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An alternative approach to sensitivity analysis: Ensemble sensitivities of the real atmosphere

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The sensitivity patterns of a particular metric of interest to precursory states and processes involved in its evolution is an important information used in many disciplines of sciences as it provides valuable cause-effect bonding links. Traditional sensitivity studies analyze the effects of one factor by comparing a control experiment with one where the factor is altered, allowing to easily track all effects of that cause on the evolution of the system. After the adoption of adjoint models by the atmospheric numerical community, the inverse approach is also possible: to estimate the set of causes that are related to one effect. An alternative cheaper method, recently proposed, is to use ensembles of simulations to estimate sensitivity fields. Essentially, the estimate is obtained by correlating the ensemble of initial conditions to the ensemble of forecasts. Here, we propose calculating sensitivities of the real atmosphere by making use of analysis fields instead of ensembles of simulations. Intense cyclones objectively detected from the ECMWF ERA-40 database are objectively classified in 25 classes based on both cyclone position at its mature stage and precursory atmospheric conditions 24 and 48 h before that time. Corrections to the raw sensitivity fields are applied to account for the limited sample size of the clusters and its heterogeneity. Further, a normalization based on the spatial dependence of the standard deviation of the analysis fields shows beneficial on the results. The climatological sensitivity fields for the 25 cyclone types are compared to previous results obtained with the adjoint model. The technique performs similarly to the overwhelmingly expensive adjoint methods, although further work is needed to objectively verify the results.