Appendix M

Report - The Effect of Houston/Galveston Emissions upon Beaumont/ Port Arthur's Ability to Attain the National Ambient Air Quality Standard for Ozone

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The Effect of Houston/Galveston Emissions upon Beaumont/Port Arthur's Ability to Attain the National Ambient Air Quality Standard for Ozone

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Table of Contents

1. Introduction 1
2. Emissions Processing and Quality Assurance 1
3. Influence of the Houston-Galveston Area on Beaumont-Port Arthur 3
   3.1 Spatial Analysis of Houston-Galveston Transport 3
   3.2 Temporal Analyses of H-G Transport at Beaumont-Port Arthur sites 9
4. Conclusions 14
5. References 14

1. INTRODUCTION

The goal of the Beaumont-Port Arthur (B-PA) modeling project is to evaluate the effectiveness of candidate emissions control strategies in demonstrating attainment of the one-hour ozone National Ambient Air Quality Standard (NAAQS) in the 3-county B-PA ozone nonattainment area. A requisite step in this process is to determine the impact of ozone and ozone precursor transport from the often upwind Houston-Galveston (H-G) nonattainment counties upon the B-PA nonattainment area. This report summarizes the effects of the H-G region upon the ability of the B-PA region to demonstrate attainment of the NAAQS for a 31 August – 2 September Coastal Oxidant Assessment for Southeast Texas (COAST) episode.

In this portion of the B-PA modeling study we ran the Comprehensive Air Quality Model (CAM_X) using the same set of air quality and meteorological inputs previously used in a base case simulation (MCNC, 1999), but with an emissions data set in which anthropogenic emissions from the 8-country H-G nonattainment area were eliminated. The resultant CAMx outputs were compared to base case model outputs over the B-PA domain for the August 31st to September 2nd 1993 COAST base year episode. The remainder of this report discusses the preparation and results of the H-G transport simulation.

2. EMISSIONS PROCESSING AND QUALITY ASSURANCE

The first step in the process of determining the effect of H-G transport on ozone in the B-PA nonattainment region was to develop an emissions input set that excluded *anthropogenic* emissions from the 8-county H-G nonattainment area. The following counties comprise the H-G nonattainment area: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. This is a fairly straightforward process.

The latest base year inventory component files were gathered then manipulated using an MCNC pre-processor (geocuts_low.x) and a "mask" file provided by TNRCC (ei_cell_mask.coast.hg_nonatt). For the area, low point, and motor vehicle component files, the VOC, NO_X, and CO emissions in grid cells within the H-G nonattainment area were multiplied by zero. These three files were then merged with the latest set of biogenic emissions to create a CAMx ready low-level emissions file. A separate MCNC pre-processor (geocuts_elev.x) and the same mask was used to generated the appropriate CAMx-ready elevated point source emissions file. Table 1 lists the component files used to create the simulation emissions input.

Table 1. Component Inventory Files used in the Simulation

Elevated point:	uamv_el_ei.$date.93.base.regular
Area source:	lo_emsar.$date.base3
Low point:	lo_emspt.all.$date
Mobile source:	lo_emsmv.jhs071995.COAST.083193,
	lo_emsmv.jhs081395.COAST.090193
	lo_emsmv.jmackay072595.COAST.090293
Biogenic:	fresh_bio.$date

As part of an effort to verify that the inventory changes were only made in the H-G nonattainment area, plots were generated comparing the emissions from the base case to those from the H-G transport simulation. These plots verified successful zeroing of H-G anthropogenic emissions, both low-level and elevated. Figure 1 displays a sample plot of this type.

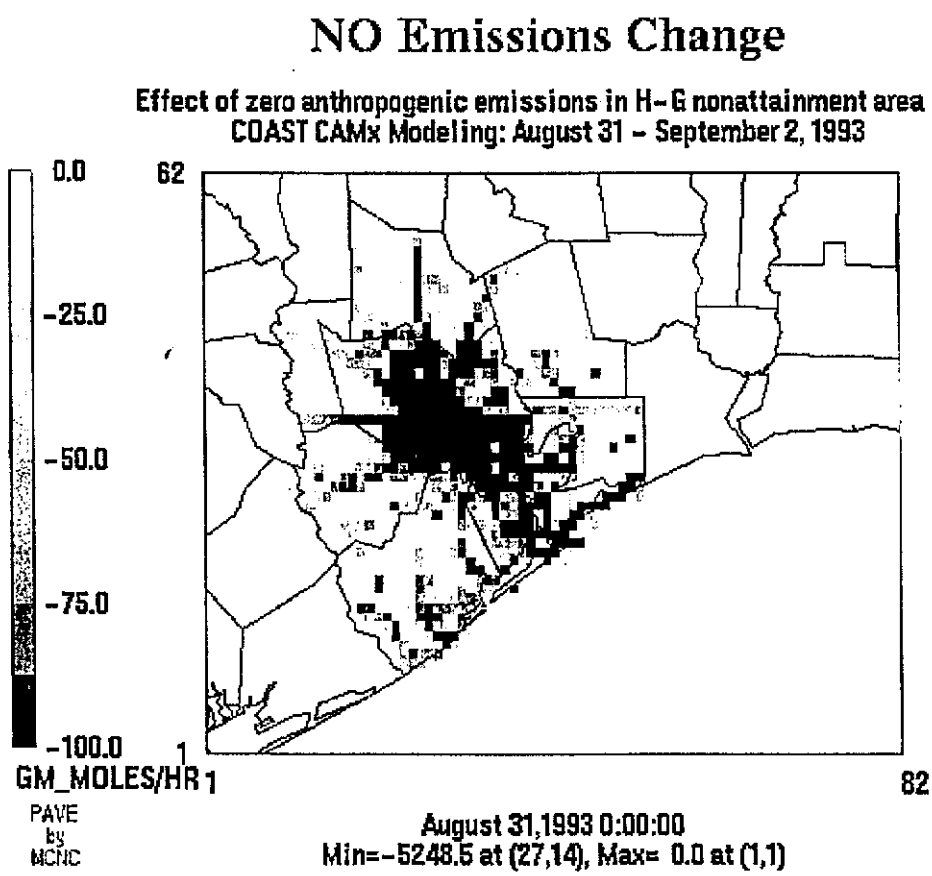

Figure 1. Change in Low-level NO_X emissions at 0000 CST due to zero anthropogenic emissions in the 8-county Houston-Galveston nonattainment area.

3. INFLUENCE OF THE HOUSTON-GALVESTON AREA ON BEAUMONT-PORT ARTHUR

Two caveats should be kept in mind regarding the conclusions reached below on the effect of H-G transport on the ability of the B-PA region to demonstrate attainment of the NAAQS. First, any findings in terms of transport from one Texas region to another are only as valid as the meteorological inputs driving the CAMx modeling. Second, only one episode has been considered in this analysis. The degree of transport from H-G to Beaumont-Port Arthur during any given ozone episode will vary as a function of the ambient meteorological conditions. The August 31 -- September 2 episode features generally southwesterly winds, especially during the two episode days and therefore should be a representative case.

3.1 SPATIAL ANALYSIS OF HOUSTON-GALVESTON TRANSPORT

As expected, ozone reductions resulting from the removal of all H-G anthropogenic sources are greatest in the 8-county H-G area itself. Ozone reductions can range from 40-80 ppb over Houston and Galveston Bay. (Ozone increases are simulated during the nighttime hours as background concentrations (~40 ppb) replace near-zero ozone from NOx titration). Figure 2 shows the decrease in episodic maximum ozone across the entire domain due to the zeroed H-G anthropogenic emissions.

Reduction in Episodic Maximum Ozone

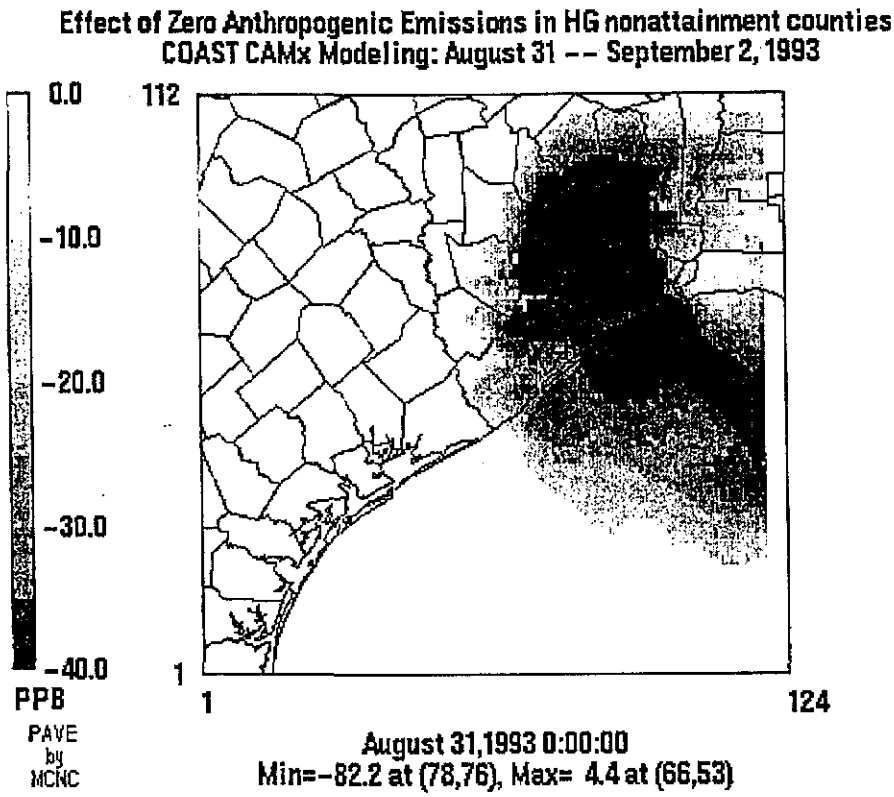

Figure 2. Reductions in episodic maximum Layer-1 ozone resulting from the removal of all Houston-Galveston nonattainment anthropogenic emissions sources.

As seen in Figure 2, episodic peak ozone is reduced by 10-30 ppb in the Beaumont-Port Arthur regions. Jefferson and Hardin counties are influenced more strongly by H-G transport than Orange County, which makes sense given their proximity to the H-G nonattainment area.

Figure 3a displays the ozone peaks with and without the influence of H-G transport over the B-PA region on 1 September 1993. As shown in the figure, without transport from the upwind H-G sources ozone does not exceed 70 ppb in most parts of Jefferson and Hardin counties. East of Beaumont, ozone is still reduced but by smaller amounts. The ozone plume that emanates from B-PA and migrates into Louisiana has nearly the same magnitude, independent of H-G transport.

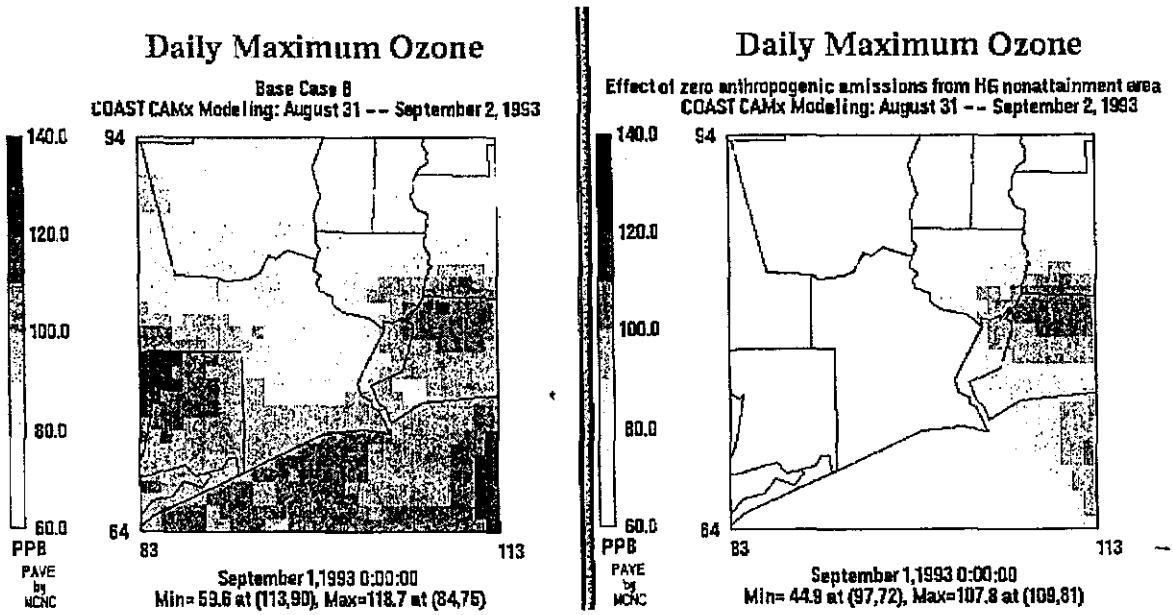

Figure 3a. Left side of the plot shows the peak modeled ozone on September 1, 1993, in the base case simulation. The right side of the plot shows the same field but with zero anthropogenic emission sources in the Houston-Galveston area.

Figure 3b shows the reduction in maximum ozone on the same day. The largest simulated ozone reductions are in the 8-county H-G nonattainment area (in excess of 40 ppb). Farther downwind, in Jefferson and Hardin counties, model ozone is approximately 15-35 ppb lower when upwind emissions are shut off. Interestingly, the Beaumont-Port Arthur ozone plume that is advecting into Louisiana on 1 September is not greatly diminished by the lack of a Houston-Galveston contribution. Maximum ozone changes of less than 5 ppb are noted in this region, i.e., most of Orange, Cameron, and Calcasieu counties.

Figure 4a shows the peak ozone fields for the two CAMx runs, side-by-side, for 2 September 1993. For this day, the peak ozone is just downwind of Beaumont in grid cell (109,85). The peak ozone is reduced from 132.5 to 120.3 ppb. Therefore, for this particular day, the influence of the upwind Houston-Galveston sources can make the difference between a simulation that demonstrates attainment of the NAAQS versus a simulation that does not.

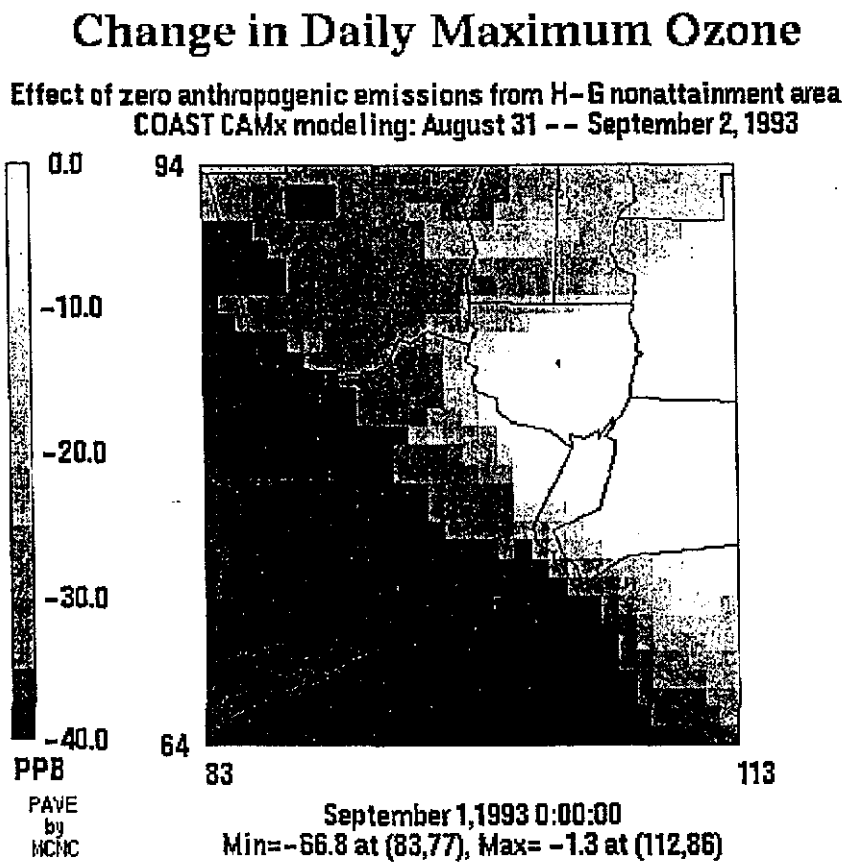

Figure 3b. Change in daily peak ozone on September 1, 1993 as a result of removing all Houston-Galveston nonattainment anthropogenic sources.

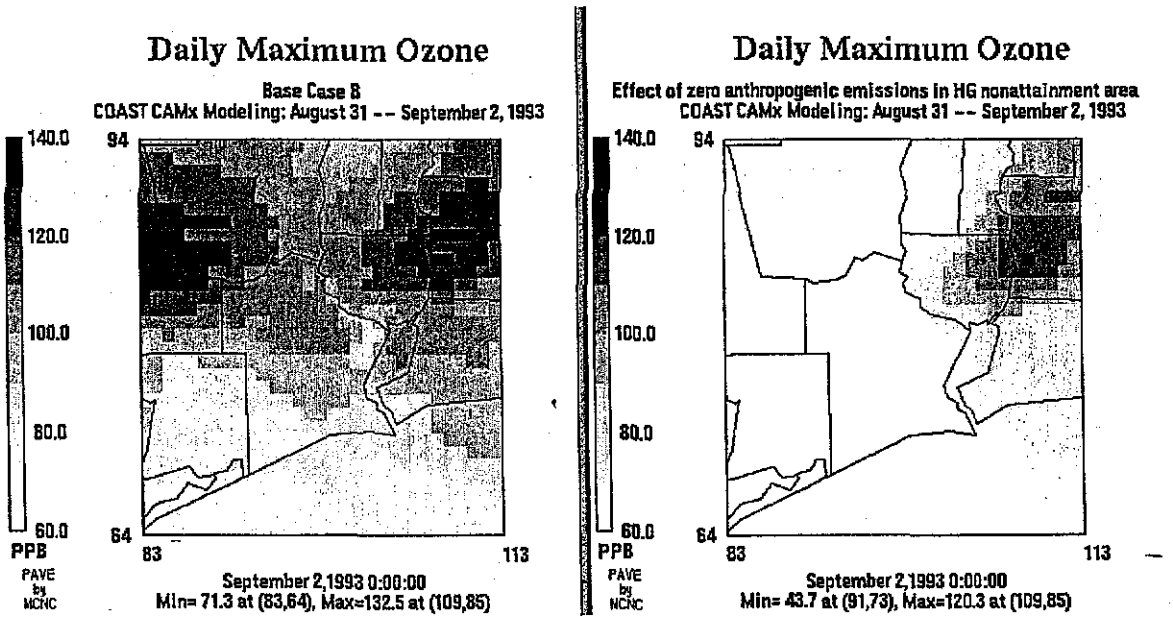

Figure 4a. Left side of the plot shows the peak modeled ozone on September 2, 1993 in the base case simulation. The right side of the plot shows the same field but with zero anthropogenic *emission sources in the Houston-Galveston area.*

Similar to the results of the preceding day, most of the ozone greater than 70 ppb is now located only to the east of the Beaumont region. The high values in Hardin and Jefferson counties are seen to be largely influenced by ozone transport from the H-G region. Unlike the preceding day, however, the Beaumont-Port Arthur plume is diminished somewhat in magnitude when H-G emissions are excluded from the modeling.

This can also be seen in Figure 4b, which displays the difference in peak ozone on September 2nd between the two runs. Most of the western half of the B-PA subregion experiences simulated ozone reductions of at least 30 ppb. The eastern half of the subregion experiences smaller, but still significant reductions of 10-30 ppb.

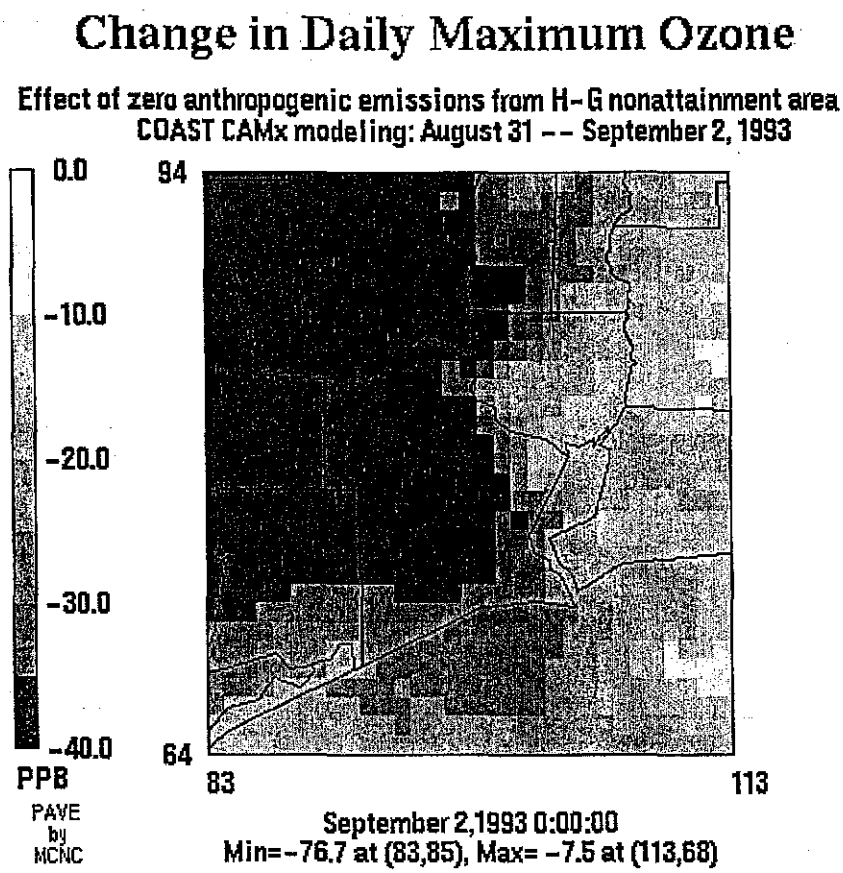

Figure 4b. Change in daily peak ozone on September 2, 1993 as a result of removing all Houston-Galveston nonattainment anthropogenic sources.

3.2 TEMPORAL ANALYSES OF H-G TRANSPORT AT BEAUMONT-PORT ARTHUR SITES

It is also useful to look at the influence of Houston-Galveston emissions on a site-by-site basis. There are seven COAST monitoring locations within the B-PA region.
Figure 5a shows the two simulated hourly ozone traces for a Beaumont site (BMTA), a rural Hardin county site (KTZA), and a site just west of Port Arthur (PAWC). (See Figure 6 for a map of the COAST monitoring locations.) At the Beaumont location, the influence of the H-G emissions is noted just 9-12 hours after model startup. The August 31 ozone peak is lower and earlier in the day without the H-G impacts. On the 1st, the effect of H-G transport is about 5-10 ppb until the late afternoon where the secondary ozone peak modeled in the base case appears to be transport-driven. Ozone is much lower on the 2nd when H-G emissions are removed and again the peak occurs much earlier in the day, e.g., around 11 a.m. CST.

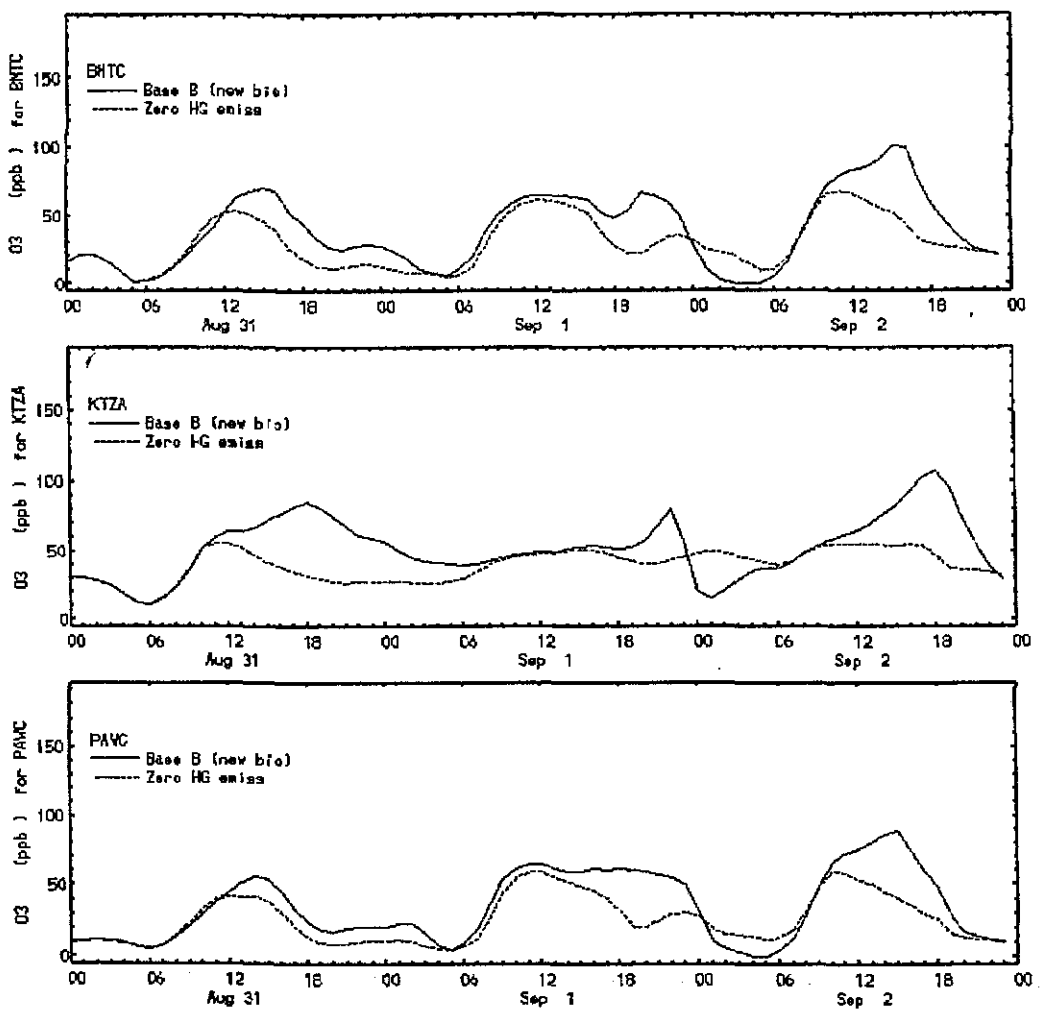

Figure 5a. Time series of simulated ozone: solid line is the base case, dashed line is the scenario without H-G anthropogenic emissions.

The rural Hardin county site appears to be dominated by H-G transport throughout the episode, except for the brief period between 8 a.m. and 3 p.m. CST on September 1st. Without the H-G influence, this site ranges fairly consistently between 40-50 ppb. The site just to the west of Port Arthur (i.e., upwind in this case) is also influenced by transport from Houston and its nonattainment surroundings. The impacts are generally on the order of 10 ppb during the first 36 hours of the episode and 20-40 ppb during the second half of the episode. At both sites, the distinct late-day peaks appear to be the result of H-G transport.

Figure 5b displays the time series plots for the remaining four B-PA monitoring locations. The S40S site is located near Sabine Pass TX, near the Gulf of Mexico shoreline. It would be expected to be strongly influenced by the inflow of polluted air from H-G that was advected out over the Gulf and it is transport-affected on the two episode days. The S42S monitor is based in central Orange county.(i.e., east of Beaumont). The ozone at this site appears to be local during the daylight period of September 1st, but transport-influenced the remainder of the episode.

The S43S site is located in Port Arthur. Ozone impacts from the absence of H-G emissions appear to be on the order of 10-40 ppb. The WORA site in West Orange, TX is the least influenced of all the monitoring locations by H-G transport. The model grid cell in which this monitor is located is typically in the afternoon B-PA ozone plume. On the last day of the episode, the ozone is still about 10-15 ppb lower at this site.

It appears the reduction in model ozone at the B-PA sites is due primarily to the reduction in ozone transported out of the H-G region, instead of a reduction in nitrogen oxide transport. Figure 7 displays the time series traces for ozone and NO_X for the base case and zero H-G emissions runs for a grid cell along the B-PA inflow flux plane. Figure 7 also highlights the tendency for local ozone peaks (i.e., without H-G influence) to occur much earlier in the day for those sites in or upwind of Beaumont-Port Arthur.

Also of interest are the differences in NO_X concentrations between the two simulations. In the early morning hours (e.g., 0600-0900) there is spike in NO_X concentrations resulting from H-G emissions. This causes early morning ozone to be chemically destroyed in the base case. This additional NO_X can enhance ozone production later in the day. There are slight differences in afternoon NO_X between the two runs in the afternoon. The base case tends toward 0.5 to 2 ppb higher concentrations than the sensitivity run.

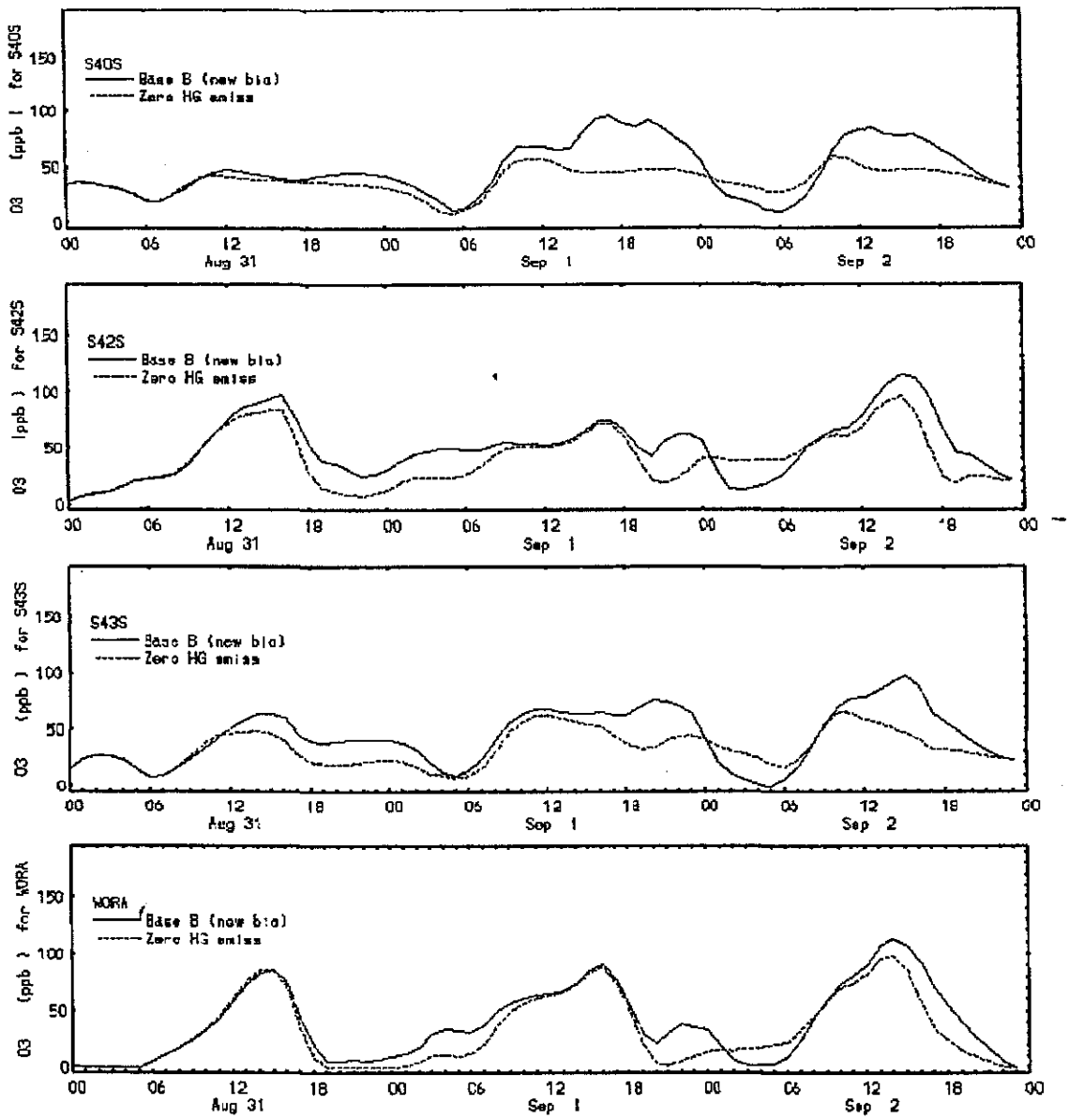

Figure 5b. Time series of simulated ozone: solid line is the base case, dashed line is the scenario without H-G anthropogenic emissions.

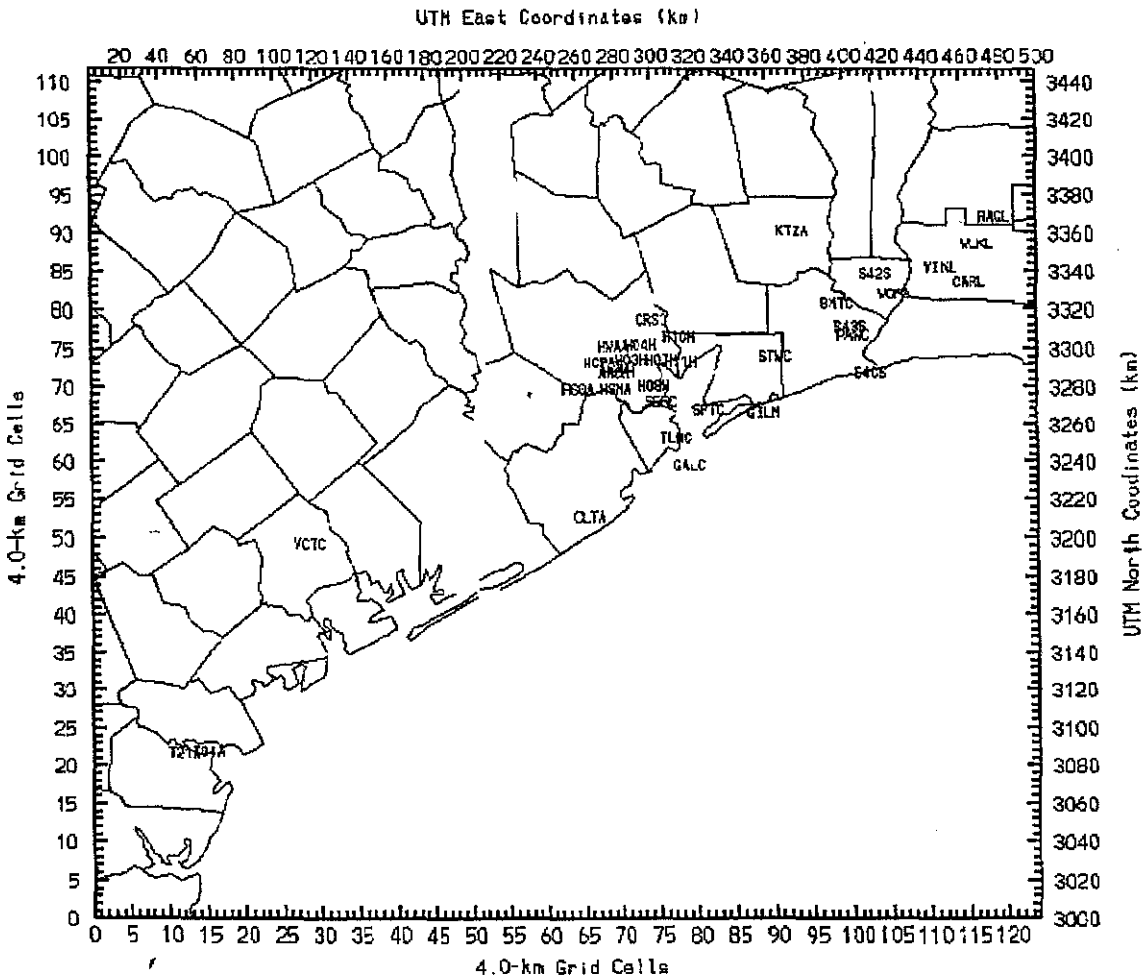

Figure 6. Map of COAST monitoring locations.

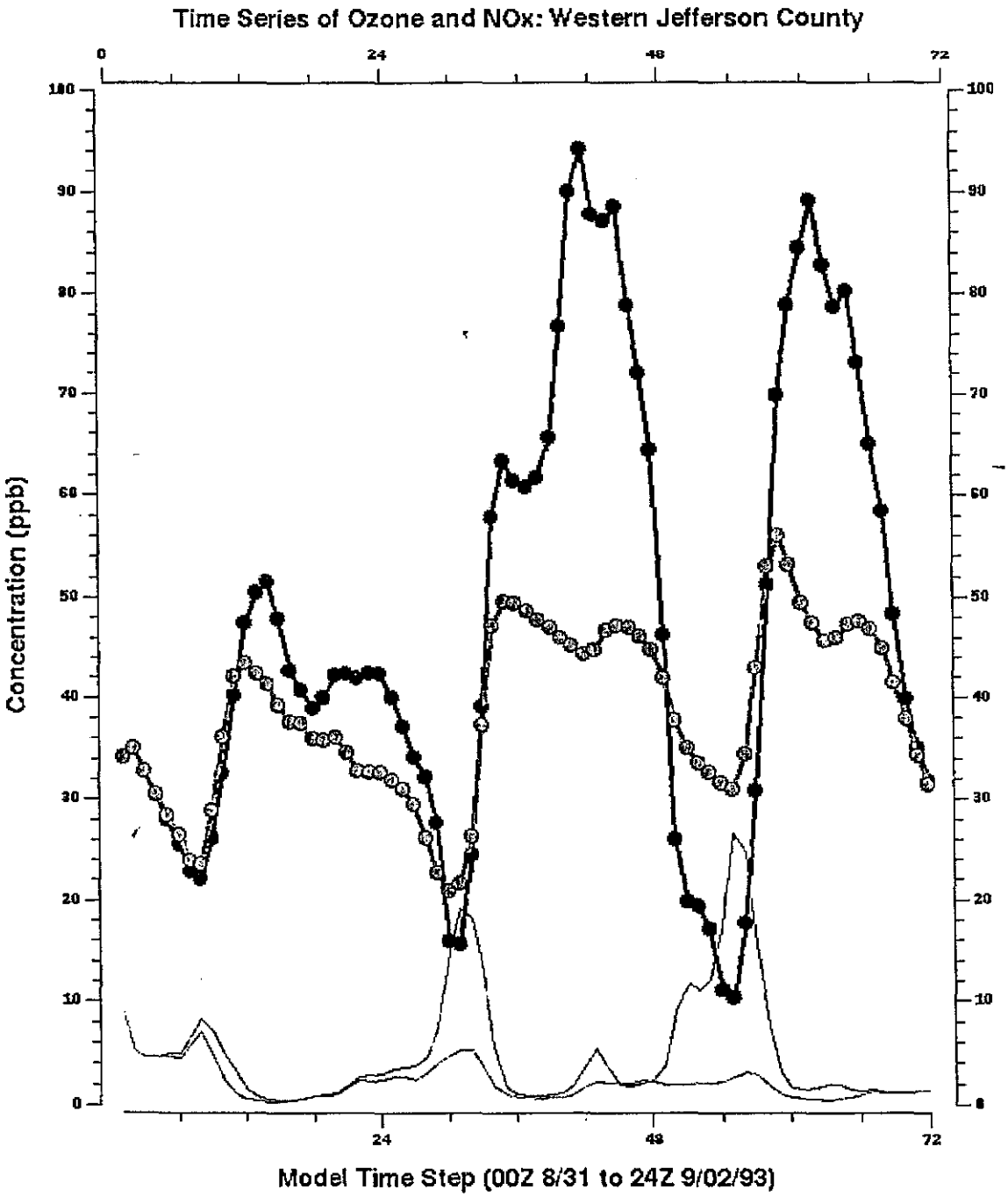

Figure 7. Time series of ozone and NO_X for the base case and zero H-G emissions runs. The thick lines with embedded circle symbols represent ozone concentrations. The thin lines represent NO_X concentrations in the model. The darker solid lines represent the base case simulation and the lighter dashed lines represent the zero H-G emissions case.

4. CONCLUSIONS

This report summarized the results of a CAMx modeling analysis investigating the effects of Houston-Galveston emissions on the ability of the Beaumont-Port Arthur region to demonstrate attainment of the NAAQS. To determine the maximum possible impact of the H-G region, the anthropogenic emissions from the 8 nonattainment counties were removed from the simulation and the resultant outputs were compared against the base case for the representative August 31st - September 2nd COAST episode.

The modeling showed that the absence of H-G anthropogenic emissions resulted in lower ozone in the B-PA region. The magnitude of the ozone decreases varied depending on the proximity of the area to the 8-county H-G region. In general, the peak ozone reductions in Beaumont and Port Arthur were on the order of 10-40 ppb. Peak occurred much earlier in the day without the upwind influence. The area least affected by the removal of H-G impacts was immediately downwind of Beaumont. The modeling indicated that 2 September had more transport than the preceding two days of the episode. These results may also be significant from a regulatory perspective as the Beaumont-Port Arthur region has simulated concentrations less than the ozone NAAQS when H-G emissions are removed from the system (i.e., episode peak reduced from 132.5 to 120.3 ppb).

5. REFERENCES

MCNC, 1999: Migration of the Beaumont-Port Arthur Ozone Modeling from UAM-V to CAMx. Research Triangle Park, NC.