Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2018-190-RC2, 2018

Geoscientific Model Development Discussions

Interactive comment on "Convective response to large-scale forcing in the Tropical Western Pacific simulated by spCAM5 and CanAM4.3" *by* Toni Mitovski et al.

Anonymous Referee #2

Received and published: 30 November 2018

Overview:

In this study, the authors compared the representation of convective precipitation in the Canadian Atmospheric Model v4.3 (CanAM4.3) against the Superparameterized Community Atmosphere Model v5.0 (spCAM5). They evaluated composite fields of precipitation, convective available potential energy, and vertical velocity over the Tropical Western Pacific in simulations with prescribed SSTs for May-July 1997. The authors found that CanAM4.3 has more frequent light convective precipitation, less frequent extreme convective precipitation, shorter convective events, and convection that is less dependent on large-scale forcing compared to spCAM5. This paper is well written and

the results will be interesting to the modeling community. However, there are several areas that require additional analysis and more details in order to make this work more relevant and impactful. Major and minor comments are listed below.

Major Comments:

1. I encourage the authors to provide a deeper discussion and interpretation of the results. For example, the lack of relationship between convective precipitation and near surface vertical velocity (Figure 2b, 3b) and the mismatch in timing with CAPE/CIN in CanAM4.3 relative to spCAM5 are particularly interesting findings. However, to some degree, this has already been known and applied to improving the parameterization in the NCAR Community Atmosphere Model, as cited by the authors (Zhang and Mu, 2005a). How are the deficiencies in the parameterizations used in CanAM4.3 (i.e., CAPE based closure), which have been identified here, different from what is already known and published? And how can new information from the results presented here be applied to further improve models beyond what has already been implemented?

2. The effort to calculate "convective precipitation in spCAM5" in a way that is comparable to "convective precipitation in a parameterized model" is a great idea and potentially very useful. However, it is not clear that the way it is calculated in spCAM5 here means the same thing as it does from parameterized convection in CanAM4.3. How sensitive are the results to the values of the criteria (vertical velocity and cloud water/ice)? More importantly, how well does a definition of "convective precipitation " based on CRM vertical velocity and cloud water/ice match what "convective precipitation" means in a global parameterized model? Since the comparison and analysis is contingent on this calculation, it would be useful to discuss other ways it could be defined within spCAM5 and/or expected differences with what convective precipitation means in CanAM4.3. It would also be helpful to use an independent calculation of "convective precipitation" that could be applied identically to both models, which would likely be dependent on large-scale conditions. Ultimately, to what degree do the results and comparison between the models depend on the way that convective precipitation

has been defined? Likewise, how is CAPE calculated in spCAM5, is it at the CSRM or GCM scale? A comparison to CAPE calculated at the GCM scale would be most consistent with CAPE from CanAM4.3. Along these same lines, the differences in the relationship of convective precipitation and omega between spCAM5 (strong correlation) and CanAM4.3 (no correlation) may be, in part, due to differences in the definition of convective precipitation. I suggest including some analysis of relationships with "total precipitation rates" or alternative definition of "convective precipitation" in spCAM5.

3. In general, an explicit inclusion of observations for comparison would be helpful to the reader. The authors note that there is no dependence of convective precipitation with CAPE in spCAM5, which they say is consistent with observations by citing Mitovski and Folkins [2014]. It would be useful to make this calculation and include the observations in the figure for both CAPE and dCAPE. Likewise, the authors note that spCAM5's relationship between min/max CAPE and the timing of rainfall is consistent with observations by referring to Mitovski and Folkins [2014], but again I think showing the actual observations (as referenced) on the same figure would help.

Minor Comments:

1. Why not evaluate the ZM scheme as implemented in the conventional CAM5 to have more consistency with spCAM5? Many other aspects of the model are different between CanAM4.3 and spCAM5, beyond just the representation of convection, which makes the comparison somewhat unconstrained. I suggest including results from CAM5 as well as CanAM4.3 and spCAM5. Since only 3 months of simulation time is being assessed here and the initial setup of CAM5 would be the same as spCAM5, this should not add a significant amount of work.

2. I am confused about the vertical resolution used in spCAM5. Typically, the vertical resolution is 30 levels in the global grid and 28 levels in the CSRM (coinciding with the lowest 28 levels). Here the authors state that there are 66 levels CAM5, which would imply 38 levels above the CSRM rather than the typical 2 levels. Have pre-

vious studies used this configuration? Have you evaluated the differences between using 30 and 66 levels? Additionally, the Khairoutdinov and Randall (2001 and 2003) references are fairly old and refer to the implementation of super-parameterization in older versions of CAM. I recommend the authors cite more recent papers describing the implementation in CAM5, such as Wang et al., 2011 (https://www.geosci-model-dev.net/4/137/2011/gmd-4-137-2011.pdf).

3. Since spCAM5 is used instead of spCAM4, it includes aerosol processes and two-moment microphysics, so it might be helpful to describe these components of the model (MAM3 aerosol and Morrison microphysics) and compare them with the same processes in CanAM4. The representation of aerosol and cloud microphysics are likely to influence precipitation as well.

4. For the relationship between vertical velocity and convective precipitation in CanAM4.3 (Figure 1a), the authors conclude that "the results are not considered robust due to the few samples". Why not use more years for the CanAM4.3 results? CanAM4.3 is relatively cheap to run, so it is unnecessary for the authors to limit their analysis to such a short period. I recommend using more data, at least for CanAM4.3, to produce more robust results.

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