An Overview of the INTEX-A/ICARTT Experiment

H. Singh, & Science Team

<u>GOAL:</u> To understand the transport, transformation, & impacts of gases & aerosols on air quality & climate on intercontinental scales

- **INTEX-A: Summer 2004**
  - **large biosphere emissions**
  - **active photochemistry**
  - **max terrestrial carbon uptake**
- **INTEX-B: Spring 2006**
  - **maximum Asian inflow to NA**
  - **seasonal contrast**

Intercontinental Chemical Transport Experiment North America
International Consortium for Atmospheric Research on Transport and Transformation

INTEX-A - Science Objectives

- Quantify North American outflow of environmentally important gases/aerosols & relate to sources & sinks

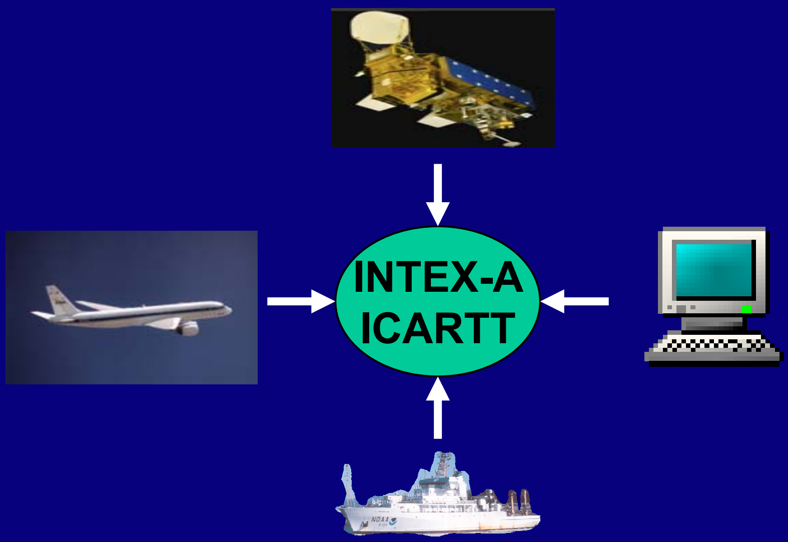
- Characterize & understand transatlantic transport of North American pollution & its chemical evolution

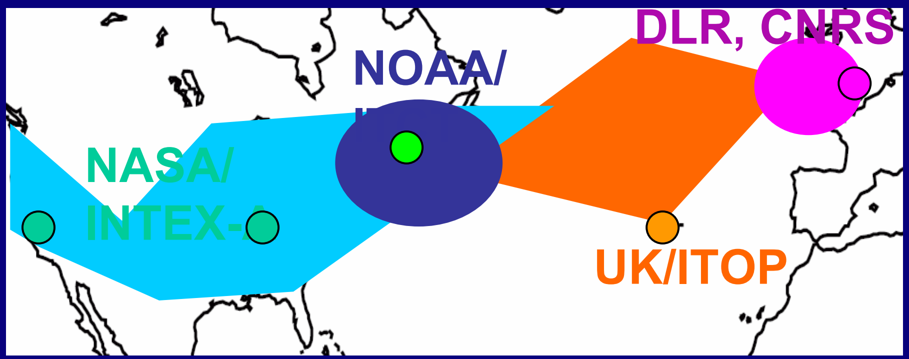
- Characterize sources of pollution over NA

- Characterize direct/indirect effects of aerosols over northeastern NA & western North Atlantic

- Validate satellite observations of tropospheric composition & relate to airborne & surface data

INTEX-A/ICARTT Plan & Coordination



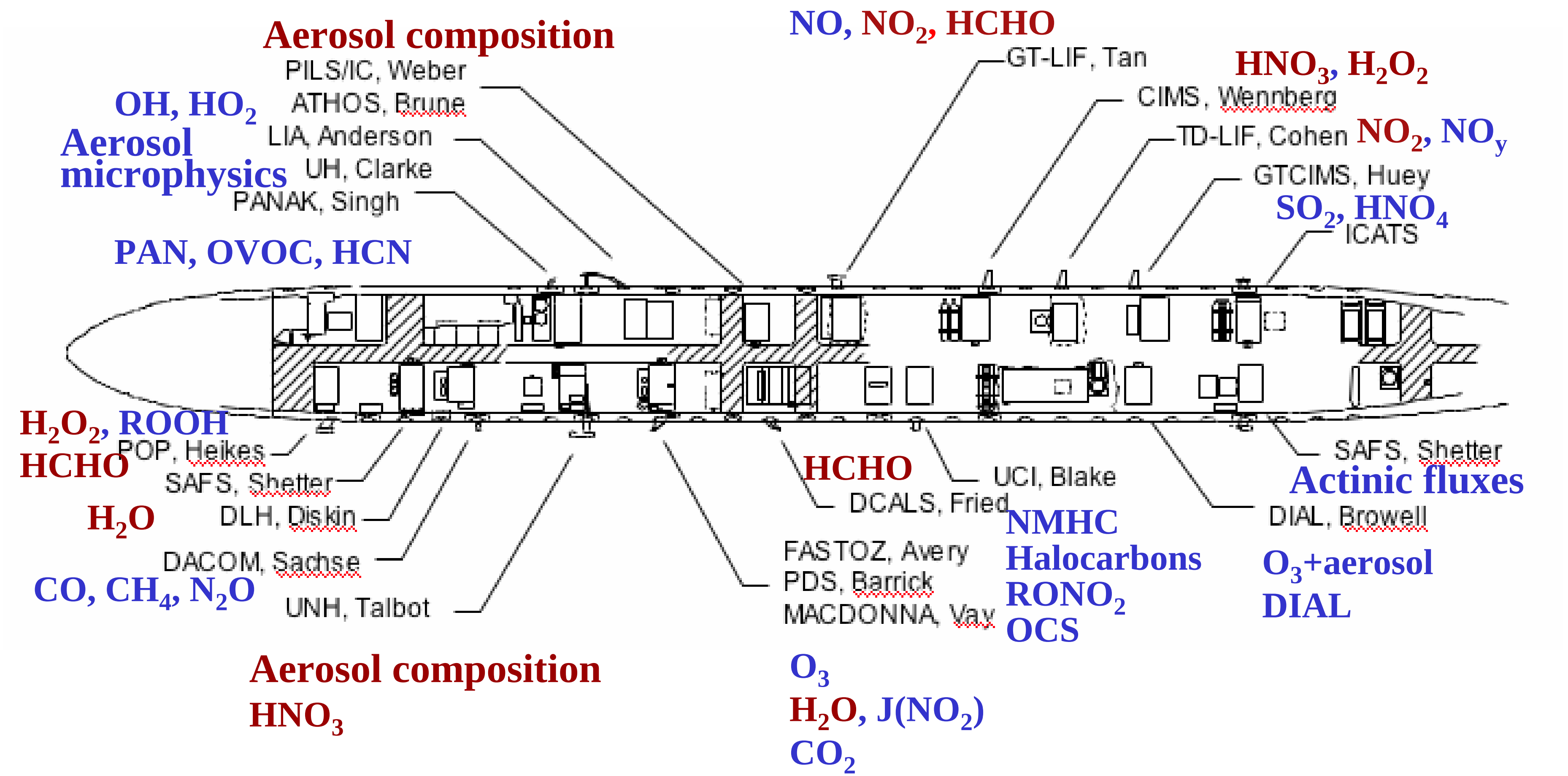


US, Canada, UK, France, Germany

- Outflow of gases/aerosols
- Source characterization
- Chemical evolution
- Carbon cycle
- Direct/indirect effects of aerosols
- Satellite validation

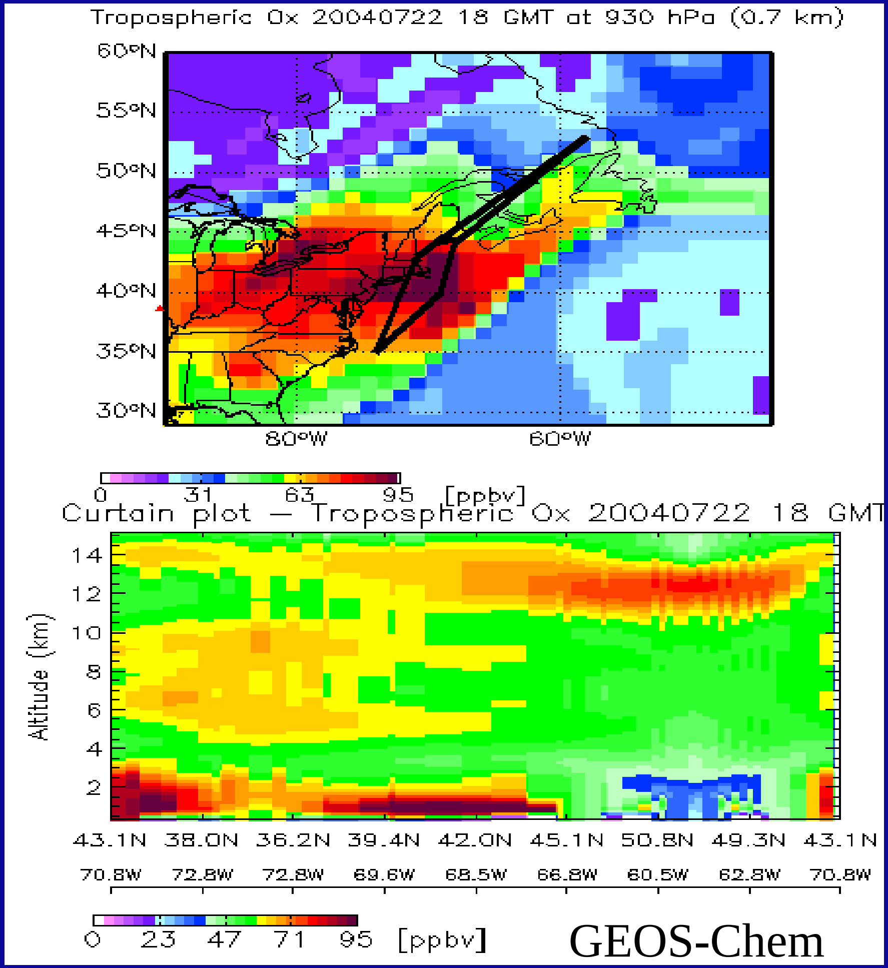
- Inter-comparisons
- Coordinated Science flights
- Sharing of forecasts & data
- Joint publications

DC-8 Payload



Aerosol composition
PILS/IC, Weber
OH, HO_2
ATHOS, Brune
Aerosol microphysics
LIA, Anderson
UH, Clarke
PANAK, Singh
PAN, OVOC, HCN
NO, NO_2, HCHO
GT-LIF, Tan
HNO_3, H_2O_2
CIMS, Wennberg
TD-LIF, Cohen
NO_2, NO_y
GTCIMS, Huey
SO_2, HNO_4
ICATS
H_2O_2, ROOH
HCHO
POP, Heikes
SAFS, Shetter
H_2O
DLH, Diskin
DACOM, Sachse
CO, CH_4, N_2O
UNH, Talbot
HCHO
DCALS, Fried
UCI, Blake
FASTOZ, Avery
PDS, Barrick
MACDONNA, Vay
NMHC
Halocarbons
$RONO_2$
OCS
SAFS, Shetter
Actinic fluxes
DIAL, Browell
O_3+aerosol
DIAL
Aerosol composition
HNO_3
O_3
H_2O, $J(NO_2)$
CO_2

Forecast Products



MET data/Trajectories (FSU)

Convective influences (GSFC/ARC)

AIRS CO (UMD)

MOPITT CO (NCAR)

MODIS Aerosol (UMD/Langley)

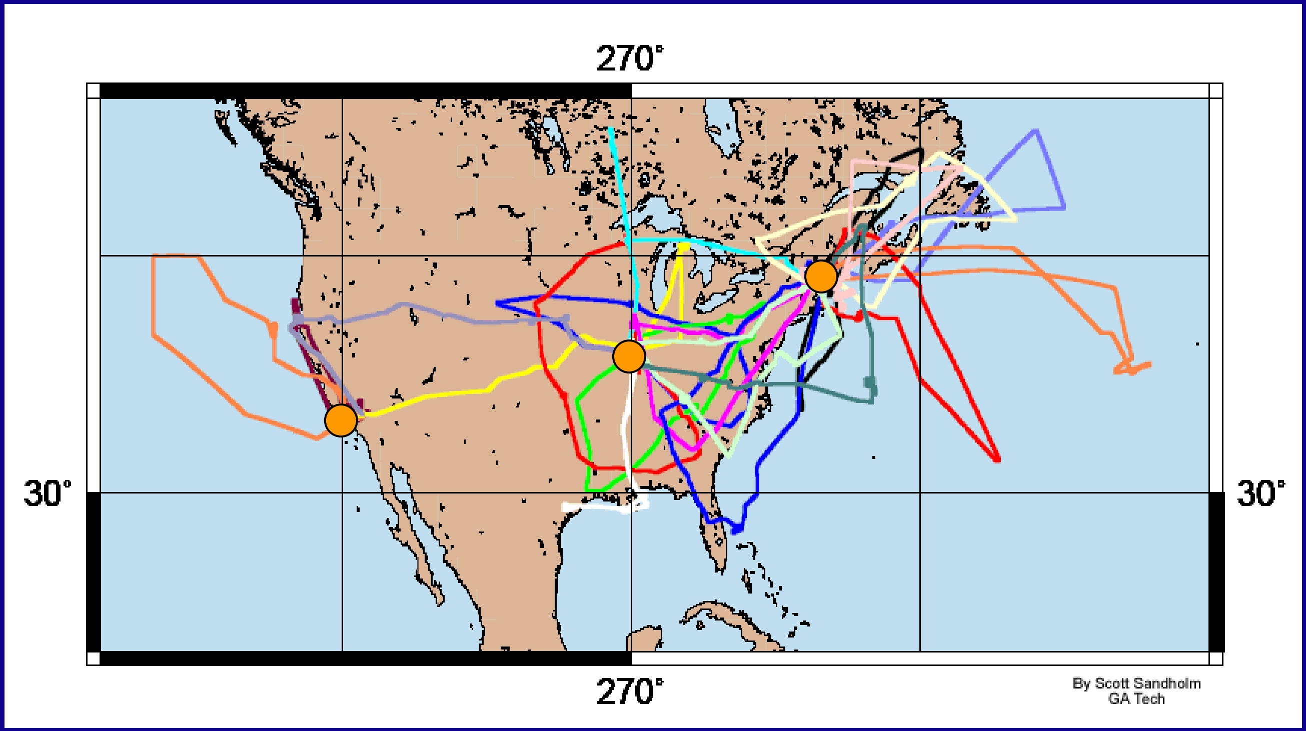
GEOS-Chem (Harvard)

MOZART (NCAR)

RAQMS (Langley)

STEM/CFORS (U. Iowa)

INTEX-A DC-8 Flight Tracks
(Missions 2-20; June 29 - August 14, 2004)



170 DC-8 flight hrs (20 fligts)

EAB- 2 T
EAB- 1 S
MA- 4 S
P- 9 S
TR- 4 S

DC-8 Coordinated Activities

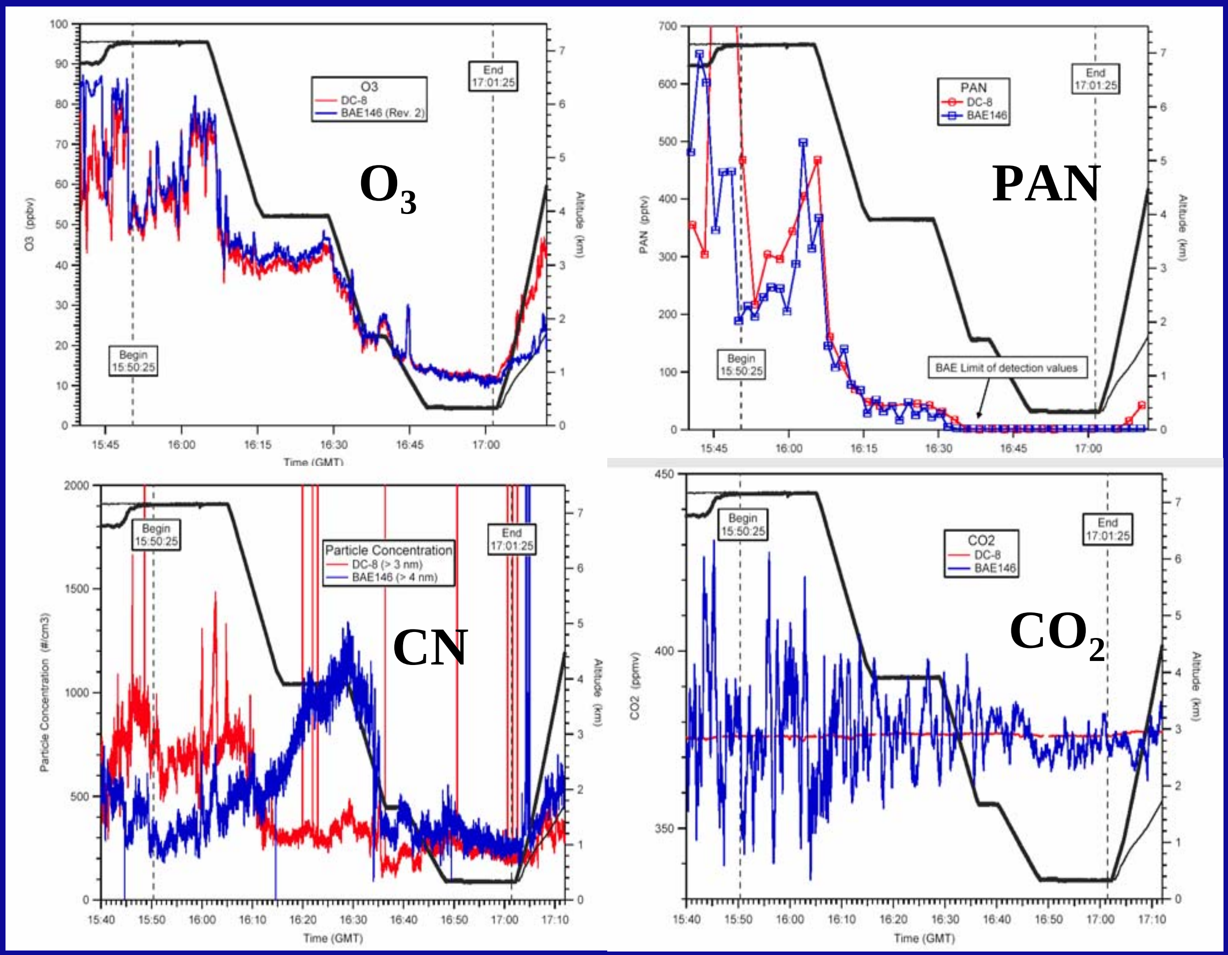
Flight No.	2004 Date	Base	DC-8	Terra	Aqua	Envisat	P-3	J-31	BAe-146	King Air	Other*
3	7/1	Dryden	X		X						
4	7/6	Transit	X								
5	7/8	MidAmerica	X	X							
6	7/10	MidAmerica	X		X	X					
7	7/12	MidAmerica	X		X	X					
8	7/15	Transit	X	X	X					X	
9	7/18	Pease	X		X	X					X
10	7/20	Pease	X		X			X			
11	7/22	Pease	X	X			X	X			X
12	7/25	Pease	X	X	X						
13	7/28	Pease	X						X		
14	7/31	Pease	X	X	X	X	X				
15	8/2	Pease	X	X	X			X			X
16	8/6	Pease	X	X							X
17	8/7	Pease	X	X			X	X			X
18	8/11	Transit	X	X	X						
19	8/13	MidAmerica	X	X	X						
20	8/14	Dryden	X		X						

* Ron Brown, Aeronet, Lidars, ground stations, Proteus

Targeted INTEX-A Science Objectives

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Large-scale characterization of the troposphere across N. America		X	X	X	X	X		X		X	X	X	X	X	X	X		
Characterization of continental boundary layer chemistry and venting			X	X	X		X	X		X			X	X		X	X	
Large-scale continental outflow characterization							X		X		X		X	X	X	X	X	
Chemical aging over the N. Atlantic												X	X					
Convective venting to the upper troposphere		X	X	X	X					X			X					
Transpacific transport of Asian pollution plumes	X					X		X					X					X
Intercomparison with other platforms						X		X	X		X	X	X		X			
Satellite validation	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	
Quasi-Lagrangian Sampling (IGAC)						X	X	X	X	X	X	X						

DC-8 Intercomparisons

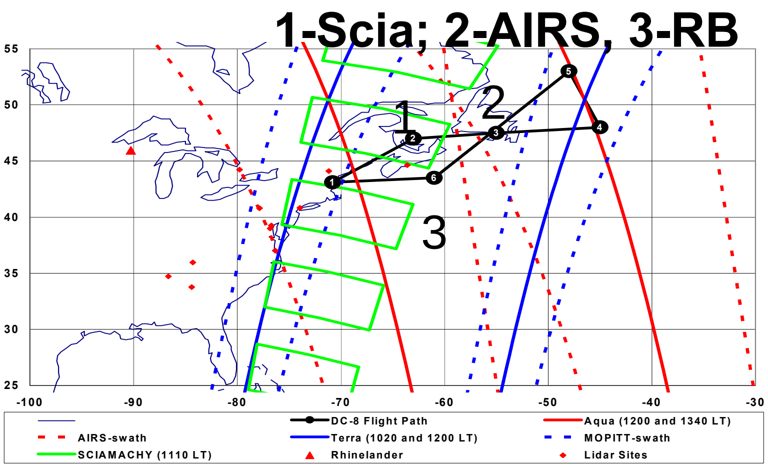


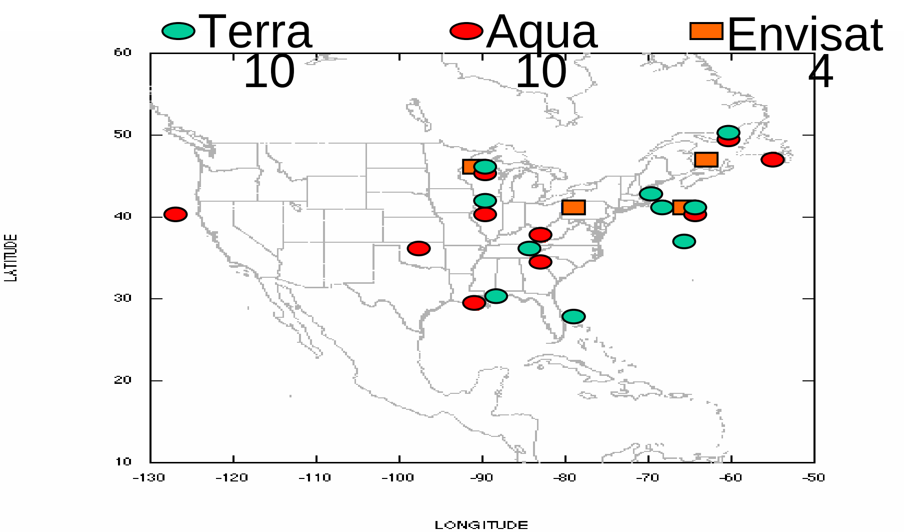
- 3 P-3
- 1 BAe146
- Ship
- Surface sites

INTEX-A DC-8 Satellite Validations

(Terra, Aqua, Envisat)

CO
HCHO
NO_2
SO_2
H_2O
HCN
O_3
Aerosol
Organics



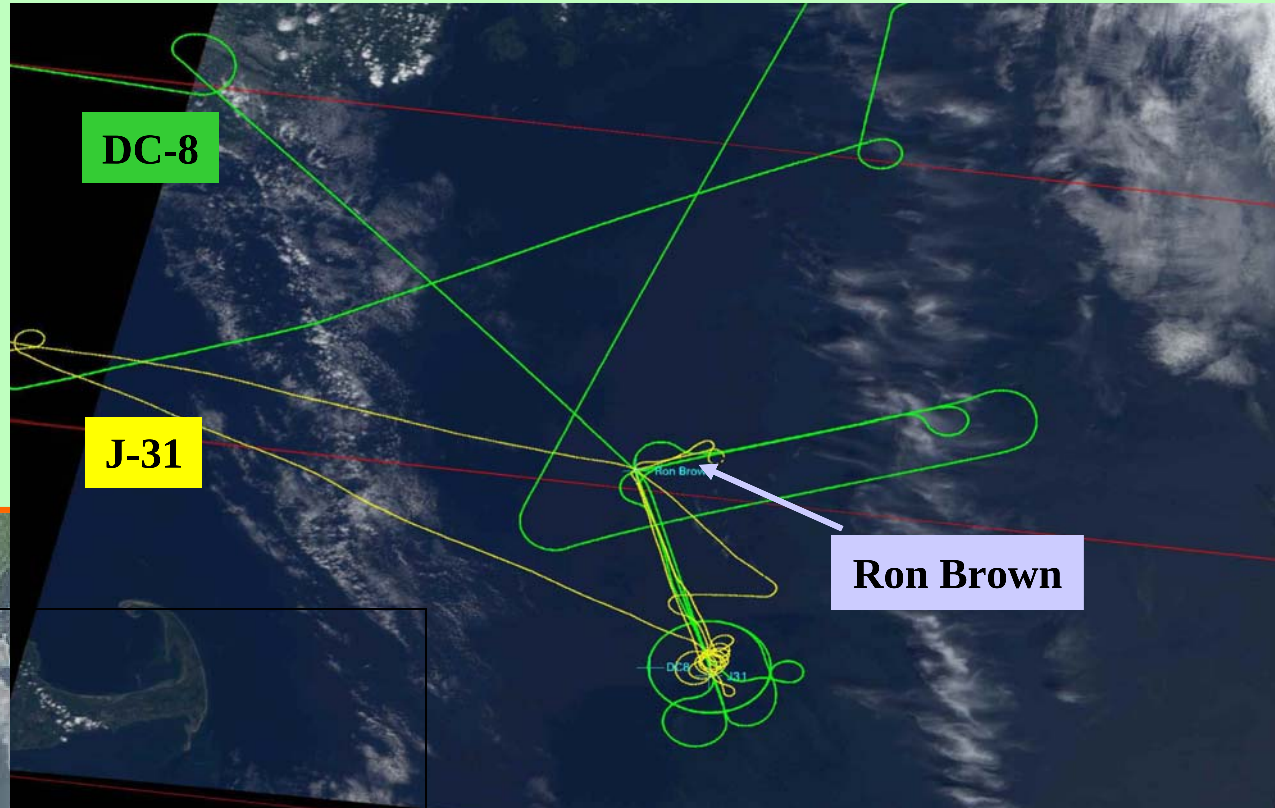


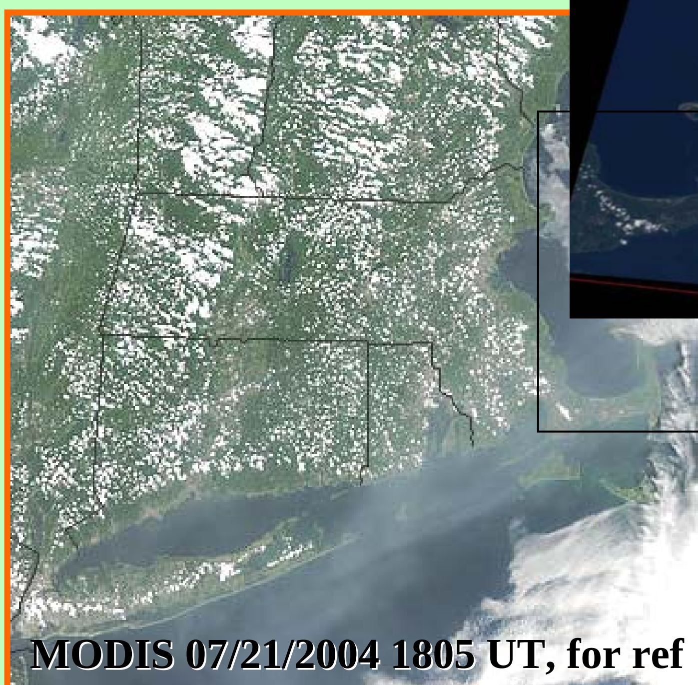
- **DC-8/J-31/RB**:
- **- MOPITT**
- **- MISR**
- **- AIRS**
- **- SCIAMACHY**

Profiles:
- **- to 11 km**
- **- cloud free**
- **- 15 mi spiral**
- **- 1 hr window**

INTEX-A MISR Stacked L's Maneuver in Co-ordination with NASA DC-8, J31 and Ron Brown (08/07/2004)

MISR Image with flight track L's Superimposed over Ron Brown Location



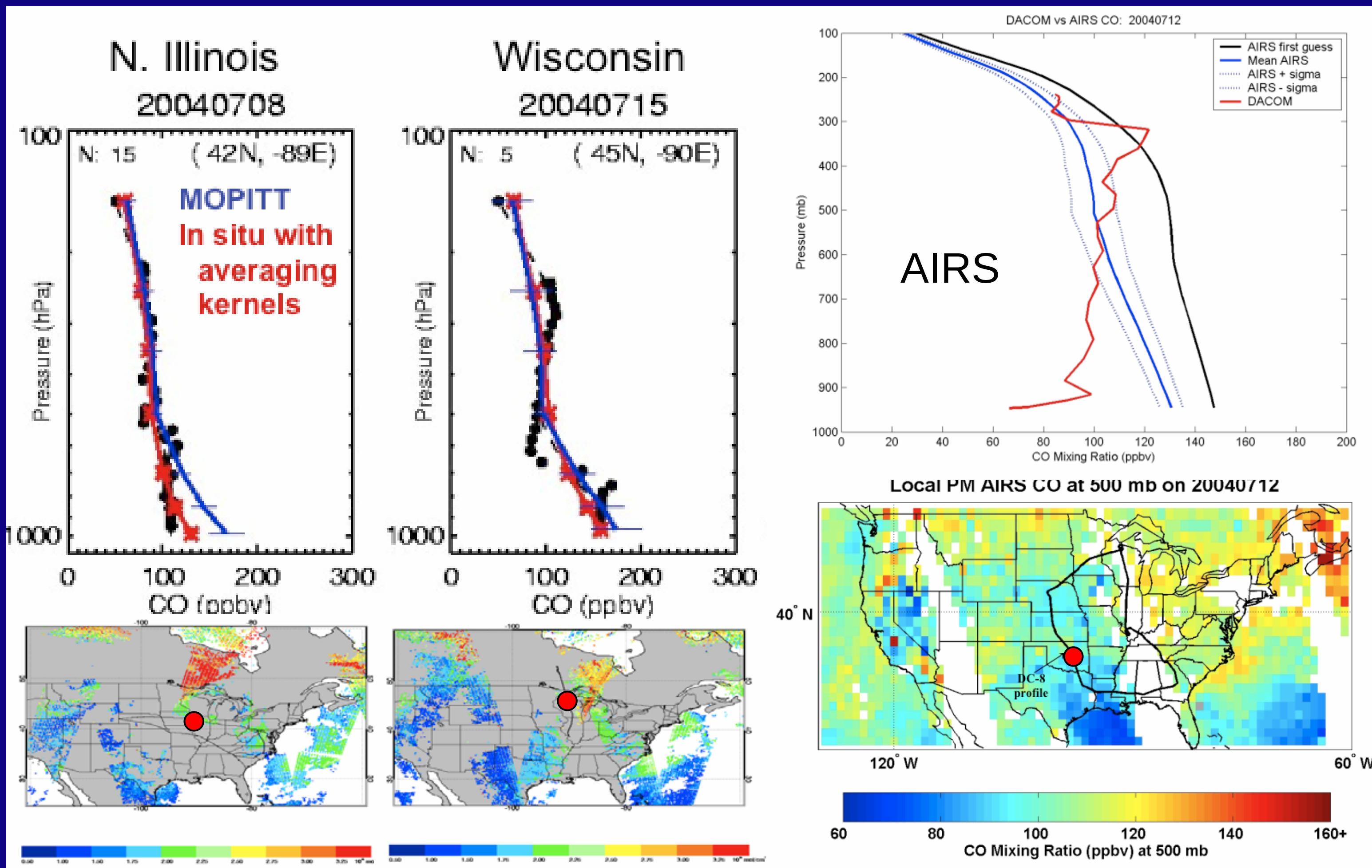


MODIS 07/21/2004 1805 UT, for ref

- **Aerosol variability along- & across-wind directions.**
- **Closure tests with *in-situ* aerosol observations**

R. Kahn/ A. Clarke/ P. Russell/T. Bates et al

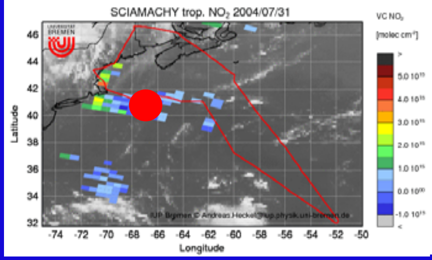
DC-8/MOPITT, AIRS Trop CO



Emmons/McMillan/Sachse et al

DC-8/SCIAMACHY Trop Column NO_2

	Atlantic	Rhinelander I	Rhinelander II	Pittsburgh	
DC8	$6.2\ 10^{14}$	$8.3\ 10^{14}$	$5.6\ 10^{14}$	$2.4\ 10^{15}$	molec/cm^2
SCIA	$7.0\ 10^{14}$	$1.8\ 10^{15}$	$1.0\ 10^{15}$	$3.1\ 10^{15}$	molec/cm^2



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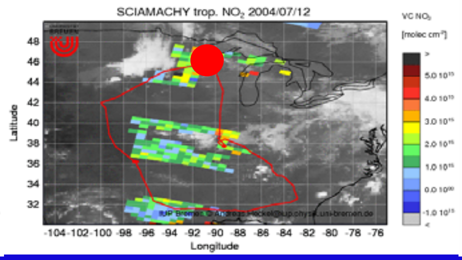

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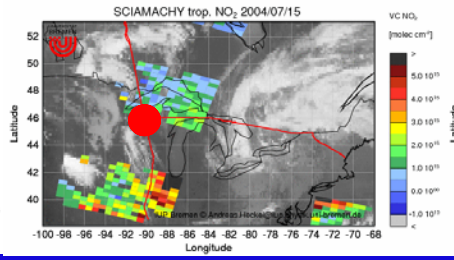

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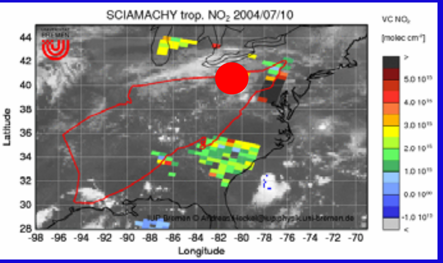
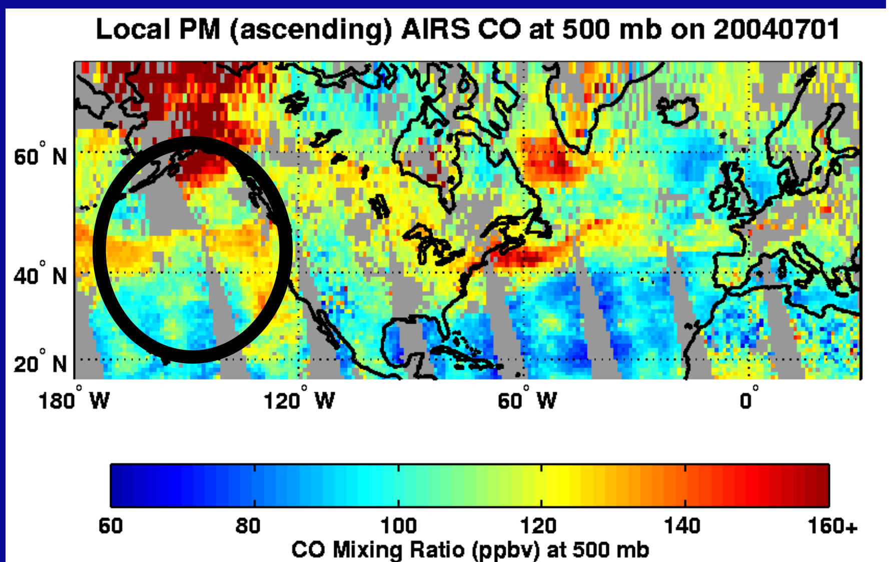


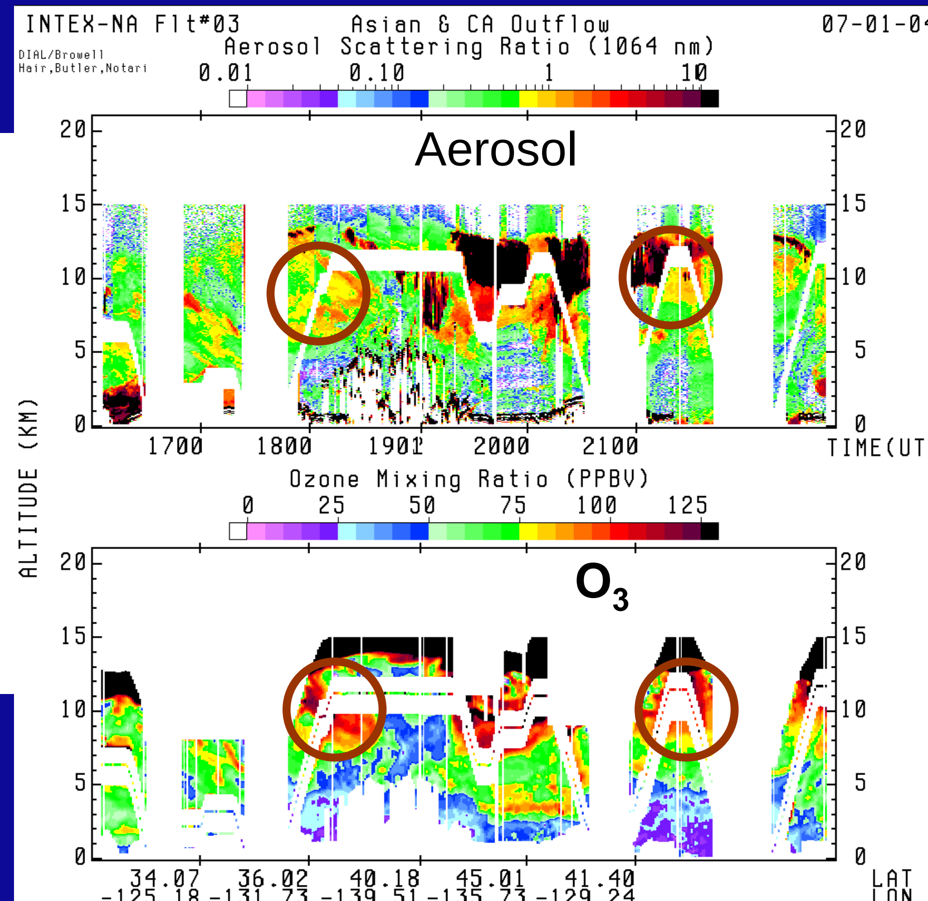
7/10

- Stratospheric correction
- Climatological airmass factors from MOZART
- Cloud screening but no cloud correction

Heckel,Richter, Burrows, Cohen

Asian Outflow Seen by AIRS & Sampled by the DC-8



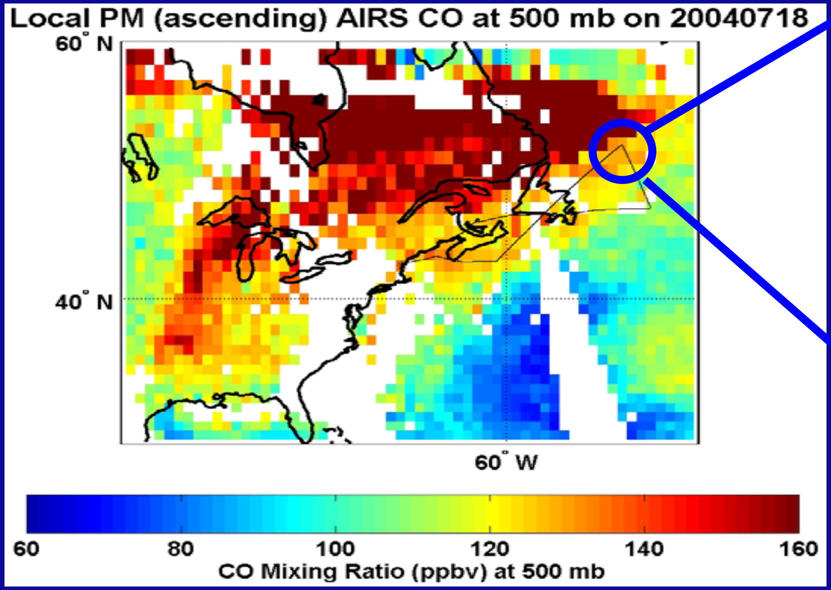


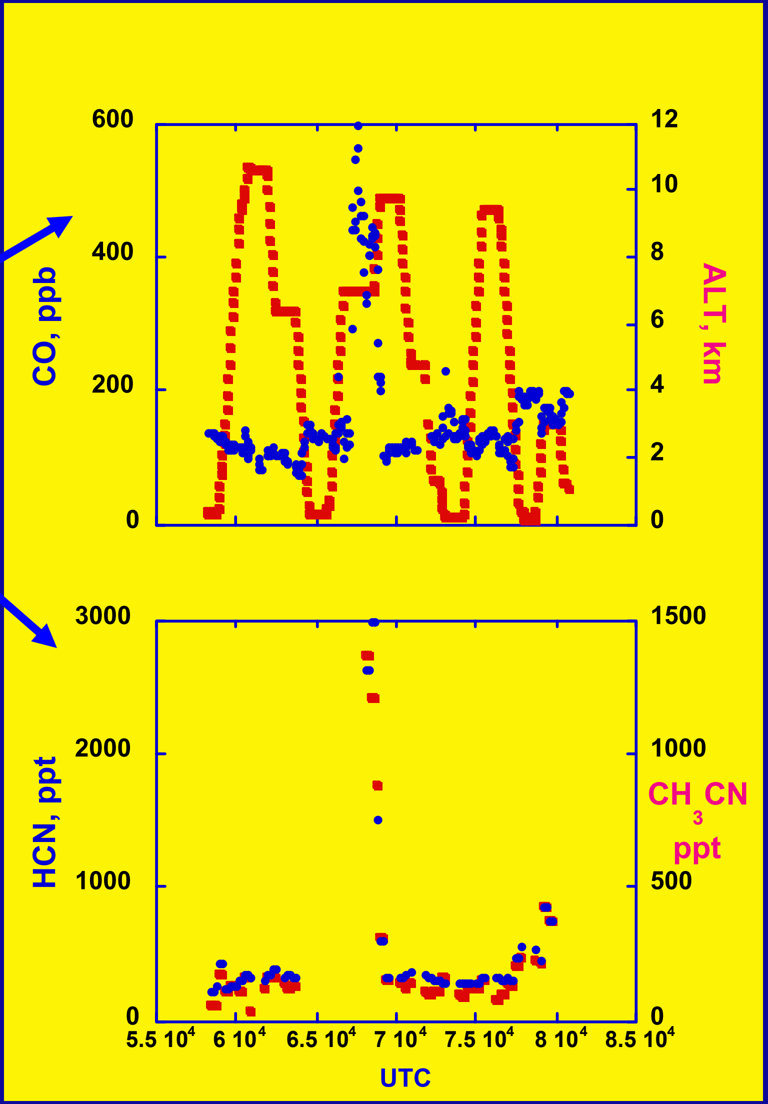
July 01, 2004

McMillan

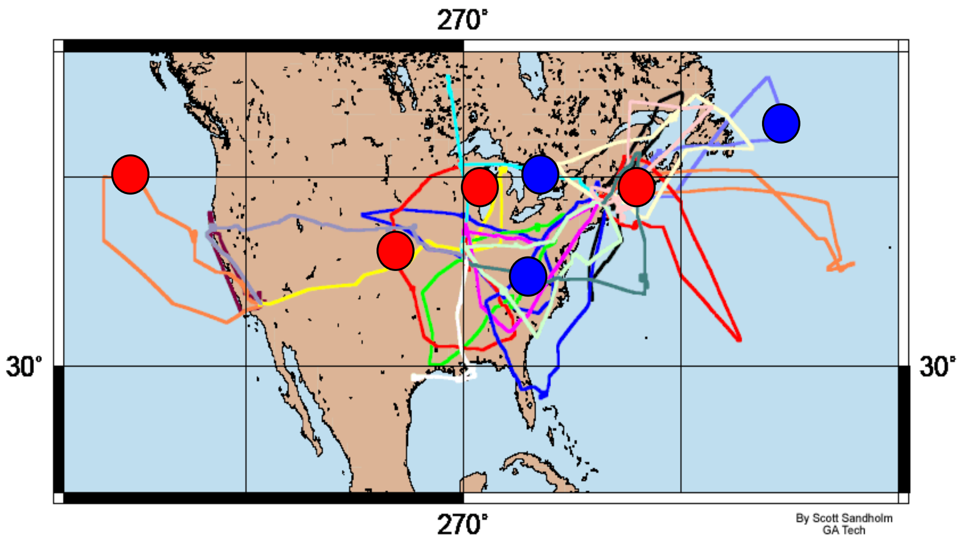
Browell

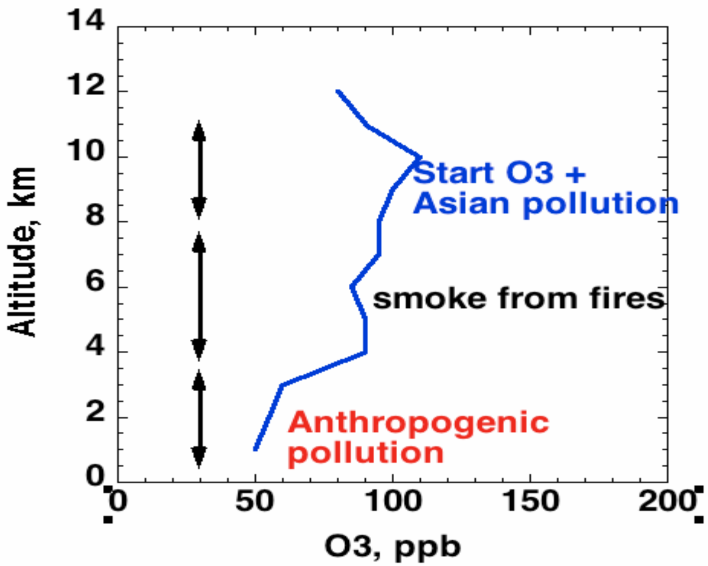
Alaskan Fire Influences Over the Atlantic



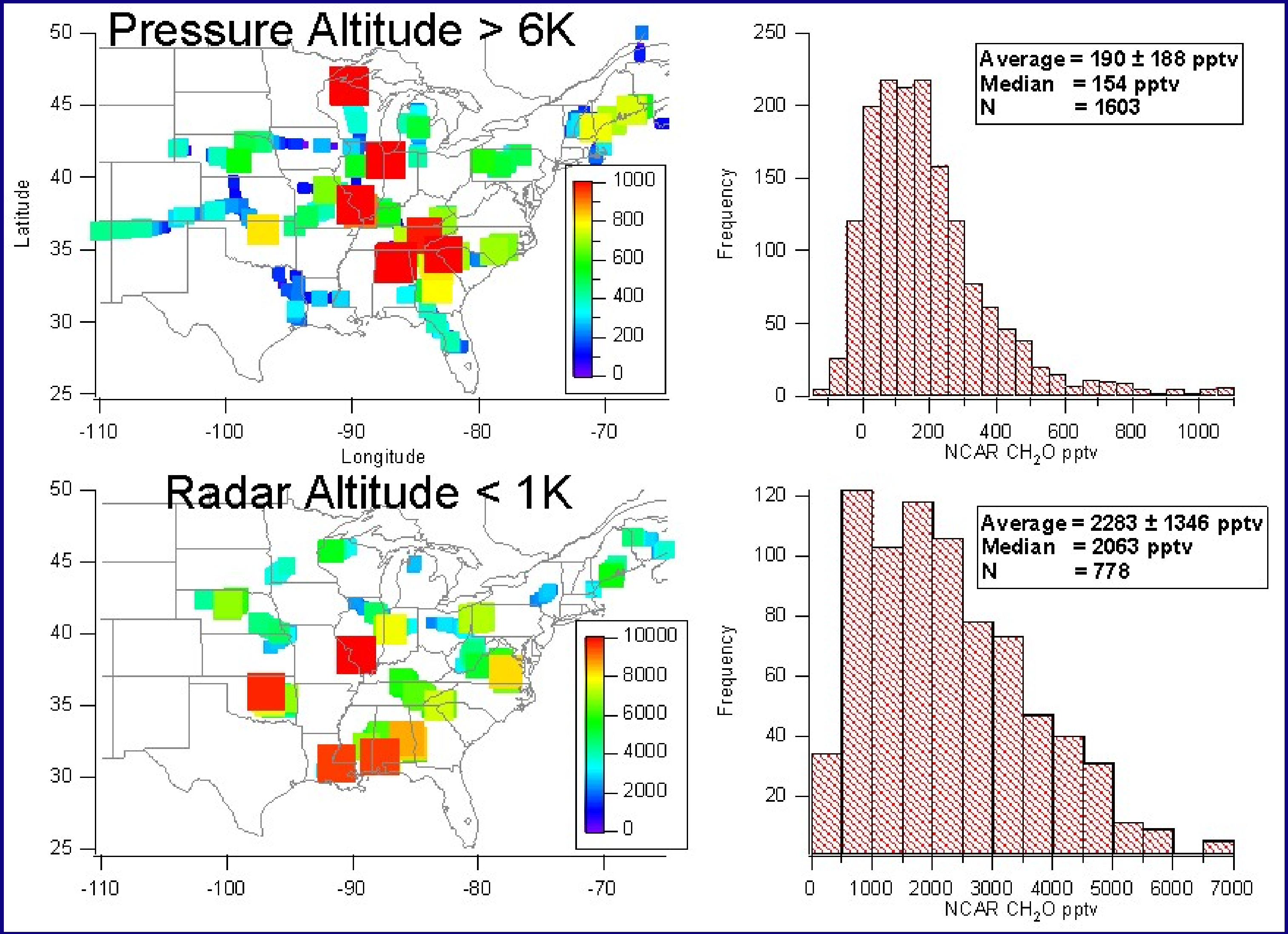


Asian Influences, Fires, & Vertical Structure



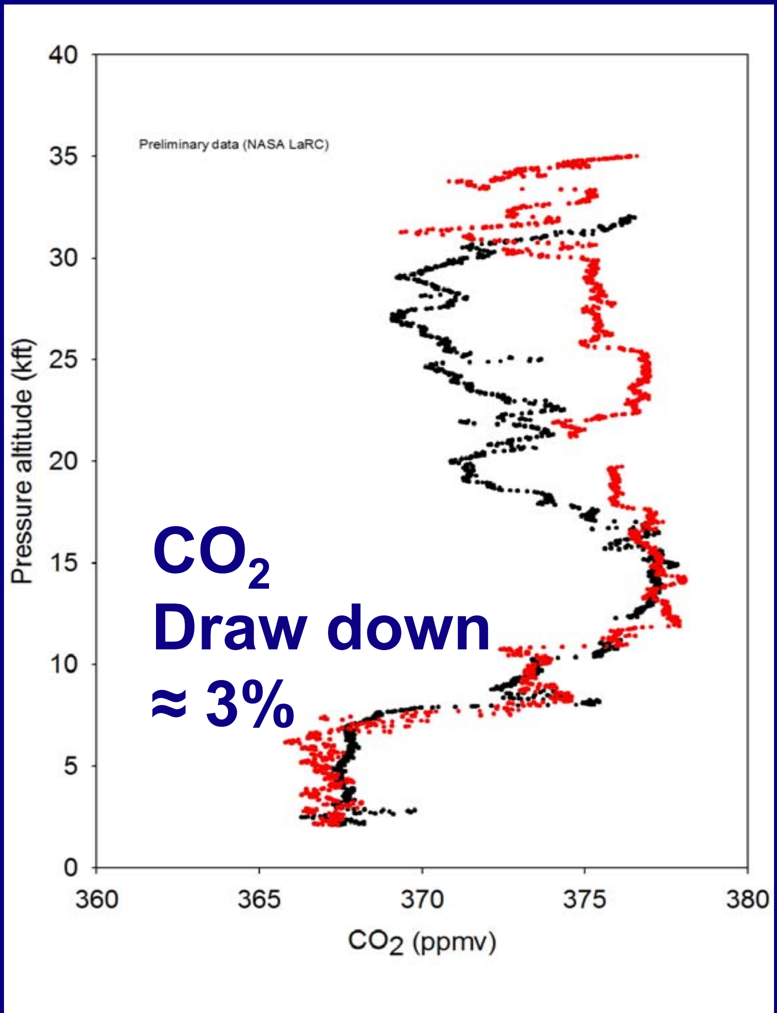


CH_2O Distributions & Convection



A. Fried et al.

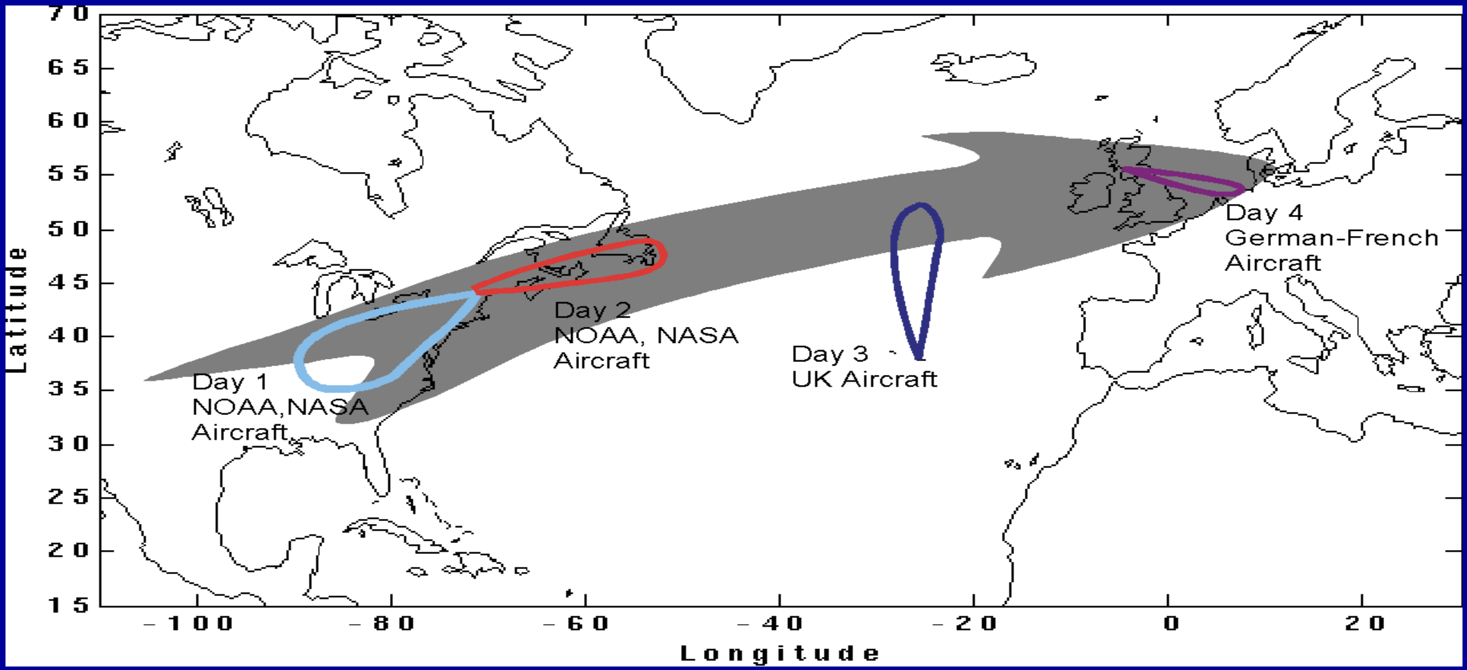
Carbon Cycle in INTEX-A



S. Vay et al

Quasi-Lagrangian Experiments Over the Atlantic

A central goal of US-EU coordination



- 7 potentially successful cases identified
- Best matches on 4 (7/18, 7/20, 7/25, 7/28)

Some Questions?

- How do the in-situ measurements from different instruments & platforms intercompare? How do we synthesize and relate data from multiple platforms?
- How do models in forecast and analysis modes intercompare with each other and with observations?
- How useful were the satellite validation flights? Have we contributed to further improvements in retrievals?
- How usefully can the satellite data be integrated with the aircraft & surface data to extend coverage?
- Can we uniquely identify Asian influences?
- How successful were the quasi-lagrangian experiments and what did we learn from them?

Some Questions? (cont.)

- Can we use INTEX-A data (& models) to further constrain estimates of anthropogenic & biogenic emissions particularly for VOC, OVOC, SO_2, CO, NO_x, & aerosols?
- What do Alaskan fires tell us about dynamical processes and can we infer BB burning emissions from INTEX-A observations?
- What are the factors controlling the outflow of pollution (especially NO_x, O_3, and aerosol) to the Atlantic?
- What are the sources and properties of aerosols & how do they evolve over the Atlantic? Is SO_2 the main precursor? Is there direct evidence for the predicted Saharan dust?
- What have we learnt about direct and indirect effects of aerosol on radiative forcing?

Some Questions? (cont.)

- Are the observed HO_x and precursor (peroxides and CH_2O) concentrations consistent with current understanding?
- How does deep convection affect the supply of HO_x and NO_x t o the upper troposphere? What is the effect of carbonyls on the HO_x and NO_x budgets?
- Is there evidence for OVOC loss by heterogeneous processes?
- Can we explain the observed drawdown of CO_2 over the continent?
- Are the new observations of HNO_4 consistent with our present understanding?

INTEX-A Team

J. Gleason, Program Manager
NASA HQ

INTEX Science Team

H. Singh, Mission Scientist & Inter-agency Co
D. Jacob, Deputy Mission Scientist for Flight
J. Crawford, Deputy Mission Scientist for Dat
W. Brune, Deputy Mission Scientist for Inter-

Project man
M. Crai
M. Gaur
K. Shif

M. Avery, NASA LaRC
B. Anderson, NASA GSFC
J. Barrick, NASA LaRC
D. Blake, UC Irvine
E. Browell, NASA LaRC
A. Clarke, Univ. of Hawaii
R. Cohen, UC Berkeley
G. Diskin- NASA LaRC, J. Podolske, NASA ARC
A. Fried, NCAR
B. Heikes, Univ. of Rhode Island
G. Huey, GIT-EAS
P. Pilewskie, NASA ARC
P. Russell, NASA ARC
G. Sachse, NASA LaRC
R. Shetter, NCAR
R. Talbot, Univ. of New Hampshire
D. Tan, GIT/EAS
S. Vay, NASA LaRC
R. Weber GIT-EAS
P. Wennberg, Cal Tech

G. Carmichael, U. Iowa
R. Chatfield, NASA ARC
V. Connors, NASA LaRC
D. Edwards, NCAR
H. Fuelberg, FSU (Mission meteorologists)
W. McMillan, UMBC
B. Pierce, LaRC
A. Thompson, GSFC/ARC

- Mission managers (Curry/Miller/Jennison)
- Navigators
- Pilots
- Crew