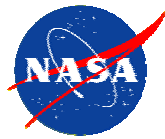

A Satellite Perspective on the Interhemispheric Transport of Pollution

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Mechanisms for Inter-Hemispheric Transport (IHT)

Tracers from one hemisphere enter another hemisphere predominantly via the upper troposphere [*Prather et al.,* 1987; *Newell et al.,* 1974, *Plumb and Mahlman,* 1987, *Yamazaki,* 1992].

Proposed Major Mechanisms:

- **Upper level divergence associated with deep convection (ITCZ) [*Prather et al.,* 1987; *Hartley ad Black*, 1995; *Lintner et al*., 2004].**
- **Interhemispheric wave propagation through zones of time mean westerlies in the equatorial upper-troposphere (westerly duct) over the eastern Pacific and Atlantic [*Prinn et al.*,1992; *Staudt et al.,* 2002, Waugh and Polvani, 2000].**
- **Monsoon circulation [*Wang and Schallcross*, 2000]**
- **Hadley circulation seasonality (zonal mean) [*Bowman and Cohen*, 1997].**

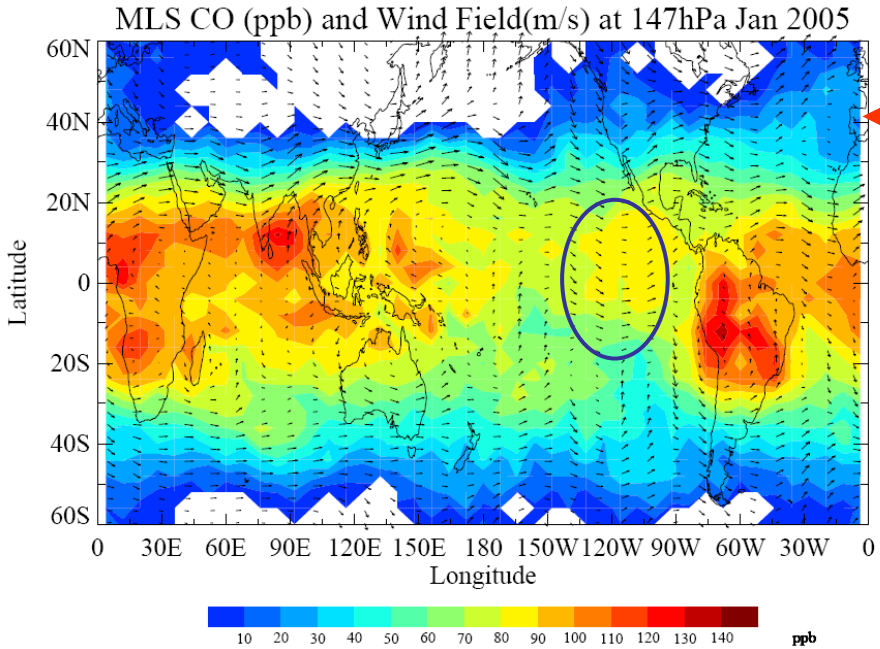
Motivation

Satellite observations of CO from MLS and MOPITT, with global coverage and consistent calibrations, provide a unique opportunity for a thorough assessment of the variability of IHT.

We analyze the multi-year MLS and MOPITT observations of CO with the GEOS-Chem global 3-D CTM to investigate:

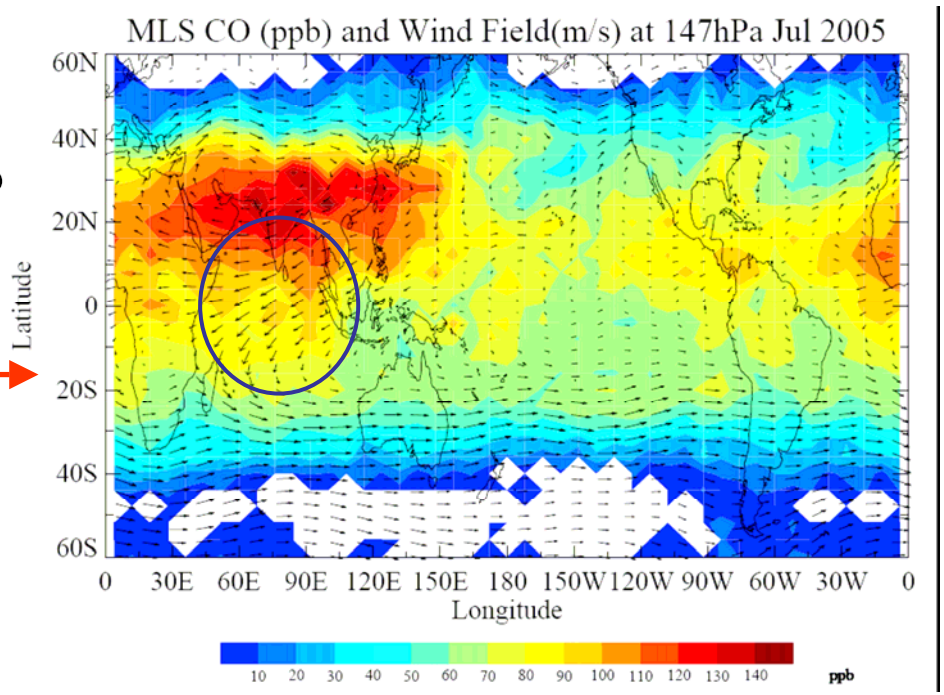
- The seasonal and interannual variability of IHT of air pollutant (indicated by CO) over different equatorial regions.
- The CO source attribution during IHT.
- The influence of large scale circulations (e.g., Monsoon circulation) on IHT.

Spatial Distributions of 147 hPa MLS CO



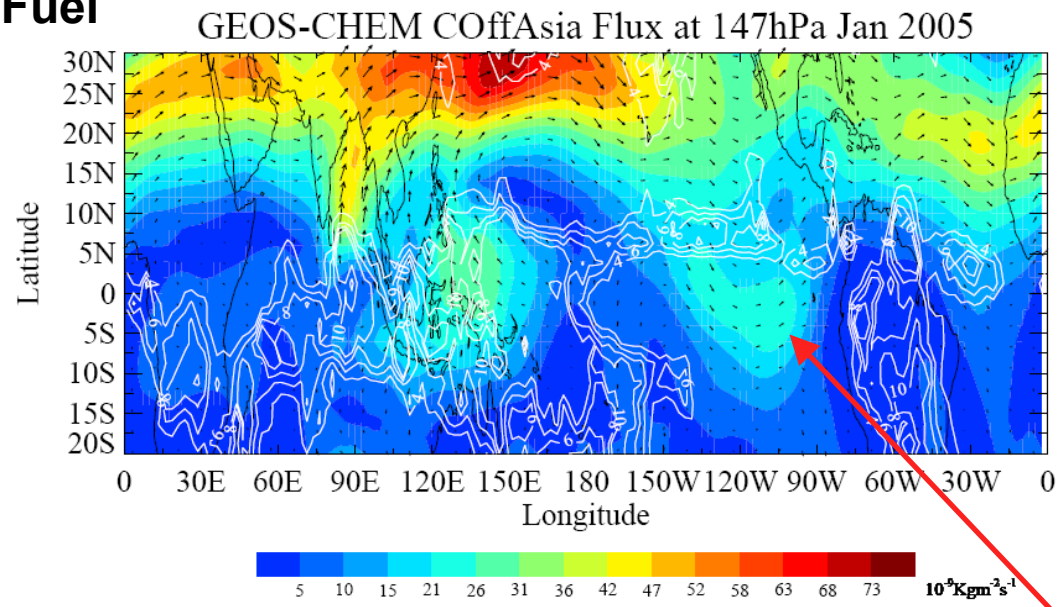
◆ **Winter**: Apparent southward transport via Westerly duct over the tropical Eastern Pacific.

◆ **Summer**: High CO over the Indian Ocean due to Asian monsoon circulation and subsequent interhemispheric transport by strong northeasterly.



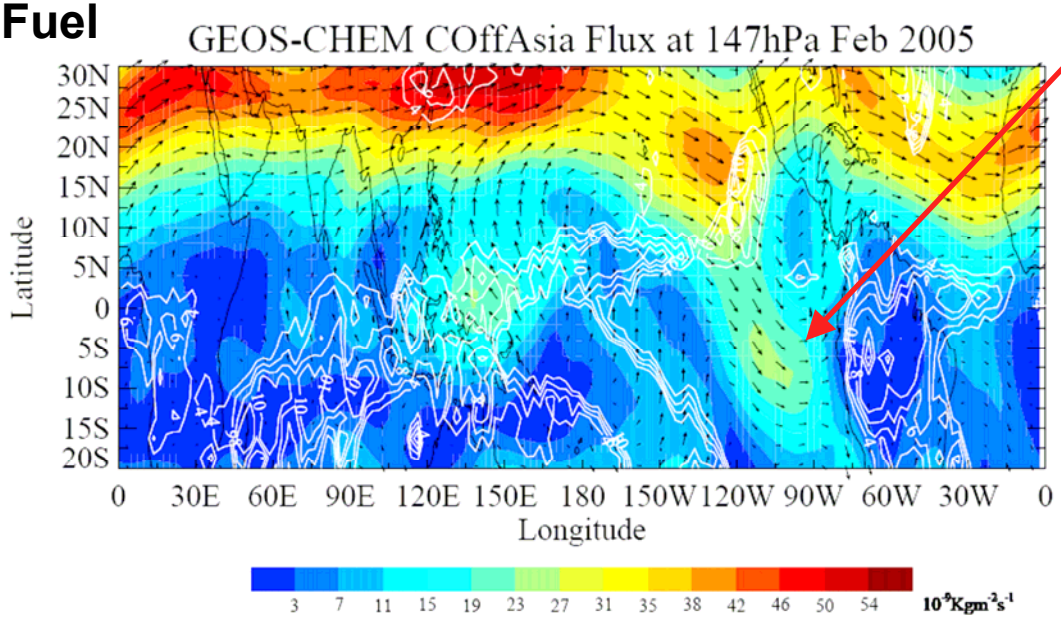
GEOS-Chem Simulated CO Fluxes (Winter)

Asian Fossil Fuel (JAN 2005)



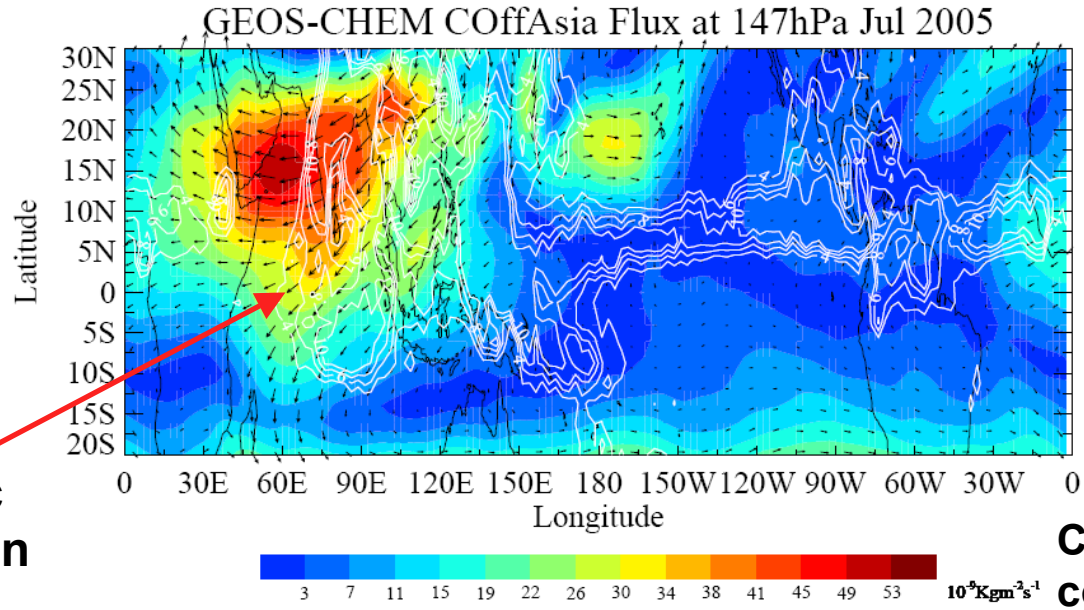
CMAP precip. (white contours) overlaid

Asian Fossil Fuel (FEB 2005)



Interhemispheric transport of Asian fossil fuel emissions over the tropical eastern Pacific.

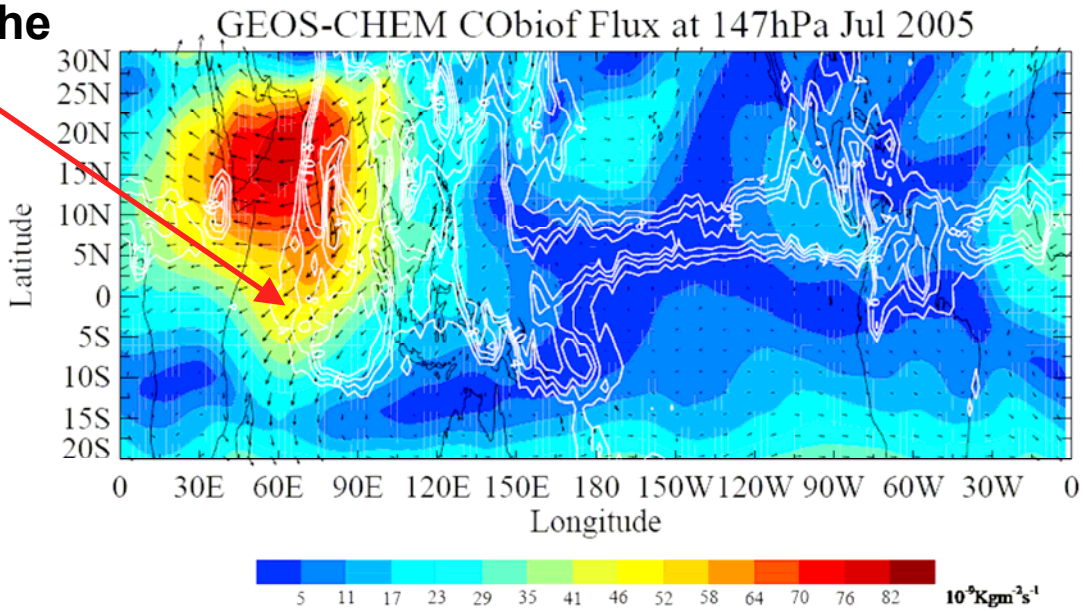
GEOS-Chem Simulated CO Fluxes (Summer)



Asian Fossil Fuel (JUL 2005)

Interhemispheric transport of Asian anthropogenic emissions over the tropical Indian Ocean.

CMAP precip. (white contours) overlaid.

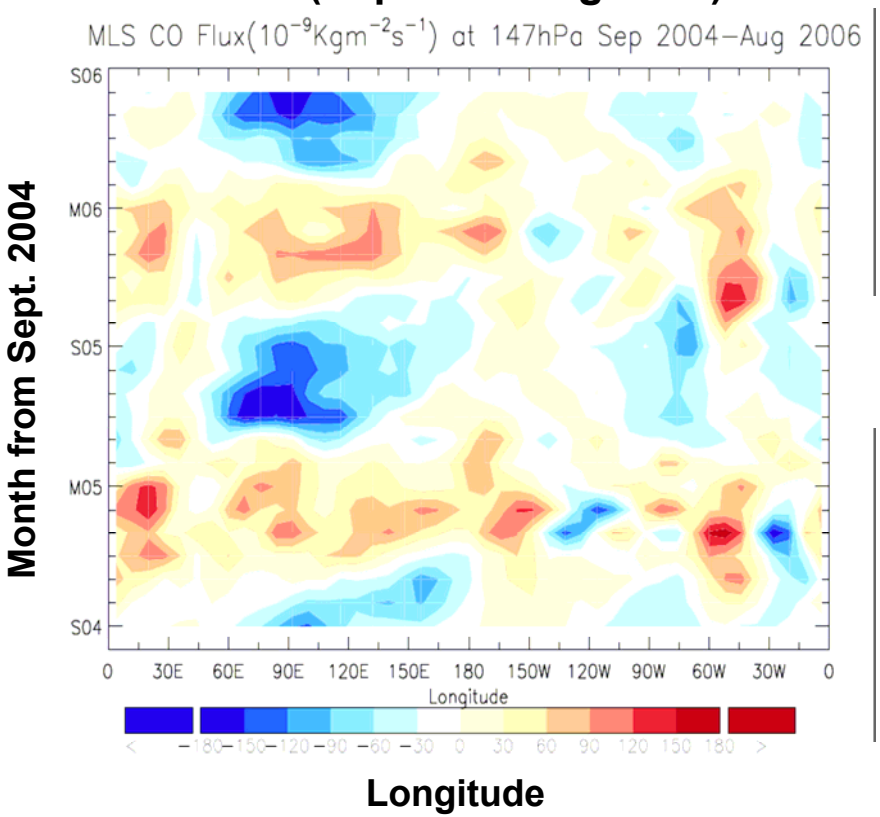


Asian Biofuel (JUL 2005)

Meridional CO Fluxes (@ 147 hPa) Across the Equator: Longitudinal, seasonal & Interannual Variability

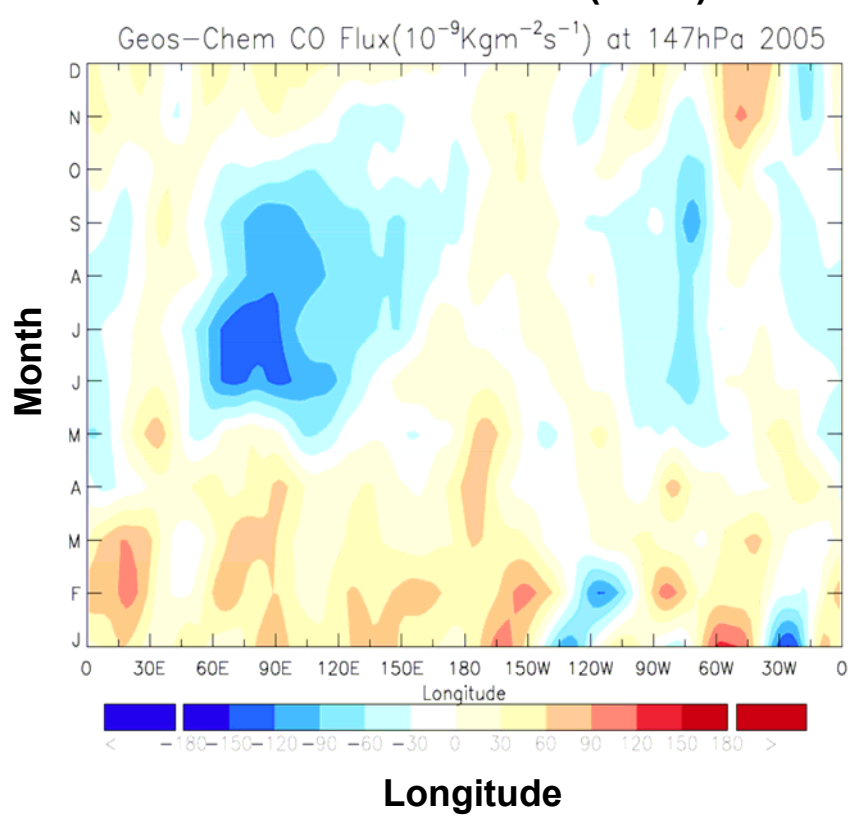
Negative values: Southward fluxes

MLS (Sep 2004-Aug 2006)



Longitude

GEOS-Chem (2005)



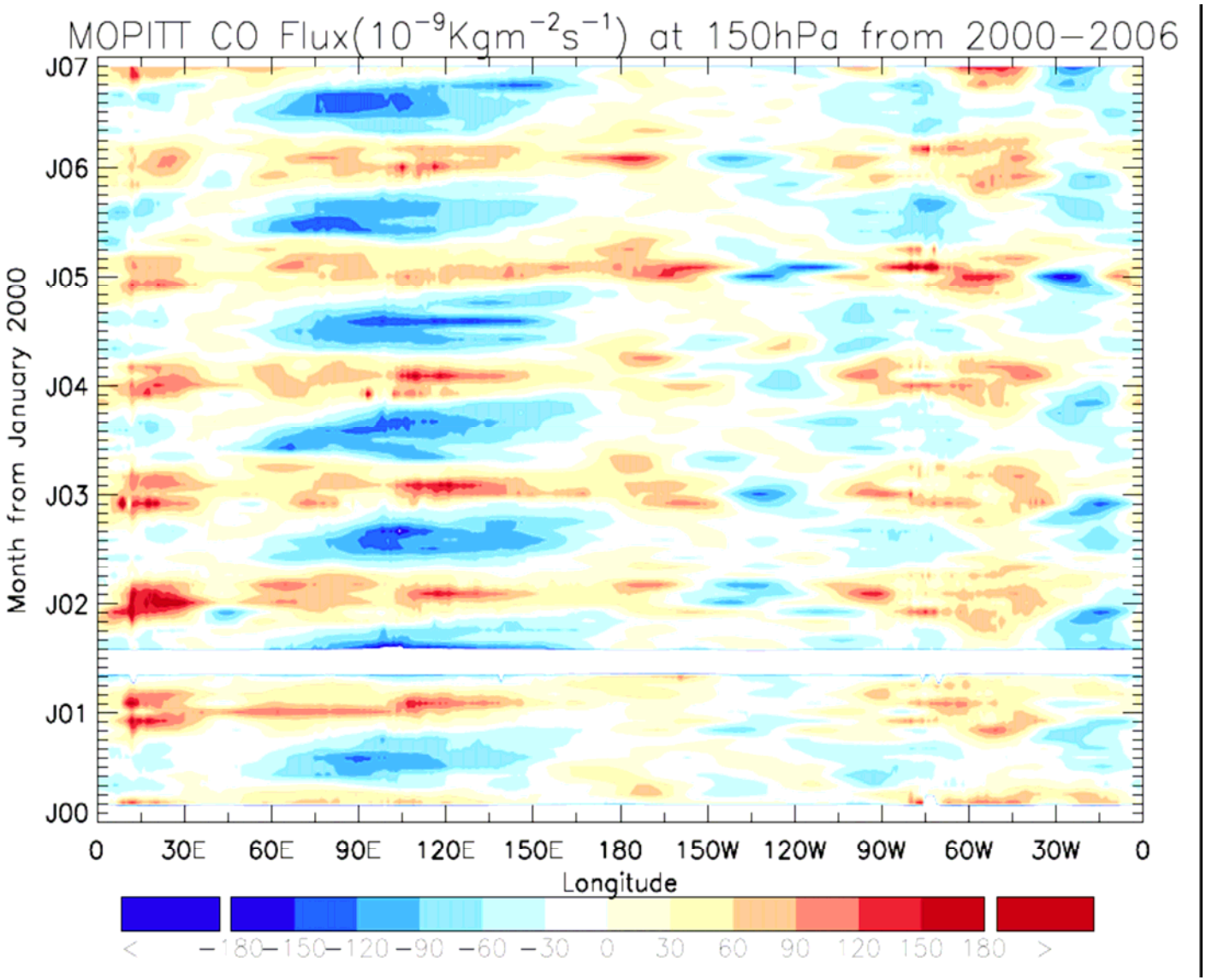
Longitude

CO flux averaged between 16°N to 16°S to account for the ITCZ migration.

Largest IHT of CO over the Indian Ocean in summer are from Asian fossil fuel, biomass burning and biofuel combustion. Over the eastern Pacific in winter to spring, Asian fossil fuel and biofuel burning and Africa biomass burning are the largest contributors.

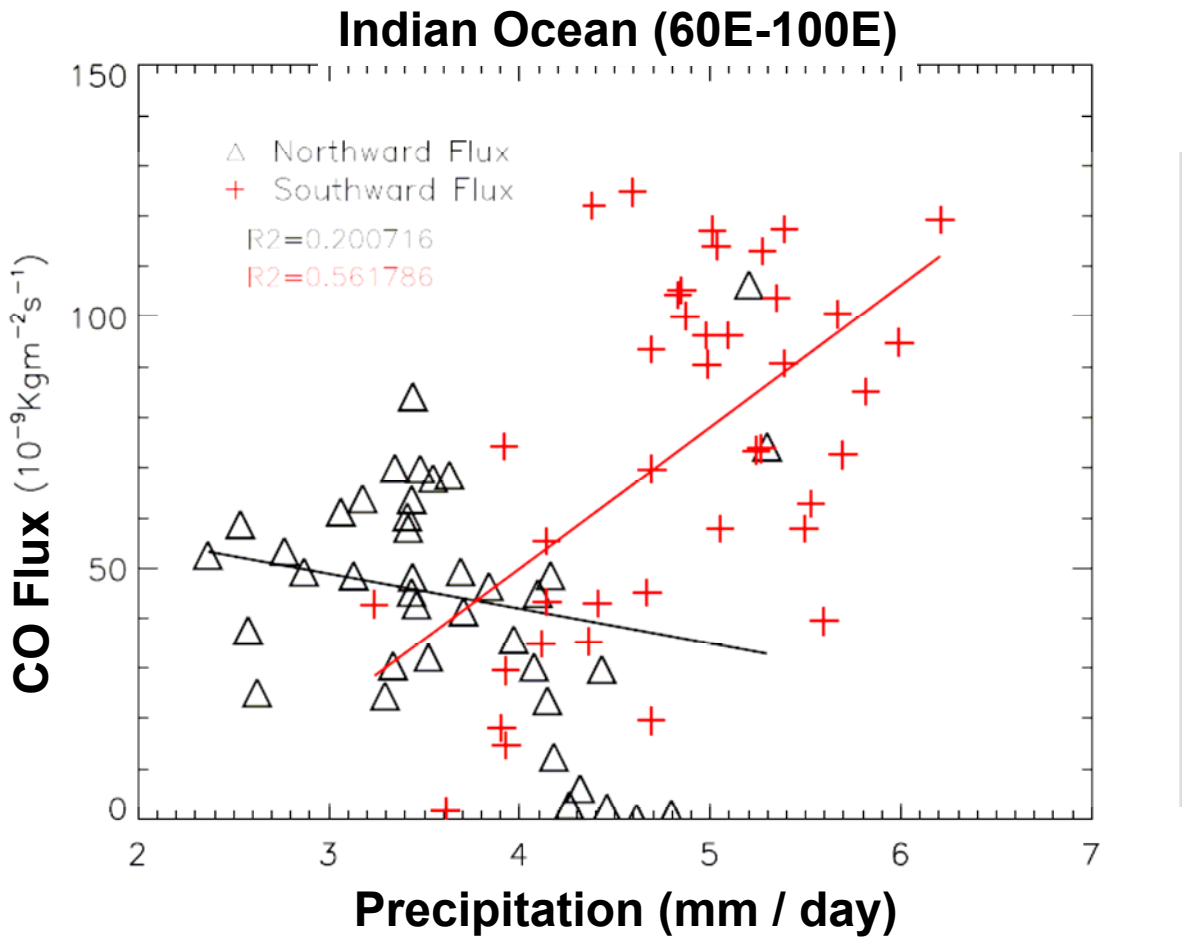
MOPITT CO Flux (@ 150 hPa) from 2000-2006

Negative values: Southward fluxes



Consistent with MLS observations and GEOS-Chem results.

Influence of Asian Monsoon Circulation

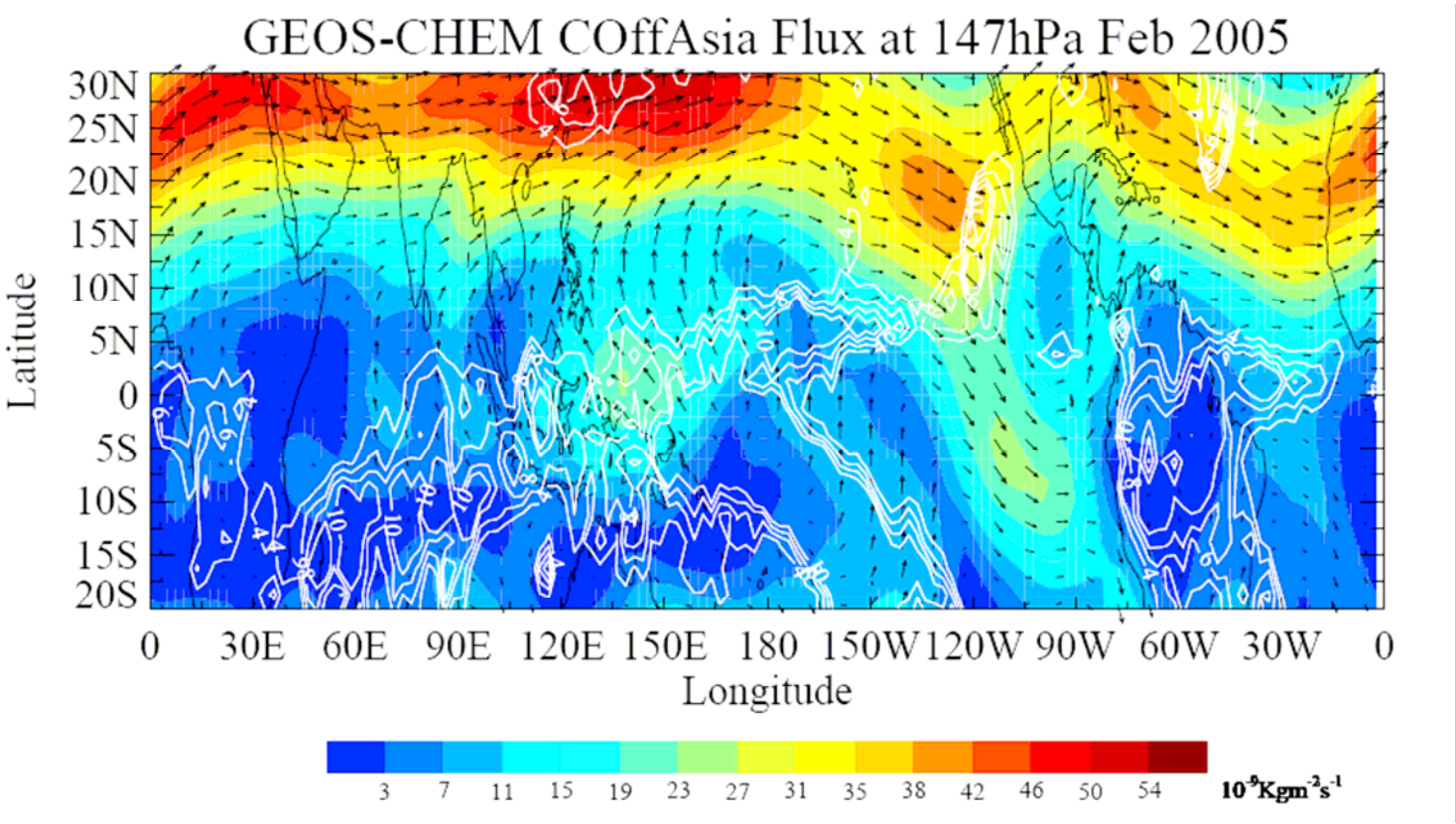


Positive correlation between the southward CO flux and precipitation (an indicator of the strength of Asian monsoon) over the Indian Ocean (mostly during summer).

Influence of ENSO

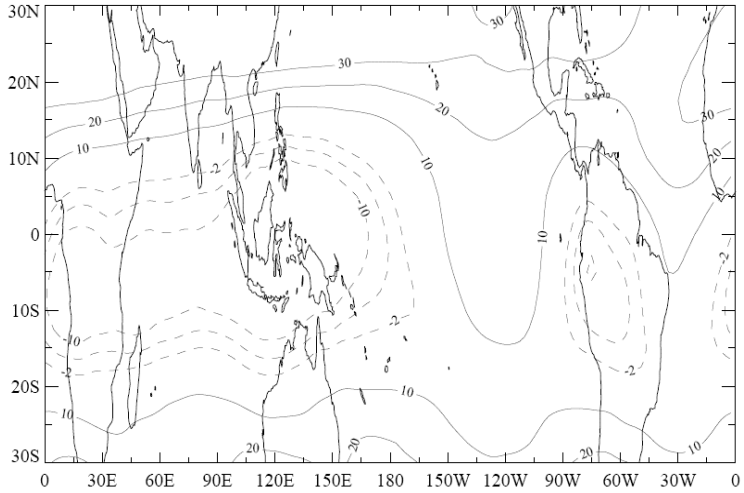
Previous studies indicate that IHT via westerly duct over the eastern Pacific during northern winter is stronger during La Nina condition and would be suppressed in El Nino conditions [e.g., Tomas and Webster 1994; Staudt et al., 2002]

However, strong inter-hemispheric transport over the eastern Pacific in winter 2005 under El Nino condition is evident.

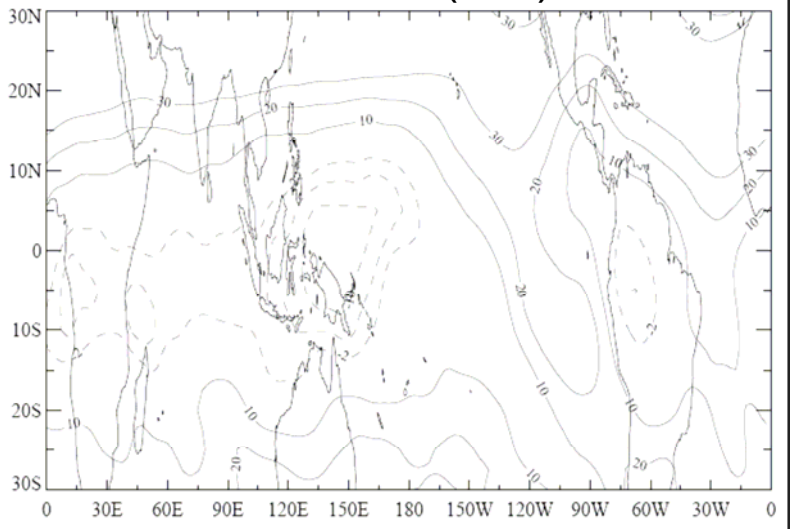


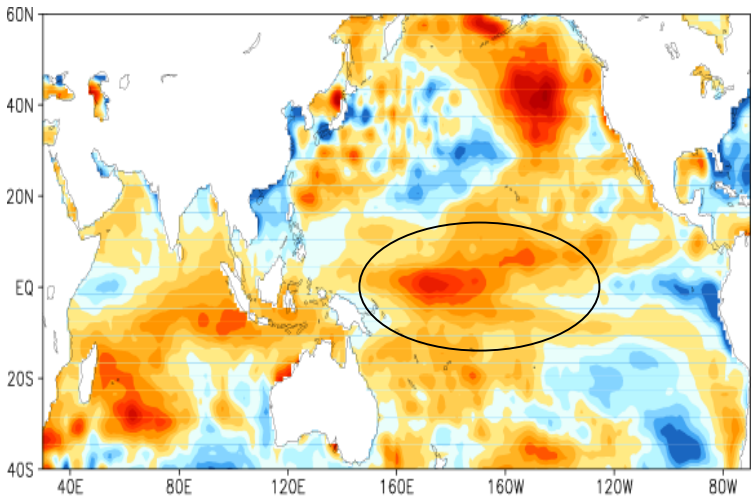
SST and Westerly Anomaly

150hPa Zonal Wind(m/s) Feb LTM



150hPa Zonal Wind(m/s) Feb 2005





Positive SST anomalies occur over the equatorial central Pacific, which correspond to the enhanced easterly at lower-level and westerly in the upper troposphere over the eastern Pacific [Gill, 1980].

Summary

- Interhemispheric transport of CO in the tropical troposphere exhibits significant seasonal and interannual variability as shown from MLS, MOPITT observations and GEOS-Chem model results.

- Strongest southward CO flux found over the Indian Ocean in summer and Eastern Pacific in winter to spring.

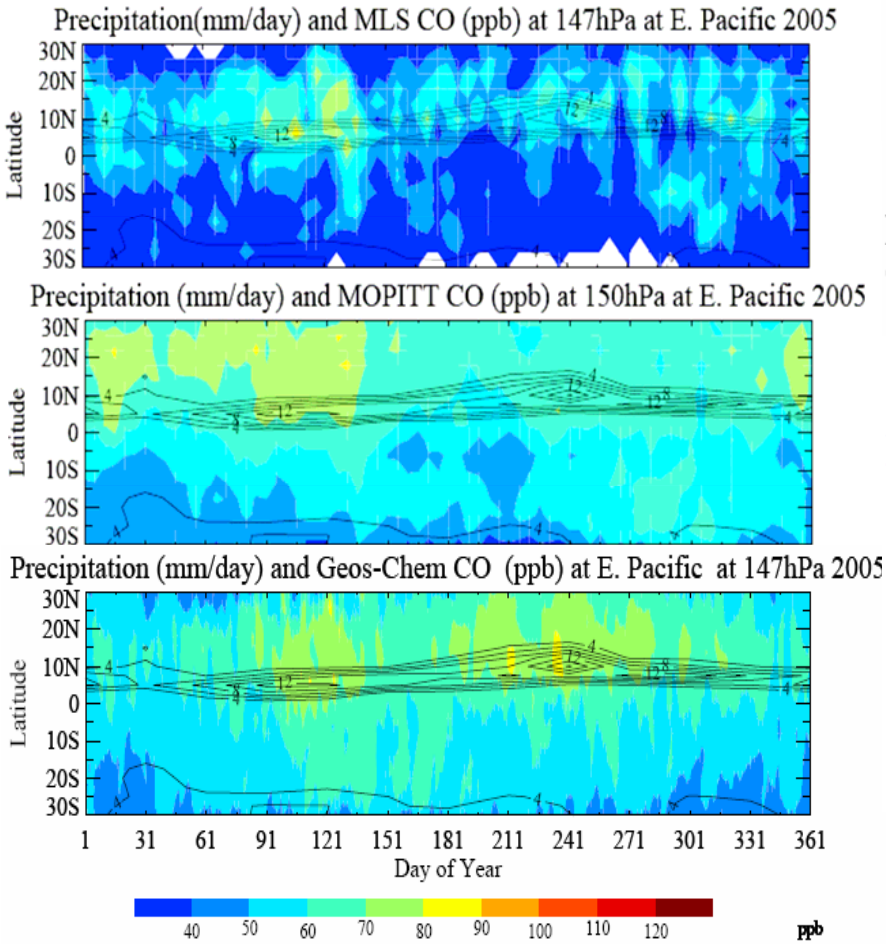
- Largest IHT of CO over the Indian Ocean in summer are from Asian fossil fuel, biomass burning, and biofuel combustion emissions. Over the Eastern Pacific in winter to spring, Asian fossil fuel and biofuel burning and Africa biomass burning are the major contributors to the IHT of CO over that region.

- Large-scale circulations including the Asian monsoon and El Nino/La Nino strongly modulates the interhemispheric transport of pollution.

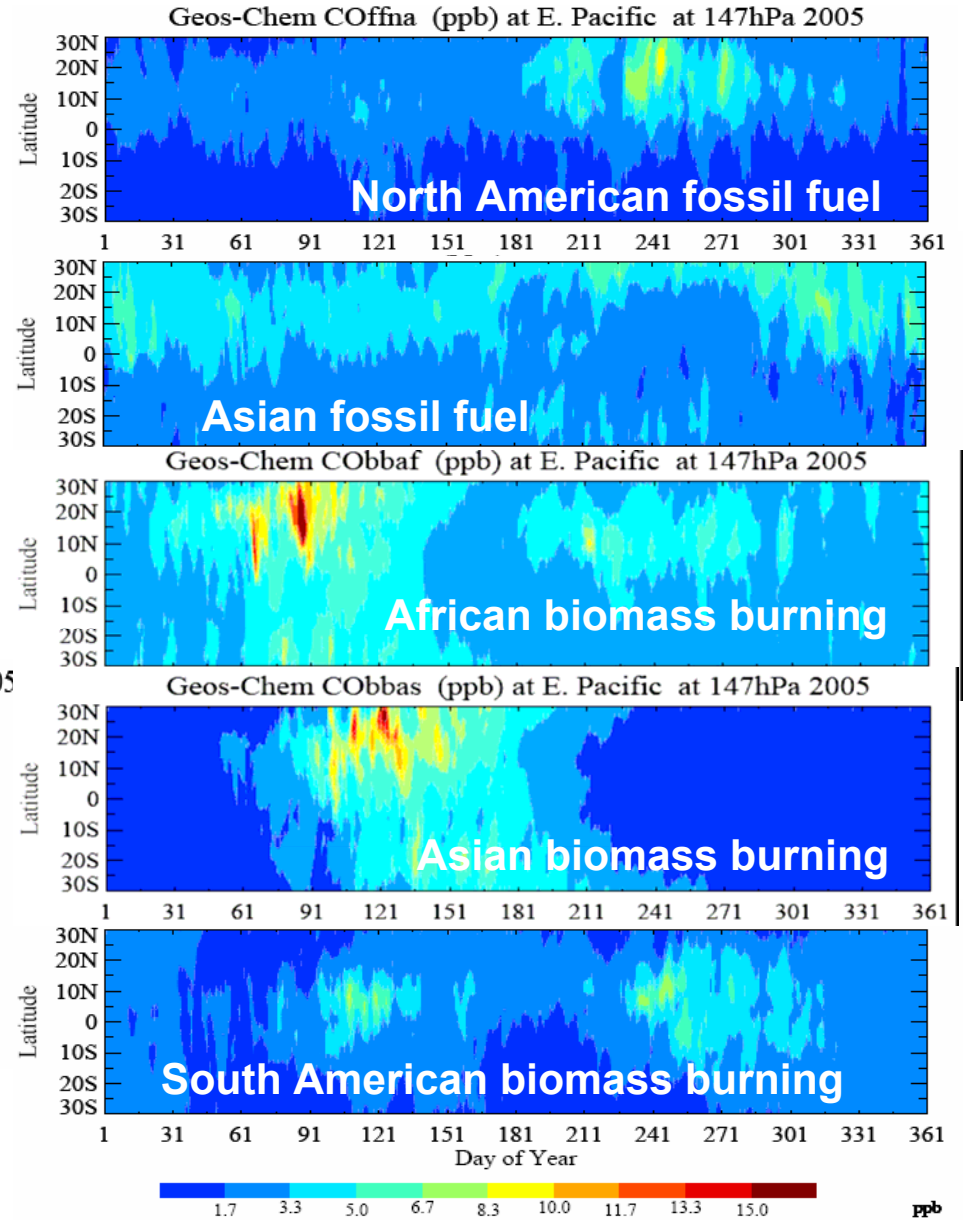
Thank you!

Temporal Variations of UT CO at E. Pacific(100°-140°w)

MLS/MOPITT/GeosChem

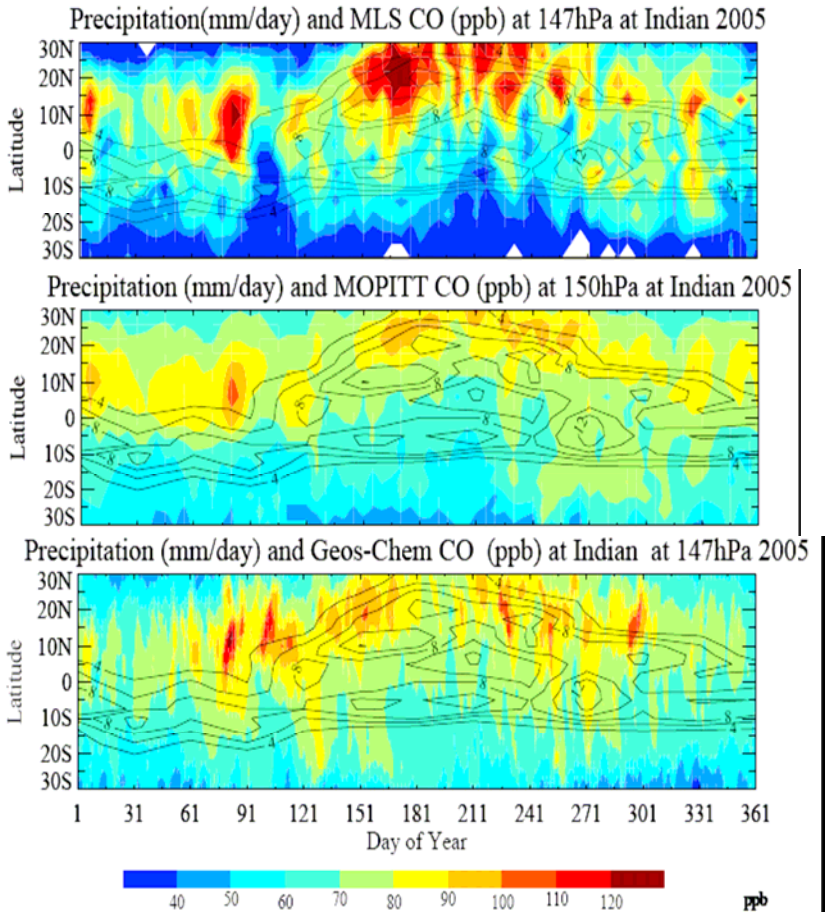


Source Attribution



Temporal Variations of UT CO at Indian Ocean (60°-100°E)

MLS/MOPITT/GeosChem



Source Attribution