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Geoscientific Model Development Discussions

Interactive comment on "Radiative-Convective Equilibrium Model Intercomparison Project" *by* Allison A. Wing et al.

Anonymous Referee #3

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Overall, I am very supportive of the initiative and recommend publication of this protocol paper in the non-discussion GMD journal. The discussion paper is largely focused on aggregation questions, which are a pressing scientific concern that this intercomparison will be critical to addressing, but there is also a lot of value in the small domain simulations (what does the cloud fraction look like there? e.g., Fig. 12). So, some additional discussion of the value of the MIP independent of aggregation questions would be well justified. I look forward to seeing the science enabled by RCEMIP.

Major points:

(i) I found it odd that the presentation of the preliminary results of the intercomparison were separated by model. Why not actually compare, for example, the OLR of the simulations in the same figure with the same color bar (vs. Fig. 3, 9, 10)? Even if

the authors decide to leave the separate structure (SAM then NICAM then CAM5), the figures should allow for an "apples-to-apples"comparison (precipitation rate intervals and colors differ between Fig. 9 and 10, for instance). Last, Fig. 12 should either have analogous results from other models or not be included.

(ii) The analytic initial condition for the small domain simulation needs to be motivated. It's only necessary if multiple equilibria are simulated. Otherwise, it's an additional barrier to participation.

(iii) Description of domains: p.10: Is it correct that only a rectangular channel geometry is part of the MIP for CRMs? This is a non-obvious choice, so it would be good to state clearly that there is no square domain simulation requested. Do you think it's best to specify approximate horizontal resolution and a fixed number of grid points in the two directions? I would prefer the opposite: like Lx = 6000km, Ly = 400km. Also, GCRMs are still non-rotating? I wasn't sure how to interpret L20 says "run on a sphere". This is like the CAM simulations shown: non-rotating but Earth's geometry, right?

(iv) Aggregation metrics: I was unsure about the need for some of these to be precomputed by the participants. The Organization index proposed is determined by the OLR distribution, so that's something that isn't necessary to pre-compute. Likewise for the subsidence fraction, unless there is something about the temporal frequency of the output that I missed. In contrast, I definitely understand that it's valuable if the modeler/modelling center provides moist static energy budgets.

(v) Climate sensitivity and connection to more comprehensively configured GCMs: Perturbing SST allows for a quantification of the "Cess-sensitivity", but the 5 K interval for the SST perturbation is larger than uniform warming simulations in comprehensive MIPs. So, please provide additional motivation for this choice. I believe it may also be "big" from the aggregation perspective (Wing et al 2014 had big changes from unaggregated to near-peak aggregation for a comparable magnitude perturbation). The other aspect of climate sensitivity that this kind of intercomparison (with both GCMs and

CRMs) could address is tropospheric cloud adjustments to changing CO2. It would be good to see how GCMs compare to CRMs in this aspect of their sensitivity (see, e.g., Wyant et al. 2012 JAMES doi:10.1029/2011MS000092). It's also an important complement to narrowly comparing the Cess sensitivity between RCE and Earth boundary conditions. The RCE configuration may have a different radiative forcing because of the differences in the control simulation cloud distribution or differences in cloud adjustments. For example, compared to GCMs, RCE may have a big Cess-sensitivity (in the large warming sense), but also a smaller radiative forcing.

Minor comments:

* author affiliations out of order 4 and 5

* p. 1 L4 "role of self-agg..." on what?

* single column models -> single-column models (though maybe conventional compound-adjective practices aren't used for SCM)

* p.1 L15 climate sensitivity estimates: expect a Manabe and Weatheral 1967 reference here

* p. 2 L9 a couple of earlier RCE precip extremes papers from Muller, Romps

* p. 2 "formulaic sensitivity" I found this confusing

* p. 6 L 29 "the lapse rate" -> " the virtual temperature lapse rate"

* p. 8 after going through the description of the continuous analytic formula for the initial condition, a discrete near-surface perturbation is used (lowest 5 layers); the perturbation seems irrelevant to GCMs, unless I'm missing something.

* p. 10 L 12 missing punctuation after GCM

* p.11 L21 stray)

* p.12 Do you want to specify the variable names for the horizontal coordinates of the

CRM output? If participants are forced to convert variables names to the CMOR format, it would be good also do something consistent for the coordinates (I'm not suggesting labelling them latitude and longitude, to be clear).

* p.18 Fig 8 caption: what are whiskers? standard deviation? Some of the simpler aggregation metrics should be evaluated in the non-SAM simulations (see major issue 1)

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