

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

M. Jucker¹, R. Goyal¹

¹Climate Change Research Centre and ARC Centre of Excellence for Climate Extremes, University of New South Wales, Sydney, Australia

Contents of this file

1. Text S1 to S2
2. Figures S1 to S5
3. Table S1

Text S1 - Correlation between IOD and SAM

To determine the correlation between the Indian Ocean Dipole and the Southern Annular Mode, we compare the monthly Marshall SAM index (<http://www.nerc-bas.ac.uk/public/icd/gjma/newsam.1957.2007.txt>, downloaded 2021-06-17) and the Dipole Mode Index (https://psl.noaa.gov/gcos_wgsp/Timeseries/Data/dmi.had.long.data, downloaded 2021-06-17) on monthly, seasonal, and yearly timescales, with the results shown in Table S1. Correlations were computed for the period 1957-2020.

monthly	DJF	MAM	JJA	SON	yearly
0.104	0.358	0.209	0.204	-0.096	0.247

Table S1. Correlation coefficients between IOD and SAM.

Text S2 - Stratospheric ozone vs. SAM in ERA5:

Besides the years 2002 and 2019 which are known for their SWEs, two earlier years are also marked with extremely high polar cap total column ozone values (marked red in Fig. S1, left). All four years show the vertical dipole of polar cap geopotential height anomalies seen in 2019, albeit in a less prominent way. While it is only as obvious in 1979, it is still visible during the first and last ozone peaks in 1988 (beginning September and November) and during the very short large ozone peak in 2002 (last few days of September and first few days of October).

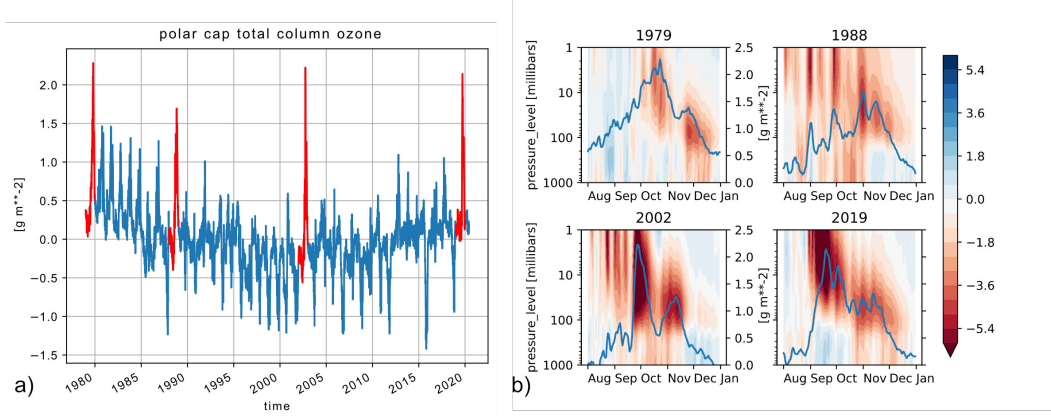


Figure S1. ERA5 polar cap total column ozone and SAM index. a) Total column ozone time-series for the complete record (minus 1979-2020 seasonal climatology). b) Similar to Fig. 1a) but for SAM as defined by the standardized first Principle Component of zonal mean geopotential height anomaly and for the four years of large peaks in the ozone timeseries (marked red on left).

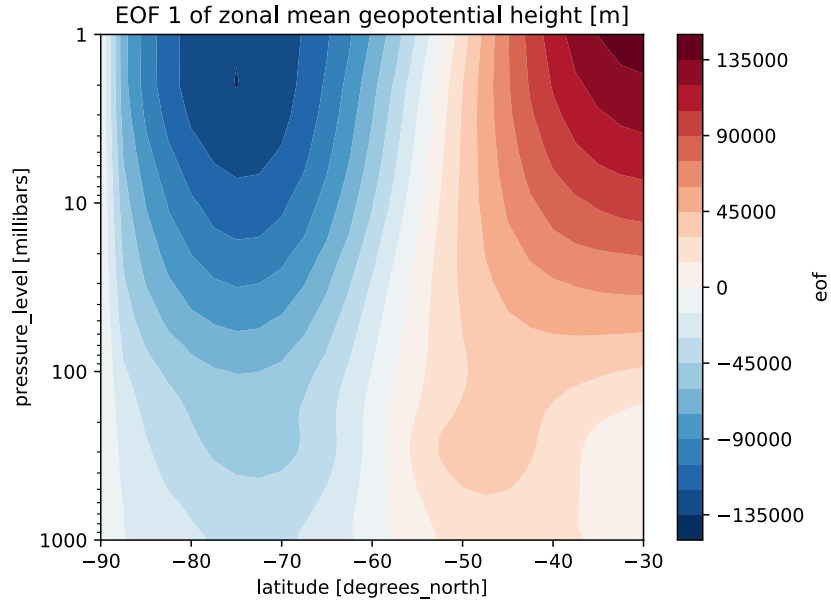


Figure S2. First Empirical Orthogonal Function (EOF) of de-seasonalised zonal mean geopotential anomalies from ERA5 data (1979-2019)). The standardised timeseries of the first principle component at each pressure level is identified as the Southern Annular Mode index.

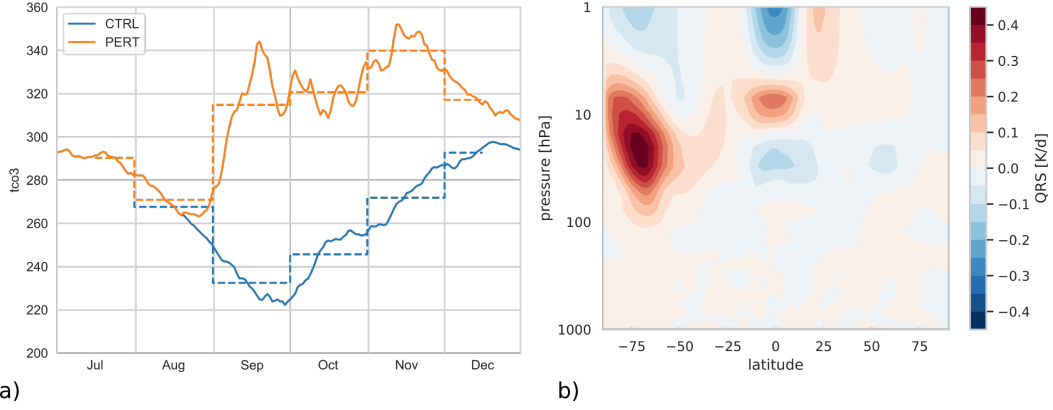


Figure S3. (a) Climatological (CTRL) and perturbation (PERT) polar cap (60-90°S) mean total column ozone. Dashed lines show monthly means as used in the model simulations. (b) Difference in time and ensemble mean shortwave heating rates between PERT-P and CTRL-P, which corresponds to the anomalous ozone heating due to 2019 September ozone.

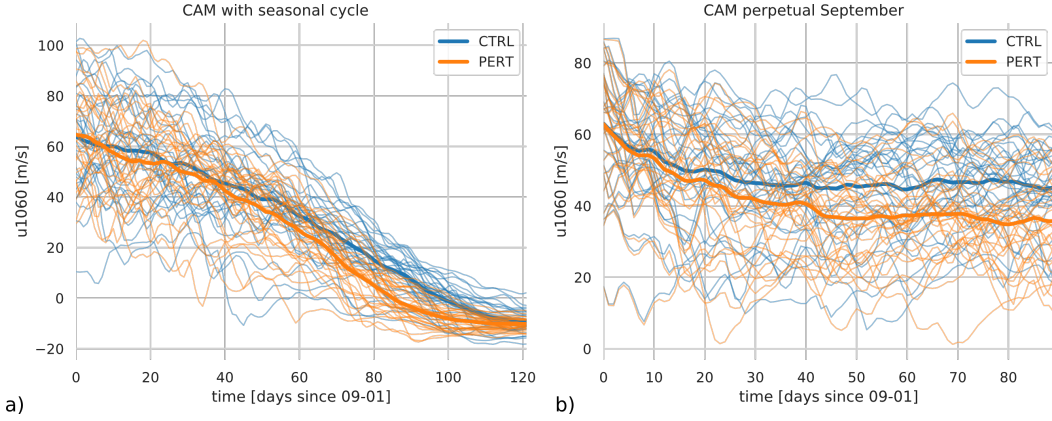


Figure S4. Zonal mean zonal wind at 60S and 10 hPa for all members (thin lines) and ensemble mean (thick lines) in the CAM simulations with (a) seasonal cycle and (b) perpetual September setup.

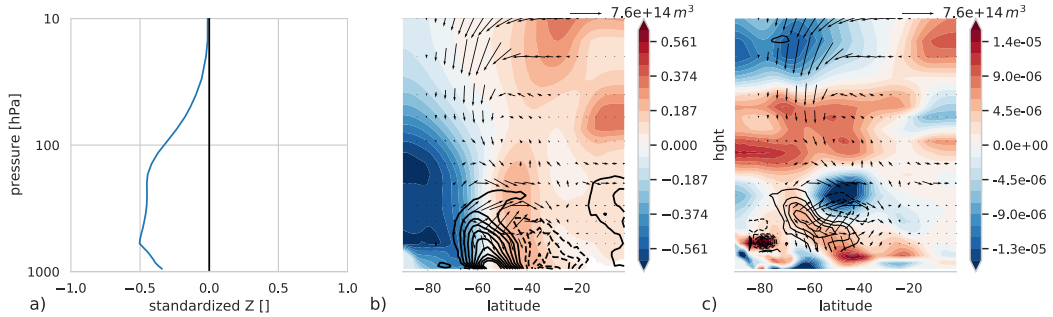


Figure S5. Same as Fig. 2 but for days when polar cap geopotential height anomalies are negative in both the troposphere and the stratosphere in the perpetual simulations. This shows that no vertical dipole in Z_{PC} is required as long as there is an increase in lower stratospheric stability for the ‘fast response’ mechanism to hold.