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A laboratory and model investigation of secondary ice production during to supercooled drop collisions with ice surfaces

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This work presents new laboratory data investigating collisions between supercooled drops and ice particles as a source of secondary ice particles in natural clouds. Furthermore we present numerical model simulations to put the laboratory measurements into context.

Secondary ice particles form during the breakup of freezing drops due to so-called “spherical freezing” (or Mode 1), where an ice shell forms around the freezing drop. This process has been studied and observed for drops in free-fall in laboratory experiments since the 1960s, and also more recently by Lauber et al. (2018) with a high-speed camera. Aircraft field measurements (Lawson et al. 2015) and lab data (Kolomeychuk et al. 1975) suggest that such a process is dependent on the size of drops, with larger drops being more effective at producing secondary ice. Collision induced break-up of rain drops has been well studied with pioneering investigations in the mid-1980s, and numerous modelling studies showing that it is responsible for observed trimodal rain drop size distributions in the atmosphere, which can be well approximated by an exponential distribution.

In mixed-phase clouds we know that rain-drops can collide with more massive ice particles. This, depending on the type of collision, may lead to the break-up of the supercooled drop (e.g. as hinted by Latham and Warwicker, 1980), potentially stimulating secondary ice formation (Phillips et al. 2018 - non-spherical, Mode 2). There is a dearth of laboratory data investigating this mechanism. This mechanism is the focus of the presentation.

Here we present the results of recent experiments where we make use of the University of Manchester (UoM) cold room facility. The UoM cold room facility consists of 3 stacked cold rooms that can be cooled to temperatures below -55 degC. A new facility has been built to study secondary ice production via Mode 2 fragmentation. We generate supercooled drops at the top of the cold rooms and allow them to interact with different ice surfaces near the bottom. This interaction is filmed with a new camera setup.

Our latest results will be presented at the conference.

References

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