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Large Scale Skill in Regional Climate Modeling and the Lateral Boundary Condition Scheme: 32-day Ensemble Experiments

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We here extend our results presented at the 2009 Assembly to integrations driven by the ECMWF's 32-day ensemble forecasts. The main question we address is can a regional climate model (RCM), with no large scale nudging, maintain the large scale skill of the driver global model supplying its lateral boundary condition (LBC)? More ambitiously, can an RCM even improve on the large scales of the driver model? Another issue we address is that of the RCM's lateral boundary condition scheme: is the almost universally used but somewhat costly relaxation scheme necessary for a desirable RCM performance?

To explore the added (or lost?) "value of the large scale" the best experiment design in our view is one using forecast driver data, so that verification of both the RCM and the driver data can be made against analyses. Thus, this is what we are doing, using as driver data an ECMWF 32-day ensemble run. As RCM we are using an upgraded version of the Eta model. At the time of this writing we have run 26 32-day forecasts, driven by the ECMWF control and 25 ensemble members, and have performed verifications of both the Eta and the driver ensemble members' results against ECMWF analyses. We have run the Eta on a 12,000 x 7,580 km domain using a 31 km/45 layer resolution.

To look into the LBC scheme issue, we have made 3 additional 32-day forecasts using the Eta model modified so as to use the traditional relaxation scheme. Note that the standard Eta scheme is one in which information is used at the outermost boundary only, with not all variables prescribed at the outflow boundary. We have compared the verification results of these two sets of Eta forecasts against each other.

A novel verification method is used in the manner of precipitation verifications in that forecast spatial wind speed distribution is verified against analyses by calculating bias adjusted (or, corrected) equitable threat score (BCETS in the notation used by Gilleland et al.) and bias score for wind speeds greater than a chosen threshold. In this way, focusing on the forecast position of high wind speed values in the upper troposphere, verification of large scale features we suggest can be done in a manner that is physically more direct than verifications via spectral decomposition often used as RCM verification method. For additional confidence, we also evaluate a standard RMS difference between the sets of Eta forecasts and the ECMWF analyses, and the same difference for the driver ensemble member forecasts.

Focusing on the last 20 days of the experiments, we find that during about 2/3 of that time the set of the Eta RCM runs had a higher BCETS than that of its driver ensemble members, with the score being about tied more than half of the remaining time. The RMS difference plot is even more favorable for the Eta. Note that one might expect our verifications to be slightly biased in favor of the driver members, because the same model is involved in the analyses. The forecasts using different LBC schemes had during the last 20 days of the experiments periods of the BCETS of the two sets being about equal and of the one or of the other having a higher value all of about the same total duration. Thus, we see these results as strongly supporting the view that an RCM does not necessarily need large scale nudging to maintain the value of the large scale, since in our experiments it has even added value of the large scale most of the time according to the verification schemes used. As for the LBC scheme, no disadvantage due to the Eta compared to the relaxation scheme is seen, while enjoying the advantage of the scheme being less demanding given that it needs driver fields at the outermost domain boundary only.