TERC-sponsored Experiments with Baylor Aztec in TexAQS II (2006)

The Experiments

1. Top-down Emissions Verification of HGA Petrochemical Sources (TDEV)

Collaborators:
Chalmers U. SOF van, Baylor Aztec,
TCEQ/UofH Met soundings, NOAA Smart Balloon,
TAMU (Wx forecast) and UAH (planning/coord'n)

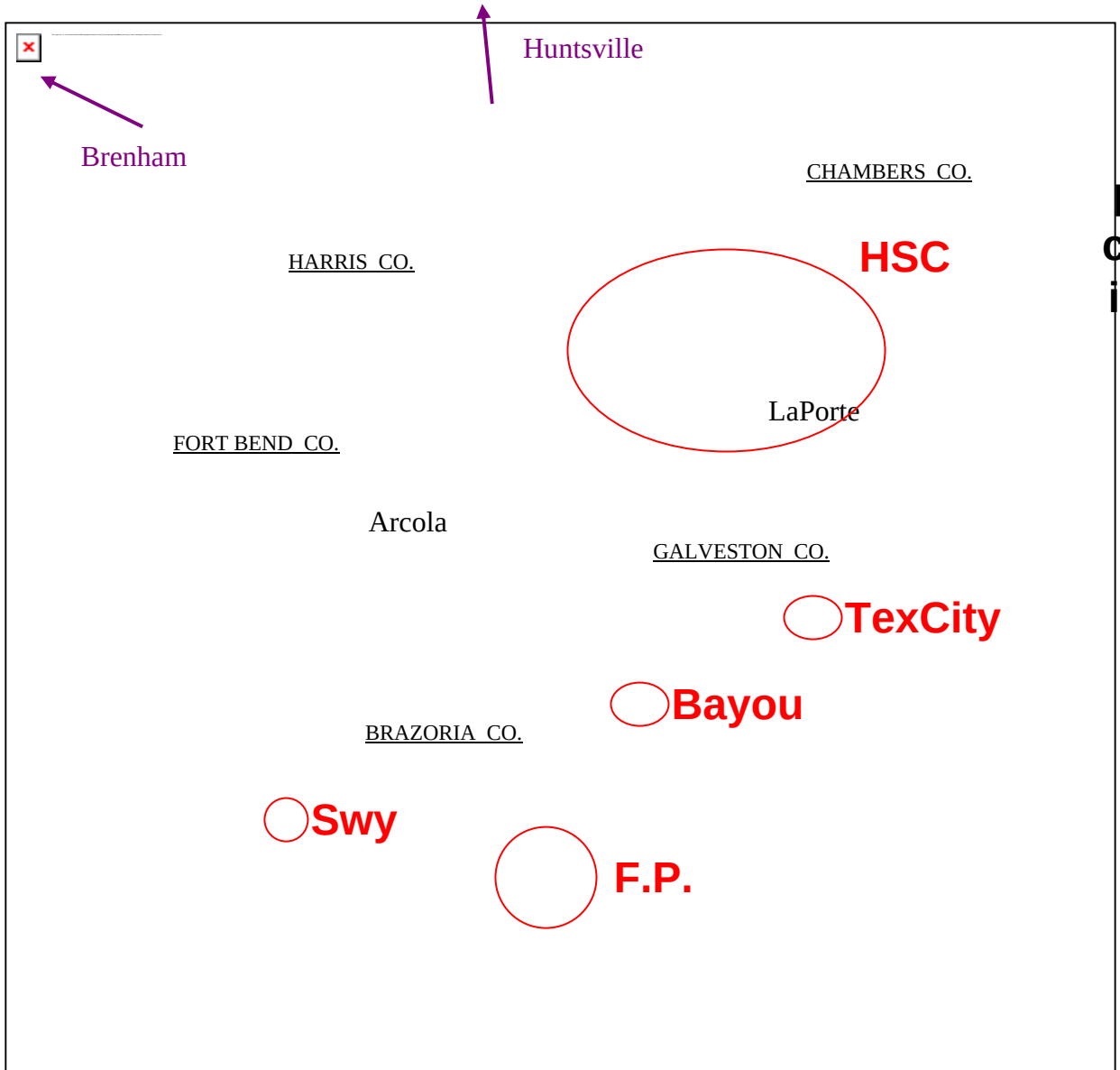
2. Vertical Mixing Experiment (VME)

Collaborators:
Baylor Aztec, TCEQ/UH Chem and Met soundings,
UAH (co-ord'n)

3. Stationary Front Experiment (SFE)

Collaborators:
Baylor Aztec, UAH (planning/coord'n)

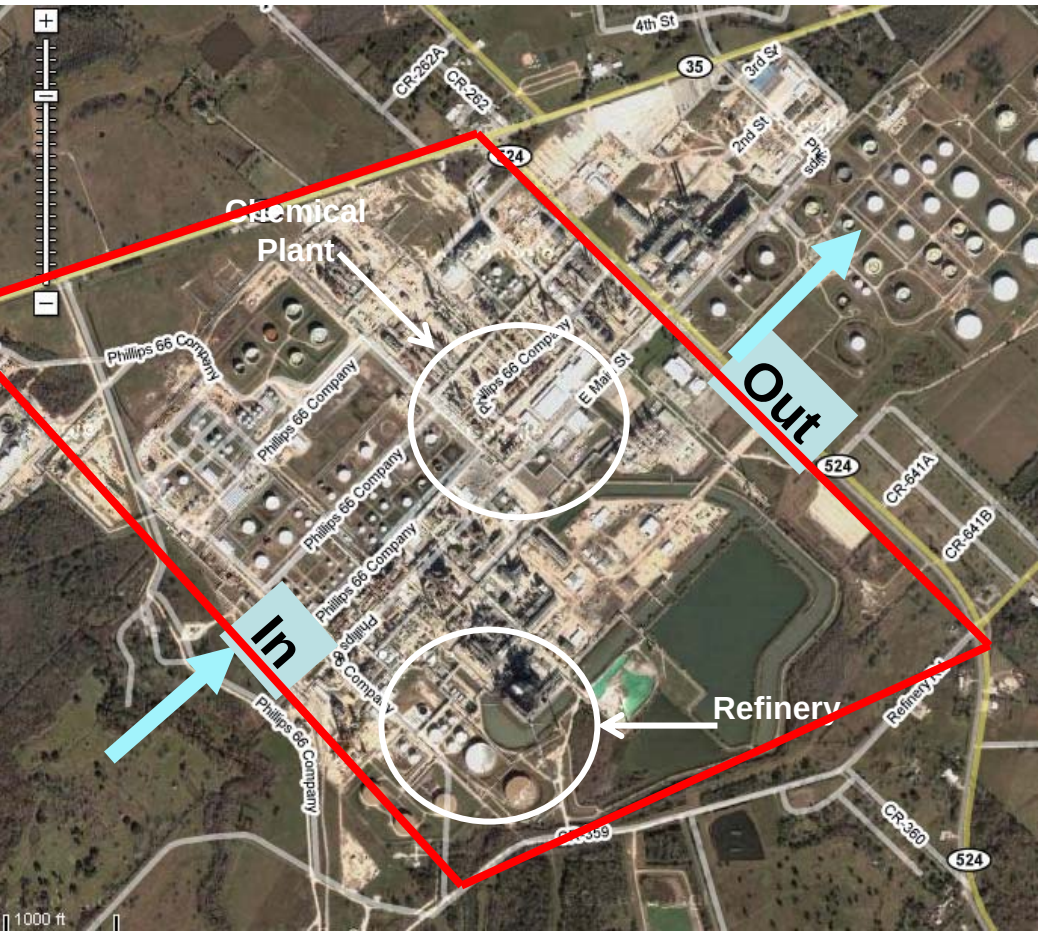
TDEV Objectives: **1) To determine emissions from petrochemical sources by TDEV experiments**
2) To determine ozone production from these emissions based on measurements/diagnostic modeling
3) To determine HCHO primary emissions and secondary formations from these emissions, based on measurements/diagnostic modeling



Houston-Galveston petrochemical source complexes aggregated into 37 sources in this map.

The TDEV Experiment : Concept

The Sweeny Complex



Similarly,
Ship channel, Texas City, Free Port, Sweeny

Mass Balance

$$\dot{m}_{in} + \dot{m}_{emis} - \dot{m}_{depl} = \dot{m}_{out}$$

$$\therefore \dot{m}_{emis} = \underbrace{(\dot{m}_{out} - \dot{m}_{in})}_{\text{Empirical}} + \dot{m}_{depl}$$

Hi-res Model (e.g., LESchem)

$$\dot{m}_j(x) = \iint_{plane} uc_j\,dydz = \int_y uB_j\,dy \sim \bar{u}\int_y B_j\,dy$$

where, $c_j = c_j(x,y,z)$ = species conc'n,

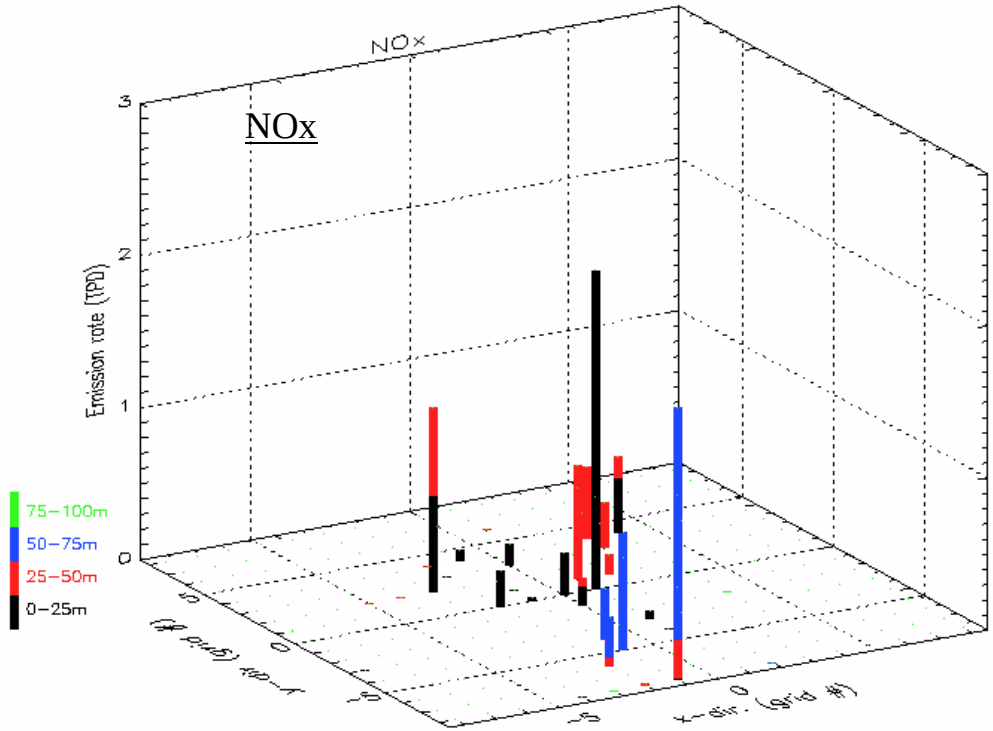
$$B_j(y) = \int_z c_j\,dz \quad \text{(SOF meas't)}$$

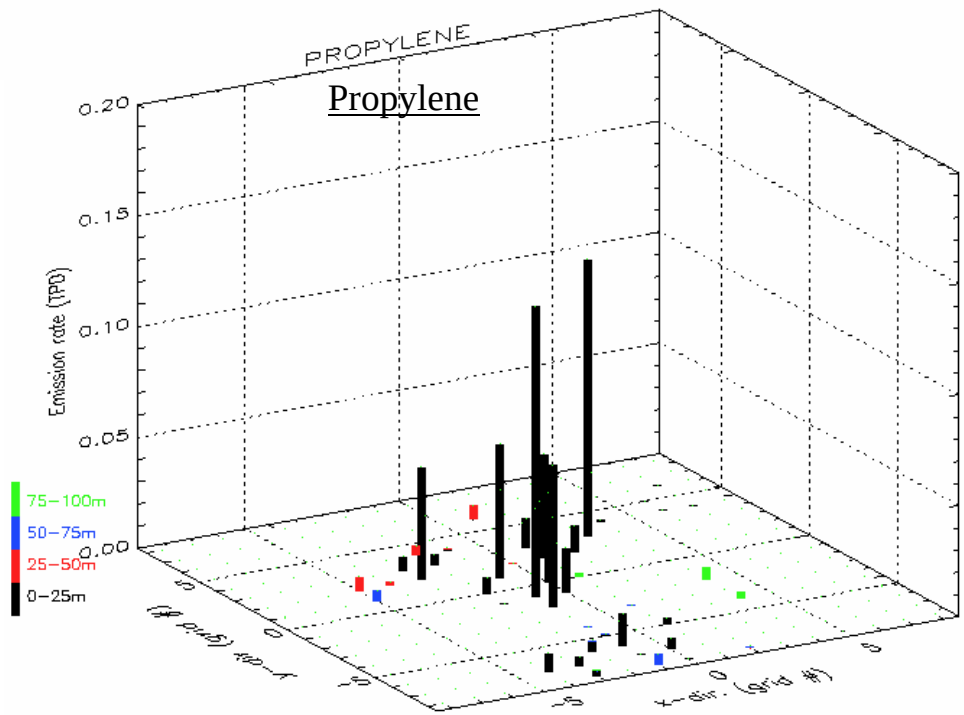
Main challenges

1. **Capture all mass: → SOF →** B_j
2. **Mass-weighted U: Soundings, Aztec** $\overline{U}$

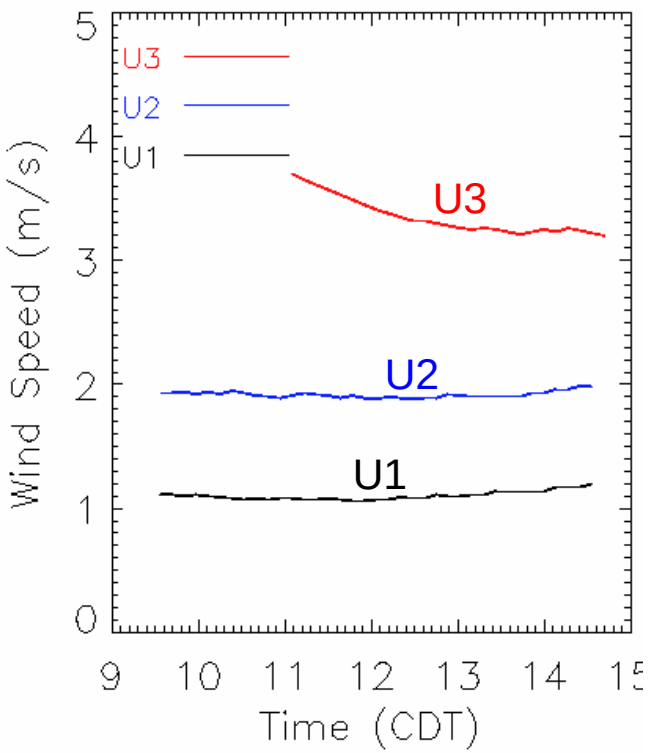
Sweeny

Spatial Distribution
and
Emission Heights
of
NOx and Propylene Sources





LESchem simulation
Sweeny plume, 8/28/2000
(t = 2h after continuous emission)



X-Y plane

Emission
@ x = 1km

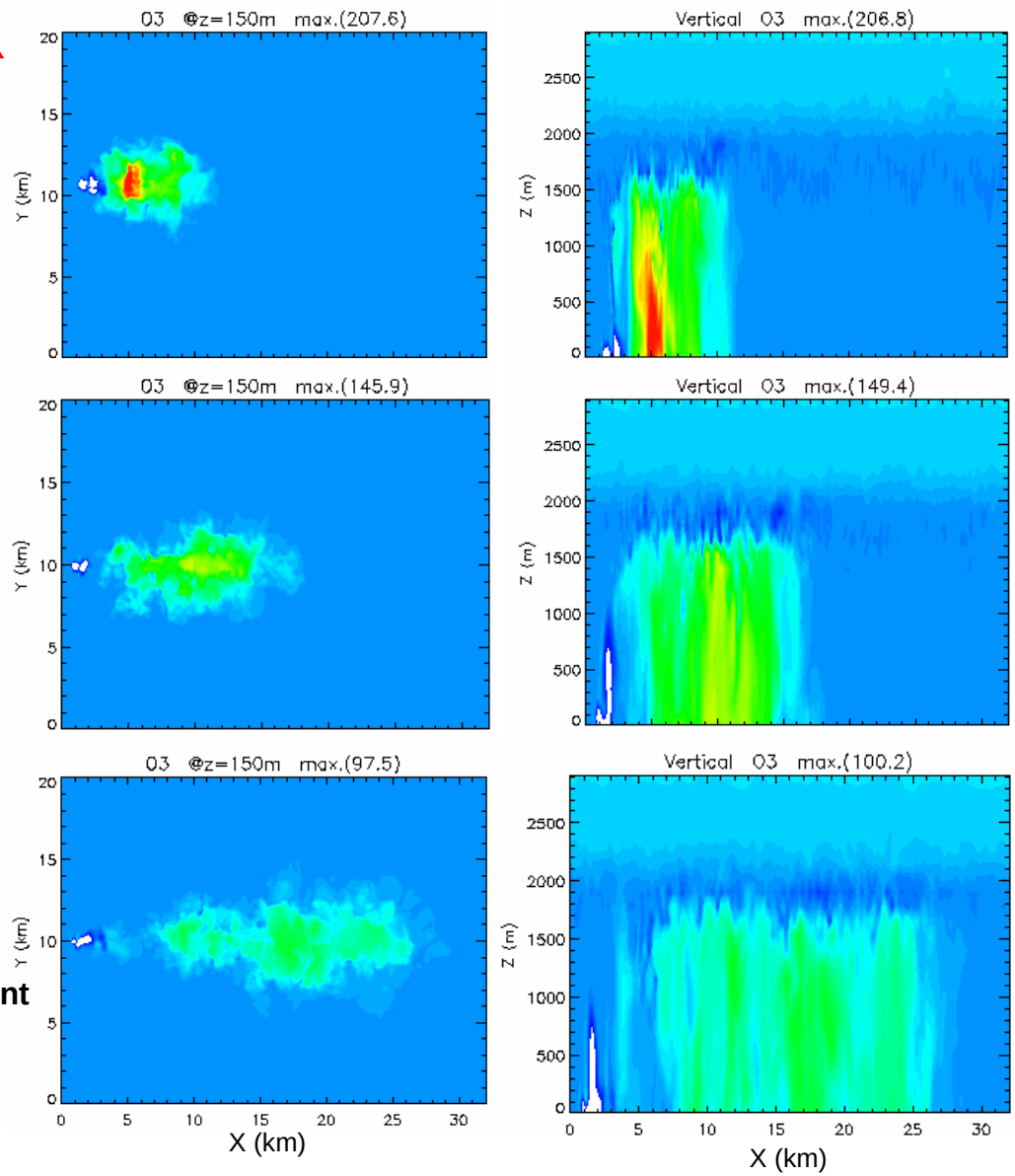
X-Z plane

U1

U2

U3

The measurement scenario



Plume ozone peaks at plume age of just over 1 hour in all three scenarios

The PLATFORMS

Baylor Aztec

Hours

30 (TDEV)
10 (VM)
10 (SF)
→ 50

Cruise
90 kn (~2.7 km/min)
7h (pref. 5-6h max)

Spiral
250 – 500 fpm

Cont. measts.
NO/NO2/NOy,
CO, RAD, SO2,
O3, HCHO, 3λ-Nephy

p, T, RH, WS/WD,
GPS

Batch-mode
VOC canister

SOF Van

Cont. measts.

Solar rad'n
absorp'n spectra
(w/ solar tracking)
of VOC etc species
including …

Ethylene
Propylene
Aldehydes
other VOCs

and

SO2, NO2, NH3,
HF, HCL, …

Measurement is of
overhead
column-integrated
concentration

Moody Tower

Instruments

Ground
T,p,RH, WS,WD,Rain
NOy, O3, Canister

Top (73m)
T,p,RH, WS,WD,Rain
NOy, O3,
autoGC, PTR-MS,
Canister

+

O3, SO2, NO2, HONO, HCHO
vert. profiles via Max-DOAS

Met Soundings

Profilers
LaPorte, Arcola,
HSV, Brenham

Sondes
Tether-S: T, p, RH, WS/WD
Radio-S: UH (2-6pd)
Mobile Mini: SOF van
GPS Mini:00Z + 12Z
+ additional
O3-Sonde: UH (13 LT)

SODARs
UH (T,p,RH, WS,WD,Rain)
UH-CRC

Aircraft
Aztec (p,T,RH, WS/WD)

The Experiments

8/21/06	Stationary	103323 – 133441 (3h 01min)
8/22/06	Front	103210 – 132248 (2h 50min)
		(5h 51min)

DATE	TDEV PLUMES	TIME(S)
1. 8/30/06	Hou. Ship Channel	am: 085843 – 110615 (2h 8min)
		pm: 141203 – 162024 (2h 8min)
2. 8/31/06	HSC	am: 074552 – 103154 (2h 46min)
		pm: 141851 – 161818 (2h 00min)
3. 9/13/06	HSC	am: 074953 – 123539 (4h 46min)
		pm: 144641 – 191745 (4h 31min)
4. 9/20/06	Tx City , Bayou, FP , Sw	081416 – 134414 (5h 30min)
5. 9/27/06	Sweeny	121327 – 173422 (5h 21min)
		(29h 10min)

10/05/06	VME	094708 – 151550 (5h 29min)
		(40 h 20min)

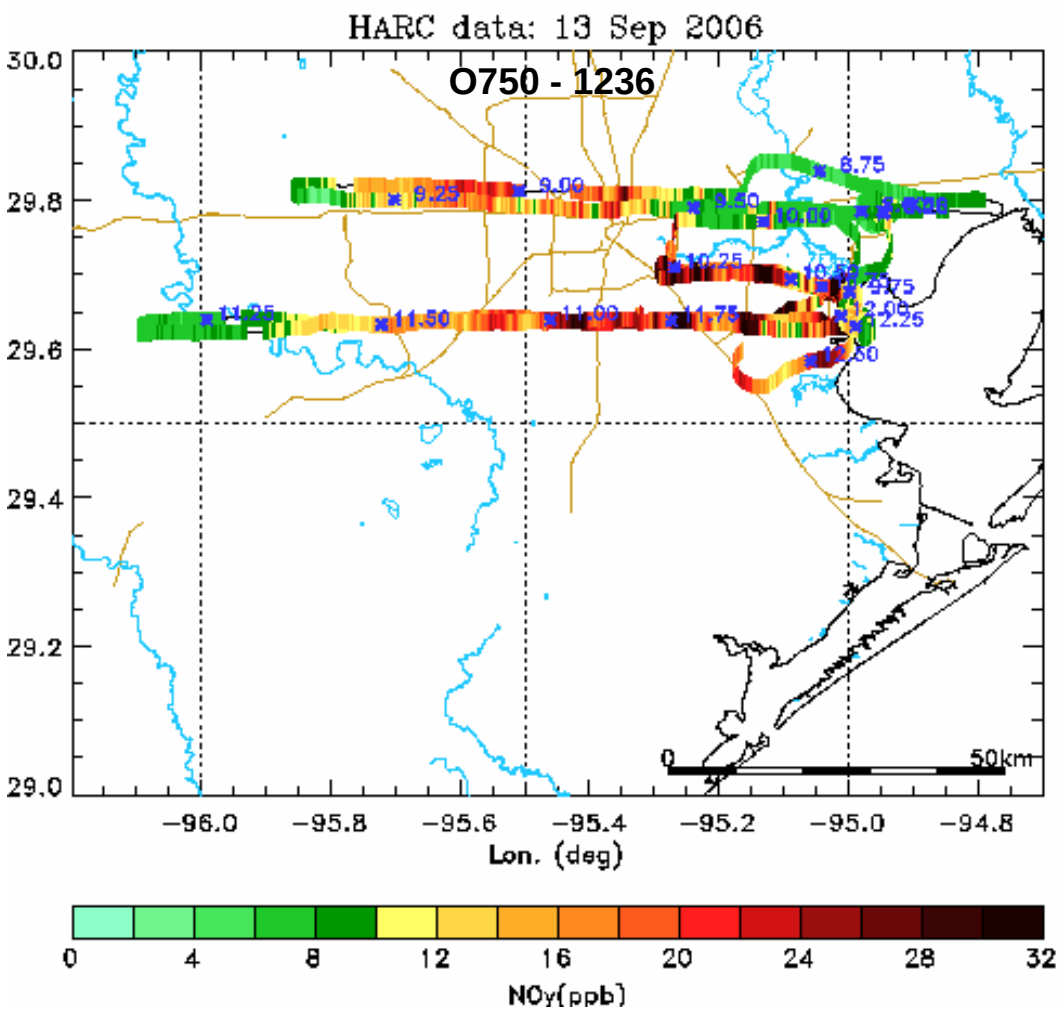
Houston Ship Channel (HSC) TDEV & Plume Transport Mission Plan for Wed 13 Sep 2006

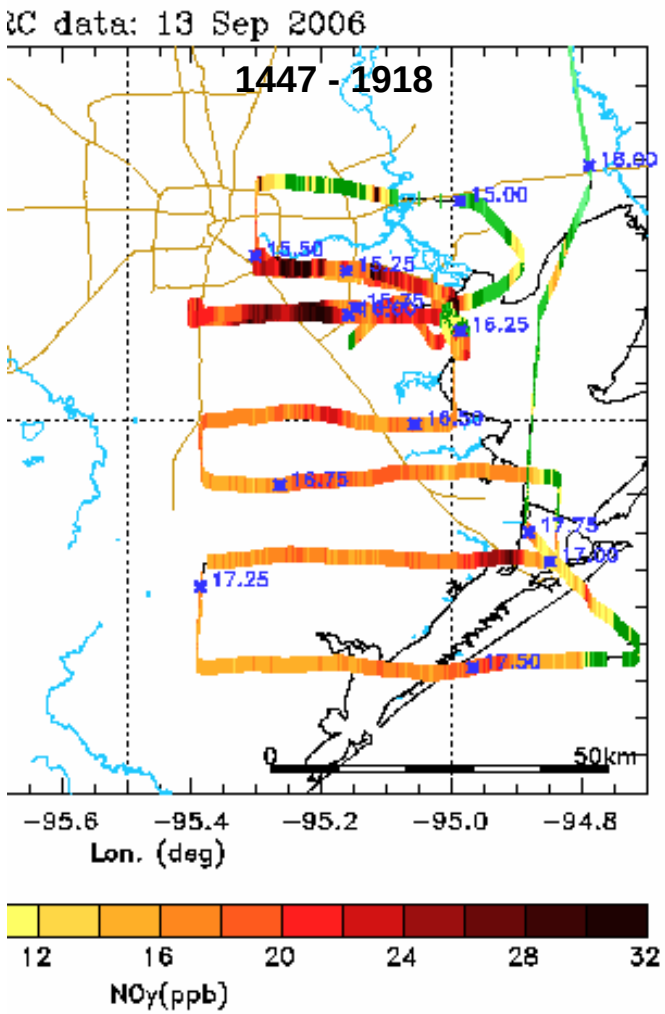
Collaborators

SOF van, Baylor Aztec, NOAA Smart Balloon, UH Met Team

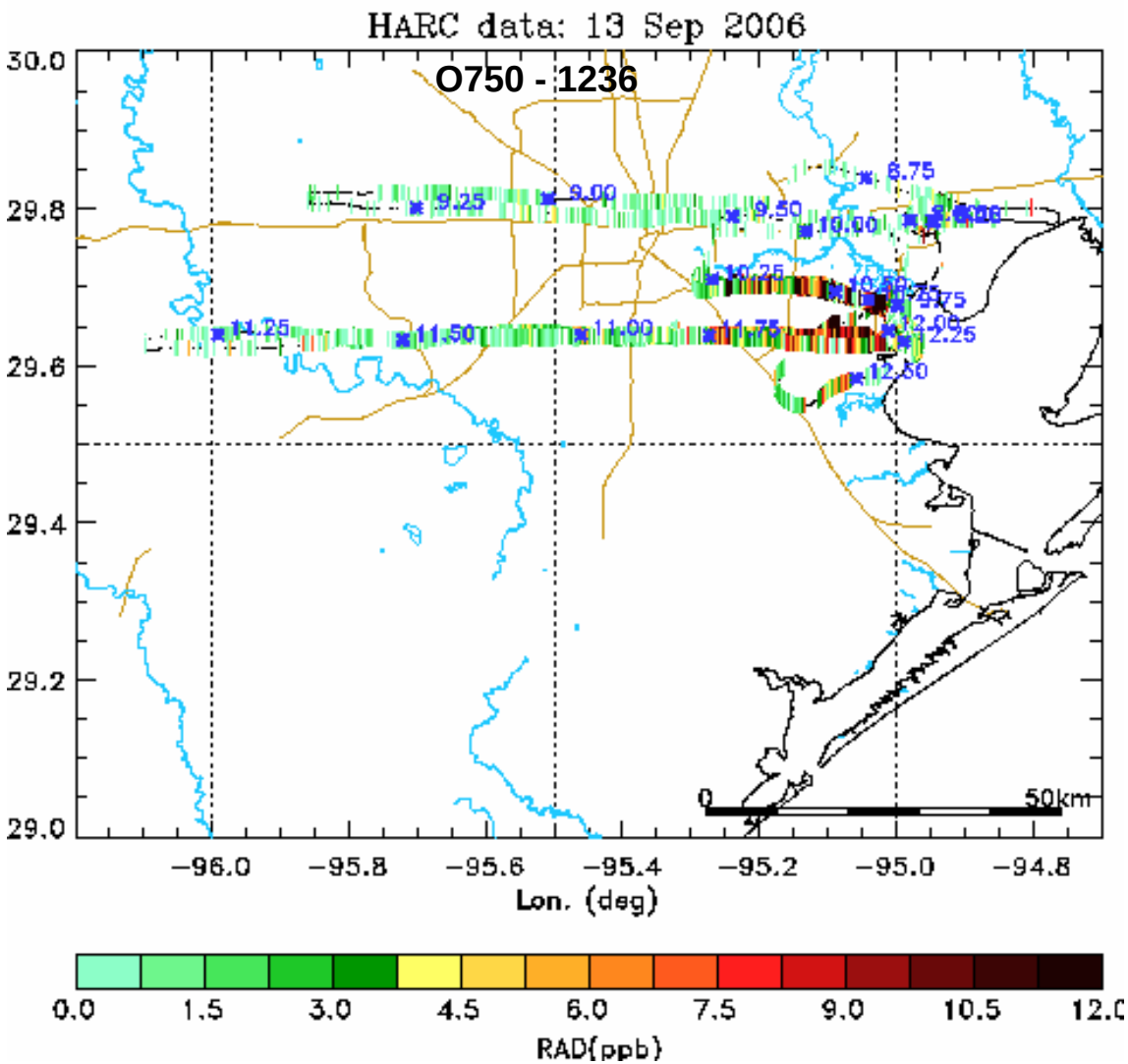
9/13/06 NOAA Smart Balloon Path

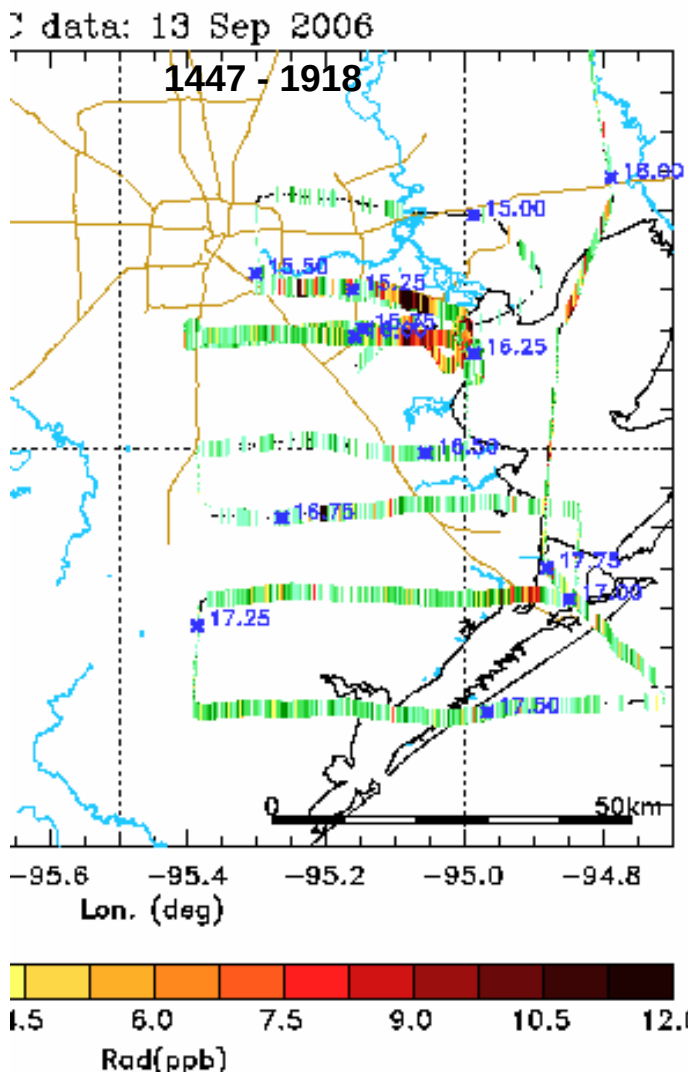
9/13/06


HARC data: 13 Sep 2006
O750 - 1236
30.0
29.8
29.6
29.4
29.2
29.0
−96.0
−95.8
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
0
50km
0
4
8
12
16
20
24
28
32
NOy(ppb)

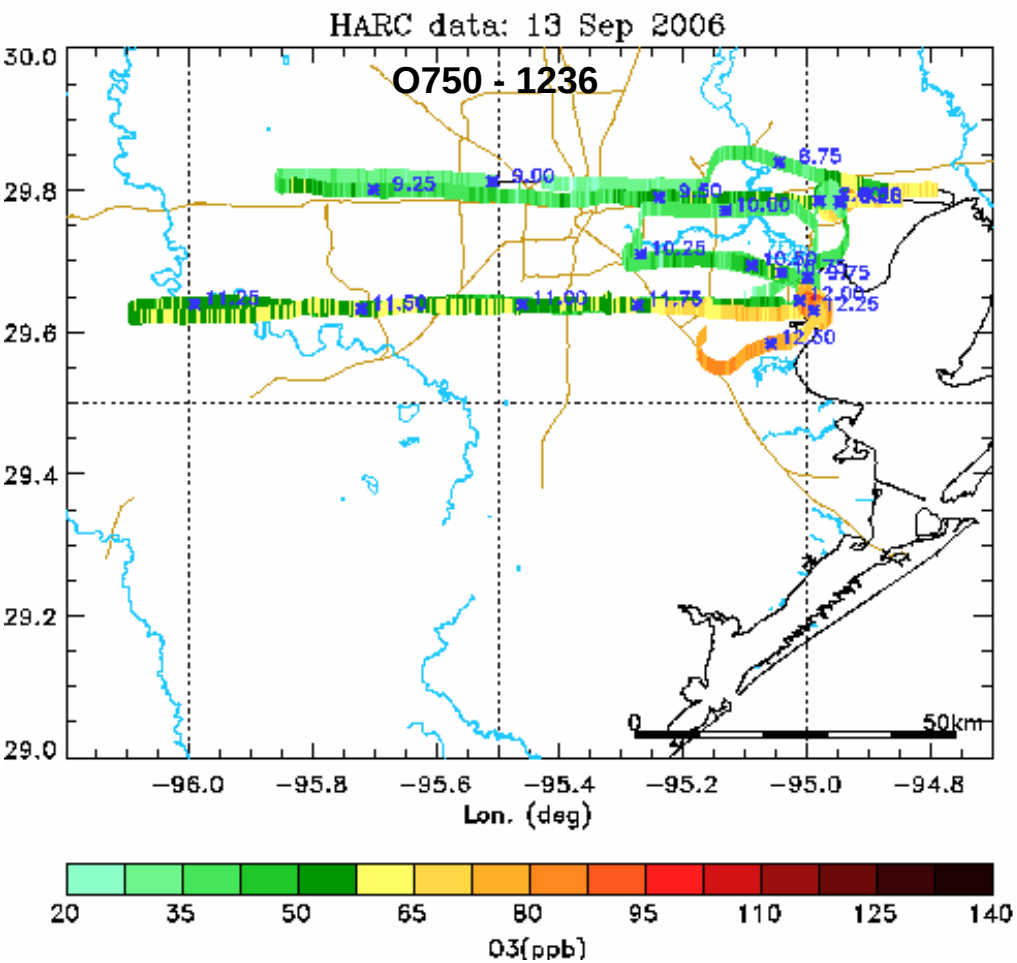

C data: 13 Sep 2006
1447 - 1918
15.00
15.50
15.25
16.25
16.75
17.25
17.50
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
0
50km
12
16
20
24
28
32
NOy(ppb)

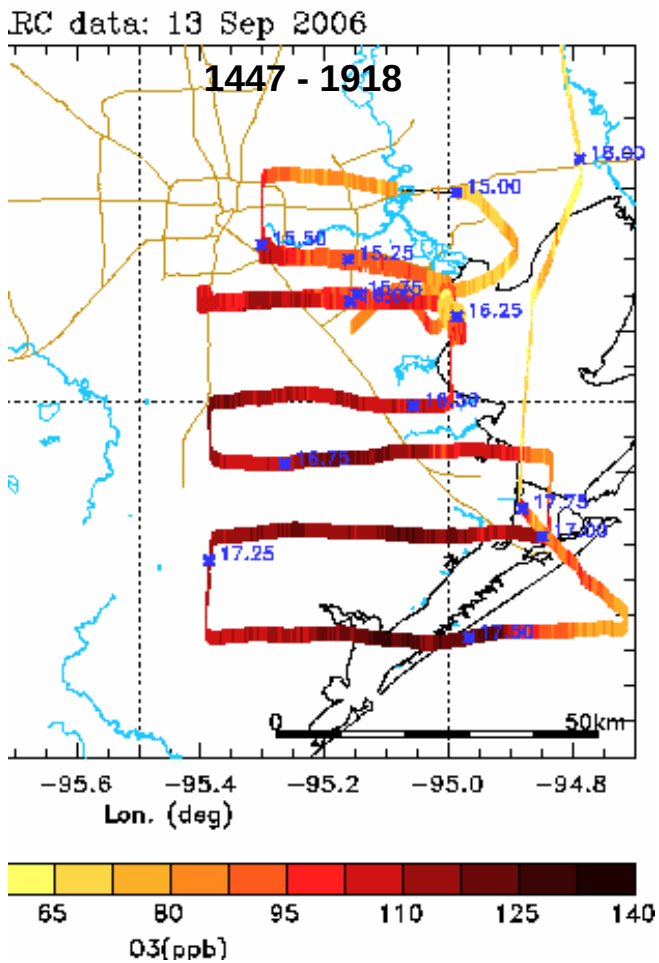
9/13/06


HARC data: 13 Sep 2006
O750 - 1236
30.0
29.8
29.6
29.4
29.2
29.0
9.25
9.00
9.50
10.00
6.75
14.25
11.50
11.00
12.50
12.25
0
50km
−96.0
−95.8
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
0.0
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
RAD(ppb)

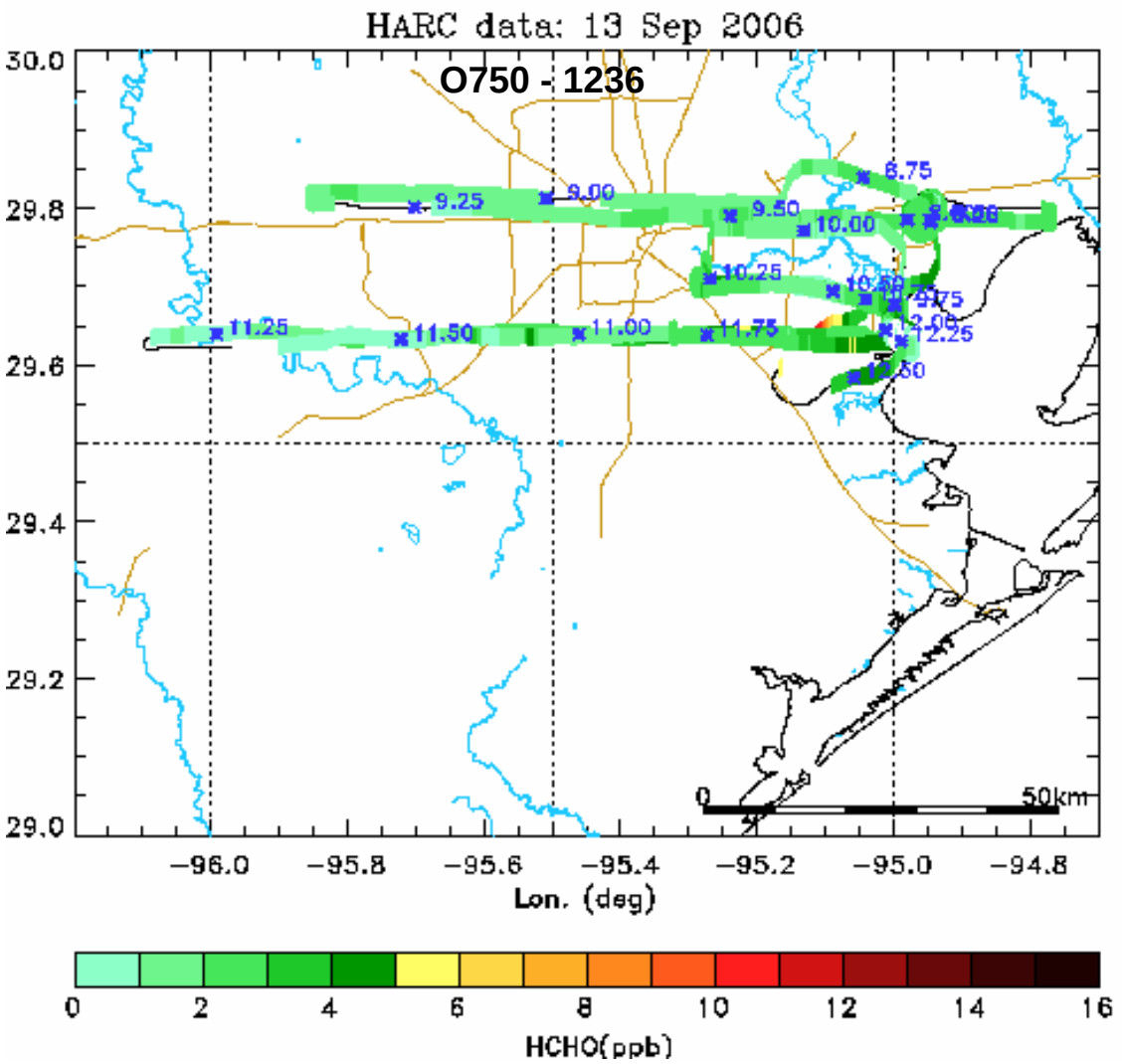

data: 13 Sep 2006
1447 - 1918
15.00
16.25
17.25
0
50km
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
6.0
7.5
9.0
10.5
Rad(ppb)

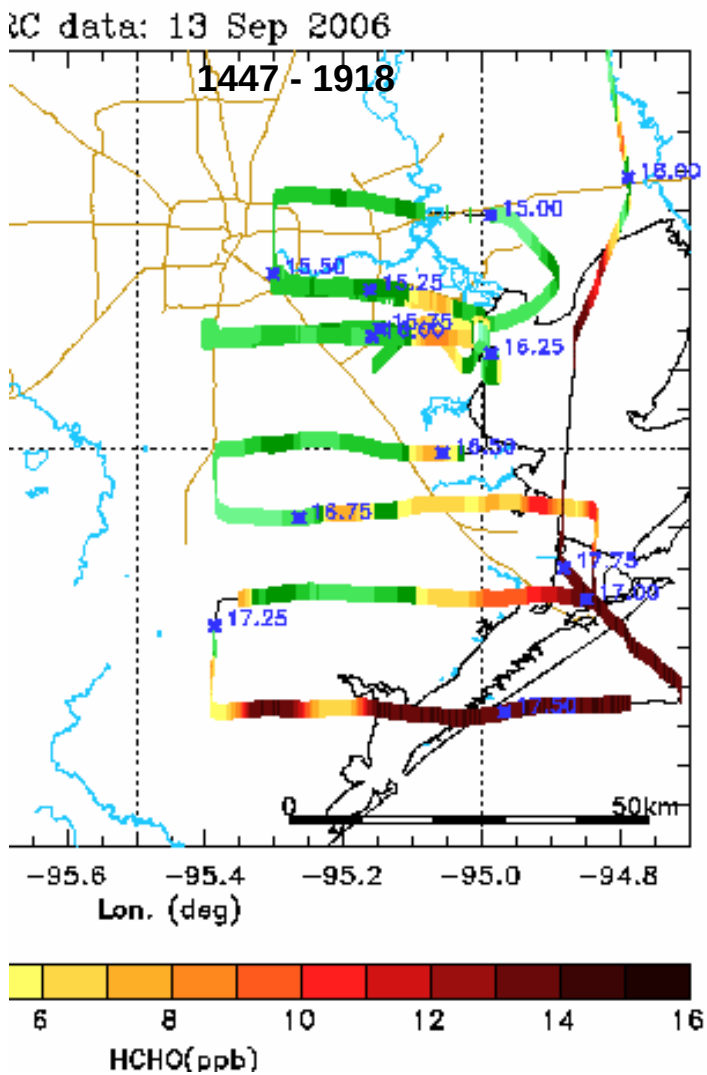
9/13/06


HARC data: 13 Sep 2006
O750 - 1236
30.0
29.8
29.6
29.4
29.2
29.0
9.25
9.00
9.50
10.00
10.25
10.50
10.75
11.00
11.25
11.50
11.75
12.00
12.25
12.50
8.75
0
50km
−96.0
−95.8
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
20
35
50
65
80
95
110
125
140
O3(ppb)

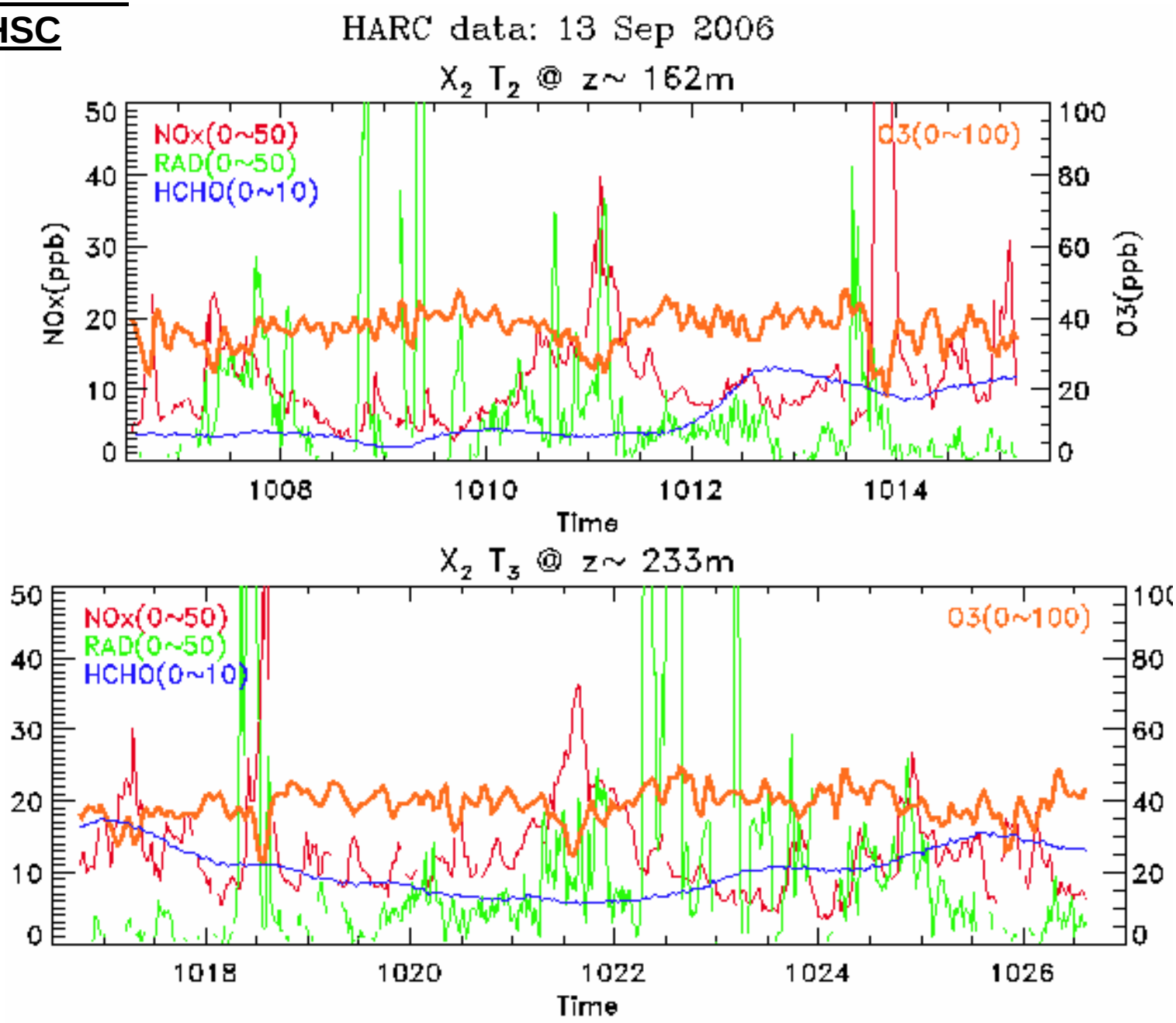

RC data: 13 Sep 2006
1447 - 1918
15.00
15.50
15.25
16.25
17.25
0
50km
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
65
80
95
110
125
140
O3(ppb)

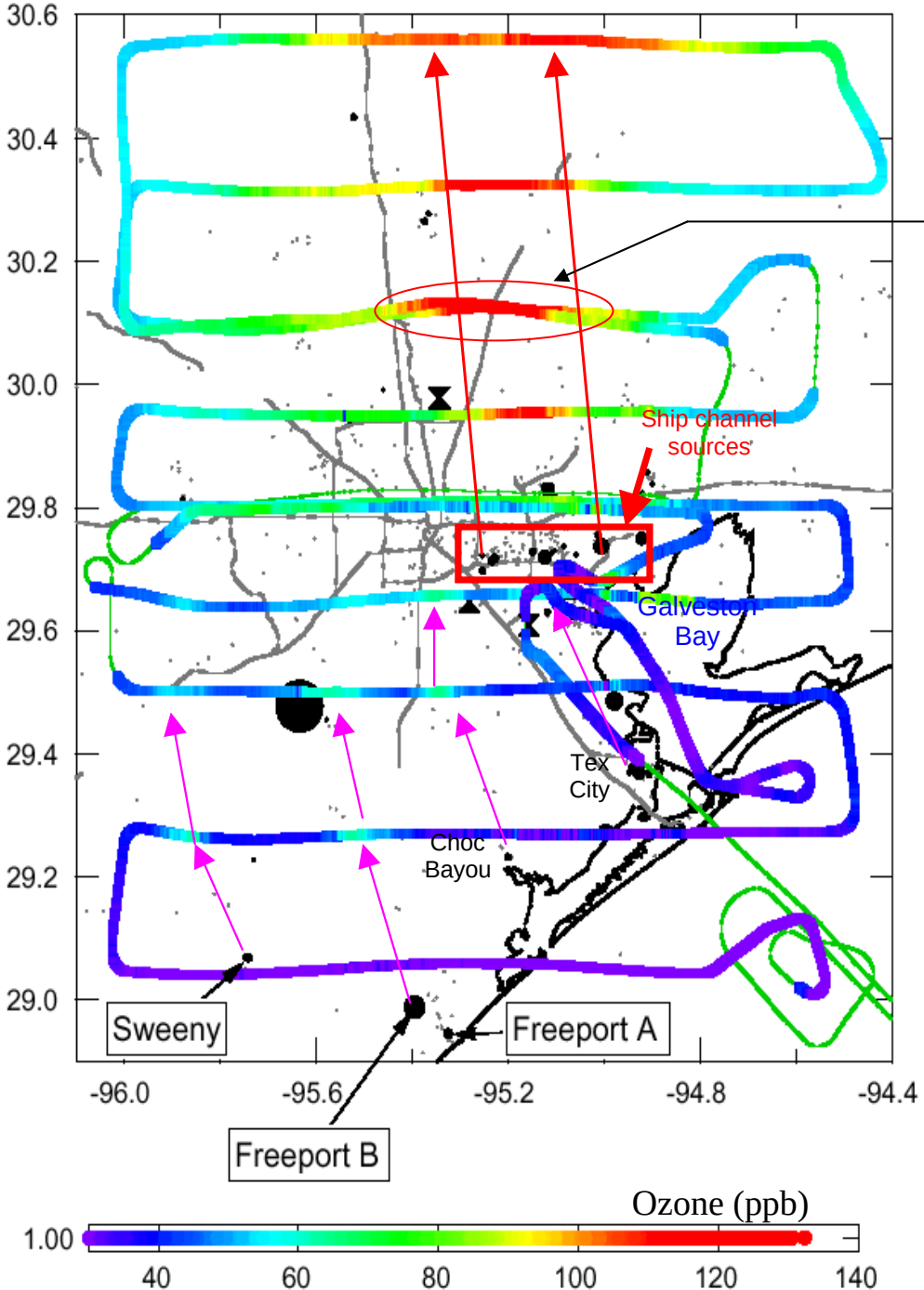
9/13/06


HARC data: 13 Sep 2006
O750 - 1236
30.0
29.8
29.6
29.4
29.2
29.0
9.25
9.00
9.50
10.00
6.75
10.25
11.25
11.50
11.00
11.75
12.25
0
50km
−96.0
−95.8
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
0
2
4
6
8
10
12
14
16
HCHO(ppb)


2C data: 13 Sep 2006
1447 - 1918
15.00
15.50
15.25
16.25
16.75
17.25
0
50km
−95.6
−95.4
−95.2
−95.0
−94.8
Lon. (deg)
6
8
10
12
14
16
HCHO(ppb)

Just downwind of HSC



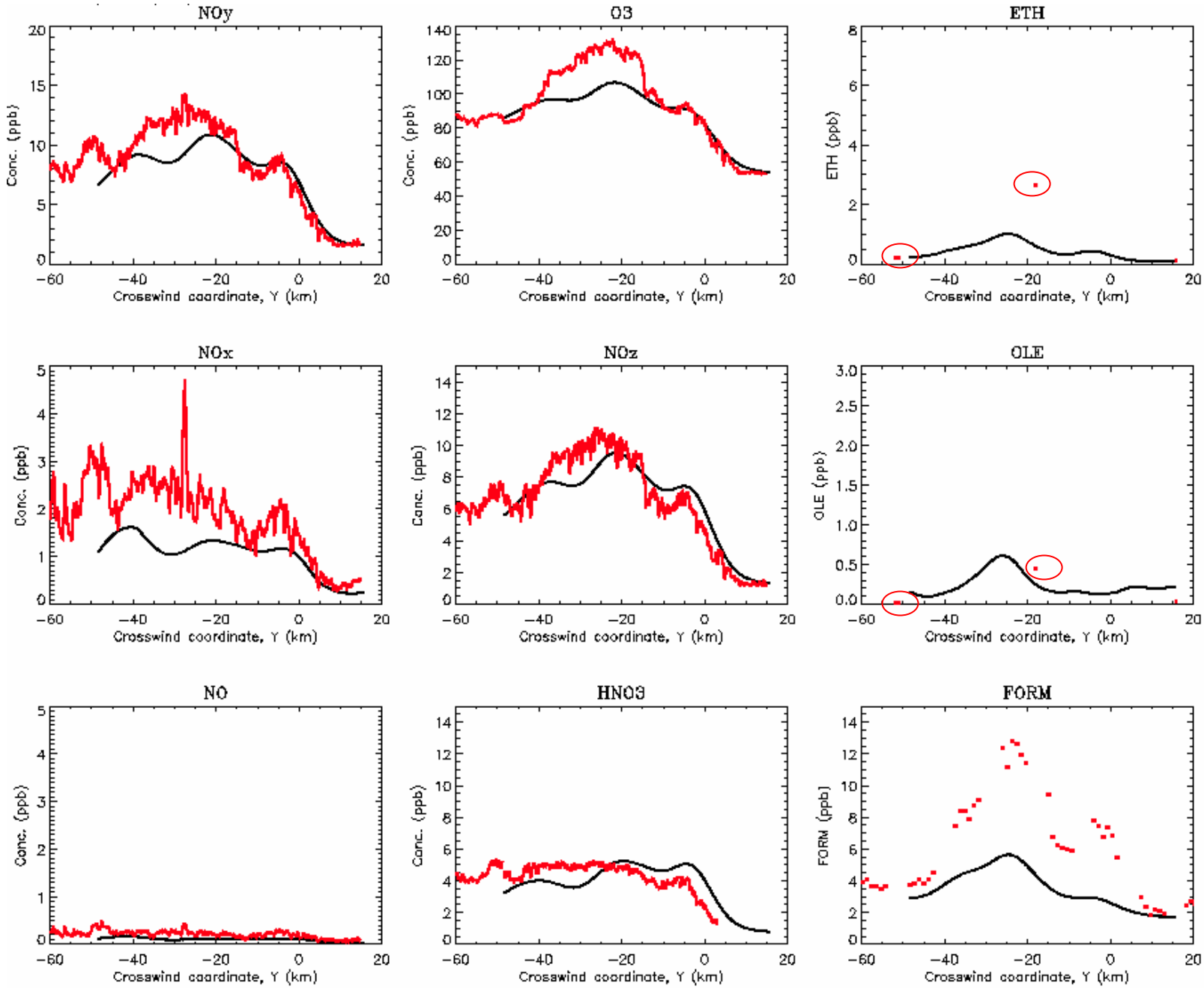


X ~ 50 km

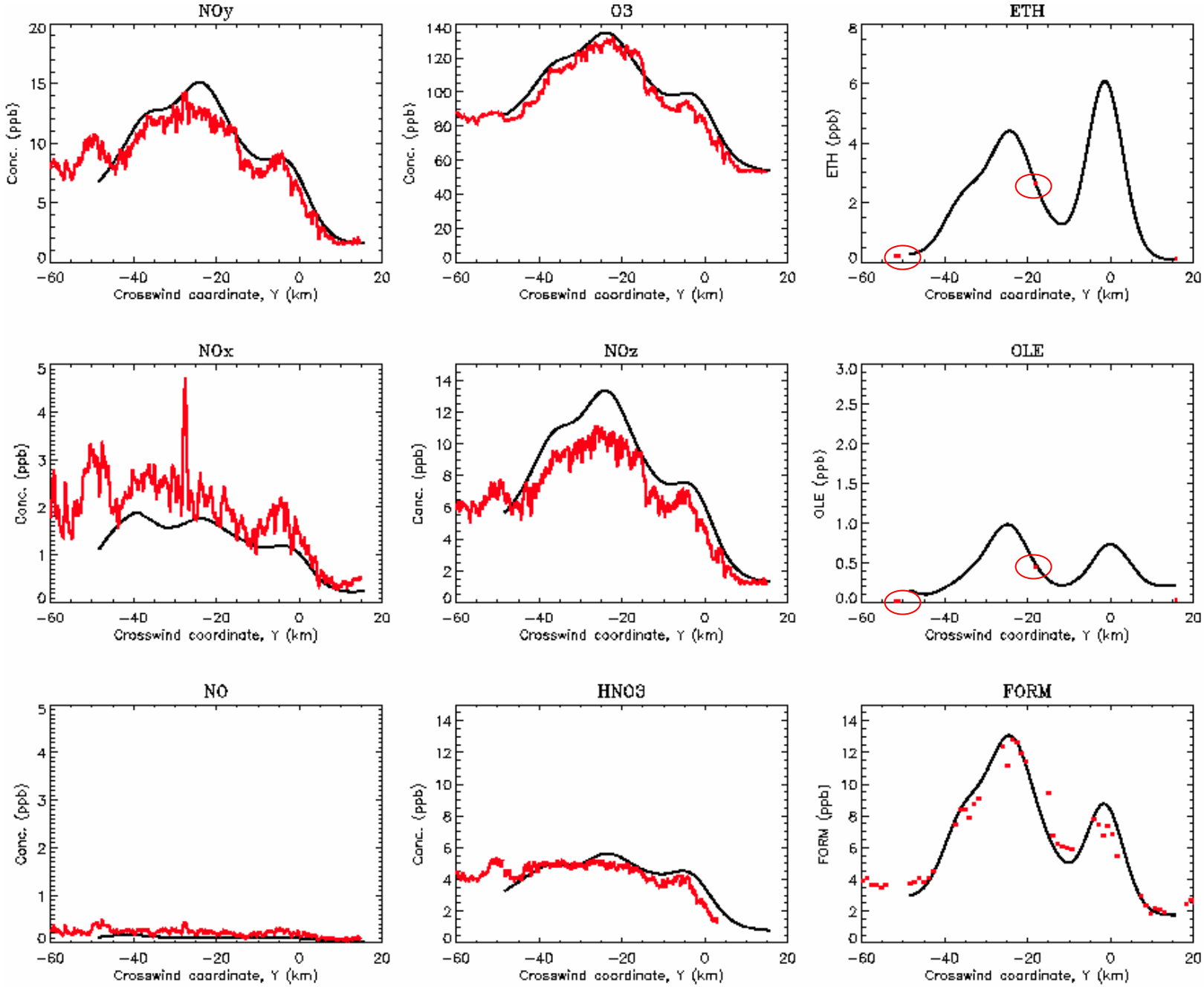
A "Good" Measurement Scenario

(28 Aug 2000, NCAR Electra Mission)

Simulation based on Emission Inventory Emissions at X = 50 km (LRPM)



Simulation based on “Corrected” Emissions at X = 50 km (LRPM)



Analysis can include:

1. **LES-chem in the near field to characterize actual emissions based on SOF data and aircraft data**

2. **LRPM farther downwind to check secondary products formation, including O3, NOz, and HCHO (and H2O2/HNO3 for ozone sensitivity analysis)**

3. **LRPM analysis can also explore O3 Production Efficiency calculations**