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Secondary Ice Production in Antarctic Clouds: a process neglected in large-scale models

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In-situ measurements of Antarctic clouds frequently show that ice crystal number concentrations are much higher than the available ice-nucleating particles, suggesting that Secondary Ice Production (SIP) may be active. Here we investigate the impact of two SIP mechanisms, Hallett-Mossop (H-M)and collisional break-up (BR), on a case from the Microphysics of Antarctic Clouds (MAC) campaign in Weddell Sea using the Weather and Research Forecasting (WRF) model. H-M is already included in the default version of the Morrison microphysics scheme in WRF; for BR we implement different parameterizations and compare their performance. H-M alone is not effective enough to reproduce the observed concentrations. In contrast, BR can result in realistic ice multiplication, independently of whether H-M is active or not. In particular, the Phillips parameterization results in very good agreement with observations, but its performance depends on the prescribed rimed fraction of the colliding ice particles. Finally, our results show low sensitivity to primary ice nucleation, as long as there are enough primary ice crystals to initiate ice-ice collisions. Our findings suggest that BR is a potentially important SIP mechanism in the pristine Antarctic atmosphere that is currently not represented in weather-prediction and climate models.