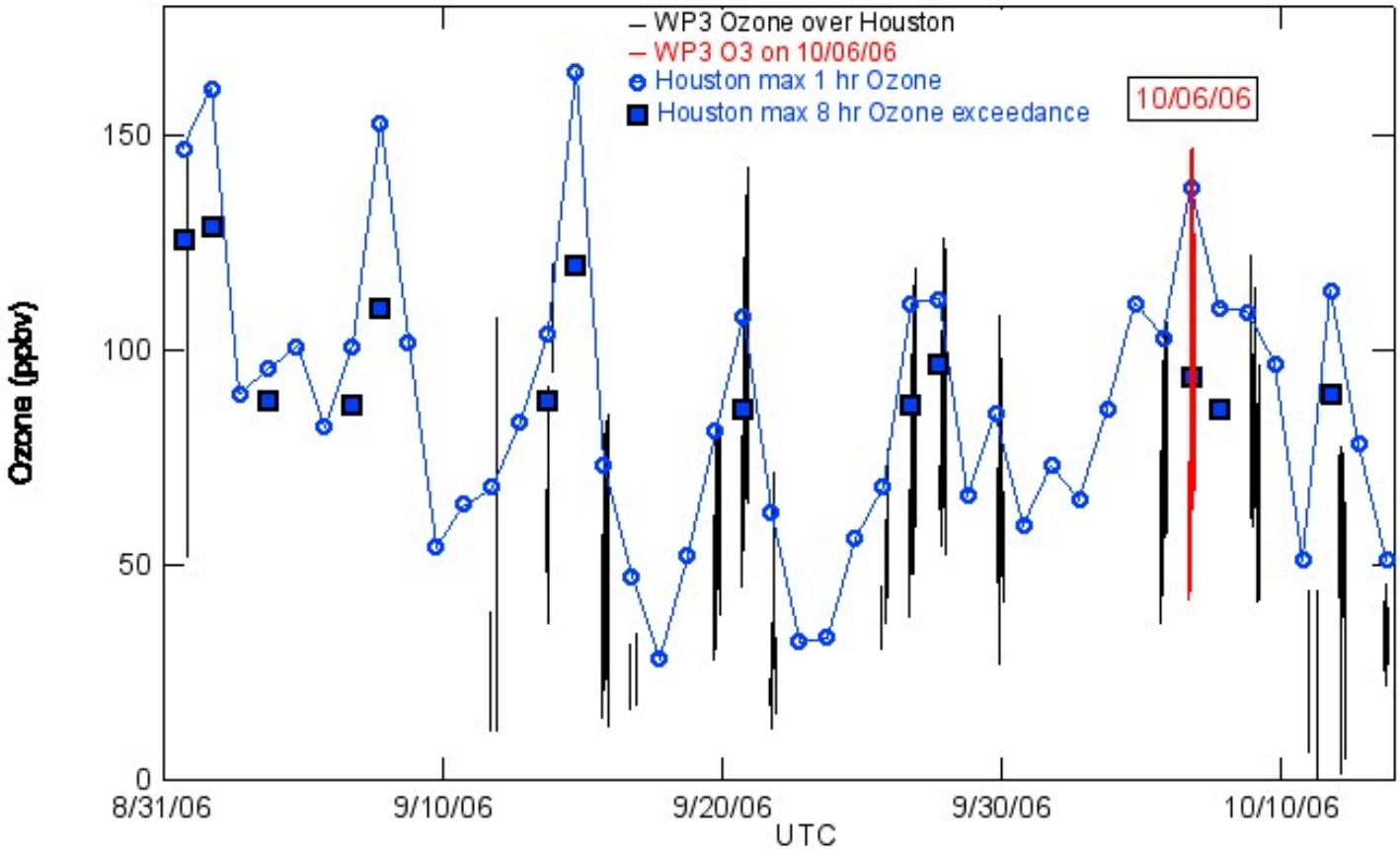
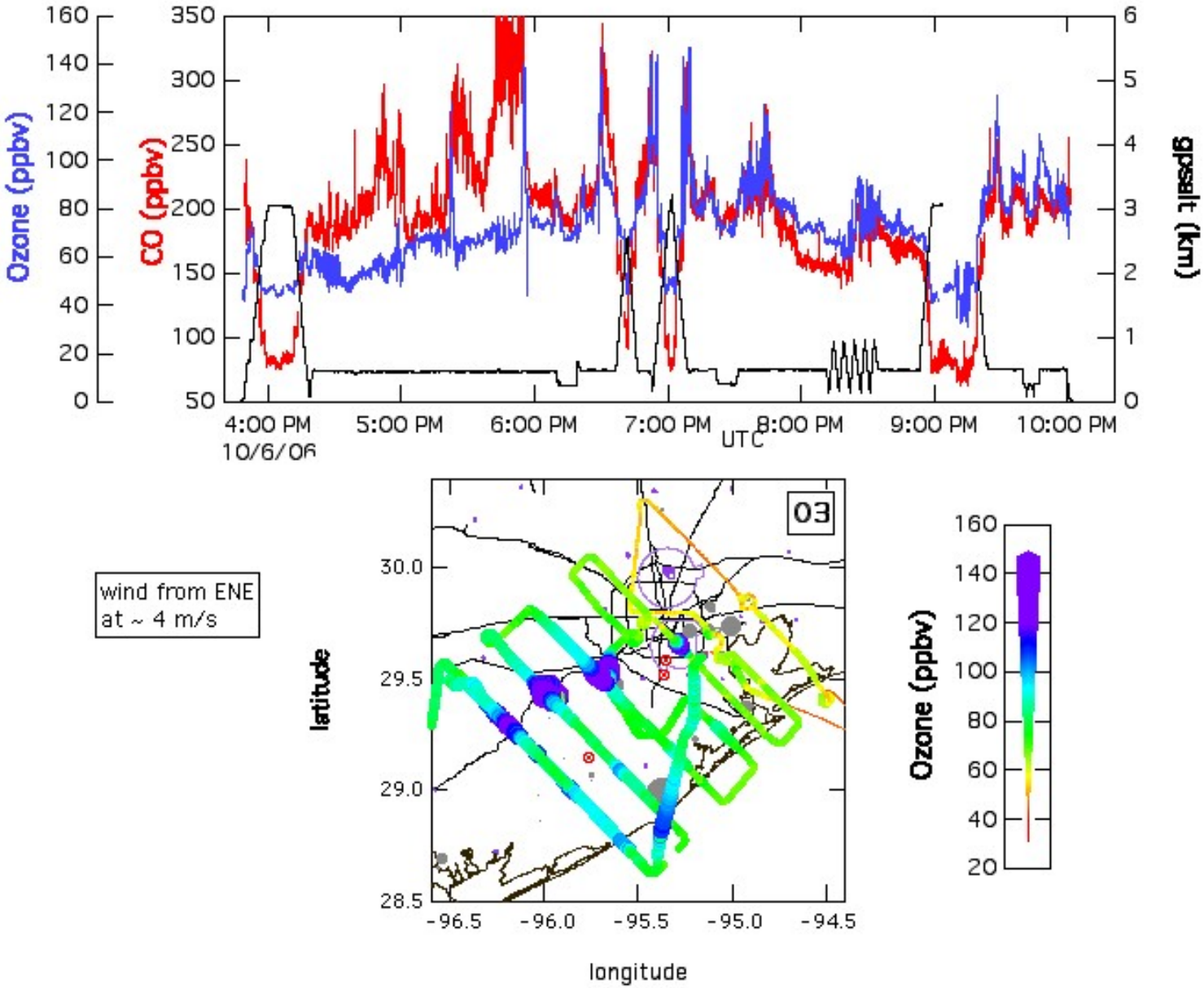
Rapid and Efficient Production of Ozone over Houston, October 6, 2006 a Case Study

E. Atlas, J. De Gouw, F. Flocke, A. Fried, J. Holloway, A. Neuman, J. Nowak, J. Peischl, D. Richter, T. Ryerson, M. Trainer, J. Walega, C. Warneke, P. Weibring, W. Zheng

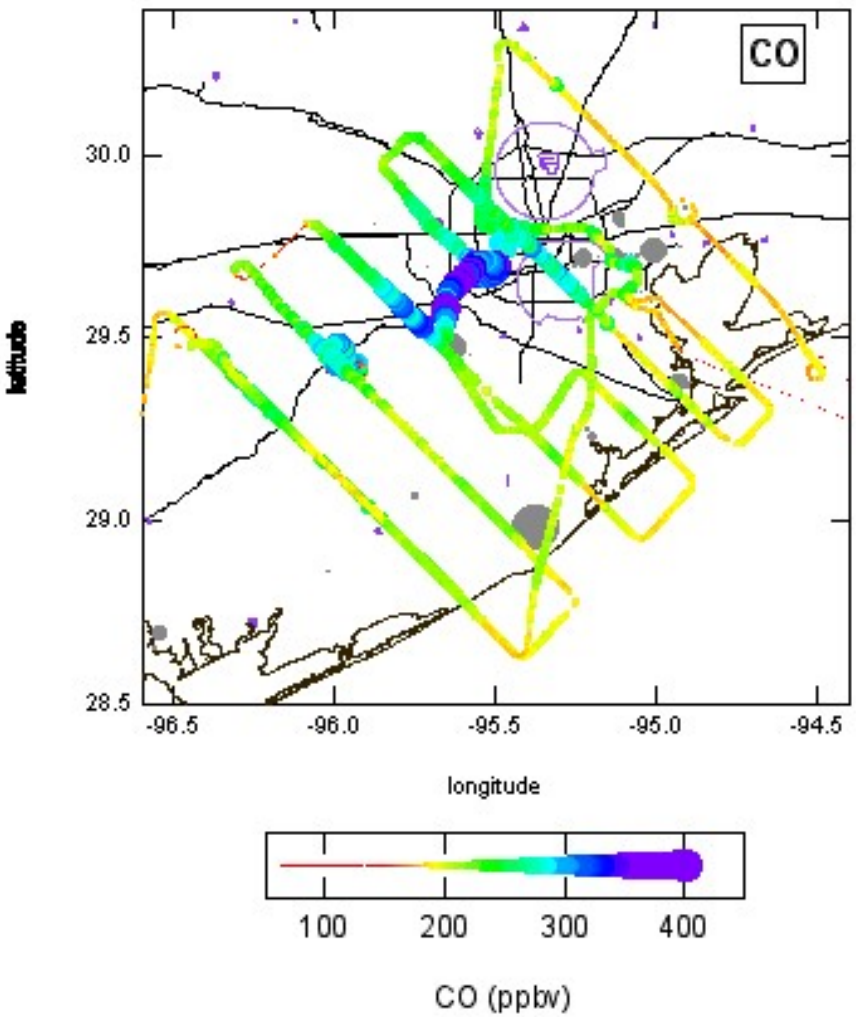


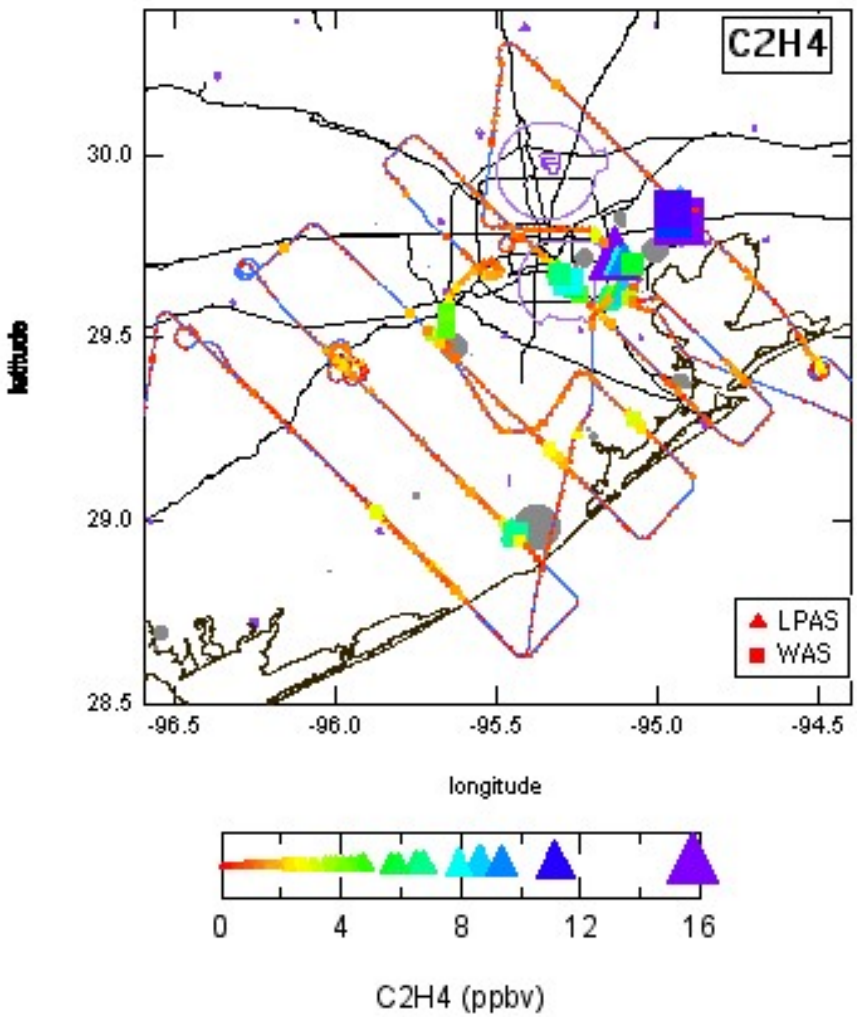
Emissions, Chemistry, Transport



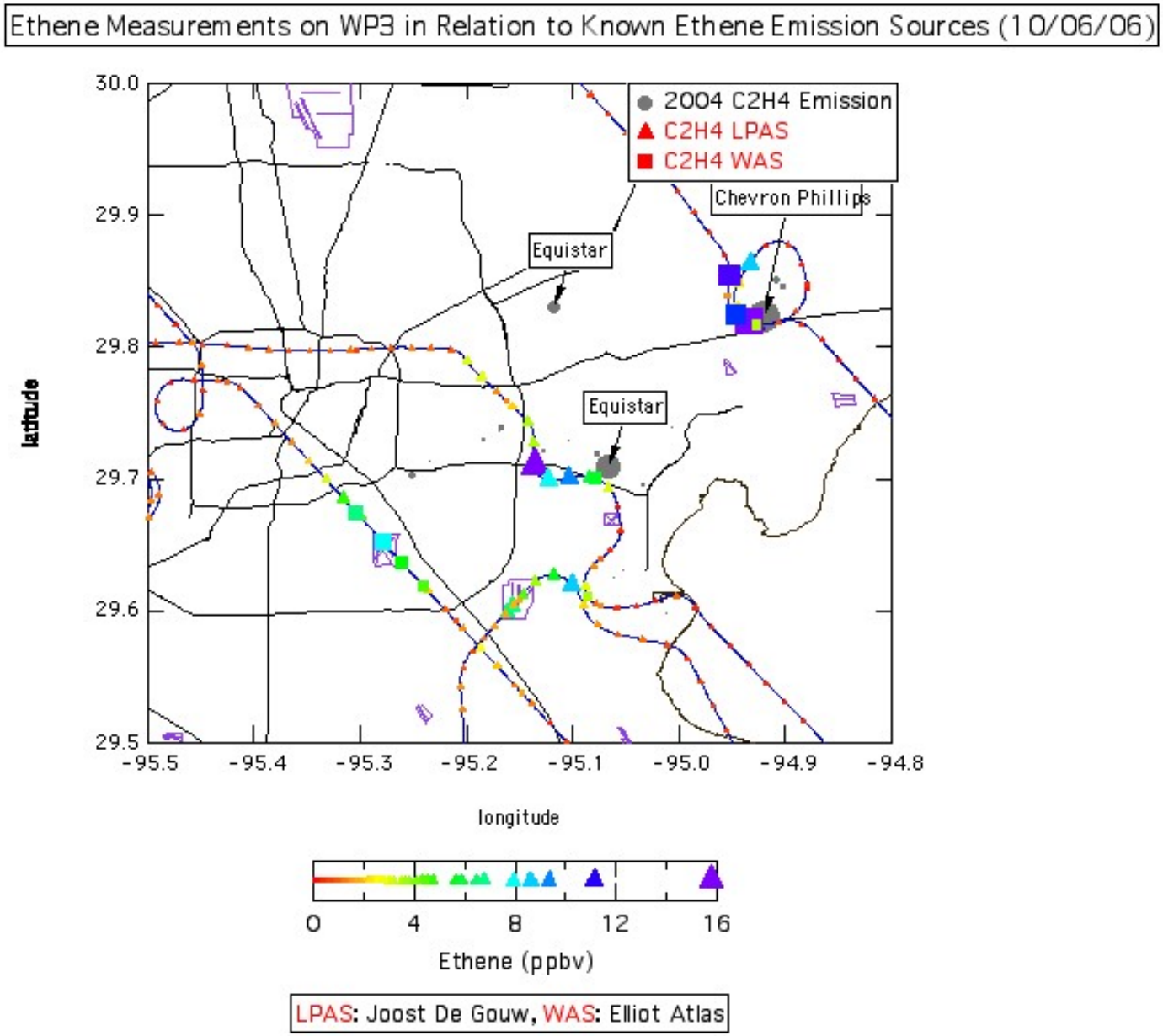
O3: Tom Ryerson, **CO**: John Holloway

Urban and Industrial Precursor Emissions

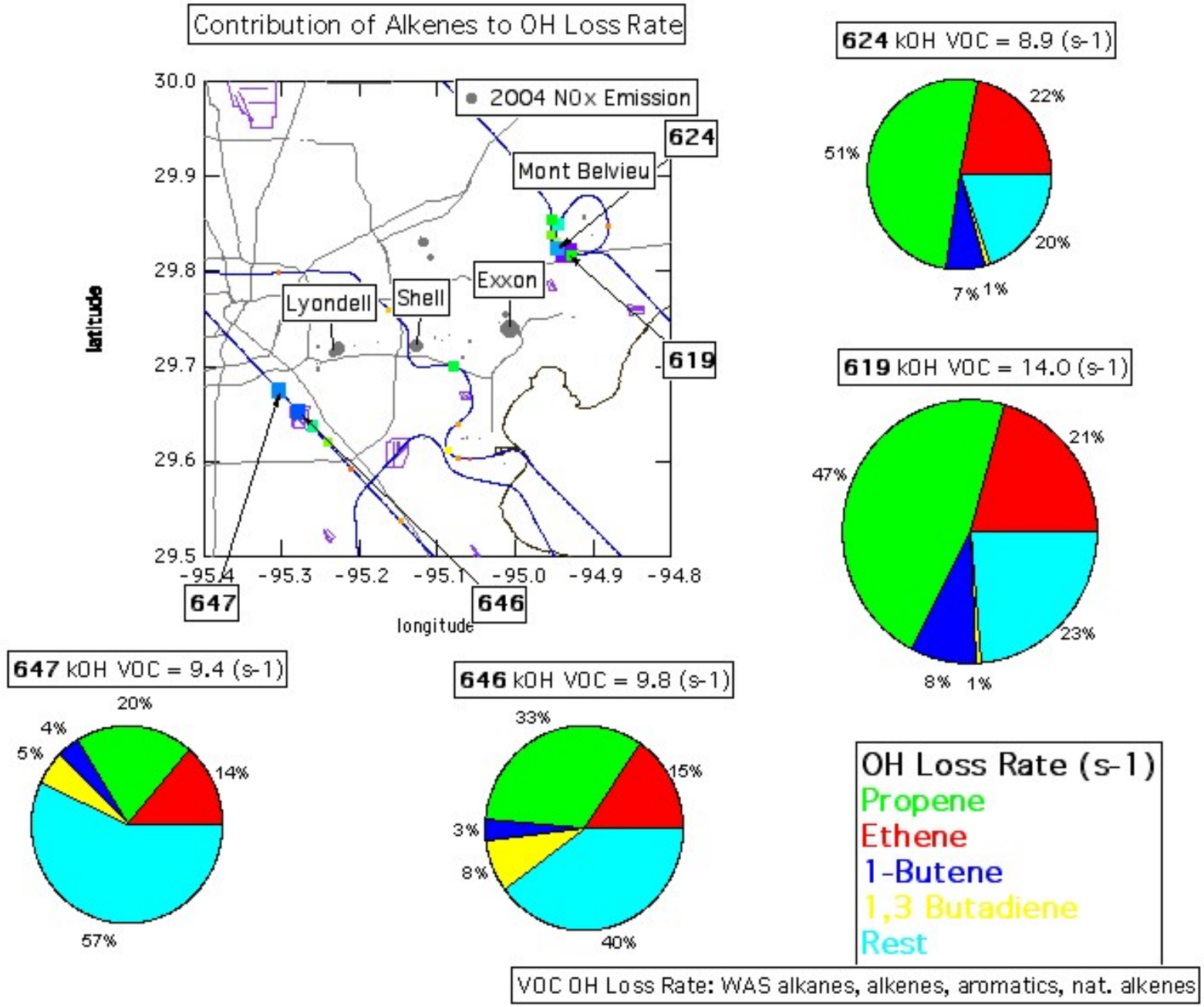




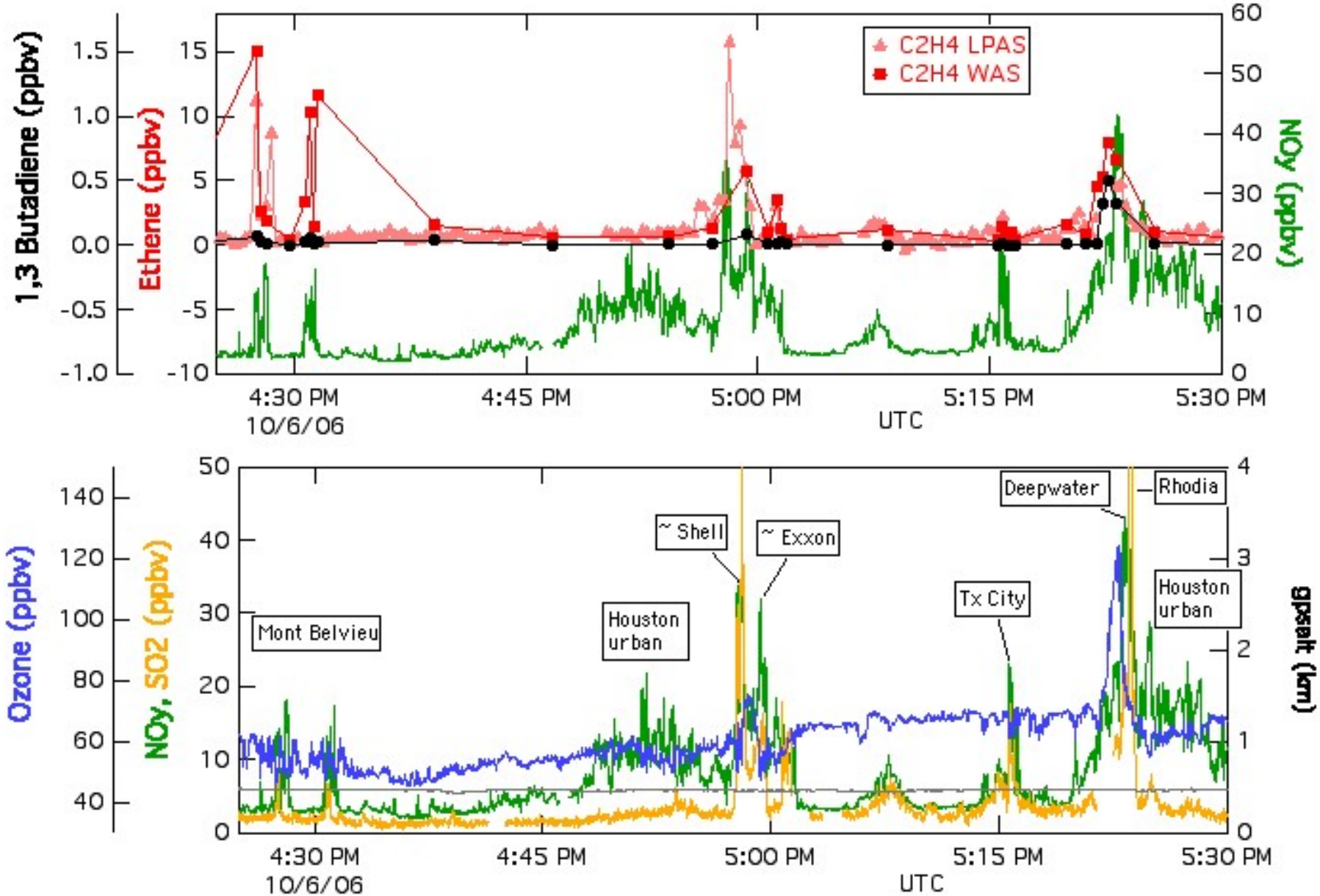
C2H4



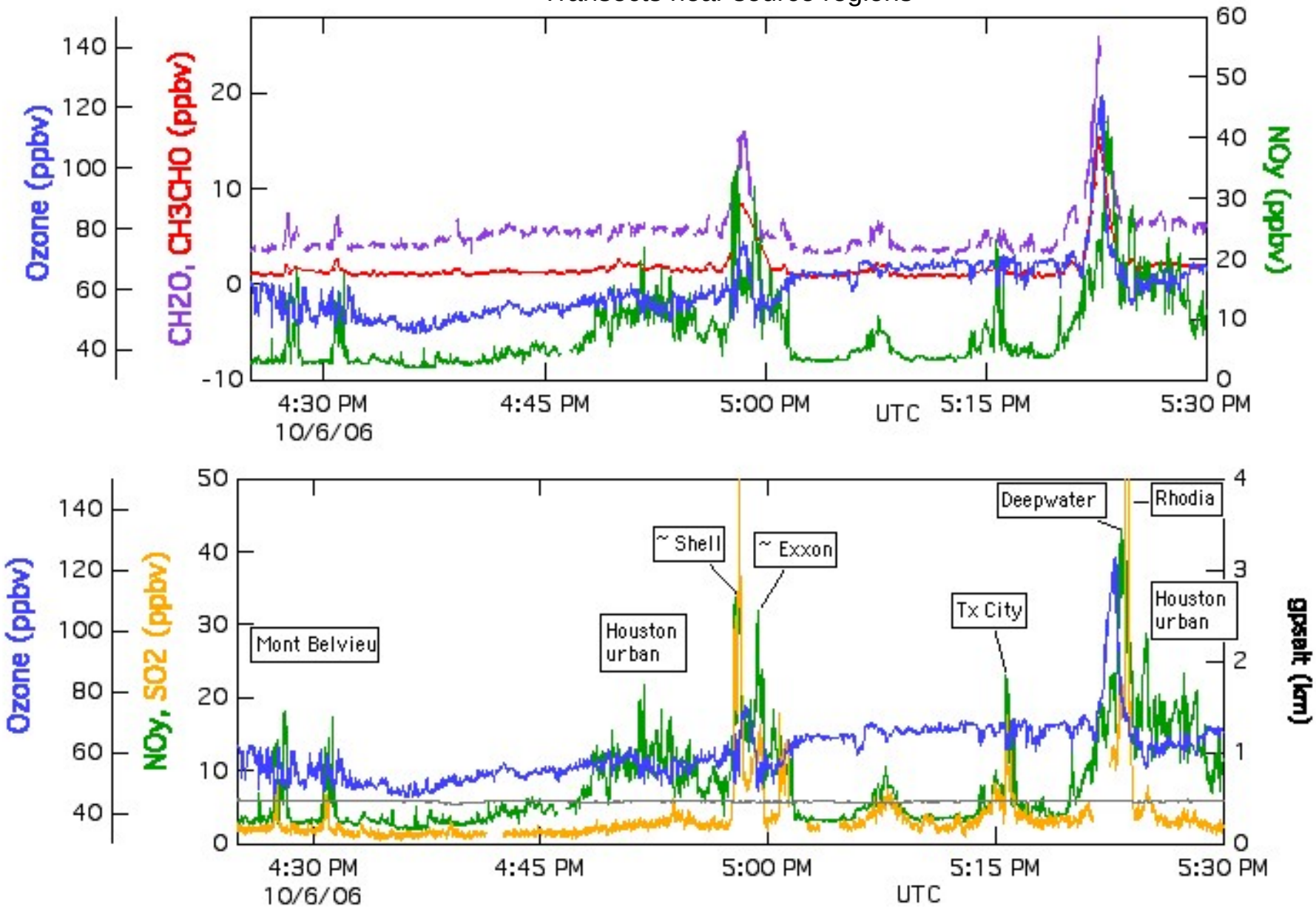
Laser **P**hotoacoustic **A**bsorption **S**pectroscopy and **W**hole **A**ir **S**ampler


Contribution of Alkenes to OH Loss Rate
2004 NOx Emission
624
Mont Belvieu
Exxon
Shell
Lyondell
619
647
646
latitude
longitude
30.0
29.9
29.8
29.7
29.6
29.5
-95.4
-95.3
-95.2
-95.1
-95.0
-94.9
-94.8
624 kOH VOC = 8.9 (s-1)
22%
51%
20%
7%
1%
619 kOH VOC = 14.0 (s-1)
21%
47%
23%
8%
1%
647 kOH VOC = 9.4 (s-1)
20%
4%
5%
14%
57%
646 kOH VOC = 9.8 (s-1)
33%
15%
3%
8%
40%
OH Loss Rate (s-1)
Propene
Ethene
1-Butene
1,3 Butadiene
Rest
VOC OH Loss Rate: WAS alkanes, alkenes, aromatics, nat. alkenes

Transects near source regions

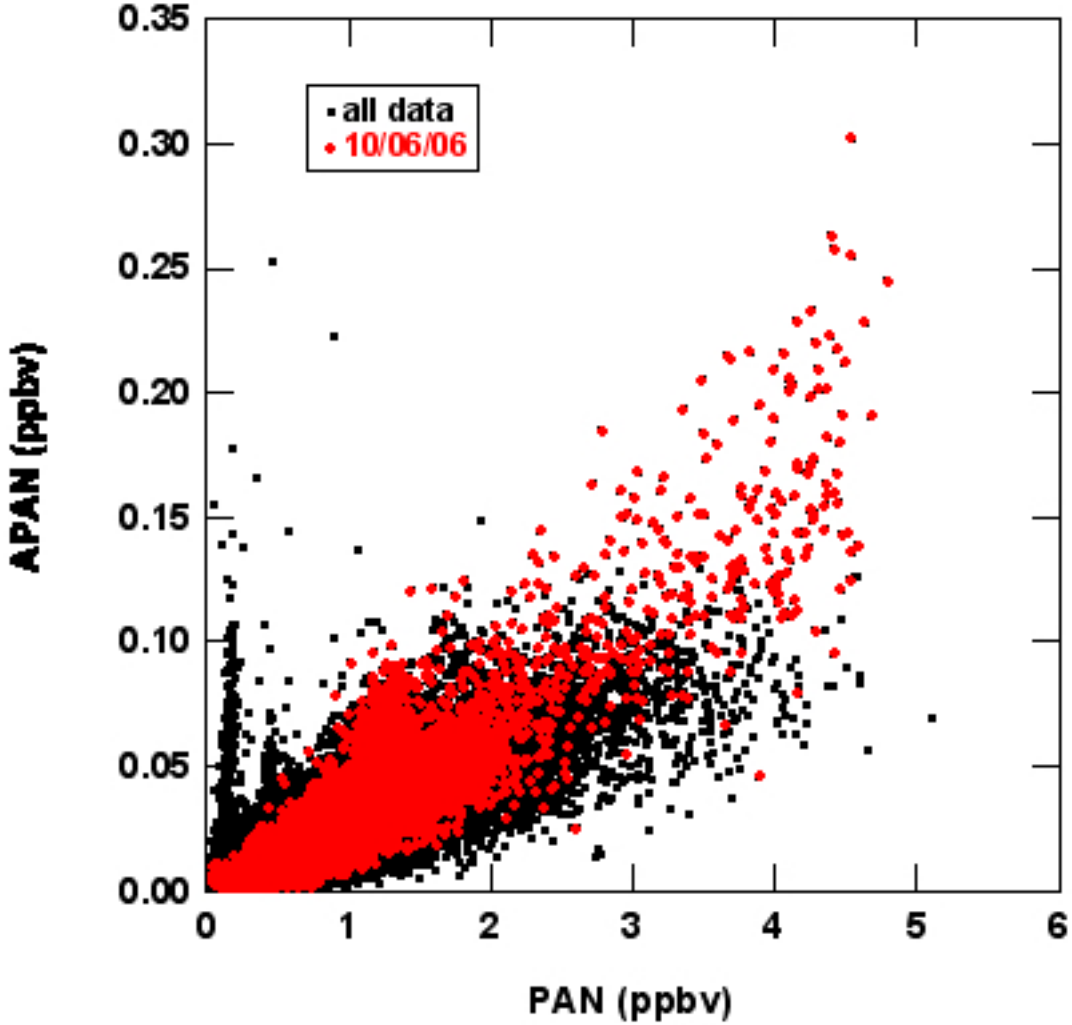


Transects near source regions



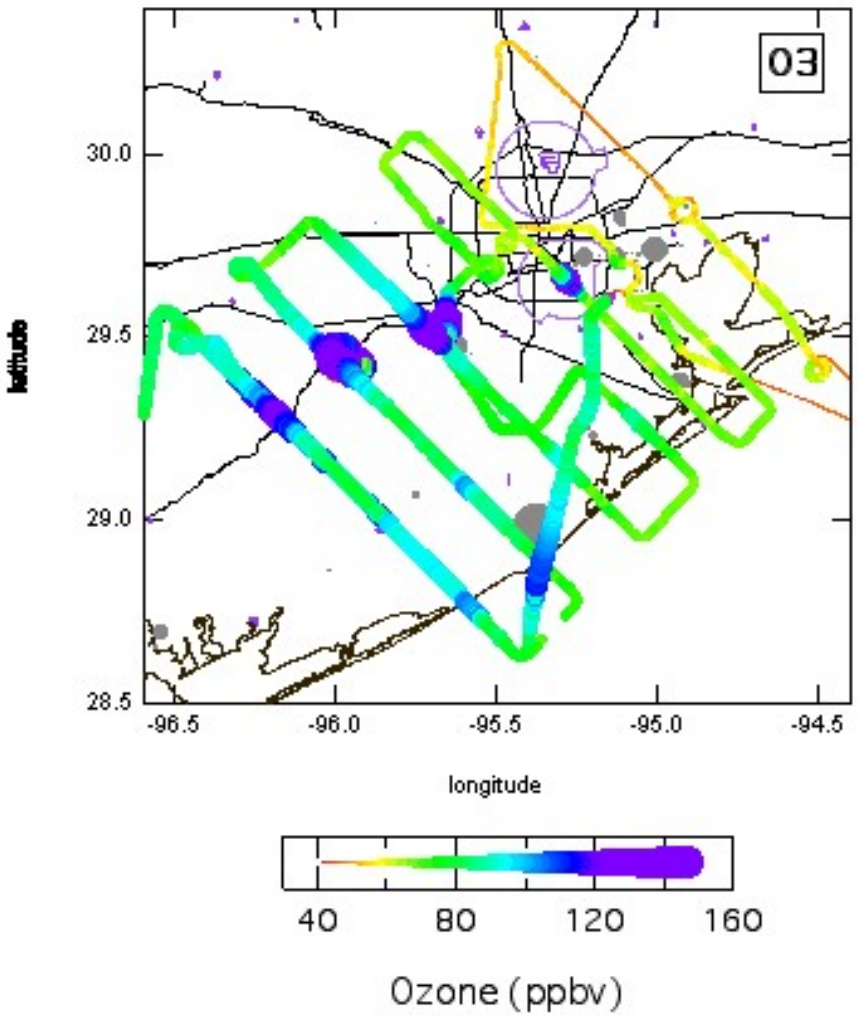
CH2O: by Dirk Richter et al., CH3CHO: Joost De Gouw & Warneke

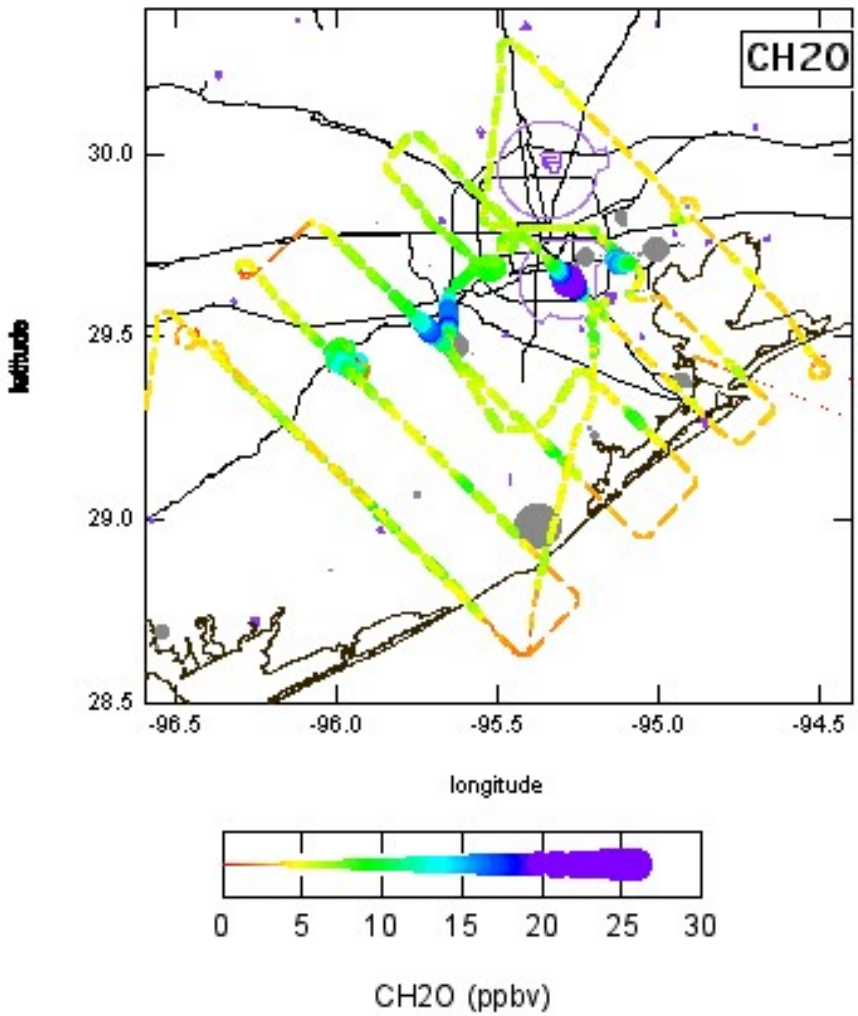
APAN and PAN on the WP3 during TexAQS 2006



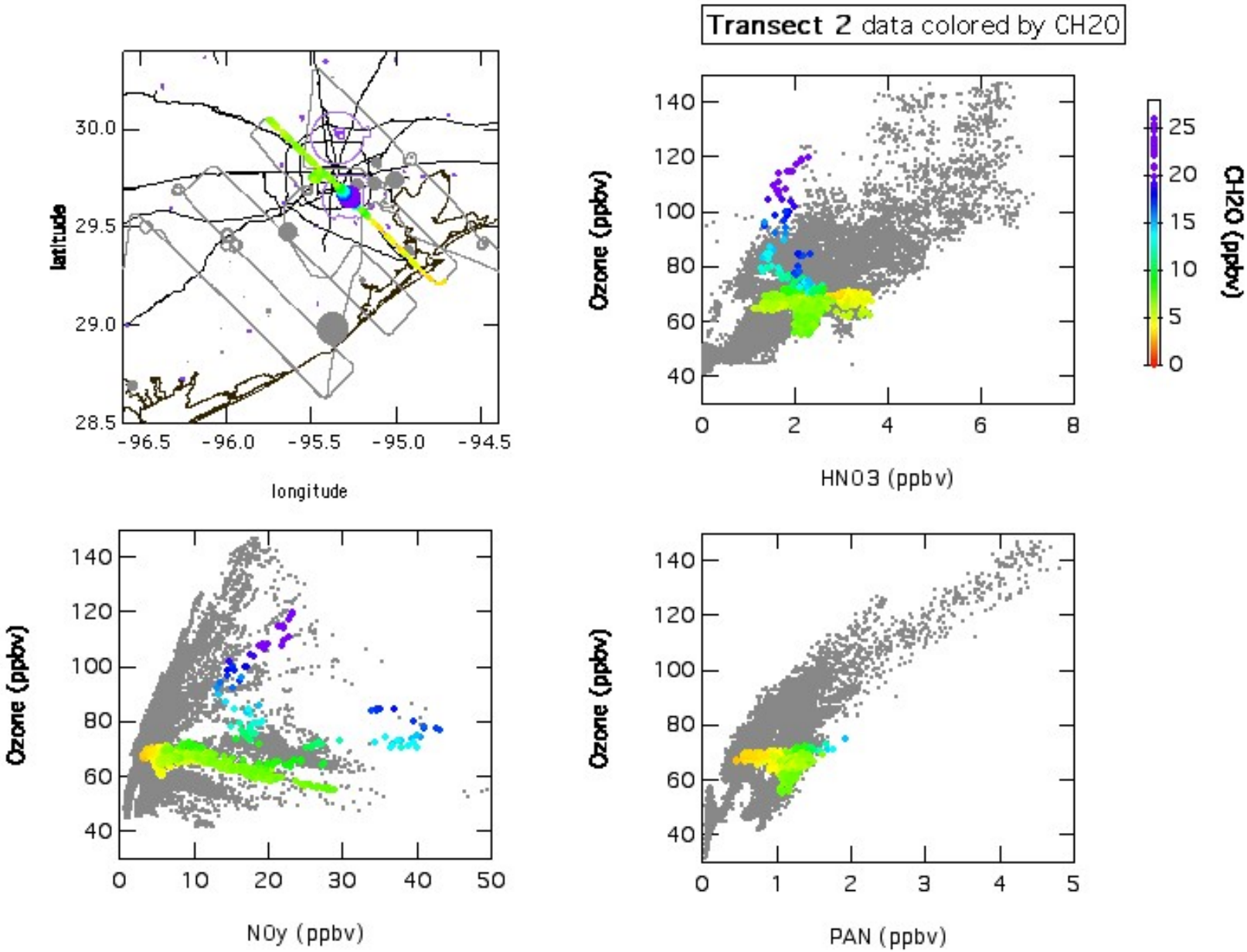
PANs:Flocke & Zheng

APAN is a reaction product of acrolein, which is a reaction product of 1,3 butadiene …….
Roberts, Flocke et al. TexAQS 2000)


O3
latitude
30.0
29.5
29.0
28.5
-96.5
-96.0
-95.5
-95.0
-94.5
longitude
40
80
120
160
Ozone (ppbv)

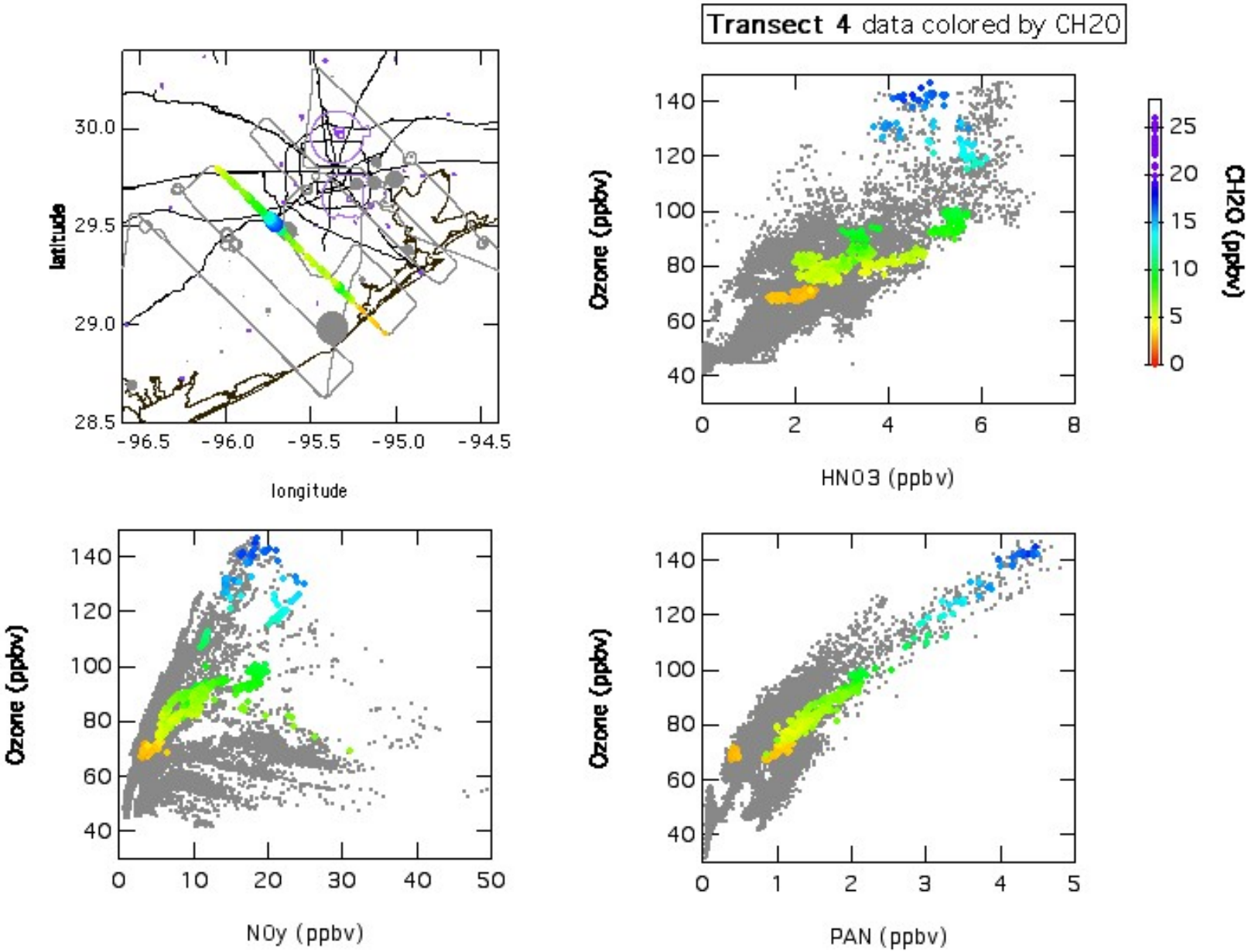

CH2O
latitude
30.0
29.5
29.0
28.5
-96.5
-96.0
-95.5
-95.0
-94.5
longitude
0
5
10
15
20
25
30
CH2O (ppbv)

Influence of VOCs on O3 formation and NOy partitioning as reflected by CH2O



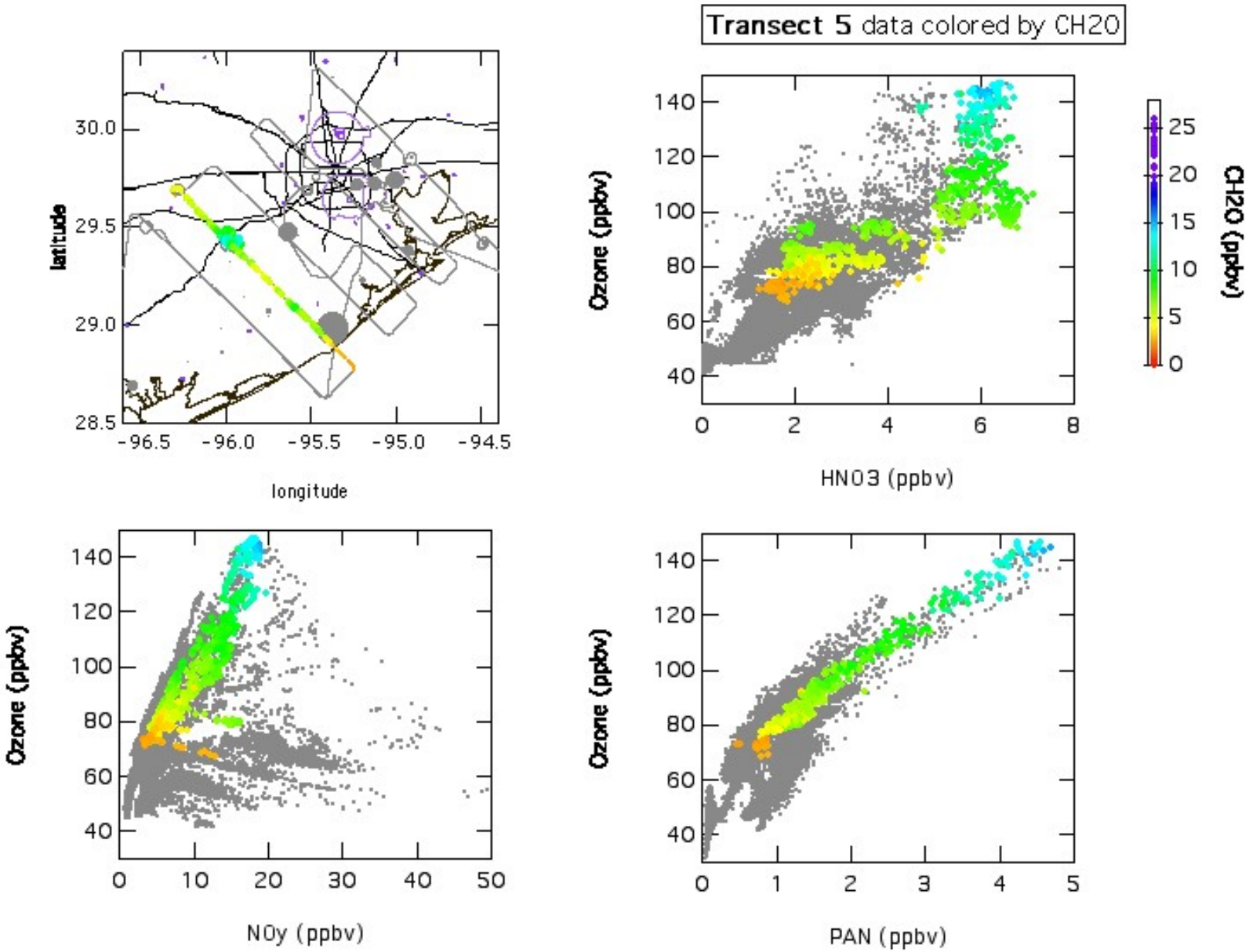
O3, NOy: Ryerson, **HNO3**: Neuman & Nowak, **PAN**s: Flocke & Zheng, **CH2O:** Richter et al.

Influence of VOCs on O3 formation and NOy partitioning as reflected by CH2O

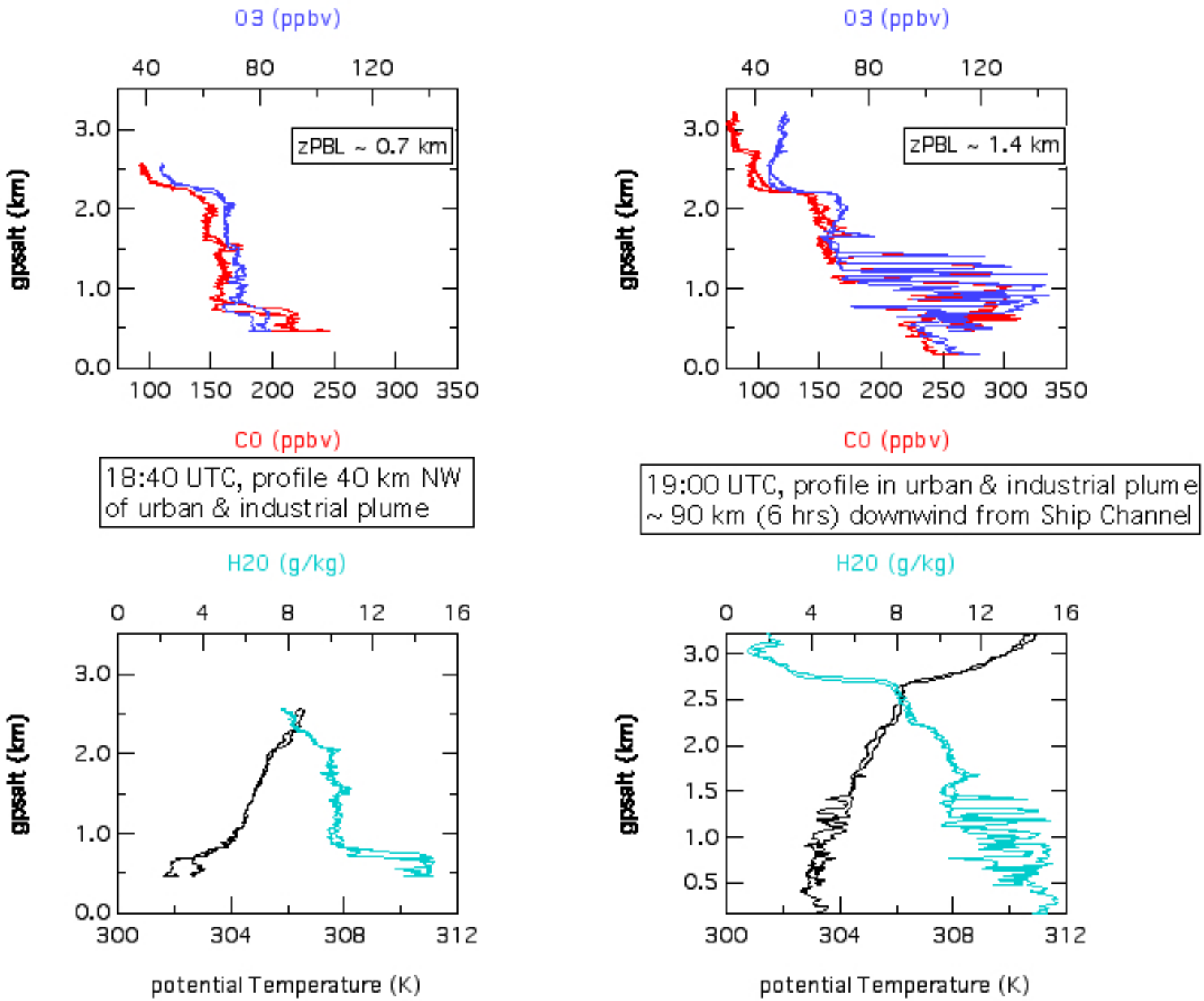


O3, Noy: Ryerson, **HNO3**: Neuman & Nowak, **PAN**s: Flocke & Zheng, **CH2O:** Richter et al.

Influence of VOCs on O3 formation and NOy partitioning as reflected by CH2O



O3, Noy: Ryerson, **HNO3**: Neuman & Nowak, **PAN**s: Flocke & Zheng, **CH2O**: Richter et al.


O3 (ppbv)
40
80
120
zPBL ~ 0.7 km
gpsalt (km)
3.0
2.0
1.0
0.0
100
150
200
250
300
350
CO (ppbv)
18:40 UTC, profile 40 km NW of urban & industrial plume
O3 (ppbv)
zPBL ~ 1.4 km
CO (ppbv)
19:00 UTC, profile in urban & industrial plume ~ 90 km (6 hrs) downwind from Ship Channel
H2O (g/kg)
0
4
8
12
16
2.5
1.5
0.5
300
304
308
312
potential Temperature (K)

Summary

On October 6, 2006 high ozone concentrations (up to 147 ppbv) were measured in a narrow plume on board the NOAA WP3 aircraft.

This plume was advected by steady winds of 4 m/s from the ENE across Houston.

Alignment of several source regions contributed to high plume concentrations of precursors and ozone.

Propene and Ethene contribute a large fraction of the reactivity.

CH2O, CH3CHO, PAN, and APAN reflect the reactive alkene photochemistry.

APAN is formed in the oxidation of acrolein which is either directly emitted or formed in the oxidation of 1,3 butadiene.

Low PBL outside of the urban/industrial plume was observed (~600m), while the pollution plume was mixed throughout a deeper layer (~ 1500m).