ENVIRON

MEMORANDUM

To: James Red, Texas Natural Resources Conservation Commission

From: Ralph Morris and Edward Tai

Date: January 4, 2001

Subject: Preliminary RAMS/CAMx ozone model performance results for the Houston area and the September 6-11, 1993 COAST episode

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Under the Texas Natural Resources Conservation Commission (TNRCC) Umbrella Contract No. 582-0-31-31984 Work Order No. 31984-05, ENVIRON International Corporation and their subcontractor the ASTeR division of the Mission Research Corporation performed (MRC/ASTeR) RAMS meteorological modeling and CAMx photochemical modeling of the September 6-11, 1993 ozone episode in the Houston/Galveston (H/G) and Beaumont Port Arthur (B/PA) regions. Previously this episode had been modeled using the SAIMM meteorological model and CAMx. In the CAMx simulation using the SAIMM wind fields, there were a few grid cells in southern Harris County that exhibited a severe overprediction tendency on September 8th. The estimated high ozone concentrations in these same grid cells were also very insensitive to reductions in NOx emissions and were driving the level of control needed to attain the ozone standard. After a review and analysis of the SAIMM/CAMx photochemical modeling database, the wind fields (and potentially other meteorological variables) were identified as potentially anomalous. Thus, the purpose of this work effort is to generate new CAMx meteorological inputs using the RAMS meteorological model and see whether the CAMx/RAMS exhibits adequate model performance and whether the estimated high ozone concentrations are also insensitive to NOx reductions. RAMS contains significant technical advances over the SAIMM (e.g., non-hydrostatic vs. hydrostatic).

This memorandum presents some preliminary CAMx/RAMS ozone model performance evaluation results.

RAMS Simulations

MRC/ASTeR has performed six RAMS meteorological simulations as shown in Table 1.

Table 1. RAMS simulations performed for the September 1993 COAST episode.

Run	Period	Description
M3	Sept. 6-8, 1993	Cold start at 00 on Sept. 6 and no FDDA
M4	Sept. 6-8, 1993	FDDA using NWS obs only
S4	Sept. 6-8, 1993	FDDA using NWS & some COAST obs
T4	Sept. 6-8, 1993	FDDA using NWS & "all" COAST obs, increased soil moisture
T5	Sept. 6-11, 1993	T4 FDDA and soil moisture between S4 and T4
T6	Sept. 8-11, 1993	Same as T5 but with cold start at 00 on Sept. 9

From a meteorological modeling perspective, the T5 run performed the best. Run T6 resulted in nearly identical statistical performance measures as the T5 run. The meteorological modeling performance summary displays can be obtained by using your Web browser attached to ftp://ftp@ftp.aster.com. Using your e-mail address as a password, click on the incoming directory and download the file "gmeta-t5-all.gz". The postscript plot file within the file can be obtained using the gunzip command.

Preliminary CAMx Ozone Model Performance Results

CAMx was run for the September 6-8, 1993 period using the RAMS S4 and T4 meteorology and for the entire September 6-11, 1993 period using the RAMS T5 meteorology. Attachment A summarizes ozone performance statistical measures, time series plots, and spatial daily maximum ozone plots for the CAMx/RAMS_T5 simulation and the September 6-11, 1993 period.

Tables 2-5 below summarize the CAMx/RAMS_T5 and the original; CAMx/SAIMM (using the aak93 base case) performance statistics for September 6-11, 1993. For the September 8th day, we have also included the CAMx/RAMS_T4 and CAMx/RAMS_S4 results.

EPA has performance goals for three statistical performance measures as follows:

- Unpaired Peak Accuracy $< \pm 20$ percent
- Normalized Bias $< \pm 15$ percent
- Normalized Gross Error $< 35\%$

On September 8, the peak observed ozone concentration (214 ppb) is reproduced by within –13, -36, -27, and –27 percent for the CAMx SAIMM, RAMS_T5, RAMS_T4, and RAMS_S4 simulations, respectively. That is, the CAMx/SAIMM is the only simulation that meets EPA's Unpaired Peak Accuracy performance goal on this day. All four model simulations meet the

bias and error performance goals with the CAMx/RAMS simulations exhibiting slightly lower bias and slightly higher error than the CAMx/SAIMM simulations.

On September 9-10, 1993, both the CAMx SAIMM and RAMS_T5 base case simulations meet EPA's performance goals with the CAMx/SAIMM simulation exhibiting slightly improved model performance statistics. On September 11th, the CAMx/RAMS_T5 simulation fails to meet EPA's unpaired peak accuracy performance goal.

Table 2. Summary CAMx ozone statistical performance measures on September 8, 1993

Performance Measure	**SAIMM**	**RAMS_T5**	**RAMS_T4**	**RAMS_S4**
Peak Observed Ozone (ppb)	214.0	214.0	214.0	214.0
Peak Predicted Ozone (ppb)	186.9	137.7	157.2	155.4
Unpaired Peak Accuracy (%)	-12.7	-35.7	-26.5	-27.4
Average Accuracy of the Peak (%)	4.1	3.7	13.4	2.9
Normalized Bias (%)	4.1	-3.1	2.1	-1.1
Normalized Gross Error (%)	21.7	24.7	29.7	25.3

Table 3. Summary CAMx ozone statistical performance measures on September 9, 1993

Performance Measure	**SAIMM**	**RAMS_T5**
Peak Observed Ozone (ppb)	195.0	195.0
Peak Predicted Ozone (ppb)	174.7	169.9
Unpaired Peak Accuracy (%)	-10.4	-12.9
Average Accuracy of the Peak (%)	11.2	13.9
Normalized Bias (%)	2.2	6.1
Normalized Gross Error (%)	24.4	28.6

Table 4. Summary CAMx ozone statistical performance measures on September 10, 1993

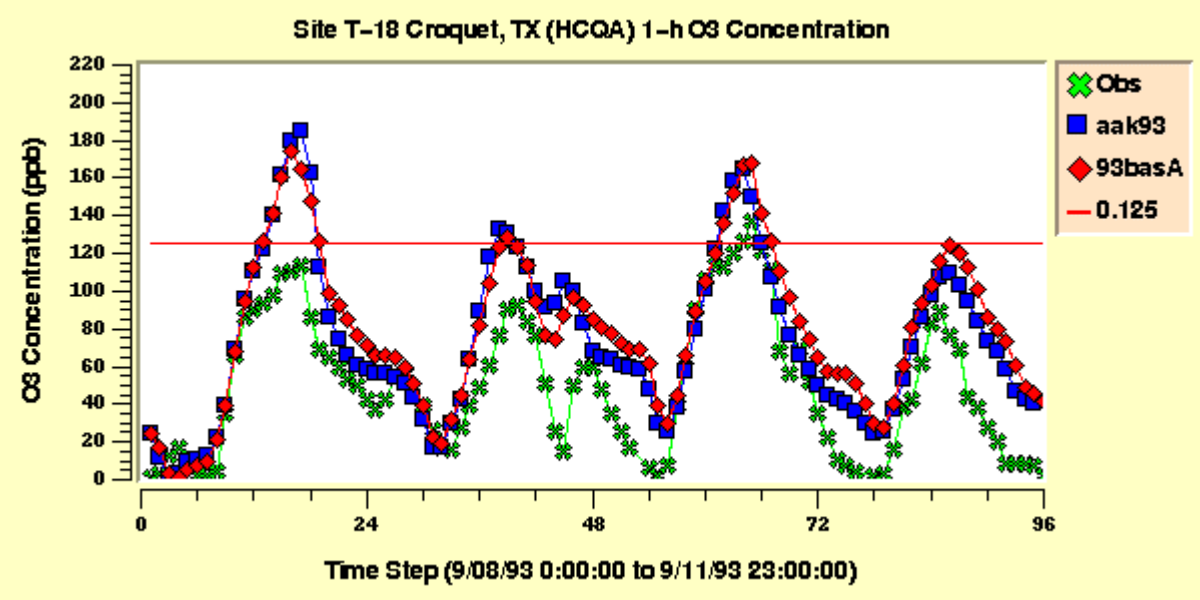
Performance Measure	**SAIMM**	**RAMS_T5**
Peak Observed Ozone (ppb)	162.0	162.0
Peak Predicted Ozone (ppb)	172.1	144.2
Unpaired Peak Accuracy (%)	6.2	-11.0
Average Accuracy of the Peak (%)	-4.4	14.9
Normalized Bias (%)	-8.6	-3.1
Normalized Gross Error (%)	23.4	33.9

Table 5. Summary CAMx ozone statistical performance measures on September 11, 1993

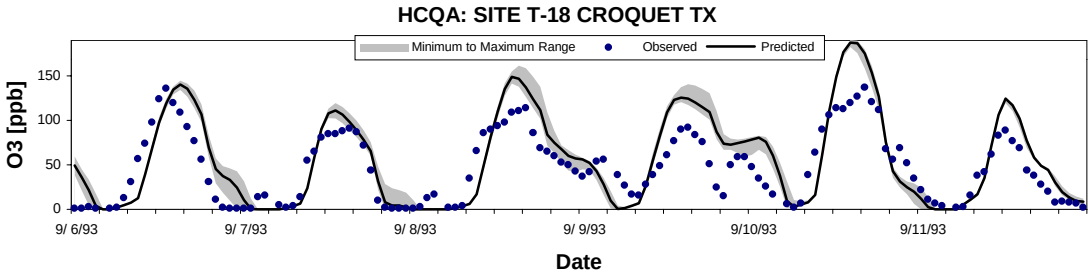
Performance Measure	**SAIMM**	**RAMS_T5**
Peak Observed Ozone (ppb)	189.0	189.0
Peak Predicted Ozone (ppb)	181.6	139.7
Unpaired Peak Accuracy (%)	-3.9	-26.1
Average Accuracy of the Peak (%)	-5.7	-5.4
Normalized Bias (%)	1.6	-6.9
Normalized Gross Error (%)	18.6	22.1

Preliminary Discussion

Based on statistical performance measures alone, the CAMx/RAMS base case simulation model performance appears to be degraded from the CAMx/SAIMM base case simulation. This is especially true for the unpaired peak performance measure on September 8th. However, the extreme overprediction in southern Harris County exhibited by the CAMx/SAIMM simulations has been improved as shown by the time series plots at the Croqet monitor for the CAMx/SAIMM and CAMx/RAMS_T5 simulation that are shown below.



CAMx/SAIMM

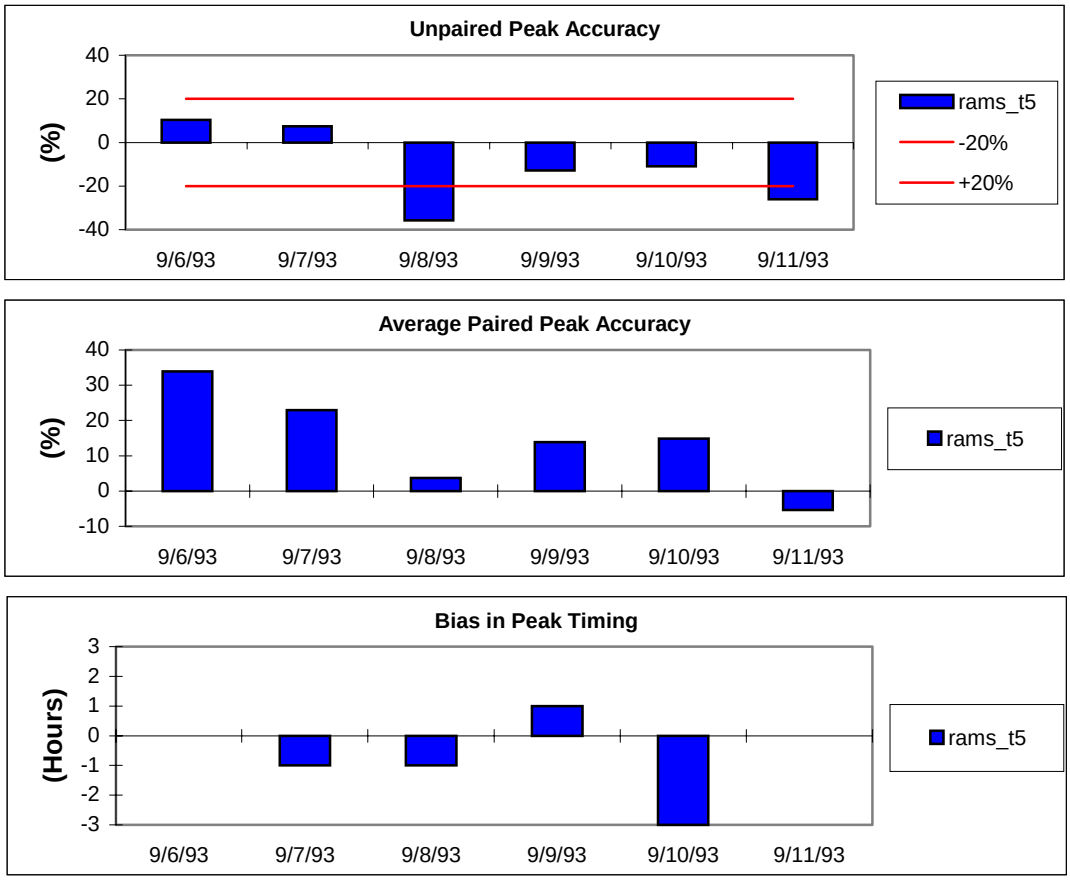


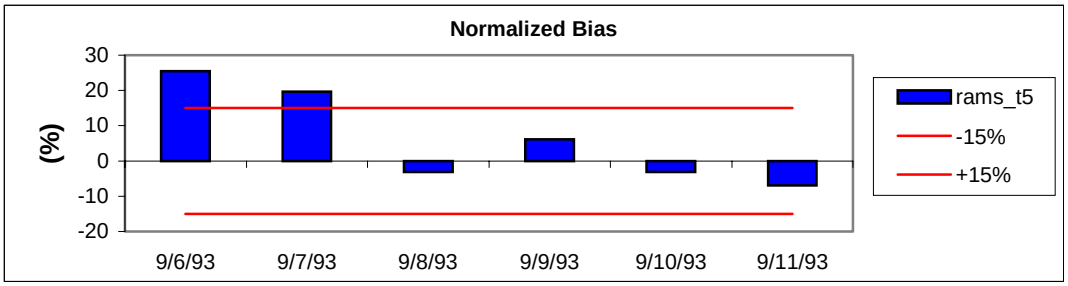
CAMx/RAMS_T5

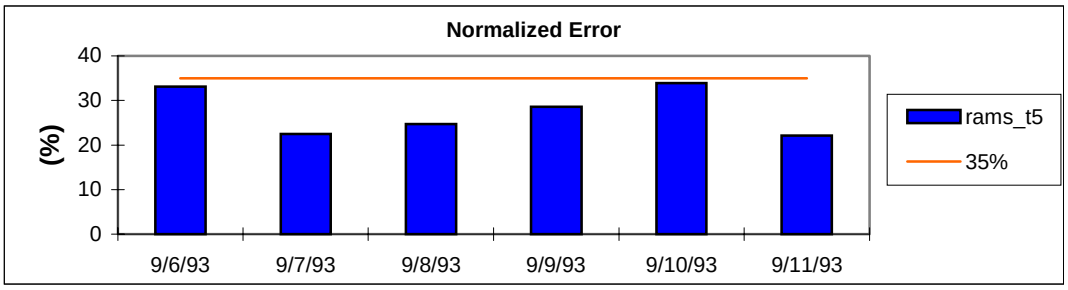
Attachment A

Summary Ozone Model Performance Results
for the CAMx RAMS_T5 Base Case Simulation

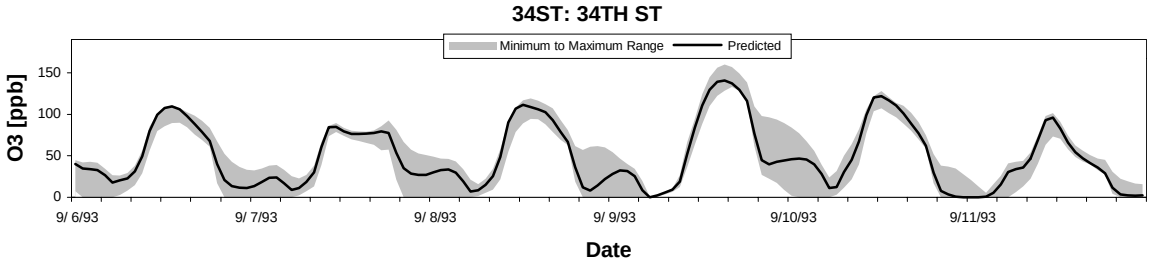
COAST Fine Grid Statistics

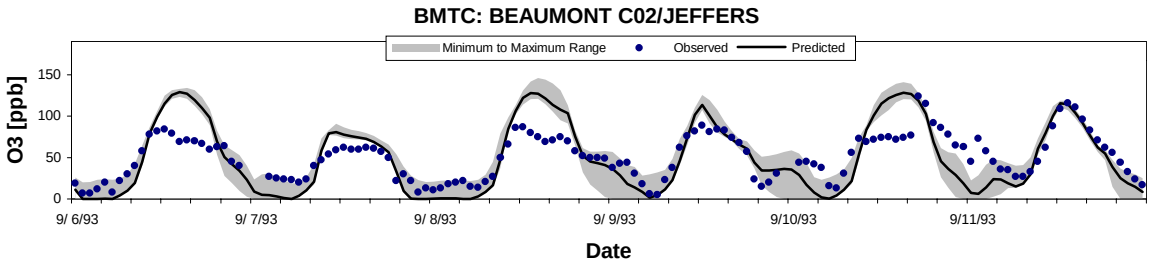


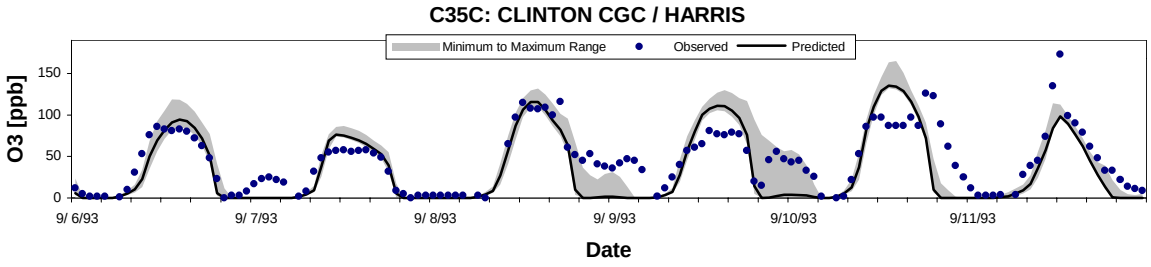

Normalized Bias
30
20
10
0
-10
-20
(%)
9/6/93
9/7/93
9/8/93
9/9/93
9/10/93
9/11/93
rams_t5
-15%
+15%

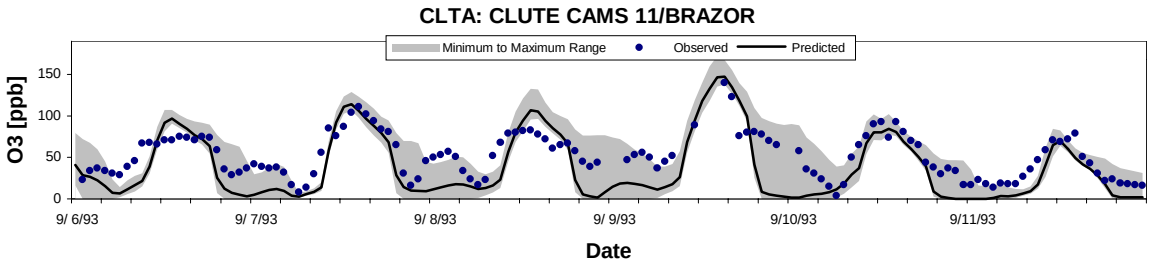

Normalized Error
40
30
20
10
0
(%)
9/6/93
9/7/93
9/8/93
9/9/93
9/10/93
9/11/93
rams_t5
35%

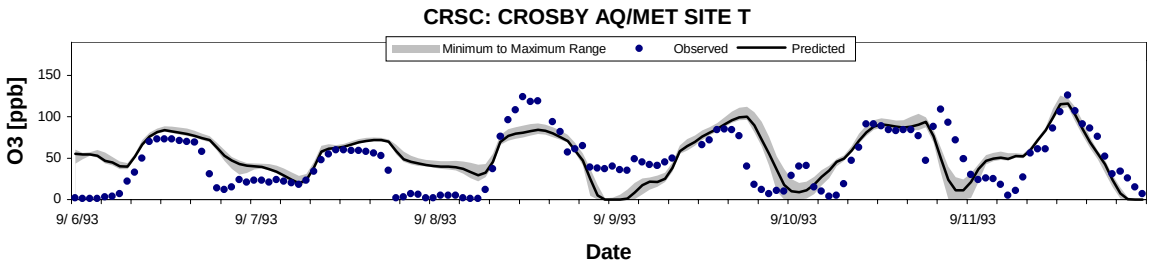
COAST September 6-11,1993



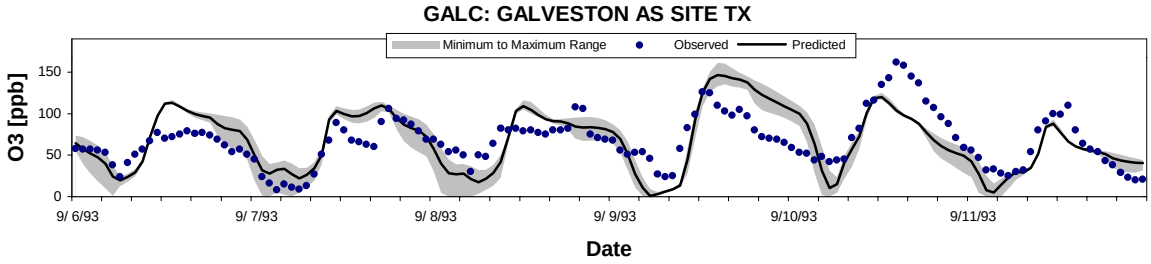


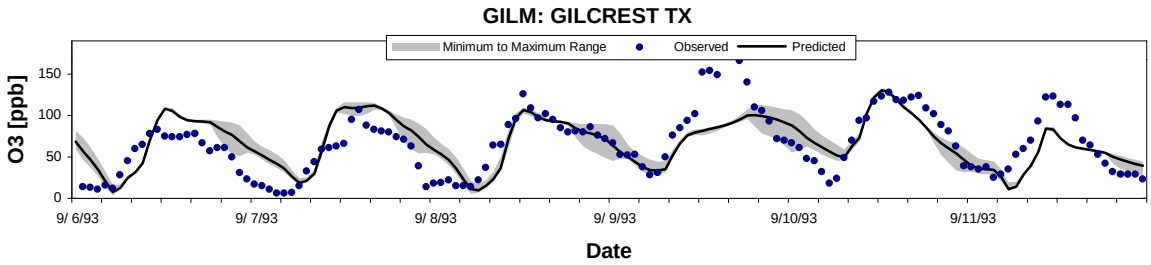


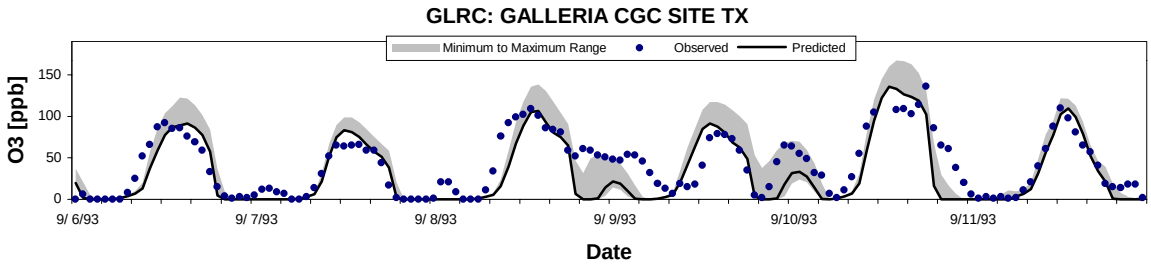


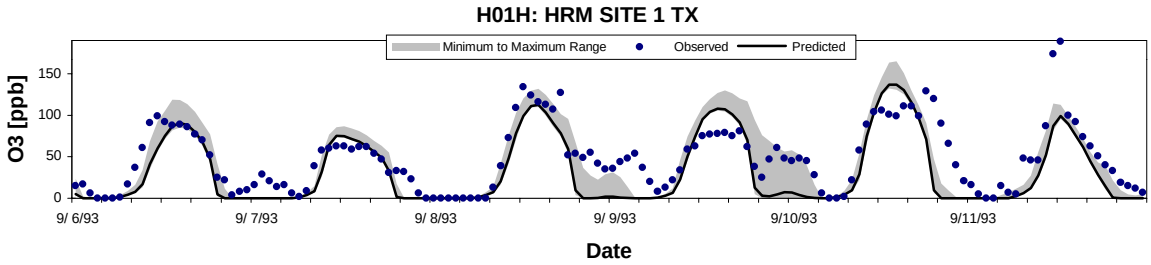


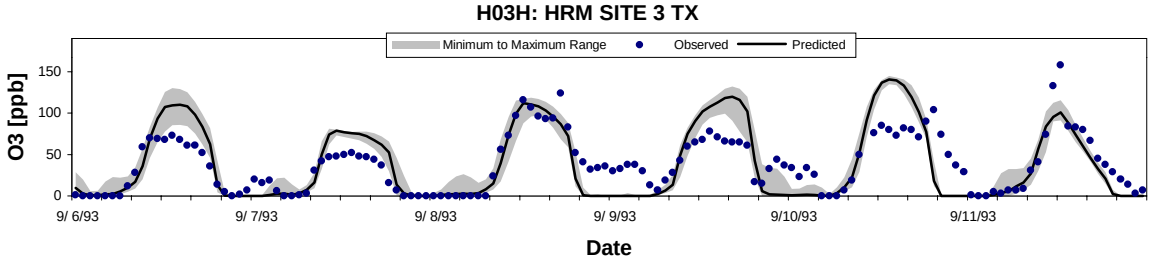
COAST September 6-11,1993











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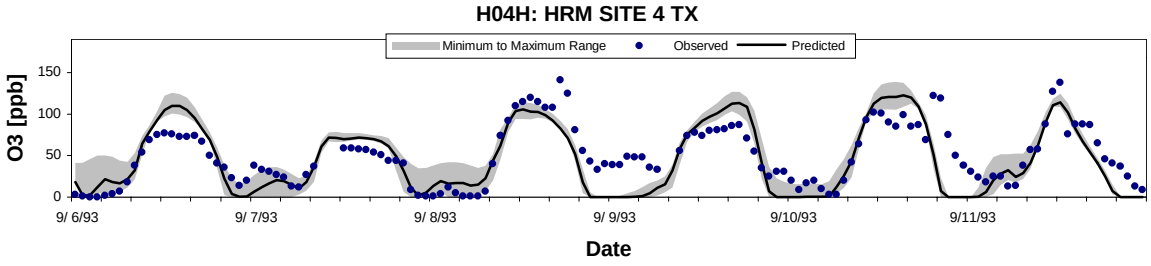
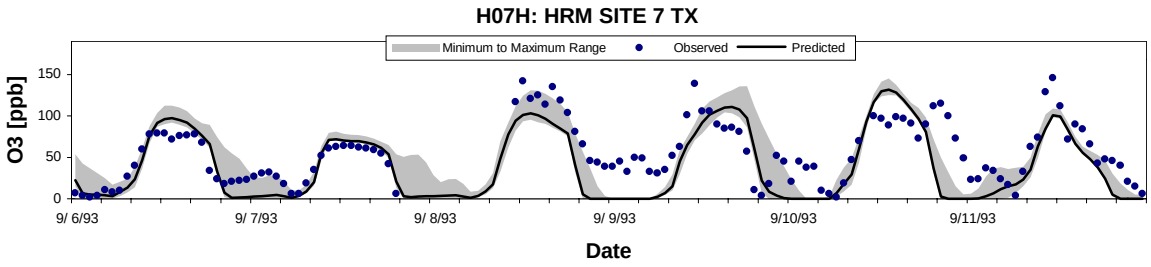
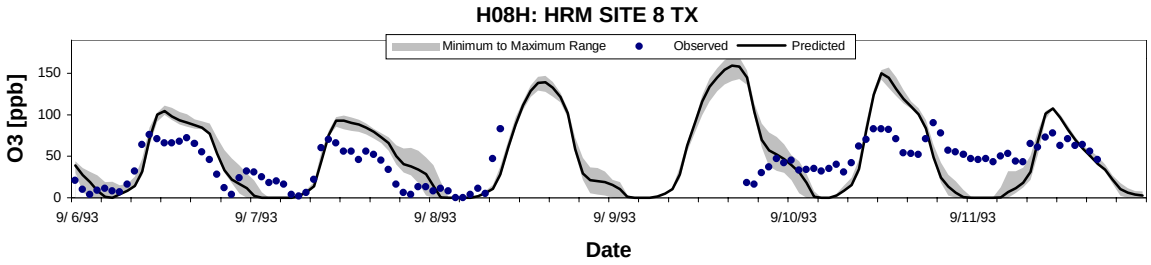
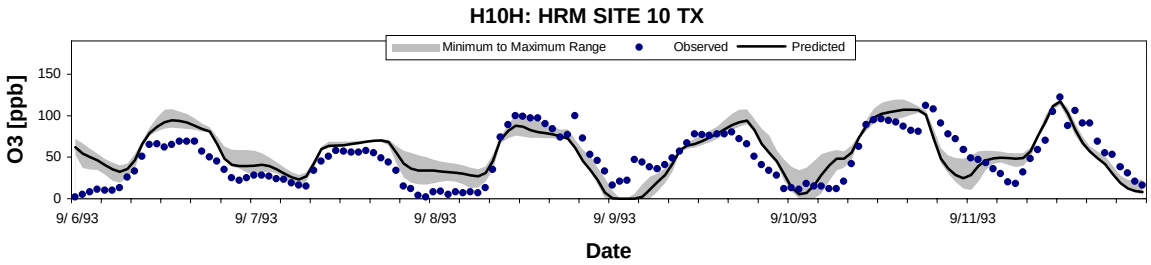
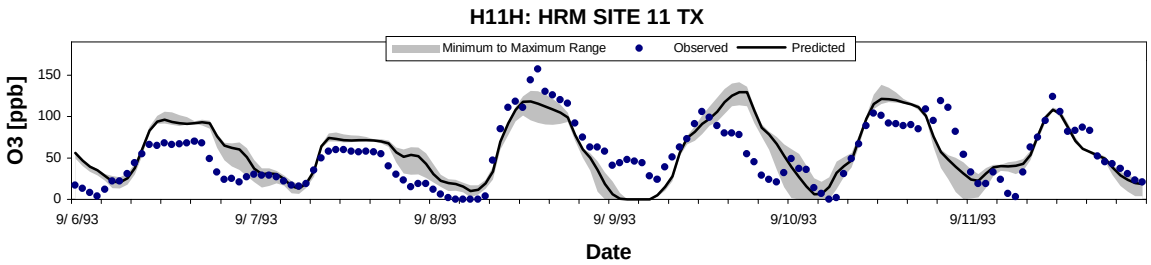


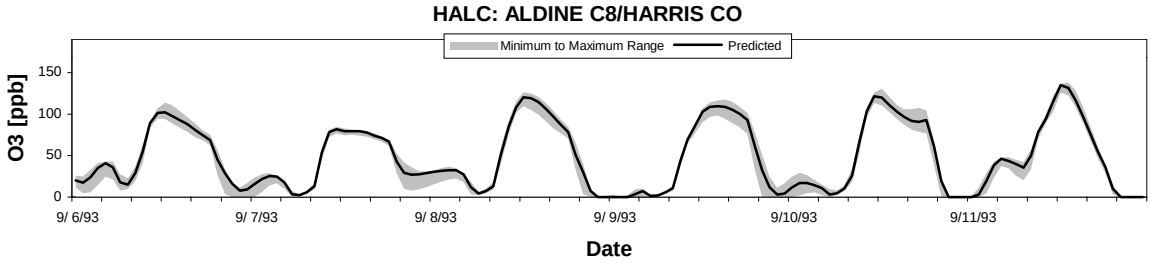


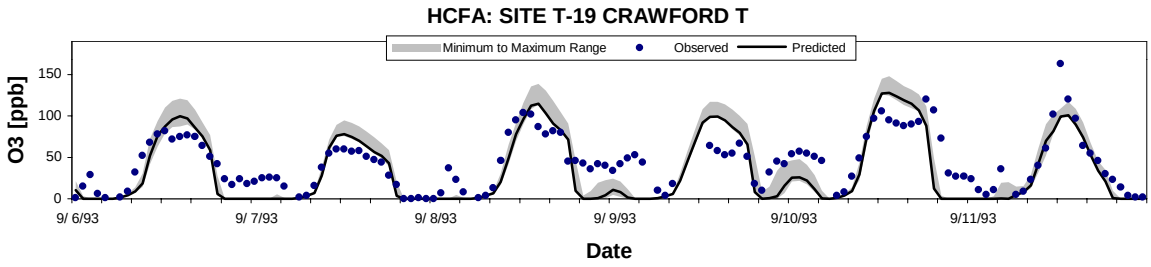


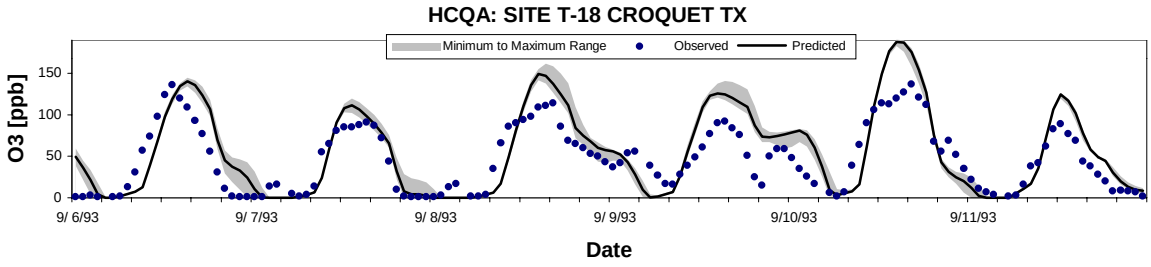


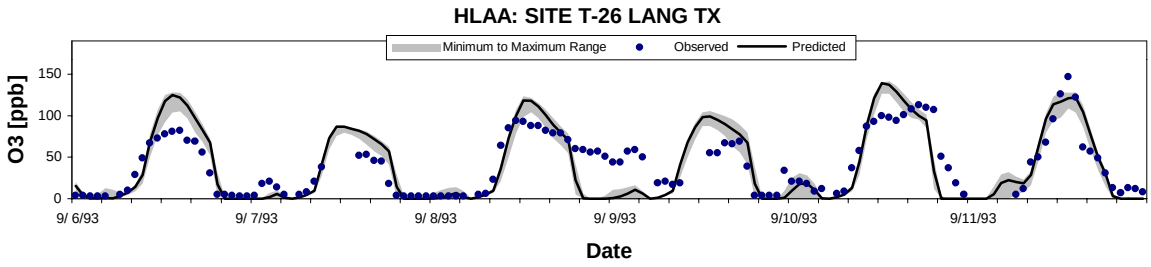


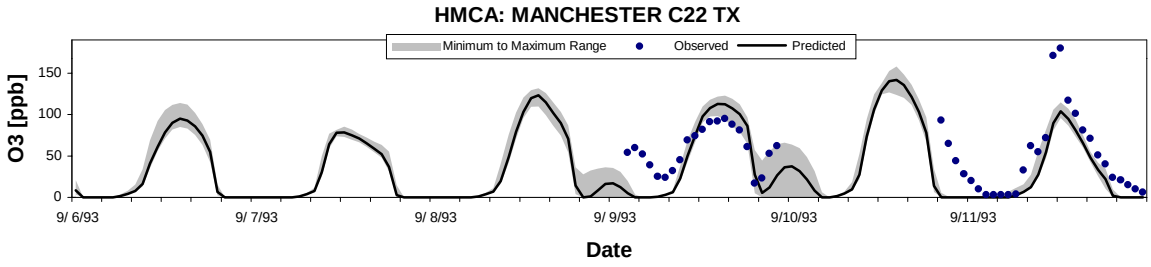
COAST September 6-11,1993











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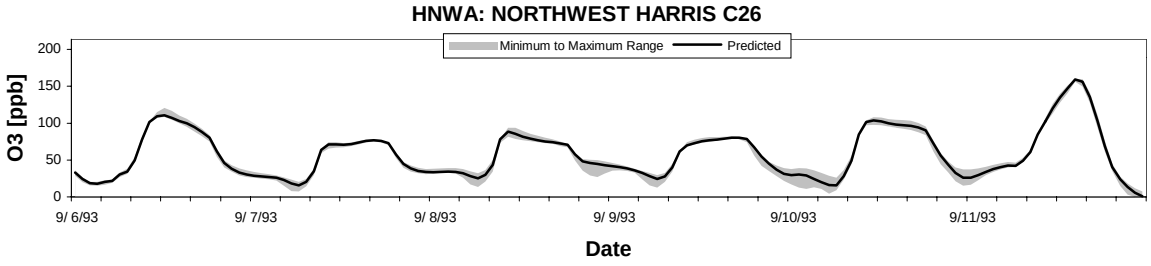

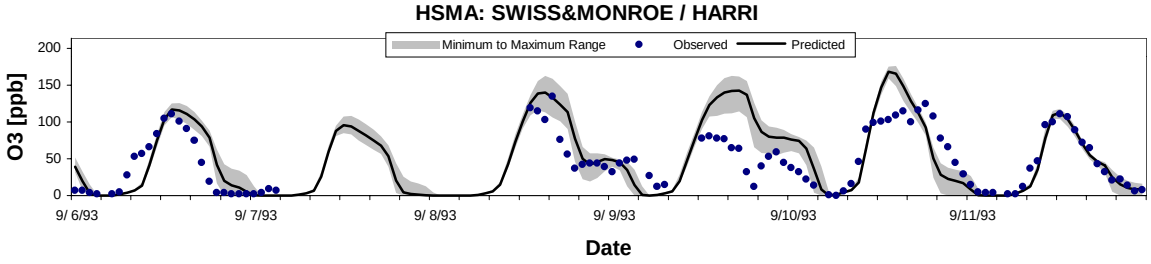

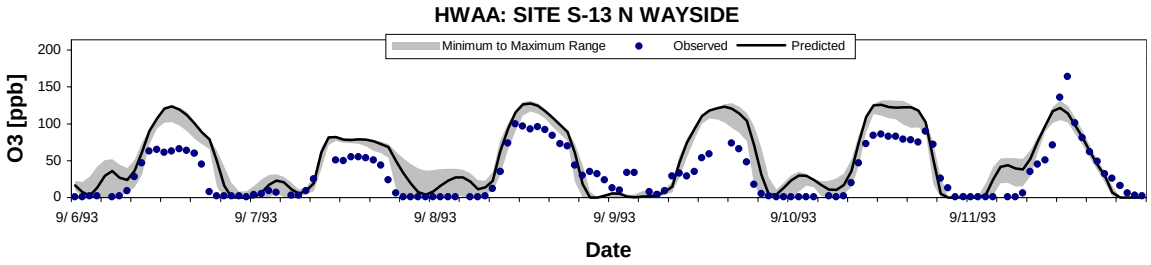

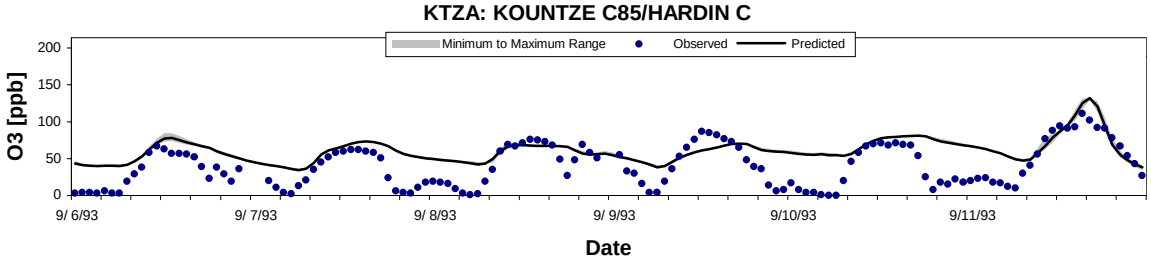

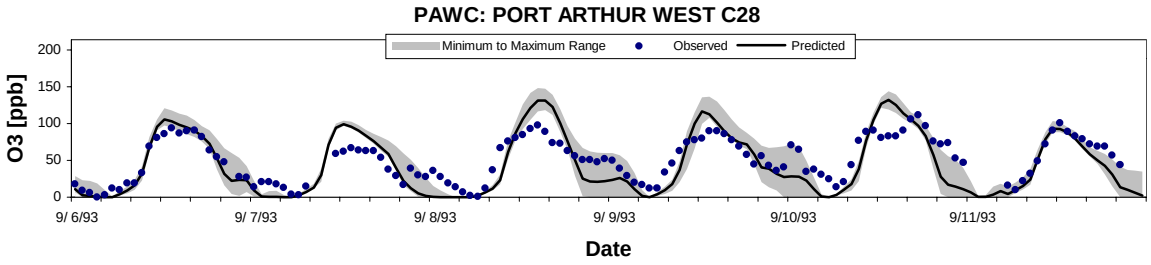

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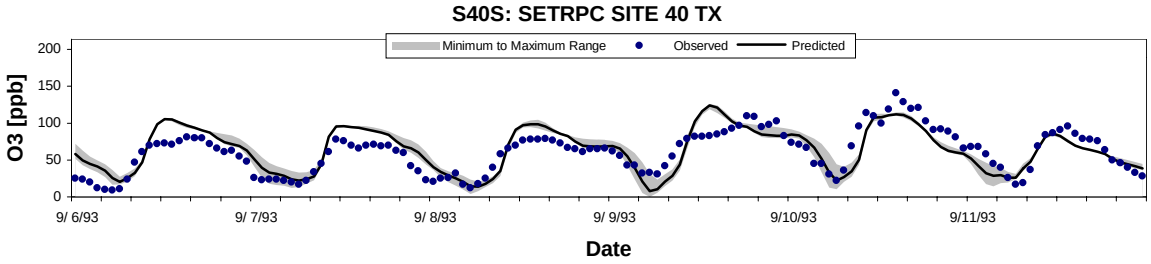
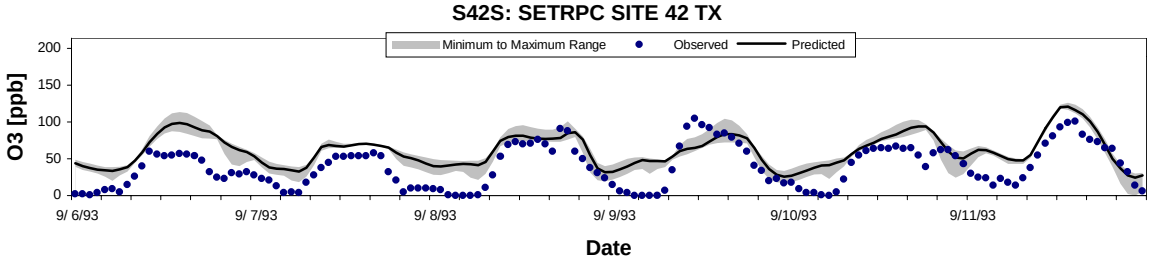
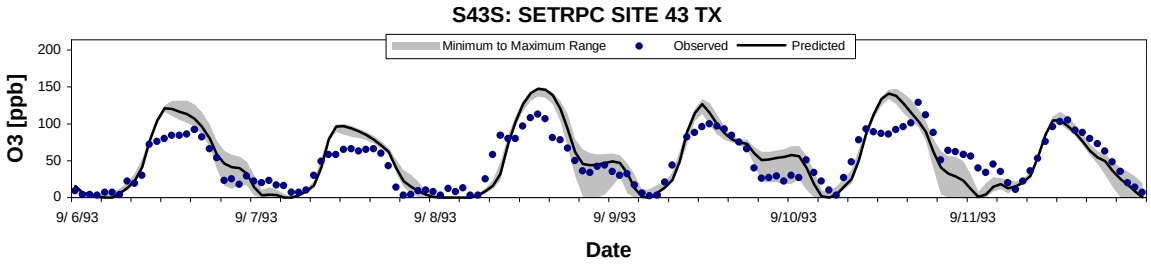
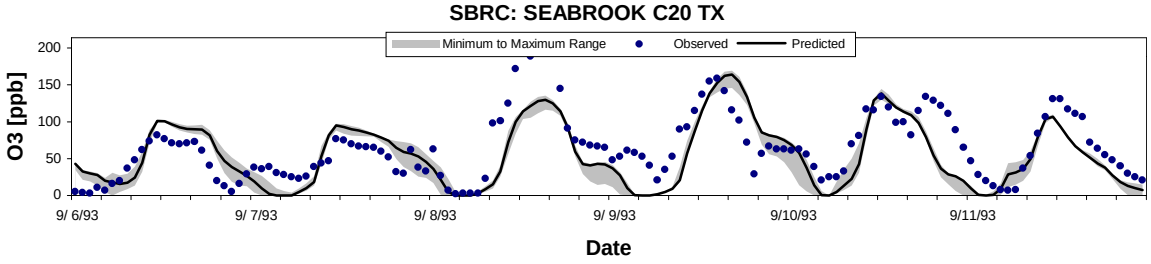
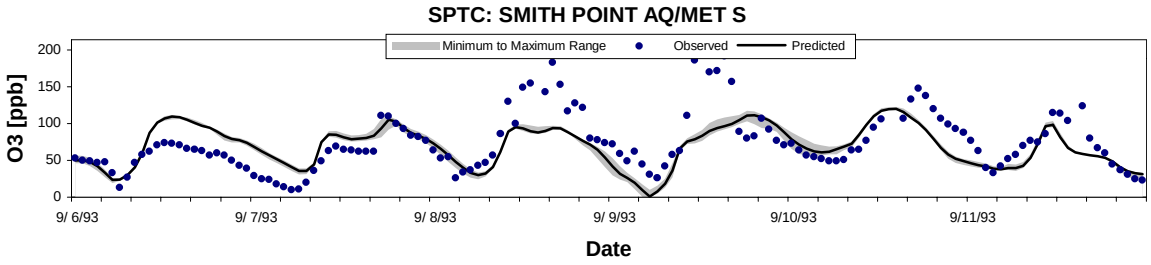


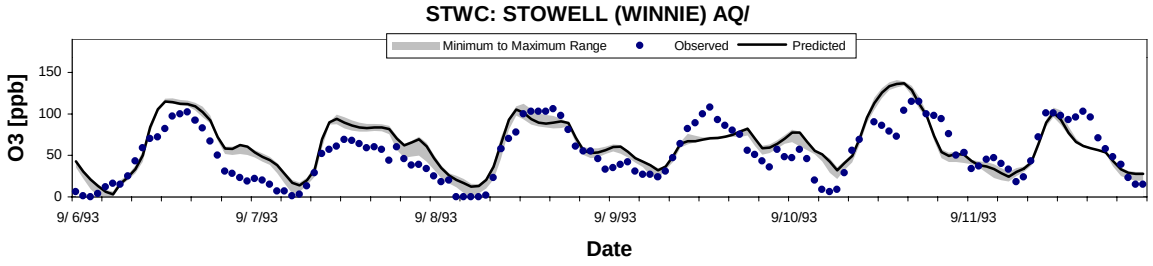


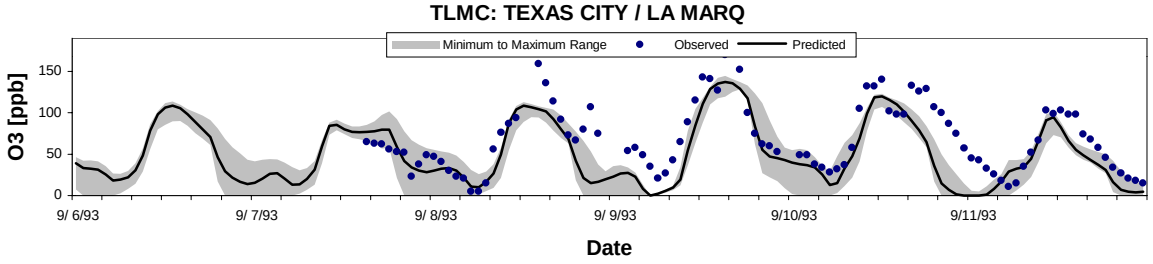


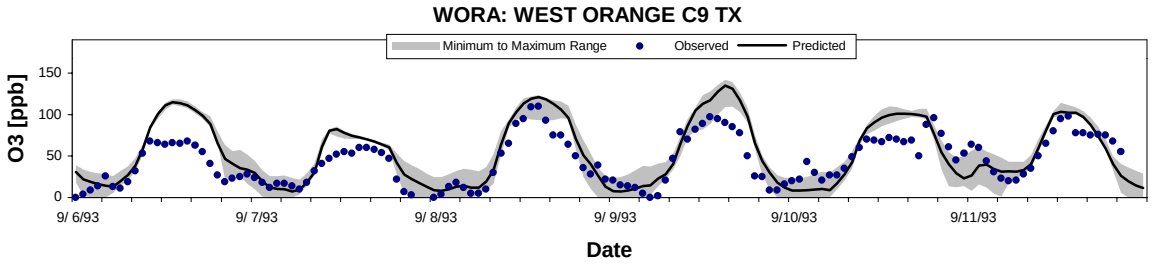


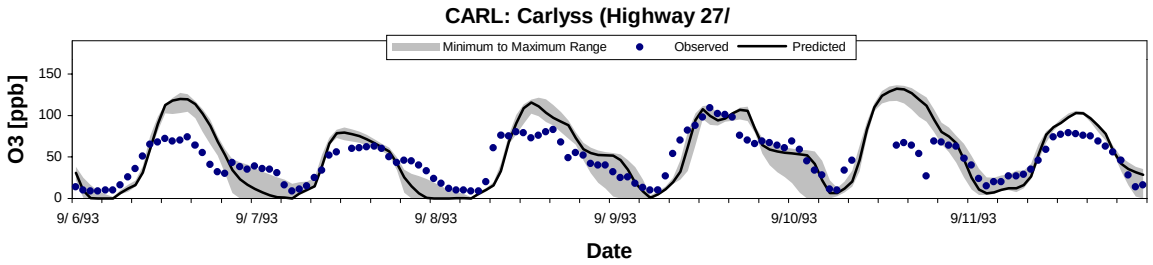


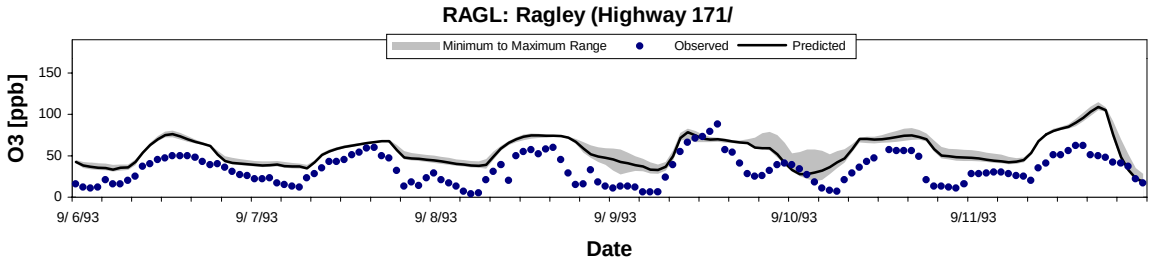
COAST September 6-11,1993



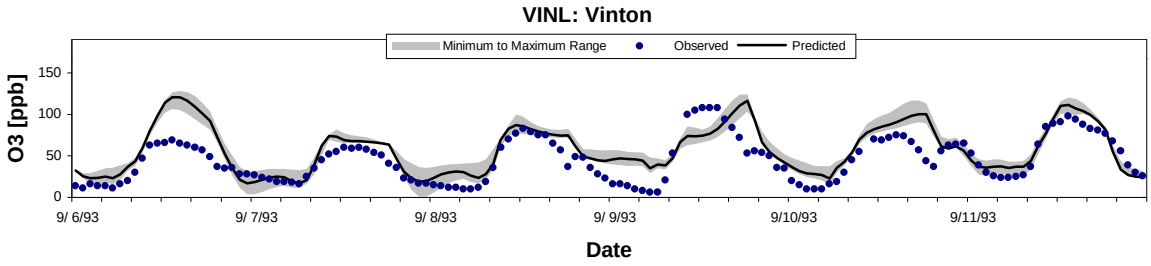


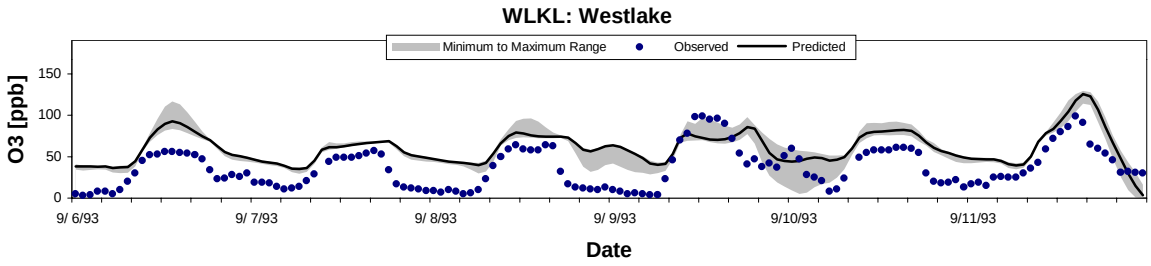


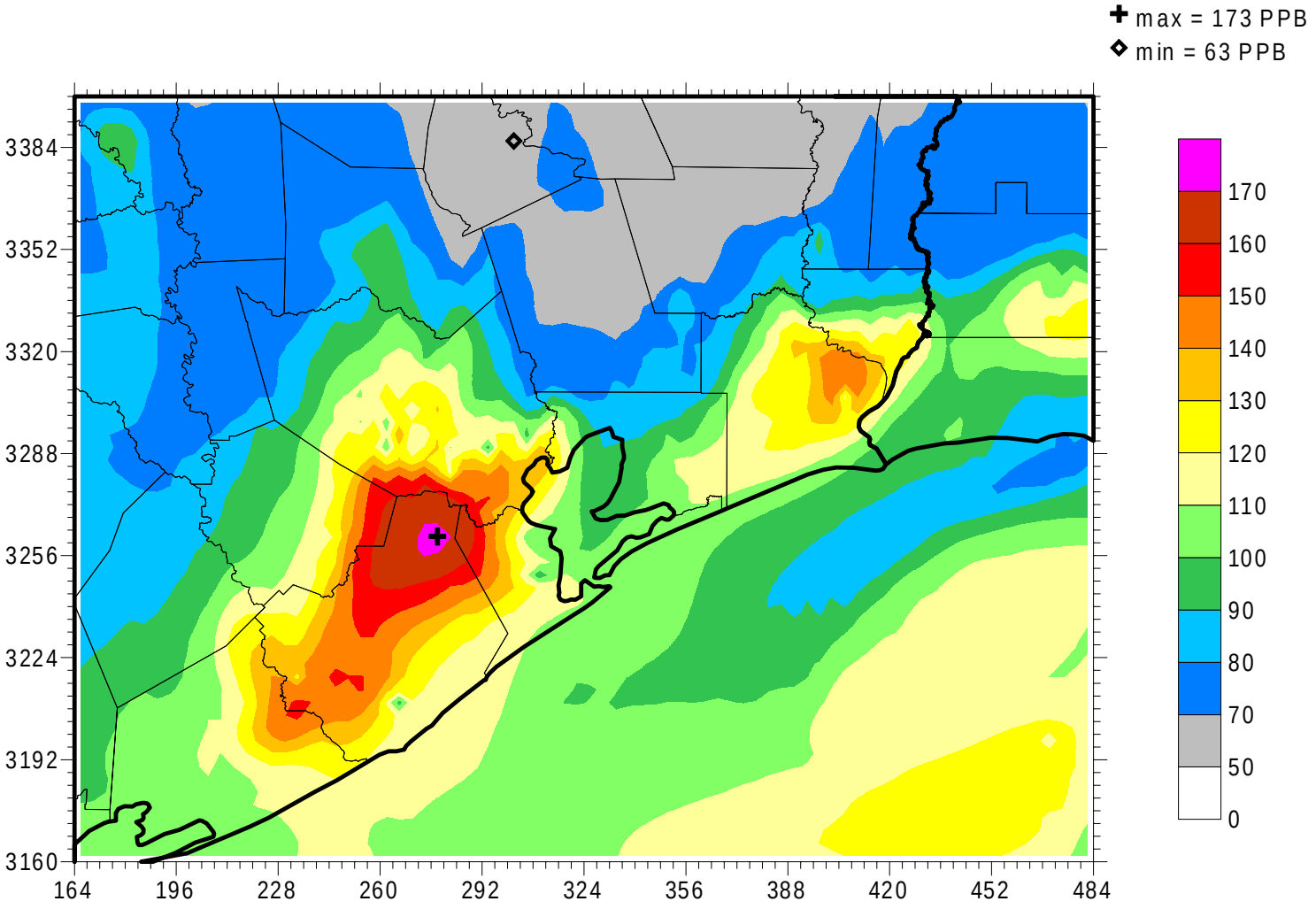




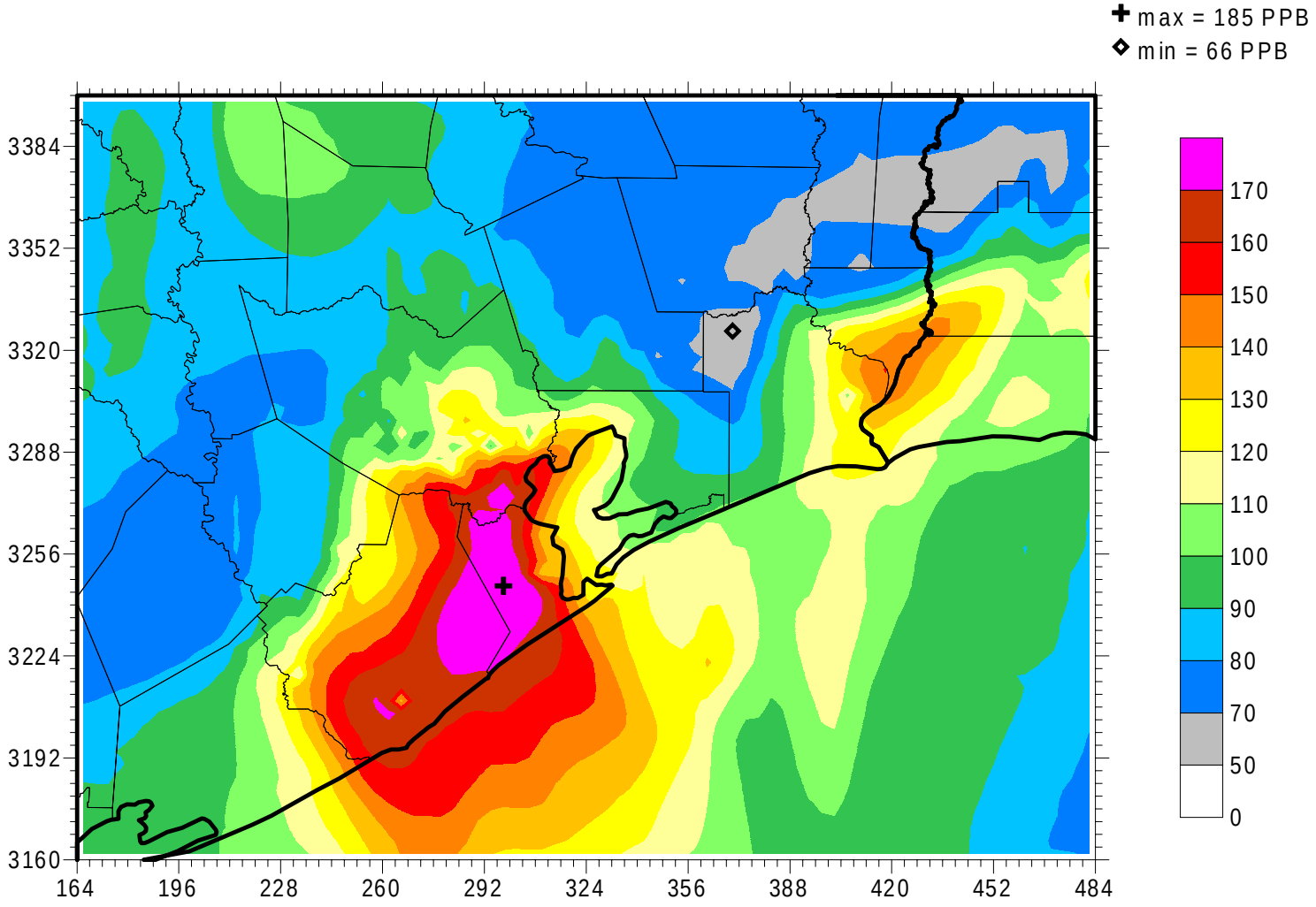
COAST September 6-11,1993



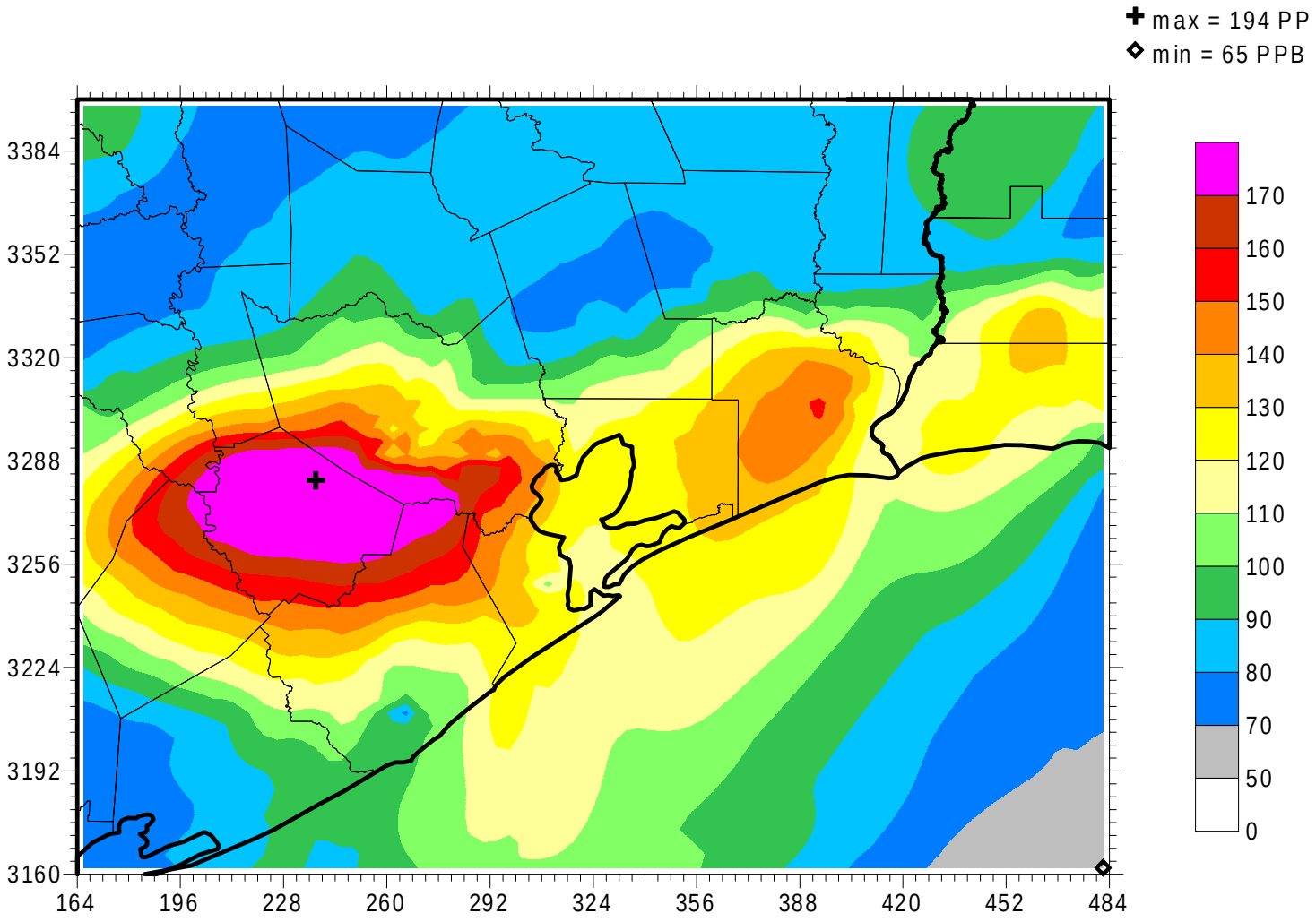




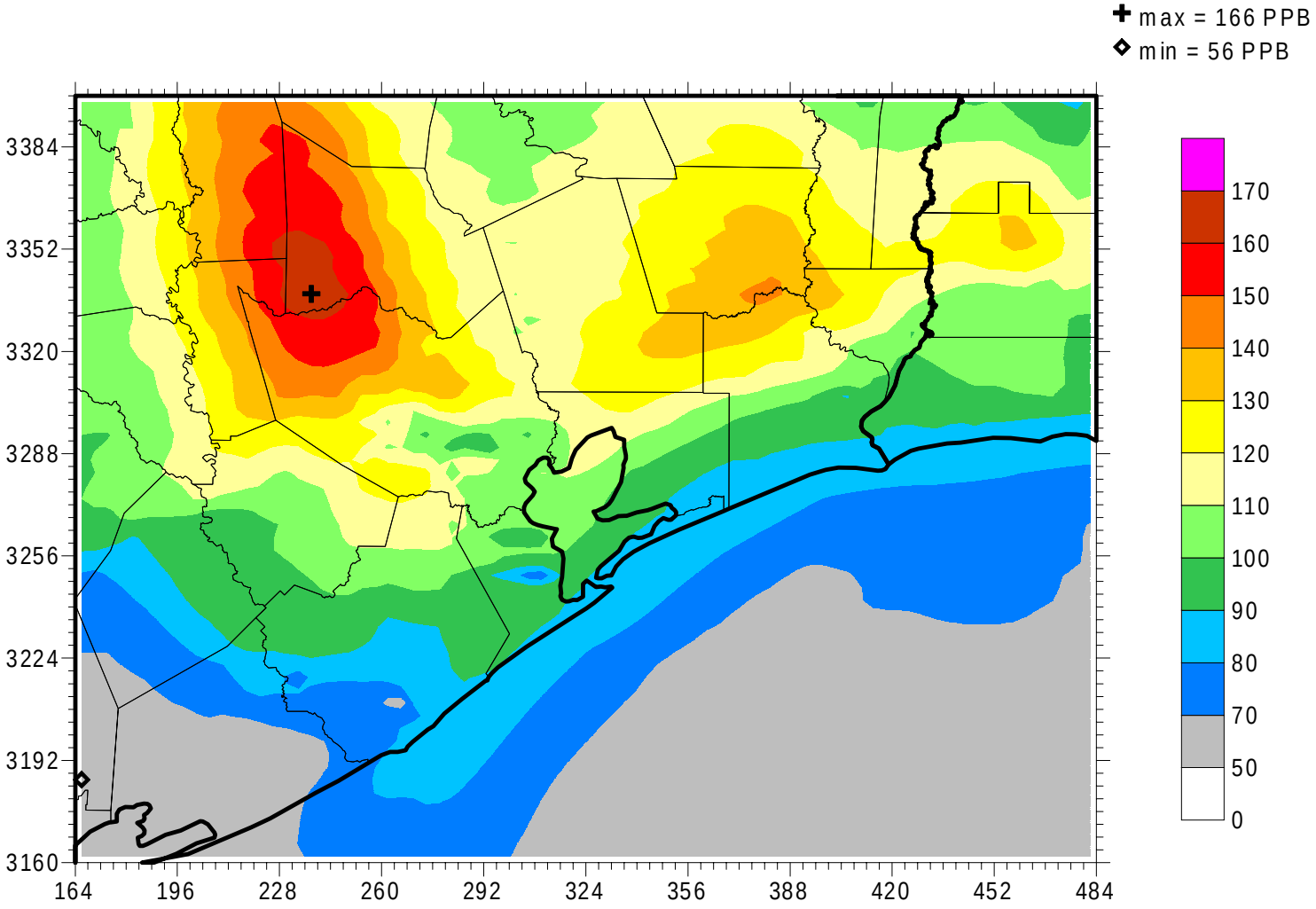
COAST 1993 Ozone using RAMS_T5
1-Hour Daily Max Ozone (ppb)
September 08, 1993 fine1 Grid



COAST 1993 Ozone using RAMS_T5
1-Hour Daily Max Ozone (ppb)
September 09, 1993 fine1 Grid



COAST 1993 Ozone using RAMS_T5
1-Hour Daily Max Ozone (ppb)
September 10, 1993 fine1 Grid



COAST 1993 Ozone using RAMS_T5
1-Hour Daily Max Ozone (ppb)
September 11, 1993 fine1 Grid