EPA Ozone Attainment Demonstration and Houston, TX

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Southeast Texas Photochemical Modeling Technical Committee

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Outline

- 2004 HGB SIP: 1-hr ozone
- EPA Attainment Method: 8-hr ozone
- Analysis of measured ozone data
- Analysis of model predictions
- Conclusions

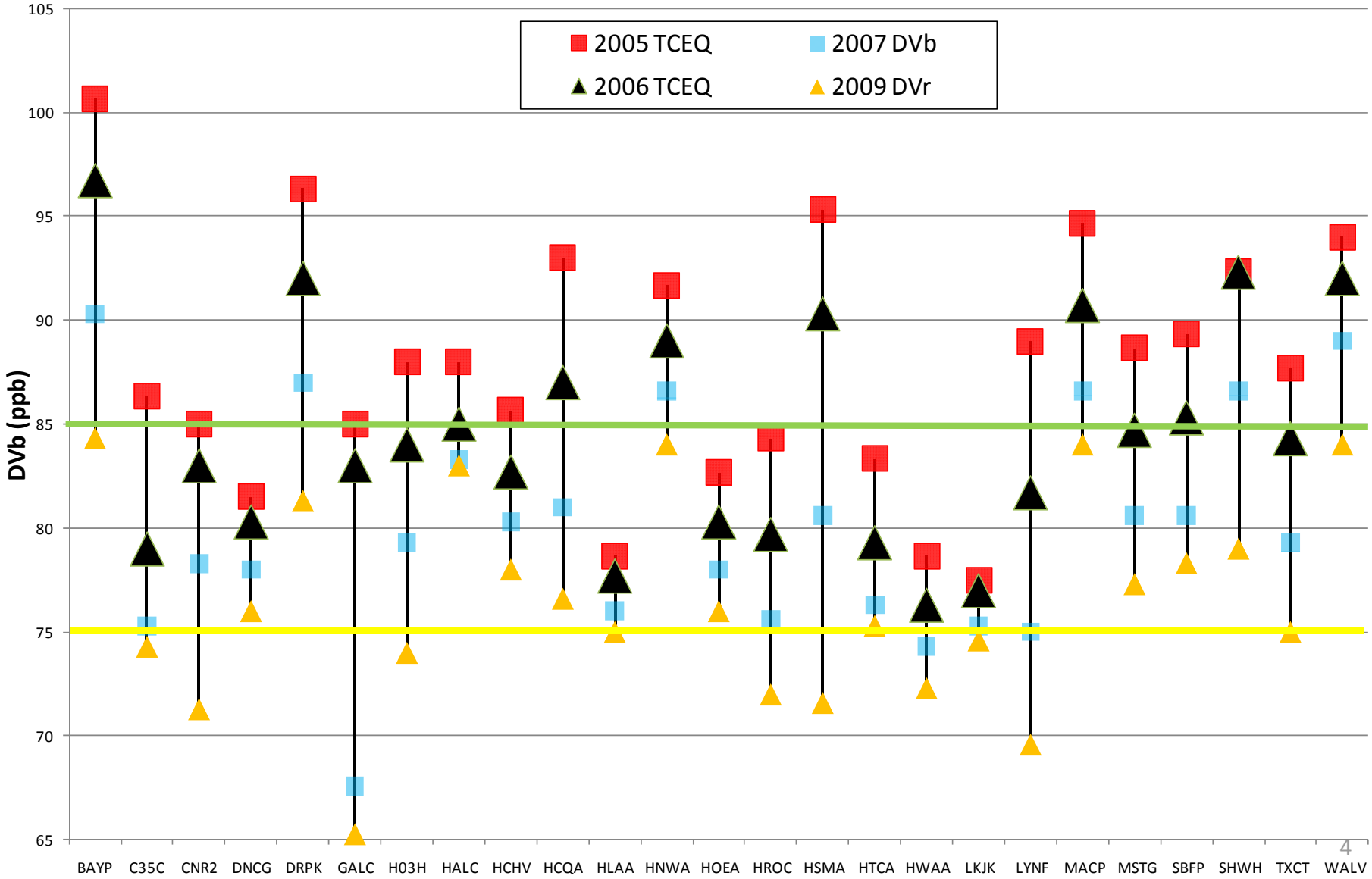
2004 1-hr Ozone SIP

- TCEQ recognized importance of HRVOC emission events
- TCEQ proposed and EPA accepted innovative mitigation plans
- Dual-Ozone management: routine (typical) and episodic releases
- Compliance with HRVOC controls
  - Polymer production facilities reported to have spent up to $2.4 million[1]
  - IR cameras: 2005 identified and reduced more than 7,000 tons per year of VOC emission[2]
  - TCEQ has reported significant reductions in annual averaged measured concentrations of HRVOC

[1]Yarwood, G. et al., *Cost Analysis of HRVOC Controls on Polymer Plants and Flares Project 2008-104. 2008, Environ International Corporation*
[2]TCEQ. *Forecast for Houston: Air Quality Improving. Natural Outlook 2008;*

Design Value Trends

Comparison of 2005 DVb, 2006 DVb, 2007 DVb, & 2009 DVr



EPA O_3 Attainment Method

Mean Relative Reduction Factor at monitor

$$DV_{F,m} = DV_{B,m} \times RRF_m$$

"weighted" DV based on observed 2004-2008 O_3 data at monitor

"average" estimated future DV
If it is below standard, monitor is in compliance of NAAQS

2018 "typical" emissions modeled with 2005 & 2006 daily meteorology

$$RRF_m = \frac{\text{Mean predicted future peak 8-hr daily max "near" monitor}}{\text{Mean predicted baseline peak 8-hr daily max "near" monitor}}$$

2006 "typical" emissions modeled with 2005 & 2006 daily meteorology

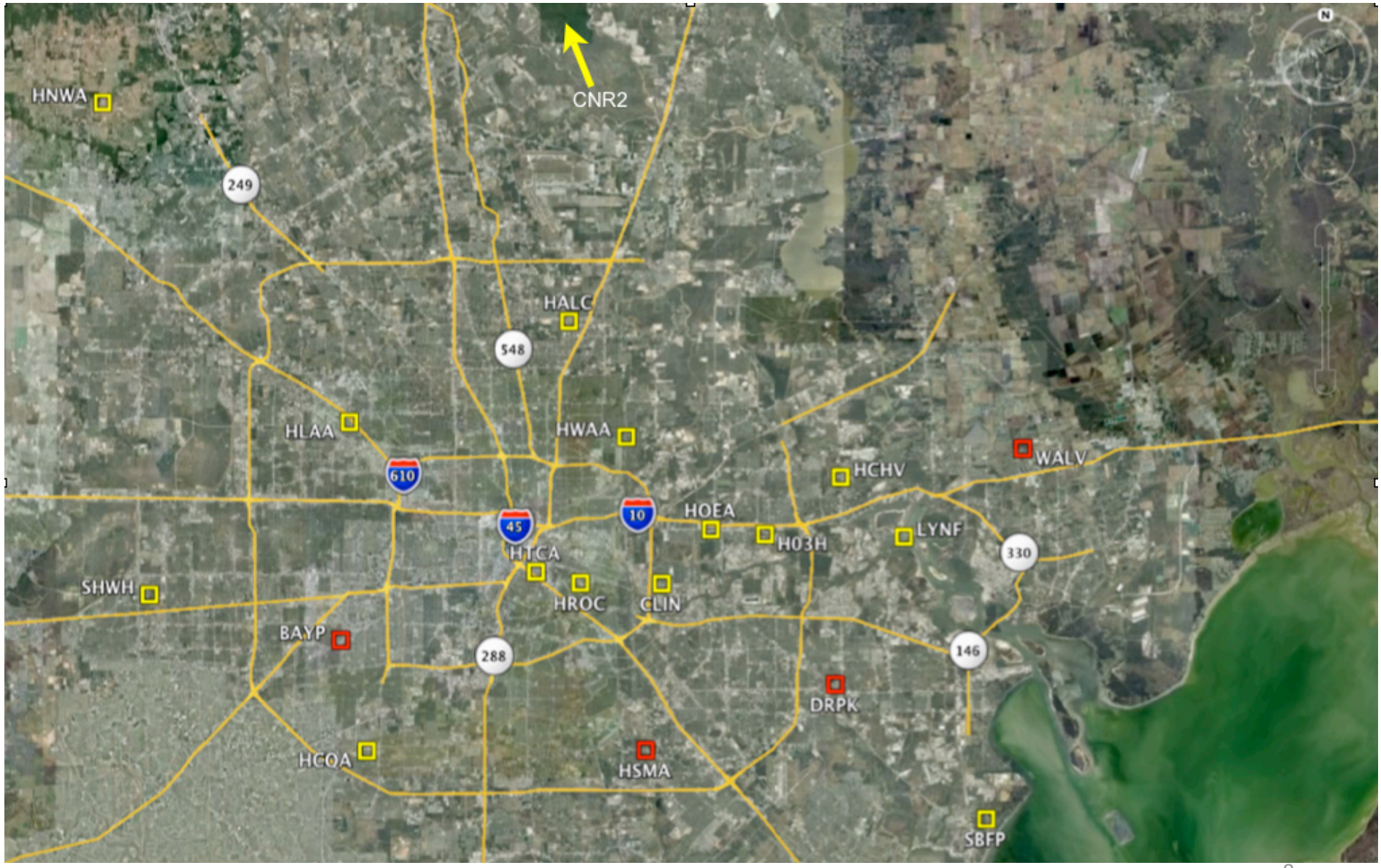
EPA O_3 Attainment Method

- Assumes daily variability in meteorology, not emissions, is main driver for high ozone
- Assumes fourth-highest ozone mixing ratios over a 3-5 year period are caused by the same emissions; ignores possibility of highly variable stochastic emissions
- Assumes that the meteorological conditions in the future and baseline year are identical

Study design

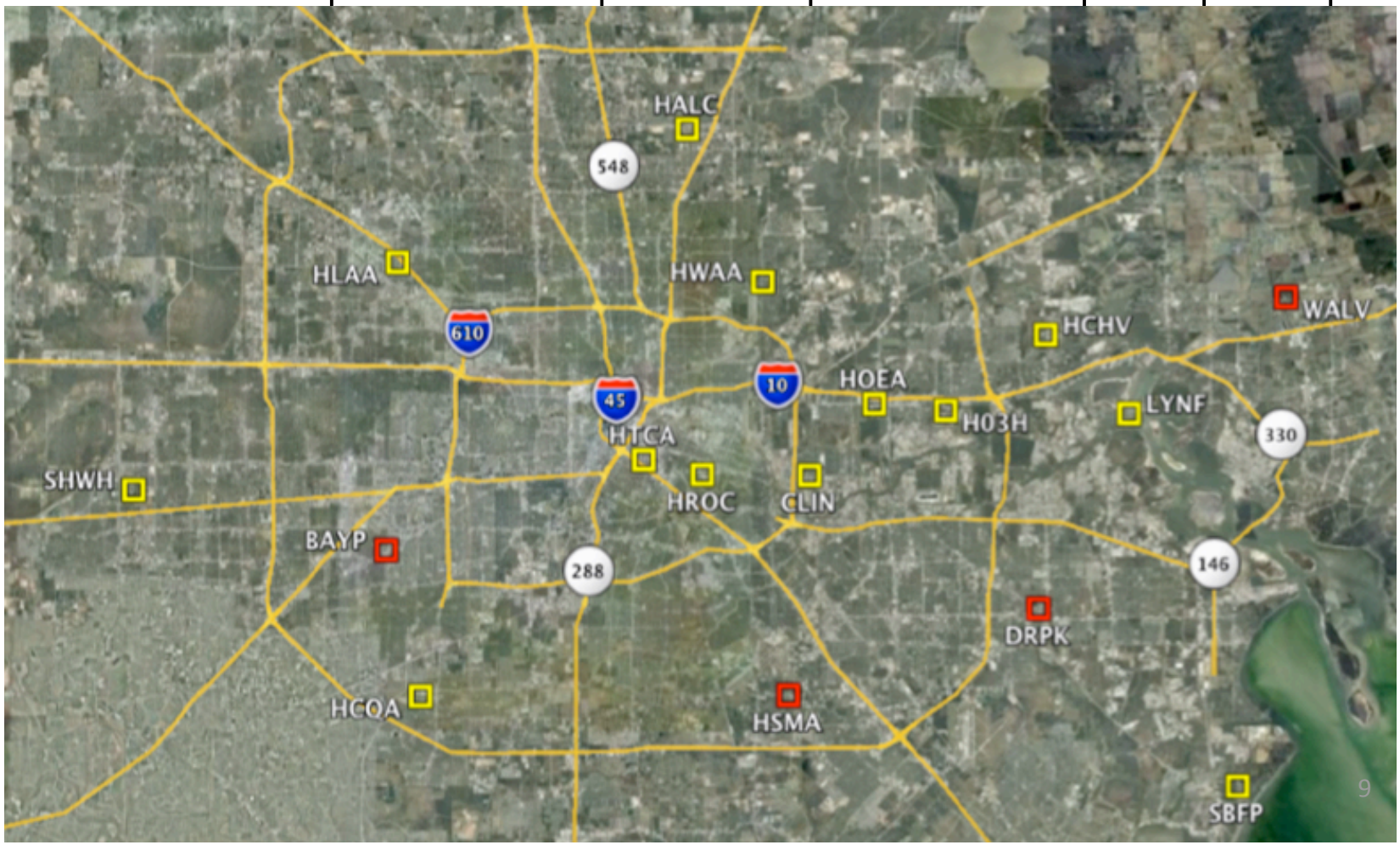
- Is EPA's 8-hr ozone attainment test sufficient for Houston TX?
- Observational Metric: Design Value Baseline (DVB)
- Modeling Metric: Relative Reduction Factor (RRF)

Observational Data



Observational Data

Monitor Name	Abbreviation	CAMS No.	AIRS No.	DV_B	RRF	DV_F
Wallisville	WALV	617	48-201-0617	92.0	0.959	88.2
Deer Park	DRPK	35	48-201-1039	92.0	0.958	88.1
Bayland Park	BAYP	53	48-201-0055	96.7	0.900	87.0
Monroe	HSMA	406	48-201-0062	90.3	0.934	84.3



Air Quality Model Data

TCEQ Regulatory Modeling
Base Case: reg10 and reg10si
Base Line (2006): reg2
Future: cs04
Met: eta_dbemis_fddats_newuhsst_newutcrslulc_grell.v45

Developer	Model Software	Simulation Period
TCEQ	CAMx v4.51	2005-05-19 to 2005-06-03
		2005-06-17 to 2005-06-30
		2005-07-26 to 2005-08-08
		2006-05-31 to 2006-06-15
		2006-08-13 to 2006-09-20
		2006-09-16 to 2006-10-11

TCEQ=Texas Commission on Environmental Quality

CB05=Carbon Bond Mechanism version 5

Observational Metric Analysis

Mean Relative Reduction Factor at monitor

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"weighted" DV based on observed 2004-2008 O_3 data at monitor

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$$RRF_m = \frac{\text{Mean predicted future peak 8-hr daily max "near" monitor}}{\text{Mean predicted baseline peak 8-hr daily max "near" monitor}}$$

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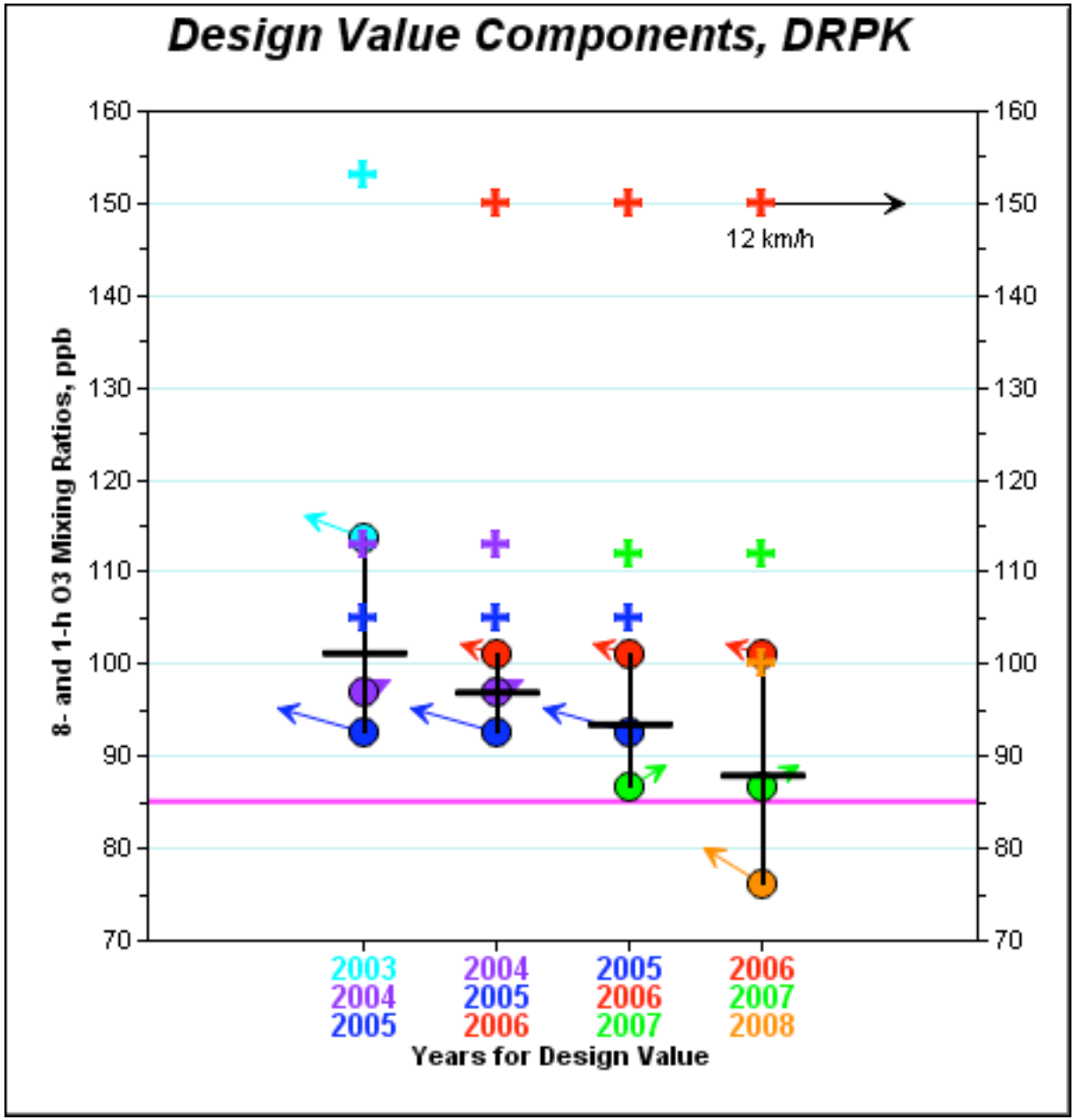
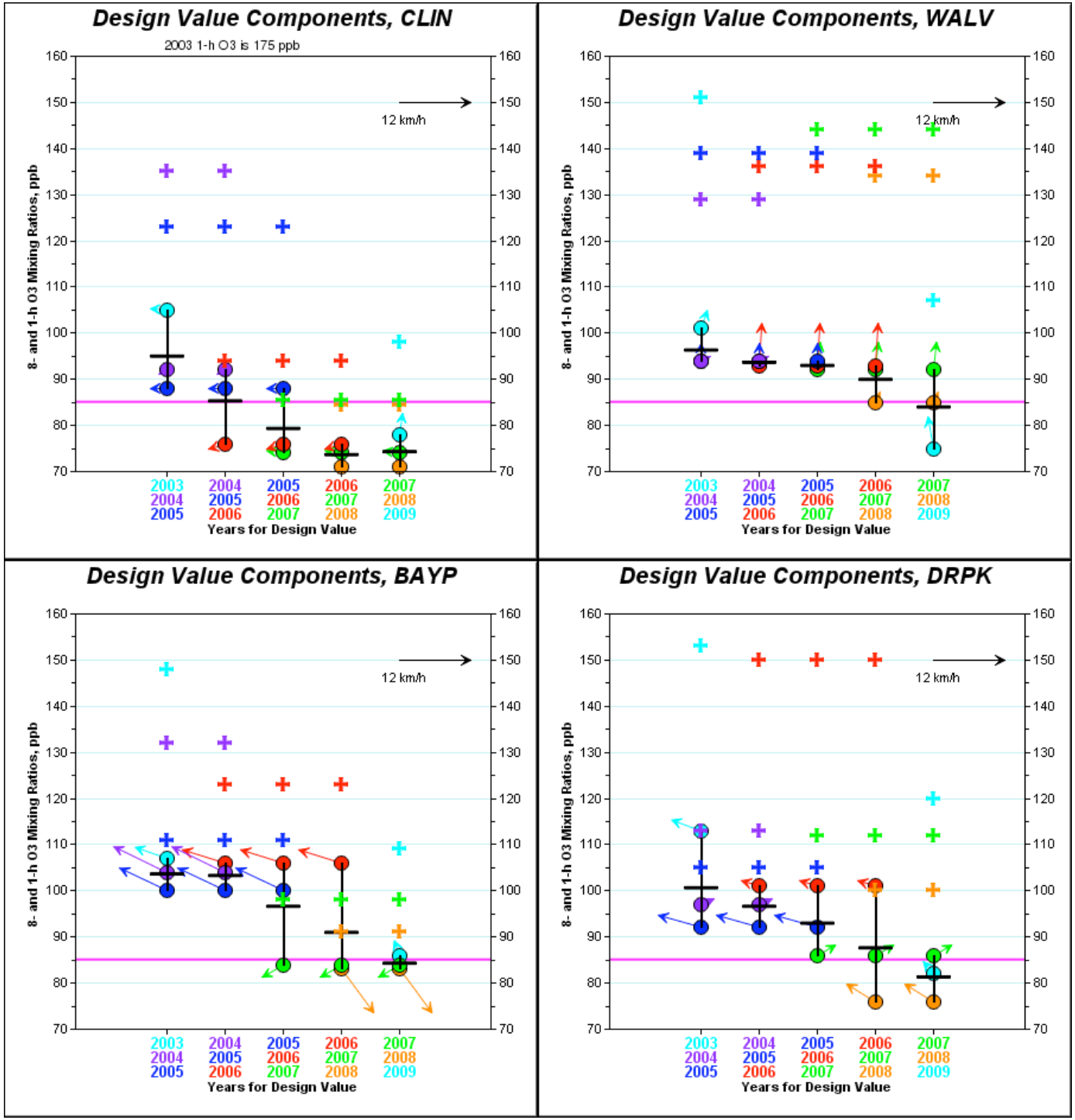
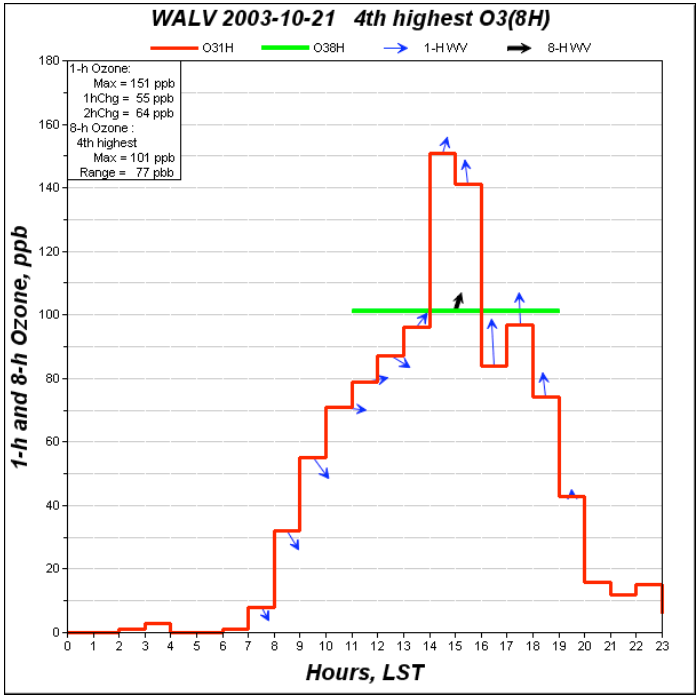
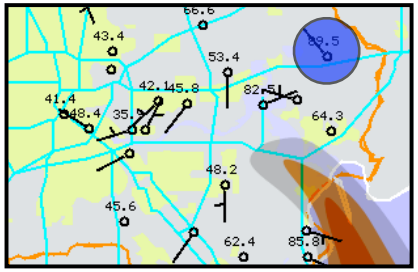
Ozone Design Value Plot



- Design value is three year average of 8-hr max ozone concentrations
- "Bar" is design value
- "o" are the three 8-hr max ozone values used for the design value
- "arrow" 8-hr resultant wind vector
- "+" is 1-hour max ozone in the 8-hour window


Design Value Components, CLIN
2003 1-h O3 is 175 ppb
12 km/h
8- and 1-h O3 Mixing Ratios, ppb
2003 2004 2005
2004 2005 2006
2005 2006 2007
2006 2007 2008
2007 2008 2009
Years for Design Value
Design Value Components, WALV
12 km/h
8- and 1-h O3 Mixing Ratios, ppb
Years for Design Value
Design Value Components, BAYP
12 km/h
8- and 1-h O3 Mixing Ratios, ppb
Years for Design Value
Design Value Components, DRPK
12 km/h
8- and 1-h O3 Mixing Ratios, ppb
Years for Design Value





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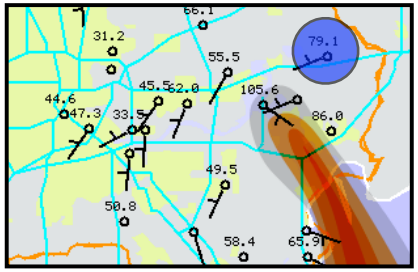

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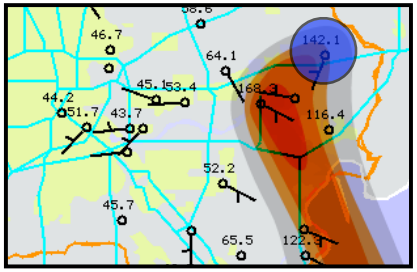

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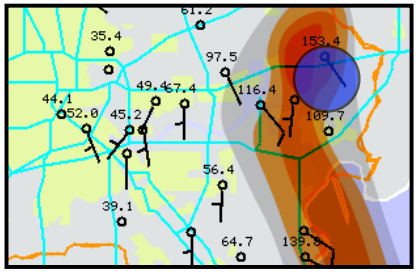

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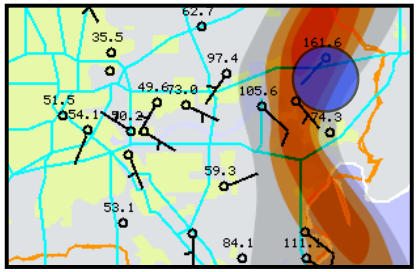

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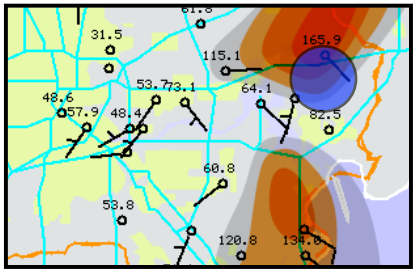

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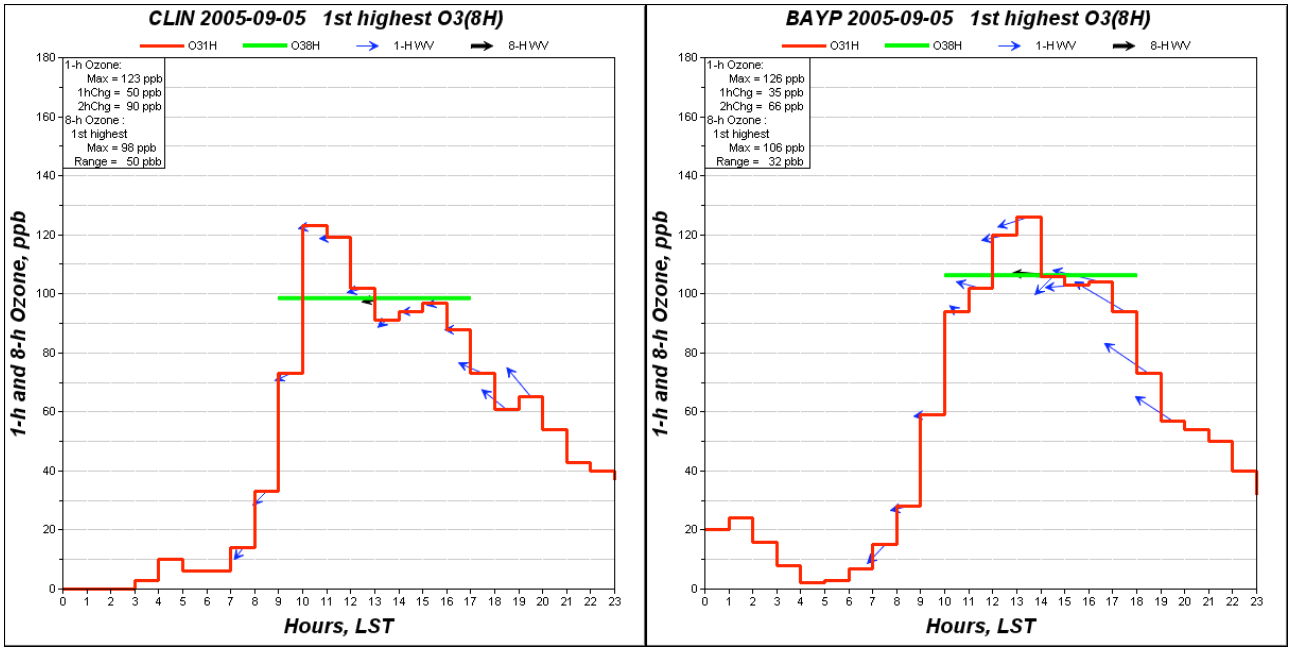
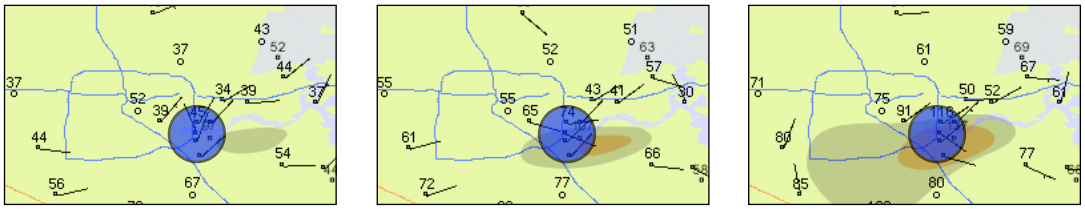
http://www.tceq.state.tx.us/compliance/monitoring/air/monops





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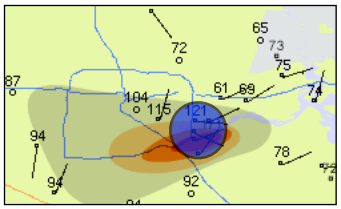
9/05/2005, 10:00 CST



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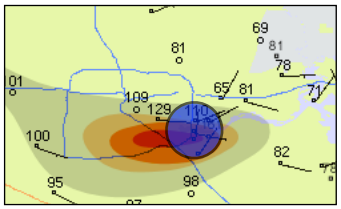

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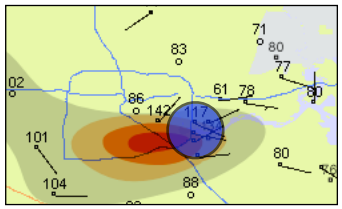
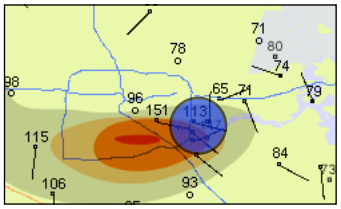


9/05/2005, 11:30 CST

- >204 ppb
- 185-204 ppb
- 165-184 ppb
- 145-164 ppb
- 125-144 ppb
- 100-124 ppb



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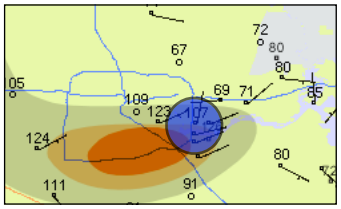

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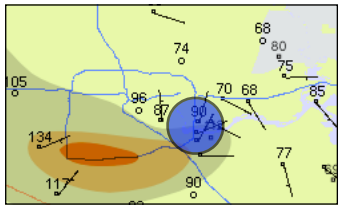

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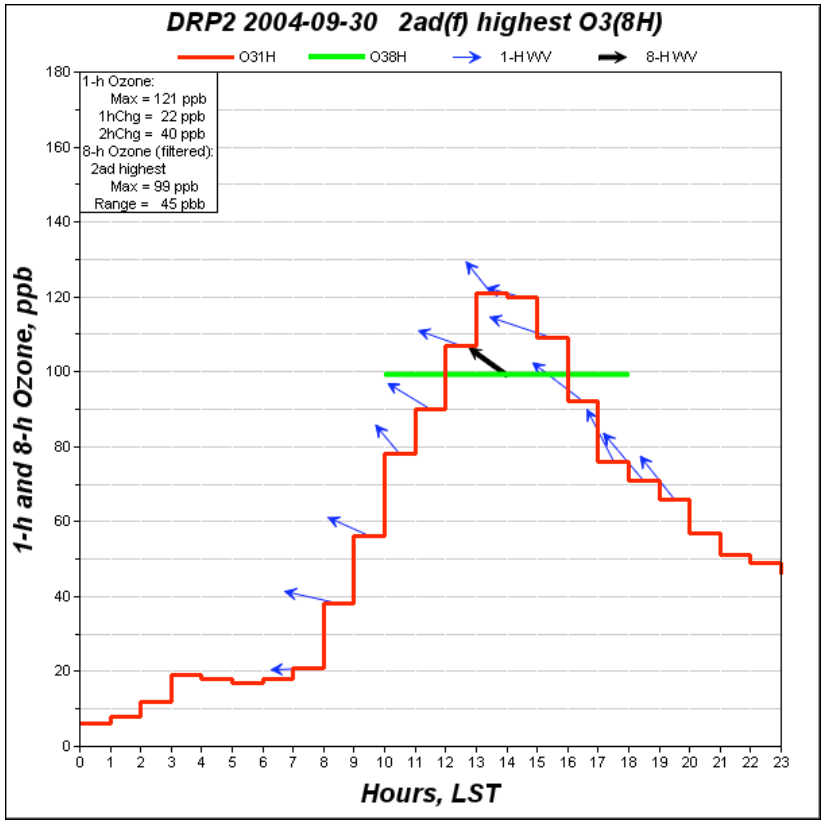
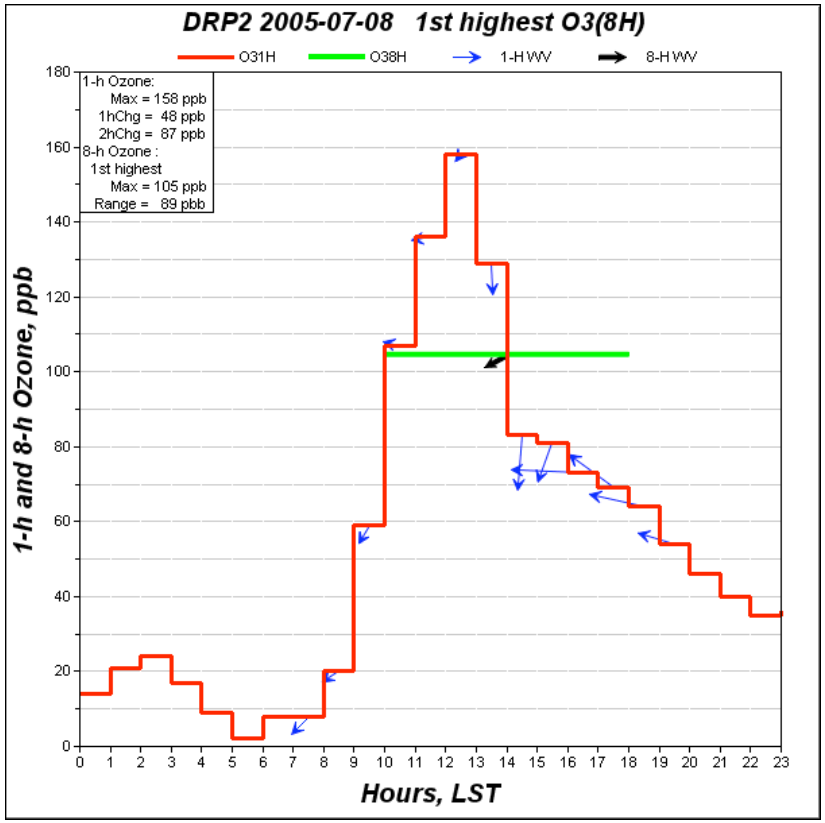
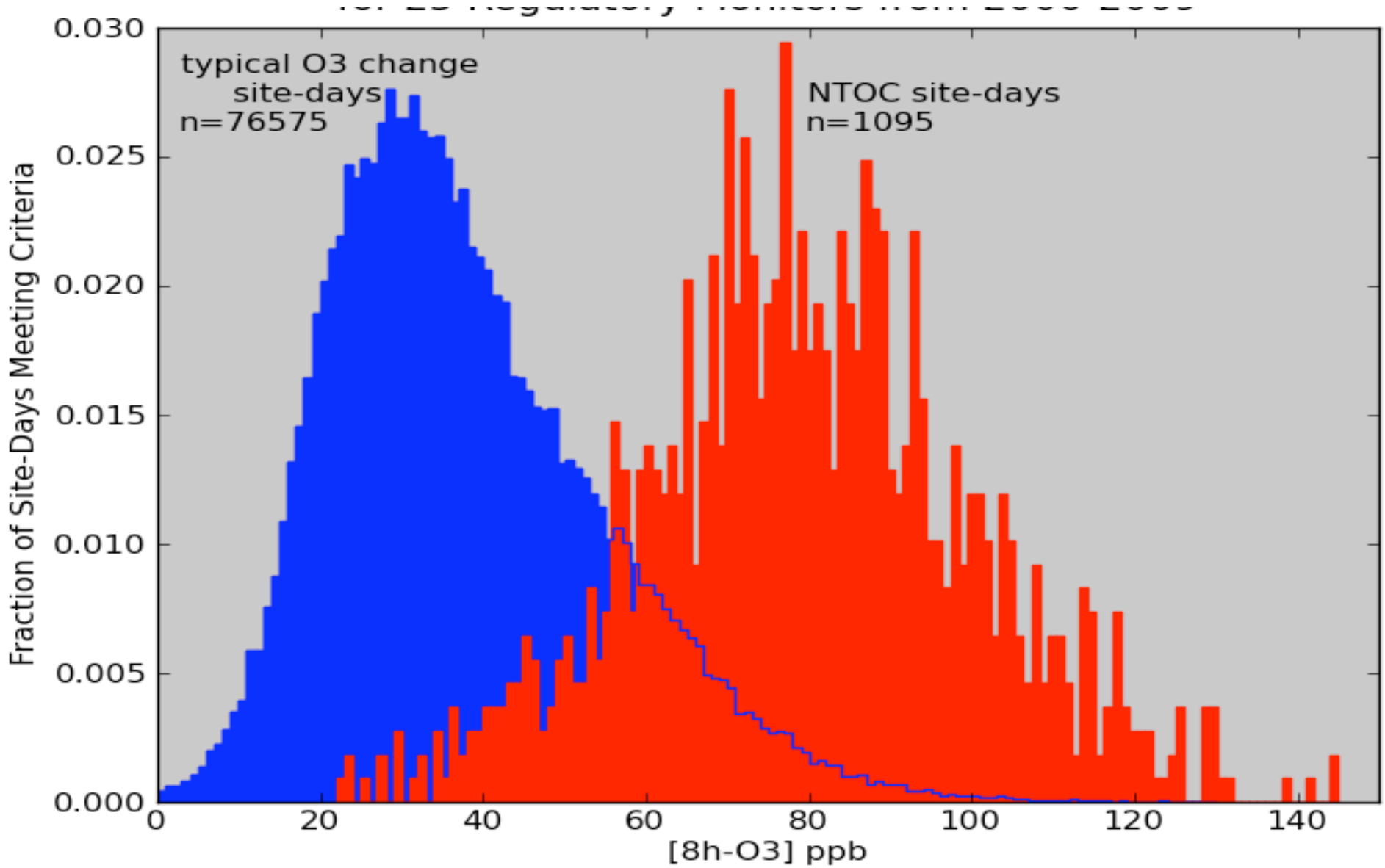
Non-typical Ozone Criteria



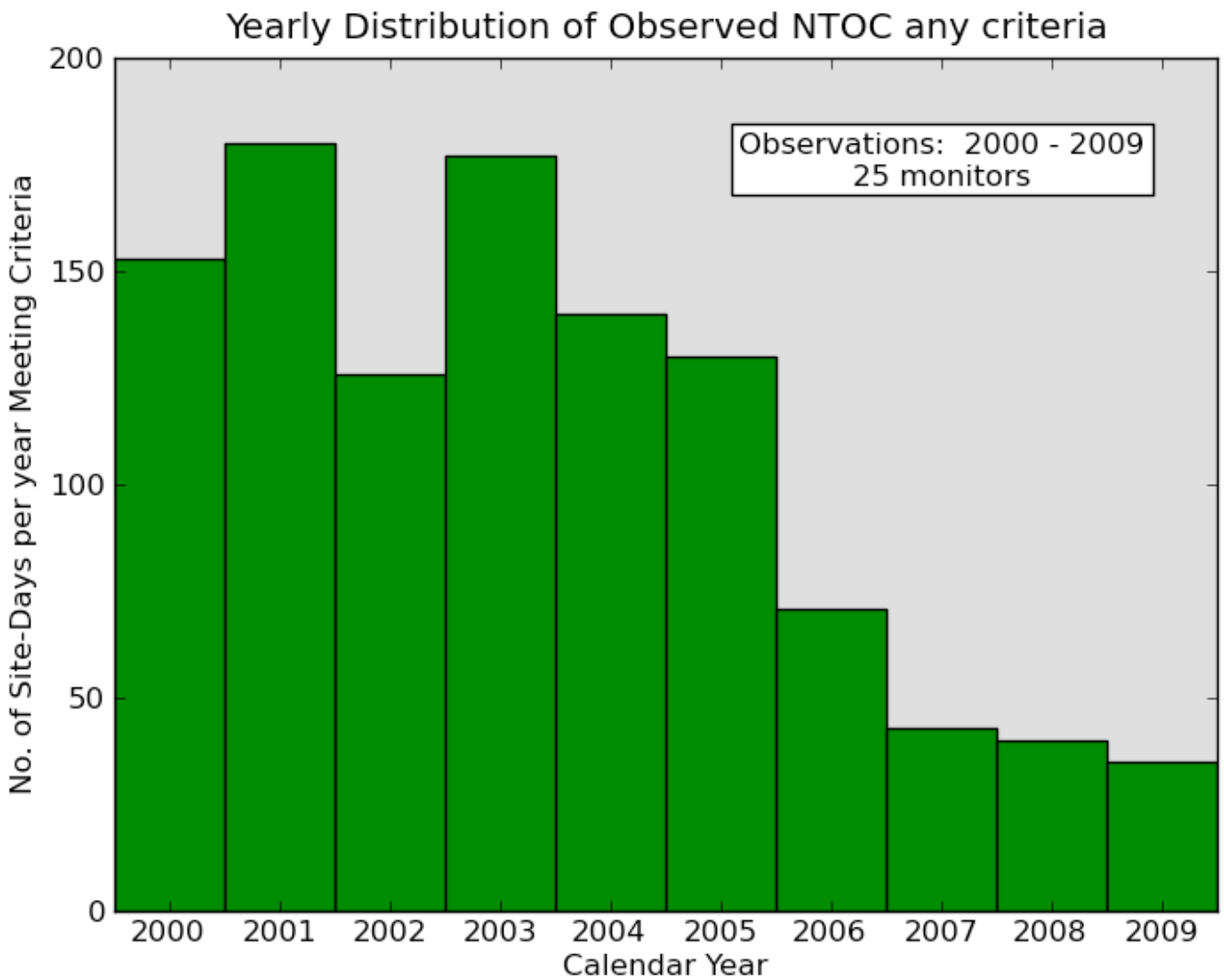


- Change in hourly O_3 > 40 ppb
- Change over two hours O_3 > 60 ppb

Distribution of TOCs & NTOCs (25 Monitors: 2000-2009)



Number of NTOC Events Have Declined Dramatically Since 2005



Ozone Violations

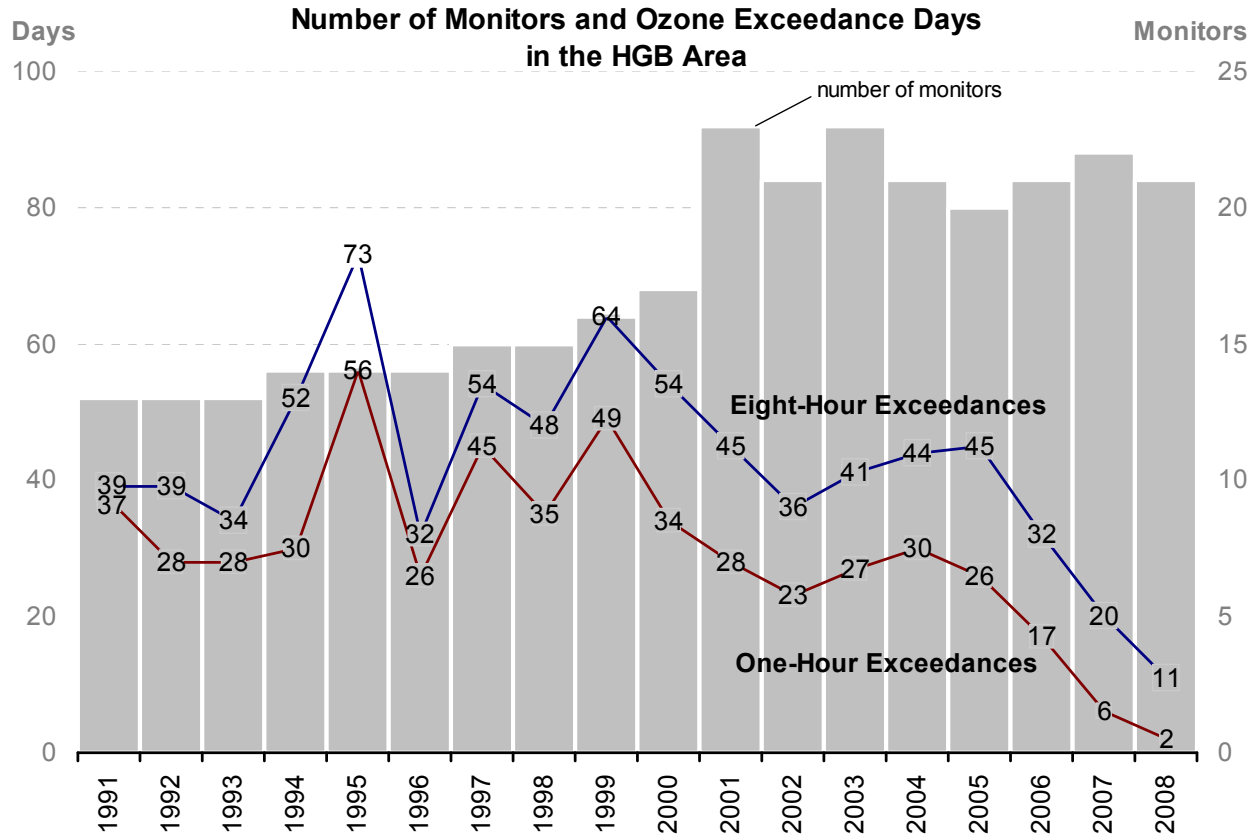
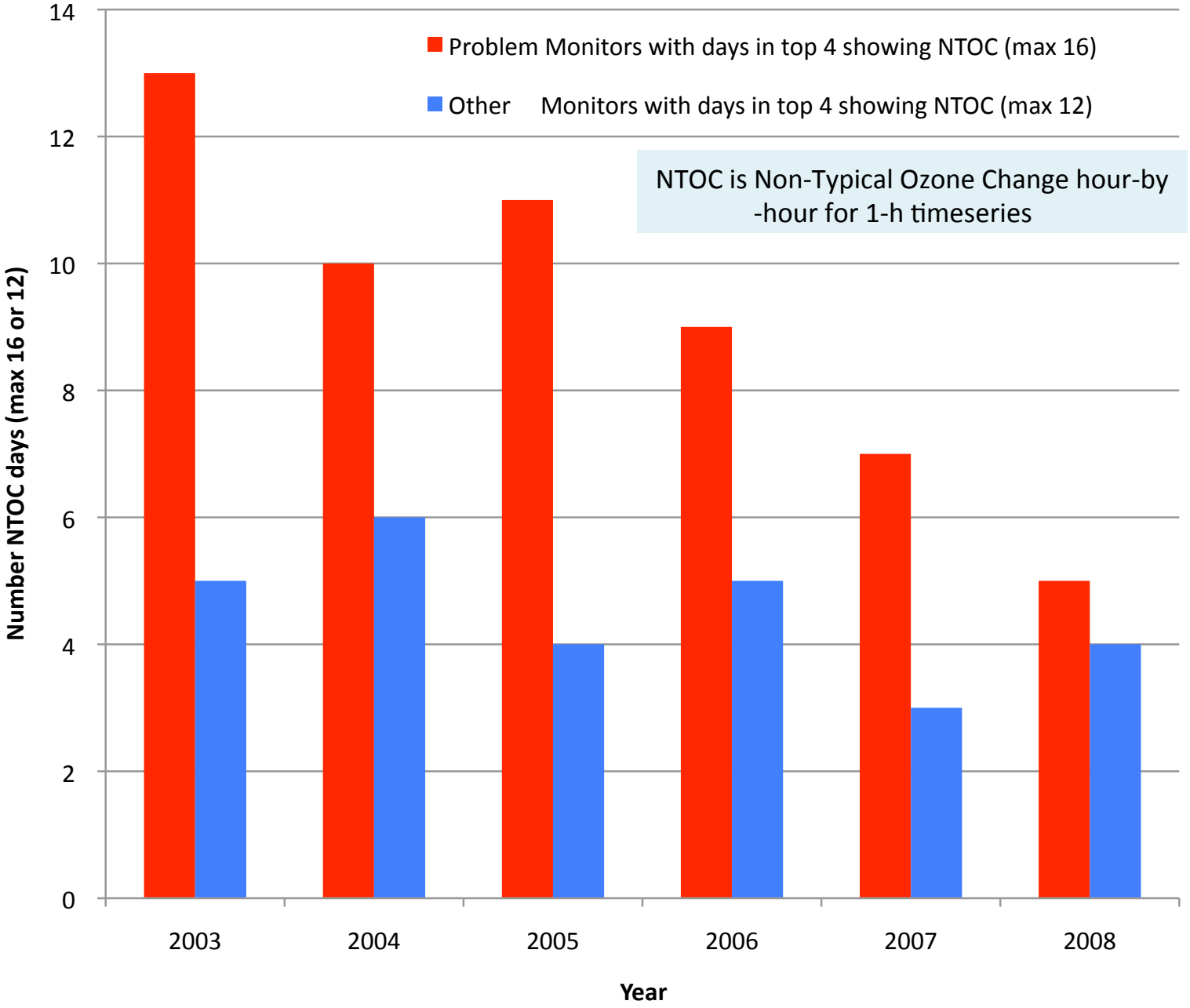


Figure 5-4: Number of Monitors and Ozone Exceedance Days in the HGB Area

From TCEQ 2009 8-H Ozone SIP Proposal, Chapter 5, page 5-16.[2]

[2] Note: there are a total of 50 O_3 data sites in the SIP 4-km domain, not all regulatory.

Number of Top 4 Monitor Days with NTOC-characteristics



Filtered Design Values

2006			
Monitor	***DVb***	***RRF06***	***DVf***
BAYP	96.7	0.899	86.9
HSMA	89.7	0.934	83.7
DRPK	92.0	0.959	88.2
WALV	92.0	0.960	88.3

2006				
Monitor	***DVb***	***RRF06***	***DVf***	***Diff***
BAYP	88.7	0.899	79.7	-7.2
HSMA	82.3	0.934	76.9	-6.8
DRPK	86.3	0.959	82.8	-5.4
WALV	82.3	0.960	79.0	-9.3

Summary

- Dramatic reductions in number of NTOC since 2005
- DV_B uses a 5 year average including period of significant change
- NTOC still impact current DV_Bs
- Dual approach 7-9 ppb difference in DV_F equivalent to significant across the board NOx/VOC controls

Modeling Data Analysis

Mean Relative Reduction Factor at monitor

$$DV_{F,m} = DV_{B,m} \times RRF_m$$

"weighted" DV based on observed 2004-2008 O_3 data at monitor

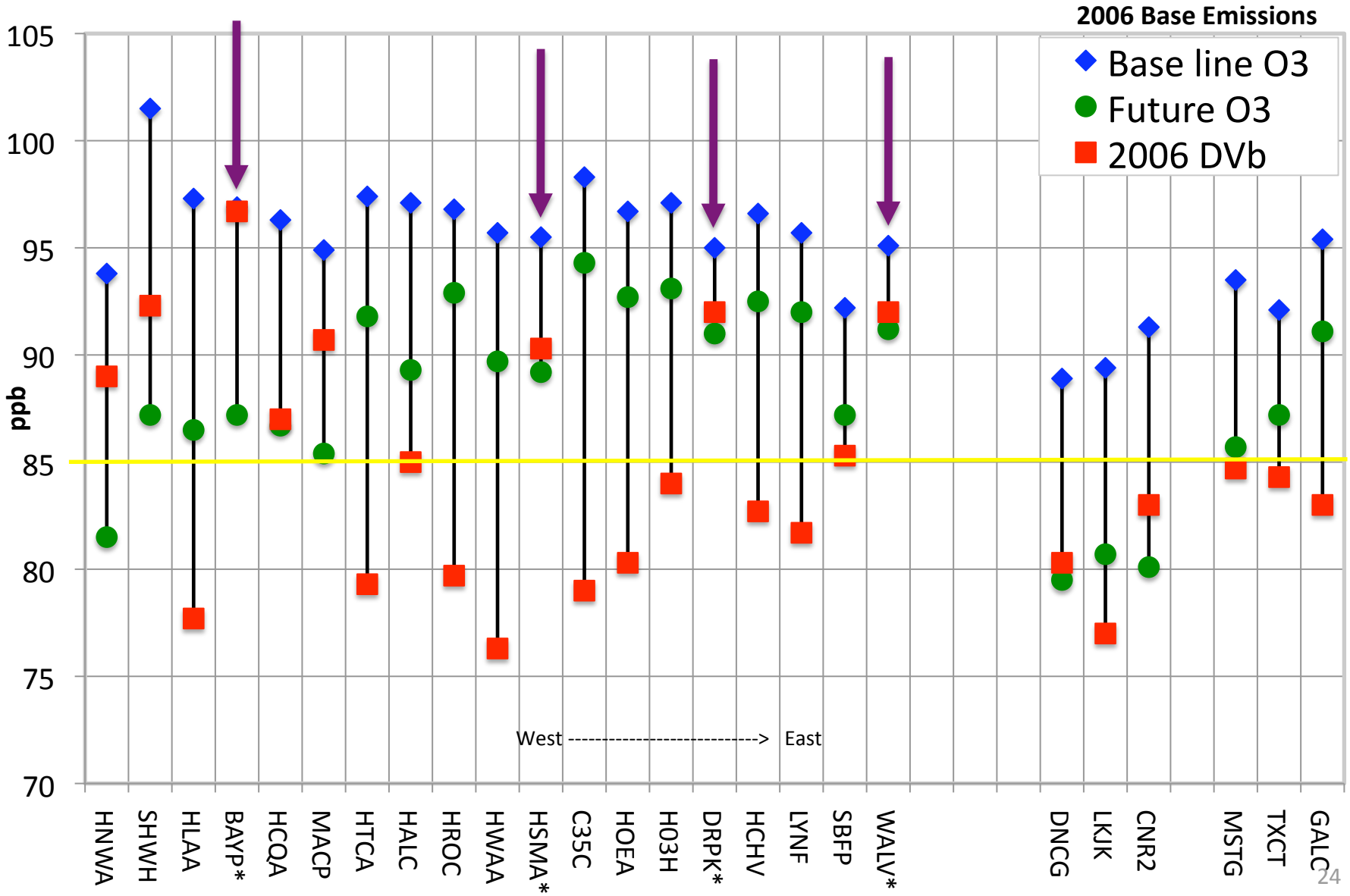
"average" estimated future DV
If it is below standard, monitor is in compliance of NAAQS

2018 "typical" emissions modeled with 2005 & 2006 daily meteorology

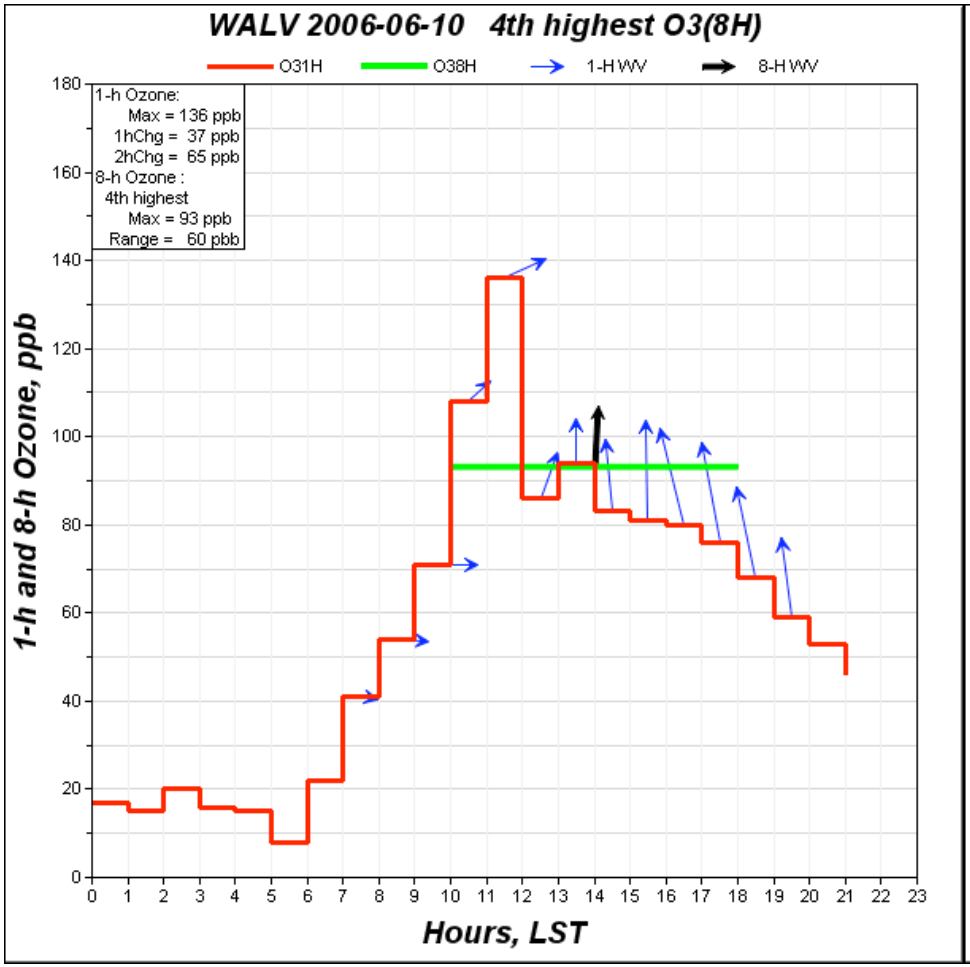
$$RRF_m = \frac{\text{Mean predicted future peak 8-hr daily max "near" monitor}}{\text{Mean predicted baseline peak 8-hr daily max "near" monitor}}$$

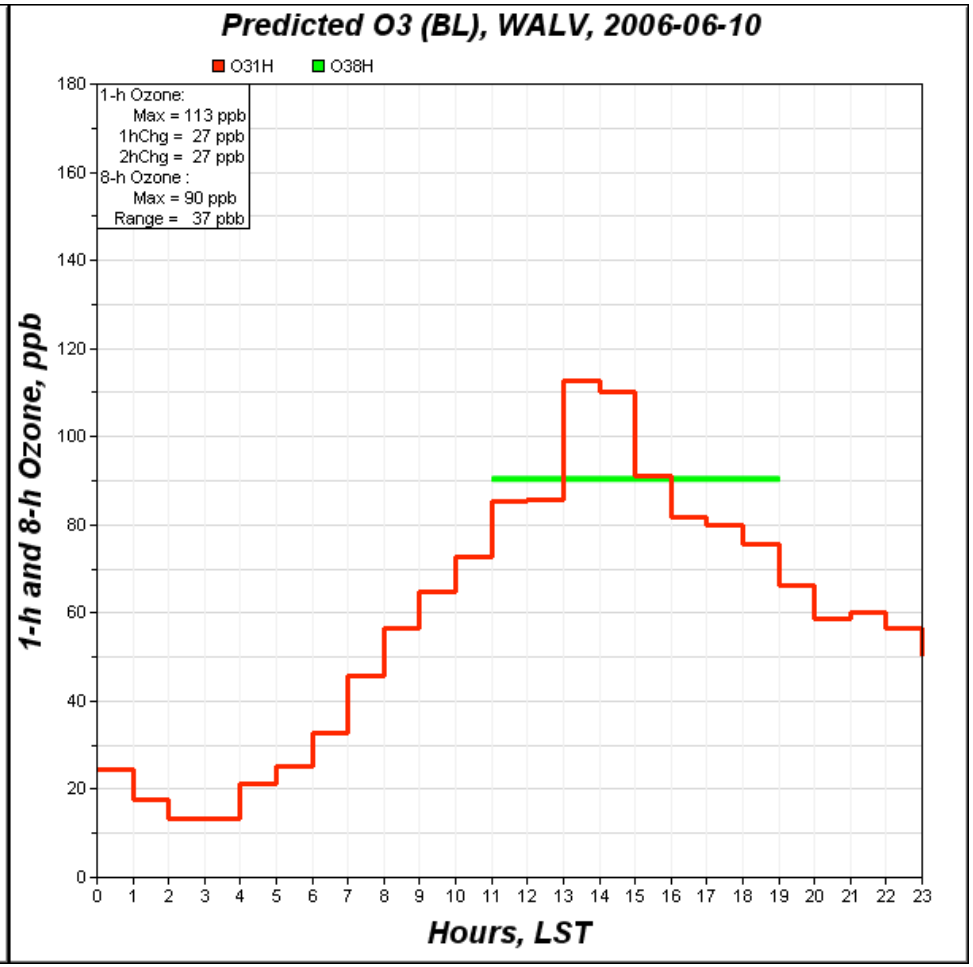
2006 "typical" emissions modeled with 2005 & 2006 daily meteorology

Relative Reduction Factor Components



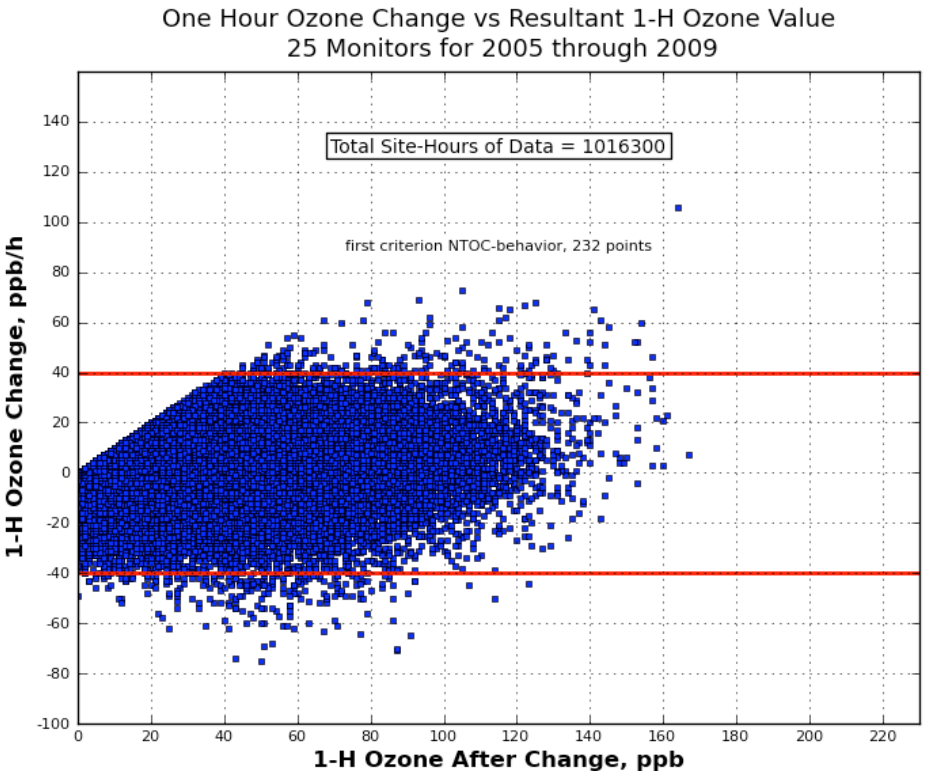
Observation and Modeling Data



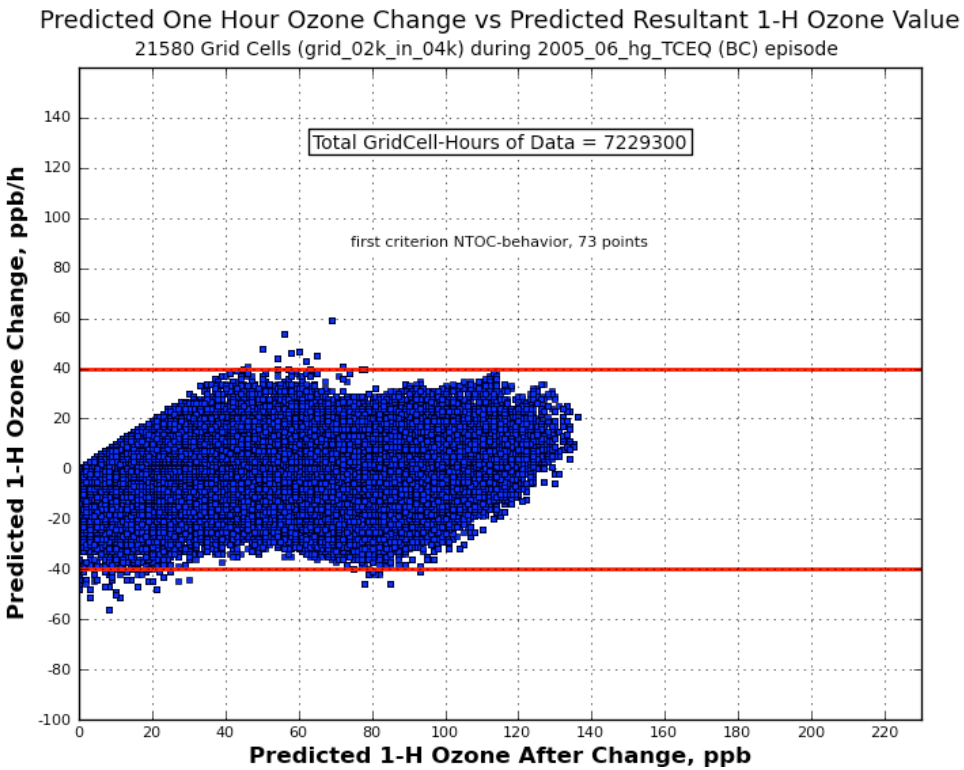


Observation vs. Base Case

Observations

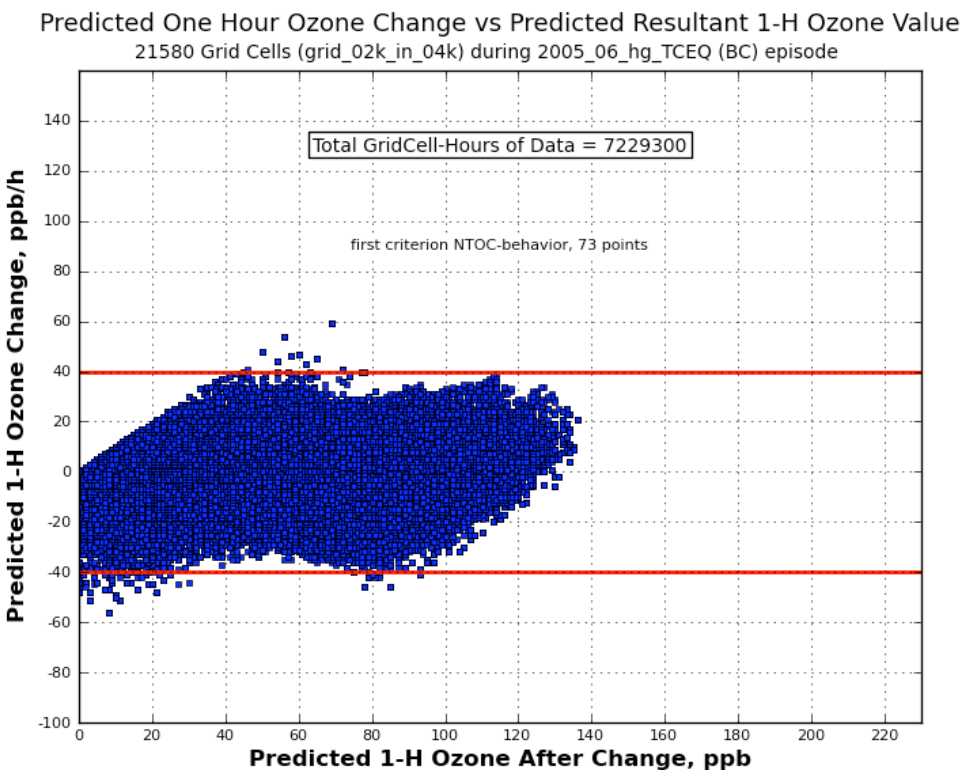


Base Case Model Predictions

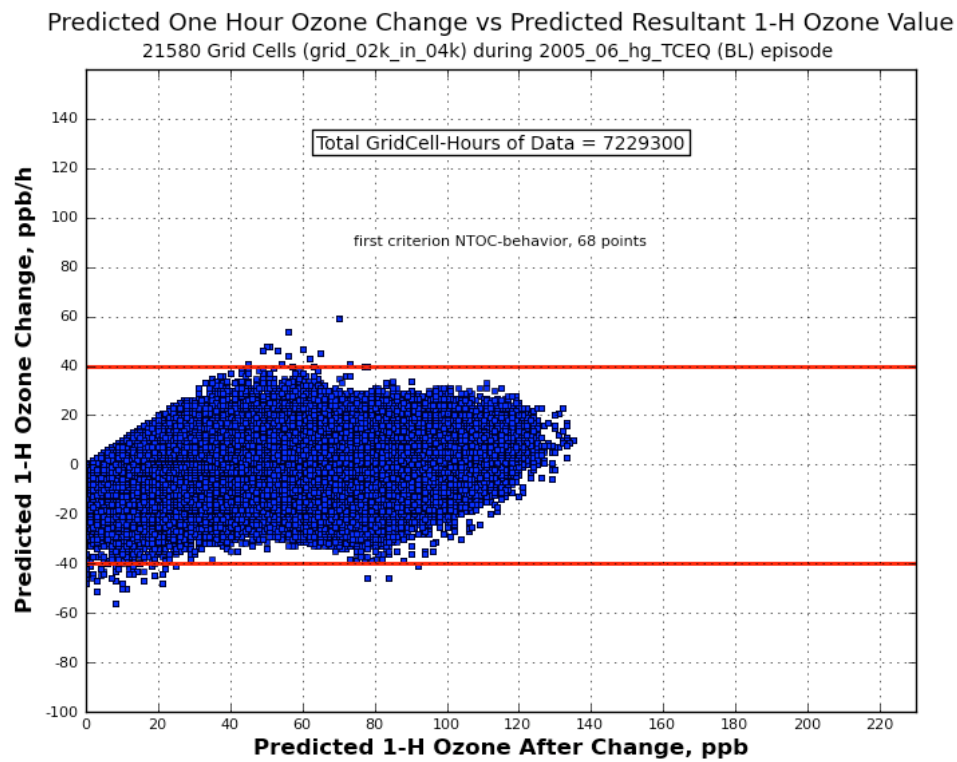


Base Case vs. Base Line Modeling Data

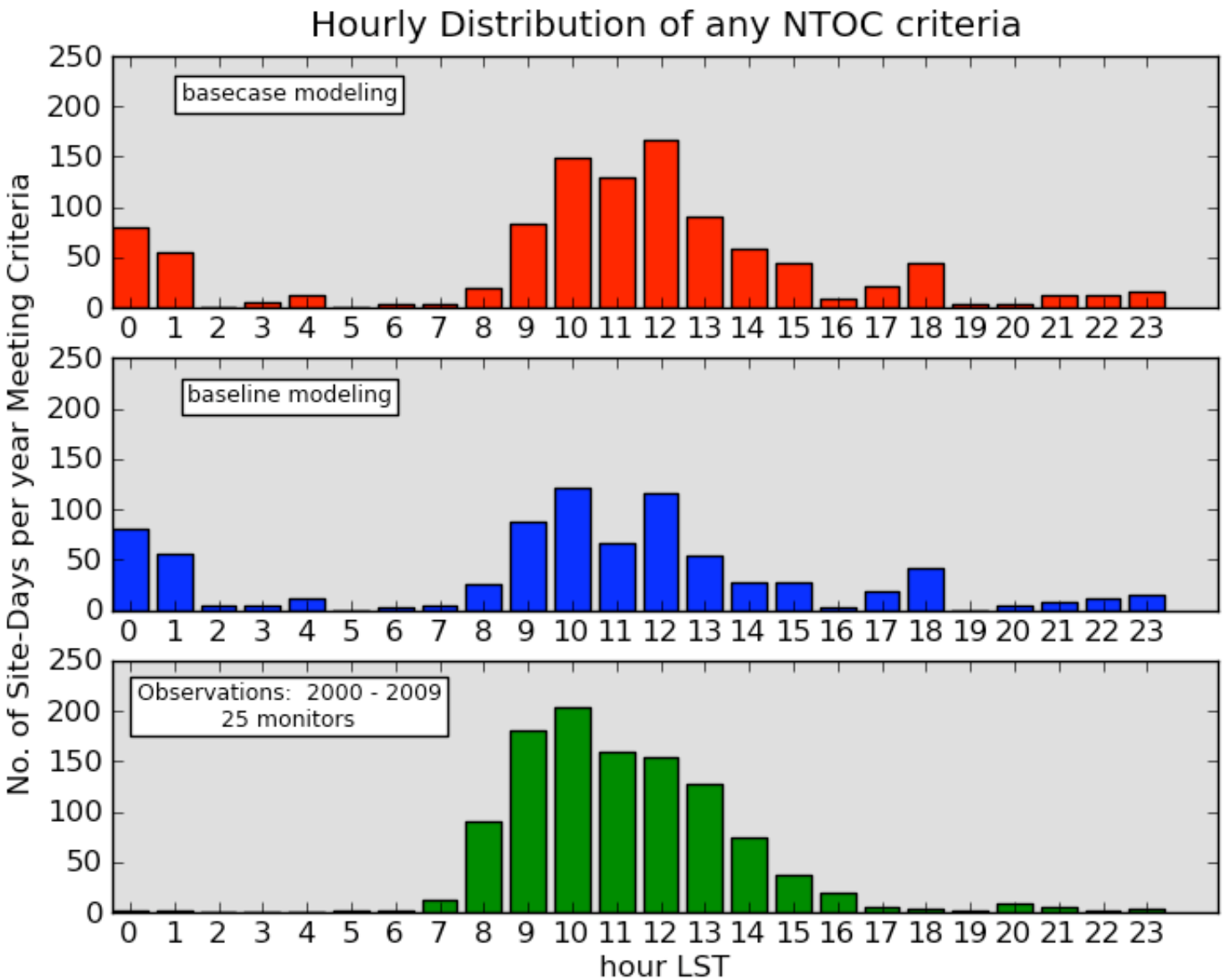
Base Case Model Predictions



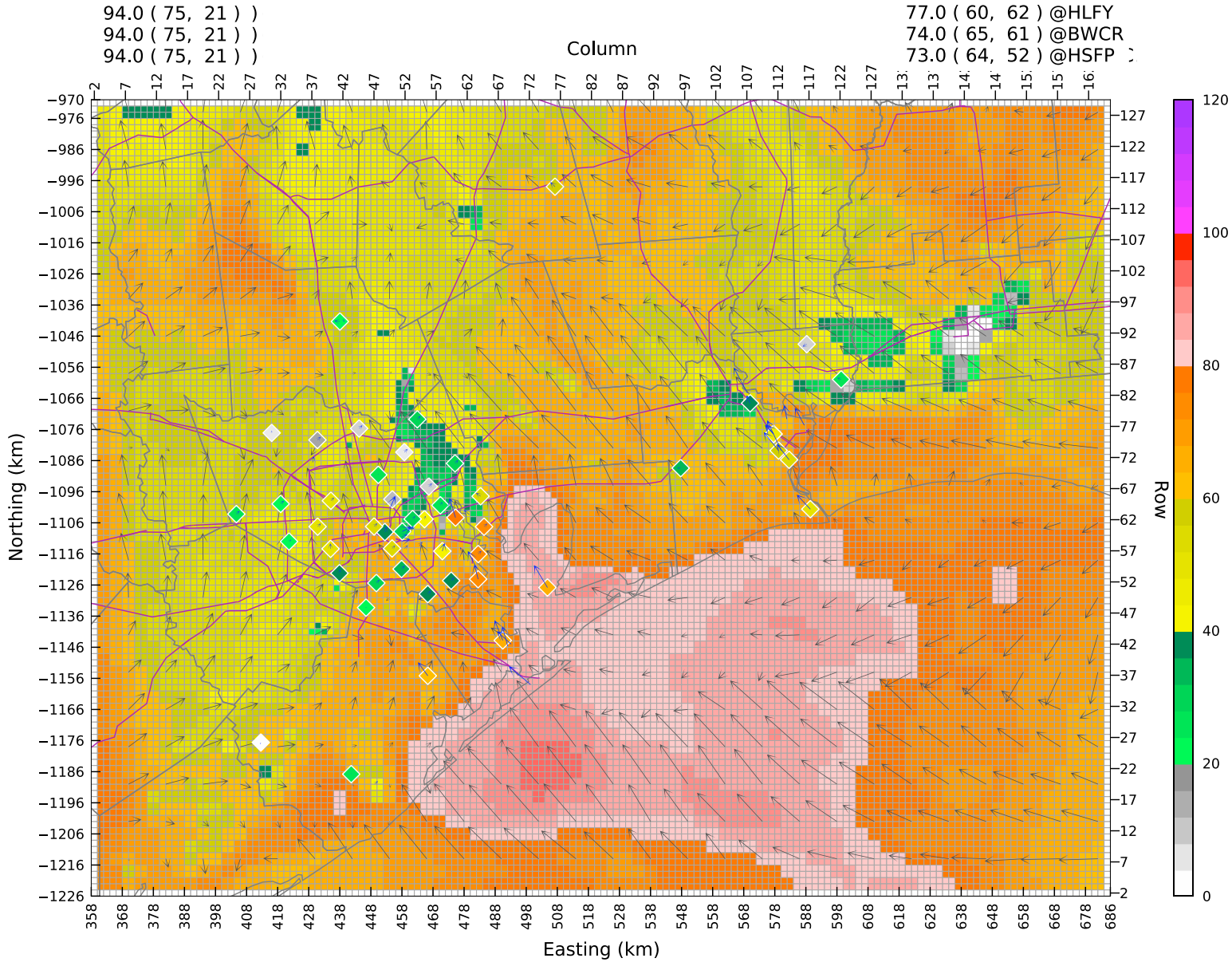
Base Line Model Predictions



Hourly Distribution of NTOC



Midnight NTOC



O3 2006-08-18 01

max120step6shade5 [ppb]

Conclusions

- Houston has dual ozone phenomena
- EPA attainment demonstration methodology recognizes one type of ozone phenomena
- Control strategies using Base Line modeling may not be as effective
- Although less frequent NTOC still impact design values
- Further investigation of cause of NTOC behavior in regulatory modeling needed

Acknowledgements

- Funded by Houston Advanced Research Center under project H-97 managed by Dr. Eduardo Olaguer
- Thanks to Mark Estes, Jim Smith, for supplying TCEQ SIP modeling input and allowing us to pursue these questions
- Thanks to Jim Wilkinson Alpine Geophysics and Tom Tesche Climate & Atmospheric Research Associates for discussions