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Differing tropospheric responses to stratospheric vortex splits and displacements in a global circulation model

Amee O'Callaghan (1), Manoj Joshi (1), David Stevens (1), and Daniel Mitchell (2)

(1) Centre for Ocean and Atmospheric Sciences, University of East Anglia, Norwich Research Park, Norwich, Norfolk, United Kingdom. (a.ocallaghan@uea.ac.uk), (2) Department of Physics, University of Oxford, Oxford, United Kingdom.

Sudden Stratospheric Warmings (SSWs) have become an increasingly popular topic of study due to the range of potential effects that they have on climate. Often stratospheric anomalies possess the ability to descend into the troposphere. These anomalies can then affect the surface climate for up to two months [Baldwin and Dunkerton, 2001] implying that improved scientific understanding could lead to extended forecasting. However, not all SSWs possess the ability to strongly affect the surface climate. Analysis of reanalysis data has shown that the behaviour of vortex splits and displacements (two classes of SSWs) is clearly distinct. Tropospheric anomalies associated with either type of event contain different spatial structures and often the response associated with vortex splits is stronger [Mitchell et al., 2013].

SSWs are identified in a 200 year integration of the Intermediate General Circulation Model (IGCM). The model's performance is evaluated following the benchmarks of Charlton et al. [2007], and is found to simulate both the frequency and the tropospheric response of SSWs well.

Distinctive differences are found in the IGCM's responses to vortex splits and displacements. The vortex split composite displays a significant weakening of the Icelandic Low and Azores High for up to 60 days following an event, indicative of a negative NAM anomaly. On the other hand the vortex displacement composite displays little significant deviation from climatology, implying a lack of NAM anomaly descent. This reaffirms the findings from reanalysis and highlights the need to separate the distinct classes of Sudden Stratospheric Warming events in model studies. We discuss the sensitivity of the model response to other processes such as the parameterisation of gravity waves.

References

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