Ozone Recovery in a Changing Climate

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NOAA Climate Attribution

- **PSD Climate Attribution Group**
  - Key player in emerging NOAA Climate Service
  - Lead of NOAA's attribution activities
- **Climate Attribution**
  - establishing the principal causes or physical explanation for observed climate conditions
- **Why is NOAA involved?**
  - Increasing public interest in climate information
  - Policy makers don't just want to know what happened, but *why it happened*…. the answer to the latter influences decisions.

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~~"The cat did it."~~

"The ozone hole did it"

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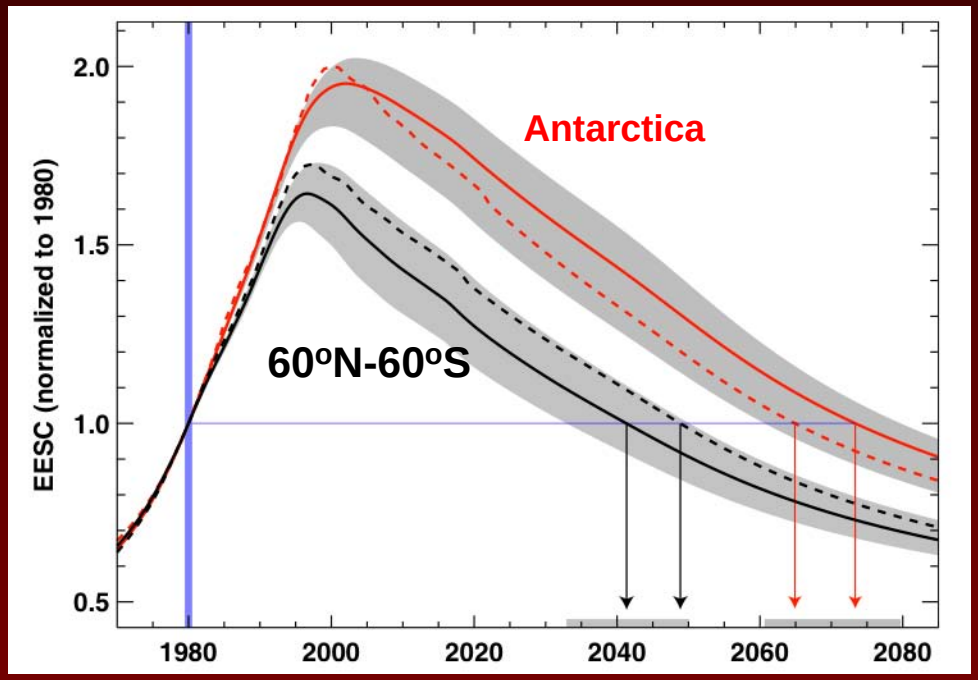
Conditions in the atmosphere will be different in the future from those observed during periods before ozone depletion

- When is the ozone layer expected to recover?
- What is the impact of the Antarctic ozone hole recovery on Southern Hemisphere circulation?

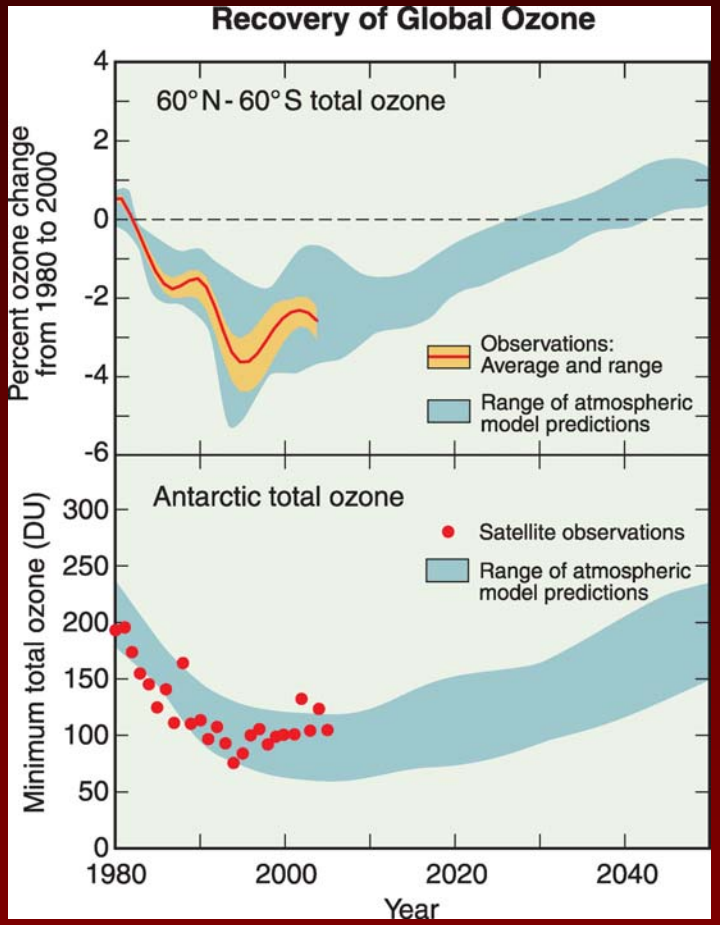
When is the ozone layer expected to recover?

Equivalent Effective Stratospheric Chlorine



UNEP/WMO (2007)

Ozone



UNEP/WMO (2007)

Year of return to 1980 values:

Region	EESC	Ozone
60ºN-60ºS	2035-2050	2025-2035
Antarctica	2060-2080	2035-2095

Potential Factors that will influence 21st century ozone layer recovery

- **Stratospheric cooling**
  - accelerates ozone recovery in upper stratosphere
  - delays ozone recovery in polar stratosphere
- **Water vapor changes**
  - increase would delay recovery
- **Volcanic Aerosol**
  - temporarily reduce global ozone amounts under high-chlorine conditions

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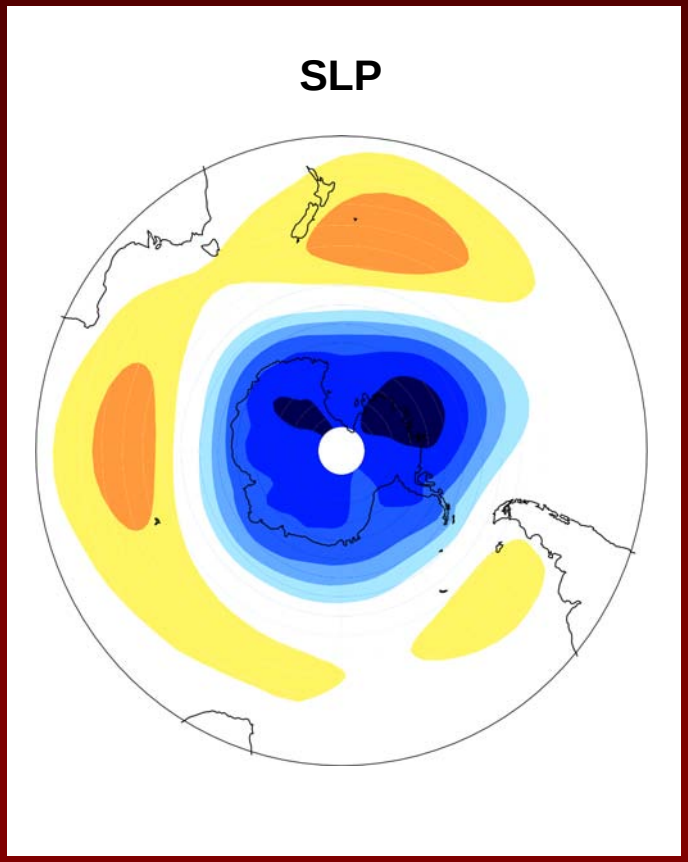
SAM - The Southern Hemisphere Annular Mode (Thompson and Wallace, 2000)

SAM-positive phase



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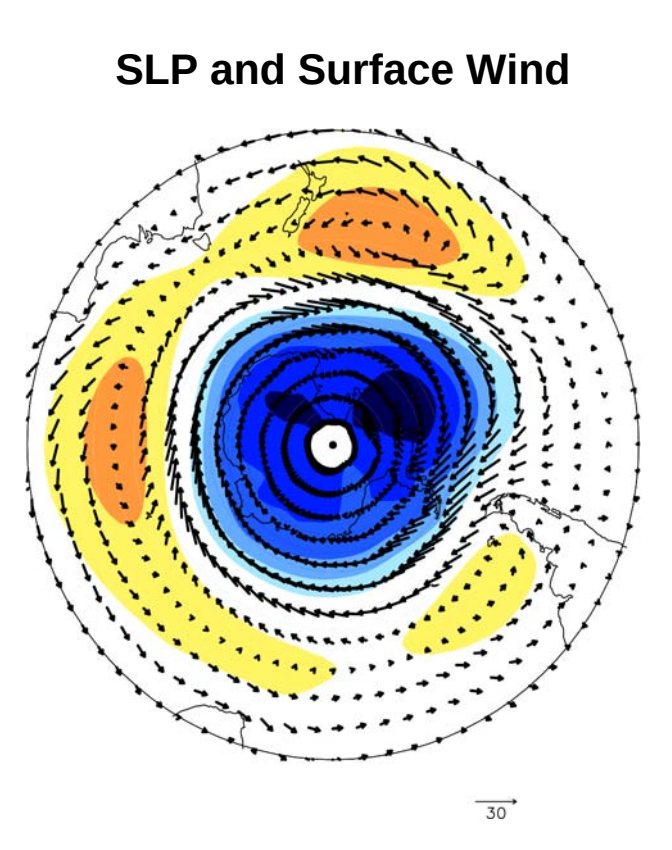
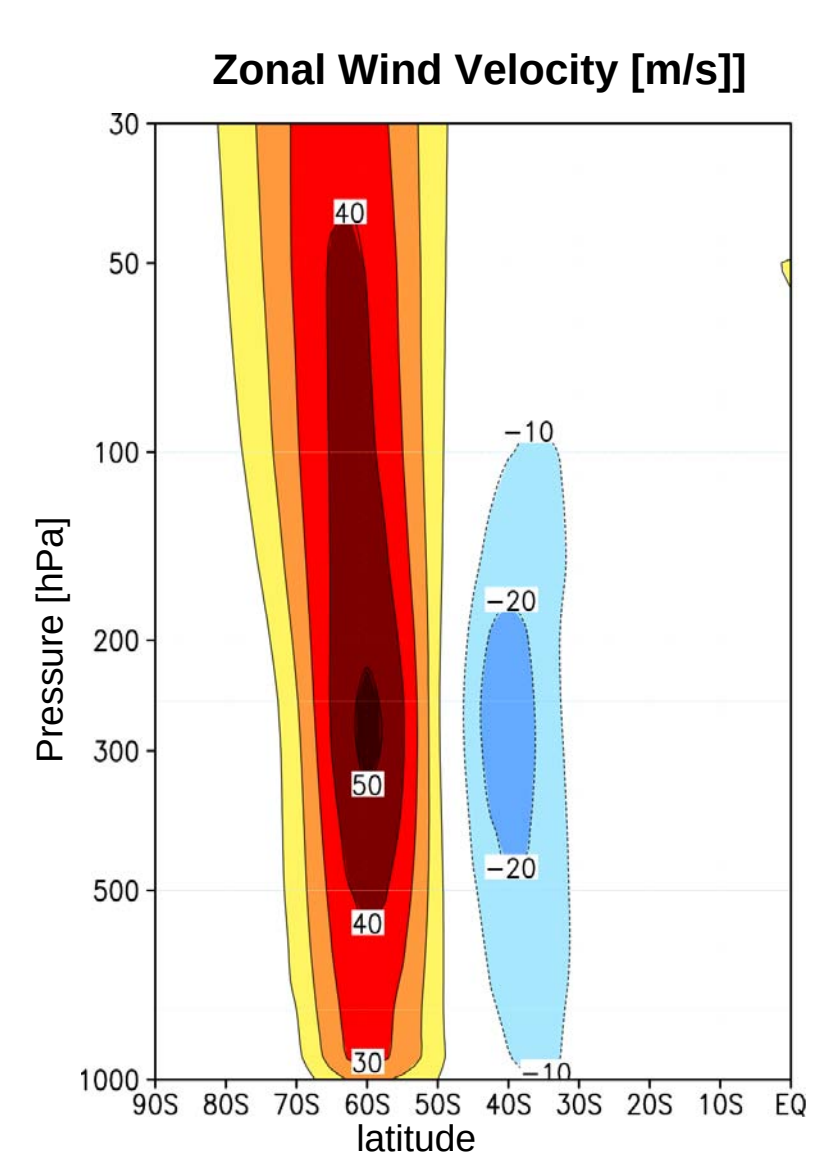
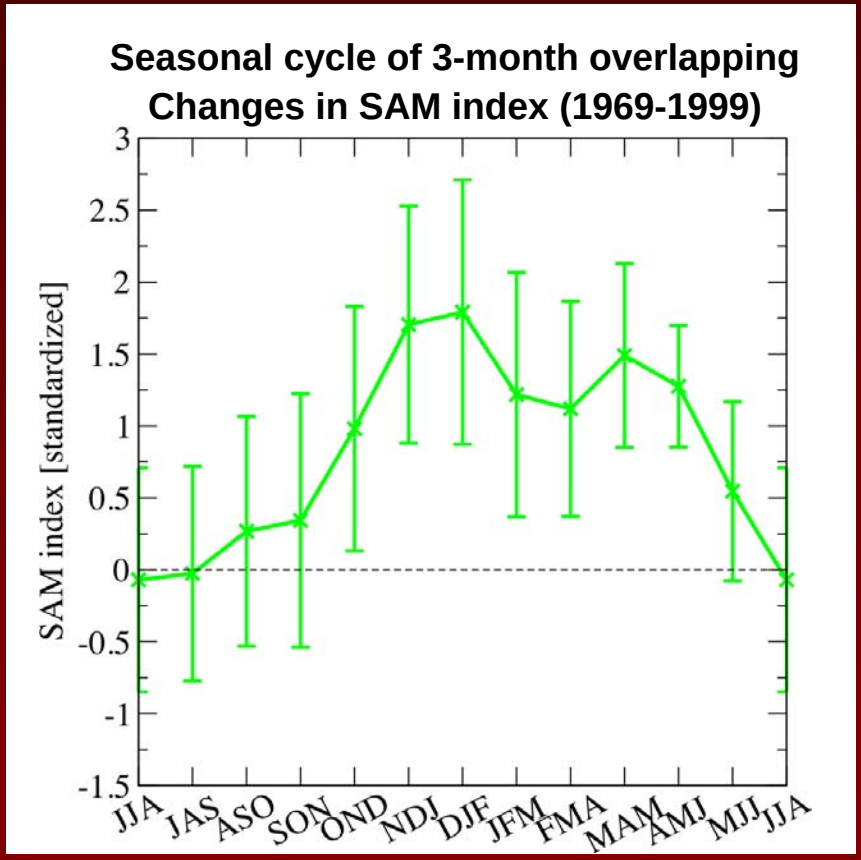
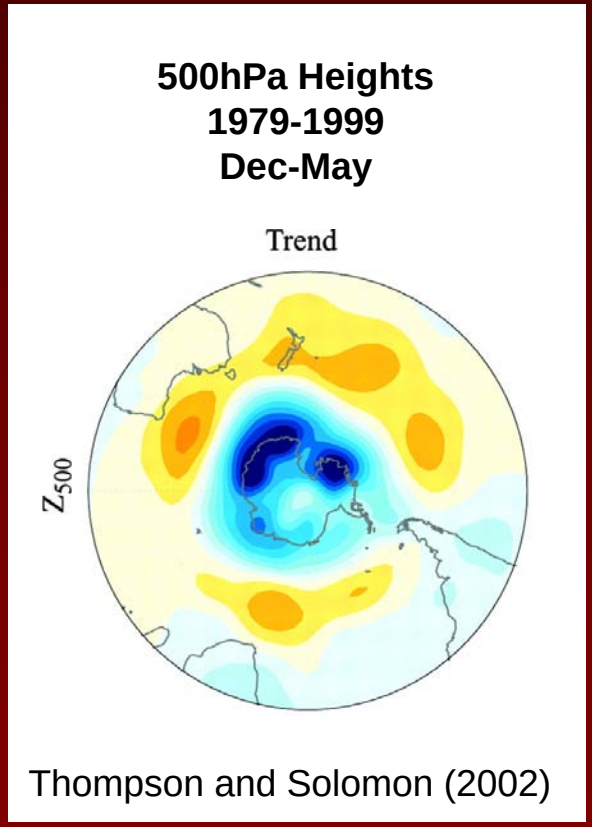




Observed Changes in SAM

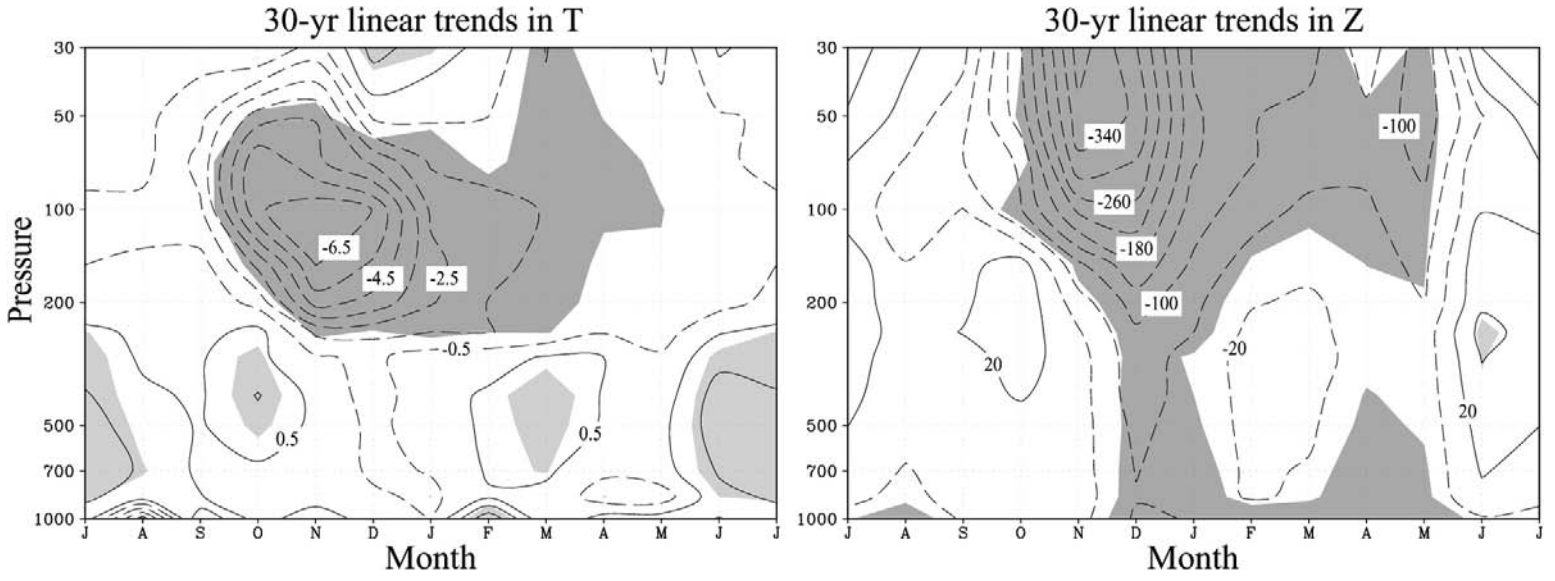




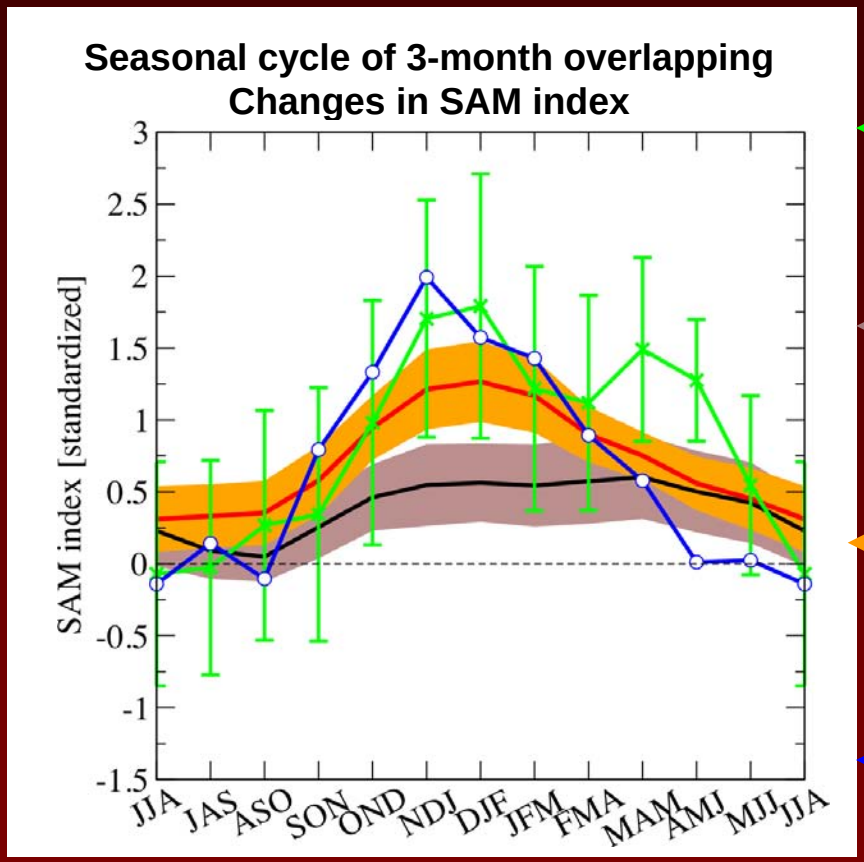
Thompson and Solomon (2002)

Attribution of SAM Changes to Ozone Depletion (Thompson and Solomon, 2002)

Changes in polar cap temperature and geopotential heights, 1969-1998



Origin of Past Changes in SAM index (1969-1999)



Observations

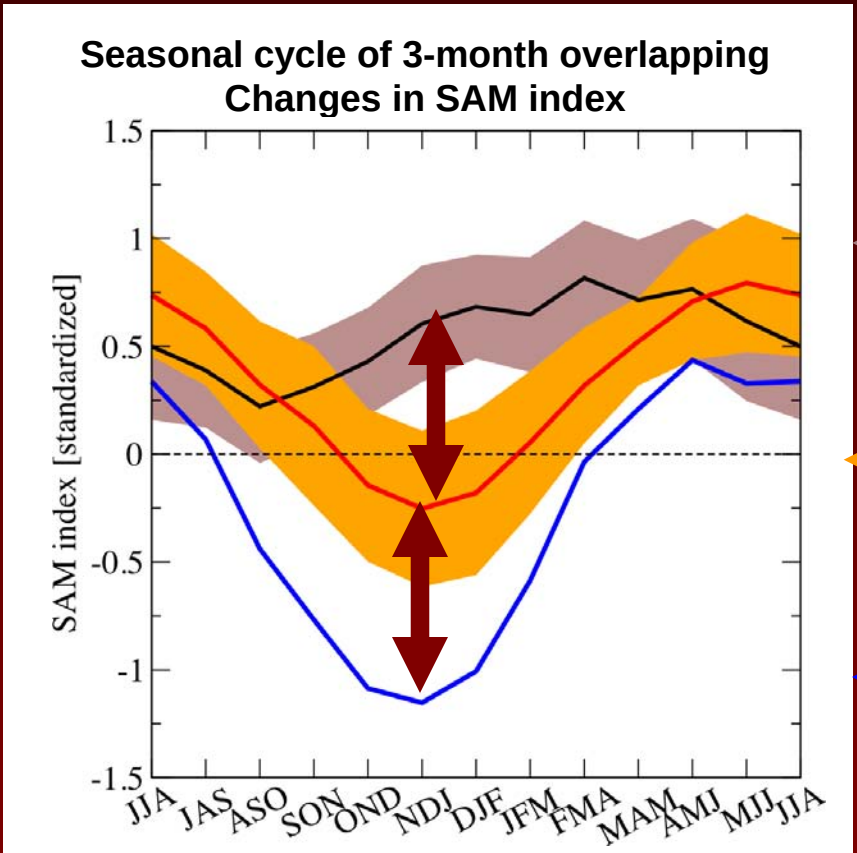
AR4 models forced with GHG increase

AR4 models forced with GHG increase and ozone depletion

GEOS-Chemistry Climate Model

Both GHG increases and ozone depletion contributed to observed shift of summertime SAM index towards positive phase with ozone forcing dominating

Projection of Future Changes in SAM Index (2001-2049)



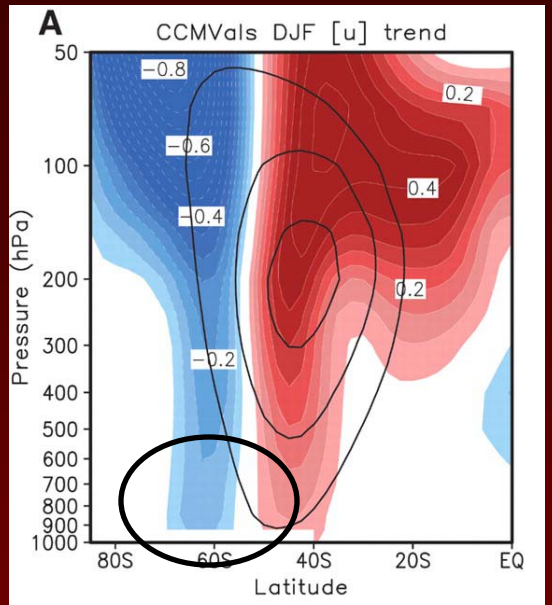
AR4 models forced with GHG increase

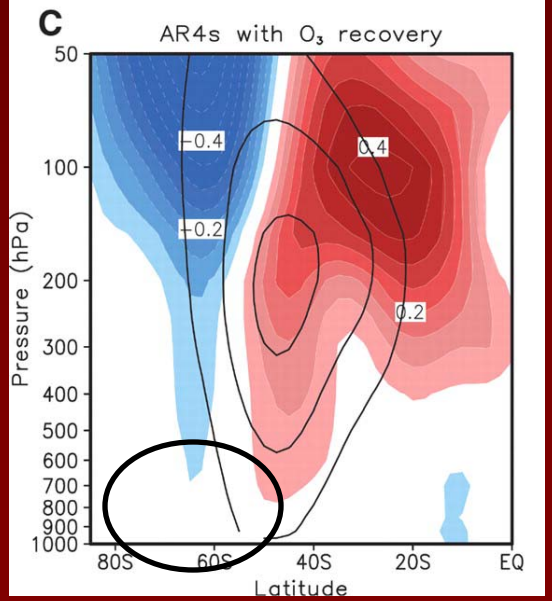
AR4 models forced with GHG increase and ozone recovery

GEOS-Chemistry Climate Model

Simulated Changes in Summertime Zonal Winds 2001-2049 (Son et al. 2008)

CCMs





IPCC AR4 Climate models with ozone recovery

Simulated tropospheric impact of ozone recovery is larger in CCMs than in IPCC AR4 models

Summary: Ozone recovery is an important forcing of 21st Century Climate Change

Next steps in climate modeling

- For climate simulations of the next IPCC assessment report, an ozone recovery scenario will be defined
- Assessment of biases in CCMs
  - Report on CCM process-oriented evaluation
  - Relevant for Ozone Assessment Report 2010
- Coupling of CCMs to ocean/sea ice models

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