Supporting Information for "Ozone-forced Southern Annular Mode during Antarctic Stratospheric Warming Events"

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1. Figures S1 to S4

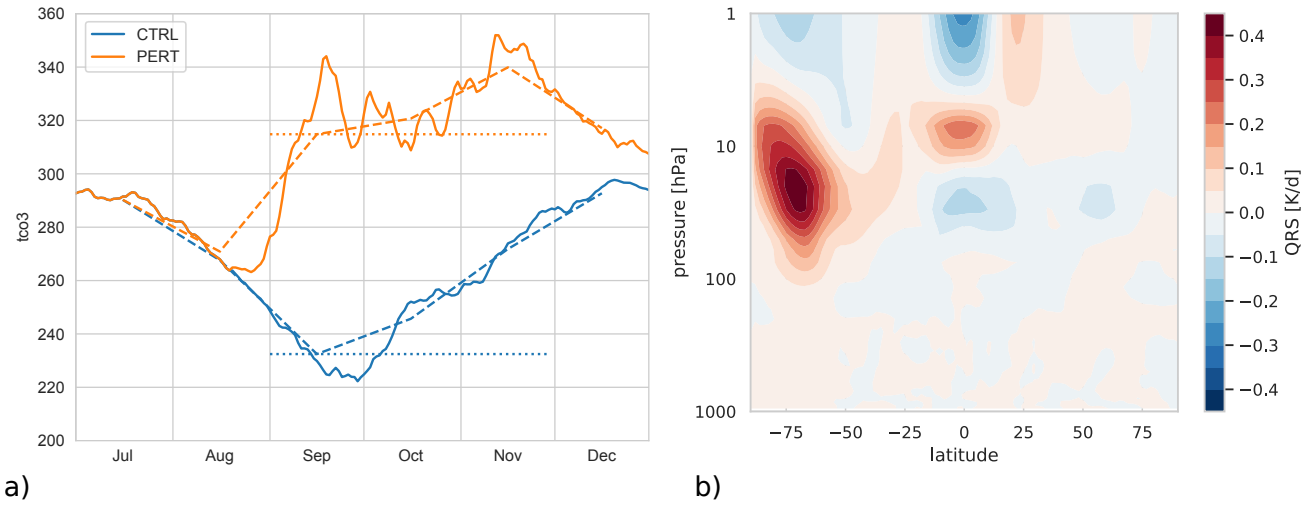

Figure S1. (a) Climatological (CTRL) and perturbation (PERT) polar cap (60-90°S) mean total column ozone. Dashed lines show linear interpolation of monthly means as used in the seasonal simulations. Dotted lines show the ozone concentrations see by the perpetual simulations. (b) Difference in time and ensemble mean shortwave heating rates between PERT-P and CTRL-P, which corresponds to the anomalous ozone heating due to 2019 September ozone.

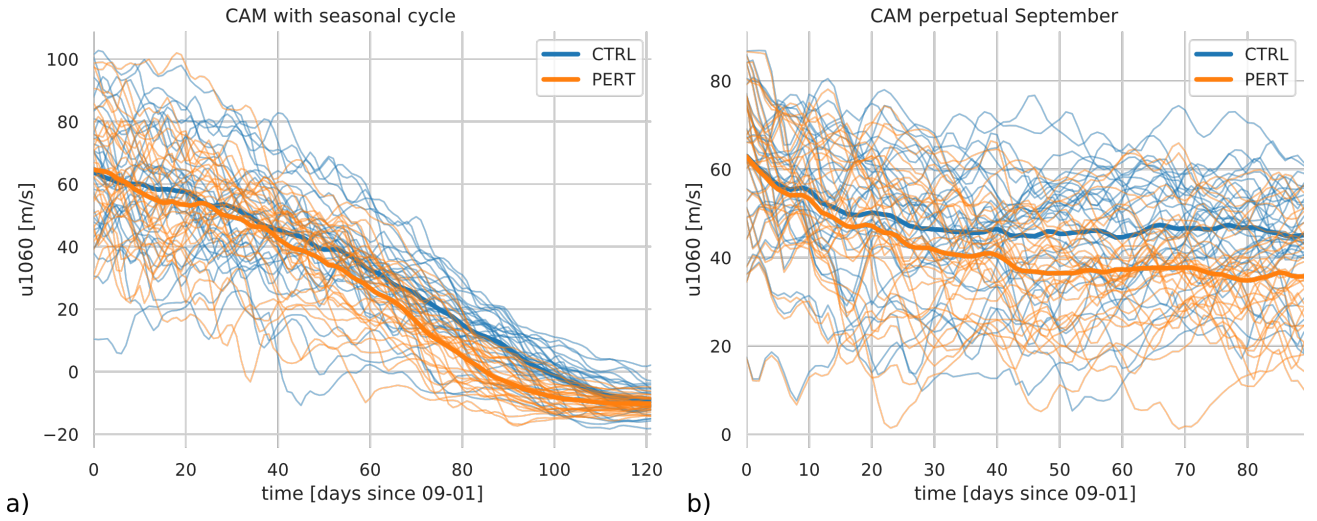

Figure S2. Zonal mean zonal wind at 60 S and 10 hPa for all members (thin lines) and ensemble mean (thick lines) in the CAM simulations with (a) seasonal cycle and (b) perpetual September setup.

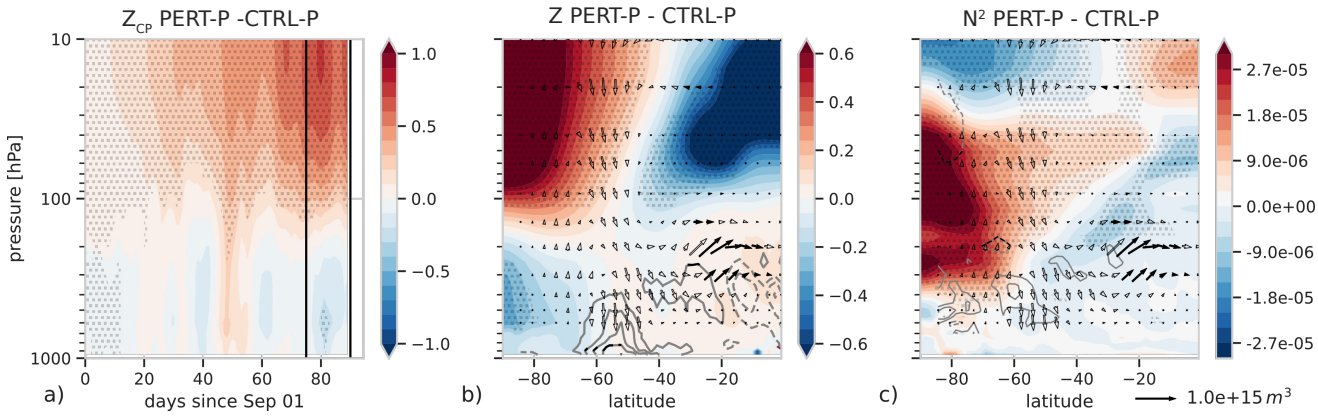

Figure S3. Same as Fig. 2 but for the perpetual simulations with CAM. Due to strong internal variability (e.g. variability across members), the tropospheric positive SAM remains weak for about 60 days, and only starts becoming statistically significant after about 80 days, when the constant ozone heating causes both the stratospheric and tropospheric anomalies to become large enough. In stark contrast to the simulations with seasonal cycle, there is no indication of a downward propagation (slow response), while the dynamical response to the ozone forcing closely resembles the fast response in the simulation with seasonal cycle.

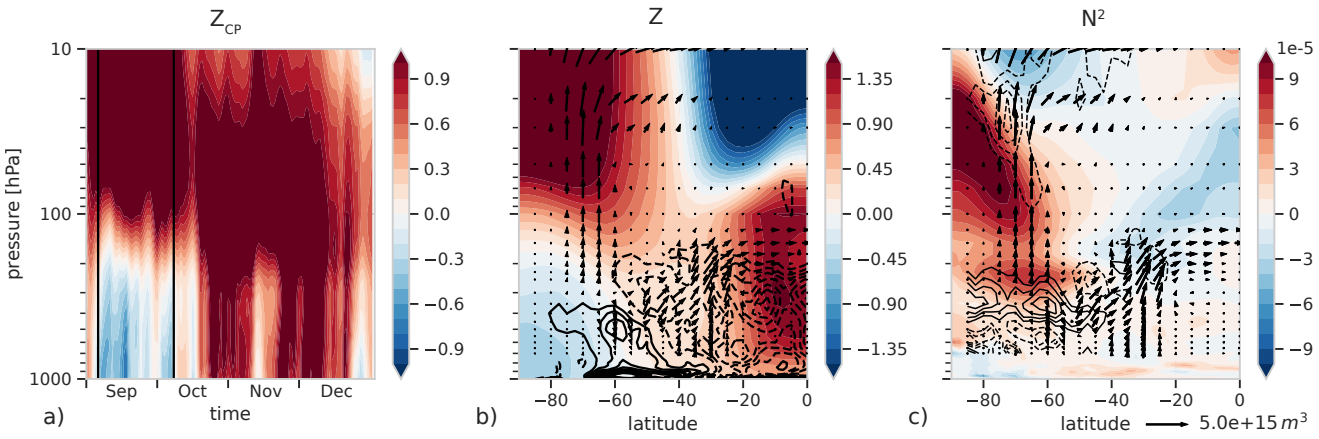

Figure S4. Same as Fig. 2 but for ERA5 data between Sep 5 and Oct 8 2019. No significance testing has been applied (single member). Even if the strong SWE occurring in 2019 increases the stratospheric perturbations and upward EP fluxes during this period compared to our model simulations without SWE, there are still many qualitative agreements between this specific observed event and our model analysis. For instance, there are anomalous equatorward EP fluxes and positive EP flux divergence just below the region of enhanced lower tropospheric stability in the extratropics (panel c), which forces an anomalous clockwise circulation centered at 60°S (panel b). Note the difference in arrow scale compared to Figs. 2 and S3. The streamfunction contours are now spaced 4e9 kg/s and EP flux divergence contours are spaced by $1\,\mathrm{ms}^{-1}\mathrm{d}^{-1}$. Anomalies are calculated relative to 1981-2010 daily climatology following the WMO climatological standard for long-term averages (`https://community.wmo.int/wmo-climatological-normals`).