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Retrieving riming in arctic mixed phase clouds from collocated remote sensing and in situ aircraft measurements during ACLOUD

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Ice crystal formation and growth processes in mixed-phase clouds (MPCs) are not sufficiently understood. This leads to uncertainties of atmospheric models in representing MPCs. This presentation is centered around riming, which occurs when liquid water droplets freeze onto ice crystals. While it is challenging to observe riming directly, we retrieve a proxy for riming from airborne radar measurements using data collected during the (AC)3 aircraft campaign ACLOUD performed in 2017. For this campaign, two closely collocated aircraft were flying in formation for obtaining collocated in situ and remote sensing observations. We aim to quantify the normalized riming fraction □□ by matching measured to simulated radar reflectivities □□□□ . For the latter we use the Passive and Active Microwave radiative TRAnsfer tool (PAMTRA) to calculate □□□□ from the in situ observed particle size distributions. Liquid droplets are assumed to be spheres and Mie scattering is applied, while we use the self-similar Rayleigh Gans approximation (SSRGA) for ice crystals. We present an Optimal Estimation algorithm to obtain ice crystal mass size - as well as SSRGA parameters from measured □□□□ and in situ parameters. We exploit the fact that mass size and SSRGA parameters depend on □□. We evaluate including empirical relationships derived via model calculations done by an aggregation and riming model as forward operators in the algorithm. Also we use the model calculations directly to restrict the prior information. We validate the obtained □□ values by looking at in situ ice crystal images for selected time periods. We compare our findings to macrophysical cloud properties and meteorological conditions to understand external drivers and variability of riming. This will lead to a better understanding of riming as a key process occurring in arctic MPCs.