An analytical model for spatially varying clear-sky CO2 forcing

Nadir Jeevanjee, Jacob Seeley, David Paynter, and Stephan Fueglistaler
Geophysical Fluid Dynamics Laboratory, Princeton, United States of America (nadir.jeevanjee@noaa.gov)

Instantaneous clear-sky CO2 forcing is known to vary significantly over the globe, but the climate factors which control this are not well understood. Building upon the work of Wilson (2012), we build a first-principles, analytical model for CO2 forcing which requires as input only the temperatures at the surface and roughly 20 hPa, as well as column relative humidity. This model quantitatively captures global variations in clear-sky CO2 forcing, and shows that the meridional forcing gradient is predominantly due to the meridional surface temperature gradient, with modulation by water vapor. In particular, the Simpsonian behavior of water vapor emission implies an upper bound on CO2 forcing (with respect to surface temperature) which is realized in the present day tropics.