Global Ozone-CO Correlations from OMI and AIRS as Constraints on Ozone Sources and Transport

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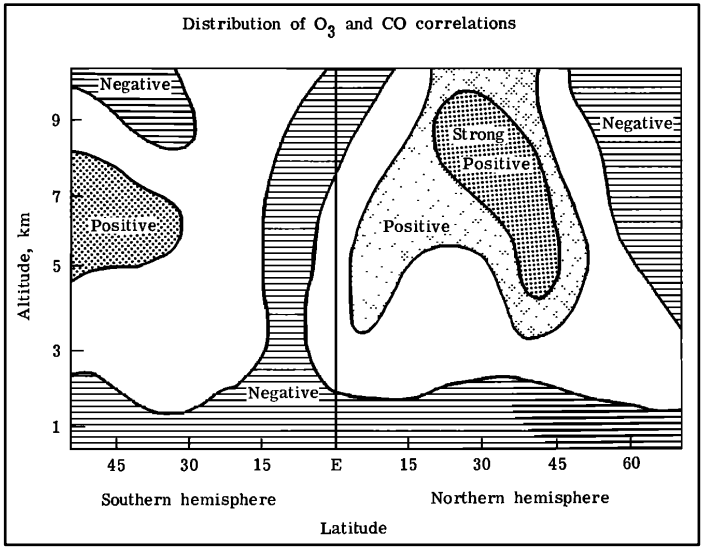
Application of O_3 - CO Correlations from In-Situ Observations

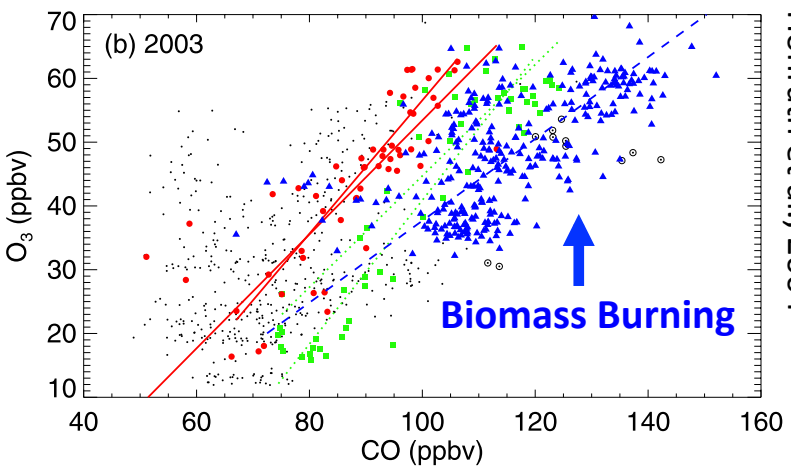
- Current global models capture observed ozone spatial and seasonal patterns, but there is large uncertainty in the driving factors
- Correlation with CO long used as a constraint on ozone sources and transport

Trace the Origin of O_3



Fishman and Seiler, 1983

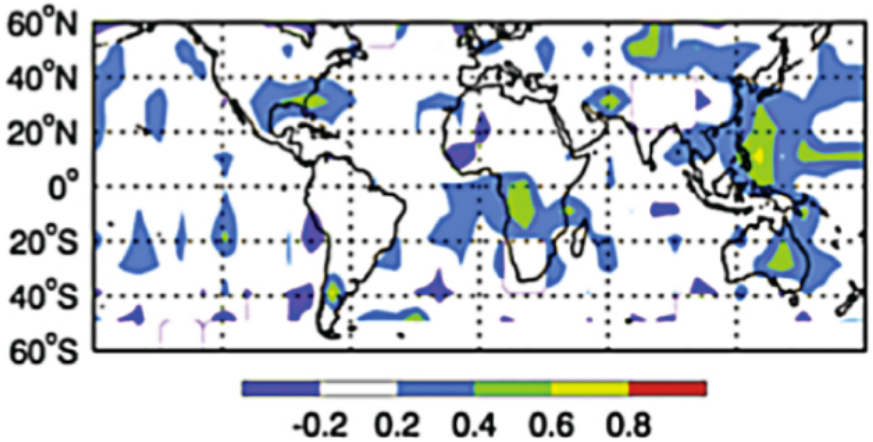
Quantifying O_3 Production During Plume Aging



Honrath et al., 2004

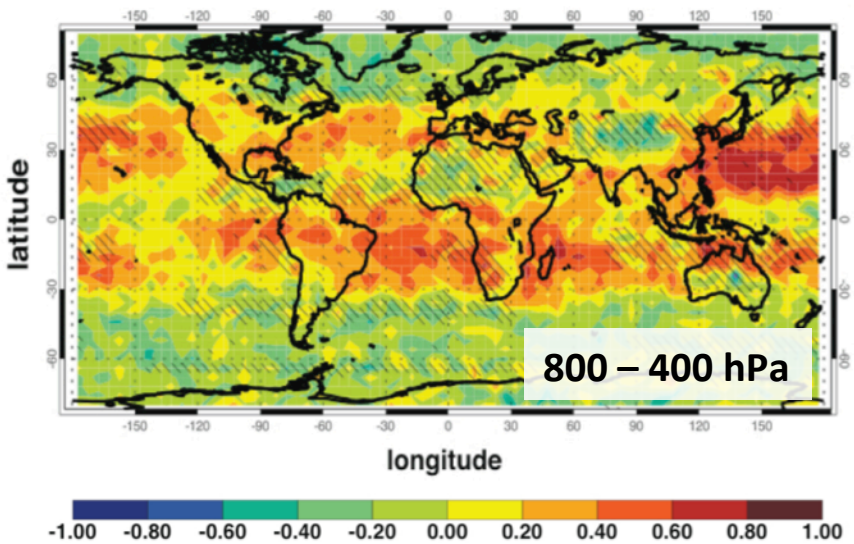
Satellite Derived Ozone-CO Correlations

July 2005 TES O_3-CO Correlation (618 hPa)



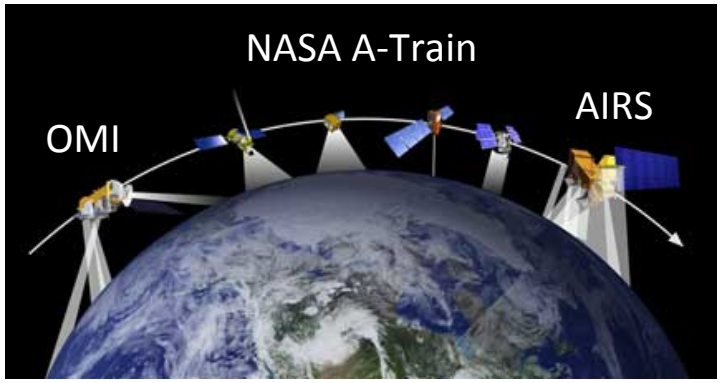
Zhang et al., 2006

July - August 2005-2008 TES O3-CO



Voulgarakis et al., 2011

- O_3-CO correlations are preserved in satellite observations despite smoothing from averaging kernels
- The ability to infer O_3-CO correlations from TES is limited by data sparsity



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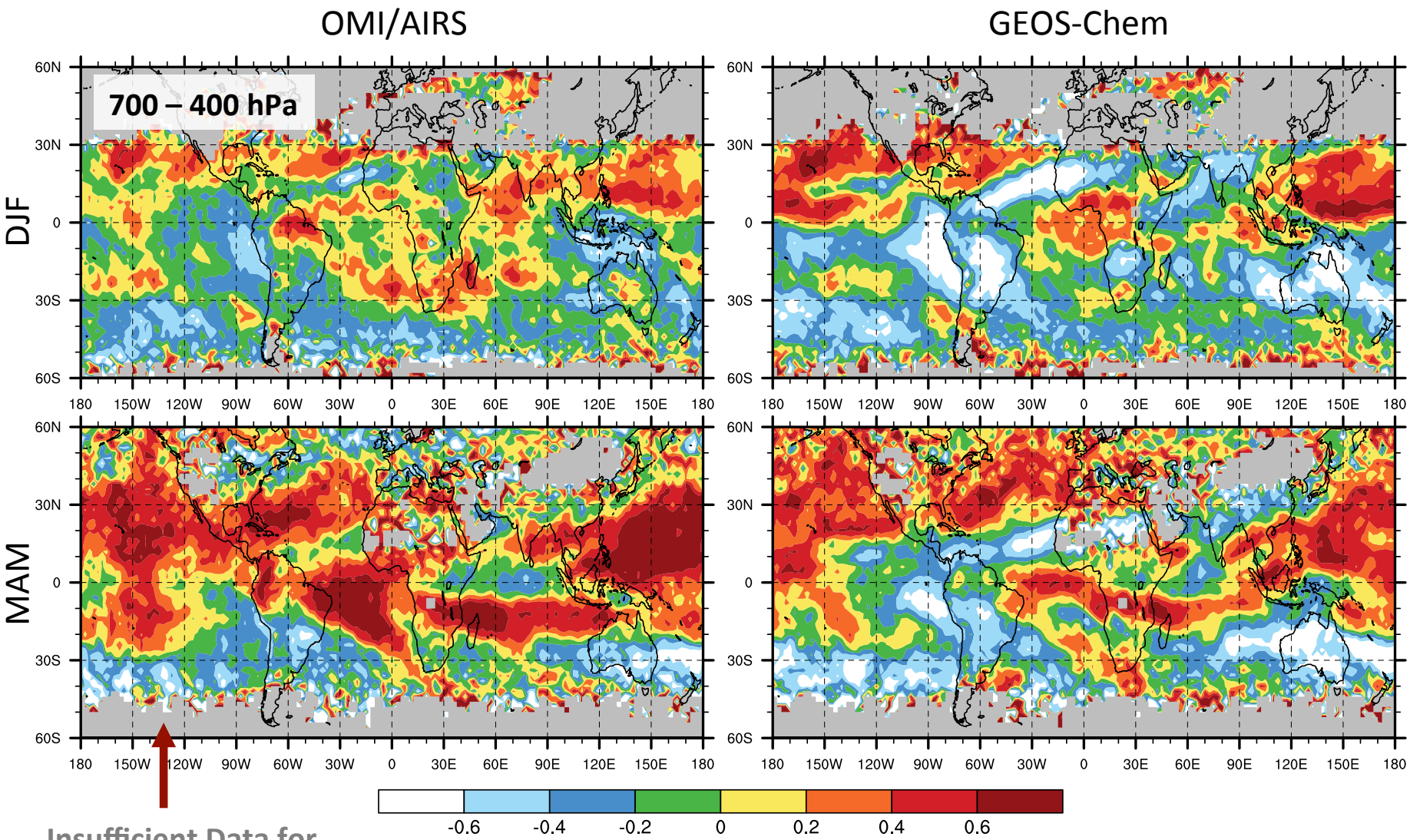
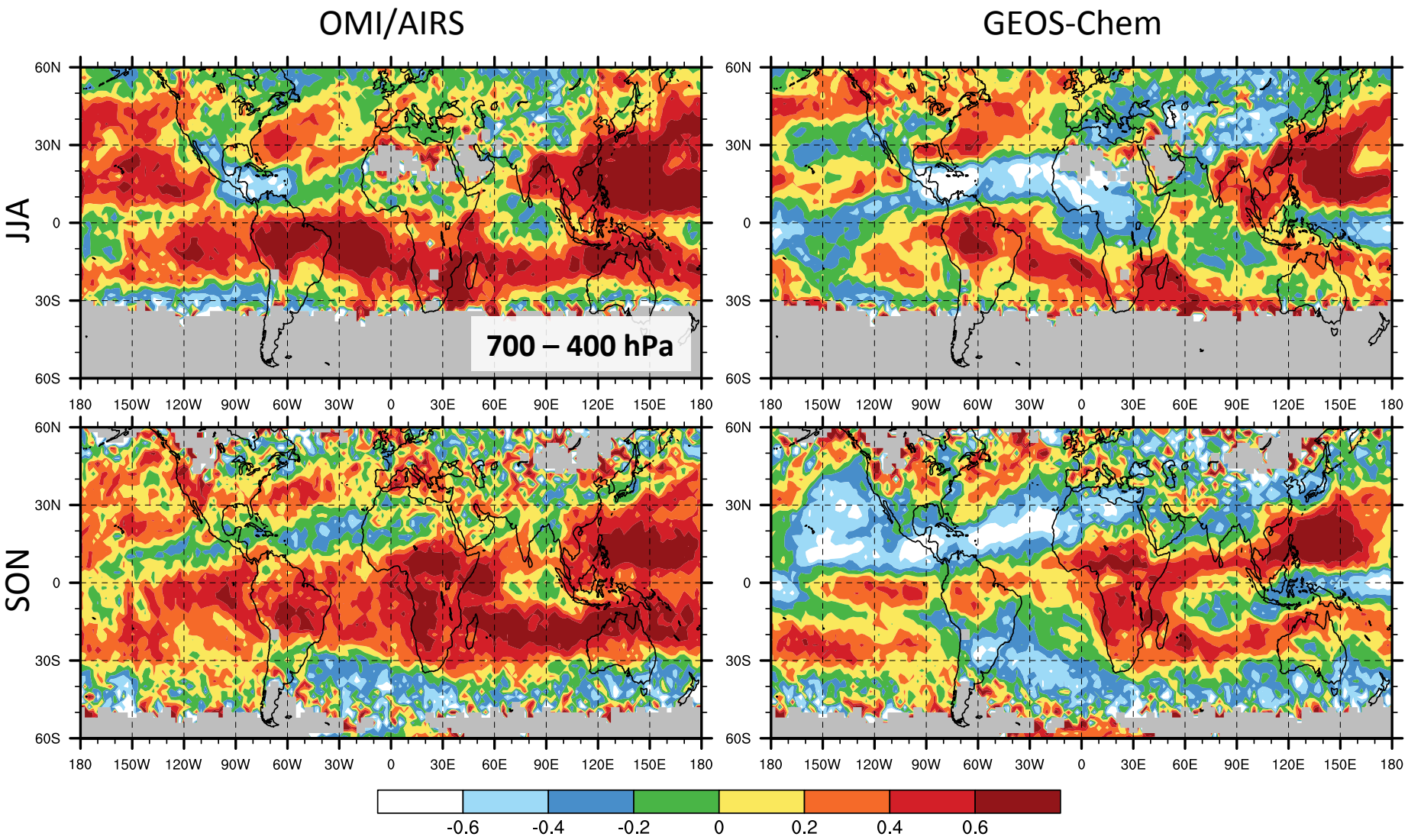
- O_3-CO correlations from OMI/AIRS retrievals avoid the sampling limitations of the TES instrument

O_3 - CO Correlations (DJF, MAM)



Insufficient Data for either OMI or AIRS

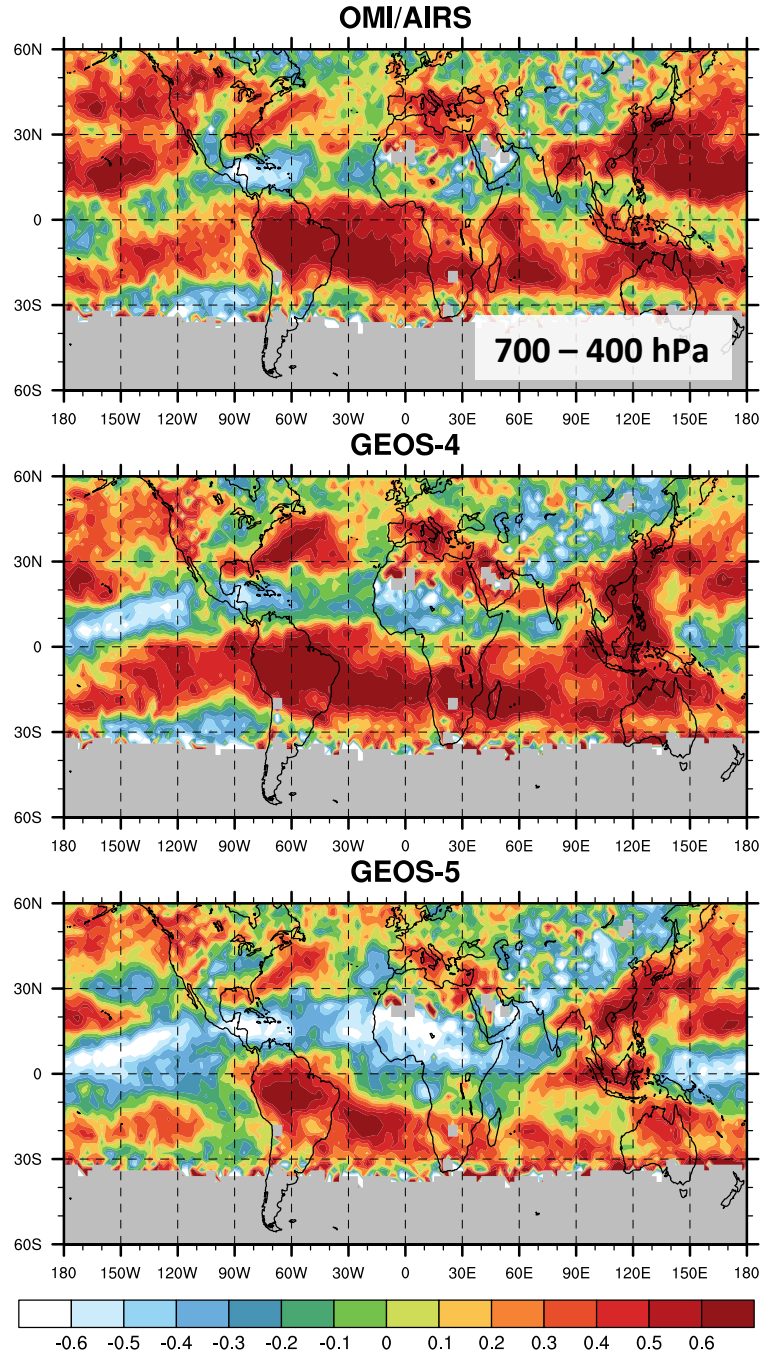
O_3 - CO Correlations (JJA, SON)



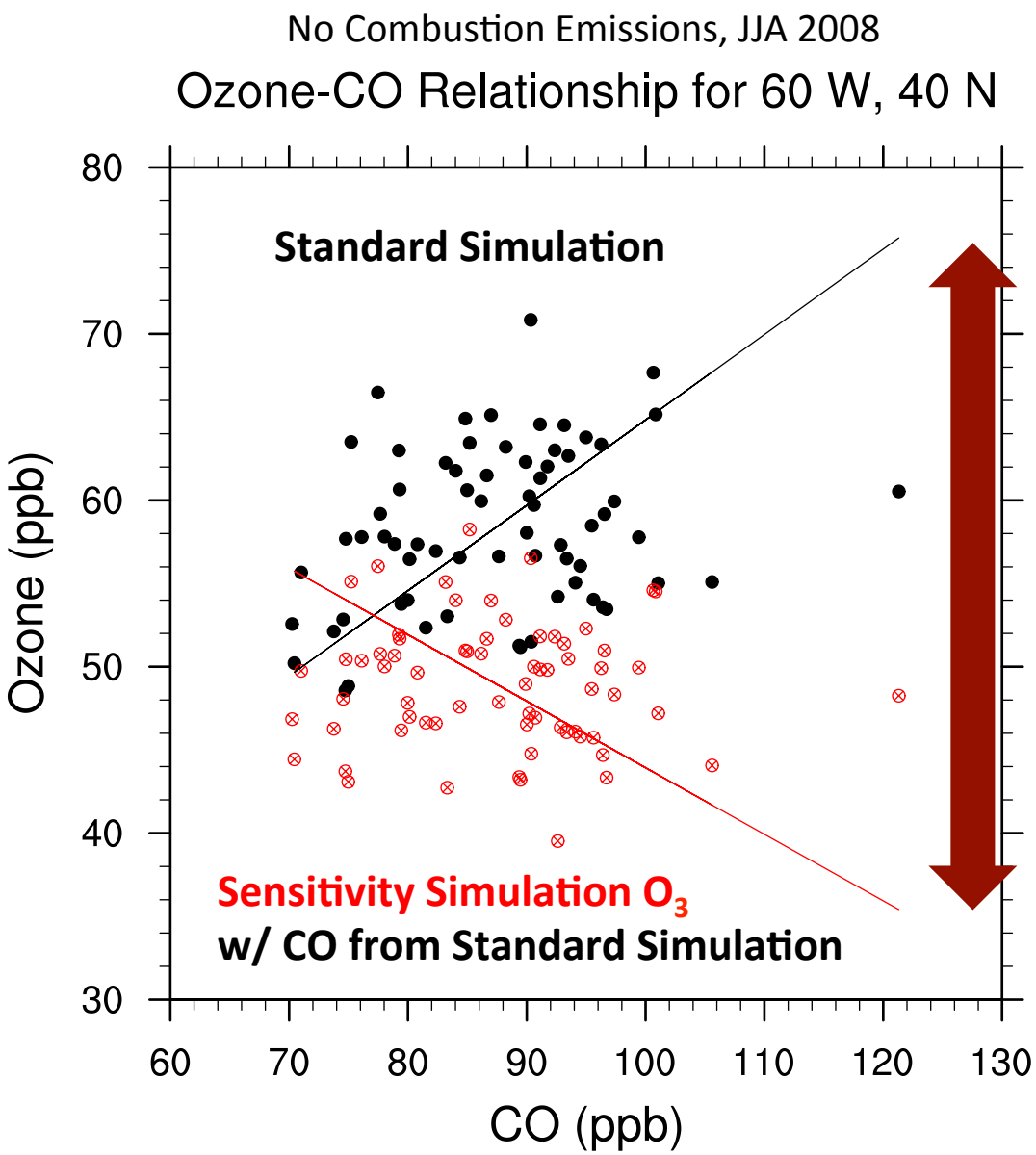
- GEOS-Chem captures large-scale structure of observed O_3 – CO correlation coefficients, but several regional discrepancies are apparent

Testing Sensitivity to Transport

- Drive GEOS-Chem with two different assimilated meteorological fields (GEOS-4 & GEOS-5) for **JJA 2006**
- Large sensitivity of simulated O_3-CO correlation to transport in the tropics
- We attribute these differences to the convective parameterizations used



Interpreting the Chemical Signature



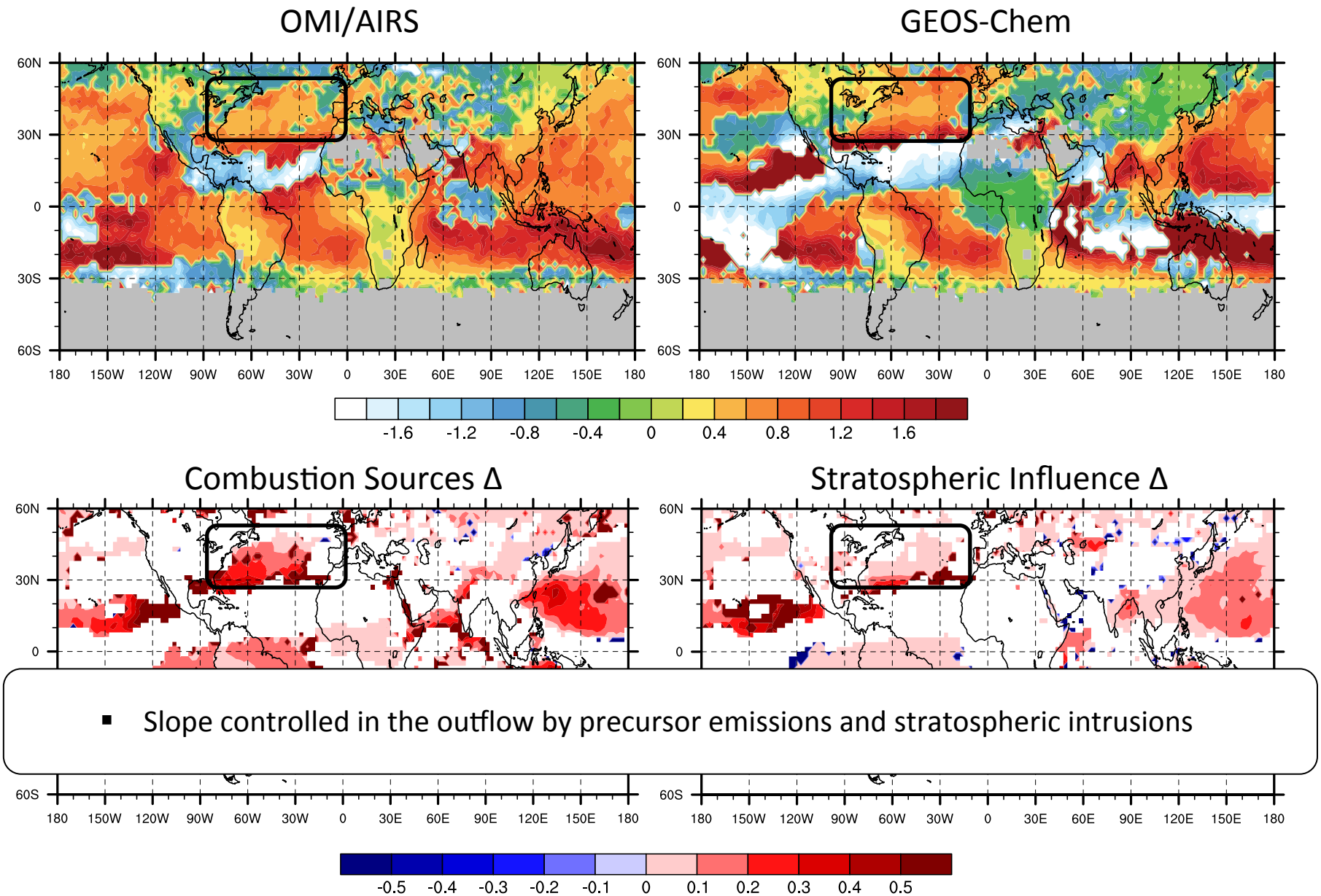
Δ = Chemical signature of process on the O_3-CO slope

- Difference in reduced major axis (RMA) regression slopes allow quantitative calculation of slope sensitivity to model processes

Correlation = .26
$d[O_3]/d[CO]$ = .51 (-0.10, +0.12)

Correlation = -.04
$d[O_3]/d[CO]$ = -0.40 (-0.09, +0.46)

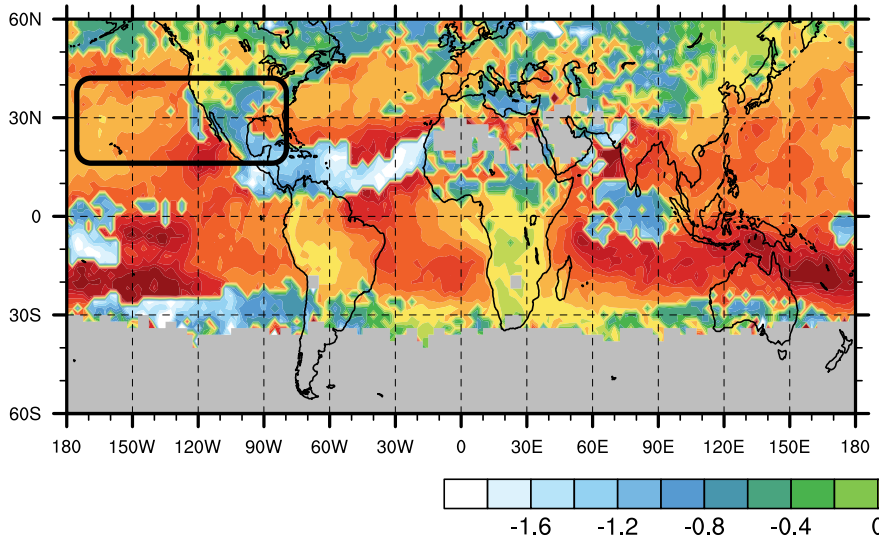
d[O_3]/d[CO] in North American Outflow (JJA 2008)



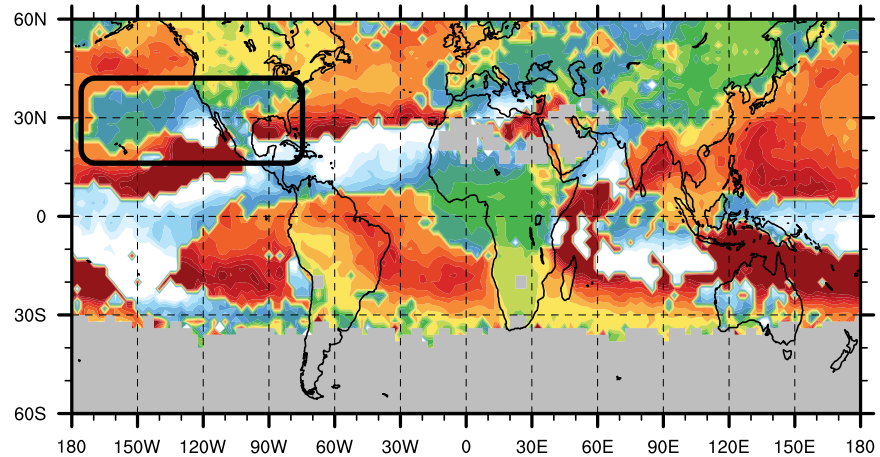
- Slope controlled in the outflow by precursor emissions and stratospheric intrusions

d[O_3]/d[CO] over the East Pacific (JJA 2008)

OMI/AIRS

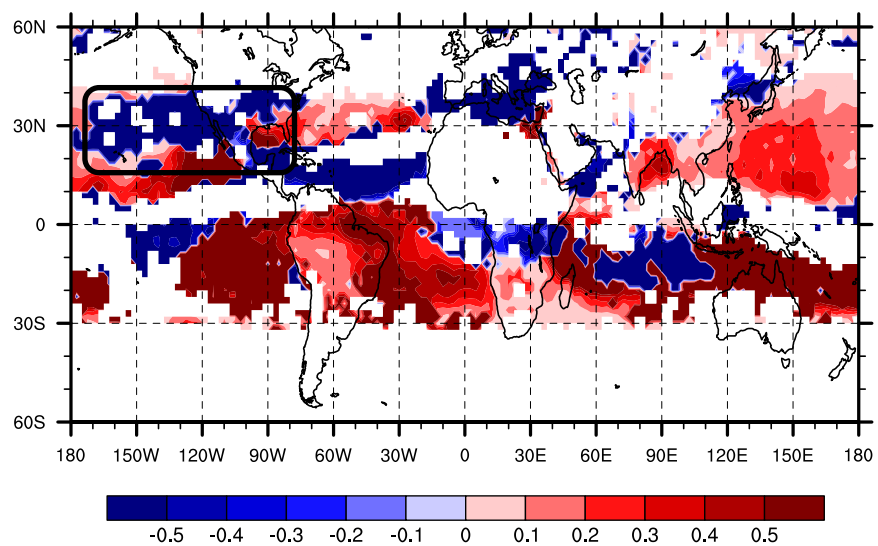


GEOS-Chem



- Lightning NO_x emissions dominate simulated ozone-CO relationship in the region
- Excellent agreement with OMI/AIRS over land
- Large negative overestimate over the East Pacific associated with the Pacific High

Lightning Δ



Summary & Future Work

- Near-daily global coverage of OMI/AIRS allows us to calculate robust statistical relationships between ozone and CO with much less error and finer spatiotemporal resolution than previous satellite studies

- GEOS-Chem captures large scale spatial structure of the observed O_3 – CO correlation coefficients, but several regional discrepancies are apparent

- O_3-CO correlations simulated by GEOS-Chem using GEOS-4 and GEOS-5 winds show strong sensitivity to convection in the tropics

- GEOS-Chem successfully simulates North American outflow, with contributions from precursor emissions and stratospheric intrusions. The two are coupled due to the structure of mid-latitude cyclones

- The representation of lightning in the model controls the good agreement with OMI/AIRS over land but also the significant model negative overestimate in the East Pacific during JJA 2008

- Future work will include examining the interannual variability of ozone-CO correlations over SE Asia