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Geoscientific Model Development Discussions

Interactive comment on "The University of Victoria Cloud Feedback Emulator (UVic-CFE): cloud radiative feedbacks in an intermediate complexity model" *by* David Ullman and Andreas Schmittner

Anonymous Referee #1

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General comments:

The paper "The University of Victoria Cloud Feedback Emulator (UVic-CFE): cloud radiative feedbacks in an intermediate complexity model" describes and evaluates a new method for applying GCM-derived cloud feedbacks to intermediate complexity models. The new method is able to capture the spread in TOA radiative feedbacks between the original GCMs, implying that the tool is generally efficient. Given that cloud feedback plays an essential role in determine the magnitude of global warming, this method is expected to be useful in improving intermediate complexity models that are in lack of cloud feedbacks. Therefore, I suggest the paper be published after addressing my following comments.

1. The cloud masking effect has not been removed from cloud radiative effect when cloud feedback is calculated. This may result in a systematic bias to the TOA radiations.

Consider an assumptive situation that there is no change in cloud properties under global warming, then no cloud terms need to be added up to Eq. (6), and the OLW_cloud(t) term in Eq. (15) should be zero. However, the cloud longwave radiative effect in GCM would still change due to changes in water vapor and temperature (cloud masking effect), leading to a non-zero value in Eq. (15). Therefore, an additional term is needed to compensate the cloud masking effect (this may be done with radiative kernels, Soden et al. 2008, doi: 10.1175/2007JCLI2110.1).

2. The calculation of "TOA feedbacks" is inaccurate, so I suggest the authors to either calculate the TOA feedbacks with the standard method, or to replace "TOA feedbacks" with another phrase. In this paper, climate forcing is included in the "TOA feedbacks" (Page 9, line 6), so the TOA feedbacks in Fig. 6 ($\sim$0W/m2/K) is much larger than that calculated by Andrews et al. 2012 (-1.08 W/m2/K).

3. The cloud rapid adjustment has not been removed from the cloud feedback (Zelinka et al. 2013, doi: 10.1175/JCLI-D-12-00555.1). This may be partially responsible to the loss of spread in UVic-CFE simulations (Fig. 6).

I expect that the UVic-CFE would be more accurate after the above comments are addressed.

Specific comments:

Page 1, Line 29. "The relative magnitude and net effect of these feedbacks depends on cloud altitude... High clouds, on the other hand, radiate at much colder temperatures than the surface, which can make the longwave effect dominate and lead to net warming"

The authors may also discuss the effect of cloud optical depth here. The net cloud radiative effect of high clouds could be either positive (high thin clouds) or negative

(high thick clouds) depending on the cloud optical depth.

Page 3, Line 30. It is worth discussing whether the cloud radiative effect is included when the empirical parameters in Eq. (6) were calculated.

Page 7, Line 17. Please provide more details for the 4xCO2 and LGM experiment design. Figure 4 and 5. There are some white pixels surrounded by blue/green pixels (for example, Central tropical Pacific Ocean in Fig. 4a,d). Are these white pixels induced by missing values? Is it possible to eliminate them?

Technical comments

Page 3, Line 25. How is the variable f calculated?

Figure 6, 8. Figure legend: “UVIC control” -> “UVic control”, to be consistent with the figure description.

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