

Geosci. Model Dev. Discuss., referee comment RC3
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Comment on gmd-2021-298

Yuan Wang (Referee)

Referee comment on "Better calibration of cloud parameterizations and subgrid effects increases the fidelity of the E3SM Atmosphere Model version 1" by Po-Lun Ma et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-298-RC3>, 2021

The manuscript presents comprehensive results from the model calibration effort to improve DOE EAM_v1. It explores the impacts of the model recalibration on the fidelity of model climate, and implications for cloud feedbacks and ERF. The documented technical details in parameter calibration are highly beneficial for the scientific community to understand the model at the process level. The calibration comprises four major parts that reflect the latest advancement in modeling cloud, convection, aerosol, and radiation. The manuscript is co-authored by leading scientists in the field. Overall, the model development processes and associated impacts on major science questions are thoroughly discussed. The work is appropriate for GMD and I recommend acceptance after the authors address the comments listed below.

1) As each experiment runs for 11 years, some more statistical analyses can be conducted. For example, for Fig. 3, are the differences significant compared with the natural variability in the control run? For those difference maps, the authors may consider wiping out those pixels with insignificant differences.

2) L139-141, the logic is unclear here. Why the smaller cloud feedback and aerosol radiative forcing can lead to a better surface temperature simulation in a couple run?

3) L343, should be "reduced conversion".

4) Fig. 4c&5c, tuning in MP apparently impacts LWP, but not cloud fraction in the Sc regions. Is it simply due to the diagnostic cloud fraction scheme which is independent with cloud microphysics? If yes, should such a disconnection be targeted in the future model development?

5) L527-534, please provide how EIS is calculated from the model.

6) Fig. 14c, it is a little surprising to see the altered cloud-rain autoconversion does not impact Eaci significantly over the subtropical warm cloud regions. Any explanation?

7) Fig. 15a, on about the same latitude, why aerosols induce opposite land temperature changes over the northeast Eurasia and the northwest North America?

8) Fig. 14e and L963-965, it is unclear to me why EAMv1_ZM shows less sensitivity of Nc and Ni to aerosols, but produces stronger ERFaci?

9) It may be beyond the scope of the study, but I am curious of the additivity of the impacts of different tuning parts. Would the total impacts from EAMv1P be a linear

addition of those from each individual configuration? In other words, are there significant nonlinear interactions among those different configurations?

10) Near the end of the paper, it is worth discussing what are the unresolved outstanding biases in EAMv1P and whether they are likely to be resolved in the next stage.