# Houston SIP Modeling Update

## Base Case Modeling: 2005 Episodes

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Southeast Texas Photochemical
Modeling Technical Committee Meeting
December 12, 2007

## 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**

# Base Case Modeling: 2005 Episodes

- Episode0: May 19 through June 3, 2005
- Episode1: June 17 through June 30, 2005
- Episode2: July 27 through August 8, 2005

(note: All Episodes were Modeled w/ HGB 2X2 KM Domain)

# Base Case Modeling: 2005 Episodes

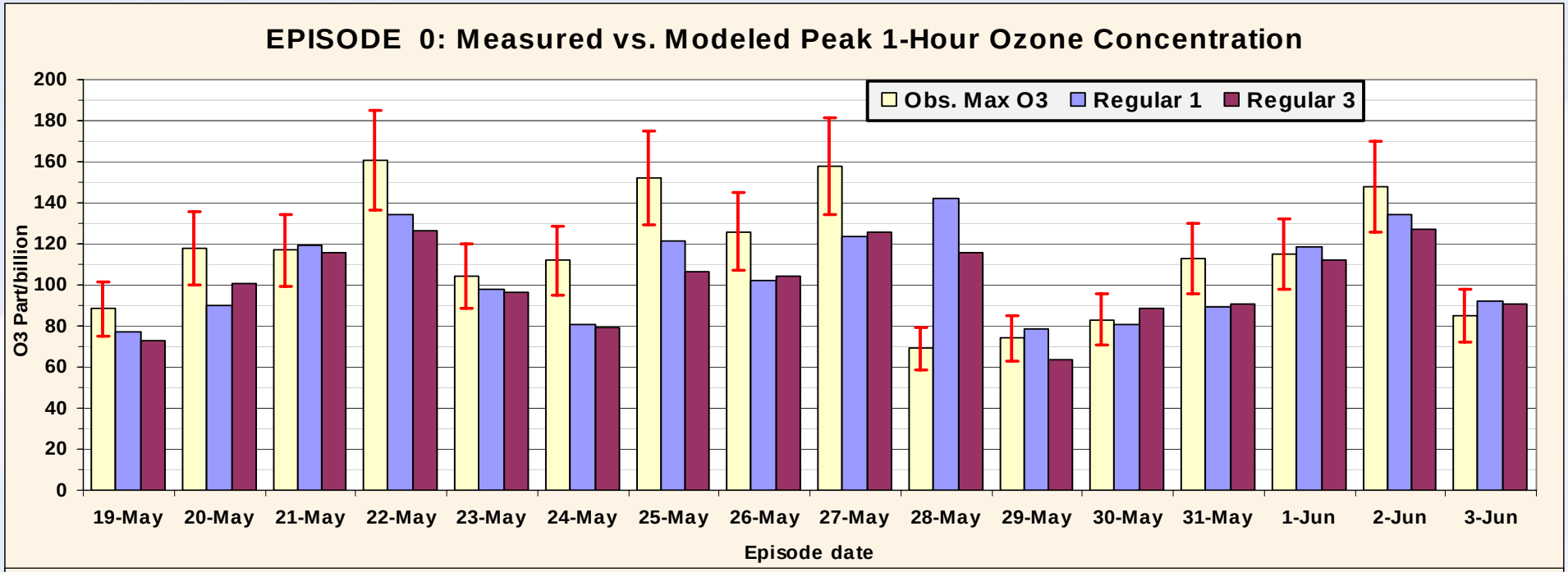
- Emissions (Regular 3)
  - Points: 2005 STARS, Hourly ARP,
  - On-Road Mobile: TTI link-based HGB & BPA*
  - Non & Off-Road Mobile & Area: 2005 TexAER
  - Biogenics: GloBEIS w/UT-CSR LU/LC and hourly PAR & temperature
- Meteorology
  - Radar Profiler Observational Nudging
  - NOAH Land Surface Model
  - NASA emissivities
  - ETA PBL
  - NCEP Sea Surface Temperature*

(Note: * denotes an update from previous Base Case Modeling; Regular 1)

# Base Case Modeling: 2005 Episodes

- Statistical Performance
  - Measured vs Modeled Peak 1-Hour & 8-Hour Ozone Concentration (O3)
  - Relative Bias (%) 1-Hr O3>60ppb & Site Average Peak 8-Hr O3
  - Relative Error (%) 1-Hr O3>60ppb & Site Average Peak 8-Hr O3

- Graphical Performance
  - Time Series of Measured vs Modeled 1-Hr (O3) for Selected Sites
  - Scatter-Plots of Measured vs Modeled (CB05) HRVOCs for Selected Sites
  - Hourly Ozone Animations


EPISODE 0: Measured vs. Modeled Peak 1-Hour Ozone Concentration
Obs. Max O3
Regular 1
Regular 3
O3 Part/billion
200
180
160
140
120
100
80
60
40
20
0
19-May
20-May
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22-May
23-May
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25-May
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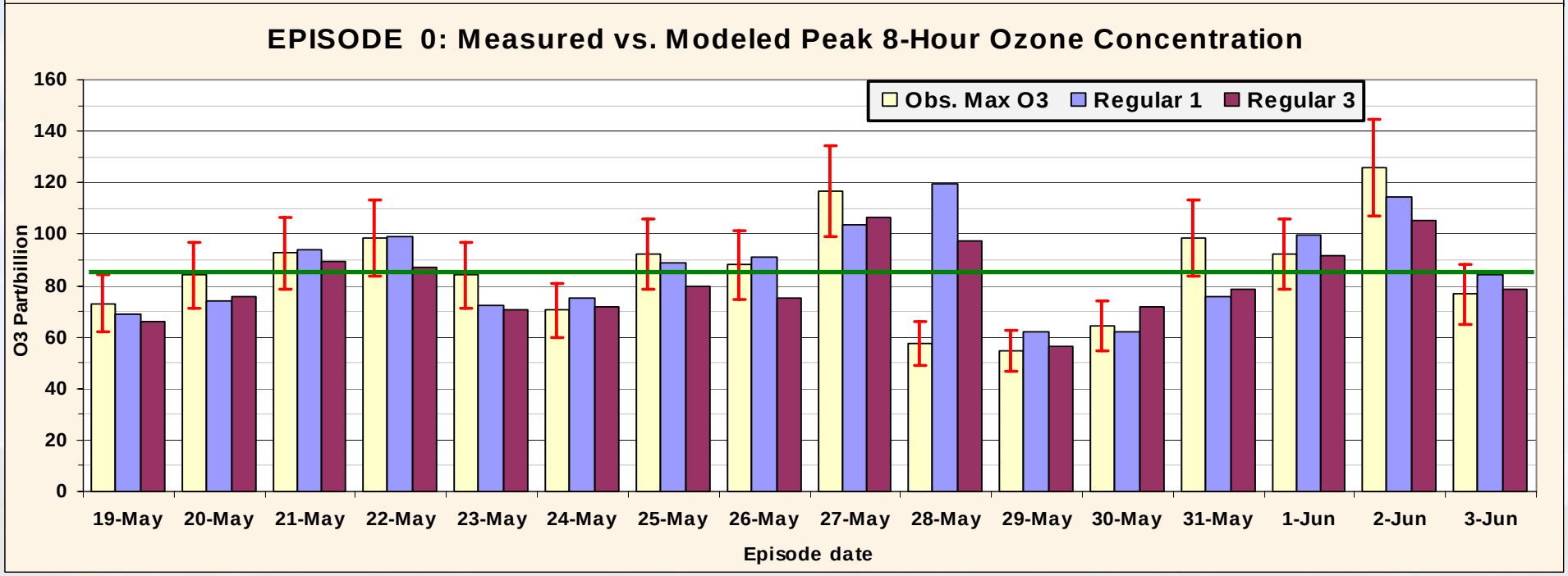
27-May
28-May
29-May
30-May
31-May
1-Jun
2-Jun
3-Jun
Episode date


EPISODE 0: Measured vs. Modeled Peak 8-Hour Ozone Concentration
Obs. Max O3
Regular 1
Regular 3
O3 Part/billion
160
140
120
100
80
60
40
20
0
19-May
20-May
21-May
22-May
23-May
24-May
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26-May
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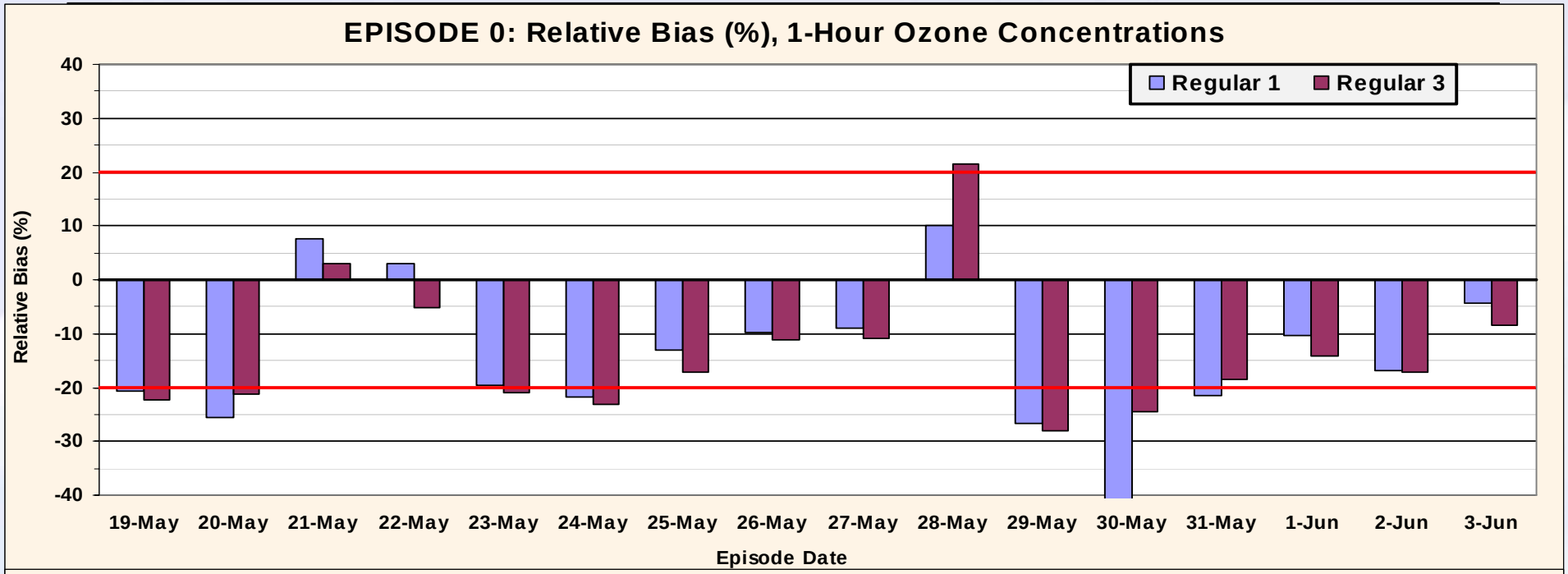
EPISODE 0: Relative Bias (%), 1-Hour Ozone Concentrations
Regular 1
Regular 3
Relative Bias (%)
40
30
20
10
0
-10
-20
-30
-40
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20-May
21-May
22-May
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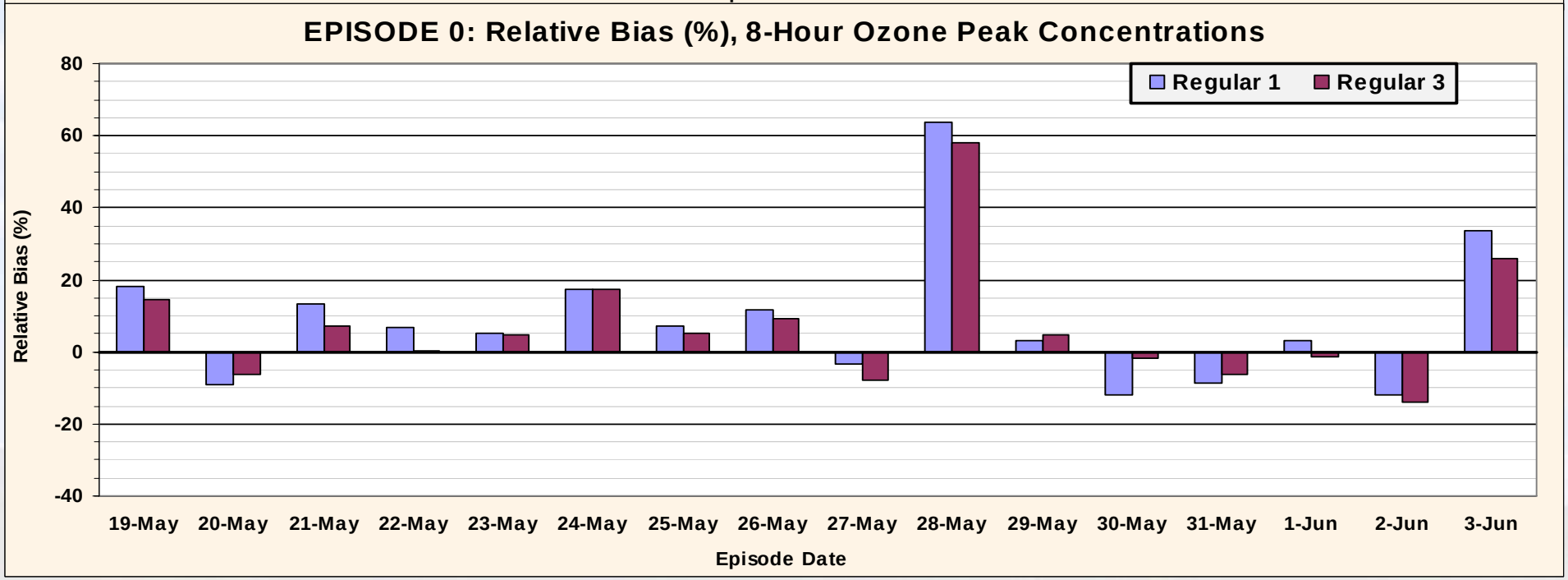
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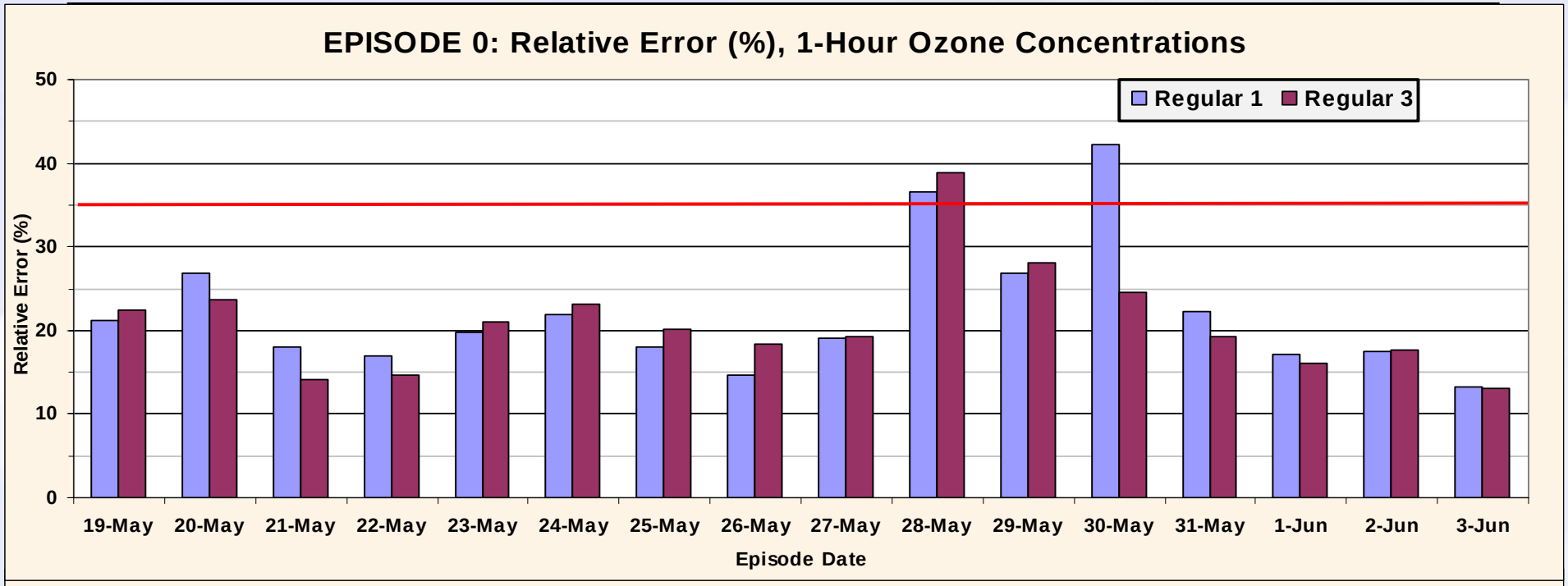
EPISODE 0: Relative Error (%), 1-Hour Ozone Concentrations
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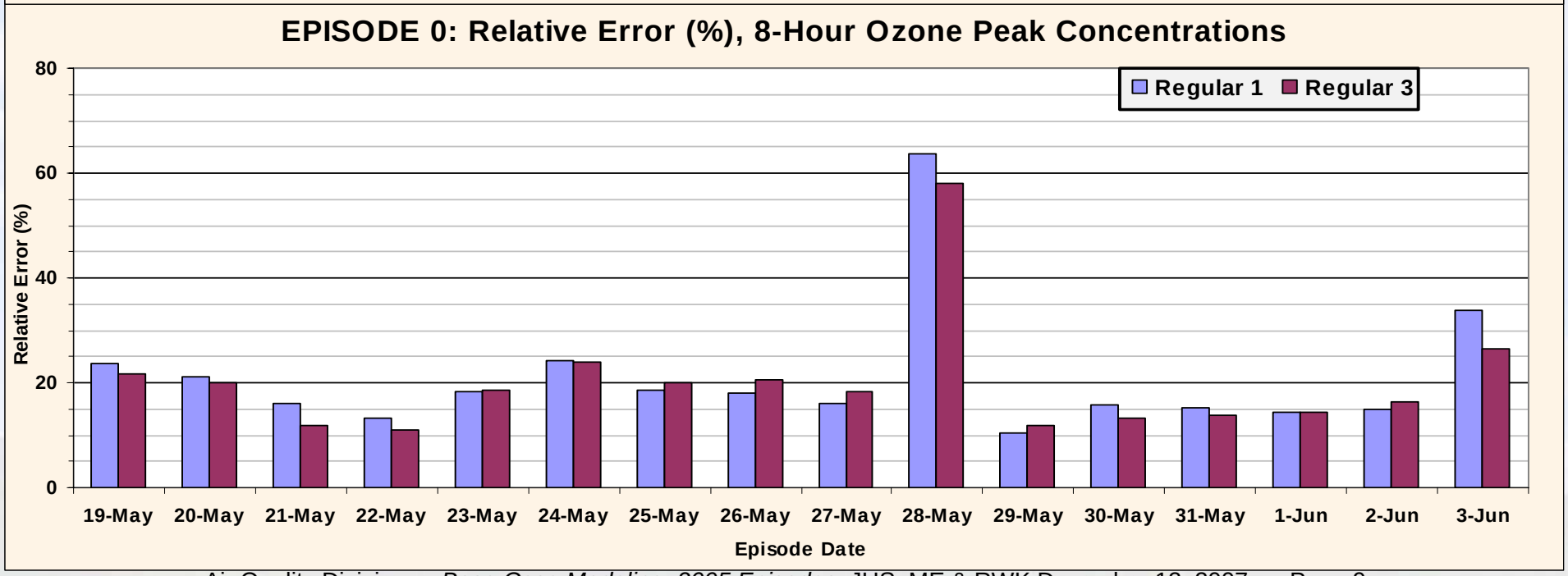
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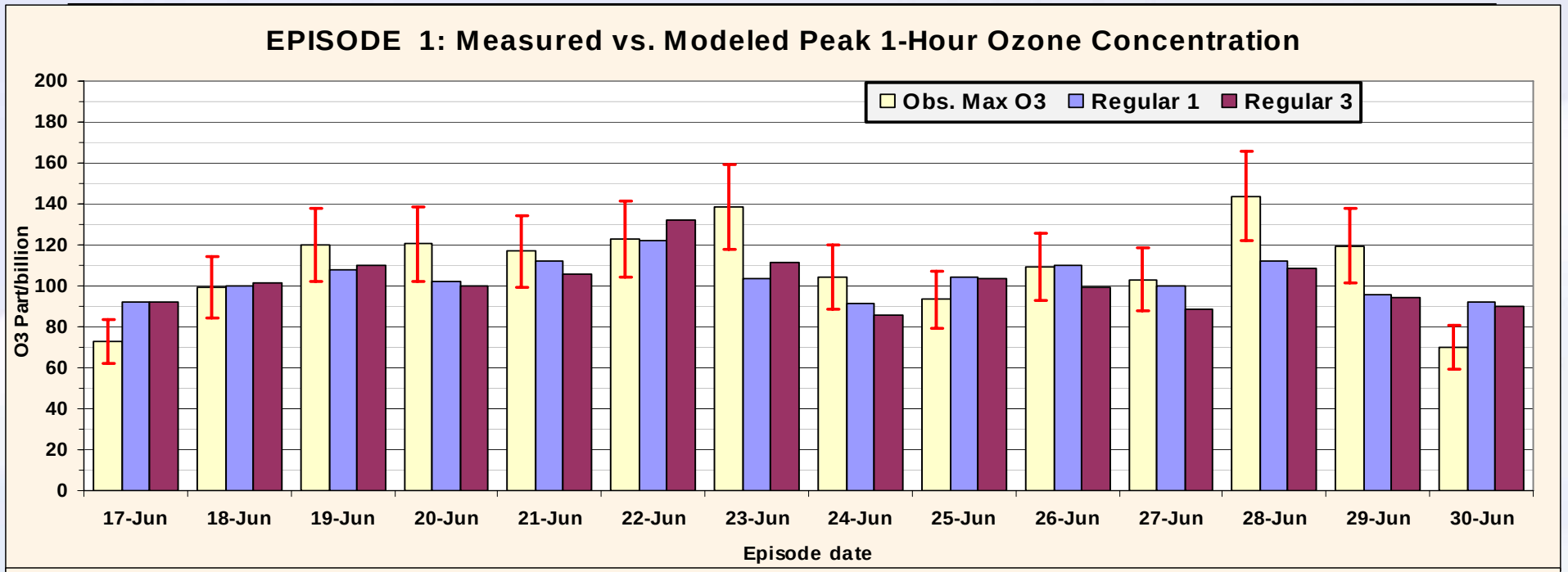
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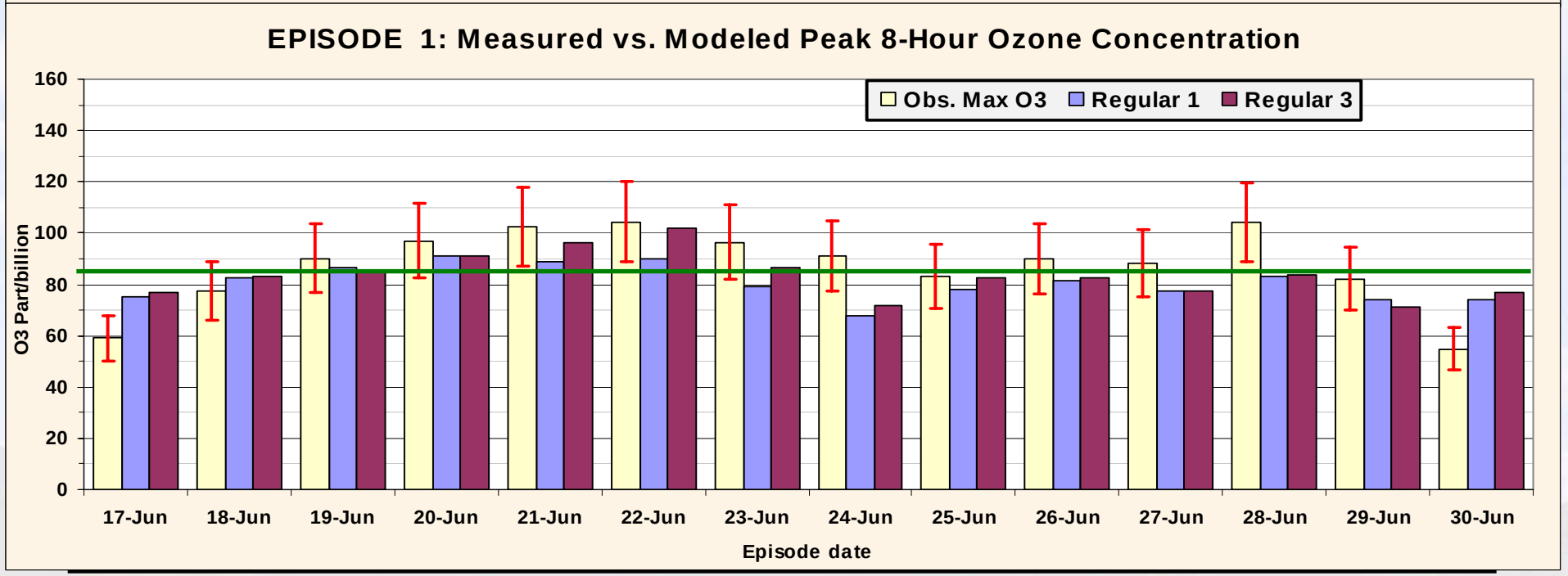
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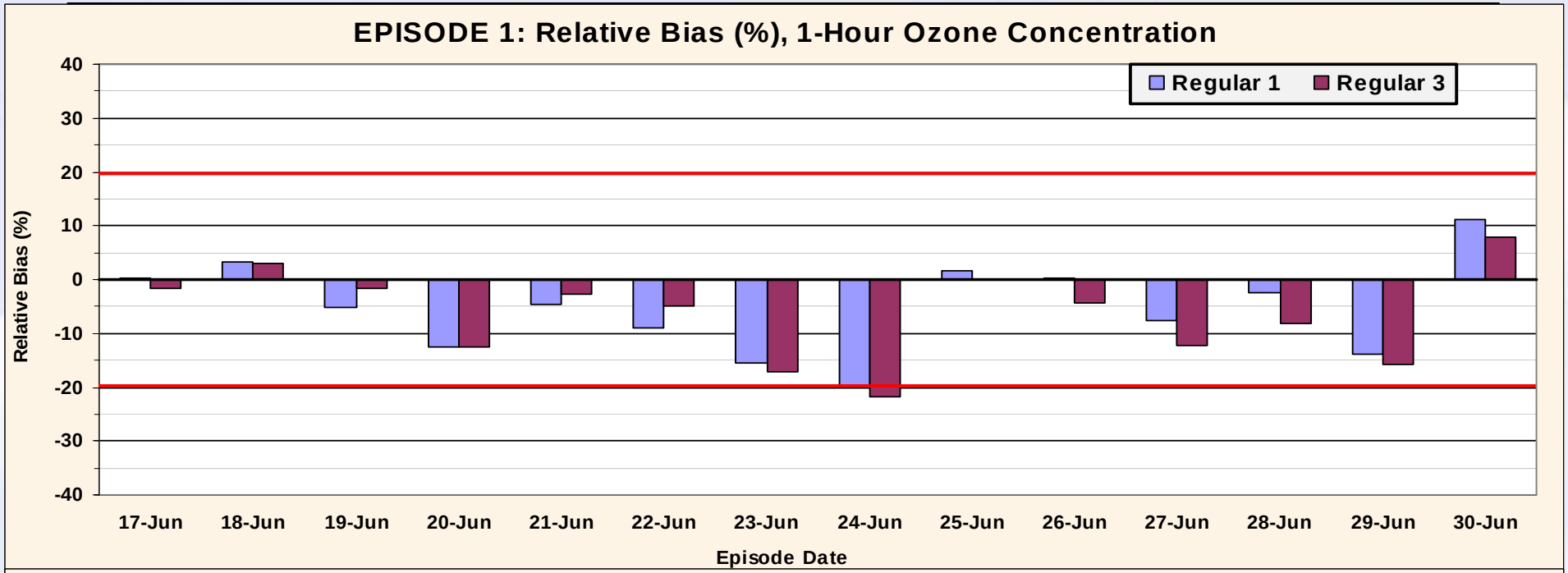
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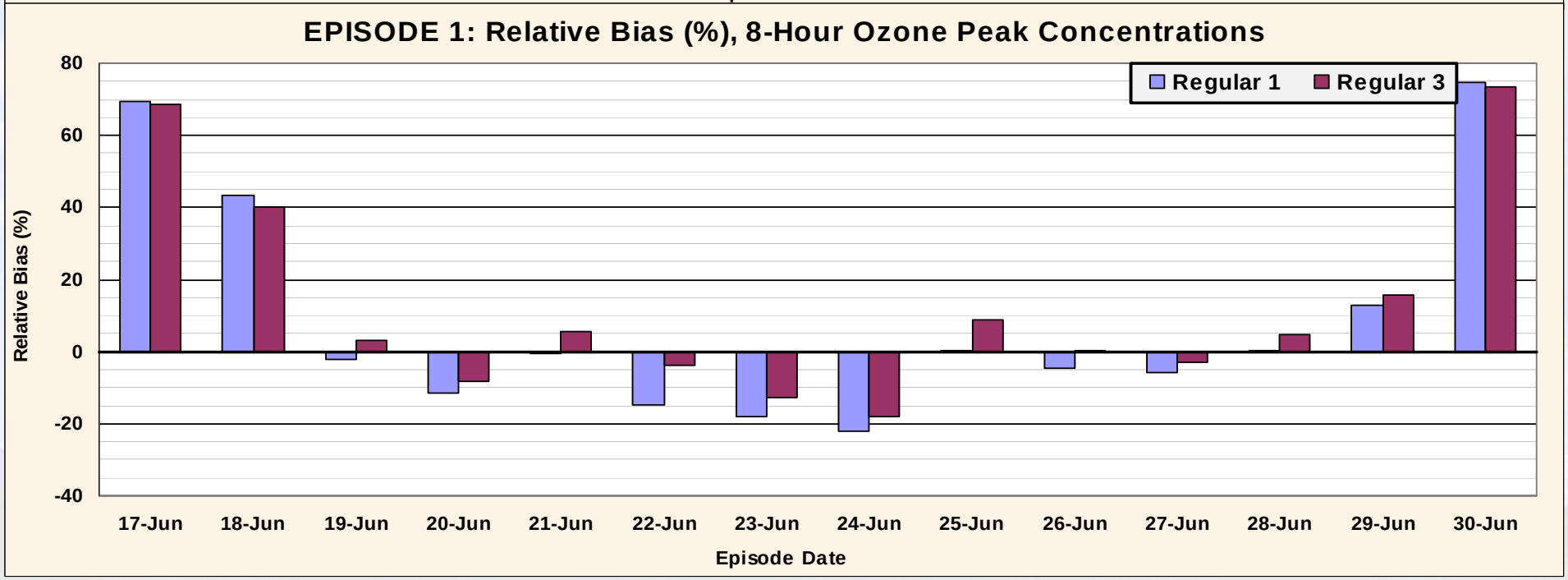
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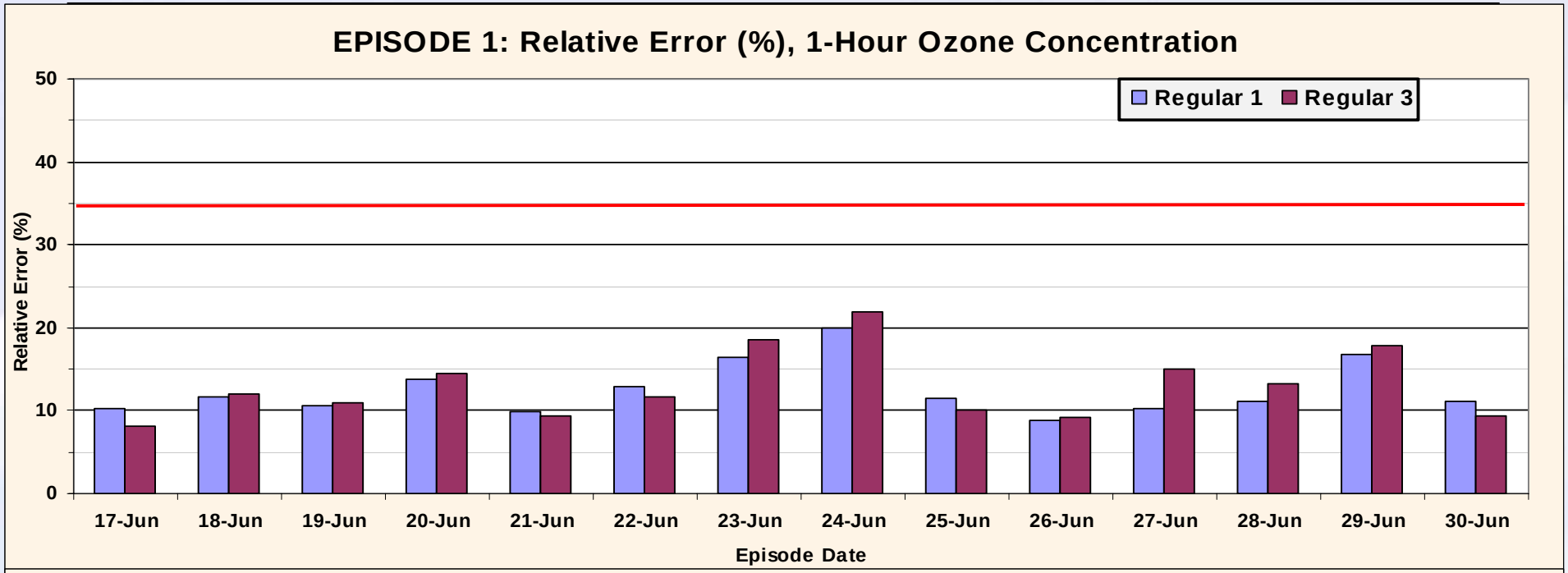
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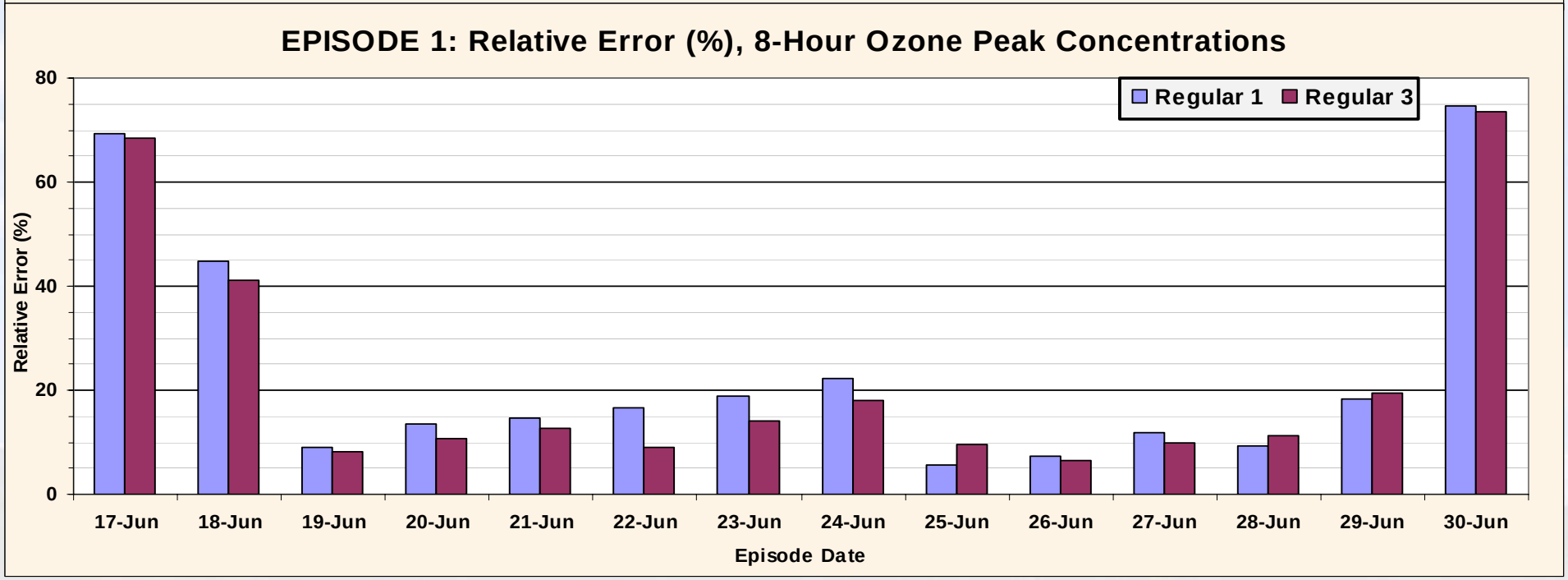
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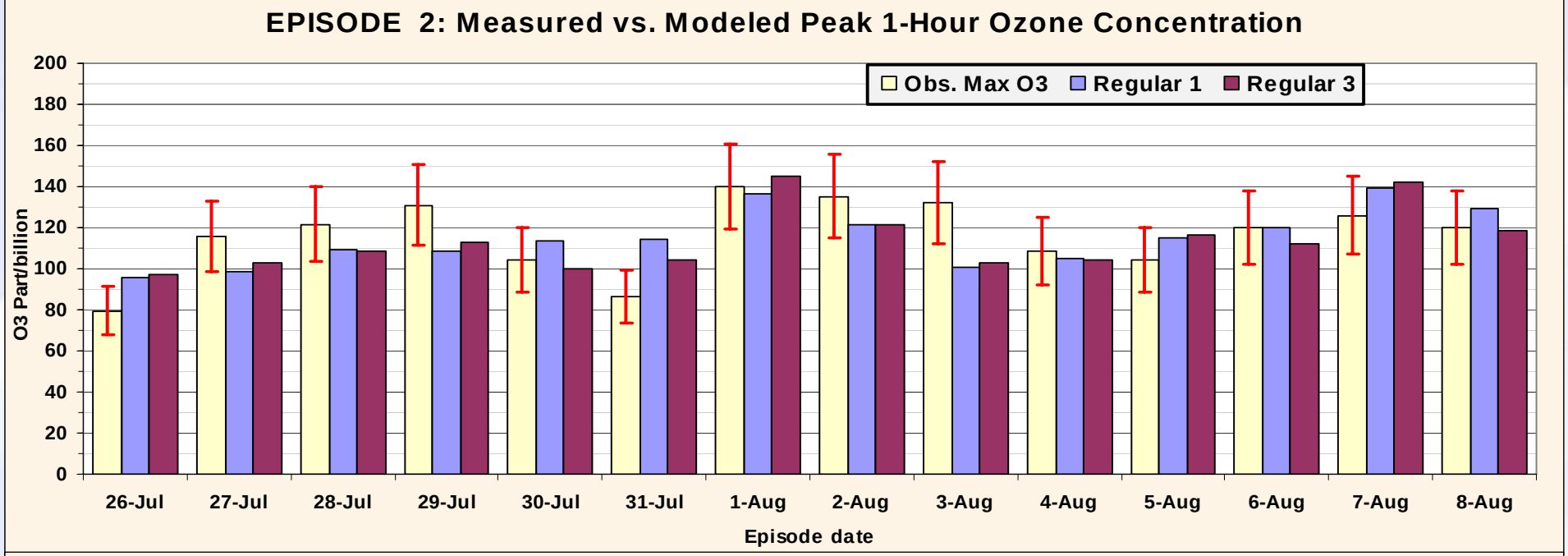
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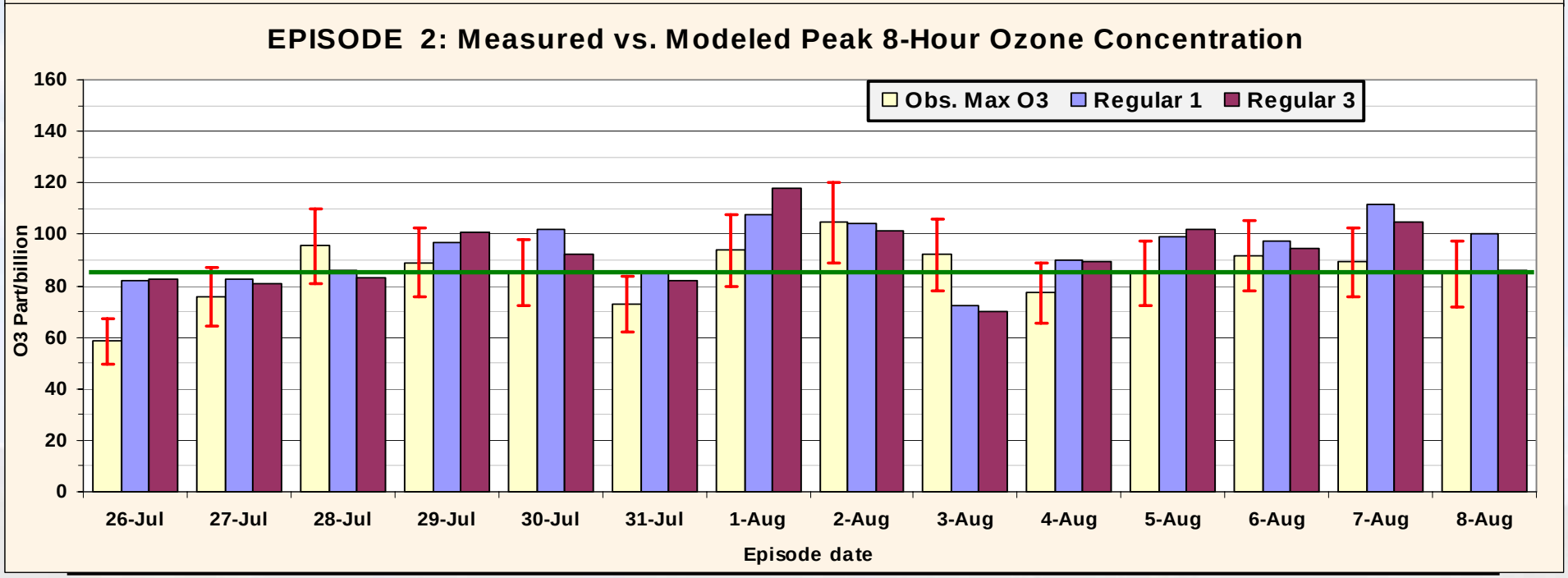
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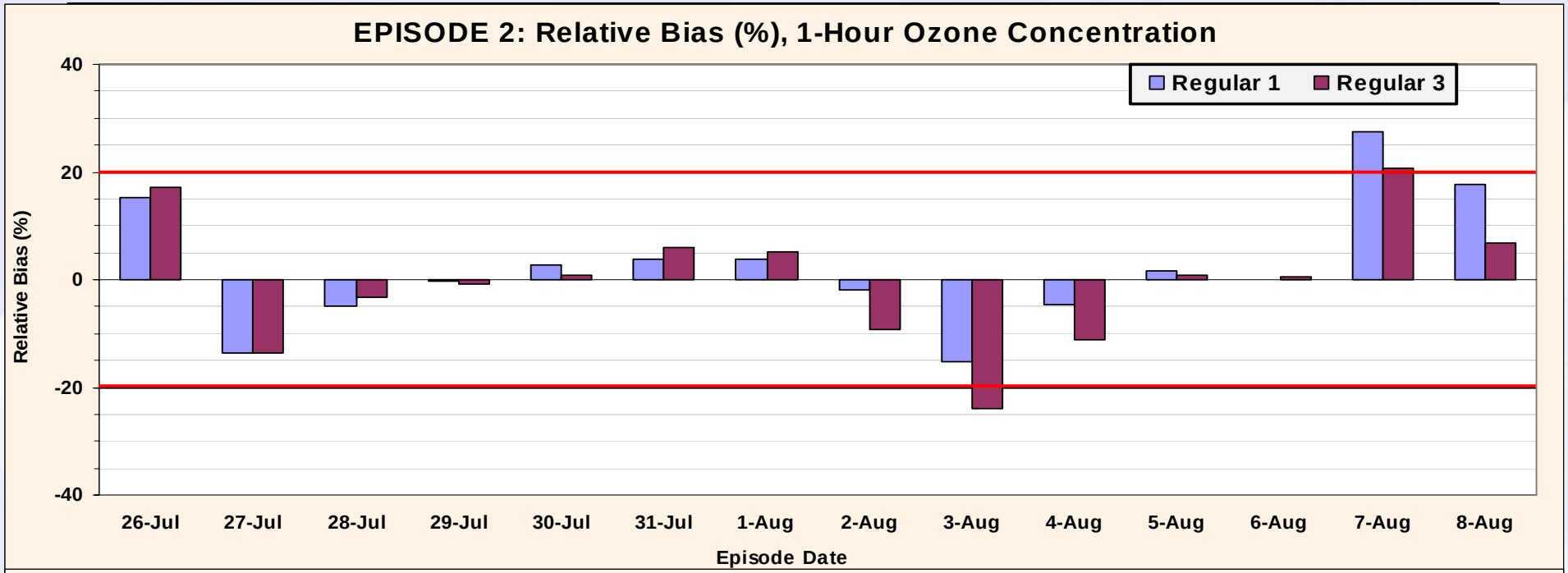
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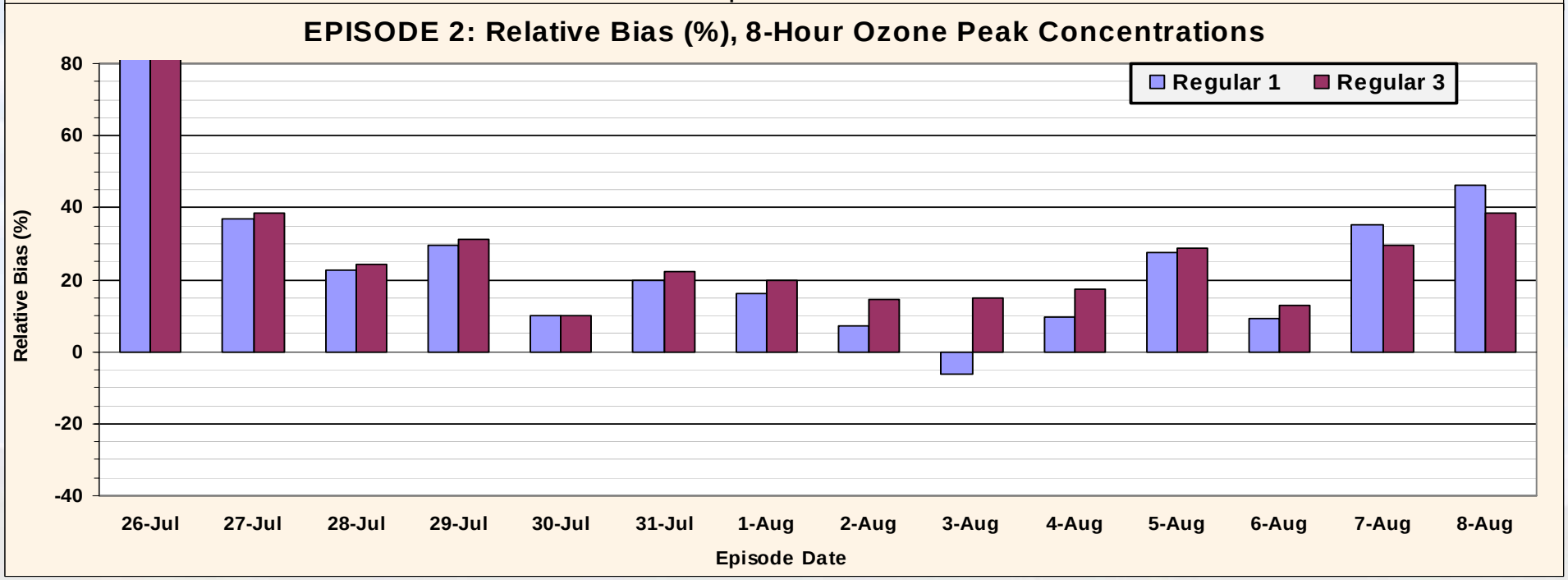
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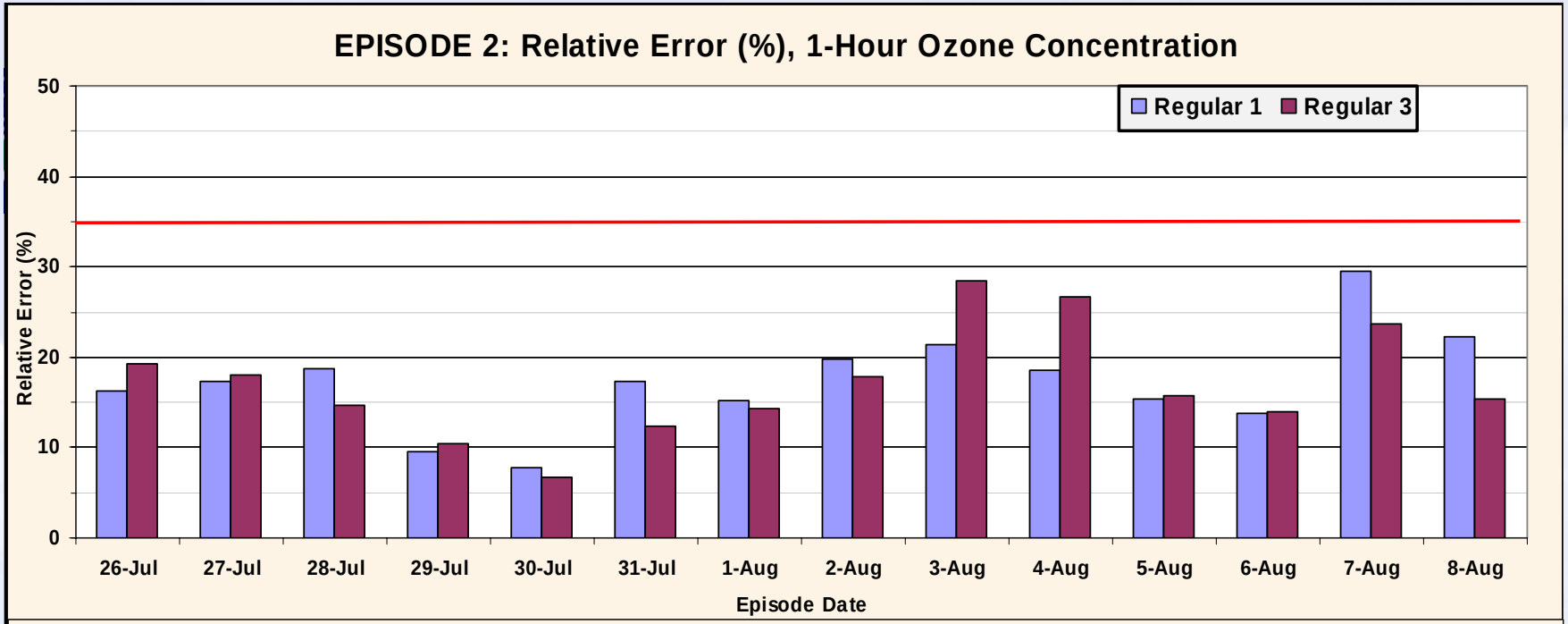
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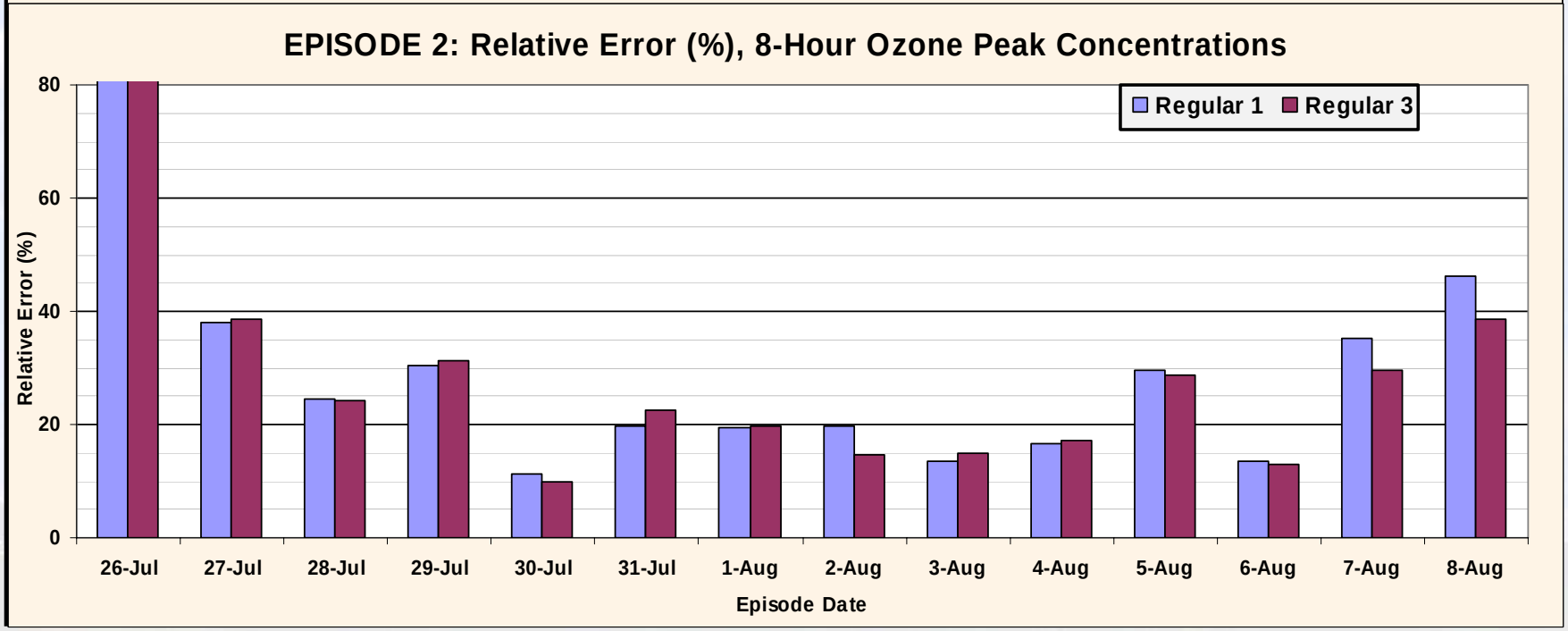
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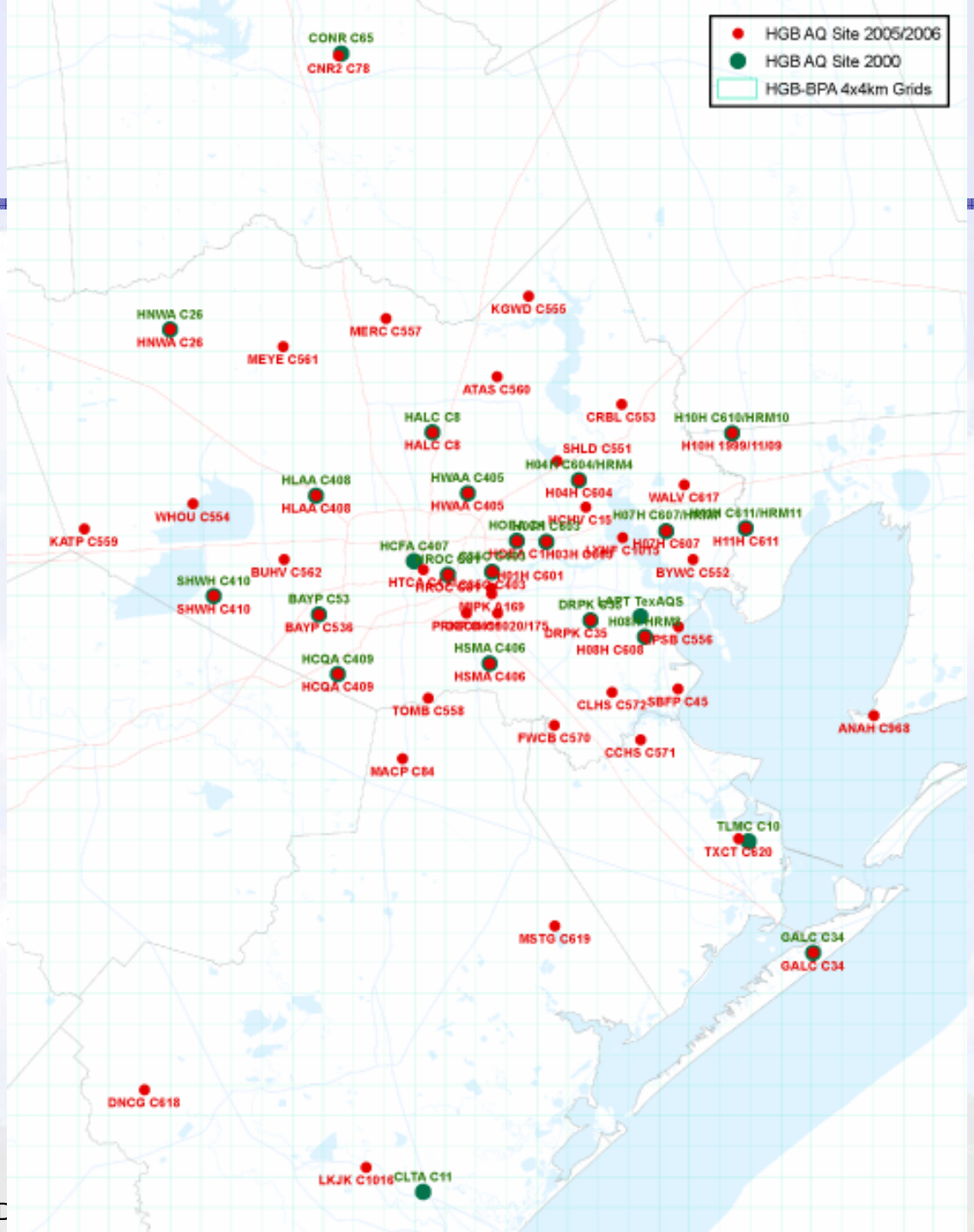
5-Aug
6-Aug
7-Aug
8-Aug
Episode Date

# Base Case Modeling: 2005 Episodes

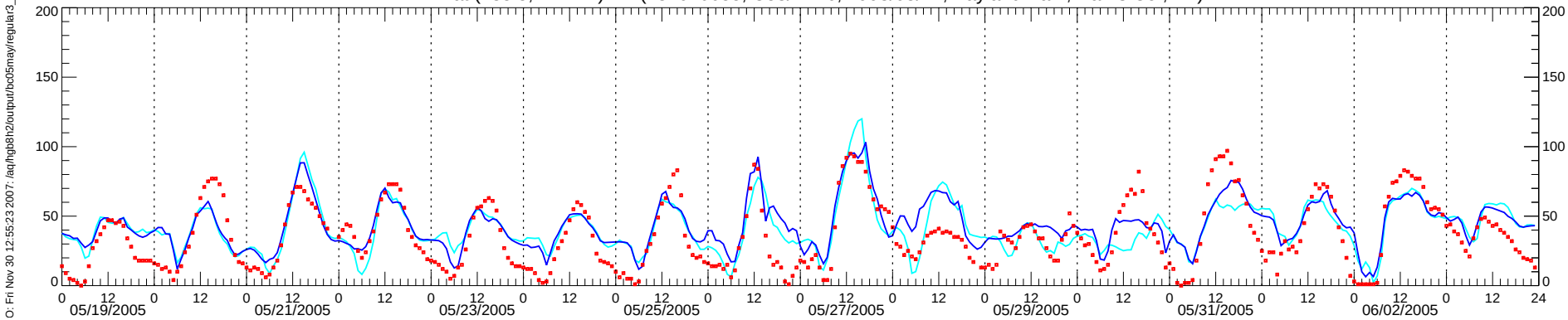
## Time Series of Measured vs Modeled 1-Hr Ozone & Ozone Precursors at Selected Sites


HGB AQ Site 2005/2006
HGB AQ Site 2000
HGB-BPA 4x4km Grids
CONR C65
CNR2 C78
HNWA C26
HNWA C26
MERC C557
MEYE C561
KGWD C555
ATAS C560
CRBL C553
H10H C610/HRM10
HALC C8
HALC C8
SHLD C551
HLAA C408
HLAA C408
HWAA C405
HWAA C405
H04H C604
WALV C617
WHOU C554
KATP C559
HCFA C407
H07H C607
H11H C611
BUHV C562
BYWC C552
SHWH C410
SHWH C410
BAYP C53
BAYP C536
DRPK C35
LAPT TexAQS
PSB C556
H08H C608
HSMA C406
HSMA C406
HCQA C409
HCQA C409
TOMB C558
CLHS C572
SBFP C45
ANAH C968
FWCB C570
CCHS C571
MACP C84
TLMC C10
TXCT C620
MSTG C619
GALC C34
GALC C34
DNCG C618
LKJK C1016
CLTA C11

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

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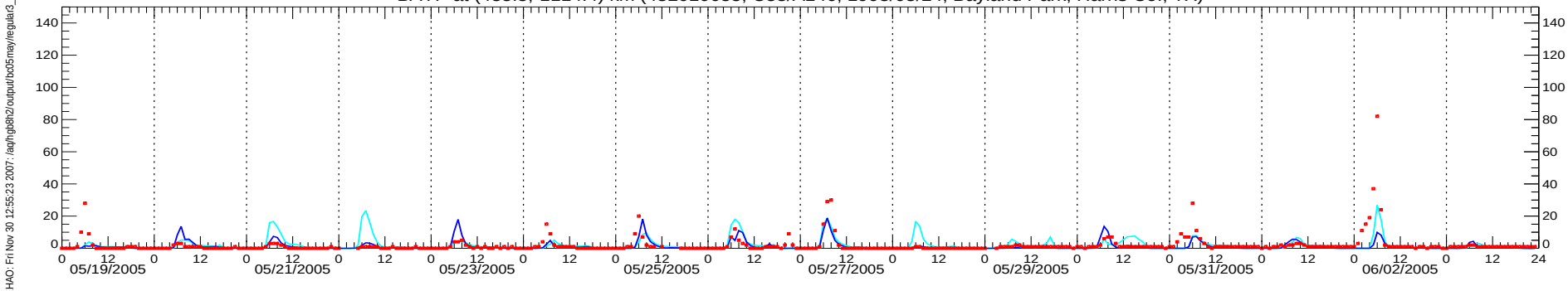


# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

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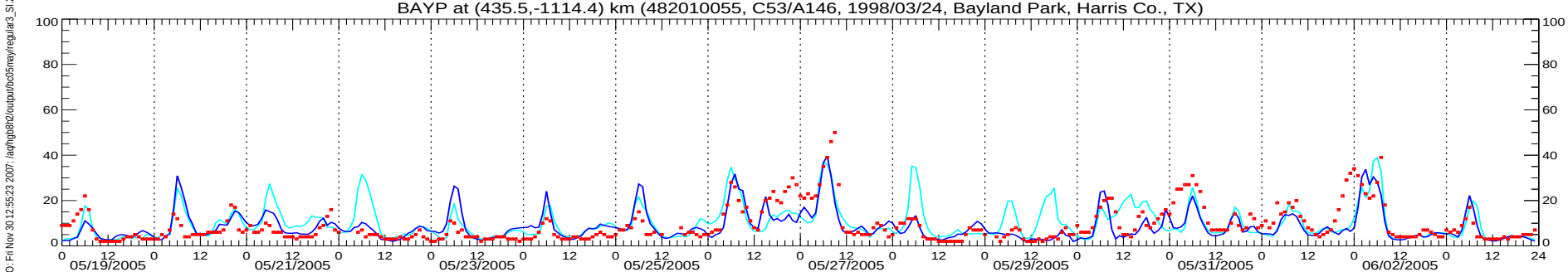


camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

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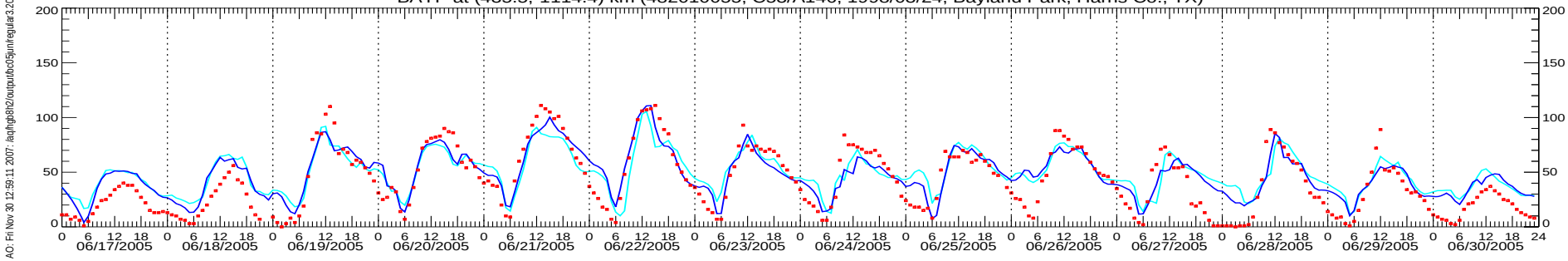


# Hourly Average NO Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

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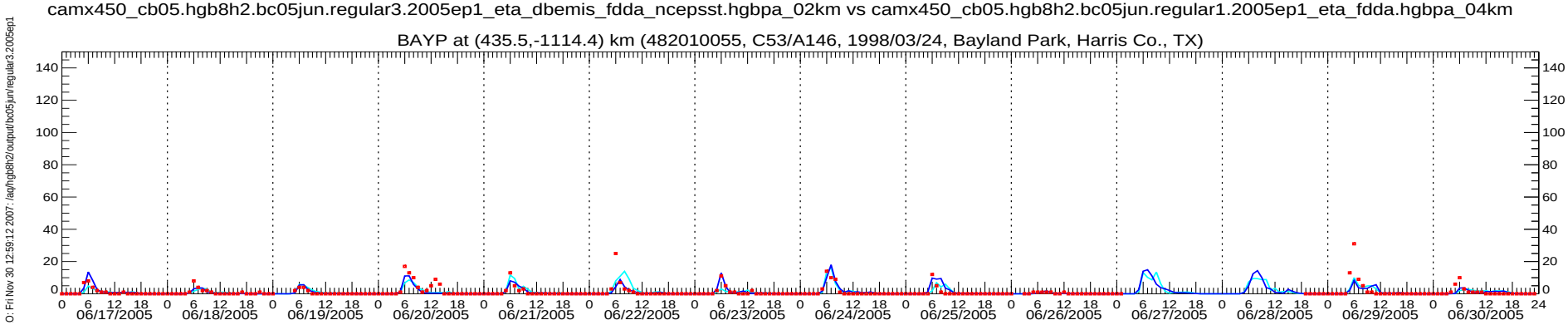


# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

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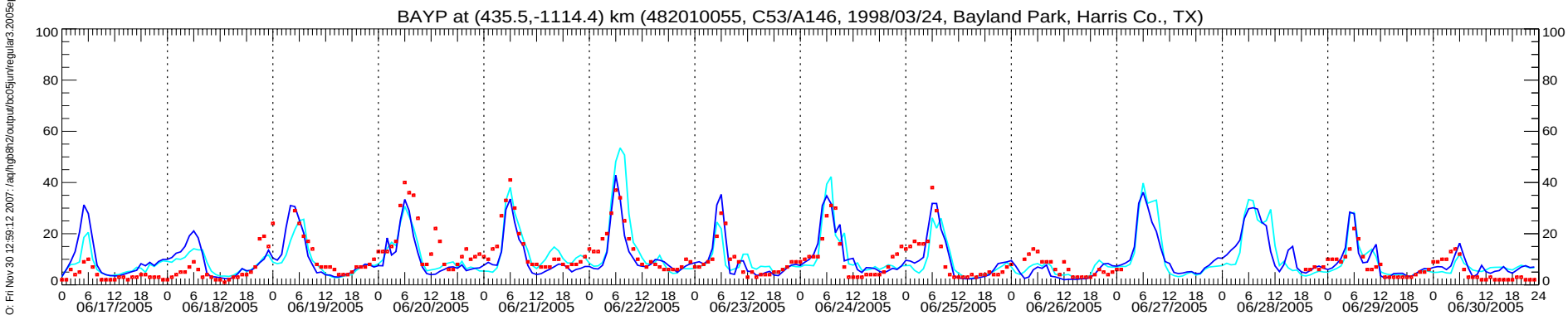



camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

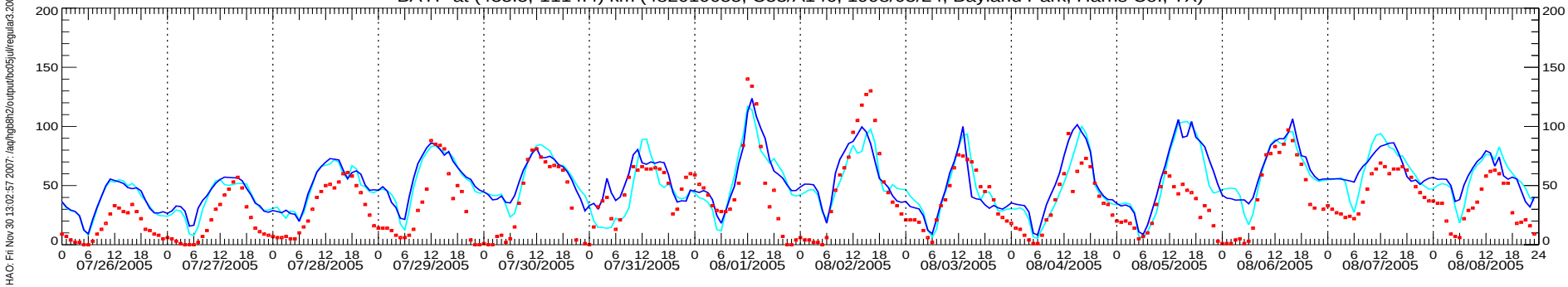
camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

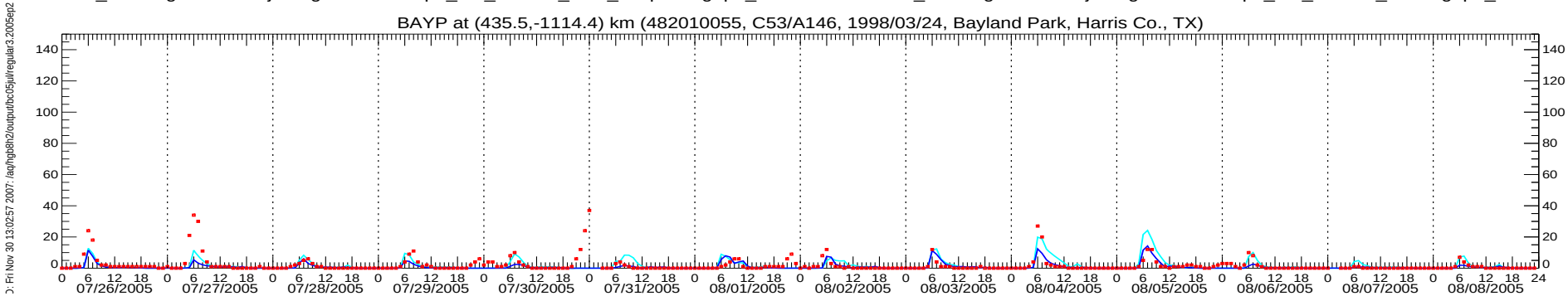
BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

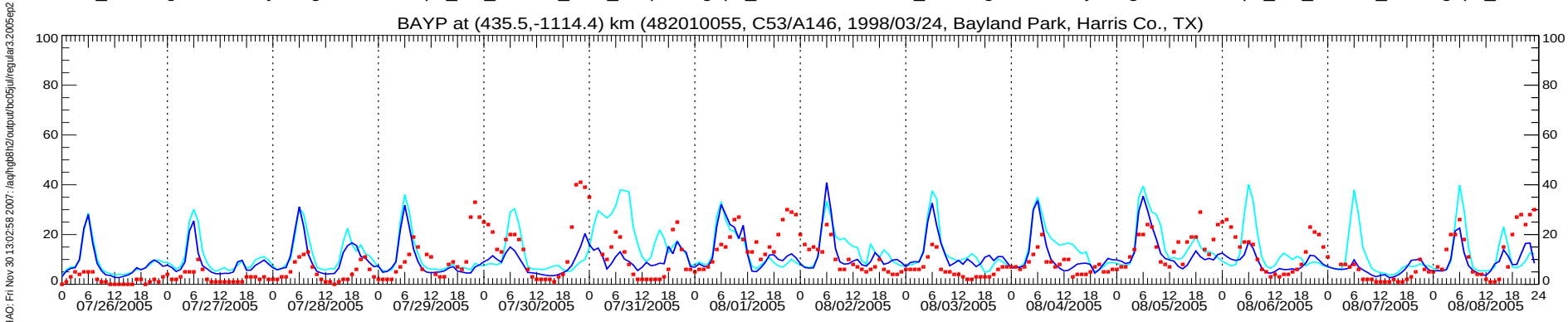
BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

BAYP at (435.5,-1114.4) km (482010055, C53/A146, 1998/03/24, Bayland Park, Harris Co., TX)




camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

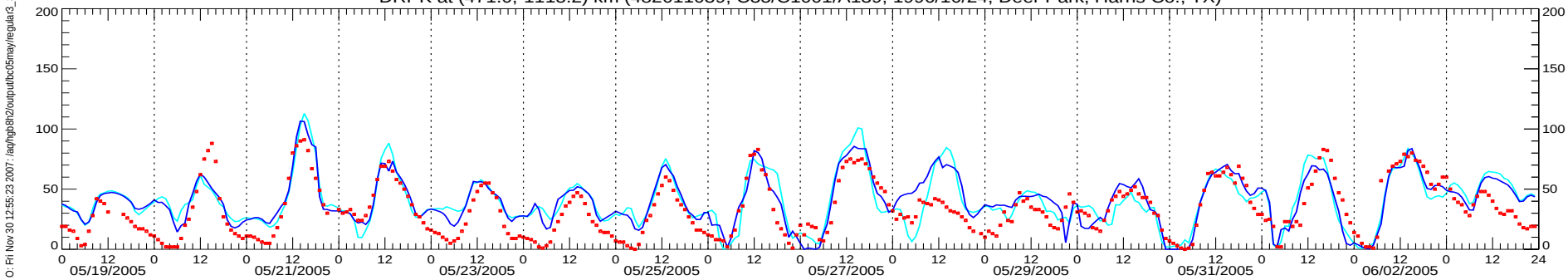
camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

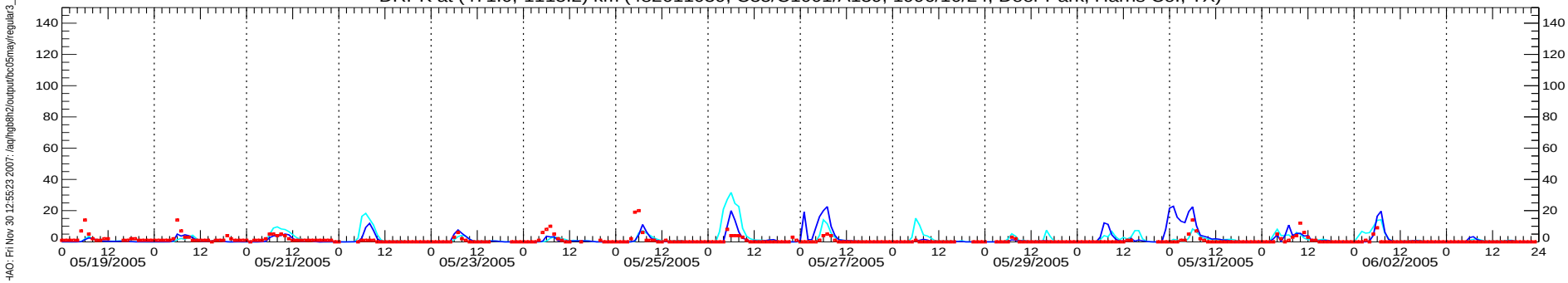
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

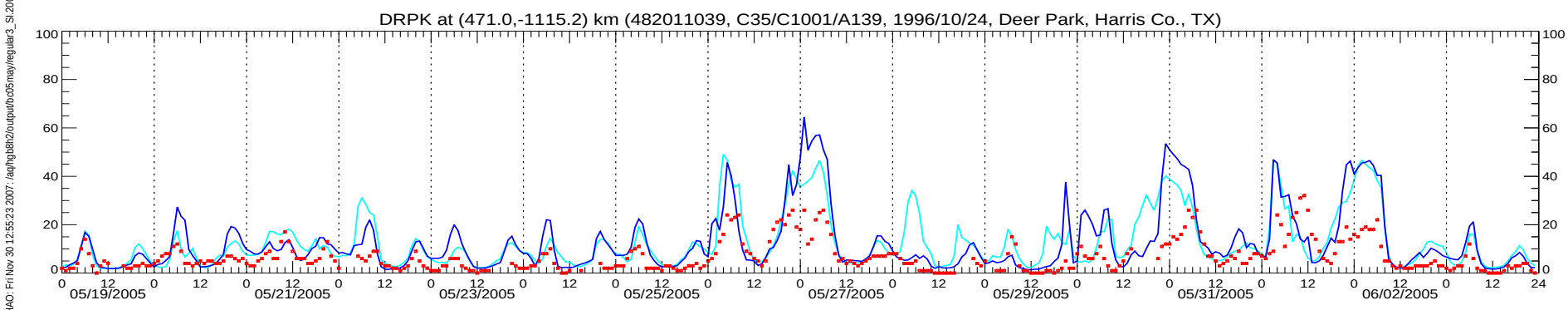
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

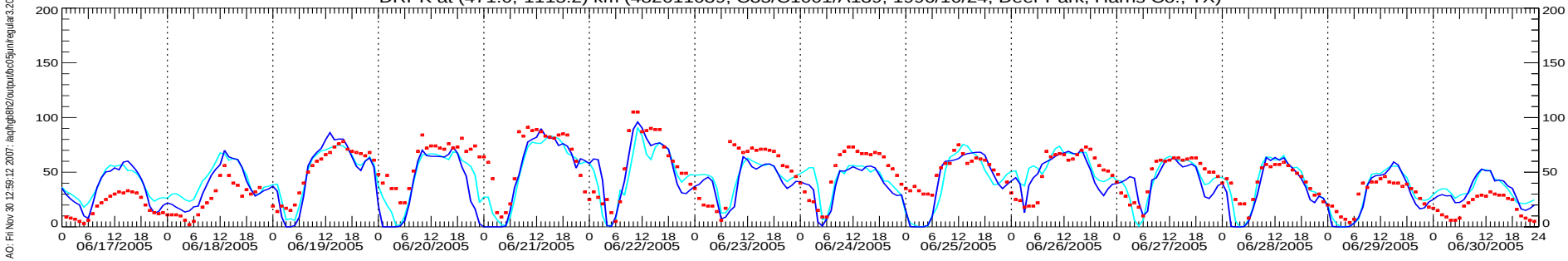
camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

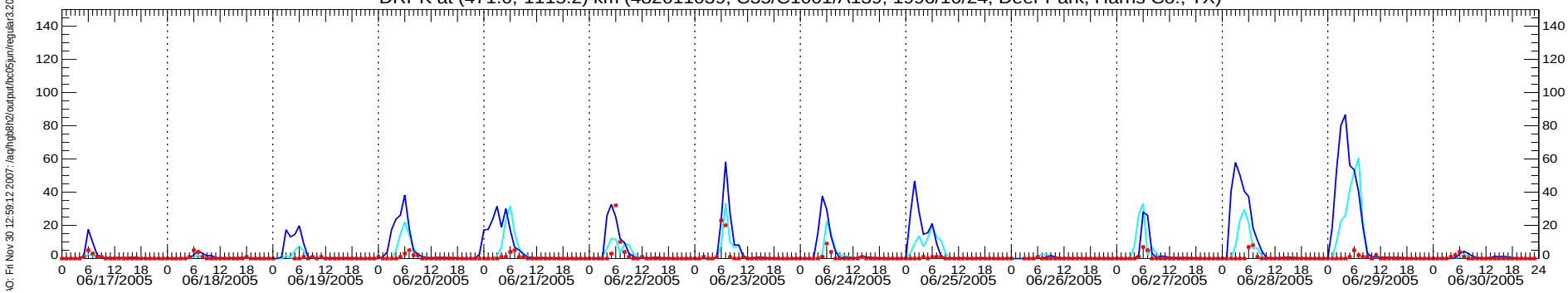
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

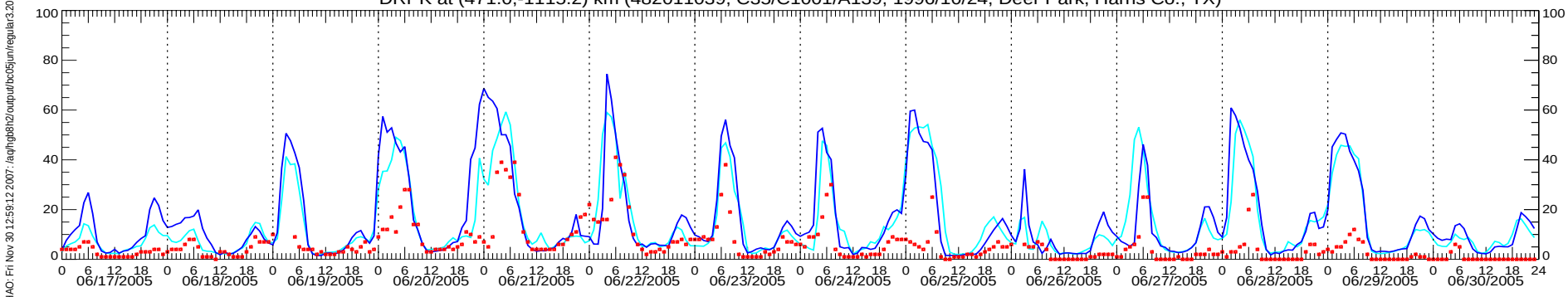
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

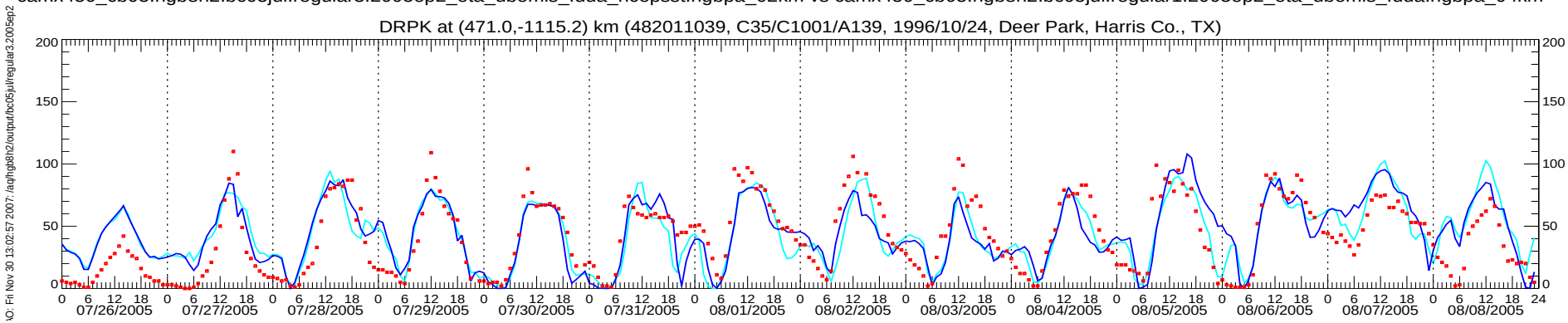
camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

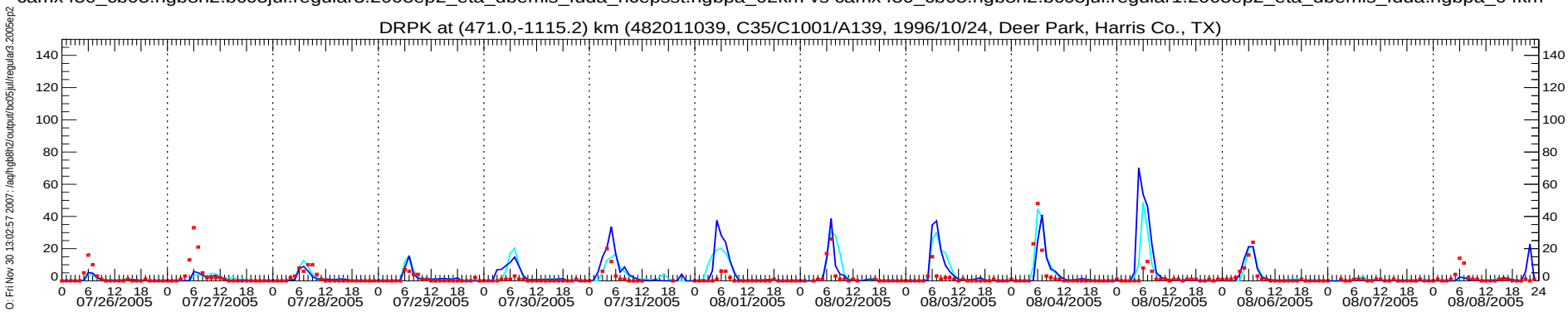
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

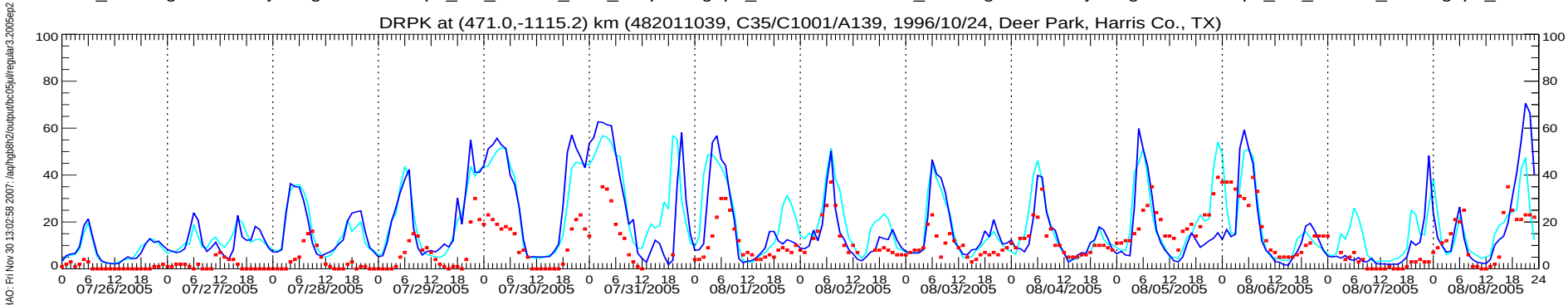
DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

DRPK at (471.0,-1115.2) km (482011039, C35/C1001/A139, 1996/10/24, Deer Park, Harris Co., TX)




camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

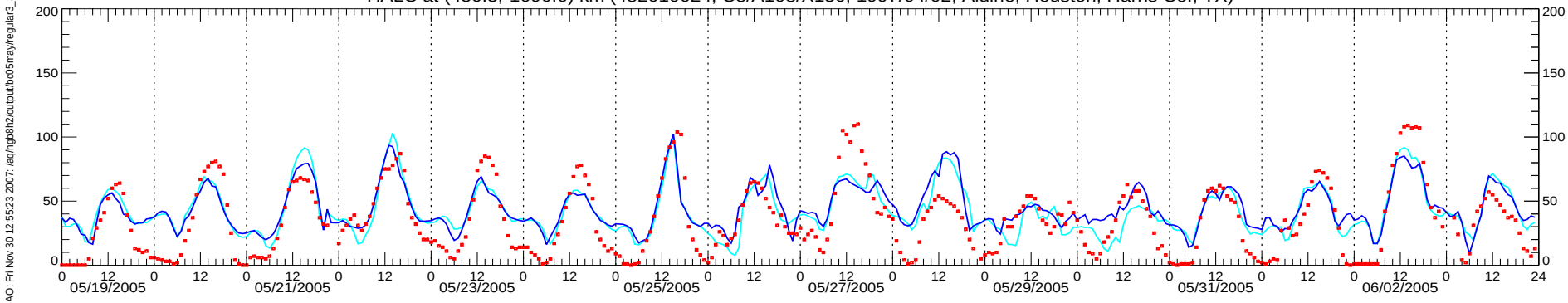
camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

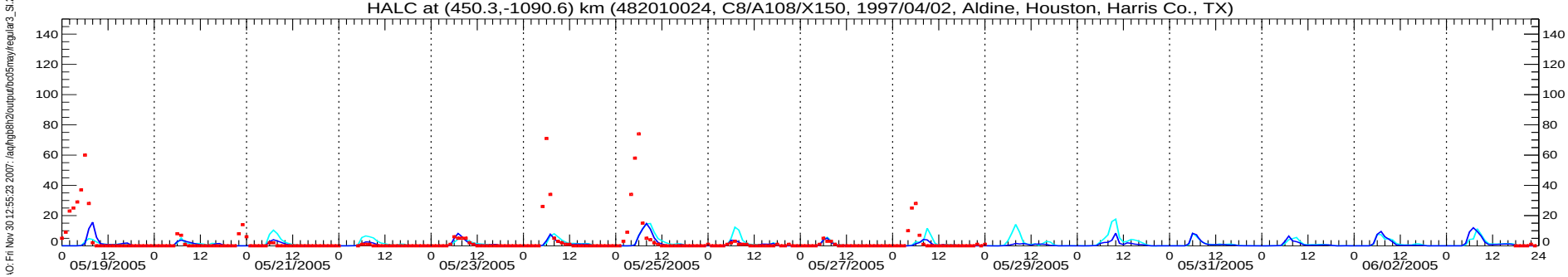
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

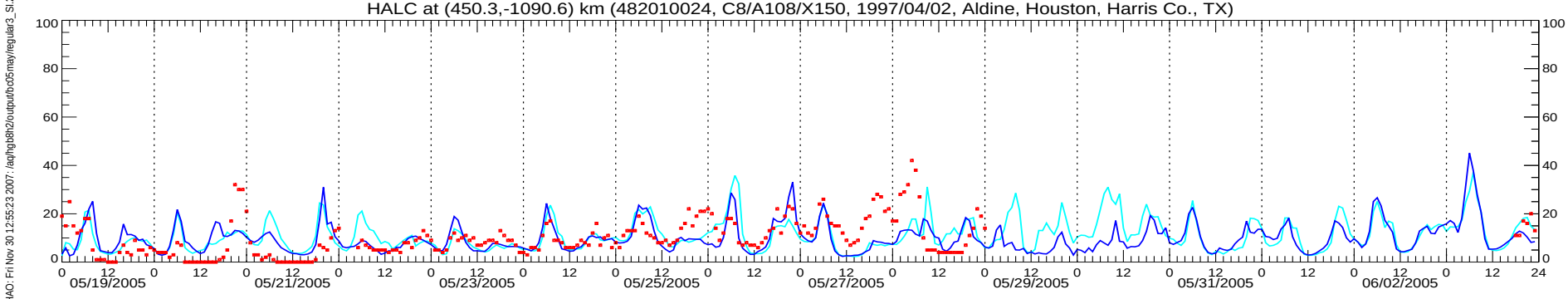
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (05/19/2005-06/03/2005)

camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




camx450_cb05.hgb8h2.bc05may.regular1_SI.2005ep0_eta_fdda.hgbpa_04km

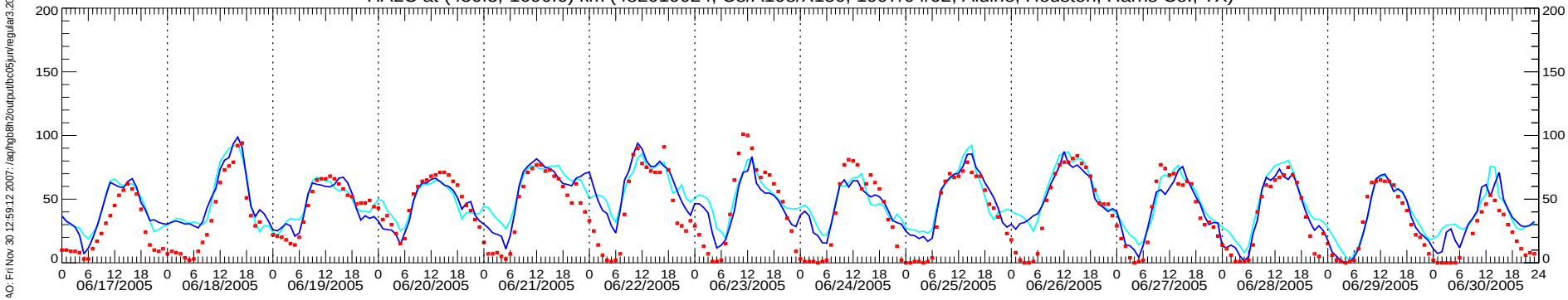
camx450_cb05.hgb8h2.bc05may.regular3_SI.2005ep0_eta_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

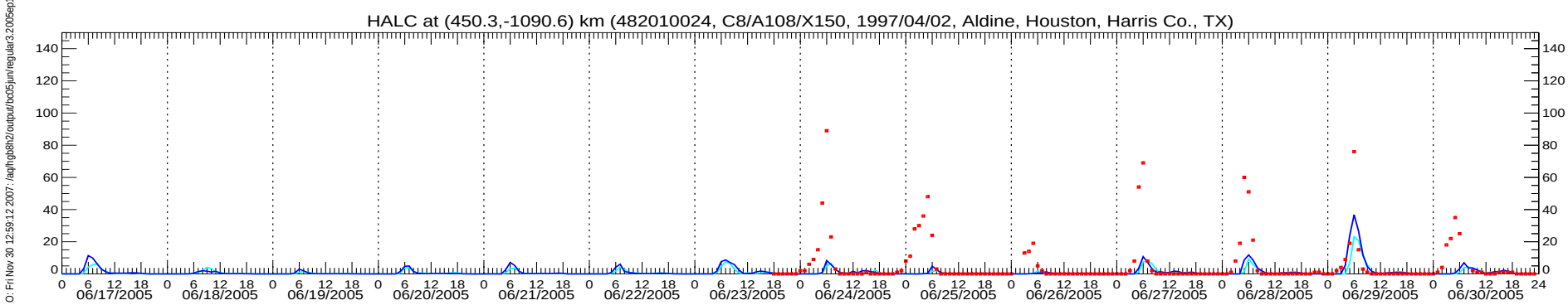
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

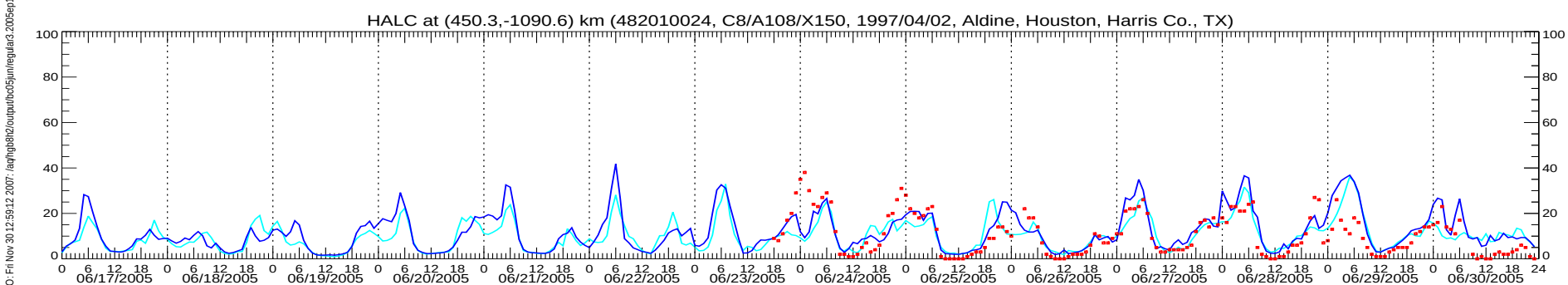
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (06/17/2005-06/30/2005)

camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




camx450_cb05.hgb8h2.bc05jun.regular1.2005ep1_eta_fdda.hgbpa_04km

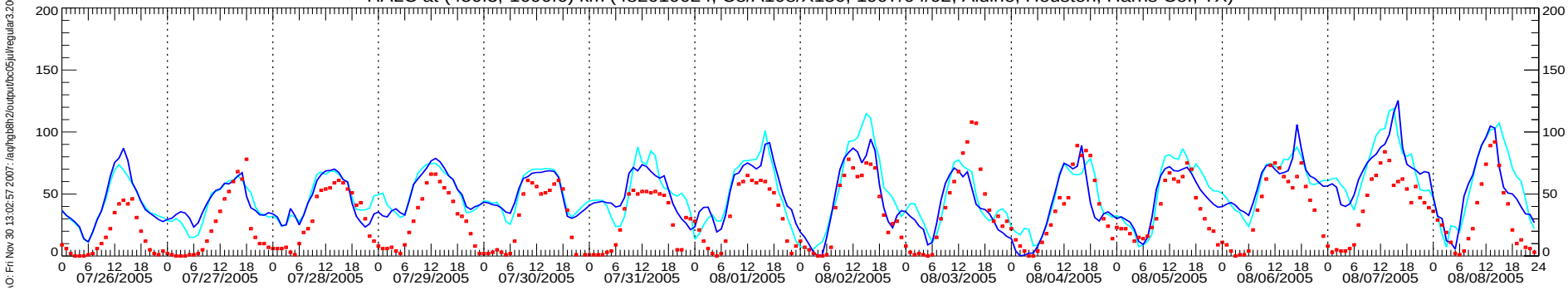
camx450_cb05.hgb8h2.bc05jun.regular3.2005ep1_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

# Hourly Average $O_3$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

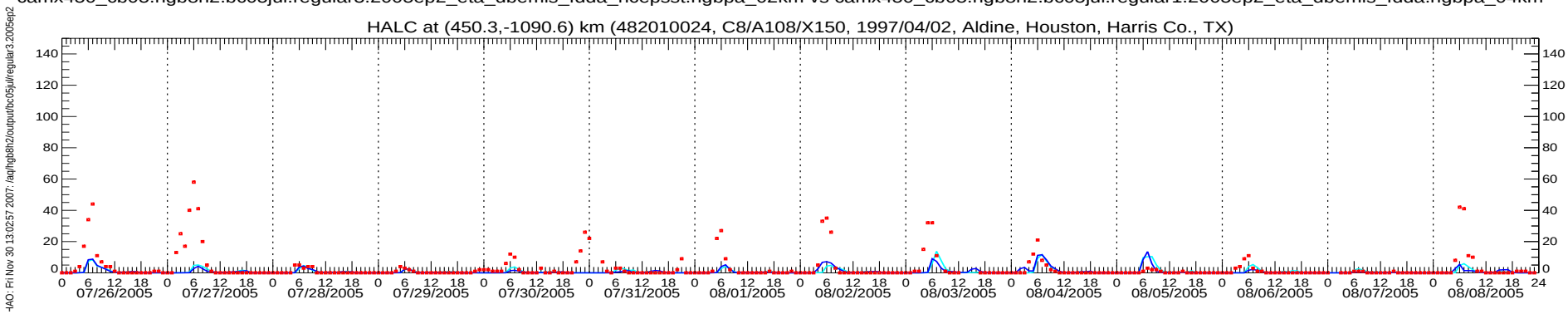
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average NO Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

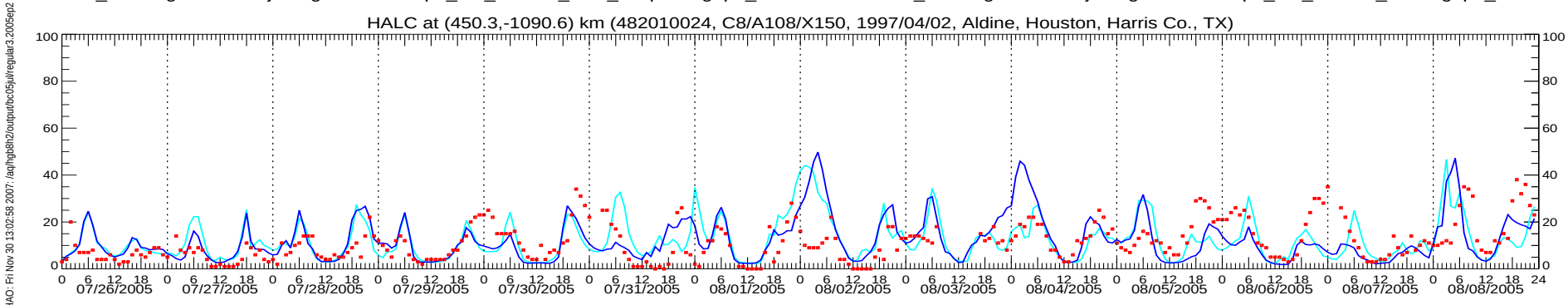
HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




# Hourly Average $NO_2$ Concentration (ppb) at Layer 1 (07/26/2005-08/08/2005)

camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km vs camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

HALC at (450.3,-1090.6) km (482010024, C8/A108/X150, 1997/04/02, Aldine, Houston, Harris Co., TX)




camx450_cb05.hgb8h2.bc05jul.regular1.2005ep2_eta_dbemis_fdda.hgbpa_04km

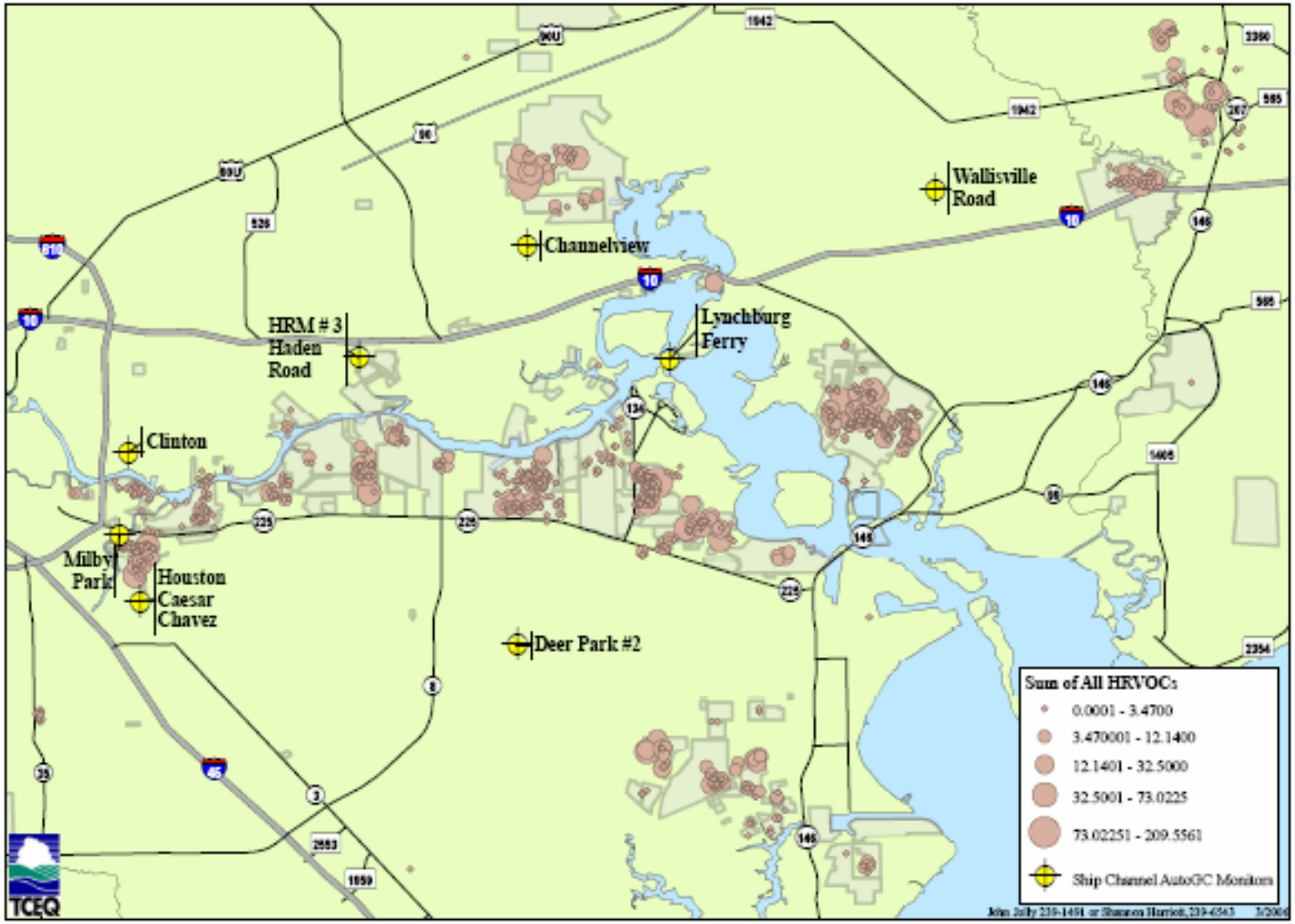
camx450_cb05.hgb8h2.bc05jul.regular3.2005ep2_eta_dbemis_fdda_ncepsst.hgbpa_02km

Observed

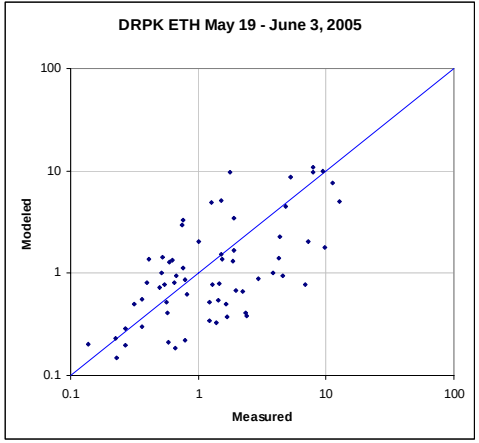
# Base Case Modeling: 2005 Episodes

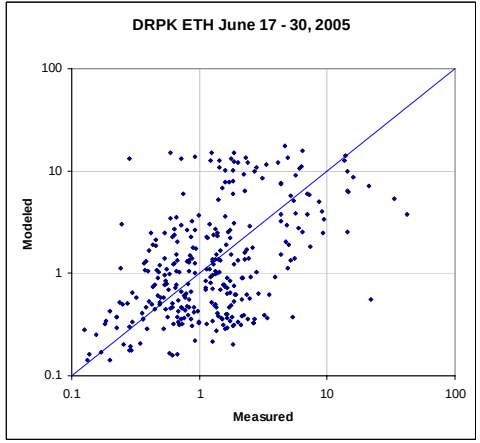
Scatter-Plots of Hourly Measured versus Modeled HRVOCs, i.e., Ethene (ETH), Terminal Olefins (OLE) & Internal Olefins (IOLE) at Selected Sites

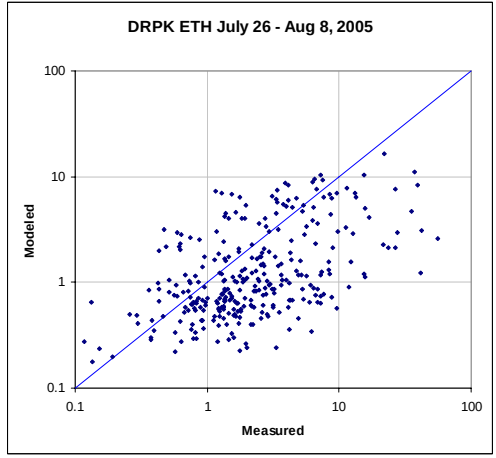
# Houston Ship Channel Auto-GC Monitors and HRVOC Point Sources

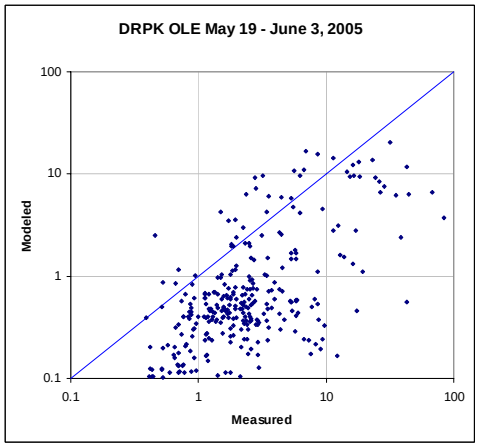


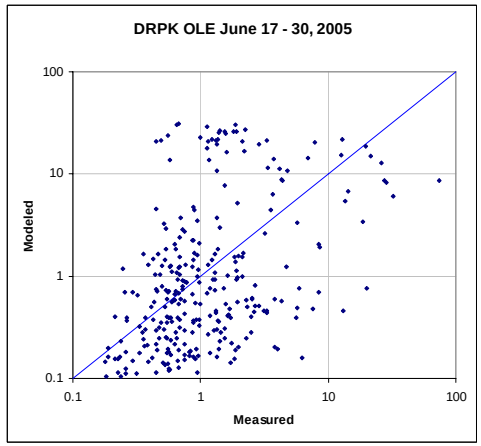
# Deer Park (DRPK) Measured vs Modeled CB05-HRVOCs (ETH, OLE & IOLE)

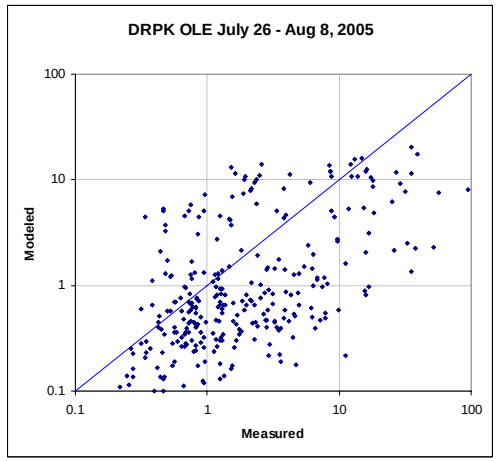


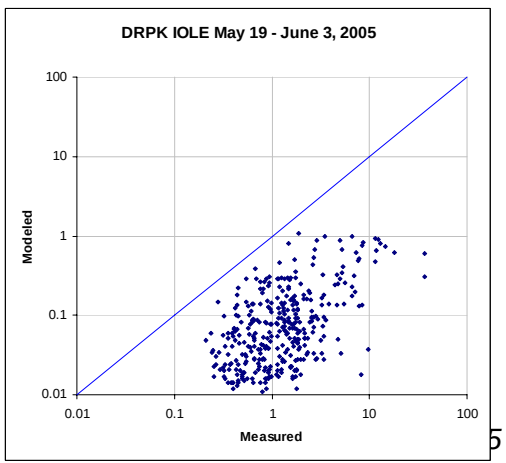



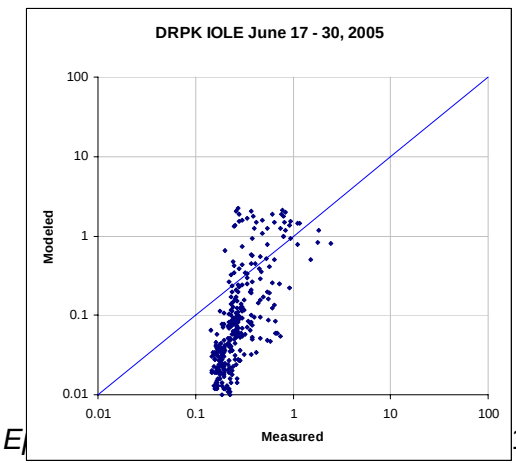



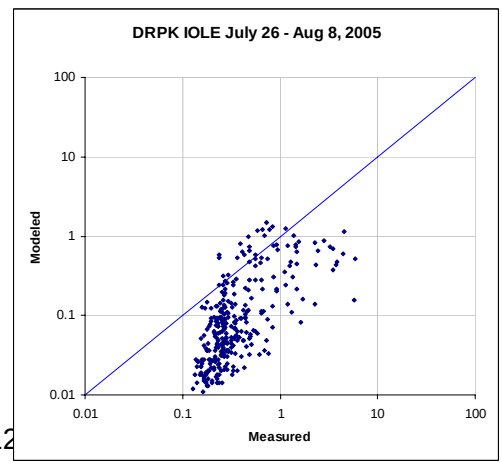



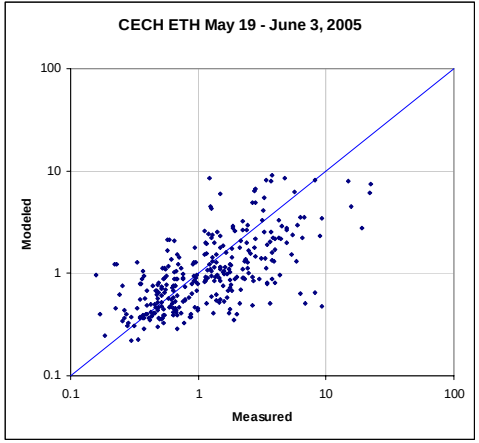



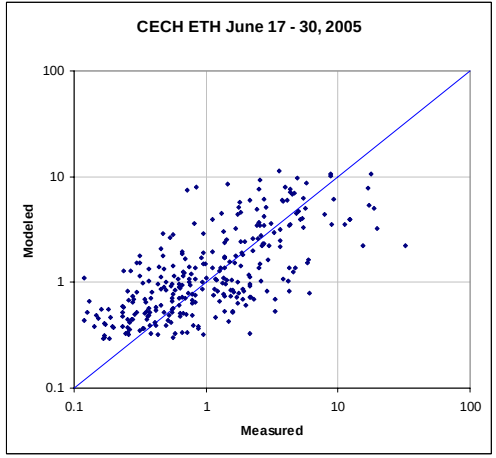



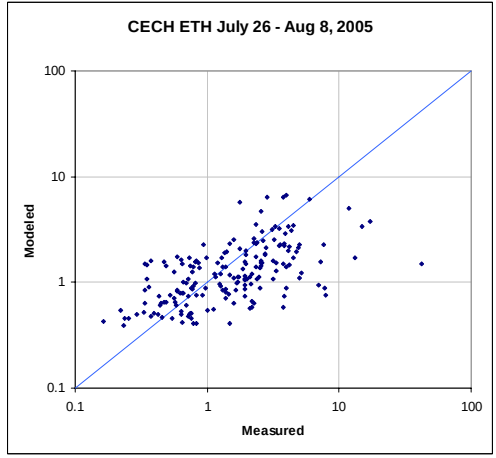



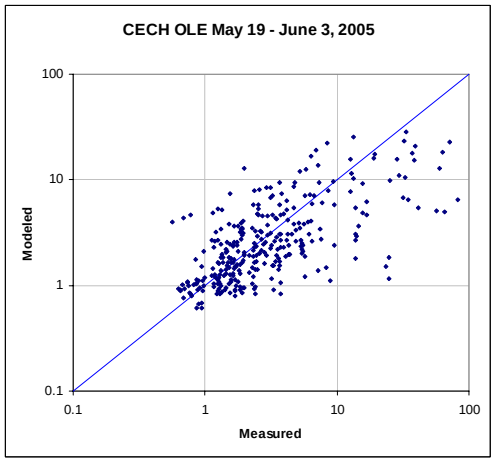



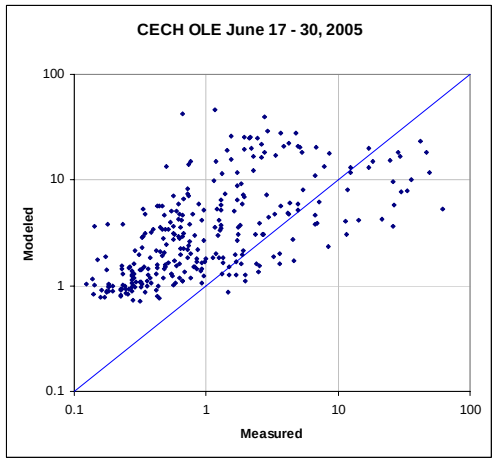
# Cesar Chavez (CECH) Measured vs Modeled CB05-HRVOCs (ETH, OLE & IOLE)

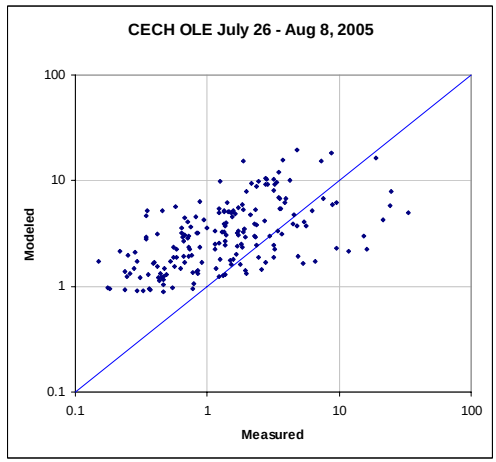


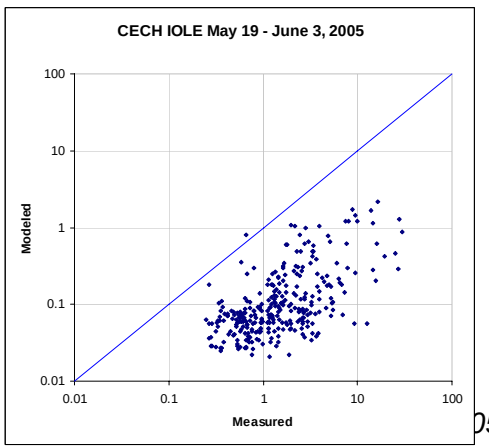



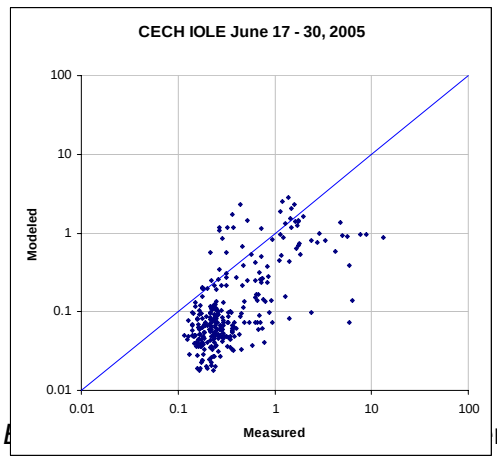



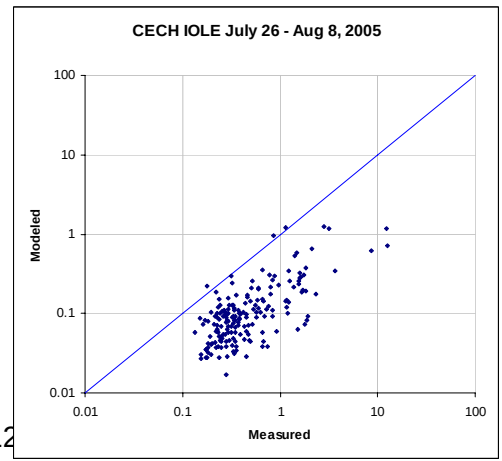



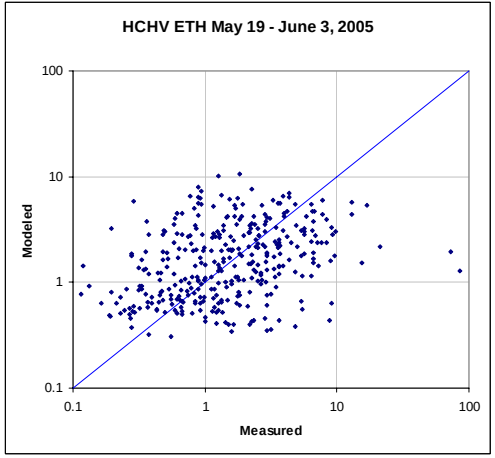



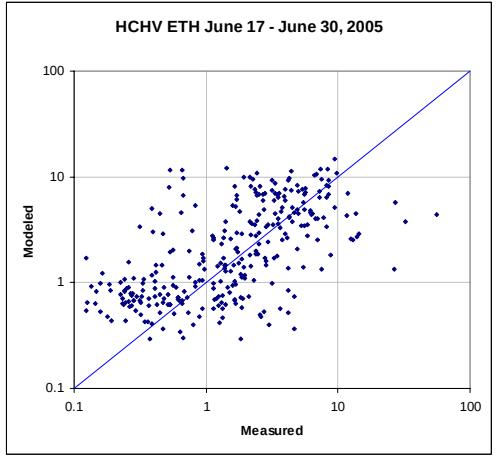



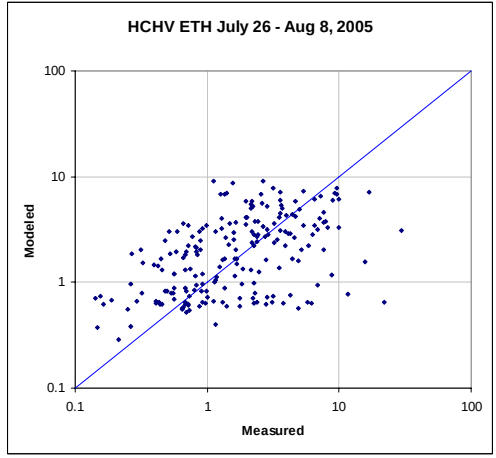



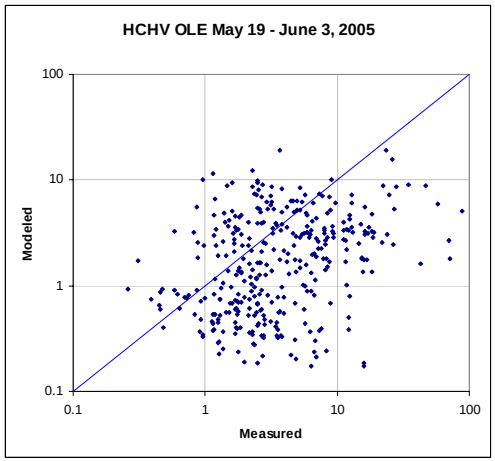



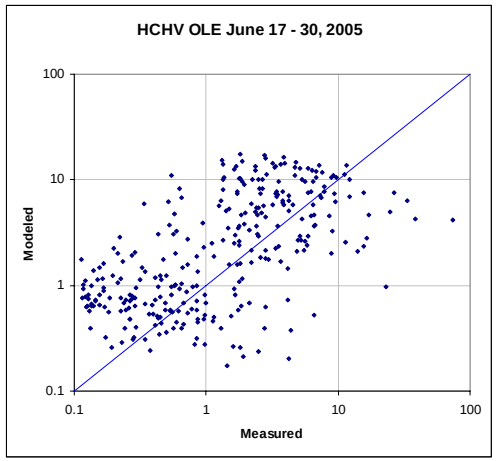
# Channelview (HCHV) Measured vs Modeled CB05-HRVOCs (ETH, OLE & IOLE)

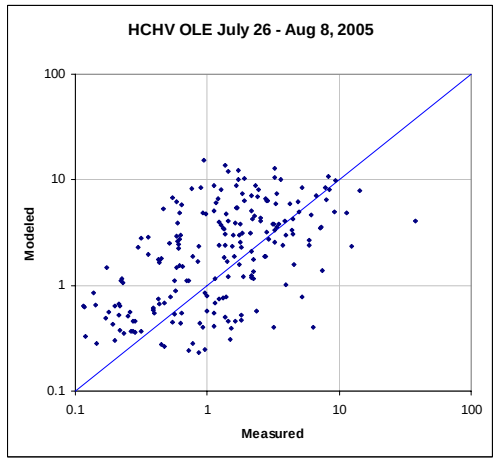


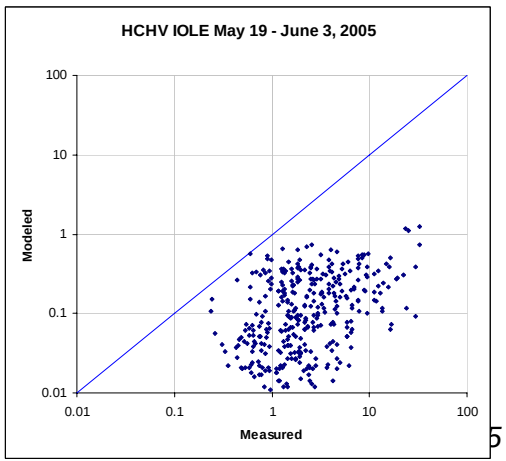



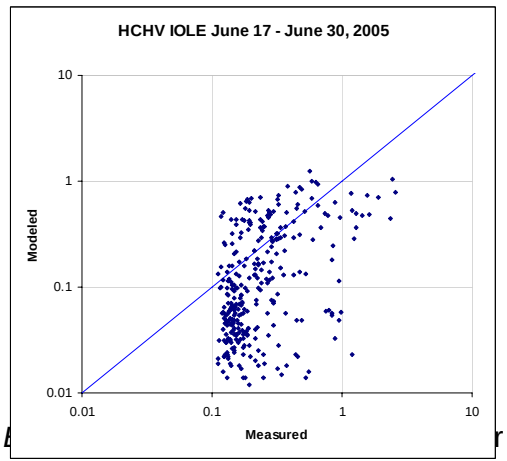



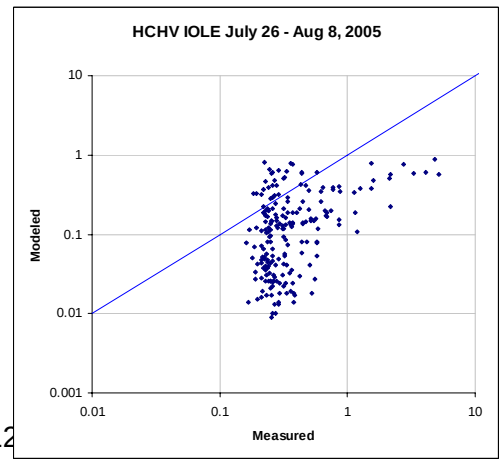



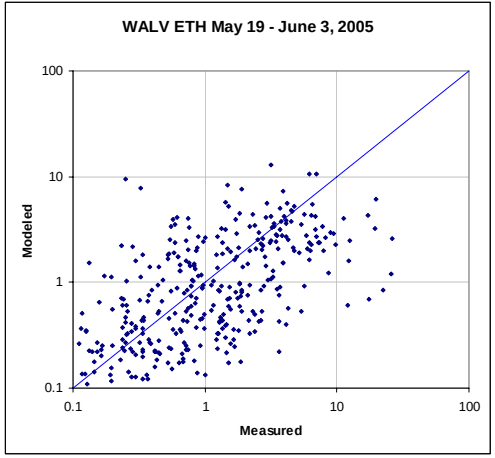



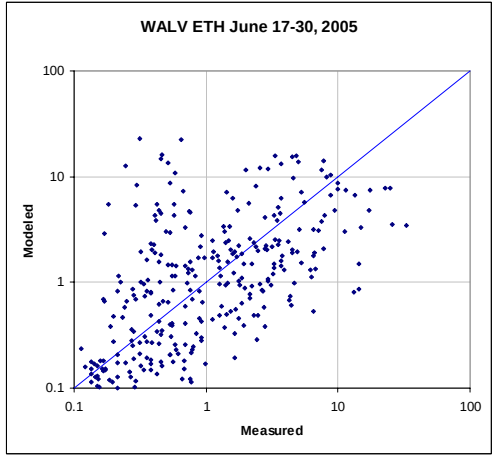



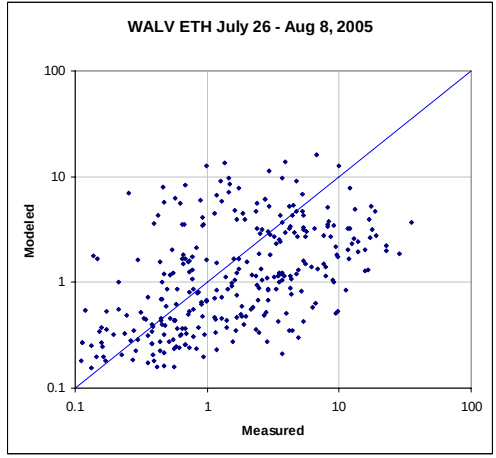



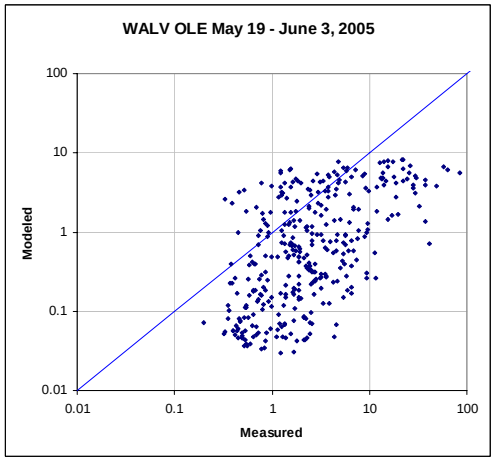



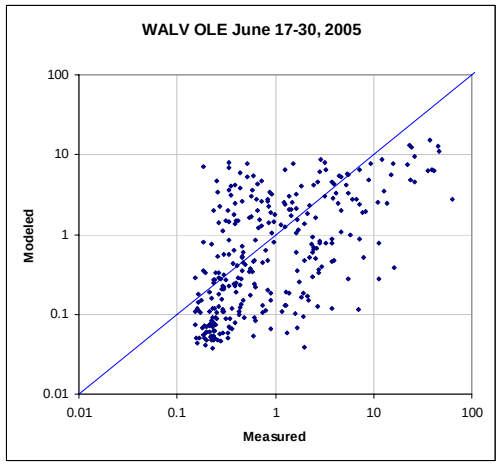
# Wallisville (WALV) Measured vs Modeled CB05-HRVOCs (ETH, OLE & IOLE)

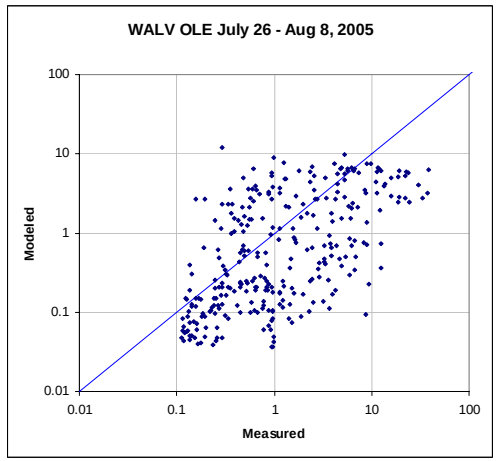


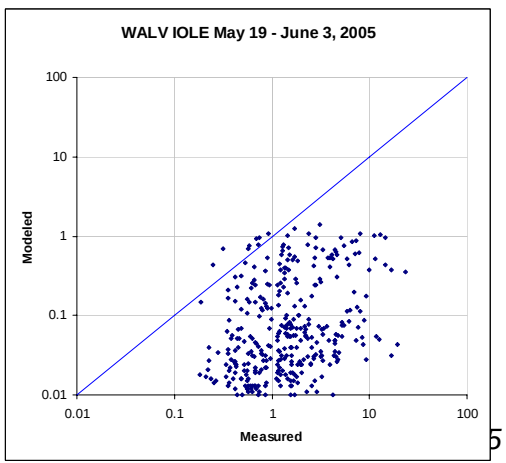



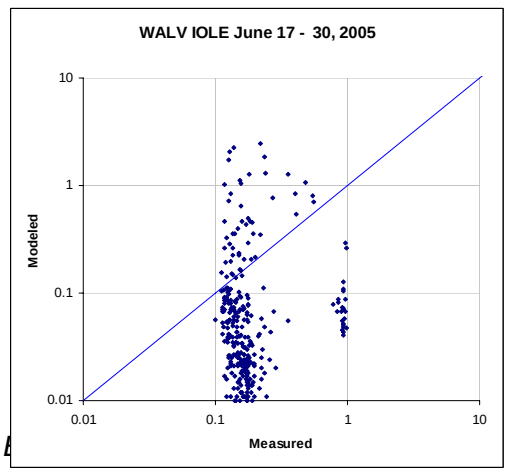



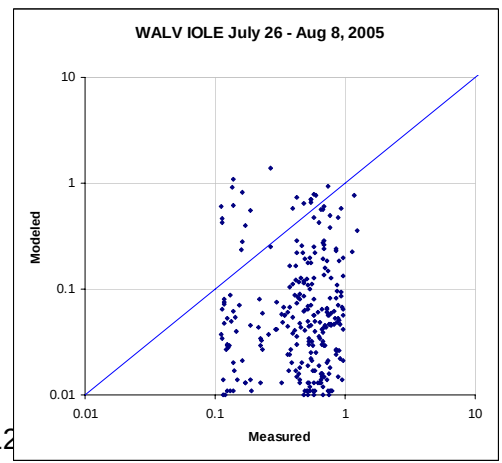



# Base Case Modeling 2005 Episodes

## General Summary Comments

- Statistical Model Performance
  - Episode0 & Episode1 both tend to under-predict the peak O3, while Episode2 tends to over-predict; and
  - The 1-hour relative bias for all three episodes indicate general under-prediction, although the relative bias of peak 8-hour shows over-predictions, especially for Episode2.
- Graphical Model Performance
  - Time-series of O3 at selected sites shows moderately good replication during the day, although generally the night-time O3 depletion is not replicated; and
  - Time series of NO & NO2 at selected sites is not well replicated, with a general over prediction of NO2.

# Base Case Modeling 2005 Episodes

## General Summary Comments

- Graphical Model Performance (continued)
  - Ethene model performance shows fairly good correlation, although the model under-predicts the highest measurements at selected sites;
  - Olefin model performance shows a general tendency to under-predict ambient measurements at selected sites; and
  - Internal olefin model performance shows a strong tendency to under-predict ambient measurements at selected sites.

# Base Case Modeling 2005 Episodes

Next Modeling Updates for the 2005 Episode Base Cases

- Meteorology
  - New LU/LC Derived from UT-CSR
  - Hourly Sea Surface Temperature
  - Updated Radar Profiler Data
- Emissions
  - Hourly Tank Landing losses
  - Reconciliation with Ambient HRVOCs
- Other
  - New BCs derived from the GEOS-CHEM Model