ENVIRON

MEMORANDUM

To: Pete Breitenbach

From: Edward Tai and Greg Yarwood

Date: May 23, 2006

Subject: Task 20: DFW 2009 Baseline APCA Results

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).

The run was 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 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 1 summarizes the weekday EGU NOx and VOC emissions for each group and Figure 1 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 1. 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

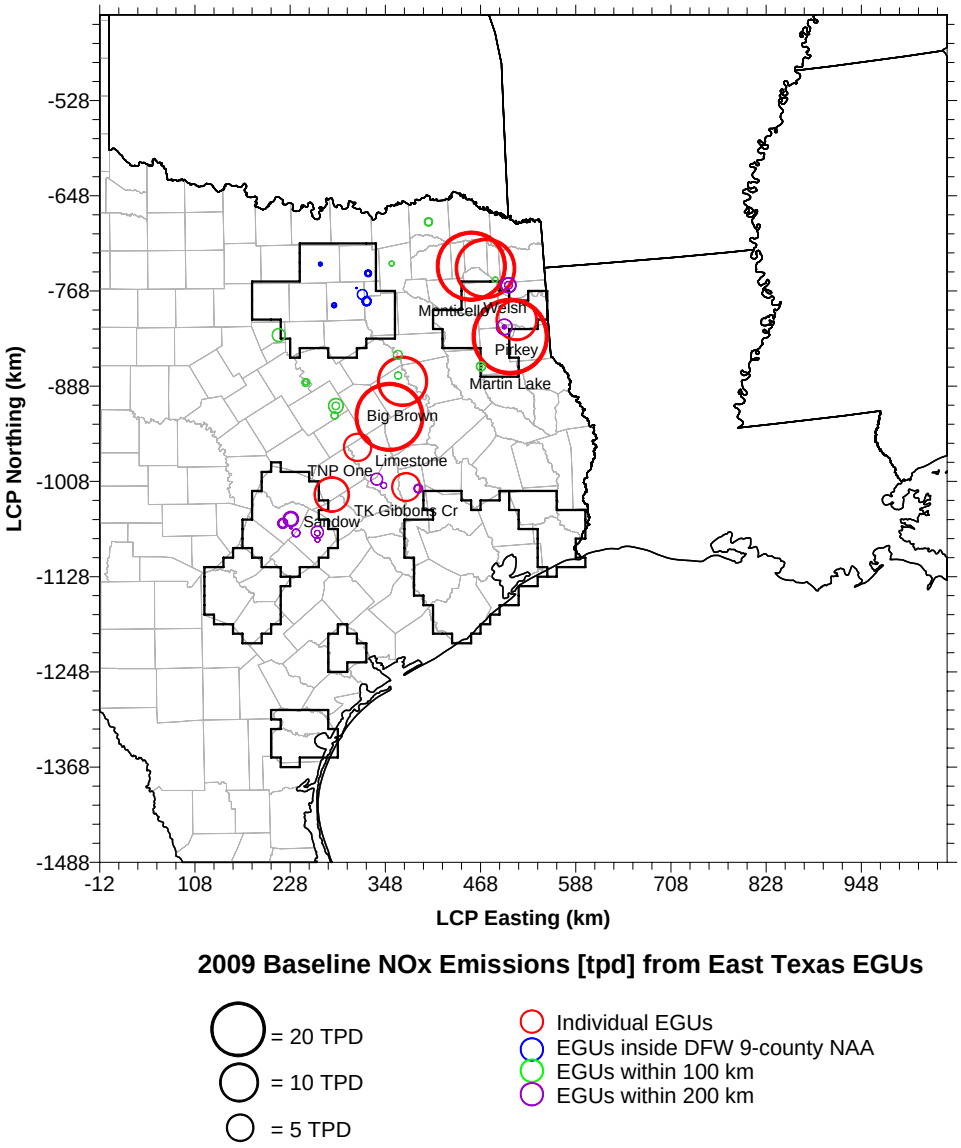

Figure 1. Location and NOx emissions level of East Texas EGUs.

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 2. 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 2 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 2. 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 3 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 compares each source's contributions to the daily maximum 8-hour ozone at Frisco.

Table 2. 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 .

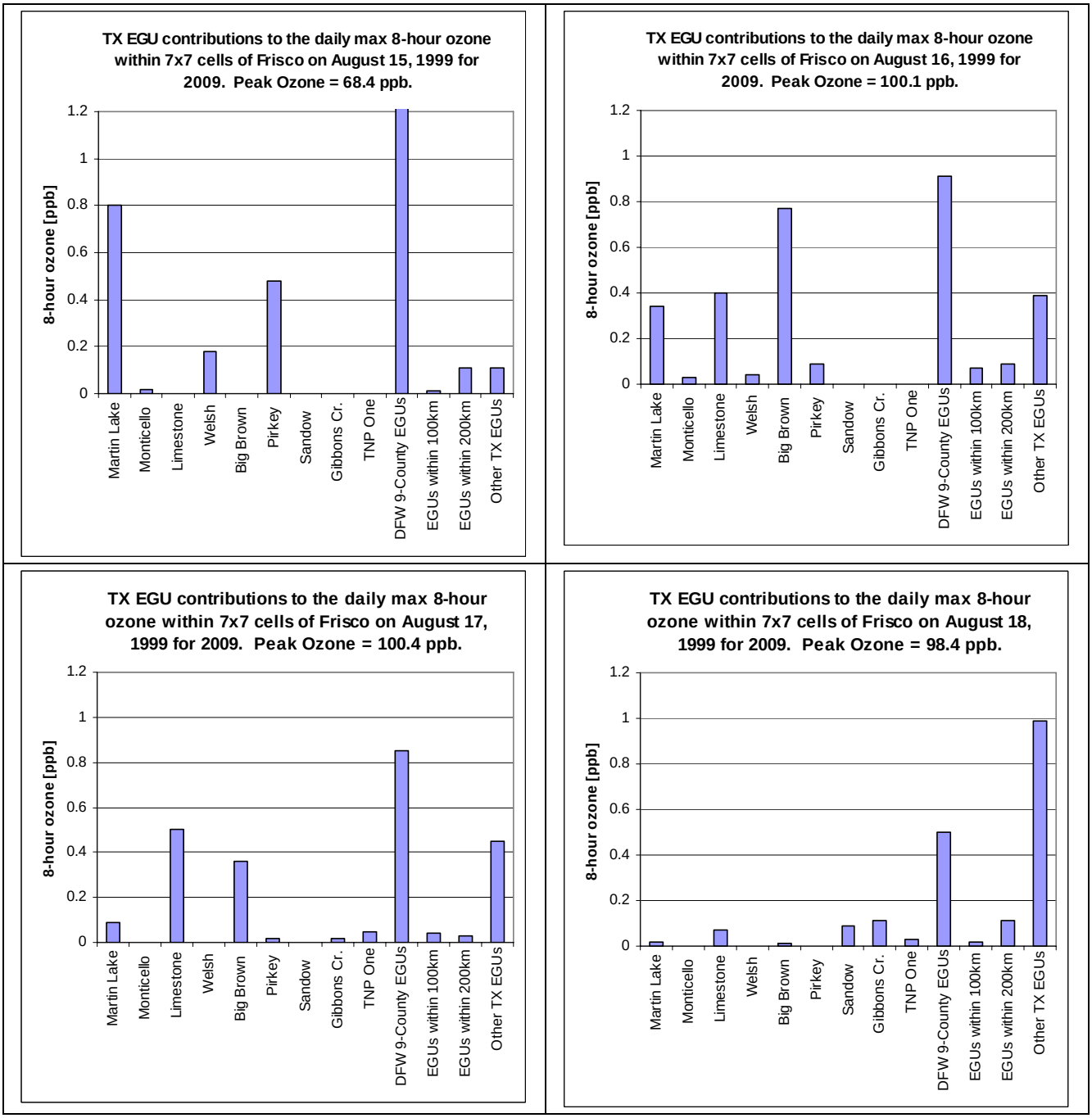

Figure 2. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Frisco.

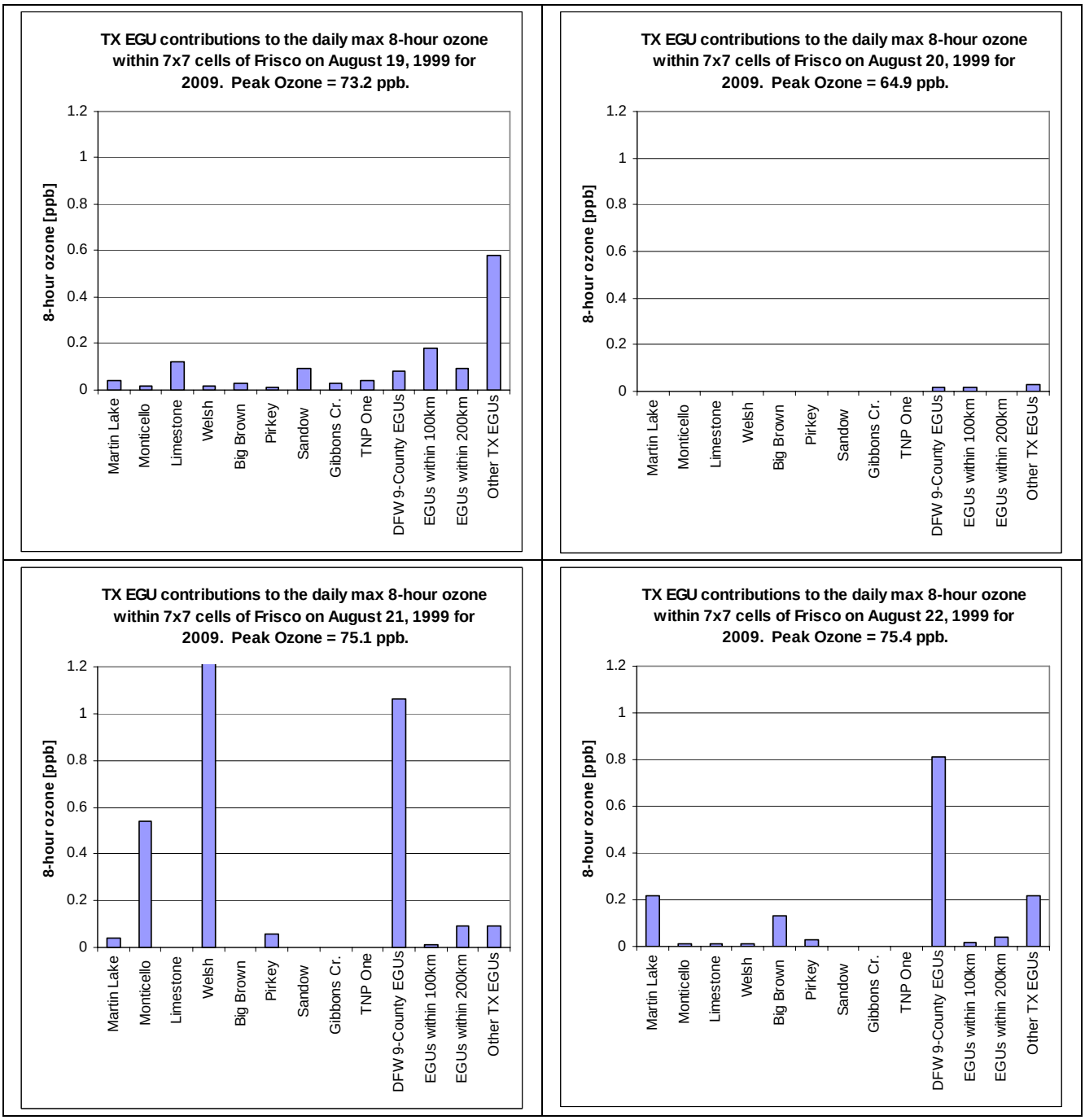

Figure 2 (concluded). Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Frisco.

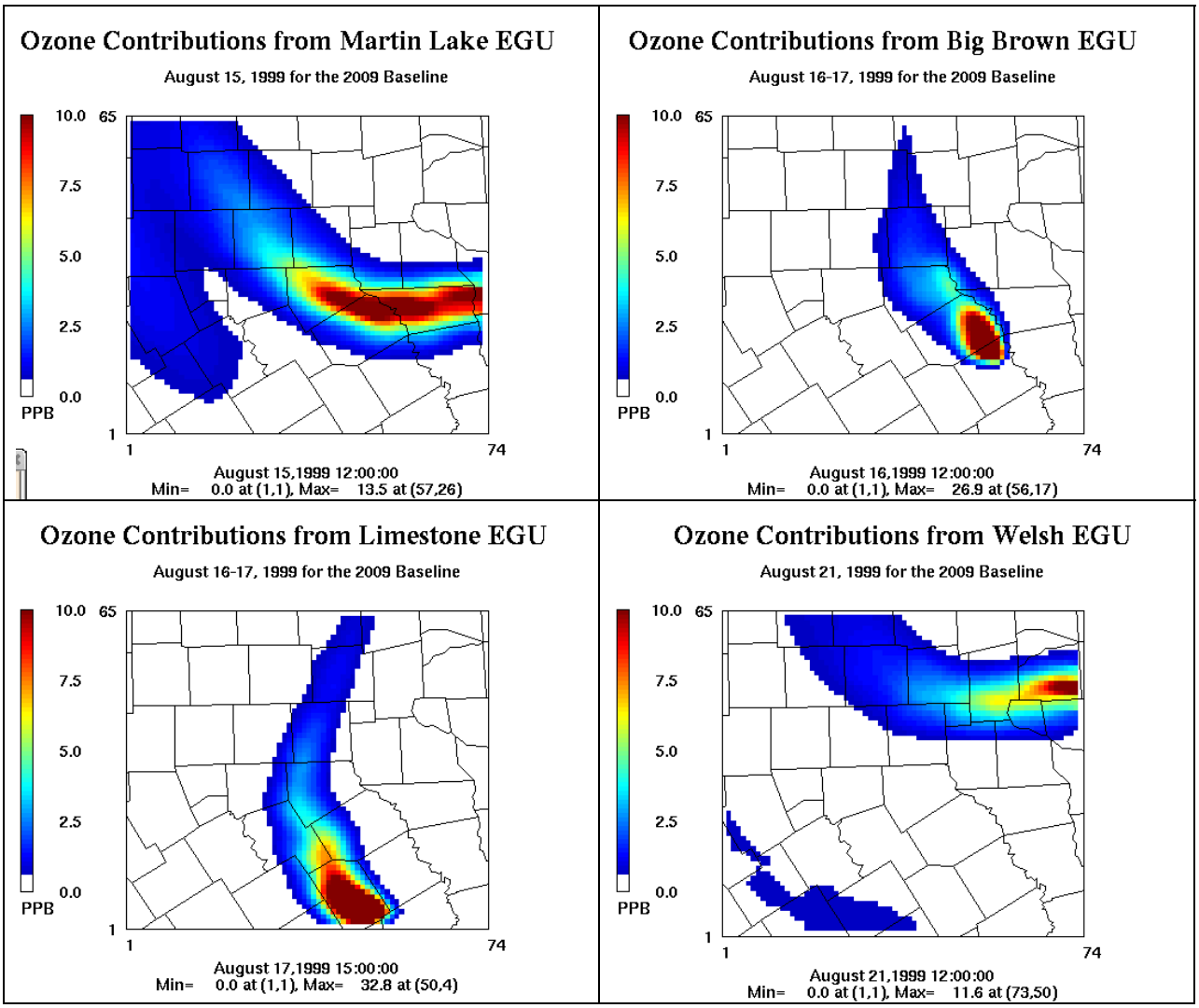

Figure 3. Spatial plots of 1-hourly ozone contributions (ppb) from select EGUs.

Table 3. 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**

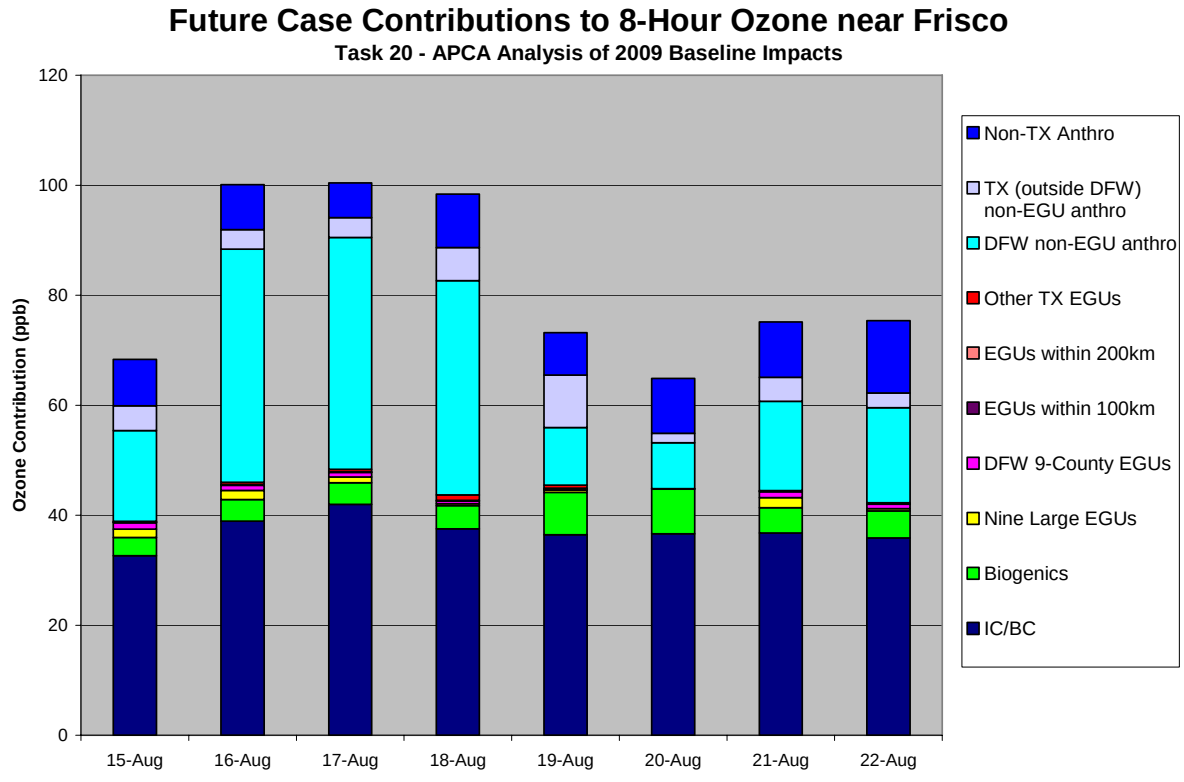

Figure 4. Stacked bar chart of daily contributions from all source groups to the peak 8-hour ozone (ppb) near Frisco.

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 5 shows bar charts of the EGU contributions to the daily maximum 8-hour ozone in the 7 by 7 cells surrounding Denton. Table 4 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 6 shows a stacked bar chart of all contributions to the daily maximum 8-hour ozone in Denton for all dates.

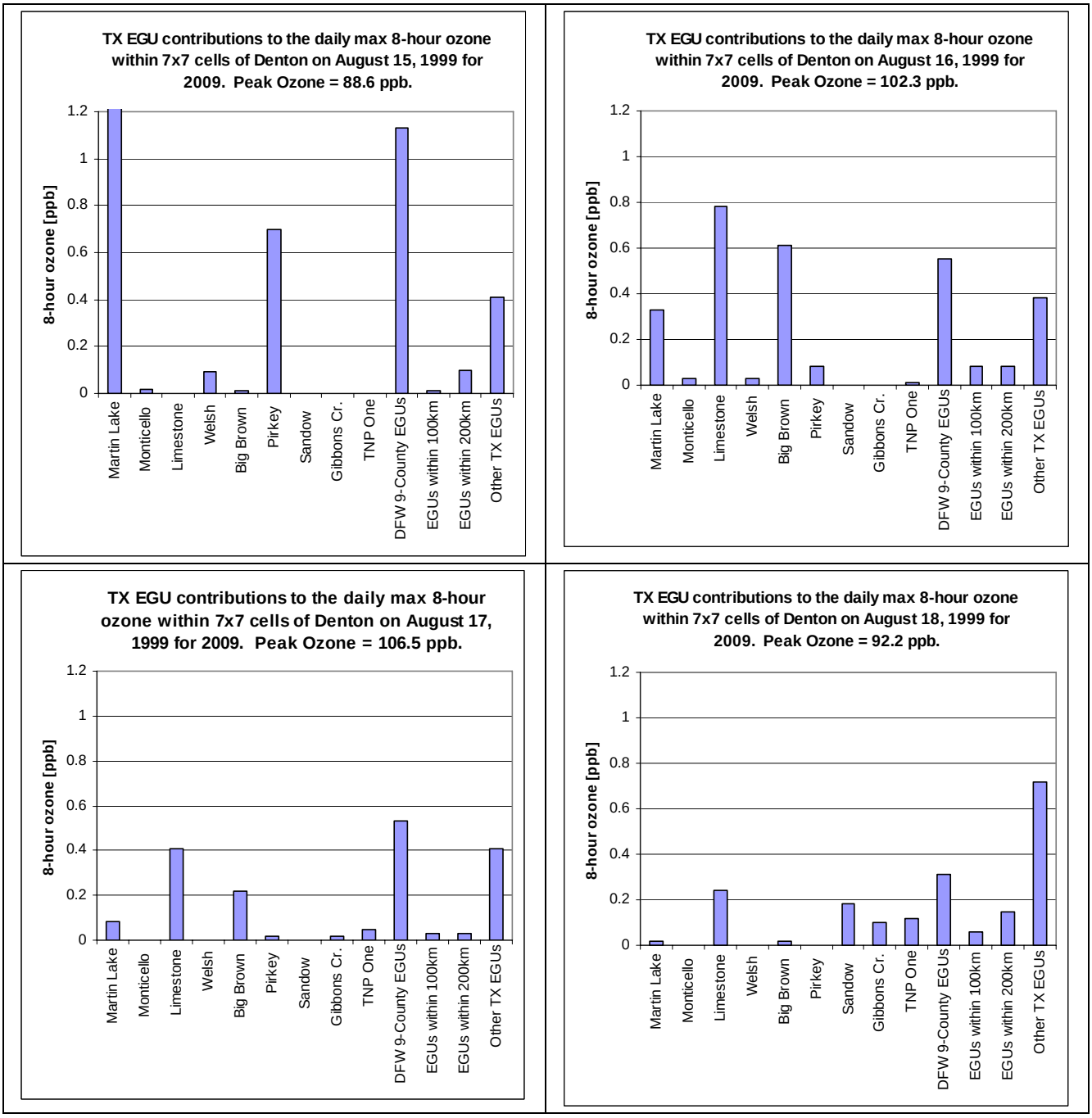

Figure 5. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Denton.

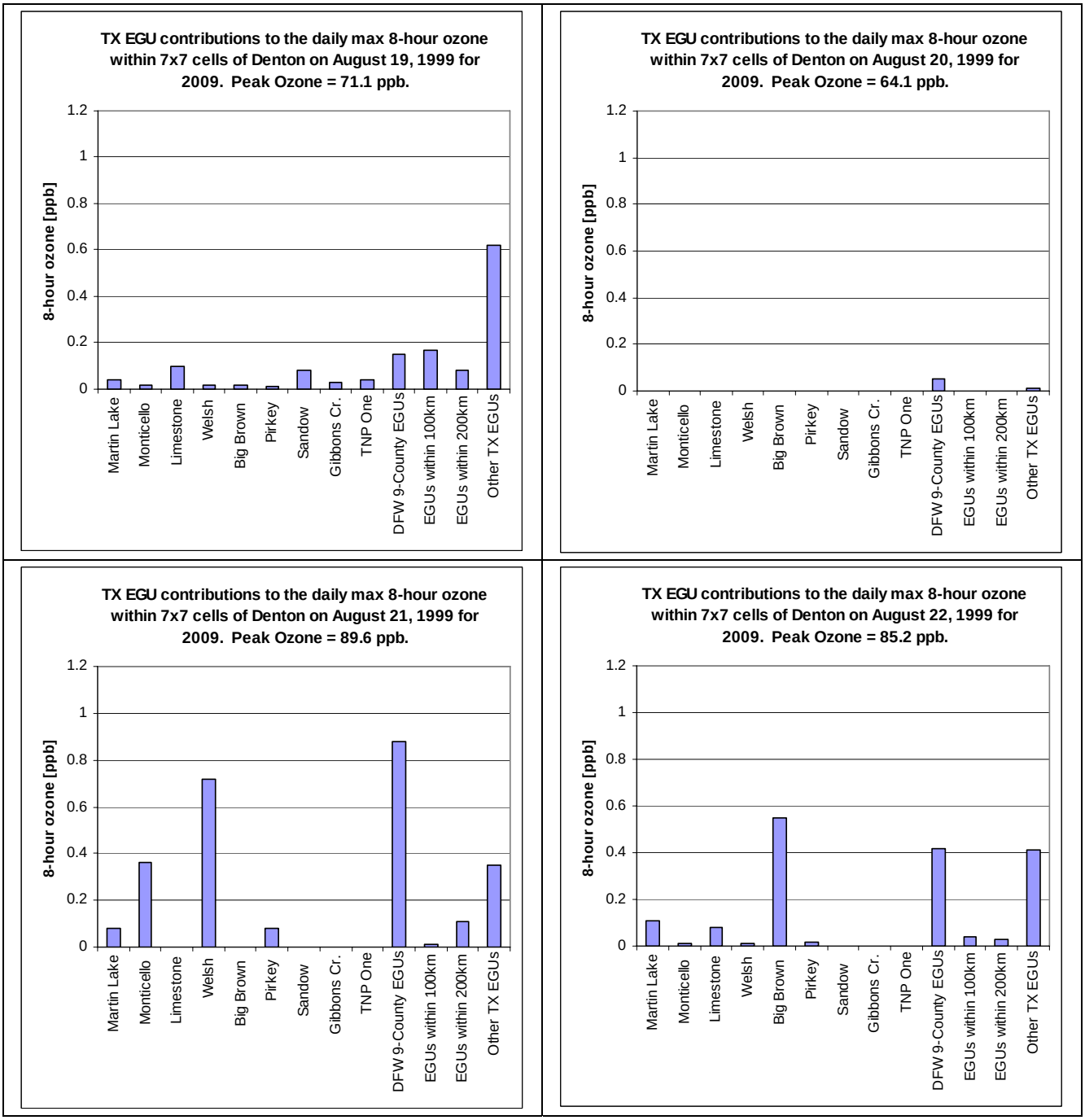

Figure 5 (concluded**).** Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) near Denton.

Table 4. 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**

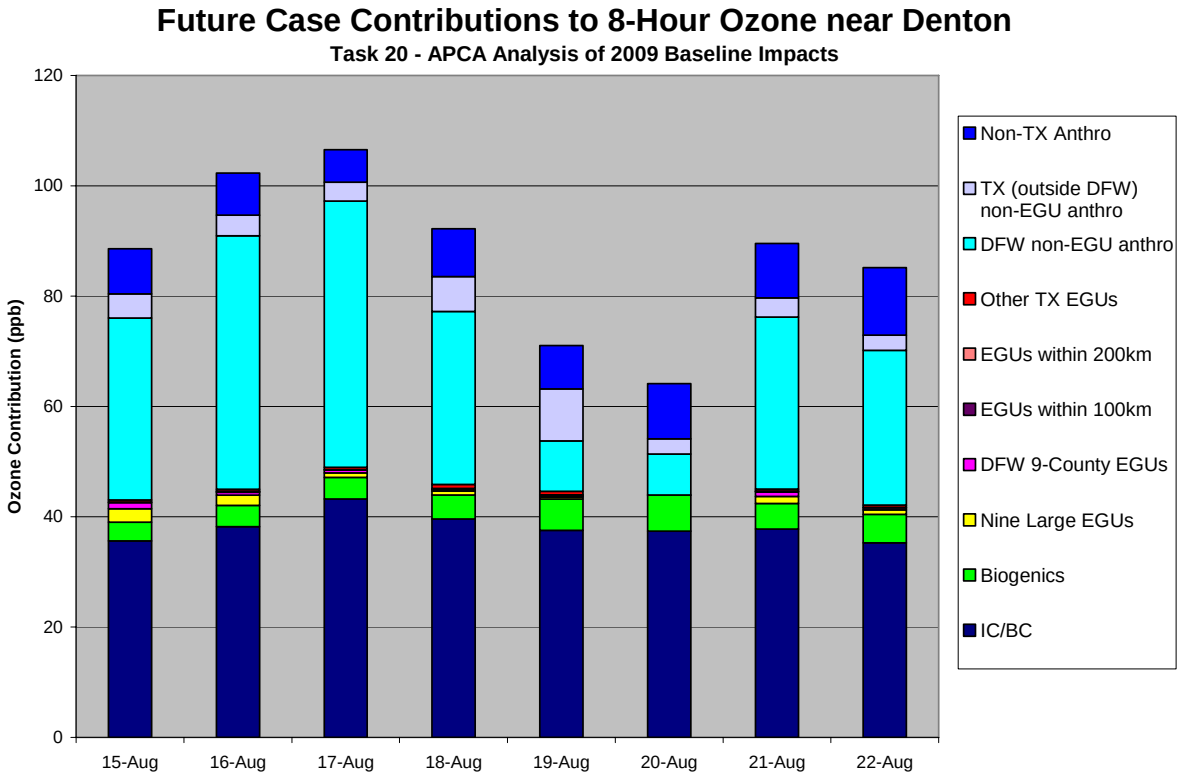

Figure 6. Stacked bar chart of contributions from all source groups to the daily peak 8-hour ozone (ppb) near Denton.

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 7 and in a stacked bar chart for all sources in Figure 8; values are listed in Table 5. 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.

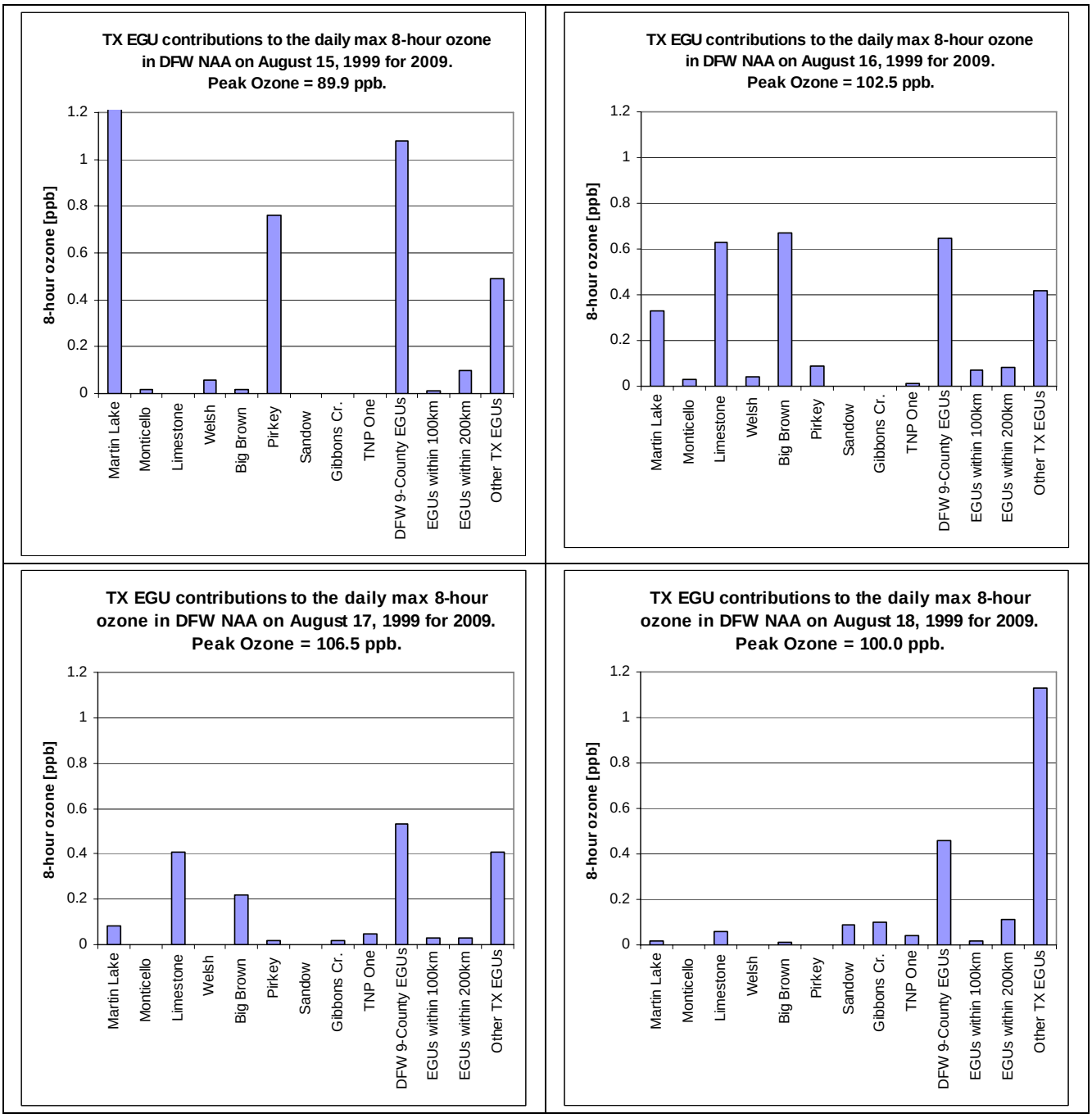

Figure 7. Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) in the DFW 9-county NAA.

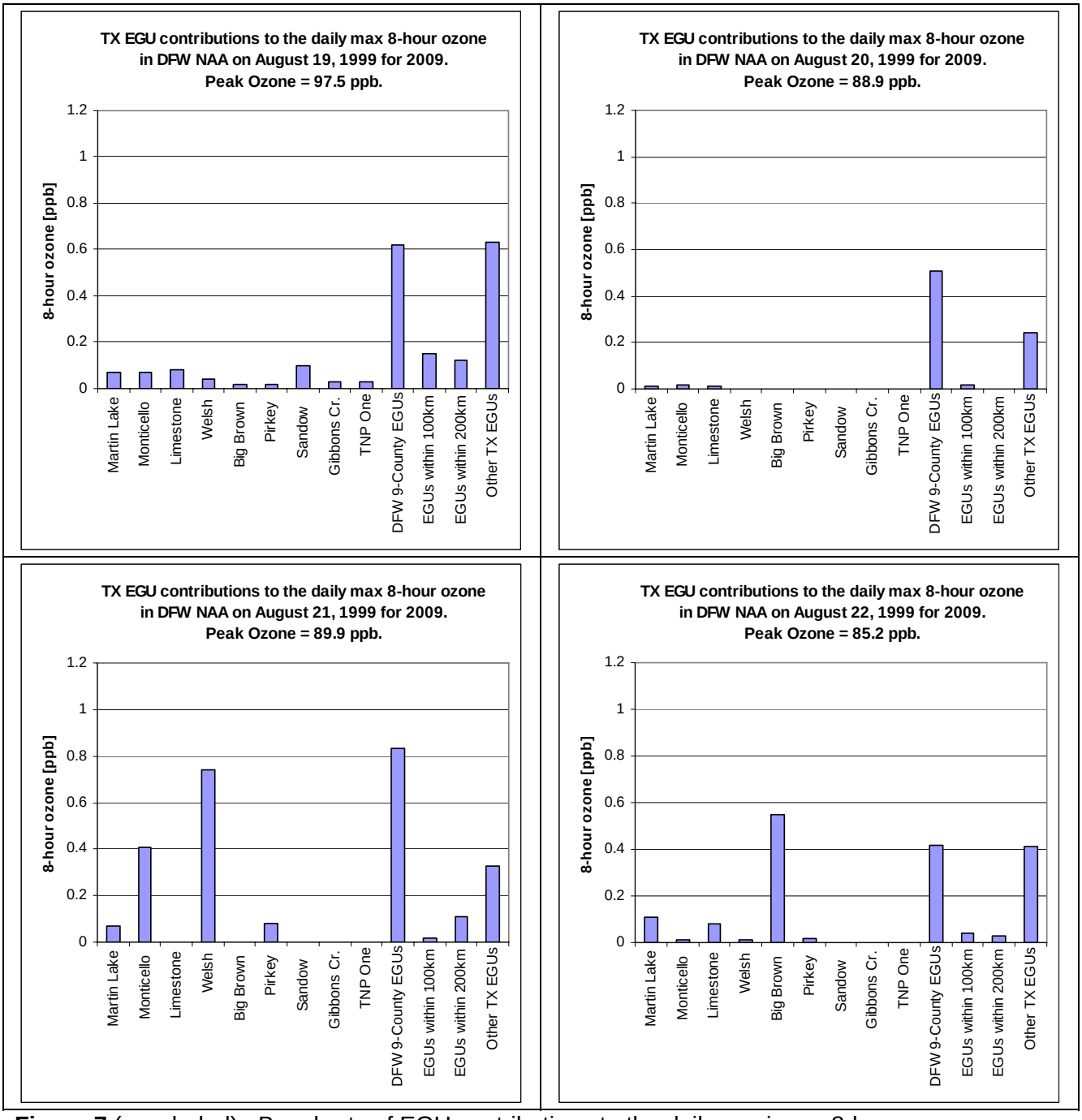

Figure 7 (concluded). Bar charts of EGU contributions to the daily maximum 8-hour ozone (ppb) in the DFW 9-county NAA.

Table 5. 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**

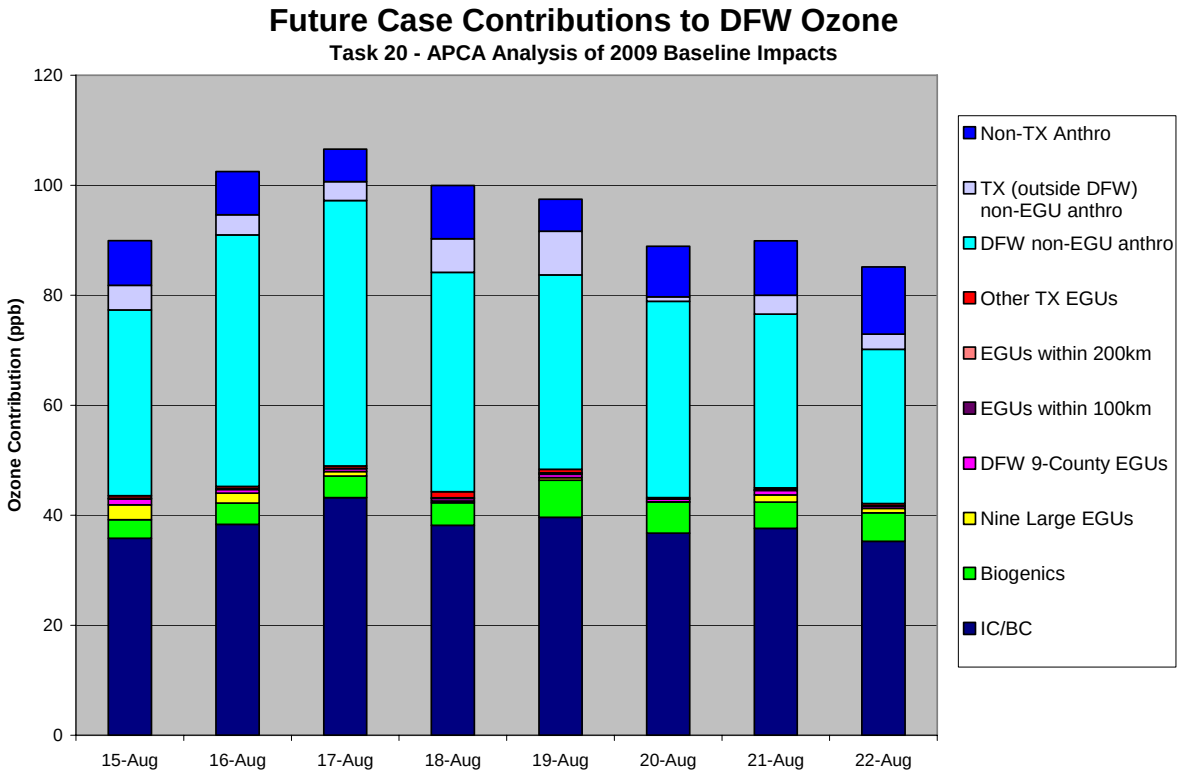

Figure 8. Stacked bar chart of daily contributions from all source groups to the peak 8-hour ozone (ppb) in the DFW 9-county NAA.

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.