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Interactive comment on "Regionally refined capability in E3SM Atmosphere Model Version 1 (EAMv1) and applications for high-resolution modelling" *by* Qi Tang et al.

Anonymous Referee #1

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Comments on the manuscript

Regionally refined capability in E3SM Atmosphere Model Version 1 (EAMv1) and applications for high-resolution modelling

Submitted by: Qi Tang, Stephen A. Klein, Shaocheng Xie, Wuyin Lin, Jean-Christophe Golaz, Erika L. Roesler, Mark A. Taylor, Philip J. Rasch, David C. Bader, Larry K. Berg, Peter Caldwell, Scott Giangrande, Richard Neale, Yun Qian, Laura D. Riihimaki, Charles S. Zender, Yuying Zhang, and Xue Zheng

General Comments

Printer-friendly version

Discussion paper

In the present manuscript the authors analyse whether a globally refined model (RRM) can be used instead of a globally high-resolution model (HRM). The RRM is computationally less demanding than the HRM. The authors compare different atmospheric quantities of simulations with the RRM, the HRM and a coarse grid global model (LRM). The RRM was run in to different configurations. One using the LRM physics and the other the HRM physics. The authors conclude that the RRM is a useful tool for high-resolution developments.

The manuscript needs major additions and major revisons (see specific comments below). After taking care of these the manuscript may be published in GMD.

Specific Comments

Comments regarding the GMD principal criteria

Scientific significance - Excellent

I am not aware of any publication that analyses in detail the effect of coarse grid global model, fine grid global model, coarse grid model with regional refined grid and tests of different physics tuning in the regional refinement.

Scientific quality - Good

The overall scientific quality is good. A major deficiency is that the cited literature in the manuscript is heavily "American" weighted. The authors should increase their literature study of articles outside of the U.S.. They would have been aware of the remarks under item 4 in "Other specific comments" below.

Scientific reproducibility - Poor

The link to the source code of the model is given at the end of the manuscript https://github.com/E3SM-Project/E3SM. However, this information is not enough to reproduce the science by a fellow scientist. What at least is missing:

- exact information where to get the observational and reanalysis data from. This can

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be provided by web links in table 2. Even this may be not enough, therefore comments on what has to be taken into account additionally should be added if needed.

- detailed technical model simulation setup (can be put into the Appendix). Actually, every information that is needed to run the model simulations as the authors did.

- post processing tools used for the statistical analyses

- time period(s) of simulations (see item 3 under "Other specific comments" below.

presentation quality - Good

The presentation of the results is overall good in a well-structured way. However, it misses some important information (see "Other specific comments" below)

Other specific comments

1. The authors claim to use a "fully-coupled Earth system model", however, in "2.1 Model overview and experiment design" they describe only the atmpospheric part. What about the ocean? What about the coupling?

2. page 5, line 7-8 "The LRM and HRM physics time steps are 30 minutes and 15 minutes, respectively". What about the dynamic time step? The dynamic time step depends on the grid width. How do the authors set the time step in the coarse grid region of the RRM and that one in the high-resolution domain?

3. Page 5, line 30 -34 "All free- running simulations are run for a period of 5 years. The first year is considered spin-up, thus we study the results from the last 4 years. The nudging run simulates year 2011, whereas the AMIP results are extracted for year 2011 from a long simulation starting from 1870 (Golaz et al., 2019). Model output is stored as monthly and hourly averages." This is the only part in the manuscript where I can find an information on the time period. From Table 2 it seems that all observations have different time periods. Are the time periods listed there are also the time periods which are compared with the model results?

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4. Page 13, line 9-11 "... incorrect diurnal cycles. The similarity between RRM and HRM indicates that RRM simulations will be valuable for understanding and addressing this important model bias." and line 28-31 "... the time of peak precipitation is a few hours early, consistent with the experience of other models. More physically based improvements are needed to find a solution to the summertime diurnal cycle issue for precipitation over the CONUS, and the RRM provides an efficient tool for parameterization testing."

As the authors state right this is a well-known problem of coarse grid models. However, they did not cite any papers on possible solutions.

A possible solution for the ECMWF convection scheme is described in BECHTOLD, P., SEMANE, N., LOPEZ, P., CHABOUREAU, J.-P., BELJAARS, A., BORMANN, N., 2014: Representing Equilibrium and Nonequilibrium Convection in Large-Scale Models. Journal of the Atmospheric Sciences 71, (Heft 2), S. 734–753.

In general this problem does not appear in convection permitting simulations (< about 2-4 km grid width). A starting point for reading on the effect of convective permitting simulations on the diurnal cycle: PREIN, A. F., LANGHANS, W., FOSSER, G., FERRONE, A., BAN, N., GOERGEN, K., KELLER, M., TOELLE, M., GUTJAHR, O., FESER, F., BRISSON, E., KOLLET, S., SCHMIDLI, J., VAN LIPZIG, N. P. M., LEUNG, R., 2015: A review on regional convection-permitting climate modeling: Demonstrations, prospects, and challenges. Reviews of Geophysics 53, (Heft 2), S. 323–361.

In general the authors seem not be very familiar with articles written in Europe.

5. Figures 5-11 Please add to each of the figures an additional one showing the absolute values of the observations. Otherwise it is hard to judge whether biases are large or small.

6. Figure 10 The authors write in the text (page 10, line 30) "... LRM simulation exhibits statistically significant positive temperature (up to 3 K) biases throughout the area (see

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Fig. 10a), ..." (meaning biases to ERA-Interim). From the the biases of HRM and RRM are then even larger compared to ERA-Interim (Fig. 10b up to 6 K and the same in Fig. 10c, but for a smaller region). These are quite large biases. Can the authors give any explanation why the temperature bias doubles for the high-resolution model versions?

Technical Corrections

1. Figure 15 Please enlarge the legend circle at the top right and add an additional radius axis with precipitation values.

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