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Blocking precursors to stratospheric sudden warming events

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Both sudden stratospheric warming (SSW) events and blocking events are major atmospheric flow phenomena. An SSW event severely disrupts the stratospheric polar night jet, as the polar vortex is either displaced equatorwards and sheared into a comma shape (a displacement SSW) or torn into two individual vortices (a splitting SSW). Similarly, blocking events severely disrupt the extra-tropical circumpolar tropopause-level jet, which is either displaced poleward of or splits around the block's core of anomalously low potential vorticity at tropopause levels.

Here we focus on the dynamical linkage between to two phenomena by examining their multiple co-occurrence over a climatological time period, and analyzing specific events. Specifically, we find clear evidence that blocking events are precursors to SSW events.

Spatial frequency composites of atmospheric blocking are constructed for the ten-day period preceding splitting and displacement SSW events, as objectively identified in the ERA-40 data set in an earlier study. Distinct differences in the location and amplitude of the blocking frequency distributions are found. Displacement events are preferentially preceded by blocking in the Atlantic basin, whereas splitting events are preceded by blocking events occurring in the Pacific basin or both basins concomitantly. These differences in the blocking distribution are mirrored in significantly different planetary wave patterns prior to the warming events.

Analysis of individual events supports the idea of tropospheric blocking as a key precursor to SSW events, and sheds further light on the relationship between the two phenomena.