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Stratospheric Sudden Warmings: a new climatology with modelling benchmarks, and a validation of current Stratosphere-resolving GCMs.

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Much recent attention has been focussed on connections between the stratosphere and troposphere particularly because of the potential impact of stratospheric climate changes on the tropospheric climate. The influence of the stratosphere on the troposphere is largest when strong perturbations to the stratospheric flow occur. The largest perturbations to the stratospheric flow occur during stratospheric major warming events. Stratospheric major warming events occur in two types, 'Vortex Displacement' events when the stratospheric polar vortex moves from its normal climatological position near the pole and 'Vortex Splitting' events when the vortex breaks down into two or more parts.

Using NCEP and ERA-40 reanalysis data, we have constructed a new climatology of major stratospheric sudden warmings. In addition to identifying when major stratospheric sudden warming occur, we have designed a new algorithm which can classify events as vortex displacements or vortex splits.

In the first part of the study we use the new climatology to compare the composite dynamics of the two types of warming. We show that although the two types of warming have significantly different stratospheric dynamics, their impact on the tropospheric flow is comparable.

In the second part of the study, we compare the major stratospheric sudden warmings simulated by six, state-of-the-art, stratosphere resolving GCMs with our new climatology. Three of the six GCMs simulate far fewer major stratospheric sudden warmings than are observed in the climatology. Simple dynamical benchmarks for major stratospheric sudden warmings, are described which give further insight into the deficiencies of models which show a lack of stratospheric variability.