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Dynamics of ice drop explosions in supercooled clouds DETLEF LOHSE, SANDER WILDEMAN, SEBASTIAN STERL, CHAO SUN, University of Twente — The rate at which ice particles are produced in the cold top of natural clouds is crucial in predicting whether a cloud will finally develop precipitation. It has been speculated that ice particles could multiply through freezing and subsequent bursting of supercooled cloud droplets. Here we present high-speed footage of cracking and explosive bursting of spherical water droplets that freeze radially inwards under carefully controlled conditions. We model the processes of freezing, the stress build up in the ice shell, and the fast dynamics following the crack formation. This allows us to predict the time it takes for a freezing droplet to explode and the energy released in this event as a function of the size of the droplet and the temperature of the surroundings. Both predictions are in good agreement with our experiments. The models also predict a minimum droplet radius of approximately $50\mu m$ below which ice explosions are unlikely to occur. This finding has direct consequences in the modeling of cloud microphysics, as the droplet sizes in clouds generally fall in this critical range. Furthermore, we identify several mechanisms, besides the final explosion, by which a freezing drop can shed ice particles. This is important for the formation of ice nucleation avalanches.

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