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Enhanced transport and mixing of Arctic ozone during SSWs

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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 and mixing properties. In this presentation we will examine the dynamics that control changes of Arctic ozone during the life cycle of SSWs, providing a quantitative analysis of both advective transport and mixing of Arctic ozone. We use output from four ensemble members (60 years each) of the Whole Atmospheric Community Climate Model, and also use reanalysis and satellite data for validation purposes. The composite evolution of ozone displays positive mixing ratio anomalies up to 0.5 – 0.6 ppmv above 550 K (□50 hPa) around the central warming date and negative anomalies below (-0.2 to -0.3 ppmv), consistently in observations, reanalysis and model.

Our analysis shows a clear temporal offset between ozone eddy transport and diffusive ozone fluxes. The initial changes in ozone are mainly driven by isentropic eddy fluxes linked to enhanced wave drag responsible for the SSW. The recovery of climatological values in the aftermath of SSWs is slower in the lower than in the upper stratosphere, and is driven by the competing effects of cross-isentropic motions (which work towards the recovery) and isentropic mixing (which delays the recovery). These features are enhanced in strength and duration during sufficiently deep SSWs, particularly those also labeled as Polar-night Jet Oscillation (PJO) events. It is found that SSW-induced ozone concentration anomalies below 600 K (□40 hPa), as well as total column estimates, persist around one month longer in PJO than in non-PJO warmings.