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Atmospheric Chemistry and Physics Discussions

Interactive comment on "New cloud parameterization with relative dispersion in CAM5.1: model evaluation and impacts on aerosol indirect effects" *by* Xiaoning Xie et al.

Anonymous Referee #1

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General comments: This study examines the behavior of different microphysics schemes used in climate models that take into account the relative dispersion effect in different ways, and explores the sensitivity of the model-simulated cloud and radiation fields to different representations of the dispersion enhancement with increasing aerosols. The results show that the aerosol indirect forcing becomes reduced significantly when incorporating the aerosol-induced increase of the relative dispersion. It is also shown that the reduced magnitude of the indirect forcing depends on choice of the scheme with different sensitivities of the dispersion to droplet number concentration. This is a useful addition to estimates of the aerosol indirect effect, particularly by means of climate modeling. The study is also (at least qualitatively) consistent with a

growing body of knowledge that tends to indicate that the aerosol indirect forcing might be smaller than what has been considered in the past. The important contribution of this study, I think, is a quantitative estimate of how much aerosol indirect forcing can be reduced by the relative dispersion effect. I would recommend the paper be accepted for publication in Atmos. Chem. Phys. after my following concerns are adequately addressed.

Specific points: Page 2, Line 19-20: "ε is increased by anthropogenic aerosols under similar dynamical conditions in clouds." Why does the relative dispersion increase with increasing cloud droplet number concentration? Please explain the basic mechanisms for it, not just providing a reference to previous studies that showed such tendencies.

Page 5, Line 21-23: "The difference between the simulations with the same ocean surface conditions but aerosol emissions for PD and PI was used to calculate the changes in cloud microphysical properties and cloud radiative forcing induced by anthropogenic aerosols in Section 4." It seems that the aerosol indirect radiative forcing (AIF) thus obtained is the effective radiative forcing that is a "net" radiative forcing remaining after the rapid adjustment occurs, rather than an instantaneous radiative forcing. Is this correct? If so, the authors should clarify that this is the effective radiative forcing, not the instantaneous radiative forcing, because these two are remarkably different in their representations as a climate driver (IPCC AR5, Chapter 7). Even in that case, the reviewer is a bit confused by the author's definition of the indirect radiative forcing (AIF): To the reviewer's understanding, the first indirect effect is categorized into the instantaneous radiative forcing while the second indirect effect is categorized into the effective radiative forcing. The authors, however, tend to define the first and second indirect forcings due to perturbations to Reff and LWP, respectively, in the same configuration of the prescribed SST. Should I interpret the AIF as the total effective radiative forcing due to aerosol-induced perturbation to clouds? I would much appreciate the reviewer to clarify these points.

Page 6, Last paragraph: It is shown that the cloud droplet number concentration is

underestimated while the effective radius agrees with satellites. How should I interpret these apparently inconsistent results? – Does this mean that the cloud water content is also underestimated?

Page 7, Line 8-11: Can these biases in SWCF and LWCF be interpreted in terms of biases in occurrence of different heights of clouds (low, middle and high clouds)? It would be useful to show cloud cover for low, middle and high clouds, as well as the total cloud cover, in Table 2.

Minor points: I found some grammatical errors/typos as follows. Hope this helps the authors improve English.

Page 5, Line 4: "as detailedly described by Neale et al. (2010)" -> "which is documented in Neale et al. (2010)".

Page 5, Line 13: "here" -> "where"

Page 9, Line 13: "PL on Nc" -> "PL with increasing Nc".

Page 9, Line 20: These results can also *be* seen. . .

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