San Juan 8-hr Ozone EAC Study:

Executive Summary

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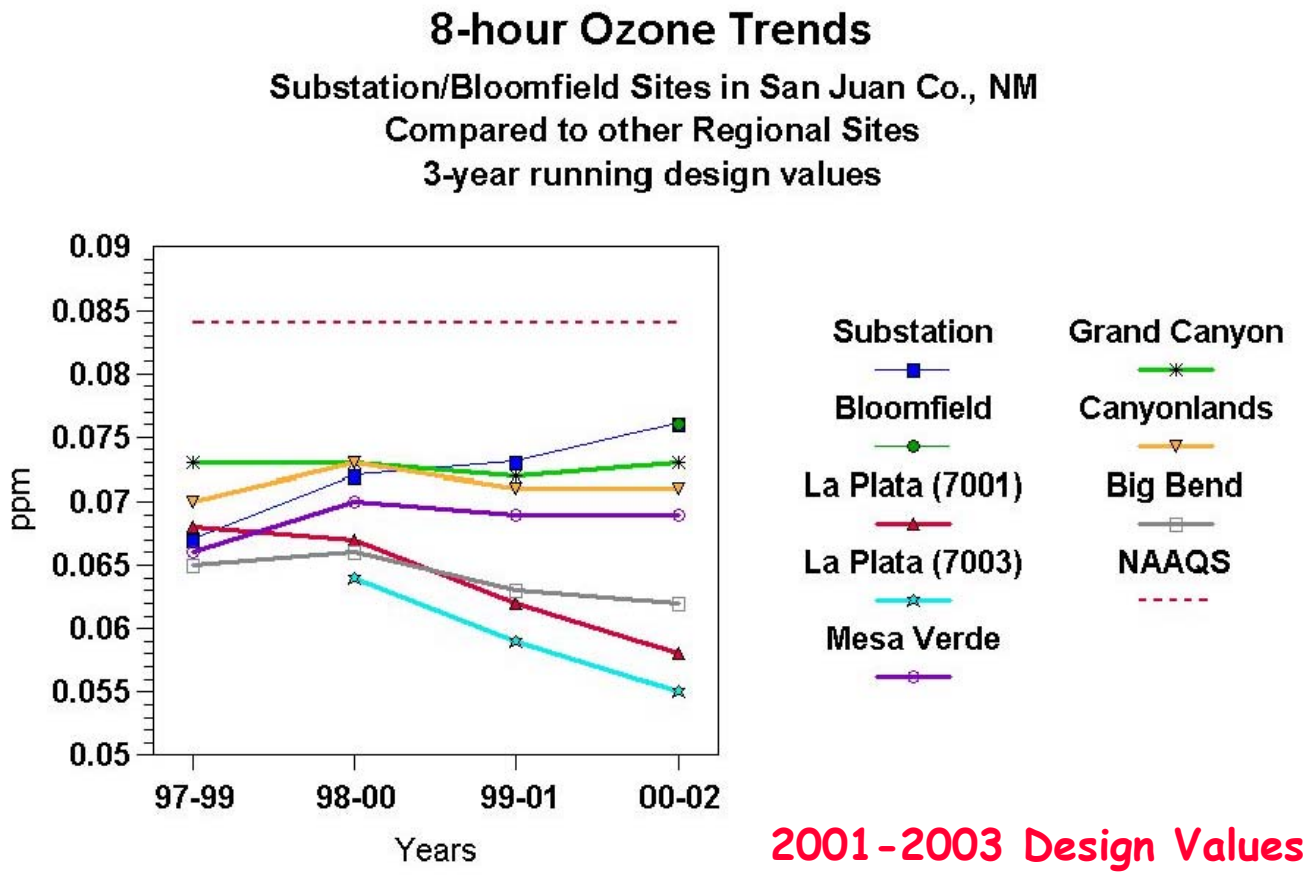
14 January 2004

Trends in 8-hr Ozone Design Values in the San Juan/Four Corners Region



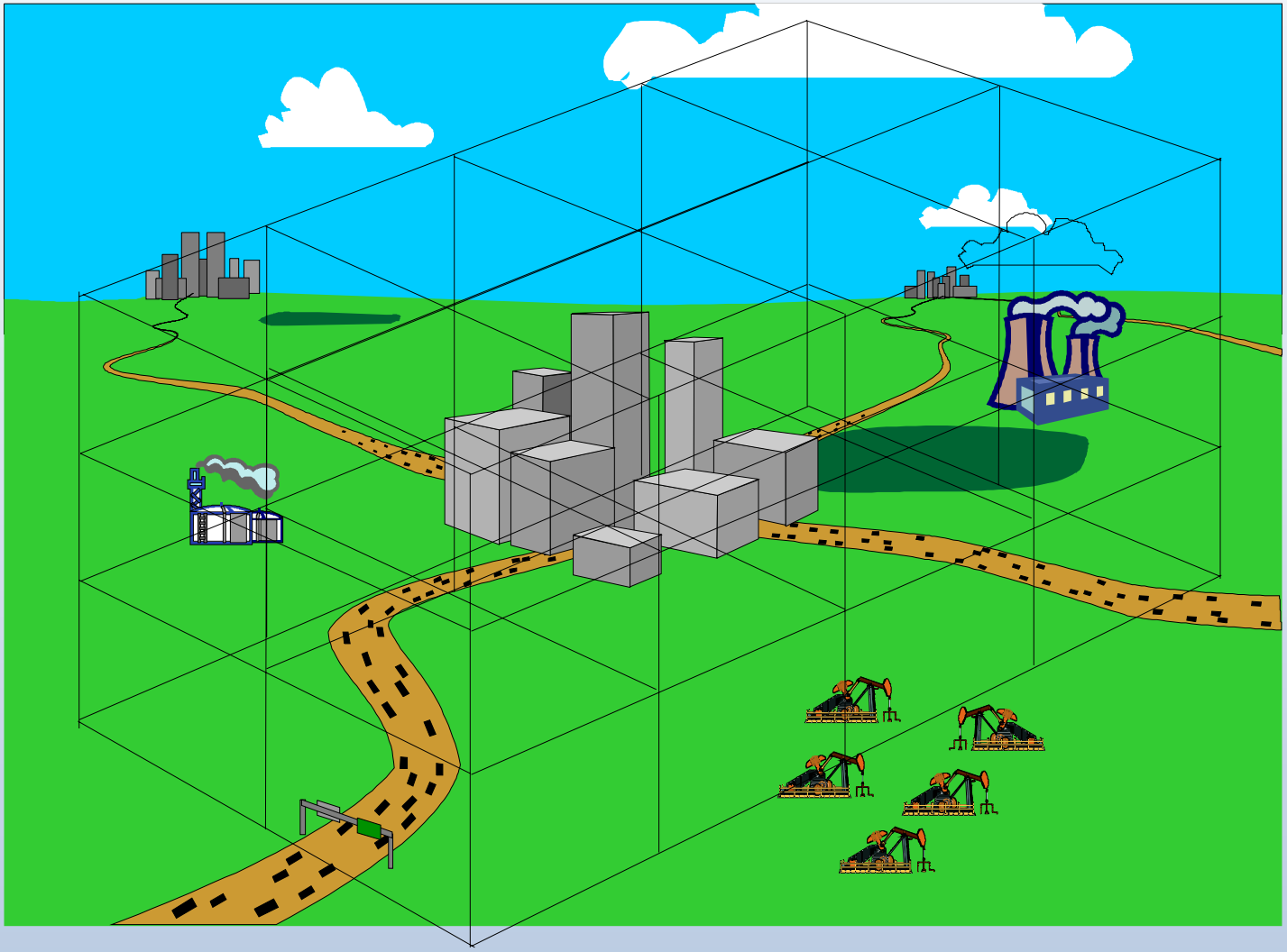
2000-2002 Design Values for Substation & Bloomfield = 0.076 ppm
Substation ozone monitoring began 5/8/97
Bloomfield ozone monitoring began 6/7/2000

2001-2003 Design Values:

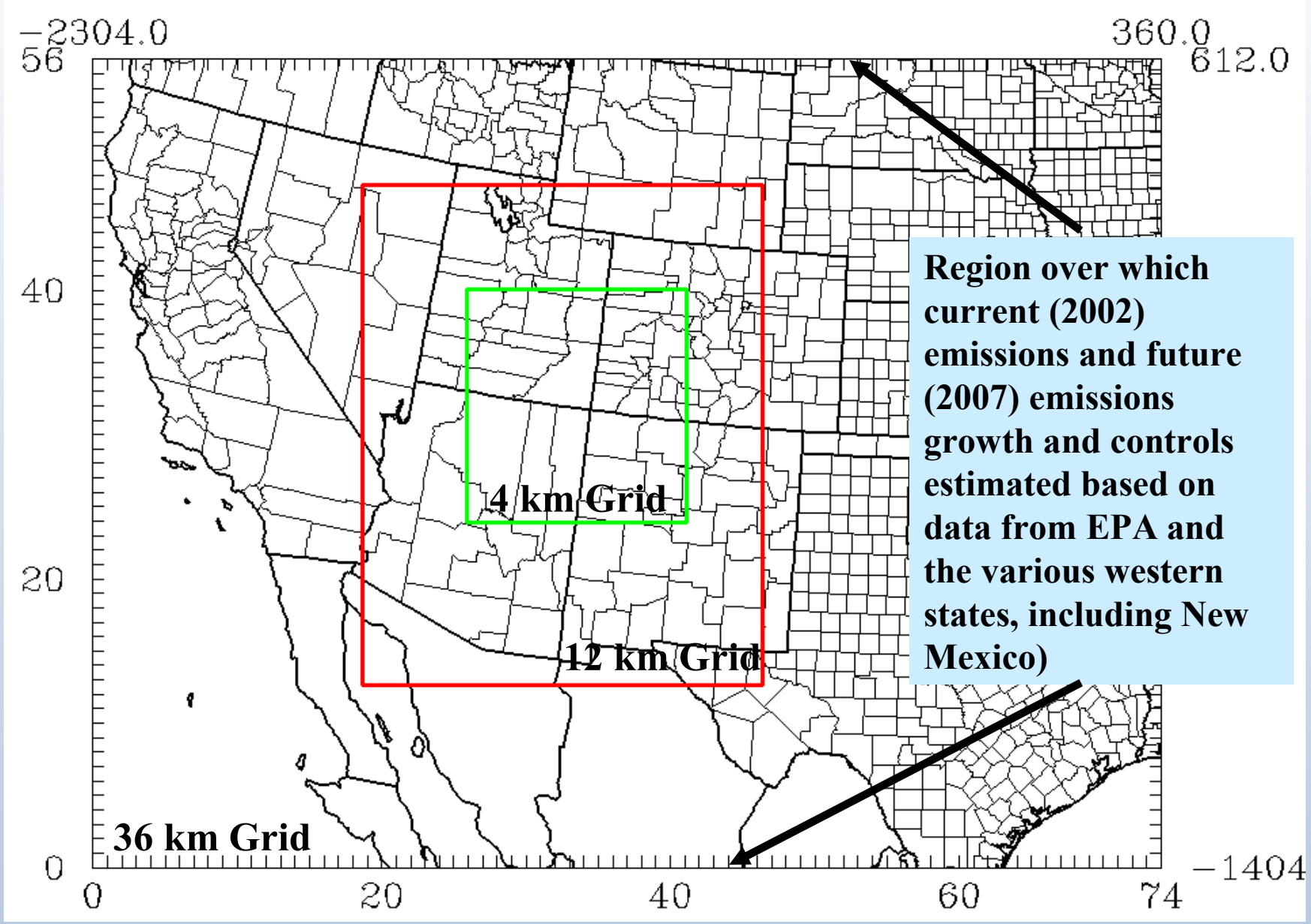
Substation = 74.7 ppb

Bloomfield = 74.3 ppb

CAMx Modeling System Set-Up



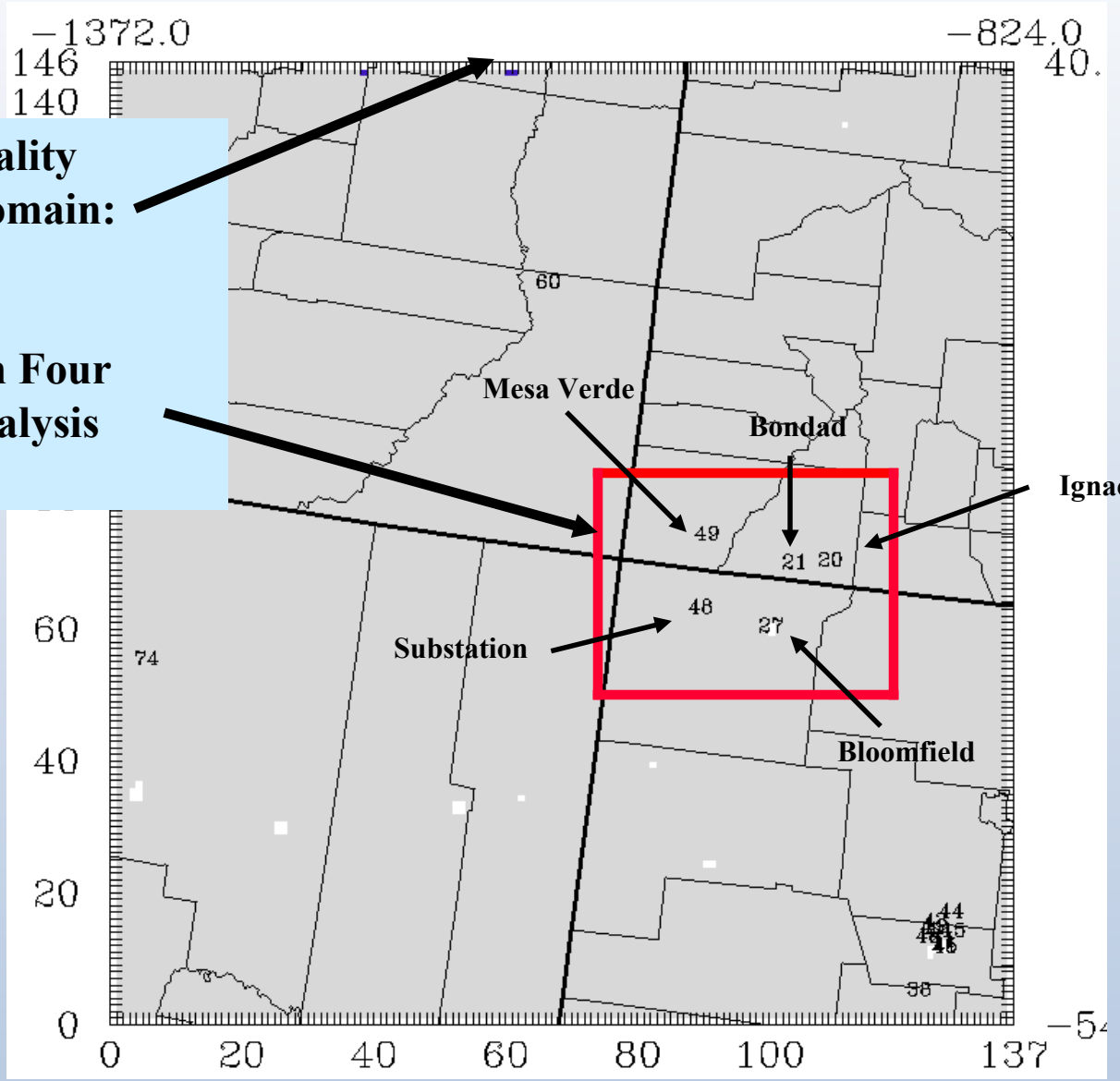
Air Quality Modeling Domain



Four Corners Analysis Region

4 km air quality modeling domain:

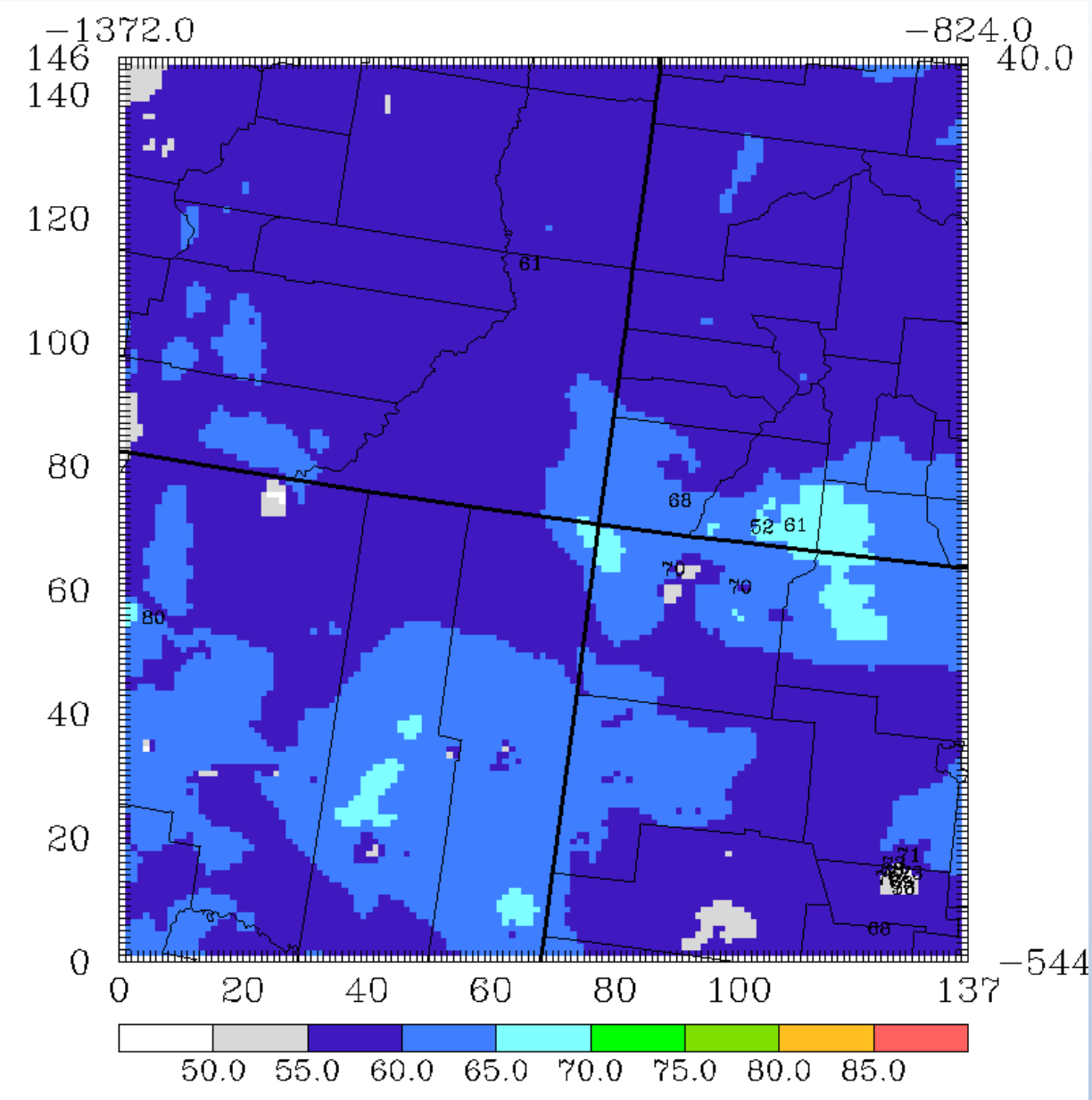
Nested 4 km Four Corners Analysis Region.



Emissions Assumptions for 2002

Table 1. Emissions Model Configuration for the San Juan 8-hr Ozone Modeling Episodes: Base Year		
Emissions Component	**Configuration**	**Details**
Emissions Processing Model	EPA2x, GloBEIS (3.1)	
Horizontal Grid Mesh	36/12/4 km	
36 km grid	165 x 129 cells	
12 km grid	151 x 139 cells	
4 km grid	163 x 160 cells	
Area Source Emissions	NM: EPA NEI99 Version 2	
	CDPHE Emissions Data	
	Other States: EPA NEI99 Version 2	
On-Road Mobile Sources	NM: EPA NEI99 Version 2	MOBILE6 used; No local transportation model data available
	CO: CDPHE Data (except Denver)	CDPHE link-based, MOBILE6 used in Denver
	Other States: EPA NEI99 Version 2	EMFAC2002 used in California; MOBILE6 used elsewhere
Point Sources	NM: NMED Point Source Data	Four Corners Area of NM, EPANEI Version 2 used elsewhere
	CO: CDPHE Data	
	Other States: EPA NEI99 Version 2	
Off-Road Mobile Sources	NM: EPA NEI99 Version 2	
	CO: CDPHE Data	
	Other States: EPA NEI99 Version 2	
Biogenic Sources	Entire Domain	GloBEIS3 with BELDS3 LULC data
Oil & Gas	NM: NMOGA Data	NMOGA unpermitted data base
	CO:	Included in Point Source Inventory
	Other States: EPA NEI99 Version 2	Included in Point Source Inventory
Temporal Adjustments	Seasonal, day, hour	Depends upon category
Chemical Speciation	CB4 Chemical Speciation	Standard splitting factors for VOC & NOx sources used
Gridding	Spatial Surrogates Used	Land use, population, housing, etc from EPA datasets
Growth and Controls	Largely Contained in NEI99	Growth & control modules in EPS2x used
Quality Assurance	QA Tools in EPS2x	Independent QA with AG's MAPS Evaluation Software
Simulation Periods		
Episode 1: 4-9 June '02		
Episode 2: 16-19 June '02		
Episode 3: 30 June-3 July '02		
Episode 4: 16-19 July '02		

Predicted Max. 8-hr Ozone on 6 June '02



8-hr Ozone Predictions Derived from on 1-hr CAMx modeling results:

Basic model output consists of sequence of 1-hr concentration fields for ozone, NO, NO2, VOC, etc.

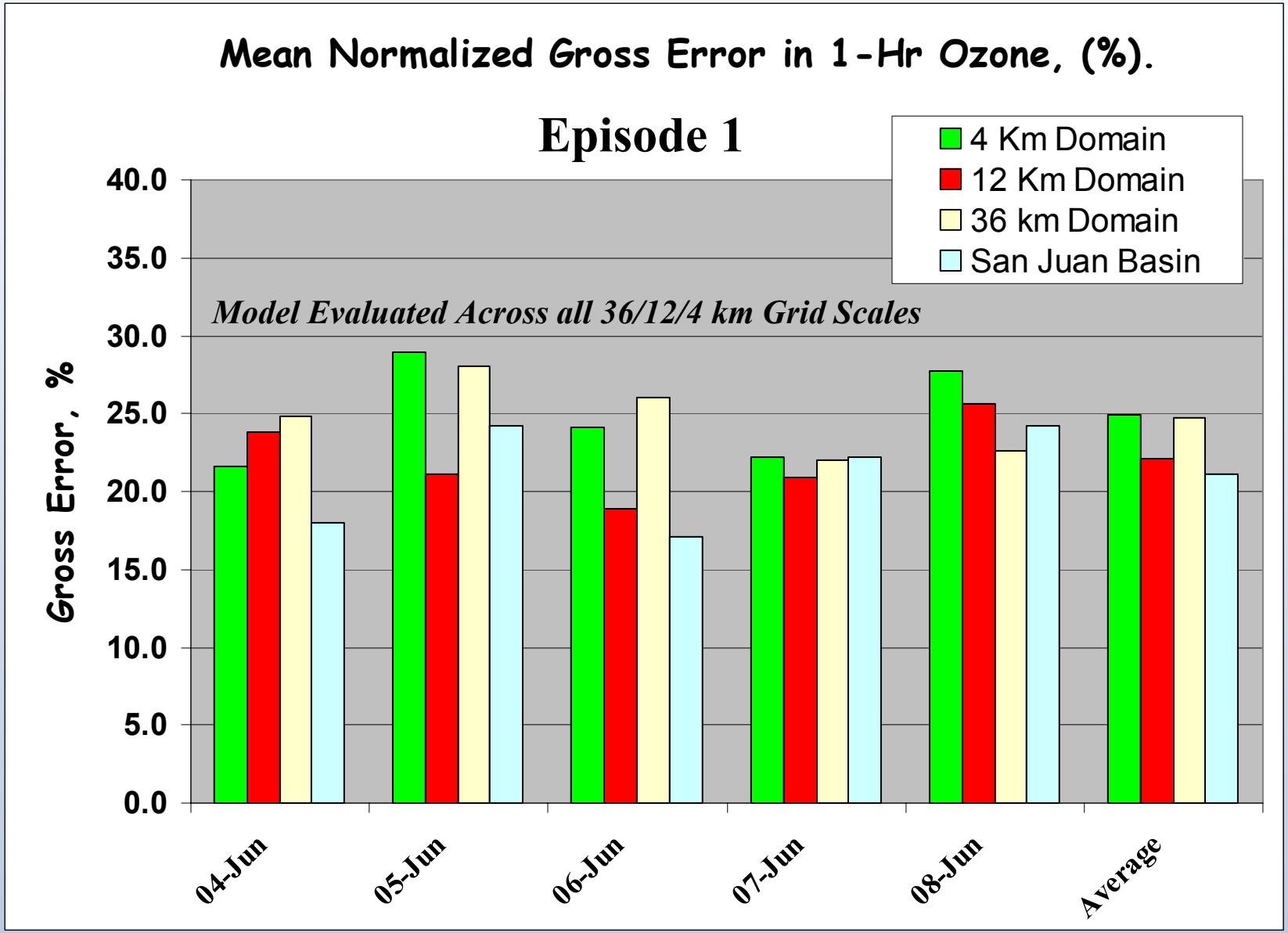
Model Evaluation for 1-hr Ozone

Table 1a. CAMx 1-hr Ozone MPE for San Juan EAC Episodes 1-4: FC Analysis Domain

		Four Corners Analysis Region											
Date	Day	ATS	FB	FE	AU	A-MEAN	N. Bias	Bias	N. Error	Error	Var	Max. O	Max. P
04-Jun	155	-30.9	-8.5	12.6	10.1	17.9	-12.4	-7.4	18.0	10.0	97.7	70.0	77.1
05-Jun	156	-29.2	-13.1	14.8	-15.6	18.3	-18.9	-12.1	24.2	14.7	153.7	87.0	73.4
06-Jun	157	-38.6	-5.2	9.9	-9.8	15.5	-6.0	-4.5	17.1	10.2	157.0	78.0	70.3
07-Jun	158	-18.0	5.5	13.8	6.2	17.8	1.8	-0.9	22.2	12.3	233.7	78.0	82.9
08-Jun	159	-27.7	-6.6	14.7	-1.6	20.3	-14.4	-10.7	24.2	15.4	216.5	79.0	77.7
16-Jun	167	-16.4	-5.8	5.9	-0.4	8.3	-8.9	-6.5	18.3	11.1	119.1	78.0	77.7
17-Jun	168	-34.2	-10.6	10.6	2.3	13.7	-7.6	-6.0	17.5	10.8	123.2	87.0	89.0
18-Jun	169	-23.9	-3.6	7.0	18.4	8.8	-4.8	-3.9	18.4	10.8	139.7	79.0	93.5
19-Jun	170	-21.7	-7.9	9.5	4.3	13.3	-8.9	-7.1	19.7	12.8	181.6	80.0	83.4
30-Jun	181	5.8	4.2	4.2	17.4	10.3	-0.9	-1.1	17.6	9.2	136.4	66.0	77.5
01-Jul	182	-21.9	-5.7	5.7	6.9	11.3	-22.2	-12.3	26.2	14.1	154.4	67.0	71.6
02-Jul	183	-34.1	-9.4	9.5	-18.6	14.9	-26.7	-16.7	28.3	17.5	192.5	91.0	74.1
16-Jul	197	-35.9	-3.8	9.5	-3.4	20.6	-13.6	-8.3	23.2	12.8	180.8	76.0	73.4
17-Jul	198	-31.0	-5.7	8.2	-11.6	16.9	-17.9	-10.7	23.8	13.6	174.2	86.0	76.0
18-Jul	199	-23.8	-4.1	5.6	-7.4	11.6	-17.4	-10.5	23.4	13.5	199.5	84.0	77.8
Average		-25.4	-5.3	9.4	-0.2	14.6	-11.9	-7.9	21.5	12.6	164.0	79.1	78.4

Salmon shaded boxes indicated those few instances where the 1-hr ozone normalized bias statistic falls outside the EPA suggested performance range (± 15%). Green boxes identify days for which EPA 1-hr performance goals are met or exceeded for all bias, error, and accuracy measures.

Model Evaluation over Western U.S.

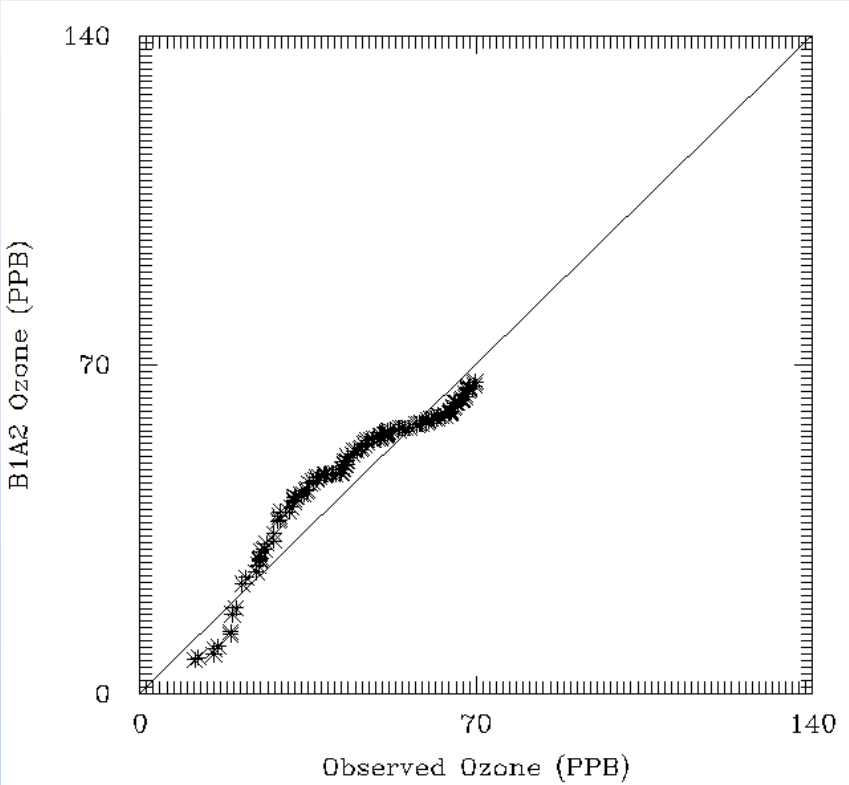


1-hr Ozone Performance Findings

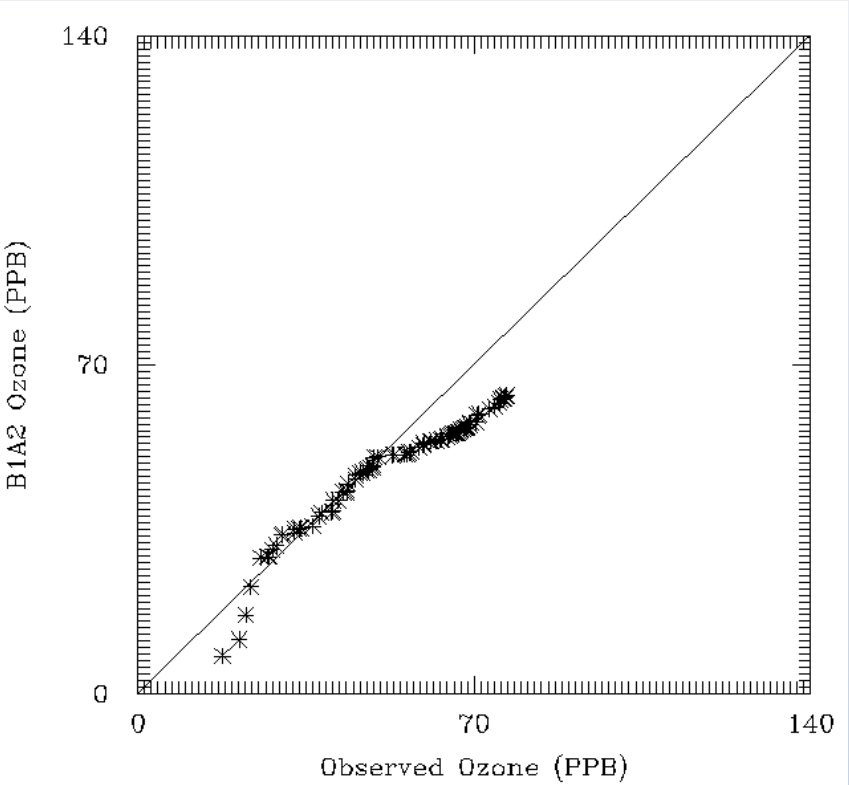
- **Comparison of CAMx base case with EPA 1-hr ozone goals on a day-by-day basis in Four Corners area shows:**
  - **For Unpaired Accuracy of Peak Prediction [± 15-20%]:**
    - **All 15 modeling days achieve the goal, most by a wide margin**
  - **For Mean Normalized Bias [± 5-15%]:**
    - **5 out of 15 modeling days miss the goal, but three of these five days are on the outer cusp of the range**
  - **For Mean Normalized Gross Error [< 30-35%]:**
    - **All 15 modeling days pass the test by a wide margin**

CAMx 8-hr Ozone Evaluation

8-hr Ozone Quantile-Quantile Plots for Episode 1

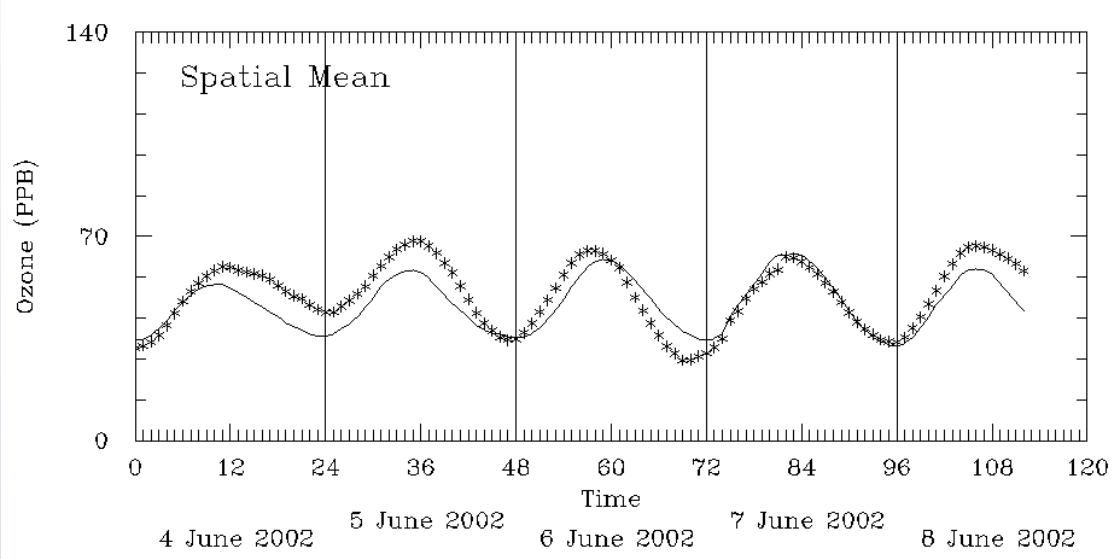


6 Jun '02

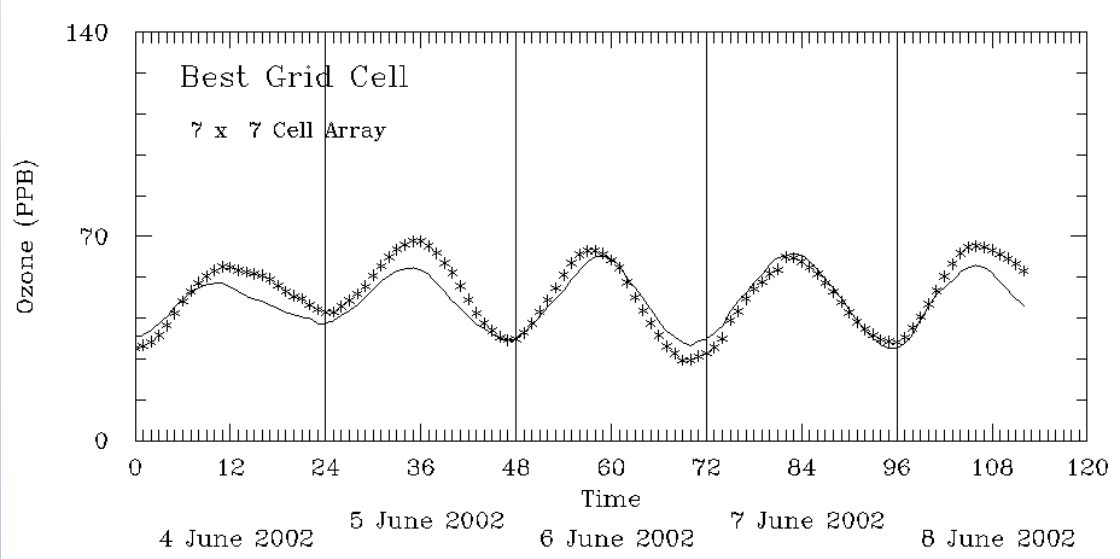


7 Jun '02

8-hr Ozone Time Series for Episode 1

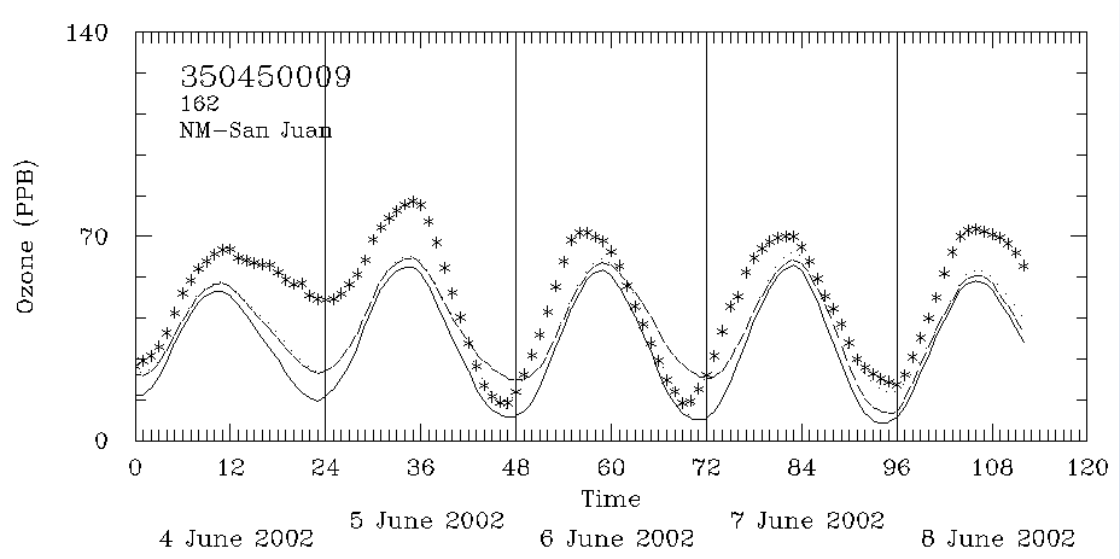


Spatial Mean: (Monitor Location in 7 x 7 Cell)

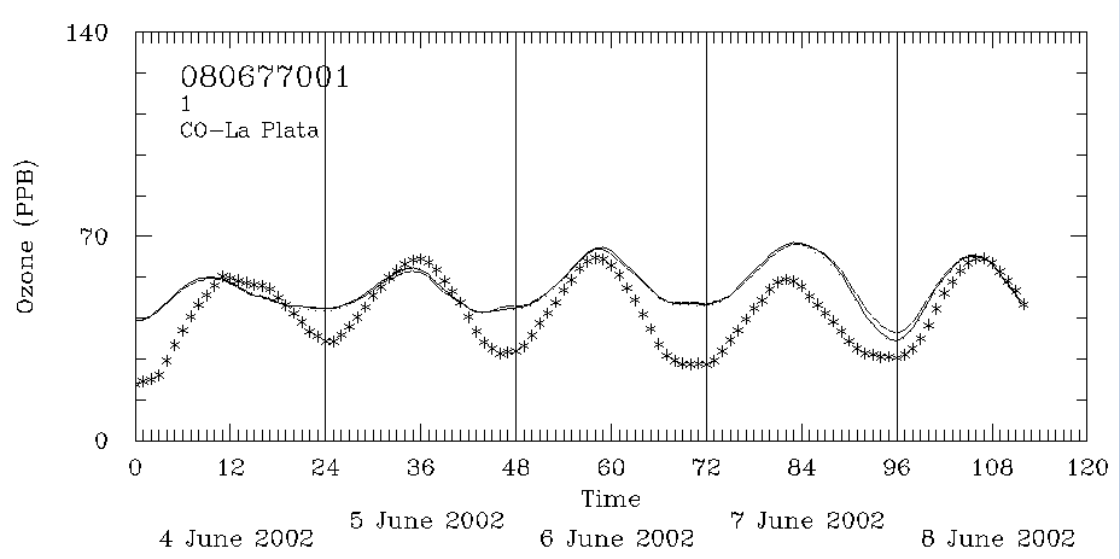


Spatial Mean: (Best Estimate in 7 x 7 Cell)

8-hr Ozone Time Series for Episode 1



Bloomfield



Bondad

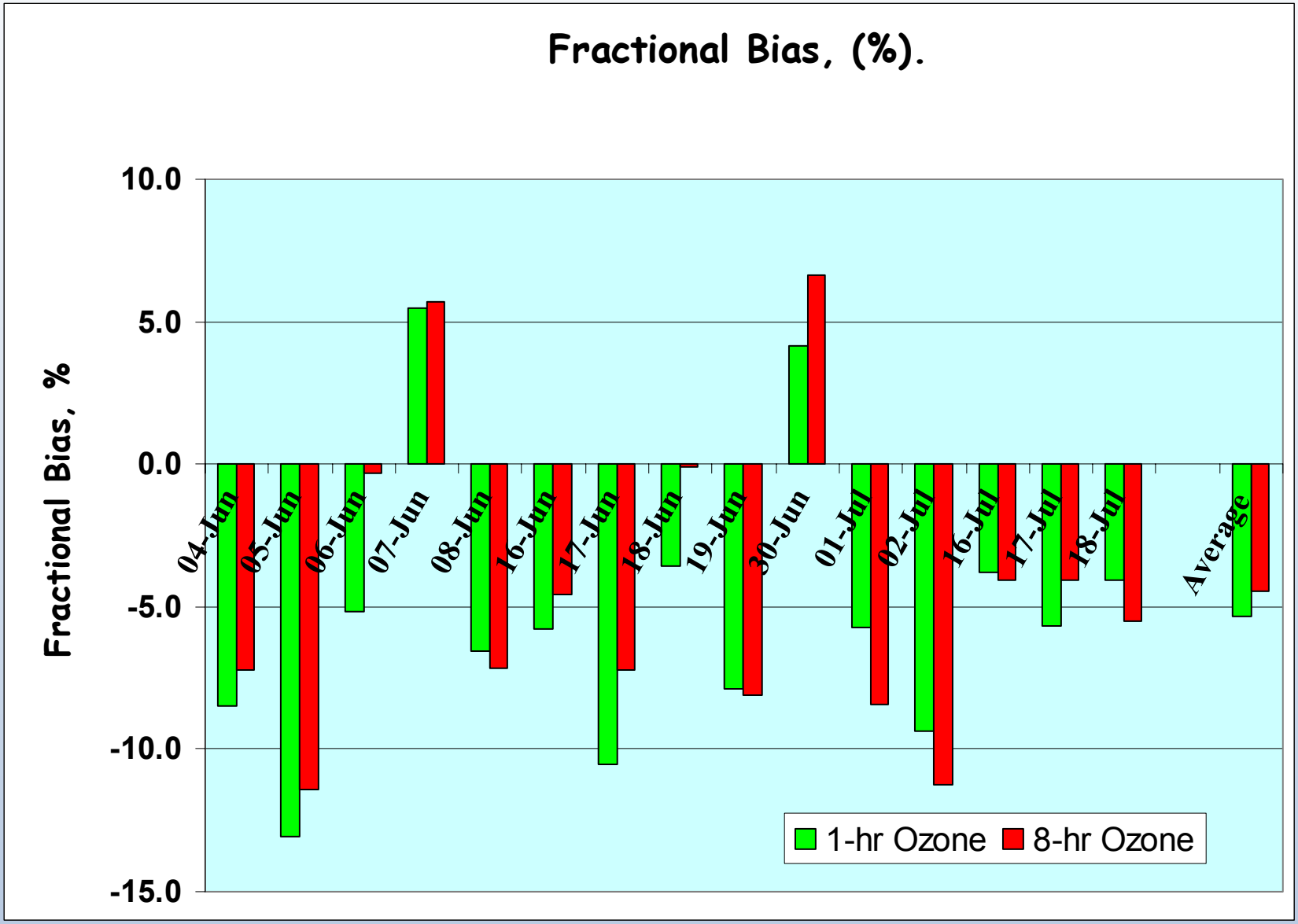
Model Evaluation for 8-hr Ozone

Table 1b. CAMx 8-hr Ozone MPE for San Juan EAC Episodes 1-4: FC Analysis Domain

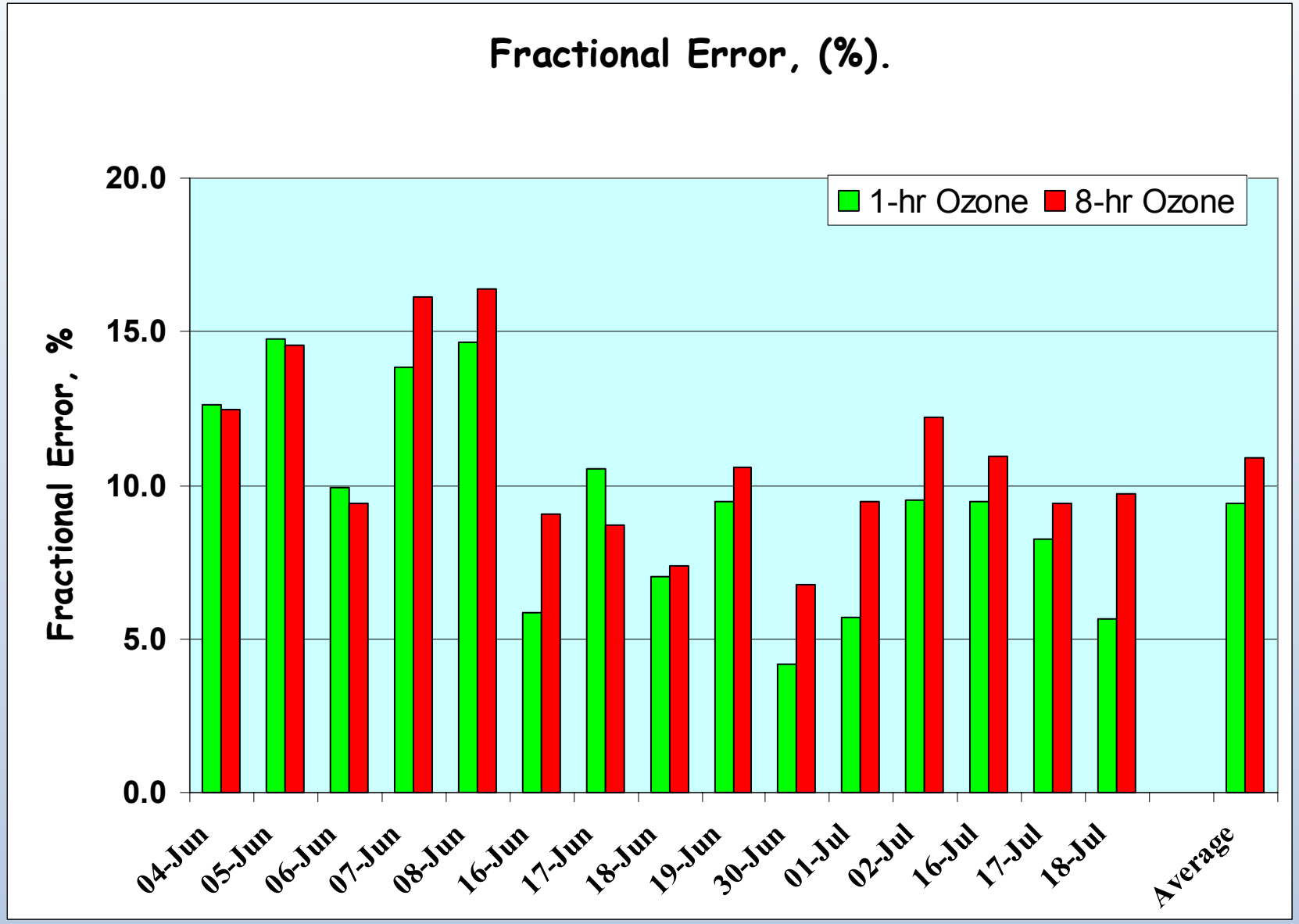
		Four Corners Analysis Region											
Date	Day	ATS	FB	FE	AU	A-MEAN	N. Bias	Bias	N. Error	Error	Var	Max. O	Max. P
04-Jun	155	-19.7	-7.2	12.5	7.9	16.4	-14.8	-8.6	21.1	11.4	112.6	65.0	70.1
05-Jun	156	-26.1	-11.4	14.5	-16.1	17.6	-16.0	-10.3	22.3	13.2	113.7	80.6	67.7
06-Jun	157	-21.1	-0.3	9.4	-2.2	14.8	0.7	-1.0	19.2	10.2	137.3	69.9	68.3
07-Jun	158	-23.0	5.7	16.1	-1.8	25.2	1.2	-1.1	21.8	11.6	191.6	77.1	75.8
08-Jun	159	-26.0	-7.2	16.4	-4.3	19.7	-10.6	-8.1	22.0	13.4	159.9	76.8	73.4
16-Jun	167	-19.2	-4.6	9.1	-4.4	14.0	-7.3	-5.3	18.1	10.4	94.8	73.8	70.5
17-Jun	168	-24.5	-7.2	8.7	-2.2	13.0	-7.8	-5.7	17.3	10.4	98.2	80.4	78.6
18-Jun	169	-16.2	-0.1	7.4	11.7	12.2	-1.6	-2.0	17.5	9.8	112.8	75.1	83.9
19-Jun	170	-21.3	-8.1	10.6	-5.0	16.3	-5.5	-4.8	20.7	12.3	145.4	77.5	73.6
30-Jun	181	2.0	6.6	6.8	12.9	11.3	-3.9	-2.7	17.3	8.9	132.5	64.3	72.5
01-Jul	182	-19.1	-8.5	9.5	3.9	13.9	-20.8	-11.4	24.4	13.0	92.2	64.4	66.9
02-Jul	183	-29.1	-11.3	12.2	-16.7	20.1	-19.6	-12.6	21.9	13.7	121.6	78.8	65.6
16-Jul	197	-27.3	-4.1	10.9	-8.7	19.7	-16.5	-9.4	24.0	12.8	155.8	70.3	64.1
17-Jul	198	-19.7	-4.1	9.4	-10.2	17.0	-17.6	-10.6	25.2	14.2	145.9	74.5	66.9
18-Jul	199	-29.0	-5.5	9.7	-15.8	13.6	-12.7	-7.9	20.3	11.5	151.6	79.2	66.7
Average		-21.3	-4.5	10.9	-3.4	16.3	-10.2	-6.8	20.9	11.8	131.0	73.8	71.0

Salmon shaded boxes indicated those few instances where the 8-hr ozone normalized bias statistic falls outside the EPA suggested performance range (± 15%). Green boxes identify days for which EPA 8-hr performance goals are met or exceeded for all bias, error, and accuracy measures.

Fractional Bias in 8-hr Ozone



Fractional Error in 8-hr Ozone



Skill of CAMx 8-Hour Ozone Modeling Relative to EPA Goals

Performance Metric	*Model Skill*
Bias in daily maxima 8-hr predictions and observations over several days	Bias in daily maximum 8-hr predictions over the 15 episode days is below 20% on 91% of the modeling days.
Fractional bias in daily maxima 8-hr predictions and observations over several days	Fractional bias in daily 8-hr predictions over the 15 episode days is below 20% on 83% of the modeling days.
Bias in 8-hr daily max and 1-hr daily average over all monitors	Bias for 8-hr & 1-hr predictions are – 3.6% & -11.9%, meeting EPA goal
Gross error in 8-hr daily max and 1-hr daily average over all monitors	Gross errors for 8-hr & 1-hr predictions are 20.9% & 21.5%, meeting EPA goal
Scatter plots & Q-Q plots of 8-hr and 1-hr concentration distributions	Scatter and Q-Q plots do not exhibit spurious trends
Correlation coefficients based on all predictions-observations, paired in time and space	8-hr and 1-hr variance measures (131.0, 164.0) acceptably small; value of R-squared dubious, therefore not calculated

Estimation of Year 2007 Emissions

- Year 2007 emissions 'grown' from year 2002 base line emissions using growth and control measures developed and/or recommended by EPA
- Emissions projections for ALL western states in 36 km domain, not just Four Corners or New Mexico
- Growth factors include estimates of population growth, economic projections, etc. obtained from EPA and state sources (e.g. Denver) where available
- Control measures include Federal and state regulations "on the books" that are presently mandated by regulations
- EPA growth and control measures used in San Juan Study consistent with methods/assumptions used in other ongoing studies in the Western U.S.

Emissions Assumptions for 2007

Table 4. Future Year (2007) Emissions Inventory Development for the San Juan 8-hr Ozone Modeling Episodes.		
Emissions Component	**Configuration**	**Inventory Future Year Projection Details**
Emissions Processing Model	EPA2x, GloBEIS (3.1)	
Horizontal Grid Mesh	36/12/4 km	
36 km grid	165 x 129 cells	
12 km grid	151 x 139 cells	
4 km grid	163 x 160 cells	
Area Source Emissions	NM: EPA's 2007 HDD Inventory	
	CDPHE Emissions Data	
	Other States: EPA's 2007 HDD Inventory	
On-Road Mobile Sources	NM: MOBILE6.2 by county for 2007 typical summer day	MOBILE6 used; No local transportation model data available
	CO: CDPHE Data (except Denver)	CDPHE link-based, MOBILE6 used in Denver
	Other States: MOBILE6.2 by county for 2007 typical summer day	MOBILE6 used
Point Sources	NM: EPA's 2007 HDD Inventory	Emission Estimates for MUSTANG plant provided by NMED
	CO: CDPHE Data	
	Other States: EPA's 2007 HDD Inventory	
Off-Road Mobile Sources	NM: NONROAD2002 w/ EPA defaults	nonNR sources from EPA's 2007 HDD Inventory (locomotives, airports, commercial marine)
	CO: CDPHE Data	
	Other States: NONROAD2002 w/ EPA defaults	nonNR sources from EPA's 2007 HDD Inventory (locomotives, airports, commercial marine)
Biogenic Sources	Entire Domain	GloBEIS3 with BELDS3 LULC data
Oil & Gas	NM: NMOGA Data	NMOGA unpermitted data base
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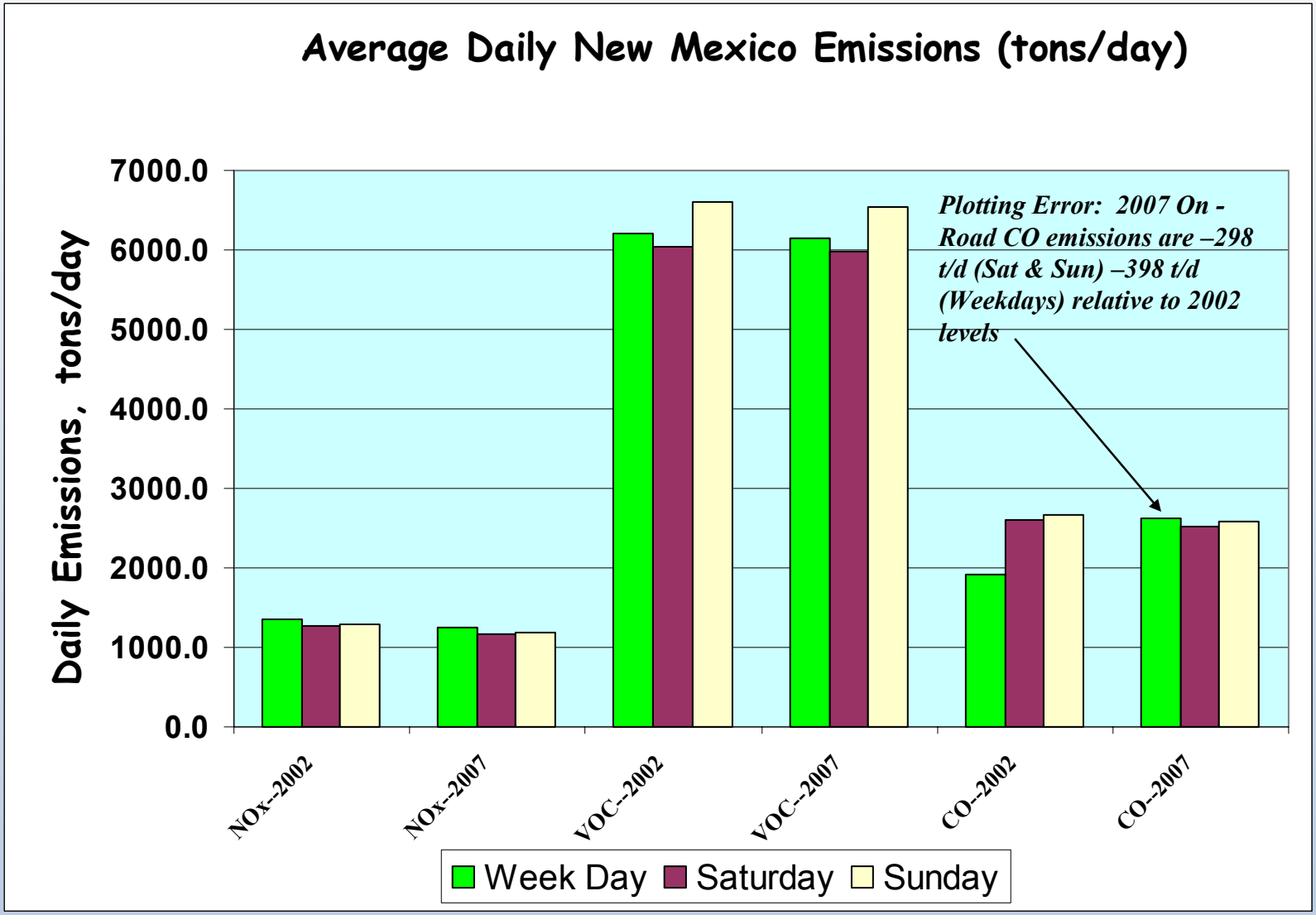
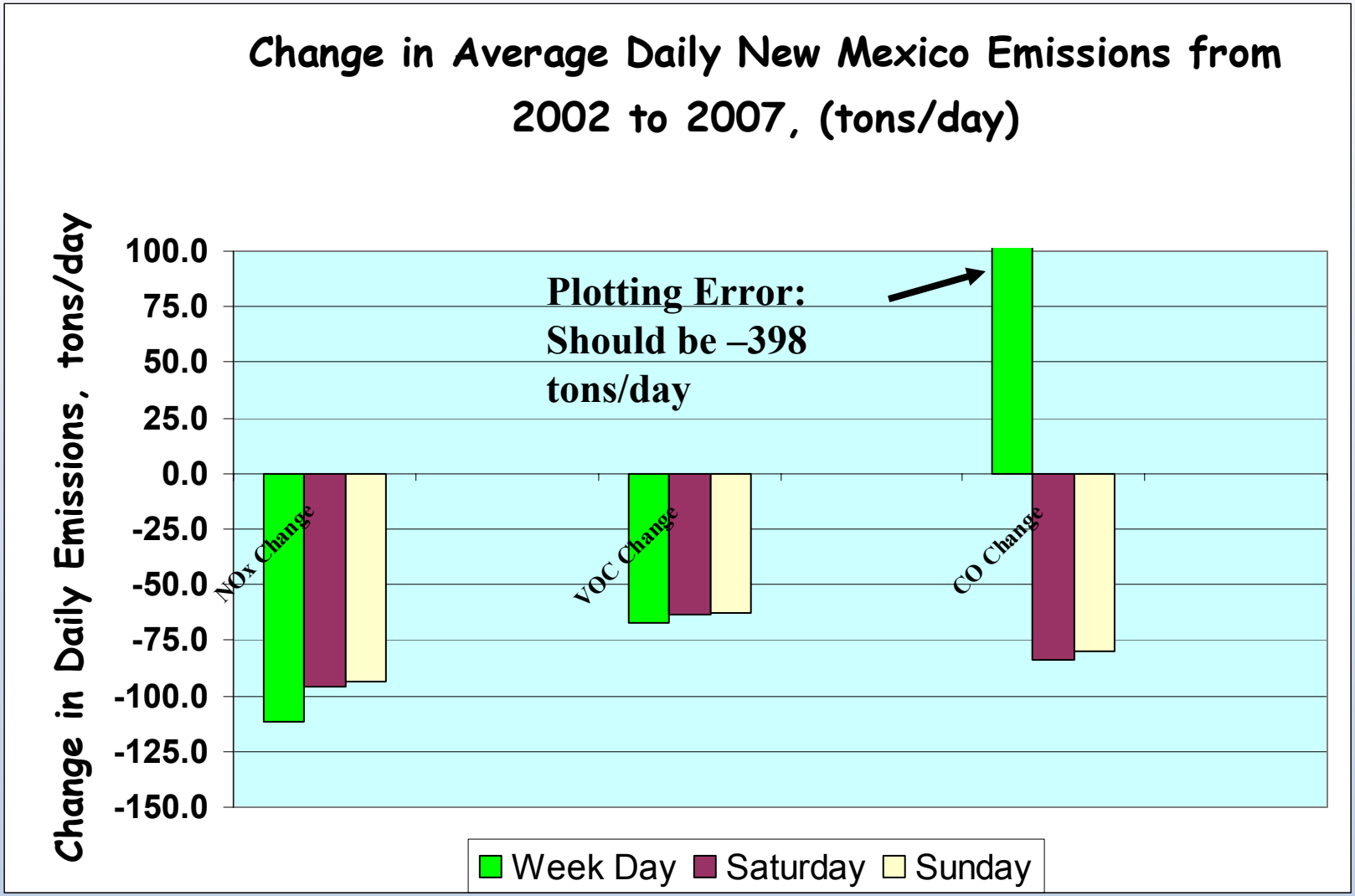
Simulation Periods		
Episode 1: 4-9 June '02		
Episode 2: 16-19 June '02		
Episode 3: 30 June-3 July '02		
Episode 4: 16-19 July '02		

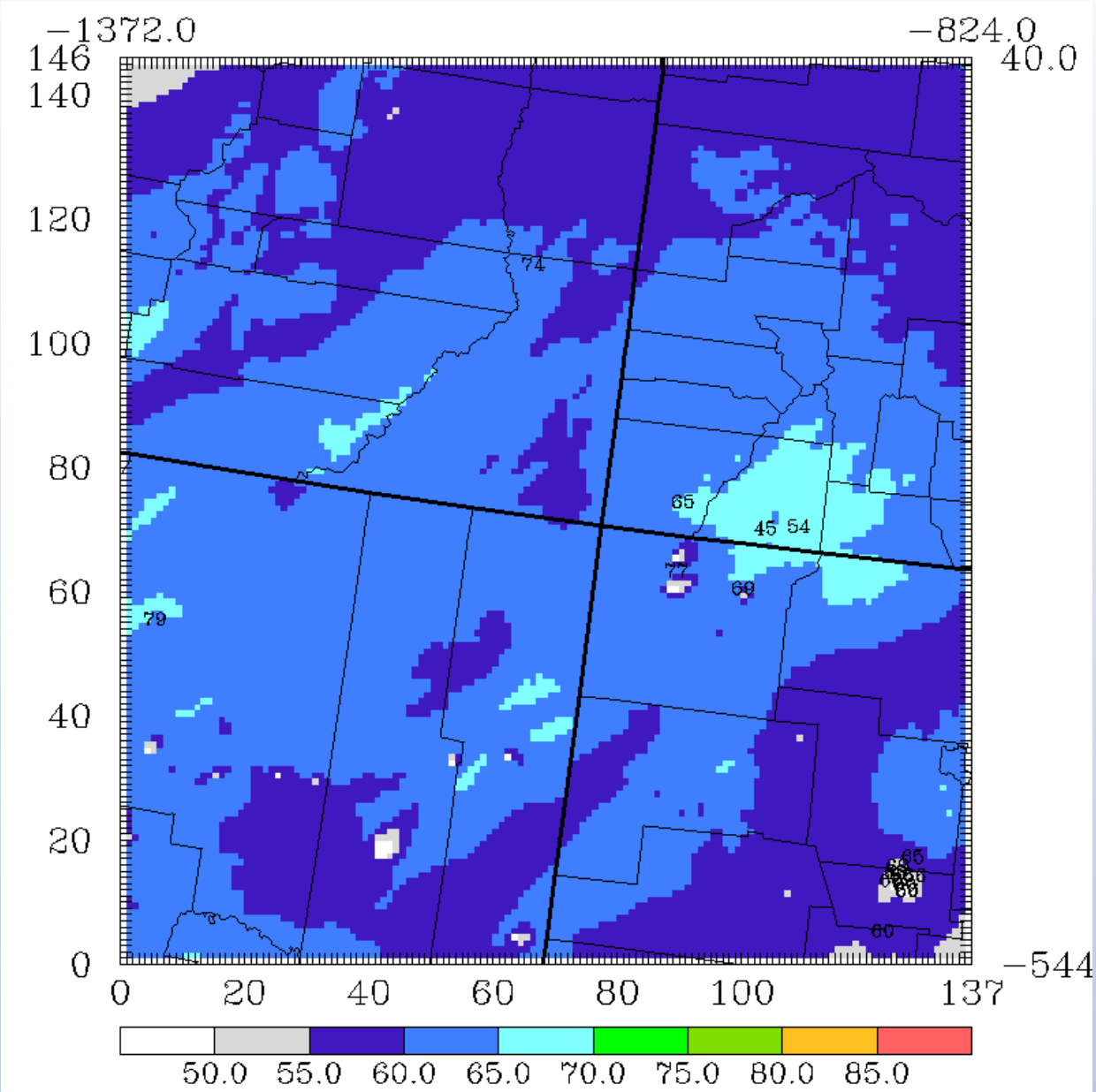
2002 and 2007 NM Baseline Emissions



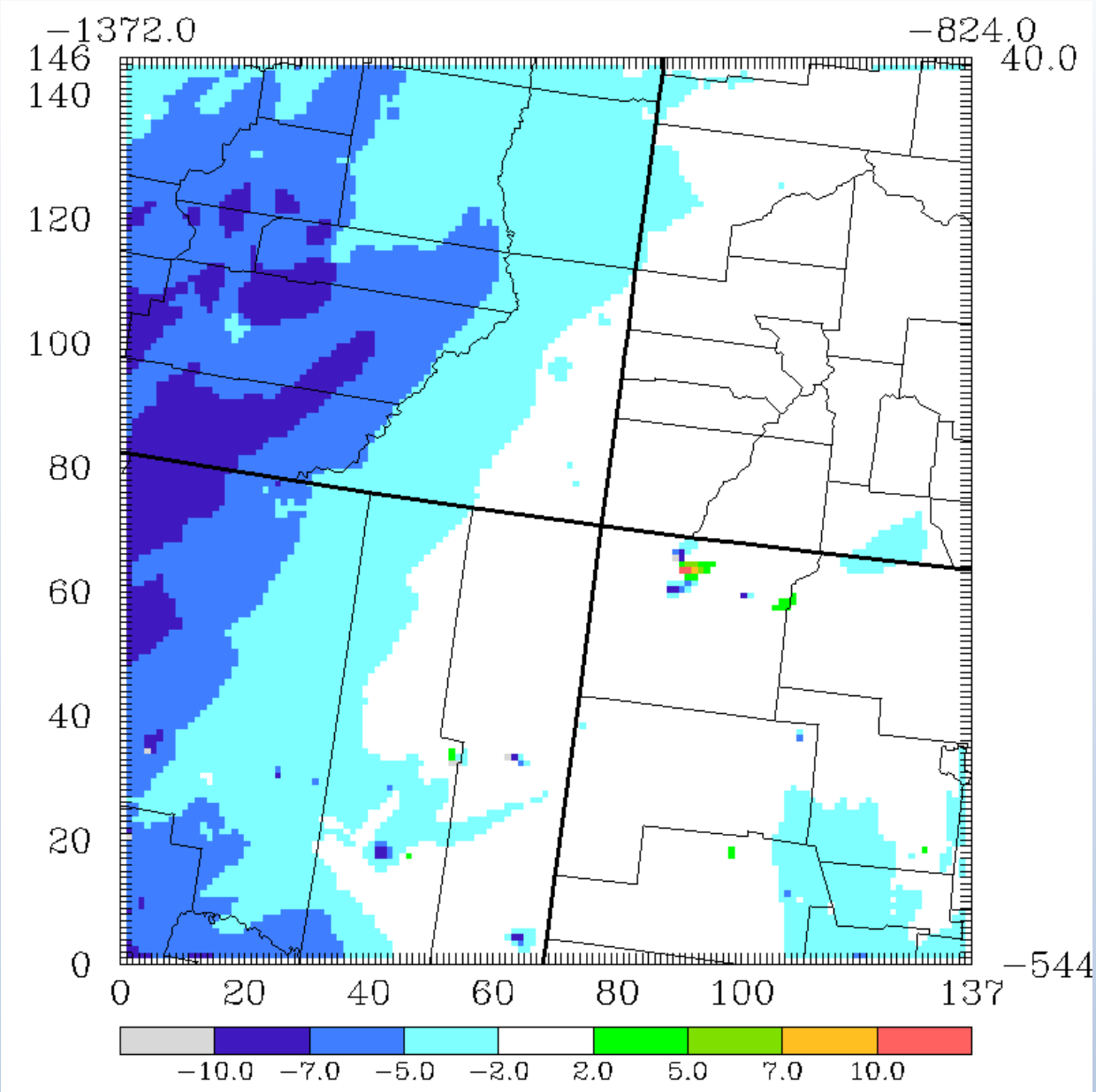
Change in NM Baseline Emissions



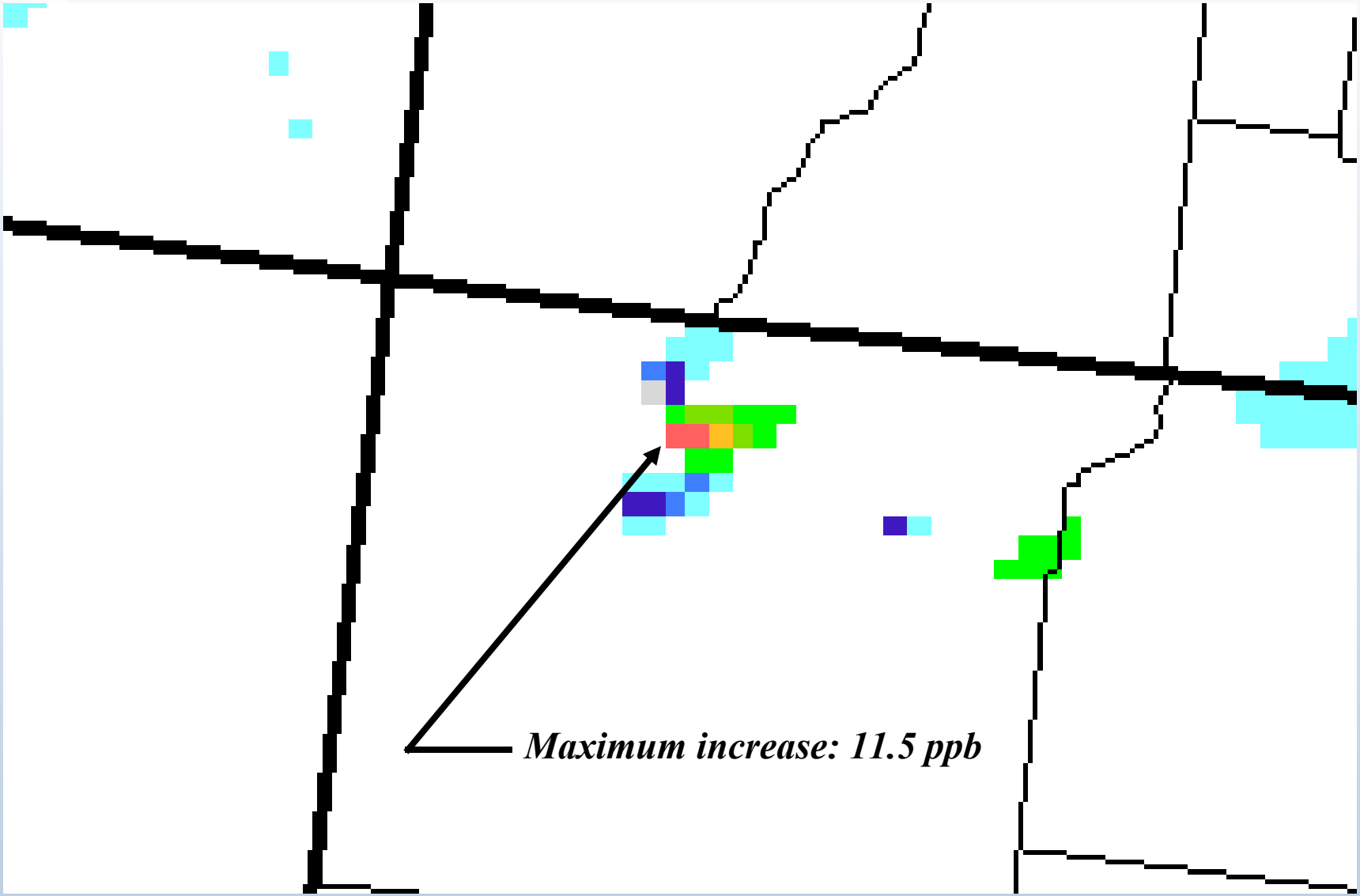
Daily Maximum 8-hr Ozone on 7 June '07

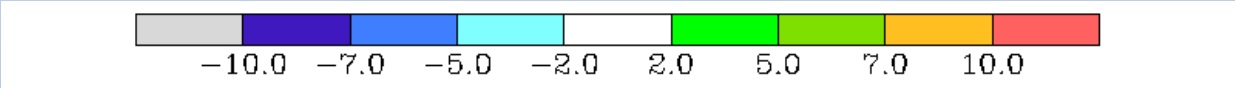


8-hr Ozone Change ('07 minus '02): 7 June

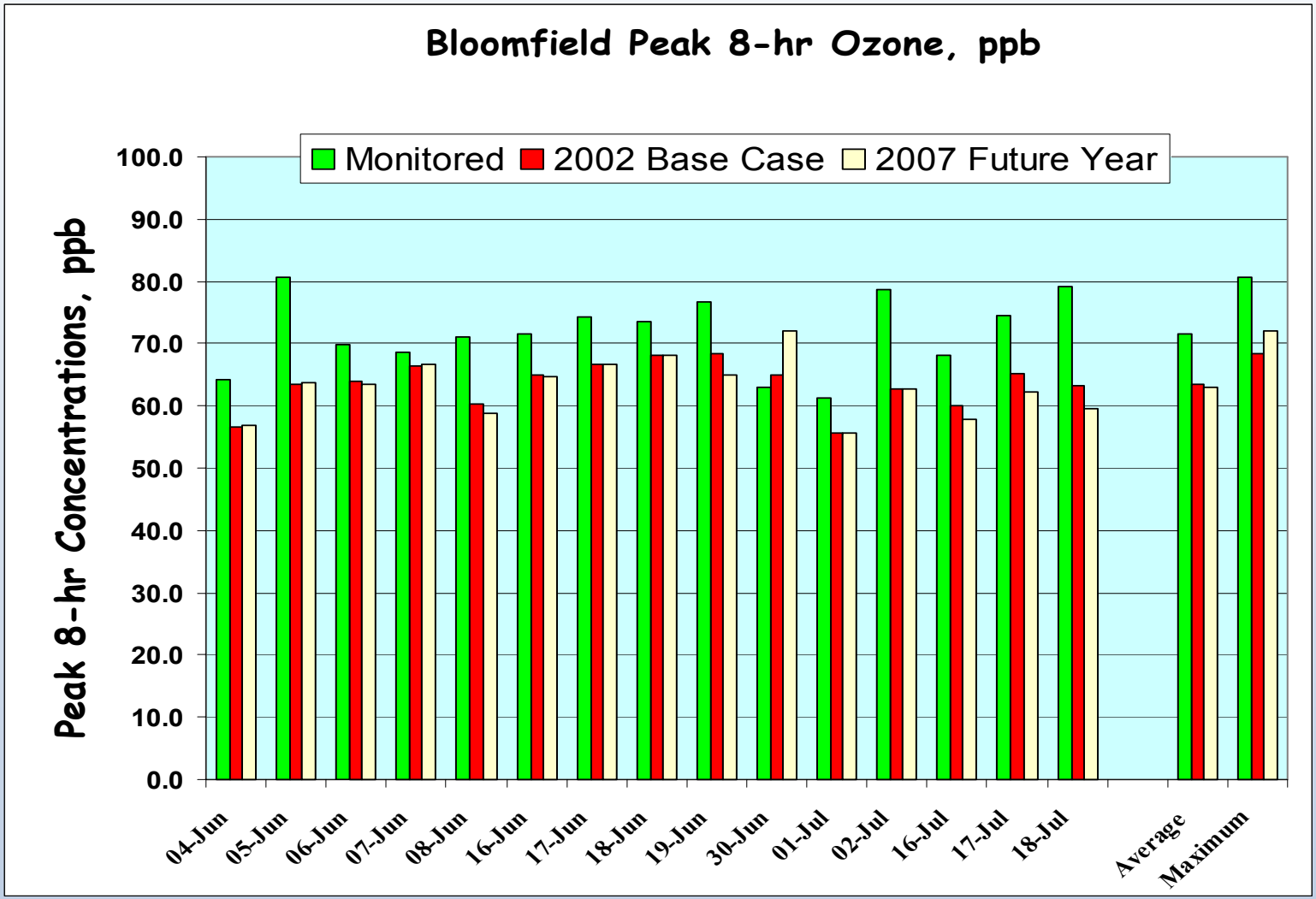


8-hr Ozone Change ('07 minus '02): 7 June



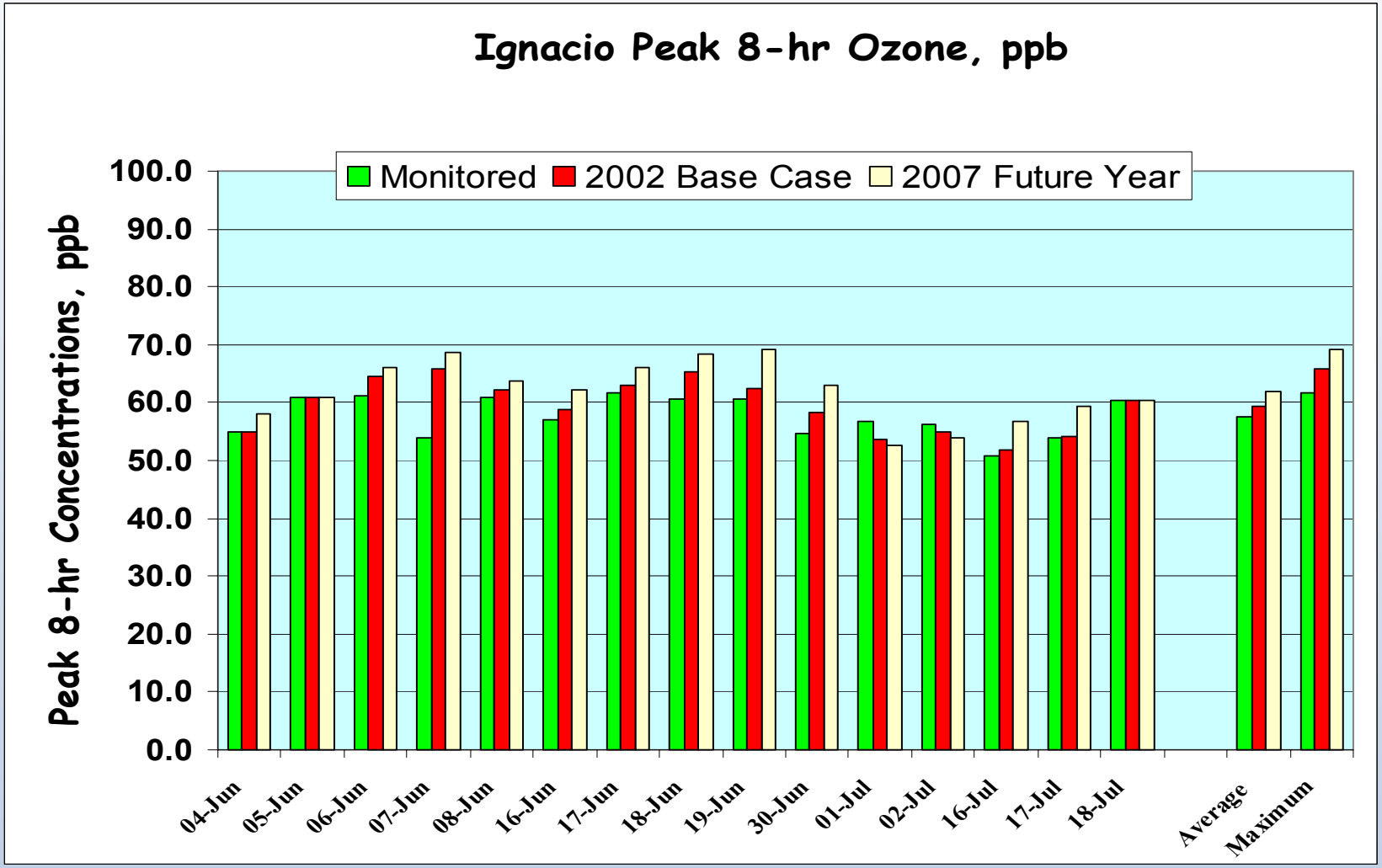


Ozone Impacts at Bloomfield



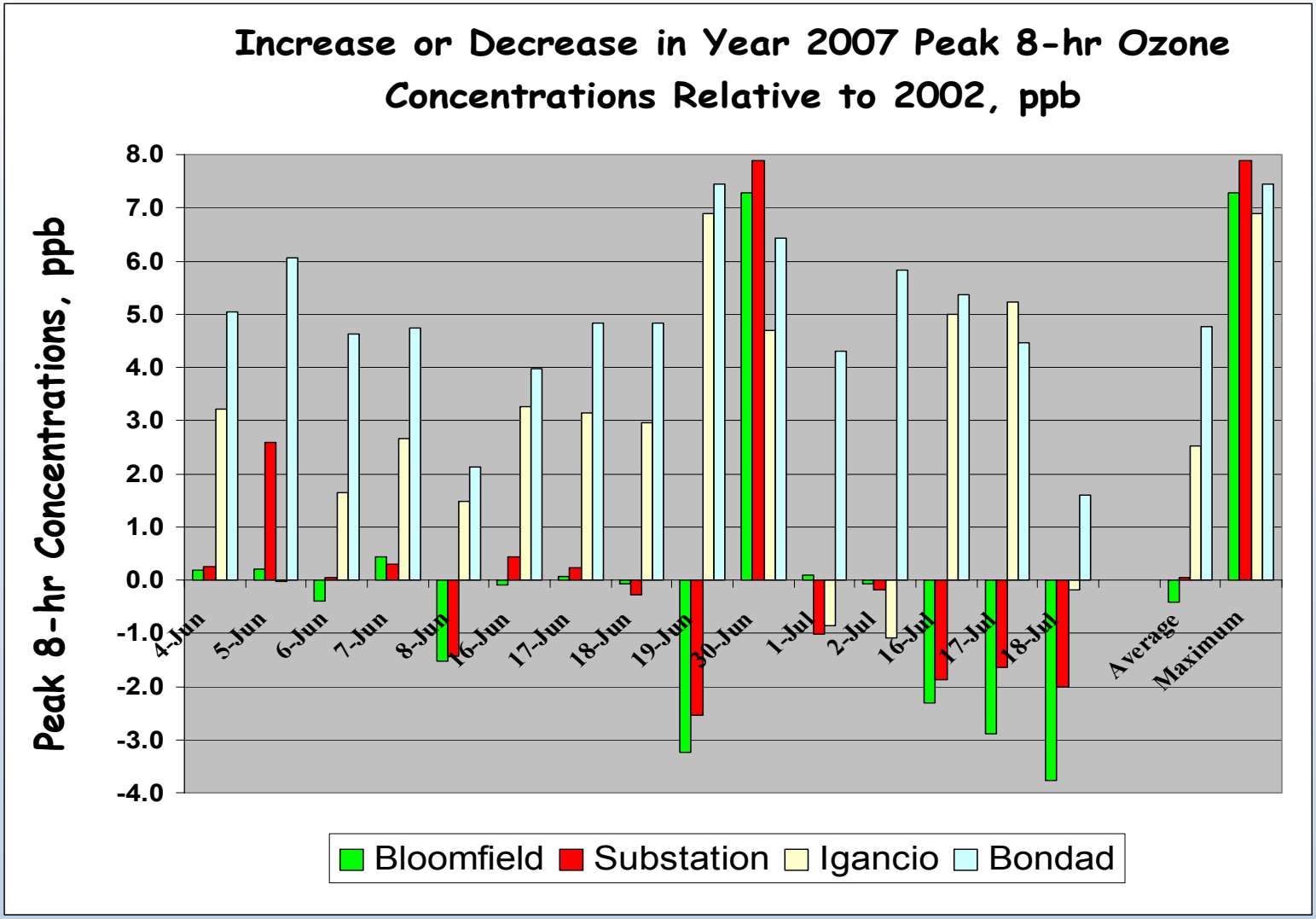
For Consistency with the CAMx Model Performance Evaluation, Base Year 2002 and Future Year 2007 Ozone Peaks Presented in this Figure are Derived from "Best" Modeled Values in the 7 x 7 Neighborhood Arrays.

Ozone Impacts at Ignacio



For Consistency with the CAMx Model Performance Evaluation, Base Year 2002 and Future Year 2007 Ozone Peaks Presented in this Figure are Derived from "Best" Modeled Values in the 7 x 7 Neighborhood Arrays.

Change in 8-hr Ozone From 2002 to 2007



For Consistency with the CAMx Model Performance Evaluation, Base Year 2002 and Future Year 2007 Ozone Peaks Presented in this Figure are Derived from "Best" Modeled Values in the 7 x 7 Neighborhood Arrays.

EPA 8-hr Ozone Attainment Test

Future Year Max 8-hr Ozone

< 85 ppb ATTAINMENT

≥ 85 ppb NOT ATTAINMENT

Future Year Ozone = D.V. x RRF

D.V. = Avg. of 4th highest 8-hr O3 over three most recent years

RRF (Relative Reduction Factor)

$$= \frac{\text{Future Year (2007) Modeled 8-hr Ozone}}{\text{Base Year (2002) Modeled 8-hr Ozone}}$$

So, model results used in a relative sense.

Modeled 2007 8-hr Design Values

Monitoring Location	Obs DV	AVG RRF	2007 DV
Bloomfield	74.3	0.976	72.49
Substation	74.7	0.996	74.37
Ignacio	75.0	0.983	73.72
Bondad	75.0	0.984	73.78
Mesa Verde	69.0	0.995	68.65

Based on Monitoring Data

Based on Modeling Results

"Highest" Values in 7 x 7 Neighborhood Array Used in Computing the RRFs

Final Step – Scenario Modeling

- Define 'Maintenance for Growth' Modeling Scenario
- Define Future Year Emissions Control Scenario(s)
- Define Additional Modeling Scenarios of Interest
  - Ozone source apportionment runs
  - Model sensitivity to future year emissions estimate uncertainties
  - Other
- Prepare Final Report