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Eta vs sigma, an update: Gallus-Klemp test, and 250 hPa wind skill compared to ECMWF in ensemble experiments

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In our presentation at the 2013 EGU Assembly experiments were reviewed comparing the Eta model results against those using the same code but switched to sigma. Using the eta, better precipitation scores, and more accurate placement of storms, stood out. Improvements with the eta were particularly noticeable over the lee slopes of the Rocky Mountains topography. A recent discovery of an omission in making the model's Smagorinsky-like horizontal diffusion aware of the sloping steps discretization enabled a replication of the Gallus and Klemp (Mon. Wea. Rev., 2000) test of flow over a bell-shaped mountain with a very high degree of resemblance to the one they obtained after addressing the flow-separation problem of the step-topography eta. Results were also discussed in the 2013 presentation of experiments in which 26 Eta ensemble members driven by an ECMWF 32-day ensemble mostly had better scores in placing strong 250 hPa winds than their driver members; and of a test of the impact of having 10 of these Eta members use sigma. While no obvious impact on 250 hPa wind scores stood out, a tendency was seen for more accurate tilt at an apparently crucial time of the 250 hPa trough of the eta compared to sigma members. To test the sensitivity to resolution and also to check on the robustness of this Eta vs ECMWF result to the choice of the period a 10-member Eta experiment was rerun for a more recent ECMWF ensemble, one initialized 4 October 2012, when its resolution was higher than of that used previously. The advantage of the Eta members more frequently than not is seen again, even though this time the resolution of the Eta during the first 10 days of the experiment was about the same as that of the driver ECMWF members. Rerunning the Eta ensemble with the code switched to sigma this time however an advantage of the Eta/eta over the Eta/sigma is seen, quite considerable during the early 2-6 day period of the experiment when a deep upper-air trough was moving across the Rockies. A test of the impact of resolution on the advantage of the Eta over its driver ECMWF members was made as well, by rerunning the Eta ensemble with a resolution about the same as that of the ECMWF after 10 days. The advantage of the Eta ensemble was not visibly degraded by this resolution change. Given that the Eta had to absorb unavoidable lateral boundary condition errors, we see these results as strongly suggesting advantage(s) in the Eta that deserve attention of modelers engaged in the design of dynamical cores of atmospheric models.