Final Report

**TERC Project H60, Phase I
Dallas/Fort-Worth Future Year
2009 Ozone Modeling with
Four Ozone Episodes from 1999 and 2002**

Prepared for

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Background

The Texas Commission on Environmental Quality (TCEQ) is developing an 8-hour ozone State Implementation Plan (SIP) for the Dallas-Fort Worth (DFW) area. Texas Environmental Research Consortium (TERC) project H60 is intended to support 8-hour ozone SIP development efforts for DFW in particular and Texas' ozone nonattainment areas (NAAs) in general. This report describes future year ozone control strategy evaluations for DFW performed in Phase 1 of TERC project H60.

2002 "CENRAP" Ozone Modeling

A new ozone modeling database was developed for DFW and the summer of 2002. The 2002 model is based on data developed by the Central Regional Air Planning Association (CENRAP) for annual modeling of regional haze and visibility. CENRAP does not perform ozone modeling analyses. CENRAP 2002 data for meteorology and emissions were used to create DFW ozone modeling databases for June through September 2002 and then three episode periods were selected for control strategy evaluations:

- Episode 1: August 3 to August 9, 2002
- Episode 2: August 28 to August 31, 2002
- Episode 3: September 11 to September 15, 2002

This provides 17 new episode days for use in control strategy evaluations. There are other potential episode periods in the summer of 2002 that could be modeled using the data developed for this project. A difference between the 2002 and 1999 episodes is that the 2002 episodes have no 4-km grid over the DFW area because no 4-km meteorological data were available. A 4-km grid is preferable for evaluating control strategies that change emissions in the DFW NAA.

Emission sensitivities for 2009 were evaluated using the meteorology from the August 13-22, 1999 DFW SIP episode and the meteorology from the three new 2002 episodes combined with 2009 emissions projections. These scenarios are referred to as emission sensitivities rather than control strategies because they are not supported by the level of analysis associated with a SIP strategy. Strategies were selected by TERC to elucidate the impacts of several types of potential local (DFW) and regional (East Texas) emission changes that may be expected to impact future DFW ozone attainment.

Control Strategies Evaluated

Reduce Emissions from Gas Compressors. Natural gas is produced in several regions of East Texas and the gas must be compressed as it moves from the wellhead into the collection and distribution system. Major distribution pipelines have large compressors that are permitted and likely to have emission controls. In contrast, the numerous small compressor engines located close to wellheads are likely uncontrolled and not included in point source inventories but rather estimated as area sources. Highly effective control technologies are available for gas compressor engines (NETAC, 2003) and one widely applicable technology (three-way exhaust catalyst for rich burn, 4-cycle engines) has been demonstrated to reduce NOx by over 95% for several gas compressor engines operating in Northeast Texas (Russell, Lindhjem and Yarwood, 2005). It would be unrealistic to apply 95% reduction to all of the area source NOx emissions from the oil and gas production sector. For this sensitivity test, we modeled a 50% reduction in Texas area source emissions from oil and gas production. This sensitivity removed 233 tons per day (tpd) of NOx and 112 tpd of VOC from the Texas emissions inventory. TCEQ recently evaluated “small engine rules” to reduce emissions from these and other small internal combustion engines (Tai and Yarwood, 2006).

Proposed new EGUs with Permits. Several new EGUs are proposed for Texas and 8 units not included in the 2009 baseline inventory were added for this sensitivity test. The emissions for the proposed units were estimated from the permit applications. The units added a combined 48.5 tpd of NOx to the 2009 emission inventory and many of the emissions were in central Texas, near Waco. *Note that this scenario is an emissions increase, not a reduction*.

Retire Currently Mothballed EGUs. Several Texas electric generating units (EGUs) currently are mothballed but are included in the 2009 baseline emission inventory because they could be re-started. These emissions were estimated from reported summer acid rain data for 2000. The estimates were based on the highest reported emissions and do not reflect periods of inactivity or shutdown. In reviewing the "Mothballed EGU" modeling performed for this project, the TCEQ determined that the 2009 emission estimates for the mothballed units were over-estimates because TCEQ had omitted expected emission reductions due to existing Texas controls (e.g. Senate Bill 7). For this sensitivity test, the mothballed units were “retired” removing 66.9 tpd of NOx from the 2009 baseline emission inventory.

Reduce all DFW EGUs to 0.033 lb/MMBtu. Most EGUs in the DFW NAA have a NOx emission limit of 0.033 lb/MMBtu. Several small-system units in the DFW NAA have a NOx emission limit of 0.06 lb/MMBtu. For this sensitivity test, these NOx emissions from the units were reduced by 50%, eliminating 1.57 tpd of NOx, to approximate the impact of reducing their emission limit from 0.06 lb/MMBtu to 0.033 lb/MMBtu.

East Texas EGU Control. In 2005, the TCEQ modeled the impact of applying additional EGU controls across Eastern Texas in a 2010 future year to implement the same control level as applied in the Houston/Galveston/Brazoria NAA. This sensitivity test modeled the same control package, but in the 2009 baseline emission inventory. The total NOx emission reduction was 329.5 tpd.

DFW 50-km EGU Control. This sensitivity test applied the “East Texas EGU Control” to an area around the DFW NAA to determine how much of the ozone benefit could be obtained by a more limited application of controls. The 50-km distance from the DFW NAA boundary was selected because it corresponded to a break point in the number of sources controlled. The total NOx reduction was 93.8 tpd.

Impacts on DFW Ozone for 2009

The 8-hr ozone impacts in the DFW area are summarized in Table ES-1 as the ppb change in the average 2009 design value (DV) across all monitors in the DFW area, for each scenario and episode. Negative values are ozone reductions (benefits) and positive values are ozone increases. Future year DV changes at individual monitors are provided in the report.

Table ES-1. Changes in 2009 NOx emissions (tpd) and average 2009 8-hr ozone DVs (ppb) over DFW monitors for four episode periods.

Episode	Reduce emissions from Gas Compressors	Add Proposed New EGUs	Retire Currently Mothballed EGUs[1]	Reduce all DFW EGUs to 0.033 lb/MMBtu	East Texas EGU Control	DFW 50-km EGU Control[2]
Emissions Change (tpd)						
NOx Decrease (Increase)	233	(48.5)	66.9	1.57	329.5	93.8
Average 2009 8-hr ozone DVs (ppb)						
1999 SIP	-0.50	0.12	-0.03	-0.16	-1.11	-0.60
2002 Episode 1	-0.25	0.06	-0.06	-0.26	-0.97	-0.22
2002 Episode 2	-0.15	0.00	-0.09	-0.10	-0.80	-0.01
2002 Episode 3	-0.45	0.07	-0.03	-0.21	-0.91	-0.34

(1) The NOx reduction from retiring mothballed EGUs may be an over-estimate, see text.
(2) DFW 50-km EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

The ozone responses for each control strategy are discussed below.

Reduce Emissions from Gas Compressors. The reductions in average DFW 2009 DVs ranged from 0.15 to 0.50 ppb and the largest benefits were for the 1999 SIP episode (0.5 ppb) and 2002 episode 1 (0.45 ppb). The benefits in DFW were smaller for 2002 episodes 2 and 3 because consistent northeasterly winds meant that benefits were not transported into the DFW NAA during these episodes.

Proposed new EGUs with Permits. The proposed new EGUs consistently caused increases in episode average daily maximum 8-hr ozone of greater than 5 ppb in Central Texas, to the south of DFW. The maximum ozone impacts were located close to the locations of several proposed new EGUs near Waco (Twin Oaks, Oak Grove and Sandy Creek). Increases in average DFW 2009 DVs ranged from zero to 0.12 ppb depending upon episode. The largest increase in average DFW 2009 DV (0.12 ppb) was for the 1999 SIP episode because of greater incidence of southerly transport winds in this episode than the three 2002 episodes (zero to 0.07 ppb increase).

Retire Currently Mothballed EGUs. Retiring currently mothballed EGUs consistently produced ozone reductions at several locations across Texas. The largest ozone reductions were from a TXU EGU near Savoy in Fannin County, to the north of DFW, and these ozone reductions were transported into the DFW NAA for all episodes. Emission reductions from several other TXU EGUs in Dallas, Collin and Tarrant counties also affected ozone for all episodes. Decreases in average DFW 2009 DVs ranged from 0.03 to 0.09 ppb depending upon episode. Decreases were larger for 2002 episodes 1 and 2 because consistent northeasterly winds during these episodes transported into DFW some benefits from retiring the TXU EGU in Fannin County.

It is interesting to consider whether emission reductions from retiring mothballed EGUs could offset emission increases from adding proposed new EGUs. These impacts offset for DFW in only 2 of 4 episodes because they produced ozone impacts in different locations. DFW ozone benefits from retiring mothballed EGUs were influenced by ozone reductions north of DFW, whereas DFW ozone increases from proposed new EGUs were influenced by ozone increases south of DFW.

Reduce all DFW EGUs to 0.033 lb/MMBtu. Reducing all DFW EGUs to 0.033 lb/MMBtu reduced emissions at only four EGUs and the estimated NOx reduction was only 1.57 tpd. However, these emission reductions occurred within the DFW NAA and were relatively effective at reducing DFW ozone. Reductions in average DFW 2009 DVs ranged from 0.1 to 0.26 ppb depending upon episode. The average ozone impacts from this 1.57 tpd NOx reduction inside the DFW NAA were always larger in absolute magnitude than either retiring mothballed EGUs (66.9 tpd NOx change) or adding proposed new EGUs (48.5 tpd change).

East Texas EGU Control. Reductions in average DFW 2009 DVs ranged from 0.8 to 1.11 ppb depending upon episode. The benefits in DFW were smallest for 2002 episode 2 (0.8 ppb) because consistent northeasterly winds meant benefits of reductions in Northeast Texas passed to the south of the DFW NAA. The benefits in DFW were greatest for the 1999 SIP episode (1.11 ppb) because of greater incidence of southerly transport winds in this episode. All four episodes showed substantial reductions in average 2009 DFW DVs because emission reductions were spread widely across eastern Texas.

DFW 50-km EGU Control. Reductions in average DFW 2009 DVs ranged from 0.01 to 0.6 ppb depending upon episode. Wind directions strongly influenced which episodes showed DFW ozone benefits from this control. The benefits in DFW were smallest for 2002 episode 2 (0.01 ppb) because consistent northeasterly winds meant almost no transport of benefits from Central Texas into the DFW NAA. The benefits in DFW were greatest for the 1999 SIP episode (0.6 ppb) because of greater incidence of southerly transport winds in this episode. Compared to the East Texas EGU control, the DFW 50-km EGU control produced much less ozone benefit in DFW, about half the benefit for the 1999 episode and about a third or less of the benefit for the 2002 episodes.

1.0 INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) is developing an 8-hour ozone State Implementation Plan (SIP) for the Dallas-Fort Worth (DFW) area. Texas Environmental Research Consortium (TERC) project H60 is intended to support 8-hour ozone SIP development efforts for DFW in particular and Texas' ozone nonattainment areas (NAAs) in general. This report describes future year ozone control strategy evaluations for DFW performed in Phase 1 of TERC project H60.

Emission sensitivities for the 2009 future year were evaluated using meteorology from the August 13-22, 1999 DFW SIP episode (see Section 2) and three new episodes from 2002 (see Section 3). These scenarios are referred to as emission sensitivities rather than control strategies because they are not supported by the level of analysis associated with a SIP strategy. Strategies were selected by TERC to elucidate the impacts of several types of potential local (DFW) and regional (East Texas) emission changes that may be expected to impact future DFW ozone attainment. The control strategy evaluation is presented in Section 4.

A new ozone modeling database was developed for DFW and the summer of 2002. The 2002 model is based on data developed by the Central Regional Air Planning Association (CENRAP) for annual modeling of regional haze and visibility. CENRAP 2002 data for meteorology and emissions were used to create DFW ozone modeling databases for June through September 2002 and then three episode periods were selected for control strategy evaluations:

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2.0 OZONE MODELING FOR 1999

The August 1999 SIP model for Dallas/Fort-Worth (DFW) was used to evaluate several future year emission scenarios for 1999. The modeling system is summarized below.

EPISODE PERIODS AND MODELING DOMAIN

The 1999 episode employed in this study is the August 13-23, 1999 period selected by TCEQ for DFW SIP modeling (Mansell et al., 2003). The modeling domain is shown in Figure 2-1. The expanded 36-km coarse grid covers the entire eastern US and portions of Canada and Mexico. The 12-km nested grid is a 1068-km by 1068-km square covering the eastern half of Texas, and most of Louisiana, Mississippi, Arkansas, and Oklahoma. The 4-km grid covers the DFW area at high resolution.

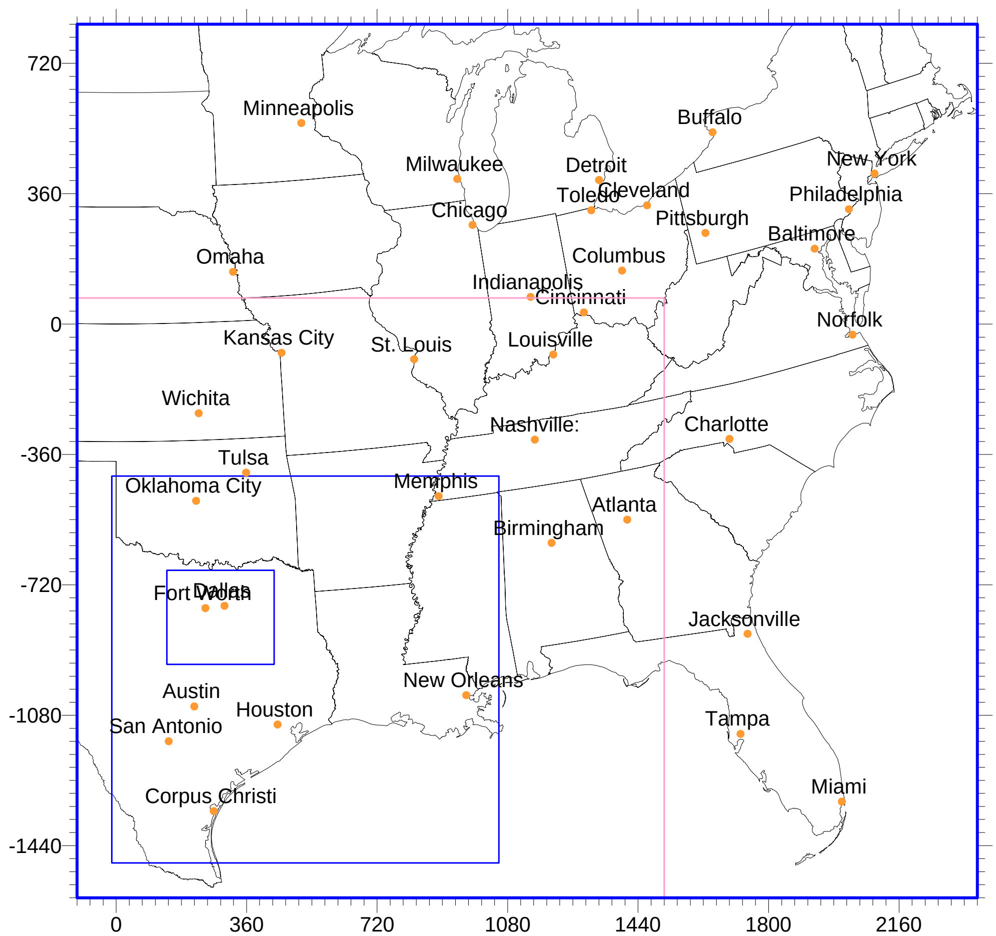


Figure 2-1. CAMx modeling domain for the August 1999 episode.

Modeling for the August 1999 episode was performed using version 4.03 of the Comprehensive Air quality Model with extensions (CAMx; ENVIRON, 2004). The modeling used the Carbon Bond 4 (CB4) chemical mechanism (Gery et al., 1989) with 2005 updates to extend the inorganic reactions and add "NOx recycling" reactions (CB4xi; Yarwood, Whitten and Rao, 2005) and tested for DFW in HARC project H35 (Tai et al., 2005).

METEOROLOGICAL DATA

Meteorological input data for CAMx were developed using the PSU/NCAR Mesoscale Model version 5 (MM5; Duhdia, 1993). The specific MM5 run used was "Run 6" completed for the TERC H35 project (Tai et al., 2005). Run 6 used the ETA PBL scheme coupled with the NOAH land surface model. Meteorological data were reformatted from MM5 to CAMx using the MM5CAMx processor with some layer aggregation above the PBL as shown in Table 2-1. CAMx was run with 20 vertical layers, a top above 15-km and a surface layer thickness of 20 m. Vertical diffusivity coefficients for CAMx were calculated from turbulent kinetic energy (TKE) produced by the MM5 ETA PBL scheme. In each vertical column, the maximum diffusivity encountered in the lowest 100 m was applied to all layers below 100 m.

Table 2-1. MM5 and CAMx vertical grid structures based on 28 sigma-p levels. Heights (m) are above ground level according to a standard atmosphere; pressure is in millibars.

Layer	sigma	pressure	height	thickness	CAMx Layers
28	0.0000	50.00	18874.41	1706.76	
27	0.0250	73.75	17167.65	1362.47	
---- Extended CAMx Top ----					
26	0.0500	97.50	**15805.17**	2133.42	--20---
25	0.1000	145.00	**13671.75**	1664.35	--19---
24	0.1500	192.50	12007.40	1376.75	
23	0.2000	240.00	**10630.65**	1180.35	--18---
22	0.2500	287.50	9450.30	1036.79	
21	0.3000	335.00	**8413.52**	926.80	--17---
20	0.3500	382.50	7486.72	839.57	
19	0.4000	430.00	6647.15	768.53	
18	0.4500	477.50	**5878.62**	709.45	--16---
17	0.5000	525.00	5169.17	659.47	
16	0.5500	572.50	4509.70	616.58	
15	0.6000	620.00	**3893.12**	579.34	--15---
14	0.6500	667.50	**3313.78**	546.67	--14---
13	0.7000	715.00	**2767.11**	517.77	--13---
12	0.7500	762.50	**2249.35**	491.99	--12---
11	0.8000	810.00	**1757.36**	376.81	--11---
10	0.8400	848.00	**1380.55**	273.60	--10---
9	0.8700	876.50	**1106.95**	266.37	---9---
8	0.9000	905.00	**840.58**	259.54	---8---
7	0.9300	933.50	**581.04**	169.41	---7---
6	0.9500	952.50	**411.63**	166.65	---6---
5	0.9700	971.50	**244.98**	82.31	---5---
4	0.9800	981.00	**162.67**	65.38	---4---
3	0.9880	988.60	**97.29**	56.87	---3---
2	0.9950	995.25	**40.43**	20.23	---2---
1	0.9975	997.62	**20.19**	20.19	---1---
0	1.0000	1000.00	**0.00**	========= Surface ======	

EMISSION INVENTORY

The emission inventory for the August 1999 base case model is the latest TCEQ baseline (Run 44) inventory developed for DFW SIP modeling. Texas emissions are based on TCEQ data. Gulf of Mexico emissions were developed by TCEQ from data provided by the Minerals Management Service. Other US emissions are from version 3 of the 1999 National Emission Inventory (NEI99v3).

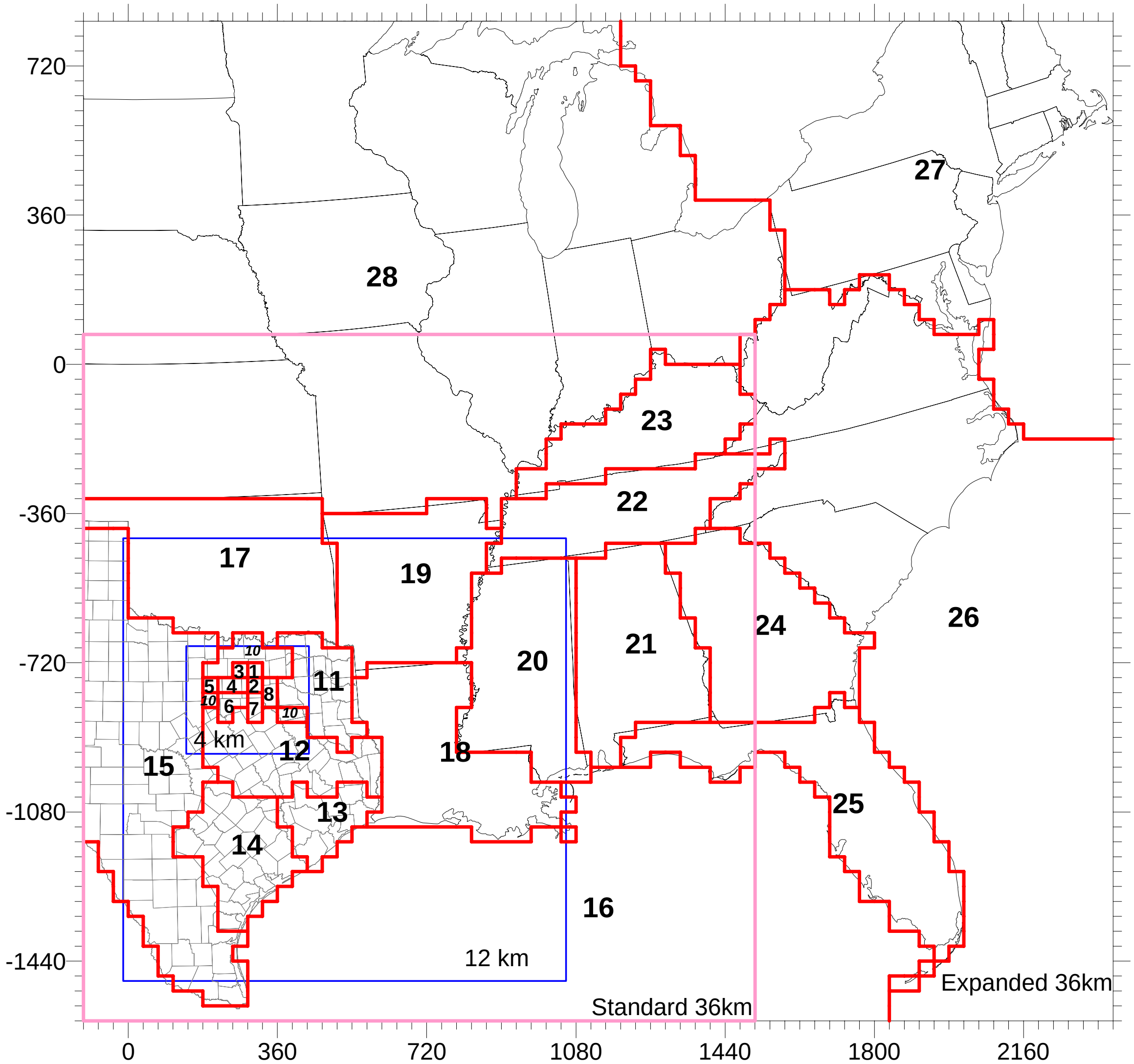
Tables 2-2 and 2-3 show the 1999 baseline weekday emissions for NOx and VOC, respectively, by emission group (on-road mobile, elevated points, low-level points, area including offshore and Canada, off-road, and biogenic sources) and source region, as defined in Figure 2-2. Biogenic emissions vary significantly from day to day due to temperature differences and the biogenic emissions shown in Tables 2-2 and 2-3 are for August 17, 1999.

Table 2-2. Baseline NOx emissions (tpd) for August 17, 1999.

	On-Road Mobile	Elevated Points	Low Points	Area & Offshore	Off-Road Mobile	Total Anthro	Biogenic
Collin Co	33	5	0	1	13	52	10
Dallas Co	185	56	1	16	61	319	4
Denton Co	33	4	0	7	13	58	8
Tarrant Co	107	31	0	9	39	185	3
Parker Co	15	1	0	1	2	19	1
Johnson Co	11	6	0	0	6	24	5
Ellis Co	22	30	0	0	9	62	15
Kaufman Co	18	0	1	0	3	21	5
Rockwall Co	5	0	0	0	2	7	2
DFW 9-County	**430**	**132**	**2**	34	**148**	**747**	**52**
DFW 16 County	**485**	**199**	**4**	53	**166**	**907**	**83**
Northeast Texas	151	330	7	58	49	594	16
Central Texas	185	333	1	46	75	639	113
Houston Region	386	727	21	45	167	1346	21
South Texas	386	438	12	62	121	1019	229
West Texas	282	269	11	173	120	856	524
Texas	**1875**	**2296**	**56**	436	**698**	**5361**	**986**
Gulf + Mexico	20	198	2	419	23	661	79
Oklahoma	369	332	253	94	327	1375	227
Louisiana	375	910	99	269	692	2345	106
Arkansas	280	289	23	90	224	906	125
Mississippi	348	456	36	11	240	1091	121
Alabama	455	825	31	62	508	1881	75
Tennessee	574	771	17	57	282	1702	118
Kentucky	450	1094	102	183	264	2093	145
Georgia	837	793	14	68	284	1996	110
Florida	1267	1819	13	81	449	3630	56
Mid Atlantic	2183	2941	241	226	906	6498	293
NE US and Canada	4362	2347	415	1858	2001	10983	314
Northern Plains	6049	6300	928	758	4892	18927	5238
Total	**19443**	**21372**	**2232**	**4028**	**11790**	**58866**	**7992**

Table 2-3. Baseline VOC emissions (tpd) for August 17, 1999.

Biogenic	On-Road Mobile	Elevated Points	Low Points	Area & Offroad	Off-Road Mobile	Total Anthro	Biogenic
Collin Co	13	0	1	11	6	31	27
Dallas Co	77	4	7	66	27	182	50
Denton co	13	1	1	12	5	33	65
Tarrant Co	44	4	8	46	14	115	64
Parker Co	4	0	0	5	1	11	121
Johnson Co	4	0	0	6	1	12	111
Ellis Co	5	4	2	6	2	20	89
Kaufman Co	6	0	1	7	1	14	112
Rockwall Co	2	0	0	2	2	5	3
DFW 9-County	**167**	**15**	**20**	160	**60**	**423**	**642**
DFW 16 County	**189**	**16**	**22**	191	**70**	**488**	**1538**
Northeast Texas	60	18	31	71	21	202	4917
Central Texas	67	26	14	75	29	211	6098
Houston Region	159	68	182	220	71	699	1683
South Texas	164	25	39	192	69	489	2069
West Texas	109	12	24	189	64	399	6198
Texas	**747**	**165**	**313**	937	**324**	**2487**	**22503**
Gulf + Mexico	16	20	1	182	56	276	658
Oklahoma	247	2	68	253	92	662	7940
Louisiana	216	48	128	250	137	779	9941
Arkansas	166	34	35	228	78	541	13925
Mississippi	188	30	112	254	79	663	14818
Alabama	314	53	114	371	124	976	13954
Tennessee	351	78	135	422	130	1117	8678
Kentucky	273	49	101	271	94	788	3753
Georgia	491	175	368	412	180	1625	12198
Florida	886	73	100	647	476	2182	9793
Mid Atlantic	1405	106	431	1330	580	3852	31294
NE US and Canada	2735	75	260	4175	1507	8753	20472
Northern Plains	3826	235	882	4077	2015	11035	40144
Total	**11861**	**1143**	**3048**	**9922**	**5873**	**31846**	**210073**



DFW Source Regions. 36 km Expanded Domain

1. Collin Co.
2. Dallas Co.
3. Denton Co.
4. Tarrant Co.
5. Parker Co.
6. Johnson Co.
7. Ellis Co.
8. Kaufman Co.
9. Rockwall Co.
10. DFW 16-County
11. NE Texas
12. Central Texas
13. Houston
14. South Texas
15. West Texas
16. Gulf of Mexico + Mexico
17. Oklahoma
18. Louisiana
19. Arkansas
20. Mississippi
21. Alabama
22. Tennessee
23. Kentucky
24. Georgia
25. Florida
26. Mid Atlantic States
27. Northeast US
28. Northern Plains

Figure 2-2. Map of regions used to report emission totals.

2009 BASELINE EMISSIONS

Future baseline emissions for 2009 include both Federal and State controls scheduled for implementation by 2009. The 2009 baseline emissions serve as a reference for comparing the impacts of hypothetical further controls. Texas EGU emissions were developed by the TCEQ from 2000 acid rain data. A summary of 2009 weekday emissions by source region (as defined in Figure 2-2) and emissions group is shown in Tables 2-4 and 2-5 for NOx and VOC, respectively. These tables also show the change in anthropogenic emissions from the 1999 weekday baseline in the rightmost column.

Weekday 2009 baseline NOx emissions in Texas were 42 % lower than in 1999, which is slightly more reduction than the domain-wide average reduction of 39 %. Weekday 2009 baseline NOx emissions in the DFW 9-county NAA were projected to be 47 % lower than 1999. Weekday anthropogenic VOC emissions in DFW were 21 % lower in 2009, which is a greater reduction than the 11 % across Texas, but less than the 26 % change domain-wide. Biogenic emissions were unchanged from the 1999 baseline run.

Table 2-4. 2009 baseline NOx emissions (tpd) for a weekday in August.

NOx (tpd)	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 1999
Collin Co	15	1	0	2	8	0	26	-51%
Dallas Co	77	6	2	18	45	0	149	-53%
Denton Co	17	1	0	12	9	0	40	-31%
Tarrant Co	46	2	2	10	28	0	89	-52%
Parker Co	6	1	0	1	2	0	10	-50%
Johnson Co	5	6	0	0	5	0	16	-33%
Ellis Co	9	35	1	0	6	0	51	-18%
Kaufman Co	6	4	0	0	2	0	13	-40%
Rockwall Co	3	0	0	0	1	0	5	-32%
DFW 9-County	**184**	**55**	**6**	**44**	**107**	**0**	**396**	**-47%**
DFW 16 County	**212**	**80**	**10**	**67**	**123**	**0**	**492**	**-46%**
NE Texas	79	189	16	71	42	1	397	-33%
Central TX	88	138	2	56	69	0	353	-45%
Houston	175	282	12	53	63	0	585	-57%
South TX	189	267	22	75	100	0	653	-36%
West TX	160	154	21	212	105	1	653	-24%
Texas	**904**	**1109**	**83**	**534**	**501**	**2**	**3133**	**-42%**
Gulf + Mexico	5	437	0	4	2	444	892	35%
Oklahoma	1	256	0	2	3	661	924	-33%
Louisiana	1	715	2	2	1	1183	1905	-19%
Arkansas	2	220	0	0	2	468	692	-24%
Mississippi	0	353	0	0	0	455	808	-26%
Alabama	0	442	0	0	0	491	932	-50%
Tennessee	0	244	0	0	0	662	906	-47%
Kentucky	0	289	0	0	0	770	1060	-49%
Georgia	0	408	0	0	0	823	1230	-38%
Florida	0	367	0	0	0	1206	1573	-57%
Mid Atlantic	0	977	0	0	0	2332	3310	-49%
NE US	0	1302	0	0	0	5748	7051	-36%
Northern Plains	0	3269	0	0	0	8623	11892	-37%
Total	**913**	**10389**	**85**	**543**	**509**	**23869**	**36308**	**-39%**

Table 2-5. 2009 baseline VOC emissions (tpd) for a weekday in August.

VOC (tpd)	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 1999
Collin Co	7	0	0	12	3	0	23	-26%
Dallas Co	43	4	5	72	17	0	141	-22%
Denton co	8	1	0	15	4	0	28	-14%
Tarrant Co	25	2	5	54	9	0	94	-19%
Parker Co	2	0	0	5	1	0	9	-23%
Johnson Co	2	0	0	6	1	0	9	-21%
Ellis Co	2	3	2	6	2	0	15	-22%
Kaufman Co	2	0	0	7	1	0	11	-26%
Rockwall Co	1	0	0	2	1	0	4	-30%
DFW 9-County	**92**	**10**	**13**	**180**	**38**	**0**	**333**	**-21%**
DFW 16- County	**103**	**34**	**15**	**216**	**44**	**1**	**413**	**-15%**
NE Texas	27	15	41	82	14	1	181	-10%
Central TX	33	20	20	85	21	1	180	-15%
Houston	80	92	215	247	41	0	675	-3%
South TX	78	20	48	217	46	0	408	-17%
West TX	59	11	28	215	52	3	367	-8%
Texas	**380**	**191**	**367**	**1060**	**218**	**6**	**2223**	**-11%**
Gulf + Mexico	3	32	0	10	4	329	378	37%
Oklahoma	1	3	0	5	1	481	490	-26%
Louisiana	0	47	3	4	1	546	601	-23%
Arkansas	0	23	0	2	0	441	466	-14%
Mississippi	0	35	0	0	0	548	583	-12%
Alabama	0	39	0	0	0	655	695	-29%
Tennessee	0	66	0	0	0	895	961	-14%
Kentucky	0	34	0	0	0	622	656	-17%
Georgia	0	53	0	0	0	869	922	-43%
Florida	0	42	0	0	0	1594	1636	-25%
Mid Atlantic	0	67	0	0	0	2836	2903	-25%
NE US	0	248	0	0	0	5407	5655	-35%
Northern Plains	0	226	0	0	0	8224	8450	-23%
Total	**384**	**1107**	**370**	**1080**	**224**	**23453**	**26618**	**-26%**

PROJECTED 2009 DESIGN VALUES

Table 2-6 shows projected future design value calculations for each DFW monitoring site using the 2009 and 1999 baseline model runs and observed 1999 design values. The future year design value (Future DV) at each monitor is the observed baseline DV multiplied by a Relative Reduction Factor (RRF). The RRF is a ratio of future year to base year ozone at the monitor[1] from CAMx calculated as shown in Table 2-6. The modeling projects that the 8-hour ozone standard will be attained in the future year if all Future DVs are below 85 ppb. EPA developed this DV scaling methodology for use in 8-hour ozone attainment demonstrations (EPA, 2005). Frisco had the highest future design value at 91.2 ppb, followed by Denton at 89.6 ppb, which had the highest baseline design value but the lowest (most effective) RRF.

Daily RRFs are provided at the bottom of Table 2-6 for information on daily model response. Values in red indicate RRFs greater than 1.0; values in blue represent RRFs less than 0.9. All daily RRFs over 1.0 occurred on August 17 and 20, indicating higher ozone in 2009 than 1999 at these monitors on these days (i.e., disbenefits from NOx reduction). The three stations in the northwest (Denton and the two Fort Worth sites) had the lowest daily RRFs on August 18; the northeast stations (Frisco and the Dallas monitors) were lowest on August 22.

[1] At the monitor is defined by EPA (2005) as the daily maximum 8-hr ozone in a 7 by 7 square of 4-km grid cells centered on the monitor. Days are included in the RRF calculation only if the base year modeled 8-hr ozone exceeded 70 ppb at the monitor.

Table 2-6. Projected 2009 baseline design values (ppb) scaled from the 1999 baseline for August 15 – 23, 1999.

Base Case[4]

Site	Aug-15	Aug-16	Aug-17	Aug-18	Aug-19	Aug-20	Aug-21	Aug-22	Model Average [ppb]	# Model Days>70		
Frisco	80.7	105.6	99.0	104.9	85.6	70.0	85.9	89.4	90.1	8		
Dallas C60	83.2	98.1	100.6	102.8	96.7	77.4	86.0	85.1	91.2	8		
Dallas C63	82.8	99.6	99.0	104.7	94.0	76.0	86.0	87.5	91.2	8		
Dallas C402	78.3	92.9	98.0	98.3	104.7	84.7	80.5	80.6	89.7	8		
Denton	102.4	110.5	108.5	113.0	83.9	72.4	101.6	100.1	99.0	8		
Midlothian	75.5	85.0	86.2	78.0	111.8	89.6	75.0	74.9	84.5	8		
Arlington	86.3	98.3	99.6	94.5	104.5	84.2	81.8	86.6	92.0	8		
Fort Worth C13	94.2	105.4	102.6	104.2	94.9	79.9	90.9	91.9	95.5	8		
Fort Worth C17	100.4	110.1	107.6	106.8	92.3	77.9	95.1	97.3	98.4	8		

Future Year[5]

Site	Aug-15	Aug-16	Aug-17	Aug-18	Aug-19	Aug-20	Aug-21	Aug-22	Model Average [ppb]	RRF[1]	Baseline DV [ppb]	Future DV[2] [ppb]
Frisco	68.4	100.1	100.4	98.4	73.2	64.9	75.1	75.4	82.0	0.909	100.3	**91.2**
Dallas C60	73.8	93.0	102.1	99.6	89.4	82.6	79.2	75.0	86.8	0.952	92.0	**87.6**
Dallas C63	71.7	95.7	100.4	100.0	84.0	78.8	77.8	74.2	85.3	0.936	93.0	**87.0**
Dallas C402	68.5	82.6	90.3	88.2	95.7	87.6	72.2	70.2	81.9	0.913	87.3	**79.7**
Denton	88.6	102.3	106.5	92.2	71.1	64.1	89.6	85.2	87.4	0.883	101.5	**89.6**
Midlothian	70.6	76.1	78.3	70.5	97.5	87.1	69.2	68.4	77.2	0.914	92.5	**84.5**
Arlington	74.3	90.3	91.6	83.6	94.4	87.6	74.1	79.5	84.4	0.918	95.0	**87.2**
Fort Worth C13	81.5	94.9	93.8	88.2	83.7	76.5	80.5	81.7	85.1	0.891	98.3	**87.6**
Fort Worth C17	88.9	97.7	102.6	90.6	79.8	71.0	87.9	84.5	87.9	0.893	96.3	**86.0**

Daily RRFs[3]

Site	Aug-15	Aug-16	Aug-17	Aug-18	Aug-19	Aug-20	Aug-21	Aug-22				
Frisco	0.847	0.948	1.015	0.938	0.855	0.926	0.875	0.844				
Dallas C60	0.887	0.948	1.015	0.968	0.925	1.067	0.921	0.881				
Dallas C63	0.866	0.961	1.014	0.955	0.894	1.038	0.904	0.848				
Dallas C402	0.875	0.889	0.921	0.897	0.914	1.034	0.897	0.871				
Denton	0.865	0.926	0.982	0.816	0.847	0.886	0.881	0.851				
Midlothian	0.935	0.896	0.909	0.904	0.872	0.972	0.923	0.913				
Arlington	0.861	0.918	0.920	0.885	0.903	1.041	0.907	0.918				
Fort Worth C13	0.866	0.901	0.914	0.846	0.882	0.958	0.886	0.888				
Fort Worth C17	0.885	0.887	0.953	0.849	0.864	0.912	0.924	0.869				

(1) RRF = Future Year Model Average / Base Case Model Average
(2) Future DV = Baseline DV x RRF
(3) Daily RRFs are for information only. They are not used to calculate the Future DV.
(4) The Base Case run is "run44."
(5) The Future Year run is "run44.fy2009.a1."

3.0 OZONE MODELING FOR 2002

A new ozone modeling database was developed for DFW and the summer of 2002. The 2002 model is based on data developed by the Central Regional Air Planning Association (CENRAP) for annual modeling of regional haze and visibility (see www.cenrap.org for information about CENRAP). We adapted CENRAP 2002 data for meteorology and emissions to create DFW ozone modeling databases for June through September 2002 that have modeling grids consistent with the DFW August 1999 episode. The objective in making the modeling grids consistent was to use the same future year (2009) anthropogenic emissions with both 2002 and 1999 episodes and thereby perform comparable emission control strategy evaluations. A difference between the 2002 and 1999 episodes is that the 2002 episodes have no 4-km grid over the DFW area because no 4-km meteorological data were available.

EPISODE PERIODS AND MODELING DOMAIN

The 2002 modeling domain is the same as the 1999 modeling domain shown in Figure 2-1 with the following differences:

- The 2002 model does not have a 4-km grid over DFW.

- The 12-km grid for the 2002 model is smaller (89 by 65) than for 1999 (89 by 89) because the south boundary is further north. This difference is due to the limited extent of the CENRAP 12-km meteorological data. The south boundary of the CAMx 12-km grid for 2002 does encompass Houston.

The TCEQ ozone monitoring data for DFW in the summer of 2002 were reviewed to identify high ozone periods and Table 3-1 summarizes days when 8-hour ozone exceeded 85 ppb in DFW. The strongest candidate episodes are multi-day periods where multiple monitors exceed 85 ppb. The project timeline was highly compressed (from model development to control strategy evaluation in about 1 month) and episodes were selected using preliminary model performance results and in order to provide rapid control strategy results. We considered episodes in August and early September so that a single model run could combine several episodes. A major episode was available in June, but there were long periods with limited exceedance days in July.

Three episode periods from 2002 were selected for control strategy evaluations:

- Episode 1: August 3 to August 9, 2002
- Episode 2: August 28 to August 31, 2002
- Episode 3: September 11 to September 15, 2002

This provides 17 episode days for control strategy evaluations. There are other potential episode periods in the summer of 2002 that could be modeled using the data developed for this project.

CAMx was run for the entire period from July 28 to September 15, 2002 at 36-km resolution (50 days). A 12-km grid was introduced for each of the 3 episode periods. The 12-km grids were started one day prior to each episode to allow the 12-km grid to develop higher resolution detail for the episode. Tests found that this approach provided 12-km episode results that were almost identical to running the 12-km grid for the entire 50 day period, but much more quickly.

Table 3-1. Days in summer 2002 when DFW monitors exceeded 85 ppb**.**

Date	Number of Monitors Exceeding 85 ppb	Maximum 8-Hour Ozone (ppb)
15-May-02	1	91
21-May-02	2	85
7-Jun-02	3	86
17-Jun-02	3	97
18-Jun-02	1	87
22-Jun-02	6	95
23-Jun-02	13	114
24-Jun-02	11	122
25-Jun-02	4	99
27-Jun-02	1	89
7-Jul-02	1	90
8-Jul-02	7	114
9-Jul-02	7	113
11-Jul-02	1	91
14-Jul-02	1	90
25-Jul-02	1	88
3-Aug-02	6	98
4-Aug-02	3	87
5-Aug-02	3	95
6-Aug-02	2	88
7-Aug-02	9	106
8-Aug-02	8	95
9-Aug-02	14	127
28-Aug-02	4	92
29-Aug-02	2	94
30-Aug-02	2	91
31-Aug-02	4	94
1-Sep-02	2	91
3-Sep-02	1	87
5-Sep-02	2	89
6-Sep-02	5	93
11-Sep-02	6	105
12-Sep-02	1	85
13-Sep-02	11	101
14-Sep-02	8	99
27-Sep-02	4	88
28-Sep-02	3	87

Modeling for the 2002 CENRAP episodes was performed using version 4.3 of the Comprehensive Air quality Model with extensions (CAMx; ENVIRON, 2006). The modeling used the Carbon Bond 4 (CB4) chemical mechanism (Gery et al., 1989) with 2005 updates to extend the inorganic reactions and add "NOx recycling" reactions (CB4xi; Yarwood, Whitten and Rao, 2005).

METEOROLOGICAL DATA

The 2002 meteorological data were developed for CENRAP by the Iowa Department of Natural Resources (IDNR) using the MM5 (Johnson, 2003). IDNR completed an annual, 36-km resolution model simulation for the entire continental US in the "Inter RPO" modeling grid being used by regional planning organizations (RPOs) such as CENRAP. CENRAP is using the 36-km grid simulation for regional haze and visibility modeling. IDNR also completed a 12-km grid simulation at the same time and using the same model configuration, but CENRAP is not using these results because the 12-km grid was slightly too small and omitted Texas to the south of Victoria. CENRAP subsequently completed 12-km modeling on a larger grid encompassing all of Texas, but only for selected episode periods in 2002. The IDNR 12-km grid modeling for all of 2002 was used to develop the 12-km CAMx meteorology for this project. IDNR graciously provided their MM5 modeling results to ENVIRON.

The IDNR MM5 data were reformatted for CAMx using the MM5CAMx processor. An issue was that the IDNR MM5 and DFW CAMx models are configured on different Lambert-Conformal projections (LCP). MM5CAMx was modified to perform the necessary interpolation of meteorological data between different LCP grids.

EMISSION INVENTORY FOR 2002

The regional emission inventory data were developed based on the CENRAP 2002 inventory data. CENRAP's 2002 emission inventory is based on EPA's 2002 National Emission Inventory with updates and corrections provided by CENRAP member states (which include Texas) and the other Regional Planning Organizations. The regional emission inventories currently in use by CENRAP were processed using the SMOKE emissions processing system for modeling domains based on the Inter-RPO Lambert Conformal Projection (LCP) coordinate system. Annual (and seasonal/monthly) county-level emissions estimates used in the SMOKE processing system are available in ASCII, "IDA" formatted data files. These data contain all the necessary information required for application of EPS3. Processing utilities were developed using Perl to re-format these data into AFS (point sources) and AMS (area and mobile sources) formatted data files for input to EPS3.

Table 3-2 lists the data files that were used in the development of the Texas regional emission inventory for the 2002 modeling episode. All of these data were taken from the CENRAP 2002 inventory data with the exception of U.S. on-road mobile and the Gulf of Mexico offshore sources. The U.S. on-road mobile emission inventory was the EPA NEI 2002 preliminary data that was posted on EPA's website in the summer of 2004. The Gulf of Mexico offshore inventory was provided by TCEQ.

Table 3-2. 2002 emission inventory data files.

Category	Region	Data File
On-Road Mobile	US	nei2002prelim.onroad.ext_reg.ams.srt
	Canada	mbinv_CANADA2000.ida
Off-road Mobile	CENRAP	CENRAP_NONROAD_SMOKE_INPUT_ANN_071305.txt
	MANE	nrinv_mane-vu2002_052505.ida.txt
	MANE	nrinv_aircraft.mane-vu2002_052505.ida.txt
	MANE	nrinv_locomotive.mane-vu2002_052505.ida.txt
	MANE	nrinv_shipping.mane-vu2002_052505.ida.txt
	VISTAS	nrinv_vistas2002_rev_100104.ida.txt
	VISTAS	nrinv_aircraft.vistas2002_rev_100104.ida.txt
	VISTAS	nrinv_locomotive.vistas2002_rev_100104.ida.txt
	VISTAS	nrinv_shipping.vistas2002_rev_100104.ida.txt
	MRPO	arinv.nroad.sep2002.mrpo.baseJ.ida.txt
	MRPO	arinv.nroad.aug2002.mrpo.baseJ.ida.txt
	MRPO	arinv.nroad.jul2002.mrpo.baseJ.ida.txt
	MRPO	arinv.nroad.jun2002.mrpo.baseJ.ida.txt
	WRAP	nrinv_wrap2002_nonCA_aut_060705.ida
	WRAP	nrinv_wrap2002_nonCA_sum_060705.ida
	WRAP	nrinv_wrap2002_Aircraft_aut_080205.ida
	WRAP	nrinv_wrap2002_Aircraft_sum_080205.ida
	WRAP	nrinv_wrap2002_locomotive_annual_tpd_080205.ida
	WRAP	nrinv_wrap2002_Comm_Marine_inshore_annual_tpd_080205.ida
	Canada	nrinv.CANADA2000_v2.ida
	Canada	nrinv_aircraft.CANADA2000_v2.ida
	Canada	nrinv_locomotive.CANADA2000_v2.ida
	Canada	nrinv_marine.CANADA2000_v2.ida
Area	CENRAP	arinv_nodust_ref_nh3_cenrap2002_081705.ida.txt
	MANE	arinv_nodust_ref_mane-vu2002_011705.ida
	MWRPO	arinv_nodust_ref_nh3_mw2002I_052305.ida
	VISTAS	arinv_nodust_ref_vistas2002_040105.ida
	VISTAS	ar_fire_2002_rev_21oct04_vistas.emis.ida
	WRAP	arinv_nodust_wrap2002_081205.ida.txt
	Canada	arinv_nodust_CANADA2000_v2.ida
	US	SMOKE_2002_OilGas_annual_tpd_082505rev.ida
Offshore	GULF	lo_ar.grdem.cb4.000830.reg_12km.MMS2000.05Aug18
	GULF	afs.gwei2000.20000801.3pol.lcp
Points	CENRAP	CENRAP_POINT_SMOKE_INPUT_ANNUAL_DAILY_072505.txt
	MANE	ptinv_mane-vu2002_sum_013105.ida
	MRPO	ptinv.ann2002.mrpo.baseI.ida
	VISTAS	ptinv_2002_08nov04_vistas.ida
	WRAP	WRAP_Point_Inventory_States-rev20050908.txt
	Canada	ptinv_CANADA2000_v2.ida

Biogenic emissions for 2002 were developed using the GloBEIS model with MM5 temperatures, solar radiation derived from analysis of GOES satellite data and landuse/landcover data developed for the August 1999 episode.

Tables 3-3 and 3-4 show the baseline weekday emissions for NOx and VOC, respectively, by emission group (on-road mobile, elevated points, low-level points, area (including offshore and Canada), off-road, and biogenic sources) and source region as defined in Figure 2-1. Biogenic emissions vary significantly from day to day due to temperature differences and the data shown in Tables 3-3 and 3-4 are for August 15, 2002.

Because the emission summaries provided in Tables 3-3 and 3-4 are prepared from model ready gridded emissions the allocation to geographic areas is approximate. For this reason the DFW nonattainment area (NAA) counties are not reported individually for 2002 (in contrast to 1999 in Section 2) because 12-km grid resolution is insufficient to report emissions by county.

Tables 3-5 and 3-6 compare the 1999 and 2002 baseline emission inventories for NOx and VOC, respectively, by emission group and source region. Differences (2002 – 1999) are shown highlighted in red for increases, blue for decreases and black for changes of less than 10 tons/day. Some of the differences for DFW area counties are attributable to the different grid resolution used to develop the 1999 (4-km grid) and 2002 (12-km grid) emission totals.

Table 3-3. Baseline NOx emissions (tons/day) for August 15, 2002.

	On-Road Mobile	Elevated Points	Low Points	Area & Offshore	Off-Road Mobile	Total Anthro	Biogenic
DFW 9-County	**348**	**74**	**3**	**54**	**143**	**622**	**47**
DFW 16 County	**391**	**117**	**3**	**68**	**159**	**738**	**74**
Northeast Texas	109	220	5	93	42	469	15
Central Texas	141	195	2	58	64	460	109
Houston Region	354	421	11	57	176	1019	20
South Texas	276	298	8	89	107	777	173
West Texas	215	177	10	191	114	707	437
Texas	**1486**	**1427**	**39**	**556**	**661**	**4170**	**827**
Gulf + Mexico	24	207	4	393	46	673	71
Oklahoma	361	509	12	297	159	1337	217
Louisiana	341	874	95	283	338	1931	102
Arkansas	262	177	54	63	218	773	106
Mississippi	333	297	39	18	248	934	110
Alabama	427	603	95	25	174	1324	68
Tennessee	524	577	14	44	247	1406	97
Kentucky	409	1139	13	98	231	1890	112
Georgia	790	537	6	81	242	1656	98
Florida	1182	796	4	71	388	2440	53
Mid Atlantic	1845	2251	70	198	616	4979	236
NE US and Canada	4153	2070	271	418	2093	9005	251
Northern Plains	5148	4659	963	712	2517	13999	4840
Total	**17286**	**16122**	**1677**	**3254**	**8177**	**17286**	**7186**

Table 3-4. Baseline VOC emissions (tons/day) for August 15, 2002.

	On-Road Mobile	Elevated Points	Low Points	Area & Offshore	Off-Road Mobile	Total Anthro	Biogenic
DFW 9-County	**196**	**7**	**11**	**117**	**65**	**397**	**469**
DFW 16 County	**218**	**8**	**13**	**138**	**83**	**460**	**1409**
Northeast Texas	58	12	20	78	27	196	3751
Central Texas	77	17	10	69	37	209	1980
Houston Region	196	37	76	133	73	515	39
South Texas	171	11	24	151	77	433	1029
West Texas	124	5	13	200	77	418	3677
Texas	**844**	**89**	**154**	**769**	**373**	**2230**	**11885**
Gulf + Mexico	17	46	3	161	85	312	654
Oklahoma	212	14	36	269	122	652	5294
Louisiana	187	44	116	182	265	793	2908
Arkansas	138	33	220	137	143	671	9548
Mississippi	163	17	73	265	88	606	9547
Alabama	260	31	75	296	105	767	11641
Tennessee	283	70	100	271	116	841	5381
Kentucky	232	38	55	190	85	601	2935
Georgia	420	35	37	553	157	1202	10202
Florida	764	47	35	759	450	2055	8508
Mid Atlantic	1084	146	263	1160	488	3142	18469
NE US and Canada	2166	136	267	2295	1690	6554	10218
Northern Plains	3035	344	499	2588	1890	8356	28181
Total	**9804**	**1091**	**1932**	**9896**	**6057**	**28781**	**135369**

Table 3-5. Change in baseline NOx emissions (tons/day) between 1999 and 2002 (2002 – 1999).

	On-Road Mobile	Elevated Points	Low Points	Area & Offshore	Off-Road Mobile	Total Anthro
DFW 9-County	**-81**	**-58**	**0**	**19**	**-5**	**-124**
DFW 16 County	**-94**	**-83**	**-1**	**15**	**-8**	**-170**
Northeast Texas	-42	-110	-1	35	-7	-125
Central Texas	-44	-138	1	12	-11	-179
Houston Region	-32	-306	-10	11	10	-327
South Texas	-110	-141	-4	27	-14	-242
West Texas	-67	-92	-2	18	-7	-149
Texas	**-389**	**-869**	**-16**	**120**	**-37**	**-1191**
Gulf + Mexico	5	9	1	-26	22	11
Oklahoma	-8	177	-241	203	-168	-38
Louisiana	-33	-37	-4	13	-353	-414
Arkansas	-18	-112	31	-27	-6	-133
Mississippi	-15	-159	2	7	8	-157
Alabama	-28	-222	63	-37	-334	-557
Tennessee	-50	-194	-3	-13	-35	-296
Kentucky	-41	45	-90	-85	-33	-203
Georgia	-47	-256	-8	13	-42	-341
Florida	-85	-1024	-9	-10	-62	-1190
Mid Atlantic	-338	-691	-171	-29	-291	-1518
NE US and Canada	-210	-277	-144	-1440	92	-1979
Northern Plains	-901	-1641	34	-46	-2375	-4929
Total	**-2157**	**-5250**	**-555**	**-1359**	**-3613**	**-12934**

Table 3-6. Change in baseline VOC emissions (tons/day) between 1999 and 2002 (2002 – 1999).

	On-Road Mobile	Elevated Points	Low Points	Area & Offshore	Off-Road Mobile	Total Anthro
DFW 9-County	**29**	**-8**	**-8**	**-43**	**5**	**-25**
DFW 16 County	**29**	**-9**	**-9**	**-53**	**13**	**-29**
Northeast Texas	-2	-6	-11	7	6	-6
Central Texas	10	-9	-5	-7	8	-2
Houston Region	38	-31	-107	-87	2	-184
South Texas	7	-14	-15	-41	8	-56
West Texas	14	-7	-12	11	13	20
Texas	**97**	**-75**	**-159**	**-168**	**49**	**-257**
Gulf + Mexico	1	26	2	-21	29	36
Oklahoma	-35	12	-32	15	30	-10
Louisiana	-30	-4	-12	-68	128	14
Arkansas	-29	-1	185	-91	65	130
Mississippi	-25	-13	-39	11	9	-57
Alabama	-54	-22	-39	-76	-19	-209
Tennessee	-67	-8	-36	-151	-14	-276
Kentucky	-41	-11	-46	-81	-9	-188
Georgia	-70	-140	-331	142	-23	-423
Florida	-122	-27	-65	113	-26	-126
Mid Atlantic	-321	40	-168	-170	-92	-710
NE US and Canada	-570	61	7	-1880	183	-2199
Northern Plains	-791	109	-383	-1489	-126	-2679
Total	**-2056**	**-52**	**-1116**	**-3915**	**185**	**-6954**

MODEL PERFORMANCE FOR 2002 EPISODES

Model performance for 8-hour ozone was evaluated against TCEQ monitoring data for the DFW area. Figures 3-1 through 3-3 summarize the analysis for episodes 1 to 3, respectively. The figures scatter plot modeled and observed daily maximum ozone at the DFW monitors and present the scatter plot data as a quantile-quantile (Q-Q) plot. In these figures, good performance would be characterized by: (1) most of the scatter plot points lying close to the 1:1 line and preferably within the +/- 20% lines and (2) a Q-Q distribution very close to the 1:1 line.

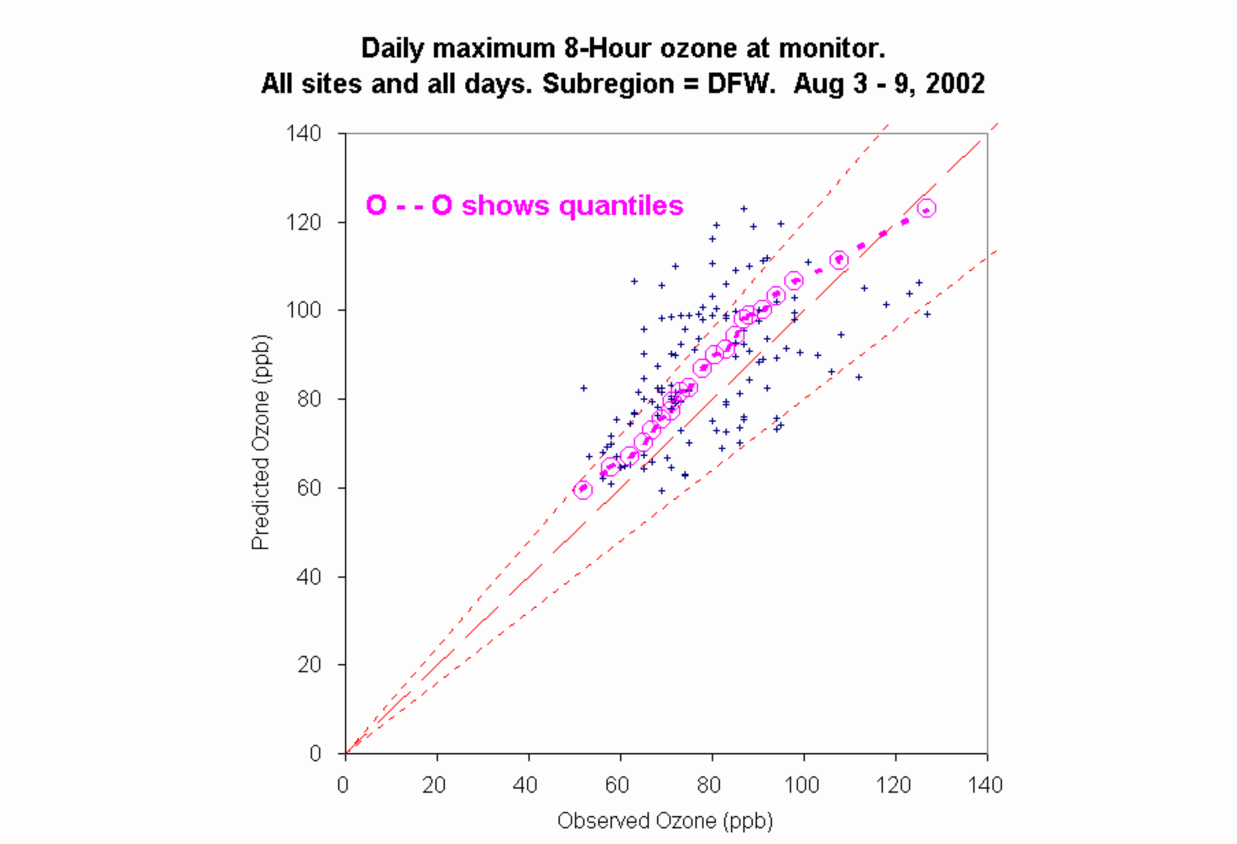


Figure 3-1. 8-hour ozone model performance for DFW area monitors during the August 3-9, 2002 period (Episode 1). Plus symbols scatter-plot the daily maximum 8-hour ozone at monitors. Dashed lines show 1:1 correlation and +/- 20%. Circles show a quantile-quantile presentation of the scatter plot data.

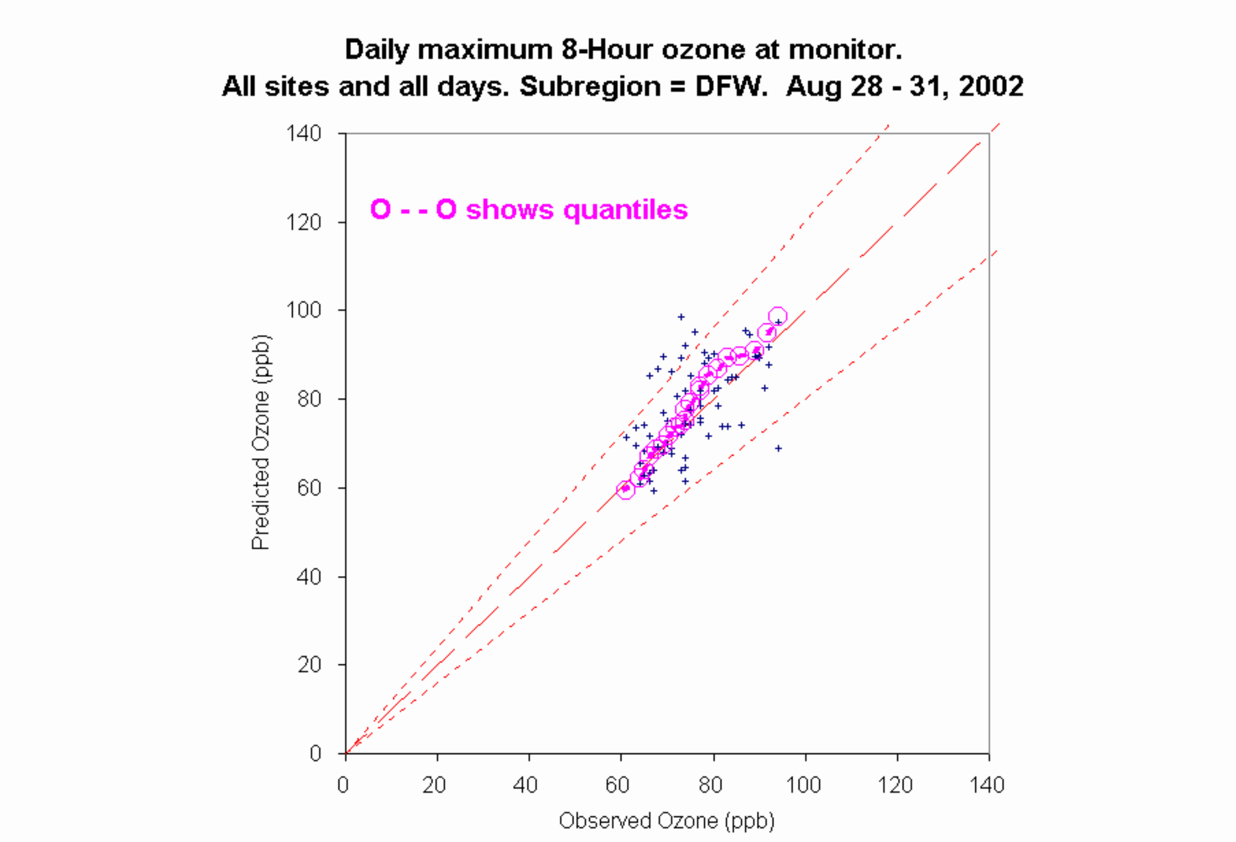


Figure 3-2. 8-hour ozone model performance for DFW area monitors during the August 28-31, 2002 period (Episode 2). Plus symbols scatter-plot the daily maximum 8-hour ozone at monitors. Dashed lines show 1:1 correlation and +/- 20%. Circles show a quantile-quantile presentation of the scatter plot data.

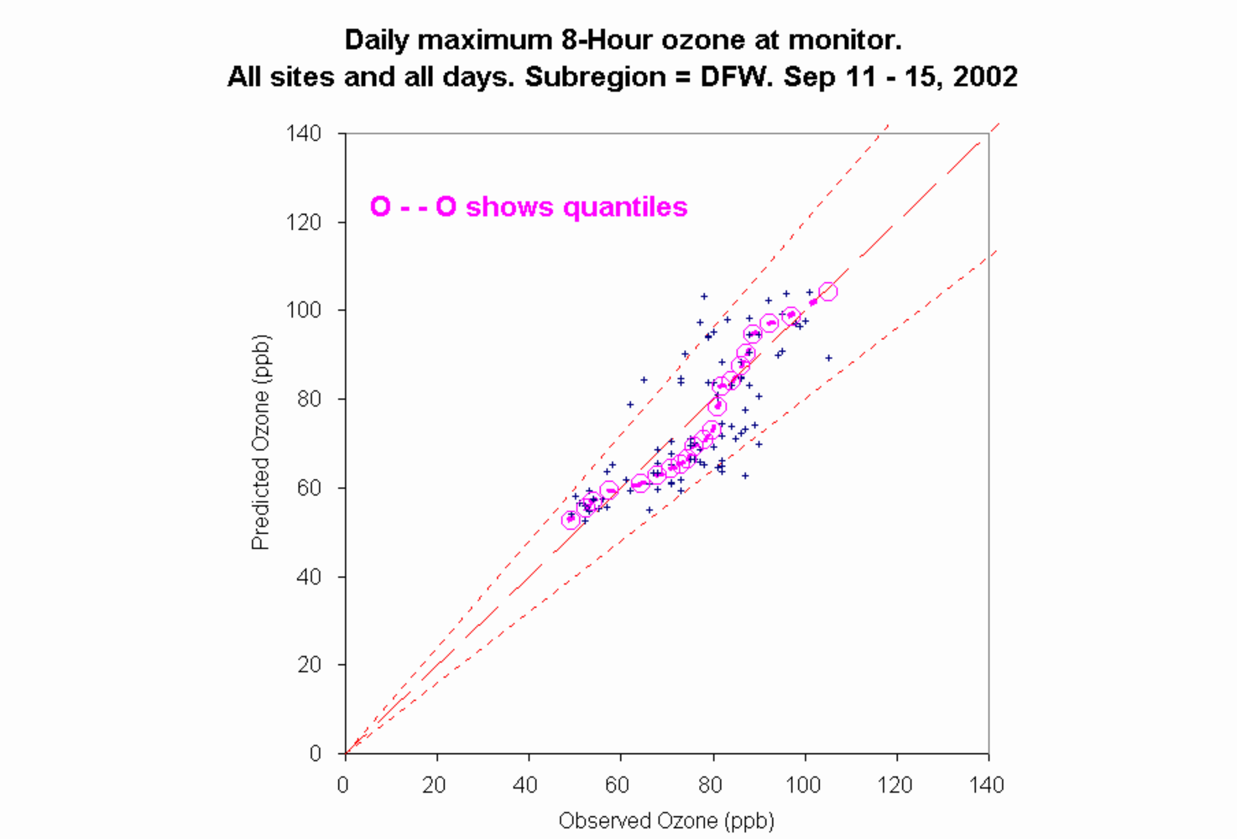


Figure 3-3. 8-hour ozone model performance for DFW area monitors during the September 11-15, 2002 period (Episode 3). Plus symbols scatter-plot the daily maximum 8-hour ozone at monitors. Dashed lines show 1:1 correlation and +/- 20%. Circles show a quantile-quantile presentation of the scatter plot data.

All three episode periods provide reasonable model performance for 8-hour ozone in the DFW area. Episode 1 has a tendency to over predict 8-hour ozone in the DFW area as shown by scatter plot points above the + 20% line and a Q-Q distribution consistently above the 1:1 line. Episode 2 performs quite well with most scatter plot points lying within the +/- 20% range and a Q-Q distribution close to the 1:1 line. Episode 3 performs the best with most scatter plot points lying within the +/- 20% range and a Q-Q distribution close to the 1:1 line. It is possible that Episode 1-3 model performance could be further improved by including a 4-km grid with refined meteorological and emissions data.

2009 BASELINE OZONE LEVELS

Future year (2009) ozone levels for the 2002 CENRAP episodes were modeled using the 2009 baseline anthropogenic emissions developed by TCEQ for the August 1999 episode in conjunction with the day-specific biogenic emissions for 2002 developed for this project. The episode average daily maximum 8-hour ozone levels are shown in Figure 3-4 to 3-6 for episodes 1 to 3, respectively. We show episode average daily maximum ozone levels to summarize each episode in a single figure and because this corresponds to the “design value scaling” methodology which averages daily maximum ozone across episode days.

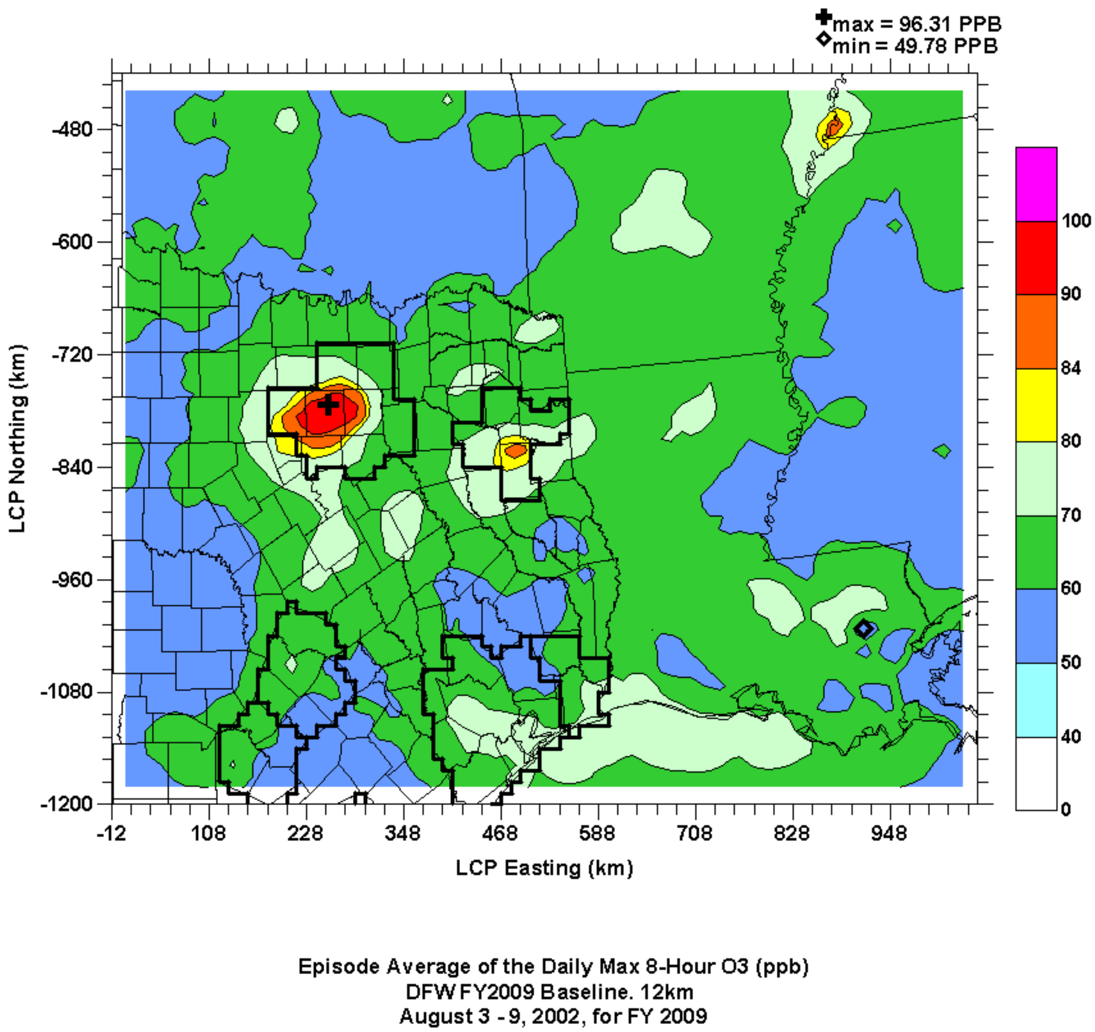


Figure 3-4. Episode average 2009 baseline daily maximum 8-hour ozone in the 12-km grid for the August 3-9, 2002 period (Episode 1).

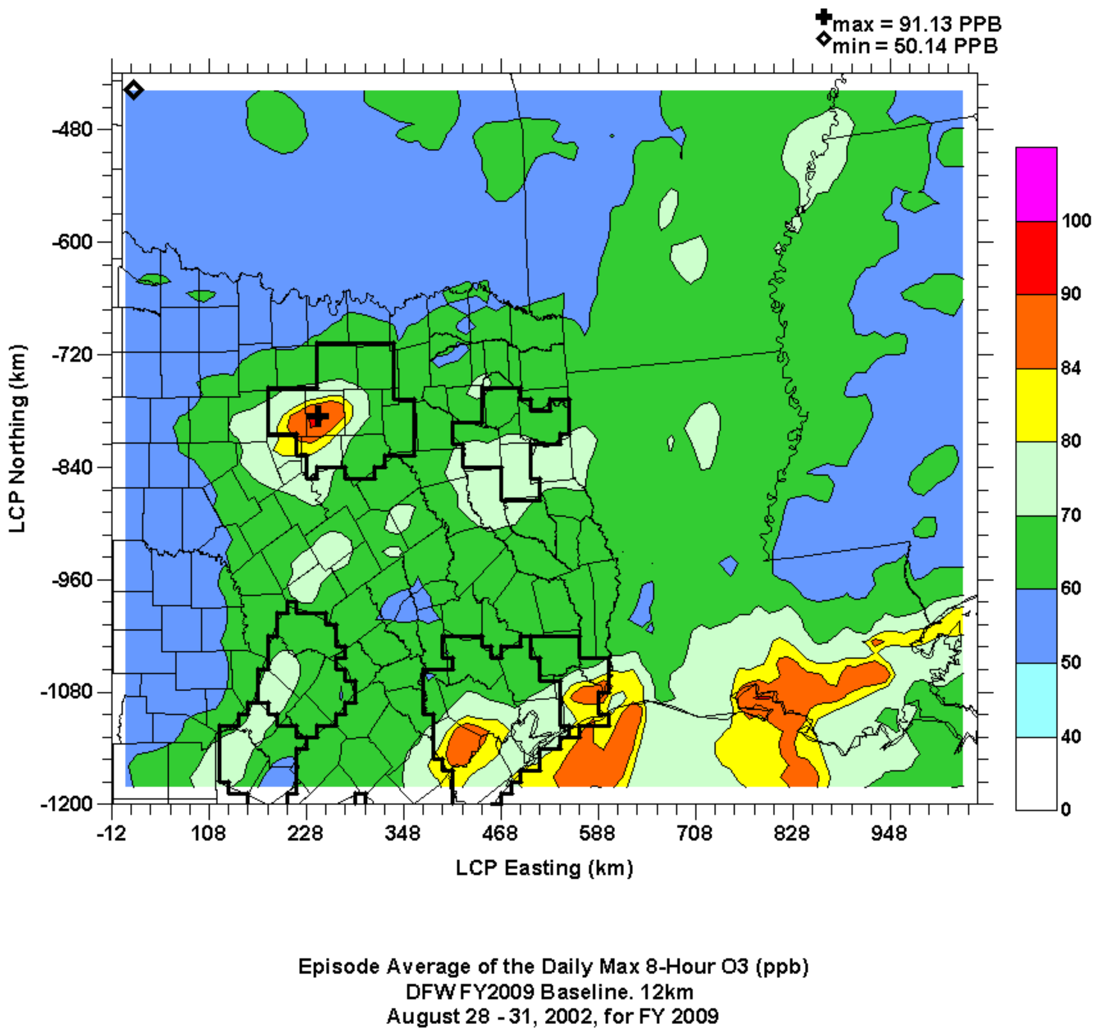


Figure 3-5. Episode average 2009 baseline daily maximum 8-hour ozone in the 12-km grid for the August 28-31, 2002 period (Episode 2).

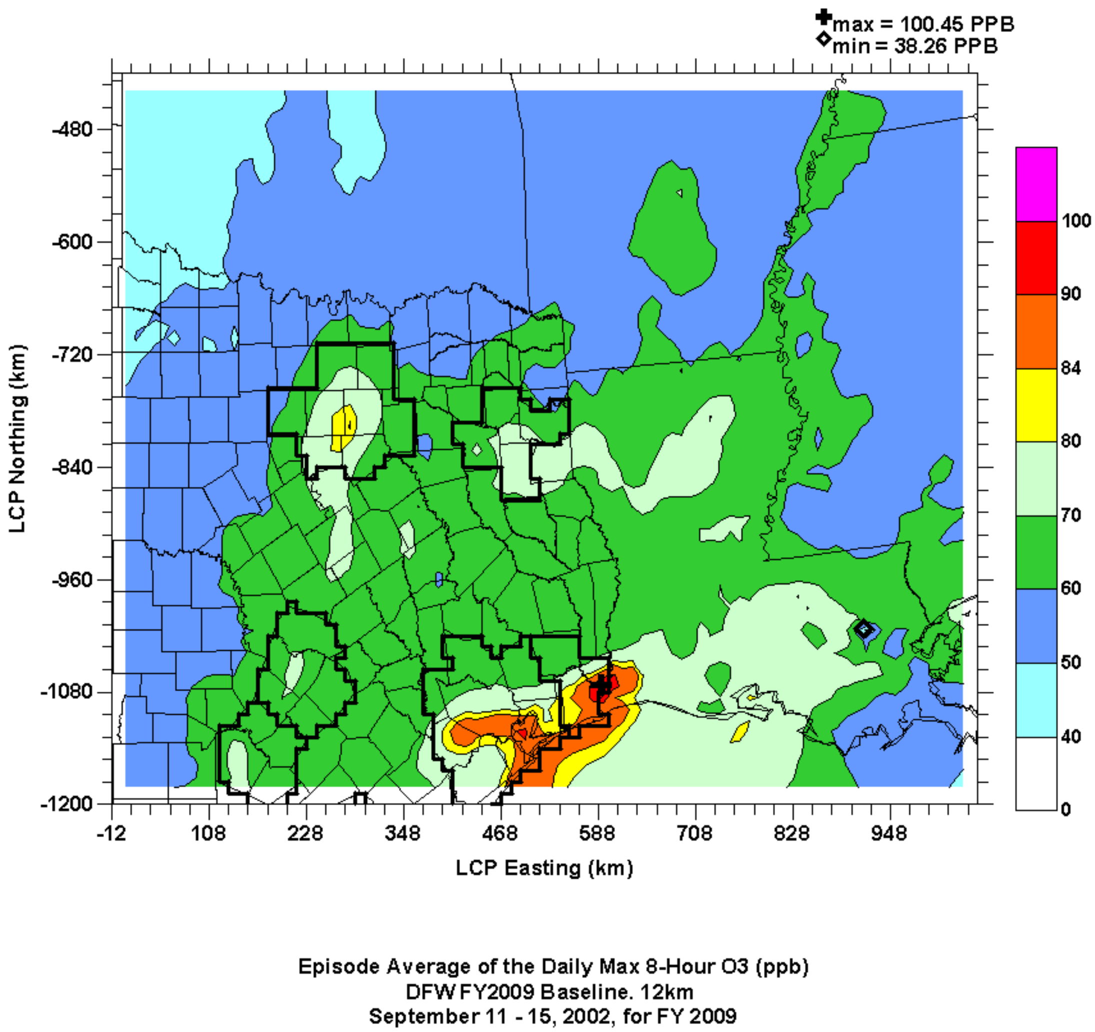


Figure 3-6. Episode average 2009 baseline daily maximum 8-hour ozone in the 12-km grid for the September 11-15, 2002 period (Episode 3).

PROJECTED 2009 DESIGN VALUES

Tables 3-7 to 3-9 show projected future (2009) design value (DV) calculations for 2002 episodes 1 to 3, respectively. The 2009 DVs are projected using the 2009 and 2002 baseline model runs and observed 2002 design values. EPA's design value scaling methodology for projecting future 8-hr ozone levels (EPA, 2005) was discussed in Section 2. Grapevine and Fort Worth C17 had the highest future design values ranging from 91.8 to 94.9 ppb depending upon episode. Episode 2 had the highest DV (94.9 ppb at Grapevine) followed by episode 3 (93.7 ppb at Fort Worth C17) and episode 1 (91.8 ppb at both Grapevine and Fort Worth C17).

Daily RRFs are provided at the bottom of Tables 3-7 to 3-9. Values in red indicate RRFs greater than 1.0; values in blue represent RRFs less than 0.9. Daily RRFs over 1.0 indicate higher ozone in 2009 than 1999 at these monitors on these days (i.e., disbenefits from NOx reduction). Daily

RRFs over 1.0 occurred most often in episode 3 (4 of 5 days) followed by episode 1 (4 of 7 days) and least often in episode 2 (1 of 4 days). Eight of 18 monitors had daily RRFs over 1.0 on one or more episode days: These monitors were Frisco, C60, C63, C402, Sunnyvale, Kaufmann, Rockwall and Eagle Mt. Lake.

Table 3-7. Projected 2009 baseline design values (ppb) scaled from the 2002 baseline for August 3 – 9, 2002 (episode 1).

Base Case[4]											
Site	**Aug-3**	**Aug-4**	**Aug-5**	**Aug-6**	**Aug-7**	**Aug-8**	**Aug-9**	**Model Average [ppb]**	**# Model Days>70**		
Frisco	83.6	109.6	107.8	78.7	94.4	67.7	87.4	93.6	6		
Anna	67.2	86.7	70.4	73.6	76.6	61.4	73.8	76.2	5		
Dallas C60	100.4	104	117.4	88.2	124.3	76.1	113.3	103.4	7		
Dallas C63	98	109.6	117.4	88.2	112.2	70.9	113.3	101.4	7		
Dallas C402	100.4	97.7	116.2	88.2	124.3	79.2	113.3	102.8	7		
Sunnyvale	82.3	92.6	83.9	74.4	114.8	66.6	88.1	89.3	6		
Denton	88.3	112.6	113.3	87.5	83.5	72.2	92.3	92.8	7		
Midlothian	96.6	85.2	90.3	86.6	116.3	80.3	97.9	93.3	7		
Granbury	90.6	79.1	92.2	116.4	98.5	90.7	101.6	95.6	7		
Cleburne	95.7	84.8	96.8	104.7	105.1	91.6	102.3	97.3	7		
Kaufman	69.1	77.6	69.1	65.8	76.7	63.1	75.6	76.6	3		
Weatherford	102.4	92.6	118	114.9	86.1	85	106.7	100.8	7		
Rockwall	70.6	81.5	71.1	69.7	95.4	64.1	76.4	79.0	5		
Arlington	104.2	98.6	119.5	106.8	123.4	86.9	117.2	108.1	7		
Eagle Mt Lake	108.1	100.7	120.8	110.5	102.4	81.1	110.5	104.9	7		
Fort Worth C13	108.1	102.7	120.8	110.5	107.2	81.1	114.1	106.3	7		
Fort Worth C17	106.9	107.4	120.8	106.9	100.2	77.3	114.1	104.8	7		
Grapevine	104.2	110.4	120.1	106.8	110.4	74.7	117.2	106.3	7		
Future Year[5]											
Site	**Aug-3**	**Aug-4**	**Aug-5**	**Aug-6**	**Aug-7**	**Aug-8**	**Aug-9**	**Model Average [ppb]**	**RRF[1]**	**Baseline DV [ppb]**	**Future DV[2] [ppb]**
Frisco	84.3	94.7	101.9	70.3	80.6	64.5	83.0	85.8	0.917	90.0	**82.5**
Anna	64.5	72.6	64.3	66.4	66.9	59.3	68.0	67.7	0.888	81.0	**71.9**
Dallas C60	97.1	90.0	108.3	83.4	123.4	76.5	108.3	98.2	0.950	90.0	**85.5**
Dallas C63	97.1	94.7	108.3	83.2	116.8	70.7	108.3	97.0	0.957	79.3	**75.9**
Dallas C402	97.1	84.8	104.9	83.4	123.4	76.5	108.3	96.9	0.943	84.0	**79.2**
Sunnyvale	83.7	79.0	75.0	72.5	112.9	67.1	83.6	84.4	0.945	77.0	**72.8**
Denton	82.5	96.3	105.3	76.1	72.0	67.3	86.5	83.7	0.902	97.3	**87.8**
Midlothian	84.5	77.4	80.9	78.8	106.4	75.0	89.9	84.7	0.908	85.0	**77.2**
Granbury	80.4	72.3	79.4	102.9	89.0	86.1	93.9	86.3	0.903	83.0	**74.9**
Cleburne	87.8	76.5	85.2	96.0	98.0	87.1	95.7	89.5	0.919	89.7	**82.5**
Kaufman	62.9	71.6	61.6	66.4	75.6	63.2	73.7	73.7	0.961	72.0	**69.2**
Weatherford	87.2	80.2	104.2	102.5	74.5	78.7	100.3	89.7	0.889	87.0	**77.4**
Rockwall	69.9	73.5	64.4	66.1	90.4	64.0	74.1	74.5	0.942	82.0	**77.3**
Arlington	99.9	90.3	108.8	100.8	117.6	85.2	112.0	102.1	0.945	87.0	**82.2**
Eagle Mt Lake	101.9	90.0	111.8	102.7	92.7	79.7	105.7	97.8	0.932	95.0	**88.6**
Fort Worth C13	101.9	91.9	111.8	102.7	99.3	81.0	109.8	99.8	0.938	95.3	**89.4**
Fort Worth C17	101.9	93.2	111.8	100.8	90.2	74.5	109.8	97.4	0.930	98.7	**91.8**
Grapevine	99.9	96.1	109.2	100.8	106.5	74.5	112.0	99.8	0.940	97.7	**91.8**

Table 3-7 (concluded). Projected 2009 baseline design values (Future DV, ppb) scaled from the 2002 baseline for episode 1.

Daily RRF[3]							
Site	**Aug-3**	**Aug-4**	**Aug-5**	**Aug-6**	**Aug-7**	**Aug-8**	**Aug-9**
Frisco	1.009	0.864	0.945	0.893	0.854	0.952	0.950
Anna	0.959	0.838	0.913	0.903	0.874	0.965	0.922
Dallas C60	0.968	0.866	0.923	0.945	0.993	1.005	0.956
Dallas C63	0.991	0.864	0.923	0.942	1.041	0.997	0.956
Dallas C402	0.968	0.868	0.903	0.945	0.993	0.965	0.956
Sunnyvale	1.017	0.853	0.894	0.974	0.983	1.007	0.949
Denton	0.935	0.855	0.929	0.870	0.863	0.933	0.937
Midlothian	0.875	0.908	0.896	0.910	0.915	0.934	0.919
Granbury	0.888	0.914	0.861	0.884	0.904	0.949	0.924
Cleburne	0.917	0.901	0.879	0.917	0.933	0.950	0.935
Kaufman	0.911	0.923	0.891	1.009	0.986	1.001	0.975
Weatherford	0.852	0.866	0.883	0.892	0.864	0.926	0.940
Rockwall	0.990	0.902	0.905	0.948	0.947	0.998	0.971
Arlington	0.959	0.916	0.910	0.944	0.953	0.981	0.956
Eagle Mt Lake	0.943	0.894	0.925	0.929	0.906	0.982	0.956
Fort Worth C13	0.943	0.895	0.925	0.929	0.927	0.998	0.962
Fort Worth C17	0.953	0.868	0.925	0.942	0.900	0.963	0.962
Grapevine	0.959	0.871	0.909	0.944	0.964	0.996	0.956

(1) RRF = Future Year Model Average / Base Case Model Average
(2) Future DV = Baseline DV x RRF
(3) Daily RRFs are for information only. They are not used to calculate the Future DV.
(4) The Base Case run is “run.a0.”
(5) The Future Year run is “baseline.fy2009.baseline.a0.”

Table 3-8. Projected 2009 baseline design values (ppb) scaled from the 2002 baseline for August 28 – 31 (episode 2).

Base Case[4]								
Site	**Aug-28**	**Aug-29**	**Aug-30**	**Aug-31**	**Model Average [ppb]**	**# Model Days>70**		
Frisco	74.8	68.0	73.4	82.3	76.9	3		
Anna	66.0	61.9	67.3	73.9	73.9	1		
Dallas C60	87.2	77.7	84.7	95.5	86.3	4		
Dallas C63	87.2	74.3	82.8	94.1	84.6	4		
Dallas C402	87.2	79.0	84.7	95.5	86.6	4		
Sunnyvale	70.4	67.8	73.4	79.9	74.6	3		
Denton	82.1	70.4	75.4	85.1	78.2	4		
Midlothian	79.9	78.9	81.9	90.5	82.8	4		
Granbury	90.3	87.1	91.7	95.5	91.1	4		
Cleburne	90.9	87.1	91.7	96.0	91.4	4		
Kaufman	62.1	63.4	69.3	72.7	72.7	1		
Weatherford	96.8	80.0	94.7	100.5	93.0	4		
Rockwall	66.3	63.0	69.2	74.3	74.3	1		
Arlington	97.8	85.1	91.3	100.5	93.7	4		
Eagle Mt Lake	100.8	87.1	95.7	105.6	97.3	4		
Fort Worth C13	100.8	87.1	95.7	105.6	97.3	4		
Fort Worth C17	95.6	77.9	89.0	101.4	91.0	4		
Grapevine	95.3	77.9	87.5	98.5	89.8	4		
Future Year[5]								
Site	**Aug-28**	**Aug-29**	**Aug-30**	**Aug-31**	**Model Average [ppb]**	**RRF**[1]	**Baseline DV [ppb]**	**Future DV [2] [ppb]**
Frisco	72.3	62.2	68.2	78.3	73.0	0.949	90.0	**85.4**
Anna	62.8	58.3	63.4	68.2	68.2	0.923	81.0	**74.8**
Dallas C60	83.4	77.4	80.1	88.9	82.4	0.956	90.0	**86.0**
Dallas C63	83.4	74.3	78.8	88.9	81.3	0.961	79.3	**76.2**
Dallas C402	83.4	77.4	80.1	88.9	82.4	0.952	84.0	**80.0**
Sunnyvale	69.0	65.9	70.0	76.4	71.8	0.963	77.0	**74.1**
Denton	77.9	63.0	68.4	78.7	72.0	0.920	97.3	**89.6**
Midlothian	72.9	74.3	75.0	80.3	75.7	0.914	85.0	**77.7**
Granbury	83.0	82.9	86.3	86.5	84.7	0.929	83.0	**77.1**
Cleburne	83.8	84.2	86.3	87.3	85.4	0.934	89.7	**83.8**
Kaufman	61.7	63.0	68.1	67.9	67.9	0.933	72.0	**67.2**
Weatherford	90.8	72.5	89.9	87.9	85.3	0.917	87.0	**79.8**
Rockwall	66.1	61.6	66.3	70.6	70.6	0.949	82.0	**77.8**
Arlington	92.9	83.6	88.2	93.0	89.4	0.954	87.0	**83.0**
Eagle Mt Lake	95.7	83.8	91.8	95.4	91.7	0.942	95.0	**89.5**
Fort Worth C13	95.7	83.8	91.8	95.4	91.7	0.942	95.3	**89.8**
Fort Worth C17	92.9	76.7	86.4	92.8	87.2	0.959	98.7	**94.7**
Grapevine	92.9	76.7	86.4	92.8	87.2	0.972	97.7	**94.9**

Table 3-8 (concluded). Projected 2009 baseline design values (ppb) scaled from the 2002 baseline for August 28 – 31 (episode 2).

Daily RRF[3]				
Site	**Aug-28**	**Aug-29**	**Aug-30**	**Aug-31**
Frisco	0.966	0.914	0.929	0.951
Anna	0.951	0.942	0.943	0.923
Dallas C60	0.956	0.997	0.946	0.930
Dallas C63	0.956	1.000	0.951	0.945
Dallas C402	0.956	0.980	0.946	0.930
Sunnyvale	0.980	0.972	0.954	0.956
Denton	0.950	0.895	0.908	0.925
Midlothian	0.913	0.942	0.916	0.888
Granbury	0.920	0.952	0.941	0.906
Cleburne	0.922	0.966	0.941	0.910
Kaufman	0.993	0.995	0.983	0.933
Weatherford	0.938	0.907	0.949	0.875
Rockwall	0.997	0.978	0.957	0.949
Arlington	0.950	0.982	0.965	0.925
Eagle Mt Lake	0.950	0.962	0.959	0.903
Fort Worth C13	0.950	0.962	0.959	0.903
Fort Worth C17	0.972	0.985	0.971	0.915
Grapevine	0.976	0.985	0.988	0.943

(1) RRF = Future Year Model Average / Base Case Model Average
(2) Future DV = Baseline DV x RRF
(3) Daily RRFs are for information only. They are not used to calculate the Future DV.
(4) The Base Case run is “run.a0.”
(5) The Future Year run is “baseline.fy2009.baseline.a0.”

Table 3-9. Projected 2009 baseline design values (ppb) scaled from the 2002 baseline for September 11 – 15, 2002 (episode 3).

Base Case[4]									
Site	**Sep-11**	**Sep-12**	**Sep-13**	**Sep-14**	**Sep-15**	**Model Average [ppb]**	**# Model Days>70**		
Frisco	69.8	66.6	108.6	105.5	59.1	107.0	2		
Anna	62.5	57.6	82.6	92.3	55.5	87.5	2		
Dallas C60	81.2	82.1	103.1	104.8	62.6	92.8	4		
Dallas C63	75.2	77.1	106.9	105.5	61.6	91.2	4		
Dallas C402	92.3	90.6	103.1	99	65.8	96.3	4		
Sunnyvale	74.7	72.2	81.3	105.5	58.9	83.4	4		
Denton	69.7	66.9	106.7	94.2	58.8	100.4	2		
Midlothian	94.2	93.6	89.5	101.8	68.2	94.8	4		
Granbury	84.7	91.4	69.9	80.8	61.5	85.6	3		
Cleburne	92.8	98.3	78.8	92.3	64.5	90.6	4		
Kaufman	69.1	61.8	65.3	92.5	57.7	92.5	1		
Weatherford	74.7	80	67.8	68.3	54.1	77.4	2		
Rockwall	69.3	62.6	73	105.5	57.5	89.3	2		
Arlington	92.3	91.8	103.1	104.6	65.8	97.9	4		
Eagle Mt Lake	79.8	80	96.1	98.5	62.4	88.6	4		
Fort Worth C13	79.8	80	99.5	104.6	63.6	91.0	4		
Fort Worth C17	76.7	73.9	103.7	100.5	61.4	88.7	4		
Grapevine	76.3	77.1	106.9	104.8	61.7	91.3	4		
Future Year[5]									
Site	**Sep-11**	**Sep-12**	**Sep-13**	**Sep-14**	**Sep-15**	**Model Average [ppb]**	**RRF**[1]	**Baseline DV [ppb]**	**Future DV**[2] **[ppb]**
Frisco	63.9	59.5	105.7	98.6	54.0	102.2	0.955	90.0	**85.9**
Anna	60.9	55.6	75.6	79.9	54.0	77.8	0.889	81.0	**72.0**
Dallas C60	79.4	83.5	101.0	102.4	59.9	91.6	0.987	90.0	**88.8**
Dallas C63	70.8	75.6	104.3	102.4	57.4	88.3	0.969	79.3	**76.8**
Dallas C402	86.4	87.6	100.5	102.2	62.4	94.2	0.978	84.0	**82.2**
Sunnyvale	72.5	70.9	84.6	102.4	59.9	82.6	0.990	77.0	**76.3**
Denton	63.5	60.6	103.3	83.4	53.1	93.3	0.929	97.3	**90.4**
Midlothian	87.5	89.4	82.3	95.3	64.6	88.6	0.935	85.0	**79.5**
Granbury	76.6	86.4	66.4	71.4	53.1	78.1	0.913	83.0	**75.7**
Cleburne	85.7	95.9	73.8	82.2	59.6	84.4	0.932	89.7	**83.6**
Kaufman	65.1	65.5	67.2	84.7	55.1	84.7	0.915	72.0	**65.9**
Weatherford	65.7	69.6	64.6	65.0	51.5	67.6	0.874	87.0	**76.1**
Rockwall	67.0	63.0	75.2	99.0	55.7	87.1	0.976	82.0	**80.0**
Arlington	86.4	88.7	100.5	100.0	62.4	93.9	0.958	87.0	**83.4**
Eagle Mt Lake	72.2	76.3	99.3	88.4	56.6	84.0	0.949	95.0	**90.1**
Fort Worth C13	73.8	78.7	99.3	99.3	58.4	87.8	0.965	95.3	**91.9**
Fort Worth C17	70.0	71.6	99.3	91.2	55.7	83.0	0.936	98.7	**92.4**
Grapevine	71.9	75.6	104.3	98.2	57.4	87.5	0.959	97.7	**93.7**

Table 3-9 (concluded). Projected 2009 baseline design values (ppb) scaled from the 2002 baseline for September 11 – 15, 2002 (episode 3).

Daily RRF[3]					
Site	**Sep-11**	**Sep-12**	**Sep-13**	**Sep-14**	**Sep-15**
Frisco	0.916	0.893	0.974	0.935	0.915
Anna	0.974	0.966	0.915	0.866	0.972
Dallas C60	0.977	1.017	0.980	0.977	0.956
Dallas C63	0.942	0.982	0.976	0.971	0.931
Dallas C402	0.936	0.966	0.975	1.032	0.948
Sunnyvale	0.971	0.982	1.041	0.971	1.016
Denton	0.911	0.905	0.968	0.885	0.903
Midlothian	0.929	0.955	0.920	0.936	0.947
Granbury	0.905	0.945	0.950	0.884	0.864
Cleburne	0.923	0.975	0.936	0.891	0.924
Kaufman	0.942	1.060	1.029	0.915	0.956
Weatherford	0.879	0.870	0.952	0.952	0.952
Rockwall	0.967	1.007	1.030	0.938	0.969
Arlington	0.936	0.966	0.975	0.955	0.948
Eagle Mt Lake	0.904	0.953	1.034	0.898	0.908
Fort Worth C13	0.924	0.983	0.998	0.949	0.919
Fort Worth C17	0.912	0.968	0.958	0.907	0.906
Grapevine	0.941	0.982	0.976	0.937	0.931

(1) RRF = Future Year Model Average / Base Case Model Average
(2) Future DV = Baseline DV x RRF
(3) Daily RRFs are for information only. They are not used to calculate the Future DV.
(4) The Base Case run is “run.a0.”
(5) The Future Year run is “baseline.fy2009.baseline.a0.”

4.0 CONTROL STRATEGY EVALUATION

Several emission sensitivities were evaluated for 2009 using the August 1999 DFW SIP episode (see Section 2) and three new episodes from 2002 (see Section 3). The emission sensitivities are described below and then the ozone impacts are presented. These scenarios are referred to as emission sensitivities rather than control strategies because they are not supported by the level of analysis associated with a SIP strategy. Note that one of the sensitivities (new EGUs) is an emissions increase. The strategies were selected by TERC to elucidate the impacts of several types of potential local (DFW) and regional (East Texas) emission changes that may be expected to impact future DFW ozone attainment.

EMISSION CHANGES EVALUATED

Reduce Emissions from Gas Compressors

Natural gas is produced in several regions of East Texas and the gas must be compressed as it moves from the wellhead into the collection and distribution system. Major distribution pipelines have large compressors that are permitted and likely to have emission controls. In contrast, the numerous small compressor engines located close to wellheads are likely uncontrolled and not included in point source inventories. Emissions from these small engines have been estimated in aggregate (from data on gas production) and included in the area source emission inventory. The area source inventory for oil and gas production sources includes several types of sources (compressors, dehydrators, etc.) but is dominated by gas compressors.

Highly effective control technologies are available for gas compressor engines (NETAC, 2003) and one widely applicable technology (three-way exhaust catalyst for rich burn, 4-cycle engines) has been demonstrated to reduce NOx by over 95% for several gas compressor engines operating in Northeast Texas (Russell, Lindhjem and Yarwood, 2005). Three way catalysts also reduce VOC and CO emissions.

It would be unrealistic to apply 95% reduction to all of the area source NOx emissions from the oil and gas production sector because: (1) not all of these emissions are from gas compressor engines; (2) not all gas compressor engines are currently uncontrolled, and (3); not all uncontrolled engines could be controlled by a rule or an incentive program such as TERP. For this sensitivity test, we modeled a 50% reduction in Texas area source emissions from oil and gas production and this resulted in 233 tpd of NOx and 112 tpd of VOC reductions within the CAMx modeling domain.

TCEQ recently evaluated “small engine rules” to reduce emissions from these and other small internal combustion engines (Tai and Yarwood, 2006). The TCEQ analysis tended to reduce emissions of larger engines that appear in the point source inventory rather than the small engines that are treated as area sources. Overall, the “small engine rules” resulted in 83 tpd of NOx reduction or 41 tpd when controls were restricted to within 200-km of DFW.

Proposed New EGUs with Permits

Several new EGUs are proposed for Texas and 8 units shown in Table 4-1 not included in the 2009 baseline inventory were added for this sensitivity test. The TCEQ did not include these new units in the 2009 inventory because it is unlikely that any will be operational by the 2009 ozone season. The emissions for the proposed units were estimated from the permit applications and therefore represent permit maximums. The units added a combined 48.5 tpd of NOx to the 2009 emission inventory and many of the emissions were in central Texas, near Waco.

Table 4-1. Emissions from proposed new Texas EGUs for 2010.

EGU	County	LCP East (km)	LCP North (km)	NOx (tpd)	VOC (tpd)	CO (tpd)
J K Spruce 2 (CPS)	Bexar	163.447	-1168.084	6.6	0.3	53.8
Formosa Plastics Corp.	Calhoun	339.682	-1236.316	2	0.2	5.4
Formosa Plastics Corp.	Calhoun	339.679	-1236.26	2	0.2	5.4
E S Joslin	Calhoun	339.178	-1236.27	2.2	0.2	4.8
Sandy Creek En. Assocs. LP	Mclennan	286.888	-923.869	6.9	0.3	29.5
Oak Grove Mgmt. Co. LP (TXU)	Robertson	332.257	-954.51	10.3	0.6	60.3
Oak Grove Mgmt. Co. LP (TXU)	Robertson	332.197	-954.424	10.3	0.6	60.3
Twin Oaks Power III, LP (Sempra)	Robertson	313.039	-964.875	8.2	0.4	44.6
Total				**48.5**	**2.8**	**264.1**

Retire Currently Mothballed EGUs

Several Texas electric generating units (EGUs) currently are mothballed but are included in the 2009 baseline emission inventory because they could be re-started. These emissions were estimated from reported summer acid rain data for 2000. The estimates were based on the highest reported emissions and do not reflect periods of inactivity or shutdown. In reviewing the “Mothballed EGU” modeling performed for this project, the TCEQ determined that the 2009 emission estimates for the mothballed units were over-estimates because they omitted expected emission reductions due to existing Texas controls (e.g. Senate Bill 7).

For this sensitivity test, the mothballed units listed in Table 4-2 were “retired” removing 66.9 tpd of NOx from the 2009 baseline emission inventory. These units were identified as mothballed by TXU at TERC’s request.

Table 4-2. Currently mothballed Texas EGUs.

Company-Facility	County	City	NOx (tpd)
Central & South West Services Inc-9	Jones	Abilene	2.66
Central Power And Light Co-14	Nueces	Corpus Christi	3.70
Central Power And Light Co-15	Nueces	Corpus Christi	4.99
Central Power And Light Co-3	Victoria	Victoria	6.29
Central Power And Light Co-47	Nueces	Corpus Christi	5.47
City Public Service-3	Bexar	San Antonio	0.60
City Public Service-6	Bexar	San Antonio	1.02
Reliant Energy Inc-3	Chambers	Houston	0.30
Reliant Energy Inc-6	Galveston	Houston	3.37
Txu Electricco-1	Mitchell	Colorado City	17.94
Txu Electricco-7	Tarrant	Fort Worth	0.68
Txu Electriccompany-10	Dallas	Dallas	0.47
Txu Generating Company Lp-1	Fannin	Savoy	12.75
Txu Generating Company Lp-12	Dallas	Dallas	2.85
Txu Generating Company Lp-2	Collin	Frisco	0.16
Txu Generating Company Lp-6	Tarrant	Fort Worth	2.21
West Texas Utilities Co-3	Tom Green	San Angelo	1.44
Total			**66.90**

Reduce All DFW EGUs to 0.033 lb/MMBtu

Most EGUs in the DFW NAA have a NOx emission limit of 0.033 lb/MMBtu. There are several small-system units in the DFW NAA (Table 4-3) with NOx emission limits of 0.06 lb/MMBtu and these units were identified by TXU at TERC's request. For this sensitivity test, the NOx emissions from the units listed in Table 4-3 were reduced by 50%, eliminating 1.57 tpd of NOx, to approximate the impact of reducing their emission limit from 0.06 lb/MMBtu to 0.033 lb/MMBtu.

Table 4-3. Small-system units in the DFW NAA with a NOx emission limit of 0.06 lb/MMBtu.

Company-Facility	County	City	NOx (tpd)
Garland Municipal Power And Light-15	Collin	Collin	1.94
Garland Municipal Power And Light-7	Dallas	Dallas	0.18
Ray Olinger - Garland-1000	Collin	Collin	0.43
Spencer Station Generating Co Lp-2	Denton	Denton	0.59
Total			**3.14**

East Texas EGU Control

In 2005, the TCEQ modeled the impact of applying additional EGU controls across Eastern Texas to implement the same control level as in the Houston/Galveston/Brazoria NAA. This sensitivity test modeled the same control package in the 2009 baseline emission inventory (TCEQ had previously modeled this control for 2010). The EGUs reduced are listed in Table 4-4. The total NOx emission reduction was 329.5 tpd.

Table 4-4. Emission reductions for the "East Texas EGU Control" sensitivity test.

Facility Name	County	NOx (tpd)	
		Regular	Controlled
Txu Electricco	Red River	0.01	0.00
Central Power And Light Co	Calhoun	0.08	0.02
Brazos Electric Power Cooperative	Parker	0.13	0.02
Greenville Electric System	Hunt	0.14	0.02
Newgulf Power Venture Inc	Wharton	0.29	0.06
Txu Electricco	Henderson	0.36	0.08
Bryan Municipal Electric System	Brazos	0.41	0.09
Southwesternelectric Power Co	Morris	0.56	0.12
City Public Service	Bexar	0.83	0.18
City Of Bryan	Brazos	1.56	0.37
Southwesternelectric Power Co	Gregg	5.46	1.16
Central Power And Light Co	Nueces	5.53	1.16
City Of Austin	Travis	5.87	1.24
Lower Colorado River Authority	Bastrop	6.15	1.29
Southwesternelectric Power Co	Marion	6.34	1.33
Central Power And Light Co	Victoria	6.36	1.34
Texas-New Mexico Power Co	Robertson	7.24	2.17
Txu Electricco	Cherokee	8.47	1.78
Central Power And Light Co	Nueces	8.88	1.95
Central Power And Light	Goliad	9.87	2.96
Texas Municipal Power Agency	Grimes	10.02	2.97
San Miguel Electric Cooperative In	Atascosa	10.18	3.02
Txu Electricco	Milam	12.41	3.74
Southwesternelectric Power Co	Harrison	12.77	3.84
Txu Generating Company Lp	Fannin	12.90	2.73
Txu Generating Company Lp	Hood	16.10	3.38
Entergy Gulfstates Inc	Orange	16.37	5.67
Txu Electricco	Freestone	29.19	8.76
Reliant Energy Inc	Limestone	31.38	9.41
Lower Colorado River Authority	Fayette	33.05	9.91
Southwesternelectric Power Co	Titus	34.35	10.31
Txu Electricco	Mclennan	36.25	8.22
Txu Electricco	Titus	37.23	11.17
Txu Electricco	Rusk	43.06	12.09
City Public Service	Bexar	45.19	12.92
Total		**455.0**	**125.5**

DFW 50-km EGU Control

This sensitivity test applied the "East Texas EGU Control" to an area around the DFW NAA to determine how much of the ozone benefit could be obtained by a more limited application of controls. The 50-km distance from the DFW NAA boundary was selected because it corresponded to a break point in the number of sources controlled. The sources controlled for this sensitivity test are listed in Table 4-5 and shown geographically in Figure 4-1. The total NOx reduction was 93.8 tpd.

Table 4-5. Emission reductions for the "DFW EGU Control" sensitivity test that controlled EGUs in counties within 50-km of the DFW NAA.

Facility Name	County	NOx (tpd)	
		Baseline	Controlled
Brazos Electric Power Cooperative	Parker	0.13	0.02
Greenville Electric System	Hunt	0.14	0.02
Txu Electric co	Henderson	0.36	0.08
Txu Generating Company Lp	Fannin	12.90	2.73
Txu Generating Company Lp	Hood	16.10	3.38
Txu Electric Co	Freestone	29.19	8.76
Reliant Energy Inc	Limestone	31.38	9.41
Txu Electric Co	Mclennan	36.25	8.22
Total		**126.44**	**32.64**

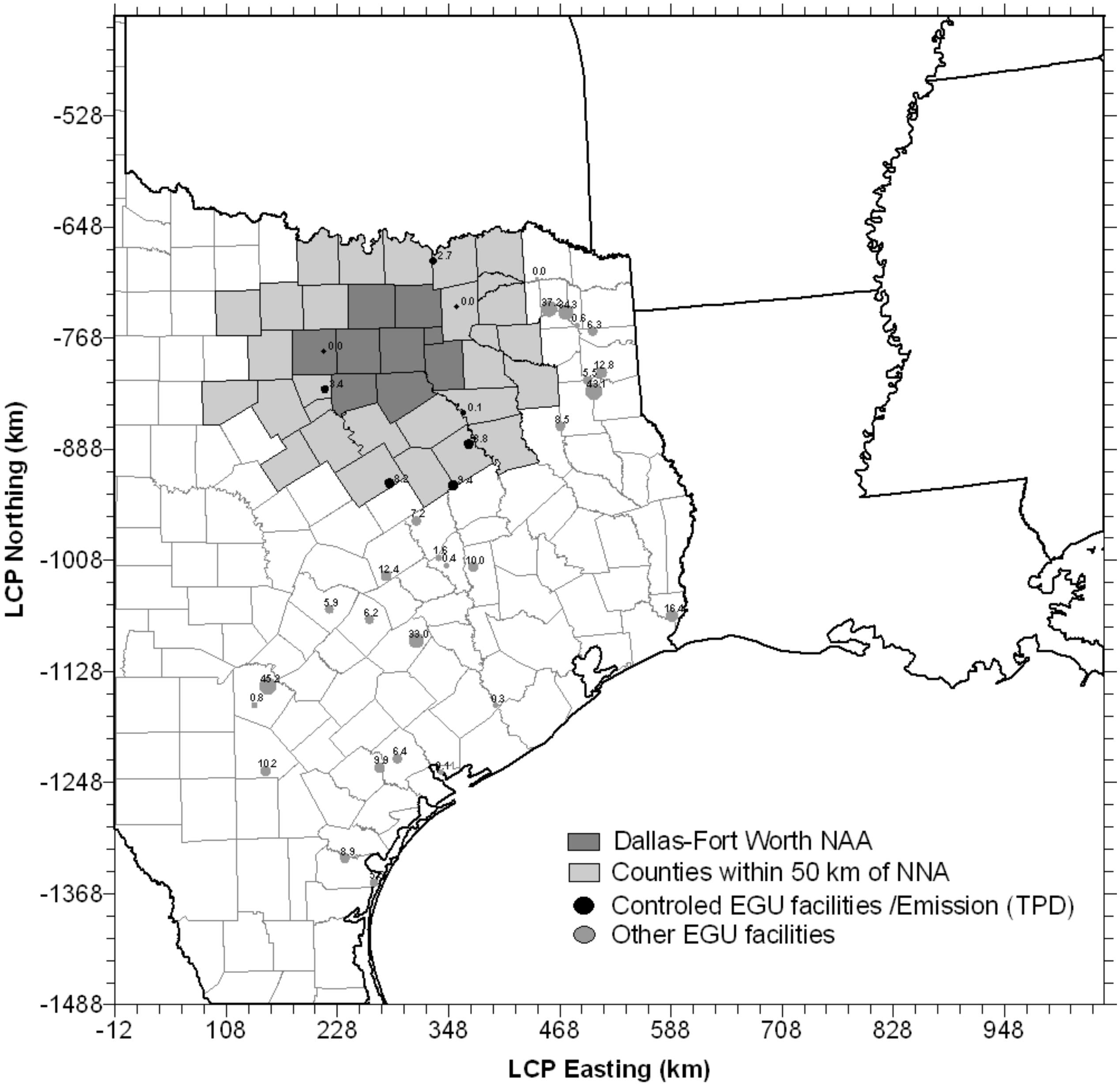


Figure 4-1. Application of EGU controls to counties with 50-km of the DFW nonattainment area (see Table 4-5 for a list of the controlled EGUs).

OZONE IMPACTS

The 8-hr ozone impacts of the emission sensitivities are presented graphically as ozone difference plots (Figures 4-2 to 4-7) and as tabular summaries of changes in 2009 design values (Tables 4-6 to 4-10). The 2009 design value (DV) changes (in ppb) were calculated using the same methodologies as for the 2009 baseline shown in Table 2-6 for the 1999 SIP episode and Tables 3-7 to 3-9 for the three 2002 episodes.[1] The 2009 baseline DVs at each monitor vary across the four episodes because (1) the 1999 episode is based on 1999 monitor DVs whereas the 2002 episodes are based on 2002 monitor DVs, and (2) the 2002 episodes all respond differently to the change in emissions from 2002 to 2009. The ozone difference plots show differences in episode average daily maximum ozone (ppb) from the 2009 baseline. This metric was chosen because it is similar (but not identical) to the DV calculations presented in Tables 4-6 to 4-10 in that both are derived from changes in daily maximum 8-hour ozone across episode days.

[1] The 2009 DVs are calculated using the method of EPA (2005) discussed in Section 2. Briefly, the future year design value at each monitor is the observed base year DV multiplied by a Relative Reduction Factor (RRF). The RRF is the ratio of future year to base year ozone at the monitor from CAMx.

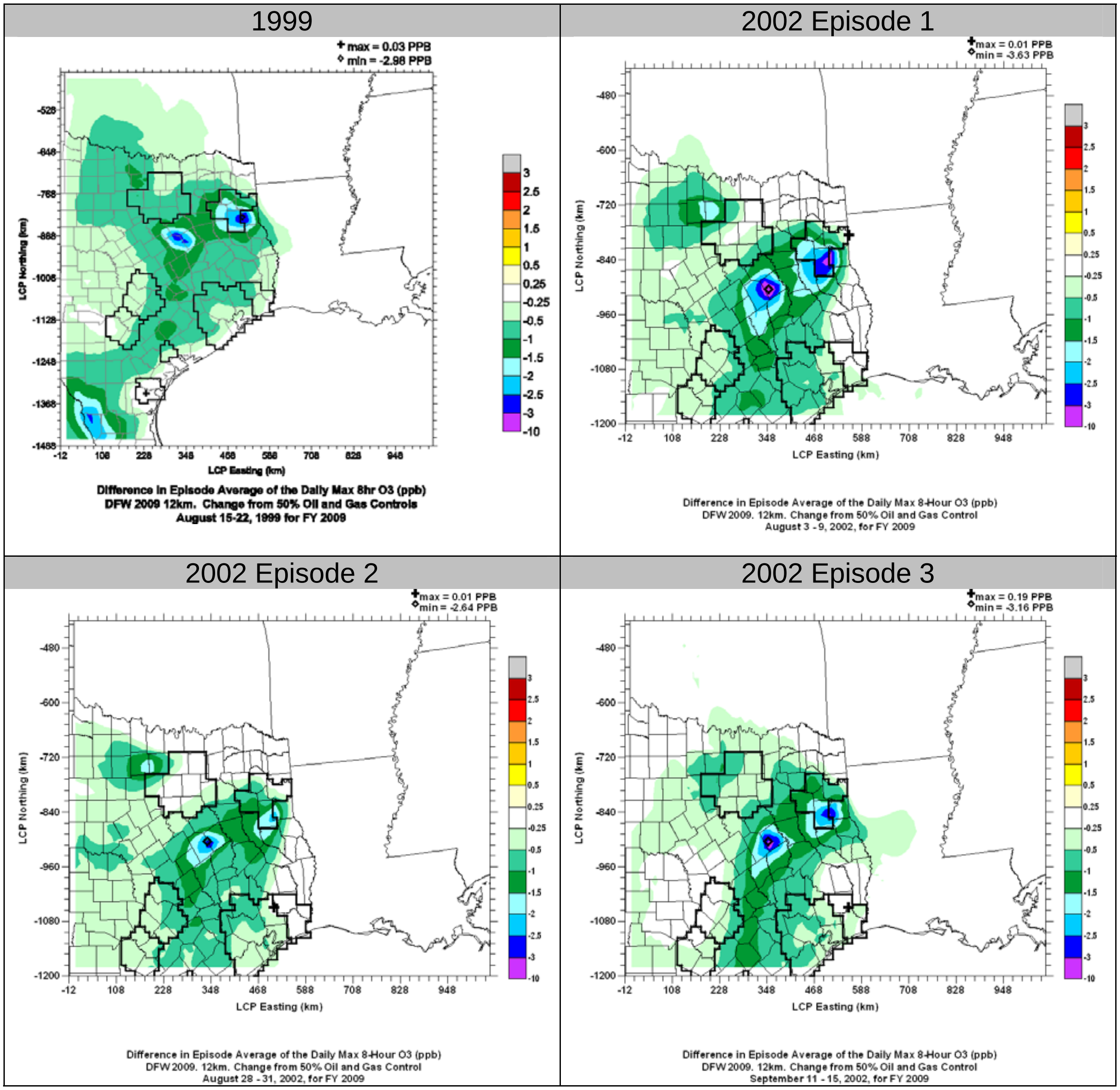


Figure 4-2. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from reducing Texas oil and gas production emissions by 50%.

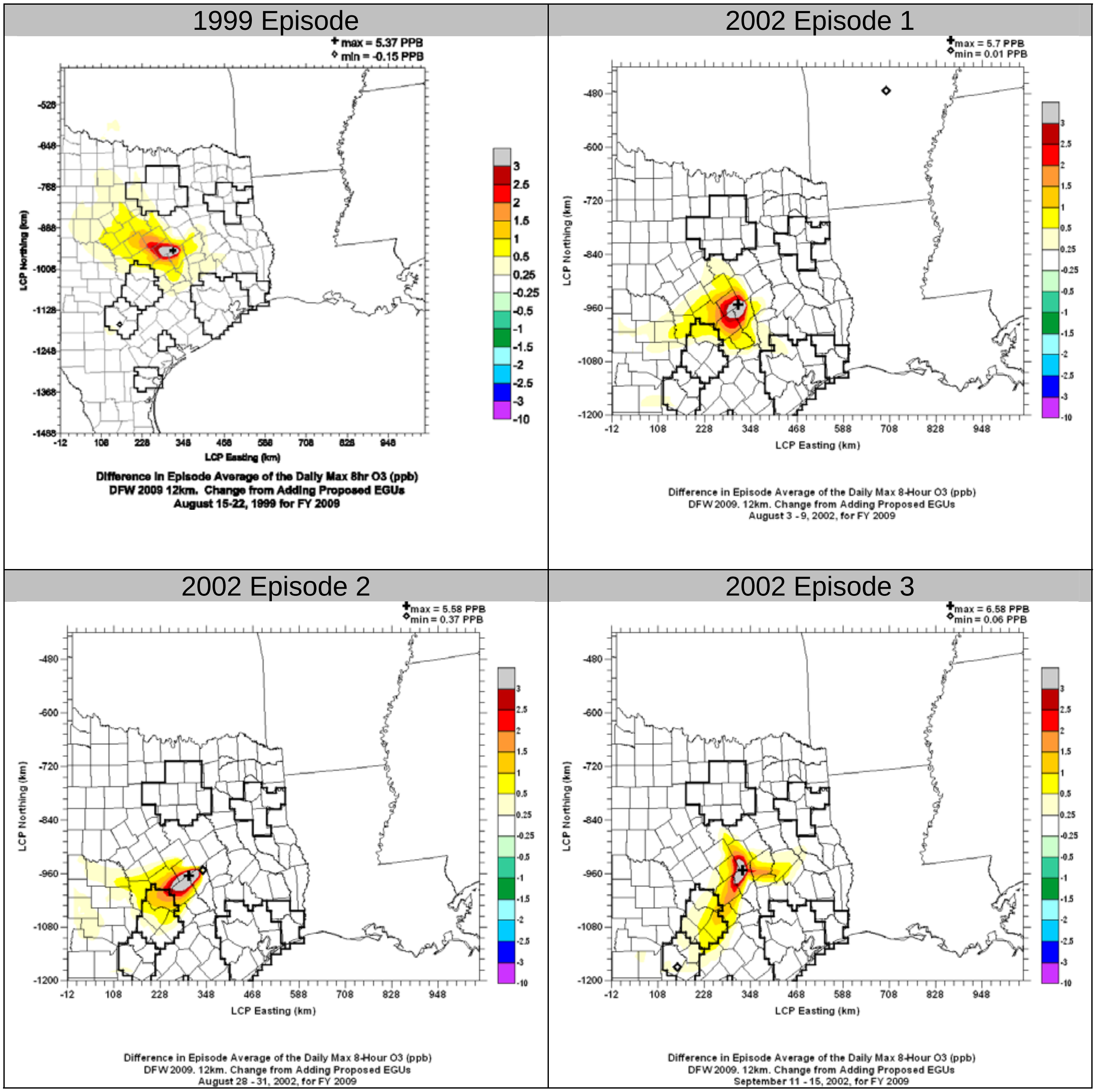


Figure 4-3. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from adding proposed new EGUs at their permit emission levels.

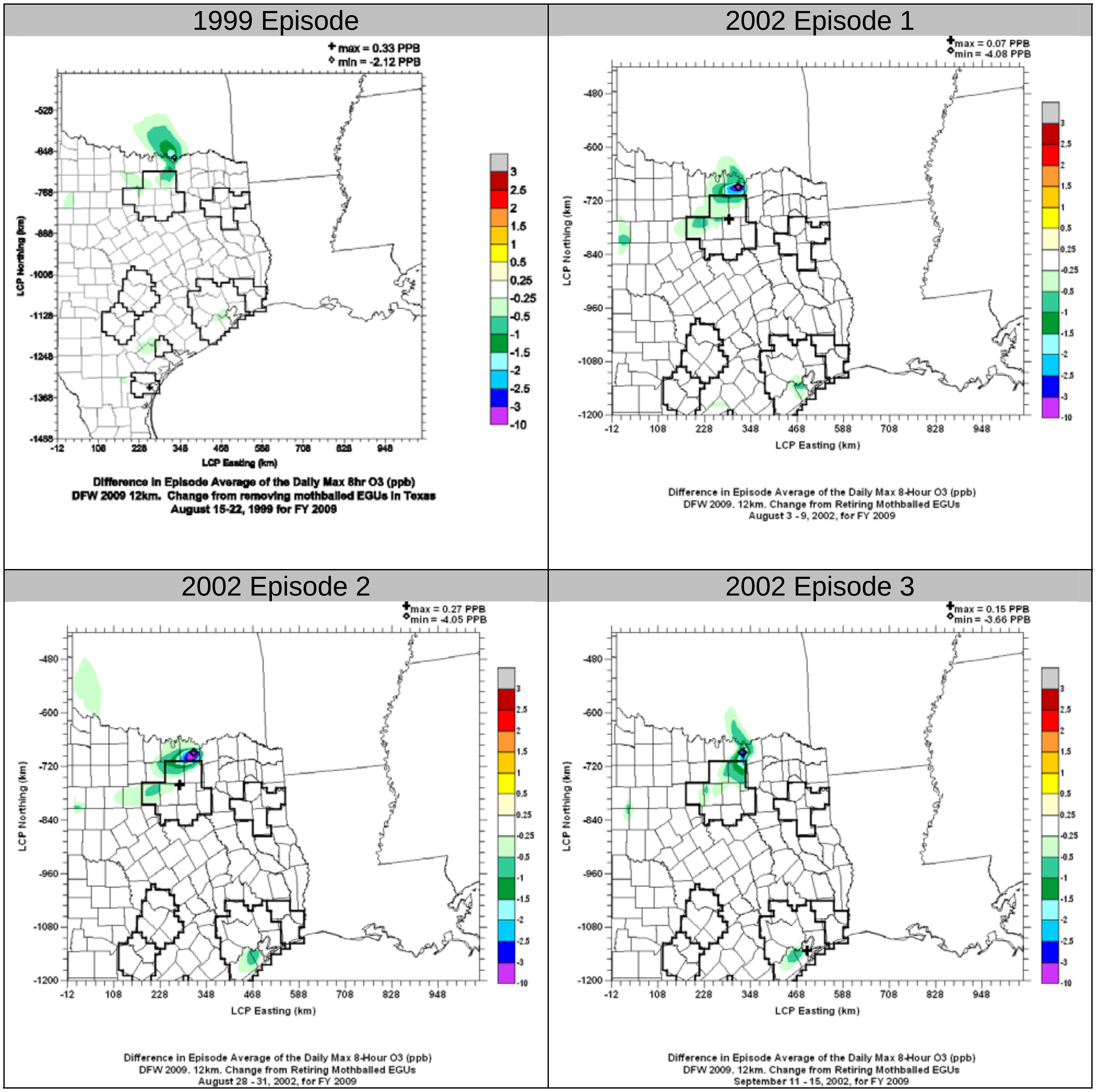


Figure 4-4. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from retiring currently mothballed EGUs.

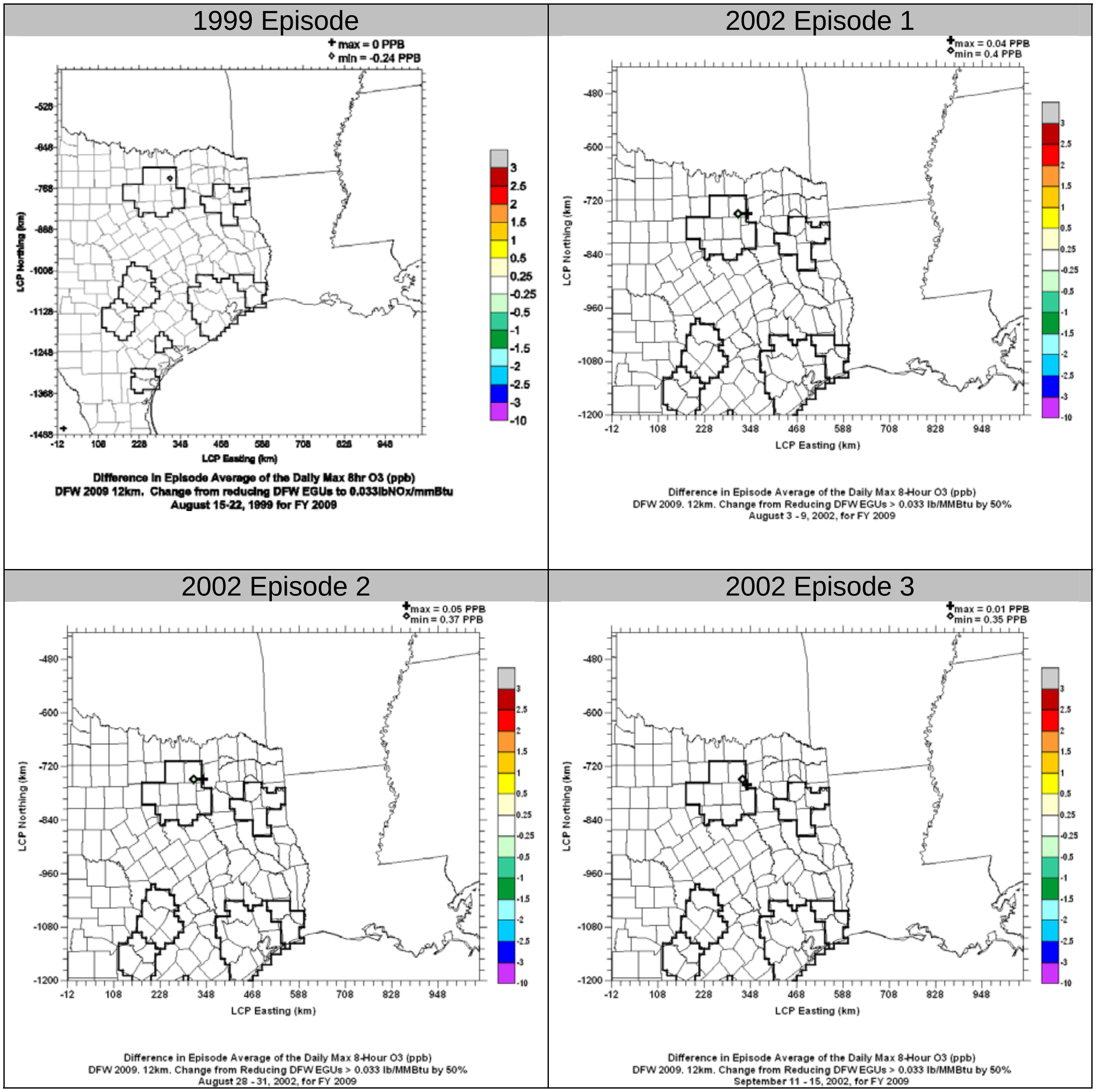


Figure 4-5. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from reducing all DFW EGUs to 0.033 lb/MMBtu.

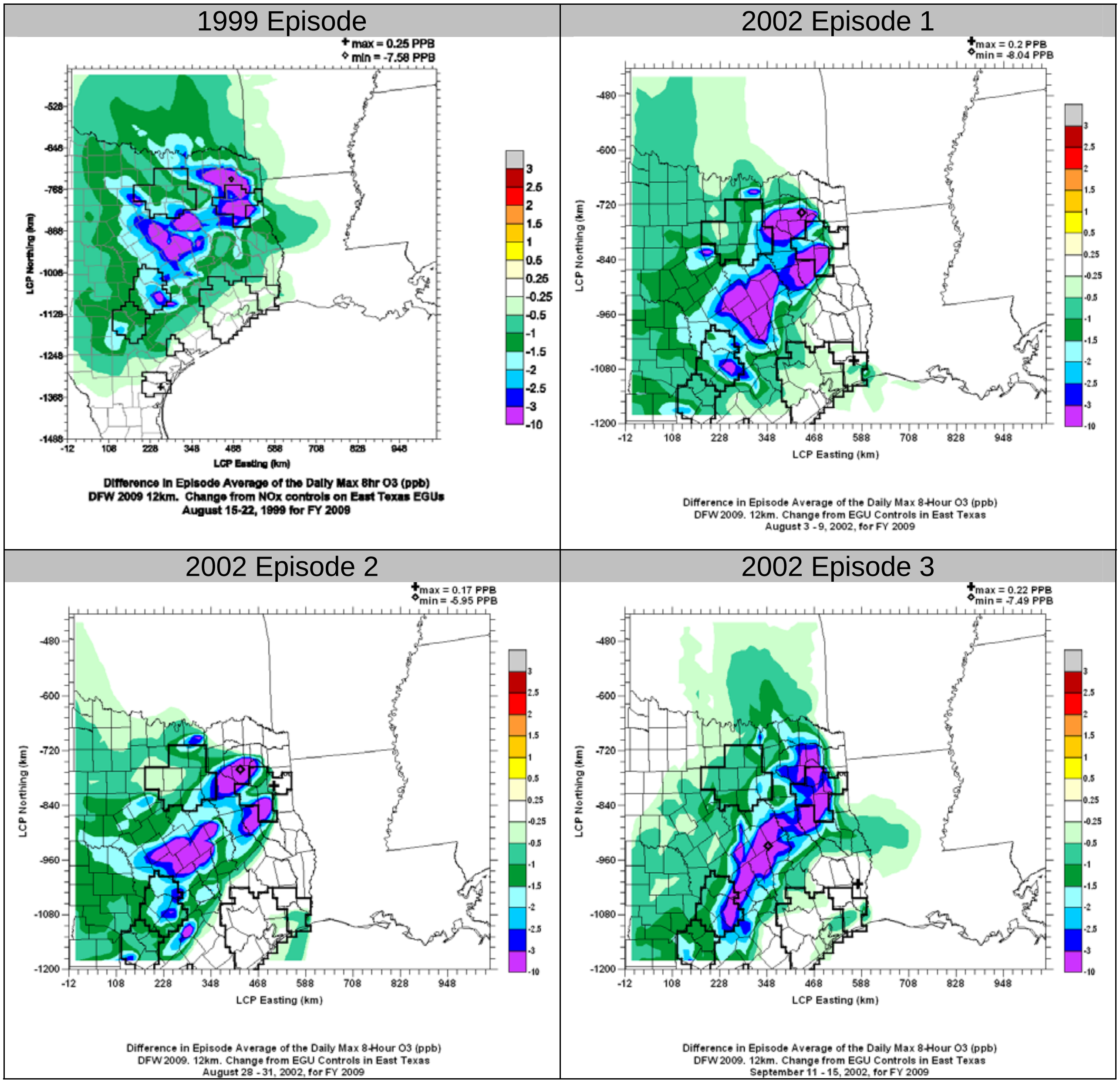


Figure 4-6. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from applying EGU controls across Eastern Texas.

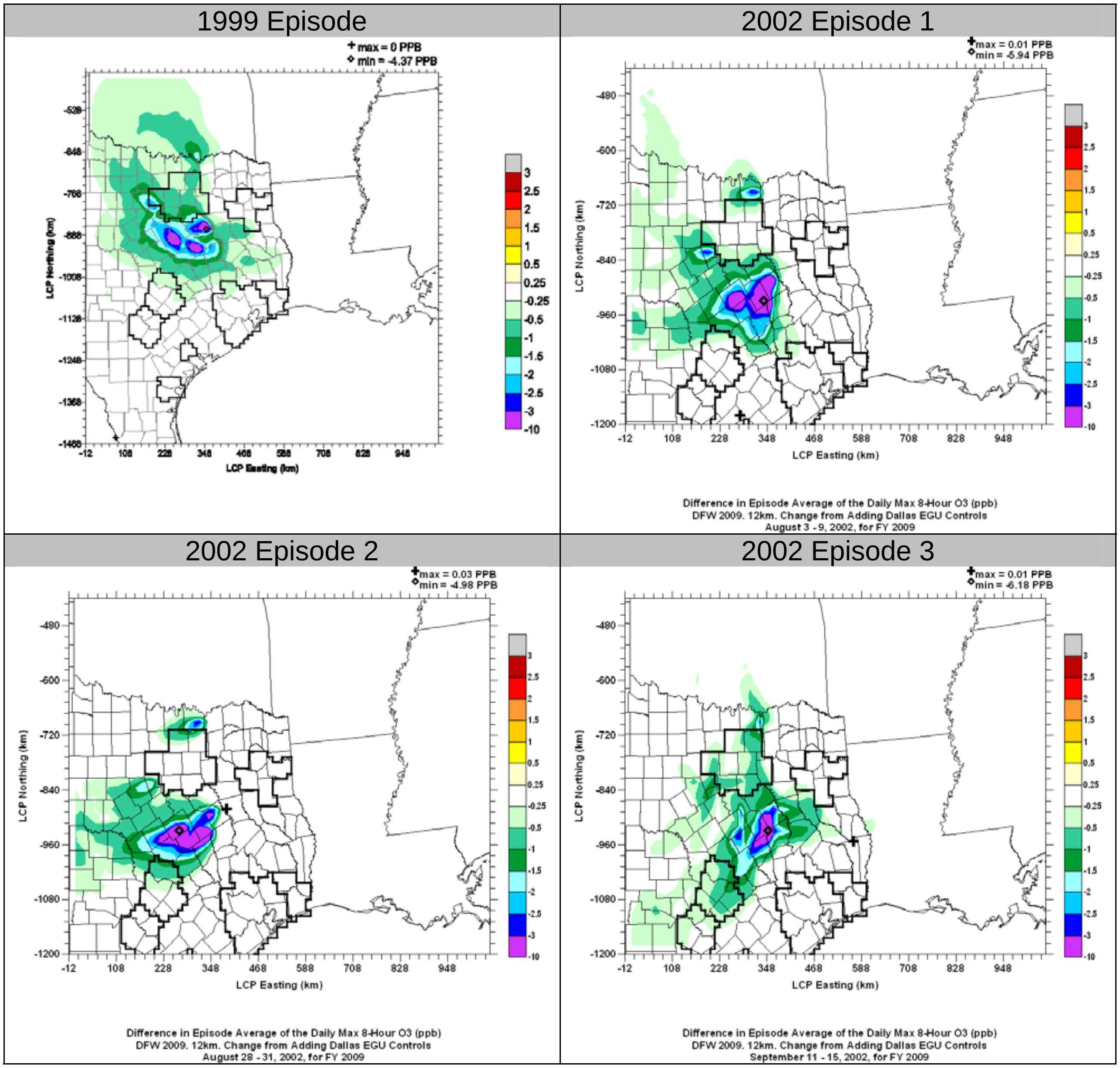


Figure 4-7. Differences in 2009 episode average daily maximum 8-hour ozone (ppb) from applying EGU controls in counties within 50-km of the DFW NAA.

Table 4-6. Projected 2009 8-hr ozone DVs (ppb) and changes from the 2009 baseline for August 15-22, 1999 (SIP episode).

Monitor	2009 Baseline	Reduce Emissions from Gas Com-pressors	Add Proposed New EGUs	DFW 50-km EGU Control [1]	East Texas EGU Control	Reduce all DFW EGUs to 0.033 lb/MMBtu	Retire Currently Mothballed EGUs
Frisco	91.9	91.5	92.0	91.3	90.8	91.5	91.9
Dallas C60	88.0	87.5	88.0	87.6	87.2	88.2	87.9
Dallas C63	87.9	87.5	88.0	87.5	87.0	87.7	87.9
Dallas C402	80.5	80.0	80.6	80.0	79.5	80.4	80.5
Denton	90.7	90.3	90.8	90.3	89.9	90.3	90.6
Midlothian	85.4	84.6	85.6	84.3	83.4	85.3	85.4
Arlington	88.4	87.9	88.6	87.6	87.1	88.3	88.4
Fort Worth C13	88.9	88.4	89.1	88.2	87.7	88.8	88.9
Fort Worth C17	86.9	86.4	87.0	86.4	86.0	86.7	86.8
Change from baseline							
Frisco		-0.4	0.1	-0.6	-1.1	-0.4	0.0
Dallas C60		-0.5	0.0	-0.4	-0.8	0.2	-0.1
Dallas C63		-0.4	0.1	-0.4	-0.9	-0.2	0.0
Dallas C402		-0.5	0.1	-0.5	-1.0	-0.1	0.0
Denton		-0.4	0.1	-0.4	-0.8	-0.4	-0.1
Midlothian		-0.8	0.2	-1.1	-2.0	-0.1	0.0
Arlington		-0.5	0.2	-0.8	-1.3	-0.1	0.0
Fort Worth C13		-0.5	0.2	-0.7	-1.2	-0.1	0.0
Fort Worth C17		-0.5	0.1	-0.5	-0.9	-0.2	-0.1
Average Change		**-0.50**	**0.12**	**-0.60**	**-1.11**	**-0.16**	**-0.03**

(1) DFW EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

Table 4-7. Projected 2009 8-hr ozone DVs (ppb) and changes from the 2009 baseline for August 3 – 9, 2002 (episode 1).

Monitor	2009 Baseline	Reduce Emissions from Gas Com-pressors	Add Proposed New EGUs	DFW 50-km EGU Control [1]	East Texas EGU Control	Reduce all DFW EGUs to 0.033 lb/MMBtu	Retire Currently Mothballed EGUs
Frisco	82.5	82.3	82.6	82.4	81.5	82.3	82.4
Anna	71.9	71.7	71.9	70.7	70.3	70.6	71.8
Dallas C60	85.5	85.3	85.5	85.4	84.6	85.3	85.4
Dallas C63	75.9	75.8	75.9	75.8	75.2	75.7	75.9
Dallas C402	79.2	79.1	79.3	79.1	78.4	79.2	79.2
Sunnyvale	72.8	72.5	72.8	72.7	71.2	72.7	72.7
Denton	87.8	87.3	87.8	87.6	86.9	87.5	87.6
Midlothian	77.2	76.9	77.3	77.0	76.3	77.1	77.2
Granbury	74.9	74.7	75.0	74.5	74.1	74.8	74.9
Cleburne	82.5	82.3	82.6	82.2	81.9	82.4	82.5
Kaufman	69.2	68.7	69.3	68.9	66.9	69.2	69.2
Weatherford	77.4	77.0	77.4	77.2	77.0	76.9	77.4
Rockwall	77.3	76.9	77.3	77.2	74.7	77.3	77.1
Arlington	82.2	82.0	82.2	82.1	81.7	81.9	82.1
Eagle Mt Lake	88.6	88.4	88.6	88.5	88.2	88.4	88.5
Fort Worth C13	89.4	89.2	89.5	89.3	89.0	89.1	89.4
Fort Worth C17	91.8	91.5	91.8	91.6	91.3	91.4	91.7
Grapevine	91.8	91.6	91.9	91.7	91.2	91.3	91.8
Change from baseline							
Frisco		-0.2	0.0	-0.1	-1.1	-0.2	-0.2
Anna		-0.2	0.0	-1.2	-1.6	-1.3	-0.1
Dallas C60		-0.2	0.0	-0.1	-0.9	-0.2	0.0
Dallas C63		-0.1	0.0	-0.1	-0.7	-0.2	-0.1
Dallas C402		-0.2	0.0	-0.1	-0.9	0.0	0.0
Sunnyvale		-0.3	0.0	-0.1	-1.6	0.0	0.0
Denton		-0.5	0.1	-0.2	-0.9	-0.3	-0.2
Midlothian		-0.3	0.1	-0.2	-0.8	0.0	0.0
Granbury		-0.3	0.1	-0.4	-0.8	-0.1	0.0
Cleburne		-0.2	0.1	-0.2	-0.6	-0.1	0.0
Kaufman		-0.5	0.1	-0.3	-2.3	0.0	0.0
Weatherford		-0.3	0.1	-0.1	-0.4	-0.4	0.0
Rockwall		-0.3	0.1	-0.1	-2.5	0.0	-0.2
Arlington		-0.2	0.1	-0.1	-0.5	-0.3	0.0
Eagle Mt Lake		-0.2	0.1	-0.1	-0.4	-0.2	0.0
Fort Worth C13		-0.2	0.1	-0.1	-0.4	-0.3	0.0
Fort Worth C17		-0.2	0.1	-0.2	-0.5	-0.4	0.0
Grapevine		-0.2	0.1	-0.1	-0.6	-0.5	0.0
Average Change		**-0.25**	**0.06**	**-0.22**	**-0.97**	**-0.26**	**-0.06**

(1) DFW EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

Table 4-8. Projected 2009 8-hr ozone DVs (ppb) and changes from the 2009 baseline for August 28 – 31, 2002 (episode 2).

Monitor	2009 Baseline	Reduce Emissions from Gas Com-pressors	Add Proposed New EGUs	DFW 50-km EGU Control [1]	East Texas EGU Control	Reduce all DFW EGUs to 0.033 lb/MMBtu	Retire Currently Mothballed EGUs
Frisco	85.4	85.3	85.4	85.4	84.5	85.4	85.3
Anna	74.8	74.8	74.8	74.7	72.3	74.8	74.8
Dallas C60	86.0	85.9	86.0	86.0	85.4	86.1	85.9
Dallas C63	76.2	76.2	76.2	76.3	75.8	76.3	76.1
Dallas C402	80.0	79.9	80.0	80.0	79.4	80.0	79.9
Sunnyvale	74.1	74.0	74.1	74.1	73.2	74.1	74.0
Denton	89.6	89.3	89.6	89.4	88.8	89.4	89.5
Midlothian	77.7	77.5	77.7	77.7	76.9	77.7	77.7
Granbury	77.1	76.9	77.1	77.1	76.8	77.0	77.1
Cleburne	83.8	83.6	83.8	83.8	83.4	83.7	83.8
Kaufman	67.2	66.8	67.2	67.2	65.4	67.2	67.2
Weatherford	79.8	79.5	79.8	79.7	79.5	79.3	79.7
Rockwall	77.8	77.7	77.8	77.8	75.2	77.8	77.3
Arlington	83.0	83.0	83.0	83.1	82.7	82.9	83.0
Eagle Mt Lake	89.5	89.4	89.5	89.5	89.2	89.3	89.5
Fort Worth C13	89.8	89.7	89.8	89.8	89.5	89.6	89.7
Fort Worth C17	94.7	94.5	94.7	94.7	94.3	94.3	94.6
Grapevine	94.9	94.8	94.9	95.0	94.6	94.6	94.9
Change from baseline							
Frisco		-0.1	0.0	0.0	-0.9	0.0	-0.1
Anna		0.0	0.0	-0.1	-2.5	0.0	0.0
Dallas C60		-0.1	0.0	0.0	-0.6	0.1	-0.1
Dallas C63		-0.1	0.0	0.0	-0.4	0.1	-0.1
Dallas C402		-0.1	0.0	0.0	-0.5	0.1	-0.1
Sunnyvale		-0.1	0.0	0.0	-1.0	0.0	-0.1
Denton		-0.3	0.0	-0.1	-0.7	-0.1	-0.1
Midlothian		-0.2	0.0	0.0	-0.8	0.0	0.0
Granbury		-0.2	0.0	0.0	-0.3	-0.1	0.0
Cleburne		-0.2	0.0	0.0	-0.4	-0.1	0.0
Kaufman		-0.4	0.0	0.0	-1.8	0.0	0.0
Weatherford		-0.3	0.0	0.0	-0.3	-0.4	0.0
Rockwall		-0.1	0.0	0.0	-2.7	0.0	-0.5
Arlington		-0.1	0.0	0.0	-0.3	-0.1	-0.1
Eagle Mt Lake		-0.1	0.0	0.0	-0.3	-0.2	0.0
Fort Worth C13		-0.1	0.0	0.0	-0.3	-0.2	-0.1
Fort Worth C17		-0.1	0.0	0.0	-0.3	-0.3	-0.1
Grapevine		-0.1	0.0	0.0	-0.3	-0.3	-0.1
Average Change		**-0.15**	**0.00**	**-0.01**	**-0.80**	**-0.10**	**-0.09**

(1) DFW EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

Table 4-9. Projected 2009 8-hr ozone DVs (ppb) and changes from the 2009 baseline for September 11 – 15, 2002 (episode 3).

Monitor	2009 Baseline	Reduce Emissions from Gas Com-pressors	Add Proposed New EGUs	DFW 50-km EGU Control [1]	East Texas EGU Control	Reduce all DFW EGUs to 0.033 lb/MMBtu	Retire Currently Mothballed EGUs
Frisco	85.9	85.4	86.0	85.6	84.8	85.6	85.9
Anna	72.0	71.3	72.1	71.7	70.9	72.0	71.9
Dallas C60	88.8	88.5	88.9	88.6	88.0	88.7	88.8
Dallas C63	76.8	76.5	76.9	76.6	76.1	76.6	76.8
Dallas C402	82.2	81.9	82.2	81.9	81.4	82.1	82.1
Sunnyvale	76.3	76.0	76.3	75.9	75.0	76.2	76.2
Denton	90.4	89.3	90.5	90.1	89.1	90.2	90.3
Midlothian	79.5	79.1	79.6	79.1	78.4	79.4	79.5
Granbury	75.7	75.4	75.8	74.9	74.6	75.6	75.7
Cleburne	83.6	83.3	83.7	83.2	82.6	83.5	83.6
Kaufman	65.9	65.7	66.1	65.8	65.3	65.9	65.9
Weatherford	76.1	75.1	76.1	76.0	76.0	75.5	76.1
Rockwall	80.0	79.5	80.1	79.0	78.5	80.0	80.0
Arlington	83.4	83.1	83.4	83.2	82.6	83.2	83.3
Eagle Mt Lake	90.1	89.7	90.2	89.9	89.3	89.8	90.1
Fort Worth C13	91.9	91.7	92.0	91.7	91.2	91.6	91.9
Fort Worth C17	92.4	92.0	92.4	92.1	91.5	91.9	92.3
Grapevine	93.7	93.2	93.7	93.4	92.8	93.1	93.6
Change from baseline							
Frisco		-0.5	0.1	-0.3	-1.1	-0.3	0.0
Anna		-0.8	0.1	-0.4	-1.1	-0.1	-0.1
Dallas C60		-0.3	0.1	-0.3	-0.8	-0.1	0.0
Dallas C63		-0.3	0.1	-0.3	-0.7	-0.2	0.0
Dallas C402		-0.3	0.0	-0.2	-0.8	-0.1	0.0
Sunnyvale		-0.3	0.1	-0.4	-1.2	-0.1	0.0
Denton		-1.1	0.1	-0.3	-1.4	-0.2	-0.1
Midlothian		-0.4	0.0	-0.5	-1.1	-0.1	0.0
Granbury		-0.4	0.0	-0.8	-1.1	-0.2	0.0
Cleburne		-0.3	0.1	-0.4	-1.0	-0.1	0.0
Kaufman		-0.2	0.2	-0.1	-0.6	0.0	0.0
Weatherford		-1.0	0.0	-0.1	-0.1	-0.5	0.0
Rockwall		-0.5	0.1	-1.0	-1.5	0.0	0.0
Arlington		-0.3	0.0	-0.2	-0.8	-0.1	0.0
Eagle Mt Lake		-0.4	0.1	-0.2	-0.8	-0.3	0.0
Fort Worth C13		-0.3	0.1	-0.2	-0.7	-0.4	0.0
Fort Worth C17		-0.4	0.1	-0.2	-0.8	-0.4	0.0
Grapevine		-0.4	0.0	-0.3	-0.8	-0.5	0.0
Average Change		**-0.45**	**0.07**	**-0.34**	**-0.91**	**-0.21**	**-0.03**

(1) DFW EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

Table 4-10. Changes in 2009 NOx emissions (tpd) and average 2009 8-hr ozone DVs (ppb) over DFW monitors for four episode periods.

Episode	Reduce emissions from Gas Compressors	Add Proposed New EGUs	Retire Currently Mothballed EGUs[1]	Reduce all DFW EGUs to 0.033 lb/MMBtu	East Texas EGU Control	DFW 50-km EGU Control[2]
Emissions Change (tpd)						
NOx Decrease (Increase)	233	(48.5)	66.9	1.57	329.5	93.8
Average 2009 8-hr ozone DVs (ppb)						
1999 SIP	-0.50	0.12	-0.03	-0.16	-1.11	-0.60
2002 Episode 1	-0.25	0.06	-0.06	-0.26	-0.97	-0.22
2002 Episode 2	-0.15	0.00	-0.09	-0.10	-0.80	-0.01
2002 Episode 3	-0.45	0.07	-0.03	-0.21	-0.91	-0.34

(1) The NOx reduction from retiring mothballed EGUs may be an over-estimate, see text.
(2) DFW 50-km EGU Control means the East Texas EGU Control applied in counties within 50-km of the DFW NAA.

Ozone reductions at the monitors with the highest 2009 DVs may be of particular interest as these monitors may be the most difficult to bring into attainment. Frisco had the highest 2009 baseline DV for the 1999 episode (Table 4-6) whereas Grapevine or Ft. Worth CAMS 17 had the highest 2009 baseline DV for the 2002 episodes (Table 4-7 to 4-10).

DISCUSSION OF RESULTS

Reduce Emissions from Gas Compressors

All four episodes showed reductions in episode average daily maximum ozone of several ppb in areas where emissions were reduced (Figure 4-2). Areas that consistently showed ozone reductions of several ppb were in Northeast Texas and Central Texas. The reductions in average DFW 2009 DVs ranged from 0.15 to 0.50 ppb (Table 4-10) and the largest benefits in DFW were for the 1999 SIP episode (0.5 ppb) and 2002 episode 3 (0.45 ppb). The benefits in DFW were smaller for 2002 episodes 1 and 2 because consistent northeasterly winds meant that benefits were not transported into the DFW NAA during these episodes (Figure 4-2). In comparison, TCEQ's "small engine rule" analysis produced about 0.3 ppb reduction in 2009 DV for the 1999 SIP episode, and restricting controls to within 200-km of DFW did not significantly reduce the ozone benefit of the "small engine rule" (Tai and Yarwood, 2006).

Proposed New EGUs with Permits

The proposed new EGUs consistently caused increases in episode average daily maximum 8-hr ozone of greater than 5 ppb in Central Texas, to the south of DFW. The maximum ozone impacts were located close to the locations of several proposed new EGUs near Waco (Twin Oaks, Oak Grove and Sandy Creek). Increases in average DFW 2009 DVs ranged from zero to 0.12 ppb (Table 4-10) depending upon episode. The largest increase in average DFW 2009 DV (0.12 ppb) was for the 1999 SIP episode because of greater incidence of southerly transport winds in this episode than the three 2002 episodes (zero to 0.07 ppb increase).

Retire Currently Mothballed EGUs

Retiring currently mothballed EGUs consistently produced ozone reductions at several locations across Texas (Figure 4-4) close to the source locations which include Houston, Victoria, Fort Worth, West Texas and to the North of Dallas (Table 4-2). As discussed above, these reductions are over-estimated because the emissions from the mothballed units were over-estimated in the 2009 baseline inventory. We have insufficient information at this time to evaluate the magnitude of this error. The largest ozone reductions were from a TXU EGU near Savoy in Fannin County, to the north of DFW, and these ozone reductions were transported into the DFW NAA for all episodes. Emission reductions from several other TXU EGUs in Dallas, Collin and Tarrant counties (Table 4-2) also affected ozone for all episodes. Decreases in average DFW 2009 DVs ranged from 0.03 to 0.09 ppb (Table 4-10) depending upon episode. Decreases were larger for 2002 episodes 1 and 2 because consistent northeasterly winds during these episodes transported in to DFW some benefits from retiring the TXU EGU in Fannin County.

It is interesting to consider whether emission reductions from retiring mothballed EGUs could offset emission increases from adding proposed new EGUs. For DFW ozone, these impacts tended not to offset (for the episodes studied) because they produced ozone impacts in different locations. DFW ozone benefits from retiring mothballed EGUs were influenced by ozone reductions north of DFW, whereas DFW ozone increases from proposed new EGUs were influenced by ozone increases south of DFW. Consequently, adding new EGUs produced the largest DFW ozone increases for the 1999 SIP episode and 2002 episode 3, whereas retiring mothballed EGUs produced the largest DFW ozone decreases for 2002 episodes 1 and 2 (Table 4-10).

Reduce All DFW EGUs to 0.033 lb/MMBtu

Reducing all DFW EGUs to 0.033 lb/MMBtu reduced emissions at only four EGUs and the estimated NOx reduction was only 1.57 tpd. However, these emission reductions occurred within the DFW NAA and were relatively effective at reducing DFW ozone. Reductions in average DFW 2009 DVs ranged from 0.1 to 0.26 ppb (Table 4-10) depending upon episode. The average ozone impacts (Table 4-10) from this 1.57 tpd NOx reduction inside the DFW NAA were always larger in absolute magnitude than either retiring mothballed EGUs (66.9 tpd NOx change) or adding proposed new EGUs (48.5 tpd change).

East Texas EGU Control

All four episodes showed widespread reductions in episode average daily maximum ozone of several ppb (Figure 4-6) with maximum reductions of about 6 to 8 ppb. Areas that consistently showed ozone reductions of several ppb stretched from Northeast Texas through Central Texas to Austin plus other areas outside DFW and San Antonio. Reductions in average DFW 2009 DVs ranged from 0.8 to 1.11 ppb (Table 4-10) depending upon episode. The benefits in DFW were smallest for 2002 episode 2 (0.8 ppb) because consistent northeasterly winds meant benefits of reductions in Northeast Texas passed to the south of the DFW NAA (Figure 4-6). The benefits in DFW were greatest for the 1999 SIP episode (1.11 ppb) because of greater incidence of southerly transport winds in this episode. All four episodes showed substantial reductions in average 2009 DFW DVs because emission reductions were spread widely across eastern Texas.

DFW 50-km EGU Control

The DFW 50-km EGU control restricted emission reductions to counties within 50-km of the DFW NAA and this reduced the area where substantial ozone reductions occurred (compare Figures 4-7 and 4-6). Central Texas consistently showed ozone reductions of several ppb with the Dallas EGU Control. Reductions in average DFW 2009 DVs ranged from 0.01 to 0.6 ppb (Table 4-10) depending upon episode. Wind directions strongly influenced which episodes showed DFW ozone benefits from this control. The benefits in DFW were smallest for 2002 episode 2 (0.01 ppb) because consistent northeasterly winds meant almost no transport of benefits from Central Texas into the DFW NAA (Figure 4-7). The benefits in DFW were greatest for the 1999 SIP episode (0.6 ppb) because of greater incidence of southerly transport winds in this episode. Compared to the East Texas EGU control, the DFW 50-km EGU control produced much less ozone benefit in DFW, about half the benefit for the 1999 episode and about a third or less of the benefit for the 2002 episodes.

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