Atmos. Chem. Phys. Discuss., 3, S419–S420, 2003
www.atmos-chem-phys.org/acpd/3/S419/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "The roles of dynamical variability and aerosols in cirrus cloud formation" *by* B. Kärcher and J. Ström

Anonymous Referee #1

Received and published: 21 April 2003

This paper provides a very interesting and innovative analysis of ice number densities in upper tropospheric cirrus. The analysis shows a remarkable agreement between probability distributions of measured ice number densities and probability distributions generated from parcel model simulations driven by measured vertical wind frequency distributions. This agreement is particularly surprising for the following reason: The parcel model predicts the ice crystal number density at the location where nucleation occurs and just after nucleation shuts off. This represents the peak ice crystal number density in the lifecycle of each cloud. In the typical lifecycle of a cirrus cloud, the ice crystal number densities should decrease substantially as the cloud matures due to dispersion, size sorting, sublimation, etc. Numerous examples of measurements through the vertical depths of cirrus show that ice number densities decrease by orders of magnitude from their peak values near cloud top to the lowest values near

cloud base. Presumably, the INCA measurements were not exclusively made in ice nucleation zones. Hence, one would expect the INCA CVI measurement ice number density frequency distribution to be shifted toward lower values compared to the model results.

This paper should at least discuss this issue. If the authors believe there is some reason why one might expect the parcel model results and measurements to agree in spite of the above issue, they should include their reasoning. If not, they should acknowledge that the agreement is somewhat of a mystery.

An interesting follow-up study would involve modeling a large number of cirrus events through the full lifecycle of each cloud. Then statistics of the ice number densities could be compared to in situ or remote sensing observations. Assuming the observations randomly sample all parts and stages of the cirrus clouds, this comparison should be more relevant than that shown for the parcel simulations in this paper. I expect that such a comparison may reveal that ice nucleation preferentially occurs in regions with rapid cooling.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 1415, 2003.