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Laboratory experiments on secondary ice production upon free falling drizzle droplets observed by high speed video and thermal imaging

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During the freezing of supercooled drizzle droplets, the ice shell forms at the droplet surface and propagates inwards, causing a pressure rise in the droplet core. If the pressure exceeds the mechanical stability of the ice shell, the shell can crack open and eject secondary ice particles or cause the full disintegration of the ice shell leading to droplet shattering. Recent in-cloud observations and modeling studies have suggested the importance of secondary ice production upon shattering of freezing drizzle droplets. The details of this process are poorly understood and the number of secondary ice particles produced during freezing remains to be quantified.

Here we present insight into experiments with freezing drizzle droplets levitated in electrodynamic balance under controlled conditions with respect to temperature, humidity and airflow velocity. Individual droplets are exposed to a flow of cold air from below, simulating free fall conditions. The freezing process is observed with high-speed video microscopy and a high-resolution infrared thermal measuring system. We show the observed frequencies for various events associated with the production of secondary ice particles during freezing for pure water droplets and aqueous solution of analogue sea salt droplets (300 µm in diameter) and report a strong enhancement of the shattering probability as compared to our previous study (Lauber et al., 2018) conducted in stagnant air. Analysis of pressure release events recorded by high-resolution infrared thermography suggest that pressure release events associated with the possible ejection of secondary ice particles occur far more frequent than previously quantified with observations by high speed video microscopy only.

Lauber, A., A. Kiselev, T. Pander, P. Handmann, and T Leisner (2018). “Secondary Ice Formation during Freezing of Levitated Droplets”, Journal of the Atmospheric Sciences 75, pp. 2815–2826.