TCEQ

Application of the Top Ten Days Attainment Test for the Dallas-Fort Worth Ozone Nonattainment Area

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Background

- The U.S. Environmental Protection Agency (EPA) released *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* in December 2014.

- From 2012 through June 2015, the Texas Commission on Environmental Quality (TCEQ) was preparing an attainment demonstration State Implementation Plan (SIP) revision for the ten-county Dallas-Fort Worth (DFW) ozone nonattainment area, which was classified as Moderate under the 2008 ozone National Ambient Air Quality Standard (NAAQS) of 75 parts per billion (ppb) averaged over eight hours.

- This DFW attainment demonstration modeled a 2018 future year, and provided an opportunity to compare projected future design values calculated under the "ALL DAYS" test from the corresponding 2007 guidance with those calculated under the "TOP TEN DAYS" test from the 2014 draft guidance.

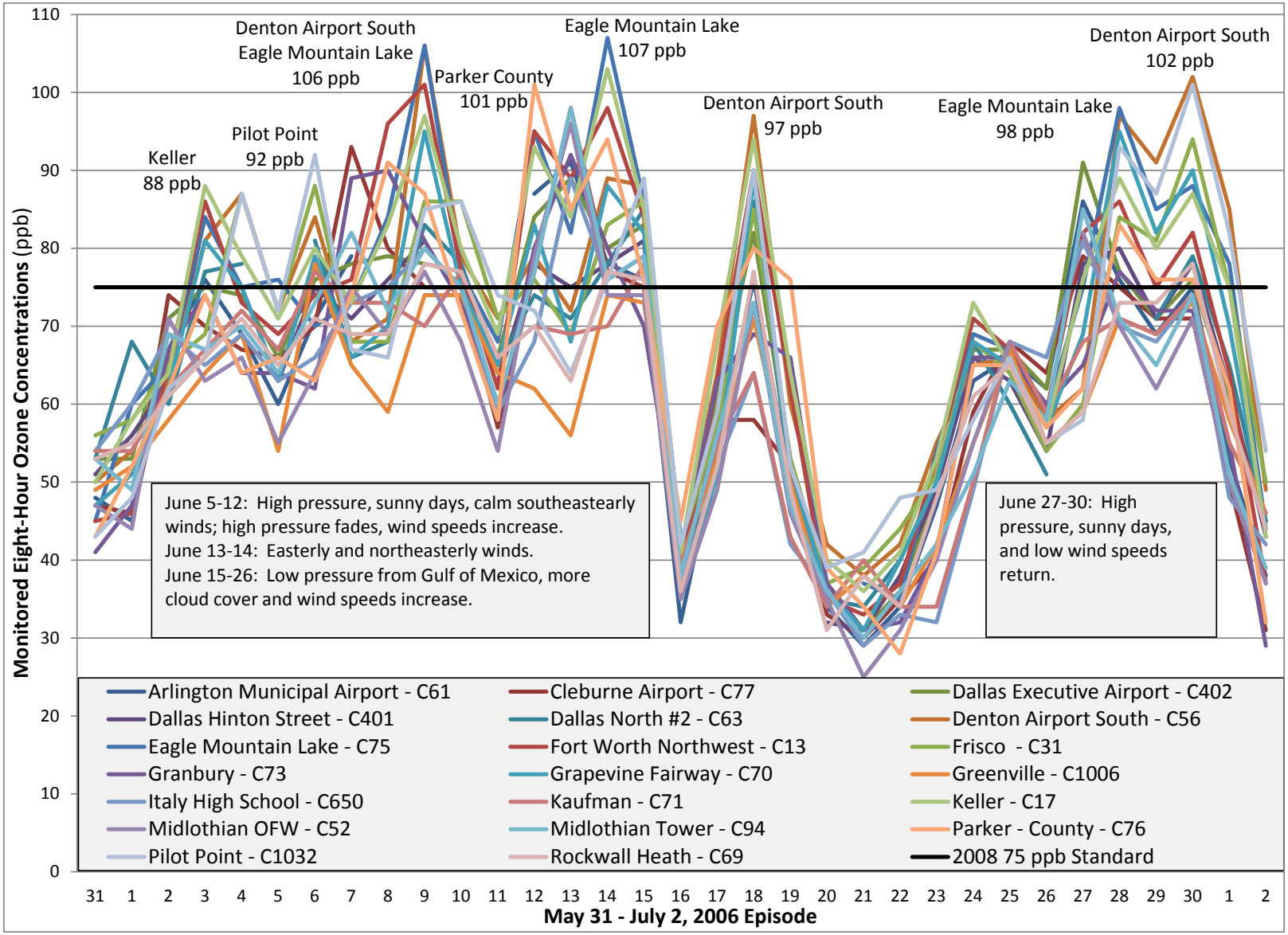
Overview of Conclusions

- In reference to the TOP TEN days attainment test, Section 4.2 of the draft 2014 guidance states:
  - "model response to decreasing emissions is generally most stable when the base ozone predictions are highest"; and
  - "on days with high ozone concentrations, there is a relatively high percentage of locally generated ozone compared to days with low base case concentrations."
- Experience with application of the TOP TEN days attainment test in DFW indicates:
  - in general, future design values decrease with use of the TOP TEN DAYS test, particularly for the most downwind monitors that have the highest design values and are most sensitive to locally generated precursor emissions; and
  - greater focus is on episode days with a greater contribution of locally produced ozone.
- A review of modeling inputs revealed that the highest modeled ozone days:
  - have lower average wind speeds during the morning and daytime compared to other episode days; and
  - are more heavily weighted toward emission inventory day types (e.g., Friday) that have the highest levels of nitrogen oxides (NO_X) emissions compared to other day types (e.g., Sunday) that have the lowest NO_X emissions.

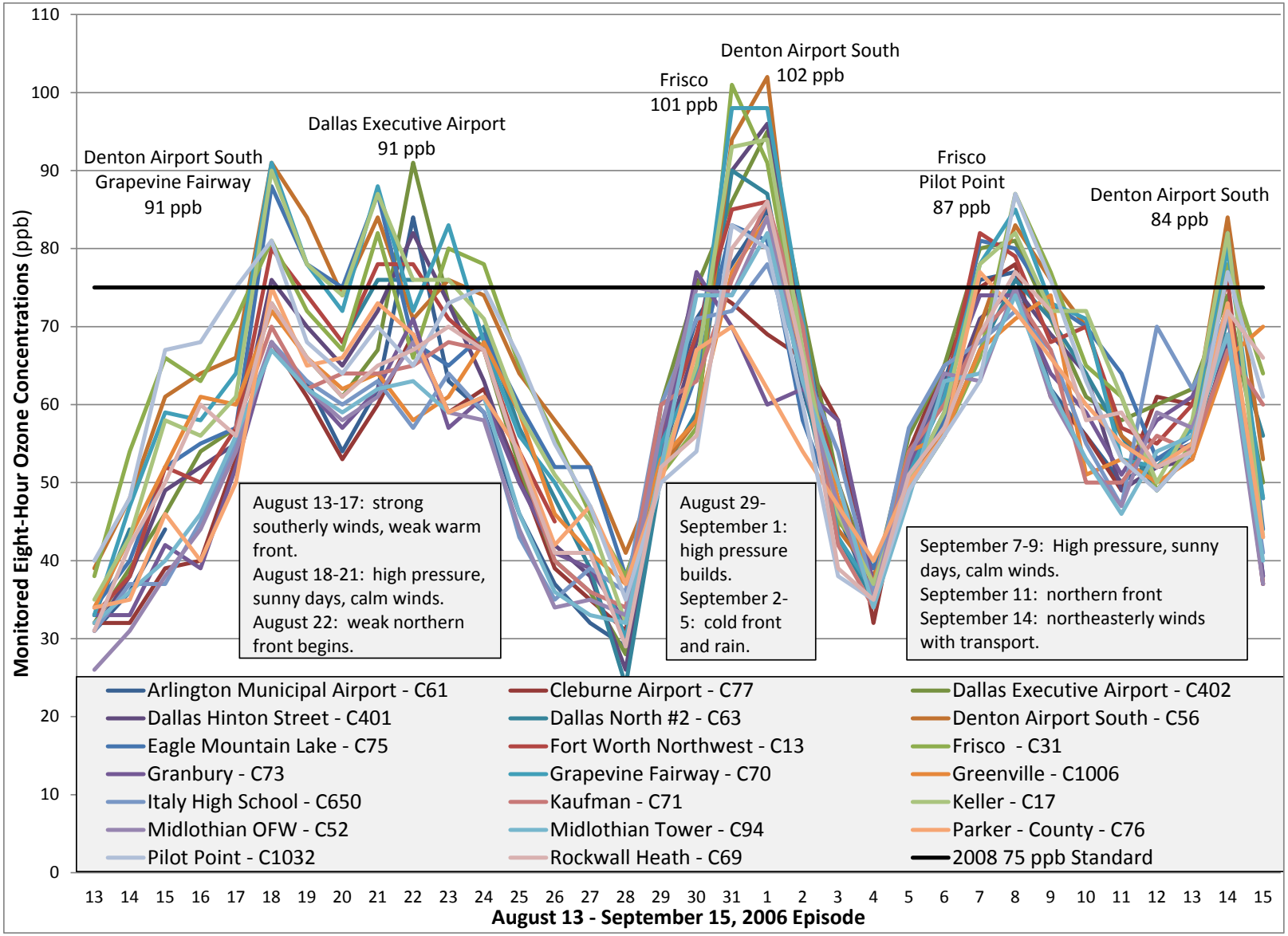
2006 Base Case Ozone Episode

- A total of 67 episode days from a 2006 base case were modeled to correspond with the historical peak periods of ozone exceedances in June, August, and early September:
  - 33 days from May 31-July 2, 2006; and
  - 34 days from August 13-September 15, 2006.
- The entire modeling domain covers:
  - eastern Texas plus portions of surrounding states at a fine resolution of 4 kilometers (km);
  - all of Texas plus portions of surrounding states at a medium 12 km resolution; and
  - the continental U.S., southern Canada, and northern Mexico at a coarse 36 km resolution.
- During ozone season, the dominant wind directions in DFW are from the south and east, which leads to the most upwind monitors such as Greenville (GRVL) and Kaufman (KAUF) measuring the lowest ozone concentrations.
- There are five downwind monitors located in the northwest corner of the DFW metropolitan area that have historically measured the highest ozone concentrations:
  - Denton Airport South (DENT)
  - Eagle Mountain Lake (EMTL)
  - Fort Worth Northwest (FWMC)
  - Grapevine Fairway (GRAP); and
  - Keller (KELC).

DFW Maximum Monitored Eight-Hour Ozone May 31 – July 2, 2006 Episode

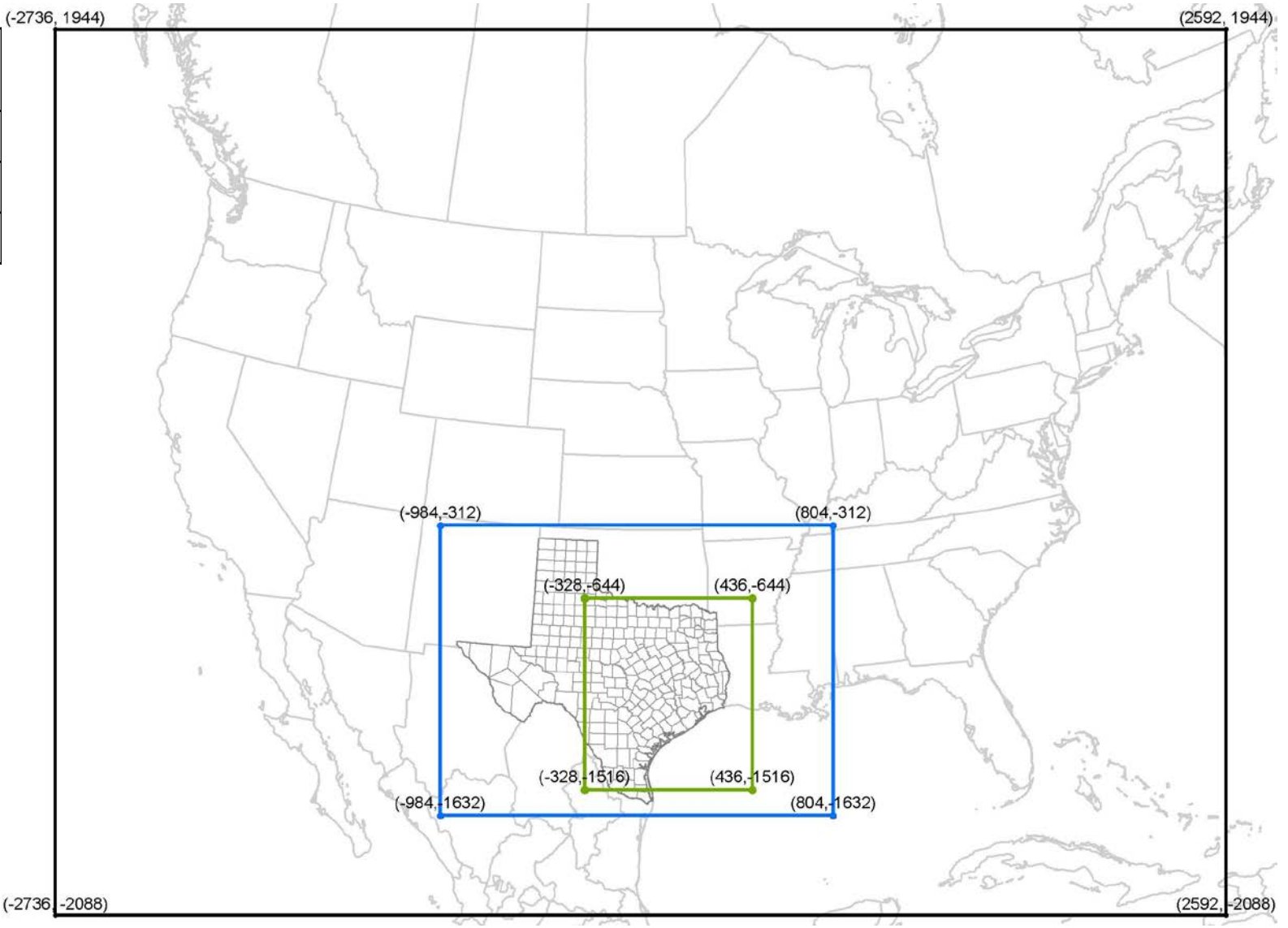


DFW Maximum Monitored Eight-Hour Ozone August 13 – September 15, 2006 Episode



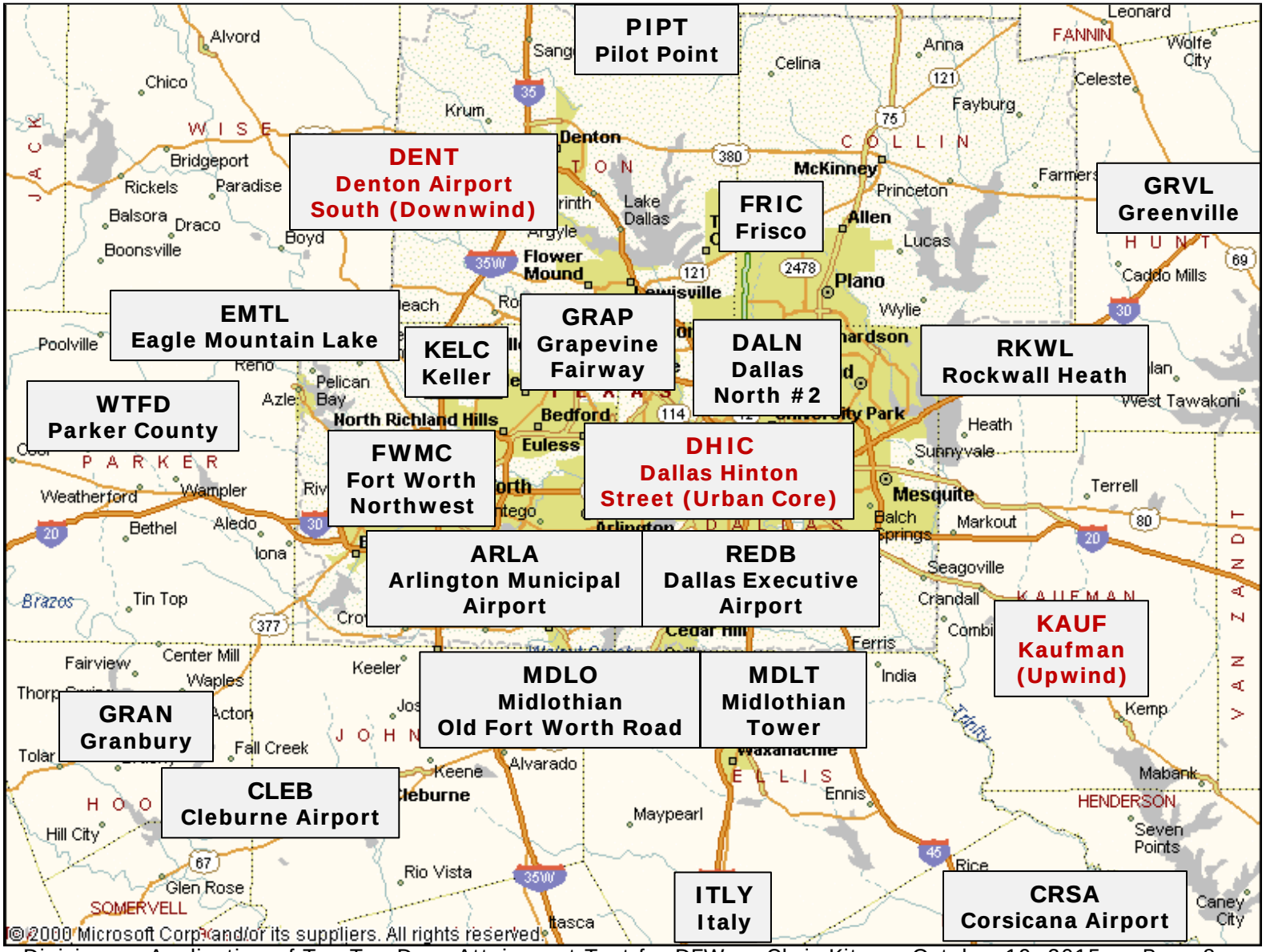
North American Regional Planning Organizations (RPO) Domains for Texas Air Quality Modeling Efforts

Domain Name	Grid Cells
tx_4km	41,638
tx_12km	16,390
rpo_36km	16,576



Geographic Distribution of Dallas-Fort Worth Area Ozone Monitors

- The four-character alpha code used by TCEQ modeling staff is shown on top for reference purposes.

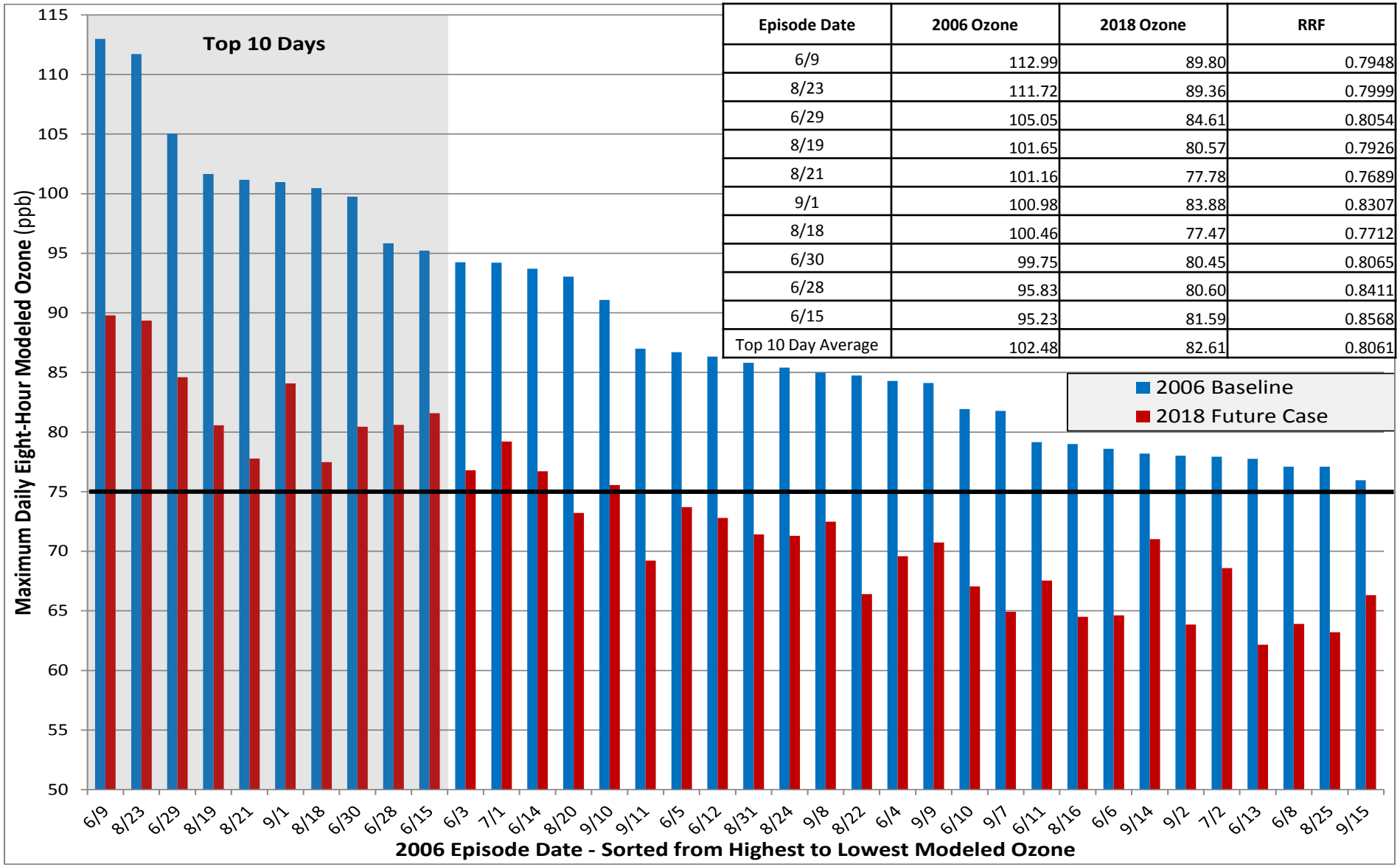


Ozone Attainment Test Differences - All Days versus Top 10 Days Methodologies

- To reduce uncertainty associated with model predictions, use of "absolute" modeled differences by individual grid cell and/or episode day should be avoided.
- Instead, the relative change in modeled ozone concentrations between two scenarios (e.g., baseline and future year) should be applied to real-world monitored values.
- To calculate the relative response factor (RRF) for the ozone attainment test:
  - EPA modeling guidance from April 2007 specifies averaging the results for all episode days in the baseline modeled above the standard, such as 75 ppb.
  - EPA draft modeling guidance from December 2014 specifies averaging the results for the 10 episode days in the baseline with the highest modeled levels.
- Example calculations for the Denton Airport South Monitor:

Description	All Days Test	Top 10 Days Test
2006 Baseline Design Value (DV_B)	93.33 ppb (remains the same for both tests)	
Episode Days in Calculation	36 days out of 67 in episode (modeled above 75 ppb in baseline)	10 days out of 67 in episode (highest modeled in baseline)
Relative Response Factor (RRF)	0.8221	0.8061
2018 Future Design Value (DV_F)	76.72 ppb	75.23 ppb
2018 Rounded/Truncated DV_F	76 ppb	75 ppb

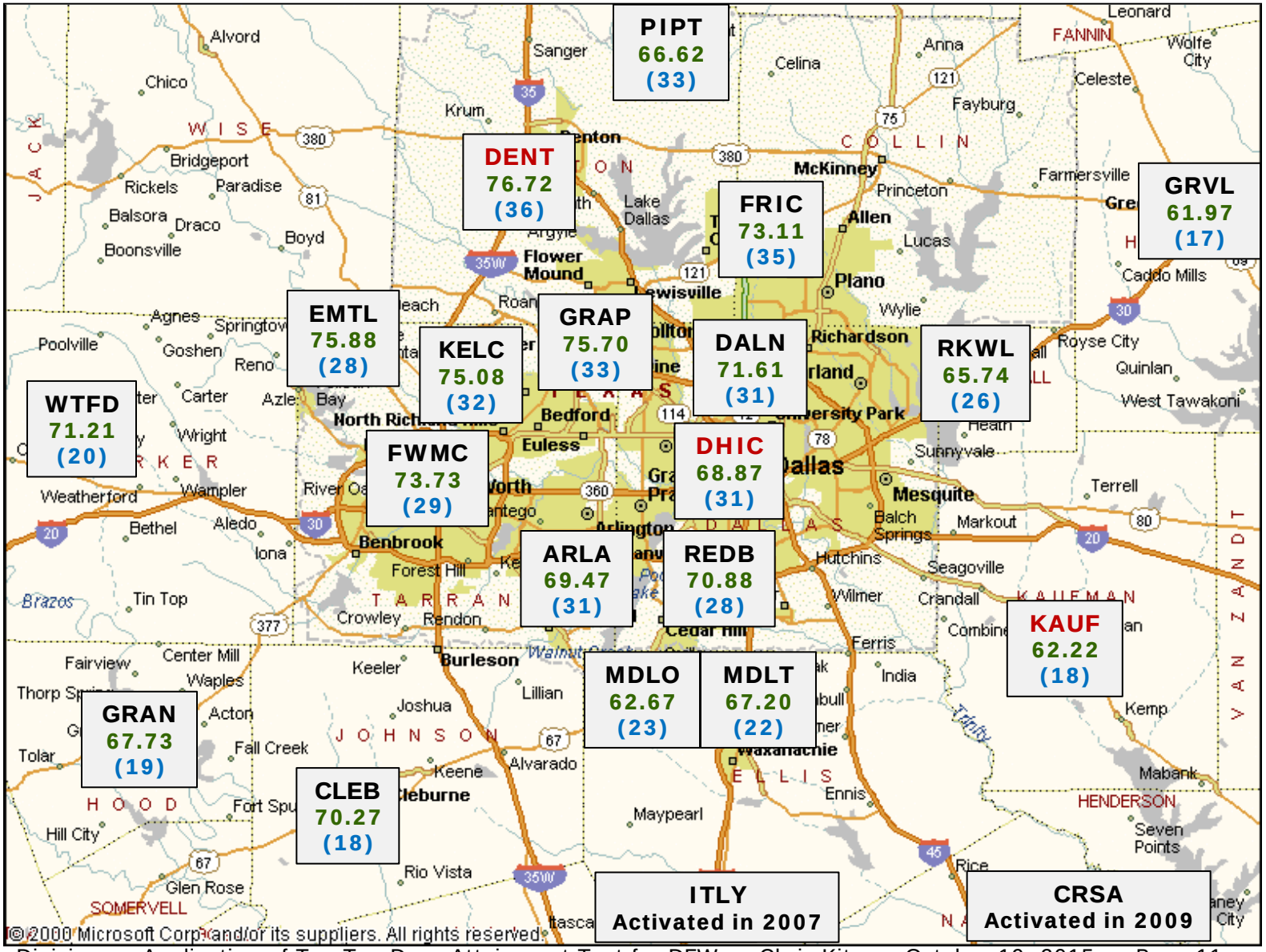
2006 Baseline and 2018 Future Case Modeled Ozone
Denton Airport South Monitor



Episode Date	2006 Ozone	2018 Ozone	RRF
6/9	112.99	89.80	0.7948
8/23	111.72	89.36	0.7999
6/29	105.05	84.61	0.8054
8/19	101.65	80.57	0.7926
8/21	101.16	77.78	0.7689
9/1	100.98	83.88	0.8307
8/18	100.46	77.47	0.7712
6/30	99.75	80.45	0.8065
6/28	95.83	80.60	0.8411
6/15	95.23	81.59	0.8568
Top 10 Day Average	102.48	82.61	0.8061

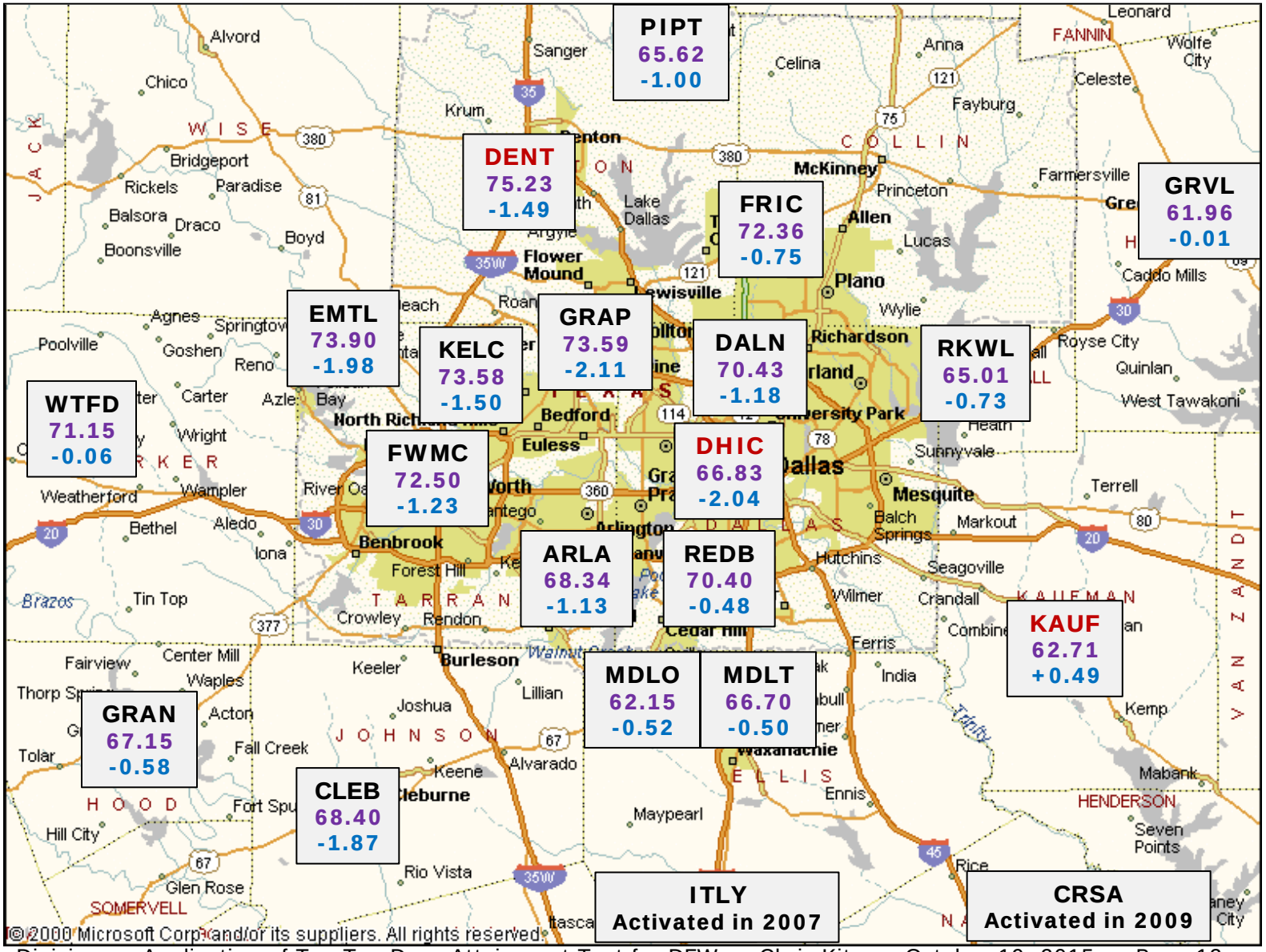
DFW Area Distribution of 2018 Future Eight-Hour Ozone Design Values for ALL DAYS Attainment Test (ppb)

- DV_F on top is from the ALL DAYS attainment test where all of the episode days modeled above 75 ppb in the baseline are used to calculate the RRFs.
- The bottom figure in brackets is the number of episode days used to calculate the RRF.



DFW Area Distribution of 2018 Future Eight-Hour Ozone Design Values for TOP TEN DAYS Attainment Test (ppb)

- The value on top is the 2018 DV_F from using only the highest ten modeled days in the baseline for the attainment test calculation.
- The value on the bottom is the net change in the 2018 DV_F by using the TOP TEN DAYS instead of the ALL DAYS attainment test.

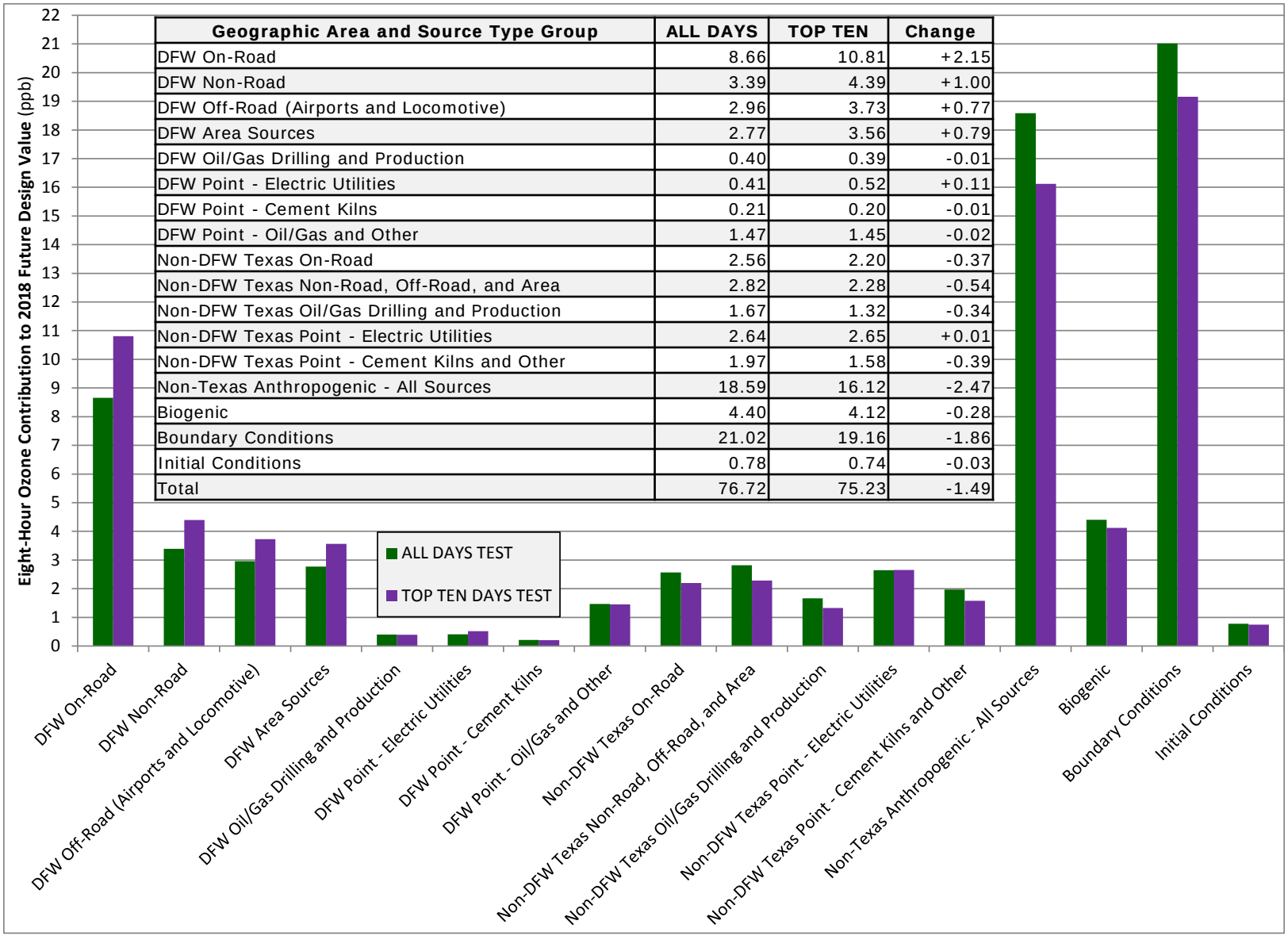


Ozone Source Apportionment Results

- Ozone source apportionment technology (OSAT) analyses were performed on the 2018 future case modeling for this episode employing the anthropogenic precursor culpability assessment (APCA) tool within the Comprehensive Air Quality Model with Extensions (CAMx):
  - peak ozone contributions by geographic and source type combination were extracted by monitor for the episode days used in both attainment tests; and
  - these APCA results were then averaged and assigned a relative contribution that was assigned to the modeled 2018 DV_F for each monitor.
- When comparing the APCA results for the different attainment tests:
  - both the Denton and Hinton monitors show increased contributions for the TOP TEN DAYS test of 0.8-2.8 ppb from the dominant local source categories of on-road, non-road, off-road, and area
  - the non-Texas anthropogenic contribution is reduced by 2.5-3.1 ppb for Denton and Hinton;
  - the results for the upwind monitor of Kaufman shows little change in attribution to local sources, but slight increases from non-DFW and non-Texas sources;
  - the two most upwind monitors of Greenville and Kaufman show slight decreases in the local ozone contribution of 0.05 ppb and 0.04 ppb, respectively, when switching from the ALL DAYS TEST to the TOP TEN DAYS one; and
  - the remaining 17 monitors show increases in the local ozone contribution ranging from 2.6-6.8 ppb.

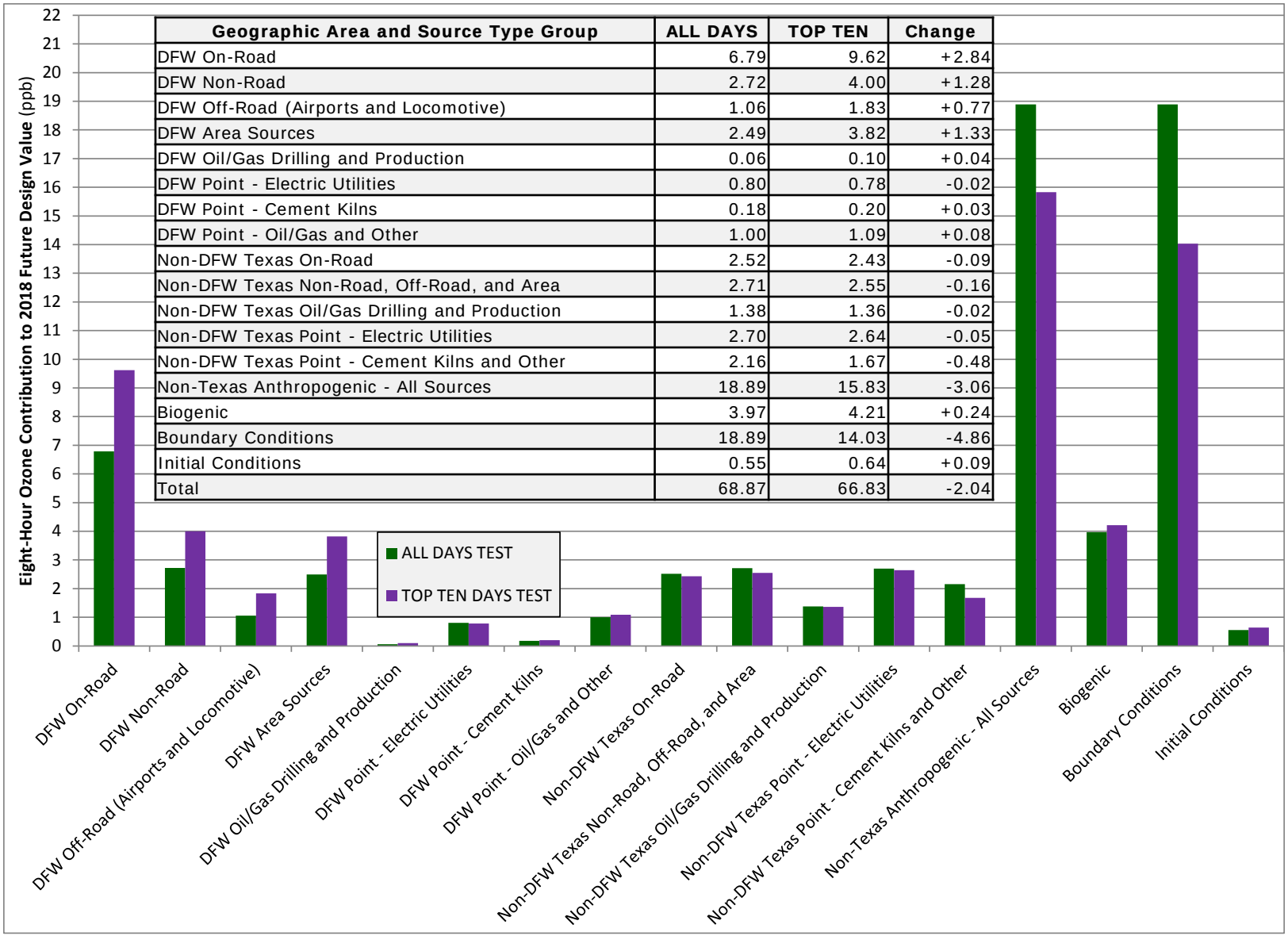
Ozone Source Apportionment Indexed to Attainment Test Days – "Downwind" Denton Airport South Monitor

Geographic Area and Source Type Group	ALL DAYS	TOP TEN	Change
DFW On-Road	8.66	10.81	+2.15
DFW Non-Road	3.39	4.39	+1.00
DFW Off-Road (Airports and Locomotive)	2.96	3.73	+0.77
DFW Area Sources	2.77	3.56	+0.79
DFW Oil/Gas Drilling and Production	0.40	0.39	-0.01
DFW Point - Electric Utilities	0.41	0.52	+0.11
DFW Point - Cement Kilns	0.21	0.20	-0.01
DFW Point - Oil/Gas and Other	1.47	1.45	-0.02
Non-DFW Texas On-Road	2.56	2.20	-0.37
Non-DFW Texas Non-Road, Off-Road, and Area	2.82	2.28	-0.54
Non-DFW Texas Oil/Gas Drilling and Production	1.67	1.32	-0.34
Non-DFW Texas Point - Electric Utilities	2.64	2.65	+0.01
Non-DFW Texas Point - Cement Kilns and Other	1.97	1.58	-0.39
Non-Texas Anthropogenic - All Sources	18.59	16.12	-2.47
Biogenic	4.40	4.12	-0.28
Boundary Conditions	21.02	19.16	-1.86
Initial Conditions	0.78	0.74	-0.03
Total	76.72	75.23	-1.49



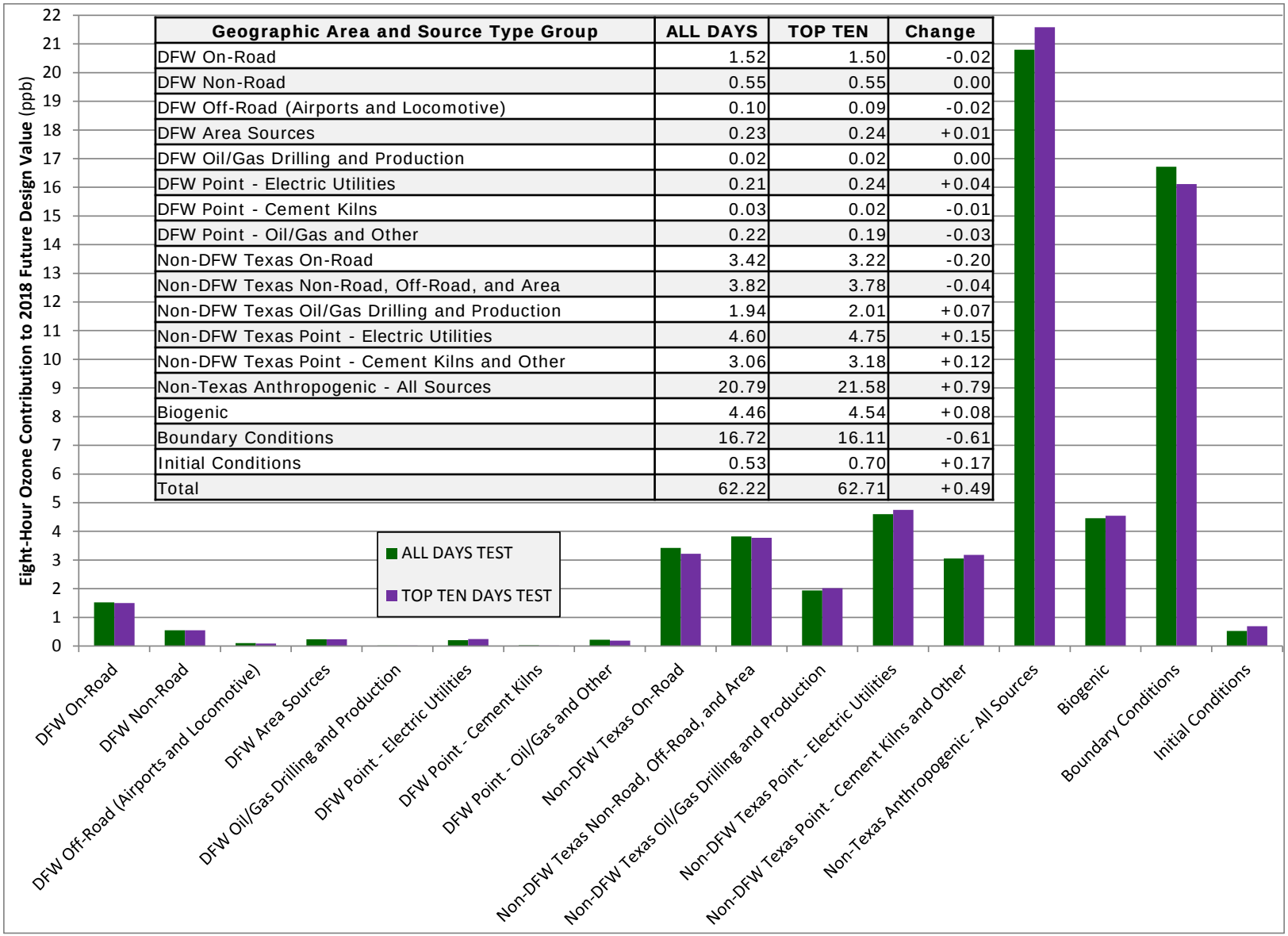
Ozone Source Apportionment Indexed to Attainment Test Days – "Urban Core" Dallas Hinton Street Monitor

Geographic Area and Source Type Group	ALL DAYS	TOP TEN	Change
DFW On-Road	6.79	9.62	+2.84
DFW Non-Road	2.72	4.00	+1.28
DFW Off-Road (Airports and Locomotive)	1.06	1.83	+0.77
DFW Area Sources	2.49	3.82	+1.33
DFW Oil/Gas Drilling and Production	0.06	0.10	+0.04
DFW Point - Electric Utilities	0.80	0.78	-0.02
DFW Point - Cement Kilns	0.18	0.20	+0.03
DFW Point - Oil/Gas and Other	1.00	1.09	+0.08
Non-DFW Texas On-Road	2.52	2.43	-0.09
Non-DFW Texas Non-Road, Off-Road, and Area	2.71	2.55	-0.16
Non-DFW Texas Oil/Gas Drilling and Production	1.38	1.36	-0.02
Non-DFW Texas Point - Electric Utilities	2.70	2.64	-0.05
Non-DFW Texas Point - Cement Kilns and Other	2.16	1.67	-0.48
Non-Texas Anthropogenic - All Sources	18.89	15.83	-3.06
Biogenic	3.97	4.21	+0.24
Boundary Conditions	18.89	14.03	-4.86
Initial Conditions	0.55	0.64	+0.09
Total	68.87	66.83	-2.04



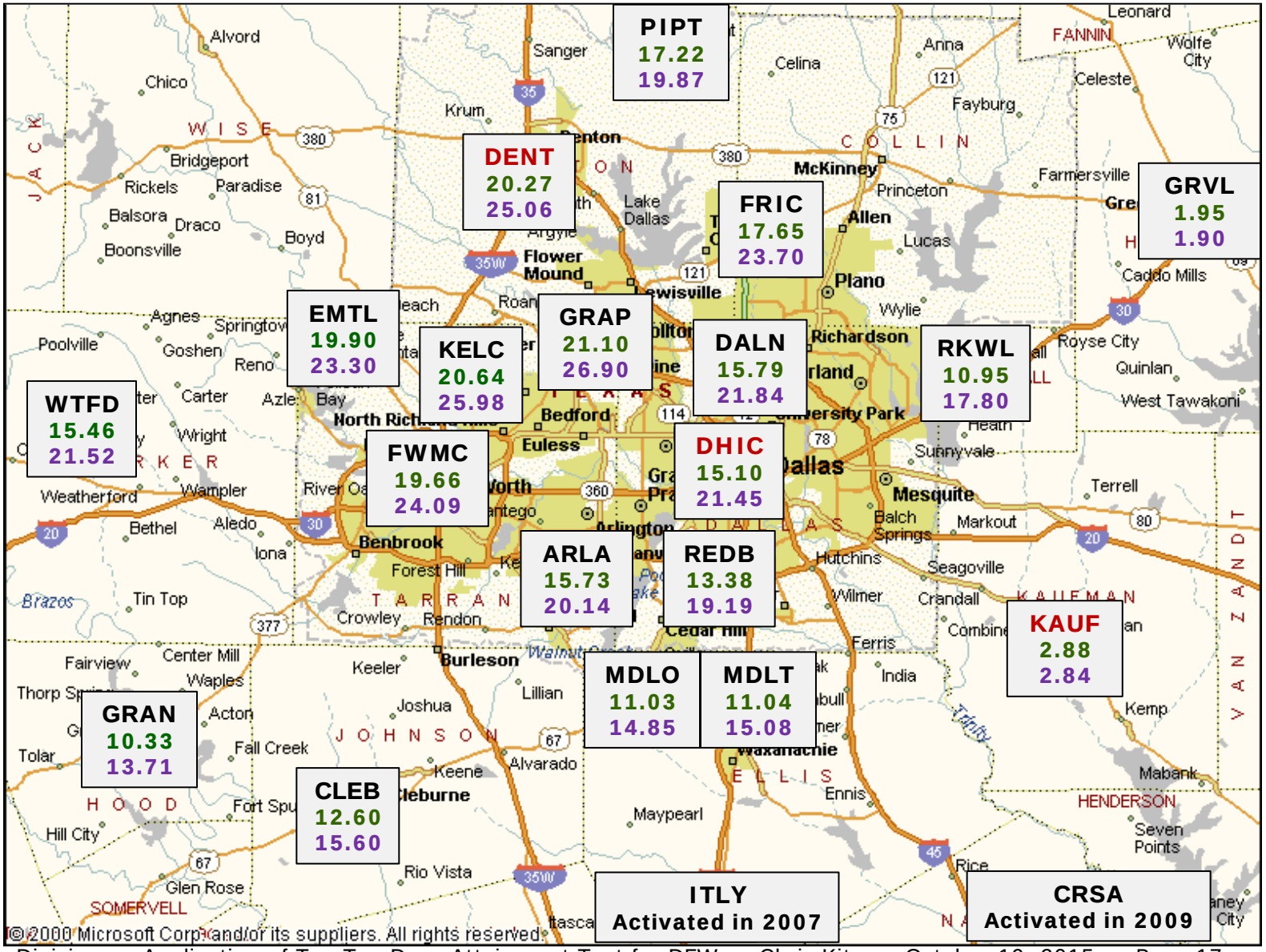
Ozone Source Apportionment Indexed to Attainment Test Days – "Upwind" Kaufman Monitor

Geographic Area and Source Type Group	ALL DAYS	TOP TEN	Change
DFW On-Road	1.52	1.50	-0.02
DFW Non-Road	0.55	0.55	0.00
DFW Off-Road (Airports and Locomotive)	0.10	0.09	-0.02
DFW Area Sources	0.23	0.24	+0.01
DFW Oil/Gas Drilling and Production	0.02	0.02	0.00
DFW Point - Electric Utilities	0.21	0.24	+0.04
DFW Point - Cement Kilns	0.03	0.02	-0.01
DFW Point - Oil/Gas and Other	0.22	0.19	-0.03
Non-DFW Texas On-Road	3.42	3.22	-0.20
Non-DFW Texas Non-Road, Off-Road, and Area	3.82	3.78	-0.04
Non-DFW Texas Oil/Gas Drilling and Production	1.94	2.01	+0.07
Non-DFW Texas Point - Electric Utilities	4.60	4.75	+0.15
Non-DFW Texas Point - Cement Kilns and Other	3.06	3.18	+0.12
Non-Texas Anthropogenic - All Sources	20.79	21.58	+0.79
Biogenic	4.46	4.54	+0.08
Boundary Conditions	16.72	16.11	-0.61
Initial Conditions	0.53	0.70	+0.17
Total	62.22	62.71	+0.49



Ozone Source Apportionment Indexed to Attainment Test Days – Local Contribution to Future Design Values

- Top value is the ozone contribution (ppb) from local DFW sources to the 2018 future ozone design value based on APCA results for the ALL DAYS attainment test.
- Bottom value is the contribution from local DFW sources based on APCA results for the TOP TEN DAYS attainment test.



Average Modeled Wind Speeds

- Since the TOP TEN DAYS test focuses on the highest exceedances, it is expected that these would occur on the days when winds are most stagnant.

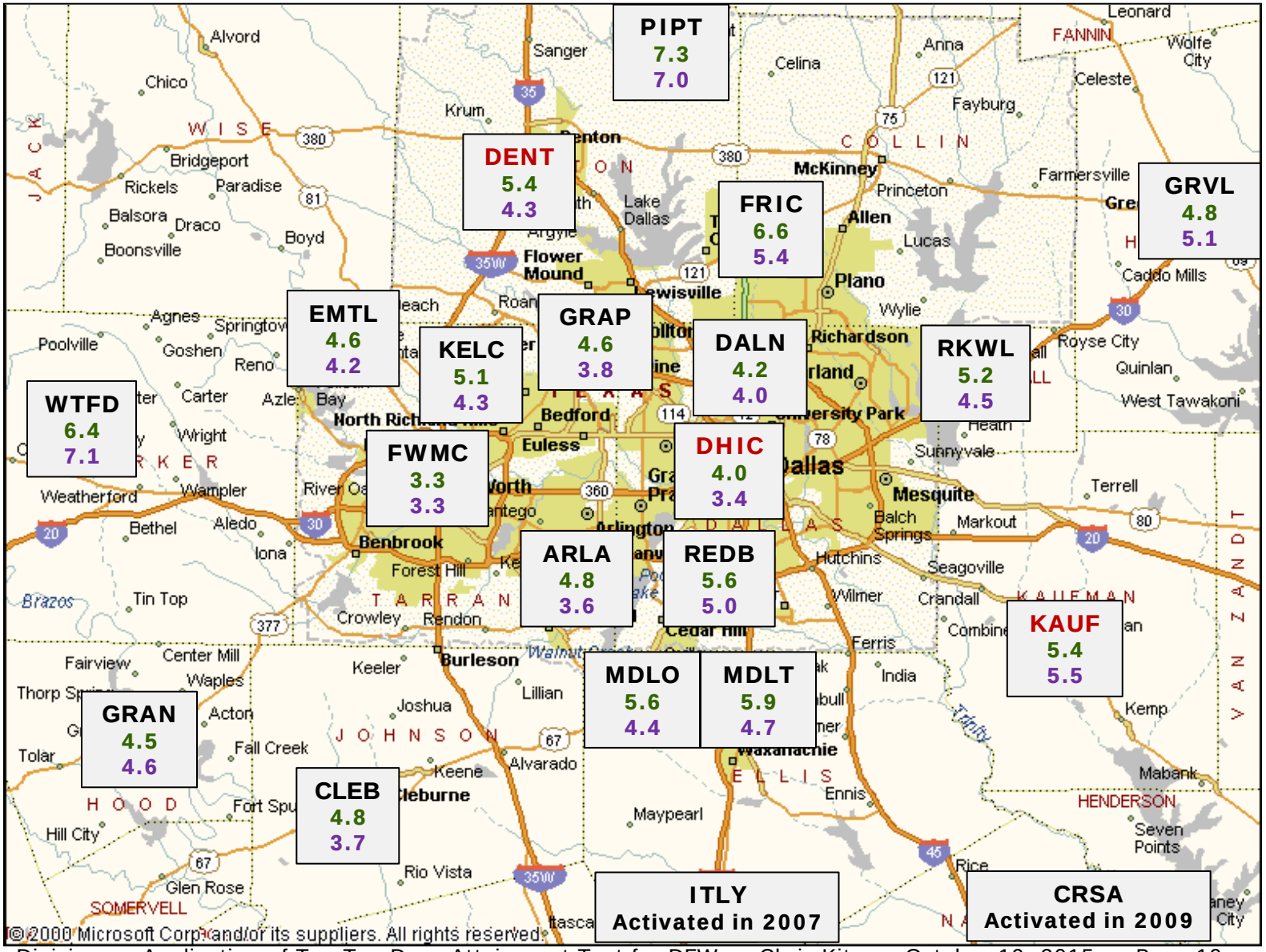
- Peak eight-hour ozone exceedances are typically monitored in the time span stretching from late morning through early evening.

- Modeled wind speeds for each monitor were averaged:
  - for the morning time span from 4-8 AM central standard time (CST), which is 5-9 AM central daylight time (CDT).
  - wind speed results for the daytime period of 8 AM-6 PM CST, which is 9 AM-7 PM CDT.

- The wind speed averages were compared for the episode days in the ALL DAYS attainment test and the TOP TEN DAYS attainment test:
  - for most of the urban core and downwind monitors with the highest ozone levels, the average morning wind speeds are lower for the days used in the TOP TEN test; and
  - even though daytime wind speeds are higher than those in the morning, a similar pattern of relatively more stagnation at urban core and downwind monitors is evident for the days used in the TOP TEN test.

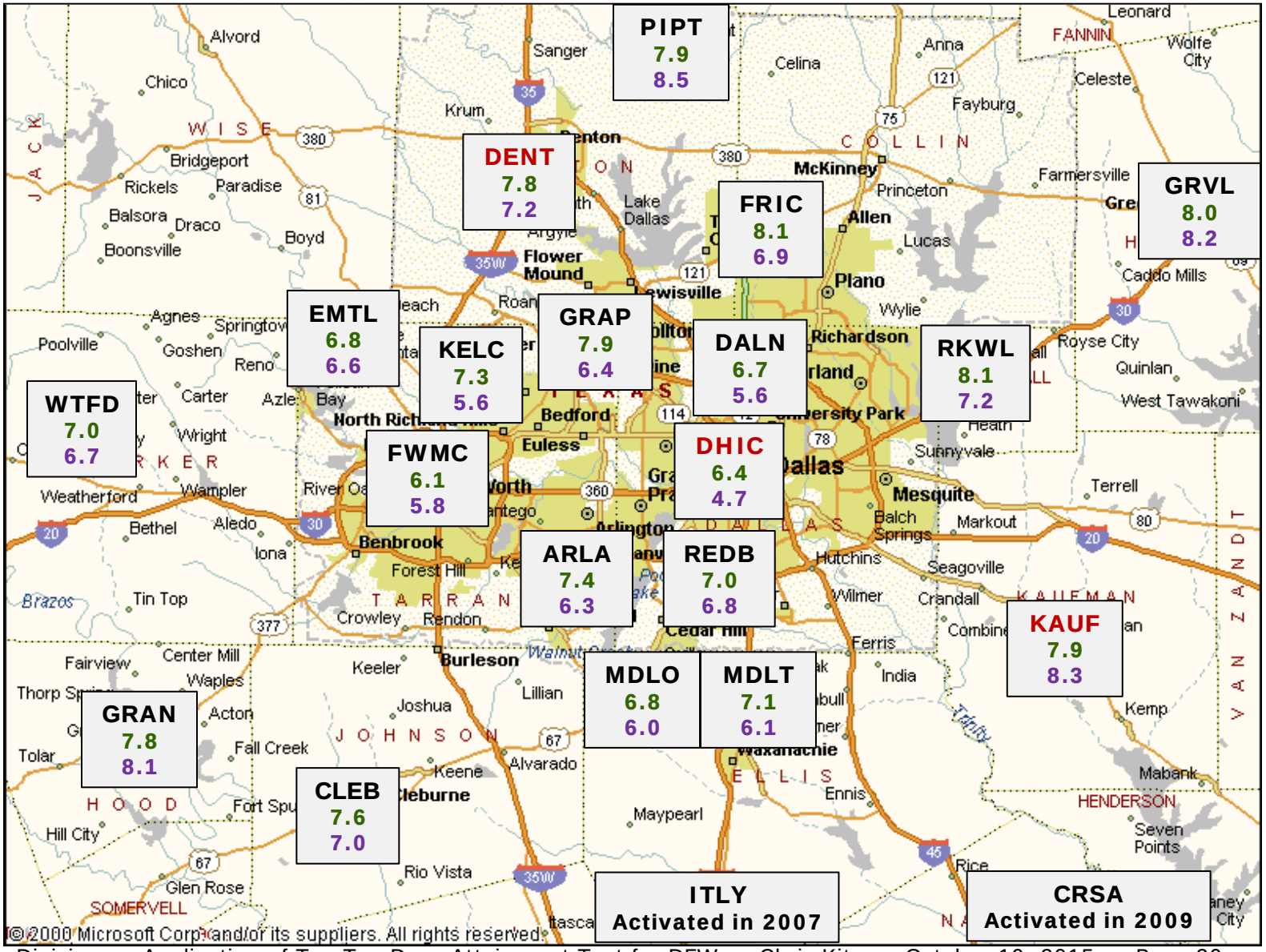
Average Modeled Morning Wind Speeds on Episode Days Used in Attainment Tests (miles per hour)

- Top value is the average modeled morning wind speed for the episode days used in the ALL DAYS test.
- Bottom value is the average modeled morning wind speed for the episode days used in the TOP TEN DAYS test.
- Morning hours are 4-8 AM standard time, or 5-9 AM daylight.



Average Modeled Daytime Wind Speeds on Episode Days Used in Attainment Tests (miles per hour)

- Top value is the average modeled morning wind speed for the episode days used in the ALL DAYS test.
- Bottom value is the average modeled morning wind speed for the episode days used in the TOP TEN DAYS test.
- Daytime hours are 8 AM-6 PM standard time, or 9 AM-7 PM daylight.



Emission Inventory Day Types

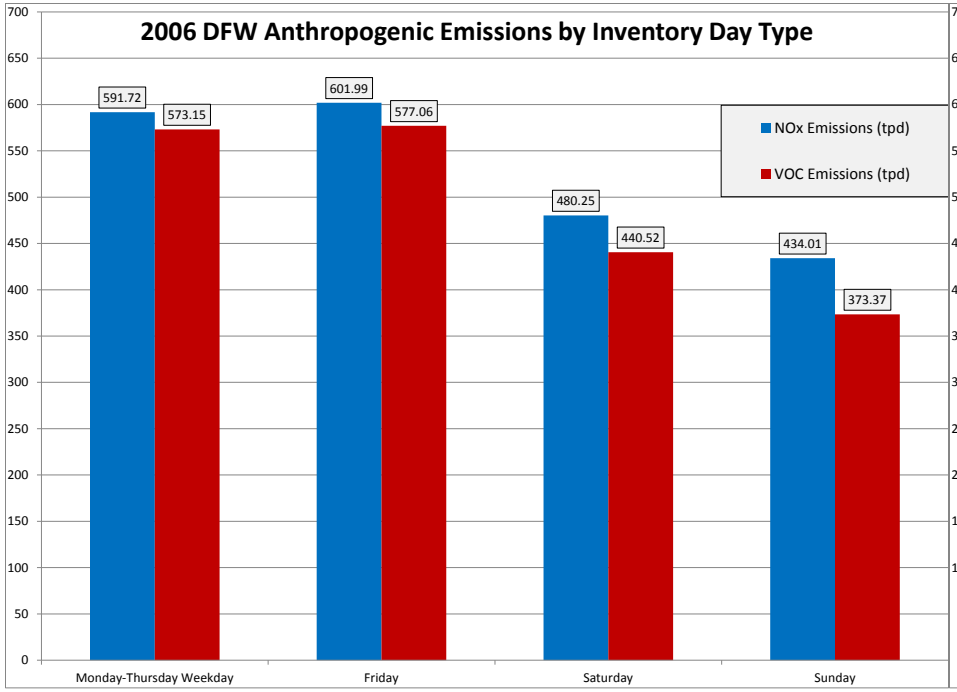
- It is expected that the TOP TEN test would also focus on the episode days with the highest precursor emissions.

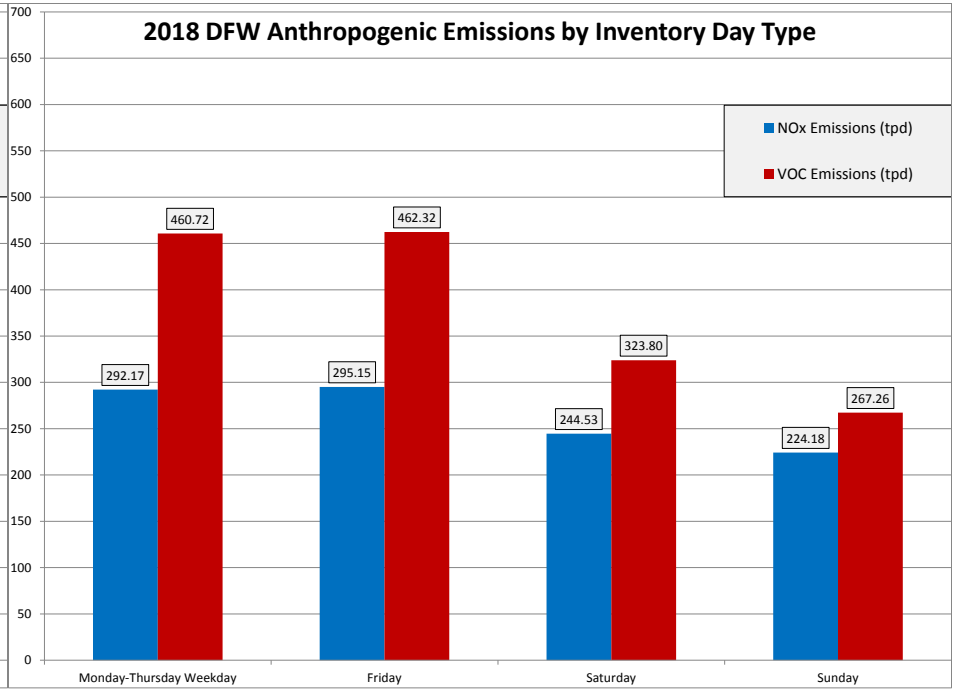
- When developing anthropogenic emission inventory inputs for ozone modeling, different on-road activity data sets are used for the four day types of Friday, Saturday, Sunday, and a Monday-Thursday average weekday:
  - similar to many metropolitan areas, vehicle miles traveled (VMT) in DFW is highest on Fridays and lowest on Sundays, with no morning rush hour for the latter.
  - for the non-road and area source categories, the emission inventory day types are Saturday, Sunday, and a Monday-Friday average weekday.

- Since Fridays have the highest ozone emissions of the week, it is expected that an increased relative portion of the ozone exceedance days would also occur on Fridays. Historical ozone monitoring data from 1997-2014 demonstrates this.

- A comparison was made of the number of emission inventory day types included in the ALL DAYS attainment test and the TOP TEN DAYS attainment test:
  - even though Fridays are roughly 15% of the 67 episode days modeled, they are included in 19% of the ALL DAYS attainment test calculations, and 26% of the TOP TEN DAYS attainment test calculations; and
  - Sundays are roughly 16% of the 67 episode days modeled, but they are included in 11% of the ALL DAYS attainment test calculations, and only 5% of the TOP TEN DAYS attainment test calculations.

Summary of Anthropogenic Emissions and Ozone Exceedances by Day of Week





Description	Weekday	Friday	Saturday	Sunday	Total
Day Type Distribution of 75 ppb Ozone Exceedance Days from 1997-2014	57.4%	17.5%	14.1%	10.9%	100.0%
Number of Emission Inventory Day Types Modeled in Episode*	37	10	9	11	67
Distribution of Emission Inventory Day Types Modeled in Episode*	55.2%	14.9%	13.4%	16.4%	100.0%
Emission Inventory Day Type Distribution in ALL DAYS Test**	50.6%	19.2%	19.2%	11.0%	100.0%
Emission Inventory Day Type Distribution in TOP TEN DAYS Test**	55.8%	25.8%	13.2%	5.3%	100.0%

* Labor Day occurred on Monday September 4 in 2006, but is modeled as a Sunday day type for emission inventory purposes.
** The emission inventory day type distributions are summed and averaged across all monitors.

References

- *DFW Attainment Demonstration State Implementation Plan Revision*, June 2015, TCEQ: http://www.tceq.state.tx.us/airquality/sip/dfw/dfw-latest-ozone

- *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze*, December 2014, U.S. EPA: http://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

- *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze*, April 2007: http://www3.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

- TCEQ Air Quality Modeling – Files and Information (2006 Episodes) Web Page: https://www.tceq.texas.gov/airquality/airmod/data/tx2006

- TCEQ Air Quality Modeling FTP Directory: ftp://amdaftp.tceq.texas.gov/pub/TX/

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