

GEOS-CHEM INTEX-A modeling and analysis

- **Bottom-up inventory of the biomass burning emissions in North America during the summer 2004, S. Turquety, Harvard University;**
- **A Summertime Ozone Maximum in the UT over the Southern U.S.: Trapping of Convective Pollution by the Upper-level Anticyclone, Qinbin Li, JPL;**
- **Summertime influence of Asian pollution in the middle and upper troposphere during INTEX-A, Qing Liang, University of Washington;**
- **HCHO during ICARTT: implications for GOME/OMI, Dylan Millet, Harvard University;**
- **A multi-platform analysis of the North American reactive nitrogen budget during the ICARTT summer intensive, Rynda Hudman, Harvard University**

ICARTT forecasts and NRT:

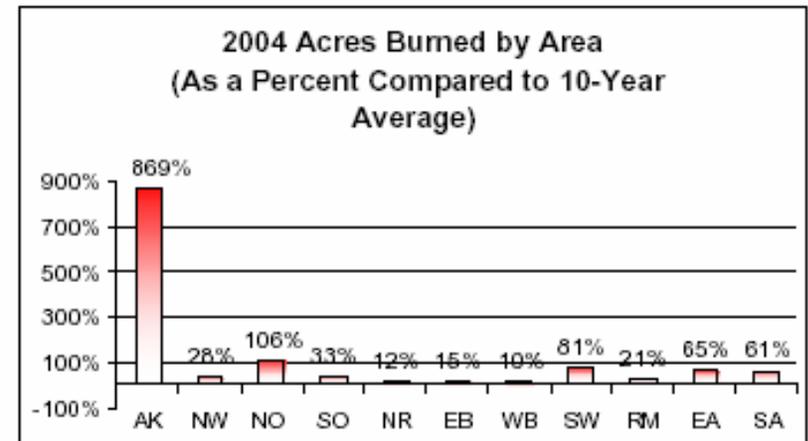
http://coco.atmos.washington.edu/cgi-bin/ion-p?page=geos_intexa.ion

Bottom-up inventory of the biomass burning emissions in North America during the summer 2004

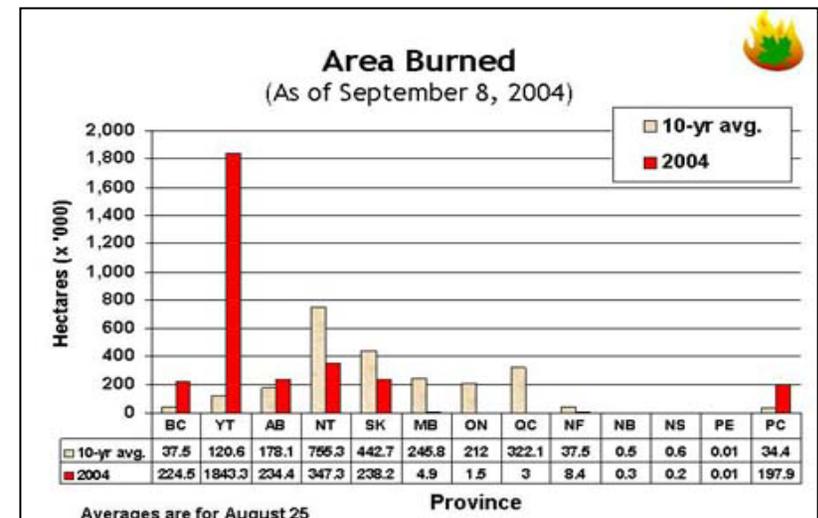
S. Turquety, D. J. Jacob, R. C. Hudman, J. A. Logan, R. M. Yevich, F. Y. Leung, R. M. Yantosca, L. K. Emmons, D. P. Edwards, INTEX Science Team



US National Interagency Coordination Center (NICCC)



Canadian Interagency Forest Fire Center (CIFFC)



▶ Alaska:

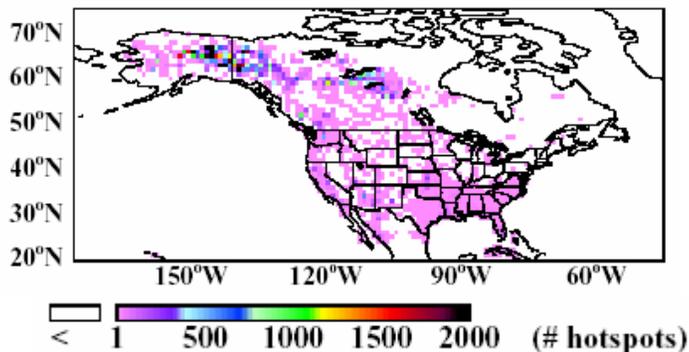
- > 2.6 million hectares burned
- > 8 x 10-year average

▶ Canada:

- 15 x average area burned in Yukon Territory (60% of national total)
- 6 x average in British Columbia

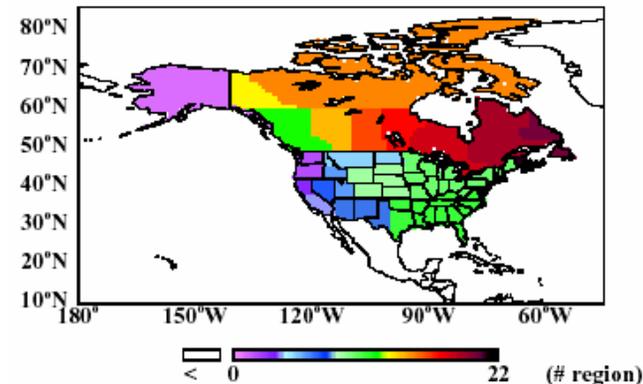
Bottom-up inventory of the biomass burning emissions in North America during the summer 2004

MODIS hotspots

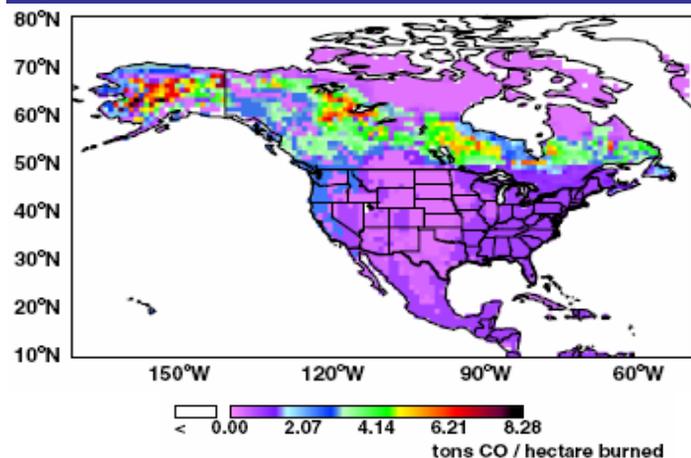


Daily reports of the area burned from the NIFC

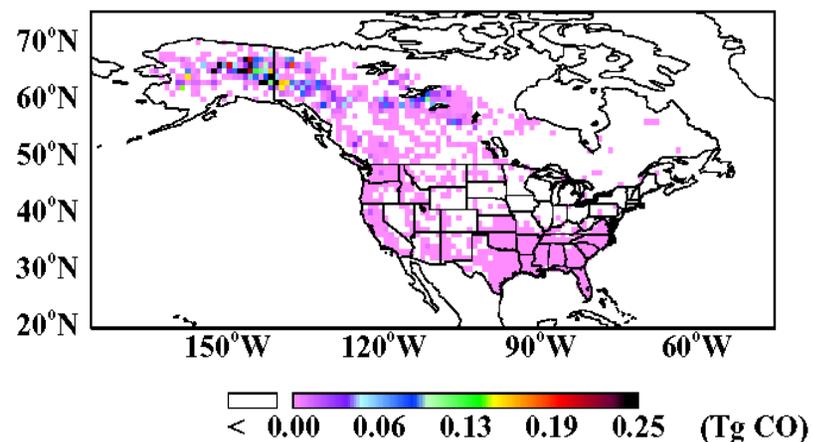
A x 60%
[W.M. Hao, FSL,
Personal comm.]



Emissions / unit area



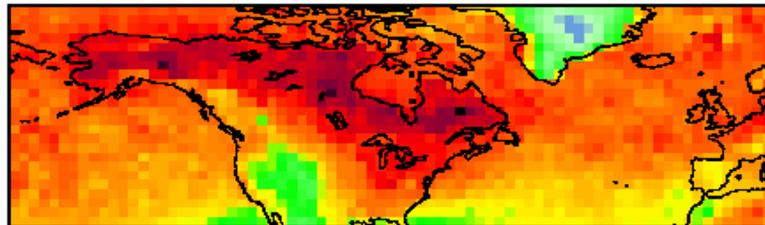
Emissions CO 2004



Derive emissions for 10 species, with 1x1 horizontal resolution:
NO_x, CO, lumped ≥ C₄ alkanes, lumped ≥ C₃ alkenes, acetone,
methyl ethyl ketone, acetaldehyde, propane, formaldehyde, and ethane.

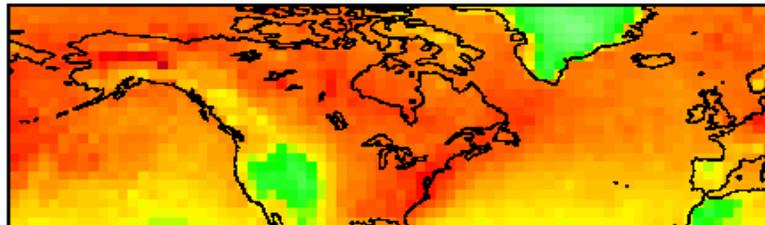
Bottom-up inventory of the biomass burning emissions in North America during the summer 2004

MOPITT Total CO



180° 120°W 60°W 0°

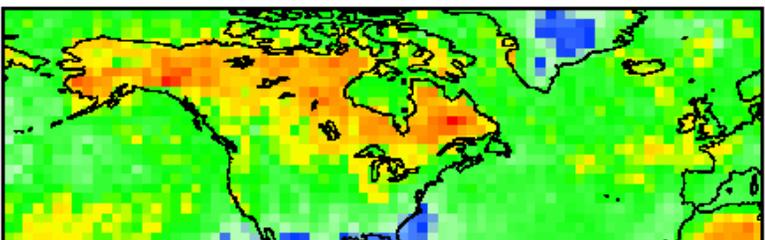
GEOS-CHEM Total CO x MOPITT AK



180° 120°W 60°W 0°

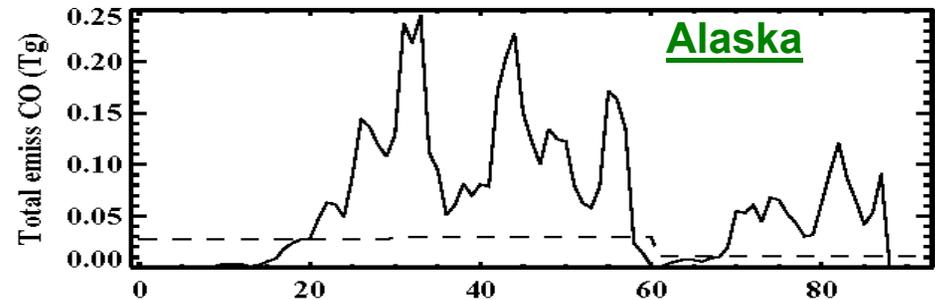
< 0.00 0.75 1.50 2.25 3.00 (10¹⁸ molec/cm²)

(MOPITT – Model)/MOPITT

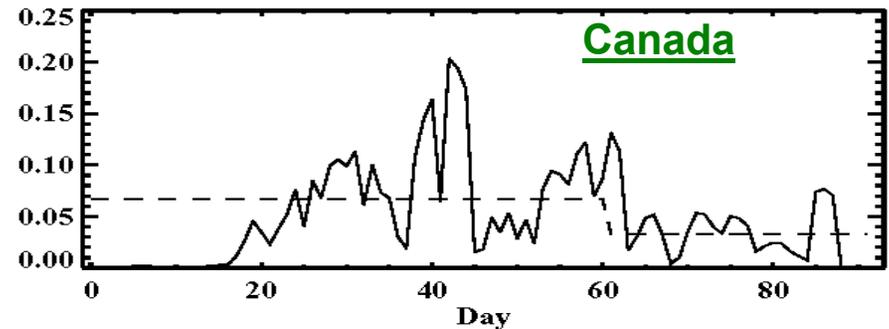


180° 120°W 60°W 0°

-50.00 -25.00 0.00 25.00 50.00 (%)



Alaska



Canada

Total emissions North America

June 1st – August 31st = 10.3 Tg CO

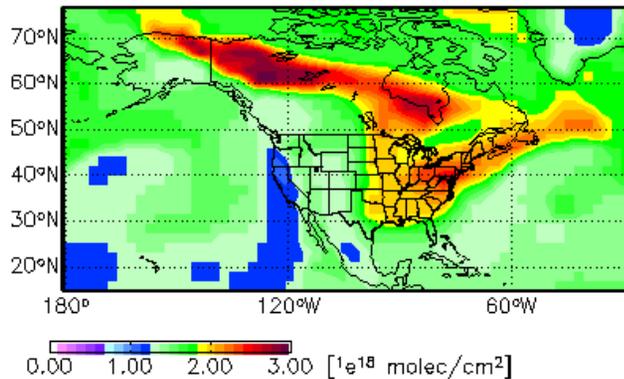
- Alaska : 5.7 Tg CO \approx 3 x climatology *Yevich et Logan*
- Canada: 4.5 Tg CO \approx 0.9 x climatology
- Yukon territory: 2.3 Tg CO \approx 4.4 x climatology

➔ Underestimate emissions by \sim 25% on average

Ongoing and future work

1. Using satellite observations to constrain the daily North American biomass burning emissions during the summer 2004
 - Magnitude?
 - Injection height?

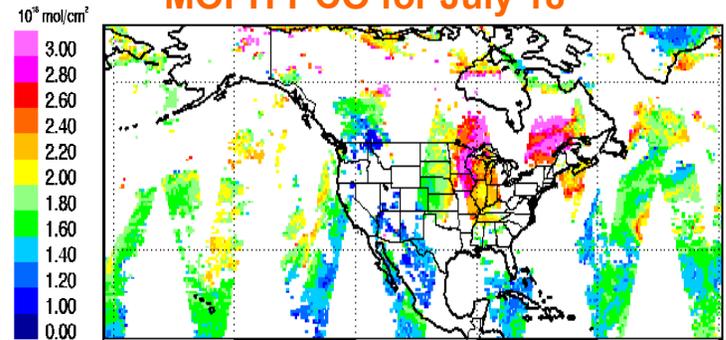
GEOS-CHEM NRT July 18



GEOS-CHEM

A priori sources

MOPITT CO for July 18



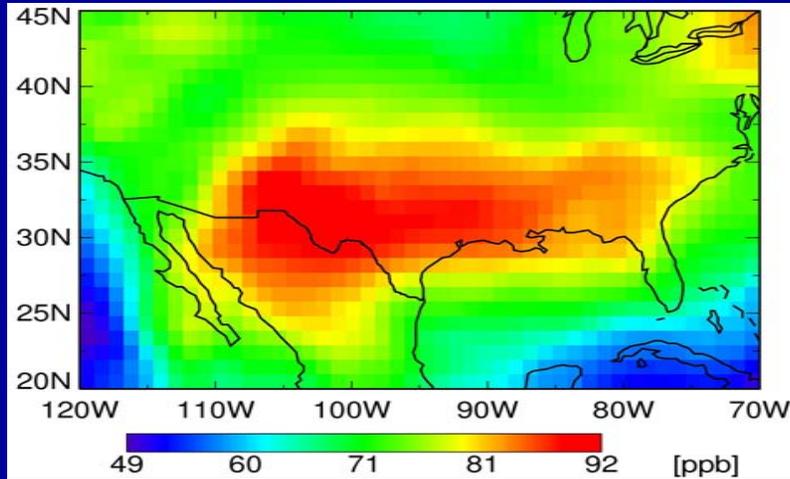
Inversion

A posteriori sources

2. Inverse modeling of North American anthropogenic emissions of CO using aircraft and satellite measurements

A Summertime Ozone Maximum in the UT over the Southern U.S.: Trapping of Convective Pollution by the Upper-level Anticyclone

GEOS-CHEM Ozone 300 hPa, July 2000



Qinbin Li¹

Daniel Jacob², Rokjin J. Park²

Yuxuan Wang², Rynda Hudman²

Robert M. Yantosca²

Randall V. Martin³, Mathew Evans⁴

¹JPL ²Harvard University

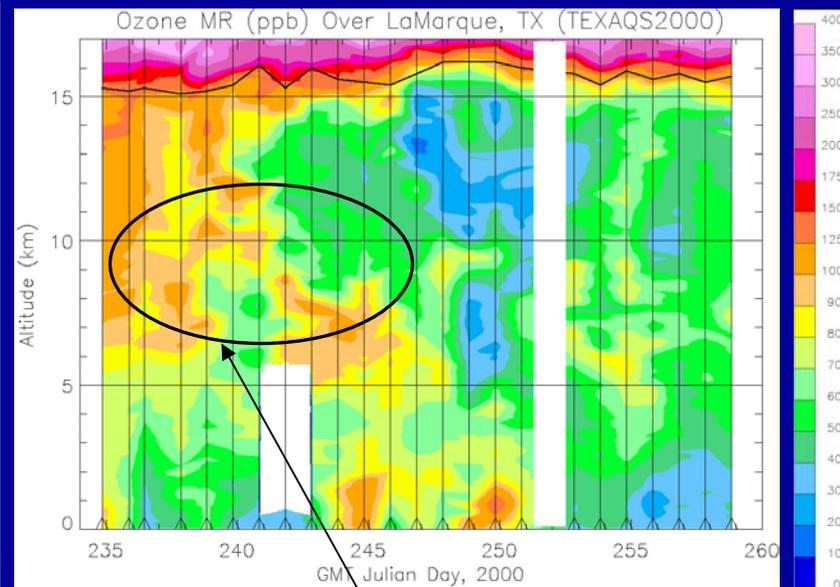
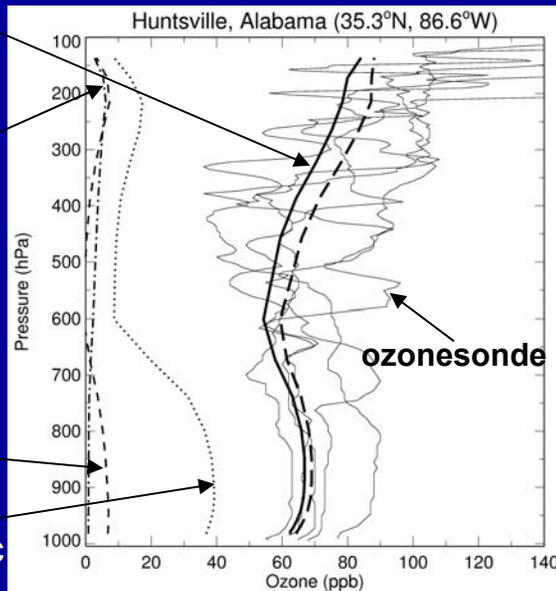
³Dalhousie University ⁴University of Leeds

GEOS-CHEM

Lightning

Biogenic

Anthropogenic

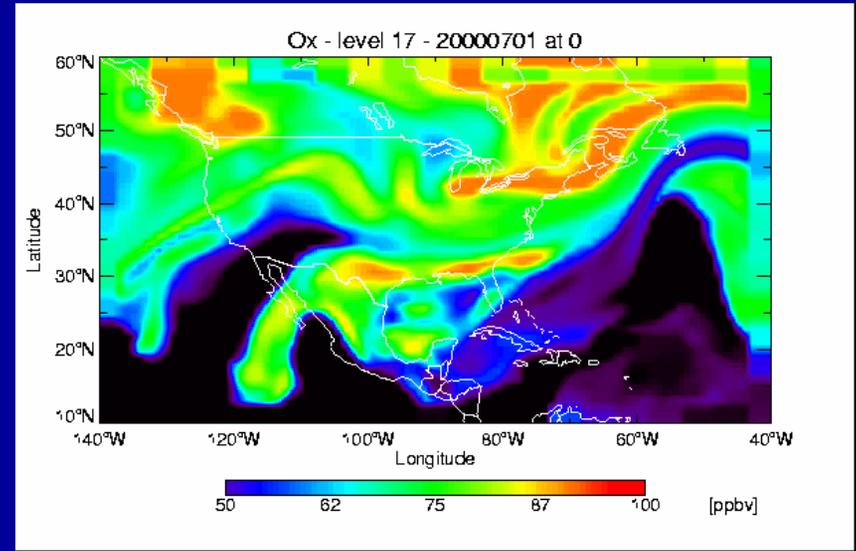
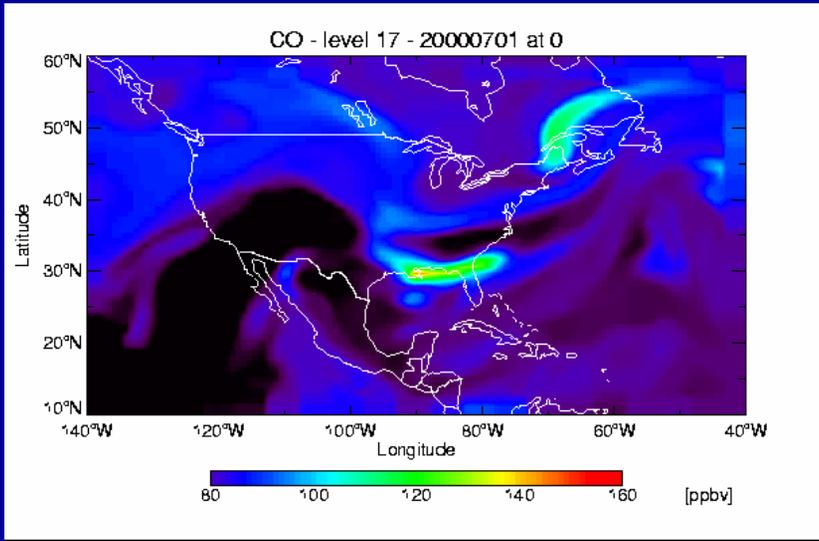


Ozonesonde data from *NewChurch et al. [2003]*

Ozone > 90 ppb

Convective Outflow Trapped by the Upper-level Anticyclone

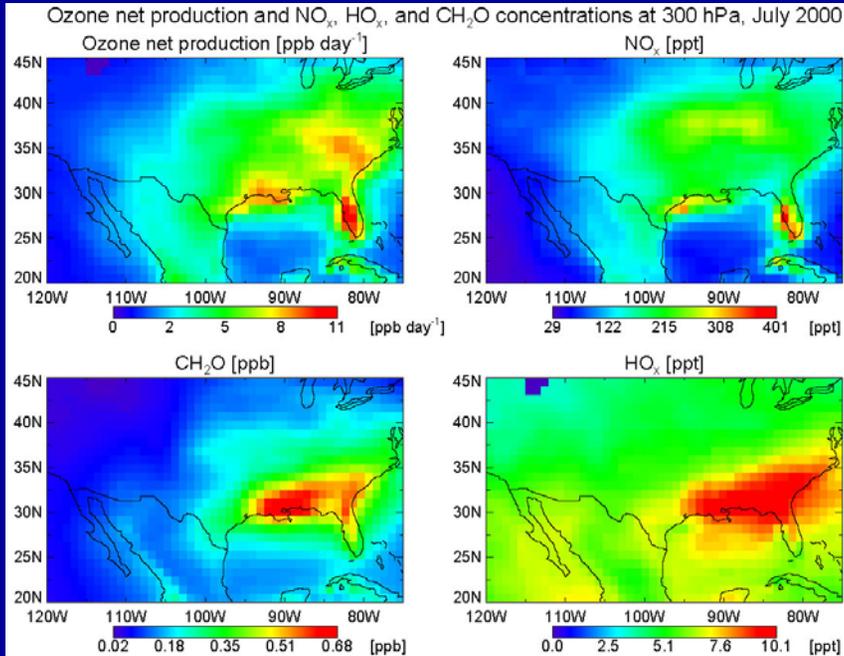
GEOS-CHEM CO and Ozone at 300 hPa



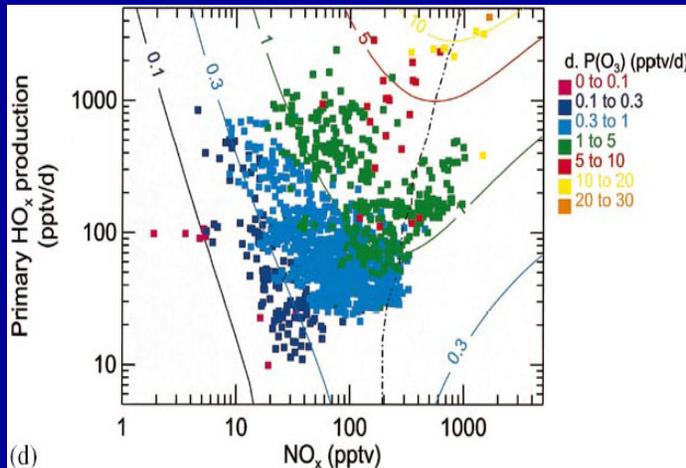
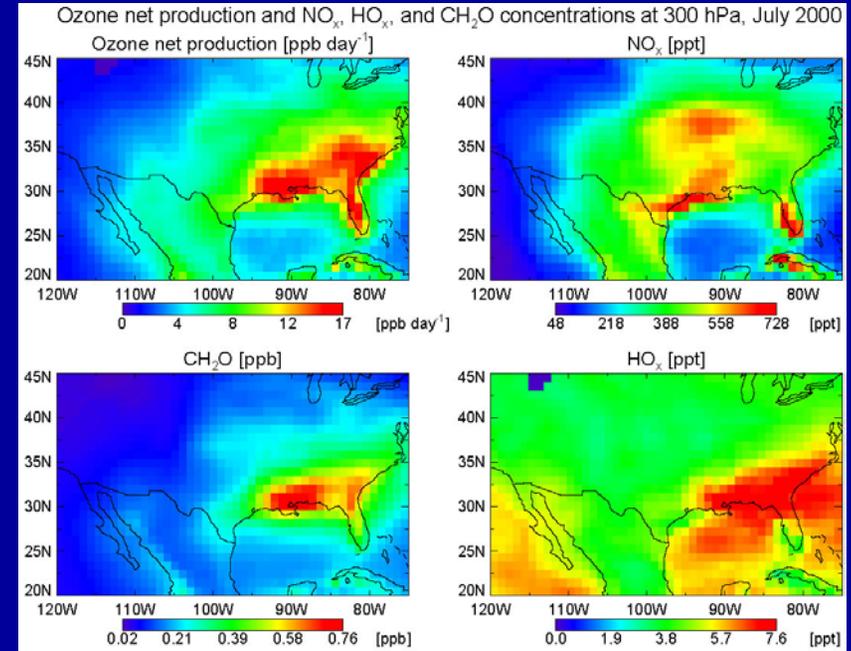
Deep convection over the central and southeast U.S. lifts surface emissions to the upper troposphere. Some of the pollution can be trapped by the upper-level anticyclone before eventual export to the North Atlantic.

Ozone production & concentrations of NO_x, CH₂O, and HO_x at 300 hPa

Standard Simulation



Lightning NO_x x 4

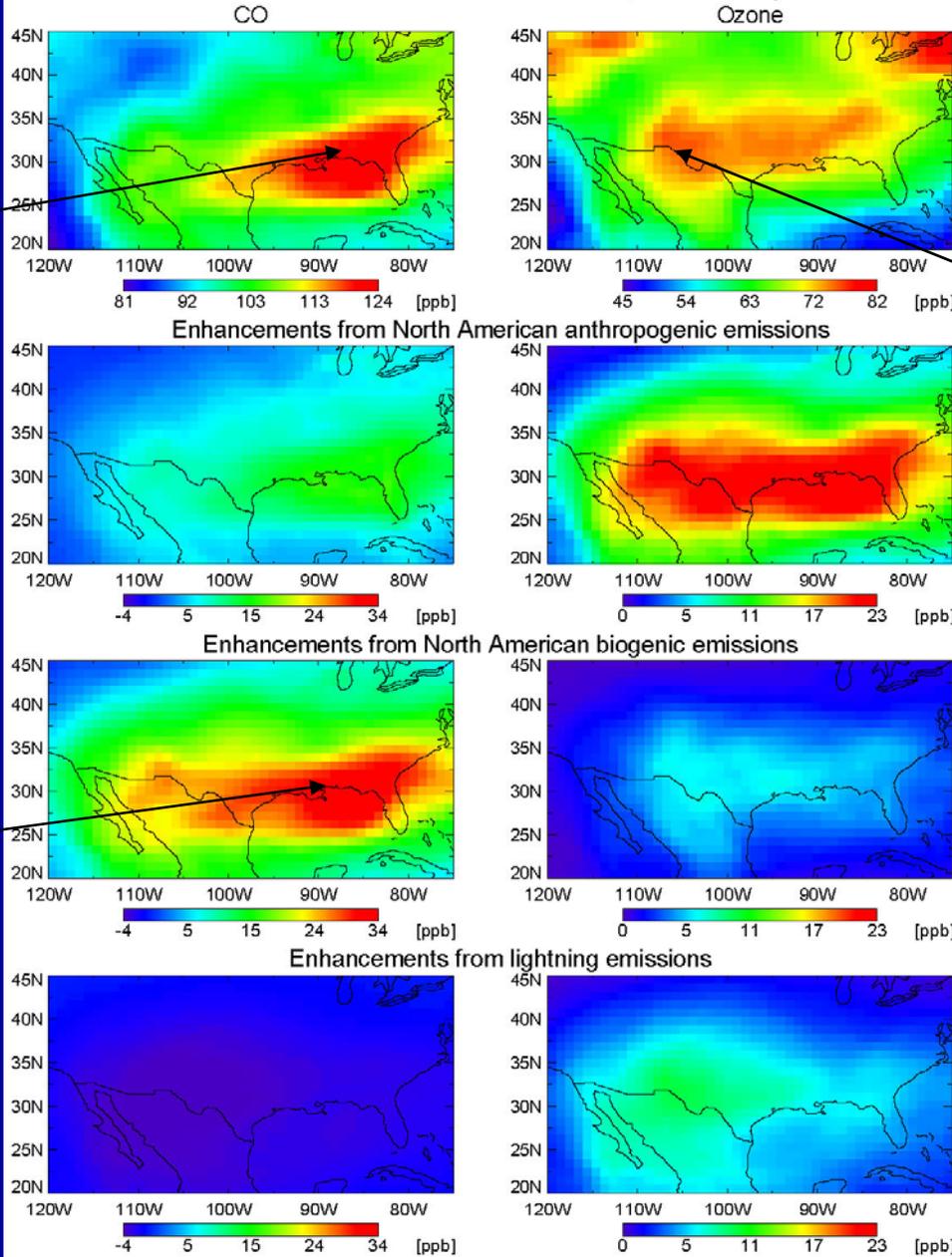


Jaegle et al. [2001]

Ozone production rates of up to 10 ppb/day over deep convective regions. NO_x are 150-300 ppt over much of the eastern US (50-100 ppt from lightning). High HO_x (~10 ppt) reflects photolysis of CH₂O from biogenic isoprene convectively lifted to the upper troposphere.

Source Attributions by Sensitivity Simulations

GEOS-CHEM CO and ozone concentrations, 300 hPa, July 2000



Strong deep convection region

Ozone production during circulation

Anthropogenic

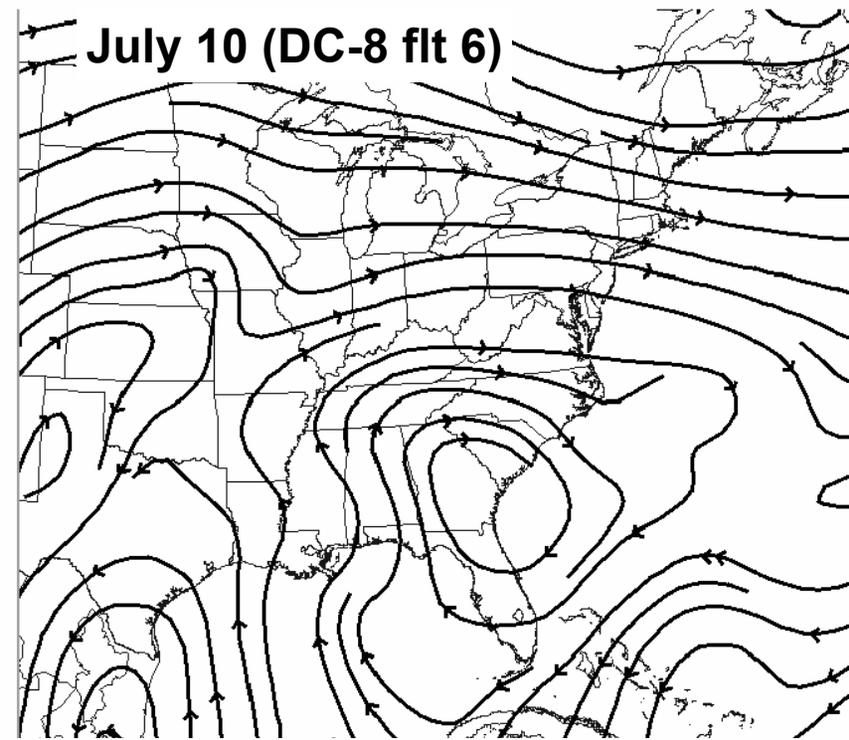
Biogenic

Dominated by high biogenic isoprene emissions

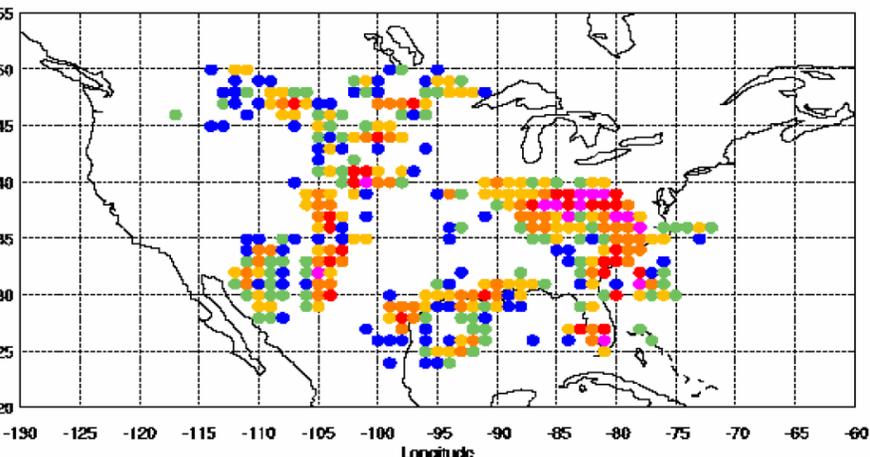
Lightning

300 mb Winds

July 10 (DC-8 flt 6)

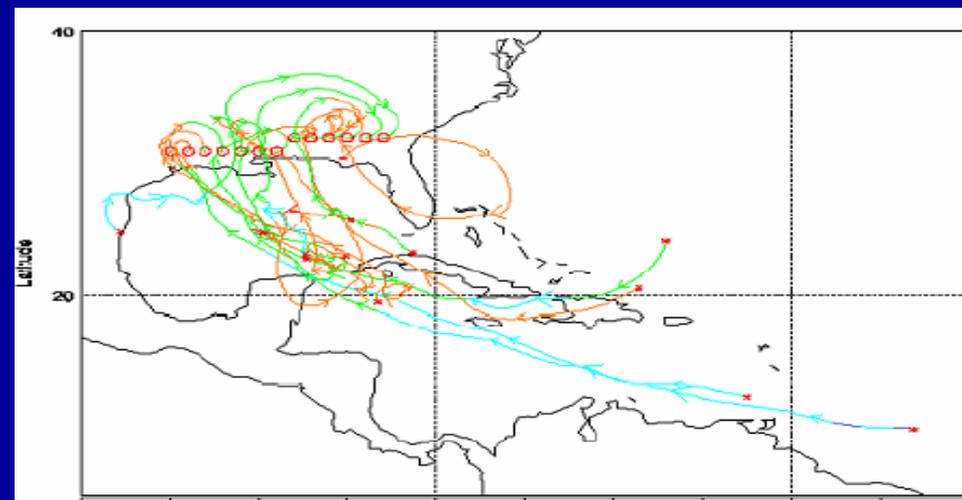


Lightning Intensity (strokes)
For 24 Hour Interval Centered on
2004 JUL 10 18 Z



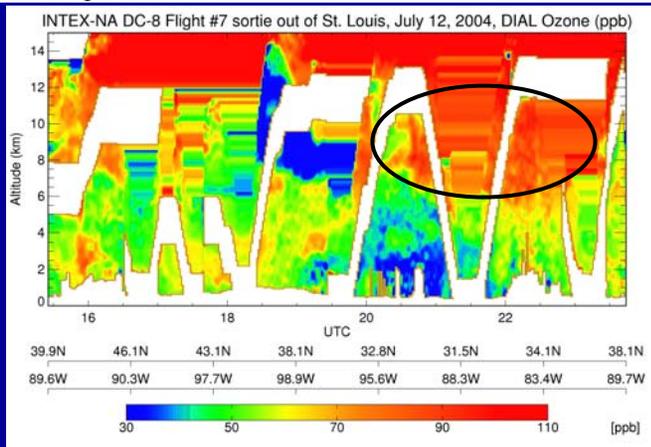
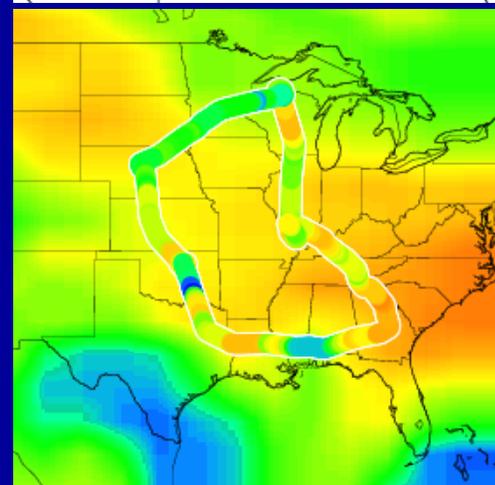
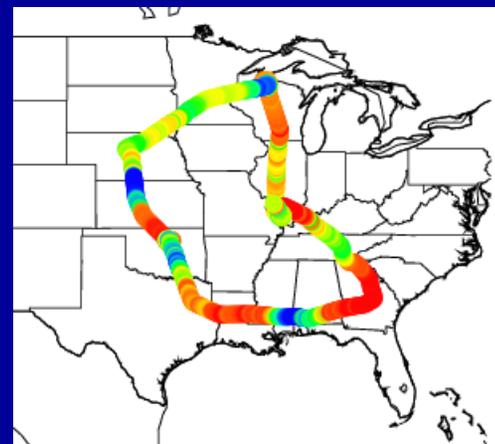
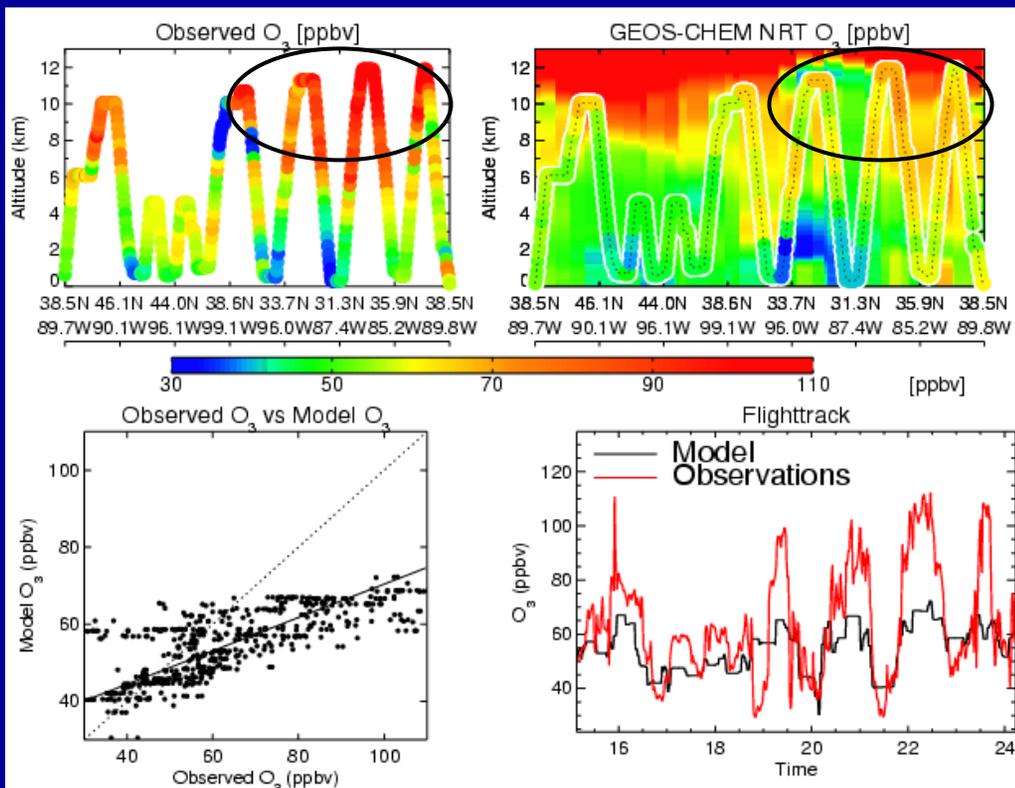
UT recirculation over SE U.S. during July 10-12 (H. Fuelberg)

300 hPa 7-day back-trajectories,
July 12 flight track (DC-8 flt 7)



DC-8 July 12 flight: 80-110 ppb O₃ observed at 6-10 km over SE U.S.

model too low by 20-30 ppbv

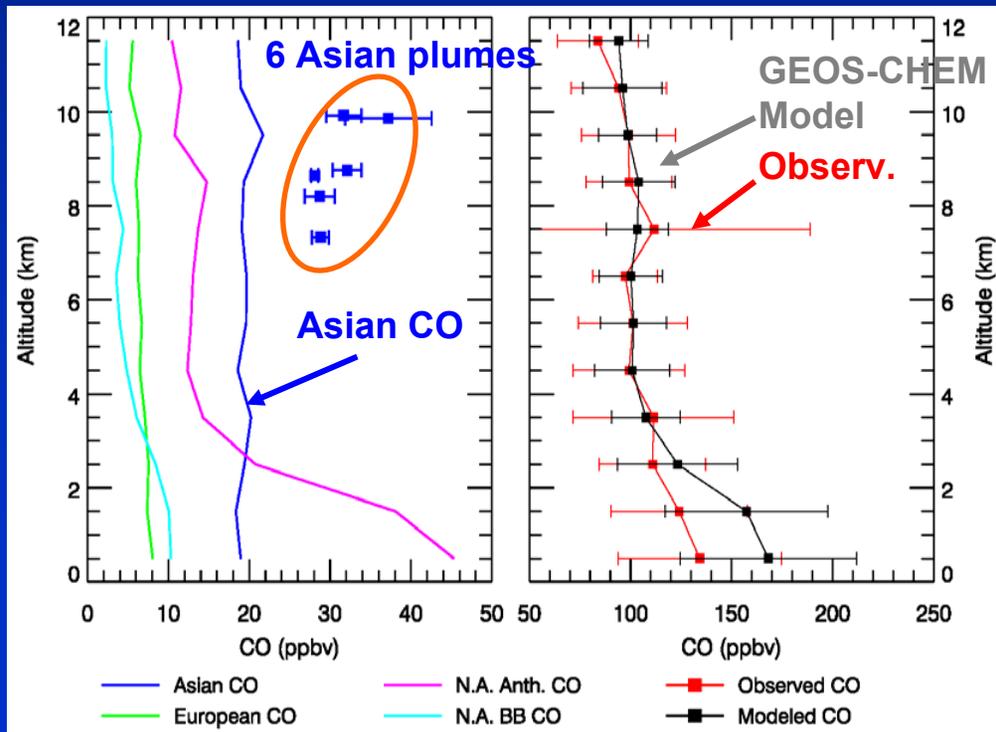


DIAL O₃

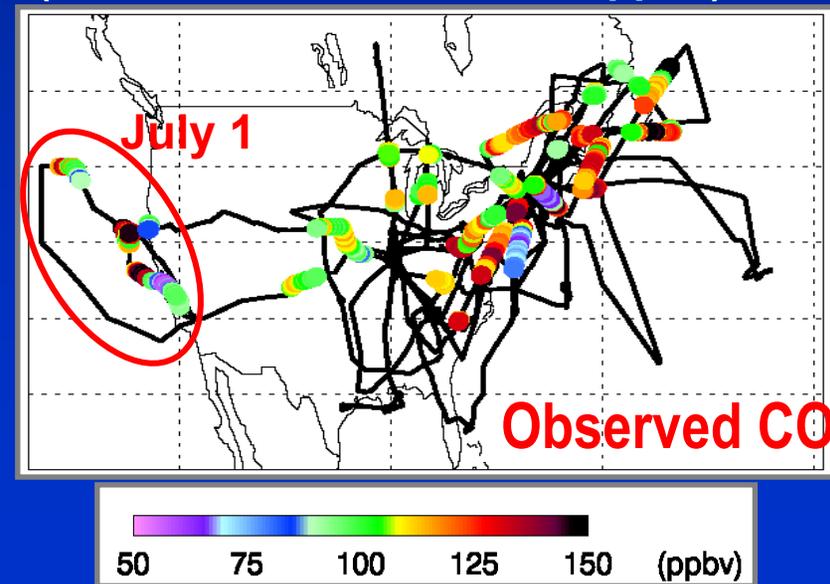
Summertime influence of Asian pollution in the middle and upper troposphere during INTEX-A

Qing Liang and Lyatt Jaeglé, University of Washington
and INTEX Science Team

- What was the extent of Asian influence over the U.S. during INTEX-A?
- Use GEOS-CHEM to identify Asian plumes in observations, characterize their composition, and elucidate their chemical evolution and transport mechanisms

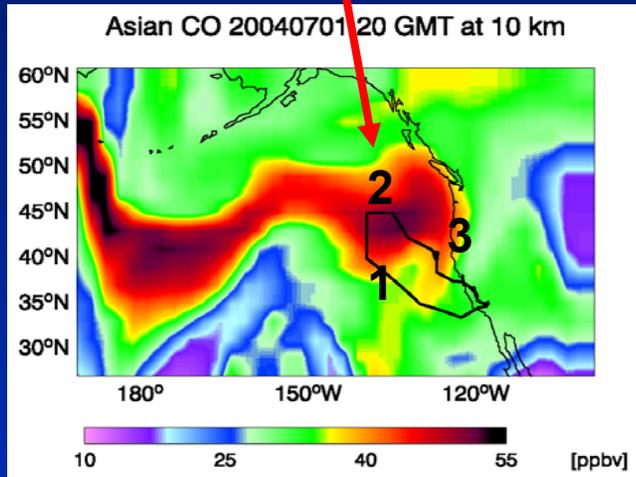


Asian plumes sampled during INTEX-A
(Modeled Asian CO > 25-30 ppbv)

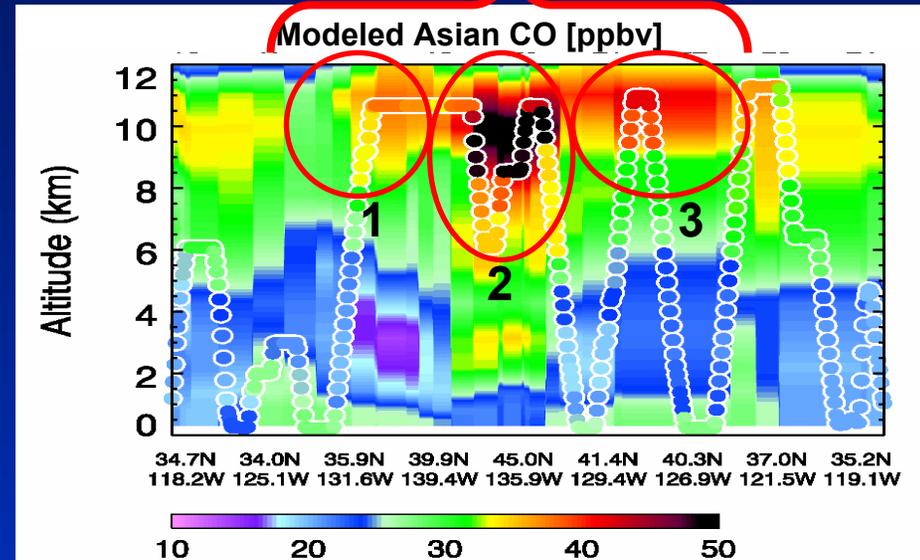


July 1, 2004: Rapid trans-Pacific transport in 3-5 days!

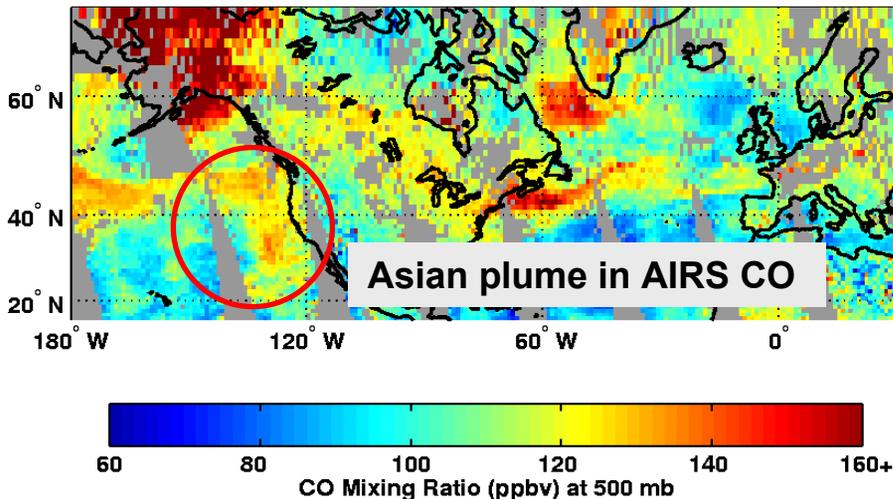
Asian plume intercepted 3 times



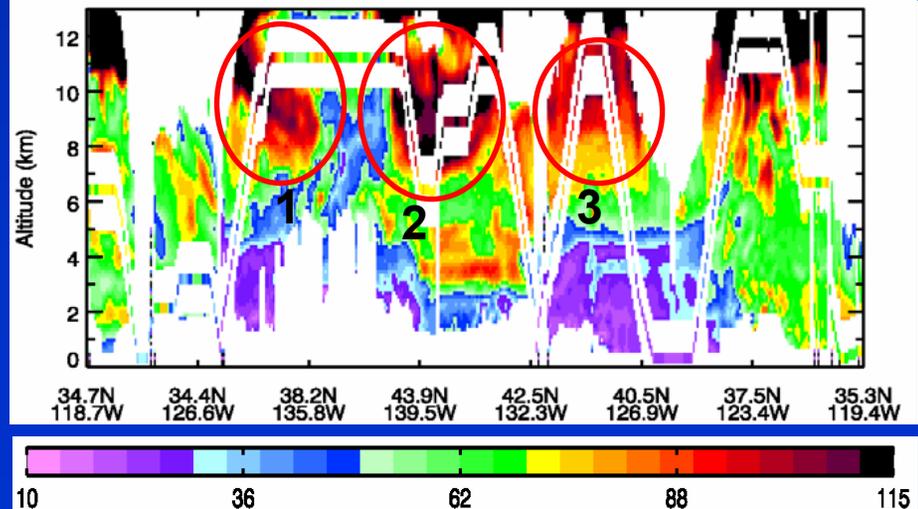
Asian Plume



Local PM (ascending) AIRS CO at 500 mb on 20040701



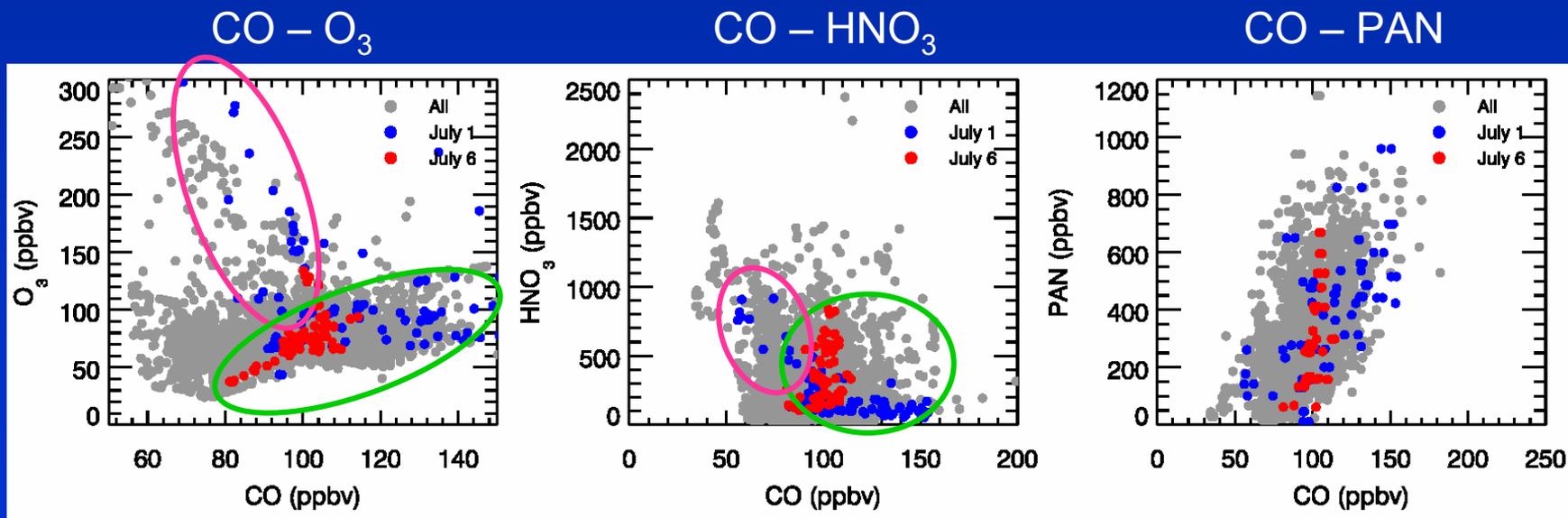
Observed O₃ [ppbv]: DIAL+FASTOZ



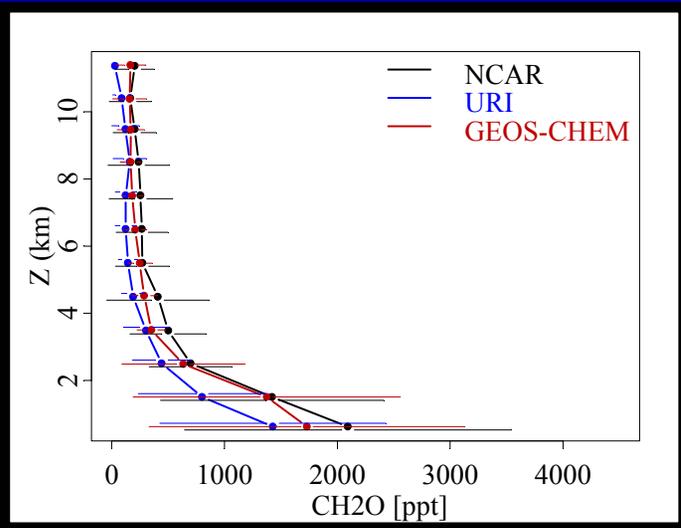
Chemical Composition of Asian Plumes

- **Asian Plumes** -- Model Asian CO > 25~30 ppbv
- **Background air** – Eliminate fresh convection, lightning, stratosphere, Alaskan fires

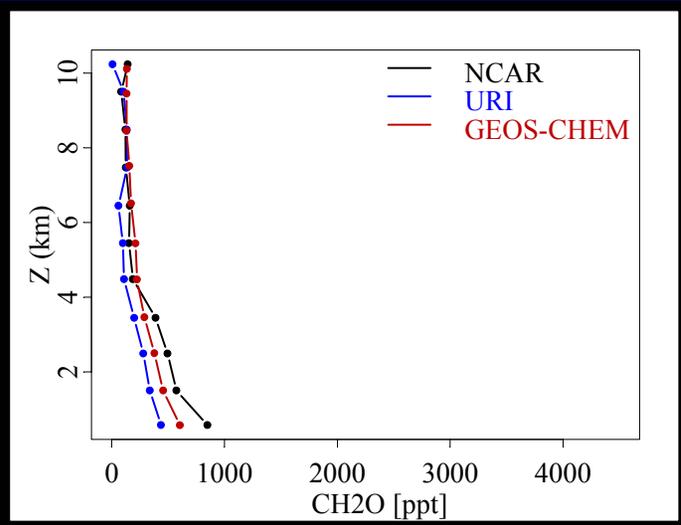
	Background	Asian Plumes	Observed Δ	Model Δ	July 1	July 1 Δ
CO, ppbv	94	113	+19	+6	108	+14
O ₃ , ppbv	69	92	+23	+13	101	+32
HNO ₃ , pptv	241	233	-8	+20	188	-53
PAN, pptv	302	399	+97	+4	316	+14
Acetylene, pptv	78	125	+47		129	+51
SO ₄ ⁼ , pptv	86	86	0		119	+33



HCHO during ICARTT: implications for GOME/OMI

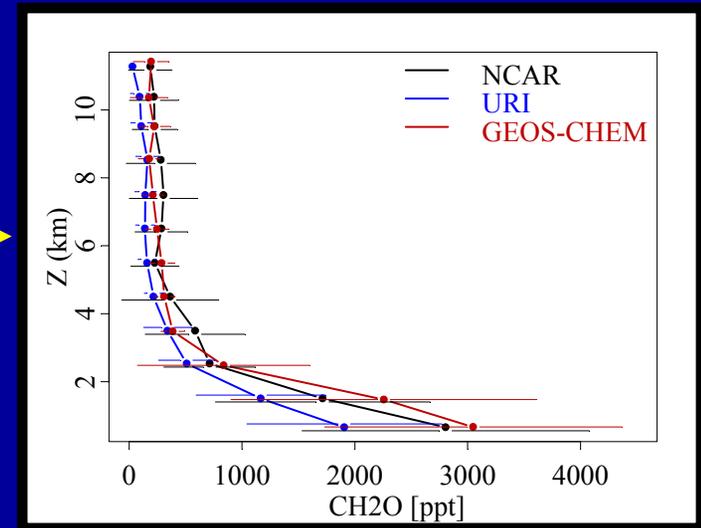


← All profiles

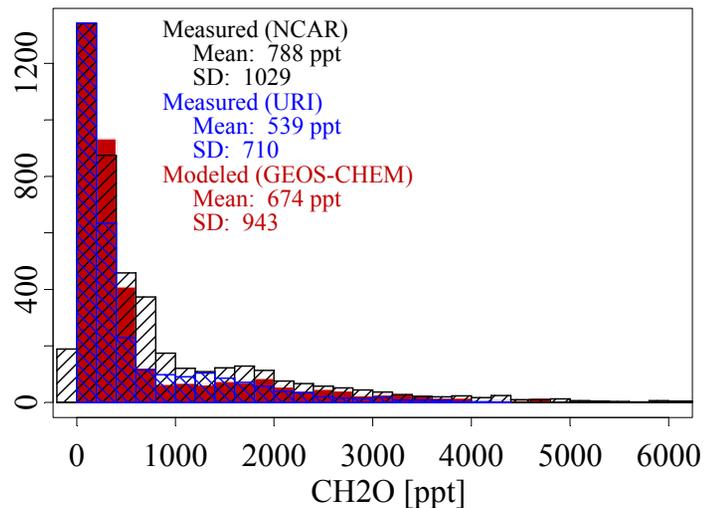


← Atlantic

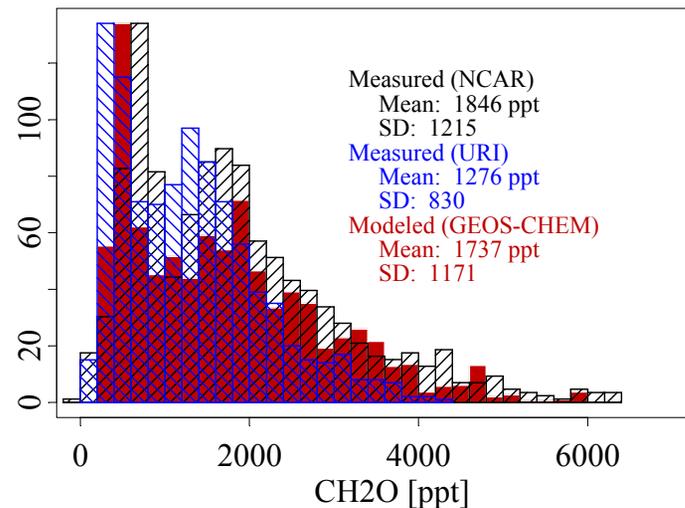
E. U.S. →



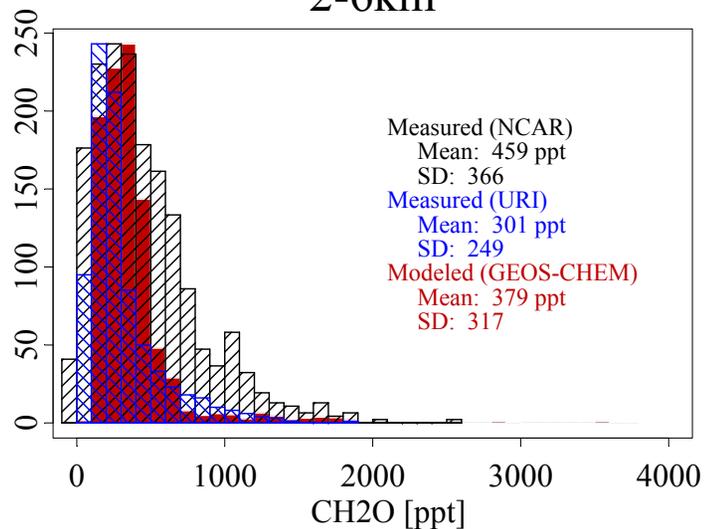
All Data



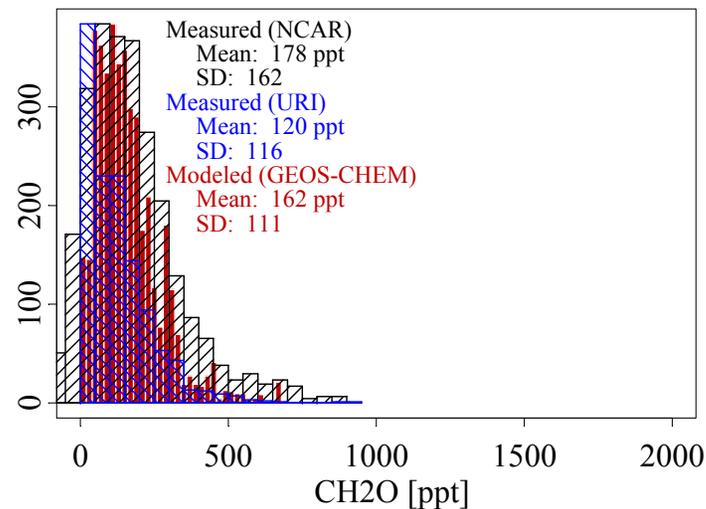
< 2km



2-6km



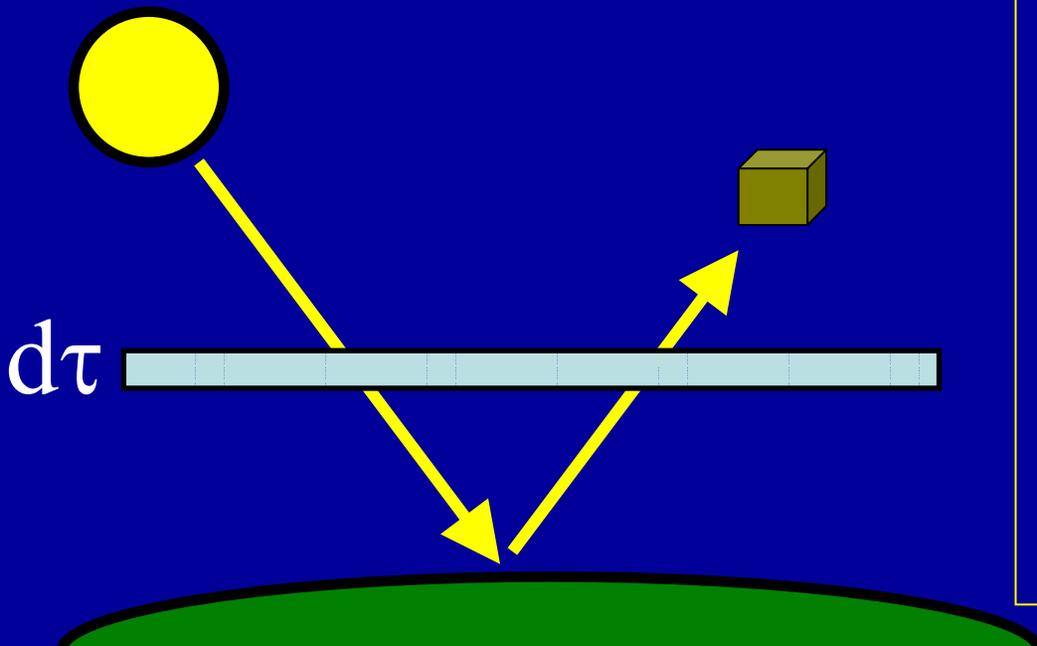
> 6km



HCHO during ICARTT: implications for GOME/OMI

$$AMF = AMF_G \int_1^0 w(\sigma) S(\sigma) d\sigma$$

AMF: Slant column / vertical column



AMF_G : Geometric factor

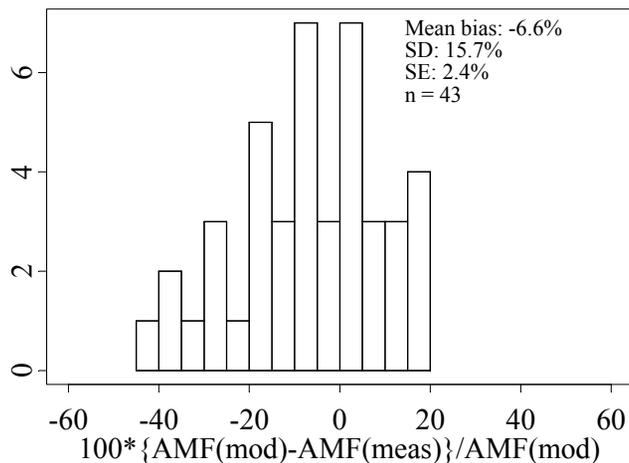
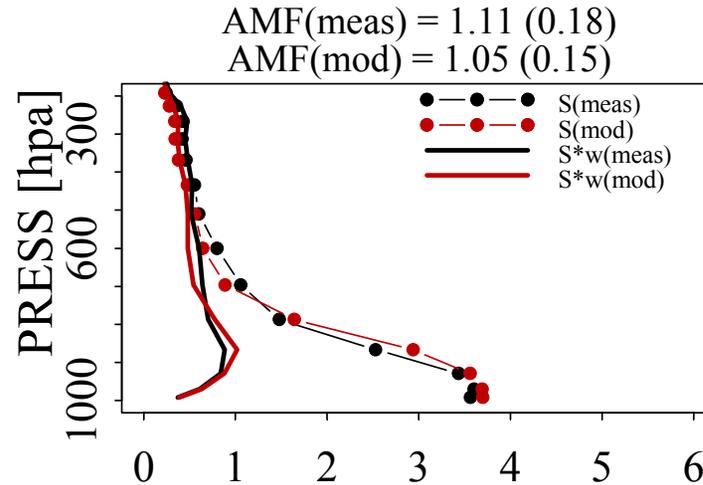
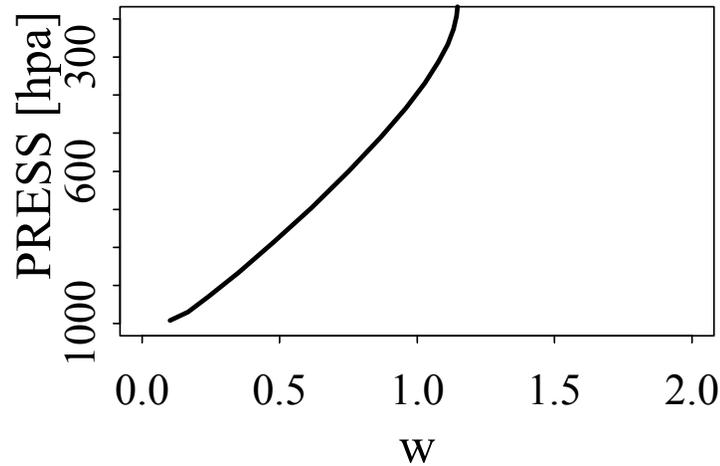
$w(\sigma)$: Scattering weights
 $\sim -\partial(\ln I_B) / \partial \tau$

$S(\sigma)$: Shape factor
Normalized vertical
distribution

From model

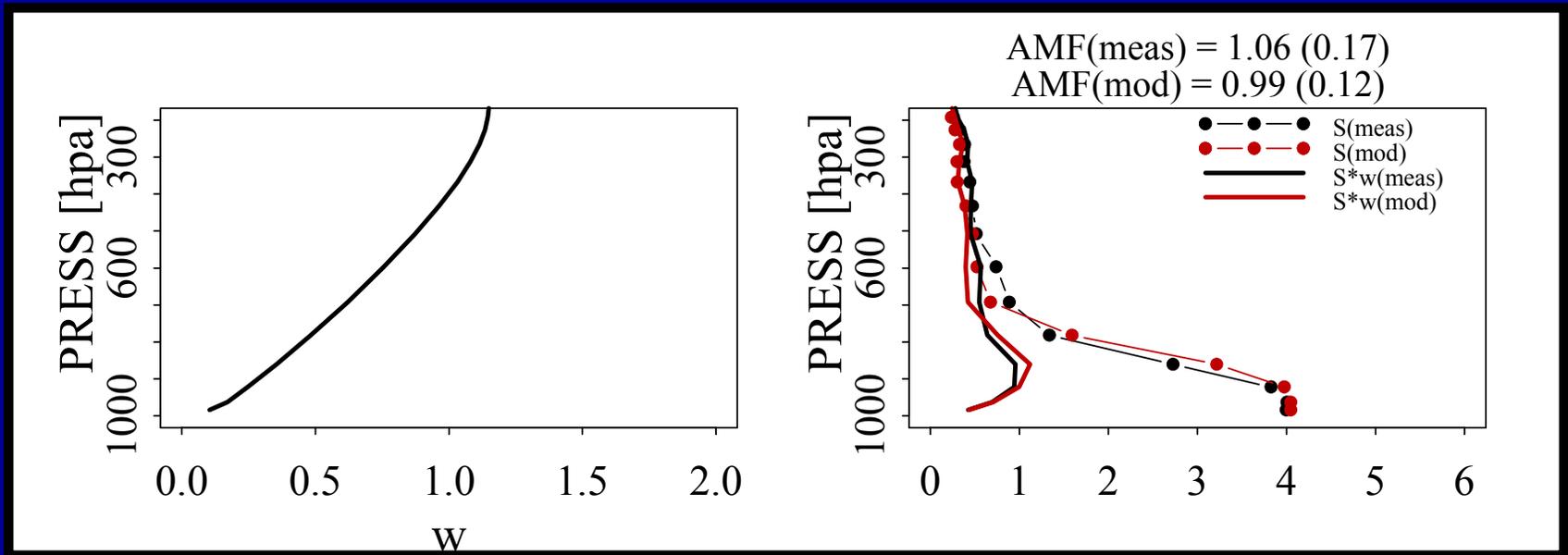
Clear Sky AMF Comparison

- all profiles -



Small negative bias (-7%) in modeled clear sky AMF

Continental profiles:



Oceanic profiles:

