NOAA/ESRL Observation Network for the NACP Mid-Continent Intensive: Overview of Tall Tower and Aircraft Measurement Plans and Potential Top-Down Data Analysis Methods

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NACP Midcontinent Task Force Meeting

21-22 February 2006

Boulder, CO

NOAA ESRL Tall Tower & Aircraft North American Network

Tower

Continuous Observations:
CO_2, CO, horizontal wind, T, RH
3 levels: 30, 100, 500m
PAR, Rainfall, Surface Pressure

Flask Samples:
Daily mid-afternoon from top level
(+5 extra per week)
Weekly aircraft profiles

Species: CO_2, CO, CH_4,
N_2O, SF_6, isotopes,
Halocarbons, COS, …

Aircraft

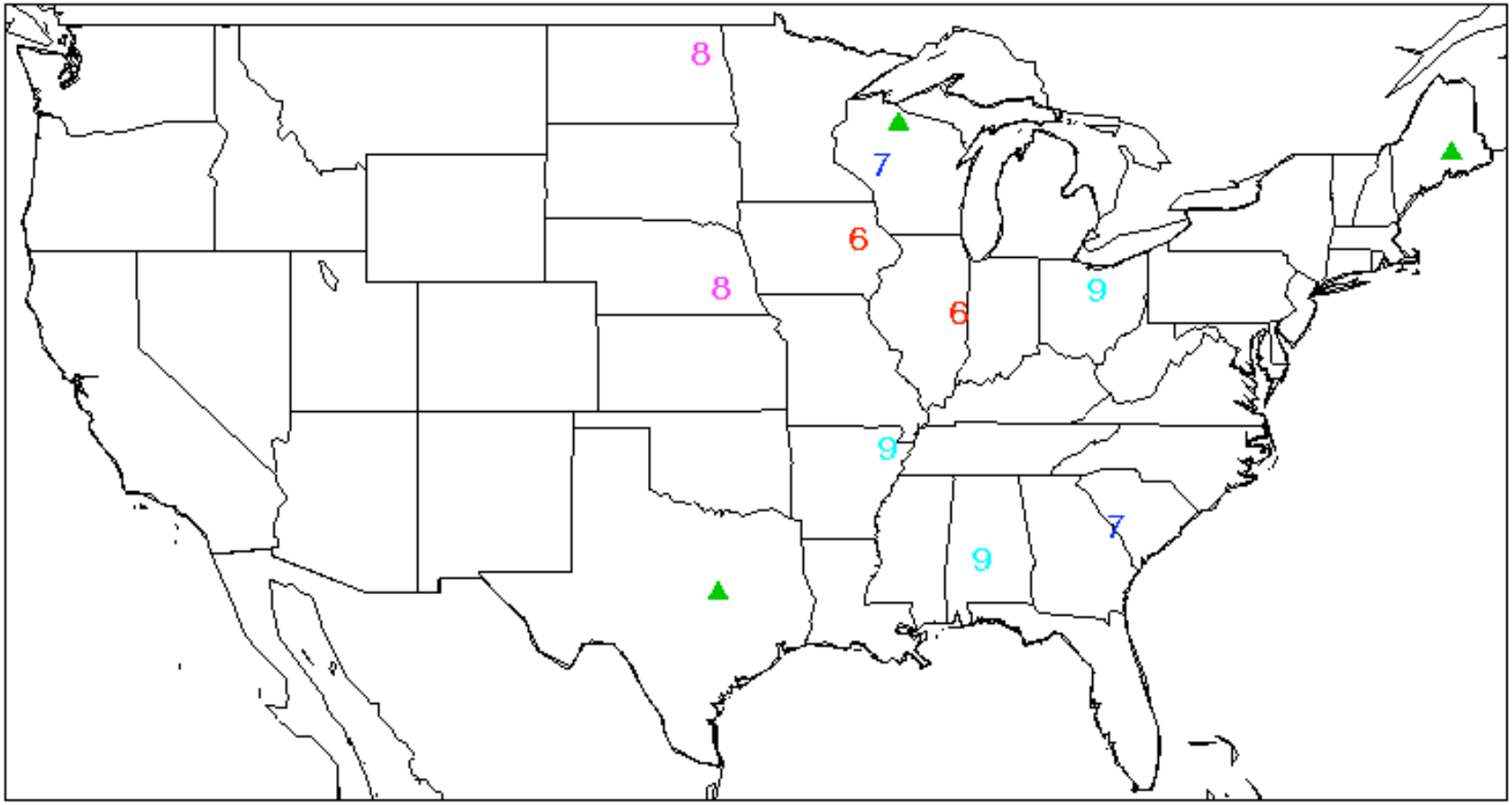
Flask Samples:
Weekly aircraft profiles
(right now every 3 weeks)

Species: CO_2, CO, CH_4,
N_2O, SF_6, isotopes,
Halocarbons, COS,
limited $^{14}CO2$

GPS, temperature, pressure

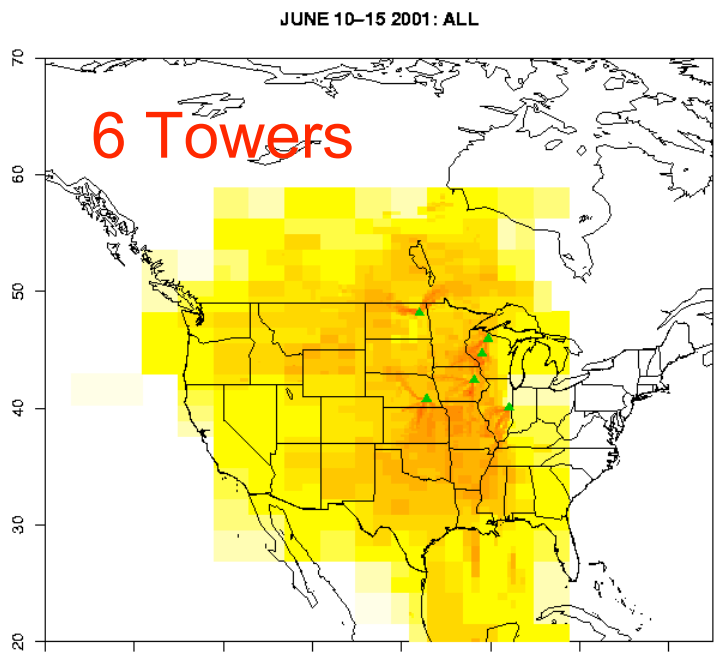
Continuous Observations on some flights: CO_2, O_3

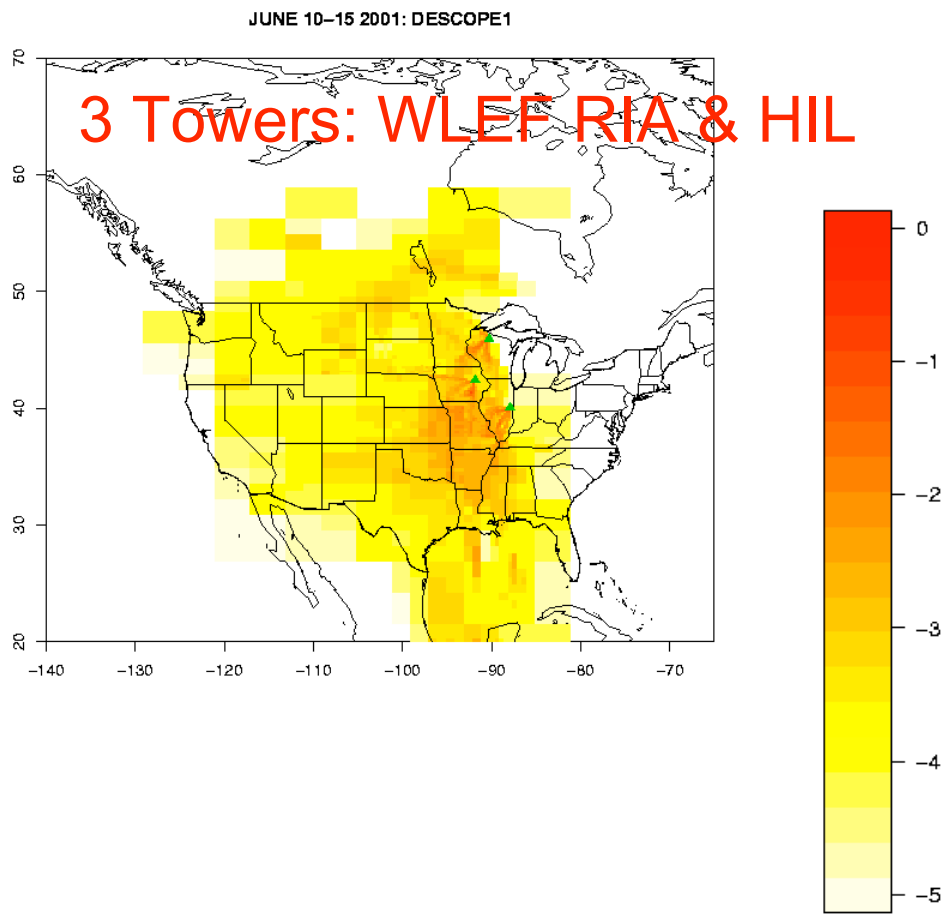
NOAA/ESRL Tall Tower Projected Network Expansion

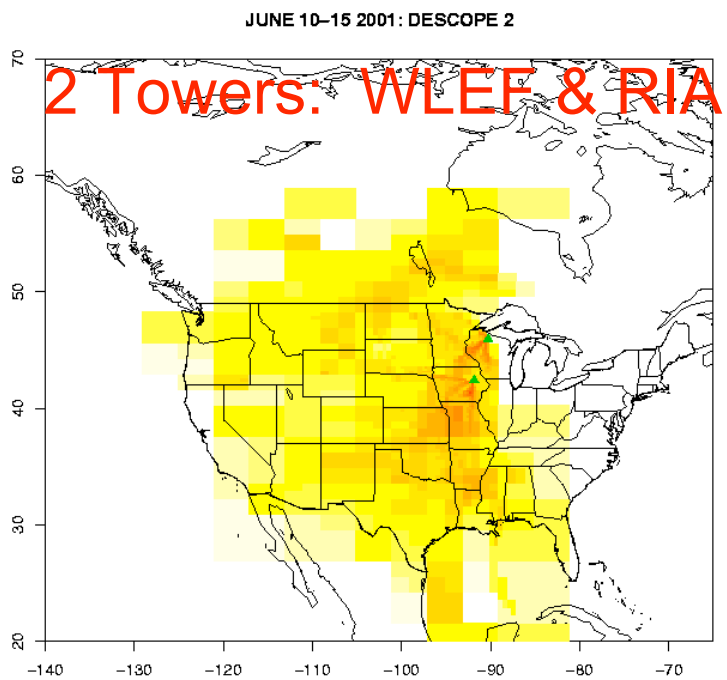


Actual schedule depends on restoration of NOAA/ESRL Climate Observations funding in 2007.

Above is optimistic.

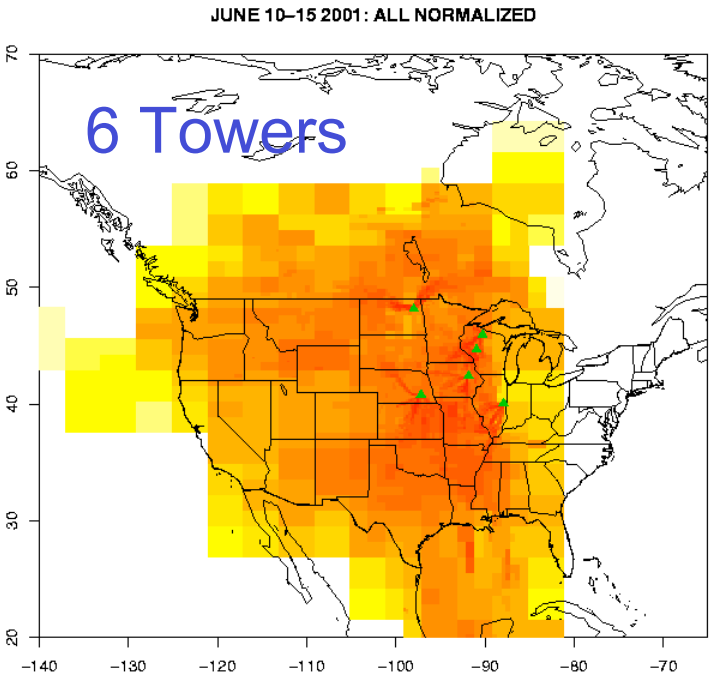


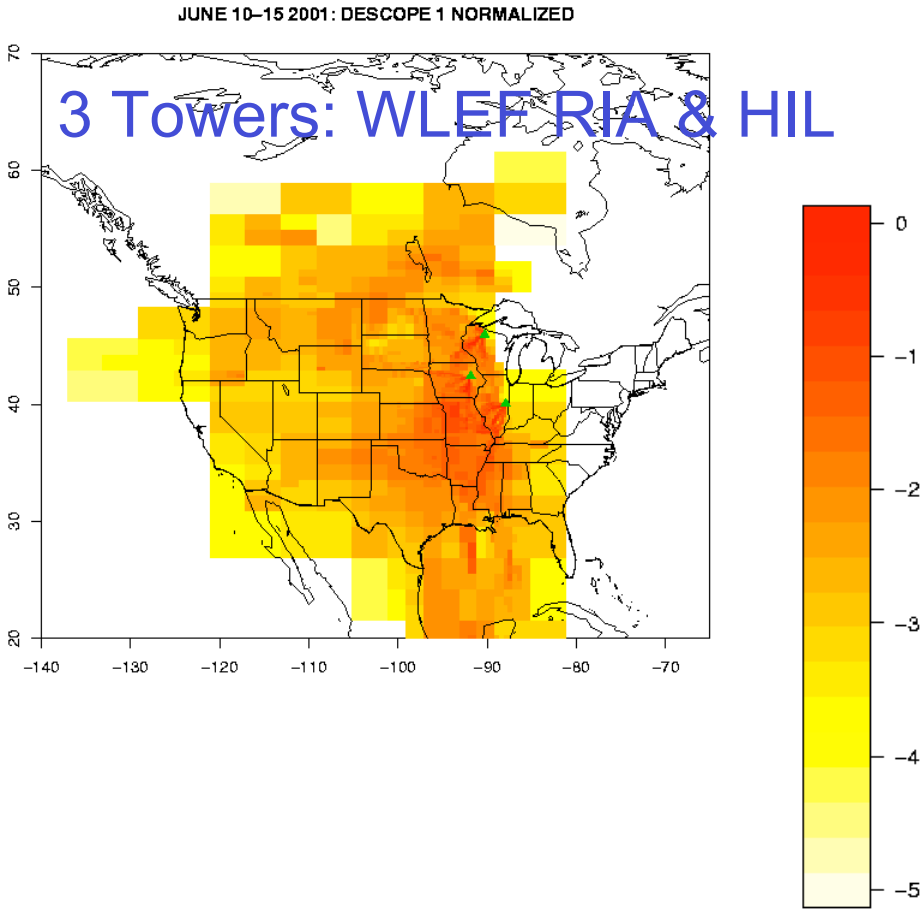


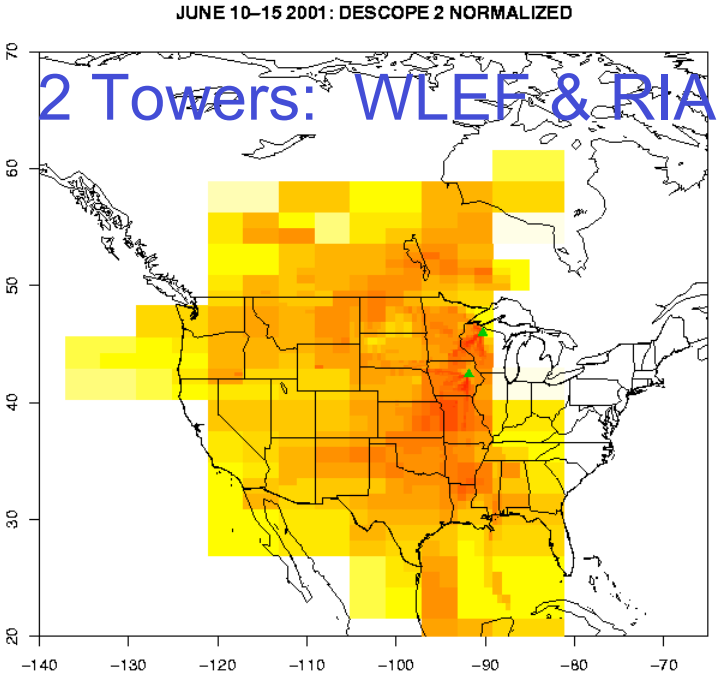


What do we lose by descoping?

Tall tower 500m footprints.
Note Log10 Scale

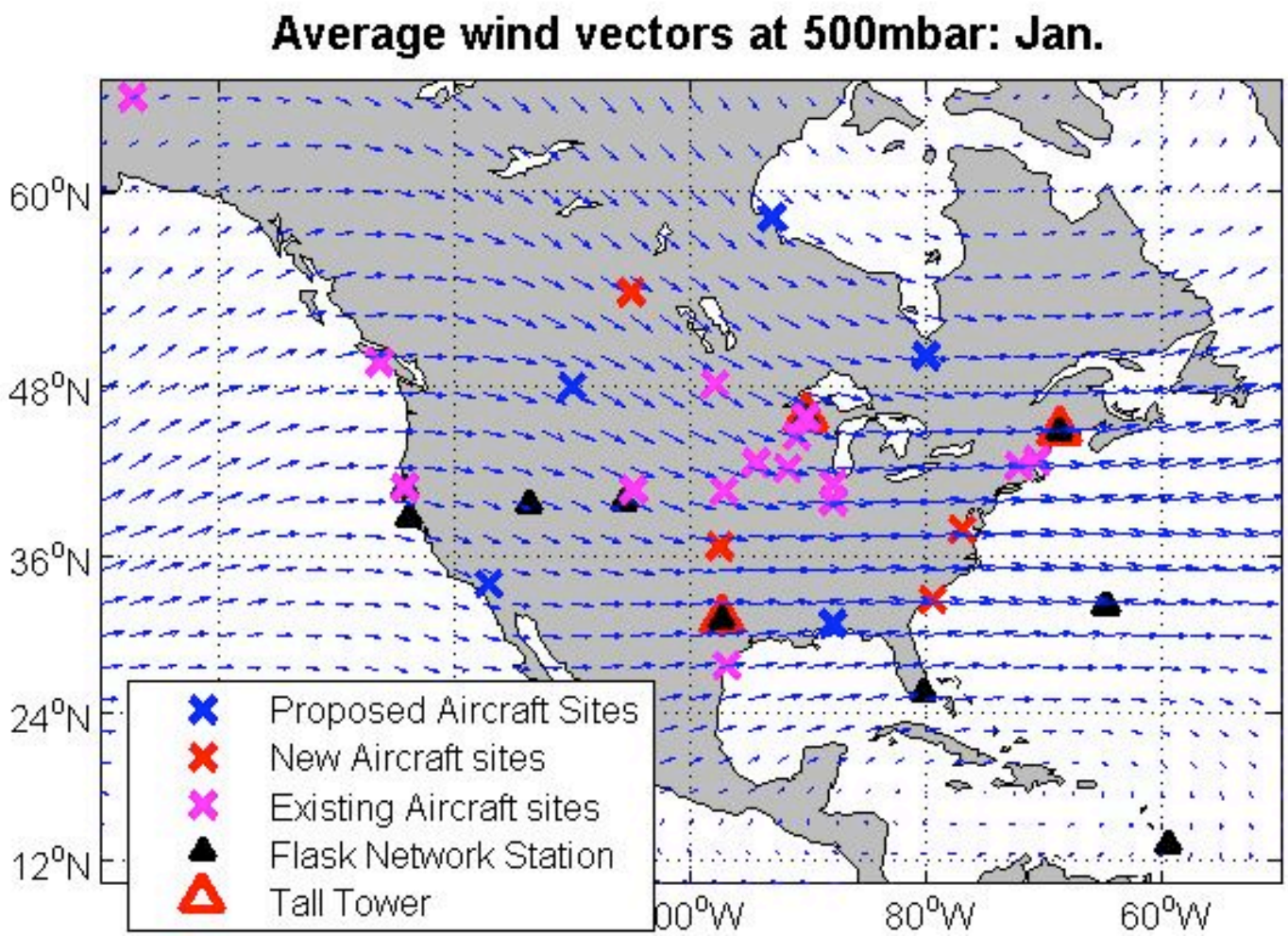






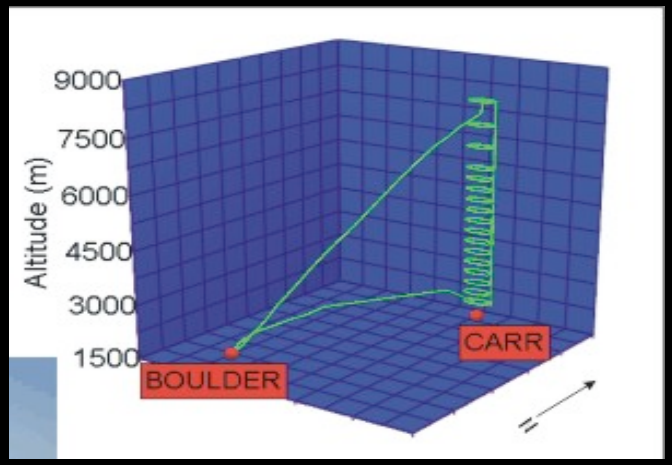
Normalized 500 m Footprints

Aircraft Sites



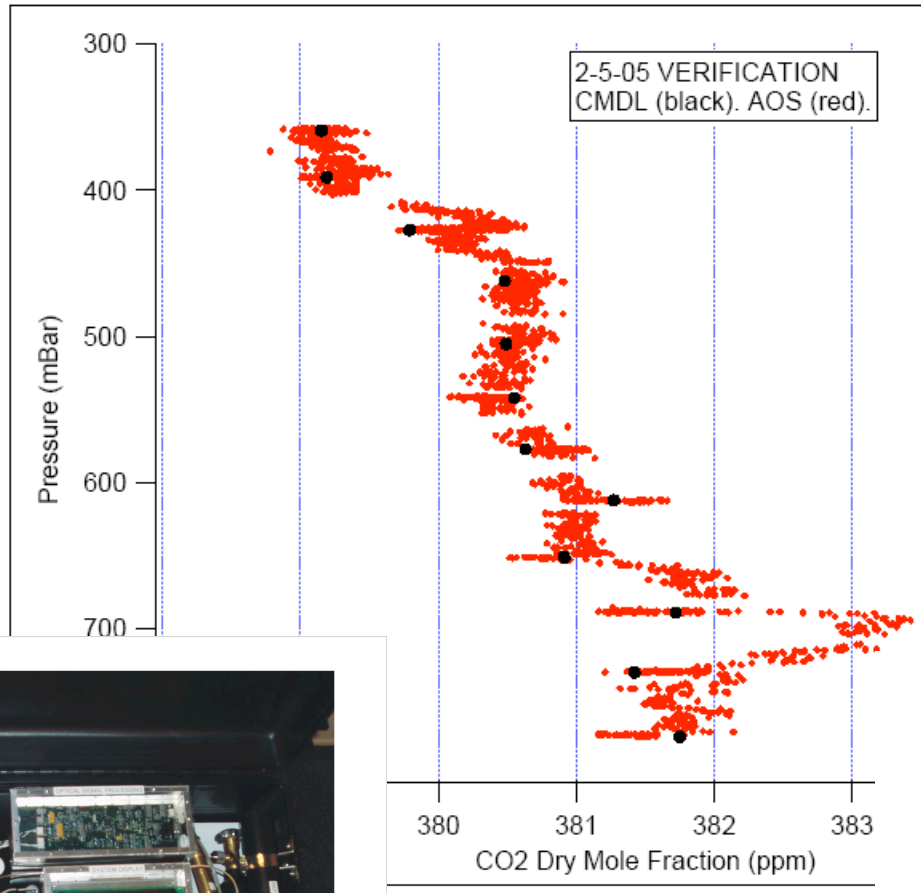
Aircraft Program

1. Sampling Frequency:
   - 2005 Weekly
   - Now every 3 weeks



2. Species:
   - CO_2, CO, CH_4, SF_6, N_2O and H
   - Isotopes: $^{13}CO_2$, $^{14}CO_2$ and ^{18}O
   - Chloroflurocarbons and …

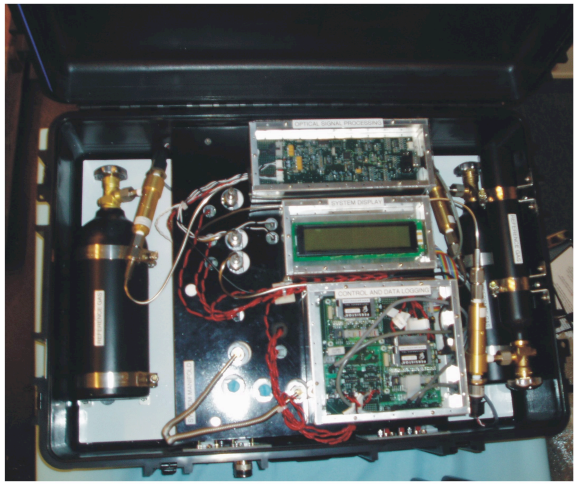
Insitu CO_2 measurements



ne descent profile by Programmable Flask

AOS Continuous Analyzers Have Compared well with CMDL Flask

9 New analyzers purchased with FY05 money. No new platforms.



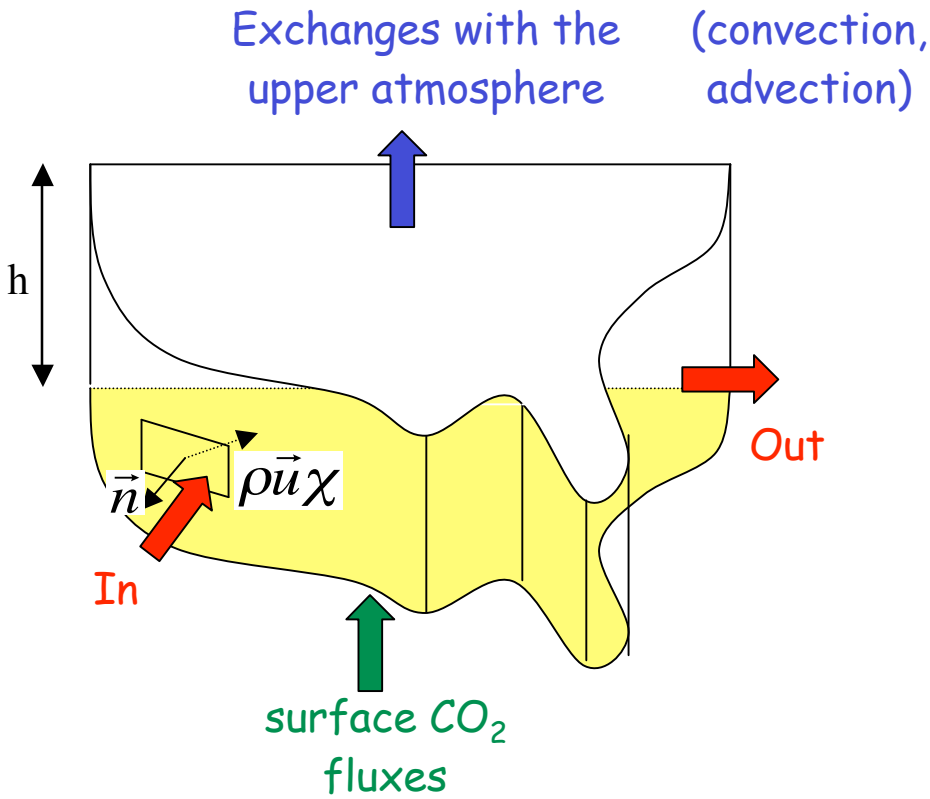
Overview of Potential Analysis Techniques:

- Direct budgeting-C. Crevoisier et al., ICDC7, Sept 2005
- Ensemble Kalman Filter Data Assimilation-W. Peters., ICDC7, Sept 200
- Baysian Inverse Approach-Transcom modelers
- Lagrangian Particle Dispersion Modeling – e.g. (Lin & Gerbig, 2003; Matross et al, submitted; Uliasz et al.)
- *Parameter Estimation – (e.g., BETHY Sholze, Rayner & others)*
- *Geostatistical Inversions –A. Michalak, JGR 2005*
- *Multi-species approaches*

Direct carbon budgeting approach

C. Crevoisier, ICDC7, Sept 2005

Let's put a 'box' over the region where we want to estimate surface fluxes.

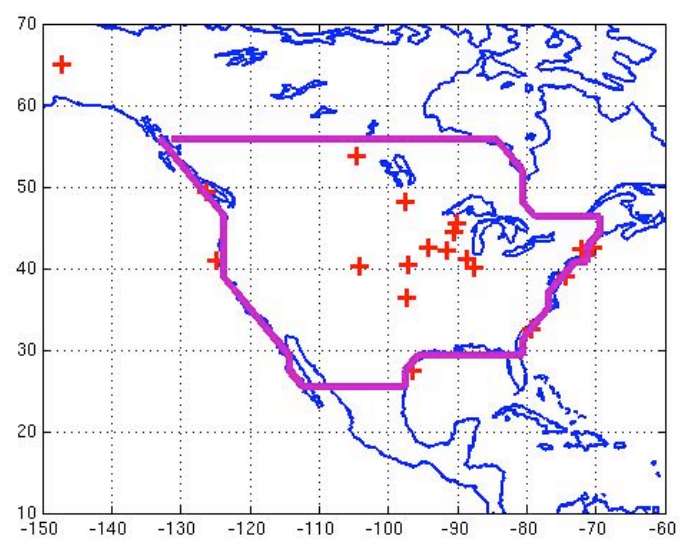


Carbon mass budget

$$dC/dt = (F^h_{in} - F^h_{out}) - F_{vertical} + F_{surf}$$

Observations aircrafts + towers.

?

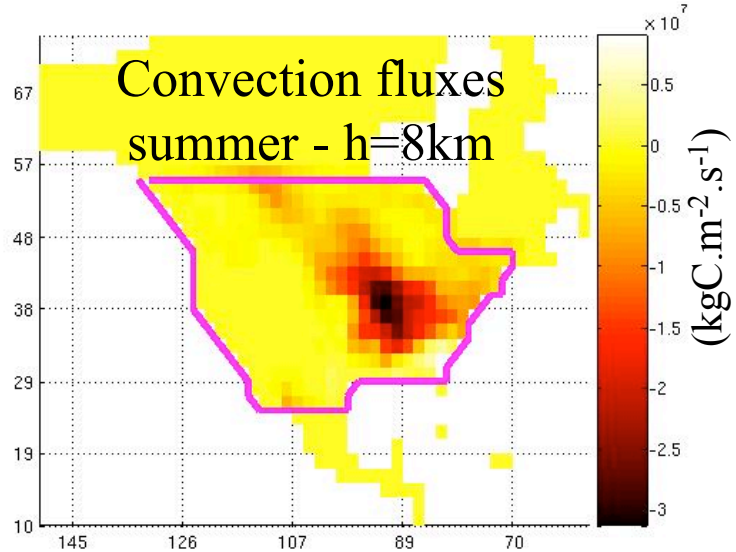


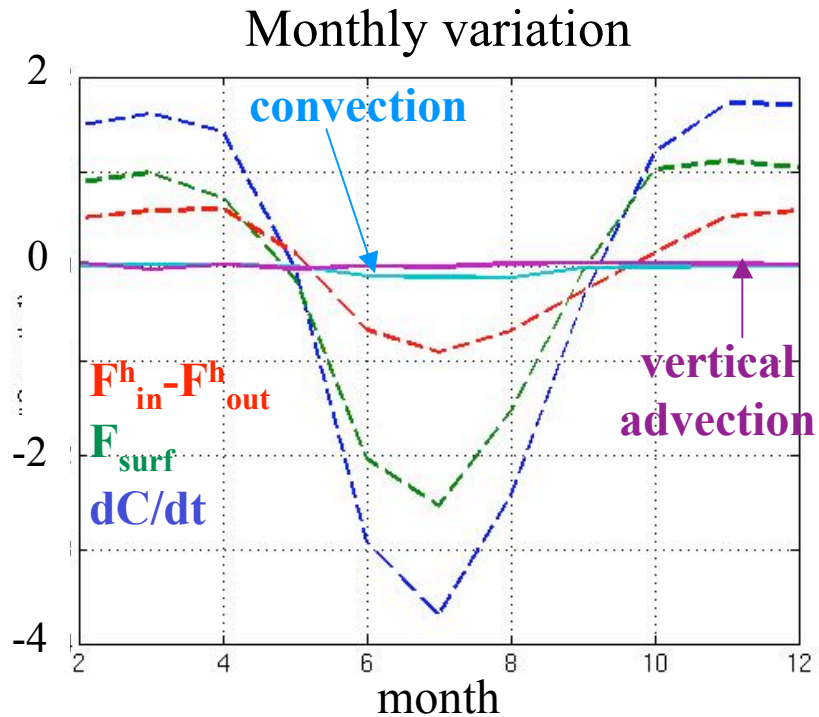
Following the existing network, we chose:

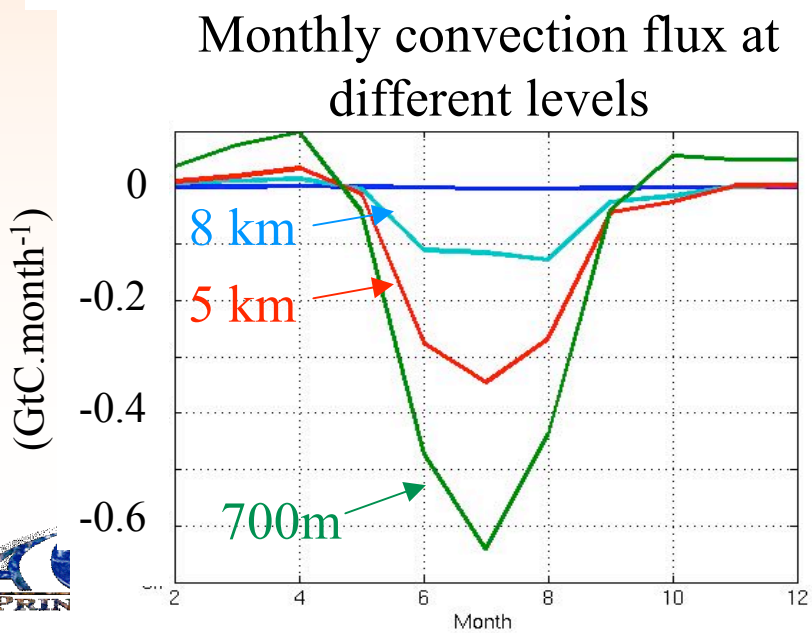
- box over the US + South Canada.
- h=8km.

Vertical fluxes: convection (and advection) at h=8 km

$$dC/dt = (F^h_{in} - F^h_{out}) - F_{vertical} + F_{surf}$$



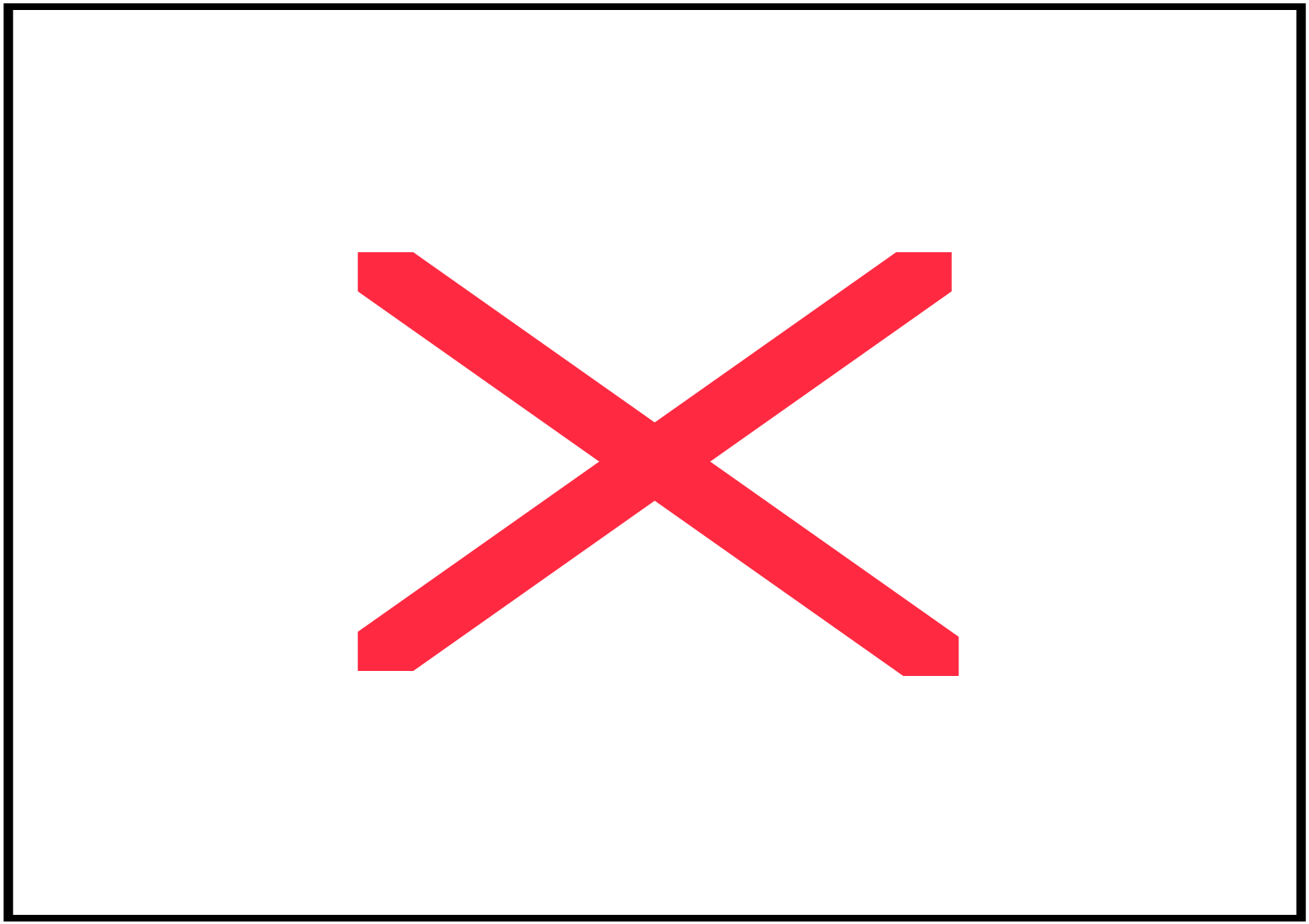




At h=8 km, the vertical fluxes are small but the lower the altitude, the higher the convection flux.

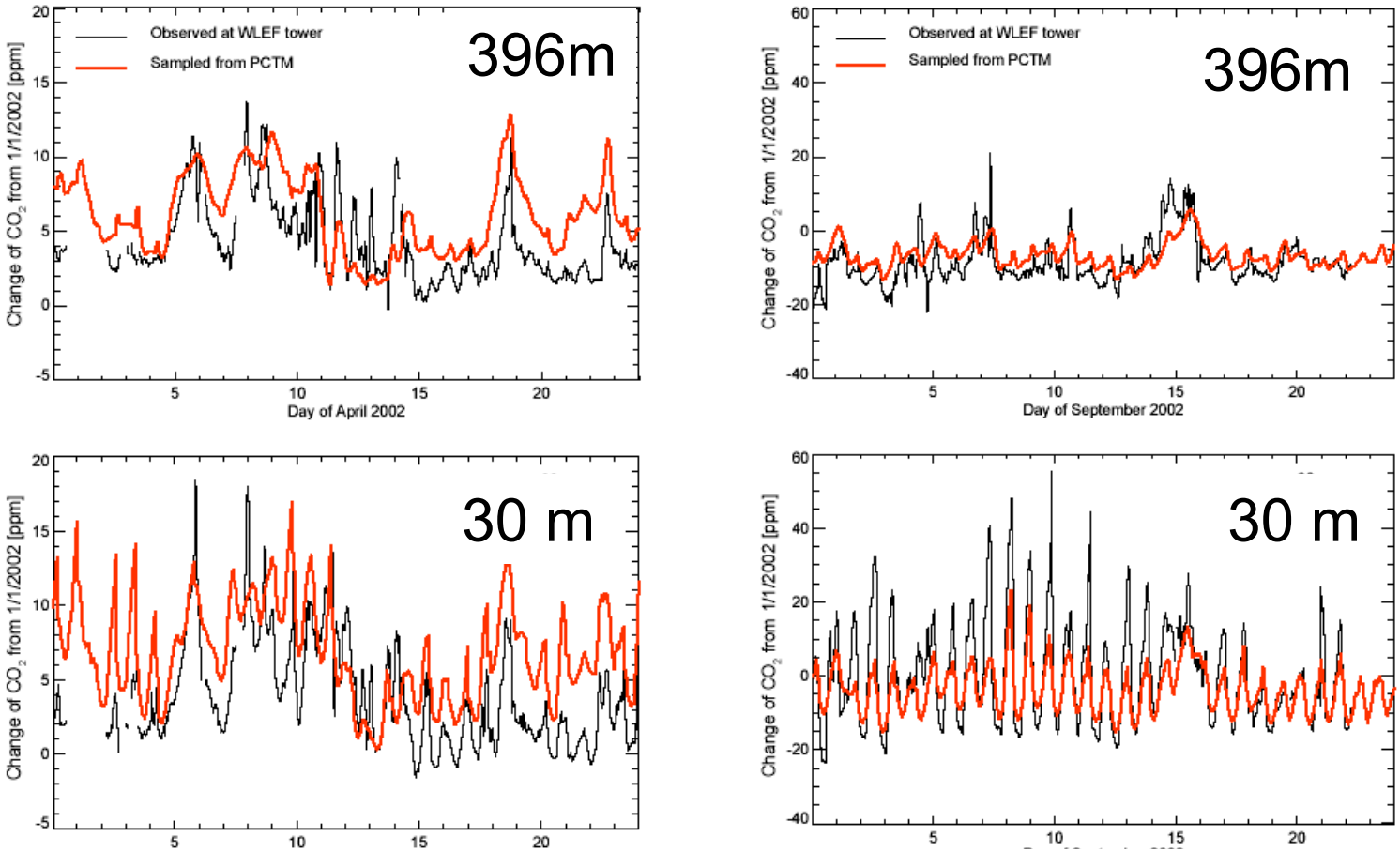
C. Crevoisier, ICDC7, Sept 2005

Wouter Peters, ICDC7, Sept 2005



Martha Butler, ICDC7, Sept 2005

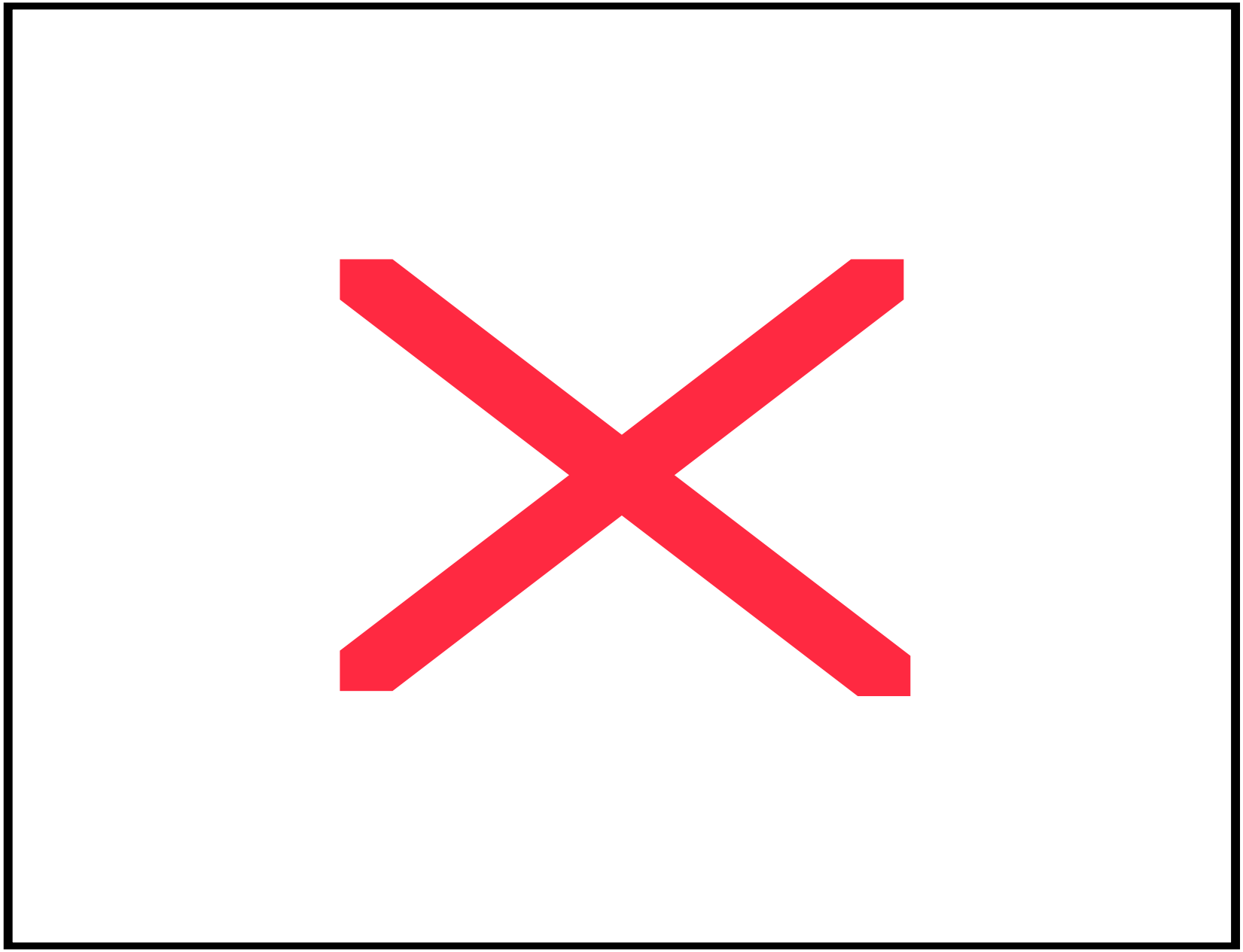
TRANSCOM Continuous Experiment
Results from GSFC Parameterized Chemistry & Transport Model, Kawa 2004
Compared to Tall Tower Observations at WLEF



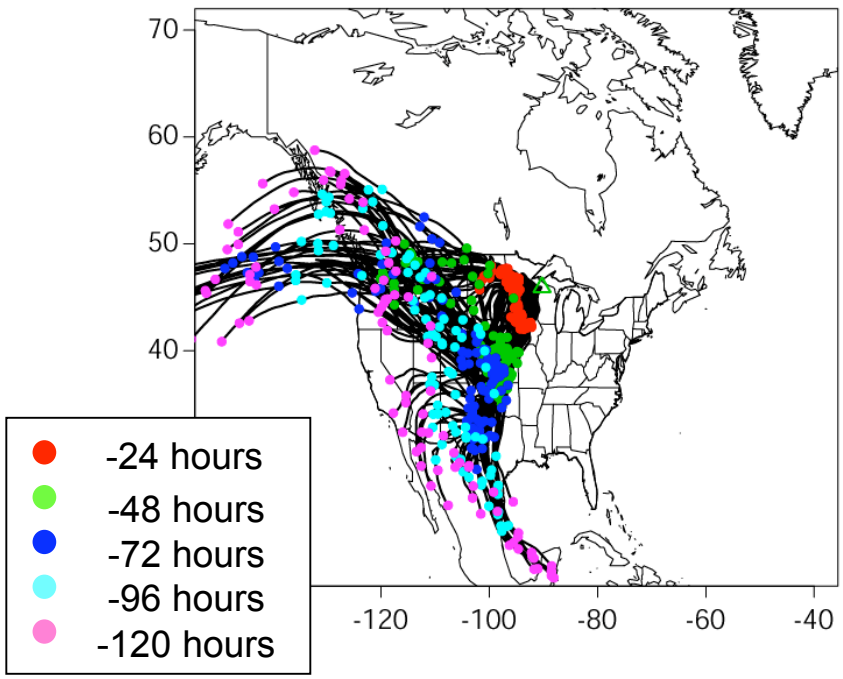
APRIL 2002

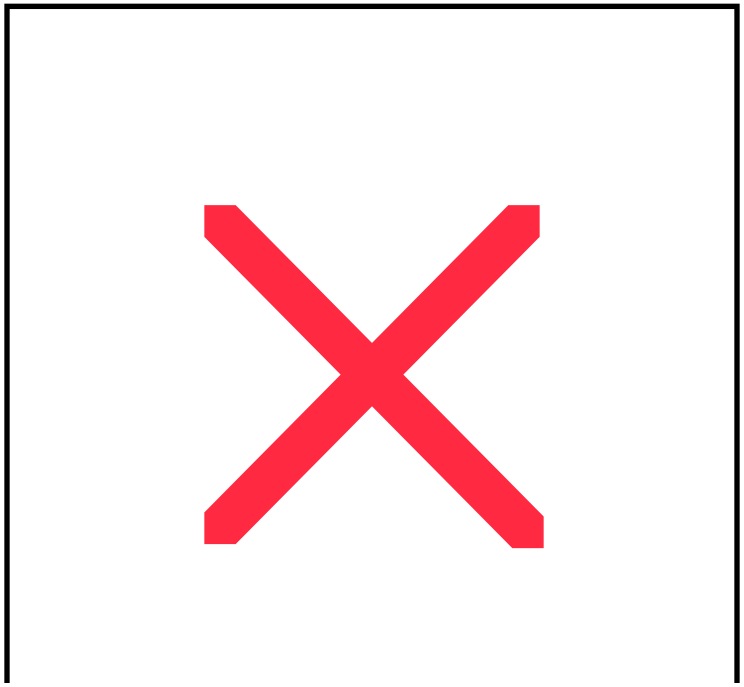
SEPT 2002

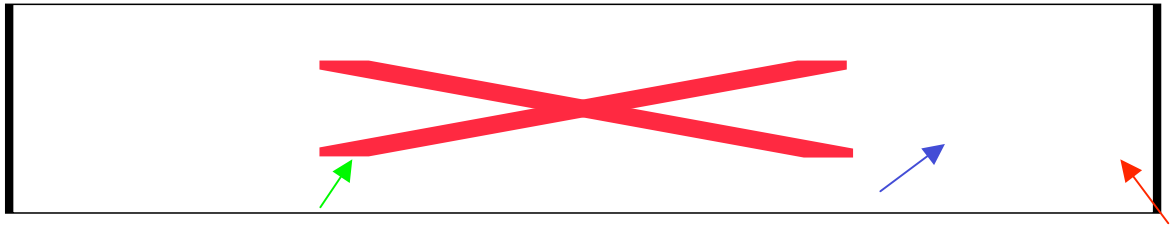
John Lin, ICDC7, Sept 2005



Lagrangian Particle Dispersion Modeling
e.g., using Stochastic Time-Inverted Lagrangian Transport Model





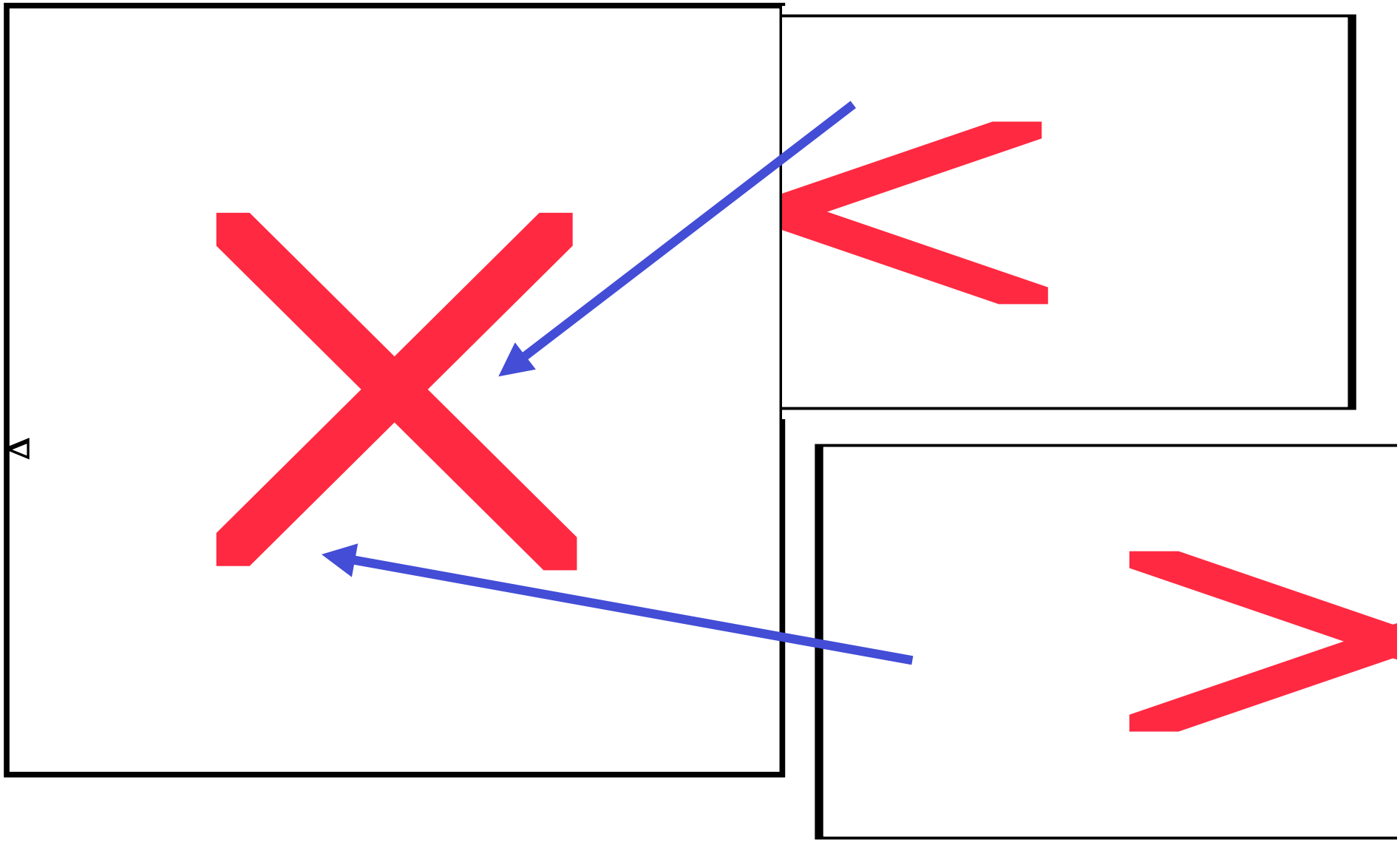


Free troposphere
(est from CMDL aircraft obs)

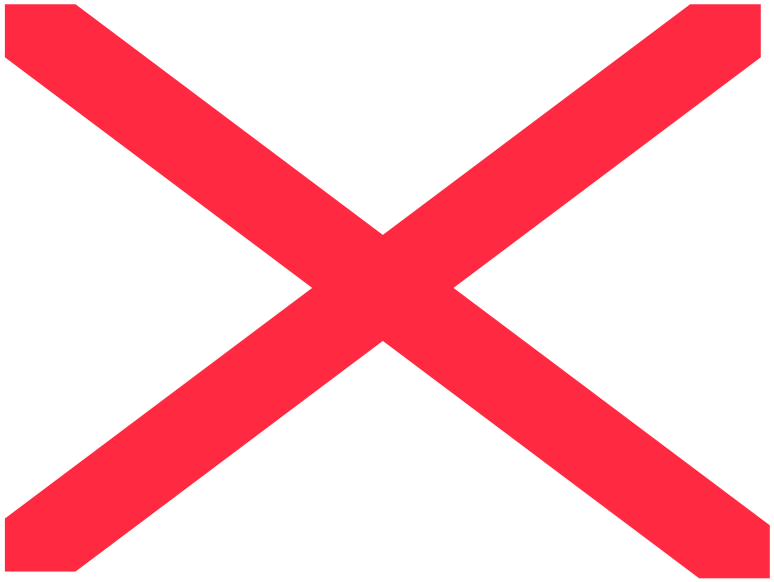
STILT
[ppm per unit flux]

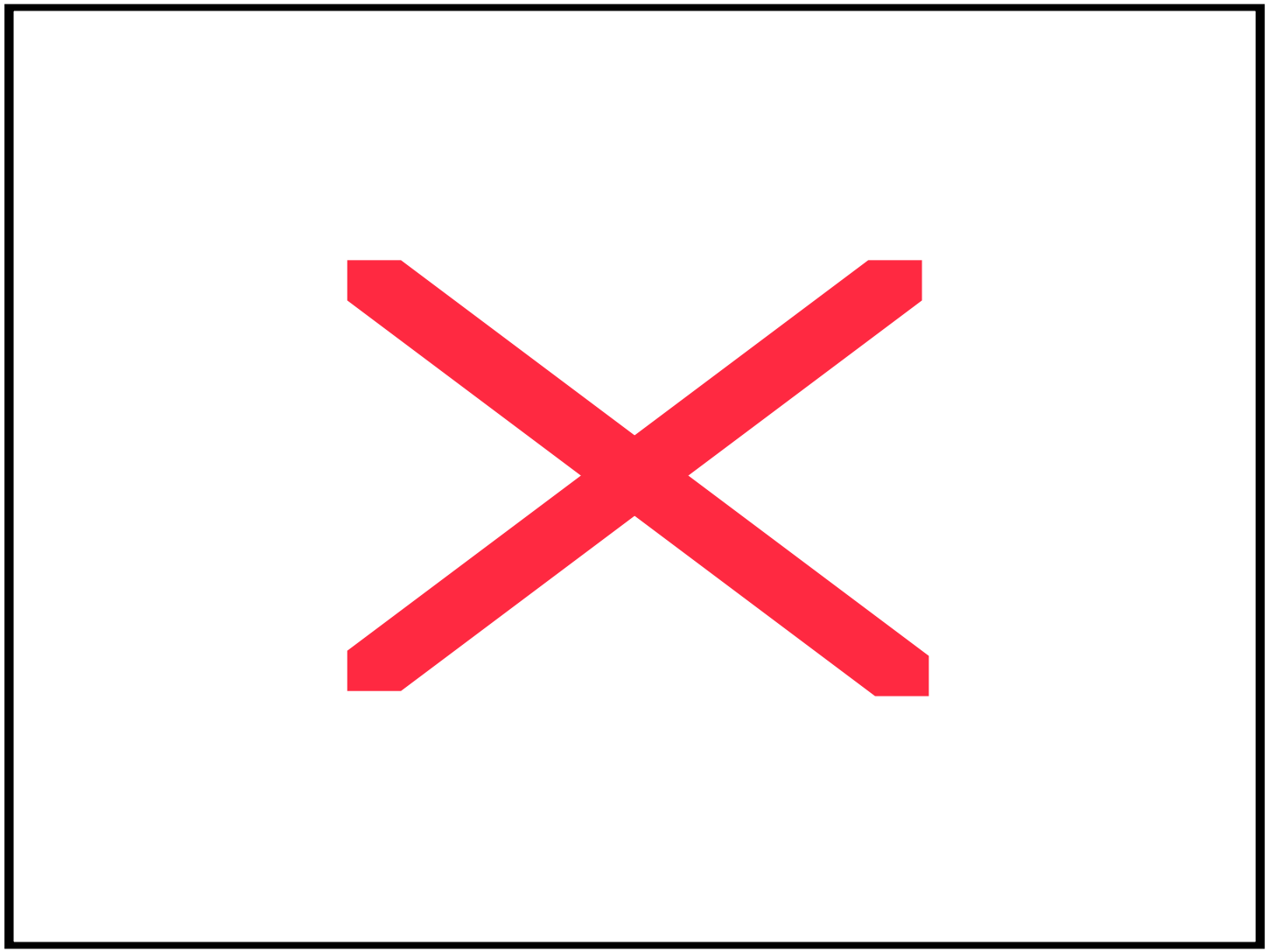
From Bottom Up
Estimate or model

Toward Quantitative Source Attribution:



John Lin, ICDC7, Sept 2005





Summary

•FY06 NOAA/ESRL is hardware rich and platform poor.

•Ability to build out backbone for ’07 growing season depends on budget. Will probably not have more than 2 new tower sites by growing season ’07 due to fact that FY07 funds will not arrive until Feb/March 07.

•Tower & Aircraft Obs will be analyzed using diverse & complementary methods.

•Aircraft Campaign (COBRA or ACME) obs can provide spatial context, a measure of how well backbone is capturing variability & additional species data for process studies. Currently no such observations funded.