important in the early stages of their lifetime, during which these cyclones develop under deep upper-tropospheric troughs [1,2]. There is a general consensus that, in their mature stage, TLC and tropical cyclones share the so-called wind induced surface heat exchange (WISHE) [3,4] as the main development mechanism, which means that these storms are maintained against dissipation entirely by sea-surface fluxes.

However, a couple of recent papers have raised some doubts concerning the application of this mechanism to two TLCs [5,6], supporting the idea that the warm-air seclusion in the extratropical cyclone’s inner core by surrounding colder air may explain the presence of a deep warm, core structure. Miglietta and Rotunno [7] identified a different evolution in the lifetime of these two TLCs: the first cyclone, after an initial baroclinic development, intensified mainly through the WISHE mechanism, while for the second cyclone, the seclusion of warm air by cold air contributed effectively to its deep warm-core structure. They showed that, within the category of Mediterranean tropical-like cyclones, different development mechanisms are possible and proposed a classification of Medicanes in different categories.

An aspect related to the development of Medicanes was analyzed in one of the four papers contributing to this *Atmosphere* Special Issue. Due to the intense wind forcings and the consequent development of high wind waves, a large number of sea spray droplets are likely to be produced at the sea surface by these intense cyclones. This aspect was taken into consideration by Rizza et al. [8] in two ways: implementing an additional sea spray source function in the WRF-Chem aerosol module, and using a parameterization of the sea surface aerodynamic roughness (within the WRF

surface layer) that explicitly considered the effects of the wave-state and sea spray on the sea surface roughness. Numerical simulations showed a benefit in the track of a specific Mediane when these changes were included.

### 3. Predictability

The accurate prediction of Medicanes is an important challenge for numerical weather prediction models, thus it is important to study the sensitivity of the simulations to different parameters and forcings. Several studies are required to analyze the development of cyclones in different environmental conditions and to improve their representation in numerical models.

For a specific case in the central Mediterranean, it was shown that the initial conditions and the microphysical schemes were the main factors controlling the cyclone depth and track in numerical simulations with the WRF model [9]. In the present Special Issue, Pytharoulis et al. [10] identified a significant sensitivity of a Mediane in the southern Mediterranean to the physical parameterizations: its intensity was mainly influenced by the boundary/surface layer schemes, its track by the cumulus convection, and its duration by the microphysics. The authors concluded that it was not possible to identify an optimal combination of physical parameterizations in order to simulate all of the characteristics of this Mediane. Finally, they found that the incorporation of recent advances in tropical cyclone research in the calculation of sea-surface fluxes, through the modification of the drag coefficient and the roughness length, improved the simulated intensity, track, and duration of the Mediane.

Climatologies of Medicanes in the Western Mediterranean based on multidecadal runs were performed with the WRF model with different resolutions and setups in another paper of this Special Issue. Ragone et al. [11] compared the statistics of Medicanes in the historical period 1979–1998 in runs using different convective and microphysical schemes. They found that different convective schemes led to different statistics of Medicanes, while the use of different microphysics mainly affected the cyclone trajectories.

In the last paper of the Special Issue, Ricchi et al. [12] focused on the comparison of two different modeling approaches, comparable in terms of computational cost, to represent the evolution of a Mediane in the central Mediterranean. First, an ensemble of WRF model runs using different microphysics and turbulence parameterization schemes was considered; next, a two-way atmosphere–ocean coupled configuration using the COAWST modeling system was employed. The advantage of using a coupled modeling system was evaluated by taking into account the air–sea interaction processes at growing levels of complexity. Coupled simulations reproduced more accurate sea surface temperature and heat fluxes when compared with a multi-physics ensemble of standalone atmospheric simulations that also affected the cyclone intensity and track. These results are consistent with previous studies [13,14], showing that coupled models are more proficient than atmospheric standalone numerical systems for systemic and detailed studies of Medicanes and can be effective tools for climate projections.

### 4. Conclusions and Future Work

Recent papers have clarified some peculiar aspects of Medicanes, from the mechanisms of development to their predictability [15], including the sensitivity of numerical simulations to different parameterization schemes. However, additional studies are necessary to provide a comprehensive picture for this particular category of cyclones. For example, the interactions between stratospheric air intrusions and Medicanes during their life cycles should be clarified as well as the role of dry air in the evolution of these cyclones. Moreover, the recently proposed classification [7] should be tested in other cases to provide definite conclusions on the ways different mechanisms can cooperate to determine the cyclone evolution. For example, it would be interesting to explore how the different nature of the cyclones is connected with the location of cyclogenesis.

Additional studies should analyze how Mediane activity will change in climate change scenarios. Recent studies using regional [16–18] and global [19,20] climate simulations agree in representing an

increase in the cyclone intensity, but a slight decrease in their number in a future climate. However, the results of these studies should be verified using higher resolution runs that have become available in recent years, possibly by using coupled modeling systems that represent in a consistent way the air–sea interaction processes. The progress in model formulation and in resolution will provide a more appropriate representation of the climate change risk associated with intense cyclones.

Finally, the attribution of the intensity of specific cyclones to climate change is an important topic that needs to be properly analyzed not only from a research perspective, but also from an operational context. This problem can be faced by analyzing simulations that include modifications in the environmental fields that are consistent with the variations of the present climate compared to the climate observed in the past and projected into the future [21].

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