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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Tropical tropopause ice clouds: a dynamic approach to the mystery of low crystal numbers" *by* P. Spichtinger and M. Krämer

Anonymous Referee #1

Received and published: 30 December 2012

Review of Spichtinger and Kramer 2012, ACPD "Tropical Tropopause Ice Clouds: A dynamic approach to the mystery of low ice crystal numbers"

This manuscript uses a simple box model of ice nucleation to hypothesize about the distribution of ice crystal numbers. The results of the simulations indicate that the superposition of large scale waves and small scale (gravity waves), the latter shutting off nucleation events, combined with 'classical' homogeneous freezing and heterogeneous ice nucleation, can explain observations of ice crystal numbers.

The paper is generally well written and suitable for publication in ACP subject to minor revisions as noted below. Most generally, I am concerned that the waves are 'tuned' to be 'just right' for the model, putting it in a special situation where variability may cause the desired 'shutdown' behavior. What happens if a larger parameter space is used?

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Also, are there other impacts of either mixing (in the physical sense in an air parcel undergoing turbulence) or sedimentation that might affect the results? What limitations of the model might affect the results?

Some minor clarifications are necessary as noted below, and a slightly more robust treatment of the 'fitting' used to account for the quantitative relative magnitudes is appropriate as well. This is an interesting and useful hypothesis that could be tested in more detailed and/or large scale eulerian models.

Page 28110, L14: Wording here in the abstract is not exactly clear. Please clarify. "mixed" seems awkward.

Page 28110, L24: Cooling what? Surface temperature? Locally in the stratosphere?

Page 28111, L8: Adiabatic cooling from upward vertical velocity...

Page 28112, L24: "Is consistent" ? With what? Awkward phrasing.

Page 28121, L10: Define low frequency here. What period, what amplitude updraught.

Page 28124, L5: What about observations of TTL vertical velocity from aircraft? Can you comment on how the distribution of your vertical velocities match them? Maybe a PDF?

Page 28125, L19: Can you comment on how tuned this makes the cases you are running? If you are not in this 'near saturation' space, then what happens in the model? No nucleation is one case, but in the higher nucleation case does the mechanism of superposition matter? It would be interesting to fill out the phase space a bit with the simulations.

Page 28126, L3: Gravity waves 'lifted' by large scale motions? What does that mean?

Page 28127, L11: What are the resulting ranges of small scale vertical velocity?

Page 28128, L3: Might be useful to show the complete numbers as well (no clipping)

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since this affects the PDF.

Page 28131, L3: This logic is starting to be a bit circular. What does 'mixing' mean? See below. What are you mixing and how?

Page 28131, L11: How did you choose the coefficients? What are you fitting exactly? Individual number concentrations? How is that 'mixed'?

Page 28133, L1: Clarify: very small ice crystal numbers below 0.01 cm-3 due to hetero, moderate due to homogeneous and large due to homo with fast updrafts.

Page 28134, L12: Restate the wavelengths.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 28109, 2012.

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