Recent Findings in Modeling Five Houston 8-hr Ozone Episodes

prepared for

Houston 8-hr Coalition

prepared by

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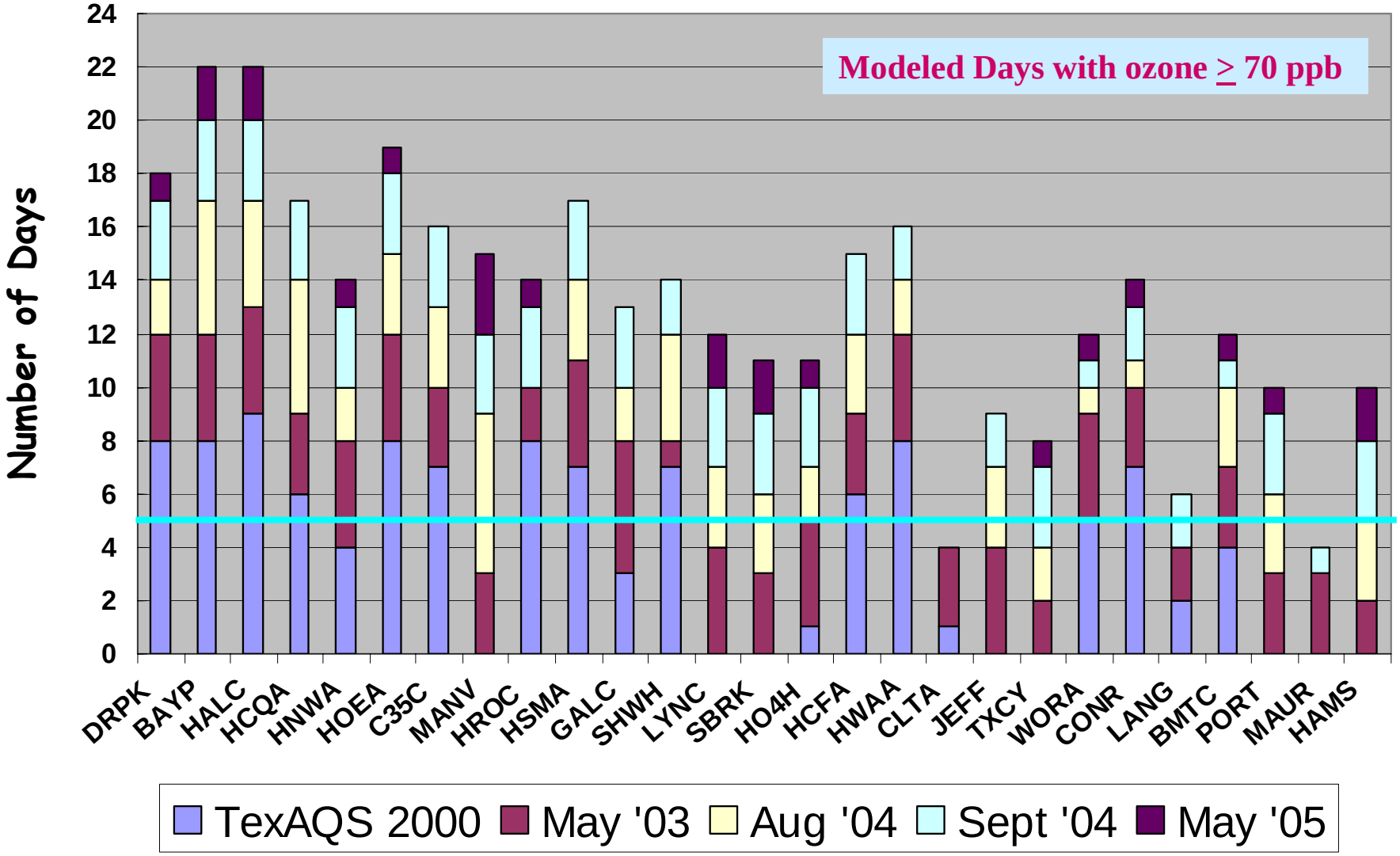
Discussion Hilights

- The Aug-Sep 2000 TCEQ episode provides a substantial foundation for developing the 8-hr HGB ozone SIP
- Addition of the post-2000 episodes will augment the 2000 TCEQ episode in several significant ways:
  - Providing the opportunity to test potential control strategies over a broader set of meteorological conditions, emissions patterns, and years
  - Providing more RRF days for the EPA Attainment Test
  - Potentially increasing the RRF 'threshold' level of days used in the Attainment Test making CAMx more responsive to controls
  - Allow attainment testing of new monitors installed after the 2000 episode
- Detailed CAMx performance testing of all five episodes, including comparisons with nearly 20 other regulatory studies in the U.S, confirms that all five HGB ozone episodes are SIP-quality and a solid framework for testing emissions reduction strategies

Post-2000 Episodes Complement the Aug-Sept 2000 TCEQ SIP Episode

Key Finding: Including the post-2000 episodes nearly <u>doubles</u> the number of days potentially available for performing EPA's 8-hr ozone Attainment Test.

Days Per Episode with 8-hr Maxima ≥ 70 ppb



Number of daily modeled peaks ≥ 70 ppb available for 8-hr Ozone Attainment Test

Size of Grid Cell Array:	2x2	3x3	5x5	7x7
▪ TCEQ 2005	275	349	408	449
▪ Post-2000	211	319	383	409
➢ May 2003	31	42	53	71
➢ Aug 2004	96	147	159	179
➢ Sept 2004	31	62	66	69
➢ May-Jun '05	53	68	75	90
total	486	668	791	858

As the size of the 'neighborhood' arrays increases from 2x2 to 7x7, the number of daily peaks potentially available for use in calculating RRFs increases. This may be important, because for a 7x7 array, for example, the 10 daily peaks needed at a monitor to calculate an RRF are likely to have larger concentrations compared with the smaller number of peaks available from smaller arrays. These larger concentrations, through the RRF/Attainment Test have been shown to produce greater photochemical model responsiveness to emissions controls.

CAMx Base Case Statistical and Graphical Performance Summary

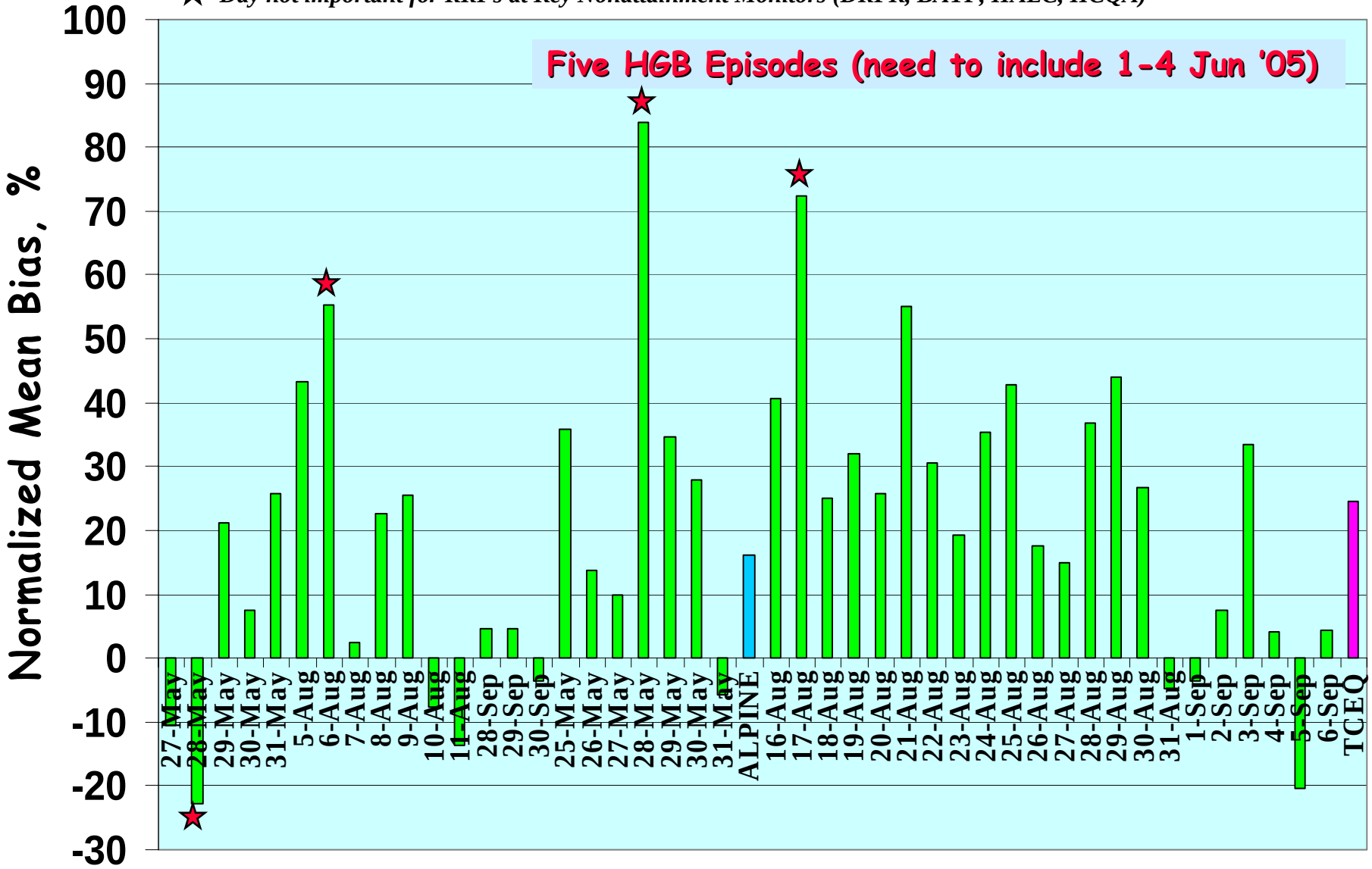
A variety of statistical measures (e.g., bias, gross errors, fractional bias, fractional error, peak prediction accuracy over all stations) and graphical displays (time series and Q-Q plots) confirm that all five HGB episodes possess many days suitable for SIP regulatory decision-making.

Also, several days where performance is 'poor' are not used in the RRF and Attainment Test calculations. So, assessment of model performance requires broad consideration of how the model was applied and how the results will be used in the SIP process.

$$\frac{\sum_{i=1}^{N}(P_i - O_i)}{\sum_{i=1}^{N} O_i}$$

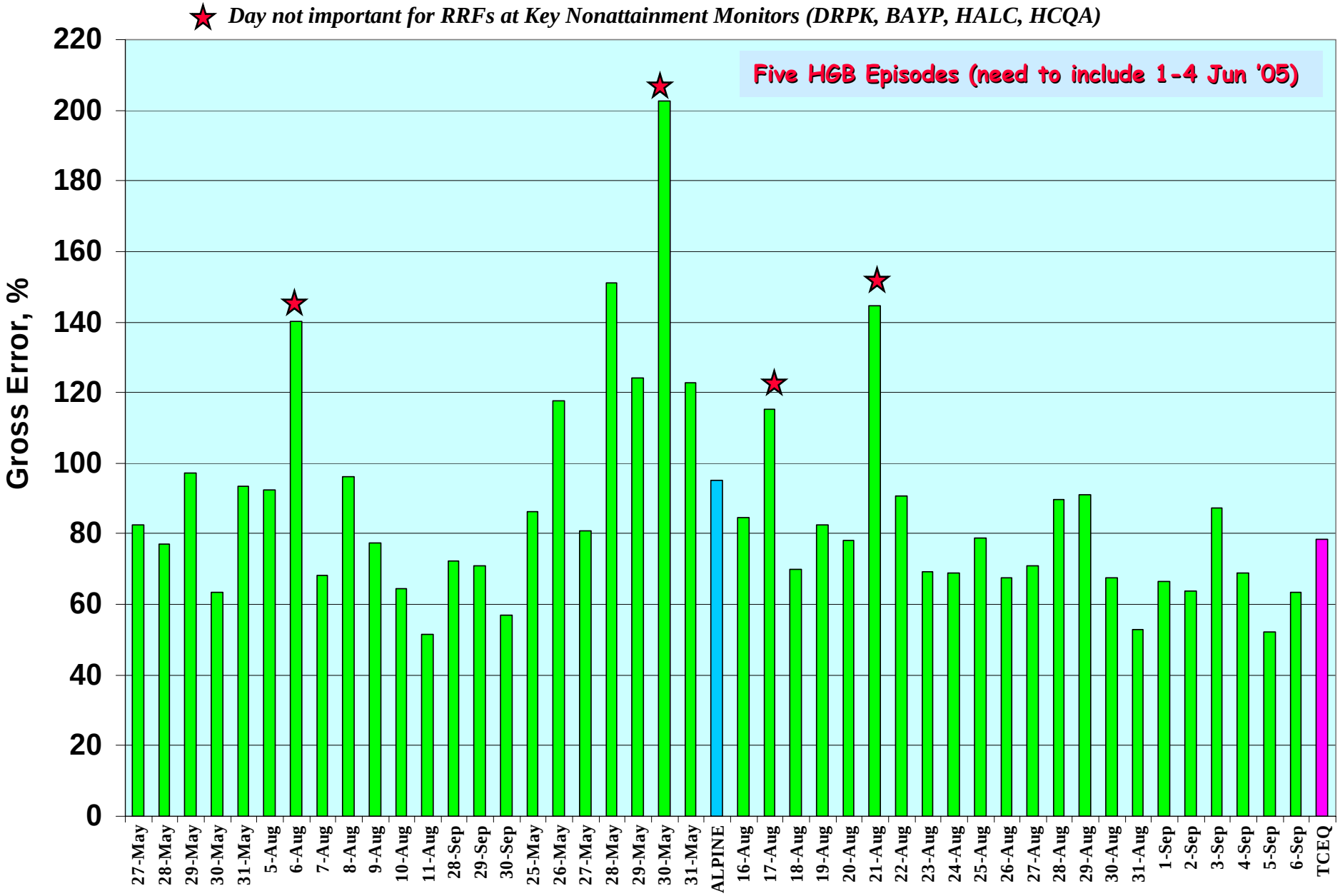
Normalized Mean Bias in 1-hr NO_2 (%)

★ *Day not important for RRFs at Key Nonattainment Monitors (DRPK, BAYP, HALC, HCQA)*



Mean Normalized Gross Error in 1-hr NO_2 (%)

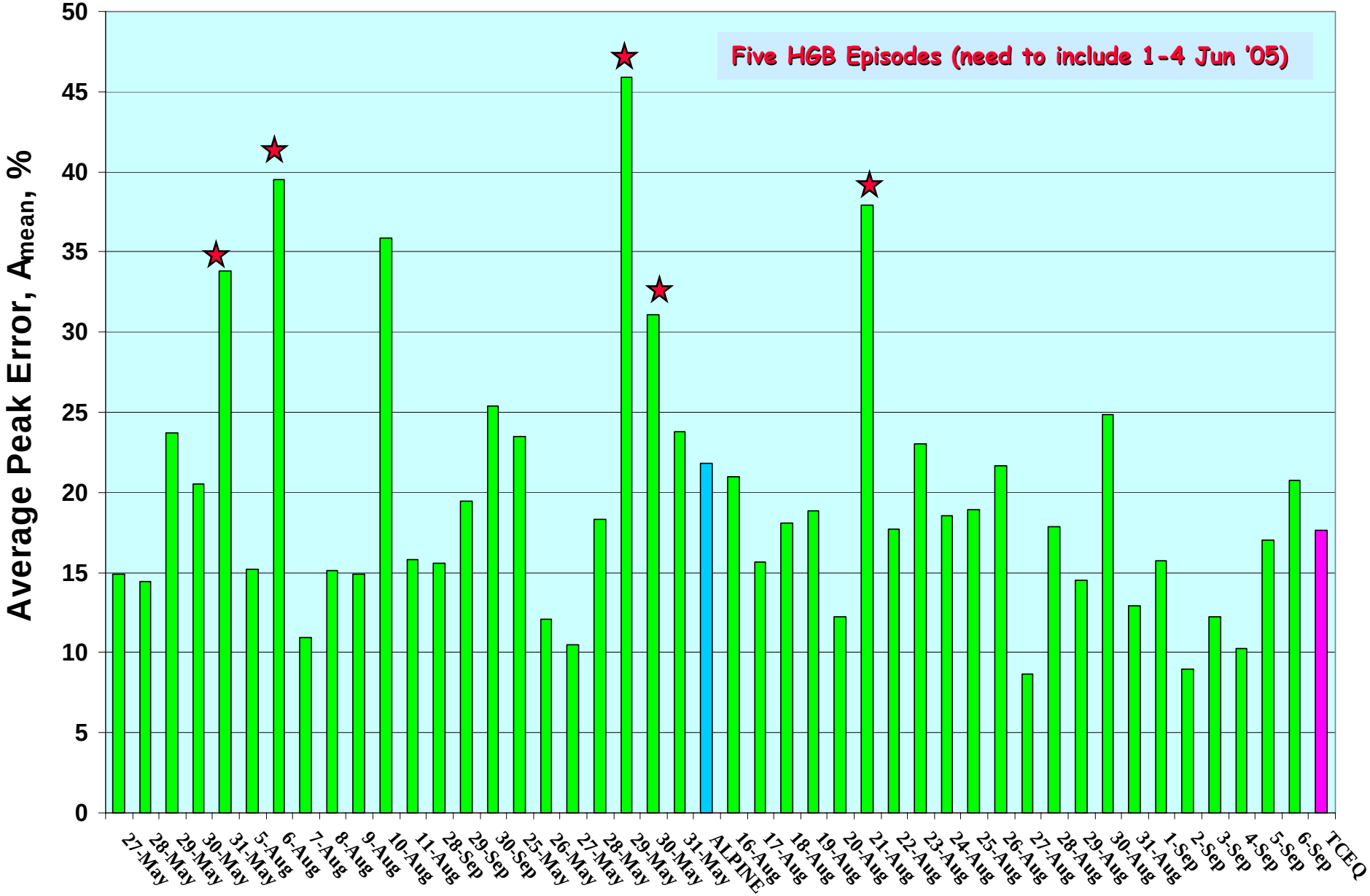
$$\frac{1}{N}\sum_{i=1}^{N}\frac{|P_i - O_i|}{O_i}$$



Average Error in Peak 1-hr Ozone Across All Monitors, A_{mean}

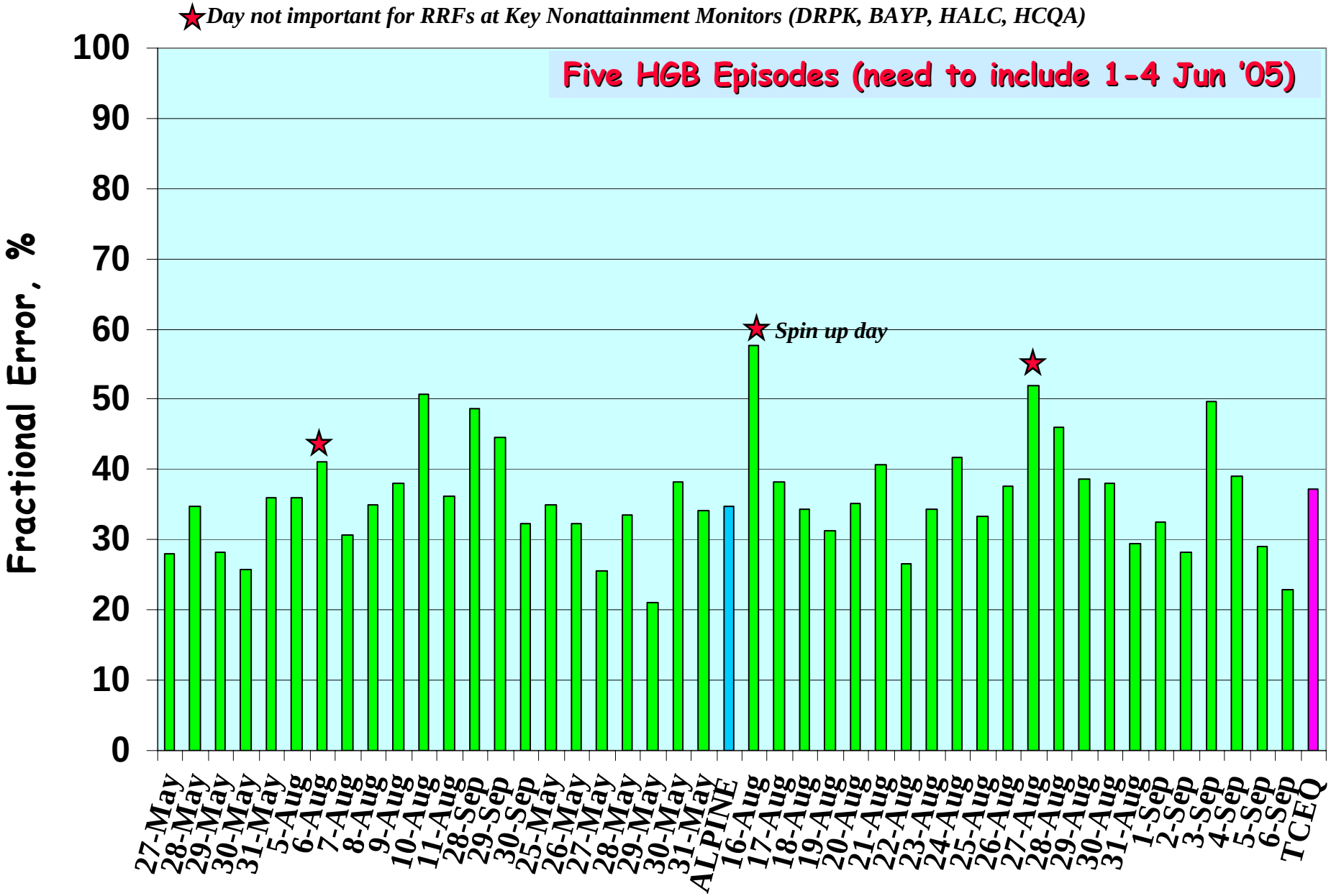
$$\sum_{i=1}^{N} \frac{(P_p - O_p)}{O_p}$$

★ *Day not important for RRFs at Key Nonattainment Monitors (DRPK, BAYP, HALC, HCQA)*



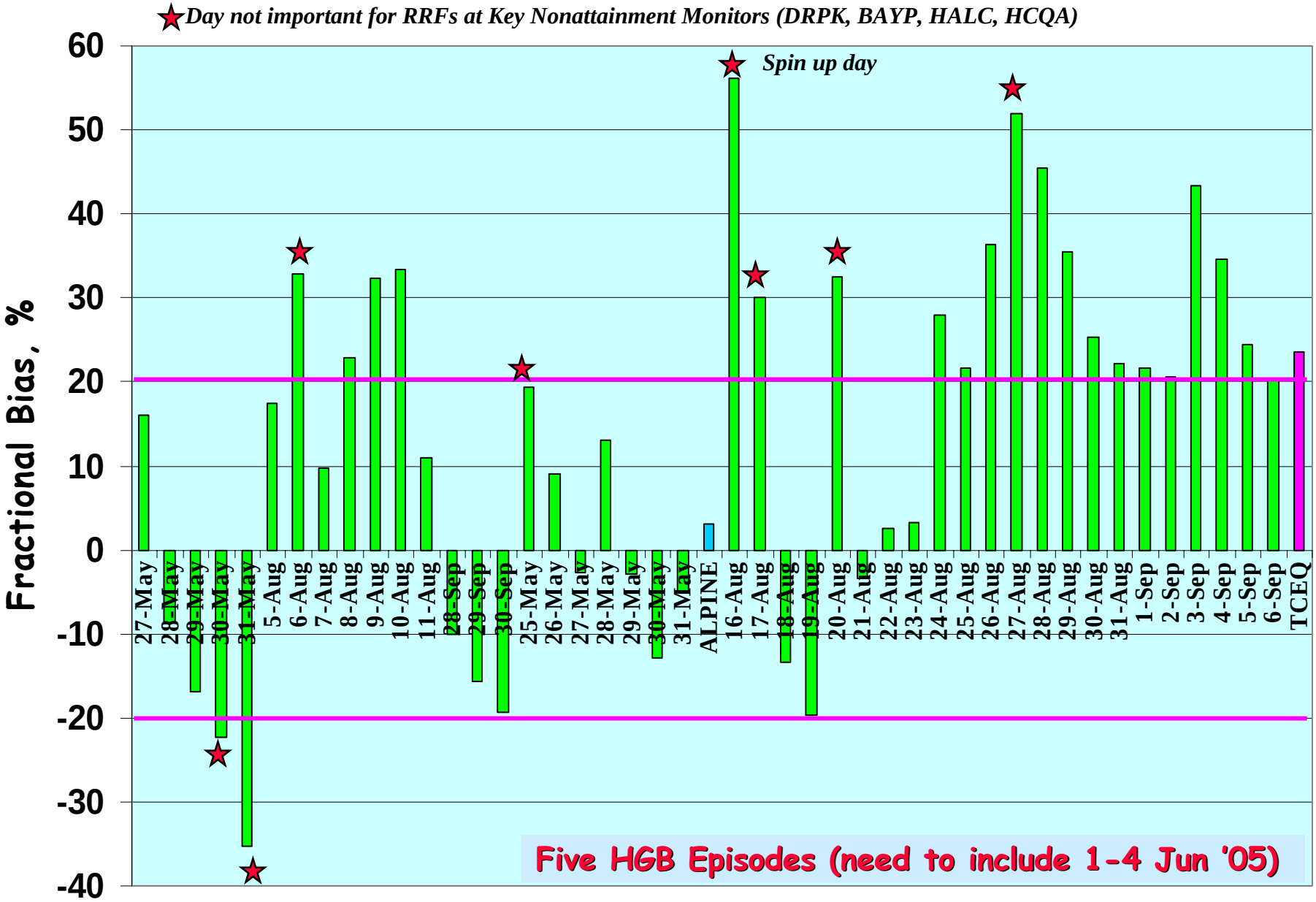
Fractional Error in 8-hr Ozone

$$\frac{2}{N}\sum_{i=1}^{N}\left|\frac{P_i - O_i}{P_i + O_i}\right|$$

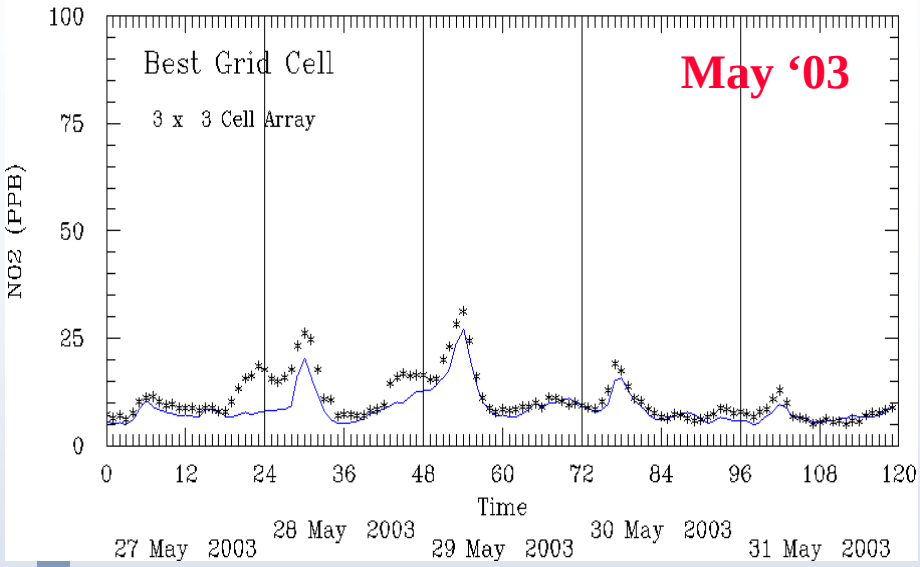


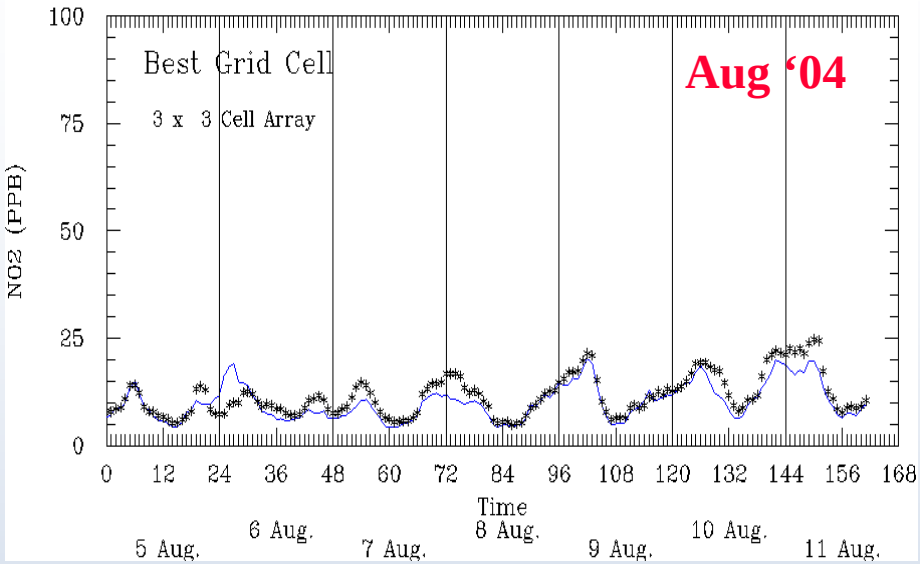
Fractional Bias in 8-hr Ozone

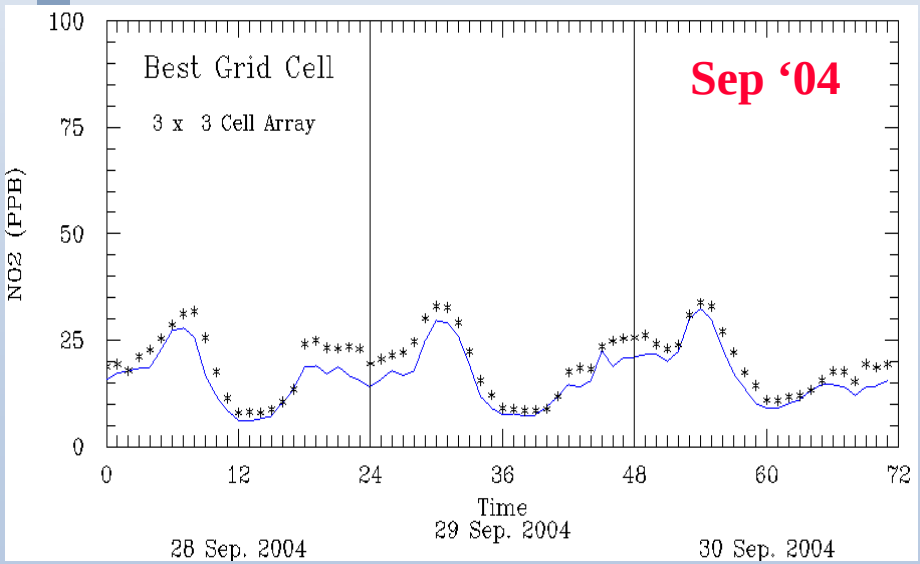
$$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$$

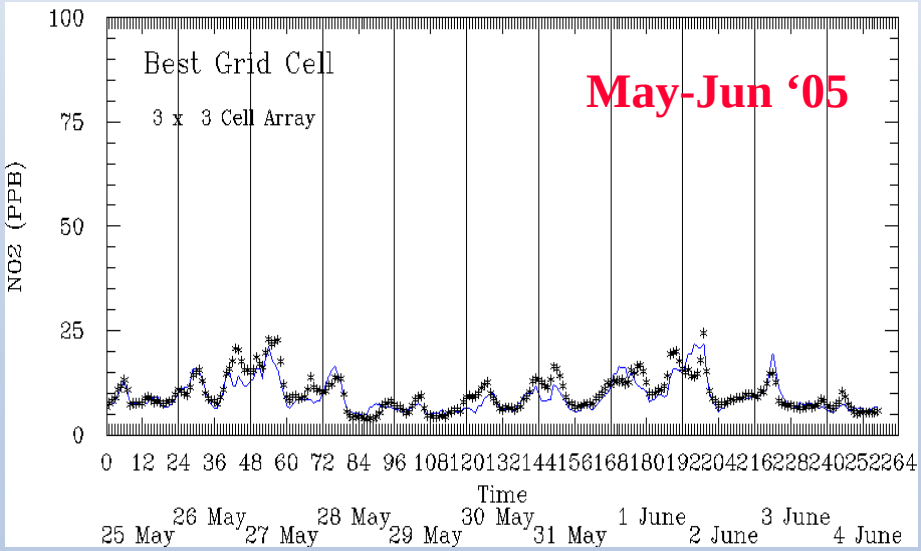


Spatial Mean 1-hr NO_2 Time Series (ppb)

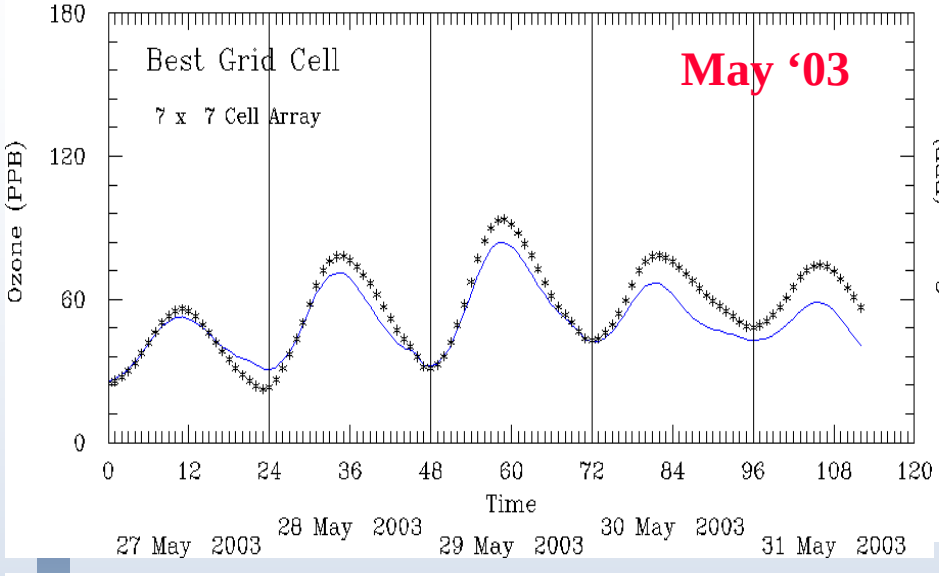


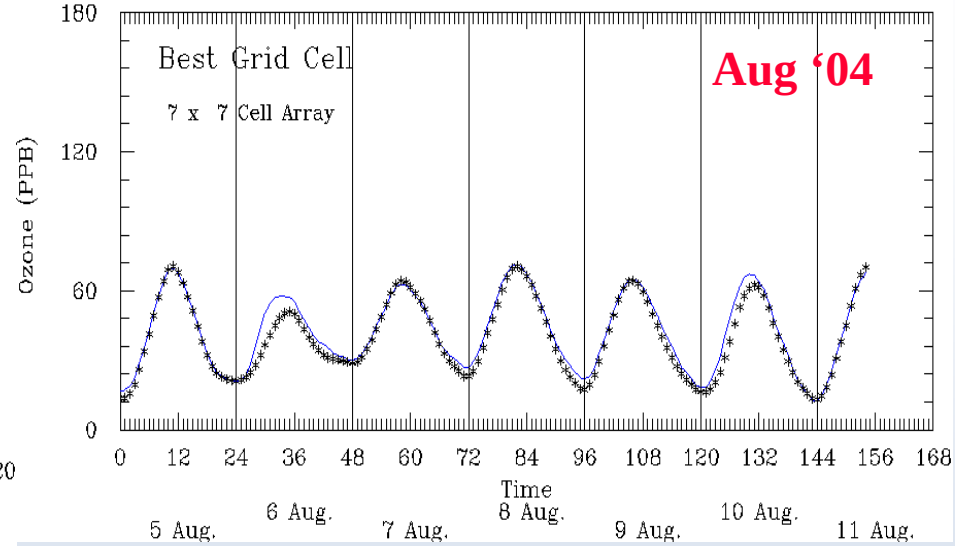


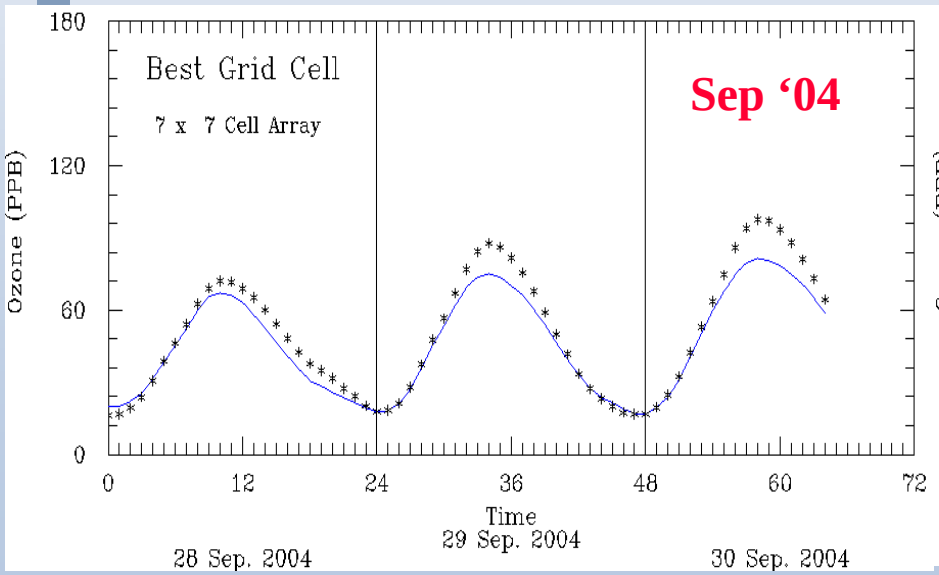


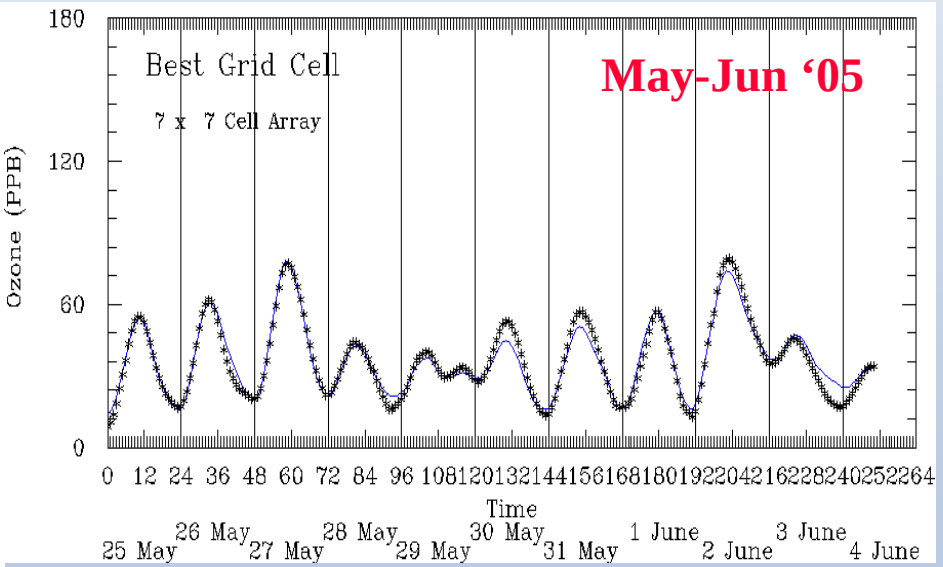


Spatial Mean 8-hr Ozone Time Series (ppb)



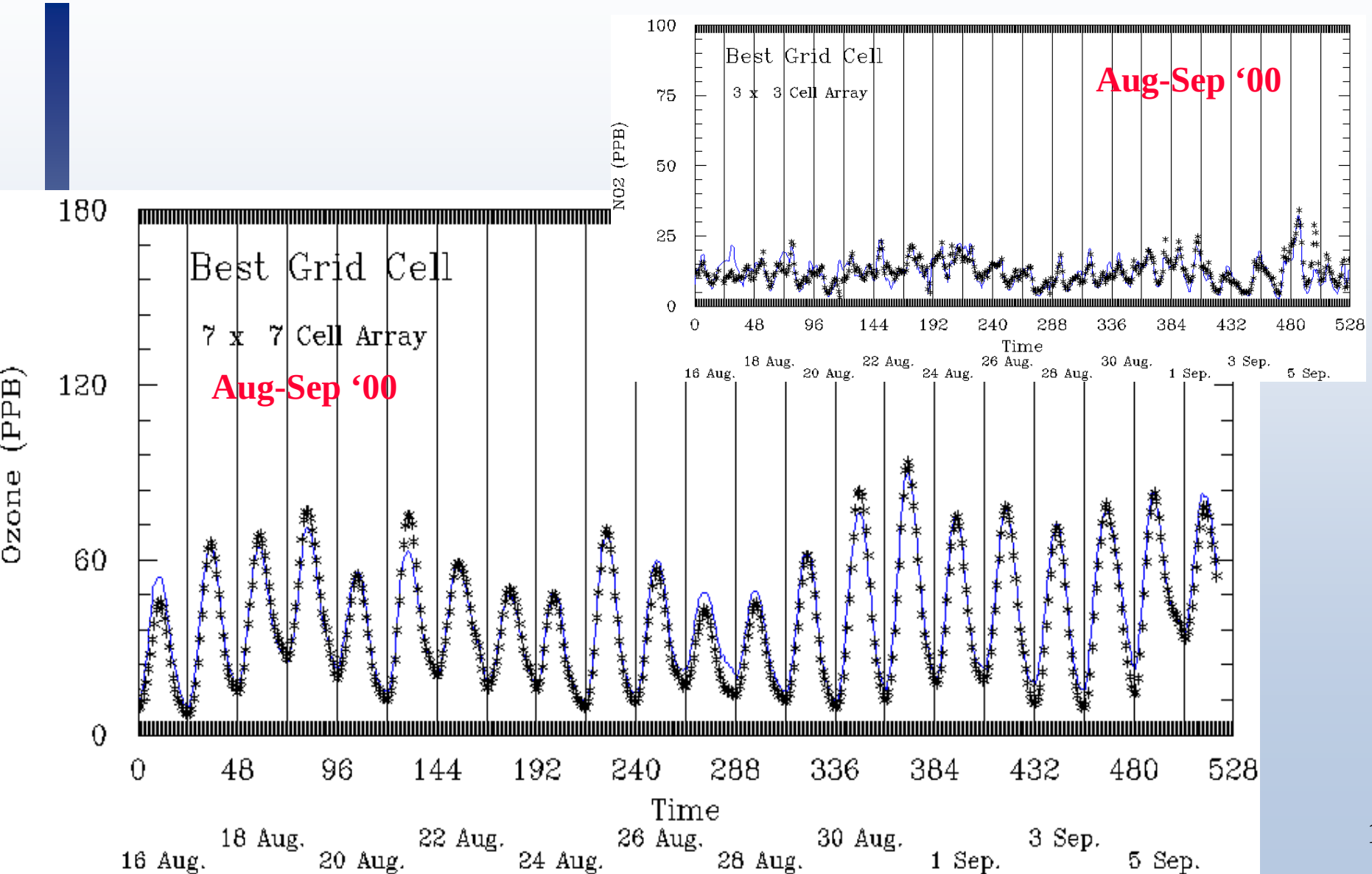






Spatial Mean 8-hr Ozone & 1-hr NO_2 Time Series

TCEQ Emissions (base1bpsito2n2.TCEQuh1_eta)

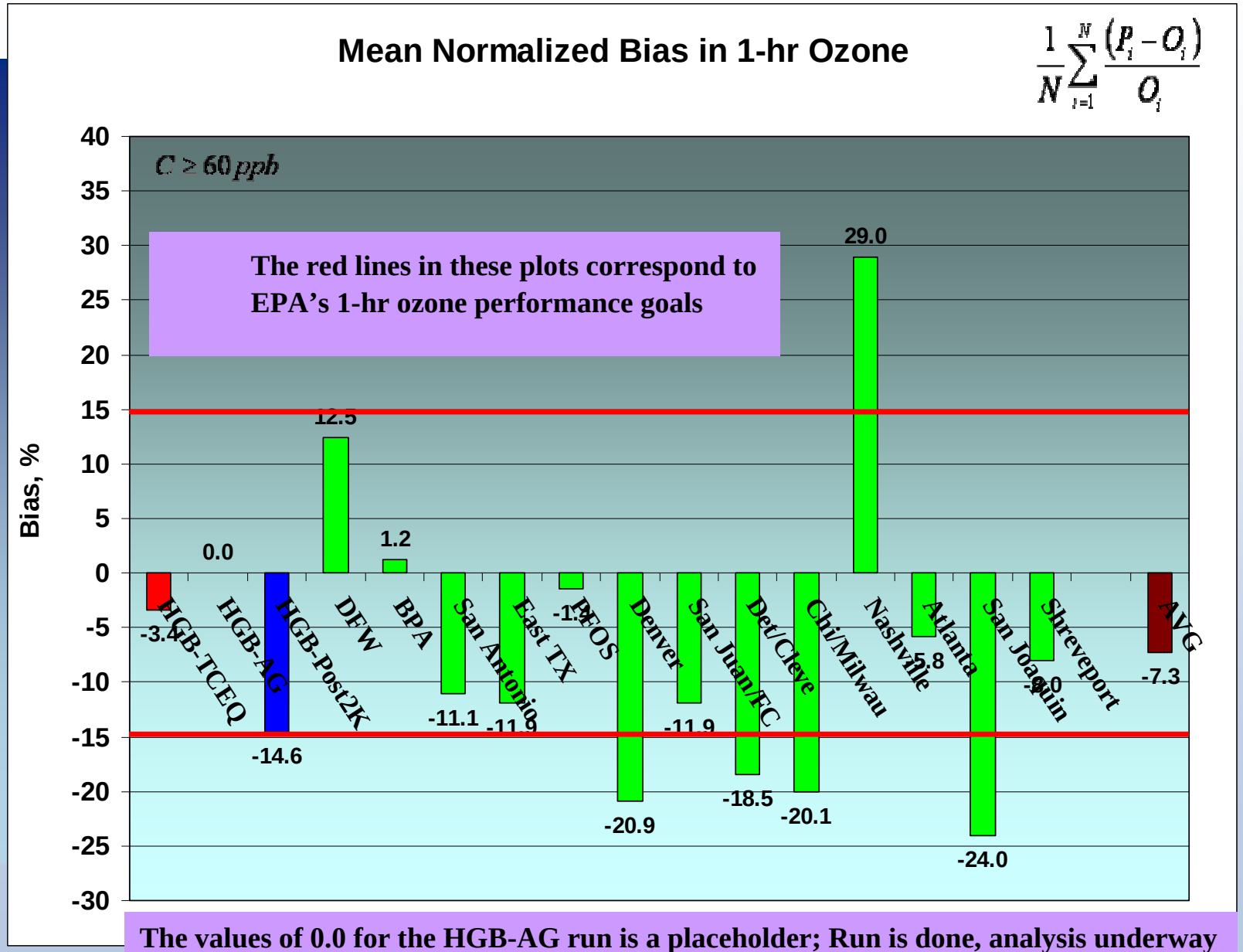


Comparison of CAMx Performance In HGB with other SIP Studies

The various statistical metrics used to test 8-hr model ozone performance have their roots in the methods developed up to three decades ago to evaluate Gaussian models and single-day airshed models (without biogenic emissions). Over time, the new and improve methods have emerged, but even today many of these 'legacy metrics' from the 1980s remain in use (and in favor) by some……..

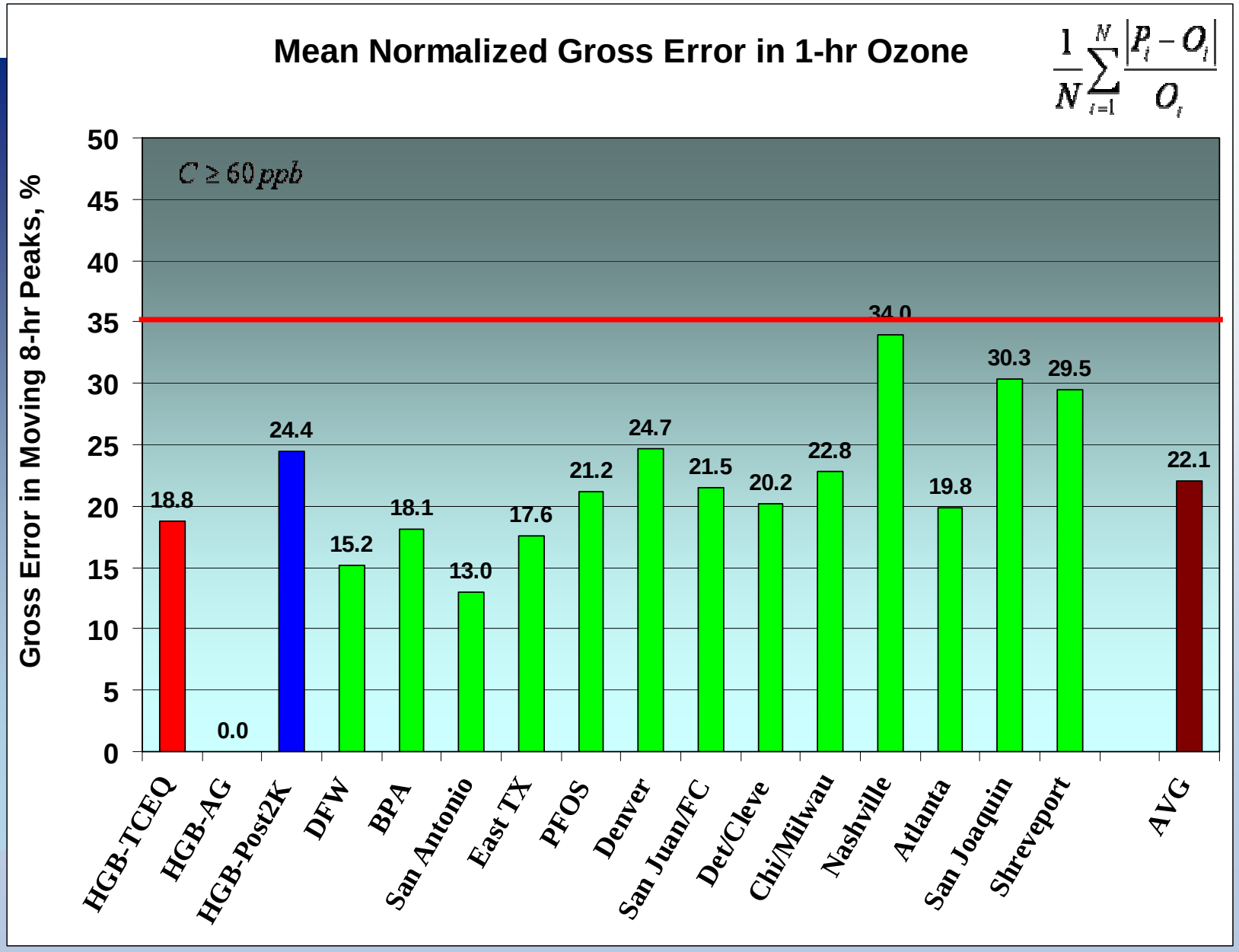
Table 1. Modeling Studies Reviewed.		
Non-Attainment	Study Name	Ref.
San Juan/Four Corners	4 Corners EAC	x
Fall Line Air Qual Stu.	Atlanta	x
Austin	Austin EAC	x
Beaumont-Pt. Arthur	BPA SIP	x
CENRAP Reg Haze	CENRAP	x
Lower Lake Michigan	Chi-Gary-Milw	x
Denver Front Range	Denver EAC	x
Detroit-Cleveland	Det/Cleve	x
Dallas-Ft.Worth	DFW SIP	x
Longview-Tyler	East TX	x
Houston-Galv-Brazoria	HGB-Post2K	x
Houston-Galv-Brazoria	HGB-TCEQ	x
SOS-SE US	Nashville	x
Oklahoma	OK EAC	x
Peninsular Florida	PFOS	x
San Antonio	SAER EAC	x
San Joaquin Valley	San Joaquin	x
Shreveport	Shrev EAC	x
St. Louis	St. Louis SIP	x
VISTAS Reg Haze	VISTAS	x

Bias in 1-hr ozone (4 km)

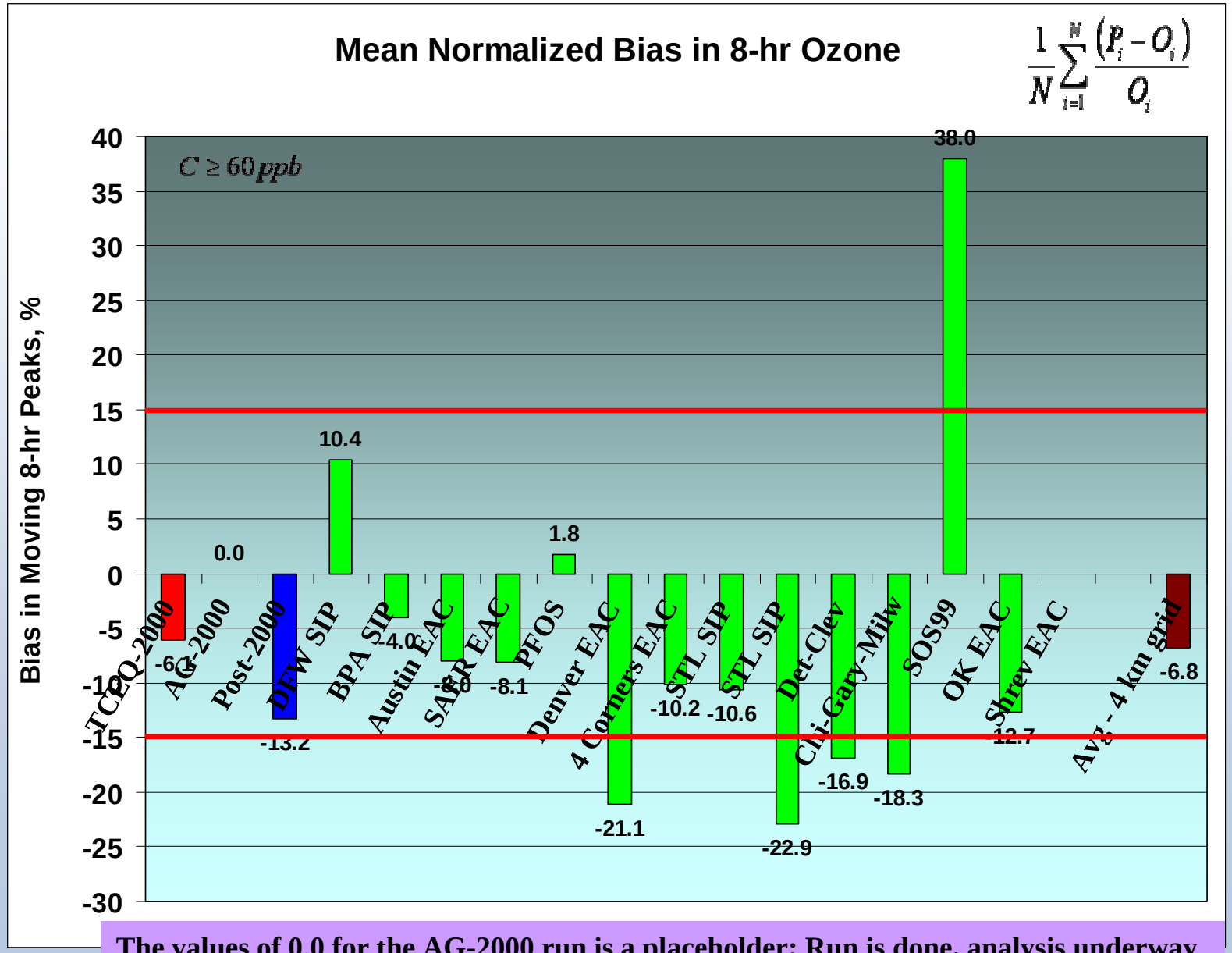


The values of 0.0 for the HGB-AG run is a placeholder; Run is done, analysis underway

Error for 1-hr ozone (4 km)

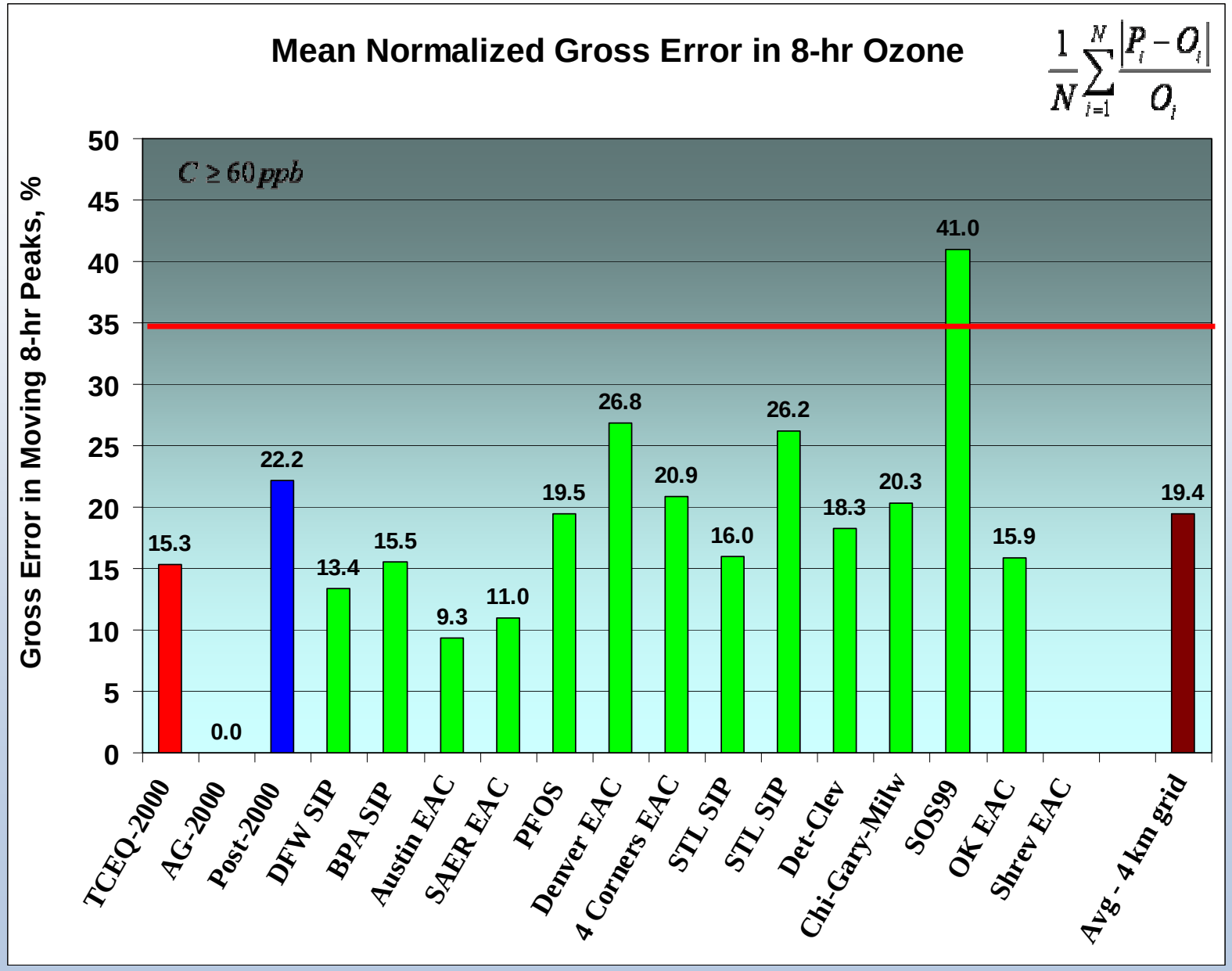


Bias for 8-hr ozone (4 km)

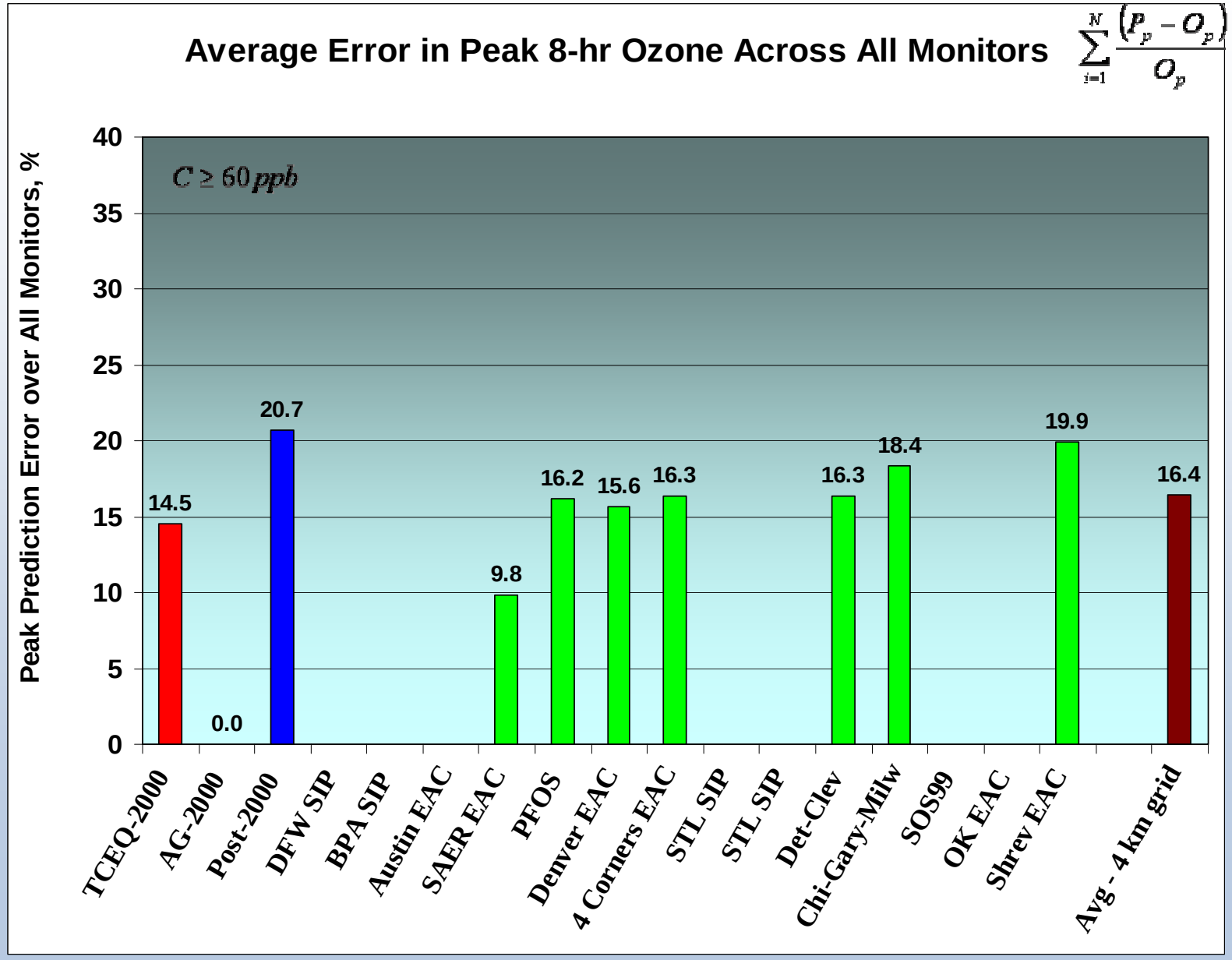


The values of 0.0 for the AG-2000 run is a placeholder; Run is done, analysis underway

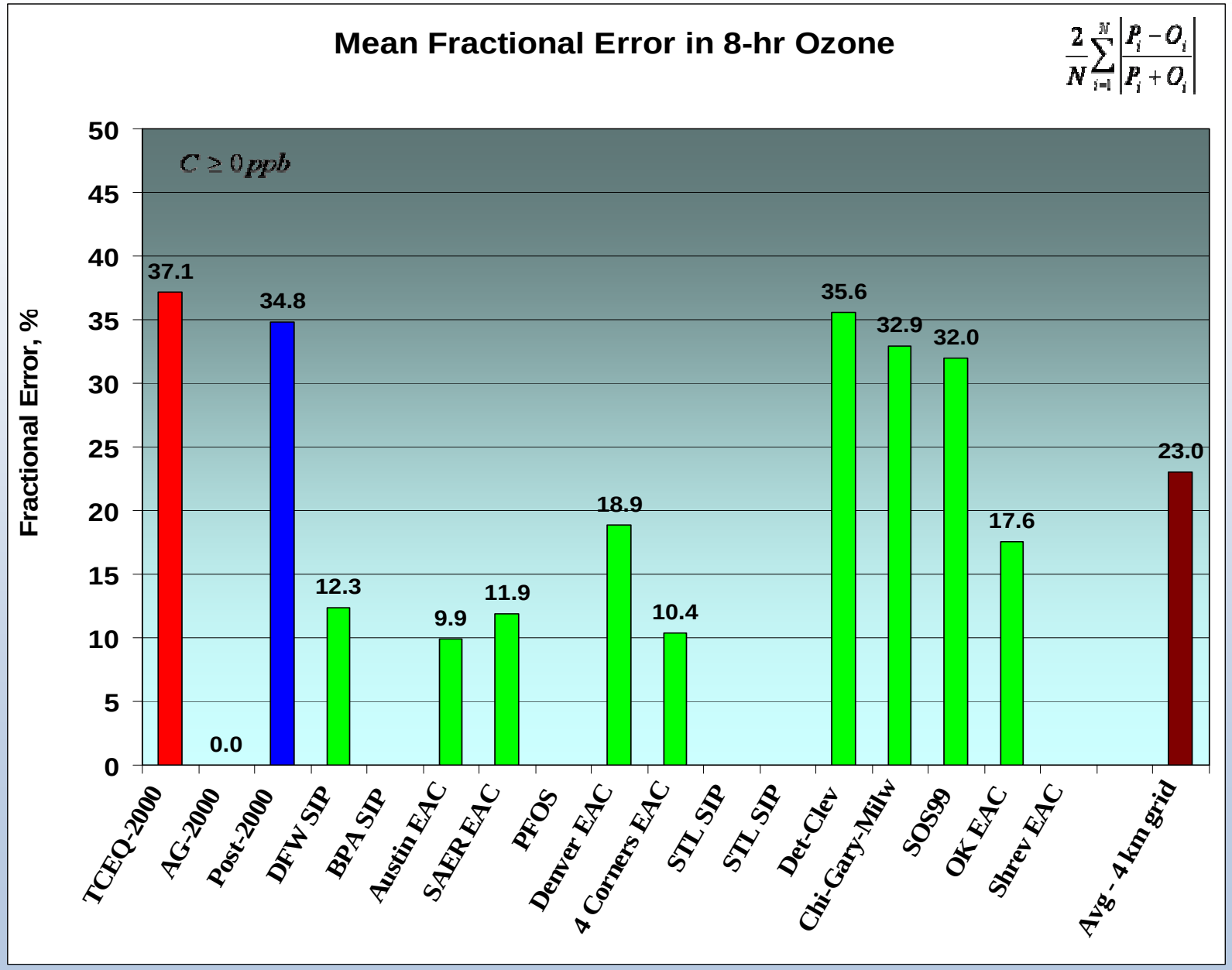
Error for 8-hr ozone (4 km)



Avg Peak Error for 8-hr ozone (4 km)



Fract Error for 8-hr ozone (4 km)



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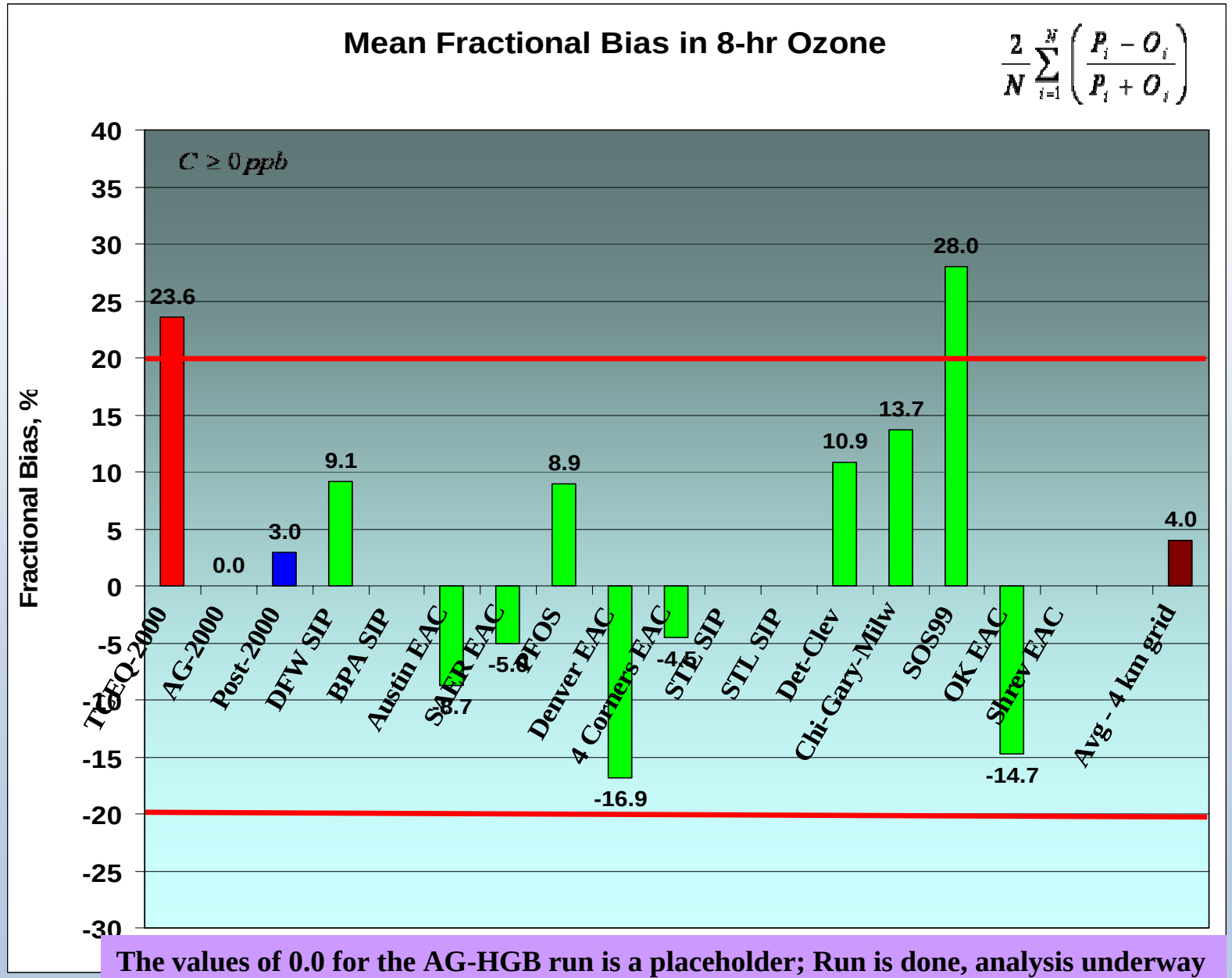

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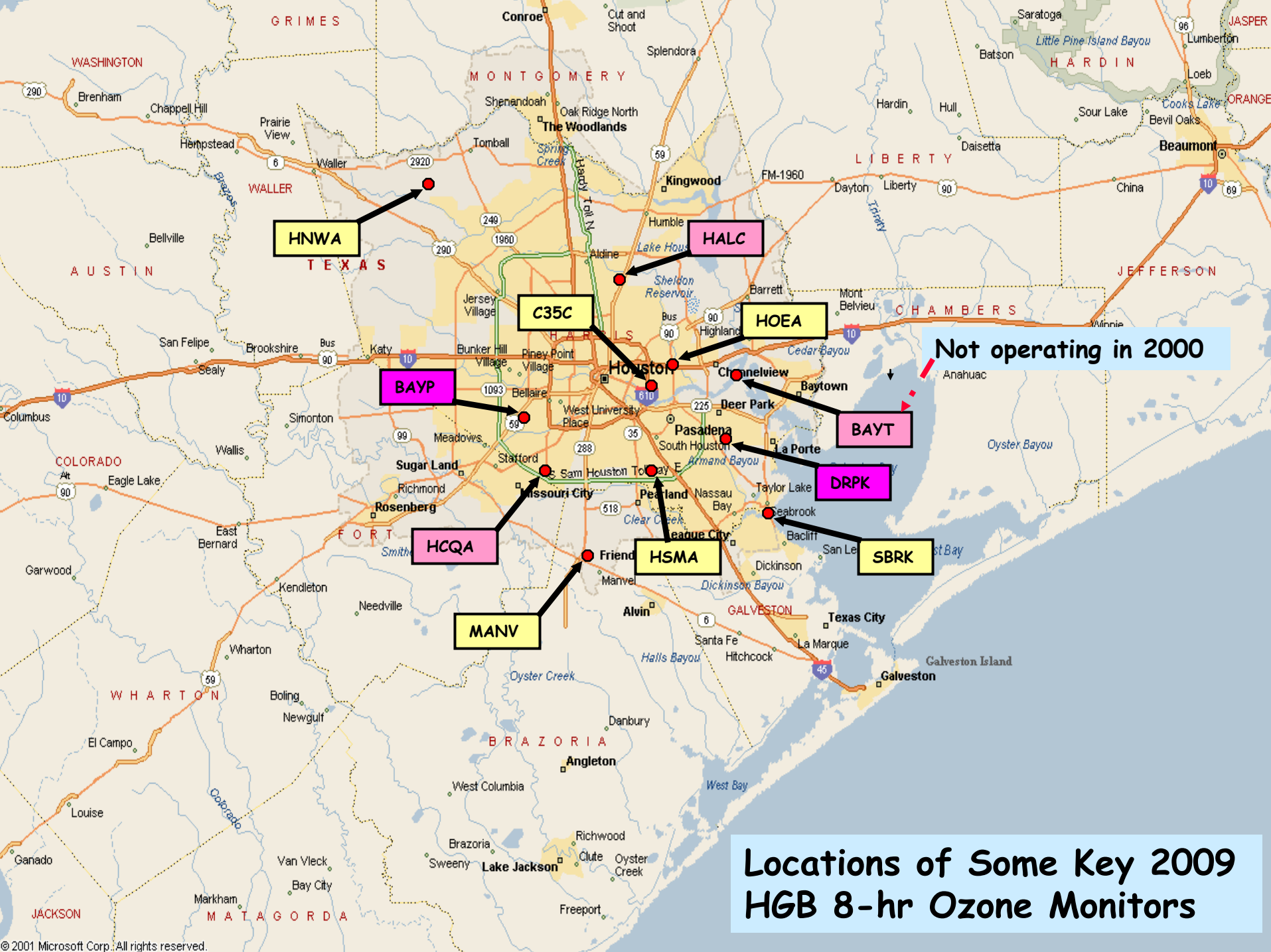
Do Post-2000 Episodes, Which Almost Double the Number of RRF Days, Potentially Make CAMx More Responsive to Emissions Controls?

Possibly.. See Tech Support Doc.

Does Recent 2009 Emissions Strategy Sensitivity Modeling Suggest Other HGB Monitors May Be <u>More</u> Difficult to Control than Deer Park, Bayland Park, Croquet, & Aldine?

Based on the recent 2009 Residual Nonattainment Modeling with the post-2000 episodes, the Deer Park, Bayland Park, Croquet, and Aldine Monitors are the highest nonattainment monitors. However, the Baytown (BAYP) monitor also shows up in the post-2000 episode and is a key nonattainment monitor. Baytown was not included in the 2000 episode because monitoring began later at this site.


HNWA
HALC
C35C
HOEA
BAYP
BAYT
DRPK
HCQA
HSMA
SBRK
MANV
Not operating in 2000
Locations of Some Key 2009
HGB 8-hr Ozone Monitors
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Summary

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- Addition of the post-2000 episodes will augment the 2000 TCEQ episode in several significant ways:
  - Providing the opportunity to test potential control strategies over a broader set of meteorological conditions, emissions patterns, and years
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- Detailed CAMx performance testing of all five episodes, including comparisons with nearly 20 other regulatory studies in the U.S, confirms that all five HGB ozone episodes are SIP-quality and a solid framework for testing emissions reduction strategies

Next Steps

- TCEQ is encouraged to add appropriate days from the four post-2000 episodes to the Aug-Sep 2000 HGB episode to strengthen the overall SIP modeling platform
  - Alpine provided complete CAMx input and output files and post-processing software for all four episodes (base year and 2009 future year) in March.
  - Project ftp sites have been established at Alpine and UNC to facilitate data transfers.
- OSAT/APCA/Roll-Out Modeling with 5 episodes completed. Results to be presented at next SETPMTC meeting.