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Geoscientific Model Development Discussions

Interactive comment on "SimCloud version 1.0: a simple diagnostic cloud scheme for idealized climate models" *by* Qun Liu et al.

Anonymous Referee #2

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General comments:

This manuscript documents a simple diagnostic cloud scheme, SimCloud, which aims to understand the dependence of cloud fraction on different diagnostic schemes and tuning parameters. The SimCloud can switch various cloud schemes within a single model framework, facilitating the evaluation of the inter-model spread in cloud biases. The authors implement the SimCloud into an idealized climate model, Isca, and perform some sensitivity experiments to show how to evaluate cloud biases in the model. Although the schemes used in the SimCloud are very simple and not new, the tool will be of importance to understand the source of uncertainties in cloud and radiation fields among multiple models for future study. The study is generally well conducted and the methods used are appropriate. I feel that this work fits within the scope of the

Geoscientific Model Development. I recommend publishing this manuscript following minor revisions because the authors need to provide some additional discussion, and have several minor presentation issues to address detailed below.

Specific comments:

Abstract: Although the abstract is supported by data and clearly reviewed the main findings of the present study, it would be helpful to readers if the authors add a brief description of the purposes of the SimCloud (e.g., Lines 529-534).

Line 34: "The simulation of low clouds nevertheless remains problematic in GCMs": This paragraph mainly describes the bias in cloud feedback, but this paper particularly focuses on the climatological cloud biases under the present-day simulations. A brief discussion about systematic biases among GCMs (e.g., too bright low-cloud bias; Nam et al., 2012) would be beneficial to the readers.

Lines 83 and/or 102: More detailed description of the "freeze-dry" method should be provided. Or, please consider simply adding "(discussed in Sect. 2.2.2)" here.

Line 107-108: Does the cloud scheme predict cloud droplet number concentration (i.e., two-moment scheme)? Please clarify how the model represents the Twomey effect (cloud albedo effect). Also, please consider adding a description of the cloud lifetime effect.

Line 149-150: This may need references.

Line 265-266 and Eq. (12): This also may need reference(s).

Line 283: Just to check, "but seasonally varying" means that the authors used monthly SST data, right?

Sect. 3: How does the SimCloud/Isca model treat aerosol chemistry and aerosol-cloud interactions? Adding a brief description in this section would be helpful for readers.

Line 304 and Table 3: I assume that the "cloud water path" is the sum of liquid and ice.

Please specify the definition here.

Table 3 (and/or Fig. 7): Although the authors used cloud amount data from ISCCP, isn't it better to use CALIPSO-GOCCP data here?

Lines 320 and 333-335: In my experiences, cloud fraction emulated from satellite instrument simulator (lidar simulator) is fewer by approximately 5–10% than the model native output. This has also been reported in previous studies (e.g., Cesana and Chepfer, 2013). So the Isca simulations are actually close to the CALIPSO-GOCCP observations if using a simulator. Please consider adding this note here. Cesana, G., and H. Chepfer, 2013: Evaluation of the cloud thermodynamic phase in a climate model using CALIPSO-GOCCP. J. Geophys. Res. -Atmos., 118, 7922–7937.

Figure 9: Please modify the unit in the figure (Wm-2 => gm-2).

Line 371-373: I think that the overestimate of CWP can be caused by neglecting the ice- and mixed-phase microphysics scheme as well (e.g., Bergeron-Findeisen process).

Line 400-401 "is closer to the observed value": The net CRE bias is more than 10 W m-2, so this sentence is not appropriate. This result means that more fundamental errors can also exist in microphysical properties (e.g., effective radius) and/or other processes in the model in addition to the macrophysical properties (cloud fraction).

Line 578-580: In addition to the cloud scheme, recent studies showed that treatment of precipitation is also a very important component in GCMs. For example, some GCMs that incorporate the prognostic type of precipitation scheme (e.g., CAM, MIROC, etc.) have improved some systematic biases in the magnitude of aerosol-cloud interactions and rain formation processes with more realistic cloud and radiation fields. A brief discussion of the importance of process-based model developments against the simple model approach would be beneficial.

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