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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observations and comparisons of cloud microphysical properties in spring and summertime Arctic stratocumulus during the ACCACIA campaign" *by* G. Lloyd et al.

Anonymous Referee #2

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This paper reports on some interesting microphysical observations from a set of flights during spring and summer through arctic stratocumulus near Svalbard. The authors point out that few in-situ measurements of ice and aerosol have been made in arctic stratocumulus and this is still largely true. However, the measurements that have been made over the years are tending to converge (see Morrison et al., 2011, Nature Geoscience). The authors note substantial seasonal differences in the microphysical, and glaciation, of mixed-phase arctic clouds. The observed summertime clouds appear to be more heterogeneous with pockets of ice formed apparently by rime splintering. Spring-time clouds generally had lower ice concentrations than summer. Comparisons

of the observed ice concentrations with predictions using the Demott et al. (2010, PNAS) were also discussed in the paper. I found the paper easy to read and the observations are quite interesting.

While I generally find the paper to be a useful contribution to the literature on the measured microphysical properties of arctic mixed-phase stratocumulus, I also think that the paper is missing some elements, I list them below.

(1) I think the paper needs a section that provides some meteorological context for the cloud cases and the observations. Since the larger scale synoptic flow can set the stage for a given microphysical response of the cloud system to aerosol/IN, providing an overview of the general flow along with the vertical thermal and moisture structure would be very helpful.

(2) The authors do a very nice job of comparing their results to results from an Antarctic study. I think the paper would be enriched if the authors could cast their results in the context of the other papers published on ice concentrations/IN in arctic clouds. For instance, Rangno and Hobbs published a paper in 2001 (J. Geophys. Res., pg 15,065) in which they also discuss the importance of rime-splintering for high ice concentrations in arctic mixed-phase stratocumulus. In addition to pointing out that there is no clear temperature dependence to ice concentrations in arctic clouds, Rangno and Hobbs also indicated that a possible threshold droplet size exists that relates to maximum ice concentration. Do your observations show similar results? Other articles have discussed ice concentrations and the vertical thermal structure of the atmosphere (Curry et al., 1997, JGR; Pinto, 1998, JAS; Rogers et al., 2001; JGR; Prenni et al., 2007; etc.); results from these papers may help place your results into a broader context.

(3) As I understand it, the IN parameterization of Demott provides an estimate of the local (in space) ice concentration based on temperature and the number of aerosol beyond a certain size. However, the ice concentration measured in clouds is a consequence of not only local ice nucleation processes, but also of convergence and diver-

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gence due to vertical sedimentation and advection. Since not all ice particles grow at the same rate, one might imagine larger ice particles, for example, sedimenting away from a nucleation zone and therefore leading to a lower measured ice concentration. I wonder if these sorts of effects are important or if they are negligible.

(4) In Demott's paper, the observed data are quite scattered about the 1:1 line in comparison to the parameterization. For your observed cases, does the scatter in the points shown in Fig.3b cover the range of your observed ice concentrations? For instance, your case 1c produces IN concentrations of 1.24 or 2.05 but the scatter in Demott's Fig. 3b indicate that observed IN concentrations at these predicted values can be up to 10 per liter or as low as a few tenths per liter. I'm primarily curious about this because if the ice concentrations sit within the range of scatter Demott shows, it might provide a small amount of evidence that IN could have been responsible for the ice. (Whereas in your rime-splintering observations, this is clearly not the case.)

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 28757, 2014.