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Ensemble prediction systems based on potential vorticity perturbations and multiphysics tested for MEDEX events. A medicane event application.

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The main goal of our regional ensemble prediction systems (EPSs) is to improve the current prediction skill of potentially hazardous heavy precipitation weather events in the western Mediterranean countries. Thanks to three different ensemble generation procedures we account for uncertainties present in both the numerical models and the initial conditions. The EPSs generation takes advantage of the connection between potential vorticity (PV) structures and cyclones, and of the different physical parameterization schemes present in the numerical model. First, we consider two PV-perturbed ensembles differing in the criteria used to locate the initial perturbation zones. One of them introduces the perturbations over the MM5 adjoint model calculated sensitivity zones (PV-adjoint), while the other one perturbs the PV field along the zones of the three-dimensional PV structure presenting the local most intense values and gradients of the field (PV-gradient). Second, a multiphysics EPS is built by incorporating different combinations of the physical parameterizations for boundary layer, cumulus and moist microphysics processes. The non hydrostatic MM5 mesoscale model has been used to run all the ensemble members. The simulations are performed for a two-day period with a 22.5 km resolution domain, Domain 1 in http://mm5forecasts.uib.es, nested in the ECMWF large-scale forecast fields.

The performance of the ensembles is evaluated with a thorough verification process using 19 MEDEX cyclonic episodes as a testbench. These MEDEX events are associated with floods and strong winds over the western Mediterranean and represent the kind of phenomena we are targeting.

Besides ratifying the advantages of an EPS over a deterministic forecast, the results of the verification procedure show that the EPSs perturbing the PV field structures are more skillful than the Multiphysics ensemble, and that among those, the PV-gradient ensemble provides a more useful forecast than the PV-adjoint at a better cost, at least when our testbed is concerned. Encouraged by these results, we apply the three EPSs to the 8 November 2011 medicane event. This tropical-like cyclone reached its mature state after passing through Majorca Island and evolved towards the Gulf of Lion region where it dissipated. The results of our EPSs for this event reveal that all three systems are able to successfully capture the event. In fact, both the cyclone track and its intensity are reasonably well represented. If this detection skill could be extrapolated to the bulk of medicane-like events, the EPSs could be a very useful tool for examining the predictability of these dangerous meteorological situations and for implementing an automatic detection and warning issue method.