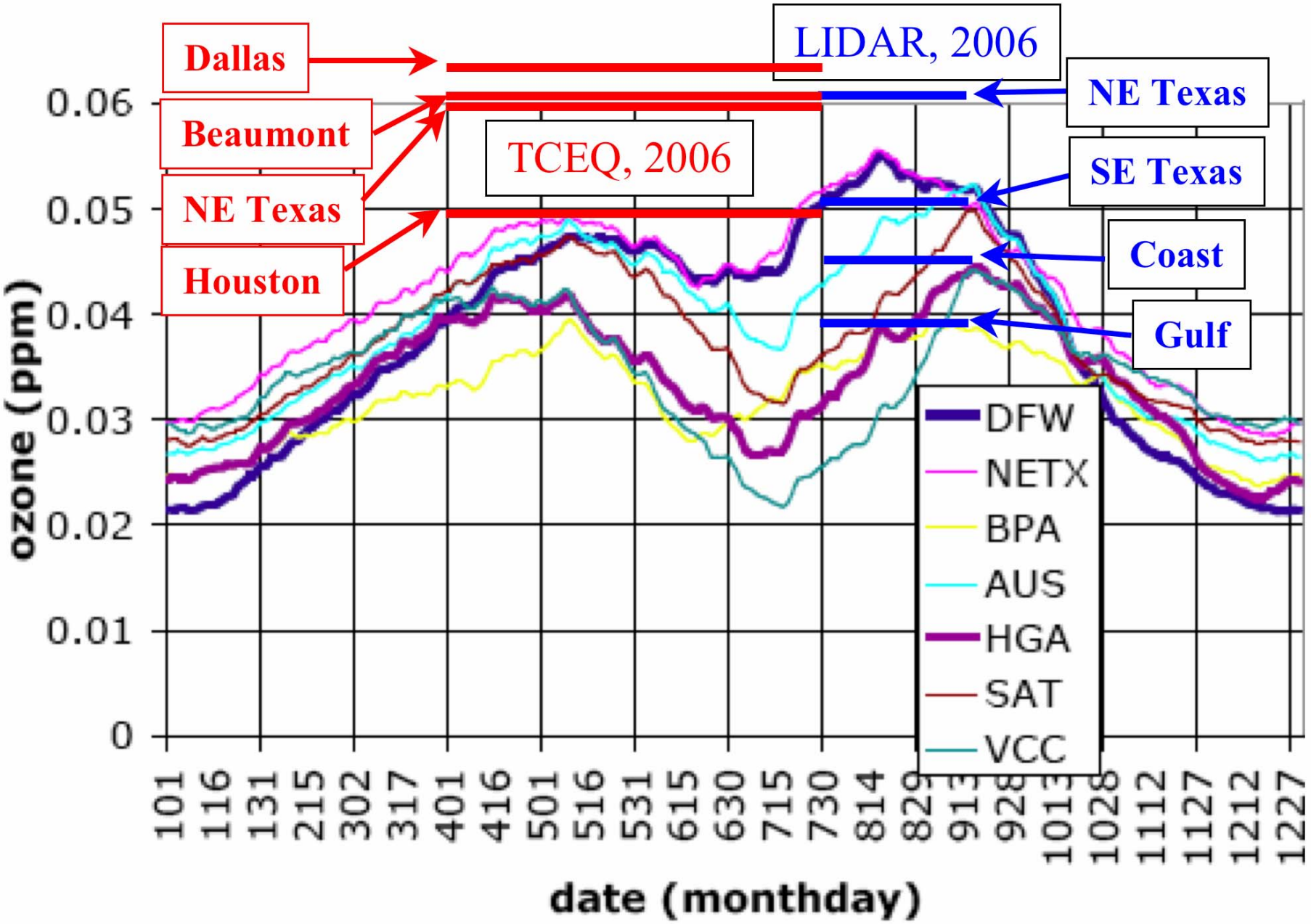
Top Ten Findings from the Rapid Science Synthesis

Southeast Texas Photochemical Modeling Technical Committee
Presented by Mark Estes, TCEQ

September 11, 2007

1. Background ozone can be higher than 85 ppbv, but it's usually about 50 ppbv.


Dallas
Beaumont
NE Texas
Houston
LIDAR, 2006
TCEQ, 2006
NE Texas
SE Texas
Coast
Gulf
DFW
NETX
BPA
AUS
HGA
SAT
VCC
ozone (ppm)
0.06
0.05
0.04
0.03
0.02
0.01
0
101
116
131
215
302
317
401
416
501
516
531
615
630
715
730
814
829
913
928
1013
1028
1112
1127
1212
1227
date (monthday)

2. “Background ozone” may include recirculated pollution

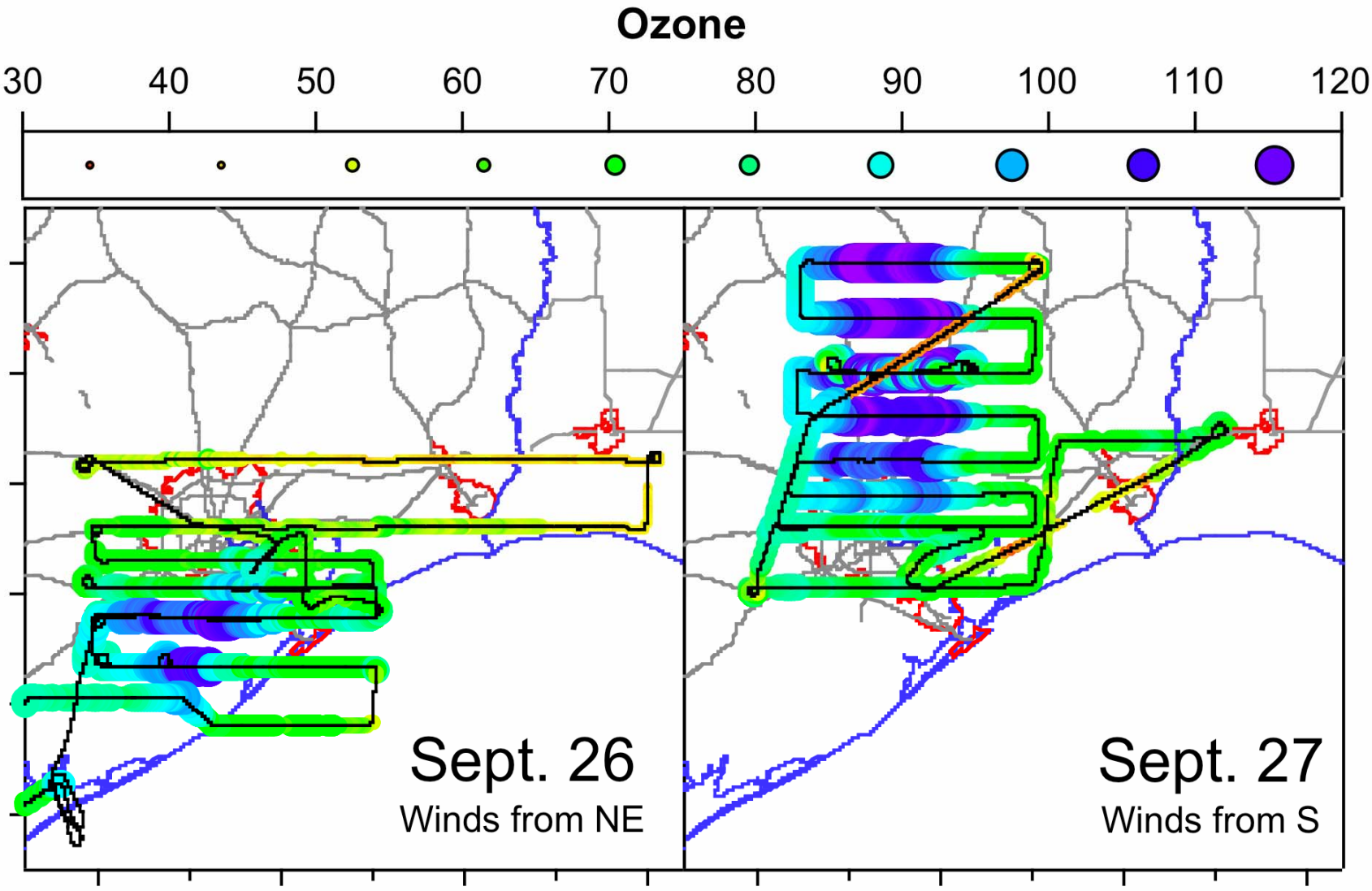
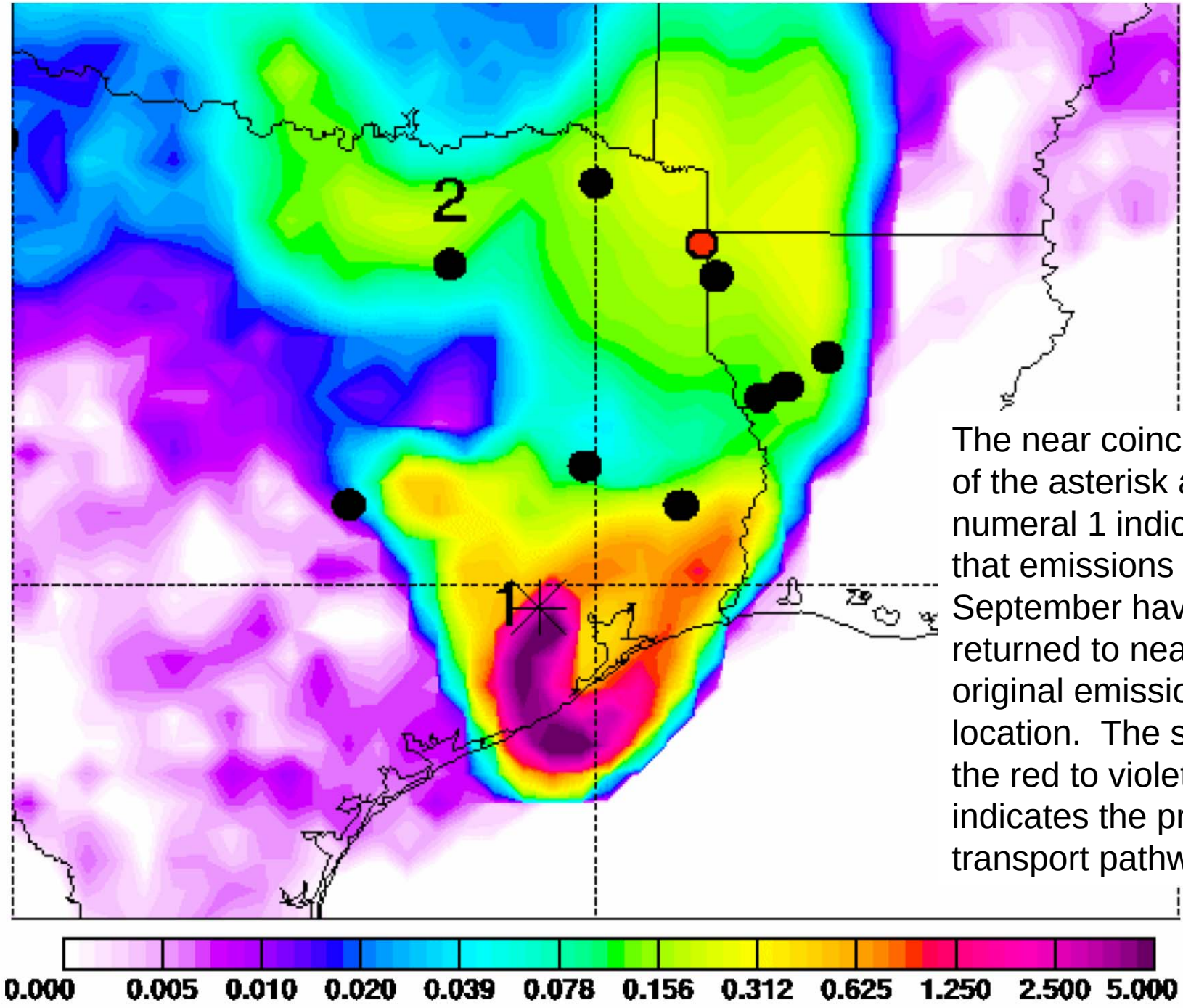


Figure G5: WP-3D flight tracks within the boundary layer in the HGB area on two successive flights color-coded and sized according to the measured O3 concentration.

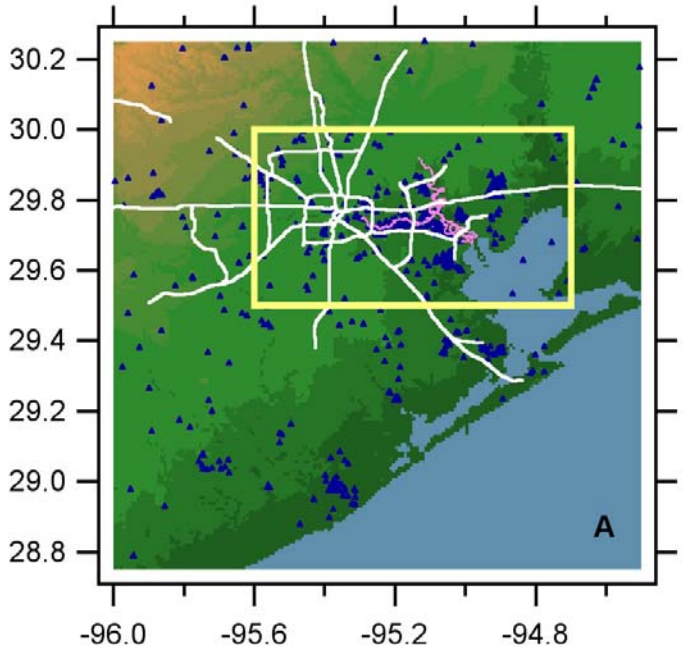


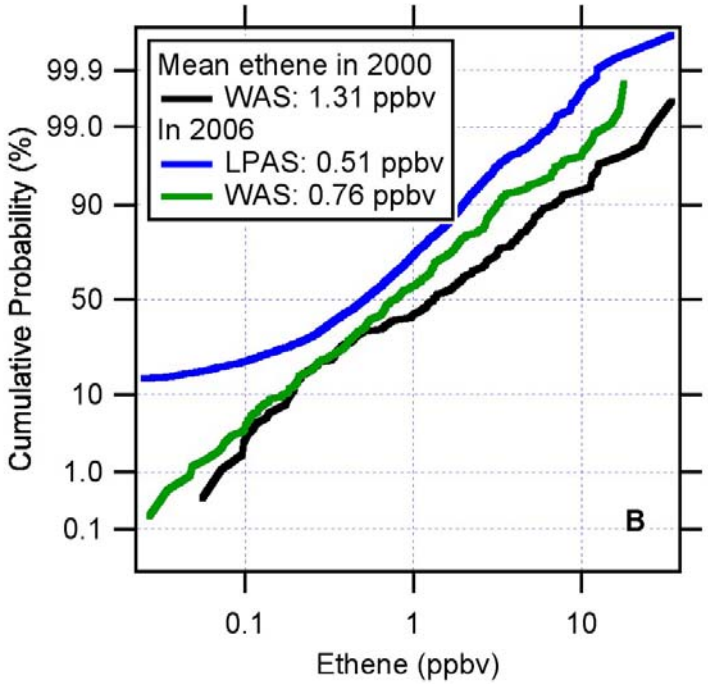
The near coincidence of the asterisk and the numeral 1 indicates that emissions from 26 September have been returned to near the original emission location. The shape of the red to violet colors indicates the primary transport pathways.

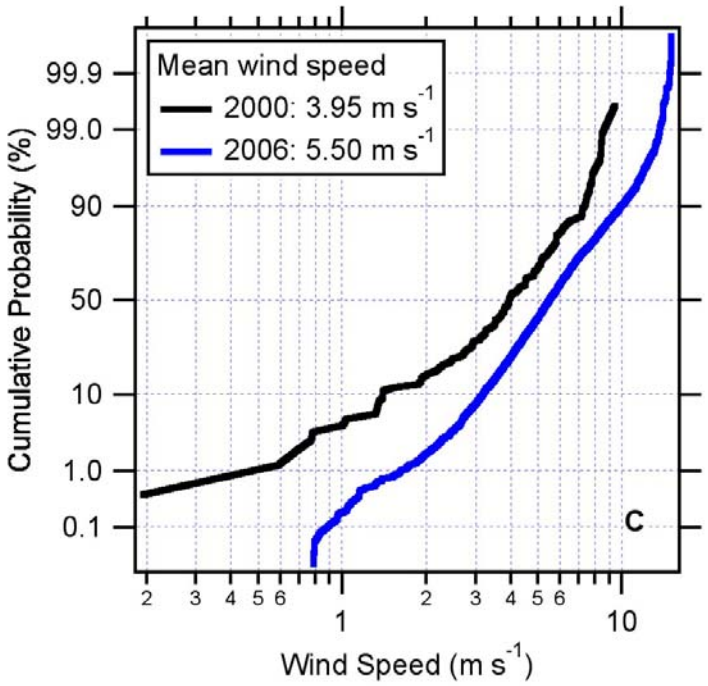
3. Use latest versions of both the Carbon Bond and SAPRC chemical mechanisms when testing control strategies. Stay tuned for more information about this topic.

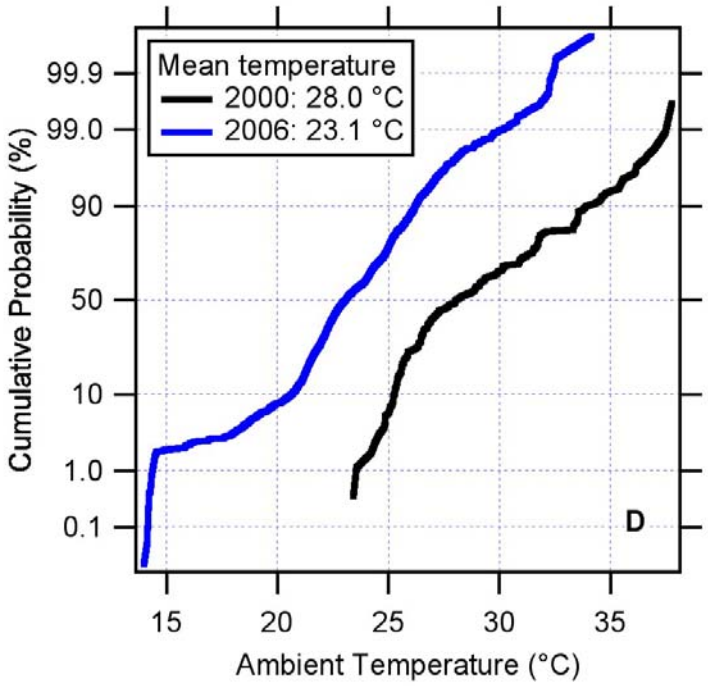
4. Industrial emissions → high HRVOCs+NOx plume(s) → rapid & efficient ozone formation → plume(s) of high ozone + wind shift (bay breeze/coastal oscillation) → “transient” high ozone

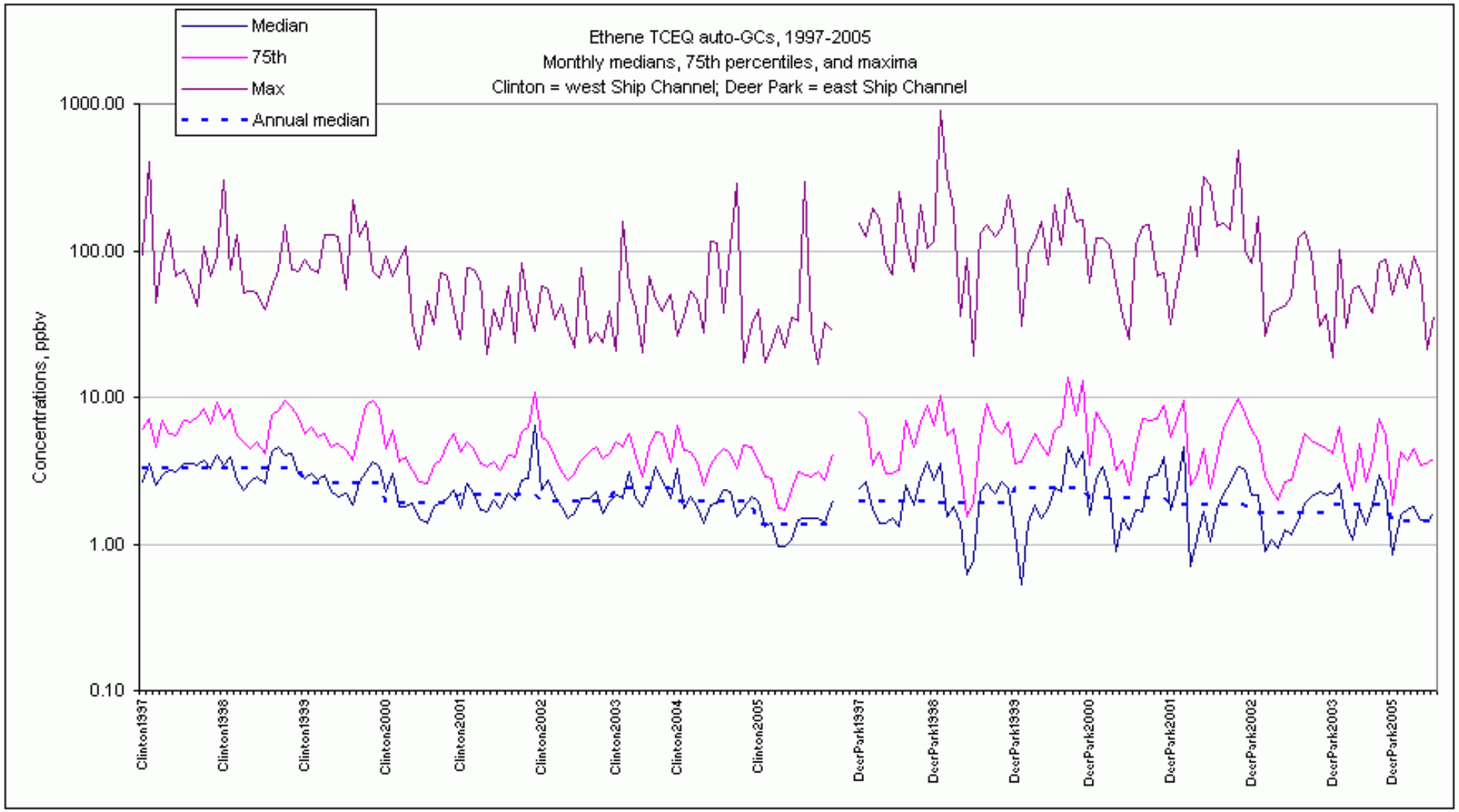
5. Ethene concentrations have decreased by about 40% since 2000.


30.2
30.0
29.8
29.6
29.4
29.2
29.0
28.8
-96.0
-95.6
-95.2
-94.8
A


Mean ethene in 2000
WAS: 1.31 ppbv
In 2006
LPAS: 0.51 ppbv
WAS: 0.76 ppbv
Cumulative Probability (%)
99.9
99.0
90
50
10
1.0
0.1
0.1
1
10
Ethene (ppbv)
B


Mean wind speed
2000: 3.95 m s-1
2006: 5.50 m s-1
Cumulative Probability (%)
99.9
99.0
90
50
10
1.0
0.1
2 3 4 5 6
1
2 3 4 5 6
10
Wind Speed (m s-1)
C


Mean temperature
2000: 28.0 °C
2006: 23.1 °C
Cumulative Probability (%)
99.9
99.0
90
50
10
1.0
0.1
15
20
25
30
35
Ambient Temperature (°C)
D


Median
75th
Max
Annual median
Ethene TCEQ auto-GCs, 1997-2005
Monthly medians, 75th percentiles, and maxima
Clinton = west Ship Channel; Deer Park = east Ship Channel
Concentrations, ppbv
1000.00
100.00
10.00
1.00
0.10
Clinton1997
Clinton1998
Clinton1999
Clinton2000
Clinton2001
Clinton2002
Clinton2003
Clinton2004
Clinton2005
DeerPark1997
DeerPark1998
DeerPark1999
DeerPark2000
DeerPark2001
DeerPark2002
DeerPark2003
DeerPark2005

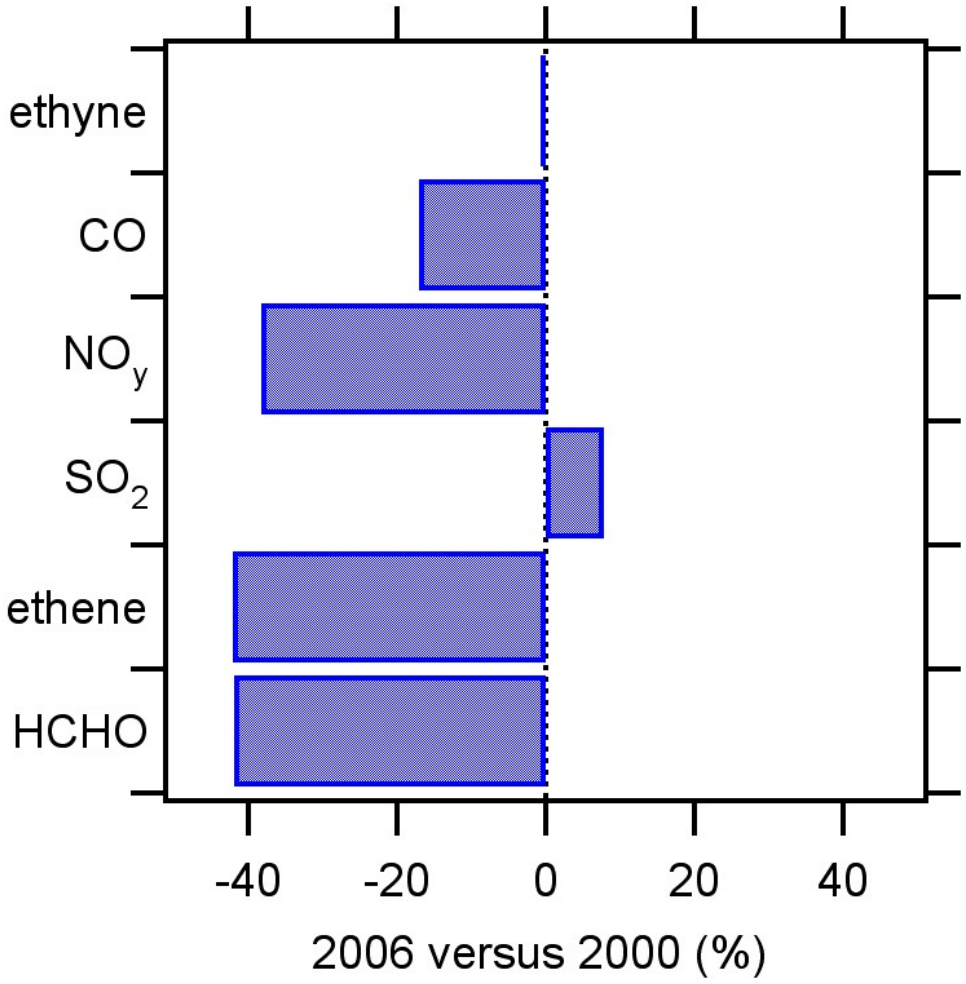


Figure C3: Difference in median mixing ratio for several trace gases measured from the NOAA WP-3D inside a box around Houston and below 1000 m altitude.

6. Ethene emissions are apparently still underestimated, by as much as a factor of 10.

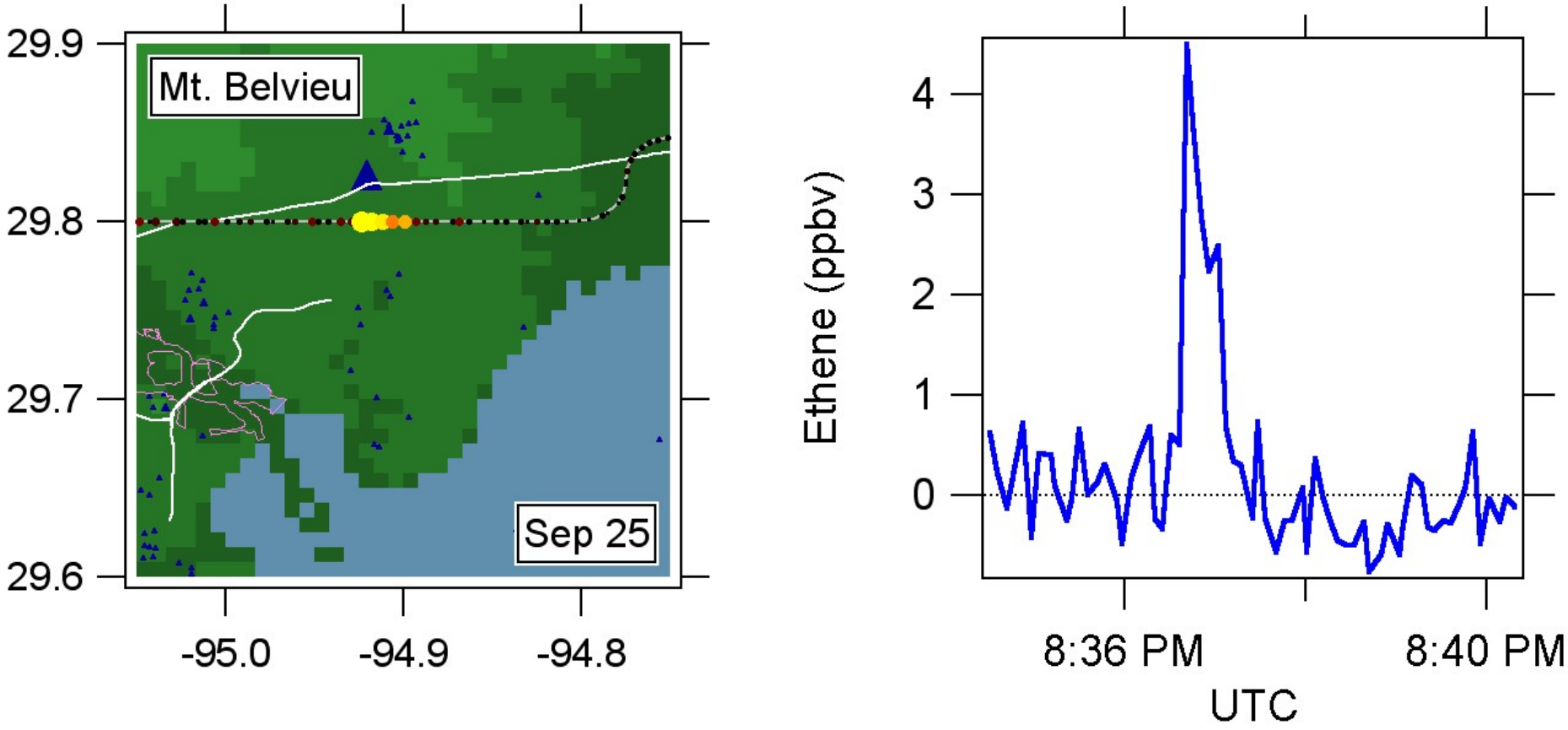


Figure C5: Transect of the WP-3D just downwind from the Mont Belvieu complex to the northeast of HSC color-coded by ethene measured by LPAS. Ethene sources from the 2004 TCEQ point source database are indicated by the blue triangles, with the size proportional to the source strength. The measured time series of ethene for this transect is shown on the right.

Table I. Measured emission rates obtained by SOF in this study, and the inventory numbers for non methane hydrocarbons

Species	Ethene kg/h		Propene kg/h		Alkanes kg/h		Tot. VOCs kg/h
Area	Meas.	Invent.	Meas.	Invent.	Meas.	Invent.	Invent.
HSC	860	47	1500	61	12400	1500	3090
Mt Belvieu	404	44	400	9	860	260	265
Baytown	72	6	260	3	980	202	437
Texas City	83	8	-	-	2890	348	686
Channelview	64	11	-	-	-	42	170
Sweeny	163	4	126	4	3630	113	137
Freeport	250	21	-	-	-	44	148
Bayport	170**	4	-	-	-	94	151
Chocolate Bayou	136**	10	273	24	-	107	150

* Nonmethane hydrocarbons corresponding to alkanes and unspeciated VOC as in the 2004 inventory database, ** Uncertain due to few measurements.

7. Power plant NOx emissions have decreased substantially since 2000. CEMS-based emission estimates are accurate.

Table D1. Measured emissions relative to CO_2 for EGUs in East Texas.

EGU name	NCAR Electra aircraft data **2000**			NOAA WP-3D aircraft data **2006**			NOx emissions decreased by factor of:
	SO_2	**CO**	**NOx**	**SO_2**	**CO**	**NOx**	
Monticello	3.5	6.4	1.0	2.8	5.4	0.80	**1.25**
Welsh	1.5	1.7	0.80	1.7	1.7	1.20	**1.5 (increase)**
Martin Lake	1.4	4.0	1.3	3.0	6.1	0.80	**1.6**
Big Brown	4.8	2.9	1.5	7.8	6.8	0.66	**2.3**
W.A. Parish	2.1	(variable)	0.88	2.1	(variable)	0.25	**3.5**

Emissions values presented as molecules per 1000 molecules of CO_2 emitted.

8. There are discrepancies between observed mobile CO/NOx and estimated mobile emissions. [But most recent EI (ca. Sept 2007) has not been compared to the observations yet.]

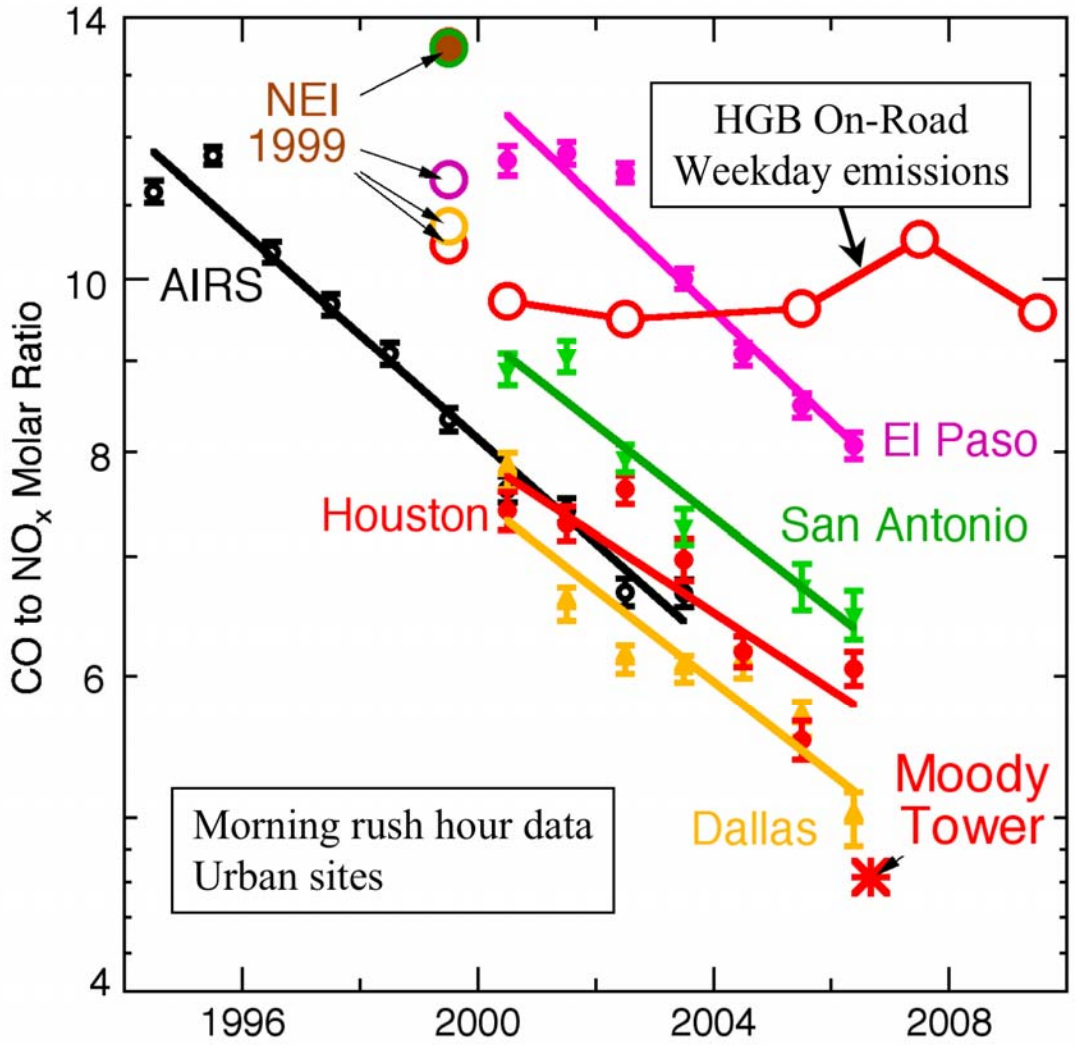


Figure D3. Determination of CO to NOx ratio in Texan on-road mobile emissions from monitoring data (solid symbols) compared to the HGB emission inventory (open symbols) color coded according to urban area. The black symbols are for all stations in the EPA AIRS network.

9. Secondary HCHO >> Primary HCHO. There's no unambiguous evidence so far that there are huge sources of primary HCHO that aren't already in the EI.

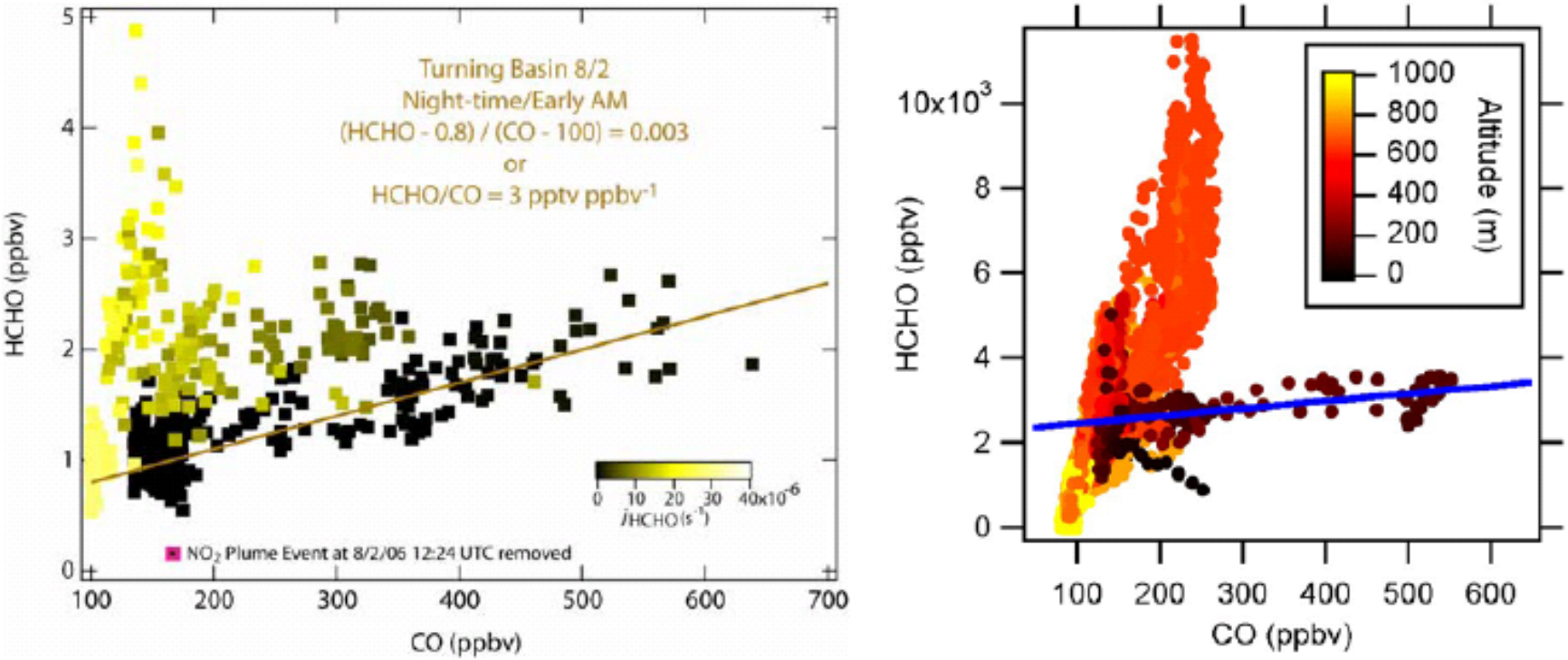


Figure E2. Relationships of HCHO to CO concentrations obtained onboard the *Ronald H. Brown* in the turning basin at the western end of the HSC (left panel), and from the WP-3D during a nighttime, missed approach at Montgomery County airport to the north of Houston.

Rapid Science Synthesis:

The observed mixing ratios and regional distribution of ambient formaldehyde are broadly consistent with daytime photochemical production from reactive VOC. An upper limit for primary formaldehyde emissions from mobile sources is obtained from nighttime measurements, and is small in comparison with the secondary, daytime formation.

10. For both Houston and Dallas:

local contributions to 8-hr ozone exceedances = regional contributions to 8-hr ozone exceedances.

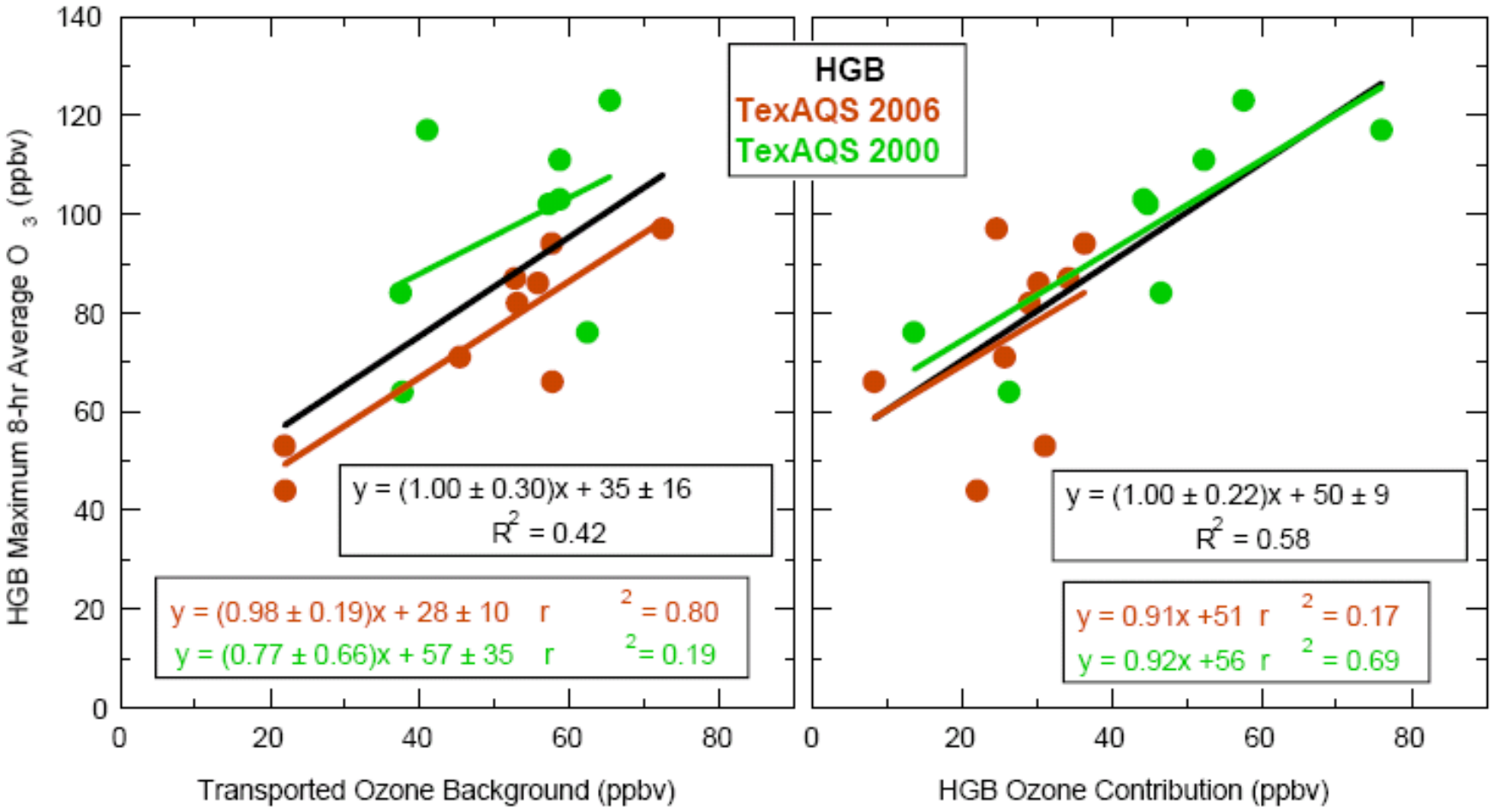
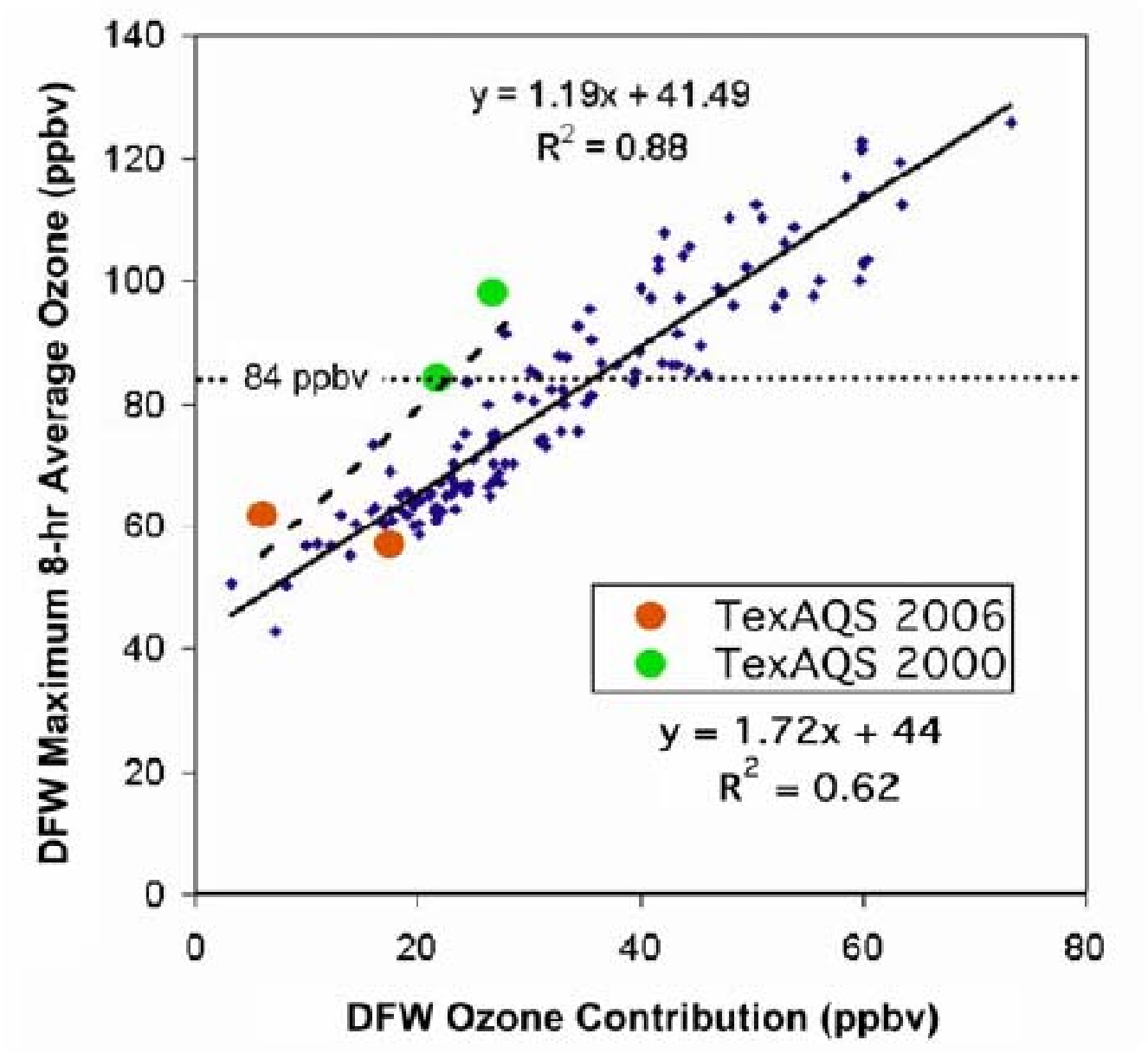


Figure H6. Measured peak 8-hour-average O3 in the HGB area as a function of the background ozone transported into the region (left) and the local HGB contribution to that peak (right). The background ozone was determined from aircraft transects upwind and across the HGB region on seventeen days in 2000 and 2006. The HGB contribution is derived from the difference between the measured peak and the background.



The small symbols are from the model results from the CAMx model for each day 1 June - 30 September 2002. The larger symbols are from aircraft transects upwind and across the DFW region on four days in 2000 and 2006.