Appendix F

Report - Incorporation of Emissions Improvements for the Beaumont/ Port Arthur CAMx Modeling

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Effects of Revised Emissions Estimates on Modeled Ozone in the Beaumont/Port Arthur Region

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Table of Contents

1. Introduction 3
2. Revisions to Emissions Inventory 3
   2.1 Revisions to Biogenic Emission Estimates 3
   2.2 Revisions to Marine Diesel Shipping Emissions Estimates 6
3. CAMx Simulation Results 7
4. Conclusions 9
5. References 10

1. INTRODUCTION

This report summarizes the results from incorporating revised emissions input data into a photochemical modeling application for the Beaumont/Port Arthur (B-PA) airshed. This exercise is part of a larger modeling study intended to evaluate the effectiveness of candidate control strategies in demonstrating attainment of the one-hour ozone National Ambient Air Quality Standard (NAAQS) for the three-county B-PA ozone nonattainment area. The photochemical modeling performed as part of this exercise used the Comprehensive Air Quality Model (CAM_X, Version 1.13) (Environ, 1998) for the Coastal Oxidant Assessment for Southeast Texas (COAST) 31 August - 2 September 1993 episode.

Before one can use the model to evaluate future year scenarios, one must confirm that the model can capably replicate a historic ozone episode. It is fairly common for the model inputs, especially the emissions inventory estimates, to be revised one or more times during this process to reflect better a understanding of the conditions that lead to the high ambient ozone. This report will discuss the effects of improving base year biogenic emission estimates as well as the effects of a revision to the shipping emissions estimates. In both cases, the inventory changes are believed to provide a more accurate characterization of the base- and projected-year emissions.

2. REVISIONS TO EMISSIONS INVENTORY

The emissions inventories that are input into the CAM_X model are separated in four distinct categories, only later to be merged into low-level and elevated CAM_X input files. The four inventory sectors are biogenic, mobile, area, and point source emissions. The Texas Natural Resource Conservation Commission (TNRCC) developed and maintains the emissions database used in the COAST modeling studies.

The original COAST 1993 base year emissions data set was revised by TNRCC to reflect a change in the composition of the biogenic estimates. Additionally, changes were made in the way marine diesel shipping emissions, an area source component, were spatially allocated. Both changes are discussed in more detail below.

2.1 REVISIONS TO BIOGENIC EMISSION ESTIMATES

The biogenic component of the inventory was revised in an attempt to better characterize the actual biogenic emissions from urban areas. While the total biogenic

Figure 1 shows the isoprene differences over the 4-km COAST domain for a representative hour between the original and revised low-level emissions input file. A couple of features can be observed: 1) large increases of emitted isoprene along the Trinity, Neches, and Sabine rivers, 2) most of the counties north of a Houston-Beaumont line experience biogenic VOC increases, 3) grid cells containing the Brazos river tend to see VOC decreases, and 4) urban areas like Harris Co. and especially Beaumont/Port Arthur have much less biogenic loading in the new base case.

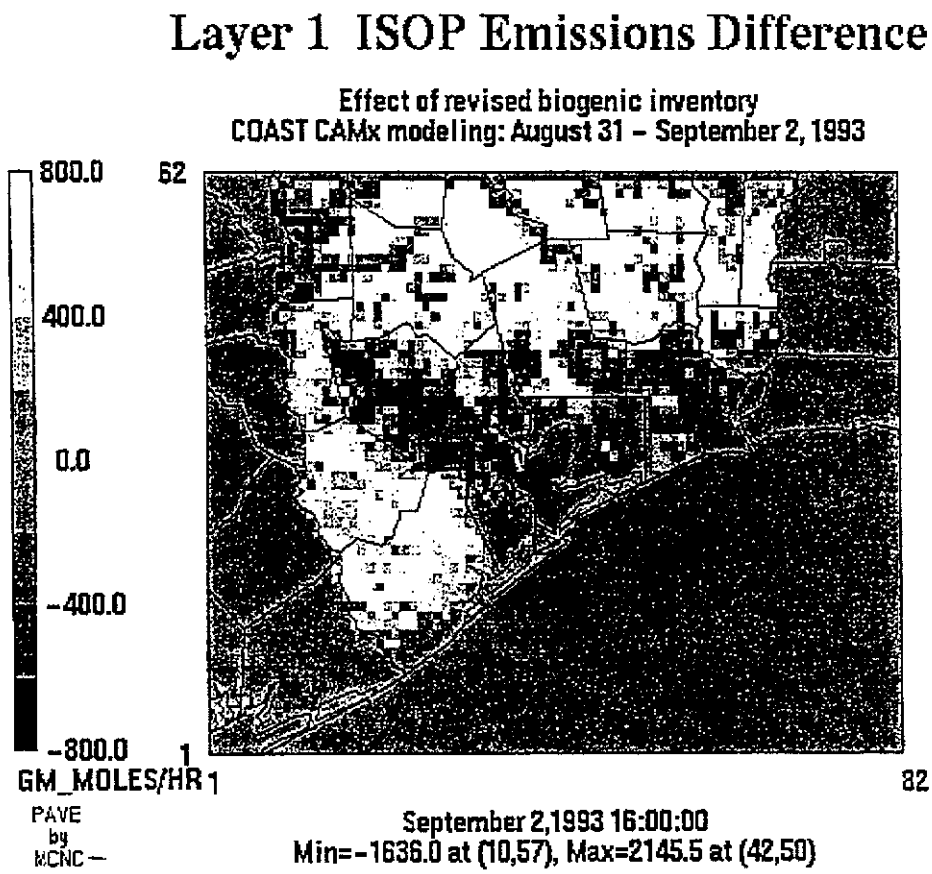

Figure 1. Isoprene emissions change between the original and current base year biogenic inventories at 4 p.m. CST on 2 September 1993. The bright white shading displays those areas in which emissions have increased. The darker colors reflect decreases in biogenic isoprene.

2.2 REVISIONS TO MARINE DIESEL SHIPPING EMISSIONS ESTIMATES

The base 2 set of area emissions was used for the original B-PA base case. The only difference between base2 and base3 area emissions that were employed in the revised inventory is a change in shipping emissions. Motor vehicle, low and elevated point emissions were unchanged from the previous inventory.

Figure 2 highlights the changes in emissions density from the marine diesel category. Emission reductions are common along the Intracoastal Waterway and the Houston Ship Channel, while increases were seen in the northern part of Galveston Bay and along certain rivers.

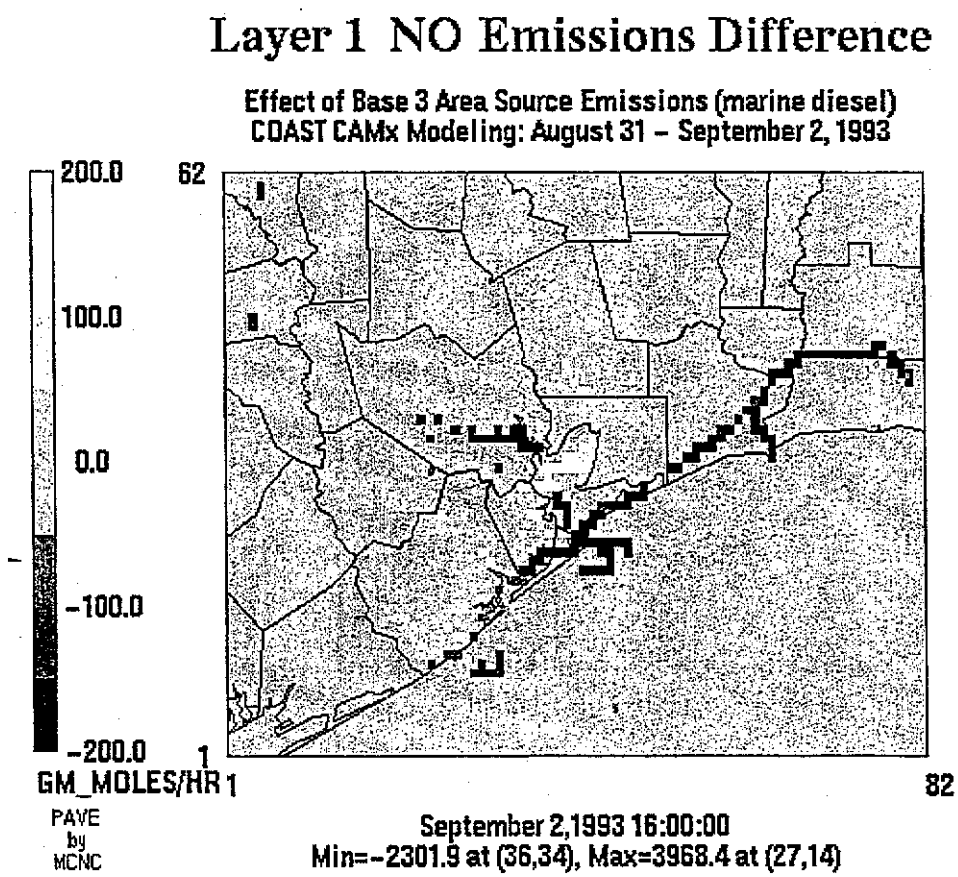

Figure 2. Nitric oxide emissions change between the original and current, base year area source inventories at 4 p.m. CST on 2 September 1993. The bright white shading displays those areas in which emissions have increased. The darker colors reflect decreases in NO.

3. CAMX SIMULATION RESULTS

The large majority of the model domain experiences ozone changes of less than plus or minus five parts per billion in response to the revised biogenic (and marine source) inventory. During the afternoon periods, more ozone (as much as 25 ppb) is produced over Fort Bend and Brazoria counties with the new biogenic estimates. Meanwhile, ozone is reduced over parts of Harris County by 15-20 ppb. The effect of the shipping emissions revision is mostly detected after 5 p.m. CDT as the lower atmosphere becomes more stable, thus trapping NO_X emissions. Ozone generally increases in response to the new shipping emission estimates, especially along the B-PA part of the Intracoastal Waterway, up to 30 ppb for some isolated hours and grid cells.

The first day of the episode, 31 August 1993, is a ramp-up day on which ozone (model & observed) was quite low across the entire COAST domain. The effect of the revised emissions is to lower the simulated ozone concentrations advecting out of Harris Co. by 5-15 ppb. In the southern parts of the Houston- Galveston nonattainment area, ozone increases of the same magnitude are seen. This increased ozone mass can be advected into Harris Co. from the surrounding southern counties, as occurs on this day.

The pattern in simulated ozone differences (original vs. revised inventory) that was seen on 8/31/93 is also detected on the episode days. The amount of ozone formed in the VOC-limited core of Houston is much lower (~20 ppb) in response to the lower urban biogenic emissions. The isoprene emissions increases seen in the areas surrounding Houston only result in more ozone in southern Harris, northern Brazoria, and northern Fort Bend Co. This is because the rural areas are already VOC-laden. Most of the ozone changes occur in the transition cells between VOC-limited and NOx-limited regions. Note that the domain-wide peak ozone is reduced from 154 to 144 ppb. Figure 3 shows the two simulated ozone fields side-by-side for a representative hour. Figure 4 shows the difference between the two simulations for the same hour.

The peaks are not as greatly reduced with the new emissions inputs on the final day of the episode, 2 September 1993. Domain-wide peaks fall from 134 to 132 ppb. The same ozone difference pattern is seen but with slightly smaller magnitudes.

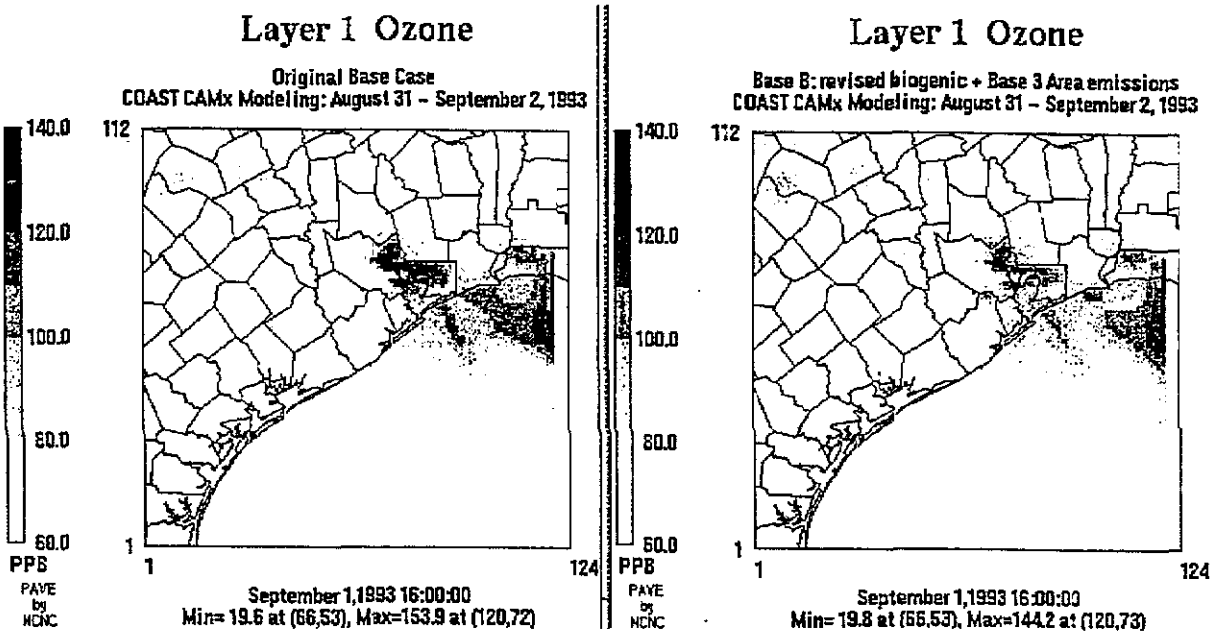

Figure 3. Model ozone at 4 p.m. CST in the original base case (left) and the revised biogenic inventory base case (right) on 1 September 1993.

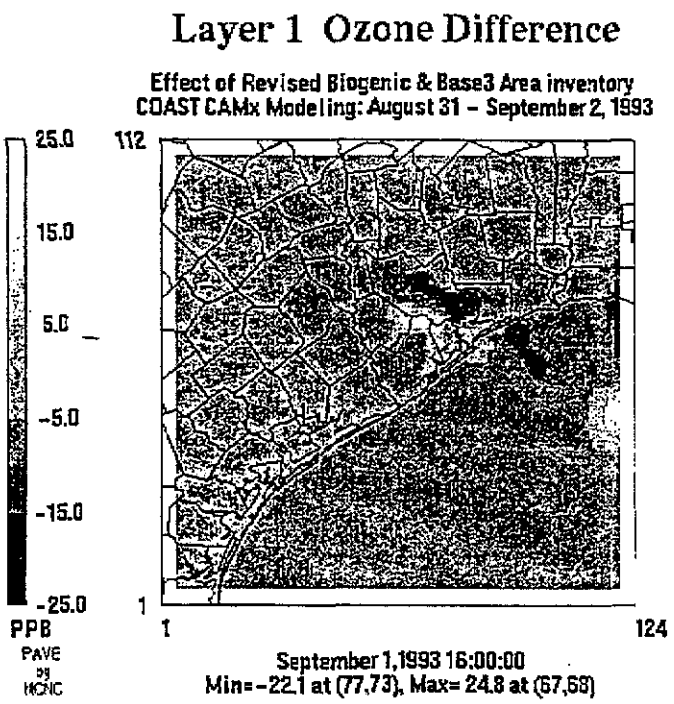

Figure 4. Difference in model ozone at 4 p.m. CST between the original base case and the revised biogenic inventory base case on 1 September 1993.

Table 1 compares some of the common evaluation statistics generated from the two runs. As can be seen from the table, the regional evaluation statistics are largely unchanged. In general, the results from this sensitivity study for the 31 August - September 2nd episode are very similar to those previously determined over the 6 September 1993 episode which was discussed in MCNC (1999).

Date	Max Model Ozone Domainwide	Max Model Ozone Stationwide	Max Obs Ozone	Average Peak Accuracy	Normalized Bias	Normalized Gross Error	Mean Simulated	Mean Obs
8/31/93	100.4/**104.1**	88.7/**86.4**	96	-.127/-.147	-.169/-.185	.314/.317	60.2/**59.1**	75.1
9/01/93	172.7/**161.9**	143.8/**131.5**	164	.171/.120	.177/.125	.307/.286	94.2/**89.7**	84.3
9/02/93	134.1/**132.5**	128.7/**123.9**	139	-.006/-.012	.027/.014	.178/.184	82.2/**80.8**	81.8

Table 1. Model performance statistics. Plain text values are original base case. Values in bold are for the simulation with the revised biogenic inventory.

4. CONCLUSIONS

This report summarizes the results from a sensitivity simulation involving changes in the COAST base year emissions data. The emissions database was improved to reflect the best estimates of the emissions into the COAST airshed. Neither change resulted in deviations in model ozone predictions that would cause one to reconsider past findings from the COAST modeling.

Increasing biogenic VOC emissions across rural areas of the COAST domain while reducing urban biogenic emissions has the following effects:

1) Peak afternoon ozone is reduced across portions of Harris Co. by approximately 5-20 ppb from the original base case. While biogenic VOC emission magnitudes are much smaller within the urban area than in rural parts of the domain, the high concentrations of anthropogenic NOx in Houston make the model somewhat sensitive to small changes in urban VOC emissions.

2) Outside of the urban areas, there were some ozone increases on the order of 5-20 ppb with the new biogenics. For the most part these increases were located in the counties just south of Houston (Fort Bend, Brazoria).

3) Most of the simulated ozone changes in the Beaumont-Port Arthur region were relatively small.

4) The changes in the spatial pattern of shipping emissions generally resulted in increased ozone at night.

5) From a model performance perspective, there is little change in the quality of model predictions when compared to observations.

5. REFERENCES

ENVIRON International Corporation, 1997: *User's Guide to the Comprehensive Air Quality Model with Extensions (CAMx)*. Novato, CA.

MCNC, 1999: *Effects of Revised Biogenic and Future-Year Mobile Emissions Estimates on Ozone in the Houston/Galveston Region*. Research Triangle Park, NC.

Texas Natural Resource Conservation Commission, 1998: *Protocol for Ozone Modeling of the Houston-Galveston area with the Comprehensive Air Quality Model with Extensions (CAMx) and COAST Data*. Austin, TX.