Glaciation of convective clouds

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Abstract:

This talk will address the following questions:
1. What is glaciation?
2. What makes glaciation (in a convective cloud)?
3. Can we observe signatures of glaciation processes in satellite observations?

On an individual particle level, glaciation – i.e. the conversion of liquid water to ice – can occur via various microphysical processes, including homogeneous and heterogeneous freezing, riming, and evaporation and deposition. On the scale of a cloud, the last process, also termed Wegener-Bergeron-Findeisen process, is nearly always dominating the mass transfer of liquid to ice. We show that a threshold ice number concentration exists for the onset of the Wegener-Bergeron-Findeisen process, with values of 100/L or higher depending on the vertical velocity. Heterogeneous or homogeneous freezing or secondary ice production all can contribute to reaching this threshold. We show in model simulations that they leave signatures in the phase distribution not only within the cloud, but also at the cloud top, i.e. the region that is observable by satellite. Finally, the analysis of convective clouds that are tracked in geostationary satellite data gives results which are consistent with the model experiments: the observed glaciation temperature correlates with the dust concentration (a proxy for heterogeneous ice nucleation) and with droplet size (potentially relevant for secondary ice processes). In summary, this combined model and observational study suggests that some ice microphysical processes are relevant for macrophysical properties at the cloud scale, with implications e.g. for radiative effects and cloud lifetime.