Tropical Convective Forcing of the Southern Hemisphere Circulation: Modulation of Polar Regions via Planetary Wave Trains in the UTLS

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The high latitude Southern Hemisphere (SH) plays crucial roles in the climate system, including the thermohaline circulation, the distribution of ice, the ozone hole, and jet migration. Centers of deep tropical convection can affect higher latitudes by mass outflow surges in the upper troposphere / lower stratosphere (UTLS) and radiation of planetary wave trains through the connecting westerly waveguide. Depending on the season and on the phase of the El Nino Southern Oscillation (ENSO), these wave trains can modulate high latitude patterns of temperature, geopotential height, and wind, and the distribution of column ozone. We employ observational analysis and simulations with the University of Wisconsin Nonhydrostatic Modeling System (UWNMS) to investigate the hypothesis that changes in the location of convective centers and changes in the UTLS wind structure (waveguide) modulate the propagation of planetary wave trains, thereby influencing the distribution of circulation anomalies from the surface of Antarctica into the polar stratosphere.

Column ozone anomalies correlate highly with barotropic temperature anomalies in the UTLS, and may be linked to distinctive patterns of Antarctic surface temperature and wind anomalies for El Nino versus La Nina during each season. During La Nina the polar vortex is stronger in each season, with influence extending to the surface, the effect being weakest during SH summer. During the SH winter and spring a westward shift in convection during La Nina of 30-50° relative to El Nino corresponds to a 30-50° westward shift of planetary wave and column ozone anomalies from the tropics to Antarctica. In SH winter and spring during La Nina, a region of significant poleward planetary wave activity flux in the UTLS occurs near (amplified) Indonesian convection, while during El Nino the poleward flux is weaker and more diffuse across the Pacific.

We are carrying out two sets of experiments with the UWNMS: 1) UTLS meridional inflow forcing experiments in a hemispheric mode and 2) synoptic case studies to diagnose climatological Antarctic temperature patterns during El Nino and La Nina for each season. VIS5d movies of a simulation for the La Nina cold period at Dome C during December 1-9 1988 will be shown. During austral summer and La Nina a notable barotropic low pressure anomaly exists over the Ross Sea. During this example synoptic case, the Ross Sea low was more pronounced, with air traveling clockwise in a long fetch across the cold surface to reach Dome C.