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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particle backscatter and relative humidity measured across cirrus clouds and comparison with state-of-the-art cirrus modelling" *by* M. Brabec et al.

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This is a well-constructed piece of work that contributes to our knowledge of cloud-and-water processes in the extra-tropical upper troposphere. The paper consists of a valuable set of simultaneous humidity and cloud backscatter data, which are compared to standard meteorological products (in this case from ECMWF), a special meteorological product of high spatial and temporal resolution (from the COSMO-7 model, provided by MeteoSwiss), and lagrangian cirrus microphysical model products. The COSMO-7 model-data comparison suggests that the model run captures the sub-synoptic situation well, although the cirrus clouds produced by the model do not match the ob-

servations exactly. The lagrangian modelling provides evidence that the interaction of small-scale waves and ice-cloud microphysics goes a long way to explaining the differences between the COSMO-7 output and the observations. The model-data comparison provides no strong evidence that additional, speculative, changes to ice-cloud microphysics – such as changing the water vapour accommodation coefficient on ice – are required. I recommend that the manuscript is published subject to adequate responses to the points below.

Major points

1. I don't see any reference to previous balloon-borne studies. The authors should put their work into the context of previous studies such as those of DiDonFrancesco et al. (2006) and the HIBISCUS campaign in general.

2. In section 2 there should be some discussion of instrument response times and of how the data from the two instruments were merged. This is needed to bat away any misgivings a reader may have on looking at Figure 1 that the "offset" between humidity and cloud backscatter is an instrumental - or data analysis – artefact.

3. The discussion in section 2.5 (p9560) needs a little refinement. Whilst it is true to say that pure lagrangian depositional growth in radius-space has no numerical diffusion, the cirrus scheme as a whole does have numerical diffusion, because of the treatment of sedimentation. When describing the re-allocation of ice to pre-existing bins, it should be made clear whether mass or number is preserved. On p9561 it was not clear to me why mixed-phase cloud processes were discussed, since they do not seem to be relevant for the paper. If the ZOMM model simulates transport of water substance through mixed-phase clouds I would expect it to handle coagulation (and splitting), which it appears not to (p9559, line 19).

4. The ms discusses sensitivity to small-scale-wave frequencies, but not to the chosen amplitude (1K) nor to the choice of ice aspect ratio or nucleation mechanism. There should be some discussion of why the modelling sensitivity study did not vary these

parameters.

Minor points

Please remove all references to state-of-the-art: it begs many more questions than it answers and is not needed.

P9555, line 16. Please say why it is important to use a different platform (balloon vs aircraft), and pick this point up again in your Conclusions.

P9556, line 6. Does the version of the ECMWF analysis data used include ice supersaturation (Tompkins et al., 2007)?

P9557, line 12: please replace “red” with “infrared” for consistency with previous discussion.

P9566, line 14: add “half as geometrically thick” presumably?

P9567, line 6. You might consider citing some of the literature on mass accommodation coefficients here (without opening the whole can of worms). I might be so bold as to suggest that the study by MacKenzie and Haynes (1992) provides a theoretical basis for the variation of “accommodation coefficient” when this parameter encapsulates surface kinetic effects as well as true mass accommodation.

References

Di Donfrancesco, G., et al., Balloonborne lidar for cloud physics studies. Applied Optics, 2006. 45(22): p. 5701-5708.

MacKenzie, A.R., and P.H. Haynes, The influence of surface kinetics on the growth of stratospheric ice crystals, J. Geophys. Res., 97, 8057-8064, 1992

Tompkins, A.M., K. Gierens, G. Rädel, 2007: Ice supersaturation in the ECMWF Integrated Forecast System

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