MOPITT during INTEX

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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
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 \textit{a priori} information.

The retrieved profile \(x'\) can be expressed as a linear combination of the true profile \(x\) and the \textit{a priori} profile \(x_a\).

\[
x' = A \, x + (I-A) \, x_a
\]

The \textbf{Averaging Kernel} \(A\) represents the \textbf{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 \textit{in situ} Profiles

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

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

For example, $x'(700\ \text{hPa}) = \ A_{700} \times x + (I-A_{700}) \times x_a$
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?)
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
Data Assimilation

Optimization of fire emissions

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

![Graph showing CO emissions over time with A Priori and A Posteriori estimates.]

- A Priori: 13 +/- 13 Tg CO
- A Posteriori: 30 +/- 5 Tg CO
Evaluation – July 2004

MOPITT

MOZART
A Priori

MOZART
A Posteriori

MOPITT Averaging Kernels applied to MOZART
Background CO

MOPITT

MOZART
Posteriori

MOZART
Posteriori
plus
Assimilation

MOPITT minus MOZART

July 2004, 700 hPa

Prior
Posterior
Posteriori/Assim
Evaluation with INTEX Data

CO from G. Sachse (DC8)

11 ± 43 ppb  $r^2 = 0.44$  A Priori
3 ± 42 ppb  $r^2 = 0.51$  A Posteriori

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


- 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)