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The importance of ice nucleation for climate sensitivity in radiative-convective equilibrium

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Large uncertainties persist with respect to the role of microphysical and other small-scale processes in high clouds and their interactions with circulation and convective processes. Moreover, the uncertainty in tropical high cloud feedback is the dominant contributor to the total cloud feedback uncertainty and is believed to be connected to the description of microphysics. A large part of changes in anvil cloud properties is due to changes in ice crystal number and their size, which in turn depend on the background amount of cloud droplet number and ice nucleating particles and the description of ice nucleation.

In this work, we use idealized radiative-convective-equilibrium and tropical limited area experiments with SAM and ICON-NWP models to explore the effect of the number of ice nucleating particles and the number of cloud droplet number concentration on the cloud feedback and climate sensitivity. Moreover, we show that cloud radiative properties are strongly dependent on ice crystal number and size, which can be adequately represented only by two-moment microphysical schemes with an interactive simulation of both hydrometeor mass and number.