# Industrial Hydrocarbon Emission Adjustments Used in 2002 Houston-Galveston-Brazoria Ozone SIP Modeling

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Texas Commission on
Environmental Quality

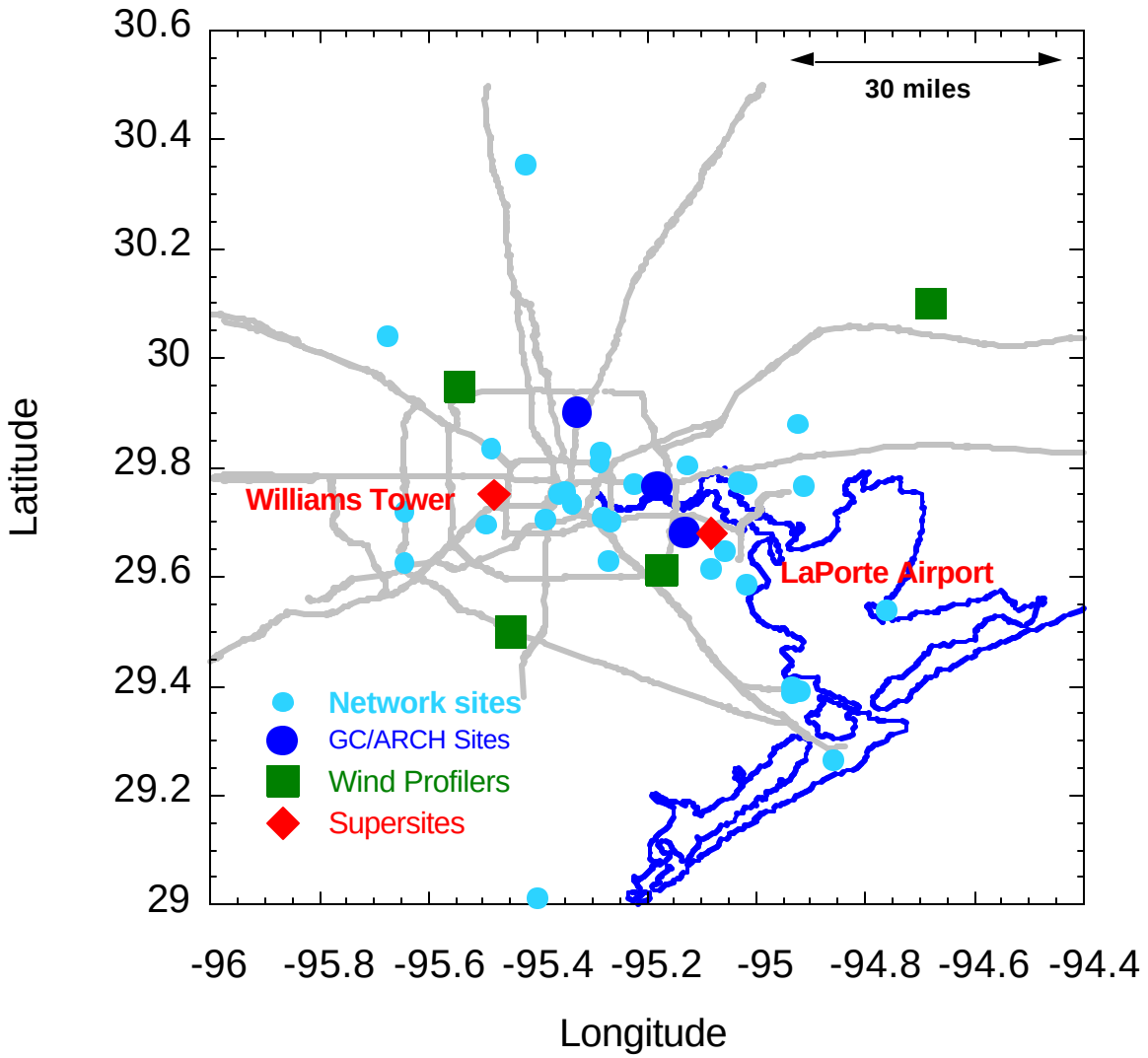
# Modeling Highlights

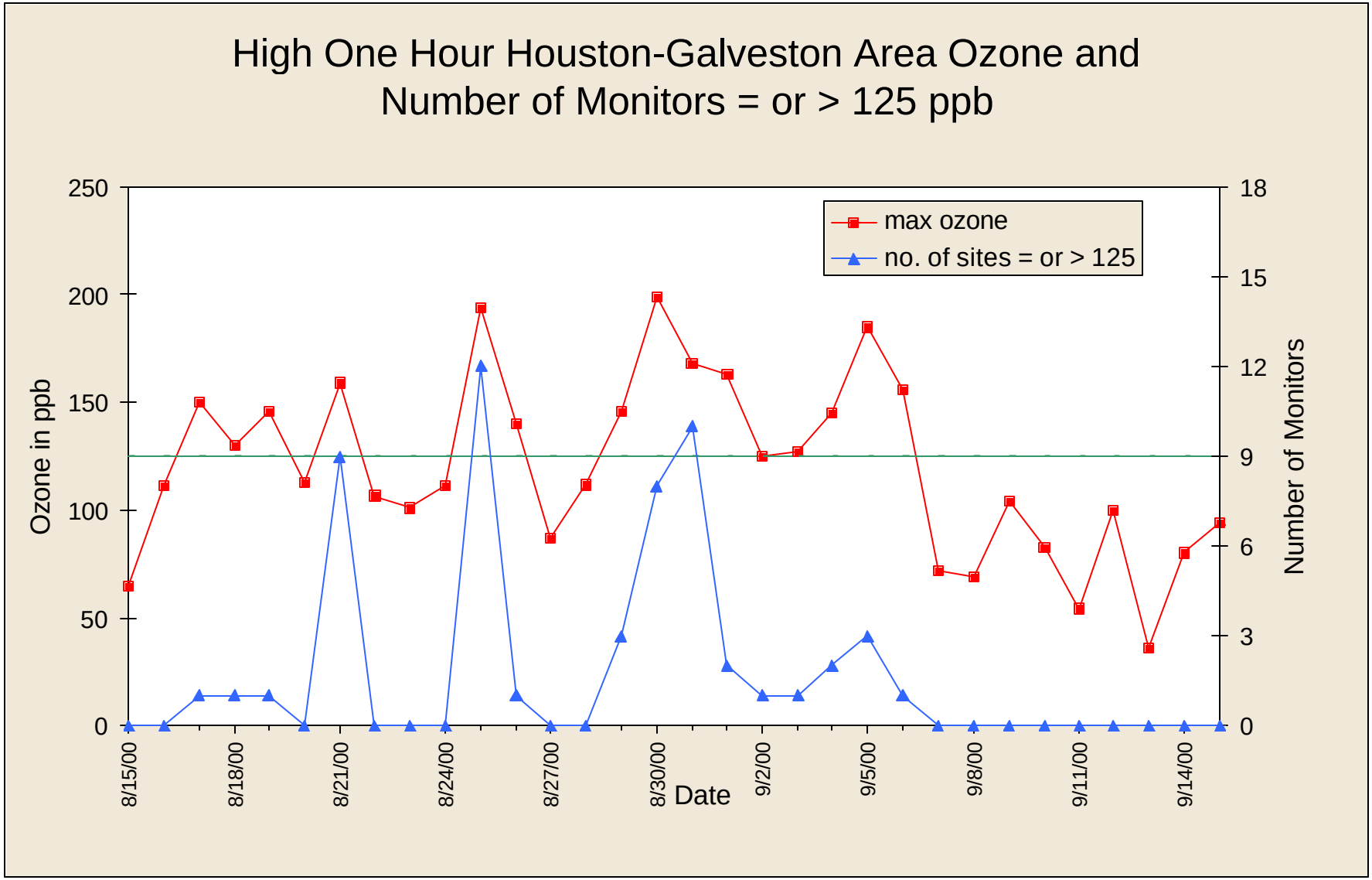
- The Texas Air Quality Study, 2000
- Meteorological Characterization by John Nielson-Gammon at Texas A&M, using state-of-the-science MM5
- Photochemical modeling with CAMx
- Extremely detailed emissions inventory
- Point source HRVOC emissions required adjustment

# TexAQS 2000 - A Major Air Quality Study

- Conducted August 15 - September 15, 2000
- Study focused on Houston, but measurements made all over East Texas.
- Collaborative experiment involving Federal, state, and local organizations including the US/DOE, NOAA, EPA, SOS, TNRCC, City of Houston, University of Texas, and a host of investigators from organizations throughout the US.
- Four aircraft including- DOE G-1, NOAA/NCAR Electra, NOAA DC-3, Baylor Twin Otter.

# Principal Project Area




High One Hour Houston-Galveston Area Ozone and Number of Monitors = or > 125 ppb
max ozone
no. of sites = or > 125
Ozone in ppb
Number of Monitors
Date
250
200
150
100
50
0
18
15
12
9
6
3
0
8/15/00
8/18/00
8/21/00
8/24/00
8/27/00
8/30/00
9/2/00
9/5/00
9/8/00
9/11/00
9/14/00

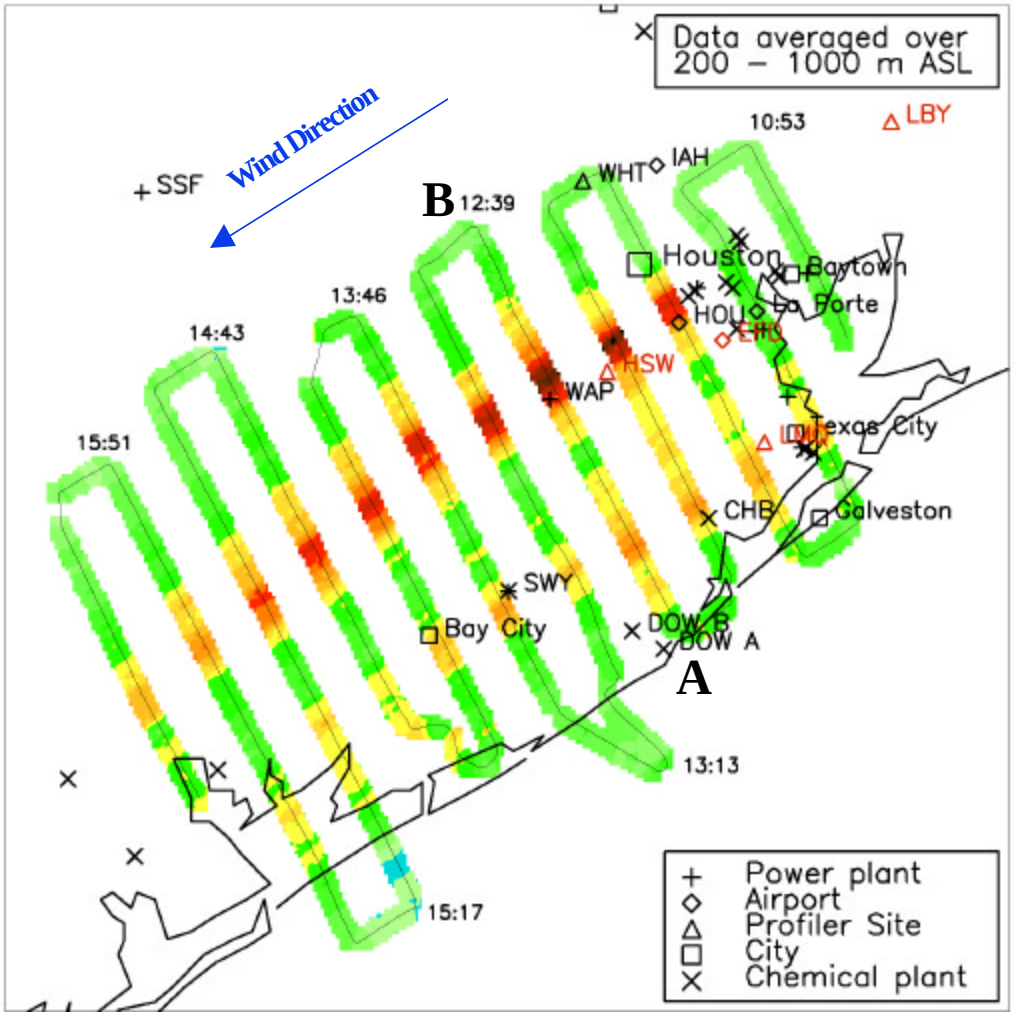
# TexAQS 6 SEP 2000

NOAA/ETL
Airborne Ozone Lidar

OZONE (ppbv)
10 40 70 100 130 160

DC-3
10:40 – 16:12 CST

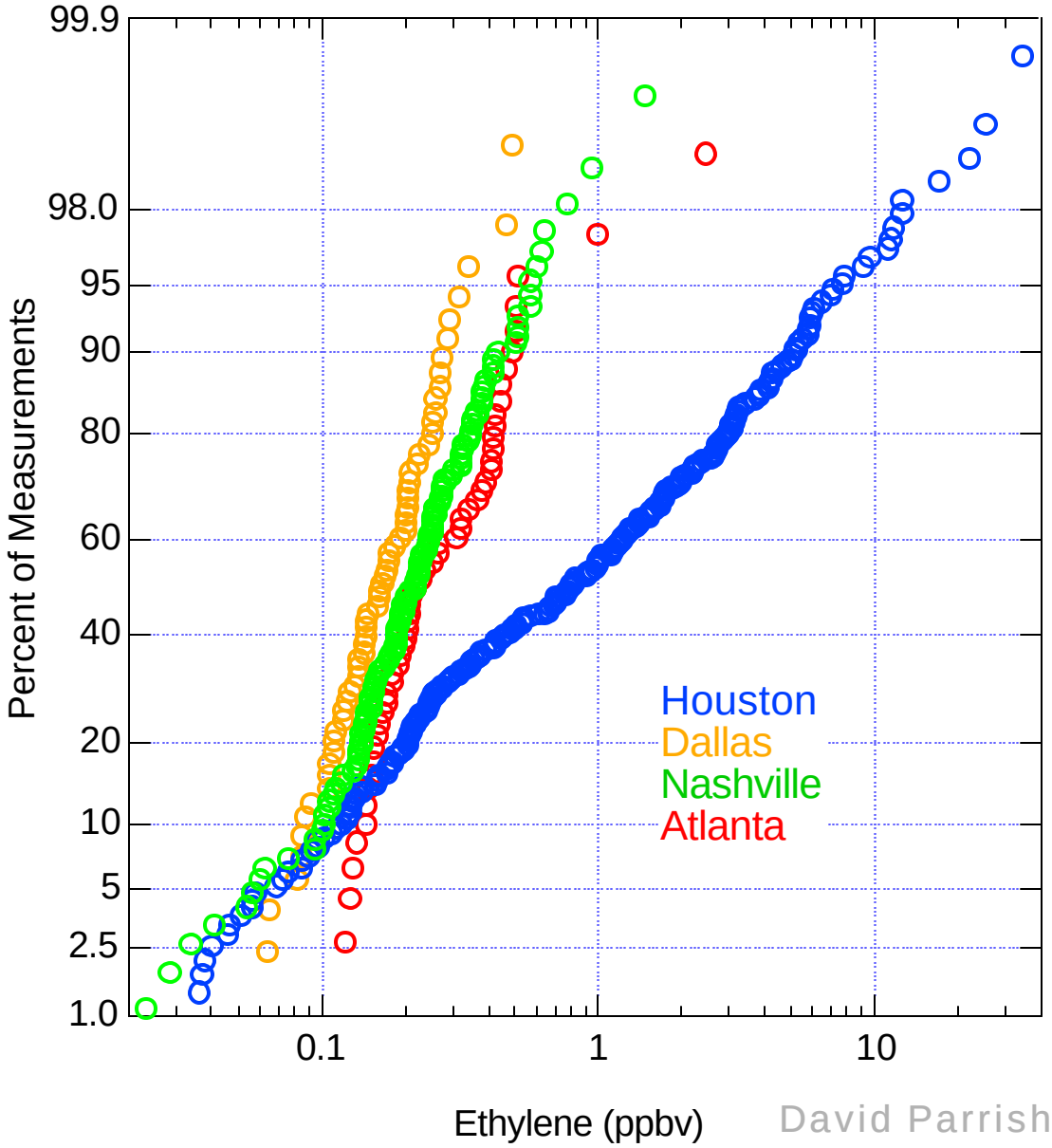
- **NE to E flow all day**




Christoph Senff

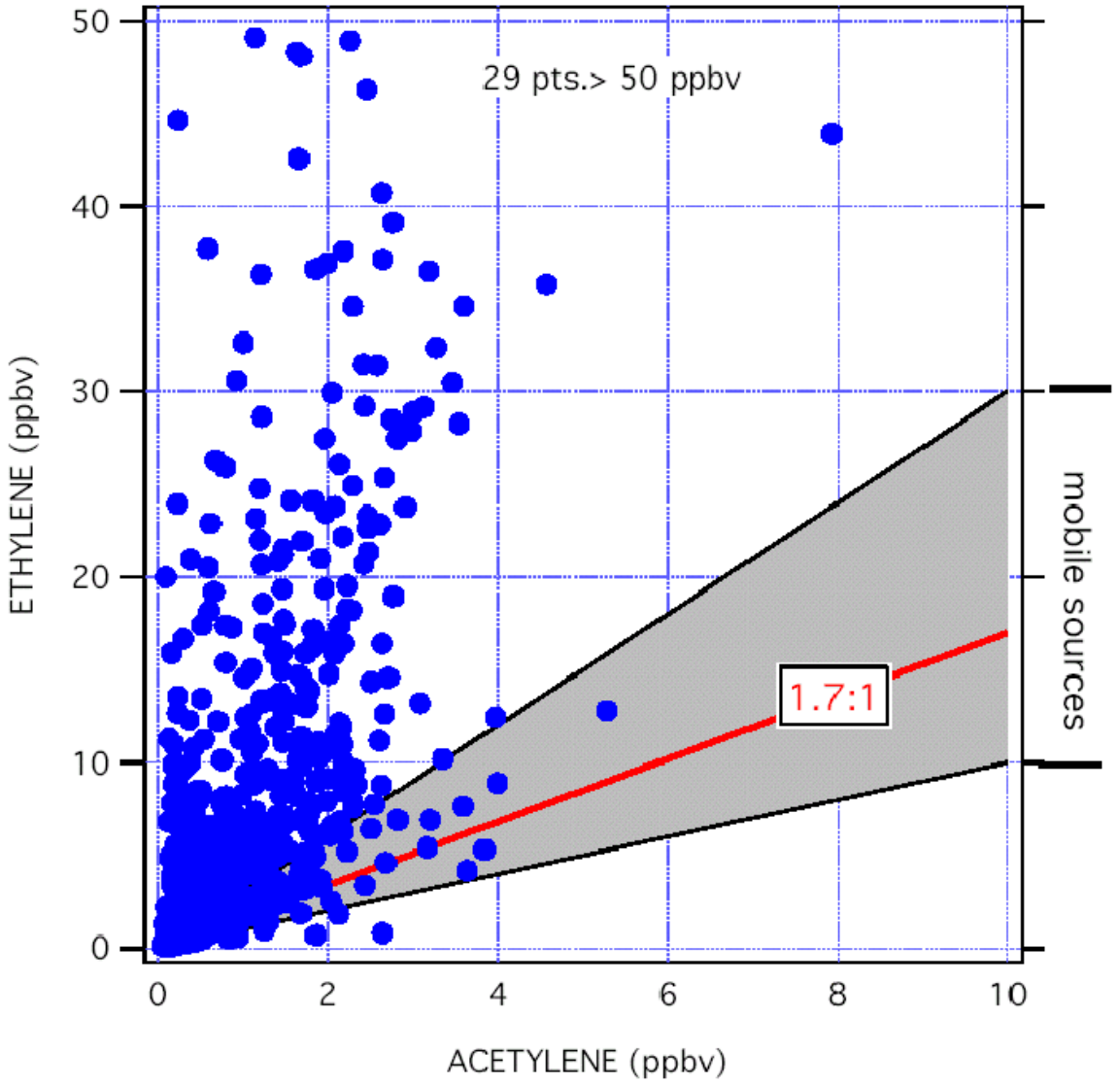
# TexAQS Finding #1:

Ethylene and other light olefins are emitted in much greater quantities in Houston than in other cities.



## TexAQS Finding #2:

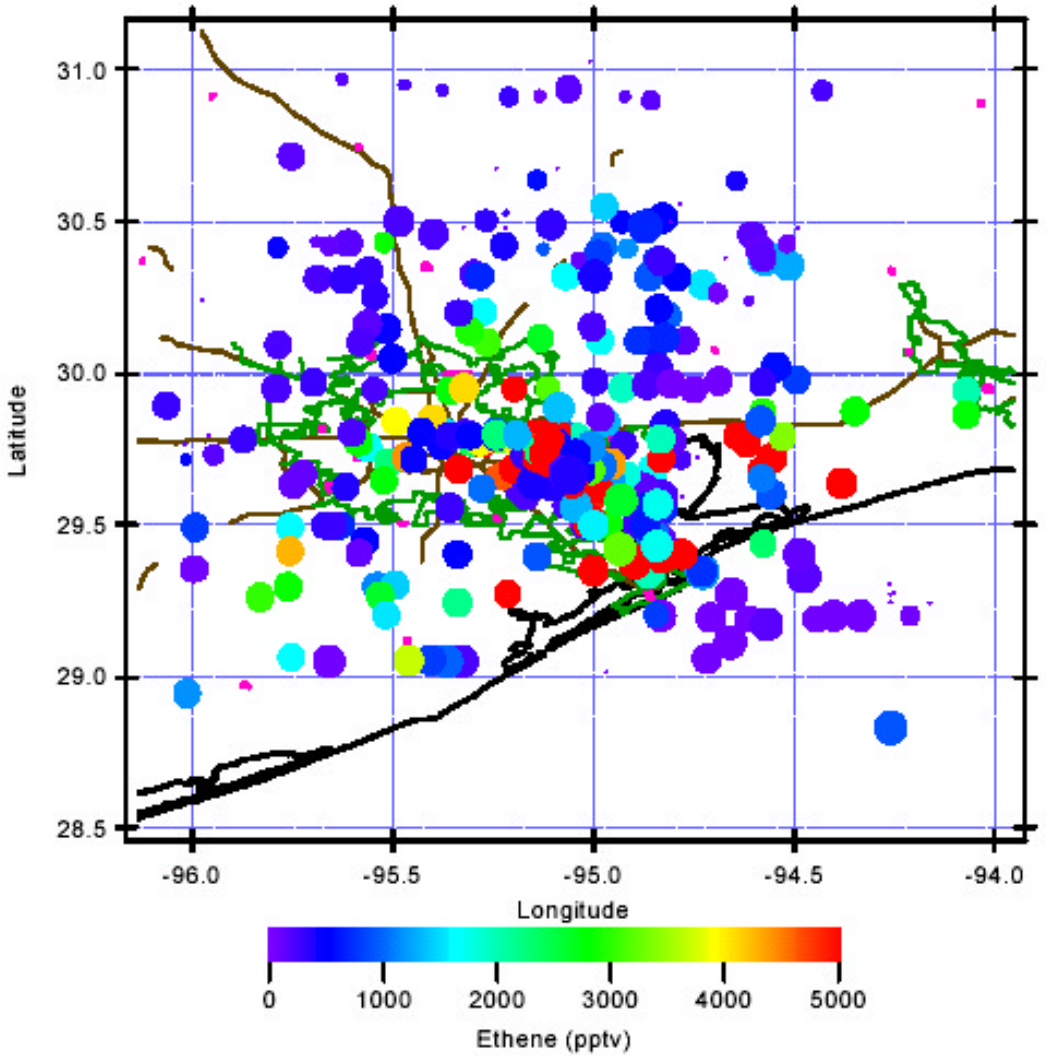
The high concentrations of ethylene and other light olefins are probably not due to mobile source emissions.




Kuster, et. al.

## TexAQS Finding #3:

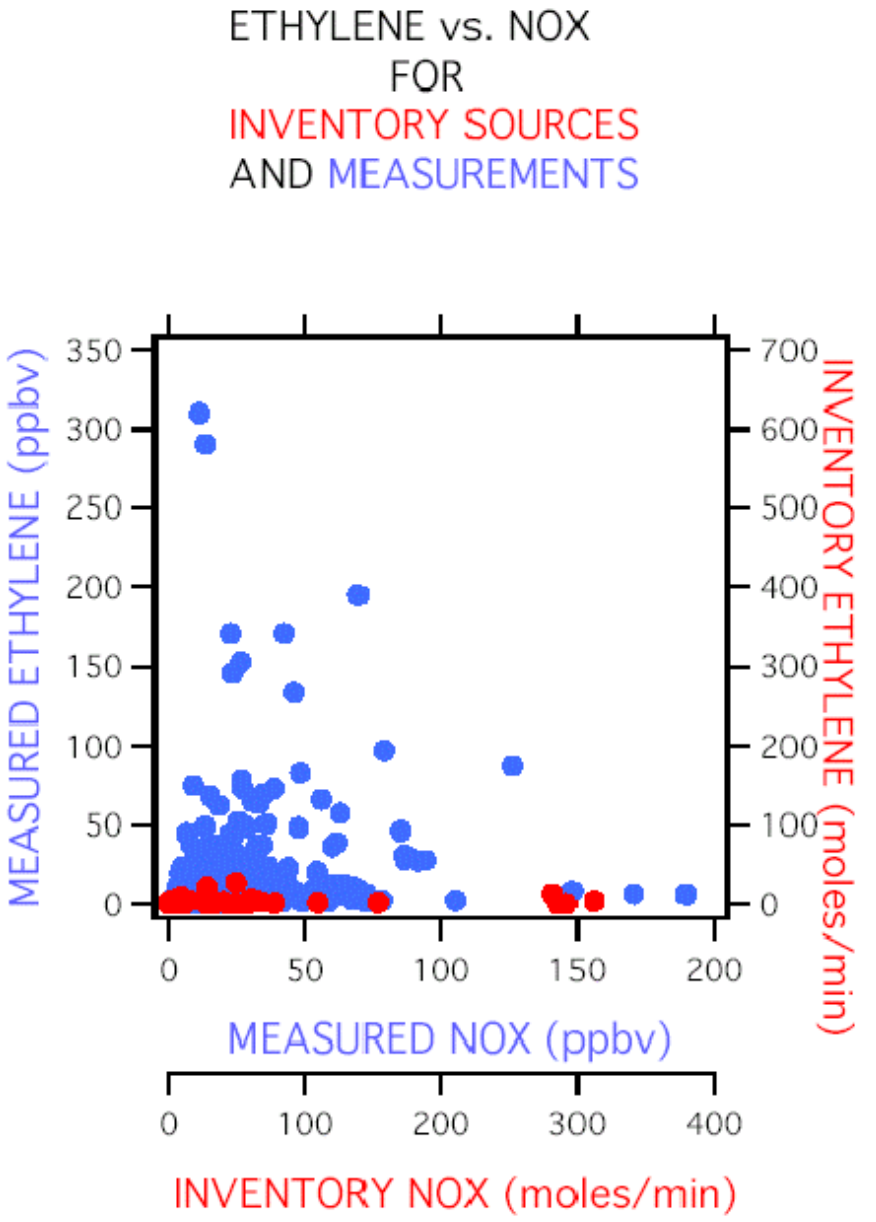
High concentrations of ethylene and other light olefins are found in and downwind of industrial source regions.




Geographic distribution of ethene concentrations, from airborne canister samples taken by NCAR/NOAA during the TexAQS 2000 study (Atlas et al., 2002.)

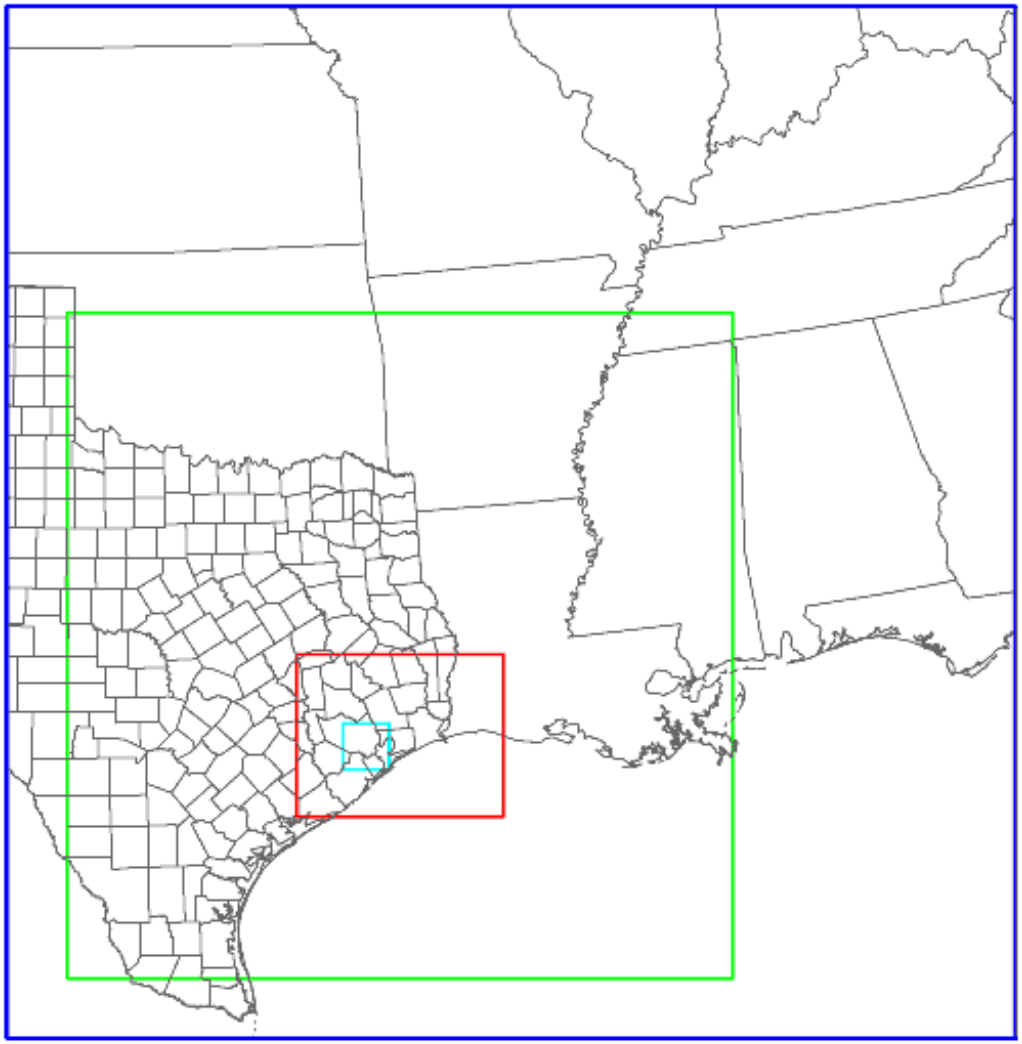
## TexAQS Finding #4:

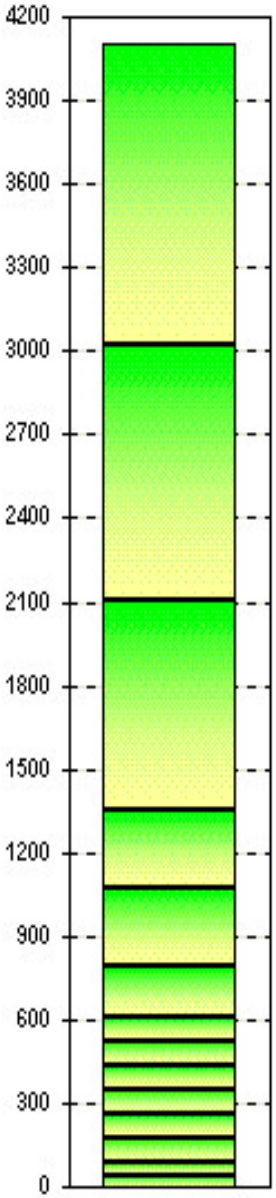
Measured ratios of olefins to nitrogen oxides are much larger than those reported in the emissions inventories.




Kuster, et. al.

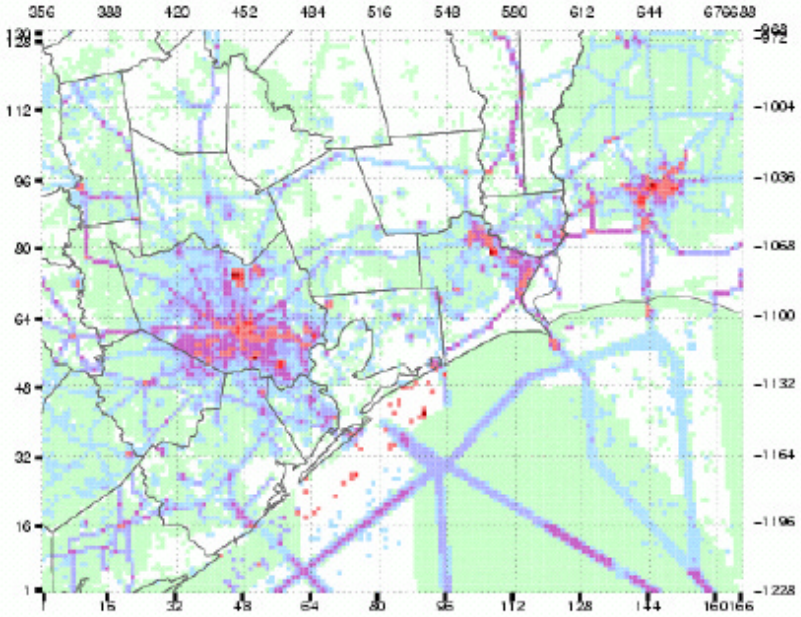
# CAMx Modeling Domain

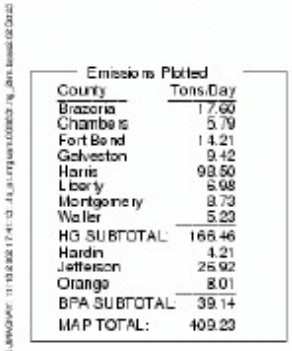


# Area & Nonroad Mobile Source Emissions, 8/31/2000

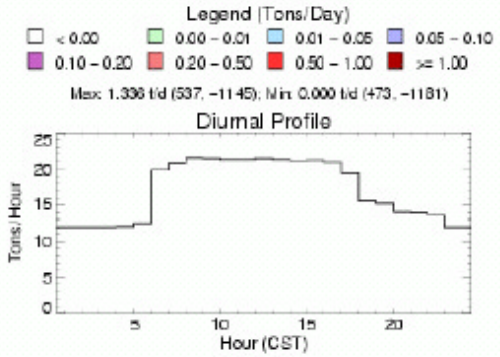
## $NO_X$



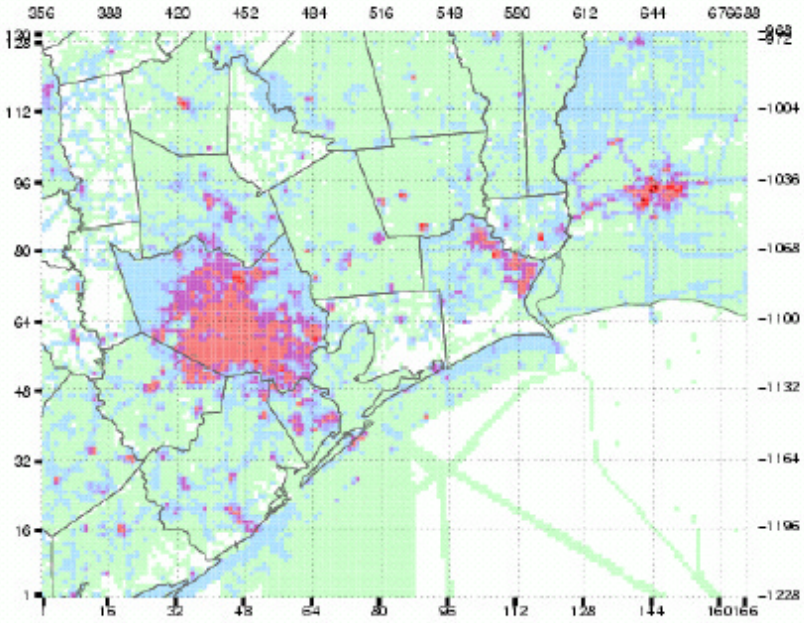


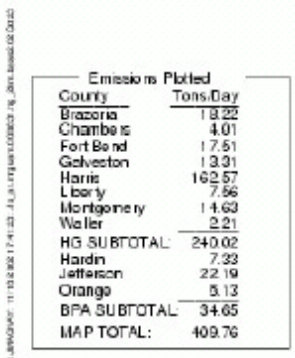
Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 17.60 |
| Chambers | 5.79 |
| Fort Bend | 14.21 |
| Galveston | 9.42 |
| Harris | 98.50 |
| Liberty | 6.98 |
| Montgomery | 8.73 |
| Waller | 5.23 |
| HG SUBTOTAL: | 166.46 |
| Hardin | 4.21 |
| Jefferson | 25.92 |
| Orange | 8.01 |
| BPA SUBTOTAL: | 39.14 |
| MAP TOTAL: | 409.23 |



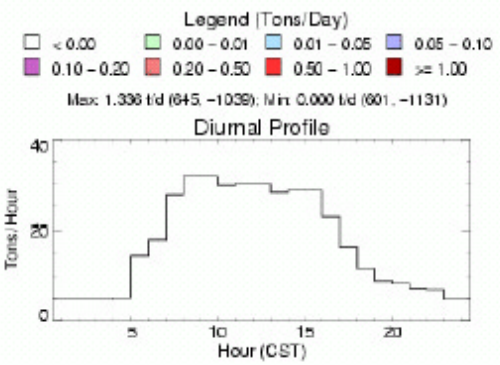

## CB-IV HC





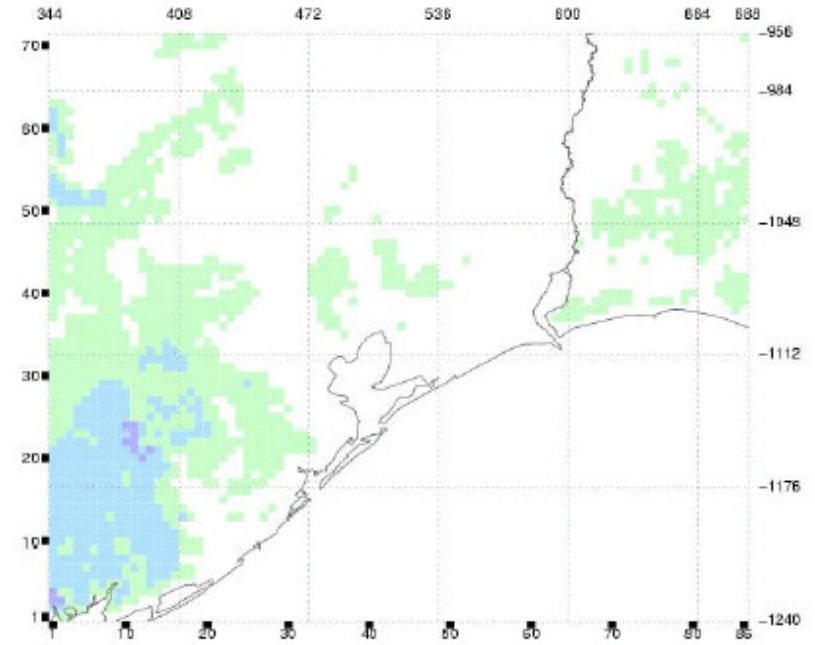
Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 18.22 |
| Chambers | 4.01 |
| Fort Bend | 17.51 |
| Galveston | 13.31 |
| Harris | 162.57 |
| Liberty | 7.56 |
| Montgomery | 14.63 |
| Waller | 2.21 |
| HG SUBTOTAL: | 240.02 |
| Hardin | 7.33 |
| Jefferson | 22.19 |
| Orange | 5.13 |
| BPA SUBTOTAL: | 34.65 |
| MAP TOTAL: | 409.76 |

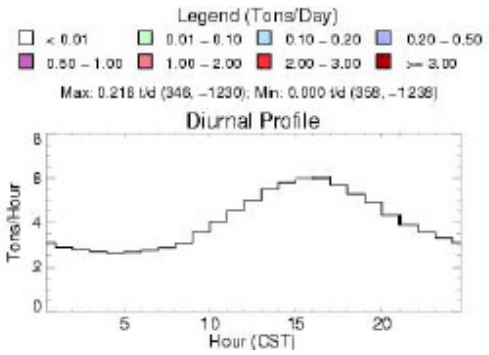


# Biogenic Emissions, 8/30/2000

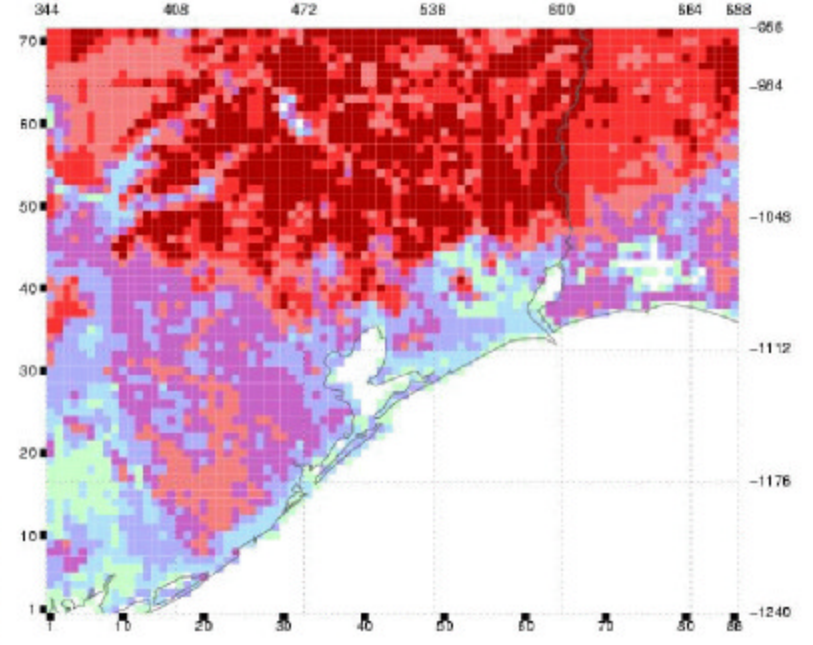
## $NO_X$



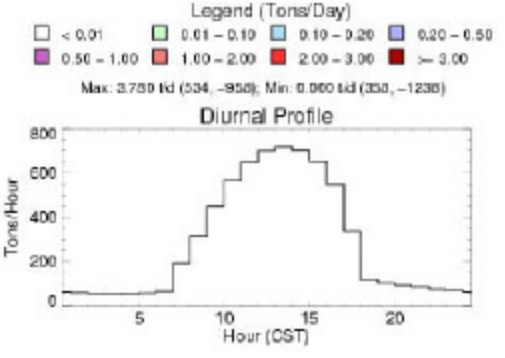

| Emissions Plotted | |
|---|---|
| County | Tons/Day |
| Brazoria | 2.37 |
| Chambers | 0.40 |
| Fort Bend | 11.04 |
| Galveston | 0.25 |
| Harris | 3.36 |
| Liberty | 1.39 |
| Montgomery | 0.70 |
| Waller | 1.25 |
| HG SUBTOTAL: | 20.76 |
| Hardin | 0.48 |
| Jefferson | 0.84 |
| Orange | 0.25 |
| BPA SUBTOTAL: | 1.57 |
| MAP TOTAL: | 98.67 |




## CB-IV HC

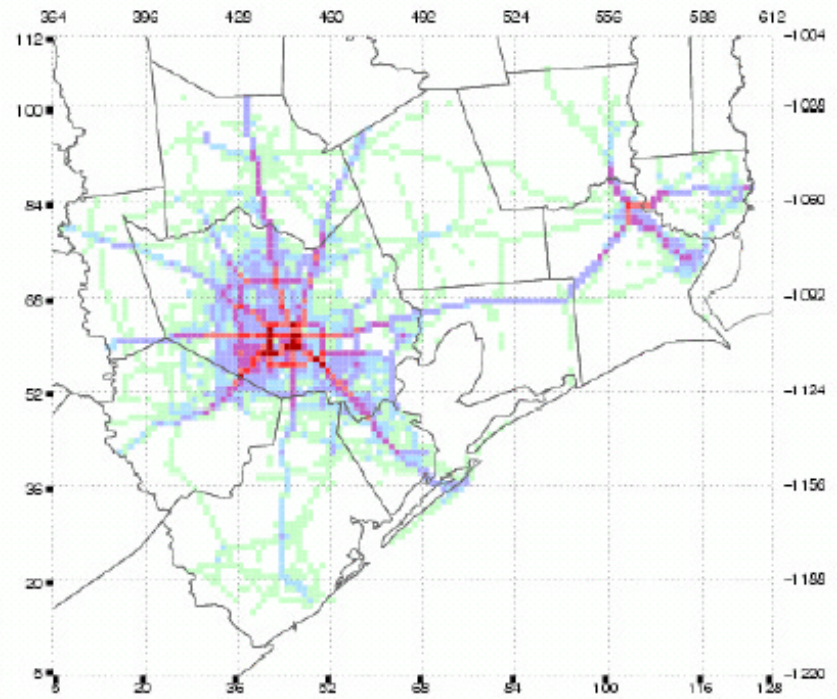



| Emissions Plotted | |
|---|---|
| County | Tons/Day |
| Brazoria | 192.85 |
| Chambers | 56.92 |
| Fort Bend | 112.98 |
| Galveston | 24.32 |
| Harris | 298.60 |
| Liberty | 459.81 |
| Montgomery | 466.26 |
| Waller | 100.46 |
| HG SUBTOTAL: | 1713.15 |
| Hardin | 427.90 |
| Jefferson | 68.67 |
| Orange | 108.85 |
| BPA SUBTOTAL: | 605.42 |
| MAP TOTAL: | 5798.24 |



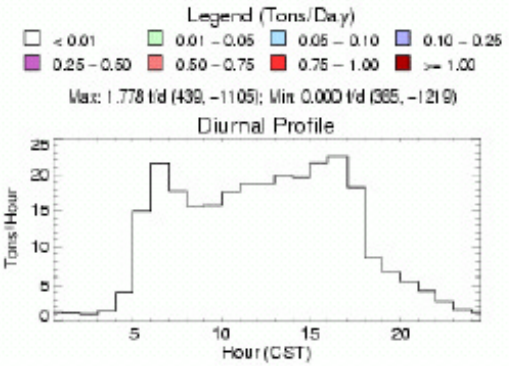
# On-Road Mobile Source Emissions, 8/30/2000

## $NO_X$

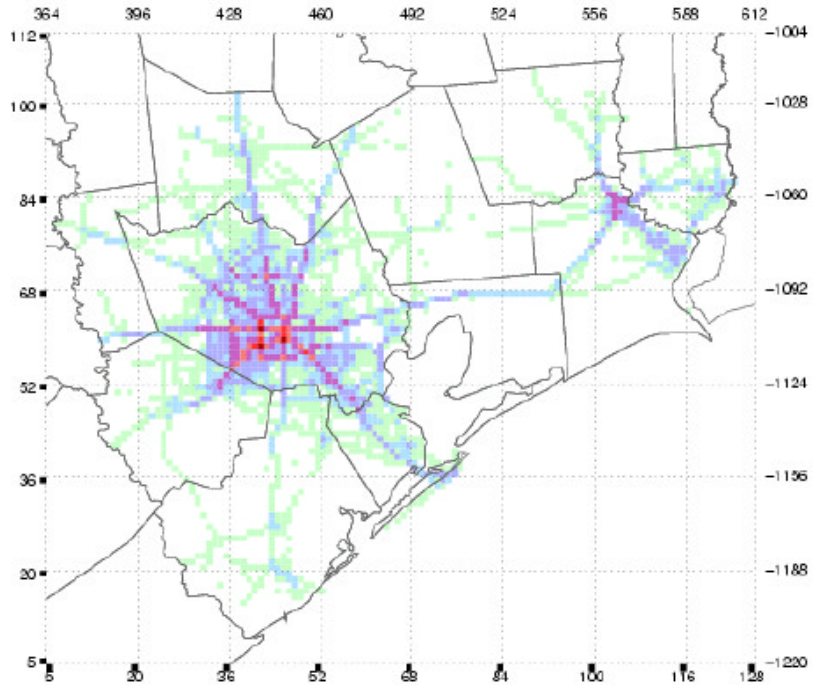



Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 11.66 |
| Chambers | 6.12 |
| Fort Bend | 13.46 |
| Galveston | 10.99 |
| Harris | 177.47 |
| Liberty | 4.69 |
| Montgomery | 15.69 |
| Waller | 4.15 |
| HG SUBTOTAL: | 244.25 |
| Hardin | 3.29 |
| Jefferson | 22.06 |
| Orange | 8.61 |
| BPA SUBTOTAL: | 33.97 |
| MAP TOTAL: | 280.18 |

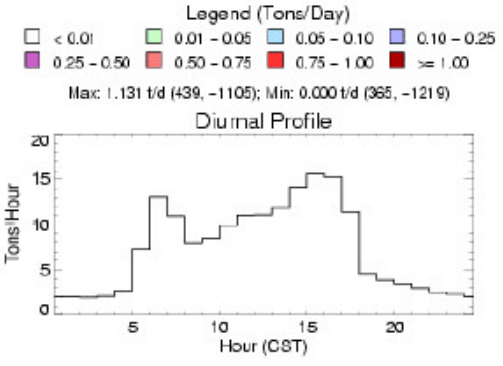



## CB-IV HC



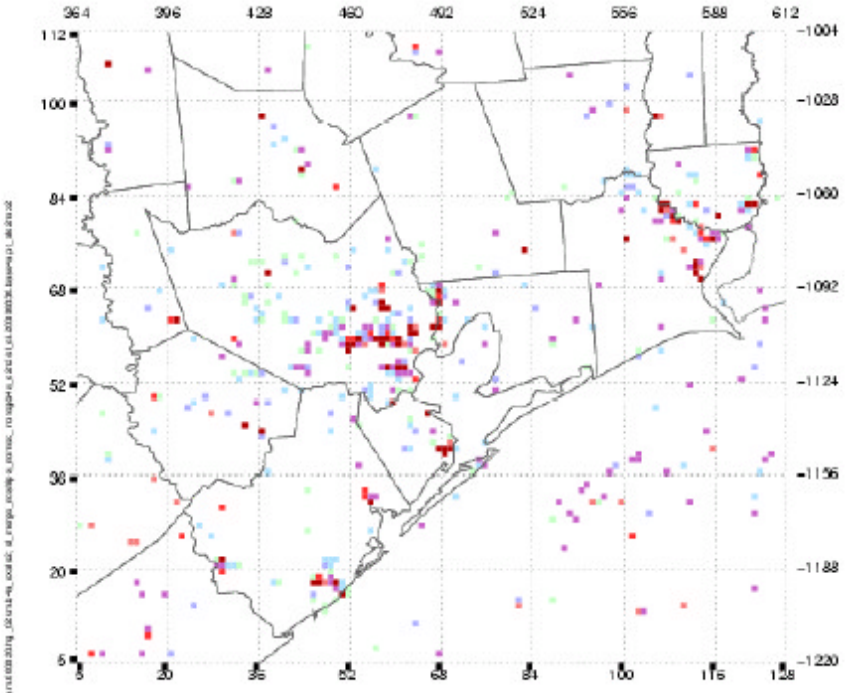

Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 7.43 |
| Chambers | 3.26 |
| Fort Bend | 8.37 |
| Galveston | 7.38 |
| Harris | 113.06 |
| Liberty | 3.08 |
| Montgomery | 9.59 |
| Waller | 2.72 |
| HG SUBTOTAL: | 154.89 |
| Hardin | 2.58 |
| Jefferson | 13.56 |
| Orange | 5.34 |
| BPA SUBTOTAL: | 21.49 |
| MAP TOTAL: | 177.68 |



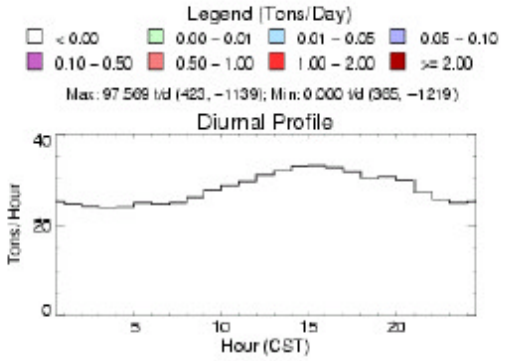
# Point Source Emissions, 8/30/2000

## $NO_X$

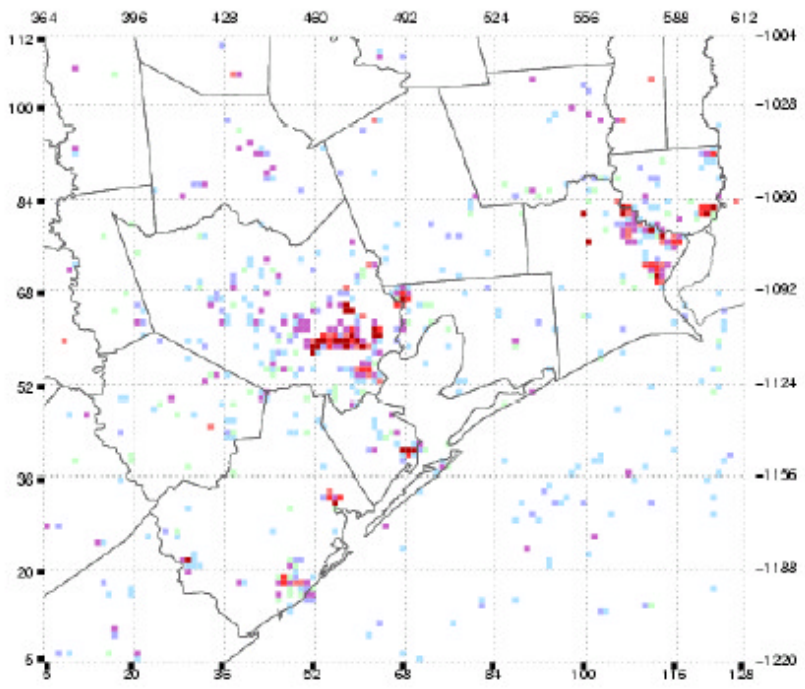



Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 59.54 |
| Chambers | 25.39 |
| Fort Bend | 103.12 |
| Galveston | 89.69 |
| Harris | 186.23 |
| Liberty | 6.59 |
| Montgomery | 13.74 |
| Waller | 5.39 |
| HG SUBTOTAL: | 489.70 |
| Hardin | 1.53 |
| Jefferson | 75.22 |
| Orange | 54.70 |
| BPA SUBTOTAL: | 131.45 |
| MAP TOTAL: | 967.05 |

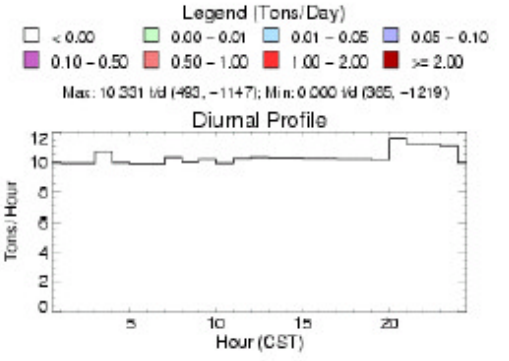



## CB-IV HC



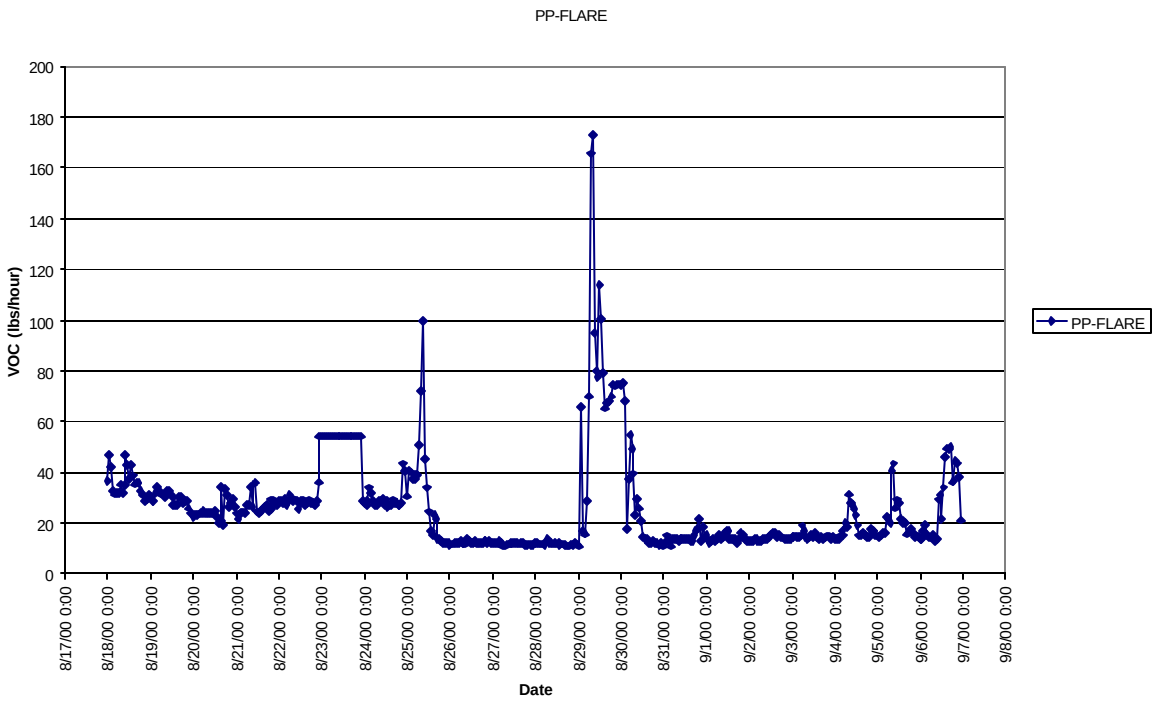

Emissions Plotted

| County | Tons/Day |
|---|---|
| Brazoria | 17.12 |
| Chambers | 8.70 |
| Fort Bend | 1.94 |
| Galveston | 28.86 |
| Harris | 117.26 |
| Liberty | 1.49 |
| Montgomery | 2.12 |
| Waller | 0.41 |
| HG SUBTOTAL: | 177.90 |
| Hardin | 1.66 |
| Jefferson | 41.50 |
| Orange | 17.17 |
| BPA SUBTOTAL: | 60.33 |
| MAP TOTAL: | 249.01 |



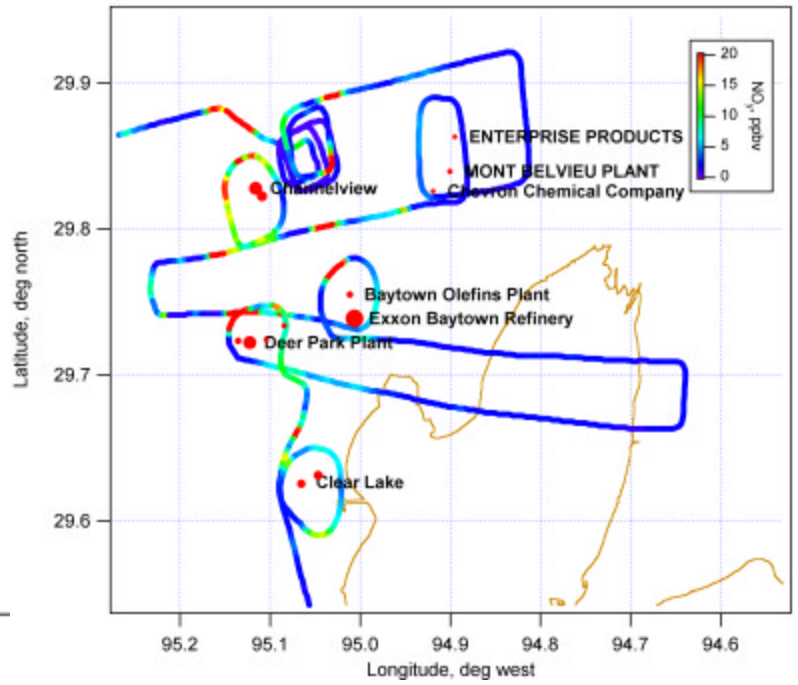
# The TexAQS Special Inventory

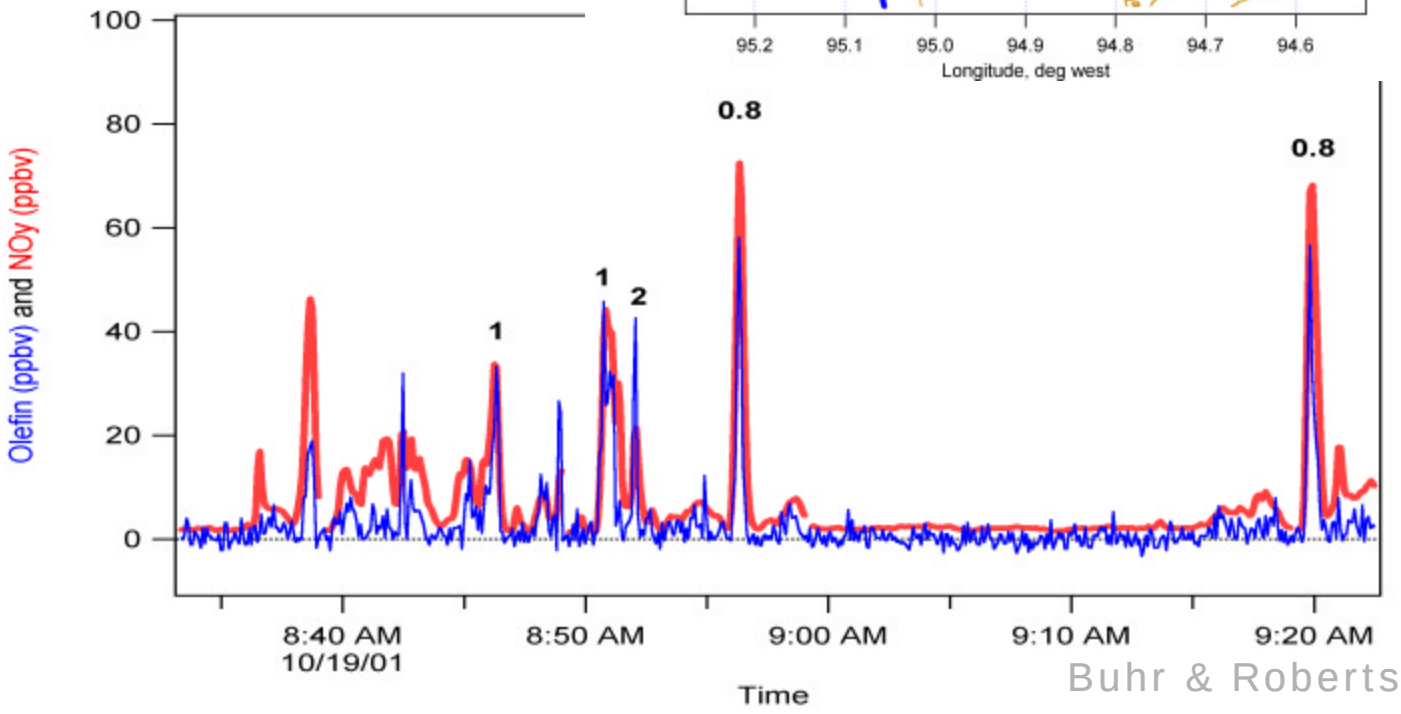
- Questionnaires mailed to 81 large accounts in HGB & BPA areas.
- Companies asked to report non-routine (> 20% different from OSD hourly average) emissions for Aug 15 - Sept 15, 2000.
- Speciation changes included.
- Non-SI upsets, reported maintenance were included.



Twin Otter flight path and continuous $NO_Y$ and olefin measurements, 10/19/01

Measurements suggest that emissions of olefins ≈ emissions of $NO_X$ from many industrial sources



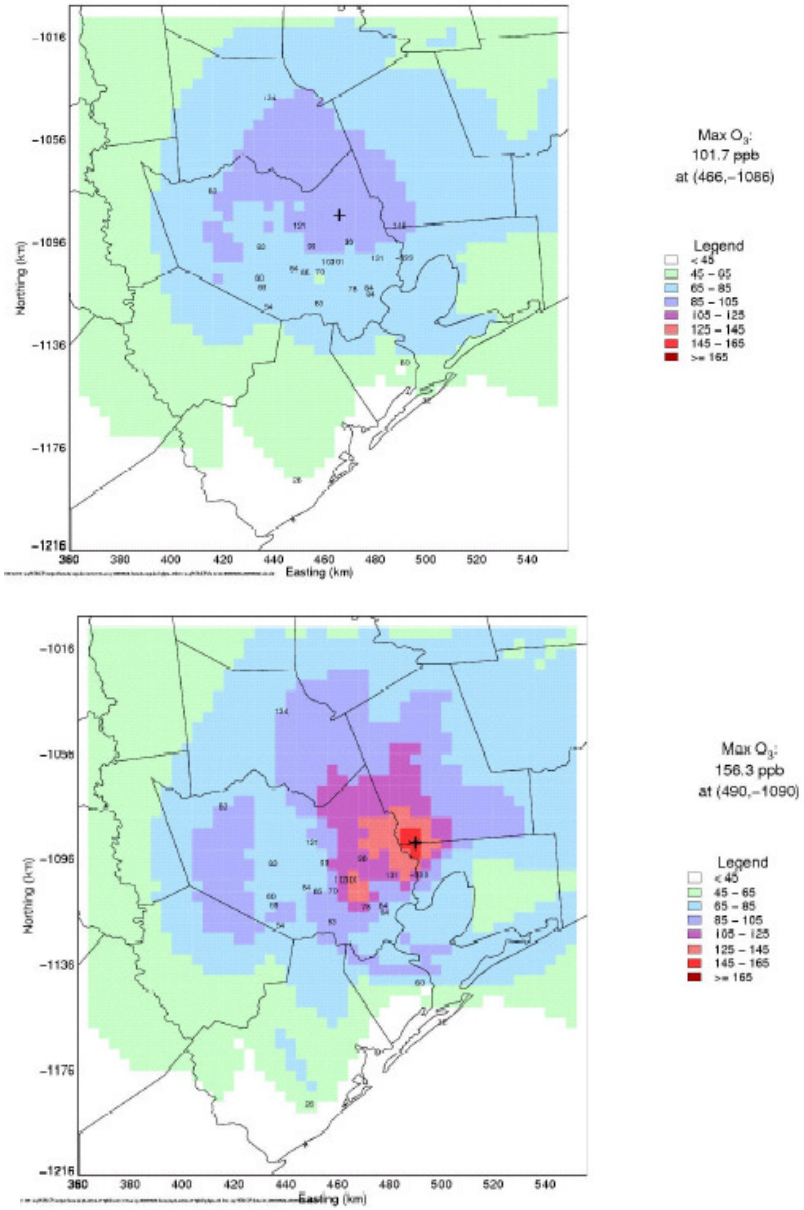
# August 29 Modeled Peak $O_3$

(2000 base case)

Point source HRVOC emissions were set = $NO_X$ emissions at 27 large industrial facilities.

Before adjustment (top) model badly under-predicts ozone peaks.

After adjustment (bottom)[1], modeled ozone concentrations agree much better with observations.




[1]Also reduced PBL by 30%.

# Issues

- What about other VOCs?
- What about $NO_X$?
- How do you use adjusted emissions in a SIP?
- How can controls be developed for emissions not in the inventory?
- What will EPA think?

# Emissions Inventory/Ambient Data Reconciliation Work for the Texas Gulf Coast

- Multiple approaches completed, underway, or planned:
  - Dispersion modeling with aircraft observations
  - Dispersion modeling with PAMS data
  - Ratio analysis (VOC/$NO_X$) with aircraft observations
  - Ratio analysis (VOC/$NO_X$) with PAMS data
  - Inverse modeling using CAMx (Environ)
  - Lagrangian Reactive Plume Modeling (Gillani)
  - Aircraft tracer sampling
- Also looking at non-olefinic VOC emissions