Atmospheric Chemistry and Physics Discussions

Interactive Comment

Interactive comment on "Does the threshold representation associated with the autoconversion process matter?" *by* H. Guo et al.

H. Guo et al.

1. How much of the sensitivity of AIE is due to the dependence of autoconversion on dispersion and how much is due to the dependence of cloud optical depth on dispersion?

A: Both the autoconversion and cloud optical depth (COD) are dependent on the cloud droplet dispersion, and they influence the estimate of AIE. However, it is not trivial to separate the sensitivity of AIE to the dispersion dependence of autoconversion from that of COD. This is because the autoconversion and the COD are correlated with each other. For example, COD depends on cloud liquid water path (LWP) and the LWP depends on autoconversion process. On the other hand, the COD influences radiative cooling/heating, and then the LWP and the autoconversion.

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2. Figure 3 caption. Change ration to ratio?
    A: This will be corrected.

3. Figure 4. Why is x_c larger for the polluted case?
    A: x_c is defined as the critical-to-mean mass ratio of cloud water. It is an increasing function of cloud droplet number concentration (N_d) but a decreasing function of the LWC [$x_c \sim N_d^{3/2} LWC^{-2}$, Eq. (12) of Liu et al., (2005, GRL)]. One reason that the 'polluted' clouds have a larger x_c is due to their larger values of N_d; and another reason is that the 'polluted' clouds are relatively drier and the LWC is smaller.
    We will add the following explanation in the 3rd paragraph on **P.** 16060:
    'x_c is an increasing function of cloud droplet number concentration (N_d) but a decreasing function of liquid water content (LWC) [$x_c \sim N_d^{3/2} LWC^{-2}$, Eq. (12) of Liu et al., (2005)]. In the 'POLL'; case, x_c is larger because the N_d is larger and the LWC is smaller.'

4. Page 8, third paragraph. The entrainment drying explanation has also been identified by Ackerman et al. (Nature 2004) and by Bretherton et al. (GRL 2007).
    A: We will add the references by Ackerman et al. (Nature 2004) and by Bretherton et al. (GRL 2007).

5. Page 8, lines 23-27. Alternately, one might conclude from this that using a 10 micron critical radius is sufficient in the time mean.
    A: In cloud resolving models, the critical radius (r_c) is typically set to be $10\mu m$; but in global climate models, r_c varies from 4.5 to 7.5 μm. However, these specifications of r_c in models are often empirical and lack of a sound physical basis. In our cases, a 10 μm r_c is sufficient in the time mean, but it does not mean that this would universally hold true.

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6. Page 8, last two lines. A value of 20 microns for the critical radius is unrealistic, so why present it?

A: We want our sensitivity tests covering a wider range of the prescribed critical radius than is typically observed, so that the full sensitivity of the results can be explored.

7. Page 8. Are these conclusions any different for the polluted case, which exhibited greater sensitivity to dispersion than the clean case does? Is there any evidence that a fixed 10 micron critical radius produces bias in any results other than at small scales?

A: In the polluted case, cloud droplet volume-mean radius is much smaller than that in the clean case (4 μm vs. 8 μm). The autoconversion process is less efficient in converting cloud water to rain water in this case, and thereby there is only a small amount of drizzle production (which is also consistent with the observations). If we artificially further increase the prescribed r_c (to say, 15 μm), the autoconversion rate and the drizzle rate are virtually zero and are not influenced by the prescribed r_c significantly. So the simulated cloud properties would become less sensitive to r_c if the autoconversion rate is (already) so small so as to be neglected.

In our study, the sensitivity test with a fixed 10 μm r_c produced different instantaneous and/or local cloud fields (e.g., cloud liquid water path) at smaller scales, as compared to larger scales. But for the averaged fields, the results are expected to be similar.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 16055, 2007.

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