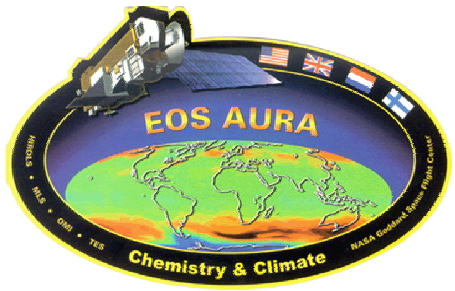
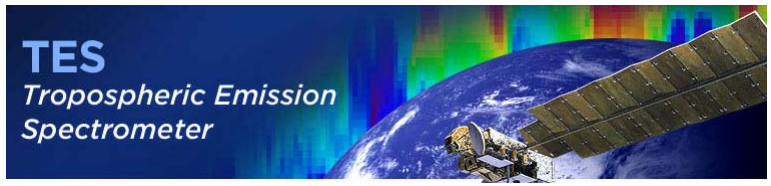
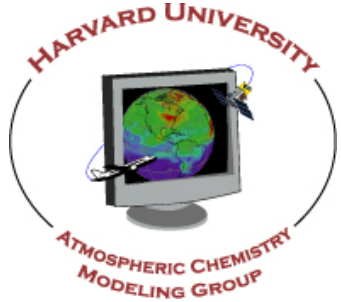
Tropical Tropospheric O_3 and CO during the 2006 El Niño from TES observations and GEOS-Chem simulations







Ray Nassar, Jennifer Logan, Inna Megretskaia, Lin Zhang,
Lee Murray & the TES Team

Aura Science Team Meeting
Pasadena, 2007-Oct-4

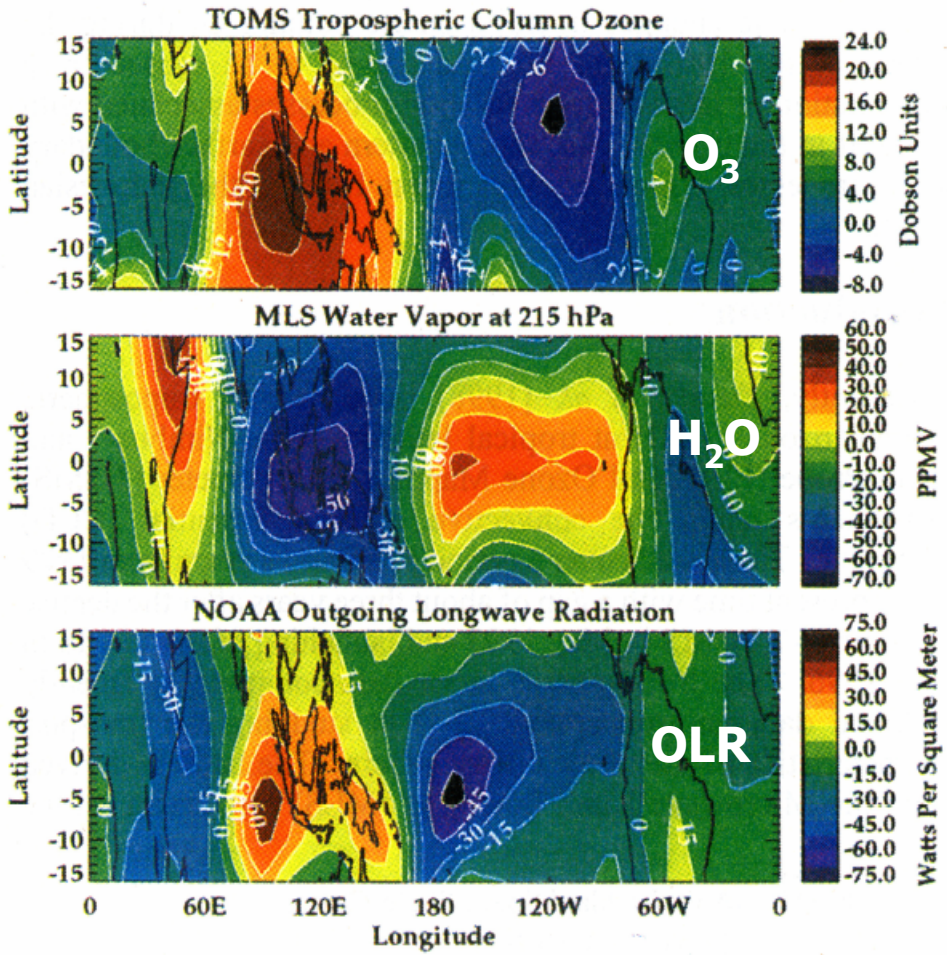
El Niño

Tropical Pacific SST anomaly induces changes in atmospheric convection, precipitation and composition

Asymmetric Dipole Anomalies:

Tropospheric ozone column residual
MLS H_2O at 215 hPa
Outgoing Longwave Radiation

1997 – 1996 Anomalies



Chandra et al. (1998) GRL

Modeling O_3 from the 1997 El Niño

***Hauglustaine, Brasseur & Levine* (1999) GRL**

MOZART model

***Sudo & Takahashi* (2001) GRL**

CHASER model

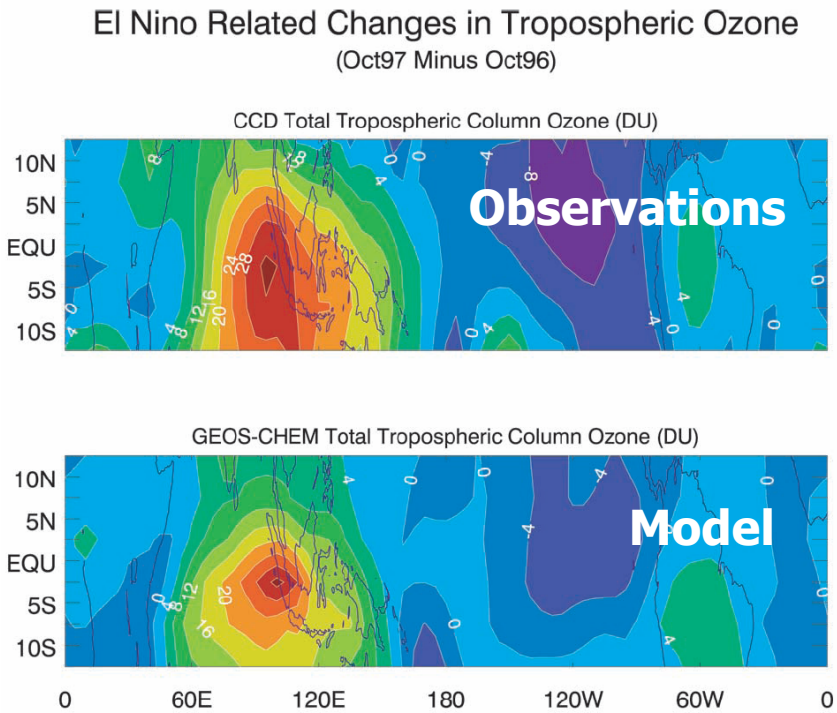
Trop Column Ozone from TOMS using Convective Cloud Differential technique

***Chandra et al.* (2002) JGR**

GEOS-Chem model

TCO using CCD, TOMS

TOMS Aerosol Index for biomass burning



Chandra et al. (2002) JGR

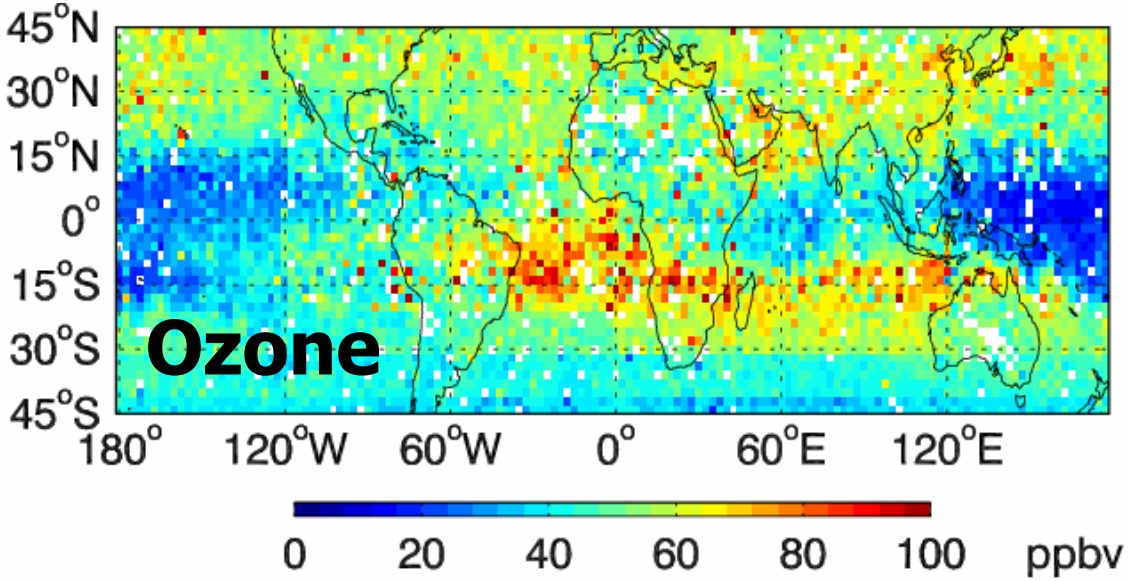
-> Biomass Burning component

-> Meteorology/Dynamics/Convection component

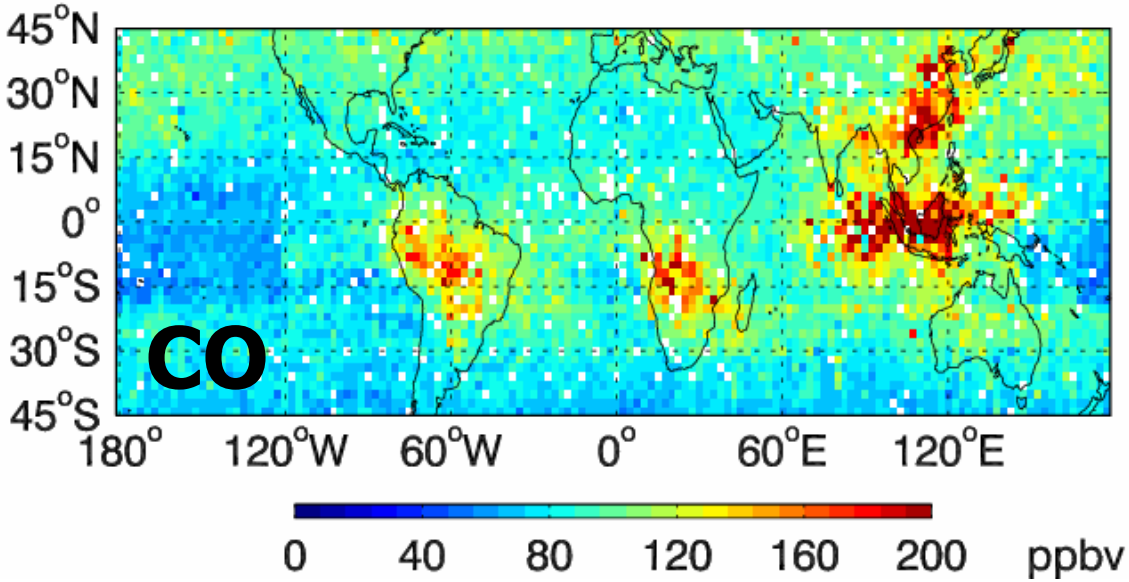
***Duncan et al.* (2003) JGR**

GEOS-Chem: biomass burning and lightning

TES Ozone and CO October 2006



Well-characterized O_3 with 2 DOFS in the troposphere



TES has simultaneous coincident CO, a better proxy for biomass burning than TOMS Aerosol Index

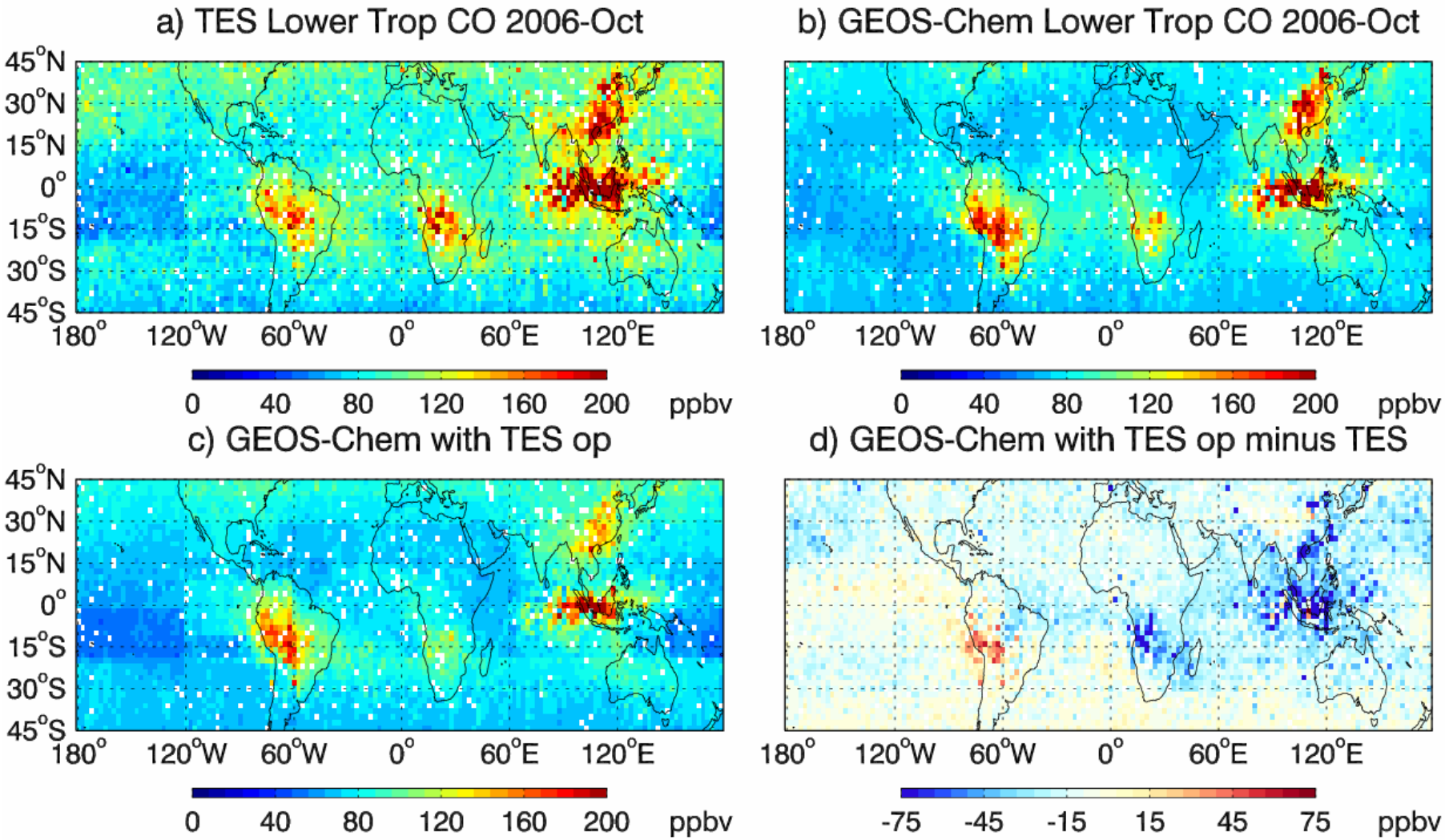
GEOS-Chem Simulations

- 3-D global tropospheric Chemical Transport Model (CTM)
- Goddard Earth Observing System 4 (GEOS-4) meteorology
- 10 month spin-up, 15 month run from 2005-09 to 2006-12
- 2º latitude x 2.5º longitude resolution
- v7.04.10 with improved lightning parameterization
- Global Fire Emission Database 2 (GFED2) emissions

TES and GEOS-Chem Comparisons

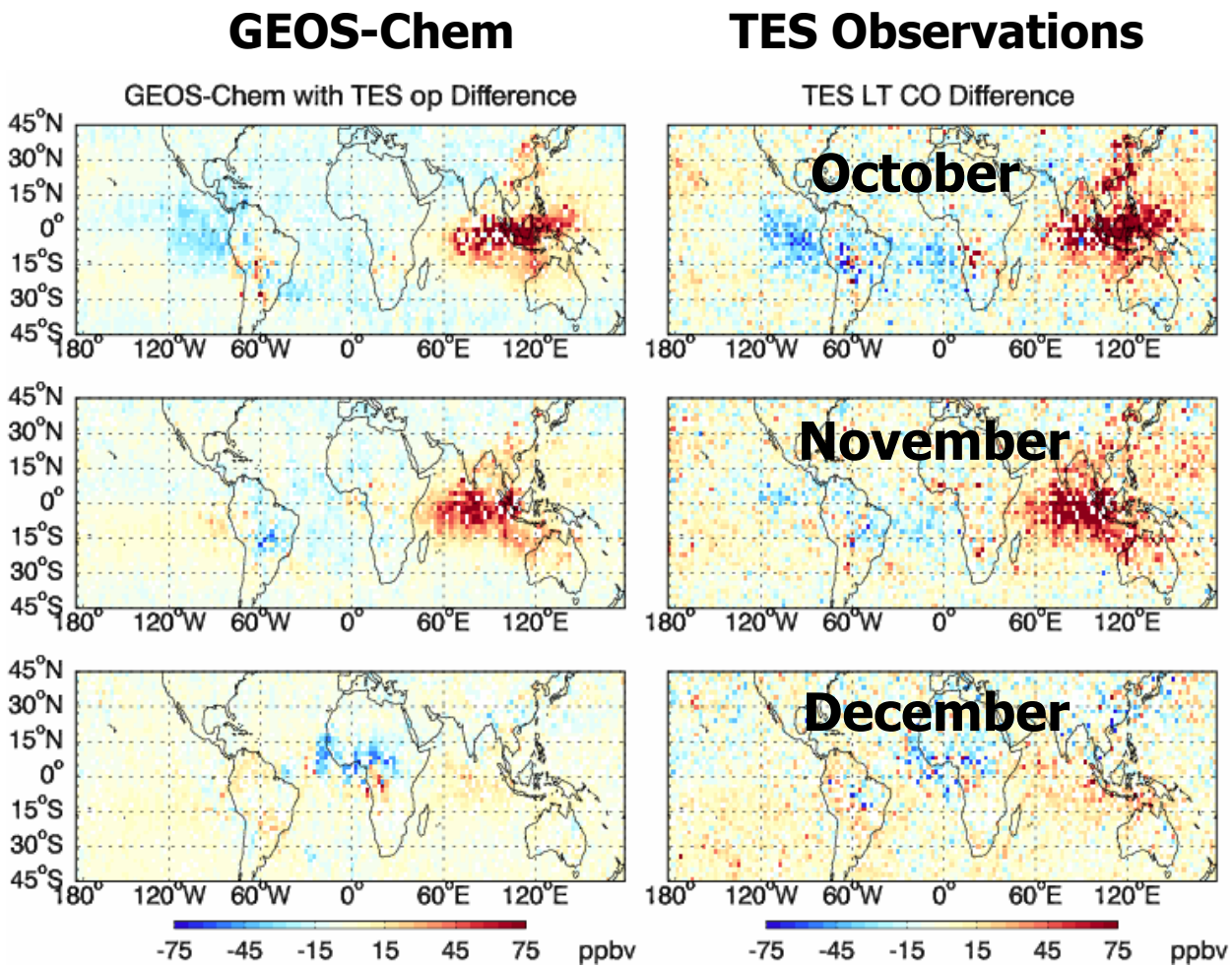
- TES v02 O_3 & CO filtered using data quality and O_3 emission layer flags
- Removed cloudy TES profiles (effOD > 2.0, cloud top above 750 hPa)
- GEOS-Chem sampled at TES positions and times ($\Delta t < 1.5$ hr)
- TES AK and constraint (TES op) applied to GEOS-Chem
- TES averaged in 2ºx 2.5º bins to match model
- TES averaged over 6 vertical levels: UT (464-287 hPa), LT (825-511 hPa)

TES & GEOS-Chem LT CO: October 2006

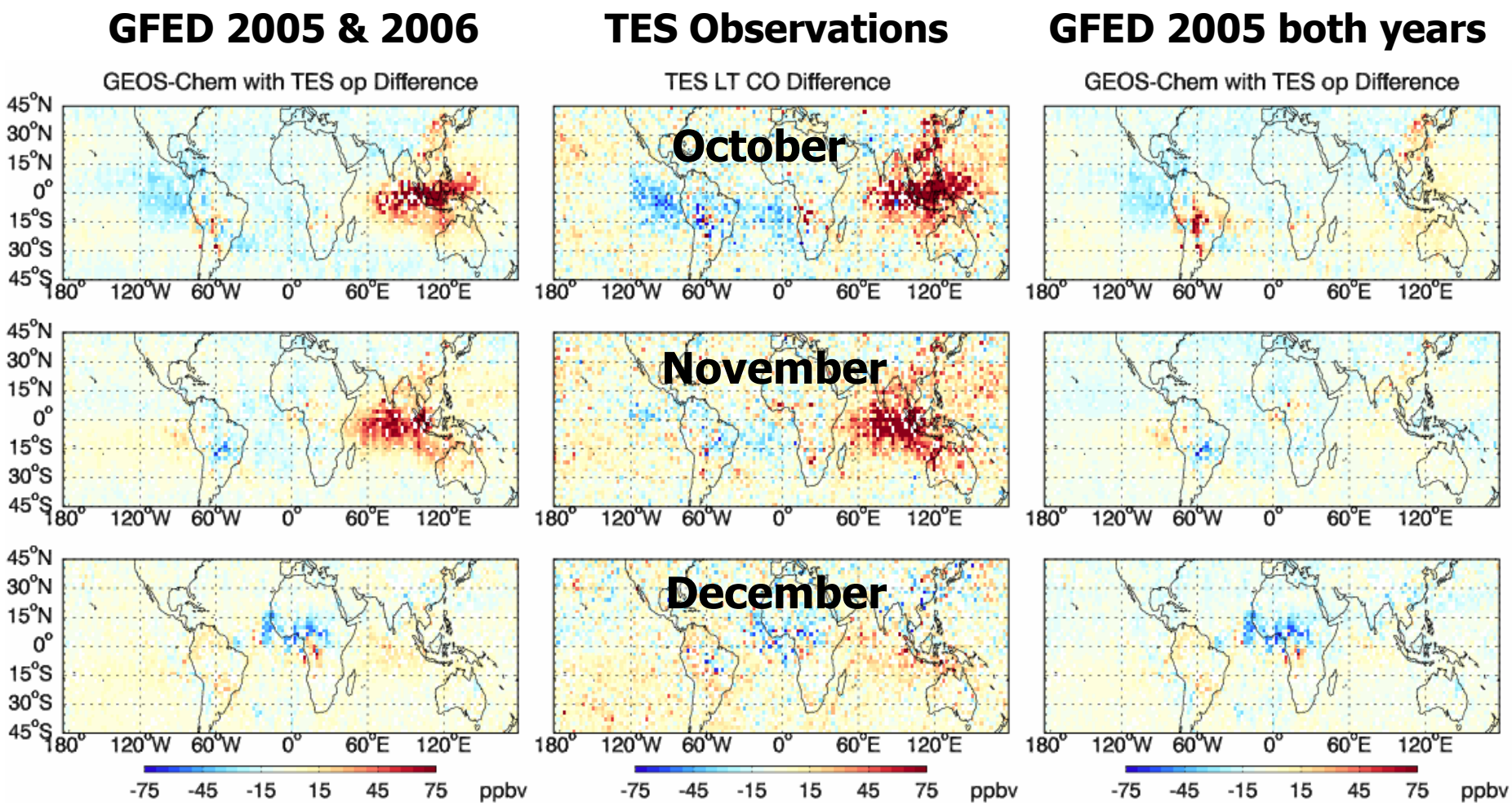


Differences exceed TES CO bias of 10%, *Luo et al.* (2007)

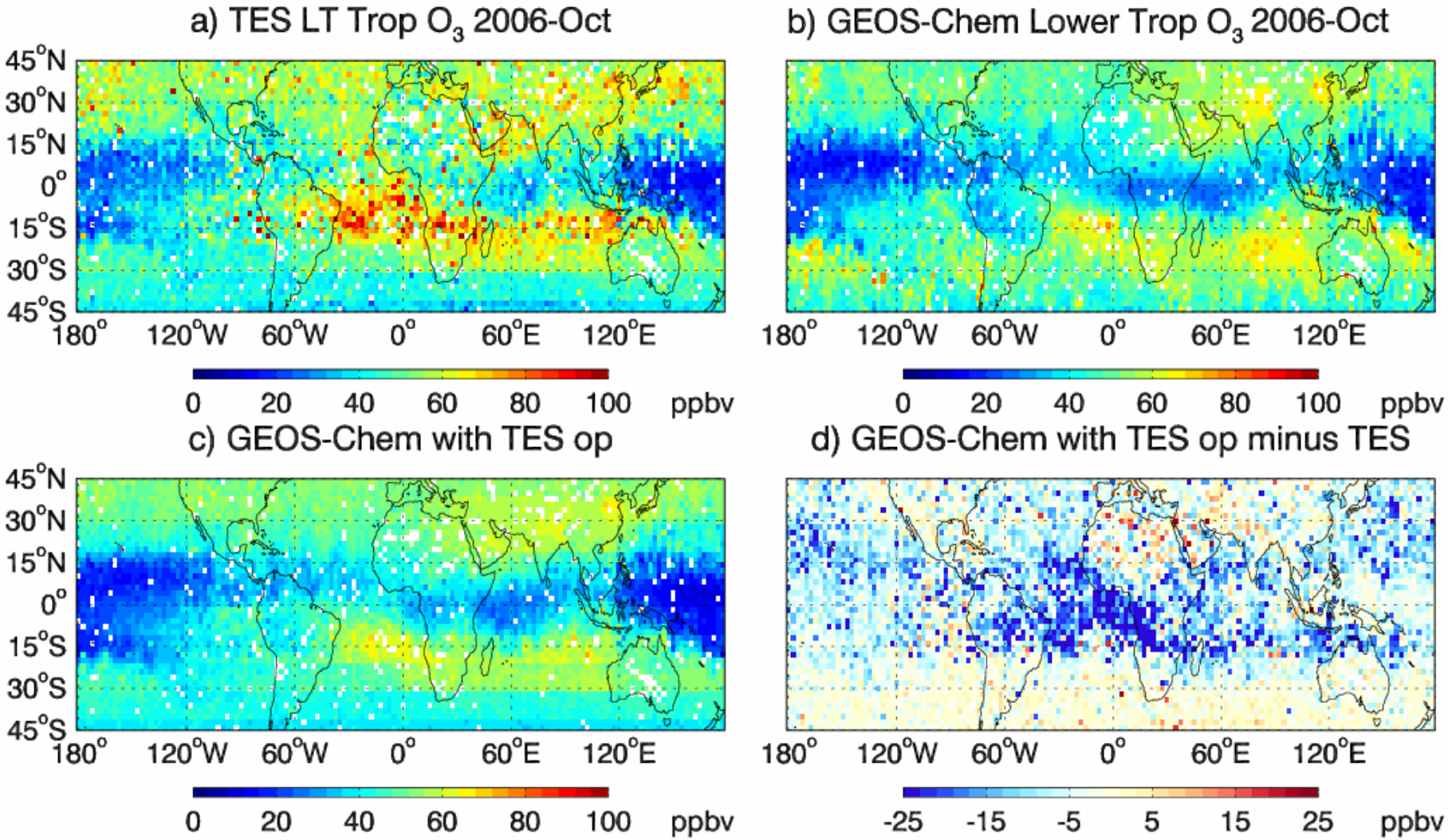
2006–2005 CO Differences



2006–2005 CO Differences

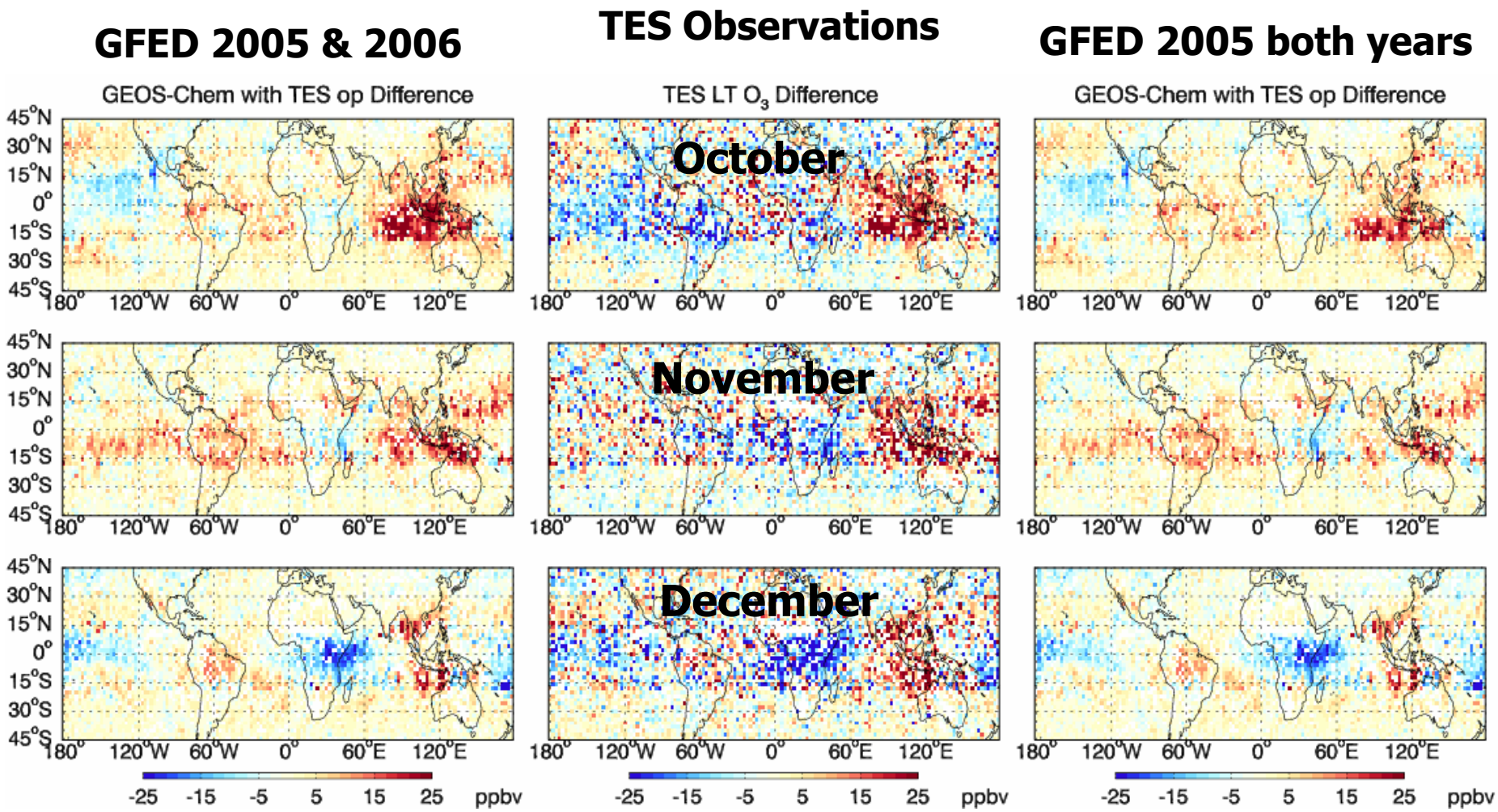


TES & GEOS-Chem LT O_3: October 2006



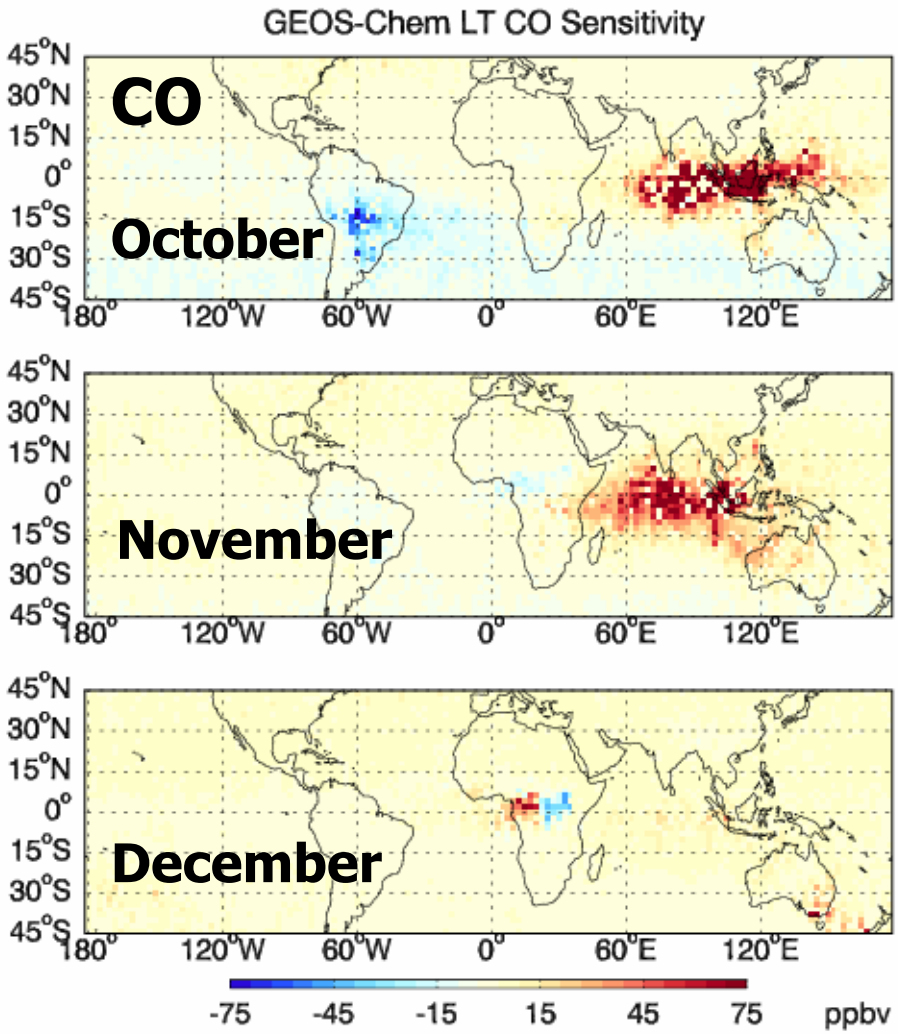
Differences exceed 3-10 ppbv bias in TES ozone *Nassar et al.* (2007)

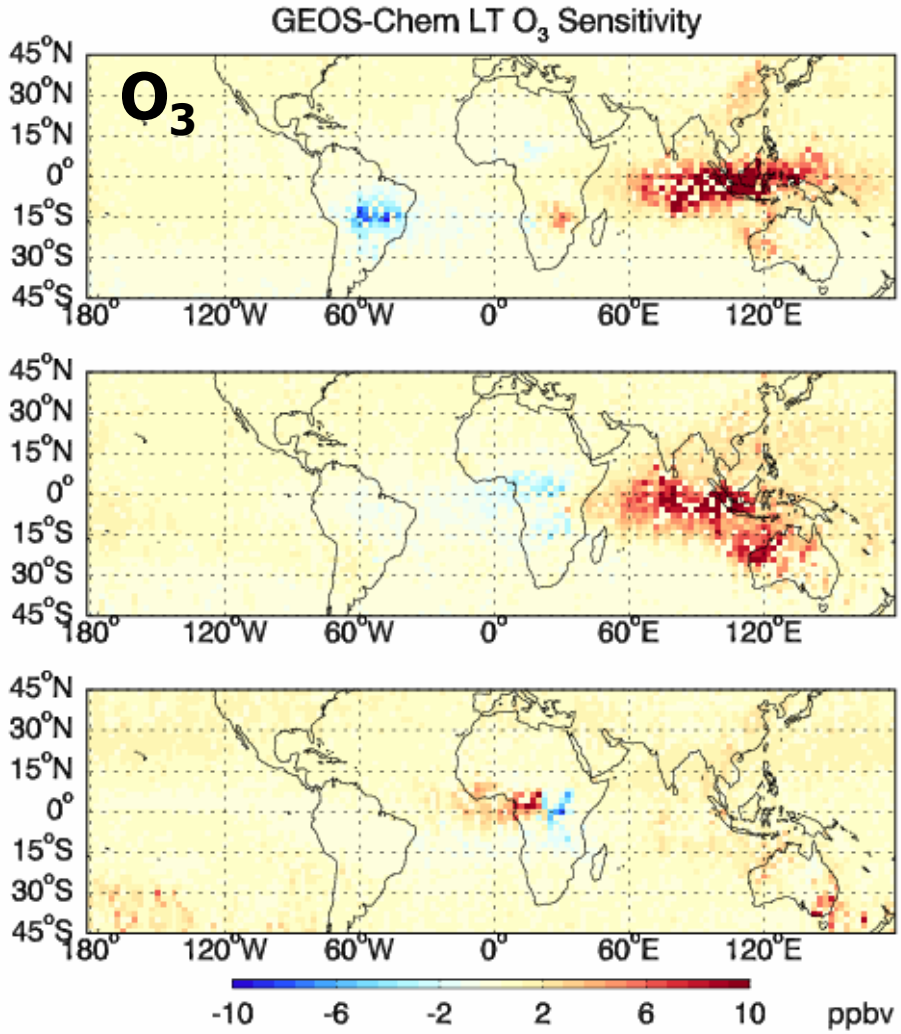
2006–2005 O_3 Differences



CO and O_3 Contribution due to Biomass Burning Changes

2006 meteorology/emissions – 2006 meteorology with 2005 emissions

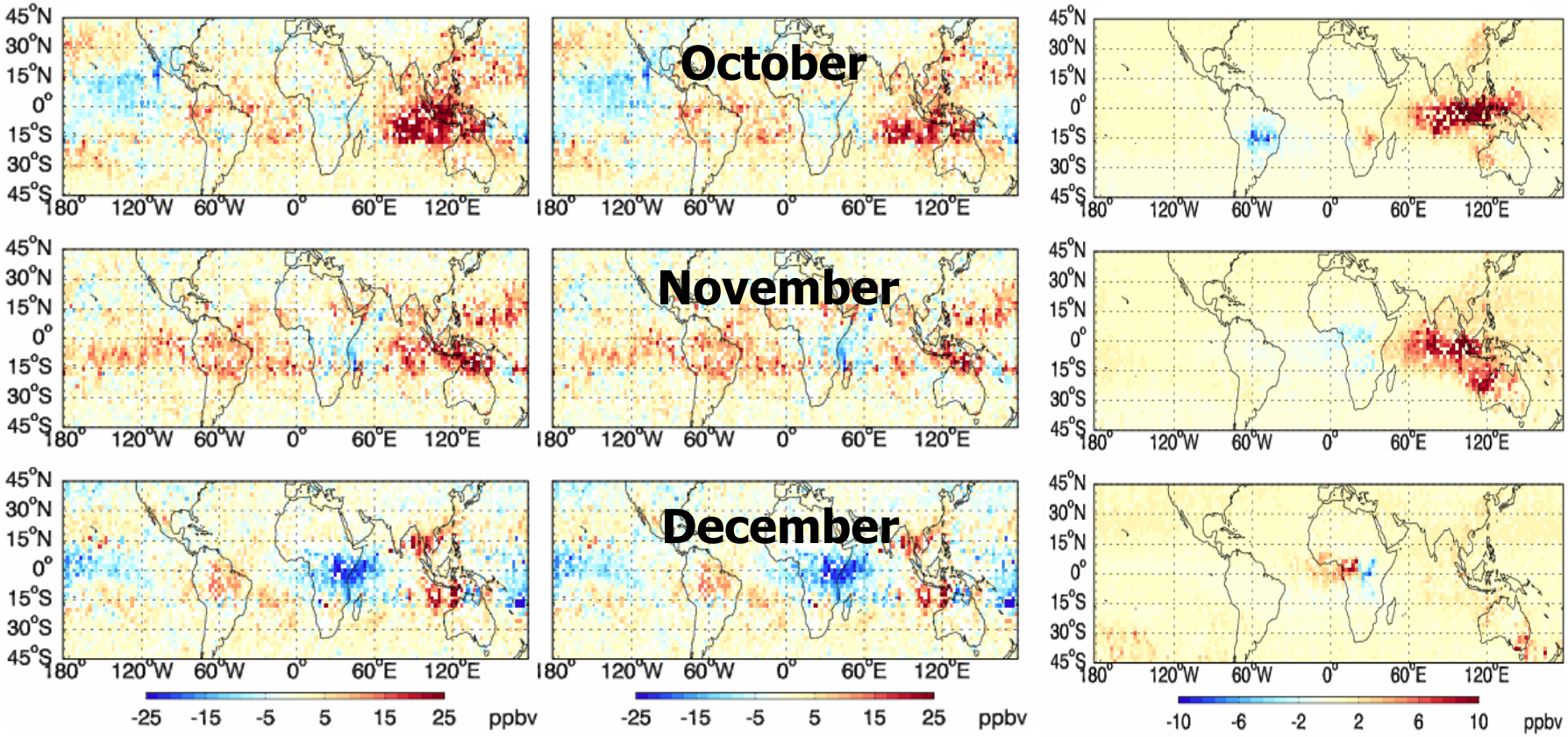




Note: different color scale

O_3: Separating the Effects of Meteorology and Emissions

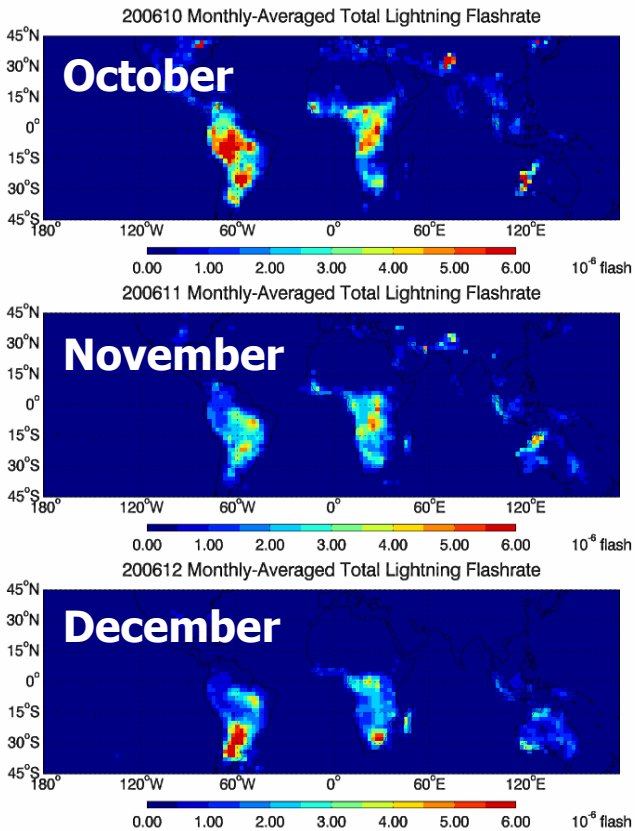
2006 - 2005 = **2006 - 2005 different meteorology same emissions** + **2006 - 2005 different emissions same meteorology**



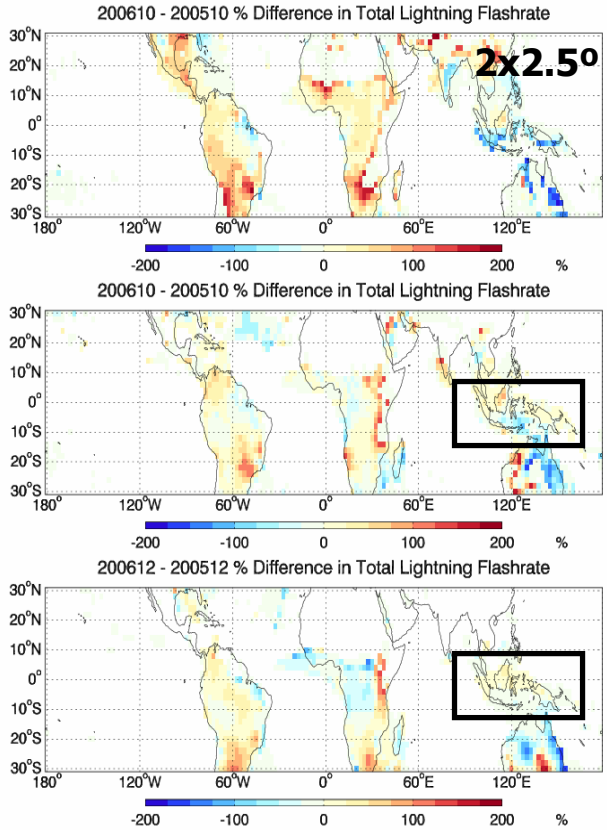
Note: different color scale

GEOS-Chem & Lightning Imaging Sensor (LIS)

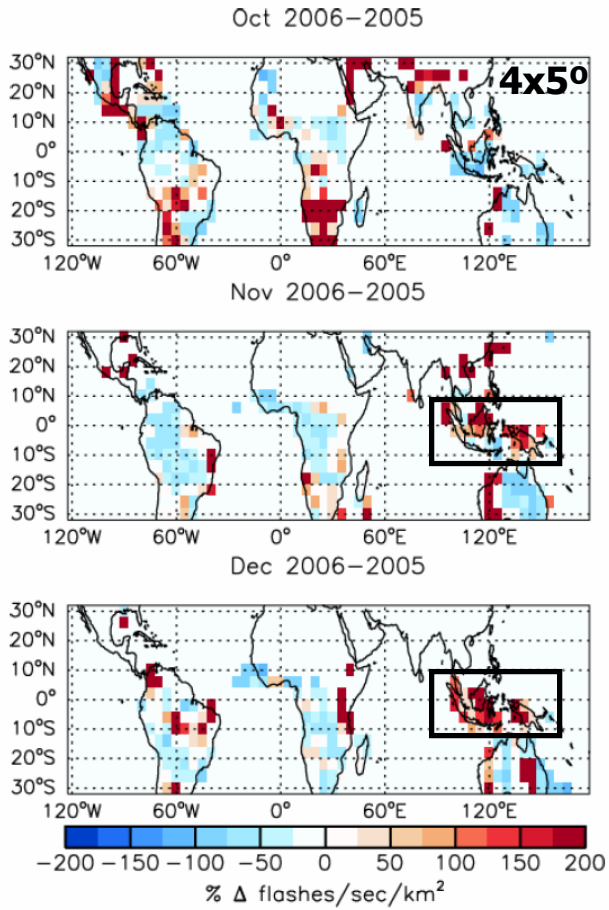
GEOS-Chem 2006 Lightning Flashrate



GEOS-Chem 2006-2005

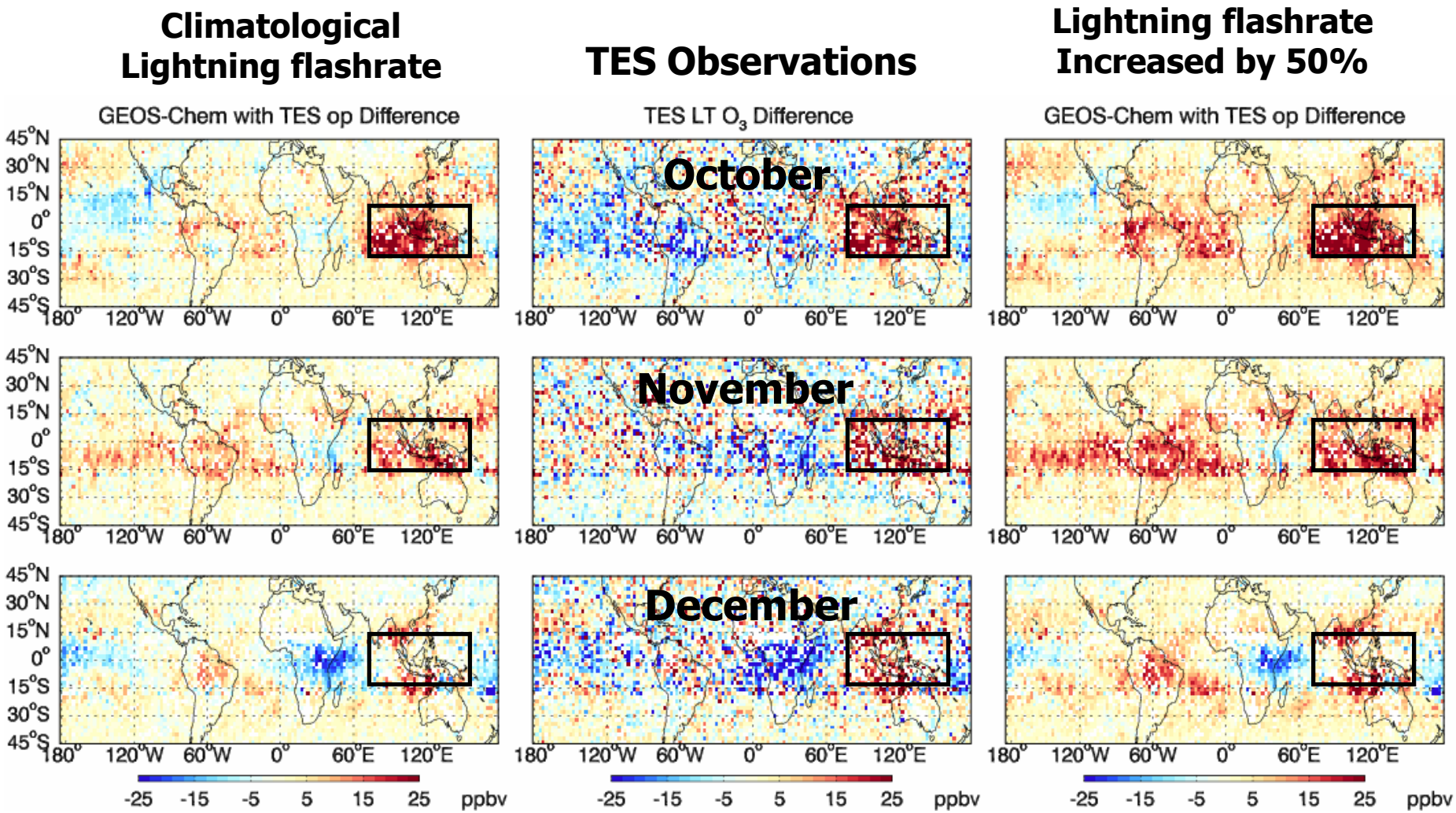


LIS Observations 2006-2005



Note: Lightning values below a given absolute threshold were omitted

2006–2005 O_3 Differences
Lightning Sensitivity



Conclusions

- GEOS-Chem tropical O_3 and CO are low relative to TES in some areas
- TES and GEOS-Chem both show elevated O_3 and CO over Indonesia in late 2006
- October/November 2006 O_3 anomalies clearly relate to increased Indonesian biomass burning during dry El Niño conditions, but also have a dynamical/convective component
- Persistent December O_3 anomaly likely relates to lightning changes coupled with weaker convection both associated with the 2006 El Niño

Future Work

- Further ozone sensitivity tests
- Run GEOS-Chem with LIS measured lightning distributions
- More quantitative assessment: GEOS-Chem vs. TES correlations, Ozone and CO budgets