Atmos. Chem. Phys. Discuss., 15, C12061–C12062, 2016
www.atmos-chem-phys-discuss.net/15/C12061/2016/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "What controls the low ice number concentration in the upper troposphere?" *by* C. Zhou et al.

Anonymous Referee #1

Received and published: 28 January 2016

Addendum to the review:

Regarding the last paragraph under General Comments, in reference to the work of Diao et al., it might be argued that this comment pertains best to heterogeneous ice nucleation (het). In the Lagrangian context of a rising air parcel, since the ice phase will first manifest through het, and if homogeneous freezing (hom) occurs it will happen after het, then it follows that pre-existing ice is present when hom occurs but is generally not present when het occurs for the cirrus sampled in the Diao et al. papers. The ice nucleation phase (phase 2) in the GRL Diao et al. papers shows the highest RHi values (on average) for the ice-containing phases, indicative of ice nucleation. However, Ni is often higher in phase 3 (early crystal growth stage), suggesting nucleation continues at lower RHi values. This seems counter-intuitive, making the Diao et al. measurements

more difficult to interpret.

Another point regarding Zhou et al. is that the time-step in CAM5 is 30 minutes. When the cirrus cloud updraft w is derived from TKE spectra, it appears that a significant percentage of the cirrus will have sufficiently high w to enable both het and hom to occur in a single time-step. In these cases pre-existing ice for either het or hom makes little sense for the cirrus cloud types sampled by Diao et al.

The cirrus cloud modeling work of Spichtinger and Gierens (2009, ACP, Part 2) appears consistent with the observed phases of cirrus evolution in Diao et al. (2013, GRL, p. 3477). The authors might refer to this detailed modeling work, noting that most of the ice supersaturated regions were consumed by ice diffusional growth within 30 minutes, with ice nucleation occurring on much shorter timescales. The question is how often do both het and hom occur in a single CAM5 time-step, and how realistic is the treatment of pre-existing ice in the updated CAM5?

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 35907, 2015.