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Comment on acp-2021-169

Anonymous Referee #3

Referee comment on "Specified dynamics scheme impacts on wave-mean flow dynamics, convection, and tracer transport in CESM2 (WACCM6)" by Nicholas A. Davis et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-169-RC3, 2021

This paper assesses the impact of various specified dynamics (SD) model configuration parameters on the fidelity of the SD circulation and tracer transport by comparing the SD output to a free-running version of the same model. This paper presents a clever and fairly comprehensive analysis of the sensitivity of the SD fidelity in WACCM6 to nudging timescale and meteorology frequency, and is an important contribution towards better understanding SD model results in general, which have been the source of conflicting results in recent years. As the paper is well written and the analysis sound, I only have a few minor comments for consideration by the authors (listed below).

Line 60: “one of more of” ☐ “one or more of”

Line 75-77: I’d also add that temperature nudging is presumably important for water vapor and cloud microphysics, which is not addressed in this paper

Lines 96 – 103: In this paper the authors are using an alternative nudging technique that is not the standard CESM configuration as I understand. It would be helpful to know if the results in this paper are in any way sensitive to the nudging methodology. Presumably the

authors chose this method because it could apply to different dynamical cores, but it would be helpful for the reader to include some discussion to either state or speculate that how the results presented here may or may not be different than the standard nudging technique. Also related, why did the authors end their sensitivity study at a nudging timescale of 48 hours. I believe the standard CESM SD nudging timescales are longer, like 3 or 5 days. It would seem important to bracket/include whatever the standard configuration is.

Paragraph starting line 96: Are the nudging variables being used instantaneous or averaged output? Please state in the text. Also, I recognize that this may be beyond the scope of this paper, but some discussion/speculation on the impact of using instantaneous vs. averaged fields would be helpful and make this more relevant to real world decisions that modelers make when they are choosing the type of reanalysis output they want to use for input in SD runs.

Lines ~209 (reference to Figs 1-3): I like that that the authors show both the nudged variable (temperature) as well as derived variables like CMF, streamfunction, etc. However, I am confused as to why zonal and meridional wind errors are not also shown here, as these are the fundamental variables that are being nudged to. For completeness, I suggest adding these to the figures and making more clear that the most basic "test" of an SD model is how well it can reproduce the things it's actually nudging to (i.e., uvT in this case).

Lines 210-211: The word nudging is repeated twice

Line 218: If I'm reading Fig. 3 correctly I believe this sentence has it backwards – T, EPF, and TEM streamfunction become biased high by *decreasing* nudging timescale, not *increasing*

Line 279: I'm confused why the displaying the negative of error regressions makes the discussion easier.

Comment on all figures – I found the choice of differing shades of blue to be somewhat difficult to distinguish on the printed page. I appreciate the need to have a color scale whose hue varies somewhat linearly and intuitively over some range, but am wondering if a two color sequential scale might be a bit more easy to track by eye?

Figure 3a – I'm confused as to why the 48h timescale T error looks closest to zero in this figure, whereas in Figures 1a and 2a it looks to have the largest error of any of the nudging timescales. Is there some subtle reason in general why the results in Fig 3 aren't more-or-less a combination of the results in Figs 1 and 2? Might be worth explaining in the text if so. Actually, now that I am looking at it, I realized that I've assumed that Fig. 3. Is the global vertical time average, but I don't see anywhere that this is explicitly stated, so that would be helpful to state clearly in the text and/or caption.