Airborne observations of gaseous elemental mercury, CO, O₃ and aerosol scattering over the coastal northwestern USA during INTEX-B

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Main Goal of INTEX-B:

- Quantify the transpacific transport and evolution of Asian pollution to North America;
- Quantify the outflow and evolution of gases and aerosols from the Mexico City;
- Investigate the transport of Asian and North America pollution to the eastern Atlantic
- Validate and refine satellite observations of tropospheric composition;
- Map emissions of trace gases and aerosols and relate atmospheric composition to sources and sinks
### INTEX-B: North America Platforms

#### C-130 Aircraft
- NCAR, NOAA;
- Droplet Measurement Technologies

#### Canadian Cessna 207
- Dalhousie University, UBC
- Environment Canada

#### DC-8 Aircraft
- NASA Langley, Dryden, Wallops, Goddard & Ames; NCAR
- UND, UC-Irvine, PSU, U. Hawaii, UC-Berkeley, URI, GA Tech, UNH

#### Duchess 76
- University of Washington Bothell

#### J-31 Aircraft
- NASA Ames & Goddard
- Sky Research, Inc.
- UC-Boulder, Columbia Univ.

#### B-200 Aircraft
- NASA Langley

#### Surface Stations & Satellites
Observations using Duchess 76

- Gaseous Elemental Mercury (Hg0)
- Carbon Monoxide (CO)
- Ozone (O₃)
- Aerosols light scattering
  (Total and Back Scattering at 450, 550, 700 nm)
- GPS (Lat, Lon, Alt)
- Temperature
- Pressure
- Relative Humidity

2.5 Min

<10 sec
Observations: Flight Tracks

Total flights = 8
April 12, 18, 19, 30
May 4, 8, 9, 15

Vertical Profiles

Note: Flight #5 (May 4\textsuperscript{th}) was a local flight sampling in vicinity of Seattle up to altitude of 2800 m (680 mb)
Observations: Inter-comparison flights

Duchess 76 inter-comparison flights with C-130 (May 9, 2006) and DC-8 (May 15, 2006)
Results from Duchess 76 Aircraft
Vertical Profiles (All 8 flights)

- O₃ (ppbv)
- σₘₐₜ (m⁻¹)
- CO (ppbv)
- Hg₀ (ng m⁻³)

Altitude (mb)

- 400
- 500
- 600
- 700
- 800
- 900
- 1000
Frequency distribution $O_3$

Aircraft-2006

MBO-2006
Time Series Vertical Profile Flight #1

U W B Flight #1 (A pril 12, 2006)

Pressure (mb)
O3 (ppbv)
σ (m-1)
CO (ppbv)
Hg0 (ng m-3)

DOY (2006)
Events based correlation of Hg0 and CO

Flight #1
b[0]=0.68
b[1]=7.8e-3
r²=0.75

Flight #3
b[0]=1.0877
b[1]=3.6-3
r²=0.29

Flight #5
b[0]=1.247
b[1]=5.3e-4
r²=0.19

FT [LRT (Asian)]

FT [LRT (Asian)]

BL [Local (USA)]
Correlation of Hg0 and CO

#1

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.07 \]

#2

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.26 \]

#3

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.31 \]

#4

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.04 \]

#5

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.01 \]

#6

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.28 \]

#7

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.01 \]

#8

\[ y = b_0 + b_1 x \]
\[ r^2 = 0.61 \]
HYSLIT BTs

Transport from Asia, NW USA and Pacific Ocean (Flight #8 May 15)

Altitude (m)
- 0 - 1500
- 1500 - 3000
- 3000 - 4500
- 4500 - 6000
- 6000 - 10000

Transport from Asia (Flight #3 April 19)

BT Levels: 1500, 3000, 4500, 6000, 10000 m
Correlation of Hg0 and CO (Integrated data)

INTEX-B (2006)

\[ b[0]=2.09 \]
\[ b[1]=-4.8033\times10^{-3} \]
\[ r^2=0.81 \]

\[ b[0]=1.074 \]
\[ b[1]=3.330\times10^{-3} \]
\[ r^2=0.36 \]
Correlation of $O_3$ and CO (Integrated data)

$O_3$ (ppbv)

CO (ppbv)

\[ b_0 = 136.3 \]
\[ b_1 = -0.51 \]
\[ r^2 = 0.50 \]

\[ b_0 = 32.5 \]
\[ b_1 = 0.31 \]
\[ r^2 = 0.93 \]
Correlation of Hg0 and O3 (Integrated data)

INTEX-B (2006)

$Hg0$ (ng m$^{-3}$)

$O3$ (ppbv)

$b[0]=0.88$

$b[1]=8.43\times10^{-3}$

$r^2=0.84$
Correlation of $O_3$ and $H_2O$ (Integrated data)

INTEX-B (2006)

$O_3$ (ppbv) vs. $H_2O$ (g kg$^{-1}$)

$y = 87.45 - 12.57x$

$R^2 = 0.86$
Conclusions:

- Most of the LRT events are observed above 700 mb.

- The observed Hg0 to CO enhancement ratios ($\Delta$Hg0/ $\Delta$CO) are very similar to our previously detected LRT events (Jaffe et al 2005; Weiss et al 2006).

- The $\Delta$Hg0/ $\Delta$CO of FT above 700mb (all from Asia?) is much higher (10x) than USA plumes.

- Negative $\Delta$Hg0/$\Delta$CO and strong positive correlation of Hg0 and O3 below 3000m indicates that mixing layer (surface) is likely a sink of Hg0 and its life time is lower in BL compared to the troposphere.
Future work

• Complete the analysis and get micro details on LRT for individual flights.
• Expand the analysis for different meteorological conditions using NCEP reanalyzed data and HySPLIT Trajectories.
• Integrate satellite observation and model runs into analysis.
• Tie with MBO observations...to see if the LRT is confined to Northwest and/or further south.
• Use and inter-comparisons of our data with other aircraft and surface observations for INTEX-B period.
• Use of our aircraft data from previous aircraft campaigns and compare/quantify LRT and its role on local AQ.
• More Ideas...?