

MOPITT during INTEX

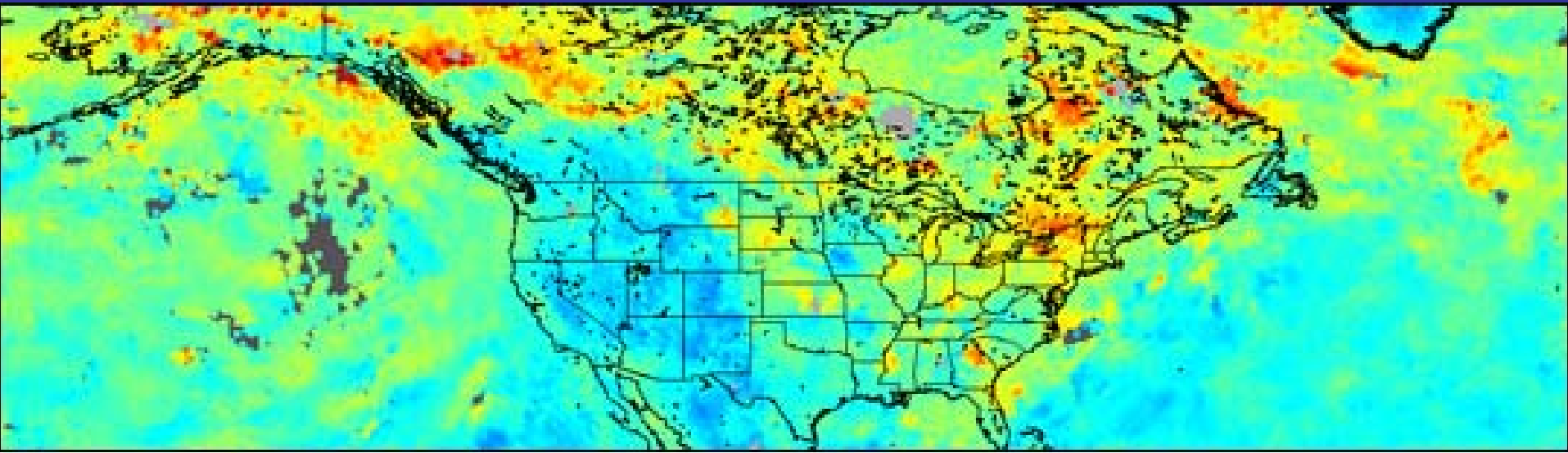
David Edwards

Louisa Emmons, Gabriele Pfister, John Gille,

Dan Ziskin, Debbie Mao

Atmospheric Chemistry Division

NCAR



Near-Real-Time MOPITT Data

<http://www.eos.ucar.edu/mopitt>

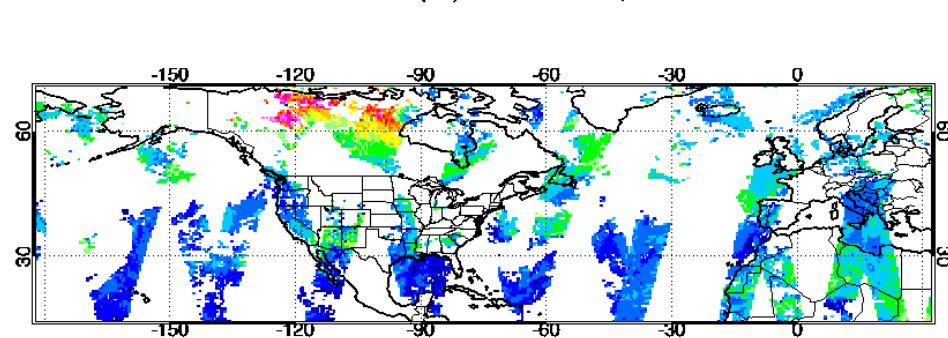
Expedited data for N. America/N. Atlantic provided within ~9 h of sampling - used for flight planning

Rapid Response data for globe available in ~1 day

HDF and text format files were made available on MOPITT website, along with images

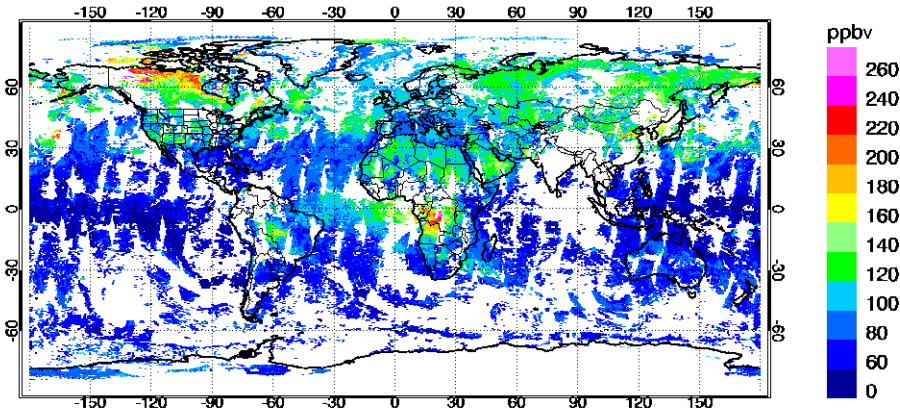
All images and data files on website have been updated with final retrievals

MOPITT CO (v3) 700hPa Jul 05, 2004



Gridded at 0.5x0.5deg from MOP02-20040705-L2V5.9.4.prov.hdf (apriori fraction < 50%)

MOPITT CO (v3) 700hPa Jul 04, 2004-Jul 06, 2004



Gridded at 0.5x0.5deg from MOP02-20040706-L2V5.9.4.prov.hdf (apriori fraction < 50%)

Final MOPITT Data

- Final retrievals are processed with the MODIS cloud mask (usually within a week) and delivered to the Langley DAAC
- All data on the DAAC is available for public use (see MOPITT website for info: www.eos.ucar.edu/mopitt)
- Gridded data (“Level 3”) will be available from the DAAC soon
 - 1° x 1° grid for each retrieval level
 - Day and night separate, averaging kernels included
 - Daily and monthly averages
- Data files suitable for posting on the INTEx data archive will be created
- Please contact us if you need assistance

MOPITT Validation

DC8 sampled 10 profiles coincident with MOPITT overpasses:

- July 8 (Flt 5) - N. Illinois (42N, 270E)
- July 15 (Flt 8) - N. Wisconsin (46N, 270E)
- July 22 (Flt 11) - Gulf of Maine (43N, 290E)
- July 25 (Flt 12) - off E. Florida (28N, 281E)
- July 31 (Flt 14) - off New England coast (41N, 294E)
- Aug 2 (Flt 15) - Gulf of St. Lawrence (49N, 298E)
- Aug 6 (Flt 16) - Tennessee (36N, 276E)
- Aug 7 (Flt 17) - Gulf of Maine (42N, 292E)
- Aug 11 (Flt 18) - off VA coast (37N, 295E)
- Aug 13 (Flt 19) - off Gulf coast (30N, 271E)

DACOM CO data (G. Sachse) used for all flights, except 7/31, where DACOM was available only below 3km; UCI can data used above

MOPITT CO Retrievals

MOPITT CO retrievals are determined by maximum likelihood (optimal estimation), incorporating *a priori* information.

The **retrieved profile x'** can be expressed as a linear combination of the true profile x and the *a priori* profile x_a .

$$x' = A x + (I-A) x_a$$

The Averaging Kernel A represents the **measurement sensitivity** to the true profile. I is the identity matrix.

Averaging kernels depend on the contrast between air and surface temperature and surface emissivity.

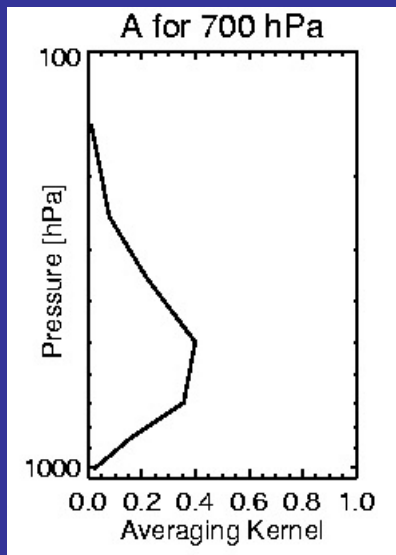
Transformation of *in situ* Profiles

The averaging kernels and a priori CO profile are used to calculate \mathbf{x}' from in situ CO (\mathbf{x}):

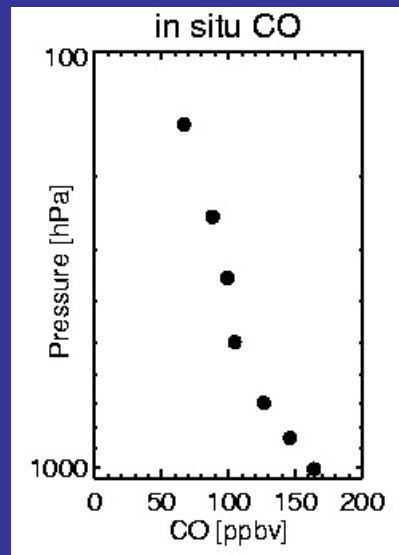
$$\mathbf{x}' = \mathbf{A} \mathbf{x} + (\mathbf{I} - \mathbf{A}) \mathbf{x}_a$$

For example, $\mathbf{x}'(700 \text{ hPa}) =$

\mathbf{A}_{700}

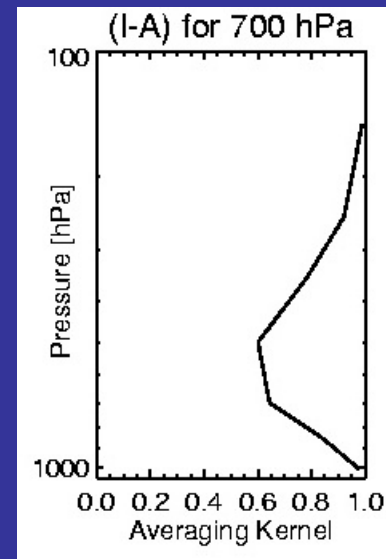


\mathbf{x}



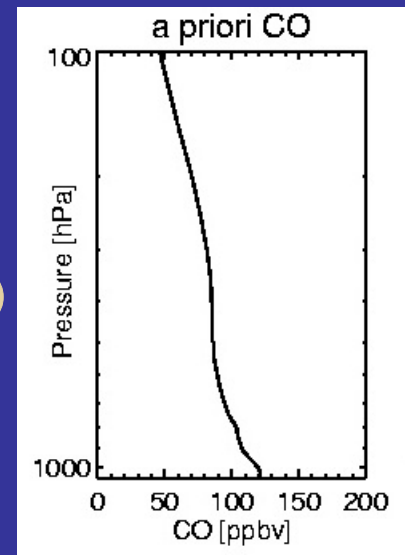
+

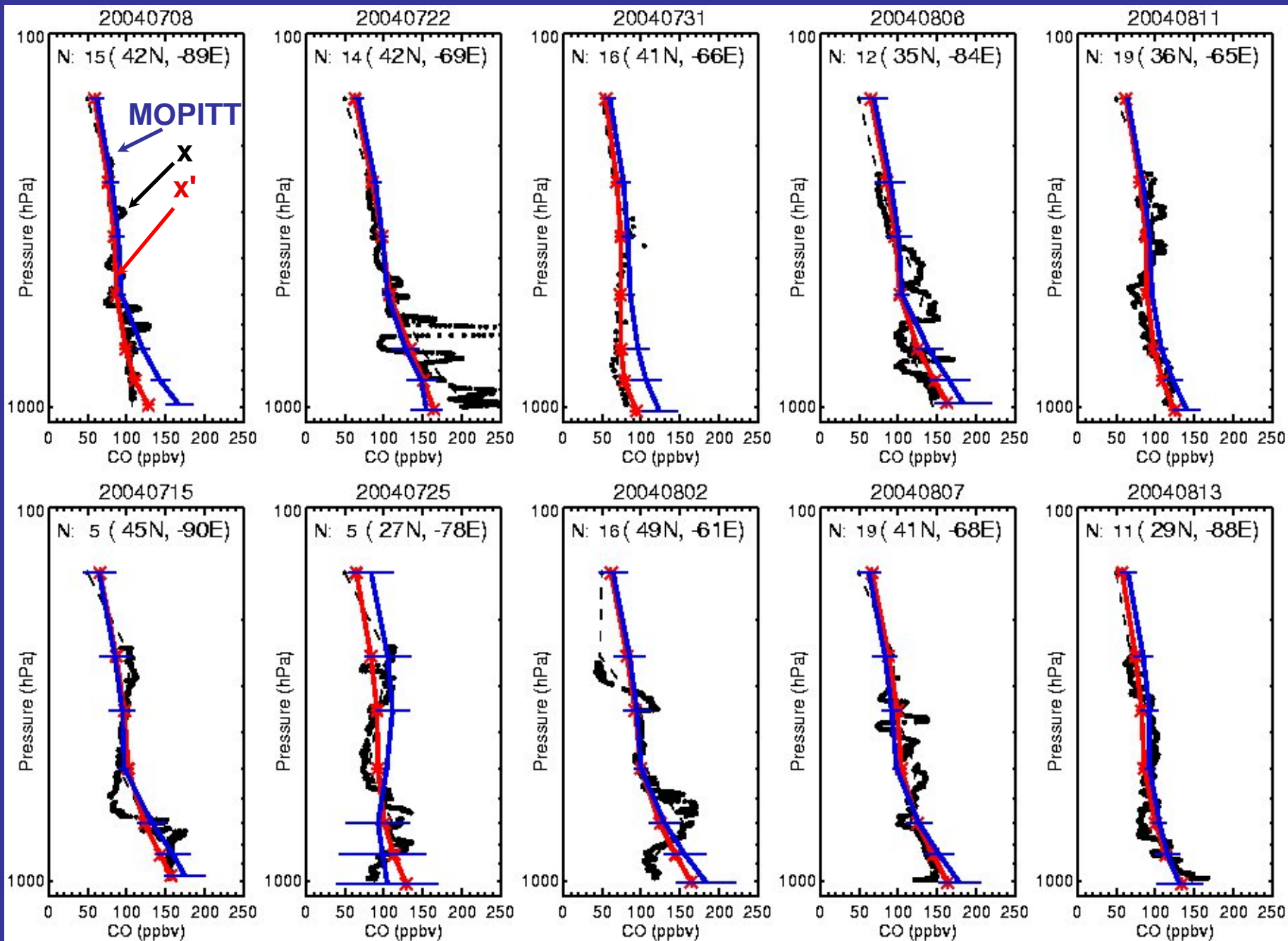
$(\mathbf{I} - \mathbf{A}_{700})$



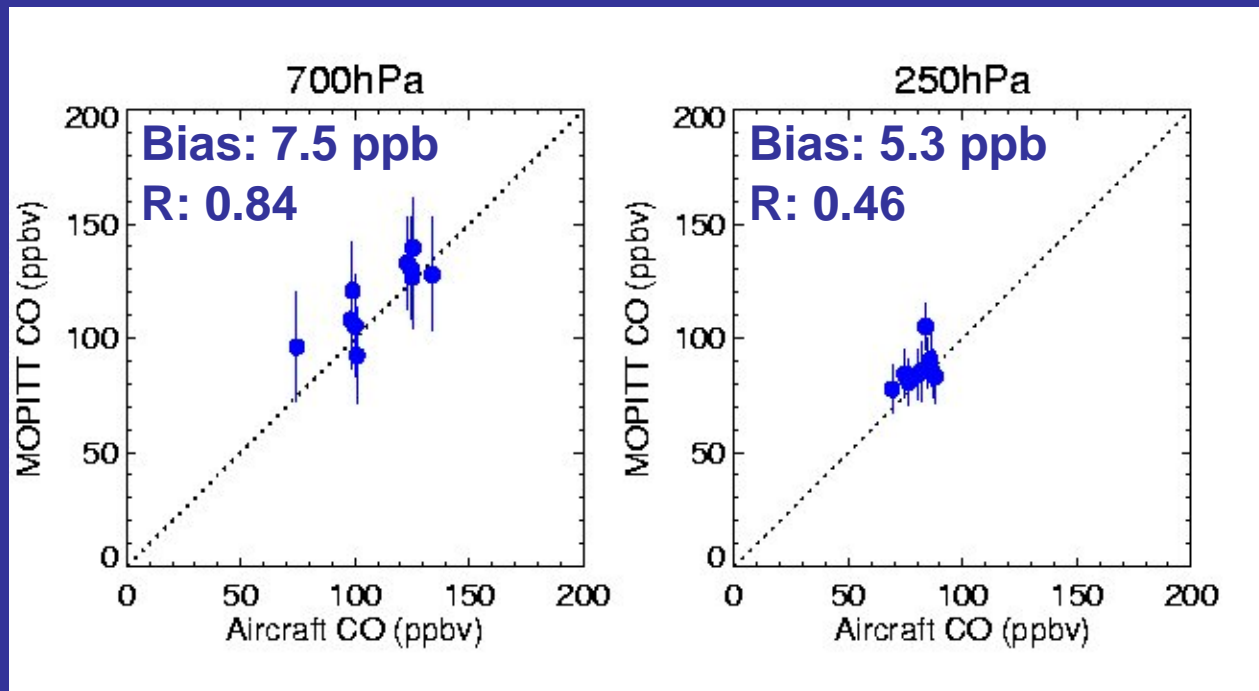
+

\mathbf{x}_a





Validation Summary



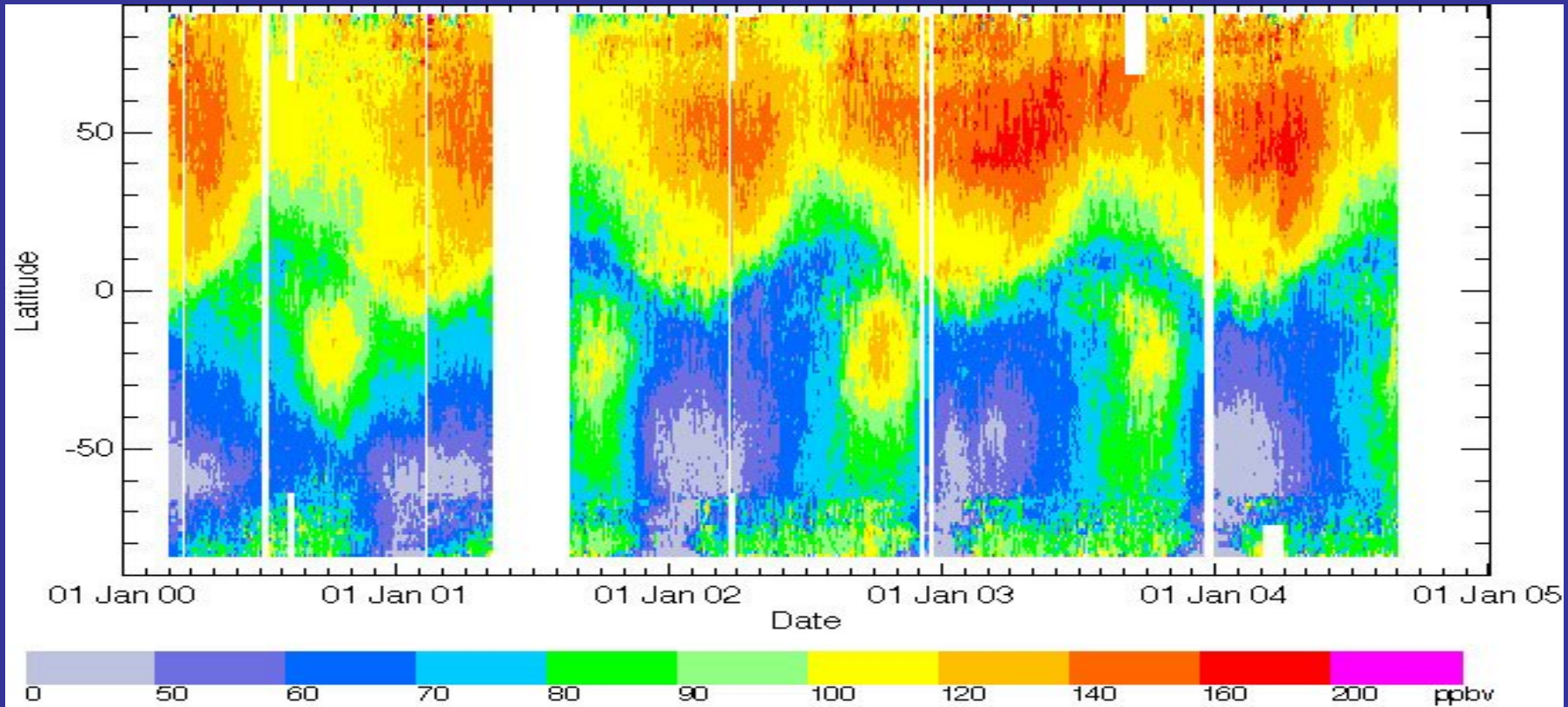
For each overpass use MOPITT pixels within 0.5 deg of average lat/lon of profile

Number of pixels varies (5-19)

On-going work: identify cause of bias and variability (cloud interference?)

Zonal Mean Variability: 2000-2004

MOPITT CO 700 hPa



The peak of the Southern hemisphere biomass burning maximum occurs each year in September-October and has variable intensity

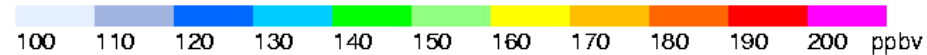
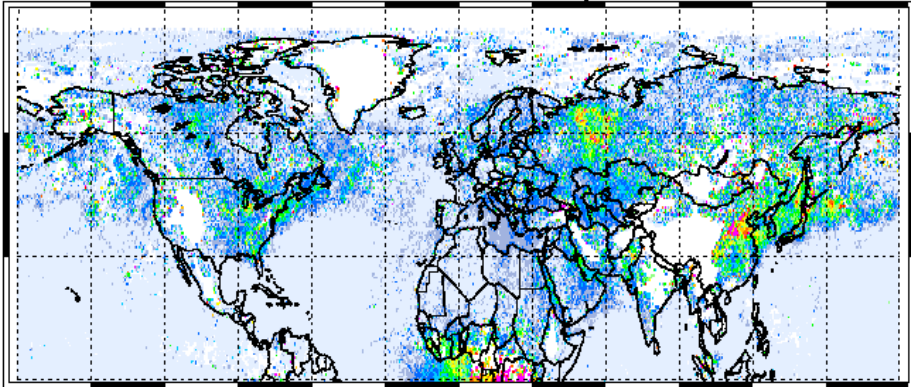
The Northern hemisphere winter maximum occurs in March-April

Apparent increase from 2000 to 2003

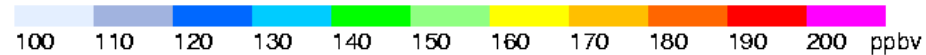
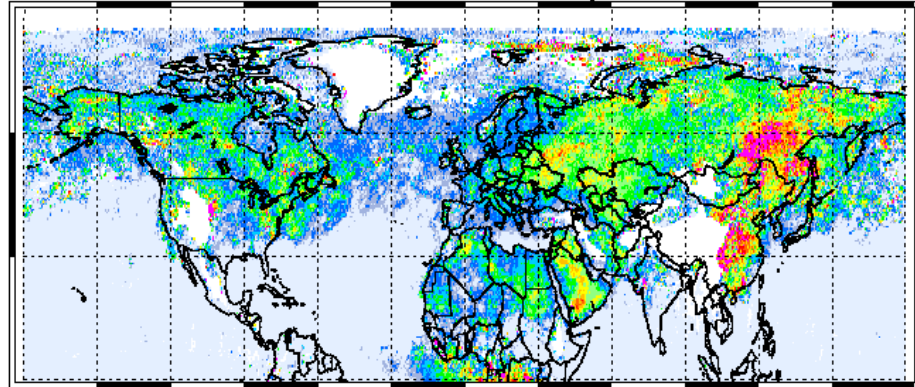
The 2002-3 winter maximum was particularly intense and started early

MOPITT for previous Julys

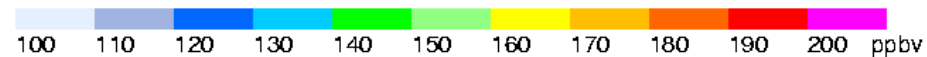
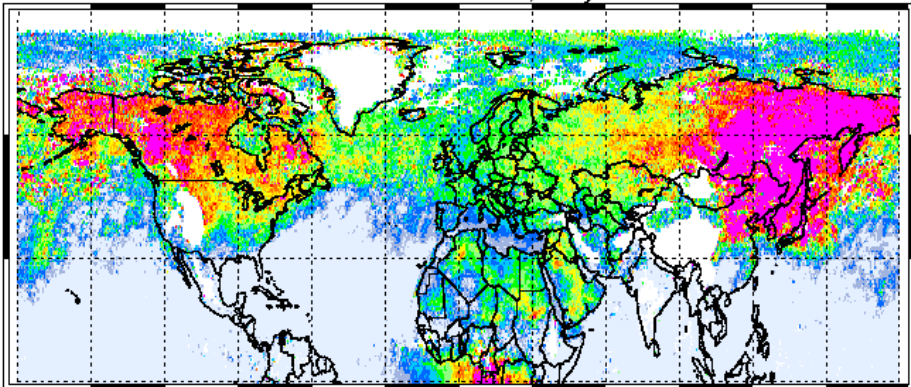
MOPITT CO 850 hPa, July 2000



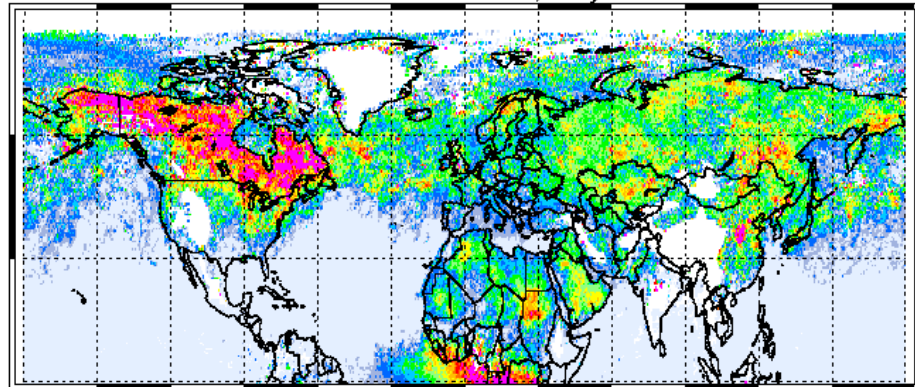
MOPITT CO 850 hPa, July 2002



MOPITT CO 850 hPa, July 2003

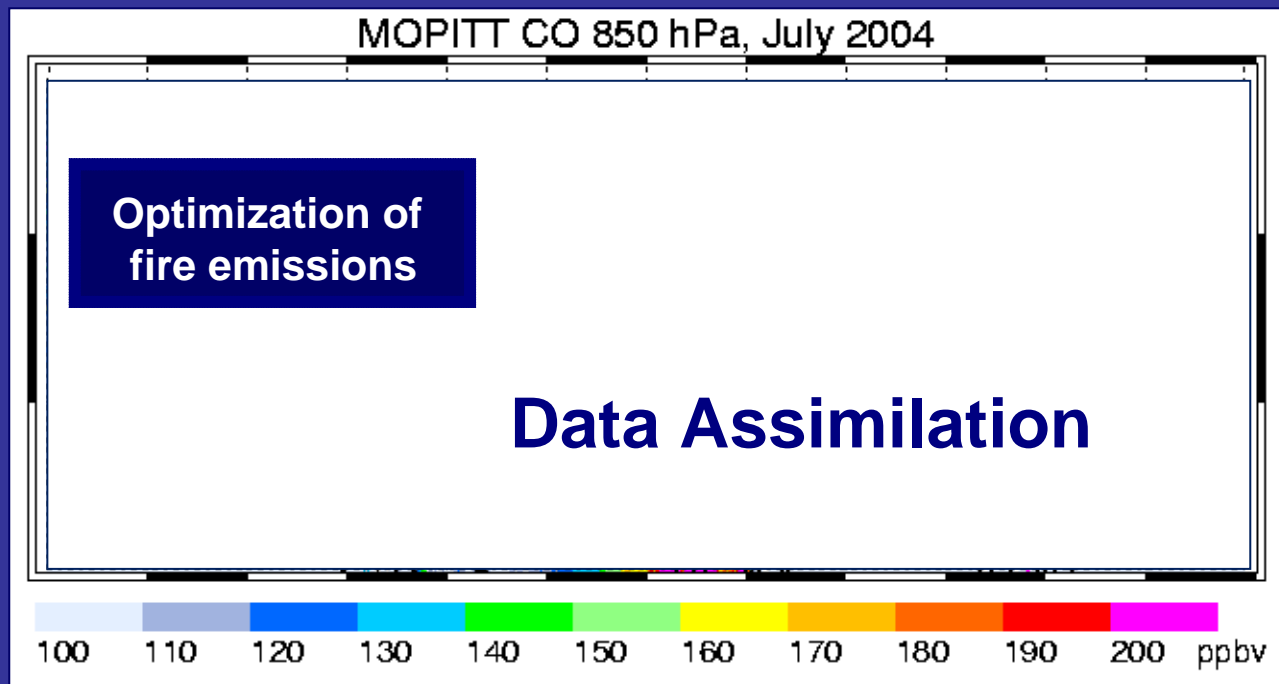


MOPITT CO 850 hPa, July 2004



Inverse Modeling of CO Fire Emissions

Gabriele Pfister et al.



Fire emissions optimized over Alaska and Canada

Assimilation of MOPITT into MOZART accounts for errors in emissions for rest of globe

Other sources within fire regions (anthropogenic, methane and NMHC oxidation) are assumed small or well known

Methodology

- **A Priori Emissions of Wildfires**

- based on MODIS Fire Counts (Christine Wiedinmyer, NCAR)
- daily for June – September 2004

- **Forward Model - MOZART**

- www.acd.ucar.edu/science/gctm/mozart
- 2.8° x 2.8°, 28 vertical levels, met. fields from NCEP

- **Assimilation Scheme**

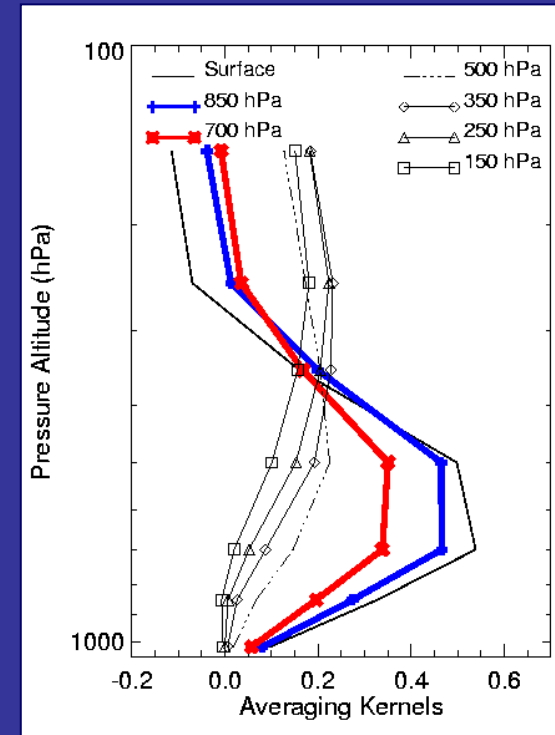
- MOPITT CO assimilated into MOZART (Lamarque et al., 1999)

- **CO Measurements – MOPITT**

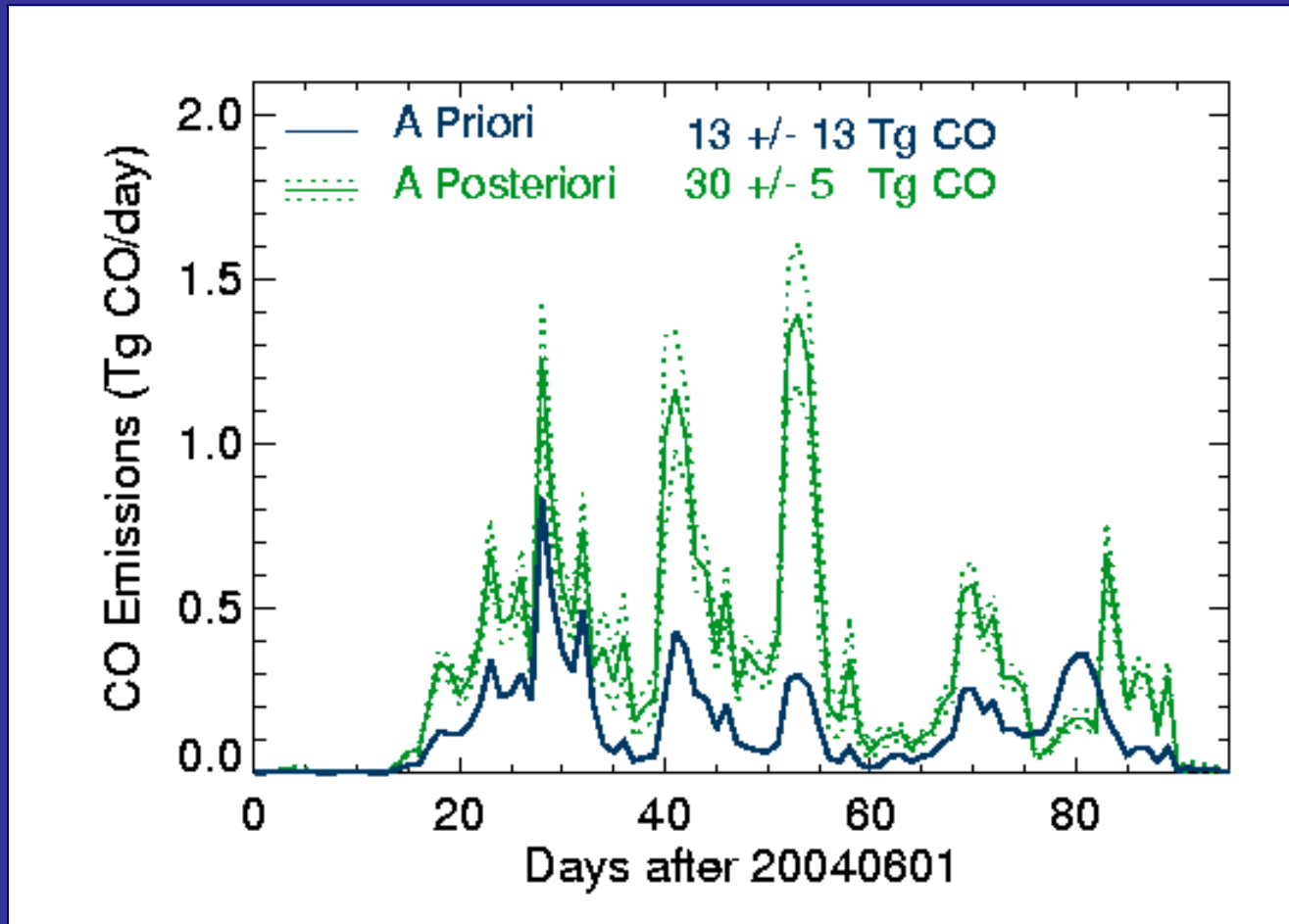
- retrievals @ 850 hPa and 700 hPa
- retrieval a priori fraction < 50%

- **Inverse Modeling Scheme**

- Bayesian Inverse Technique (Rodgers, 2000)



A Priori and A Posteriori Emissions



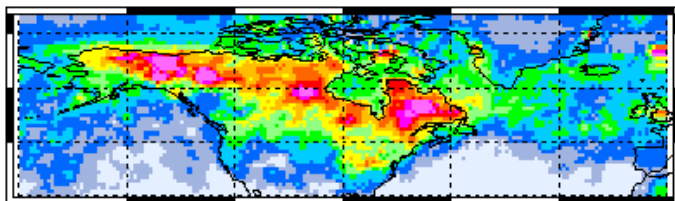
Evaluation – July 2004

700 hPa

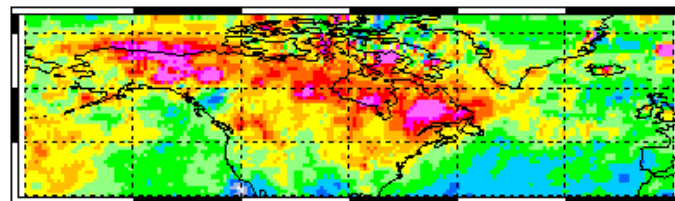
350 hPa

MOPITT

MOPITT 700 hPa 200407

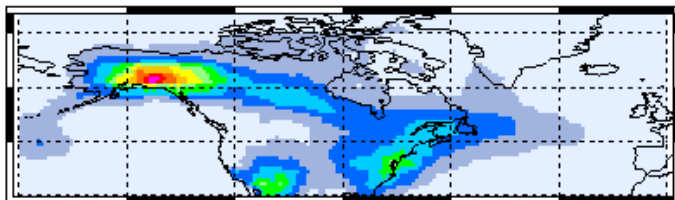


MOPITT 350 hPa 200407

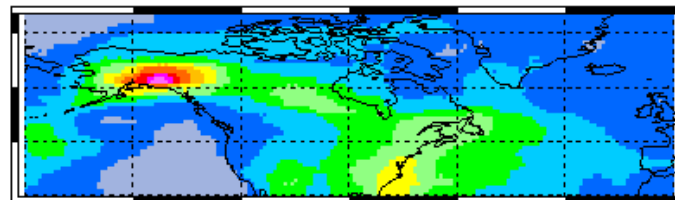


MOZART
A Priori

MOZART 700 hPa 200407

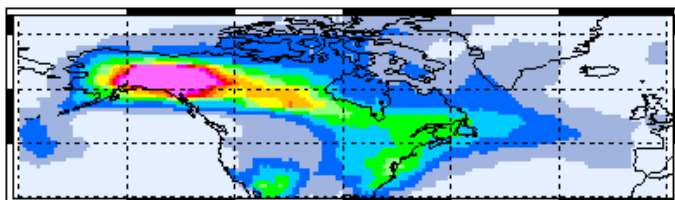


MOZART 350 hPa 200407

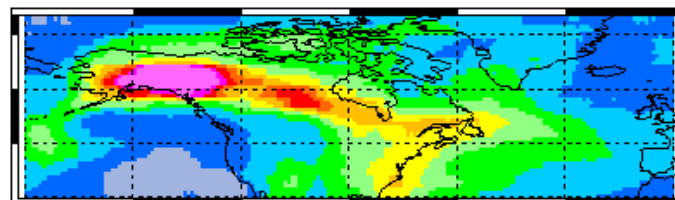


MOZART
A Posteriori

MOZART 700 hPa 200407



MOZART 350 hPa 200407

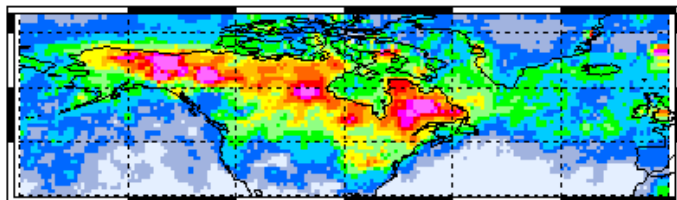


MOPITT Averaging Kernels applied to MOZART

Background CO

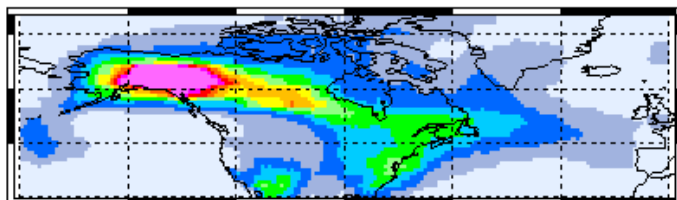
MOPITT

MOPITT 700 hPa 200407



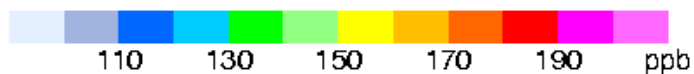
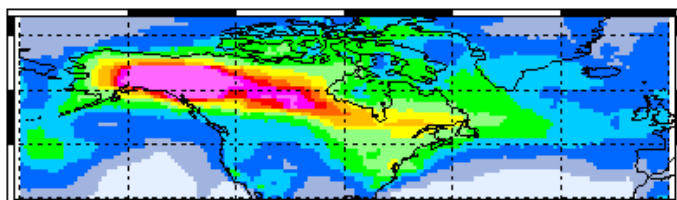
MOZART
Posteriori

MOZART 700 hPa 200407



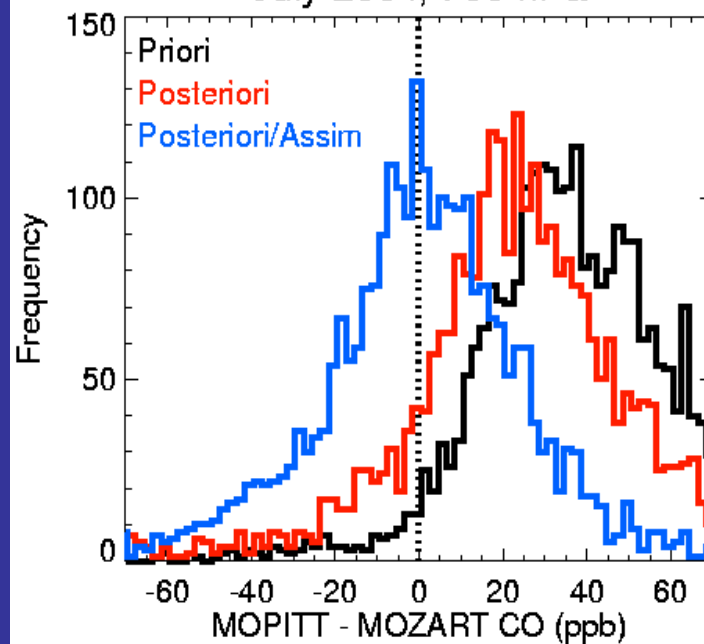
MOZART
Posteriori
plus
Assimilation

MOZART 700 hPa 200407



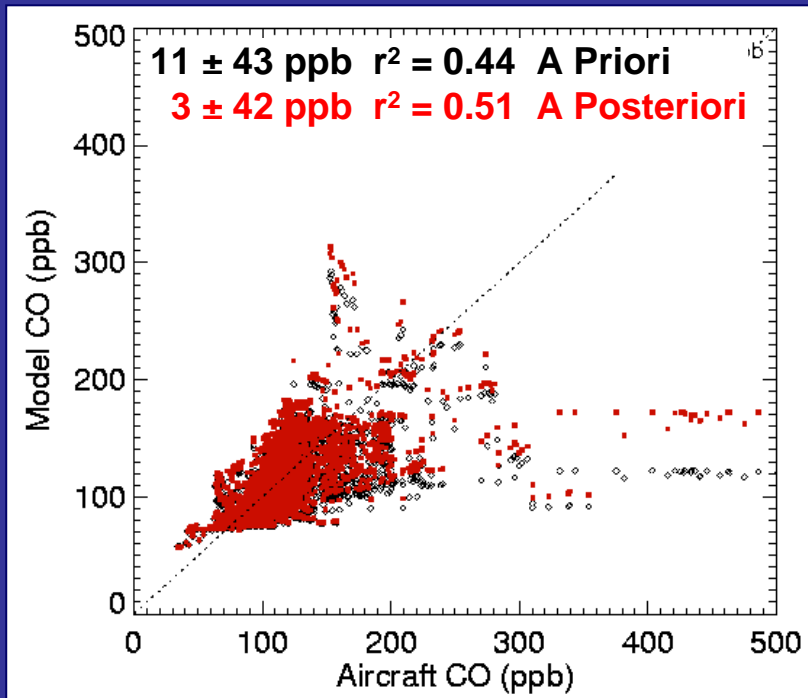
MOPITT *minus* MOZART

July 2004, 700 hPa

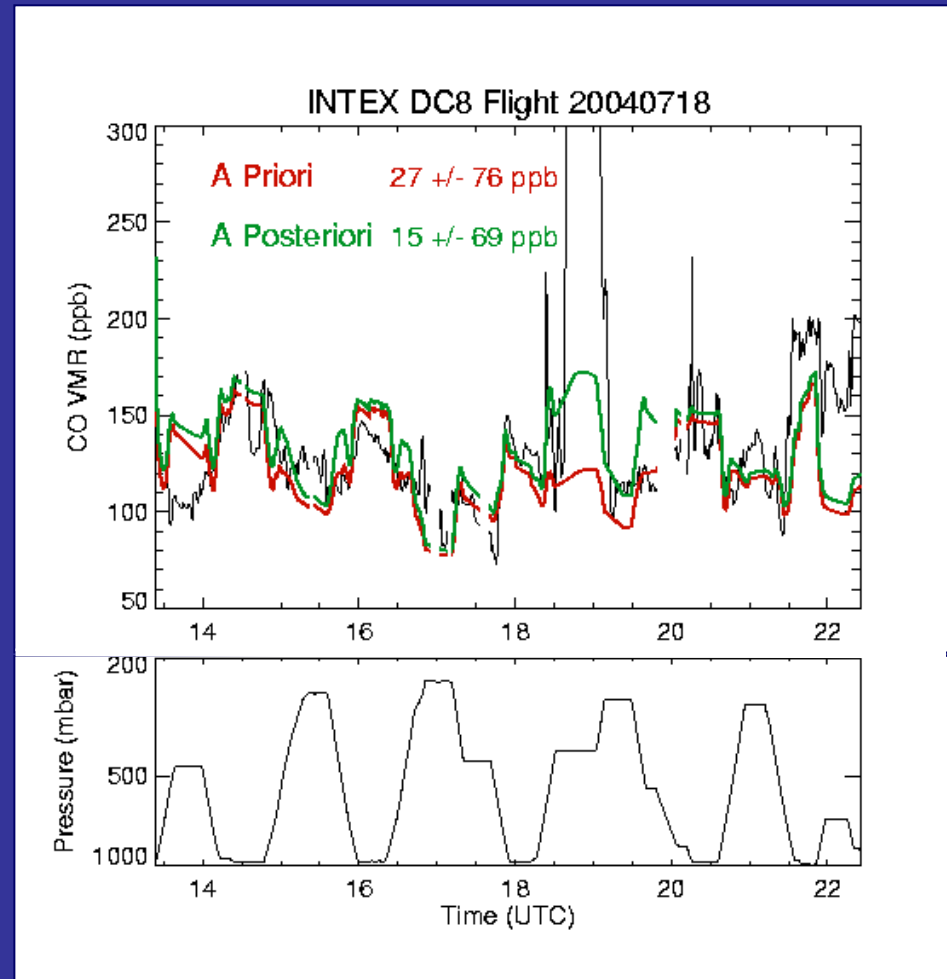


Evaluation with INTEX Data

CO from G. Sachse (DC8)



Flights in New England
July/August 2004



Request for Early Publication

Constraints on Emissions for the Alaskan Wildfires 2004 using Data Assimilation and Inverse Modeling of MOPITT CO

Pfister, G., P.G. Hess, L.K. Emmons, J.-F.
Lamarque, C. Wiedinmyer, D.P. Edwards, G. Pétron,
J.C. Gille, G.W. Sachse,
for *Geophys. Res. Lett.*

- Primarily a MOPITT inverse modeling study
- MOPITT data is not bound by INTEX data protocol -- they are made public as soon as they are processed
- Results could be useful for on-going INTEX studies

*Emissions files will be made available - contact us
(pfister@ucar.edu or emmons@ucar.edu)*