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Secondary ice production in NorESM2 climate model: quantifying the impact on Arctic clouds

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Arctic clouds are among the largest sources of uncertainty in predictions of Arctic weather and climate. This is mainly due to errors in the representation of the cloud thermodynamic phase and the associated radiative impacts, which largely depends on the parameterization of cloud microphysical processes. Secondary ice processes (SIP) are among the microphysical processes that are poorly represented, or completely absent, in climate models. In most models, including the Norwegian Earth System Model -version 2 (NorESM2), Hallet-Mossop (H-M) is the only SIP mechanism available. In this study we further improve the description of H-M and include two additional SIP mechanisms (collisional break-up and drop-shattering) in NorESM2. Our results indicate that these additions improve the agreement between observed and modeled ice crystal number concentrations and liquid water path in mixed-phase clouds observed at Ny-Alesund in 2016-2017. We then conclude by quantifying the impact of these overlooked SIP mechanisms for cloud microphysical characteristics, properties and the radiative balance throughout the Arctic.