EGU21-11327
https://doi.org/10.5194/egusphere-egu21-11327
EGU General Assembly 2021

Secondary Ice Production – development of a new experimental set-up

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Mixed-phase clouds are essential elements in Earth's weather and climate system. Aircraft measurements of mixed-phase clouds demonstrated a strong discrepancy between the observed ice particle and ice nucleating particle number concentration of one to four orders of magnitude [1-4]. Different secondary ice production (SIP) mechanisms have been hypothesized which can increase the total ice particle number concentration by multiplication of primary ice particles and hence might explain the observed discrepancy [5-7].

In a joint project of KIT and Tropos, we focus on the investigation two SIP processes: shattering of large freezing droplets (KIT) and SIP as a result of droplet-ice collisions (Tropos), commonly known as Hallett-Mossop [9] or rime-splintering process. Thereby, we aim at a quantitative understanding of the SIP underlying physical mechanisms, utilizing a newly developed experimental set-up (Ice Droplets splintEring on FreezIng eXperiment, IDEFIX).

IDEFIX is based on a modular concept and consists of three modules, i.e., the SIP chamber, the growth section, and the ice particle detector. We developed two different versions of the SIP chamber: in the KIT-SIP chamber a freezing drizzle droplet is levitated in electrodynamic balance; and in the TROPOS-SIP chamber quasi-monodisperse droplets collide with an ice particle which is fixed on thin carbon fibers. IDEFIX is designed to match realistic fall or impact velocities and collision rates of the droplets with the ice particle. The SIP process will be observed with high-speed video microscopy and an infrared measuring system. In the growth section, which features supersaturated conditions with respect to ice, the presumably small secondarily produced ice particles will be grown to detectable sizes. Finally, to count the number of secondarily produced ice particles either an optical particle spectrometer will be used for distinguishing between droplets and ice particles, or the ice particles will be impacted on a metastable sugar solution. Currently, we characterize velocity, temperature and humidity fields of the TROPOS-collision chamber and determine droplet-ice particle collision rates.