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Probing secondary ice formation at around -15 °C in mixed-phase clouds

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In-situ observations are necessary to improve the fundamental understanding and model parametrizations of ice formation in mixed-phase clouds, also at temperatures colder than those where the Hallett-Mossop process plays an important role (i.e. < -8 °C). Planar, branched snow crystals (e.g. dendrites) grow through vapour deposition within a relatively narrow temperature window (-12 °C to -17 °C). Their growth starts from an insoluble ice nucleating particle (INP) or from an ice crystal resulting from a secondary process. A dendrite can be probed individually in a drop freezing assay for the presence of an INP that could have triggered its formation. During February and March of 2018, we analysed 190 individual dendritic snow crystals at Jungfraujoch (3580 m a.s.l.). One in eight of them were found to contain an INP active at -17 °C or warmer. Assuming the temperature at which an initial crystal forms is not much different from its growth temperature, we estimated that one in eight of the dendrites were formed via primary ice nucleation, and the remainder were of secondary origin. Since we have randomly sampled crystals from many different clouds over a period of 10 days of precipitation, the multiplication factor (8) we found is an average for dendrites in mixed-phase clouds at Jungfraujoch in February and March 2018. During the 'Davos2019' field campaign in February and March 2019, we will quantify the ice enhancement factor likewise at Weissfluhjoch (2693 m a.s.l. and about 140 km east of Jungfraujoch). We will present ice enhancement factors obtained from both locations and discuss which mechanisms may be responsible for the observed secondary ice formation.