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Interactive Comment

Interactive comment on "Ultrathin Tropical Tropopause Clouds (UTTCs): II. Stabilization mechanisms" *by* B. P. Luo et al.

B. P. Luo et al.

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Special comment :

p. 1582, par. 1, and p. 1585, par. 2: Have a look on Fig. 9ąV29 in Pruppacher and Klett (1978). The active fraction of aerosol particles increases strongly with decreasing temperature. In particular for the AgI mentioned by the authors the active fraction increases between -8 and -15Ďa C by 5 orders of magnitude. I think that this dramatic change renders extrapolations from about -10Ďa C to an almost 75 K lower temperature impossible. The other reviewer had also difficulties with this argument. The weak point is less the questionable applicability of the available data to much lower temperatures, but rather whether the assumption holds that the contact angle is independent of temperature. We have added a statement concerning this point. In addition, following a suggestion of the other reviewer we included the reference to new low-temperature experiments.

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Interactive Discussion

Discussion Paper

p. 1587, par 1 The authors present one solution of their single particle model for a certain choice of uplift speed and supersaturation profile. When reading it, my first impression was that there is a need of a delicate balance between the SiceąVprofile and the vairąVprofile, which would be at least as difficult to explain for a wide region as the question how nature would maintain a slight supersaturation over that region. However, playing around with a numerical solution, I found that the details of the profiles are not as important as my first impression suggested. It would be good for the paper if the conditions the profiles must fulfil for a suitable solution would be discussed in more depth. This is a very good point. Indeed, the only condition for UTTC is that Sice is increasing with height and that there is an upwelling motion. We added a paragraph at the end of section 4 highlighting the insensitivity of the stabilization mechanism against changes in the input vertical profiles. Thank you!

p. 1588, last par. In the column model the UTTC is the remnant from an evaporating SVC. The evaporation of the SVC is triggered by a slight warming over 8h. How exact must the warming be in order to produce the UTTC at the observed vertical thickness. What happens, if there is less or more warming? I believe that the resulting UTTC thickness and lifetime is sensitive to the assumed initial warming, although it is stable then against 0.5 K temperature fluctuations. How probable is it that just the right warming appears, and how probable is it that this is the case over ten thousands of square kilometres? Are the fluctuations anyhow in phase or correlated with the oscillations we saw in the single particle model, or is it just white noise? Another good point. The temperature range, where UTTCs may remain upon the evaporation a thicker SVC during a warming event, is defined by the maximum ice saturation above the clouds (the upper limit, say 1.5) and the frost point of the SVC (including ice water content, say 1.1). This Č`Sice = 0.4 corresponds to a temperature range of about 2 K. We would argue that this temperature range is relatively large compared to the ubiquitous gravity waves in the tropics. Even the temperature amplitudes of Kelvin waves might be small enough [Boehm and Verlinde, GRL, 27, 3209, 2000], and such waves offer sufficient horizontal scale to simultaneously affect many 1000s of square kilometres. However, waves on even larger scales might develop amplitudes too high for UTTCs to survive (i.e. they fully evaporate) or might lead to new ice nucleation. We feel that this offers a comfortable range for the generation of UTTCs, though a statistical analysis is beyond this paper. We added this paragraph close to the end of the paper.

p. 1590, end of par.1 Slow uplift and sufficiently humid air are essential conditions for UTTCs anyway, may they be remnants from thicker clouds or formed in situ by suitable IN. We added this sentence as suggested.

p. 1590, last par. In the column model the UTTC vanished by a forced cooling after 25 h. This leads to dehydration. However, this is not the only possibility. A forced warming would probably lead to evaporation of the UTTC without dehydration of this layer. It is not clear which mechanism dominates. We agree. Had there been a warming instead of a cooling the UTTC would evaporate without effect on the gas phase water. We added this clarification to the manuscript.

Figure 4(e) Can you explain the sudden jumps by almost 1 km of the lower saturation level during the UTTC lifetime? The sudden jumps in Sice are caused by the small-scale temperature fluctuations and the fact that the saturation ratio is close to unity in the altitude range of the former thick SVC.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1579, 2003.