Appendix H

Report - Migration of Emission Inventory Components from EPS-2 to SMOKE for the August 31,1993 - September 2, 1993 COAST Episode

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Evaluation of the Migration of Inventory Components from the EPS-2 to SMOKE for the August 31- September 2, 1993 COAST Episode

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Table of Contents

1. INTRODUCTION 1

2. MIGRATION FROM EPS2 TO SMOKE 1

2.1 ACQUIRE, ORGANIZE AND TEST INPUTS 1
2.2 VALIDATE PROCESSING 3

3. CAM-X SIMULATION RESULTS 3

4. SUMMARY AND CONCLUSIONS 7

5. REFERENCES 7

APPENDIX A: EMISSIONS TOTALS AND COMPARISONS 8

APPENDIX B: CAM-X SIMULATION RESULTS 16

1. Introduction

In the recent past, a limitation in air quality modeling studies has been the time to process emissions inventories to produce data to be used in photochemical modeling. A prototype emissions modeling system has been created to significantly reduce the time required to perform emissions preprocessing. The Sparse Matrix Operator Kernel Emissions (SMOKE) model was developed to demonstrate using matrix-vector multiplication for efficient emissions processing. It reprqduces the core functions of emissions processing (i.e., spatial allocation, temporal allocation, chemical speciation, and growth and control of inventory emissions). For a five-day test case for a regional scale application, SMOKE has previously been shown to be 27 times faster than Emissions Modeling System '95 (EMS-95) for point sources and 38 times faster for area sources (MCNC 1998). A test case comparison was made with the Emissions Preprocessing System version 2 (EPS2) versus SMOKE for an urban scale domain. SMOKE produced significant reductions in computing time and disk space usage (MCNC, 1996).

This report will summarize the issues encountered during the migration of the Coastal Oxidant Assessment for Southeast Texas (COAST) emissions inventories from the EPS2 modeling system to the SMOKE modeling system. The COAST inventory components that were migrated were the point, area and non-road sources for the Beaumont-Port Arthur episode of August 31-September 2, 1993. These inventories were processed through the SMOKE modeling system and comparisons with EPS2 output were made. The SMOKE generated emissions were then merged with the mobile and biogenic emissions components to create new emissions data for input into the Comprehensive Air Quality Model with Extensions (CAM_X). SMOKE was used to generate emissions for the 1993 base year. Comparisons were then performed with CAM_X to determine the effect of the SMOKE generated emissions inputs.

2. Migration from EPS2 to SMOKE

2.1 Acquire, Organize and Test Inputs

MCNC acquired point, area and non-road source inventory data from the TNRCC. The point source inventory data is in the AIRS Facility Subsystem (AFS) format. The area and non-road inventory data is in the AIRS Area and Mobile Subsystem (AMS) format. Other necessary input data acquired included spatial surrogates, temporal profiles, chemical speciation profiles, and cross-reference files.

The point source inventory acquired was broken up into three different sections in the EPS2 processing. Since a number of the cross-reference files were closely tied to a certain section

of the inventory, SMOKE processed the same inventory sections as in the EPS2 processing. The point source inventory sections were Texas, Louisiana and Offshore sources.

The area source inventory was also broken up into three sections in EPS2 processing. Most of the non-road sources are contained in a TNRCC generated AMS inventory (TNRCC AMS). However, there were non-road and area sources in another section (SAI AMS). While TNRCC generated all the emissions (except off-shore), the distinction between the TNRCC and SAI datasets was actually based upon the spatial surrogates (TNRCC or SAI generated). The final section consisted of an offshore AMS inventory (OS AMS). The TNRCC AMS section contained link data for a few area source categories (commercial marine and railroad). These area and non-road emission inventories were very similar to the inventories used for the Houston-Galveston episode (September 6-11, 1993). The only difference being the addition of Tyler county emissions. The Tyler county area source emissions were found to be missing in the Houston-Galveston episode.

MCNC reviewed the input data and had to make necessary file preparations for SMOKE compatibility. Some of these file preparations included:

- Reformatting Fast EPS2 packets: TNRCC provided cross-references, spatial surrogates, and control packets in the Fast EPS2 format. These were first reformatted to traditional EPS2 format and subsequently processed for migration to SMOKE.
- Changing any alphanumeric source category codes (SCC) and plant identification codes in the point source inventory to just numeric identifications (i.e. CHARACTER to INTEGER).
- Reorganizing daily and hourly point source emissions data into separate daily emissions and hourly emissions data files. The separate files are still in the AFS format.
- Separating the link-based non-road emissions from the AMS data generated at TNRCC. Surrogates were generated at MCNC for these link-based emissions (LINK AMS) since the SMOKE Area Source Model does not support link-based emissions yet. These link-base emissions were processed separately from the TNRCC AMS data. Quality assurance was performed after surrogate generation as well as a SMOKE vs. EPS2 output comparison. This means SMOKE processed four different AMS raw inventory files: TNRCC AMS, SAI AMS, OS AMS and LINK AMS.
- The point and area offshore inventories included the Total Volatile Organic Compounds (TVOC) pollutant instead of the reactive VOC pollutant. At the beginning of this task SMOKE did not support the TVOC pollutant. However, after a review of the SMOKE modeling system, it was determined that only minor code changes were necessary to support TVOC. These code changes were implemented in SMOKE and the offshore components of the inventory were quality assured in the same manner as the other sections of the inventory.
- Add Tyler county area and non-road emissions to the TNRCC AMS, SAI AMS, and LINK AMS inventories.

2.2 Validate Processing

MCNC performed tests to validate the SMOKE modeling system with the TNRCC emissions inputs. Report files generated from EPS2 processing were acquired from TNRCC and were used as a basis for assessment. The tools used to validate the processing included:

- Package for Analysis and Visualization of Environmental data (PAVE)
- State and county totals (EPS2 vs. SMOKE)
- SCC or ASC totals (EPS2 vs. SMOKE)
- Other SMOKE quality assessment reporting tools

During the validation process, a bug in the PSTPNT EPS2 code was found through joint MCNC and TNRCC collaboration. A minor portion of the hour specific point source emissions was being dropped. Also, several errors in the inventory were found and corrected during the validation process. The errors found in the inventory were minor.

The state and county totals from EPS2 and SMOKE generated emissions are shown in Appendix A. While the area and non-road emissions are summarized for September 1st, the point sources are summarized for September 2, 1993. The totals indicate that there is little difference between EPS2 and SMOKE generated emissions. However, there are some minor differences to note:

- A few sources that are treated as elevated sources in EPS2 instead are treated as low-level point sources in SMOKE. This is due to small differences in the plume rise approximation algorithms used to determine if a source should be treated as an elevated source. Slight differences in the CAM_X simulations are possible around these few sources due to a plume rise algorithm not being applied on these sources. These sources in issue were not flagged for plume-in-grid treatment in previous EPS2-CAMx runs.
- Offshore point sources have latitude and longitude data instead of UTM coordinates. The conversion algorithm for latitude and longitude to UTM seems to vary a little in SMOKE compared to EPS2. A few sources in SMOKE ended up in adjacent grid cells when compared to EPS2. This is not unusual and occurs when grid coordinates are very close to the border of a grid cell.

3. CAM-x Simulation Results

CAMx Version 1.13 was used to model both the scenarios, i.e., 93Base_E, where the emissions inputs were generated using EPS-2 and 93Base_S, where the emissions inputs were generated using SMOKE. For purposes of this report, these two names for the two basecases will be used during the remainder of this discussion.

Most of the COAST modeling domain experienced minor changes in daily maximum ozone concentrations throughout the August 31 – September 2, 1993 episode. The differences were less than 1 ppb on all the modeled days. The peak predicted ozone concentrations within the 8-county Houston-Galveston non-attainment area (which includes the counties of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller) and the 3-county Beaumont-Port Arthur non-attainment area (which includes the counties of Hardin, Jefferson and Orange) were also compared and as can be seen from Table 1, these differences were also less than 1 ppb on all the episode days.

Figure 1 shows the spatial distribution of maximum differences in ozone concentrations predicted throughout the episode from the two cases. The episode composite maximum difference is 19.7 ppb for one cell in Calcasieu parish in the state of Louisiana, directly east of Beaumont, Texas. Further analysis indicated that this difference was at 2300 hrs on September 1st. The time series of the difference in ozone concentrations for this individual cell is shown in Figure 3. These differences can be attributed to the fact that certain sources in Calcasieu county which were treated as elevated sources by EPS2.0 became ground-level sources when processed through SMOKE. Difference plots of the daily maximum ozone concentrations for the individual episode days September 1st and 2nd are shown in Appendix B Figure B-1.

The differences between the episode composite maximum one-hour ozone concentrations for the 2 simulations are shown in Figure 2. The maximum difference between the episode composite peaks is 4.9 ppb, also in Calcasieu parish, Louisiana.

The complete set of objective metrics computed within the 8-county Houston-Galveston non-attainment area and the 3-county Beaumont-Port Arthur non-attainment area for the two sets of simulations are shown in Tables B-1 through B-4 of Appendix B.

	Scenario	930831	930901	930902
	Observed	96	164	139
93Base_E	Domain-wide Peak	104	162	133
	Peak in 8-county HGA[1]	102	137	130
	Peak in 3-county BPA[2]	101	106	131
93Base_S	Domain-wide Peak	104	162	133
	Peak in 7-county HGA[1]	102	137	130
	Peak in 3-county BPA[2]	101	106	132

Table 1: Daily Maximum 1-hr Ozone concentrations for the August 31-September 2, 1993 Episode.

[1] Houston-Galveston Non-attainment area
[2] Beaumont-Port Arthur Non-attainment area

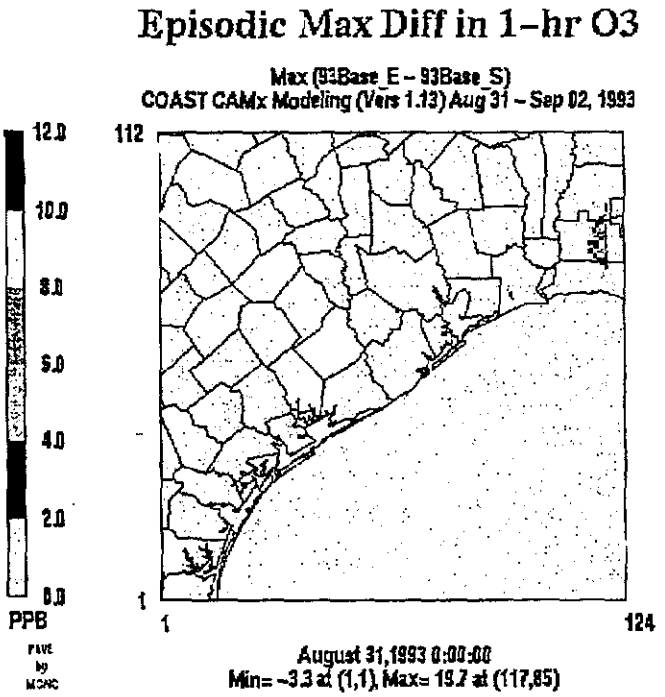


Figure 1: Episode composite maximum difference in modeled 1-hr ozone concentrations between 93Base_E and 93Base_S.

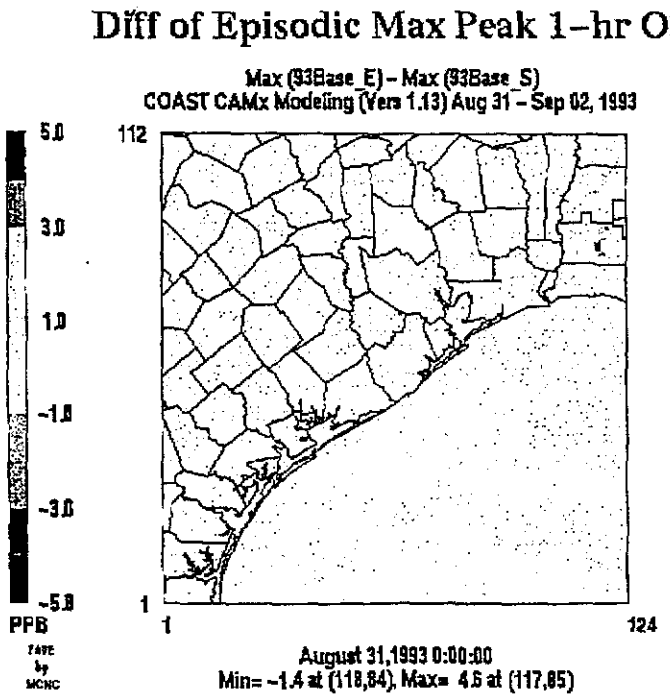


Figure 2: Episode composite difference in maximum modeled 1-hr ozone concentrations

between 93Base_E and 93Base_S.

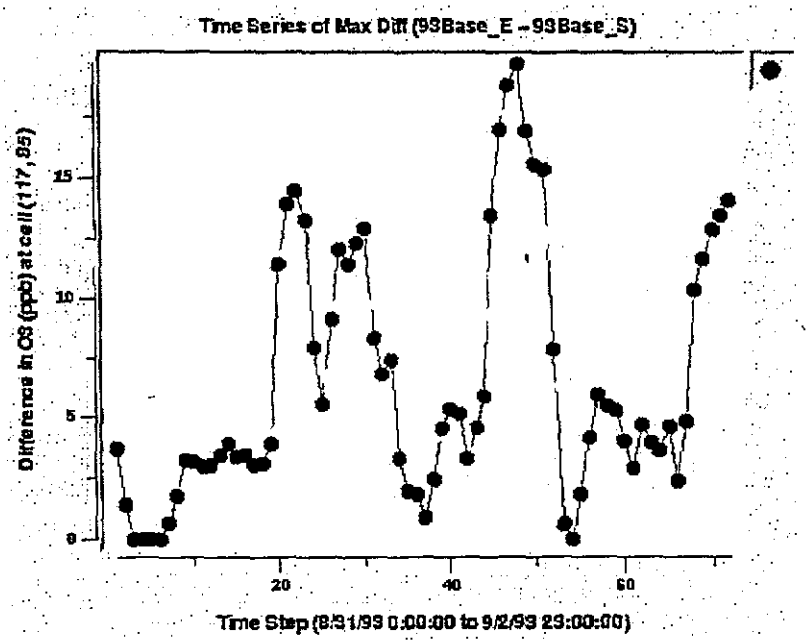


Figure 3: Time series showing the difference between 93Base_E and 93Base_S at the grid cell showing maximum difference in modeled 1-hr ozone concentrations in the COAST domain.

4. Summary and Conclusions

The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system developed at MCNC has been set up for the Houston/Galveston CAM-x modeling domain and emissions inventory components developed for the August 31 – September 2, 1993 episode using EPS2.0 were successfully migrated to SMOKE. Minor modifications were made to the SMOKE modeling system to process the Fast EPS2.0 packets provided by TNRCC. These packets were initially reformatted to the traditional EPS2.0 format and then processed for migration. All emissions information obtained were quality assured, processed through SMOKE and subsequently validated. Various comparisons were made at the SCC/ASC level and county level and any discrepancies found were addressed through collaboration and continuous interaction with TNRCC staff.

The model-ready emissions from the two systems – EPS2.0 and SMOKE were subsequently used as inputs to CAM-x Version 1.13. Modeling outputs from CAM-x simulations showed very minor differences in predicted ozone concentrations. However, there were a few grid cells in the modeling domain in Calcasieu parish, which showed a higher difference and this was due to the difference in treatment of a few point sources. While EPS2.0 treated them as elevated, SMOKE did not and this led to a decrease in ozone concentrations in grid cells that were in the immediate vicinity of the point sources.

5. References

1) Coats, C. J., Jr.; Houyoux, M. R. "Fast Emissions Modeling with the Sparse Matrix Operator Kernel Emissions Modeling System," Presented at *The Emissions Inventory: Key to Planning, Permits, Compliance, and Reporting,* Air & Waste Mgt. Assoc., New Orleans, LA, September 1996.

2) Houyoux, M.; Vukovich, J. "Emissions Inventory Development and Processing for the Seasonal Model for Regional Air Quality" Presented at *The Emission Inventory: Living in a Global Environment,* Air & Waste Mgt. Assoc., New Orleans, LA, December 1998.

APPENDIX A: Emissions Totals and Comparisons

	SMOKE SAI area src			EPS2 SAI area src			
FIPS	CO	NOX	VOC	CO	NOx	VOC	COUNTY
22003	0.32	0.13	0.13	0.32	0.13	0.13	AllenPar
22011	8.80	2.13	2.04	8.80	2.13	2.04	BeauregardPar
22019	44.81	11.86	10.11	44.81	11.86	10.11	CalcasieuPar
22023	2.14	0.55	0.50	2.14	0.55	0.50	CameronPar
22053	0.04	0.01	0.02	0.04	0.01	0.02	JeffersonDavisPar
22115	11.78	3.01	3.01	11.78	3.01	3.01	VernonPar
22000	67.89	17.69	15.81	67.88	17.69	15.81	Louisiana
	SMOKE SAI area src			EPS2 SAI area src			
FIPS	CO	NOX	VOC	CO	NOx	VOC	COUNTY
48005	6.90	0.33	1.87	6.90	0.33	1.87	AngelinaCo
48007	6.43	0.23	1.37	6.43	0.23	1.37	AransasCo
48015	7.37	0.27	2.10	7.37	0.27	2.10	AustinCo
48021	14.02	0.53	3.84	14.01	0.53	3.84	BastropCo
48025	9.21	0.35	2.14	9.21	0.35	2.14	BeeCo
48027	31.36	1.09	7.95	31.36	1.09	7.95	BellCo
48031	0.01	0.00	0.00	0.01	0.00	0.00	BlancoCo
48039	37.37	7.07	14.00	37.37	7.07	14.01	BrazoriaCo
48041	44.65	1.68	11.91	44.65	1.68	11.91	BrazosCo
48047	0.01	0.00	0.00	0.01	0.00	0.00	BrooksCo
48051	5.07	0.19	1.36	5.07	0.19	1.36	BurlesonCo
48053	0.98	0.02	0.41	0.98	0.02	0.41	BurnetCo
48055	9.66	0.36	2.67	9.66	0.36	2.67	CaldwellCo
48057	6.98	0.26	1.95	6.98	0.26	1.95	CalhounCo
48071	5.28	0.22	2.88	5.28	0.22	2.88	ChambersCo
48089	6.79	0.25	1.97	6.79	0.25	1.97	ColoradoCo
48091	3.00	0.11	0.81	3.00	0.11	0.81	ComalCo
48099	0.00	0.00	0.00	0.00	0.00	0.00	CoryellCo
48123	6.90	0.26	1.87	6.90	0.26	1.87	DeWittCo
48145	0.98	0.04	0.35	0.98	0.04	0.35	FallsCo
48149	7.36	0.28	2.00	7.36	0.28	2.00	FayetteCo
48157	29.07	2.94	12.36	29.07	2.94	12.36	FortBendCo
48167	29.08	4.12	13.84	29.08	4.12	13.84	GalvestonCo
48175	2.19	0.08	0.51	2.19	0.08	0.51	GoliadCo
48177	6.30	0.24	1.46	6.30	0.24	1.46	GonzalesCo
48185	6.97	0.26	1.87	6.97	0.26	1.87	GrimesCo
48187	20.03	0.81	5.22	20.03	0.81	5.22	GuadalupeCo
48199	14.29	0.69	4.94	14.29	0.69	4.94	HardinCo
48201	586.82	111.84	174.77	586.77	111.85	174.88	HarrisCo
48209	23.44	0.88	6.38	23.44	0.88	6.38	HaysCo
48225	0.74	0.02	0.16	0.74	0.02	0.16	HoustonCo
48239	4.77	0.18	1.30	4.77	0.18	1.30	JacksonCo
48241	11.39	0.54	3.18	11.39	0.54	3.18	JasperCo
48245	63.83	16.91	17.05	63.83	16.90	17.05	JeffersonCo
48249	2.30	0.07	0.53	2.30	0.07	0.53	JimWellsCo
48255	4.54	0.17	1.19	4.54	0.17	1.19	KarnesCo
48261	0.06	0.00	0.02	0.06	0.00	0.02	KenedyCo
48273	11.09	0.42	3.01	11.09	0.42	3.01	KlebergCo
48281	0.29	0.01	0.08	0.29	0.01	0.08	LampasasCo
48285	6.85	0.26	1.86	6.85	0.26	1.86	LavacaCo
48287	4.71	0.18	1.28	4.71	0.18	1.28	LeeCo
48289	0.20	0.01	0.21	0.21	0.01	0.21	LeonCo
48291	12.18	1.11	4.79	12.18	1.11	4.79	LibertyCo
48297	1.35	0.04	0.21	1.35	0.04	0.21	LiveOakCo
48313	4.00	0.15	0.88	4.00	0.15	0.88	MadisonCo

Table A-1 : Area source comparison for the SAI AMS inventory for Sept. 1, 1993

FIPS	CO	NOX	VOC	CO	NOx	VOC	COUNTY
48321	13.53	0.51	3.64	13.53	0.51	3.64	MatagordaCo
48331	8.40	0.32	2.28	8.40	0.32	2.28	MilamCo
48339	62.88	2.85	16.02	62.88	2.85	16.02	MontgomeryCo
48351	4.97	0.19	1.33	4.97	0.19	1.33	NewtonCo
48355	107.01	4.02	29.12	107.01	4.02	29.12	NuecesCo
48361	13.24	2.57	5.02	13.24	2.57	5.02	OrangeCo
48373	11.24	0.42	3.19	11.24	0.42	3.19	PolkCo
48391	2.92	0.11	0.68	2.92	0.11	0.68	RefugioCo
48395	5.03	0.19	1.34	5.03	0.19	1.34	RobertsonCo
48405	0.16	0.01	0.04	0.16	0.01	0.04	SanAugustineCo
48407	6.02	0.23	1.70	6.02	0.23	1.70	SanJacintoCo
48409	21.52	0.81	5.90	21.52	0.81	5.90	SanPatricioCo
48453	211.75	7.95	54.41	211.76	7.95	54.41	TravisCo
48455	3.67	0.14	0.83	3.67	0.14	0.83	TrinityCo
48457	6.10	0.29	1.70	NA	NA	NA	TylerCo
48469	27.33	1.03	7.23	27.33	1.03	7.23	VictoriaCo
48471	18.64	0.70	3.18	18.64	0.70	3.18	WalkerCo
48473	4.77	0.19	2.02	4.77	0.19	2.02	WallerCo
48477	9.71	0.36	2.95	9.71	0.36	2.95	WashingtonCo
48481	14.64	0.74	3.86	14.64	0.74	3.86	WhartonCo
48491	51.11	1.93	14.00	51.11	1.92	14.00	WilliamsonCo
48493	2.77	0.11	0.75	2.77	0.11	0.75	WilsonCo
48000	1664.23	181.14	479.74	1658.11	180.82	478.16	Texas
Total	1732.12	198.83	494.55	1725.99	198.51	493.97	TX and LA

Table A-1 : Area source comparison for the SAI AMS inventory for Sept. 1, 1993

FIPS	SMOKE Link	SMOKE Link	SMOKE Link	SMOKE TNRCC	SMOKE TNRCC	SMOKE TNRCC	TNRCC + Link	TNRCC + Link	TNRCC + Link	EPS2	EPS2	EPS2	
	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOx	VOC	COUNTY NAME
22003	0.13	0.38	0.10	0.17	0.01	0.04	0.30	0.39	0.14	0.30	0.39	0.14	AllenPar
22011	0.18	0.51	0.13	4.81	0.18	1.56	4.99	0.69	1.69	4.99	0.69	1.69	BeauregardPar
22019	1.32	5.43	0.89	26.94	1.11	6.35	28.26	6.54	7.24	28.26	6.54	7.24	CalcasieuPar
22023	0.30	2.44	0.15	4.93	2.59	4.08	5.23	5.03	4.23	5.25	5.11	4.25	CameronPar
22053	0.02	0.18	0.01	0.03	0.01	0.00	0.05	0.19	0.01	0.07	0.22	0.02	JeffersonDavisPar
22115	0.34	0.97	0.25	5.06	0.17	2.36	5.40	1.14	2.61	5.40	1.15	2.61	VernonPar
22000	2.29	9.91	1.53	41.94	4.07	14.39	44.23	13.98	15.92	44.27	14.09	15.95	Louisiana
FIPS	SMOKE Link	SMOKE Link	SMOKE Link	SMOKE TNRCC	SMOKE TNRCC	SMOKE TNRCC	TNRCC + Link	TNRCC + Link	TNRCC + Link	EPS2	EPS2	EPS2	
	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	COUNTY NAME
48005	0.11	0.90	0.04	2.39	0.06	0.86	2.50	0.96	0.90	2.50	0.96	0.90	AngelinaCo
48007	0.05	0.33	0.02	4.56	0.87	2.30	4.61	1.20	2.32	4.60	1.20	2.31	AransasCo
48015	0.03	0.25	0.01	3.77	0.15	1.47	3.80	0.40	1.48	3.80	0.40	1.48	AustinCo
48021	0.02	0.12	0.01	6.01	0.27	1.64	6.03	0.39	1.65	6.02	0.39	1.65	BastropCo
48025	0.04	0.31	0.01	4.83	0.19	2.14	4.87	0.50	2.15	4.87	0.50	2.15	BeeCo
48027	0.30	2.39	0.10	16.00	0.90	3.73	16.30	3.29	3.83	16.30	3.28	3.83	BellCo
48031	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	BlancoCo
48039	0.81	5.95	0.34	28.05	2.96	7.69	28.86	8.91	8.03	28.85	8.91	8.03	BrazoriaCo
48041	0.19	1.52	0.07	23.17	0.92	6.37	23.36	2.44	6.44	23.36	2.44	6.43	BrazosCo
48047	0.00	0.00	0.00	0.03	0.00	0.01	0.03	0.00	0.01	0.03	0.01	0.01	BrooksCo
48051	0.02	0.17	0.01	2.59	0.10	1.88	2.61	0.27	1.89	2.61	0.27	1.88	BurlesonCo
48053	0.04	0.28	0.01	0.58	0.10	0.15	0.62	0.38	0.16	0.61	0.39	0.16	BurnetCo
48055	0.01	0.08	0.00	3.61	0.29	2.92	3.62	0.37	2.92	3.62	0.37	2.92	CaldwellCo
48057	0.05	0.29	0.03	19.19	1.37	8.79	19.24	1.66	8.82	19.24	1.66	8.81	CalhounCo
48071	1.32	11.54	0.64	32.39	2.23	9.95	33.71	13.77	10.59	33.71	13.76	10.60	ChambersCo
48089	0.03	0.23	0.01	3.50	0.14	2.80	3.53	0.37	2.81	3.53	0.37	2.81	ColoradoCo
48091	0.09	0.69	0.03	0.23	0.12	0.07	0.32	0.81	0.10	0.32	0.82	0.10	ComalCo
48099	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	CoryellCo
48123	0.03	0.24	0.01	3.62	0.14	1.88	3.65	0.38	1.89	3.65	0.38	1.89	DeWittCo
48145	0.00	0.00	0.00	0.37	0.01	0.08	0.37	0.01	0.08	0.37	0.04	0.08	FallsCo
48149	0.03	0.25	0.01	3.86	0.15	2.64	3.89	0.40	2.65	3.89	0.40	2.65	FayetteCo
48157	0.28	2.20	0.09	17.55	2.63	3.46	17.83	4.83	3.55	17.83	4.83	3.55	FortBendCo
48167	2.02	18.54	1.50	53.96	3.61	10.75	55.98	22.15	12.25	55.98	22.14	12.25	GalvestonCo
48175	0.01	0.07	0.00	1.15	0.05	1.81	1.16	0.12	1.81	1.16	0.12	1.82	GoliadCo
48177	0.03	0.21	0.01	3.30	0.13	1.08	3.33	0.34	1.09	3.33	0.34	1.09	GonzalesCo
48185	0.03	0.24	0.01	3.63	0.14	1.18	3.66	0.38	1.19	3.66	0.38	1.19	GrimesCo
48187	0.03	0.20	0.01	7.32	0.36	2.77	7.35	0.56	2.78	7.34	0.56	2.78	GuadalupeCo
48199	0.17	1.35	0.06	6.47	0.40	1.48	6.64	1.75	1.54	6.64	1.74	1.53	HardinCo
48201	2.49	20.26	1.42	248.88	16.78	25.94	251.37	37.04	27.36	251.33	37.03	27.36	HarrisCo

Table A-2 : Area source totals for the TNRCC AMS and LINK AMS for Sept. 1, 1993

FIPS	SMOKE Link	SMOKE Link	SMOKE Link	SMOKE TNRCC	SMOKE TNRCC	SMOKE TNRCC	TNRCC + Link	TNRCC + Link	TNRCC + Link	EPS2	EPS2	EPS2	
	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	COUNTY NAME
48209	0.03	0.20	0.01	6.33	0.38	0.95	6.36	0.58	0.96	6.35	0.58	0.96	HaysCo
48225	0.03	0.27	0.01	0.70	0.03	0.48	0.73	0.30	0.49	0.73	0.30	0.50	HoustonCo
48239	0.02	0.16	0.01	2.52	0.11	2.37	2.54	0.27	2.38	2.54	0.27	2.38	JacksonCo
48241	0.05	0.39	0.02	5.97	0.24	1.82	6.02	0.63	1.84	6.02	0.62	1.83	JasperCo
48245	0.58	4.60	0.35	24.49	2.66	11.88	25.07	7.26	12.23	25.07	7.25	12.24	JeffersonCo
48249	0.06	0.47	0.02	3.59	0.13	1.61	3.65	0.60	1.63	3.65	0.60	1.63	JimWellsCo
48255	0.02	0.16	0.01	2.10	0.09	1.12	2.12	0.25	1.13	2.12	0.24	1.13	KarnesCo
48261	0.06	0.33	0.02	0.37	0.21	0.96	0.43	0.54	0.98	0.43	0.54	0.98	KenedyCo
48273	0.08	0.58	0.03	6.54	0.70	4.22	6.62	1.28	4.25	6.62	1.28	4.25	KlebergCo
48281	0.02	0.13	0.01	0.01	0.00	0.00	0.03	0.13	0.01	0.03	0.14	0.01	LampasasCo
48285	0.03	0.23	0.01	3.59	0.14	3.08	3.62	0.37	3.09	3.62	0.37	3.09	LavacaCo
48287	0.02	0.16	0.01	2.47	0.10	0.88	2.49	0.26	0.89	2.49	0.26	0.88	LeeCo
48289	0.02	0.16	0.01	0.28	0.02	0.28	0.30	0.18	0.29	0.30	0.17	0.29	LeonCo
48291	0.21	1.61	0.07	38.98	1.84	4.71	39.19	3.45	4.78	39.19	3.45	4.78	LibertyCo
48297	0.02	0.12	0.01	1.17	0.03	1.22	1.19	0.15	1.23	1.19	0.15	1.22	LiveOakCo
48313	0.02	0.14	0.01	2.08	0.08	1.07	2.10	0.22	1.08	2.10	0.22	1.07	MadisonCo
48321	0.07	0.54	0.02	7.86	0.82	6.33	7.93	1.36	6.35	7.93	1.35	6.36	MatagordaCo
48331	0.04	0.29	0.01	4.40	0.17	1.80	4.44	0.46	1.81	4.44	0.46	1.82	MilamCo
48339	0.29	2.28	0.10	27.02	1.45	6.05	27.31	3.73	6.15	27.30	3.72	6.15	MontgomeryCo
48351	0.02	0.17	0.01	2.38	0.10	0.63	2.40	0.27	0.64	2.40	0.27	0.64	NewtonCo
48355	0.47	3.66	0.30	57.47	6.03	24.75	57.94	9.69	25.05	57.94	9.68	25.05	NuecesCo
48361	0.42	3.71	0.25	15.59	0.54	2.81	16.01	4.25	3.06	16.02	4.25	3.06	OrangeCo
48373	0.05	0.38	0.02	5.89	0.23	2.03	5.94	0.61	2.05	5.94	0.61	2.05	PolkCo
48391	0.01	0.10	0.00	1.79	0.23	2.35	1.80	0.33	2.35	1.81	0.33	2.36	RefugioCo
48395	0.02	0.19	0.01	2.68	0.09	0.78	2.70	0.28	0.79	2.71	0.28	0.78	RobertsonCo
48405	0.00	0.00	0.00	0.22	0.00	0.08	0.22	0.00	0.08	0.22	0.01	0.08	SanAugustineCo
48407	0.03	0.20	0.01	3.48	0.12	1.13	3.51	0.32	1.14	3.50	0.33	1.14	SanJacintoCo
48409	0.02	0.19	0.01	21.51	0.61	7.96	21.53	0.80	7.97	21.54	0.80	7.97	SanPatricioCo
48453	0.22	0.96	0.04	94.55	5.26	22.95	94.77	6.22	22.99	94.77	6.22	22.99	TravisCo
48455	0.02	0.14	0.01	2.01	0.05	0.55	2.03	0.19	0.56	2.03	0.20	0.55	TrinityCo
48457	0.03	0.21	0.01	3.20	0.13	0.92	3.23	0.34	0.93	NA	NA	NA	TylerCo
48469	0.03	0.23	0.01	10.82	0.67	4.60	10.85	0.90	4.61	10.85	0.90	4.61	VictoriaCo
48471	0.08	0.64	0.03	10.03	0.38	2.56	10.11	1.02	2.59	10.11	1.02	2.59	WalkerCo
48473	0.00	0.00	0.00	5.73	1.36	2.20	5.73	1.36	2.20	5.73	1.36	2.20	WallerCo
48477	0.04	0.33	0.01	4.97	0.20	1.70	5.01	0.53	1.71	5.01	0.52	1.72	WashingtonCo
48481	0.06	0.50	0.02	7.59	0.30	7.46	7.65	0.80	7.48	7.66	0.80	7.48	WhartonCo
48491	0.06	0.44	0.02	26.73	1.04	6.79	26.79	1.48	6.81	26.79	1.50	6.81	WilliamsonCo
48493	0.01	0.07	0.00	0.74	0.07	0.46	0.75	0.14	0.46	0.74	0.10	0.47	WilsonCo
48000	11.49	93.55	5.95	918.86	61.68	249.38	930.35	155.23	255.33	927.06	154.87	254.38	Texas
Total	13.78	103.46	7.48	960.80	65.75	263.78	974.58	169.21	271.26	971.33	168.96	270.33	TX and LA

Table A-2 : Area source totals for the TNRCC AMS and LINK AMS for Sept. 1, 1993

	SMOKE Elevated point src			SMOKE Low point src			SMOKE Total point src			EPS2 point src			
FIPS	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOx	VOC	COUNTY
48005	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	AngelinaCo
48007	87.37	0.19	2.99	0.00	0.00	0.00	87.37	0.19	2.99	87.37	0.20	2.99	AransasCo
48021	1.23	4.50	0.07	0.00	0.00	0.08	1.23	4.50	0.15	1.23	4.50	0.15	BastropCo
48025	0.41	1.09	0.12	0.10	0.73	0.49	0.51	1.82	0.61	0.51	1.82	0.61	BeeCo
48027	13.81	0.16	0.00	0.00	0.00	0.00	13.81	0.16	0.00	13.81	0.16	0.00	BellCo
48039	19.23	95.02	13.44	7.68	12.08	42.83	26.91	107.10	56.27	26.91	107.08	56.26	BrazoriaCo
48055	0.35	4.86	0.20	0.00	0.03	0.72	0.35	4.89	0.92	0.35	4.89	0.93	CaldwellCo
48057	10.73	20.97	2.86	0.23	2.93	1.75	10.96	23.90	4.61	10.96	23.90	4.61	CalhounCo
48071	14.51	43.02	2.28	1.40	0.84	15.17	15.91	43.86	17.45	15.91	43.84	17.46	ChambersCo
48089	1.74	3.20	0.17	0.05	0.05	2.66	1.79	3.25	2.83	1.78	3.25	2.83	ColoradoCo
48123	0.68	1.58	0.02	0.00	0.00	0.00	0.68	1.58	0.02	0.68	1.58	0.02	DeWittCo
48149	10.22	71.43	1.82	0.14	0.14	0.77	10.36	71.57	2.59	10.36	71.56	2.59	FayetteCo
48157	13.05	90.86	1.48	0.18	0.53	2.60	13.23	91.39	4.08	13.23	91.38	4.08	FortBendCo
48167	34.79	117.30	15.26	2.29	4.15	54.13	37.08	121.45	69.39	37.08	120.78	69.39	GalvestonCo
48175	2.01	44.75	0.24	0.00	0.00	0.01	2.01	44.75	0.25	2.01	44.74	0.25	GoliadCo
48177	0.00	0.01	0.00	0.25	0.13	0.25	0.25	0.14	0.25	0.25	0.14	0.25	GonzalesCo
48187	0.90	0.28	0.25	0.00	0.00	0.14	0.90	0.28	0.39	0.90	0.28	0.39	GuadalupeCo
48199	1.40	5.70	6.00	0.05	0.04	1.94	1.45	5.74	7.94	1.45	5.74	7.95	HardinCo
48201	176.41	303.76	83.53	6.32	9.38	169.51	182.73	313.14	253.04	182.74	313.09	253.07	HarrisCo
48209	4.41	4.04	0.37	0.00	0.00	0.00	4.41	4.04	0.37	4.41	4.03	0.37	HaysCo
48225	0.01	0.09	0.04	0.00	0.00	0.07	0.01	0.09	0.11	0.01	0.09	0.11	HoustonCo
48239	1.84	12.98	1.48	0.01	0.07	1.21	1.85	13.05	2.69	1.85	13.04	2.68	JacksonCo
48241	11.93	16.27	1.51	0.24	0.06	1.21	12.17	16.33	2.72	12.17	16.33	2.72	JasperCo
48245	40.94	99.13	29.53	1.34	4.00	112.58	42.28	103.13	142.11	42.28	103.11	142.12	JeffersonCo
48255	0.25	1.68	0.02	0.05	0.37	0.55	0.30	2.05	0.57	0.30	2.05	0.57	KamesCo
48261	0.17	1.23	0.03	0.10	0.23	0.19	0.27	1.46	0.22	0.27	1.46	0.22	KenedyCo
48273	0.36	2.12	0.11	0.06	0.10	1.41	0.42	2.22	1.52	0.42	2.22	1.52	KlebergCo
48285	1.91	2.37	2.42	0.20	0.68	2.54	2.11	3.05	4.96	2.11	3.06	4.96	LavacaCo
48287	2.40	5.37	0.27	0.28	0.29	0.94	2.68	5.66	1.21	2.69	5.66	1.21	LeeCo
48291	1.64	3.66	2.36	0.34	0.73	2.00	1.98	4.39	4.36	1.98	4.39	4.36	LibertyCo
48297	0.09	0.35	0.03	0.00	0.00	0.12	0.09	0.35	0.15	0.09	0.35	0.15	LiveOakCo
48321	2.89	8.18	3.70	0.31	0.22	4.50	3.20	8.40	8.20	3.21	8.40	8.19	MatagordaCo
48331	118.68	87.54	6.68	4.28	0.06	0.14	122.96	87.60	6.82	122.95	87.58	6.81	MilamCo
48339	6.00	20.56	0.64	0.10	0.09	3.17	6.10	20.65	3.81	6.10	20.65	3.82	MontgomeryCo
48351	0.14	0.41	1.65	0.01	0.06	0.18	0.15	0.47	1.83	0.14	0.47	1.83	NewtonCo
48355	17.97	80.32	11.66	0.24	1.36	41.55	18.21	81.68	53.21	18.21	81.66	53.22	NuecesCo
48361	54.60	65.80	15.43	0.14	0.30	13.59	54.74	66.10	29.02	54.74	66.09	29.02	OrangeCo
48373	4.98	3.89	4.04	0.00	0.00	0.45	4.98	3.89	4.49	4.98	3.89	4.49	PolkCo
48391	3.28	15.79	0.43	0.58	1.82	2.57	3.86	17.61	3.00	3.86	17.61	3.00	RefugioCo
48395	2.25	5.42	2.50	0.00	0.00	1.52	2.25	5.42	4.02	2.25	5.42	4.03	RobertsonCo
48409	4.32	18.22	0.71	0.25	0.27	1.11	4.57	18.49	1.82	4.57	18.49	1.82	SanPatricioCo
48453	4.24	11.61	0.80	0.16	0.32	1.82	4.40	11.93	2.62	4.40	11.92	2.61	TravisCo
48469	5.96	18.48	1.73	6.10	0.57	4.51	12.06	19.05	6.24	12.07	19.05	6.24	VictoriaCo
48473	1.85	5.93	0.09	0.01	0.00	2.61	1.86	5.93	2.70	1.86	5.93	2.69	WallerCo
48491	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.03	WilliamsonCo
48000	681.95	1300.12	218.97	33.49	42.63	493.64	715.44	1342.75	712.61	715.47	1341.90	712.63	Texas

Table A-3 : Point source totals for Texas for September 2, 1993

	SMOKE Elevated pt src			SMOKE Low point src			SMOKE Total point src			EPS Total point src			
FIPS	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	CO	NOX	VOC	COUNTY
22011	52.76	18.45	3.52	0.00	0.00	0.72	52.76	18.45	4.24	52.76	18.44	4.24	BeauregardPar
22019	28.47	117.47	14.01	0.42	1.34	34.82	28.89	118.81	48.83	28.89	118.79	48.79	CalcasieuPar
22023	2.93	8.81	1.15	1.05	4.56	3.62	3.98	13.37	4.77	3.98	13.37	4.77	CameronPar
22053	0.33	0.91	0.02	0.00	0.00	0.90	0.33	0.91	0.92	0.33	0.91	0.92	JeffDavisPar
22115	0.01	0.04	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.01	0.04	0.00	VernonPar
22000	84.50	145.68	18.70	1.47	5.90	40.06	85.97	151.58	58.76	85.97	151.55	58.72	Louisiana

Table A-4: Point source totals for Louisiana for September 2, 1993

	SMOKE Elevated pt src			SMOKE Low point src			SMOKE Total point src			
FIPS	CO	NOX	TVC	CO	NOX	TVC	CO	NOX	TVC	COUNTY
99007	0.50	2.20	0.98	0.16	0.72	1.89	0.66	2.92	2.87	BrazosOS
99009	0.00	0.00	0.00	0.12	0.55	0.61	0.12	0.55	0.61	BrazosSouthAddn
99023	0.16	0.54	2.31	0.09	0.41	0.49	0.25	0.95	2.80	EastBreaksOS
99025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	EastCameronOS
99037	0.15	0.71	0.32	0.15	0.69	1.03	0.30	1.40	1.35	GalvestonOS
99041	0.10	0.48	0.24	0.13	0.60	0.35	0.23	1.08	0.59	GardenBanksOS
99049	0.76	3.50	1.71	0.59	2.46	4.38	1.35	5.96	6.09	HighIslandOS
99051	0.21	0.94	0.42	0.08	0.27	1.13	0.29	1.21	1.55	HighIslandEast
99053	1.06	4.79	2.82	0.84	3.25	7.68	1.90	8.04	10.50	HIEastSouthExt
99055	2.03	9.29	4.40	1.73	7.46	8.47	3.76	16.75	12.87	HISouthAdd
99067	0.51	2.18	1.19	1.37	6.15	12.08	1.88	8.33	13.27	MatagordaIsland
99073	0.14	0.62	0.28	0.24	0.97	6.73	0.38	1.59	7.01	MustnagIsland
99075	0.00	0.00	0.00	0.10	0.44	0.25	0.10	0.44	0.25	MustnagIslandEast
99087	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NorthPadreIsl
99089	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05	NPadreIslEAdd
99097	0.00	0.00	0.00	0.04	0.16	0.14	0.04	0.16	0.14	SabinePass
99137	0.62	2.82	1.36	1.33	5.58	27.66	1.95	8.40	29.02	WestCameronOS
99139	0.64	2.42	1.05	1.23	4.79	5.14	1.87	7.21	6.19	WCameronSAddn
99141	0.25	1.16	0.83	0.23	1.07	15.35	0.48	2.23	16.18	WCameronWAddn
99000	7.13	31.65	17.91	8.43	35.57	93.43	15.56	67.22	111.34	Offshore

Table A-5 : SMOKE point source totals for Offshore sources for September 2, 1993

	SMOKE area source			EPS2 area source			
FIPS	CO	NOX	TVC	CO	NOX	VOC	COUNTY NAME
72023	1.99	2.34	0.74	2.00	2.34	0.71	CameronParishOS
72000	1.99	2.34	0.74	2.00	2.34	0.71	OffshoreParishes
	SMOKE area source			EPS2 area source			
FIPS	CO	NOX	TVC	CO	NOX	VOC	COUNTY NAME
98007	0.88	0.38	0.43	0.88	0.38	0.39	AransasOS
98039	4.23	1.37	2.16	4.25	1.37	1.94	BrazoriaOS
98057	0.83	0.59	0.42	0.83	0.59	0.39	CalhounOS
98071	0.59	0.46	0.34	0.59	0.46	0.31	ChambersOS
98167	4.34	0.83	2.21	4.36	0.83	1.98	GalvestonOS
98245	5.44	0.91	2.79	5.45	0.91	2.50	JeffersonOS
98261	0.11	0.32	0.06	0.11	0.32	0.06	KenedyOS
98273	0.38	0.43	0.20	0.38	0.43	0.18	KlebergOS
98321	1.19	1.27	0.59	1.20	1.27	0.54	MatagordaOS
98355	4.55	0.91	2.41	4.56	0.91	2.16	NuecesOS
98000	22.54	7.47	11.61	22.61	7.47	10.45	Offshore
	SMOKE area source			EPS2 area source			
FIPS	CO	NOX	TVC	CO	NOX	VOC	COUNTY NAME
99007	2.04	3.32	1.14	2.04	3.32	1.04	BrazosOS
99009	0.45	1.70	0.27	0.45	1.70	0.26	BrazosSouthAddn
99017	0.05	0.47	0.02	0.05	0.47	0.02	CorpusChristiOS
99023	0.98	7.73	0.38	0.97	7.73	0.37	EastBreaksOS
99025	0.03	0.13	0.02	0.03	0.13	0.02	EastCameronOS
99037	11.39	22.10	5.79	11.41	22.12	5.28	GalvestonOS
99039	0.30	2.33	0.21	0.30	2.33	0.21	GalvestonSAdd
99041	1.36	11.66	0.51	1.36	11.67	0.51	GardenBanksOS
99049	2.49	21.38	1.17	2.48	21.39	1.17	HighIslandOS
99051	0.82	7.08	0.39	0.82	7.08	0.39	HighIslandEast
99053	0.41	1.78	0.26	0.41	1.78	0.25	HIEastSouthExt
99055	0.89	3.33	0.53	0.89	3.33	0.50	HISouthAdd
99067	1.16	4.83	0.62	1.16	4.83	0.58	MatagordaIsland
99073	0.99	4.06	0.55	0.99	4.06	0.52	MustnagIsland
99075	0.57	3.35	0.35	0.57	3.35	0.34	MustnagIslandEast
99087	0.11	0.20	0.07	0.11	0.20	0.07	NorthPadreIsl
99089	0.05	0.34	0.04	0.05	0.34	0.04	NPadreIslEAdd
99097	0.20	1.72	0.09	0.20	1.72	0.09	SabinePass
99137	0.99	5.82	0.50	0.98	5.82	0.50	WestCameronOS
99139	2.86	14.79	1.38	2.87	14.78	1.32	WCameronSAddn
99141	1.09	8.79	0.52	1.09	8.79	0.52	WCameronWAddn
99000	29.23	126.91	14.81	29.23	126.94	14.00	Offshore
Total	66.53	51.81	54.35	66.61	51.81	53.16	All Offshore

Table A-6 : SMOKE vs. EPS2 Offshore area sources for September 2, 1993

APPENDIX B: CAM-x Simulation Results

OBJECTIVE MEASURES: Houston-Galveston
DOMAIN NAME: 93Base_E
BASE : 93Base_E

O3	930831	930901	930902	Total
Peak 1 Hour (ppb)	102	137	130	137
Total # of Grid Cells				
> 80 (ppb)	151	775	428	1354
>100 (ppb)	5	252	213	470
>124 (ppb)	0	35	26	61
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Total hours over threshold				
> 80 (ppb)	537	3172	1818	5527
>100 (ppb)	7	652	590	1249
>124 (ppb)	0	60	27	87
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Peak 8 Hour (ppb)	91	110	100	110
Total # of Grid Cells				
> 60 (ppb)	285	1281	493	2059
> 84 (ppb)	17	256	227	500
>100 (ppb)	0	45	2	47
>120 (ppb)	0	0	0	0
>140 (ppb)	0	0	0	0

Table B-1: Objective Metrics for 93Base_E within the 8-county Houston-Galveston Area.

OBJECTIVE MEASURES: Houston-Galveston
DOMAIN NAME: 93Base_S
BASE : 93Base_S

O3	930831	930901	930902	Total
Peak 1 Hour (ppb)	102	137	130	137
Total # of Grid Cells				
> 80 (ppb)	152	775	428	1355
>100 (ppb)	5	253	213	471
>124 (ppb)	0	35	26	61
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Total hours over threshold				
> 80 (ppb)	541	3174	1825	5540
>100 (ppb)	7	653	590	1250
>124 (ppb)	0	60	27	87
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Peak 8 Hour (ppb)	91	110	100	110
Total # of Grid Cells				
> 60 (ppb)	285	1281	495	2061
> 84 (ppb)	17	262	228	507
>100 (ppb)	0	45	3	48
>120 (ppb)	0	0	0	0
>140 (ppb)	0	0	0	0

Table B-2: Objective Metrics for 93Base_S within the 8-county Houston-Galveston Area.

OBJECTIVE MEASURES: Beaumont-Port Arthur
DOMAIN NAME: 93Base_E
BASE : 93Base_E

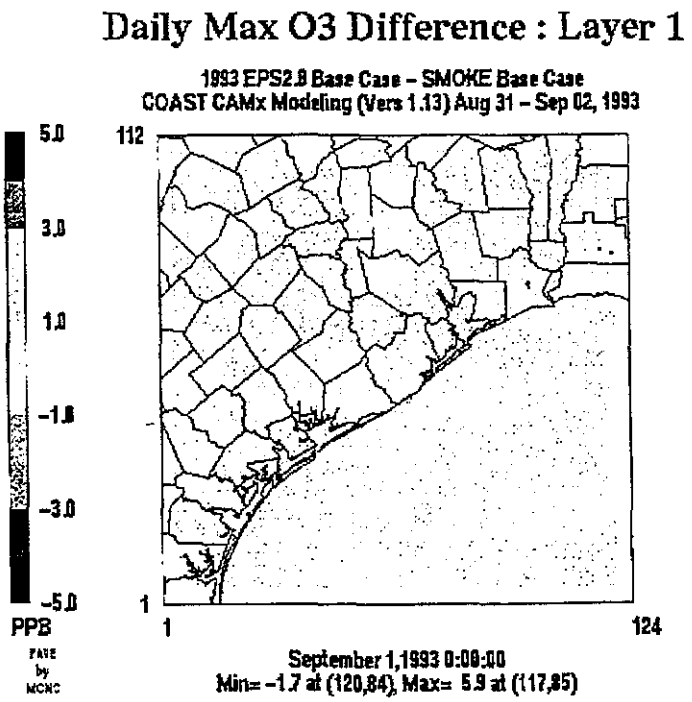
O3	930831	930901	930902	Total
Peak 1 Hour (ppb)	101	106	131	131
Total # of Grid Cells				
> 80 (ppb)	232	318	416	966
>100 (ppb)	7	24	277	308
>124 (ppb)	0	0	13	13
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Total hours over threshold				
> 80 (ppb)	808	934	2006	3748
>100 (ppb)	7	29	584	620
>124 (ppb)	0	0	15	15
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Peak 8 Hour (ppb)	81	93	98	98
Total # of Grid Cells				
> 60 (ppb)	250	398	440	1088
> 84 (ppb)	0	60	271	331
>100 (ppb)	0	0	0	0
>120 (ppb)	0	0	0	0
>140 (ppb)	0	0	0	0

Table B-3: Objective Metrics for 93Base_E within the 3-county Beaumont-Port Arthur Area.

OBJECTIVE MEASURES: Beaumont-Port Arthur
DOMAIN NAME: 93Base_S
BASE : 93Base_S

O3	930831	930901	930902	Total
Peak 1 Hour (ppb)	101	106	132	132
Total # of Grid Cells				
> 80 (ppb)	232	319	417	968
>100 (ppb)	7	26	278	311
>124 (ppb)	0	0	14	14
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Total hours over threshold				
> 80 (ppb)	810	934	2013	3757
>100 (ppb)	7	31	587	625
>124 (ppb)	0	0	16	16
>140 (ppb)	0	0	0	0
>160 (ppb)	0	0	0	0
Peak 8 Hour (ppb)	81	93	98	98
Total # of Grid Cells				
> 60 (ppb)	250	398	440	1088
> 84 (ppb)	0	60	274	334
>100 (ppb)	0	0	0	0
>120 (ppb)	0	0	0	0
>140 (ppb)	0	0	0	0

Table B-4: Objective Metrics for 93Base_S within the 3-county Beaumont-Port Arthur Area.



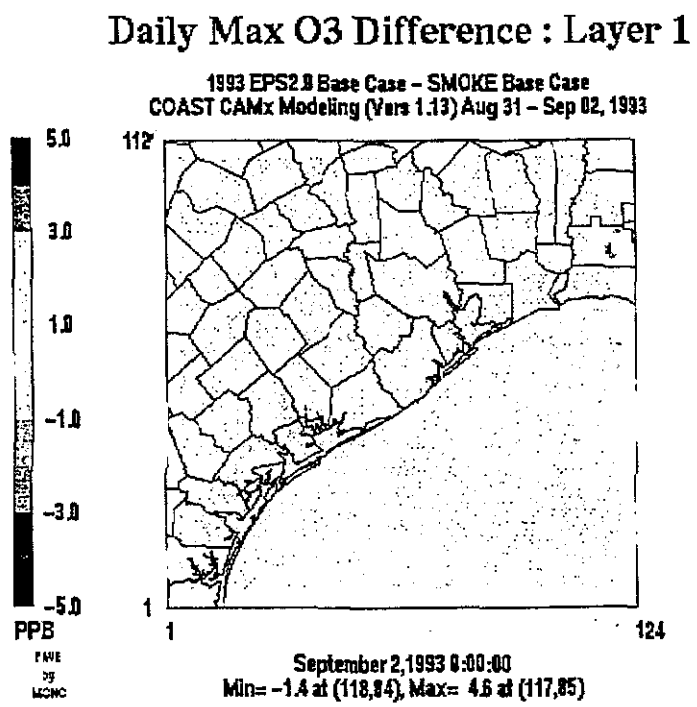


Figure B-1: Difference plots of Daily maximum 1-hr ozone concentrations between 93Base_E and 93Base_S on September 1 and 2, 1993.