Response of stratospheric transport and mixing to sudden stratospheric warmings in WACCM: Impacts on Arctic ozone

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The extreme disruptions of the wintertime stratospheric circulation during sudden stratospheric warmings (SSW) have important effects on tracer concentrations through alterations in transport properties. The goal of this study is to provide a quantitative analysis of those changes examining the anomalies of the advective Brewer-Dobson circulation and the effective diffusivity as a measure of isentropic mixing (de la Cámara et al. 2018). We composite data around the central day of SSWs from thirty-six years of reanalysis data (ERA-Interim), and from five ensemble members (60 years each) of the Whole Atmospheric Community Climate Model version 4 (WACCM4) performed for the Chemistry Climate Model Initiative. We find: i) A weakened residual circulation and intensified isentropic mixing after the onset of SSWs that persist for more than two months in the lower stratosphere; ii) sufficiently deep SSWs (i.e. those followed by Polar-night Jet Oscillation events, or PJO) have a stronger and more persistent response in the meridional circulation and isentropic mixing; and iii) long after the strong wave forcing that drives the SSWs has declined, diffusive fluxes of potential vorticity (PV) remain anomalously high in the lower stratosphere delaying the recovery of the vortex.

We also explore the impacts of the above-mentioned circulation changes on the simulated Arctic ozone field. Positive mixing ratio anomalies above 550 K (~ 50 hPa) and negative anomalies below are mainly driven by adiabatic eddy fluxes around the central warming date. The recovery of climatological values is slower in the lower than in the upper stratosphere, and is driven by the competing effects of diabatic motions and isentropic mixing. As found with the PV field, there is a lag between the effects of the eddy terms (that drive the SSW and the large-scale stirring of the flow) and the effects of microscale mixing measured by the ozone-derived effective diffusivity. Sudden warmings that occur during PJO events are found to have larger and more persistent impacts on Arctic ozone.

Key words: Sudden stratospheric warming, transport and mixing, effective diffusivity, Arctic ozone

References

de la Cámara, A., and Coauthors, 2018: *Journal of Geophysical Research Atmospheres*, **123**, DOI:10.1002/2017JD028007.