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New Connections Between Tropical Dynamics and Lower Stratospheric Chemistry

Catherine Wilka[1], Susan Solomon[1], Timothy Cronin[1], Douglas Kinnison[2], and Rolando Garcia[2]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA (cwilka@mit.edu)
[2]National Center for Atmospheric Research, Boulder, CO, USA

Matsuno-Gill circulations arising from tropospheric heating have been widely studied in tropical meteorology, but their impact on stratospheric chemistry and composition has seldom been explicitly evaluated. We show how anticyclonic Rossby wave gyres that form near the tropopause due to equatorially-symmetric Matsuno-Gill heating in near-equinox months provide a mechanism to influence chemistry in the tropical and subtropical upper-troposphere/lower-stratosphere (UTLS). This heating both generates anticyclonic flow in the lower stratosphere, which entrains extratropical air from higher latitudes deeper into the tropics of both hemispheres, and induces cooling in this already cold region. These two aspects of the circulation combine to allow heterogeneous chlorine activation on the surface of sulfuric acid aerosols to proceed rapidly. We use reanalysis to show that these Matsuno-Gill heating and wind response patterns are present in the months of interest, and then demonstrate that, in the WACCM model, they can substantially influence the distributions of species related to chlorine activation such as ClO and NO_2. This provides a potential target for future tropical UTLS observation campaigns, and demonstrates a previously unrecognized mechanism in near-equinox months for dynamical influences on the spatial structures of atmospheric composition changes in this region.