Impacts of immersion freezing schemes on Arctic mixed-phase clouds simulated with a habit prediction scheme

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Long-lasting mixed-phase clouds in high latitudes are often observed to initiate with liquid particles before ice particles are formed (de Boer et al. 2011). This suggests the ice nucleation process dominant in the clouds involve cloud droplets and/or water saturation. Development of the mixed-phase clouds is sensitive to ice crystal number simulated in models (e.g., Morrison et al. 2011, Young et al. 2017). In this study, two different schemes for immersion freezing mode are contrasted for cases observed during SHEBA and ISDAC campaigns, and impacts on habits and particle size distributions are discussed.

A cloud microphysics scheme called SHIPS (Hashino and Tripoli 2007, 2008, 2011ab) has been installed in a non-hydrostatic model, UW-NMS (Tripoli and Smith 2014ab) for 3D LES experiments. Bigg-type volume-dependent immersion freezing parameterization (Bigg), classical nucleation theory based scheme (CNT) are tested by starting simulation from supercooled liquid layers. Cloud top temperature observed during the SHEBA May 7th case is around -20C with low cloud top height (~400m). The freezing rate simulated CNT shows dependency on supersaturation fields and small frozen particles are formed in updraft region. On the other hand, Bigg cases show freezing of larger particles with more occurring in downdraft. In turn, this larger initial size of frozen particles in Bigg lead to smaller sizes of plates than CNT. The ISDAC April 8th case has cloud top temperature of around -15C and higher cloud top (~1000m), and the observation indicates active aggregation of dendritic crystals. In the presentation, we plan to discuss any impacts on the aggregation process as well.

Keywords: Arctic clouds, Ice nucleation, LES

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