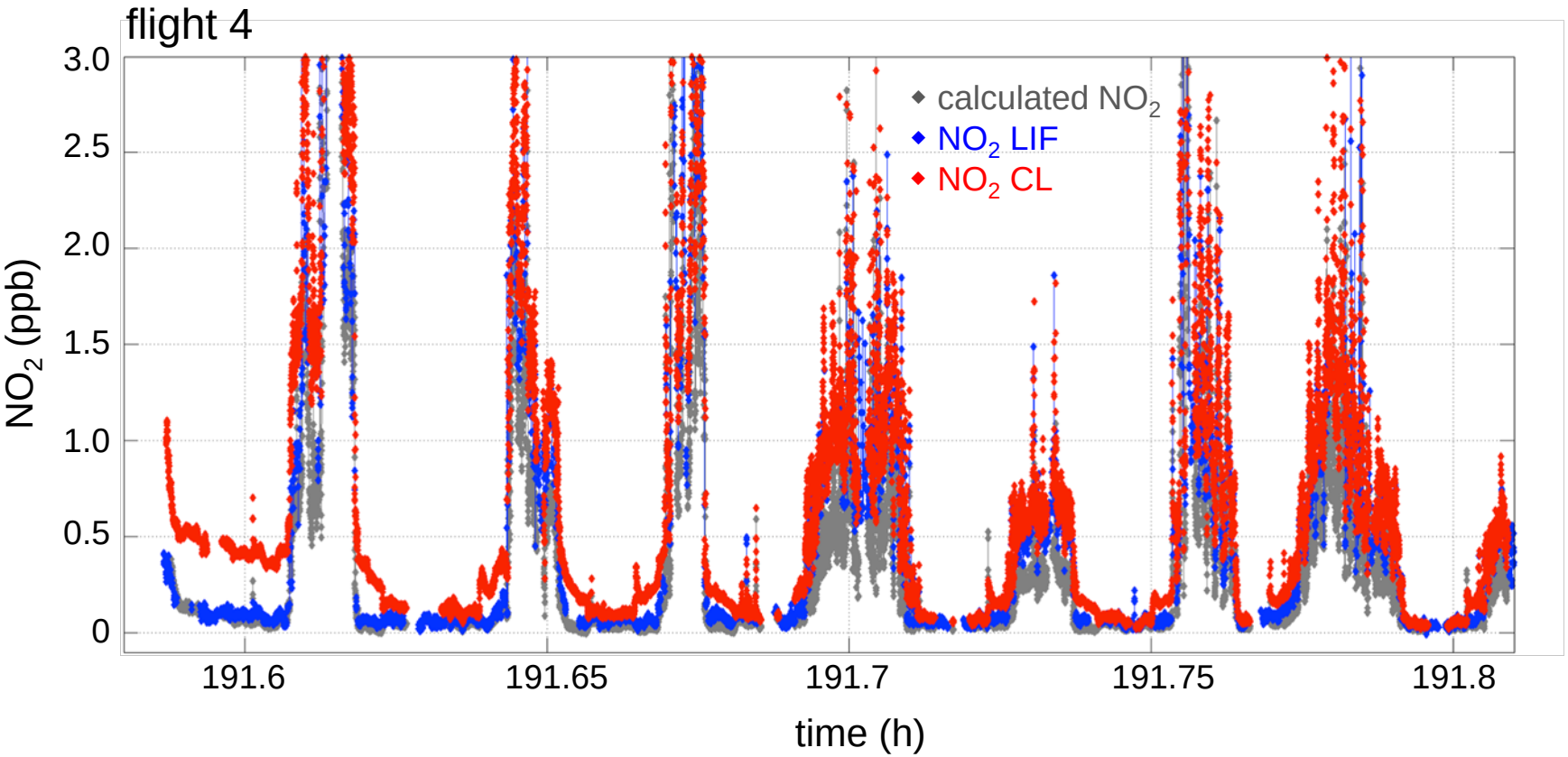
Berkeley NO_2/NO_{yi} observations from onboard the P-3

Sally Pusede, Charity Garland, Paul Wooldridge, and
Ron Cohen

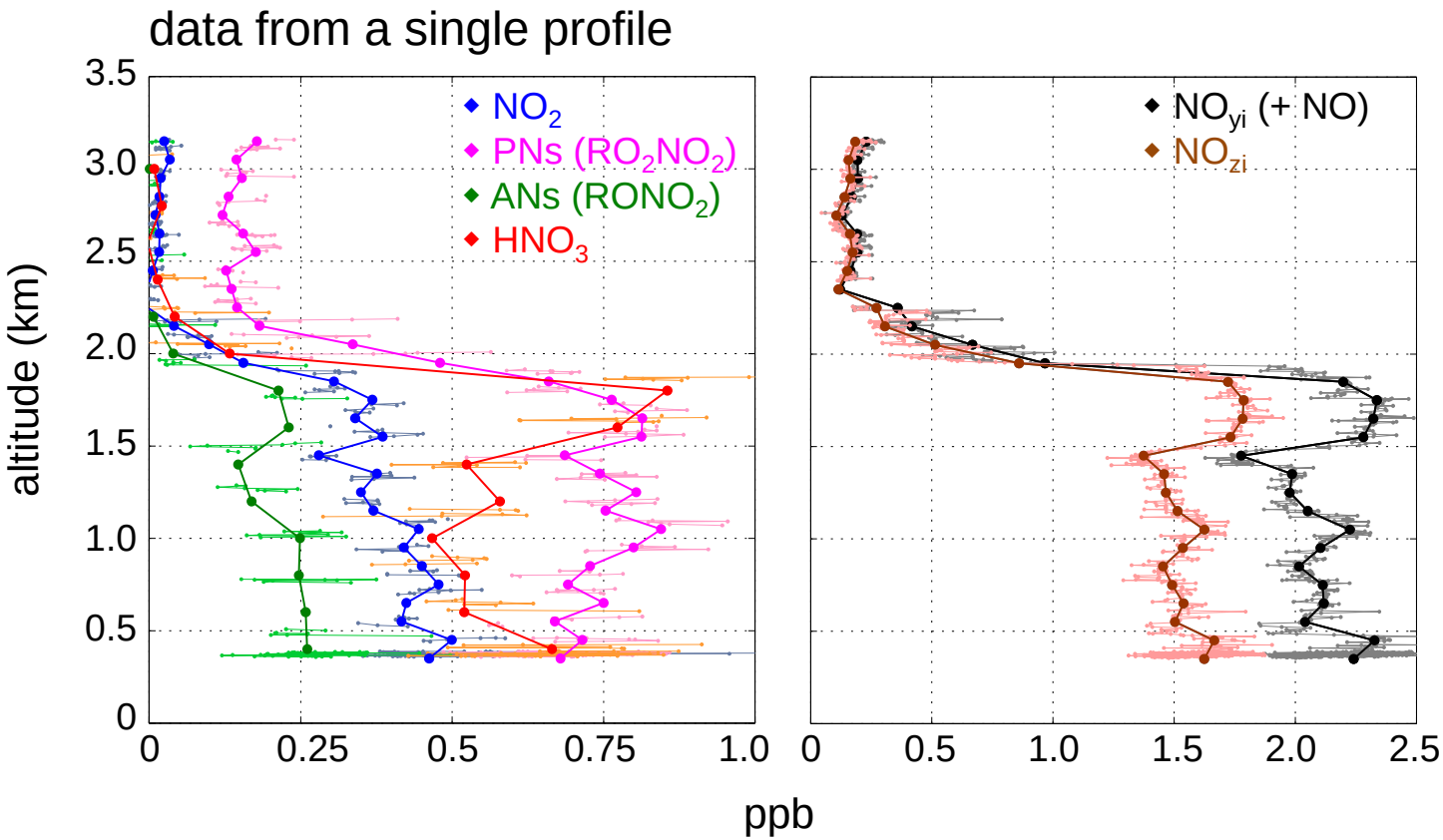
NO_2 measurements

At high concentrations, Berkeley and NCAR NO_2 are within 5% of each other.

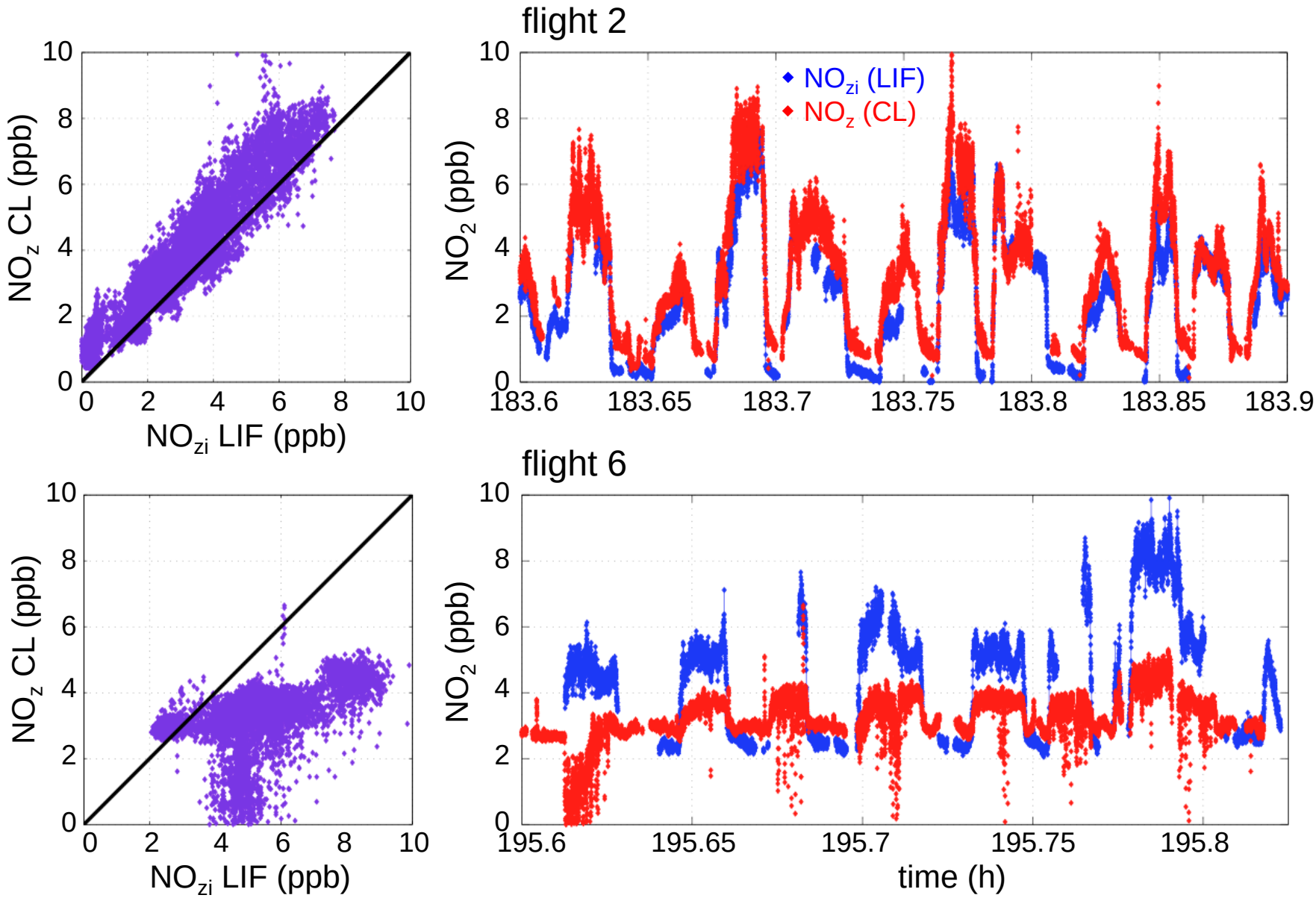
Large disagreements exist at low NO_2/high altitude.



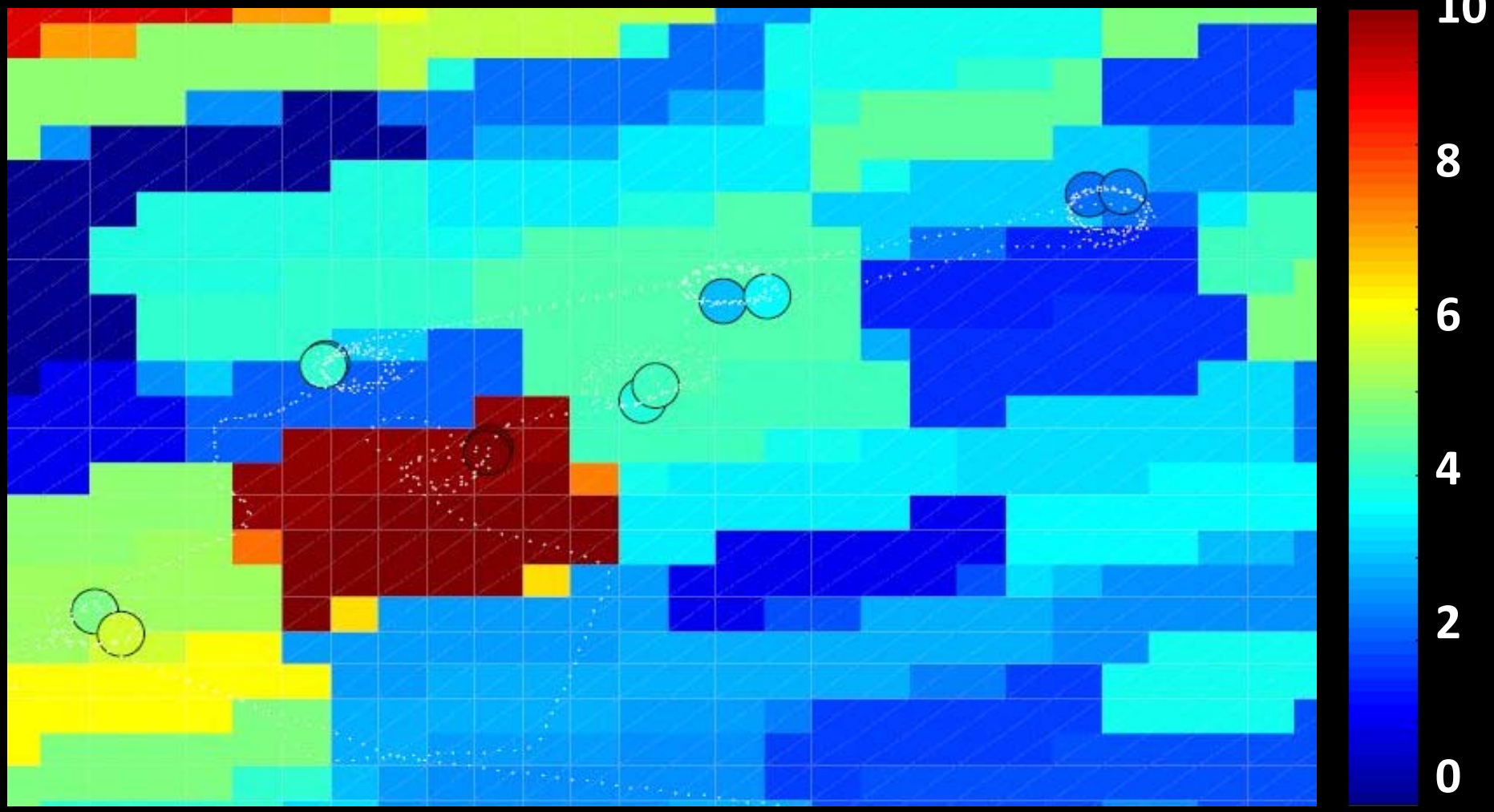
Higher nitrogen oxides measured by TD-LIF and NO_{zi}

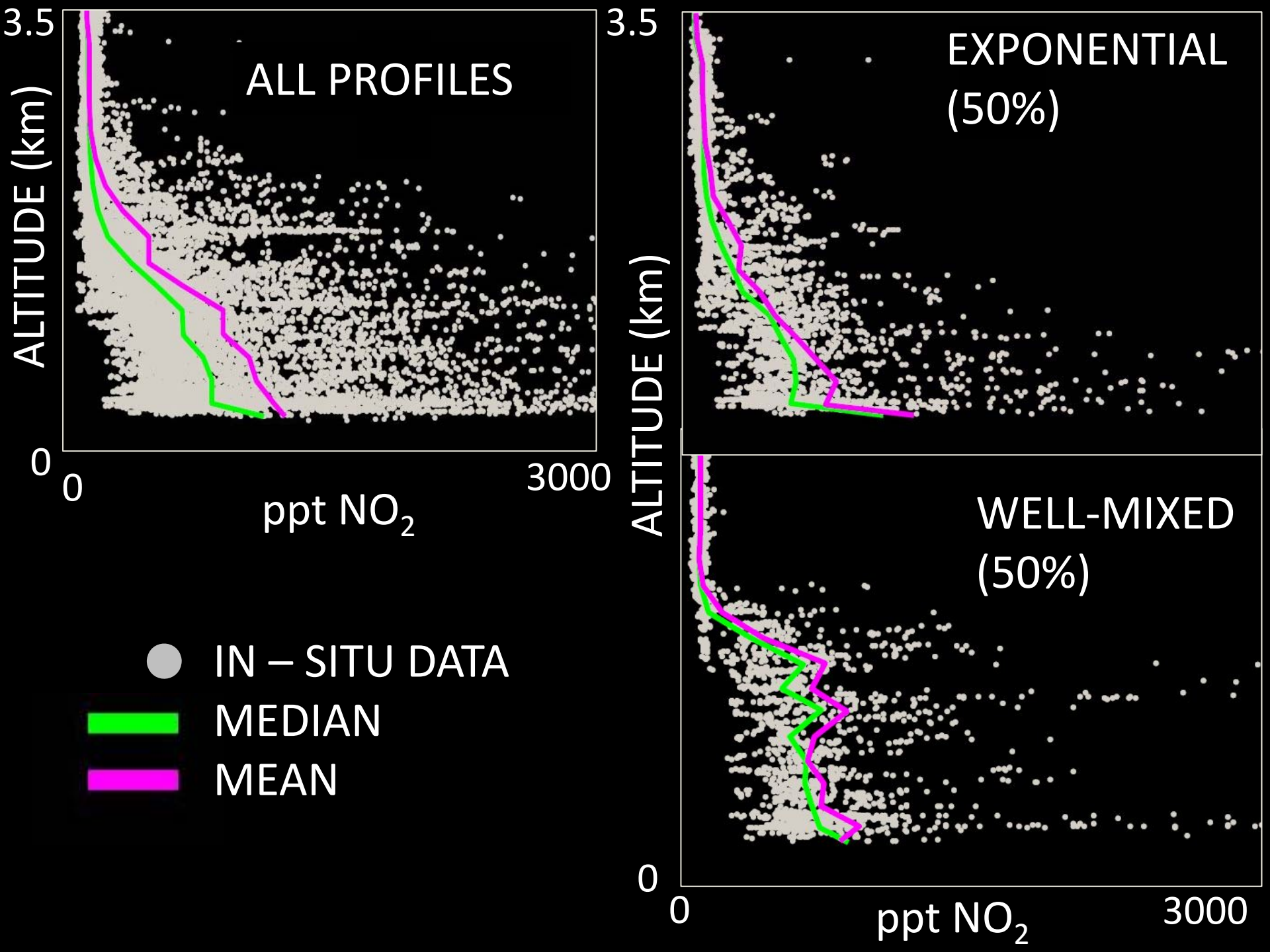


Higher nitrogen oxides measured by TD-LIF and NO_{zi}

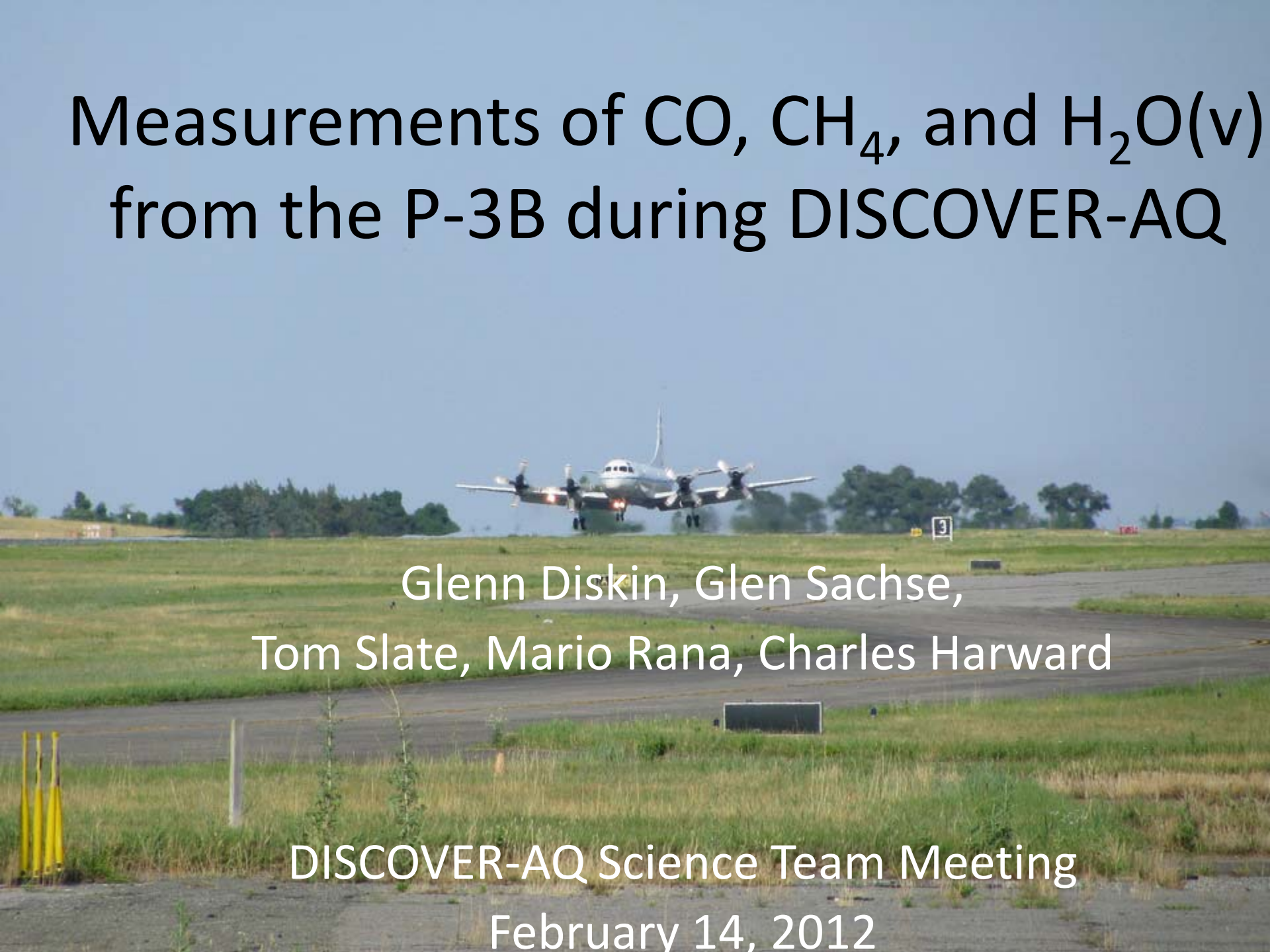


NO_2 columns: in situ and the BEHR retrieval



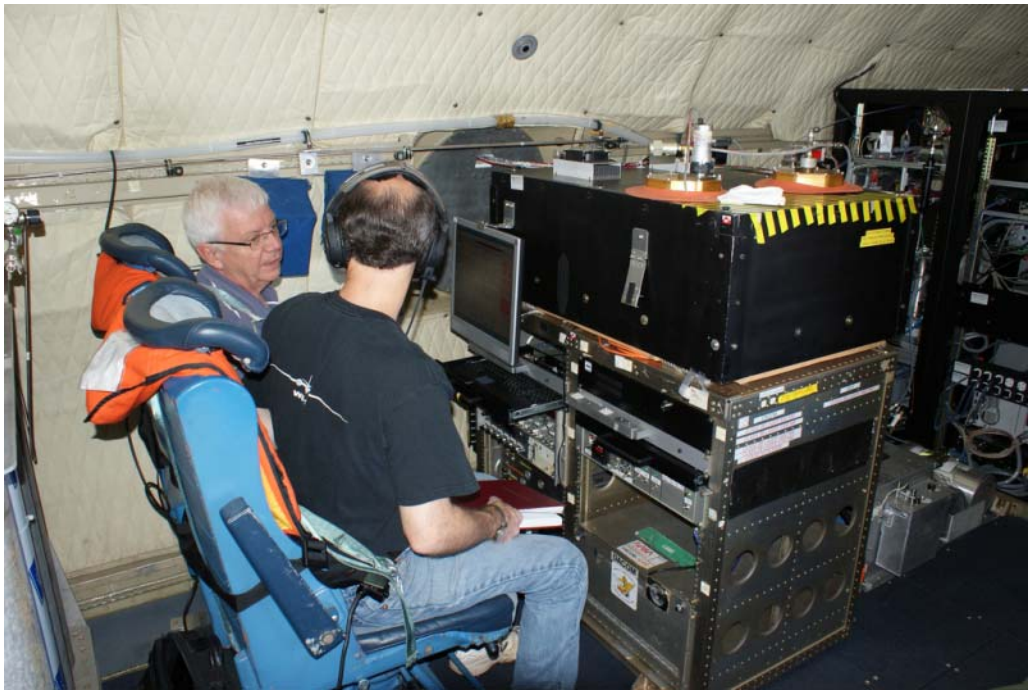

3.5
ALTITUDE (km)
ALL PROFILES
0
0
3000
ppt NO_2
3.5
EXPONENTIAL
(50%)
ALTITUDE (km)
WELL-MIXED
(50%)
0
0
3000
ppt NO_2
IN – SITU DATA
MEDIAN
MEAN

Measurements of CO, CH_4, and $H_2O(v)$ from the P-3B during DISCOVER-AQ



Glenn Diskin, Glen Sachse,
Tom Slate, Mario Rana, Charles Harward

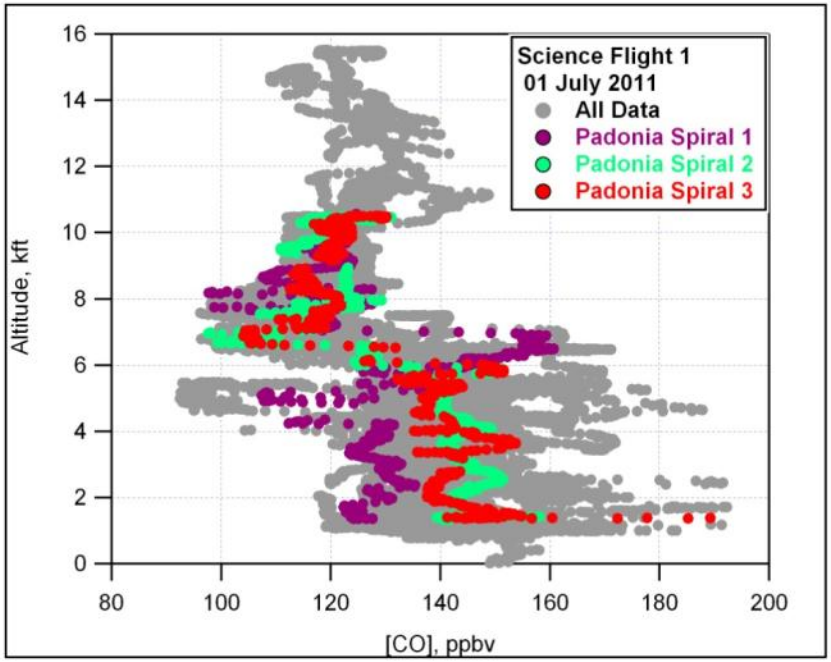
DISCOVER-AQ Science Team Meeting
February 14, 2012

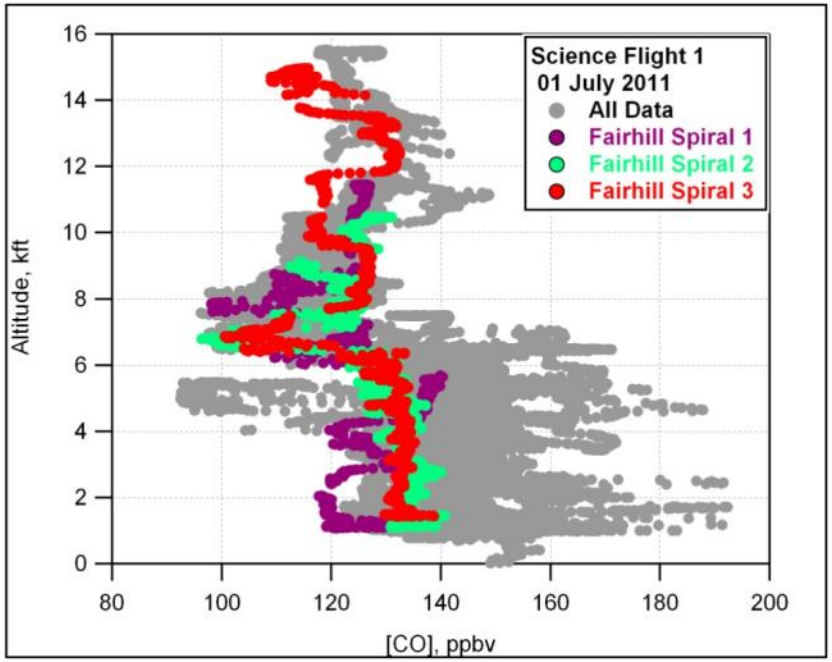


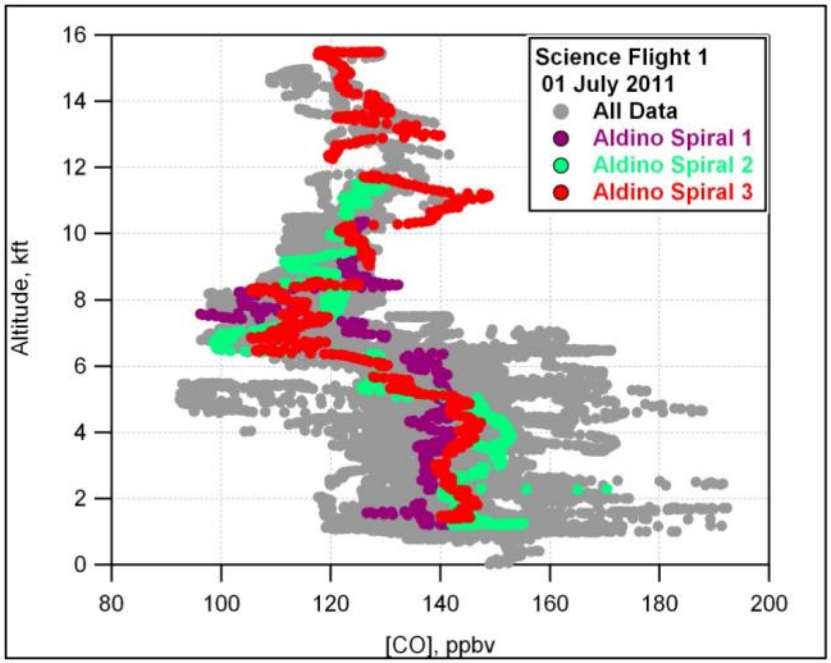
NASA

Data Status

- DACOM
  - Data available for all flights
  - Data revised as of Feb 13 to reflect NOAA calibration of primary cylinder used during D-AQ
  - Test flight data revised – error corrected
- DLH
  - New instrument built for D-AQ
  - External beam path between “tophat” and vertical tail
  - R0 data available for all science flights
  - Will generate R1 data following laboratory calibration, planned for March

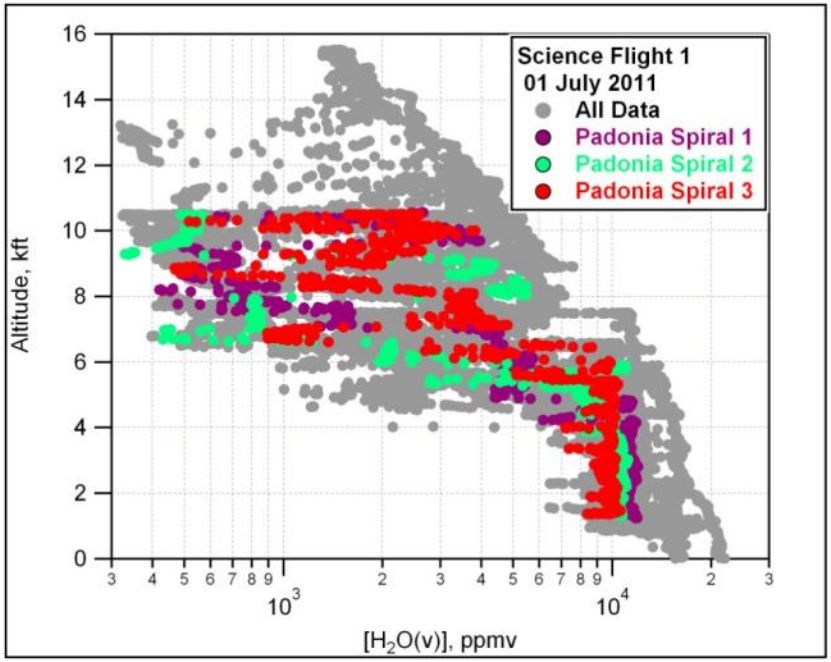


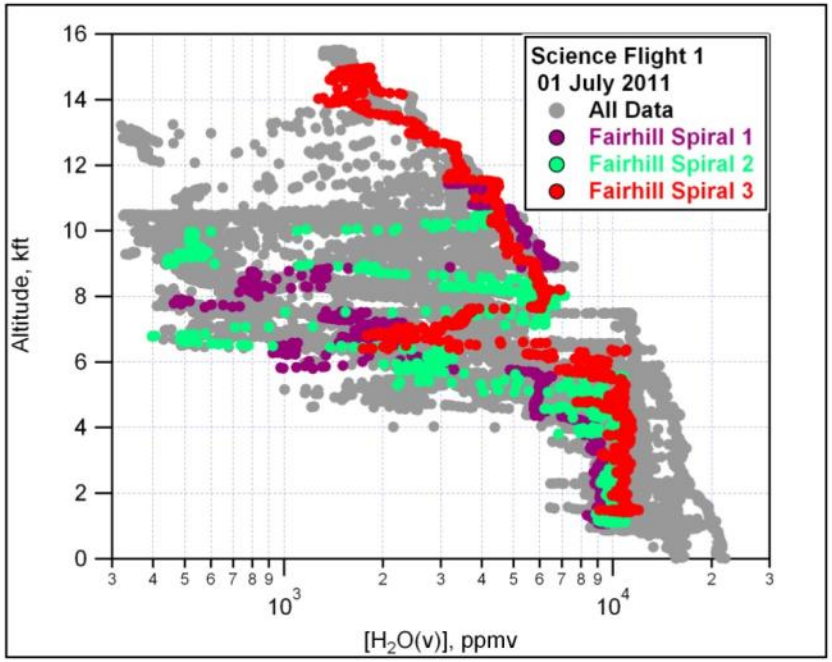


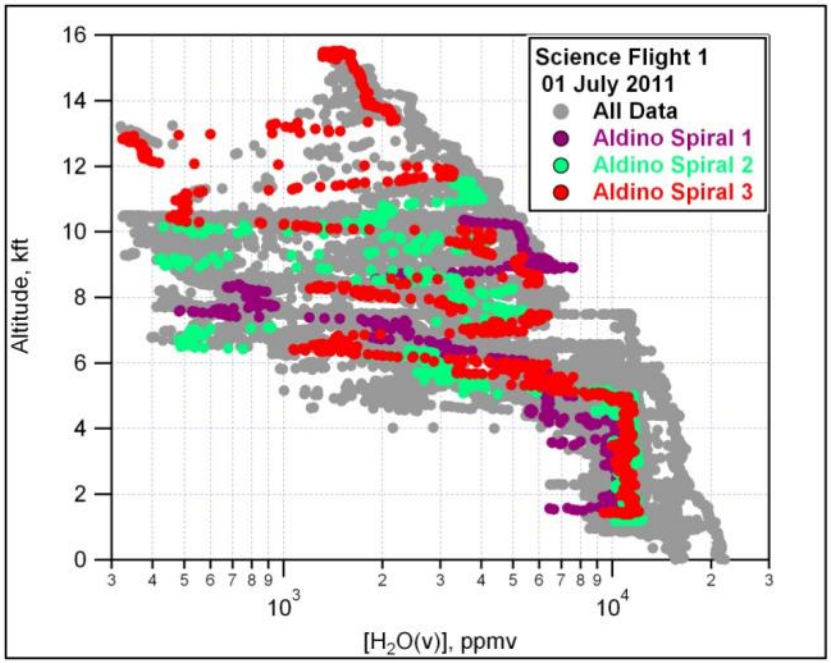


CO Altitude Profiles

- comparison of site-specific with entire flight
- vertical profile changes with location and time of day

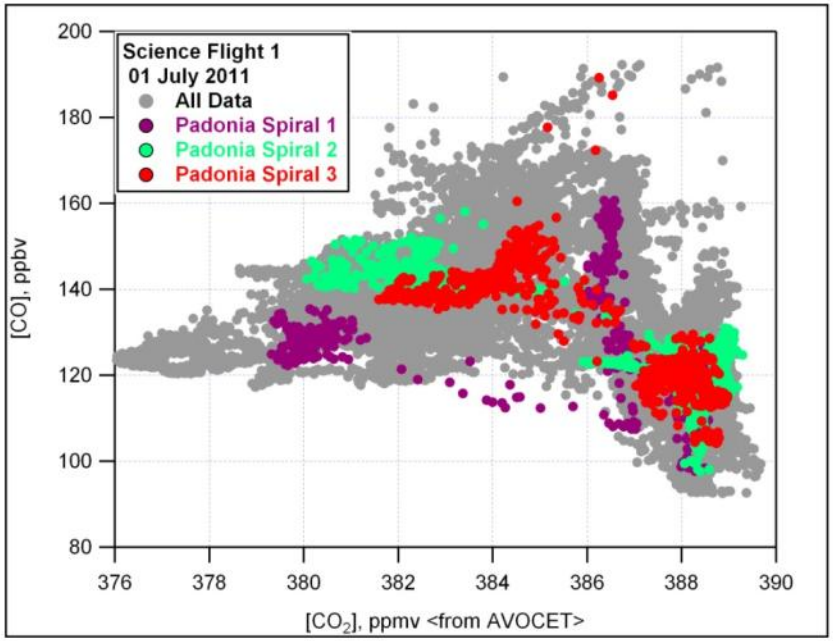


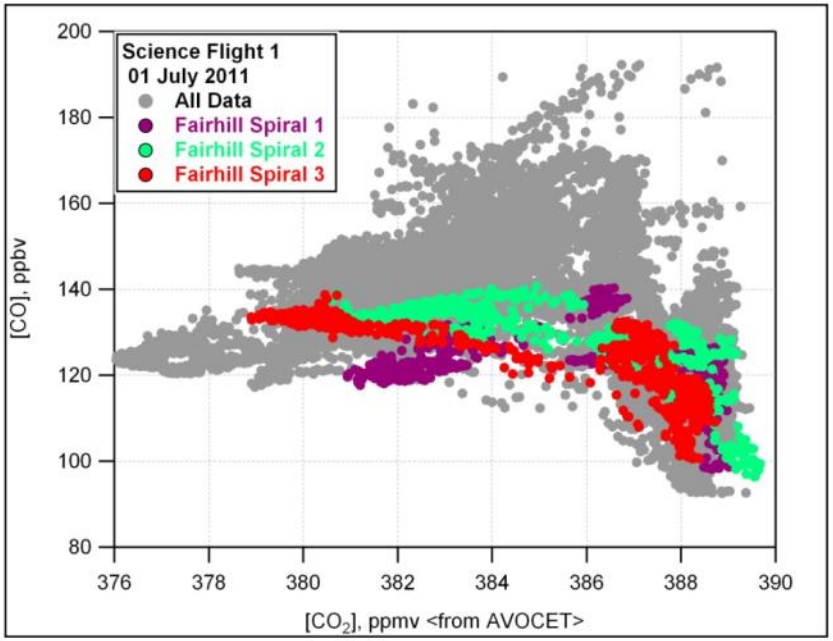


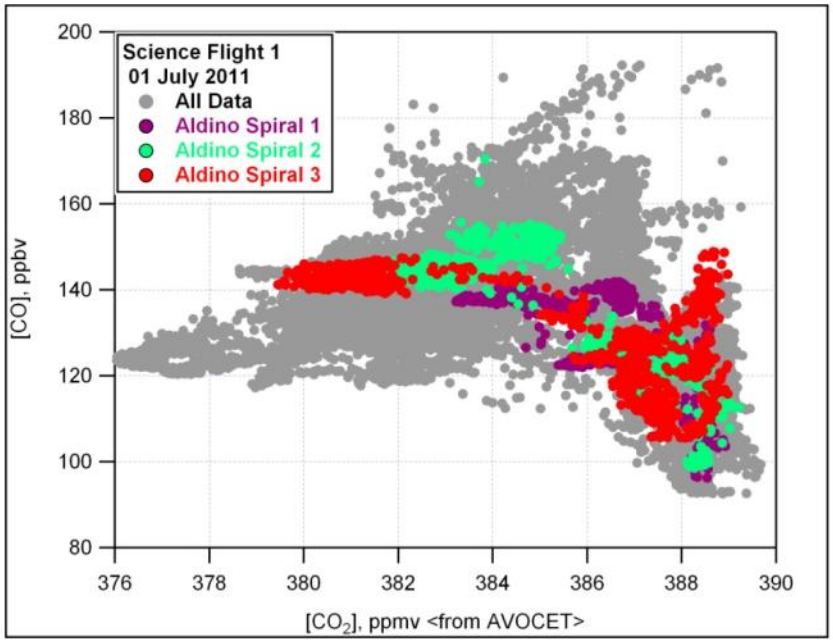


$H_2O(v)$ Altitude Profiles

- comparison of site-specific with entire flight
- vertical profile changes with location and time of day
- note behavior of dry layers





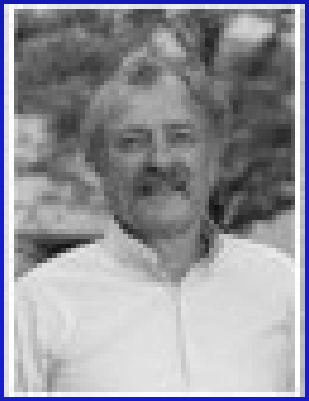


CO vs AVOCET CO_2

- comparison of site-specific with entire flight
- various slopes indicative of changing nature of sample
- need to segregate data between BL and free troposphere

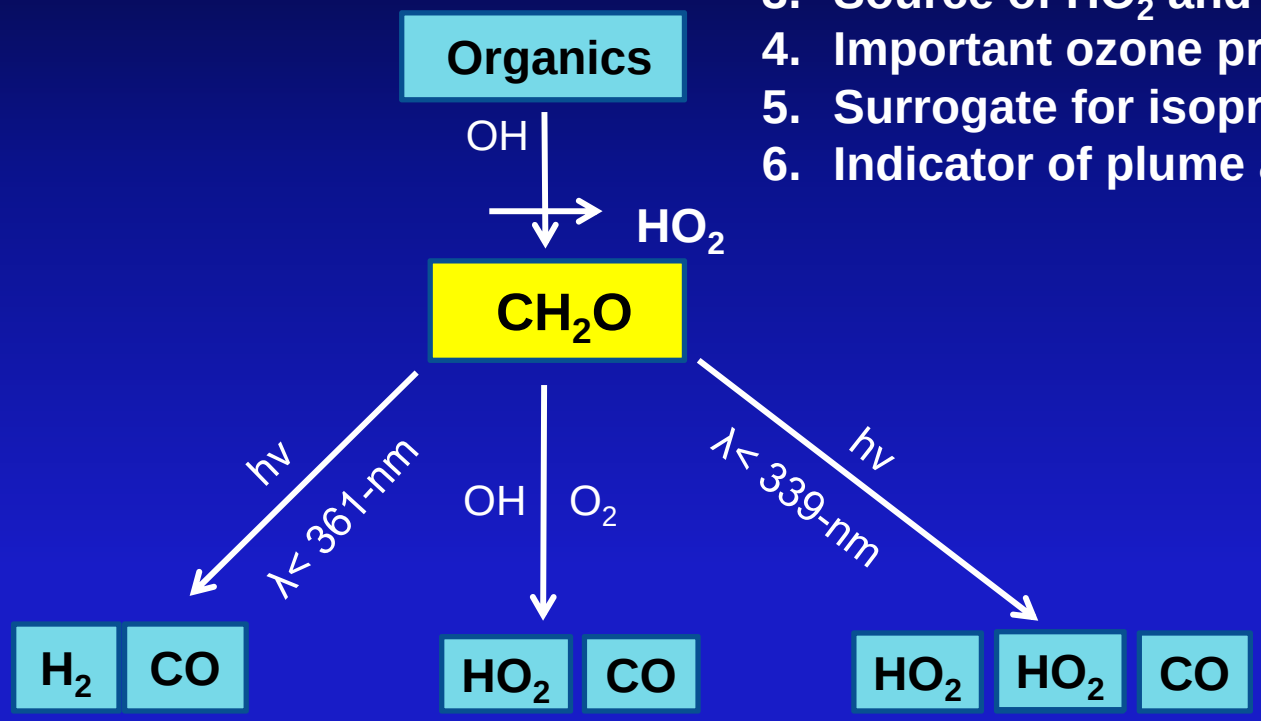
Fast Airborne Measurements of Formaldehyde on the NASA WP-3

Alan Fried, James Walega, Petter Weibring, & Dirk Richter
Institute for Arctic & Alpine Research
The University of Colorado



Formaldehyde in the Atmosphere

1. Indicator of HC activity
2. Test species in HC oxidation (meas.-model comps.)
3. Source of HO_2 and CO
4. Important ozone precursor
5. Surrogate for isoprene (from satellites)
6. Indicator of plume age



CH_2O-O_3 Correlations & Plume Age

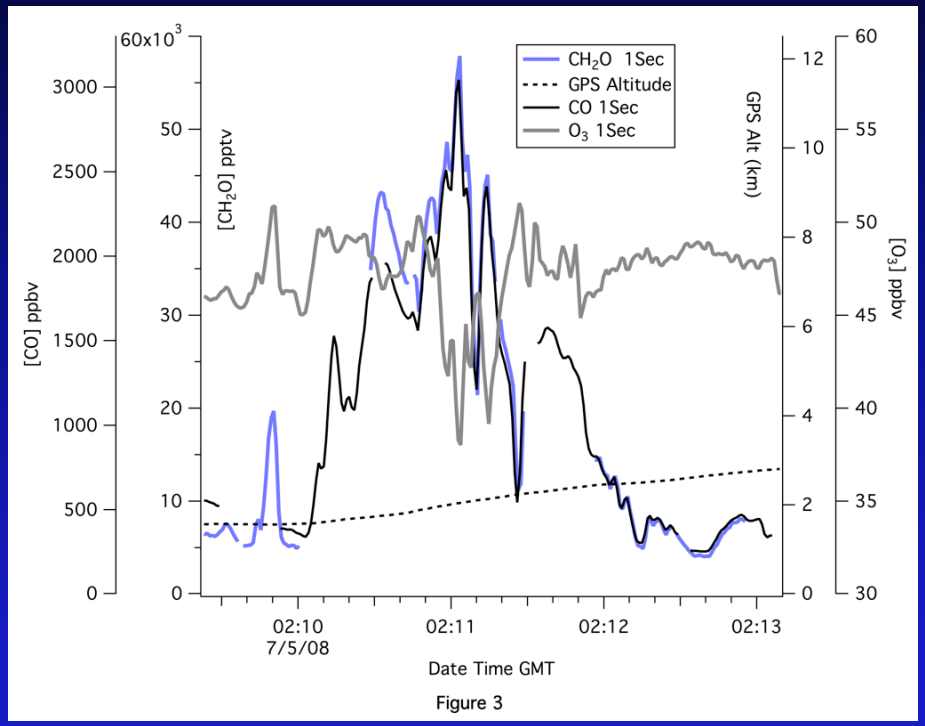
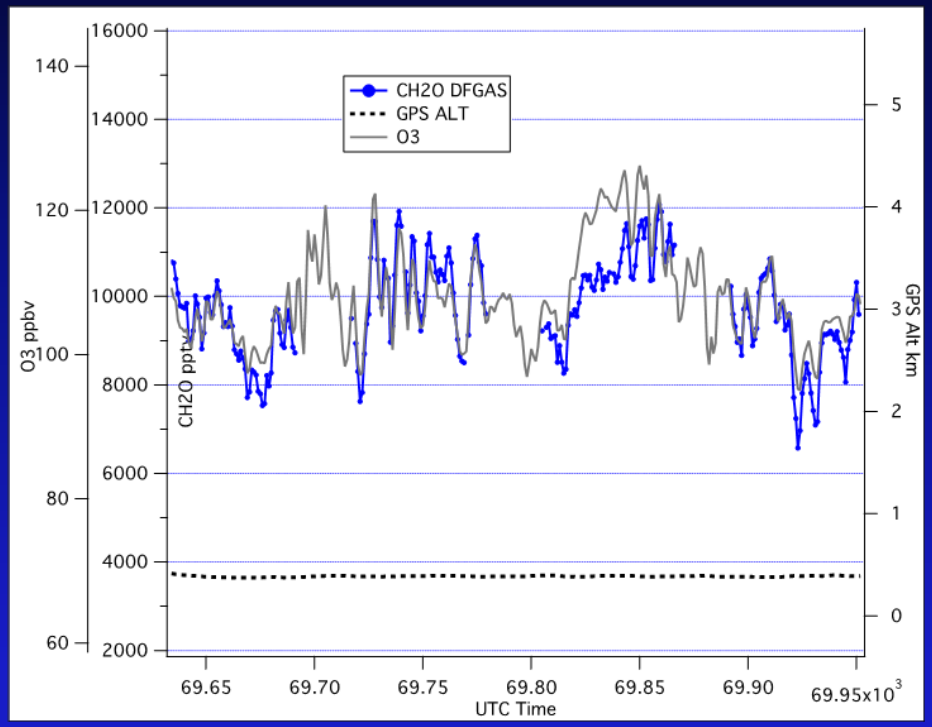


Figure 3



ARCTAS Fresh Fire Plume

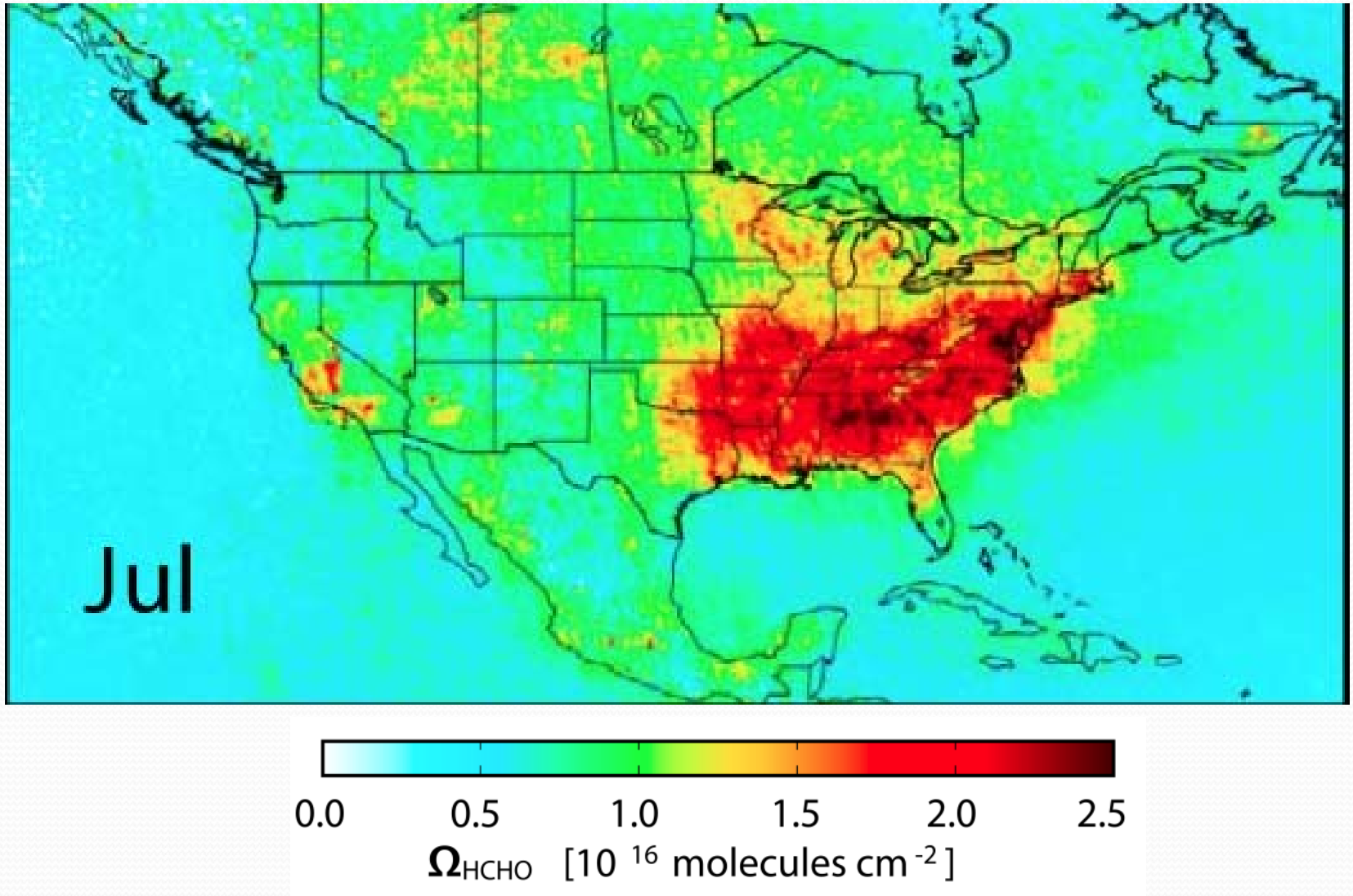
More Aged BL Air VC Meas. 7/22/11

Some Questions Trying to Resolve

- Correlations of remote (ground & aircraft) CH_2O observations with WP3 CH_2O in situ measurements & effect of controlling variables (BL depth, emissions, chemistry, diurnal)
- Can repeated in situ CH_2O meas. over same sites under different conditions reduce large uncertainties in CH_2O sources (CH4, NMVOCs: alkanes, alkenes, aromatics, & isoprene)?
- What is variability of CH_2O column densities (day-to-day, sites, time of day)? Defines variance remote measurements need to resolve
- Agreement between WP3 CH_2O columns with satellite columns (OMI)
  - Satellite columns (SC) used to constrain CH_2O budgets. Correct? (large SC uncertainties (50-105% in many cases)
  - SC used as proxy of isoprene emissions. OMI CH_2O columns over NA show temporal and spatial patterns consistent with biogenic VOCs. How accurate is this picture?
  - Reanalysis SC suggests NMVOC CH_2O sources too large (35% 2005 to 2008), implying overestimate of isoprene emissions in GEIA inventory

Monthly North America Mean OMI CH_2O SC - (2005-2007)

From: Boeke et al. JGR, 116, 2011



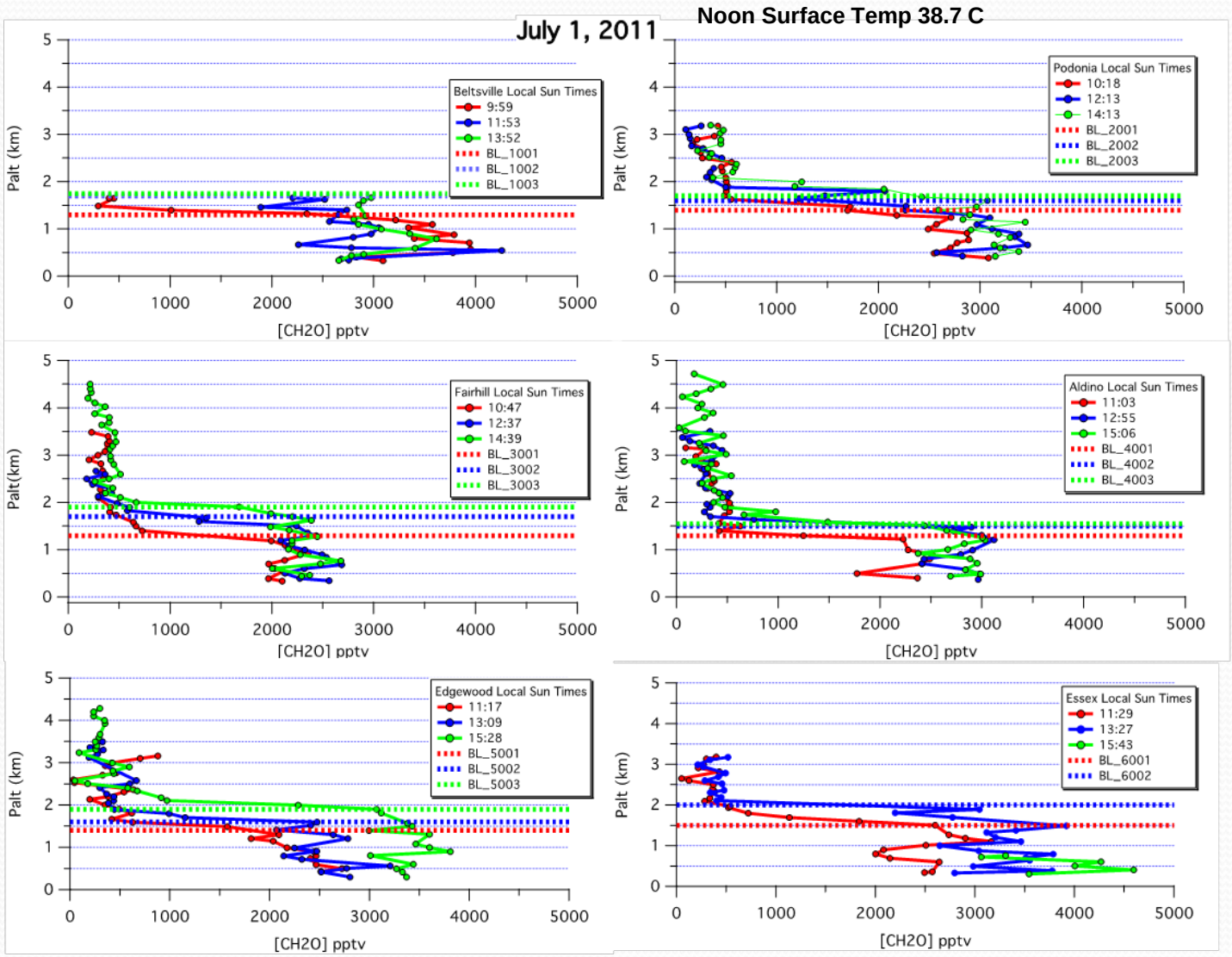
DFGAS on NASA DC-8 During ARCTAS

Once system running no optical adjustments (semi-autonomous)

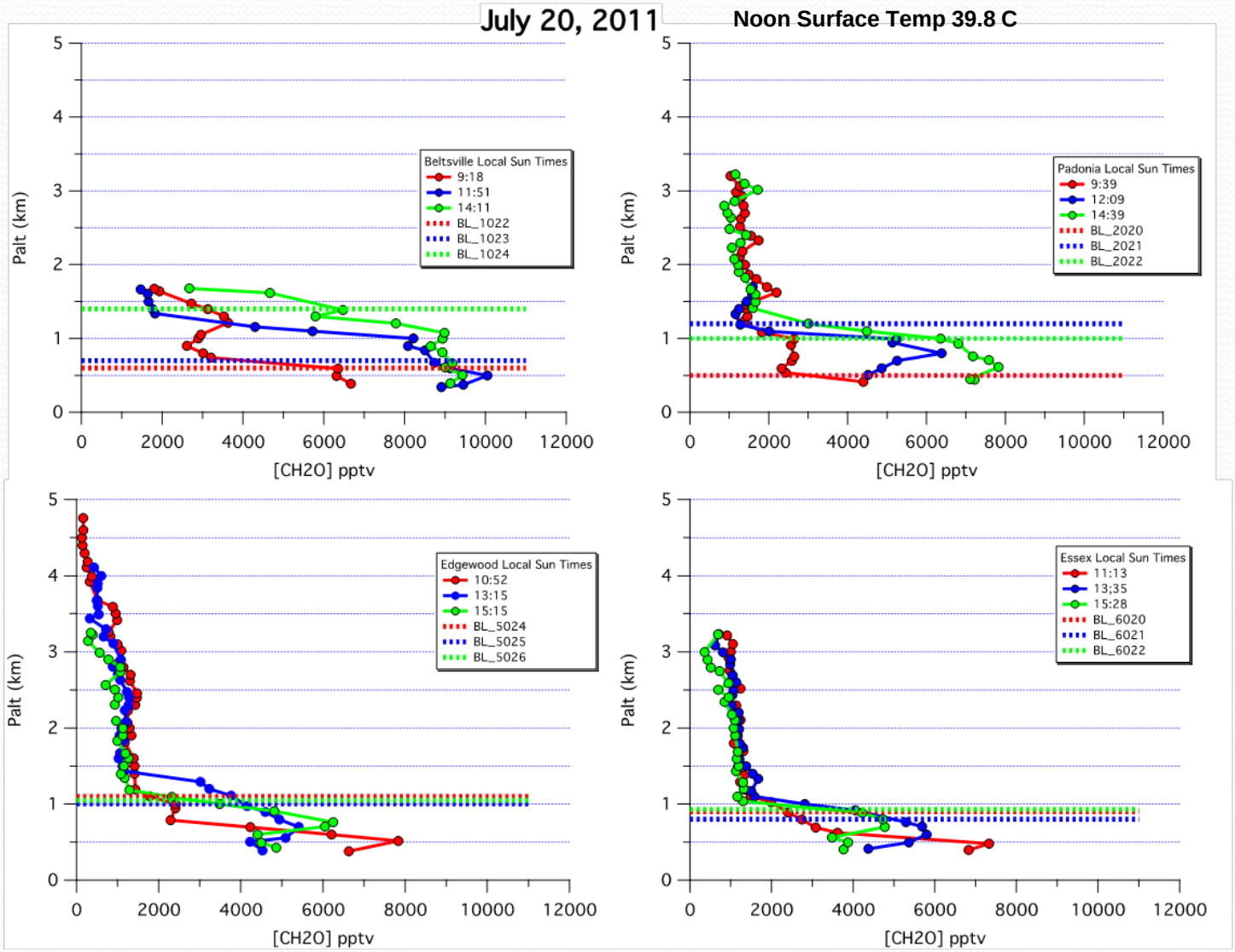
1 Sec LOD (1 σ) primarily 50- 100 pptv range

Measurement Accuracy ~ 4% (1σ)

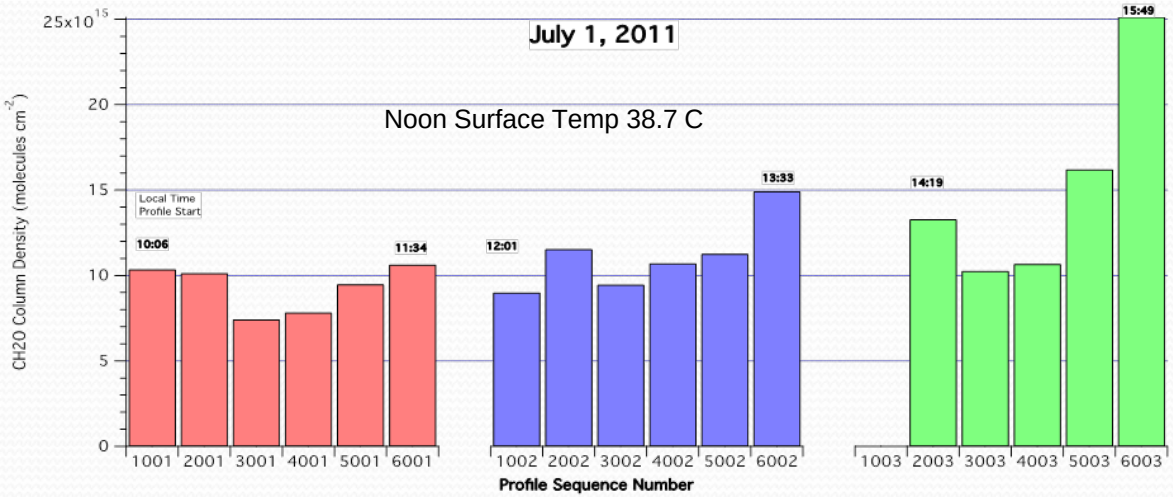
Binned Average CH_2O Altitude Profiles

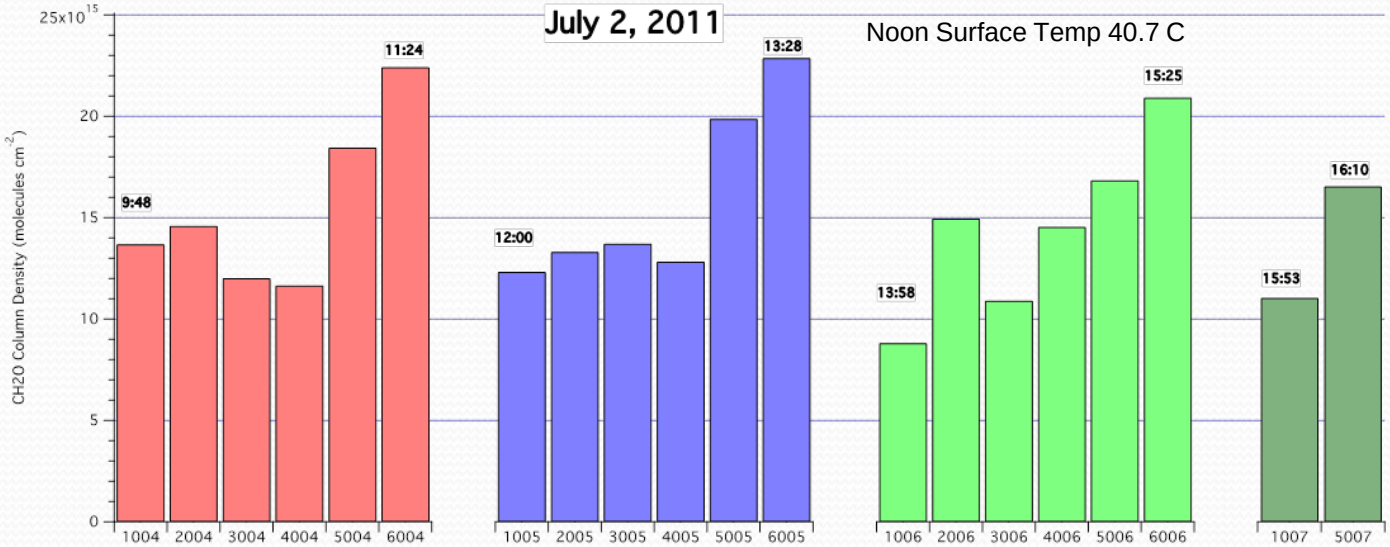


Binned CH_2O Altitude Profiles

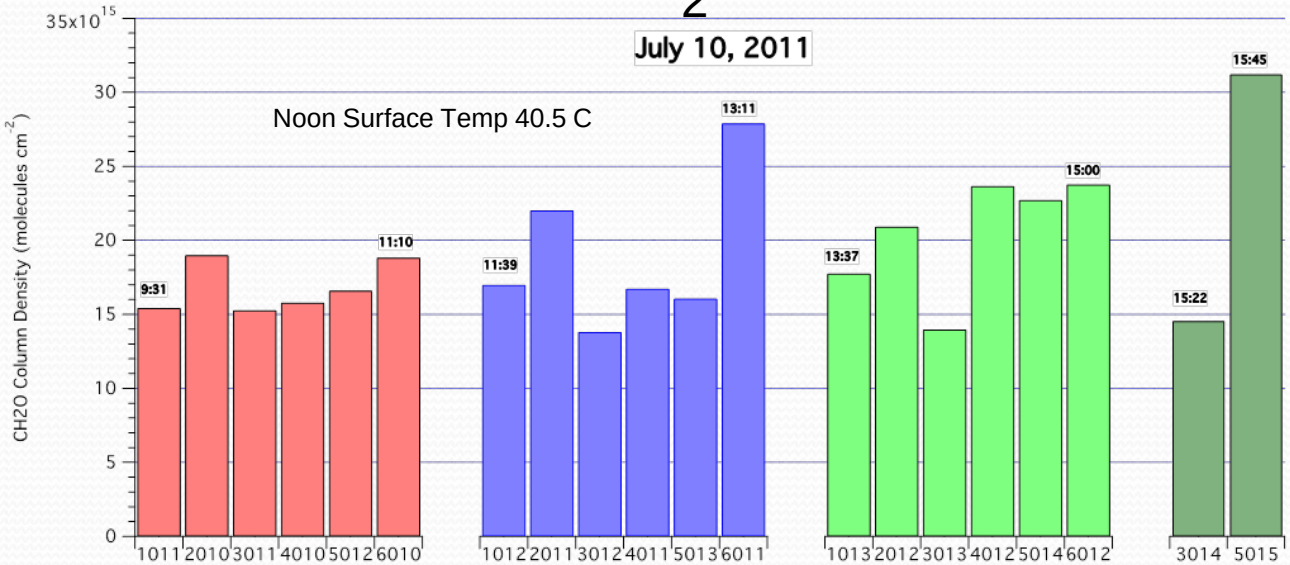


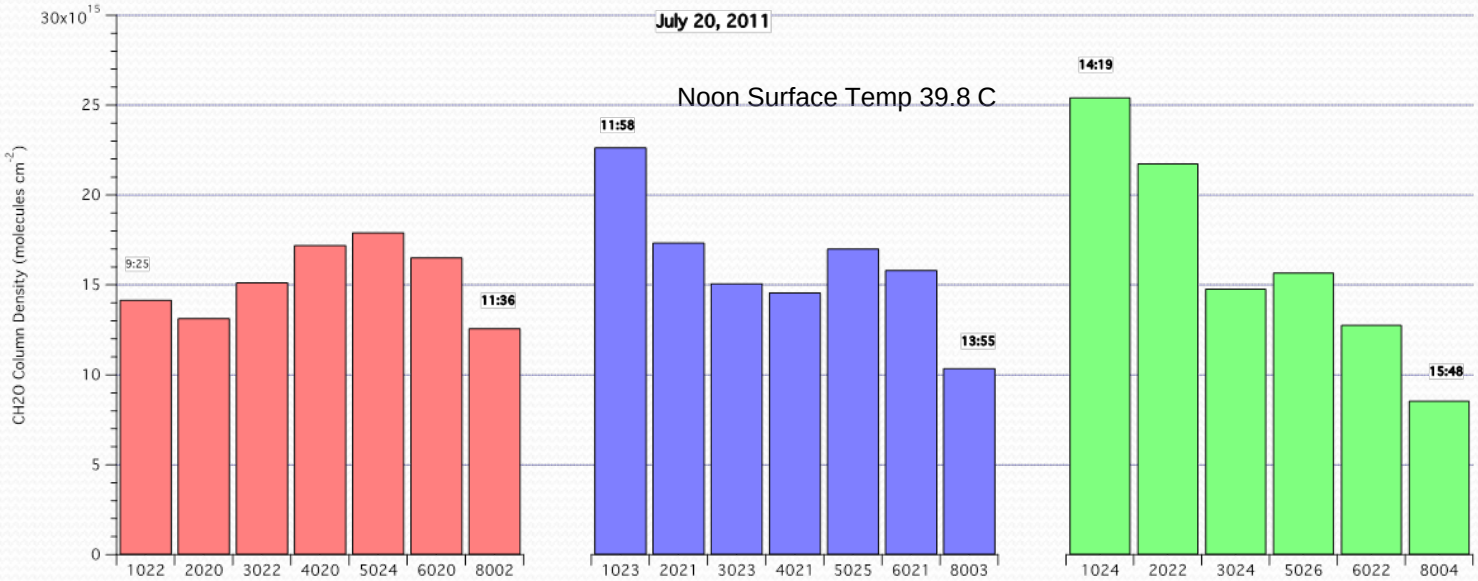
CH_2O Column Densities





CH_2O Column Densities





In Situ Measurements of NO, NO_2, NO_y, and O_3 on the P3

Andrew J. Weinheimer

David J. Knapp

Denise D. Montzka

NCAR Earth System Laboratory

NCAR is sponsored by the National Science Foundation

Measurement & Calibration

- NO via chemiluminescence (rxn w/ reagent O_3).
- NO_2 via photolytic conversion to NO.
- NO_y via Au-catalyzed conversion to NO.
- All three calibrated several times per flight with NO and NO_2 addition to sample flow.
- O_3 via chemiluminescence (rxn w/ reagent NO). Calibrated on ground several times before, during, after project.
- Continuous, 1-Hz data.

Data Quality

- NO, NO_2, O_3 are nominal. Very stable calibrations.
- NO_y suffered from variable (and sometimes poor) conversion efficiency:
  - Post-mission lab tests indicated that due to CO bottle used.
  - TBD: error estimate time series to quantify errors.

Thank You

The NESL Mission is:
To advance understanding of weather, climate, atmospheric composition and processes;
To provide facility support to the wider community; and,
To apply the results to benefit society.

NCAR is sponsored by the National Science Foundation

Vertical profiles of VOC

Armin Wisthaler
and
Tomáš Mikoviny

Universität Innsbruck

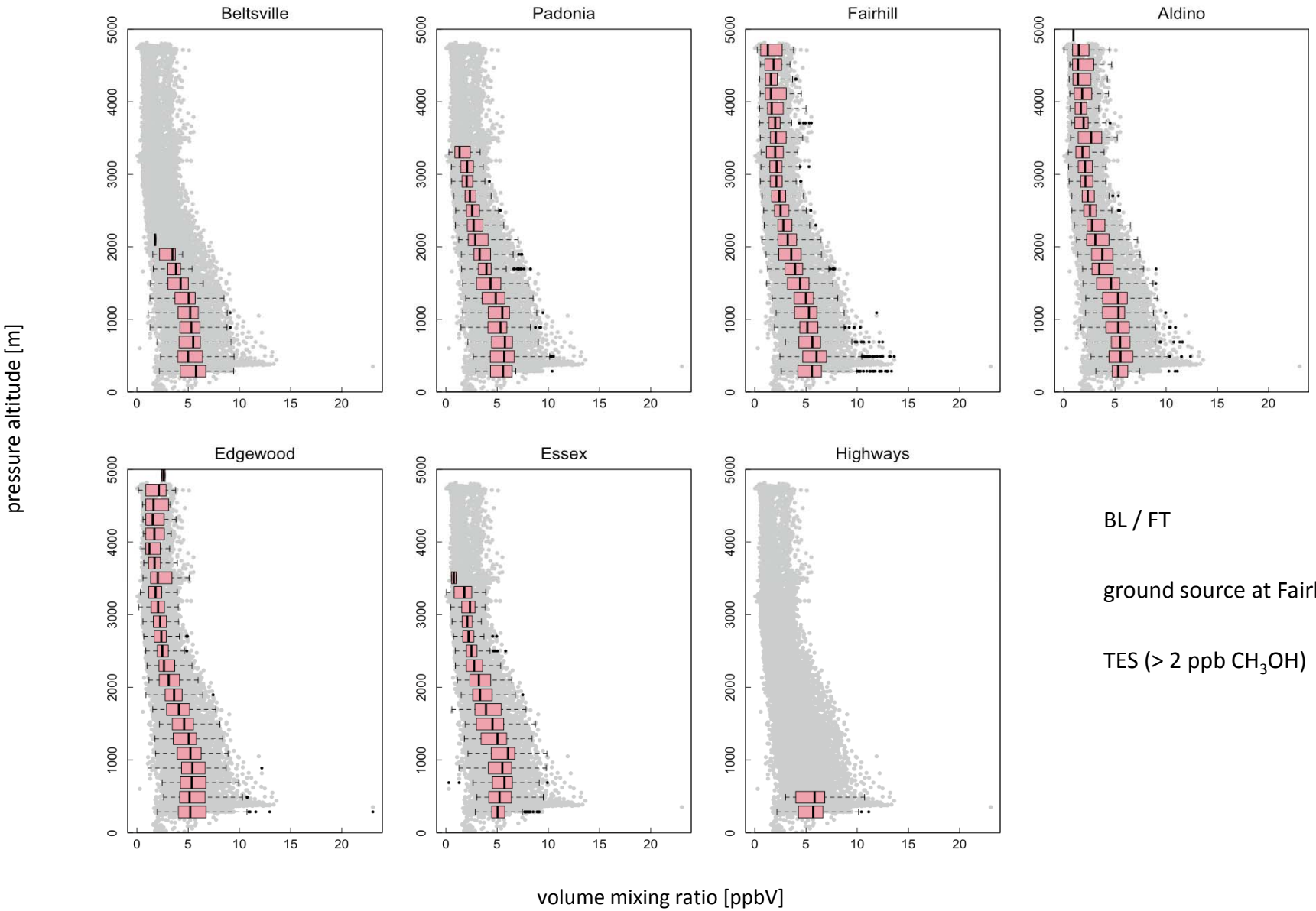
OVOC

methanol

acetone

acetaldehyde

Methanol

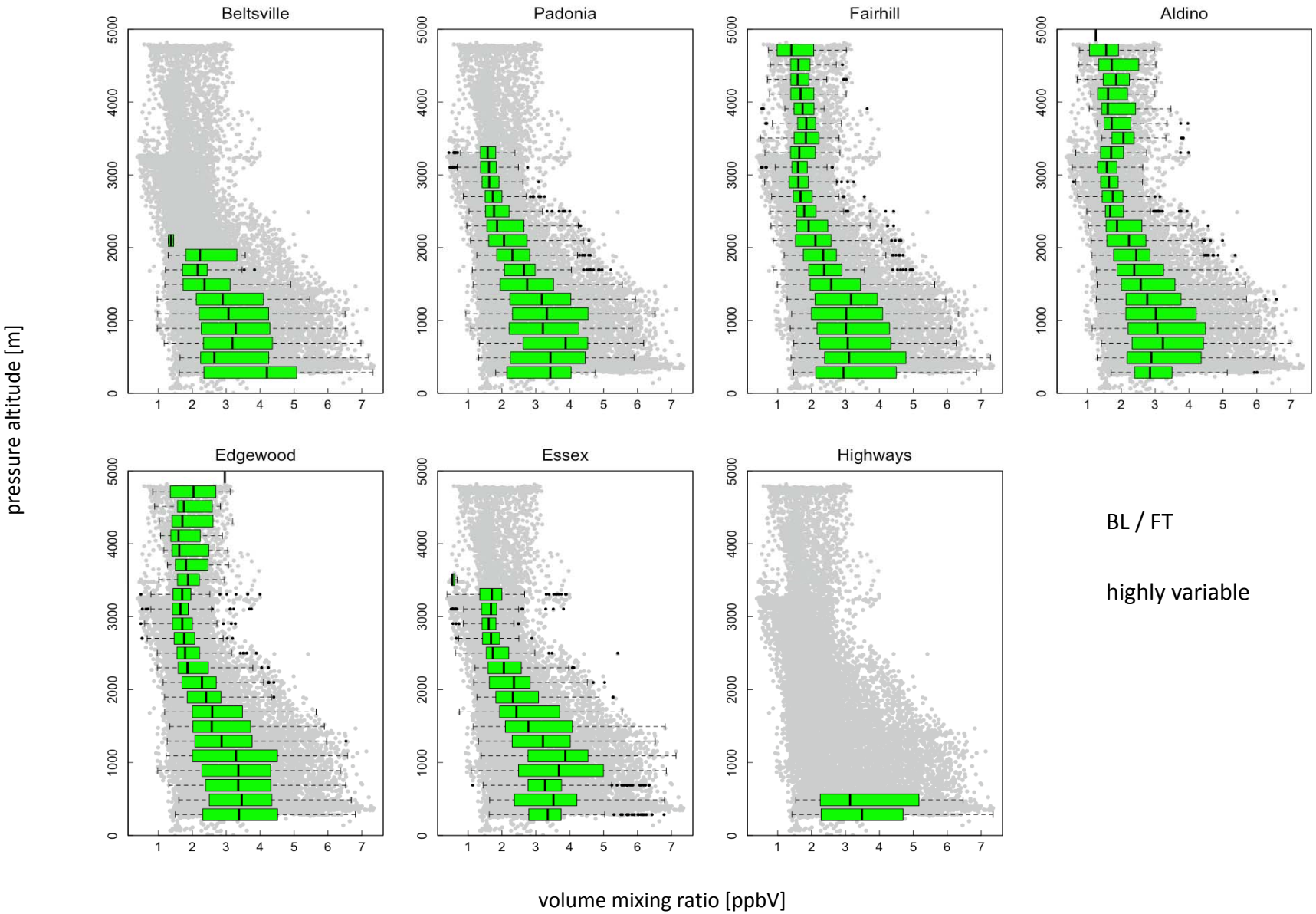


BL / FT

ground source at Fairhill

TES (> 2 ppb CH_3OH)

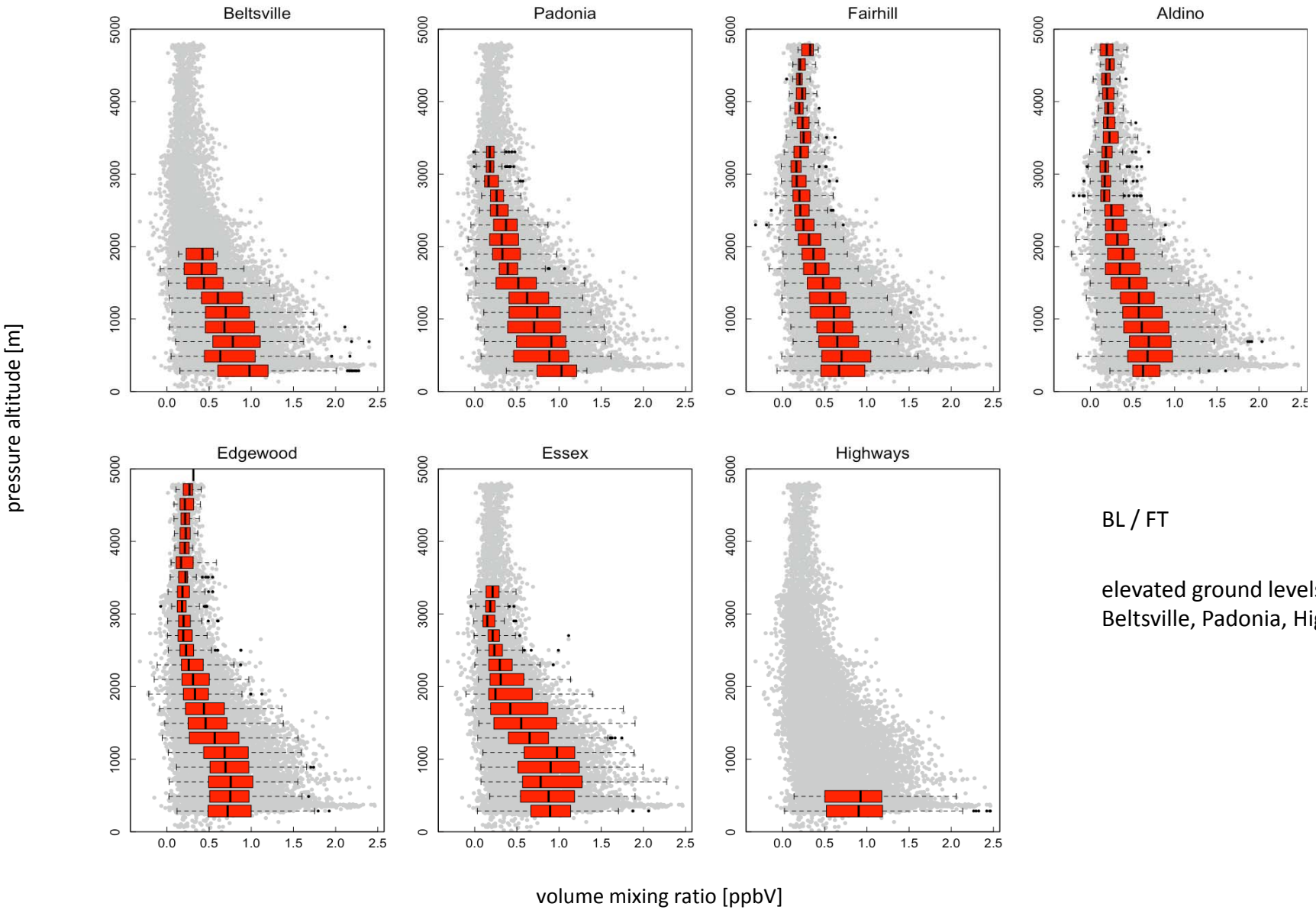
Acetone



BL / FT

highly variable

Acetaldehyde



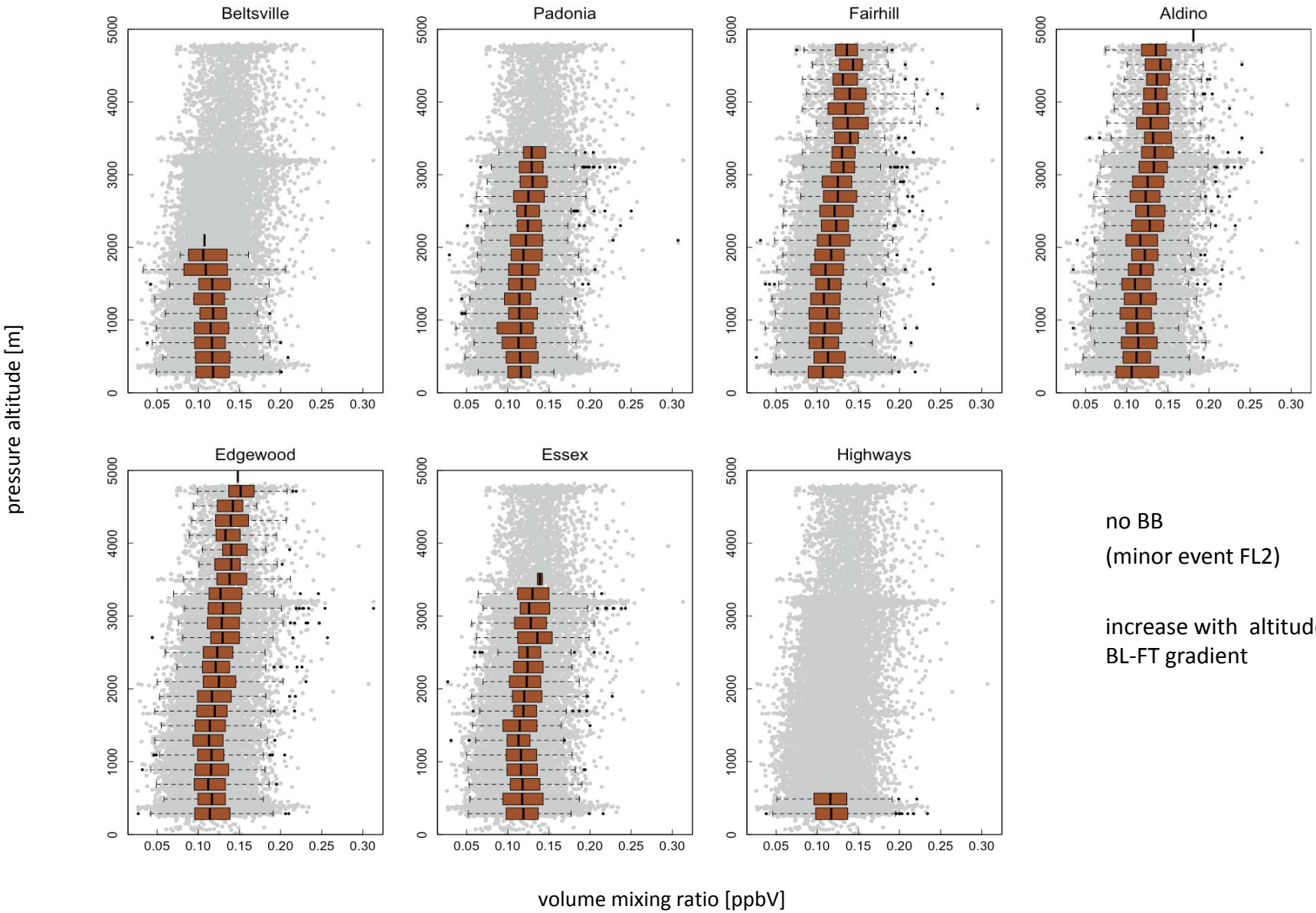
BL / FT

elevated ground levels at Beltsville, Padonia, Highways

Acetonitrile

biomass burning tracer

Acetonitrile



no BB
(minor event FL2)

increase with altitude, no BL-FT gradient

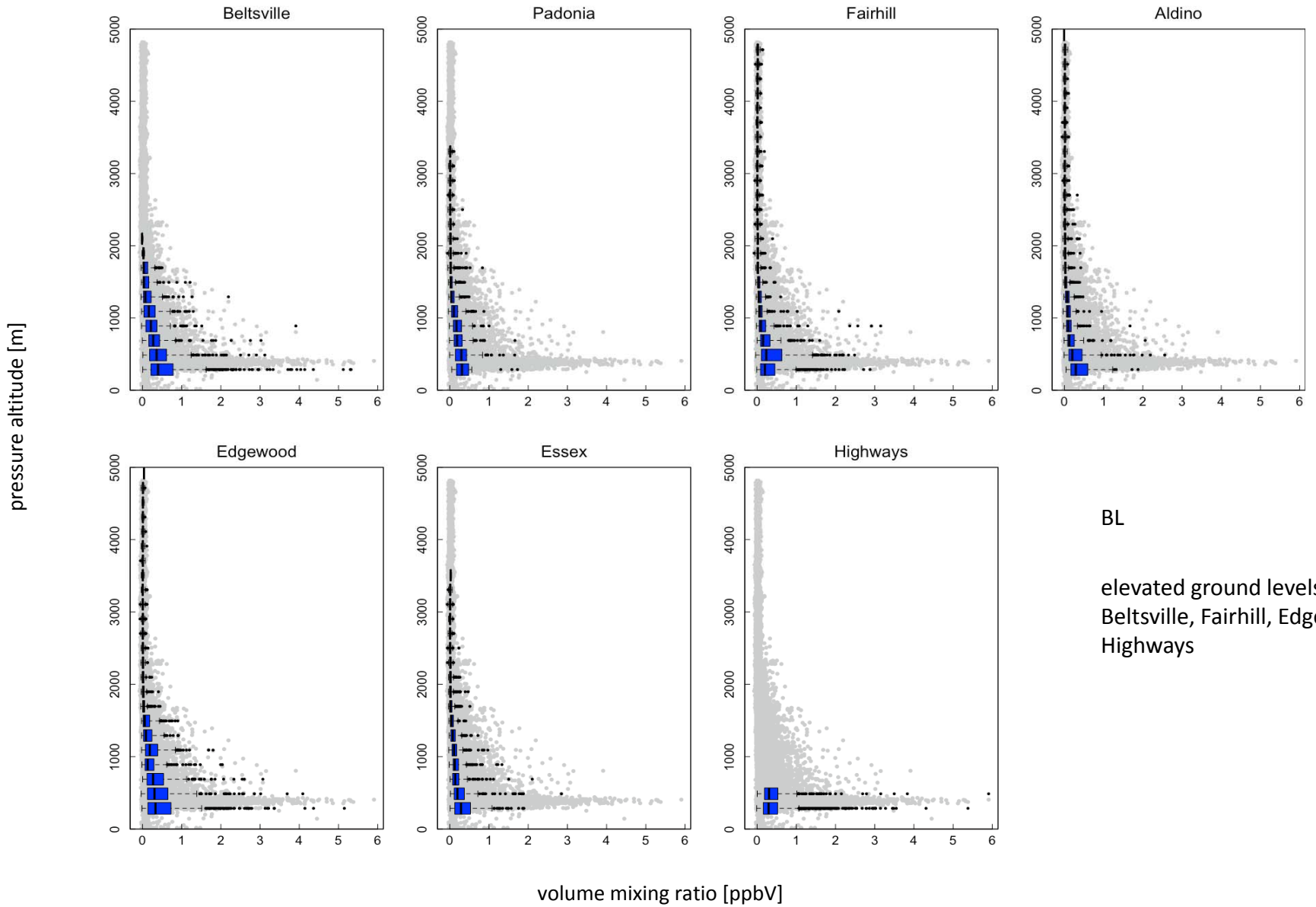
Biogenics

isoprene

MVK + MACR

monoterpenes

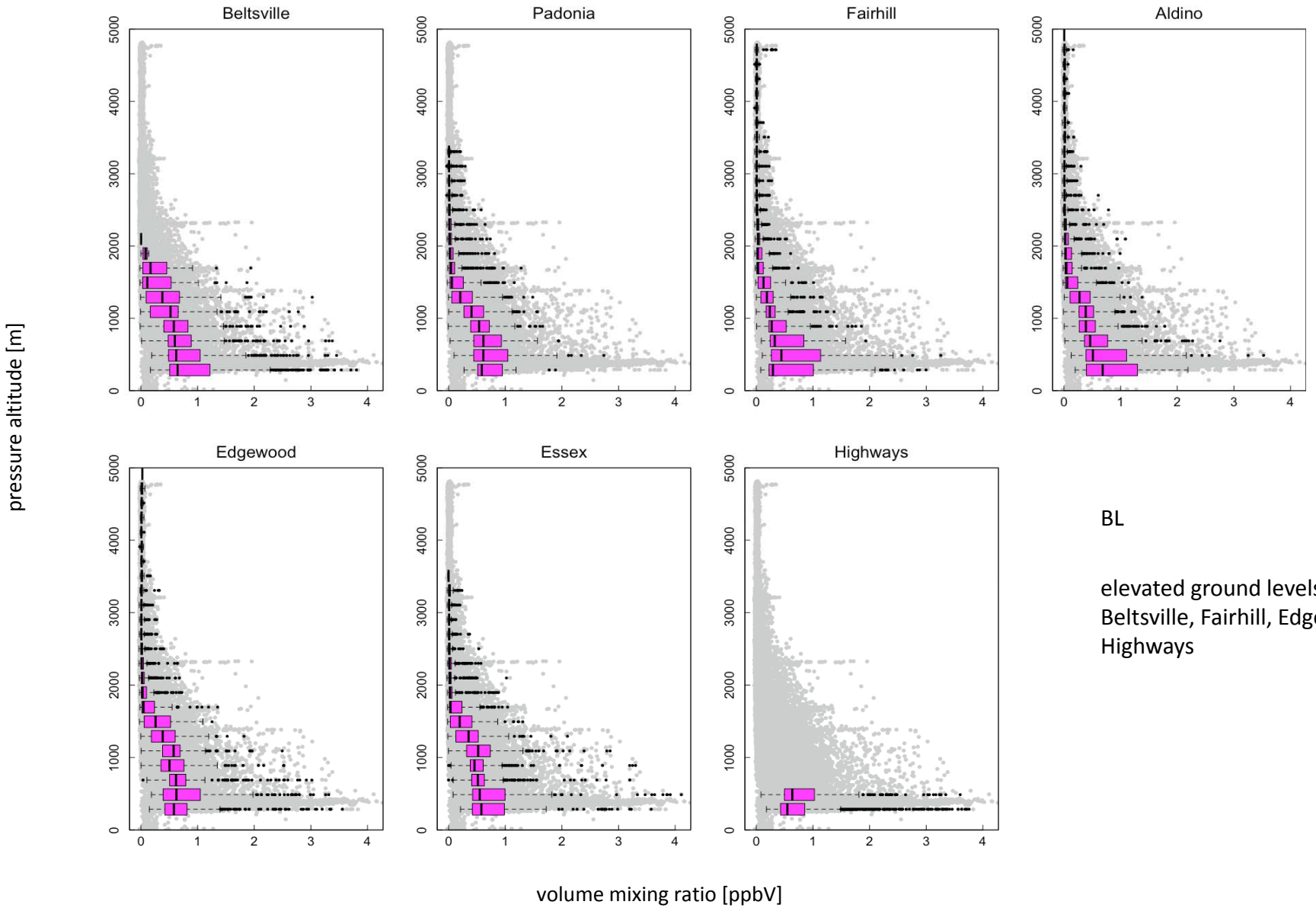
Isoprene



BL

elevated ground levels at Beltsville, Fairhill, Edgewood, Highways

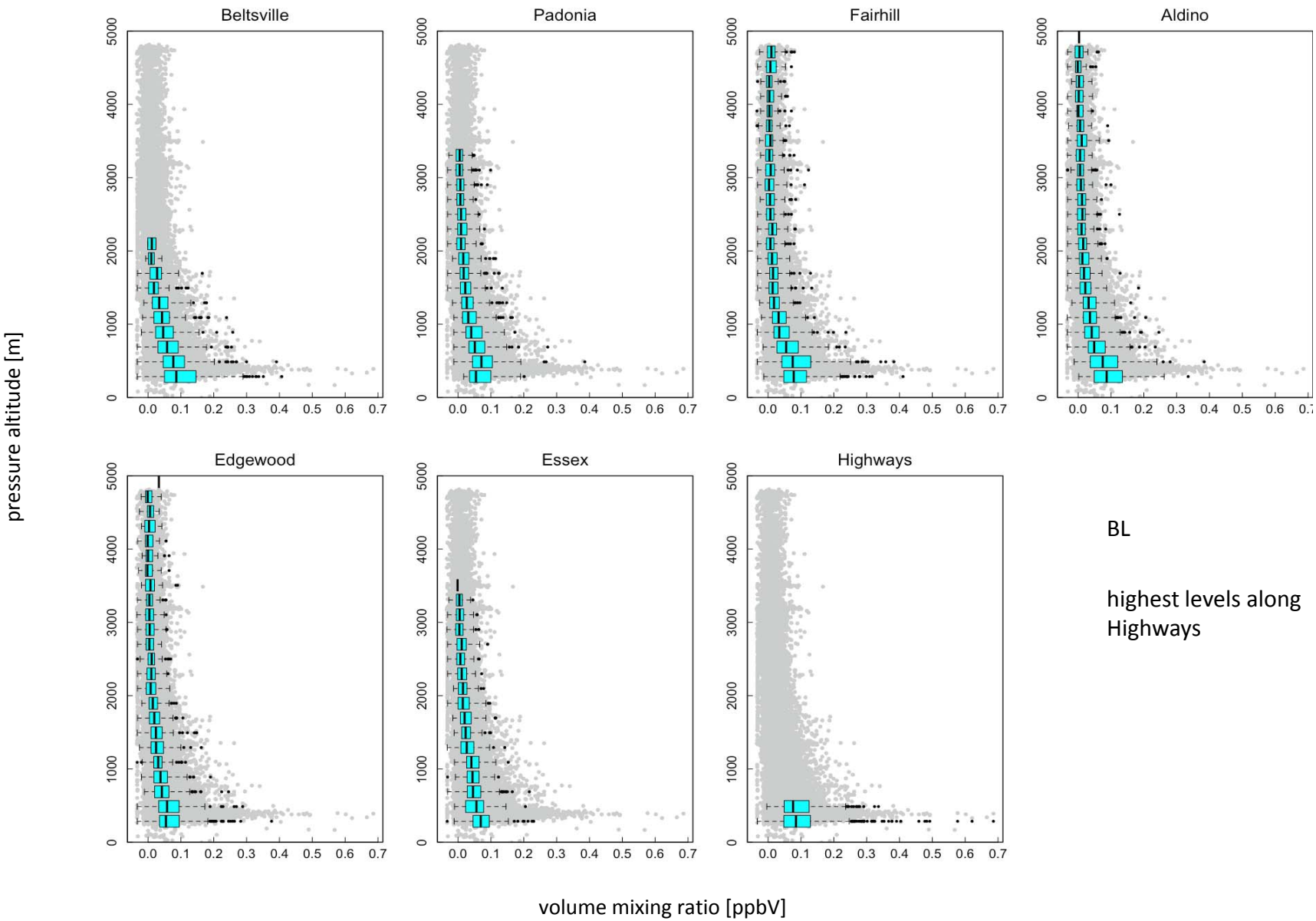
MVK/MACR



BL

elevated ground levels at Beltsville, Fairhill, Edgewood, Highways

Monoterpenes



BL

highest levels along Highways

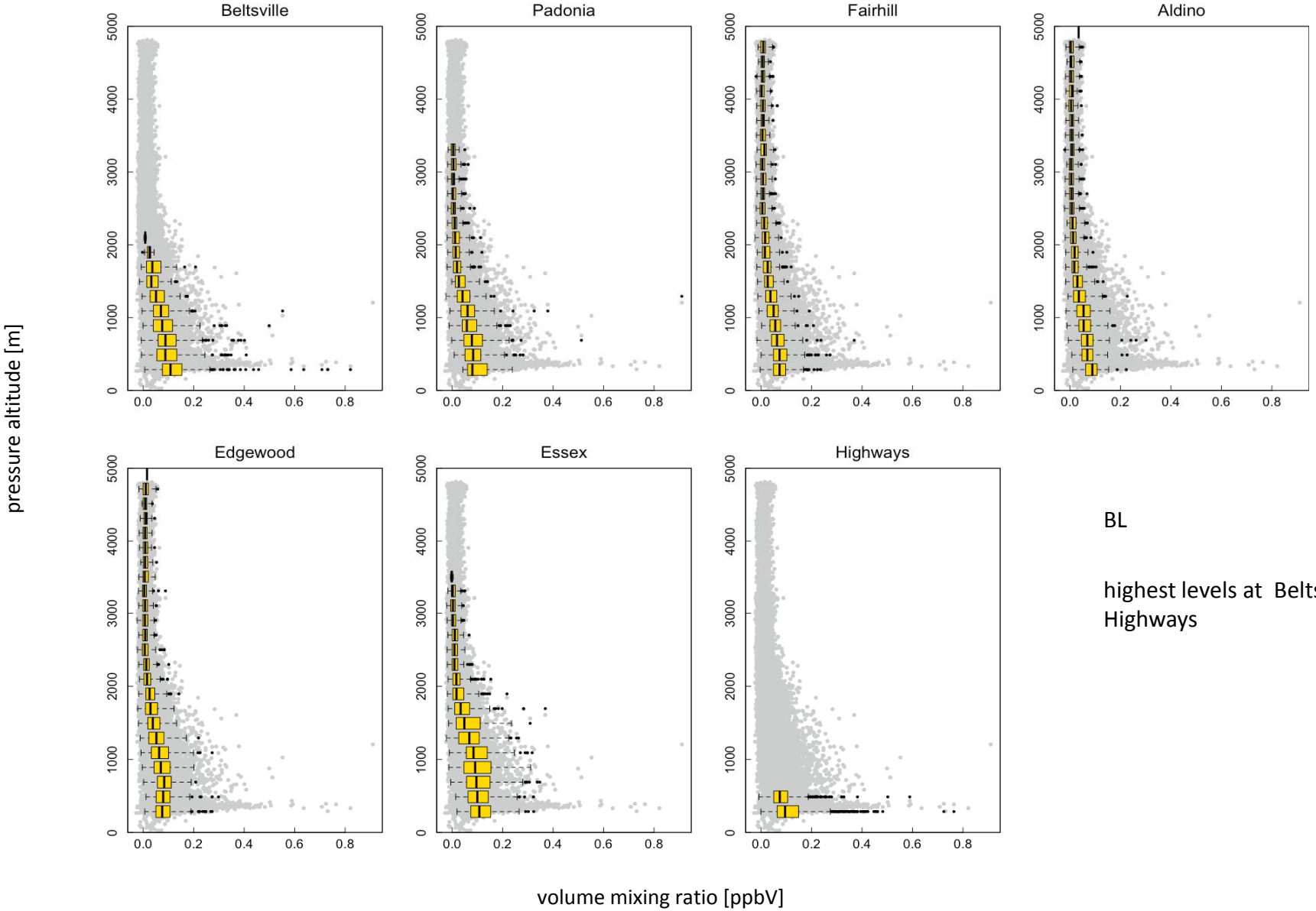
Aromatics

(benzene)

toluene

xylenes + ETB

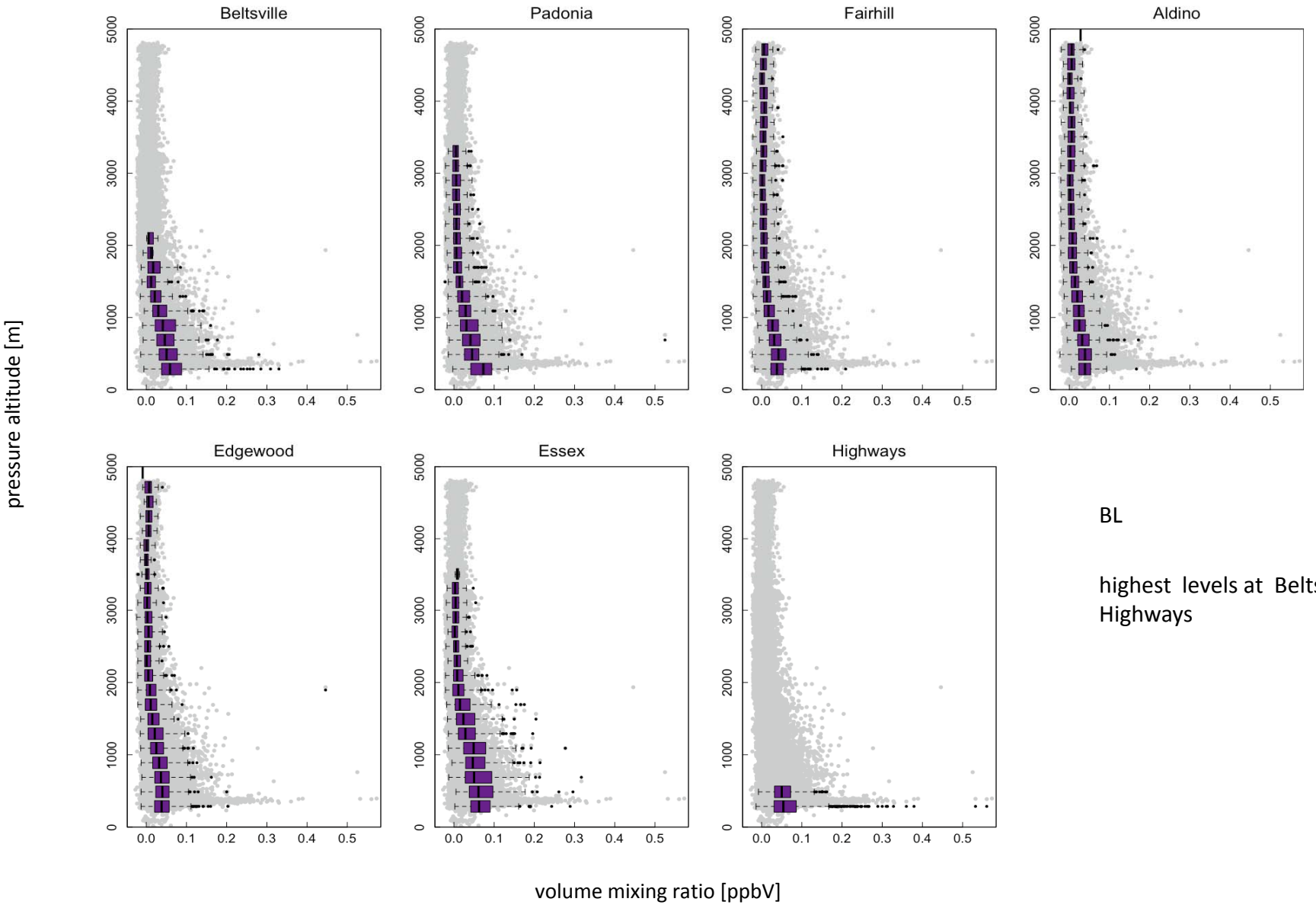
Toluene



BL

highest levels at Beltsville, Highways

Xylenes/ETB



BL

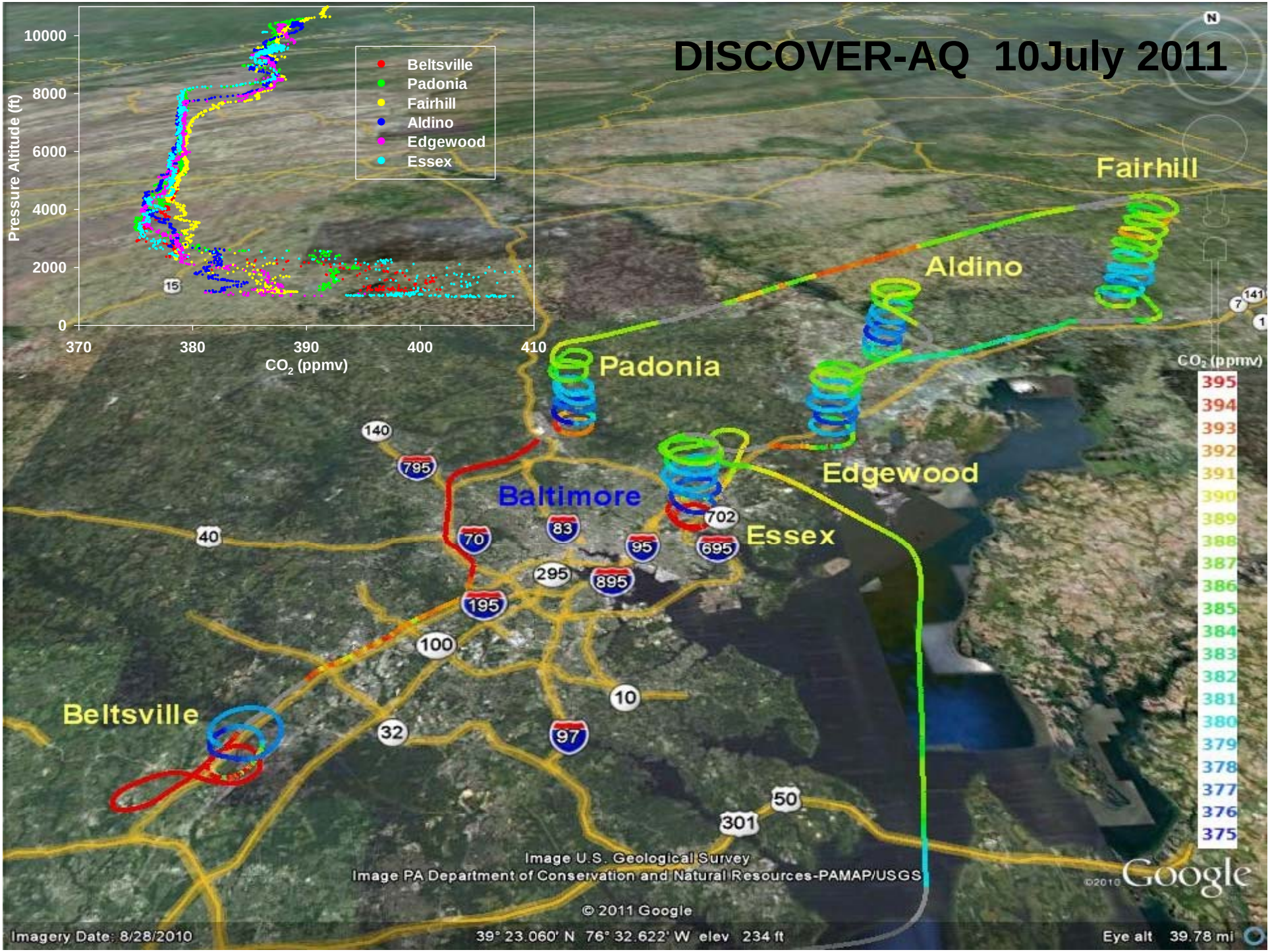
highest levels at Beltsville, Highways

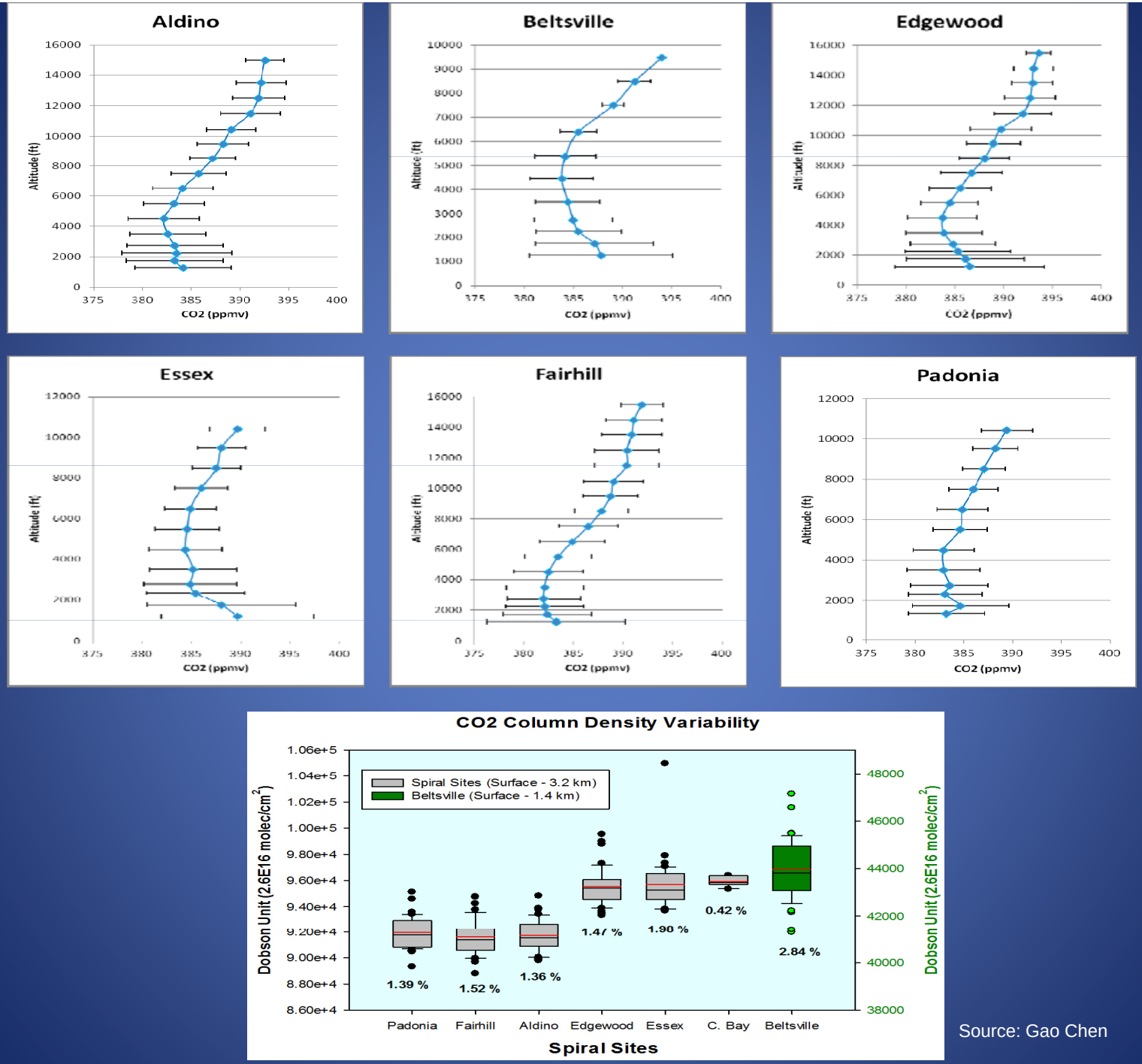
AVOCET - Atmospheric Vertical Observations of CO_2 in the Earth's Troposphere

M. Yang , Y. Choi, S. Vay, A. Aknan, J. Geiger, R. Martin, J. Plant, S. Kooi

High performance capabilities including high precision (<0.1 ppm) and accuracy (±0.25 ppm) traceable to the WMO CO_2 primary scale; fast-response, continuous (1 s), real-time measurements.

Stephanie Retires


DISCOVER-AQ 10July 2011
Pressure Altitude (ft)
10000
8000
6000
4000
2000
0
370
380
390
400
410
CO2 (ppmv)
Beltsville
Padonia
Fairhill
Aldino
Edgewood
Essex
Baltimore
CO2 (ppmv)
395
394
393
392
391
390
389
388
387
386
385
384
383
382
381
380
379
378
377
376
375
Image U.S. Geological Survey
Image PA Department of Conservation and Natural Resources-PAMAP/USGS
© 2011 Google
Imagery Date: 8/28/2010
39° 23.060' N 76° 32.622' W elev 234 ft
Eye alt 39.78 mi



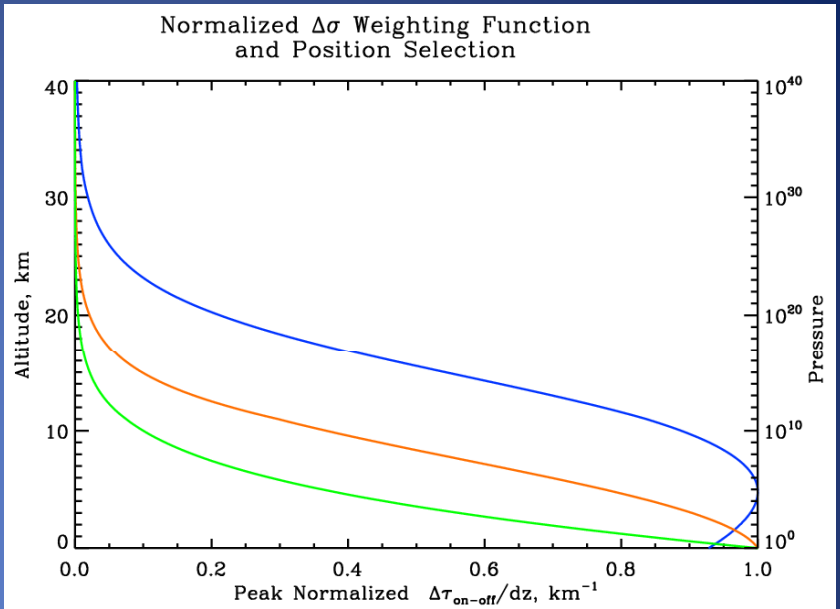
Source: Gao Chen

MID - TROPOSPHERE (1.571111 μm + 3 pm)

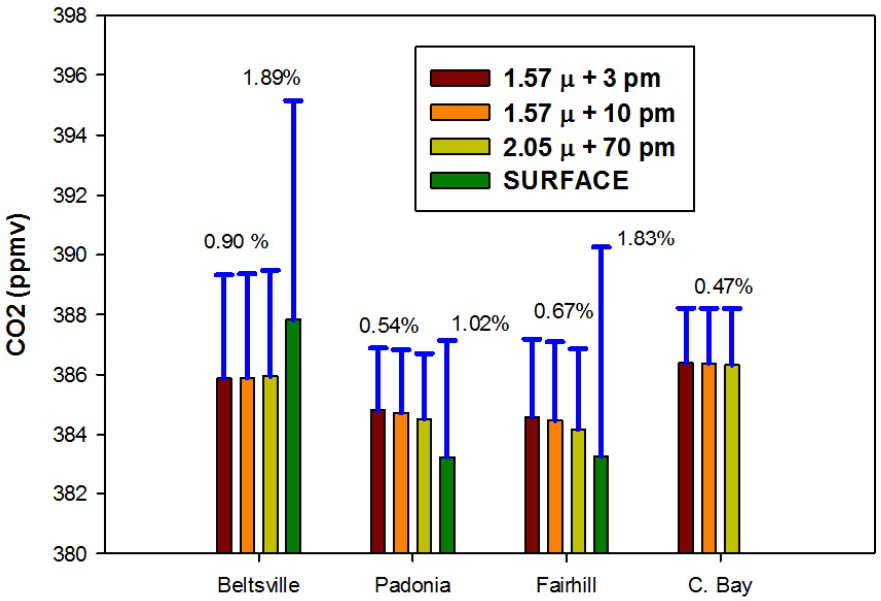
BOUNDARY LAYER (1.571111 μm + 10 pm)

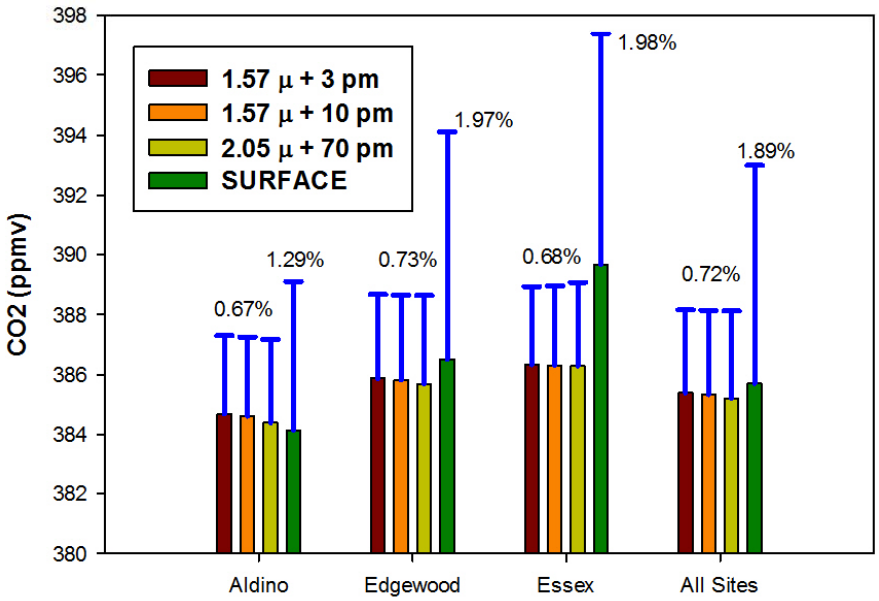
NEAR SURFACE (2.050 μm + 67 pm)

***More details in Yonghoon's poster, "CO_2 variability in lower troposphere over the DC/Baltimore metro area: Insight for future remote CO_2 sensors."

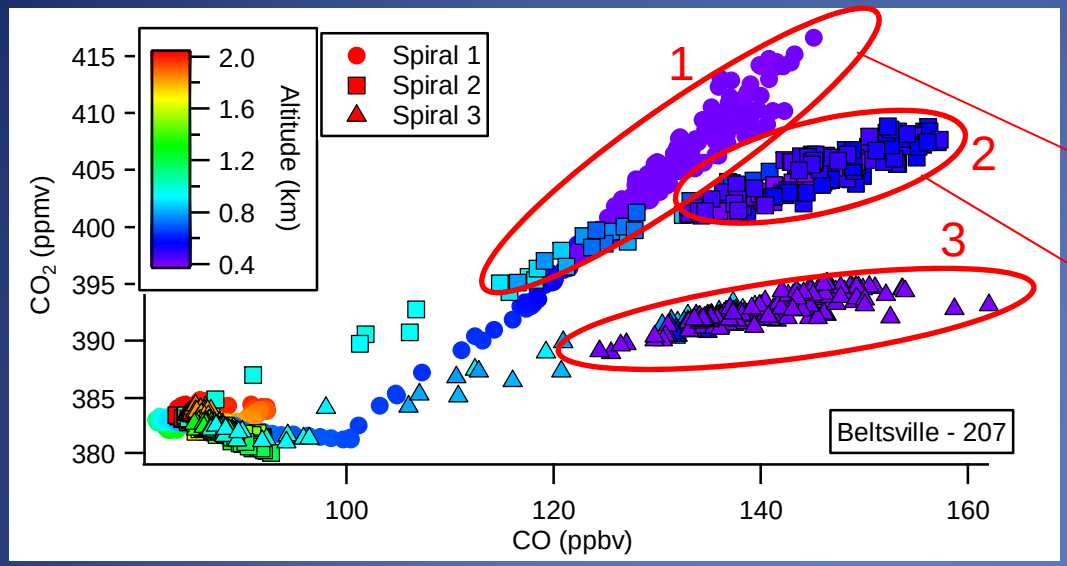


Dry Column Averaged MR using different Weighting Functions

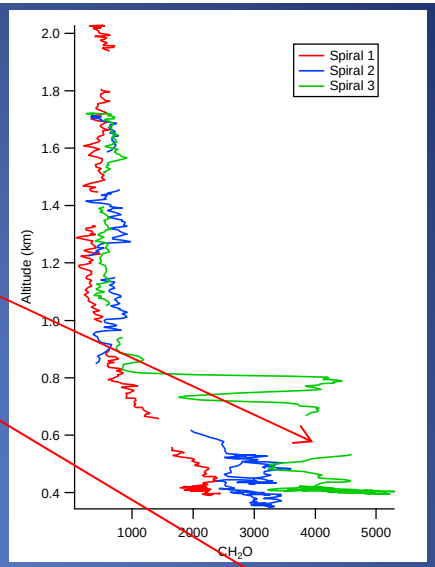




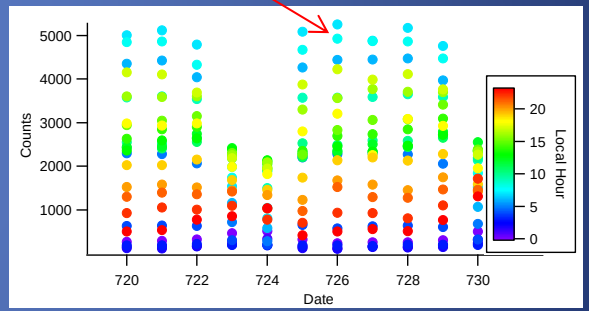
Quantifying Sources and Sinks with CO_2/CO emissions ratio



Source of CO data: Glenn Diskin



Source: Alan Fried



Source: Abhay Nigam - Maryland State Highway Administration; Jennifer Hains - Maryland Department of the Environment

The CO_2/CO emissions ratio varies with the source of CO_2 and provides a characteristic signature of source regions and source types

Correlations	Time of day	CO2/CO slope	Possible sources/sinks
1	0633hr	794.86	Traffic/Power Plant
2	0837hr	321.89	Traffic
3	1047hr	188.01	Respiration from plants