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Low-frequency variability and future trends of sudden stratospheric warmings

S. Schimanke, H. Huebener, T. Spangehl, and U. Cubasch
Freie Universität Berlin, Institut für Meteorologie, Berlin, Germany (Semjon.Schimanke@met.fu-berlin.de)

The goal of this study is to assess the variability of sudden stratospheric warmings (SSWs) and their future trends on time scales longer than 10 years with the EGMAM model.
EGMAM is 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. Two long control simulations (550 and 300 years) under constant pre-industrial and present day conditions respectively are investigated to estimate the internal variability in the number of SSWs. Future trends are evaluated from IPCC-SRES B1, A1B and A2 scenarios (2000-2100). Each scenario 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.
The automated algorithm to identify SSWs uses 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.
The analysis of the control simulations shows that in the model SSWs occur with a mean frequency of 2.1 SSWs/decade. Compared to observations the model underestimates the number of SSWs by a 60%. In terms of monthly distribution and decadal variability the model shows comparable characteristics to observations e.g. the number of events per decade varies from 0-9. The model reveals also a high variability on longer timescales which cannot be verified by observations due to the limited length of the data.
Future scenario experiments indicate an increase of SSWs. 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 control simulation.