

ENVIRON

MEMORANDUM

To: Pete Breitenbach
From: Edward Tai and Greg Yarwood
Date: March 15, 2006
Subject: Ozone sensitivity test with DFW major source and DFW EGU controls

Introduction

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.

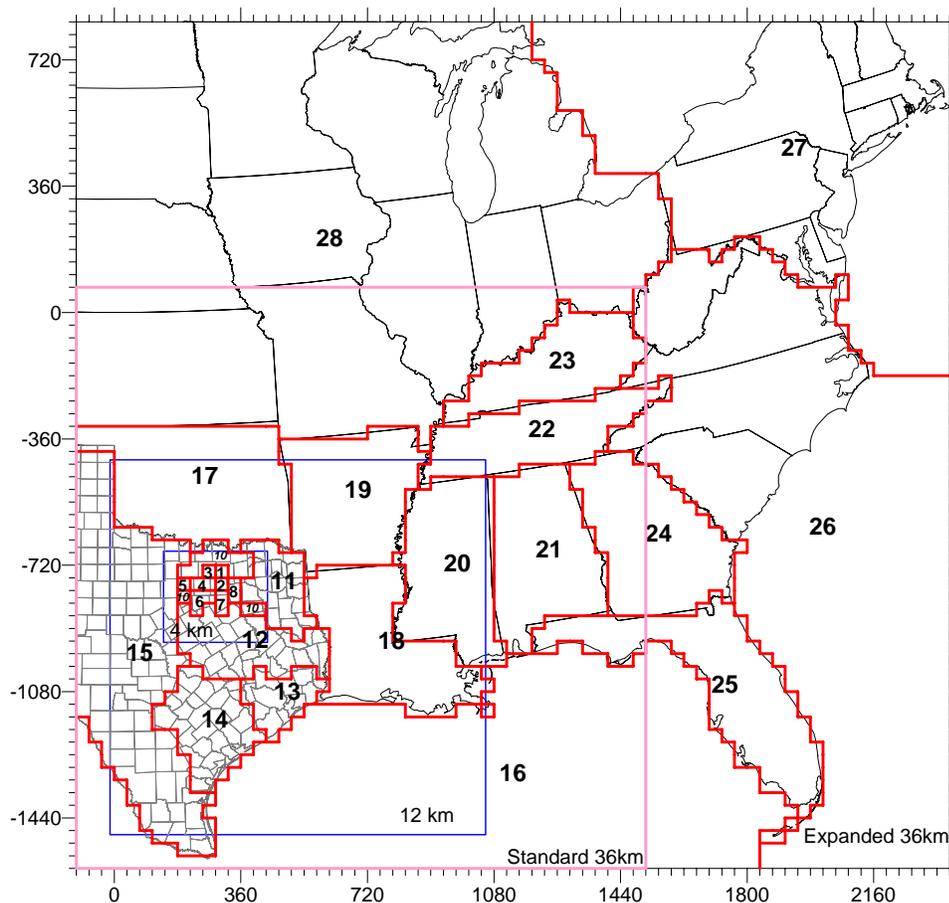
The runs were based on the Run 44 baseline configuration, with the modeling domain covering the expanded 36 km domain with 14 km model top. Inputs included meteorology from MM5 Run 6, which was based on the ETA PBL scheme coupled with the Noah land surface model, with the kv100 patch applied to the vertical diffusivity. The boundary conditions assigned moderate conditions in the mixed layer over land, and clean conditions over the Gulf, Atlantic and all areas aloft. A modified version of CAMx 4.03 was used in which several NOx recycling reactions were added to the CB4 mechanism (CB4xi).

Emissions

The DFW controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs. 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 1 and 2, respectively, by source region, as defined in Figure 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 2 shows a tile plot of the local NO_x 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 NO_x, and in central Ellis County, where NO_x reductions totaled 2.9 tpd from two 4 km grid cells.



DFW Source Regions. 36 km Expanded Domain

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

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

Table 1. 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 2. 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

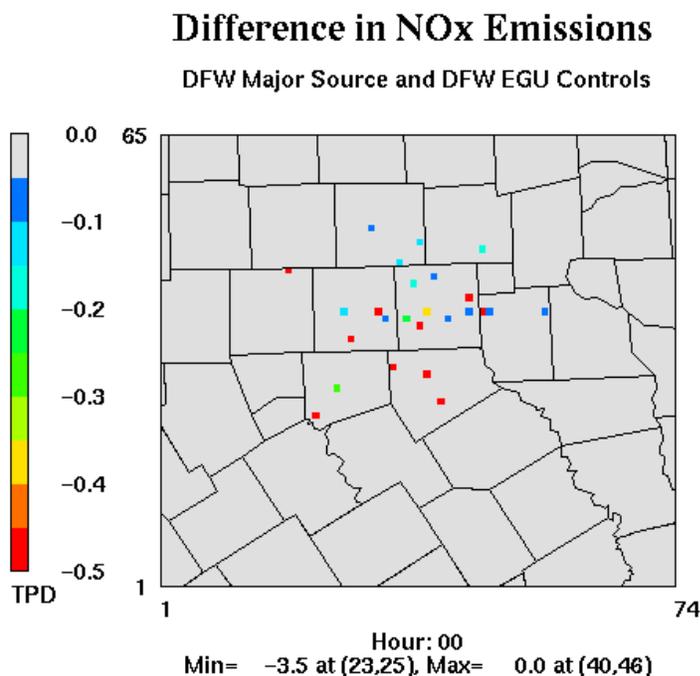


Figure 2. Tile plot of differences in NO_x emissions from the DFW major source and EGU controls.

Model Results

Spatial plots of the daily maximum 8-hour ozone and differences from the 2009 baseline are shown in Figure 2 for each episode date in the DFW 4 km domain. On most dates, three plumes of ozone benefits originated near three areas with large NO_x 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 3 for all DFW monitoring sites using the 1999 baseline design value, and is compared to the 2009 baseline design values in Table 4. 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 5 to 7 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 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 6 shows this occurring on August 20.

Table 7 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.

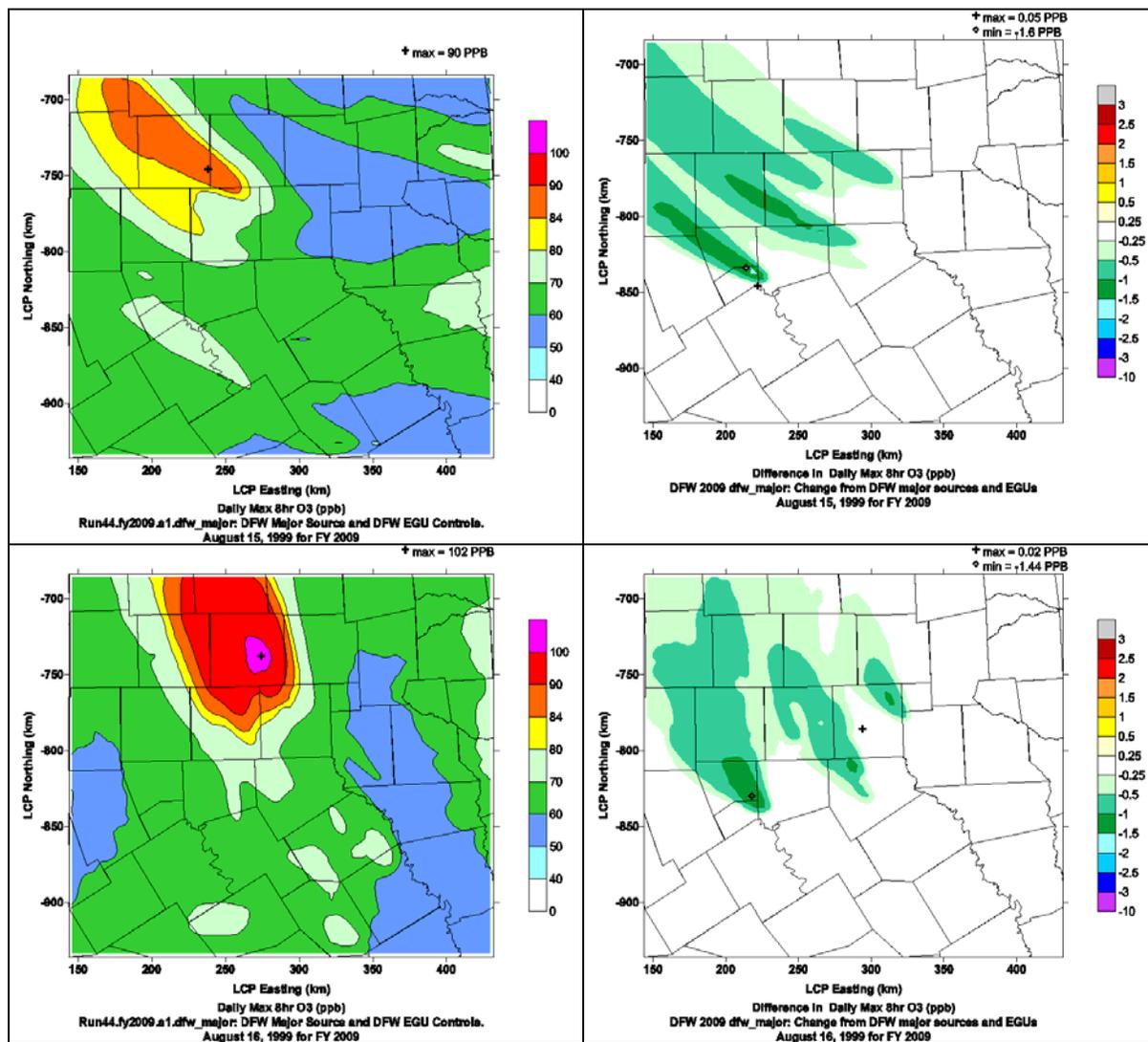


Figure 3. Spatial plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for each episode date.

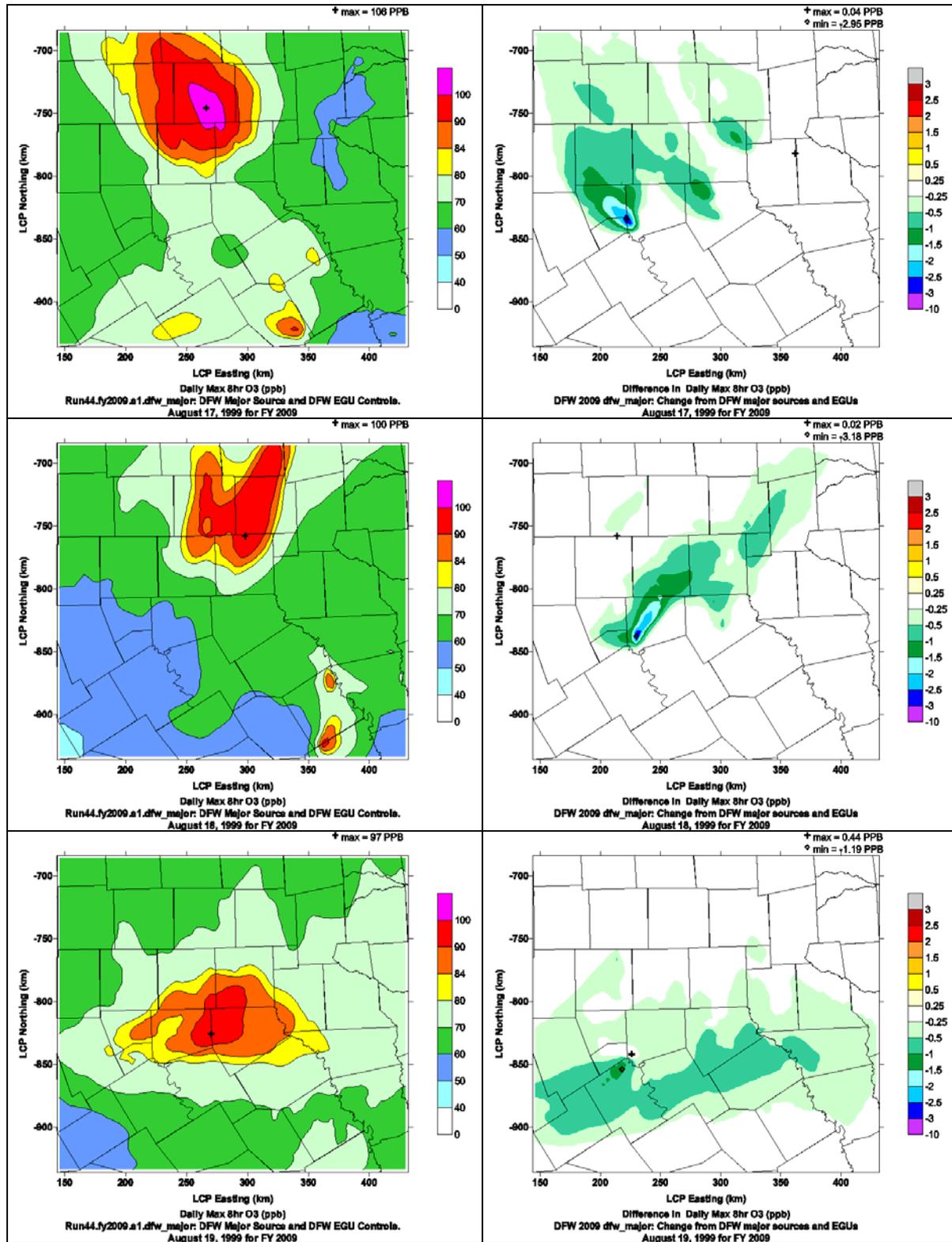


Figure 3. (Continued) Spatial plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for each episode date.

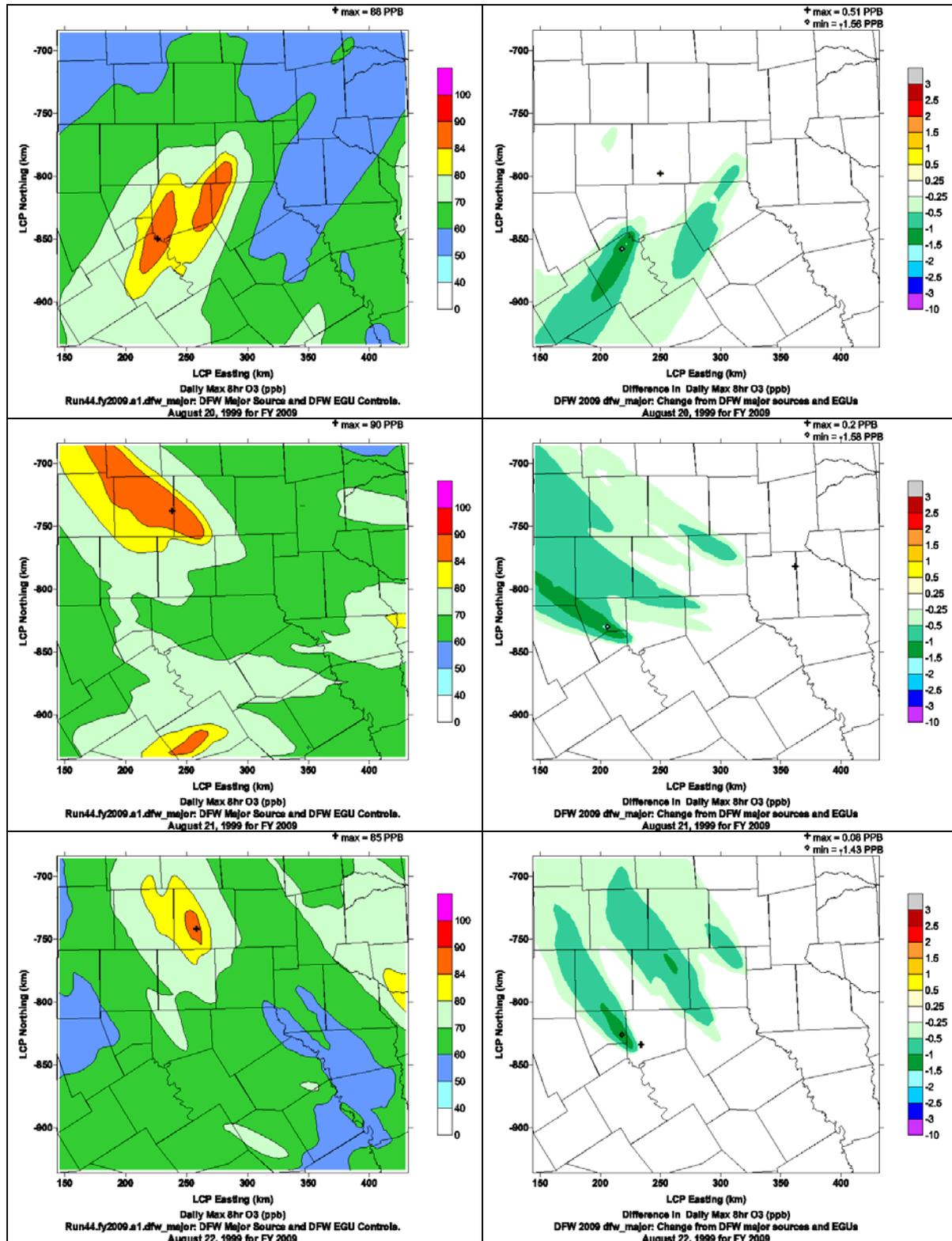


Figure 3. (Concluded) Spatial plots of the daily maximum 8-hour ozone (left) and differences from the 2009 baseline (right) for each episode date.

Table 3. Future design value calculation for the DFW major source and DFW EGU control scenario

Design Value Scaling												
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.fv2009.a1.dfw major												
Site	990815	990816	990817	990818	990819	990820	990821	990822	Average	EPA RRF	BaseDV	FutureDV
Frisco	67.8	99.8	100.2	98.0	73.0	64.8	74.6	75.0	81.7	0.906	100.3	90.86
Dallas C60	73.0	92.7	102.0	99.2	89.2	82.7	78.7	74.7	86.5	0.948	92.0	87.23
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	86.68
Dallas C402	68.1	81.9	89.9	87.6	95.4	87.5	72.0	69.6	81.5	0.908	87.3	79.28
Denton	88.1	102.1	106.3	92.0	70.9	64.1	89.2	84.7	87.2	0.880	101.5	89.34
Midlothian	69.7	75.4	77.5	69.9	97.0	86.9	68.8	67.9	76.6	0.907	92.5	83.92
Arlington	73.6	89.6	91.0	82.7	94.1	87.5	73.7	78.5	83.9	0.912	95.0	86.63
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	87.08
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	85.65
Daily RRFs												
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				

Table 4. 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 5. 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 6. Number of daily maximum 8-hour ozone exceedance¹ cells in DFW reduced by at least 1 ppb.

Scenario	DFW major source and DFW EGU Control [# cells]
Run	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 7. Number of ppb's in the daily maximum 8-hour ozone in the DFW 9-county NAA in excess of 85 ppb¹.

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%

$\Sigma(\max(O_3-85, 0.0))$ for all 4-km grid cells in DFW

Summary

An ozone sensitivity test examined the impact from reducing NO_x 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 NO_x 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 NO_x 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.