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The influence of input large scale fields on the ability of a mesoscale model to simulate medicanes: from very high to low resolution

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Tropical-like cyclones occasionally develop over the Mediterranean Sea, sometimes attaining hurricane intensity and threating the islands and coastal regions. These small-scale warm-core storms, called medicanes (MEDIterranean hurriCANES), operate on the thermodynamic disequilibrium between the sea and the atmosphere and in this respect, as well in their visual appearance in satellite images, are much like tropical cyclones.

A database of twelve medicanes was created based on Meteosat satellite images for the period 1982-2005. It was necessary to decide a selection criteria to isolate medicanes from other Mediterranean cyclones, typically baroclinic storms. Main selection criteria are cyclone size, cyclone eye clarity and lifetime. The identification on the satellite images was done subjectively.

Some meteorological features of the large-scale environments associated to tropical cyclones, here extended to medicanes, are low-tropospheric vorticity centres, high mid-tropospheric relative humidity, large sea surface temperature values combined with cold air aloft, and low tropospheric wind shear. The precursor role of a cold-core cyclone in the upper and middle troposphere has been identified in most of the detected medicane events.

Mesoscale simulations of the case studies at 7.5 km horizontal resolution show the ability of MM5 model to capture the general features of these systems, like the development of quasi-symmetric intense low-pressure centres at surface with an isolated warm-core structure aloft, especially during the mature phase. But these experiments also exhibit tangible errors in the trajectories and time evolutions of the medicanes compared with the satellite data. These errors might be associated to the small size of these cyclones, which would require very special simulation conditions and the use of very high resolution, and to its dependence on parameterized physical processes like air-sea exchange, boundary layer turbulence, cumulus convection and moist microphysics. In addition, observational data over the Mediterranean basin is too sparse to capture mesoscale features involved in the triggering and evolution of maritime convection.

Since this work is included in the framework of the project "MEDICANES: meteorological environments, numerical predictability and risk assessment", which pursues the quantitative assessment of medicane risk and its uncertainty under future climate conditions by nesting the MM5 model within a large collection of GCM simulations, it is necessary to evaluate the capability of MM5 to resolve medicane events depending on the varying spatial resolution of the GCM forcing. Then, different simulations of the case studies have been performed by degrading the resolution of the input large scale fields. Available data for the control runs comes from ECMWF analyses with a resolution of T213 ($\sim$85 km), higher than typical grid lengths of future climate models. Two coarser experiments using $\sim$125 km and $\sim$250 km input resolutions have been compared with the control one, generally revealing the development of medicane-like structures even in the coarsest experiment.

Furthermore, the occurrence of the meteorological environments described above are much more frequent than the observed medicane events. For that reason, it is expected that other special conditions are necessary for medicane development, but they are still unknown. Very high resolution reanalysis can be useful to improve this knowledge. To this aim, several case studies have been selected and explored in detail using the Integrated Forecast System (IFS) from the ECMWF, at an increased horizontal resolution of T1279 ($\sim$16 km).