

Early 1990s Southern Hemisphere tropospheric and lower stratospheric circulation variations during the winter and early spring

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A number of authors have found changes in the behavior of Southern Hemisphere (SH) troposphere and lower stratosphere atmospheric processes during the early 1990s. During this period changes in the SAM inter-annual variability, in Antarctic heat flux, water vapor flux and sea-ice distribution, in the stratospheric polar vortex dynamics and the ozone layer, as well as in mid-tropospheric circulation PC field pattern occurrence over subtropical South America have been observed, among others. These changes appear to occur primarily at mid to high latitudes of the hemisphere. This paper aims to study the SH tropospheric and lower stratospheric circulation shifts around the early 1990s during winter and early spring. Rotated Principal Analysis (RPCA) is applied in T and S-modes to fields in both height ranges in order to isolate time and space modes of variability. The 100hPa E-P flux vertical component is used to assess planetary wave activity variability at SH mid to high latitudes. A statistically significant interannual jump in the winter-early spring cumulative 100hPa E-P flux vertical component is observed between 1990 and 1991, suggesting an overall rapid increased wave activity in the early 1990s. The VARIMAX rotated 3rd principal component (PC) yields a change in behavior around the early 1990s in June in both S and T-mode RPCA. Note that in June and in October the SH wave activity maximizes. The T-mode PC resembles a PSA-like pattern: a subtropical to high latitude stationary wave pattern extending from the vicinity of Oceania towards the South Atlantic. The spatial distribution of areas of gridpoint time series with significant correlation or anticorrelation with the 3rd PC in the S-mode analysis also points to a PSA-like pattern. The combined PC results suggest the presence of a robust atmospheric process associated with this spatial pattern. Changes in the T-mode 3rd PC factor loading (FL) during the early 1990s appear to be associated with changes in moisture and mass convergence in the lower troposphere over the Maritime Continent. Before the early 1990s the correlation between the factor loading and a moisture index for this region are uncorrelated. However after 1990 the correlation becomes significant, with a correlation over 0.6. The interactions of the S-mode PSA-like component with previously observed SAM variability changes during this period is discussed.