The Impact of Stratospheric Ozone Hole Recovery on Antarctic Climate

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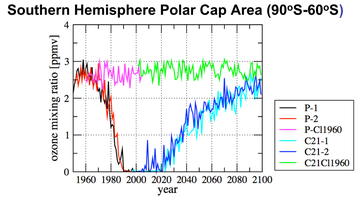
Introduction

- Model experiments have revealed that both stratospheric polar ozone depletion and anthropogenic increase of greenhouse gases (GHG) have contributed to the observed increase of summertime tropospheric westerlies in the Southern Hemisphere (SH) , but with ozone influence dominating.
- As the stratospheric halogen loading decreases in the future, ozone is expected to return to higher values, with the disappearance of the Antarctic ozone hole. The relative contributions of ozone hole recovery and GHG increases on the SH circulation changes during the 21st century (C21) are not well quantified.
- We estimate the impact of ozone recovery on SH polar climate using the coupled chemistry climate model GEOS-CCM.
- We will contrast the impacts of polar ozone depletion in the 20th century and recovery in the 21st century on the circulation, and relate the results to those from IPCC AR4 C21 simulations.

Experiments

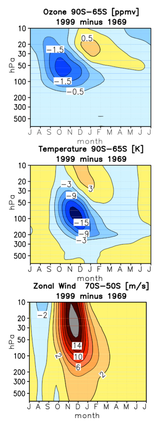
Experiment	Time Period	SST	Halogens	Greenhouse Gases
P-1	1950-2004	Had1SST	Observed	Observed
P-2	1951-2004	Had1SST	Observed	Observed
P-Cl1960	1960-2004	Had1SST	Chlorine fixed at 1960 values	Observed with chlorine fixed at 1960 values
C21-1	1996-2099	HadGEM1	WMO Baseline scenario Ab	IPCC/GHG scenario A1b (medium)
C21-2	2000-2099	CCSM3.0	WMO Baseline scenario Ab	IPCC/GHG scenario A1b (medium)
C21-Cl1960	2001-2099	CCSM3.0	Chlorine fixed at 1960 values	IPCC/GHG scenario A1b (medium), with chlorine fixed at 1960 values

70-hPa Minimum Zonal Mean Ozone over Southern Hemisphere Polar Cap Area (90ºS-60ºS)



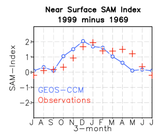
Ozone-Antarctic Climate: Past Changes 1969-1999

Atmospheric Changes



Changes in Near Surface Pressure

3-Month Overlapping SAM Index



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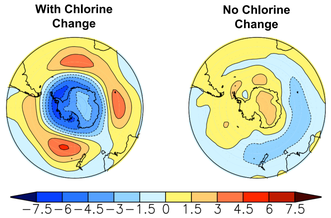
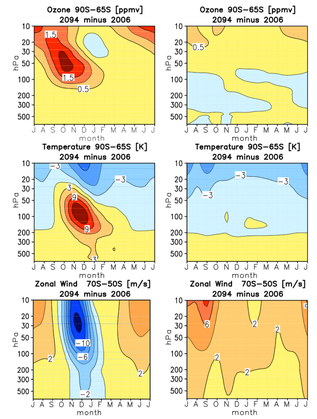


Ozone-Antarctic Climate: 21st Century Changes 2094 minus 2006

With Chlorine change | **No Chlorine change**



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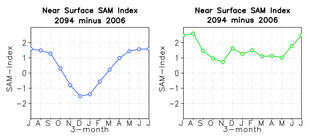

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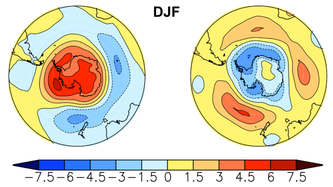
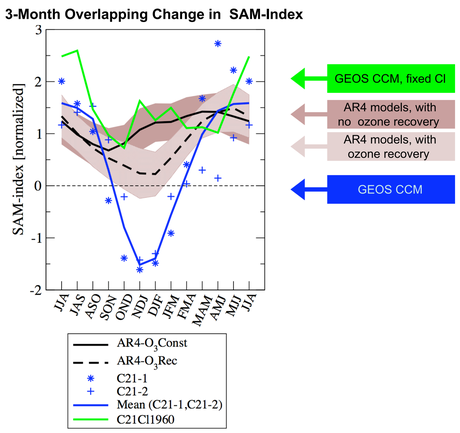


Comparison with AR4 Models 21st Century Changes 2094-2006

3-Month Overlapping Change in SAM-Index



Summary and Conclusions

- In the GEOS CCM, ozone hole causes substantial seasonal circulation changes in accord with prior observations and model based studies
- This signal diminishes as ozone recovers through the 21st Century, even as GHGs continue to increase
- Ozone change signals swamp the impact of GHG increases in the 1970-2100 period
- AR4 ensembles suggest this same impact can be captured in climate models (with no stratosphere and imposed ozone change), though damped
- Need to test this in a fully coupled ocean-atmosphere-chemistry model.

More Information:

Perlwitz J., S. Pawson, R. Fogt, J. E. Nielsen, and W. Neff, (2008): The impact of stratospheric ozone hole recovery on Antarctic Climate. *Geophys. Res. Lett.*, in press.
http://www.cdc.noaa.gov/people/judith.perlwitz/PUBLICATIONS/PERLWITZ-ETAL-GRL-2008rev.pdf

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