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High-resolution ensemble data assimilation of a medicane event: challenges and beneffits

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A small quasi-tropical cyclone of small dimensions formed in central Mediterranean on 7th November 2014, affecting the islands of Pantelleria, Lampedusa, Malta and Sicily with hurricane wind speeds. The physical analysis of this so-called Medicane clearly shows the tropical transition of the initial baroclinic development into a pure warm-core axissymetric system. Medicanes have got the attention of the community in the recent years and there is still open debate regarding their definition, genesis mechanisms, discriminant parameters for their formation and the requirements to predict them.

We investigate the physical processes of the development and the predictability properties of the 7 November 2014 event by means of an ensemble data assimilation system based on Kalman filtering (EnKF). The predictability of these systems is tipically very limited owing to the highly diabatic (nonlinear) physical processes involved and their maritime (highly unobserved) origin. Consequently, we generate the ensemble assimilation and forecasting system sampling the uncertainty space of initial conditions and physical processes. Initial conditions sampling is adopted from the ECMWF ENS global forecasts. Aditionally, multiple PBL, Microphysics and radiative parameterized schemes are used to account for physical processes unvertainties.

The experimental high resolution ensemble allows to produce probabilistic forecasts of specific aspects of the genesis and evolution of the event. Besides providing a probability of accurrence of the event with lead times of 24-36h, forecasts provide valuable information about the intensity the wind and pressure fields. The trajectory forecast is a key aspect for accurate civil protection actions. The experimental system produces a fairly uncertainty and unaccurate trajectory, which largely depends on small scale features of the environment.

Additionally, we investigate the covariances that can be derived from the ensemble in order to shred some light on the discriminant aspects between medicane formation and non formation scenarios. Although constrained by linear assumptions, results show the connections of the central pressure and wind fields of the medicane with precursing fields.

Although based on a single case study, results are encouraging regarding the predictability of the formation, trajectory and intensity of medicanes based on ensemble data assimilation techniques. Additionally, covariance fields provide a valuable tool for physical processes diagnosis even in this highly nonlinear evolutions.