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Atmospheric Chemistry and Physics Discussions

Interactive comment on "" by

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We want to thank Reviewer #1 for his/her careful review, and apologize for the length of time it has taken us to respond.

Major points

1. "In the introduction, in section 4, and in the Summary and Discussions the importance of aerosols is emphasized, as well as the contribution of the new methodology to resolve open issues in aerosol-cloud interactions. On the other hand, no solution is offered how to measure aerosols quantitatively in the vicinity of convective clouds. It is known that clouds strongly affect retrievals of aerosol properties from passive instruments, in particular for such optically thick clouds as addressed here. Please concentrate the paper on clouds, unless you really offer a solution for the aerosol and please don't raise expectations of the reader in the introduction which you cannot satisfy later. In particular, the statements on page 4503, line 5 ('a full set of aerosol and cloud ...') and page 4503, line 22 ('presence, amount, and type of aerosol particles') and page 4504, line 8 ('aerosol amount and type in the neighbourhood of the clouds') are not

justified on the basis of this manuscript."

We feel that the evidence continues to mount showing the strong connection between aerosols and cloud vertical development, which has been the motivation for us to develop the cloud side remote sensing measurements and retrievals. The aerosol measurements are an important aspect of the CLAIM-3D concept. Still we understand the reviewer's point that the emphasis of this paper must be the cloud measurements and have kept the aerosol measurement section to a minimum. We note that Reviewer #2 did ask us about other measurements needed from the same platform, and we need to accommodate his/her interests also. However, we agree with Reviewer #1 that some of our statements in this section may have been too strong, and therefore, have toned down some of the stronger statements that Reviewer #1 specifically indentified. We have also added new references (Hasekamp 2010 and Koren 2010) that address the issue of making aerosol retrievals in a cloudy environment.

2. "The question if the effective radius varies horizontally is not really addressed for the scales of interest. On page 4496, bottom, it is outlined that observations show little horizontal variability of droplet size. But is this also true close to cloud edges where droplet sizes could be easily affected by entrainment? At 2.1 micron, the retrieved droplet size is probably representative of an optical depth less than 5 (Platnick et al. calculated something like 2 for the stronger absorbing 3.7 micron channel). This translates to a horizontal distance of less than 100m. Could you elaborate on the penetration depth for your channel combination and the question if droplets really don't vary at distances less than 100m of the cloud edge?"

We agree that the assumption of r_eff invariability along constant altitude is a major assumption of the method. We dedicate an entire section to this discussion (section 2.5) and list four published references and two personal communications giving evidence that r_eff remains constant for a given altitude. We point the reviewer to Rosenfeld and Lensky (1998), Figure 10. Note that we direct the reader specifically to this figure in the text of our manuscript. This figure shows measurements of r_eff through a level cross

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section of a convective cloud plotted as a function of cloud optical thickness (COT) from the edge. When COT=0 in this figure, the aircraft is right at the cloud side. As COT increases the plane transverses deeper and deeper into the cloud. The figure shows the very small variability of r_eff along the entire transverse, even as COT approaches zero.

We agree that the case is not closed. Therefore throughout the paper we reiterate that this is a major assumption of the method including in the Summary and Discussion section where we have added a paragraph discussing some of the limitations of the method. We offer appropriate caveats when making claims, and at the end of Section 2.5 we suggest a remote sensing method using variable penetration distances into the cloud that can test this assumption.

3. "In Figure 4 you show the reflectance for 2.1 micron. It would be very interesting to see the non-absorbing 0.66 micron reflectance for comparison. It shouldn't be too difficult to produce the plot as you already have the data available, as you mention in the text."

The curve for the 0.66 μm reflectance has been added.

4. "page 4485, line 3: Is the 'warm rain paradox' common knowledge? Please explain briefly!"

The term "warm rain paradox" has been changed to "the extent by which warm rain dominates clouds that extend to very cold temperatures near the tropopause under different aerosol conditions"

5. "page 4485, line 25: Was 1998 really 'recently'?"

Of course not. Wording has been changed.

6. . "page 4486, line 1: 'dg' is used as abbreviation of 'degree' which seems quite uncommon. You could rather used 'deg' or the degrees symbol"

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The abreviation was changed to the degree symbol where appropriate, or to the full word, ‘degree’.

7. Why was Freud et al., (2005) still at ACPD?

We see the irony in answering this question now, after our own delay of 4 years in addressing the reviews of our current paper. We will simply answer that the Freud paper was accepted for publication at ACP in 2008 and all references and citations have been updated in our revised manuscript.

8. Change “learn physics” to “gain information”

Done

9. Add “validate Rosenfeld hypothesis” to objectives of these measurements

Done

10. What have cloud shadows to do with “relatively large scattering angles”?

We meant to say “relatively large range of scattering angles” as opposed to observations made at exactly the backscattering angle where the sensor would view the cloud completely illuminated. Wording has been changed.

11. “rule of thumb” is inappropriate description

Wording was changed

12. Better discussion of Figure 5 including an estimate of accuracy of the retrieval using cylindrical clouds Discussion was added in Section 2.4

13. It appears that you are saying that the retrieved profiles are of little value if the cloud properties change close to the cloud edges.

Yes, we are. Here again we are addressing this major assumptions in the method.

14. Where did the temperature profile come from?

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We realized that there was inadequate description of the instrumentation used to obtain the data displayed in Figures 6 and 7. We have added substantial information to Section 3.1 describing the instruments. The temperature profile comes from a thermal sensor measuring emitted radiation at 11 μm.

15. Did you use a single look-up table or separate tables for ice and water. If there were separate tables, how did you choose when to use each?

We have added additional description on how the retrievals were done to Section 3.1. Two LUTs were employed, one for ice and one for water clouds, with the choice of cloud phase determined by the ratio of 2.1 and 2.25 μm reflectances, appearing in the bottom right hand panel of Figure 7, and explained below. However, the retrieval was not sensitive to the choice of either water or ice LUTs, at the geometries measured during this campaign. Differences between using water or ice LUTs were generally less than 2 μm.

16. You make a lot of strong statements based on the assumption that the profile retrieved from cloud edge applies to the entire cloud.

Again, back to this major assumption that we support with multiple evidence. But we do agree that some of those statements in the paragraph at the end of Section 3.1 may be too strong and have added caveats expressing the conclusions are dependent on this assumption.

17. How do you separate water and ice portions of the cloud in Figure 10?

We have added this text to the description of Figure 10 in Section 3.2. The separation was done using the measured brightness temperatures. Clouds and portions of clouds with brightness temperatures warmer than 0oC were obviously water. Clouds and portions of clouds with temperatures colder than -38oC were obviously ice. The thermal range in which mixed phase might occur were avoided.

18. Don't you want to propose a real satellite mission and not a hypothetical one?

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Well, sure. But here in this paper we are describing a hypothetical, generic mission, not a specific response to a specific NASA call for proposals. We have changed the wording to “a potential satellite mission”.

19. Figure 6 needs a color scale for the right hand image.

Done.

Typographical and grammatical corrections.

We thank the reviewer for taking the time to point these out. We have corrected the identified mistakes, and hopefully have not introduced new ones.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 4481, 2007.

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Interactive Comment