Impact of the eta coordinate on the large-scale skill of the Eta achieved against its ECMWF driver ensemble

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Many authors involved in regional climate modeling resort to nudging of the large scales of their regional climate models (RCMs), or to spectral nudging as this is also referred to. While some believe RCMs should not attempt to change the large scales of their driver global models, yet others consider that nested models are unable to improve on the large scales fed at their lateral boundaries. There are some grounds to that conviction since nested models have to absorb unavoidable errors in accepting their lateral boundary conditions.

In this context it is of interest to note Veljovic et al. (2010) which included results showing that most of the time Eta ensemble members had better 250 hPa wind scores than their driver ECMWF 32-day ensemble members. Verification scores used were Bias adjusted Equitable Threat Scores (ETSa) that reflect placement accuracy of wind speeds greater than a chosen threshold, which were set at 45 m s^{-1}; and RMS difference between forecast winds and those of ECMWF analyses. The intention of choosing these verification measures was to test possible improvements in large scales.

Looking for a major reason behind this result 10 members of the 26 member Eta ensemble were run switched to use sigma, but no obvious advantage of one or the other coordinate could be seen in the two verification scores mentioned. However, of the 10 eta members 3 displayed a visibly more accurate tilt of the 250 hPa wind speed contours than their sigma counterparts at an apparently crucial 12-day time; one showed the opposite result. For illustration of one of these cases of improved tilt see Fig. 5 of Mesinger and Veljovic (2014).

This perhaps not being all that convincing search for the impact of the choice of coordinate and/or other possible factors was continued by running a 10-member experiment for a period more recent than that of Veljovic et al. (2010), this time initialized at 0000 UTC 4 October 2012, when the ECMWF ensemble resolution was about 32 km the first 10 days, and about 63 km thereafter. The resolution of the Eta ensemble was unchanged, about 31 km. This at the same time tests the robustness of the result to the choice of the period, an issue of interest given the impression of considerable influence of a specific synoptic event on the result reported in Veljovic et al. (2010). The 10 Eta members were run using the eta coordinate, and also switched to use sigma.

The results of this experiment using the same two verification measures as in Veljovic et al. (2010) are shown in Fig. 1. ETSa scores are shown in the upper panel, and the RMS ones in the lower one; ECMWF driver ensemble results are shown in red, Eta in blue, and the Eta run using sigma in orange, respectively. It is seen that the overall advantage of the Eta over ECMWF is perhaps about the same as it was for the 26 member experiment of Veljovic et al. (2010). With the resolution difference now practically removed the first 10 days, and being reduced thereafter, it seems safe to conclude that the impact of the resolution advantage of the Eta in the results of Veljovic et al. (2010) was not significant.

One feature standing out in Fig. 1 is the very visible advantage of the Eta members in placing the jet stream winds during days 2-6 of the experiment. This happened at the time of the movement of a deep upper level trough over the Rockies, a situation that in numerous previous tests was seen as favorable to the Eta. Interestingly, the Eta/sigma members display during that time ETSa scores better than ECMWF ones as well, and better than both the Eta/eta and ECMWF at about days 8 to 11. Overall however the Eta/eta ETSa scores are decidedly best during this early period of about the same resolution of the three models, and so are its RMS scores.

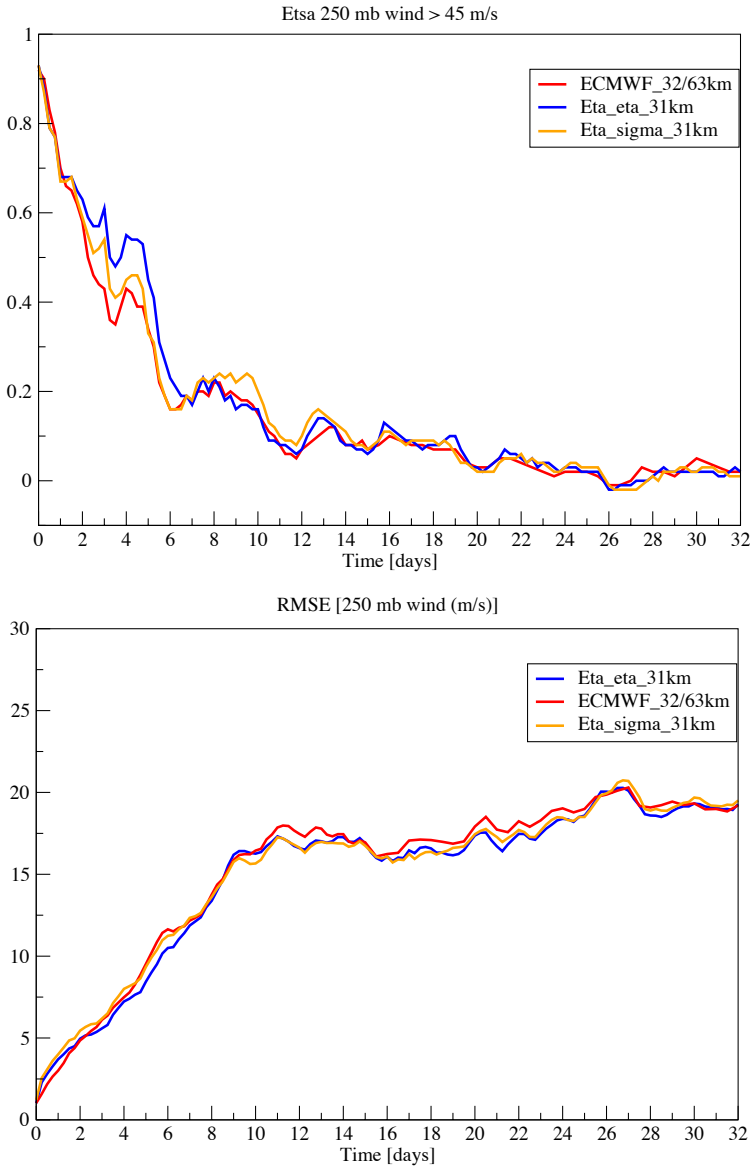

Fig. 1. Bias adjusted ETS scores of wind speeds greater than 45 m s^{-1}, upper panel, and RMS wind difference, lower panel, of the driver ECMWF ensemble members (red), Eta members run at 31 km resolution (blue), and Eta members run at 63 km resolution (turquoise), all at 250 hPa and with respect to ECMWF analyses. Initial time is 0000 UTC 4 October 2012.

Along with the results of Mesinger et al. reported on in another contribution to this issue, summarizing the skill of the Eta against Eta switched to use sigma and the precipitation scores of its system against that of NMM/WRF in pre-implementation "parallel," as well as the emulation of the Gallus-Klemp experiment using the latest version of the sloping steps discretization, this result is considered a strong evidence of the opportunity wasted using terrain following coordinates. For additional comments see Mesinger and Veljovic (2014).

References

Mesinger, F., K. Veljovic, 2014: Precipitation and placement of storms, Gallus-Klemp test, and 250 hPa wind skill compared to ECMWF in ensemble experiments. Eugenia Kalnay Symposium, 7 January 2015. ["Handout" at https://ams.confex.com/ams/95Annual/webprogram/Paper269029.html.]

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