SNMOS Background and Objectives

• The southern Doña Ana County region has the highest ozone levels of any area in New Mexico
  – The southern Doña Ana County area is within 95% of the federal standard for ozone
  – The New Mexico Air Quality Control Act requires the New Mexico Environment Department to develop a plan for reducing ozone levels in areas that are within 95% of the ozone standard

• The first step towards developing the plan is to understand the causes of high ozone in Doña Ana County

• SNMOS objectives:
  – Study the factors contributing to high ozone in Doña Ana County
  – Investigate future emissions scenarios that will produce attainment of the ozone standard
Overview of Approach

• SNMOS builds off of the Western Air Quality Study (WAQS)
  – WAQS 2011 modeling platform: WRF/SMOKE/CAMx
  – Adjustments to the meteorology and modeling domains to optimize for southern New Mexico
• Modeling 2011 New Mexico ozone season: May 1 – August 31
• Modeling Plan
  – Prepare base year emission inventories
  – Run WRF/SMOKE/CAMx for 2011 base year
    • Evaluate 2011 base year model against observations, refine model if needed
  – Prepare future year emission inventories for 2025
  – Run SMOKE/CAMx for future year
    • Modeled Attainment Test
    • Emissions sensitivity/control runs
    • Source apportionment to diagnose causes of high ozone in Doña Ana County
  – Reporting
SNMOS Tasks

- **Completed**
  - **Task 1**: 2011 WRF 36/12/4 km with 4 km focus on Dona Ana/El Paso/Juarez and Work Plan (11/30/15)
  - **Task 2**: 2011 update Permian Basin O&G (11/30/15)
  - **Task 3**: 2011 update of Juarez and nearby Mexico EI, 2020 Mexico emissions update (11/30/15)
  - **Task 4**: SMOKE current 2011 NEI for 4 km domain (2/29/16)
  - **Task 5**: Gridded 2011 biogenic, fires, wind-blown dust, lightning emissions for 4 km domain (2/29/16)
  - **Task 6**: Develop 2011 4 km CAMx database and perform base case (2/29/16)
  - **Task 7**: 2011 MPE and sensitivity modeling for Dona Ana County (4/30/16)
  - **Task 8**: SMOKE current FY US EI and FY Mexico emissions update (4/30/16)
  - **Task 9**: FY 12/4-km CAMx simulation (5/31/16)
  - **Task 10**: FY ozone projections (MATS) (5/31/16)
  - **Task 11**: 2025 emissions sensitivity/controls (8/15/16)

- **This Deliverable Period (9/15/2016)**
  - **Task 12**: Ozone source apportionment modeling of 2011 and 2025

- **Pending**
  - **Task 13**: Air Quality Technical Support Document (AQTSD)
Task 12: Objectives and Deliverables

- **Objective**
  - Carry out SNMOS ozone source apportionment CAMx modeling of 2011 and 2025 *(Completed July 18, 2016)*

- **Deliverables**
  - PowerPoint presentation on ozone source apportionment modeling *(Completed September 8, 2016)*

- **Tasks**
  - Run CAMx 12/4 km using ozone source apportionment for 2011 and 2025
  - Use EPA’s MATS to calculate design values for both years
    - Determine the source regions and source categories that contribute to elevated ozone concentrations in Doña Ana County and vicinity
    - Obtain the contributions of Mexico emissions to 2011 ozone Design Values (DVs)
    - Calculate 2025 ozone DVs without the contributions of fire emissions
  - Prepare PowerPoint Presentation (this document)
  - Provide interactive spreadsheet source apportionment results on ozone DVs
  - Provide SA Visualization Tool for 2011 and 2025 ozone contributions to MDA8 ozone at monitors (hosted on IWDW and available through wiki)
CAMx Air Quality Modeling

• CAMx configured as in SNMOS Base11b
  – See SNMOS Task 7 MPE report
• CAMx run for April–August, 2011 and 2025
  – 2011 dates for 2025 run
• Emissions
  – Primarily from EPA NEI2011 v6.2 modeling platform 2025 projection
  – 2020 WAQS oil and gas projections
  – Biogenic, lightning, fires, and sea salt constant at 2011 levels
  – SNMOS Task 3 deliverable for Mexico future year EI details
  – SNMOS Task 8 deliverable for US future year EI details
• CAMx OSAT tool used for source apportionment modeling of 2011 and 2025
  – Presenting results from 4 km grid
MATS Configuration

• DVF calculation uses maximum concentration from a matrix of modeled grid cells surrounding a monitor
  – Current EPA guidance followed here: 3x3 matrix (9 cells)
• RRF calculation
  – Used top 10 modeled days
  – 70 ppb threshold
  – Minimum number of days at or above threshold: 1 day
• To calculate contribution of each source group
  – Ran MATS with full CAMx output
  – Subtracted ozone contribution from source group X from full model output
  – Reran MATS without contribution from X
  – Difference of two MATS runs is contribution from X to the DV
  – Slides 51 and 52 have calculation details
Source Groups

- **4 source regions**
  - (1) New Mexico; (2) Texas; (3) Mexico; and (4) Arizona with remainder of other states in the 12 km domain

- **8 emissions source categories**
  - Natural (biogenics and lighting NOx)
  - On-Road Mobile
  - Non-Road Mobile
  - Oil and Gas (point and non-point)
  - Electrical Generating Unit (EGU) Point
  - Non-EGU Point
  - Open Land Fires (wildfire, prescribed, and agricultural burning)
  - Remainder Anthropogenic (mainly area)

- **Initial and boundary conditions**

- **34 total Source Groups** \(34 = 4 \times 8 + 2\)
Boundary Conditions (BCs)

- BCs represent transport from outside of the 12/4 km SNMOS domain:
  - Transport from sources in remainder of U.S.
  - International transport
  - Natural global ozone background including stratospheric intrusions

- Includes more than just U.S. background (USB) or North American background (NAB)
Natural Emissions: Biogenic Isoprene

Emissions: 4 km Grid

MEGAN v2.10 Episode Average Isoprene
Emissions on 4 km Grid

Google Earth Imagery
Of 4 km Domain Region

- Large contribution from Mexico natural emissions
- Discontinuity at US-Mexico border (white arrow) suggests uncertainty in biogenic emission inventory
Natural Emissions: Lightning NOx
July 27-28, 2011

• LNOx emissions are uncertain and may affect the contribution from Mexico natural emissions
SNMOS 2025 Emissions Modeling

- **Dona Ana**
  - Decreases in onroad and offroad mobile NOx emissions
- **Mexico**
  - Decreases in onroad mobile NOx
  - Increases in EGU and non-EGU point NOx emissions
- **West Texas**
  - Decreases in onroad and offroad mobile
  - Increases in O&G

Percent Difference ([2025-2011]/2011)

**New Mexico**

**West Texas**

**Mexico**

Southern New Mexico Ozone Modeling Study
SNMOS 2025 Emissions Modeling

New Mexico 2011 and 2025 NOx Emissions Differences

Absolute Difference (2025-2011)

2025-2011 NOx Emissions

Southern New Mexico Ozone Modeling Study
Which Source Groups Contribute to Doña Ana County Ozone?

• How important is transport in determining ozone at Doña Ana monitors?
  – Boundary conditions, transport within 12/4 km domain

• What emissions source categories contribute at Doña Ana monitors?
  – Top contributing source groups at each monitor
  – Contribution of New Mexico anthropogenic emissions
  – Evaluate consistency of OSAT results with UNC 2011/2025 emissions plots

• Detailed results for Desert View and Santa Teresa monitors
  – Results for other monitors follow End slide
Role of Transport

Ozone DV at Desert View Monitor

- 12 km BC contribution to DVs is far larger than those of regions within the 12 km domain
- BCs contain effect of:
  - Sources within the US (e.g. Los Angeles and Phoenix)
  - Sources outside the US (Asia, regions of Mexico outside the 12/4 km grid)
  - Stratosphere contribution
- Similar results for other Doña Ana monitors
Desert View

DVC: 71.0 ppb  DVF: 65.1 ppb

- NM contribution smaller than Texas and Mexico contributions
- Reduction in 2025 DV driven by decrease in BCs and in contributions from New Mexico, Texas and Other 12 km
- Contribution from Mexico increases slightly
Desert View

DVC: 71.0 ppb  DVF: 65.1 ppb

- Reductions in Texas, New Mexico and Mexico on-road contributions are responsible for much of ozone decrease in Desert View DV in 2025
- Largest 2011 contributions to Desert View DV are from Texas and Mexico on-road and Mexico EGU and natural emissions
- Largest 2025 contributions are from Mexico EGU and non-EGU point sources and on-road emissions from Texas and Mexico
Santa Teresa

DVC: 70.3 ppb  DVF: 63.8 ppb

- Reduction in DV driven by reductions in BCs and contributions from Texas and New Mexico
- Contribution from Other 12 km declines
- Slight decrease in Mexico contribution
Santa Teresa

DVC: 70.3 ppb  DVF: 63.8 ppb

- Large reduction in onroad mobile contribution in 2025
- Increases in Mexico EGU and Texas oil and gas contributions in 2025
- Largest 2011 contributions from Texas, New Mexico and Mexico on-road emissions and Mexico EGUs
Most Frequent Top 5 Contributors to the DVs of the 6 Doña Ana Monitors

- On-road, natural (Mexico) and EGU emissions appear most frequently in the list of top 5 contributors to Doña Ana County monitor DVs
  - All 6 Doña Ana County monitors have TX on-road mobile sources in top 5 in 2011
- Mexico is the most frequently appearing source region
Monitors in the 4 km Domain

Southern New Mexico Ozone Modeling Study
Contribution of Anthropogenic Emissions from Mexico to DVs for Monitors in 4 km Grid

- Contributions to DV from Mexico anthropogenic emissions range from ~2-6 ppb at Doña Ana monitors and are similar in 2011 and 2025
- Monitors in NM near US-Mexico border and El Paso monitors have larger contributions from Mexico anthropogenic emissions
Contribution of Onroad Mobile Emissions to DVs for Monitors in 4 km Grid

- Large 2011 contributions from on-road emissions to DVs at Doña Ana and El Paso monitors
- Large decreases in onroad mobile contribution in 2025 for all sites
Contribution of NM Anthropogenic Emissions to 4 km Grid NM Monitor DVs

- Onroad mobile emissions make largest NM anthropogenic contribution to DV at most NM monitors
  - Solano monitor has largest contribution from onroad mobile
  - Decreases in 2025
- Nonroad and O&G make next largest contributions, followed by EGU points
- Oil and gas dominates at Carlsbad
  - Influence of Permian Basin
  - Impact increases in 2025 consistent with projected growth in emissions
Which Source Groups Contribute to Doña Ana County Ozone?

• Boundary conditions are by far the largest contributor
  – Typical result for a regional modeling grid

• NM contribution smaller than either TX and MEX contribution to DVs for all Doña Ana monitors except Solano
  – Solano has a large onroad mobile contribution

• In 2011, emissions source categories contributing most to DVs were onroad mobile (TX, NM, MEX), natural emissions (MEX) and EGUs (MEX)
  – Onroad mobile contribution is smaller in 2025
Contribution of Emissions from Mexico to Doña Ana County Ozone

• Assess contribution of Mexico emissions to DVs at Dona Ana monitors in 2011 and 2025
  – Compare with results of Task 11 Sensitivity Testing

• Section 179B “But for” test
Ozone Contribution to 2011 DVs from Mexico Anthropogenic Emissions

<table>
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<tr>
<th>Site ID</th>
<th>Observed 2011 DVC</th>
<th>CAMx Source Apportionment 2011 DV NoMexAnthro</th>
<th>Mexico Anthro Contribution</th>
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- But for the contribution of emissions from Mexico, the Desert View monitor would have attained the 70 ppb NAAQS in 2011
- Monitors closer to US-Mexico border have larger Mexico contribution (e.g. El Paso monitors)
Comparison of Sensitivity Test and Source Apportionment Results

Contribution of Mexico Emissions to 2011 DVs for Doña Ana County Monitors (4 km Grid Results)

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<th>Average (ppb)</th>
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- Results are comparable in magnitude and are consistent in showing that Mexico emissions had a significant impact on Doña Ana County DV in 2011
- Source apportionment results show similar maximum and average impacts than sensitivity test and lower minimum impact
Contribution of Emissions from Mexico to Doña Ana County Ozone: Summary

• But for the contribution of emissions from Mexico, the Desert View monitor would have attained the 70 ppb NAAQS in 2011
  – Also true for UTEP monitor in El Paso
• Mexico SA contribution to Doña Ana monitor 2011 DVs ranges from 2.5 – 6.3 ppb with average of 4.9 ppb
• Monitors closer to US-Mexico border have larger Mexico contribution (e.g. El Paso monitors)
• Results of sensitivity test (Task 11) and source apportionment modeling (Task 12) are consistent
Contribution of Fire Emissions to Doña Ana County Ozone

- CAMx modeling of 2011 showed large impacts from fire emissions
  - Active fire season during 2011 with large fires within 12 km domain
- Treated fires separately from the rest of the natural emission inventory so their impacts could be tracked
- Used source apportionment to quantify effect of fire emissions on Doña Ana DVs
Fire Ozone Impact Example

• Wallow Fire plume has modeled 1-hour ozone values > 160 ppb
• Model overestimates ground level ozone impacts
Impact of Fire Emissions on 4 km Grid Monitor DV Results: 2025

- Impact of fire emissions on 4 km grid monitor 2025 DVFs is small (< |0.5| ppb)
  - Used MATS Unmonitored Area Analysis (UAA) to view results across modeling domain

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<th>Site ID</th>
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Impact of Fire Emissions on DV Results: 2011 Unmonitored Area Analysis

2011 DVs With Fires

2011 DVs Without Fires
Impact of Fire Emissions on DV Results: 2011 Unmonitored Area Analysis

- Impact of fire emissions is $\leq |0.5|$ ppb at Doña Ana County monitors
  - Does not affect 2011 DV results
- Larger fire impacts on DVs (> 5 ppb) occur elsewhere in 4 km domain downwind of 2011 fires
Impact of Fire Emissions on DV Results: 2025 Unmonitored Area Analysis

2025 DVs With Fires

2025 DVs Without Fires
Impact of Fire Emissions on DV Results: 2025 Unmonitored Area Analysis

- Impact of fire emissions is $\leq 0.5$ ppb at Doña Ana County monitors – Does not affect 2025 DVF results
- Larger fire impacts on DVs (> 5 ppb) occur elsewhere in 4 km domain downwind of 2011 fires
Contribution of Fire Emissions to Doña Ana County Ozone: Summary

• Fire emissions affected 2011 and 2025 DVs at grid cells within the 4 km domain
  – UAA shows DV impacts > 5 ppb downwind of the fire locations

• Fire emissions had a small (≤ |0.5| ppb) effect on 2011 and 2025 DVs at Doña Ana County monitors
  – Impacts too small to affect attainment status results for 2011 and 2025
  – Small impacts due to location of monitors relative to 2011 fires
SA Vis Tools Overview

- Modeling results loaded into a web-based Source Apportionment Visualization Tool
- Displays base (2011) and future (2025) year MDA8 SA results
  - By monitor, by date
  - Information on model performance
- Documentation in SNMOS wiki on IWDW website
SA Vis Tools: Results by Region

• Results for Sunland Park monitor, 2011
SA Vis Tools: Source Breakdown by Region

Source Breakdown by Region: All
- NAT: 3.6%
- FIRE: 0.1%
- MV: 6.7%
- NR: 2.8%
- OQ: 0.3%
- EGU: 0.9%
- NEGU: 2.5%
- QANT: 0.4%

Note that the percentages are the % of Total ozone and NOT the % non-BC represented by the pie chart.
SA Vis Tools: Results by Emissions Sector

Note that the percentages are the % of Total ozone and NOT the % non-BC represented by the pie chart.
SA Vis Tools: Regional Breakdown by Emissions Source

Hover and click to view or switch to study day

10 Days

Regional Breakdown by Source:
Electrical Generating Unit (EGU) Point (EGU)

- Mexico - 0.8%
- New Mexico - 0.0%
- Other 12 km - 0.1%
- Texas - 0.1%

Note that the percentages are the % of Total ozone and NOT the % non-BC represented by the pie chart.
Access SNMOS Ozone SA Vis Tool wiki through IWDW Website (in development)

- http://views.cira.colostate.edu/tsdw/

The IWDW has been fully supported by multiple federal and state agencies, with assistance from WESTAR-WRAP, since its creation through the 3SAQS Pilot Study. The IWDW provides air quality data, photochemical grid modeling products, and analysis tools to support various air quality applications. Available datasets include emissions inventories, meteorological data, air quality modeling platforms, and monitoring data.
Task 12 Summary

- Transported ozone contributes far more to Doña Ana monitor DVs than New Mexico emissions in 2011 and 2025
  - Boundary conditions are the largest contributor, then Mexico and Texas
  - Mexico contribution to Doña Ana monitor 2011 DVs ranges from 2.5 – 6.3 ppb with average of 4.9 ppb

- **OSAT results indicate but for the contribution of anthropogenic emissions from Mexico, the Desert View monitor would have attained the 70 ppb NAAQS in 2011**

- In 2011 and 2025, emissions source categories contributing most to Doña Ana monitor DVs were onroad mobile (TX, NM, MEX), natural emissions (MEX) and EGUs (MEX)
  - Onroad mobile contribution is much (~50%) lower in 2025

- Of all New Mexico anthropogenic emissions sources, onroad mobile emissions make largest contribution to DVs at all Doña Ana monitors
  - Decreases in 2025
  - Nonroad and O&G make next largest contributions, followed by EGU points

- Impact of fire emissions on Doña Ana DV analysis is small
Task 13: Air Quality Technical Support Document

• Prepare Air Quality Technical Support Document (TSD)
  – TSD will summarize methods and finding of all tasks of the SNMOS

• Steps
  – Prepare draft TSD documenting Tasks 1-12
  – Submit draft TSD for review
  – Update draft TSD to reflect comments received and prepare a Response to Comments (RtC) document.
  – Submit final TSD
Air Quality Technical Support Document Outline

I. Executive Summary

II. Introduction

III. SNMOS Task Summaries
   A. Task 1-13
      1. Task Summary
      2. Significant Findings
      3. Milestones and Deliverables

IV. References
Task 13: Air Quality Technical Support Document

- **Current (September 8, 2016) Status:**
  - All project technical work has been completed
  - Currently writing technical support document:
    - Outline completed
  - **Deliverables:**
    - **Sep 30** Draft Technical Support Document (TSD)
    - **Oct 14** Comments from NMED
    - **Oct 28** Final TSD
      - Response to Comments (RtC) document for NMED
      - Modeling data, RtC document, and final TSD also posted on WAQS data warehouse.
### Next Steps

**Tasks to be Completed by November 18, 2016**

- **Task 1**: 2011 WRF 36/12/4 km with 4 km focus on Dona Ana/El Paso/Juarez and Work Plan (Completed)
- **Task 2**: 2011 update Permian Basin O&G (Completed)
- **Task 3**: 2011 update of Juarez and nearby Mexico EI, 2020 Mexico emissions update (Completed)
- **Task 4**: SMOKE current 2011 NEI for 4 km domain (2/29/16)
- **Task 5**: Gridded 2011 biogenic, fires, wind-blown dust, lightning emissions for 4 km domain (2/29/16)
- **Task 6**: Develop 2011 4 km CAMx database and perform base case (2/29/16)
- **Task 7**: 2011 MPE and sensitivity modeling for Dona Ana County (4/30/16)
- **Task 8**: SMOKE current FY US EI and FY Mexico emissions update (4/30/16)
- **Task 9**: FY 4 km CAMx simulation (5/31/16)
- **Task 10**: FY ozone projections (MATS) (5/31/16)
- **Task 11**: FY emissions sensitivity/controls (8/11/16)
- **Task 12**: FY 4 km source apportionment run (9/15/16)
- **Task 13**: Air Quality Technical Support Document (10/28/16)
End—Questions?
Biogenic Emissions: 12 km Grid

MEGAN v2.10 Episode Average Isoprene Emissions on 12 km Grid

Apr 15 - Sep 1 Period Average
Min(1,1) = 0.000, Max(99.18) = 6.001

kg/hr/km2

MEGAN v2.10 Episode Average Monoterpene Emissions on 12 km Grid

Apr 15 - Sep 1 Period Average
Min(1,1) = 0.000, Max(84.4) = 0.406

kg/hr/km2
Sunland Park

DVC: 66.7 ppb  DVF: 61.3 ppb

- Reduction in DV driven by reductions in BCs and contributions from Texas and New Mexico
- Contribution from Other 12 km declines
- Slight decrease in Mexico contribution
Sunland Park

DVC: 66.7 ppb  DVF: 61.3 ppb

- Largest 2011 contributions from Texas and Mexico on-road emissions
- Increase in Mexico EGU contribution in 2025
Solano

DVC: 64.3 ppb  DVF: 58.7 ppb

- Reduction in DV driven by reductions in BCs and contributions from Texas and New Mexico
- Contribution from Other 12 km declines
- Slight decrease in Mexico contribution
Solano

DVC: 64.3 ppb  DVF: 58.7 ppb

- Largest 2011 contributions from Texas and Mexico on-road emissions
- Increase in Mexico EGU contribution in 2025
La Union

DVC: 64.7 ppb  DVF: 58.3 ppb

- Reduction in DV driven by reductions in BCs and contributions from Texas and New Mexico
- Contribution from Other 12 km declines
- Slight decrease in Mexico contribution
La Union

DVC: 64.7 ppb  DVF: 58.3 ppb

- Largest 2011 contributions from Texas and Mexico on-road emissions
- Increase in Mexico EGU contribution in 2025
Chaparral

DVC: 67.7 ppb  DVF: 60.8 ppb

- Reduction in DV driven by reductions in BCs and contributions from Texas and New Mexico
- Contribution from Other 12 km declines
- Slight decrease in Mexico contribution
Chaparral

DVC: 67.7 ppb  DVF: 60.8 ppb

• Largest 2011 contributions from Texas and Mexico on-road emissions
• Increase in Mexico EGU contribution in 2025
Top 5 Contributors to 4 km Grid Non-Doña Ana New Mexico Monitor DVs

- Largest 2011 contributions from Texas and Mexico on-road emissions
- Increase in Mexico EGU contribution in 2025
Ozone Contribution Calculations: 2025

Standard DVF calculation for 2025 uses full CAMx model outputs CAMx_total_{2025}

\[ DVF_{2025} = \frac{CAMx_total_{2025}}{CAMx_total_{2011}} \times DVC_{2011} \]

Incremental contribution to the 2025 DVF from the i^{th} source group is

\[ DVF_{2025}^i = \frac{CAMx_total_{2025} - SrcGrpContri_{2025}^i}{CAMx_total_{2011}} \times DVC_{2011} \]

Contribution to 2025 DVF from source group i is

\[ \Delta DVF_{2025}^i = DVF_{2025} - DVF_{2025}^i \]
Ozone Contribution Calculations: 2011

Incremental contribution to the 2011 DVF from the \( i \)th source group is

\[
DVF_{2011}^i = \frac{CAMx_{\text{total}}_{2011} - SrcGrpContribution_{2011}^i}{CAMx_{\text{total}}_{2011}} \times DVC_{2011}
\]

Contribution to 2011 DVC from source group \( i \) is

\[
\Delta DVC_{2011}^i = DVC_{2011} - DVF_{2011}^i
\]