ENVIRON

MEMORANDUM

To: Pete Breitenbach

From: Edward Tai and Greg Yarwood

Date: March 6, 2006

Subject: Dallas/Fort Worth 2009 East Texas Engine Sensitivity Tests

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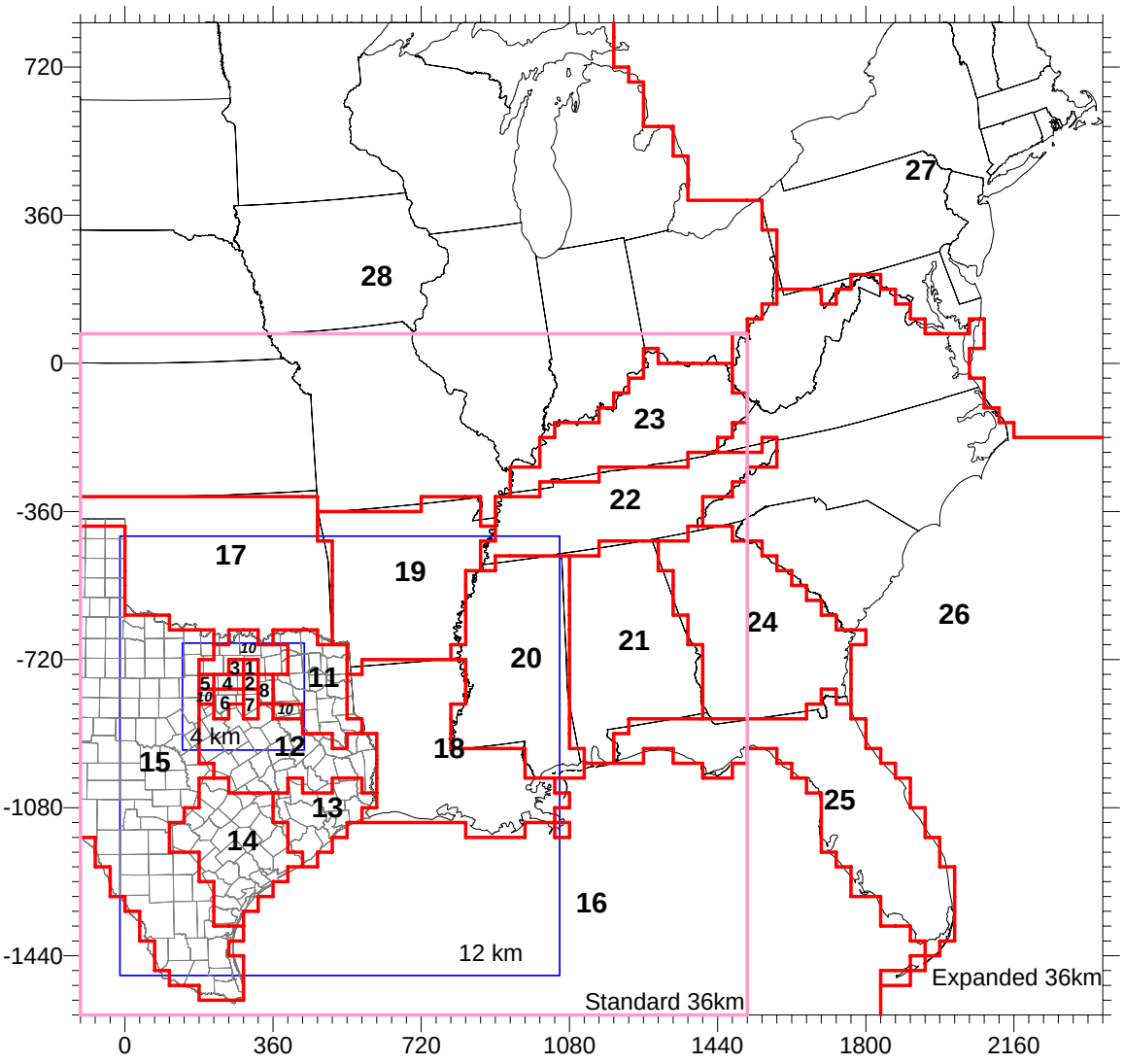
Introduction

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 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 Benefits

The engine controls were applied to the 2009 "a1" baseline emissions, which incorporated 2005 acid rain data for the Texas EGUs. 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 1 and 2 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 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 3, were unchanged from the baseline in both scenarios. Plots of the difference in NOx emissions due to each control scenario are shown in Figure 2.



DFW Source Regions. 36 km Expanded Domain

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

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

Table 1. 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 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 2. 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 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 3. 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**

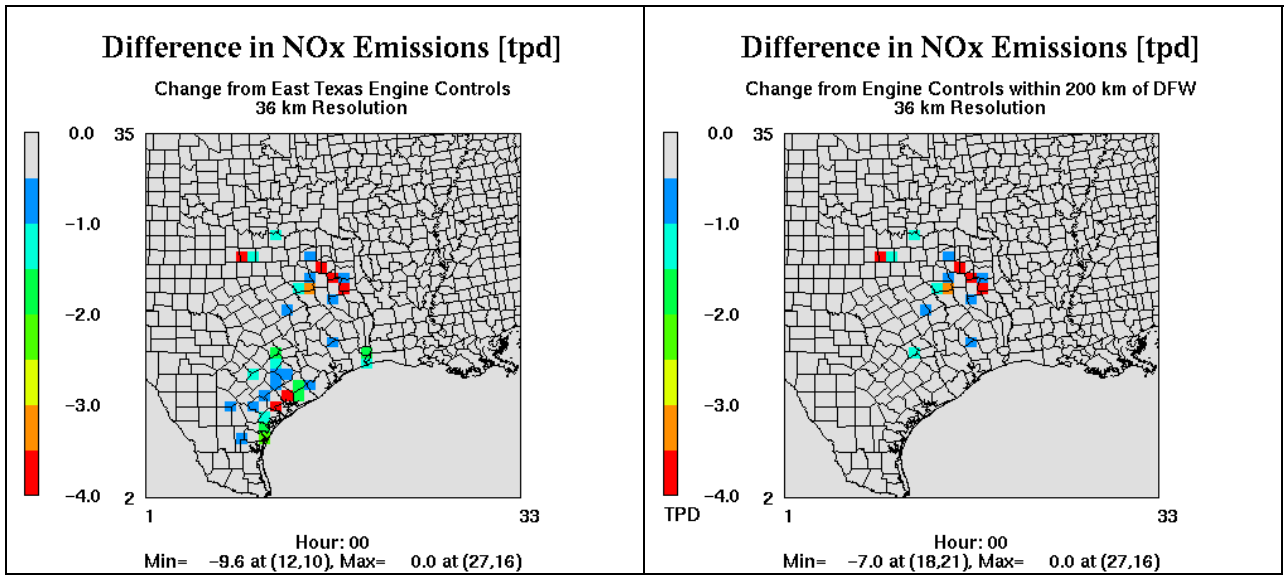


Figure 2. Tile plots of NOx reductions from the engine controls in East Texas (left) and within 200 km of DFW (right).

Ozone Benefits

Four daily maximum ozone and difference plots inside the DFW 4 km domain are shown in Figure 3 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.

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.

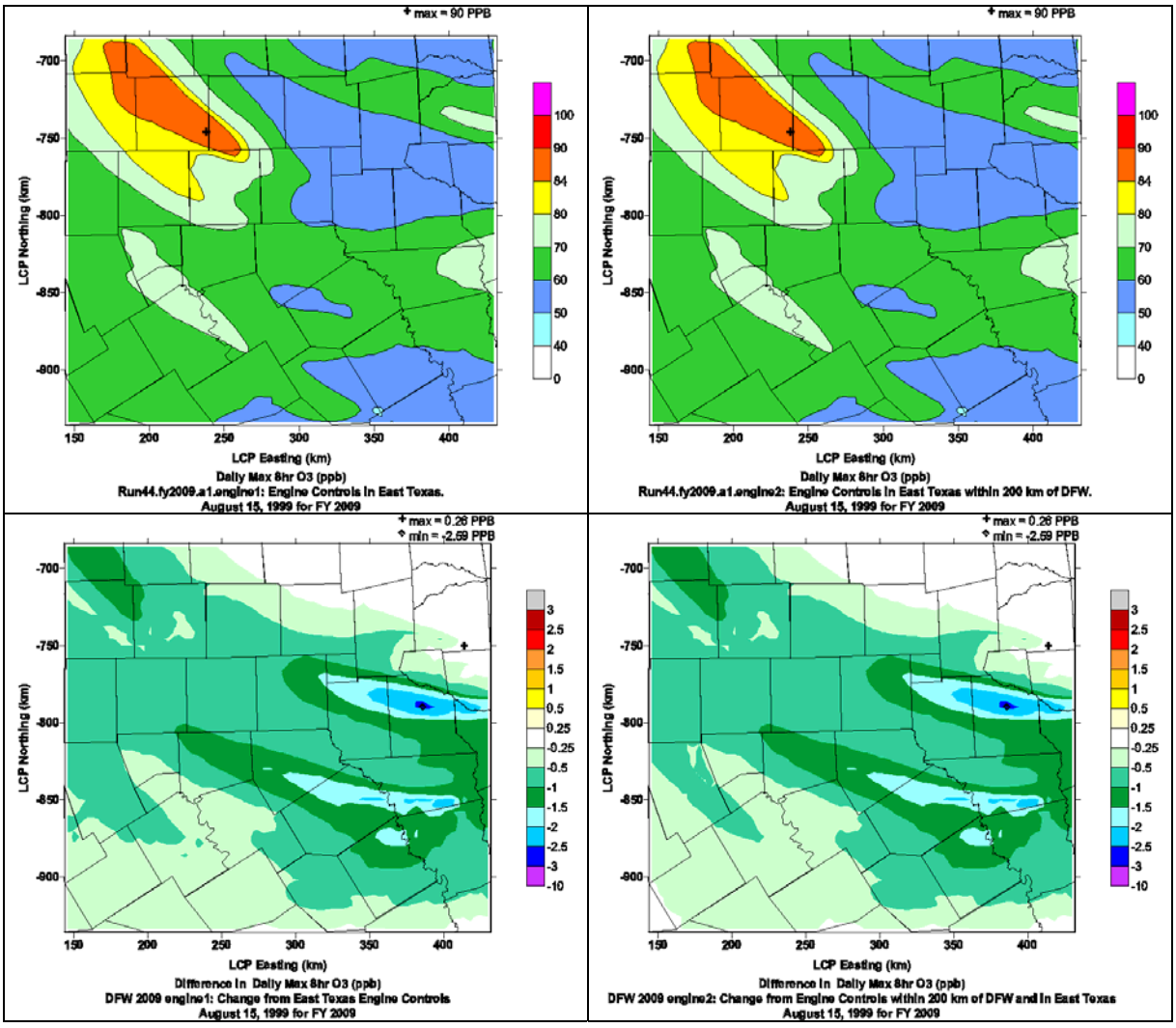


Figure 3. Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

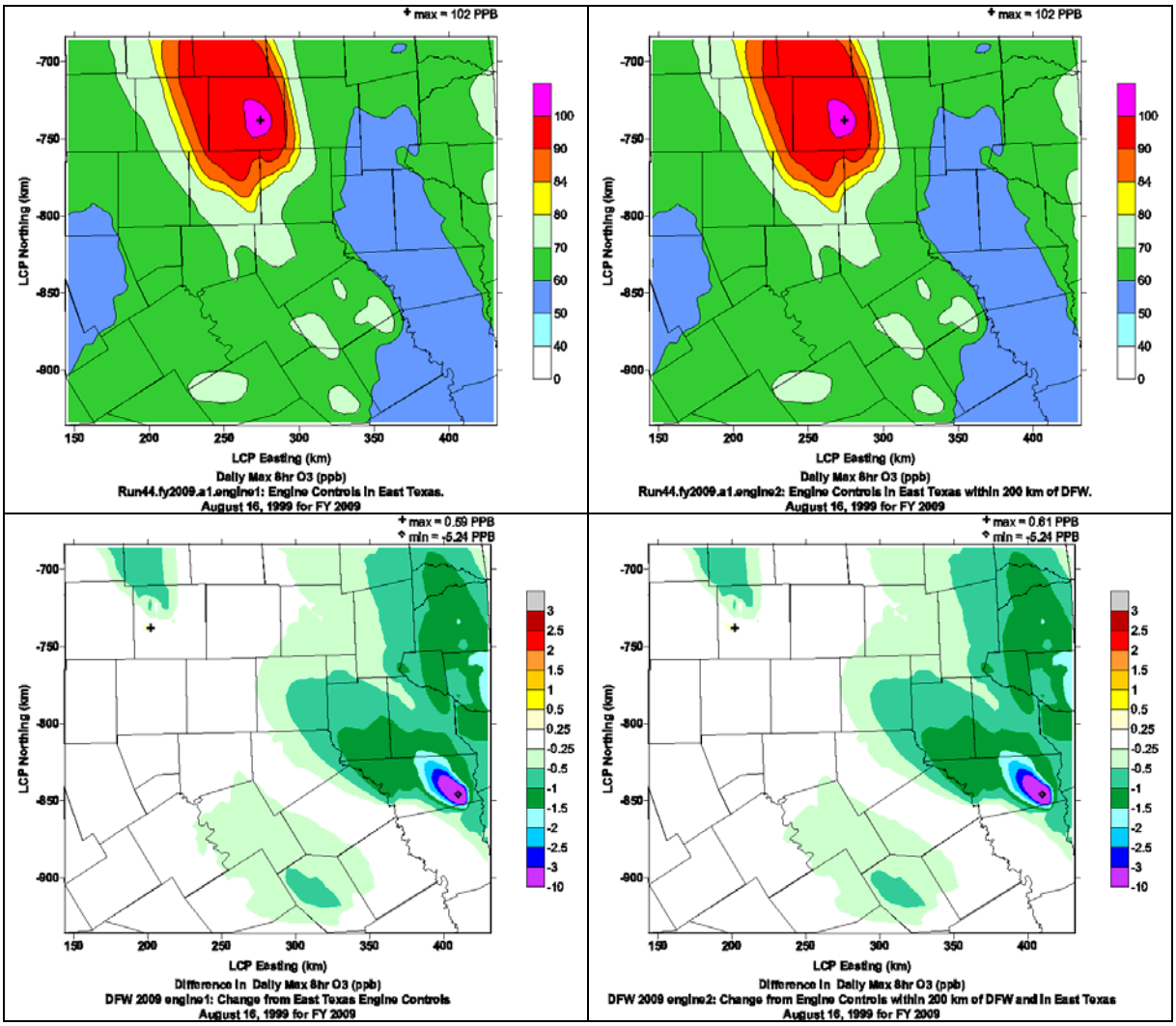
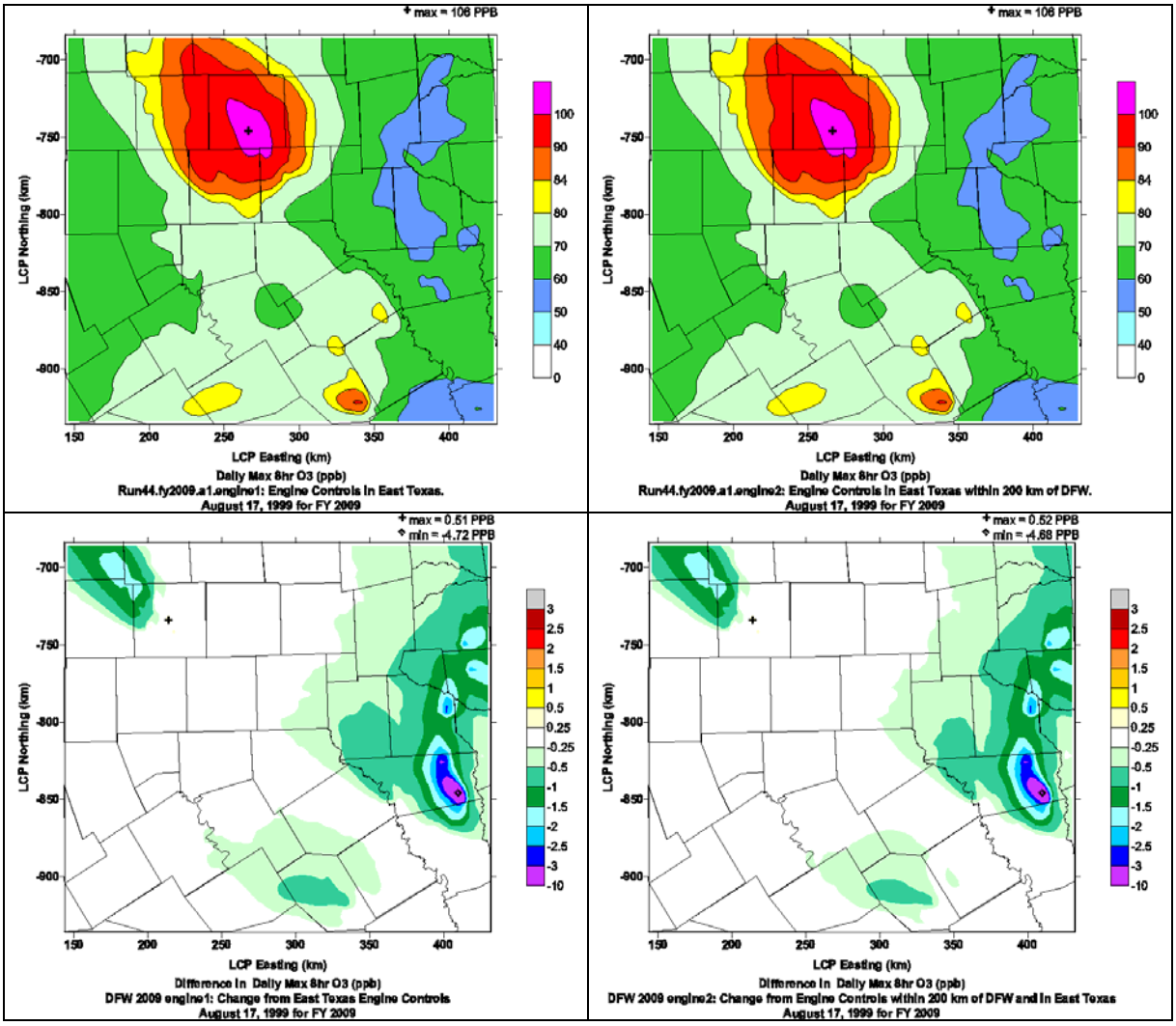


Figure 3. (continued). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).



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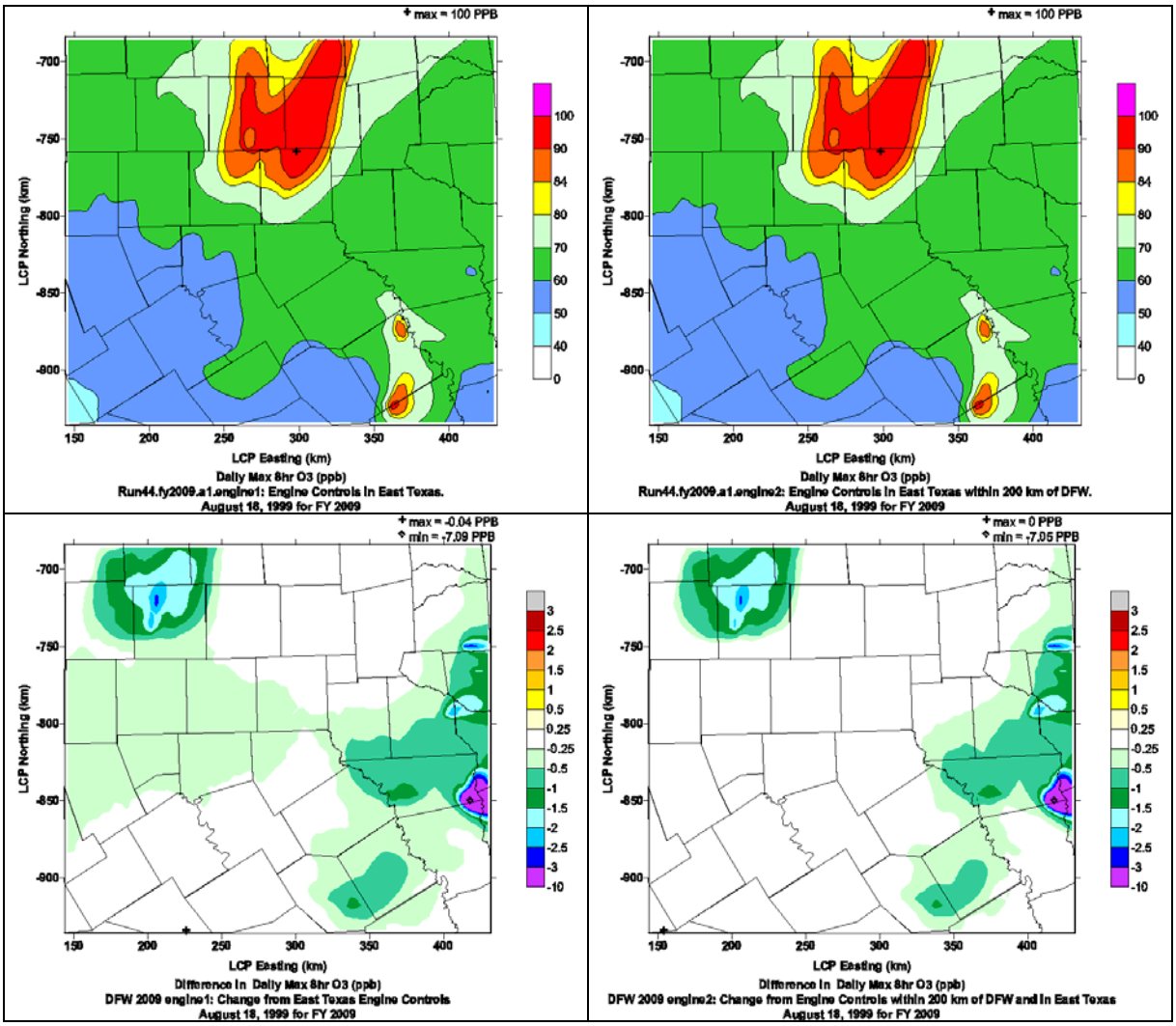

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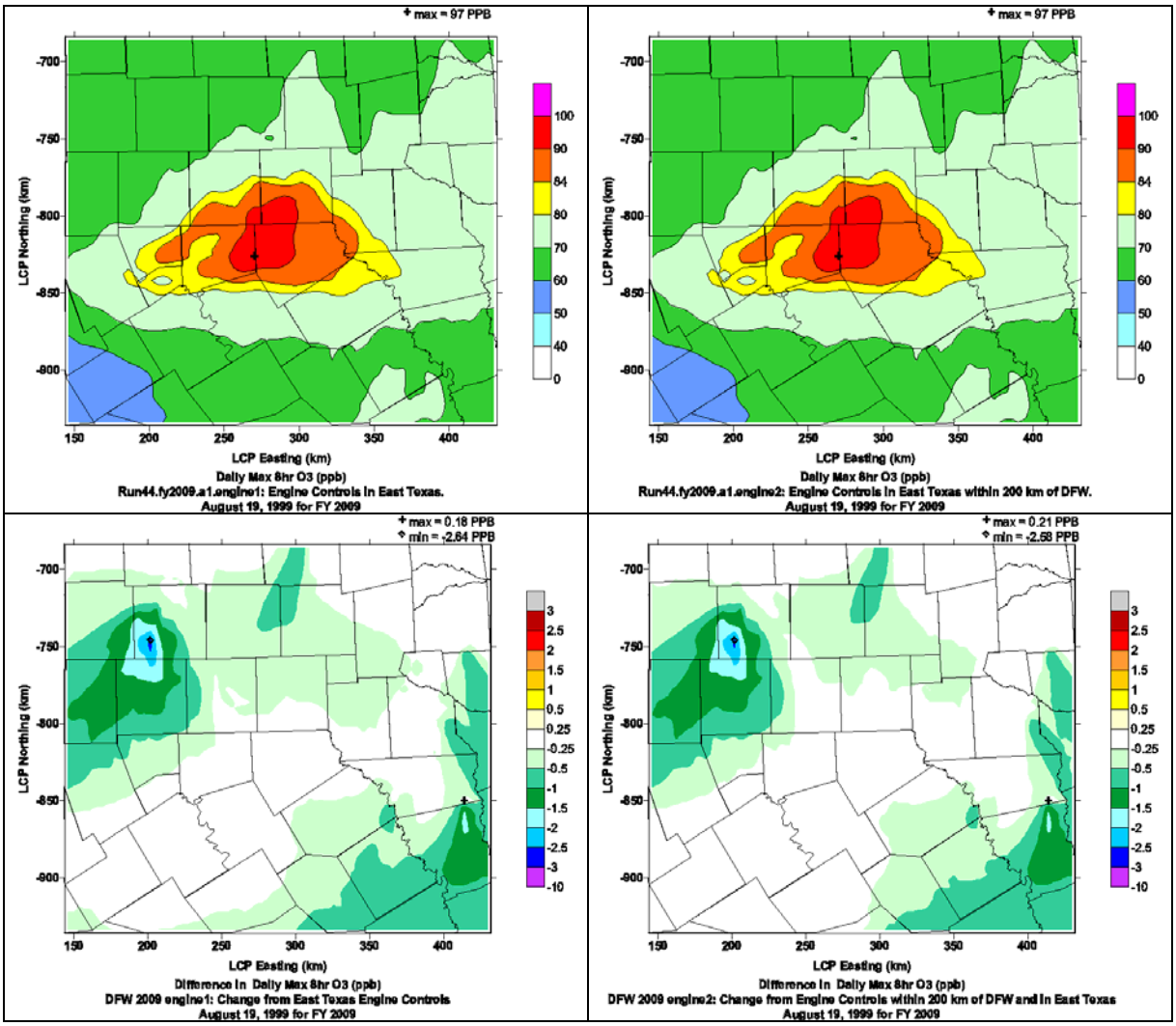

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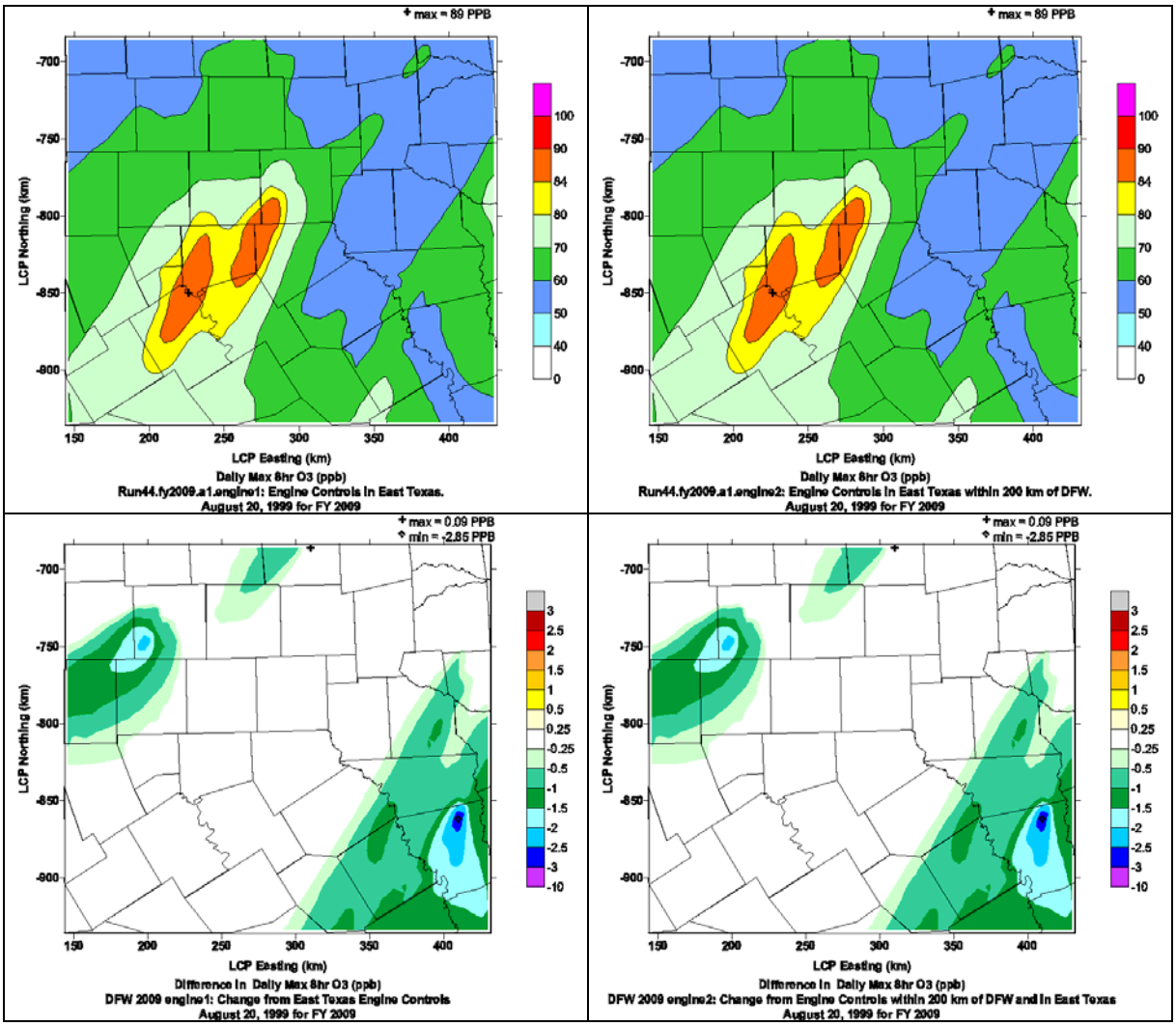

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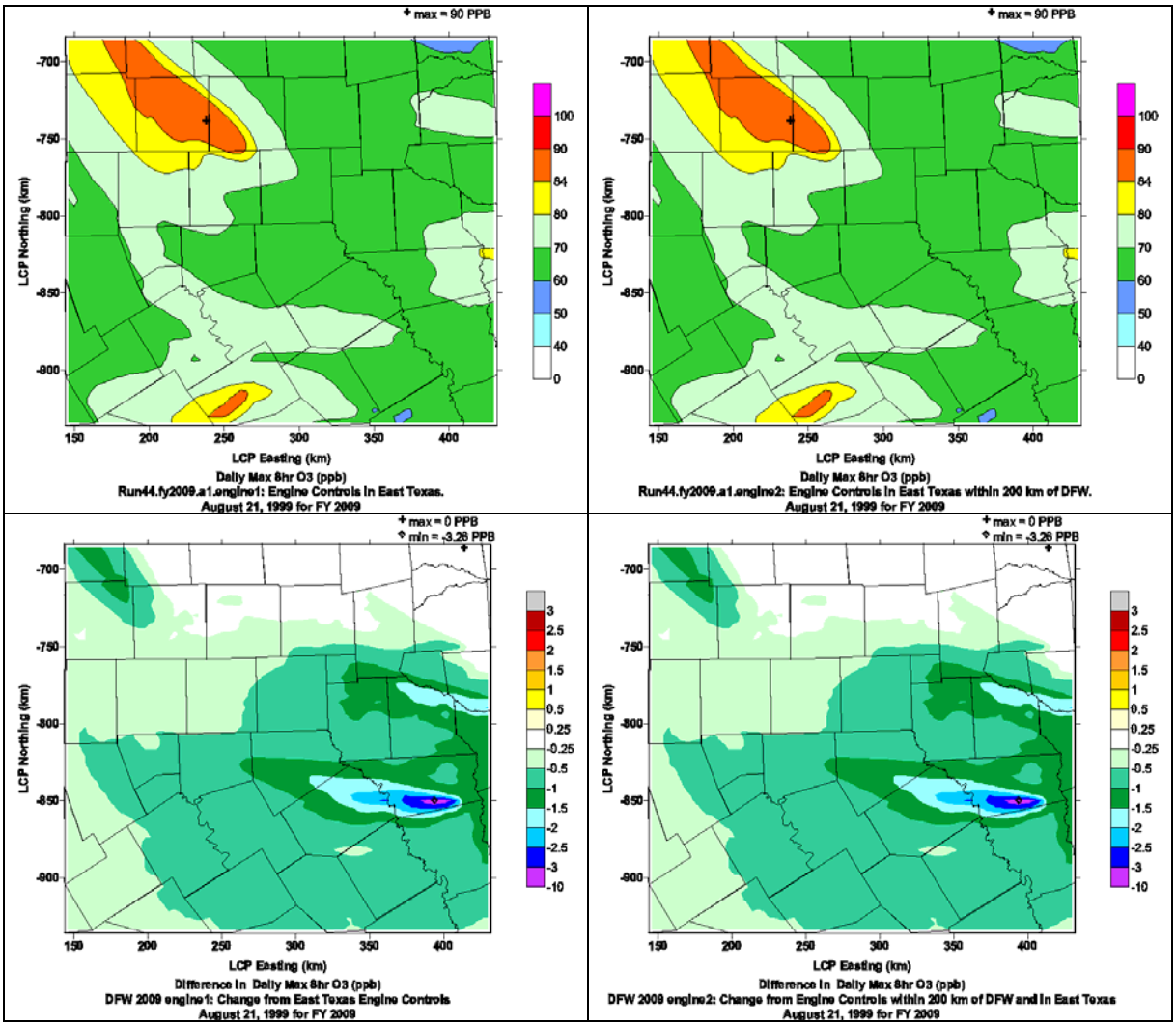

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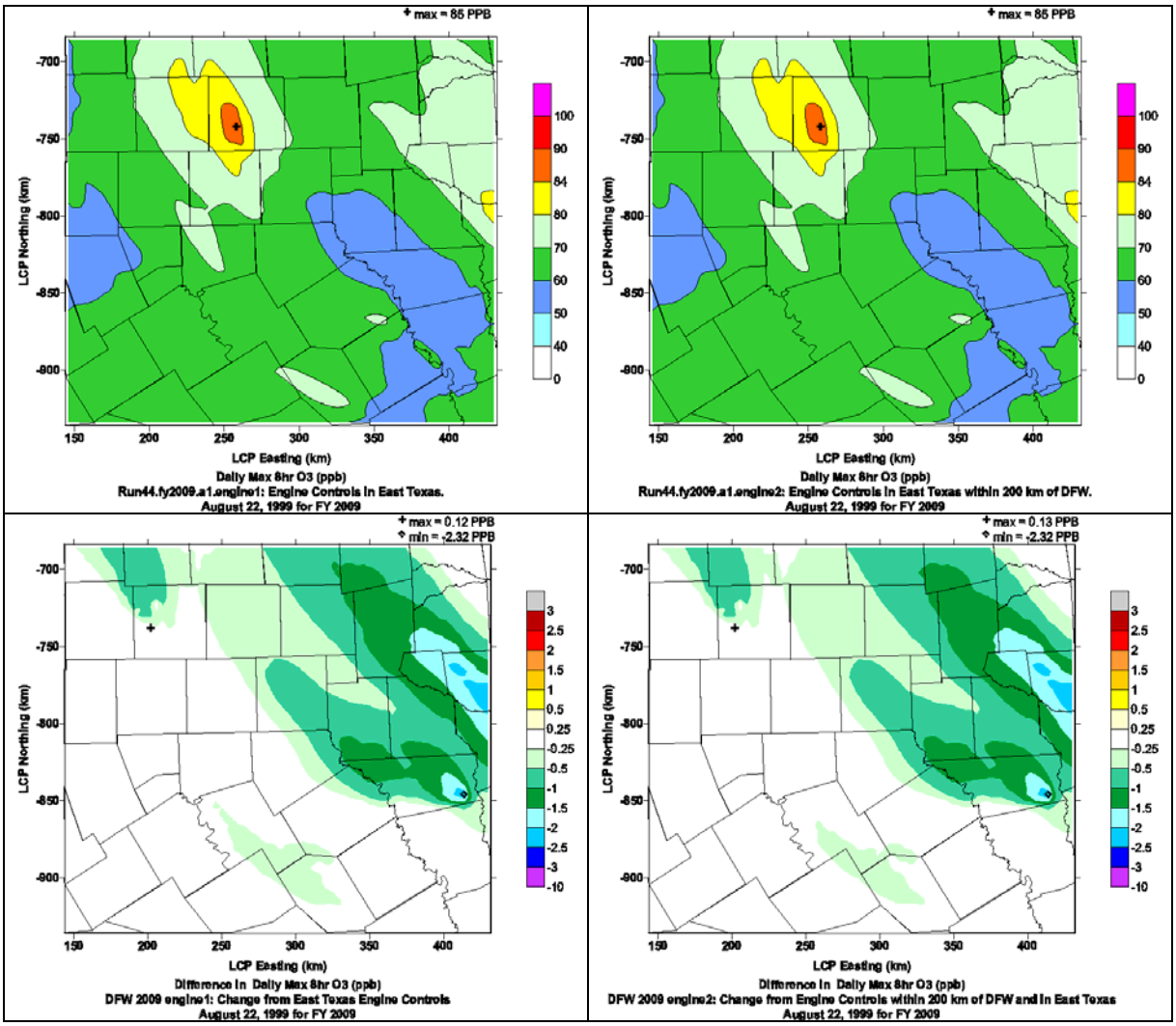


Figure 3. (concluded). Spatial plots of the daily maximum 8-hour ozone in the 4 km domain with engine controls in East Texas (top left), East Texas engine controls within 200 km of DFW (top right), and their differences from the 2009 baseline (bottom left and right, respectively).

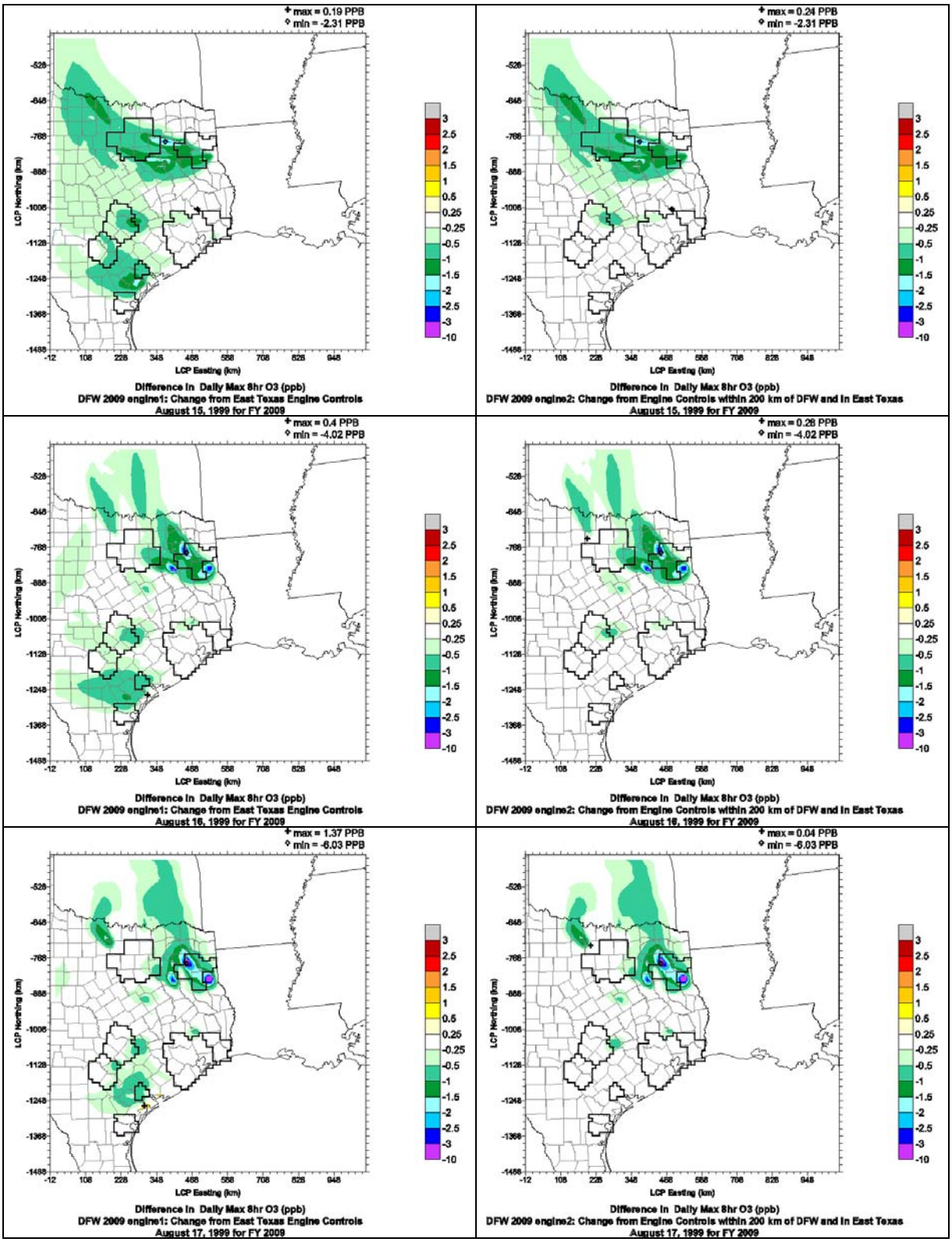
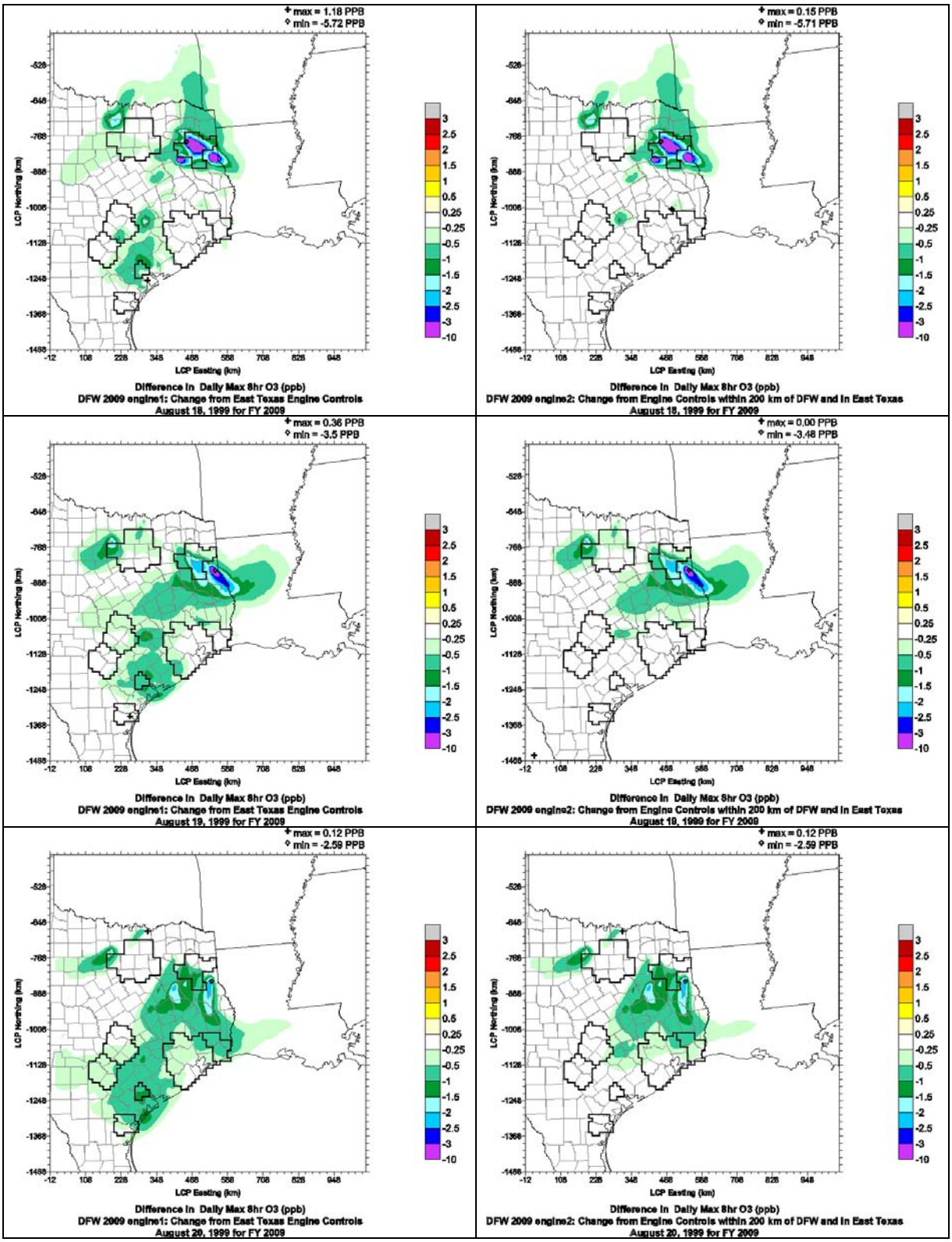


Figure 4. Spatial plots of the difference in daily maximum 8-hour ozone from engine controls in East Texas (left) and within 200 km of DFW (right) for each episode date.



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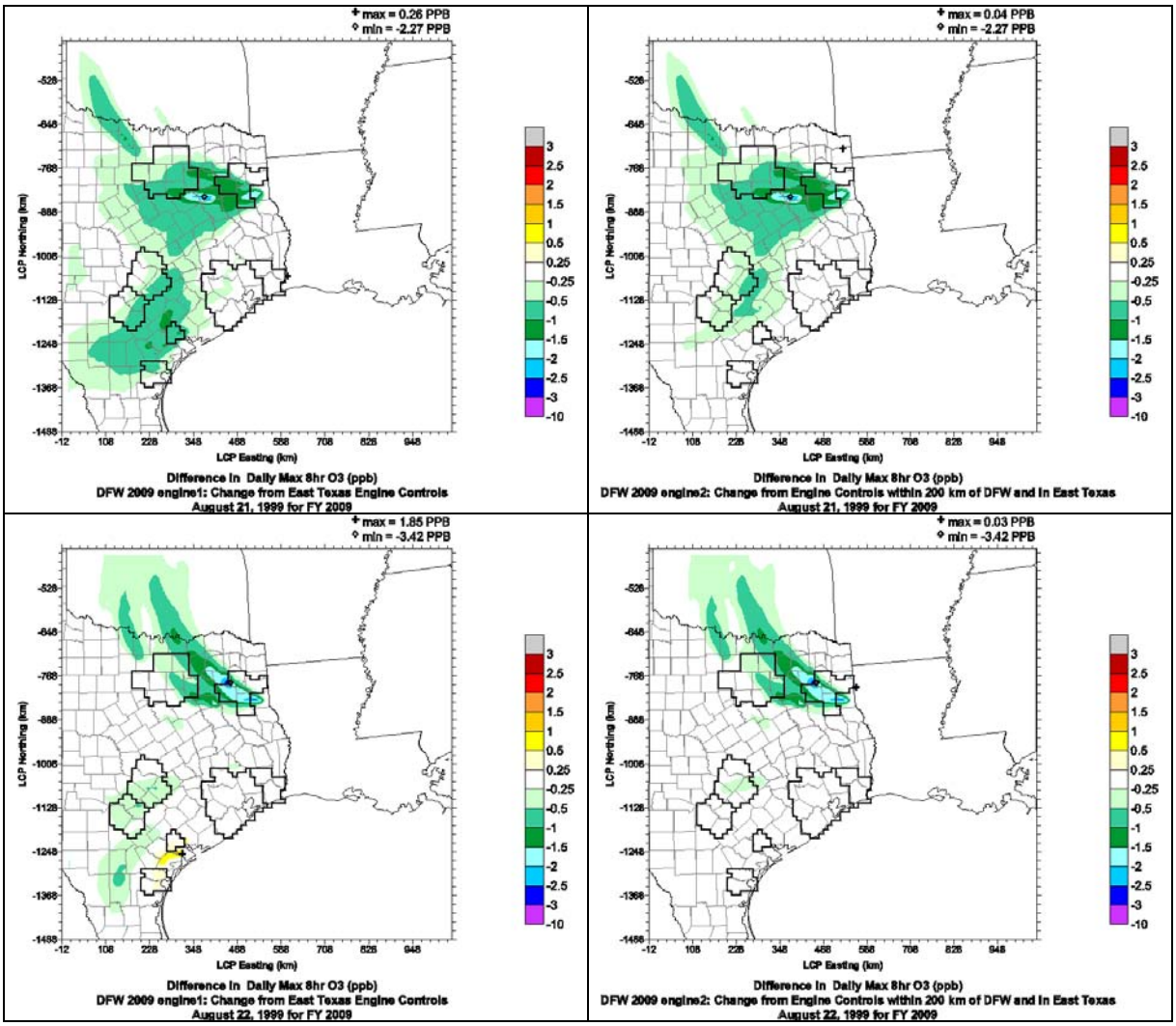

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DFW 8-Hour Ozone Design Values

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 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 5 and 6 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.

Table 4. Summary of 2009 future design values and differences from the two East Texas engine controls.

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 5. 2009 future design values calculation for the East Texas engine control.

Base Case: run44												
Site	**990815**	**990816**	**990817**	**990818**	**990819**	**990820**	**990821**	**990822**	**Avg**	**#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**	**Avg**	**EPA RRF**	**BaselineDV**	**FutureDV**
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												
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				

Red values denote daily RRFs > 1.0; blue values are below 0.9.

Table 6. 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**	**Avg**	**#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**	**Avg**	**EPA RRF**	**BaselineDV**	**FutureDV**
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												
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				

Red values denote daily RRFs > 1.0; blue values are below 0.9.

Other Ozone Metrics for DFW

Tables 7 to 10 analyze the areal extent of the daily maximum 8-hour ozone exceeding 85 ppb in the DFW 9-county NAA. Table 7 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. Table 8 shows the percent change in exceedance area resulting from each control. Table 9 counts the number of daily maximum 8-hour ozone exceedance cells that are reduced by at least 1 ppb when applying the controls. Table 10 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 7. Daily count of unique grid cells exceeding 85 ppb in the DFW 9-county NAA.

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

Table 8. Change in exceedance area due to the cement kiln 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	---	-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 9. Number of daily maximum 8-hour ozone exceedance[1] cells in DFW reduced at least 1 ppb.

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 10. 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].

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