Response to Reviewer #3 of gmd-2019-104

Dear Johannes Mülmenstädt (Referee),

Thank you very much for taking your time to review our paper. We think that your comments greatly help improve the manuscript. We have revised the manuscript according to your comments as explained below with point-by-point responses to your comments. We hope that the revision is enough to address your comments to make the manuscript now acceptable for publication in *GMD*.

[RC]: *Referee comment*
[AC]: **Author comment**

Johannes Mülmenstädt (Referee):

[RC] *I have reviewed "Incorporation of inline warm-rain diagnostics into the COSP2 satellite simulator for process-oriented model evaluation" by Michibata et al. The manuscript documents extensions to the COSP v2 satellite simulator package that, in my opinion, will greatly advance the understanding of warm rain processes in GCMs and contribute to improvements in process realism. Below is a list of fairly minor comments that should be addressed before publication.*
[AC] We would like to thank Dr. Johannes Mülmenstädt for his very positive review. We agree with you and have incorporated this suggestion throughout our paper, as listed below. Note here that, page and line numbers denoted in the authors' responses below correspond to the track-changes file, not original manuscript.

Specific points:

[RC1] *I am not complaining about the –15 and 0 dBZe thresholds (they seem to be used frequently), but I would appreciate a sentence of discussion or a reference on why these particular values were chosen.*
[AC1] We have added the following notes in the revised manuscript: "This threshold of Z_{max} is often used to separate non-precipitating and precipitating clouds for warm rain studies (Wood et al., 2009; Kubar et al., 2009). Since this study extracts only single-layered warm clouds, ocean-specific (Haynes et al., 2009) and land-specific (Smalley et al., 2014) thresholds originated from radar attenuation and/or phase partitioning are not used in our diagnostics (see also Kay et al., 2018). This enables us to assess global clouds uniformly."

[RC2] *Similarly, I am not complaining about the use of simple, column-maximum Z_e, but perhaps the authors could comment on the advantages and disadvantages of this approach compared to the CloudSat precipitation flag simulator presented in Kay et al. (2018).*
[AC2] It has been described at Page 4 Line 17 as shown in the **AC1**.

[RC3] *I believe the recommendation of 100 subcolumns per one degree (lat/lon) of model resolution deserves explanation or a reference.*
[AC3] This statement is based on the README file in CFMIP2 experiments for recommended configuration (cfmip2/cosp_input_cfmip2_long_inline.txt). We noted this in the revised manuscript as follows (Page 3, Line 6): "The CFMIP recommendation to COSP users is … of model grid spacing (cfmip2/cosp_input_cfmip2_long_inline.txt) to enable comparison to satellite sampling at the kilometer scale."

[RC4] *In the same vein, it appears that the authors intend for the number of subcolumns to scale with the grid spacing, not the grid-box area (140 subcolumns at 1.4 degree resolution, p. 4, l. 31). It would be good to explain why.*

[AC4] As described in **AC3**, the value of NCOLUMNS (= 140, i.e. 100 subcolumns per one degree of model resolution) was determined based on the recommendation in CFMIP2 experiments in order to downscale the GCM grid mean values to the observation scale. We have checked the sensitivity of the warm rain statistics to varying settings of NCOLUMNS = 20, 140 (this study), and 280, and found that the result was insensitive to the NCOLUMNS, as shown in Fig. R1, at least in MIROC6. These following note has been added in the revised manuscript.

Page 5 Line 27: "Although the numbers of subcolumns (NCOLUMNS) was set to 140, obtained warm rain diagnostics were insensitive to the choice of NCOLUMNS at least in MIROC6 (not shown).".
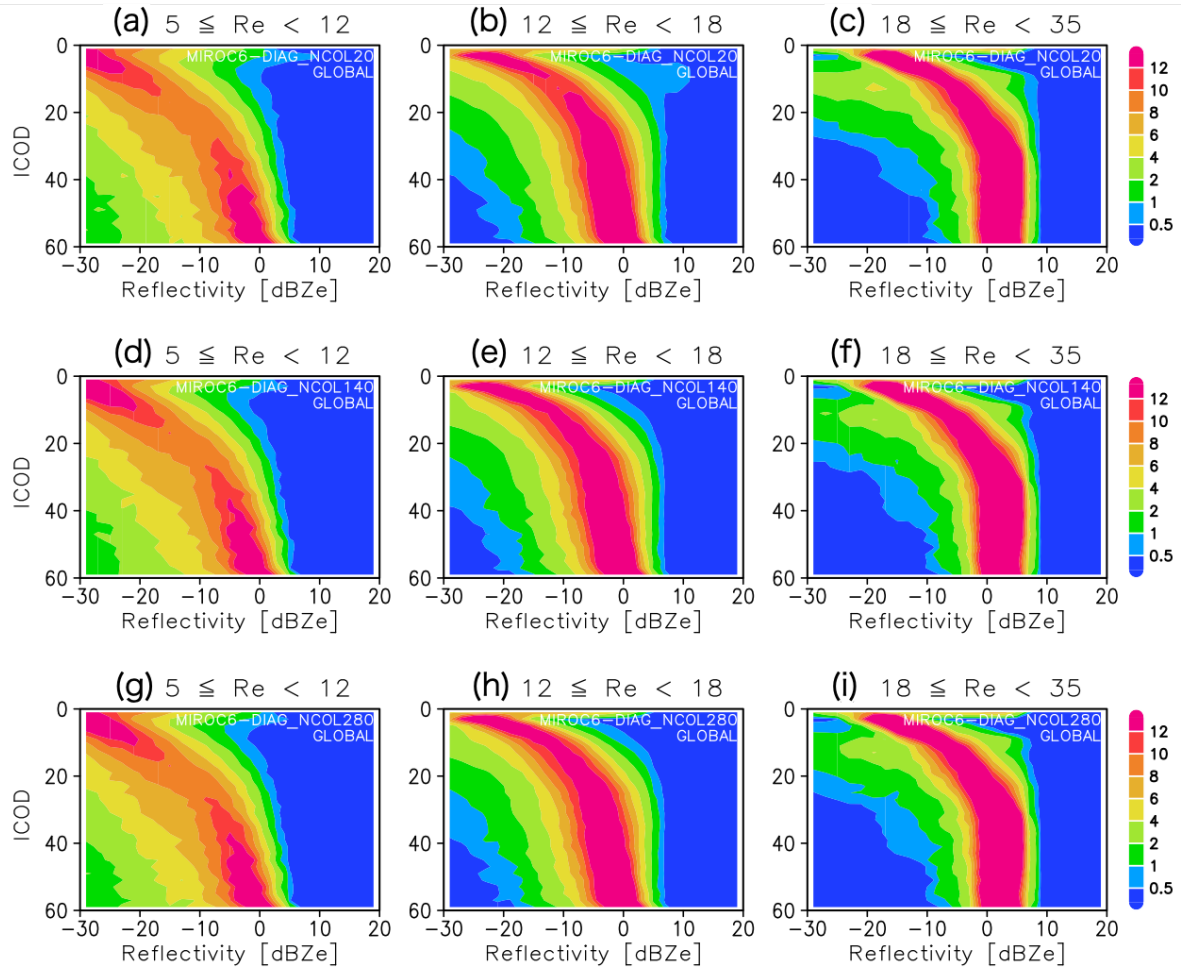

Figure R1. CFODDs obtained from MIROC6 for different NCOLUMNS defined as (a–c) 20, (d–f) 140, and (g–i) 280.

[RC5] *In the discussion of the model results, the authors should explain whether their CFODDs include convective precipitation or only stratiform, and whether MIROC uses the same microphysics in convective and stratiform clouds.*

[AC5] Yes, it is important information for readers. We have added description about the cloud parameterization in MIROC6 and sampling in the COSP diagnostic as follows.

Page 5 Line 24: "MIROC6 applies a PDF-based large-scale condensation parameterization (Watanabe et al., 2009) with Berry (1968) warm rain microphysics, and an entrainment plume model for

convective precipitation (Chikira and Sugiyame, 2010) including shallow cumulus scheme (Park and Bretherton, 2009).".

Page 6 Line 12: "It should be noted that although only the stratiform subcolumns were analyzed in the model (defined as fracout = 1 in COSP, see also Fig. 1), A-Train analysis includes both convective and stratiform clouds. Strictly speaking, the model–observation comparisons are in this regard not equivalent. However, given that the sampling criteria of SLWCs exclude deep convective clouds significantly, the inconsistency in cloud type between model and observation is minimized.".

[RC6] *Please confirm that one of the repositories listed in the code availability section will contain the source code for the online statistics (I assume so, but the wording is a bit ambiguous).*
[AC6] The source code of COSP2 for the online diagnostics[1] and data[2] used in this study are included in the Zenodo repository, and are now open to public. We have modified the 'Code and data availability' section in the revised manuscript.
[1] https://doi.org/10.5281/zenodo.1442468
[2] https://doi.org/10.5281/zenodo.3370823

[RC7] *I am also attaching an annotated PDF with very minor comments that the authors may find helpful in proofreading the manuscript.*
Please also note the supplement to this comment:
https://www.geosci-model-dev-discuss.net/gmd-2019-104/gmd-2019-104-RC3-supplement.pdf
[AC7] Thank you very much for your rigorous and constructive suggestions. The answer and corrections on individual comments are listed below.
Page 2 Line 6: removed ", which are central to the aerosol–cloud inteteractions of low clouds,".
Page 3 Line 6: changed "simulators are" to "simulator is".
Page 5 Line 9: changed "fracout = 2" to "fracout = 1".
Page 5 Line 16: changed "in each grid-box (lambda, phi)" to "in each GCM grid".
Page 6 Line 17: changed "of SLWCs and their fractional occurrences" to "of fractional occurrences of SLWCs".
Page 4 Line 16: added the unit "dBZe".
Page 8 Line 15: added the unit "dBZe".
Caption in Figure 2: added the unit "dBZe".
Code and data availability: We have clearly stated the availability of codes in this section, as described in **AC6**.

Thank you very much again for reviewing our paper.

Sincerely yours,

Takuro Michibata