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From ice crystals to climate: clearing high clouds of uncertainty

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The net radiative effects of tropical clouds are determined by the evolution of thick, freshly detrained anvil clouds that cool the climate into thin anvil clouds that warm the climate. To determine the role of these clouds in climate change it is important to understand how their microphysical and macrophysical properties control their radiative properties. We use cloud resolving model simulations to study the small-scale processes that drive anvil evolution and determine a delicate balance between thick and thin anvil clouds. Tiny differences in how ice crystals form, grow, shrink, or interact with solar or terrestrial radiation can lead to large differences in the climatic role of anvils. In this talk, we highlight the large impact of the interaction between radiation and ice crystal nucleation on the climatic properties of anvils. Such processes are currently not well represented in models used for climate projections. Therefore it is also not surprising that the uncertainty in tropical anvil cloud feedback is the dominant contributor to the total cloud feedback uncertainty. In addition, we show evidence that the high cloud feedback depends on the description of ice nucleation and the environmental amount of ice nucleating particles and cloud droplet number concentration.