Title: Response of the zonal mean atmospheric circulation: global warming vs. El Niño

The change in the zonal mean atmospheric circulation under global warming is studied in comparison with the response to El Nino forcing, by examining the model simulations conducted for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). In contrast to the strengthening and contraction of the Hadley cell and the equatorward shift of the tropospheric zonal jets in response to El Nino, the Hadley cell weakens and expands poleward, and the jets move poleward under a warmed climate, despite the “El Nino-like” enhanced warming over equatorial central and eastern Pacific. The hydrological impacts of global warming also exhibit distinct patterns over the subtropics and mid-latitudes in comparison to the El Nino.

Two feasible mechanisms are proposed for the zonal mean circulation response to global warming: (1) The increase in static stability of the subtropical and mid-latitude troposphere, a result of the quasi-moist adiabatic adjustment to the surface warming, tends to stabilize the eddy growth on the equatorward side of the storm track and push the eddy activity and the associated eddy-driven wind and subsidence poleward, leading to the poleward expansion of the Hadley cell and the shift of jet; (2) the strengthening of the mid-latitude wind at the upper-troposphere and lower-stratosphere, arguably a consequence of the rise in the height of the tropopause and the associated increase in the meridional temperature gradient, can increase the phase speed of the eddies emanating from the mid-latitudes, and thus the critical latitudes (where the eddy phase speed matches the background zonal wind, and where the eddies break and extract angular momentum from the thermally driven wind) displace poleward and carry the eddy-driven circulation with it. Both mechanisms are somewhat, if not completely, distinct from those in response to the El Nino condition.