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Predictability of Mediterranean cyclones: medium-range modeling at kilometer resolution

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Mediterranean cyclones, and the disasters they potentially result in, are still poorly predicted by operational models for medium-range weather forecasts. Among other factors, the presence of an upper-level trough, originating from the North Atlantic Rossby wave, is a crucial ingredient for the development of such a cyclone. Moreover, it plays an important role in the starting of extreme precipitation events. During the extra-tropical transition of a tropical storm in the North Atlantic, the Rossby wave is itself poorly forecasted. Describing the complex interaction between the storm and the Rossby wave in this situation is still a challenge for operational models. In particular, an insufficient spatial resolution is responsible for a poor representation of strong diabatic effects in clouds. A model with a kilometer resolution allows the use of an explicit convection. It may therefore improve the description and understanding of the extra-tropical transition of a tropical storm, as well as its interaction with the Rossby wave. Thus, a better location of the upper-level trough downstream should follow, and the predictability of any potential Mediterranean cyclone should be enhanced.

This study focuses on the impact of the extra-tropical transition of hurricane Helene on the Mediterranean storm which occurred in South-East Italy on September 26th 2006. This storm was absent in operational forecasts at d+3. On these forecasts, the upper-level trough did not interact with a preexisting surface low which resulted into the storm. This situation is modeled with Meso-NH, the meso-scale non-hydrostatic research model of the French community. Simulations use a domain encompassing both the Mediterranean and the North Atlantic, and start from the ECMWF analysis on September 23rd 2006. They are compared to ECMWF analysis of the subsequent days and to ECMWF forecasts from the same starting date. Microwave observations from the space-borne instrument AMSU-B are also used to better analyze the convection patterns. Runs at 24 km resolution represent the extra-tropical transition of hurricane Helene slightly better than ECMWF forecasts, which use a similar spatial resolution. However, they do not predict the Mediterranean cyclone downstream. Runs at 4 km resolution give the most realistic modeling of the interaction between hurricane Helene and the Rossby wave. Still, the development of the Mediterranean storm remains very sensitive to the precise location and depth of the upper-level trough on Italy.

These high-resolution simulations on large grids take profit of a new generation of supercomputers for intensive parallel calculation recently acquired by the GENCI-CINES (Grant 2010-01-569). This work is done in the framework of the HYMEX and T-NAWDEX programs.