Atmos. Chem. Phys. Discuss., 8, S7371–S7373, 2008
www.atmos-chem-phys-discuss.net/8/S7371/2008/
© Author(s) 2008. This work is distributed under
the Creative Commons Attribute 3.0 License.

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Diffusional and accretional growth of water drops in a rising adiabatic parcel: effects of the turbulent collision kernel" *by* W. W. Grabowski and L.-P. Wang

Anonymous Referee #1

Received and published: 22 September 2008

This paper presents a modeling exercise to investigate the evolution of cloud droplet spectra due to condensation and collision-coalescence in an adiabatic air parcel. The simulation results are shown to be sensitive towards the numbers of bins used to resolve the droplet size spectrum and towards the formulation of the collection kernel. Including turbulence effects in the formulation of the kernel causes decreases in the rain initiation time. This speedup appears to be rather independent on activation spectrum, updraft velocity and number of bins used.

The paper addresses one of the important open questions in atmospheric sciences, the numerical treatment of cloud droplet growth in a turbulent flow. The quantification

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

of numerical versus physical effects regarding the broadening of the spectrum will be of interest to the community. I recommend publication of the paper after the comments below are addressed.

1. Figures 4-10 show the results for 120 bins. Since one of the main results of the paper is that the solutions appear to converge when using 300+ bins, showing the 120-bin-results does not make sense to me. I suggest showing the simulations with 300 bins as the reference case.

2. Model description of adiabatic parcel model: It should be explicitly mentioned here (not only later in the discussion) that all the droplets are assumed to remain in the air parcel. The authors should also emphasize that this is a serious limitation inherent to the parcel model approach represents another reason why rain is initiated too early.

3. Formulation of the collection kernel: Fig. 2 indicates that the r.m.s. velocity fluctuation is 202 cm/s for the flow dissipation rate of 400 cm2/s3. What is the corresponding r.m.s. velocity for the case with 100 cm2/s3? How sensitive are the result towards the assumption of r.m.s. velocity? How important is the effect of preferential concentration versus the effect due to turbulence-induced relative velocities?

4. Figure 9 and 10: Please clarify the "time-independent scaling factors" that were used to produce these figures.

5. The fact that numerical spreading of the size distribution results in artificially rapid production of rain has been knows for a long time (see e.g. Berry and Reinhardt 1974). This should be referenced.

6. The impact on the collision-coalescence kernel is only one of several ways how turbulence can impact cloud droplet growth. Since the manuscript includes the condensational growth, the authors should at least include a reference to the potential impact of fluctuations in supersaturation, even if this is not the main focus of the paper.

7. Page 14730, line 28: "differences between continental and maritime case mostly

ACPD

8, S7371–S7373, 2008

Interactive Comment

due to different concentrations of activated cloud droplets.": It seems that this is in fact the only difference between the continental and the maritime case. Please clarify.

8. Page 14722, line 17: Typo - This should read "right-hand-side".

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 14717, 2008.

ACPD

8, S7371–S7373, 2008

Interactive Comment