Session: C8 Poster: M64A

The seasonal cycle of stratosphere-troposphere coupling at southern high latitudes associated with the semi-annual oscillation in sea-level pressure

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The semi-annual oscillation (SAO) in sea-level pressure at high southern latitudes is the consequence of a twice-yearly contraction (and strengthening) and expansion (and weakening) of the storm track between 50 and 65oS, with the contracted phases in spring and autumn. In this study the extent to which inter-annual variability of the SAO is correlated with inter-annual variability in mid- to lower-stratospheric circulation at 60oS was determined using NCEP/NCAR Reanalysis 1 data for the period 1979-2009. The second harmonic of the annual cycle of an SAO index was used to assess SAO amplitude and phase (the date of the first peak of the second harmonic). Zonal mean zonal wind at 60oS was used as an index for atmospheric circulation. The results show that year-to-year variability in the SAO amplitude is significantly correlated with mid-stratospheric (10 hPa) circulation variability in late summer/early autumn (February-March) and late winter/early spring (August-September). However, variability in the SAO phase is significantly correlated with mid-stratospheric circulation variability in spring (September-November). These maxima in significant correlations at 10 hPa propagate down to the surface in approximately one month. The characteristics of upward planetary wave propagation alone do not explain the late summer/early autumn and spring maxima in correlations. Evidence is shown that internal reflection of stationary wave-number 1 is important for explaining the strong correlations in late summer/early autumn, but that large variability during polar vortex break-up dominates the spring correlations. The results may be important for understanding seasonal differences in how stratospheric ozone depletion influences tropospheric circulation.