Geophysical Research Abstracts
Vol. 21, EGU2019-6056, 2019
EGU General Assembly 2019

The Life Cycle and Net Radiative Effect of Tropical Anvil Clouds

Blaž Gasparini, Dennis Hartmann, and Peter Blossey
University of Washington Seattle, Department of Atmospheric Sciences, Seattle, United States (blazg@uw.edu)

The tropical cloud radiative effects are largely determined by the fraction of thin anvil cirrus, which lead to positive cloud radiative effects, and thick anvil cirrus, which lead to negative cloud radiative effects. Interestingly, the two roughly counteract each other, yielding a near neutral net cloud radiative effect. We explore the importance of the life cycle of detrained anvil clouds in producing this near neutral net cloud radiative effect using the System for Atmospheric Modeling (SAM) cloud resolving model with a range modeling setups: a 2-dimensional anvil cloud covered domain, simulations of isolated convection, 3-dimensional simulations of radiative-convective equilibrium.

Suppressing the radiative effects of clouds within atmosphere reveals that cloud radiative heating and in-cloud convection are fundamental in driving net radiative neutrality. In-cloud convection acts to thin initially thick anvil clouds and loft and maintain thin cirrus, increasing the coverage of thin anvil clouds. The maintenance of anvil clouds is tied to the recycling of water vapor and cloud ice through sublimation, ice nucleation and deposition as air parcels circulate vertically within the cloud layer. In addition, radiatively driven turbulence enhances the outflow circulation leading to a larger spread of thin anvil clouds. The formulation of microphysical processes in the model can substantially change the magnitude of the impact of radiative heating on the simulated cloud evolution. In radiative-convective equilibrium simulations the spreading and thinning effects are partially compensated by a general decrease in anvil clouds due to upper tropospheric warming.

The radiatively driven thinning of anvil is robust across model setups of various complexity and various microphysical schemes, however, indicating the importance of small-scale processes for the determination of net cloud radiative effects in the Tropics.