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A comparison of ensemble reduction methods

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Mesoscale probabilistic forecasts are normally obtained from ensembles of high-resolution numerical weather predictions, whose initial and boundary conditions are drawn from the members of a global ensemble prediction system (EPS). Due to the computational requirements of high-resolution simulations, limited-area ensembles have only a few members, typically 10-15, considerably less than global EPS. Therefore, the first step in the design of a mesoscale ensemble is the definition of a method to choose the global ensemble members that provide the initial conditions for the high-resolution simulations. This task is referred to as ensemble reduction.

In principle, global ensemble members are statistically equiprobable, so random selection is a legitimate approach to ensemble reduction. However, other methods are currently in use; for instance, cluster analysis is adopted in COSMO-LEPS, the limited-area EPS of the COSMO consortium. Cluster analysis (and analogous approaches, e.g., tubing) organize forecasts from different ensemble members into groups, based on the degree of similarity of their forecast trajectories. Ensemble reduction is performed by choosing one representative member from each cluster.

Reducing ensemble size causes a loss of forecast accuracy. It is generally known that the deterioration of accuracy depends primarily on the size of the reduced ensemble, and becomes larger as the ensemble gets smaller. In this contribution, we estimate the loss of forecast accuracy caused by different ensemble reduction methods. The analysis compares the probabilistic forecasts obtained from a full ensemble (the 51-member EPS ran by ECMWF) with those derived from different reduced ensembles (10-member subsets of the same EPS), in terms of the continuous rank probability score.

Our results show that: 1) Different ensemble reduction methods cause marginally different loss of accuracy; 2) Clustering methods generally cause slightly smaller skill deterioration; 3) The effectiveness of clustering depends, at least in part, on the forecast range and on the variables used to cluster the global ensemble members (in other words, not all meteorological parameters are equally good clustering variables).