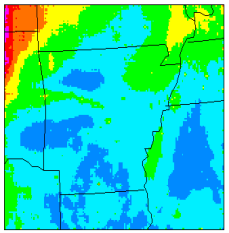




CRITERIA POLLUTANT MODELING ANALYSIS FOR ARKANSAS

Air Quality Modeling Results

20 August 2014

Prepared for: Arkansas Department of Environmental Quality

Presented by: Sharon Douglas & Jay Haney, ICF

Today's Presentation

- Overview and Objectives
- Arkansas Air Quality (Current Conditions/Trends)
- Overview of the Statewide Modeling Exercise
  - Modeling tools/application procedures
  - Modeling domain
  - Simulation periods
- Base- and Future-year Emissions
- Base-year Modeling (Model Performance)
- Future-year Modeling Results
  - Simulated differences in concentration
  - Key findings for ozone, $PM_{2.5}$, NO_2, SO_2 and visibility

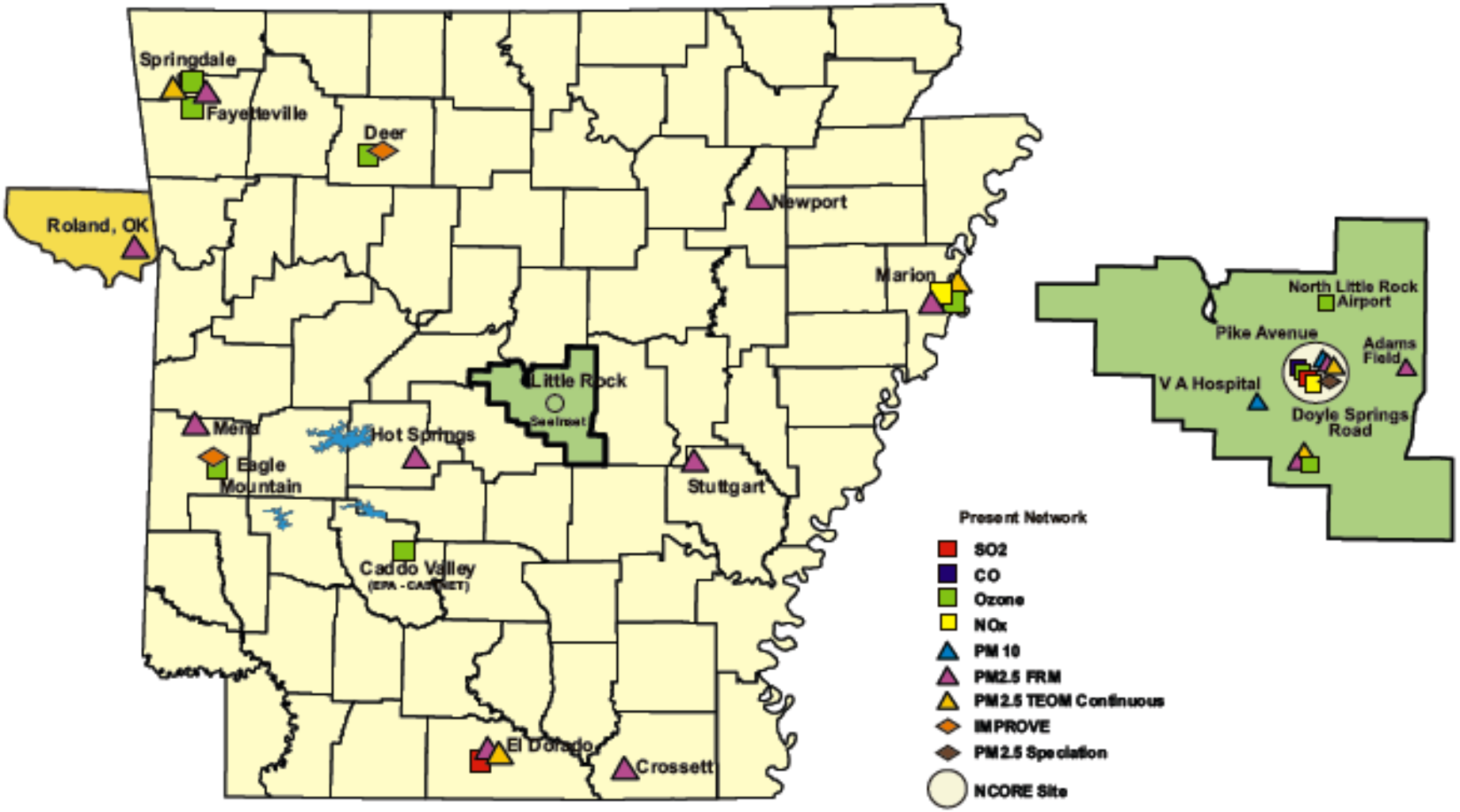
Overview of the Modeling Study

- Statewide criteria pollutant modeling analysis is an air quality modeling study of future-year air quality for the State of Arkansas
- Pollutants of interest:
  - Ozone (O_3)
  - Fine particulate matter ($PM_{2.5}$)
  - Nitrogen dioxide (NO_2)
  - Sulfur dioxide (SO_2)
- Modeling analysis includes two base years (2005 & 2008) and a future year (2015)

Objectives

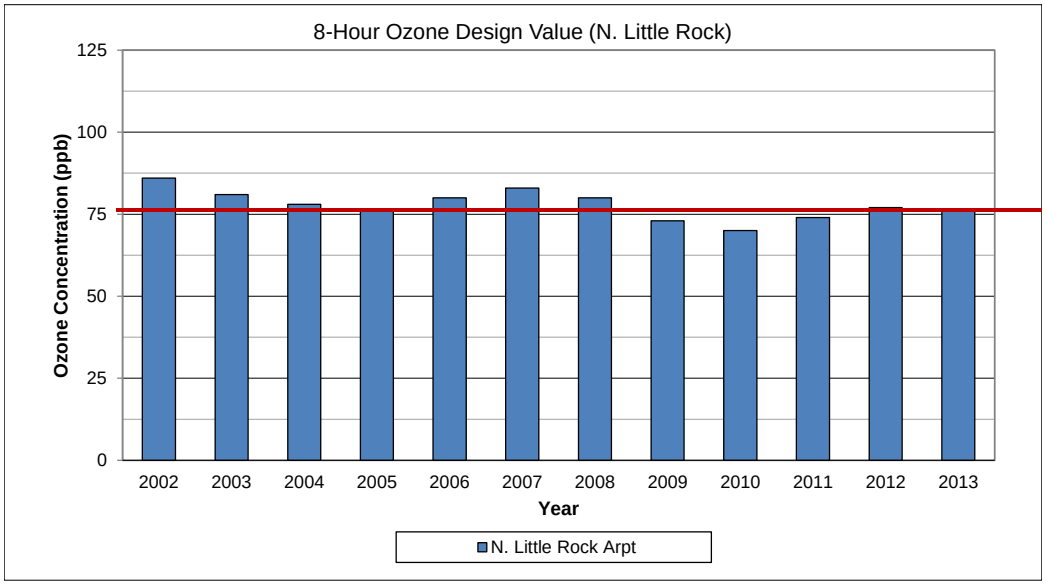
- Identify areas with potential ozone, $PM_{2.5}$, SO_2 and NO_2 air quality issues throughout the state
- Examine expected changes in concentrations between the base and future years
- Identify areas within the state where additional air quality monitoring may be used to ensure compliance with existing National Ambient Air Quality Standards (NAAQS)

ADEQ Air Quality Monitoring Network

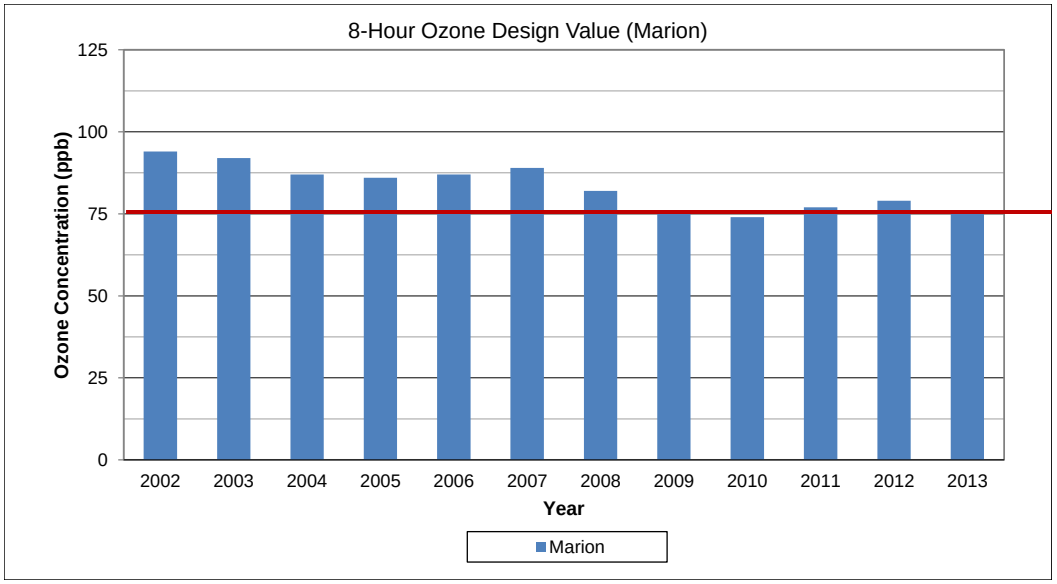


Source: ADEQ (2014)

Current Conditions/Trends: Ozone

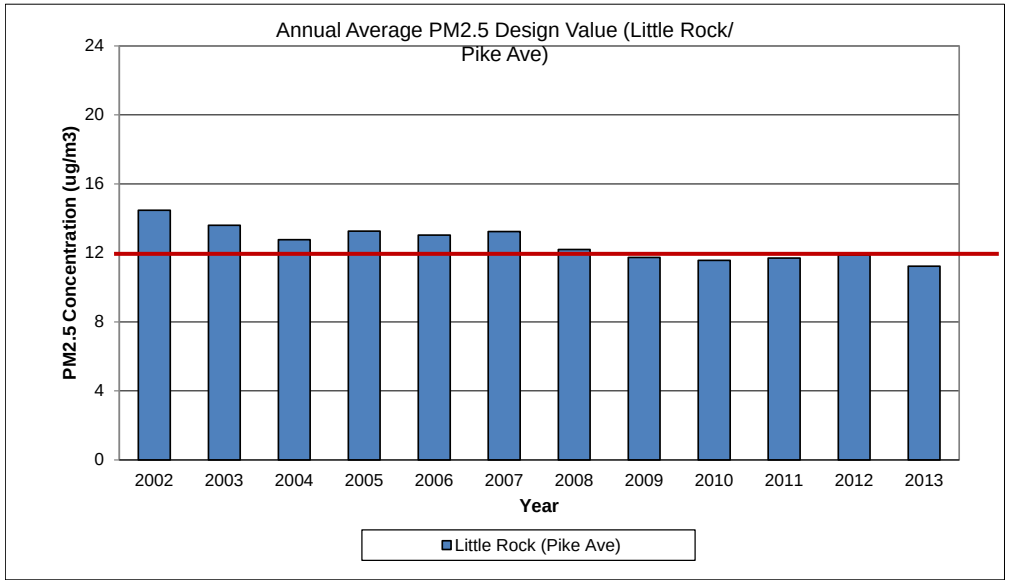


75 ppb



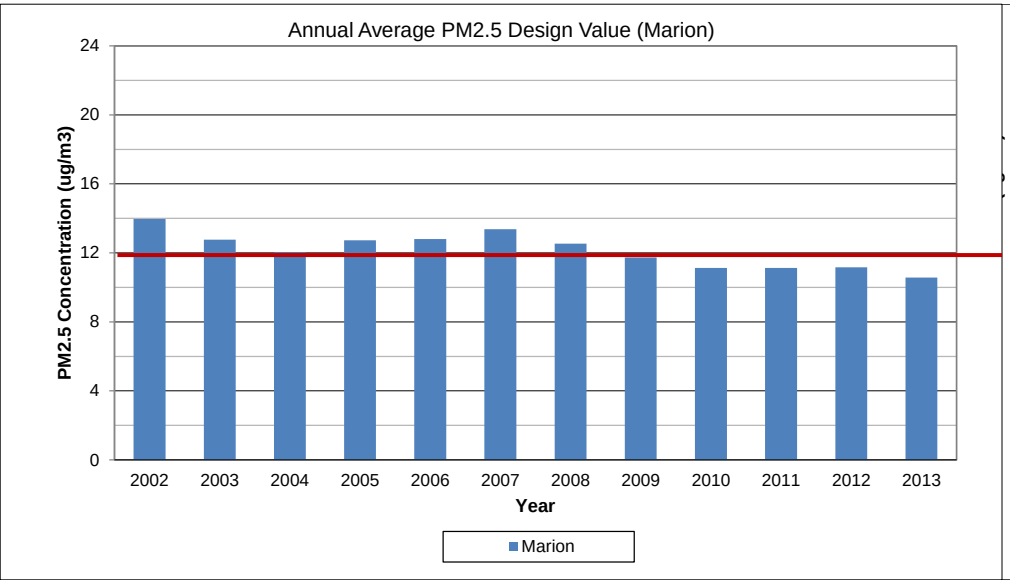
The 8-hr ozone NAAQS is 75 ppb

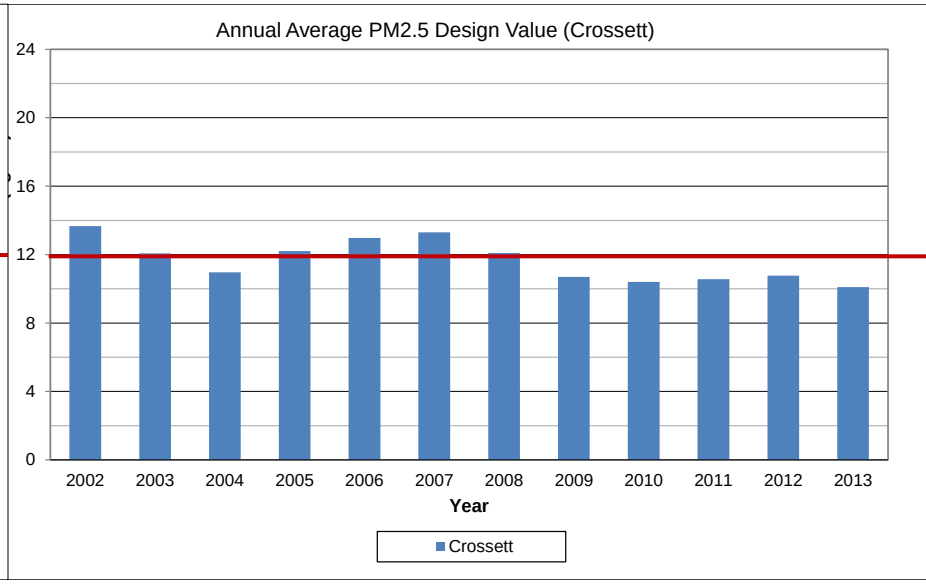
Current Conditions/Trends: PM2.5



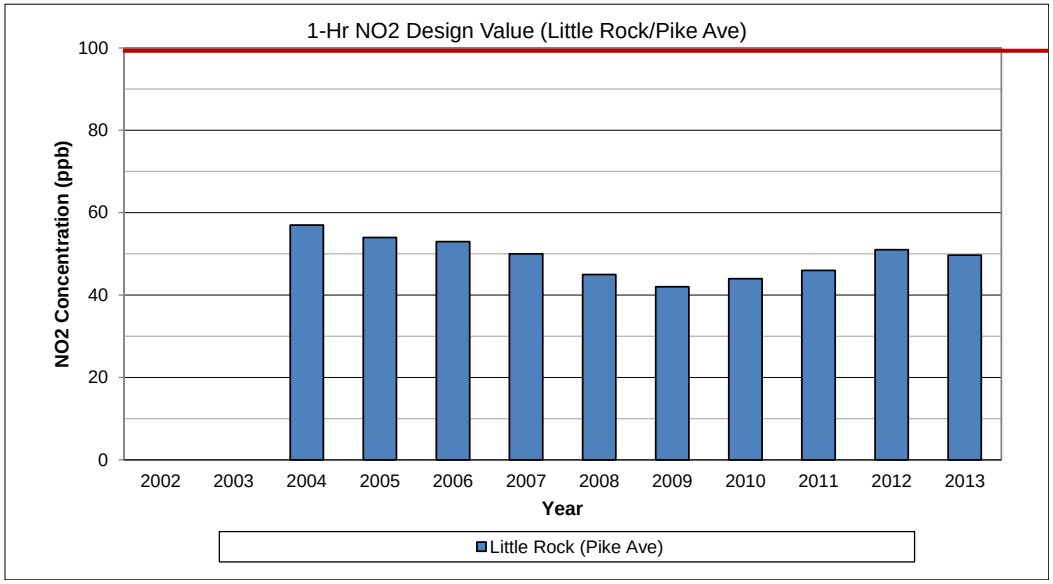
12 µg/m^3

The annual $PM_{2.5}$ NAAQS is 12 µg/m^3

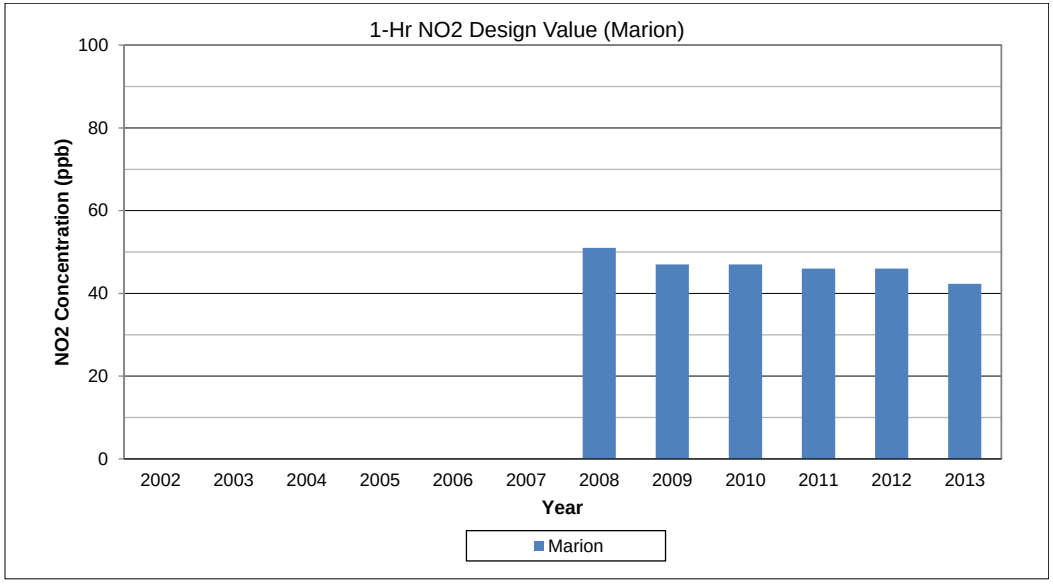




Current Conditions/Trends: NO2

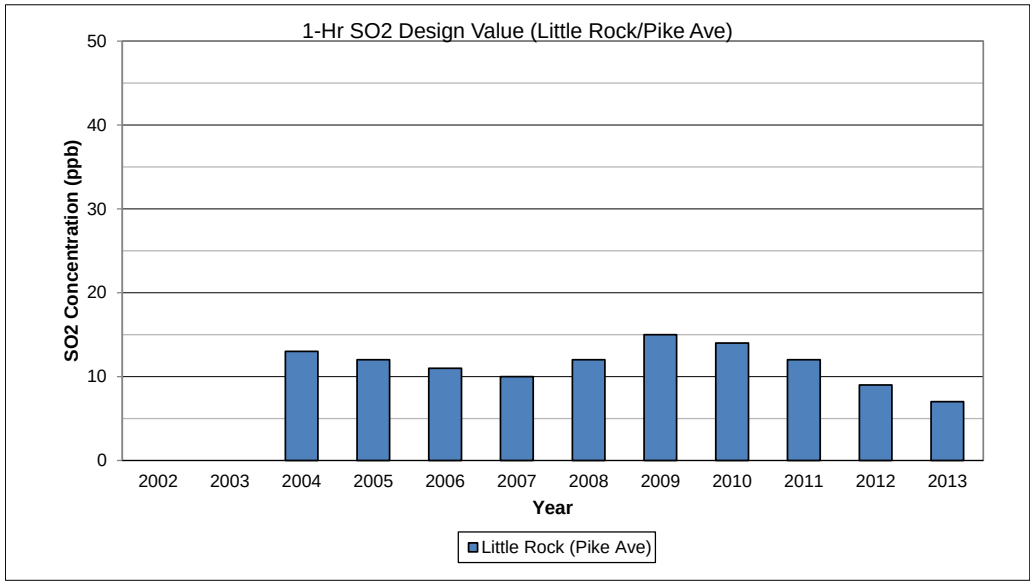


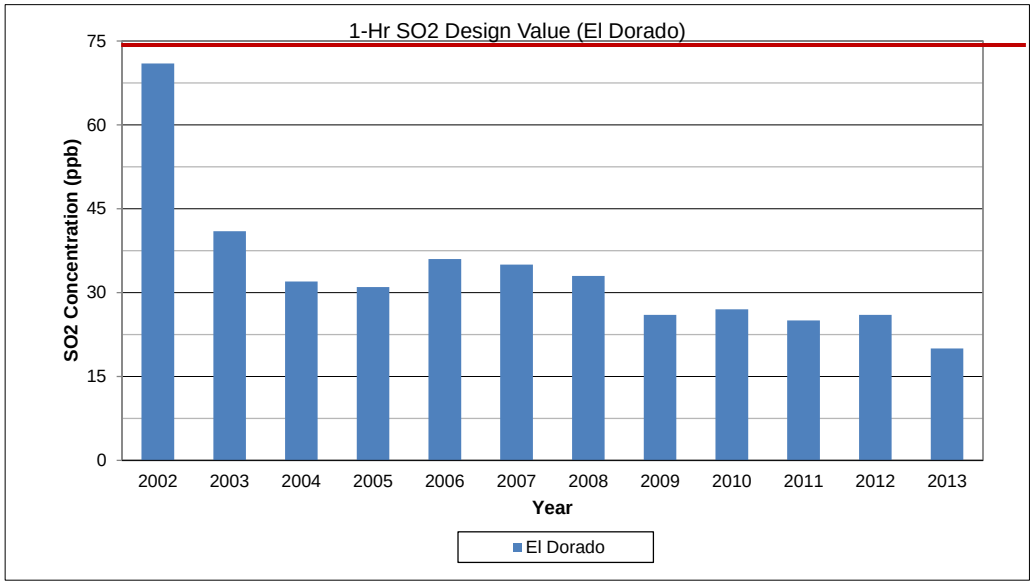
100 ppb



The 1-hr NO_2 NAAQS is 100 ppb

Current Conditions/Trends: SO2





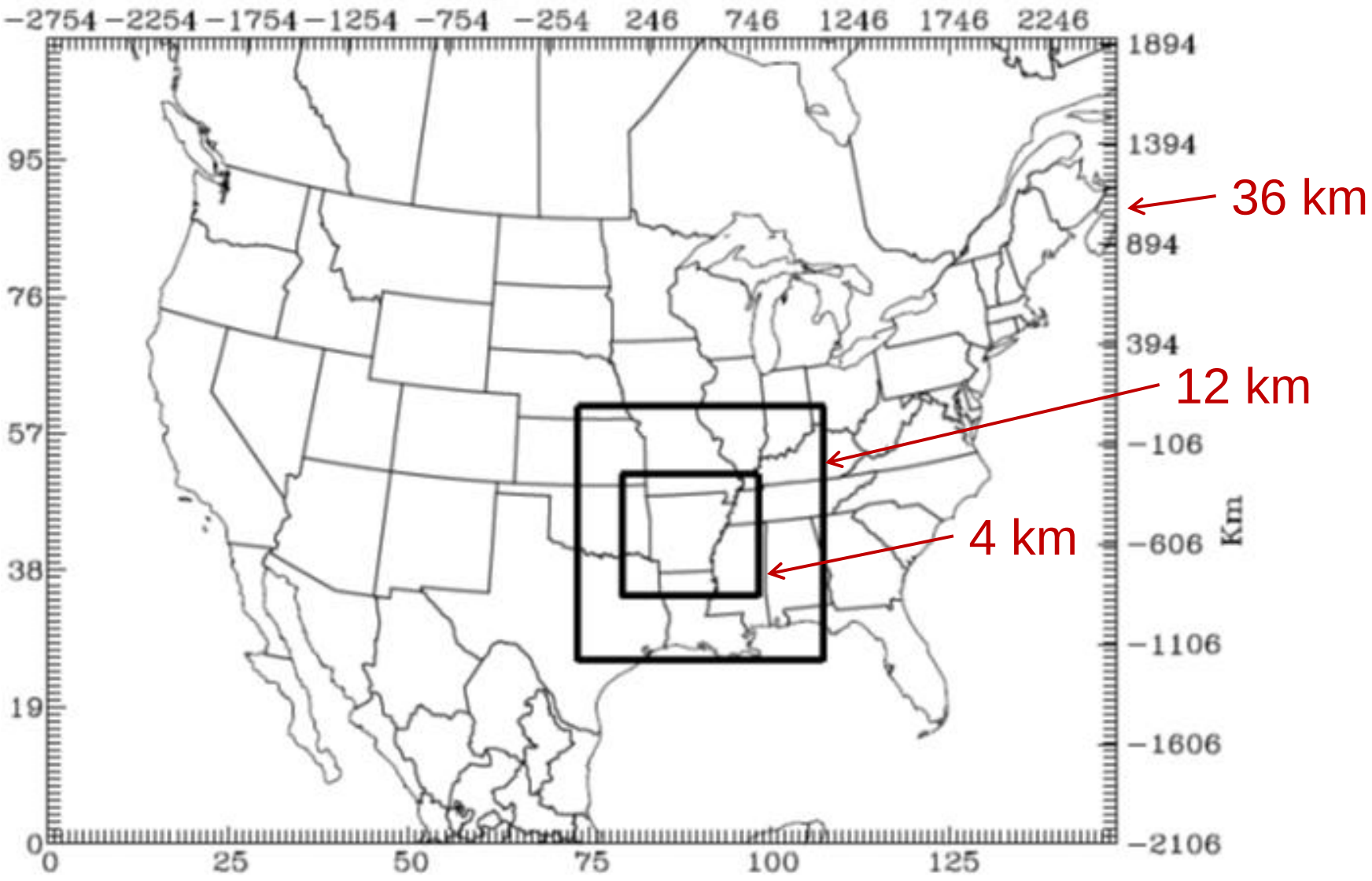
75 ppb

The 1-hr SO_2 NAAQS is 75 ppb

CMAQ Modeling

- CMAQ Version 5.0 (5.0.1)
- Multi-scale modeling domain (36-, 12- & 4-km grids)
- Two annual simulation periods (2005 & 2008)
- MM5-derived meteorological inputs
- 2005, 2008 & 2015 emissions
  - National Emissions Inventory (NEI)
  - SMOKE emissions processing tool
- Detailed base-year model performance evaluation

CMAQ Modeling Domain

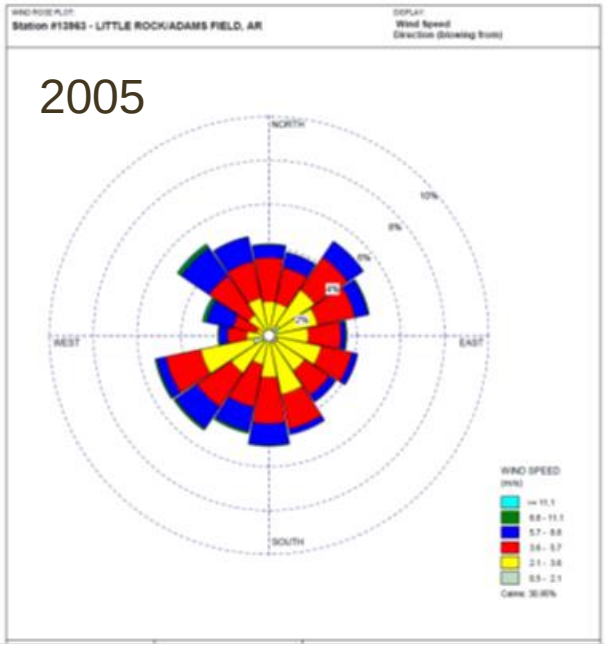


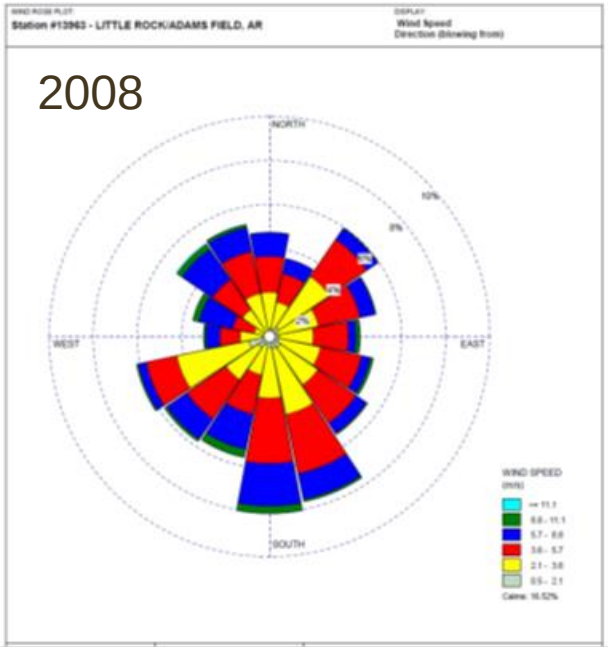
Comparison of 2005 & 2008 Periods

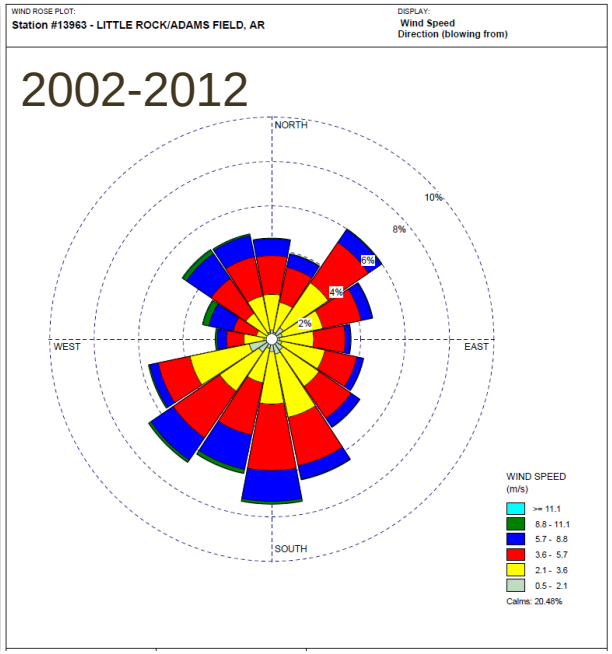
- Air quality (compared to 2002-2012 averages)
  - 2005
    - Highest overall concentrations for ozone and $PM_{2.5}$
    - Higher than average concentrations for NO_2
    - Lowest overall concentrations for SO_2
  - 2008
    - Lowest overall concentrations for ozone and NO_2
    - Lower than average concentrations for $PM_{2.5}$
    - Higher than average concentrations for SO_2
- Meteorology
  - 2005 was a warmer, dryer year and 2008 was a cooler, wetter year compared to 2002-2012 multi-year period

Comparison of 2005 & 2008 Periods

- Both periods capture the range of wind directions that characterize 2002-2012
  - 2005 characterized by lower wind speeds and less frequent southerly winds than the full period
  - 2008 characterized by higher wind speeds than the full period



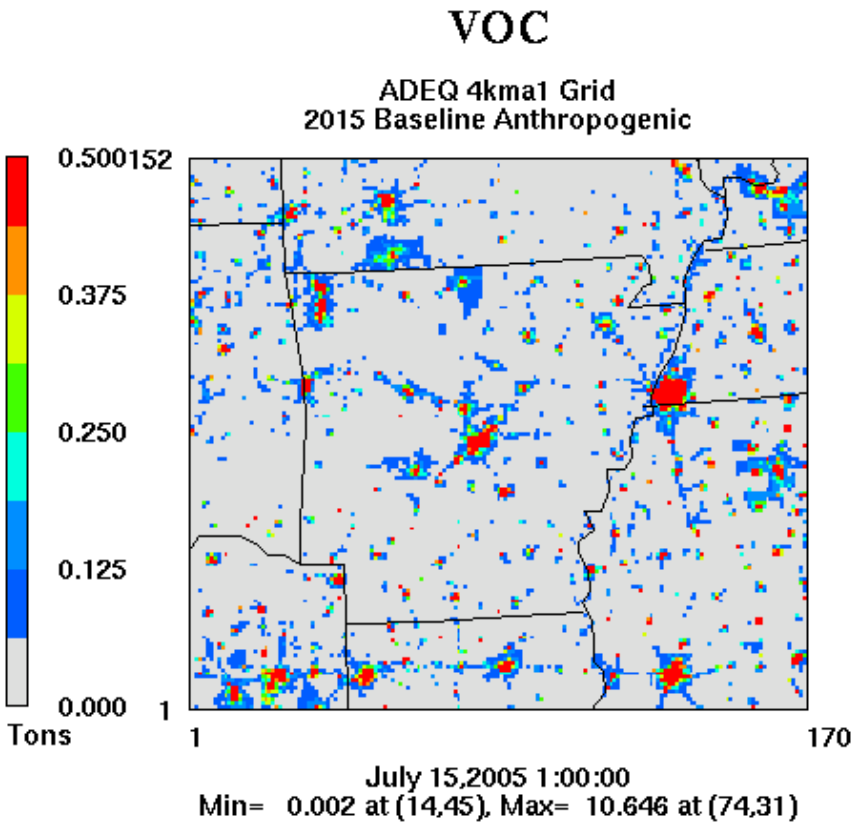


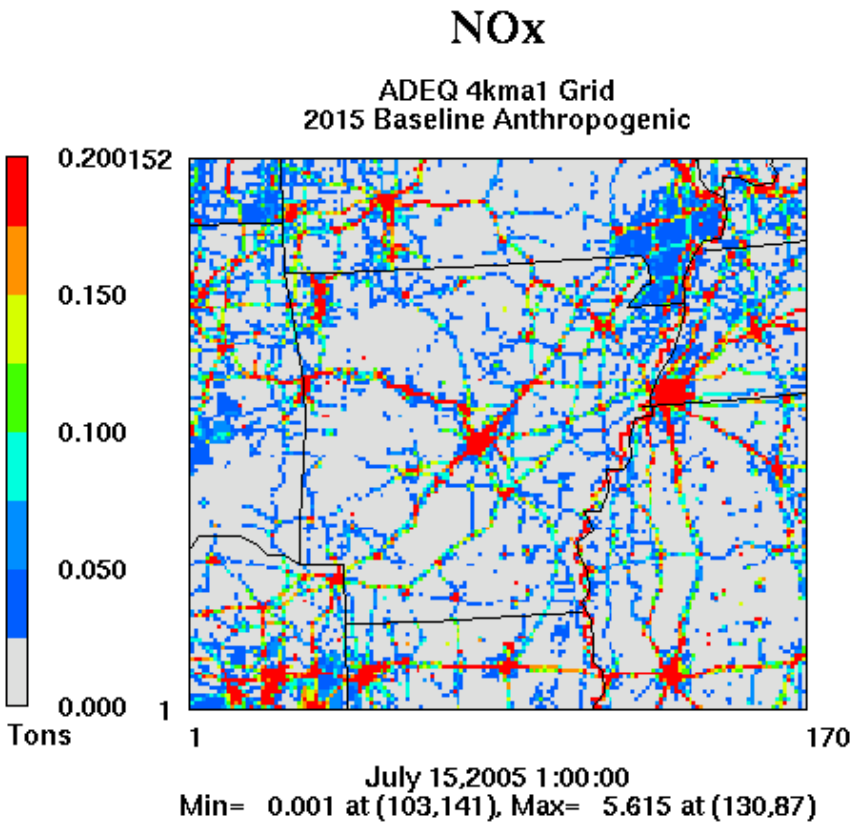


Emission Inventories

- Emission source categories
  - Point sources (Electric Generating Units (EGU))
  - Point sources (non-EGUs)
  - Area (non-point) sources
  - Non-road mobile sources
  - On-road mobile sources
  - Biogenic sources
  - Wildfires

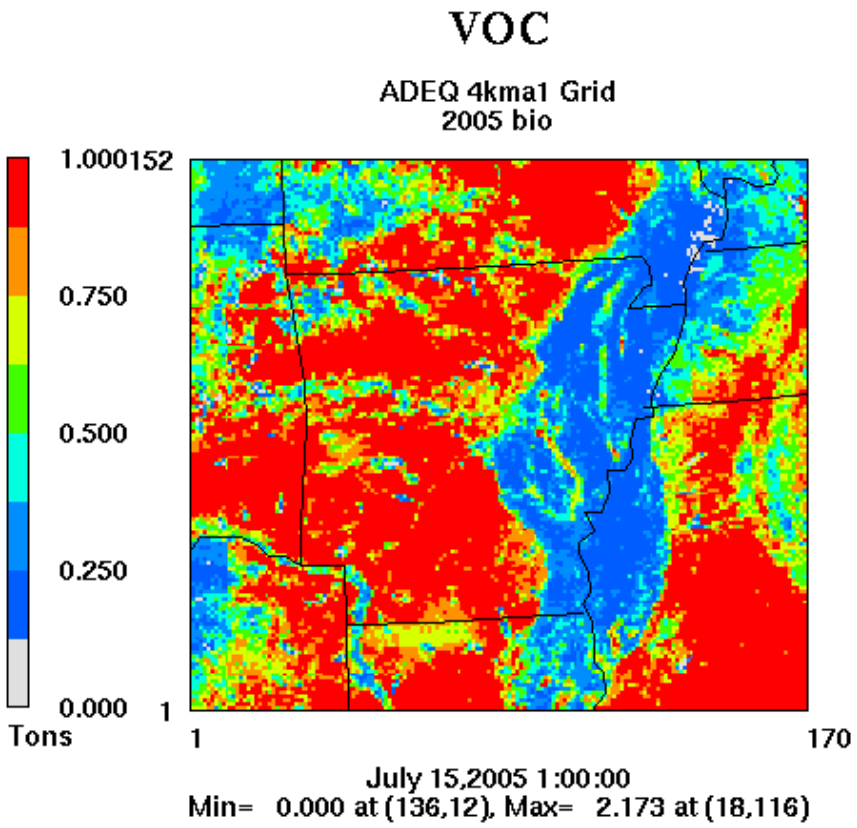
VOC & NOx Emissions* (4-km Grid)





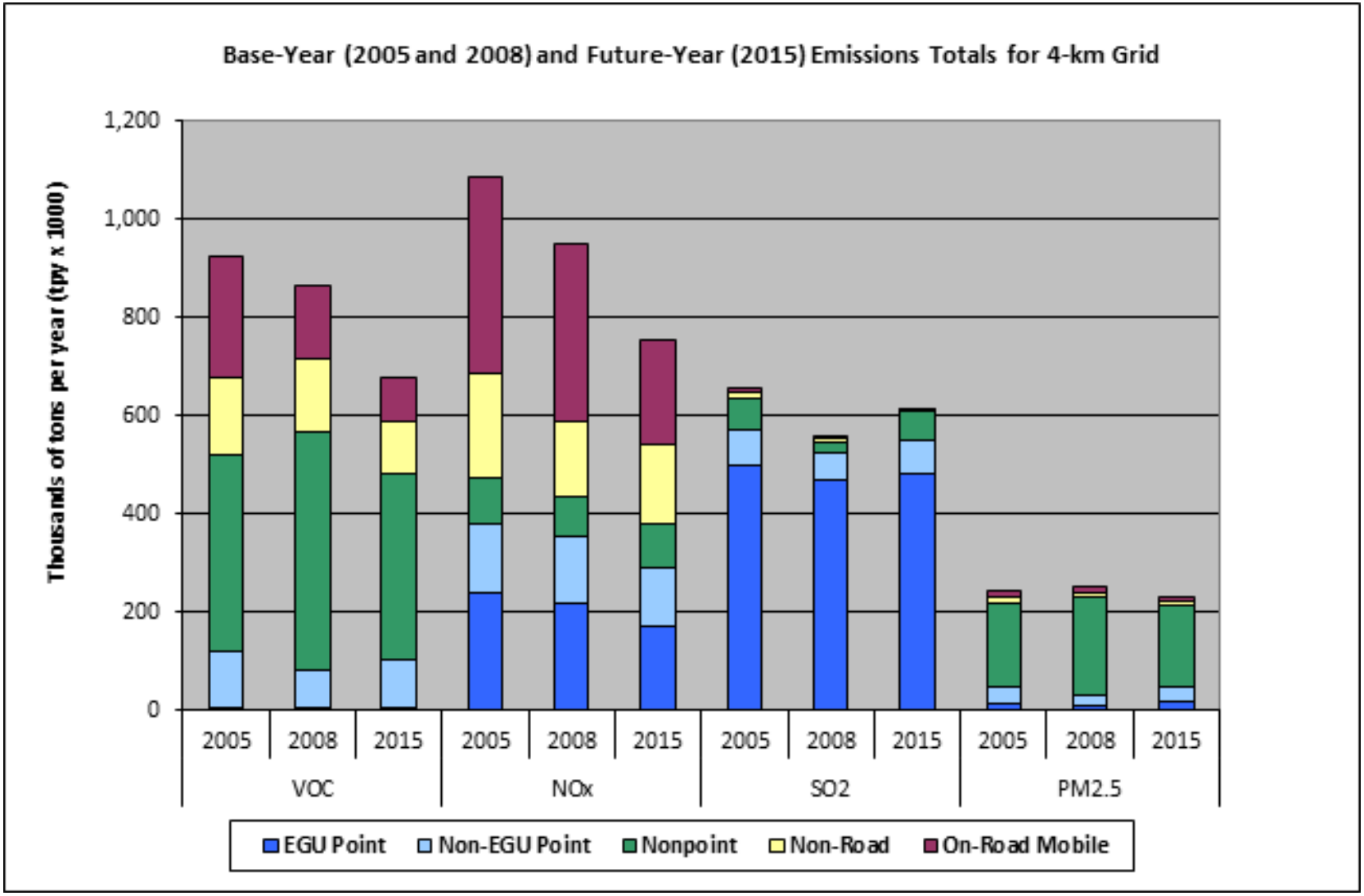
*Anthropogenic emissions
for 15 July 2005

Biogenic VOC Emissions (4-km Grid)

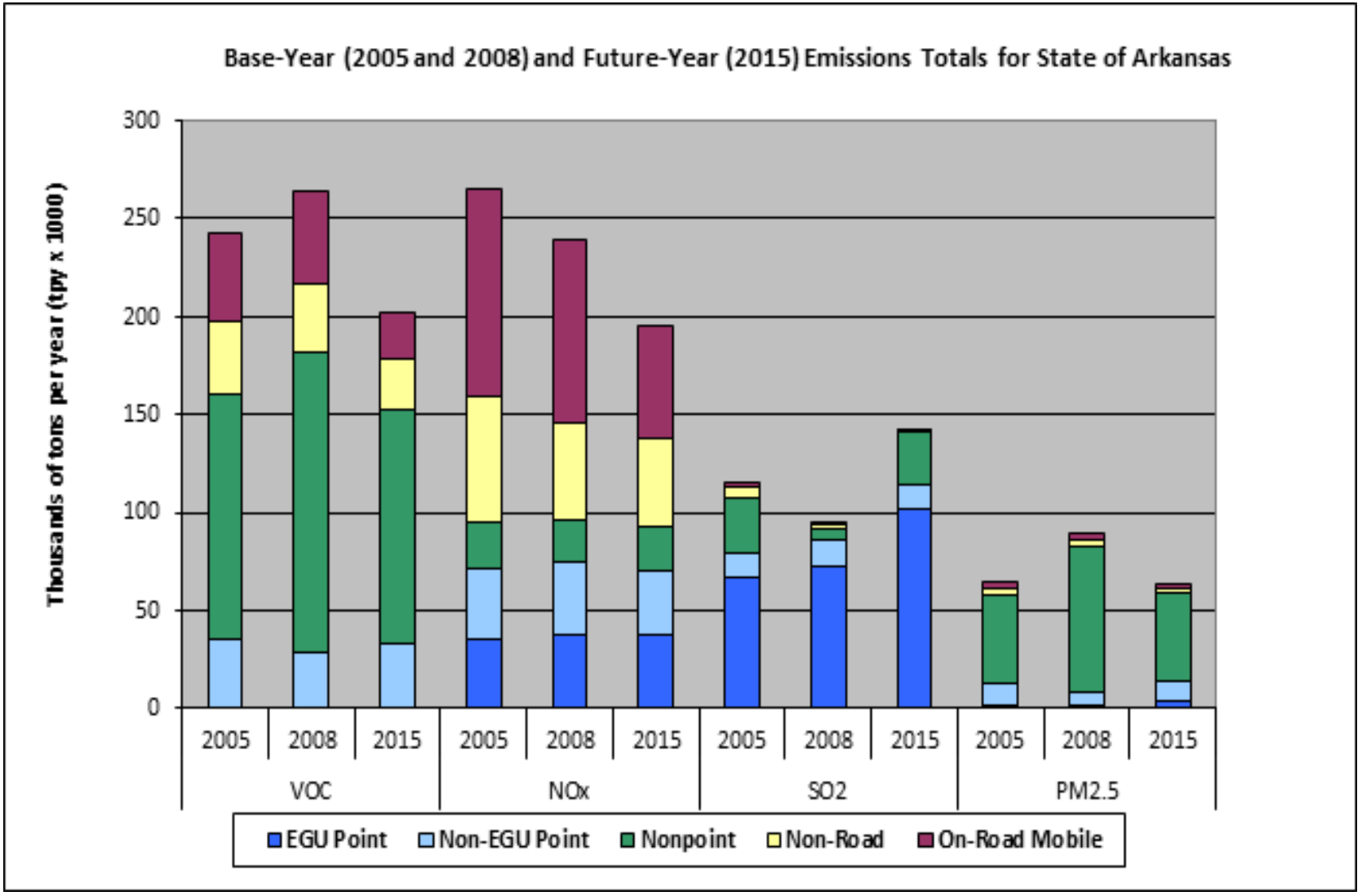


15 July 2005

Anthropogenic Emissions (4-km Grid)



Anthropogenic Emissions (Arkansas)



Emission Changes (Future vs Base Year)

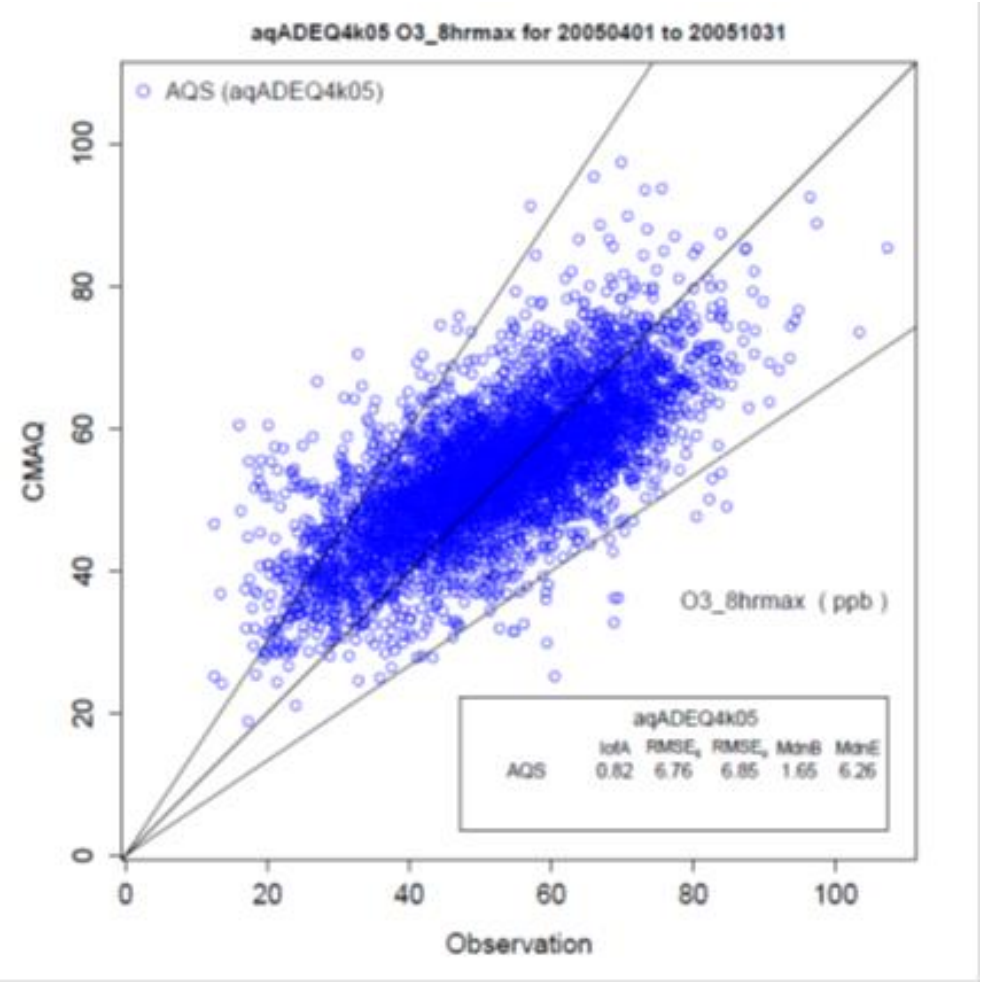
- 2015 vs 2005/2008
  - Anthropogenic VOC emissions lower for 2015
  - NO_x and CO emissions lower for 2015
  - SO_2 emissions slightly lower for the 4-km grid (2005 only) but otherwise higher (4-km grid [2008] and AR only [both years])
  - Changes reflect expected future emission reductions due to:
    - On-road mobile fleet turnover & cleaner fuels
    - Cleaner non-road engines, fuel, and other equipment
    - Mandated reductions in EGU NO_x emissions
    - Increases in EGU SO_2 emissions

Base-Year Emission Differences

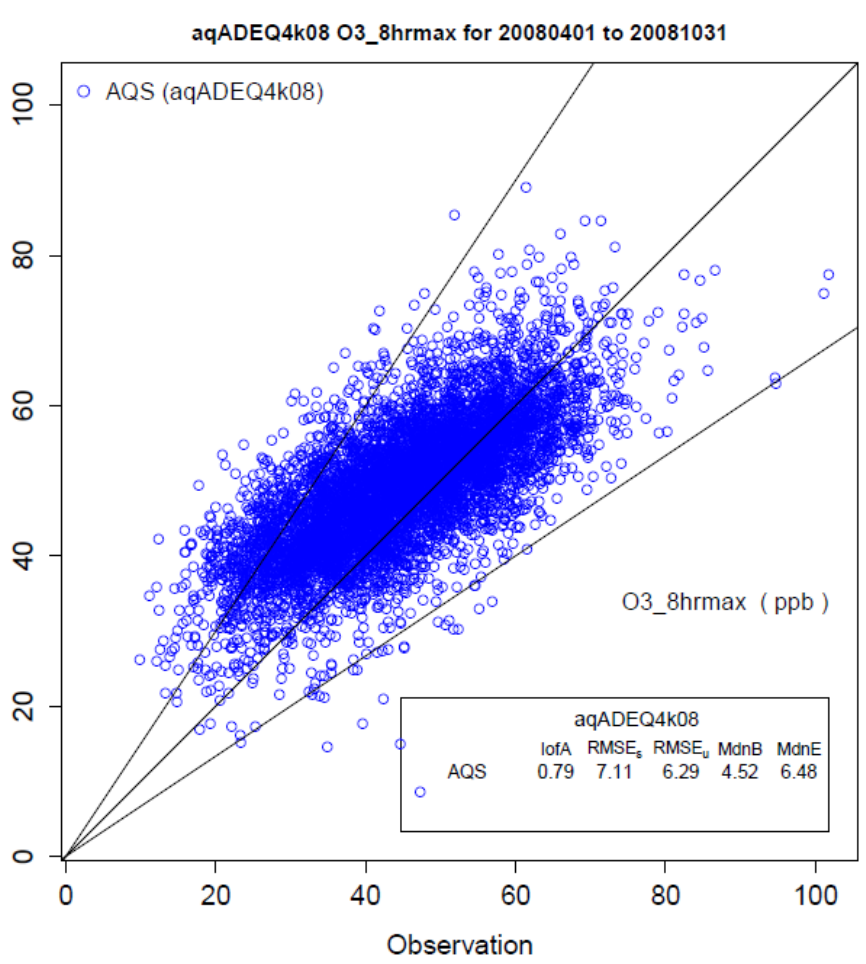
- 2008 vs 2005
  - Both decreases and increases compared to 2005
  - Differences reflect:
    - Differences due to meteorology
    - Differences in wildfires
    - Methodological differences in the 2005 & 2008 estimates from EPA
  - 2008 emissions were used for base-year model performance, but “current-year” emissions, reflecting only the differences due to meteorology, were used as the basis for future-year air quality projections

Base-Year Model Performance (Ozone)

2005



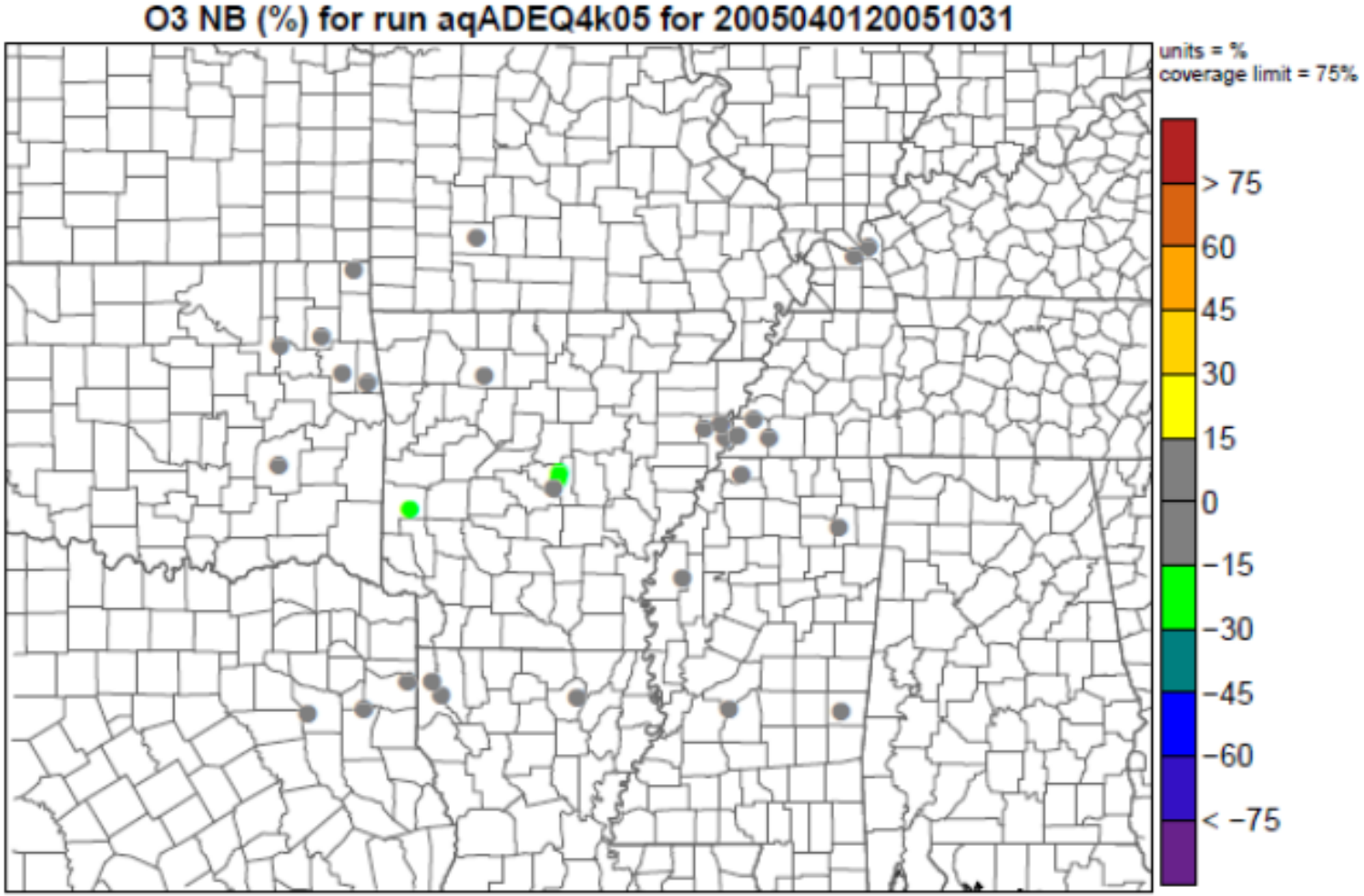
2008



Simulated vs Observed 8-Hour Ozone: 4-km Grid

Base-Year Model Performance (Ozone)

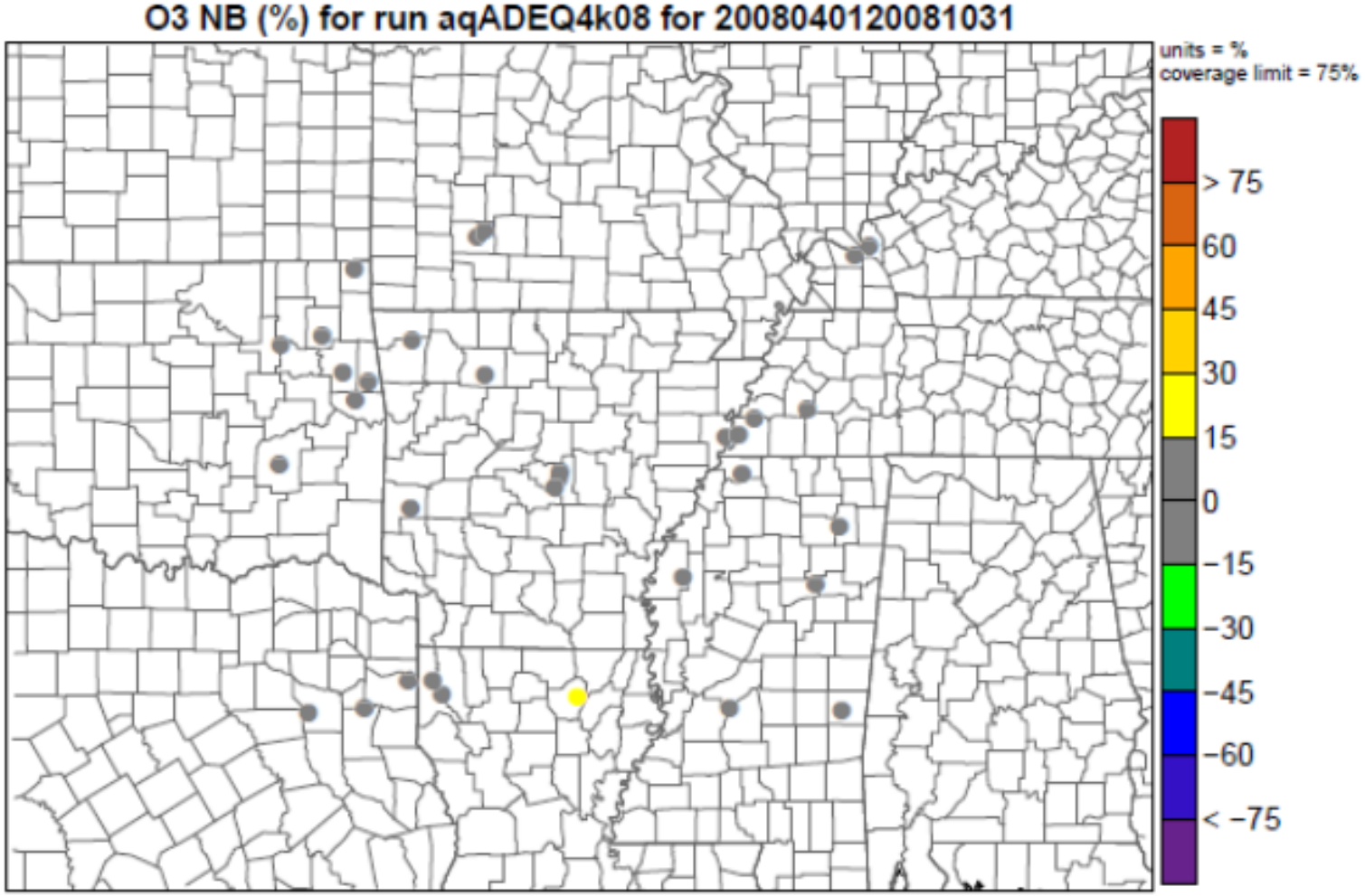
2005



Normalized Bias in Simulated 8-Hr Ozone: 4-km Grid

Base-Year Model Performance (Ozone)

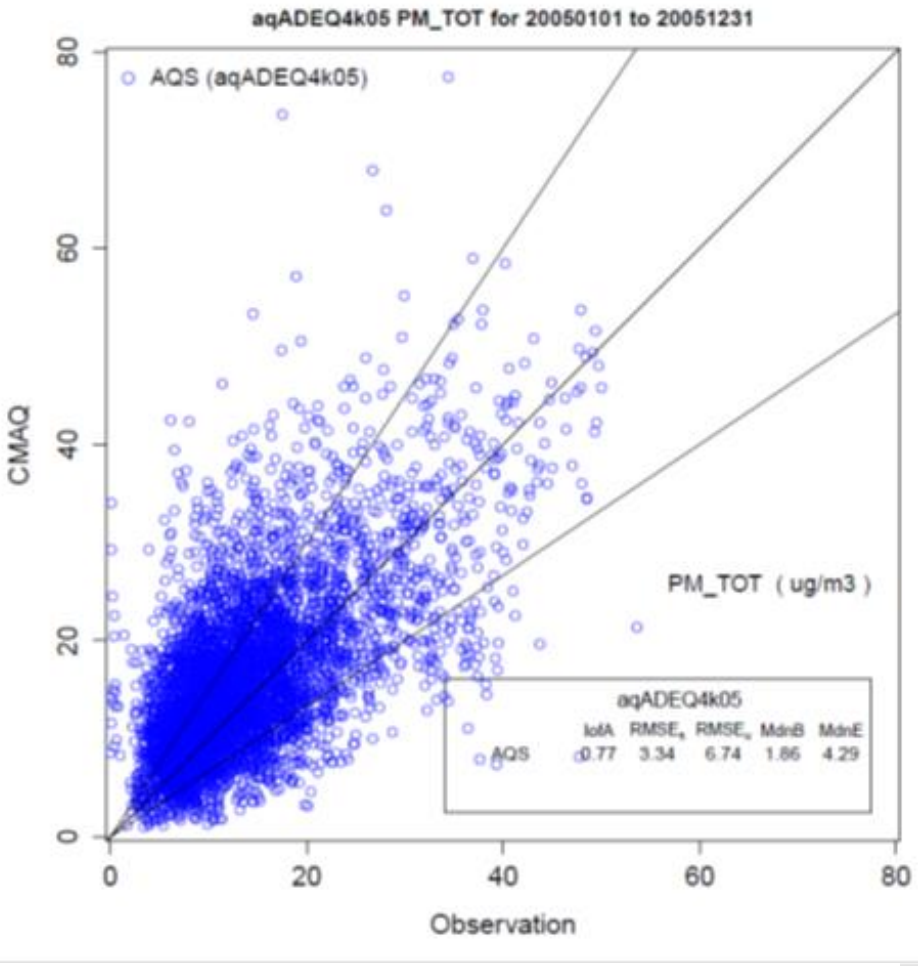
2008



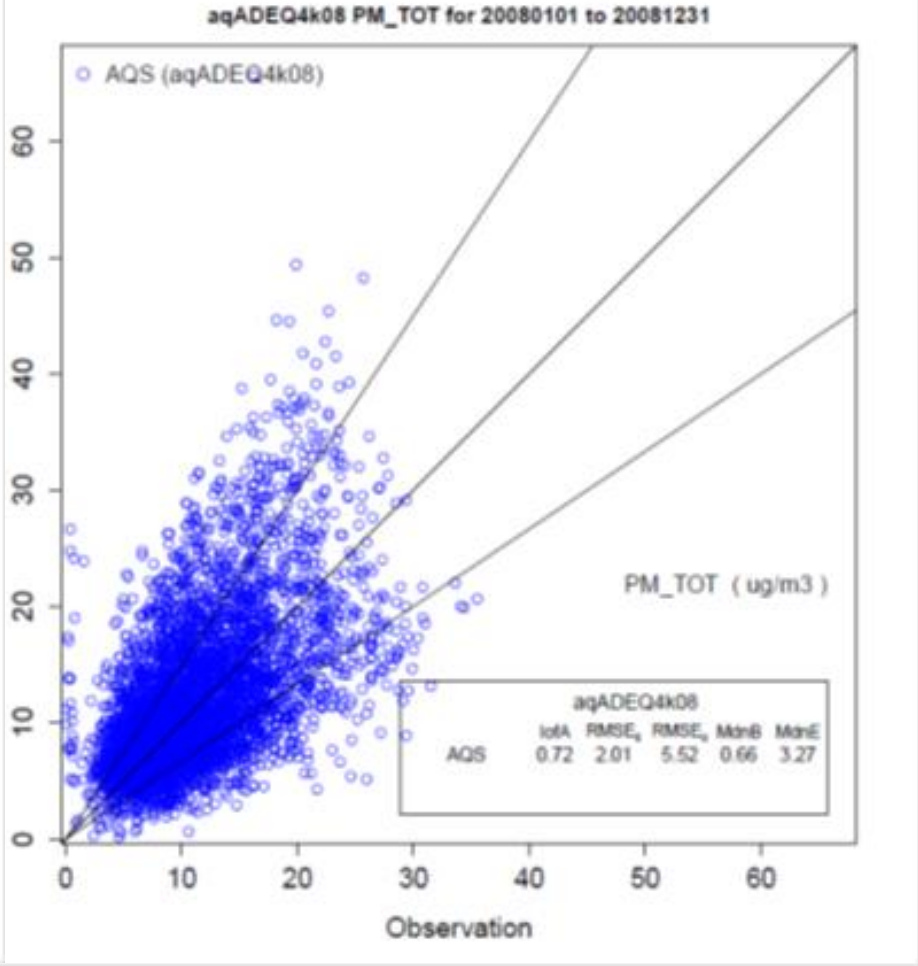
Normalized Bias in Simulated 8-Hr Ozone: 4-km Grid

Base-Year Model Performance (PM2.5)

2005



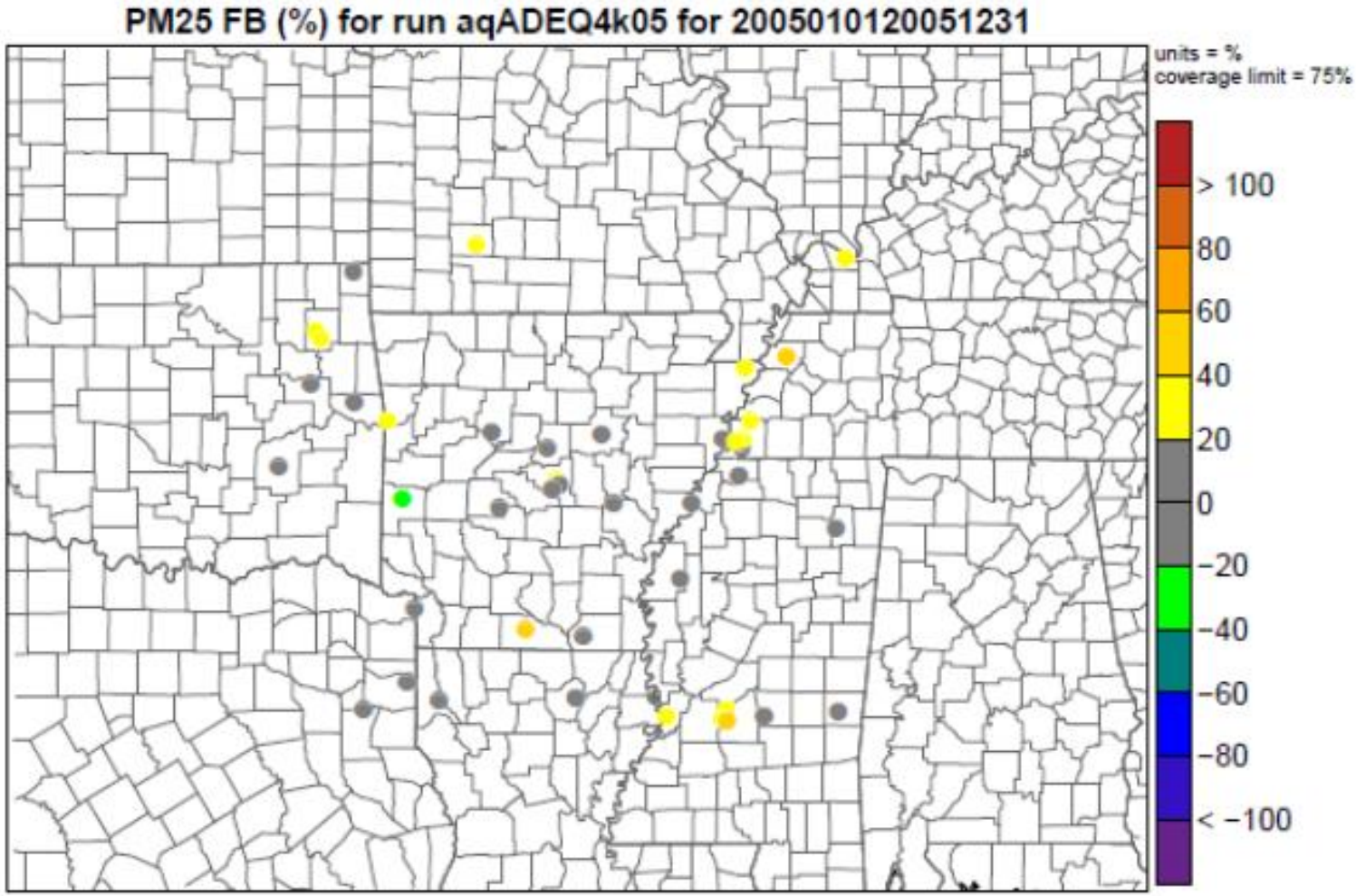
2008



Simulated vs Observed 24-Hour $PM_{2.5}$: 4-km Grid

Base-Year Model Performance (PM2.5)

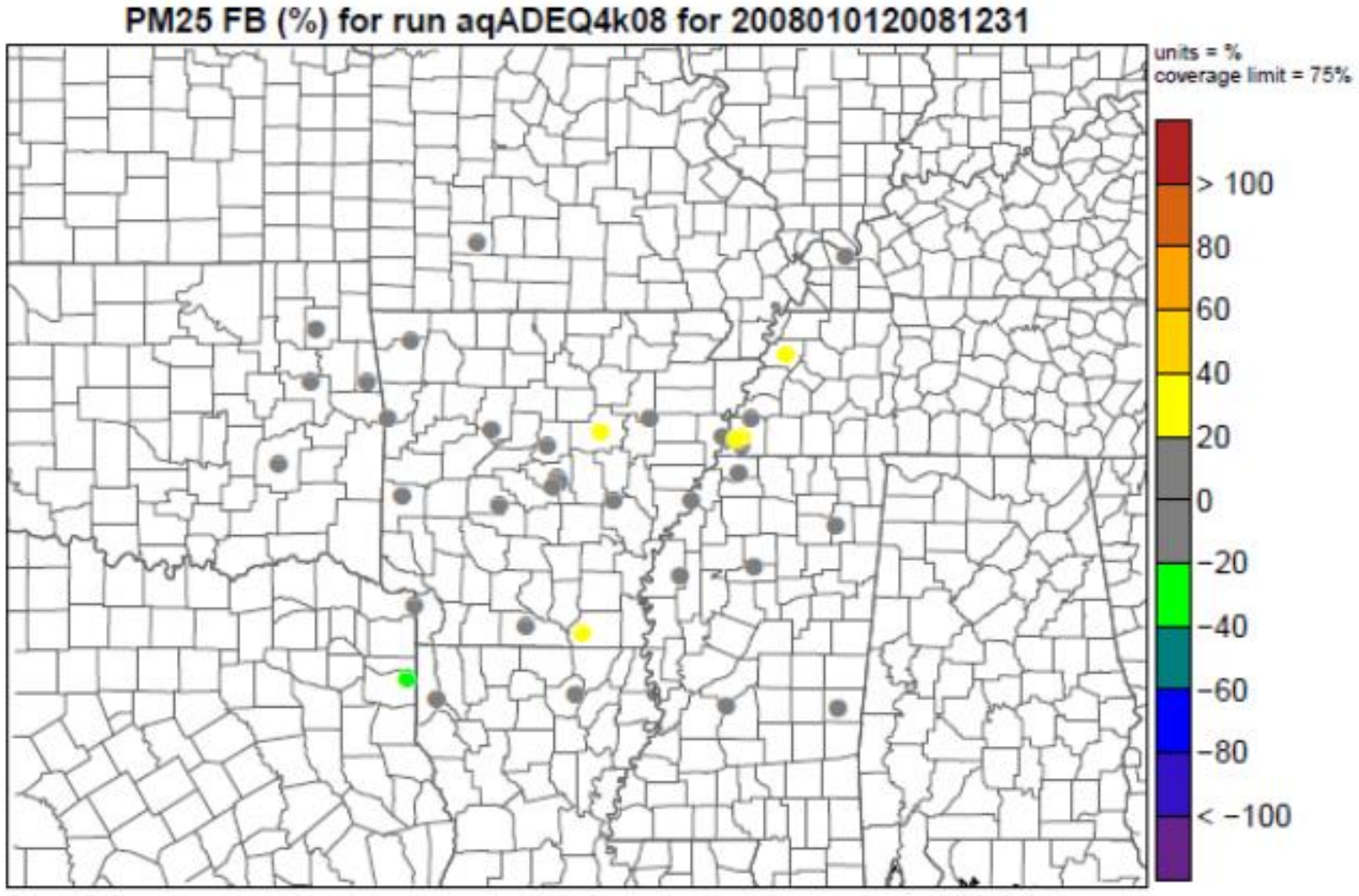
2005



Normalized Bias in Simulated 24-Hr $PM_{2.5}$: 4-km Grid

Base-Year Model Performance (PM2.5)

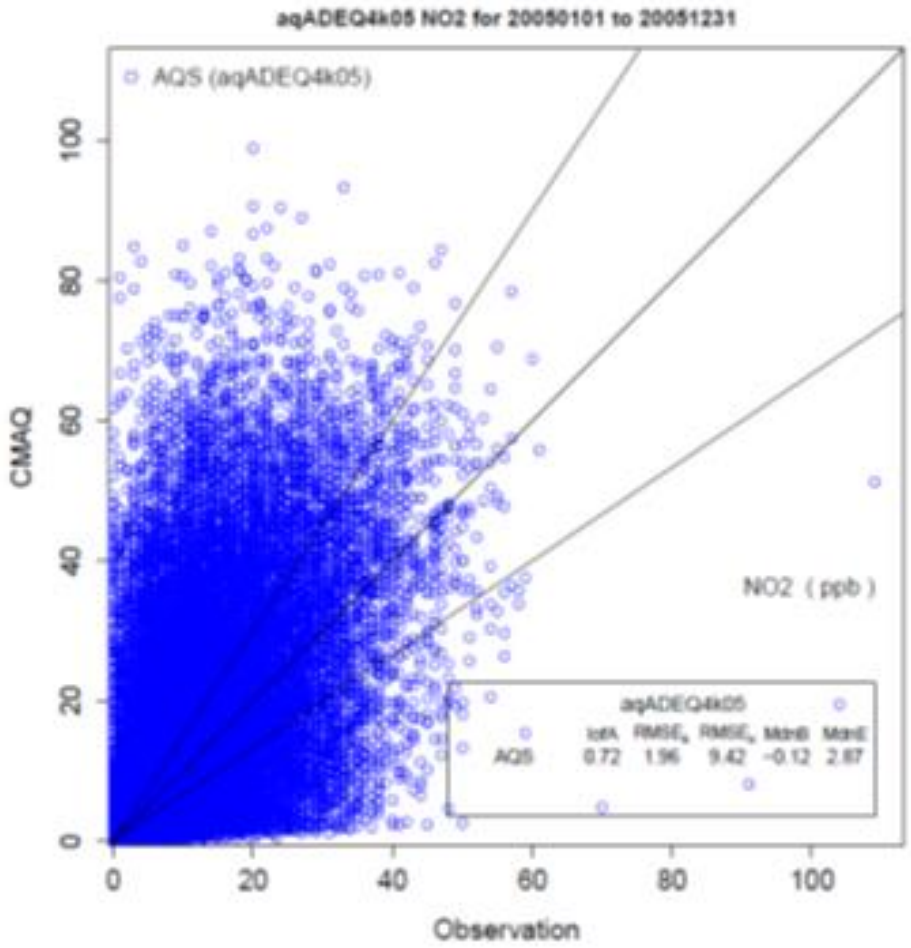
2008



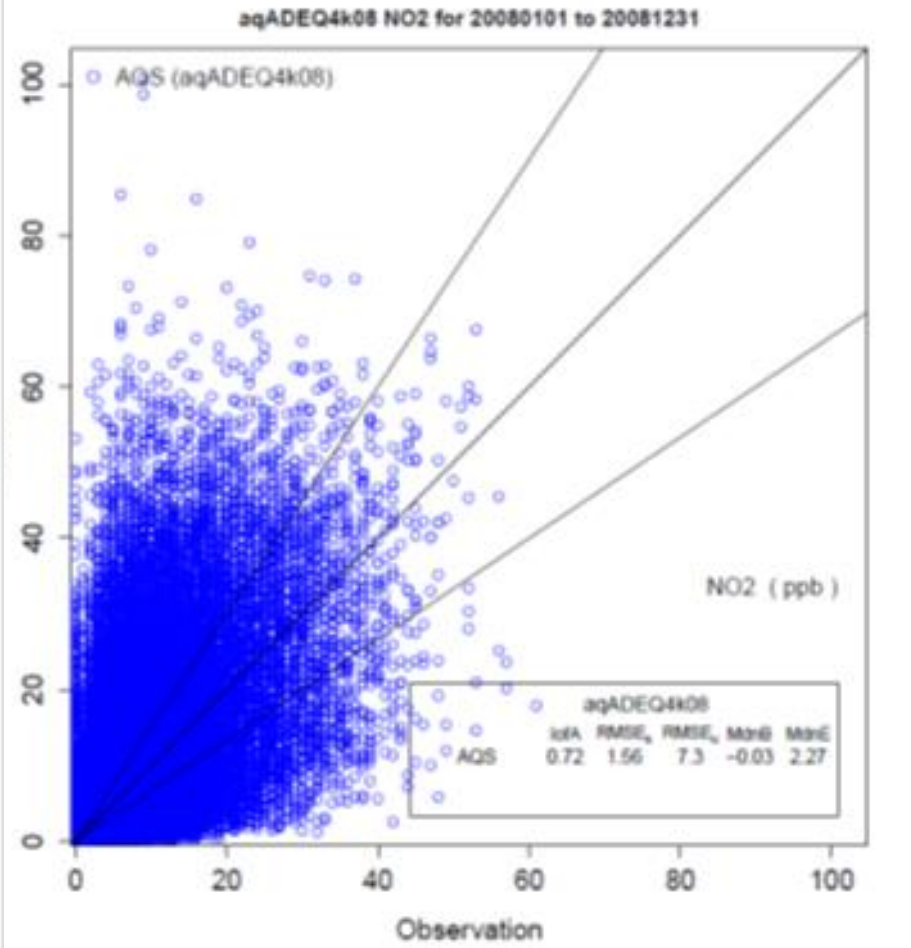
Normalized Bias in Simulated 24-Hr $PM_{2.5}$: 4-km Grid

Base-Year Model Performance (NO_2)

2005



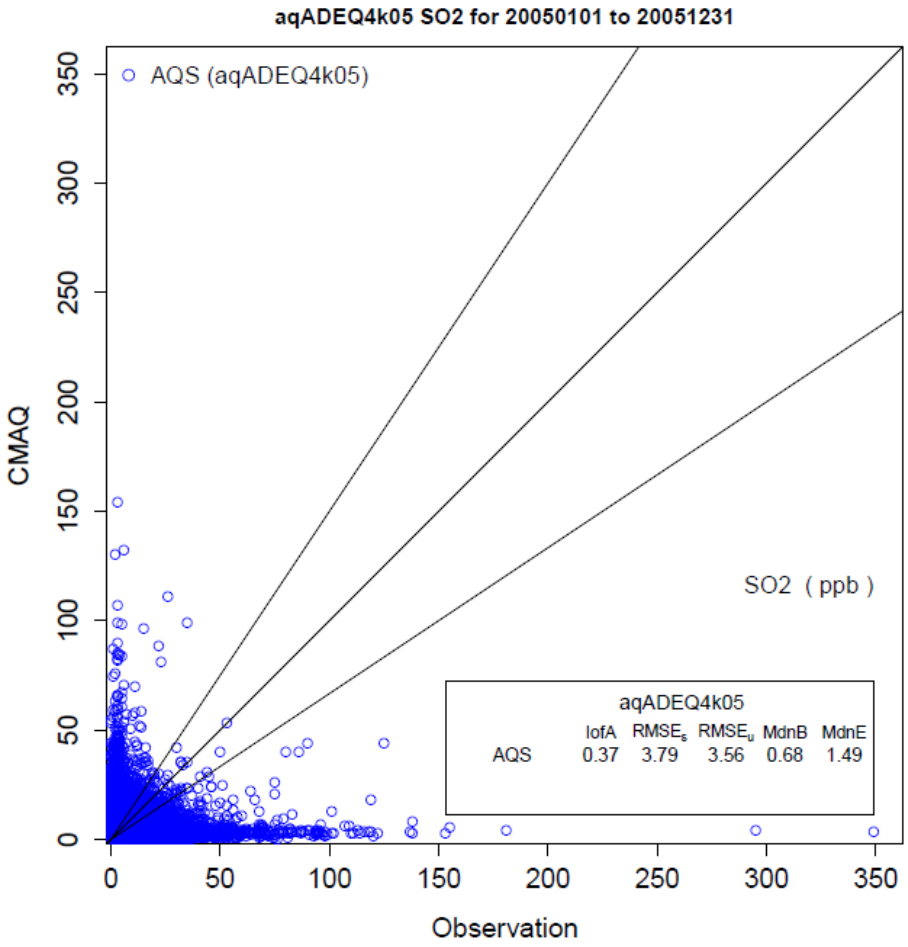
2008



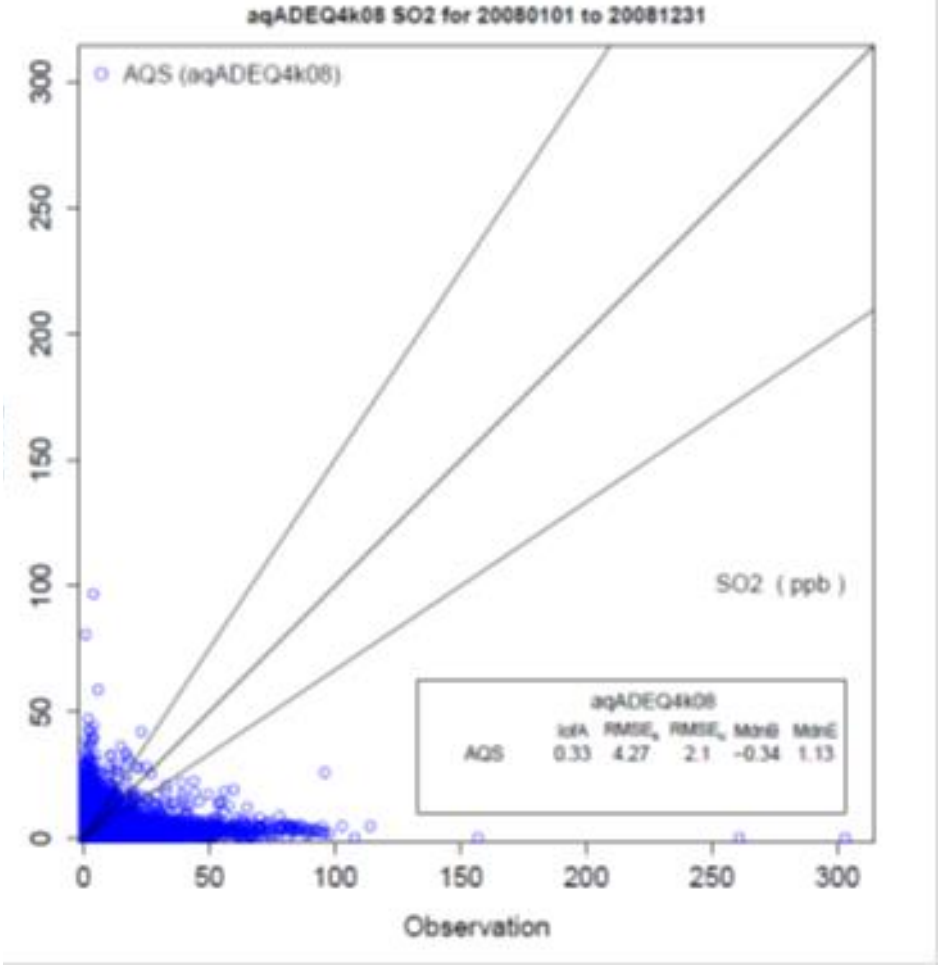
Simulated vs Observed 1-Hour NO_2: 4-km Grid

Base-Year Model Performance (SO_2)

2005



2008



Simulated vs Observed 1-Hour SO_2: 4-km Grid

Summary of Model Performance

- Model performance for ozone is very good
  - Slight tendency to overestimated low ozone concentrations and to underestimate higher ozone concentrations
  - Statistical measures are well within established goals
- Model performance for $PM_{2.5}$ is good
  - Tendency to overestimated low ozone concentrations (cooler months)
  - Best performance achieved for the warmer months (when $PM_{2.5}$ concentrations are highest)
  - Statistical measures are well within established goals

Summary of Model Performance

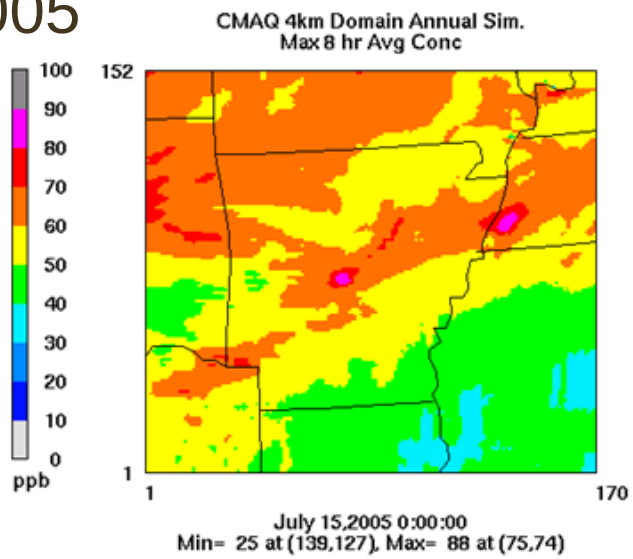
- Model performance for NO_2 and SO_2 is not very good
  - CMAQ may not capture the sub grid-scale variations in concentration due to local emissions sources; data may not be representative of the area encompassed by a grid cell
  - Nevertheless, simulated values are, on average, within a factor of two of the observed values and statistical measures within the goals established for $PM_{2.5}$

Future-Year Air Quality Assessment

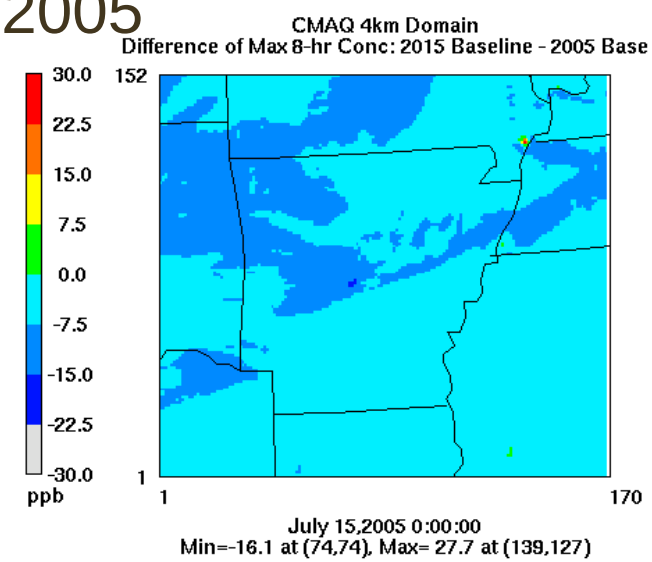
- EPA Modeled Attainment Test Software (MATS)
  - MATS specifically addresses ozone and $PM_{2.5}$
  - Same procedures applied for NO_2 and SO_2
- Methodology based on relative (rather than absolute) use of modeling results
  - Relies on ability of the air quality model to simulate the change in concentration
  - Future-year estimated design values (FDV) calculated using “current-year” design value and future-year and base-year modeling results
  - Current-year design values based on data for 2005 through 2008

Future-Year Modeling Results: Ozone

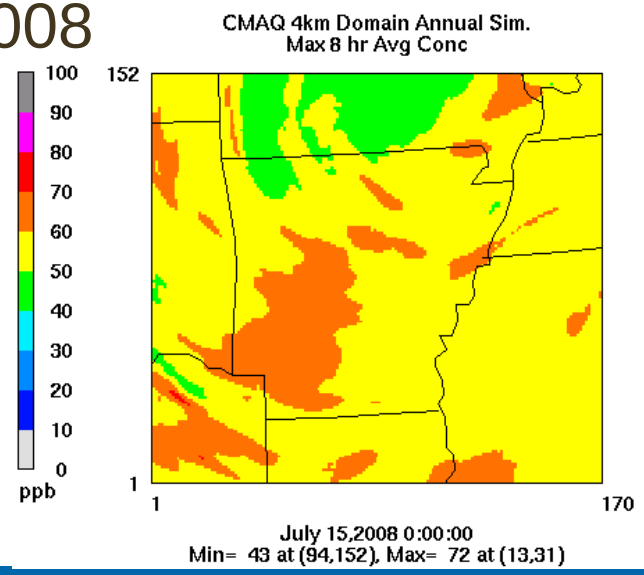
2005



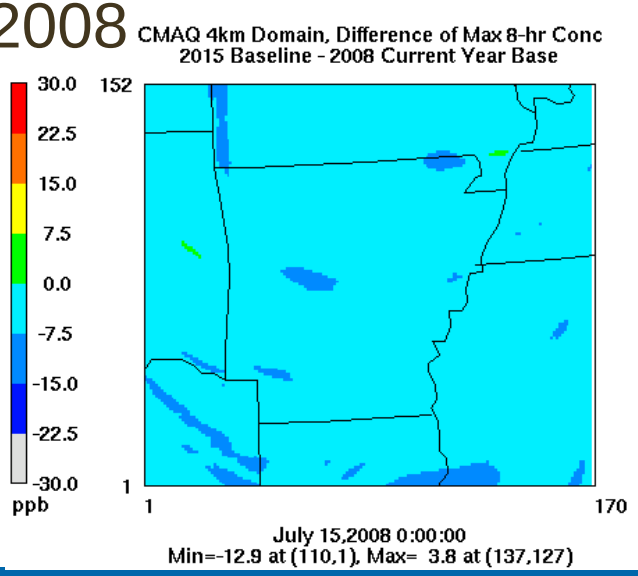
2015 - 2005



2008



2015 - 2008



Example:
15 July

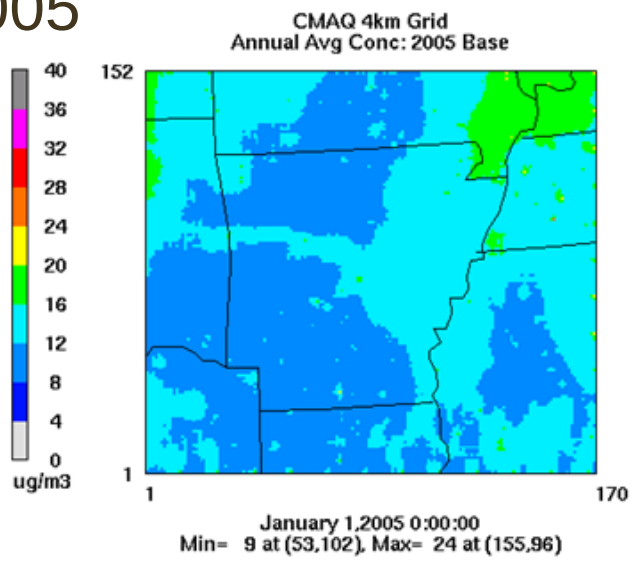
Projected Ozone Design Values (2015)

Site/Location	County	2005/2015 8-Hr Ozone Design Values (ppb)			2008/2015 8-Hr Ozone Design Values (ppb)		
		Current Year DV	Future Year DV	Difference	Current Year DV	Future Year DV	Difference
North Little Rock (Pike Ave)	Pulaski	77	66	-11	77	68	-9
North Little Rock Airport	Pulaski	81	70	-11	81	71	-10
Little Rock (DSR)	Pulaski	71	61	-10	71	62	-9
Marion	Crittenden	85	74	-11	85	77	-8
Deer	Newton	71	62	-9	71	63	-8
Springdale	Washington	61*	53	-8	61*	54	-7
Fayetteville	Washington	66	57	-9	66	57	-9
Mena	Polk	74	66	-8	74	67	-7
Caddo Valley	Clark	64*	56	-8	64*	57	-7

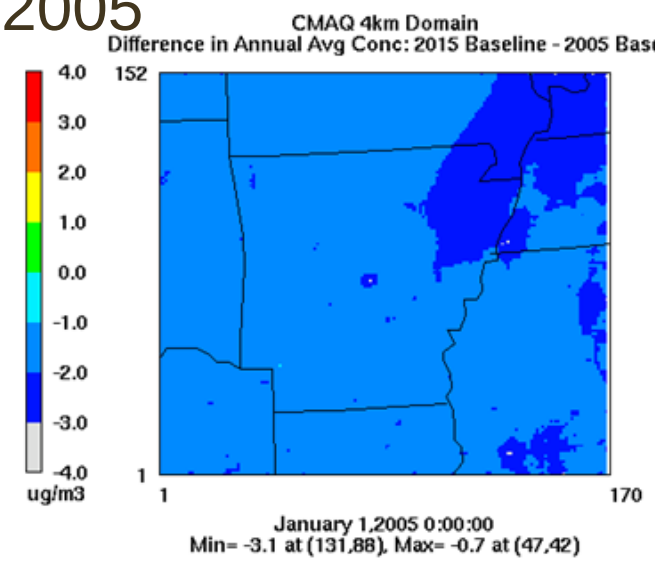
* Estimated

Future-Year Modeling Results: PM2.5

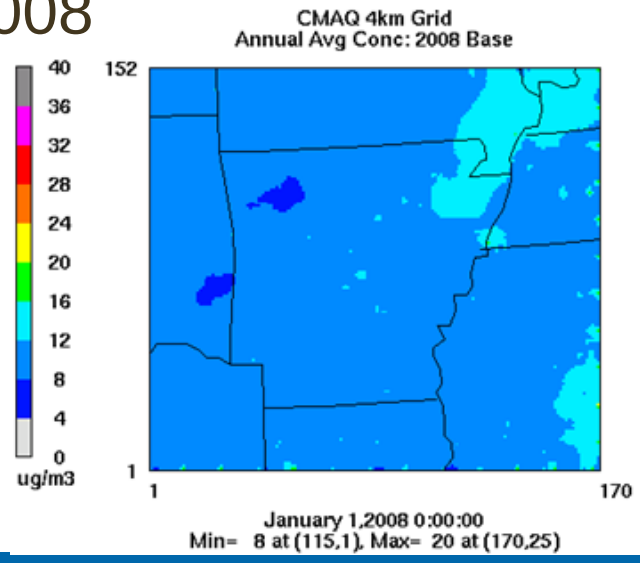
2005



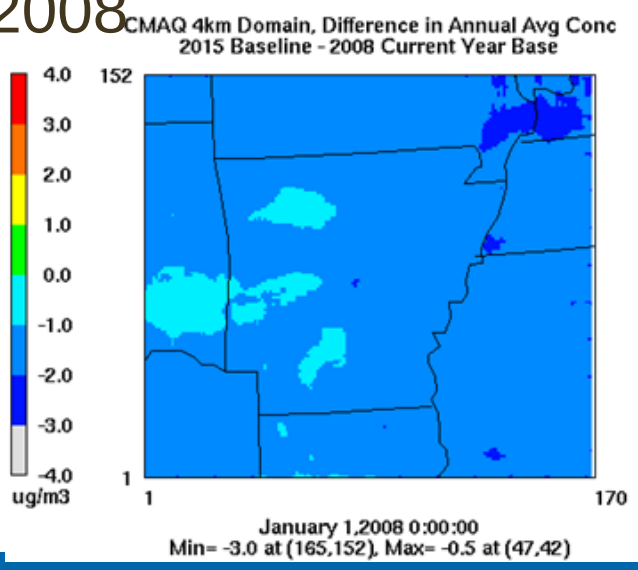
2015 - 2005



2008



2015 - 2008



Annual

* Estimated

Projected 24-Hr PM2.5 Design Values (2015)

Site/Location	County	2005/2015 24-Hr $PM_{2.5}$ Design Values ($\mu g/m^3$)			2008/2015 24-Hr $PM_{2.5}$ Design Values ($\mu g/m^3$)		
		Current Year DV	Future Year DV	Difference	Current Year DV	Future Year DV	Difference
North Little Rock (Pike Ave)	Pulaski	29.1	24.7	-4.4	29.1	25.3	-3.8
Little Rock (Adams)	Pulaski	30.9	26.1	-4.8	30.9	26.3	-4.6
Little Rock (DSR)	Pulaski	29.5	24.9	-4.6	29.5	25.1	-4.4
Marion	Crittenden	32.8	25.7	-7.1	32.8	27.0	-5.8
Stuttgart	Arkansas	28.1	23.0	-5.1	28.1	24.0	-4.1
Newport	Jackson	30.5*	25.1	-5.4	30.5*	24.5	-6.0
Springdale	Washington	26.7*	23.6	-3.1	26.7*	21.5	-5.2
Mena	Polk	26.3	21.9	-4.4	26.3	22.6	-3.7
Hot Springs	Garland	27.2	22.3	-4.9	27.2	22.8	-4.4
El Dorado	Union	27.0	22.5	-4.5	27.0	23.3	-3.7
Crossett	Ashley	27.7	23.5	-4.2	27.7	24.1	-3.6
Roland	Sequoyah (OK)	26.5*	23.0	-3.5	26.5*	21.4	-5.1

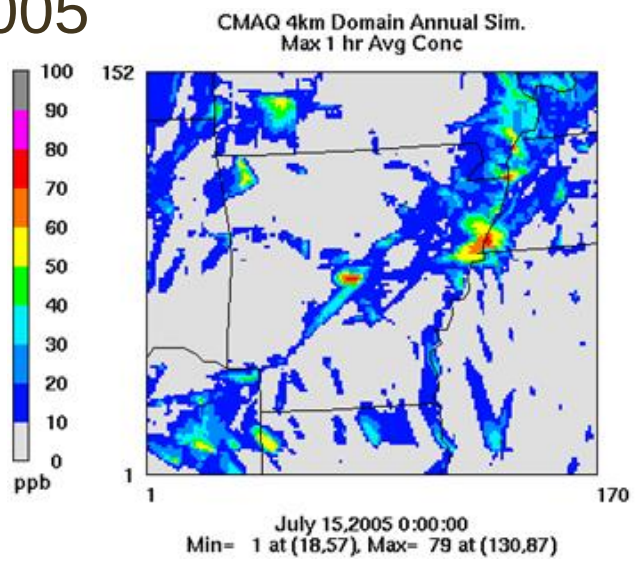
* Estimated

Projected Annual PM2.5 Design Values (2015)

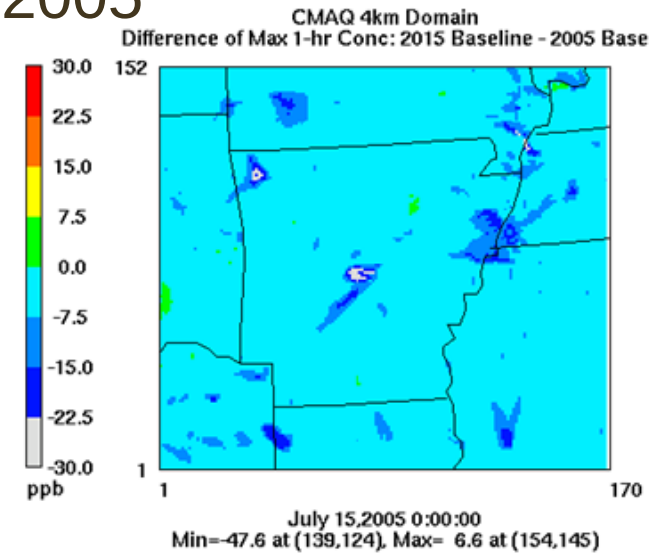
Site/Location	County	2005/2015 Annual $PM_{2.5}$ Design Values ($\mu g/m^3$)			2008/2015 Annual $PM_{2.5}$ Design Values ($\mu g/m^3$)		
		Current Year DV	Future Year DV	Difference	Current Year DV	Future Year DV	Difference
North Little Rock (Pike Ave)	Pulaski	12.7	11.0	-1.7	12.7	11.1	-1.6
Little Rock (Adams)	Pulaski	13.2	11.5	-1.7	13.2	11.7	-1.5
Little Rock (DSR)	Pulaski	13.2	11.5	-1.7	13.2	11.7	-1.5
Marion	Crittenden	12.9	11.1	-1.8	12.9	11.3	-1.6
Stuttgart	Arkansas	12.2	10.7	-1.5	12.2	10.9	-1.3
Newport	Jackson	12.6*	10.7	-1.9	12.6*	10.9	-1.7
Springdale	Washington	11.9*	10.3	-1.6	11.9*	10.3	-1.6
Mena	Polk	11.7	10.4	-1.3	11.7	10.5	-1.2
Hot Springs	Garland	12.1	10.8	-1.3	12.1	11.0	-1.1
El Dorado	Union	12.4	10.9	-1.5	12.4	11.1	-1.3
Crossett	Ashley	12.7	11.2	-1.5	12.7	11.4	-1.3
Roland	Sequoyah (OK)	11.8*	10.3	-1.5	11.8*	10.4	-1.4

Future-Year Modeling Results: NO_2

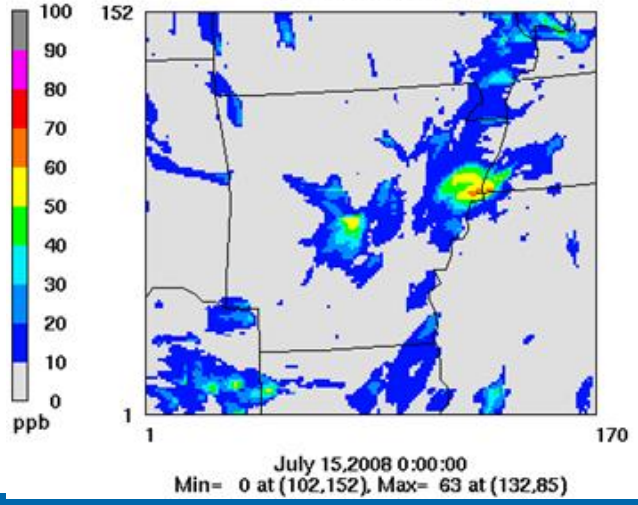
2005



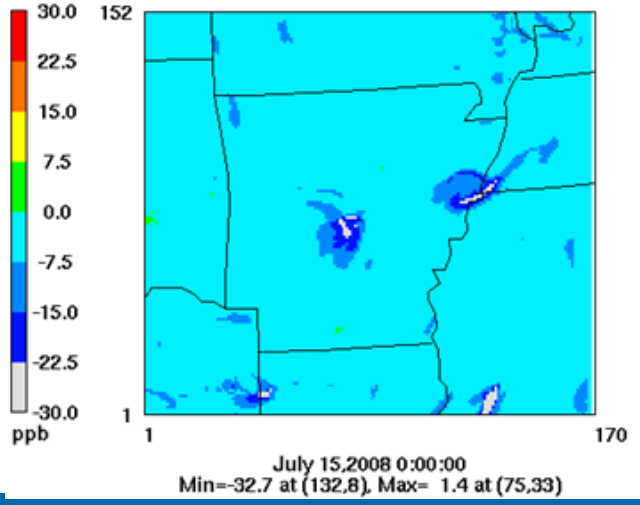
2015 - 2005



2008



2015 - 2008



Example:
15 July

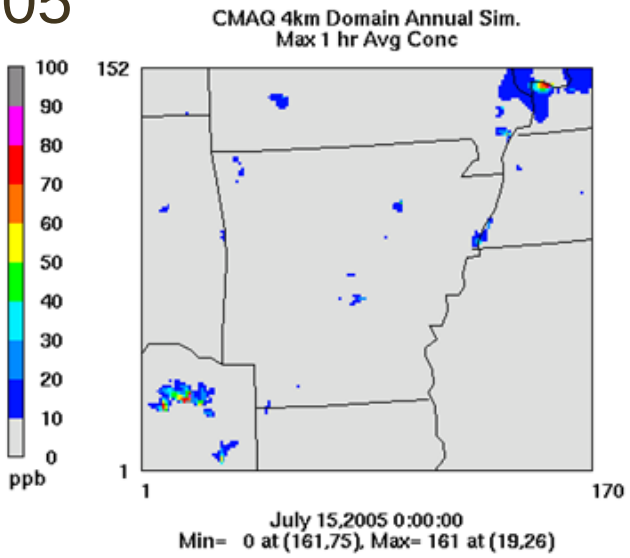
Projected NO_2 Design Values (2015)

Site/Location	County	2005/2015 1-Hr NO_2 Design Values (ppb)			2008/2015 1-Hr NO_2 Design Values (ppb)		
		Current Year DV	Future Year DV	Difference	Current Year DV	Future Year DV	Difference
North Little Rock (Pike Ave)	Pulaski	47.5	35.5	-12.0	47.5	38.4	-9.1
Marion	Crittenden	52.0	38.6	-13.4	52.0	42.6	-9.4
Unmonitored 1	Benton	52.0*	30.8	-21.2	52.0*	34.0	-18.0
Unmonitored 2	Jefferson	52.0*	42.0	-10.0	52.0*	37.7	-14.3
Unmonitored 3	Independence	52.0*	41.4	-10.6	52.0*	35.7	-16.3

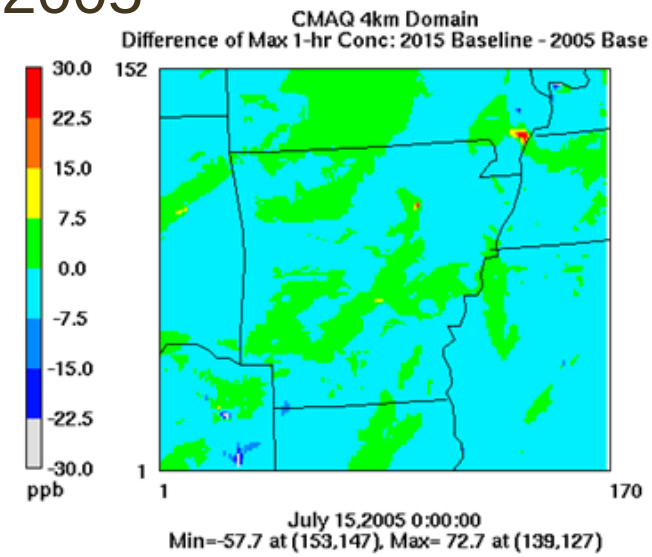
* Estimated

Future-Year Modeling Results: SO_2

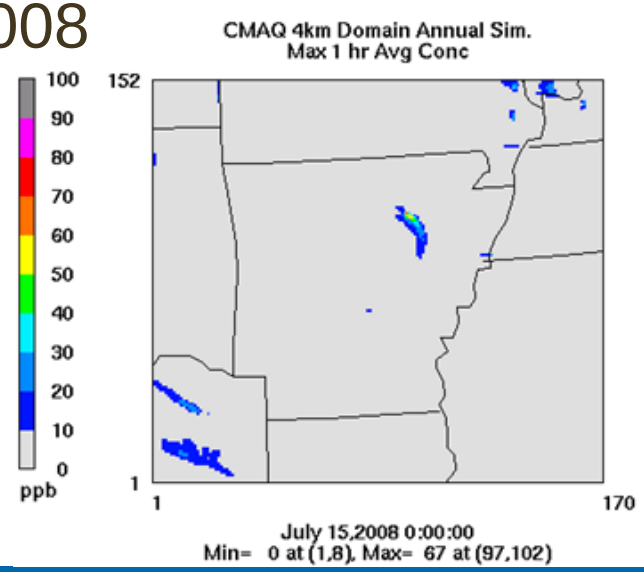
2005



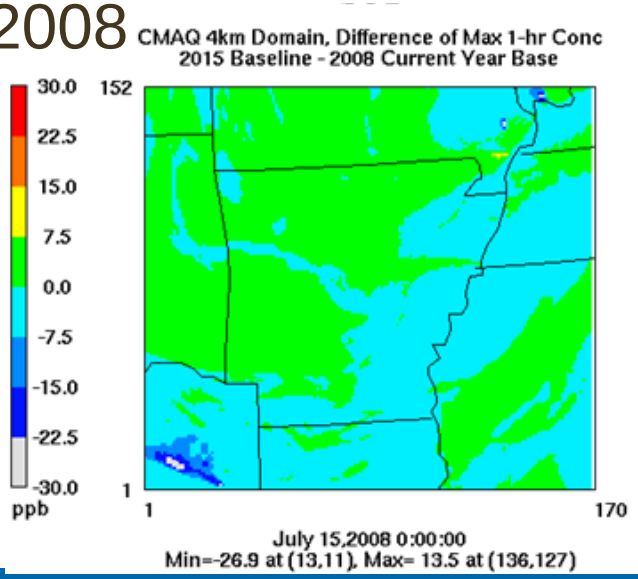
2015 - 2005



2008



2015 - 2008



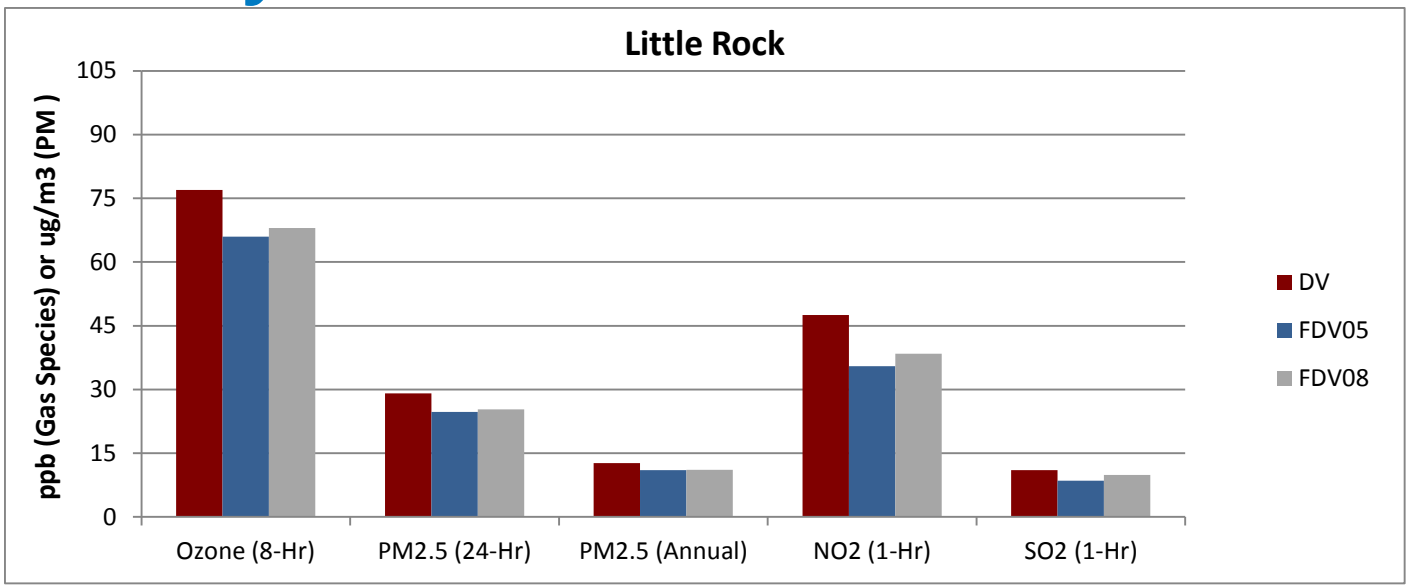
Example:
15 July

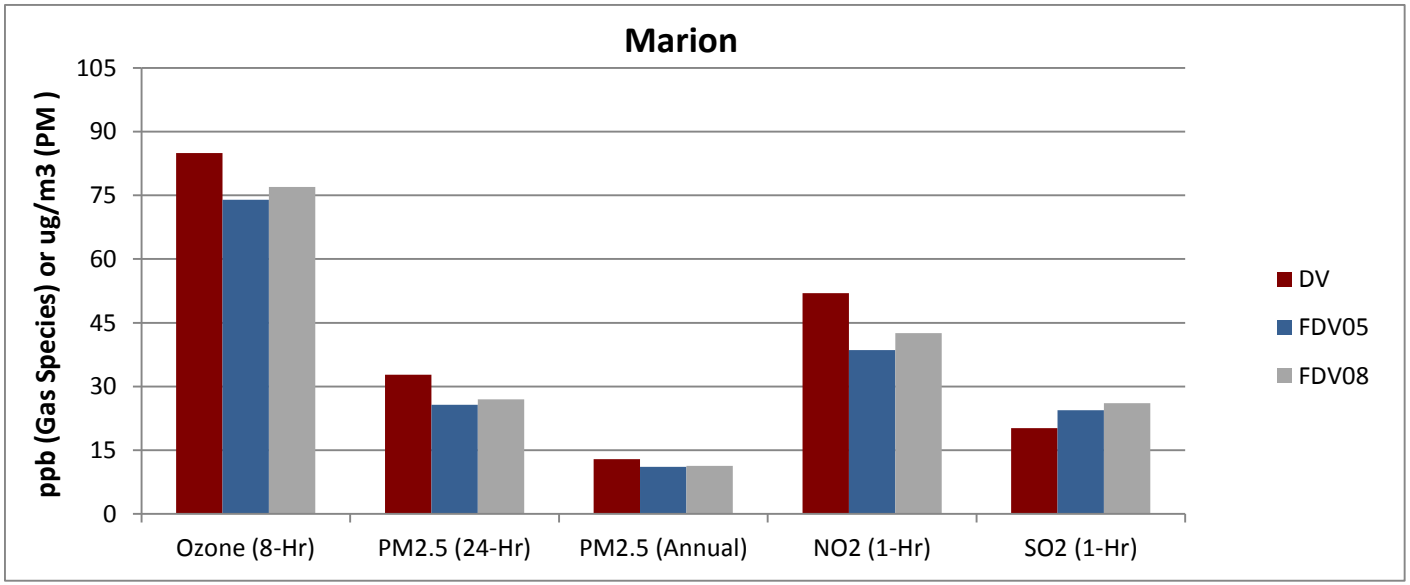
Projected SO_2 Design Values (2015)

Site/Location	County	2005/2015 1-Hr SO_2 Design Values (ppb)			2008/2015 1-Hr SO_2 Design Values (ppb)		
		Current Year DV	Future Year DV	Diff-erence	Current Year DV	Future Year DV	Diff-erence
North Little Rock (Pike Ave)	Pulaski	11.0	8.5	-2.5	11.0	9.9	-1.1
Marion	Crittenden	20.2*	24.4	**4.2**	20.2*	26.1	**5.9**
El Dorado	Union	34.0	29.7	-4.3	34.0	32.0	-2.0
Unmonitored 1	Benton	20.9*	35.9	**15.0**	20.9*	33.3	**12.4**
Unmonitored 2	Jefferson	16.3*	23.2	**6.9**	16.3*	22.7	**6.4**
Unmonitored 3	Independence	18.1*	26.0	**7.9**	18.1*	25.6	**7.5**

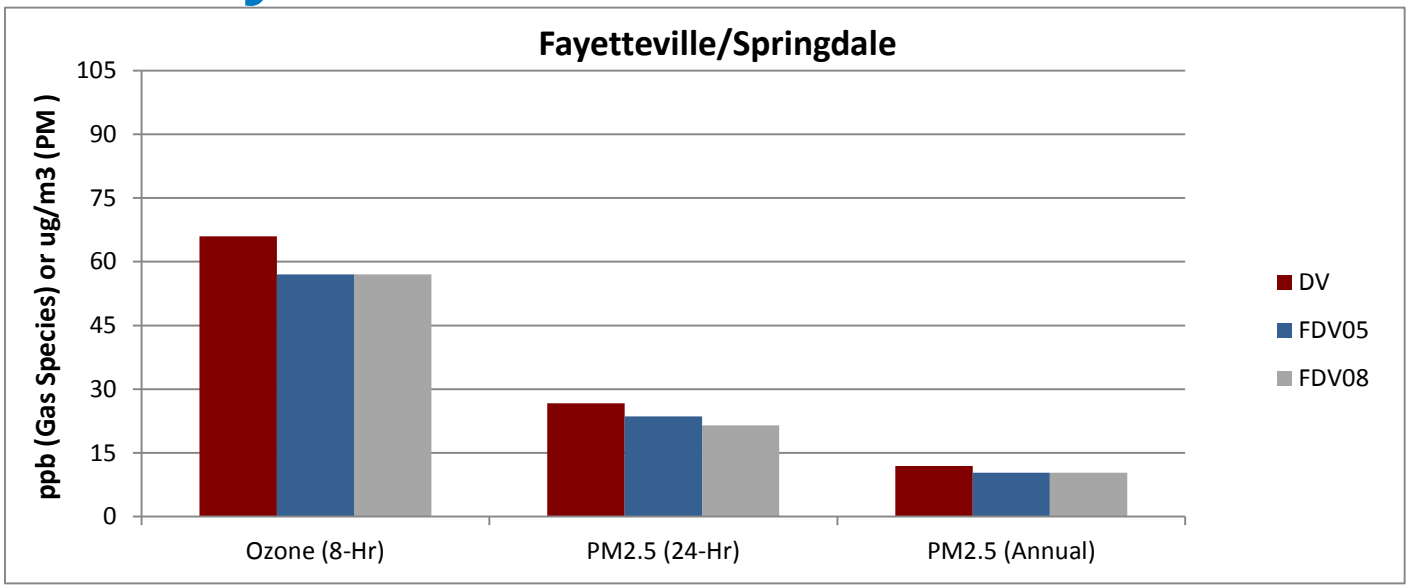
* Estimated

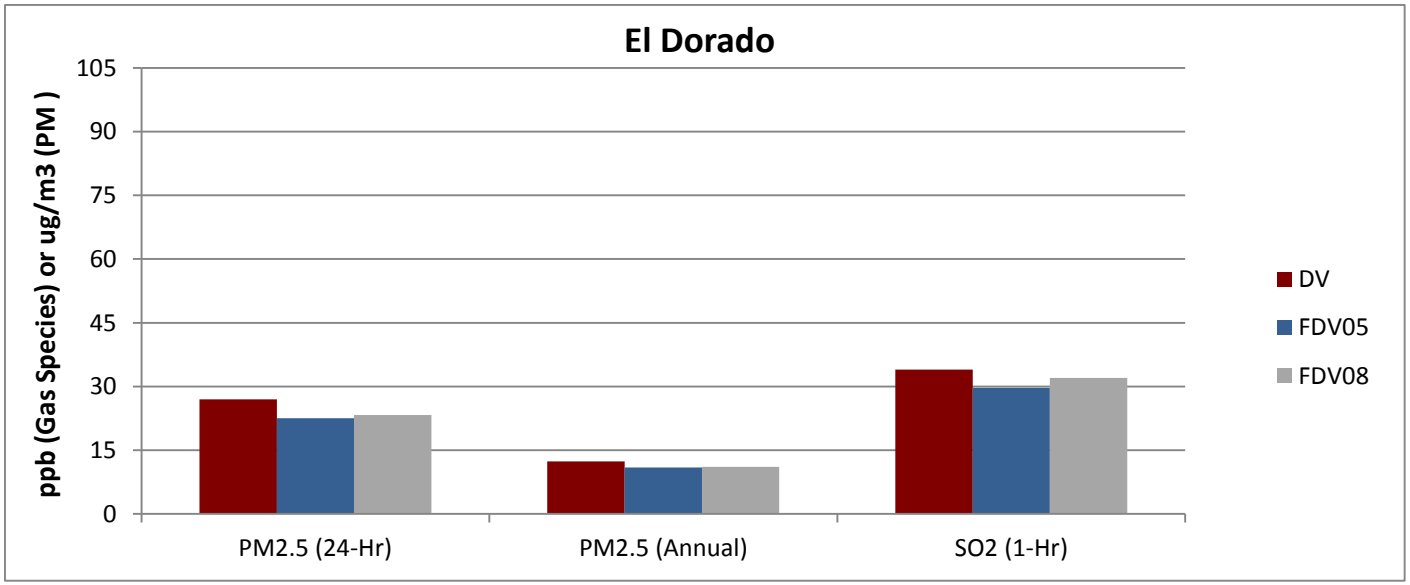
Summary of Results: Criteria Pollutants





Summary of Results: Criteria Pollutants





Estimated Future-Year Visibility (2015)

20% Best Days

Site/Location	County	2005/2015 Visibility Values (dV)			2008/2015 Visibility Values (dV)		
		Current Year DV	Future Year DV	Difference	Current Year DV	Future Year DV	Difference
Caney Creek Wilderness	Polk	12.2	11.7	-0.5	12.2	11.6	-0.6
Upper Buffalo Wilderness	Newton	12.3	11.6	-0.7	12.3	11.7	-0.6

20% Worst Days

Caney Creek Wilderness	Polk	26.3	23.9	-2.4	26.3	24.0	-2.3
Upper Buffalo Wilderness	Newton	26.7	24.5	-2.2	26.7	24.6	-2.1

Key Findings

- Future-year projections vary based on meteorological conditions
- For most areas and most pollutants, criteria pollutant concentrations are expected to decrease between 2005/2008 and 2015
- This is consistent with expected future emission reductions due to:
  - On-road mobile fleet turnover & cleaner fuels
  - Cleaner non-road engines, fuel, and other equipment
  - Mandated reductions in EGU NO_x and (SO_2 emissions in other states)

Key Findings

- There are a few areas throughout the state where SO_2 concentrations are expected to increase (but are still below the standard)
- This is consistent with expected emission increases in SO_2 emissions from EGUs in AR
- Modeling results indicate continued potential for ozone attainment issues for Crittenden Co. (FDV ranges from 74 to 77 ppb)
- Modeling results indicate improvement in visibility for the two Class I areas between the current-year period and 2015