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Using PV Inversion to Investigate the Impact of Synoptic -scale Tropospheric Perturbations in Driving Stratospheric Variability and the Southern Hemisphere Major Warming in 2002.

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Traditionally, sudden stratospheric warmings have been explained in terms of linear wave theory whereby large, planetary waves of zonal wavenumber 1 and 2 are generated in the troposphere and propagate into the stratosphere when the zonal mean flow is westerly and below a critical value. By the Charney-Drazin theorem smaller waves with zonal wavenumbers 3 and higher are 'trapped' in the troposphere and exert no influence on the stratospheric flow fields aloft.
This work tests the idea that in realistic flows, where many of the assumptions of the Charney-Drazin theory do not hold, tropospheric perturbations of synoptic-scale may be important in driving Stratospheric variability. This work is relevant to the unprecedented Southern Hemisphere major sudden stratospheric warming (SSW) which took place in 2002. Whilst the stratospheric polar vortex became highly elongated, a synoptic scale Potential Vorticity (PV) anomaly, approximately wavenumber 4, developed directly below its elongated tip. It is proposed that whilst the vortex was highly elongated, this PV anomaly, traditionally thought to be too small to have an impact on the stratosphere, induced a cyclonic circulation across the edge of the vortex causing it to split off. This hypothesis is tested using a set of PV Inversion experiments. Using a given PV distribution and specifying balanced conditions i.e. geostrophic balance, and boundary conditions, to conserve mass, all other dynamical fields can be deduced. The relative impact of tropospheric perturbations of varying synoptic size is investigated in progressively more complex stratospheric and tropospheric flows, approaching the real state in September 2002. While for simple states, the typical Rossby height is a good estimate of the stratospheric impact of small tropospheric perturbations, more complex behavior is revealed in more realistic flows. The implications of these experiments for SSWs are discussed.