Air Quality Modeling of 2017 Ozone Episodes in the City of Albuquerque

Kenneth Craig
Sonoma Technology, Inc.
Petaluma, CA

for

City of Albuquerque
Air Quality Control Board
Albuquerque, NM

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Sonoma Technology, Inc.

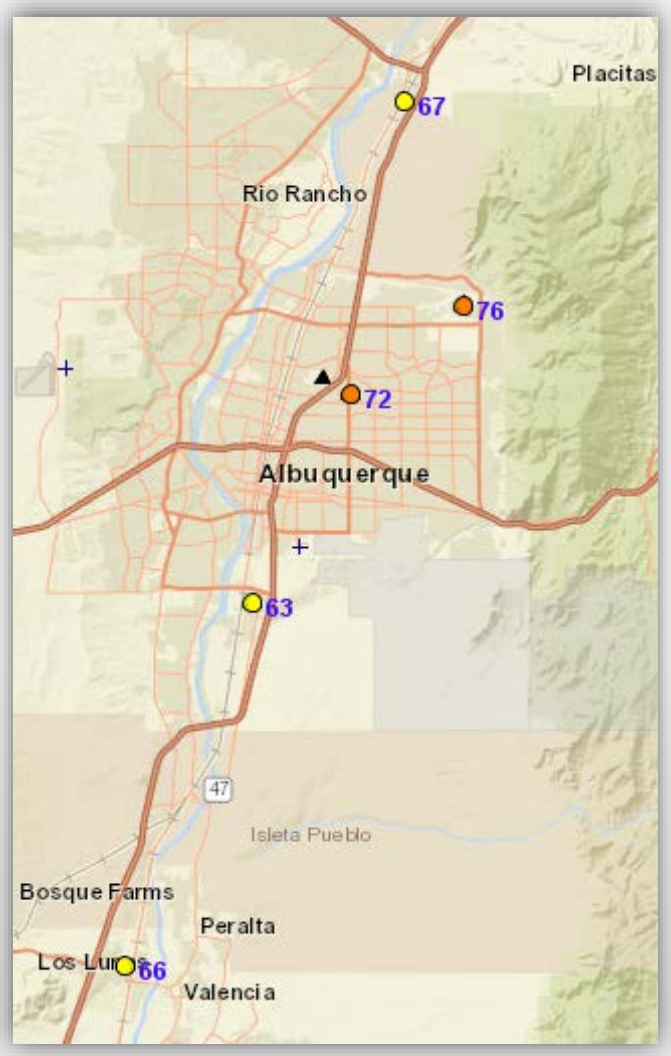
Work Steps (Outline)

- Purpose and Background (6 minutes)
- Episode Selection (1 minute)
- Meteorological Modeling (1 minute)
- Emissions Modeling (3 minutes)
- Air Quality Modeling (5 minutes)
- Source Apportionment Modeling (5 minutes)
- Sensitivity Modeling (4 minutes)
- Future-Year Modeling (4 minutes)
- Conclusion (3 minutes)

Purpose

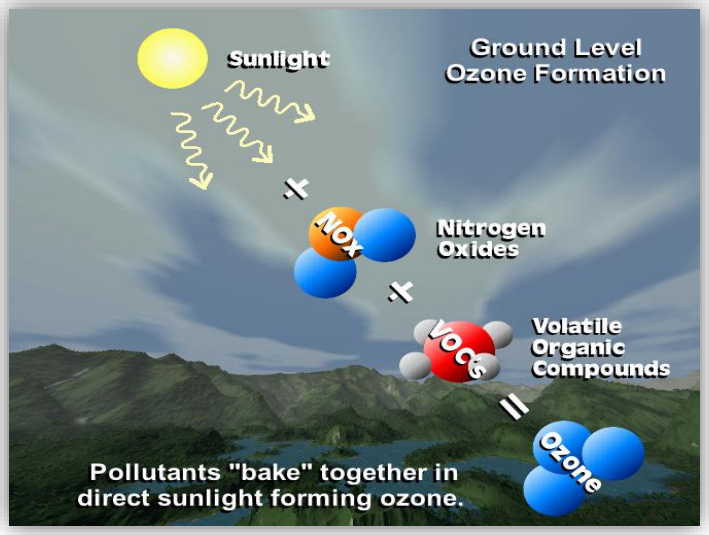
Use scientific data and modeling analysis to:

- Further the understanding of high ozone in the Albuquerque area.
- Understand control strategies that (if necessary) can be helpful for reducing ozone in the region.



Ozone on July 10, 2017

What Is Ozone?



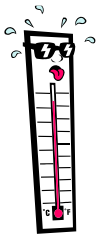
Secondary pollutant formed from precursor emissions:

- Nitrogen Oxides (NO_x = NO + NO_2)
- Volatile organic compounds (VOCs)

Ground-level ozone can affect human health and damage plants.

Naturally occurring ozone in the upper atmosphere protects earth from the sun's UV radiation.

How Weather Impacts Ozone

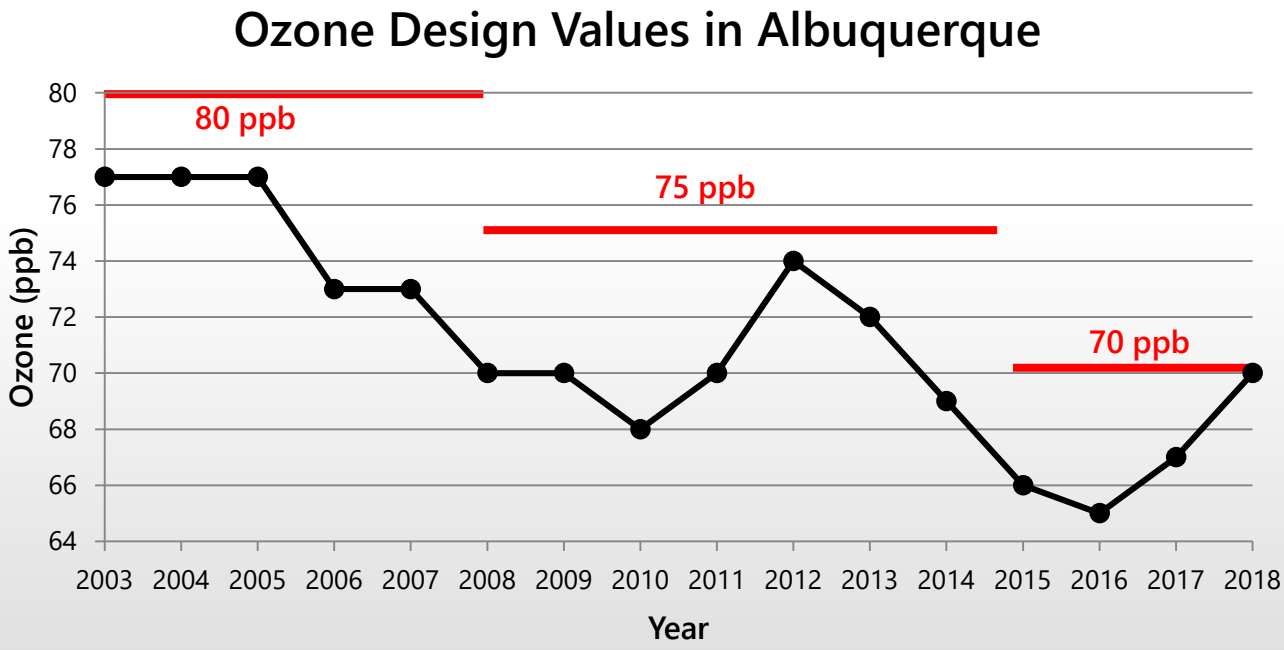


- Sunlight facilitates ozone formation.
- Warm days with a temperature-induced lid (inversion) can trap ground-level ozone and precursors.
- Winds can transport and disperse ozone and its precursors.
- Winds may vary vertically and horizontally and affect different emission sources differently.

Ozone Monitoring Sites

National Ambient Air Quality Standards (NAAQS)

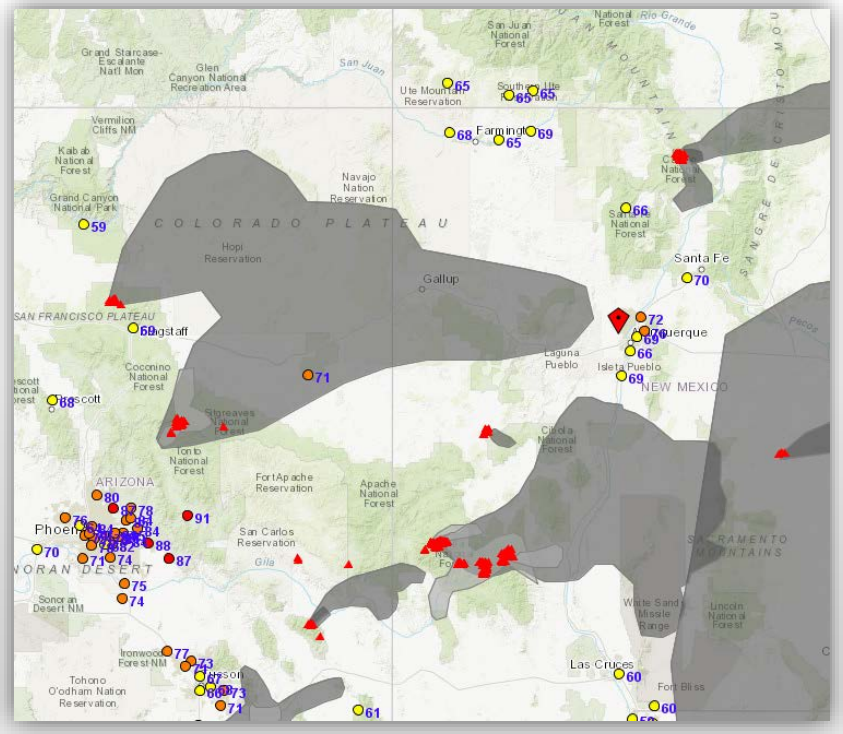
- Current 8-hr ozone NAAQS is 70 ppb
- **Design value** based on annual 4th highest maximum 8-hr concentration, averaged over three years



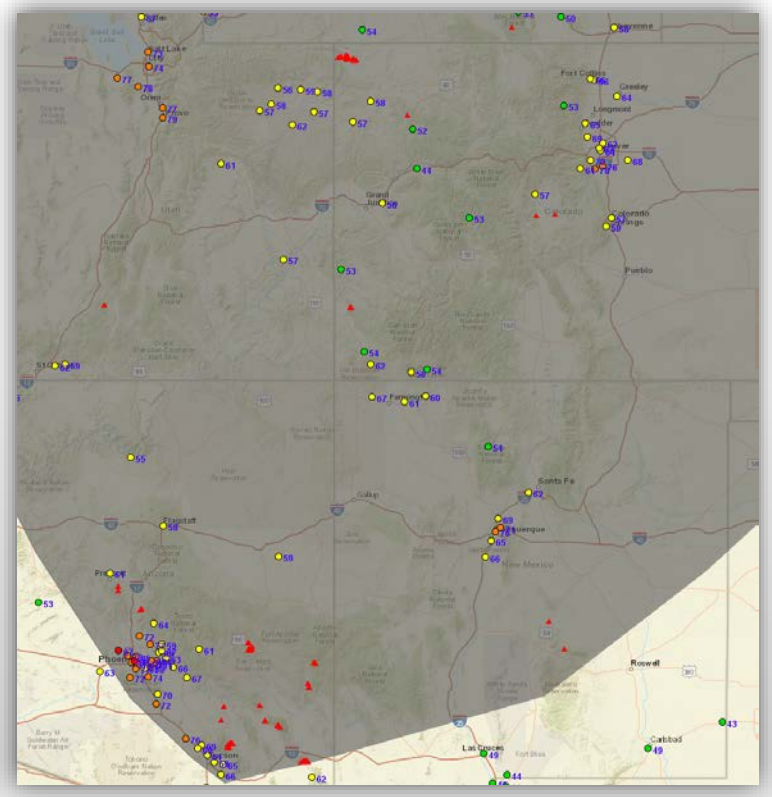
Fire Emissions and Ozone

NO_x and VOC emissions from fires can create ozone.

Smoke and ozone on June 14, 2017



Smoke and ozone on July 7, 2017



Photochemical Modeling Concepts

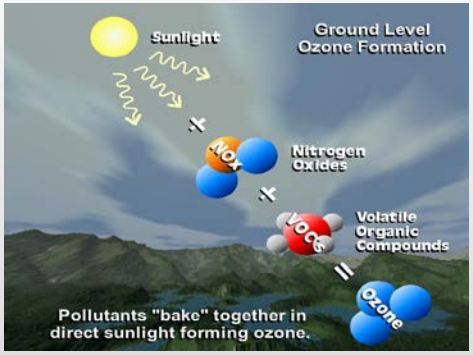
Transport - Where pollutants go

Diffusion - How pollutants are diluted

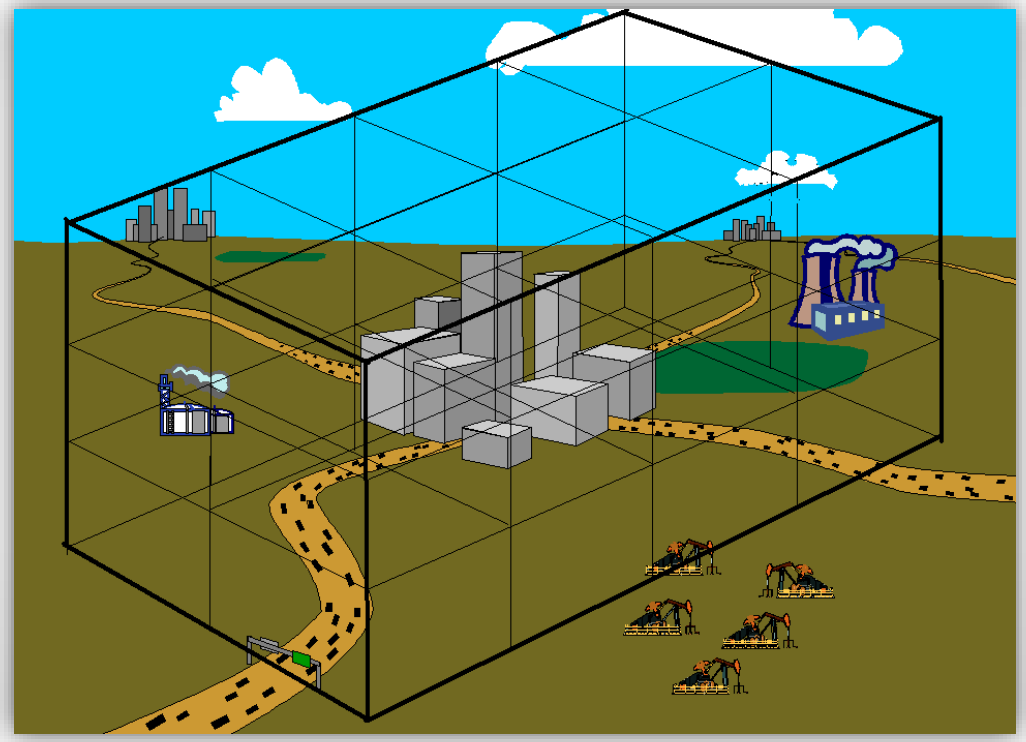
Deposition - How pollutants are removed

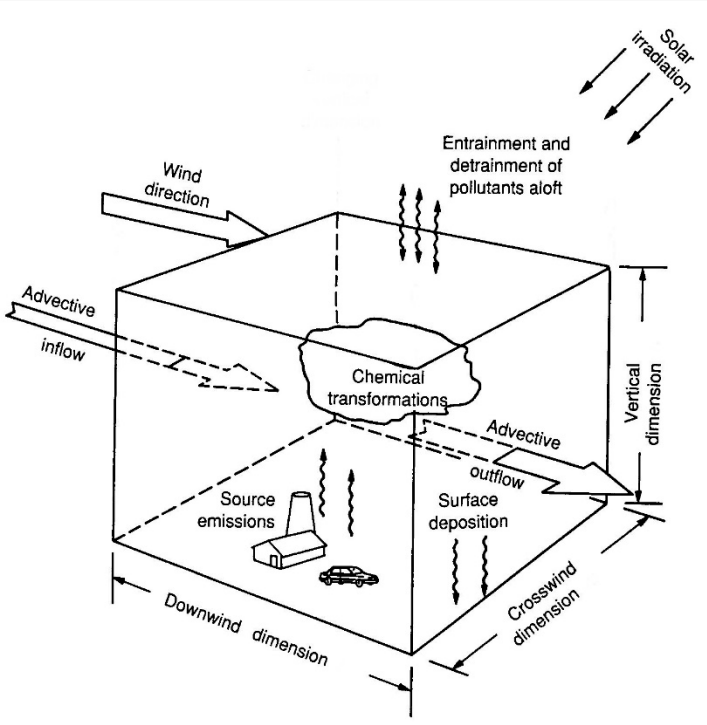
Chemistry - How pollutants are created or destroyed (nonlinear)

Critical modeling inputs include meteorology, emissions, and boundary conditions.



Air Quality Modeling Concepts





Size of boxes = "grid resolution"

Air Quality Modeling Concepts

- **Model Performance Evaluation**: A statistical and diagnostic comparison of modeled and observed concentrations.
- **Source Apportionment Modeling**: Tracks NOx and VOC emissions as they form ozone downwind.
- **Sensitivity Modeling**:
  - Alter the emissions
  - Conduct a sensitivity simulation
  - Compare results to the base case simulation

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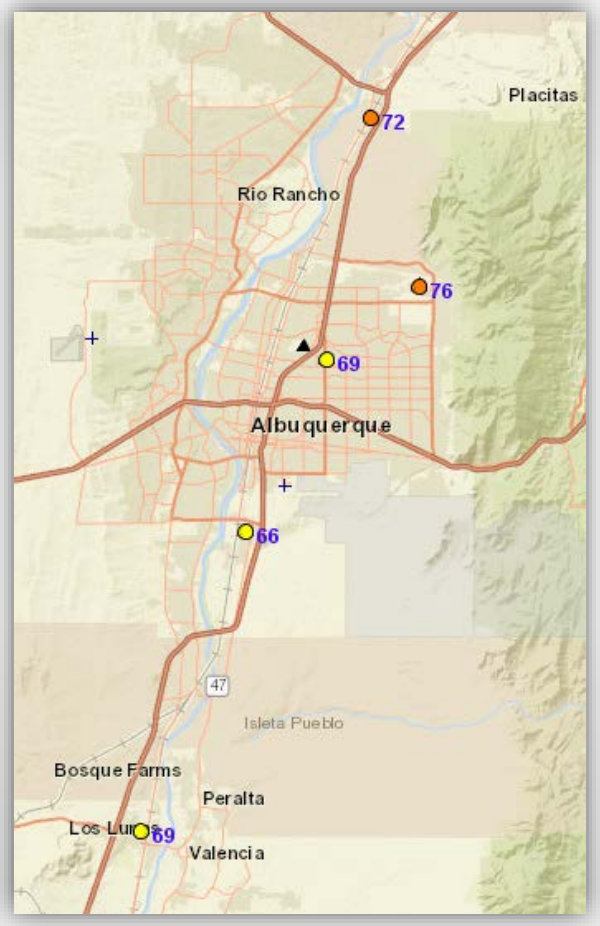
Modeling Episodes

Two Episodes
- June 12-16, 2017
- July 3-14, 2017

Ozone was Unhealthy for Sensitive Groups in Albuquerque on 4 days during these episodes.

These episodes include most of the high ozone days that occurred in 2017.



Ozone on June 14, 2017

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Meteorological Modeling

- Weather inputs were developed with the Weather Research and Forecast (WRF) numerical weather prediction model.
- Modeled winds, temperature, and humidity were evaluated against available observations.
- Model performance was good and within benchmarks established by the air quality modeling community.

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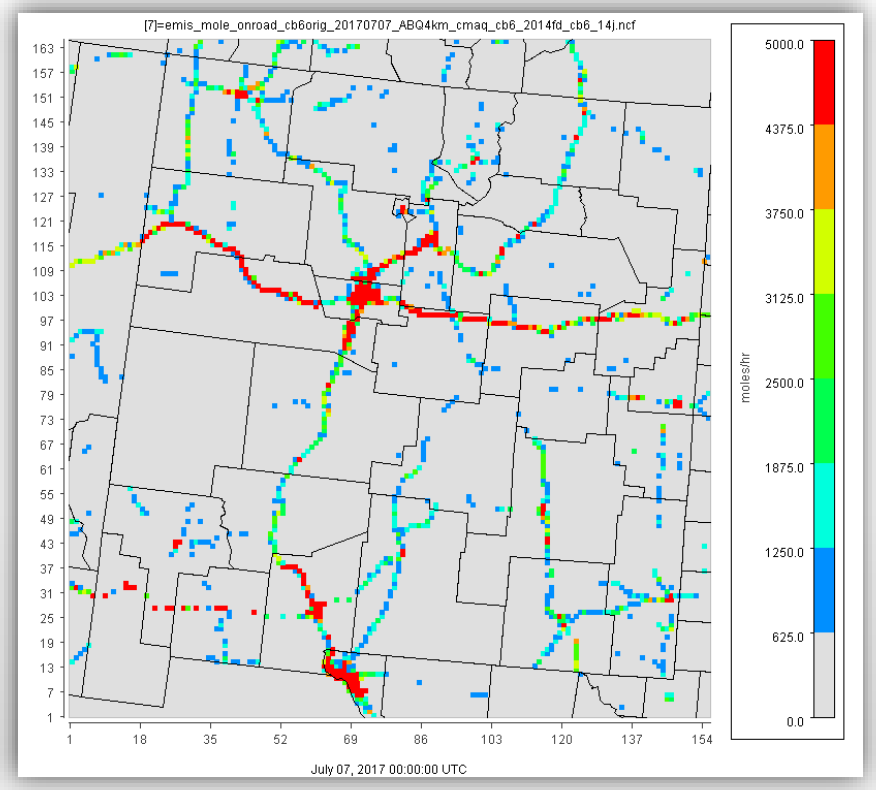
Emissions Modeling

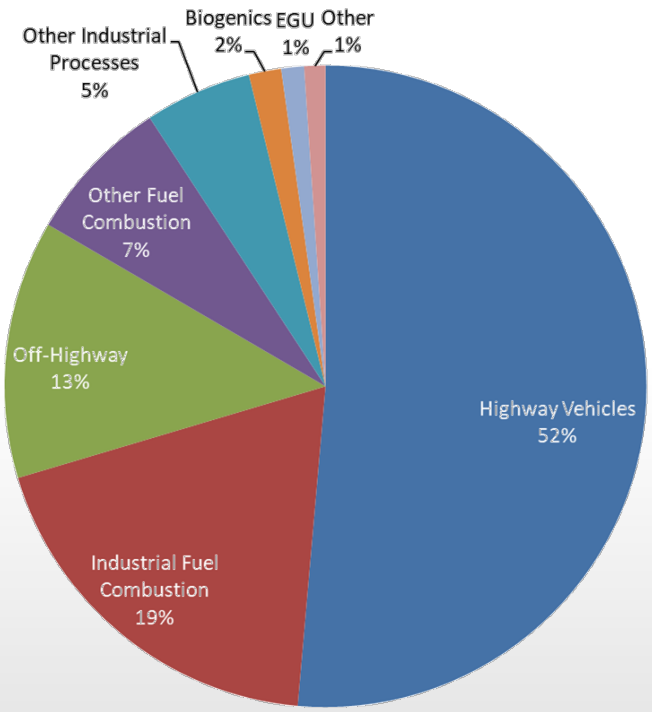
- Based on EPA's 2014 National Emissions Inventory (NEI).
- 2017 day-specific emissions for power plants and wildfires.
- Mobile sources in Bernalillo County adjusted from 2014 to 2017.



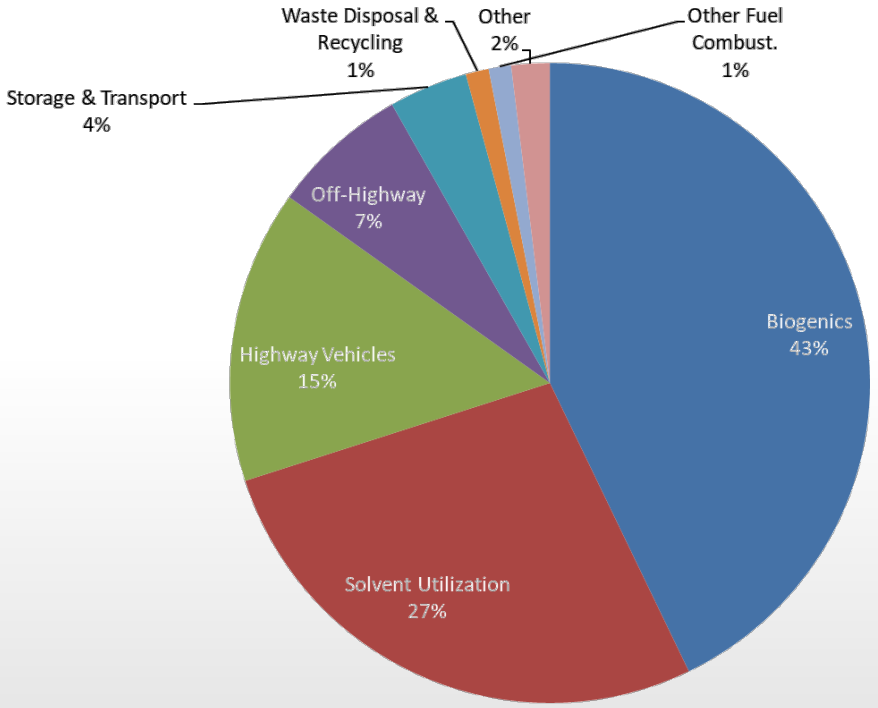
U.S. onroad mobile source NO_x emissions in the modeling domain.

Annual 2014 Emissions in Bernalillo County

NOx Emissions



VOC Emissions

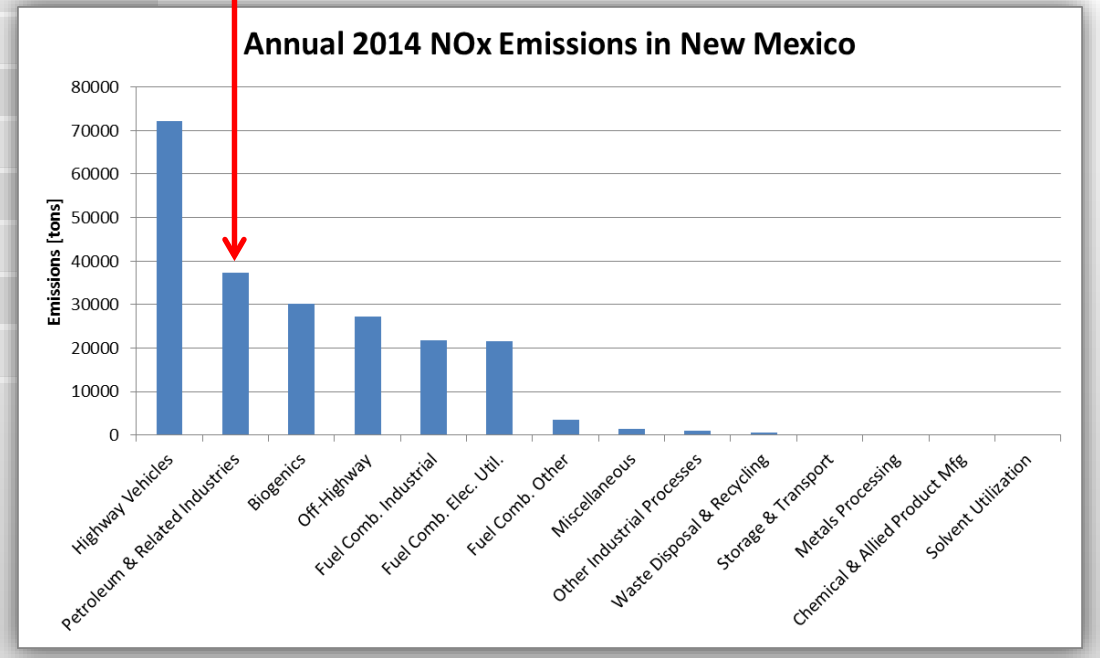


Annual 2014 New Mexico Emissions

VOC Emissions

Sector	Emissions [tons/year]
Biogenics	1,256,514
Petroleum & Related Industries	175,223
Miscellaneous	25,636
Highway Vehicles	24,625
Solvent Utilization	22,503
Off-Highway	9,526
Storage & Transport	7,465
Fuel Comb. Industrial	2,848
Fuel Comb. Other	2,108
Waste Disposal & Recycling	1,553
Fuel Comb. Elec. Util.	309
Other Industrial Processes	290
Metals Processing	1

Oil and Gas Sector



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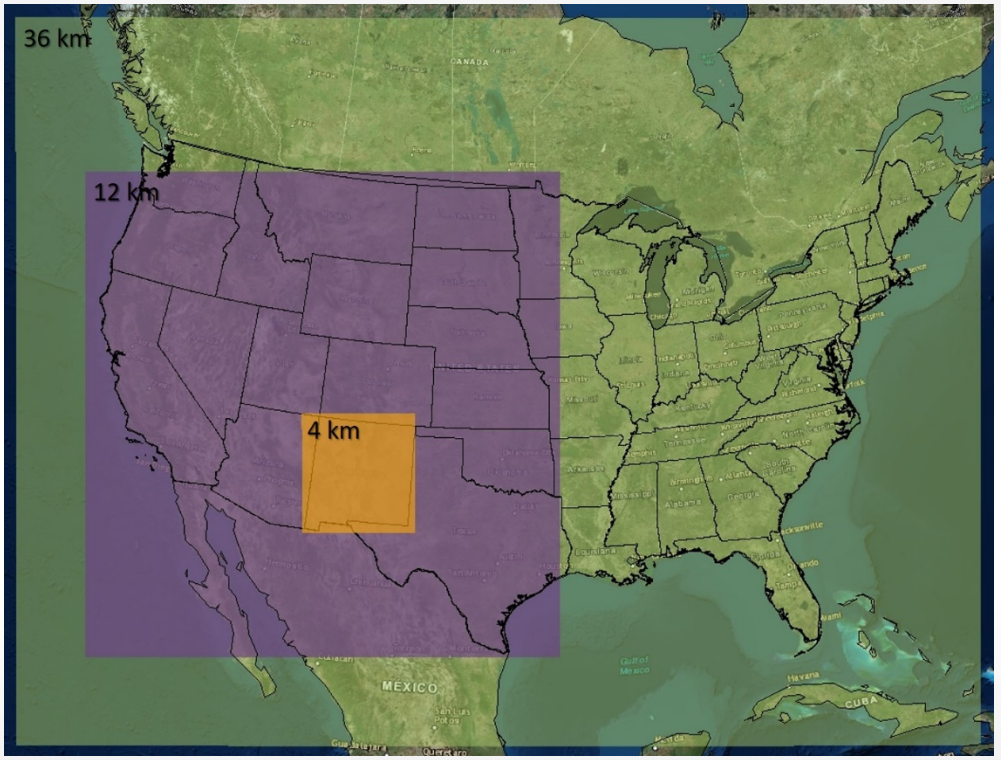
Air Quality Modeling

- Comprehensive Air Quality Model with Extensions (CAMx).
- EPA-approved, state-of-science model that simulates atmospheric transport, diffusion, deposition, and chemistry.
- Boundary conditions from "global" air quality modeling conducted by NCAR.
- Grid resolution of 4 km (about 2.5 miles) over New Mexico.

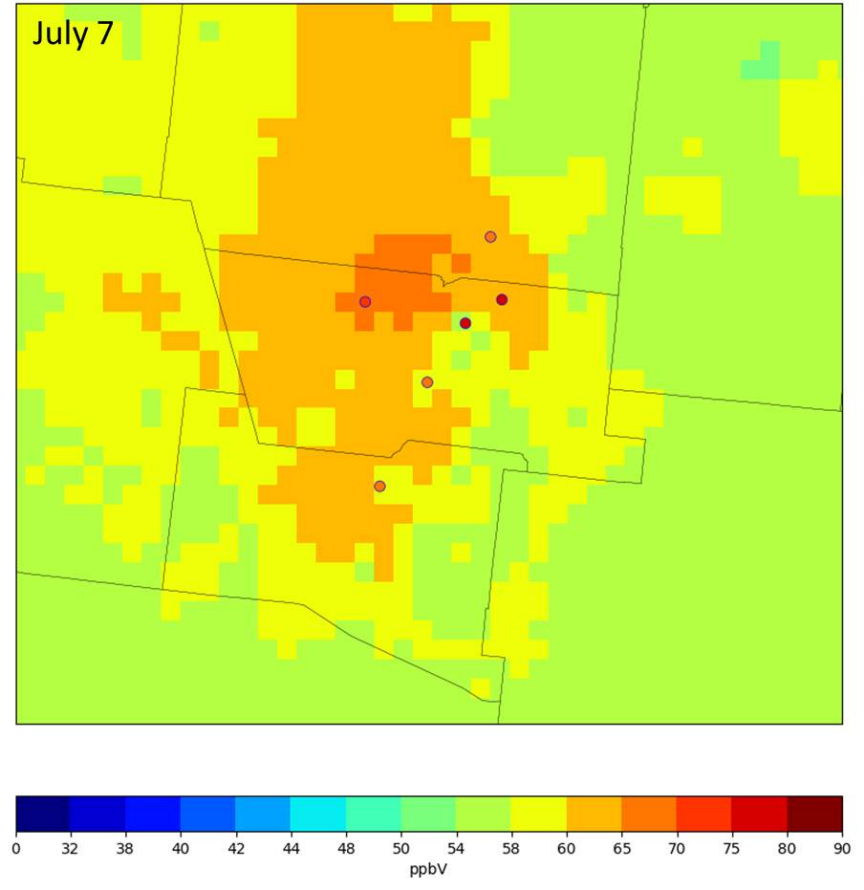


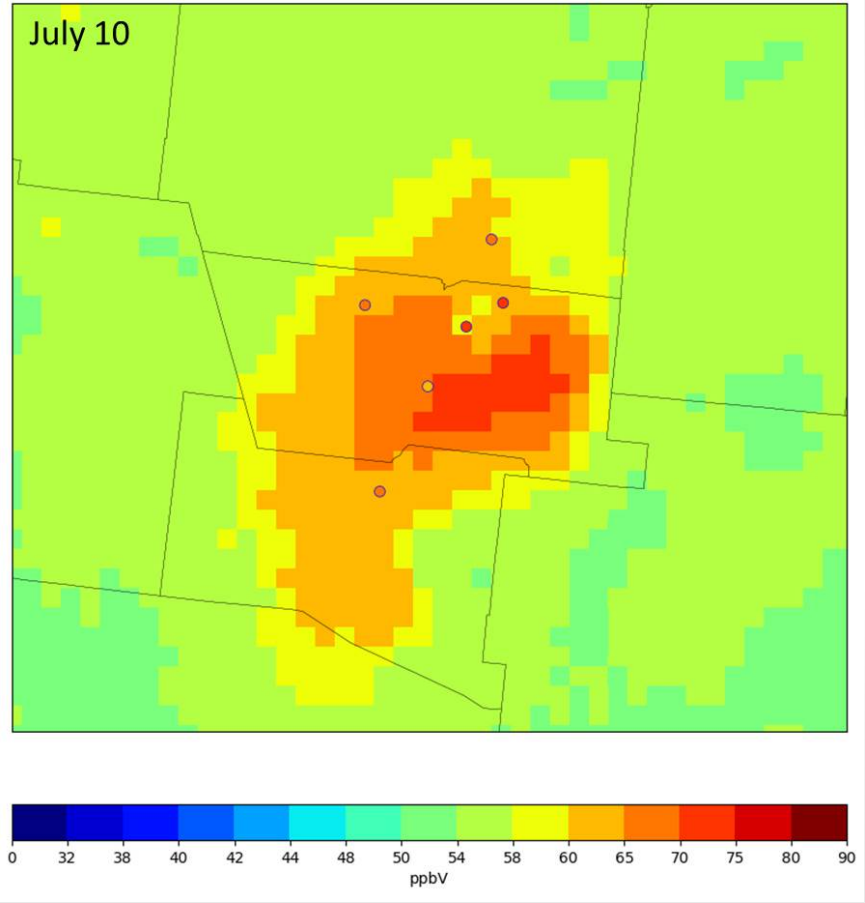
Modeling domains.

Air Quality Modeling

- The model was evaluated against available air quality observations.
- Model performance was good (especially considering the complex terrain) and within benchmarks established by the air quality modeling community.
- High ozone in afternoon with clear skies, light southerly/southwesterly winds, and warm-to-hot temperatures.

Air Quality Modeling





Modeled peak 8-hr ozone

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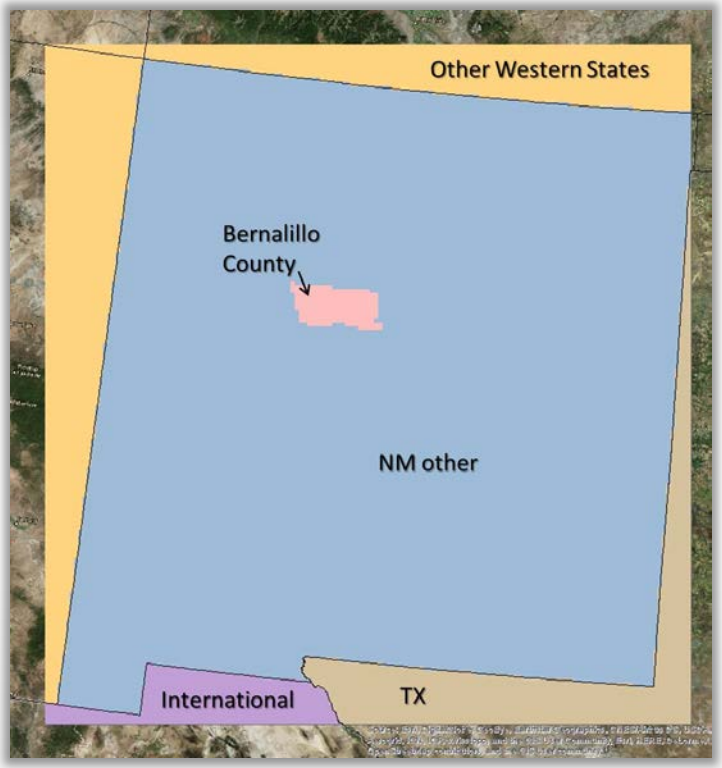
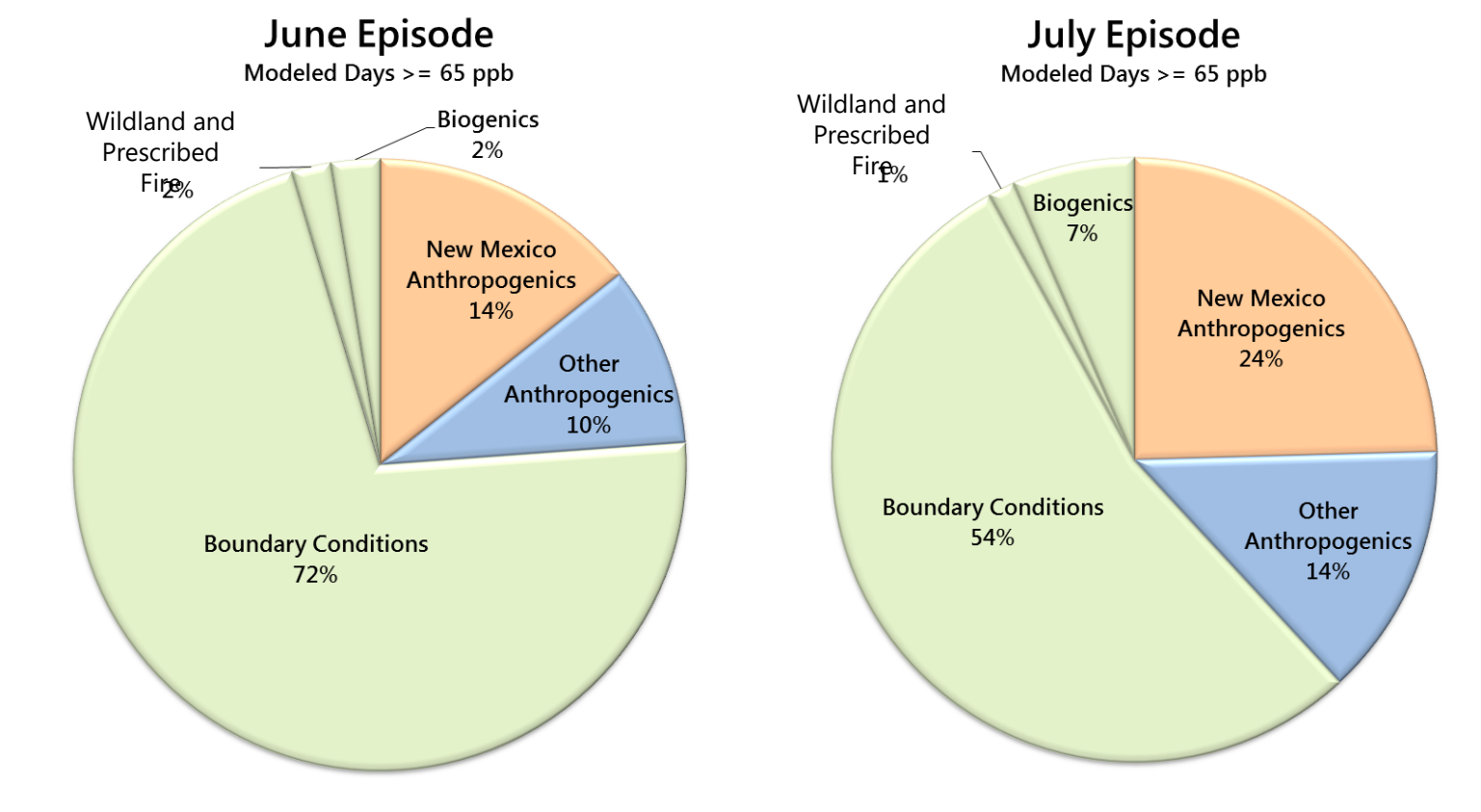
Ozone Source Apportionment



We also tracked ozone formation due to NOx and VOC emissions from specific emission sources (e.g., cars, power plants, and fires); and conducted separate sensitivity simulations to assess ozone impacts from emissions in Sandoval and Valencia counties.

Contributions to Ozone in Albuquerque



Bernalillo County accounted for up to 75% of New Mexico's anthropogenic contribution.

Contributions to Ozone in Albuquerque

- Transport from outside New Mexico is always important and accounts for over half of the ozone in Albuquerque.
- Local emissions in Albuquerque and Bernalillo County are also important. Half of the locally generated ozone is due to onroad mobile emissions.
- Local contributions were less prevalent during the June ozone episode, which was driven largely by long-range transport.

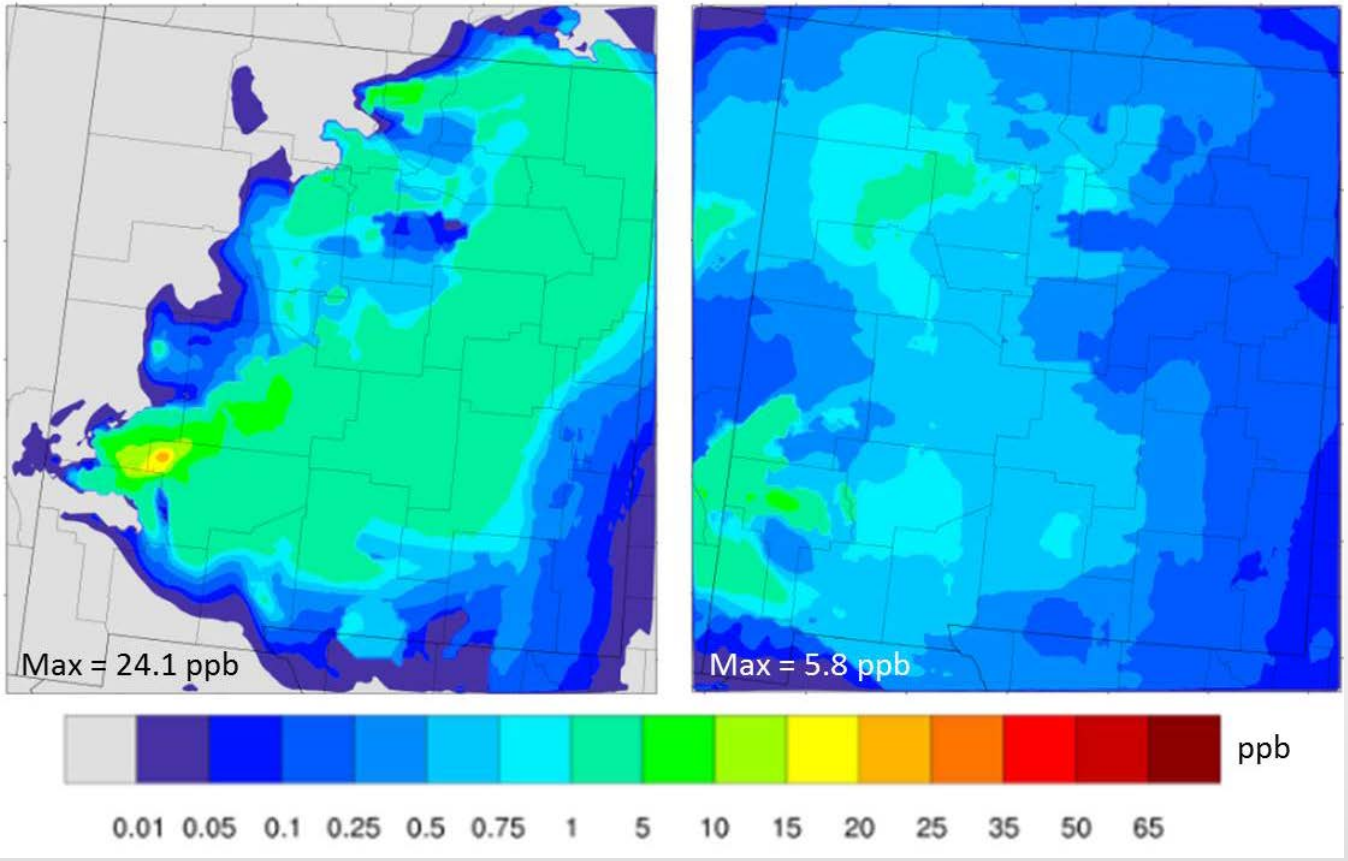
Contributions to Ozone in Albuquerque

- On high ozone days in the two modeled episodes, contributions from major power plants in northern New Mexico were small at sites in Albuquerque.
- Impacts from man-made emissions in western states, including California, are non-negligible.
- Ozone contributions from wildfire smoke were important during both episodes.
- Emissions from nonroad and non-mobile source sectors are becoming increasingly important.

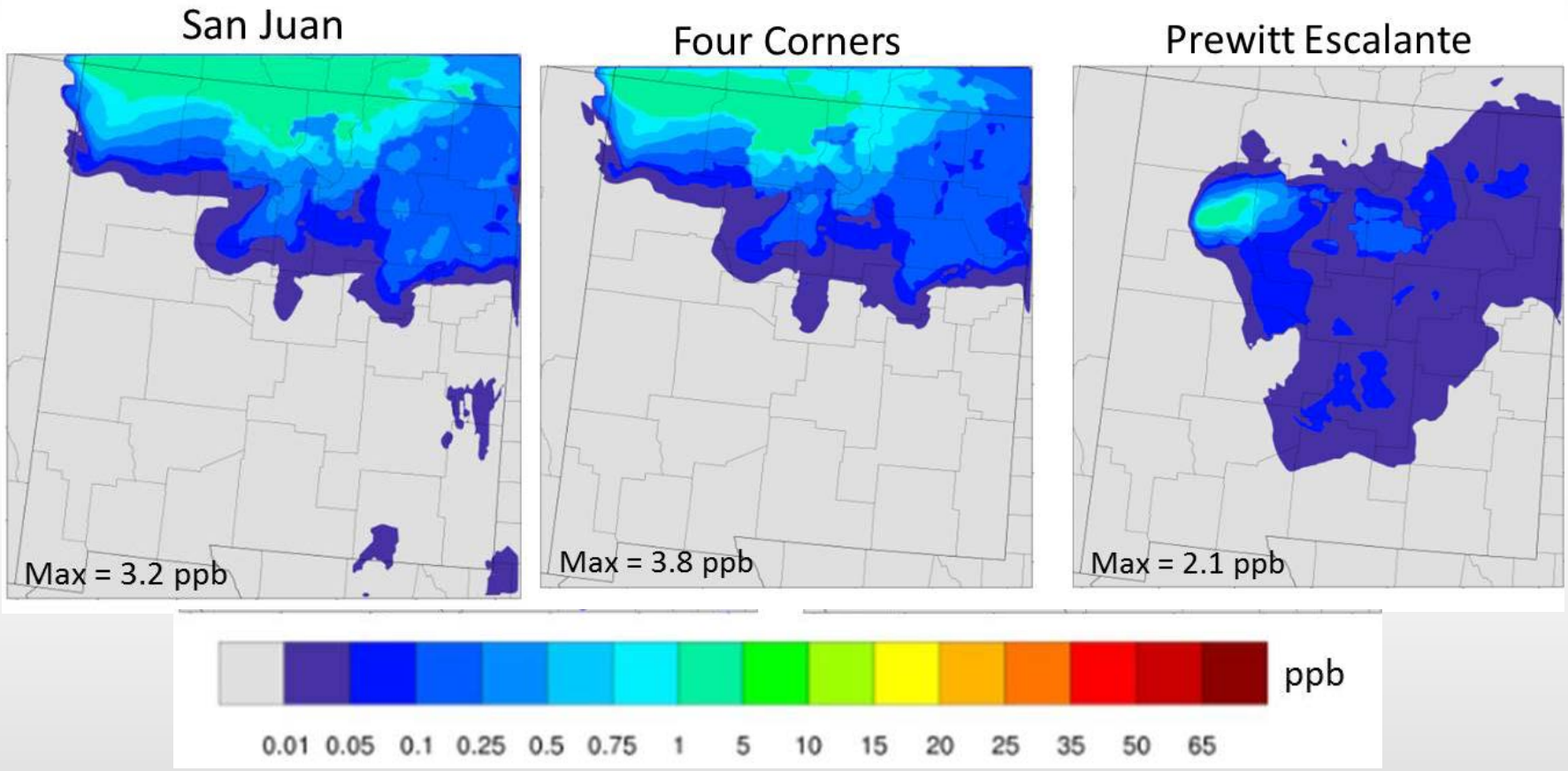
Fire Impacts on Ozone
June 15, 2017

Fires within New Mexico

Fires outside New Mexico



Ozone Impacts from Major Power Plants (June 15, 2017)



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Sensitivity Modeling Simulations

1. 10% reduction of Bernalillo County anthropogenic NO_x emissions
2. 10% reduction of Bernalillo County anthropogenic VOC emissions
3. 25% reduction of Bernalillo County onroad mobile source NO_x emissions
4. 25% reduction of New Mexico Oil and Gas emissions
5. Impact of Bernalillo County Inspection and Maintenance (I&M) Program
6. Reeves and Rio Bravo power plants running at full capacity and permitted emission levels
7. 100% reduction of Sandoval County anthropogenic emissions
8. 100% reduction of Valencia County anthropogenic emissions

Reeves and Rio Bravo Power Plants

Facility	Actual NOx	Permitted NOx
Reeves	0.5-2.0 tons/day	11.8 tons/day
Rio Bravo	0.2-0.4 tons/day	3.5 tons/day

Key Takeaways from Sensitivity Modeling

- NOx emission controls will be effective at reducing ozone in Albuquerque. VOC emission controls may not be effective unless they are substantial (>10%).
- Emissions from Valencia and Sandoval counties impact ozone in Albuquerque.
- Reeves and Rio Bravo power plants would impact ozone in Albuquerque if they operated at full capacity and with permitted emission levels.

Key Takeaways from Sensitivity Modeling

- Local emission controls will be less effective on days when ozone is driven primarily by long-range transport (e.g., June 2017 ozone episode).
- The I&M program in Bernalillo County reduces onroad NOx emissions by 5% and VOC emissions by 7% and helps to reduce ozone in Albuquerque.
- Ozone in Albuquerque is sensitive to emissions from oil and gas operations throughout New Mexico.

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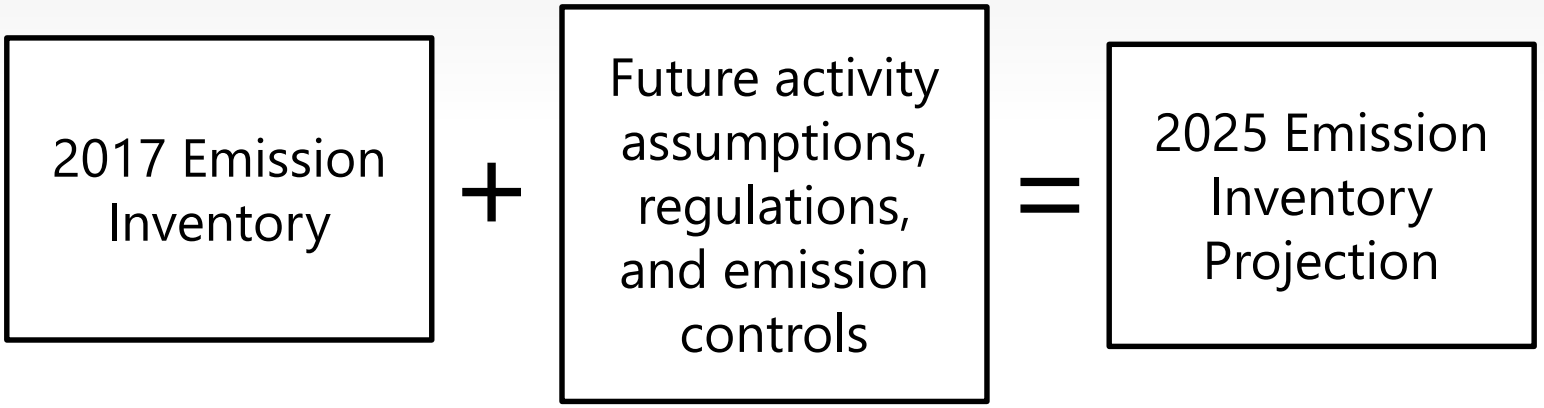
Future-Year Modeling



- Based on EPA's 2025 emission inventory projections.
- New Mexico power plant emissions based on committed shutdowns and emission controls.
- Other modeling inputs remain unchanged.

Future-Year Modeling

1. Impact of 2025 emissions on ozone in Albuquerque.
2. Reeves and Rio Bravo power plants operating at full capacity and at permitted emission levels.
3. 25% reduction of NOx and VOC emissions from Bernalillo, Sandoval, and Valencia counties.
4. Conversion of light-duty gasoline-powered vehicle fleet in Bernalillo County to electric.

Takeaways from Future-Year Modeling

- Projected emission reductions by 2025 would reduce ozone in Albuquerque by 3-7%.
- For example, a 5% reduction by 2025 could reduce the future-year ozone design value in Albuquerque by 3-4 ppb.

Takeaways from Future-Year Modeling

- Reeves and Rio Bravo power plants would also impact ozone in Albuquerque in the future if they were operated at full capacity and with permitted emission levels (up to 7%).
- A 25% reduction of NOx and VOC emissions in Bernalillo, Sandoval, and Valencia counties reduces ozone at Albuquerque sites by as much as 4%.
- Replacing the light-duty vehicle fleet by electric vehicles in Bernalillo County reduces ozone levels by about 1-3%.

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Overall Conclusions

Ozone in Albuquerque is:

- Complex (meteorology, emissions, chemistry)
- The result of local and non-local emissions
- Impacted by fire emissions
- Responsive to NOx emission controls
- Not responsive to small levels of VOC controls
- Sensitive to statewide oil and gas emissions
- Not sensitive to emissions from major power plants in northern New Mexico during the modeled episodes

Overall Conclusions

Other important takeaways:

- Local emission controls will be less effective on days when ozone is driven primarily by long-range transport (e.g., June 2017 ozone episode).
- Although I&M program impacts on modeled ozone were small in the modeled 2017 episodes, the program reduced onroad NOx emissions by 5% and reduced VOC emissions by 7% and continues to be an important way to control local emissions in Albuquerque.
- Ozone impacts at sites in Albuquerque from major power plants in northern New Mexico were small in the modeled 2017 episodes, and will likely be smaller in the future, given recent decommissionings and NOx emission controls.

Contact Us

Kenneth Craig

Manager, Atmospheric Modeling Group
kcraig@sonomatech.com

Sonoma Technology, Inc.
Innovative Environmental Solutions

707.665.9900 sonomatech.com @sonoma_tech