New Research for the Texas SIP: A Science-Policy Synthesis

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TERC Research Program

- Texas Environmental Research Consortium (TERC) formed to promote air quality research to support SIP for Houston and later DFW.
- Since 2002, TERC has funded over $10 MM of research (NOAA CIAP + TX HB1365).
- For FY2006-2007, TERC will deploy $5-6 MM in additional TERP funds for AQ research (TX HB 2481), including some from the NTRD program.
- Purpose of Science-Policy Synthesis is to guide allocation of funds to support TexAQS 2 + SIPs.

Key Dates for 8-Hour SIPs

SIP Revision	Proposal Documents Due	Adoption Documents Due
DFW	5/17/2006	11/15/2006
HGB	11/15/2006	6/16/2007
Regional Haze	5/2007	11/2007

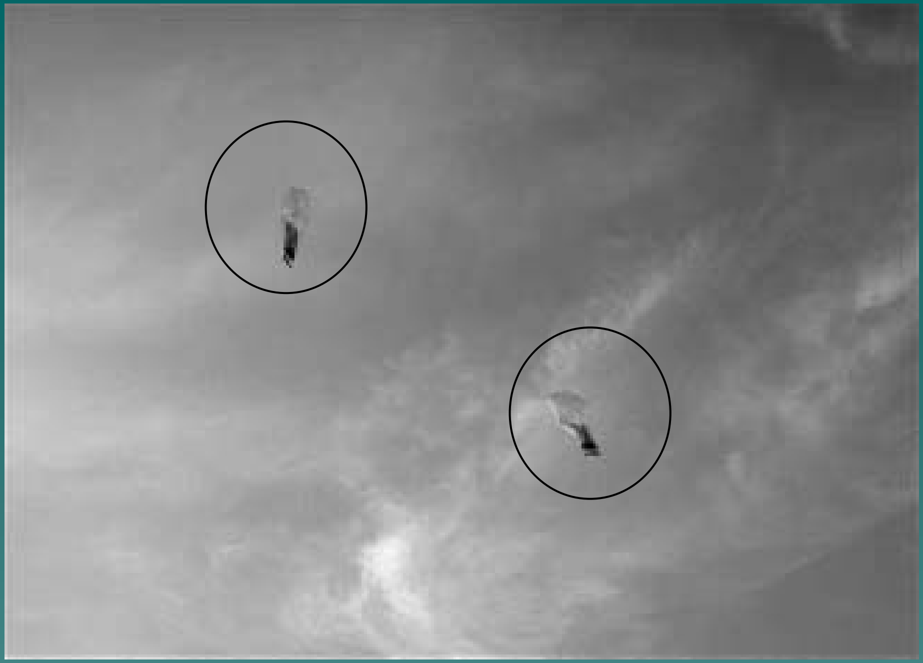
External input should be submitted about 3 months prior to each official date.

TERC 2005
Major Program Elements

- *TexAQS II 2005 Field Study*
  - Southeast Texas Transport Study (H39)
  - Northeast Texas Plume Study (H44, H44.A)
  - Real Time Meteorology and Air Quality Forecasting (H45)
- *SIP Modeling for DFW and HGB*
  - 8-Hr O_3 Conceptual Model (H12.8HRA)
  - Out-of-State Transport Impacts on DFW (H35)
  - HGB Model Sensitivity Analysis (H12.8HRB)
  - Urban Heat Island Modeling (H17.A)
- *Control Strategy Assessment*
  - HRVOC Emission Event Controls (H12.EE)
  - Out-of-State EGU Controls (H36)
  - Mobile Source Controls (H18.A, H37, H42)
  - Monitoring Strategy Assessment (H31)

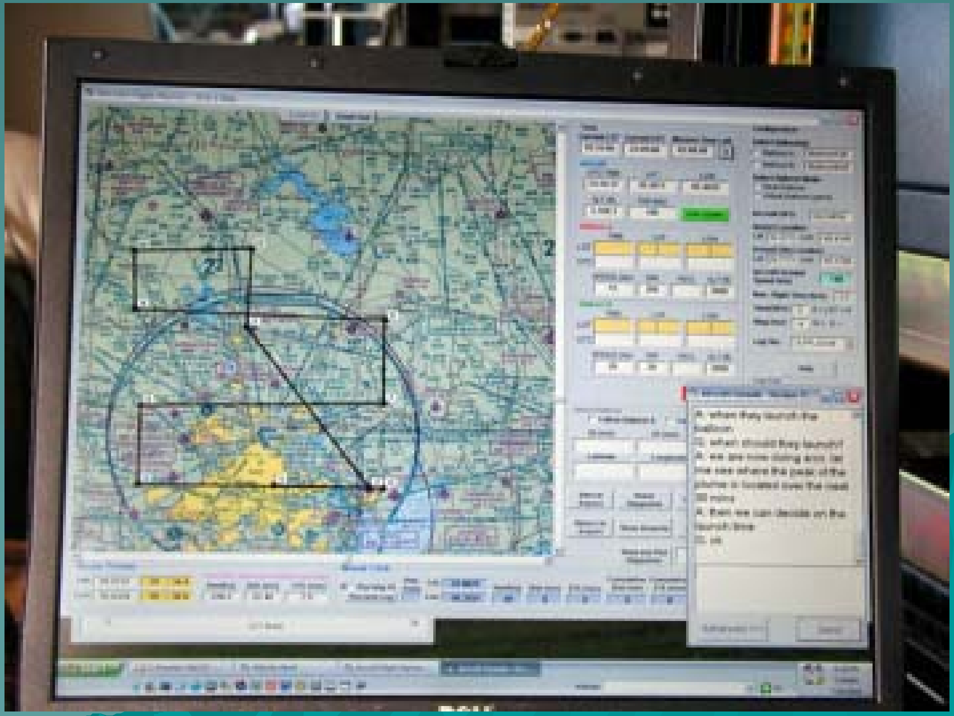
TexAQS II 2005

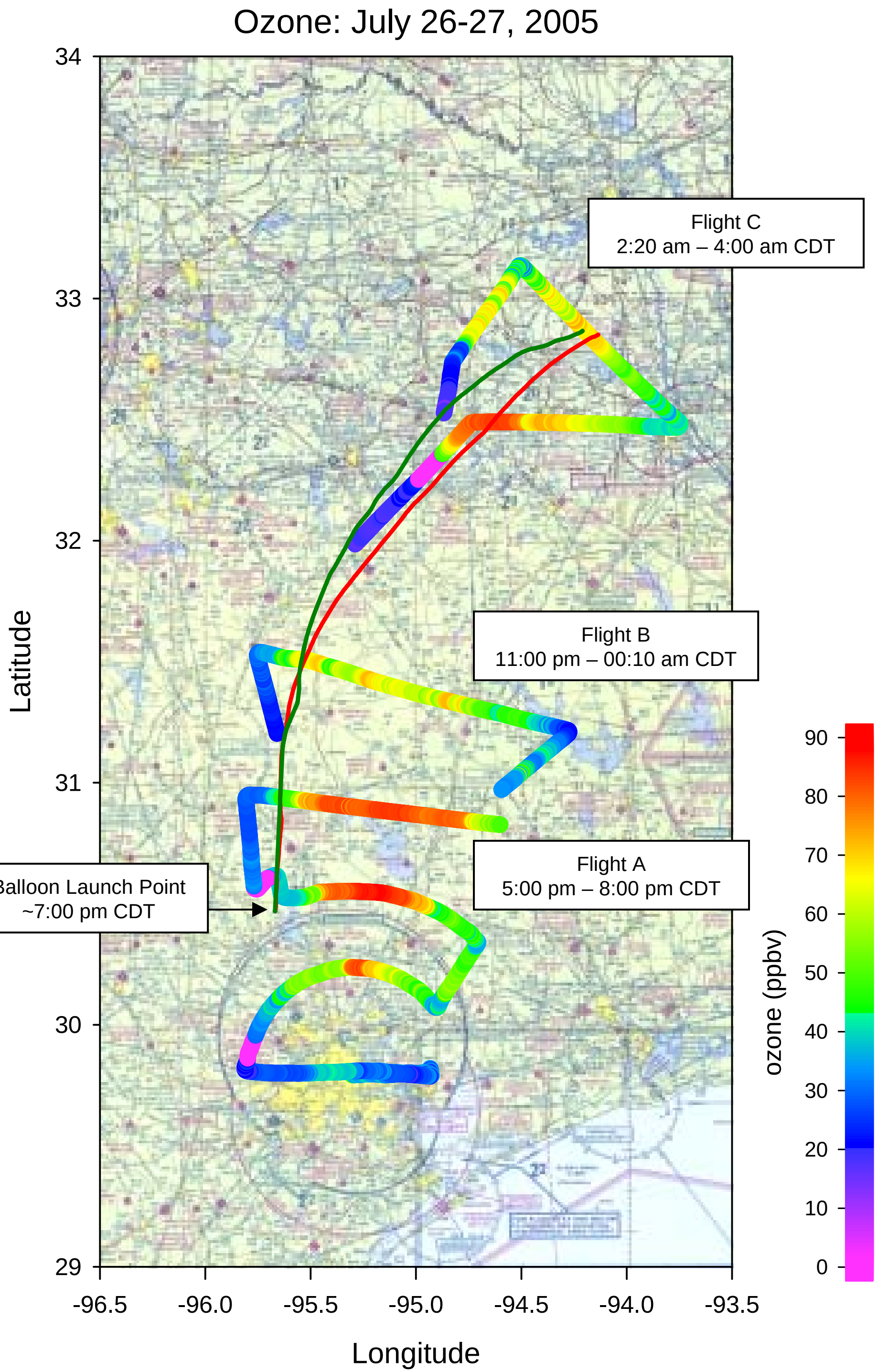
- Southeast Texas Transport Study (H39)
  - Tetroons as air parcel trajectory markers
  - Chase aircraft to measure ozone chemistry
- Northeast Texas Plume Study (H44, H44.A)
  - Aircraft to measure EGU plume impacts on DFW
  - UAH Lagrangian particle modeling for flight planning
- Real-time Forecasting (H45)
  - Meteorological forecasts by Texas A&M
  - Air Quality forecasts by University of Houston
- Supporting Instruments (H48, H56)
  - C-Band Radar (3-D wind profiling)
  - Proton Transfer Reaction Mass Spectrometery (VOCs)

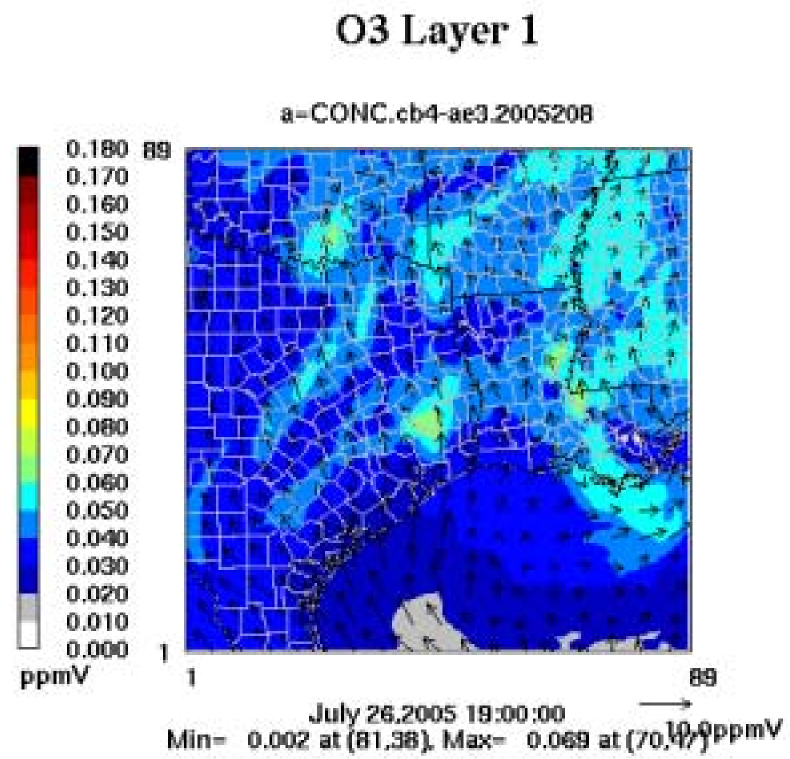


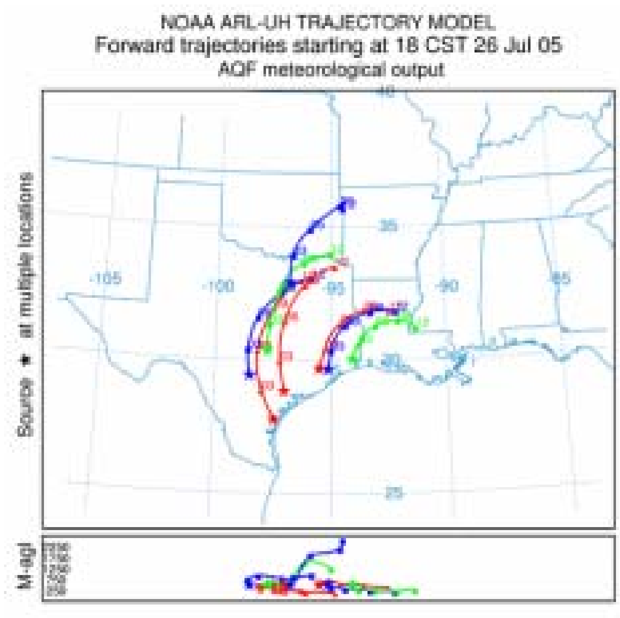
Real-time flight planning program on the aircraft, with the communication software used to track the balloons. This software, and associated satellite links and modems, allowed the pilots to safely navigate in the vicinity of the balloons.

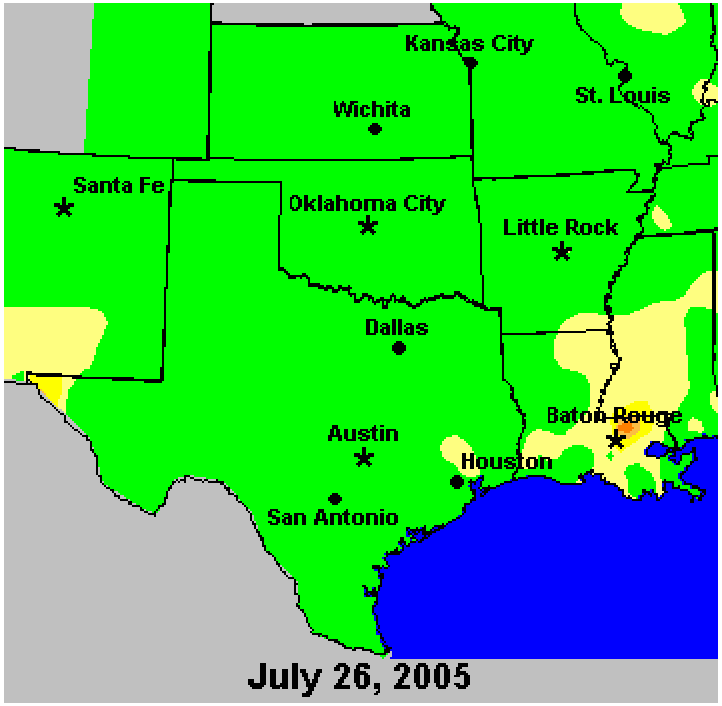
Two balloons shortly after launch (in circles) on July 26, ~0700 PM, LST. One balloon was programmed to fly at a constant altitude while the other made a series of soundings that provided information on the vertical stability of the atmosphere and winds.

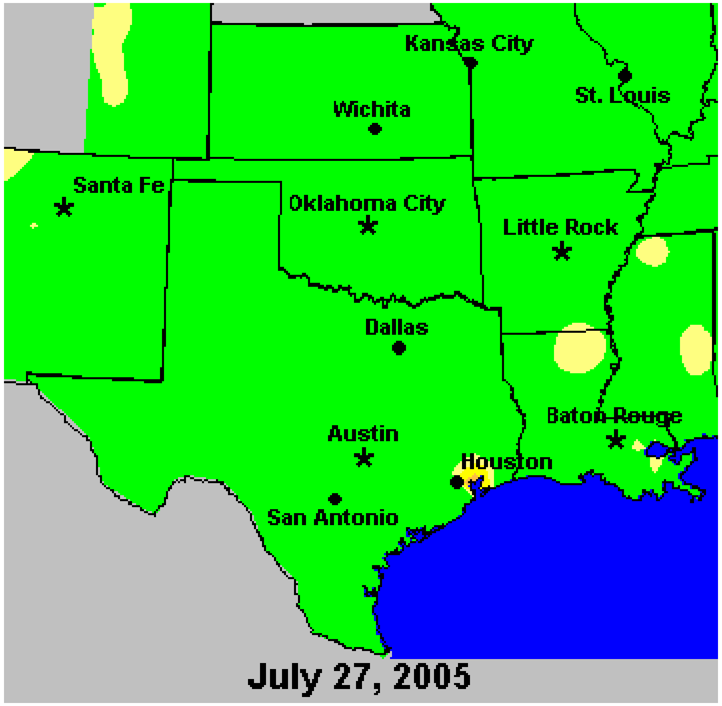



Ozone: July 26-27, 2005
Flight C
2:20 am – 4:00 am CDT
Flight B
11:00 pm – 00:10 am CDT
Flight A
5:00 pm – 8:00 pm CDT
Balloon Launch Point
~7:00 pm CDT
Latitude
Longitude
ozone (ppbv)
34
33
32
31
30
29
-96.5
-96.0
-95.5
-95.0
-94.5
-94.0
-93.5
90
80
70
60
50
40
30
20
10
0


O3 Layer 1
a=CONC.cb4-ae3.2005208
0.180
0.170
0.160
0.150
0.140
0.130
0.120
0.110
0.100
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
ppmV
89
1
1
89
July 26,2005 19:00:00
Min= 0.002 at (81,38), Max= 0.069 at (70,47)
10.0ppmV


NOAA ARL-UH TRAJECTORY MODEL
Forward trajectories starting at 18 CST 26 Jul 05
AQF meteorological output
Source ★ at multiple locations
M-agl





Images from EPA's Air Now site show the observed 1-hr peak ozone on July 26 and 27. Green is below 60 ppb.

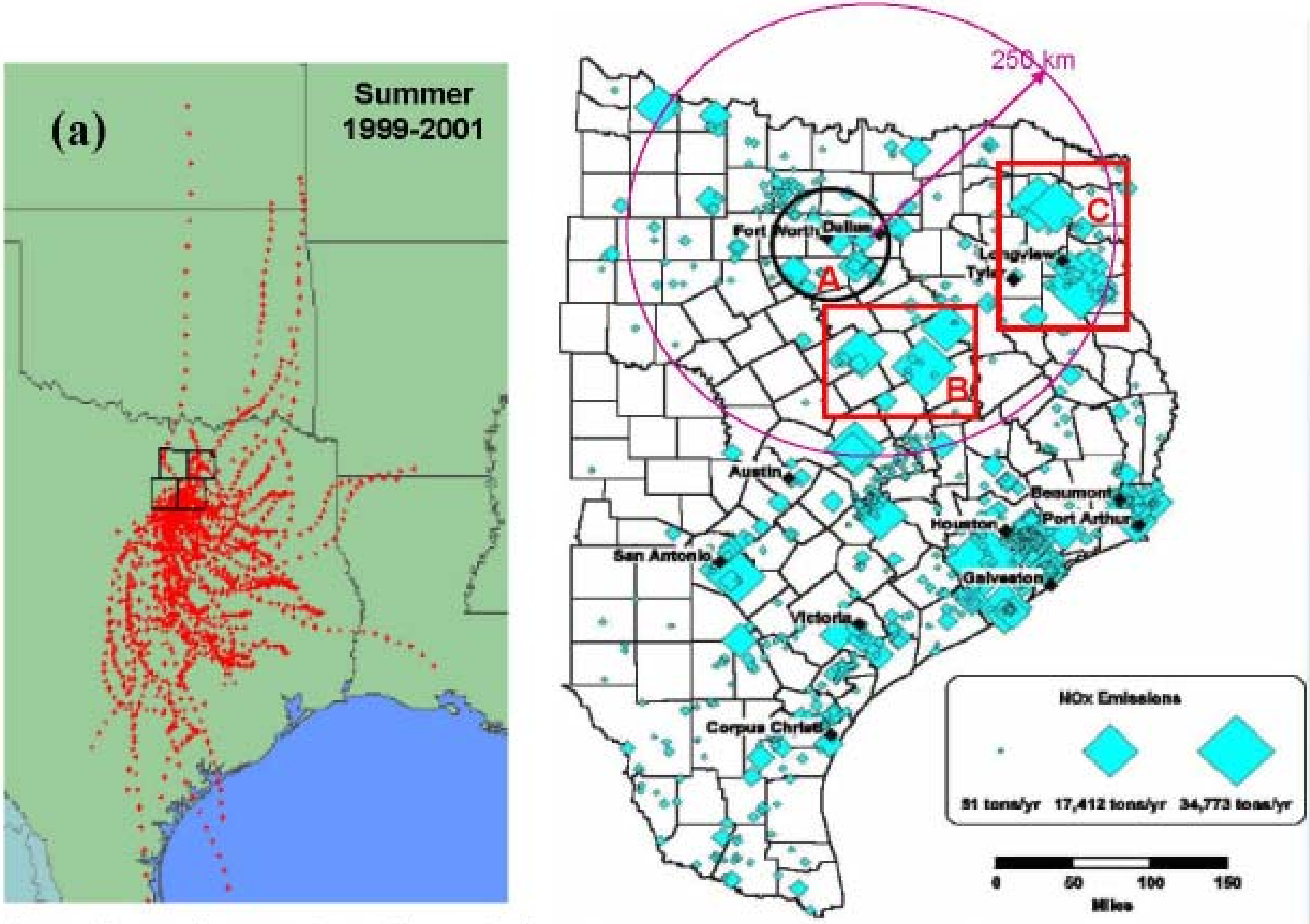


Figure 2. (a) A map of E. Texas and surrounding states showing a climatology of 24-hour back-trajectories from the four-county DFW ozone non-attainment area on high-ozone days during summers 1999-2001, and (b) a map of E. Texas showing major NOx sources. In (b), the NETPS study area of radius 250 km from Dallas is highlighted and delineated into three zones A, B, C. The impact on DFW ozone of NOx sources in these zones will be the principal goal of NETPS (adapted from Breitenbach, 2003).

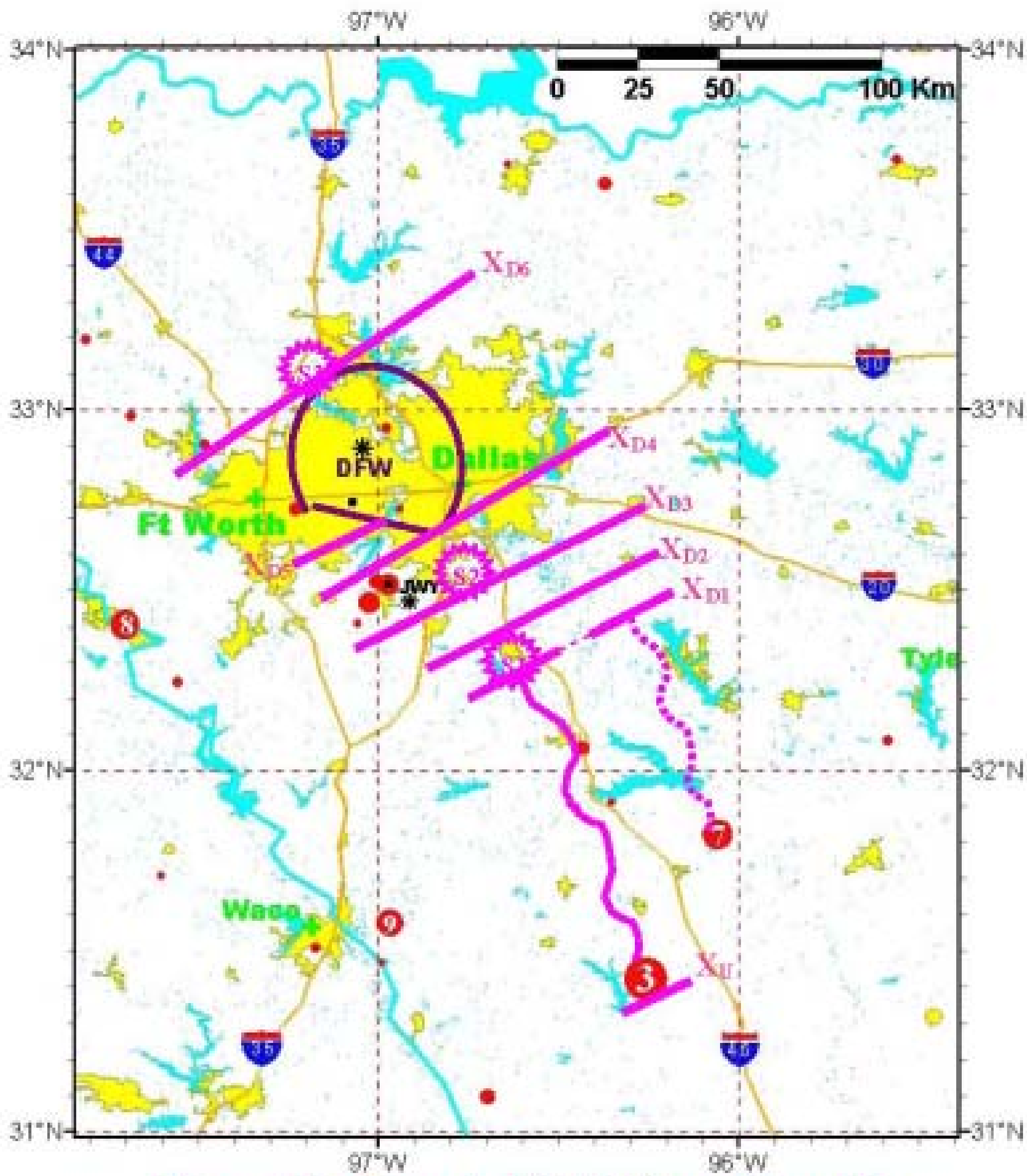


Figure 15. Sample Flight Plan: Zone B --- Limestone/Big Brown Powerplants

Flight Plan (Limestone ~0330 release) (Big Brown ~ 0430 release)

0645 Take-off (JWY)

0645-0725 Ferry to X_U

0725-0810 X_U 1T(5nm, 1000') and Limestone plume tracking, X_U to X_{D1} (~60nm)

0805-0850 Sampling at X_{D1} (~5h)
S_1(L, 5000'+); **HC1**
1T(L & BB+ @ ~ plume heights)

0855-0955 Sampling at X_{D2} (~6h)
2T(plumes+, ~40nm @ 1000', 2000')
HC2-bg

1000-1100 Sampling at X_{D3} (~7h)
1T(plumes+upwind of Ellis CO sources, 50nm+, @ 1500'); S_3(L, Z_i(+)) **HC3-L**

1115-1145 Land/refuel at JWY

1145-1150 TO/ferry to X_{D4}

1150-1310 Sampling at X_{D4} (~ 9h) --- L+B+Ellis CO
2T(~55nm @ 1500', 3000') **HC4 (E)**

1250-1320 Sampling at X_{D5} (Ellis CO plumes)
2T(plumes+, <20nm, @ 1000', 2500') **HC5(E)**

1320-1345 Ferry to X_{D6}

1345-1525 Sampling at X_{D6} (Downwind of No-Fly))
2T(<60nm @ 1500', 3000' and 90 knots)
S_4(P, Z_i(+)); **HC6-bg**

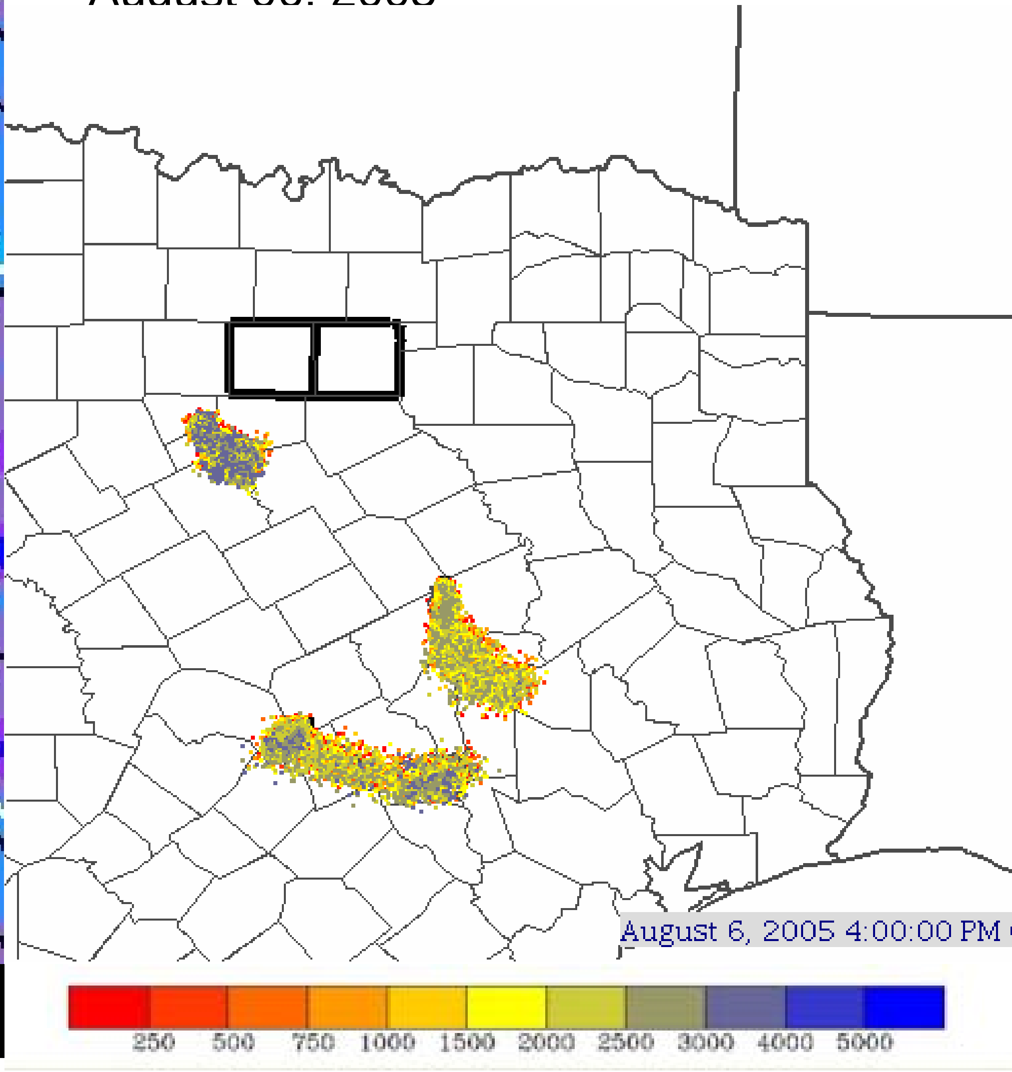
1525-1545 Ferry/Land JWY

Total flight time used: 8h 30min

Long ferry speed ~ 125+ knots
Plume sampling speed ~ 80 knots

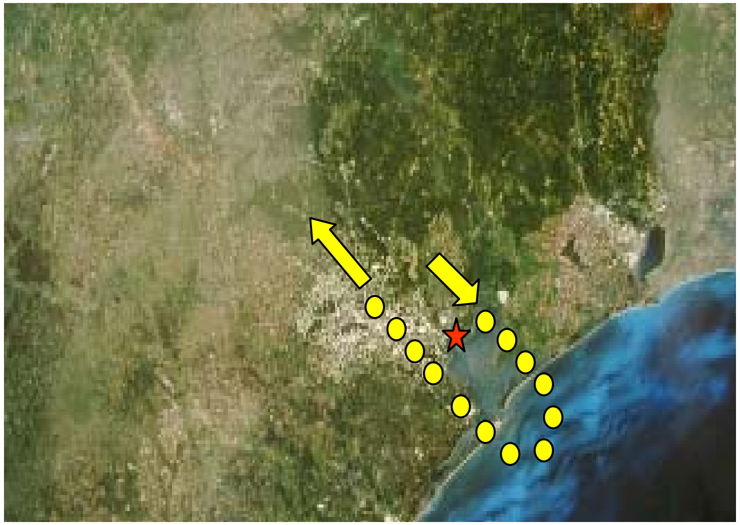
MM5 Winds Aug 06, 2005 4:00:00 PM CDT

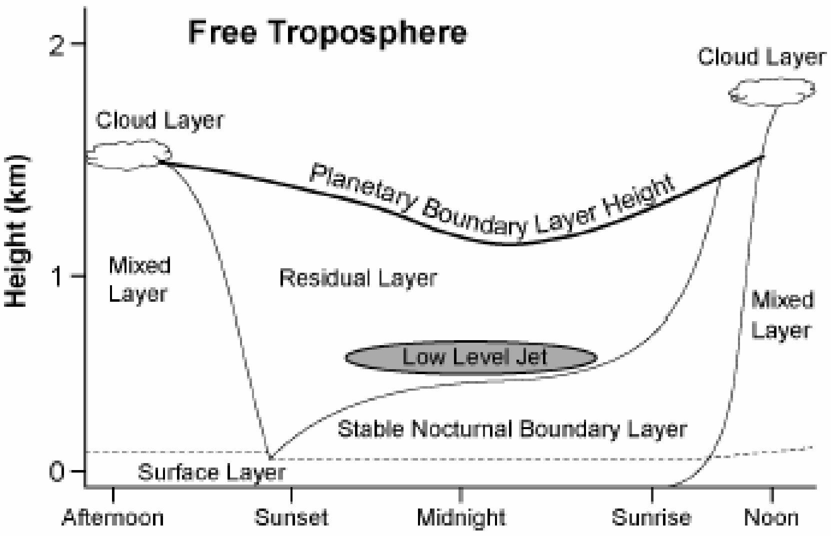
12-hour Lagrangian Particle Model run, August 06, 2005



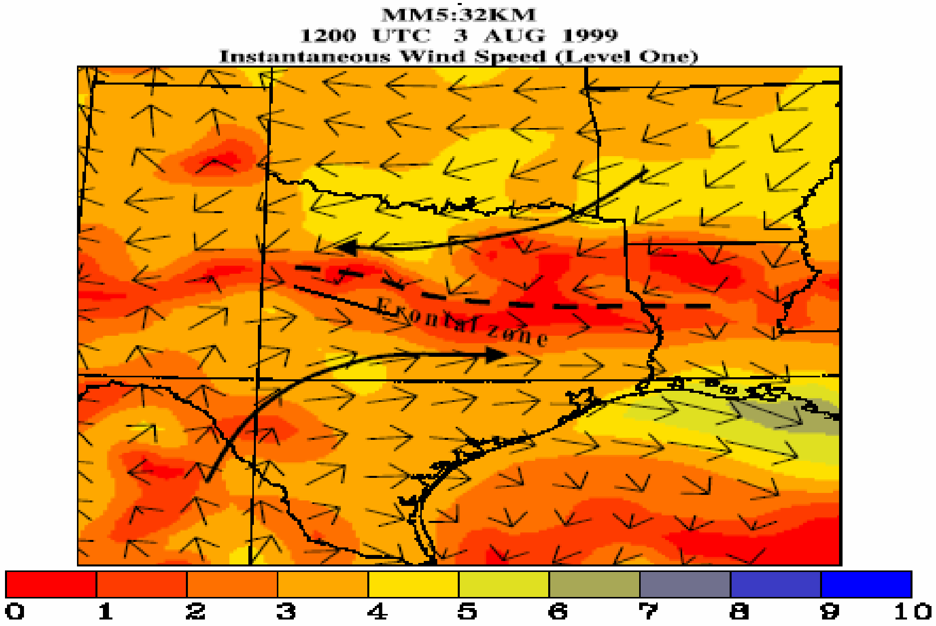
TexAQS 2006 Research Needs
Meteorological Mechanisms

Mechanism	Importance to Air Quality
Sea Breeze	Slow wind rotation traps pollution over Houston, allowing ozone to “cook” longer.
Nocturnal Jet	A fast night-time wind near the surface can spew pollution large distances downwind.
PBL Evolution	PBL height determines the concentration of ozone precursors and the efficiency of ozone formation.
Cumulus Convection	Cumulus towers rapidly vent pollution to free troposphere where it can be transported long distances. Slow subsidence around cumulus towers can also entrain pollution back into PBL.
Vertical Diffusion	Transfers pollution from surface to higher levels, raising O_3 (high NOx) or diluting O_3 (low NOx).
Stationary Front	Causes “dead zones” allowing O_3 to “cook” longer or bring pollution down from free troposphere.





Free Troposphere
Cloud Layer
Cloud Layer
Planetary Boundary Layer Height
Mixed Layer
Residual Layer
Mixed Layer
Low Level Jet
Stable Nocturnal Boundary Layer
Surface Layer
Height (km)
2
1
0
Afternoon
Sunset
Midnight
Sunrise
Noon



MM5:32KM
1200 UTC 3 AUG 1999
Instantaneous Wind Speed (Level One)
Frontal zone
0 1 2 3 4 5 6 7 8 9 10

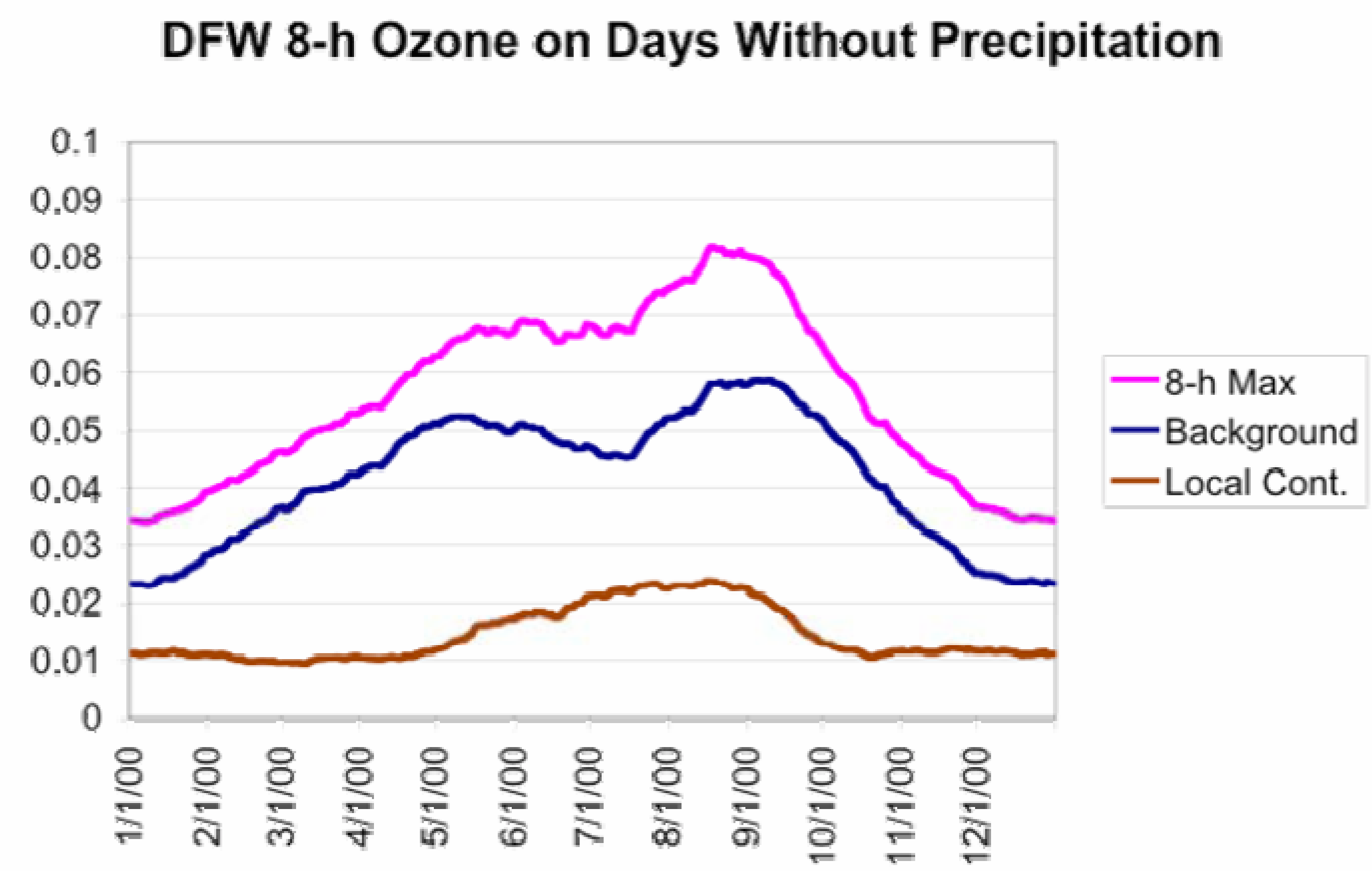
Background Ozone and Transport

- Episode Average APCA Contributions to 8-Hr O_3 Exceedances in DFW during August 1999 (H27)

Source Category	**Ozone Contribution**
Intra-State Transport	11.7 ppb
Out-of-State Transport	11.3 ppb
Model Boundary Conditions	31.3 ppb
Total Background	**54.3 ppb (agrees with H12.8HRA)**
Local Production	**39.5 ppb**

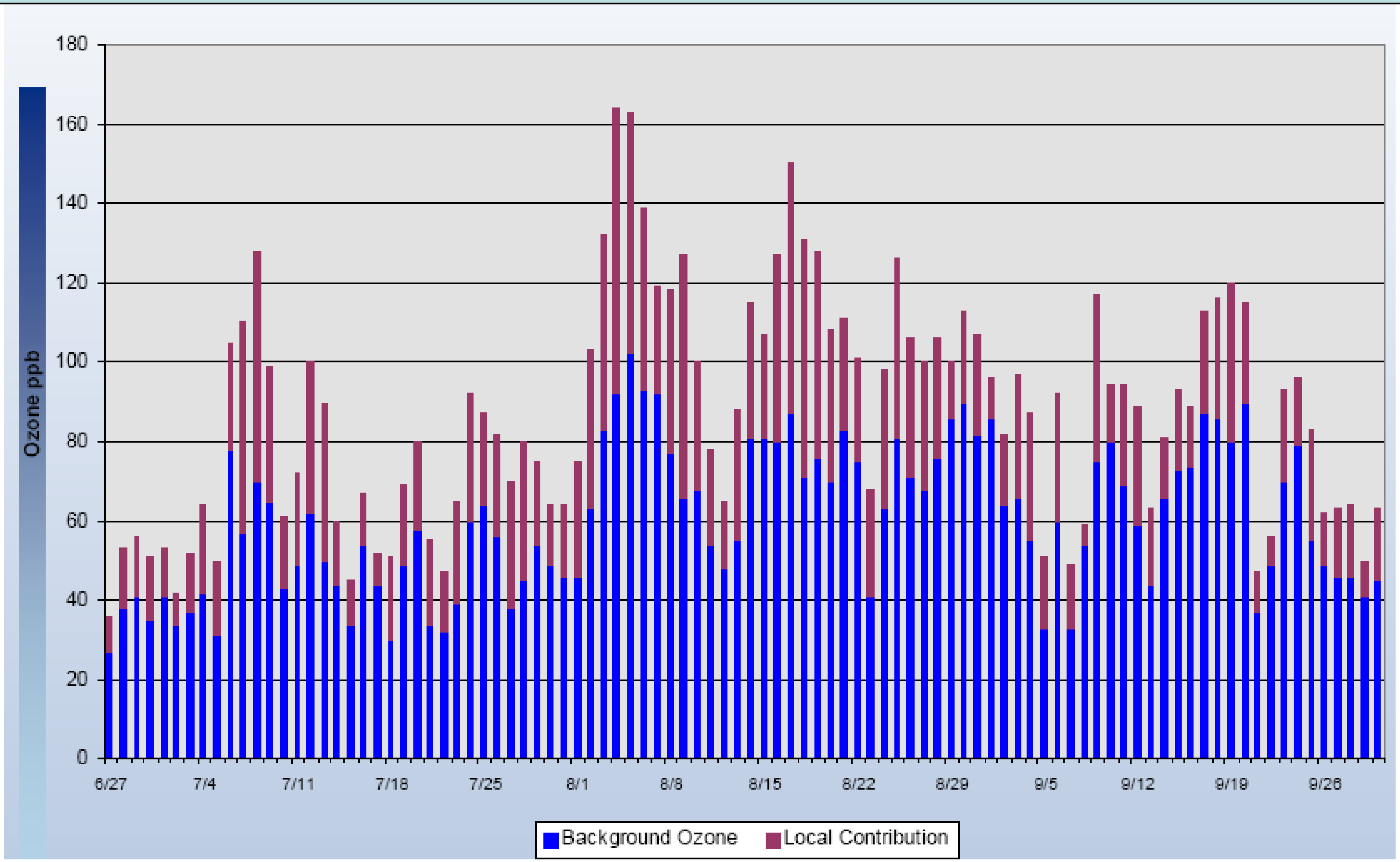
- Natural background ozone (~20 ppb) vs. anthropogenic background ozone (~34.3 ppb) vs. local ozone (~39.5 ppb)
- CAIR rule impact on DFW < 0.3 ppb (H35)
- Houston and BC contribution uncertainty ~2 ppb (H35)

H12.8HRA Upwind/Downwind



Six year average

TCEQ Upwind/Downwind by Day



SIP Modeling
East Texas Research Needs

- Better treatments of transport and chemistry of O_3 and precursors aloft, both night and day.
- Improved simulation of vertical exchange between the surface and layers aloft.
- Better characterization of emissions sources at large distances upwind.
- Include seasonal behavior of background ozone.
- Improved modeling of LU/LC and biogenics.
- Better boundary conditions (link to global model?).

SIP Modeling
DFW Research Needs

- Monitoring for ozone precursors
  - More sites and species (NOx, VOC, CO, SO_2)
  - Long-term trends -- beyond field study
- Control strategy catalogue
  - Local and regional (work in progress)
  - Mine existing results for contribution estimates
  - Coordinate with regional haze SIP
- DFW urban/suburban biogenic VOCs
  - Check and refine these critical emissions
- Integrate future land-use planning with SIP
  - Long-term urban growth patterns

SIP Modeling
HGB Research Needs

- Better quantification/resolution of HRVOC emissions.
- Better tree speciation in modeling biogenic emissions.
- Better treatment of Galveston Bay influence.
- Vastly improved meteorology (sea breeze, night-time winds, vertical mixing, etc.)
- More detailed ozone chemistry, including OVOCs, radical sources and sinks, and reactive nitrogen.
- Incorporation of springtime episodes to account for 8-hour design values and to satisfy EPA guidance.
- More certainty as to how ozone responds to control strategies (SIP model has too much VOC and NOx; grossly inefficient O_3 production).

Control Strategies
Major Findings

- Significant OVOC co-benefits to controlling annual, but not event, HRVOC emissions.
- Concentrated HRVOC hot spots are unlikely to result from HRVOC emissions trading.
- Need many (~20) more VOC speciation monitors to detect emission events in Houston.
- Locomotive NOx emissions may be 32% lower for HGB, 26% lower for DFW, compared to previous estimates.
- NOx from major sources such as EGUs in some States are subject to less stringent control than in Texas.
- Possible emission reduction benefits from CA LEV II.
- TERP emission reductions could fall short of SIP goals, particularly in the Houston region.

Control Strategies
Research Needs

- We need to determine the feasibility and effectiveness of out-of-State controls beyond CAIR rule to reduce transport.
- We need to find new alternatives to previously proposed control strategies.
  - Better assess impacts of CA LEV II adoption.
  - Reduce NOx from compressor engines.
  - Study benefits of controlling OVOCs.