Geoscientific
Model Development
Discussions

Interactive comment on "An effective parameter optimization with radiation balance constraint in CAM5 (version 5.3)" *by* Li Wu et al.

Anonymous Referee #1

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This study applied an automated parameter optimization algorithm subject to TOA radiation balance constraint to improve the performance of the Community Atmospheric Model in climate simulations. Results showed that the optimized parameters evidently improve the model performance while the energy balance principle can always hold across the entire optimization iterations. This paper conforms the importance of radiation balance constraint for optimization applications in climate models. The manuscript is well organized and the presentation is generally good. However, there are some aspects need to be improved before considering of publication.

Recommendation: Minor revision

Specific comments: 1. The optimization results using the constrained algorithm are quite different from the unconstrained results (Fig. 2). Does this indicate that the bet-

ter model performance based on the synthesized metric (eq. 3) often leads to more serious radiation imbalance at TOA? This issue might be related to the structural inadequacy in the model physics as discussed in Qian et al. (2018) and Yang et al. (2019).

2. The penalty term applied in the cost function (eq. 6) is a key element of the optimization method the authors presented here. I am wondering what the optimization results will be if the net radiation budgets at TOA are directly included in the synthesized metric that is used for optimization. I think by doing this, the best members would be located in some areas between the red and black markers in Fig. 2. The authors can check the results by using the experiments that have already been completed with constrained or unconstrained algorithm.

3. P2L31-32, please check the grammar.

4. P3L18, "into to"?

5. P4L15, "it has been identified as the second most influential parameter in climate", second most influential parameter for which aspects of climate?

6. P4L22, is 1.9*1.9 a standard option of resolution in CAM5? F19 should correspond to a resolution of 1.9*2.5.

7. P4L26, The synthesized metric was based on MSE, while the abstract (i.e. P1L15) said it used global mean values. Please make the statements consistent.

8. Eq. 3, outputs from the control run were used to normalize model errors for different variables. So will the optimization results be different if a different set of parameter values were used in the default configuration?

9. P6L10, "leading" or "leading to"?

10. P7L7, "When the time scale is shorter with unchanged cloud bottom convective mass flux", what is the meaning of "unchanged cloud bottom convective mass flux"?

Shorter time scale should lead to stronger mass flux at cloud base.

Reference Qian, Y., et al. (2018). Parametric Sensitivity and Uncertainty Quantification in the Version 1 of E3SM Atmosphere Model Based on Short Perturbed Parameter Ensemble Simulations, J. Geophys. Res. Atmos., 123, 13046, 2018. Yang, B. et al. (2019).Parametric and structural sensitivities of turbine-height wind speeds in the boundary layer parameterizations in the Weather Research and Forecasting model. J. Geophys. Res. Atmos, 124. https://doi.org/10.1029/2018JD029691