Mesoscale numerical simulations of medicanes: Comparison against satellite-derived trajectories and isolation of key physical processes

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A few tropical-like cyclones have been developed over the Mediterranean Sea during the last decades according to the inventory of images provided by Meteosat satellite. These extreme small-scale warm-core storms, also called "medicanes", operate on the thermodynamical disequilibrium between the sea and the atmosphere, and sometimes attain hurricane intensity and threat the islands and coastal regions.

Despite their small size, mesoscale model runs at moderate horizontal resolutions (7.5 km) made with MM5 are able to simulate the cyclone formation and general trajectory for most of the cases and emphasize the warm-core, axi-symmetrical structure of the storms. Simulation of the timing and precise details of the storm trajectories are shown to be more problematic when compared against the satellite images available for the events. It is hypothesized that the small size of the systems and the crucial role of moist microphysics, deep convection and boundary layer parameterizations are the main factors beyond these errors. On the other hand, a sensitivity analysis examining the role of the large-scale dynamic forcing and sea surface fluxes is conducted. Specifically, the potential-vorticity (PV) inversion technique is used to reduce the amplitude of the upper-level precursor trough in the model initial conditions, and the latent and sensible heat fluxes from the Mediterranean are switched off during the course of the simulations. Using a factor-separation technique, the individual effects of the aforementioned factors, as well as their interaction are determined.

Results show that just before their mature phases, the enthalpy fluxes from the sea grow up, helping to develop these cyclones and inducing further cyclone deepening by diabatic heating. The joint action of the upper-level PV anomalies and these fluxes becomes the basic main factor for the genesis and evolution of the medicanes.