

DFW Modeling Review

1999 Base Case Modeling Evaluation

SIP Steering Committee

Pete Breitenbach

November 19, 2004



Executive Summary

DFW Modeling Review

- The DFW modeling review continues to improve model performance, but did not solve all the problems
 - We are producing the right amount of ozone
 - But in the wrong locations on 2 days
- Model performance
 - Daily peaks track well (1-hour and 8-hour)
 - Modeled peak ozone is higher than monitored on most days
 - However, Ozone production still low in city core
 - Biased low at monitors, but significantly improved
 - Gross Error satisfactory every day, less error than before
 - Six days (out of 8) meet EPA 1-hour statistical criteria

Action Plan

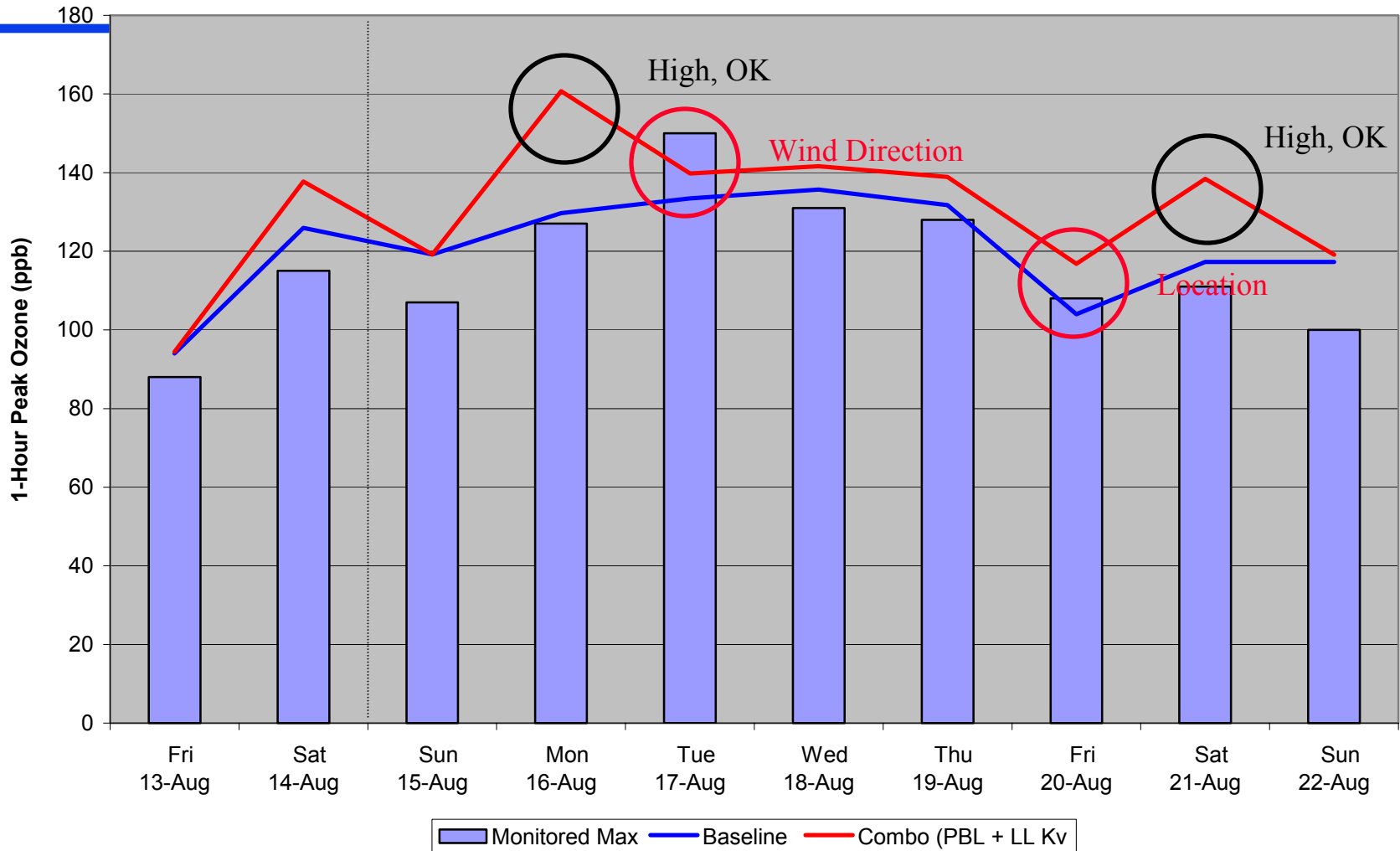
- Analyze Vertical Mixing
- Evaluate Precursor Concentrations
- Identify Long Range Projects
- Identify Potential New Episodes
- Involve EPA in Evaluation Process
- Test Moisture Sensitivity

Problems Identified

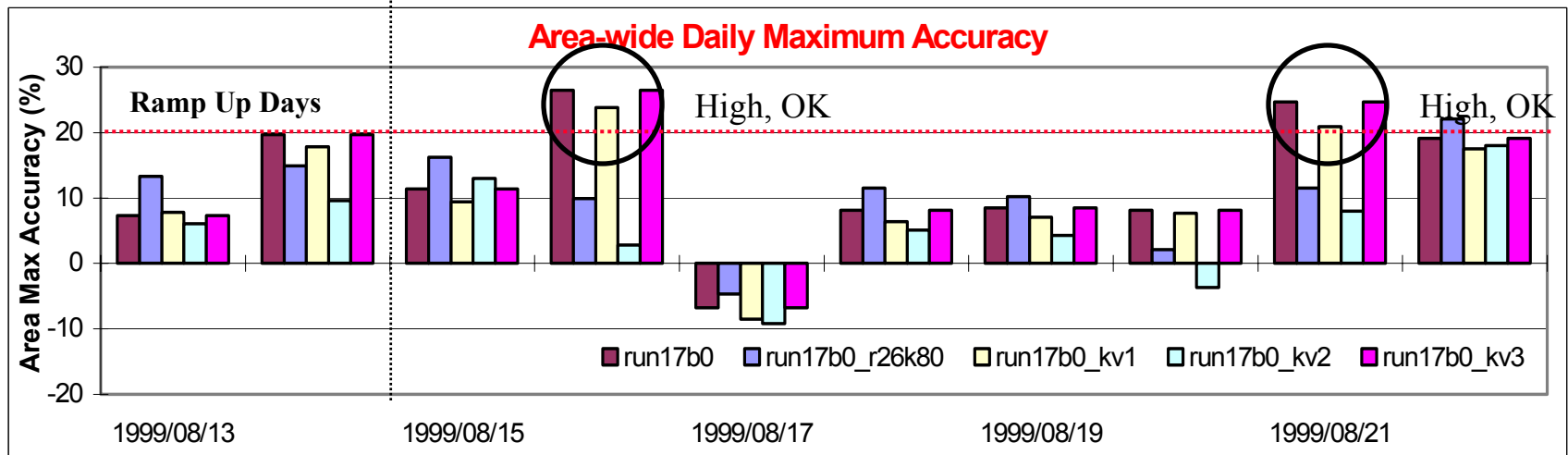
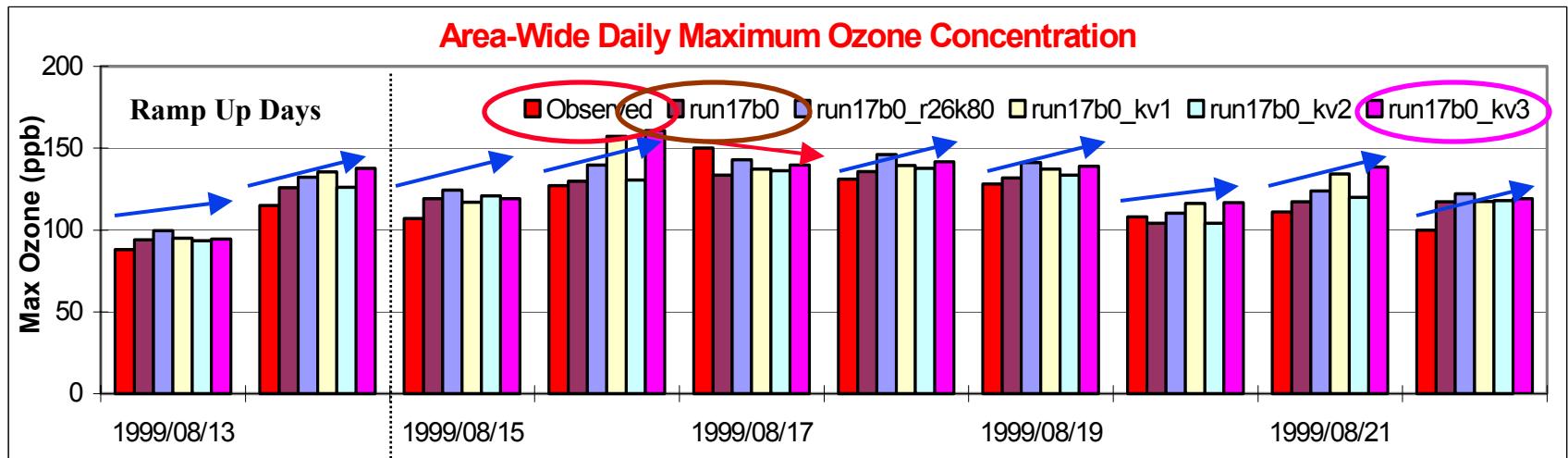
- MM5 Wind Speeds too strong at the surface
 - Repaired by Environ
- MM5 Wind direction error on August 17th
 - Still present, unresolved
- MM5 vertical mixing too deep, Planetary Boundary Layer too high
- Precursor Concentrations at surface too high
- MM5 modeling dry, moisture low at the surface
- Process Analysis – Ozone production low in city

DFW Model Performance Improvement

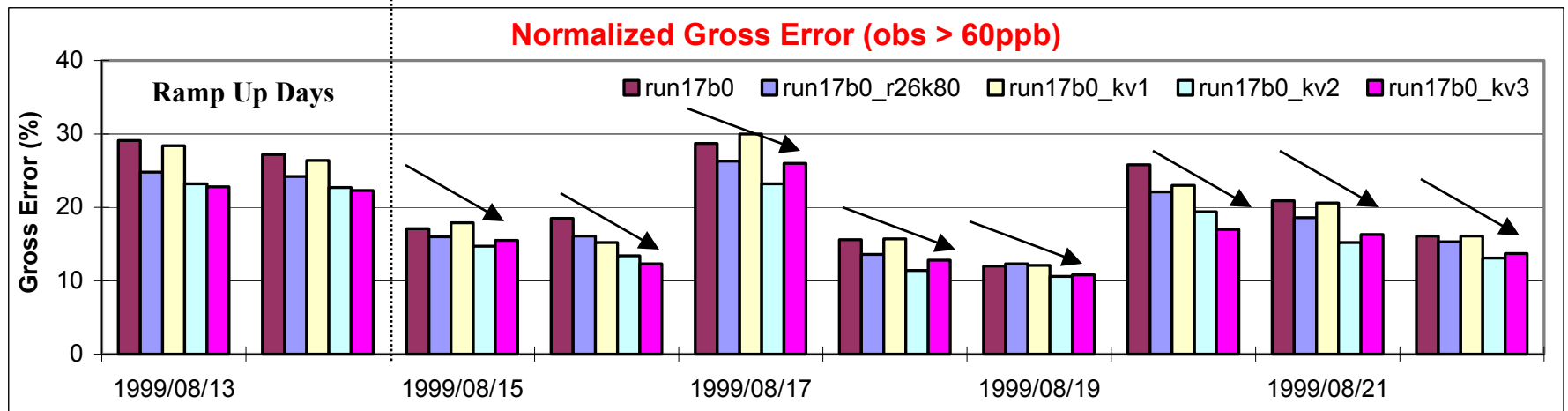
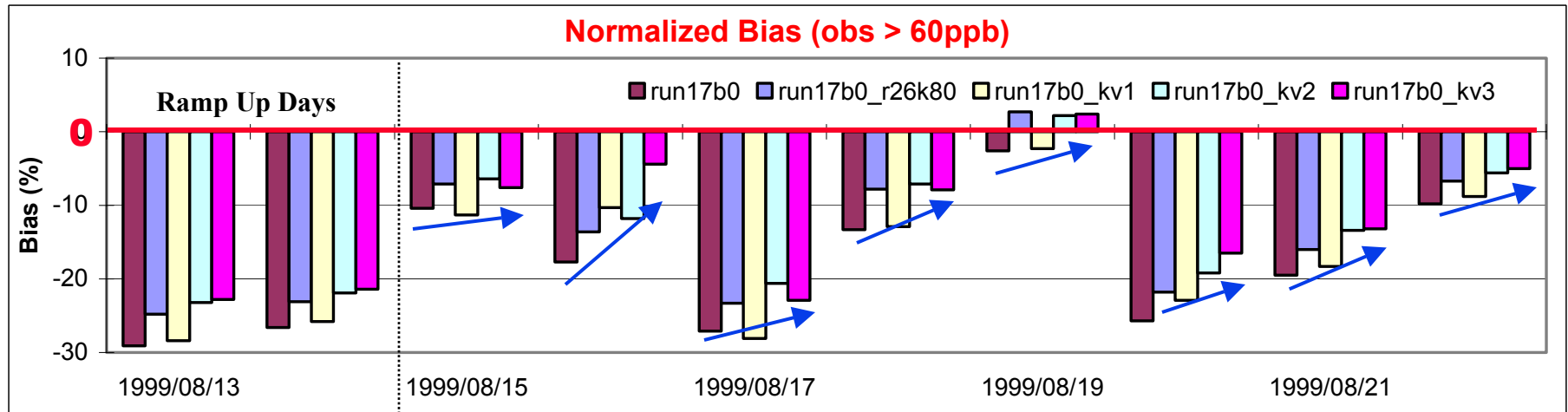
August 13-22, 1999 Episode - Peak to Peak Statistics



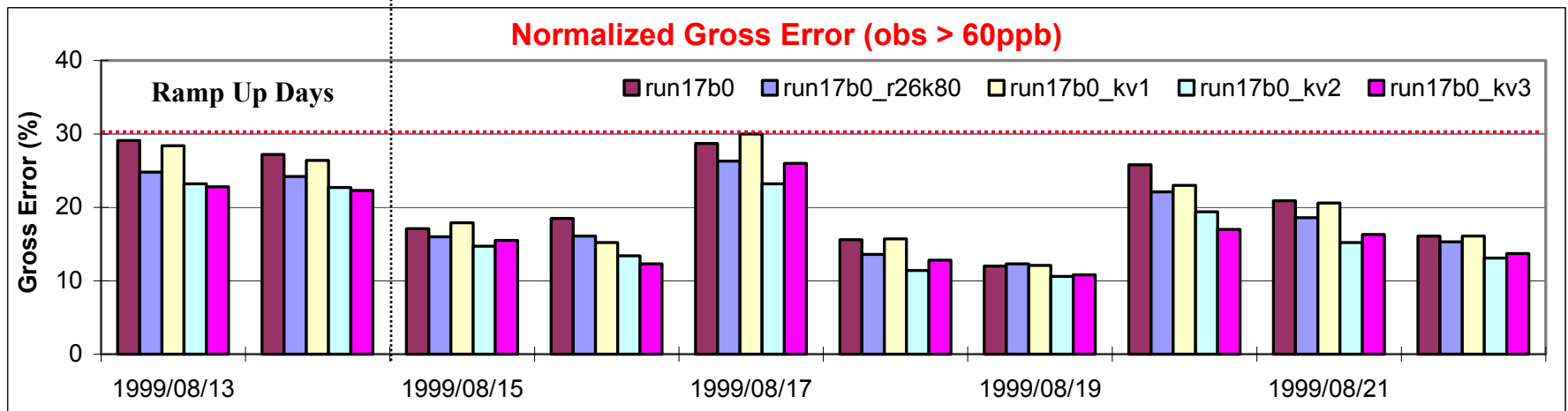
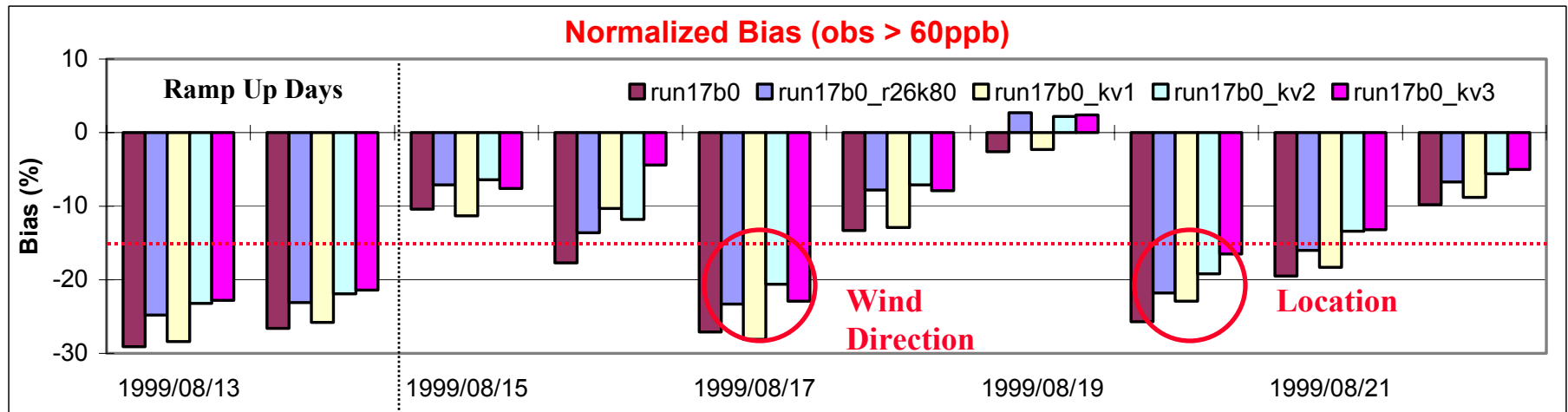
1-Hour Peak Statistics



1-Hour Bias and Gross Error Stats

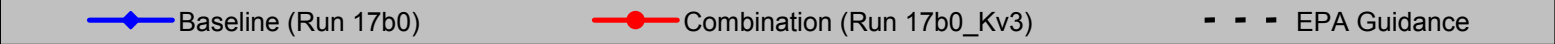
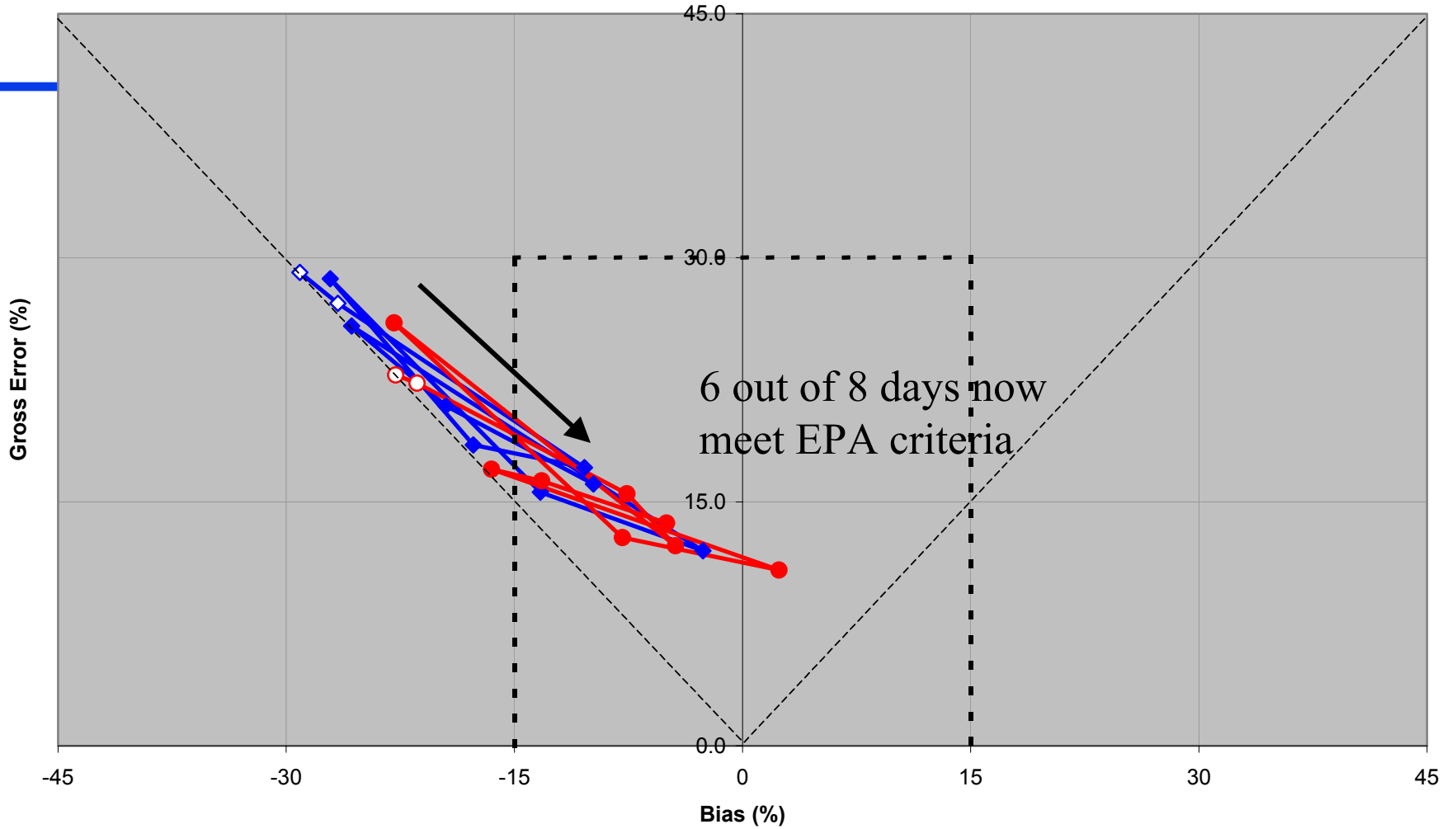


1-Hour Bias and Gross Error Stats

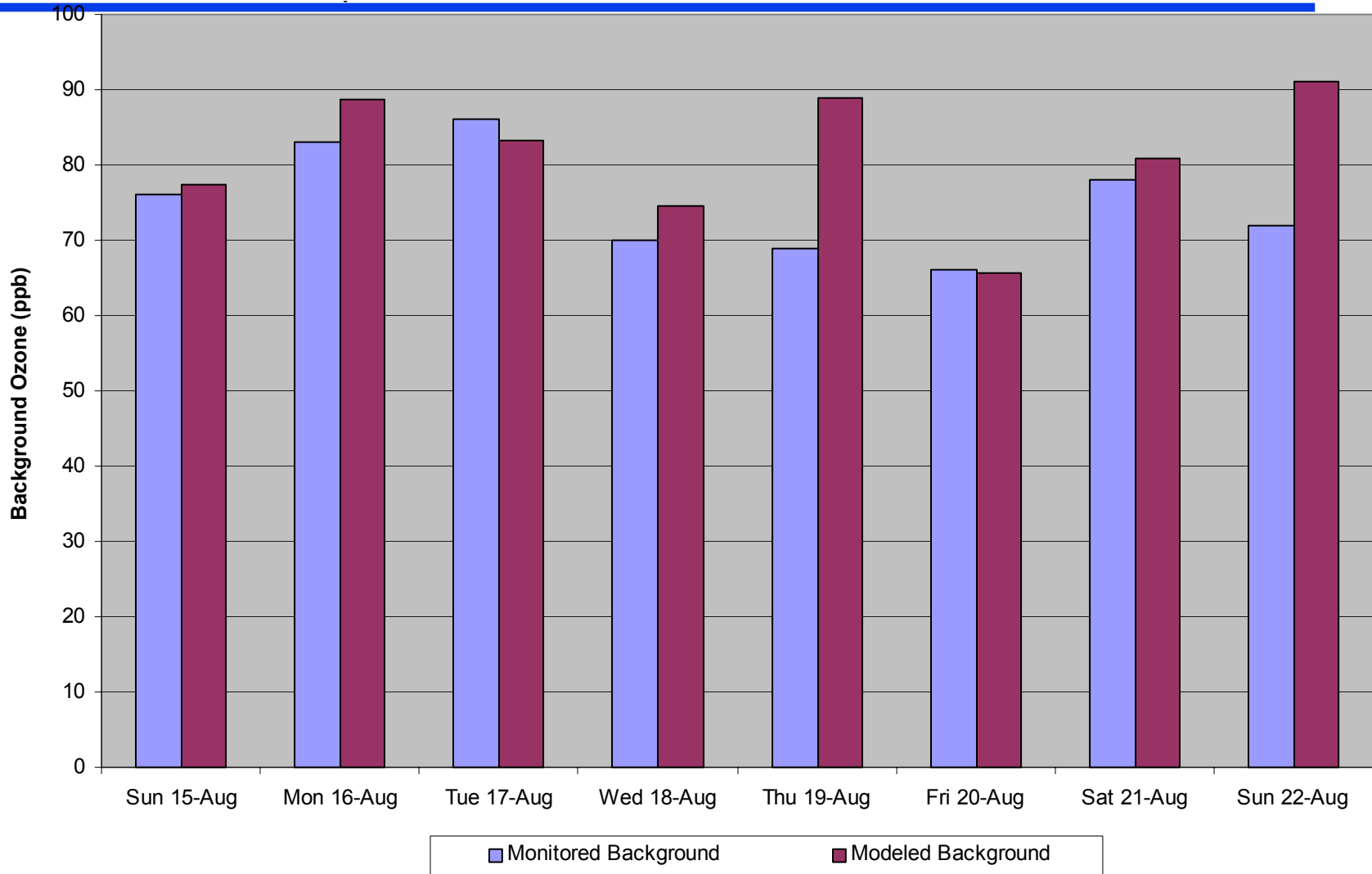


DFW Model Performance Improvement

August 13-22, 1999 - Bias/Gross Error Statistics

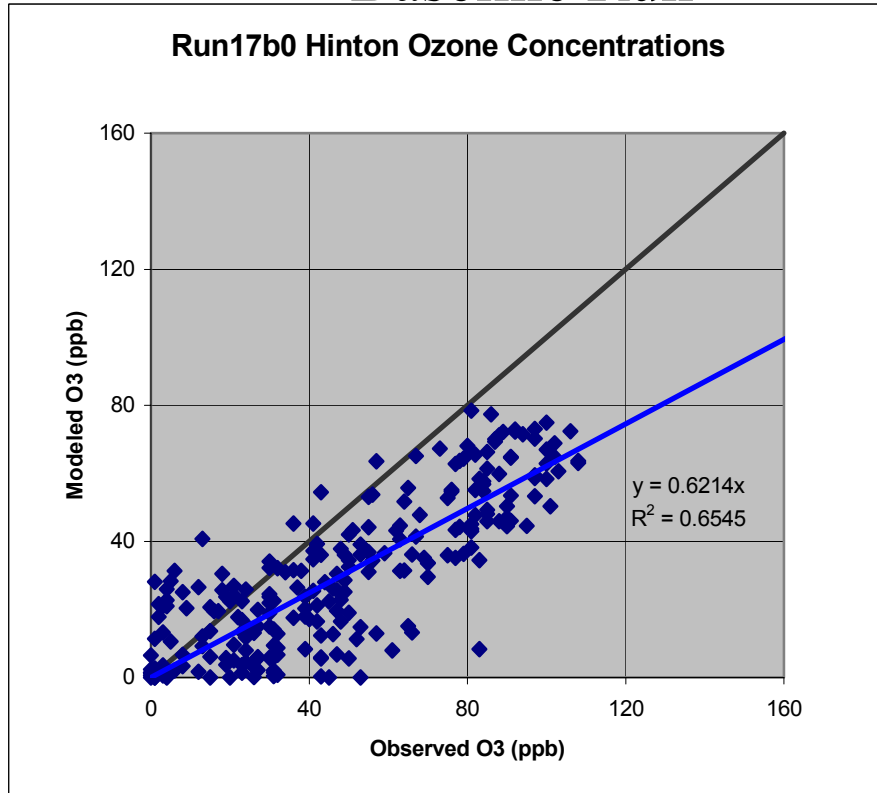


Are We Generating Enough Background Ozone?

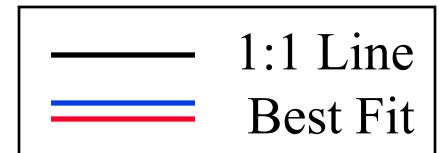
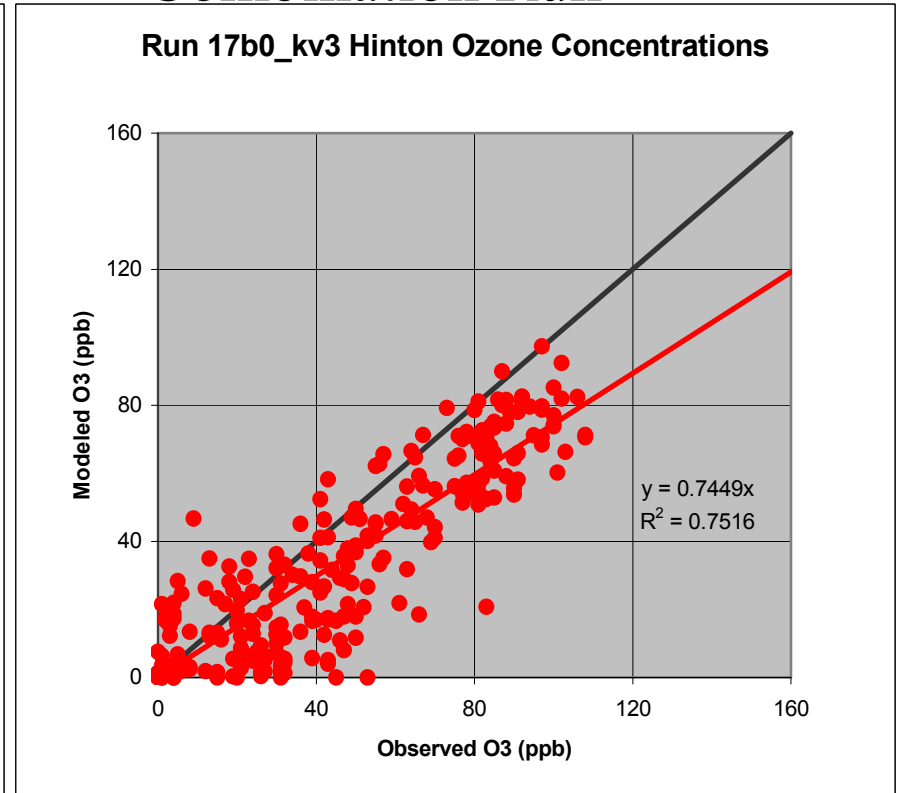


Hinton Drive Ozone Improvement

Baseline Run

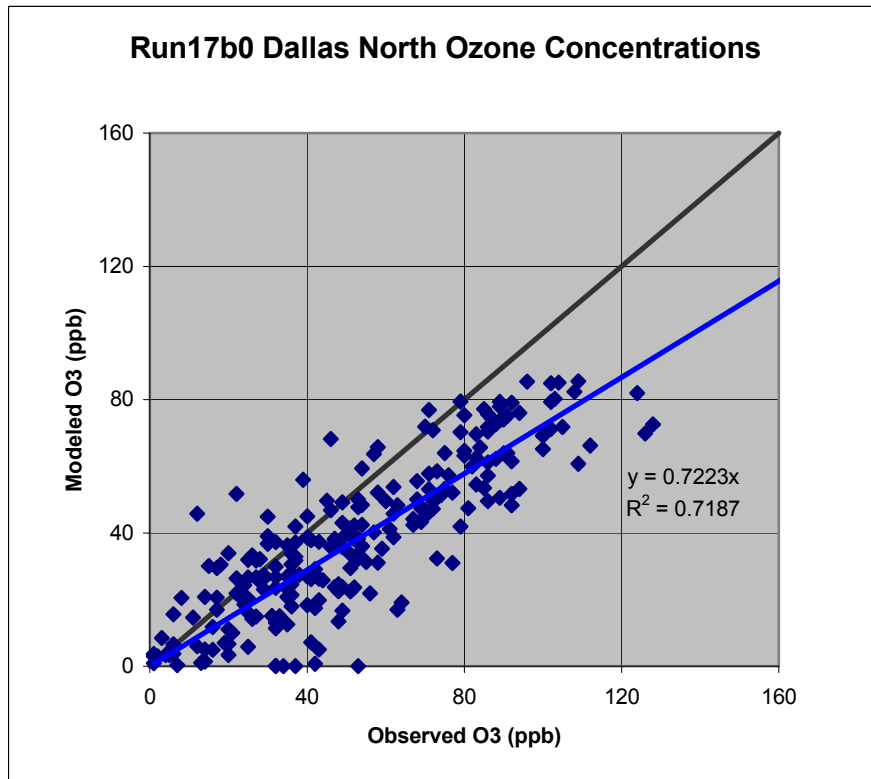


Combination Run

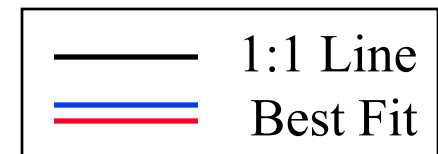
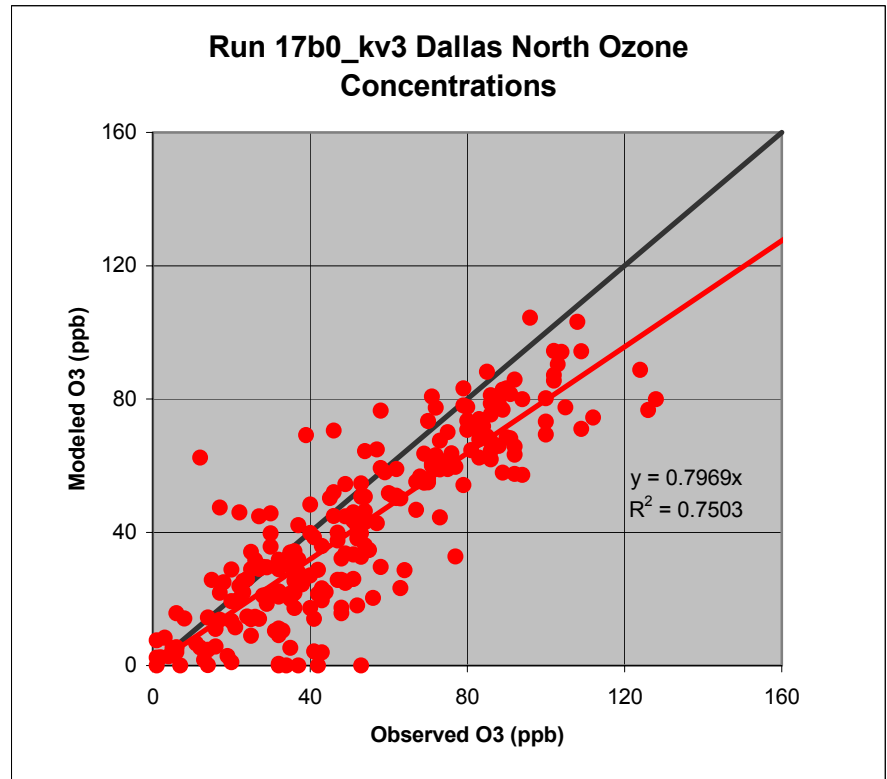


Dallas North Ozone Improvement

Baseline Run



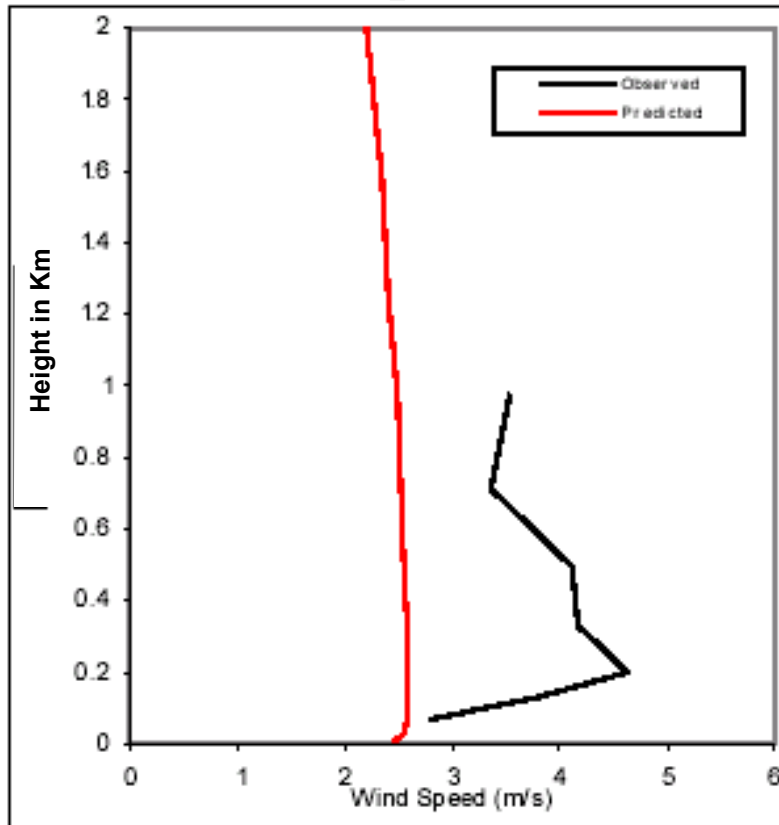
Combination Run



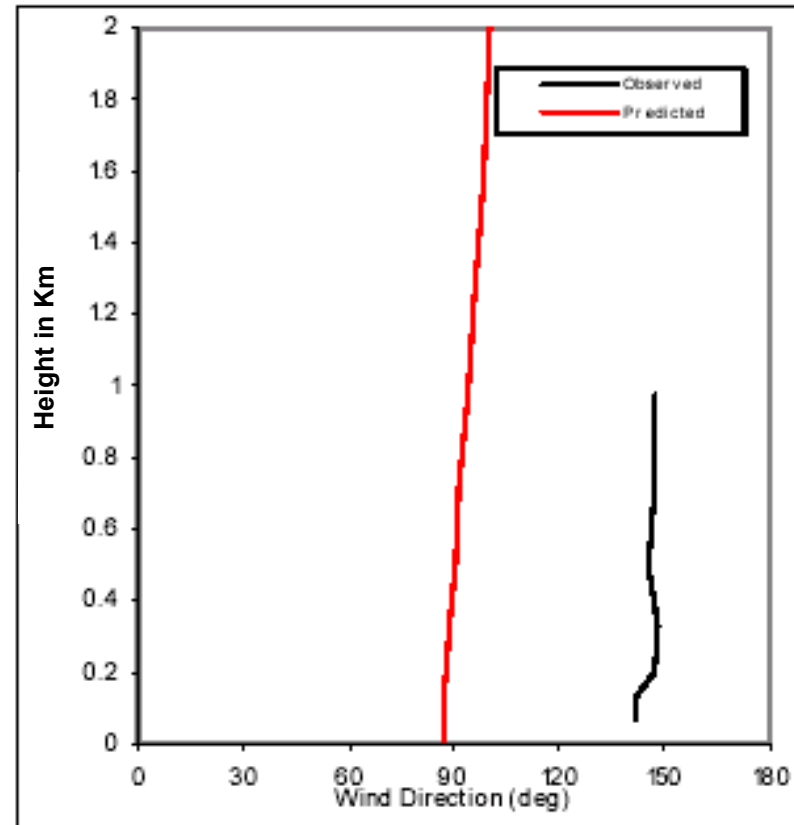
MM5 Vertical Wind Profile

(Aug 17, 2004 @ 1400 CST)

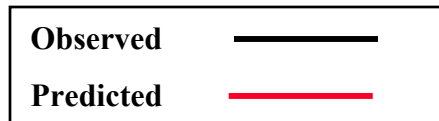
Wind Speed



Wind Direction



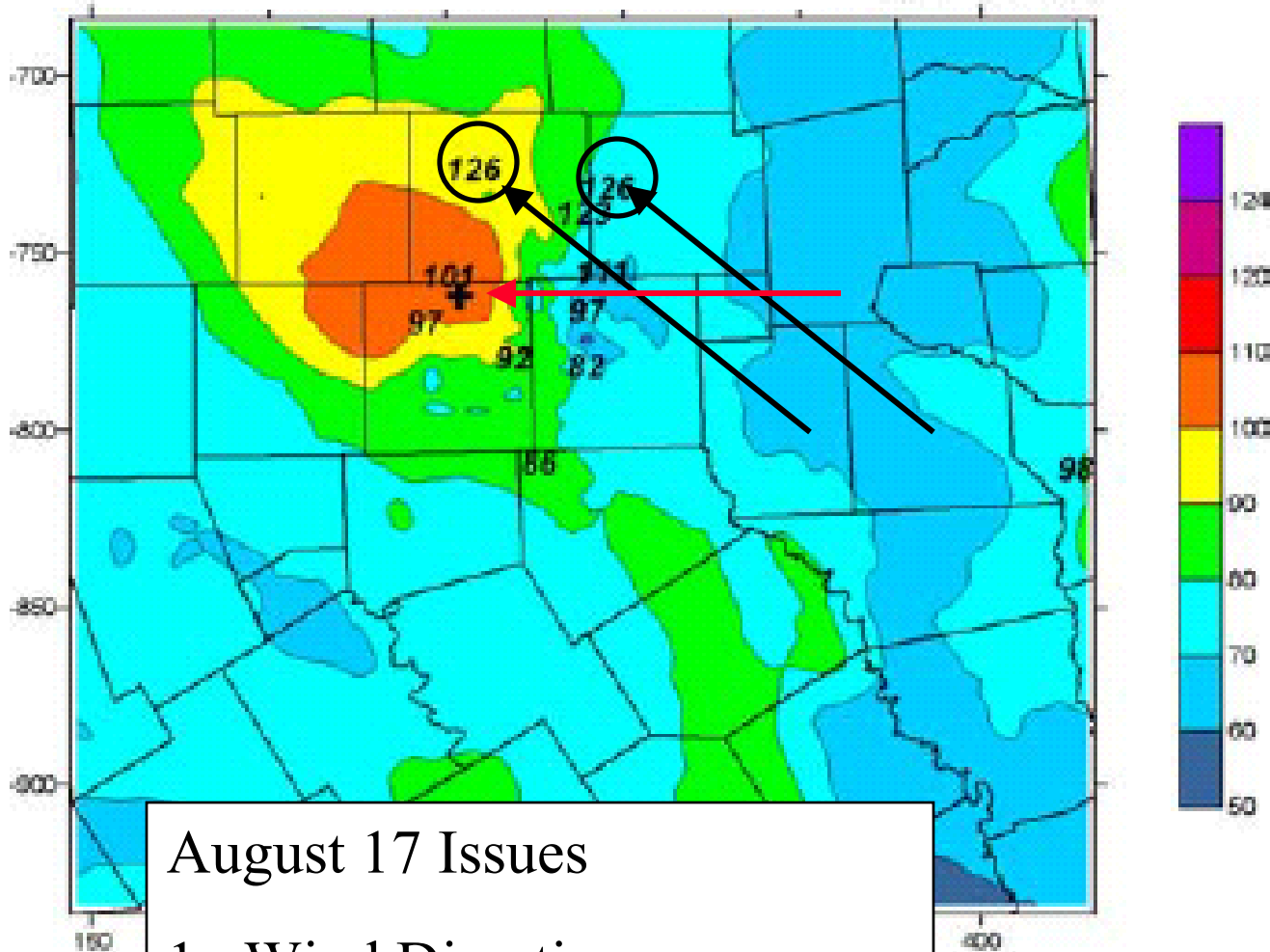
Peak 8-Hour Ozone 126 @ Frisco, Denton + 6 Sites



Tuesday August 17

Max = 108.0 ppb

1999



August 17 Issues

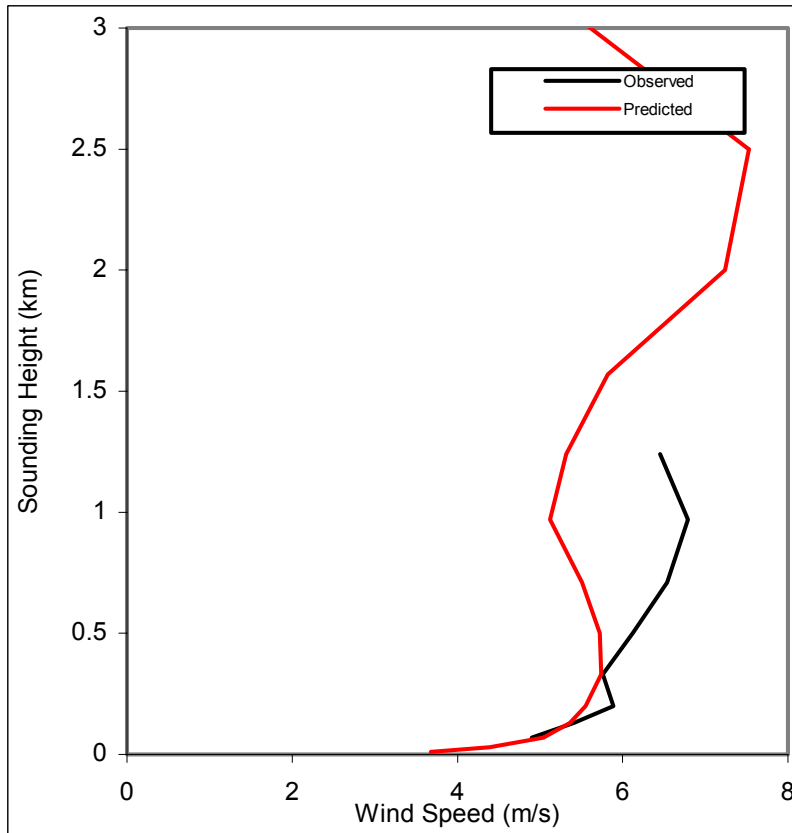
1. Wind Direction
2. Low Ozone Production

August 17, 1999

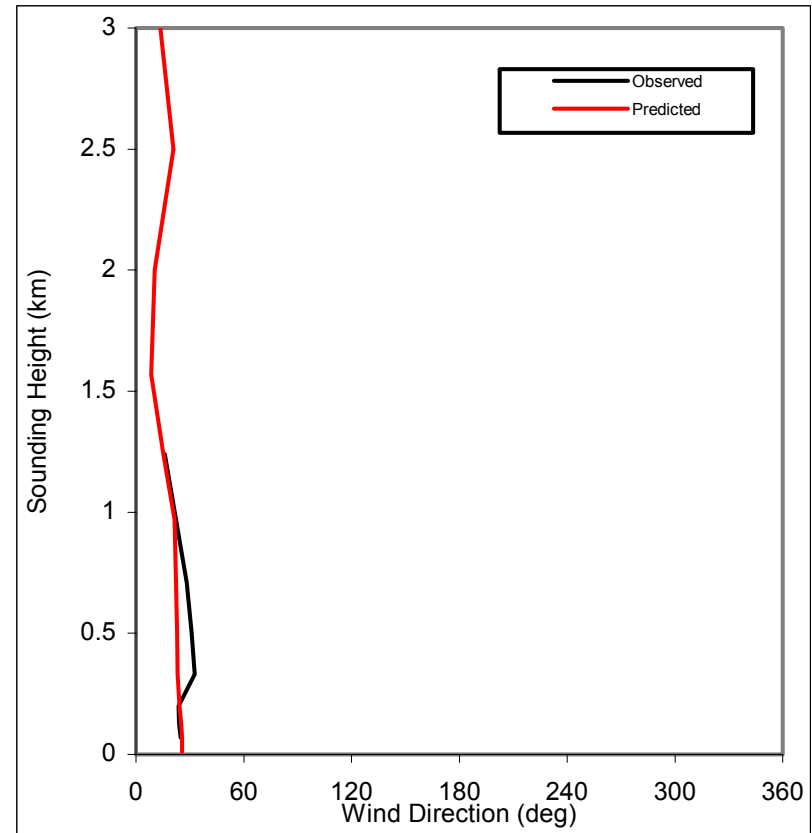
MM5 Vertical Wind Profile

(Aug 20, 2004 @ 1800 CST)

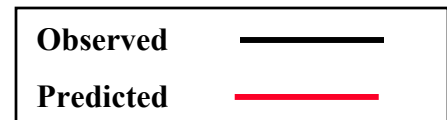
Wind Speed



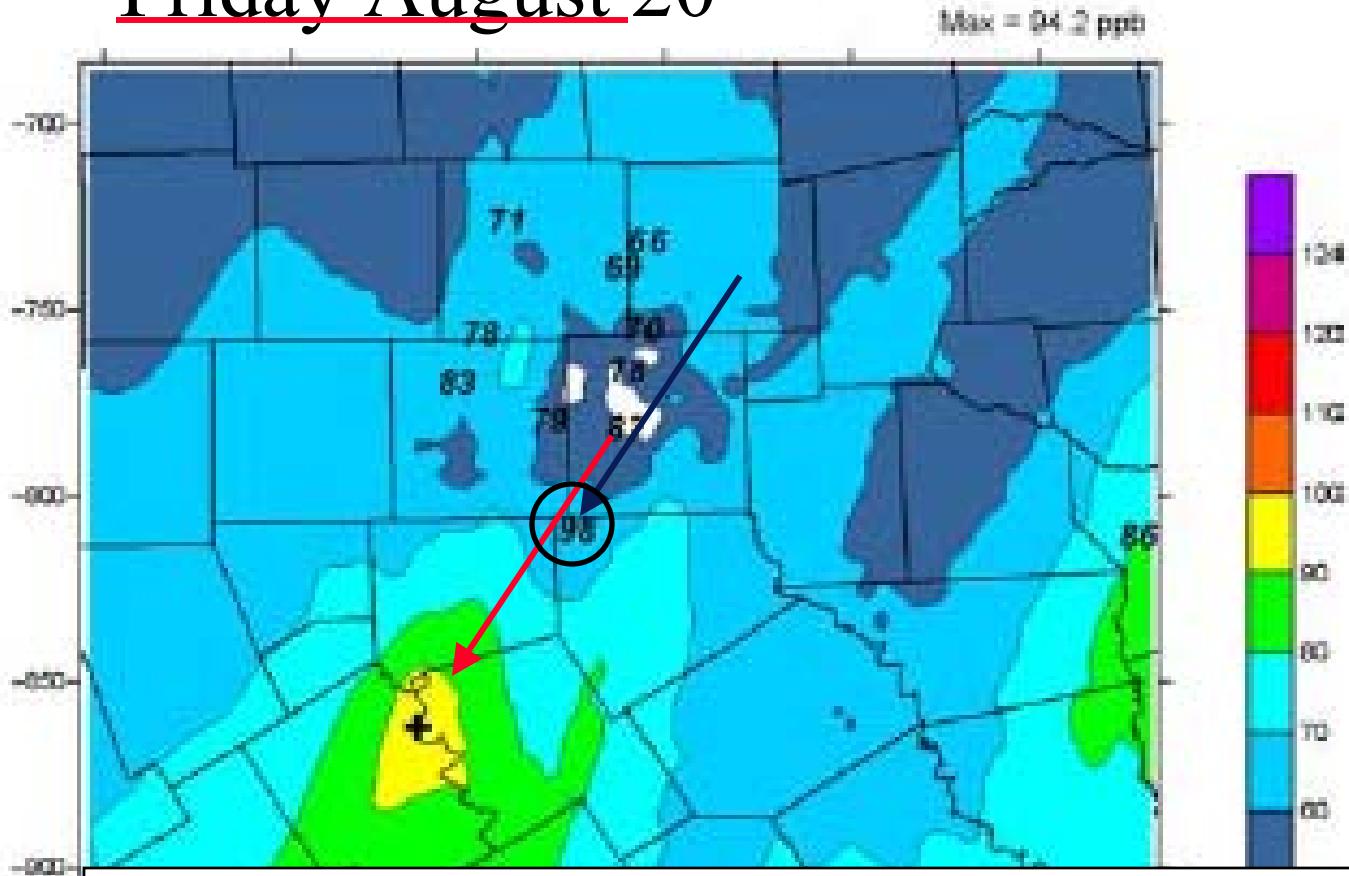
Wind Direction



Peak 8-Hour Ozone 98 @ Midlothian



Friday August 20



August 20 Issues

1. Wind Direction Appears OK
2. Ozone Low at Midlothian, maybe OK downwind

Sensitivity Tests

1. Duplicate Environ run as Baseline
2. Limit Vertical Mixing (Limit PBL)
3. Enhance Low Level Mixing (LL Kv)
4. Combination (PBL + LL Kv)
5. Sensitivity to SAPRC Reaction rate
6. Increase Moisture (Hydroxyl radicals)

Vertical Mixing Test

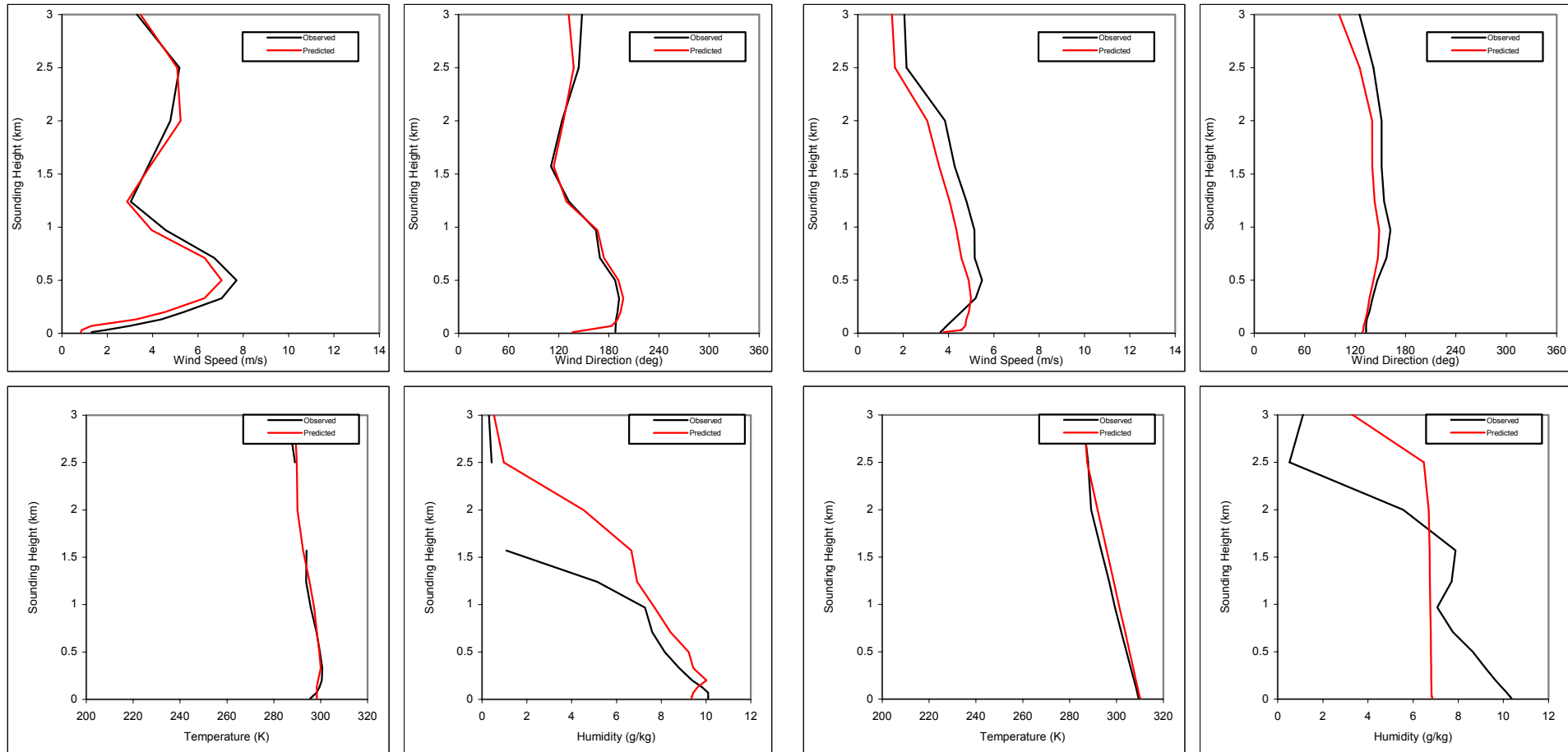
- Test
 - Limit PBL(Vertical Mixing) to the real mixing heights observed each afternoon at the Meacham Rawinsonde site
- Results
 - Limiting mixing to a shallower layer raised ozone concentrations
 - Minor improvement in performance.
- Why did we do this?

MM5 Afternoon Mixing Too Strong

Morning

August 17, 1999

Afternoon



Observed —

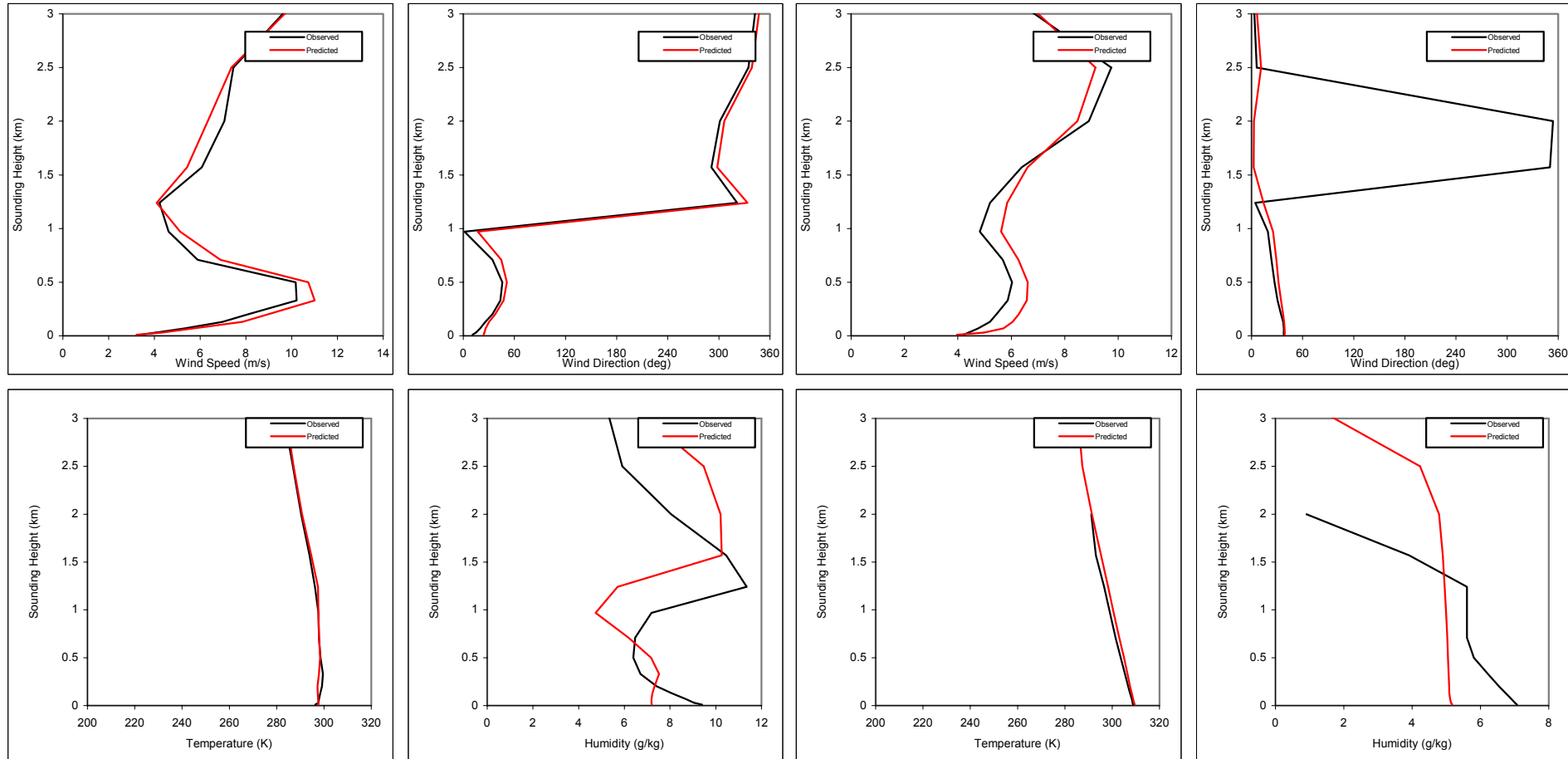
Predicted —

MM5 Afternoon Mixing Too Strong

Morning

August 20, 1999

Afternoon



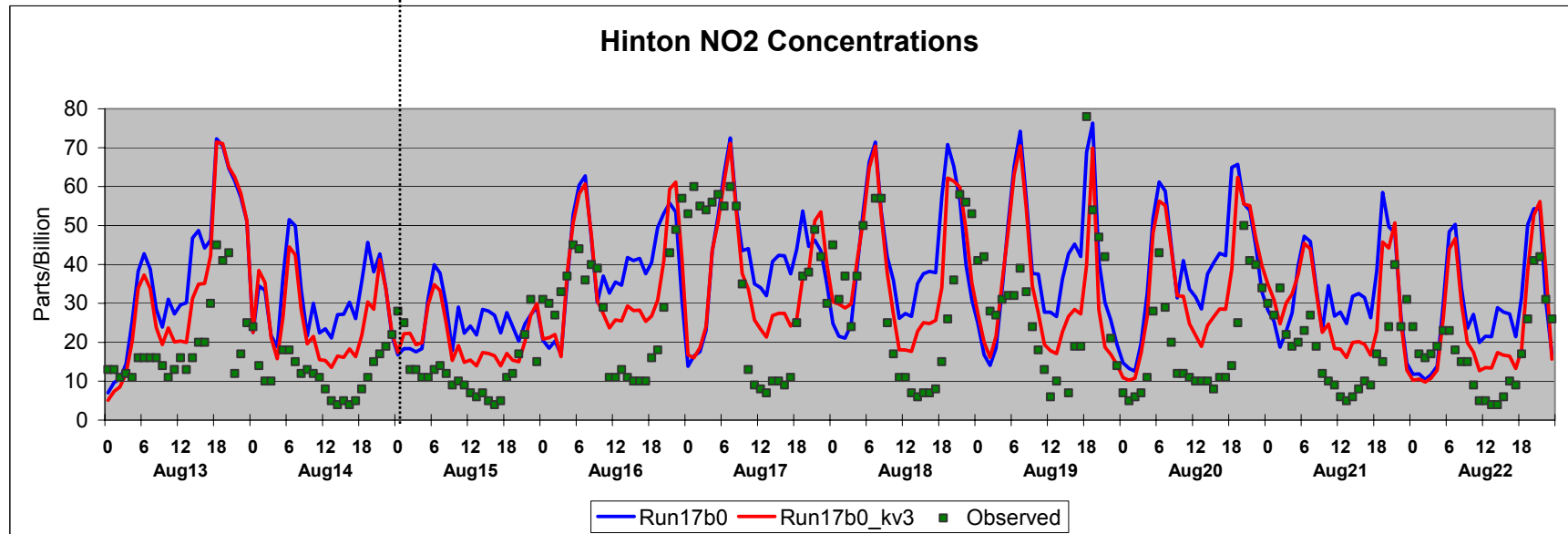
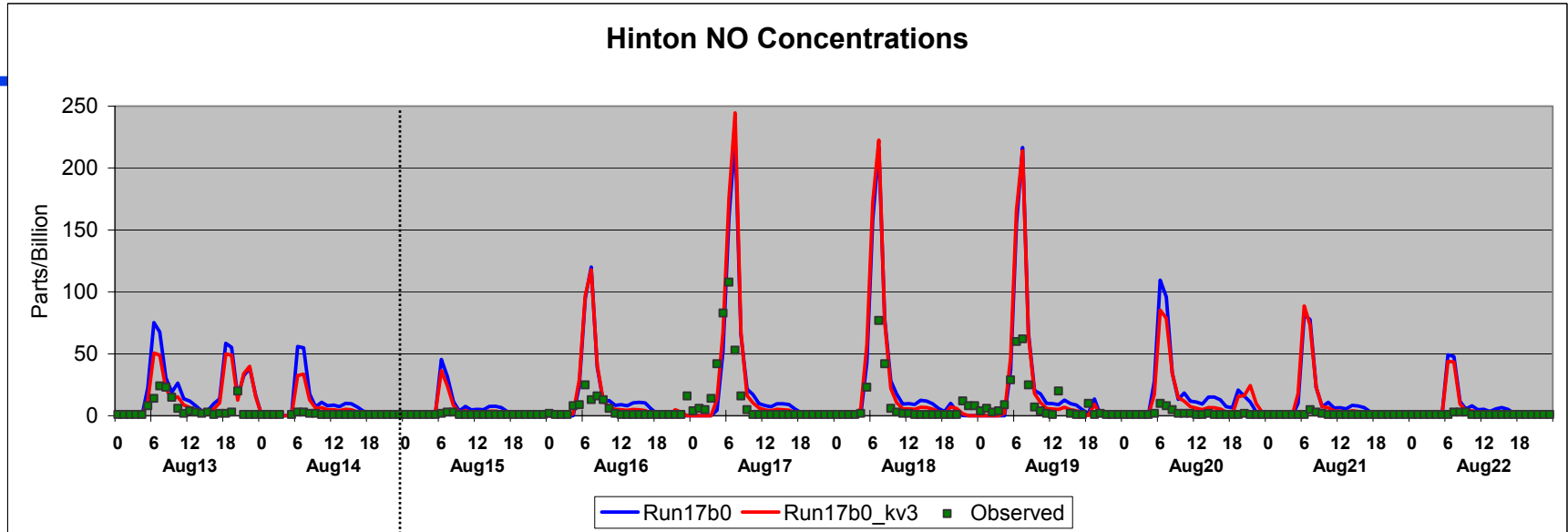
Observed ———

Predicted ———

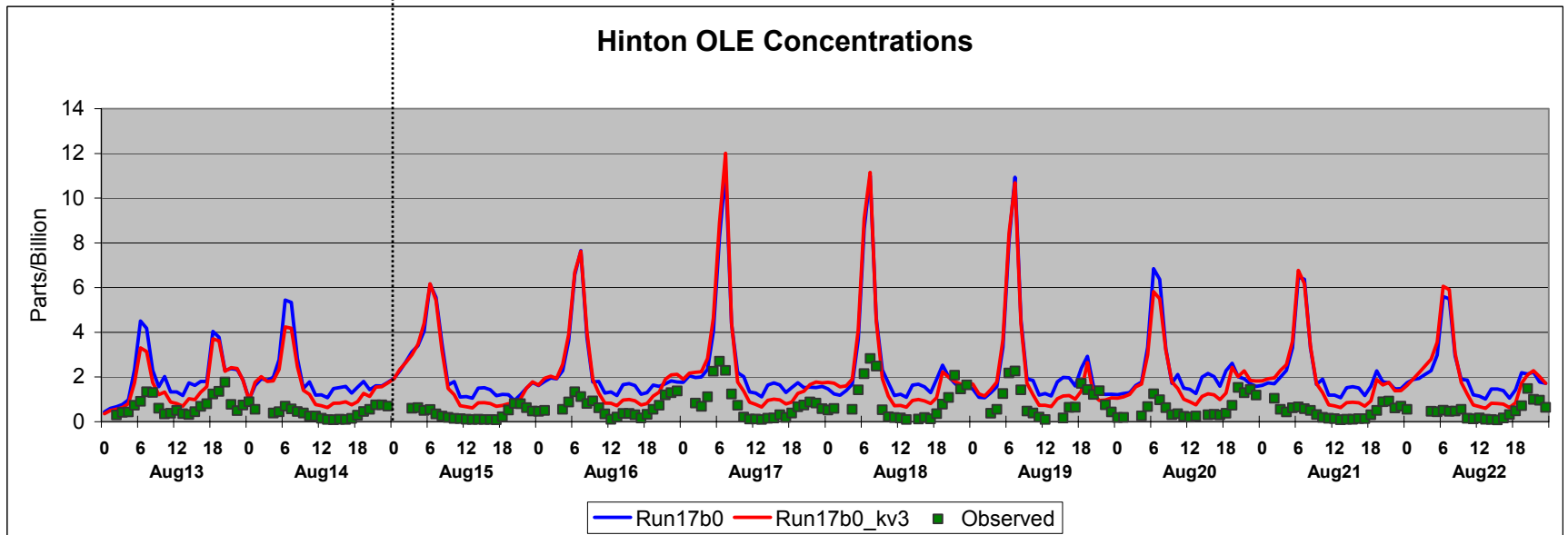
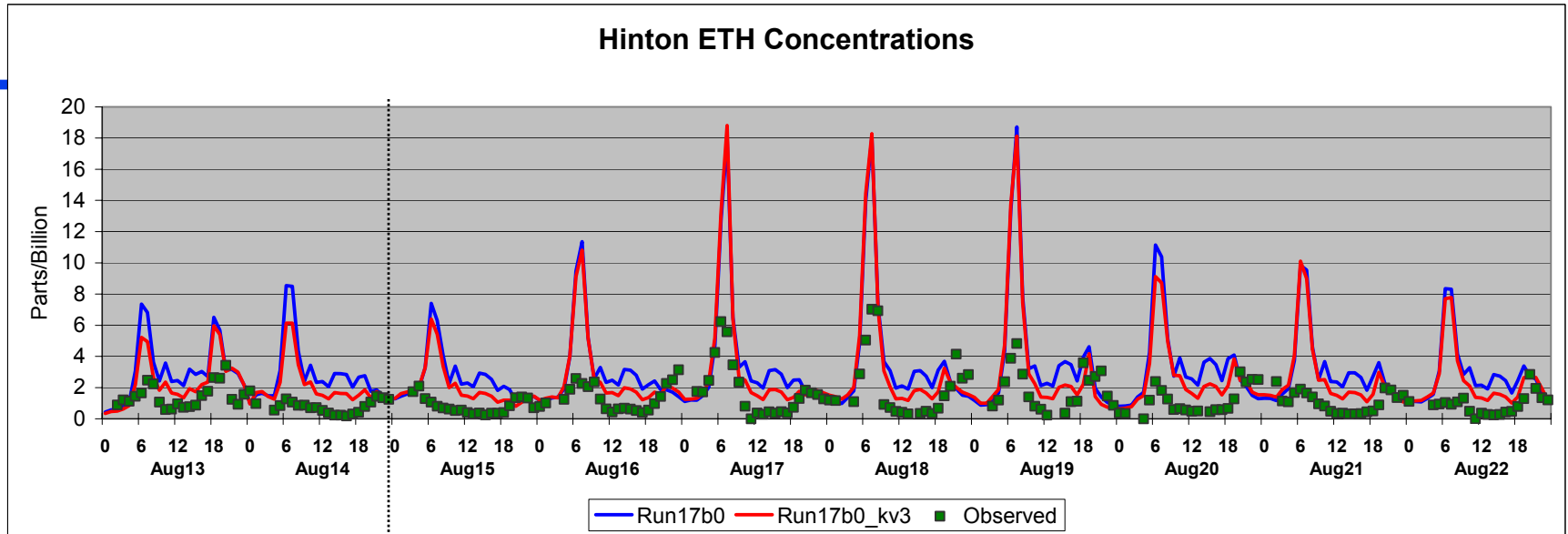
Low Level Kv Test

- Compare Modeled concentrations to measured data.
 - Modeled NO_x higher than measured NO_x at most locations
 - Modeled VOC higher than measured VOC at Hinton Drive Automatic Gas Chromatograph
- Results
 - Low Level Kv adjustment resulted in significant improvement in model performance
- Why did we do this?
 - O'Brian technique seems to develop weak mixing (small Kvs) in the thin layers near the surface

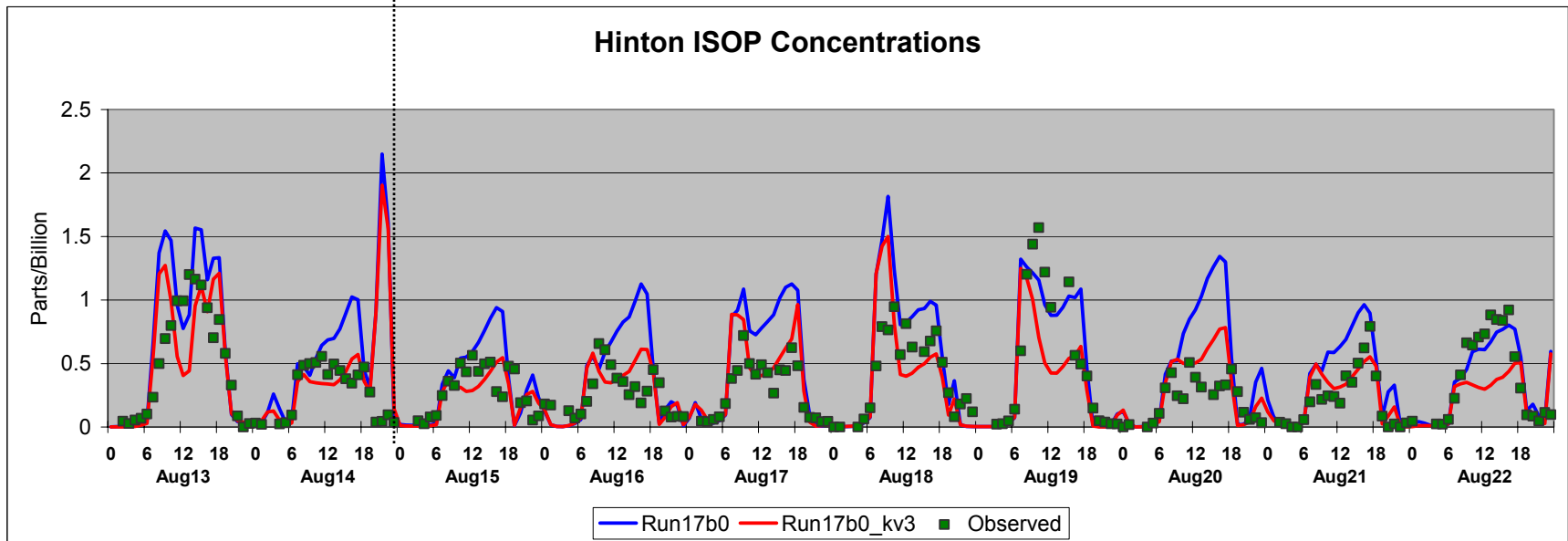
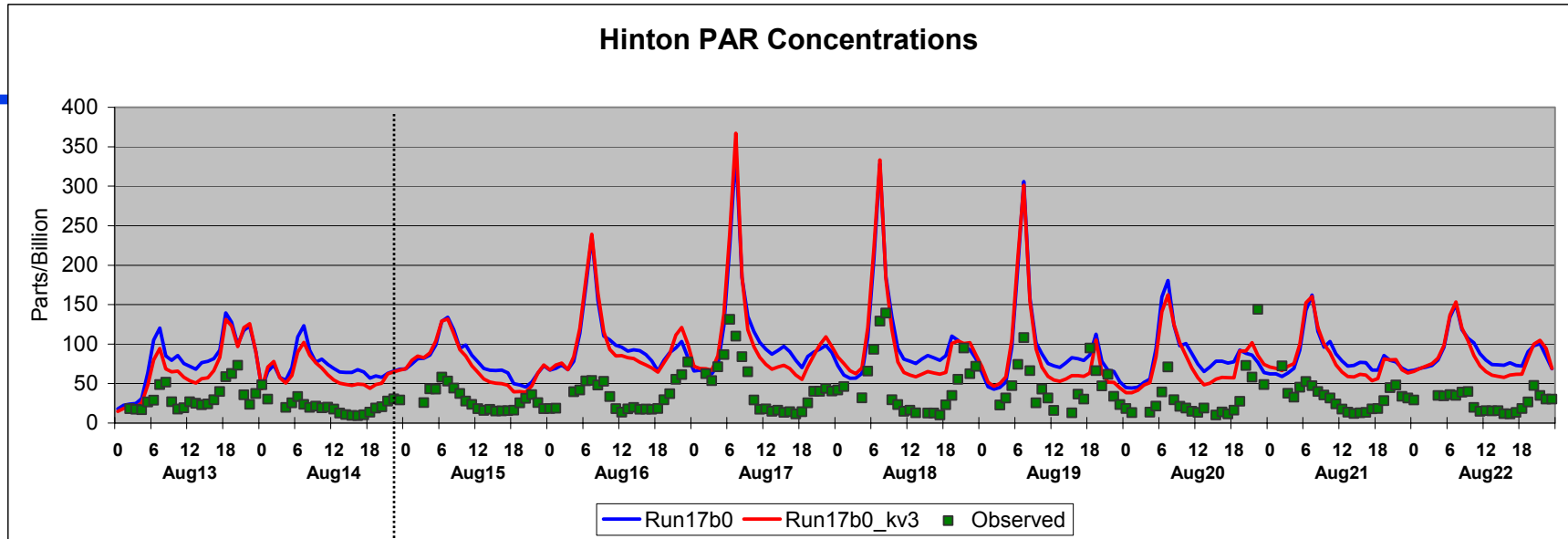
Hinton NOx Concentrations



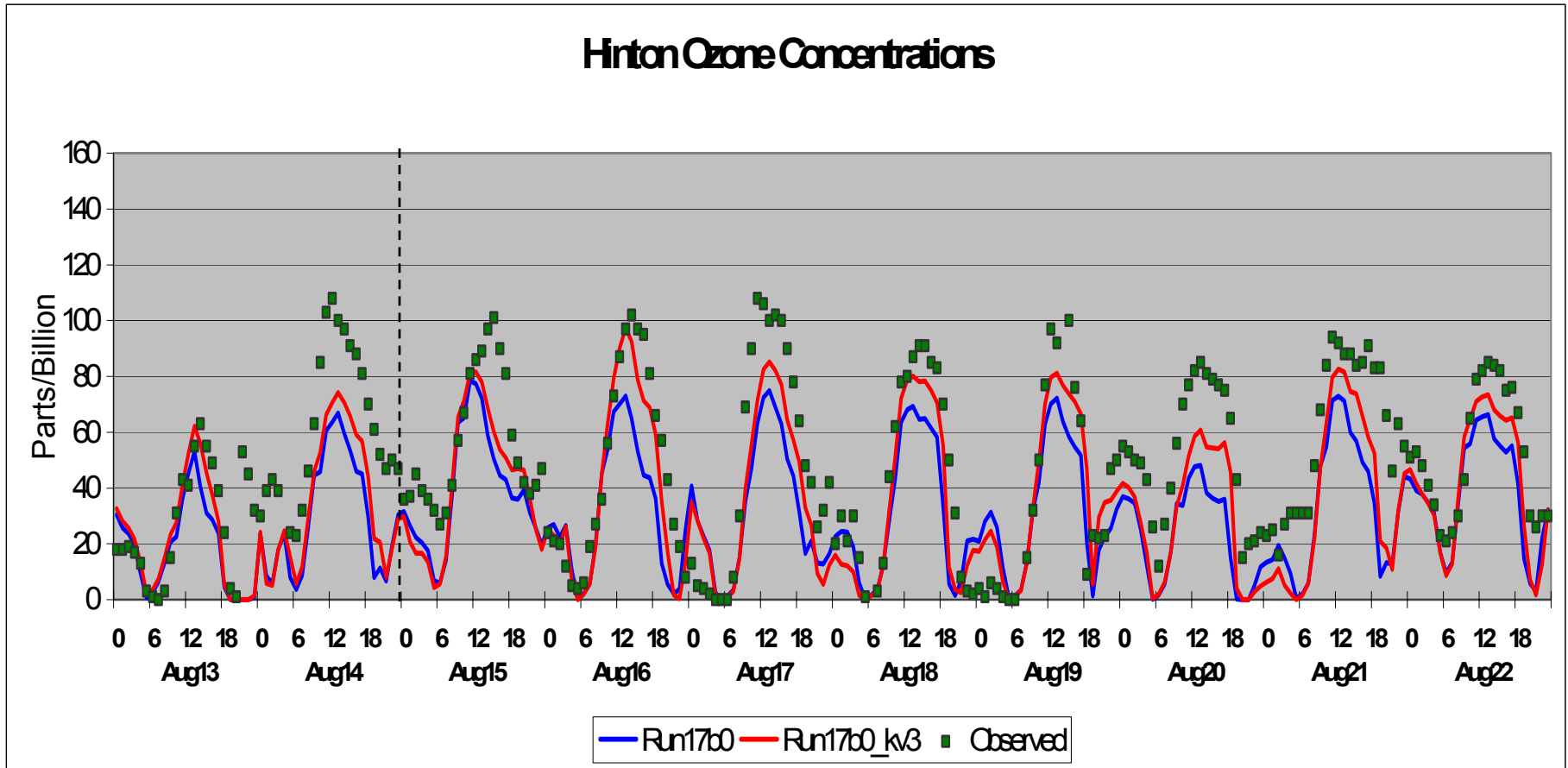
Hinton VOC Concentrations



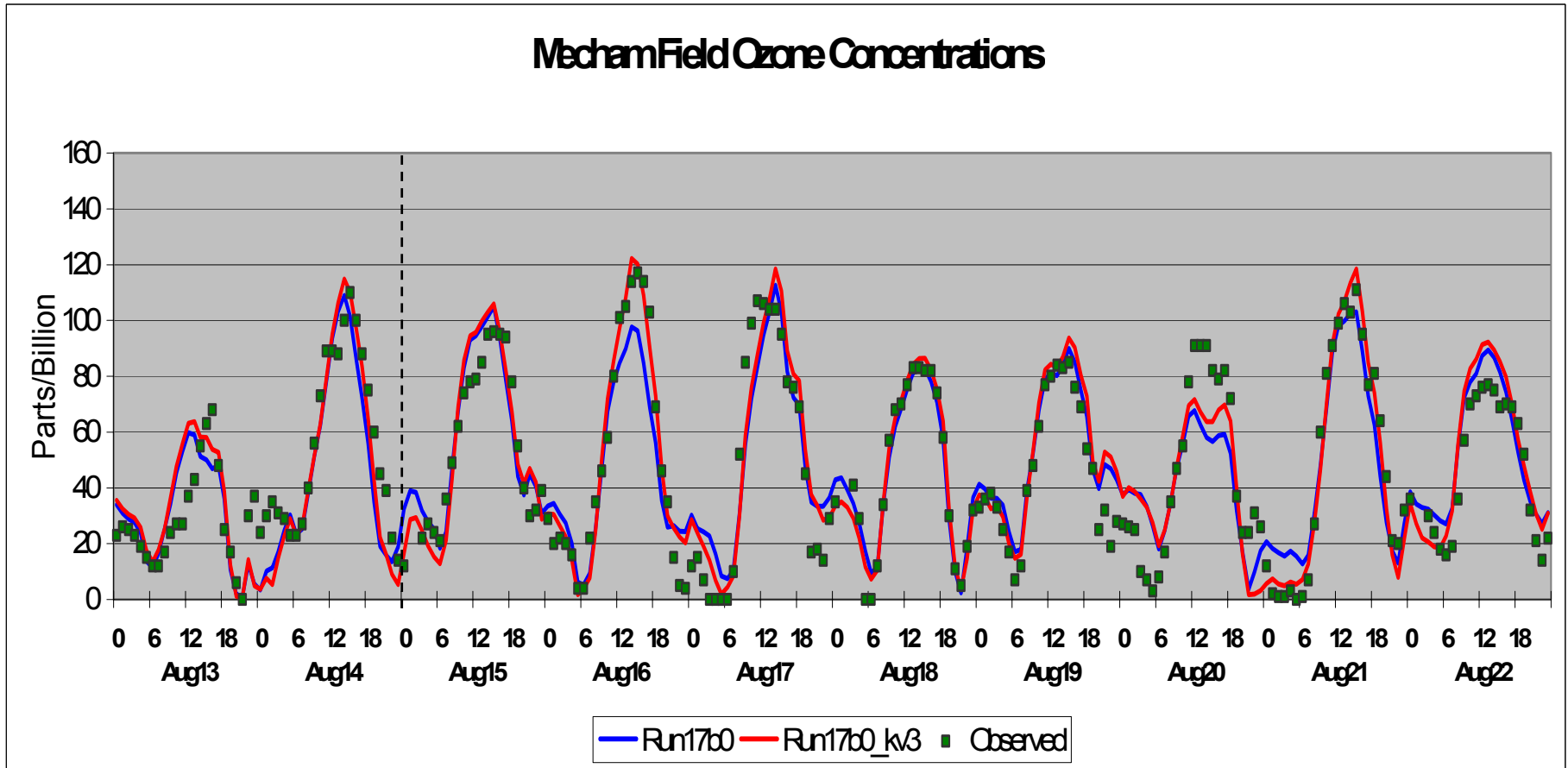
Hinton VOC Concentrations



Hinton Drive Daily Ozone



Meacham Field Ozone

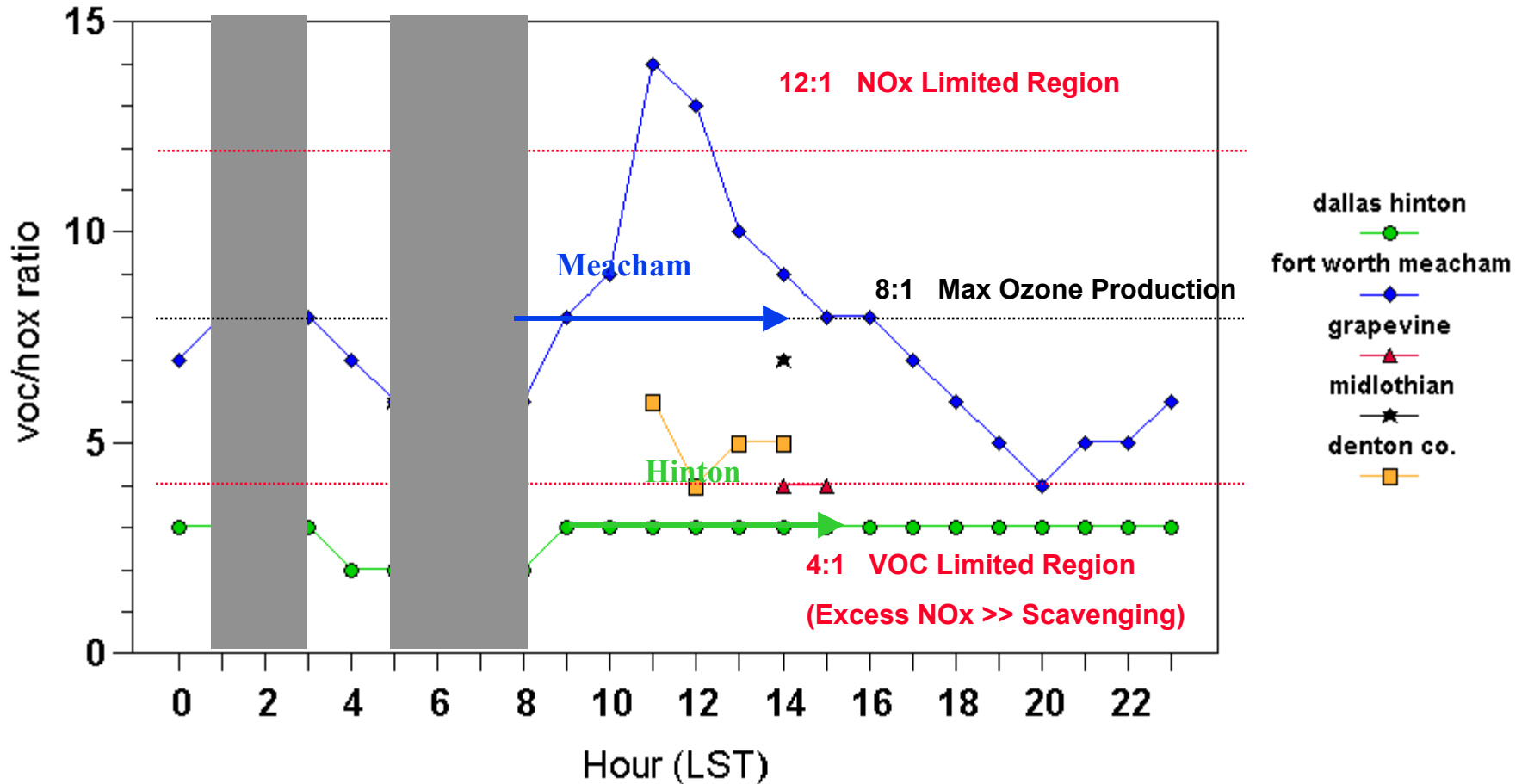


Evaluate VOC/NO_x Ratios

- Compare real VOC/NO_x ratios to modeled ratios
 - Determine which areas are NO_x limited, which are VOC limited
- NO_x data
 - In 1999, available at several monitors in the DFW area
- VOC Data
 - In 1999, available only at Hinton Drive
 - In 2003, available at Hinton and Meacham Field

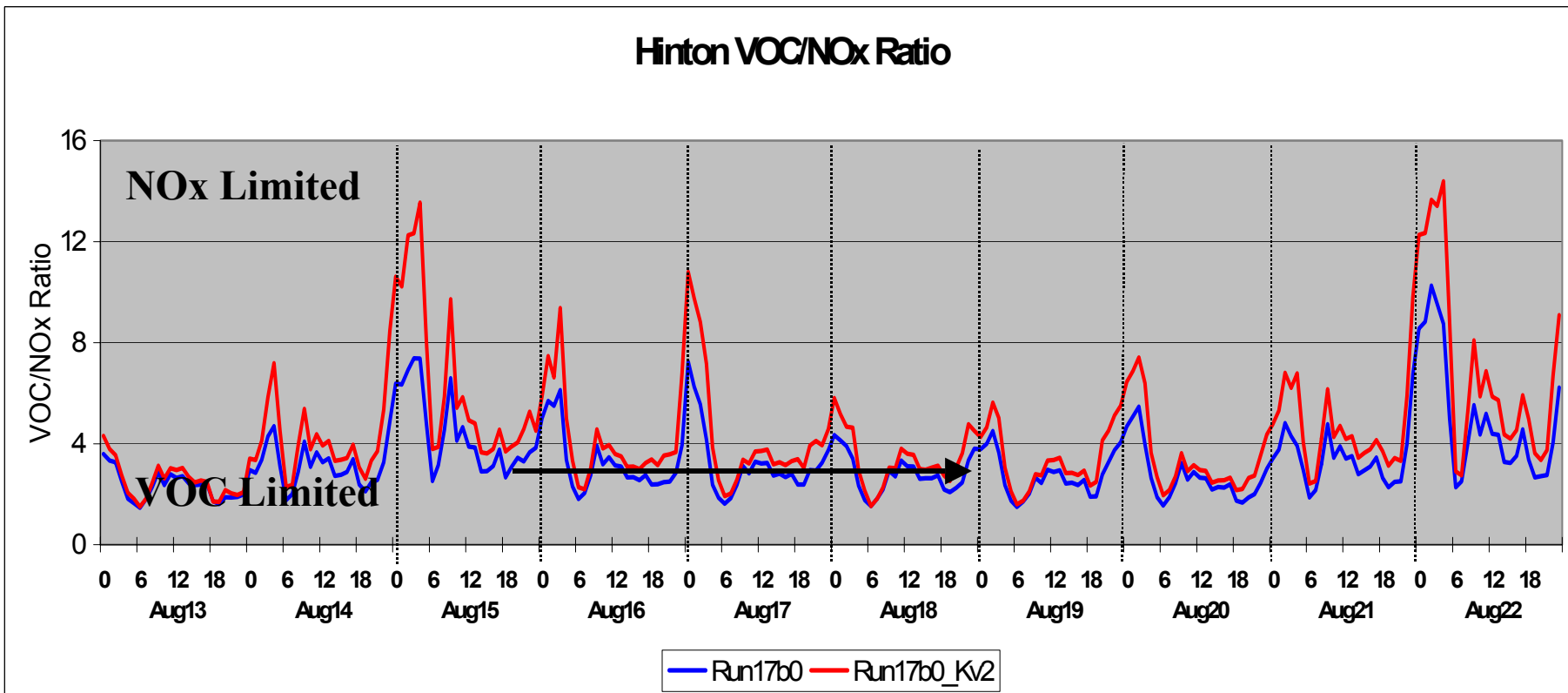
Mean VOC/NOx Ratios

June-August Weekday 2003



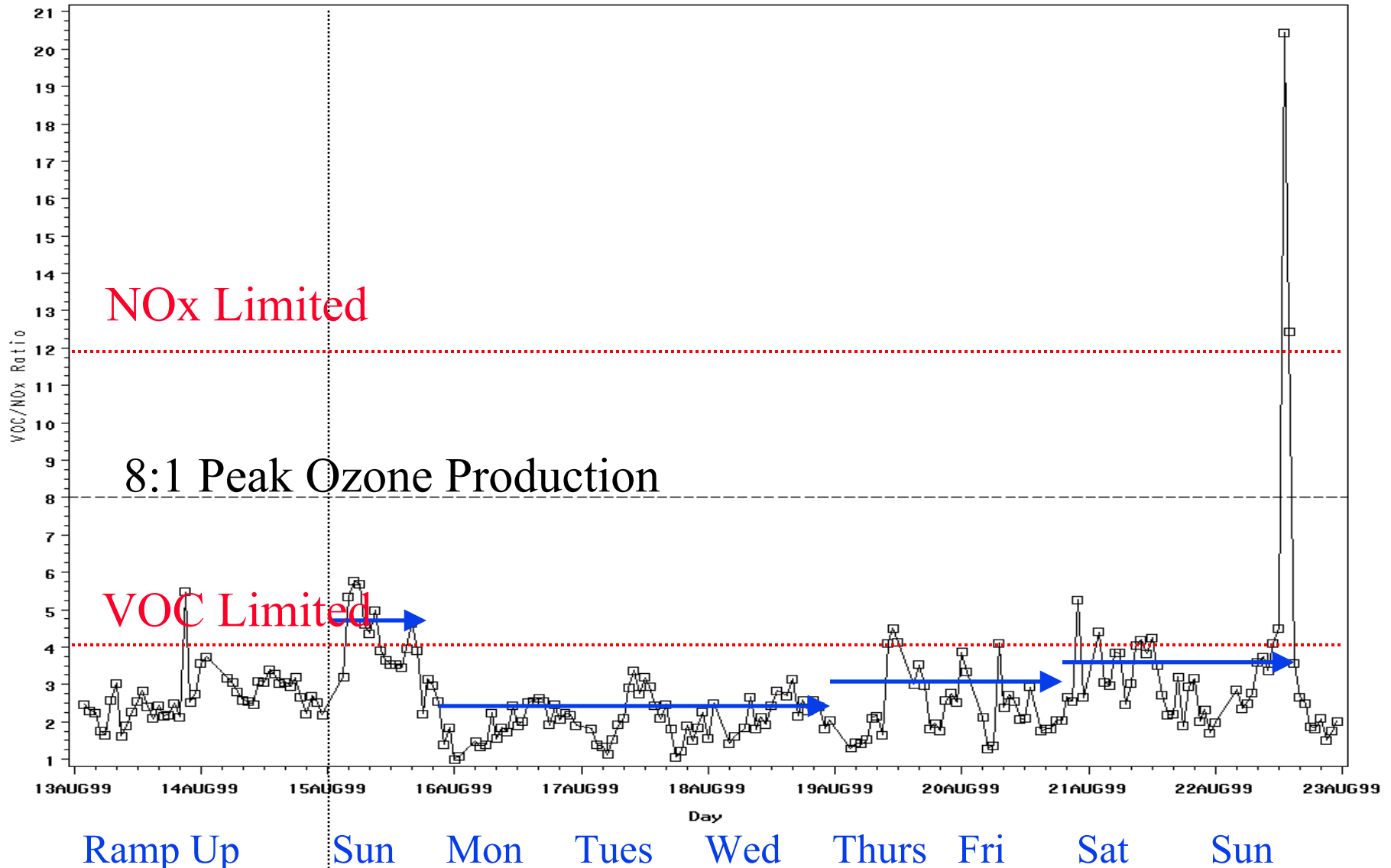
dallas hinton and fort worth meacham data from continuous auto-gc
 grapevine and midlothian data from canisters for 6 weekdays, denton co. data from canisters for 5 weekdays

Modeled VOC/NO_x Ratio at Hinton

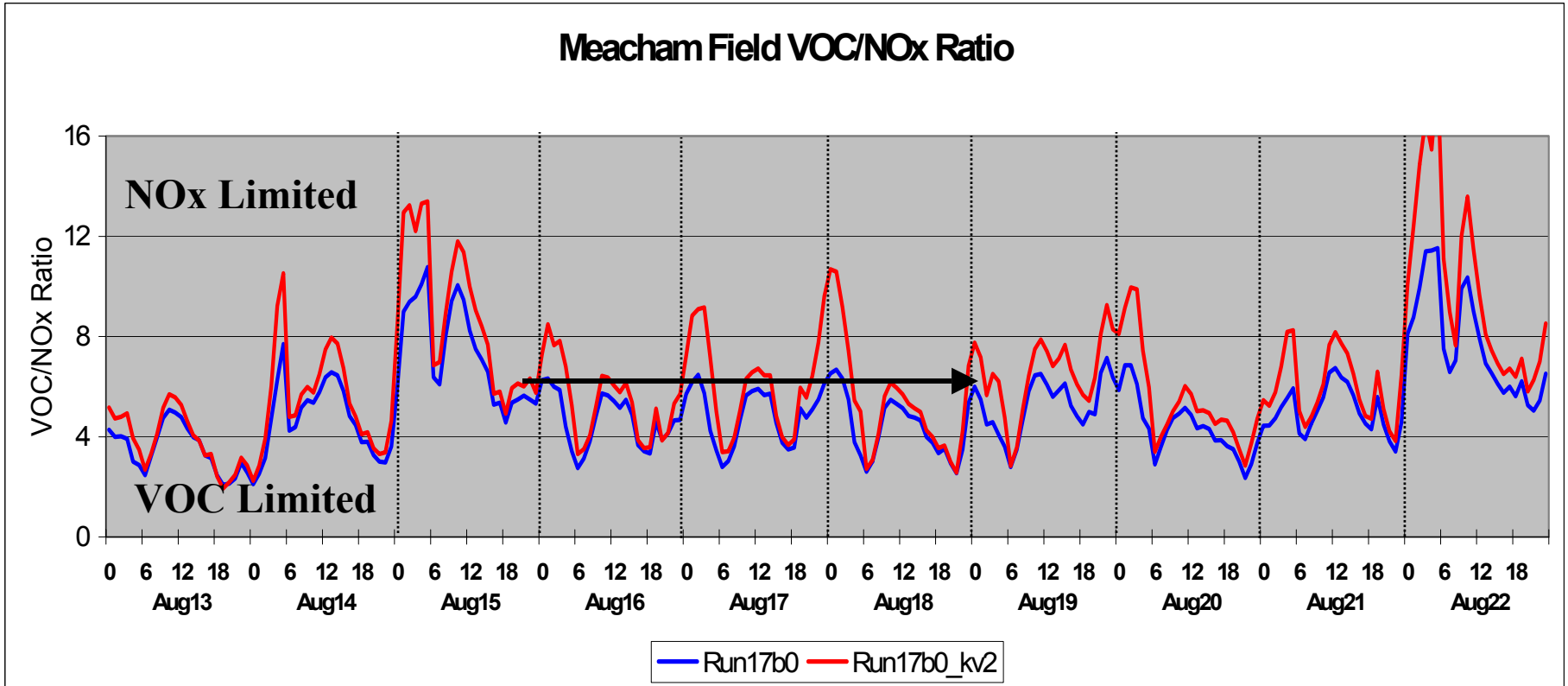


Hinton VOC/NOx Ratio

August 13-22, 1999, Actual Data

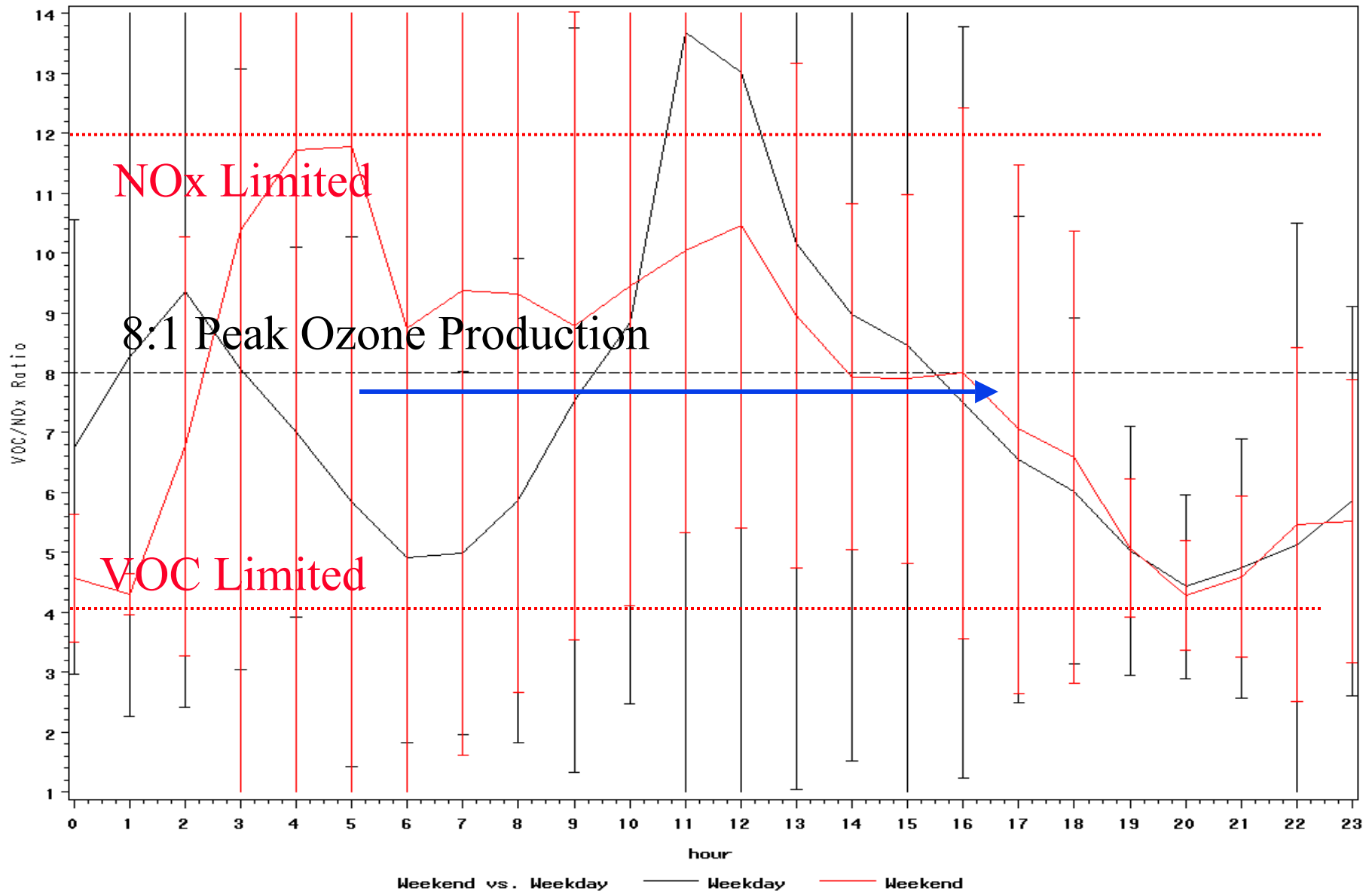


Modeled VOC/NO_x Ratio at Meacham



Meacham VOC/NOx Ratio

June-August 2003, Average



Conclusions

- We are generating plenty of ozone, background and peak
- Six out of eight days meet EPA statistical performance criteria
 - Aug 17th - Low production at measured peak, probably due to wind direction error.
 - Aug 20th - Low production at Midlothian, more ozone formed further downstream, may be OK.
- DFW urban core appears to be NO_x rich (VOC limited), which limits ozone formation in the core.
 - Ozone is formed in outlying areas, when the NO_x rich air mixes with biogenic isoprene downwind of the city.
 - On weekends, when mobile source emissions are reduced, the ozone forms closer to the urban core

DFW Modeling Review

Contributors:

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- David Halliday
- Mark Sather (EPA)



Clean Air for
Everyone in Texas