Impact of initial condition uncertainties on the predictability of heavy rainfall in the Mediterranean: a case study

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This study explores the predictability of a heavy rainfall event which struck North Africa the 9 and 10 November 2001. During these two days, the meteorological situation was dominated by the presence of a deep upper-level trough associated with an intense cyclone which developed over the western Mediterranean basin. Using the French non-hydrostatic mesoscale model MESO-NH, numerical experiments starting from various initial atmospheric states have been conducted so as to assess the impact of initial condition uncertainties on the precipitation and the cloud cover forecast along Algerian and Moroccan coasts. In order to generate a set of perturbed atmospheric states, a simple date-shifting initialization method has been used. Two sets of simulations have been performed, using lateral boundaries and initial conditions derived from both the French operational global assimilation system ARPEGE (Action de Recherche Petite Echelle Grande Echelle) and the European Centre for Medium Range Weather Forecasting (ECMWF).

Initial perturbations of the upper-level trough propagate and intensify throughout the simulation leading to some discrepancy on the low-level cyclone forecast. While it is found that the upper-level trough and the low-level cyclone control the position of the overall rainfall pattern and of the main convective areas, the predicatbility of smaller-scale features such as heavy rainfall is directly related to specific mesoscale structures. The convergence zone between the easterly flow and the low-level jet as well as coastal orography are shown to be involved in the triggering and sustainement of the convective cells. As a consequence, small-scale perturbations of these features lead to large errors on the precipitation forecast, especially in Algiers' area. These findings suggest that, even if numerical prediction modelling is continually prone to improvements, the deterministic prediction of heavy rainfall remains a difficult task, strongly limited by the level of predictability characterizing mesoscale features associated with convection.