

Robustness of the simulated tropospheric response to ozone depletion



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1. Introduction

Recent studies have shown large inter-model differences in the the magnitude of the Southern Hemisphere tropospheric circulation response to ozone depletion (e.g., Gerber and Son 2014; Waugh et al 2015)

There are two potential reasons for these differences: (a) differences in the ozone forcing, and (b) differences in the dynamical response to a given forcing. Here we investigate the latter point: *how robust is the model circulation response to a given ozone forcing?*

2. Hierarchy of simulations

Name	Ozone	SST	GHG
CAM-2000	SPARC 1960/2000	HadISST (2000)	2000
CAM-1960	SPARC 1960/2000	HadISST (1960)	1960
CAM-1870	SPARC 1960/2000	HadISST (1870)	1870
CAM-1870CM2	SPARC 1960/2000	CM2.1 control	1870
GFDL-A	SPARC 1960/2000	ESM2Mc control	1860
GFDL-O	SPARC 1960/2000	Coupled	1860
GEOSCCM-A	Interactive	HadISST	Transient
GEOSCCM-O	Interactive	Coupled	Transient
CMAM	Interactive	Coupled	1960

We analyse a hierarchy of simulations, shown above, ranging from an atmosphere-only model with specified chemistry, to a coupled model with interactive stratospheric chemistry. We also impose a range of background SSTs and GHG concentrations.

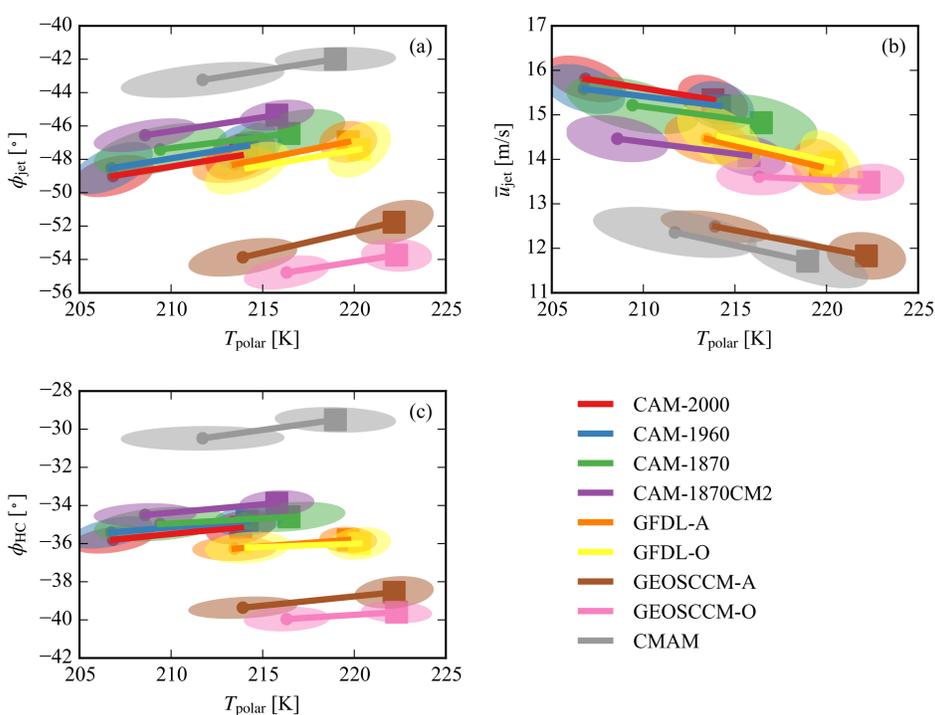


Fig 1. DJF jet latitude (a), jet strength (b), and Hadley Cell edge (c), relative to the change in ONDJ 100hPa polar cap temperature, T_{polar} , for each pair of simulations. Ellipses show the one standard deviation contour of interannual variability. Squares represent simulations with 1960 ozone, circles 2000 ozone.

3. Comparing model responses

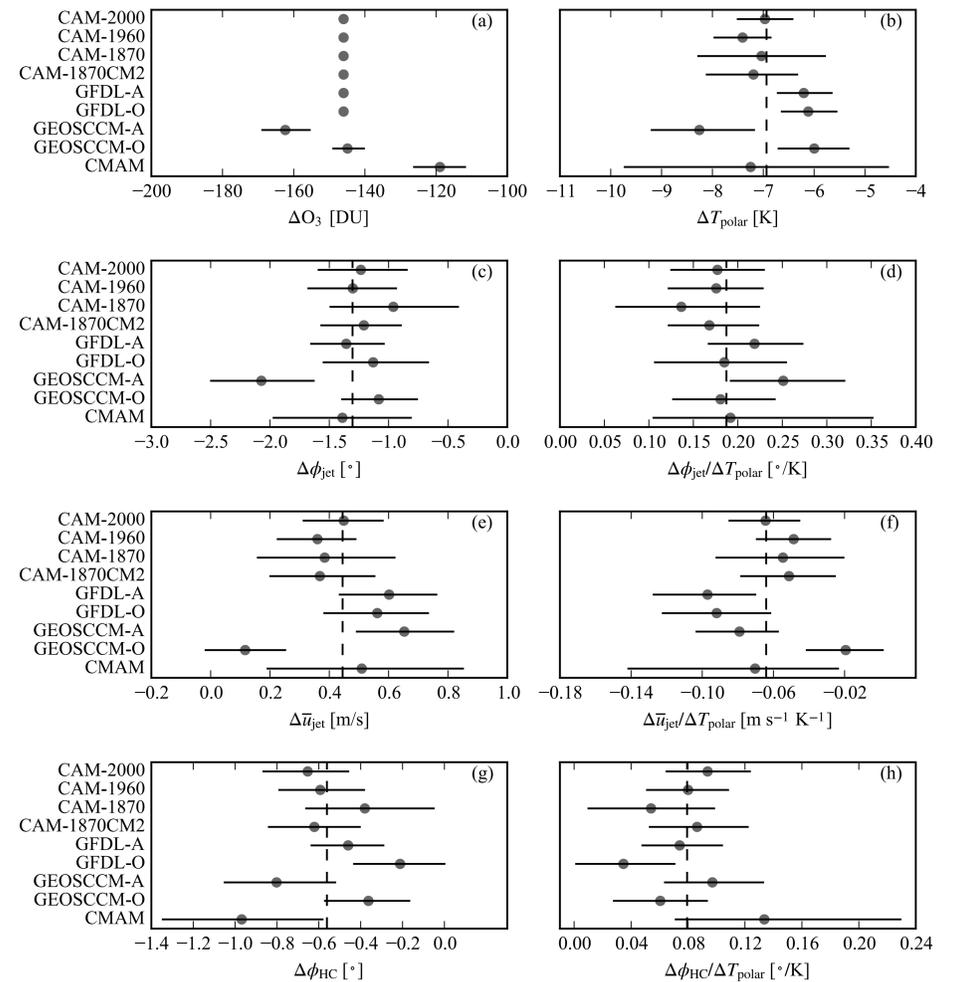


Fig 2. Ozone depletion-induced changes in each pair of simulations. Horizontal bars show the 95% uncertainty range and the dashed vertical line is the multi-model mean. d,f,h show changes normalised by the lower stratospheric response, ΔT_{polar} .

4. Conclusions

The poleward shift in jet latitude is consistent across all models. The intensification of the jet and poleward expansion of the Hadley Cell are less consistent, but interannual variability leads to a large degree of uncertainty in the changes, even with 100 year long time-slice simulations.

We find no significant relationship between the climatological jet latitude and ozone depletion-induced jet shift, even though our model climatologies span about 12° latitude (an order of magnitude greater than the average jet shift).

The differences in ozone depletion response found in previous studies are therefore unlikely to be due to differences in model dynamics. Instead these may result from large uncertainty due to interannual variability, as well as differences in the prescribed ozone concentrations.

References

Gerber, E. P. and S.-W. Son, 2014, *J. Clim.*, 27
 Waugh, D. W., C. I. Garfinkel, and L. M. Polvani, 2015, *J. Clim.*, 28