Ensemble sensitivities of the real atmosphere: Application to Mediterranean Intense Cyclones

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The sensitivity patterns of a certain feature of interest to precursing states and processes involved in its evolution is an important information used in many disciplines of sciences as it provides cause-effect bonding links. Classical sensitivity studies analyze the effect of one factor by comparing a control experiment with one where the factor is removed. This approach allows to easily track all effects of one cause on the system. After the adoption of adjoint models by the atmospheric numerical community, the inverse approach is also possible: estimating the set of causes that are related to an effect. Adjoint models provide a tangent linear estimate of the sensitivities of a forecast aspect to the initial and boundary conditions fields. Another approach, that has been recently proposed, is to use ensembles of simulations of one episode to estimate the sensitivity fields. The estimate is obtained by correlating the ensemble initial conditions perturbations to the dispersion of the ensemble of forecasts. In this study we use this approach to compute sensitivities of intense Mediterranean cyclones. Intense cyclones from the ECMWF ERA-40 database are objectively classified in 24 classes based on both cyclone position at its mature stage and precursing atmospheric conditions 24 and 48 h before that time. Sensitivities are derived using the ensemble method with each cluster providing the initial conditions and "forecast" dispersion in which the original method is based on. Thus, this technique is not based on numerical modeling but just on the ERA-40 analysis fields.

Results from the application of this technique on intense Mediterranean cyclones are provided. The North-Atlantic, western Europe and north Africa are the areas persistently highlighted by the sensitivity fields. A comparison of the estimates obtained using the ensemble method and adjoint techniques are shown. Differences among them are highlighted and further discussed.