Albuquerque Ozone Modeling Analysis Project

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Presented to:
Albuquerque-Bernalillo County
Air Quality Control Board
Albuquerque, NM

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Overview

- Background and Questions
- Ozone Chemistry
- Photochemical Models
- Methods
- Modeling Analyses
- Summary of Findings

Background and Questions

- Background: 2003 and 2005 high ozone events
- Questions:
  - What are the contributions from other cities and wildfires to Albuquerque's high ozone days?
  - What will 2010 ozone levels be in Albuquerque?
  - Will 2010 ozone concentrations in Albuquerque be sensitive to VOC controls, NOx controls, or both?
  - What would be the impact on ozone in the Albuquerque area if a 10% ethanol (E10) gasoline blend were used year round in all gasoline engines in Bernalillo County?

Ozone

- Colorless gas composed of three oxygen atoms
  - Oxygen molecule (O_2)—needed to sustain life
  - Ozone (O_3) —the extra oxygen atom makes ozone very reactive
- Secondary pollutant that forms from precursor gases
  - Nitric oxide (NO) – combustion product
  - Volatile organic compounds (VOCs) – evaporative and combustion products
- National Ambient Air Quality Standards (NAAQS)

How Ozone is Formed

1. NO_2 + sunlight $\rightarrow$ NO + O
2. O + O_2 $\rightarrow$ O_3
3. NO + O_3 $\rightarrow$ NO_2 + O_2
4. VOC + OH $\rightarrow$ RO_2 + H_2O
5. RO_2 + NO $\rightarrow$ NO_2 + RO

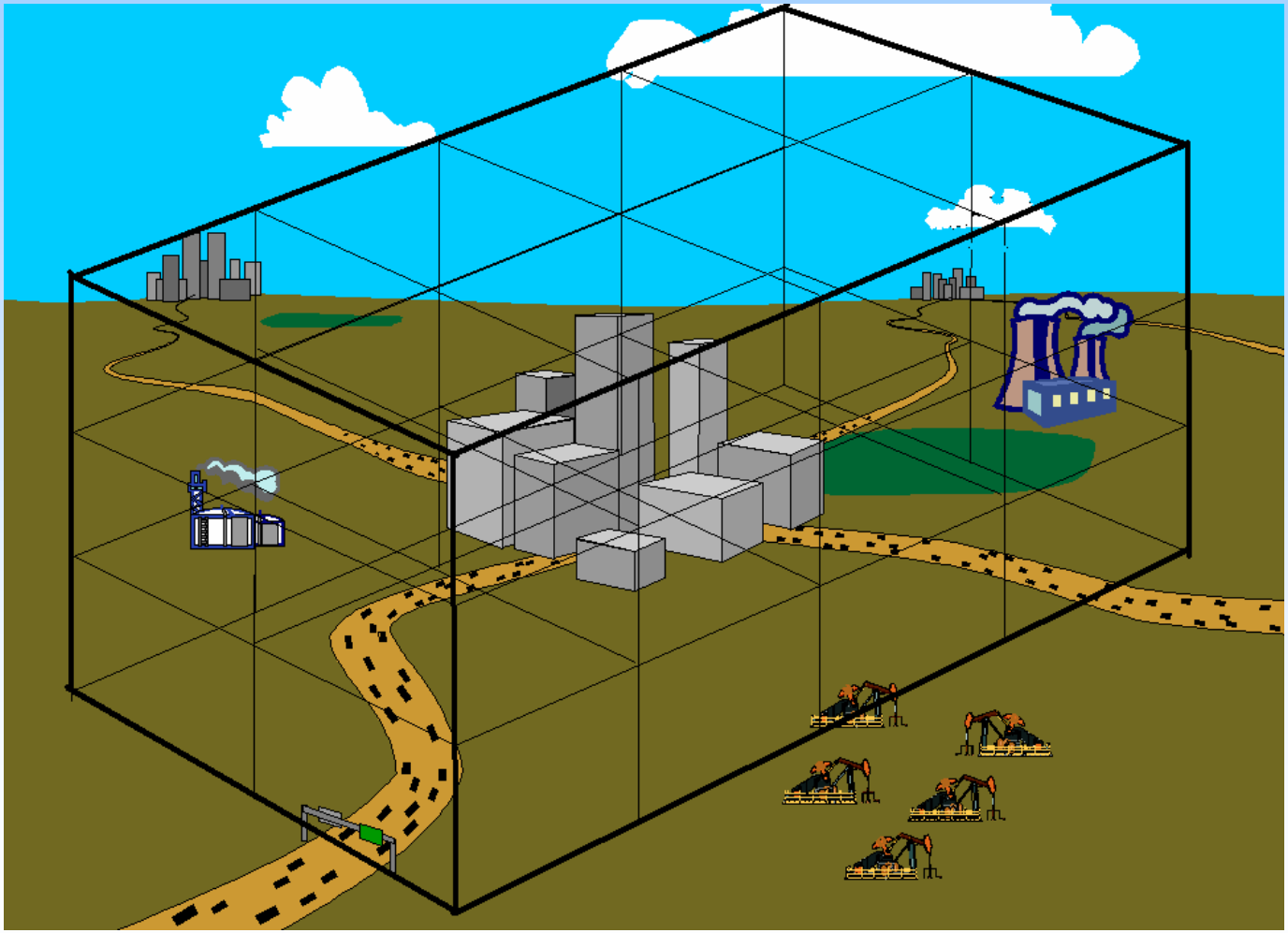
During the day, **reactions 4 and 5** can be faster than **reaction 3** at producing nitrogen dioxide (NO_2)

During the night, reaction 1 stops because of lack of sunlight, but reaction 3 continues to occur; thus, ground-level ozone concentrations decrease at night .

Photochemical Models

- Simulate the physical and chemical processes in the atmosphere
  - Transport
  - Diffusion
  - Chemical reactions (non-linear)
  - Removal processes
- Inputs include Emissions and Meteorology
- Can be used to answer “What if ” questions

Photochemical Grid Model Concept



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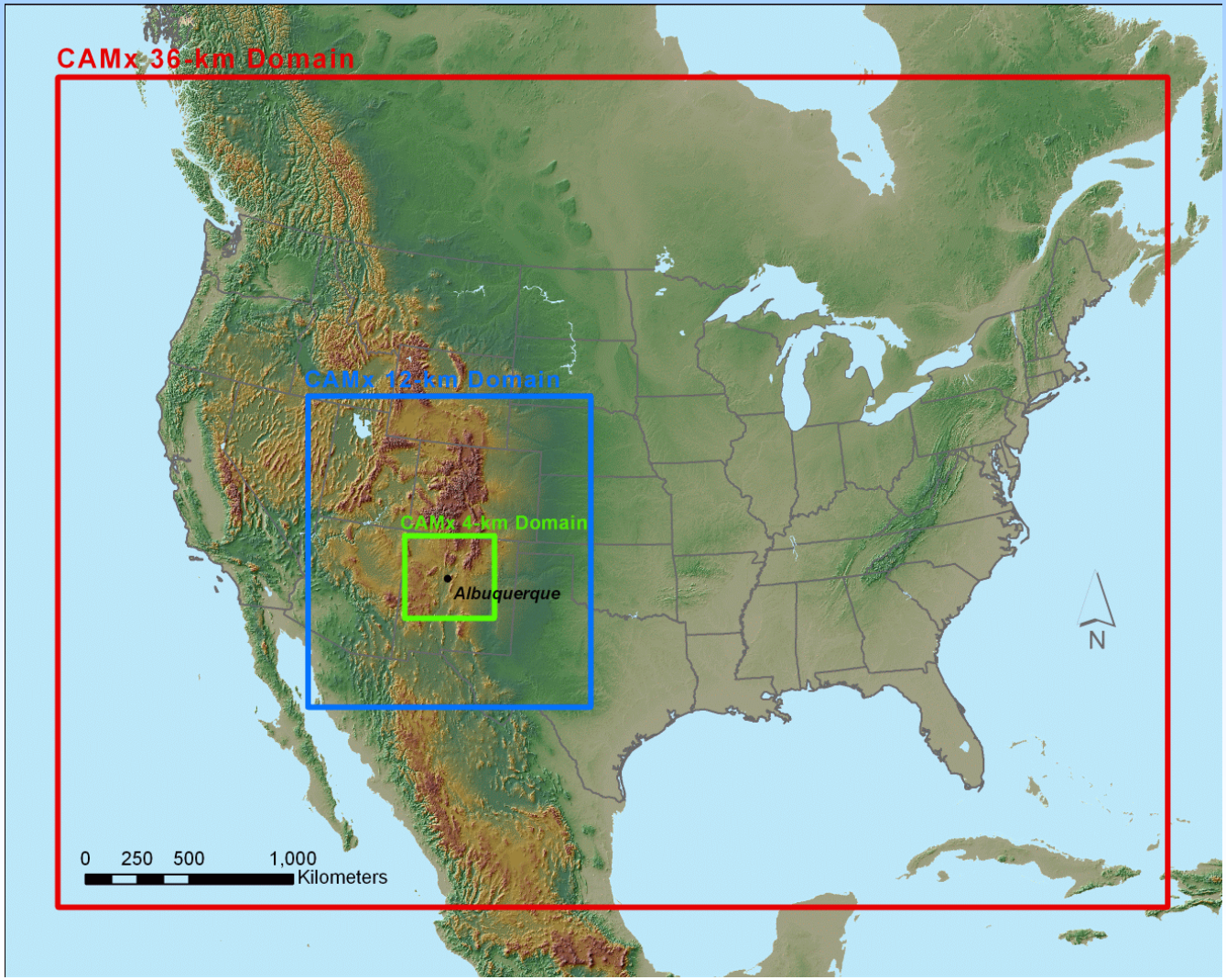
Modeling Methods

- Episode and Model Selection
- Meteorological Modeling (MM5)
- Emissions Processing (SMOKE)
  - 2002 National Emission Inventory (NEI) grown to 2003, 2005, and 2010
  - Local point source and vehicle miles traveled (VMT)
  - Wild fire emissions
- Photochemical Modeling (CAMx)
  - Base Cases (2003 and 2005)
  - Model Evaluation and Improvement
  - Future Year Base Case (2010)
  - Modeling Analyses

Modeling Domains



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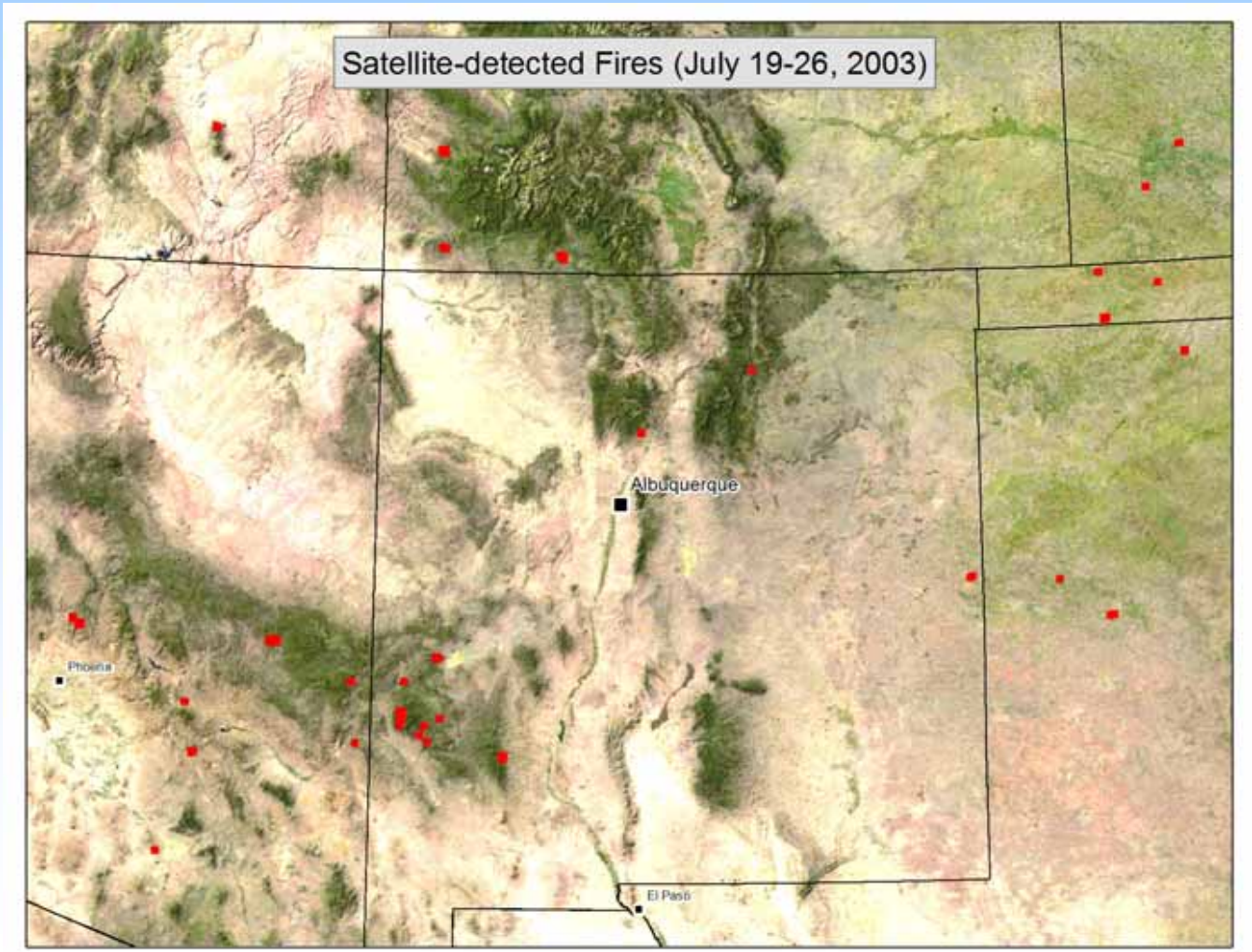
Wild Fire Emissions



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Bernalillo County Emissions

Source Type	CO	NO_x	VOC
2003			
Area	15.8	5.6	16.7
Nonroad	177.6	11.1	14.2
Onroad	205.2	35.7	18.5
Point	1.9	4.4	1.7
Total	400.4	56.8	51.1
2005			
Area	15.8	5.6	16.7
Nonroad	185.7	10.6	13.0
Onroad	187.3	31.6	16.3
Point	1.9	3.7	1.3
Total	390.6	51.5	47.2

Source Type	CO	NO_x	VOC
2010			
Area	6.6	3.4	17.0
Nonroad	238.3	8.9	11.0
Onroad	187.7	21.9	13.7
Point	1.9	4.9	1.4
Total	434.5	39.1	43.1

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Modeling Analyses Results

- Source Contributions
- 2010 Air Quality
- Growth Scenarios
- Sensitivity to VOC and NOx Reductions
- Impact of Ethanol use on Ozone

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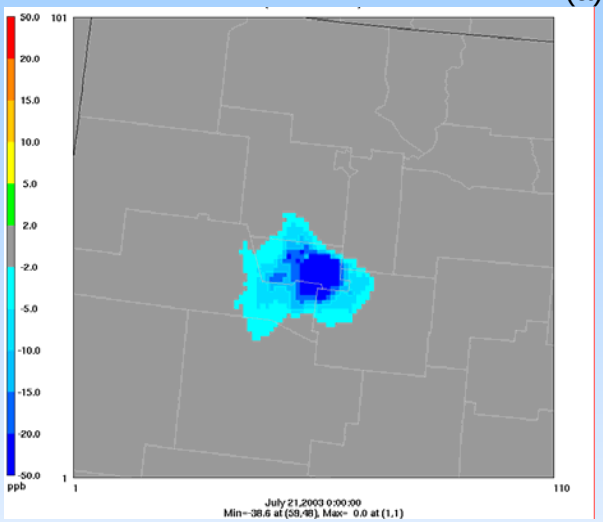
Contributions from Albuquerque

(a)



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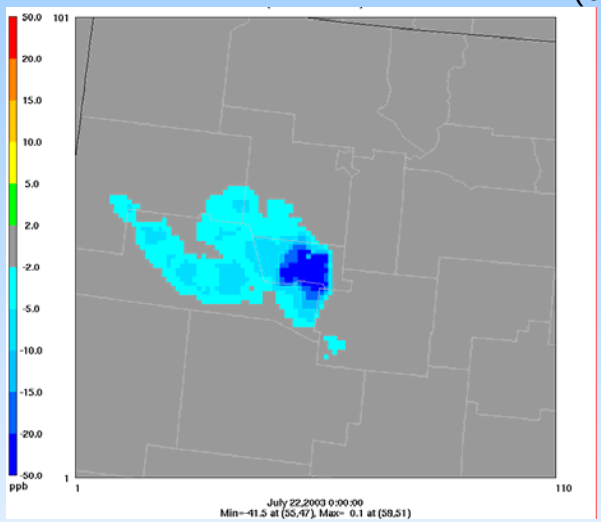

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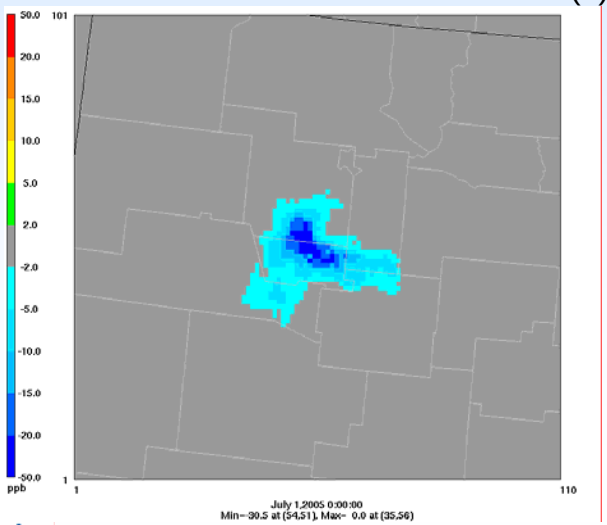

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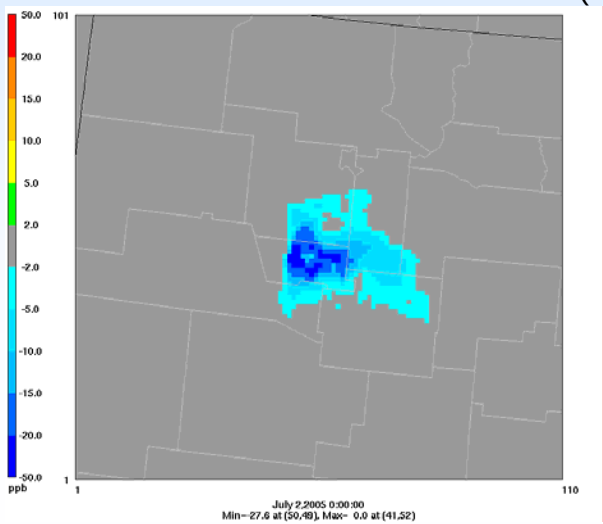

13 – 42 ppb

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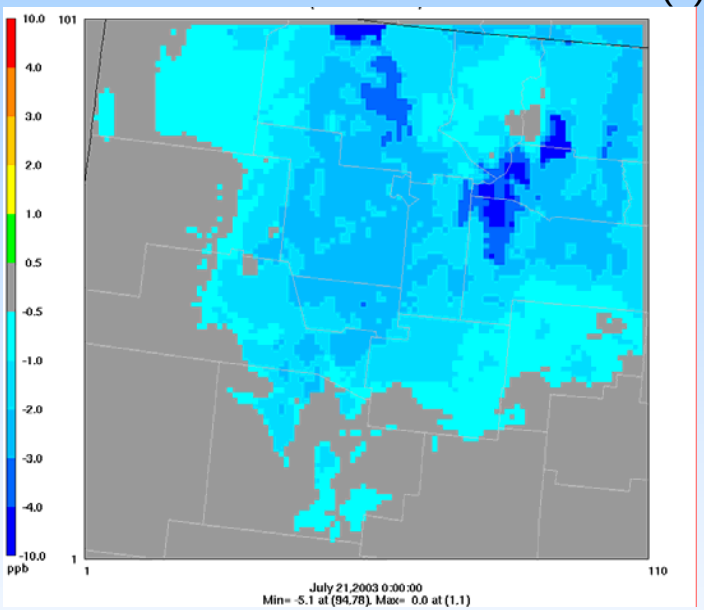
Contributions from Denver

(a)



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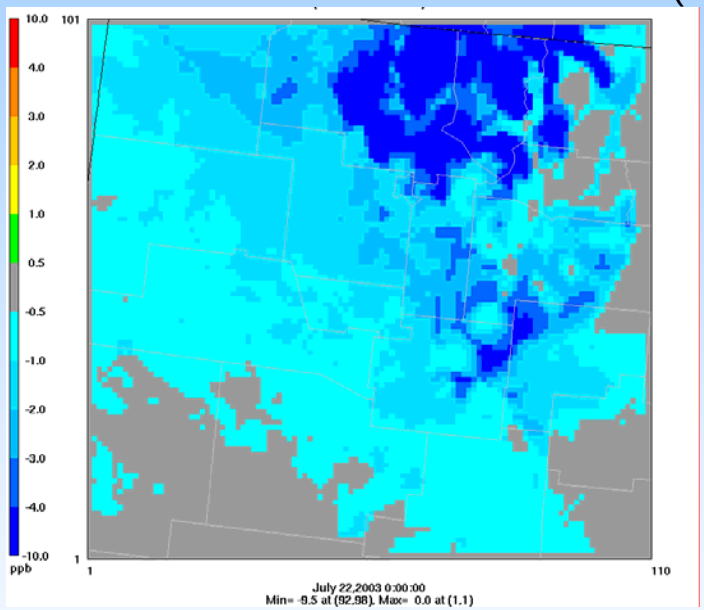

0 – 3 ppb; 9.5 max

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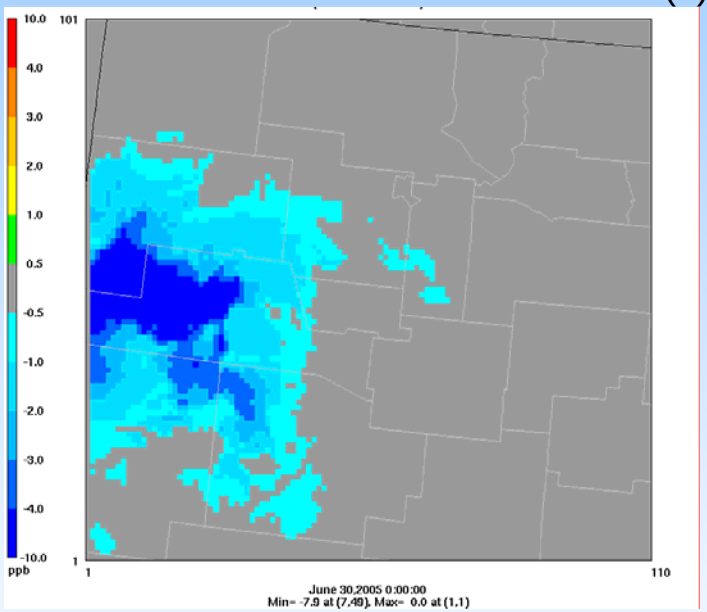
Contributions from Phoenix

(a)



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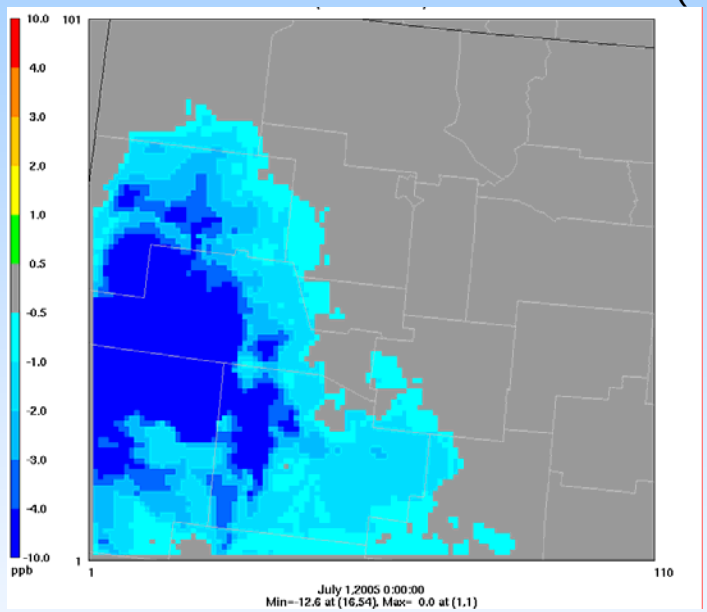

0 – 1.5 ppb; 12.6 max

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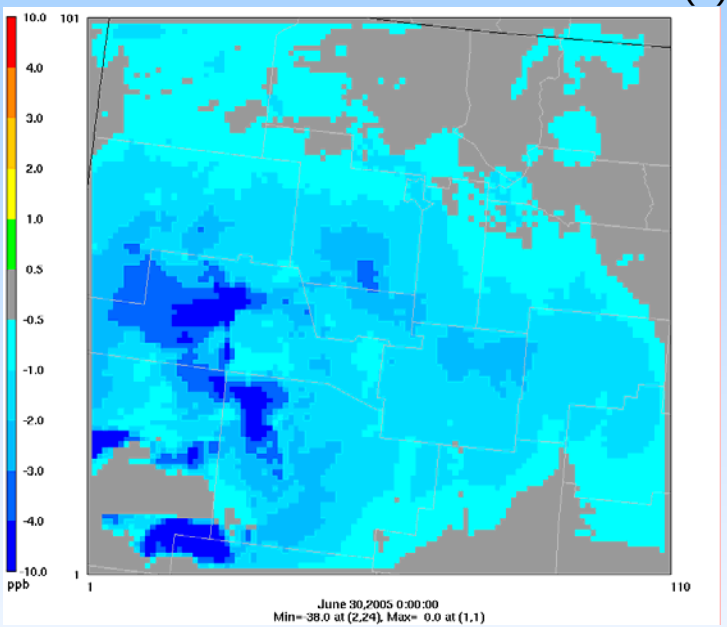
Contributions from Fires

(a)



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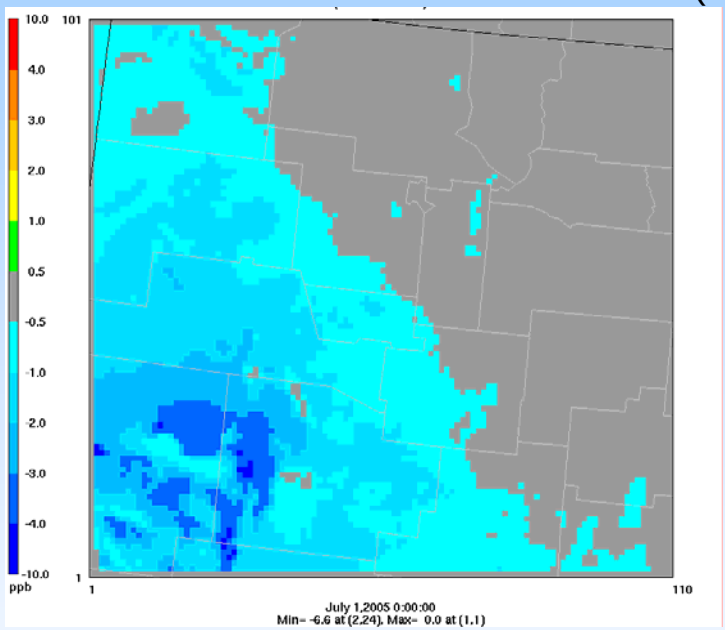

0 – 3.6 ppb; 38 Max (Analysis > 20 ppb)

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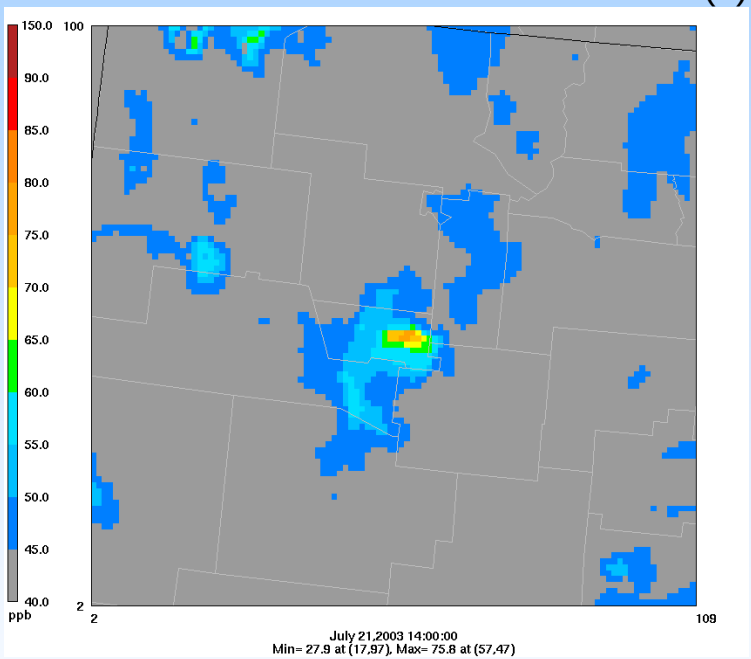
2010 Air Quality

(a)



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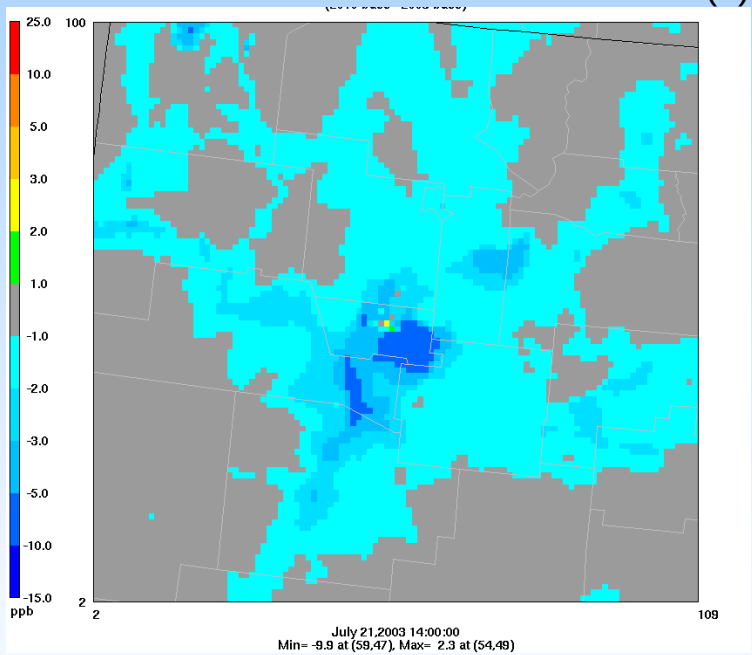

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8-hr Ozone Concentrations

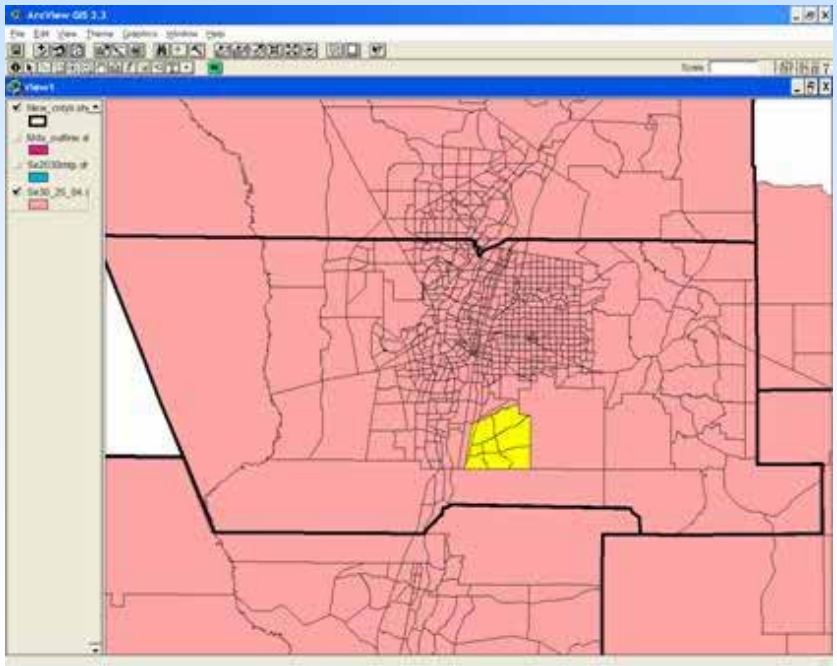
Site	Observation	2003 base	2010 base	Ratio
Zuni Park	80.5	58.5	61.2	1.05
SE Heights	78.0	61.1	62.7	1.03
Westside Taylor Ranch	81.0	62.4	61.0	0.98
S Valley Mountain View	69.3	61.2	58.7	0.96
Far NE Heights	91.5	65.5	64.9	0.99
North Valley	82.3	63.0	65.8	1.04
Westside Corrales	78.9	63.8	65.1	1.02
Bernalillo	78.6	61.3	61.0	0.99
Rio Rancho Estate	79.1	65.2	65.9	1.01
Del Norte HS	80.3	57.2	61.7	1.08
Maximum	91.5	65.5	65.9	1.08
Minimum	69.3	57.2	58.7	0.96

Sensitivity Simulations

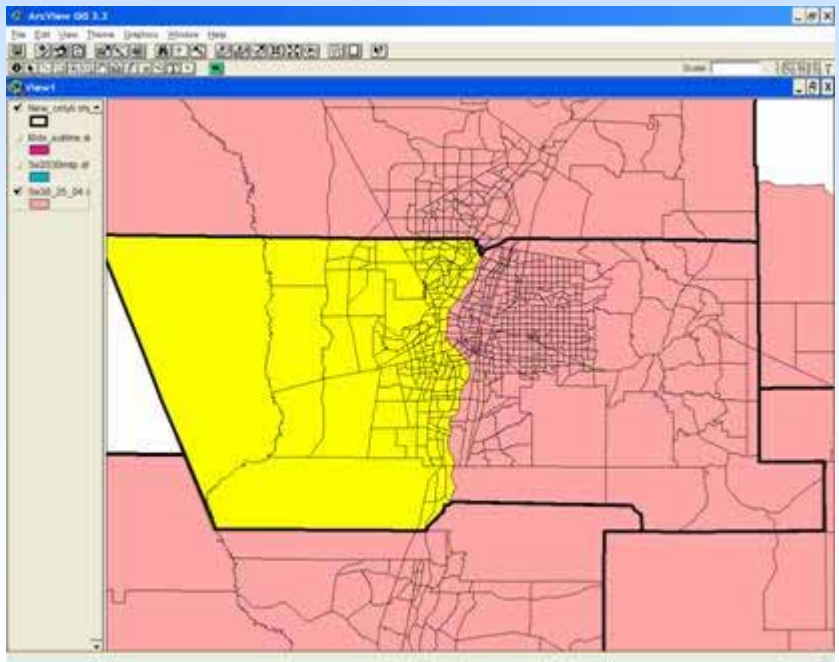
1. Population increase of 10% occurring entirely in the Mesa del Sol area.
2. Population increase of 10% occurring entirely to the west of the Rio Grande River.
3. New point source emitting 500 tons/year to the northwest corner of the Albuquerque metropolitan area.
4. Across-the-board VOC reduction of 10%.
5. Across-the-board NOx reduction of 10%.
6. Population increase of 20% geographically distributed consistent with existing 2025 forecasts.

Scenarios 1 and 2 – Growth Redistribution

10% of 2010 base case VOC, NOx, and CO emissions for Bernalillo County were redistributed to each of the two regions shown below.



Mesa del Sol



West of Rio Grande

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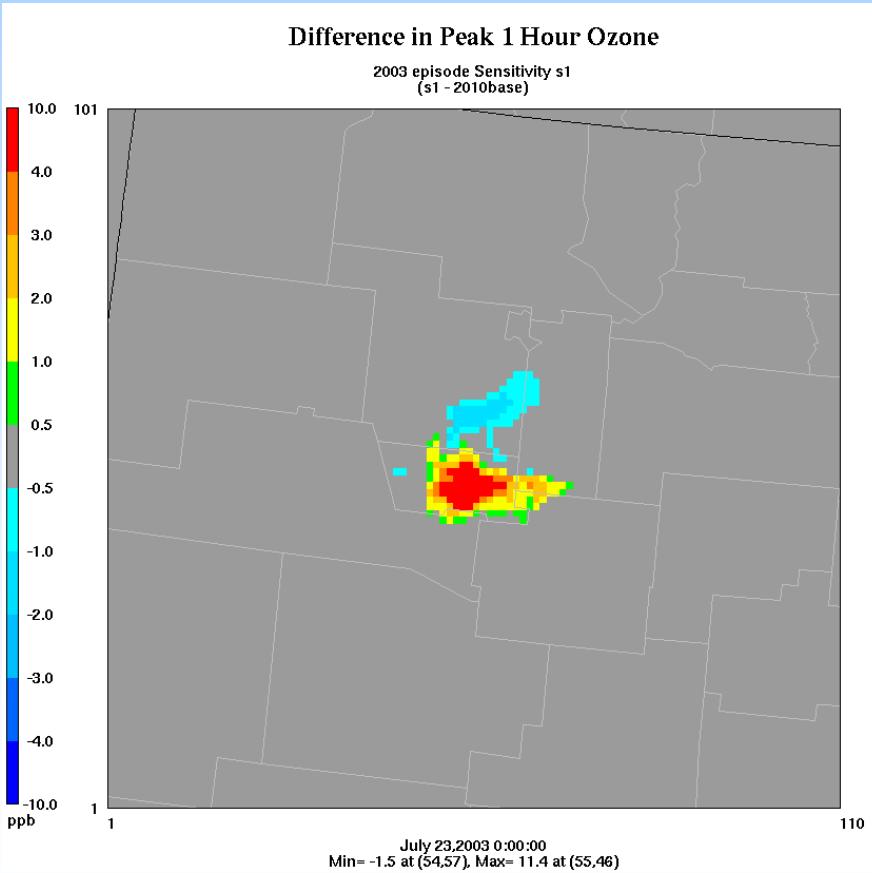
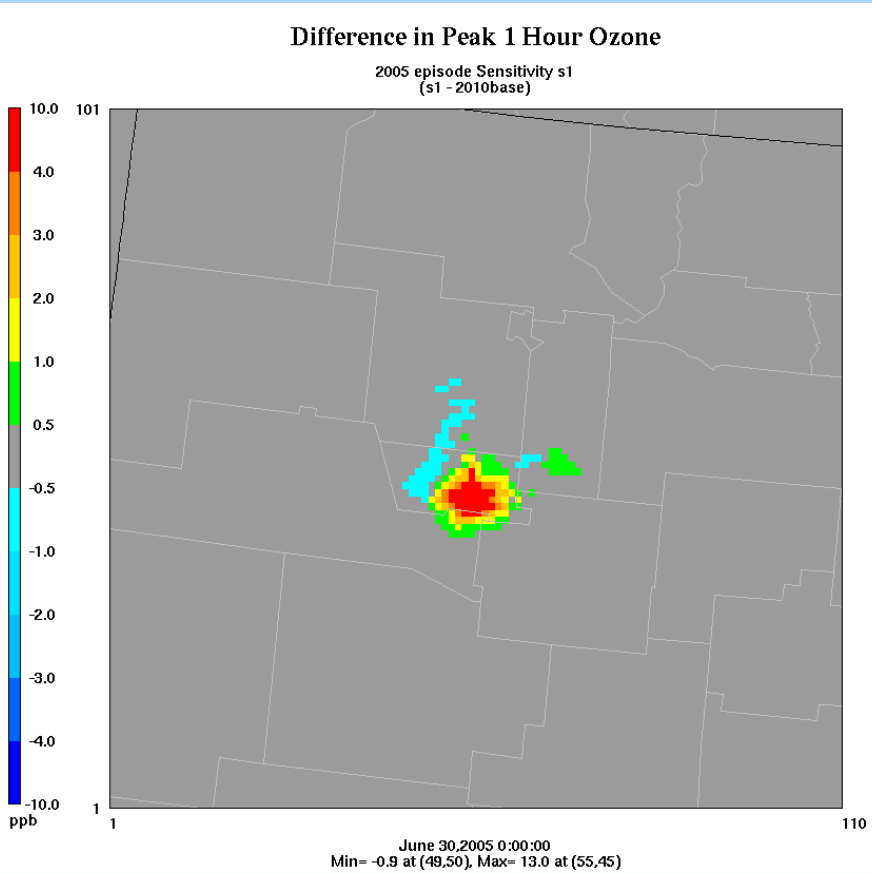
Impact on 1-hr Ozone

Scenario 1 (10% increase in Mesa del Sol)





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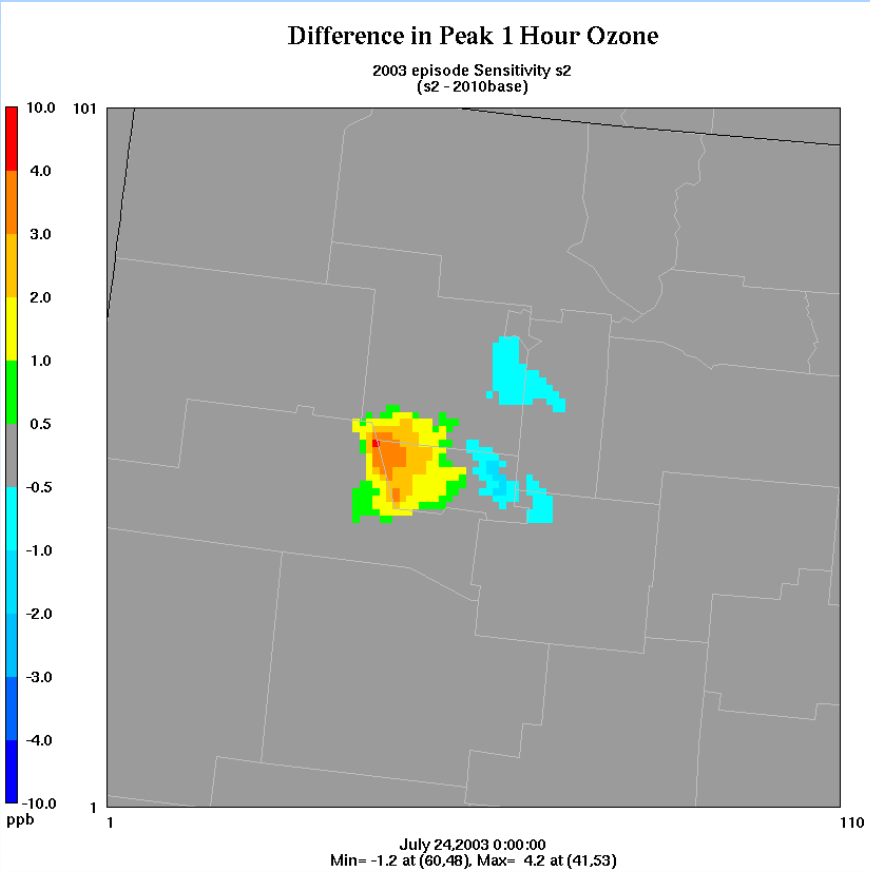
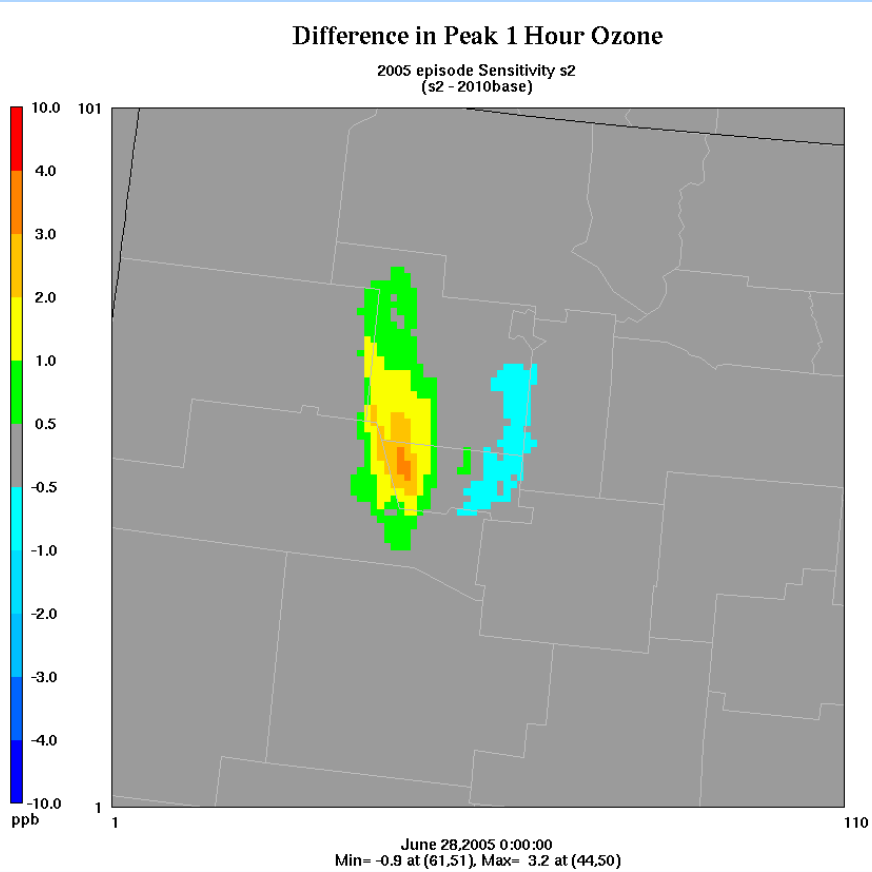
Impact on 1-hr Ozone

Scenario 2 (10% increase west of Rio Grande)





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Scenario 3 – New VOC Source

A new point source emitting 500 tons/year of VOC was added near Double Eagle Airport and modeled after a large VOC source at an existing refinery in the area.

Result: No ozone impacts above 0.1 ppb

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Scenarios 4 and 5 – 10% Reductions

Scenario 4

Across-the-board VOC reduction of 10% for Bernalillo County.

Scenario 5

Across-the-board NOx reduction of 10% for Bernalillo County.

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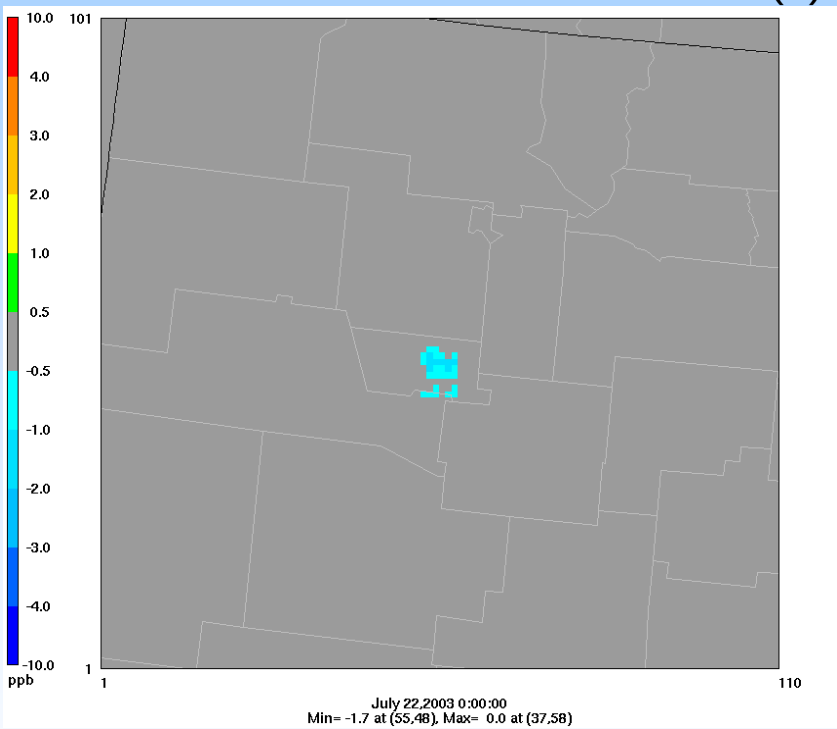
Impact on 1-hr Ozone

Scenario 4 (10% across-the-board VOC reduction)

(a)



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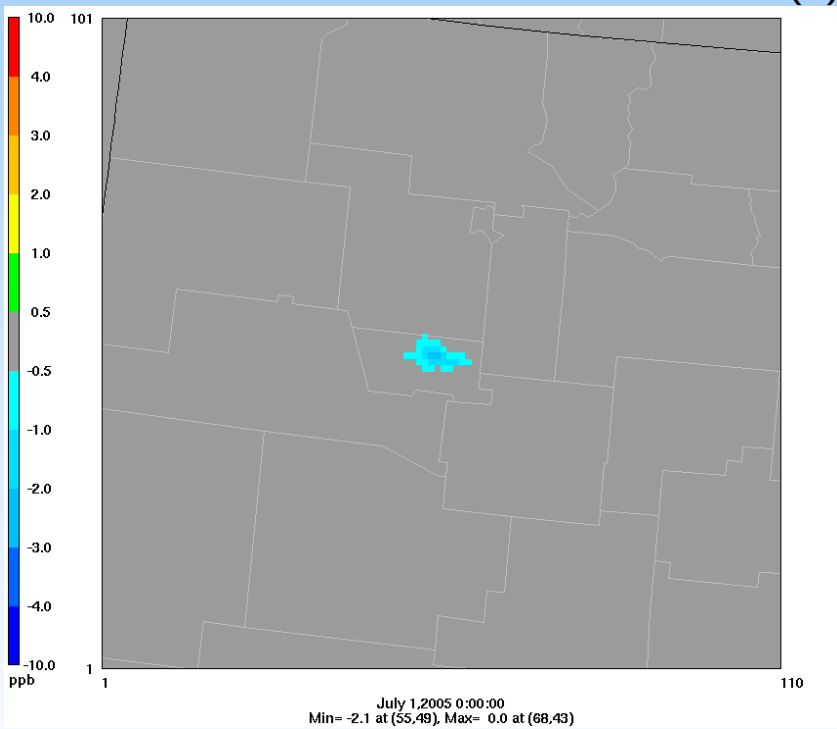

0.1 to 0.8 ppb

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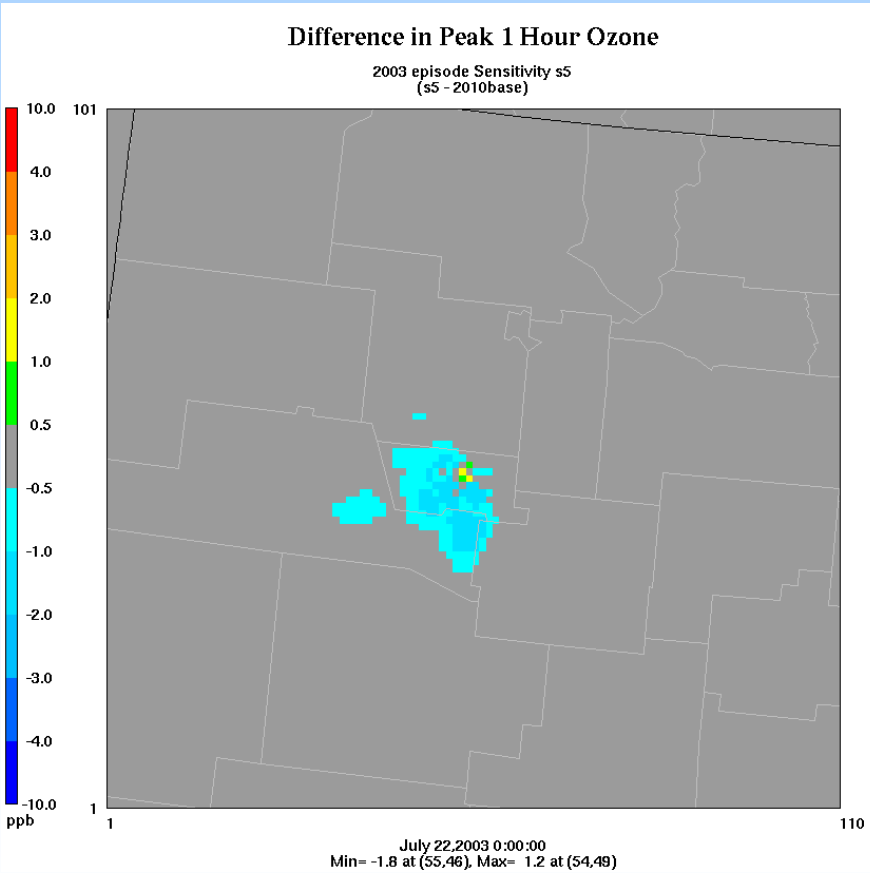
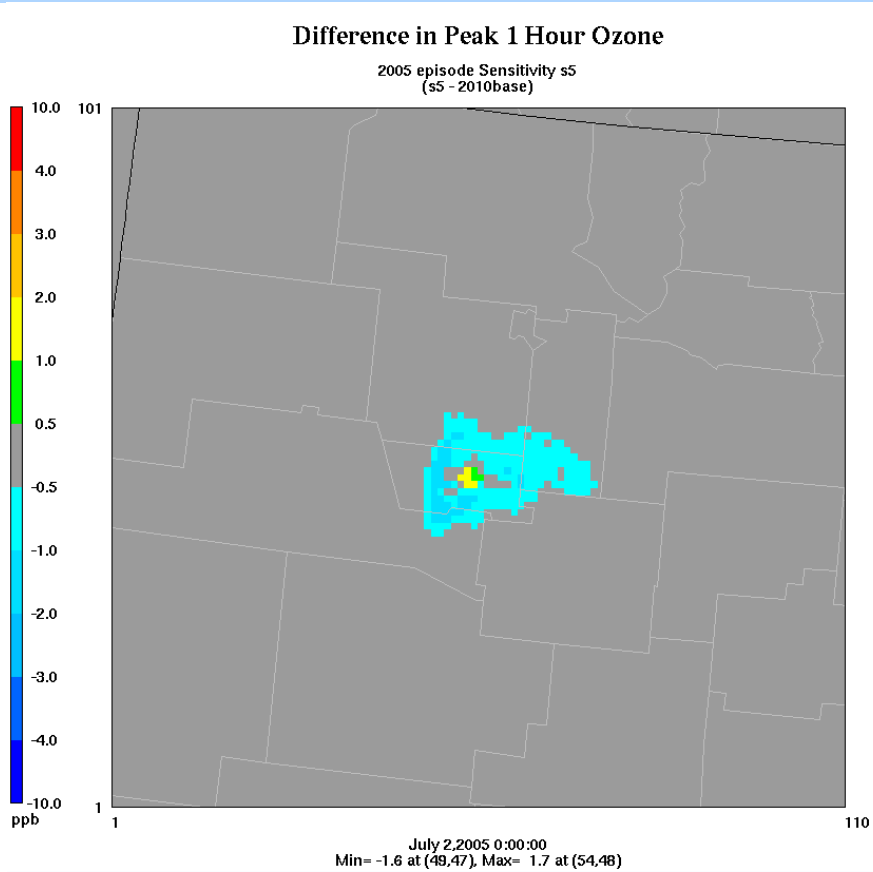
Impact on 1-hr Ozone

Scenario 5 (10% across-the-board NOx reduction)





0.1 to 0.7 ppb

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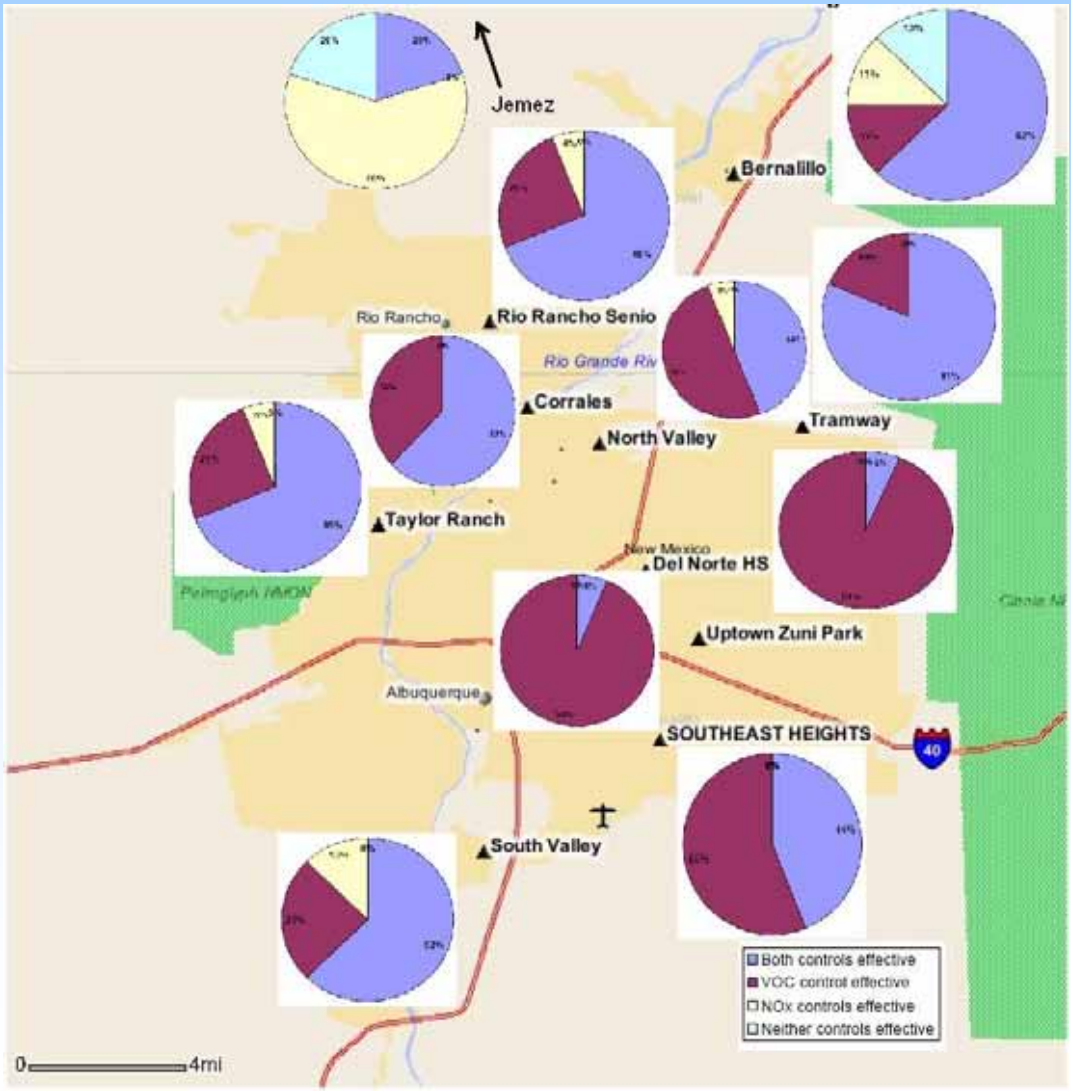
Effectiveness of VOC and NOx Reductions



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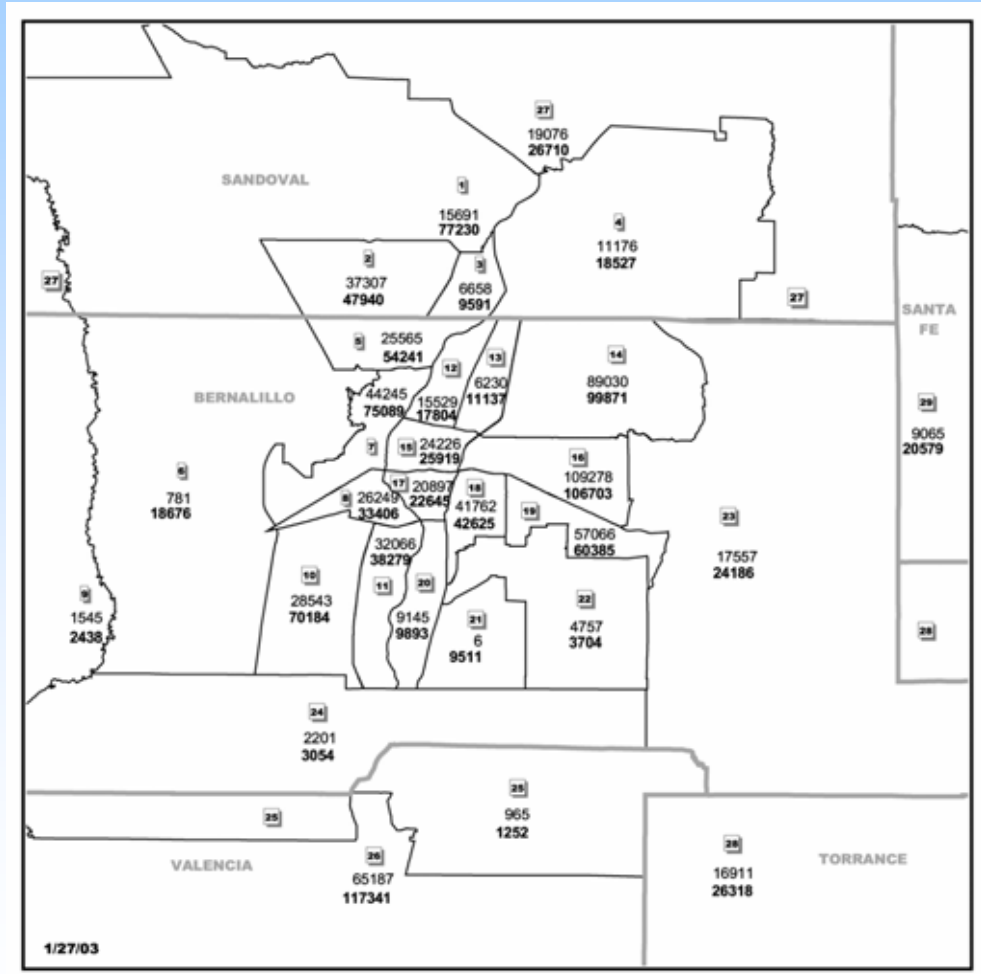
Scenario 6 – Accelerated Growth

- Population increase of 20% (a 10% increase over the 2010 base case).
- 10% increase in 2010 NOx, VOC and CO emissions for Bernalillo County was assumed and distributed to MRCOG subzones based on existing 2025 forecasts.



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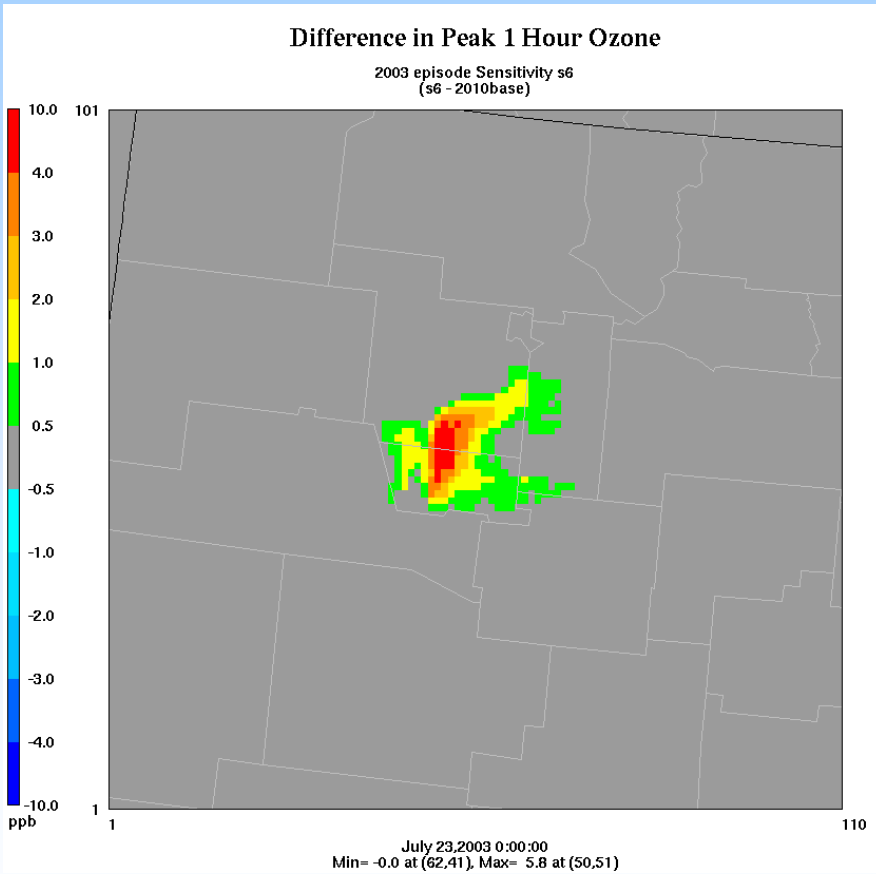
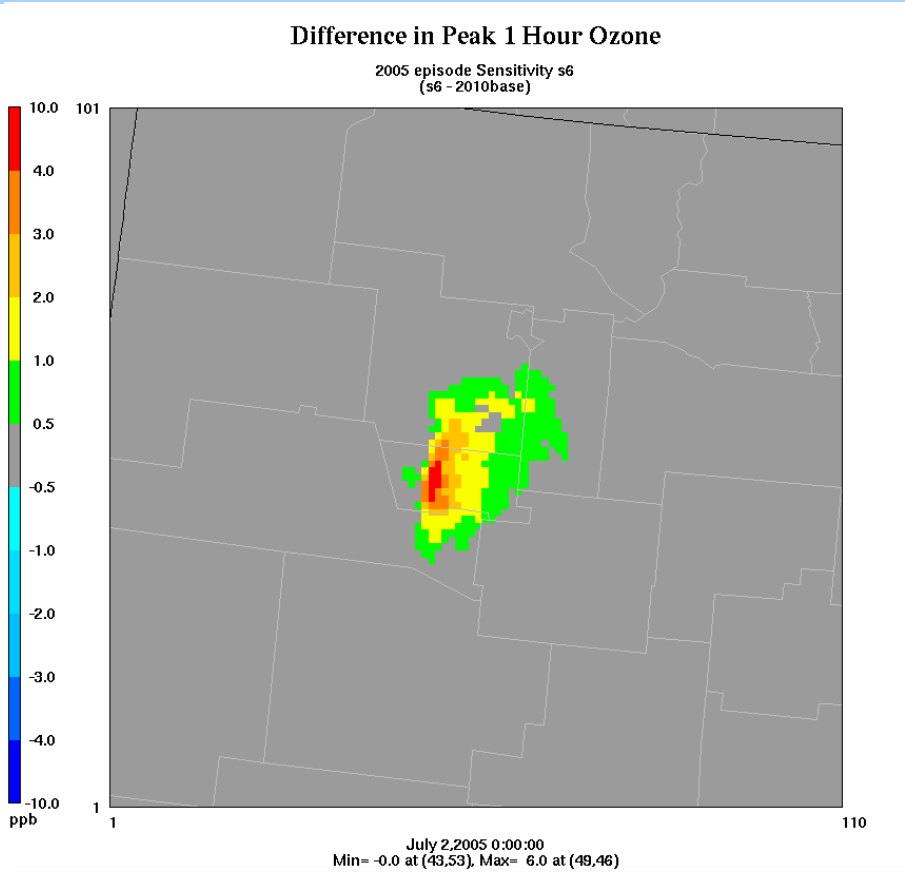
Impact on 1-hr Ozone

Scenario 6 (20% population increase geographically distributed consistent with existing 2025 forecasts)





0.3 to 2.0 ppb

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Ethanol Sensitivity

10% ethanol (E10) blend in all gasoline engines in Bernalillo County.

Pollutant	Emissions (tons/day)			%Difference
	2010 Base	2010 E10	Difference	
CO	378.4	354.6	-23.8	-6.3%
NO_x	26.4	26.8	0.4	1.5%
VOC	22.0	23.2	1.2	5.5%

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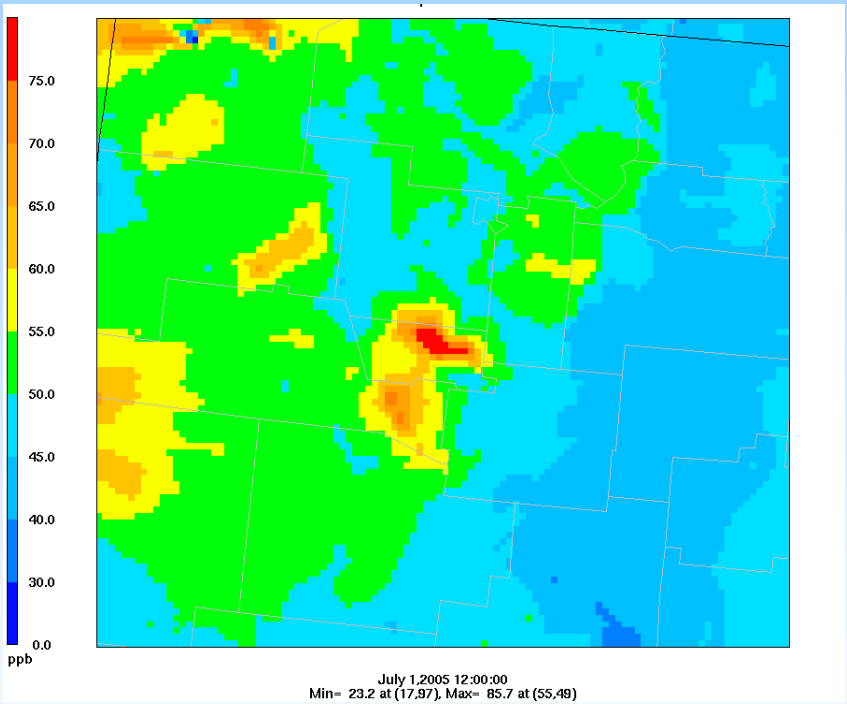
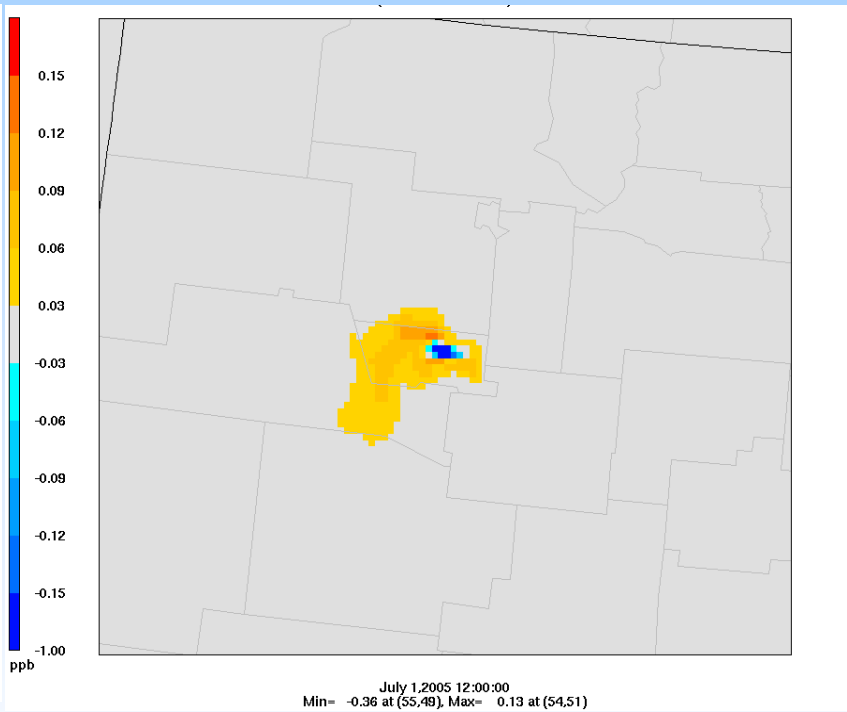
Ethanol Sensitivity Results





Peak 8-hr: +/- 0.1 ppb

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Summary of Findings (1 of 2)

- Albuquerque's emissions contribute from 13 to 42 ppb to peak 1-hr ozone in the Albuquerque area on the days modeled.
- Emissions from other cities and wild fires contribute to high ozone concentrations in the Albuquerque area.
- The contribution from wild fires to ozone concentrations in the Albuquerque area based on CAMx modeling may be underestimated by 20 ppb or more.
- Although it is assumed that population in the Albuquerque area will grow 10% by 2010, emissions will be smaller in 2010 than in 2003 and 2005.
- Reductions in emissions by 2010 will decrease 1-hr peak ozone concentrations but may increase peak 8-hr ozone concentrations.
- Population growth in the Mesa del Sol area will result in higher ozone concentrations in the metropolitan Albuquerque area while population growth in the area west of the Rio Grande will have a lesser impact.

Summary of Findings (2 of 2)

- Additional VOC sources in western Bernalillo County will have little impact on the metropolitan area but may increase ozone concentrations in the western portions of the County, particularly if there is population growth in those regions.
- VOC emission reductions are more effective at reducing peak 8-hr ozone concentrations at sites closer to Albuquerque's urban center while both VOC and NOx reductions are effective at locations 10 – 15 km down wind of the urban center. For locations 30 km or more down wind of the urban center, NOx reductions are more effective.
- Rapid population growth (20% by 2010) in the Albuquerque area could increase peak 8-hr ozone concentrations by as much as 2 ppb.
- Year round use of a 10% ethanol blend (E10) in all gasoline engines in Bernalillo County would result in very small increases (less than 0.1 ppb) in summer time peak 8-hr ozone in the areas surround the Albuquerque urban core and may decrease peak 8-hr ozone concentration within the urban core.

Thank You