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Understanding the responses of deep convective clouds to changing thermodynamic environments

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Clouds cover a significant part of the globe and have profound impact on the Earth's radiative budget because of their interaction with the propagation of radiation through scattering, absorption and emission processes. Clouds also play an important role in regulating the hydrological cycle through the transport of heat and moisture, which leads to precipitation that is essential in maintaining the biosphere. Berg et al. (2013) reported that convective precipitation is sensitive to temperature change. It is also expected that cloud processes and their radiative effects may change with global warming (Ceppi and Hartmann, 2015). However, cloud responses remain a significant contributor to uncertainties in the climate sensitivity of global warming simulations (Soden and Held, 2006) due to the complex interactions between clouds and other atmospheric processes.

Clouds are sensitive to changes in thermodynamic structure of the atmosphere and large-scale circulation (Bony et al. (2004). Past studies have looked at the effects of dynamical variability and external perturbations (e.g. aerosol loading and temperature) on cloud and radiation (e.g. Fan et al., 2008; Sherwood et al., 2015). Other studies also looked at the microphysical scale of cloud evolution as computing power improved (Morrison, 2010). However, there is a lack of knowledge about the thermodynamic effects on clouds, especially on convection. Therefore, it is important to understand how changes in the thermodynamic structure predicted from global warming simulations affect the formation and growth of clouds, with a particular focus on the microphysical processes during the cloud evolution and associated cloud radiative properties.

Results will be presented from WRF simulations of deep convective clouds that were run based on past and future thermodynamic profiles derived from climate model simulations (CCSM3). Simulations were performed for a range of locations in the USA and cloud and radiative property changes were evaluated to indicate the effects of modelled thermodynamic climate changes.