CCM Status

Anne Douglass (with contributions from lots of people)

The GEOSCCM with GMI COMBO stratosphere/troposphere chemistry

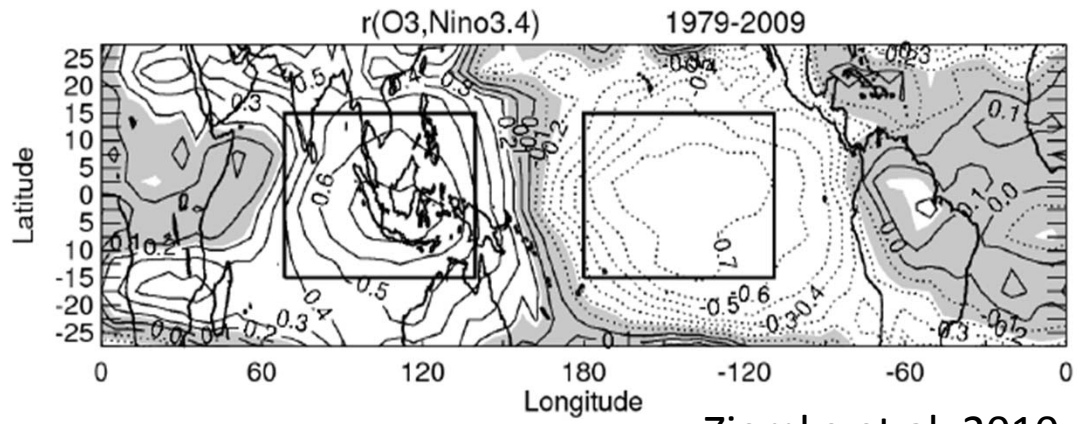
- Various time-slice simulations completed
  - Evaluation
  - Application
  - Anticipation and Development

Application: ENSO Related Variability in Ozone

The El Nino Southern Oscillation is the dominant mode of tropical variability on interannual timescales (Philander, 1989).

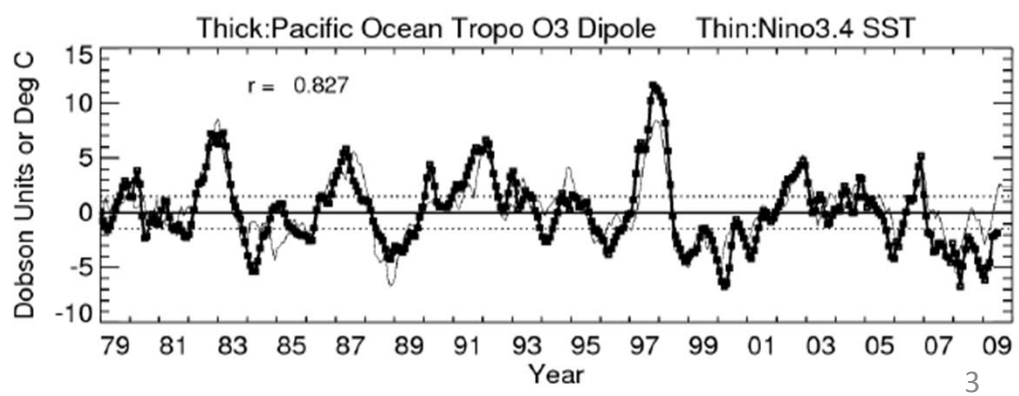
ENSO is known to cause significant thermal and dynamical perturbations to the atmosphere and also influences the constituent distributions.

Ziemke et al. (2010) showed that ENSO related response of tropical ozone dominated interannual variability and created the Ozone ENSO Index.



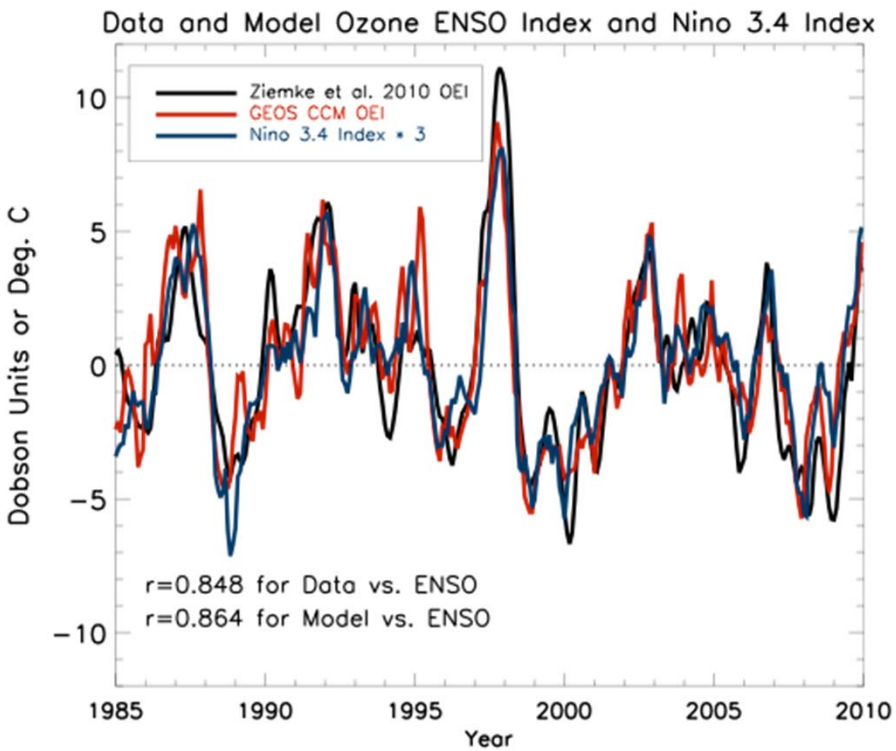
Ziemke et al. 2010

OEI = W TCO – E TCO



Comparison of the 25 year record OEI from data, model, and Niño 3.4 Index

GEOS CCM does an amazingly good job capturing this variability over the 1985-2009 time period.



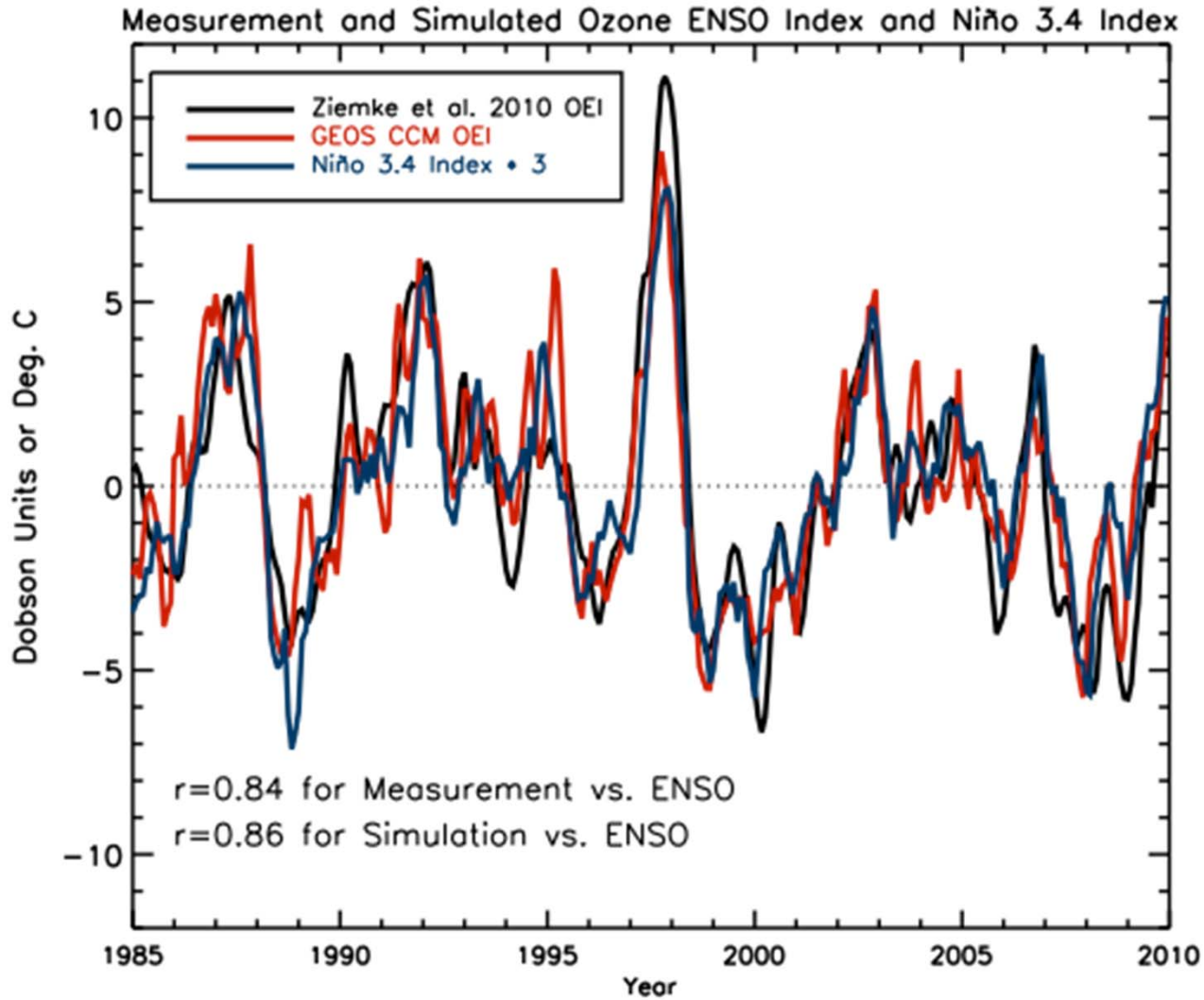
This work recently appeared in GRL along with comparison of simulated and modeled vertical structure (using several SHADOZ sondes)

The response of tropical tropospheric ozone to ENSO
Oman et al., *Geophys. Res. Lett.*, 38

Publication Date: 13 July 2011

Comparison of the 25 year record OEI from data, model, and Niño 3.4 Index

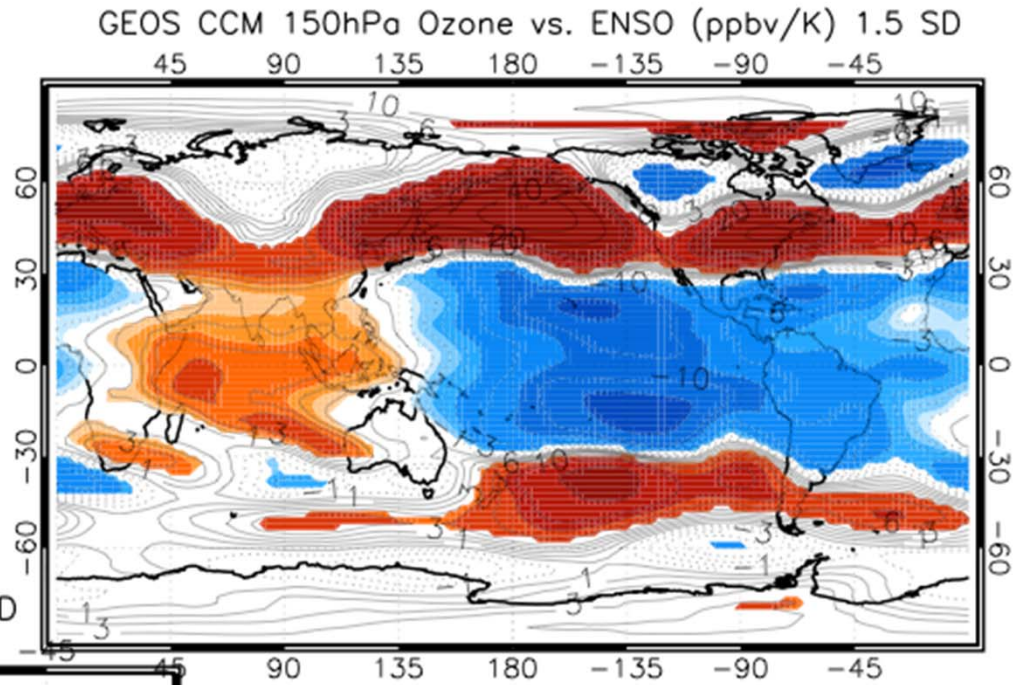
GEOS CCM does a very good job capturing this variability over the 1985-2009 time period.

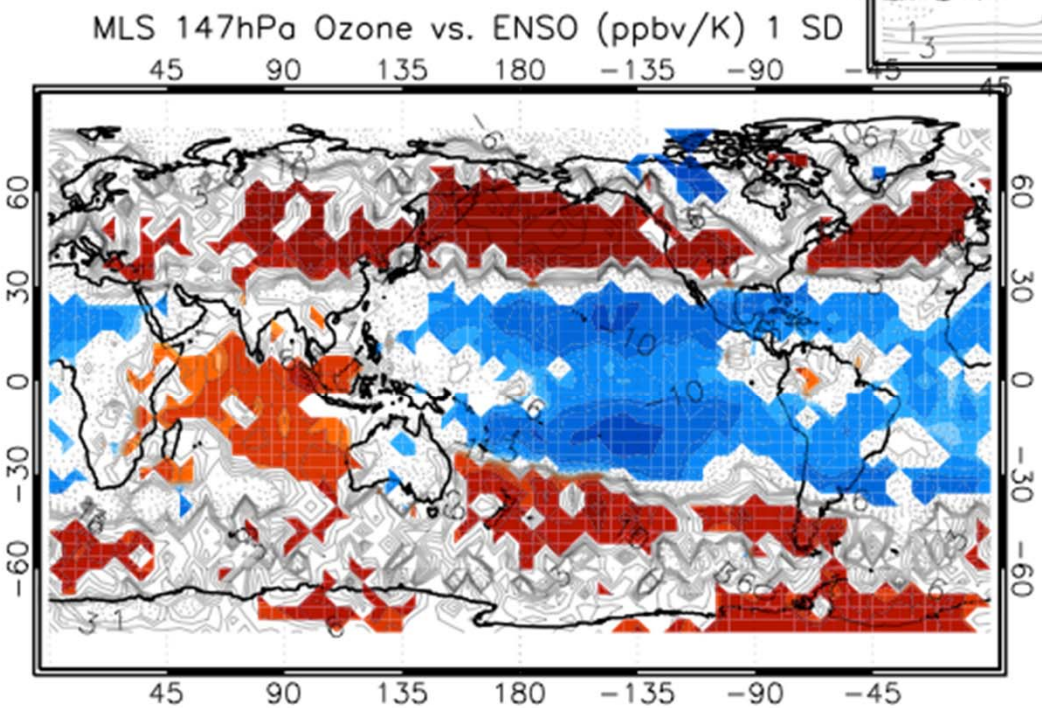


(150 hPa CCM, 147 hPa MLS) Spatial Ozone Sensitivity to ENSO

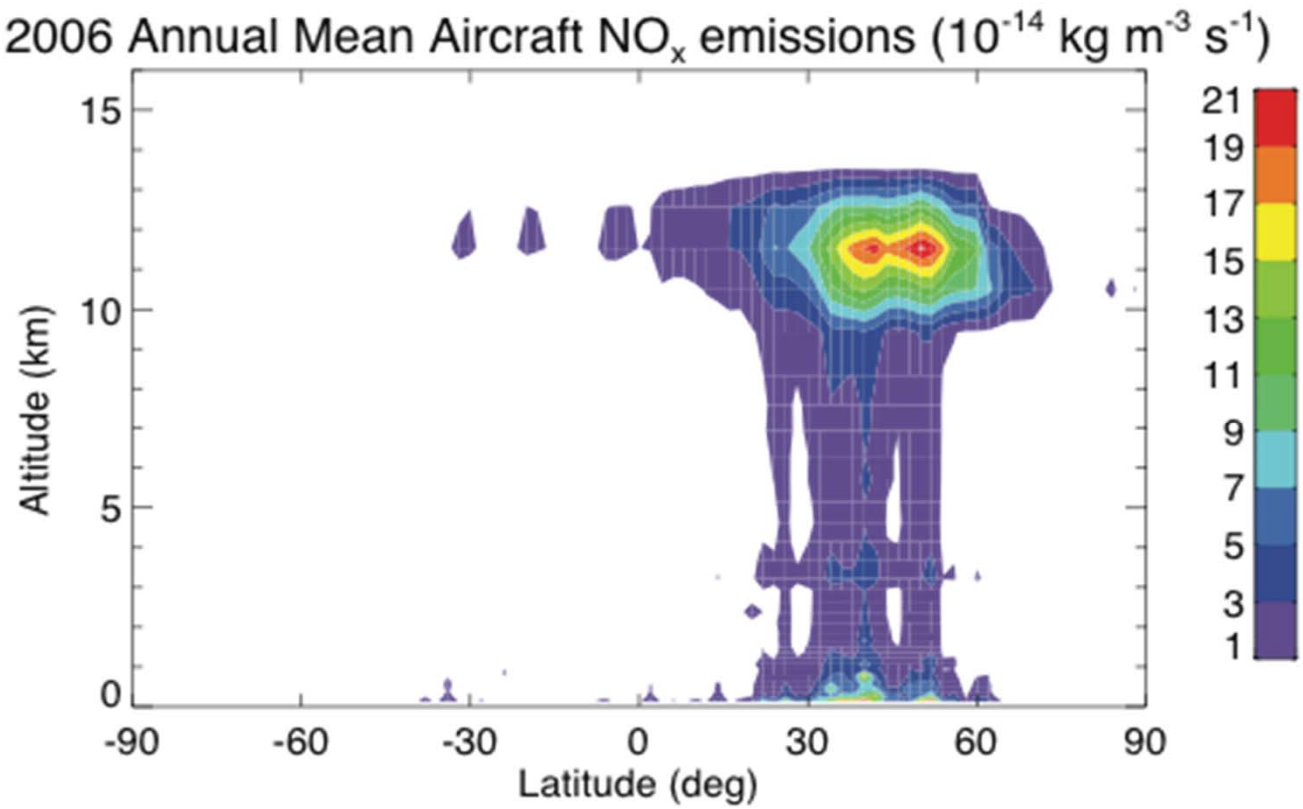
Color contours shown for sensitivities significant above 1.5 SD for CCM and 1 SD for MLS.

Very nice representation of both the pattern and magnitude response using only 6 years of MLS data.



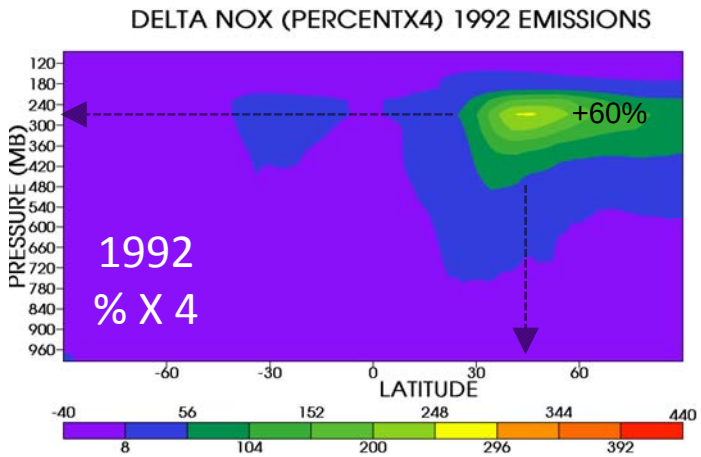


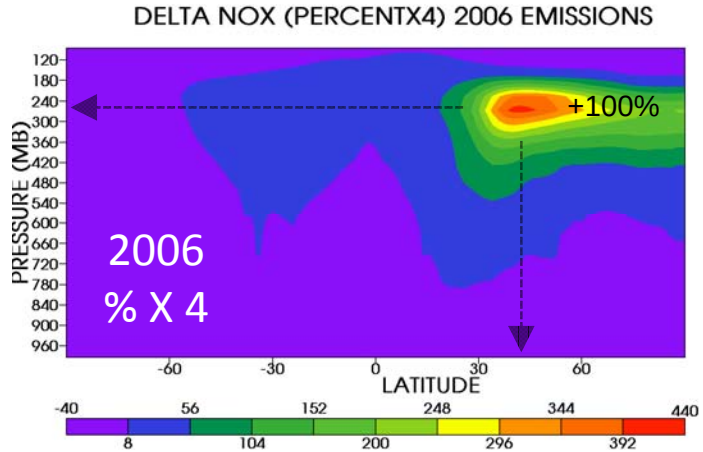
Application: AEDT Annual Mean 2006 NO_x emissions
[equivalent NO_2]

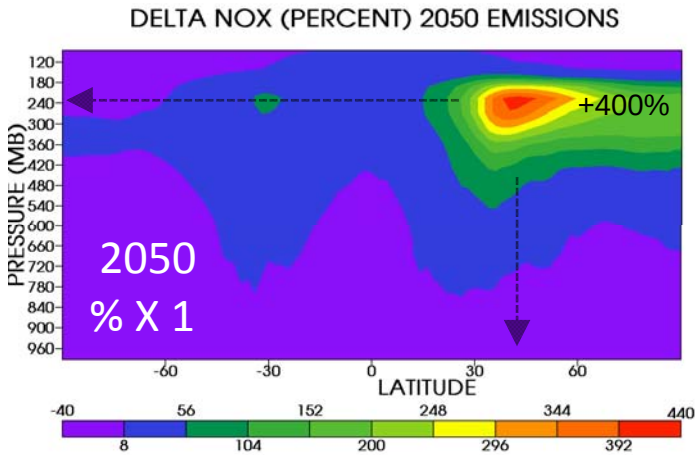


GMI NO_x perturbations

[6th year of El Niño conditions]







Peak NO_X response

- 1992 emissions: +60-70%; ~10 km
- 2006 emissions: +90-100%; ~10 km
- 2050 scenario: +400%; ~11 km

✓ *all three cases show max at 40-45°N*

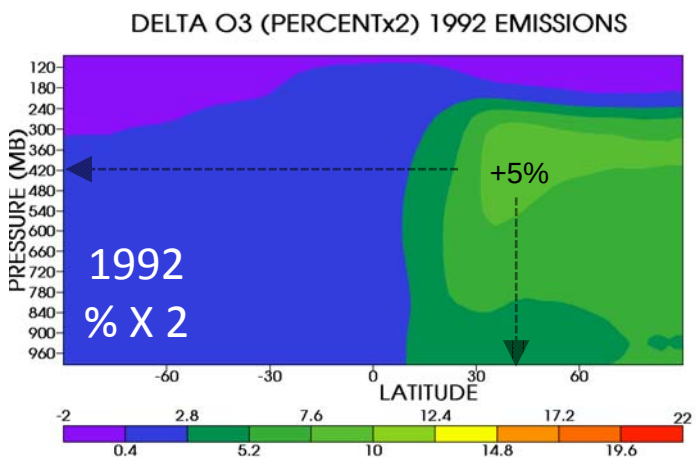
✓ *long tails into Arctic*

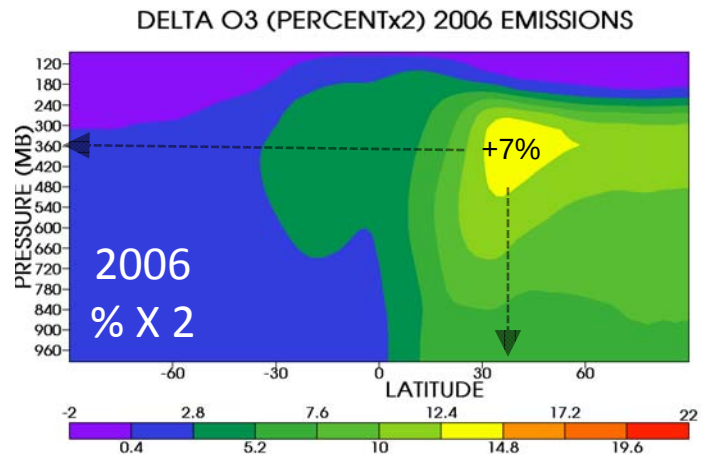
✓ *2050 scenario peaks about 1 km higher*

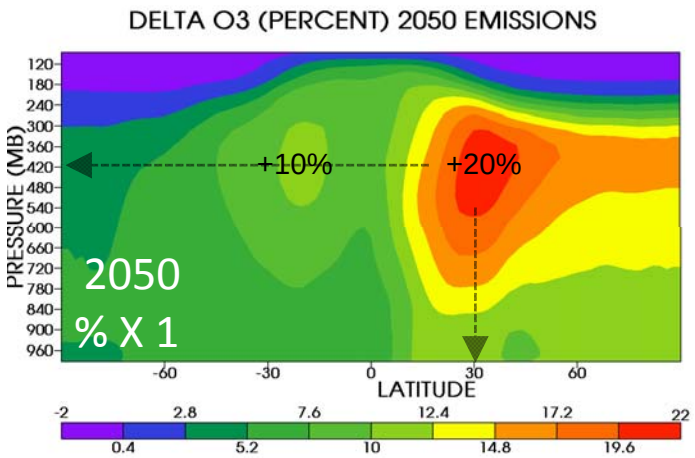
✓ *progressively more response in SH*

GMI Ozone perturbations

[6th year of El Niño conditions]







Peak OZONE response

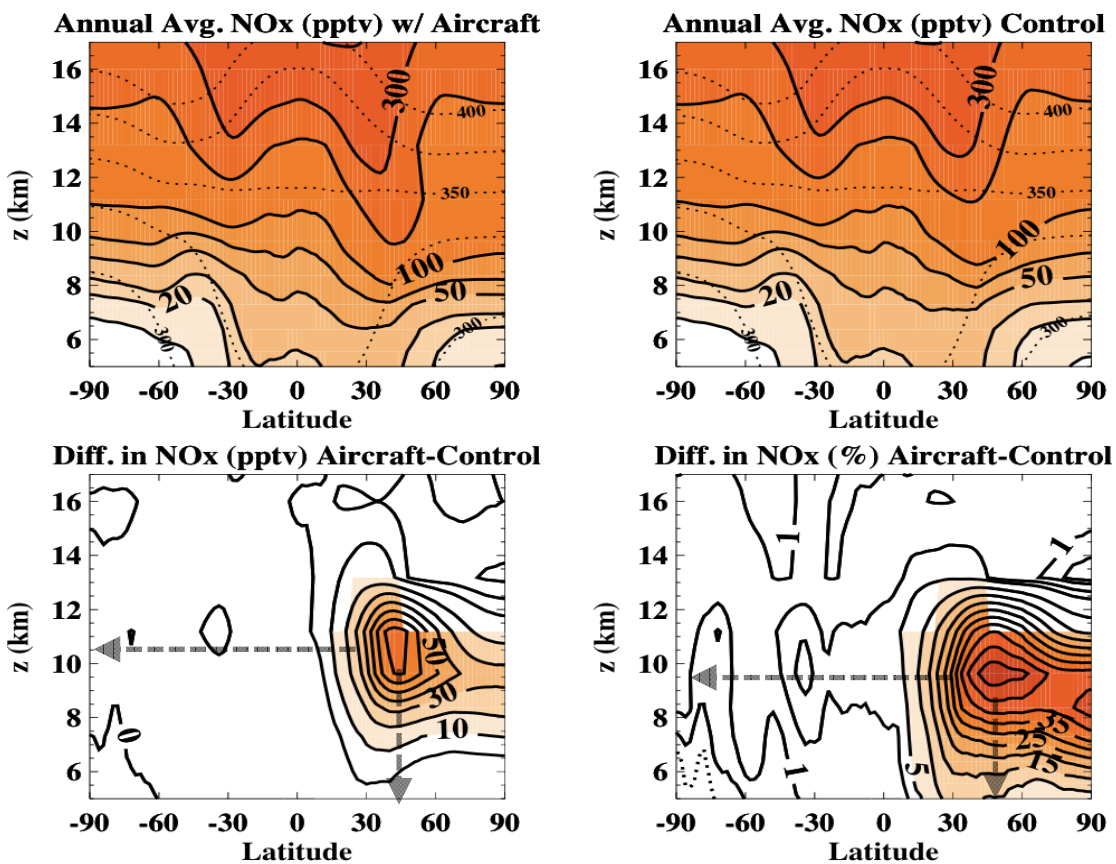
- 1992 emissions: ~5%; ~7 km
- 2006 emissions: ~7%; ~8 km
- 2050 scenario: ~20%; ~7 km

✓ *ozone peaks ~3km below NO_x*

✓ *positive perturbations at the surface*

✓ *progressively more response in SH*

GEOS CCM - NO_x Perturbations, 2006



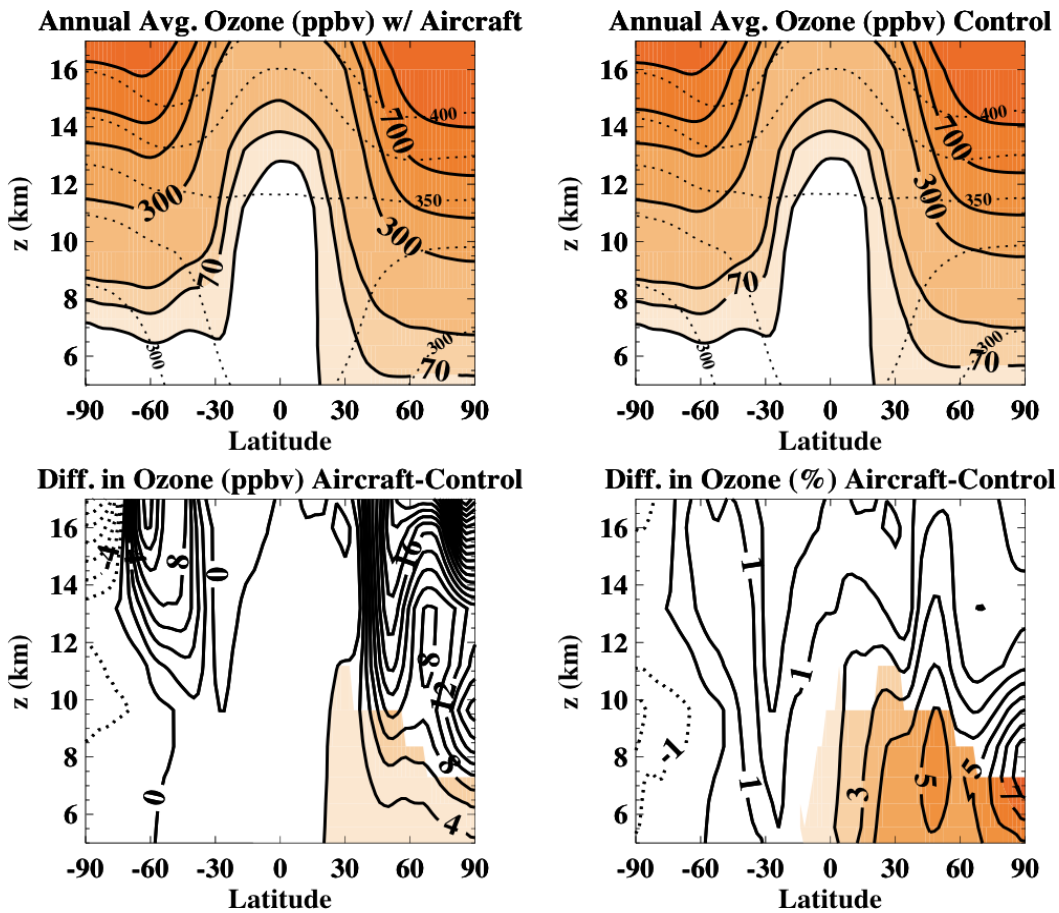
Ensemble of 26 1-year simulations; control includes IPCC/NASA 1992

NO_x absolute peak:
~70 pptv, 10.5 km ~45°N

NO_x relative peak:
>50%, 9.5 km, ~48°N

Secondary max near North Pole

GEOS CCM – O_3 Perturbations, 2006



Ensemble of 26 1-year simulations; control includes IPCC/NASA 1992

Two 95% significant peaks in ozone relative response:

- *>5%, 7 km, ~45°N*
- *>8%, 7 km, pole*

Other on-going applications

- Participation in ACC-MIP (Sarah Strode)
- Changes in tropospheric ozone due to changes in stratospheric ozone 1960 – 2000 – 2100 (Chang Land and Darryn Waugh)
  - Change in influx from the stratosphere
    - Stratospheric Ozone change due to ODSs
    - Stratospheric Ozone change due to climate change (stratospheric circulation and temperature)
  - Change in Methane but other emissions constant

Other ongoing applications

- Change in tropospheric OH (Salawitch and grad student)

Anticipation and Development

- Hindcast for CCM that would parallel the hindcast for the GMI-CTM (CCM hindcast likely to be longer as CCM does not have issues with met fields)
- Biggest problem – development/implementation of lightning Nox that would be similar enough to that used in the GMI CTM that a comparison of these two simulations would be sensible and enlightning.