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Understanding stratosphere-troposphere links using new diagnostics of the polar vortex

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During extreme events in the Stratosphere the Northern Hemisphere polar vortex can break down in an event known as a Stratospheric Sudden Warming (SSW). The structure and evolution of the vortex during winter is analysed with special regard towards such events. Initially the traditional methods of zonal mean zonal wind and polar cap temperature are employed to study the vortex, the analysis then proceeds using a novel technique known as elliptical diagnostics to provide an in-depth look at how the vortex is evolving. Elliptical diagnostics calculate the centre, aspect ratio and strength of the vortex on different isentropic surfaces, this allows the structure of the vortex to be captured in more detail than the traditional methods would alone. Distributions of the diagnostics are then build and examined using extreme value theory, this gives a view of the vortex during its rare states which often refer directly to SSW events.

The elliptical diagnostics are then composited in time and height for different climate forcings. Such forcings include ENSO, large volcanic eruptions, the solar cycle and different phases of the quasi-biennial oscillation. The analysis shows that under certain forcings, such as El Nino, volcanically influenced winters the vortex is more disturbed, warmer and more equatorward than usual. Where as for other forcings, for example La Nina and QBO-west, the vortex becomes more poleward, stronger and colder. These results tie in well with the current understanding of each forcing, but also provide more information on how the vortex is evolving during these periods.