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Modeling the relative contributions of secondary ice formation processes to ice crystal number concentrations within mixed-phase clouds

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Measurements of in-cloud ice crystal number concentrations can be three or four orders of magnitude greater than the in-cloud ice nuclei number concentrations. This discrepancy can be explained by various secondary ice formation processes, which occur after initial ice nucleation, but the relative importance of these processes, and even the exact physics of each, is still unclear. A simple bin microphysics model (2IM) is constructed to investigate these knowledge gaps. 2IM extends the time-lag collision parameterization of Yano and Phillips, 2011 to include rime splintering, ice-ice aggregation, and droplet shattering and to incorporate the aspect ratio evolution as in Jensen and Harrington, 2015. The relative contribution of the secondary processes under various conditions are shown. In particular, temperature-dependent efficiencies are adjusted for ice-ice aggregation versus collision around -15°C, when rime splintering is no longer active, and the effect of aspect ratio on the process weighting is explored. The resulting simulations are intended to guide secondary ice formation parameterizations in larger-scale mixed-phase cloud schemes.