The Downward Influence of Sudden Stratospheric Warmings: Insight using an Idealised Moist GCM

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Stratospheric sudden warmings (SSWs) are events whereby the polar vortex rapidly decelerates and the winter Pole subsequently warms in the matter of just a few days. Such events have been shown in recent years to have a significant downward influence on the tropospheric circulation below, in some cases lasting for up to two months. However, the mechanism(s) by which this downward influence occurs are not well understood, nor are the factors governing the magnitude of the downward influence. It is particularly difficult to attempt to understand this coupling process as nonlinear tropospheric feedbacks effectively bury the mechanisms by which the stratospheric anomaly is initially communicated downward to the troposphere. Here, we use an idealised moist general circulation model (GCM) to understand the mechanisms which govern the downward influence of SSWs, and to constrain the factors that govern the magnitude of the downward influence. This model of 'intermediate complexity' is particularly suited to this study as it incorporates the radiation scheme that is utilised by operational forecast systems, including both the ECMWF and NCEP, as well as in the CMIP atmospheric models, in addition to allowing us to easily remove physical processes in order to bear down on the mechanisms at work. The radiation scheme also allows us to force the model with a realistic ozone profile, and thus to simulate realistic radiative timescales in the stratosphere. Four different topography options are here used: realistic Earth's topography, idealised zonal wavenumbers one and two, and a flat bottom, which together give rise to a large ensemble of SSW events to analyse. Finally the flexibility of the model enables us to easily modify the vertical resolution, and we assess the sensitivity of model simulated downward coupling to the placement of vertical levels. Results will be compared to SSW events in 1500 years of model output from the chemistry-climate model GEOSCCM and to SSW events in the observational record.

Key words: SSW, Stratosphere-troposphere coupling