Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC3
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Reply on RC2

Peter A. Bogenschutz et al.

Author comment on "Combining regional mesh refinement with vertically enhanced physics to target marine stratocumulus biases as demonstrated in the Energy Exascale Earth System Model version 1" by Peter A. Bogenschutz et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-175-AC3, 2022

We thank Reviewer 2 for their time, comments, and helping to make this a better manuscript. Please see our reply to each comment below. For exact wording changes and additions made to the manuscript, please refer to the marked up manuscript.

Reviewer Comment: I find the article interesting and well written. The lack of improvement in representing stratocumulus and other boundary-layer clouds remains challenging. Therefore, the focus of the paper is of particular interest. Given the rise of global high-resolution modeling, it is important to provide insight into the effectiveness of improving low clouds with refined resolutions. However, I don't really understand how this happens. Using FIVE, some parameterized processes should be better represented, but it is not explained which of them mostly explains this difference, and how the changes act on the cloud coverage. Is it related to the way some processes are represented at the sub-grid scale and are sensitive to resolution (e.g. scale awareness)? Is it cloud-top entrainment, convective transport, turbulence closure, cloud radiation? This would help clarify why resolutions are so important, and how other climate modeling groups might use this framework.

So I thus suggest that the article be accepted after the minor comments I highlight. I would like to see the authors describe in more detail the reasons why vertical resolution is so important, and which processes are most sensitive to this refinement.

Response: Thank you for this excellent suggestion. Yes, we agree more description and context was needed. At the end of section 4.1 we added a couple paragraphs to address this.

Specific comments:

Reviewer Comment: Line 59: "panacea": Unclear and not necessary.

Response: The wording has been changed here.

Reviewer Comment: Line 100: "elements": Unclear. Do you mean grid boxes/columns?

Response: The wording here has been made more clear and with appropriate references given.

Reviewer Comment: Lines 283-285 + Figure 6b: How do you explain that the RMSE is as high in the HR simulations as in LR? Does this suggest that HR simulations are not realistic in reproducing spatial pattern of low clouds?

Response: Spatial patterns of low clouds are realistic in the HR simulations, as demonstrated by the geographical bias patterns in figure 4. Though, the bias is reduced locally in the stratocumulus regions, those regions are geographically quite small and thus does not have a dramatic effect on the global skill scores. In addition, it appears that the HR simulations have slightly more bias and error in the storm tracks, which is likely compensating the improved error scores in the stratocumulus regions.

Reviewer Comment: The variability of the COSP low-cloud amount may differ from the model cloud variability by changes in the high-cloud amount. How much does this influence the biases in the seasonal variability (Figure 12)? Overall, do the authors find the same result (improvement by FIVE, and HR) if using the model low-cloud amount?

Response: Using the model low-cloud amount (specifically the variable "CLDLOW") produces nearly scientifically indistinguishable results when compared to using the LIDAR simulated low-cloud ("CLDLOW_CAL"). See attached figure (which uses CLDLOW) and compare that to figure 12.

Reviewer Comment: Line 370-371: What is the relative coverage of the SEP-RRM region? This would be a relevant comparison to the 0.05% the authors put forward.

Response: The SEP-RRM covers approximately 4.3% percent of the globe. This has been added to the text.

Please also note the supplement to this comment:
https://gmd.copernicus.org/preprints/gmd-2022-175/gmd-2022-175-AC3-supplement.pdf