Draft Report

Ozone Benefits in DFW from Emission Controls in the 2009 and 2012 Future Years

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EXECUTIVE SUMMARY

The August 13-22, 1999 episode was identified as being representative of a high 8-hour ozone episode in the Dallas/Fort Worth area. In this report, numerous emission controls were applied to this episode in the 2009 and 2012 future years to evaluate 8-hour ozone benefits to the DFW 9-county NAA. Controls included:

- High and low-end controls to the Midlothian cement kilns.
- Spark-ignition engine controls in East Texas and within a 200 km radius of DFW.
- DFW major source and DFW EGU controls.
- DFW EGU controls.
- DFW minor source controls.
- High and low-end NCTCOG on-road and off-road mobile source controls.
- East Texas EGU controls.
- A combination of controls listed above.

Impacts to 8-hour ozone were evaluated using design value scaling. In each scenario, Frisco had the highest future design value; Denton was second highest. Among all of the individual controls applied to the 2009 baseline, most DFW monitors showed the greatest ozone reduction from the high-end NCTCOG on-road and off-road controls in the DFW area; the low-end NCTCOG controls produced half the ozone benefit of the high-end controls. The NOx reduction from East Texas EGU controls also benefited DFW. None of the individual controls or combination of controls evaluated was able to lower the 2009 future design values below 85 ppb at Frisco and Denton. The lowest 2009 future design value evaluated for Frisco was 88.3 ppb. Attainment was not demonstrated for the 2009 future year.

In 2012, NOx emissions from Texas on-road mobile sources were significantly lower than in 2009. Design value scaling of the 2012 baseline (using the current release of CAMx version 4.31) put Frisco at 86.7 ppb and Denton at 86.3 ppb. All other DFW monitors had future design values below 85 ppb. A combination of DFW controls (DFW major and minor sources, DFW EGUs, low-end NCTCOG, low-end cement kiln, and East Texas engine controls within 200 km of DFW) reduced the 2012 future design values at all DFW monitors below 85 ppb. Attainment for 8-hour ozone in DFW was demonstrated for 2012.

1. INTRODUCTION

The August 13-22, 1999 period was identified as being representative of a high 8-hour ozone episode in the Dallas/Fort Worth (DFW) area. Numerous sensitivity runs were evaluated to examine the impacts to 8-hour ozone in DFW in the 2009 future year when applying one or a combination of controls.

In previous work for the Texas Commission on Environmental Quality (TCEQ), the Run 17b base case configuration examined the level of emission controls needed to reach attainment for 8-hour ozone in 2010 during the core period by applying a matrix of VOC and NOx reductions inside the DFW 9-county non-attainment area (NAA) (Mansell et al., 2004). Numerous sensitivity runs performed for the Houston Advanced Research Council (HARC), project H35 (Tai, 2005a) tested different domain configurations, meteorology, and chemistry to optimize the 1999 base case. A new base case, Run 40, combined all components that improved model performance and was the basis for more control scenarios in the 2010 future year for TCEQ (Tai, 2005b).

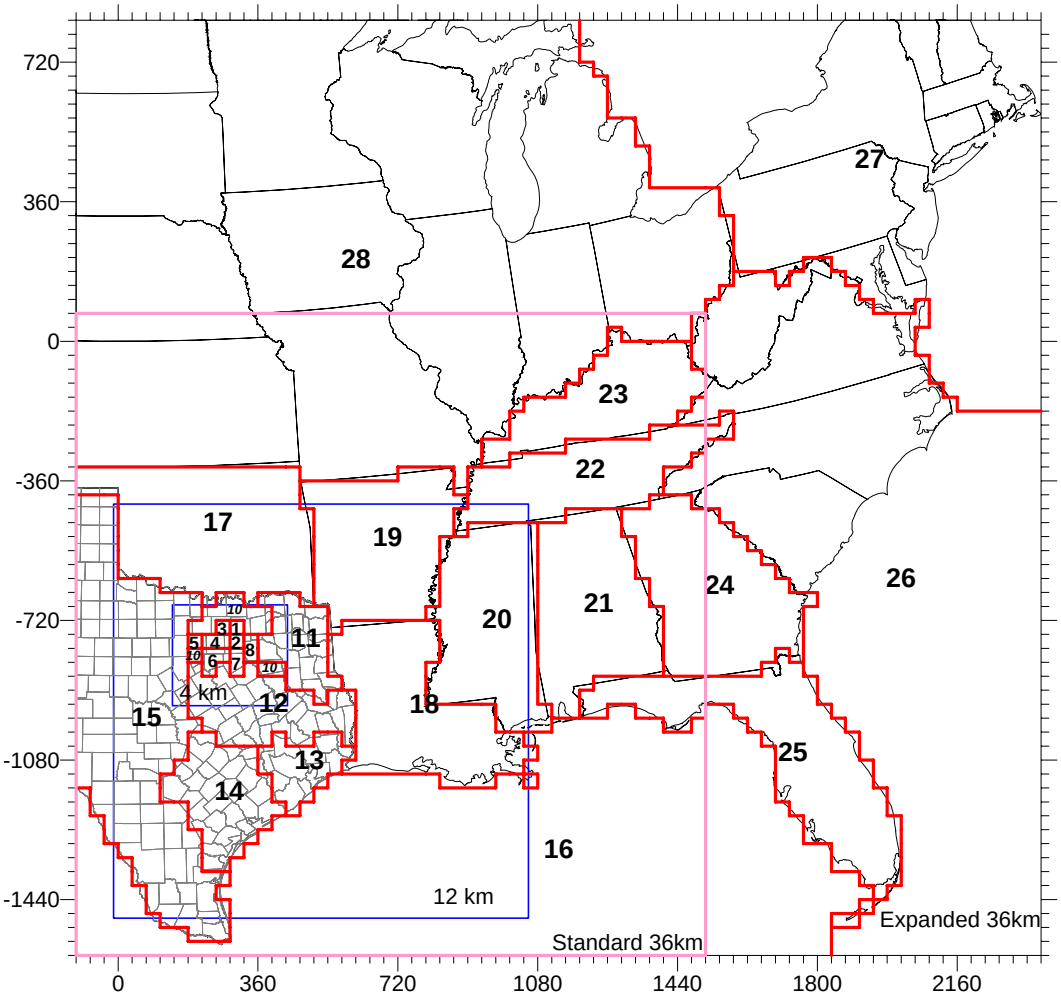
In October, 2005, the EPA published new procedures for attainment demonstration, including the use of baseline emissions instead of base case emissions and an updated method for computing the baseline design values (EPA, 2005). In addition, the DFW attainment demonstration year was changed from 2010 to 2009.

This report evaluates 8-hour ozone in 1999 using updated base case and baseline emissions inventories in Section 2. There were three versions of the 2009 baseline emissions, each described in a separate report section. Section 3 discusses the first 2009 baseline and includes a matrix of local “across-the-board” anthropogenic controls to estimate the level of emissions needed to achieve attainment. In Section 4, the 2009 baseline was revised to version “a1” with updated point source emissions to include 2005 acid rain data. Numerous DFW emission control scenarios were applied to the 2009 a1 baseline to evaluate their benefits to 8-hour ozone in DFW. Section 5 includes minor updates and corrections to the 2009 point source inventory to version “a2.” In addition, a new version of CAMx was introduced (version 4.31), resulting in new baseline runs for 1999, 2009, and a new 2012 future year. Combinations of controls were applied to both future years to try to lower the future design values at all DFW monitors below 85 ppb.

2. DEVELOPMENT OF A 1999 BASELINE

Improvements were made to the DFW Run 40 base case configuration (Tai, 2005b) for the August 13-22, 1999 episode. Run 41 updated the Texas on-road mobile and offshore emissions. Run 42 fixed the vertical diffusivity (kv100) patch. Runs 44 and 45 upgraded all emissions based on the NEI99 version 2 dataset to NEI99 version 3 for the baseline and base case, respectively.

The runs were based on the Run 40 configuration with an expanded 36 km domain covering most of central and eastern US with a 4 km nested grid over DFW as shown in Figure 2–1. Inputs included meteorology from MM5 Run 6, which was based on the ETA PBL scheme coupled with the Noah land surface model, using the vertical layering structure displayed in Table 2–1. Boundary conditions assigned moderate conditions in the mixed layer over land, and clean conditions over the Gulf and Atlantic, and all areas aloft. Table 2–2 lists the boundary conditions used in the modeling. A modified version of CAMx 4.03 was used in which several NOx recycling reactions were added to the CB4 mechanism (CB4xi) (Tai et al., 2005a).



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

CAMx Grid Definitions

36 km expanded:	69 x 67	(-108, -1584) to (2376, 828)
12 km	89 x 89	(-12, -1488) to (1056, -420)
04 km	74 x 65	(140, -940) to (436, -680)

Figure 2–1. Map of source regions in the 36 km expanded domain.

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	IC/BC
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		Clean IC/BC
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		|
---------- Original CAMx Top ----------						|
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---	v
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---	Moderate IC/BC
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---	|

Table 2–2. Concentrations (ppb) used to define CAMx initial and boundary conditions.

CB4 Species	Moderate	Clean
O3	40	40
CO	200	100
NO	0.1	0.1
NO2	1	1
HNO3	3	1
HNO2	0.001	0.001
ALD2	0.555	0.05
ETH	0.51	0.15
HCHO	2.1	0.05
OLE	0.3	0.05
PAR	14.9	7.6
TOL	0.18	0.0786
XYL	0.0975	0.0688
ISOP	0.1	0.001
PAN	0.1	0.1
H2O2	3	1
MEOH	0.001	0.001
ETOH	0.001	0.001

2.1 UPDATES TO THE 1999 BASE CASE (RUNS 41 AND 42)

Two CAMx base case runs were evaluated for the August 13-22, 1999 Dallas/Fort Worth episode to incorporate the latest updates in the emissions inventory. Changes included on-road mobile improvements and offshore platform and non-platform emissions provided by TCEQ. Biogenics, area, off-road, and point sources (excluding offshore sources) were unchanged.

Figure 2–2 shows the NOx change from the emission inventory updates for the 12PM hour on Saturday, August 14 (left) and Tuesday, August 17 (right) for low-level gridded emissions in the 4 km domain (top) and 12 km domain (center), and for the elevated points (bottom). The greatest changes were found near Dallas/Fort Worth, Waco, and offshore.

The first run, called “Run 41,” was identical to the previous base case, Run 40, but with the emission updates. This run applied a “kvpatch1” patch to the vertical diffusivity, which had been applied to all runs since at least Run 20. This was thought to be the kv100 patch, which set the value of the largest vertical diffusivity in the lowest 100 m of each column and hour to all layers below 100m, but turned out to be a different patch. The correct kv100 patch with updated emissions was applied to the second run – “Run 42”.

The vertical diffusivity in both runs was extracted from MM5 Run 6 using the TKE Kv method. The kvpatch1 patch applied minor adjustments to the low level vertical diffusivity, while the kv100 patch, which is the officially released patch for vertical diffusivity in CAMx, significantly increased the kv in the lowest 100 m to enhance the low-level vertical mixing, particularly in the daytime. Neither patch made any adjustments to the vertical diffusivity above 100 m. Plots comparing the diffusivity profiles over Frisco at 3 AM and 3 PM on August 17 with and without the patch are shown in Figure 2–3.

A comparison of the two runs with the previous base case, Run 40, follows. Included are plots of 1-hour ozone time series (Figure 2–4), 1-hour and 8-hour model performance statistics (Figures 2–5 and 2–6, respectively), 8-hour model performance soccer-goal plot (Figure 2–7), and spatial plots of the daily maximum 8-hour ozone in the DFW 4 km domain for Run 41 (left) and Run 42 (right) (Figure 2–8). In addition, differences in the daily maximum 8-hour ozone on August 17 are included to distinguish changes from the emissions inventory and changes from the kvpatch correction (Figure 2–9).

Findings from the updated emissions (Run 41 vs. Run 40):

- The updated emissions made minor changes to ozone at the DFW receptors. The biggest change when viewing the time series plots appeared to be the higher nighttime ozone in Denton.
- The most substantial change in the 4 km domain was in and downwind of McLennon County (Waco), where the daily maximum 8-hour ozone was up to 5 ppb higher due to the higher on-road mobile NOx emissions in the region.
- Normalized bias for the DFW sites was slightly higher in Run 41 than in Run 40 on all dates for both 1 and 8 hour ozone.

Findings from the corrected kv100 patch (Run 42 vs. Run 41):

- Time series plots showed higher afternoon peaks in Run 42, mainly at sites in Dallas and Tarrant Counties, particularly Dallas CAMS 60.
- Normalized bias was higher in Run 42 on all dates for 1-hour and 8-hour ozone.
    - **On August 17, Run 42's normalized bias for 8-hour ozone (-12.7%) reached the EPA ±15% goal**. This was also achieved on August 14 (a spin-up date).
    - August 19's normalized bias for 8-hour ozone was pushed beyond the +15% EPA goal.
- Normalized error was better in Run 42 compared to Run 41 on all dates when the normalized bias was negative, and worse when the normalized bias was positive. The soccer goal plot shows this fairly well.
- The area of high ozone near DFW shifted eastward on August 17 in Run 42, agreeing better with the observations. The larger low-level vertical diffusivity associated with the kv100 patch most likely helped mix out some of the NOx in western Collin and Dallas Counties, resulting in more favorable ozone producing conditions.

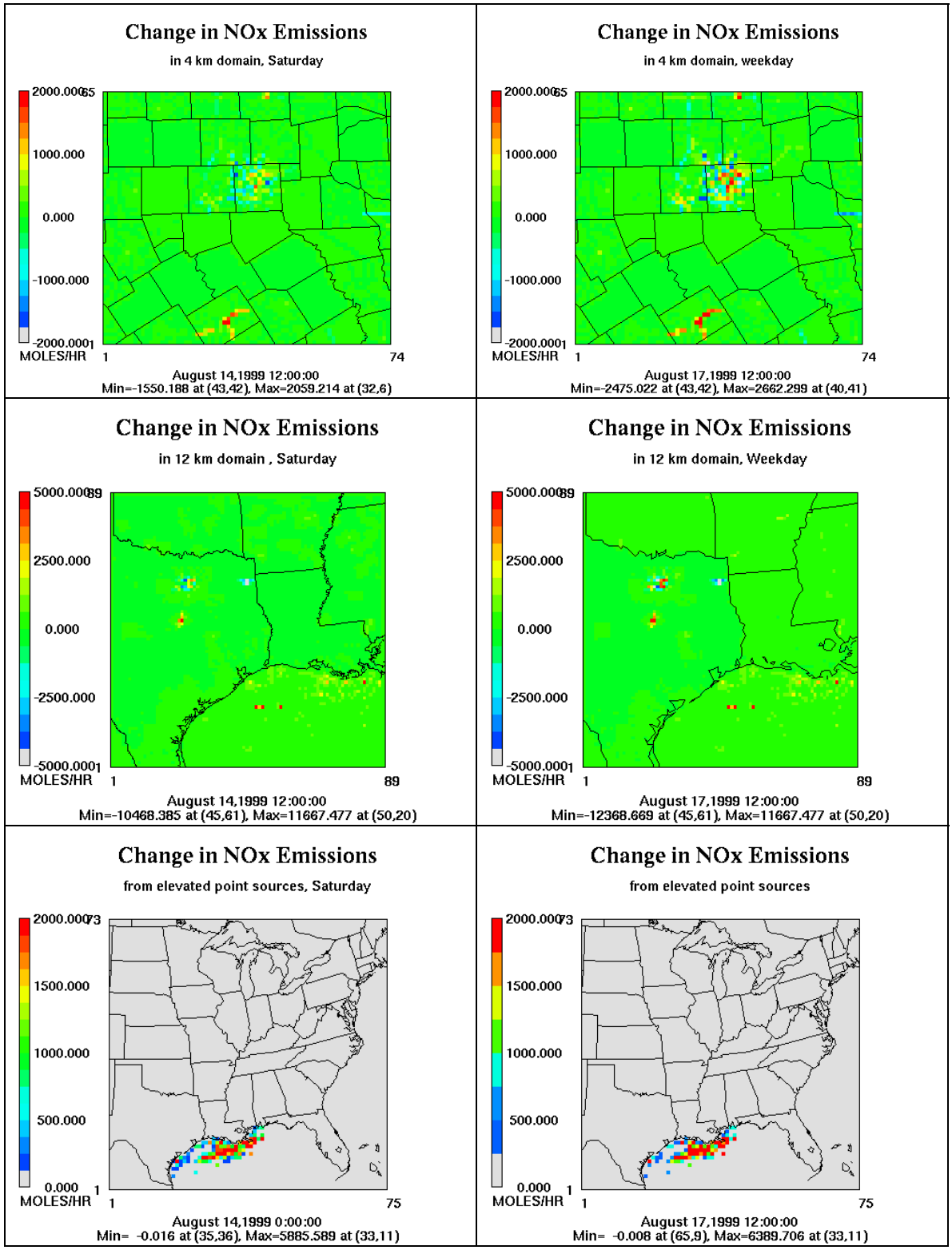
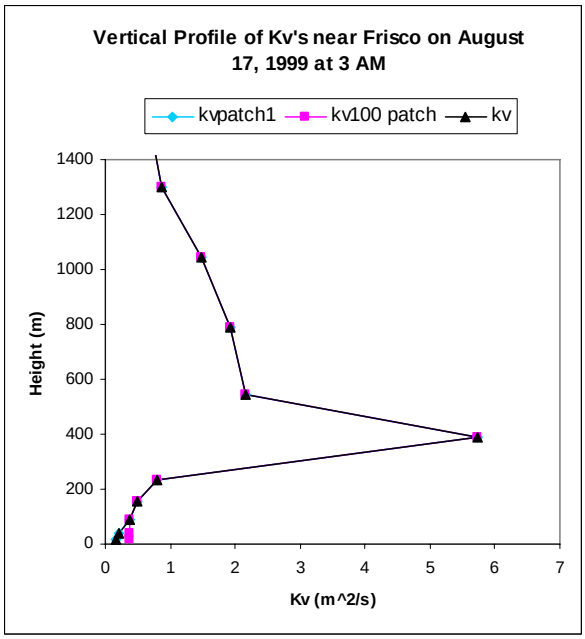
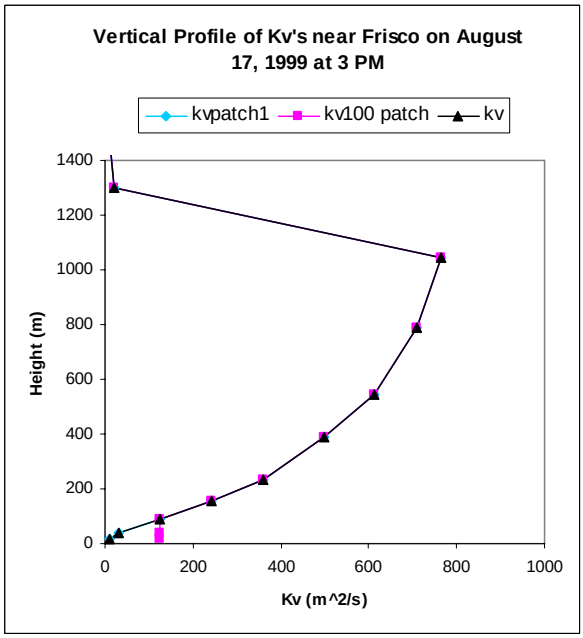


Figure 2–2. Change in noontime NOx emissions from the emission updates on Saturday, August 14 (left) and Tuesday, August 17 (right) from low-level sources in the 4 km domain (top) and 12 km domain (middle), and elevated points (bottom).



Kv at 3AM



Kv at 3 PM

Figure 2–3. Vertical profiles of the vertical diffusivity at 3AM (left) and 3PM (right) on August 17, 1999 over Frisco.

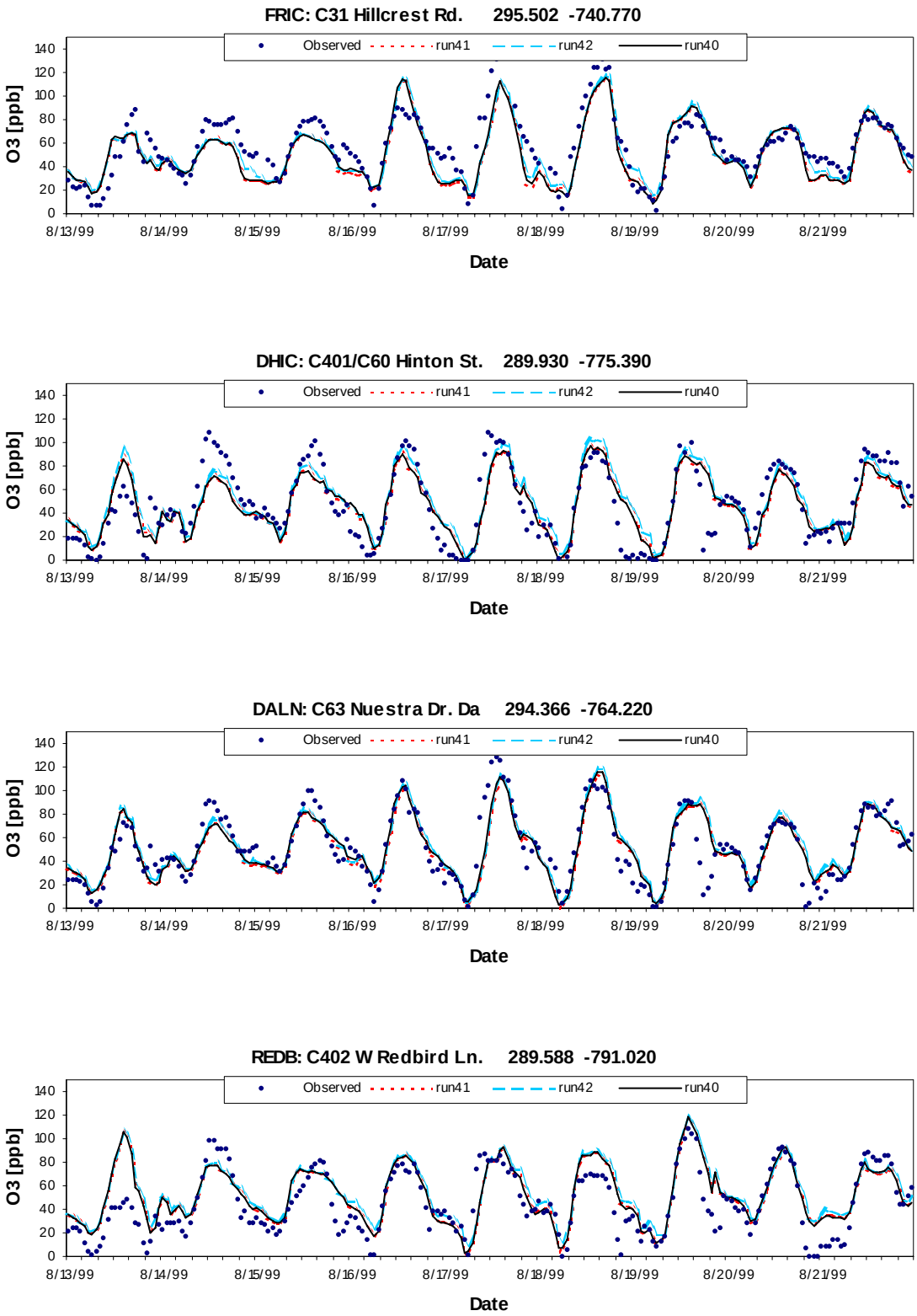


Figure 2–4. Time series of 1-hour ozone.

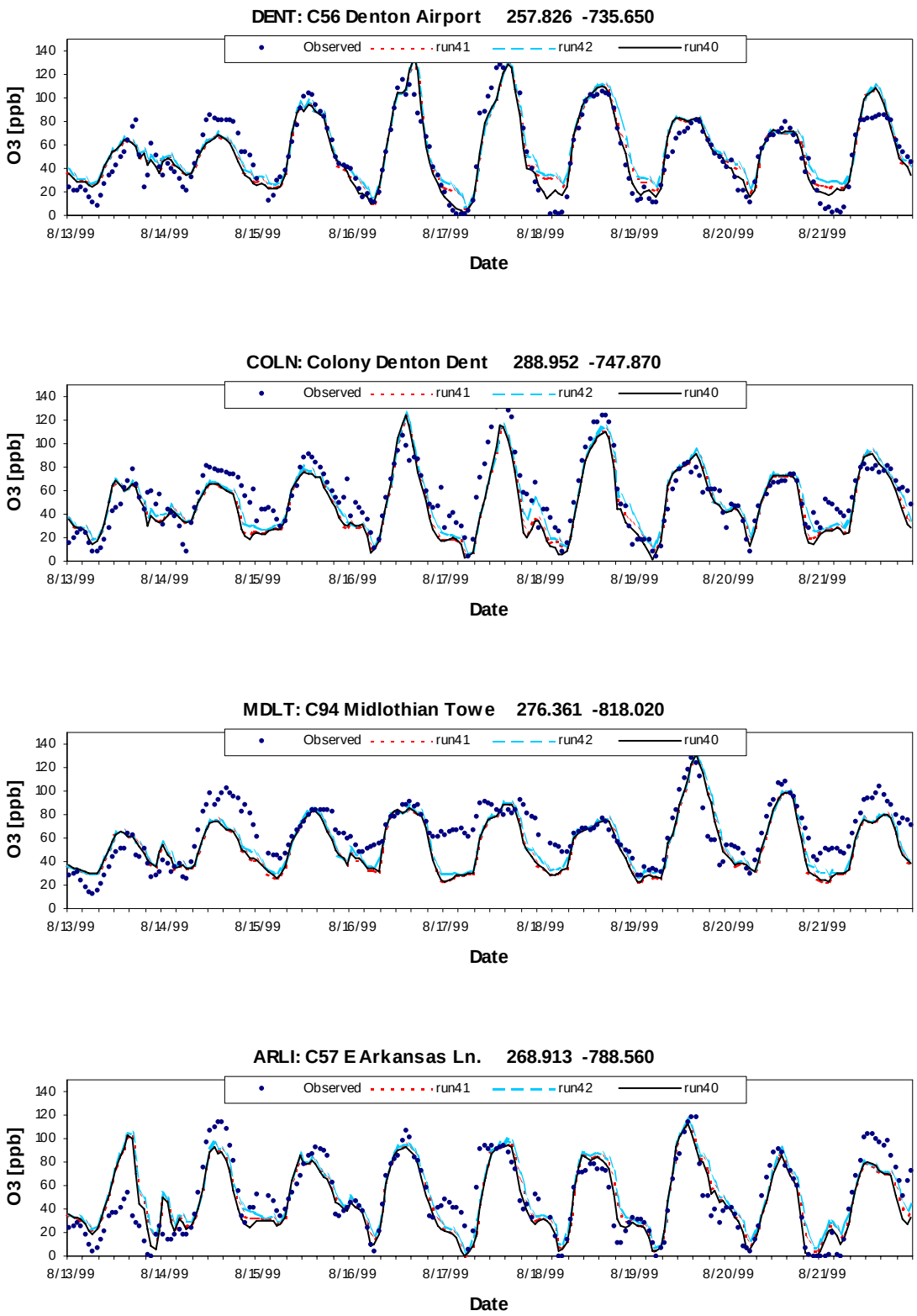
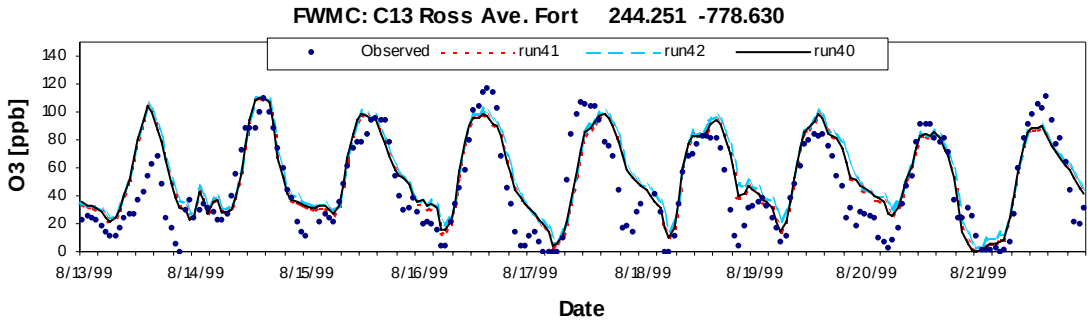


Figure 2–4 (continued). Time series of 1-hour ozone.



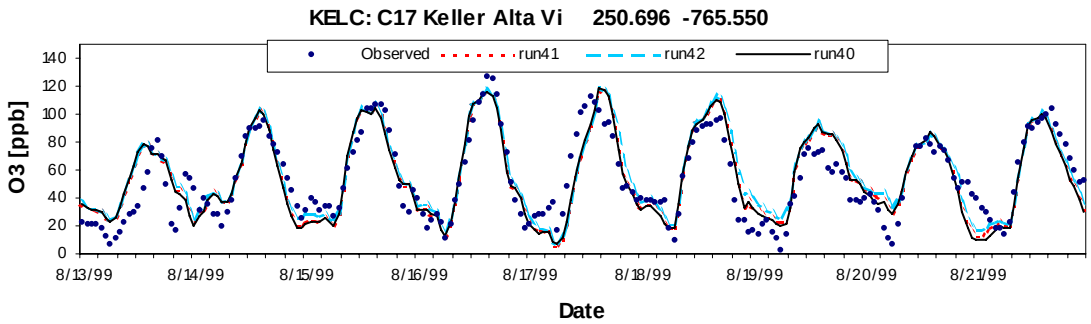


Figure 2–4 (concluded). Time series of 1-hour ozone.

DFW 1999 Base Case 1hr O3.

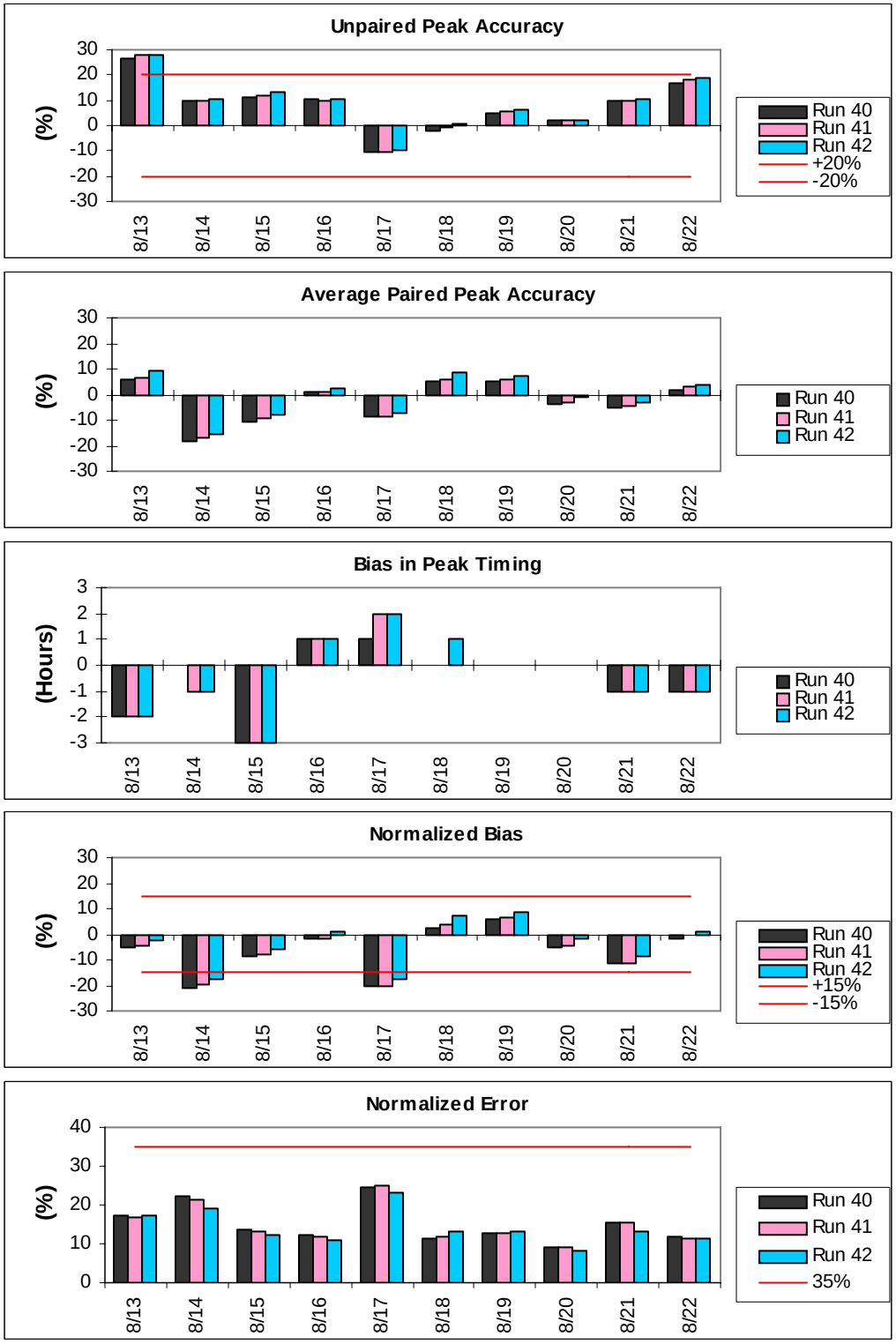


Figure 2–5. Model performance statistics for 1-hour ozone.

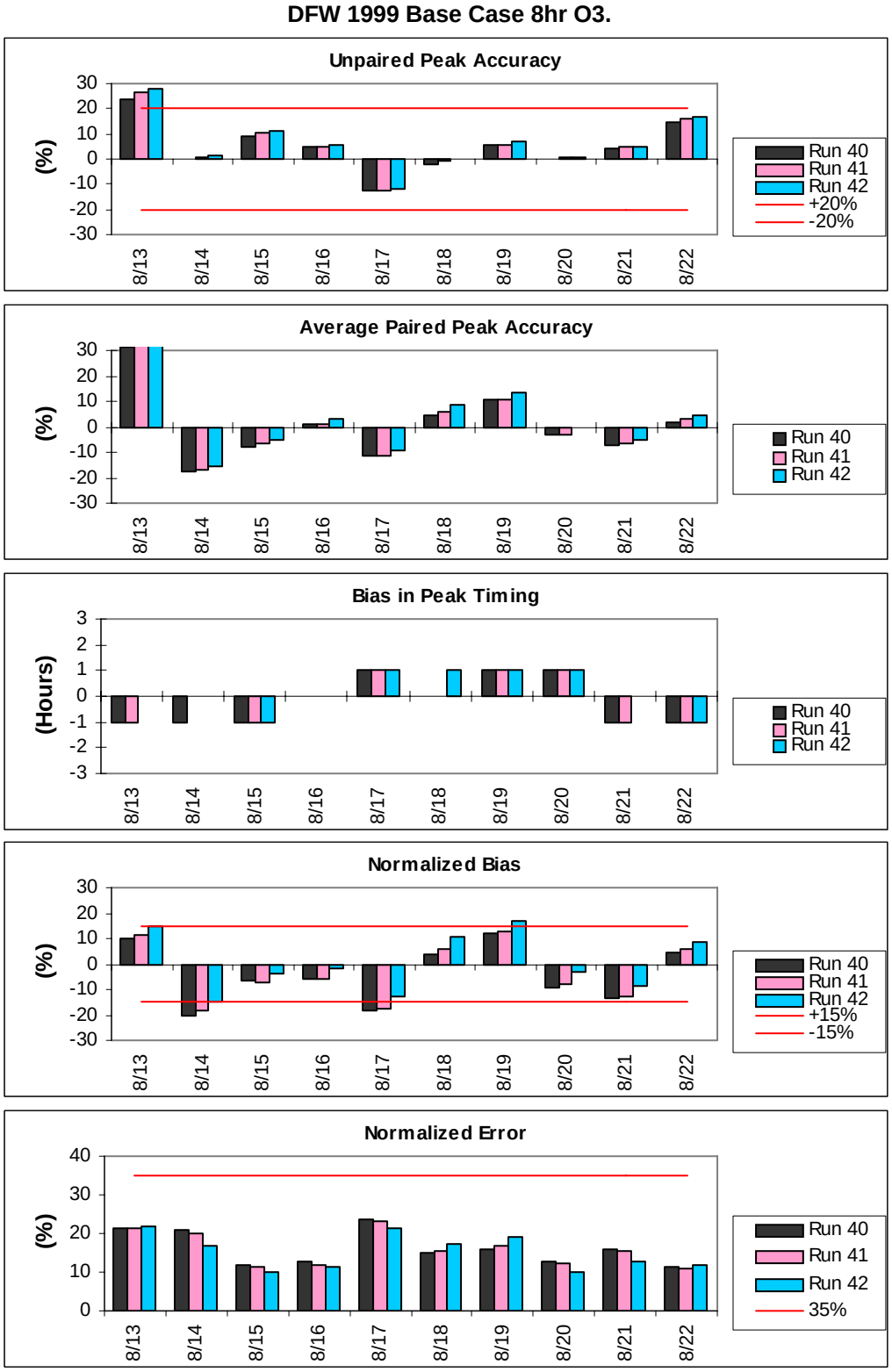


Figure 2–6. Model performance statistics for 8-hour ozone.

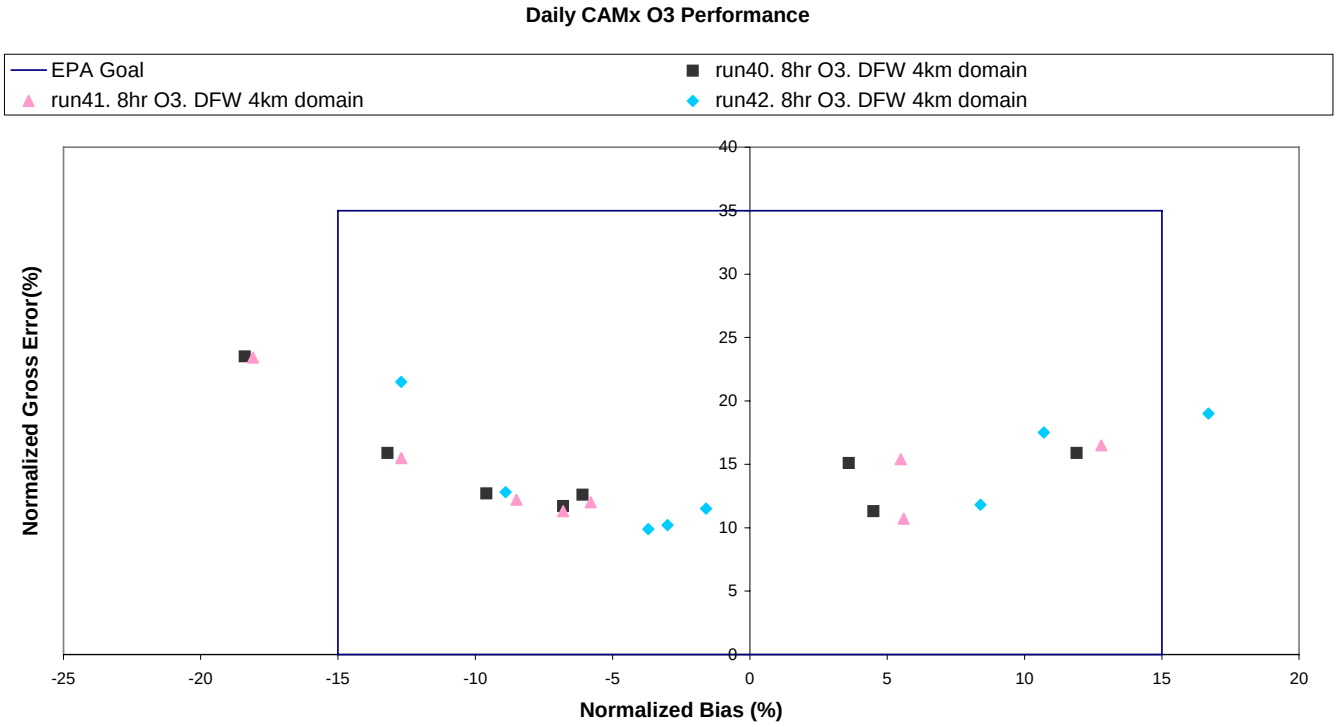


Figure 2–7. Model performance statistics of 8-hour ozone as a soccer goal plot.

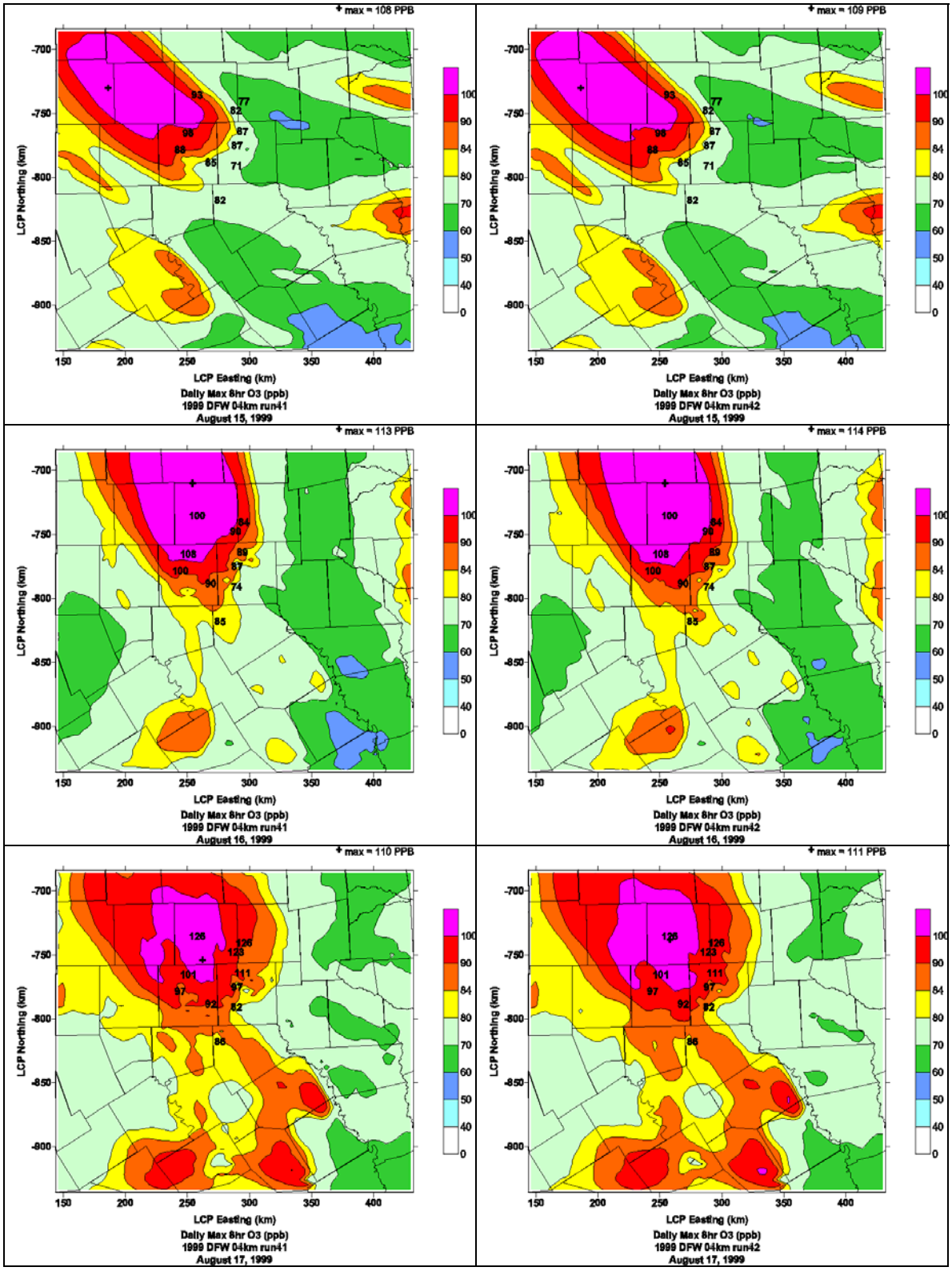


Figure 2–8. Spatial plots of each date's maximum 8-hour ozone in the DFW 4 km domain from Run 41 (left) and Run 42 (right).

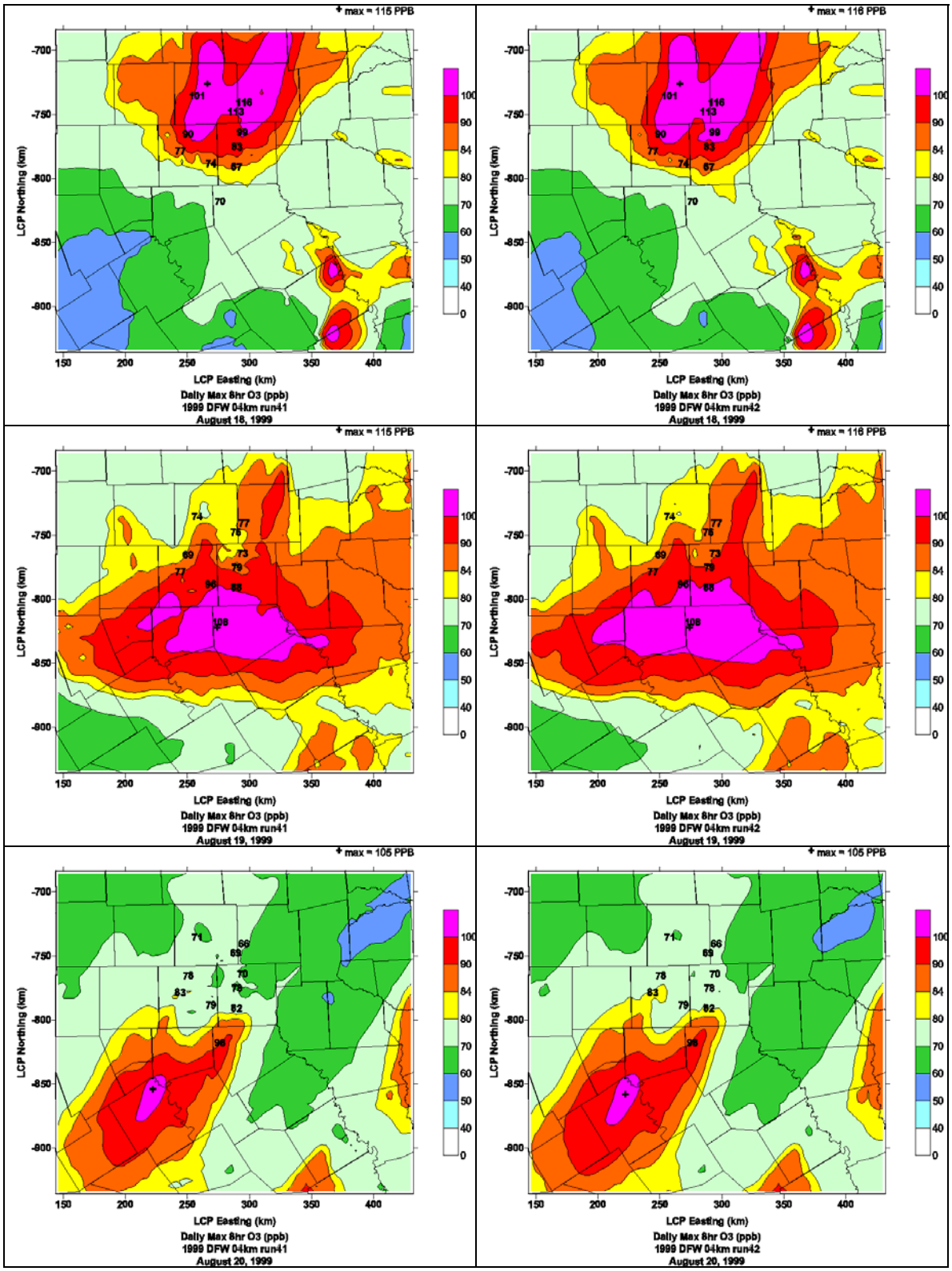
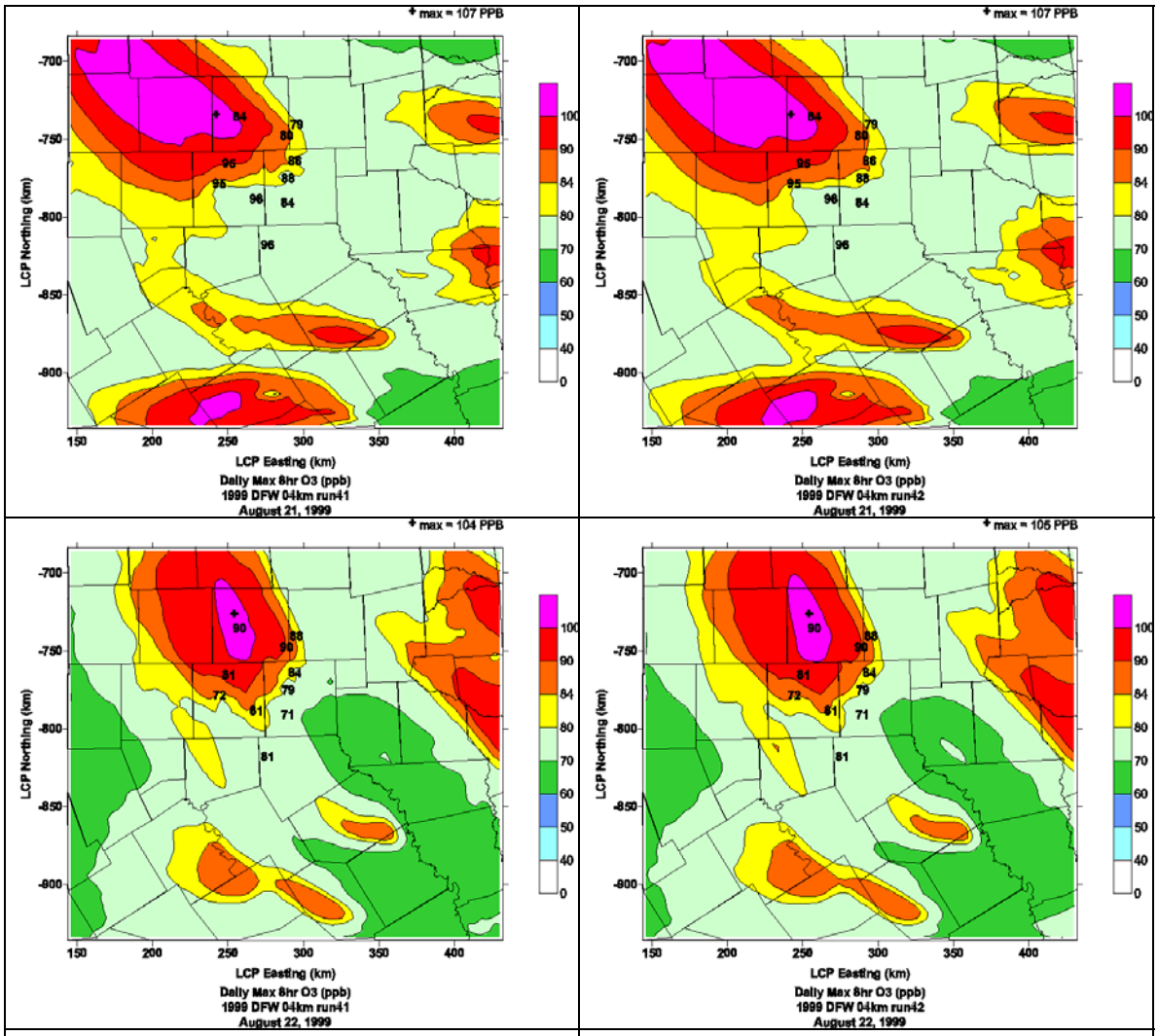
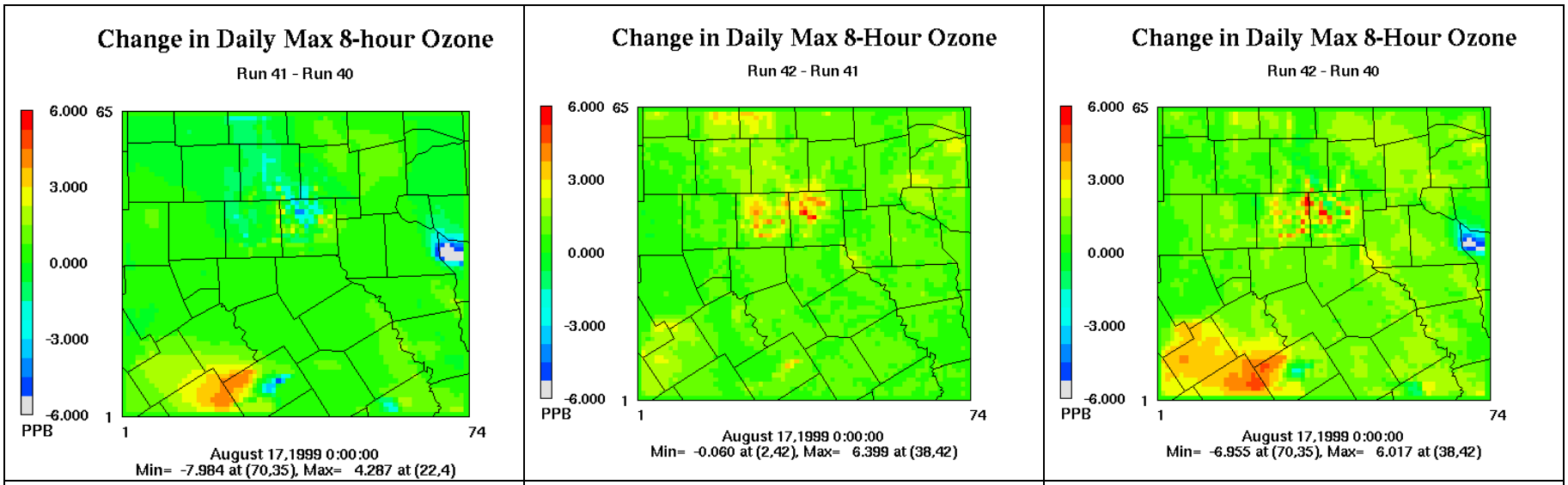


Figure 2–8 (continued). Spatial plots of each date's maximum 8-hour ozone in the DFW 4 km domain from Run 41 (left) and Run 42 (right).



Run 41	Run 42

Figure 2–8 (concluded). Spatial plots of each date's maximum 8-hour ozone in the DFW 4 km domain from Run 41 (left) and Run 42 (right).



Run 41 – Run 40 Impacts from updated emissions	Run 42 – Run 41 Impacts from kvpatch	Run 42 – Run 40 Impacts from emissions and kvpatch

Figure 2–9. Spatial plots of the difference in daily maximum 8-hour ozone in the DFW 4 km domain on August 17, 1999.

2.2 DFW 1999 BASELINE AND BASE CASE (RUNS 44 AND 45)

New CAMx base case (Run 45) and baseline (Run 44) runs were performed for the Dallas Fort Worth August 13-22, 1999 episode. Both runs were identical to the Run 42 base case configuration with the corrected "kv100" vertical diffusivity patch, but with emission updates. The difference between base case and baseline emissions is that the base case includes date specific information (e.g. point source CEM data) whereas the baseline represents seasonal average conditions. The base case should provide the most accurate model performance evaluation, whereas the baseline is more consistent with future year inventory methods.

Run 45 Base Case Emissions

Tables 2–3 and 2–4 show the updated base case emissions on Tuesday, August 17, 1999 for NOx and VOC, respectively, by emission group (biogenics, on-road mobile, elevated points, low-level points, area, off-road, and other sources (offshore and Canada) and by source region, as defined in Figure 2–1 for the 36 km expanded domain. The right side of the tables compares the latest base case emissions to those used in the previous base case, Run 42, on August 17. Differences greater than 10 tpd were highlighted in red; differences less than –10 tpd were highlighted in blue.

Run 45 incorporated new area, off-road, and on-road mobile emissions of Texas, which were provided by TCEQ in December 2005. Point sources in Texas and biogenics were unchanged. The on-road mobile and offshore emissions had already been updated for Run 42; thus, no difference was shown in Tables 2–3 and 2–4. The latest area source emissions within Texas were reduced 89 tpd NOx (-17 %) and 643 tpd VOC (-41 %) compared to the Run 42 emissions on August 17. West Texas accounted for most of the area source NOx reductions within Texas. Area source VOC emissions were lower in all regions of Texas except Houston. Off-road emissions were lower in most of Texas, decreasing 291 tpd NOx (-29%) and 140 tpd VOC (-30%) within the state.

Outside of Texas, most states inside the standard 36 km domain received area, off-road, and point source updates replacing data from NEI99 version 2 by version 3. Elevated point source emissions from both NEI99 datasets on August 17, 1999 were compared to the 1999 annual statewide point source NOx summaries obtained from the EPA (downloaded at ftp://ftp.epa.gov/pub/EmisInventory/nei_criteria_summaries/1999criteriasummaryfiles/1999facilitysummarymade08102005.zip). A spot check of three states shown in Table 2–5 revealed that the NEI99 version 2 elevated point source NOx emissions were significantly higher than the EPA annual average, especially in Kentucky and Tennessee, while version 3 appeared more reasonable. Thus, all data based on NEI99 version 2 was replaced with NEI99 version 3.

The NEI99 documentation reports that changes between versions 2 and 3 were in response to State's review of and comments on Version 2. Emissions outside of Texas that were not based on NEI data were unchanged. These included a select group of off-road emissions (aircraft, commercial marine, and railroads) in Oklahoma and date-specific point source emissions in Louisiana and Oklahoma. Emissions outside the standard 36 km domain were already based on NEI99 version 3 data and show no changes in Tables 2–3 and 2–4.

The use of NEI99 version 3 data reduced elevated point source emissions outside of Texas by over 4000 tpd NOx (-18 %) and 200 tpd VOC (-18 %). The elevated point emissions were lower in all source regions except Mississippi (NOx and VOC) and Georgia (VOC only). Low-level point emissions were lower in most source regions except for VOCs in Georgia and NOx in Oklahoma, which offset the NOx reduction from the elevated point sources. Non-Texas low point NOx was 659 tpd lower (-23 %) and VOC was 463 tpd lower (-14 %).

Non-Texas area source emissions were 236 tpd NOx (-10%) and 2245 tpd VOC (-17%) lower. Area source emissions were lower in all regions outside of Texas except NOx in Oklahoma and Alabama. Off-road emissions did not change significantly as NOx and VOC emissions outside of Texas changed +1 % and –2 %, respectively.

Domain-wide, the anthropogenic NOx and VOC emissions were 8 % and 10 % lower, respectively. Changes in anthropogenic NOx in Texas (-7 %) were comparable to the domain-wide change. Changes in anthropogenic VOCs in Texas (-24 %) were much larger than the domain average.

Run 45 Base Case Results

Figures 2–10 and 2–11 show spatial plots of the daily maximum 8-hour base case ozone from Run 45 on the left, and differences in the daily maximum 8-hour ozone from the previous base case (run42) on the right for each date in the 4 km and 12 km domains, respectively. Figure 2–12 shows time series plots of 1-hour ozone at the 10 DFW monitoring sites. Figures 2–13 and 2-14 compare daily model performance statistics between Runs 42 and 45 for 1-hour and 8-hour ozone, respectively. The 8-hour ozone statistics are shown in a soccer goal plot in Figure 2–15.

Main findings:

- The daily maximum 8-hour base case ozone in the DFW 9-county NAA was almost always lower in Run 45 compared to Run 42. August 17 showed the least change while August 22 showed the greatest decrease, as the daily maximum ozone in DFW was up to 8 ppb lower in Run 45.
- 8-hour ozone in most of the 4 km domain was lower in Run 45 except in and downwind of Freestone County, where ozone was about the same or higher than Run 42, particularly on August 17 and 18.
- In the 12 km domain, most areas showed lower ozone peaks except in South Texas and along the Gulf of Mexico coast, where differences, some positive and some negative, were generally small.
- Time series and model performance statistics at the 10 DFW monitoring sites confirmed that the ozone peaks in Run 45 were lower than in Run 42.
- Normalized bias was lower on each date for 1-hour and 8-hour ozone. In Run 42, all dates except August 19 fell within the ±15 % EPA performance goal for normalized bias for 8-hour ozone. In Run 45, all dates (excluding the two spin-up dates) achieved this goal.
- Normalized error improved on all dates in Run 45 when the normalized bias was positive. When the normalized bias was negative, the error was worse or about the same

Table 2–3. Base case NOx emissions used in Run 45 by emission group and source region (left), and differences from the previous base case emissions (Run 42) on August 17, 1999 (right).

DFW Base Case NOx Emissions on August 17, 1999 used in Run 45. [tpd]									Change in NOx Emissions: Run 45 – Run 42. [tpd]						
	Bio	Mobile	Elev. Pts	Low Pts	Area	Off-Road	Other	Anthro	Mobile	Elev Pts	Low Pts	Area	Off-Road	Other	Anthro
Collin Co	10	33	5	0	1	13	0	53	0	0	0	0	-9	0	-9
Dallas Co	4	188	61	1	16	61	0	326	0	0	0	2	-17	0	-15
Denton co	8	34	5	0	7	13	0	60	0	0	0	5	-5	0	0
Tarrant Co	3	110	39	0	9	39	0	197	0	0	0	2	-9	0	-7
Parker Co	1	15	2	0	1	2	0	21	0	0	0	-9	-3	0	-12
Johnson Co	5	12	6	0	0	6	0	24	0	0	0	0	-1	0	-1
Ellis Co	15	23	30	0	0	9	0	62	0	0	0	0	1	0	1
Kaufman Co	5	18	0	1	0	3	0	22	0	0	0	0	-2	0	-2
Rockwall Co	2	5	0	0	0	2	0	7	0	0	0	0	1	0	1
DFW 9-County	**52**	**438**	**148**	**2**	**34**	**148**	**0**	**771**	**0**	**0**	**0**	**1**	**-45**	**0**	**-44**
DFW 16 County	**83**	**494**	**220**	**4**	**53**	**166**	**0**	**936**	**0**	**0**	**0**	**-16**	**-57**	**0**	**-73**
NE Texas	16	151	331	7	58	49	0	596	0	0	0	-7	-29	0	-36
Central TX	113	185	332	1	45	75	0	638	0	0	0	17	-47	0	-30
Houston	21	386	683	21	45	167	0	1302	0	0	0	15	-53	0	-38
South TX	229	386	446	12	62	121	0	1026	0	0	0	-2	-72	0	-74
West TX	524	282	269	11	173	120	0	856	0	0	0	-96	-32	0	-129
Texas	**986**	**1884**	**2281**	**56**	**435**	**698**	**1**	**5354**	**0**	**0**	**0**	**-89**	**-291**	**0**	**-380**
Gulf + Mexico	79	20	200	2	6	23	413	663	0	0	0	1	-2	0	-1
Oklahoma	227	369	418	248	94	327	0	1456	0	-202	198	18	6	0	20
Louisiana	106	375	1097	76	253	692	17	2509	0	0	0	-75	7	0	-67
Arkansas	125	280	289	23	90	224	0	906	0	-123	-14	-24	7	0	-153
Mississippi	121	348	456	36	10	240	1	1091	0	217	-228	1	5	0	-4
Alabama	75	455	825	31	62	508	0	1881	0	-14	-1	26	4	0	14
Tennessee	118	574	771	17	57	282	0	1702	0	-492	6	-12	6	0	-492
Kentucky	145	450	1094	102	183	264	0	2093	0	-595	-388	-48	6	0	-1026
Georgia	110	837	793	14	68	284	0	1996	0	-404	-10	-15	6	0	-423
Florida	56	1267	1819	13	81	449	0	3630	0	-304	0	0	1	0	-304
Mid Atlantic	293	2183	2941	241	226	906	0	6498	0	-346	-5	-1	2	0	-350
NE US	314	4362	2347	415	397	2001	1461	10983	0	0	0	0	0	0	0
Northern Plains	5238	6049	6300	928	676	4892	82	18927	0	-1910	-217	-106	65	-1	-2168
Total	**7992**	**19452**	**21631**	**2204**	**2639**	**11790**	**1974**	**59691**	**0**	**-4173**	**-659**	**-325**	**-177**	**-1**	**-5334**
% Change (all)									0%	-16%	-23%	-11%	-1%	0%	-8%
% Change (TX)									0%	0%	0%	-17%	-29%		-7%
% Change (no TX)									0%	-18%	-23%	-10%	1%	0%	-8%

Table 2–4. Base case VOC emissions used in Run 45 by emission group and source region (left), and differences from the previous base case emissions (Run 42) on August 17, 1999 (right).

DFW Base Case VOC Emissions on August 17, 1999 used in Run 45. [tpd]									Change in VOC Emissions: Run 45 – Run 42. [tpd]						
	Bio	**Mobile**	**Elev. Pts**	**Low Pts**	**Area**	**Off-Road**	**Other**	**Anthro**	**Mobile**	**Elev Pts**	**Low Pts**	**Area**	**Off-Road**	**Other**	**Anthro**
Collin Co	27	12	0	1	11	6	0	31	0	0	0	0	-6	0	-6
Dallas Co	50	77	5	7	66	27	0	182	0	0	0	-1	-29	0	-30
Denton co	65	13	1	1	12	5	0	33	0	0	0	-1	-3	0	-4
Tarrant Co	64	44	5	8	46	14	0	116	0	0	0	-3	-12	0	-16
Parker Co	121	4	0	0	5	1	0	11	0	0	0	-5	0	0	-5
Johnson Co	111	4	0	0	6	1	0	12	0	0	0	-1	-1	0	-2
Ellis Co	89	5	4	2	6	2	0	20	0	0	0	-2	0	0	-2
Kaufman Co	112	6	0	1	7	1	0	14	0	0	0	-3	0	0	-3
Rockwall Co	3	2	0	0	2	2	0	5	0	0	0	-1	0	0	0
DFW 9-County	**642**	**167**	**16**	**20**	**160**	**60**	**0**	**423**	**0**	**0**	**0**	**-18**	**-51**	**0**	**-69**
DFW 16 County	**1538**	**189**	**17**	**22**	**191**	**70**	**0**	**489**	**0**	**0**	**0**	**-54**	**-51**	**0**	**-105**
NE Texas	4917	60	19	31	71	21	0	202	0	0	0	-78	-3	0	-81
Central TX	6098	67	26	14	75	29	1	211	0	0	0	-76	-3	0	-79
Houston	1683	159	70	183	220	71	0	702	0	0	0	48	-56	0	-7
South Tx	2069	164	25	39	191	69	0	489	0	0	0	-148	-24	0	-172
West Tx	6198	109	13	24	188	64	1	399	0	0	0	-335	-3	0	-338
Texas	**22503**	**747**	**170**	**314**	**934**	**324**	**3**	**2492**	**0**	**0**	**0**	**-643**	**-140**	**0**	**-783**
Gulf + Mexico	658	16	21	2	27	56	154	276	0	-13	0	-3	-1	-9	-28
Oklahoma	7940	247	2	68	253	92	1	662	0	-29	2	-69	-8	0	-104
Louisiana	9941	216	71	165	245	137	5	839	0	0	0	-177	-16	1	-193
Arkansas	13925	166	34	35	227	78	1	541	0	-26	-10	-163	-9	0	-208
Mississippi	14818	188	30	112	253	79	1	663	0	28	-68	-178	-9	0	-227
Alabama	13954	314	53	114	371	124	0	976	0	-16	-18	-114	-14	0	-161
Tennessee	8678	351	78	135	422	130	0	1117	0	-59	-24	-290	-13	0	-386
Kentucky	3753	273	49	101	271	94	0	788	0	-18	-117	-174	-9	0	-317
Georgia	12198	491	175	368	411	180	0	1625	0	116	325	-81	-9	0	351
Florida	9793	886	73	100	646	476	0	2182	0	-155	-6	-38	-5	0	-204
Mid Atlantic	31294	1405	106	431	1328	580	2	3852	0	-7	-5	-24	-2	0	-38
NE US	20472	2735	75	260	2848	1507	1327	8753	0	0	0	0	0	0	0
Northern Plains	40144	3826	235	882	3995	2015	83	11035	0	-42	-541	-936	-42	0	-1560
Total	**210073**	**11860**	**1172**	**3086**	**12232**	**5873**	**1578**	**35802**	**0**	**-222**	**-463**	**-2888**	**-277**	**-8**	**-3858**
% Change (all)									0	-16%	-13%	-19%	-4%	0%	-10%
% Change (TX)									0%	0%	0%	-41%	-30%		-24%
Change (no TX)									0%	-18%	-14%	-17%	-2%	-1%	-8%

Table 2–5. A comparison of elevated point source NOx emissions on August 17, 1999.

State	EPA Annual Summary (tpd)	NEI99 version 2 (tpd)	NEI99 version 3 (tpd)
Alabama	791	839	825
Kentucky	986	1690	1094
Tennessee	744	1263	771

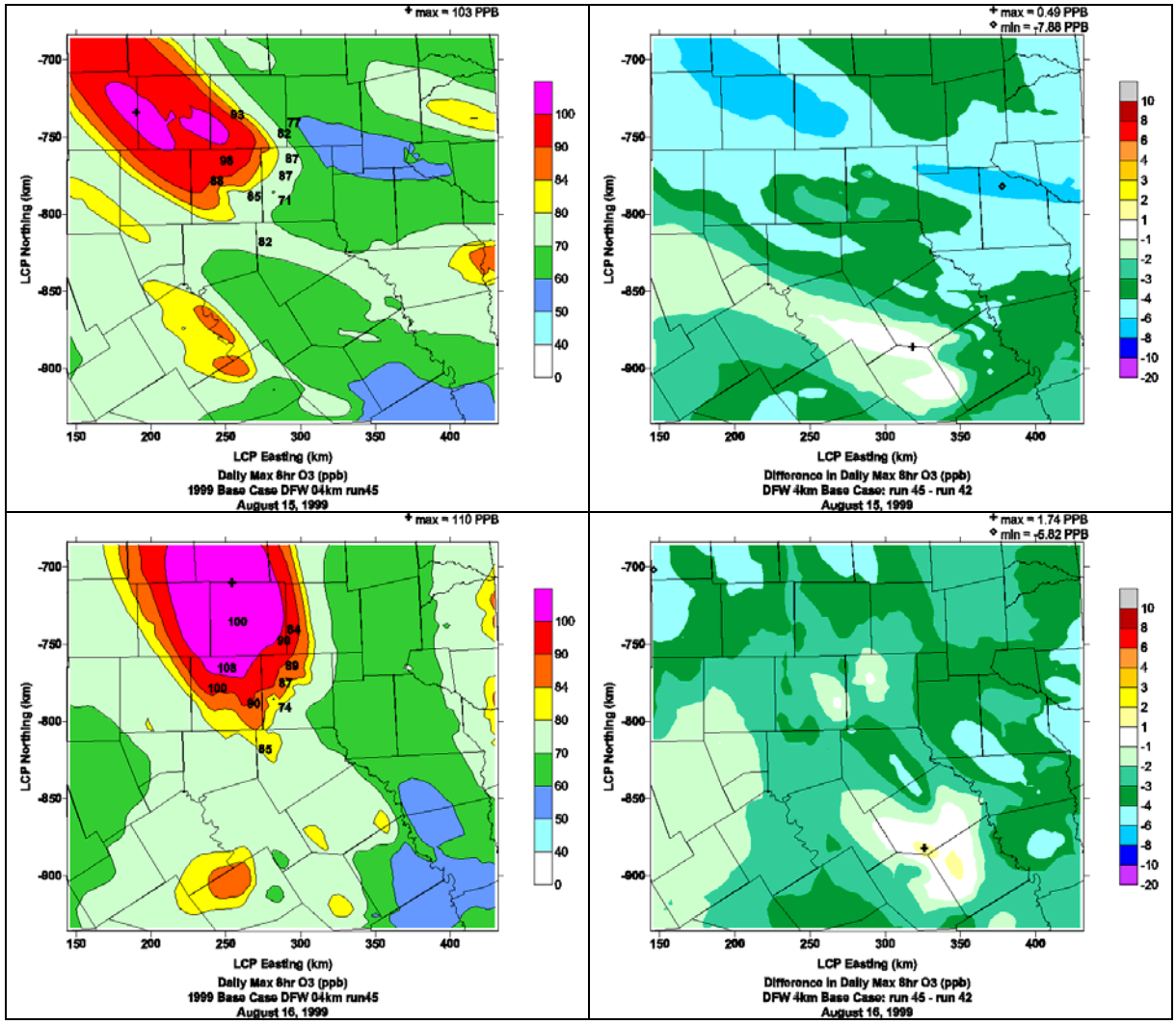


Figure 2–10. Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 4 km domain (left), and differences from the previous base case (Run 42, right).

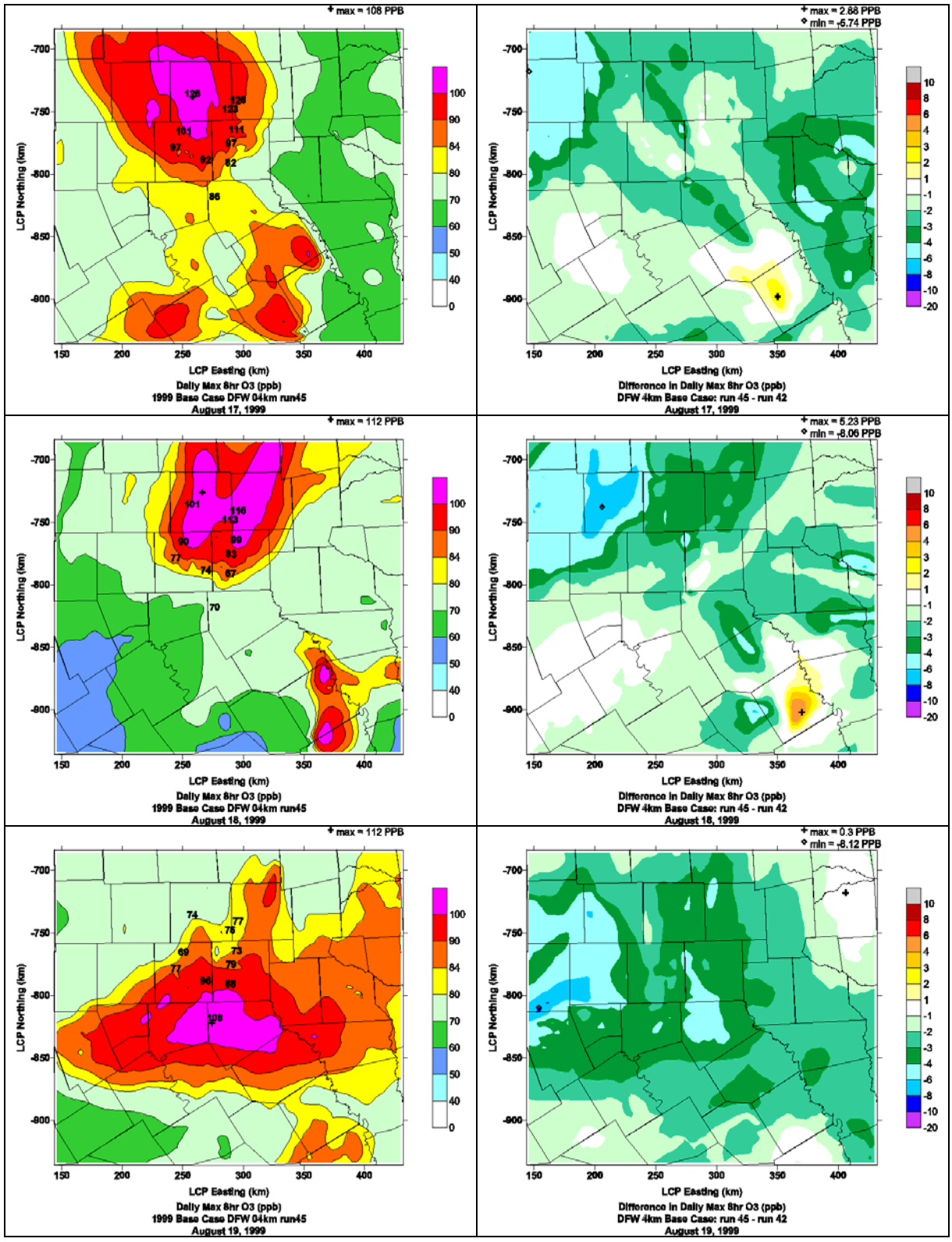
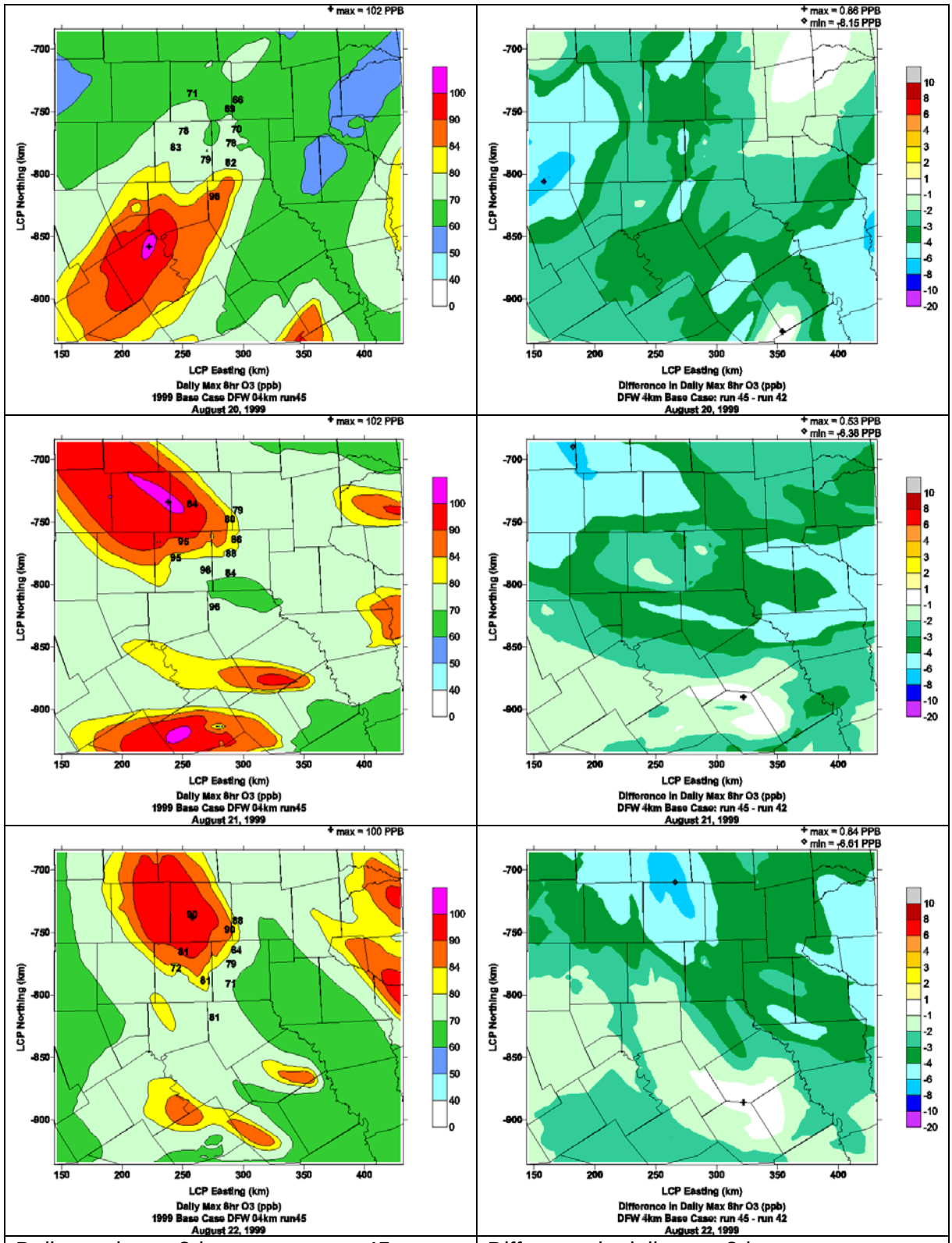


Figure 2–10. (continued). Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 4 km domain (left), and differences from the previous base case (Run 42, right).



Daily maximum 8-hour ozone, run 45	Difference in daily max 8-hour ozone, Run 45 – Run 42

Figure 2–10. (concluded). Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 4 km domain (left), and differences from the previous base case (Run 42, right).

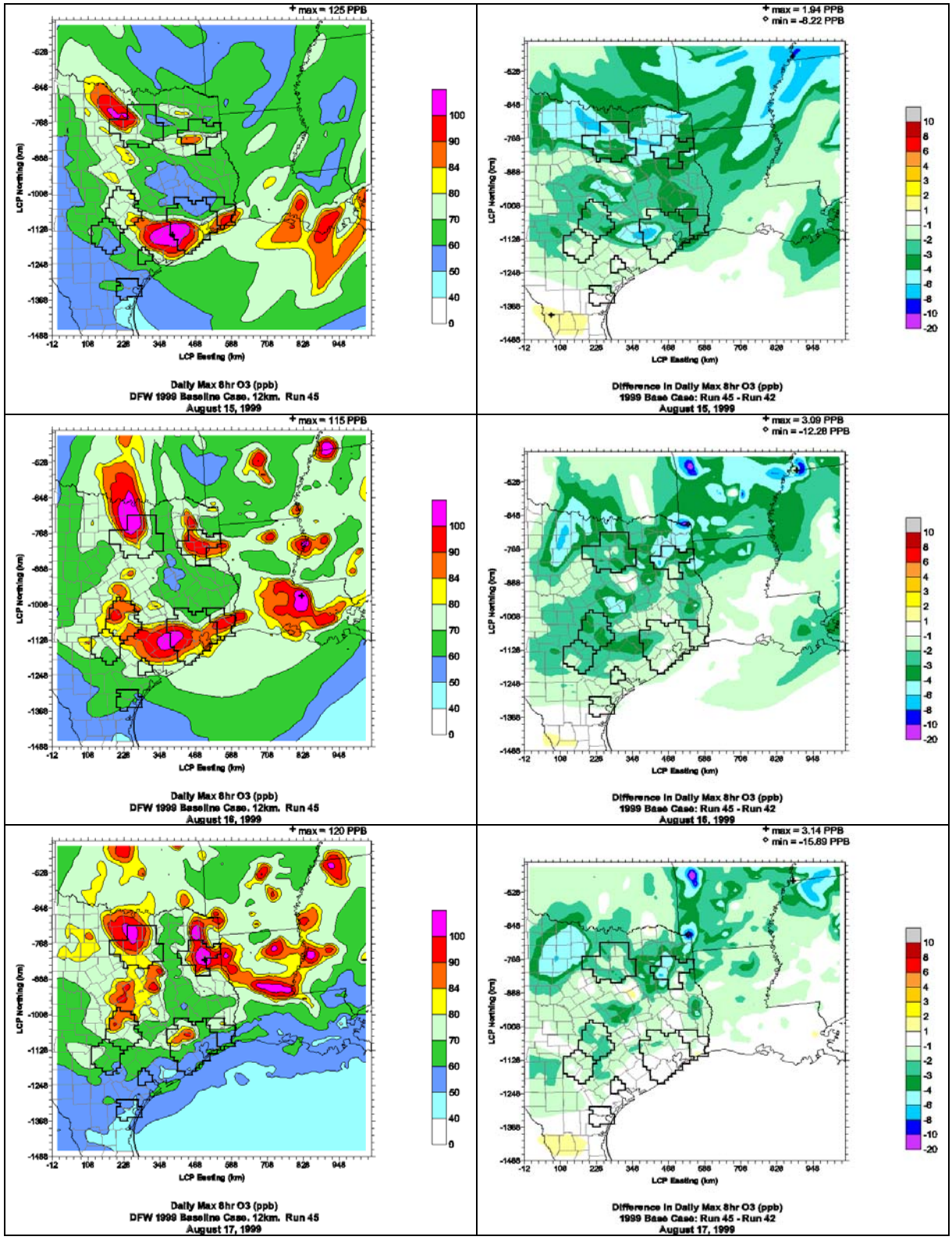


Figure 2–11. Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 12 km domain (left), and differences from the previous base case (Run 42, right).

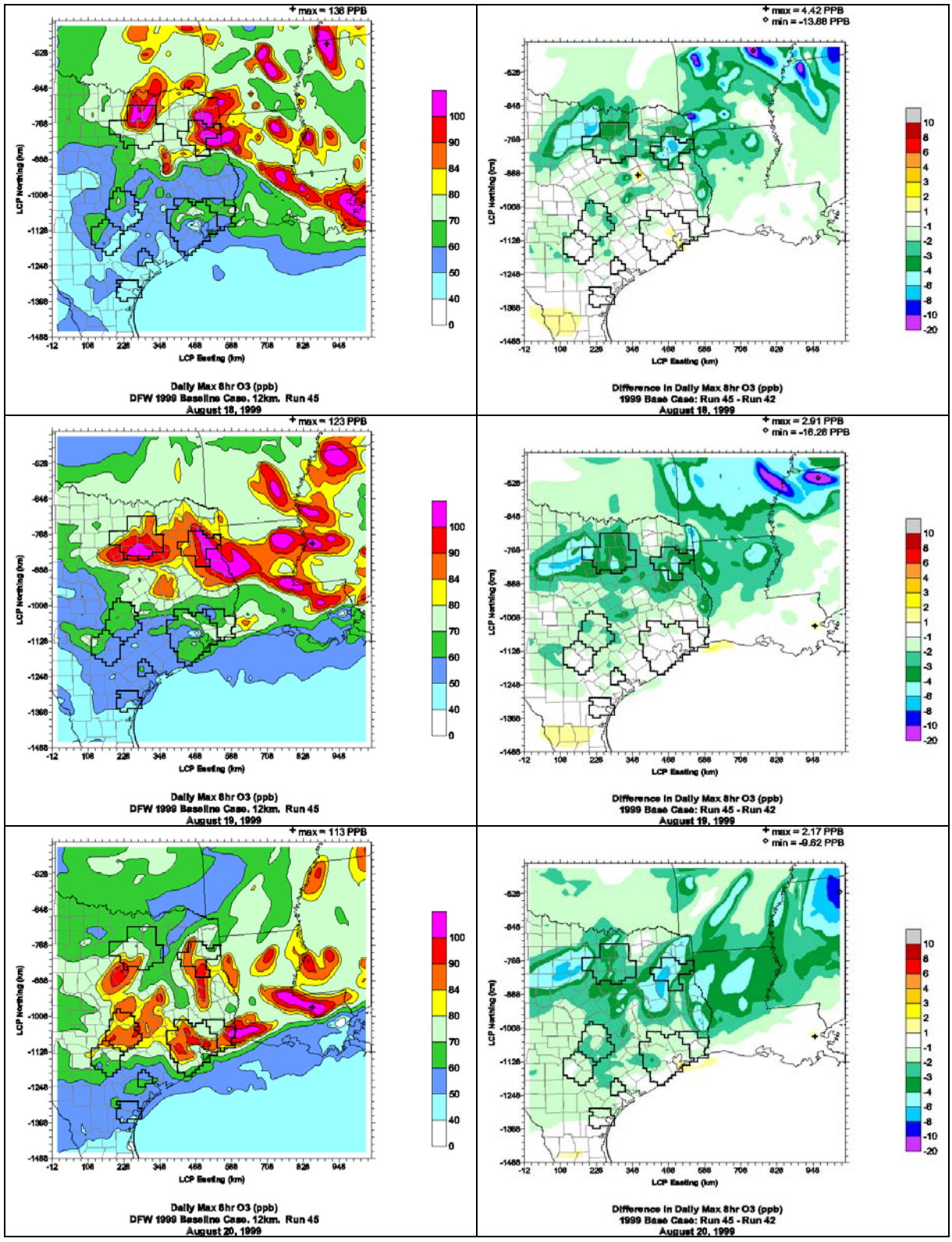


Figure 2–11. (continued). Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 12 km domain (left), and differences from the previous base case (Run 42, right).

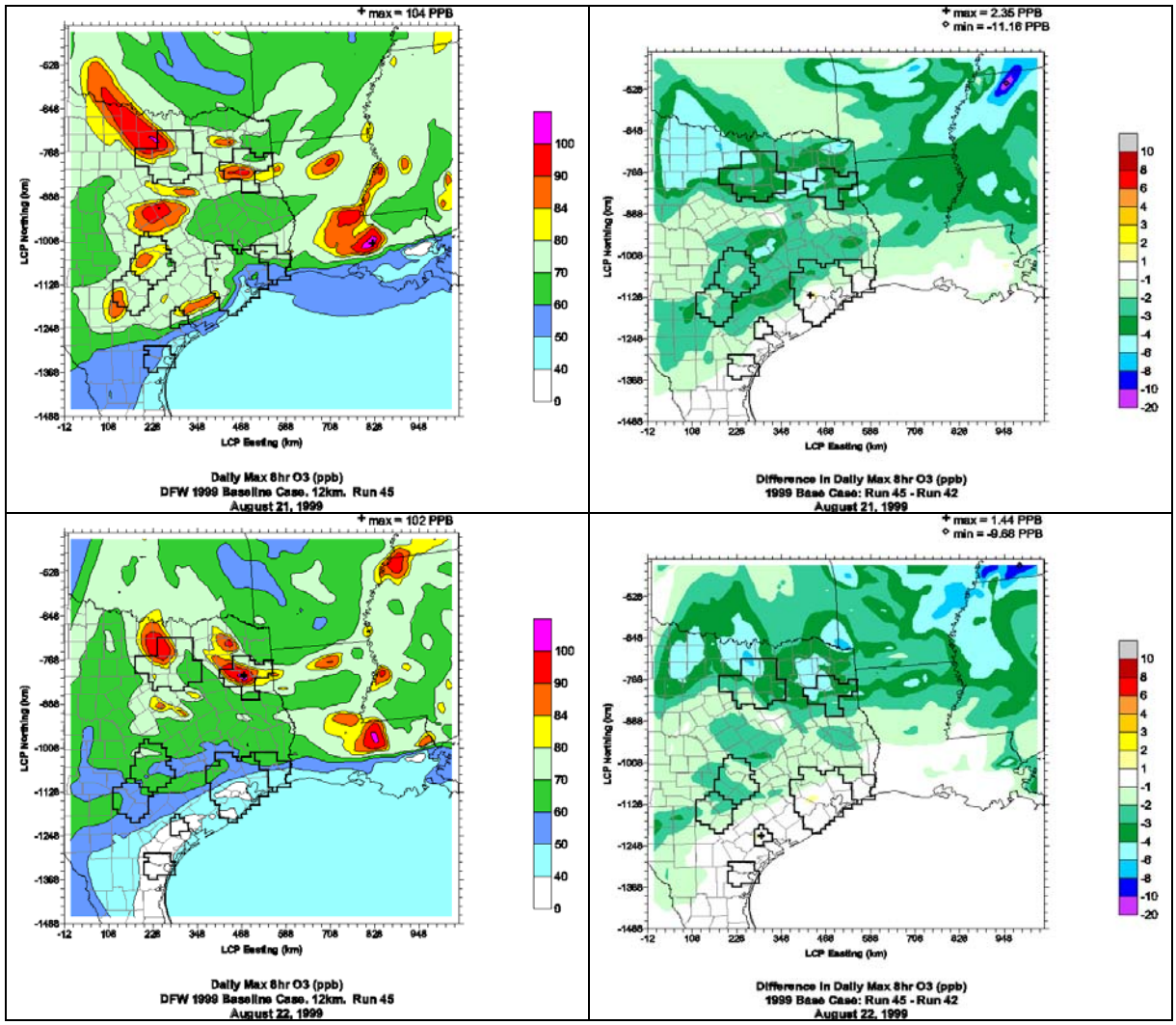


Figure 2–11. (concluded). Spatial plots of the daily maximum 8-hour base case ozone (Run 45) in the 12 km domain (left), and differences from the previous base case (Run 42, right).

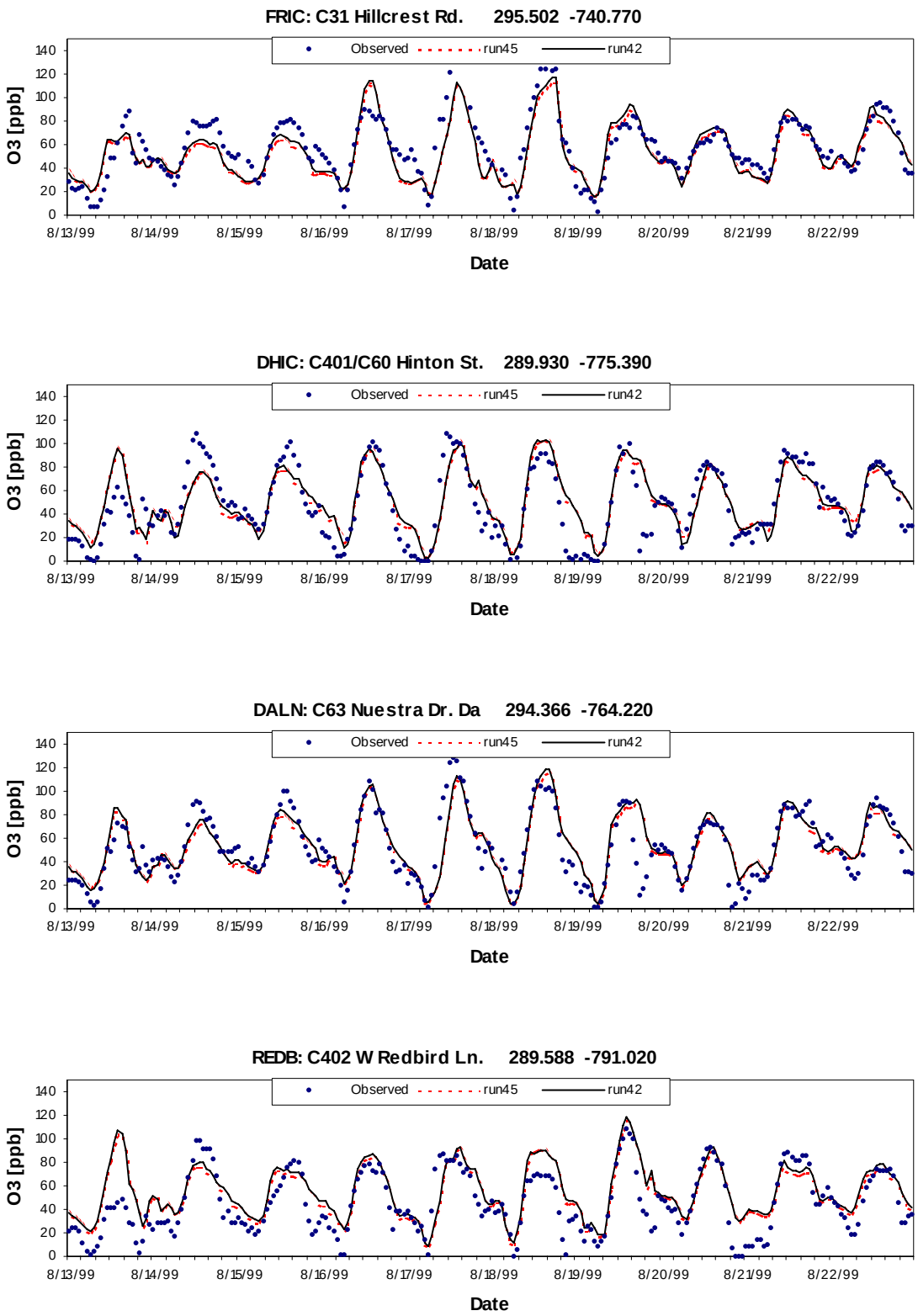


Figure 2–12. Time series of 1-hour ozone for Run 42 (previous base case), Run 45 (current base case), and Run 44 (current baseline).

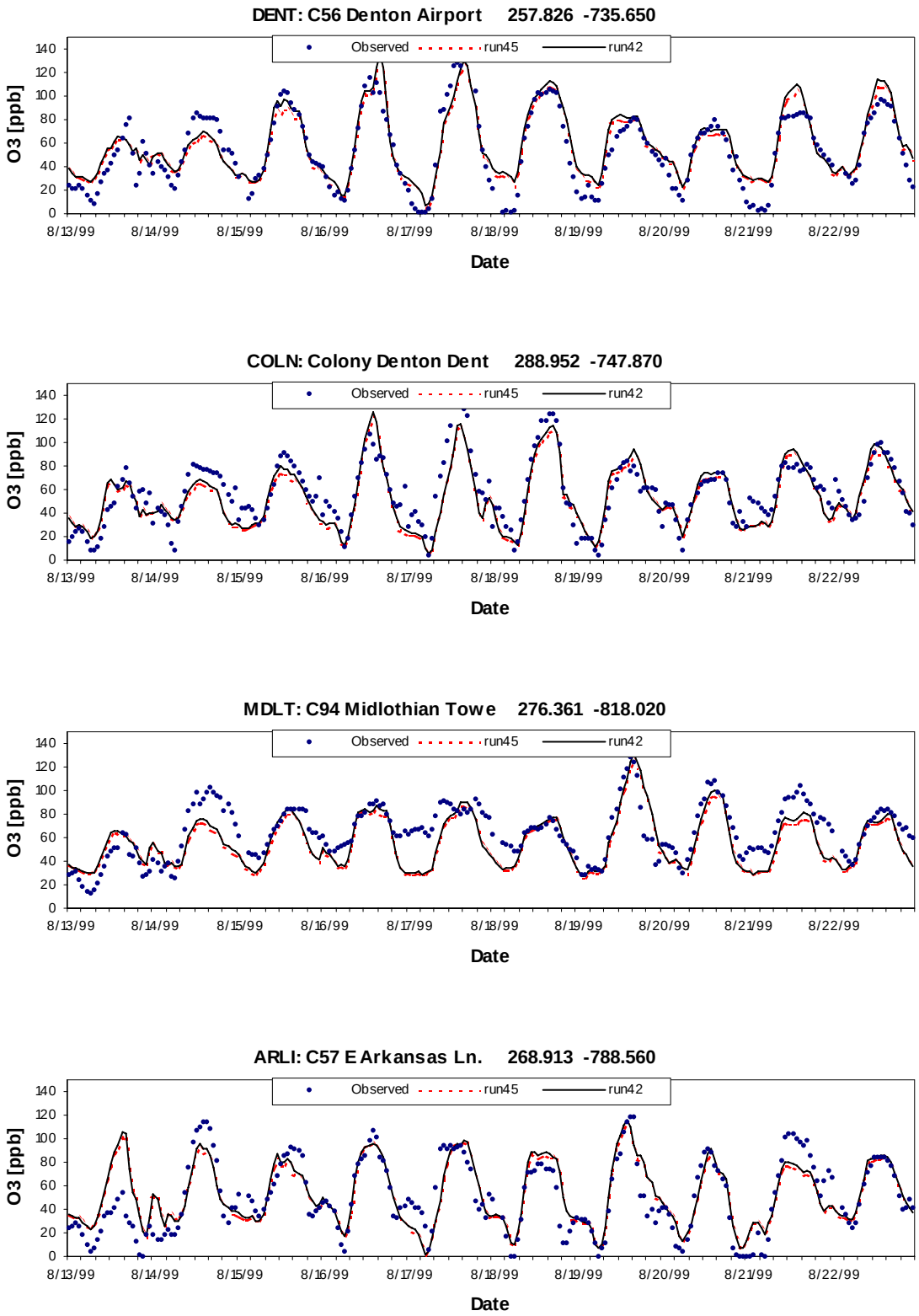
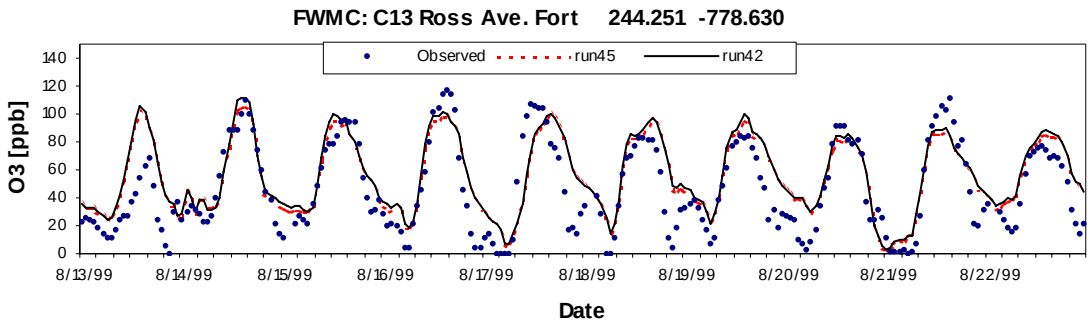


Figure 2–12. (continued). Time series of 1-hour ozone for Run 42 (previous base case), Run 45 (current base case), and Run 44 (current baseline).



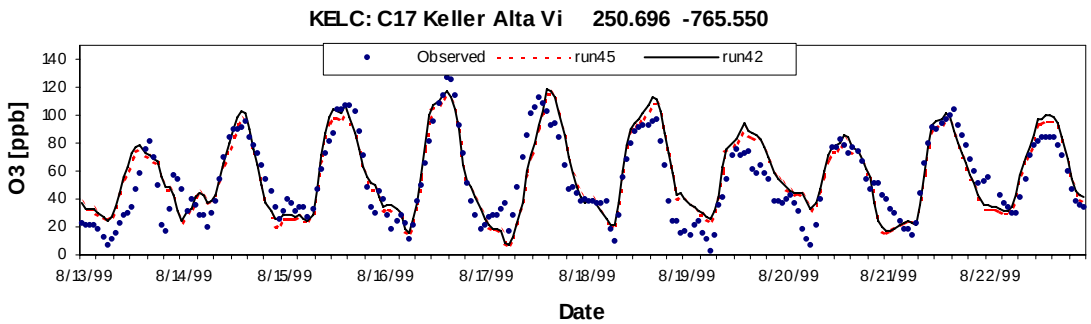


Figure 2–12. (concluded). Time series of 1-hour ozone for Run 42 (previous base case), Run 45 (current base case), and Run 44 (current baseline).

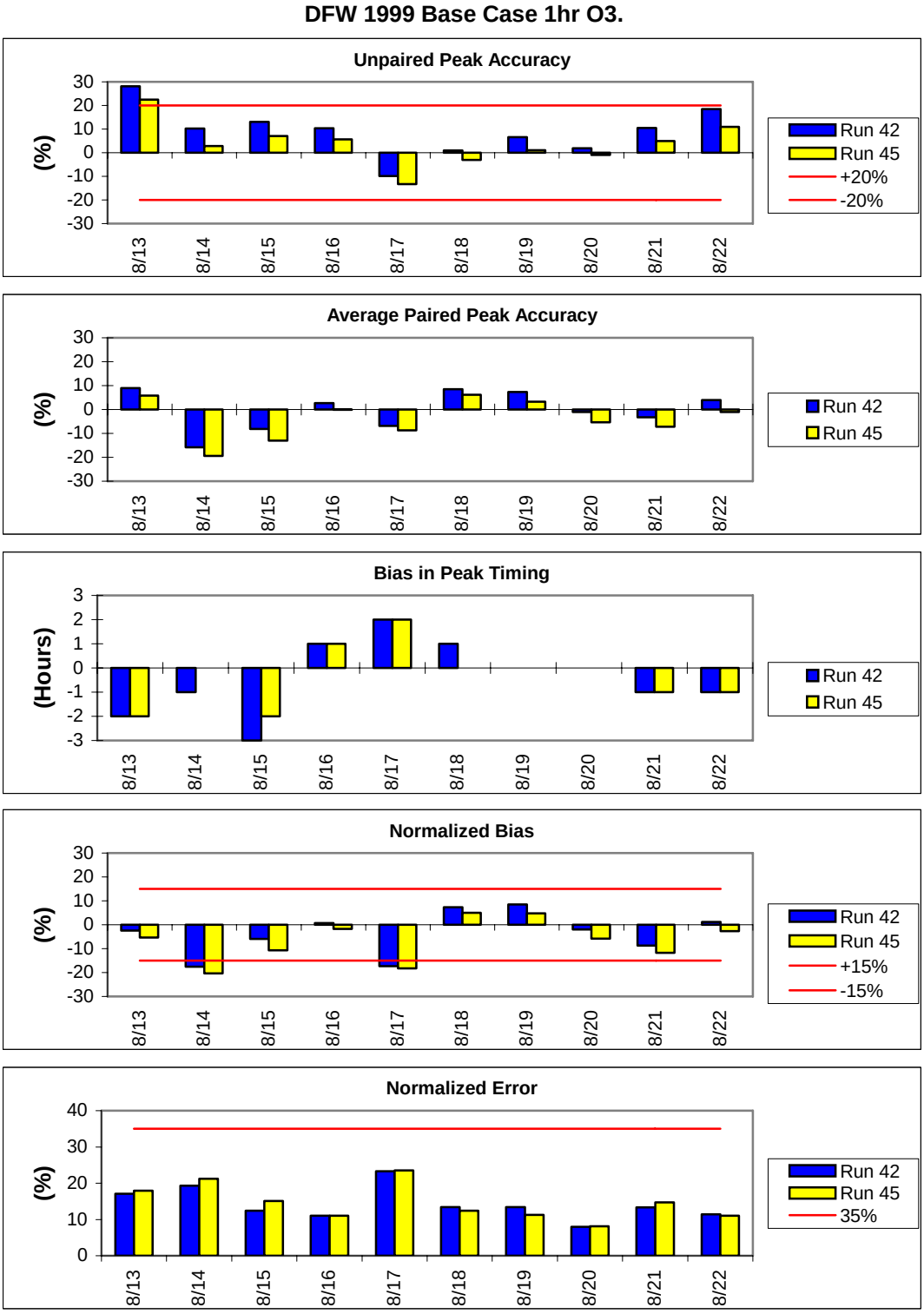


Figure 2–13. Model performance statistics for 1-hour ozone in DFW.

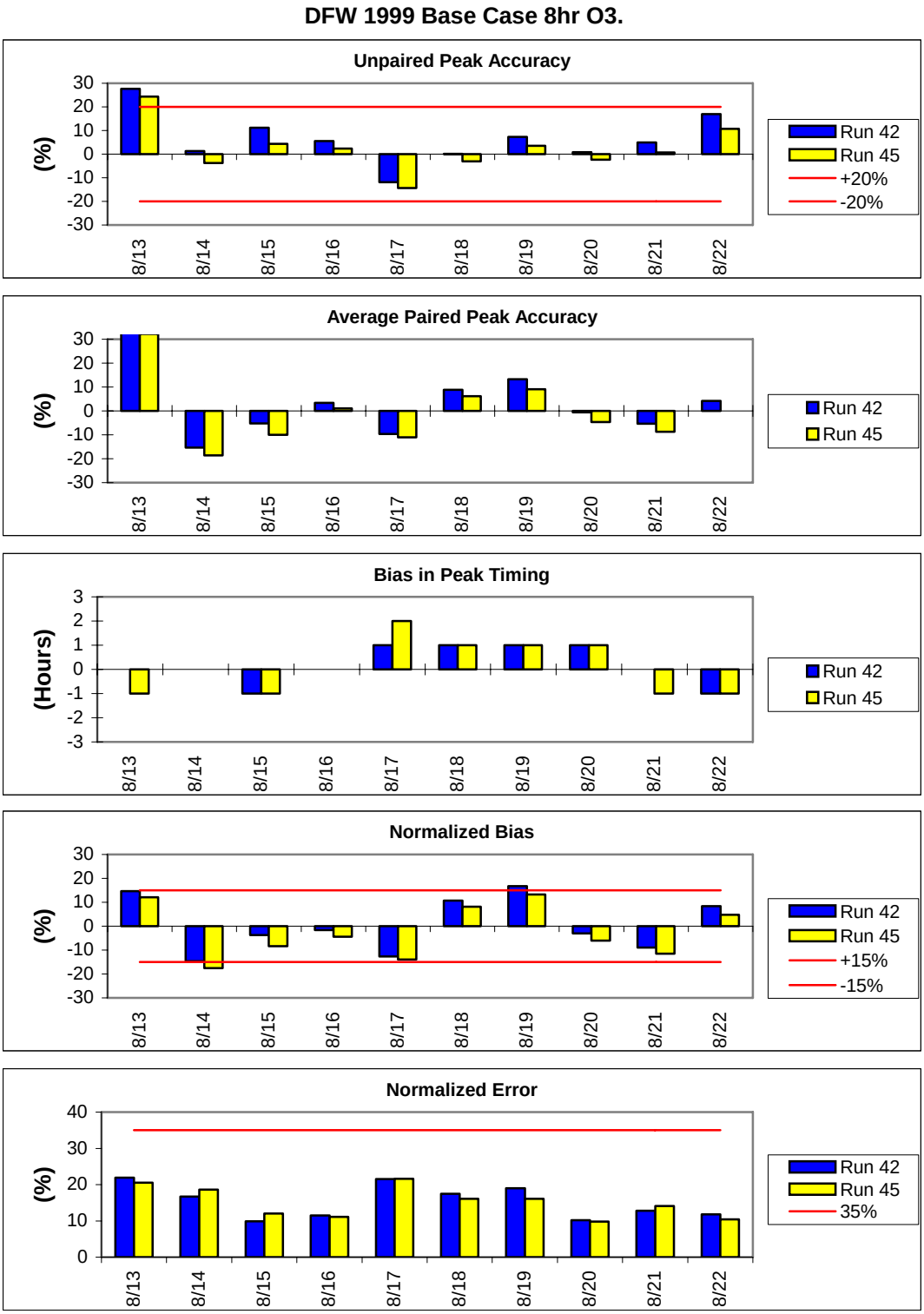


Figure 2–14. Model performance statistics for 8-hour ozone in DFW.

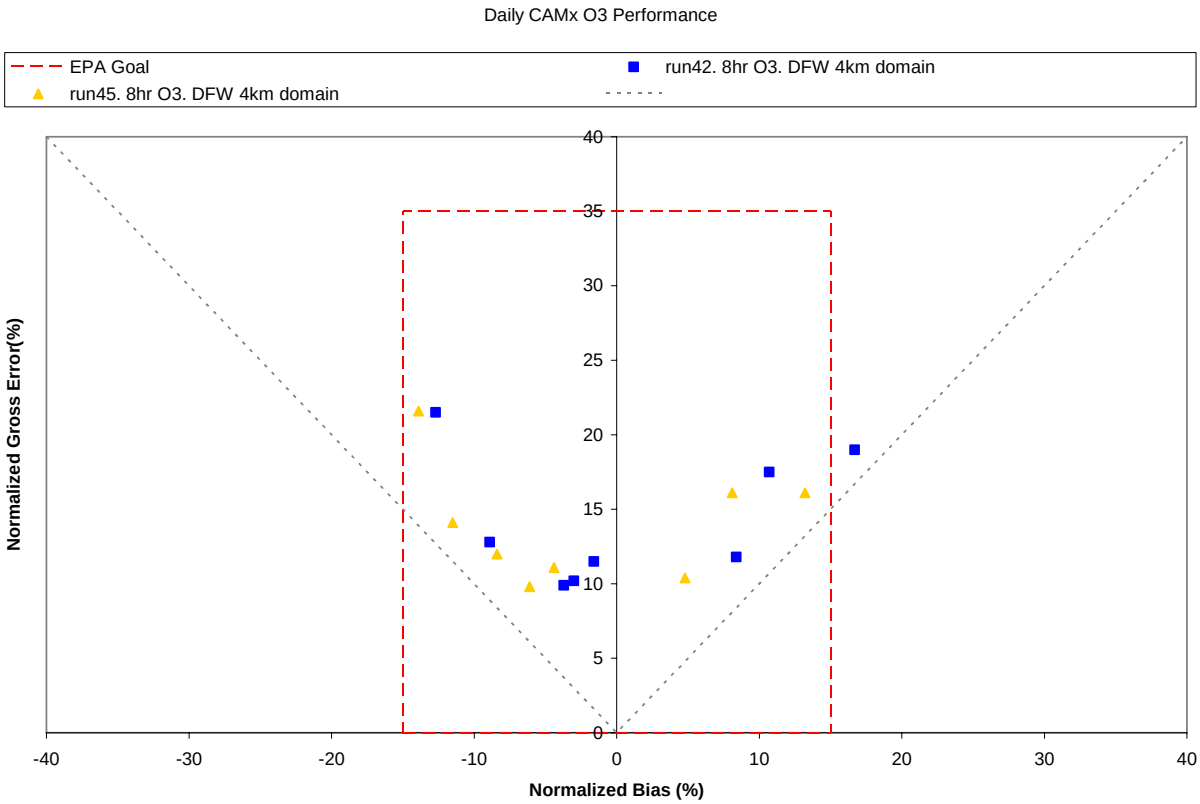


Figure 2–15. Soccer goal plot of 8-hour ozone model performance statistics.

Run 44 Baseline Emissions

The DFW 1999 baseline emissions were almost identical to the Run 45 base case emissions. The only differences were in the on-road mobile and point sources. Tables 2–6 and 2–7 display the baseline NOx and VOC weekday emissions, respectively, by source region and emission group. Differences from the Run 45 base case emissions on Tuesday, August 17, 1999 are also provided. Values in red and blue represent baseline emissions that were at least 1 tpd greater and less than the base case, respectively.

All on-road mobile differences were inside the 4 km domain, where date-specific emissions were averaged together by day of the week (Friday, Saturday, Sunday, and weekday). The weekday baseline mobile NOx emissions were 9 tpd less than the August 17 base case emissions; on-road VOCs had little change.

Point sources differed inside of Texas because the baseline incorporated a 32-day average (August 15-September 15, 1999) of hourly EGU emissions in Texas, which were provided by TCEQ, while the base case used date-specific emissions. This resulted in a reduction of 16 tpd NOx and 1 tpd VOC from elevated point sources in the DFW 9-county NAA in the baseline compared to the August 17 base case. Texas as a whole emitted 16 tpd NOx more from elevated point sources in the baseline due to greater NOx emissions in the Houston region. Low-level point sources were unchanged.

Oklahoma and Louisiana low and elevated point sources differed because the date-specific

emissions in the base case were replaced with NEI99 version 3 data. Weekday baseline NOx emissions from Oklahoma and Louisiana elevated point sources combined were 262 tpd lower than the August 17 base case emissions, while low level point source NOx were 27 tpd higher. A spatial plot of the elevated point source NOx differences between the weekday baseline and August 17 base case emissions is shown in Figure 2–16. All points within a 12 km by 12 km grid cell were aggregated together to prepare Figure 2–16. All differences shown were at least ±2 tpd NOx.

Run 44 Baseline Results

Plots of the daily maximum 8-hour baseline ozone are displayed in Figures 2–17 and 2–18 for the 4 km and 12 km domains, respectively. These figures also show the differences from the Run 45 base case daily maximum ozone. Figure 2–19 displays the 1-hour ozone time series charts at each of the 10 DFW monitoring sites, and Figures 2–20 and 2–21 show performance statistics for 1 and 8-hour ozone, respectively.

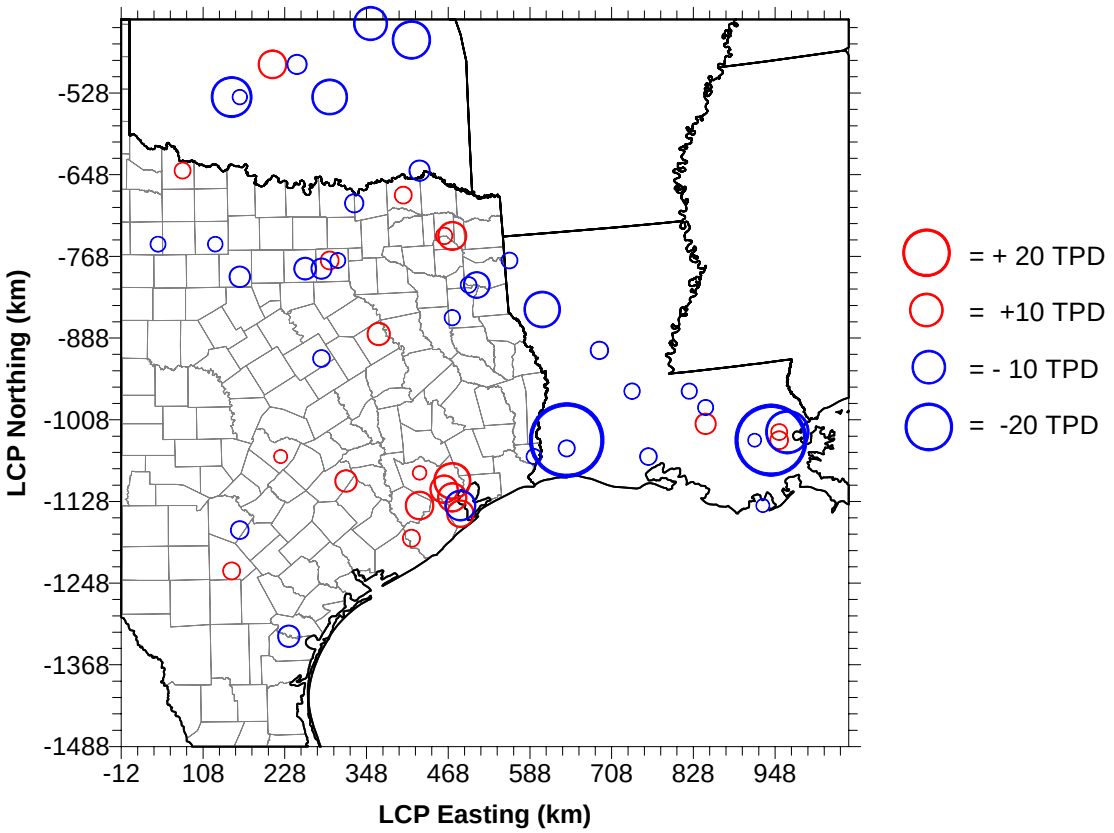
- All detectable differences between the baseline and base case were inside Texas, Louisiana, and Oklahoma, where the emissions differences occured.
- Most differences were local with the difference plume extending only a short distance downwind. Most originated from areas where the elevated point source NOx emissions differed.
- In the 4 km domain, the area of higher 8-hour ozone originating near Freestone County in Run 45 was further enhanced in the baseline, particularly on August 15 and 16. This appears to be due to a 6 tpd NOx increase in the weekday baseline NOx emissions from elevated point sources in Freestone County compared to the base case on August 17, as indicated by the red circle in Freestone County in Figure 2–16. Run 44 transported up to 3 ppb more 8-hour ozone into DFW on August 16 and 17 than Run 45. On other dates, differences in DFW were mostly local.
- The 1-hour ozone time series and performance statistics showed little difference between the baseline and base case, although normalized bias was slightly better in the baseline case on August 16 and 17 due to higher ozone from sources in Freestone County.

Table 2–6. Weekday baseline NOx emissions for each emission group and source region (left), and differences from the Run 45 base case emissions on August 17, 1999 (right).

DFW Baseline NOx Emissions [tpd]. Weekday for August 1999.									Change in NOx from the Run 45 base case emissions [tpd]						
	Bio	Mobile	Elev. Pts	Low Pts	Area	Off-Road	Other	Anthro	Mobile	Elev. Pts	Low Pts	Area	Off-Road	Other	Anthro
Collin Co	10	33	5	0	1	13	0	52	-1	0	0	0	0	0	-1
Dallas Co	4	185	56	1	16	61	0	319	-3	-5	0	0	0	0	-7
Denton co	8	33	4	0	7	13	0	58	-1	-1	0	0	0	0	-2
Tarrant Co	3	107	31	0	9	39	0	185	-3	-9	0	0	0	0	-12
Parker Co	1	15	1	0	1	2	0	19	0	-1	0	0	0	0	-2
Johnson Co	5	11	6	0	0	6	0	24	0	0	0	0	0	0	0
Ellis Co	15	22	30	0	0	9	0	62	0	0	0	0	0	0	0
Kaufman Co	5	18	0	1	0	3	0	21	0	0	0	0	0	0	0
Rockwall Co	2	5	0	0	0	2	0	7	0	0	0	0	0	0	0
DFW 9-County	**52**	**430**	**132**	**2**	**34**	**148**	**0**	**747**	**-9**	**-16**	**0**	**0**	**0**	**0**	**-25**
DFW 16 County	**83**	**485**	**199**	**4**	**53**	**166**	**0**	**907**	**-9**	**-20**	**0**	**0**	**0**	**0**	**-29**
NE Texas	16	151	330	7	58	49	0	594	0	-2	0	0	0	0	-2
Central TX	113	185	333	1	45	75	0	639	0	2	0	0	0	0	2
Houston	21	386	727	21	45	167	0	1346	0	43	0	0	0	0	43
South TX	229	386	438	12	62	121	0	1019	0	-7	0	0	0	0	-7
West TX	524	282	269	11	173	120	0	856	0	0	0	0	0	0	0
Texas	**986**	**1875**	**2296**	**56**	**435**	**698**	**1**	**5361**	**-9**	**16**	**0**	**0**	**0**	**0**	**7**
Gulf + Mexico	79	20	198	2	6	23	413	661	0	-2	0	0	0	0	-2
Oklahoma	227	369	332	253	94	327	0	1375	0	-86	4	0	0	0	-81
Louisiana	106	375	910	99	253	692	17	2345	0	-186	22	0	0	0	-164
Arkansas	125	280	289	23	90	224	0	906	0	0	0	0	0	0	0
Mississippi	121	348	456	36	10	240	1	1091	0	0	0	0	0	0	0
Alabama	75	455	825	31	62	508	0	1881	0	0	0	0	0	0	0
Tennessee	118	574	771	17	57	282	0	1702	0	0	0	0	0	0	0
Kentucky	145	450	1094	102	183	264	0	2093	0	0	0	0	0	0	0
Georgia	110	837	793	14	68	284	0	1996	0	0	0	0	0	0	0
Florida	56	1267	1819	13	81	449	0	3630	0	0	0	0	0	0	0
Mid Atlantic	293	2183	2941	241	226	906	0	6498	0	0	0	0	0	0	0
NE US	314	4362	2347	415	397	2001	1461	10983	0	0	0	0	0	0	0
Northern Plains	5238	6049	6300	928	676	4892	82	18927	0	0	0	0	0	0	0
Total	**7992**	**19443**	**21372**	**2232**	**2639**	**11790**	**1974**	**59451**	**-9**	**-258**	**27**	**0**	**0**	**0**	**-240**

Table 2–7. Weekday baseline VOC emissions for each emission group and source region (left), and differences from the Run 45 base case emissions on August 17, 1999 (right).

DFW Baseline VOC Emissions [tpd]. Weekday for August 1999.									Change in VOC from the Run 45 base case [tpd]						
	Bio	Mobile	Elev. Pts	Low Pts	Area	Off-Road	Other	Anthro	Mobile	Elev. Pts	Low Pts	Area	Off-Road	Other	Anthro
Collin Co	27	13	0	1	11	6	0	31	0	0	0	0	0	0	0
Dallas Co	50	77	4	7	66	27	0	182	0	0	0	0	0	0	0
Denton co	65	13	1	1	12	5	0	33	0	0	0	0	0	0	0
Tarrant Co	64	44	4	8	46	14	0	115	0	0	0	0	0	0	0
Parker Co	121	4	0	0	5	1	0	11	0	0	0	0	0	0	0
Johnson Co	111	4	0	0	6	1	0	12	0	0	0	0	0	0	0
Ellis Co	89	5	4	2	6	2	0	20	0	0	0	0	0	0	0
Kaufman Co	112	6	0	1	7	1	0	14	0	0	0	0	0	0	0
Rockwall Co	3	2	0	0	2	2	0	5	0	0	0	0	0	0	0
DFW 9-County	**642**	**167**	**15**	**20**	**160**	**60**	**0**	**423**	**0**	**-1**	**0**	**0**	**0**	**0**	0
DFW 16 County	**1538**	**189**	**16**	**22**	**191**	**70**	**0**	**488**	**0**	**-1**	**0**	**0**	**0**	**0**	-1
NE Texas	4917	60	18	31	71	21	0	202	0	0	0	0	0	0	-1
Central TX	6098	67	26	14	75	29	1	211	0	0	0	0	0	0	0
Houston	1683	159	68	182	220	71	0	699	0	-2	0	0	0	0	-3
South TX	2069	164	25	39	191	69	0	489	0	-1	0	0	0	0	-1
West TX	6198	109	12	24	188	64	1	399	0	-1	0	0	0	0	-1
Texas	**22503**	**747**	**165**	**313**	**934**	**324**	**3**	**2487**	**0**	**-5**	**-1**	**0**	**0**	**0**	-5
Gulf + Mexico	658	16	20	1	27	56	154	276	0	0	-1	0	0	0	-1
Oklahoma	7940	247	2	68	253	92	1	662	0	0	0	0	0	0	0
Louisiana	9941	216	48	128	245	137	5	779	0	-23	-37	0	0	0	-60
Arkansas	13925	166	34	35	227	78	1	541	0	0	0	0	0	0	0
Mississippi	14818	188	30	112	253	79	1	663	0	0	0	0	0	0	0
Alabama	13954	314	53	114	371	124	0	976	0	0	0	0	0	0	0
Tennessee	8678	351	78	135	422	130	0	1117	0	0	0	0	0	0	0
Kentucky	3753	273	49	101	271	94	0	788	0	0	0	0	0	0	0
Georgia	12198	491	175	368	411	180	0	1625	0	0	0	0	0	0	0
Florida	9793	886	73	100	646	476	0	2182	0	0	0	0	0	0	0
Mid Atlantic	31294	1405	106	431	1328	580	2	3852	0	0	0	0	0	0	0
NE US	20472	2735	75	260	2848	1507	1327	8753	0	0	0	0	0	0	0
Northern Plains	40144	3826	235	882	3995	2015	83	11035	0	0	0	0	0	0	0
Total	**210073**	**11861**	**1143**	**3048**	**12232**	**5873**	**1578**	**35735**	**0**	**-29**	**-38**	**0**	**0**	**0**	**-67**



Differences in Elevated Point Source NOx (TPD)
Weekday Baseline - Base Case on Tuesday, August 17, 1999

Figure 2–16. Spatial plot of the differences in elevated point source NOx emissions between the baseline and base case for a August 17, 1999 (weekday).

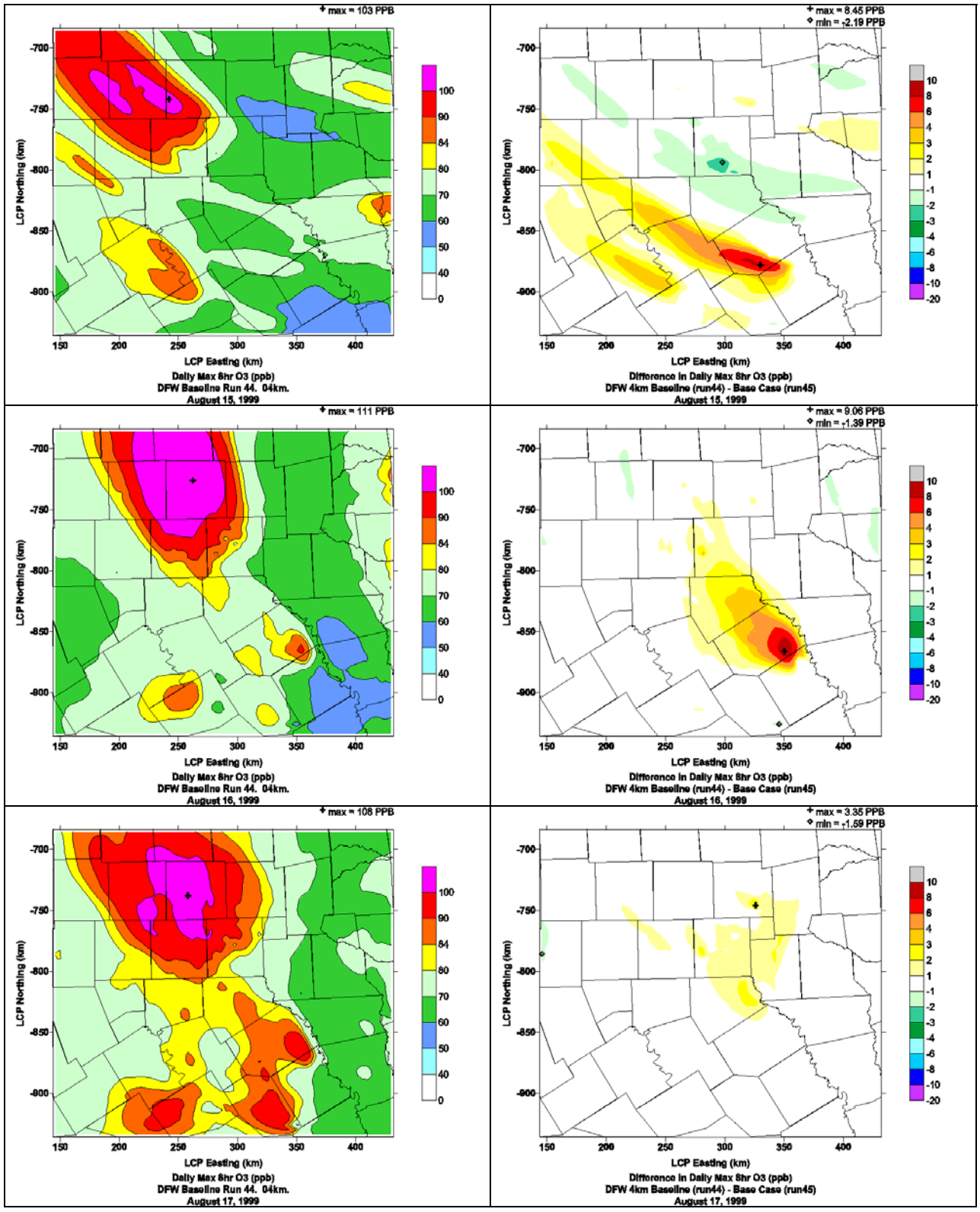


Figure 2–17. Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 4 km domain (left) and differences from the Run 45 base case (right).

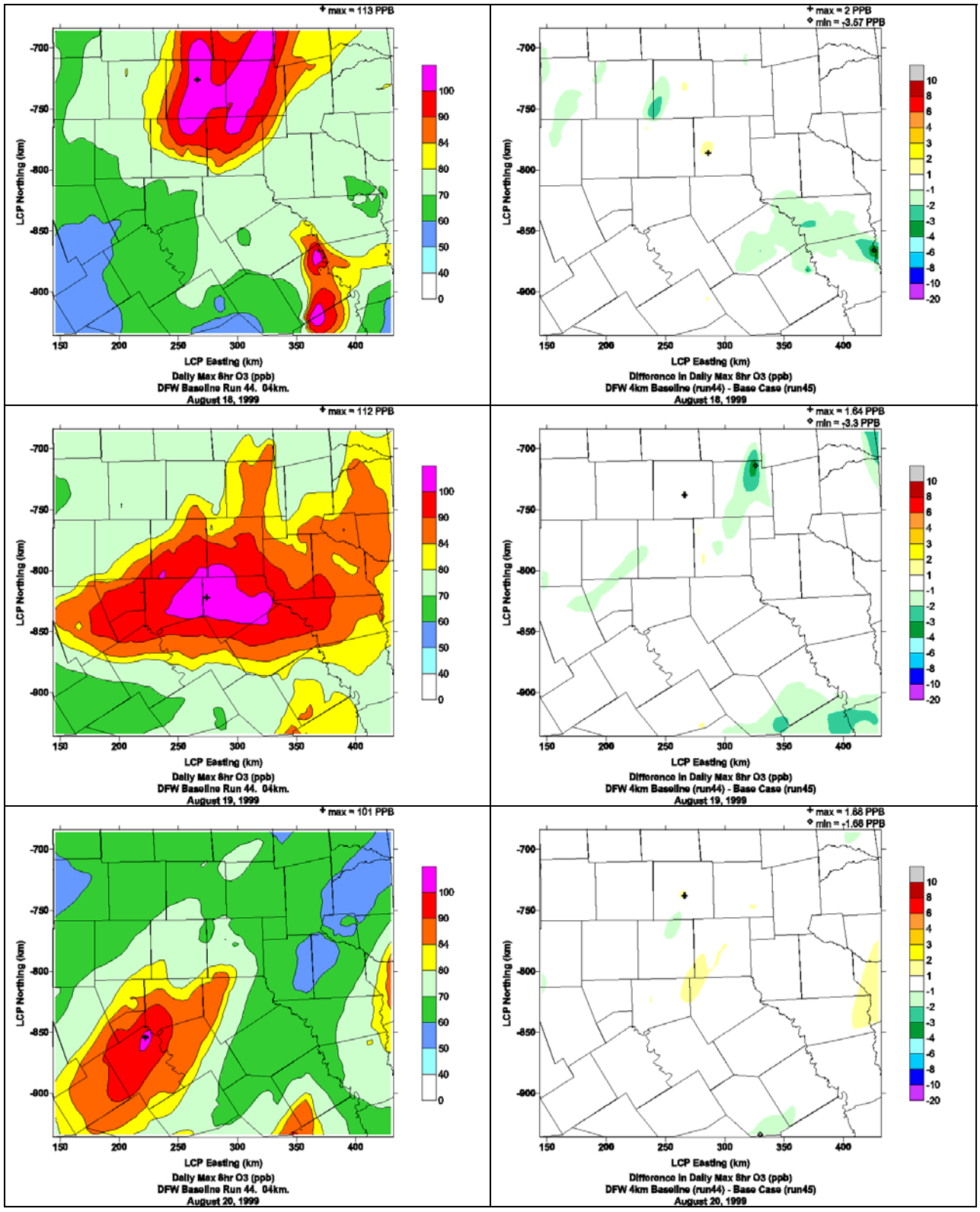


Figure 2–17. (continued). Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 4 km domain (left) and differences from the Run 45 base case (right).

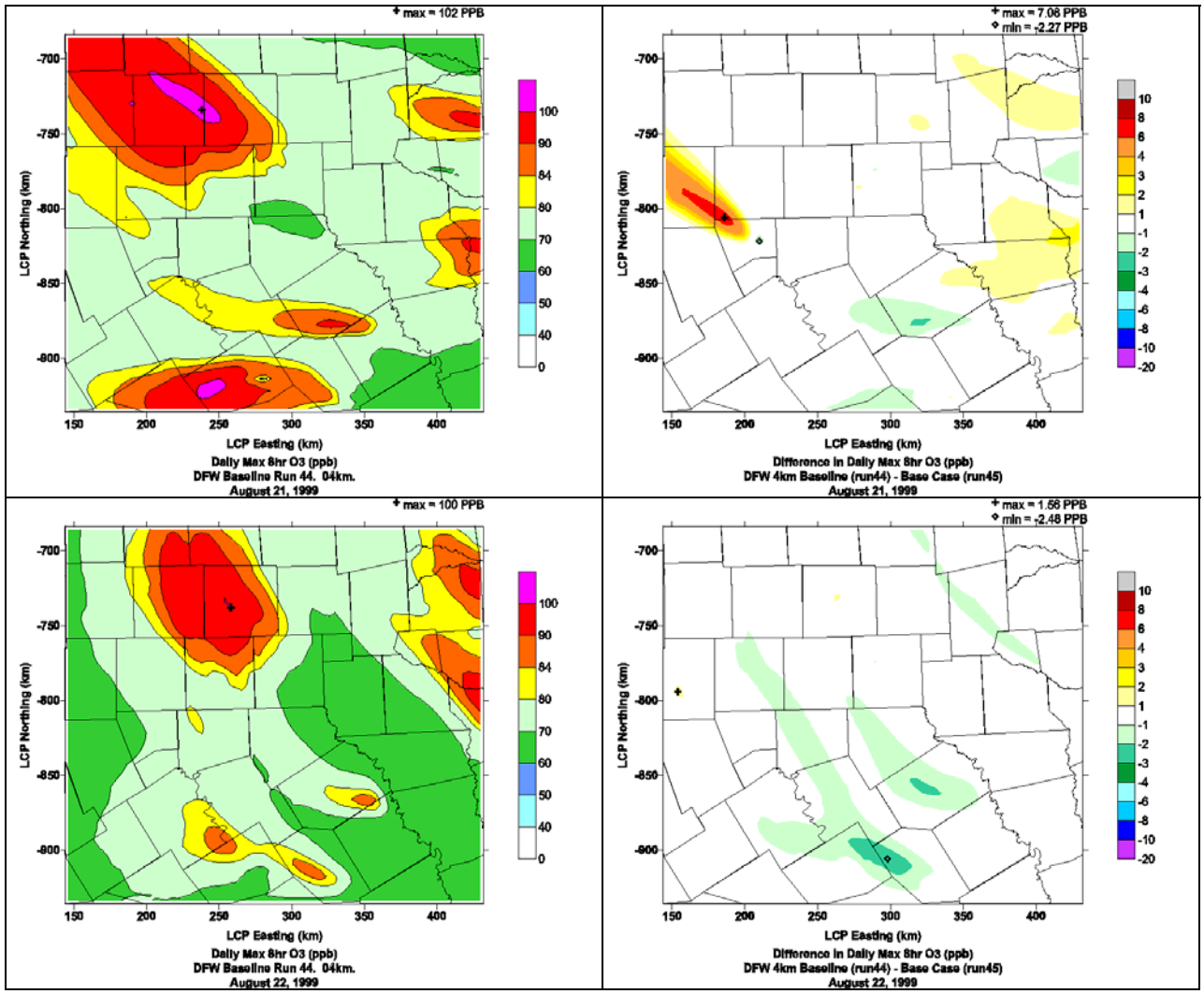


Figure 2–17. (concluded). Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 4 km domain (left) and differences from the Run 45 base case (right).

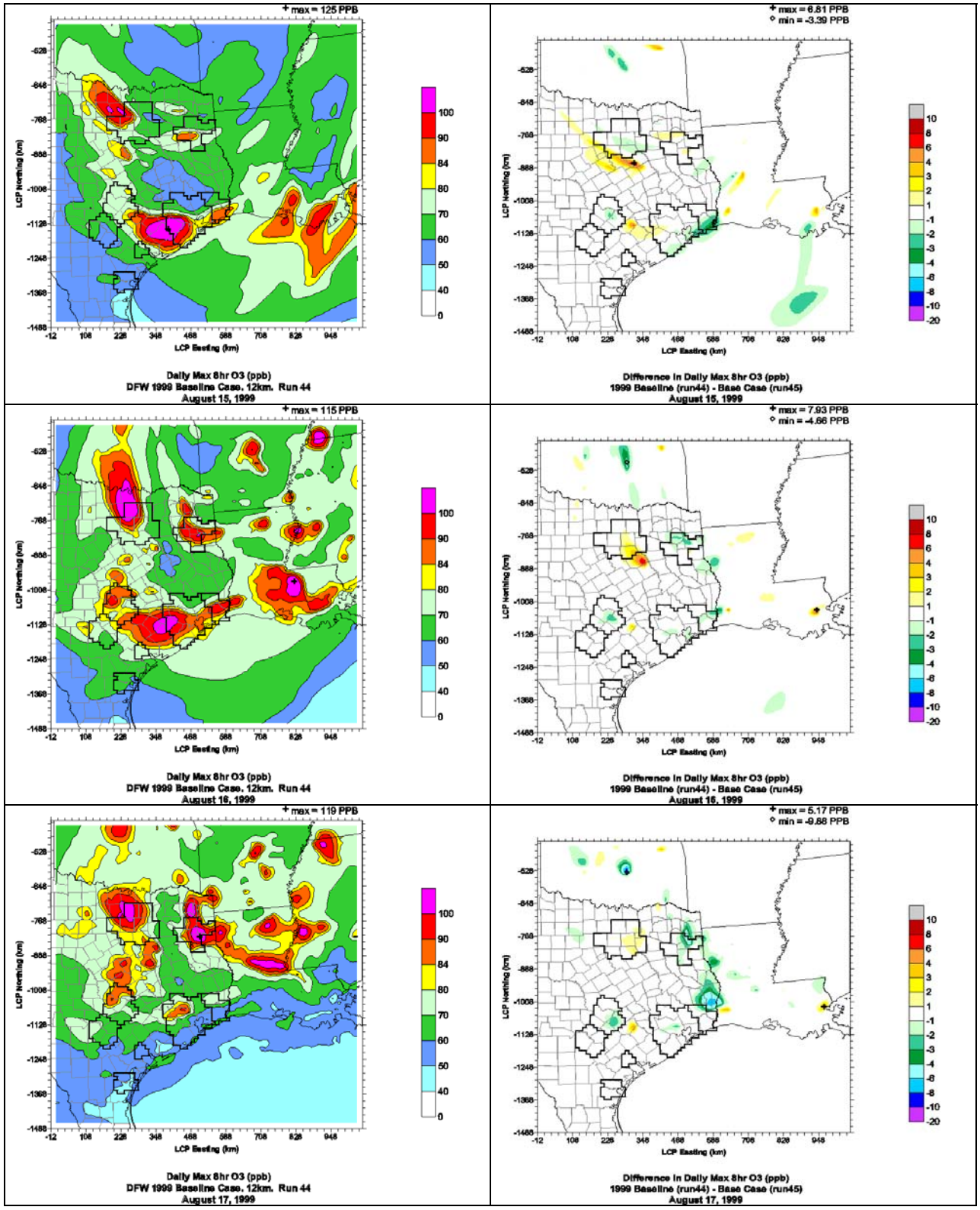


Figure 2–18. Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 12 km domain (left) and differences from the Run 45 base case (right).

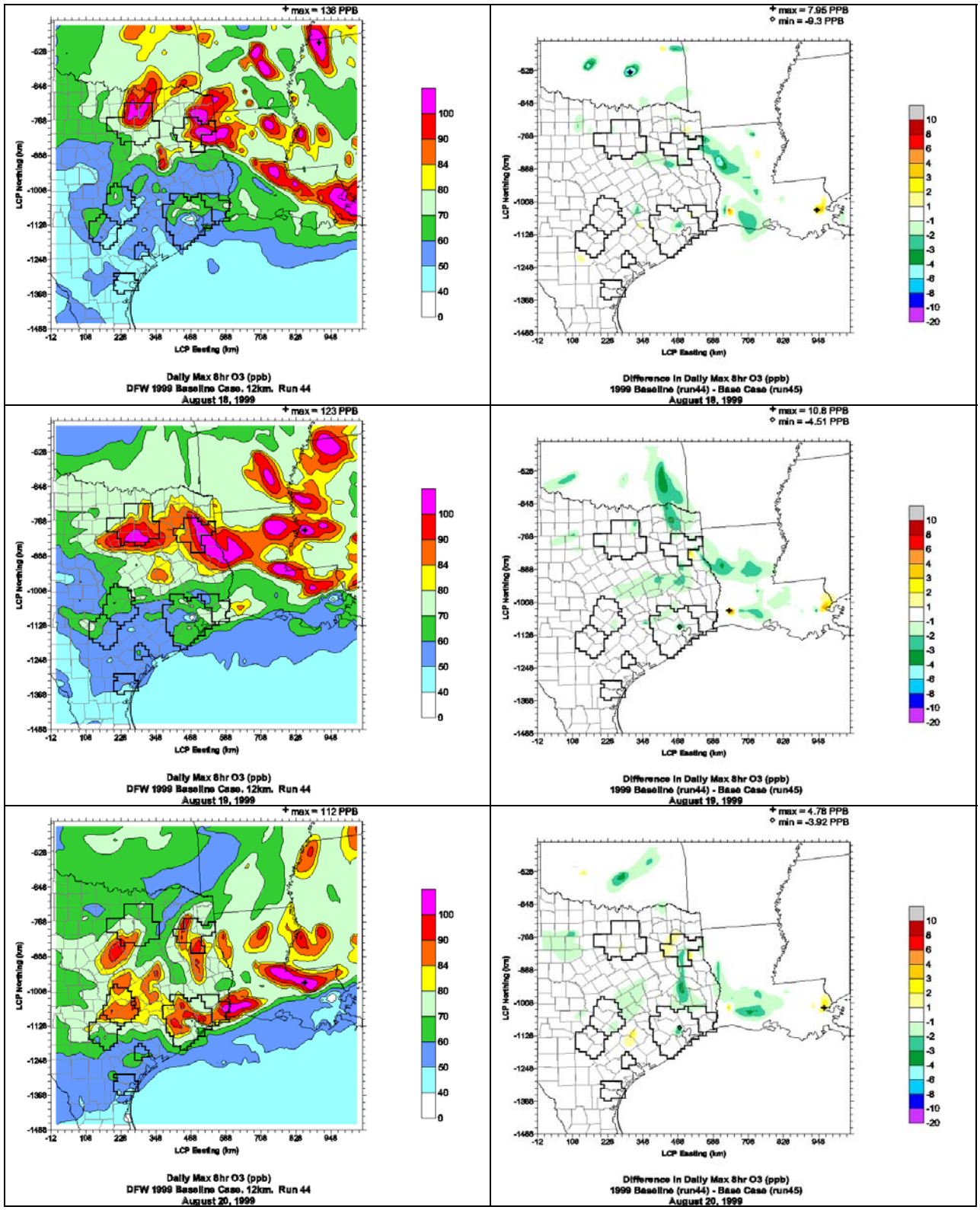


Figure 2–18. (continued). Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 12 km domain (left) and differences from the Run 45 base case (right).

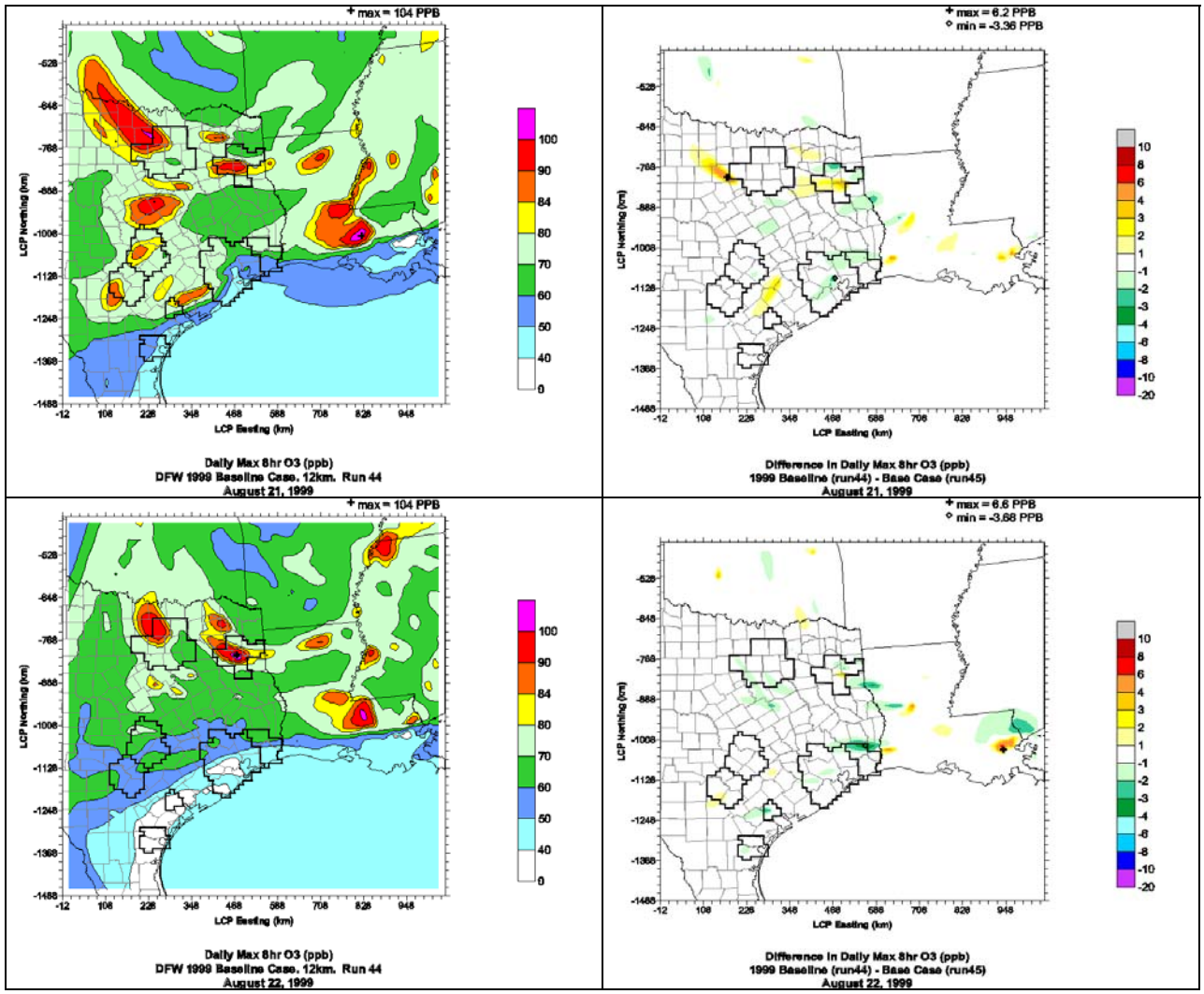


Figure 2–18. (concluded). Spatial plots of the daily maximum 8-hour ozone in the Run 44 baseline case in the DFW 12 km domain (left) and differences from the Run 45 base case (right).

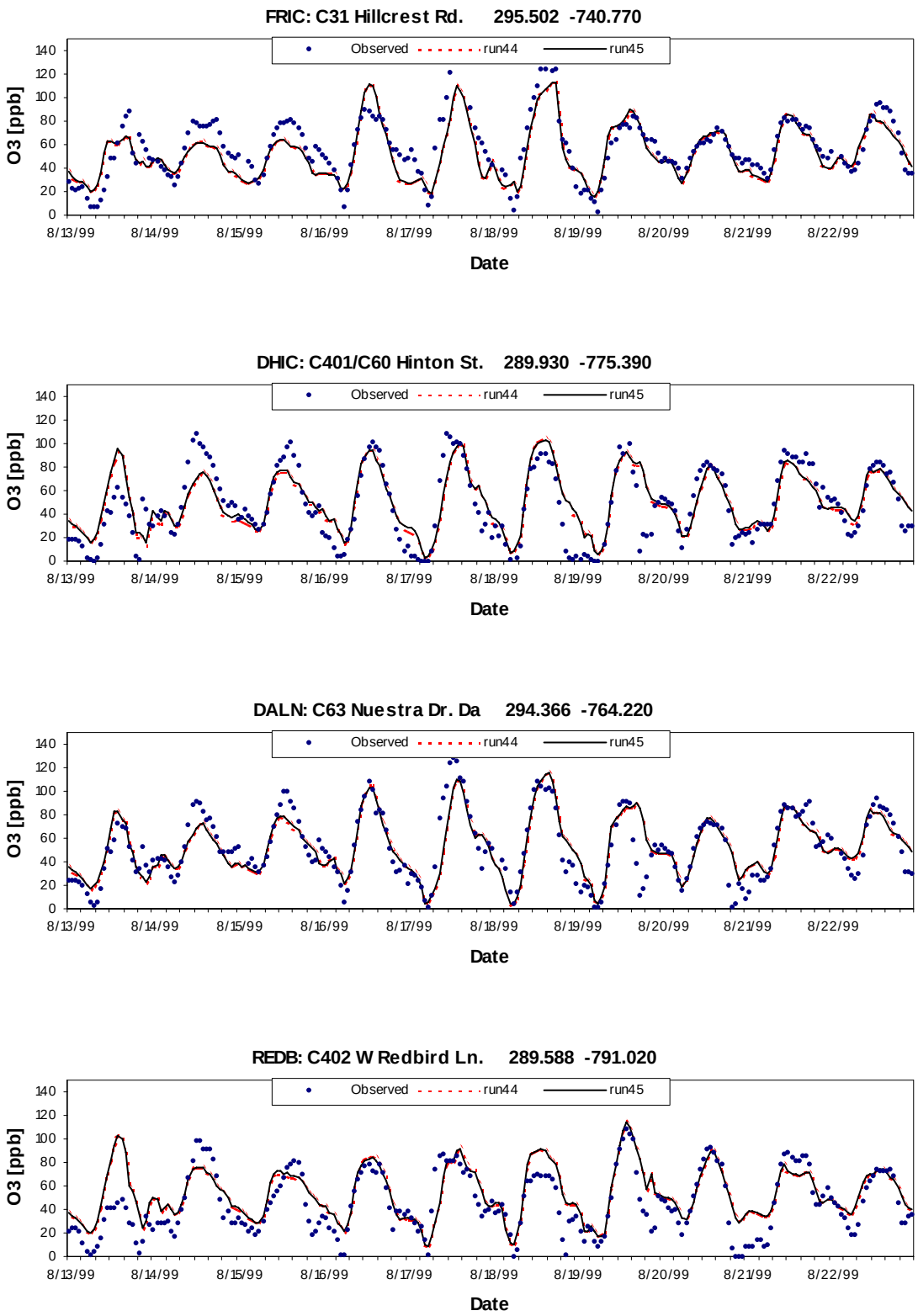


Figure 2–19. Time series of 1-hour ozone from Runs 44 (baseline) and 45 (base case).

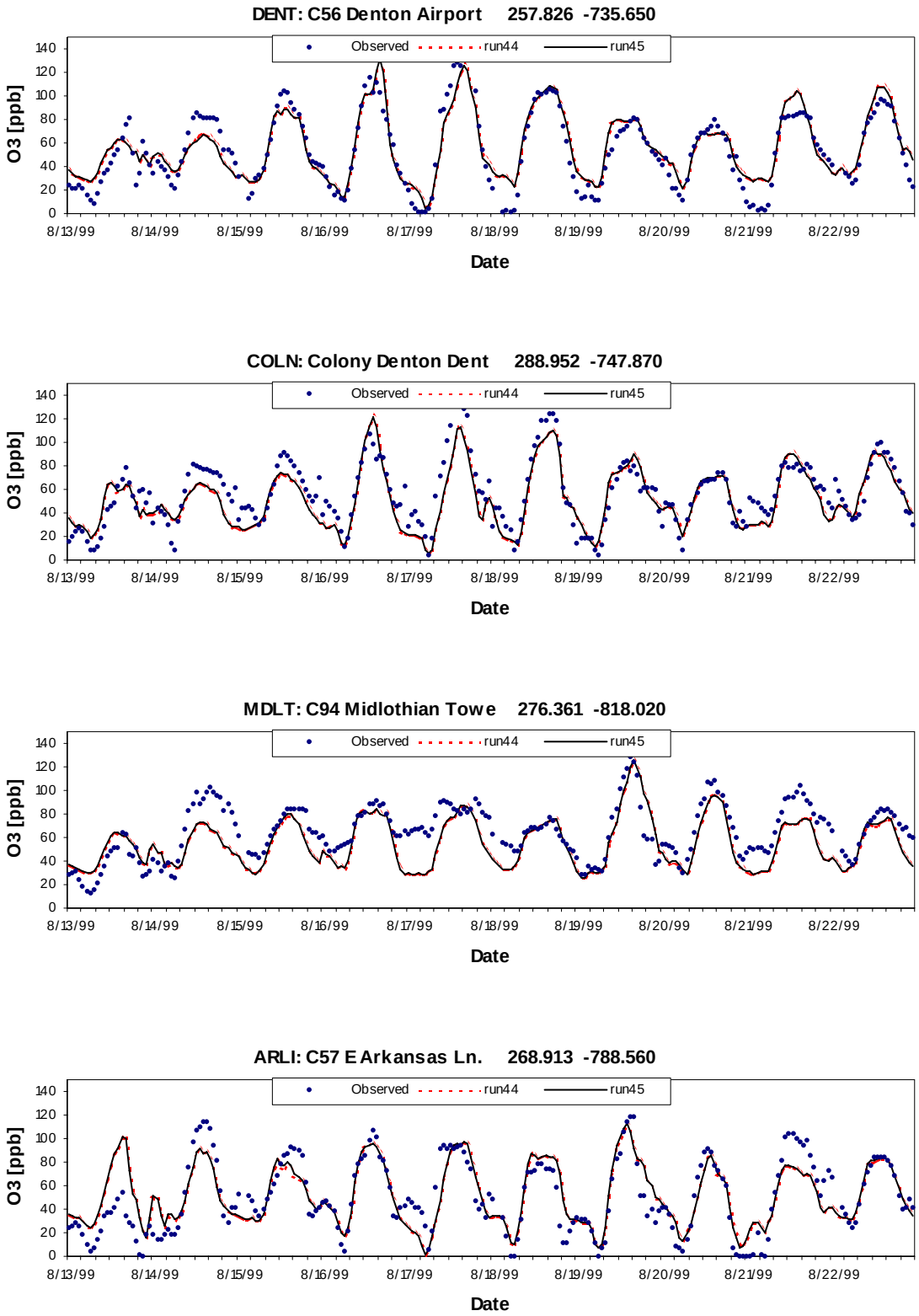
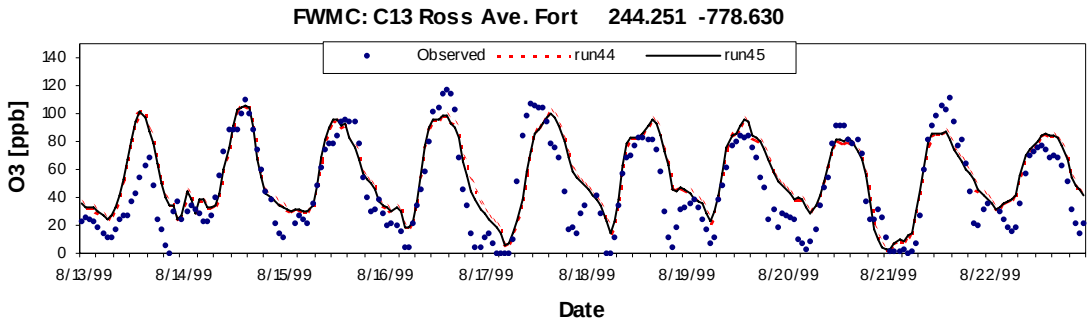


Figure 2–19. (continued). Time series of 1-hour ozone from Runs 44 (baseline) and 45 (base case).



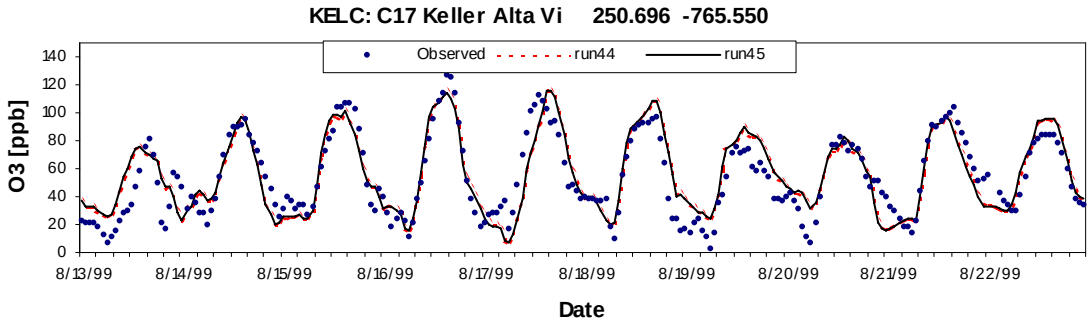


Figure 2–19. (concluded). Time series of 1-hour ozone from Runs 44 (baseline) and 45 (base case).

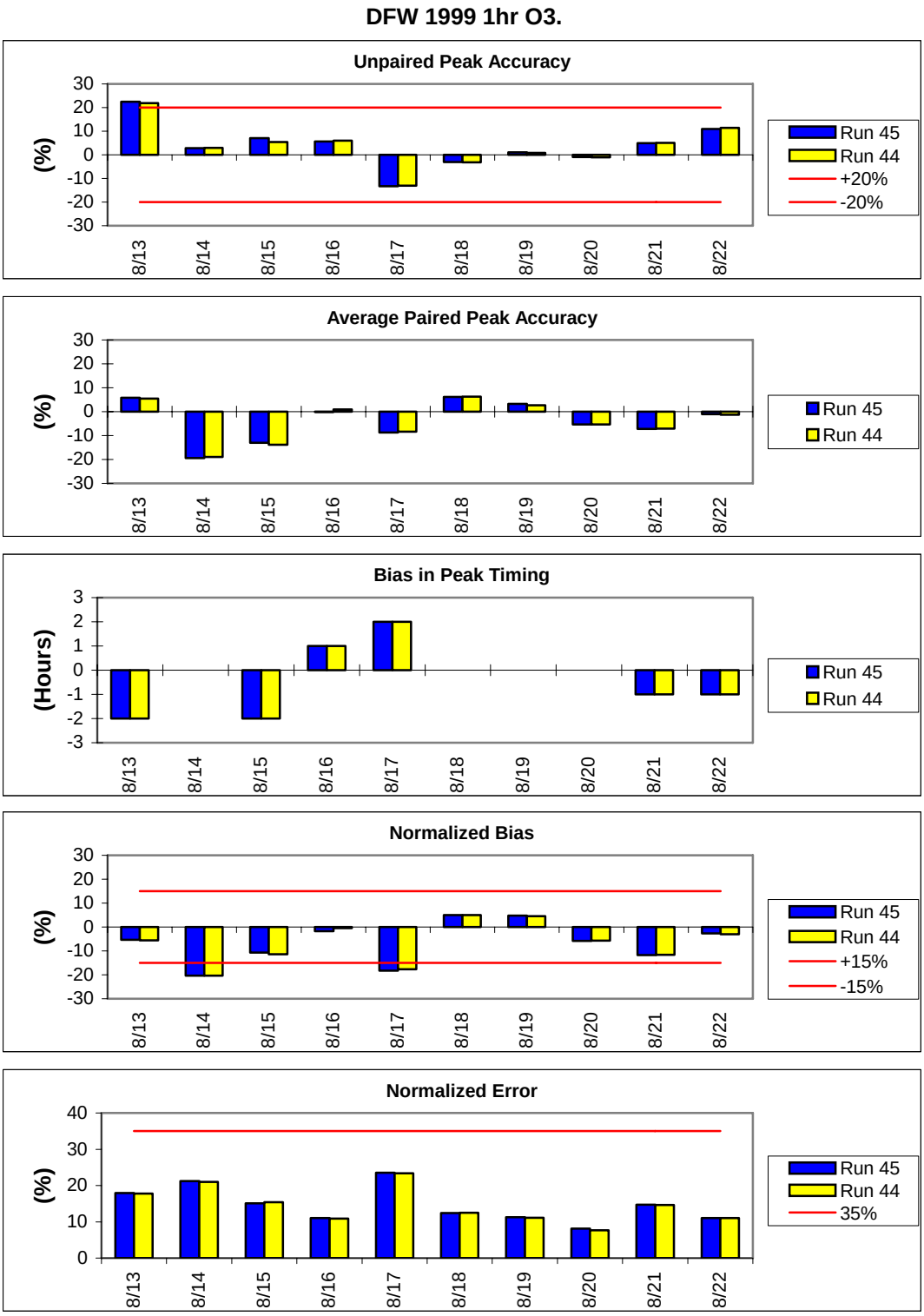


Figure 2–20. Model performance statistics for 1-hour ozone between the base case (Run 45) and baseline case (Run 44).

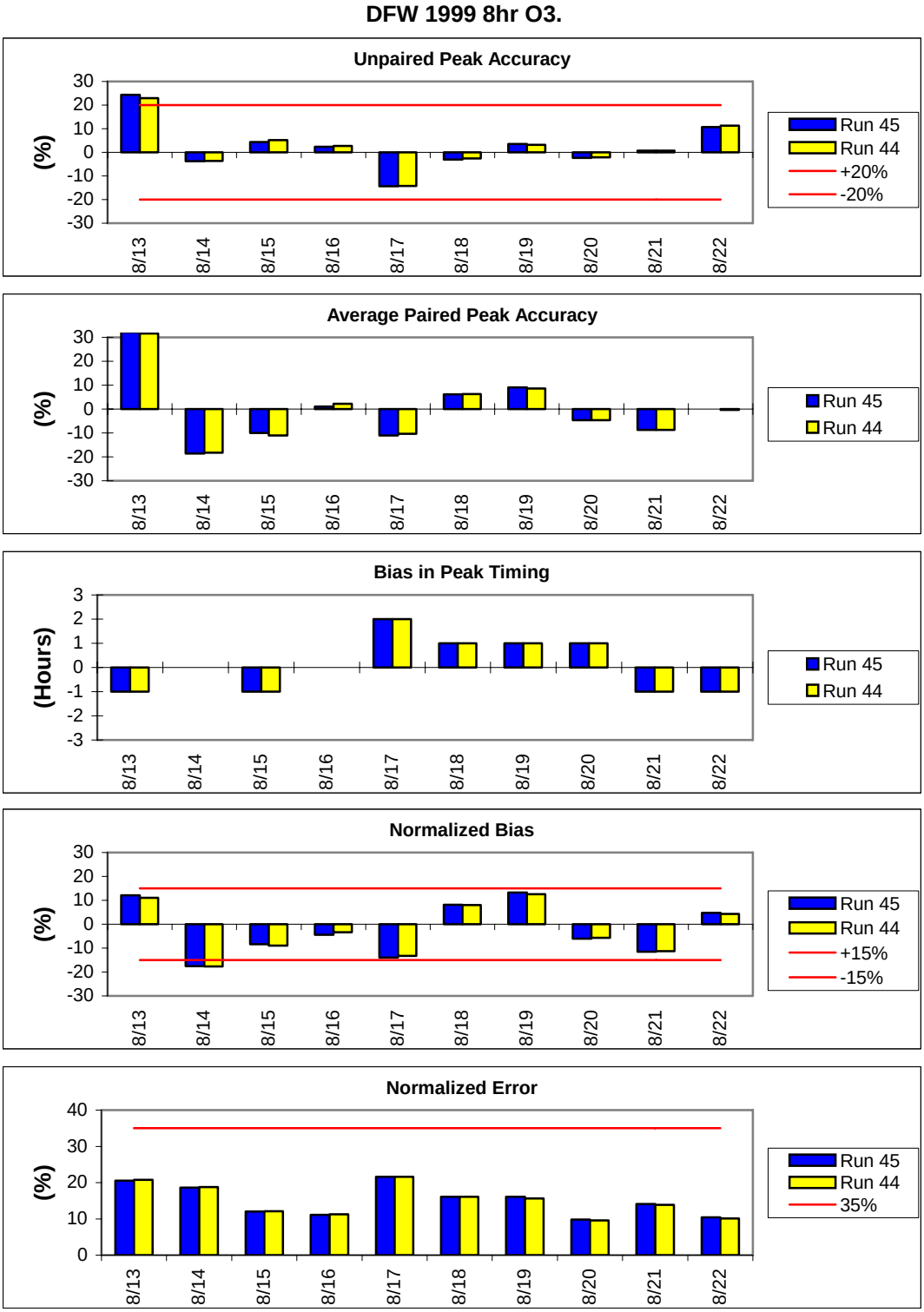


Figure 2–21. Model performance statistics for 8-hour ozone between the base case (Run 45) and baseline case (Run 44).

Summary

A new base case (Run 45) of the DFW August 13-22, 1999 episode incorporated the latest Texas emissions provided by TCEQ and replaced all emissions from other states that were based on NEI99 version 2 data with NEI99 version 3. These changes reduced NOx emissions in Texas by 7 % and outside of Texas by 8 %. VOC emissions were 24 % lower in Texas and 8 % lower outside of Texas. The lower emissions resulted in lower 8-hour ozone in DFW and lower normalized bias on all dates, allowing all non-spin-up dates to meet the ±15 % EPA performance goal. The new base case (Run 45) has similar performance for DFW ozone to the previous base case (Run 42) and is based on more up to date emissions.

The corresponding baseline run (Run 44) replaced date-specific point source emissions with a 32-day average in Texas and weekday/Saturday/Sunday emissions based on NEI99 version 3 data in Oklahoma and Louisiana. Model performance was similar to the Run 45 base case. Local differences were observed, most notably the plume originating from Freestone County, which increased the daily maximum 8-hour ozone in DFW up to 3 ppb on August 16 and 17, and made marginal improvements to the normalized bias.

3. DFW 2009 BASELINE AND A MATRIX OF CONTROLS

A new future year baseline for 2009 was developed to examine 8-hour ozone sensitivities in DFW from a matrix of nine "across the board" NOx and/or VOC controls within the DFW 9-county NAA. All runs in this section were based on the August 13-22, 1999 Run 44 baseline configuration presented in Section 2. Inputs included meteorology from MM5 Run 6, which was based on the ETA PBL scheme coupled with the Noah land surface model, with the kv100 patch applied to the vertical diffusivity. The boundary conditions assigned moderate conditions in the mixed layer over land, and clean conditions over the Gulf, Atlantic and all areas aloft. A modified version of CAMx 4.03 was used in which several NOx recycling reactions were added to the CB4 mechanism (CB4xi) (Tai et al., 2005a).

3.1 2009 BASELINE

2009 Baseline Emissions

The 2009 emissions were provided by TCEQ. A summary of 2009 weekday emissions by source region, as defined in Figure 2–1, and emissions group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenic) is shown in Tables 3–1 and 3–2 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 38 % lower than in 1999, which is comparable to the domain-wide average reduction of 39 %. Weekday 2009 baseline NOx emissions in the DFW 9-county NAA were projected to be 43 % lower than 1999. Weekday anthropogenic VOC emissions in DFW were 19 % lower in 2009, which is a greater reduction than the 10 % across Texas, but less than the 25 % change domain-wide. Biogenic emissions were unchanged from the 1999 baseline run.

Table 3–1. 2009 baseline NOx emissions for a weekday in August.

NOx (tpd)	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 1999 baseline
Collin Co	10	15	3	0	2	8	0	27	-48%
Dallas Co	4	77	13	2	18	45	0	155	-51%
Denton Co	8	17	1	0	12	9	0	40	-30%
Tarrant Co	3	46	8	2	10	28	0	95	-49%
Parker Co	1	6	1	0	1	2	0	10	-49%
Johnson Co	5	5	6	0	0	5	0	16	-32%
Ellis Co	15	9	42	1	0	6	0	58	-6%
Kaufman Co	5	6	8	0	0	2	0	17	-22%
Rockwall Co	2	3	0	0	0	1	0	5	-32%
DFW 9-County	**52**	**184**	**81**	**6**	**44**	**107**	**0**	**423**	**-43%**
DFW 16 County	**83**	**212**	**136**	**10**	**67**	**123**	**0**	**549**	**-39%**
NE Texas	16	79	210	16	71	42	1	418	-30%
Central TX	113	88	191	2	56	69	0	406	-37%
Houston	21	175	235	12	53	63	0	538	-60%
South TX	229	189	319	22	75	100	0	705	-31%
West TX	524	160	186	21	212	105	1	686	-20%
Texas	**986**	**904**	**1277**	**83**	**534**	**501**	**2**	**3301**	**-38%**
Gulf + Mexico	79	5	438	0	4	2	444	893	35%
Oklahoma	227	1	256	0	2	3	661	924	-33%
Louisiana	106	1	718	2	2	1	1183	1908	-19%
Arkansas	125	2	220	0	0	2	468	692	-24%
Mississippi	121	0	353	0	0	0	455	808	-26%
Alabama	75	0	442	0	0	0	491	932	-50%
Tennessee	118	0	244	0	0	0	662	906	-47%
Kentucky	145	0	289	0	0	0	770	1060	-49%
Georgia	110	0	408	0	0	0	823	1230	-38%
Florida	56	0	367	0	0	0	1206	1573	-57%
Mid Atlantic	293	0	977	0	0	0	2332	3310	-49%
NE US	314	0	1302	0	0	0	5748	7051	-36%
Northern Plains	5238	0	3269	0	0	0	8623	11892	-37%
Total	**7992**	**913**	**10561**	**86**	**543**	**509**	**23869**	**36481**	**-39%**

Table 3–2. 2009 baseline VOC emissions for a weekday in August.

VOC (tpd)	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 1999 baseline
Collin Co	27	7	0	1	12	3	0	23	-24%
Dallas Co	50	43	4	8	72	17	0	144	-21%
Denton co	65	8	1	1	15	4	0	29	-12%
Tarrant Co	64	25	2	7	54	9	0	97	-16%
Parker Co	121	2	0	0	5	1	0	9	-23%
Johnson Co	111	2	0	0	6	1	0	9	-22%
Ellis Co	89	2	4	2	6	2	0	17	-15%
Kaufman Co	112	2	2	0	7	1	0	12	-15%
Rockwall Co	3	1	0	0	2	1	0	4	-30%
DFW 9-County	**642**	**92**	**14**	**20**	**180**	**38**	**0**	**343**	**-19%**
DFW 16- County	**1538**	**103**	**38**	**22**	**216**	**44**	**1**	**424**	**-13%**
NE Texas	4917	27	17	41	82	14	1	183	-9%
Central TX	6098	33	20	20	85	21	1	181	-14%
Houston	1683	80	84	216	247	41	0	668	-4%
South TX	2069	78	23	48	217	46	0	411	-16%
West TX	6198	59	13	28	215	52	3	369	-7%
Texas	**22503**	**380**	**196**	**375**	**1060**	**218**	**6**	**2237**	**-10%**
Gulf + Mexico	658	3	32	0	10	4	329	378	37%
Oklahoma	7940	1	3	0	5	1	481	490	-26%
Louisiana	9941	0	48	3	4	1	546	602	-23%
Arkansas	13925	0	23	0	2	0	441	466	-14%
Mississippi	14818	0	35	0	0	0	548	583	-12%
Alabama	13954	0	39	0	0	0	655	695	-29%
Tennessee	8678	0	66	0	0	0	895	961	-14%
Kentucky	3753	0	34	0	0	0	622	656	-17%
Georgia	12198	0	53	0	0	0	869	922	-43%
Florida	9793	0	42	0	0	0	1594	1636	-25%
Mid Atlantic	31294	0	67	0	0	0	2836	2903	-25%
NE US	20472	0	248	0	0	0	5407	5655	-35%
Northern Plains	40144	0	226	0	0	0	8224	8450	-23%
Total	**210073**	**384**	**1113**	**378**	**1080**	**224**	**23453**	**26633**	**-25%**

2009 Baseline Results (Run 44.fy2009.a0)

Figures 3–1 and 3–2 show plots of the daily maximum 8-hour ozone from the 2009 baseline in the left column for each episode day in the 4 km and 12 km domains, respectively. The right column shows the difference in daily maximum ozone from the 1999 baseline (run44). In the 4 km domain, 8-hour ozone was lower in 2009 in most areas except locally in Limestone County on most dates and locally in the DFW core on August 17 and 20, when ozone was up to 8 ppb higher. In the 12 km domain, ozone was generally lower except near Houston, where ozone became significantly higher starting on August 17, and locally in Bexar County (near San Antonio) from August 15-20.

The 2009 baseline future design value calculation for 8-hour ozone is shown in Table 3–3 for the 9 DFW monitoring sites available in 1999. The daily maximum 8-hour ozone in the 7 by 7 4-km cells surrounding each monitor are listed for each episode date for both the base year (top) and the 2009 future year (bottom). For each monitor, the ratio of the episode averaged daily maximum 8-hour ozone in the future year to the base year was scaled to the current design value to compute the future design value. Dates with ozone peaks below 70 ppb in the base year were excluded from the calculation.

The future design values were higher than the previously calculated 2010 design values (based on the Run 40 configuration) at all stations except two of the three Dallas monitors, as shown in Table 3–4. Higher values in 2009 are highlighted in red; lower values, in blue. The highest future design value continued to be at Frisco, which was 1.1 ppb higher than in 2010.

Tables 3–5 and 3–6 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 3–5 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline. Table 3–6 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. There were 1356 exceedance cells and 9235 exceedance ppb's in the episode. August 19 had the largest area of grid cells over 85 ppb while August 17 had the most exceedance ppb's.

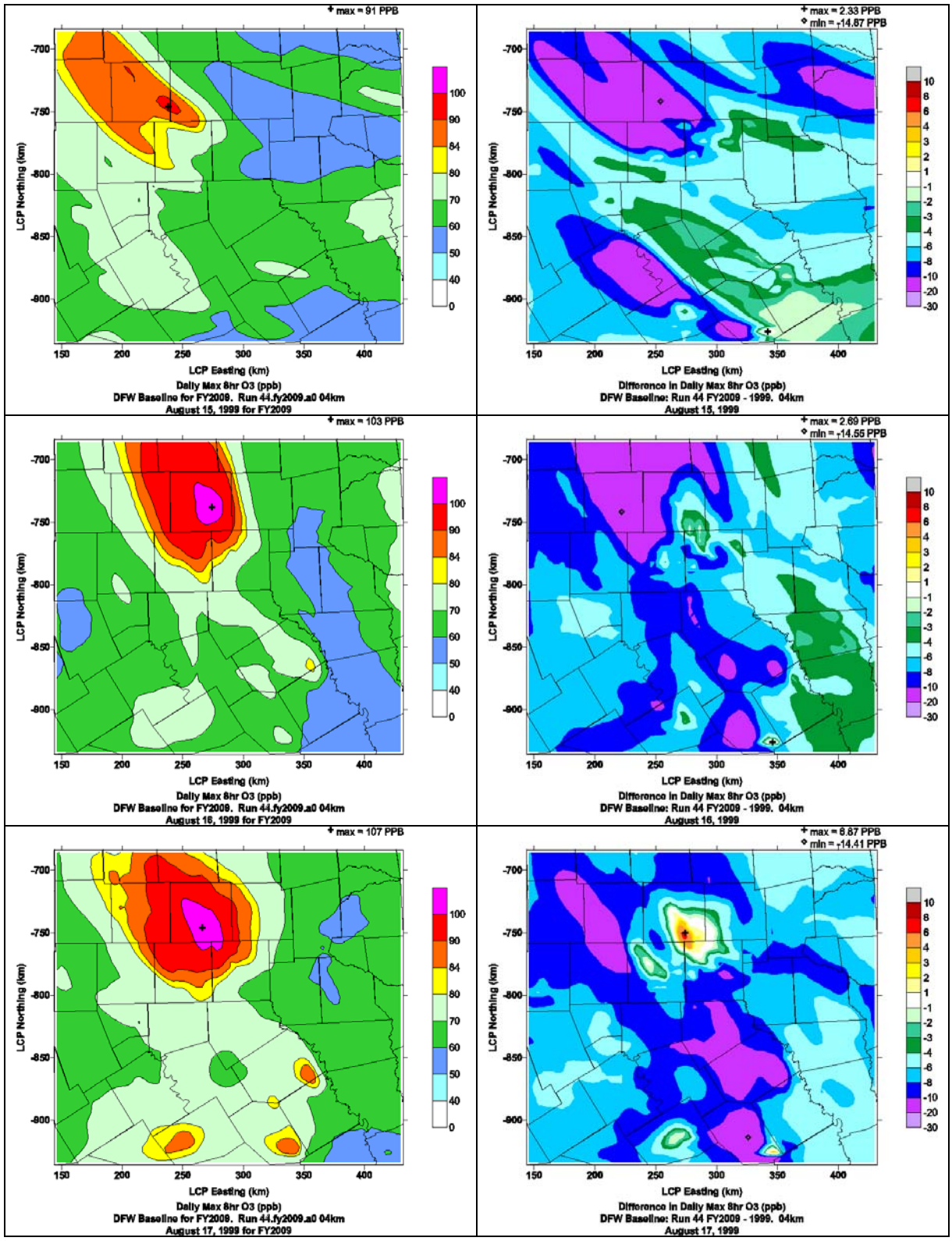


Figure 3–1. Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 4 km domain (left), and differences from the 1999 baseline (right).

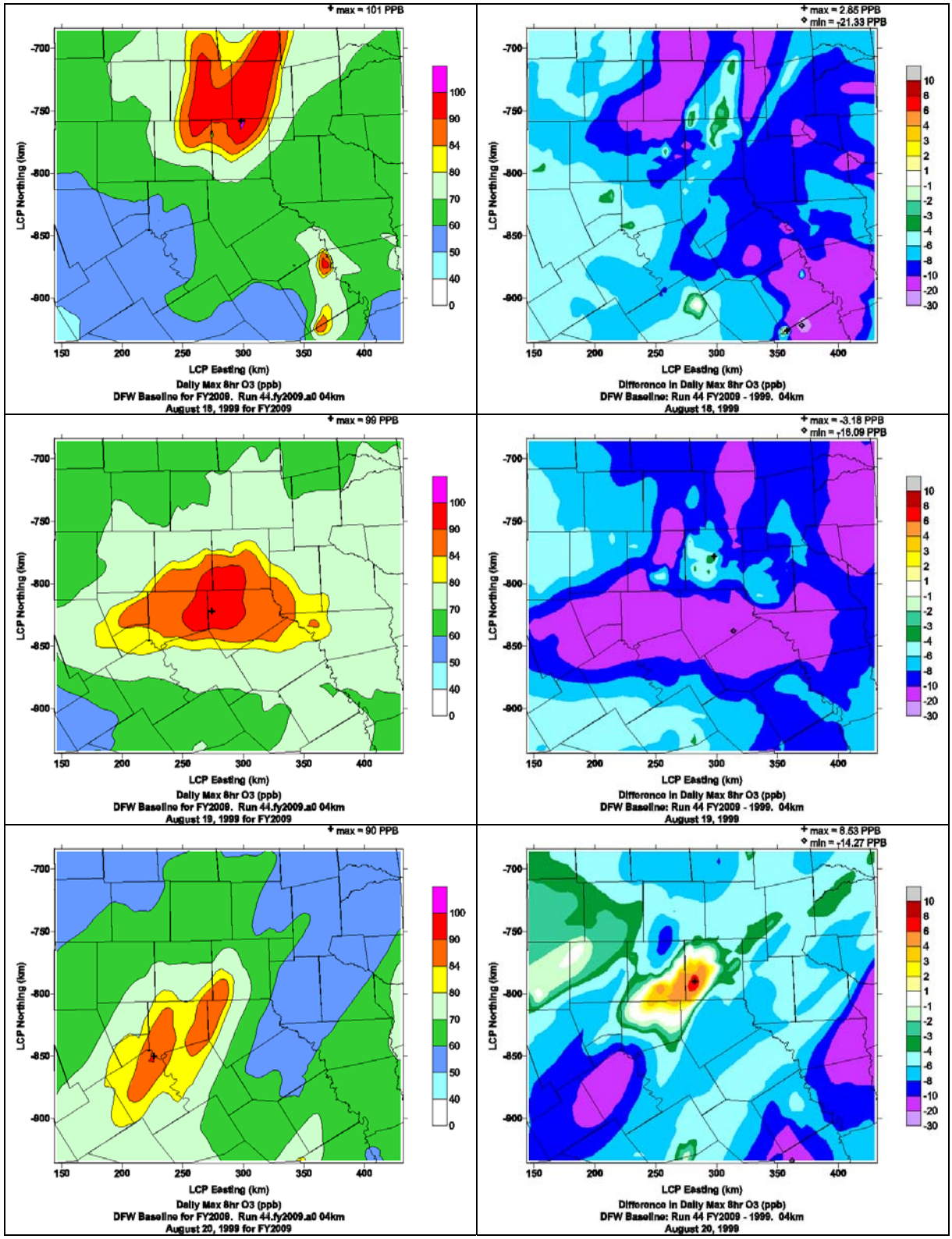


Figure 3–1. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 4 km domain (left), and differences from the 1999 baseline (right).

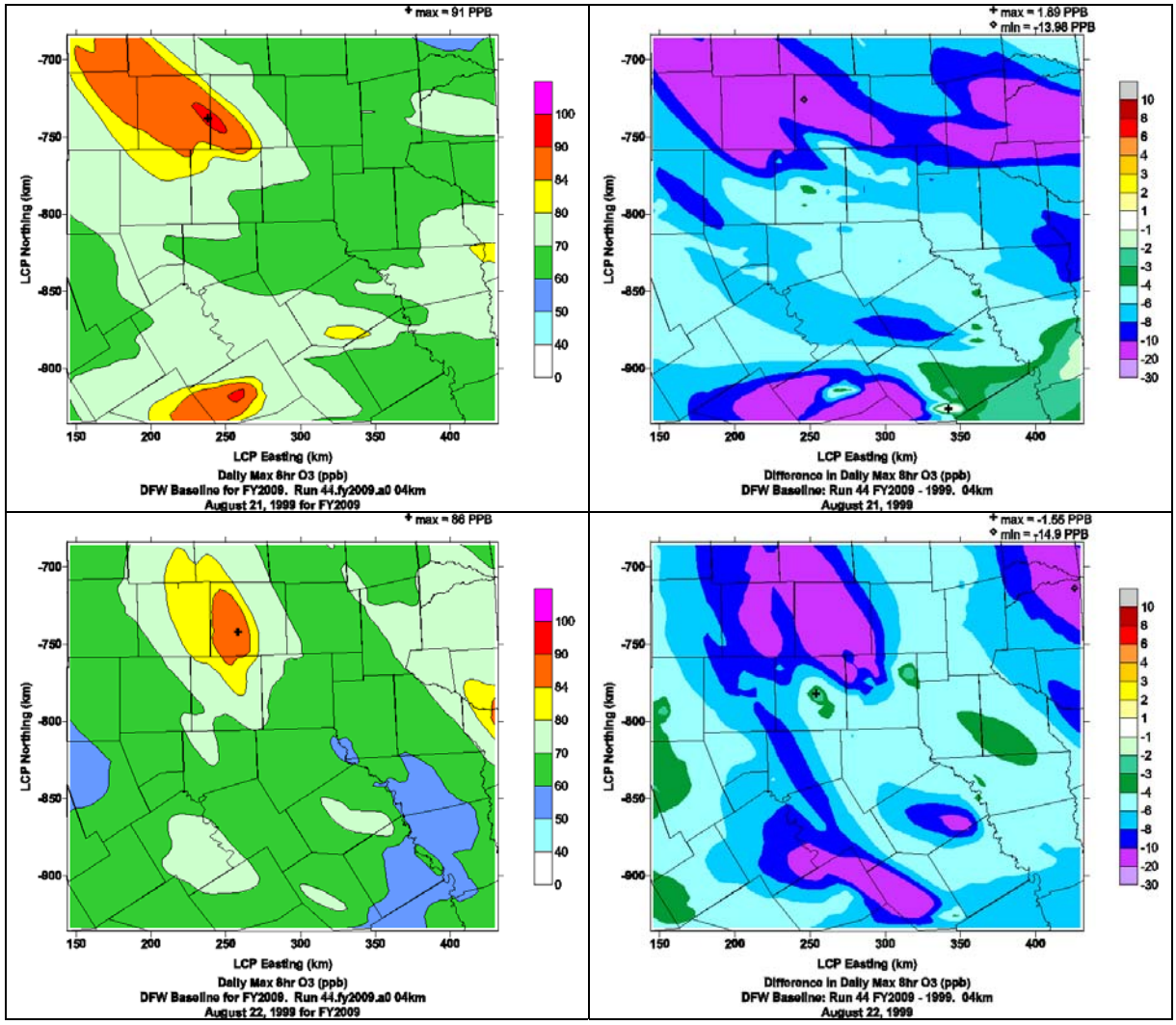


Figure 3–1. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 4 km domain (left), and differences from the 1999 baseline (right).

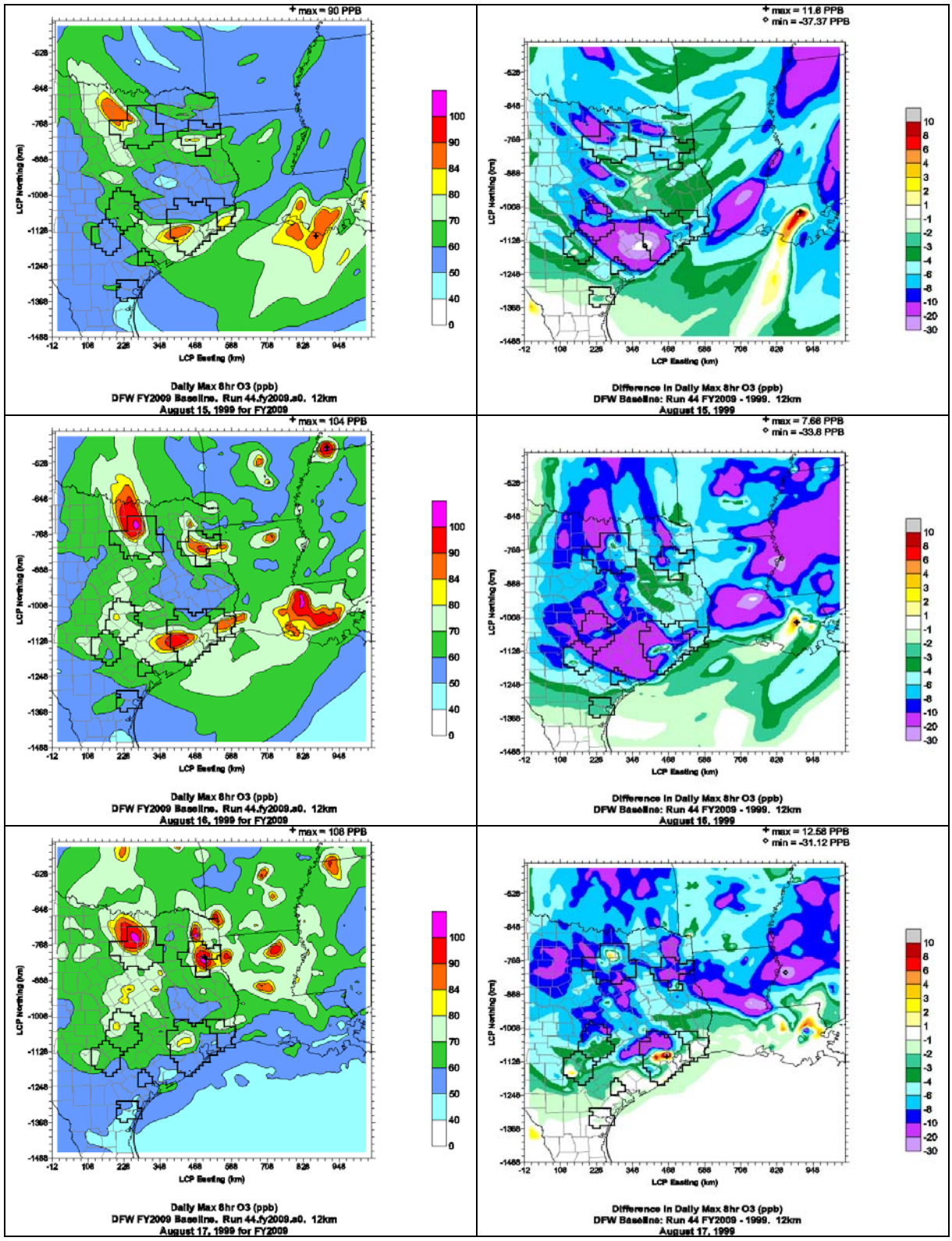


Figure 3–2. Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 12 km domain (left), and differences from the 1999 baseline (right).

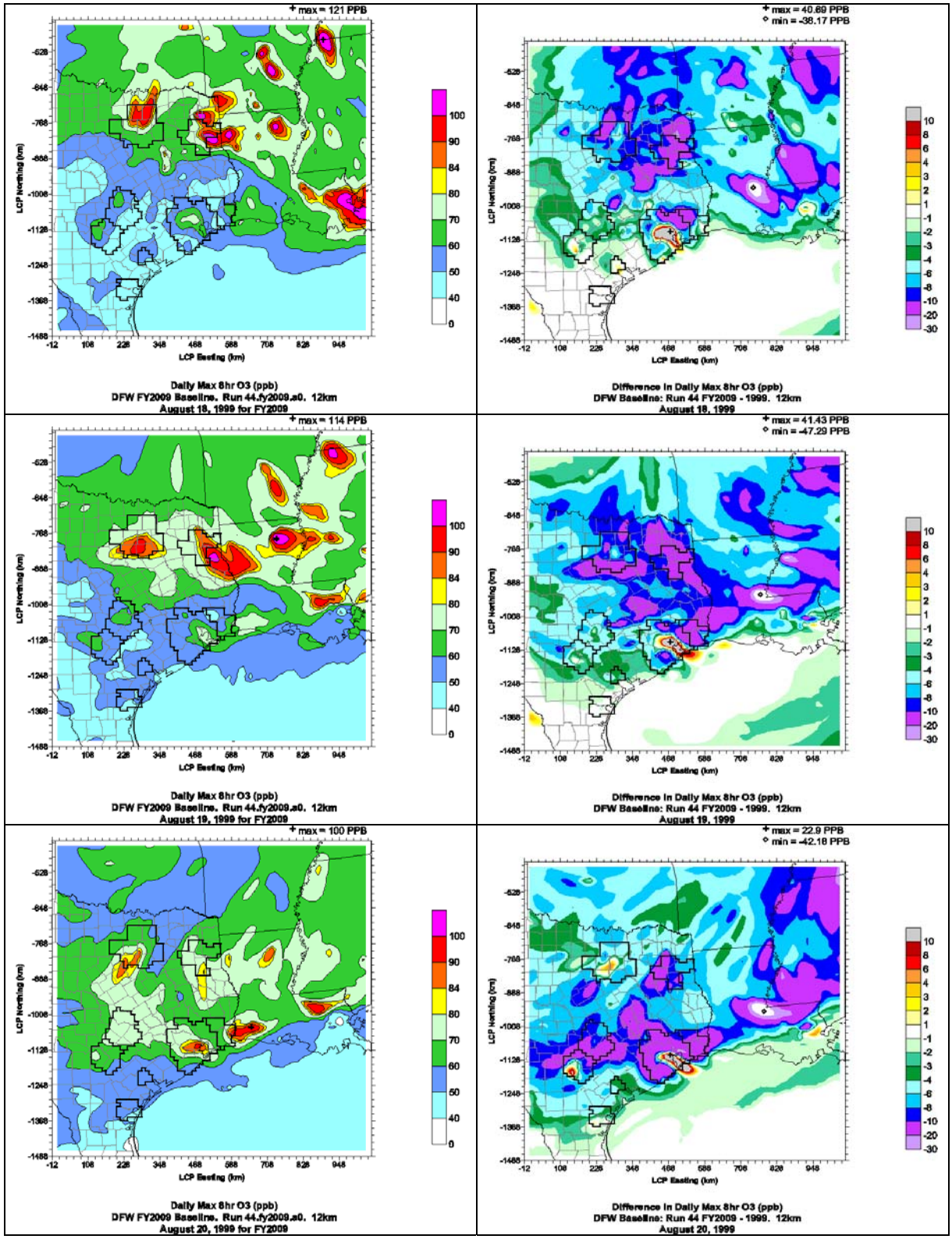


Figure 3–2. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 12 km domain (left), and differences from the 1999 baseline (right).

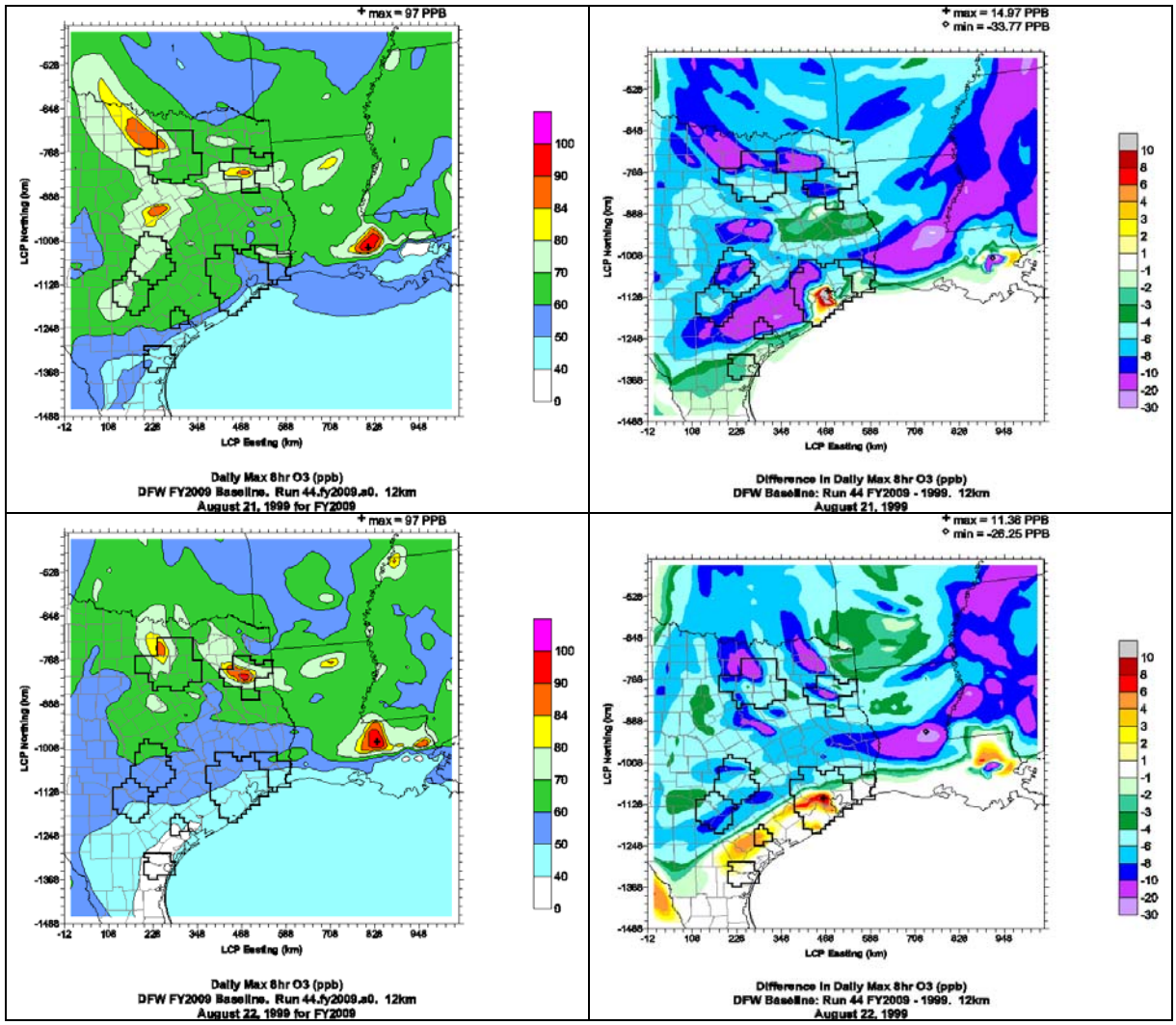


Figure 3–2. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 2009 baseline (run44.fy2009) in the 12 km domain (left), and differences from the 1999 baseline (right).

Table 3–3. Design Value Scaling for Baseline Run44.fy2009.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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: run44.fy2009.a0												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Current DV [ppb]**	**Future DV[2] [ppb]**
Frisco	69.2	101.0	101.0	99.1	76.1	65.9	76.3	76.3	83.1	0.922	99.7	91.9
Dallas C60	74.5	93.4	101.5	100.5	90.5	82.5	79.8	75.1	87.2	0.956	92.0	88.0
Dallas C63	72.5	96.6	101.0	100.8	85.9	79.1	79.0	74.8	86.2	0.945	93.0	87.9
Dallas C402	68.6	84.1	91.1	89.2	96.8	88.0	72.7	71.5	82.8	0.922	87.3	80.5
Denton	90.1	103.3	107.2	93.7	72.2	64.3	90.6	86.5	88.5	0.893	101.5	90.7
Midlothian	70.6	76.3	79.4	71.6	99.2	87.5	69.2	70.2	78.0	0.923	92.5	85.4
Arlington	74.8	91.2	92.6	85.9	95.8	88.0	74.7	81.8	85.6	0.931	95.0	88.4
Fort Worth C13	82.5	96.2	94.8	90.8	84.9	76.6	81.6	83.8	86.4	0.905	98.3	88.9
Fort Worth C17	89.5	98.6	103.4	92.7	80.7	71.2	88.5	85.7	88.8	0.902	96.3	86.9

1. RRF = Future year average / base year average.
2. Future DV = Baseline DV * RRF.

Table 3–4. A comparison of the 2009 baseline and 2010 base case 8-hour ozone design values [ppb].

Monitor	FY 2010*[1]	FY2009*[2]	FY2009 – 2010
Frisco C31	90.8	91.9	1.1
Dallas C60	88.2	88.0	-0.2
Dallas C63	87.6	87.9	0.3
Dallas C402	80.9	80.5	-0.4
Denton C56	88.6	90.7	2.1
Midlothian C94	84.5	85.4	0.9
Arlington C57	87.6	88.4	0.8
Fort Worth C13	87.5	88.9	1.4
Fort Worth C17	85.3	86.9	1.6

*[1] based on the run40 configuration
*[2] based on the run44 baseline configuration

Table 3–5. Exceedance Area in the 2009 baseline (Number of 4-km grid cells in DFW with daily max 8-hour ozone > 85 ppb).

Monitor	Run44.fy2009.a0
990815	30
990816	236
990817	305
990818	277
990819	364
990820	77
990821	34
990822	33
Total	1356

Table 3–6. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1] in the 2009 baseline.

Monitor	Run44.fy2009.a0
990815	72
990816	2438
990817	2883
990818	1981
990819	1616
990820	117
990821	104
990822	25
Total	9235

3.2 OZONE SENSITIVITY TO LOCAL EMISSION REDUCTIONS

Nine "across the board" emissions reductions (controls) were applied to the 2009 anthropogenic emissions inside the DFW 9-county NAA to evaluate ozone sensitivity to each control. Table 3–7 shows the matrix of NOx and VOC controls applied to the 2009 baseline emissions.

Table 3–7. Emission reduction matrix for 2009 ozone sensitivity simulations.

Anthropogenic Reduction		NOx			
		0%	**20%**	**40%**	**60%**
	0%	2009 baseline	X	X	X
	25%	X	X		
	50%	X		X	
VOC	**75%**	X			X

Future design values were calculated for each of the nine control levels. A summary of the future year design values at each monitoring site and control level is shown in Table 3–8. Response curves of VOC controls, NOx controls, and VOC and NOx controls at each monitoring site are shown in Figure 3–3.

The 2009 emission response curves shown in Figure 3–3 are similar to the 2010 response curves (Tai, 2005b). Ozone was responsive to anthropogenic NOx controls and not very responsive to VOC controls. Frisco, which had the highest 2009 design value, needed a local NOx reduction of around 47% to demonstrate attainment. The available sensitivity tests show that the required level of local NOx reductions could be reduced to 43% if accompanied by a 55% anthropogenic VOC reduction in the DFW 9-county region to achieve attainment. Regional emission reductions also would be expected to reduce the level of local emission reduction needed to demonstrate attainment of the 8-hour ozone standard.

Table 3–8. Summary of 2009 future design values in the matrix of emission reductions inside the DFW 9-county NAA.

Site	CurDV	Base	n100v75	n100v50	n100v25	n80v100	n60v100	n40v100	n80v75	n60v50	n40v25
NOx Anthro reduction (%)		**0**	**0**	**0**	**0**	**20**	**40**	**60**	**20**	**40**	**60**
VOC Anthro reduction (%)		**0**	**25**	**50**	**75**	**0**	**0**	**0**	**25**	**50**	**75**
Frisco	99.7	91.9	91.3	90.6	89.8	89.6	86.4	82.0	89.2	85.7	81.5
Dallas C60	92.0	88.0	87.1	86.2	85.3	86.0	82.8	78.0	85.4	81.9	77.2
Dallas C63	93.0	87.9	87.1	86.3	85.4	85.8	82.6	77.9	85.2	81.7	77.2
Dallas C402	87.3	80.5	80.1	79.6	79.1	78.4	75.8	72.1	78.1	75.2	71.7
Denton	101.5	90.7	90.2	89.7	89.1	87.7	83.8	78.8	87.4	83.4	78.6
Midlothian	92.5	85.4	85.1	84.7	84.3	83.9	81.9	79.1	83.7	81.6	78.9
Arlington	95.0	88.4	88.0	87.5	87.0	86.0	82.7	78.3	85.7	82.2	77.9
Fort Worth C13	98.3	88.9	88.6	88.3	87.9	86.1	82.7	78.2	85.9	82.2	77.9
Fort Worth C17	96.3	86.9	86.5	86.0	85.6	84.0	80.3	75.3	83.7	79.9	75.1

Values in red denote values below 85 ppb.
Read "n40v25" as 60% NOx reduction and 75% VOC reduction.

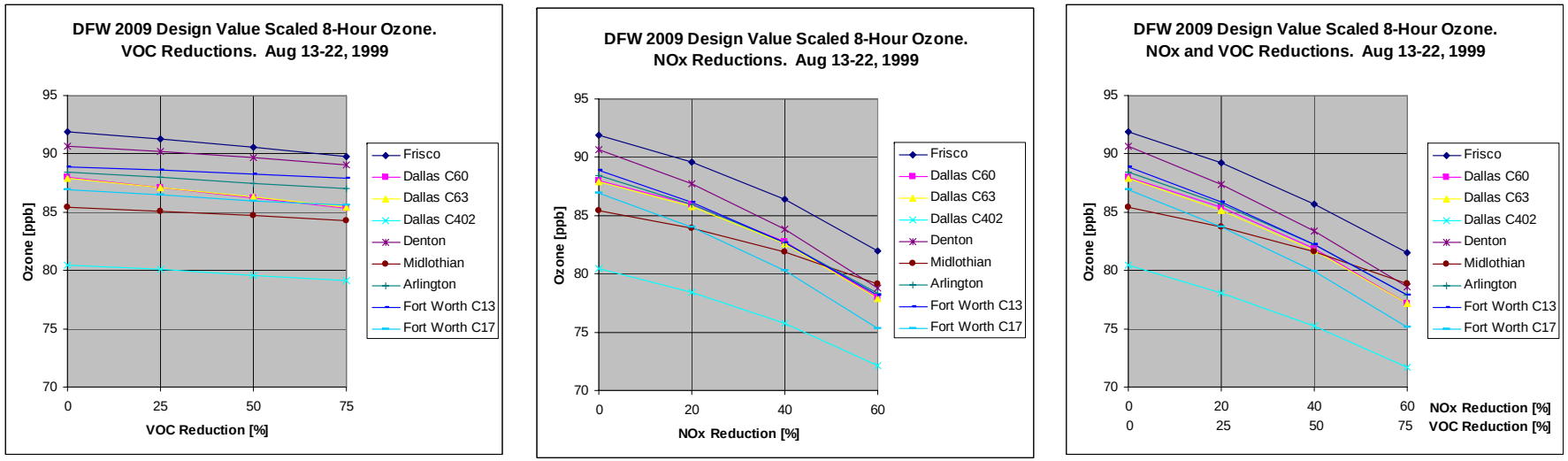


Figure 3–3. Response curves of ozone sensitivity to anthropogenic VOC reductions (left), NOX reductions (center), VOC and NOx reductions (right) in the DFW 9-county area.

4. REVISED 2009 "A1" BASELINE AND EMISSION CONTROLS

The 2009 baseline was updated with a new point source inventory. The following controls were applied to the updated 2009 "a1" baseline to examine ozone sensitivity in DFW:

- A matrix of nine "across the board" NOx and/or VOC controls inside the DFW 9-county NAA.
- High and low-end controls to the Midlothian cement kilns.
- Spark-ignition engine controls in East Texas and within a 200 km radius of DFW.
- DFW major source and DFW EGU controls.
- DFW EGU controls.
- DFW minor source controls (revised).
- High and low-end NCTCOG on-road and off-road mobile source controls.
- A combination of controls.
- East Texas EGU controls.

All runs in this section were based on the Run 44 baseline configuration. Inputs included meteorology from MM5 Run 6, which was based on the ETA PBL scheme coupled with the Noah land surface model, with the kv100 patch applied to the vertical diffusivity. The boundary conditions assigned moderate conditions in the mixed layer over land, and clean conditions over the Gulf, Atlantic and all areas aloft. A modified version of CAMx 4.03 was used in which several NOx recycling reactions were added to the CB4 mechanism (CB4xi) (Tai et al., 2005a).

4.1 REVISED 2009 "A1" BASELINE

An updated 2009 future year baseline run ("run44.fy2009.a1") was analyzed for the DFW August 13-22, 1999 episode. The emissions were updated to incorporate improved Texas point source emission projections to 2009, including the use of 2005 acid rain data for the Texas EGUs, as provided by TCEQ. The new 2009 "a1" series of baseline emissions lowered NOx emissions by 173 tpd from the previous 2009 emissions, including a 26 tpd reduction inside the DFW 9-county NAA. VOCs were reduced 15 tpd domain-wide, with 10 tpd in the DFW NAA. The new emissions were lower or the same in all regions of Texas except Houston. A summary of 2009 weekday emissions by source region, as defined in Figure 2-1, and emissions group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenic) is shown in Tables 4–1 and 4–2 for NOx and VOC, respectively. Anthropogenic differences from the previous 2009 baseline emissions are listed in the rightmost column.

Weekday 2009 baseline NOx emissions in Texas were 42 % lower than in 1999, which is slightly greater 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 4–1. 2009 “a1”baseline NOx emissions for a weekday in August.

NOx (tpd)	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from original 2009
Collin Co	10	15	1	0	2	8	0	26	-1.6
Dallas Co	4	77	6	2	18	45	0	149	-6.4
Denton Co	8	17	1	0	12	9	0	40	-0.5
Tarrant Co	3	46	2	2	10	28	0	89	-6.3
Parker Co	1	6	1	0	1	2	0	10	-0.2
Johnson Co	5	5	6	0	0	5	0	16	-0.1
Ellis Co	15	9	35	1	0	6	0	51	-7.1
Kaufman Co	5	6	4	0	0	2	0	13	-3.9
Rockwall Co	2	3	0	0	0	1	0	5	0.0
DFW 9-County	**52**	**184**	**55**	**6**	**44**	**107**	**0**	**396**	**-26.1**
DFW 16 County	**83**	**212**	**80**	**10**	**67**	**123**	**0**	**492**	**-56.9**
NE Texas	16	79	189	16	71	42	1	397	-20.7
Central TX	113	88	138	2	56	69	0	353	-53.2
Houston	21	175	282	12	53	63	0	585	46.9
South TX	229	189	267	22	75	100	0	653	-51.9
West TX	524	160	154	21	212	105	1	653	-32.7
Texas	**986**	**904**	**1109**	**83**	**534**	**501**	**2**	**3133**	**-168.6**
Gulf + Mexico	79	5	437	0	4	2	444	892	-0.8
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	-3.7
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**913**	**10389**	**85**	**543**	**509**	**23869**	**36308**	**-173.1**

Table 4–2. 2009 "a1" baseline VOC emissions for a weekday in August.

VOC (tpd)	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from original 2009
Collin Co	27	7	0	0	12	3	0	23	-0.7
Dallas Co	50	43	4	5	72	17	0	141	-3.3
Denton co	65	8	1	0	15	4	0	28	-0.7
Tarrant Co	64	25	2	5	54	9	0	94	-2.9
Parker Co	121	2	0	0	5	1	0	9	0.0
Johnson Co	111	2	0	0	6	1	0	9	0.0
Ellis Co	89	2	3	2	6	2	0	15	-1.3
Kaufman Co	112	2	0	0	7	1	0	11	-1.6
Rockwall Co	3	1	0	0	2	1	0	4	0.0
DFW 9-County	**642**	**92**	**10**	**13**	**180**	**38**	**0**	**333**	**-10.3**
DFW 16-County	**1538**	**103**	**34**	**15**	**216**	**44**	**1**	**413**	**-11.1**
NE Texas	4917	27	15	41	82	14	1	181	-2.2
Central TX	6098	33	20	20	85	21	1	180	-1.2
Houston	1683	80	92	215	247	41	0	675	6.7
South TX	2069	78	20	48	217	46	0	408	-3.9
West TX	6198	59	11	28	215	52	3	367	-1.9
Texas	**22503**	**380**	**191**	**367**	**1060**	**218**	**6**	**2223**	**-13.7**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	-0.8
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	655	695	0.0
Tennessee	8678	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12198	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**384**	**1107**	**370**	**1080**	**224**	**23453**	**26618**	**-14.5**

Figures 4–1 and 4– 2 show spatial plots of the daily maximum 8-hour ozone for each episode date in the 4 km and 12 km domains, respectively. The top plots show the daily maximum from the 1999 baseline (run44), the center plots show the 2009 baseline (run44.fy2009.a1), and the bottom plots show the difference between the two.

In the 4 km domain, the 2009 8-hour ozone was lower than the 1999 ozone in most areas except locally in eastern McLennan and Limestone Counties on most dates and in the DFW core on August 17 and 20, when ozone was up to 8 ppb higher. In the 12 km domain, ozone was

generally lower in 2009, except near Houston, where ozone became significantly higher starting on August 17, and locally in Bexar County (near San Antonio) from August 15-20.

Table 4–3 shows the future design value calculations for each DFW monitoring site using the 1999 baseline design values. Frisco's current design value was corrected from 99.7 ppb to 100.3 ppb. 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 episode relative reduction factor (RRF).

Daily RRFs are provided at the bottom of Table 4–3. Values in red indicate RRFs greater than 1.0; values in blue represent RRFs less than 0.9. All daily RRFs over 1.0 took place on August 17 and 20, coinciding with the positive values in the difference plots of the 2009-1999 daily maximum 8-hour ozone in Figure 4–1. 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.

A comparison of the 2009 design values between the previous 2009 baseline and the updated baseline is shown in Table 4–4. The improved emission projections to 2009 helped lower the future design values at all DFW monitoring sites. Four sites lowered their future design values a full 1.0 ppb, including Frisco and Denton.

Table 4–5 counts the number of 4-km grid cells in the DFW 9-county NAA when the daily maximum 8-hour ozone exceeds 85 ppb for both the 1999 and 2009 baseline runs. August 19 had the largest area of exceedance cells, but most of those cells were on the southern end of the DFW NAA, where fewer monitoring stations existed. For the entire episode, the 2009 baseline had about half as many exceedance cells as the 1999 baseline.

Table 4–6 sums the number of ppb's in excess of 85 ppb in the DFW NAA in 4 km resolution using the daily maximum 8-hour ozone for each date of the 1999 and 2009 baseline runs. The total exceedance from all dates dropped 69 % from 1999 to 2009. August 19 had the most exceedance ozone in 1999. August 17, the date with the highest observed 8-hour ozone, had the greatest level of exceedance ozone in 2009, as exceedances declined only 44 % from 1999 – the lowest percent reduction among the episode dates.

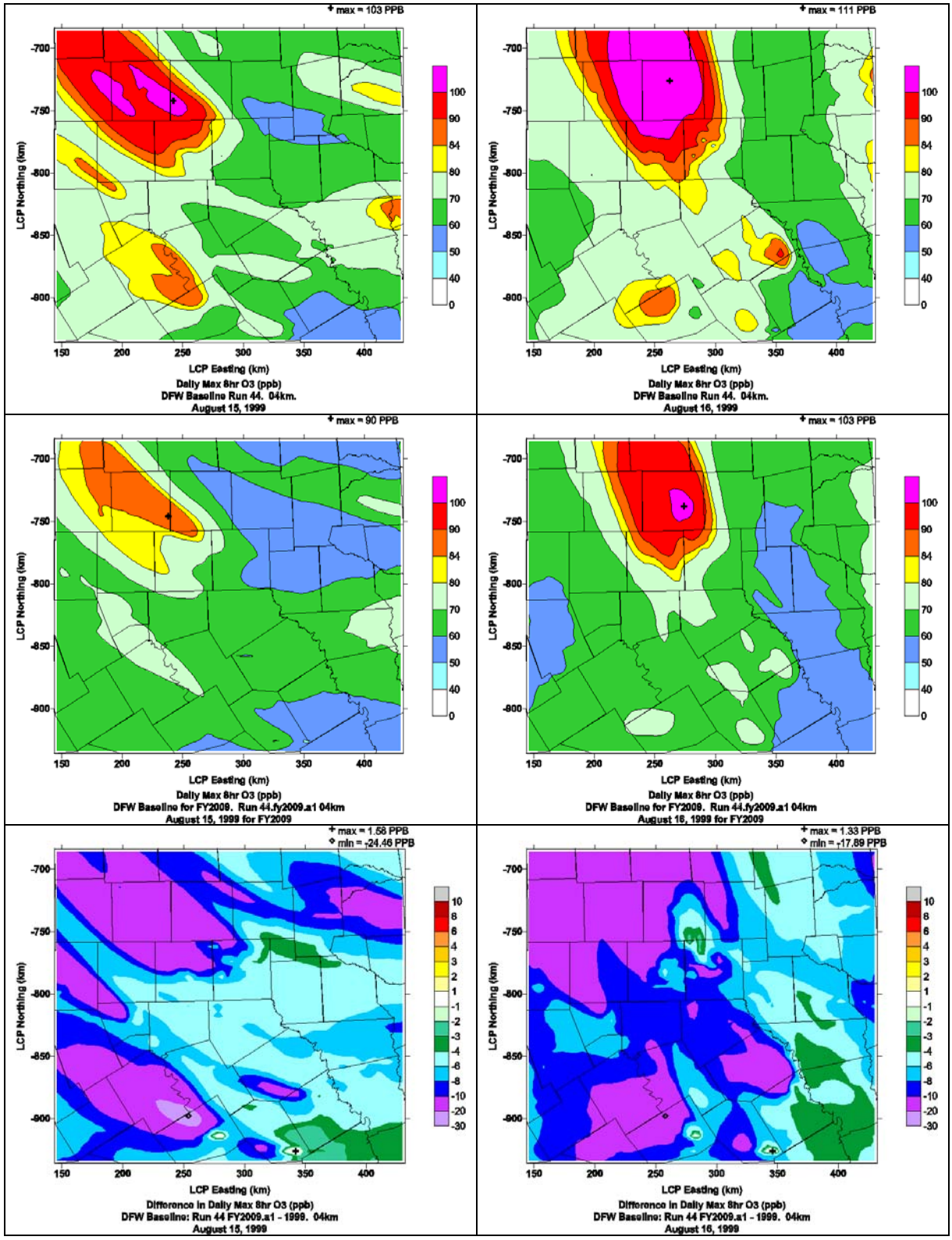


Figure 4–1. Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the DFW 4 km domain.

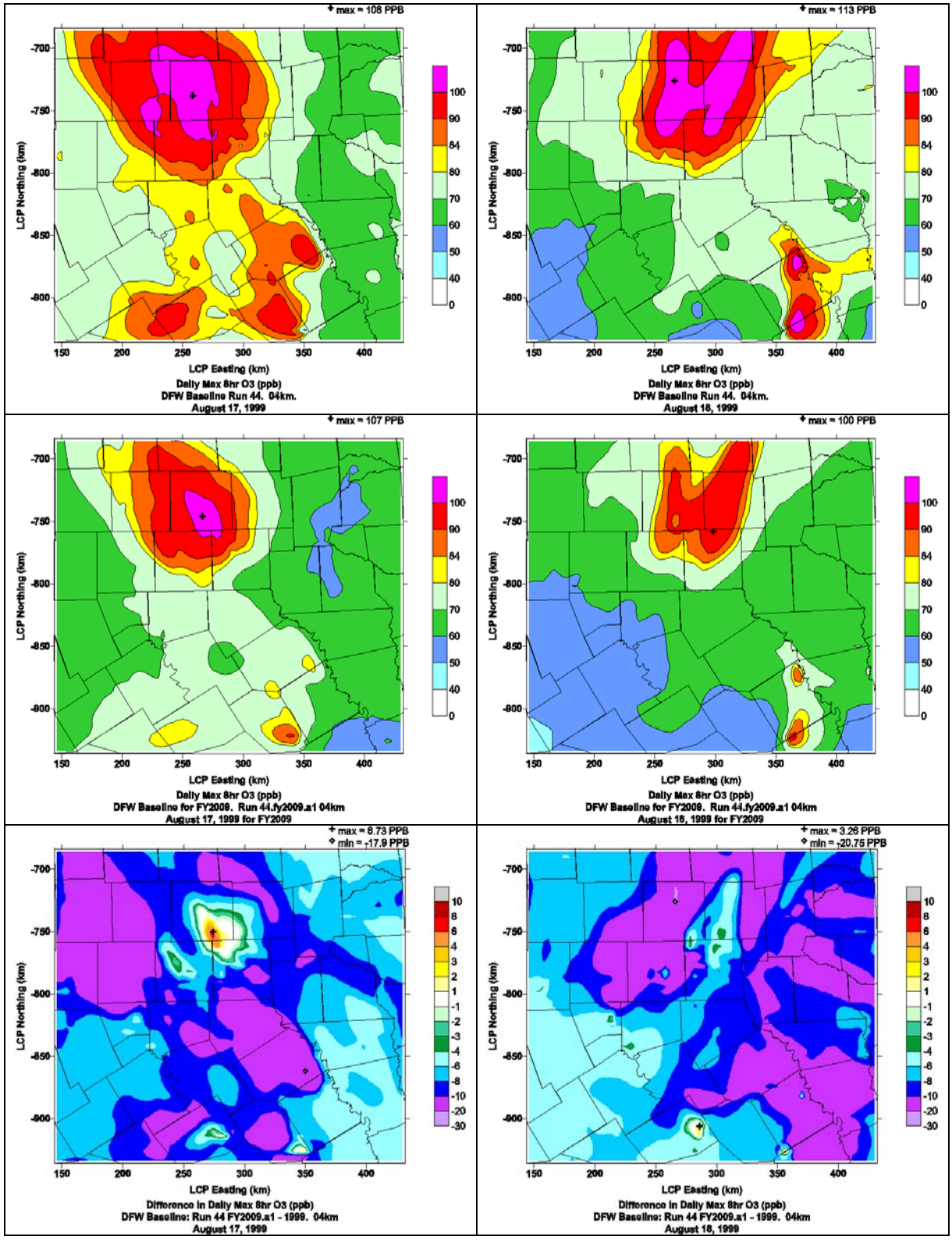


Figure 4–1. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the DFW 4 km domain.

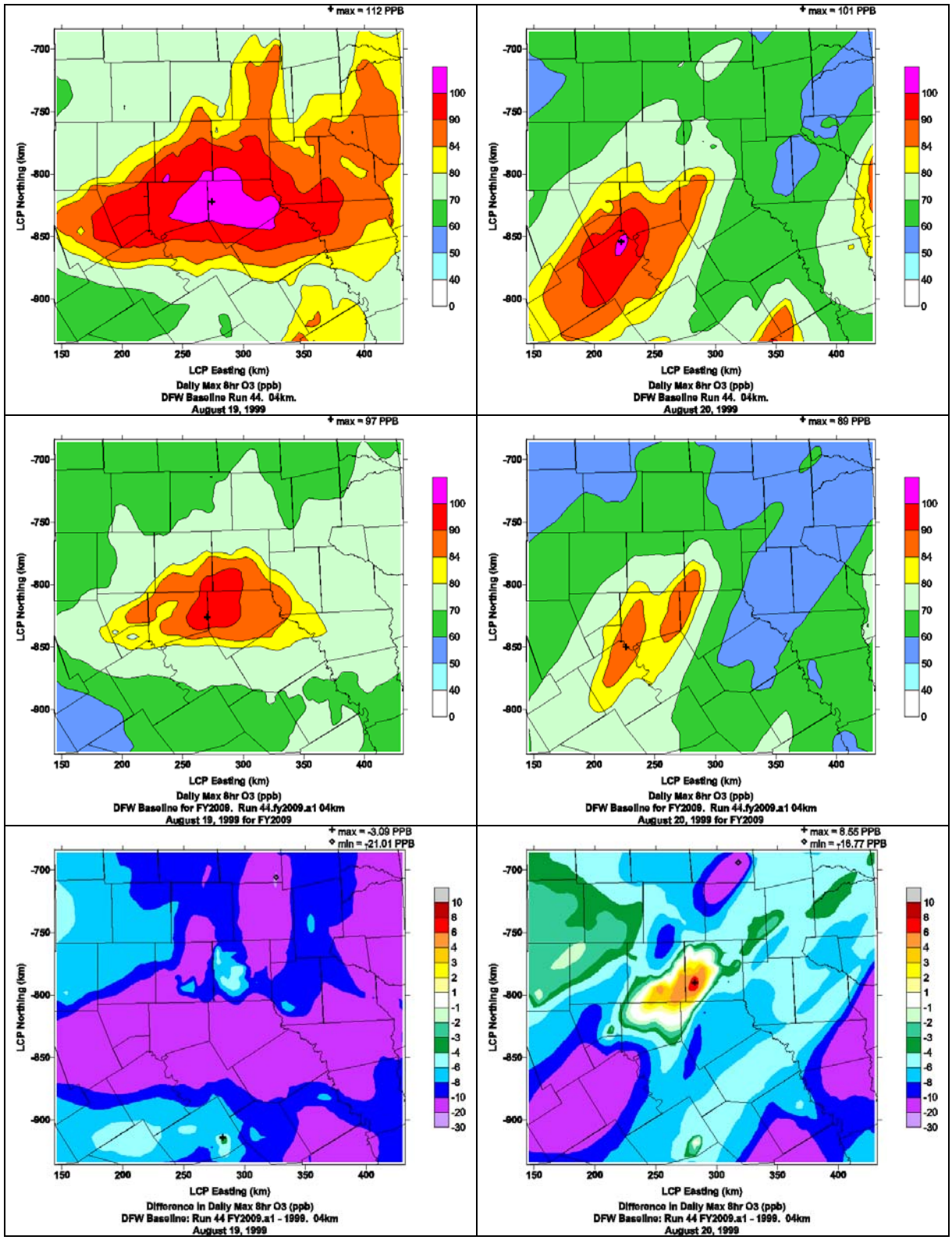


Figure 4–1. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the DFW 4 km domain.

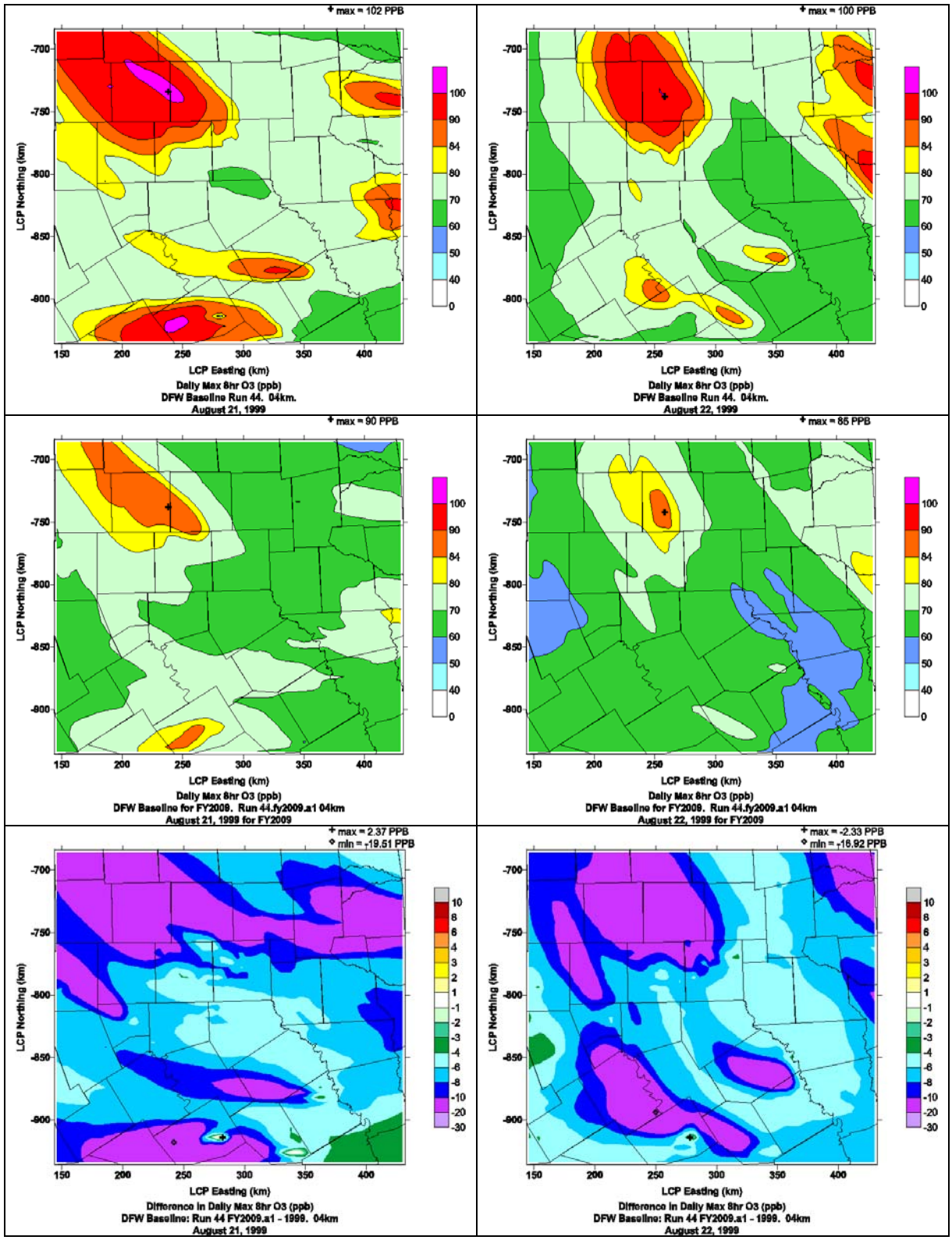


Figure 4–1. (Concluded) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the DFW 4 km domain.

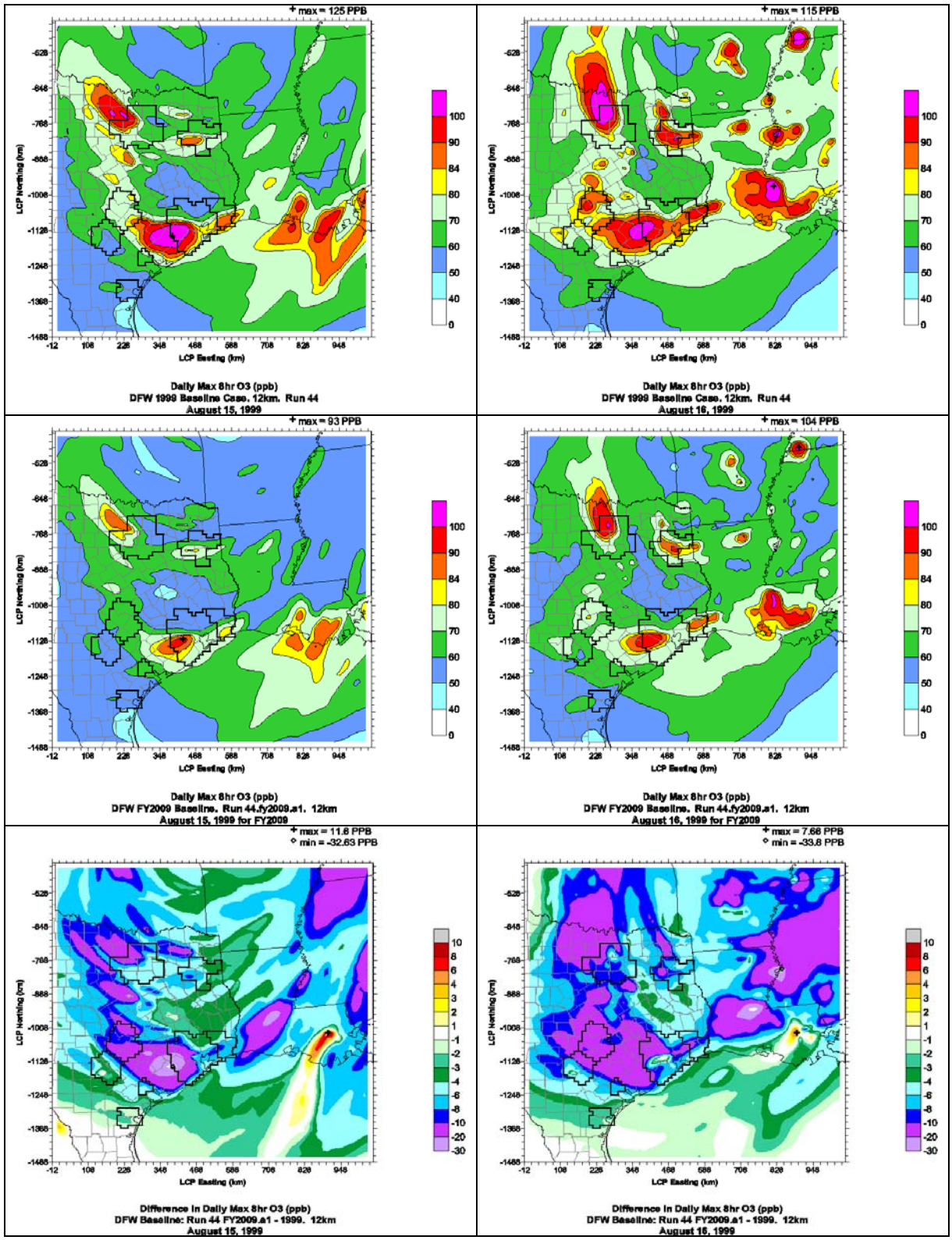


Figure 4–2. Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the 12 km domain.

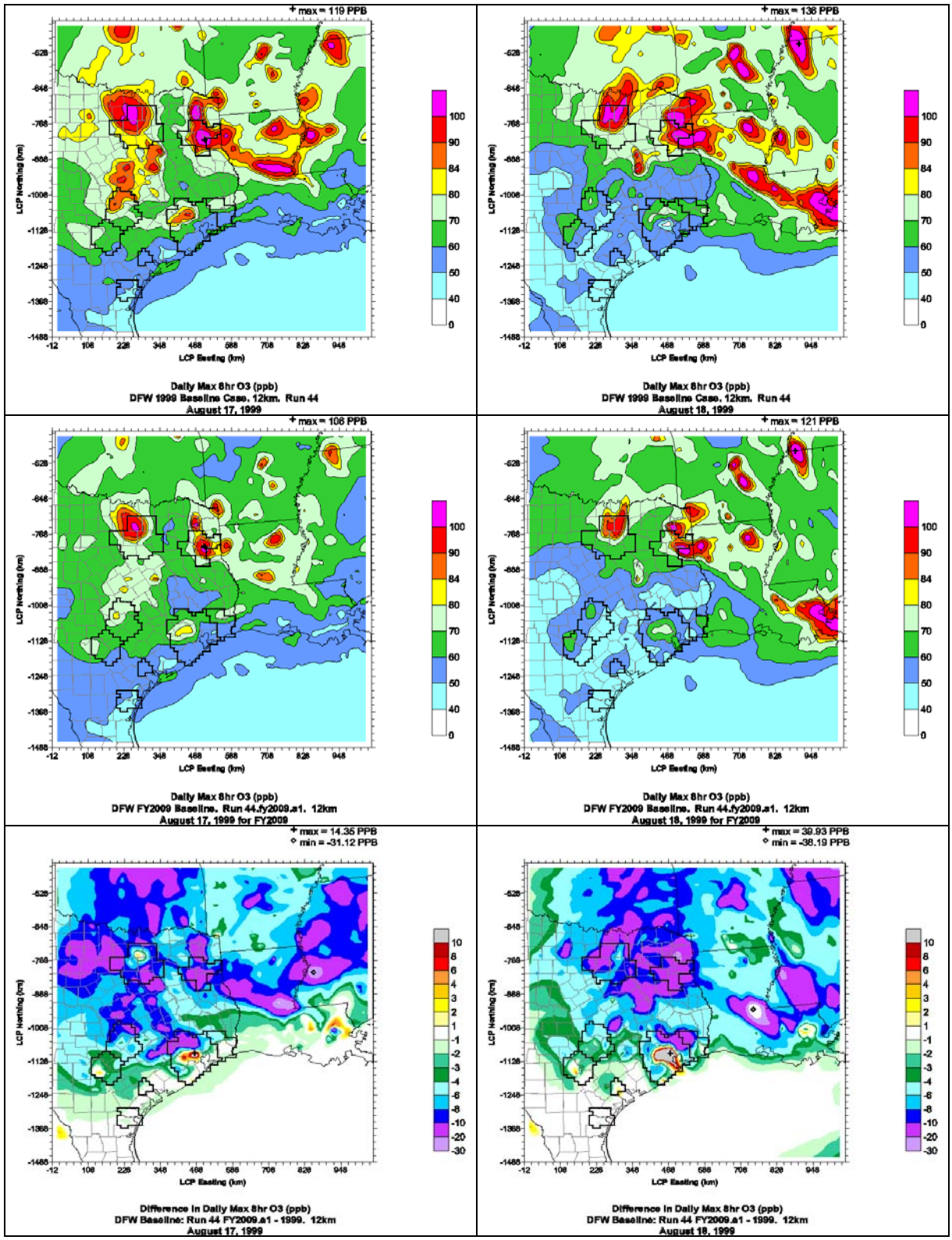


Figure 4–2. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the 12 km domain.

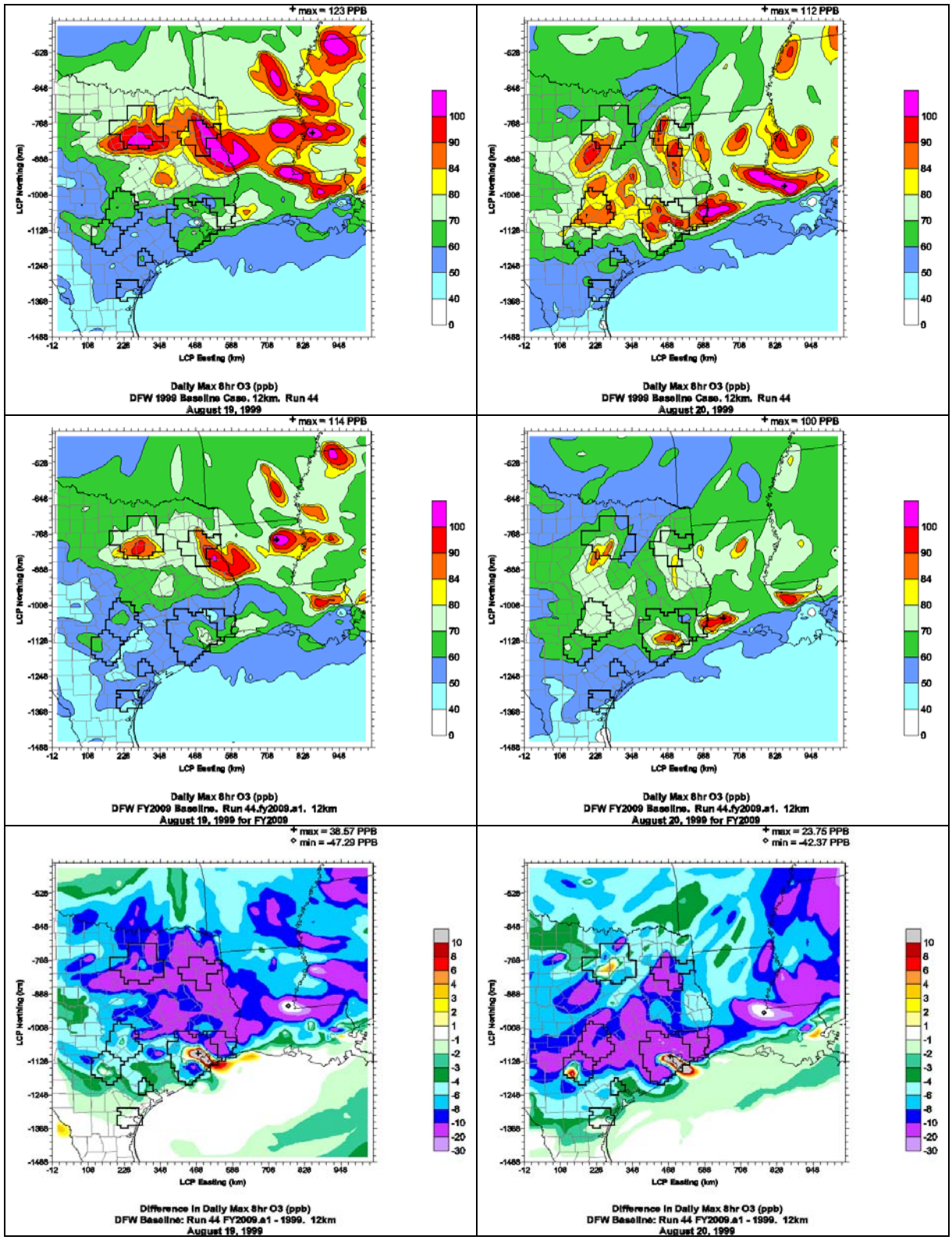


Figure 4–2. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the 12 km domain.

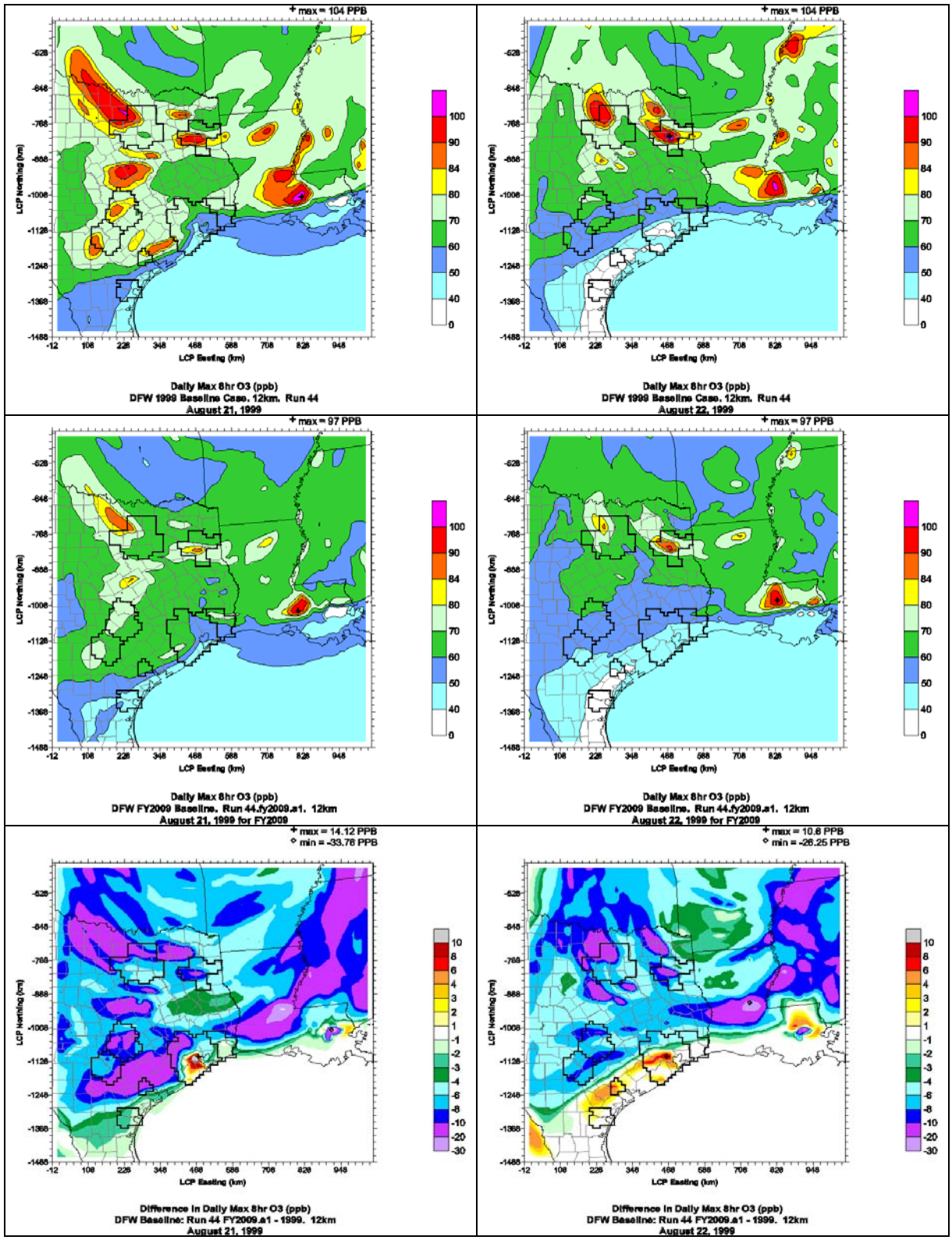


Figure 4–2. (Continued) Spatial plots of the daily maximum 8-hour ozone from the 1999 baseline (run44, top), 2009 baseline (run44.fy2009.a1, center), and 2009 – 1999 baseline differences (bottom) in the 12 km domain.

Table 4–3. Design Value Scaling for Baseline Run44.fy2009.a1.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**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: run44.fy2009.a1												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**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	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
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 average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–4. Comparison of 2009 future design values between the previous and current baselines.

Scenario	Old Baseline [ppb]	New Baseline [ppb]	Difference [ppb]
Run	**Run44.fy2009.a0**	**Run44.fy2009.a1**	
Frisco	92.5	91.2	-1.3
Dallas C60	88.0	87.6	-0.4
Dallas C63	87.9	87.0	-0.9
Dallas C402	80.5	79.7	-0.8
Denton	90.7	89.6	-1.1
Midlothian	85.4	84.5	-0.9
Arlington	88.4	87.2	-1.2
Fort Worth C13	88.9	87.6	-1.3
Fort Worth C17	86.9	86.0	-0.9

Table 4–5. Exceedance Area in the 1999 and 2009.a1 baselines (Number of 4-km grid cells in DFW with daily maximum 8-hour ozone > 85 ppb).

Scenario	1999 Baseline [# cells]	2009 Baseline [# cells]	% Difference
Run	**Run44**	**run44.fy2009.a1**	
990815	180	19	-89%
990816	332	223	-33%
990817	446	296	-34%
990818	423	253	-40%
990819	658	304	-54%
990820	102	70	-31%
990821	188	29	-85%
990822	169	5	-97%
Total	2498	1199	-52%

Table 4–6. Number of ppb's from 4-km grid cells in DFW with the daily maximum 8-hour ozone in excess of 85 ppb [1] for the 1999 and 2009 a1 baselines.

Scenario	1999 Baseline [ppb]	2009 Baseline [ppb]	% Difference
Run	**Run44**	**run44.fy2009.a1**	
990815	1300	50	-96%
990816	4659	2184	-53%
990817	4658	2594	-44%
990818	5191	1660	-68%
990819	6798	1201	-82%
990820	413	84	-80%
990821	1092	74	-93%
990822	1289	1	-100%
Total	25399	7846	-69%

[1] $\Sigma(\max(O3-85, 0.0))$

4.2 OZONE SENSITIVITY TO THE MATRIX OF LOCAL NOX AND VOC CONTROLS

The nine "across the board" emissions reductions (controls) were applied to the updated 2009 "a1" anthropogenic emissions inside the DFW 9-county NAA to evaluate ozone sensitivity to each control. Table 4–7 shows the matrix of NOx and VOC controls applied.

Table 4–7. Emission reduction matrix for 2009 "a1" ozone sensitivity simulations.

Anthropogenic Reduction		**NOx**			
		0%	**20%**	**40%**	**60%**
	0%	2009 baseline	X	X	X
	25%	X	X		
	50%	X		X	
VOC	**75%**	X			X

Future design values were calculated for each of the nine control levels. A summary of the future year design values at each monitoring site and control level is shown in Table 4–8. Response curves of VOC controls, NOx controls, and VOC and NOx controls at each monitoring site are shown in Figure 4–3.

The 2009 emission response curves shown in Figure 4–3 are similar to the original 2009 response curves. Ozone was responsive to anthropogenic NOx controls and not very responsive to VOC controls. Frisco had the highest future design value in all scenarios. Even though the corrected current design value at Frisco was higher, the level of local NOx reductions needed to achieve attainment was lower (42 %) than in the previous 2009 matrix runs (47 %). The NOx reduction inside the DFW 9-county NAA could be reduced to 40 % when accompanied by a 50 % VOC reduction.

Table 4–8. Summary of 2009 "a1" future design values in the matrix of emission reductions inside the DFW 9-county NAA.

Site	Current DV	Base	n100v75	n100v50	n100v25	n80v100	n60v100	n40v100	n80v75	n60v50	n40v25
NOx Anthro reduction (%)		**0**	**0**	**0**	**0**	**20**	**40**	**60**	**20**	**40**	**60**
VOC Anthro reduction (%)		**0**	**25**	**50**	**75**	**0**	**0**	**0**	**25**	**50**	**75**
Frisco	100.3	91.2	90.6	89.9	89.1	88.9	85.7	81.2	88.4	85.0	80.7
Dallas C60	92.0	87.6	86.8	85.8	85.0	85.4	82.0	77.2	84.8	81.1	76.5
Dallas C63	93.0	87.0	86.2	85.4	84.5	84.9	81.7	77.2	84.4	80.8	76.4
Dallas C402	87.3	79.7	79.3	78.8	78.3	77.6	74.9	71.2	77.3	74.4	70.8
Denton	101.5	89.6	89.1	88.7	88.1	86.6	82.6	77.7	86.3	82.2	77.4
Midlothian	92.5	84.5	84.2	83.9	83.5	82.9	80.9	78.1	82.7	80.6	77.8
Arlington	95.0	87.2	86.8	86.5	86.0	84.6	81.2	76.9	84.3	80.8	76.6
Fort Worth C13	98.3	87.6	87.3	87.0	86.6	84.7	81.3	76.8	84.4	80.8	76.6
Fort Worth C17	96.3	86.0	85.6	85.1	84.7	83.1	79.3	74.3	82.8	78.9	74.1

Values in red denote values below 85 ppb
Read "n40v25" as 60% NOx reduction and 75% VOC reduction

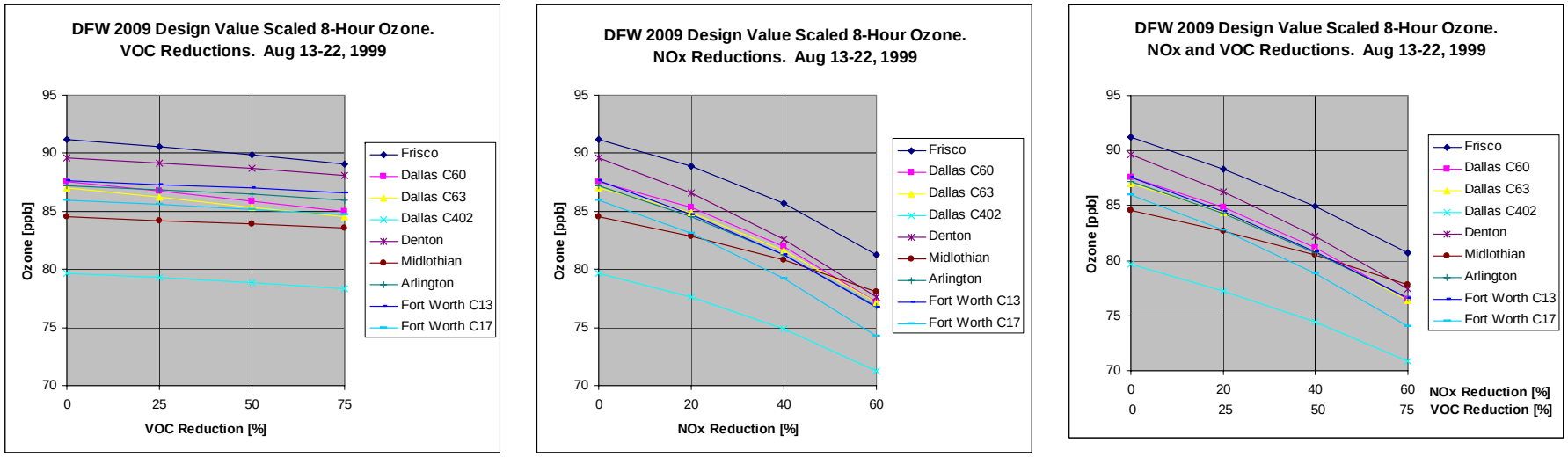


Figure 4–3. Response curves of ozone sensitivity to anthropogenic VOC reductions (left), NOX reductions (center), VOC and NOx reductions (right) in the DFW 9-county area based on the 2009 a1 baseline.

4.3 MIDLOTHIAN CEMENT KILN CONTROLS

Two cement kiln sensitivity tests were analyzed for 8-hour ozone in the Dallas/Fort Worth August 13-22, 1999 episode for the 2009 future year. The kiln controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs.

The 2009 baseline NOx emitted from the Midlothian cement kilns was 28 tpd. The high control scenario (run44.fy2009.a1.kiln1) reduced the kiln emissions by 20 tpd NOx. The low control scenario (run44.fy2009.a1.kiln2) reduced Midlothian kiln NOx by 10 tpd. Table 4–9 shows the August 17 biogenic and weekday anthropogenic NOx emissions by source region as defined in Figure 2-1 for the two control scenarios. Differences from the baseline, all coming from elevated point sources, are also shown. VOC emissions were unchanged.

Spatial plots of the daily maximum 8-hour ozone when applying the high cement kiln controls and differences from the 2009 baseline are shown in Figure 4–4 for each date. Similar plots for the low cement kiln control scenario are shown in Figure 4–5. Ozone reduction was always greater under the high control scenario. The plume of ozone reduction was strongest over Tarrant County on all dates except from August 18 to 20.

The difference plume approached Denton on August 16 and 17, but was weaker on the latter date, and missed Denton on the other dates. Frisco never took a direct hit from the kiln controls. Local ozone increases near the Midlothian kilns were observed on all dates as less NOx became available to scavenge the ozone. A small increase in 8-hour ozone was also detected in western Dallas County on August 17.

The future design value calculations for 8-hour ozone at all DFW monitors are shown in Tables 4–10 and 4–11 for 2009 with high and low Midlothian cement kiln controls, respectively. Table 4–12 compares the future design values between the 2009 a1 baseline and the two cement kiln control scenarios. The future design values were lower at all DFW monitors when applying the high cement kiln control. Two sites in Tarrant County -- Arlington and Fort Worth (CAMS13) – showed the greatest reduction at –1.0 and –0.9 ppb, respectively, when applying the higher control scenario; the lower control scenario reduced 8-hour ozone by about half as much. At the three Dallas monitoring sites and the two northern stations – Frisco and Denton, both kiln controls reduced most future design values less than a tenth of a ppb. At the Midlothian monitor, its proximity to the cement kilns led to a 0.4 ppb increase in its design value when applying the smaller kiln controls, but a 0.3 ppb decrease when using larger cement kiln controls.

Tables 4–13 counts the number of unique grid cells in DFW in 4 km resolution when 8-hour ozone exceeds 85 ppb for each date. Values are shown for the 2009 a1 baseline and both cement kiln control runs. Differences in the exceedance area resulting from each control are listed at the bottom of the table. Table 4–14 counts the number of exceedance cells that are reduced at least 1 ppb when applying the controls.

The high cement kiln control strategy reduced the number of exceedance grid cells in the DFW NAA by 4 % through the episode. Among the 2009 baseline exceedance cells, 14 % (166 out of 1199) were reduced at least 1 ppb. The controls appeared most effective on August 16, when 38 % (84 out of 223) exceedance grid cells were reduced at least 1 ppb, accounting for half the episode total; the exceedance area was lower by 5 %.

The low cement kiln control scenario reduced the total number of exceedance cells by 2 %. This control reduced 8-hour ozone at least 1 ppb in only 2 % of the exceedance cells, in contrast to the 14 % from the high control scenario; the majority of cells reduced at least 1 ppb also took place on August 16.

Table 4–9. Weekday NOx emissions in 2009 for the two cement kiln control runs.

		High Midlothian Cement Kiln Control		Low Midlothian Cement Kiln Control	
NOx [tpd]	**Biogenics**	**Anthro**	**Change from 2009 Baseline**	**Anthro**	**Change from 2009 Baseline**
Collin Co	10	26	0	26	0
Dallas Co	4	149	0	149	0
Denton Co	8	40	0	40	0
Tarrant Co	3	89	0	89	0
Parker Co	1	10	0	10	0
Johnson Co	5	16	0	16	0
Ellis Co	15	31	-20	41	-10
Kaufman Co	5	13	0	13	0
Rockwall Co	2	5	0	5	0
DFW 9-County	**52**	**376**	**-20**	**386**	**-10**
DFW 16 County	**83**	**472**	**-20**	**482**	**-10**
NE Texas	16	397	0	397	0
Central TX	113	353	0	353	0
Houston	21	585	0	585	0
South TX	229	653	0	653	0
West TX	524	653	0	653	0
Texas	**986**	**3112**	**-20**	**3123**	**-10**
Gulf + Mexico	79	892	0	892	0
Oklahoma	227	924	0	924	0
Louisiana	106	1905	0	1905	0
Arkansas	125	692	0	692	0
Mississippi	121	808	0	808	0
Alabama	75	932	0	932	0
Tennessee	118	906	0	906	0
Kentucky	145	1060	0	1060	0
Georgia	110	1230	0	1230	0
Florida	56	1573	0	1573	0
Mid Atlantic (SC, NC, VA, WV)	293	3310	0	3310	0
NE US	314	7051	0	7051	0
Northern Plains	5238	11892	0	11892	0
Total	**7992**	**36288**	**-20**	**36298**	**-10**

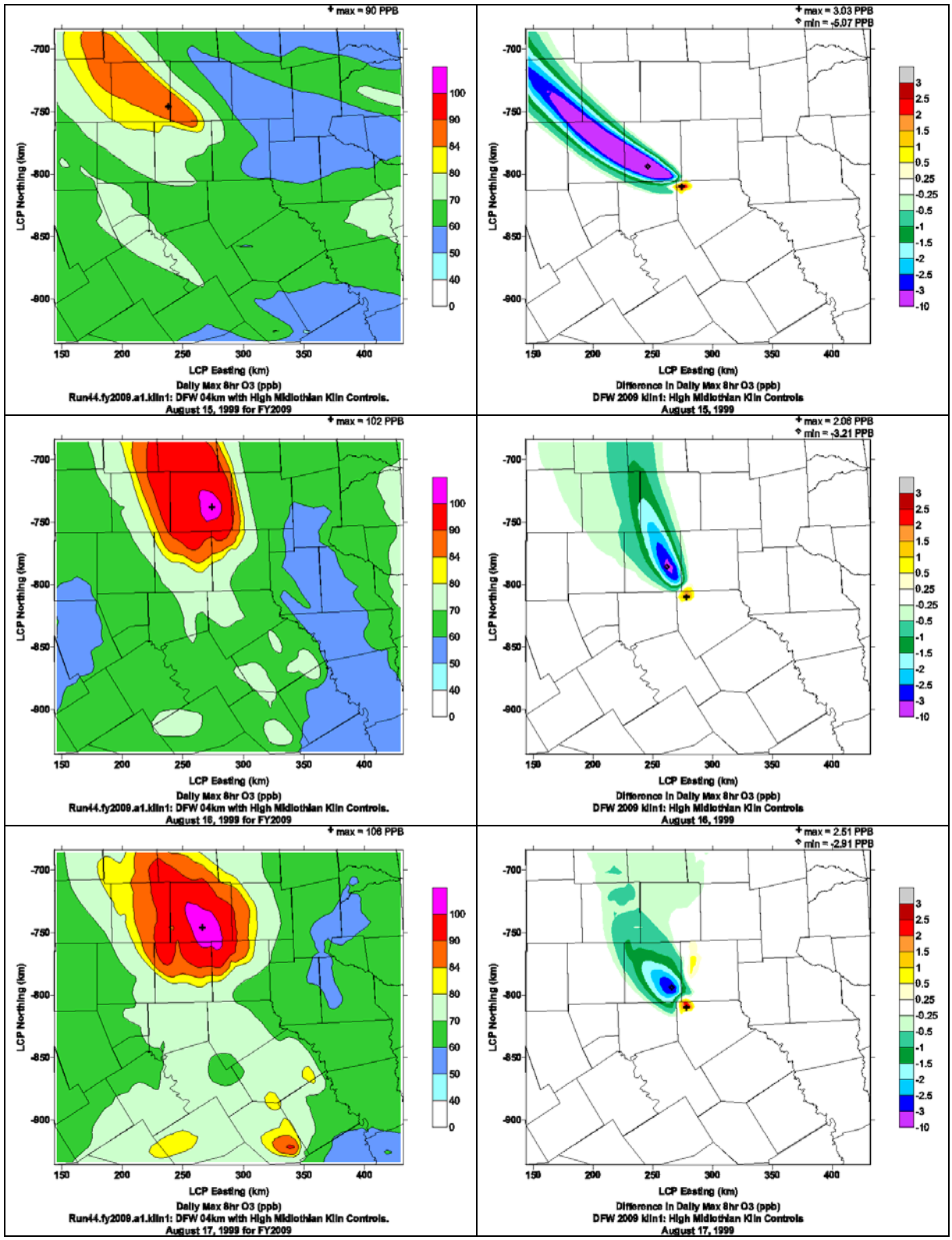


Figure 4–4. Spatial plots of the daily maximum 8-hour ozone with the high cement kiln controls (left) and difference from the 2009 baseline (right).

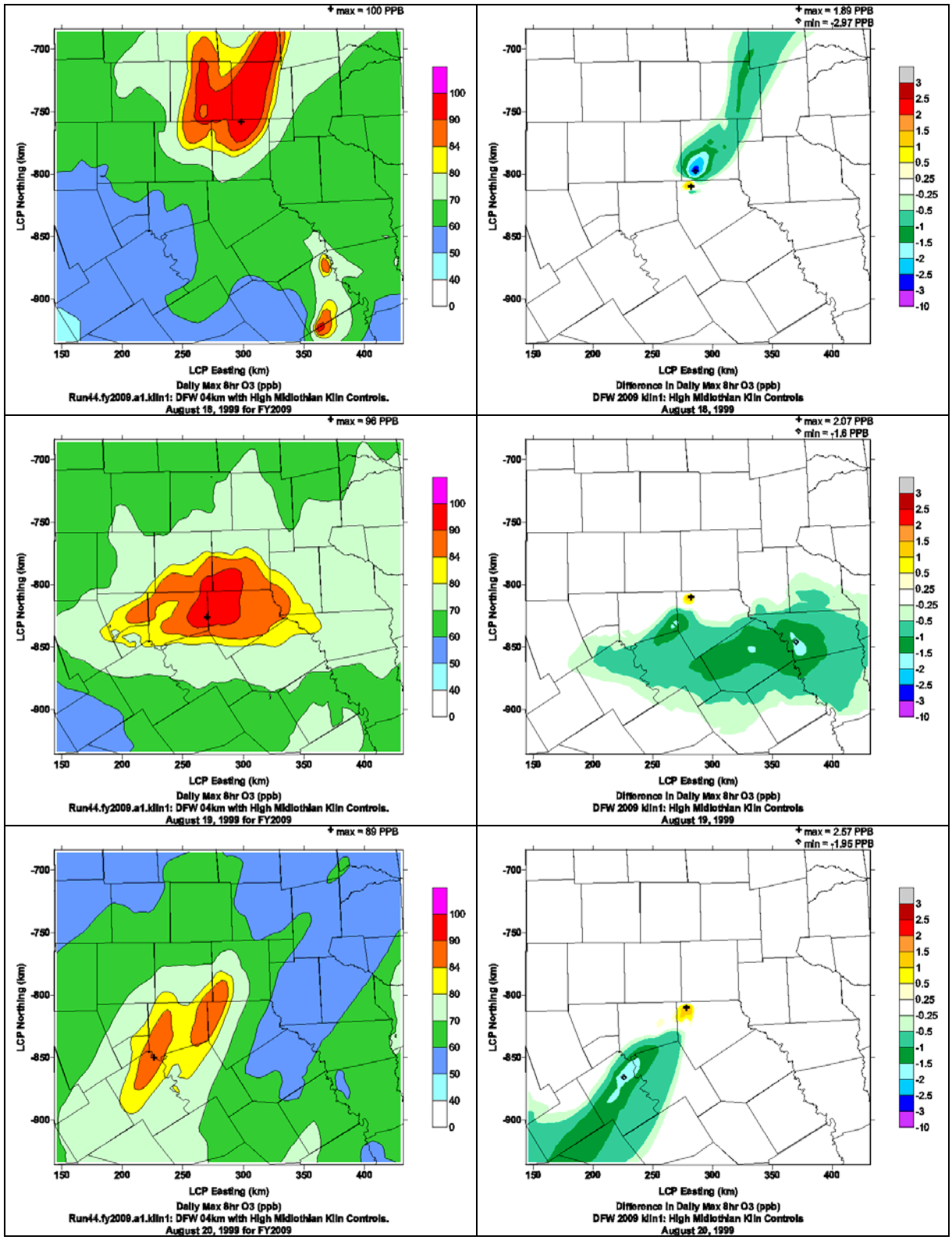


Figure 4–4. (continued). Spatial plots of the daily maximum 8-hour ozone with the high cement kiln controls (left) and difference from the 2009 baseline (right).

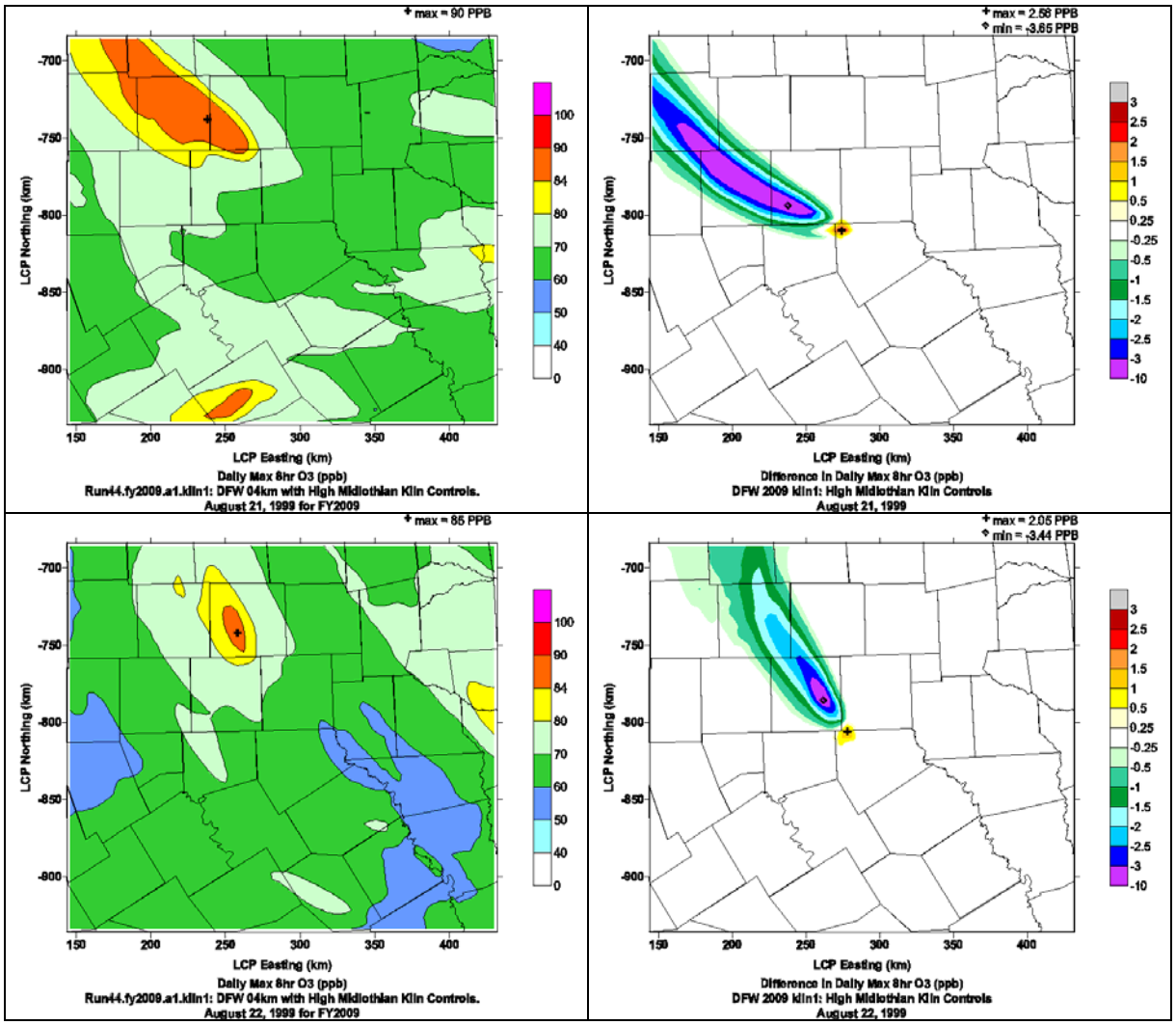


Figure 4–4. (concluded). Spatial plots of the daily maximum 8-hour ozone with the high cement kiln controls (left) and difference from the 2009 baseline (right).

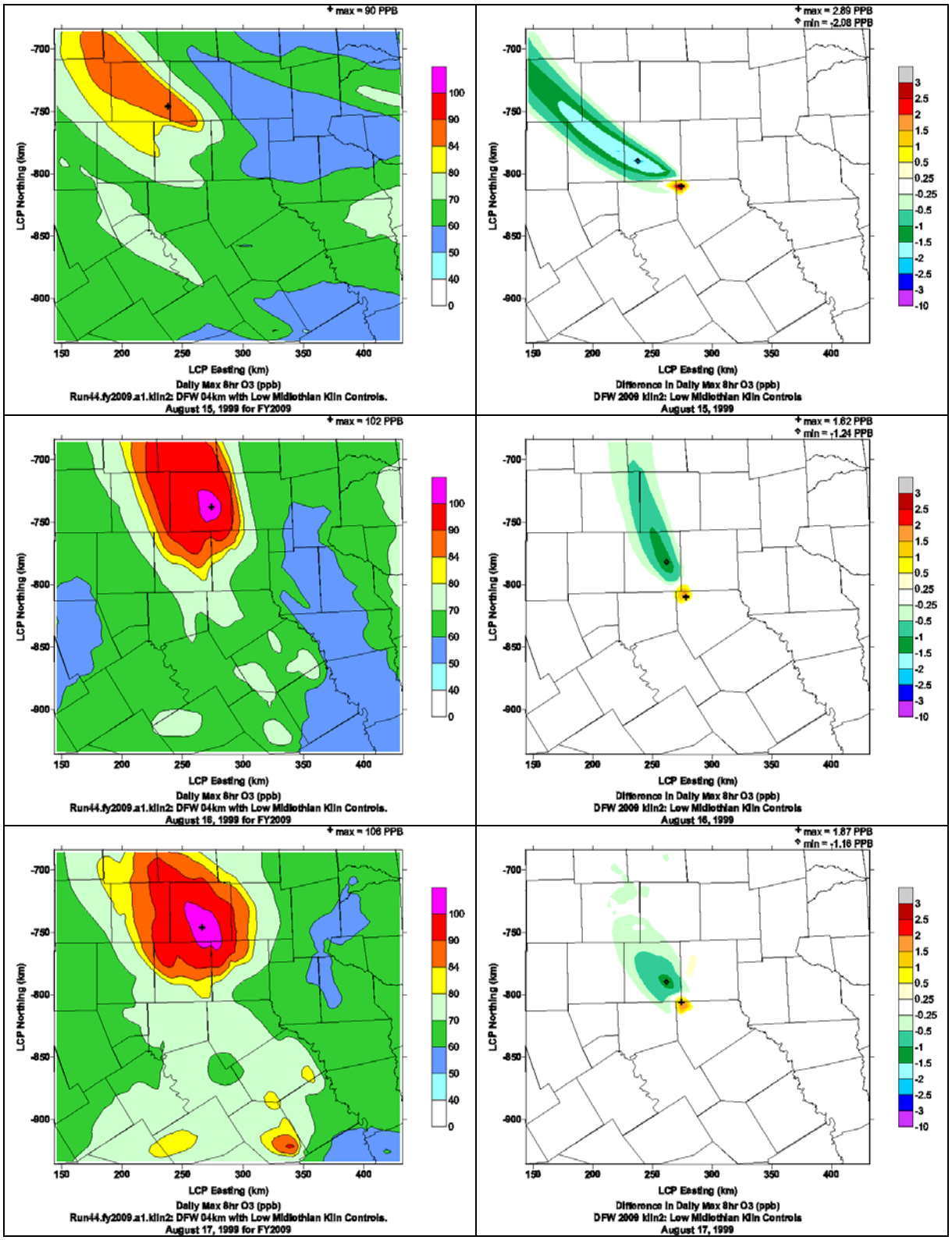


Figure 4–5. Spatial plots of the daily maximum 8-hour ozone with the low cement kiln controls (left) and difference from the 2009 baseline (right).

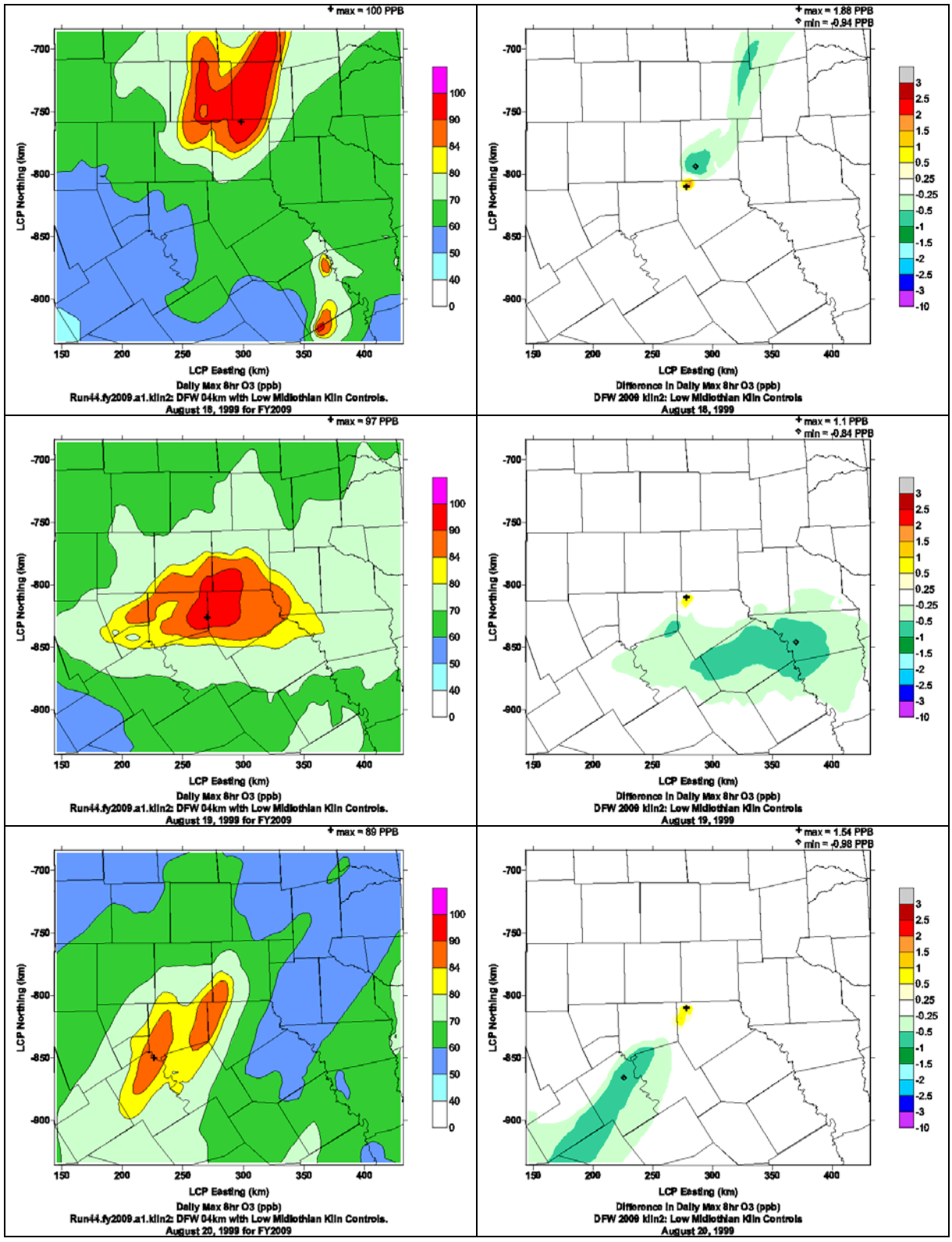


Figure 4–5. (continued). Spatial plots of the daily maximum 8-hour ozone with the low cement kiln controls (left) and difference from the 2009 baseline (right).

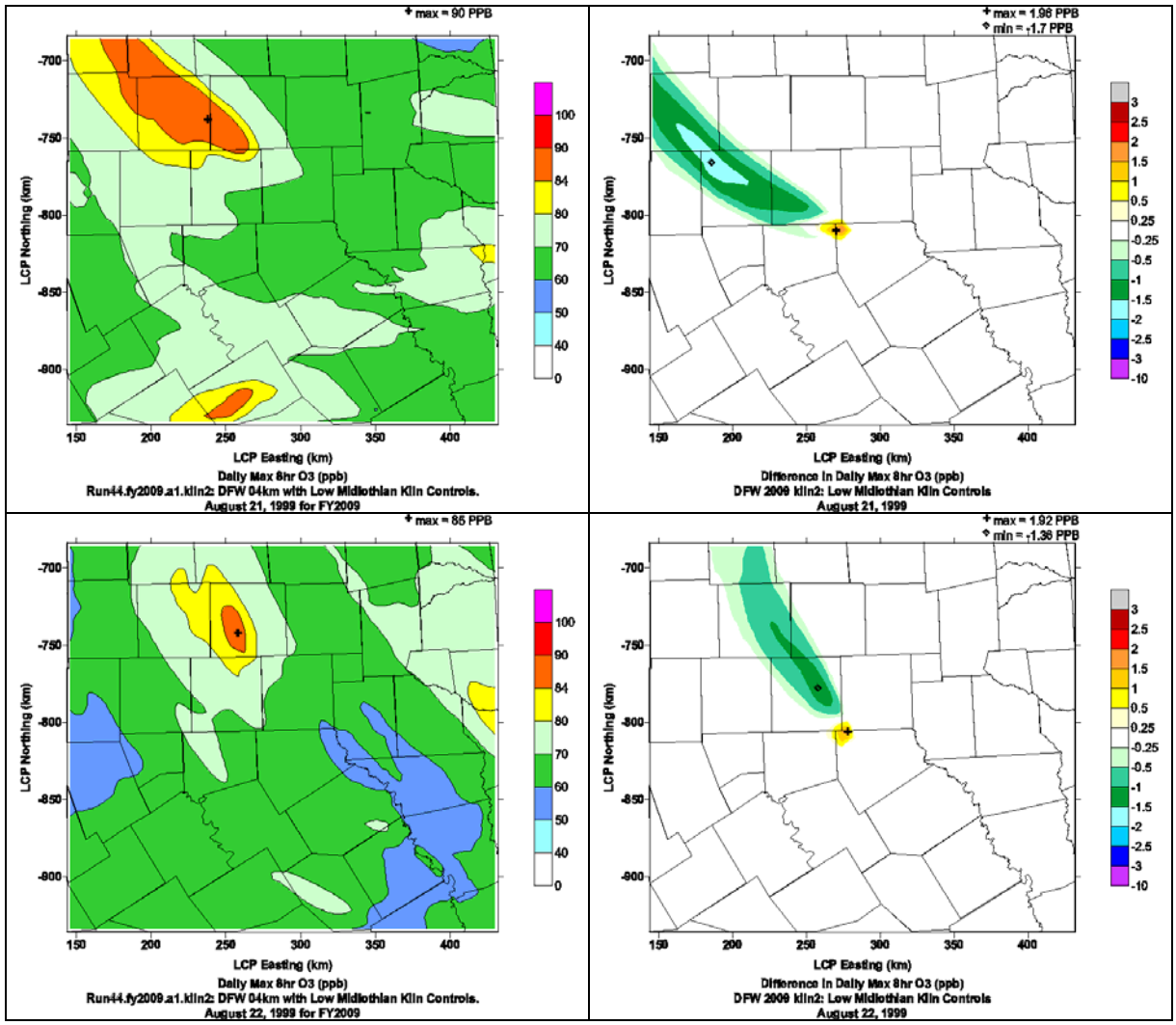


Figure 4–5. (concluded). Spatial plots of the daily maximum 8-hour ozone with the low cement kiln controls (left) and difference from the 2009 baseline (right).

Table 4–10. Future design value calculation for 2009 with high cement kiln controls.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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: run44.fy2009.a1.kiln1												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV[ppb]**	**Future DV[2][ppb]**
Frisco	68.4	100.1	100.6	98.2	73.2	64.9	75.1	75.4	82.0	0.909	100.3	91.2
Dallas C60	73.8	92.9	102.3	99.2	89.3	82.6	79.2	75.0	86.8	0.951	92.0	87.5
Dallas C63	71.7	95.7	100.6	99.7	83.9	78.8	77.8	74.2	85.3	0.935	93.0	87.0
Dallas C402	68.5	82.3	90.5	87.1	95.6	87.7	72.2	70.2	81.7	0.911	87.3	79.5
Denton	88.6	102.1	106.3	92.2	71.0	64.1	89.6	85.0	87.4	0.882	101.5	89.6
Midlothian	69.3	75.8	77.4	70.7	96.1	87.7	69.2	68.7	76.9	0.910	92.5	84.2
Arlington	74.3	87.3	90.5	83.0	94.5	87.7	74.1	76.3	83.4	0.907	95.0	86.2
Fort Worth C13	80.2	92.5	92.9	88.2	83.7	76.5	80.5	79.4	84.2	0.882	98.3	86.7
Fort Worth C17	88.9	96.5	102.1	90.6	79.7	71.0	87.9	84.3	87.6	0.890	96.3	85.7
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.847	0.947	1.017	0.935	0.855	0.926	0.875	0.844				
Dallas C60	0.887	0.947	1.017	0.964	0.924	1.067	0.921	0.881				
Dallas C63	0.866	0.960	1.016	0.952	0.893	1.038	0.904	0.848				
Dallas C402	0.875	0.886	0.923	0.886	0.913	1.035	0.897	0.871				
Denton	0.865	0.924	0.981	0.816	0.847	0.886	0.881	0.850				
Midlothian	0.918	0.892	0.899	0.907	0.860	0.979	0.923	0.917				
Arlington	0.861	0.888	0.908	0.878	0.904	1.041	0.907	0.881				
Fort Worth C13	0.851	0.878	0.905	0.846	0.881	0.958	0.885	0.864				
Fort Worth C17	0.885	0.877	0.948	0.849	0.864	0.912	0.924	0.866				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–11. Future design value calculation for 2009 with low cement kiln controls.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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: run44.fy2009.a1.kiln2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV [ppb]**	**Future DV[2][ppb]**
Frisco	68.4	100.1	100.5	98.3	73.2	64.9	75.1	75.4	82.0	0.910	100.3	91.23
Dallas C60	73.8	93.0	102.2	99.4	89.4	82.6	79.2	75.0	86.8	0.952	92.0	87.54
Dallas C63	71.7	95.7	100.5	99.9	83.9	78.8	77.8	74.2	85.3	0.936	93.0	87.01
Dallas C402	68.5	82.5	90.5	87.8	95.6	87.6	72.2	70.2	81.9	0.912	87.3	79.64
Denton	88.6	102.3	106.5	92.2	71.0	64.1	89.6	85.1	87.4	0.883	101.5	89.59
Midlothian	71.0	76.8	78.6	71.4	97.1	87.1	69.2	69.4	77.6	0.918	92.5	84.94
Arlington	74.3	89.1	90.9	83.3	94.4	87.6	74.1	78.2	84.0	0.913	95.0	86.77
Fort Worth C13	80.2	93.9	93.4	88.2	83.7	76.5	80.5	80.6	84.6	0.886	98.3	87.10
Fort Worth C17	88.9	97.2	102.3	90.6	79.7	71.0	87.9	84.4	87.8	0.892	96.3	85.86
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.847	0.948	1.016	0.937	0.855	0.926	0.875	0.844				
Dallas C60	0.887	0.948	1.016	0.967	0.924	1.067	0.921	0.881				
Dallas C63	0.866	0.961	1.015	0.954	0.893	1.038	0.904	0.848				
Dallas C402	0.875	0.888	0.923	0.893	0.914	1.034	0.897	0.871				
Denton	0.865	0.925	0.982	0.816	0.847	0.886	0.881	0.850				
Midlothian	0.940	0.904	0.913	0.916	0.868	0.973	0.923	0.927				
Arlington	0.861	0.906	0.913	0.882	0.904	1.041	0.907	0.902				
Fort Worth C13	0.851	0.891	0.910	0.846	0.881	0.958	0.885	0.877				
Fort Worth C17	0.885	0.883	0.951	0.849	0.864	0.912	0.924	0.868				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–12. 2009 future design values [ppb] with high and low-end cement kiln controls and differences from the 2009 a1 baseline.

Site	Run44.fy2009.a1 2009 a1 baseline	Run44.fy2009.a1.kiln1 High kiln controls	Run44.fy2009.a1.kiln2 Low kiln controls
Frisco	91.2	91.2	91.2
Dallas C60	87.6	87.5	87.5
Dallas C63	87.0	87.0	87.0
Dallas C402	79.7	79.5	79.6
Denton	89.6	89.6	89.6
Midlothian	84.5	84.2	84.9
Arlington	87.2	86.2	86.8
Fort Worth C13	87.6	86.7	87.1
Fort Worth C17	86.0	85.7	85.9
Change from 2009 a1 baseline [ppb]			
Frisco		-0.01	0.01
Dallas C60		-0.06	-0.02
Dallas C63		-0.02	0.00
Dallas C402		-0.16	-0.04
Denton		-0.07	-0.03
Midlothian		-0.35	0.41
Arlington		-1.02	-0.46
Fort Worth C13		-0.91	-0.50
Fort Worth C17		-0.23	-0.10

Table 4–13. Exceedance area with cement kiln controls (number of unique grid cells exceeding 85 ppb in the DFW 9-county NAA) and differences from the 2009 baseline.

Scenario Run	2009 Future Base run44.fy2009.a1	High Cement Kiln Control run44.fy2009.a1.kiln1	Low Cement Kiln Control run44.fy2009.a1.kiln2
990815	19	19	19
990816	223	211	219
990817	296	288	291
990818	253	243	249
990819	304	291	301
990820	70	65	68
990821	29	29	29
990822	5	1	4
Total	1199	1147	1180
Change from the 2009 a1 baseline			
990815	---	0%	0%
990816	---	-5%	-2%
990817	---	-3%	-2%
990818	---	-4%	-2%
990819	---	-4%	-1%
990820	---	-7%	-3%
990821	---	0%	0%
990822	---	-80%	-20%
Total	---	-4%	-2%

Table 4–14. Number of exceedance[1] grid cells that reduce the daily maximum 8-hour ozone by at least 1 ppb in DFW.

Scenario Run	2009 Future Base run44.fy2009.a1	High Cement Kiln Control run44.fy2009.a1.kiln1	Low Cement Kiln Control run44.fy2009.a1.kiln2
990815	---	0	0
990816	---	84	21
990817	---	48	2
990818	---	14	0
990819	---	18	0
990820	---	2	0
990821	---	0	0
990822	---	0	0
Totals	---	166	23

[1] Exceedance cells are 2009 baseline grid cells exceeding 85 ppb.

Summary

Two control scenarios were applied to the Midlothian cement kilns. The high control scenario lowered NOx emissions by 20 tpd; the low control scenario lowered NOx by 10 tpd. Their greatest impacts to 8-hour ozone reduction were in Tarrant County, where the 2009 8-hour ozone design value was reduced nearly 1.0 ppb and 0.5 ppb when applying the high and low levels of the kiln controls, respectively. The high cement kiln control reduced the future design value at least 0.1 ppb at 5 of the 9 monitoring sites; the remaining sites were all located further to the north. The low cement kiln controls reduced the 2009 design value by 0.1 ppb at 3 of the 9 sites. The plume of ozone reduction never made a direct hit on Frisco or Dallas CAMS 63 on any date in the episode.

The high and low cement kiln controls reduced the episode exceedance area by 4 % and 2 %, respectively. The controls were particularly important on August 16, when the plume headed slightly west of Denton, helping lower 38 % and 9% of all exceedance grid cells by at least 1 ppb from the high and low kiln controls, respectively.

4.4 EAST TEXAS ENGINE CONTROLS

Two CAMx sensitivity tests examined the impact from emission reductions in spark-ignition engines in East Texas to 8-hour ozone in the Dallas/Fort Worth August 13-22, 1999 episode for the 2009 future year. One run (run44.fy2009.a1.engine1) applied engine controls in all of East Texas, as specified in SB7; the second run (run44.fy2009.a1.engine2) applied the same controls, but only within a 200 km radius of influence outside the DFW 9-county area.

The engine controls were applied to the 2009 “a1” baseline emissions. The “engine1” scenario reduced weekday NOx emissions in East Texas, but outside the DFW 9-county NAA, by 83 tpd. South Texas accounted for almost half the NOx reduction (-39 tpd), while Northeast Texas accounted for about a quarter (-23 tpd NOx). When the controls were restricted to within 200 km of the DFW NAA and most of South Texas was not controlled, NOx reductions totaled only 41 tpd. Summaries of the 2009 weekday NOx emissions (with August 17 biogenics) are shown in Tables 4–15 and 4–16 by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-

level anthropogenic) for the engine controls in all of East Texas and within the 200 km radius of DFW, respectively. The rightmost column in each table shows the NOx reduction from each control. VOC emissions, shown in Table 4–17, were unchanged from the baseline in both scenarios. Plots of the difference in NOx emissions due to each control scenario are shown in Figure 4–6.

Table 4–15. Weekday NOx emissions in 2009 using engine controls in all of East Texas.

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a1 baseline
Collin Co	10	15	1	0	2	8	0	26	0
Dallas Co	4	77	6	2	18	45	0	149	0
Denton co	8	17	1	0	12	9	0	40	0
Tarrant Co	3	46	2	2	10	28	0	89	0
Parker Co	1	6	1	0	1	2	0	10	0
Johnson Co	5	5	6	0	0	5	0	16	0
Ellis Co	15	9	35	1	0	6	0	51	0
Kaufman Co	5	6	4	0	0	2	0	13	0
Rockwall Co	2	3	0	0	0	1	0	5	0
DFW 9-County	**52**	**184**	**55**	**6**	**44**	**107**	**0**	**396**	**0**
DFW 16 County	**83**	**212**	**71**	**7**	**66**	**123**	**0**	**480**	**-12**
NE Texas	16	79	179	7	66	42	1	374	-23
Central TX	113	88	136	2	53	69	0	348	-5
Houston	21	175	279	12	53	63	0	581	-3
South TX	229	189	244	11	70	100	0	615	-39
West TX	524	160	153	21	212	105	1	652	-1
Texas	**986**	**904**	**1063**	**60**	**520**	**501**	**2**	**3050**	**-82**
Gulf + Mexico	79	5	437	0	4	2	444	892	0
Oklahoma	227	1	256	0	2	3	661	924	0
Louisiana	106	1	715	1	2	1	1183	1904	-1
Arkansas	125	2	220	0	0	2	468	692	0
Mississippi	121	0	353	0	0	0	455	808	0
Alabama	75	0	442	0	0	0	491	932	0
Tennessee	118	0	244	0	0	0	662	906	0
Kentucky	145	0	289	0	0	0	770	1060	0
Georgia	110	0	408	0	0	0	823	1230	0
Florida	56	0	367	0	0	0	1206	1573	0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0
NE US	314	0	1302	0	0	0	5748	7051	0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0
Total	**7992**	**913**	**10343**	**62**	**529**	**509**	**23869**	**36224**	**-83**

Table 4–16. Weekday NOx emissions in 2009 using engine controls in East Texas within 200 km of the DFW 9-county area.

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro change from 2009 a1 baseline
Collin Co	10	15	1	0	2	8	0	26	0
Dallas Co	4	77	6	2	18	45	0	149	0
Denton co	8	17	1	0	12	9	0	40	0
Tarrant Co	3	46	2	2	10	28	0	89	0
Parker Co	1	6	1	0	1	2	0	10	0
Johnson Co	5	5	6	0	0	5	0	16	0
Ellis Co	15	9	35	1	0	6	0	51	0
Kaufman Co	5	6	4	0	0	2	0	13	0
Rockwall Co	2	3	0	0	0	1	0	5	0
DFW 9-County	**52**	**184**	**55**	**6**	**44**	**107**	**0**	**396**	**0**
DFW 16 County	**83**	**212**	**71**	**7**	**66**	**123**	**0**	**480**	**-12**
NE Texas	16	79	179	7	66	42	1	374	-23
Central TX	113	88	136	2	53	69	0	348	-4
Houston	21	175	282	12	53	63	0	585	0
South TX	229	189	266	21	75	100	0	651	-2
West TX	524	160	154	21	212	105	1	653	0
Texas	**986**	**904**	**1088**	**71**	**525**	**501**	**2**	**3092**	**-41**
Gulf + Mexico	79	5	437	0	4	2	444	892	0
Oklahoma	227	1	256	0	2	3	661	924	0
Louisiana	106	1	715	2	2	1	1183	1904	0
Arkansas	125	2	220	0	0	2	468	692	0
Mississippi	121	0	353	0	0	0	455	808	0
Alabama	75	0	442	0	0	0	491	932	0
Tennessee	118	0	244	0	0	0	662	906	0
Kentucky	145	0	289	0	0	0	770	1060	0
Georgia	110	0	408	0	0	0	823	1230	0
Florida	56	0	367	0	0	0	1206	1573	0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0
NE US	314	0	1302	0	0	0	5748	7051	0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0
Total	**7992**	**913**	**10369**	**73**	**534**	**509**	**23869**	**36267**	**-41**

Table 4–17. Weekday VOC emissions in 2009 for both engine control scenarios.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	27	7	0	0	12	3	0	23	0
Dallas Co	50	43	4	5	72	17	0	141	0
Denton co	65	8	1	0	15	4	0	28	0
Tarrant Co	64	25	2	5	54	9	0	94	0
Parker Co	121	2	0	0	5	1	0	9	0
Johnson Co	111	2	0	0	6	1	0	9	0
Ellis Co	89	2	3	2	6	2	0	15	0
Kaufman Co	112	2	0	0	7	1	0	11	0
Rockwall Co	3	1	0	0	2	1	0	4	0
DFW 9-County	**642**	**92**	**10**	**13**	**180**	**38**	**0**	**333**	**0**
DFW 16 County	**1538**	**103**	**34**	**15**	**216**	**44**	**1**	**413**	**0**
NE Texas	4917	27	15	41	82	14	1	181	0
Central TX	6098	33	20	20	85	21	1	180	0
Houston	1683	80	92	215	247	41	0	675	0
South TX	2069	78	20	48	217	46	0	408	0
West TX	6198	59	11	28	215	52	3	367	0
Texas	**22503**	**380**	**191**	**367**	**1060**	**218**	**6**	**2223**	**0**
Gulf + Mexico	658	3	32	0	10	4	329	378	0
Oklahoma	7940	1	3	0	5	1	481	490	0
Louisiana	9941	0	47	3	4	1	546	601	0
Arkansas	13925	0	23	0	2	0	441	466	0
Mississippi	14818	0	35	0	0	0	548	583	0
Alabama	13954	0	39	0	0	0	655	695	0
Tennessee	8678	0	66	0	0	0	895	961	0
Kentucky	3753	0	34	0	0	0	622	656	0
Georgia	12198	0	53	0	0	0	869	922	0
Florida	9793	0	42	0	0	0	1594	1636	0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0
NE US	20472	0	248	0	0	0	5407	5655	0
Northern Plains	40144	0	226	0	0	0	8224	8450	0
Total	**210073**	**384**	**1107**	**370**	**1080**	**224**	**23453**	**26618**	**0**

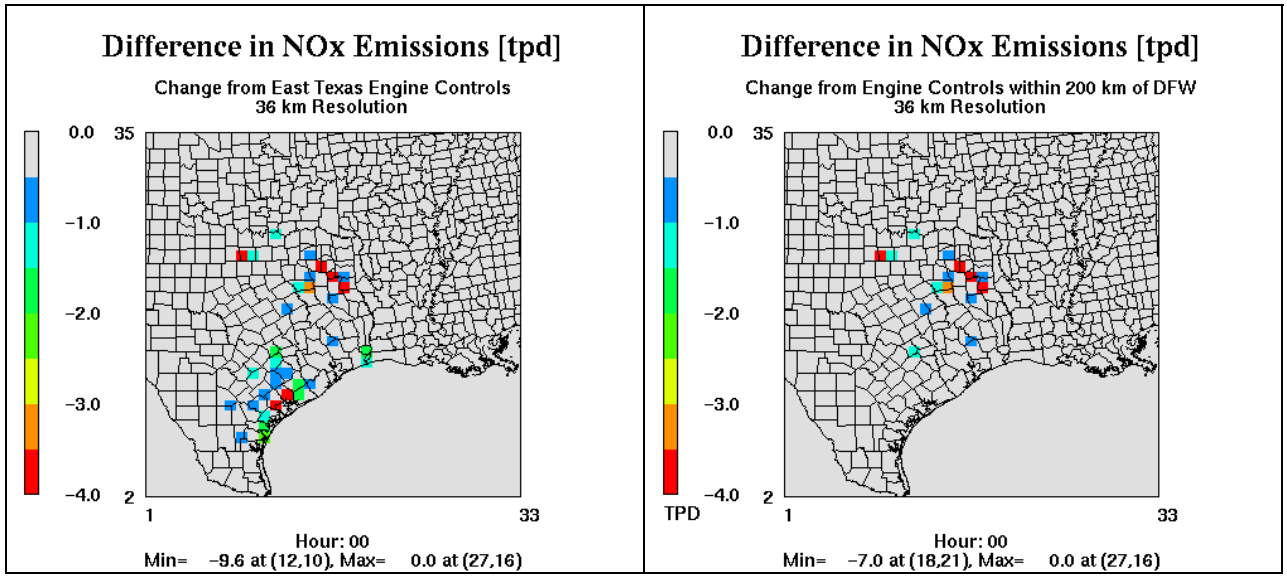


Figure 4–6. Tile plots of NOx reductions from the engine controls in East Texas (left) and within 200 km of DFW (right).

Model Results

Four daily maximum ozone and difference plots inside the DFW 4 km domain are shown in Figure 4–7 for each episode date. The top plots show the daily maximum 8-hour ozone when applying engine controls in East Texas (left) and within 200 km of DFW (right); the bottom plots show their differences from the 2009 baseline. Difference plots for the two engine controls in the 12 km domain are shown in Figure 4–8.

In the East Texas engine control scenario, the greatest ozone reduction on each date was located in or downwind of Northeast Texas, where significant NOx controls were applied. The daily maximum 8-hour ozone was reduced up to 6 ppb. On dates with an easterly wind (August 15, 16, 21, and 22), the benefits of reduced ozone were transported from Northeast Texas into the DFW 9-county NAA. Inside the 4 km domain, the greatest ozone reduction was found near the eastern boundary and near Wise County. Ozone reductions occasionally exceeded 1 ppb inside the DFW 9-county NAA, but 1 ppb reductions never coincided with 8-hour ozone exceeding 85 ppb.

The impact of engine controls within 200 km of DFW was nearly identical to the engine controls across East Texas in the 4 km domain, except on August 18, when the winds were southerly and the NOx controls in South Texas (in the East Texas engine control only) reduced 8-hour ozone slightly over a widespread area in the southwestern DFW 9-county NAA. In the 12 km domain, differences between the two controls were evident on all dates, particularly in South Texas near Victoria. When the engine controls were applied throughout East Texas, 8-hour ozone was up to 1 ppb lower on most dates in the South Texas region; this ozone reduction was not evident when the engine controls were limited to within 200 km of DFW, which excluded most of the NOx controls in South Texas.

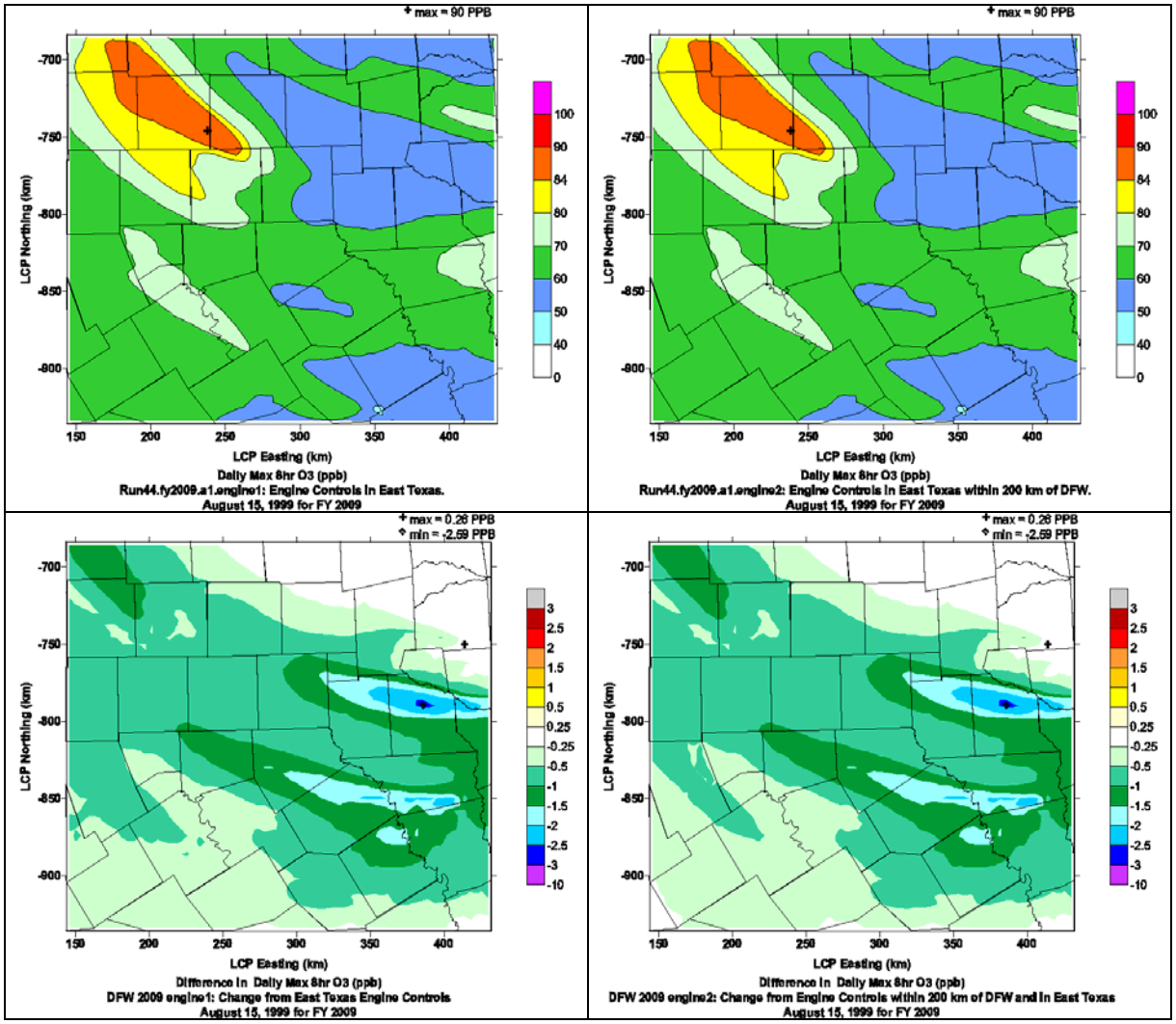


Figure 4–7. Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

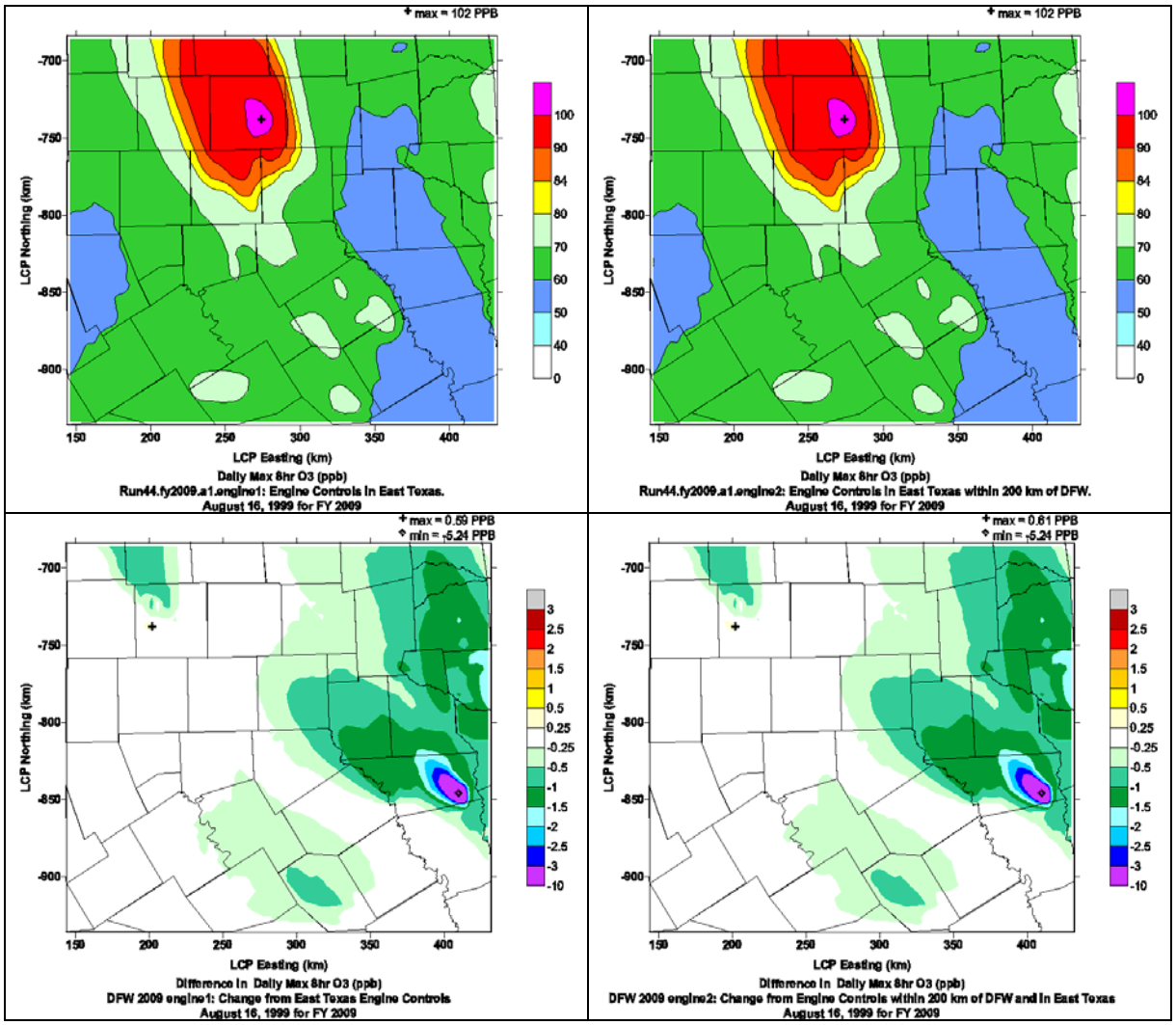


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

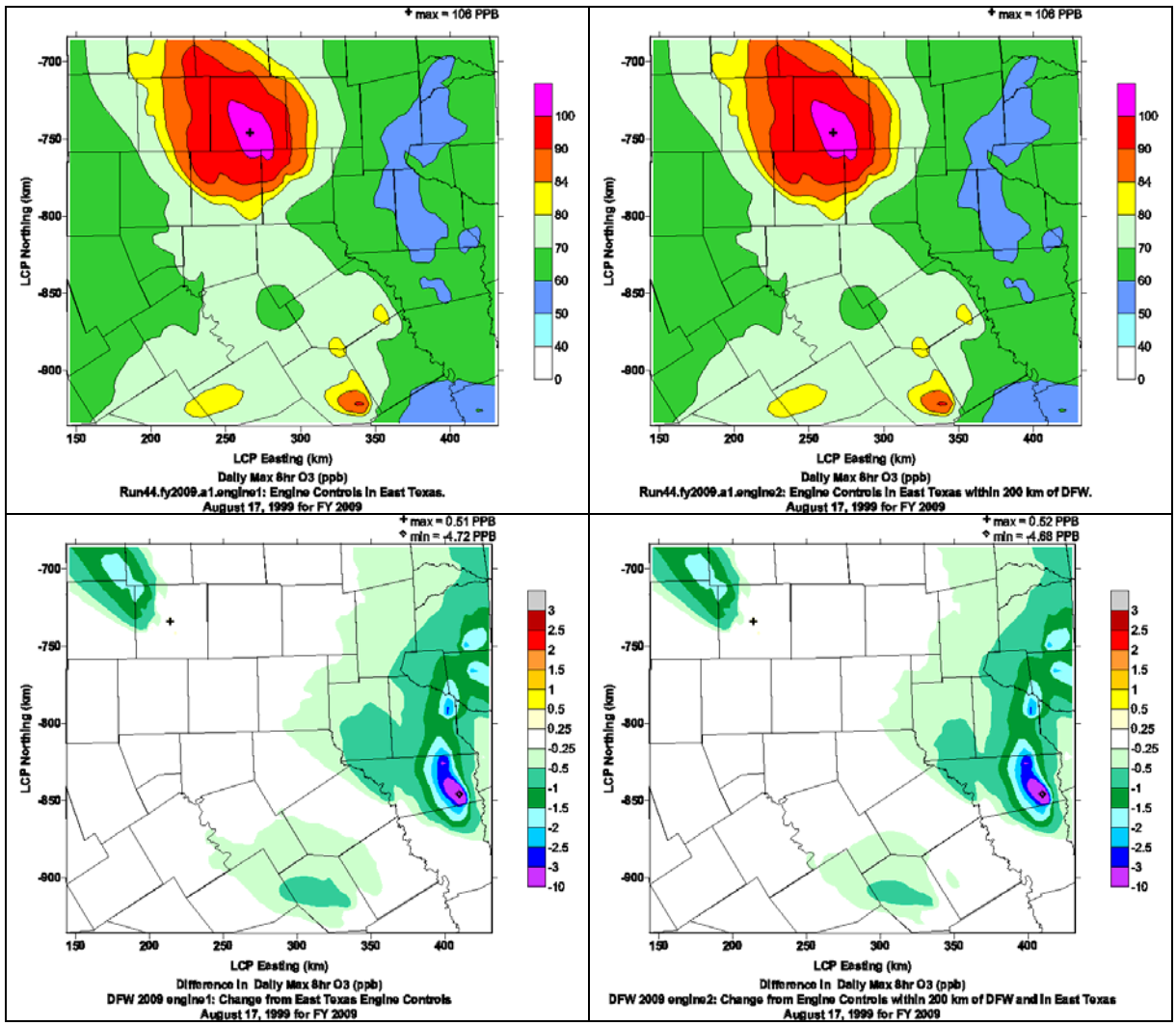


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

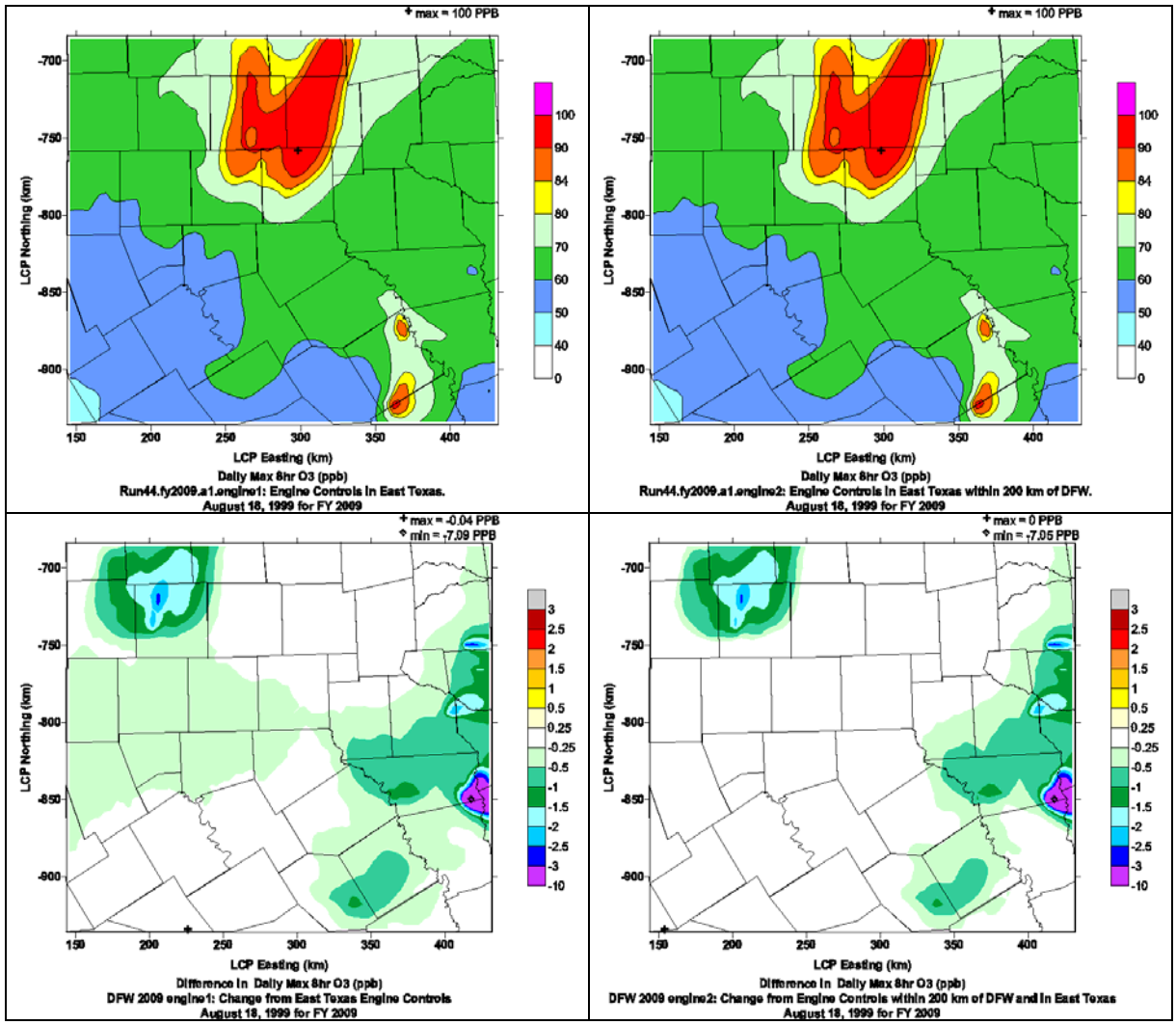


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

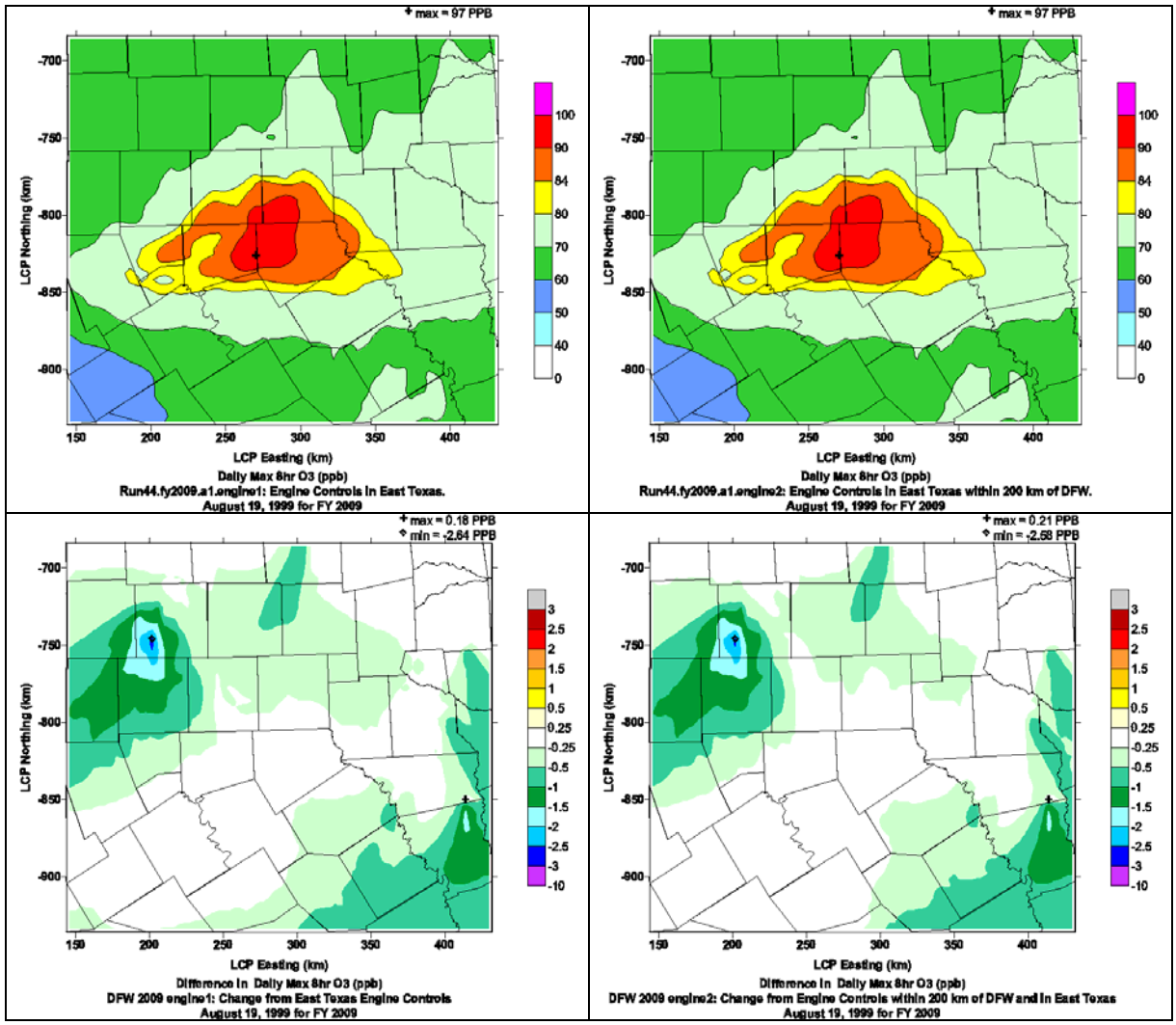


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

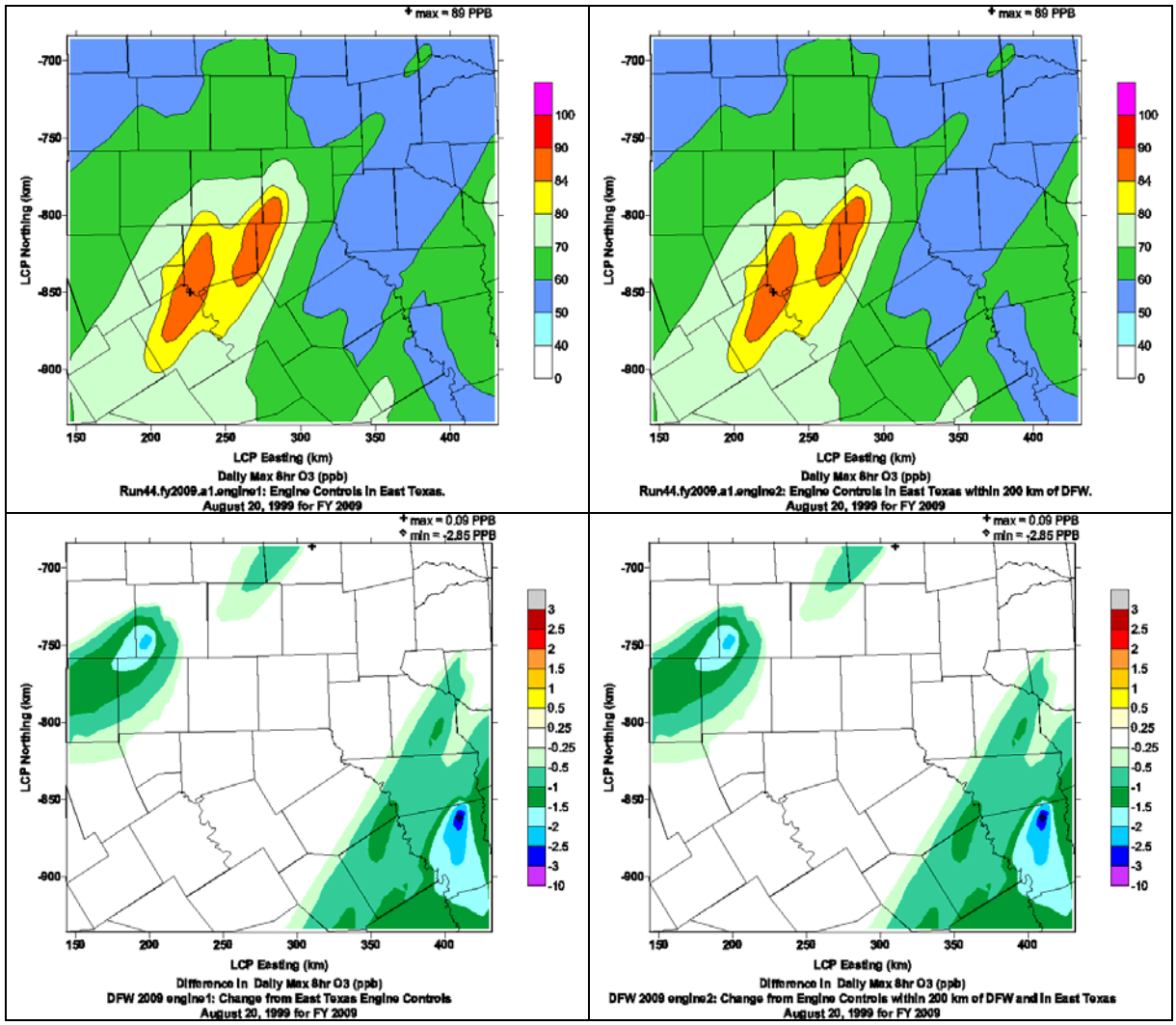


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

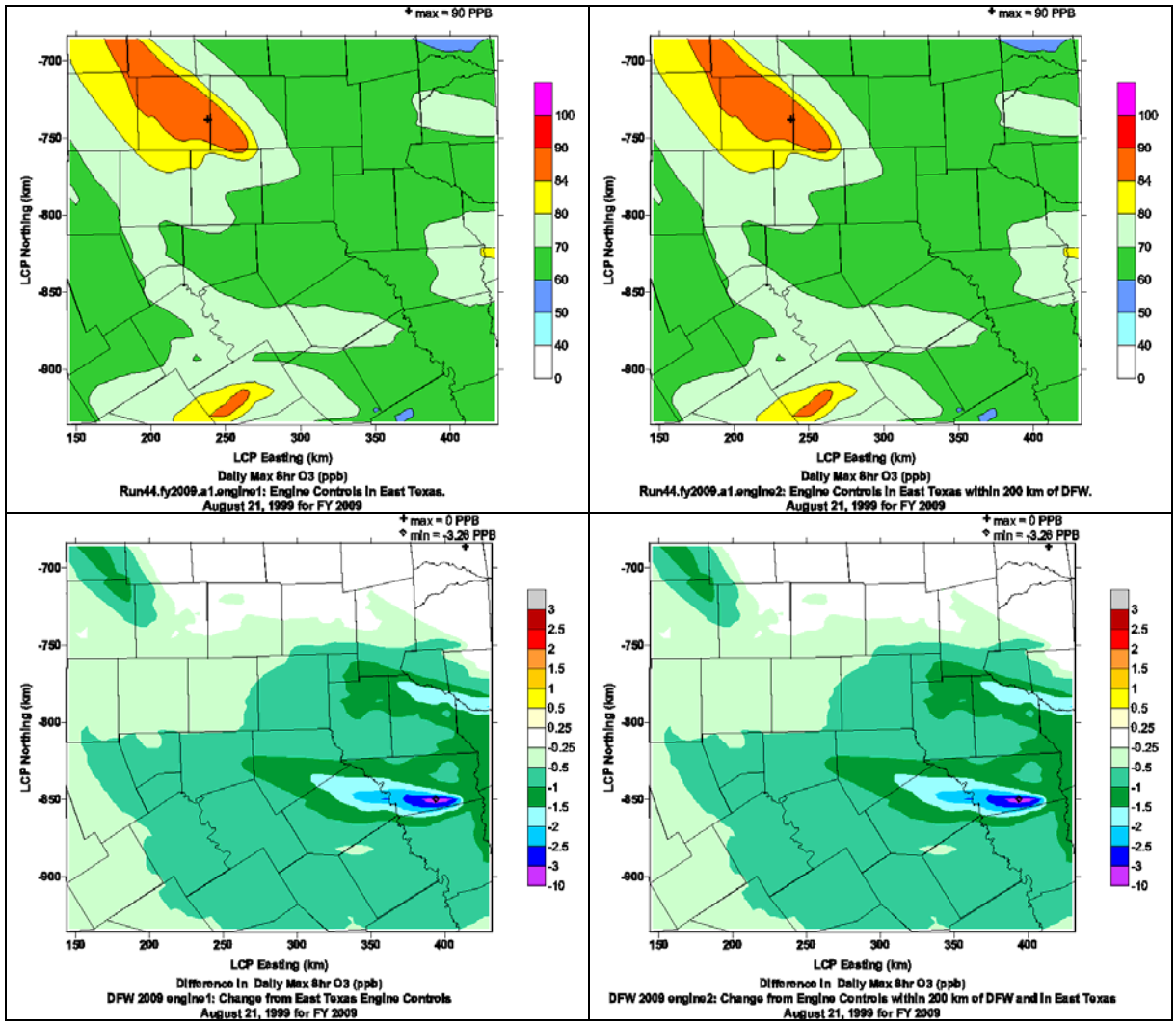


Figure 4–7. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

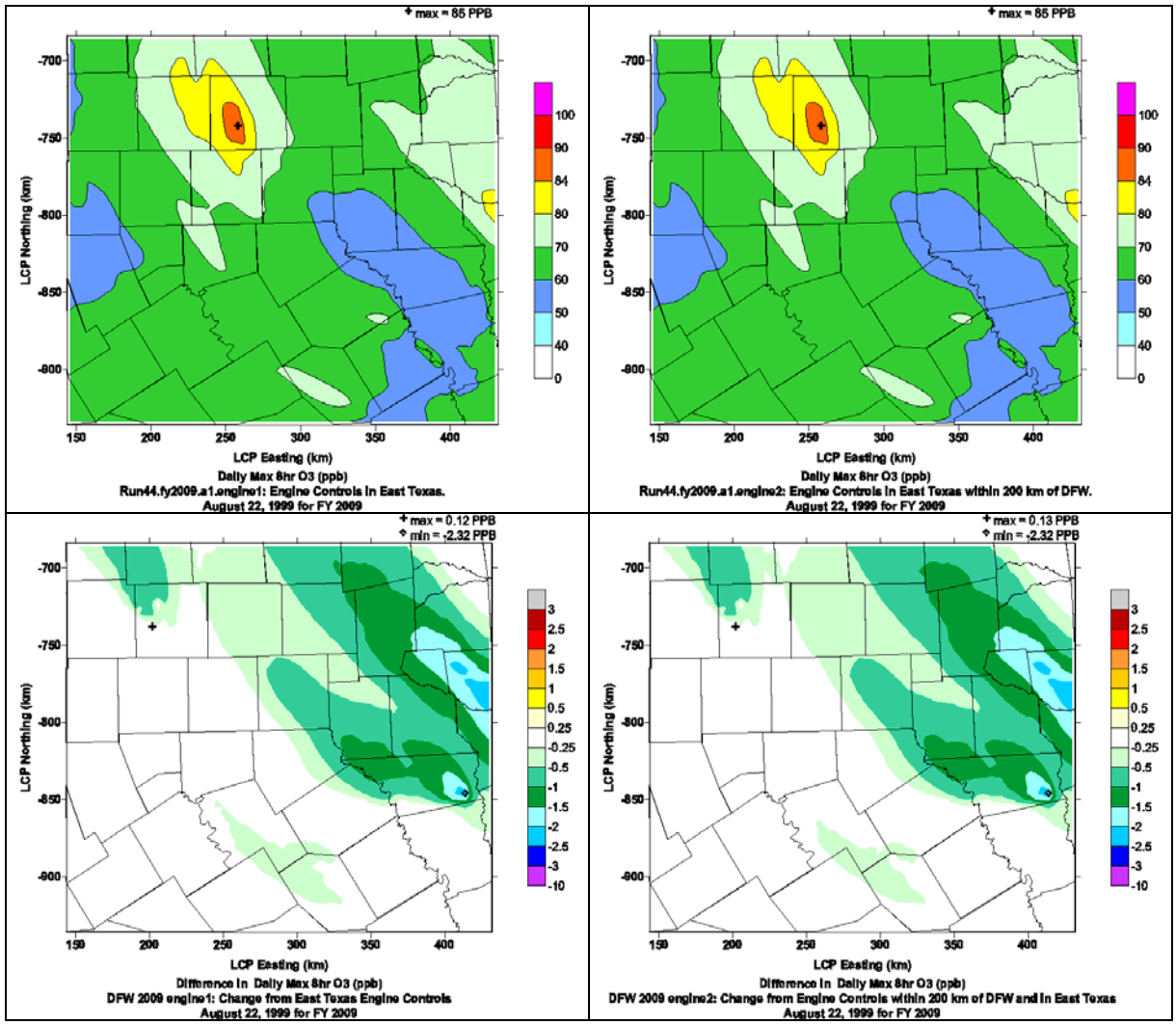


Figure 4–7. (concluded). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

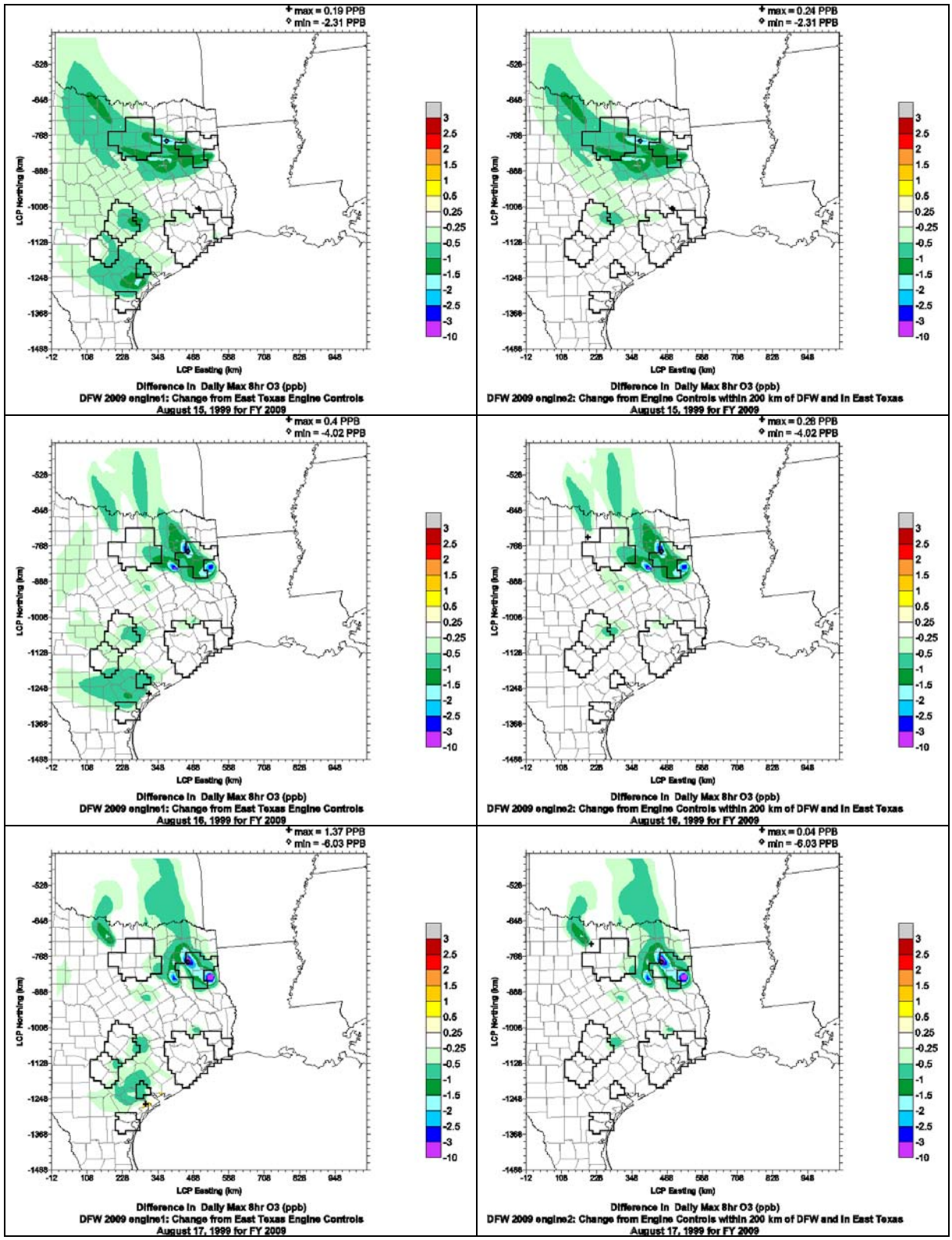


Figure 4–8. Spatial plots of the difference in daily maximum 8-hour ozone from engine controls in East Texas (left) and within 200 km of DFW (right) for each episode date.

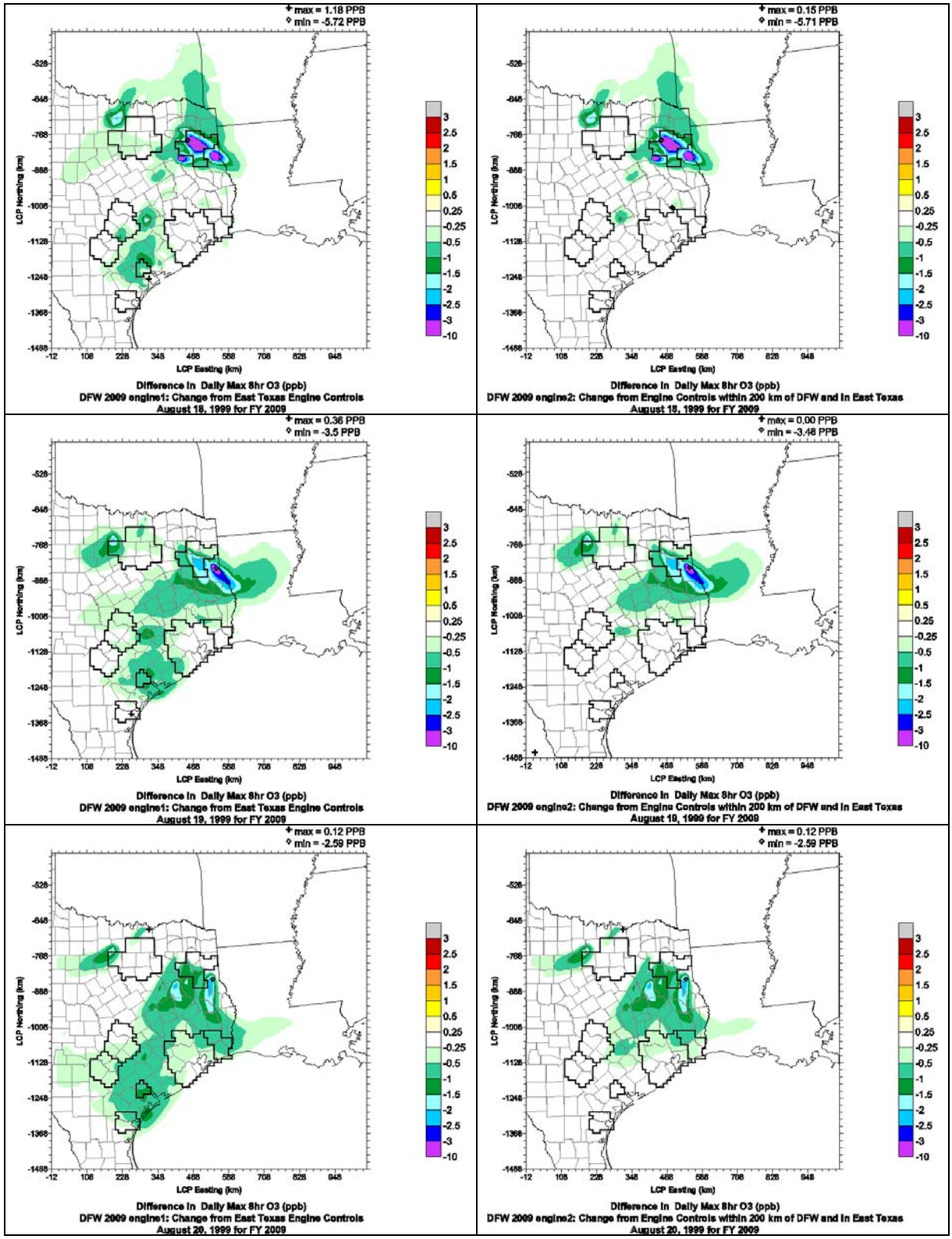


Figure 4–8. (continued). Spatial plots of the difference in daily maximum 8-hour ozone from engine controls in East Texas (left) and within 200 km of DFW (right) for each episode date.

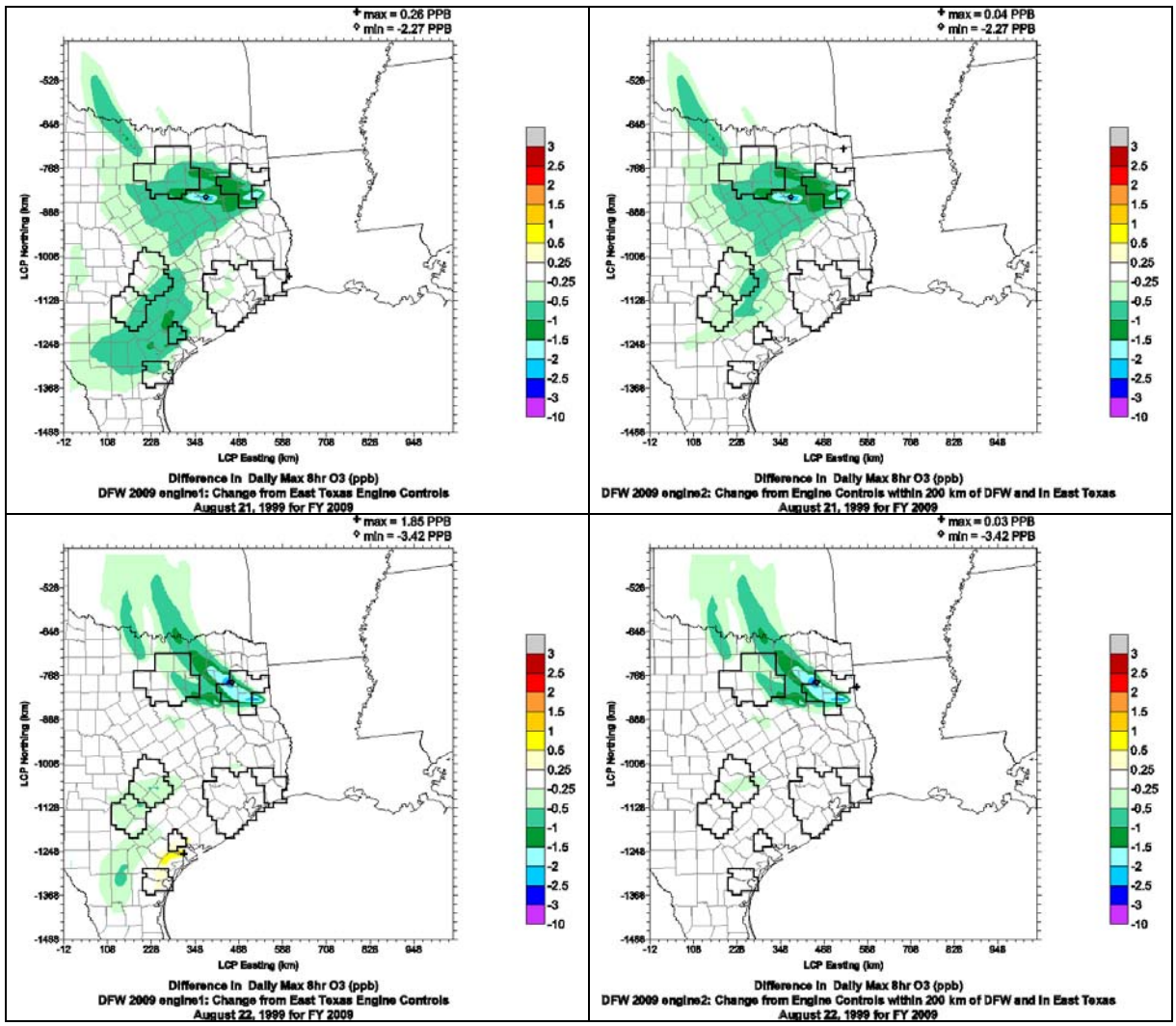


Figure 4–8. (concluded). Spatial plots of the difference in daily maximum 8-hour ozone from engine controls in East Texas (left) and within 200 km of DFW (right) for each episode date.

The 2009 future design values scaled from the 1999 baseline design values for 8-hour ozone at all available DFW monitoring sites are summarized in Table 4–18 for the 2009 baseline and two engine control scenarios. The bottom of table shows the differences from the baseline, reported to the nearest hundredth of a ppb so that the two engine control scenarios may be compared. The complete design value scaling calculation table including daily relative reduction factors are shown in Tables 4–19 and 4–20 for the engine controls in East Texas and near DFW, respectively.

Future design values were lower at all monitoring stations when applying the East Texas engine controls. The reductions were fairly uniform among the nine sites, ranging from -0.25 ppb at Fort Worth to -0.37 ppb at Midlothian. The reduction at Frisco was the second largest, at –0.34 ppb. The engine controls within 200 km of DFW resulted in similar 2009 design value reductions, but were a few hundredths of a ppb weaker at all sites.

Tables 4–21 to 4–23 analyze the areal extent of the daily maximum 8-hour ozone exceeding 85 ppb in the DFW 9-county NAA. Table 4–21 lists the number of unique 4 km grid cells in the

DFW 9-county NAA where 8-hour ozone exceeded 85 ppb for each date. Values are shown for the 2009 base case and both engine control runs. Differences from the 2009 a1 baseline are shown at the bottom of the table. Table 4–22 counts the number of daily maximum 8-hour ozone exceedance cells that are reduced by at least 1 ppb when applying the controls. Table 4–23 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances.

The engine controls in East Texas and within 200 km of DFW reduced the episode exceedance area by 2.2 % and 1.8 % respectively. The change in exceedance area was identical from both controls on all dates except August 18, when the south wind reduced 3 additional exceedance cells below 85 ppb due to the NOx controls in South Texas in the East Texas control scenario, and on August 19, when one additional grid cell dropped below 85 ppb in the East Texas engine control. If only the four east-wind dates are analyzed, the exceedance area is reduced by 3.3 % in both control scenarios.

The episode sum of excess ppb's over 85 ppb from the daily maximum 8-hour ozone in the DFW NAA dropped 2.6 % and 2.1 % from the East Texas and near DFW engine controls, respectively. The greatest number of exceedance ppb's was found on August 17, but on this date, the percent of excess ppb reduction was only about half the episode average (1.3 % for East Texas controls and 1.2 % for controls near DFW). August 19 reduced the most exceedance ppb's in both controls (-64 ppb in the East Texas engine control; -54 ppb in the engine control within 200 km of DFW). Neither control lowered any exceedance 8-hour ozone by at least 1 ppb.

Table 4–18. Summary of 2009 future design values with East Texas engine controls, and differences from the 2009 baseline.

Site	Run44.fy2009.a1 2009 base case	Run44.fy2009.a1.engine1 East TX engine controls	Run44.fy2009.a1.engine2 East TX engine controls within 200 km of DFW
Future Design Values [ppb]			
Frisco	91.2	90.9	90.9
Dallas C60	87.6	87.2	87.3
Dallas C63	87.0	86.7	86.7
Dallas C402	79.7	79.4	79.4
Denton	89.6	89.3	89.4
Midlothian	84.5	84.2	84.2
Arlington	87.2	87.0	87.0
Fort Worth C13	87.6	87.4	87.4
Fort Worth C17	86.0	85.7	85.7
Change from 2009 base [ppb]			
Frisco		-0.34	-0.32
Dallas C60		-0.33	-0.30
Dallas C63		-0.33	-0.31
Dallas C402		-0.32	-0.29
Denton		-0.28	-0.27
Midlothian		-0.37	-0.33
Arlington		-0.26	-0.23
Fort Worth C13		-0.25	-0.23
Fort Worth C17		-0.25	-0.23

Table 4–19. 2009 future design values calculation for the East Texas engine control.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.engine1												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Base DV [ppb]**	**Future DV[2] [ppb]**
Frisco	67.6	99.9	100.3	98.2	72.8	64.9	74.8	75.0	81.7	0.906	100.3	90.9
Dallas C60	73.0	92.8	102.0	99.4	89.2	82.6	78.8	74.5	86.5	0.948	92.0	87.2
North Dallas C63	70.9	95.5	100.3	99.8	83.7	78.8	77.3	73.8	85.0	0.932	93.0	86.7
Dallas C402	67.7	82.3	90.2	87.9	95.4	87.6	71.6	69.8	81.6	0.909	87.3	79.4
Denton	88.0	102.2	106.4	92.0	70.7	64.0	89.3	84.8	87.2	0.880	101.5	89.3
Midlothian	69.9	75.9	78.2	70.2	97.3	87.1	68.1	68.3	76.9	0.910	92.5	84.2
Arlington	73.7	90.1	91.5	83.4	94.2	87.6	73.7	79.3	84.2	0.915	95.0	87.0
Fort Worth C13	80.9	94.7	93.7	87.9	83.4	76.5	80.1	81.5	84.9	0.889	98.3	87.4
Fort Worth C17	88.3	97.4	102.5	90.4	79.5	71.0	87.5	84.2	87.6	0.890	96.3	85.7
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.837	0.946	1.013	0.936	0.851	0.926	0.870	0.839				
Dallas C60	0.878	0.945	1.013	0.967	0.922	1.067	0.916	0.875				
North Dallas C63	0.856	0.958	1.012	0.953	0.891	1.038	0.899	0.843				
Dallas C402	0.865	0.886	0.920	0.895	0.912	1.034	0.890	0.866				
Denton	0.859	0.924	0.981	0.815	0.843	0.883	0.879	0.847				
Midlothian	0.925	0.894	0.907	0.900	0.870	0.972	0.909	0.912				
Arlington	0.854	0.917	0.919	0.882	0.901	1.041	0.902	0.916				
Fort Worth C13	0.859	0.899	0.913	0.844	0.878	0.958	0.882	0.887				
Fort Worth C17	0.879	0.885	0.952	0.847	0.861	0.912	0.921	0.865				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–20. 2009 future design values calculation for the engine controls in a 200 km radius of the DFW 9-county NAA.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.engine2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV [ppb]**	**Future DV[2] [ppb]**
Frisco	67.6	99.9	100.3	98.3	72.8	64.9	74.8	75.0	81.7	0.906	100.3	90.9
Dallas C60	73.0	92.8	102.0	99.5	89.2	82.6	78.8	74.5	86.5	0.948	92.0	87.3
North Dallas C63	70.9	95.5	100.3	99.9	83.7	78.8	77.3	73.8	85.0	0.932	93.0	86.7
Dallas C402	67.7	82.3	90.2	88.1	95.5	87.6	71.6	69.8	81.6	0.909	87.3	79.4
Denton	88.0	102.2	106.4	92.1	70.7	64.0	89.3	84.8	87.2	0.880	101.5	89.4
Midlothian	69.9	75.9	78.2	70.4	97.3	87.1	68.1	68.3	76.9	0.910	92.5	84.2
Arlington	73.7	90.1	91.5	83.6	94.2	87.6	73.7	79.3	84.2	0.916	95.0	87.0
Fort Worth C13	80.9	94.7	93.7	88.1	83.4	76.5	80.1	81.5	84.9	0.889	98.3	87.4
Fort Worth C17	88.3	97.4	102.5	90.5	79.5	71.0	87.5	84.2	87.6	0.890	96.3	85.7
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.837	0.946	1.013	0.937	0.851	0.926	0.870	0.839				
Dallas C60	0.878	0.945	1.014	0.968	0.922	1.067	0.916	0.875				
North Dallas C63	0.856	0.958	1.013	0.954	0.891	1.038	0.899	0.843				
Dallas C402	0.865	0.886	0.920	0.897	0.912	1.034	0.890	0.866				
Denton	0.859	0.924	0.982	0.815	0.843	0.883	0.879	0.847				
Midlothian	0.925	0.894	0.907	0.903	0.870	0.972	0.909	0.912				
Arlington	0.854	0.917	0.919	0.885	0.902	1.041	0.902	0.916				
Fort Worth C13	0.859	0.899	0.913	0.846	0.879	0.958	0.882	0.887				
Fort Worth C17	0.879	0.885	0.952	0.848	0.862	0.912	0.921	0.865				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–21. Exceedance Area (number of grid cells > 85 ppb in the DFW 9-county NAA) for the engine control scenarios and differences from the 2009 a1 baseline.

Scenario Run	2009 Future Base run44.fy2009.a1	East Texas Engine Control run44.fy2009.a1.engine1	East Texas Engine Control within 200 km of DFW run44.fy2009.a1.engine2
990815	19	18	18
990816	223	222	222
990817	296	294	294
990818	253	247	250
990819	304	295	296
990820	70	70	70
990821	29	27	27
990822	5	0	0
Total	1199	1173	1177
% Change from the 2009 a1 baseline			
990815	---	-5.3%	-5.3%
990816	---	-0.4%	-0.4%
990817	---	-0.7%	-0.7%
990818	---	-2.4%	-1.2%
990819	---	-3.0%	-2.6%
990820	---	0.0%	0.0%
990821	---	-6.9%	-6.9%
990822	---	-100.0%	-100.0%
Total	---	-2.2%	-1.8%

Table 4–22. Number of daily maximum 8-hour ozone exceedance[1] cells in DFW reduced at least 1 ppb from the East Texas engine controls.

Scenario Run	2009 Future Base run44.fy2009.a1	East Texas Engine Control run44.fy2009.a1.engine1	East Texas Engine Control within 200 km of DFW run44.fy2009.a1.engine2
990815	---	0	0
990816	---	0	0
990817	---	0	0
990818	---	0	0
990819	---	0	0
990820	---	0	0
990821	---	0	0
990822	---	0	0
Totals	---	0	0

[1] Exceedance cells are 2009 baseline grid cells exceeding 85 ppb.

Table 4–23. Number of ppb's from grid cells in the daily maximum 8-hour ozone in the DFW 9-county NAA in excess of 85 ppb[1] when applying East Texas engine controls.

Scenario Run	2009 Future Base run44.fy2009.a1	East Texas Engine Control run44.fy2009.a1.engine1	East Texas Engine Control within 200 km of DFW run44.fy2009.a1.engine2
990815	50	39	39
990816	2184	2140	2140
990817	2594	2559	2562
990818	1660	1617	1640
990819	1201	1137	1147
990820	84	84	84
990821	74	66	66
990822	1	0	0
Totals	7846	7641 (-2.6 %)	7678 (-2.1 %)

[1] Σ(max(O3-85, 0.0)) for all grid cells in DFW.

Summary

Two ozone sensitivity tests applied NOx controls to engines in East Texas and within a 200 km radius of the DFW 9-county NAA, which reduced NOx emissions by 83 tpd and 41 tpd, respectively. Most of the NOx reductions in the 83 tpd scenario were in South and Northeast Texas; in the 41 tpd scenario, most controls were in Northeast Texas. The greatest impact from both control scenarios to 8-hour ozone reduction in DFW occurred on dates with an east wind (August 15, 16, 21, and 22) due to the proximity of DFW to the controlled emissions in Northeast Texas. The ozone reduction on these dates was nearly identical between the two control scenarios, approaching 1 ppb in the DFW NAA. When the wind was southerly on August 18, the NOx controls in South Texas, applied only to the East Texas engine control scenario, reduced more 8-hour ozone in DFW than the controls "within 200 km of DFW".

Neither control scenario reduced any exceedance 8-hour ozone in any cell inside the DFW NAA by 1 ppb. The East Texas and "within 200 km of DFW" engine controls were able to drive 2.2 % and 1.8 % of the exceedance cells below 85 ppb, respectively.

Both control scenarios reduced the future 8-hour ozone design values at all monitoring sites by approximately a quarter to a third of a ppb. The East Texas engine control reduced the design values only a few hundredths of a ppb more than the controls "within 200 km of DFW" scenario, showing that DFW ozone was much more responsive to the engine controls in Northeast Texas than in South Texas.

4.5 DFW MAJOR SOURCE CONTROLS

A CAMx sensitivity run (run44.fy2009.a1.dfw_major) examined the impact to 8-hour ozone in the DFW 9-county NAA during the August 13-22, 1999 episode for the 2009 future year when reducing NOx emissions in both DFW major sources and DFW EGUs to Houston ESAD levels.

Emissions

The DFW controls were applied to the 2009 "a1" baseline emissions. The controls reduced NOx emissions by 15 tpd, mostly in the southern counties (Dallas, Tarrant, Johnson, and Ellis Counties) of the DFW NAA. The DFW major source controls lowered NOx emissions by 13 tpd (72 % elevated, 28 % low-level) and the DFW EGU controls reduced NOx by 2 tpd (all elevated). VOCs were unchanged from the 2009 baseline.

Summaries of the 2009 weekday NOx and VOC emissions (with August 17 biogenics) are shown in Tables 4–24 and 4–25, respectively, by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column in each table shows the change in emissions from the 2009 baseline.

Figure 4–9 shows a tile plot of the local NOx reductions in the DFW 4-km domain. The largest differences were in southwestern Johnson County, where an individual 4 km grid cell was reduced 3.5 tpd NOx, and in central Ellis County, where NOx reductions totaled 2.9 tpd from two 4 km grid cells.

Table 4–24. Weekday NOx emissions in 2009 with DFW major source and EGU controls.

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	10	15	1	0	2	8	0	25	0
Dallas Co	4	77	5	1	18	45	0	146	-3
Denton Co	8	17	0	0	12	9	0	39	0
Tarrant Co	3	46	1	1	10	28	0	86	-2
Parker Co	1	6	1	0	1	2	0	10	0
Johnson Co	5	5	2	0	0	5	0	12	-4
Ellis Co	15	9	32	0	0	6	0	47	-4
Kaufman Co	5	6	3	0	0	2	0	12	-1
Rockwall Co	2	3	0	0	0	1	0	5	0
DFW 9-County	**52**	**184**	**44**	**3**	**44**	**107**	**0**	**382**	**-14**
DFW 16 County	**83**	**212**	**69**	**6**	**67**	**123**	**0**	**477**	**-15**
NE Texas	16	79	189	16	71	42	1	397	0
Central TX	113	88	138	2	56	69	0	353	0
Houston	21	175	282	12	53	63	0	585	0
South TX	229	189	267	22	75	100	0	653	0
West TX	524	160	154	21	212	105	1	653	0
Texas	**986**	**904**	**1097**	**79**	**534**	**501**	**2**	**3118**	**-15**
Gulf + Mexico	79	5	437	0	4	2	444	892	0
Oklahoma	227	1	256	0	2	3	661	924	0
Louisiana	106	1	715	2	2	1	1183	1905	0
Arkansas	125	2	220	0	0	2	468	692	0
Mississippi	121	0	353	0	0	0	455	808	0
Alabama	75	0	442	0	0	0	491	932	0
Tennessee	118	0	244	0	0	0	662	906	0
Kentucky	145	0	289	0	0	0	770	1060	0
Georgia	110	0	408	0	0	0	823	1230	0
Florida	56	0	367	0	0	0	1206	1573	0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0
NE US	314	0	1302	0	0	0	5748	7051	0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0
Total	**7992**	**913**	**10378**	**82**	**543**	**509**	**23869**	**36293**	**-15**

Table 4–25. Weekday VOC emissions in 2009 with DFW major source and EGU controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	27	7	0	0	12	3	0	23	0
Dallas Co	50	43	4	5	72	17	0	141	0
Denton Co	65	8	1	0	15	4	0	28	0
Tarrant Co	64	25	2	5	54	9	0	94	0
Parker Co	121	2	0	0	5	1	0	9	0
Johnson Co	111	2	0	0	6	1	0	9	0
Ellis Co	89	2	3	2	6	2	0	15	0
Kaufman Co	112	2	0	0	7	1	0	11	0
Rockwall Co	3	1	0	0	2	1	0	4	0
DFW 9-County	**642**	**92**	**10**	**13**	**180**	**38**	**0**	**333**	**0**
DFW 16 County	**1538**	**103**	**34**	**15**	**216**	**44**	**1**	**413**	**0**
NE Texas	4917	27	15	41	82	14	1	181	0
Central TX	6098	33	20	20	85	21	1	180	0
Houston	1683	80	92	215	247	41	0	675	0
South TX	2069	78	20	48	217	46	0	408	0
West TX	6198	59	11	28	215	52	3	367	0
Texas	**22503**	**380**	**191**	**367**	**1060**	**218**	**6**	**2223**	**0**
Gulf + Mexico	658	3	32	0	10	4	329	378	0
Oklahoma	7940	1	3	0	5	1	481	490	0
Louisiana	9941	0	47	3	4	1	546	601	0
Arkansas	13925	0	23	0	2	0	441	466	0
Mississippi	14818	0	35	0	0	0	548	583	0
Alabama	13954	0	39	0	0	0	655	695	0
Tennessee	8678	0	66	0	0	0	895	961	0
Kentucky	3753	0	34	0	0	0	622	656	0
Georgia	12198	0	53	0	0	0	869	922	0
Florida	9793	0	42	0	0	0	1594	1636	0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0
NE US	20472	0	248	0	0	0	5407	5655	0
Northern Plains	40144	0	226	0	0	0	8224	8450	0
Total	**210073**	**384**	**1107**	**370**	**1080**	**224**	**23453**	**26618**	**0**

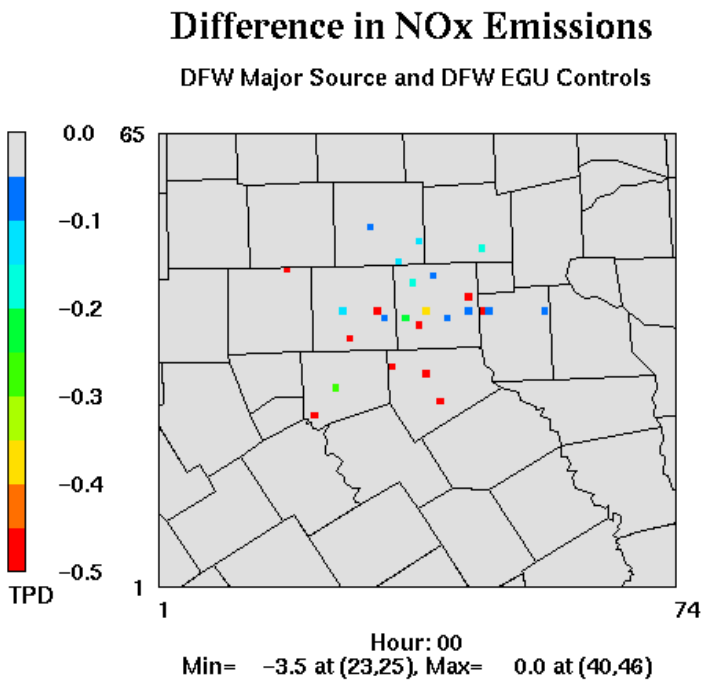


Figure 4–9. Tile plot of differences in NOx emissions from the DFW major source and EGU controls.

Model Results

Spatial plots of the daily maximum 8-hour ozone and differences from the 2009 baseline are shown in Figure 4–10 for each episode date in the DFW 4 km domain. On most dates, three plumes of ozone benefits originated near three areas with large NOx controls – southwestern Johnson County, central Ellis County, and northwestern Kaufman County. Areas downwind of southwestern Johnson County experienced 8-hour ozone reductions up to 3 ppb on the two south wind dates (August 17 and 18). On other dates, the ozone benefits were around 1 ppb or less.

The 8-hour ozone design value calculation is shown in Table 4–26 for all DFW monitoring sites using the 1999 baseline design value, and is compared to the 2009 baseline design values in Table 4–27. The DFW major source and DFW EGU controls reduced the future design values at all sites between 0.3 to 0.6 ppb. The southern monitoring stations (Midlothian and Arlington), which were closer to the controlled sources, had the largest design value reductions. Denton and Frisco's future design values were reduced 0.3 and 0.4 ppb, respectively.

Tables 4–28 to 4–30 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–28 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in both the 2009 baseline and control scenario. The rightmost column shows the percent change in exceedance area; the episode reduction was 4 %.

Only one baseline exceedance cell out of 1199 was reduced by at least 1 ppb when applying the major source and EGU controls. Table 4–29 shows this occurring on August 20.

Table 4–30 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The percent reduction is shown in the rightmost column. The episode averaged a 5 % reduction, but the two dates with southerly winds (August 17 and 18) had the lowest percent reduction.

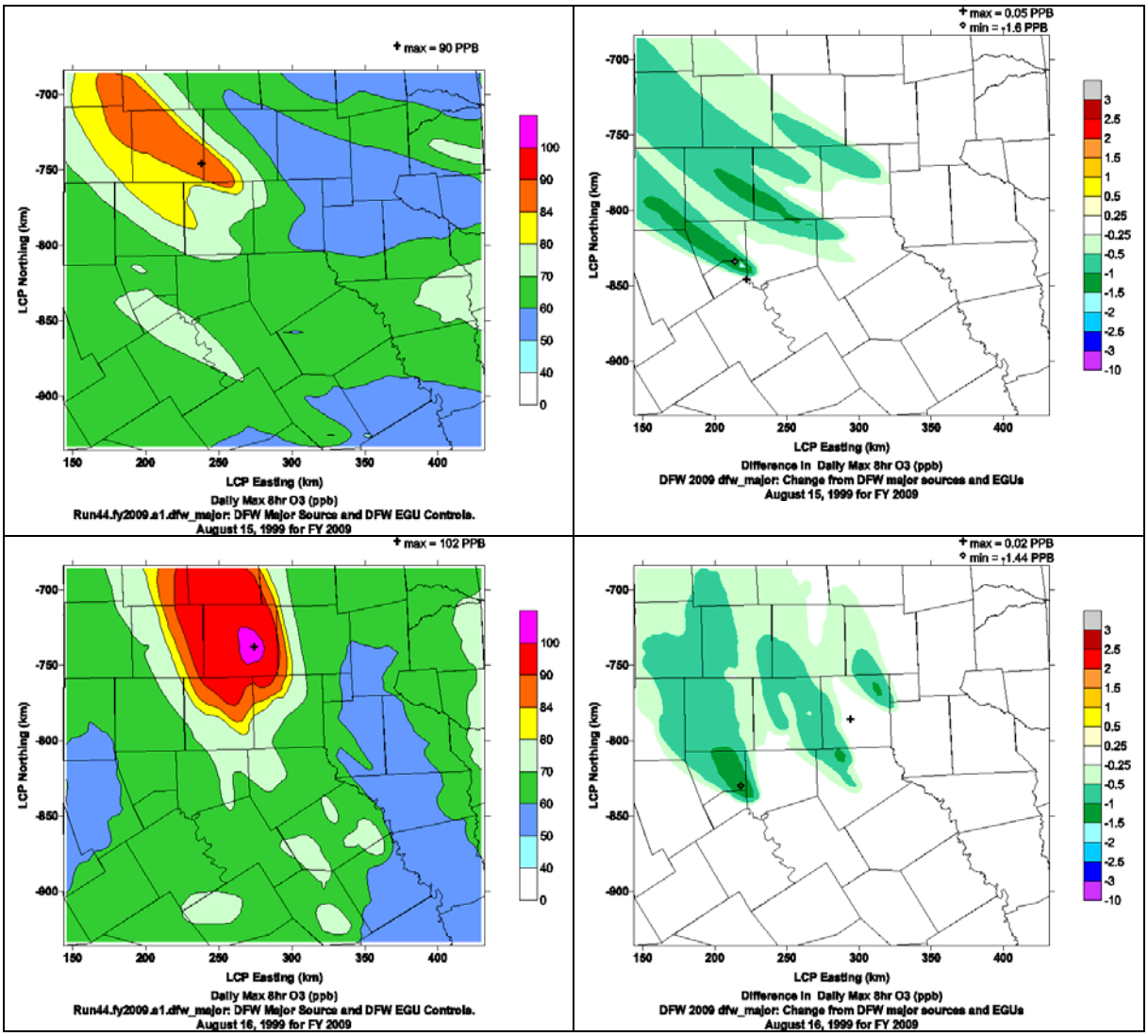


Figure 4–10. Spatial plots of the daily maximum 8-hour ozone in 2009 with DFW major source and DFW EGU controls (left) and differences from the 2009 baseline (right) for each episode date.

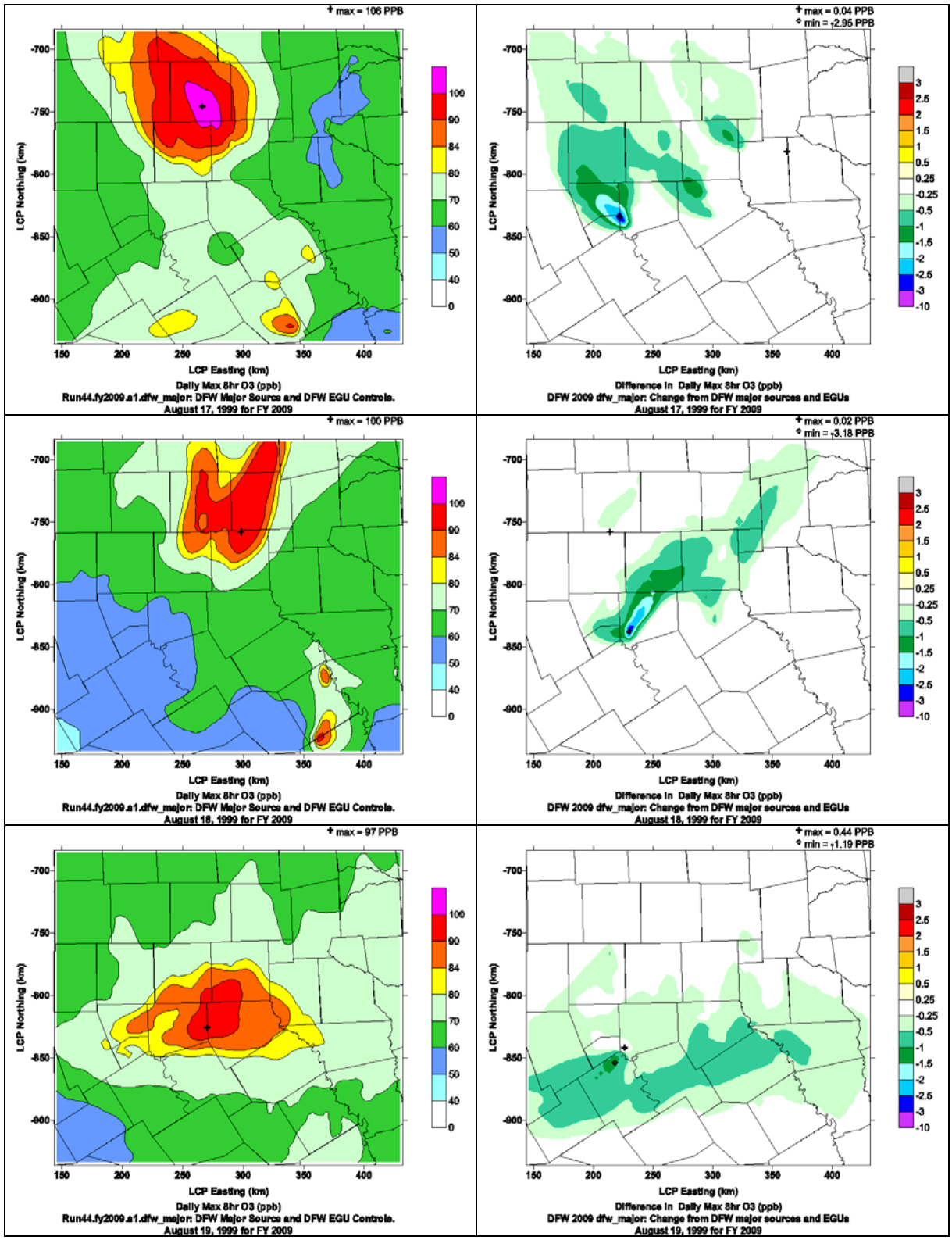


Figure 4–10. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2009 with DFW major source and DFW EGU controls (left) and differences from the 2009 baseline (right) for each episode date.

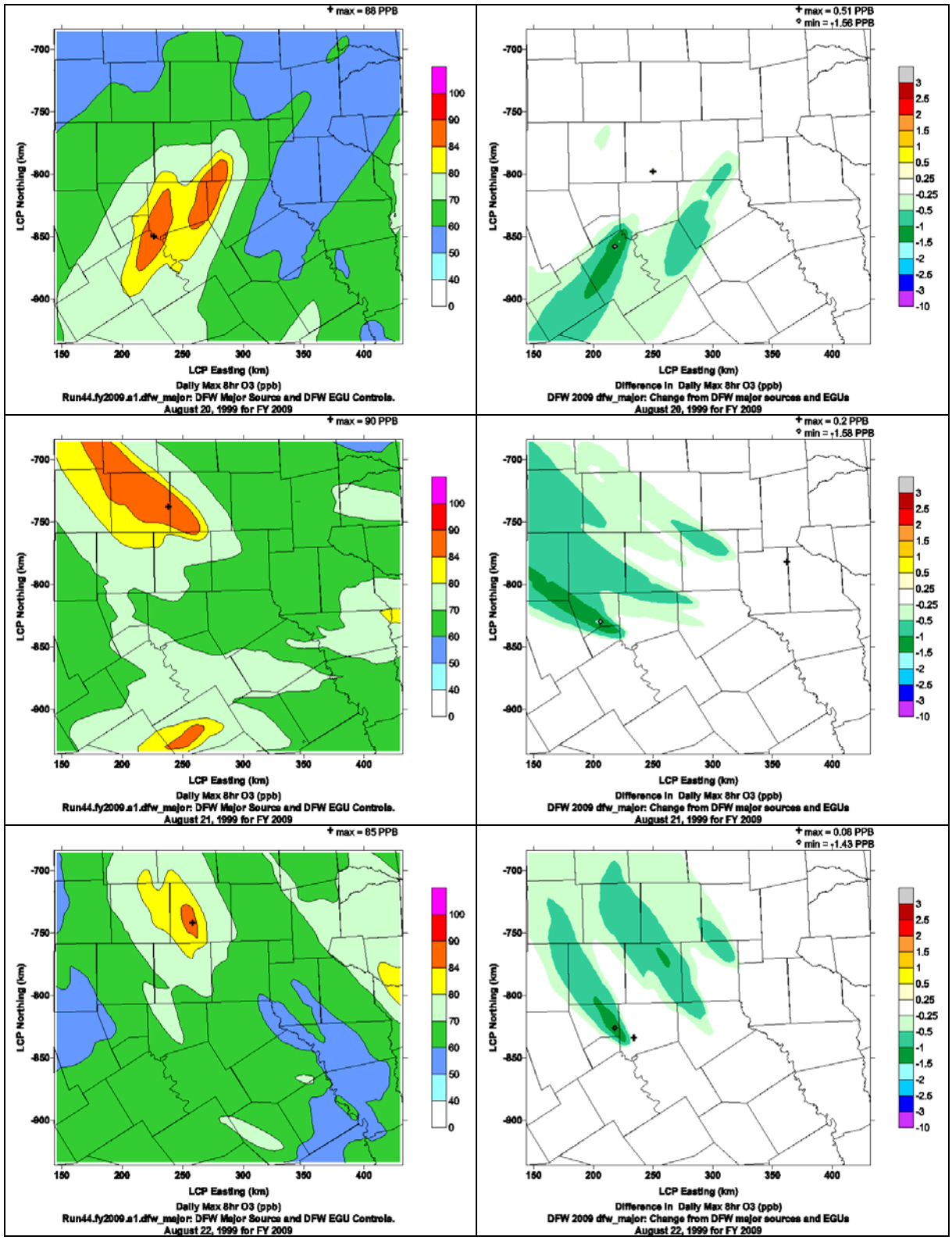


Figure 4–10. (Concluded) Spatial plots of the daily maximum 8-hour ozone in 2009 with DFW major source and DFW EGU controls (left) and differences from the 2009 baseline (right) for each episode date.

Table 4–26. Future design value calculation for the DFW major source and DFW EGU control scenario.

Base Case: run44												
Site	990815	990816	990817	990818	990819	990820	990821	990822	Average	#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		
North 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: run44.fy2009.a1.dfw_major												
Site	990815	990816	990817	990818	990819	990820	990821	990822	Average	RRF[1]	BaseDV [ppb]	Future DV[2] [ppb]
Frisco	67.8	99.8	100.2	98.0	73.0	64.8	74.6	75.0	81.7	0.906	100.3	90.9
Dallas C60	73.0	92.7	102.0	99.2	89.2	82.7	78.7	74.7	86.5	0.948	92.0	87.2
North Dallas C63	71.1	95.4	100.2	99.6	83.8	78.8	77.3	73.9	85.0	0.932	93.0	86.7
Dallas C402	68.1	81.9	89.9	87.6	95.4	87.5	72.0	69.6	81.5	0.908	87.3	79.3
Denton	88.1	102.1	106.3	92.0	70.9	64.1	89.2	84.7	87.2	0.880	101.5	89.3
Midlothian	69.7	75.4	77.5	69.9	97.0	86.9	68.8	67.9	76.6	0.907	92.5	83.9
Arlington	73.6	89.6	91.0	82.7	94.1	87.5	73.7	78.5	83.9	0.912	95.0	86.6
Fort Worth C13	80.7	94.2	93.3	87.8	83.5	76.5	80.1	80.7	84.6	0.886	98.3	87.1
Fort Worth C17	88.5	97.1	102.2	90.4	79.6	71.0	87.6	84.0	87.5	0.889	96.3	85.7
Daily RRFs[3]												
Site	990815	990816	990817	990818	990819	990820	990821	990822				
Frisco	0.840	0.945	1.012	0.934	0.853	0.926	0.869	0.839				
Dallas C60	0.878	0.945	1.013	0.964	0.923	1.068	0.914	0.878				
North Dallas C6	0.859	0.958	1.012	0.951	0.891	1.038	0.898	0.844				
Dallas C402	0.870	0.882	0.917	0.891	0.911	1.033	0.894	0.864				
Denton	0.860	0.923	0.981	0.814	0.845	0.885	0.878	0.847				
Midlothian	0.923	0.887	0.899	0.897	0.868	0.971	0.918	0.906				
Arlington	0.853	0.912	0.914	0.876	0.900	1.040	0.902	0.906				
Fort Worth C13	0.857	0.894	0.909	0.843	0.880	0.958	0.881	0.877				
Fort Worth C17	0.881	0.882	0.950	0.847	0.862	0.912	0.921	0.863				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–27. Future design value summary and differences from the 2009 baseline.

Scenario	2009 baseline [ppb]	DFW major source + DFW EGU control [ppb]	Difference [ppb]
Run	**run44.fy2009.a1**	**run44.fy2009.a1.dfw_major**	
Frisco	91.2	90.9	-0.4
Dallas C60	87.6	87.2	-0.3
Dallas C63	87.0	86.7	-0.3
Dallas C402	79.7	79.3	-0.4
Denton	89.6	89.3	-0.3
Midlothian	84.5	83.9	-0.6
Arlington	87.2	86.6	-0.6
Fort Worth C13	87.6	87.1	-0.5
Fort Worth C17	86.0	85.7	-0.3

Table 4–28. Daily count of unique 4-km grid cells exceeding 85 ppb in the DFW 9-county NAA and differences from the 2009 baseline.

Scenario	2009 Baseline	DFW major source and DFW EGU control	Difference (%)
Run	**run44.fy2009.a1**	**run44.fy2009.a1.dfw_major**	
990815	19	19	0%
990816	223	219	-2%
990817	296	288	-3%
990818	253	243	-4%
990819	304	287	-6%
990820	70	66	-6%
990821	29	28	-3%
990822	5	0	-100%
Totals	1199	1150	-4%

Table 4–29. Number of daily maximum 8-hour ozone exceedance[1] cells in DFW reduced by at least 1 ppb.

Scenario Run	DFW major source and DFW EGU Control [# cells] run44.fy2009.a1.dfw_major
990815	0
990816	0
990817	0
990818	0
990819	0
990820	1
990821	0
990822	0
Totals	1

1 Exceedance cells are 2009 baseline grid cells exceeding 85 ppb.

Table 4–30. Number of ppb's in the daily maximum 8-hour ozone in the DFW 9-county NAA in excess of 85 ppb[1].

Scenario Run	2009 Baseline [# ppb's] run44.fy2009.a1	DFW major source and DFW EGU control [# ppb's] run44.fy2009.a1.dfw_major	Difference [%]
990815	50	40	-19%
990816	2184	2091	-4%
990817	2594	2497	-4%
990818	1660	1589	-4%
990819	1201	1098	-9%
990820	84	68	-19%
990821	74	64	-13%
990822	1	0	-100%
Totals	7846	7447	-5%

Σ(max(O3-85, 0.0)) for all 4-km grid cells in DFW.

Summary

An ozone sensitivity test examined the impact from reducing NOx emissions at major sources and EGUs inside the DFW 9-county NAA to the same level as the Houston ESADs. Most of the 15-tpd NOx reductions were localized in the southern DFW counties, resulting in 3 distinct plumes of 8-hour ozone benefits on most dates. Areas downwind of southwestern Johnson County, central Ellis County, and northwestern Kaufman County, where the most NOx controls were applied, received the greatest ozone reduction.

Future 8-hour ozone design values were reduced at all sites from 0.3 to 0.6 ppb. The southern monitoring stations (Midlothian and Arlington), which were closer to the controlled sources, had the largest reductions.

4.6 DFW EGU CONTROLS

A CAMx sensitivity run (run44.fy2009.a1.dfw_egu) examined the impact to 8-hour ozone in the DFW 9-county NAA during the August 13-22, 1999 episode for the 2009 future year when reducing NOx emissions from DFW EGUs to Houston ESAD levels. This run isolates the DFW EGU controls, which had been bundled with the DFW major source controls in an earlier run.

Emissions

NOx controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs. The 15 DFW EGUs with controls are listed in Table 4–31. Most of the 2.0 tpd NOx reduction was in Dallas and Kaufman Counties, as shown in Figure 4–11. VOCs were unchanged from the 2009 baseline.

Table 4–31. DFW EGUs with NOx controls.

EGU	LCPx [km]	LCPy [km]	County	Facility	Stack	Baseline NOx [tpd]	NOx after Controls [tpd]	Change in NOx [tpd]
Ray Olinger	326.247	-745.762	Collin	15	1	0.42	0.27	-0.14
Ray Olinger	326.247	-745.762	Collin	15	4	0.17	0.13	-0.04
Ray Olinger	326.466	-746.556	Collin	15	1000	0.03	0.03	0.00
C E Newman	311.478	-764.272	Dallas	7	4	0.02	0.01	0.00
Lake Hubbard	318.967	-772.391	Dallas	9	2	0.86	0.28	-0.59
Mountain Creek Gen	283.419	-786.197	Dallas	10	2	0.01	0.00	0.00
Mountain Creek Gen	283.423	-786.075	Dallas	10	8	0.13	0.09	-0.04
Mountain Creek Gen	283.422	-786.043	Dallas	10	10	0.23	0.07	-0.16
Spencer	266.050	-734.020	Denton	2	4	0.03	0.03	0.00
Cobisa Forney FPLE	324.467	-780.715	Kaufman	1000	100	0.59	0.48	-0.11
Cobisa Forney FPLE	324.453	-780.751	Kaufman	1000	200	0.60	0.49	-0.11
Cobisa Forney FPLE	324.440	-780.903	Kaufman	1000	300	0.49	0.41	-0.09
Cobisa Forney FPLE	324.392	-780.903	Kaufman	1000	400	0.68	0.42	-0.26
Cobisa Forney FPLE	324.377	-780.939	Kaufman	1000	500	0.70	0.50	-0.20
Cobisa Forney FPLE	324.362	-780.975	Kaufman	1000	600	0.72	0.44	-0.27
Total						**5.67**	**3.66**	**-2.01**

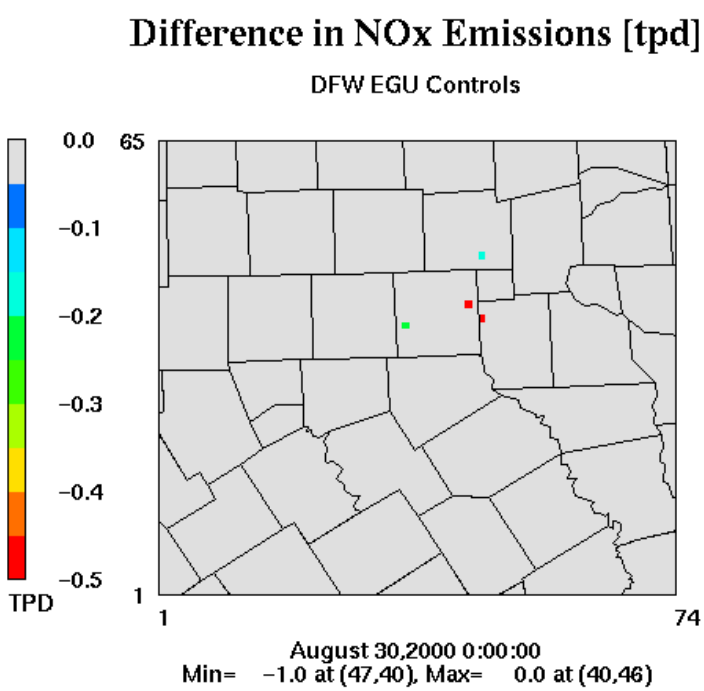


Figure 4–11. Tile plot of the change in NOx emissions from the DFW EGU controls.

Modeling Results

Spatial plots of the daily maximum 8-hour ozone and differences from the 2009 baseline are shown in Figure 4–12 for each episode date in the DFW 4 km domain. On dates with a south or east wind, the greatest 8-hour ozone reduction was located near northeast Dallas County, with peak benefits ranging from 0.7 to 1.1 ppb. On the two dates with north winds (August 19 and 20), the maximum ozone reduction was smaller and located more to the south.

The 8-hour ozone design value calculation is shown in Table 4–32 for all DFW monitoring sites using the 1999 baseline design value, and is compared to the 2009 baseline design values in Table 4–33. The 2 tpd NOx reduction from the DFW EGUs benefited Frisco the most as its future design value was reduced 0.25 ppb; Denton was 0.10 ppb lower. Midlothian saw a slight disbenefit as its future design value increased 0.02 ppb, but remained in attainment for 8-hour ozone.

Table 4–34 compares the change in future design values when applying controls to the DFW EGUs only, and controls to both the DFW EGUs and DFW major sources (Task 11), which reduced NOx by 15 tpd. Assuming that the difference in future design values between the two control runs yields benefits solely from the DFW major sources, as shown in the rightmost column of Table 4–34, then the 8-hour ozone benefit at Frisco was greater from the DFW EGU controls than the DFW major source controls. Both controls had comparable impacts at Dallas C63 and C60; at all other sites, the DFW major source controls had greater ozone benefits.

Tables 4–35 to 4–37 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–35 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in both the 2009 baseline and control scenario. The rightmost column shows the percent change in exceedance area. The DFW EGU controls only dropped 11 (1 %) of the 1199 exceedance cells below 85 ppb. Table 4–36 shows that no 8-hour ozone exceedance cells were reduced by more than 1 ppb from the controls during the episode.

Table 4–37 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The episode averaged a 1.3 % reduction.

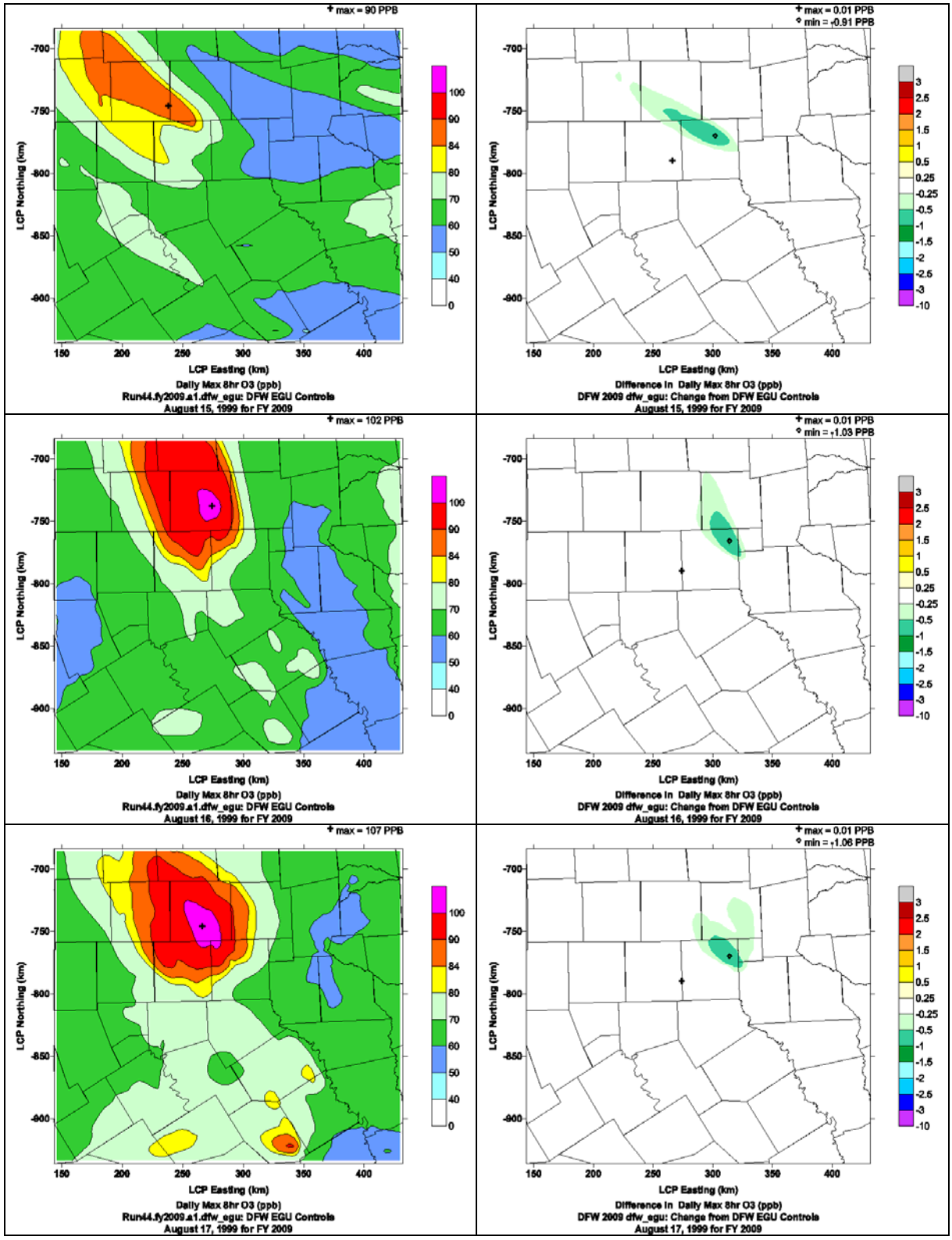


Figure 4–12. Daily maximum 8-hour ozone in the DFW EGU control scenario (left) and differences from the 2009 baseline (right) for each episode date.

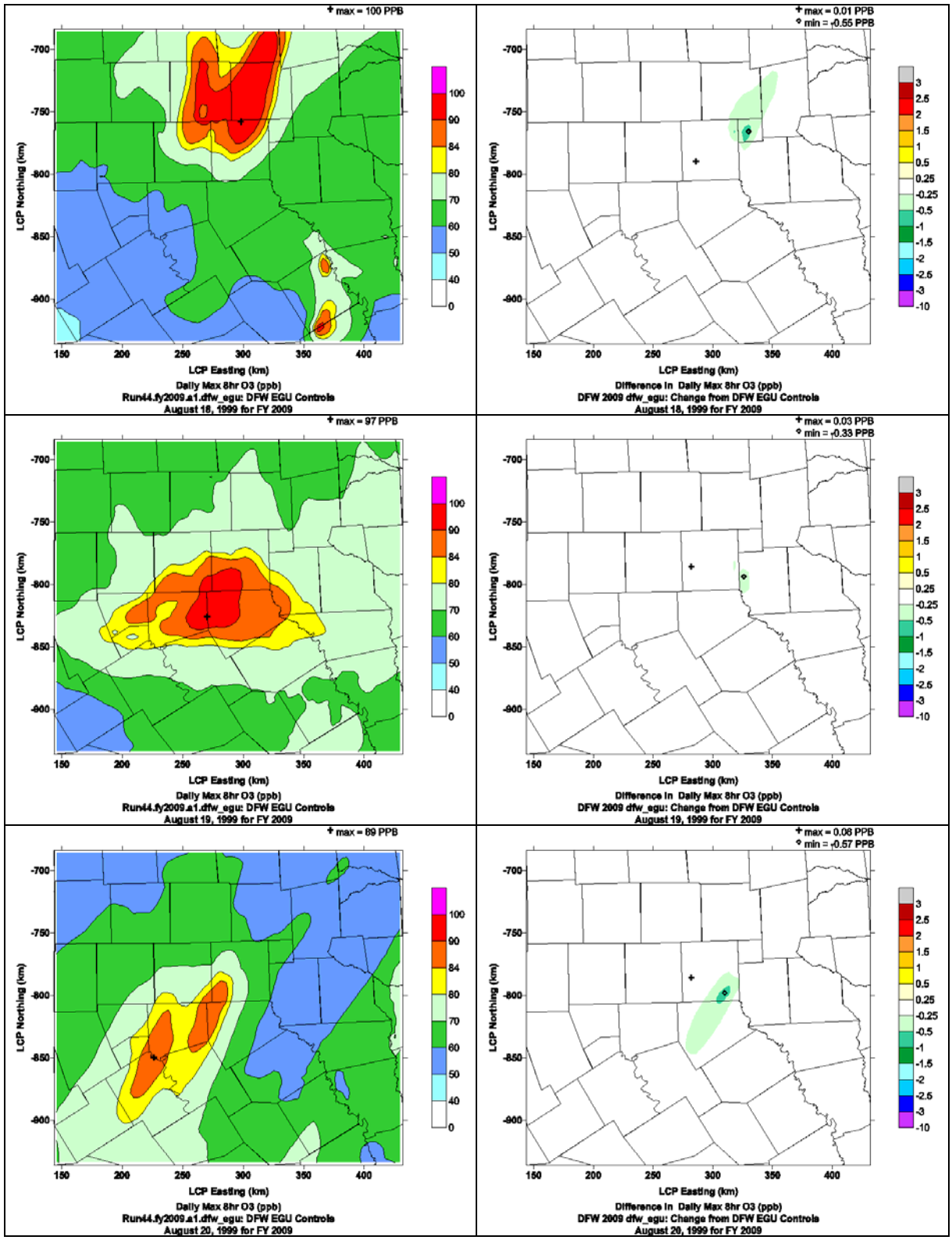


Figure 4–12. (Continued) Daily maximum 8-hour ozone in the DFW EGU control scenario (left) and differences from the 2009 baseline (right) for each episode date.

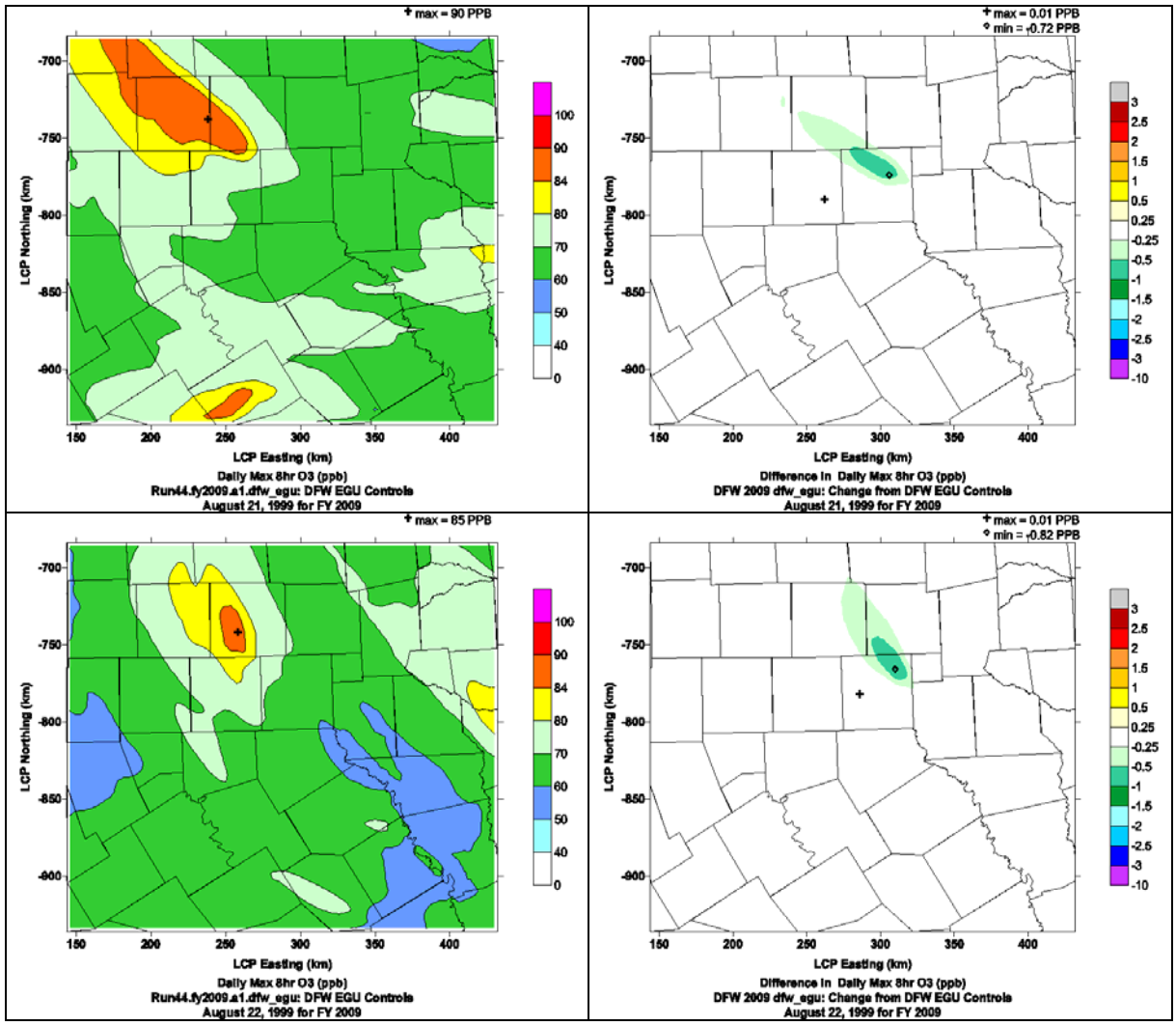


Figure 4–12. (Concluded) Daily maximum 8-hour ozone in the DFW EGU control scenario (left) and differences from the 2009 baseline (right) for each episode date.

Table 4–32. Design value calculation for the DFW EGU control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.dfw_egu												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Base DV [ppb]**	**Future DV[2] [ppb]**
Frisco	67.9	99.9	100.2	98.3	73.2	64.9	74.7	75.1	81.8	0.907	100.3	91.0
Dallas C60	73.2	93.0	102.1	99.5	89.4	82.7	78.7	75.0	86.7	0.950	92.0	87.4
North Dallas C63	71.2	95.6	100.2	99.9	83.9	78.8	77.3	74.0	85.1	0.934	93.0	86.9
Dallas C402	68.4	82.5	90.2	88.1	95.6	87.6	72.1	70.1	81.8	0.912	87.3	79.6
Denton	88.3	102.3	106.5	92.2	71.0	64.1	89.4	85.1	87.4	0.882	101.5	89.5
Midlothian	70.6	76.1	78.3	70.5	97.4	87.0	69.2	68.4	77.2	0.914	92.5	84.6
Arlington	74.2	90.3	91.6	83.6	94.3	87.6	74.0	79.5	84.4	0.917	95.0	87.1
Fort Worth C13	81.5	94.9	93.7	88.2	83.7	76.5	80.4	81.6	85.1	0.891	98.3	87.6
Fort Worth C17	88.7	97.6	102.5	90.6	79.8	71.0	87.7	84.5	87.8	0.892	96.3	85.9
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.841	0.946	1.013	0.937	0.855	0.926	0.869	0.840				
Dallas C60	0.880	0.947	1.014	0.968	0.924	1.068	0.916	0.881				
North Dallas C63	0.861	0.960	1.012	0.954	0.893	1.038	0.899	0.846				
Dallas C402	0.873	0.888	0.920	0.897	0.913	1.034	0.896	0.870				
Denton	0.862	0.925	0.982	0.816	0.847	0.886	0.879	0.850				
Midlothian	0.935	0.896	0.909	0.904	0.871	0.971	0.923	0.913				
Arlington	0.860	0.918	0.920	0.885	0.903	1.041	0.905	0.918				
Fort Worth C13	0.865	0.900	0.914	0.846	0.882	0.958	0.885	0.888				
Fort Worth C17	0.883	0.887	0.952	0.849	0.864	0.912	0.922	0.868				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–33. 2009 design value summary of 2009 with DFW EGU controls [ppb].

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_egu	
Scenario	**2009 baseline [ppb]**	**DFW EGU Controls [ppb]**	**Difference [ppb]**
Frisco	91.2	91.0	-0.25
Dallas C60	87.6	87.4	-0.16
Dallas C63	87.0	86.9	-0.15
Dallas C402	79.7	79.6	-0.06
Denton	89.6	89.5	-0.10
Midlothian	84.5	84.6	0.02
Arlington	87.2	87.1	-0.11
Fort Worth C13	87.6	87.6	-0.01
Fort Worth C17	86.0	85.9	-0.06

Table 4–34. Estimation of DFW major source control impacts to the 2009 future design values [ppb].

Run	run44.fy2009.a1.dfw_major	run44.fy2009.a1.dfw_egu	
Scenario	**DFW EGU + DFW Major Source Controls (Task 11) [ppb]**	**DFW EGU Controls [ppb]**	**Estimated DFW Major Source Controls[1] [ppb]**
Frisco	-0.36	-0.25	-0.11
Dallas C60	-0.33	-0.16	-0.17
Dallas C63	-0.33	-0.15	-0.18
Dallas C402	-0.40	-0.06	-0.34
Denton	-0.28	-0.10	-0.18
Midlothian	-0.61	0.02	-0.63
Arlington	-0.60	-0.11	-0.49
Fort Worth C13	-0.52	-0.01	-0.51
Fort Worth C17	-0.31	-0.06	-0.25

1. Estimated by assuming a linear relationship.

Table 4–35. Exceedance Area in 2009 with DFW EGU controls (Number of 4-km grid cells in DFW with daily maximum 8-hour ozone > 85 ppb).

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_egu	
Scenario	**2009 Baseline**	**DFW EGU Controls**	**Difference**
990815	19	19	0.0%
990816	223	223	0.0%
990817	296	292	-1.4%
990818	253	251	-0.8%
990819	304	303	-0.3%
990820	70	68	-2.9%
990821	29	28	-3.4%
990822	5	4	-20.0%
Totals	1199	1188	-0.9%

Table 4–36. Number of exceedance grid cells reduced at least 1 ppb from the DFW EGU controls.

Run	run44.fy2009.a1.dfw_egu
Scenario	DFW EGU Controls
990815	0
990816	0
990817	0
990818	0
990819	0
990820	0
990821	0
990822	0
Totals	0

Table 4–37. Number of ppb's exceeding 85 ppb[1] in the daily maximum ozone in DFW NAA.

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_egu
Scenario	2009 Future Base	DFW EGU Controls
990815	50	44
990816	2184	2164
990817	2594	2563
990818	1660	1648
990819	1201	1177
990820	84	80
990821	74	67
990822	1	0
Total	7846	7744
% Reduced		-1.3%

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW.

Summary

A CAMx sensitivity run examined the 8-hour ozone impact from NOx controls on EGUs inside the DFW 9-county NAA to the same level as the Houston ESADs. The controls lowered NOx emissions by 2.0 tpd. Most of the reductions were located in Dallas and Kaufman Counties.

Ozone benefits were greatest in northeast Dallas County, ranging from 0.7 to 1.1 ppb on dates with south or east winds. Frisco had the greatest future design value reduction of 0.25 ppb while Midlothian showed a slight gain of 0.02 ppb. Denton's future design value was 0.10 ppb lower. When compared to the future design value benefits from the combined DFW EGU and major source control scenario in Task 11, the northeastern DFW monitoring sites benefited more from the EGU controls while the southern and western sites benefited more from the DFW major source controls. The DFW EGU controls did not change the grid cell statistics significantly due to the small magnitude of NOx reduction.

4.7 DFW MINOR SOURCE CONTROLS

A CAMx sensitivity run (run44.fy2009.a1.dfw_minor2) examined the impact to 8-hour ozone in the DFW 9-county NAA during the August 13-22, 1999 episode for the 2009 future year when applying NOx controls on DFW minor sources to Houston ESAD levels.

Emissions

The controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs. NOx emissions from the DFW minor sources were reduced 4.6 tpd to achieve the same level as the Houston ESADs. Four counties accounted for 90 % of the NOx reduction – Denton, Dallas, Parker, and Tarrant Counties. VOCs were unchanged from the 2009 baseline.

A summary of the 2009 weekday NOx emissions is shown in Table 4–38 by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column shows the change in emissions from the 2009 baseline. The area with the largest NOx decrease from the 2009 baseline was in western Denton County, as can be seen in the tile plot in Figure 4–13.

Table 4–38. Weekday NOx emissions in 2009 with DFW minor source controls.

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a1 baseline
Collin Co	10	15	1	0	2	8	0	26	-0.1
Dallas Co	4	77	6	2	17	45	0	148	-0.9
Denton Co	8	17	1	0	11	9	0	38	-1.6
Tarrant Co	3	46	2	2	9	28	0	88	-0.6
Parker Co	1	6	1	0	1	2	0	9	-0.9
Johnson Co	5	5	6	0	0	5	0	16	-0.2
Ellis Co	15	9	35	1	0	6	0	51	-0.1
Kaufman Co	5	6	4	0	0	2	0	13	0.0
Rockwall Co	2	3	0	0	0	1	0	5	0.0
DFW 9-County	**52**	**184**	**55**	**6**	**40**	**107**	**0**	**392**	**-4.4**
DFW 16 County	**83**	**212**	**80**	**10**	**62**	**123**	**0**	**487**	**-4.5**
NE Texas	16	79	189	16	71	42	1	397	0.0
Central TX	113	88	138	2	56	69	0	353	0.0
Houston	21	175	282	12	53	63	0	585	0.0
South TX	229	189	267	22	75	100	0	653	0.0
West TX	524	160	154	21	212	105	1	653	0.0
Texas	**986**	**904**	**1109**	**83**	**529**	**501**	**2**	**3128**	**-4.6**
Gulf + Mexico	79	5	437	0	4	2	444	892	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	0.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a1 baseline
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**913**	**10389**	**85**	**538**	**509**	**23869**	**36303**	**-4.6**
Total change from a1 baseline	**0.0**	**0.0**	**0.0**	**0.0**	**-4.6**	**0.0**	**0.0**	**-4.6**	

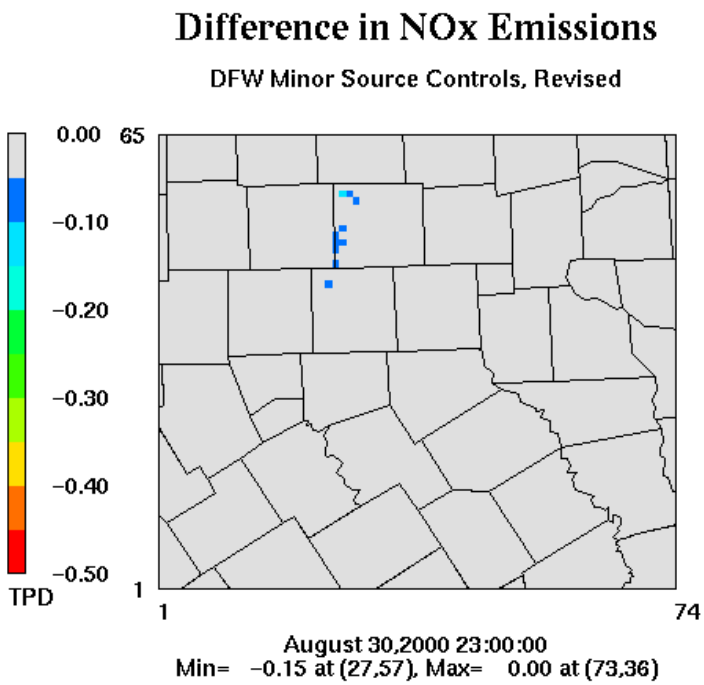


Figure 4–13. Tile plot of differences in NOx emissions from the revised DFW minor source controls.

Modeling Results

Spatial plots of the daily maximum 8-hour ozone and differences from the 2009 baseline are shown in Figure 4–14 for each episode date in the DFW 4 km domain. From August 18 to 20, the revised DFW minor source controls reduced 8-hour ozone between 0.25 to 0.4 ppb in parts of Parker County, and western Denton and Tarrant Counties. On all other episode dates, ozone was reduced less than 0.25 ppb throughout the DFW 9-county NAA.

The 8-hour ozone design value calculation is shown in Table 4–39 for all DFW monitoring sites using the 1999 baseline design value, and is compared to the 2009 baseline design values in Table

4–40. Fort Worth C13, which was the western-most monitoring site, had the largest future design value reduction of 0.11 ppb. Denton and Frisco were reduced 0.10 and 0.05 ppb, respectively.

Tables 4–41 to 4–43 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–41 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in both the 2009 baseline and control scenario. The rightmost column shows the percent change in exceedance area. The revised DFW minor source controls only dropped 10 (1 %) of the 1199 exceedance cells below 85 ppb, all occurring between August 17 and 19. Table 4–42 shows that no 8-hour ozone exceedance cells were reduced more than 1 ppb from the controls during the episode.

Table 4–43 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The episode averaged a 1.2 % reduction.

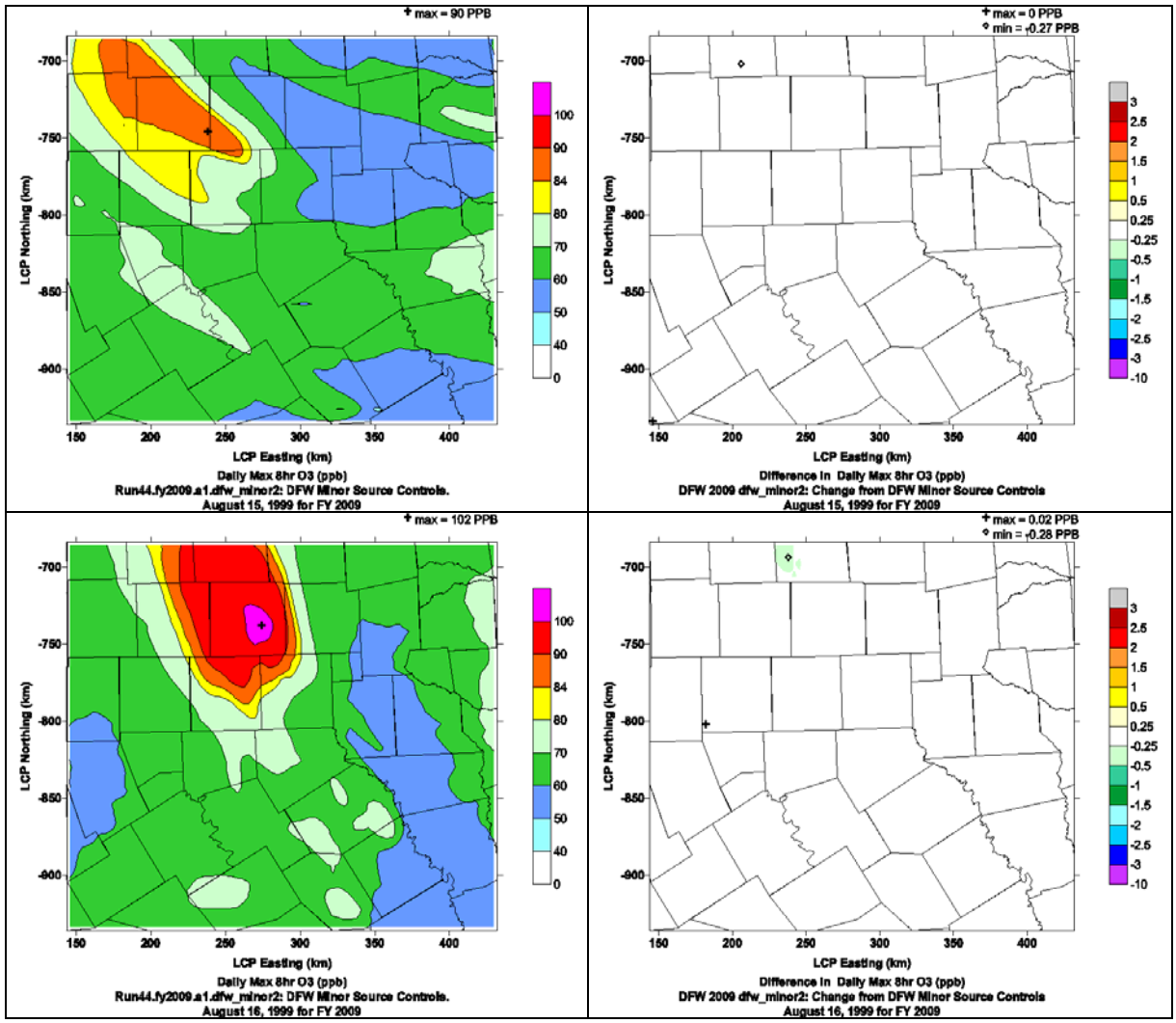


Figure 4–14. Spatial plots of the daily maximum 8-hour ozone with the revised DFW minor source controls (left) and differences from the 2009 baseline (right).

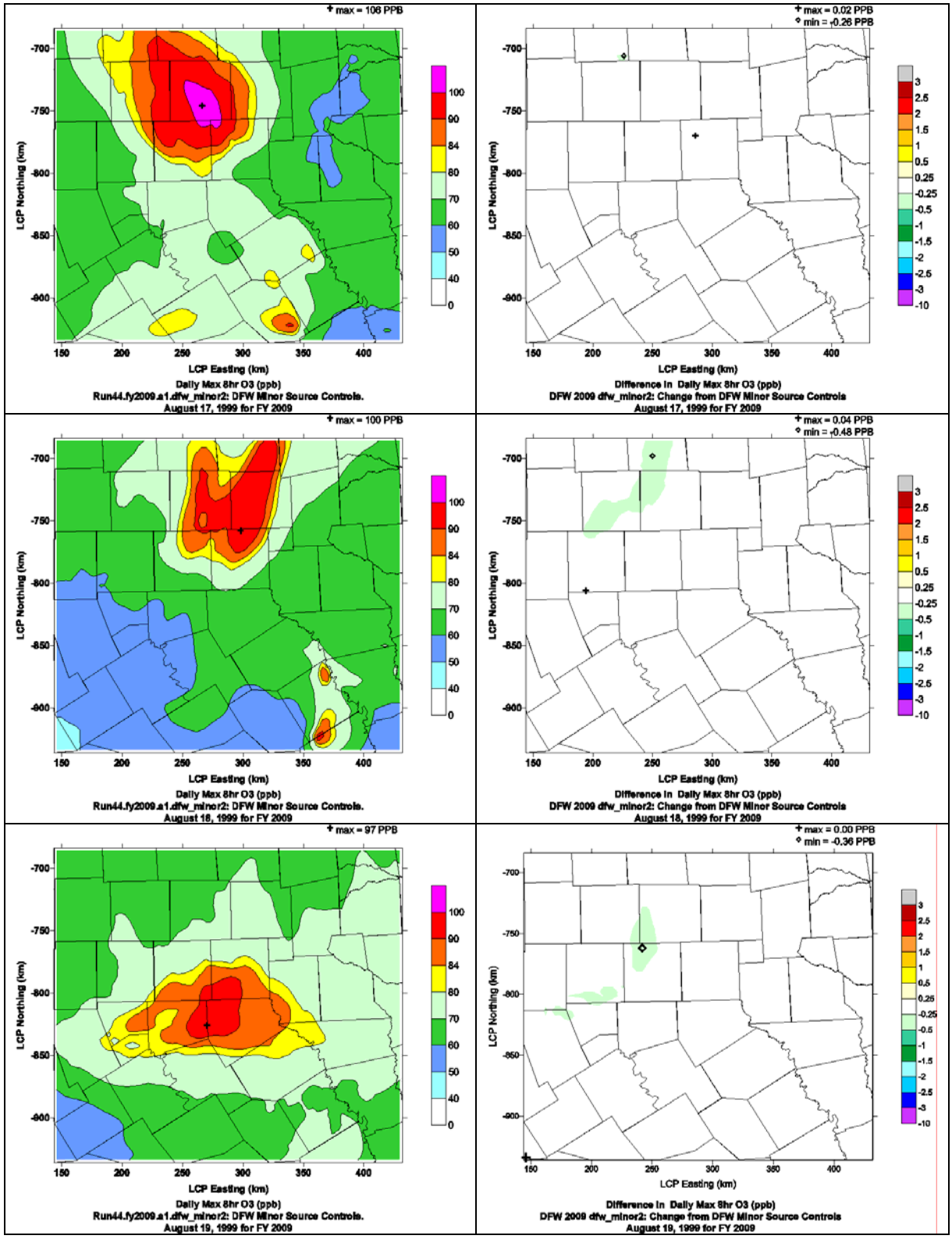


Figure 4–14. (Continued) Spatial plots of the daily maximum 8-hour ozone with the revised DFW minor source controls (left) and differences from the 2009 baseline (right).

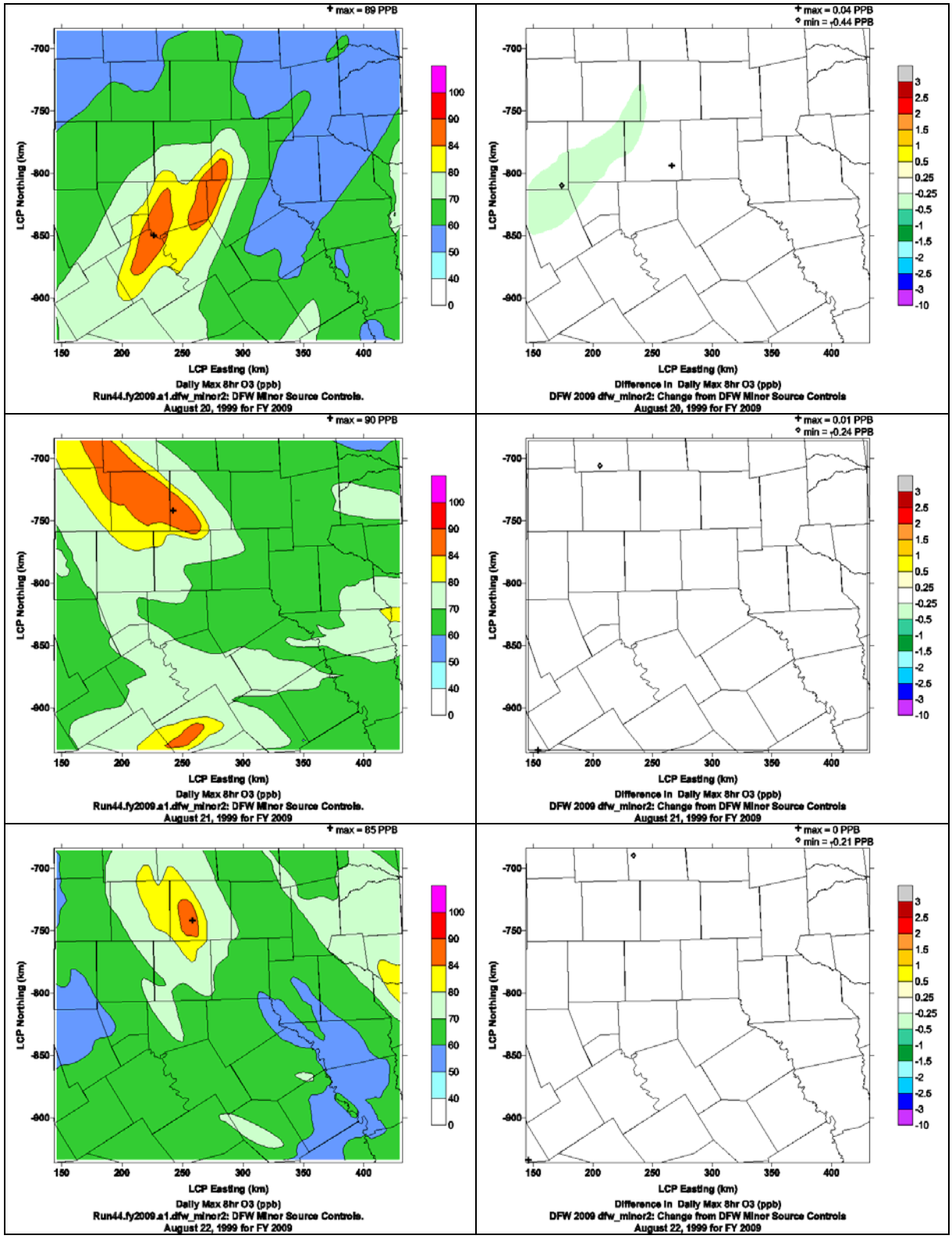


Figure 4–14. (Concluded) Spatial plots of the daily maximum 8-hour ozone with the revised DFW minor source controls (left) and differences from the 2009 baseline (right).

Table 4–39. Design value calculation for the revised DFW minor source control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.dfw_minor2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Base DV [ppb]**	**FutureDV[2] [ppb]**
Frisco	68.3	100.1	100.4	98.3	73.1	64.9	75.1	75.3	81.9	0.909	100.3	91.2
Dallas C60	73.7	93.0	102.1	99.5	89.3	82.6	79.2	75.0	86.8	0.951	92.0	87.5
North Dallas C63	71.6	95.7	100.4	99.9	83.9	78.8	77.8	74.2	85.3	0.935	93.0	87.0
Dallas C402	68.4	82.5	90.3	88.1	95.6	87.6	72.2	70.2	81.9	0.912	87.3	79.6
Denton	88.5	102.3	106.5	92.0	70.9	63.9	89.5	85.1	87.3	0.882	101.5	89.5
Midlothian	70.6	76.1	78.3	70.5	97.3	87.0	69.2	68.4	77.2	0.913	92.5	84.5
Arlington	74.3	90.3	91.5	83.5	94.3	87.6	74.1	79.5	84.4	0.918	95.0	87.2
Fort Worth C13	81.5	94.8	93.7	88.1	83.5	76.4	80.4	81.6	85.0	0.890	98.3	87.5
Fort Worth C17	88.8	97.6	102.5	90.5	79.6	71.0	87.8	84.5	87.8	0.892	96.3	85.9
Daily RRFs[3]												
Site	990815	990816	990817	990818	990819	990820	990821	990822				
Frisco	0.846	0.947	1.014	0.937	0.854	0.926	0.874	0.843				
Dallas C60	0.887	0.947	1.014	0.968	0.924	1.067	0.920	0.881				
North Dallas C63	0.866	0.960	1.014	0.954	0.893	1.038	0.904	0.848				
Dallas C402	0.874	0.889	0.921	0.897	0.913	1.034	0.897	0.871				
Denton	0.865	0.925	0.982	0.815	0.845	0.882	0.881	0.850				
Midlothian	0.934	0.895	0.908	0.904	0.871	0.972	0.923	0.913				
Arlington	0.861	0.918	0.919	0.884	0.902	1.041	0.906	0.917				
Fort Worth C13	0.865	0.900	0.913	0.846	0.880	0.957	0.885	0.888				
Fort Worth C17	0.884	0.886	0.952	0.848	0.862	0.912	0.924	0.868				

1. RRF = Future year average / base year average.
2. Future DV = Baseline DV * RRF.
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–40. 2009 design value summary with DFW minor source controls [ppb].

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_minor2	
Scenario	**2009 baseline**	**DFW minor sources at HGB ESADs, revised**	**Difference from 2009 baseline [ppb]**
Frisco	91.2	91.2	-0.05
Dallas C60	87.6	87.5	-0.07
Dallas C63	87.0	87.0	-0.05
Dallas C402	79.7	79.6	-0.06
Denton	89.6	89.5	-0.10
Midlothian	84.5	84.5	-0.08
Arlington	87.2	87.2	-0.02
Fort Worth C13	87.6	87.5	-0.11
Fort Worth C17	86.0	85.9	-0.06

Table 4–41. Exceedance Area in 2009 with DFW minor source controls (Number of 4-km grid cells in DFW with daily maximum 8-hour ozone > 85 ppb).

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_minor2	Difference [%}
Scenario	**2009 baseline**	**DFW minor sources at HGB ESADs, revised**	
990815	19	19	0%
990816	223	223	0%
990817	296	295	0%
990818	253	250	-1%
990819	304	298	-2%
990820	70	70	0%
990821	29	29	0%
990822	5	5	0%
Total	1199	1189	-1%

Table 4–42. Number of exceedance 4-km grid cells reduced at least 1 ppb from DFW minor source controls.

Run	run44.fy2009.a1.dfw_minor2
Scenario	**DFW minor sources at HGB ESADs, revised**
990815	0
990816	0
990817	0
990818	0
990819	0
990820	0
990821	0
990822	0
Total	0

Table 4–43. Number of ppb's from 4-km grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1].

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_minor2
Scenario	2009 baseline	DFW minor sources at HGB ESADs, revised
990815	50	48
990816	2184	2166
990817	2594	2577
990818	1660	1641
990819	1201	1169
990820	84	80
990821	74	72
990822	1	0
Total	7846	7753
% Difference		-1.2 %

[1] Σ(max(O3-85, 0.0)).

Summary

A CAMx sensitivity test examined the 8-hour ozone impacts from revised DFW minor source controls to reduce NOx emissions to the same level as the Houston ESADs. The controls lowered NOx emissions by 4.6 tpd, of which a third were found in western Denton County.

Ozone benefits between 0.25 and 0.40 ppb were found in parts of Parker County and western Denton and Tarrant Counties from August 18 to 20. On all other dates, 8-hour ozone was reduced less than 0.25 ppb throughout the DFW 9-county NAA. Future design values were reduced 0.02 ppb to 0.11 ppb among all monitoring sites; Denton and Frisco were 0.10 and 0.05 ppb lower, respectively. The 8-hour ozone benefits were less than other sensitivity tests due to two factors: (1) the change in NOx emissions was relatively small, and (2) a majority of the emission reductions was downwind of the monitoring sites on most dates.

4.8 NCTCOG ON-ROAD AND OFF-ROAD EMISSION CONTROLS

Two CAMx sensitivity runs examined the impacts to 8-hour ozone in the DFW 9-county NAA during the August 13-22, 1999 episode for the 2009 future year when applying NCTCOG-proposed high-end and low-end controls to onroad and non-road emissions in DFW.

Emissions

The two NCTCOG onroad and off-road controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs. Date-specific mobile emissions were averaged by day of the week to form Friday, Saturday, Sunday, and weekday emissions, as had been performed for the baseline emissions.

The high-end scenario reduced weekday emissions inside the DFW 9-county NAA by 33 tpd NOx (18 tpd from onroad mobile and 16 tpd from off-road) and 8 tpd VOC (mostly from onroad controls). Dallas and Tarrant Counties accounted to 41 % and 25 % of all NOx reductions, respectively. Emission reductions on weekends were smaller.

The NOx reductions in the NCTCOG low-control scenario were approximately half of the high-end controls. The total NOx reduction in the low control case was 16 tpd (9 tpd from onroad and 7 tpd from off-road controls). Most reductions were in Dallas and Tarrant Counties. VOC reductions were identical to the high-end controls.

Summaries of the 2009 weekday NOx emissions from the NCTCOG high-end and low-end control scenarios are shown in Tables 4–44 and 4–45, respectively, by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column in each table shows the change in emissions from the 2009 baseline. A similar table of weekday VOC emissions from both NCTCOG controls is shown in Table 4–46.

Figure 4–15 plots the spatial distribution of the weekday NOx and VOC reductions in the DFW 4-km domain for the two control scenarios.

Table 4–44. Weekday NOx emissions in 2009 with NCTCOG high-end controls.

NOx [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	10	13	1	0	2	7	0	23	-2.6
Dallas Co	4	70	6	2	18	39	0	135	-13.7
Denton Co	8	15	1	0	12	8	0	37	-3.0
Tarrant Co	3	42	2	2	10	24	0	80	-8.2
Parker Co	1	5	1	0	1	1	0	9	-1.0
Johnson Co	5	4	6	0	0	5	0	15	-1.2
Ellis Co	15	8	35	1	0	5	0	49	-1.7
Kaufman Co	5	5	4	0	0	2	0	12	-1.1
Rockwall Co	2	3	0	0	0	1	0	4	-0.6
DFW 9-County	**52**	**166**	**55**	**6**	**44**	**92**	**0**	**363**	**-33.1**
DFW 16 County	**83**	**195**	**80**	**10**	**67**	**108**	**0**	**459**	**-33.2**
NE Texas	16	79	189	16	71	42	1	397	0.0
Central TX	113	88	138	2	56	69	0	353	0.0
Houston	21	175	282	12	53	63	0	585	0.0
South TX	229	189	267	22	75	100	0	653	0.0
West TX	524	160	154	21	212	105	1	653	0.0
Texas	**986**	**886**	**1109**	**83**	**534**	**486**	**2**	**3099**	**-33.2**
Gulf + Mexico	79	5	437	0	4	2	444	892	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	0.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**895**	**10389**	**85**	**543**	**494**	**23869**	**36274**	**-33.2**
Total change from baseline	**0.0**	**-17.6**	**0.0**	**0.0**	**0.0**	**-15.6**	**0.0**	**-33.2**	

Table 4–45. Weekday NOx emissions in 2009 with NCTCOG low-end controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	10	14	1	0	2	8	0	24	-1.3
Dallas Co	4	74	6	2	18	42	0	142	-6.6
Denton Co	8	16	1	0	12	9	0	38	-1.4
Tarrant Co	3	44	2	2	10	26	0	85	-3.9
Parker Co	1	5	1	0	1	2	0	9	-0.6
Johnson Co	5	4	6	0	0	5	0	15	-0.6
Ellis Co	15	8	35	1	0	5	0	50	-0.8
Kaufman Co	5	6	4	0	0	2	0	12	-0.6
Rockwall Co	2	3	0	0	0	1	0	4	-0.3
DFW 9-County	**52**	**174**	**55**	**6**	**44**	**100**	**0**	**380**	**-16.2**
DFW 16 County	**83**	**203**	**80**	**10**	**67**	**116**	**0**	**476**	**-16.3**
NE Texas	16	79	189	16	71	42	1	397	0.0
Central TX	113	88	138	2	56	69	0	353	0.0
Houston	21	175	282	12	53	63	0	585	0.0
South TX	229	189	267	22	75	100	0	653	0.0
West TX	524	160	154	21	212	105	1	653	0.0
Texas	**986**	**894**	**1109**	**83**	**534**	**494**	**2**	**3116**	**-16.3**
Gulf + Mexico	79	5	437	0	4	2	444	892	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	0.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**903**	**10389**	**85**	**543**	**502**	**23869**	**36291**	**-16.3**
Total change from baseline	**0.0**	**-9.4**	**0.0**	**0.0**	**0.0**	**-6.9**	**0.0**	**-16.3**	

Table 4–46. Weekday VOC emissions in 2009 with NCTCOG controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	27	7	0	0	12	3	0	22	-0.6
Dallas Co	50	39	4	5	72	17	0	137	-3.7
Denton Co	65	7	1	0	15	4	0	27	-0.7
Tarrant Co	64	23	2	5	54	9	0	92	-2.2
Parker Co	121	2	0	0	5	1	0	8	-0.2
Johnson Co	111	2	0	0	6	1	0	9	-0.2
Ellis Co	89	2	3	2	6	2	0	15	-0.2
Kaufman Co	112	2	0	0	7	1	0	11	-0.2
Rockwall Co	3	1	0	0	2	1	0	4	-0.1
DFW 9-County	**642**	**84**	**10**	**13**	**180**	**37**	**0**	**325**	**-8.0**
DFW 16 County	**1538**	**95**	**34**	**15**	**216**	**44**	**1**	**405**	**-8.0**
NE Texas	4917	27	15	41	82	14	1	181	0.0
Central TX	6098	33	20	20	85	21	1	180	0.0
Houston	1683	80	92	215	247	41	0	675	0.0
South TX	2069	78	20	48	217	46	0	408	0.0
West TX	6198	59	11	28	215	52	3	367	0.0
Texas	**22503**	**372**	**191**	**367**	**1060**	**218**	**6**	**2215**	**-8.1**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	655	695	0.0
Tennessee	8678	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12198	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**377**	**1107**	**370**	**1080**	**224**	**23453**	**26610**	**-8.0**
Total change from baseline	**0.0**	**-7.7**	**0.0**	**0.0**	**0.0**	**-0.3**	**0.0**	**-8.0**	

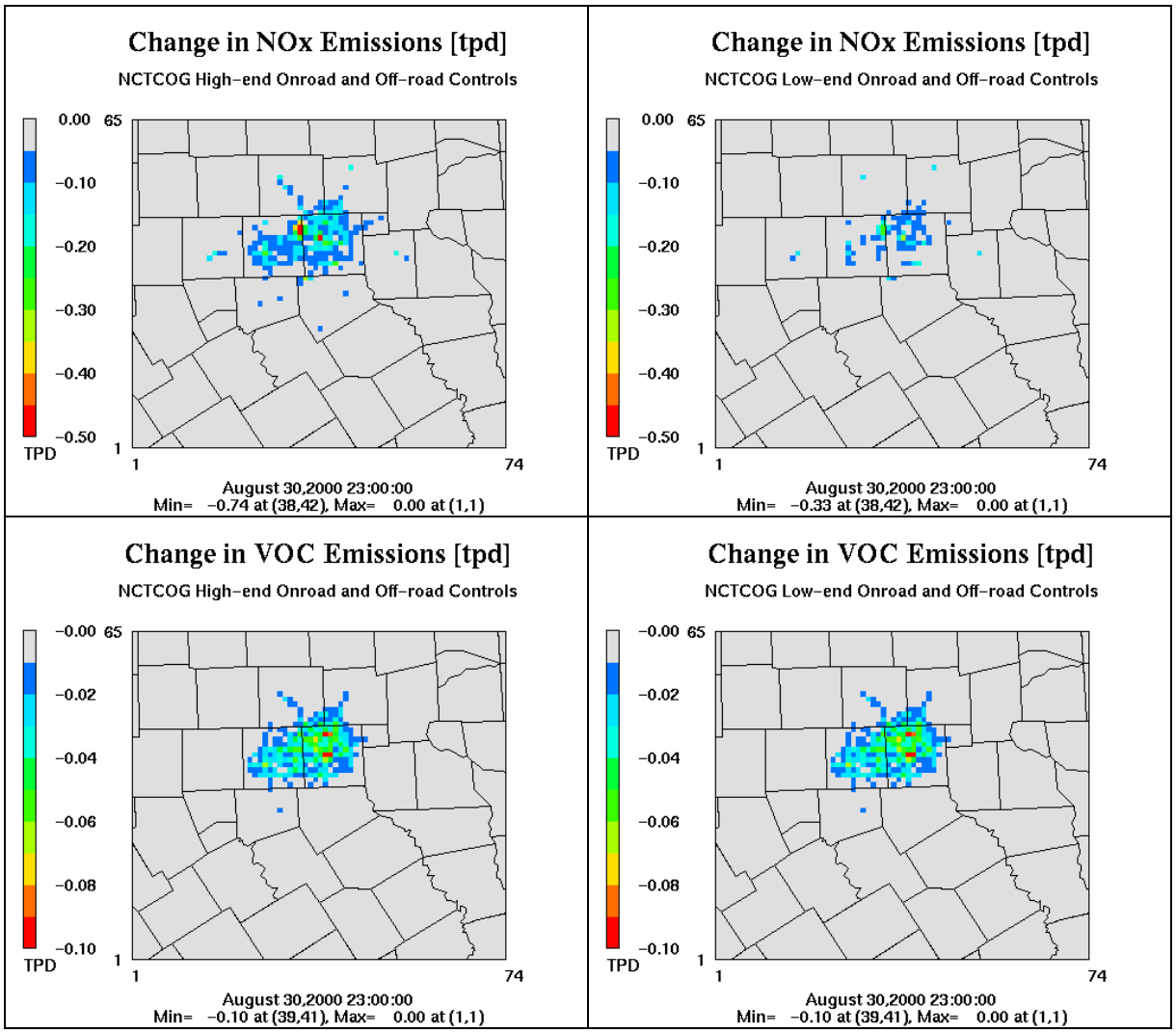


Figure 4–15. Tile plot of weekday NOx (top) and VOC (bottom) reductions from the NCTCOG high-end (left) and low-end (right) onroad and off-road controls.

Modeling Results

Figure 4–16 displays spatial plots of the daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for each episode date in the DFW 4 km domain. The left side shows the NCTCOG high-end controls; the right side shows the low-end controls.

The high-end controls reduced the daily maximum 8-hour ozone in or near Denton between 1.5 and 2.0 ppb on all episode dates except August 19 and 20, when the wind was northerly. The areas of high ozone reduction corresponded well with the areas of high 8-hour ozone.

The spatial distribution of the 8-hour ozone benefits from the NCTCOG low-end controls was similar to the high-end controls on all episode dates; the magnitude was about half of the high-control scenario.

The 8-hour ozone design value calculations for the NCTCOG high and low control scenarios are shown in Tables 4–47 and 4–48, respectively, for all DFW monitoring sites using the 1999 baseline design value. Daily relative reduction factors are included at the bottom of each table. Table 4–49 compares the 2009 design values from the two controls with the 2009 baseline.

The high-control scenario lowered the 2009 8-hour ozone design values from 0.5 ppb at Midlothian to 1.4 ppb at Denton, making this control strategy more responsive than any of the others evaluated. Fort Worth CAMS 17's future design value dropped 1.3 ppb to 84.7 ppb, which puts this site in attainment for 8-hour ozone when following the EPA computation guidelines. Frisco's future design value was reduced by 1.0 ppb.

The NCTCOG onroad and off-road low-control scenario lowered the future design values almost half as much as the high-end controls. Reductions ranged from 0.3 ppb at Midlothian to 0.7 ppb at Denton; these are comparable to the design value reductions from the DFW minor source control scenario, which controlled area source NOx emissions by 17 tpd inside the DFW 9-county NAA.

Tables 4–50 to 4–52 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–50 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline and two NCTCOG control scenarios. The bottom of the table shows the percent change in exceedance area from each control. The high-end controls reduced the daily maximum 8-hour ozone below 85 ppb in 161 (13 %) out of 1199 exceedance cells in the episode. A majority of these cells were found on August 19 and 20, when the wind was northerly. The low-control scenario lowered 81 exceedance cells (7 %) below 85 ppb – half as many as the high-control scenario.

Table 4–51 shows the number of baseline exceedance cells that were reduced by at least 1 ppb from the NCTCOG controls. The high-end controls reduced 71 % (847 out of 1199) of all 8-hour ozone exceedance cells by at least 1 ppb; the low-end controls did not accomplish this in any cell.

Table 4–52 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The high and low control reduced the number of exceedance ppb's among all episode dates by 17 % and 9 %, respectively.

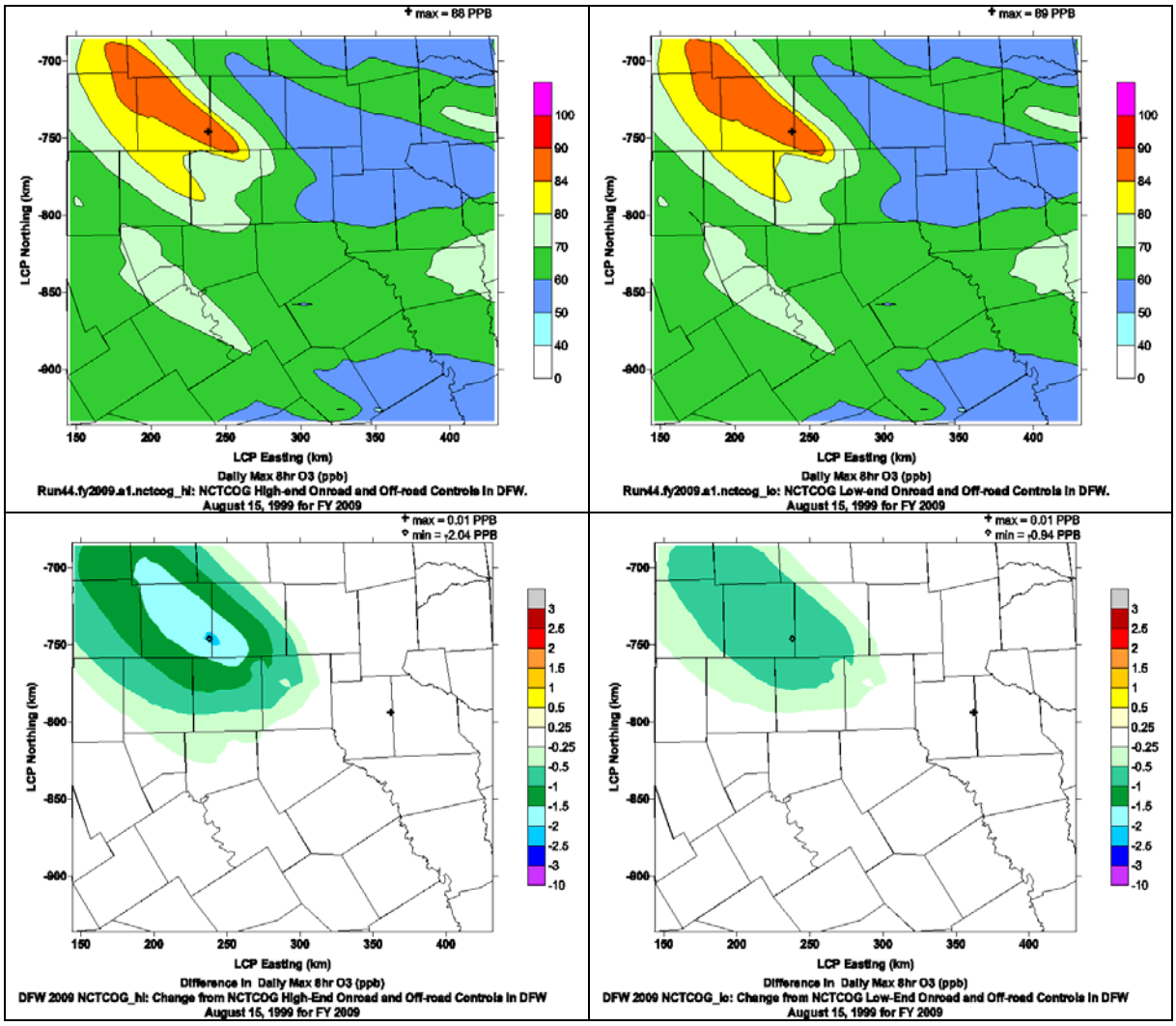


Figure 4–16. Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

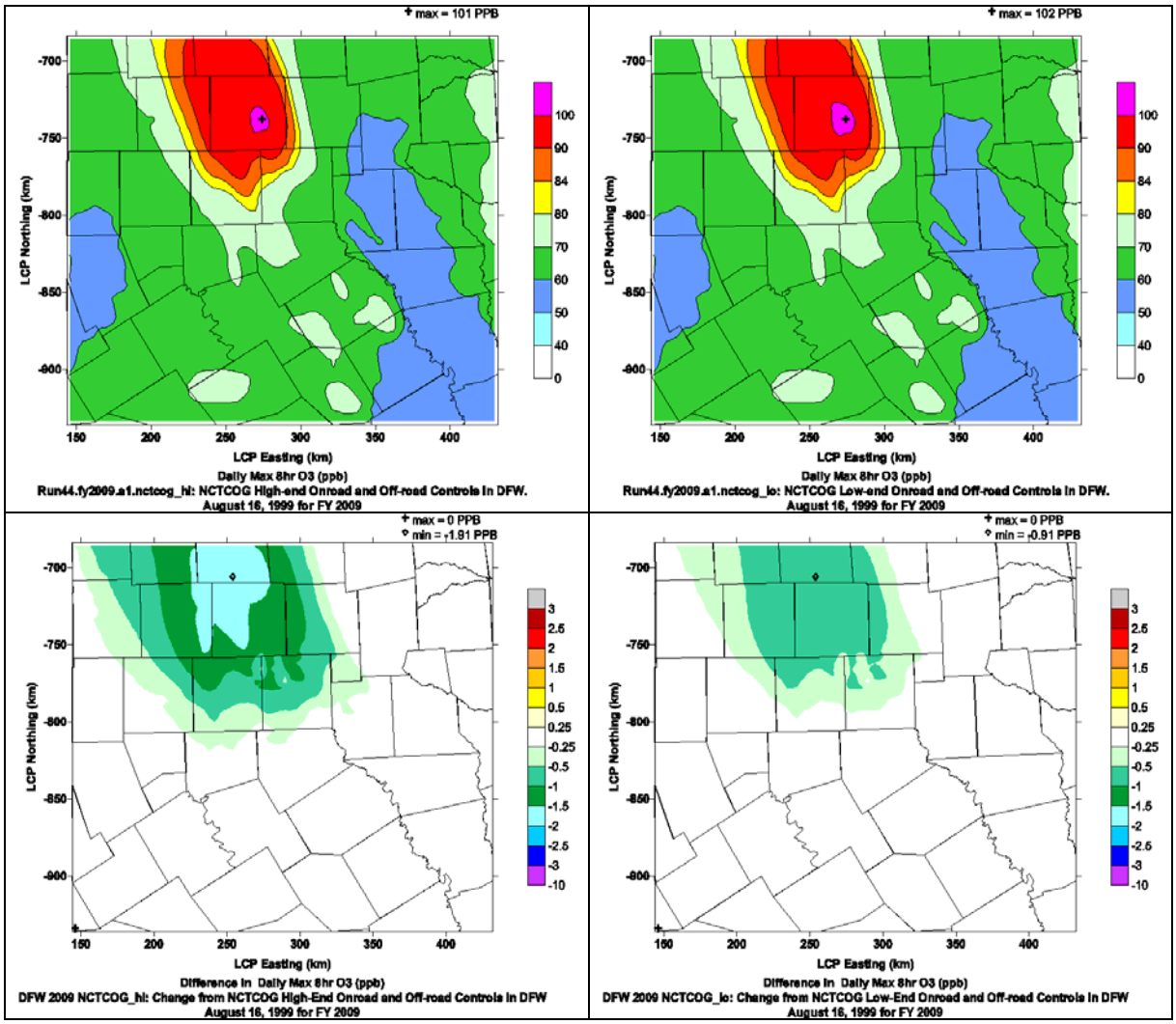


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

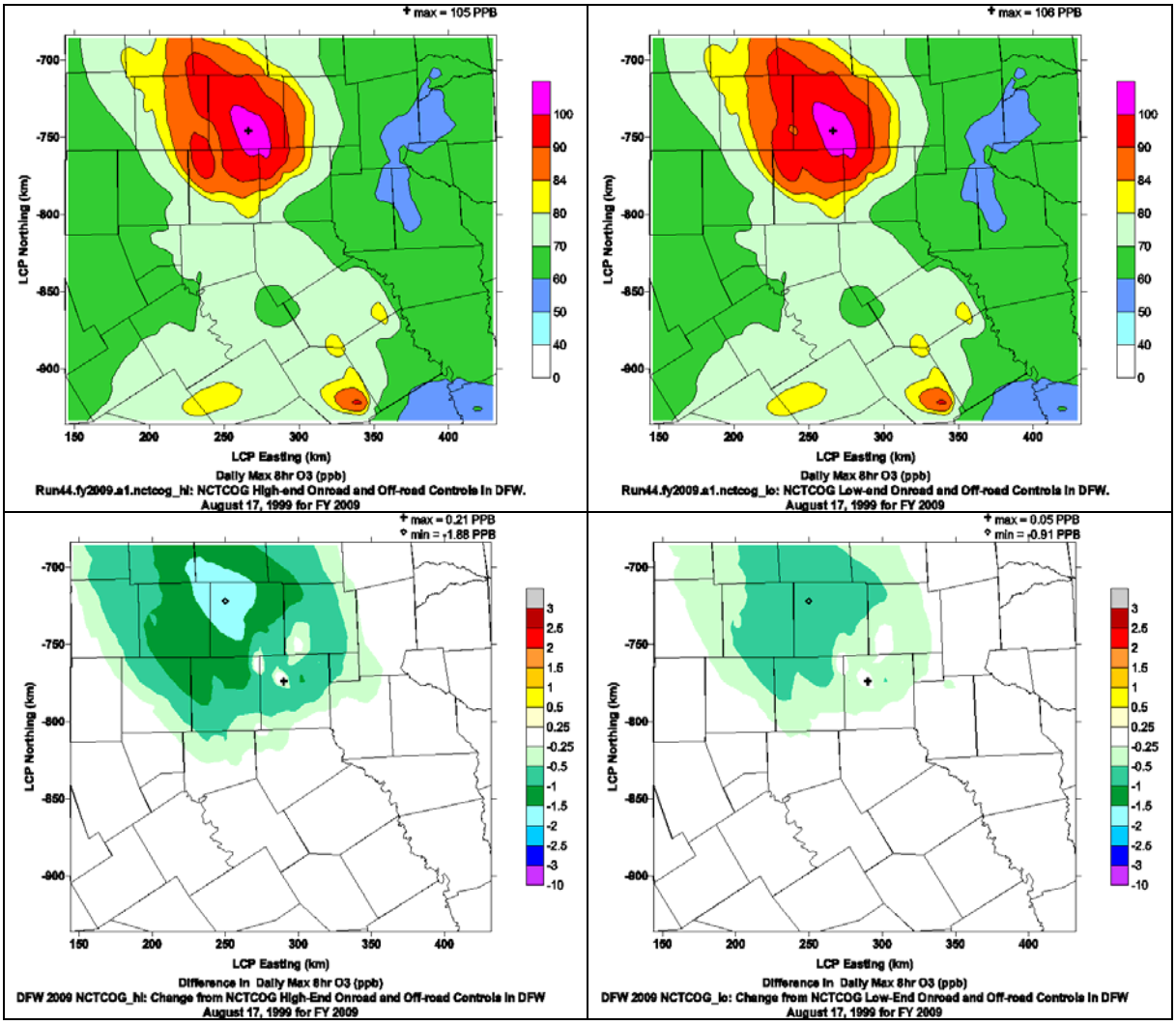


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

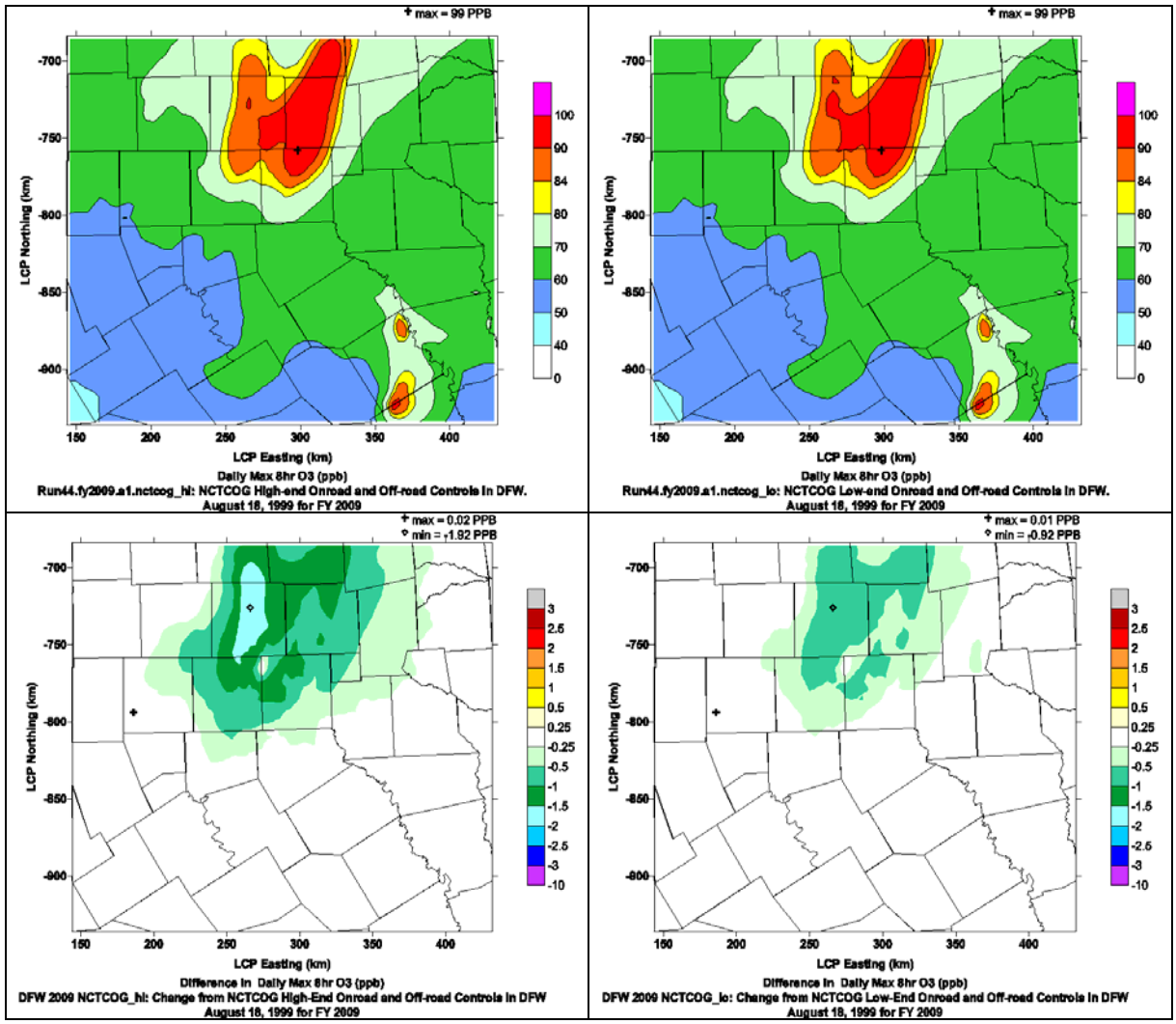


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

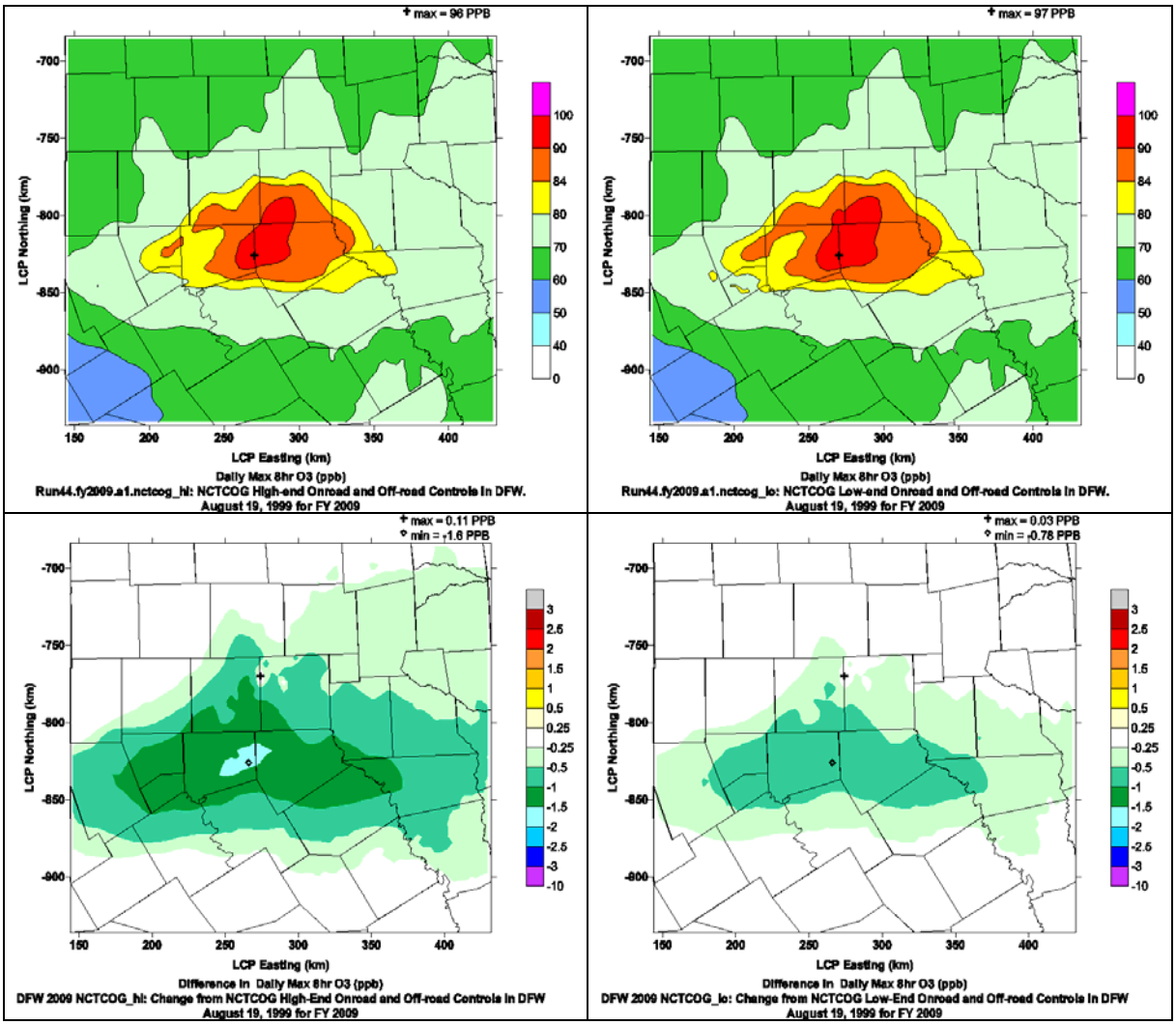


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

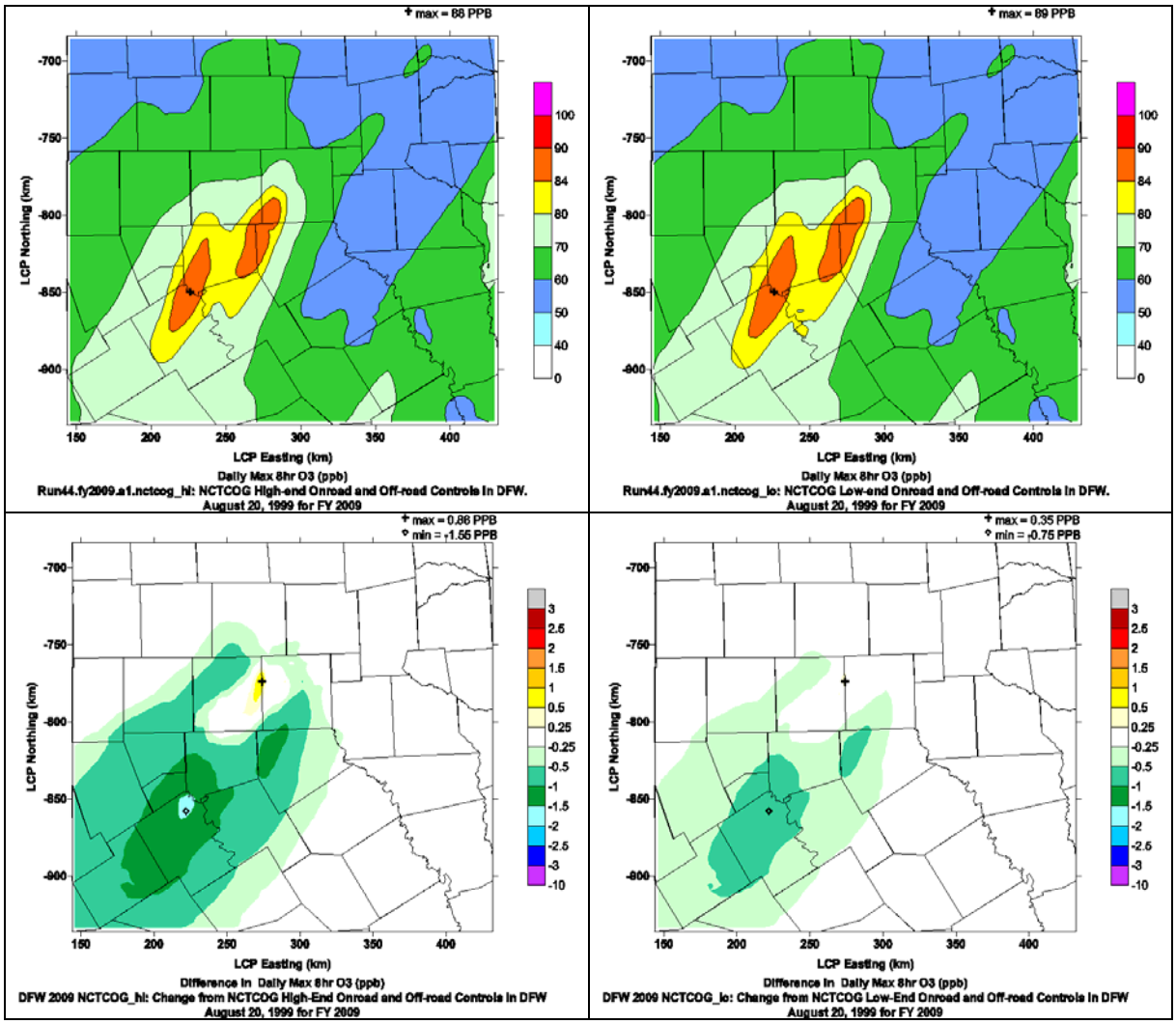


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

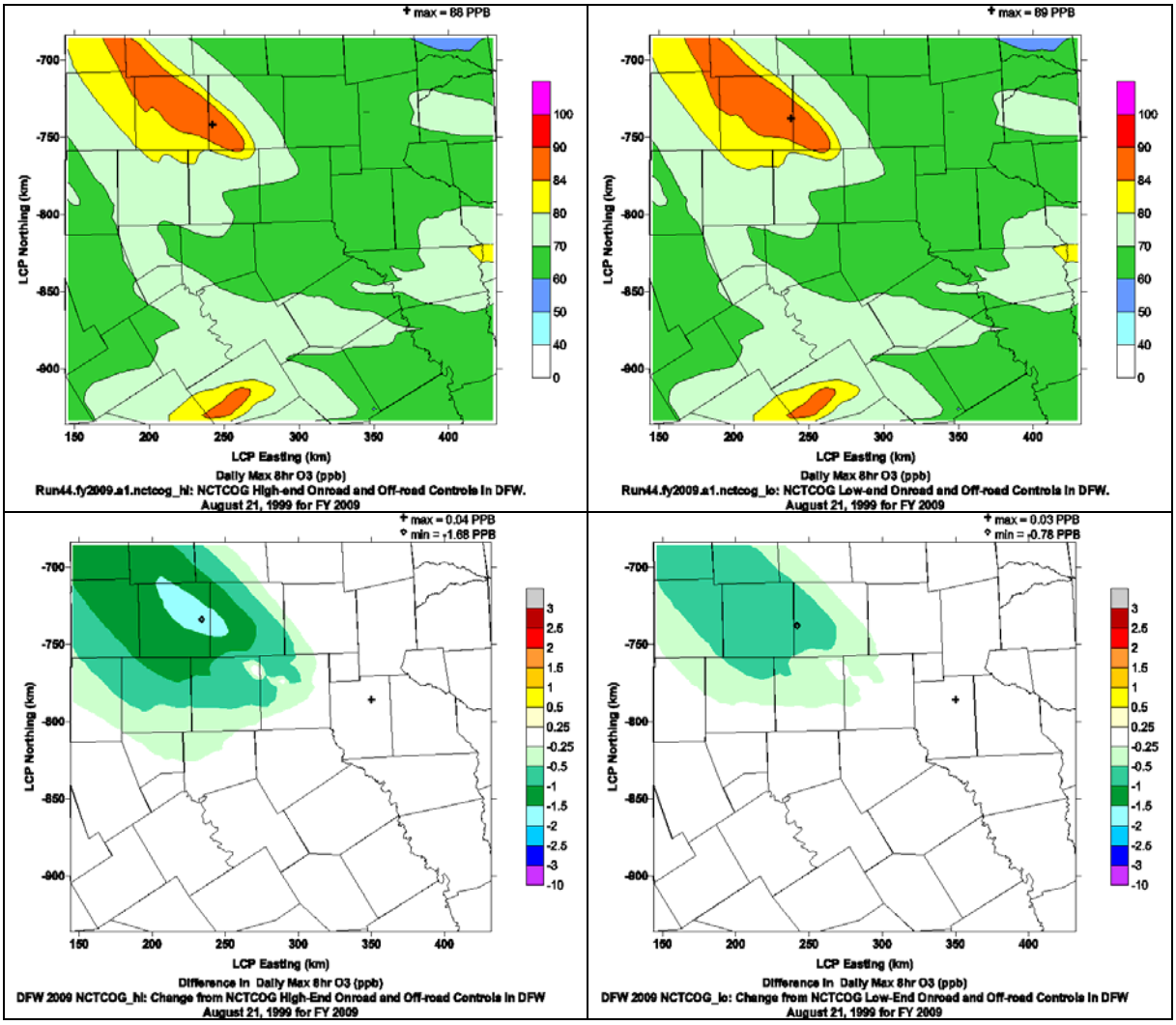


Figure 4–16. (Continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

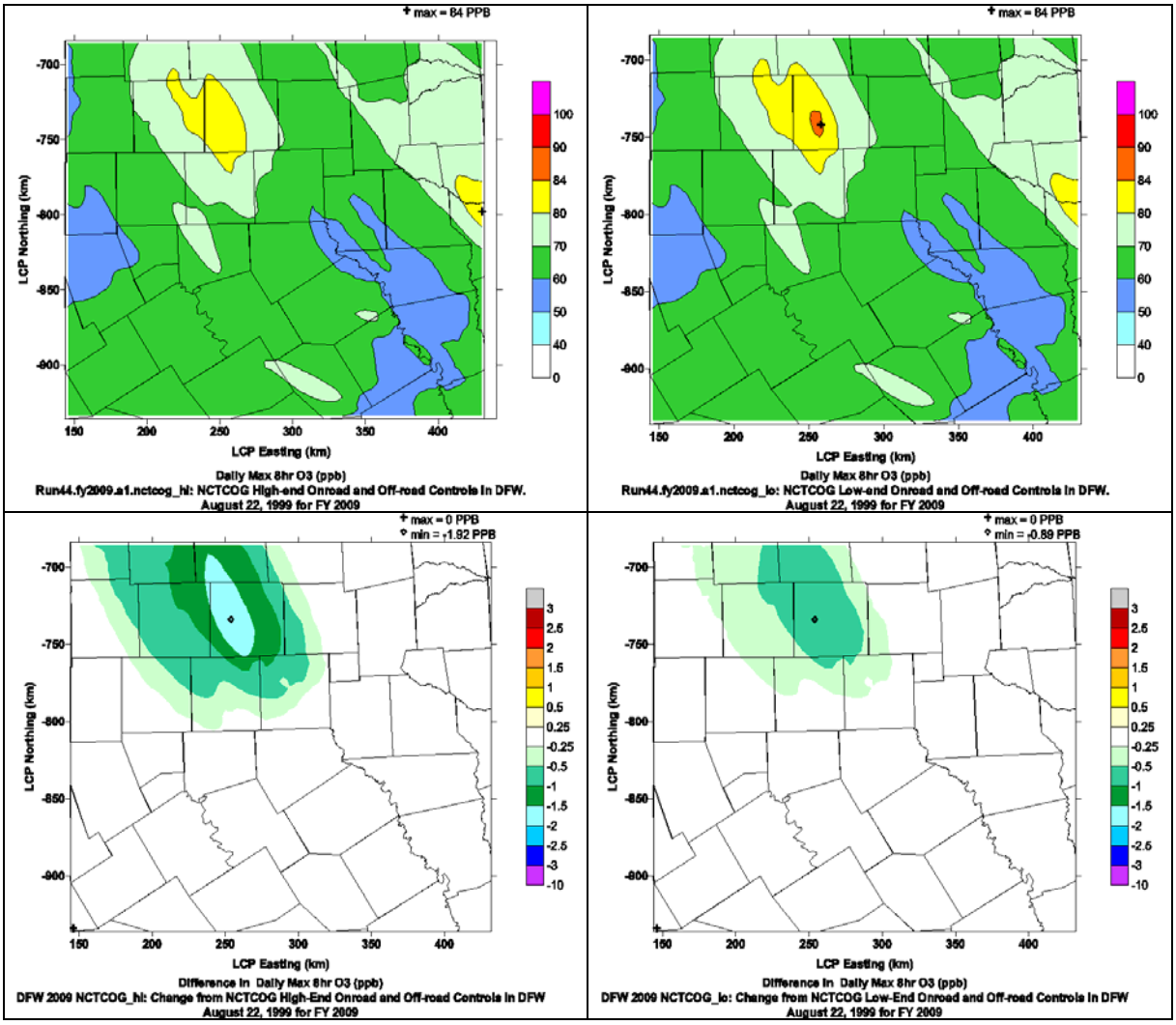


Figure 4–16. (Concluded). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the NCTCOG high-end controls (left) and low-end controls (right) for each episode date.

Table 4–47. Future design value calculation for the NCTCOG high-end control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North Dallas	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: run44.fy2009.a1.nctcog_hi												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	67.4	98.8	99.6	97.5	72.7	64.5	74.4	74.2	81.1	0.900	100.3	90.3
Dallas C60	72.7	91.8	101.4	98.5	88.7	82.5	78.4	73.9	86.0	0.942	92.0	86.7
North Dallas	70.8	94.7	99.6	98.8	83.1	78.7	77.1	73.1	84.5	0.927	93.0	86.2
Dallas C402	67.7	81.5	89.5	87.4	94.4	87.0	71.6	69.5	81.1	0.903	87.3	78.8
Denton	86.6	101.1	105.2	90.3	70.5	63.7	88.1	83.3	86.1	0.869	101.5	88.2
Midlothian	70.3	75.9	78.0	70.2	95.9	86.3	69.1	68.3	76.7	0.908	92.5	84.0
Arlington	73.6	89.6	90.5	82.3	93.0	87.0	73.4	78.9	83.5	0.908	95.0	86.3
Fort Worth C13	80.7	93.8	92.5	86.7	82.7	76.1	79.4	80.8	84.1	0.881	98.3	86.6
Fort Worth C17	86.9	96.2	101.2	89.1	78.6	70.7	86.8	82.9	86.6	0.879	96.3	84.7
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.835	0.935	1.007	0.929	0.850	0.921	0.866	0.830				
Dallas C60	0.874	0.936	1.008	0.958	0.917	1.066	0.911	0.868				
North Dallas	0.855	0.951	1.006	0.944	0.884	1.037	0.896	0.836				
Dallas C402	0.865	0.878	0.913	0.890	0.901	1.026	0.889	0.862				
Denton	0.846	0.914	0.970	0.799	0.841	0.880	0.866	0.832				
Midlothian	0.931	0.893	0.905	0.900	0.858	0.964	0.922	0.911				
Arlington	0.853	0.911	0.909	0.871	0.890	1.033	0.898	0.911				
Fort Worth C13	0.857	0.890	0.901	0.832	0.871	0.954	0.874	0.879				
Fort Worth C17	0.865	0.874	0.940	0.834	0.852	0.908	0.913	0.852				

1. RRF = Future year average / base year average.
2. Future DV = Baseline DV * RRF.
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–48. Future design value calculation for the NCTCOG low-end control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.nctcog_lo												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	67.9	99.5	100.0	97.9	72.9	64.7	74.8	74.8	81.6	0.905	100.3	90.8
Dallas C60	73.2	92.4	101.7	99.1	89.0	82.5	78.8	74.5	86.4	0.947	92.0	87.1
North Dallas C63	71.2	95.2	100.0	99.4	83.5	78.7	77.5	73.7	84.9	0.931	93.0	86.6
Dallas C402	68.1	82.1	89.9	87.8	95.0	87.3	71.9	69.9	81.5	0.908	87.3	79.3
Denton	87.7	101.7	105.9	91.3	70.8	63.9	88.9	84.3	86.8	0.876	101.5	88.9
Midlothian	70.4	76.0	78.2	70.4	96.7	86.7	69.1	68.4	77.0	0.911	92.5	84.3
Arlington	73.8	89.9	91.1	83.0	93.7	87.3	73.8	79.2	84.0	0.913	95.0	86.7
Fort Worth C13	81.1	94.4	93.2	87.5	83.2	76.3	80.0	81.3	84.6	0.886	98.3	87.1
Fort Worth C17	88.0	97.0	101.9	89.9	79.2	70.8	87.4	83.8	87.2	0.886	96.3	85.3
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.841	0.942	1.011	0.933	0.852	0.924	0.871	0.837				
Dallas C60	0.881	0.942	1.011	0.963	0.921	1.066	0.916	0.875				
North Dallas C63	0.861	0.956	1.010	0.949	0.889	1.037	0.900	0.842				
Dallas C402	0.870	0.884	0.917	0.894	0.908	1.030	0.893	0.867				
Denton	0.856	0.920	0.976	0.808	0.844	0.883	0.874	0.842				
Midlothian	0.933	0.894	0.907	0.902	0.865	0.968	0.922	0.912				
Arlington	0.856	0.915	0.915	0.879	0.897	1.037	0.902	0.915				
Fort Worth C13	0.861	0.896	0.908	0.840	0.876	0.956	0.880	0.884				
Fort Worth C17	0.876	0.881	0.947	0.842	0.859	0.909	0.919	0.861				

1. RRF = Future year average / base year average.
2. Future DV = Baseline DV * RRF.
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–49. Future design value summary [ppb] and differences from the 2009 baseline.

Scenario	2009 baseline	NCTCOG high-end onroad and off-road controls	NCTCOG low-end onroad and off-road controls
Run	**run44.fy2009.a1**	**run44.fy2009.a1.nctcog_hi**	**run44.fy2009.a1.nctcog_lo**
Frisco	91.2	90.3	90.8
Dallas C60	87.6	86.7	87.1
Dallas C63	87.0	86.2	86.6
Dallas C402	79.7	78.8	79.3
Denton	89.6	88.2	88.9
Midlothian	84.5	84.0	84.3
Arlington	87.2	86.3	86.7
Fort Worth C13	87.6	86.6	87.1
Fort Worth C17	86.0	84.7	85.3
Change from the 2009 base [ppb]			
Frisco		-1.0	-0.5
Dallas C60		-0.9	-0.4
Dallas C63		-0.8	-0.4
Dallas C402		-0.9	-0.4
Denton		-1.4	-0.7
Midlothian		-0.5	-0.3
Arlington		-1.0	-0.5
Fort Worth C13		-1.0	-0.5
Fort Worth C17		-1.3	-0.6

Table 4–50. Exceedance area for 2009 with NCTCOG controls and differences from the 2009 baseline (number of 4-km grid cells exceeding 85 ppb in the DFW 9-county NAA).

Scenario	2009 baseline	NCTCOG high-end onroad and off-road controls	NCTCOG low-end onroad and off-road controls
Run	**run44.fy2009.a1**	**run44.fy2009.a1.nctcog_hi**	**run44.fy2009.a1.nctcog_lo**
990815	19	12	17
990816	223	216	220
990817	296	282	288
990818	253	233	239
990819	304	234	271
990820	70	38	56
990821	29	23	27
990822	5	0	0
Totals	1199	1038	1118
Change from the 2009 Baseline [%]			
990815	---	-37%	-11%
990816	---	-3%	-1%
990817	---	-5%	-3%
990818	---	-8%	-6%
990819	---	-23%	-11%
990820	---	-46%	-20%
990821	---	-21%	-7%
990822	---	-100%	-100%
Totals	---	-13%	-7%

Table 4–51. Number of daily maximum 8-hour ozone exceedance[1] cells in DFW reduced by at least 1 ppb from the NCTCOG controls.

Scenario	2009 Baseline	NCTCOG high-end onroad and off-road controls	NCTCOG low-end onroad and off-road controls
Run	**run44.fy2009.a1**	**run44.fy2009.a1.nctcog_hi**	**run44.fy2009.a1.nctcog_lo**
990815	---	19	0
990816	---	191	0
990817	---	180	0
990818	---	161	0
990819	---	235	0
990820	---	30	0
990821	---	26	0
990822	---	5	0
Totals	---	847	0

Exceedance cells are 2009 baseline grid cells exceeding 85 ppb.

Table 4–52. Number of ppb's in the daily maximum 8-hour ozone in the DFW NAA in excess of 85 ppb[1] when applying NCTCOG controls.

Scenario	2009 Baseline	NCTCOG high-end onroad and off-road controls	NCTCOG low-end onroad and off-road controls
Run	**run44.fy2009.a1**	**run44.fy2009.a1.nctcog_hi**	**run44.fy2009.a1.nctcog_lo**
990815	50	19	34
990816	2184	1893	2044
990817	2594	2279	2436
990818	1660	1380	1519
990819	1201	875	1030
990820	84	29	53
990821	74	38	56
990822	1	0	0
Totals	7846	6512	7170
% Reduced		-17.0%	-8.6%

[1]Σ(max(O3-85, 0.0)) for all 4-km grid cells in DFW.

Summary

Two ozone sensitivity tests examined the impacts from the NCTCOG-proposed high-end and low-end controls to onroad and off-road sources in the DFW 9-county NAA. The high-end control scenario lowered NOx and VOC emissions by 33 tpd and 8 tpd, respectively, mostly in Dallas and Tarrant Counties.

The NCTCOG high-end control scenario reduced 8-hour ozone near Denton between 1.5 and 2.0 ppb on 6 of the 8 episode dates; its future design value reduction of 1.4 ppb was the largest among all sites and control scenarios evaluated. Fort Worth CAMS 17 achieved 8-hour ozone attainment as its future design value dropped 1.3 ppb to 84.7 ppb. Frisco's design value was 1.0 ppb lower. Most areas where the daily maximum 8-hour ozone exceeded 85 ppb benefited from

the NCTCOG high-end control, as 71 % of the 4-km exceedance cells in DFW were reduced by at least 1 ppb.

The NCTCOG low-end control scenario reduced NOx by 16 tpd – half as much as in the high-end control – and VOC by 8 tpd – the same level as in the high-end control. The low-end control's ozone benefits were in the same area as the high-control scenario on each date. When the NOx reduction was cut in half, the ozone benefits were also halved; however, a linear relationship between the two should not be assumed. Since the VOC controls in the low-control scenario were not any lower than in the high-control scenario, the "full" VOC reductions may have added to the ozone benefit to coincidentally make the relationship appear linear.

The NCTCOG low-end control scenario generated ozone benefits similar to the DFW minor source control scenario. Both scenarios reduced comparable amounts of low-level NOx, mainly in Dallas and Tarrant Counties.

4.9 2009 COMBINATION OF CONTROLS

Two CAMx sensitivity runs examined the impacts from combining emission controls inside the DFW 9-county NAA to 8-hour ozone in DFW during the August 13-22, 1999 episode for the 2009 future year. The following controls were applied: Midlothian cement kilns (both high control level and low control level), DFW major sources, DFW EGUs, revised DFW minor sources, and low-end NCTCOG-proposed on-road and off-road sources.

Emissions

Table 4–53 summarizes the emission reductions from the 2009 baseline ("a1 series") for each control component. Both runs applied emission controls to the DFW major sources, DFW EGUs, revised DFW minor sources, and low-end NCTCOG-proposed on-road and off-road sources. The DFW high-combination control scenario (run44.fy2009.a1.dfw_hi_combo) applied a higher control level to the Midlothian cement kilns while the low-combination scenario (run44.fy2009.a1.dfw_lo_combo) included the lower kiln control level. The combined controls reduced 56 tpd NOx and 8 tpd VOC in the high-combination scenario, and 46 tpd NOx and 8 tpd VOC in the low-combination scenario.

Table 4–53. Change in Emissions from Each Control.

Controls	DFW High Combo		DFW Low Combo	
	NOx [tpd]	VOC [tpd]	NOx [tpd]	VOC [tpd]
Midlothian cement kilns	20.1	0.0	10.0	0.0
DFW major source + EGUs	14.8	0.0	14.8	0.0
DFW minor sources (revised)	4.6	0.0	4.6	0.0
Low-end NCTCOG-proposed on-road and off-road	16.3	8.1	16.3	8.1
Total	55.7	8.1	45.6	8.1

Summaries of the 2009 weekday NOx and VOC emissions (with August 17 biogenics) for the DFW high-combination scenario are shown in Tables 4–54 and 4–55, respectively, by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column and bottom row in each table show the change in emissions from the 2009 baseline. The DFW low-combination scenario was identical except NOx emissions inside Ellis County were 10.1 tpd lower.

Table 4–54. Weekday NOx emissions in 2009 in the DFW high-combination control scenario.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	10	14	1	0	2	8	0	24	-1.6
Dallas Co	4	74	5	1	17	42	0	139	-10.0
Denton co	8	16	0	0	11	9	0	36	-3.4
Tarrant Co	3	44	1	1	9	26	0	82	-6.8
Parker Co	1	5	1	0	1	2	0	8	-1.5
Johnson Co	5	4	2	0	0	5	0	11	-4.6
Ellis Co	15	8	12	0	0	5	0	26	-24.8
Kaufman Co	5	6	3	0	0	2	0	11	-1.8
Rockwall Co	2	3	0	0	0	1	0	4	-0.3
DFW 9-County	**52**	**174**	**24**	**3**	**40**	**100**	**0**	**342**	**-54.9**
DFW 16 County	**83**	**203**	**48**	**6**	**62**	**116**	**0**	**436**	**-55.6**
NE Texas	16	79	189	16	71	42	1	397	0.0
Central TX	113	88	138	2	56	69	0	353	0.0
Houston	21	175	282	12	53	63	0	585	0.0
South TX	229	189	267	22	75	100	0	653	0.0
West TX	524	160	154	21	212	105	1	653	0.0
Texas	**986**	**894**	**1077**	**79**	**529**	**494**	**2**	**3077**	**-55.7**
Gulf + Mexico	79	5	437	0	4	2	444	892	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	0.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**903**	**10358**	**82**	**538**	**502**	**23869**	**36252**	**-55.7**
Total change from baseline	0.0	-9.4	-31.4	-3.4	-4.6	-6.9	0.0	-55.7	N/A

Table 4–55. Weekday VOC emissions in 2009 in the DFW high-combination control scenario.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	27	7	0	0	12	3	0	22	-0.6
Dallas Co	50	39	4	5	72	17	0	137	-3.7
Denton co	65	7	1	0	15	4	0	27	-0.7
Tarrant Co	64	23	2	5	54	9	0	92	-2.2
Parker Co	121	2	0	0	5	1	0	8	-0.2
Johnson Co	111	2	0	0	6	1	0	9	-0.2
Ellis Co	89	2	3	2	6	2	0	15	-0.2
Kaufman Co	112	2	0	0	7	1	0	11	-0.2
Rockwall Co	3	1	0	0	2	1	0	4	-0.1
DFW 9-County	**642**	**84**	**10**	**13**	**180**	**37**	**0**	**325**	**-8.0**
DFW 16 County	**1538**	**95**	**34**	**15**	**216**	**44**	**1**	**405**	**-8.0**
NE Texas	4917	27	15	41	82	14	1	181	0.0
Central TX	6098	33	20	20	85	21	1	180	0.0
Houston	1683	80	92	215	247	41	0	675	0.0
South TX	2069	78	20	48	217	46	0	408	0.0
West TX	6198	59	11	28	215	52	3	367	0.0
Texas	**22503**	**372**	**191**	**367**	**1060**	**218**	**6**	**2215**	**-8.1**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	655	695	0.0
Tennessee	8678	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12198	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**377**	**1107**	**370**	**1080**	**224**	**23453**	**26610**	**-8.1**
Total change from baseline	0.0	-7.7	0.0	0.0	0.0	-0.3	0.0	-8.1	N/A

MODELING RESULTS

Figure 4–17 shows tile plots of the daily maximum 8-hour ozone from the high and low-combination control scenarios and their changes from the 2009 baseline for each episode date. The difference between the two runs was the magnitude of the ozone reduction downwind of the Midlothian cement kilns, where the greatest 8-hour ozone reductions were found on most dates. The high combination control reduced the daily maximum 8-hour ozone up to 6.7 ppb; the low-combination scenario reduced maximum ozone up to 3.7 ppb.

Design value calculations for the high and low combination control scenarios are shown in Tables 4–56 and 4–57, respectively. Future design values from both control runs are compared to the 2009 baseline design values, shown in Table 4–58. In the low-combination control scenario, Arlington and Fort Worth CAMS13, both in Tarrant County, which was downwind of the cement kilns on 5 of the 8 dates, reduced their future design values 1.6 and 1.7 ppb, respectively. The future design value at Midlothian showed the least change (-0.5 ppb); all other sites were 0.8 to 1.1 ppb lower, bringing Fort Worth C17's future design value below 85 ppb. Frisco and Denton's design values were reduced 0.8 and 1.1 ppb, respectively from the low-combination controls.

The high-combination control scenario reduced future design values from 0.8 to 2.2 ppb. Using the high cement kiln controls instead of the low kiln controls helped reduce the future design values at Midlothian and the Tarrant County sites more, but had small additional impacts (up to 0.1 ppb extra reduction) at the Frisco, Denton, and the Dallas C60/C63 monitoring sites. Arlington almost achieved attainment in the high-combination scenario (85.03 ppb).

Tables 4–59 to 4–61 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–59 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline and two combined control scenarios. The bottom of the table shows the percent change in exceedance area from each control. The high and low combination controls reduced the number of exceedance cells by 184 (15 %) and 161 (13 %), respectively.

Table 4–60 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the combined controls. The high-combination control reduced 74 % (882 out of 1199) of all 8-hour ozone exceedance cells by at least 1 ppb; the low-combination control reduced 68 % (819 out of 1199).

Table 4–61 sums the number of ppb’s in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The high and low combination controls reduced the number of exceedance ppb’s among all episode dates by 20 % and 17 %, respectively.

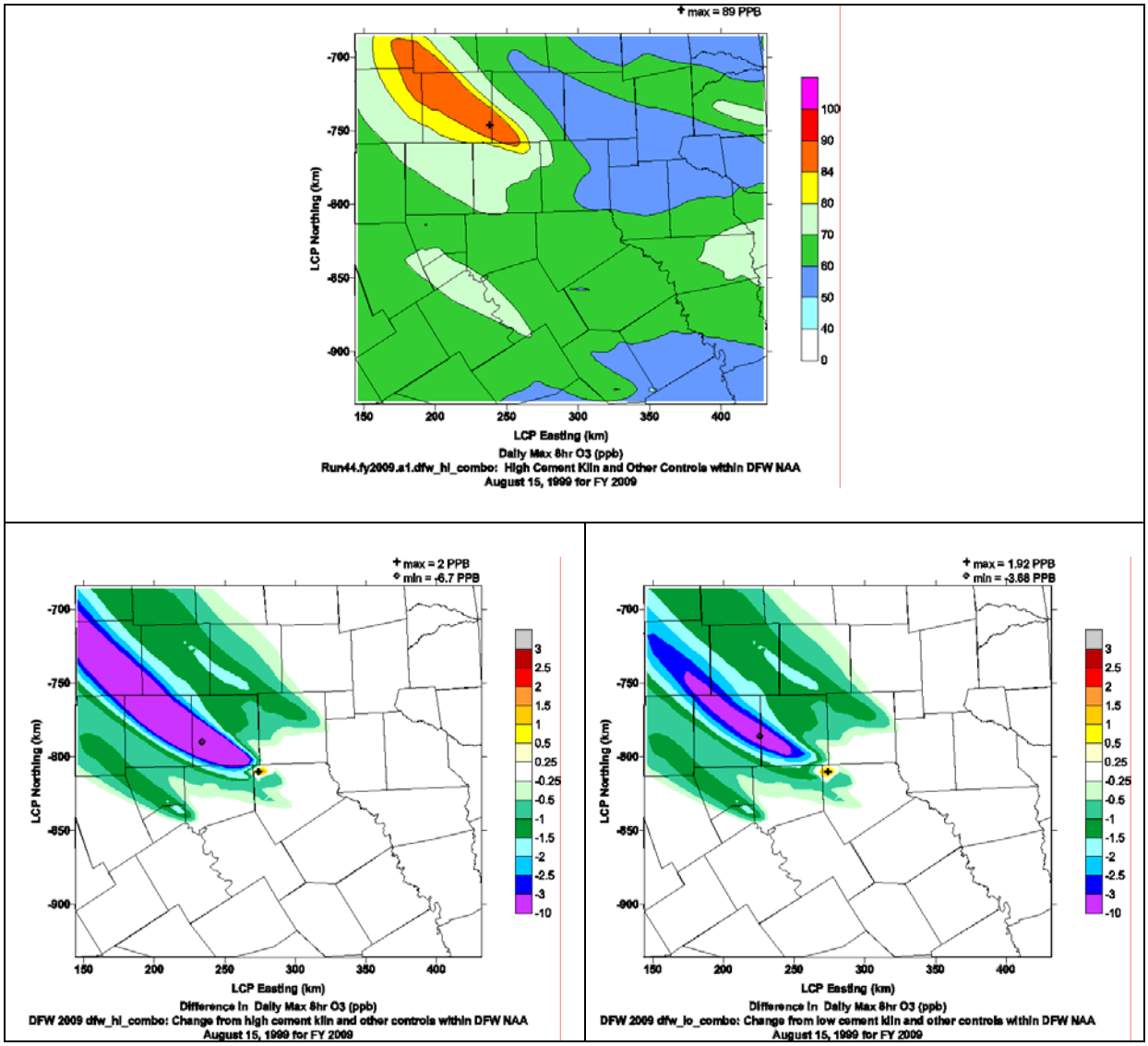


Figure 4–17. Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

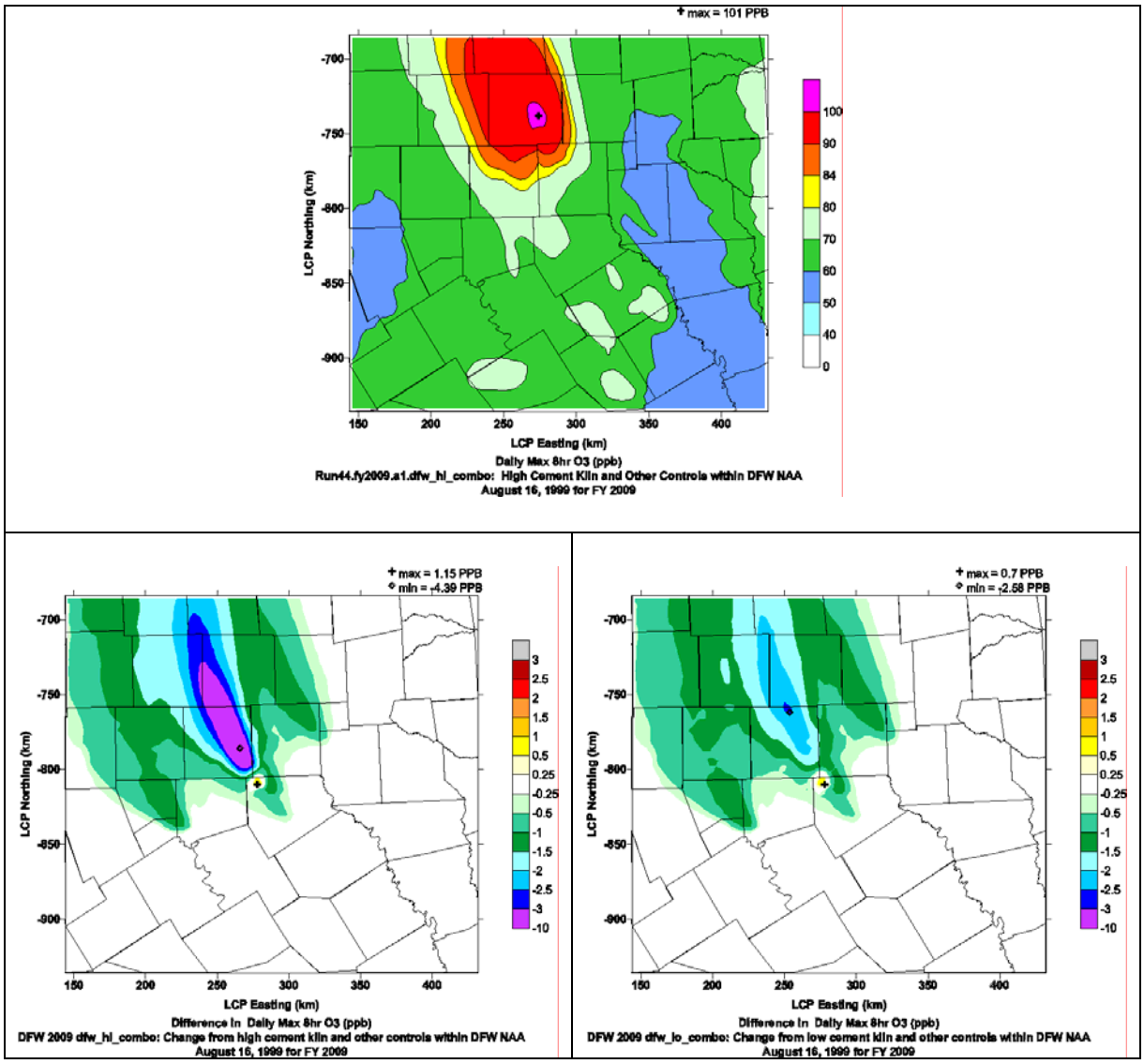


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

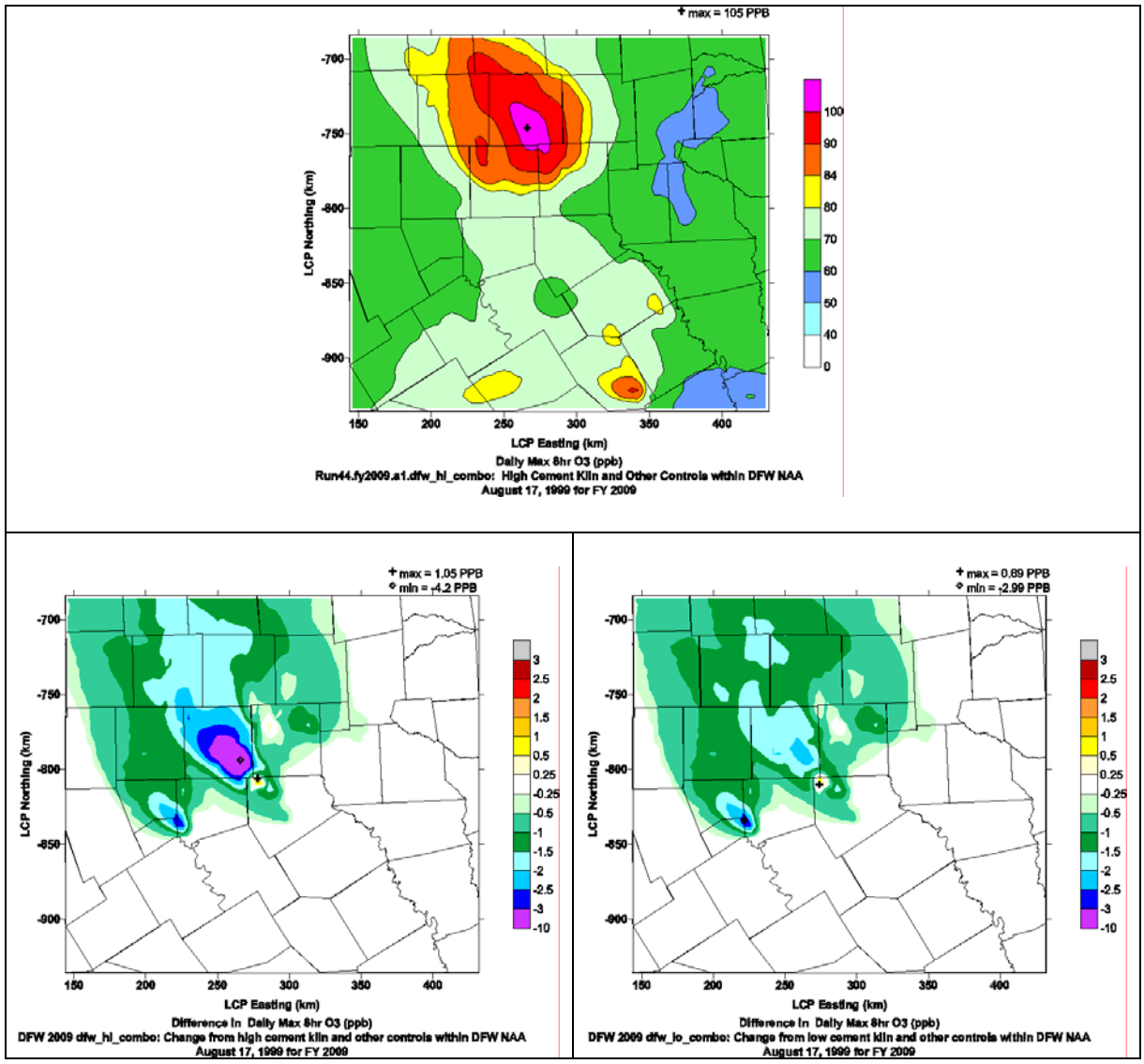


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

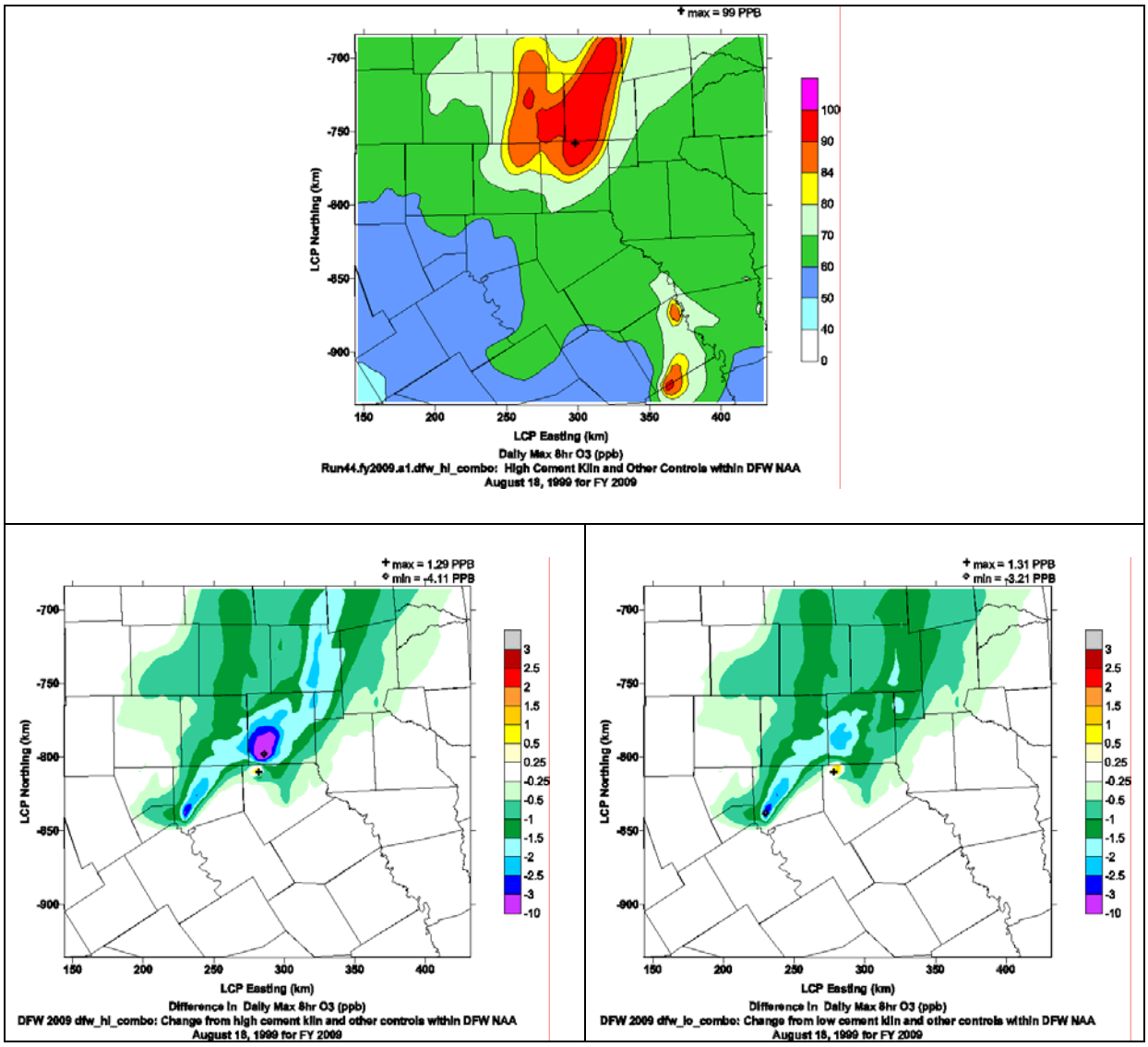


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

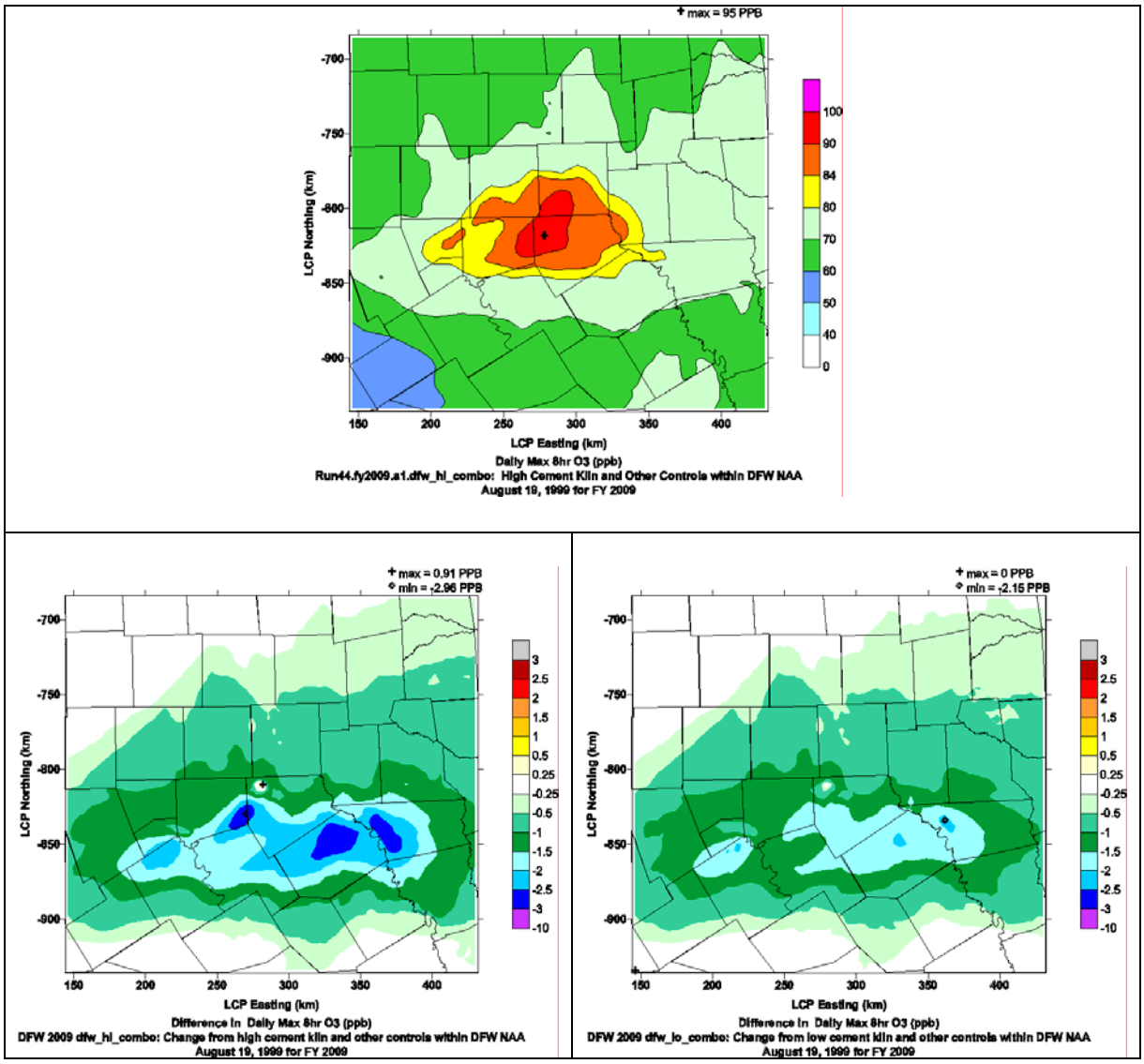


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

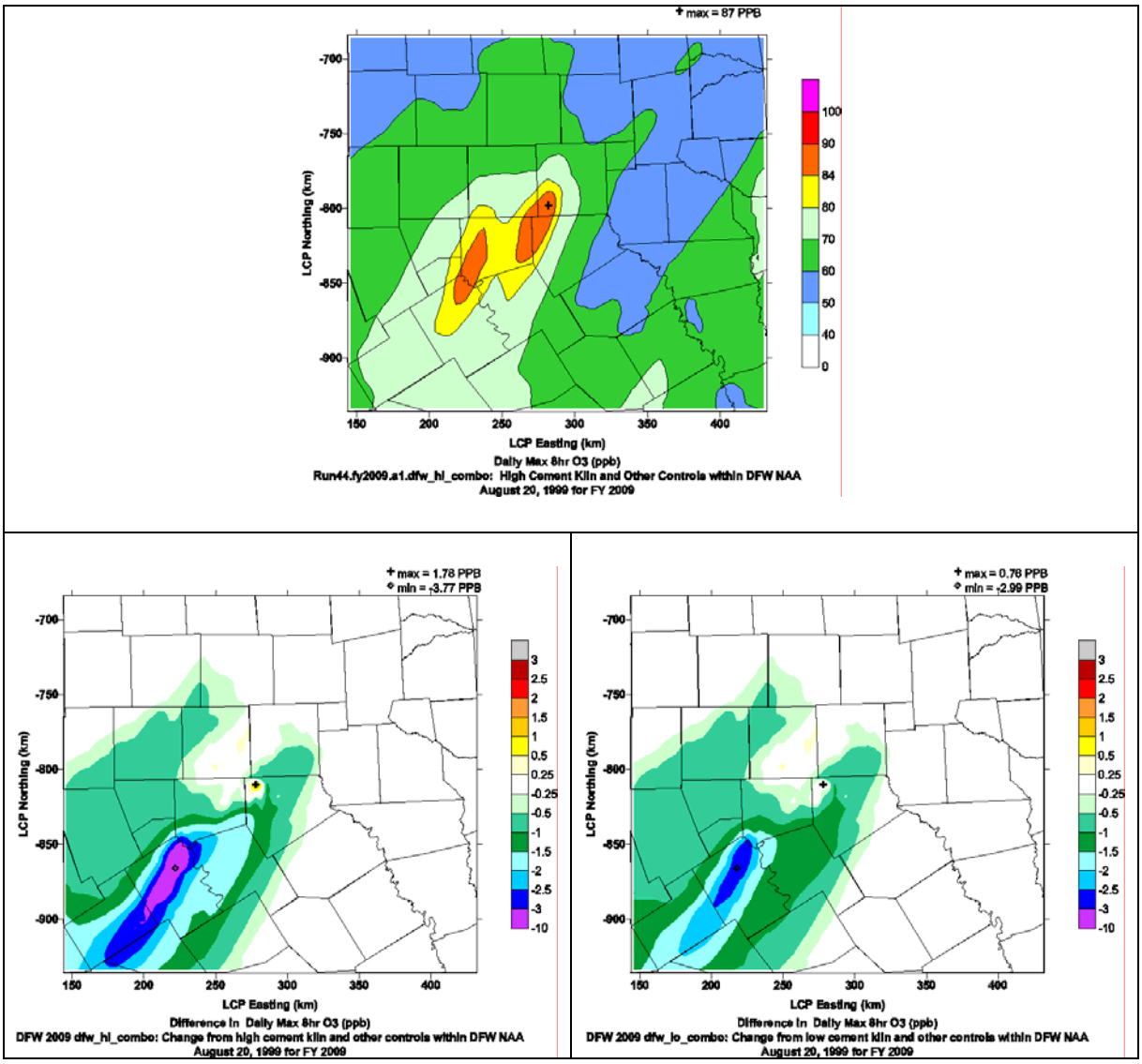


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

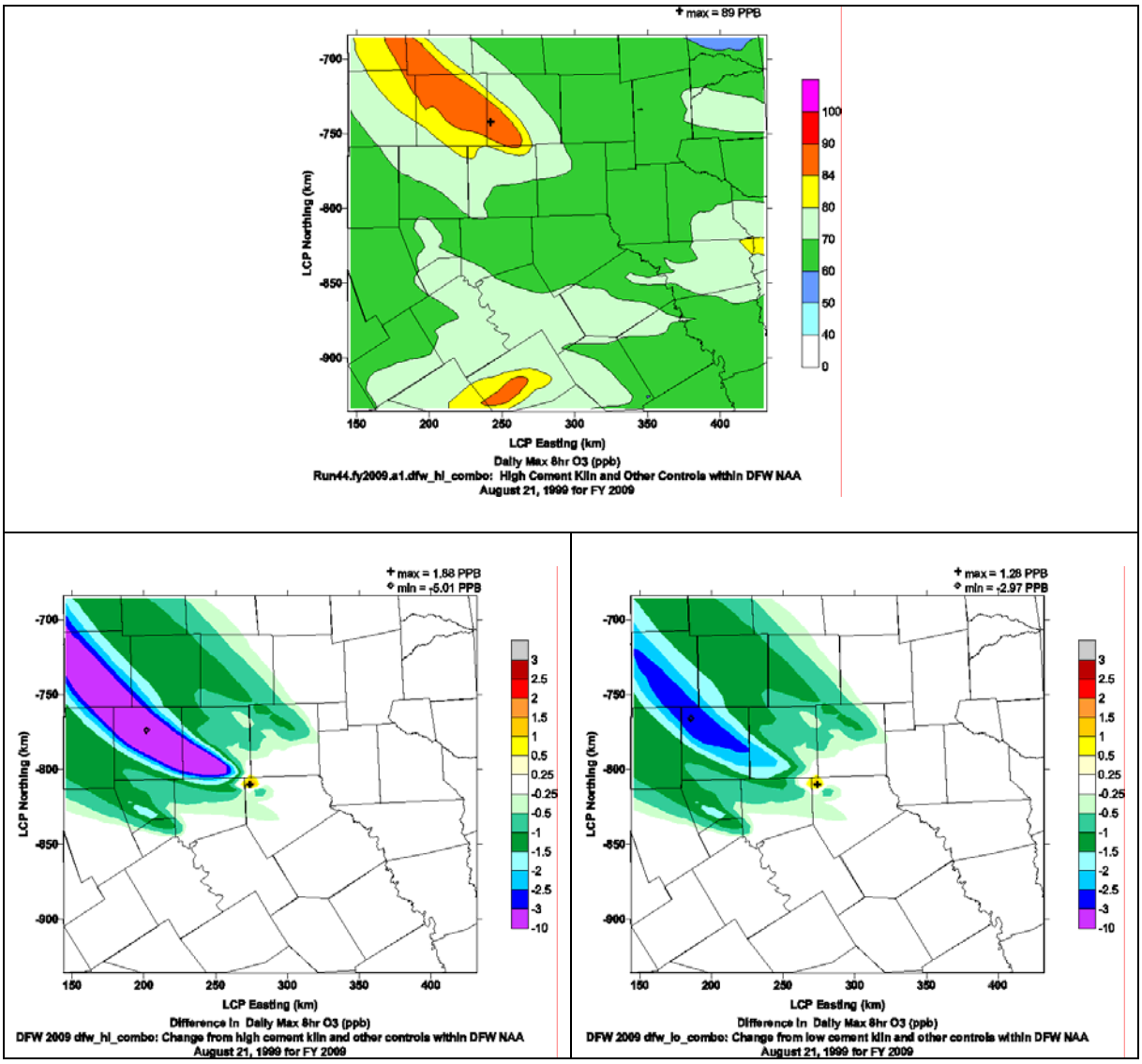


Figure 4–17 (continued). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

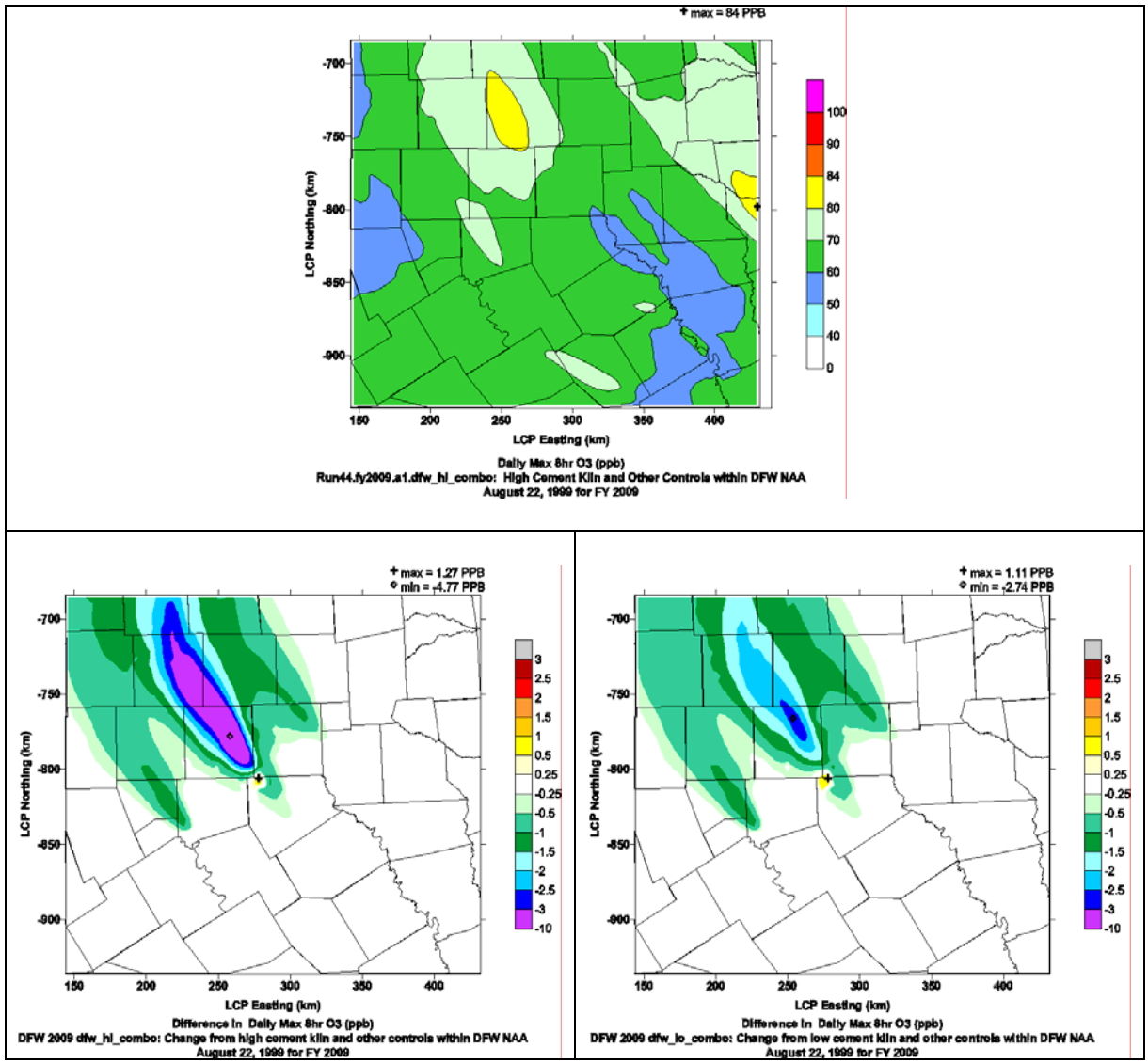


Figure 4–17 (concluded). Daily maximum 8-hour ozone (top) and differences from the 2009 baseline (bottom) for the DFW high-combination control scenario (left) and DFW low-combination control scenario (right).

Table 4–56. Design value calculation for the DFW high-combination control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.dfw_hi_combo												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV [ppb]**	**FutureDV[2] [ppb]**
Frisco	67.3	99.0	99.8	97.2	72.6	64.7	74.2	74.3	81.1	0.900	100.3	90.3
Dallas C60	72.5	91.8	101.6	98.1	88.7	82.6	78.2	74.1	85.9	0.942	92.0	86.7
North Dallas C63	70.6	94.8	99.8	98.6	83.2	78.7	76.9	73.3	84.5	0.927	93.0	86.2
Dallas C402	67.7	81.0	89.3	85.9	94.5	87.1	71.6	69.2	80.8	0.900	87.3	78.6
Denton	87.1	101.1	105.3	90.9	70.4	63.7	88.5	83.6	86.3	0.872	101.5	88.5
Midlothian	68.0	74.9	76.0	69.9	94.8	86.9	68.8	67.9	75.9	0.899	92.5	83.2
Arlington	73.1	85.9	89.3	81.4	93.3	87.1	73.3	74.8	82.3	0.895	95.0	85.0
Fort Worth C13	79.1	90.9	91.5	87.0	82.7	76.2	79.4	77.7	83.1	0.870	98.3	85.5
Fort Worth C17	87.5	95.1	100.9	89.6	78.8	70.7	87.0	82.9	86.6	0.879	96.3	84.7
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.833	0.938	1.009	0.927	0.849	0.923	0.864	0.832				
Dallas C60	0.871	0.936	1.009	0.954	0.918	1.067	0.909	0.871				
North Dallas C63	0.854	0.952	1.008	0.942	0.885	1.037	0.894	0.838				
Dallas C402	0.864	0.872	0.911	0.874	0.903	1.028	0.890	0.858				
Denton	0.850	0.915	0.971	0.805	0.840	0.879	0.870	0.836				
Midlothian	0.901	0.881	0.882	0.897	0.848	0.971	0.918	0.907				
Arlington	0.847	0.874	0.897	0.862	0.893	1.035	0.897	0.863				
Fort Worth C13	0.840	0.863	0.892	0.835	0.872	0.954	0.874	0.845				
Fort Worth C17	0.871	0.864	0.937	0.839	0.854	0.908	0.915	0.852				

(1) RRF = future year average / baseline average.
(2) Future DV = baseline DV * RRF.
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 4–57. Design value calculations for the DFW low-combination control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North Dallas	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: run44.fy2009.a1.dfw_lo_combo												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV [ppb]**	**FutureDV[2] [ppb]**
Frisco	67.3	99.1	99.8	97.4	72.6	64.7	74.2	74.3	81.2	0.901	100.3	90.4
Dallas C60	72.5	91.9	101.6	98.4	88.8	82.6	78.2	74.1	86.0	0.943	92.0	86.8
North Dallas	70.6	94.8	99.8	98.8	83.2	78.7	76.9	73.3	84.5	0.927	93.0	86.2
Dallas C402	67.7	81.2	89.5	86.7	94.6	87.1	71.6	69.2	80.9	0.902	87.3	78.7
Denton	87.1	101.3	105.5	90.9	70.4	63.7	88.5	83.7	86.4	0.872	101.5	88.5
Midlothian	70.0	75.9	77.5	70.8	95.7	86.4	68.8	68.7	76.7	0.908	92.5	84.0
Arlington	73.1	87.9	89.8	81.6	93.3	87.1	73.3	76.8	82.9	0.901	95.0	85.6
Fort Worth C13	79.1	92.5	92.1	87.0	82.8	76.2	79.4	79.0	83.5	0.874	98.3	85.9
Fort Worth C17	87.5	95.8	101.2	89.6	78.8	70.7	87.0	83.0	86.7	0.881	96.3	84.8
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.833	0.938	1.009	0.928	0.849	0.923	0.864	0.832				
Dallas C60	0.871	0.937	1.009	0.957	0.918	1.067	0.909	0.871				
North Dallas	0.854	0.952	1.008	0.944	0.885	1.037	0.894	0.838				
Dallas C402	0.864	0.874	0.913	0.882	0.903	1.028	0.890	0.859				
Denton	0.850	0.916	0.973	0.805	0.840	0.879	0.870	0.837				
Midlothian	0.927	0.893	0.899	0.908	0.856	0.965	0.918	0.917				
Arlington	0.847	0.894	0.902	0.864	0.893	1.035	0.897	0.887				
Fort Worth C13	0.840	0.877	0.897	0.835	0.872	0.954	0.874	0.860				
Fort Worth C17	0.871	0.870	0.940	0.839	0.854	0.908	0.915	0.854				

(1) RRF = future year average / baseline average.
(2) Future DV = baseline DV * RRF.
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 4–58. 2009 design value summary [ppb].

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_hi_combo	run44.fy2009.a1.dfw_lo_combo
Scenario	**2009 base case**	**High kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**	**Low kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**
Frisco	91.2	90.3	90.4
Dallas C60	87.6	86.7	86.8
Dallas C63	87.0	86.2	86.2
Dallas C402	79.7	78.6	78.7
Denton	89.6	88.5	88.5
Midlothian	84.5	83.2	84.0
Arlington	87.2	85.0	85.6
Fort Worth C13	87.6	85.5	85.9
Fort Worth C17	86.0	84.7	84.8
Change from 2009 base (ppb)			
Frisco		-0.95	-0.85
Dallas C60		-0.90	-0.80
Dallas C63		-0.80	-0.80
Dallas C402		-1.11	-0.94
Denton		-1.11	-1.11
Midlothian		-1.37	-0.54
Arlington		-2.20	-1.63
Fort Worth C13		-2.08	-1.69
Fort Worth C17		-1.31	-1.12

Table 4–59. Exceedance Area (Number of 4-km grid cells in DFW with daily max 8-hour ozone > 85 ppb).

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_hi_combo	run44.fy2009.a1.dfw_lo_combo
Scenario	**2009 base case**	**High kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**	**Low kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**
990815	19	12	12
990816	223	206	211
990817	296	271	275
990818	253	225	230
990819	304	234	236
990820	70	43	50
990821	29	24	24
990822	5	0	0
Totals	1199	1015	1038
Change from the 2009 Baseline [%]			
990815	---	-37%	-37%
990816	---	-8%	-5%
990817	---	-8%	-7%
990818	---	-11%	-9%
990819	---	-23%	-22%
990820	---	-39%	-29%
990821	---	-17%	-17%
990822	---	-100%	-100%
Totals	---	-15%	-13%

Table 4–60. Number of exceedance 4-km grid cells reduced by at least 1 ppb.

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_hi_combo	run44.fy2009.a1.dfw_lo_combo
Scenario	**2009 base case**	**High kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**	**Low kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**
990815	---	19	19
990816	---	208	197
990817	---	211	199
990818	---	170	152
990819	---	221	207
990820	---	30	22
990821	---	18	18
990822	---	5	5
Totals	---	882	819

Table 4–61. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1].

Run	run44.fy2009.a1	run44.fy2009.a1.dfw_hi_combo	run44.fy2009.a1.dfw_lo_combo
Scenario	**2009 base case**	**High kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**	**Low kiln controls + DFW EGU, major, and updated minor sources + NCTCOG low-end controls**
990815	50	25	25
990816	2184	1744	1845
990817	2594	2181	2255
990818	1660	1372	1404
990819	1201	847	889
990820	84	36	39
990821	74	45	45
990822	1	0	0
Total	**7846**	**6252**	**6502**
% Reduced		-20.3%	-17.1%

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

SUMMARY

Two CAMx simulations examined the 8-hour ozone impact to DFW when applying multiple controls within the 9-county NAA. Both runs applied the DFW major source, revised minor source, DFW EGU, and NCTCOG-proposed low-end on-road and off-road controls. The high combination scenario added high-end Midlothian cement kiln controls while the low combination control scenario added low-end cement kiln controls. The combined controls lowered VOCs by 8 tpd in both scenarios and NOx emissions 56 and 46 tpd in the high and low combination scenarios, respectively.

The strongest ozone reduction was found downwind of the cement kilns on most dates. Tarrant County benefited the most as Arlington and Fort Worth C13's future design values were lowered over 2 ppb in the high-combination control scenario and over 1.6 ppb in the low-combination scenario. Fort Worth C17 achieved attainment in both combined control scenarios while Arlington almost reached attainment in the high-combination scenario. Future design values at Frisco, Denton, and Dallas C60/C63 were 0.8 to 1.1 ppb lower in the low-combination control scenario; The cement kilns had little impact near these monitoring sites, so the ozone benefits in the high-combination control were similar to the low combination scenario (up to 0.1 ppb extra reduction).

4.10 SOURCE APPORTIONMENT ANALYSIS OF EAST TEXAS EGUS – 2009 BASELINE

A CAMx source apportionment analysis examined the impacts from Texas EGUs to the daily maximum 8-hour ozone at DFW monitoring sites for the 2009 baseline (run44.fy2009.a1).

Emissions

The EGUs were separated into 14 groups. The first nine groups consisted of the nine highest-emitting EGUs in East Texas. The other Texas EGUs were separated into four groups: EGUs inside the DFW 9-county NAA, EGUs within 100 km of DFW (and outside the DFW NAA), EGUs within 200km of DFW (but outside 100 km), and all other Texas EGUs. Table 4–62 summarizes the weekday EGU NOx and VOC emissions for each group and Figure 4–18 plots the East Texas EGUs sorted by region and scaled by weekday NOx emission totals.

Texas non-EGU anthropogenic sources were divided into two regions – inside the DFW 9-county NAA and outside DFW. The remaining two groups were biogenics and all anthropogenic emissions outside of Texas.

Table 4–62. 2009 weekday baseline Texas EGU emissions.

	NOx [tpd]	VOC [tpd]
Martin Lake	47.5	1.0
Monticello	40.0	0.9
Limestone	38.7	0.9
Welsh	29.9	0.2
Big Brown	20.6	0.5
Pirkey	14.0	0.2
Sandow	10.3	0.8
TK Gibbons Cr	6.8	0.3
TNP One	6.6	0.0
DFW 9-County EGUs	9.4	0.7
EGUs within 100km	13.5	0.8
EGUs within 200 km	21.2	1.0
Other TX EGUs	264.4	13.0

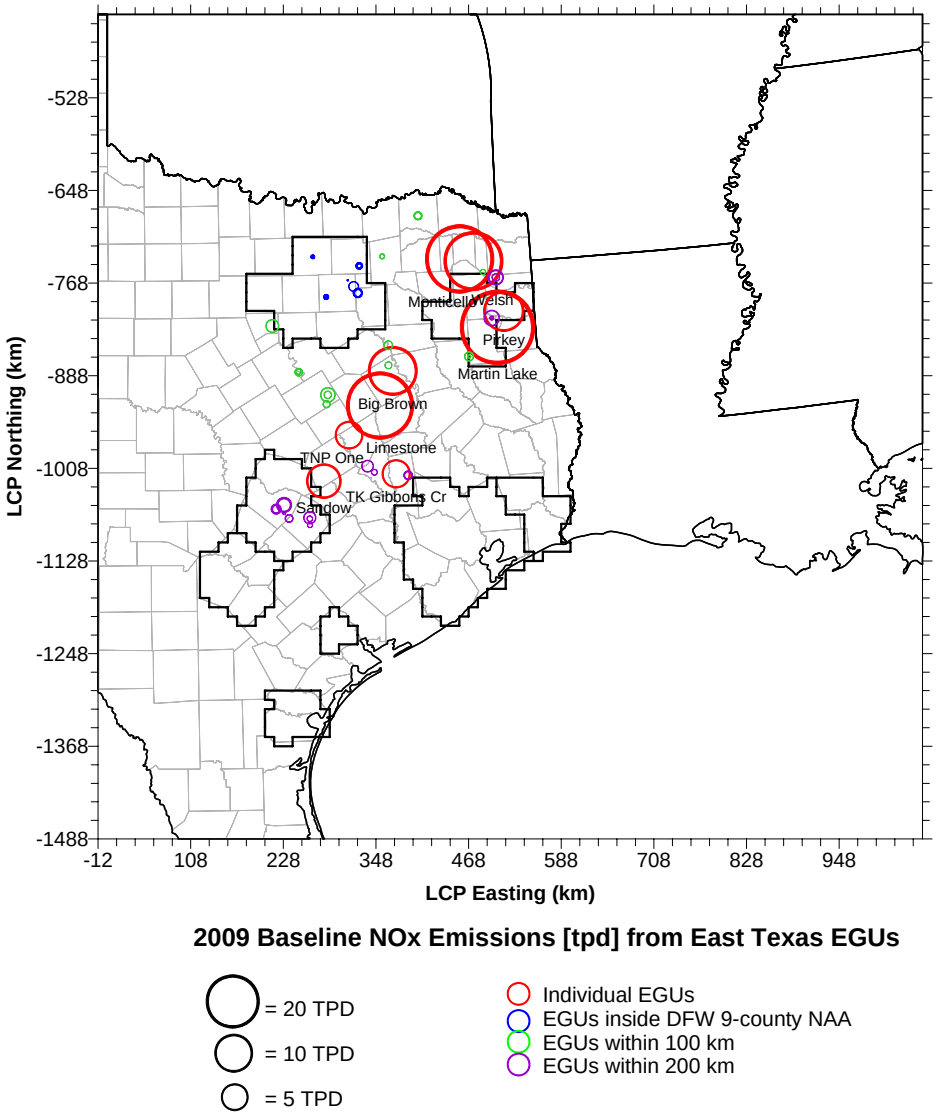


Figure 4–18. Location and NOx emissions level of East Texas EGUs.

Modeling Results

The APCA source apportionment modeling results focused on contributions to the two ozone monitoring sites with the highest future design values – Frisco and Denton. Impacts from each emissions group to the daily maximum 8-hour ozone within the 7 by 7 cells surrounding each monitor were examined, corresponding to the values used for design value scaling, shown in Table 4–63. Ozone contributions to the cell containing the daily maximum 8-hour ozone in the DFW 9-county NAA were also examined.

Contributions to Frisco

Figure 4–19 shows bar charts of the daily contributions from each EGU group to the daily maximum 8-hour ozone near Frisco. The largest contributions among the nine individual EGUs in East Texas were from the Welsh EGU on August 21 (1.22 ppb), the Martin Lake EGU on August 15 (0.80 ppb), and the Big Brown EGU on August 16 (0.77 ppb), all situated upwind of Frisco on their respective dates. The Monticello, Limestone, and Pirkey EGUs each contributed 0.5 ppb on dates when upwind of Frisco.

Snapshots of animations showing some of the larger 1-hourly ozone impacts from individual EGUs to DFW are displayed in Figure 4–20. Select animated plots will be provided separately. The 1-hourly ozone contributions were very high near each source, exceeding 30 ppb near the Limestone EGU on August 17, but were significantly reduced approaching Frisco as the emissions were dispersed over time and the wind did not transport the ozone plume directly over the receptor for an extended period of time.

The nine large EGUs combined contributed less than 2 ppb 8-hour ozone on each episode date as the wind typically aligned only one or two of the large EGUs upwind of Frisco on each date. Table 4–64 summarizes the daily contributions from all source components to the peak 8-hour ozone in Frisco.

The EGUs inside the DFW 9-county NAA contributed nearly 1 ppb to the peak 8-hour ozone near Frisco on 5 of the 8 episode dates. Ozone contributions from EGUs within 100 km and 200 km of DFW were 0.2 ppb or less on all dates; from all other EGUs in Texas, the 8-hour ozone contribution was 1.0 ppb (August 18) or less. The largest impact from all EGUs in Texas was 3.1 ppb on August 16 and 21.

On the three dates when Frisco exceeded 85 ppb in the simulation (August 16-18), nearly 40 ppb ozone originated from non-EGU anthropogenic sources within the DFW 9-county NAA; these local non-EGU sources contributed much less on the other dates. The stacked bar chart in Figure 4–21 compares each source's contributions to the daily maximum 8-hour ozone at Frisco.

Table 4–63. Design value calculation for the Run 44.fy2009.a1 baseline.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**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: run44.fy2009.a1												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**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	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
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 average / base year average.
2. Future DV = Baseline DV * RRF.
3. Daily RRFs are for information only and are not used to calculate the future DVs .

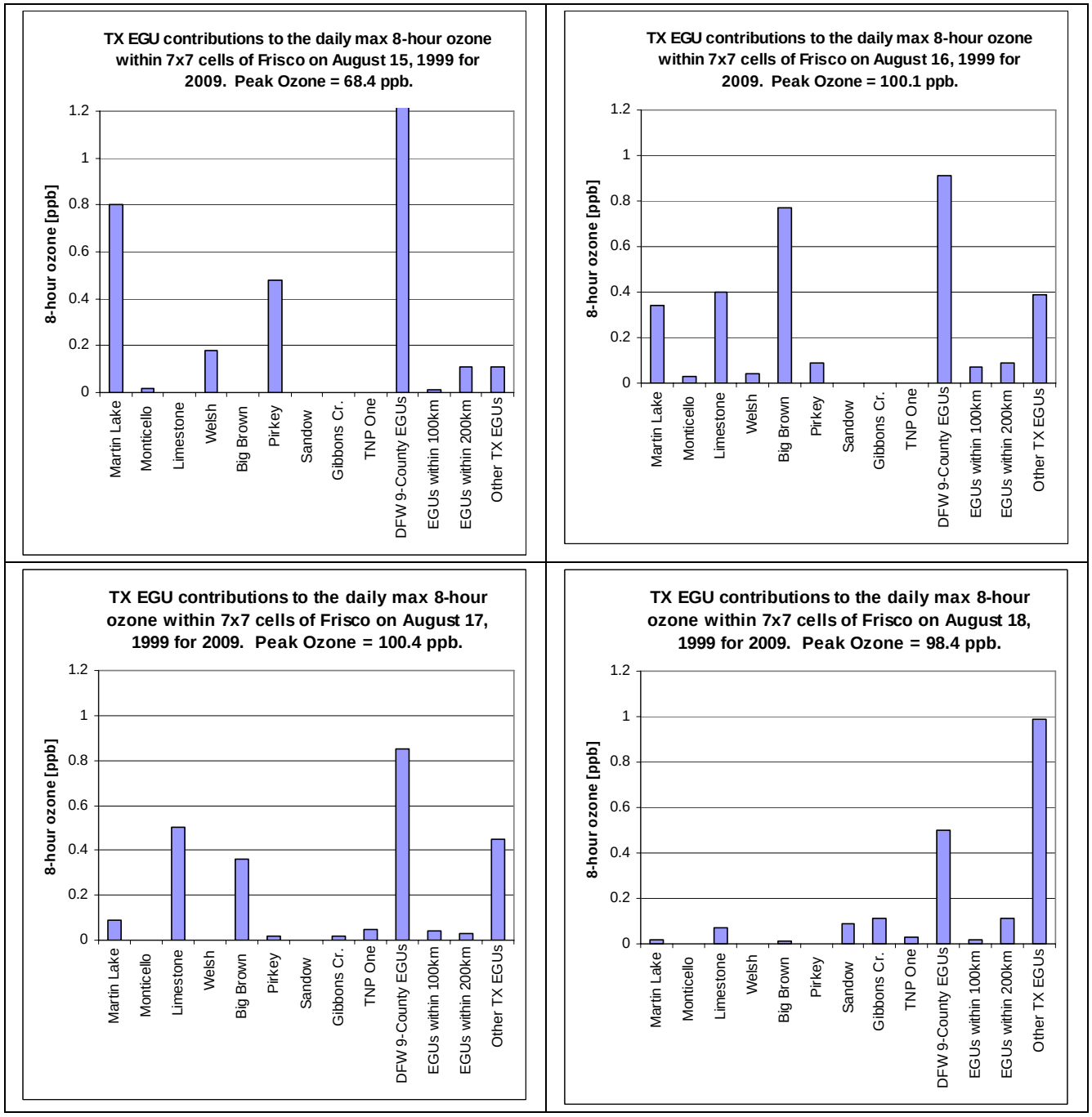


Figure 4–19. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Frisco in the 2009 baseline.

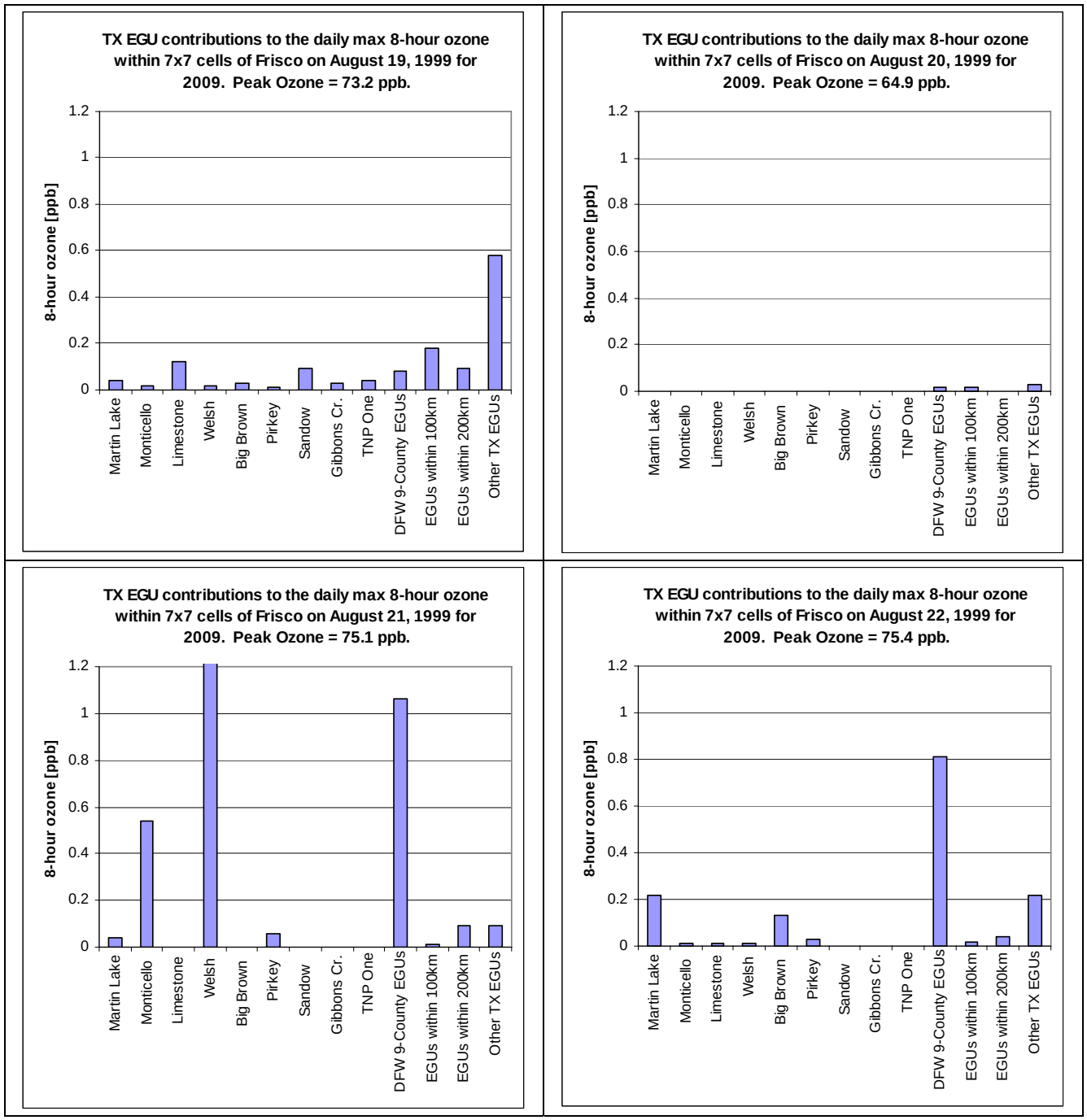


Figure 4–19 (concluded). Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Frisco in the 2009 baseline.

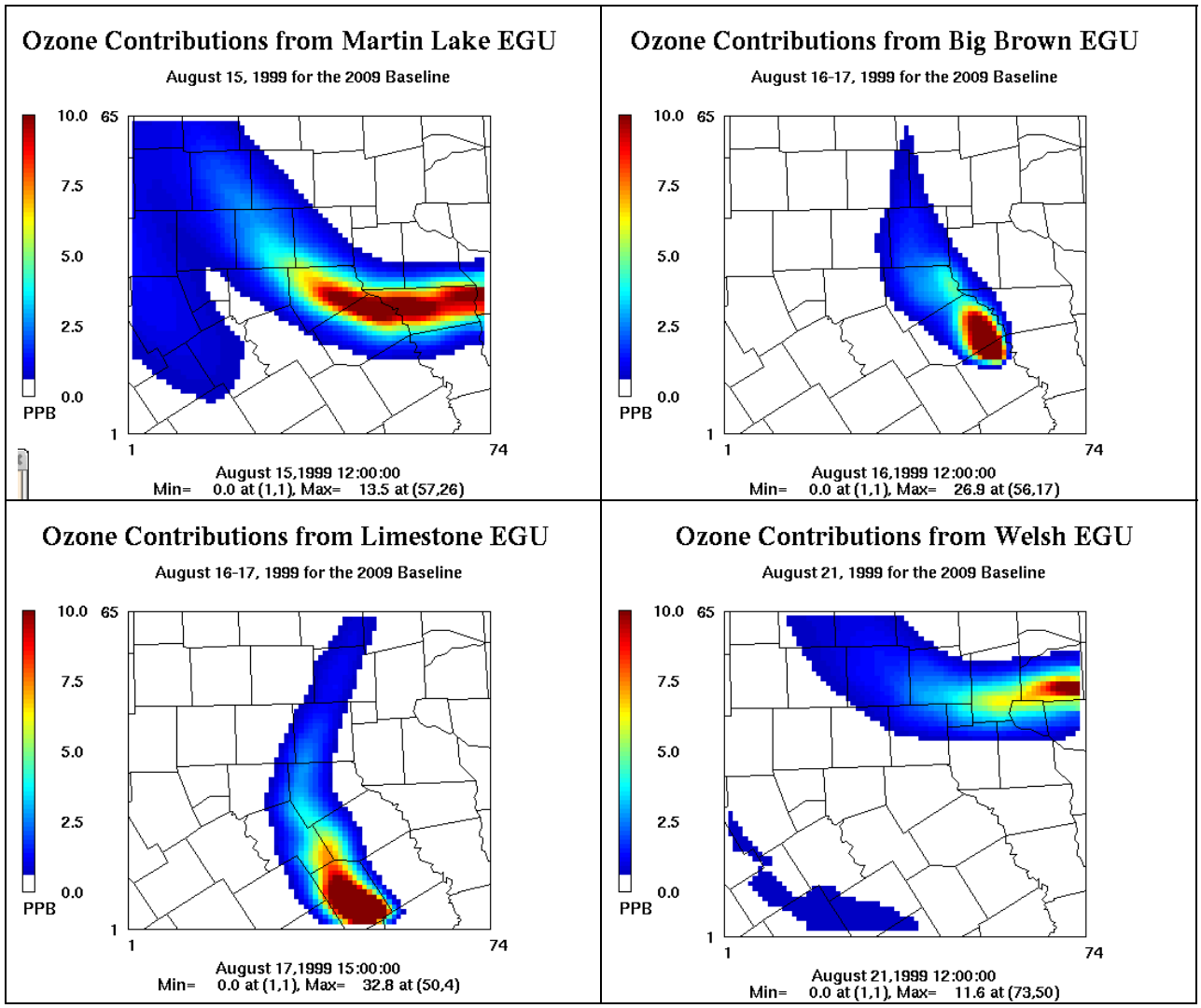


Figure 4–20. Spatial plots of 1-hourly ozone contributions (ppb) from select EGUs in the 2009 baseline.

Table 4–64. Contributions to the daily peak 8-hour ozone (ppb) in the 7x7 cells surrounding Frisco.

Source	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
IC	9.66	2.36	2.04	9.14	4.28	0.03	0.03	0.06
BC	22.99	36.58	39.93	28.42	32.19	36.59	36.74	35.83
Biogenics	3.33	3.93	3.94	4.20	7.69	8.14	4.59	4.91
Martin Lake	0.80	0.34	0.09	0.02	0.04	0.00	0.04	0.22
Monticello	0.02	0.03	0.00	0.00	0.02	0.00	0.54	0.01
Limestone	0.00	0.40	0.50	0.07	0.12	0.00	0.00	0.01
Welsh	0.18	0.04	0.00	0.00	0.02	0.00	1.22	0.01
Big Brown	0.00	0.77	0.36	0.01	0.03	0.00	0.00	0.13
Pirkey	0.48	0.09	0.02	0.00	0.01	0.00	0.06	0.03
Sandow	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0
Gibbons Cr.	0.00	0.00	0.02	0.11	0.03	0.00	0.00	0
TNP One	0.00	0.00	0.05	0.03	0.04	0.00	0.00	0
9 large EGUs	**1.48**	**1.67**	**1.04**	**0.33**	**0.40**	**0.00**	**1.86**	**0.41**
DFW 9-County EGUs	1.22	0.91	0.85	0.50	0.08	0.02	1.06	0.81
EGUs within 100km	0.01	0.07	0.04	0.02	0.18	0.02	0.01	0.02
EGUs within 200km	0.11	0.09	0.03	0.11	0.09	0.00	0.09	0.04
Other TX EGUs	0.11	0.39	0.45	0.99	0.58	0.03	0.09	0.22
All Texas EGUs	**2.93**	**3.13**	**2.41**	**1.95**	**1.33**	**0.07**	**3.11**	**1.50**
DFW non-EGU anthro	16.48	42.40	42.20	38.93	10.44	8.36	16.26	17.24
TX (outside DFW) non-EGU anthro	4.53	3.53	3.58	6.01	9.55	1.71	4.35	2.69
Non-TX Anthro	8.44	8.18	6.32	9.73	7.71	9.96	10.06	13.14
Total (All Sources)	**68.36**	**100.11**	**100.42**	**98.38**	**73.19**	**64.86**	**75.14**	**75.37**

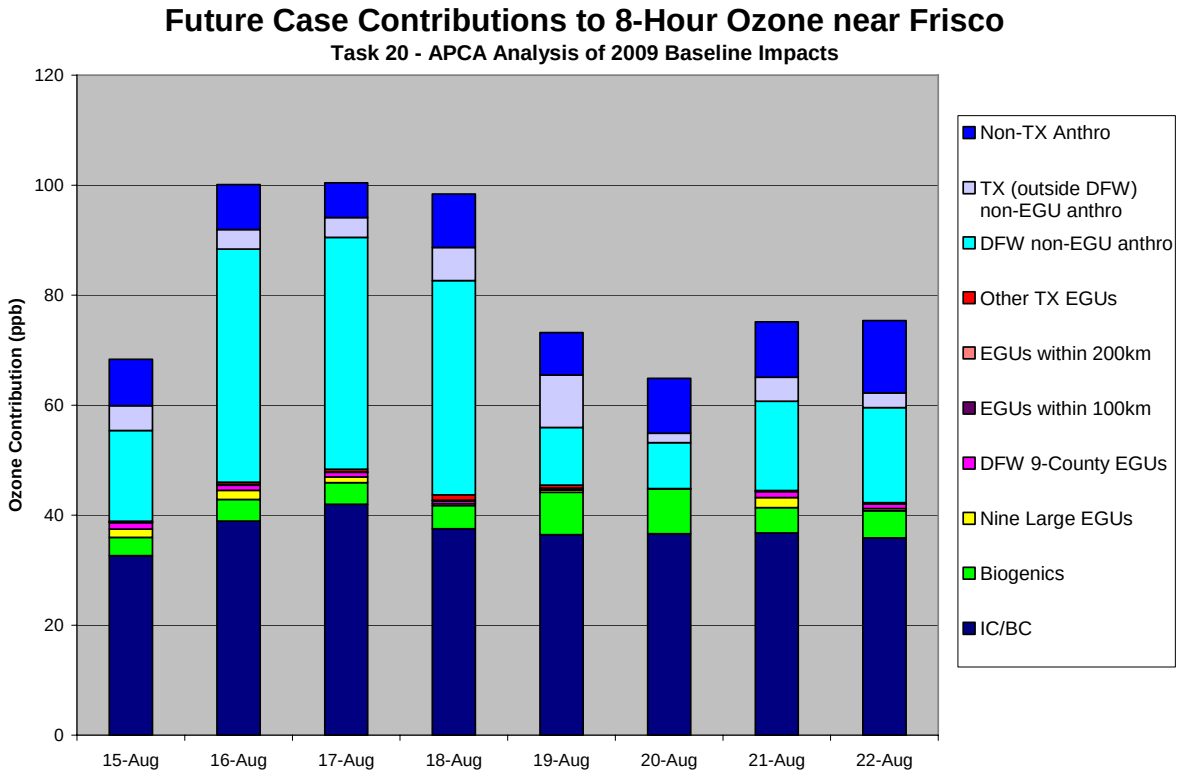


Figure 4–21. Stacked bar chart of daily contributions from all source groups to the peak 8-hour ozone (ppb) near Frisco.

Contributions to Denton

In the 2009 baseline run, Denton exceeded 85 ppb on all dates except August 19 and 20, when the winds were from the north. Figure 4–22 shows bar charts of the EGU contributions to the daily maximum 8-hour ozone in the 7 by 7 cells surrounding Denton. Table 4–65 lists contributions from all source groups for each date.

Most of the larger contributions from individual EGUs to Denton occurred on the same dates as the larger impacts to Frisco. The Martin Lake and Pirkey EGUs contributed 1.58 and 0.70 ppb, respectively, to Denton on August 15, the Limestone and Big Brown EGUs (0.78 and 0.61 ppb, respectively) were the largest on August 16, and the Welsh and Monticello EGUs (0.72 and 0.36 ppb, respectively) were highest on August 21.

The 8-hour ozone contributions to the daily maximum at Denton from the 9 large EGUs combined were highest on the dates with east winds (August 15, 16, and 21). On these three dates, the 9 EGUs accounted for almost half of the total Texas EGU contributions. The highest contributions from the 9 EGUs combined (2.4 ppb) and all Texas EGUs (4.1 ppb) both occurred on August 15. Ozone impacts from the 9 large EGUs combined were near ¾ ppb on dates with a south wind (August 17, 18, and 22), and were even lower on dates with a north wind (August 19 and 20). The 9 large EGUs had a greater impact to the daily maximum 8-hour ozone near Denton than the DFW 9-county EGUs on most dates, and always contributed more than the EGUs within 100 km and 200 km of DFW combined.

Like Frisco, the non-EGU anthropogenic group inside the DFW 9-county NAA was the largest contributor to 8-hour ozone in Denton. On dates when the model simulated ozone greater than 85 ppb, the DFW non-EGUs contributed 28 ppb or more to the daily peaks; on the other dates, this group contributed less than 10 ppb. Figure 4–23 shows a stacked bar chart of all contributions to the daily maximum 8-hour ozone in Denton for all dates.

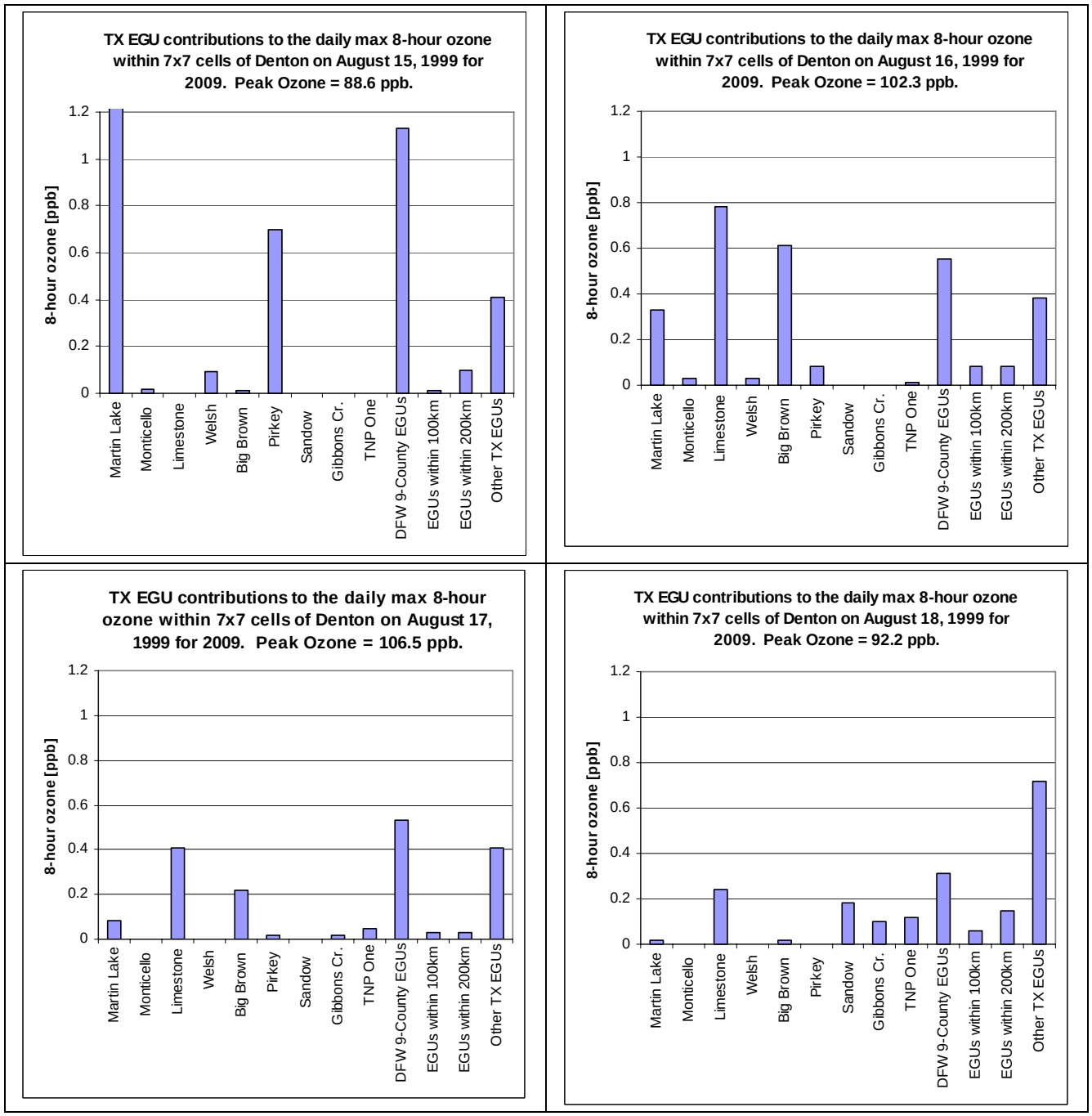


Figure 4–22. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Denton in the 2009 baseline.

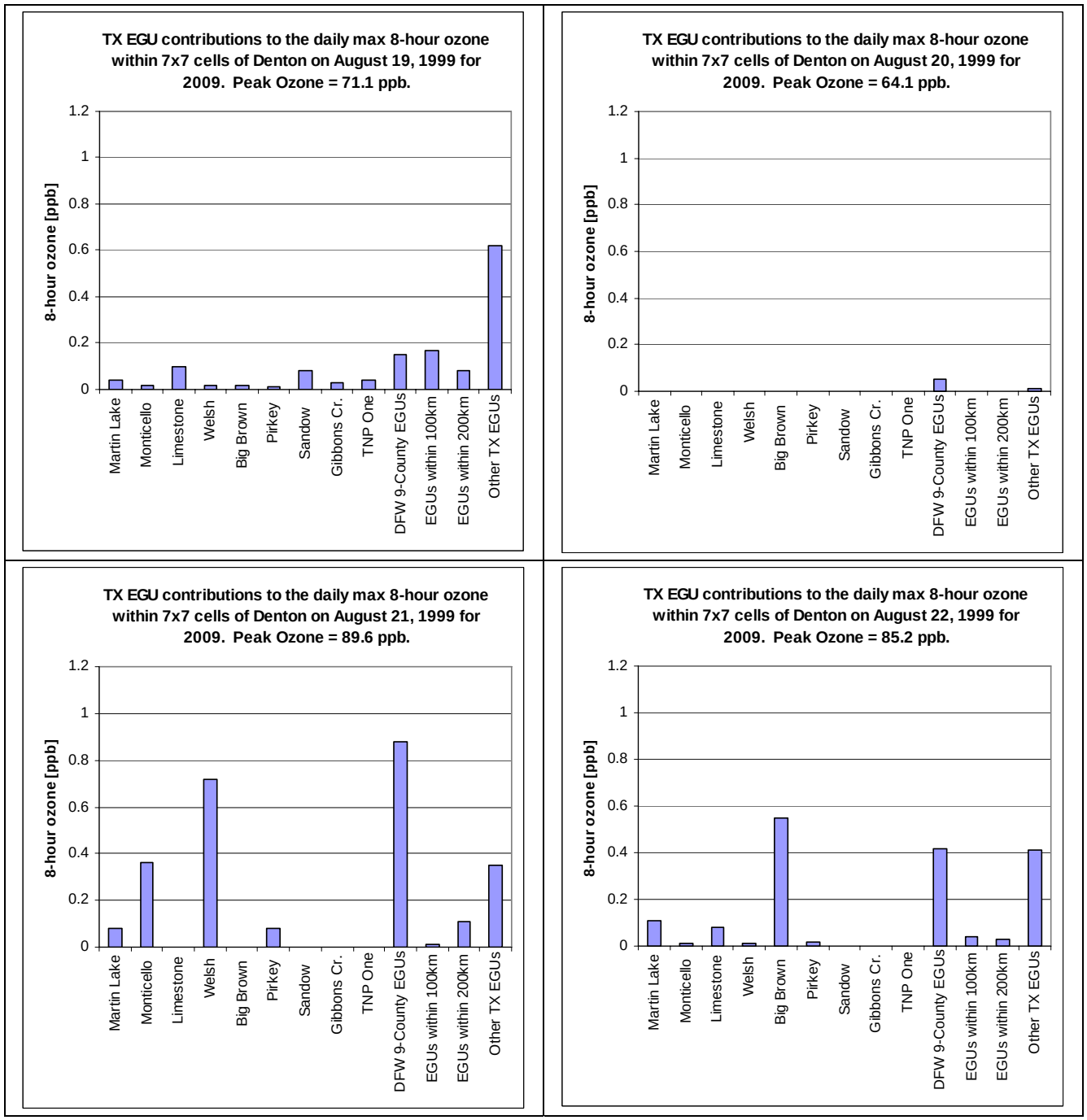


Figure 4–22 (concluded**).** Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Denton in the 2009 baseline.

Table 4–65. Contributions to the daily peak 8-hour ozone (ppb) in the 7x7 cells surrounding Denton.

Source	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
IC	9.57	2.66	1.96	7.14	3.88	0.03	0.03	0.07
BC	26.06	35.53	41.25	32.46	33.65	37.36	37.73	35.21
Biogenics	3.39	3.85	3.95	4.34	5.68	6.51	4.66	5.17
Martin Lake	1.58	0.33	0.08	0.02	0.04	0.00	0.08	0.11
Monticello	0.02	0.03	0.00	0.00	0.02	0.00	0.36	0.01
Limestone	0.00	0.78	0.41	0.24	0.10	0.00	0.00	0.08
Welsh	0.09	0.03	0.00	0.00	0.02	0.00	0.72	0.01
Big Brown	0.01	0.61	0.22	0.02	0.02	0.00	0.00	0.55
Pirkey	0.70	0.08	0.02	0.00	0.01	0.00	0.08	0.02
Sandow	0.00	0.00	0.00	0.18	0.08	0.00	0.00	0
Gibbons Cr.	0.00	0.00	0.02	0.10	0.03	0.00	0.00	0
TNP One	0.00	0.01	0.05	0.12	0.04	0.00	0.00	0
9 Large EGUs	**2.40**	**1.87**	**0.80**	**0.68**	**0.36**	**0.00**	**1.24**	**0.78**
DFW 9-County EGUs	1.13	0.55	0.53	0.31	0.15	0.05	0.88	0.42
EGUs within 100km	0.01	0.08	0.03	0.06	0.17	0.00	0.01	0.04
EGUs within 200km	0.10	0.08	0.03	0.15	0.08	0.00	0.11	0.03
Other TX EGUs	0.41	0.38	0.41	0.72	0.62	0.01	0.35	0.41
All Texas EGUs	**4.05**	**2.96**	**1.80**	**1.92**	**1.38**	**0.06**	**2.59**	**1.68**
DFW non-EGU anthro	32.94	45.93	48.24	31.36	9.15	7.41	31.20	28.02
TX (outside DFW) non-EGU anthro	4.40	3.74	3.45	6.32	9.44	2.75	3.48	2.78
Non-TX Anthro	8.18	7.65	5.88	8.68	7.88	10.01	9.86	12.21
Total (All Sources)	**88.59**	**102.32**	**106.53**	**92.22**	**71.06**	**64.13**	**89.55**	**85.14**

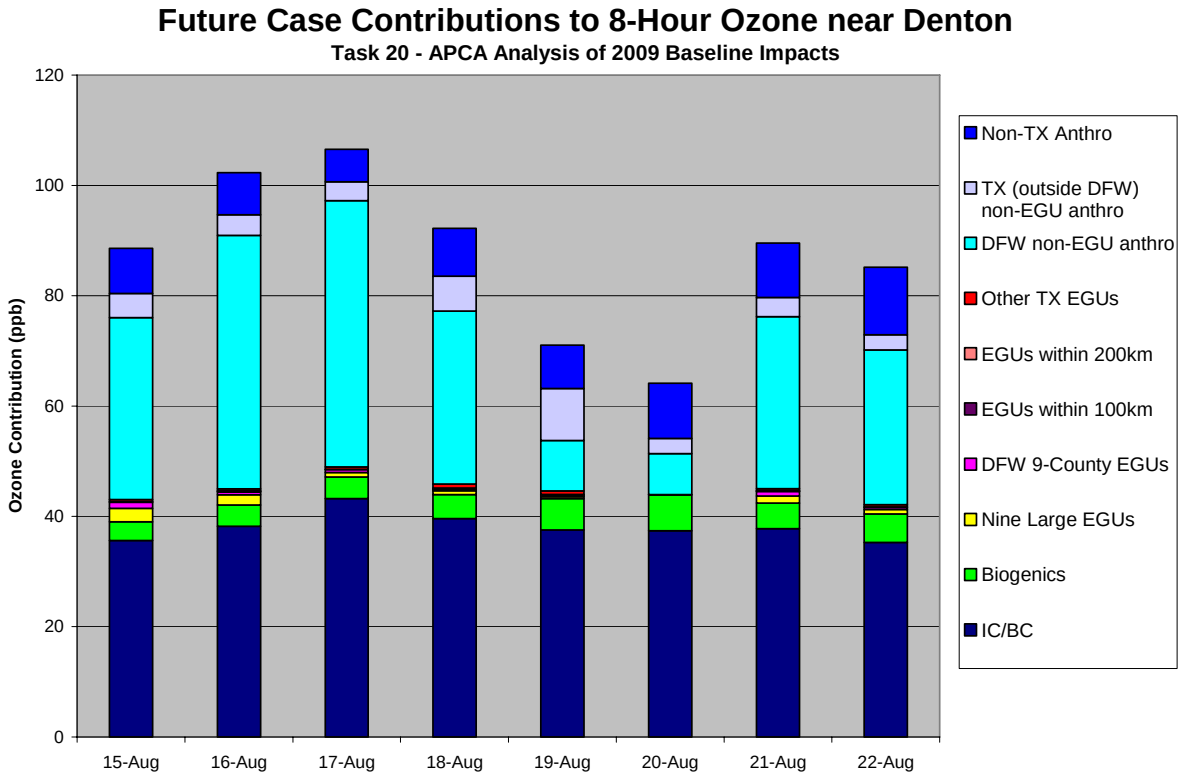


Figure 4–23. Stacked bar chart of contributions from all source groups to the daily peak 8-hour ozone (ppb) near Denton.

Contributions to the DFW 9-county NAA peak.

Contributions to the daily maximum 8-hour ozone anywhere inside the DFW 9-county NAA are displayed in the bar charts for the EGUs in Figure 4–24 and in a stacked bar chart for all sources in Figure 4–25; values are listed in Table 4–66. The daily peaks were near Denton on 5 of the 8 episode dates (August 15-17 and August 21-22); thus, the contributions from each emissions group to the peak 8-hour ozone in DFW were similar to those in Denton. The largest contribution among the 9 individual EGUs came from the Martin Lake EGU on August 15 at 1.82 ppb.

On August 18, the peak 8-hour ozone in the DFW NAA was located near North Dallas, but the impact from all Texas EGUs combined was comparable to the impact to Denton (2.04 ppb vs. 1.92 ppb). The Texas EGUs outside the 200 km radius of DFW made a larger impact to the DFW peak compared to the Denton peak while the 9 large EGUs combined made a smaller impact.

On the two dates with north winds (August 19 and 20), the DFW peak 8-hour ozone was on the southern end of the 9-county NAA. The DFW EGUs contributed 0.5 ppb more to the daily peak than to Denton; the other EGU groups were comparable to the contributions to Denton. Impacts from the DFW non-EGU anthropogenic group were greater from August 18-20.

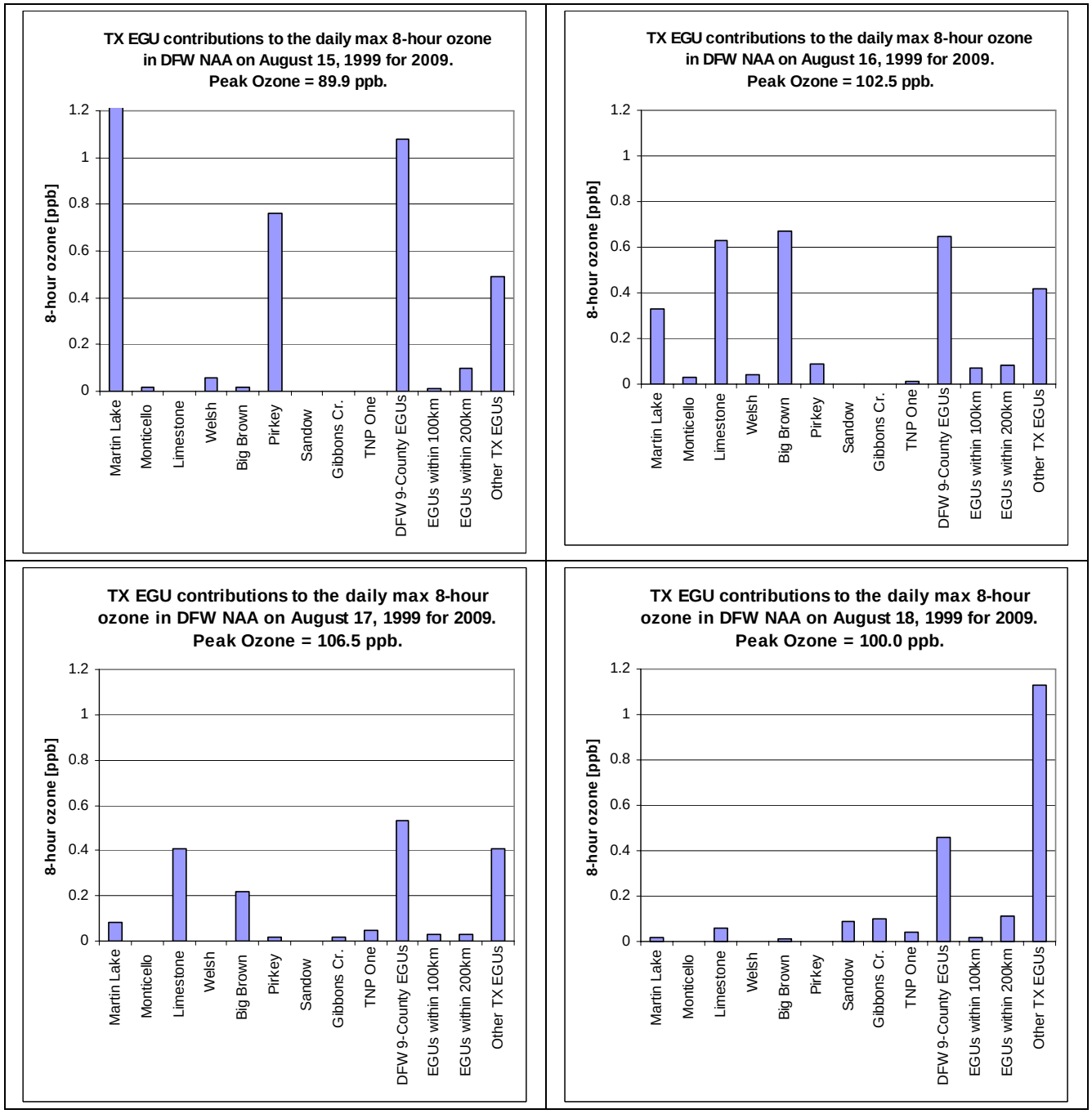


Figure 4–24. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) in the DFW 9-county NAA in the 2009 baseline.

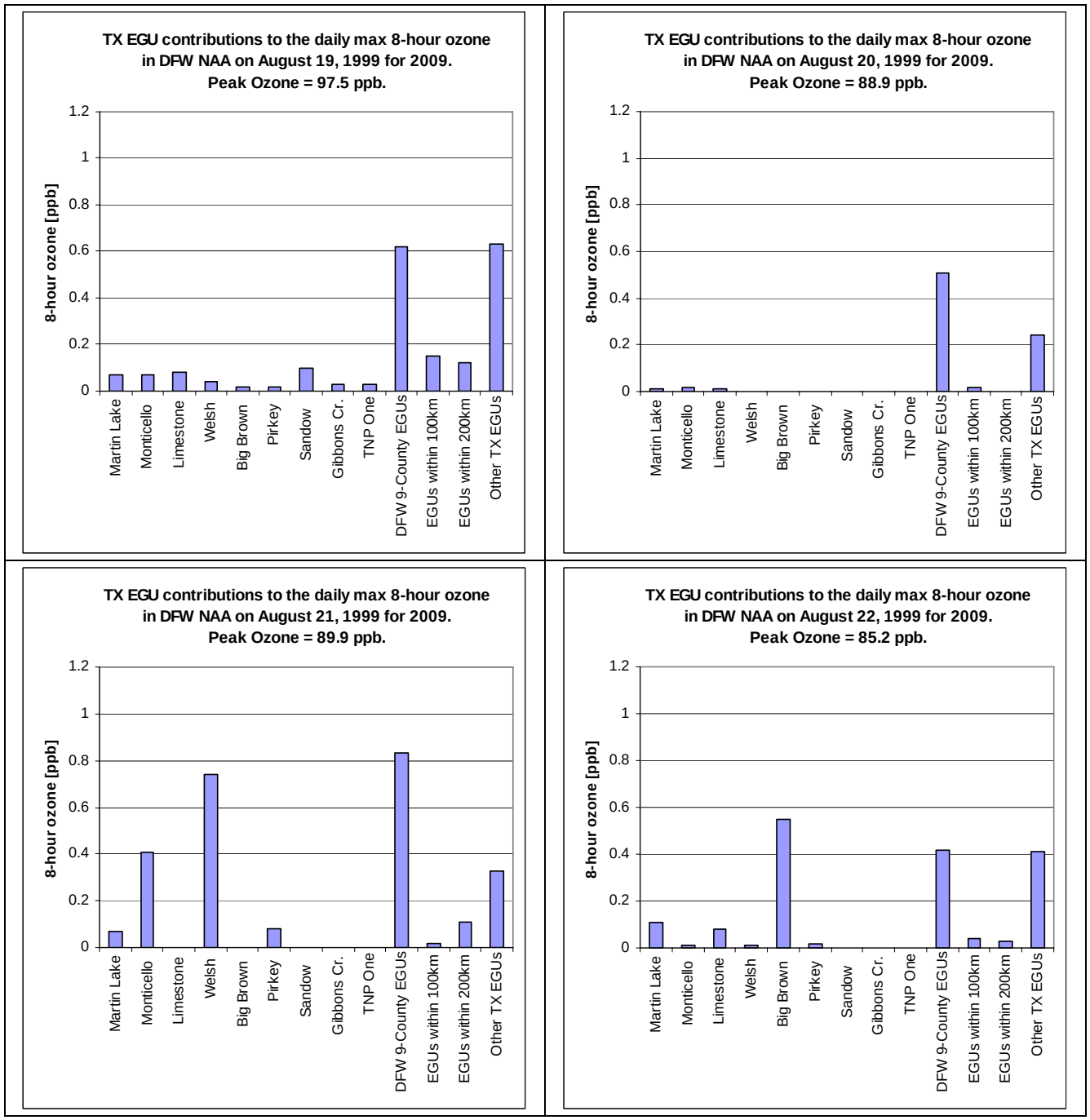


Figure 4–24 (concluded). Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) in the DFW 9-county NAA in the 2009 baseline.

Table 4–66. Contributions to the daily peak 8-hour ozone (ppb) in the DFW 9-county NAA.

Source	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
IC	9.49	2.55	1.96	9.23	4.51	0.11	0.04	0.07
BC	26.34	35.80	41.25	28.95	35.12	36.62	37.57	35.21
Biogenics	3.38	3.87	3.95	4.09	6.74	5.68	4.80	5.17
Martin Lake	1.82	0.33	0.08	0.02	0.07	0.01	0.07	0.11
Monticello	0.02	0.03	0.00	0.00	0.07	0.02	0.41	0.01
Limestone	0.00	0.63	0.41	0.06	0.08	0.01	0.00	0.08
Welsh	0.06	0.04	0.00	0.00	0.04	0.00	0.74	0.01
Big Brown	0.02	0.67	0.22	0.01	0.02	0.00	0.00	0.55
Pirkey	0.76	0.09	0.02	0.00	0.02	0.00	0.08	0.02
Sandow	0.00	0.00	0.00	0.09	0.10	0.00	0.00	0
Gibbons Cr.	0.00	0.00	0.02	0.10	0.03	0.00	0.00	0
TNP One	0.00	0.01	0.05	0.04	0.03	0.00	0.00	0
9 Large EGUs	**2.68**	**1.80**	**0.80**	**0.32**	**0.46**	**0.04**	**1.30**	**0.78**
DFW 9-County EGUs	1.08	0.65	0.53	0.46	0.62	0.51	0.83	0.42
EGUs within 100km	0.01	0.07	0.03	0.02	0.15	0.02	0.02	0.04
EGUs within 200km	0.10	0.08	0.03	0.11	0.12	0.00	0.11	0.03
Other TX EGUs	0.49	0.42	0.41	1.13	0.63	0.24	0.33	0.41
All Texas EGUs	**4.36**	**3.02**	**1.80**	**2.04**	**1.98**	**0.81**	**2.59**	**1.68**
DFW non-EGU anthro	33.74	45.73	48.24	39.85	35.35	35.69	31.57	28.02
TX (outside DFW) non-EGU anthro	4.50	3.67	3.45	6.13	7.93	0.82	3.43	2.78
Non-TX Anthro	8.13	7.86	5.88	9.68	5.83	9.17	9.90	12.21
Total (All Sources)	**89.94**	**102.50**	**106.53**	**99.97**	**97.46**	**88.90**	**89.90**	**85.14**

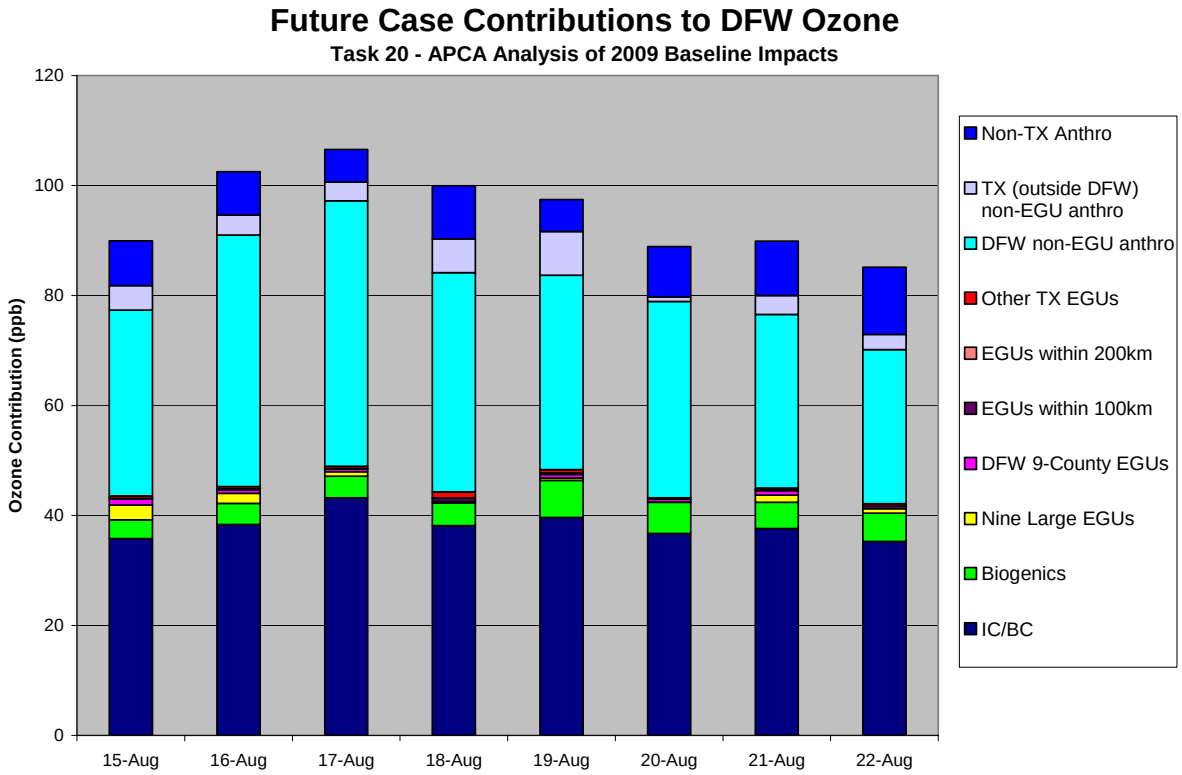


Figure 4–25. Stacked bar chart of daily contributions from all source groups to the peak 8-hour ozone (ppb) in the DFW 9-county NAA.

Summary

A CAMx source apportionment run for the DFW 2009 baseline examined EGU contributions to the peak 8-hour ozone near Frisco, Denton, and the entire DFW 9-county NAA. The EGU sources were separated into 9 individual EGUs in East Texas, EGUs in the DFW 9-county NAA, EGUs within 100 km of DFW, EGUs within 200 km of DFW, and all other EGUs.

Impacts from the individual EGUs depended on how well the wind aligned each EGU to each receptor. On the three dates with easterly winds (August 15, 16, and 21), contributions from the nine large EGUs combined were highest for each receptor (1.2 to 2.7 ppb), accounting for nearly half of all Texas EGU contributions (2.6 to 4.4 ppb) to the daily peak 8-hour ozone. Making the assumptions that the EGU contributions scale with NOx emissions and are independent of other sources, these results suggest that controls to Texas EGUs alone would be insufficient to lower the Frisco or Denton 2009 design values below 85 ppb.

The Martin Lake EGU, which emitted the most NOx among the 9 large EGUs, had one of the greatest impacts to each receptor, contributing 0.80, 1.58, and 1.82 ppb to the ozone peaks near Frisco, Denton, and DFW NAA, respectively, on August 15. The Pirkey EGU was also a large contributor on August 15. The Limestone and Big Brown EGUs were the largest contributors on August 16 to all 3 receptors, and the Welsh and Monticello EGUs were highest on August 21. On the date with the highest observed ozone (August 17), the Limestone EGU was the largest contributor at 0.4 to 0.5 ppb for each of the receptors.

The DFW 9-county EGUs contributed 0.8 to 1.2 ppb to the Frisco 8-hour ozone peak on 5 of the 8 episode dates, and slightly less to the Denton and DFW peaks. The DFW non-EGU anthropogenic group was the dominant source group, with contributions over 40 ppb on August 16 and 17 when the 8-hour peak ozone was over 100 ppb, and contributions below 20 ppb on dates when the peak ozone dropped below 85 ppb. Controls in this group seem necessary to achieve 8-hour ozone attainment.

4.11 SOURCE APPORTIONMENT ANALYSIS OF EAST TEXAS EGUs WITH CONTROLS

A CAMx source apportionment run examined the impacts from Texas EGUs to the daily maximum 8-hour ozone in the DFW 9-county NAA for the August 13-22, 1999 episode for 2009 after applying three levels of fuel-specific emission controls to the East Texas EGUs within 200 km of DFW.

Emissions

The 2009 East Texas EGU NOx emission rates were reduced to levels shown in Table 4–67 for each fuel type. NOx was reduced 137 tpd, of which 59 % was in Northeast Texas and 35 % was in Central Texas. VOC emissions were unchanged. Summaries of the 2009 weekday NOx emissions are shown in Table 4–68 by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column shows the change in emissions from the 2009 baseline.

Table 4–67. East Texas EGU controlled emission rates.

Fuel Type	Emissions [lb NOx/MMBtu]
Lignite	0.08
Other Coal	0.05
Gas	0.03

Table 4–68. Weekday NOx emissions in 2009 with East Texas EGU controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 baseline
Collin Co	10	15	1	0	2	8	0	25	-0.4
Dallas Co	4	77	5	2	18	45	0	148	-1.0
Denton Co	8	17	1	0	12	9	0	40	0.0
Tarrant Co	3	46	2	2	10	28	0	89	0.0
Parker Co	1	6	1	0	1	2	0	10	0.0
Johnson Co	5	5	6	0	0	5	0	16	0.0
Ellis Co	15	9	35	1	0	6	0	51	0.0
Kaufman Co	5	6	3	0	0	2	0	12	-0.6
Rockwall Co	2	3	0	0	0	1	0	5	0.0
DFW 9-County	**52**	**184**	**53**	**6**	**44**	**107**	**0**	**394**	**-2.0**
DFW 16 County	**83**	**212**	**76**	**10**	**67**	**123**	**0**	**488**	**-3.5**
NE Texas	16	79	108	16	71	42	1	316	-81.3
Central TX	113	88	90	2	56	69	0	305	-47.7
Houston	21	175	282	12	53	63	0	585	0.0
South TX	229	189	262	22	75	100	0	648	-4.9
West TX	524	160	154	21	212	105	1	653	0.0
Texas	**986**	**904**	**971**	**83**	**534**	**501**	**2**	**2995**	**-137.4**
Gulf + Mexico	79	5	437	0	4	2	444	892	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	2	2	1	1183	1905	0.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**913**	**10252**	**85**	**543**	**509**	**23869**	**36170**	**-137.4**
Total change from baseline	**0.0**	**0.0**	**-137.4**	**0.0**	**0.0**	**0.0**	**0.0**	**-137.4**	

The Texas EGUs were separated into 13 emission groups. The first nine groups consisted of the nine highest-emitting EGUs in East Texas, which accounted for 85 % (117 tpd) of the total NOx reduction. The remaining Texas EGUs were separated into four groups: EGUs inside the DFW 9-county NAA, EGUs within 100 km of DFW (and outside the DFW NAA), EGUs within 200km of DFW (but outside 100 km), and all other Texas EGUs. Table 4–69 summarizes the weekday NOx for each EGU group and Figure 4–26 plots the change in weekday NOx from the EGU controls, color-coded by emissions group.

All other emissions were divided into 3 additional source groups: (1) biogenics, (2) Texas non-EGU anthropogenic sources, and (3) all anthropogenic emissions outside of Texas.

Table 4–69. 2009 weekday NOx from Texas EGUs and differences from the 2009 baseline.

	NOx [tpd]	Change from baseline [tpd]	Change [%]
Martin Lake	24.1	-23.4	-49%
Monticello	18.1	-21.9	-55%
Limestone	15.2	-23.5	-61%
Welsh	8.3	-21.6	-72%
Big Brown	11.5	-9.1	-44%
Pirkey	6.6	-7.4	-53%
Sandow	4.3	-6.0	-58%
TK Gibbons Cr	2.5	-4.3	-63%
TNP One	6.6	0.0	0%
DFW 9-County EGUs	7.3	-2.0	-22%
EGUs within 100km	6.9	-6.6	-49%
EGUs within 200 km	9.7	-11.5	-54%
Other TX EGUs	264.4	0.0	0%

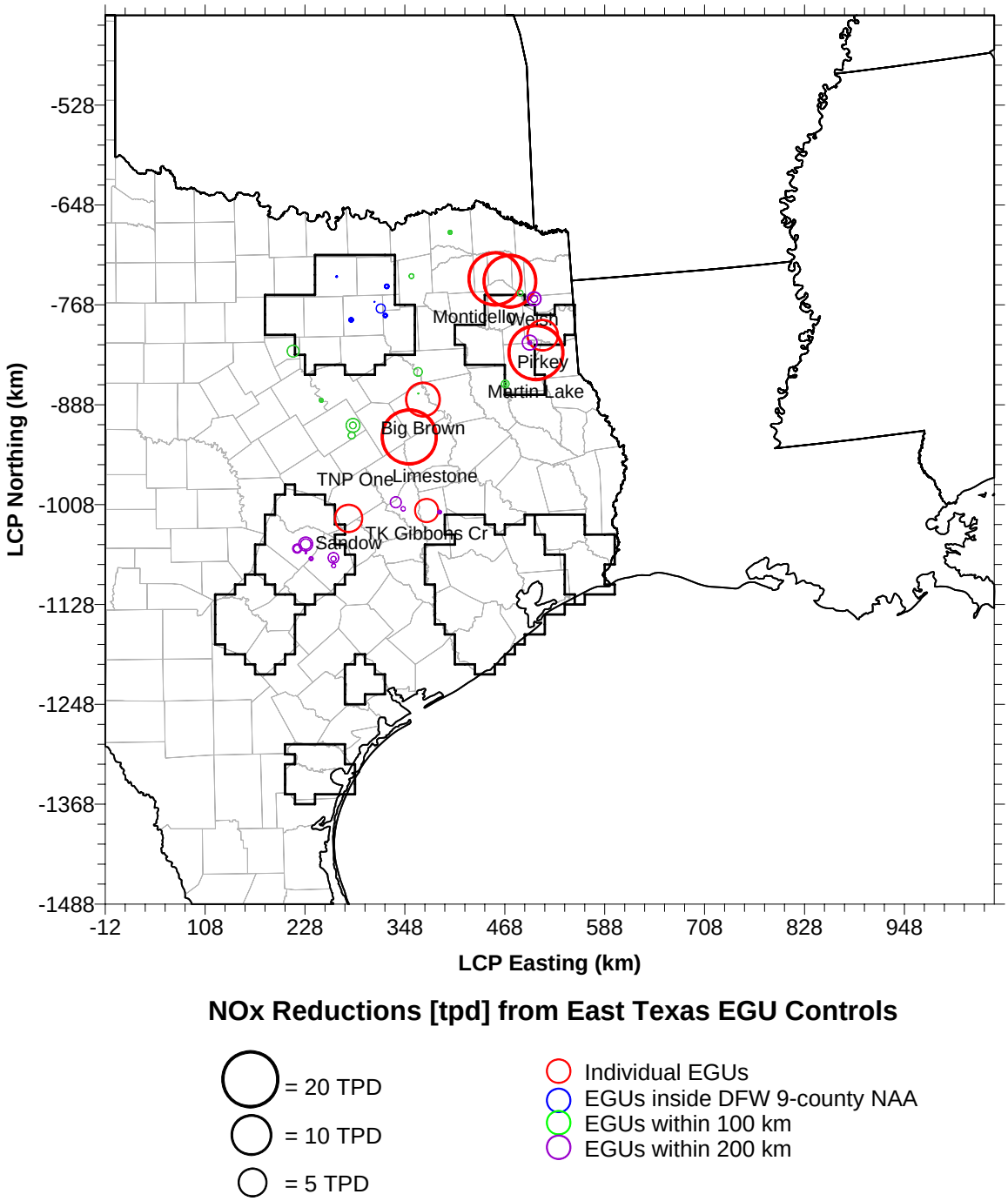


Figure 4–26. Change in weekday NOx emissions from East Texas EGU controls.

MODELING RESULTS

Figure 4–27 displays spatial plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for each episode date in the DFW 4 km domain. On two of the three dates with an east wind (August 15 and 21), the DFW 9-county NAA was surrounded by a plume of ozone reduction in northern DFW with origins near the Monticello and Welsh EGUs, and a plume in southern DFW with origins near the Pirkey and Martin Lake EGUs. On dates with a south wind (particularly August 17), ozone reduction was strongest in southern DFW, mainly

due to the NOx controls at the Big Brown and Limestone EGUs. Changes to the daily maximum 8-hour ozone in DFW on the two north wind dates (August 19 and 20) were very small.

The 8-hour ozone future design value calculations for the East Texas EGU control scenario are shown in Table 4–70 for all DFW monitoring sites using the 1999 baseline design value. Daily relative reduction factors are included at the bottom of the table. Table 4–71 compares the future design values with the 2009 baseline.

The two monitors in southern DFW showed the greatest future design value reduction from the East Texas EGU controls; Midlothian and Arlington dropped 1.5 and 1.0 ppb, respectively. Future design values at all other monitors were 0.5 to 0.8 ppb lower. Frisco's future design value was reduced 0.8 ppb to 90.5 ppb; Denton was 0.6 ppb lower at 89.0 ppb.

Tables 4–72 to 4–74 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 4–72 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline and control scenario; the percent change in exceedance area is shown in the right column. For the episode, the East Texas EGU controls reduced the exceedance area by 6 %.

Table 4–73 shows the number of baseline exceedance cells that were reduced by at least 1 ppb from the EGU controls. Of the 1199 exceedance cells in the episode, 201 (17 %) were reduced at least 1 ppb, all taking place on dates with an east wind or on August 17.

Table 4–74 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The number of exceedance ppb's among all episode dates was reduced 8 %.

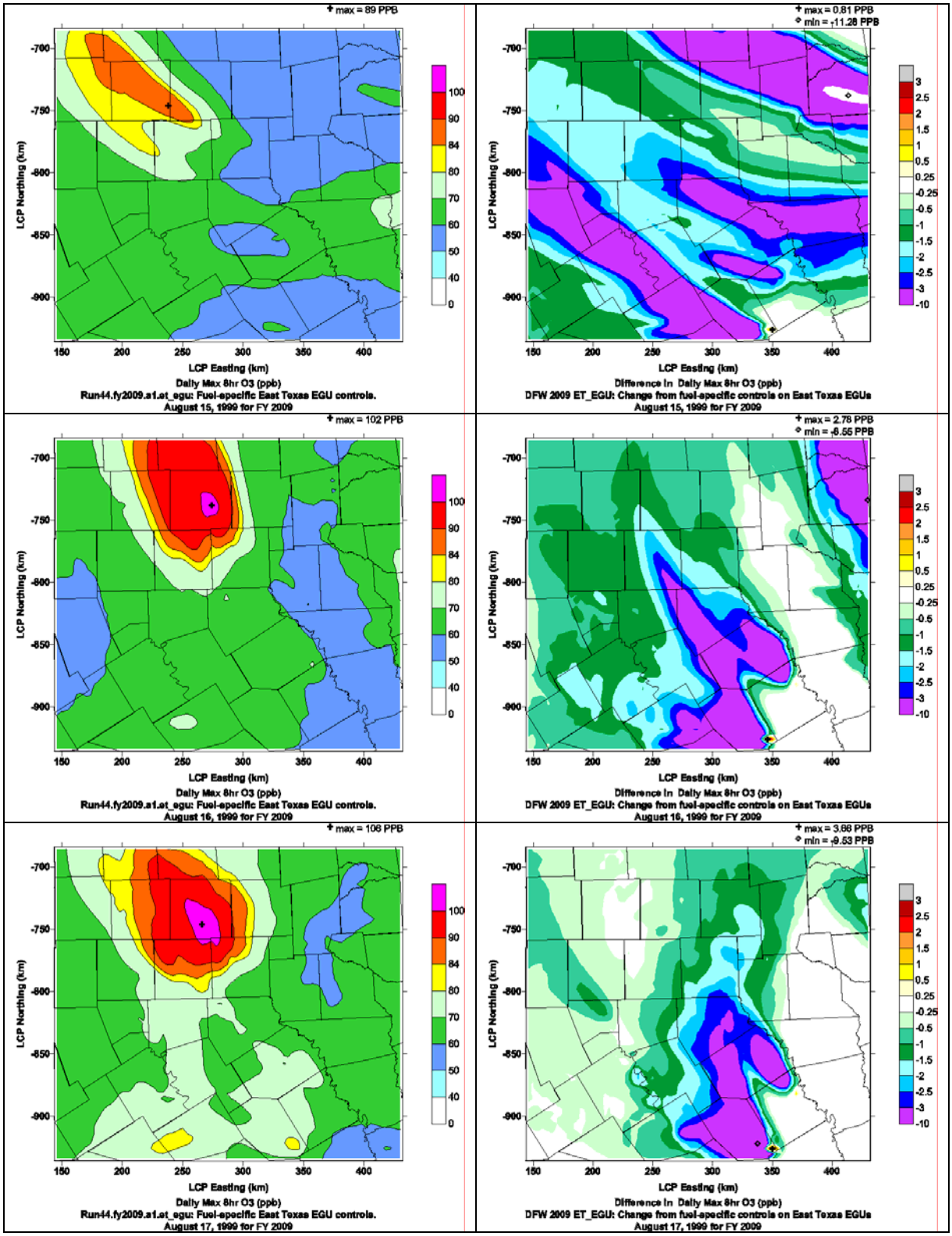


Figure 4–27. Plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for the fuel-specific East Texas EGU controls scenario.

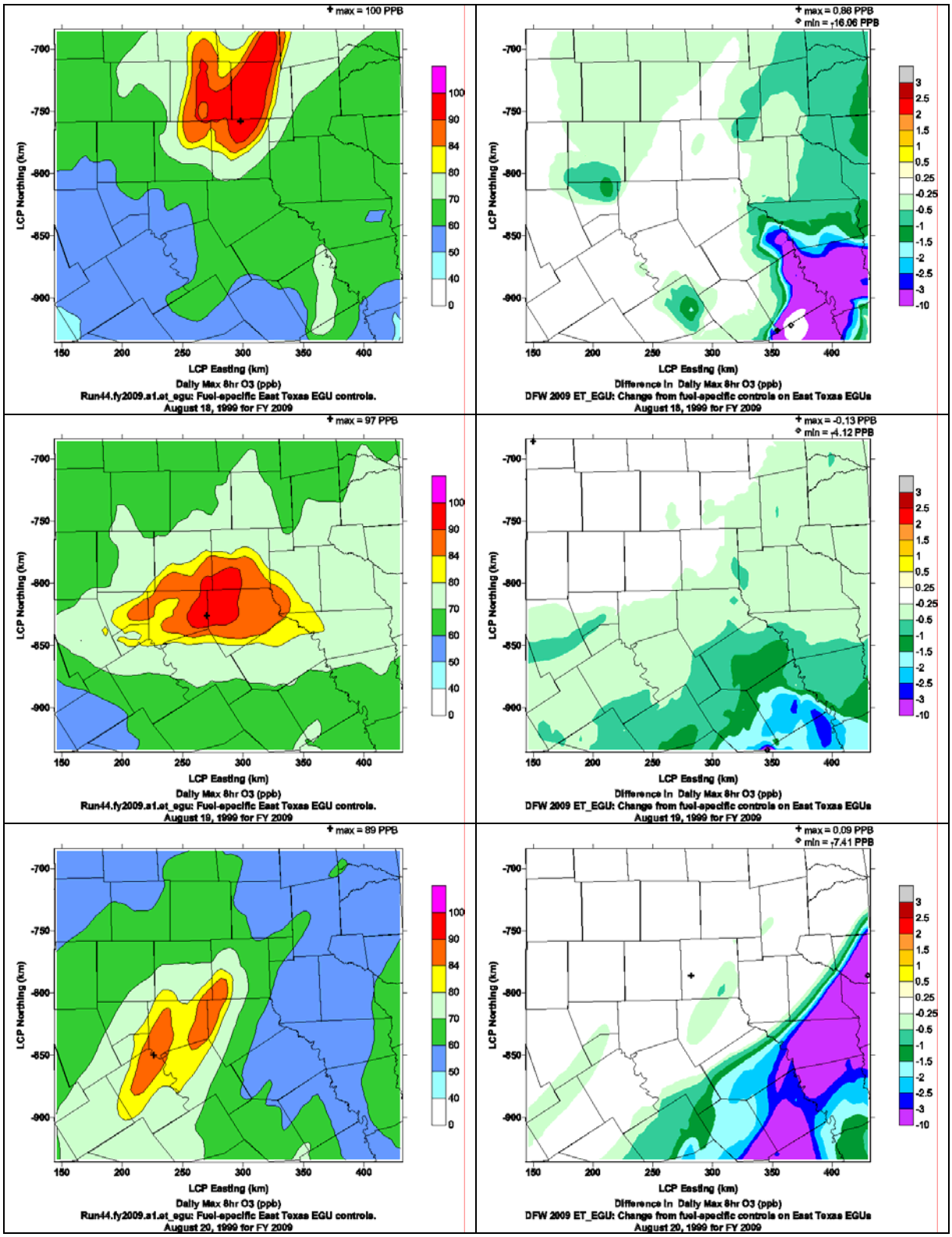


Figure 4–27. (continued). Plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for the fuel-specific East Texas EGU controls scenario.

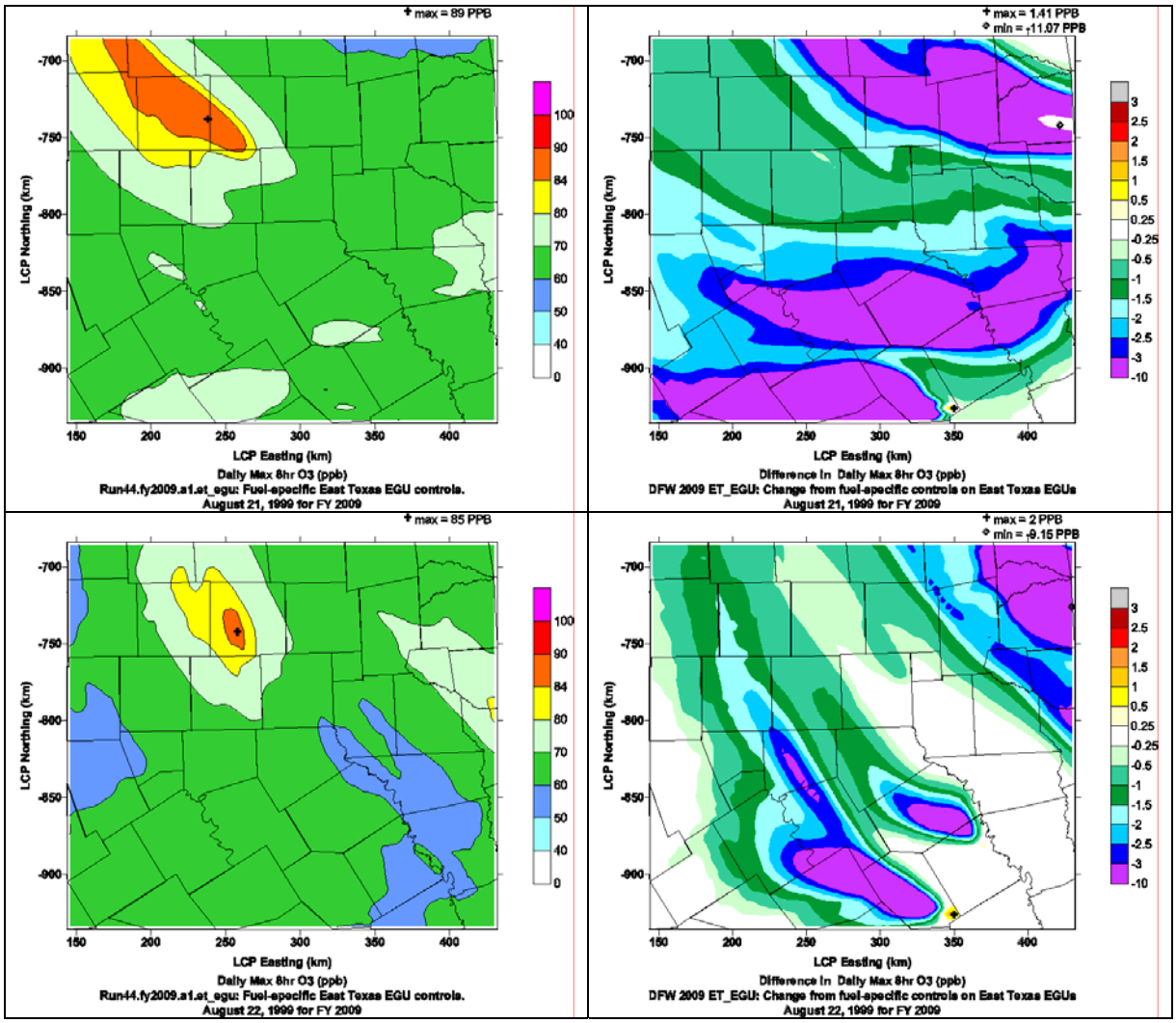


Figure 4–27. (concluded). Plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for the fuel-specific East Texas EGU controls scenario.

Table 4–70. Design value calculation for the East Texas EGU control scenario.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#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		
North 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: run44.fy2009.a1.apca.et_egu												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Baseline DV [ppb]**	**Future DV[2] [ppb]**
Frisco	67.2	99.2	99.6	98.2	72.9	64.9	73.6	75.0	81.3	0.902	100.3	90.5
Dallas C60	72.2	92.0	101.4	99.4	89.2	82.7	78.1	74.8	86.2	0.945	92.0	86.9
North Dallas C63	70.2	94.7	99.6	99.8	83.7	78.8	76.8	73.9	84.7	0.929	93.0	86.4
Dallas C402	66.7	81.0	89.4	88.0	95.4	87.6	71.6	69.7	81.2	0.905	87.3	79.0
Denton	87.1	101.5	106.1	91.9	70.8	64.1	88.9	84.8	86.9	0.877	101.5	89.0
Midlothian	67.9	72.6	77.3	70.4	97.1	87.0	67.0	67.3	75.8	0.898	92.5	83.1
Arlington	72.1	88.1	90.8	83.4	94.1	87.6	73.6	78.5	83.5	0.908	95.0	86.3
Fort Worth C13	79.5	93.1	93.3	88.0	83.5	76.5	79.9	80.8	84.3	0.883	98.3	86.8
Fort Worth C17	87.4	96.4	102.1	90.4	79.5	71.0	87.3	84.1	87.3	0.887	96.3	85.4
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.833	0.939	1.006	0.935	0.852	0.926	0.857	0.839				
Dallas C60	0.868	0.937	1.008	0.967	0.922	1.068	0.909	0.879				
North Dallas C63	0.848	0.951	1.005	0.953	0.891	1.037	0.892	0.845				
Dallas C402	0.852	0.873	0.912	0.896	0.911	1.033	0.890	0.865				
Denton	0.851	0.918	0.978	0.814	0.844	0.886	0.874	0.847				
Midlothian	0.899	0.855	0.897	0.903	0.869	0.971	0.894	0.898				
Arlington	0.836	0.896	0.912	0.883	0.900	1.040	0.900	0.906				
Fort Worth C13	0.844	0.883	0.909	0.844	0.880	0.958	0.879	0.879				
Fort Worth C17	0.870	0.876	0.949	0.847	0.862	0.912	0.918	0.864				

1. RRF = Future year average / base year average
2. Future DV = Baseline DV * RRF
3. Daily RRFs are for information only and are not used to calculate the future DVs.

Table 4–71. Summary of future design values.

Run	run44.fy2009.a1	run44.fy2009.a1.et_egu	
Scenario	**2009 baseline**	**3 levels of fuel-specific emissions to ET EGUs within 200 km of DFW NAA**	**Difference from 2009 baseline [ppb]**
Frisco	91.2	90.5	-0.8
Dallas C60	87.6	86.9	-0.6
Dallas C63	87.0	86.4	-0.6
Dallas C402	79.7	79.0	-0.7
Denton	89.6	89.0	-0.6
Midlothian	84.5	83.1	-1.5
Arlington	87.2	86.3	-1.0
Fort Worth C13	87.6	86.8	-0.8
Fort Worth C17	86.0	85.4	-0.5

Table 4–72. Exceedance Area (Number of grid cells in the DFW NAA with daily maximum 8-hour ozone > 85 ppb).

Run	run44.fy2009.a1	run44.fy2009.a1.et_egu	Difference [%}
Scenario	**2009 baseline**	**3 levels of fuel-specific emissions to ET EGUs within 200 km of DFW NAA**	
990815	19	13	-32%
990816	223	211	-5%
990817	296	279	-6%
990818	253	247	-2%
990819	304	286	-6%
990820	70	68	-3%
990821	29	25	-14%
990822	5	0	-100%
Total	1199	1129	-6%

Table 4–73. Number of exceedance grid cells reduced at least 1 ppb.

Run Scenario	run44.fy2009.a1.et_egu 3 levels of fuel-specific emissions to ET EGUs within 200 km of DFW NAA
990815	19
990816	136
990817	40
990818	0
990819	0
990820	0
990821	6
990822	0
Total	201

Table 4–74. Number of ppb's exceeding 85 ppb[1] in the daily maximum ozone in DFW NAA.

Run	run44.fy2009.a1	run44.fy2009.a1.et_egu
Scenario	2009 baseline	3 levels of fuel-specific emissions to ET EGUs within 200 km of DFW NAA
990815	50	25
990816	2184	1916
990817	2594	2424
990818	1660	1598
990819	1201	1101
990820	84	79
990821	74	52
990822	1	0
Total	7846	7194
% Difference		-8.3 %

1 Σ(max(O3-85, 0.0))

SOURCE APPORTIONMENT RESULTS

The APCA source apportionment modeling results focused on contributions to the two ozone monitoring sites with the highest 8-hour ozone future design values – Frisco and Denton. Impacts from each emissions group to the daily maximum 8-hour ozone within the 7 by 7 cells surrounding each monitor were examined, corresponding to the values used for design value scaling.

Contributions to Frisco

Table 4–75 lists contributions from each of the 9 large EGUs in East Texas to the daily maximum 8-hour ozone near Frisco for the 2009 baseline (top) and EGU controls (center). The change in contributions, expressed as a percentage, is shown at the bottom of the table. The highest contributions in the control scenario were from the same EGUs and dates as in the baseline, but were much smaller. All contributions greater than 0.2 ppb from the individual EGUs occurred on dates with east winds: Martin Lake (0.36 ppb) and Pirkey (0.21 ppb) on August 15, Big Brown (0.40 ppb) on August 16, and Welsh (0.31 ppb) and Monticello (0.24 ppb) on August 21. The percent change in ozone contributions to Frisco from the East Texas control scenario showed little variation from day to day from each of the large EGUs, as shown in Figure 4–28. Percentages were not plotted when the baseline contribution was less than 0.001 ppb. In Figure 4–29, the episode average change in ozone contributions to Frisco from each of the large EGUs is compared to each EGU's change in NOx emissions. EGUs that reduced more NOx, by percent, reduced nearly the same percentage of their 8-hour ozone contributions to Frisco.

A summary of contributions to the daily maximum 8-hour ozone near Frisco from all sources is listed in Table 4–76 and displayed as a stacked bar chart for all episode dates in Figure 4–30. The largest contribution from all Texas EGUs combined was 1.9 ppb on August 16, down from 3.1 ppb in the 2009 baseline. On the three dates exceeding 85 ppb (August 16- 18), the Texas non-EGU anthropogenic source group contributed over 40 ppb to Frisco's peak 8-hour ozone; on the remaining dates, contributions were nearly halved.

Table 4–75. Contributions [ppb] from the 9 large EGUs to the daily maximum 8-hour ozone near Frisco for the baseline (top) and East Texas EGU control scenario (center), with differences in percent (bottom).

2009 Baseline										
Source	**15-Aug**	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	
Martin Lake	0.80	0.34	0.09	0.02	0.04	0.00	0.04	0.22	0.19	
Monticello	0.02	0.03	0.00	0.00	0.02	0.00	0.54	0.01	0.08	
Limestone	0.00	0.40	0.50	0.07	0.12	0.00	0.00	0.01	0.14	
Welsh	0.18	0.04	0.00	0.00	0.02	0.00	1.22	0.01	0.18	
Big Brown	0.00	0.77	0.36	0.01	0.03	0.00	0.00	0.13	0.16	
Pirkey	0.48	0.09	0.02	0.00	0.01	0.00	0.06	0.03	0.09	
Sandow	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.02	
Gibbons Cr.	0.00	0.00	0.02	0.11	0.03	0.00	0.00	0.00	0.02	
TNP One	0.00	0.00	0.05	0.03	0.04	0.00	0.00	0.00	0.02	
East Texas EGU controls										
Source	**15-Aug**	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	
Martin Lake	0.36	0.18	0.05	0.01	0.02	0.00	0.02	0.11	0.10	
Monticello	0.01	0.02	0.00	0.00	0.01	0.00	0.24	0.00	0.04	
Limestone	0.00	0.13	0.14	0.03	0.05	0.00	0.00	0.01	0.04	
Welsh	0.06	0.01	0.00	0.00	0.01	0.00	0.31	0.00	0.05	
Big Brown	0.00	0.40	0.18	0.00	0.02	0.00	0.00	0.07	0.08	
Pirkey	0.21	0.04	0.01	0.00	0.00	0.00	0.03	0.02	0.04	
Sandow	0.00	0.00	0.00	0.04	0.04	0.00	0.00	0.00	0.01	
Gibbons Cr.	0.00	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.01	
TNP One	0.00	0.00	0.04	0.03	0.04	0.00	0.00	0.00	0.02	
Difference (ET EGU - Baseline)	**15-Aug**	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	**Emissions reduction**
Martin Lake	-55%	-46%	-43%	-45%	-47%	-50%	-49%	-47%	-51%	-49%
Monticello	-50%	-52%	-44%	-50%	-50%	-55%	-56%	-54%	-55%	-55%
Limestone		-68%	-72%	-53%	-58%	-61%	-64%	-58%	-68%	-61%
Welsh	-67%	-70%	-68%	-67%	-70%	-72%	-75%	-71%	-74%	-72%
Big Brown	-40%	-49%	-50%	-42%	-44%	-40%	-44%	-46%	-49%	-44%
Pirkey	-57%	-52%	-49%	-50%	-51%	-57%	-52%	-51%	-55%	-53%
Sandow		-50%	-38%	-56%	-57%	-50%	-50%	-67%	-57%	-58%
Gibbons Cr.		-65%	-66%	-63%	-62%	-50%	-100%	-63%	-63%	-63%
TNP One		-15%	-4%	0%	0%	0%	0%	0%	-2%	0%

Red values denote contributions > 0.40 ppb in the baseline and > 0.20 ppb in the control scenario.

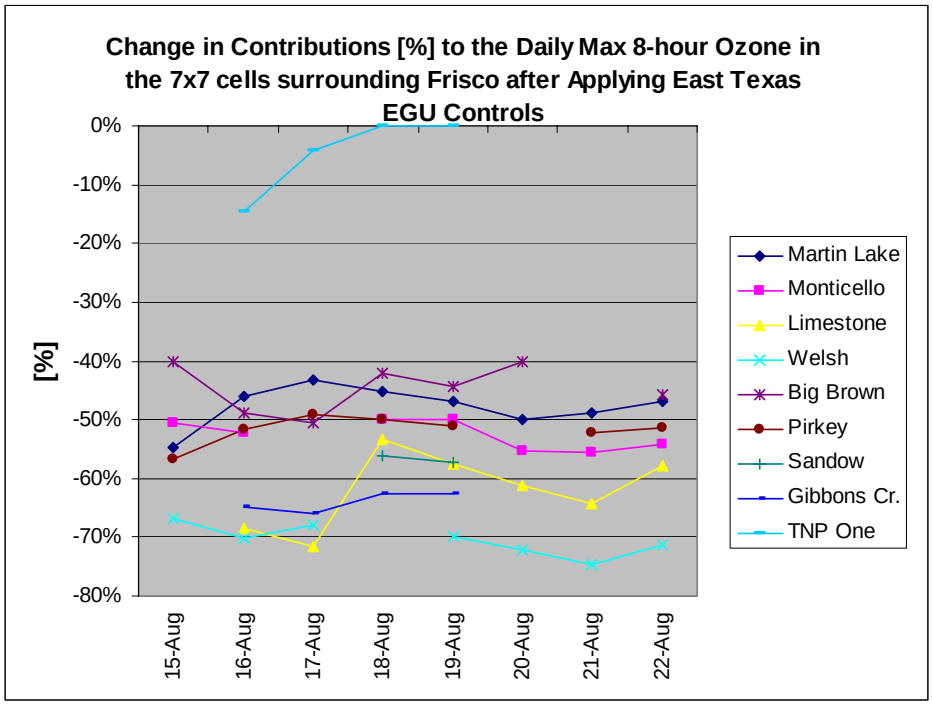


Figure 4–28. Change in contributions [%] to the daily maximum 8-hour ozone in Frisco from 9 large EGUs in the East Texas EGU control scenario.

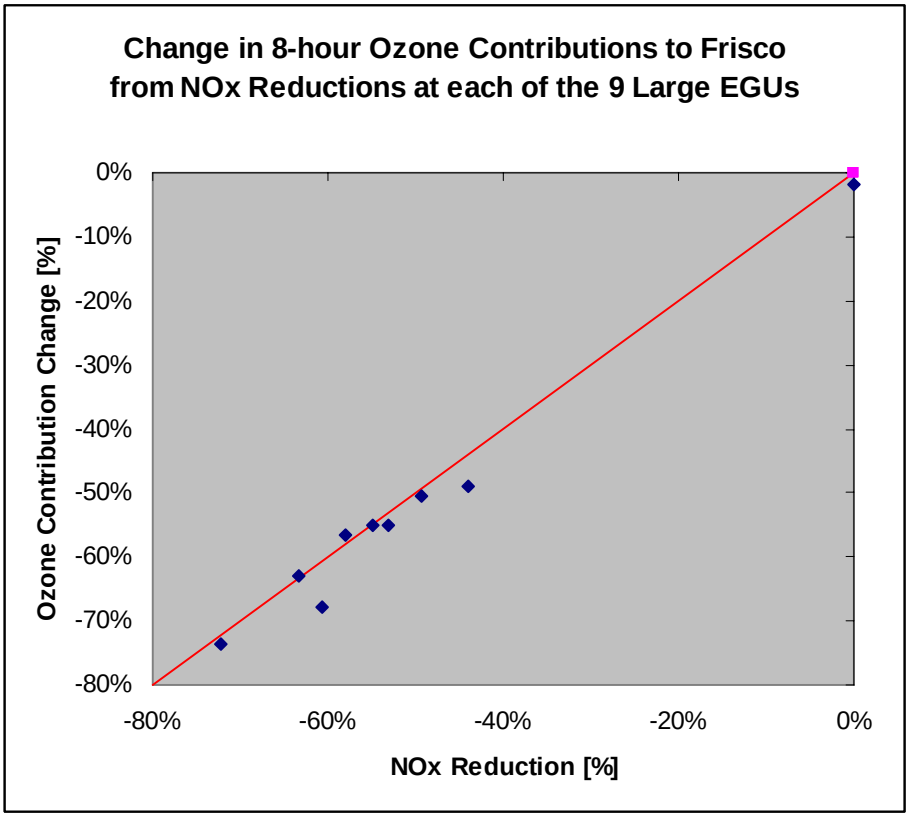


Figure 4–29. Relationship between the average change in ozone contributions [%] to Frisco and the change in NOx emissions [%] from each large EGU.

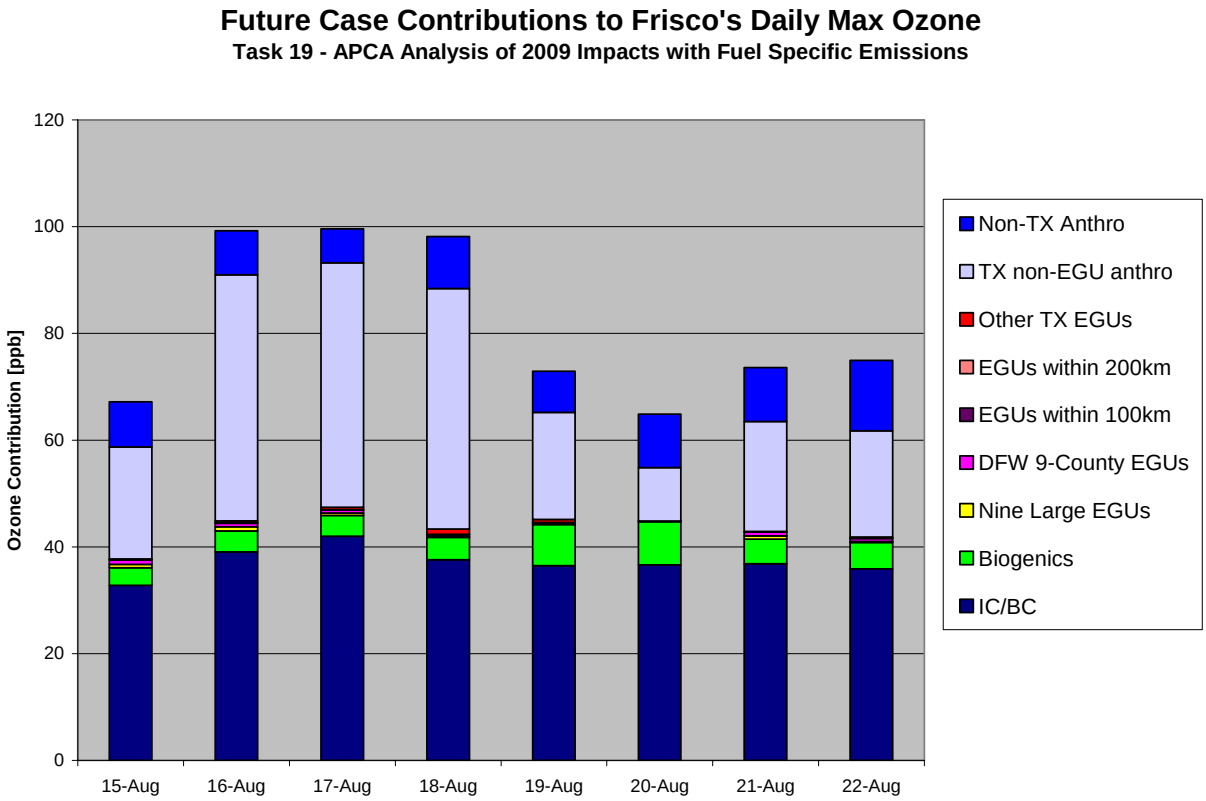


Figure 4–30. 8-hour ozone contributions to Frisco from all source groups in the East Texas EGU control scenario.

Table 4–76. Consolidated contributions [ppb] from all sources in the East Texas EGU control scenario to the daily maximum 8-hour ozone near Frisco.

Source	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
IC/BC	32.77	39.05	42.00	37.59	36.47	36.62	36.86	35.91
Biogenics	3.33	3.93	3.91	4.22	7.72	8.15	4.60	4.91
Nine Large EGUs	0.64	0.78	0.43	0.15	0.19	0.00	0.60	0.21
DFW 9-County EGUs	0.85	0.66	0.59	0.35	0.06	0.01	0.72	0.57
EGUs within 100km	0.00	0.04	0.02	0.02	0.09	0.01	0.00	0.01
EGUs within 200km	0.03	0.04	0.02	0.06	0.04	0.00	0.02	0.03
Other TX EGUs	0.11	0.39	0.45	0.99	0.59	0.03	0.09	0.22
All Texas EGUs	**1.63**	**1.91**	**1.51**	**1.57**	**0.97**	**0.05**	**1.43**	**1.04**
TX non-EGU Anthro	20.99	46.09	45.82	45.03	20.04	10.07	20.61	19.92
Non-TX Anthro	8.47	8.23	6.33	9.74	7.73	9.97	10.12	13.17
Total	**67.19**	**99.21**	**99.57**	**98.15**	**72.93**	**64.86**	**73.62**	**74.95**

Contributions to Denton

Table 4–77 lists contributions from each of the 9 large EGUs in East Texas to the daily maximum 8-hour ozone near Denton in the 2009 baseline (top) and EGU control scenario (center) for each episode date. The change in contributions, expressed as a percentage, is shown at the bottom of the table. The highest contributions in the control scenario were from the same

EGUs and dates as in the baseline, but were smaller. On August 15, the Martin Lake (0.69 ppb) and Pirkey (0.29 ppb) EGUs were strongest. The Big Brown (0.28 ppb) and Limestone (0.40 ppb) EGUs were largest on August 16, the Welsh EGU (0.20 ppb) was highest on August 21, and the Big Brown EGU contributed another 0.25 ppb on August 22.

Like Frisco, the percent change in ozone contributions to Denton from the NOx reductions at each of the large EGUs did not show significant variations from day to day, as shown in Figure 4–31. The episode average 8-hour ozone change, expressed as a percent, was almost equal to or greater than the NOx reduction rate at each of the 9 large EGUs, as displayed in Figure 4–32.

A summary of contributions from all sources to the daily maximum 8-hour ozone near Denton is listed in Table 4–78 and displayed as a stacked bar chart for all episode dates in Figure 4–33. The largest contribution from all Texas EGUs combined was 2.3 ppb on August 16, down from 4.1 ppb on the same date in the 2009 baseline. The Texas non-EGU anthropogenic emissions group accounted for 39 % to 49 % of the total ozone when the daily 8-hour ozone peak near Denton exceeded 85 ppb.

Table 4–77. Contributions from the 9 large EGUs to the daily maximum 8-hour ozone near Denton for the baseline (top) and East Texas EGU control scenario (center), with differences in percent (bottom).

2009 Baseline [ppb]										
Source	**15-Aug**	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	
Martin Lake	1.58	0.33	0.08	0.02	0.04	0.00	0.08	0.11	0.28	
Monticello	0.02	0.03	0.00	0.00	0.02	0.00	0.36	0.01	0.06	
Limestone	0.00	0.78	0.41	0.24	0.10	0.00	0.00	0.08	0.20	
Welsh	0.09	0.03	0.00	0.00	0.02	0.00	0.72	0.01	0.11	
Big Brown	0.01	0.61	0.22	0.02	0.02	0.00	0.00	0.55	0.18	
Pirkey	0.70	0.08	0.02	0.00	0.01	0.00	0.08	0.02	0.12	
Sandow	0.00	0.00	0.00	0.18	0.08	0.00	0.00	0.00	0.03	
Gibbons Cr.	0.00	0.01	0.02	0.10	0.03	0.00	0.00	0.00	0.02	
TNP One	0.00	0.01	0.05	0.12	0.04	0.00	0.00	0.00	0.03	
East Texas EGU controls [ppb]										
Source	**15-Aug**	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	
Martin Lake	0.69	0.19	0.05	0.01	0.02	0.00	0.04	0.06	0.13	
Monticello	0.01	0.01	0.00	0.00	0.01	0.00	0.17	0.01	0.03	
Limestone	0.00	0.26	0.12	0.11	0.05	0.00	0.00	0.02	0.07	
Welsh	0.03	0.01	0.00	0.00	0.01	0.00	0.20	0.00	0.03	
Big Brown	0.01	0.28	0.11	0.01	0.01	0.00	0.00	0.25	0.08	
Pirkey	0.29	0.04	0.01	0.00	0.01	0.00	0.04	0.01	0.05	
Sandow	0.00	0.00	0.00	0.07	0.03	0.00	0.00	0.00	0.01	
Gibbons Cr.	0.00	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.01	
TNP One	0.00	0.01	0.05	0.12	0.04	0.00	0.00	0.00	0.03	
Difference (ET EGU - Baseline)										
	15-Aug	**16-Aug**	**17-Aug**	**18-Aug**	**19-Aug**	**20-Aug**	**21-Aug**	**22-Aug**	**Average**	**Emissions Reduction**
Martin Lake	-56%	-43%	-44%	-47%	-41%	-50%	-49%	-41%	-53%	-49%
Monticello	-51%	-51%	-47%	-52%	-42%	-56%	-54%	-58%	-53%	-55%
Limestone	-60%	-67%	-71%	-55%	-54%	-67%	-64%	-76%	-66%	-61%
Welsh	-68%	-71%	-70%	-70%	-66%	-69%	-72%	-73%	-71%	-72%
Big Brown	-44%	-55%	-49%	-43%	-35%	-50%	-44%	-56%	-54%	-44%
Pirkey	-59%	-49%	-49%	-51%	-45%	-57%	-53%	-52%	-57%	-53%
Sandow		-37%	-46%	-58%	-59%	-67%	-50%	-50%	-58%	-58%
Gibbons Cr.		-58%	-65%	-62%	-62%	-50%		-72%	-63%	-63%
TNP One		13%	-4%	0%	0%	0%	0%	-21%	0%	0%

Red values denote contributions > 0.40 ppb in the baseline and > 0.20 ppb in the control scenario.

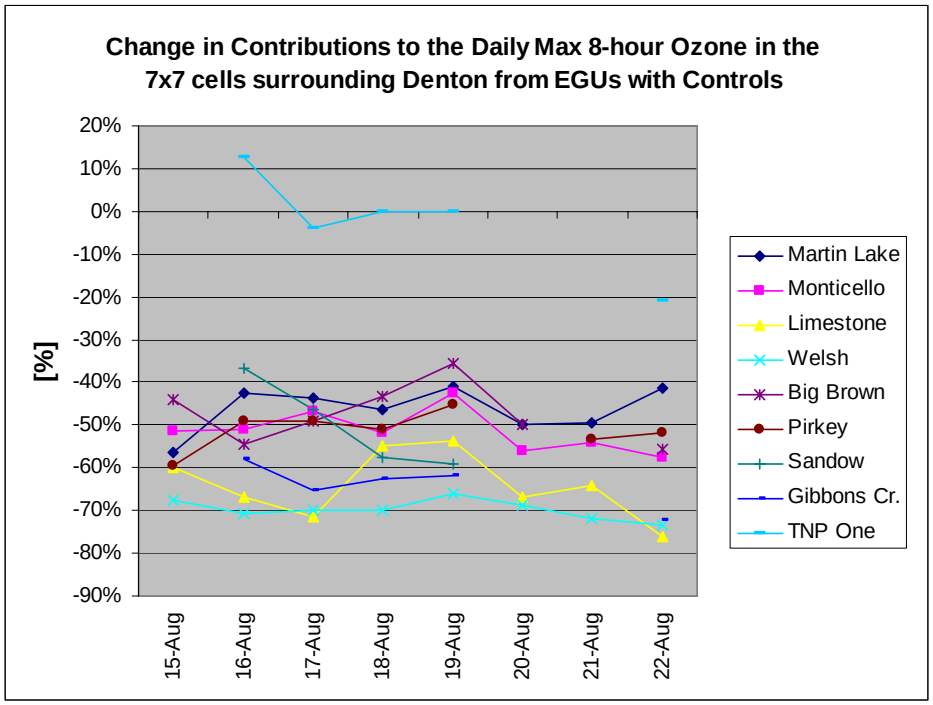


Figure 4–31. Change in contributions [%] to the daily maximum 8-hour ozone in Denton from 9 large EGUs in the East Texas EGU control scenario.

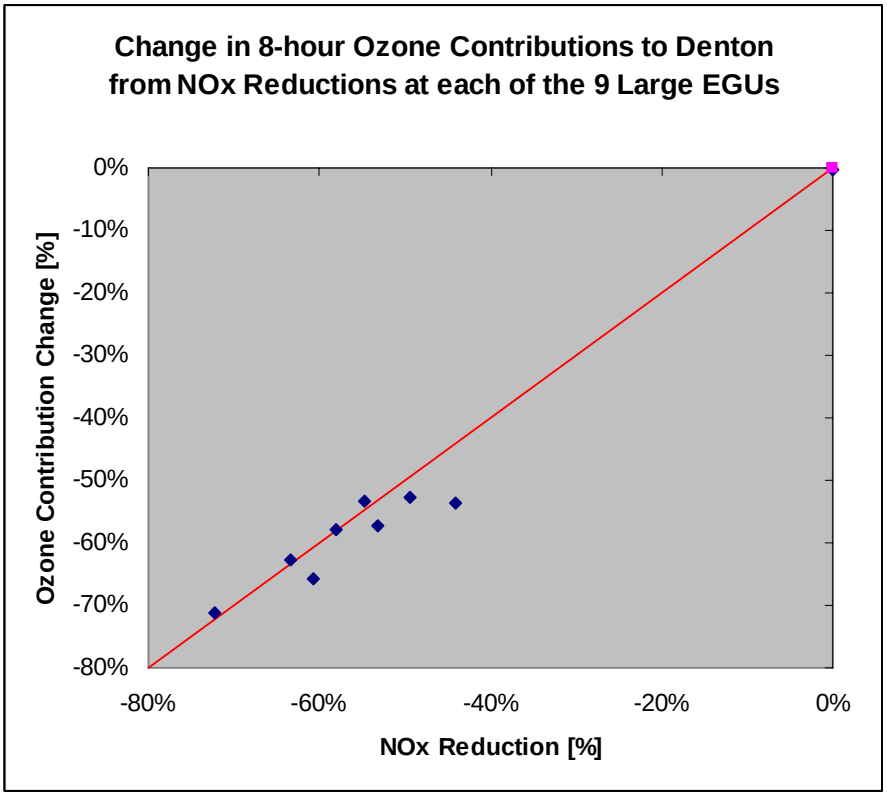


Figure 4–32. Relationship between the average change in ozone contributions [%] to Denton and the change in NOx emissions [%] from each large EGU.

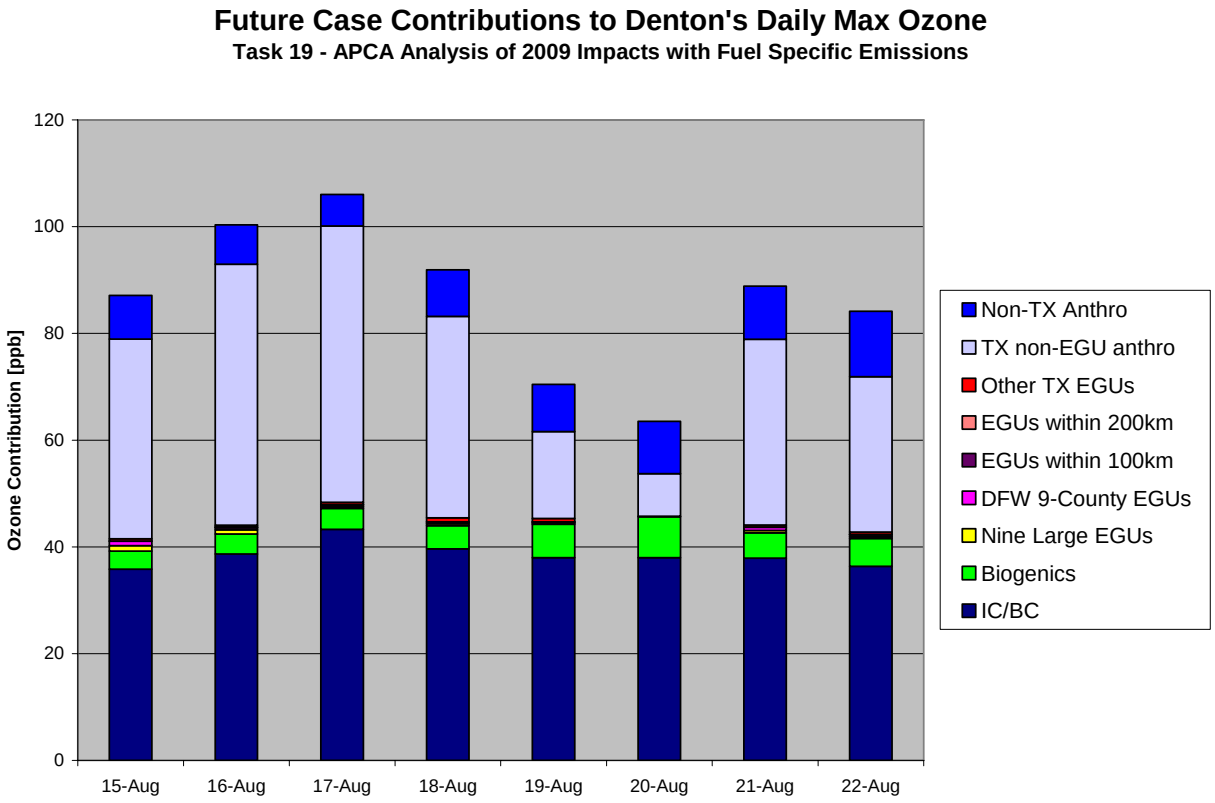


Figure 4–33. 8-hour ozone contributions to Denton from all source groups in the East Texas EGU control scenario.

Table 4–78. Consolidated contributions [ppb] from all sources in the East Texas EGU control scenario to the daily maximum 8-hour ozone near Denton.

Source	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
IC/BC	35.82	38.68	43.27	39.64	38.00	38.01	37.93	36.37
Biogenics	3.39	3.73	3.93	4.36	6.27	7.63	4.68	5.22
Nine Large EGUs	1.02	0.81	0.34	0.36	0.19	0.00	0.45	0.35
DFW 9-County EGUs	0.82	0.40	0.38	0.27	0.15	0.10	0.64	0.37
EGUs within 100km	0.00	0.05	0.02	0.02	0.07	0.00	0.00	0.03
EGUs within 200km	0.04	0.05	0.02	0.07	0.04	0.00	0.03	0.02
Other TX EGUs	0.41	0.34	0.41	0.73	0.61	0.01	0.35	0.41
All Texas EGUs	2.30	1.65	1.17	1.45	1.06	0.12	1.47	1.18
TX non-EGU anthro	37.41	48.90	51.76	37.76	16.28	7.99	34.83	29.12
Non-TX Anthro	8.22	7.37	5.89	8.70	8.83	9.77	9.94	12.24
Total (All sources)	87.14	100.32	106.02	91.91	70.44	63.51	88.85	84.13

Summary

A CAMx source apportionment run examined the 8-hour ozone impacts to DFW when applying three fuel-specific levels of NOx controls to the East Texas EGUs. NOx emissions were reduced 137 tpd, of which 117 tpd (85 %) came from the 9 largest EGUs.

DFW monitors in the south (Midlothian and Arlington) showed the greatest reduction in the 2009 8-hour ozone design values, dropping 1.5 and 1.0 ppb, respectively. The future design values at all other monitors were reduced 0.5 to 0.8 ppb from the 2009 baseline, including Frisco, down 0.8 ppb to 90.5 ppb. The East Texas EGU controls reduced the episode exceedance area by 6 %, as 17 % of the exceedance cells were reduced at least 1 ppb.

A source apportionment analysis separated the Texas EGUs into 13 groups. The first nine groups consisted of the 9 largest individual EGUs in East Texas. The remaining groups represented the EGUs in the DFW 9-county NAA, EGUs within 100 km of DFW, EGUs within 200 km of DFW, and all other EGUs in Texas. Ozone contributions from the 9 individual EGUs to both Frisco and Denton showed that the fractional change in the ozone contributions from each EGU on each date was proportional to the fractional change in the NOx controls.

At Frisco, the largest contribution from the 9 large EGUs combined was 0.8 ppb on August 16, down from 1.7 ppb in the baseline on the same date. At Denton, the EGU controls lowered the ozone contribution from the 9 large EGUs combined from 2.4 ppb to 1.0 ppb on August 15. The largest contributions from all Texas EGUs to Frisco and Denton were 1.9 and 2.3 ppb, respectively.

5. REVISED BASELINES USING CAMx 4.31 AND "A2" EMISSIONS

In Section 4, sensitivity runs examined the impacts to 8-hour ozone in DFW during the August 13-22, 1999 episode for the 2009 future year using a modified version of CAMx 4.03 and 2009 "a1" emissions. This section upgrades CAMx to the current release, version 4.31, and makes minor upgrades to the 2009 point sources for the "a2" baseline. In addition, a new future year was introduced – 2012.

Sensitivity tests first compared the 1999 model performance between CAMx 4.03, the current release of CAMx, version 4.31, and a beta version of CAMx 4.40. In addition, the 2009 baseline was evaluated when upgrading from the "a1" to "a2" emissions. A new 2012 baseline was then developed. Combinations of DFW controls were applied to both the 2009 and 2012 baselines to examine the ozone sensitivity in the DFW 9-county NAA.

All runs used the same modeling domain covering the expanded 36 km domain with 14 km model top. Inputs included meteorology from MM5 Run 6, which was based on the ETA PBL scheme coupled with the Noah land surface model, with the kv100 patch applied to the vertical diffusivity. The boundary conditions assigned moderate conditions in the mixed layer over land, and clean conditions over the Gulf, Atlantic and all areas aloft.

5.1 MODEL PERFORMANCE OF THE 1999 BASELINE USING THREE VERSIONS OF CAMx

The 1999 baseline was evaluated using three versions of CAMx: a modified CAMx 4.03, which had been used in all previous tasks for the TCEQ DFW Work Order 12, CAMx 4.31, which is the current release of the model, and a beta version of the upcoming CAMx 4.40.

One of the major differences between the three versions was the restructuring of the plume-in-grid (PiG) submodel. CAMx 4.31 improved the puff structure and dynamics, and now includes a second-order closure puff spread calculation. CAMx 4.40 beta added more chemistry.

Several NOx recycling reactions were added to the CB4 mechanism (CB4xi) (Tai et al., 2005a) in the modified version of CAMx 4.03. These reactions were incorporated into CAMx chemistry mechanism 4 in CAMx 4.31 and 4.40 beta.

Figure 5–1 overlays time series of hourly ozone at each monitoring site using the three versions of CAMx. Figures 5–9 and 5–10 compare the model performance statistics for 8-hour ozone among the three runs as a bar chart and soccer goal plot, respectively. Figure 5–1 shows spatial plots of the daily maximum 8-hour ozone for each date using CAMx 4.03 (run 44), 4.31 (run 46), and 4.40 beta (run50) in the left, center, and right columns, respectively.

The 1-hour ozone peaks tended to be higher when using CAMx 4.31 and 4.40 compared to 4.03. For 8-hour ozone, model performance between CAMx 4.03 and 4.31 was comparable, and both met EPA guidance on all dates (excluding the two model initialization dates). On August 17, the date with the highest observed 8-hour ozone, the domain peak in CAMx 4.31 was 2 ppb higher than in CAMx 4.03, when ozone was under predicted. The area with daily maximum 8-hour

ozone greater than 100 ppb expanded eastwards, corresponding better with the observations. Both normalized error and bias improved on this date.

The tendency for CAMx 4.31 to predict higher ozone in major NOx source plumes than CAMx 4.03 in the DFW area appears to result mostly from the improvements to the plume-in-grid sub-model. Another consequence of the PiG change, discussed below, was that future ozone levels became more responsive to NOx reductions at major NOx sources with CAMx 4.31.

CAMx 4.40 beta resembled CAMx 4.31 more than version 4.03, particularly on August 17, but 8-hour ozone tended to be slightly higher. The normalized bias was higher than CAMx 4.31 and 4.03 on most dates, improving performance on dates when ozone was under predicted (August 16-17 and 20-21) but worsening performance when ozone was already over predicted. Normalized error was approximately the same or slightly worse compared to 4.31 on all dates.

It was decided that all subsequent runs be based on the CAMx 4.31 (run 46 configuration).

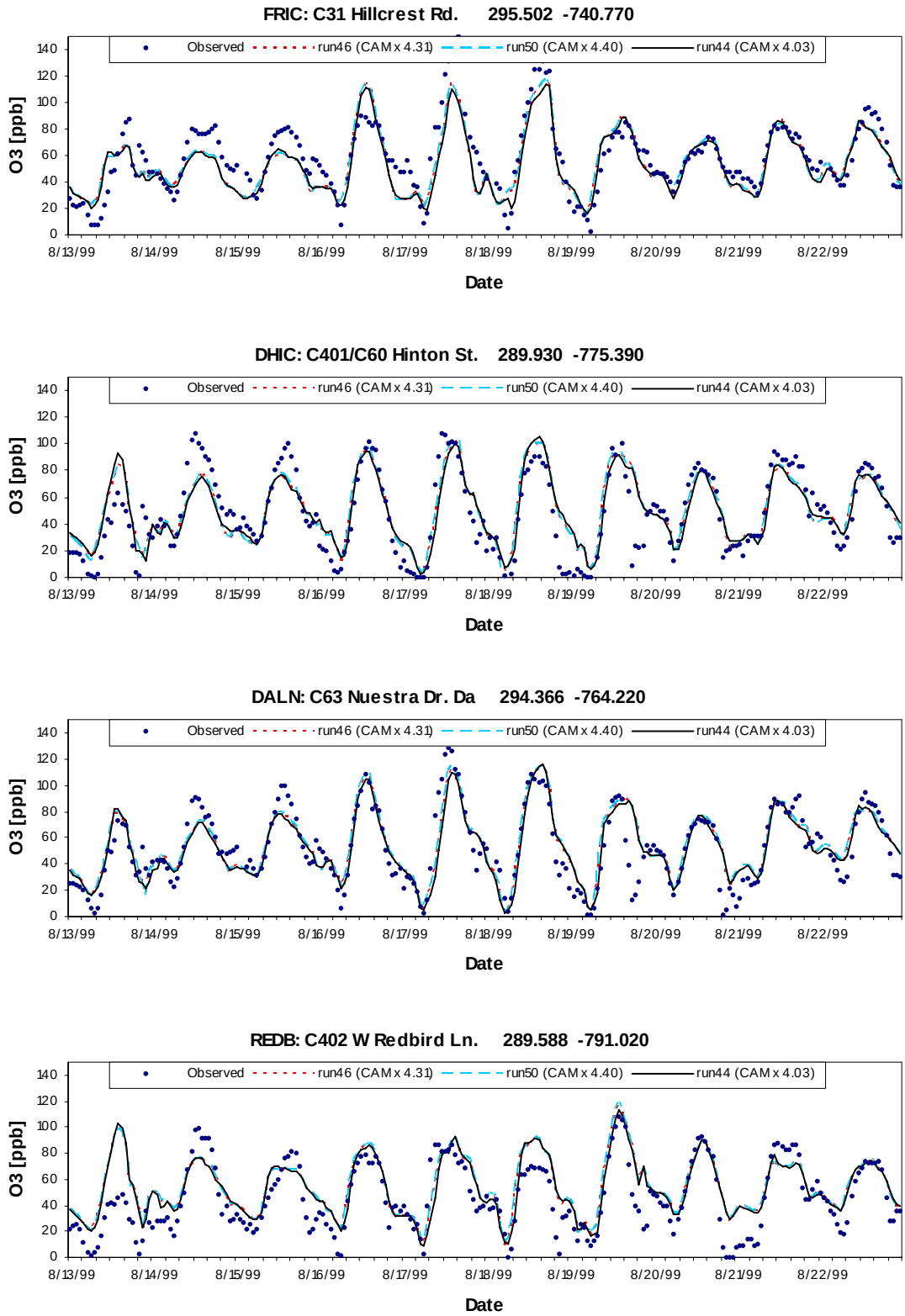


Figure 5–1. Time series of 1-hour ozone in the 1999 baseline comparing three versions of CAMx.

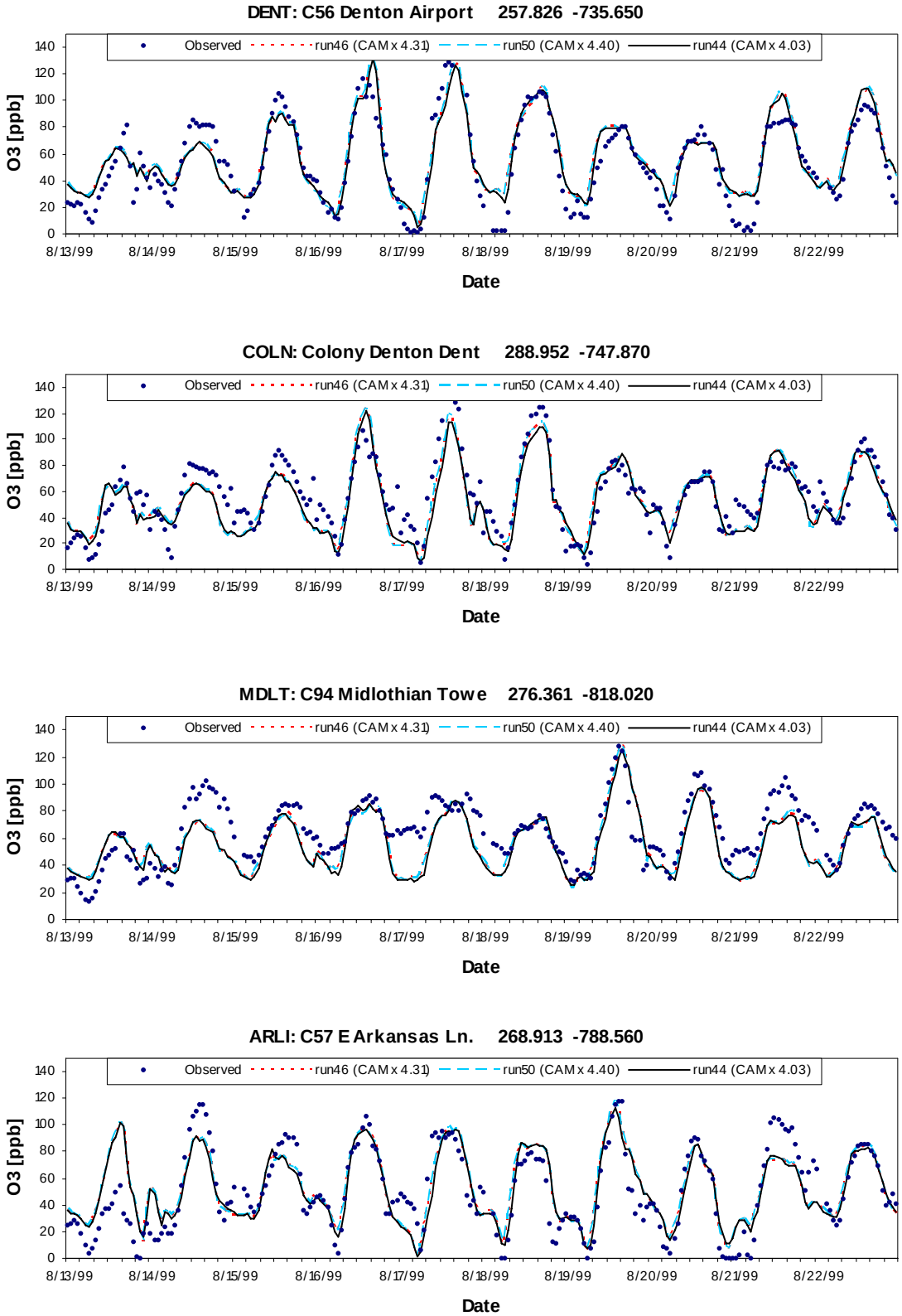
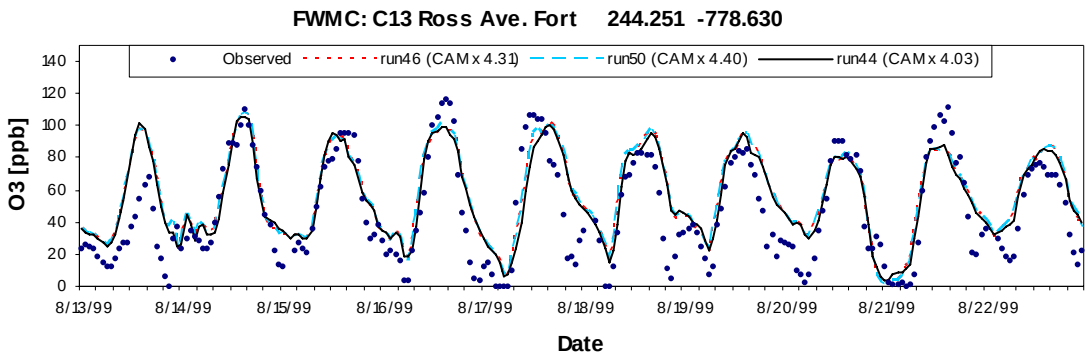


Figure 5–1(continued). Time series of 1-hour ozone in the 1999 baseline comparing three versions of CAMx.



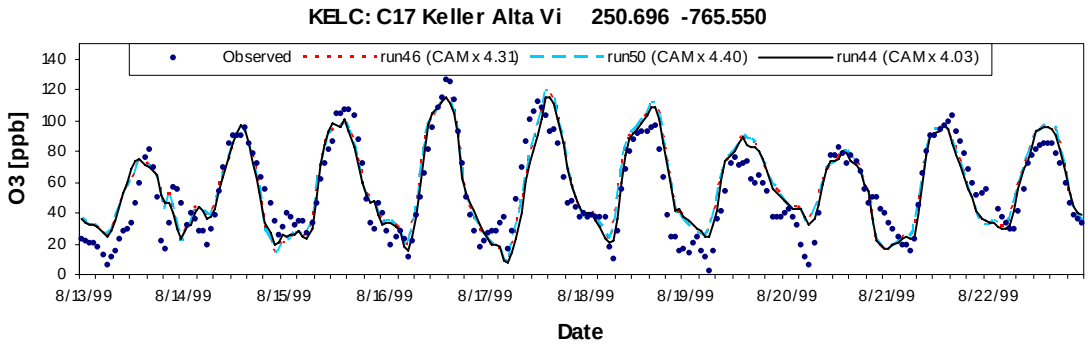


Figure 5–1 (concluded). Time series of 1-hour ozone in the 1999 baseline comparing three versions of CAMx.

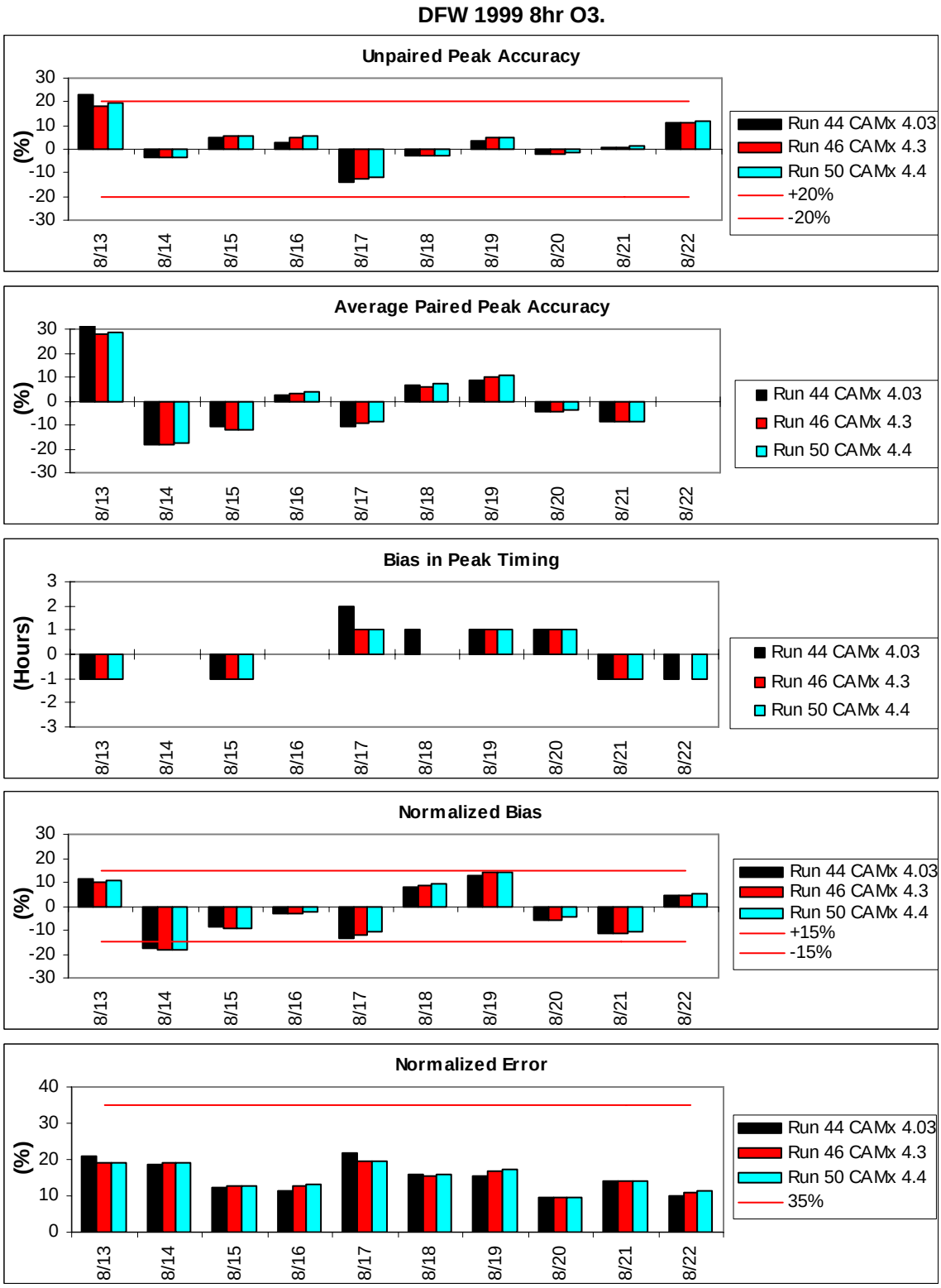


Figure 5–2. Model performance statistics for 8-hour ozone in DFW.

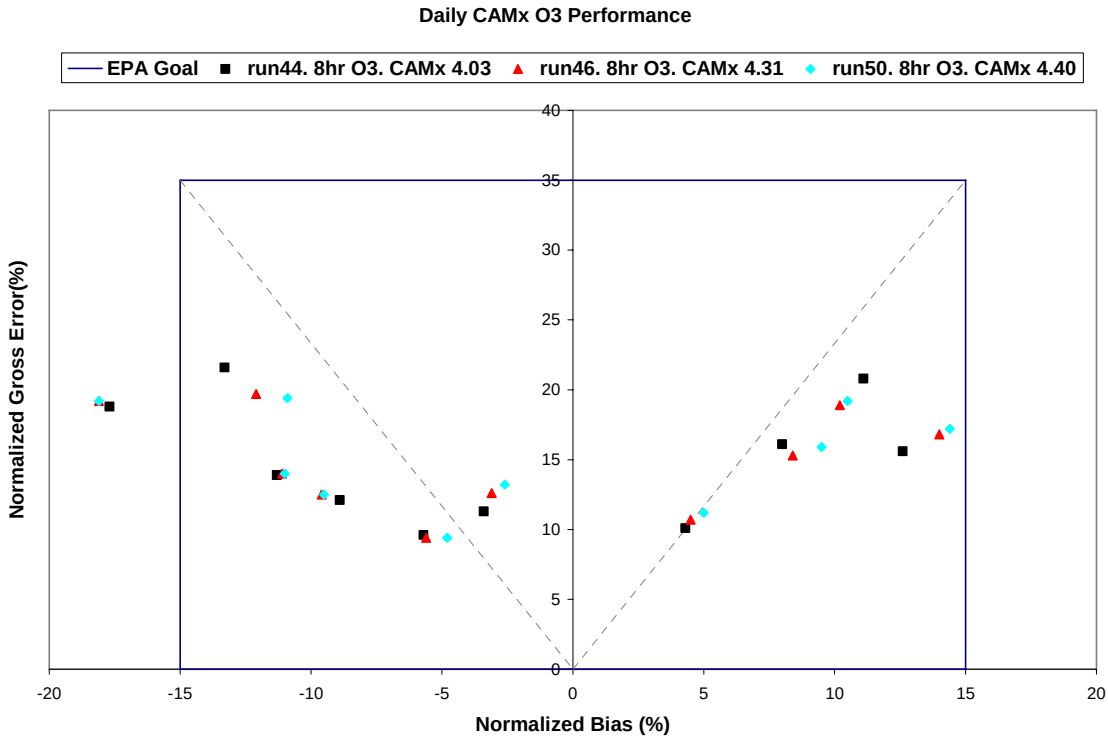


Figure 5–3. Model performance statistics of 8-hour ozone as a soccer goal plot.

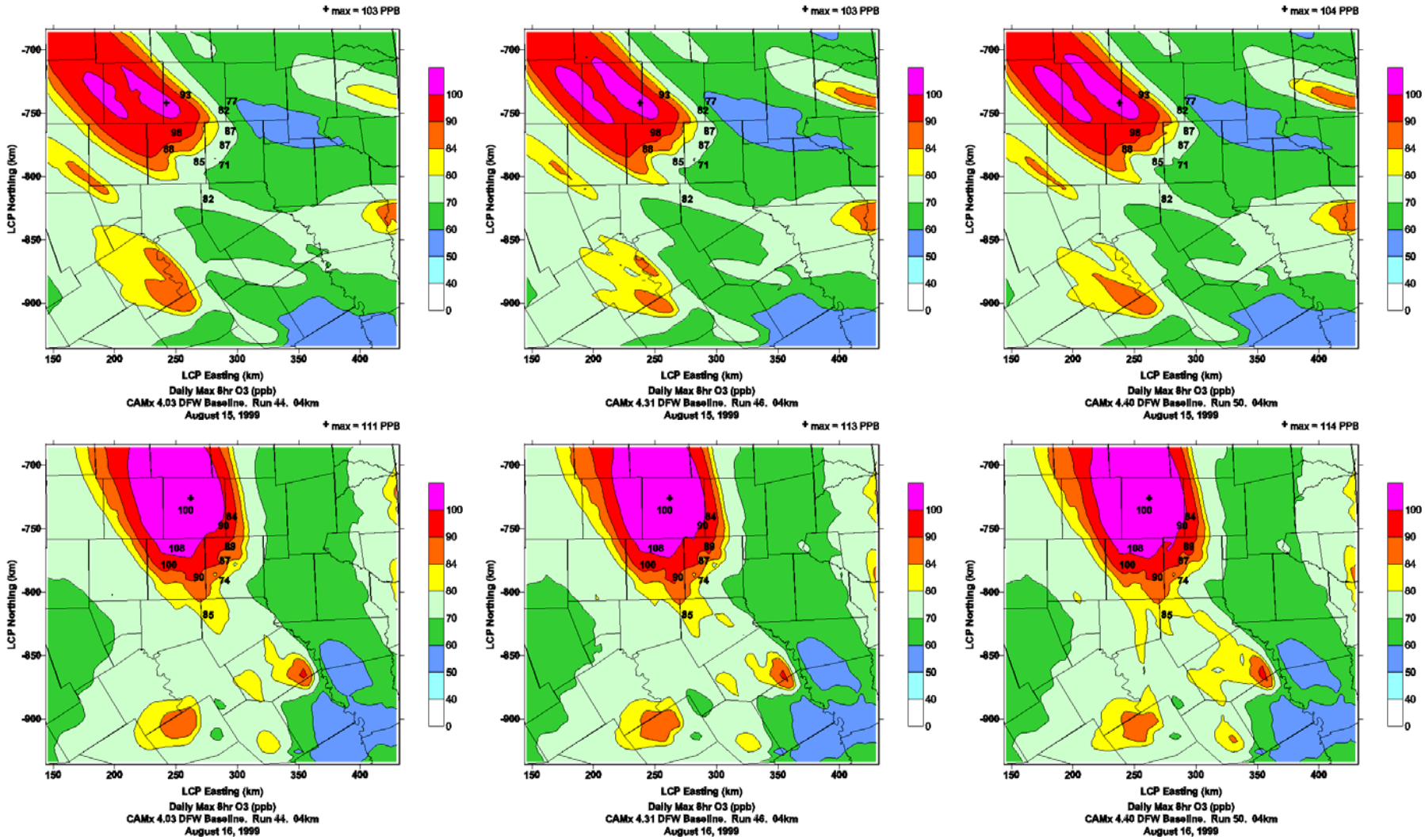


Figure 5–4. Spatial plots of the daily maximum 8-hour ozone in the DFW 4 km domain using CAMx 4.03 (left), CAMx 4.31 (center), and CAMx 4.40 beta (right) for each episode date.

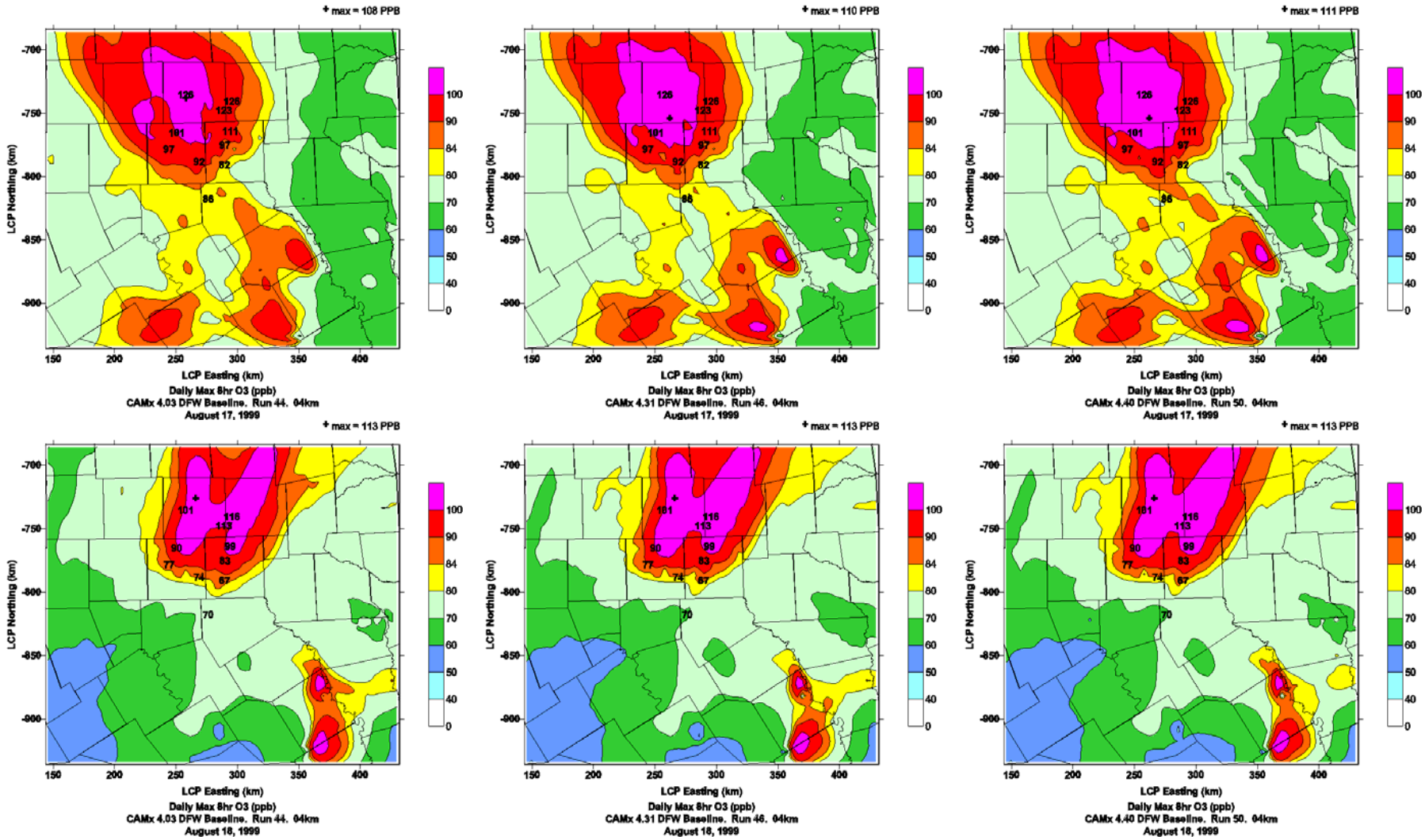


Figure 5–4 (continued). Spatial plots of the daily maximum 8-hour ozone in the DFW 4 km domain using CAMx 4.03 (left), CAMx 4.31 (center), and CAMx 4.40 beta (right) for each episode date.

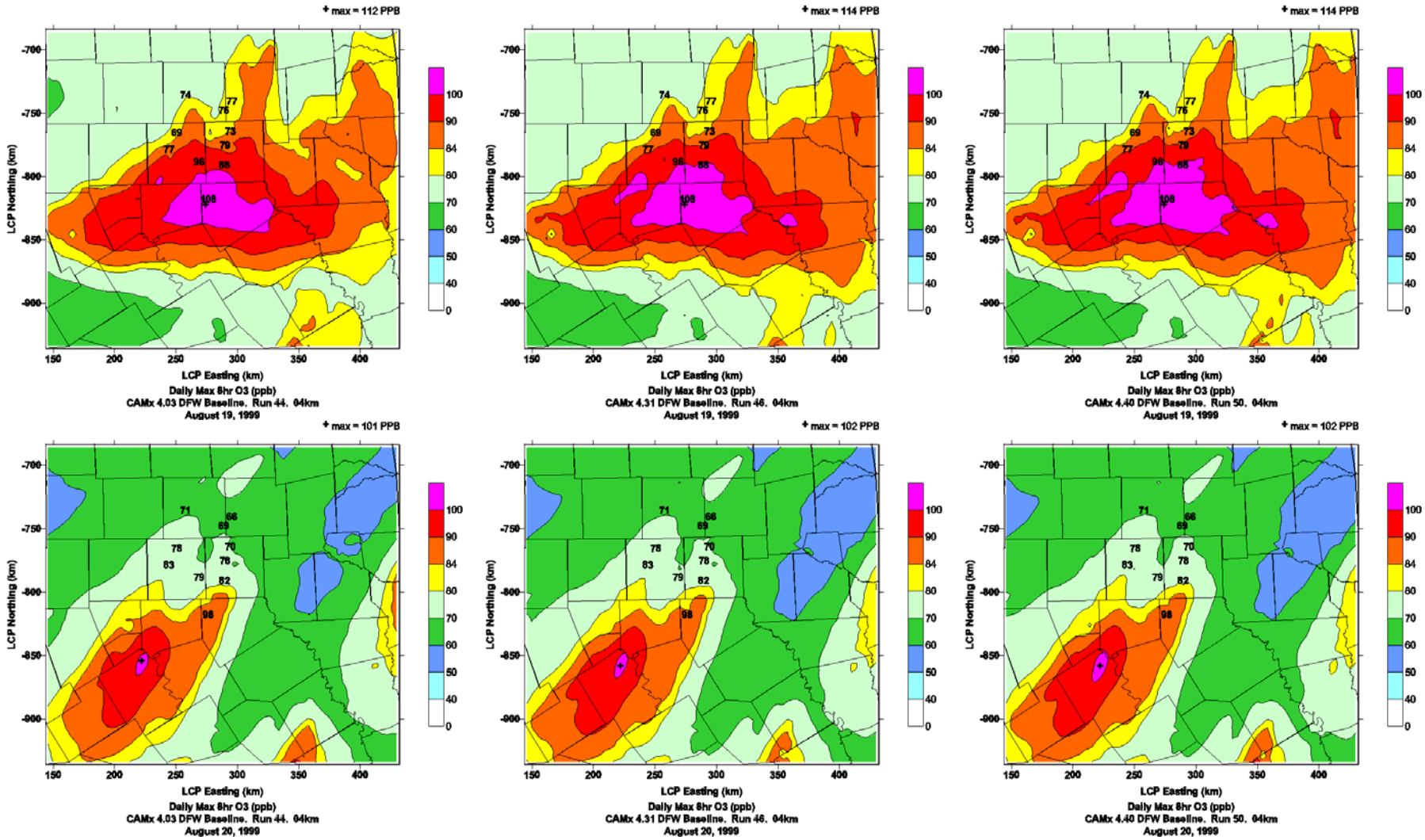


Figure 5–4 (continued). Spatial plots of the daily maximum 8-hour ozone in the DFW 4 km domain using CAMx 4.03 (left), CAMx 4.31 (center), and CAMx 4.40 beta (right) for each episode date.

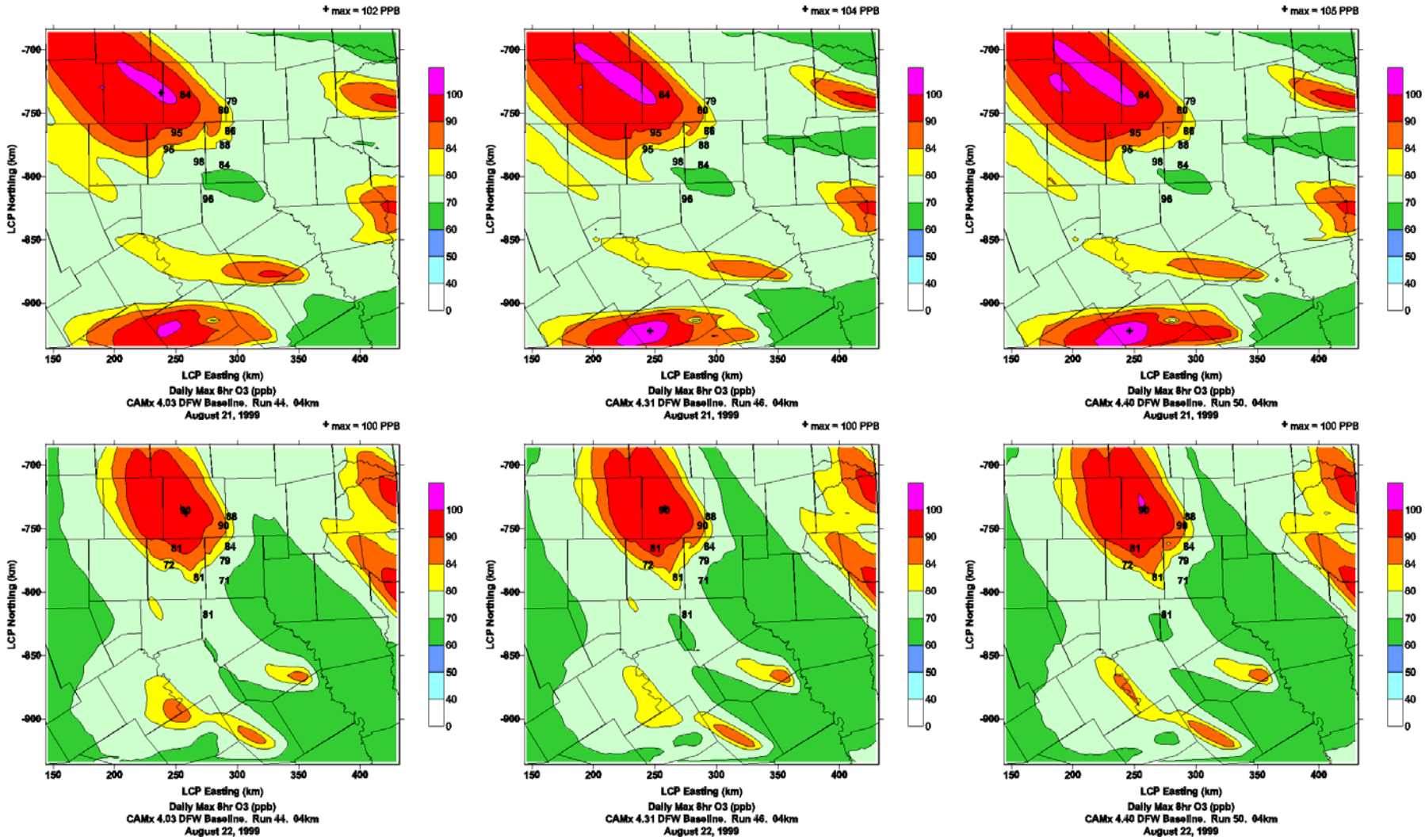


Figure 5–4 (concluded). Spatial plots of the daily maximum 8-hour ozone in the DFW 4 km domain using CAMx 4.03 (left), CAMx 4.31 (center), and CAMx 4.40 beta (right) for each episode date.

5.2 2009 "A2" BASELINE

The 2009 "a2" emissions inventory update included a newer version of the 2005 acid rain data and corrections to EGUs in the Houston area and to cement kilns in Midlothian. Compared to the a1 inventory, NOx emissions were 84 tpd lower, mostly from elevated point sources in Houston. Changes within the DFW 9-county NAA were less than 2 tpd. VOC emissions increased 7 tpd from low-level point sources inside the DFW 9-county NAA, but decreased 3 tpd outside of DFW.

Summaries of the 2009 a2 weekday NOx and VOC emissions (with August 17 biogenics) are shown in Tables 5–1 and 5–2, respectively, by the source regions defined in Figure 2-1 and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenic). The rightmost column in each table shows the changes from the 2009 a1 inventory.

Using CAMx version 4.03, the 2009 future design values were computed using both a1 and a2 emissions. Table 5–3 compares the future design values at each DFW monitoring site. The point source updates in version a2 made no significant difference to the future design values as all DFW sites differed no more than 0.1 ppb.

The 2009 baseline with a2 emissions was also run using CAMx 4.31 and 4.40 beta; their future design value calculations are shown in Tables 5–4 and 5–5, respectively. Table 5–6 compares the 2009 "a2" baseline future design values from the three versions of CAMx. The future design values with CAMx 4.31 were lower than CAMx 4.03 at most DFW sites, ranging from a 1.6 ppb decrease at North Dallas to a 0.1 ppb increase at Midlothian. Frisco dropped 1.4 ppb to 89.8 ppb while Denton was 0.3 ppb lower at 89.3 ppb. Midlothian and Dallas C402 were the only two sites with future design values below 85 ppb. The changes in 2009 future design values between CAMx 4.03 and 4.31 were partly due to improvements in the PiG sub-model. The updated PiG tended to produce higher ozone in plumes from major NOx sources. This combined with reductions in EGU NOx between 1999 and 2009 produced lower 2009 design values with CAMx 4.31.

The daily maximum 8-hour ozone at almost every site and date in both 1999 and 2009 was higher in CAMx 4.40 than in CAMx 4.31, concurring with the higher normalized bias found in the 1999 baseline analysis. The future design values were lower than CAMx 4.31 at the three Dallas sites when using CAMx 4.40 beta, but higher at all other sites. Differences in future design values between CAMx 4.40 and 4.31 were no greater than 0.3 ppb.

Tables 5–7 and 5–8 examine grid cells in the DFW 9-county NAA in 4-km resolution where the daily maximum 8-hour ozone exceeds 85 ppb. Table 5–7 counts the number of exceedance cells on each date in four runs of the 2009 baseline. When the a1 emissions were used with CAMx 4.03, there were 1199 exceedance cells in the episode. The upgrade to a2 emissions reduced the exceedance area less than 1 % to 1190 cells. The use of a2 emissions with CAMx 4.31 and CAMx 4.40 changed the exceedance area by -3 % and +2 %, respectively, with respect to the a2 baseline with CAMx 4.03.

Table 5–8 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 –

85 ppb) to the sum of ozone exceedances. The update from a1 to a2 emissions lowered the number of exceedance ppb's less than 1 % when CAMx 4.03 was used. Compared to CAMx 4.03 with a2 emissions, CAMx 4.31 increased the number of exceedance ppb's by 8 %; CAMx 4.40 beta, by 16 % due to its higher normalized bias.

Table 5–1. 2009 weekday NOx emissions [tpd], a2 baseline.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a1 baseline
Collin Co	10	15	1	0	2	8	0	26	0.0
Dallas Co	4	77	6	2	18	45	0	149	0.2
Denton Co	8	17	1	0	12	9	0	40	0.1
Tarrant Co	3	46	2	2	10	28	0	89	0.1
Parker Co	1	6	0	0	1	2	0	10	-0.1
Johnson Co	5	5	5	0	0	5	0	16	-0.5
Ellis Co	15	9	33	1	0	6	0	49	-1.5
Kaufman Co	5	6	4	0	0	2	0	13	0.0
Rockwall Co	2	3	0	0	0	1	0	5	0.0
DFW 9-County	**52**	**184**	**53**	**6**	**44**	**107**	**0**	**395**	**-1.7**
DFW 16 County	**83**	**212**	**76**	**10**	**67**	**123**	**0**	**489**	**-3.3**
NE Texas	16	79	186	16	71	42	1	394	-3.1
Central TX	113	88	138	2	56	69	0	353	0.0
Houston	21	175	226	11	53	63	0	528	-56.9
South TX	229	189	261	22	75	100	0	648	-5.4
West TX	524	160	140	21	212	105	1	639	-13.7
Texas	**986**	**904**	**1027**	**82**	**534**	**501**	**2**	**3050**	**-82.3**
Gulf + Mexico	79	5	436	0	4	2	444	891	-0.9
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	1	2	1	1183	1904	-1.0
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**913**	**10307**	**83**	**543**	**509**	**23869**	**36223**	**-84.2**
Total change from a1 baseline	0.0	0.0	-82.4	-1.8	0.0	0.0	0.0	-84.2	

Table 5–2. 2009 weekday VOC emissions [tpd], a2 baseline.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a1 baseline
Collin Co	27	7	0	1	12	3	0	23	0.6
Dallas Co	50	43	4	8	72	17	0	144	2.9
Denton Co	65	8	1	1	15	4	0	29	0.6
Tarrant Co	64	25	2	7	54	9	0	96	2.4
Parker Co	121	2	0	0	5	1	0	8	0.0
Johnson Co	111	2	0	0	6	1	0	9	0.0
Ellis Co	89	2	3	2	6	2	0	15	-0.1
Kaufman Co	112	2	0	0	7	1	0	11	0.1
Rockwall Co	3	1	0	0	2	1	0	4	0.0
DFW 9-County	**642**	**92**	**10**	**20**	**180**	**38**	**0**	**340**	**6.5**
DFW 16 County	**1538**	**103**	**34**	**22**	**216**	**44**	**1**	**419**	**6.3**
NE Texas	4917	27	14	41	82	14	1	179	-1.4
Central TX	6098	33	20	20	85	21	1	180	0.2
Houston	1683	80	91	215	247	41	0	674	-0.4
South TX	2069	78	20	48	217	46	0	408	0.0
West TX	6198	59	10	28	215	52	3	367	-0.5
Texas	**22503**	**380**	**188**	**374**	**1060**	**218**	**6**	**2227**	**4.4**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	655	695	0.0
Tennessee	8678	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12198	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**384**	**1104**	**377**	**1080**	**224**	**23453**	**26622**	**4.4**
Total change from a1 baseline	0.0	0.0	-2.9	7.3	0.0	0.0	0.0	4.4	

Table 5–3. Summary of 2009 future design values [ppb] and differences when using a2 vs. a1 baseline emissions.

Site	Run44.fy2009.a1 CAMx 4.03 baseline, a1 emissions	Run44.fy2009.a2 CAMx 4.03 baseline, a2 emissions	Difference CAMx 4.03 baseline, a2 –a1 emissions
Frisco	91.2	91.2	-0.05
Dallas C60	87.6	87.6	0.02
North Dallas C63	87.0	87.0	-0.05
Dallas C402	79.7	79.6	-0.06
Denton	89.6	89.6	0.00
Midlothian	84.5	84.6	0.11
Arlington	87.2	87.1	-0.11
Fort Worth C13	87.6	87.5	-0.11
Fort Worth C17	86.0	85.9	-0.06

Table 5–4. Future design value calculation for 2009 using CAMx 4.31 and a2 emissions.

Base Case: run46												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2009.a2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	67.7	100.9	101.9	100.5	73.2	63.9	74.8	74.4	84.8	0.895	100.3	89.8
Dallas C60	73.1	93.0	103.5	97.8	91.4	80.7	78.0	74.0	86.4	0.937	92.0	86.2
North Dallas C63	71.0	95.6	101.9	99.7	84.4	77.4	76.2	74.1	85.0	0.918	93.0	85.4
Dallas C402	66.7	82.4	89.5	85.1	97.0	85.2	70.3	71.3	80.9	0.905	87.3	79.0
Denton	88.5	103.4	108.0	92.0	71.6	64.6	89.8	83.5	87.7	0.880	101.5	89.3
Midlothian	72.6	77.3	78.8	70.3	99.0	85.7	69.9	70.7	78.0	0.916	92.5	84.7
Arlington	75.0	89.2	90.6	81.8	95.5	85.2	73.1	79.6	83.8	0.907	95.0	86.2
Fort Worth C13	80.9	94.7	94.3	87.9	83.6	75.7	79.2	81.1	84.7	0.883	98.3	86.8
Fort Worth C17	89.3	99.1	104.4	90.3	79.2	70.6	88.1	82.2	87.9	0.887	96.3	85.4
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.833	0.942	0.993	0.921	0.851	0.915	0.859	0.831				
Dallas C60	0.880	0.932	1.001	0.942	0.921	1.035	0.912	0.867				
North Dallas C63	0.860	0.944	0.993	0.935	0.875	1.014	0.878	0.838				
Dallas C402	0.866	0.883	0.908	0.881	0.903	1.018	0.886	0.897				
Denton	0.863	0.914	0.982	0.817	0.845	0.883	0.883	0.838				
Midlothian	0.927	0.898	0.917	0.922	0.869	0.966	0.923	0.922				
Arlington	0.870	0.907	0.904	0.859	0.894	1.025	0.892	0.918				
Fort Worth C13	0.863	0.897	0.904	0.830	0.871	0.945	0.882	0.881				
Fort Worth C17	0.883	0.893	0.946	0.834	0.857	0.898	0.919	0.866				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–5. Future design value calculation for 2009 using CAMx 4.40 beta and a2 emissions.

Base Case: run50												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	82.0	107.6	104.6	109.3	86.5	70.2	87.2	90.1	92.2	8		
Dallas C60	83.8	101.0	104.7	105.2	100.0	79.0	86.2	86.3	93.3	8		
North Dallas C63	83.4	102.4	104.7	107.6	97.6	77.3	87.2	89.3	93.7	8		
Dallas C402	77.0	94.2	99.6	97.2	108.2	84.3	79.9	80.9	90.2	8		
Denton	103.0	113.9	110.6	112.8	85.1	73.6	102.2	100.3	100.2	8		
Midlothian	77.1	85.5	87.7	77.1	114.0	89.5	76.4	75.9	85.4	8		
Arlington	86.6	98.2	101.0	95.1	107.4	83.6	83.0	87.7	92.8	8		
Fort Worth C13	93.4	105.8	104.7	106.1	96.7	80.9	91.5	92.1	96.4	8		
Fort Worth C17	101.2	111.3	111.0	108.3	92.5	79.5	96.5	95.8	99.5	8		
Future Year: run50.fy2009.a2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	68.5	101.6	103.4	101.0	73.6	64.3	75.2	74.7	82.8	0.898	100.3	90.1
Dallas C60	73.7	94.2	104.7	98.8	91.9	81.5	78.4	74.5	87.2	0.935	92.0	86.0
North Dallas C63	71.6	96.7	103.4	100.2	85.1	78.2	76.8	74.5	85.8	0.916	93.0	85.2
Dallas C402	66.6	83.4	90.5	86.3	97.5	85.8	70.7	71.9	81.6	0.905	87.3	79.0
Denton	89.3	104.5	109.0	92.0	71.8	64.8	90.6	84.3	88.3	0.881	101.5	89.4
Midlothian	74.0	77.4	80.0	70.3	99.3	86.1	70.9	69.9	78.5	0.919	92.5	85.0
Arlington	76.3	89.7	91.6	81.9	95.8	85.8	73.7	80.2	84.4	0.909	95.0	86.4
Fort Worth C13	82.0	95.2	94.6	88.0	84.1	76.0	79.7	81.9	85.2	0.884	98.3	86.9
Fort Worth C17	90.0	99.8	104.7	90.4	79.4	70.8	88.8	83.0	88.4	0.888	96.3	85.5
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.836	0.944	0.989	0.924	0.851	0.915	0.863	0.829				
Dallas C60	0.880	0.932	1.000	0.940	0.919	1.032	0.909	0.863				
North Dallas C63	0.859	0.944	0.988	0.931	0.872	1.011	0.881	0.835				
Dallas C402	0.865	0.885	0.909	0.888	0.901	1.018	0.885	0.889				
Denton	0.867	0.918	0.986	0.816	0.844	0.880	0.886	0.841				
Midlothian	0.959	0.906	0.912	0.912	0.871	0.961	0.927	0.921				
Arlington	0.881	0.913	0.907	0.860	0.892	1.026	0.889	0.915				
Fort Worth C13	0.878	0.900	0.904	0.829	0.870	0.939	0.872	0.889				
Fort Worth C17	0.889	0.897	0.943	0.835	0.858	0.890	0.921	0.866				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–6. Summary of 2009 baseline future design values [ppb] with a2 emissions using three versions of CAMx.

Site	Run44.fy2009.a2 CAMx 4.03, a2 emissions	Run46.fy2009.a2 CAMx 4.31, a2 emissions	Run50.fy2009.a2 CAMx 4.40 beta a2 emissions
Frisco	91.2	89.8	90.1
Dallas C60	87.6	86.2	86.0
North Dallas C63	87.0	85.4	85.2
Dallas C402	79.6	79.0	79.0
Denton	89.6	89.3	89.4
Midlothian	84.6	84.7	85.0
Arlington	87.1	86.2	86.4
Fort Worth C13	87.5	86.8	86.9
Fort Worth C17	85.9	85.4	85.5
Differences		**DV change from CAMx 4.03 [ppb]**	**DV change from CAMx 4.03 [ppb]**
Frisco		-1.4	-1.1
Dallas C60		-1.4	-1.6
North Dallas C63		-1.6	-1.8
Dallas C402		-0.6	-0.6
Denton		-0.3	-0.2
Midlothian		0.1	0.4
Arlington		-1.0	-0.8
Fort Worth C13		-0.7	-0.6
Fort Worth C17		-0.5	-0.4

Table 5–7. Exceedance Area in the 2009 baseline (Number of Grid Squares > 85 ppb in DFW NAA).

Run Scenario	Run44.fy2009.a1 2009,a1 baseline, CAMx 4.03	Run44.fy2009.a2 2009.a2 baseline CAMx 4.03	Run46.fy2009.a2 2009.a2 baseline, CAMx 4.31	Run 50.fy2009.a2 2009.a2 baseline, CAMx 4.40 beta
990815	19	19	18	18
990816	223	223	220	230
990817	296	296	291	305
990818	253	249	248	253
990819	304	299	323	333
990820	70	71	30	44
990821	29	29	28	28
990822	5	4	0	0
Totals	1199	1190	1158	1211

Table 5–8. Number of ppb's in DFW NAA in the daily maximum 8-hour ozone in excess of 85 ppb[1] in the 2009 baseline.

Run	Run44.fy2009.a1	Run44.fy2009.a2	Run46.fy2009.a2	Run 50.fy2009.a2
Scenario	2009,a1 baseline, CAMx 4.03	2009.a2 baseline CAMx 4.03	2009.a2 baseline, CAMx 4.31	2009.a2 baseline, CAMx4.40 beta
990815	50	50	47	60
990816	2184	2172	2269	2431
990817	2594	2593	2880	3138
990818	1660	1640	1634	1700
990819	1201	1175	1478	1563
990820	84	88	23	39
990821	74	75	69	86
990822	1	0	0	0
Totals	7846	7792	8400	9017

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

5.3 DFW 2012 "A2" BASELINE

The DFW 2012 baseline emissions were based on the 2009 a2 inventory, with 2012 emissions for Texas on-road and off-road mobile sources (both with TERP controls) and for Texas point sources. Tables 5–9 and 5–10 summarize the weekday NOx and VOC emissions, respectively, by source region and emission group. The rightmost column and bottom row in each table show the changes from the 2009 a2 emissions.

NOx emissions were 275 tpd lower than the 2009 a2 emissions, mainly from reductions in on-road mobile sources. The 40 tpd reduction from Texas off-road mobile sources was offset by a 44 tpd NOx increase from elevated point sources. Almost two-thirds of the NOx reduction within the DFW 9-county NAA was in Dallas and Tarrant Counties. VOCs were 86 tpd lower from 2009, mostly from on-road mobile sources.

A 2012 baseline with a2 emissions (run46.fy2012.a2) was run with CAMx 4.31. Figure 5–5 shows spatial plots of the daily maximum 8-hour ozone in the 2012 baseline for each episode date in the left column, and differences from the corresponding 2009 baseline. Ozone was lower in 2012 compared to 2009 in most parts of the DFW 9-county NAA on all dates. The largest differences were in Denton County on all dates except August 19 and 20, when winds were northerly. The daily maximum 8-hour ozone was 4 ppb lower on August 16, 17, and 18 near the domain peaks.

The design value calculations for the 2012 baseline are shown in Table 5–11 using CAMx 4.31. Table 5–12 compares the 2012 baseline with 2009. In the 2012 baseline, the future design values at all DFW sites were below 85 ppb except at Frisco (86.7 ppb) and Denton (86.3 ppb). All future design values in 2012 were lower than 2009. Frisco and Denton showed the greatest changes, dropping 3.1 and 3.0 ppb, respectively; Midlothian had the lowest reduction at 1.5 ppb. These changes from 2009 to 2012 were consistent with similar analyses using CAMx 4.03 and 4.40 (not shown).

Table 5–13 lists the number of unique grid cells in the DFW 9-county NAA in 4 km resolution when 8-hour ozone exceeds 85 ppb in the 2012 a2 baseline for each date. The exceedance area dropped 30 % compared to the 2009 baseline as the number of exceedance cells was reduced from 1158 to 814.

Table 5–14 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The number of exceedance ppb's dropped to 4919 in future year 2012, down 41 % from the 2009 baseline.

Table 5–9. 2012 weekday NOx emissions [tpd], "a2" baseline.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a2 baseline
Collin Co	10	9	1	0	2	7	0	19	-6.2
Dallas Co	4	52	6	2	18	42	0	120	-29.0
Denton Co	8	11	1	0	12	8	0	33	-7.0
Tarrant Co	3	31	2	2	10	26	0	71	-17.3
Parker Co	1	3	0	0	1	2	0	7	-2.4
Johnson Co	5	3	5	0	0	5	0	14	-1.6
Ellis Co	15	5	33	1	0	5	0	45	-3.9
Kaufman Co	5	4	4	0	0	2	0	10	-2.5
Rockwall Co	2	2	0	0	0	1	0	3	-1.5
DFW 9-County	**52**	**122**	**53**	**6**	**44**	**97**	**0**	**323**	**-71.7**
DFW 16 County	**83**	**141**	**76**	**10**	**67**	**113**	**0**	**407**	**-81.6**
NE Texas	16	52	202	16	71	38	1	380	-13.8
Central TX	113	60	149	2	56	66	0	333	-19.5
Houston	21	126	226	11	53	54	0	470	-58.1
South TX	229	132	273	22	75	93	0	595	-53.3
West TX	524	117	145	21	212	98	1	594	-45.1
Texas	**986**	**628**	**1071**	**82**	**534**	**462**	**2**	**2779**	**-271.5**
Gulf + Mexico	79	4	436	0	4	2	444	890	-1.3
Oklahoma	227	1	255	0	2	3	661	923	-0.6
Louisiana	106	1	715	1	2	1	1183	1903	-0.4
Arkansas	125	1	220	0	0	2	468	692	-0.7
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	906	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2332	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**634**	**10351**	**83**	**543**	**469**	**23869**	**35949**	**-274.5**
Total change from 2009 a2 baseline	0.0	-278.7	43.9	0.1	0.0	-39.8	0.0	-274.5	

Table 5–10. 2012 weekday VOC emissions [tpd], "a2" baseline.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a2 baseline
Collin Co	27	6	0	1	12	3	0	22	-1.7
Dallas Co	50	34	4	8	72	16	0	134	-9.7
Denton co	65	6	1	1	15	3	0	27	-2.1
Tarrant Co	64	20	2	7	54	8	0	91	-5.7
Parker Co	121	1	0	0	5	1	0	8	-0.4
Johnson Co	111	2	0	0	6	1	0	9	-0.4
Ellis Co	89	2	3	2	6	1	0	15	-0.6
Kaufman Co	112	2	0	0	7	1	0	10	-0.5
Rockwall Co	3	1	0	0	2	1	0	4	-0.3
DFW 9-County	**642**	**73**	**10**	**20**	**180**	**35**	**0**	**318**	**-21.5**
DFW 16 County	**1538**	**82**	**34**	**22**	**216**	**41**	**1**	**395**	**-24.1**
NE Texas	4917	22	14	43	82	13	1	174	-4.8
Central TX	6098	27	20	21	85	19	1	173	-6.6
Houston	1683	65	91	215	247	38	0	656	-18.6
South TX	2069	64	20	50	217	41	0	392	-15.6
West TX	6198	49	11	30	215	46	3	352	-15.1
Texas	**22503**	**309**	**190**	**379**	**1060**	**197**	**6**	**2143**	**-84.7**
Gulf + Mexico	658	2	32	0	10	4	329	377	-0.9
Oklahoma	7940	0	3	0	5	1	481	490	-0.2
Louisiana	9941	0	47	3	4	1	546	601	-0.2
Arkansas	13925	0	23	0	2	0	441	466	-0.1
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	655	695	0.0
Tennessee	8678	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12198	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**313**	**1105**	**383**	**1080**	**203**	**23453**	**26536**	**-86.1**
Total change from baseline	0.0	-71.3	1.7	5.4	0.0	-21.8	-0.1	-86.1	

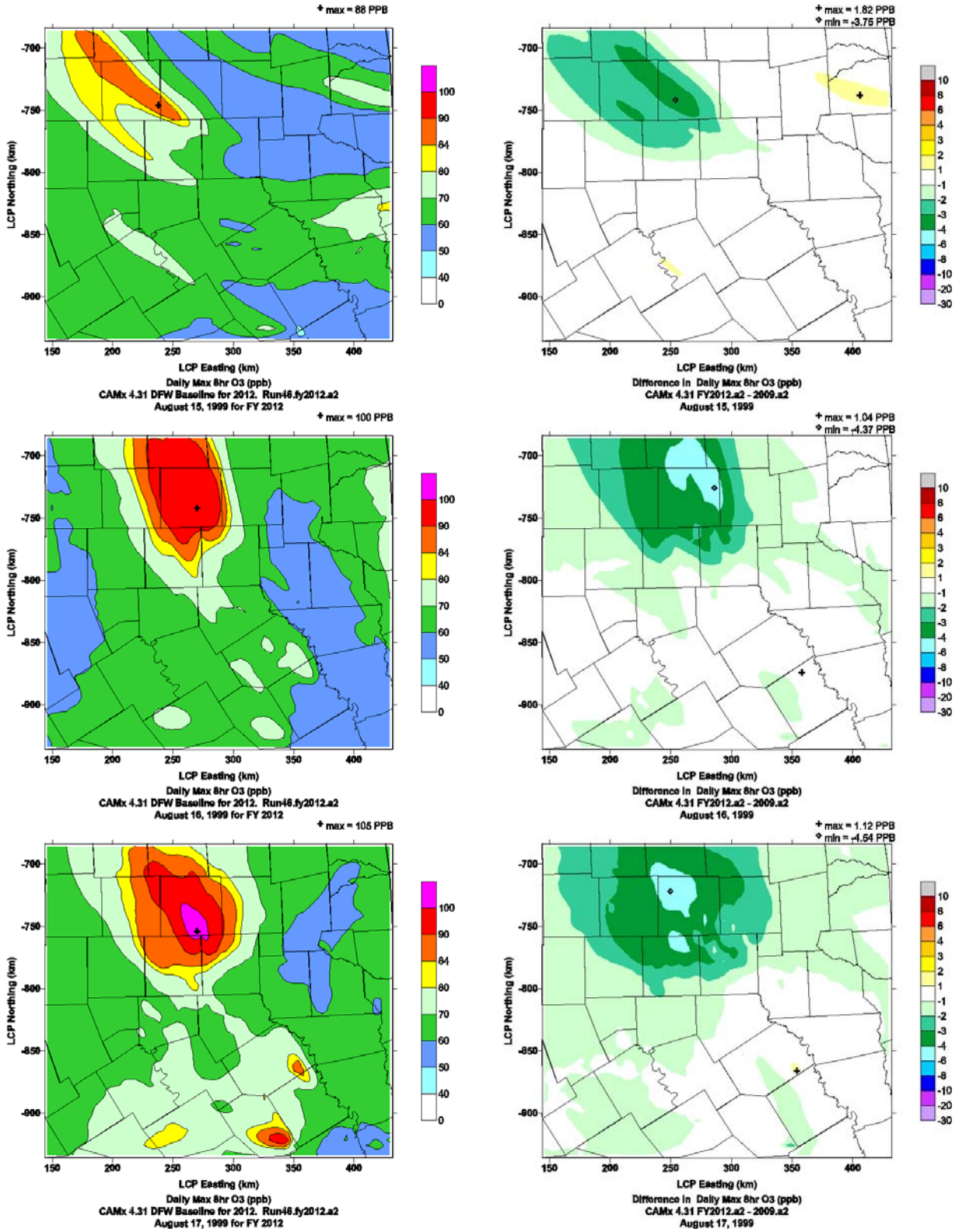


Figure 5–5. Daily maximum 8-hour ozone for the 2012 baseline using CAMx 4.31 and a2 emissions, and differences from the 2009 baseline.

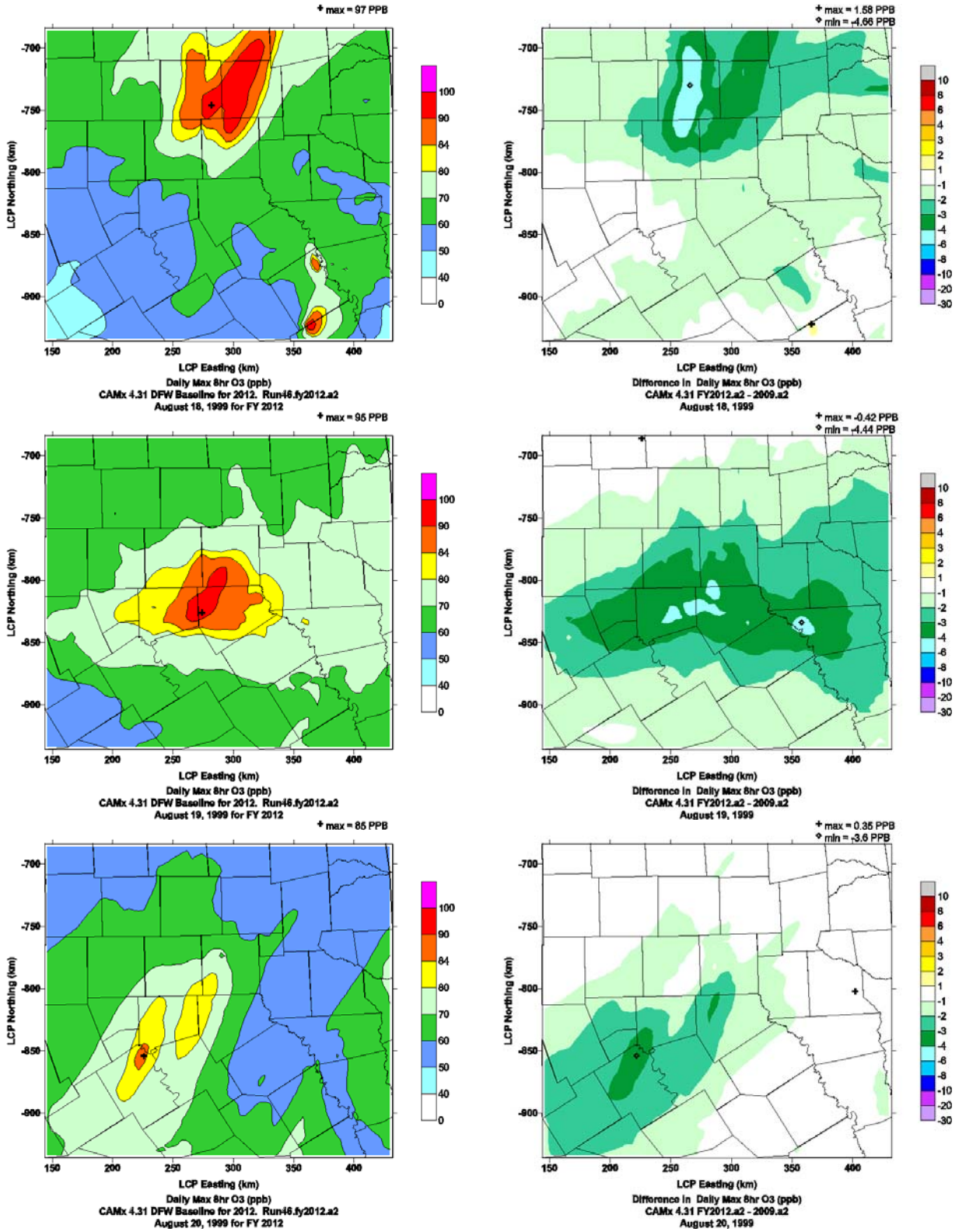


Figure 5–5- (continued). Daily maximum 8-hour ozone for the 2012 baseline using CAMx 4.31 and a2 emissions, and differences from the 2009 baseline.

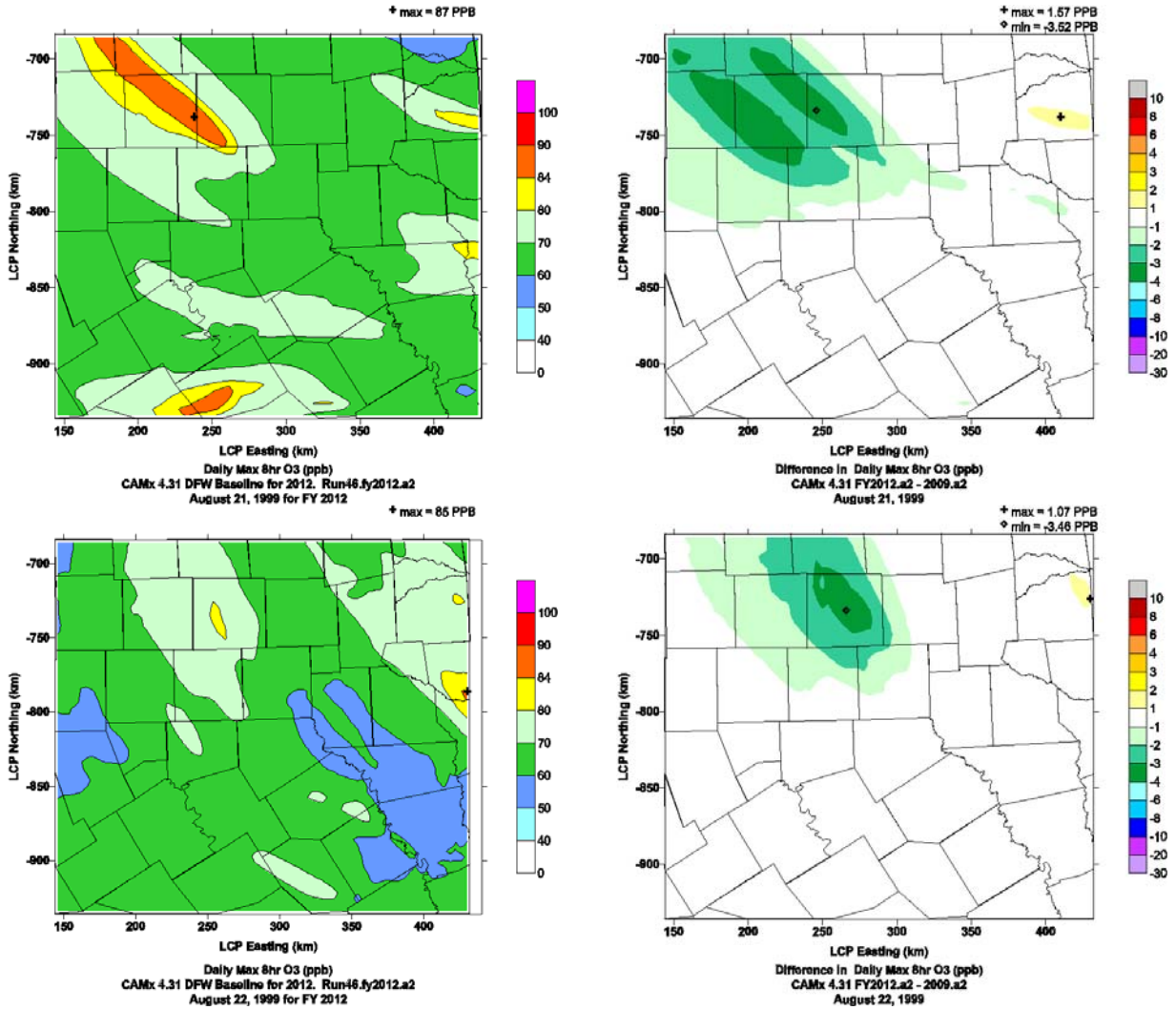


Figure 5–5 (concluded). Daily maximum 8-hour ozone for the 2012 baseline using CAMx 4.31 and a2 emissions, and differences from the 2009 baseline.

Table 5–11. Design value scaling calculations for the 2012 baseline with a2 emissions using CAMx 4.31.

Base Case: run46 (CAMx 4.31)												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2012.a2												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	65.3	96.9	98.3	97.0	71.0	62.7	72.6	71.5	81.8	0.864	100.3	86.7
Dallas C60	70.8	89.4	100.3	94.3	88.1	79.4	75.6	71.6	83.7	0.907	92.0	83.4
North Dallas C63	69.1	92.3	98.3	95.7	81.1	76.0	74.0	71.5	82.3	0.888	93.0	82.6
Dallas C402	64.9	79.5	86.2	82.3	92.9	82.9	68.5	70.9	78.5	0.878	87.3	76.7
Denton	85.5	99.9	104.3	87.3	69.5	63.3	87.2	80.8	84.7	0.850	101.5	86.3
Midlothian	72.4	76.9	77.5	69.1	94.9	83.3	69.2	70.4	76.7	0.900	92.5	83.3
Arlington	74.6	87.3	87.2	78.0	91.4	82.9	70.9	78.6	81.4	0.881	95.0	83.7
Fort Worth C13	80.0	91.8	90.1	83.6	80.2	74.6	76.1	79.5	82.0	0.855	98.3	84.1
Fort Worth C17	86.8	95.5	100.6	85.8	76.1	69.6	85.9	79.7	85.0	0.858	96.3	82.6
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.803	0.905	0.958	0.889	0.826	0.897	0.834	0.799				
Dallas C60	0.852	0.896	0.970	0.909	0.888	1.018	0.884	0.839				
North Dallas C63	0.837	0.911	0.958	0.897	0.841	0.994	0.853	0.809				
Dallas C402	0.843	0.852	0.875	0.852	0.865	0.990	0.863	0.892				
Denton	0.833	0.883	0.948	0.776	0.821	0.865	0.857	0.811				
Midlothian	0.924	0.893	0.903	0.906	0.833	0.938	0.914	0.918				
Arlington	0.865	0.887	0.870	0.819	0.855	0.998	0.866	0.906				
Fort Worth C13	0.853	0.870	0.864	0.789	0.836	0.931	0.848	0.865				
Fort Worth C17	0.859	0.860	0.912	0.792	0.824	0.885	0.896	0.840				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–12. Summary of the 2012 baseline future design values and differences from the 2009 baseline.

	Run46.fy2012.a2	Differences from 2009. Also with CAMx 4.31 and a2 emissions [ppb]
	2012 with CAMx 4.31, a2 emissions [ppb]	
Frisco	86.7	-3.1
Dallas C60	83.4	-2.8
North Dallas C63	82.6	-2.8
Dallas C402	76.7	-2.4
Denton	86.3	-3.0
Midlothian	83.3	-1.5
Arlington	83.7	-2.5
Fort Worth C13	84.1	-2.8
Fort Worth C17	82.6	-2.8

Table 5–13. Exceedance Area in 2012 (Number of Grid Squares > 85 ppb in DFW NAA) and change from 2009.

Run	run46.fy2012.a2	
Scenario	2012 baseline CAMx 4.31 and a2 emissions	Change from 2009 baseline, CAMx 4.31 and a2 emissions
990815	10	-44%
990816	191	-13%
990817	250	-14%
990818	190	-23%
990819	161	-50%
990820	0	-100%
990821	12	-57%
990822	0	N/A
Totals	814	-30%

Table 5–14. Number of ppb's in DFW NAA in the daily maximum 8-hour ozone in excess of 85 ppb[1] in the 2012 baseline and change from 2009.

Run	run46.fy2012.a2	
Scenario	2012 baseline, CAMx 4.31 and a2 emissions	Change from 2009 baseline, CAMx 4.31 and a2 emissions
990815	13	-72%
990816	1535	-32%
990817	1909	-34%
990818	850	-48%
990819	597	-60%
990820	0	-100%
990821	16	-77%
990822	0	N/A
Totals	4919	-41%

5.4 2012 WITH DFW COMBINATION CONTROLS

A combination of DFW controls was applied to the 2012 "a2" baseline using CAMx 4.31. Controls were applied to the DFW major sources, DFW EGUs, Midlothian cement kilns, and off-road sources using low-end NCTCOG controls. Table 5–15 lists the NOx and VOC reductions from each control. NOx was reduced 32 tpd; VOC, only 0.3 tpd. Table 5–16 shows the weekday NOx emissions by source group and region, with changes from the 2012 baseline listed in the right column and bottom row. Almost half of the NOx reduction was inside Ellis County, mainly due to cement kiln controls.

Spatial plots of the daily maximum 8-hour ozone and differences from the 2012 baseline are shown in Figure 5–6 for each episode date. The greatest ozone reduction was downwind of Midlothian; on four dates, the daily maximum 8-hour ozone in part of Tarrant County dropped at least 3 ppb. Tarrant County also benefited from the DFW major source controls in Johnson County on August 18 as 8-hour ozone was up to 2 ppb lower. The 8-hour ozone in the northern end of Dallas County was reduced nearly 1 ppb on all dates except the two dates with north winds.

The future design value scaling calculations for 2012 with the combination of DFW controls are shown in Table 5–17. Changes from the 2012 baseline are shown in Table 5–18. The controls reduced the 2012 future design values from 0.7 ppb at Dallas C60 to 1.9 ppb at Fort Worth C13. The controls lowered the 2012 design values at Frisco and Denton each by 0.8 ppb to 85.9 ppb and 85.5 ppb, respectively. Future design values at all other DFW monitors were below 85 ppb.

Tables 5–19 to 5–21 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 5–19 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2012 baseline and the DFW combined control scenario. The total number of exceedance cells in the episode dropped from 814 in the 2012 baseline to 729 (-10 %) when applying controls.

Table 5–20 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the control scenario. The DFW combined controls reduced 38 % (313 out of 814) of all 8-hour ozone exceedance cells in DFW by at least 1 ppb, including over 100 grid cells on August 18.

Table 5–21 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The controls reduced the number of excess ppb's by 18%.

Table 5–15. Emission reductions from each control component for the 2012 control run.

Controls	NOx reduction [tpd]	VOC reduction [tpd]
DFW major source	-12.7	0.0
DFW EGUs	-2.0	0.0
Low-end Midlothian cement kilns	-11.0	0.0
Low-end NCTCOG off-road	-6.7	-0.3
Total	-32.4	-0.3

Table 5–16. Weekday NOx emissions [tpd] after applying the DFW combination controls for 2012.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2012.a2 baseline
Collin Co	10	9	1	0	2	7	0	19	-0.7
Dallas Co	4	52	5	1	18	39	0	114	-5.5
Denton Co	8	11	0	0	12	8	0	32	-0.9
Tarrant Co	3	31	1	1	10	24	0	67	-4.1
Parker Co	1	3	0	0	1	1	0	7	-0.2
Johnson Co	5	3	2	0	0	5	0	10	-3.8
Ellis Co	15	5	19	0	0	5	0	30	-15.2
Kaufman Co	5	4	3	0	0	2	0	9	-1.3
Rockwall Co	2	2	0	0	0	1	0	3	-0.1
DFW 9-County	**51**	**122**	**32**	**3**	**44**	**91**	**0**	**291**	**-31.8**
DFW 16 County	**83**	**141**	**54**	**6**	**67**	**106**	**0**	**375**	**-32.4**
NE Texas	16	52	202	16	71	38	1	380	0.0
Central TX	113	60	149	2	56	66	0	333	0.0
Houston	21	126	226	11	53	54	0	470	0.0
South TX	229	132	273	22	75	93	0	595	0.0
West TX	524	117	145	21	212	98	1	594	0.0
Texas	**986**	**627**	**1049**	**78**	**534**	**455**	**2**	**2746**	**-32.4**
Gulf + Mexico	79	4	436	0	4	2	444	890	0.0
Oklahoma	227	1	256	0	2	3	661	923	0.0
Louisiana	106	1	715	1	2	1	1183	1903	0.0
Arkansas	125	1	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	907	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2333	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**634**	**10329**	**80**	**543**	**463**	**23869**	**35917**	**-32.4**
Total change from baseline	0.0	0.0	-22.1	-3.6	0.0	-6.7	0.0	-32.4	

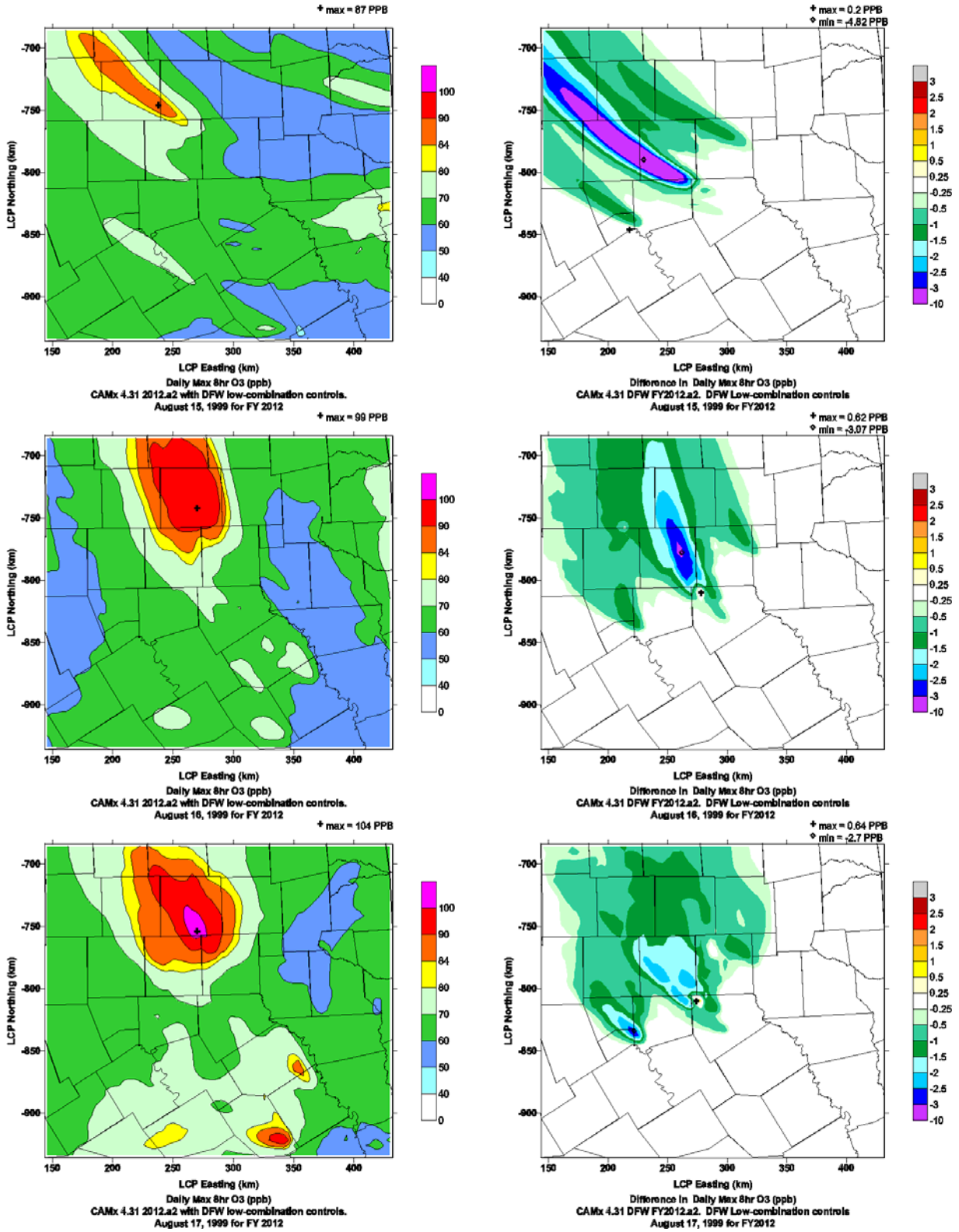


Figure 5–6. Spatial plots of the daily maximum 8-hour ozone in 2012 with a combination of DFW controls (left) and differences from the 2012 baseline (right) for each episode date.

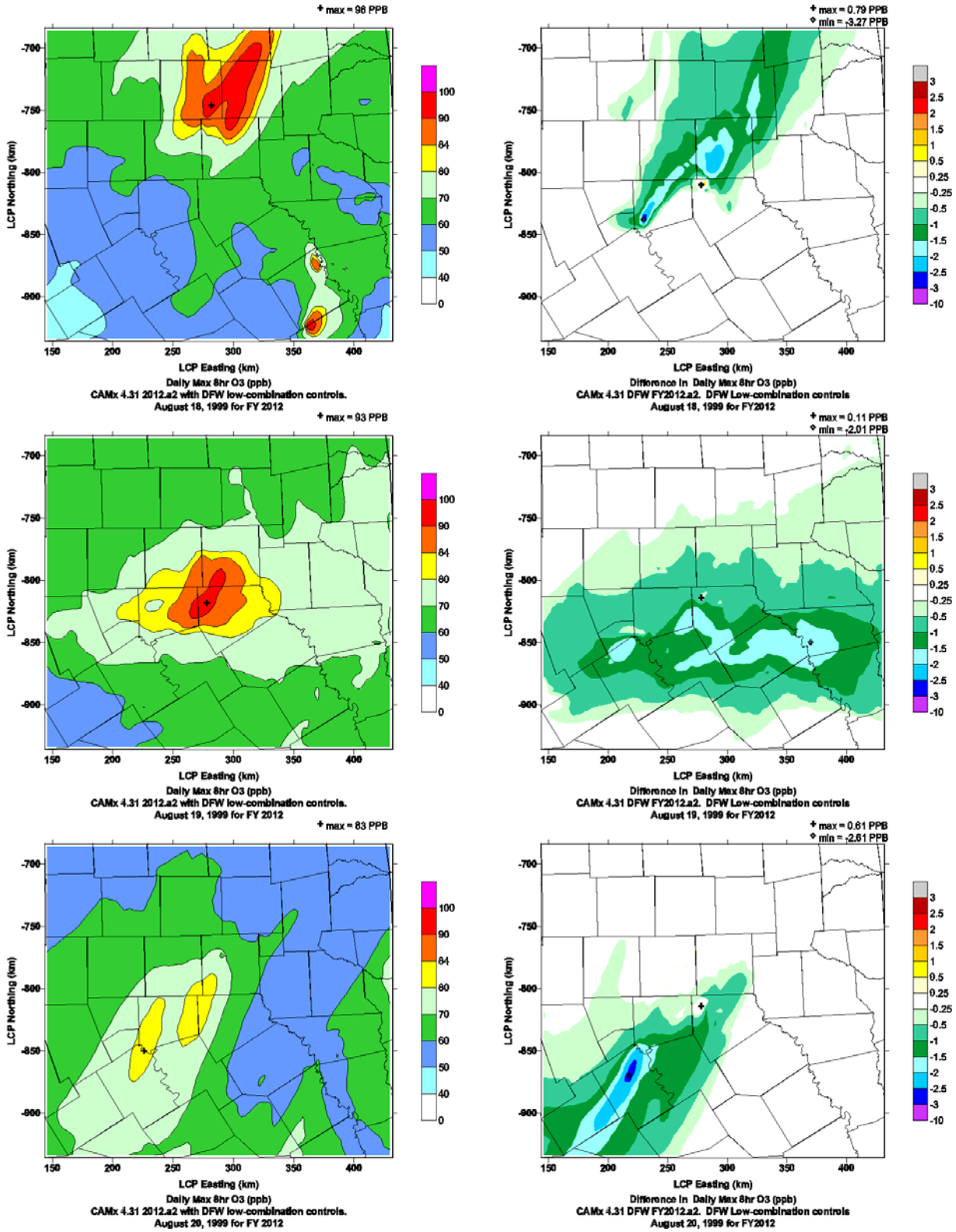


Figure 5–6 (continued). Spatial plots of the daily maximum 8-hour ozone in 2012 with a combination of DFW controls (left) and differences from the 2012 baseline (right) for each episode date.

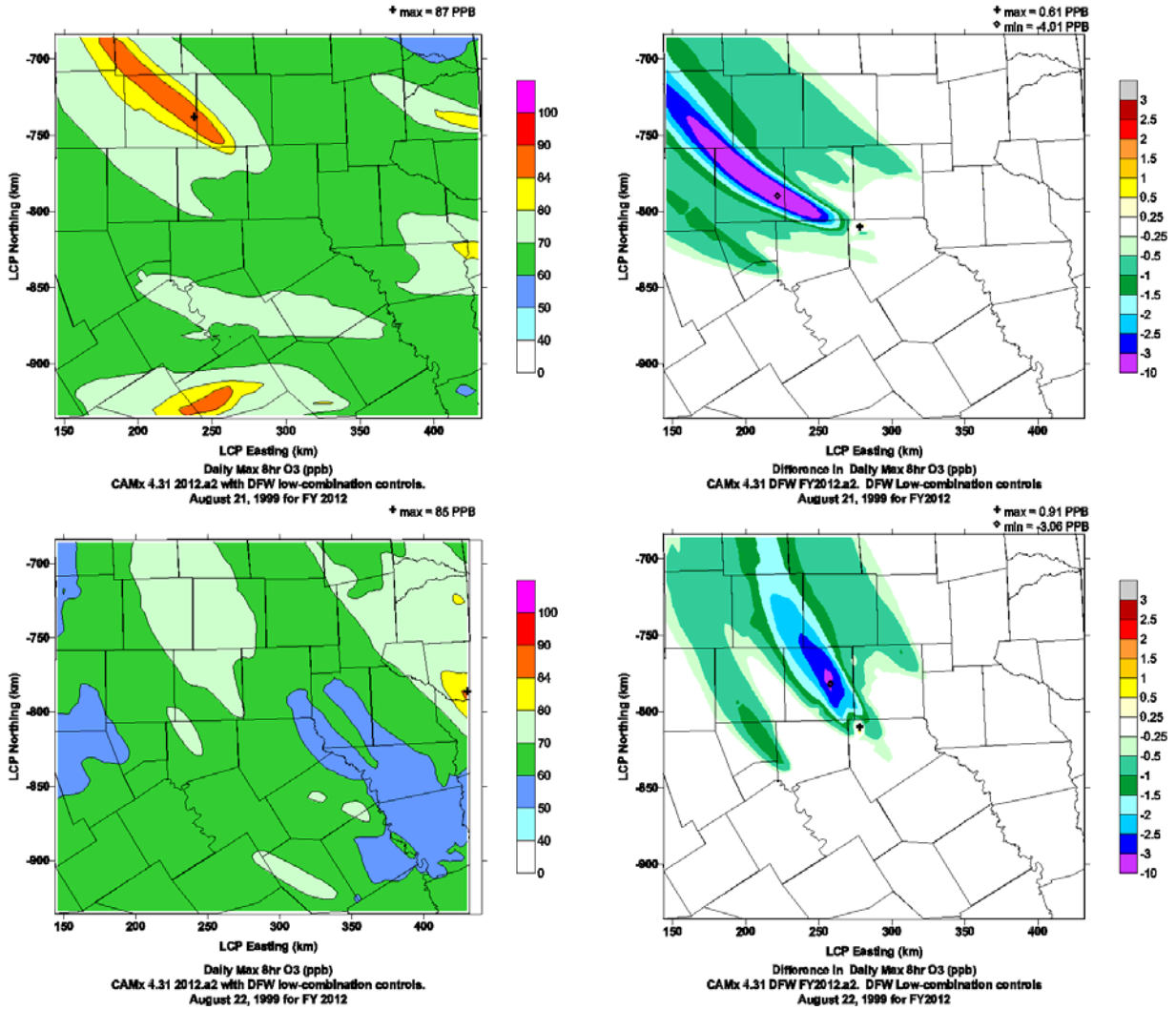


Figure 5–6 (concluded). Spatial plots of the daily maximum 8-hour ozone in 2012 with a combination of DFW controls (left) and differences from the 2012 baseline (right) for each episode date.

Table 5–17. Future design value scaling calculations for 2012 with DFW low-combination controls.

Base Case: run46												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2012.a2.dfw_lo_combo												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb] [**	**FutureDV[2] [ppb]**
Frisco	64.4	96.0	97.5	96.0	70.6	62.6	71.8	70.9	81.0	0.856	100.3	85.9
Dallas C60	70.0	88.4	99.2	93.0	87.7	79.3	74.8	71.0	82.9	0.899	92.0	82.7
North Dallas C63	68.3	91.5	97.5	94.5	80.6	75.8	73.4	70.9	81.6	0.880	93.0	81.8
Dallas C402	64.4	78.2	84.9	80.2	92.0	82.4	68.1	69.0	77.4	0.866	87.3	75.6
Denton	84.3	98.8	103.3	86.7	69.2	63.1	86.3	79.8	83.9	0.842	101.5	85.5
Midlothian	69.7	75.1	76.9	69.2	93.5	82.5	68.3	69.4	75.6	0.887	92.5	82.1
Arlington	71.0	84.2	85.5	77.1	90.6	82.4	70.1	75.5	79.5	0.862	95.0	81.9
Fort Worth C13	75.4	88.8	88.4	82.8	79.6	74.5	75.3	76.5	80.2	0.836	98.3	82.2
Fort Worth C17	85.7	93.5	99.3	85.2	75.7	69.5	85.2	78.7	84.1	0.849	96.3	81.8
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.792	0.897	0.950	0.880	0.821	0.895	0.824	0.792				
Dallas C60	0.842	0.886	0.960	0.895	0.884	1.017	0.875	0.832				
North Dallas C63	0.827	0.904	0.950	0.886	0.836	0.992	0.846	0.802				
Dallas C402	0.837	0.838	0.862	0.830	0.856	0.984	0.859	0.868				
Denton	0.821	0.874	0.938	0.770	0.817	0.863	0.849	0.800				
Midlothian	0.890	0.872	0.896	0.908	0.820	0.929	0.902	0.905				
Arlington	0.823	0.856	0.853	0.809	0.848	0.992	0.856	0.871				
Fort Worth C13	0.804	0.842	0.847	0.782	0.830	0.930	0.839	0.832				
Fort Worth C17	0.848	0.842	0.900	0.787	0.819	0.884	0.888	0.829				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–18. 2012 future design value summary and differences from the 2012 baseline.

Run	Run46.fy2012.a2	Run46.fy2012.a2.dfw_lo_combo	
Scenario	**2012 baseline using CAMx 4.31 and a2 emissions[ppb]**	**2012 baseline with controls to cement kilns, DFW major sources, DFW EGUs, and off-road sources [ppb]**	**Difference [ppb]**
Frisco	86.7	85.9	-0.8
Dallas C60	83.4	82.7	-0.7
Dallas C63	82.6	81.8	-0.7
Dallas C402	76.7	75.6	-1.1
Denton	86.3	85.5	-0.8
Midlothian	83.3	82.1	-1.2
Arlington	83.7	81.9	-1.8
Fort Worth C13	84.1	82.2	-1.9
Fort Worth C17	82.6	81.8	-0.9

Table 5–19. Exceedance Area in 2012 (Number of 4-km grid cells in DFW with daily max 8-hour ozone > 85 ppb).

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo	
Scenario	**2012 baseline**	**2012 baseline with controls to cement kilns, DFW major sources, DFW EGUs, and off-road sources**	**% Change**
990815	10	5	-50%
990816	191	176	-8%
990817	250	235	-6%
990818	190	164	-14%
990819	161	139	-14%
990820	0	0	N/A
990821	12	10	-17%
990822	0	0	N/A
Total	814	729	-10.4%

Table 5–20. Number of exceedance 4-km grid cells reduced at least 1 ppb from the controls in 2012.

Run	Run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo
Scenario	**2012 baseline**	**2012 baseline with controls to cement kilns, DFW major sources, DFW EGUs, and off-road sources**
990815	---	4
990816	---	84
990817	---	68
990818	---	116
990819	---	27
990820	---	6
990821	---	8
990822	---	0
Total	---	313

Table 5–21. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1] in 2012 with a combination of controls.

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo
Scenario	2012 baseline	2012 baseline with controls to cement kilns, DFW major sources, DFW EGUs, and off-road sources
990815	13	6
990816	1535	1255
990817	1909	1634
990818	850	695
990819	597	457
990820	0	0
990821	16	7
990822	0	0
Totals	4919	4053
% Reduced		-17.6%

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

SUMMARY

This task introduced a new version of CAMx, updates to the future year baseline emissions, and a new future year, 2012, when evaluating the 8-hour ozone in the DFW 9-county NAA. Model performance of the DFW August 13-22, 1999 baseline compared CAMx 4.03 (run44), which had been used in all previous tasks, CAMx 4.31 (run 46), which is the current release, and CAMx 4.40 beta (run50). CAMx 4.31 had mixed performance compared to CAMx 4.03, but modeled the daily maximum 8-hour ozone on August 17 better. CAMx 4.40 beta had a higher normalized bias compared to 4.31 on all episode dates. It was decided that all runs hereafter be based on Run 46 utilizing the current release of CAMx, version 4.31.

The update in 2009 Texas point source emissions from version "a1" to "a2" lowered NOx emissions by 84 tpd and increased VOC emissions by 4 tpd. These changes in emissions had little impact on the 2009 future design values at all DFW monitors.

Table 5–22 summarizes the DFW future design values from four runs with the "a2" series of emissions. Values in red represent future design values over 85 ppb. The first two columns list the 2009 baseline future design values using CAMx 4.03 and CAMx 4.31. The 2009 design values were up to 1.6 ppb lower when using CAMx 4.31, mainly due to improvements in the plume-in-grid algorithm. Frisco's future design value dropped from 91.2 ppb using CAMx 4.03 to 89.8 ppb in CAMx 4.31.

Table 5–22. Future design value summary with a2 emissions.

CAMx 4.31	2009.a2 baseline, CAMx 4.03 [ppb]	2009.a2 baseline, CAMx 4.31 [ppb]	2012.a2 baseline, CAMx 4.31 [ppb]	2012.a2 with DFW combined controls, CAMx 4.31 [ppb]
Frisco	91.2	89.8	86.7	85.9
Dallas C60	87.6	86.2	83.4	82.7
Dallas C63	87.0	85.4	82.6	81.8
Dallas C402	79.6	79.0	76.7	75.6
Denton	89.6	89.3	86.3	85.5
Midlothian	84.6	84.7	83.3	82.1
Arlington	87.1	86.2	83.7	81.9
Fort Worth C13	87.5	86.8	84.1	82.2
Fort Worth C17	85.9	85.4	82.6	81.8

In the 2012 future year, weekday NOx and VOC emissions were 275 and 86 tpd lower, respectively, mostly from on-road mobile source reductions. Dallas and Tarrant Counties accounted for almost two-thirds of the NOx reduction within the DFW 9-county NAA compared to the 2009 baseline, but Denton County showed the most ozone reduction. The 2012 baseline future design values, shown in Table 5–22, were at least 2 ppb lower than the 2009 baseline (using CAMx 4.31) at all sites except Midlothian, which was only 1.5 ppb lower. Frisco and Denton showed the greatest changes, dropping 3.1 ppb to 86.7 ppb and 3.0 ppb to 86.3 ppb, respectively. All other sites had future design values below 85 ppb in the 2012 baseline.

When controls to the DFW major sources, DFW EGUs, Midlothian cement kilns, and off-road sources (using low NCTCOG controls) were applied to the 2012 baseline, NOx emissions were reduced 32 tpd with about half coming from Ellis County. The future design values were up to 1.9 ppb lower than the 2012 baseline. Frisco and Denton were each reduced 0.8 ppb to 85.9 and 85.6 ppb, respectively.

5.5 2009 AND 2012 DFW COMBINATION 3 CONTROLS

A new combination of controls (combination 3) was applied to the 2009 and 2012 baselines to evaluate their impacts to 8-hour ozone in DFW during the August 13-22, 1999 episode. Controls were applied to the following: DFW major sources, DFW EGUs, Midlothian cement kilns, NCTCOG on-road and off-road sources, and East Texas engines within 200 km of DFW. Both runs were based on the Run 46 baseline configuration. CAMx version 4.31 was used with chemistry mechanism 4.

2009 WITH DFW COMBINATION 3 CONTROLS

Table 5–23 summarizes the NOx and VOC reductions from the 2009 "a2" baseline for each control component. In Run46.fy2009.a2.dfw_lo_combo3, NOx was reduced 83 tpd, of which half was from the DFW 9-county NAA. Among the nine DFW NAA counties, Ellis County had the most NOx reductions at 15.7 tpd, mainly due to the cement kiln controls. Tables 5–24 and 118 summarize the weekday NOx and VOC emissions by source region as defined in Figure 2-1 and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column and bottom row show the change in emissions from the 2009 a2 baseline.

Table 5–23. Emission reductions from the 2009 a2 baseline for each control component.

Controls	NOx reduction [tpd]	VOC reduction [tpd]
DFW major sources	-12.7	0.0
DFW EGUs	-2.0	0.0
Low-end Midlothian cement kilns	-11.0	0.0
Low-end NCTCOG off-road mobile	-6.9	-0.3
Low-end NCTCOG on-road mobile	-9.4	-7.7
East Texas engines (<200 km DFW)	-40.9	0.0
Total	-82.9	-8.0

Table 5–24. Weekday NOx emissions [tpd] for 2009 with DFW combination 3 controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a2 base
Collin Co	10	14	1	0	2	8	0	24	-1.6
Dallas Co	4	74	5	1	18	43	0	140	-9.2
Denton Co	8	16	0	0	12	9	0	38	-1.8
Tarrant Co	3	44	1	1	10	26	0	83	-6.3
Parker Co	1	5	0	0	1	2	0	9	-0.6
Johnson Co	5	4	2	0	0	5	0	12	-4.0
Ellis Co	15	8	19	0	0	5	0	33	-15.7
Kaufman Co	5	6	3	0	0	2	0	11	-1.8
Rockwall Co	2	3	0	0	0	1	0	4	-0.3
DFW 9-County	**51**	**174**	**32**	**3**	**44**	**100**	**0**	**353**	**-41.3**
DFW 16 County	**83**	**203**	**46**	**4**	**66**	**116**	**0**	**435**	**-53.6**
NE Texas	16	79	176	7	66	42	1	371	-22.8
Central TX	113	88	136	2	53	69	0	348	-4.4

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a2 base
Houston	21	175	226	11	53	63	0	528	0.0
South TX	229	189	261	21	75	100	0	646	-1.9
West TX	524	160	140	21	212	105	1	639	0.0
Texas	**986**	**894**	**985**	**67**	**525**	**494**	**2**	**2968**	**-82.7**
Gulf + Mexico	79	5	436	0	4	2	444	891	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	1	2	1	1183	1903	-0.1
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	907	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2333	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**903**	**10264**	**68**	**534**	**502**	**23869**	**36141**	**-82.9**
Total change from 2009 a2 baseline	0.0	-9.4	-42.6	-15.4	-8.6	-6.9	0.0	-82.9	

Table 5–25. Weekday VOC emissions [tpd] for 2009 with DFW combination 3 controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a2 base
Collin Co	27	7	0	1	12	3	0	23	-0.6
Dallas Co	50	39	4	8	72	17	0	140	-3.7
Denton Co	65	7	1	1	15	4	0	28	-0.7
Tarrant Co	64	23	2	7	54	9	0	94	-2.1
Parker Co	121	2	0	0	5	1	0	8	-0.2
Johnson Co	111	2	0	0	6	1	0	9	-0.2
Ellis Co	90	2	3	2	6	2	0	15	-0.2
Kaufman Co	112	2	0	0	7	1	0	11	-0.2
Rockwall Co	3	1	0	0	2	1	0	4	-0.1
DFW 9-County	**641**	**84**	**10**	**20**	**180**	**37**	**0**	**332**	**-7.9**
DFW 16 County	**1538**	**95**	**34**	**22**	**216**	**44**	**1**	**411**	**-7.9**
NE Texas	4917	27	14	41	82	14	1	179	0.0
Central TX	6098	33	20	20	85	21	1	180	0.0
Houston	1683	80	91	215	247	41	0	675	0.0
South TX	2069	78	20	48	217	46	0	408	0.0
West TX	6198	59	11	29	215	52	3	367	0.0
Texas	**22503**	**373**	**188**	**374**	**1060**	**218**	**6**	**2220**	**-7.9**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009 a2 base
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	656	695	0.0
Tennessee	8679	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12199	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**377**	**1104**	**377**	**1080**	**224**	**23453**	**26614**	**-8.0**
Total change from 2009 a2 baseline	0.0	-7.7	0.0	0.0	0.0	-0.3	0.0	-8.0	

Spatial plots of the daily maximum 8-hour ozone and differences from the 2009 “a2” baseline are shown in Figure 5–7 for each episode date in the DFW 4 km domain. Within the DFW 9-county NAA, the largest 8-hour ozone reduction was located downwind of Midlothian. On four of the episode dates, the daily maximum 8-hour ozone in part of Tarrant County was reduced at least 3 ppb.

Table 5–26 shows the future design value scaling calculations for 2009 with the combination of controls, which are compared to the 2009 a2 baseline future design values in Table 5–27. The controls lowered the future design values between 1.3 ppb at Dallas C60 and 2.2 ppb at Arlington. In the 2009 baseline, seven of the nine DFW monitoring sites had future design values exceeding 85 ppb. The combination of controls reduced the number of exceedance sites to two: Frisco’s 2009 future design value was reduced 1.4 ppb to 88.4 ppb, and Denton was 1.3 ppb lower at 88.0 ppb.

Tables 5–28 to 5–30 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 5–28 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline and combined control run. For the episode, the controls reduced the exceedance area 14 % to 1000 grid cells.

Table 5–29 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the combined controls. The controls reduced 85 % (984 out of 1158 cells) of all 8-hour ozone exceedance cells by at least 1 ppb.

Table 5–30 sums the number of ppb’s in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The controls reduced the number of exceedance ppb’s among all episode dates by 18 %.

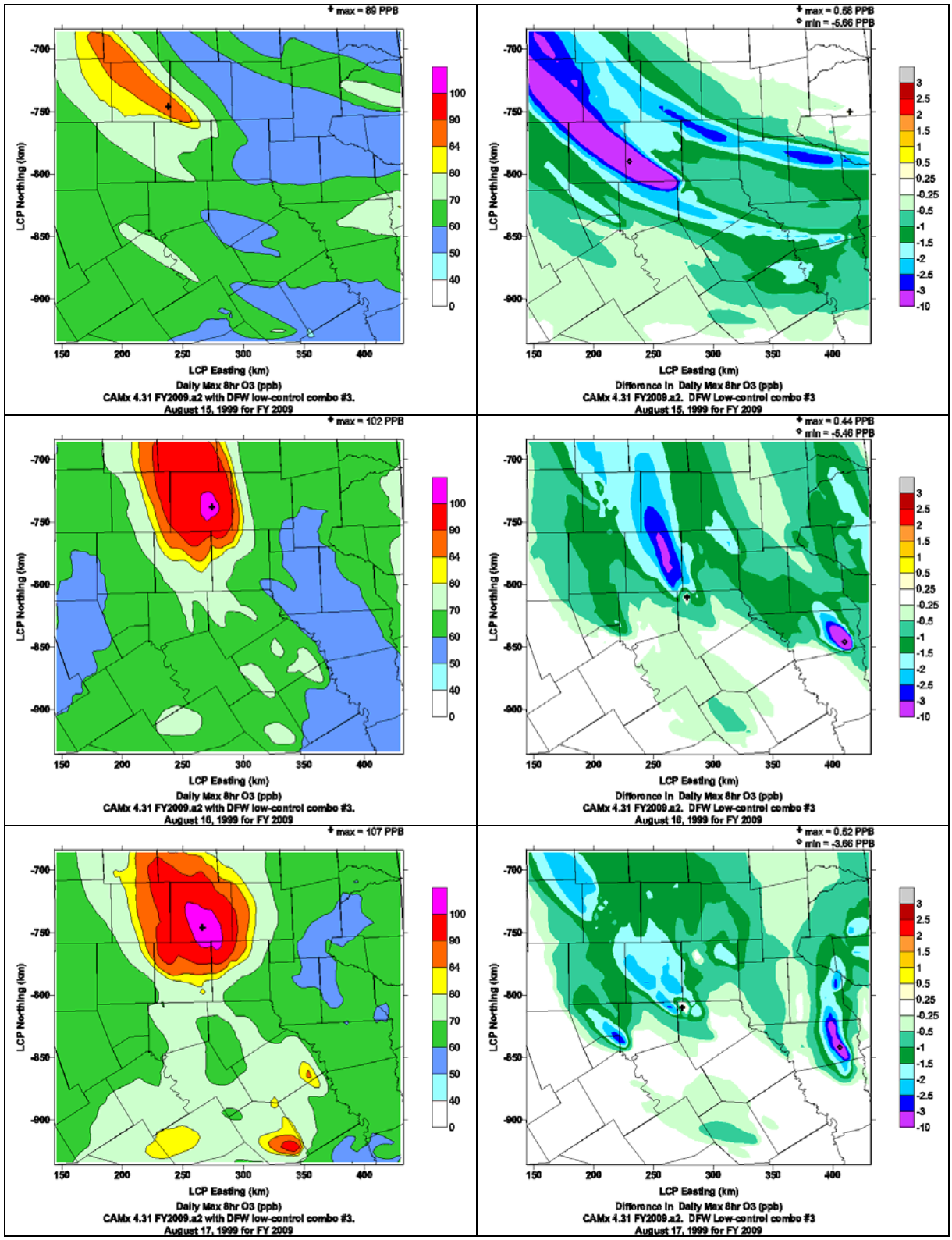


Figure 5–7. Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 3 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

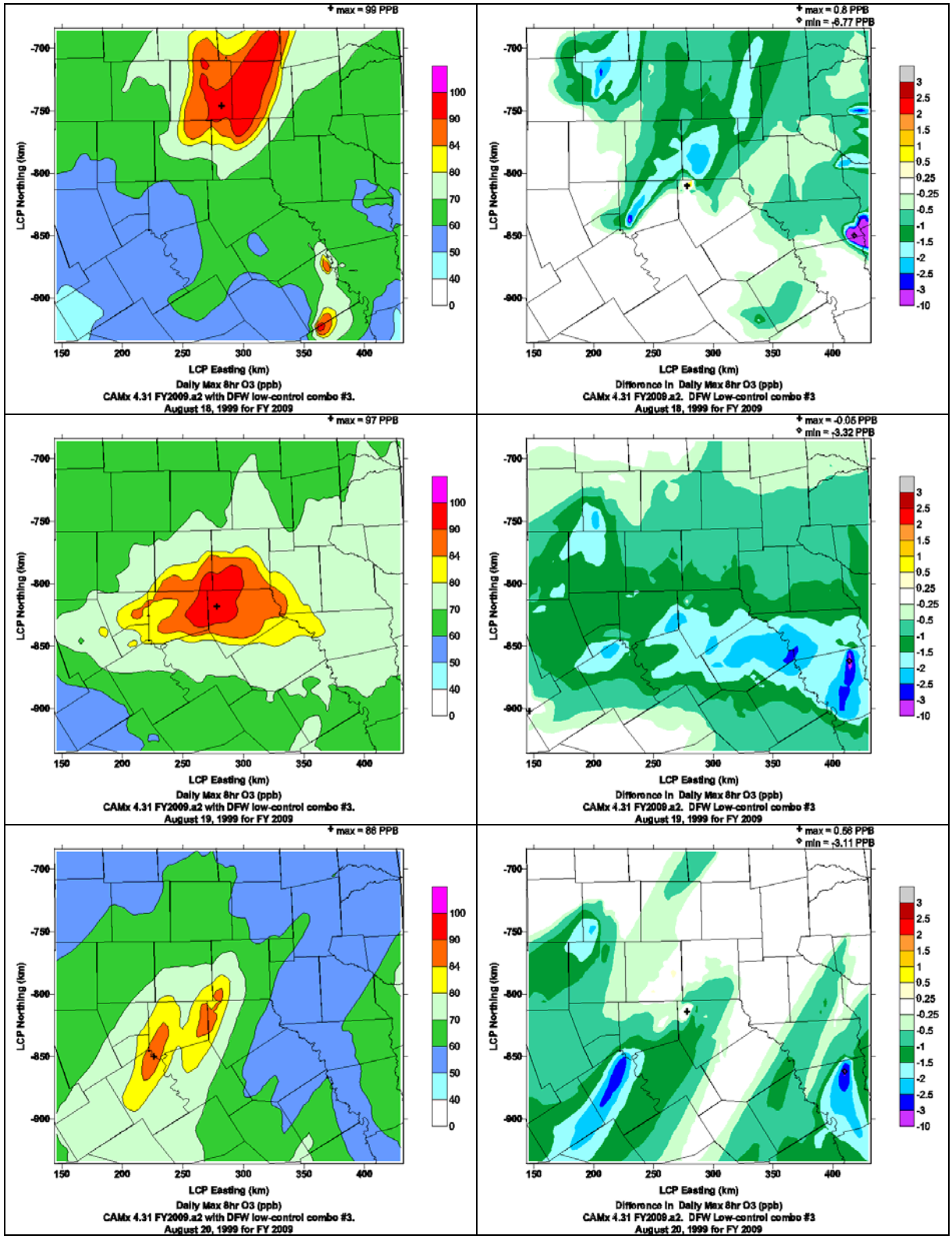


Figure 5–7. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 3 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

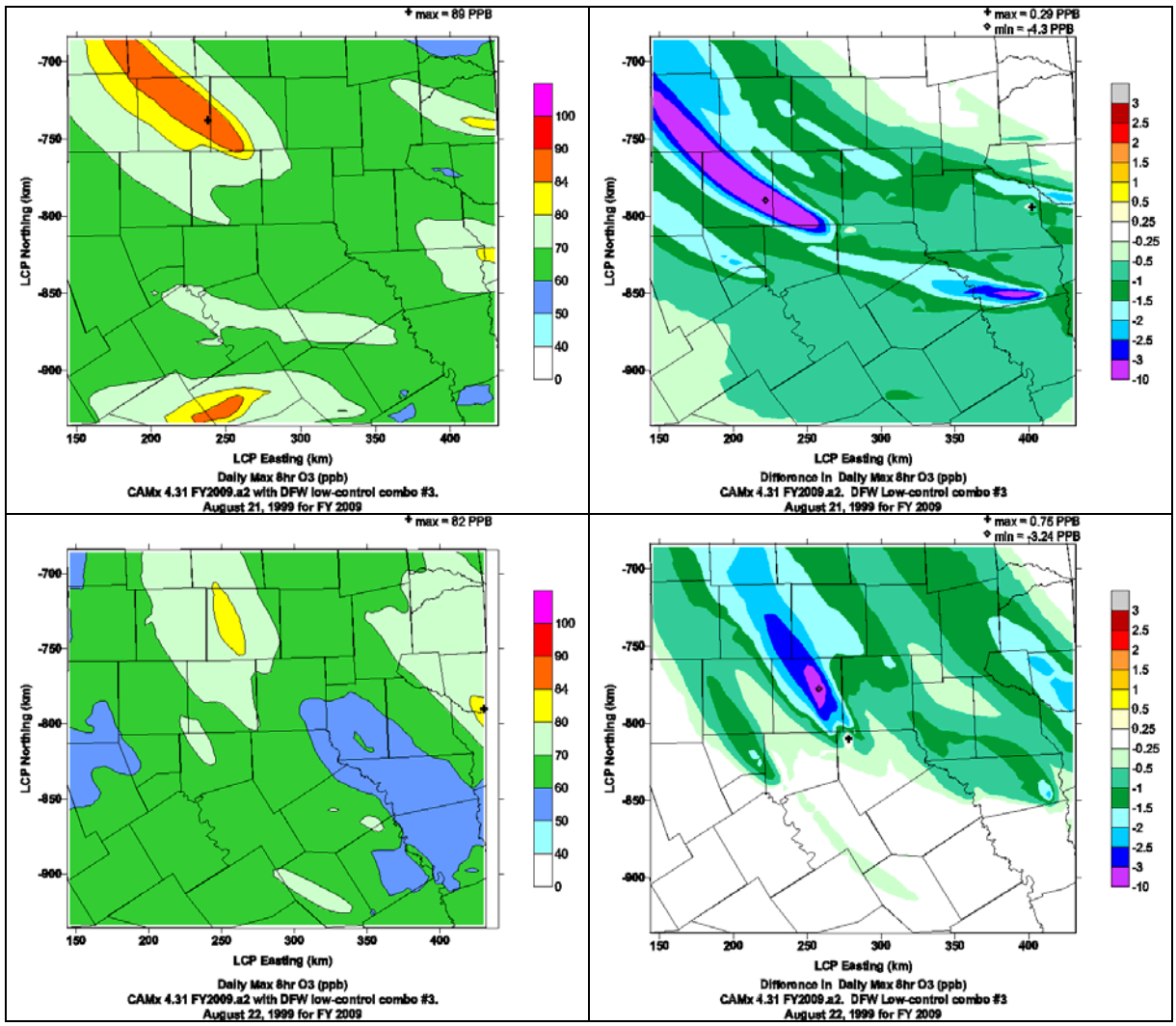


Figure 5–7. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 3 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

Table 5–26. Future design value calculation for 2009 with DFW combination 3 controls.

Base Case: run46												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2009.a2.dfw_lo_combo3												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	65.5	99.6	100.9	99.3	72.4	63.7	73.3	72.9	83.4	0.881	100.3	88.4
Dallas C60	70.8	91.5	102.5	96.3	90.5	80.6	76.4	72.6	85.2	0.923	92.0	84.9
North Dallas C63	69.0	94.4	100.9	98.2	83.4	77.3	74.6	72.6	83.8	0.904	93.0	84.1
Dallas C402	65.2	80.5	88.1	83.0	95.7	84.7	69.2	69.3	79.5	0.888	87.3	77.5
Denton	86.2	101.9	106.9	90.8	70.8	64.1	88.4	81.8	86.4	0.867	101.5	88.0
Midlothian	69.0	75.4	78.1	70.1	97.3	84.9	67.9	69.6	76.5	0.898	92.5	83.1
Arlington	71.5	86.1	88.8	80.1	94.2	84.7	71.6	76.4	81.7	0.884	95.0	84.0
Fort Worth C13	76.9	91.6	92.4	86.7	82.5	75.3	77.7	78.0	82.6	0.862	98.3	84.7
Fort Worth C17	87.4	96.8	102.9	89.2	78.2	70.4	86.9	80.6	86.5	0.873	96.3	84.1
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.806	0.930	0.984	0.910	0.842	0.912	0.842	0.814				
Dallas C60	0.852	0.917	0.992	0.928	0.912	1.034	0.893	0.850				
North Dallas C63	0.836	0.932	0.984	0.921	0.865	1.011	0.859	0.821				
Dallas C402	0.848	0.863	0.894	0.860	0.890	1.011	0.872	0.871				
Denton	0.840	0.901	0.971	0.807	0.836	0.876	0.870	0.821				
Midlothian	0.882	0.876	0.909	0.920	0.854	0.956	0.897	0.907				
Arlington	0.829	0.875	0.885	0.841	0.882	1.019	0.874	0.881				
Fort Worth C13	0.820	0.868	0.886	0.819	0.859	0.940	0.865	0.848				
Fort Worth C17	0.864	0.871	0.932	0.824	0.847	0.895	0.906	0.849				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–27. 2009 future design value summary [ppb].

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo3	
Scenario	**2009 baseline, a2 emissions**	**2009 with controls to DFW major sources, DFW EGUs, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**	**Difference**
Frisco	89.8	88.4	-1.4
Dallas C60	86.2	84.9	-1.3
Dallas C63	85.4	84.1	-1.3
Dallas C402	79.0	77.5	-1.5
Denton	89.3	88.0	-1.3
Midlothian	84.7	83.1	-1.7
Arlington	86.2	84.0	-2.2
Fort Worth C13	86.8	84.7	-2.1
Fort Worth C17	85.4	84.1	-1.4

Table 5–28. Exceedance Area in 2009 (Number of 4-km grid cells in DFW with the daily max 8-hour ozone >= 85 ppb).

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo3	
Scenario	**2009 baseline, a2 emissions**	**2009 with controls to DFW major sources, DFW EGUs, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**	**Difference**
990815	18	11	-39%
990816	220	202	-8%
990817	291	274	-6%
990818	248	227	-8%
990819	323	260	-20%
990820	30	7	-77%
990821	28	19	-32%
990822	0	0	n/a
Totals	1158	1000	-14%

Table 5–29. Number of exceedance cells in 2009 reduced at least 1 ppb.

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo3
Scenario	**2009 baseline, a2 emissions**	**2009 with controls to DFW major sources, DFW EGUs, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**
990815	--	18
990816	--	219
990817	--	230
990818	--	181
990819	--	292
990820	--	16
990821	--	28
990822	--	0
Totals	--	984

Table 5–30. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1] in 2009.

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo3
Scenario	2009 baseline, a2 emissions	2009 with controls to DFW major sources, DFW EGUs, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)
990815	47	19
990816	2269	1867
990817	2880	2497
990818	1634	1361
990819	1478	1082
990820	23	3
990821	69	37
990822	0	0
Totals	8400	6866 (-18.3 %)

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

2012 WITH DFW COMBINATION 3 CONTROLS

A similar set of controls was applied to the 2012 a2 baseline in Run46.fy2012.a2.dfw_lo_combo3. Reductions from each control were the same as in 2009 except the change in off-road NOx was 0.2 tpd less. Table 5–31 shows the NOx and VOC reductions from each component for 2012; the combined controls lowered NOx and VOC by 83 and 8 tpd, respectively. The NOx reduction was 51 tpd greater than the first combination of controls for 2012 (Task 21) due to the addition of the NCTCOG on-road mobile controls and East Texas engine controls within a 200 km radius of DFW. Tables 5–32 and 5–33 show the weekday NOx and VOC emissions, respectively, by source region, defined in Figure 2-1, and by emission group. The rightmost column and bottom row show changes from the 2012 a2 baseline. The anthropogenic NOx emissions in the DFW 9-county NAA in 2012 (282 tpd) were 20 % lower than in 2009.

Table 5–31. Emission reductions for 2012 with combination 3 controls.

Controls	NOx reduction [tpd]	VOC reduction [tpd]
DFW major source	-12.7	0.0
DFW EGUs	-2.0	0.0
Low-end Midlothian cement kilns	-11.0	0.0
Low-end NCTCOG off-road mobile	-6.7	-0.3
Low-end NCTCOG on-road mobile	-9.4	-7.7
Low-end East Texas engines (<200 km DFW)	-40.9	0.0
Total	-82.6	-8.0

Table 5–32. Weekday NOx emissions [tpd] for 2012 with DFW combination 3 controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2012 a2 baseline
Collin Co	10	9	1	0	2	7	0	18	-1.5
Dallas Co	4	48	5	1	18	39	0	110	-9.5
Denton Co	8	10	0	0	12	8	0	31	-1.7
Tarrant Co	3	29	1	1	10	24	0	65	-6.5
Parker Co	1	3	0	0	1	1	0	7	-0.4
Johnson Co	5	3	2	0	0	5	0	10	-4.1
Ellis Co	15	5	19	0	0	5	0	30	-15.6
Kaufman Co	5	4	3	0	0	2	0	9	-1.6
Rockwall Co	2	2	0	0	0	1	0	3	-0.2
DFW 9-County	**51**	**112**	**32**	**3**	**44**	**91**	**0**	**282**	**-41.1**
DFW 16 County	**83**	**132**	**46**	**4**	**66**	**106**	**0**	**354**	**-53.2**
NE Texas	16	52	192	7	66	38	1	357	-22.7
Central TX	113	60	147	2	53	66	0	329	-4.4
Houston	21	126	226	11	53	54	0	470	0.0
South TX	229	132	272	21	75	93	0	593	-1.8
West TX	524	117	145	21	212	98	1	594	0.0
Texas	**986**	**618**	**1029**	**67**	**525**	**455**	**2**	**2696**	**-82.1**
Gulf + Mexico	79	4	436	0	4	2	444	890	0.0
Oklahoma	227	1	256	0	2	3	661	923	0.0
Louisiana	106	1	715	1	2	1	1183	1903	-0.1
Arkansas	125	1	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	907	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2333	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**625**	**10308**	**68**	**534**	**463**	**23869**	**35866**	**-82.6**
Total change from 2012 a2 baseline	0.0	-9.4	-42.5	-15.4	-8.6	-6.7	0.0	-82.6	

Table 5–33. Weekday VOC emissions [tpd] for 2012 with DFW combination 3 controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2012 a2 baseline
Collin Co	27	5	0	1	12	3	0	21	-0.6
Dallas Co	50	30	4	8	72	16	0	130	-3.6
Denton Co	65	6	1	1	15	3	0	26	-0.7
Tarrant Co	64	18	2	7	54	8	0	88	-2.2
Parker Co	121	1	0	0	5	1	0	8	-0.2
Johnson Co	111	1	0	0	6	1	0	9	-0.2
Ellis Co	90	2	3	2	6	1	0	14	-0.2
Kaufman Co	112	2	0	0	7	1	0	10	-0.2
Rockwall Co	3	1	0	0	2	1	0	3	-0.1
DFW 9-County	**641**	**65**	**10**	**20**	**180**	**35**	**0**	**310**	**-7.9**
DFW 16 County	**1538**	**74**	**34**	**22**	**216**	**41**	**1**	**387**	**-8.0**
NE Texas	4917	22	14	43	82	13	1	174	0.0
Central TX	6098	27	20	21	85	19	1	173	0.0
Houston	1683	65	91	215	247	38	0	656	0.0
South TX	2069	64	20	50	217	41	0	392	0.0
West TX	6198	49	11	30	215	46	3	352	0.0
Texas	**22503**	**302**	**190**	**380**	**1060**	**197**	**6**	**2135**	**-8.0**
Gulf + Mexico	658	2	32	0	10	4	329	377	0.0
Oklahoma	7940	0	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	656	695	0.0
Tennessee	8679	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12199	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**305**	**1105**	**383**	**1080**	**202**	**23453**	**26528**	**-8.0**
Total change from 2012 a2 baseline	0.0	-7.7	0.0	0.0	0.0	-0.3	0.0	-8.0	

Figure 5–8 displays spatial plots of the daily maximum 8-hour ozone for 2012 with combination 3 controls and differences from the 2012 baseline for each episode date in the DFW 4 km domain. The spatial distribution of the ozone reductions in 2012 was similar to those in 2009. The largest ozone reductions in the DFW 9-county NAA were downwind of the Midlothian cement kilns, benefiting Tarrant County the most. Ozone reductions in 2012 were generally larger than in 2009.

Table 5–34 shows the 2012 future design value calculation for 8-hour ozone when applying DFW combination 3 controls; attainment was achieved as the future design values at all monitors were below 85 ppb. Frisco's 2012 future design value was 84.9 ppb; Denton was 84.7 ppb. Table 5–35 compares the 2012 future design values between the baseline and two combination control scenarios. Monitors in red are over 85 ppb. In the first 2012 combination control (Task 21), future design values were reduced 0.7 to 1.9 ppb. The addition of the East Texas engine controls and NCTCOG on-road mobile controls in combination 3 reduced the future design values between 1.6 and 2.6 ppb. The two monitors with the greatest reduction in future design values from the combination 3 controls were in Tarrant County – Arlington and Ft. Worth C13.

Tables 5–36 to 5–38 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 5–36 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2012 baseline and combined control run. The controls reduced the exceedance area from 814 grid cells in the 2012 baseline to 668 cells (-18 %).

Table 5–37 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the combined controls. All but eight exceedance grid cells (99 %) were reduced at least 1 ppb due to the controls; the eight exceedance cells were found on August 17 and 19.

Table 5–38 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The controls reduced the number of exceedance ppb's among all episode dates by 28 %.

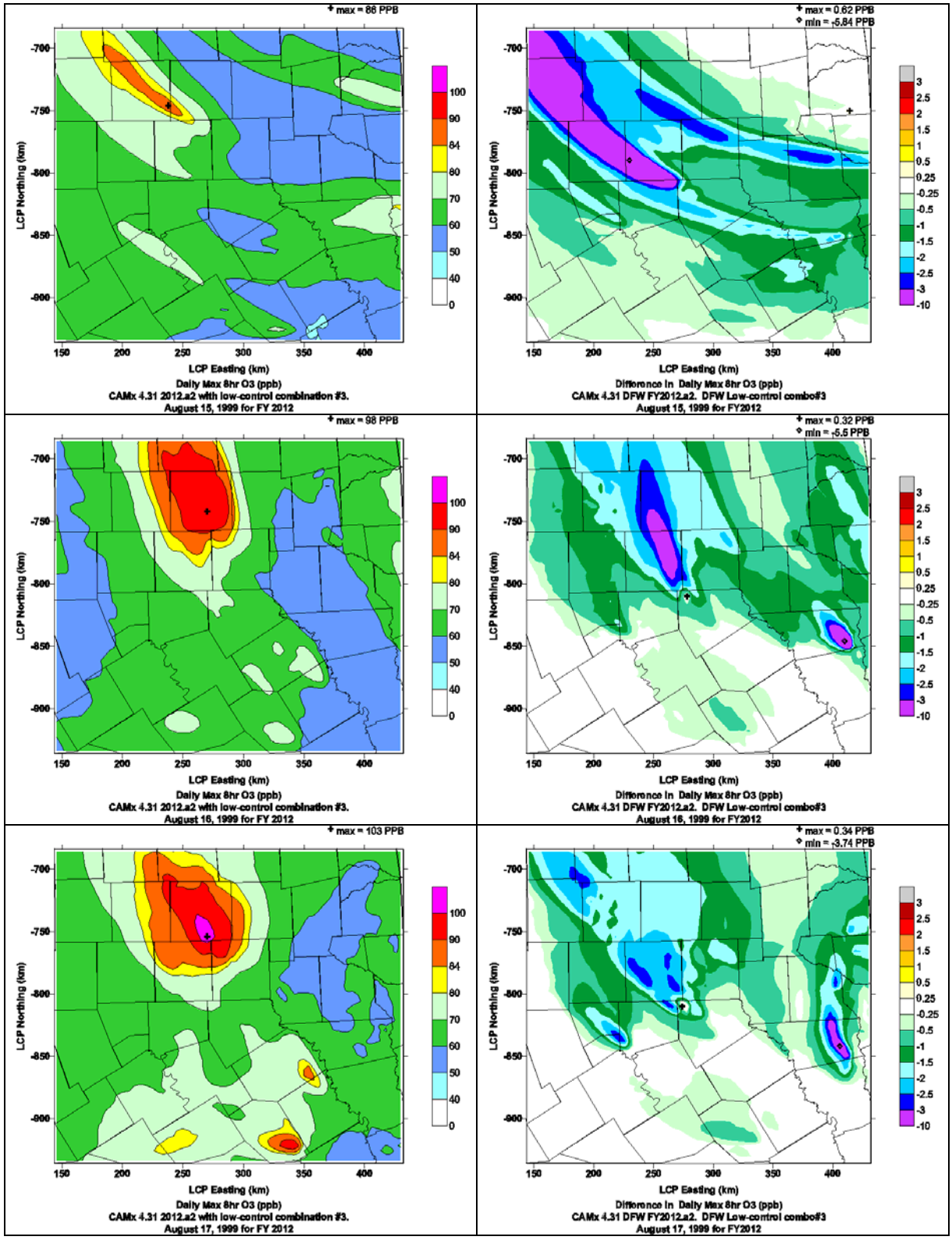


Figure 5–8. Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 3 controls and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

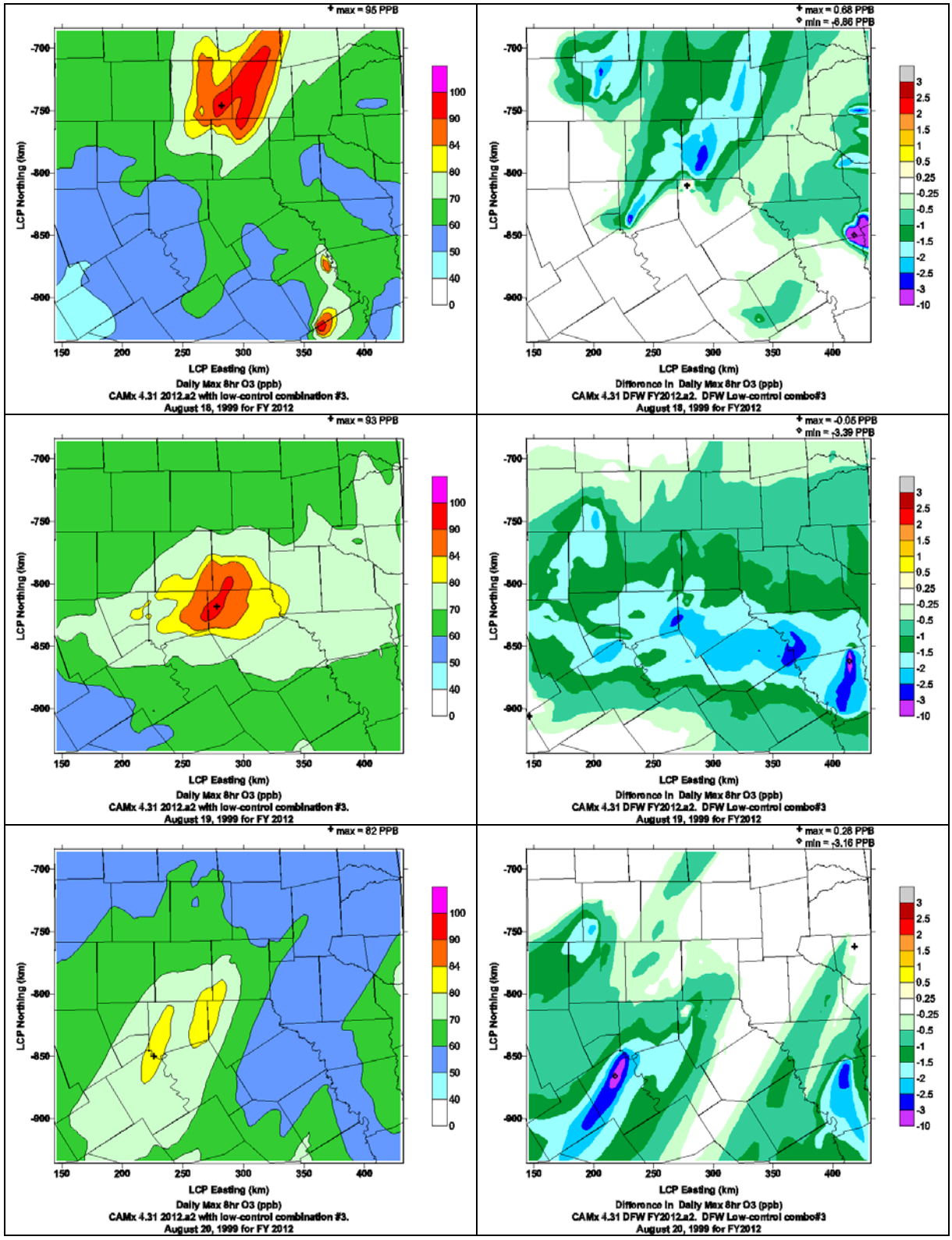


Figure 5–8. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 3 controls and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

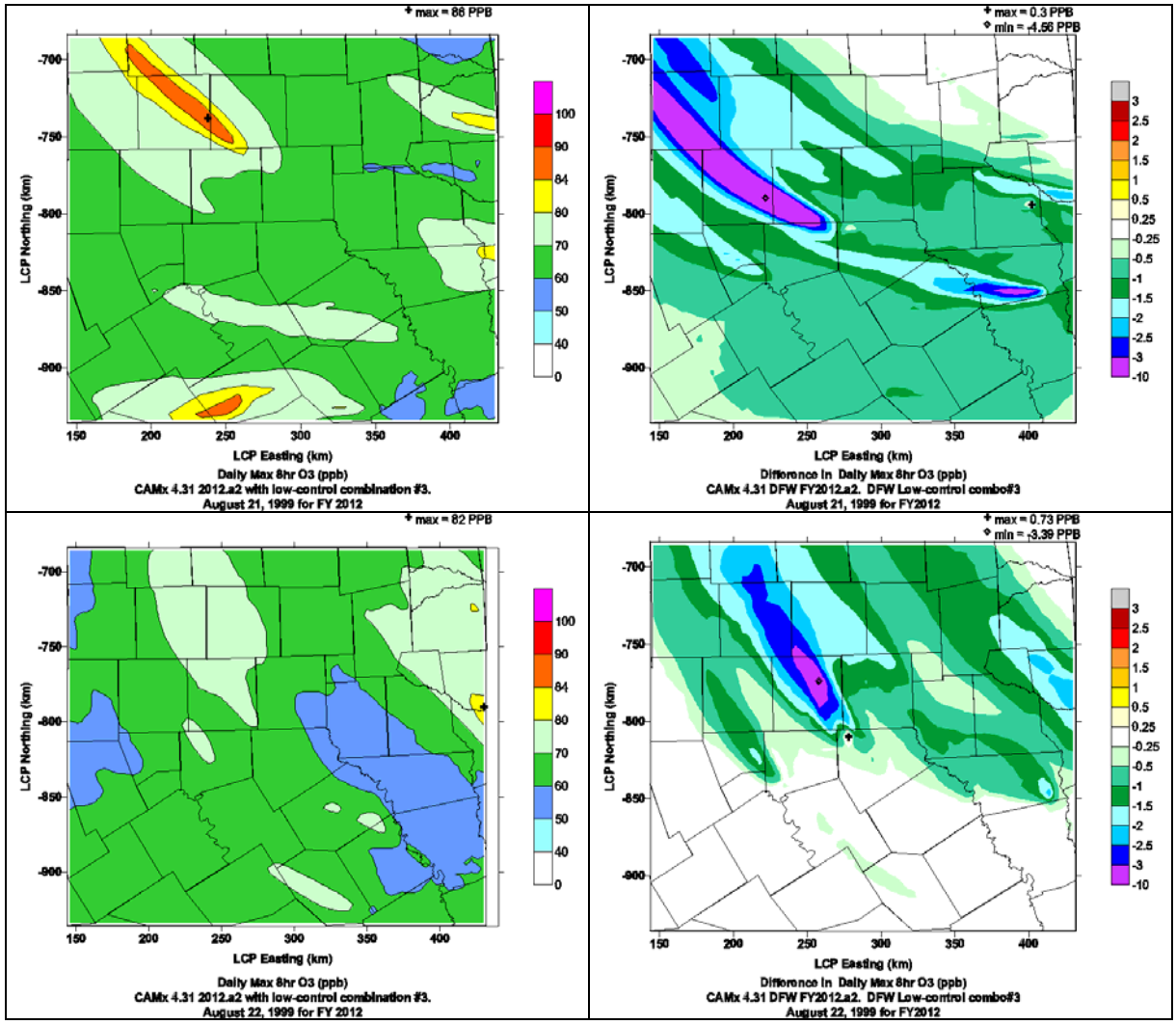


Figure 5–8. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 3 controls and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

.Table 5–34. Future design value calculations for 2012 with DFW combination 3 controls.

Base Case: run46												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2012.a2.dfw_lo_combo3												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**BaseDV [ppb]**	**FutureDV[2] [ppb]**
Frisco	62.9	95.0	96.6	95.3	70.1	62.4	70.9	69.8	80.1	0.846	100.3	84.9
Dallas C60	68.7	87.5	98.5	92.3	87.0	78.9	73.9	70.0	82.1	0.890	92.0	81.9
North Dallas C63	67.0	90.6	96.6	93.7	80.0	75.5	72.5	69.8	80.7	0.871	93.0	81.0
Dallas C402	63.3	77.5	84.3	79.7	91.2	82.0	67.2	68.8	76.7	0.858	87.3	74.9
Denton	82.9	97.9	102.5	85.9	68.7	62.8	85.5	78.9	83.1	0.834	101.5	84.7
Midlothian	68.8	74.8	76.7	69.1	92.8	82.1	67.1	69.2	75.1	0.881	92.5	81.5
Arlington	70.1	83.7	84.8	76.5	89.8	82.0	69.2	75.2	78.9	0.855	95.0	81.2
Fort Worth C13	74.4	88.1	87.6	82.1	79.0	74.3	74.3	76.1	79.5	0.829	98.3	81.5
Fort Worth C17	84.5	92.7	98.6	84.5	75.0	69.3	84.4	77.9	83.4	0.841	96.3	81.0
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.773	0.888	0.942	0.874	0.815	0.893	0.815	0.780				
Dallas C60	0.827	0.876	0.952	0.889	0.876	1.013	0.865	0.821				
North Dallas C63	0.811	0.894	0.942	0.879	0.829	0.988	0.835	0.790				
Dallas C402	0.823	0.830	0.855	0.826	0.849	0.979	0.846	0.865				
Denton	0.808	0.866	0.931	0.763	0.811	0.858	0.841	0.791				
Midlothian	0.878	0.869	0.893	0.906	0.814	0.925	0.886	0.903				
Arlington	0.812	0.851	0.846	0.804	0.840	0.986	0.845	0.868				
Fort Worth C13	0.793	0.835	0.840	0.775	0.823	0.928	0.828	0.828				
Fort Worth C17	0.836	0.834	0.893	0.780	0.812	0.882	0.879	0.821				

1 RRF = future year average / baseline average
2. Future DV = baseline DV * RRF
3. Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–35. Future design value summary for 2012 [ppb].

Run	Run46.fy2012.a2	Run46.fy2012.a2.dfw_lo_combo	Run46.fy2012.a2.dfw_lo_combo3
Scenario	**2012 baseline**	**2012 baseline with DFW low combination controls (DFW major source, DFW EGUs, low cement kiln, and low NCTCOG off-road)**	**2012 baseline with DFW low combination controls + East Texas engines + low NCTCOG on-road controls**
Frisco	86.7	85.9	84.9
Dallas C60	83.4	82.7	81.9
Dallas C63	82.6	81.8	81.0
Dallas C402	76.7	75.6	74.9
Denton	86.3	85.5	84.7
Midlothian	83.3	82.1	81.5
Arlington	83.7	81.9	81.2
Fort Worth C13	84.1	82.2	81.5
Fort Worth C17	82.6	81.8	81.0
Difference from baseline			
Frisco		-0.8	-1.8
Dallas C60		-0.7	-1.6
Dallas C63		-0.7	-1.6
Dallas C402		-1.1	-1.8
Denton		-0.8	-1.6
Midlothian		-1.2	-1.8
Arlington		-1.8	-2.5
Fort Worth C13		-1.9	-2.6
Fort Worth C17		-0.9	-1.6

Table 5–36. Exceedance Area in 2012 (Number of 4-km grid cells in DFW with the daily max 8-hour ozone >= 85 ppb).

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo3	
Scenario	**2012 baseline**	**2012 with controls to DFW major, DFW EGU, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**	**Difference**
990815	10	2	-80%
990816	191	171	-10%
990817	250	227	-9%
990818	190	145	-24%
990819	161	119	-26%
990820	0	0	--
990821	12	4	-67%
990822	0	0	--
Totals	814	668	-18%

Table 5–37. Number of exceedance cells in 2012 reduced at least 1 ppb

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo3
Scenario	**2012 baseline**	**2012 with controls to DFW major, DFW EGU, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**
990815	--	10
990816	--	191
990817	--	244
990818	--	190
990819	--	159
990820	--	0
990821	--	12
990822	--	0
Totals	--	806

Table 5–38. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1] in 2012.

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo3
Scenario	**2012 baseline**	**2012 with controls to DFW major, DFW EGU, cement kilns, NCTCOG on-road and off-road, and East Texas engines (<200km of DFW)**
990815	13	1
990816	1535	1106
990817	1909	1469
990818	850	598
990819	597	362
990820	0	0
990821	16	2
990822	0	0
Totals	4919	3538

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

SUMMARY

A new combination of controls (combination #3) was applied to the 2009 and 2012 baselines using CAMx version 4.31 and a2 baseline emissions to examine their impacts to 8-hour ozone in the DFW 9-county NAA. Controls were applied to DFW major sources, DFW EGUs, Midlothian cement kilns, on-road and off-road mobile sources, as proposed by NCTCOG, and East Texas engines within 200 km of DFW. In both future years, NOx and VOC emissions were reduced 83 and 8 tpd, respectively, with the greatest ozone reduction downwind of Midlothian due to controls applied to the cement kilns.

In 2009, future design values at DFW monitors were reduced between 1.3 and 2.2 ppb from the combined set of controls. All monitors had future design values below 85 ppb except Frisco (88.4 ppb) and Denton (88.0 ppb). In the 2009 baseline, there were 1158 4-km grid cells with 8-

hour ozone greater than 85 ppb in the DFW 9-county NAA during the episode. The combined controls reduced the 8-hour ozone at least 1 ppb in 85 % of these cells, reducing the exceedance area by 14 %.

A similar set of controls was applied to the 2012 baseline. Ozone was more responsive as future design values were reduced between 1.6 and 2.6 ppb. Attainment was achieved in 2012 as future design values at all nine DFW monitors dropped below 85 ppb. Frisco was at 84.9 ppb and Denton was at 84.7 ppb. Among the 814 4-km grid cells in the DFW 9-county NAA exceeding 85 ppb during the episode, 99 % were at least 1 ppb lower due to the controls as the exceedance area dropped 18 %.

5.6 2009 and 2012 A2 COMBINATION 4 CONTROLS

A new combination of controls (combination 4) was applied to the 2009 and 2012 baselines to evaluate their impacts to 8-hour ozone in DFW during the August 13-22, 1999 episode. This combination added DFW minor source controls to the DFW combination 3 controls discussed previously. Combination 4 applied controls to the following: DFW major and minor sources, DFW EGUs, Midlothian cement kilns, NCTCOG on-road and off-road sources, and East Texas engines within 200 km of DFW. Both runs were based on the Run 46 baseline configuration using CAMx version 4.31.

2009 WITH COMBINATION 4 CONTROLS

Table 5–39 summarizes the NOx and VOC reductions for each control component in combination 4 for the 2009 future year (Run46.fy2009.a2.dfw_lo_combo4). NOx and VOC emissions were reduced 87 and 8 tpd, respectively, from the 2009 a2 baseline. Compared to combination 3, NOx reductions were 4.5 tpd higher with the addition of DFW minor source controls. Over half of the DFW minor source NOx controls were in western Denton and Parker Counties; another third was in Dallas and Tarrant Counties. VOCs were unchanged from combination 3.

Tables 5–40 and 5–41 summarize the weekday NOx and VOC emissions (with August 17 biogenics) by source region, as defined in Figure 2-1, and by emission group (biogenics, elevated points, Texas mobile, low points, area, and off-road, and non-Texas low-level anthropogenics). The rightmost column and bottom row show the change in emissions from the 2009 a2 baseline. Within the DFW 9-county NAA, Ellis County had the most reductions in NOx (-15.8 tpd) due to the controls at the cement kilns; Dallas County was second at -10.1 tpd, largely due to on-road and off-road mobile controls.

Table 5–39. Emission reductions from the 2009 a2 baseline for each control component in combination control 4.

Controls	NOx reduction [tpd]	VOC reduction [tpd]
DFW major source	-12.7	0.0
DFW minor source	-4.5	0.0
DFW EGUs	-2.0	0.0
Low-end Midlothian cement kilns	-11.0	0.0
Low-end NCTCOG off-road mobile	-6.9	-0.3
Low-end NCTCOG on-road mobile	-9.4	-7.7
Low-end East Texas engines (<200 km DFW)	-40.9	0.0
Total	-87.4	-8.0

Table 5–40. Weekday NOx emissions [tpd] for 2009 with DFW combination 4 controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a2 baseline
Collin Co	10	14	1	0	2	8	0	24	-1.6
Dallas Co	4	74	5	1	17	43	0	139	-10.1
Denton Co	8	16	0	0	11	9	0	36	-3.4
Tarrant Co	3	44	1	1	9	26	0	82	-6.9
Parker Co	1	5	0	0	1	2	0	8	-1.5
Johnson Co	5	4	2	0	0	5	0	11	-4.2
Ellis Co	15	8	19	0	0	5	0	33	-15.8
Kaufman Co	5	6	3	0	0	2	0	11	-1.8
Rockwall Co	2	3	0	0	0	1	0	4	-0.3
DFW 9-County	**51**	**174**	**32**	**3**	**40**	**100**	**0**	**349**	**-45.7**
DFW 16 County	**83**	**203**	**46**	**4**	**61**	**116**	**0**	**431**	**-58.1**
NE Texas	16	79	176	7	66	42	1	371	-22.8
Central TX	113	88	136	2	53	69	0	348	-4.4
Houston	21	175	226	11	53	63	0	528	0.0
South TX	229	189	261	21	75	100	0	646	-1.9
West TX	524	160	140	21	212	105	1	639	0.0
Texas	**986**	**894**	**985**	**67**	**521**	**494**	**2**	**2963**	**-87.2**
Gulf + Mexico	79	5	436	0	4	2	444	891	0.0
Oklahoma	227	1	256	0	2	3	661	924	0.0
Louisiana	106	1	715	1	2	1	1183	1903	-0.1
Arkansas	125	2	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	907	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2333	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**903**	**10264**	**68**	**530**	**502**	**23869**	**36136**	**-87.4**
Total change from baseline	0.0	-9.4	-42.6	-15.4	-13.1	-6.9	0.0	-87.4	

Table 5–41. Weekday VOC emissions [tpd] for 2009 with DFW combination 4 controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2009.a2 baseline
Collin Co	27	7	0	1	12	3	0	23	-0.6
Dallas Co	50	39	4	8	72	17	0	140	-3.7
Denton Co	65	7	1	1	15	4	0	28	-0.7
Tarrant Co	64	23	2	7	54	9	0	94	-2.1
Parker Co	121	2	0	0	5	1	0	8	-0.2
Johnson Co	111	2	0	0	6	1	0	9	-0.2
Ellis Co	90	2	3	2	6	2	0	15	-0.2
Kaufman Co	112	2	0	0	7	1	0	11	-0.2
Rockwall Co	3	1	0	0	2	1	0	4	-0.1
DFW 9-County	**641**	**84**	**10**	**20**	**180**	**37**	**0**	**332**	**-7.9**
DFW 16 County	**1538**	**95**	**34**	**22**	**216**	**44**	**1**	**411**	**-7.9**
NE Texas	4917	27	14	41	82	14	1	179	0.0
Central TX	6098	33	20	20	85	21	1	180	0.0
Houston	1683	80	91	215	247	41	0	675	0.0
South TX	2069	78	20	48	217	46	0	408	0.0
West TX	6198	59	11	29	215	52	3	367	0.0
Texas	**22503**	**373**	**188**	**374**	**1060**	**218**	**6**	**2220**	**-7.9**
Gulf + Mexico	658	3	32	0	10	4	329	378	0.0
Oklahoma	7940	1	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	656	695	0.0
Tennessee	8679	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12199	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**377**	**1104**	**377**	**1080**	**224**	**23453**	**26614**	**-8.0**
Total change from baseline	0.0	-7.7	0.0	0.0	0.0	-0.3	0.0	-8.0	

Spatial plots of the daily maximum 8-hour ozone in the 2009 run with combination 4 controls and differences from the 2009 baseline are shown in Figure 5–9 for each episode date in the DFW 4 km domain. Like DFW combination 3, ozone reduction was greatest downwind of Midlothian on most dates, benefiting Tarrant County the most. Areas west of the DFW core showed more ozone reduction with the addition of the DFW minor source controls.

The future design value calculations for 2009 with combination 4 controls are shown in Table 5–42, which are compared to the 2009 baseline and combination 3 controls in Table 5–43. The addition of the DFW minor source controls in combination 4 had little impact on the DFW

monitors. Future design values were the same or 0.1 ppb lower than the 2009 combination 3 scenario at all DFW monitors. Compared to the baseline, future design values were 1.3 to 2.2 ppb lower. Frisco's design value dropped 1.5 ppb to 88.3 ppb; Denton dropped 1.4 ppb to 87.9 ppb. The other seven DFW monitors were below 85 ppb.

Tables 5–44 to 5–46 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 5–44 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2009 baseline and combined control run. Among the 1158 grid cells over 85 ppb in the 2009 baseline episode, 176 cells (15 %) dropped below 85 ppb due to the DFW combination 4 controls – 18 more grid cells than with combination 3.

Table 5–45 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the combined controls. The controls reduced 90 % (1043 out of 1158 cells) of all 8-hour ozone exceedance cells by at least 1 ppb. Without the DFW minor source controls, only 85 % of the baseline exceedance cells were reduced at least 1 ppb.

Table 5–46 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. For example, if the daily maximum ozone in a grid cell is 90 ppb, the grid cell adds 5 ppb (90 – 85 ppb) to the sum of ozone exceedances. The controls reduced the number of exceedance ppb's among all episode dates by 19 %.

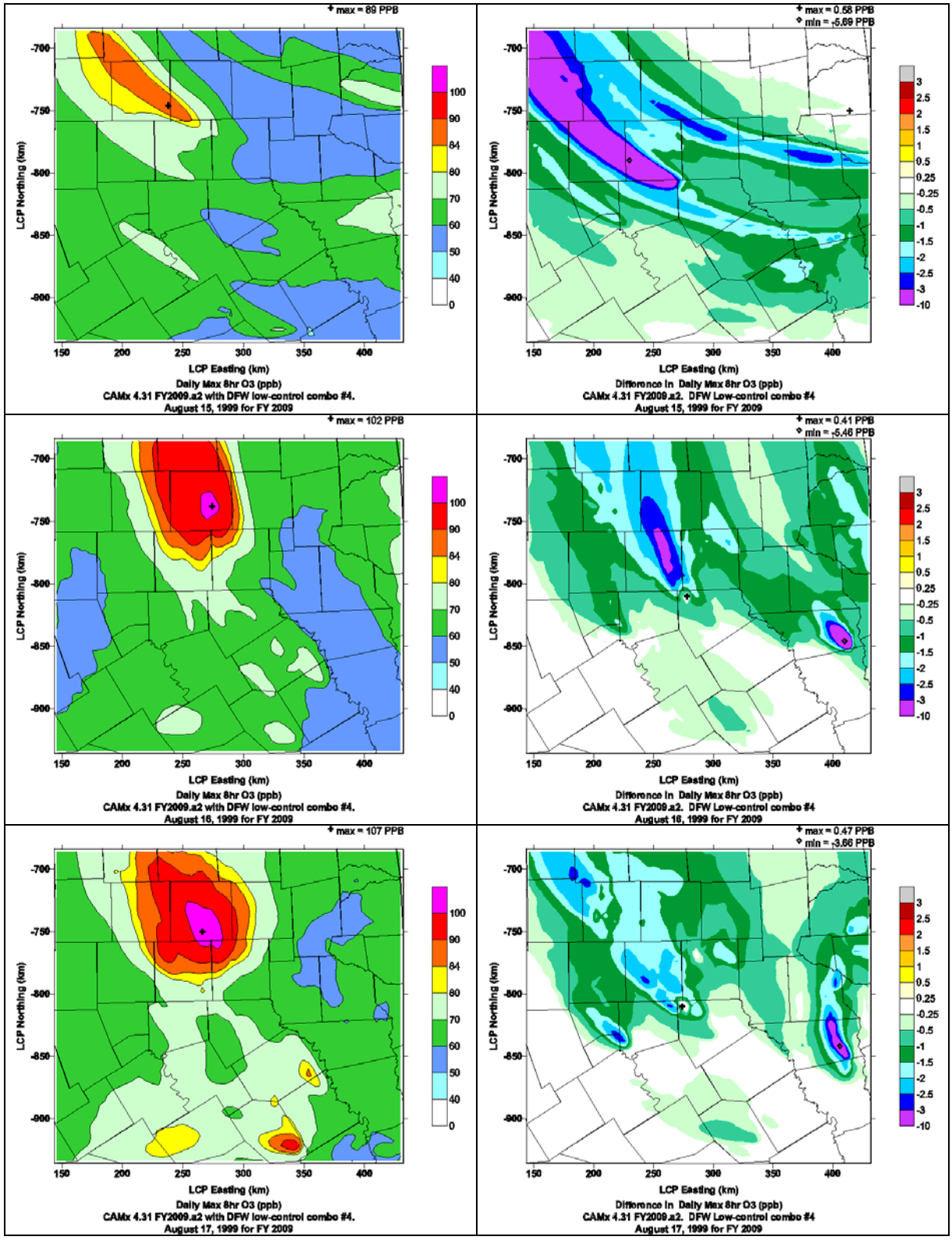


Figure 5–9. Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 4 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

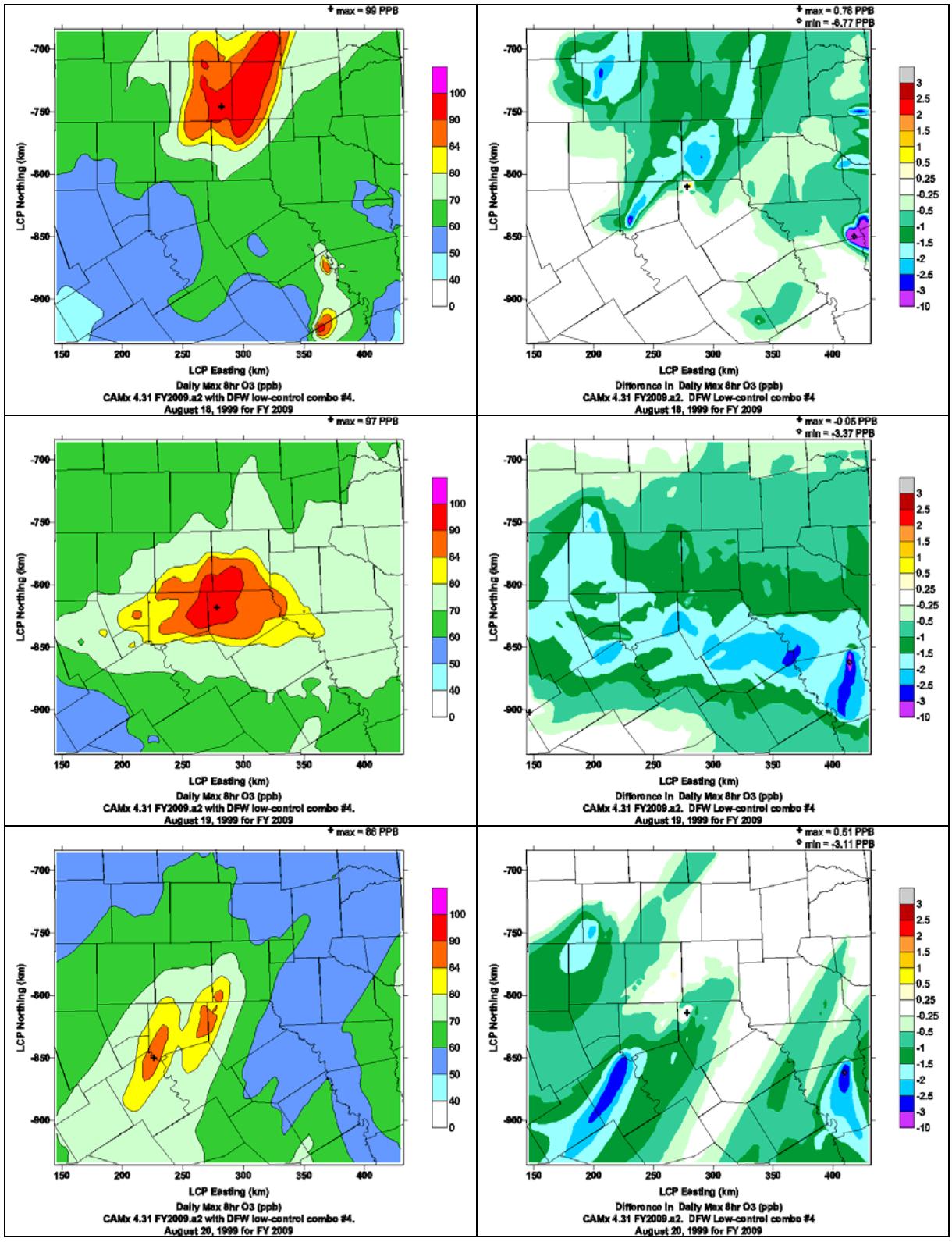


Figure 5–9. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 4 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

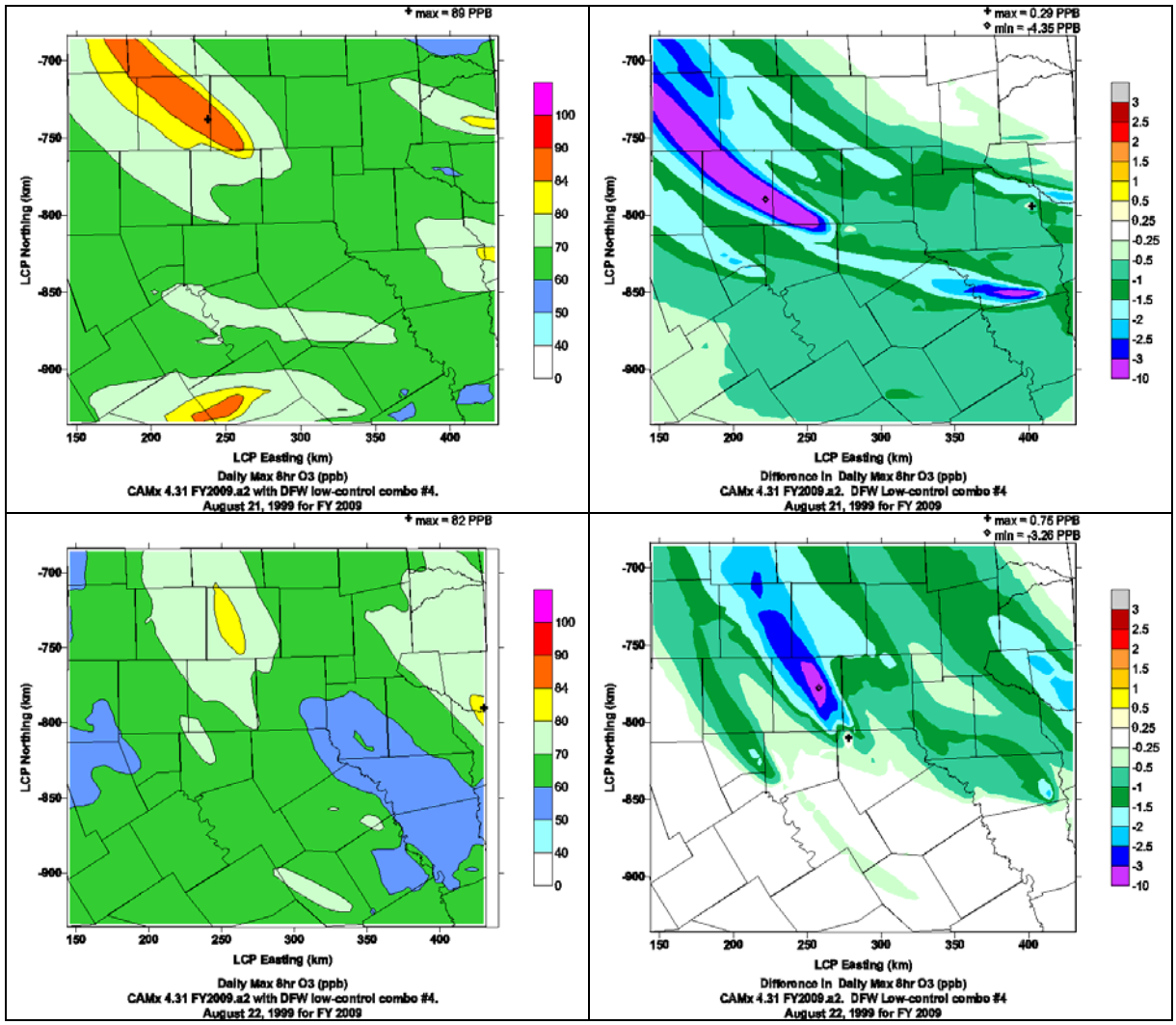


Figure 5–9. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2009 with combination 4 controls, and differences from the 2009 baseline for each episode date in the DFW 4 km domain.

Table 5–42. Future design value scaling calculation for 2009 with DFW combination 4 controls.

Base Case: run46												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**#Days>70**		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2009.a2.dfw_lo_combo4												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Current DV[ppb]**	**FutureDV[2] [ppb]**
Frisco	65.5	99.5	100.9	99.2	72.3	63.7	73.3	72.8	83.3	0.88	100.3	88.3
Dallas C60	70.8	91.4	102.5	96.2	90.4	80.6	76.3	72.5	85.1	0.922	92.0	84.8
North Dallas C63	69.0	94.3	100.9	98.1	83.3	77.2	74.5	72.5	83.7	0.904	93.0	84.1
Dallas C402	65.2	80.5	88.0	83.0	95.5	84.6	69.1	69.3	79.4	0.888	87.3	77.5
Denton	86.2	101.8	106.8	90.6	70.6	64.0	88.3	81.8	86.3	0.866	101.5	87.9
Midlothian	69.0	75.4	78.1	70.1	97.2	84.9	67.9	69.5	76.5	0.898	92.5	83.1
Arlington	71.4	86.0	88.7	80.0	94.1	84.6	71.5	76.3	81.6	0.884	95.0	84.0
Fort Worth C13	76.9	91.5	92.3	86.6	82.3	75.2	77.6	77.9	82.5	0.861	98.3	84.6
Fort Worth C17	87.3	96.7	102.8	89.1	78.0	70.3	86.8	80.5	86.4	0.873	96.3	84.1
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.805	0.929	0.983	0.909	0.841	0.912	0.842	0.813				
Dallas C60	0.852	0.916	0.991	0.927	0.911	1.034	0.893	0.850				
North Dallas C63	0.835	0.931	0.983	0.920	0.864	1.011	0.859	0.820				
Dallas C402	0.847	0.862	0.893	0.859	0.889	1.011	0.871	0.871				
Denton	0.840	0.900	0.970	0.805	0.834	0.875	0.869	0.820				
Midlothian	0.881	0.876	0.909	0.920	0.852	0.956	0.897	0.907				
Arlington	0.828	0.874	0.885	0.841	0.880	1.018	0.873	0.880				
Fort Worth C13	0.820	0.867	0.885	0.818	0.857	0.939	0.864	0.847				
Fort Worth C17	0.864	0.870	0.932	0.823	0.844	0.895	0.905	0.849				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV.

Table 5–43. 2009 design value summary [ppb].

Site	run46.fy2009.a2 2009 a2 baseline	run46.fy2009.a2.dfw_lo_combo3 2009 with combination 3 controls (DFW major source, DFW EGUs, low NCTCOG on-road + off-road, low cement kilns, East Texas engines (within 200km DFW))	run46.fy2009.a2.dfw_lo_combo4 2009 with combination 4 controls (combo 3 controls and DFW minor source controls)
Frisco	89.8	88.4	88.3
Dallas C60	86.2	84.9	84.8
North Dallas C63	85.4	84.1	84.1
Dallas C402	79.0	77.5	77.5
Denton	89.3	88.0	87.9
Midlothian	84.7	83.1	83.1
Arlington	86.2	84.0	84.0
Fort Worth C13	86.8	84.7	84.6
Fort Worth C17	85.4	84.1	84.1
Difference from baseline			
Frisco		-1.4	-1.5
Dallas C60		-1.3	-1.4
North Dallas C63		-1.3	-1.3
Dallas C402		-1.5	-1.5
Denton		-1.3	-1.4
Midlothian		-1.7	-1.7
Arlington		-2.2	-2.2
Fort Worth C13		-2.1	-2.2
Fort Worth C17		-1.4	-1.4

Table 5–44. Exceedance Area in 2009 (Number of 4-km grid cells in DFW with the daily max 8-hour ozone >= 85 ppb).

Run Scenario	run46.fy2009.a2 2009.a2 baseline	run46.fy2009.a2.dfw_lo_combo4 2009 with DFW combination 4 controls	Difference
990815	18	11	-39%
990816	220	201	-9%
990817	291	272	-7%
990818	248	225	-9%
990819	323	248	-23%
990820	30	6	-80%
990821	28	19	-32%
990822	0	0	--
Totals	1158	982	-15%

Table 5–45. Number of exceedance cells in 2009 reduced at least 1 ppb.

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo4
Scenario	2009.a2 baseline	2009 with DFW combination 4 controls
990815	--	18
990816	--	220
990817	--	241
990818	--	206
990819	--	312
990820	--	18
990821	--	28
990822	--	0
Totals	--	1043

Table 5–46. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1].

Run	run46.fy2009.a2	run46.fy2009.a2.dfw_lo_combo4
Scenario	2009.a2 baseline	2009 with DFW combination 4 controls
990815	47	18
990816	2269	1846
990817	2880	2476
990818	1634	1340
990819	1478	1050
990820	23	2
990821	69	36
990822	0	0
Totals	8400	6768 (-19 %)

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

2012 WITH DFW COMBINATION 4 CONTROLS

A similar set of controls was applied to the 2012 a2 baseline in Run46.fy2012.a2.dfw_lo_combo4. Reductions from each control were the same as in 2009 except the off-road mobile NOx reduction was 0.2 tpd lower. Like 2009, the only difference between combination 3 and 4 was the addition of DFW minor source controls, which had the largest NOx reductions in western Denton and Parker Counties. Table 5–47 shows the NOx and VOC reductions from each control for 2012; Tables 5–48 and 5–49 show the weekday emissions by source region, defined in Figure 2-1, and emission group for NOx and VOC, respectively.

Table 5–47. Emission reductions from the 2012 a2 baseline for each control component in combination 4.

Controls	NOx reduction [tpd]	VOC reduction [tpd]
DFW major source	-12.7	0.0
DFW minor source (revised)	-4.5	0.0
DFW EGUs	-2.0	0.0
Low-end Midlothian cement kilns	-11.0	0.0
Low-end NCTCOG off-road mobile	-6.7	-0.3
Low-end NCTCOG on-road mobile	-9.4	-7.7
Low-end East Texas engines (<200 km DFW)	-40.9	0.0
Total	-87.1	-8.0

Table 5–48. Weekday NOx emissions [tpd] for 2012 with DFW combination 4 controls.

NOX [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2012.a2 baseline
Collin Co	10	9	1	0	2	7	0	18	-1.5
Dallas Co	4	48	5	1	17	39	0	109	-10.4
Denton Co	8	10	0	0	11	8	0	29	-3.3
Tarrant Co	3	29	1	1	9	24	0	64	-7.1
Parker Co	1	3	0	0	1	1	0	6	-1.3
Johnson Co	5	3	2	0	0	5	0	10	-4.2
Ellis Co	15	5	19	0	0	5	0	29	-15.7
Kaufman Co	5	4	3	0	0	2	0	8	-1.6
Rockwall Co	2	2	0	0	0	1	0	3	-0.2
DFW 9-County	**51**	**112**	**32**	**3**	**40**	**91**	**0**	**277**	**-45.5**
DFW 16 County	**83**	**132**	**46**	**4**	**61**	**106**	**0**	**349**	**-57.7**
NE Texas	16	52	192	7	66	38	1	357	-22.7
Central TX	113	60	147	2	53	66	0	329	-4.4
Houston	21	126	226	11	53	54	0	470	0.0
South TX	229	132	272	21	75	93	0	593	-1.8
West TX	524	117	145	21	212	98	1	594	0.0
Texas	**986**	**618**	**1029**	**67**	**521**	**455**	**2**	**2692**	**-86.7**
Gulf + Mexico	79	4	436	0	4	2	444	890	0.0
Oklahoma	227	1	256	0	2	3	661	923	0.0
Louisiana	106	1	715	1	2	1	1183	1903	-0.1
Arkansas	125	1	220	0	0	2	468	692	0.0
Mississippi	121	0	353	0	0	0	455	808	0.0
Alabama	75	0	442	0	0	0	491	932	0.0
Tennessee	118	0	244	0	0	0	662	907	0.0
Kentucky	145	0	289	0	0	0	770	1060	0.0
Georgia	110	0	408	0	0	0	823	1230	0.0
Florida	56	0	367	0	0	0	1206	1573	0.0
Mid Atlantic (SC, NC, VA, WV)	293	0	977	0	0	0	2333	3310	0.0
NE US	314	0	1302	0	0	0	5748	7051	0.0
Northern Plains	5238	0	3269	0	0	0	8623	11892	0.0
Total	**7992**	**625**	**10308**	**68**	**530**	**463**	**23869**	**35862**	**-87.1**
Total change from 2012 a2 baseline	0	-9.4	-42.5	-15.4	-13.1	-6.7	0.0	-87.1	

Table 5–49. Weekday VOC emissions [tpd] for 2012 with DFW combination 4 controls.

VOC [tpd]	Bio	TX Mobile	Elev Points	TX Low Points	TX Area	TX Offroad	Non-TX Low Anthro	All Anthro	Anthro Change from 2012 a2 baseline
Collin Co	27	5	0	1	12	3	0	21	-0.6
Dallas Co	50	30	4	8	72	16	0	130	-3.6
Denton co	65	6	1	1	15	3	0	26	-0.7
Tarrant Co	64	18	2	7	54	8	0	88	-2.2
Parker Co	121	1	0	0	5	1	0	8	-0.2
Johnson Co	111	1	0	0	6	1	0	9	-0.2
Ellis Co	90	2	3	2	6	1	0	14	-0.2
Kaufman Co	112	2	0	0	7	1	0	10	-0.2
Rockwall Co	3	1	0	0	2	1	0	3	-0.1
DFW 9-County	**641**	**65**	**10**	**20**	**180**	**35**	**0**	**310**	**-7.9**
DFW 16 County	**1538**	**74**	**34**	**22**	**216**	**41**	**1**	**387**	**-8.0**
NE Texas	4917	22	14	43	82	13	1	174	0.0
Central TX	6098	27	20	21	85	19	1	173	0.0
Houston	1683	65	91	215	247	38	0	656	0.0
South TX	2069	64	20	50	217	41	0	392	0.0
West TX	6198	49	11	30	215	46	3	352	0.0
Texas	**22503**	**302**	**190**	**380**	**1060**	**197**	**6**	**2135**	**-8.0**
Gulf + Mexico	658	2	32	0	10	4	329	377	0.0
Oklahoma	7940	0	3	0	5	1	481	490	0.0
Louisiana	9941	0	47	3	4	1	546	601	0.0
Arkansas	13925	0	23	0	2	0	441	466	0.0
Mississippi	14818	0	35	0	0	0	548	583	0.0
Alabama	13954	0	39	0	0	0	656	695	0.0
Tennessee	8679	0	66	0	0	0	895	961	0.0
Kentucky	3753	0	34	0	0	0	622	656	0.0
Georgia	12199	0	53	0	0	0	869	922	0.0
Florida	9793	0	42	0	0	0	1594	1636	0.0
Mid Atlantic (SC, NC, VA, WV)	31294	0	67	0	0	0	2836	2903	0.0
NE US	20472	0	248	0	0	0	5407	5655	0.0
Northern Plains	40144	0	226	0	0	0	8224	8450	0.0
Total	**210073**	**305**	**1105**	**383**	**1080**	**202**	**23453**	**26528**	**-8.0**
Total change from 2012 a2 baseline	0.0	-7.7	0.0	0.0	0.0	-0.3	0.0	-8.0	

Figure 5–10 displays spatial plots of the daily maximum 8-hour ozone for 2012 with combination 4 controls and differences from the 2012 baseline for each episode date in the DFW 4 km domain. Impacts were greatest downwind of Midlothian, benefiting Tarrant County the most. The largest 8-hour ozone reduction in the DFW 9-county NAA was 5.9 ppb in Tarrant County on August 15. Compared to 2012 with combination 3 controls, most of the changes due to the addition of the DFW minor source controls were west of the nine DFW ozone monitoring sites.

Table 5–50 shows the 2012 future design value scaling calculations with the combination 4 controls. A comparison of future design values from all 2012 runs is shown in Table 5–51. The 2012 future design values were below 85 ppb at all DFW monitors in both combination 3 and 4. Differences in future design values between the two combination control runs were no greater than 0.1 ppb at all DFW monitors. The combination 4 controls lowered the future design values in DFW between 1.6 ppb and 2.7 ppb, with the highest reductions in Tarrant County; these differences were larger than in 2009 using the same set of controls. The 2012 future design values at Frisco and Denton were 84.8 and 84.6 ppb, respectively.

Tables 5–52 to 5–54 examine the 4-km grid cells in the DFW 9-county NAA in which the daily maximum 8-hour ozone exceeded 85 ppb. Table 5–52 lists the number of unique grid cells in DFW that exceed 85 ppb for each date in the 2012 baseline and combined control run. Among the 814 grid cells over 85 ppb in the 2012 baseline episode, 154 cells (19 %) dropped below 85 ppb due to the DFW combination 4 controls – 8 more grid cells than with the combination 3 controls.

Table 5–53 shows the number of baseline exceedance cells that were reduced at least 1 ppb from the combined controls. The controls reduced all but 5 of the 814 exceedance cells by at least 1 ppb – 3 cells more than in combination 3.

Table 5–54 sums the number of ppb's in the daily maximum 8-hour ozone that exceed 85 ppb. The controls reduced the number of exceedance ppb's among all episode dates by 30 %.

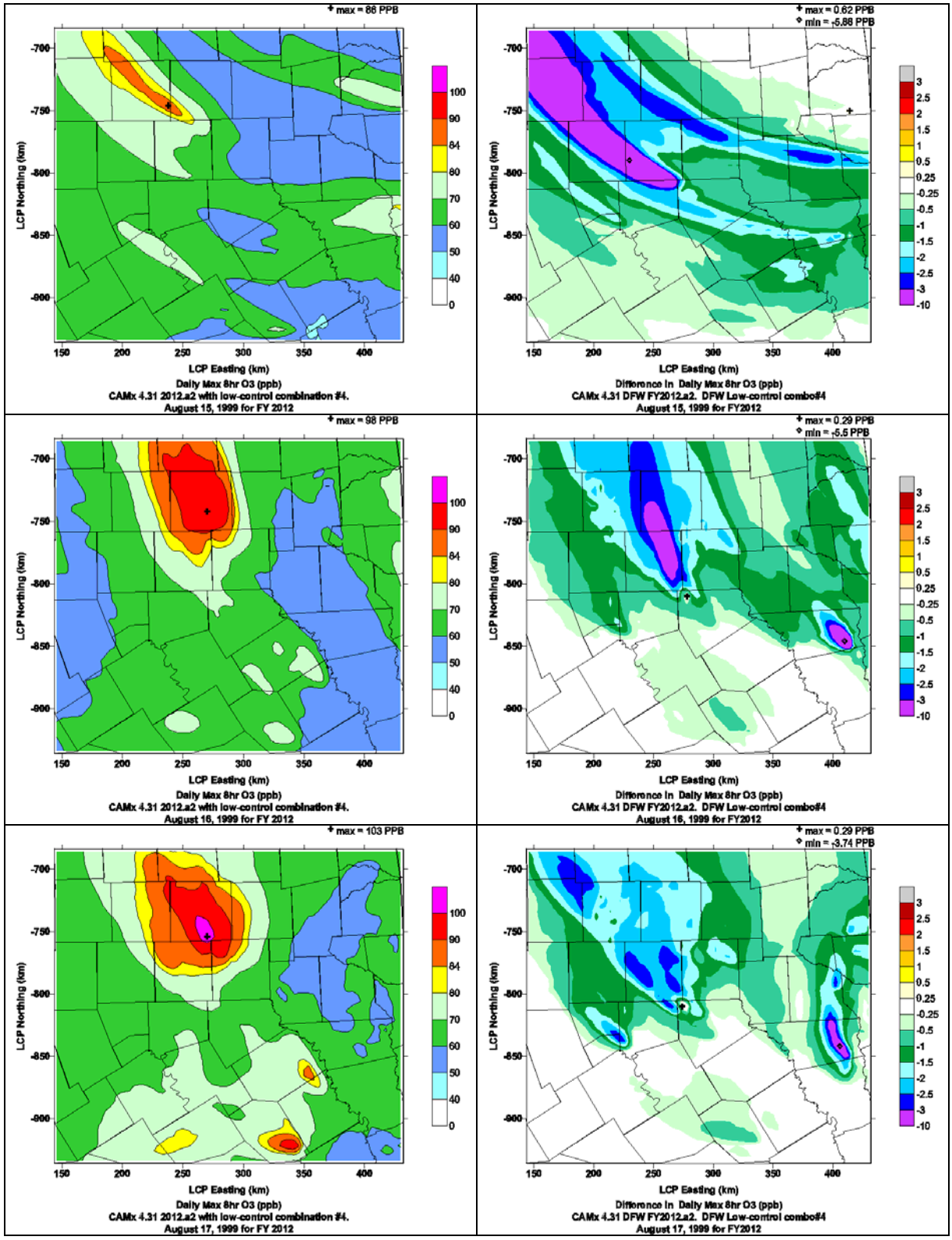


Figure 5–10. Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 4 controls, and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

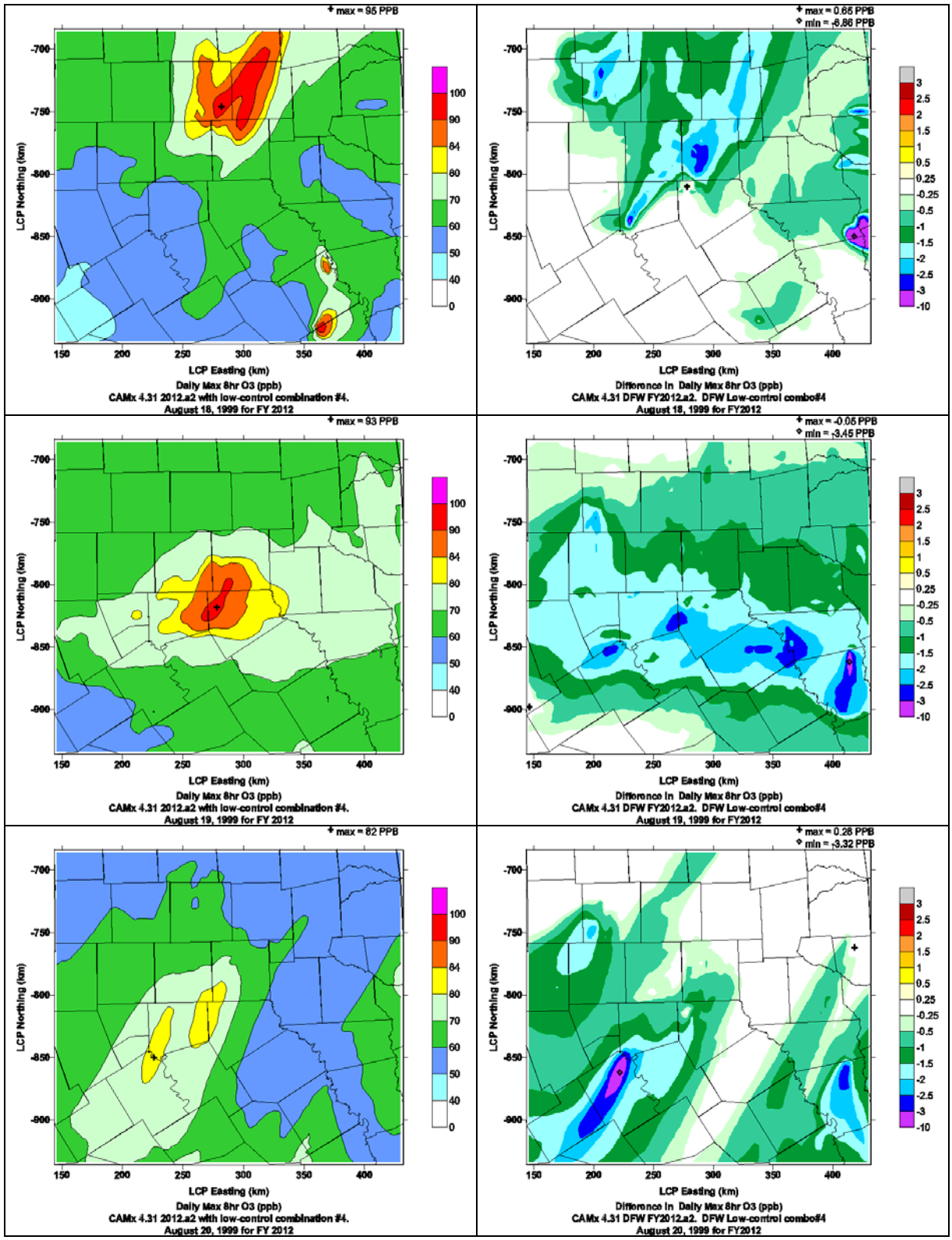


Figure 5–10. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 4 controls, and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

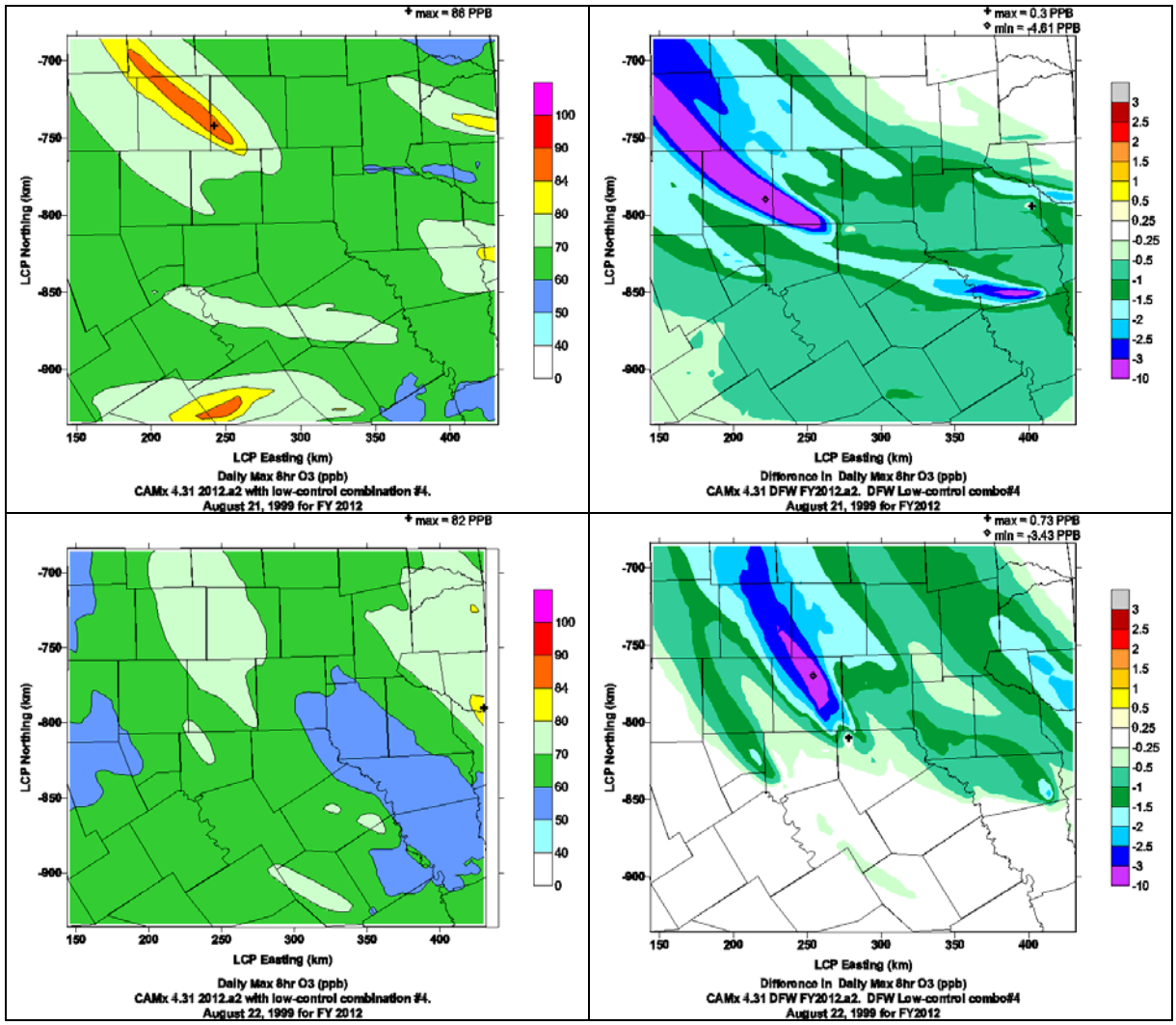


Figure 5–10. (Continued) Spatial plots of the daily maximum 8-hour ozone in 2012 with combination 4 controls, and differences from the 2012 baseline for each episode date in the DFW 4 km domain.

Table 5–50. Future design value scaling calculation for 2012 with DFW combination 4 controls.

Base Case: run46												
Site	990815	990816	990817	990818	990819	990820	990821	990822	Average	#Days>70		
Frisco	81.3	107.0	102.6	109.2	86.0	69.9	87.1	89.5	94.7	7		
Dallas C60	83.1	99.8	103.4	103.8	99.2	78.0	85.5	85.3	92.3	8		
North Dallas C63	82.6	101.3	102.6	106.6	96.5	76.4	86.8	88.4	92.6	8		
Dallas C402	77.0	93.3	98.5	96.6	107.4	83.7	79.4	79.5	89.4	8		
Denton	102.6	113.1	110.0	112.5	84.7	73.1	101.6	99.6	99.7	8		
Midlothian	78.3	86.1	85.9	76.2	114.0	88.8	75.7	76.7	85.2	8		
Arlington	86.2	98.4	100.2	95.2	106.9	83.1	81.9	86.7	92.3	8		
Fort Worth C13	93.8	105.5	104.3	106.0	96.0	80.1	89.8	92.0	95.9	8		
Fort Worth C17	101.1	111.1	110.4	108.3	92.4	78.6	95.9	94.9	99.1	8		
Future Year: run46.fy2012.a2.dfw_lo_combo4												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Average**	**RRF[1]**	**Current DV[ppb]**	**FutureDV[2] [ppb]**
Frisco	62.8	94.9	96.5	95.2	70.0	62.4	70.9	69.8	80.0	0.845	100.3	84.8
Dallas C60	68.7	87.4	98.3	92.2	86.8	78.9	73.9	70.0	82.0	0.889	92.0	81.8
North Dallas C63	66.9	90.5	96.5	93.6	79.8	75.5	72.4	69.8	80.6	0.870	93.0	80.9
Dallas C402	63.3	77.4	84.2	79.6	91.0	81.9	67.1	68.8	76.7	0.857	87.3	74.8
Denton	82.8	97.7	102.3	85.7	68.5	62.7	85.4	78.8	83.0	0.833	101.5	84.6
Midlothian	68.7	74.8	76.6	69.1	92.6	82.0	67.0	69.2	75.0	0.880	92.5	81.4
Arlington	70.0	83.6	84.7	76.4	89.6	81.9	69.2	75.2	78.8	0.854	95.0	81.1
Fort Worth C13	74.4	88.0	87.5	82.0	78.7	74.3	74.2	76.1	79.4	0.828	98.3	81.4
Fort Worth C17	84.5	92.5	98.5	84.3	74.8	69.3	84.3	77.8	83.2	0.840	96.3	80.9
Daily RRFs[3]												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**				
Frisco	0.773	0.887	0.941	0.872	0.814	0.893	0.814	0.779				
Dallas C60	0.826	0.875	0.951	0.888	0.875	1.012	0.864	0.820				
North Dallas C63	0.811	0.893	0.941	0.877	0.828	0.988	0.835	0.789				
Dallas C402	0.822	0.829	0.854	0.825	0.847	0.978	0.846	0.865				
Denton	0.807	0.865	0.930	0.762	0.809	0.857	0.840	0.791				
Midlothian	0.878	0.869	0.892	0.906	0.813	0.924	0.885	0.903				
Arlington	0.812	0.850	0.845	0.803	0.838	0.985	0.844	0.867				
Fort Worth C13	0.793	0.835	0.839	0.774	0.820	0.927	0.827	0.827				
Fort Worth C17	0.836	0.833	0.892	0.779	0.809	0.881	0.879	0.820				

(1) RRF = future year average / baseline average
(2) Future DV = baseline DV * RRF
(3) Daily RRFs are for information only. They are not used to calculate the future DV

Table 5–51. 2012 future design value summary [ppb].

Run	Run46.fy2012.a2	Run46.fy2012.a2.dfw_lo_combo3	Run46.fy2012.a2.dfw_lo_combo4
Scenario	**2012 a2 baseline**	**2012 with DFW combination control 3 (DFW major sources, DFW EGUs, low cement kilns, low NCTCOG, and East TX engines within 200 km of DFW)**	**2012 with DFW combination control 4 (combo 3 and DFW minor sources)**
Frisco	86.7	84.9	84.8
Dallas C60	83.4	81.9	81.8
Dallas C63	82.6	81.0	80.9
Dallas C402	76.7	74.9	74.8
Denton	86.3	84.7	84.6
Midlothian	83.3	81.5	81.4
Arlington	83.7	81.2	81.1
Fort Worth C13	84.1	81.5	81.4
Fort Worth C17	82.6	81.0	80.9
Difference from baseline			
Frisco		-1.8	-1.9
Dallas C60		-1.6	-1.6
Dallas C63		-1.6	-1.7
Dallas C402		-1.8	-1.8
Denton		-1.6	-1.7
Midlothian		-1.8	-1.8
Arlington		-2.5	-2.6
Fort Worth C13		-2.6	-2.7
Fort Worth C17		-1.6	-1.7

Table 5–52. Exceedance Area in 2012 (Number of 4-km grid cells in DFW with the daily max 8-hour ozone >= 85 ppb).

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo4	
Scenario	**2012 a2 baseline**	**2012.a2 with DFW combination control 4**	**Difference**
990815	10	1	-90%
990816	191	171	-10%
990817	250	226	-10%
990818	190	142	-25%
990819	161	116	-28%
990820	0	0	--
990821	12	4	-67%
990822	0	0	--
Totals	814	660	-19%

Table 5–53. Number of exceedance cells reduced at least 1 ppb from combination control 4 in 2012.

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo4
Scenario	**2012 a2 baseline**	**2012 with DFW combination control 4**
990815	--	10
990816	--	191
990817	--	246
990818	--	190
990819	--	160
990820	--	0
990821	--	12
990822	--	0
Totals	--	809

Table 5–54. Number of ppb's from grid cells in the daily maximum 8-hour ozone in excess of 85 ppb[1].

Run	run46.fy2012.a2	run46.fy2012.a2.dfw_lo_combo4
Scenario	**2012 a2 baseline**	**2012 with DFW combination control 4**
990815	13	1
990816	1535	1083
990817	1909	1442
990818	850	581
990819	597	342
990820	0	0
990821	16	1
990822	0	0
Totals	4919	3450 (-30 %)

[1]Σ(max(O3-85, 0.0)) for all grid cells in DFW 9-county NAA.

SUMMARY

A new combination of controls (combination #4) was applied to the 2009 and 2012 baselines using CAMx version 4.31 and "a2" emissions to examine their impacts to 8-hour ozone in the DFW 9-county NAA. This combination added DFW minor source controls to combination 3. The controls included DFW major and minor sources, DFW EGUs, Midlothian cement kilns, on-road and off-road mobile sources proposed by NCTCOG, and East Texas compressor engines within 200 km of DFW. In both future years, NOx and VOC emissions were reduced 87 and 8 tpd, respectively. The greatest ozone reduction was downwind of Midlothian due to the controls applied to the cement kilns.

In 2009, future design values at DFW monitors were reduced between 1.3 and 2.2 ppb due to combination 4 controls. All monitors had future design values below 85 ppb except Frisco (88.3 ppb) and Denton (87.9 ppb). In the 2009 baseline, there were 1158 4-km grid cells with 8-hour

ozone greater than 85 ppb in the DFW 9-county NAA during the episode. The combined controls reduced the 8-hour ozone at least 1 ppb in 90 % of these cells, reducing the exceedance area by 15 %.

A similar set of controls was applied to the 2012 baseline. Ozone was more responsive as future design values were reduced between 1.6 and 2.7 ppb. Attainment was achieved in 2012 as future design values at all nine DFW monitors dropped below 85 ppb. Frisco was at 84.8 ppb and Denton was at 84.6 ppb. Among the 814 4-km grid cells in the DFW 9-county NAA exceeding 85 ppb during the episode, 99 % were at least 1 ppb lower due to the controls as the exceedance area dropped 19 %.

Most of the DFW minor source controls were west of the nine DFW monitors so future design values at all DFW monitors changed no more than 0.1 ppb in both 2009 and 2012 when comparing DFW combination controls 3 and 4.

6. SUMMARY

Numerous DFW control scenarios were evaluated to examine the benefits to 8-hour ozone in the DFW 9-county NAA using the August 13-22, 1999 episode for the 2009 and 2012 future years. Controls evaluated in this study include:

- High and low-end controls to the Midlothian cement kilns.
- Spark-ignition engine controls in East Texas and within a 200 km radius of DFW.
- DFW major source and DFW EGU controls.
- DFW EGU controls.
- DFW minor source controls (revised).
- High and low-end NCTCOG on-road and off-road mobile source controls.
- East Texas EGU controls.
- A combination of controls listed above.

A new 1999 baseline (Run 44) was based on the DFW Run 40 base case configuration (Tai, et al., 2005b), but with updated Texas on-road mobile and offshore emissions, and an upgrade to NEI99 version 3 data outside of Texas. Modeling was based on a modified version of CAMx version 4.03.

Impacts to 8-hour ozone were evaluated using design value scaling. Table 6–1 shows the 2009 future design values at all available DFW ozone monitors for 12 control scenarios, and changes from the 2009 "a1" baseline. Values above 85 ppb are listed in red. Dallas C402 and Midlothian were the only two sites below 85 ppb in the 2009 baseline. Frisco and Denton had the highest baseline future design values at 91.2 and 89.6 ppb, respectively.

The largest reduction from any individual control to the future design values in 2009 was at Midlothian, where the East Texas EGU controls lowered the design value by 1.5 ppb. At all other sites, the greatest change in future design values came from the high-end NCTCOG on-road and off-road controls in the DFW area; future design values dropped between 0.8 and 1.4 ppb. Frisco and Denton's future design values were lowered to 90.3 and 88.2 ppb, respectively. The high-end NCTCOG control was the only individual control that reduced the future design value at Fort Worth C17 below 85 ppb.

The cement kiln and DFW major source controls had a greater impact at the southern DFW monitors than the northern sites, whereas the East Texas engine controls had a small, but relatively uniform impact throughout the 9 DFW monitors. The DFW minor source controls had the least impact as they reduced the future design values no more than 0.1 ppb at all monitors.

The 2009 high-end combination of controls (DFW major and minor source, DFW EGUs, low NCTCOG controls, and high cement kiln controls) reduced the future design values over 2 ppb at two monitors in Tarrant County, but only half as much at Denton and Frisco.

DFW modeling was upgraded to the current release of CAMx version 4.31, which included a restructuring of the plume-in-grid submodel. There was also a minor point source emissions update for 2009, which had little impact in DFW. In the new 1999 baseline with CAMx 4.31 (DFW Run 46), model performance was comparable to CAMx 4.03 (Run 44), and was better on August 17, the date with the highest observed ozone.

The first two columns of Table 6–2 compare the 2009 baseline future design values between the two versions of CAMx using the latest 2009 “a2” emissions. The future design values were lower in the Run 46 (CAMx 4.31) configuration compared to the Run 44 (CAMx 4.03) configuration at most DFW locations. Differences ranged from -1.6 ppb at Dallas C63 to +0.1 ppb at Midlothian. Frisco and Denton’s 2009 baseline future design values with CAMx 4.31 were 89.8 and 89.3 ppb, respectively. Dallas C402 and Midlothian were the only two sites in the 2009 baseline with future design values below 85 ppb.

The two rightmost columns of Table 6–2 show the future design values when applying two sets of combination controls. Combination 3 consists of controls to DFW major sources, DFW EGUs, low-end NCTCOG and cement kiln controls, and East Texas engine controls within 200 km of DFW. Combination 4 adds DFW minor source controls. Both combinations lowered 7 of the 9 DFW monitors below 85 ppb. Frisco and Denton continued to have future design values above 85 ppb and therefore could not demonstrate attainment for 8-hour ozone in DFW. Frisco had a 2009 future design value of 88.3 ppb; Denton, 87.9 ppb.

Future design values were also examined for the 2012 future year. Anthropogenic NOx emissions in Texas were 9 % lower in the 2012 baseline compared to 2009, largely due to on-road mobile NOx reductions. Table 6–3 shows the 2012 future design values using CAMx 4.31 for the baseline and similar combinations of controls that were applied in 2009. Future design values in the 2012 baseline were at least 2.4 ppb lower than the 2009 baseline at all DFW monitors except Midlothian. The 2012 baseline design values at Frisco and Denton were 86.7 and 86.3 ppb; all other monitors were below 85 ppb. When either combination of controls was applied to the 2012 baseline, attainment was achieved as all DFW monitors showed future design values below 85 ppb.

Table 6–1. Summary of future design values [ppb] for the 2009 a1 baseline and differences from each of the 12 controls.

	2009 a1 baseline	Max cement kiln	Min cement kiln	East TX engines	East TX engines (<200km DFW)	DFW major sources	DFW EGUs	DFW minor sources	High end NCTCOG onroad + off-road	Low end NCTCOG on-road + offroad	East TX EGU (<200 km DFW)	High combo (high kilns, lowNCTCOG, and DFW major, minor, and EGU	Low combo (low kilns, lowNCTCOG, DFW major, minor, and EGU)
Change in emissions [tpd]													
NOx	0	-20	-10	-83	-41	-15	-2	-5	-33	-16	-137	-56	-46
VOC	0	0	0	0	0	0	0	0	-8	-8	0	-8	-8
2009 Future design values													
Frisco	91.2	91.2	91.2	90.9	90.9	90.9	91.0	91.2	90.3	90.8	90.5	90.3	90.4
Dallas C60	87.6	87.5	87.5	87.2	87.3	87.2	87.4	87.5	86.7	87.1	86.9	86.7	86.8
Dallas C63	87.0	87.0	87.0	86.7	86.7	86.7	86.9	87.0	86.2	86.6	86.4	86.2	86.2
Dallas C402	79.7	79.5	79.6	79.4	79.4	79.3	79.6	79.6	78.8	79.3	79.0	78.6	78.7
Denton	89.6	89.6	89.6	89.3	89.4	89.3	89.5	89.5	88.2	88.9	89.0	88.5	88.5
Midlothian	84.5	84.2	84.9	84.2	84.2	83.9	84.6	84.5	84.0	84.3	83.1	83.2	84.0
Arlington	87.2	86.2	86.8	87.0	87.0	86.6	87.1	87.2	86.3	86.7	86.3	85.0	85.6
Fort Worth C13	87.6	86.7	87.1	87.4	87.4	87.1	87.6	87.5	86.6	87.1	86.8	85.5	85.9
Fort Worth C17	86.0	85.7	85.9	85.7	85.7	85.7	85.9	85.9	84.7	85.3	85.4	84.7	84.8
Change from a1 baseline													
Frisco		0.0	0.0	-0.3	-0.3	-0.4	-0.3	0.0	-1.0	-0.5	-0.8	-1.0	-0.8
Dallas C60		-0.1	0.0	-0.3	-0.3	-0.3	-0.2	-0.1	-0.9	-0.4	-0.6	-0.9	-0.8
Dallas C63		0.0	0.0	-0.3	-0.3	-0.3	-0.2	-0.1	-0.8	-0.4	-0.6	-0.8	-0.8
Dallas C402		-0.2	0.0	-0.3	-0.3	-0.4	-0.1	-0.1	-0.9	-0.4	-0.7	-1.1	-0.9
Denton		-0.1	0.0	-0.3	-0.3	-0.3	-0.1	-0.1	-1.4	-0.7	-0.6	-1.1	-1.1
Midlothian		-0.3	0.4	-0.4	-0.3	-0.6	0.0	-0.1	-0.5	-0.3	-1.5	-1.4	-0.5
Arlington		-1.0	-0.5	-0.3	-0.2	-0.6	-0.1	0.0	-1.0	-0.5	-1.0	-2.2	-1.6
Fort Worth C13		-0.9	-0.5	-0.3	-0.2	-0.5	0.0	-0.1	-1.0	-0.5	-0.8	-2.1	-1.7
Fort Worth C17		-0.2	-0.1	-0.3	-0.2	-0.3	-0.1	-0.1	-1.3	-0.6	-0.5	-1.3	-1.1

Values over 85 ppb are in red

Table 6–2. Summary of 2009 future design values [ppb] with the 2009 "a2" inventory.

	2009 a2 baseline, CAMx 4.03	2009 a2 baseline, CAMx 4.31	2009 a2 with combination 3 controls, CAMx 4.31	2009 a2 with combination 4 controls CAMx 4.31
2009 Future design values				
Frisco	91.2	89.8	88.4	88.3
Dallas C60	87.6	86.2	84.9	84.8
Dallas C63	87.0	85.4	84.1	84.1
Dallas C402	79.6	79.0	77.5	77.5
Denton	89.6	89.3	88.0	87.9
Midlothian	84.6	84.7	83.1	83.1
Arlington	87.1	86.2	84.0	84.0
Fort Worth C13	87.5	86.8	84.7	84.6
Fort Worth C17	85.9	85.4	84.1	84.1
		Change from 4.03	**Change from 2009 baseline with CAMx 4.31**	
Frisco		-1.4	-1.4	-1.5
Dallas C60		-1.4	-1.3	-1.4
Dallas C63		-1.6	-1.3	-1.3
Dallas C402		-0.6	-1.5	-1.5
Denton		-0.3	-1.3	-1.4
Midlothian		0.1	-1.7	-1.7
Arlington		-1.0	-2.2	-2.2
Fort Worth C13		-0.7	-2.1	-2.2
Fort Worth C17		-0.5	-1.4	-1.4

Table 6–3. Summary of 2012 future design values [ppb] using CAMx 4.31.

	2009 a2 baseline	2012 a2 baseline	2012 a2 with combination 3 controls	2012 a2 with combination 4 controls
2009 Future design values				
Frisco	89.8	86.7	84.9	84.8
Dallas C60	86.2	83.4	81.9	81.8
Dallas C63	85.4	82.6	81.0	80.9
Dallas C402	79.0	76.7	74.9	74.8
Denton	89.3	86.3	84.7	84.6
Midlothian	84.7	83.3	81.5	81.4
Arlington	86.2	83.7	81.2	81.1
Fort Worth C13	86.8	84.1	81.5	81.4
Fort Worth C17	85.4	82.6	81.0	80.9
		Change from 2009	**Change from 2012 baseline**	
Frisco		-3.1	-1.8	-1.9
Dallas C60		-2.8	-1.6	-1.6
Dallas C63		-2.8	-1.6	-1.7
Dallas C402		-2.4	-1.8	-1.8
Denton		-3.0	-1.6	-1.7
Midlothian		-1.5	-1.8	-1.8
Arlington		-2.5	-2.5	-2.6
Fort Worth C13		-2.8	-2.6	-2.7
Fort Worth C17		-2.8	-1.6	-1.7

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