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Characteristics and trends of sudden stratospheric warmings

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For the first time characteristics and long-term trends of sudden stratospheric warmings (SSWs) are assessed based on both observations and multi-century simulations. Simulations are based on EGMAM a middle atmosphere version of ECHO-G with 39 vertical levels (top level 0.01 hPa) and a better representation of the middle atmosphere dynamics. The period 1860-1999 is modeled using observed GHG concentrations. The period is used for a comparison to observed characteristics of SSWs such as mean number, variability, strength, duration and intra-seasonal distribution. Future trends are evaluated from IPCC-SRES B1, A1B and A2 scenario simulations (2000-2100). Each experiment consists of three members building a small ensemble. For B1 and A1B a stabilisation period from 2100 until 2200 is also included in the analysis. As observations we use NCEP-reanalysis data and SSW-data of the Freie Universität Berlin. The automated algorithm to identify SSWs is based on 10hPa zonal mean zonal wind at 60° and the mean temperature gradient between 60° and the polar region. A climatological threshold is applied to separate SSWs from final warmings.

In comparison to observations the model underestimates the number of SSWs especially in early winter which is connected to an underestimation of tropospheric wave forcing. Future scenario experiments indicate an increase of SSWs. Despite the high internal variablity statistical significant changes are found. The strongest increase appears in the A2 scenario experiment. Here, the ensemble mean reveals an increase to 3.5 events/decade until the end of the 21st century which implies nearly a doubling when compared to the mean state of the pre-industrial period. While no change is found for the mean duration of SSWs there is a tendency towards less intense events. Changes in stratospheric dynamics as well as changes in tropospheric wave forcing seem to be the main reason for the increase of SSWs.