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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The two faces of cirrus clouds" *by* D. Barahona and A. Nenes

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The study by Barahona and Nenes presents a very interesting view on cirrus cloud formation and development in the the tropical tropopause temperature range. I think that the different pieces of information are known, but this study compiles the possible cirrus states very concisely in a new way.

I'm not an official referee of the paper, but would be pleased if the authors would also consider the points/questions I listed in the following in the order of importance.

1) The simulations shown in Fig. 4 ff are initialized with T = 195K, p = 100 hPa and S = 0. This corresponds to a water vapor mixing ratio of 7.55141 ppmv, which is quite unlikely to find at this temperatures. In Fig.4 of Krämer et al. (2009) frequencies of clear sky RHi are shown as a function of temperature. The most frequent RHi at 195K is around 30-60%, corresponding to 1.5-3 ppmv.

How would your model results be influenced when using the observed lower water vapor mixing ratios as initial values? The freezing temperature will be lower, so maybe more and smaller ice crystals would appear? (By the way, the modelled ice crystal sizes in the dynamical equilibrium are significantly larger than 20 micron, which is the observed mean mass diameter at low temperatures, see Fig.9, Krämer et al., 2009).

Would the Nc observations still be matched by the simulations?

2) Model studies shown in Fig. 1 and Fig. 4ff:

a) The initial temperature in Fig. 1 is T = 185 K, but in Fig. 4ff T = 195 K. I suggest that both temperatures should be the same. Then it could already be seen in Fig. 1 that at 195 K homogeneous freezing can produce ice crystal numbers falling into the range of observations if the vertical velocity is small, because the lower the temperature the higher the ice crystal numbers.

b) How would the results shown in Fig. 4ff would look like at T = 185/190 K? Would the simulated Nc in the 'dynamical range' in Fig. 8 still match the observations?

3) Page 30862: I agree with the points 9) and 10) made by Ben Murray.

4) I missed some discussions of other studies:

a) Page 30859-30860:

'These mechanisms however only act under specific conditions and cannot explain the low Nc and high S coexisting in low temperature cirrus clouds (Peter et al., 2006).'

In Krämer et al. (2009) it is shown that the coexistence of low Nc and high S is not a surprise, since classical microphysics explains that in case of low Nc the supersat-uartion is persistently high because the few ice crystals cannot efficiently deplete the water vapor. Only the low Nc are still under discussion.

b) Page 30860, line 7:

Gensch et al. (2008) performed a combined model-observation case study (superposing small temperature fluctuations to the large scale updraft) showing that heterogeneous freezing may be a candidate to explain the features of cirrus clouds at low temperature.

c) Jensen et al. (2010) suggested ammonium sulfate particles as a potential IN candidate for TTL cirrus that may explain the low Nc.

References:

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Jensen, E. J., L. Pfister, T.-P. Bui, P. Lawson, and D. Baumgardner: Ice nucleation and cloud microphysical properties in tropical tropopause layer cirrus Atmos. Chem. Phys., 10, 1369-1384, 2010

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