

Interactive comment on “The non-hydrostatic global atmospheric model for CMIP6 HighResMIP simulations (NICAM16-S): Experimental design, model description, and sensitivity experiments” by Chihiro Kodama et al.

Anonymous Referee #2

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In this manuscript, the authors detail the particular configuration of NICAM used for the High Resolution Model Intercomparison Project (HighResMIP). This is using NICAM16 instead of NICAM12, a previous version used for CMIP-class experiments. Updates are described in components such as microphysics and the land surface. The mean climatology at three different resolutions (56, 28, and 14km) and a few basic sensitivity experiments are discussed. The authors finish by discussing computational performance and post-processing needs.

I assume the primary purpose of this manuscript is to detail the particular configura-

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tion of NICAM that is used in HighResMIP so it can serve as a reference for scientific papers using such datasets. As such, the paper really doesn't describe any new science; rather, just discusses particular aspects of a specific model configuration. This seems acceptable for a journal such as GMD, even if the results are overly novel from a scientific perspective.

I find it to feel somewhat hastily thrown together. Some details regarding NICAM16 are discussed in detail, others are left to the reader to try and track down. Data isn't always presented in the cleanest manner, making jumping from figure to table a bit difficult. Some figures need work, including axis labels and resizing. In some ways, the manuscript feels approximately 75% finished, thrown together a bit quickly with some holes that need to be filled and smoothed over before publication. There also is a bit of a mix of 'model description' and then 'high-resolution evaluation,' although the authors then note that more formal climate evaluation is left for future work. I would perhaps focus most of the time in this manuscript on explicitly defining the precise design choices for the contributed runs.

I recommend major revisions to clean many pieces of this up and make it more useful as a basic reference for future users of HighResMIP data who wish to learn more about how NICAM operates.

The manuscript reads somewhat disjointed, as if multiple authors were e-mailed and asked to 'provide a paragraph or two' and it was eventually stitched together. Some passages are riddled with grammatical errors, while others are much more cleanly written. Although it didn't rise to the level of making the manuscript illegible, I recommend a thorough read-through by one or two proficient English speakers before submission to clean as many of these up before proofreading as possible. Even small corrections to tense and terminology would make for a much more pleasant read.

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Major comments

- Tables 5 and 6 need to be better presented. I am not sure why Table 5 only shows differences between model simulations and Table 6 shows a mean climatology for the three different resolutions. Without the mean values, the numbers in Table 5 are relatively meaningless, as it is tough to gauge how large the changes are relative to the base (reference) state and whether these changes are moving values towards or away from observations at the global level. The easiest thing to do here would be to effectively combine Tables 5 and 6, with mean climatology presented in additional columns, so it is trivial for the reader to mentally process what the difference in the sensitivity experiments (e.g., g-g3, etc.) actually mean.
- Page 4, Lines 16-17. Is one year enough to get usable climate signals here? I have generally understood the rule of thumb to be at least a few years, if not a decade to ensure differences are driven by design choices and not internal variability. How are the authors confident they are not confounding these?
- Page 9, Line 28. I cannot find the g9 simulations in the tables, is there a reason they are not included like the other sensitivity experiments?
- The naming convention is fairly confusing and there are times when names are redundant and refer to the same simulation (i.e., the 'g' simulation refers to a control run, which is occasionally referred to as NICAM16 or NICAM16-S). Is there a particular reason why these naming conventions are used. Are there ways to simplify this so that they are more clear 'in-text.'

Minor comments

- Page 2, Lines 6-7. I am not sure exactly what is meant by 'cloud-system resolving climate simulations.' I'd argue cloud-resolving simulations really need to be

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O(1km). A cloud 'system' may be a larger feature, but I can't recall seeing this as common parlance.

- Page 2, Lines 26-30. Does this mean that NICAM16 is the first NICAM version to allow for transient CMIP forcing, or does this mean special code was added for only HighResMIP/CMIP6?
- Page 3, Line 14. 38 vertical levels seems low, particularly for a 14km experiment. Assuming the levels are not evenly spaced, this implies a dz of greater than 1km toward model top, which is really pushing the common notion that $dx \gg dz$. The authors later discuss higher vertical resolution, more information should be added about the potential impact of this in HighResMIP, especially if prior work can be cited.
- Page 3, Line 25. More information is needed about timestep of the gravity wave drag, boundary layer parameterization, etc. Are these called at the same timestep of the dynamics? Is the dynamics subcycled?
- Page 4, Line 10. How quickly does the land spin up from this state? Within days, weeks, months? This may be important given the some of the short runs.
- Page 4, Line 24. Is SST 'standardized' in HighResMIP (i.e., do all models use the same file?) or was this specific to NICAM16? I would also quibble that this is more of a boundary condition than an 'external forcing.'
- Page 6, Lines 18-22. Regarding the dynamical core, diffusion, boundary layer parameterization, etc. it is critical that they at least cite previous work when discussing these aspects where interested parties can get model details. Preferably, they would use 1-2 sentences to explain such components and then refer readers to more detailed publications for further information.

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- Page 6, Lines 22-25. 'Although most climate models... in the future.' I am not sure I philosophically agree with the notion of removing convective parameterization even at 56km (this would imply extremely large grid point updrafts in my experience). That said, this sentence is long and preferably requires further justification. Has anyone from the NICAM team published a paper regarding their philosophy around the lack of convective parameterizations, even coarser than 20km?
- Page 7, Lines 32-33. I am not sure this is 'more than twice,' but this is where the aforementioned reformulation of Tables 5 and 6 would be quite helpful.
- Page 8, Line 2. '... graupel in the simulation.' Which one, the reference?
- Page 8, Line 19. 'was replaced with zero ... whereas it was zero and unchanged in this study.' I'm a bit confused – the sentence makes it seem like the study applied something different than Roh et al. but it seems like it was zero in both cases?
- Page 11, Line 2. This is quite a large resolution sensitivity (the aerosol forcing completely changes sign going from 56km to 14km if I interpret this correctly).
- Fig. 9. This needs to be bigger. Perhaps stack the three panels vertically?

Typographical errors and grammar

- Page 3, Lines 17-18. Awkward grammar and typos.
- Page 11, Line 5. The first letters used in the acronym should be capitalized.
- Table 3. 'Laege' should be 'large.'
- Fig. 4, The color bar should read 50 and not 50.01.

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- Fig. 5, Label the order of differencing for the lower three panels (e.g., g-g3).
- Fig. 5., are the units on the vertical axis 'km?'

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