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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulating mixed-phase Arctic stratus clouds: sensitivity to ice initiation mechanisms" *by* I. Sednev et al.

Anonymous Referee #1

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This study evaluates the relative importance of CCN characteristics, coalescence, ice nucleation mechanisms and supersaturation wrt to water and ice on the microphysical properties of mixed-phase Arctic stratus cloud. The principal conclusion appears to be that the dominating factor, whether in water only processes or in the production of ice crystals is the shape of the initial CCN spectrum.

The authors go to great length in explaining the various details of their bin resolved model, including a set of appendices that are almost as long as the main text. It is not clear to this reviewer how important these appendices are with respect to the principal conclusions given that there is virtually nothing that is discussed in the appendices that helps the reader understand how the CCN spectra were originally selected or how they are modified in order to obtain scenarios W3 and W4 in contrast to W1 and

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Interactive Discussion
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W2. Equations A1 and A2 show the functional relationship but, unless I have missed something in the discussion of the various scenarios, I was unable to locate information about: 1) the reference source from which the initial CCN spectrum was derived, i.e. why ammonium sulfate and why the relatively high concentrations of particles larger than 1 um and 2) what is the scheme for changing spectrum shape, i.e. what is being changed - total concentration, modes in the distribution, length of the large particle tail...?

There have been a couple of recent papers on mixed-phase clouds and the importance of the Wegener-Bergeron-Findeisen process. Both of these papers use fundamental, analytical solutions for deriving the relationship of water and ice growth, supersaturation with respect to water and ice, and vertical velocity in mixed-phase clouds. Korolev and Field (2007, JAS) show that the necessary and sufficient conditions for activation of water in ice clouds is that 1) the vertical velocity of an ice cloud parcel must exceed a threshold velocity to activate liquid water and 2) the activation of liquid water within an ice cloud parcel, below water saturation, requires a vertical ascent above some threshold altitude to bring the vapor pressure of the parcel to water saturation. Korolev (2008, QJRMS) shows that there are four scenarios of mixed phase equilibrium but only two lead to WBF. Maximum efficiency of the WBF process occurs at uz˜0 for all mixed phase clouds and it does not depend either on the integral radius of water or of ice.

Given that these papers precede the manuscript under review, and that they concern the WBF and mixed phase processes, it would seem that their conclusions are very relevant to the conclusions of the current paper. Would the authors care to comment? In particular, in the current manuscript, very little is said about the sensitivity of vertical velocity other than it is controlled by large-scale lifting, yet the sensitivity of the liquid phase processes to supersaturation with respect to water, shouldn’t vertical velocity have been one of the independent parameters that is evaluated?

Minor points:

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Interactive Comment

The use of content instead of water content throughout the manuscript and in the figures is awkward.

I think Wegener-Bergeron-Findeisen process (WBFP) should be used instead of Bergeron-Findeisen process (BFP) in recognition of Wegener’s contribution to our understanding of mixed-phase processes.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 11755, 2008.

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Interactive Comment