

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

**Anonymous Referee #1**

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Observations in the upper troposphere often shows low amount of ice crystals, and high supersaturation values. This is in contradiction with common knowledge of cirrus formation at cold temperatures. Heterogeneous freezing of dust, effloresced ammonium sulfate, glassy aerosols or organics has been suggested to explain the observations. However, the authors of this manuscript shows that the mechanisms put forward cannot likely explain the observations. Instead, they put forward a new theory based on a newly discovered dynamical equilibrium regime between ice production and sedimentation loss.

Their findings are very interesting and of high relevance for the understanding of properties in the upper troposphere. The paper is well written, the work is of high quality and I recommend publication in ACP. I have only a few technical comments and suggestions.

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Abstract, line 10: I suggest changing “..heterogeneous nuclei to occur..” to something like “heterogeneous freezing to occur”, or “heterogeneous ice nucleation”

Page 30861 last line: “..inhibition of heterogeneous freezing and ...” . Should that rather be homogeneous freezing?

Page 30862, first line in the new section: “though” should be “through”

Page 30862, line 21: I suggest adding “and” before “hence depends on their size”

Page 30864, line 20: Water vapor diffusion coefficient is  $D_v'$  in the equation and  $D_v$  in the text. Does the prime indicate that you use the modified diffusion coefficient? If so, this should be indicated in the text.

Page 30865, line 20: I suggest that you add “d” when mentioning Fig. 4 in the parenthesis.

Page 30865, line 21: I believe you missed something on the last line “the assumption that ...?.. does not vary...”

Page 30868, line 14: You also missed something in this sentence: “Since ...?... is determined by random...”

Page 30873, line 1: Is  $u_{\text{term}}$  on the same order as  $D_c$  ( $\sim$ ) or rather proportional to  $D_c$ ?

Page 30874, line 7: Which subfigure are you referring to in Fig5?

Page 30874, line 23: Equation for  $f_{\text{ps}}$  on this page is slightly different from the equation for  $f_{\text{ps}}$  on page 30871. But are they basically the same?

Page 30876. I suggest that you indicate the subfigure when referring to Fig 4 on line 14, Fig 5 on line 21 and Fig 5 on line 28.

Figures Fig. 1: Please indicate the section number for the Methods section.

Fig. 2: I believe you have not defined  $\alpha_d$  anywhere.

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Fig. 3: I do not think Fig. 3c is mentioned in the text.

Fig 7: I suggest labeling  $u$ ,  $H$  and  $T_0$  on the figures instead of in the text. This might make it easier to see what the different conditions are for the simulations.

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 30857, 2010.