



## **Is heterogeneous ice nucleation terminology going to be revised? A comparison of immersion and condensation freezing using ZINC**

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Cloud formation and precipitation in the atmosphere are predominantly coupled to ice nucleation processes. Immersion freezing, an ice nucleation mechanism in which an ice nucleating particle (INP) that is fully immersed in a cloud droplet freezes, is amongst the most important heterogeneous freezing mechanisms in mixed-phase clouds. Condensation freezing, another ice nucleation mechanism can also occur when supercooled water condenses and freezes on an INP. As both processes only differ by the temperature ( $T$ ) at which water condensation takes place, the measured ice nucleation efficiency could be similar for  $(T) > 235$  K. In this context, heterogeneous freezing experiments of Illite NX ( $D_p = 200$ ) are conducted with the Zurich Ice Nucleation Chamber (ZINC), a continuous flow diffusion chamber. Ice nucleation efficiencies of condensation freezing experiments at a relative humidity with respect to water ( $RH_w$ ) ranging between 100% and 130% for  $T > 235$  K are compared to the ones of immersion freezing at  $RH_w \sim 100\%$  for  $230$  K  $< T < 250$  K. For immersion freezing, ZINC is extended by an immersion mode cooling chamber (IMCA) in which dry particles are activated as cloud condensation nuclei prior to the cooling process in ZINC. Ice crystals and water droplets are detected in the lower part of IMCA-ZINC by the in-situ ice optical depolarization detector (IODE), enabling the determination of the frozen fraction (FF), in addition to an optical particle counter (OPC, Lighthouse Inc.) downstream of ZINC. The OPC, measuring ice and droplet residues, allowed for the determination of an activated fraction (AF) in immersion as well as condensation freezing mode. For  $T < 242$  K, the AF of immersion freezing and condensation freezing differed by at least one order of magnitude for  $D_p = 200$  nm. The immersion freezing experiments showed a higher efficiency compared the condensation freezing which implies either a different underlying mechanism for the nucleation of ice or instrument limitations. The differences in ice nucleation observed between the condensation and immersion freezing experiments will be presented in this work.