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Earth System Dynamics
Discussions

Interactive comment on "Spectral nudging in the Tropics" *by* Breogán Gómez and Gonzalo Miguez-Macho

Anonymous Referee #2

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In this paper, the authors investigate the impact of spectral nudging on the WRF simulation a domain that covers the Gulf of Mexico. For the first part of this paper, the authors summarize the behaviors of different spectral nudging settings over this domain with ERA-Inteirm as reference. The interesting part is on the second half of this paper: the authors proposed to apply different nudging scales to different model variables and tested its impact on simulation of tropical cyclones. The results show that compared with a uniform spectral nudging for all variables, a variable-dependent nudging leads to smaller intensity errors (i.e., maximum wind, center SLP).

While this paper shows detailed behaviors of spectral nudging, the discussion of Figure 2 & 3 seems not solid, and it needs to be revised. Due to unknown reasons, Figures 1-6 seem of low-resolution, which makes interpretation difficult. Labels and legends of

some figures are also missing. Considering all these, I recommend a major revision for this paper.

Major comments:

1. Page 2, Line 20: The authors say "In this work, we aim at finding more evidence to support our hypothesis that the nudging scale should be related to the typical scale of the synoptic systems and not with other factors related to the experimental set-up, such as the resolution of the forcing dataset or the model simulation itself. ": Why do authors stress SYNOPTIC system here? Should it be large-scale motion of your simulation? For example, for different applications, its large-scale motion might refer to different wavenumbers, but nudging is preferred to constrain the large-scale motion, instead of small-scale one. The boundary to separate these two scales is based on researchers' own needs. In addition, what do you mean exactly for "model simulation itself"? Can you be more specific?

2. Though the spin-up time is not the focus of this paper, but from authors' Figure 3, it seems spin-up time is not sensitive to the configuration of spectral nudging: the RMSD of most experiments get saturated after 10 hours for WRF-GDAS case, while longer for WRF-ERA interim. If this spin-up time is almost similar for all configurations, what's the reason to inspect this?

3. It seems the focus (or the innovative part) of this study is about the influence of variable-dependent spectral nudging over the simulation of tropical cyclones. It might be good to change the current title to something like "variable-dependent spectral nudging for the simulation of tropical cyclones". The original title is misleading.

4. The legend of 3 is missing. Though the authors claim Figure 2 & 3 share the same legend, the line types in these two figures are different. Please revise these figures.

5. If I match the color correctly, the discussion of Figure 3 seems not solid: (1) Page 5, Line 15 "This reflects the fact that the model is developing its own solution. . . Applying

spectral nudging, even at the smallest wave number, has an immediate constraining effect, preventing the model from separating from its boundary condition.": How did you get the conclusion that nudging prevents the model separate from BOUNDARY CONDITION? In spectral nudging, you are regulating the large-scale motion of WRF simulation with the GDAS large-scale motion. This alone, in my view, is enough to enable WRF to have similar large-scale motion as GDAS. Boundary condition doesn't need to be involved in this process. (2) Page 5, Line 25 "The analysis of the Power Spectrum indicates that spectral nudging is very effective at separating nudged and non-nudged scales. The non-nudged scales develop a similar amplitude to those in the free run case, while the nudged scales are-closer to their counterparts in the grid nudging case. ": This argument seems not solid. From figure 2, we know the kinetic energy spectrum (which is a statistical term) for large-scale is similar, but their specific patterns (e.g., figures of streamline, and geopential height) can be different. It seems a more straight-forward way to support your argument is to plot the 2D maps such as streamlines for different scales. From these figures, we can directly check if the large-scale pattern for the spectral nudging case is similar to those of GDAS or ERA-Interim, while their small-scale features are different. (3) Page 4, Line 31 "It can be seen the nudging in the largest wavelength represents a substantial improvement....": Why it's a substantial improvement? In Figure 2 & 3, you calculate the RMSD of your WRF simulation from GDAS and ERA-Interim. The larger RMSD here only indicates larger deviation from GDAS and ERA-Interim, which is expected.

6. For all the map figures, the latitude and longitude are not shown. Please add them.

Detailed comments: 1. Please add a legend for figure 3. The line types shown in this figure are not consistent with those as in Figure 2.

2. What are those markers in Figure 4(a) and (c)? Are those inflection points or the points where the errors are reduced to a 15% of their maximum value? If they are inflection points, why they are not on the line for QVAPOR in 4(a)?

3. Figure 6: The color chosen for the precipitation field are difficult to interpret, and the labels of MSLP contours are missing. Please reconstruct this figure.

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