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Interactive comment on "Ice phase in altocumulus clouds over Leipzig: remote sensing observations and detailed modelling" *by* M. Simmel et al.

Anonymous Referee #3

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General comments:

The authors simulate two mixed-phase cloud layers that were observed by remote sensing. However, the dynamical model used is unsophisticated, and key observations needed to initialize, force, and validate the simulations are unavailable. For instance, the study concludes that IWP is sensitive to IN number, but there are no IN measurements to assess how much IN number should be varied in the sensitivity study. Hence the conclusions must necessarily be regarded as tentative. Furthermore, only two cloud cases are examined, limiting the conclusions' generality.

If the authors wish to simulate a case study, then I recommend that they choose a more complete dataset to simulate, one that uses more accurate (e.g. in situ) measurements.

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Also, I recommend that they use a more sophisticated model (e.g. LES).

If the authors wish to do an observational study, then I recommend that they exploit the instruments they have. Given the facts that the set of instruments is incomplete, that none are in situ, but that they can be run continuously, the instruments seem better suited to assessing climatological relationships between variables.

If, instead, the authors wish to invest the time to maximize the usefulness of the present study, I would attempt to better quantify the statement "the liquid phase is mainly determined by the model dynamics (location and strength of vertical velocity) whereas the ice phase is much more sensitive to the microphysical parameters (ice nuclei (IN) number, ice particle shape)." In particular, instead of varying w_ave from 0.1 to 0.4 m/s, I would vary it by "observed" values taken from obs or reanalyses or the literature. Instead of varying N_AP by a factor of 10, vary it by the suitable range given by values in the literature. That would provide a better sense of the practical sensitivity of LWP and IWP to w_ave versus N_AP. Consider doing likewise for the other sensitivity experiments.

Specific comments:

The abstract is well written, but the introductory section could more clearly introduce the main issues that will be addressed in the paper. What is the gap in knowledge, and how will it be addressed in the subsequent sections?

p. 1576: "The liquid part of the cloud extends from about 4250 to 4450 m height at temperatures of about -6 C according to the GDAS reanalysis data for Leipzig."

Some of the discussion relates to the temperature at which various IN are active. Therefore, it is of relevance to know: What are the error bars on the temperature measurement? I wouldn't expect a reanalysis to be terribly accurate.

p. 1577: "For the model studies an Asai–Kasahara type model is used (Asai and Kasahara, 1967). The model geometry is axisymmetric and consists of an inner and

an outer cylinder."

By today's standards, the Asai-Kasahara model is crude. Instead, I recommend using a large-eddy simulation (LES) model. These days, LES are affordable and easy to configure. If not LES, then I recommend trying a prescribed dynamics model like the Kinematic Driver (KiD) model, because it will provide flexibility and control.

p. 1577: "Since during the above mentioned observations no measurements of the IN are available, the parameterization of DeMott et al. (2010) is used assuming that all IN are active in the immersion freezing mode."

The observations needed to address the scientific questions are lacking. Consider focusing your efforts on addressing a question that your instruments are better positioned to answer.

p. 1579: "For case 1, profiles from both methods show a similar general behaviour but the radiosonde profile of Meiningen measured at 00:00 UTC is used since it provides a finer vertical resolution than the GDAS reanal- 15 ysis data. However, for case 2 the Meiningen RS profile misses the humidity layer at the level where the clouds were observed and, therefore, GDAS reanalysis data for Leipzig at 21:00 UTC were chosen."

Apparently, the observations are too inaccurate to initialize the simulations.

p. 1581: "Since no in situ aerosol measurements are available, literature data is used."

The dataset is inadequate for the purpose of studying sensitivity to IN.

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 1573, 2015.

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