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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A numerical study of aerosol influence on mixed-phase stratiform clouds through modulation of the liquid phase" *by* G. de Boer et al.

Anonymous Referee #1

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General Comments

This manuscript describes numerical simulations aimed at an improved understanding of aerosol effects on mixed-phase clouds, in particular through impacts of the liquid phase. Specifically, these authors characterized the impact of insoluble particle type, soluble mass fraction, freezing point depression, and aerosol number concentration. Aerosol insoluble mass type (i.e. freezing efficiency) was found to be the most important factor controlling cloud lifetime. Overall, the paper explores several important processes and yields interesting results. My biggest complaint about the manuscript is in regards to the figures, which I think are at times unclear (and mislabeled).

Specific Comments

p. 22061, line 24. CCN activity of a variety of dust particles has been demonstrated in the lab. A relevant reference here would be: Koehler et al., GRL, 2009, DOI: 10.1029/2009GL037348.

Section 2.2. The authors show that insoluble aerosol type is an important factor in their study. Yet the authors only use freezing efficiencies from one study 8 years ago (Diehl and Wurzler, 2004), which ignores a lot of laboratory work that has been completed since that time. The authors note that these values really just represent a range of freezing efficiencies (p. 22071 lines 22-25), and not strictly these components, but I think it would be worthwhile to direct the reader to some of these studies to demonstrate the wide range of values measured for the broad range of particle types in the atmosphere (e.g. Broadley et al., 2012, ACP, doi:10.5194/acp-12-287-2012; Zimmerman et al., 2008, JGR, doi:10.1029/2008JD010655; Murray et al., 2012, Chem Soc Rev, DOI:10.1039/c2cs35200a and references therein, to name just a few).

Section 2.2 and Figure 1. I think the authors need to make some effort to make this figure clear and consistent with Section 2.2. First, all red lines and all pink lines appear to be identical; these should be differentiated. Second, why 'ln' in Eq. 3 and 'log' in Figure 1 for Bh,i and Vd? Variables should also be identical in the equation and figure (e.g. Bh,i in both). What is 'T10' in the figure?

Section 4.2, 2nd paragraph and Figure 4. Immediately following a paragraph in which the authors state that freezing point depression is not an important process for this study, except in the case of haze droplets (which the model does not consider for freezing), the manuscript goes on to show and discuss results related to freezing point depression. Is this figure necessary?

Discussion. Given that the authors show results from a mixed-phase cloud case from SHEBA (Figs 3, 6, 8, and 11), it would be worthwhile to add some discussion (in the Discussion) relating their modeling results to the measurements and giving some rec-

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ommendations as to how to this study has improved our understanding of this particular case.

Figure 3. It is interesting that there was no ice from the observations until >3 hours. Does this correspond to a change in temperature? What does this say about your ice parameterization?

Technical Comments

p. 22061, line 27. Deposition nucleation occurs on SOME IN.

p. 22067, line 13. 'complementary'.

p. 22070, lines 6-7. The 'Bergeron-Findeissen effect' was earlier referred to as 'Wegener-Bergeron-Findeissen mechanism.' Be consistent throughout.

p. 22070, line 9. I believe 'simulations' should be 'observations'.

p. 22070, lines 11-12. Is it really several orders of magnitude? It looks like <2 orders of magnitude.

p. 22078, line 2. Do you mean 'droplet number concentration'?

p. 22080, line 7. 'reached'.

p. 22080, line 7. Why the '$\pm$'?

p. 22080, line 21. Add 'in'.

Figure 3 caption. 'NOICE, black and KAO, green'

Figure 5 and Figure 5 caption. The text notes that only the snapshot at 10 min includes information about the ILL or MON simulations, but I see no indication of these in the bottom 2 panels of the figure, even at 10 min. Also, the caption states that for the top panel that the 'NOICE line and markers are not included,' and yet they appear to be included, while I see no lines for ILL and MON. And why is there a particle freezing efficiency in the top of Figure 5 for NOICE?

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Figure 6 caption. There is not a 'time series for ice number density (bottom left)' in the manuscript, as the caption suggests.

Figure 7. Don't change color scheme for this figure; i.e. don't change MON to purple.

Figure 8 and p. 22075, lines 17-18. The caption does not accurately describe the figure (ice # concentration is missing).

Figure 11 and p. 22077, lines 6-9. Again, the caption does not accurately describe the figure.

Figure 14. One of the positive feedbacks is blue. What do the black symbols represent?

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 22059, 2012.