Earth System
Dynamics
Discussions

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

Anonymous Referee #1

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Review of article "Spectral Nudging in the Tropics" by Gomez and Miguez-Macho.

This paper examines the impact of spectral nudging in the tropical-subtropical area centered in the Gulf of Mexico and tropical cyclone simulations using WRF model. The authors find that 72-96h time is necessary for model to fully spin-up, and cut off wavenumber in between 1000-1500km is optimal to perform best. The authors also investigated the role of spectral nudging in hurricane case simulations. Overall, I find this is an informative study and helps readers for better understanding the role of spectral nudging in the numerical simulation. However, some of the arguments in this paper sound too generic and the results are questionable due to the lack of physical explanation. Therefore I am recommending major revisions to this manuscript before I can consider it is suitable for publication. My comments sorted by major and specific are

below:

Major comments: 1) This manuscript is entitled "Spectral Nudging in the Tropics", but the model domain is centered in the Gulf of Mexico (domain covers roughly 0-45N?), where strictly speaking, it is not tropical area. The reviewer wants to know if the similar results still hold in the more conventional tropical area like 30S-30N where tropical wave activities are more active? 2) Since authors use GDAS as the nudging input, using ERA-interim as an independent verification is a good choice. However, I think authors can make more comparisons with some satellite/in-situ observation, which does not or less use data assimilation. For example, authors can reproduce Figure 3 with the usage of TRMM/NCEP Stage IV precipitation. 3) I agree that spectral nudging with high cut-off wavenumber make tropical cyclone (TC) simulation very analogous to the ERA5 results. However, since both ERA5 and GDAS have already assimilated TC circulations (https://journals.ametsoc.org/view/journals/wefo/26/6/waf-d-11-00045_1.xml?tab_body=fulltext-display), it's not surprising to see these results. However, if model simulation is extremely similar to the ERA5 or other reanalysis with nudging, what is the benefit of running WRF model? Comparing free run and nudging runs, it clearly to see that, with stronger nudging, the more model internal dynamics/physics lose.

Specific comments: 1) WRF uses terrain-following sigma coordinate. The same sigma level does not share the same height level, then why authors claim sigma levels 11, 19 and 23 are at 1200, 5000 and 10400m high? Why not interpolate to the pressure/z level directly? 2) Some of the figures are in poor quality and without useful captions. For example, Figure3 needs an individual legend even though it shares the same one with Figure3. This really bothers me to figure out the line types and corresponding experiments. 3) Figure 6 is really hard to read clearly. Although ERA5 is the state-of-the-art reanalysis, it is still not the observation, especially for the hurricane case studies. What is the suggested TC MSLP at this time by NHC? What is the value from the ERA5? 4) Again regarding Figure 6, based on the eyeballing, it seems that

although the free run (FR8000) has the very departed TC center location comparing to the observation, it has the strongest intensity in terms of the MSLP, as the isobars are heavily overlapped. For high wavenumber spectral nudging and analysis nudging runs, on the other hand, the TC center is nicely reproduced but the TC intensity is quite weaker than the free run. Is that because high wavenumber nudging constrain too much to the model internal TC dynamics? 5) In Figure 7 and 8, what does the dashed vertical line stand for? What do the "X:4;Y:3" like ratios mean? I may miss something in the manuscript main text, but it will be much more friendly for the readers to better understand the plots if authors can add more useful information in the Figure captions. 6) Figure 9 is also hard to understand. Since all errors are normalized by the 3VARS, does each small box in 3VARS column stands for the unified error (as 1)? This manuscript really needs a better figure captions. 7) Page 8, Line13-17: This is too generic. Is that really because of the short tracks of Michael (2012) and Ingrid (2013)? Not due to the relative weak steering flow and strong TC internal dynamics? 8) Page 11, Line 8-11: "However, the best prediction of the hurricane intensity" I really didn't see any analysis regarding to the prediction in this paper. Authors made suites of TC hindcast simulations, and find that 3VARS gives the most analogous results comparing to the NHC observations. However, authors use GDAS as the nudging inputs. In the true prediction, you cannot nudge anything that has not happened! If authors really want to disentangle the prediction problem, authors need let model run freely in forecast mode.