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Responses of Deep Convection to Global Warming

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Convection plays a major role in atmospheric dynamics, thermodynamics, and chemical transport. Changes in convection under projected global warming are important aspects of climate change. This presentation will examine changes in convective mass fluxes, precipitation, and chemical transport for a mid-range climate-change scenario from IPCC AR4.

Expected behaviors, such as deeper convection with global warming and associated, increased tracer concentrations at the highest detrainment levels, will be described quantitatively. The dependence of the response of deep convection to the formulation of the cumulus parameterization in general circulation models will be examined by comparing two different parameterizations in GFDL AM2. The dependence of the response of deep convection to a wider range of model formulations will be examined by comparing GFDL AM2 and AM3, which differ not only in cumulus parameterization but also dynamical core and cloud-aerosol interactions.

The convective mass fluxes in both current and warmed climates vary widely among the three models. The response of convective mass fluxes to global warming also differs, with smaller responses in AM2 than AM3, and smaller responses for AM2 using a cumulus parameterization that does not allow cumulus towers to overshoot their level of zero buoyancy and uses a closure based on cloud work function instead of convective available potential energy.