Separating dynamic and thermodynamic impacts of climate change on daytime convective development over land

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This presentation will discuss results from cloud-resolving simulations applying piggybacking methodology to separate dynamical and thermodynamical impacts of climate change on convection developing during daytime over summertime continents. Dynamical impacts include an increase of convective updraft strength due to an increase of CAPE in a warmer climate. Thermodynamical impacts concern an increase of cloudiness and surface precipitation resulting from the increase of water vapor that the warmer atmosphere can hold and convection can work with. The main idea behind the piggybacking method is to use two sets of thermodynamic variables (the potential temperature, water vapor mixing ratio, and all variables describing aerosol, cloud and precipitation particles) in a single cloud field simulation. The first set is coupled to the dynamics and drives the simulation (set D, as in Driving), and the second set piggybacks the simulated flow but does not affect it (set P, as in Piggybacking). Because the two sets are driven by the same flow, the methodology allows assessing the impact of initial thermodynamic profiles with high accuracy, and it is capable of detecting small impacts on bulk cloud properties such as the cloud cover, liquid and ice water path, and surface precipitation. The impact on the dynamics is assessed by performing a second simulation with thermodynamic sets swapped so the D set becomes the P set, and vice versa. This presentation will illustrate the potential of the piggybacking approach by applying it to the case of a global climate-model predicted change of atmospheric profiles in the Amazon region. The first set of thermodynamic variables represents the initial (i.e., at the sunrise) thermodynamic profiles of the modeling case developed based on observations during the Large-Scale Biosphere–Atmosphere (LBA) experiment in Rondonia (Brazil) used previously in studies of convective development over summertime continents. The second set of thermodynamic profiles corresponds to the first set modified by the climate change signal over the Amazon at the end of the 21st century. Potential for applying the piggybacking methodology to studies in other regions and to other types of deep convection in changing climates will be discussed.