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Stratosphere-troposphere coupling: Abrupt circulation responses to climate change-like forcings in a relatively simple, whole-atmosphere GCM

Lorenzo Polvani[†]; Shuguang Wang; Ed Gerber
[†] Columbia University, USA
Leading author: lmp@columbia.edu

he circulation response of the coupled troposphere-stratosphere system to climate change-like thermal forcings is explored with a simple atmospheric general circulation model (AGCM). As in Butler et al. (2010), the imposed forcings mimic the warming induced by greenhouse gasses and other anthropogenic factors in the low-latitude upper troposphere. We progressively increase the amplitude of the imposed warming to study the changes in circulation, up to and beyond those projected by the IPCC models under the A2 emission scenario. For weak to moderate forcing amplitudes, the circulation response is remarkably similar to the one found in comprehensive models: the Hadley cell widens, the tropospheric mid-latitude jets displace poleward, and the Brewer-Dobson Circulation (BDC) increases. However, when the warming of the upper tropical troposphere exceeds approximately 5 K, as projected by the end of the 21st century under the A2 scenario, an abrupt change of the whole atmosphere circulation is observed. In the troposphere the near surface jet jumps poleward by nearly 10 degrees, while in the stratosphere the polar vortex greatly intensifies, sudden warming events are severely reduced, the BDC weakens considerably, and the intra-seasonal coupling between the troposphere and stratosphere disappears. This abrupt transition is found to be robust to a doubling of either the horizontal or vertical resolution.