HGB SIP Modeling Update

First Interim June 2006 Episode Modeling

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SETPMTC Meeting

June 11, 2008

CAMx Ozone Modeling in SIP Development

The Big Picture

Base Case	Day-specific meteorology and emissions; replicate what actually happened
Baseline Case	Day-specific meteorology and Typical emissions; used in RRF to predict future design values
Future Base Case	Apply future growth + on-the-books controls to estimate future ozone
Control Strategy Testing	Determine control strategies that will effectively reduce ozone
SIP	Document modeling procedures

CAMx Ozone Modeling in SIP Development

Base Case – Historical Episode Replication

Meteorological Modeling

Winds, Mixing Depth, Temperature, etc.

Emissions Modeling

VOC, CO & NO_X

Point, Area, on- & Non-Road & Biogenic

CAMx Modeling

O_3, NO_X, VOC, CO, etc.

Chemical Mechanism (CBIV, CB05), "Mixing" schemes

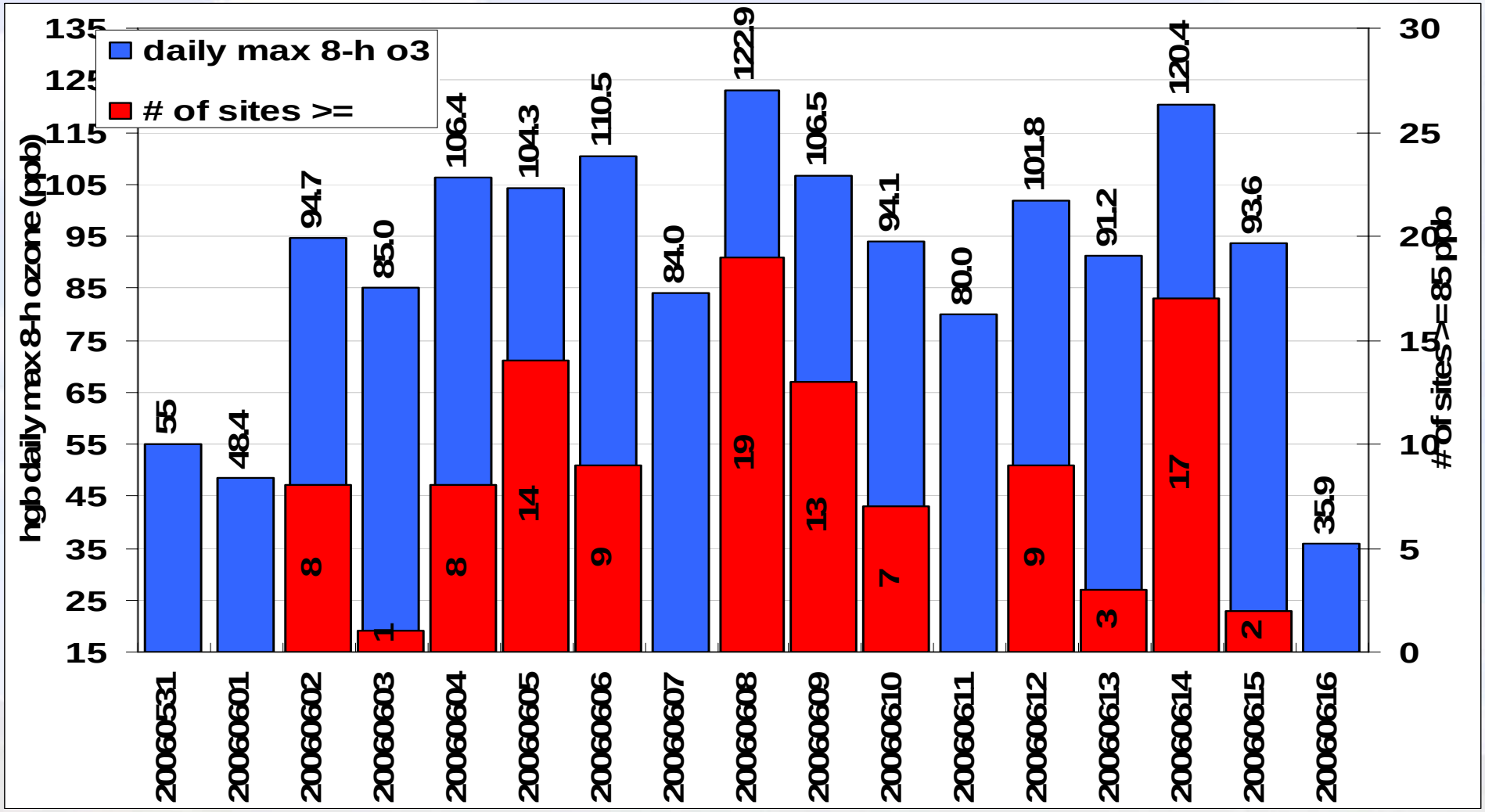
Evaluate CAMx Performance

(How well does the model replicate the episode?)

Bias, Time Series, Contour Plots

Suitable Base Case

June 2006 Episode



First Interim June 2006 Episode Modeling

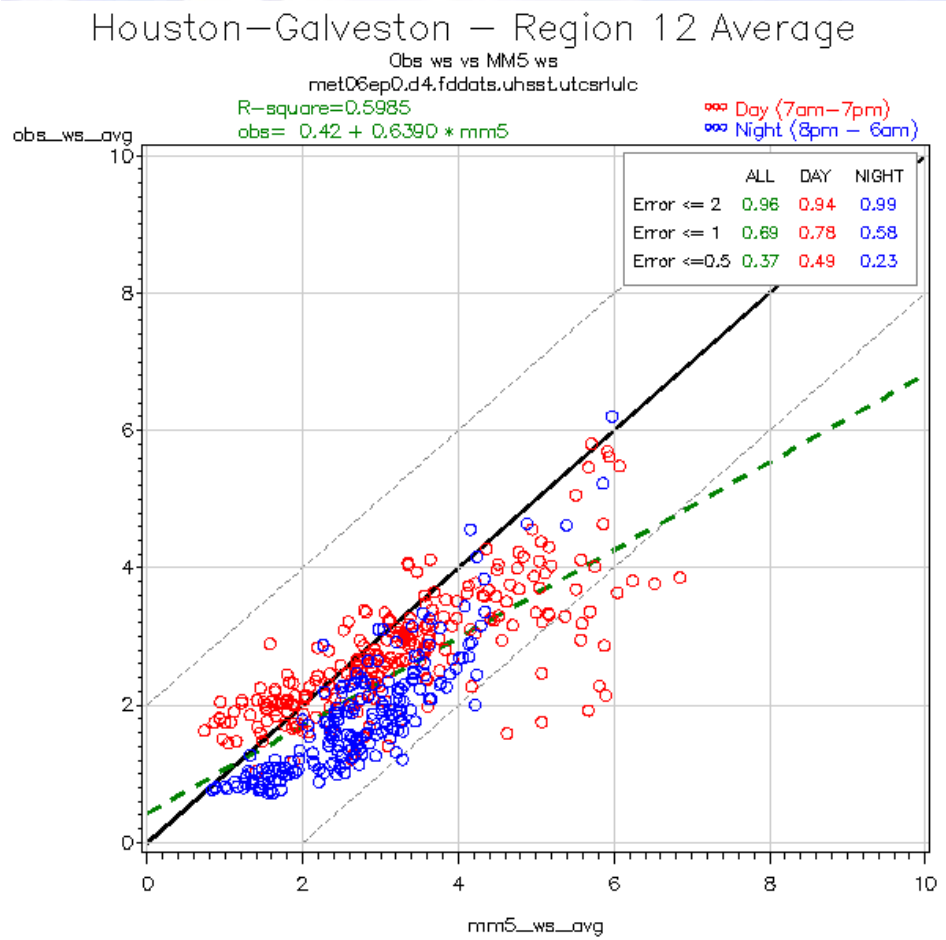
- Met Modeling for the June 2006 Episode
- EI Modeling for the June 2006 Episode
- CAMx Modeling for the June 2006 Episode

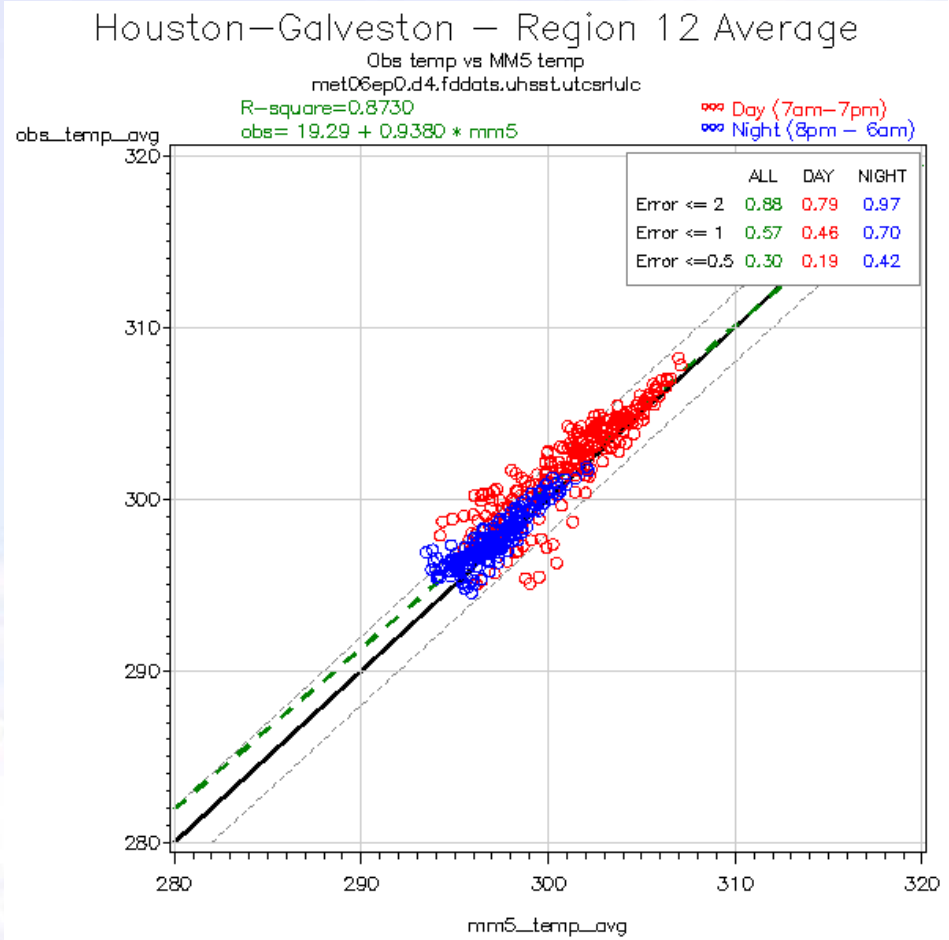
Met Modeling for June 2006 Episode

Met Modeling for the June 2006 Episode includes:

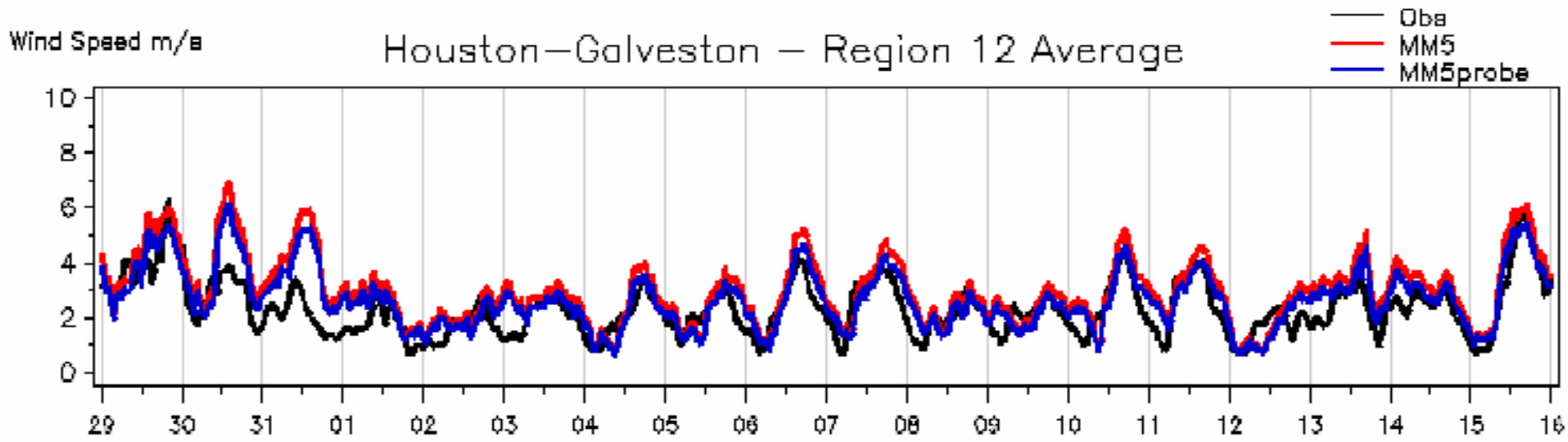
- New UT-CSR land use/land cover (LU/LC) data
- Latest QA'd Radar Profiler observation-nudging data
- Hourly Sea Surface Temperatures, as per UH-SST

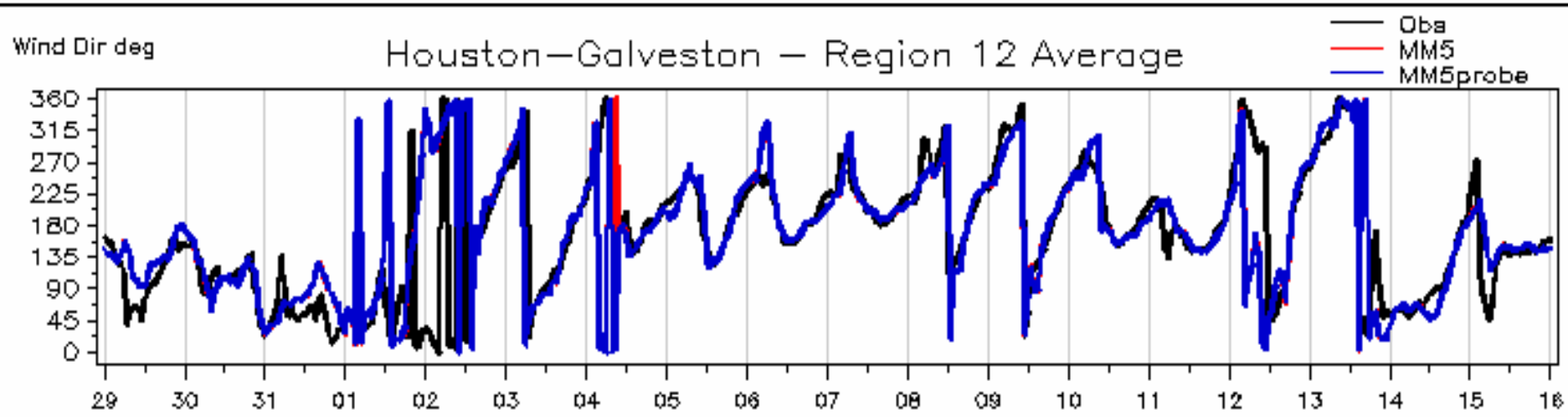
Met Modeling for the June 2006 Episode
Wind Speed and Temperature Scatter Plots



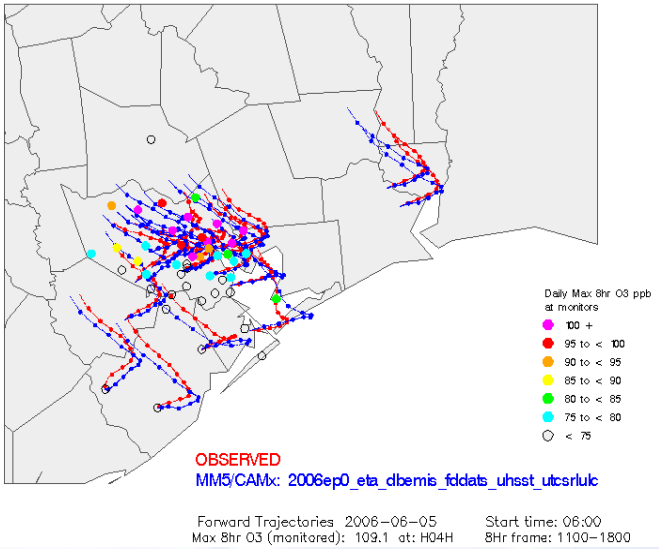


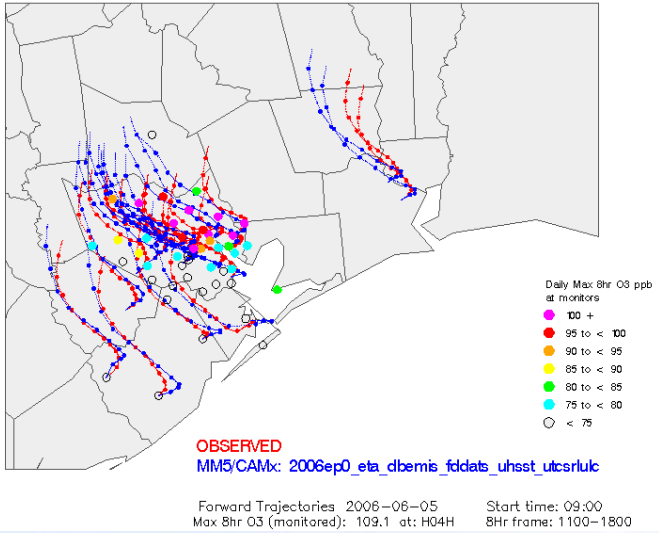
Met Modeling for the June 2006 Episode
Time Series of Wind Speed and Direction

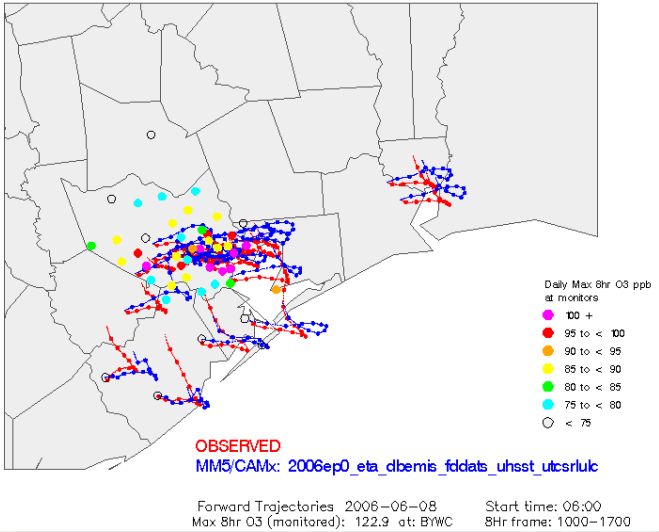


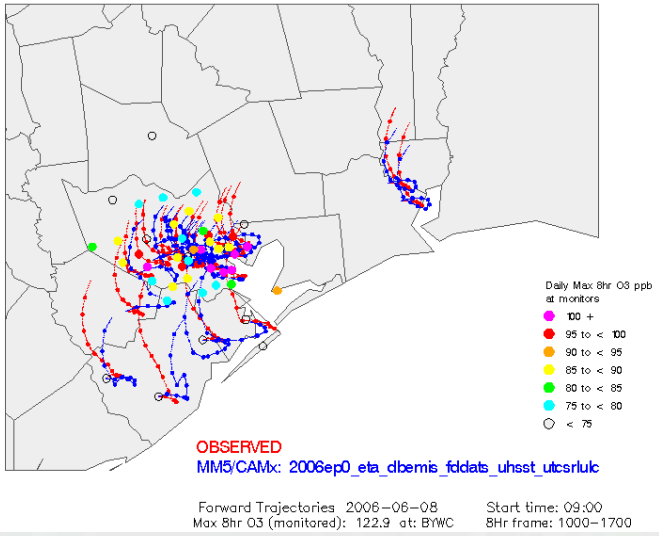


Met Modeling for the June 2006 Episode
Plume Plot Trajectories

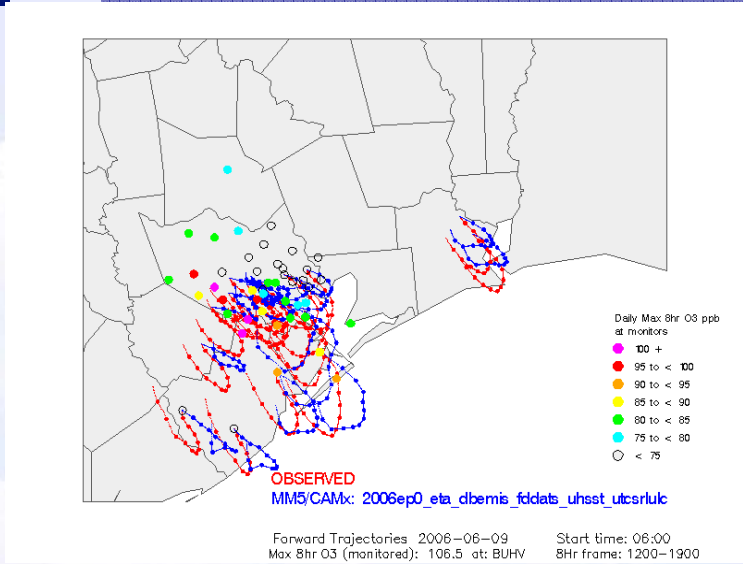


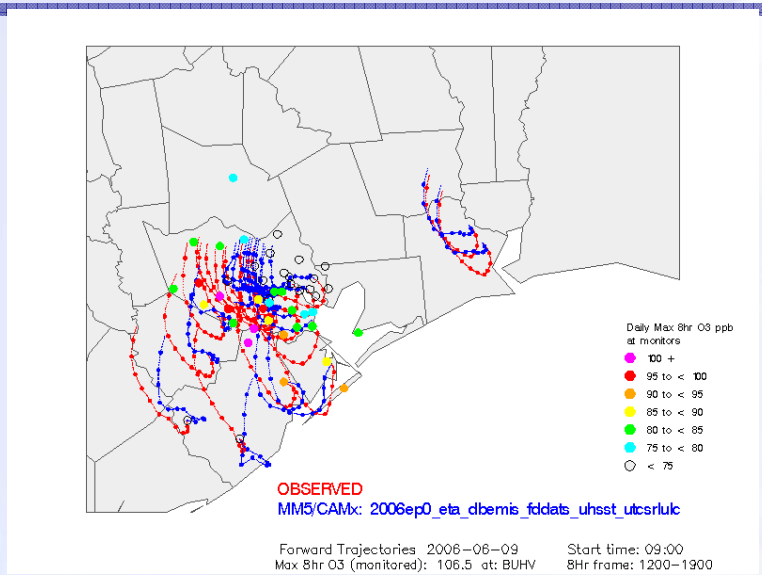


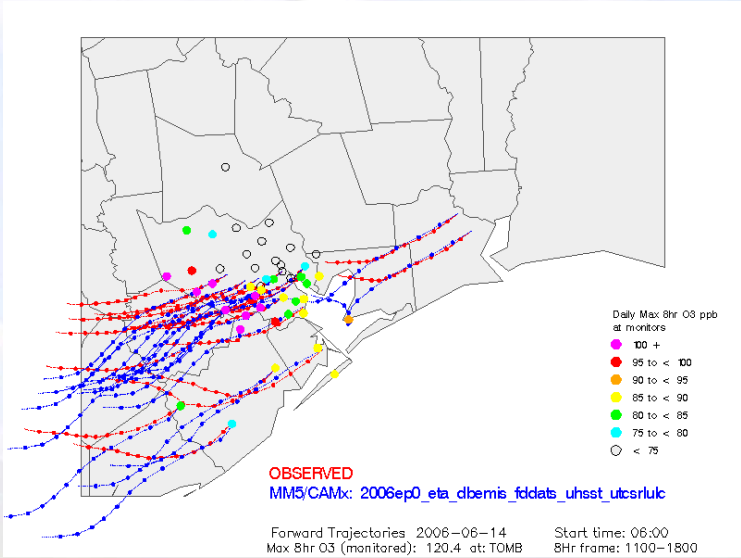


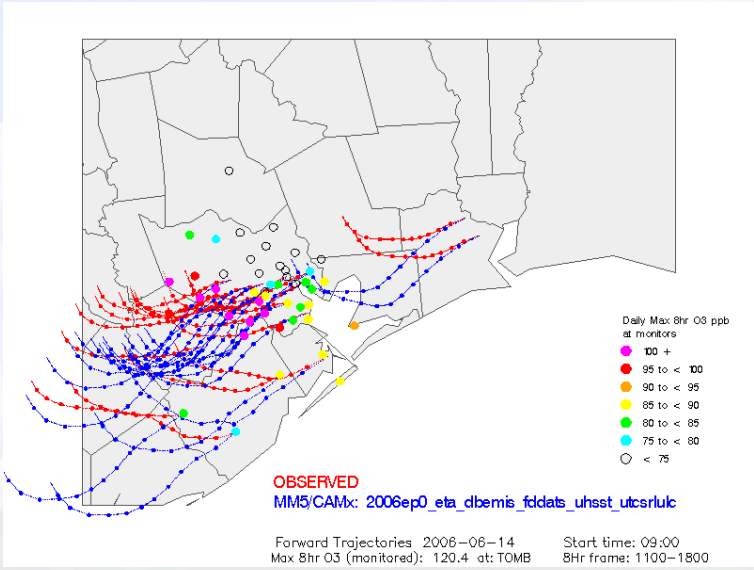


Met Modeling for the June 2006 Episode
Plume Plot Trajectories







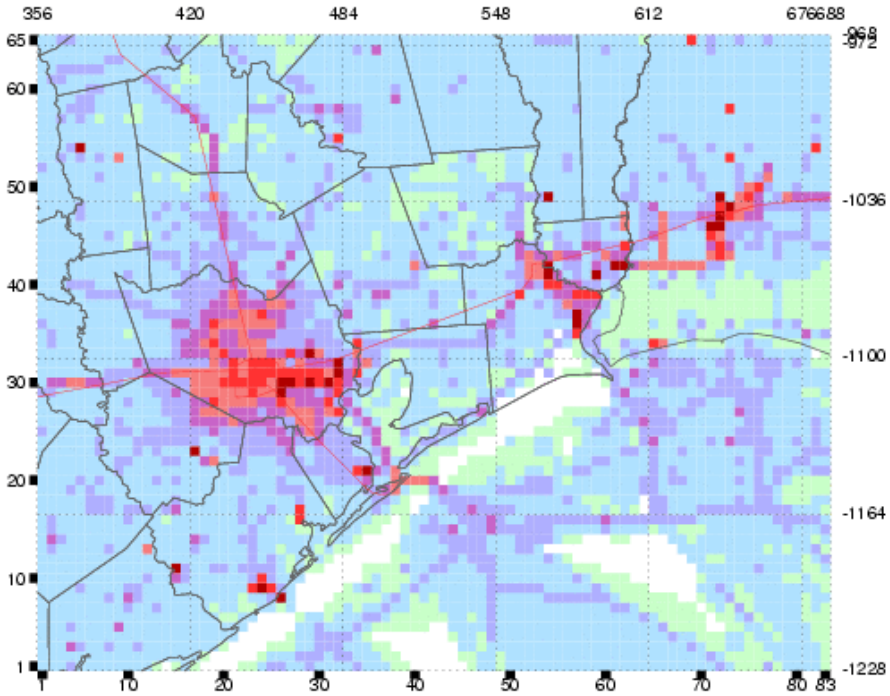


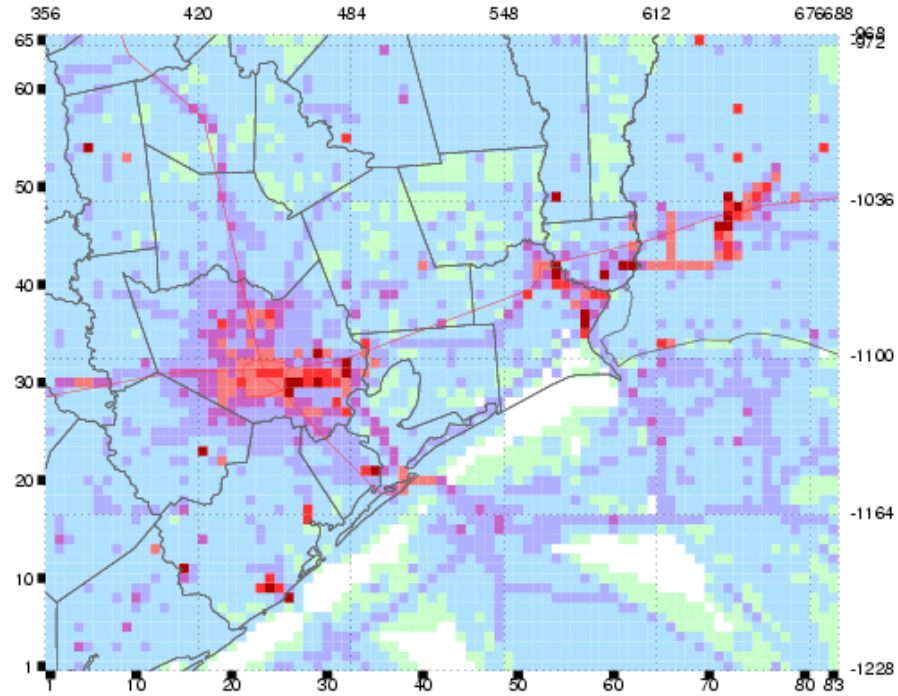
EI Modeling for June 2006 Episode

EI modeling for the June 2006 Episode includes:

- Point source emissions from 2006 STARS
- EGU emissions from Acid Rain Program Database
- Tank landing Loss emissions from TCEQ Survey
- Fire emissions from the Texas Forest Service
- On-road mobile emissions, as per TTI
- Non-road mobile emissions, NMIM 2006
- Off-road & Area sources from 2005 TexAER w/appropriate growth
- Biogenics from GloBEIS w/2006 satellite PAR and Temperature

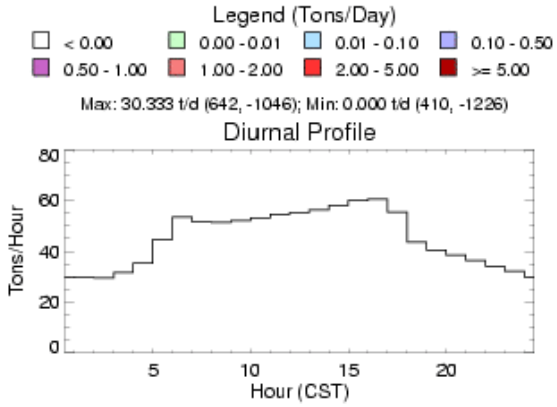
EI Modeling for June 2006 Episode
Weekday (6/7/06) and Sunday (6/11/06) NOx





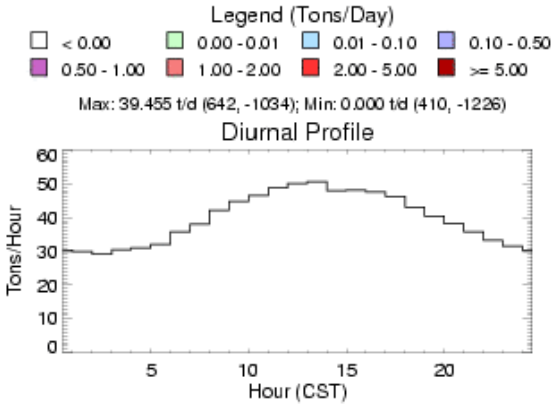
Emissions Plotted

County	Tons/Day
Brazoria	60.37
Chambers	20.12
Fort Bend	45.07
Galveston	40.45
Harris	333.65
Liberty	16.09
Montgomery	24.89
Waller	6.78
HGB SUBTOTAL:	547.42
Hardin	7.66
Jefferson	74.42
Orange	46.22
BPA SUBTOTAL:	128.30
MAP TOTAL:	1088.65

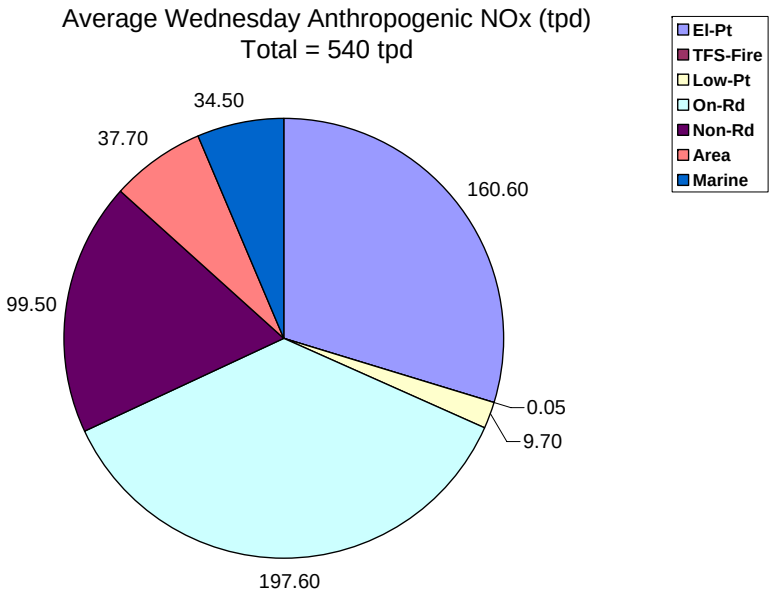


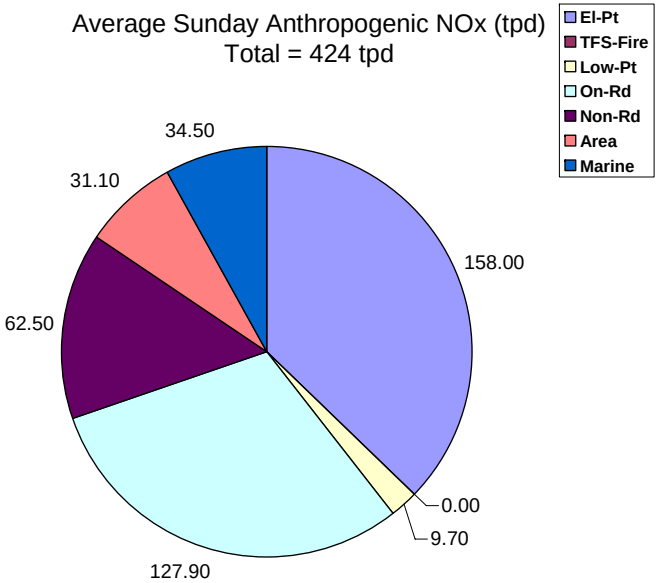
Emissions Plotted

County	Tons/Day
Brazoria	55.12
Chambers	17.98
Fort Bend	35.90
Galveston	36.87
Harris	247.40
Liberty	14.30
Montgomery	16.89
Waller	5.29
HGB SUBTOTAL:	429.75
Hardin	6.00
Jefferson	64.13
Orange	39.42
BPA SUBTOTAL:	109.55
MAP TOTAL:	951.55

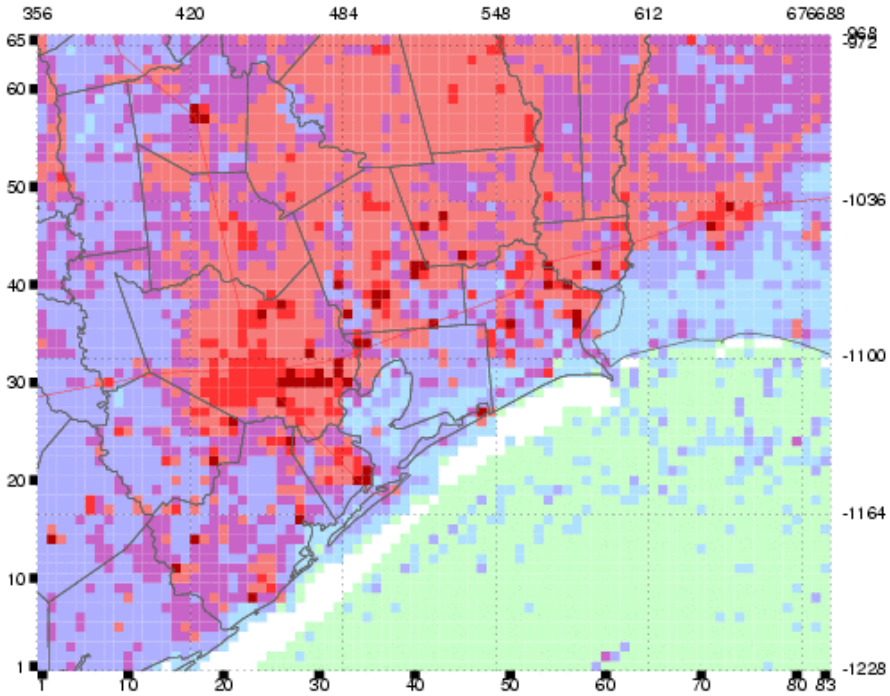


EI Modeling for June 2006 Episode Weekday and Sunday NOx

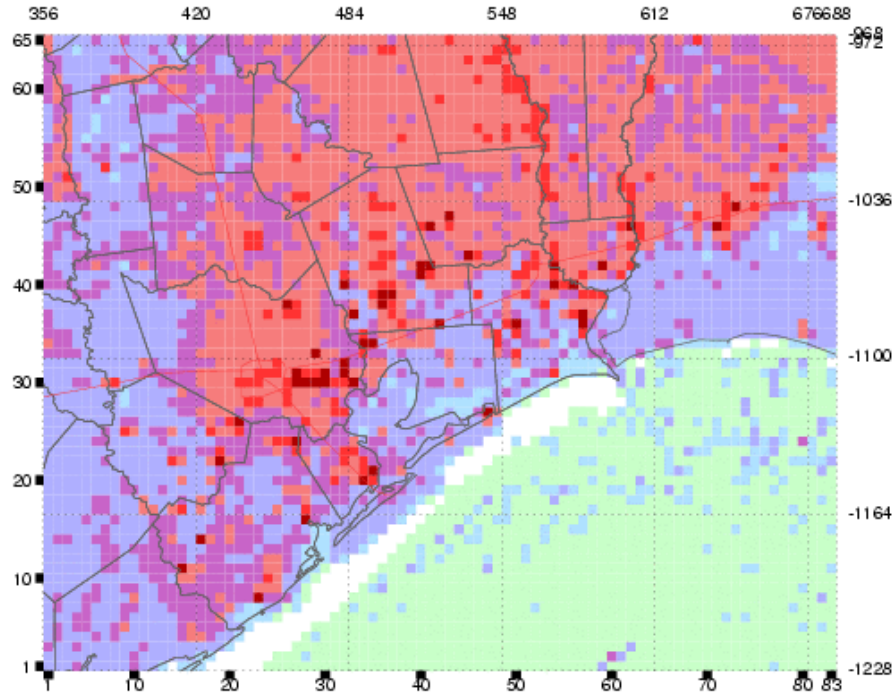




EI Modeling for June 2006 Episode
Weekday (6/7/06) and Sunday (6/11/06) VOC



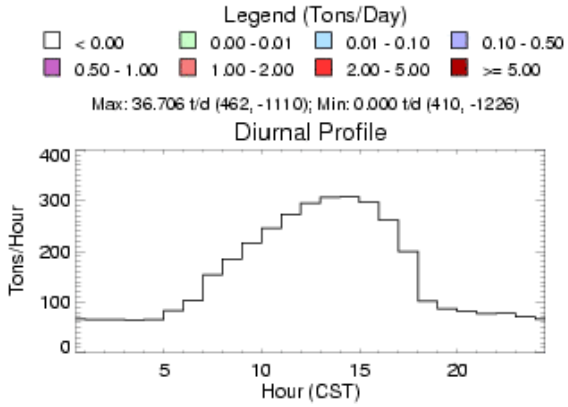
hgb8h2.bc06jun.reg7a.hgbpa_04km Total Emissions, 06/07/2006: All VOC



hgb8h2.bc06jun.reg7a.hgbpa_04km Total Emissions, 06/11/2006: All VOC

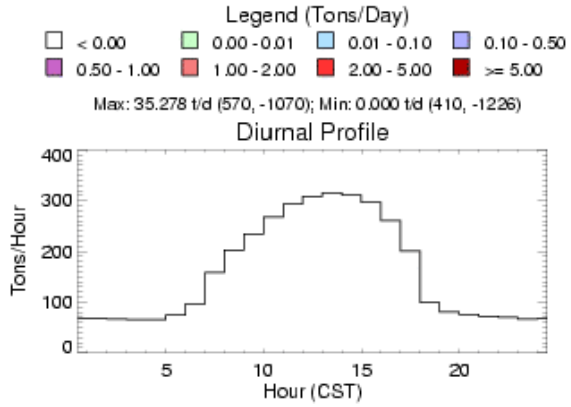
Emissions Plotted

County	Tons/Day
Brazoria	188.04
Chambers	76.01
Fort Bend	115.52
Galveston	119.06
Harris	575.60
Liberty	305.55
Montgomery	178.06
Waller	34.61
HGB SUBTOTAL:	1592.45
Hardin	188.26
Jefferson	223.85
Orange	99.63
BPA SUBTOTAL:	511.74
MAP TOTAL:	3753.36

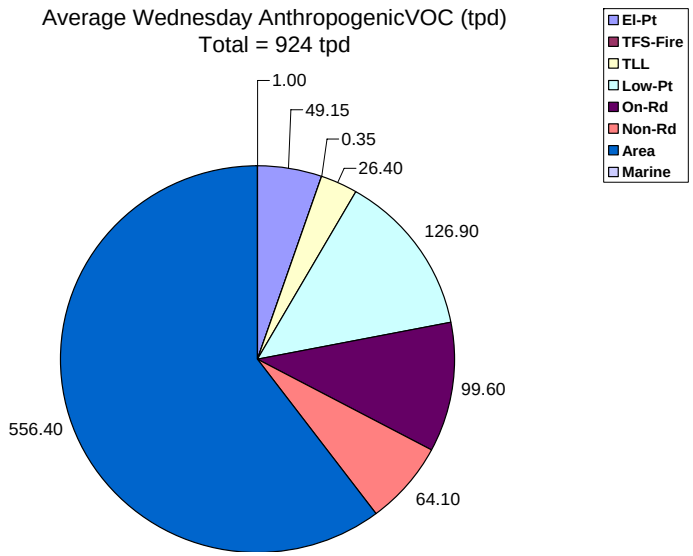


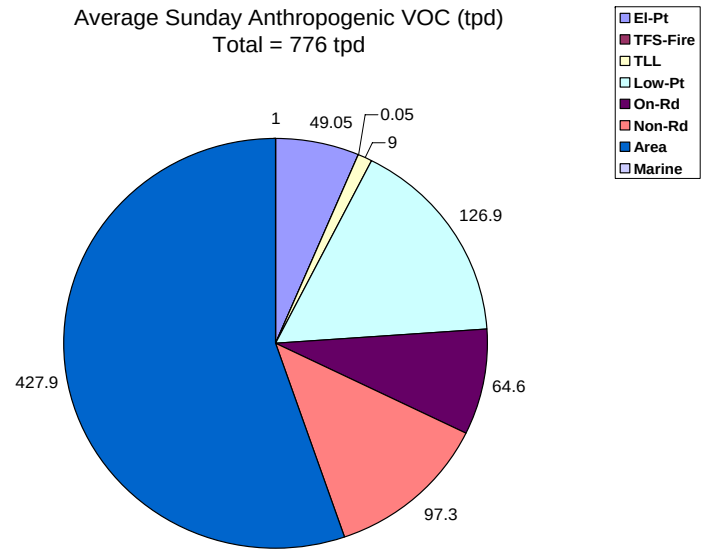
Emissions Plotted

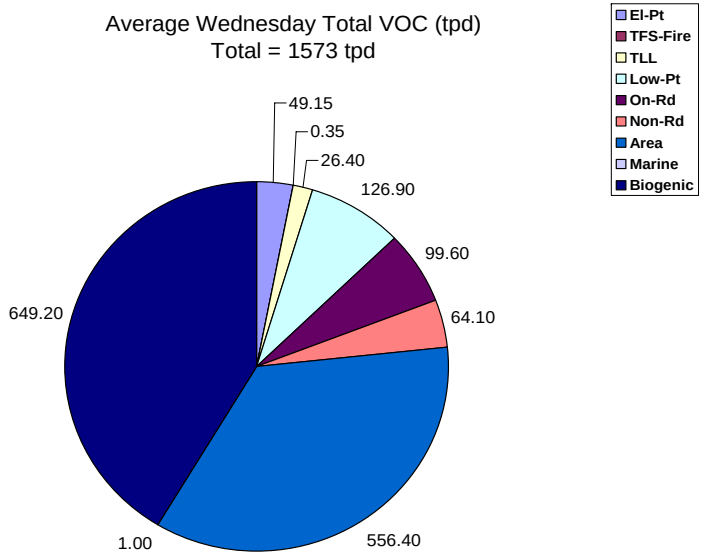
County	Tons/Day
Brazoria	185.90
Chambers	78.86
Fort Bend	104.80
Galveston	122.67
Harris	446.33
Liberty	312.64
Montgomery	172.19
Waller	33.42
HGB SUBTOTAL:	1456.81
Hardin	203.77
Jefferson	219.85
Orange	106.52
BPA SUBTOTAL:	530.14
MAP TOTAL:	3816.39

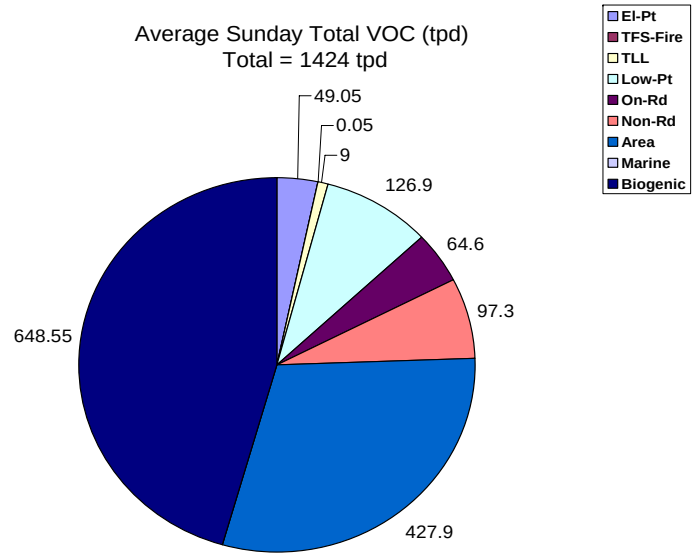


EI Modeling for June 2006 Episode Wednesday and Sunday VOC









CAMx Modeling for the June 2006 Episode

- Statistical Performance Evaluations
  - Peak 1-hour and 8-hour ozone concentrations
  - Relative bias (%) 1-hour ozone > 60 ppb and site average peak 8-hour ozone
  - Relative error (%) 1-hour ozone > 60 ppb and site average peak 8-hour ozone

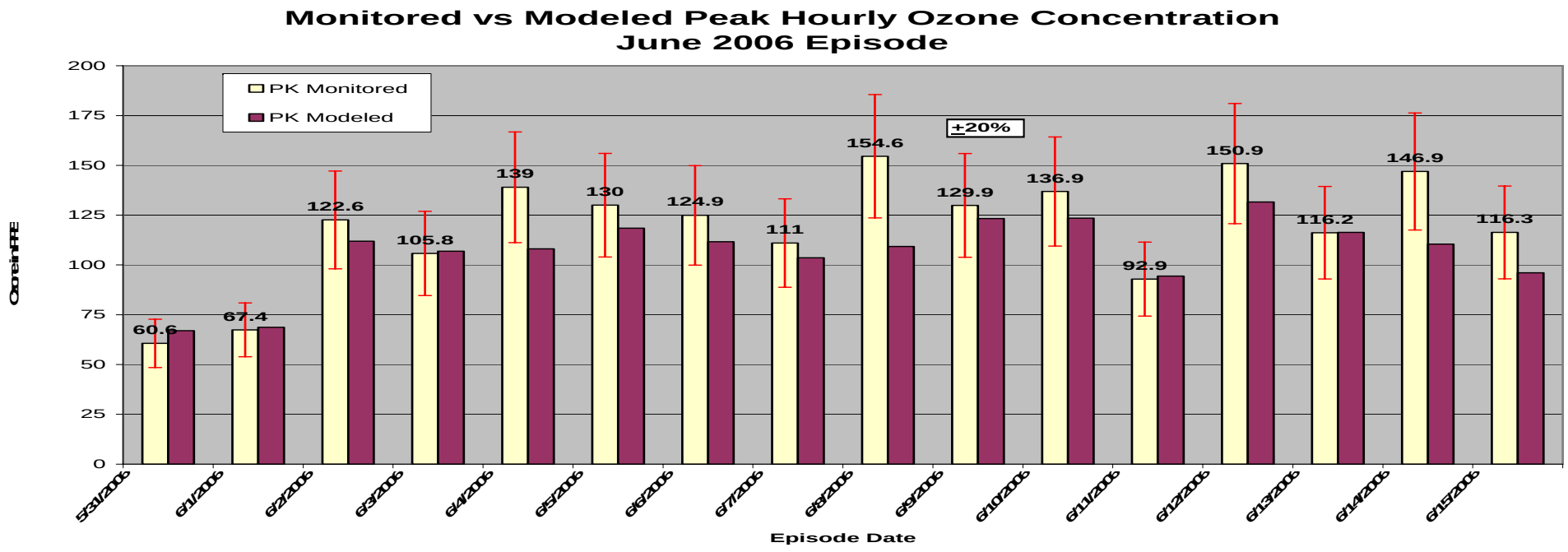
- Graphical Performance Evaluations
  - Time series of measured vs modeled 1-hour ozone for selected sites
  - Time series of measured vs modeled precursors for selected sites
  - Time Series of measured vs modeled 8-hour daily max. for selected sites
  - Daily maximum 8-hour ozone tile plots for selected episode days
  - Scatter-plots of ETH, OLE & IOLE for selected sites

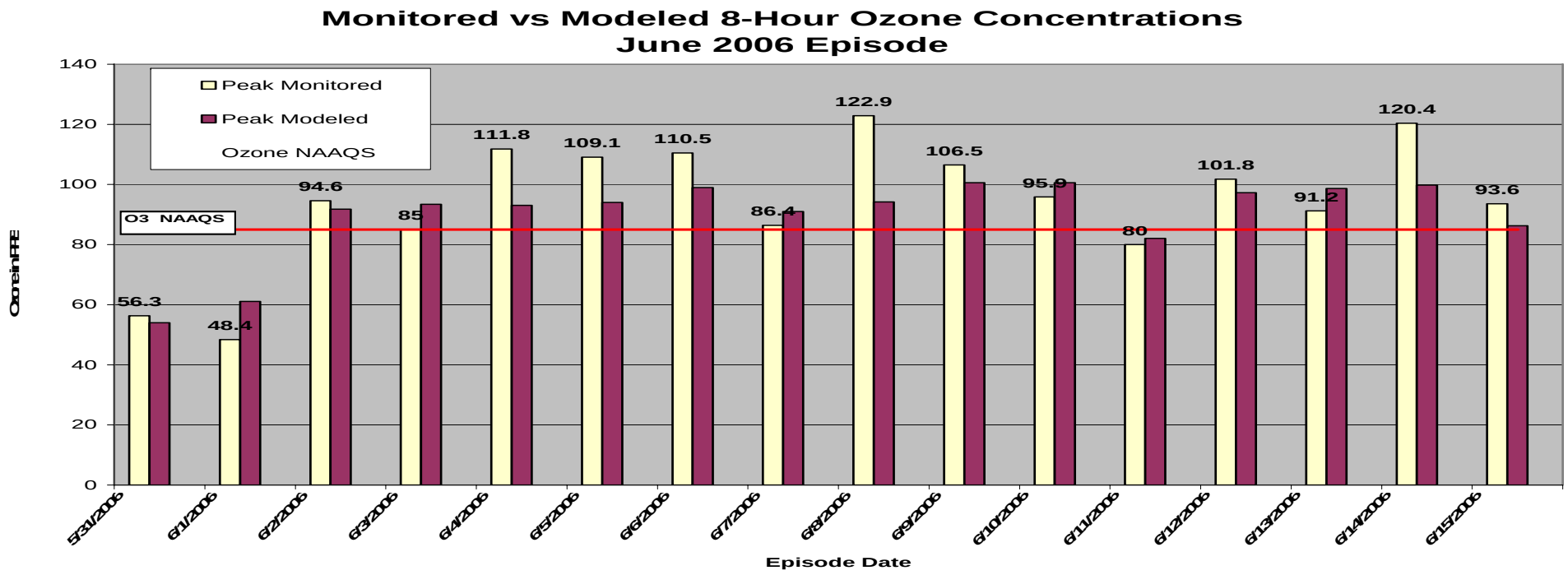
Statistical Performance Evaluations

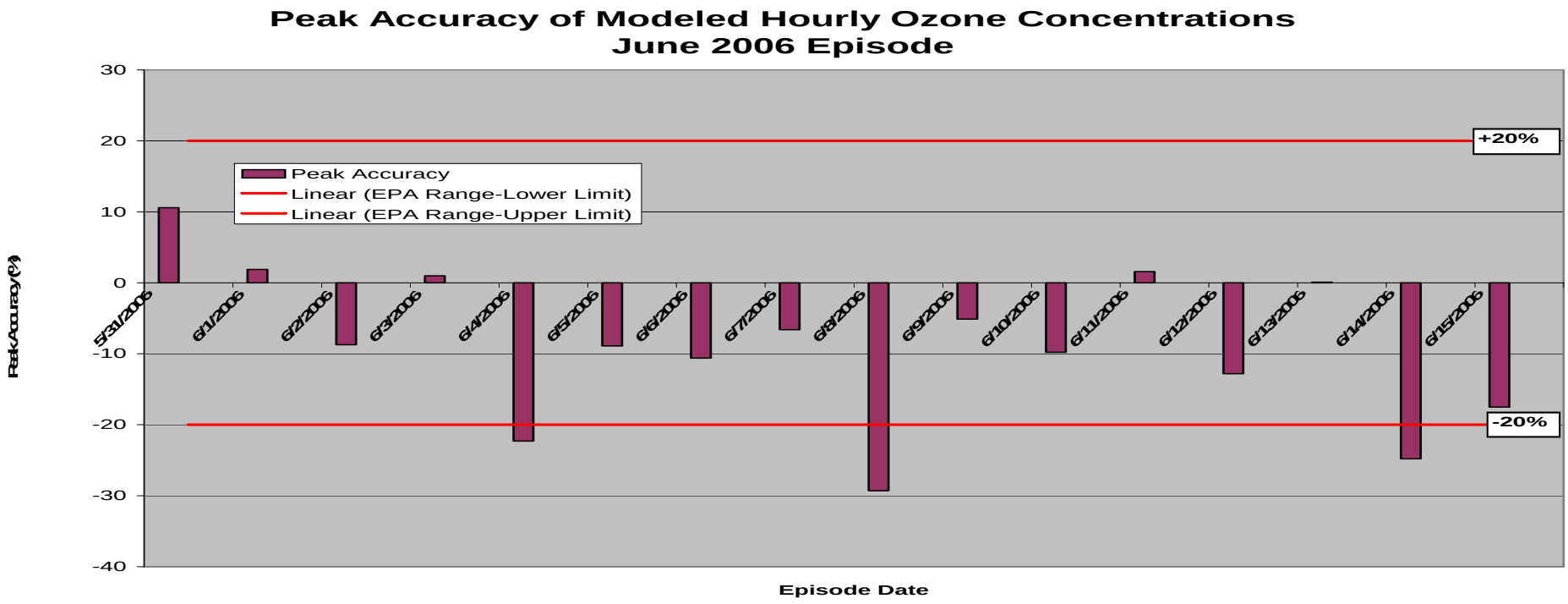
Modeled vs monitored peak ozone concentrations

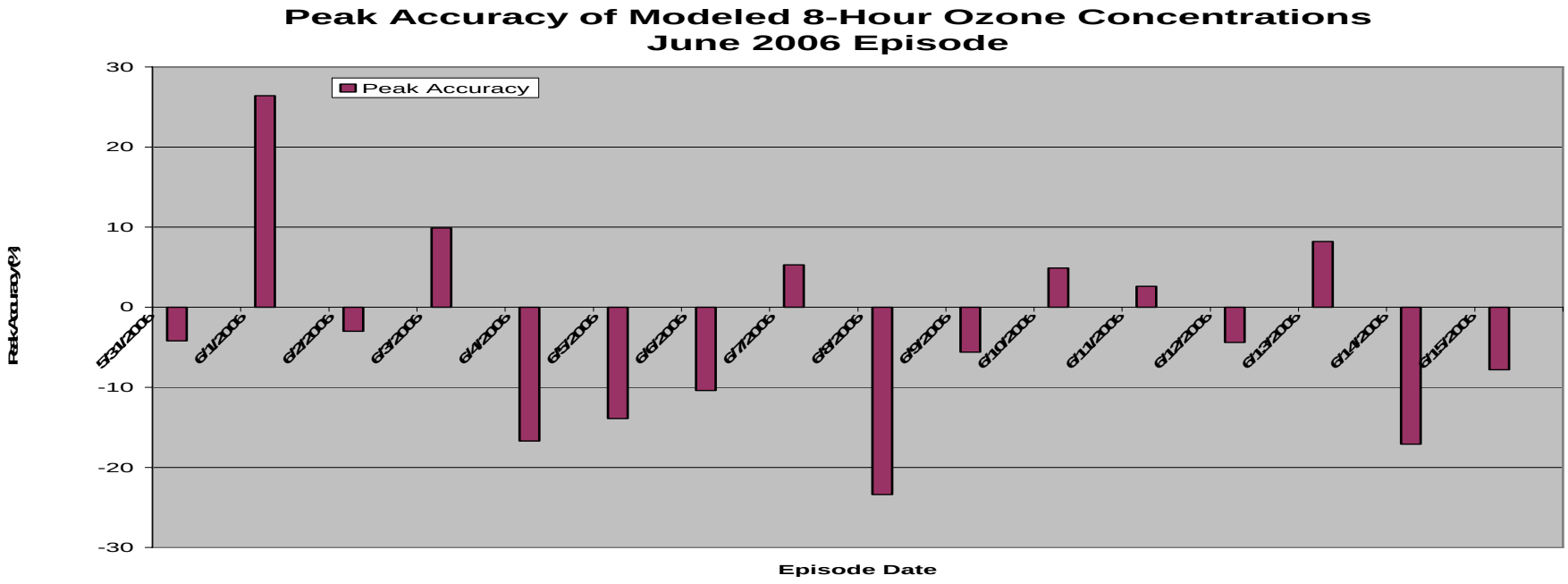
Modeled vs Monitored Relative Bias

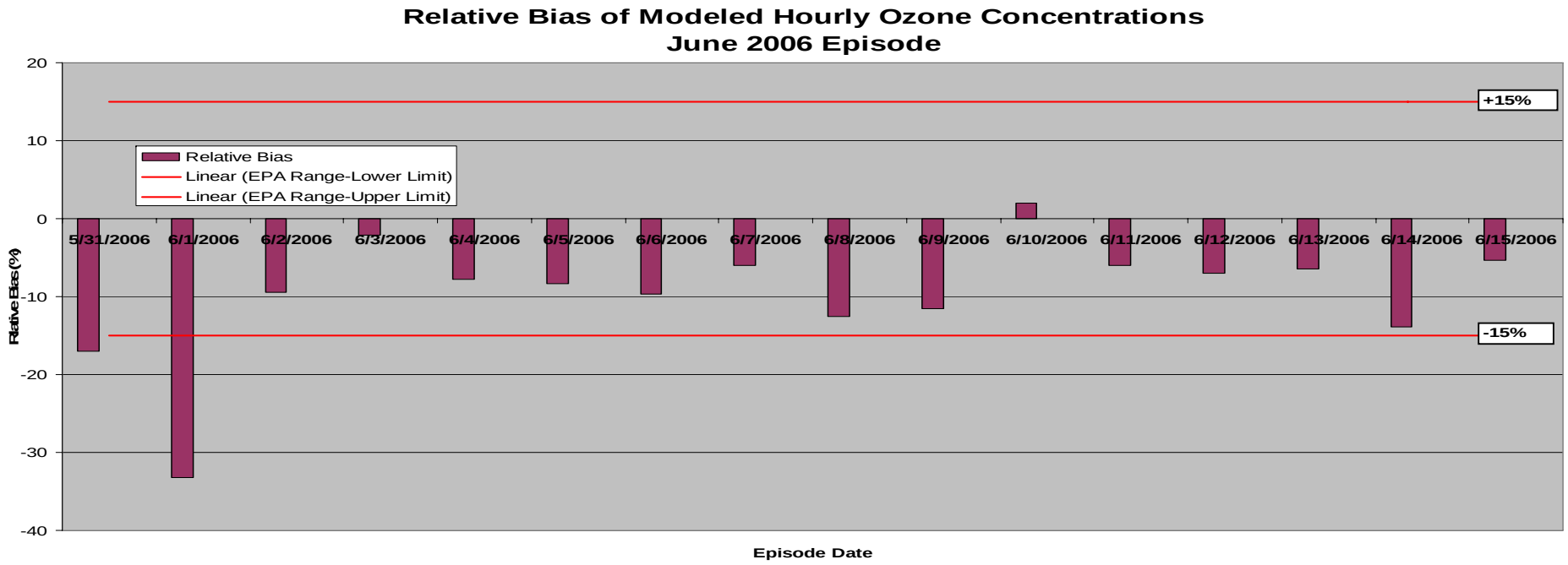
Modeled vs Monitored Relative Error

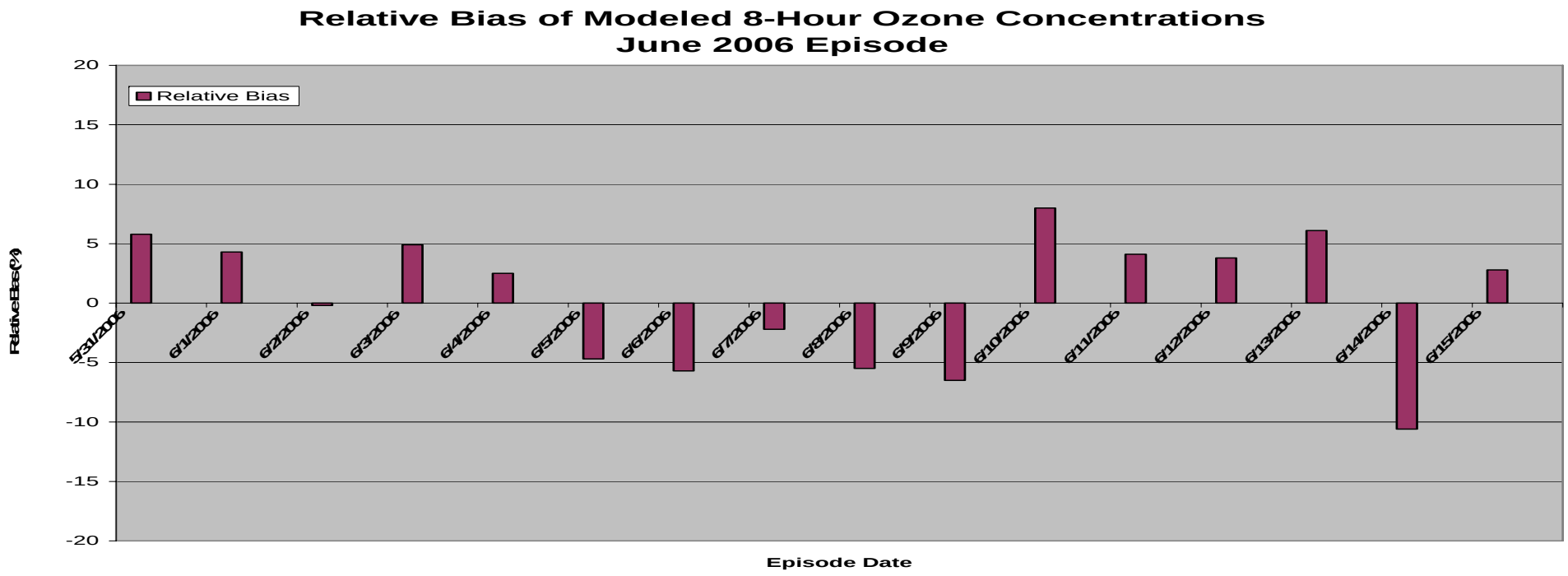

Monitored vs Modeled Peak Hourly Ozone Concentration
June 2006 Episode
PK Monitored
PK Modeled
±20%
Ozone in PPB
Episode Date
60.6
67.4
122.6
105.8
139
130
124.9
111
154.6
129.9
136.9
92.9
150.9
116.2
146.9
116.3
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006

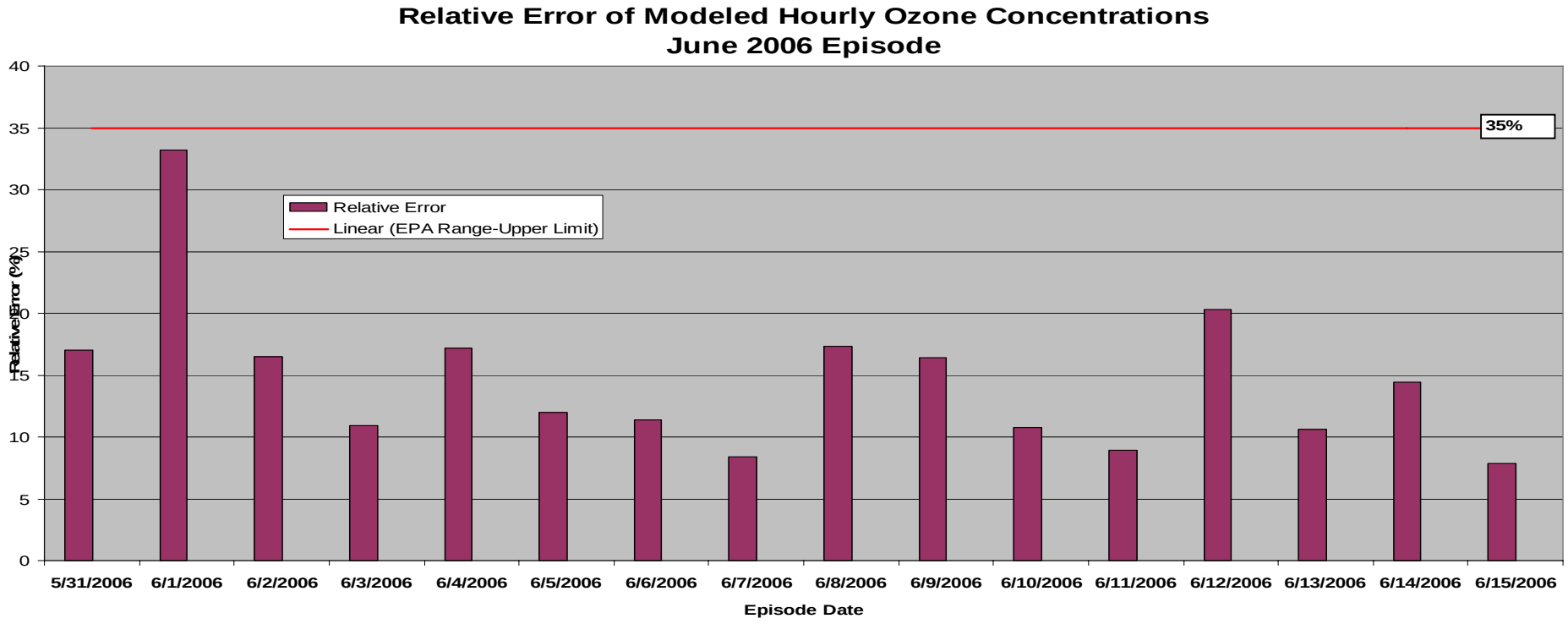

Monitored vs Modeled 8-Hour Ozone Concentrations
June 2006 Episode
Peak Monitored
Peak Modeled
Ozone NAAQS
O3 NAAQS
Ozone in PPB
Episode Date
56.3
48.4
94.6
85
111.8
109.1
110.5
86.4
122.9
106.5
95.9
80
101.8
91.2
120.4
93.6
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006

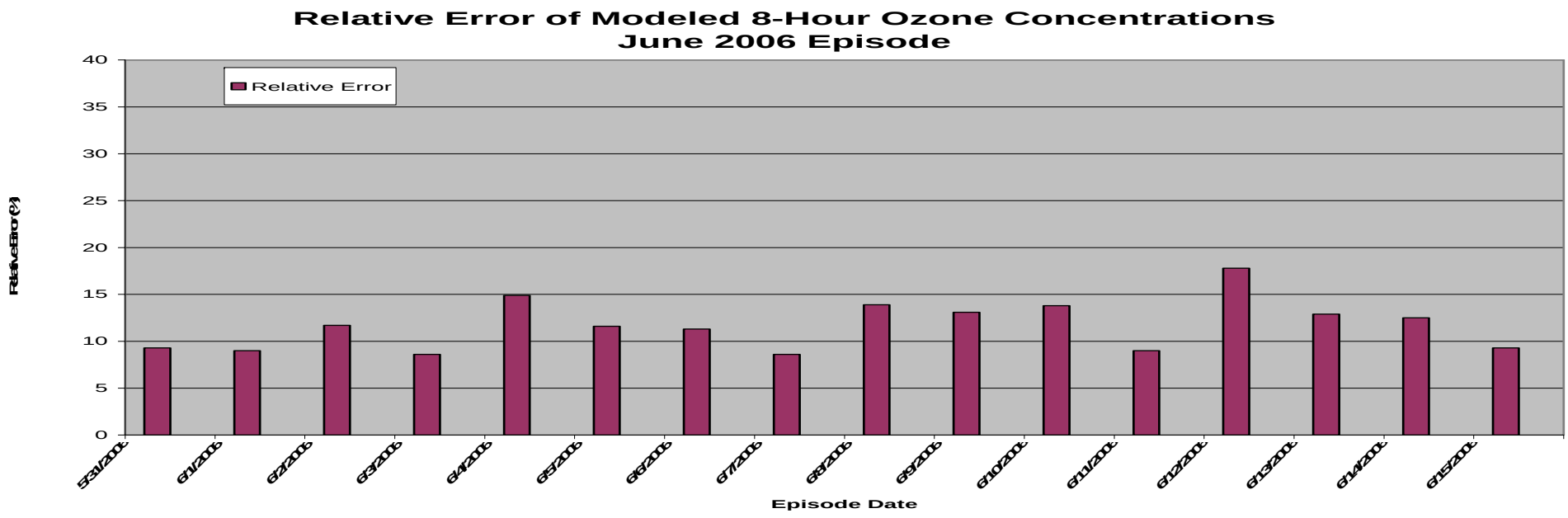

Peak Accuracy of Modeled Hourly Ozone Concentrations
June 2006 Episode
Peak Accuracy
Linear (EPA Range-Lower Limit)
Linear (EPA Range-Upper Limit)
+20%
-20%
30
20
10
0
-10
-20
-30
-40
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Peak Accuracy(%)
Episode Date


Peak Accuracy of Modeled 8-Hour Ozone Concentrations
June 2006 Episode
Peak Accuracy
30
20
10
0
-10
-20
-30
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Peak Accuracy(%)
Episode Date


Relative Bias of Modeled Hourly Ozone Concentrations
June 2006 Episode
20
10
0
-10
-20
-30
-40
Relative Bias (%)
Relative Bias
Linear (EPA Range-Lower Limit)
Linear (EPA Range-Upper Limit)
+15%
-15%
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Episode Date


Relative Bias of Modeled 8-Hour Ozone Concentrations
June 2006 Episode
20
15
10
5
0
-5
-10
-15
-20
Relative Bias (%)
Relative Bias
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Episode Date


Relative Error of Modeled Hourly Ozone Concentrations
June 2006 Episode
Relative Error (%)
Relative Error
Linear (EPA Range-Upper Limit)
35%
0
5
10
15
20
25
30
35
40
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Episode Date

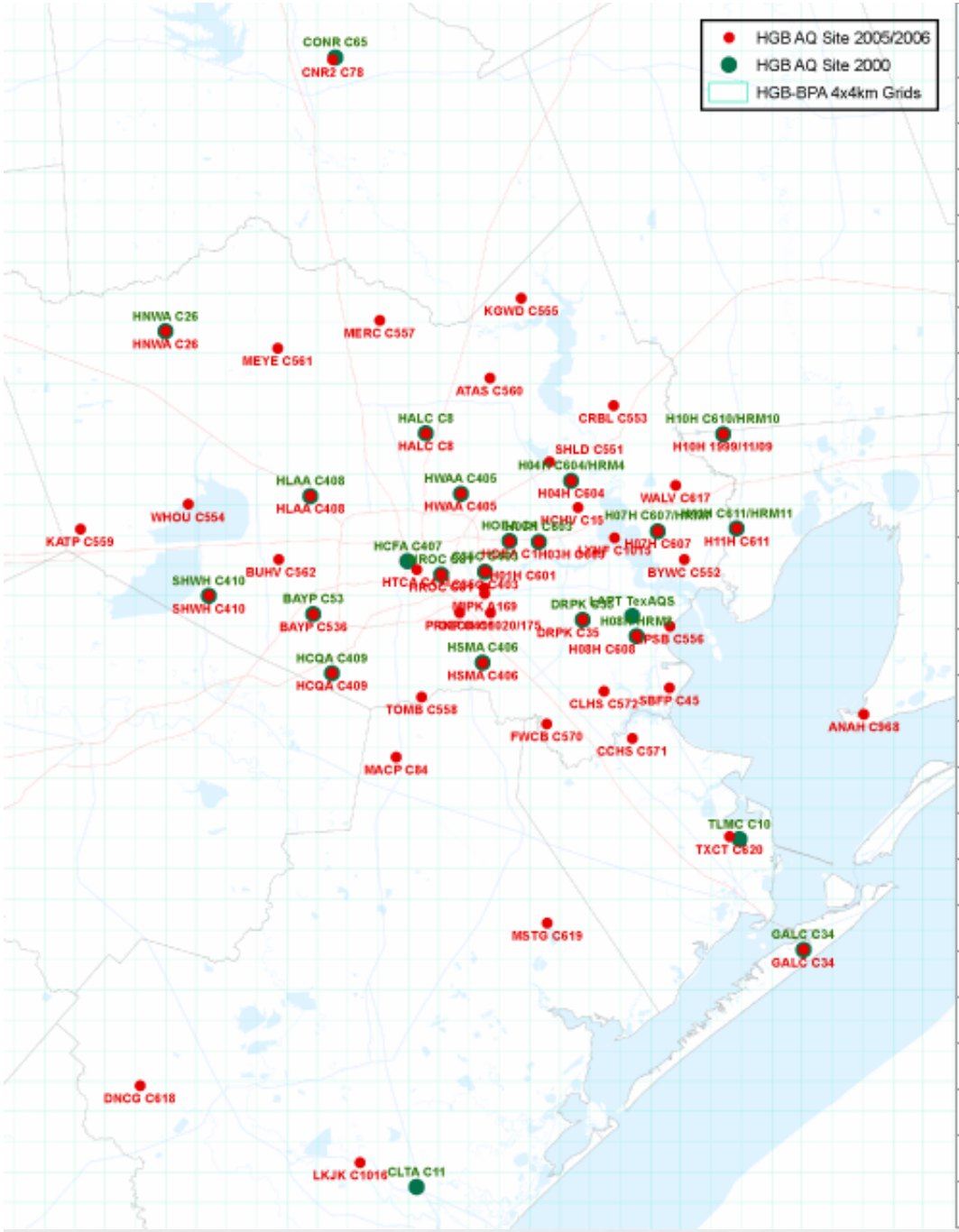

Relative Error of Modeled 8-Hour Ozone Concentrations
June 2006 Episode
Relative Error (%)
Relative Error
0
5
10
15
20
25
30
35
40
5/31/2006
6/1/2006
6/2/2006
6/3/2006
6/4/2006
6/5/2006
6/6/2006
6/7/2006
6/8/2006
6/9/2006
6/10/2006
6/11/2006
6/12/2006
6/13/2006
6/14/2006
6/15/2006
Episode Date

Graphical Performance Evaluations

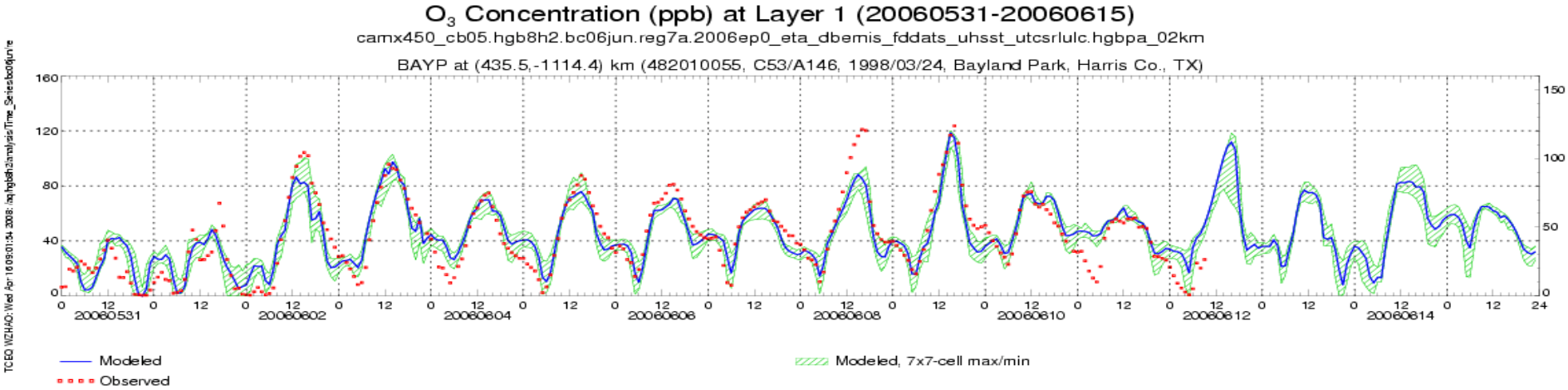
Modeled vs monitored Time Series

Modeled vs Monitored Daily Maximum 8-hour Ozone

Modeled vs Monitored HRVOC Scatter Plots



Site Code	Site Info
BAYP	Bayland Park, Harris Co., TX
C35C	Clinton, Harris Co., TX
CNR2	Conroe Relocated, Montgomery Co., TX
DRPK	Deer Park, Harris Co., TX
GALC	Galveston, Galveston Co., TX
H03H	HRM-3, Haden Road, Harris Co., TX
H08H	HRM Site 8, La Porte, Harris Co., TX
H10H	HRM-10, Mt Belvieu, Chambers Co., TX
H11H	HRM-11, , Chambers Co., TX
HALC	Aldine, Houston, Harris Co., TX
HCHV	Channelview, Houston, Harris Co., TX
HCQA	Croquet, Houston, Harris Co., TX
HNWA	NW Harris, Tomball, Harris Co., TX
HOEA	Houston East, Houston, Harris Co., TX
HROC	Houston Regional Office, Harris Co., TX
HSMA	Swiss and Monroe,, Harris Co., TX
HTCA	Texas Avenue, Houston, Harris Co., TX
HWAA	North Wayside, Houston, Harris Co., TX
LYNF	Lynchburg Ferry, Harris Co., TX
MACP	Manvel Croix Park, Brazoria Co., TX
MSTG	Mustang Bayou, Brazoria Co., TX
SBFP	Seabrook Friendship Park, Harris Co., TX
SHWH	Westhollow, Houston, Harris Co., TX
TXCT	Texas City, Galveston Co., TX
WALV	Wallisville Road, Harris Co., TX


O3 Concentration (ppb) at Layer 1 (20060531-20060615)
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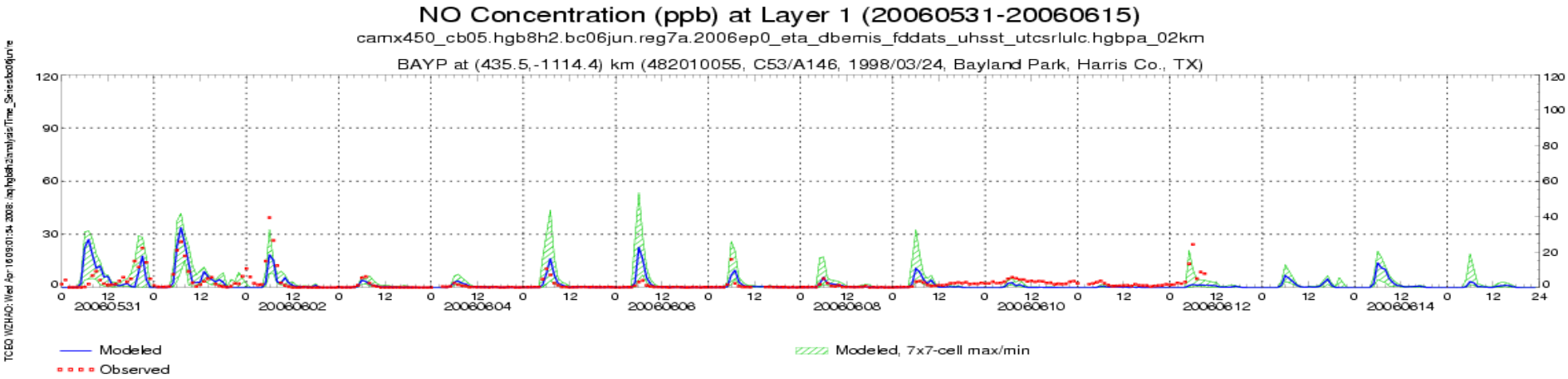
BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min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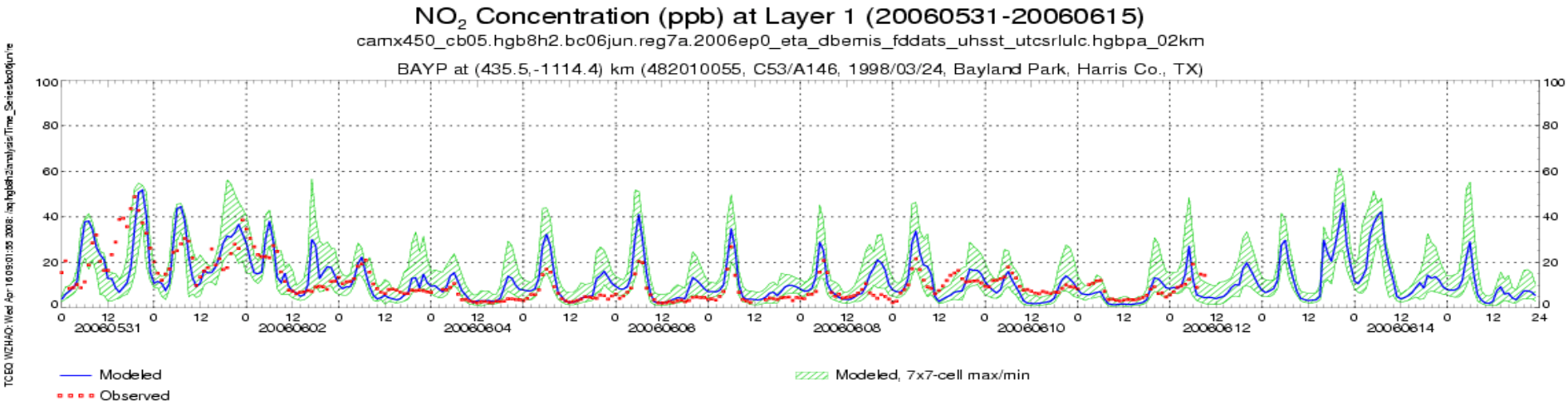
Modeled
Observed
Modeled, 7x7-cell max/min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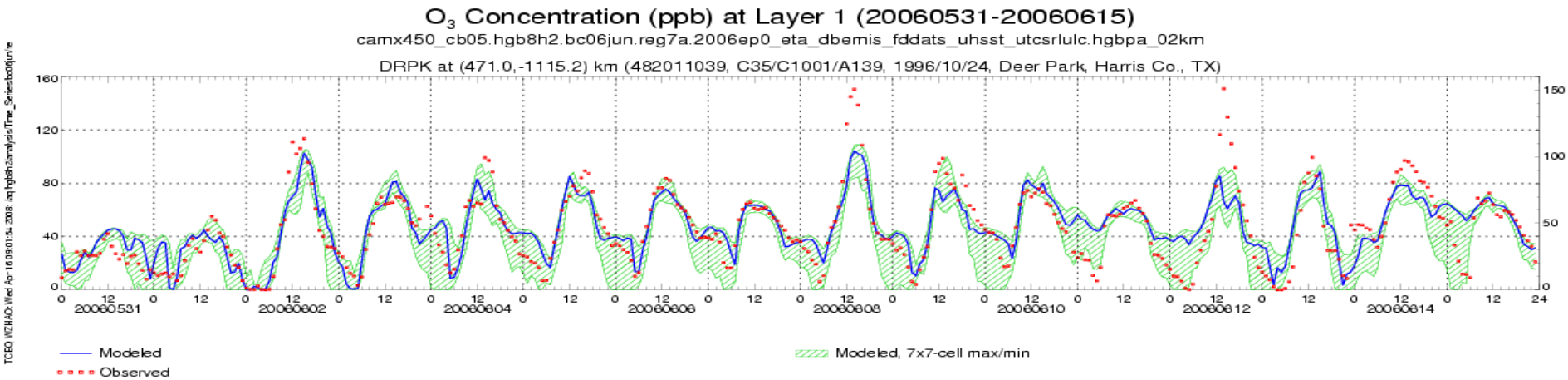
BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min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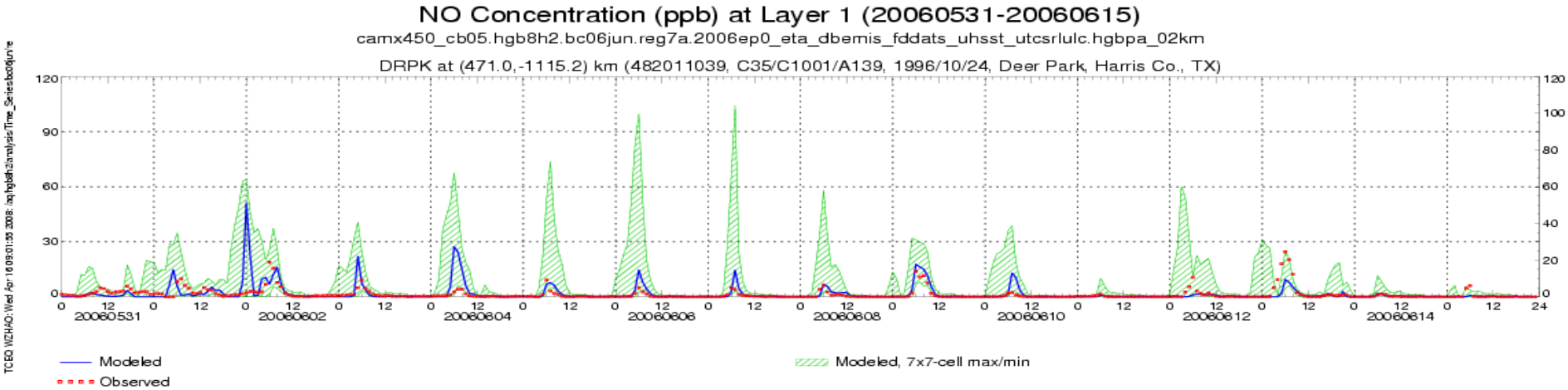
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min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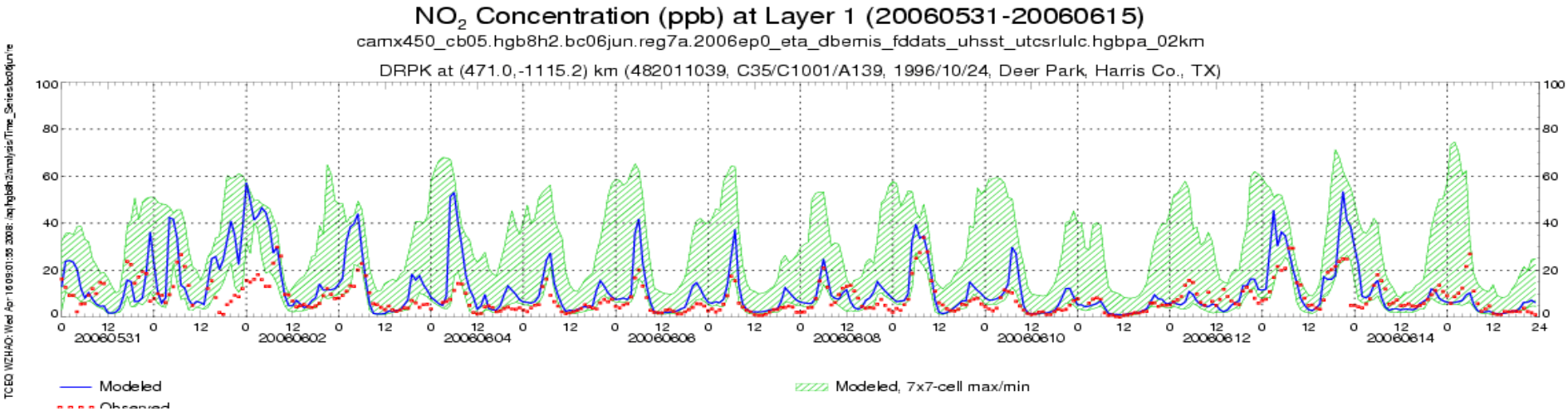
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min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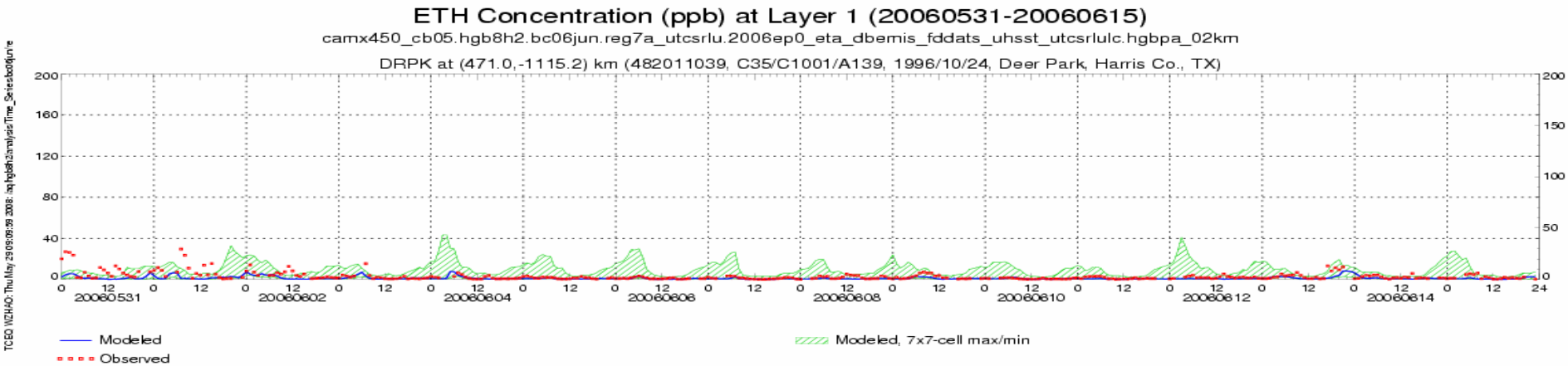
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Modeled, 7x7-cell max/min


ETH Concentration (ppb) at Layer 1 (20060531-20060615)
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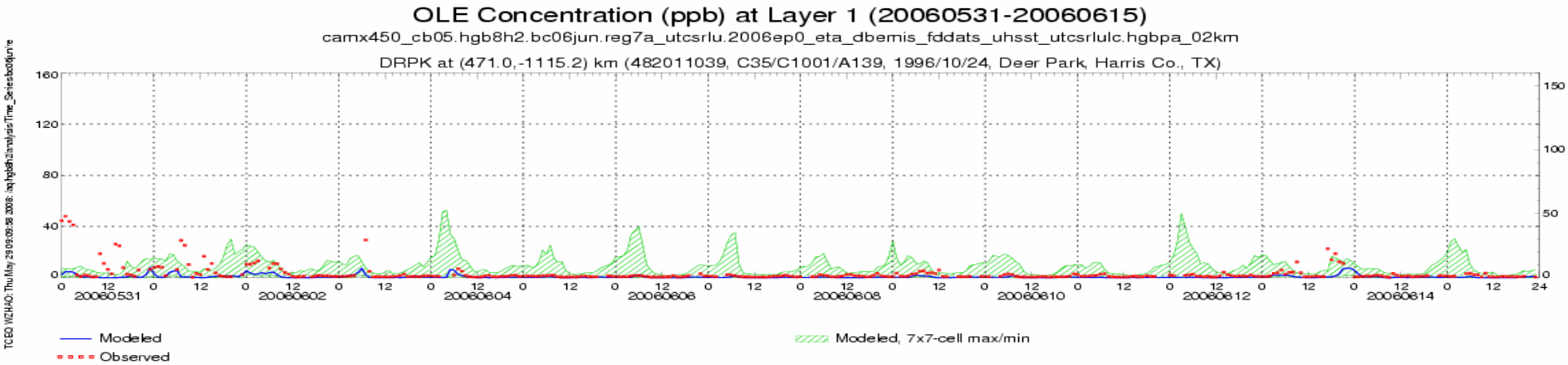
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


OLE Concentration (ppb) at Layer 1 (20060531-20060615)
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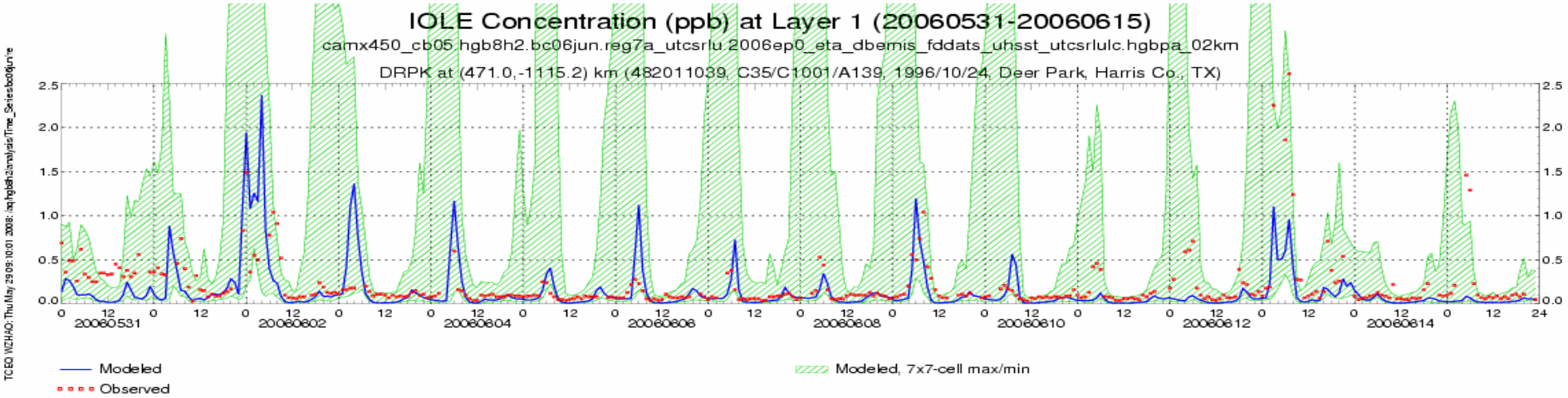
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


IOLE Concentration (ppb) at Layer 1 (20060531-20060615)
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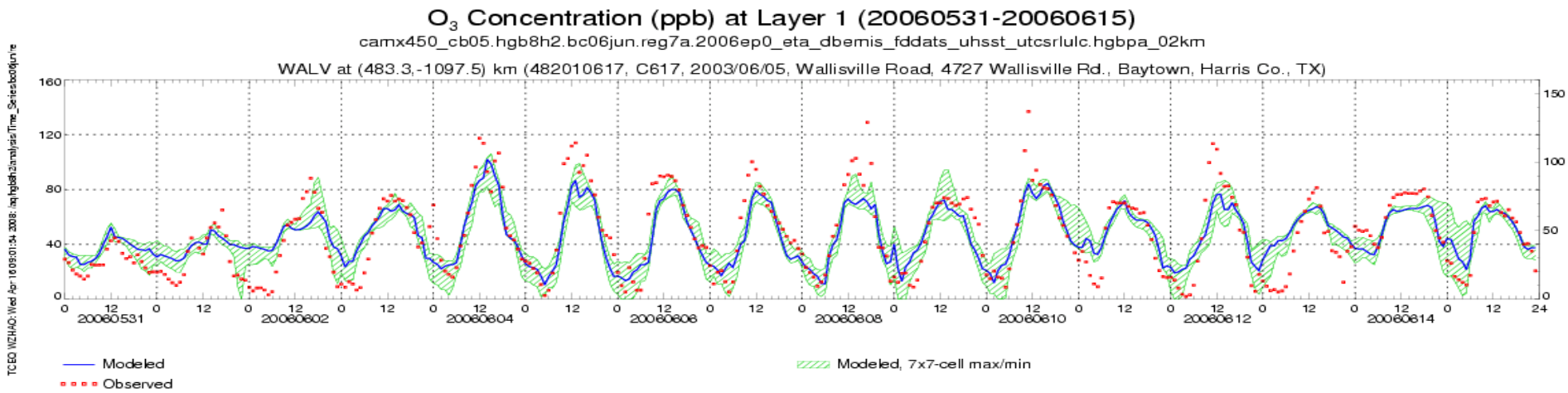
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


O3 Concentration (ppb) at Layer 1 (20060531-20060615)
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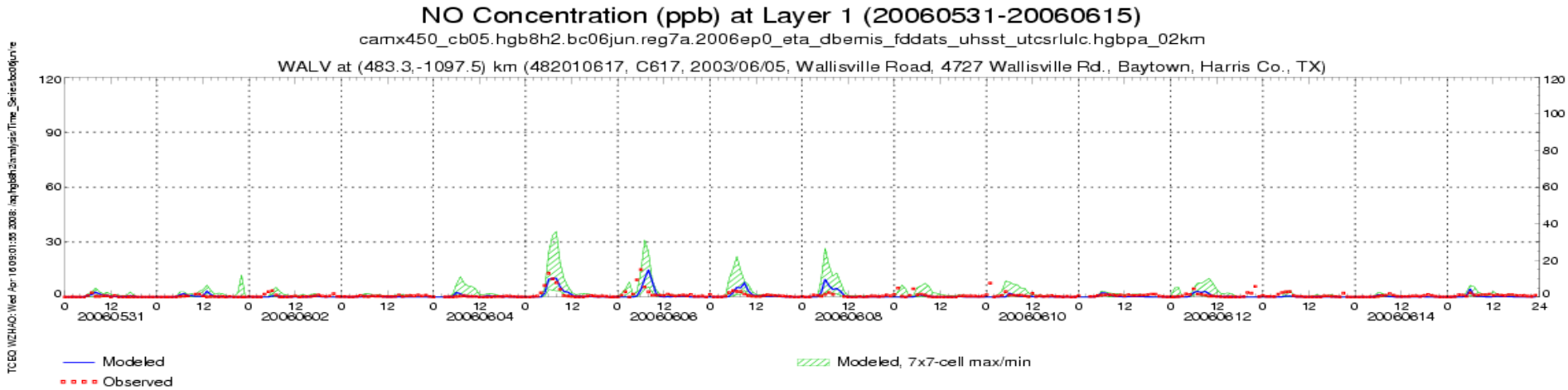
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


NO Concentration (ppb) at Layer 1 (20060531-20060615)
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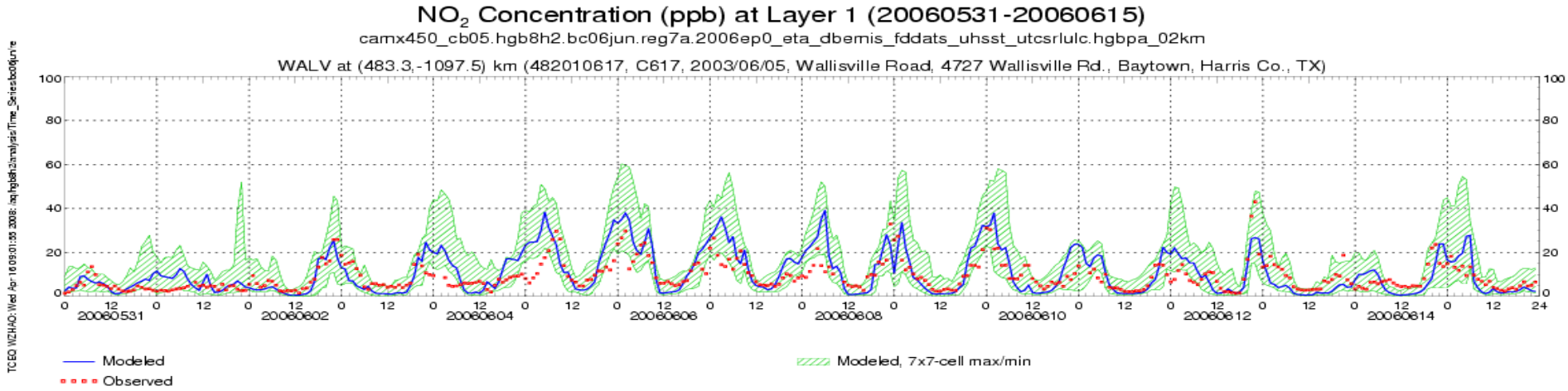
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


NO2 Concentration (ppb) at Layer 1 (20060531-20060615)
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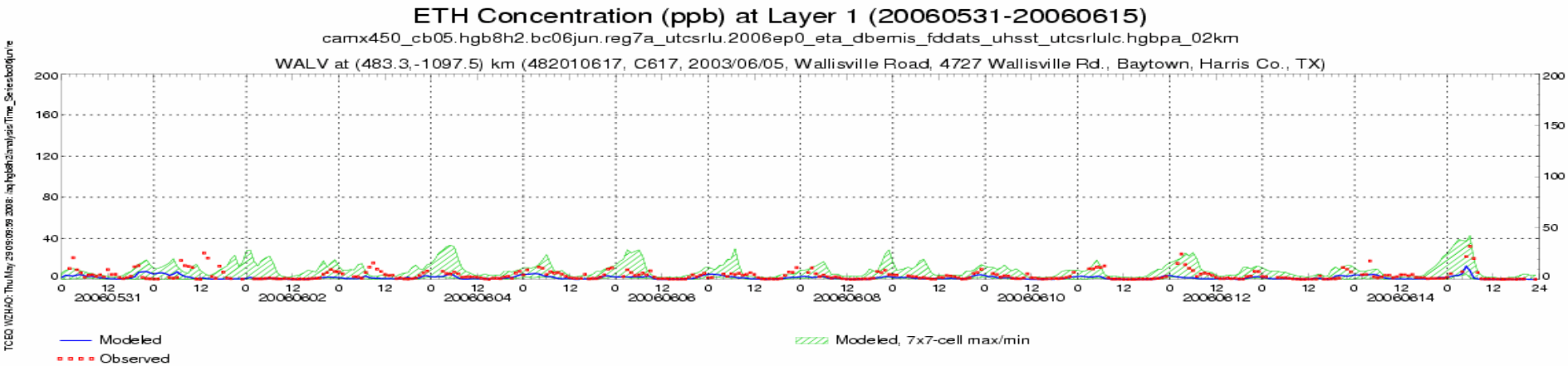
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


ETH Concentration (ppb) at Layer 1 (20060531-20060615)
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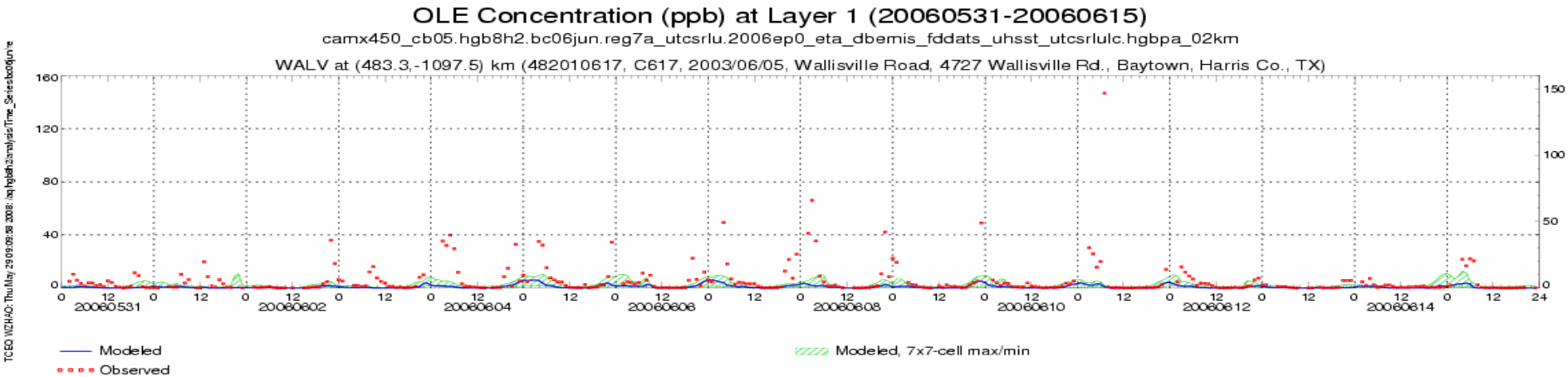
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


OLE Concentration (ppb) at Layer 1 (20060531-20060615)
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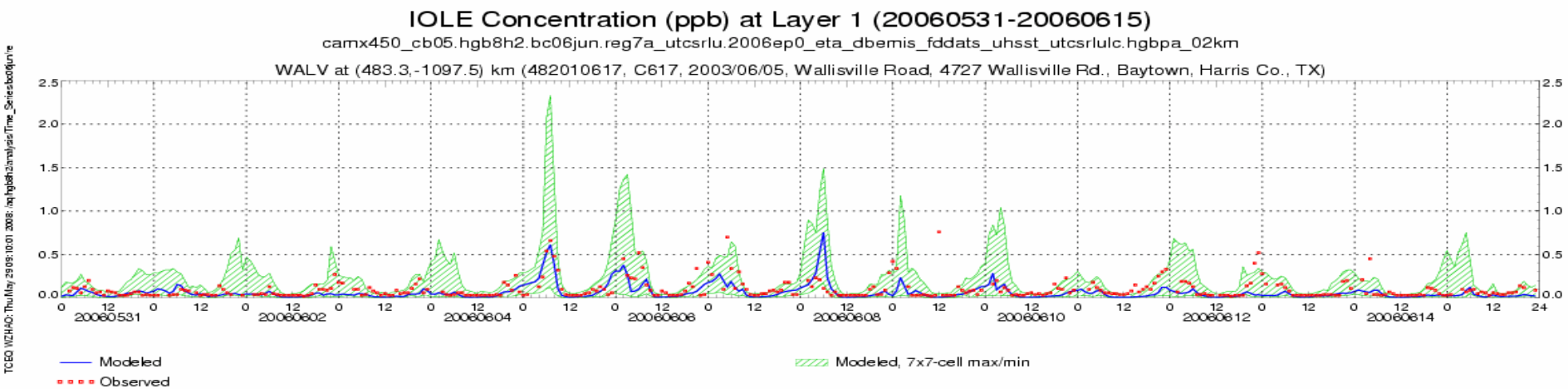
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min


IOLE Concentration (ppb) at Layer 1 (20060531-20060615)
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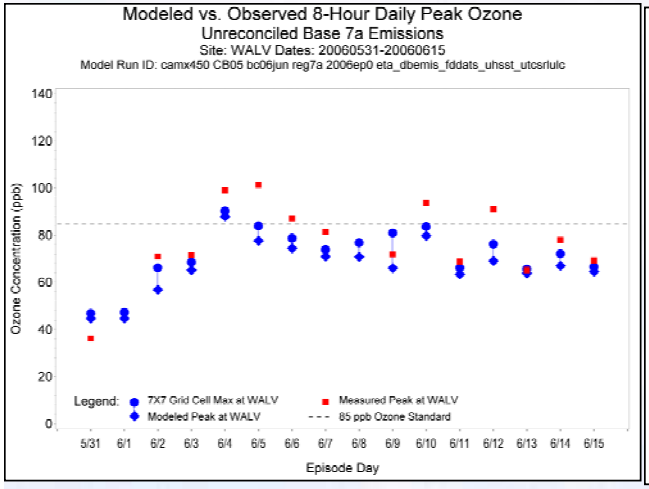
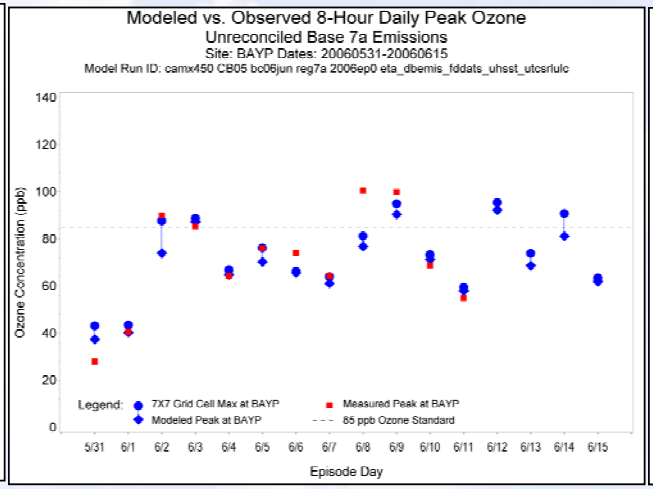
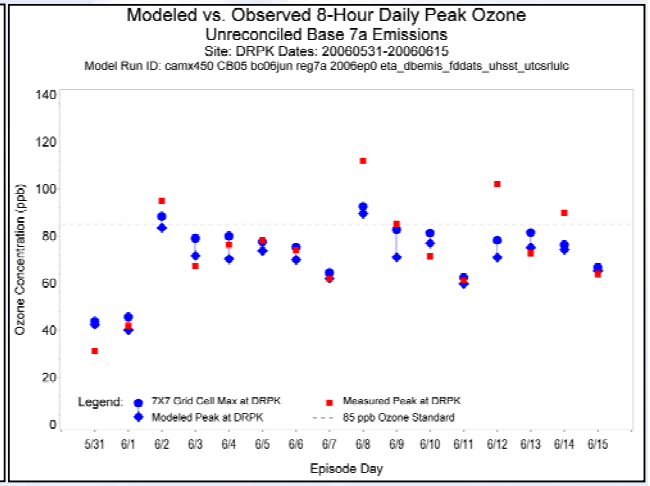
WALV at (483.3,-1097.5) km (482010617, C617, 2003/06/05, Wallisville Road, 4727 Wallisville Rd., Baytown, Harris Co., TX)
Modeled
Observed
Modeled, 7x7-cell max/min

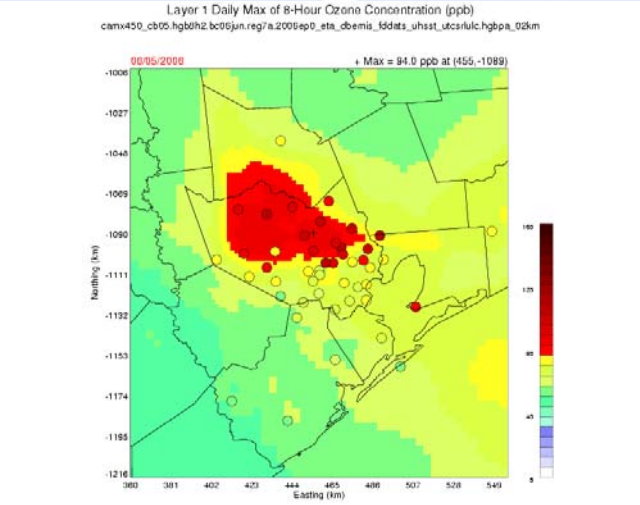
Time Series of Daily Maximum 8-hour Ozone



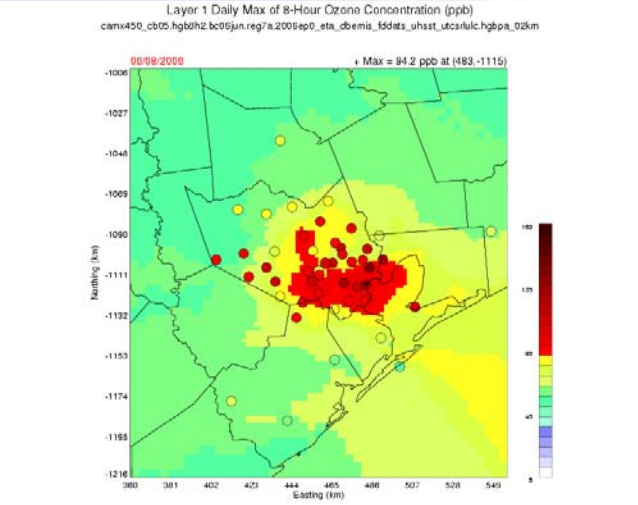




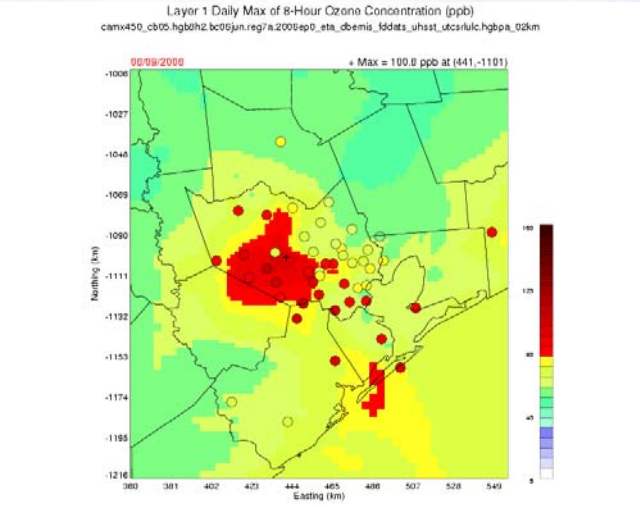
Daily Maximum 8-Hour ozone
Modeled vs Monitored



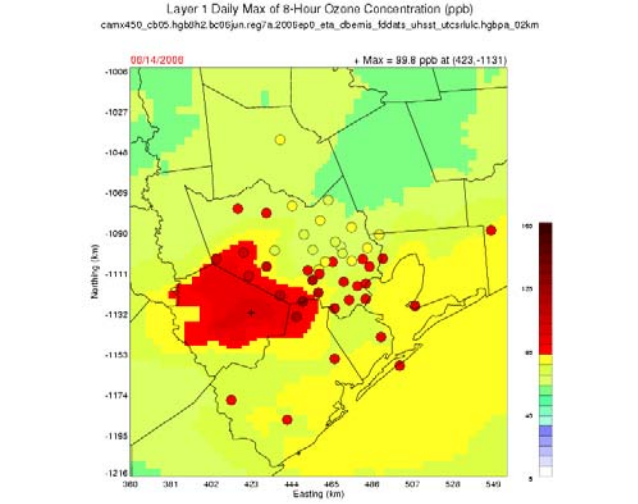
June 5, 2006



June 8, 2006

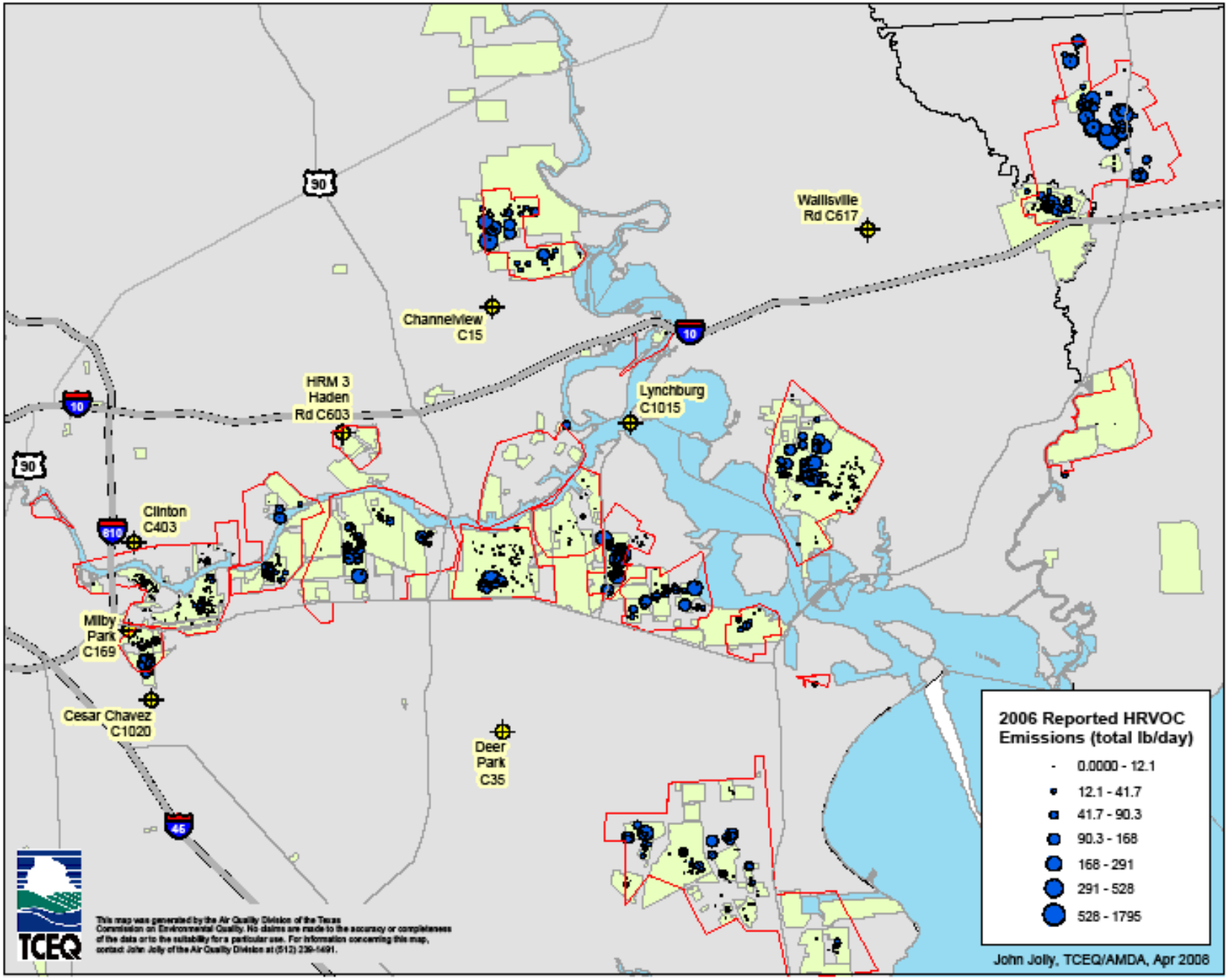


June 9, 2006

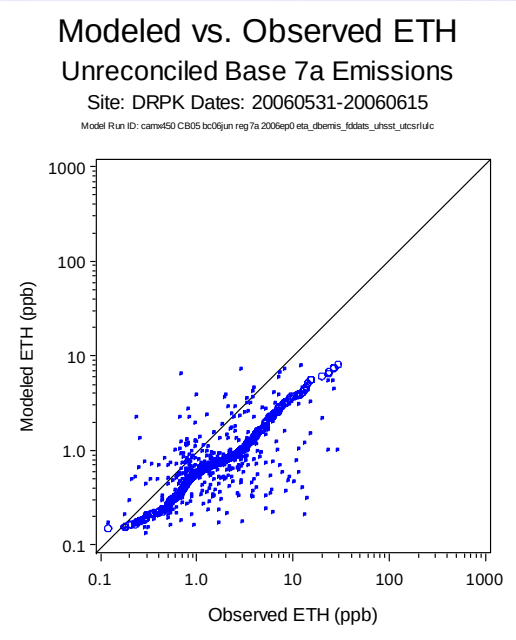


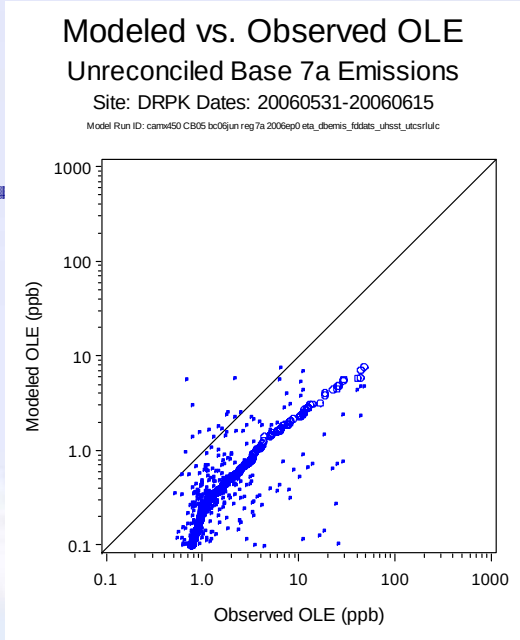
June 14, 2006

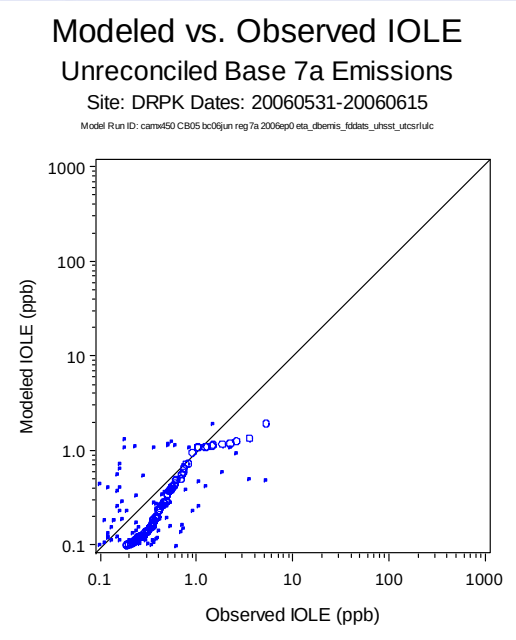
Houston Ship Channel Auto-GC Monitors and HRVOC Point Sources (2006 Annual EI)

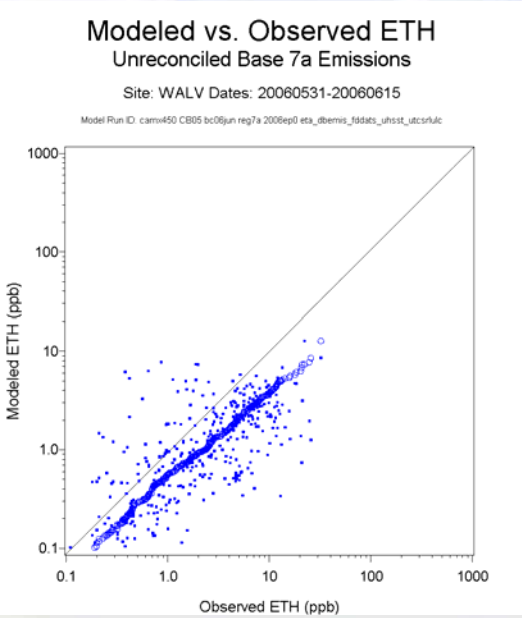


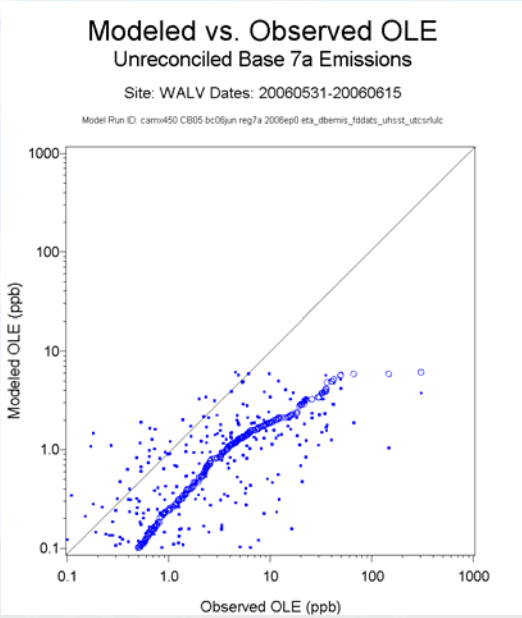
DRPK & WALV Measured vs Modeled CB05-HRVOC (ETH, OLE & IOLE)

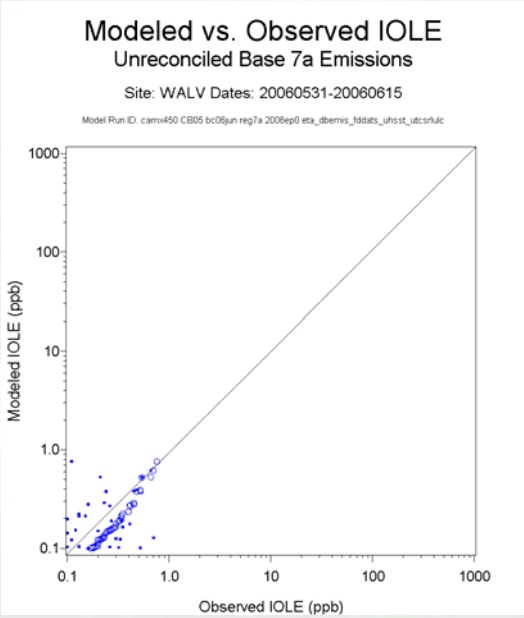












General Summary Comments

Statistical Performance Evaluation (excluding spin-up days: 5/31 & 6/1/06)

- This episode includes both high 8-hour exceedances and high 1-hour peaks
- The model generally under-predicts 1-hour peaks, especially on days with measured $O_3 \geq 120$ ppb
- The model generally under-predicts 8-hour peaks, most notably those with measured $O_3 \geq 100$ ppb.
- The relative bias of the 1-hour modeled versus monitored O_3 shows under-prediction on all days, although they are within the EPA $\pm$15%
- The relative bias of the 8-hour modeled versus monitored O_3 is mixed, with under-predictions on some days and over-prediction on others

General Summary Comments

Statistical Performance Evaluation: continued

- The relative error of the 1-hour modeled versus monitored O_3 is less than the EPA 35% and with the exception of 6/12/06, it is less than 20%
- The relative error for the 8-hour modeled versus monitored O_3 is less than 15%, again with the exception of 6/12/06.
- Based upon the EPA statistical performance measures for the 1-hour measured versus modeled O_3, this modeling is deemed suitable for SIP purpose

General Summary Comments

Graphical Performance Evaluation (time series at selected sites)

- The time series of 1-hour O_3 show the tendency of the model to under-predict the higher measurements
- The time series of NO and NO_2 are not well replicated, with a general over-prediction of NO_2, especially at DRPK
- The time series of ETH, OLE and IOLE are not well replicated, with a general under-prediction, especially at WALV (note: no reconciliation of the HRVOC emissions has been included)
- The time series of 8-hour O_3 show the general tendency of the model to under-predict measured values greater than 84 ppb, which may be problematic for determining the RRF.

General Summary Comments

Graphical Performance Evaluation (Daily Max. 8-hour Tile-plots)

- The tile-plots for the selected days show the geographic extent of the model's general tendency to under-predict

Graphical Performance Evaluation (HRVOC scatter-plots at selected sites)

- The scatter-plots of ETH, OLE and IOLE show a general tendency of the model to under-predict, especially the higher measurements (e.g., ETH and OLE $\geq$ 10 ppb)
- The scatter-plots show that the discrepancies between measured and modeled values can exceed an "order-of-magnitude", which is more than might be expected from the uncertainty in meteorological modeled parameters (e.g., mixing depth, winds) , and therefore is likely due to unreported and/or under-reported emissions

Future Modeling Updates for the June 2006 Episode

- Emissions
  - Update Drilling Rig emissions
  - Update Locomotive emissions
  - Reconcile HRVOC emissions with ambient concentrations
- Other
  - New boundary conditions derived from the GEOS-CHEM model
  - New Land-use/Land-cover (UT-CSR LU/LC) in CAMx
  - Chemical process analysis to explore performance evaluation

Acknowledgements

- Air Modeling Team – Meteorological Modelers
  - Doug Boyer
  - Pete Breitenbach
  - Bright Dornblaser
  - Khalid Al-Wali
- Air Modeling Team – Emission Modelers
  - Barry Exum
  - Chris Kite
  - Marvin Jones
  - Jim MacKay
  - Jocelyn Mellberg
  - Ron Thomas
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  - Jim MacKay
  - Weining Zhao