Geophysical Research Abstracts
Vol. 14, EGU2012-6449, 2012
EGU General Assembly 2012

Large-scale thermodynamic and dynamic controls on aerosol-induced invigoration of tropical deep convection

H. Morrison and W. W. Grabowski
National Center for Atmospheric Research, Boulder, United States (morrison@ucar.edu)

Several modeling studies have supported the idea of convective invigoration in polluted conditions resulting from a delay in warm rain formation and release of additional latent heat through enhancement of freezing. However, this process-level viewpoint neglects feedbacks between convection and its environment, which may obscure the effects of cloud microphysics. To investigate such interactions, we performed multi-day large-member ensemble cloud-resolving simulations with increased latent heating in updrafts above the freezing level, mimicking the effect of enhanced ice processes in polluted conditions. Increased latent heating produces an initial invigoration, but convection returns to its unperturbed characteristics over a timescale of several hours because of accompanying changes in mean stability. Factors controlling the adjustment timescale will be discussed.

The significant difference in temperature profiles in simulations with and without latent heating perturbations (of order 1 K) suggests that strong mesoscale circulations may develop between perturbed and unperturbed regions. To investigate this aspect, simulations were performed with heating perturbations applied in updrafts, but only to a portion of the domain. In these simulations, larger-scale circulations driven by differences in mean radiative and latent heating between the perturbed and unperturbed regions help to sustain weak convective invigoration in the perturbed region. Overall, these results suggest that convective invigoration from aerosol-induced enhancement of freezing and latent heating may occur but is limited primarily to the impacts on larger-scale heating gradients and circulations. This presents a much different picture compared to previous studies in which only convective-scale buoyancy effects were considered.