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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Remote sensing of cloud sides of deep convection: towards a three-dimensional retrieval of cloud particle size profiles" *by* T. Zinner et al.

Anonymous Referee #2

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General remarks

The manuscript presents a radiative transfer modeling study that relates reflected solar and emitted thermal radiation from cloud tops and cloud sides to the microphysical properties of the cloud particles. The authors follow the general approach of Nakajima & King and take additionally cloud height information from the thermal radiances into account in order to obtain vertical profiles of cloud effective radii. A major improvement to previous work on this subject results from the use of high resolved 3d inhomogeneous convective clouds. Despite these geometrical "complications" the authors find a robust relation between radiances and cloud microphysical properties, and thus lay the

basis for a more realistic satellite based cloud remote sensing. However, in my view the authors conclusions are a bit too optimistic. There are a number of limitations in the cloud realizations used for this study, which deserve a more critical discussion, see my specific review points below. In general, I favor publication in ACP.

Specific remarks

1) General: In addition to the vertical cloud size variability, which is mostly driven by cloud particle growth processes, there is also some horizontal variability due to local up- and downdrafts as well as due to turbulence. Aircraft measurements of drop size distributions (e.g. Fast FSSP) nicely demonstrate this variability. In order to establish and conclude about a robust relation between cloud and radiance properties, this kind of noisy behavior should be addressed in such a study. The situation is further complicated by the fact that the formulas to derive particle size from water or ice mixing ratios presented in sections 2.2.1 and 2.2.2 are certainly not absolutely perfect. This implies an additional noise that needs to be added to the cloud realizations. I understand that handling 100s of cloud scenarios is not feasible even with modern computer capacities. However, a discussion of the role of noisy cloud microphysical variability on the Bayesian retrieval should be added.

2) page 4268, line 25: "controlled" is too strong a word: The major drivers in cloud particle growth are supersaturation and particle number concentration, both in turn driven by updraft velocity. I would say that the aerosol plays a minor role here, and that there is always sufficient background aerosol

3) page 4269, lines 1-4: Again, I think this cloud-aerosol relation is overstated. There are other processes that effect cloud particle size more than the aerosol characteristics.

4) page 4269, line 8: see 2), 3)

5) page 4269, lines 14-15: Well, the recent IPCC report states that

Substantial progress has been made in understanding the inter-model differences in

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equilibrium climate sensitivity. Cloud feedbacks have been confirmed as a primary source of these differences, with low clouds making the largest contribution.

So, I would give aerosol-cloud interactions a high uncertainty, but not the highest. There are other more important processes, which trouble the climate change community.

6) page 4270, lines 24-26: Is the Nakajima & King scheme applicable to situations for large optical thickness where even large changes in optical thickness have little effect on the reflected (non-absorbed) radiance. If I remember correctly, the NIR radiance requires a correct estimate of the optical thickness form the VIS measurement to obtain effective radius. Given the high convective clouds and the slant viewing geometry (which imply large effective optical thickness) this may pose a problem in the retrieval.

7) next sentence: "Due to the strong slanted viewing geometry...": Sorry, I don't understand this statement...

8) chapter 2: Is there no en/de-trainment parameterization in the CRM?

9) page 4277, lines 9-10: From my understanding of this section you need liquid water content AND particle number concentration to get effective drop radius?

10) Conclusions: In my eyes 13 (x4) clouds is not a "large number of cloud cases"

11) "Conclusions" -> "Summary & Conclusions"

12) Appendices: I suggest to replace Appendix A1 with a reference to Emde & Mayer. Hasn't the "solar delta-scaling" (Appendix A2) been described elsewhere, already?

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 4267, 2008.