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Secondary Ice Production by drizzle droplets freezing in free fall

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The excess concentration of ice crystals as compared to the concentration of ice nuclei in cumuli has been one of the longest debated issues in cloud physics. Several ice multiplication mechanisms have been proposed to explain this discrepancy, with the Hallett-Mossop mechanism being the most well-known of them. Recent in-cloud observations have underlined the importance of secondary ice production upon shattering of freezing drizzle droplets. In this presentation, we report the recent results of the experimental study aimed to clarify the physics of this mechanism and to investigate its dependence on the environmental parameters. Applying the experimental technique developed in the previous study (Lauber et al., 2018), we levitate supercooled water droplets in an electrodynamic balance and observe the freezing process with a high-speed video camera. However, in the new setup the droplets are exposed to a pre-cooled humidified gas flow mimicking the free fall at terminal velocity. Surprisingly, we observe a strong enhancement of shattering probability as compared to the previous studies conducted under stagnant conditions. The high-definition video records of shattering events reveal the coupling between various microphysical processes caused by ice propagation inside the freezing drop. Additionally, we show that the shattering probability at freezing correlates with the thermal non-equilibrium of s supercooled droplet shortly before freezing. Finally, we discuss the physical mechanism behind the shattering of drizzle droplets and its implication for cloud glaciation rate.

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.