DFW Modeling

Update on Modeling Sensitivity Tests

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Photochemical Modeling Technical Committee

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DFW Modeling Projects

- 2010 Sensitivity Tests
  - Cement Kiln Emissions Variability
  - East Texas EGU Controls
- 2009 Future Case Modeling
- Future Plans

Cement Kiln Emissions Variability

- Question: Since hourly emissions vary so much, how should we model cement kilns in the future case?

- Current emissions are highly variable,
  - Need to base future modeling on recent emissions data
  - Model using average emissions, high and low estimates
  - Determine impact of high vs low cement kiln emissions

NOx from Electric Utility Boilers

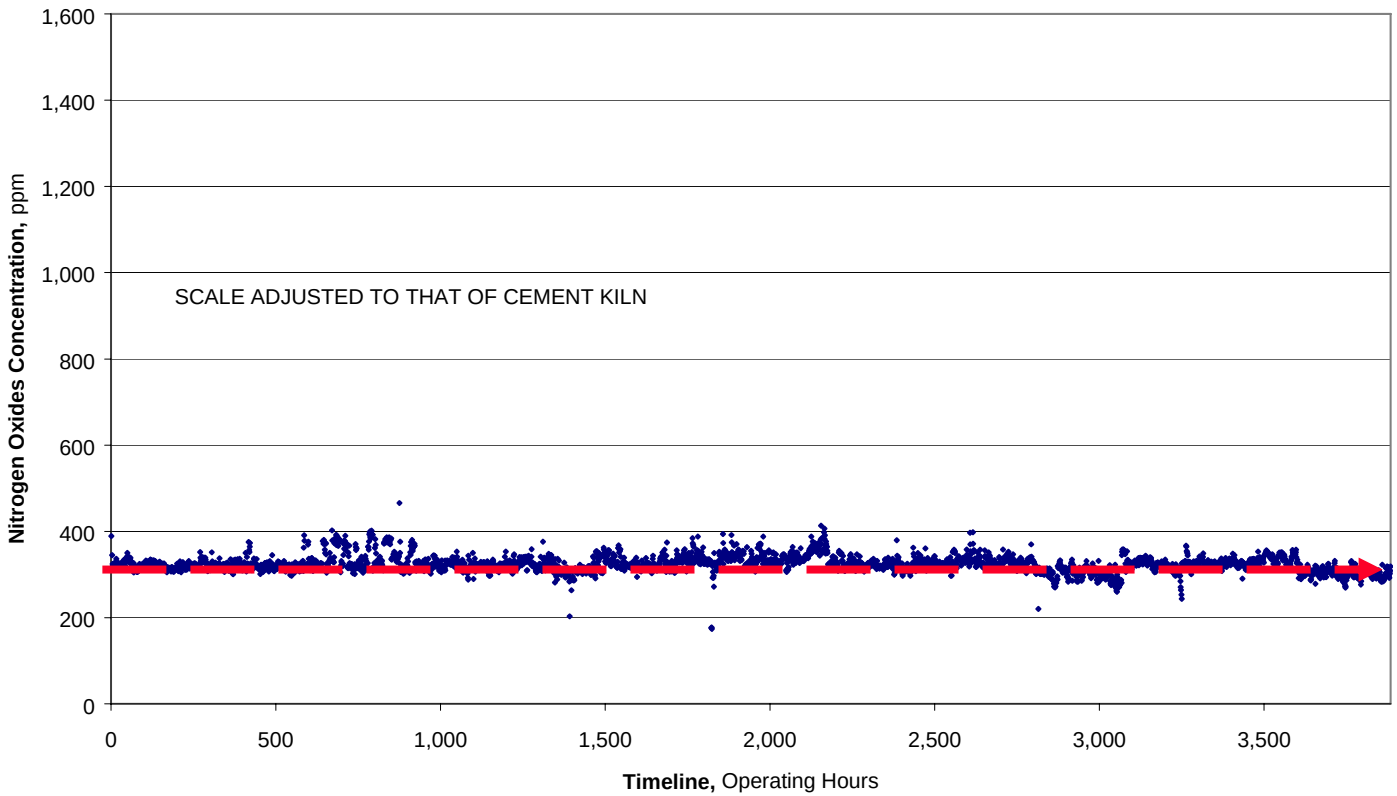


Figure 1. Example of nitrogen oxides from an electric power boiler[7]

NOx from Cement Kilns

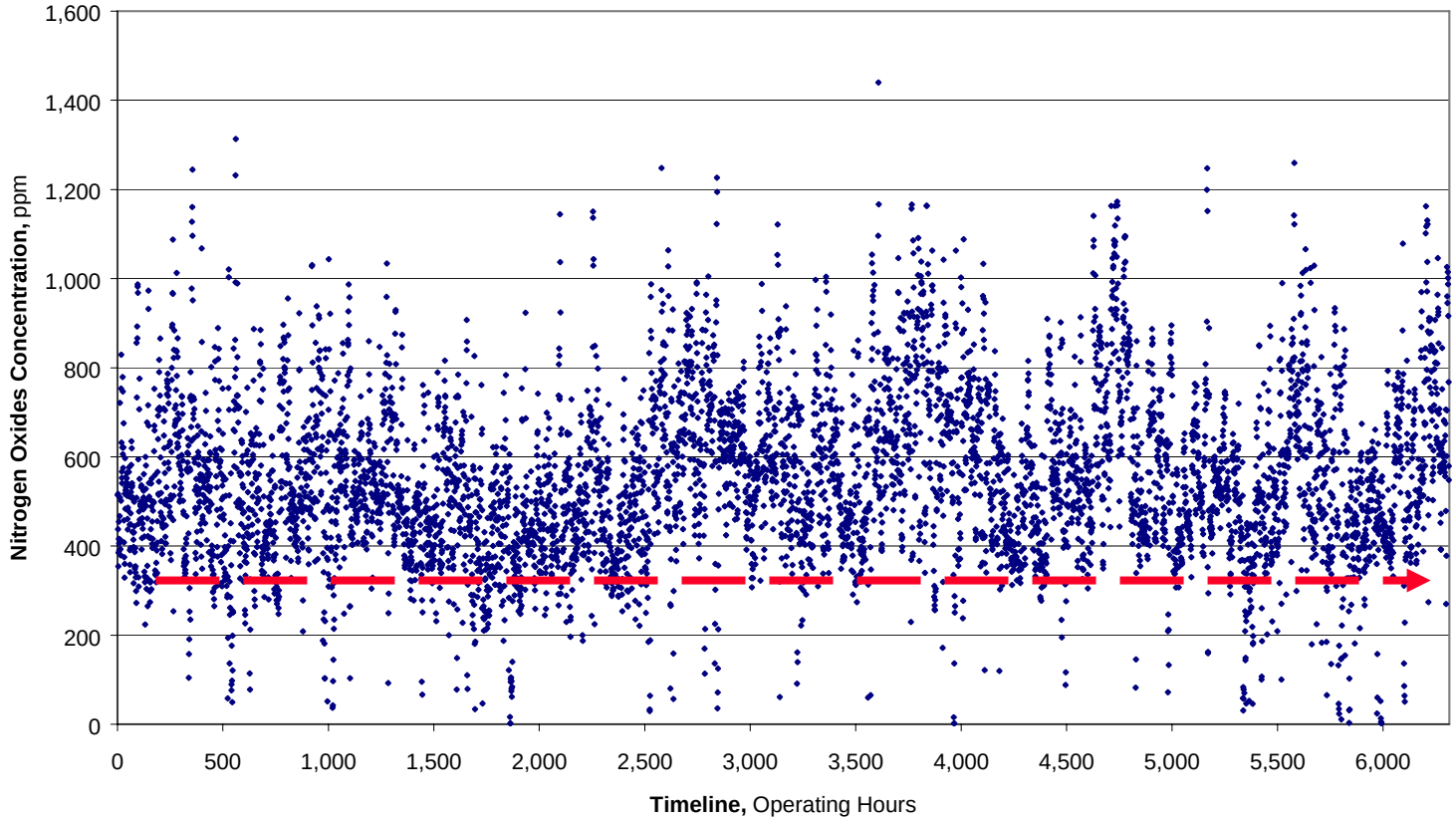


Figure 2. Example of nitrogen oxides from a cement kiln[7]

Why are NOx Emissions So High?

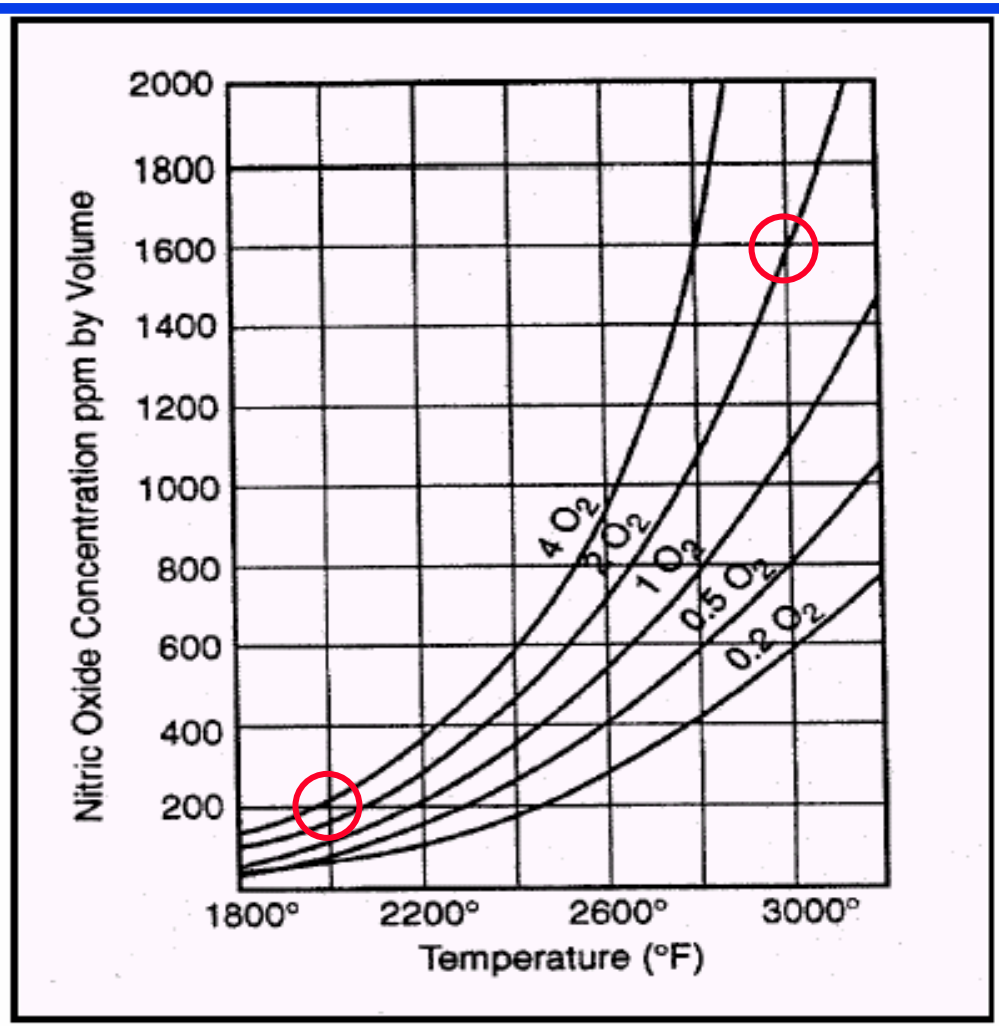
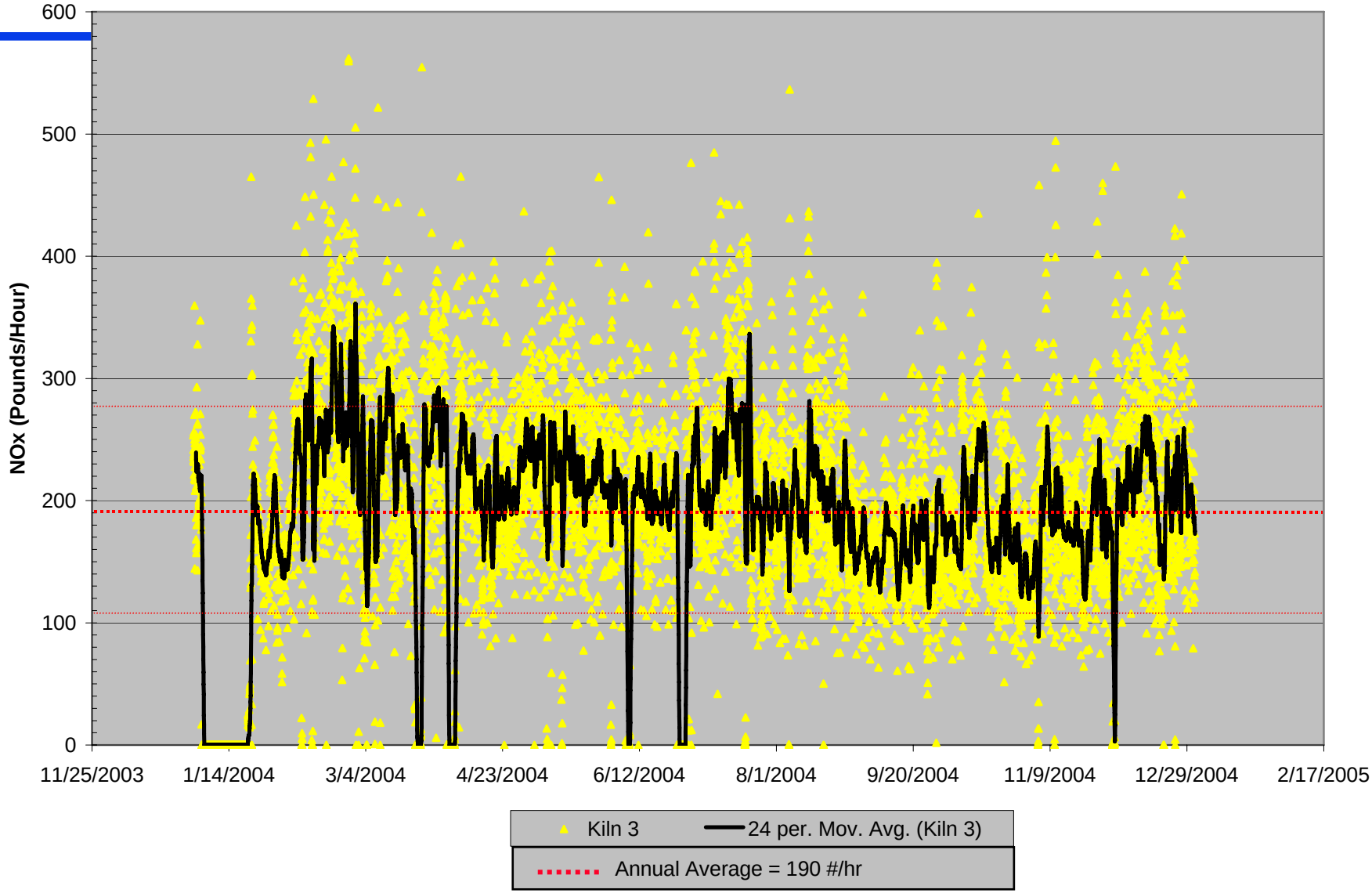


Figure 4-1. Theoretical equilibrium concentrations of NO in gas from combustion sustained in air.[1]

Ashgrove 2004 Hourly Emissions



Cement Kiln Variability Modeling

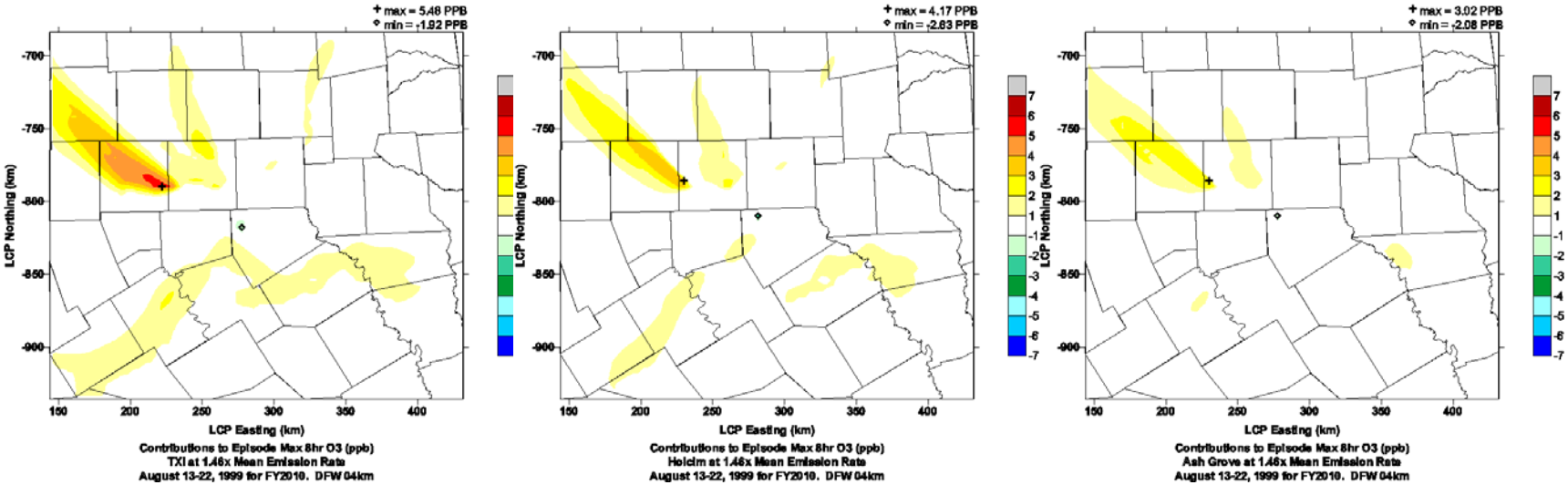
- Analyze Real World Operational Data
  - Collect data from all three plants
  - ‘Trim’ data to remove startup/shutdown hours
  - Determine average emissions and variation
  - Standard Deviation approximately 28% of average
- Model at Various Emissions Levels
  - Zero emissions case for baseline
  - Use 2010 estimate as average emissions
  - Low and high (5th and 95th percentile)
- Evaluate Impact on DFW Area

Cement Kiln Variability Modeling

- TXI is the biggest plant, has most kilns and therefore the largest impact
- Worst case was all three plants operating at max simultaneously (95th %-ile)
  - Probability is $(.05)^3$ = 0.01% or once each year
- Little evidence of scavenging in DFW area
  - Evidently, NOx released above boundary layer,
  - Carried by winds over urban area
  - Mixed with surface VOC further downstream
- Ozone increases typically displaced downstream
  - Max impact in Parker County with southeast winds

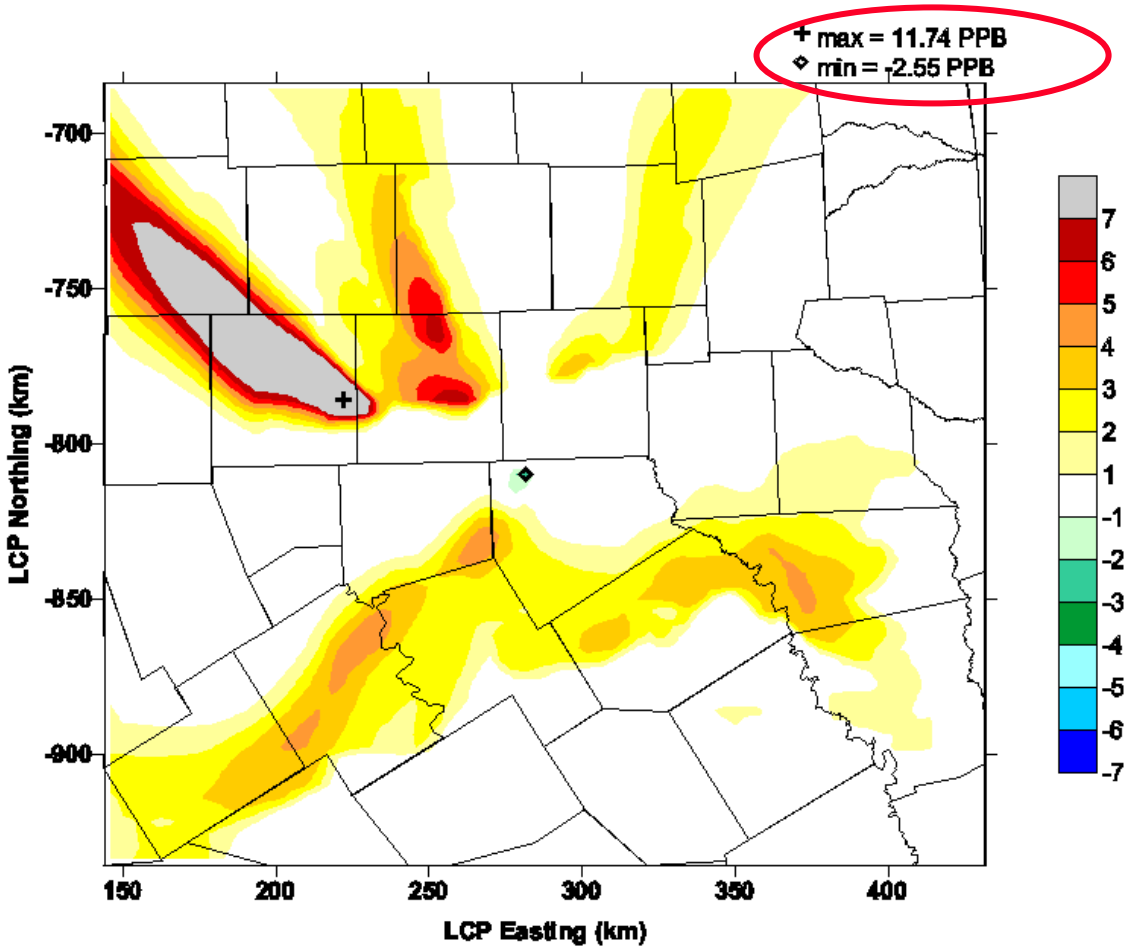
Individual Cement Kiln Impacts

TXI	Holcim	Ashgrove
Max = 5.48 ppb	4.17ppb	3.02ppb



Impacts 1-3 ppb in DFW core area with each plant operating individually at high end of emission range (95th %-ile)

Worst Case – All Three @ Max



Contributions to Episode Max 8hr O3 (ppb)
All 3 Cement Kilns at 1.46x Mean Emission Rate
August 13-22, 1999 for FY2010. DFW 04km

2010 Benefits from Cement Kiln Emissions Reductions

- Percent of Cells Affected
  - Impacts compared to Baseline (Zero Out)
  - All three kilns operating at same rate

% of Average Emission Rate	54%	72%	**Average 100%**	128%	146%
% of cells increased by > 1 ppb	4.5%	6.25	**8.1%**	9.4%	10.1%
% of cells pushed over >85 ppb	0.85%	1.2%	**1.6%**	2.0%	2.2%

- Time of Day Variations Test
  - Worst case was peak emissions during morning
  - 6-11 AM

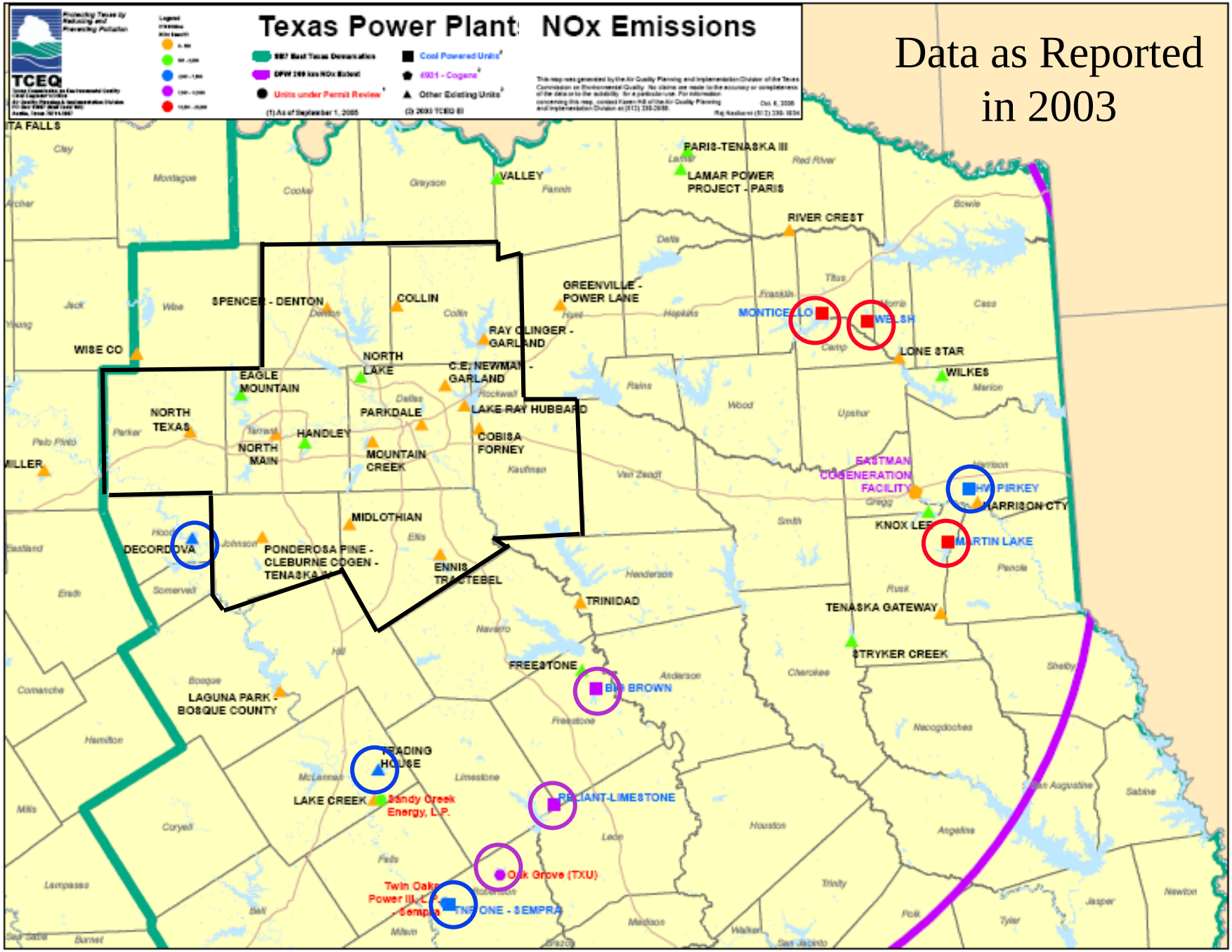
East Texas EGU Controls

- Question: How much difference would it make if the Houston EGU controls were applied to the other EGUs in East Texas?
  - Houston and Dallas point sources have already reduced emissions by approximately 80-88%
  - Other sources in East Texas have already reduced NOx emissions by approximately 50%

- Run sensitivity test to determine future case benefit from additional reductions from large point sources
  - Reduce emissions from other EGU sources in East Texas to match Houston controls

Texas Power Plant NOx Emissions

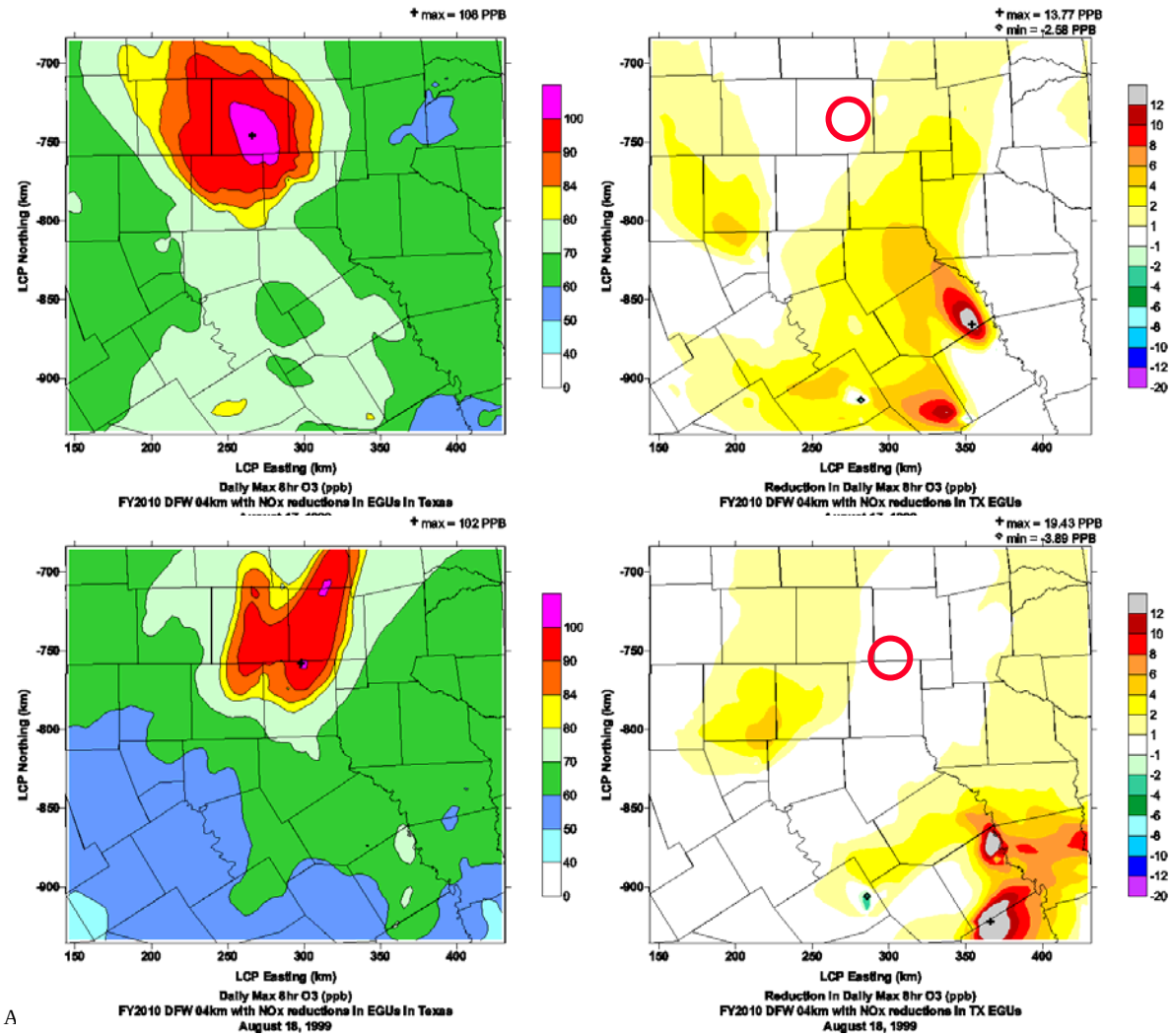
Data as Reported in 2003



Impact of East TX EGU Controls

DFW Area - August 17th and 18th

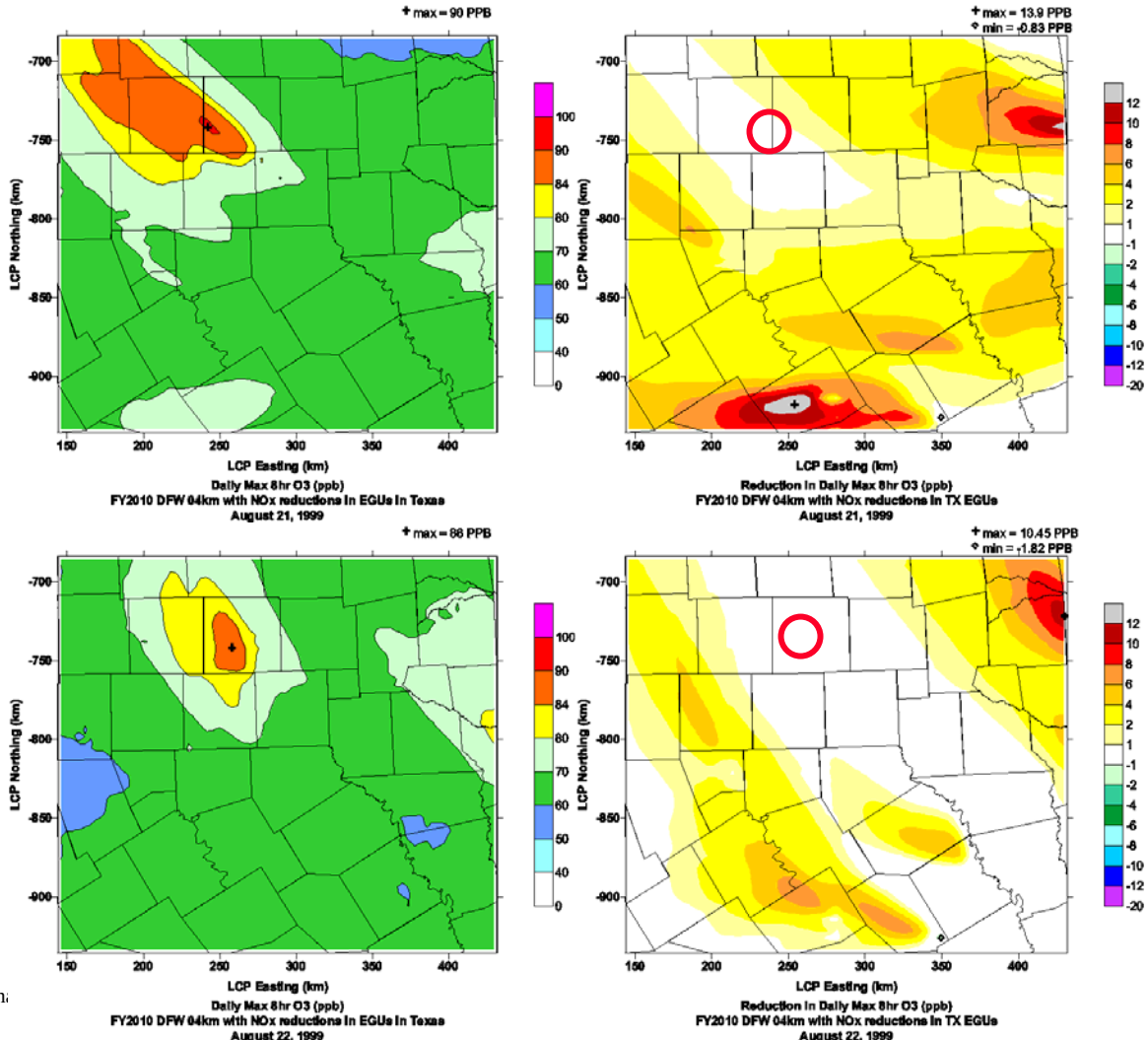
Max 8-Hour Ozone | Difference Plot



Impact of East TX EGU Controls

DFW Area - August 21st and 22nd

Max 8-Hour Ozone | Difference Plot



2010 Benefits at DFW Monitors from EGU NOx Reductions

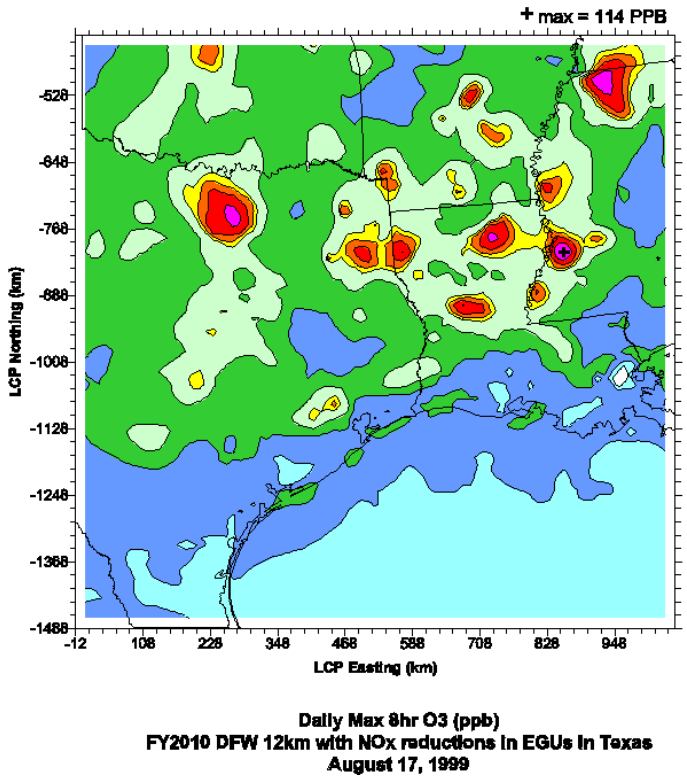
Site	Projected 2010 Design Value (ppb)		
	Future Base Case	EGU NOx Control	EGU NOx Benefit
Frisco C31	90.8	89.5	-1.3
Dallas C60	88.2	87.3	-0.9
Dallas C63	87.6	86.6	-1.0
Dallas C402	80.9	79.9	-1.0
Denton C56	88.6	87.8	-0.8
Midlothian C94	84.5	82.9	-1.6
Arlington C57	87.6	86.3	-1.3
Fort Worth C13	87.5	86.4	-1.1
Fort Worth C17	85.3	84.4	-0.9

The average reduction over all the DFW monitors was 1.1 ppb

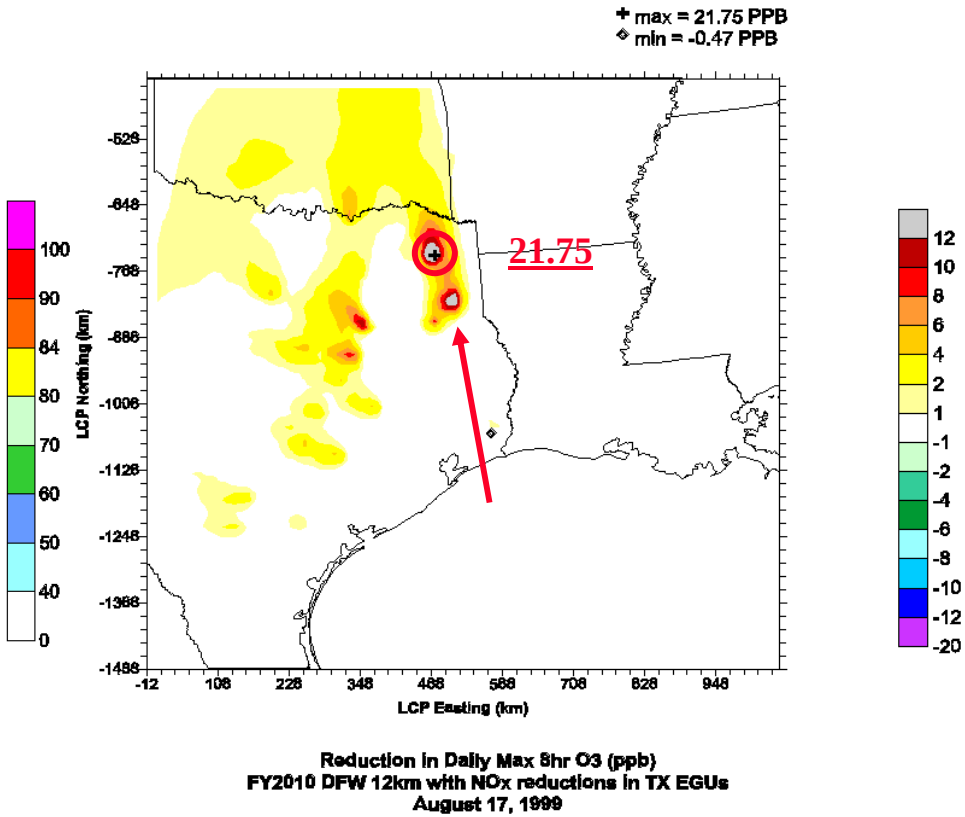
Impact of East TX EGU Controls

East Texas - August 17th

Max 8-Hour Ozone



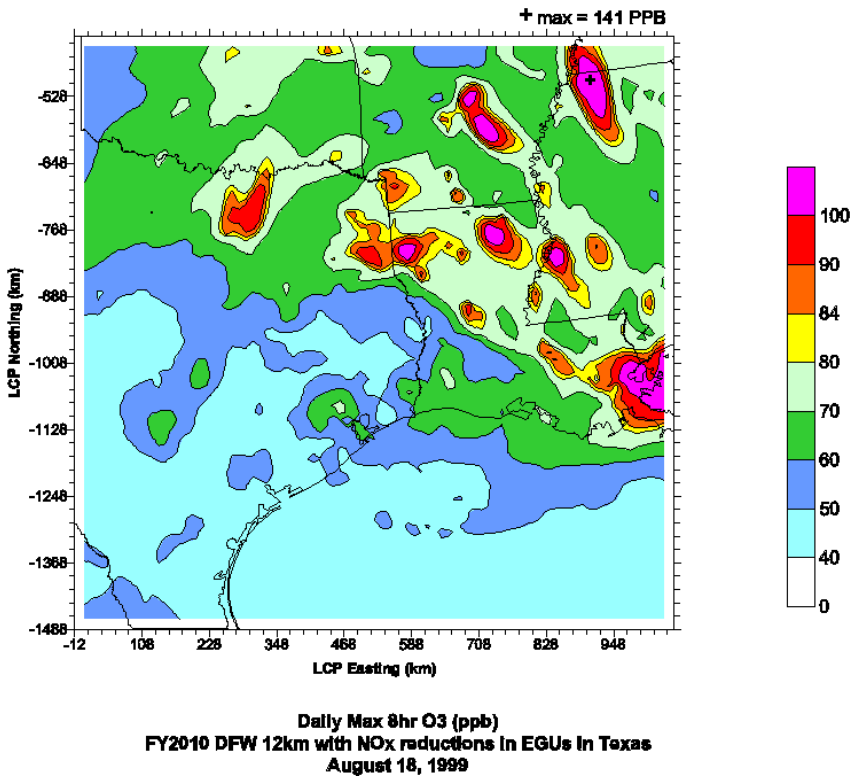
Difference Plot



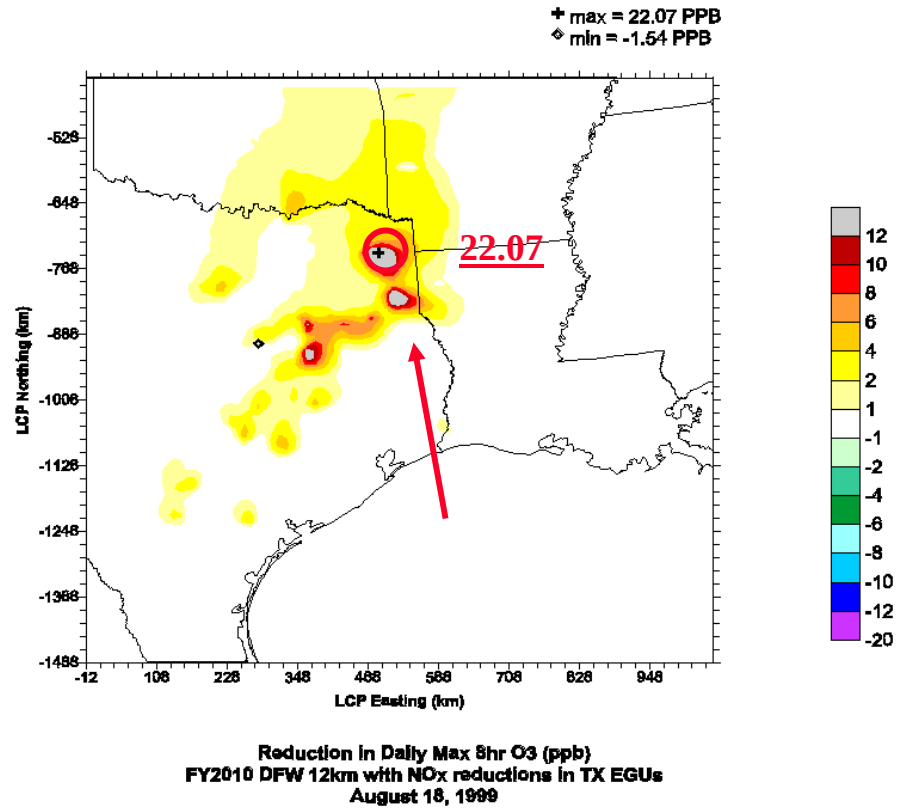
Impact of East TX EGU Controls

East Texas - August 18th

Max 8-Hour Ozone



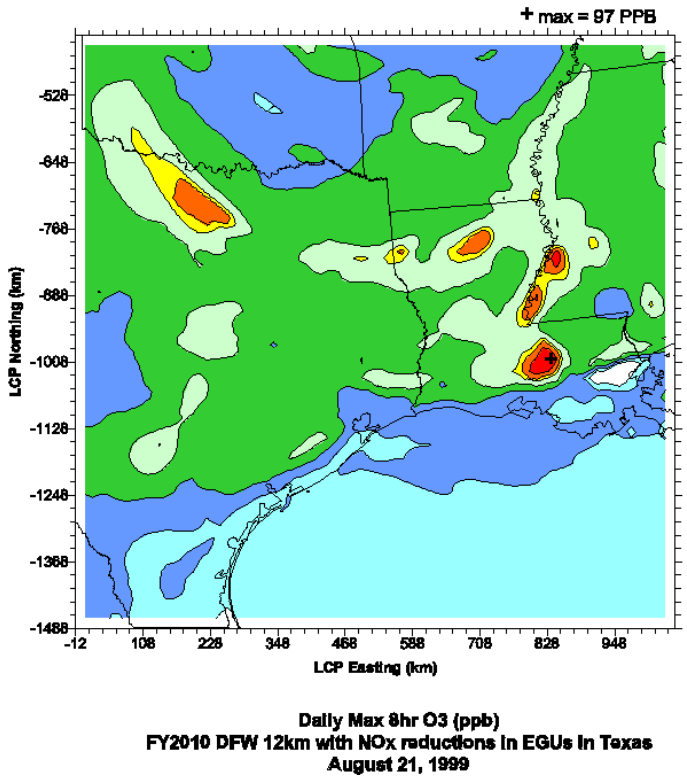
Difference Plot



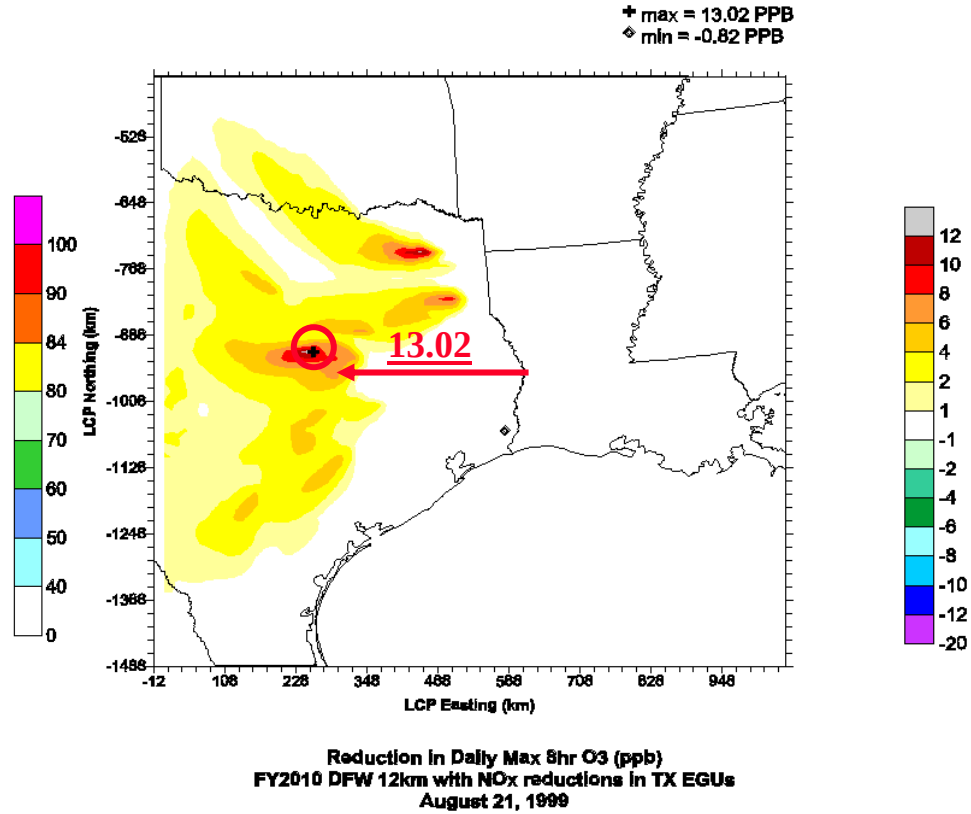
Impact of East TX EGU Controls

East Texas - August 21st

Max 8-Hour Ozone



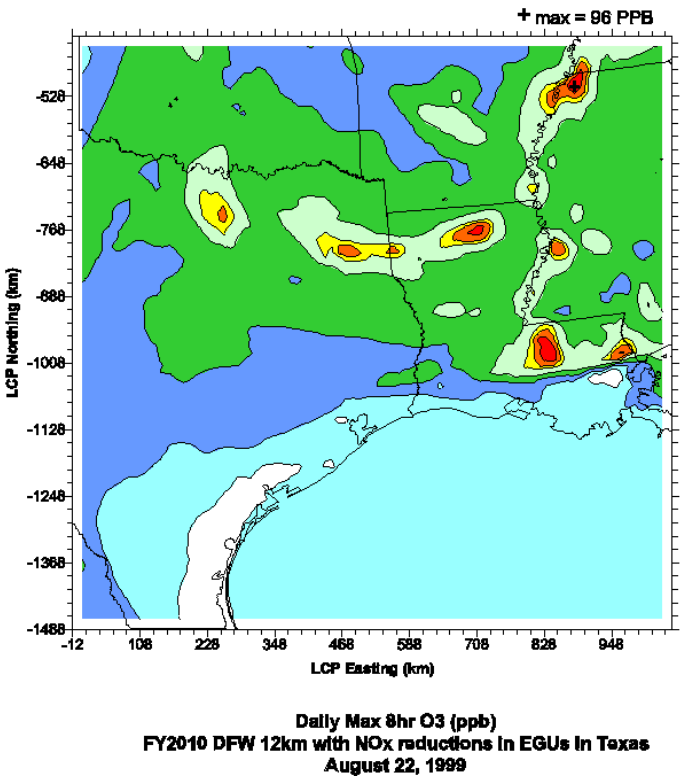
Difference Plot



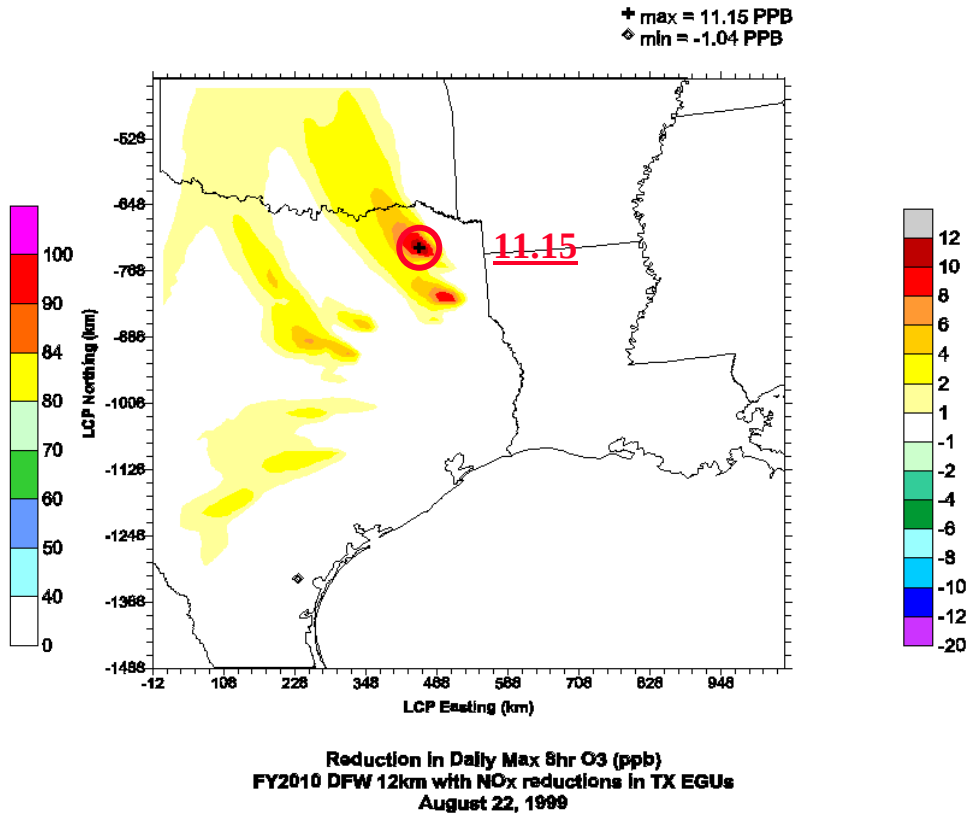
Impact of East TX EGU Controls

East Texas - August 22nd

Max 8-Hour Ozone



Difference Plot



How Much Difference Do the EGU Reductions Make in East Texas?

Episode Day	Peak 8-Hour Ozone	Max Difference Downwind	East Texas Location
Aug 15	97	-12.71	NE Texas
Aug 16	111	-16.02	NE Texas
Aug 17	114	-21.75	NE Texas
Aug 18	141	-22.07	NE Texas
Aug 19	130	-13.11	NE Texas
Aug 20	107	-11.24	NE Texas
Aug 21	97	-13.02	Central Texas
Aug 22	96	-11.15	NE Texas

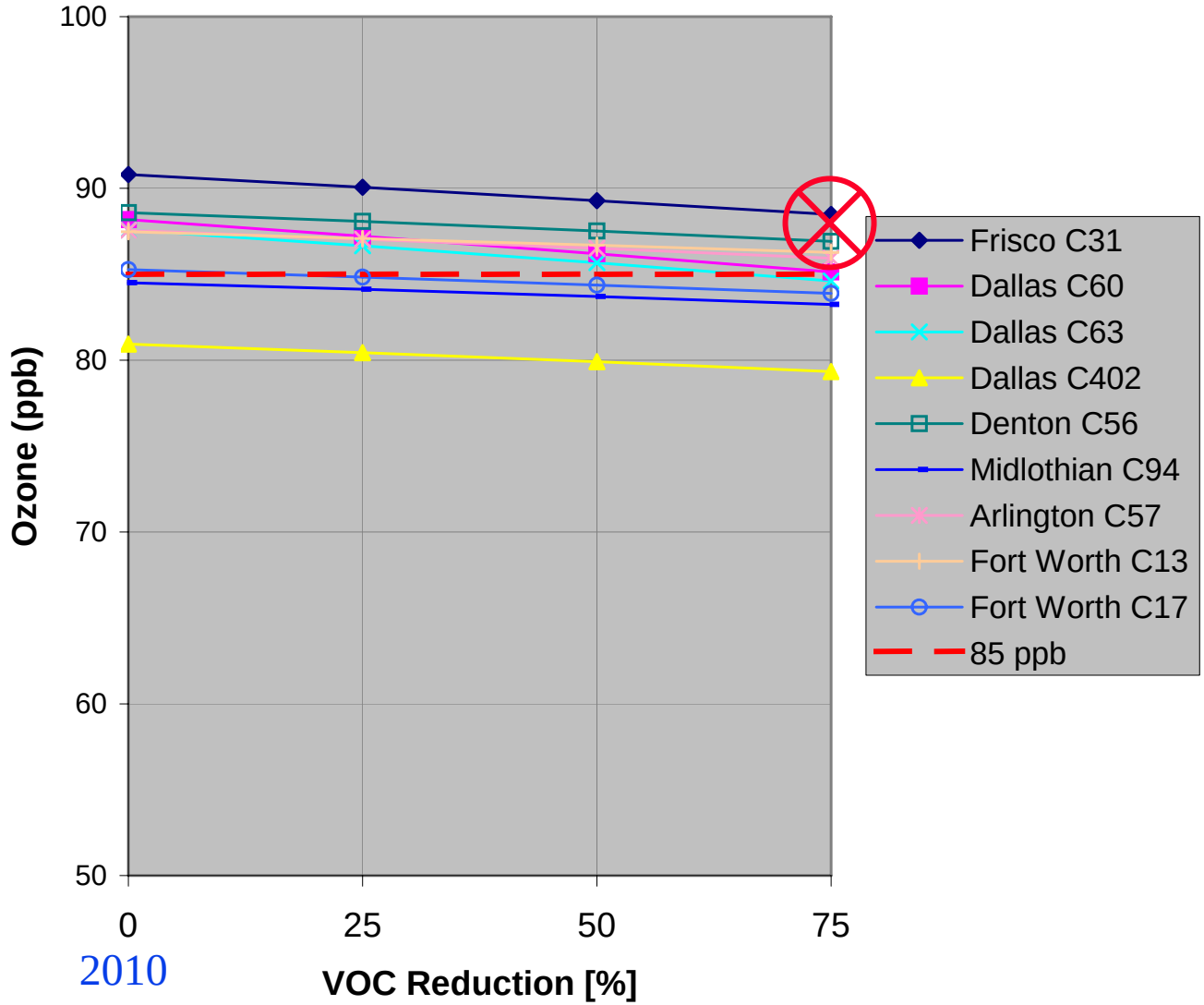
Impact of EGU NOx Reductions

- Additional NOx reductions applied to East Texas EGUs in 2010 lead to widespread reductions in 8-hour ozone on all days.
- The largest ozone reductions occur primarily in plumes in central and northeast Texas, but benefits extend into the DFW area on all days
- Future 8-hour Design Values (DVs) in Dallas are reduced by 0.9 to 1.6 ppb
  - Midlothian is reduced the most, by 1.6 ppb
  - Frisco 8-hour Ozone is reduced by 1.3 ppb

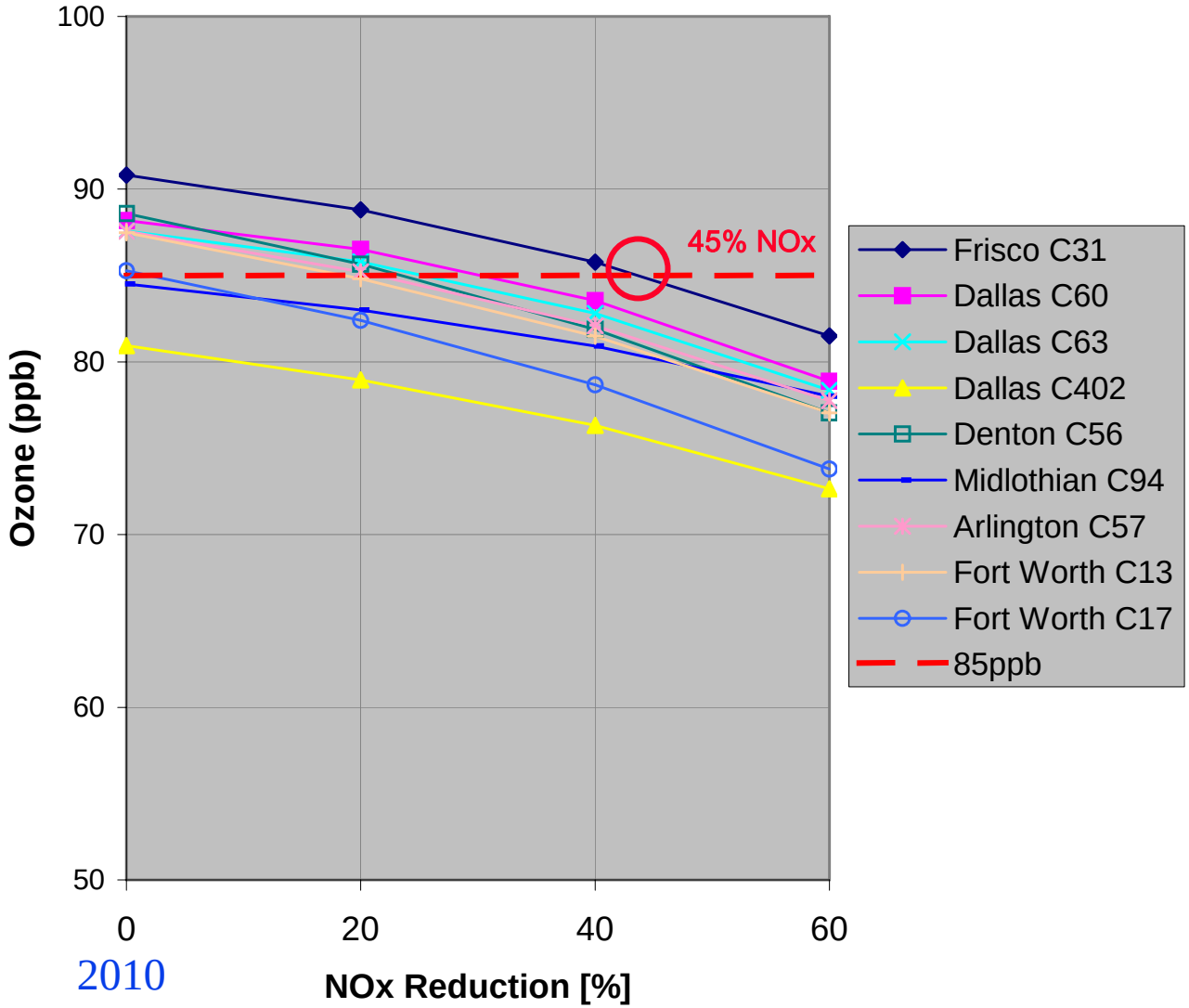
Review:

Level of Controls Needed to Show Attainment by 2010

Design Value-Scaled 2010 DFW 8-Hour Ozone VOC Reductions. Aug 13-22, 1999 Core Period.

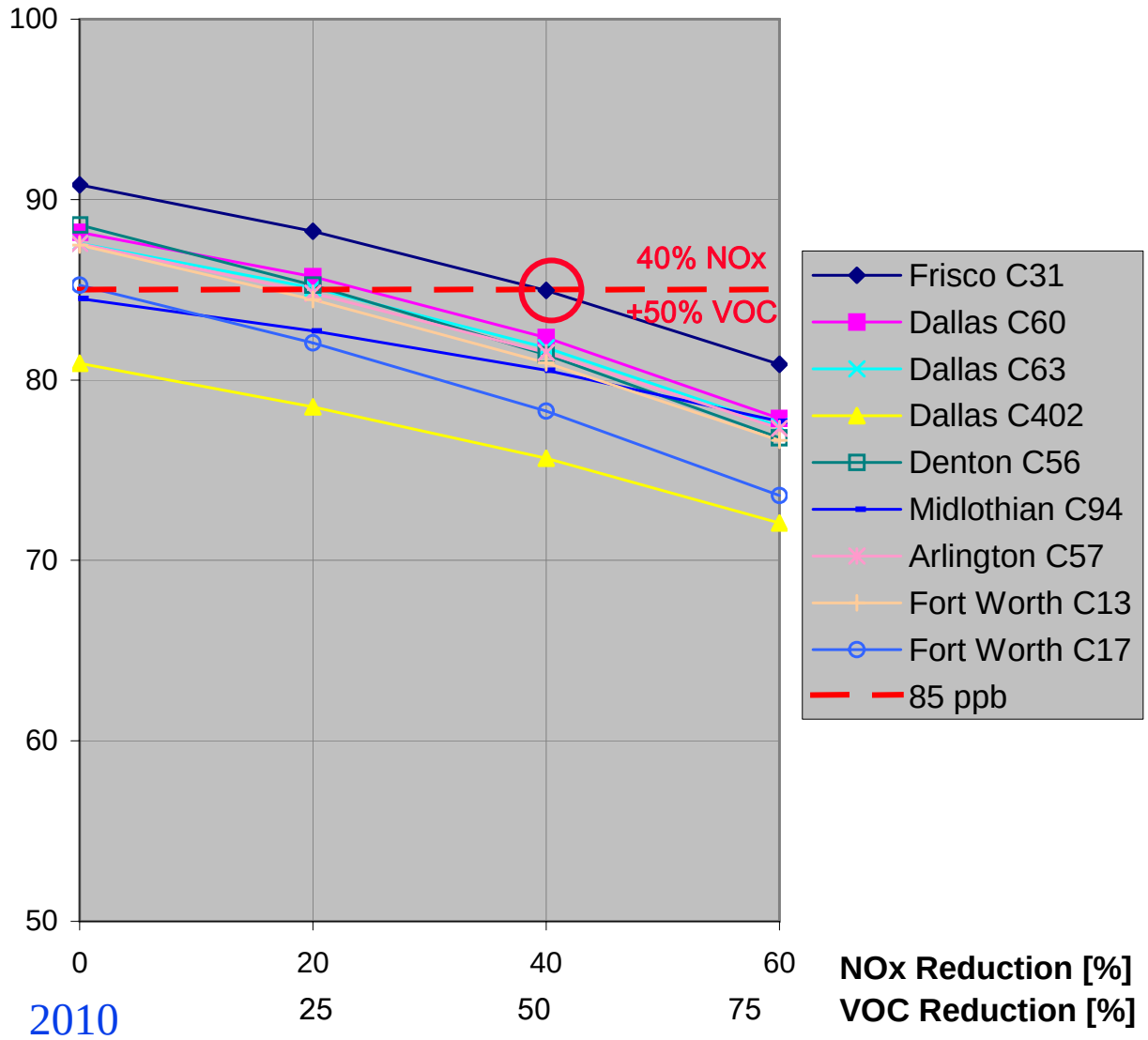


Design Value Scaled 2010 DFW 8-Hour Ozone
NOx Reductions. Aug 13-22, 1999 Core Period.



Design Value-Scaled 2010 DFW 8-Hour Ozone

NOx and VOC Reductions. Aug 13-22, 1999 Core Period.



2010 Modeling Results

Years Tested Episode	1999-2010 First Time	1999-2010 Core	1999-2010 Supp
CAMx Config	17b	40	40
Worst Case Site	Frisco	Frisco	Frisco
‘Current’ DV	101	99.7	99.7
‘Future’ DV	92.4	90.8	90.5
NOx Reduction	52%	45%	42%
If NOx + VOC	47% +60%	40% + 50%	35% + 40%
# Sites Exceeding	8	7	7

What's Next?

- Work Order #12 Signed Last Week
  - Can resume Modeling
- Finalize 2009 Emissions Inventory
  - Mobile Source Update (base and 2009)
  - Point, Area/Nonroad (2009)
- Modeling Plans
  - Redo 1999 Base Case with Adjusted Weekend Mobile Emissions
  - Run 2009 Future Base, Get Future DV
  - Evaluate Impact of National Transport
  - Sensitivity Tests on Texas Regional Controls
  - Run DFW Local Control Packages