**Abstract**

The dynamical core of the Institute of Atmospheric Physics of Chinese Academy of Sciences Atmospheric General Circulation Model (IAP AGCM4.0) and the Eulerian dynamical core of Community Atmosphere Model (CAM3.1) are used with the same CAM3.1 physical parameterizations to study the sensitivity of simulated climate. We report that the model with the IAP dynamical core simulated a colder troposphere than that from the CAM3.1 core, reducing the CAM3.1 warm bias in the troposphere from above 2 K to less than 1 K. However, when the two dynamical cores are used in the idealized Held-Suarez tests without moisture physics, the IAP AGCM core simulated a warmer troposphere than that in CAM3.1. The causes of the differences in the full models and in the dry models are then investigated.

We show that the IAP dynamical core simulated weaker eddies in both the full physics and the dry models than those in the CAM due to different numeric schemes. In the dry IAP model, the weaker eddies lead to smaller heat loss from poleward dynamical transport and thus warmer tropical and mid-latitude troposphere. When moist physics is included, however, weaker eddies also lead to weaker transport of water vapor and reduction of high clouds in the IAP model, which then caused a colder troposphere. Our results show how interactive physical processes can change the effect of a dynamical core on climate simulations.