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2026 Ozone Source Apportionment Modeling for the Permian Basin using the 2022v1 Modeling Platform

2022v1 Model Evaluation and 2026v1 Source Apportionment Results – Draft



Contents

1.0 INTRODUCTION	1
1.1 Ozone Concentrations in the Permian Basin	1
1.2 Purpose	2
1.3 Conceptual Model of Ozone Formation in New Mexico	2
1.4 Overview of Approach	3
1.4.1 EMP 2022v1 Modeling Platform	3
1.4.2 Episode Selection	6
1.4.3 2022 Base Case Modeling and Model Performance Evaluation	9
1.4.4 2026 Ozone Source Apportionment Modeling	9
2.0 2022 BASE CASE MODELING AND MODEL PERFORMANCE EVALUATION	10
2.1 CAMx 2022v1 12 km Base Case Simulation	10
2.2 CAMx 2022v1 12 km Model Performance Evaluation Approach	10
2.2.1 Ozone Model Performance Goals and Criteria	10
2.3 Ozone Monitoring Sites Within and Near New Mexico	11
2.4 Ozone Model Performance Across the New Mexico Analysis Domain	13
2.5 Ozone Model Performance in the Permian Basin	18
2.6 Ozone Model Performance in Southern New Mexico	24
2.7 Ozone Model Performance in El Paso, Texas	30
2.8 Ozone Model Performance in Central New Mexico	34
2.9 Ozone Model Performance in the South San Juan Basin in Northwest New Mexico	39
2.10 NO _x Model Performance	44
2.11 Evaluation for Days Use in Making Future Year Ozone Design Value Projections	52
2.11.1 Highest Modeled MDA8 Ozone Performance at Permian Basin Sites	52
2.11.1 Highest Modeled MDA8 Ozone Performance at Southern New Mexico Sites	55
3.0 2026 Ozone Design Value Projections using the 2022 EMP CAMx 12 km Modeling Platform	58
3.1 2026 Ozone DVF Projections at Monitoring Sites	58
3.2 2026 Ozone DVF Projections Across New Mexico	60
3.3 2026 Ozone Projection Conclusions	64
4.0 2026 OZONE SOURCE APPORTIONMENT MODELING APPROACH	65
4.1.1 Definition of Source Regions	65
4.1.2 Definitions of Source Categories	66
4.1.3 Definition of Source Groups	66
4.2 CAMx 2026 VOC/NO _x Emission Sensitivity Modeling	67
5.0 CONTRIBUTIONS TO PROJECTED 2026 OZONE DESIGN VALUES ACROSS NEW MEXICO	68
5.1 Contributions of Total New Mexico Emissions to 2026 Ozone DVFs	68
5.2 Contributions of Permian Basin Oil and Gas Emissions to 2026 Ozone DVFs	71

5.3	Anthropogenic Emissions Contributions to 2026 Ozone DVF	74
5.4	Effects of No New Mexico Permian Basin O&G Emissions on 2026 Ozone DVF....	75
5.5	Effects of No Mexico Anthropogenic Emissions on 2026 Ozone DVF.....	77
6.0	CONTRIBUTIONS TO 2026 MDA8 OZONE CONCENTRATIONS AT MONITORING SITES	79
6.1	2026 Ozone Contributions at the Carlsbad City Site in Eddy County	79
6.2	2026 Ozone Contributions at the Hobbs Monitor in Lea County.....	84
6.3	2026 Ozone Contributions at the Desert View Monitor in Dona Ana County	86
6.4	2026 Ozone Contributions at the Foot Hills Monitor in Bernalillo County	89
6.5	2026 Ozone Contributions at the Navajo Lake Monitor in San Juan County	89
6.6	Conclusions 2026 Ozone Source Apportionment at New Mexico Monitoring Sites.....	92
7.0	ANALYSIS OF 2026 APCA OZONE APPORTIONMENT O3N AND O3V TRACERS.....	93
7.1	2026 MDA8 Ozone O3N/O3V Contributions at Carlsbad City.....	93
7.2	2026 MDA8 Ozone O3N/O3V Contributions at Desert View and El Paso	96
7.3	2026 MDA8 Ozone O3N/O3V Contributions at Foot Hills and Navajo Lake	96
8.0	RESULTS OF THE 2026 BRUTE FORCE EMISSION REDUCTION SENSITIVITY TESTS	98
9.0	REFERENCES	107

TABLES

Table 1-1.	Summary of 2022 and 2026 annual VOC and NO _x emissions (average TPD) for New Mexico from the 2022 EMP 2022v1 modeling platform.	5
Table 1-2.	2022 observed MDA8 ozone at the three New Mexico monitoring sites in the Permian Basin on days when any one of the sites measures an exceedance of the 70 ppb 2015 ozone NAAQS. The HMS smoke density over the Permian Basin is also indicated in the last column.....	8
Table 2-1.	Recommended Performance Goals and Criteria benchmarks for photochemical model statistics (Source: Emery et al., 2017).	11
Table 2-2.	Bias (NMB and FB), error (NME and FE) and correlation (COR) MDA8 ozone performance statistics by site for the CAMx 2022v1 12 km base case and summer, 2022.	15
Table 2-3.	Bias (NMB and FB), error (NME and FE) and correlation (COR) hourly ozone performance statistics by site for the CAMx 2022v1 12 km base case and summer 2022.	17
Table 2-4.	20 highest modeled MDA8 ozone days at the Carlsbad Cavern monitor and comparison with observed MDA8 ozone.....	53
Table 2-5.	20 highest modeled MDA8 ozone days at the Carlsbad City monitor and comparison with observed MDA8 ozone.....	54
Table 2-6.	20 highest modeled MDA8 ozone days at the Hobbs monitor and comparison with observed MDA8 ozone.....	55
Table 2-7.	20 highest modeled MDA8 ozone days at the Desert View monitor and comparison with observed MDA8 ozone.....	56

Table 2-8.	20 highest modeled MDA8 ozone days at the La Union monitor and comparison with observed MDA8 ozone.....	57
Table 3-1.	Current year 2020-2024 ozone Design Values (DVB) and future year projected 2026 ozone Design Values (DVF) for monitoring sites in New Mexico and adjacent to New Mexico using the 2022 EMP CAMx 12 km 2022v1 and 2026v1 modeling results.	59

FIGURES

Figure 1-1.	Ozone DV trends for 2014-2023 at the Carlsbad Caverns (350150010) and Carlsbad City (350151005) monitors in Eddy County and the Hobbs (350250008) monitor in Lea County.	2
Figure 1-2.	2022 EMP 36/12 km modeling domains used in the EPA 2022v1 emissions development and photochemical modeling platforms. The CAMx and CMAQ 2022v1 modeling platforms used the 36US3 and 12US2 modeling domains (Source: 2022v1 Summary Documentation).	4
Figure 2-1.	Locations of ozone monitoring sites operating in 2022 in New Mexico and adjacent areas.	13
Figure 2-2.	Spatial distribution of CAMx 2022v1 12 km NMB (left) and NME (right) MDA8 ozone performance statistics for the summer 2022.....	14
Figure 2-3.	Spatial distribution of CAMx 2022v1 12 km NMB (left) and NME (right) hourly ozone performance statistics for the summer 2022.....	16
Figure 2-4.	Ozone Design Value trends from 2014 to 2023 for New Mexico sites located in the Permian Basin: Carlsbad Cavern (350150010) and Carlsbad City (350151005) in Eddy County and Hobbs (350250008) in Lea County.....	18
Figure 2-5.	Scatter plots of predicted and observed MDA8 ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Cavern (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).	19
Figure 2-6.	Time series plots of predicted and observed MDA8 ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Caverns (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).	20
Figure 2-7.	Scatter plots of predicted and observed hourly ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Cavern (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).	22
Figure 2-8.	Time series of predicted and observed hourly ozone concentration at the Permian Basin Carlsbad Cavern (350150010) and Carlsbad City (350151005) monitoring sites for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.	23
Figure 2-9.	Time series of predicted and observed hourly ozone concentration at the Permian Basin Hobbs (350250008) monitoring site for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.	24
Figure 2-10.	Ozone Design Value trends from 2014 to 2023 for sites located in Dona Ana County in Southern New Mexico: La Union (350130008), Chaparral (350130020), Desert View (350130021), Santa Teresa (350130022) and Solano (350130023).....	25

Figure 2-11. Scatter plots of predicted and observed MDA8 ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.....	26
Figure 2-12. Time series of predicted and observed MDA8 ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.....	27
Figure 2-13. Scatter plots of predicted and observed hourly ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.....	28
Figure 2-14. Time series of predicted and observed hourly ozone concentration at the Dona Ana County Desert View (350130021) and La Union (350130008) monitoring sites for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.	29
Figure 2-15. Scatter plots of predicted and observed MDA8 ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.	30
Figure 2-16. Time series of predicted and observed MDA8 ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.	31
Figure 2-17. Scatter plots of predicted and observed hourly ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.	32
Figure 2-18. Time series of predicted and observed hourly ozone concentration at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.	33
Figure 2-19. Ozone Design Value trends from 2014 to 2023 for sites located in Central New Mexico: Del Norte (350010023), South Valley (350010029) and Foot Hills (350011012) in Bernalillo County; Bernalillo (350431001) in Sandoval County; Santa Fe (350490021) in Santa Fe County; and Los Lunas (35061008) in Valencia County.	34
Figure 2-20. Scatter plots of predicted and observed MDA8 ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.....	35
Figure 2-21. Time series of predicted and observed MDA8 ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.....	36
Figure 2-22. Scatter plots of predicted and observed hourly ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.....	37
Figure 2-23. Time series of predicted and observed hourly ozone concentration at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.....	38
Figure 2-24. Ozone Design Vales (DVs; ppm) for sites in the South San Juan Basin in Northwest New Mexico: Coyote (350390026), Bloomfield (350450009), Navajo Lake (350450018), Chaco (350450020) and Sub Station (350451005).	39

Figure 2-25. Scatter plots of predicted and observed MDA8 ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.	40
Figure 2-26. Time series of predicted and observed MDA8 ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.	41
Figure 2-27. Scatter plots of predicted and observed hourly ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.	42
Figure 2-28. Time series of predicted and observed hourly ozone concentration at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.	43
Figure 2-29. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO ₂ (middle) and NO _x (bottom) concentrations at the Carlsbad City (350151005; left) and Hobbs (35025008; right) monitoring site in the Permian Basin.	45
Figure 2-30. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO ₂ (middle) and NO _x (bottom) concentrations at the Santa Teresa (350130021; left) and Desert View (35025008; right) monitoring sites in Dona Ana County.	47
Figure 2-31. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO ₂ (middle) and NO _x (bottom) concentrations at the Del Norte (350010023; left) and South Valley (350010029) monitoring sites in Bernalillo County in Central New Mexico.	49
Figure 2-32. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO ₂ (middle) and NO _x (bottom) concentrations at the Broomfield (350450009; left) and Navajo Lake (350450018) monitoring sites in San Juan County in Northwest New Mexico.	51
Figure 3-1. Spatial distribution of the 2020-2024 base year ozone Design Value (DVB) using the SMAT-CE UAA interpolation procedure with (UAA-GA; top) and without (UAA-nonGA; bottom) using the modeled 2022 ozone concentration gradients in the 2020-2024 ozone DVB spatial interpolation.	61
Figure 3-2. Spatial distribution of the projected 2026 future year ozone Design Value (DVF) using the SMAT-CE UAA interpolation procedure with (UAA-GA; top) and without (UAA-nonGA; bottom) using the modeled 2022 ozone concentration gradients.	63
Figure 4-1. Six Source Regions used in the CAMx 2026v1 12 km APCA ozone source apportionment simulation using the 2022 EMP CAMx 2022v1 12 km modeling platform.	66
Figure 5-1. Contributions of New Mexico Anthropogenic emissions to the projected 2026 ozone DVFs across New Mexico.	69
Figure 5-2. Contributions of New Mexico All Sources (anthropogenic and natural) emissions to the projected 2026 ozone DVFs across New Mexico and adjacent areas.	70
Figure 5-3. Contributions of New Mexico Permian Basin Oil and Gas emissions to 2026 ozone DVFs for: low-level (area) O&G emissions (top left); elevated (point) O&G emissions (top right); and total (area + point) O&G emissions (bottom).	72
Figure 5-4. Contributions of New Mexico and Texas Permian Basin Oil and Gas emissions to 2026 ozone DVFs.	73
Figure 5-5. Contributions of anthropogenic emissions in New Mexico (top left), Texas (top right), Mexico (bottom left) and remainder of the domain (bottom right; i.e., not NM, TX or Mexico) to 2026 ozone DVFs.	75

Figure 5-6.	Projected 2026 ozone DVFs using SMAT-CE UAA with all emissions (top) and with the contributions of New Mexico Permian Basin O&G emissions removed (bottom).	76
Figure 5-7.	Projected 2026 ozone DVFs using SMAT-CE UAA with all emissions (top) and without the contributions of anthropogenic emissions from Mexico in the 12 km domain (bottom).	78
Figure 6-1.	MDA8 Ozone Dashboard that displays Source Category and Source Region contributions to 2026 MDA8 ozone concentrations at Carlsbad City monitoring site on the 10 days used by SMAT-CE to make 2026 ozone DVF projections. .	80
Figure 6-2.	Pie charts of 2026 ozone contributions at Carlsbad City averaged across the 4 May (left) and 6 Non-May (right) SMAT days.	81
Figure 6-3.	Contributions of Source Regions to the average of the 2026 MDA8 ozone concentrations on the 10 SMAT days at Carlsbad City.	83
Figure 6-4.	Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb at the Carlsbad City monitoring site.	84
Figure 6-5.	Contributions to the 2026 MDA8 ozone concentrations at Hobbs for the 10 SMAT days.	85
Figure 6-6.	Contributions to monthly average MDA8 ozone concentrations at Hobbs.	86
Figure 6-7.	Contributions to the 2026 MDA8 ozone concentrations at Desert View for the 10 SMAT days.	87
Figure 6-8.	Contributions of Source Regions to the average of the 2026 MDA8 ozone concentrations on the 10 SMAT days at Desert View.	88
Figure 6-9.	Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb in July at the Foot Hills monitoring site: New Mexico (middle left), Texas (middle right), Mexico (bottom left) and Remainder Domains (bottom right). .	90
Figure 6-10.	Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb in July at the Navajo Lake monitoring site: New Mexico (middle left), Texas (middle right), Mexico (bottom left) and Remainder of Domain (bottom right).	91
Figure 7-1.	O3N and O3V contributions to the 2026 MDA8 ozone concentrations at Carlsbad City on days the modeled 2026 MDA8 ozone is greater than 60 ppb in June – September.	94
Figure 7-2.	O3N/O3V contributions by Source Regions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Carlsbad City.	95
Figure 7-3.	Anthropogenic emissions Source Category O3N/O3V contributions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Desert View in Dona County (left) and Socorro Hueco in El Paso County (right).	96
Figure 7-4.	Anthropogenic emissions Source Category O3N/O3V contributions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Foot Hills in Bernalillo County (left) and Navajo Lake in San Juan County (right).	97
Figure 8-1.	Projected 2026 ozone DVF for the BF CAMx 2026v1 12 km base case simulation.	99
Figure 8-2.	Differences in 2026 ozone DVFs between the 2026v1 base case and the 20% New Mexico NO _x (top) and VOC (bottom) anthropogenic emissions reduction sensitivity simulation.	100

Figure 8-3.	Differences in 2026 ozone DVFs between the 2026v1 base case and the 20% New Mexico Permian Basin Oil and Gas NO _x (top) and VOC (bottom) anthropogenic emissions reduction sensitivity simulation.	101
Figure 8-4.	2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NO _x (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on June 30 (left) and July 1 (right).	103
Figure 8-5.	2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NO _x (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on July 3 (left) and July 11 (right).	104
Figure 8-6.	2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NO _x (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on August 1 (left) and September 8 (right).	105

1.0 INTRODUCTION

In 2015, EPA promulgated a new 70 ppb ozone National Ambient Air Quality Standard (NAAQS). The new ozone NAAQS uses the three-year average of the fourth highest Maximum Daily Average 8-hour (MDA8) ozone concentration as the indicator for comparison with the 70 ppb threshold. This is the definition of ozone Design Value (DV). EPA originally designated ozone nonattainment areas (NAA) under the 2015 ozone NAAQS using the 2014-2016 ozone DVs on August 3, 2018.

1.1 Ozone Concentrations in the Permian Basin

The Permian Basin is currently the most active producing oil and gas (O&G) basin in the U.S. The Permian Basin covers areas that include southeast New Mexico (NM) and northwest Texas (TX). In New Mexico, most of the Permian Basin O&G production is within Eddy and Lea Counties. In 2022, three ozone monitoring sites were operating in Eddy and Lea Counties:

- Carlsbad Caverns (35-015-0010), 727 Carlsbad Caverns Highway, Eddy County.
- Carlsbad City (35-015-1005), 2811 Holland St., Carlsbad, Eddy County.
- Hobbs (35-25-0008), 2320 N. Jefferson St., Hobbs, Lea County.

Figure 1-1 displays the ozone DV trends at the three monitoring sites in Eddy and Lea Counties over the 10-year period of 2014 to 2023. The Carlsbad Caverns monitor has been in operation only since 2019 and did not have a 2014-2016 ozone DV when NAAs were designated. The Carlsbad City and Hobbs 2014-2016 ozone DVs were, respectively, 67 and 66 ppb, which were below the 70 ppb NAAQS so Eddy and Lea Counties were designated as attainment areas under the 2015 ozone NAAQS in August 2018. However, since then there has been increases in ozone at the two sites such that by 2023 the Carlsbad City and Hobbs monitoring sites had ozone DVs of, respectively, 78 and 71 ppb that violate the 2015 ozone NAAQS. In fact, the Carlsbad City site in Eddy County has been violating the 70 ppb 2015 ozone NAAQS since 2018 and has been violating the 75 ppb 2008 ozone NAAQS since 2019. Although the Eddy County Carlsbad Caverns monitor only has three valid years of ozone DVs, it confirms the high ozone trends showed at the nearby Carlsbad City site as both had an ozone DV of 78 ppb in 2023.

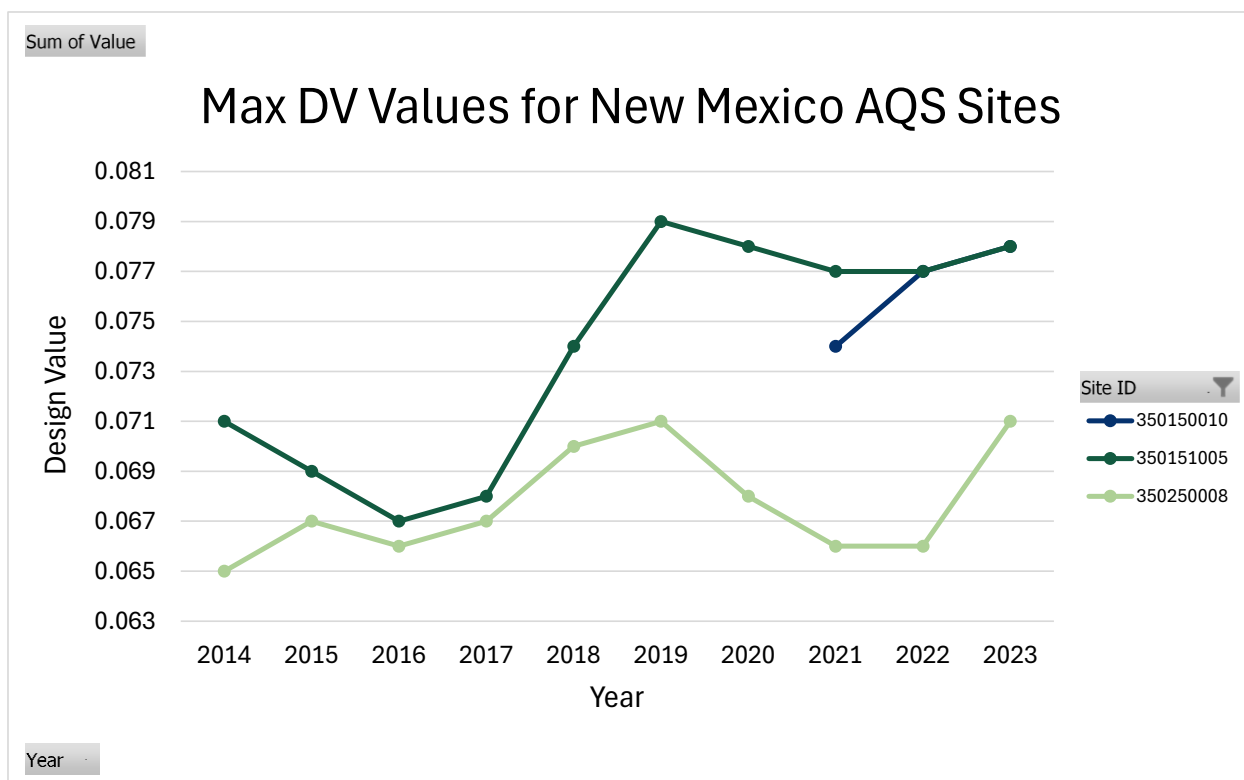


Figure 1-1. Ozone DV trends for 2014-2023 at the Carlsbad Caverns (350150010) and Carlsbad City (350151005) monitors in Eddy County and the Hobbs (350250008) monitor in Lea County.

1.2 Purpose

The New Mexico Environmental Department (NMED), Air Quality Bureau (AQB) would like to understand the causes of the elevated ozone concentrations within the New Mexico portion of the Permian Basin. The NMED/AQB contracted with Ramboll to conduct ozone source apportionment modeling to estimate the contributions of emissions from oil and gas emissions in the Permian Basin to ozone concentrations in New Mexico. The work is divided into two Phases with the first Phase conducted between mid-April to June 30, 2025 (FY2024-2025) and the second Phase starting in July 2025 (FY2025-2026). Phase I will use the Comprehensive Air-quality Model with extensions (CAMx) photochemical grid model (PGM) with an existing 2022v1 12 km database and conduct simulations for a 2022 base case and a 2026 future year, the latter invoking the source apportionment technology. An enhanced CAMx 2022 modeling database with a higher resolution 4 km grid covering New Mexico will be partially developed under Phase I with the CAMx 2022 12/4 km base case and future year modeling conducted during Phase II. This report documents the Phase I CAMx 2022 base case and 2026 ozone source apportionment modeling using an existing summer 12 km modeling platform.

1.3 Conceptual Model of Ozone Formation in New Mexico

There are several interrelated but distinct geographic regions with ozone monitoring sites in New Mexico and adjacent areas:

- NM-PB: the New Mexico portion of the Permian Basin that in 2022 includes two sites operating in Eddy and one site operating in Hobbs Counties (note for model evaluation for this group we also include a site operating in Culberson County Texas that is right over the border from Eddy County, TX-PB).
- NM-S: the Southern New Mexico sites in Dona Ana County includes the Sunland Park ozone nonattainment area (NAA) across the border from El Paso, Texas.
- TX-EP: the sites in El Paso, Texas many of which are adjacent to the ones in the Sunland Park area in NM-S.
- NM-Cen: Central New Mexico that includes Bernalillo County (Albuquerque) and one site each in three adjacent counties (Sandoval, Sante Fe and Valencia).
- NM-SSJ: South San Juan Basin in San Juan County in northwestern New Mexico.
- CO-NSJ: North San Juan Basin in Archuleta, La Plata and Montezuma Counties in southwestern Colorado.

All four of the New Mexico geographic regions with ozone monitors share a common attribute that ozone transport dominates ozone concentrations on all days. Days with the highest local ozone formation are typically hot summer days with a high pressure system or ridge that slows the synoptic westerly winds without an excessive amount of precipitation (summer monsoon). The highest ozone in the southern New Mexico Dona Ana County and vicinity area (NM-S) occurs during transport from the south including contributions from El Paso, Texas, Juarez, Mexico and other international emissions. The Eddy and Lea Counties portion of southeastern New Mexico (NM-PB) also has ozone contributions from O&G emissions in the Permian Basin added to the transported ozone. Ozone concentrations in Northwestern New Mexico (NM-SSJ) are affected by O&G emissions from the San Juan Basin in addition to transport. Ozone at sites in Bernalillo and adjacent counties (NM-Cen) are affected by emissions from Albuquerque, which is New Mexico's largest city, in addition to transport.

1.4 Overview of Approach

The EPA 2022v1 12 km CAMx modeling platform was used to conduct CAMx 2022v1 12 km base case modeling and model performance evaluation and future year 2026 ozone source apportionment modeling to assess the contributions of Source Regions and Source Categories to ozone concentrations in the Permian Basin and elsewhere in New Mexico. The procedures used were outlined in our Work Plan (Ramboll, 2025) at the outset of the study and are summarized below.

1.4.1 EMP 2022v1 Modeling Platform

The 2022 base case emissions are from the National Emissions Collaborative ([NEC](#)) [2022v1 Emissions Modeling Platform](#) (EMP). The 2022v1 platform is based on the 2020 National Emissions Inventory (NEI) released in the spring of 2023 with updates from EPA and States to better represent the year 2022. The EMP 2022v1 includes point sources, non-point sources, on-road mobile sources, non-road mobile sources, biogenic emissions and fires for the U.S., Canada, and Mexico.

EPA processed the 2022v1 inventories to generate CAMx and CMAQ model-ready emission inputs for the 36/12 km domains (Figure 1-2). The 2022 EMP 2022v1 and 2026v1 model-ready emissions for the 36/12 km domains were downloaded via [EPA's Open Data Program site](#) and used in Phase I of the NMED Permian Basin ozone modeling study.

The description of the 2022 EMP 2022v1 platform emissions development (including the 2022hc and 2026hc emissions used in this study) is documented in a May 2025 2022v1 emissions inventory Technical Support Document ([2022v1-EITSD](#); EPA, 2025) that provides more detail than the previous October 21, 2024 document: [2022v1 emissions docn.pdf](#). The 2022 EMP 2022v1 emissions were based on the 2020 National Emissions Inventory ([2021NEI](#)) published in April 2023 (EPA, 2023). As part of the NEC 2022 EMP, states and tribes provided updates to the preliminary draft 2022v1 emissions prepared by EPA and the NEC 2022 EMP Workgroups. The resultant draft 2022v1 emissions were subsequently review by states, tribes and others who provided comments that were implemented to produce the final 2022v1 emissions. EPA processed the 2022v1 emissions primarily using the Sparse Matric Operator Kernal Emissions ([SMOKE version 5.1](#)) to generate CMAQ and CAMx emission inputs for the 36 km (36US3) and 12 km (12US2) modeling domains (Figure 1-2) and the 2022 annual year. The procedures for the processing of the 2022v1 emissions to develop model-ready emissions for the 36/12 km domains are detailed in Chapter 3 of the 2022v1-EITSD (EPA, 2025).



Figure 1-2. 2022 EMP 36/12 km modeling domains used in the EPA 2022v1 emissions development and photochemical modeling platforms. The CAMx and CMAQ 2022v1 modeling platforms used the 36US3 and 12US2 modeling domains (Source: 2022v1 Summary Documentation).

Table 1-1 summarizes the 2022 EMP 2022v1 platform 2022 and 2026 New Mexico annual VOC and NO_x emissions by major source sector. Half of the NM 2022v1 anthropogenic NO_x emissions are due to the O&G Non-Point source sector with another 18% from the O&G Point sector (i.e., 68% of the New Mexico 2022 anthropogenic NO_x emissions come from the O&G Source Sector alone). NM O&G Non-Point NO_x emissions are projected to go down by 40% between 2022 and 2026. Total NM anthropogenic NO_x emissions are estimated to be reduced by 27% with 3/4 of that reduction due to the O&G Non-Point sector.

The NM O&G Non-Point is also the largest VOC source sector contributing almost 70% of the NM anthropogenic VOC emissions in 2022 and ~50% in 2026. NM O&G Non-Point is projected to go down by 54% between 2022 and 2026 and accounts for most of the anthropogenic VOC emissions reductions between 2022 and 2026.

The 2022v1 platform estimates that 87% of the 2022 NO_x emissions in NM were due to anthropogenic emissions sources. However, the 2022v1 platform only has 36% of the total VOC emissions in NM due to anthropogenic sources with 35% due to wildfires and 29% due to biogenic emissions.

Table 1-1. Summary of 2022 and 2026 annual VOC and NO_x emissions (average TPD) for New Mexico from the 2022 EMP 2022v1 modeling platform.

New Mexico State-Wide Emission Summaries including Tribal Emissions						
Tons per Day (TPD)	NO _x			VOC		
Source Sector	2022	2026	%Diff	2022	2026	%Diff
Airports	1.6	1.7	6.0%	1.0	1.0	5.6%
Livestock				7.1	7.0	-1.3%
Non-Point	14.1	13.7	-2.7%	37.0	39.5	6.8%
Non-Road	11.0	9.0	-17.6%	12.3	11.7	-4.7%
O&G Non-Point	271.5	160.8	-40.8%	773.0	356.0	-53.9%
Solvents				47.7	50.0	4.8%
On-Road	67.9	45.4	-33.1%	27.8	21.8	-21.7%
Open Burn	0.7	0.7	0.0%	1.2	1.2	0.0%
O&G Point	95.8	97.6	1.9%	174.8	179.7	2.8%
Agriculture Fires	0.4	0.4	0.0%	1.4	1.4	0.0%
EGU	27.7	15.1	-45.5%	0.9	0.7	-24.0%
Non-EGU	7.0	6.7	-4.4%	5.4	5.5	1.0%
Rail	43.4	43.1	-0.8%	1.8	1.7	-0.8%
RWC	2.2	2.2	0.0%	23.4	23.4	0.0%
Total Anthropogenic	543.4	396.6	-27.0%	1,114.7	700.6	-37.1%
Biogenic	43.6	43.6	0.0%	923.3	923.3	0.0%
Prescribed Fires	0.5	0.5	0.0%	7.4	7.4	0.0%
Wildfires	37.9	37.9	0.0%	1,085.6	1,085.6	0.0%
Total Anthro + Natural	625.3	478.6	-23.5%	3,131.0	2,716.9	-13.2%

The gridded meteorological model used to provide input data for the emissions and CMAQ/CAMx air quality modeling was developed using the Weather Research and Forecasting Model ([WRF](#)) version 4.2, Advanced Research WRF core (Skamarock, et al., 2008). The WRF Model is a mesoscale numerical weather prediction system developed for both operational forecasting and atmospheric research applications. The WRF model was run for 2022 over a domain covering the continental U.S. (CONUS) at both 12 km and 36 km resolution domains, which are slightly larger than the SMOKE/CMAQ/CAMx domains, with 35 vertical layers (12US1 and 36NOAM domains, Figure 1-2). The WRF simulation for the 2022v1 EMP platform included high resolution sea surface temperature data from the Group for High Resolution Sea Surface Temperature ([GHR SST](#)).

Data files and summaries for the EMP 2022v1 platform are available from the air emissions modeling website (<https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform>).

1.4.2 Episode Selection

In this section we select the modeling period for the CAMx simulations for this study. For the CAMx 2022v1 12 km base case we modeled the entire 2022 year. For the CAMx 2026v1 12 km ozone source apportionment simulation modeling period, we analyzed the observed ozone concentrations at the three sites in the New Mexico portion of the Permian Basin (Carlsbad City and Carlsbad Cavern in Eddy County and Hobbs in Lea County) and the potential that the observed ozone may be influenced by smoke from wildfires.

1.4.2.1 2022 Ozone Exceedances in the New Mexico Permian Basin

Table 1-2 lists the Maximum Daily Average 8-hour (MDA8) ozone concentrations during 2022 that exceed the 70 ppb 2015 ozone NAAQS at the three New Mexico sites in the Permian Basin (Appendix A of the Work Plan contains MDA8 ozone concentrations at all the sites in New Mexico and all days during summer 2022 [Ramboll, 2025]). The MDA8 ozone concentrations in Table 2-1 are colored red if they exceed the 75 ppb 2008 ozone NAAQS, yellow if they are between 70 and 75 ppb, and green if they are between 68 ppb and 70 ppb. In 2022, there were 28 days that exceed the 70 ppb 2015 ozone NAAQS and 11 days that exceed the 75 ppb 2015 ozone NAAQS for at least one of the three monitoring sites in the New Mexico portion of the Permian Basin. The first Permian Basin 2015 NAAQS exceedance day in 2022 was April 30th with a 73 ppb value at the Carlsbad City site that was followed by an exceedance day three days later on May 3rd with 72 and 71 ppb measured at Carlsbad City and Carlsbad Cavern respectively. During May 2022, the 2015 ozone NAAQS is exceeded during 7 days in the Permian Basin.

The last 2022 exceedance day in the Permian Basin was October 13th with a 76 ppb value at Carlsbad City (Carlsbad Cavern recorded a 65 ppb ozone value in this day). However, the 2nd to last 2022 exceedance day in the Permian Basin is over a month earlier on September 8th with a 71 ppb value at Carlsbad (ozone was missing at Carlsbad City on this day). Before September 8th there was a 71 ppb exceedance day on August 24 and before that were three exceedance days in a row during August 12 to 14, 2022 with both Carlsbad Cavern and Carlsbad City recording exceedances of the 75 ppb 2008 ozone NAAQS on all three days.

2022 was a year with very high wildfire activity in New Mexico. 2022 included the Calf Canyon/Hermits Peak Fire in San Miguel, Mora and Taos Counties in northeast New Mexico that burned 342,000 acres from April 6 to August 22, 2022 and accounted for approximately a third of the acreage burned by wildfires in New Mexico during 2022. The

Calf Canyon/Hermits Peak Fire was the largest wildfire in New Mexico history and was the largest 2022 wildfire in the contiguous U.S. Wildfire smoke covered much of New Mexico, including the Permian Basin, over many days in 2022. Smoke density maps from the Hazard Mapping System ([HMS](#)) Fire and Smoke Product were analyzed for each ozone exceedance day in the Permian Basin with the HMS smoke density over the Permian Basin given in the last column of Table 1-2 (Appendix B of the Work Plan included maps of the HMS smoke products for all 2022 ozone exceedance days in the Permian Basin; Ramboll, 2025). The HMS is a NOAA product where satellite images are analyzed and polygons of Light, Medium and Heavy smoke density are developed and digitized in kml files that can be visualized using Google Earth. Of the 28 ozone exceedance days in 2022 in the Permian Basin, 24 (86%) may have been impacted by smoke based on the HMS smoke product (Table 1-2). Most of these Permian Basin smoky ozone exceedance days had HMS Light density smoke so their influence on ozone concentrations is uncertain. Note that the presence of HMS smoke density at a location does not necessarily indicate that the wildfire smoke is at ground level and potentially influencing the surface ozone measurements.

Table 1-2. 2022 observed MDA8 ozone at the three New Mexico monitoring sites in the Permian Basin on days when any one of the sites measures an exceedance of the 70 ppb 2015 ozone NAAQS. The HMS smoke density over the Permian Basin is also indicated in the last column.

Local Name:	Carlsbad Caverns	Carlsbad City	Hobbs	HMS
County:	Eddy	Eddy	Lea	Smoke
Site ID:	35-015-0010	35-015-1005	35-025-0008	Density
4/30/2022	70	73	53	Light-Medium
5/3/2022	71	72	56	None
5/14/2022	64	71	63	Light
5/15/2022	68	71	50	Light-Medium
5/16/2022	71	79	55	Light-Medium
5/26/2022	71	73	70	Light-Medium
5/27/2022	60	74	59	Medium-Heavy
5/30/2022	72	72	72	Light
6/4/2022	51	59	74	Light
6/9/2022	72	71	52	Light
6/10/2022	71	69	54	Light
6/15/2022	68	69	50	Light
6/29/2022	81	77	75	Light
6/30/2022	69	71	69	Light
7/1/2022	78	76	69	Light
7/2/2022	72	75	68	Light
7/8/2022	85	72	66	None
7/9/2022	71	71	62	Light
7/10/2022	71	67	61	Light
7/11/2022	83	79	65	Light
7/13/2022	71	74	66	Light
7/14/2022	71	71	68	Light
7/15/2022	76	78	75	Light
8/12/2022	86	84	70	Light
8/13/2022	84	83	67	Light
8/14/2022	78	80	62	Light
8/24/2022	71	66	56	None
9/8/2022	83	NA	68	Light
10/13/2022	65	76	64	None
#Exceedances	21	23	4	

Given the number of ozone exceedance days during May 2022 in the Permian Basin, we started the modeling period for the CAMx 2026v1 12 km ozone source apportionment modeling on April 16, 2022 so that at least 15 days of initialization are simulated before the first exceedance day on April 30. To meet the Phase I schedule constraints, we are ending the 2026 ozone source apportionment modeling period on August 15 as the computational requirements of adding an additional ~60 days of the source apportionment modeling period to capture the last three 2022 exceedance days in the Permian Basin would jeopardize completing and documenting the work by the Phase I June 30, 2025 deadline. In the CAMx 2022v1 12 km base case model performance evaluation, we will examine the ozone model performance of these last three 2022 ozone exceedance days at sites in the Permian Basin and potentially extend the modeling period in Phase II if the model is performing well enough on these days. For Phase I, we decided to include 122 days for the 2026 ozone source apportionment modeling period: April 16 to August 15, 2022.

1.4.3 2022 Base Case Modeling and Model Performance Evaluation

A CAMx 2022v1 12 km base case simulation was performed with a subsequent model performance evaluation (MPE). The CAMx 2022v1 12 km base case was evaluated for April 1 through October 15, 2022 including all NM Permian Basin ozone exceedance days in 2022. Chapter 2 discusses the model performance evaluation of the CAMx 2022v1 12 km base case simulation.

1.4.4 2026 Ozone Source Apportionment Modeling

The CAMx 2026v1 12 km April 16 – August 15, 2022 ozone source apportionment modeling approach is described in Chapter 3 and the results are presented in Chapters 5, 6 and 7.

2.0 2022 BASE CASE MODELING AND MODEL PERFORMANCE EVALUATION

This Chapter discusses the CAMx 2022v1 12 km base case simulation and model performance evaluation.

2.1 CAMx 2022v1 12 km Base Case Simulation

A CAMx 2022v1 base case simulation for the 2022 annual period was performed using the NEC 2022 EMP CAMx 2022v1 12 km modeling platform. No updates or changes were made from the EPA configuration provided in the CAMx 2022v1 12 km input files.

2.2 CAMx 2022v1 12 km Model Performance Evaluation Approach

The Atmospheric Model Evaluation Tool ([AMET](#)) was used to evaluate the CAMx 2022v1 12 km base case. AMET includes standard AQS monitoring data. The focus of the model evaluation was on ozone concentrations within an analysis domain shown in Figure 2-1 that includes all of New Mexico, parts of adjacent states and all the Permian Basin oil and gas production area in Texas.

AMET was used to generate numerous displays and metrics of ozone model performance:

- Scatterplots of MDA8 and hourly ozone concentrations.
- Spatial plots of bias and error at monitoring sites across a New Mexico analysis domain (Figure 2-1).
- Time series plots of predicted and observed MDA8 ozone from April 1 to October 15, 2022, and hourly ozone time series for these six episodes:
 - May 14 – 16
 - May 25 – 30
 - June 8 – 11
 - June 30 – July 3
 - July 13 – 15, 2022
 - August 12 – 14
- Model performance for NO_x/NO₂/NO with available observations.

2.2.1 Ozone Model Performance Goals and Criteria

Model Performance Goals and Criteria allow one to assess the model performance of a PGM base case and compare it with past PGM model performance evaluations. EPA first proposed the use of model performance goals in their 1991 ozone modeling guidance (EPA, 1991) with goals for bias ($\leq \pm 15\%$) and error ($\leq 35\%$). Since then, EPA has de-emphasized the use of model performance goals as some users were focusing on achieving the model performance goals rather than whether the model was accurately simulating the atmospheric processes that produced the air quality issues under study. However, model performance goals are still useful for interpreting model performance and putting the performance of the model in context with past applications. Since the development of the EPA 1991 ozone performance goals, Boylan and Russell (2006) extended the ozone performance goals to PM species and visibility. Simon, Baker and Phillips (2012) summarized the model performance statistics of 69 PGM applications from 2006 to 2012

and found significant variability but were able to isolate model performance statistical levels for the best performing models.

Emery et al., (2017) built off the work of Simon, Baker and Phillips (2012) by including additional PGM model applications and came up with a set of PGM model Performance Goals and Criteria based on the variability in past PGM model applications in the peer-reviewed literature. Model performance “Goals” indicate statistical values that approximately a third of the top performing past PGM applications have met and should be viewed as the best a PGM application can be expected to achieve. “Criteria” indicates statistical values that approximately two thirds of past PGM applications have met and should be viewed as what most of the model applications have achieved. We will compare the CAMx 2022 base case simulation ozone model performance statistics for normalized mean bias (NMB) and normalized mean error (NME) against the ozone model Performance Goals and Criteria summarized by Emery et al., (2017) given in Table 2-1 (for completeness we also include the PM performance goals and criteria).

Table 2-1. Recommended Performance Goals and Criteria benchmarks for photochemical model statistics (Source: Emery et al., 2017).

Species	NMB		NME		r	
	Goal	Criteria	Goal	Criteria	Goal	Criteria
1-hr & MDA8 Ozone	<±5%	<±15%	<15%	<25%	>0.75	>0.50
24-hr PM _{2.5} , SO ₄ , NH ₄	<±10%	<±30%	<35%	<50%	>0.70	>0.40
24-hr NO ₃	<±15%	<±65%	<65%	<115%	NA	NA
24-hr OC	<±15%	<±50%	<45%	<65%	NA	NA
24-hr EC	<±20%	<±40%	<55%	<75%	NA	NA

The NMB is defined as the Mean Bias (MB; i.e., the average of the differences between the Measured and Observed concentrations) divided by the average Observed value:

$$\text{Normalized mean bias} = \frac{\sum_{i=1}^n (M - O)}{\sum_{i=1}^n O}$$

The NME is a similar formula as the NMB only the numerator is the average of the absolute value differences between the Measured and Observed Value. We also compare the bias and error Performance Goals and Criteria against the Fractional Bias and Error (FB and FE) that are similar to the NMB and NME only instead of dividing the Mean Bias or Error by the average Observation it is divided by the average of the Observed and Measured value divided by 2. This results in the FB bounded by -200% and +200% and FE bounded by 0% to +200%.

2.3 Ozone Monitoring Sites Within and Near New Mexico

Figure 2-1 displays the locations of ozone monitoring sites operating in 2022 that are within the New Mexico analysis domain (red rectangle in the figure) that covers all of New Mexico and portions of adjacent states including all the Permian Basin, which covers a large portion of West Texas. There are several regions within this analysis area where model performance was examined at available monitors:

NM-PB: The Permian Basin portion of New Mexico includes the Carlsbad City and Carlsbad Cavern monitors in Eddy County and the Hobbs monitor in Lea County. When examining ozone model performance in the NM-PB region we also discuss the performance at the Guadalupe Mountain NP monitor in Culberson County in the Texas portion of the Permian Basin (TX-PB) that is right across the border from Eddy County.

NM-S: There are five monitors in Dona Ana County, New Mexico that are next to El Paso, Texas.

TX-EP: There are six monitors in El Paso, Texas.

NM-Cen: The Central New Mexico grouping includes three monitors in Bernalillo County and one monitor each in the adjacent counties of Sandoval, Santa Fe and Valencia.

NM-SSJ: The South San Juan Basin region of New Mexico includes monitors in San Juan and Rio Arriba Counties.

CO-NSJ: The North San Juna Basin region of Colorado includes monitors in Archuleta, La Plata and Montezuma Counties.

AZ-Misc: There are two miscellaneous monitors at Class I areas in Arizona just west of the border of New Mexico in Chiricahua National Monument and Petrified Forest National Park. There is also a miscellaneous ozone monitor (TX-Misc) in Randall County in the Texas Panhandle east of the border with New Mexico.

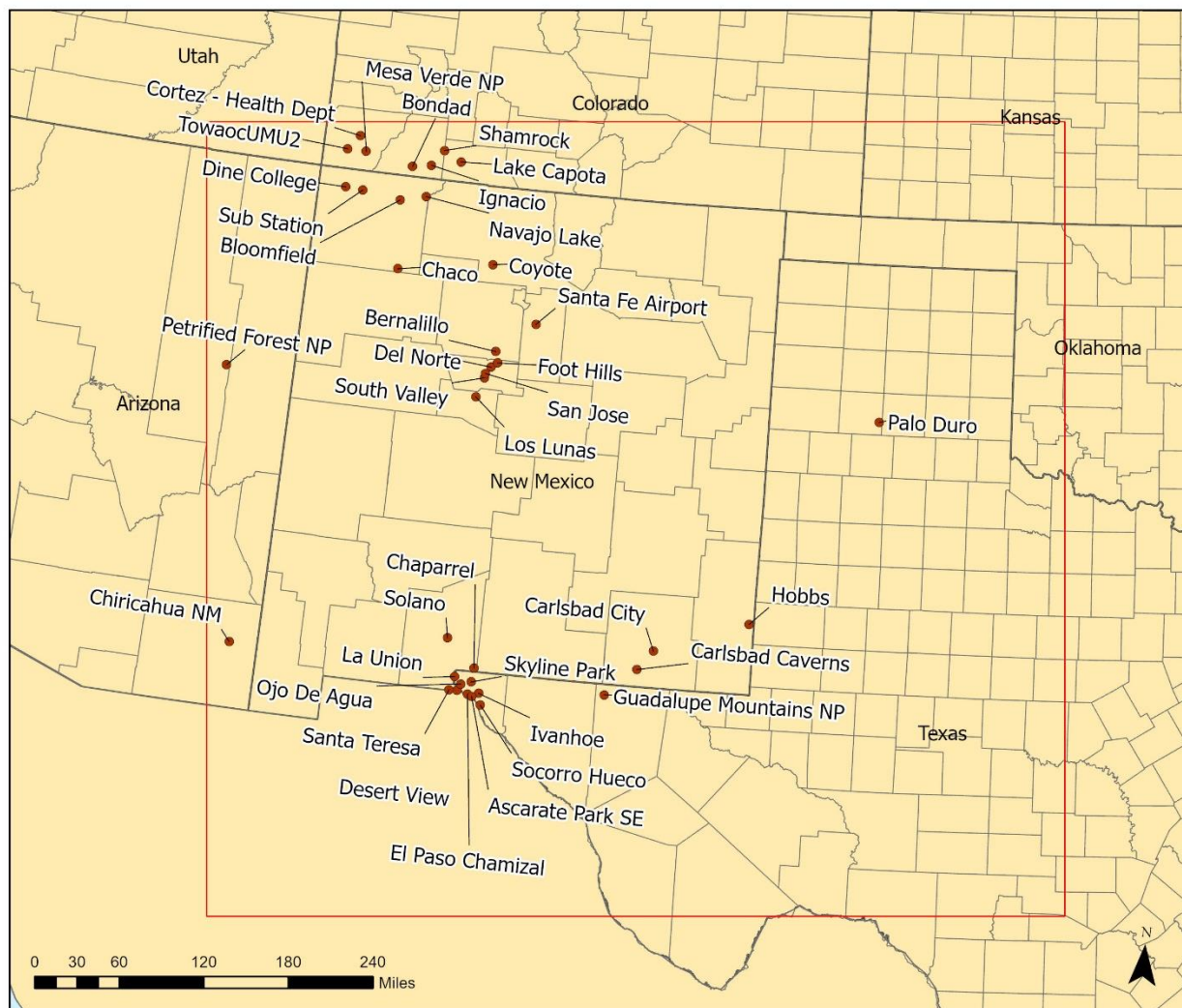


Figure 2-1. Locations of ozone monitoring sites operating in 2022 in New Mexico and adjacent areas.

2.4 Ozone Model Performance Across the New Mexico Analysis Domain

Figure 2-2 displays the spatial distribution CAMx 202v1 12 km MDA8 ozone NMB and NME performance statistics at sites across the New Mexico analysis domain. When the NMB at a site achieves the Performance Goal ($\leq \pm 5\%$) the symbol is colored grey. Table 2-2 is a tabular summary of the site-specific NMB and NME MDA8 ozone performance statistics and includes the Fractional Bias and Error (FB and FE) and correlation (COR or r) statistics. In Table 2-2, if the performance statistics achieves the Performance Goal it is colored green, it is colored yellow if it falls between Performance Goal and Criterion, and if it fails to achieve the Performance Criteria it is colored red. With the exception of the Palo Duro site on the Texas Panhandle, all sites achieve the bias Performance Criterion and half the sites achieve the bias Performance Goal. Over 90% of the sites achieve the error Performance Goal ($\leq 15\%$). The correlation for MDA8 ozone for over 80% of the sites falls between the Performance Goal and Criterion (i.e., between 0.50 and 0.75) and at the 5 sites where the

correlation fails to achieve the Performance Criterion (>0.50), the values are just barely below (0.48 to 0.50). As discussed in more detail below, within the Permian Basin region, the CAMx 2022v1 base case has a MDA8 ozone underestimation bias (as indicated by the bright green and slightly duller green NMB symbols in Figure 2-2, left).

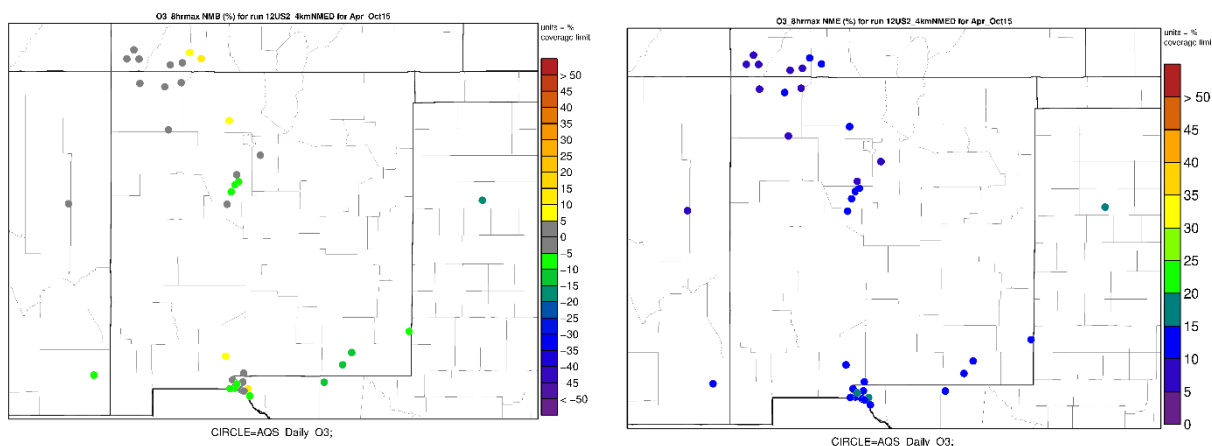


Figure 2-2. Spatial distribution of CAMx 2022v1 12 km NMB (left) and NME (right) MDA8 ozone performance statistics for the summer 2022.

Table 2-2. Bias (NMB and FB), error (NME and FE) and correlation (COR) MDA8 ozone performance statistics by site for the CAMx 2022v1 12 km base case and summer, 2022.

Region	Local Name	County	Site ID	N	NMB	FB	NME	FE	COR
NM-PB	Carlsbad Cavern	Eddy	35-015-0010	181	-11.5	-12.4	13.6	14.7	0.69
NM-PB	Carlsbad City	Eddy	35-015-1005	188	-10.6	-11.5	13.1	14.3	0.71
NM-PB	Hobbs	Lea	35-025-0008	193	-5.3	-5.3	13.0	13.5	0.60
TX_PB	Guadalupe Mtn NP	Culberson	48-109-0002	79	-10.2	-10.7	13.4	14.1	0.49
NM-S	La Union	Dona Ana	35-013-0008	192	-4.8	-5.0	11.7	12.1	0.64
NM-S	Chaparral	Dona Ana	35-013-0020	196	-4.9	-5.3	11.1	11.5	0.65
NM-S	Desert View	Dona Ana	35-013-0021	196	-9.7	-10.5	13.5	14.5	0.64
NM-S	Santa Teresa	Dona Ana	35-013-0022	188	-6.3	-6.5	12.7	13.6	0.65
NM-S	Solano	Dona Ana	35-013-0023	194	5.5	5.4	11.4	11.6	0.69
TX_EP	Ivanhoe	El Paso	48-141-0029	193	10.9	9.9	16.1	15.8	0.68
TX_EP	El Paso Chamizal	El Paso	48-141-0044	182	4.0	3.4	11.3	11.8	0.75
TX_EP	Ascarate Park SE	El Paso	48-141-0055	179	4.9	4.2	13.4	14.0	0.66
TX_EP	Socorro Hueco	El Paso	48-141-0057	196	-5.6	-6.1	12.1	12.8	0.69
TX_EP	Skyline Park	El Paso	48-141-0058	194	0.6	0.7	13.1	13.6	0.54
TX_EP	Ojo De Agua	El Paso	48-141-1021	189	-8.6	-9.4	15.1	16.3	0.48
NM-Cen	Del Norte	Bernalillo	35-001-0023	191	-5.4	-5.4	12.5	13.0	0.54
NM-Cen	South Valley	Bernalillo	35-001-0029	181	-5.1	-5.3	10.2	10.6	0.65
NM-Cen	Foot Hills	Bernalillo	35-001-1012	191	-9.0	-9.2	12.2	12.7	0.62
NM-Cen	Bernalillo	Sandoval	35-043-1001	194	-2.0	-1.9	9.5	9.7	0.68
NM-Cen	Santa Fe	Santa Fe	35-049-0021	194	-4.4	-4.6	9.7	10.0	0.62
NM-Cen	Los Lunas	Valencia	35-061-0008	196	1.2	1.0	11.5	11.4	0.47
NM-SSJ	Coyote	Rio Arriba	35-039-0026	181	8.2	8.3	12.9	12.6	0.64
NM-SSJ	Bloomfield	San Juan	35-045-0009	186	0.2	0.0	10.3	10.5	0.50
NM-SSJ	Navajo Lake	San Juan	35-045-0018	190	-3.4	-3.6	8.8	8.9	0.66
NM-SSJ	Chaco	San Juan	35-045-0020	190	-3.0	-3.3	9.8	10.0	0.54
NM-SSJ	Sub Station	San Juan	35-045-1005	191	-3.7	-4.1	9.2	9.5	0.63
CO-NSJ	Lake Capota	Archuleta	08-007-7004	190	11.2	11.0	14.0	13.6	0.50
CO-NSJ	Shamrock	La Plata	08-067-1004	185	6.2	6.1	10.9	10.5	0.60
CO-NSJ	Ignacio	La Plata	08-067-7001	195	-0.7	-0.9	8.8	8.8	0.66
CO-NSJ	Bondad	La Plata	08-067-7003	195	-1.9	-2.2	8.6	8.8	0.69
CO-NSJ	Cortez	Montezuma	08-083-0006	194	3.1	3.1	9.9	9.8	0.57
CO-NSJ	Mesa Verde NP	Montezuma	08-083-0101	198	0.1	0.0	8.9	8.9	0.60
CO-NSJ	TowaocUMU2	Montezuma	08-083-8001	197	3.2	3.1	9.7	9.5	0.59
TX-Misc	Palo Duro	Randall	48-381-9991	172	-16.2	-17.5	17.5	18.8	0.64
AZ-Misc	Chiricahua NM	Cochise	04-003-8001	195	-5.1	-5.4	10.7	11.3	0.74
AZ-Misc	Petrified Forest NP	Navajo	04-017-0119	192	-3.2	-3.4	9.7	9.9	0.64

Except for the correlation coefficient, the CAMx 2022v1 model performance for hourly ozone is not as good as it is for MDA8 ozone (Figure 2-3 and Table 2-3). Whereas the MDA8 ozone NMB achieved the Performance Criterion at all sites and Performance Goal at half the sites, for hourly ozone there are three sites with NMB that fail to meet the Performance Criterion and only approximately a third of the sites have an NMB that meet the bias Performance Goal. Not surprisingly, the hourly ozone has much higher error than the MDA8 ozone performance; the NME only meets the error Performance Goal at three sites (MDA8 NME met the Performance Goal at all sites but one) with 5 sites with hourly NME failing to meet the Performance Criterion.

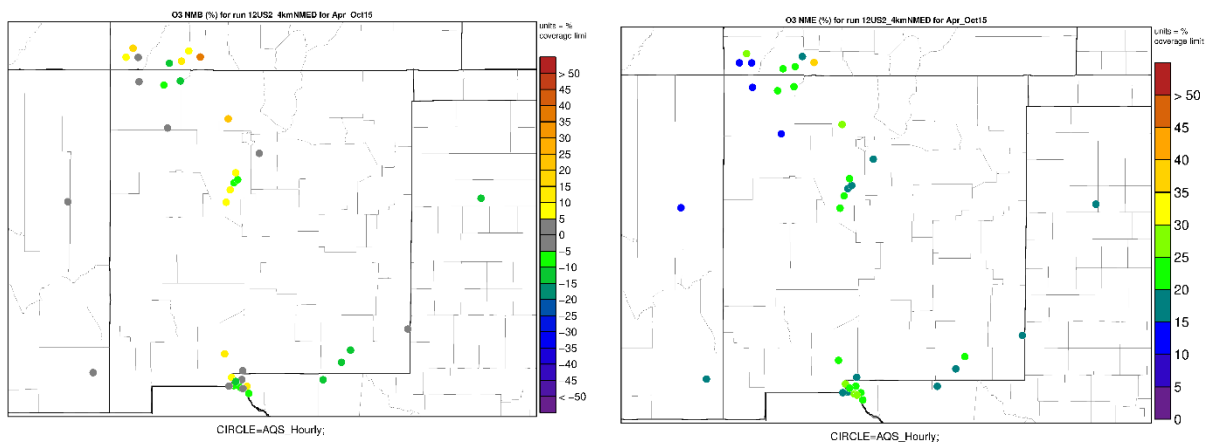


Figure 2-3. Spatial distribution of CAMx 2022v1 12 km NMB (left) and NME (right) hourly ozone performance statistics for the summer 2022.

Table 2-3. Bias (NMB and FB), error (NME and FE) and correlation (COR) hourly ozone performance statistics by site for the CAMx 2022v1 12 km base case and summer 2022.

Region	Local Name	County	Site ID	N	NMB	FB	NME	FE	COR
NM-PB	Carlsbad Cavern	Eddy	35-015-0010	4564	-12.3	-12.9	16.9	18.6	0.742
NM-PB	Carlsbad City	Eddy	35-015-1005	4563	-13.0	-16.1	21.2	28.8	0.838
NM-PB	Hobbs	Lea	35-025-0008	4685	-0.2	2.4	16.3	17.8	0.787
TX_PB	Guadalupe Mtn NP	Culberson	48-109-0002	2058	-13.2	-14.2	17.0	18.3	0.667
NM-S	La Union	Dona Ana	35-013-0008	4668	7.2	15.9	26.1	32.6	0.695
NM-S	Chaparral	Dona Ana	35-013-0020	4697	0.9	3.7	17.4	19.3	0.701
NM-S	Desert View	Dona Ana	35-013-0021	4700	-7.2	-5.7	19.6	23.1	0.737
NM-S	Santa Teresa	Dona Ana	35-013-0022	4577	-4.0	-2.5	19.2	21.9	0.718
NM-S	Solano	Dona Ana	35-013-0023	4672	14.4	18.5	23.0	26.6	0.713
TX_EP	Ivanhoe	El Paso	48-141-0029	4615	10.8	11.9	22.1	24.8	0.732
TX_EP	El Paso Chamizal	El Paso	48-141-0044	4417	-5.7	-9.8	25.8	37.8	0.725
TX_EP	Ascarate Park SE	El Paso	48-141-0055	4594	-1.7	-2.7	28.3	42.8	0.729
TX_EP	Socorro Hueco	El Paso	48-141-0057	4666	-5.4	-2.3	22.4	31.2	0.758
TX_EP	Skyline Park	El Paso	48-141-0058	4584	1.3	4.1	21.4	25.1	0.655
TX_EP	Ojo De Agua	El Paso	48-141-1021	4490	-14.3	-17.1	23.5	27.8	0.582
NM-Cen	Del Norte	Bernalillo	35-001-0023	4510	-7.3	-5.9	19.8	23.3	0.730
NM-Cen	South Valley	Bernalillo	35-001-0029	4300	6.0	14.0	23.3	29.4	0.670
NM-Cen	Foot Hills	Bernalillo	35-001-1012	4570	-8.8	-8.2	16.0	17.2	0.686
NM-Cen	Bernalillo	Sandoval	35-043-1001	4687	8.8	15.2	21.2	26.0	0.751
NM-Cen	Santa Fe	Santa Fe	35-049-0021	4660	1.6	4.9	17.0	19.3	0.690
NM-Cen	Los Lunas	Valencia	35-061-0008	4700	9.6	15.0	22.5	26.8	0.711
NM-SSJ	Coyote	Rio Arriba	35-039-0026	4374	20.7	23.1	25.8	27.3	0.623
NM-SSJ	Bloomfield	San Juan	35-045-0009	4522	-7.5	-9.6	22.5	36.1	0.820
NM-SSJ	Navajo Lake	San Juan	35-045-0018	4591	-14.3	-24.0	20.8	31.1	0.819
NM-SSJ	Chaco	San Juan	35-045-0020	4585	-1.4	-0.3	13.6	14.5	0.676
NM-SSJ	Sub Station	San Juan	35-045-1005	4646	-2.7	-2.1	14.1	15.5	0.812
CO-NSJ	Lake Capota	Archuleta	08-007-7004	4492	35.0	37.6	38.5	40.1	0.671
CO-NSJ	Shamrock	La Plata	08-067-1004	4363	8.2	9.0	15.4	15.9	0.662
CO-NSJ	Ignacio	La Plata	08-067-7001	4612	12.4	16.2	23.6	26.7	0.715
CO-NSJ	Bondad	La Plata	08-067-7003	4582	-10.5	-18.3	20.1	29.1	0.807
CO-NSJ	Cortez	Montezuma	08-083-0006	4718	17.4	20.9	25.2	27.5	0.635
CO-NSJ	Mesa Verde NP	Montezuma	08-083-0101	4714	-4.7	-5.4	11.9	12.5	0.651
CO-NSJ	TowaocUMU2	Montezuma	08-083-8001	4730	5.6	6.1	14.0	14.2	0.688
AZ-Misc	Chiricahua NM	Cochise	04-003-8001	4693	0.9	2.8	15.8	17.0	0.686
AZ-Misc	Petrified Forest NP	Navajo	04-017-0119	4684	-3.3	-3.1	12.5	13.1	0.740
TX-Misc	Palo Duro	Randall	48-381-9991	3934	-11.1	-9.5	18.4	19.6	0.709

2.5 Ozone Model Performance in the Permian Basin

There were four ozone monitoring sites operating in the New Mexico portion of the Permian Basin operating in 2022, three in New Mexico and one site in Texas. Figure 2-4 displays the ozone Design Values from 2014-2023 for the three New Mexico Permian Basin sites. The 2022 ozone Design Values at the Carlsbad City and Carlsbad Cavern sites in Eddy County were 77 ppb whereas the Hobbs site 2022 and 2023 ozone Design Values in Lea County were, respectively, 66 and 71 ppb.

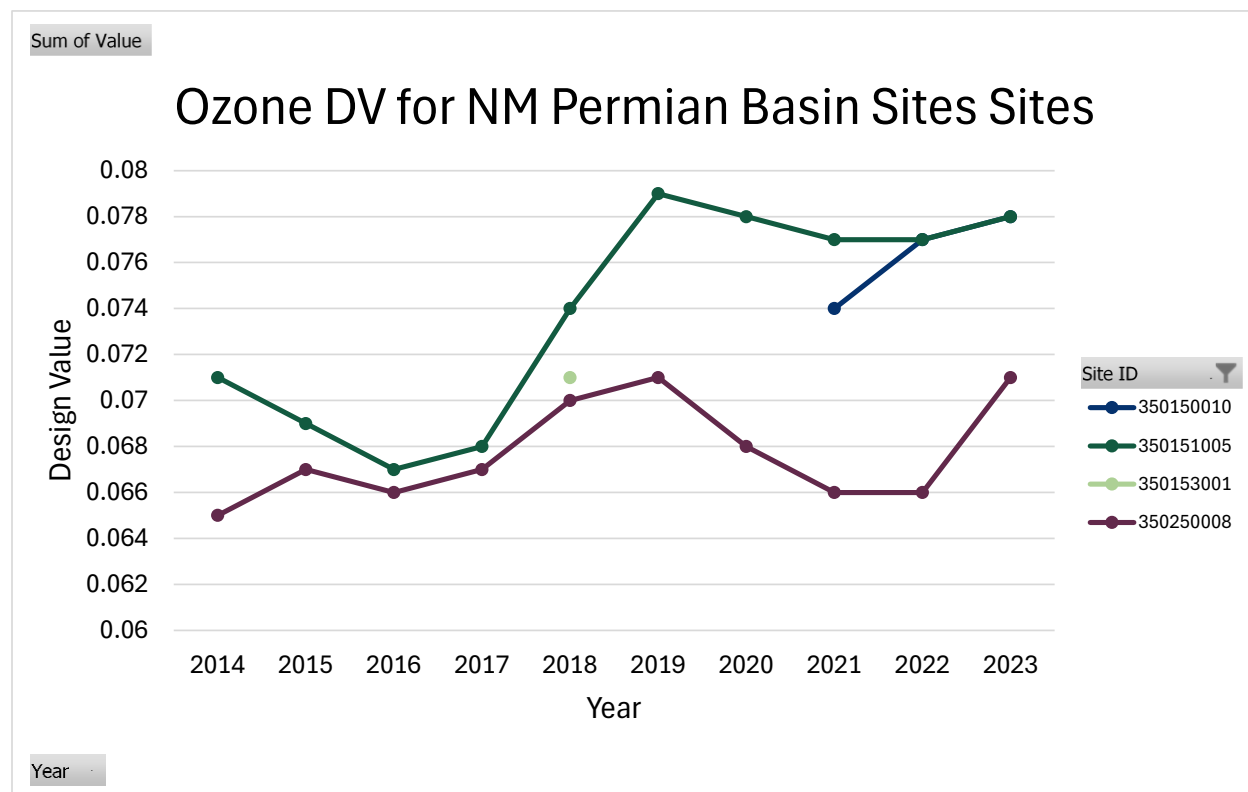


Figure 2-4. Ozone Design Value trends from 2014 to 2023 for New Mexico sites located in the Permian Basin: Carlsbad Cavern (350150010) and Carlsbad City (350151005) in Eddy County and Hobbs (350250008) in Lea County.

In the previous section (Tables 2-2 and 2-3), we showed that the NMB at the four sites in the Permian Basin fall between the Performance Goal and Criterion for MDA8 and hourly ozone concentrations (i.e., NMB between -5% and -15%), indicative of an underestimation bias. Scatter and time series plots of predicted and observed MDA8 ozone concentrations at the four sites in the Permian Basin are shown in Figures 2-5 and 2-6. The scatter plots display a MDA8 ozone underestimation tendency that is more evident at the two Eddy County and adjacent Texas Permian Basin sites (NMB of approximately -11%) than at the Hobbs site (NMB of -5%). At the two Eddy County and adjacent Texas Permian Basin sites, the 1:1 line of perfect agreement is approximately 5 ppb higher than it would be to go through the center of the predicted and observed MDA8 ozone scatter plot.

The time series of predicted and observed MDA8 ozone concentrations display better performance in April, May and early- to mid-June with ozone underestimations in late-June, July and August (Figure 2-6).

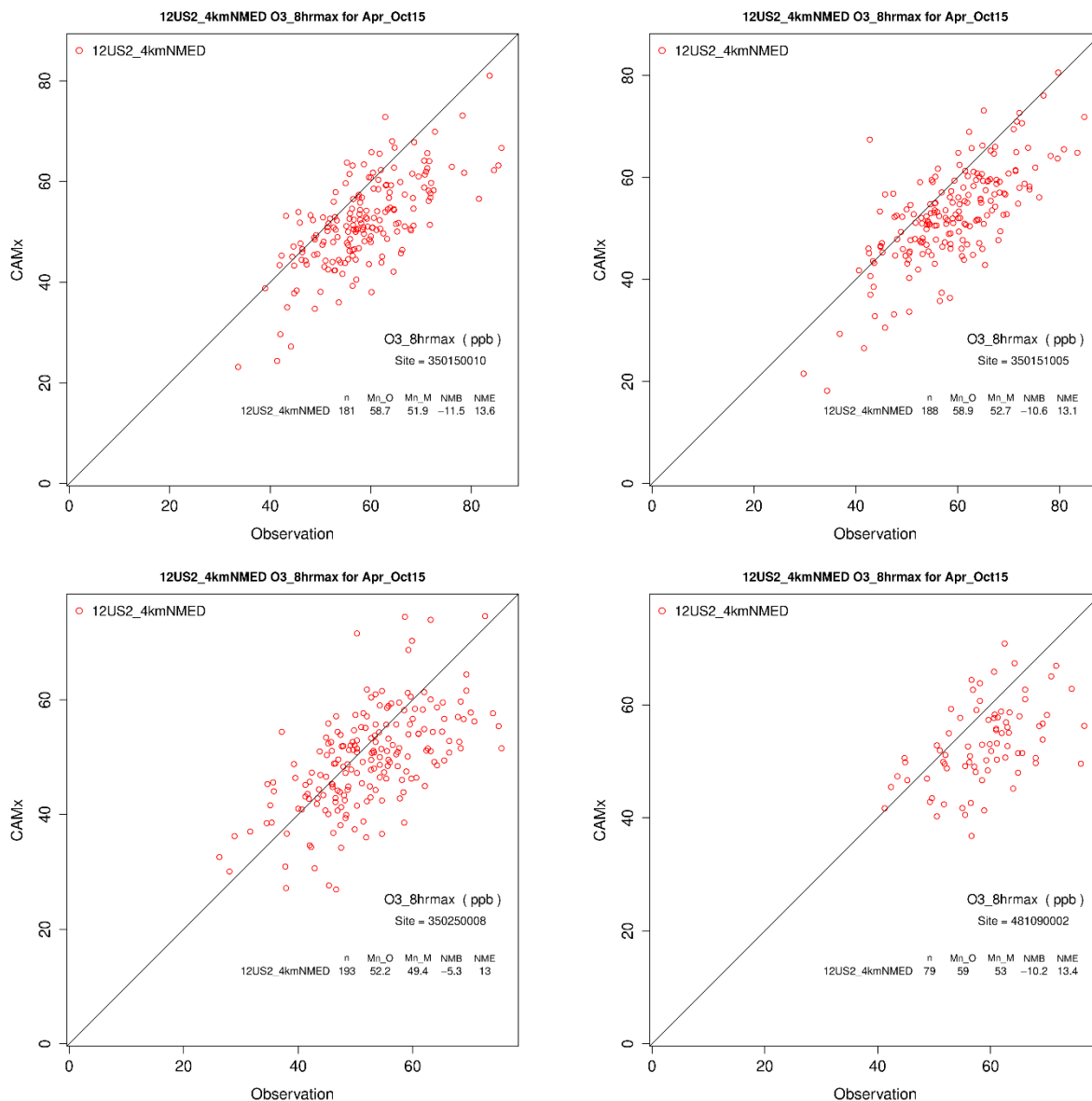


Figure 2-5. Scatter plots of predicted and observed MDA8 ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Cavern (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).

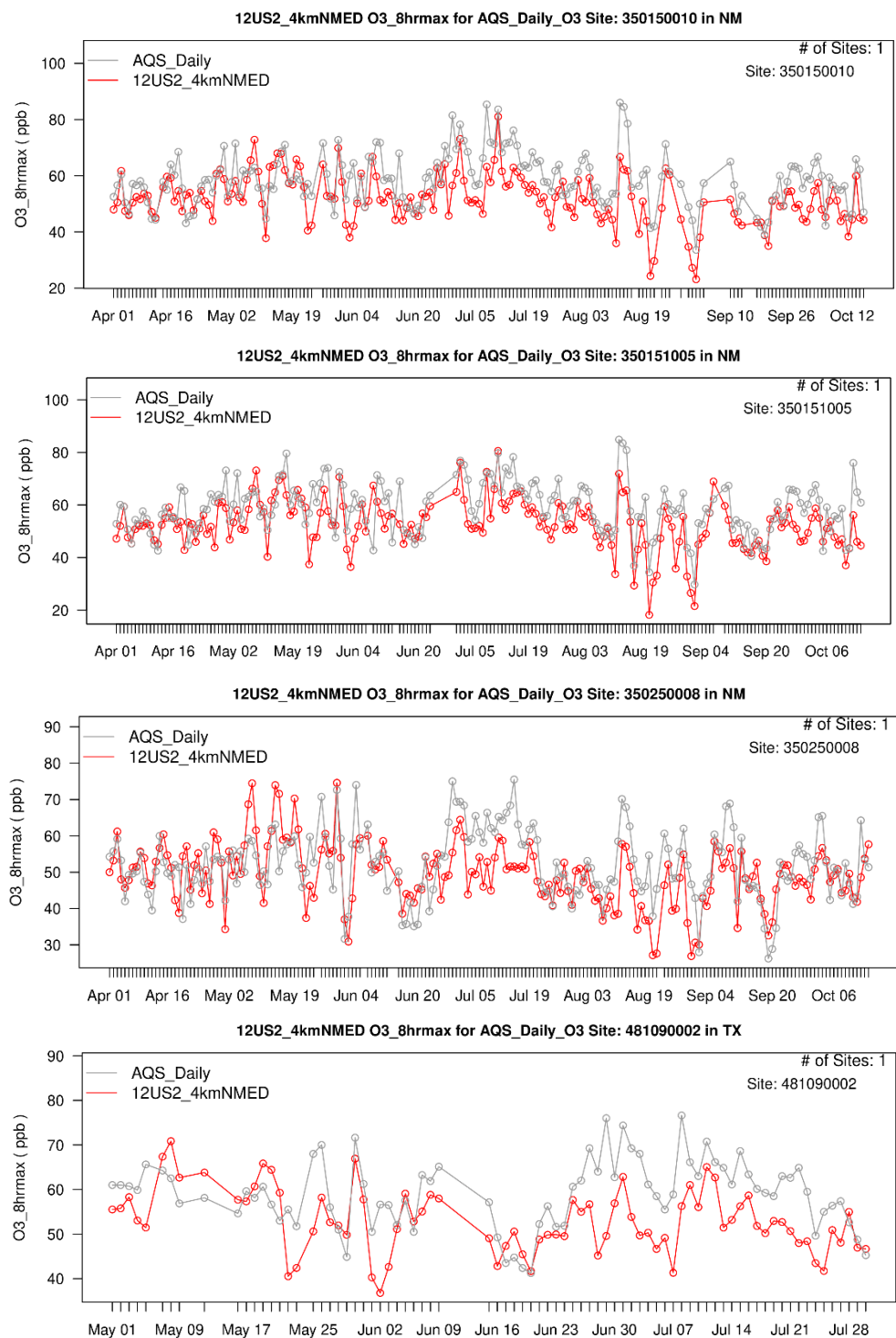


Figure 2-6. Time series plots of predicted and observed MDA8 ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Caverns (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).

The hourly ozone scatter plots for sites in the Permian Basin are shown in Figure 2-7. As seen for the MDA8 ozone, the NMB at the Eddy County and nearby Guadalupe Mountains, Texas sites has a negative bias of approximately -13% while the bias at Hobbs is zero. The scatter of predicted and observed hourly ozone concentrations is shifted downward by ~5 ppb relative to the 1:1 line of perfect agreement at the two Eddy County sites. The modeled and observed hourly ozone at the Carlsbad City site approach zero while they stay more elevated at the Carlsbad Cavern site indicating that the Carlsbad City site is more affected by local NO_x emissions that titrate the nighttime ozone than the Carlsbad Caverns site. The 1:1 line of perfect agreement goes through the center of the hourly ozone scatter plot for the Hobbs site that is consistent with the zero bias.

The time series of predicted and observed hourly ozone concentrations for six episodes during the April to October 2022 evaluation period and the three New Mexico Permian Basin monitoring sites are shown in Figures 2-8 and 2-9. The hourly time series comparisons are particularly informative of the CAMx 2022v1 12 km ozone model performance in the Permian Basin showing that the model frequently underestimates the observed afternoon hourly ozone peaks on many days, whereas on others the model matches the observed hourly ozone diurnal ozone pattern quite well. Given the coarse 12 km grid resolution used in the EMP 2022v1 modeling platform, it is not surprising that the observed afternoon elevated peak hourly ozone concentrations are understated by the modeled spatial averaged concentrations. For the first episode analysis period, the model matches the observed hourly ozone extremely well on May 14 to 15 and match the observed ozone rise in the morning of May 16 but the modeled afternoon hourly ozone peak is not as high as observations (Figure 2-8 top panels and Figure 2-9, top left panel). For the second episode period (May 25 to 30), the model matches the observed hourly ozone diurnal pattern well except for the afternoon peaks on some days, while on others (e.g., May 30) the observed hourly ozone peaks are matched well. There is a worsening in ozone model performance as the summer of 2022 progresses such that by July and August there is a clear ozone underestimation at the Permian Basin sites on most days (good hourly ozone performance is seen on July 10-11).

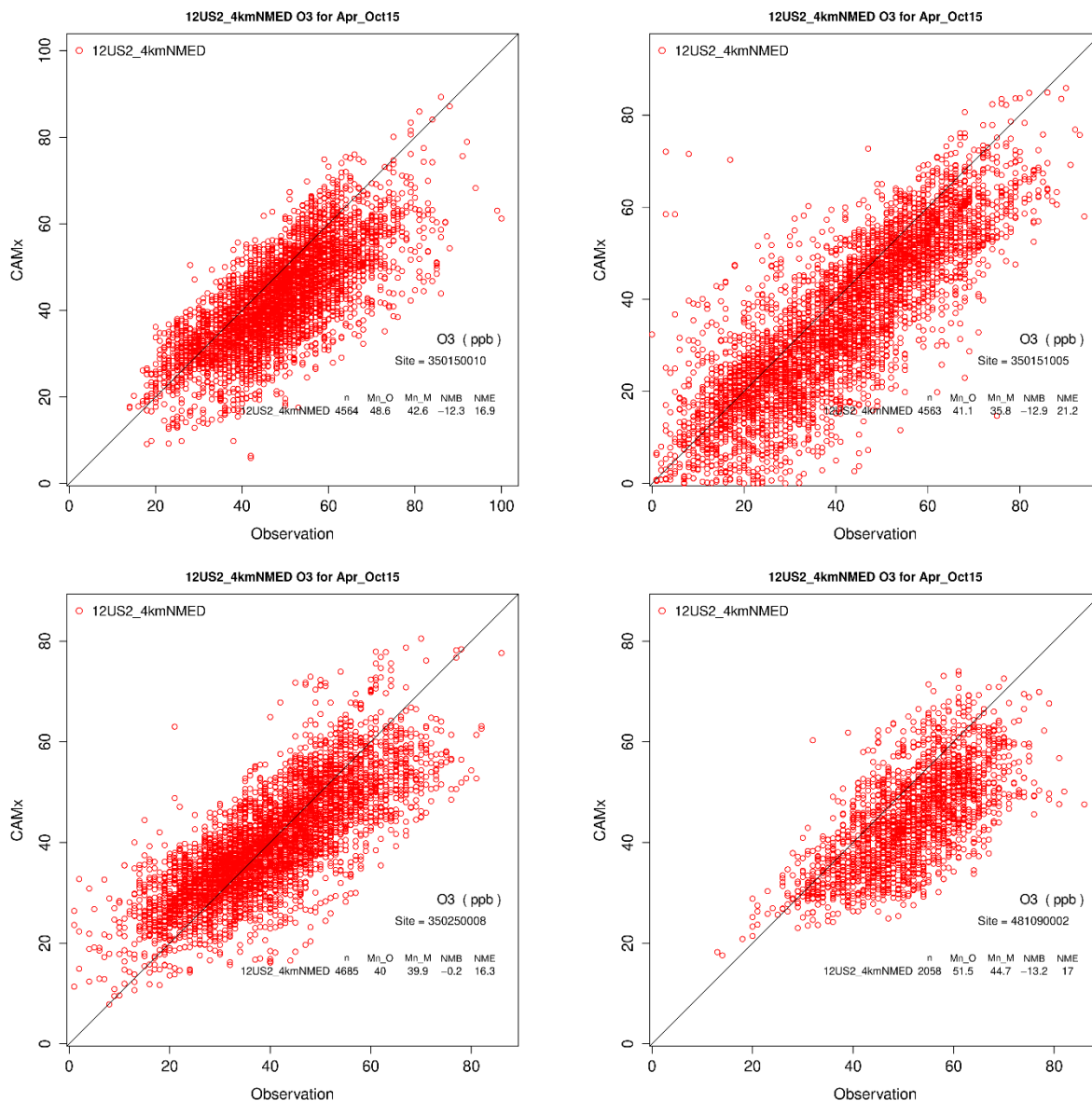


Figure 2-7. Scatter plots of predicted and observed hourly ozone concentrations at monitoring sites in the Permian Basin: Carlsbad Cavern (350150010), Carlsbad City (350151005), Hobbs (350250008) and Guadalupe Mountains NP (481090002).

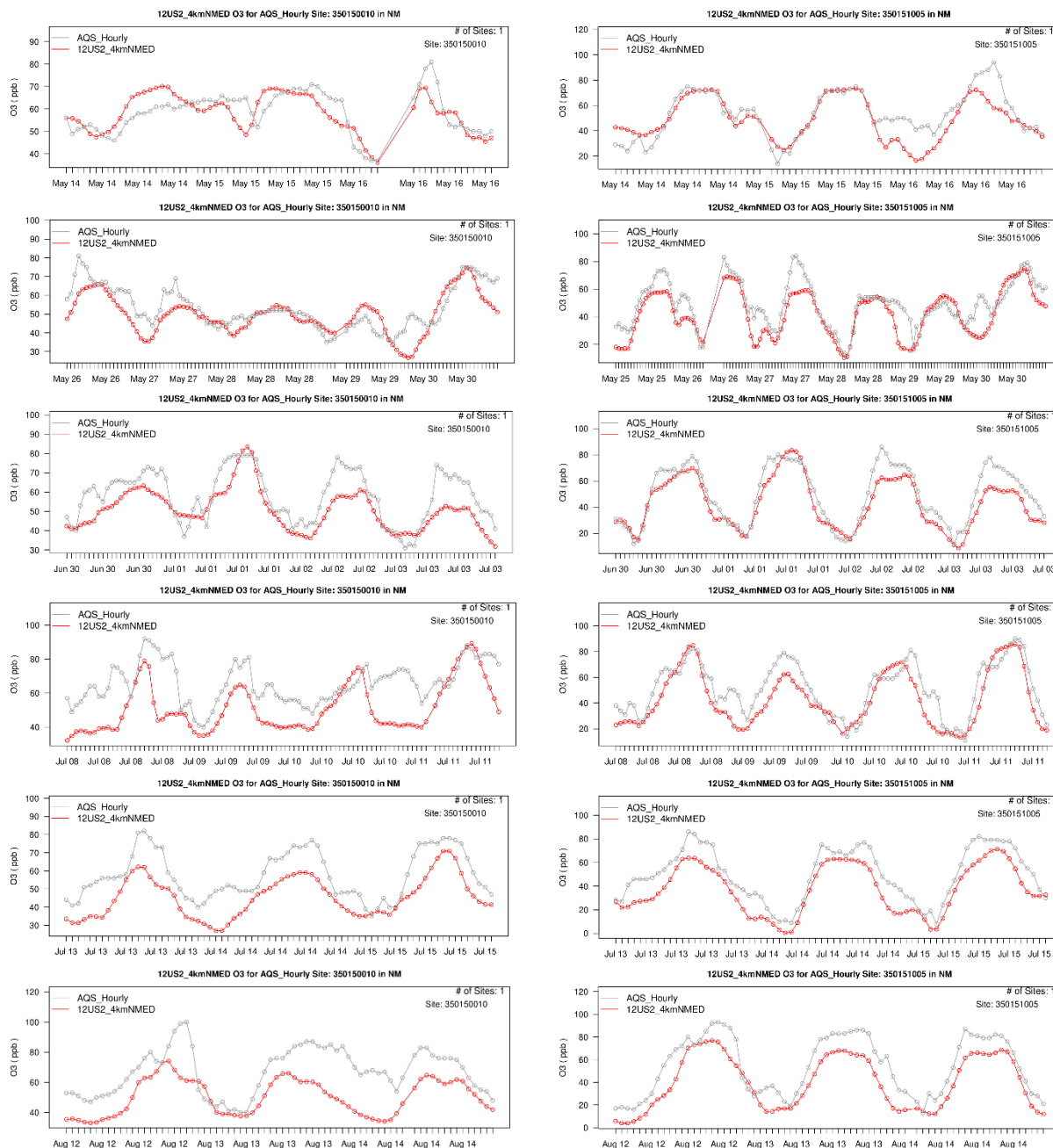


Figure 2-8. Time series of predicted and observed hourly ozone concentration at the Permian Basin Carlsbad Cavern (350150010) and Carlsbad City (350151005) monitoring sites for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

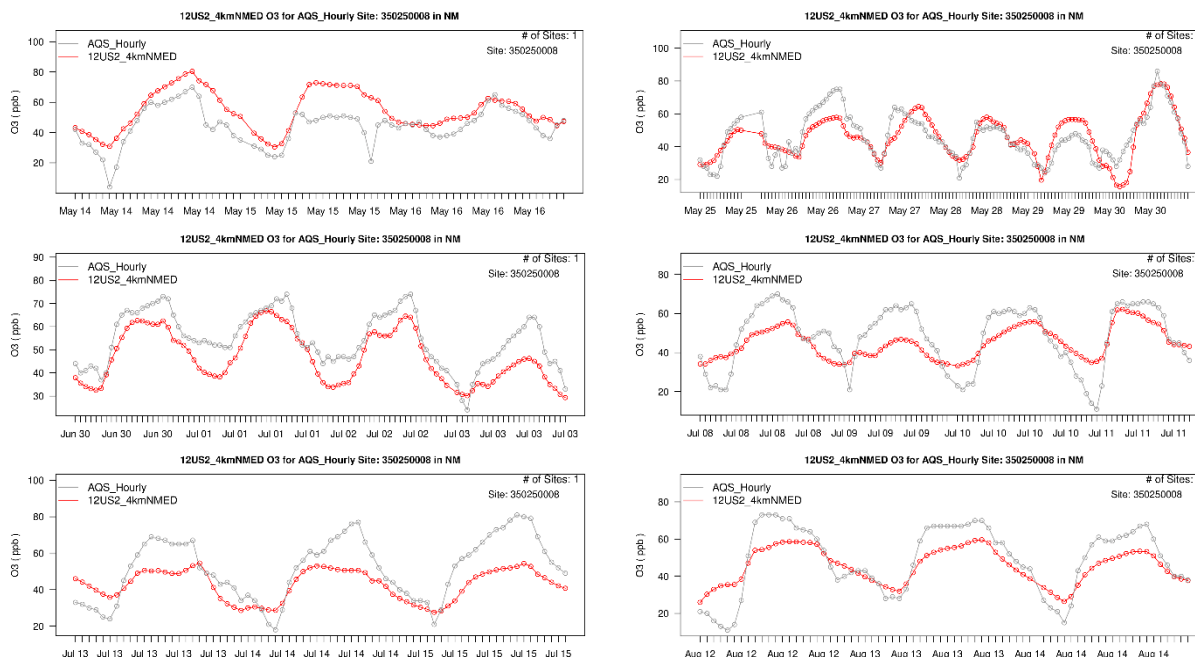


Figure 2-9. Time series of predicted and observed hourly ozone concentration at the Permian Basin Hobbs (350250008) monitoring site for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

2.6 Ozone Model Performance in Southern New Mexico

There are five sites in Dona Ana County in southern New Mexico with most of them located in the El Paso-Las Cruces TX-NM ozone nonattainment area for the 2015 ozone NAAQS. Except for the Solano monitoring site that is located in central Dona Ana County outside of the nonattainment area, the other four southern New Mexico sites are located near El Paso, TX and have similar model performance to the El Paso sites adjacent to southeast Dona Ana County. The ozone MPE results for the Desert View (350130021) and La Union (350130008) sites in southern Dona Ana County that have the highest ozone concentrations (e.g., 2021-2023 ozone DVs of, respectively, 79 and 76 ppb; Figure 2-10) are presented below to represent ozone performance at the southern New Mexico sites.

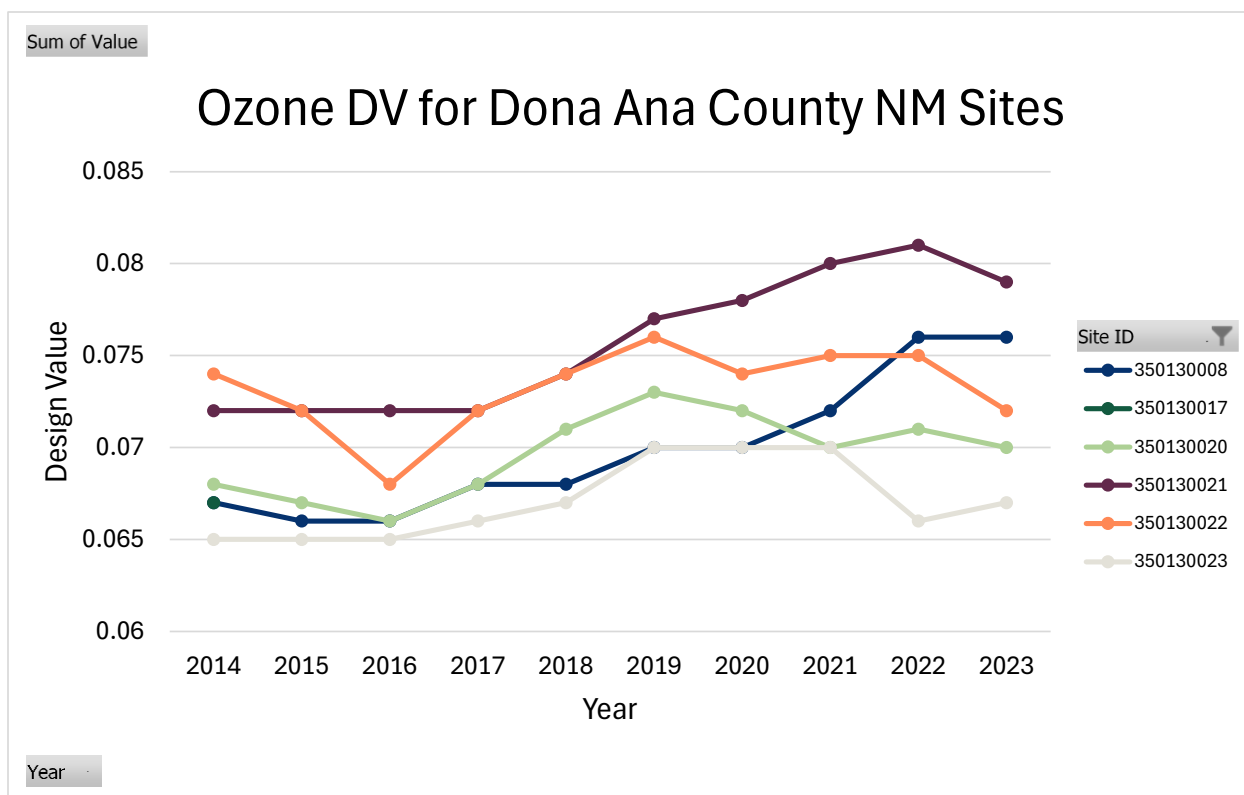


Figure 2-10. Ozone Design Value trends from 2014 to 2023 for sites located in Dona Ana County in Southern New Mexico: La Union (350130008), Sunland Park (350130017), Chaparral (350130020), Desert View (350130021), Santa Teresa (350130022) and Solano (350130023).

With one exception, the Dona Ana County sites have an NMB MDA8 ozone underestimation bias that range from -4.8% to -9.7% for sites in the Sunland Park area adjacent to El Paso (Table 2-2). The exception is the Solano site in central Dona Ana County whose MDA8 ozone NMB is +5.5%. The scatter plots of predicted and observed MDA8 ozone concentrations at the Desert View and La Union sites are shown in Figure 2-11. The MDA8 ozone underestimation bias at Desert View (-10%) is greater than at La Union (-5%) due to higher observed ozone at Desert View as the modeled MDA8 ozone is similar at the two sites.

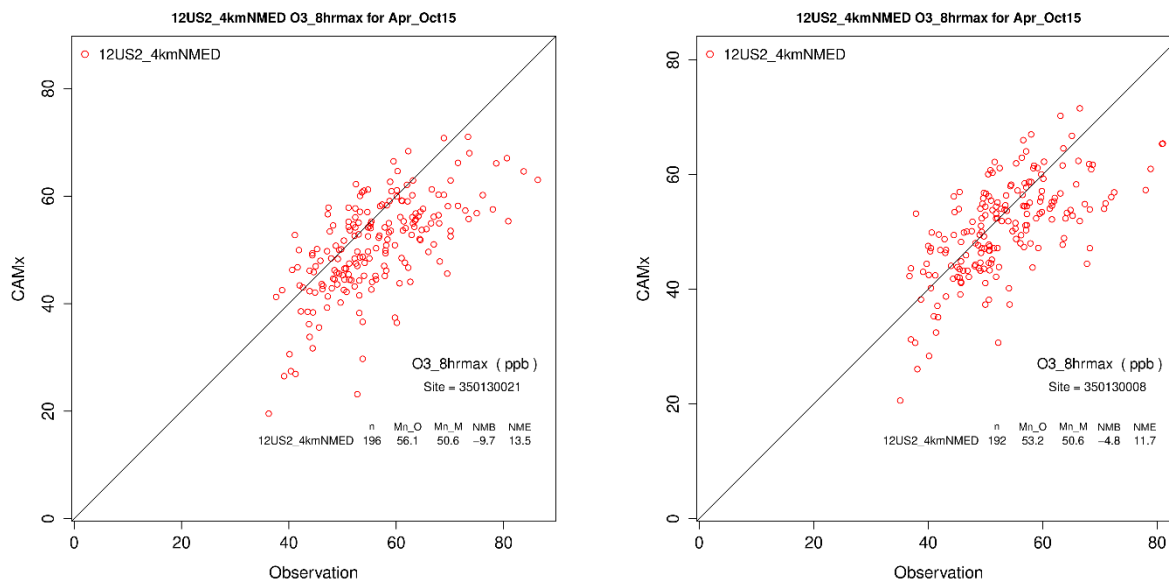


Figure 2-11. Scatter plots of predicted and observed MDA8 ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.

Time series of predicted and observed MDA8 ozone concentrations at Desert View and La Union sites are shown in Figure 2-12. The model reproduces the observed MDA8 ozone reasonably well in April, May and most of June. As seen for the Permian Basin ozone sites, at the end of June the model starts exhibiting a larger and almost systematic underestimation bias of the observed MDA8 ozone concentrations that persists through July and August.

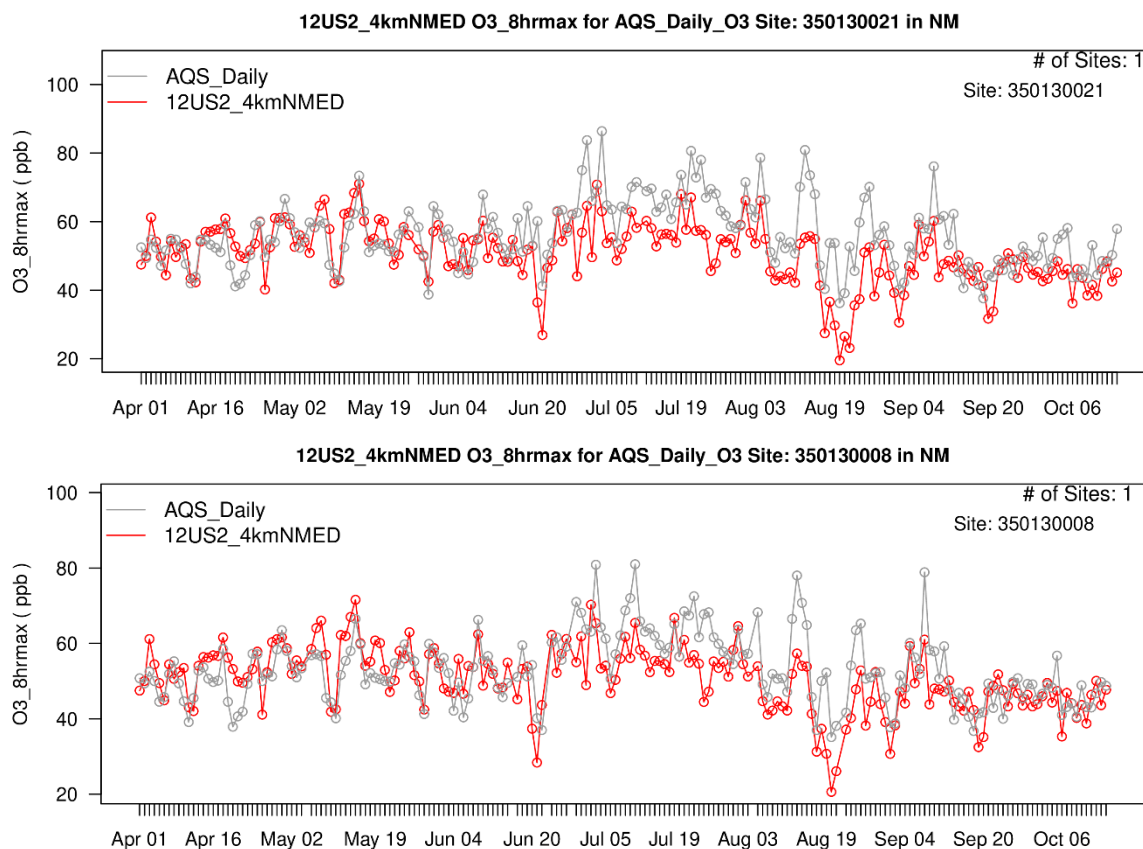


Figure 2-12. Time series of predicted and observed MDA8 ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.

The hourly ozone scatter plots for the two Sunland Park monitors are shown in Figure 2-13 with Desert View having a NMB of -7.2% and La Union having a NMB of +7.2%. The La Union positive bias is due to overestimating the low nighttime observed ozone, likely due to excessive dilution of the local NO_x emissions in the coarse 12 km grid resulting in less ozone titration than observed.

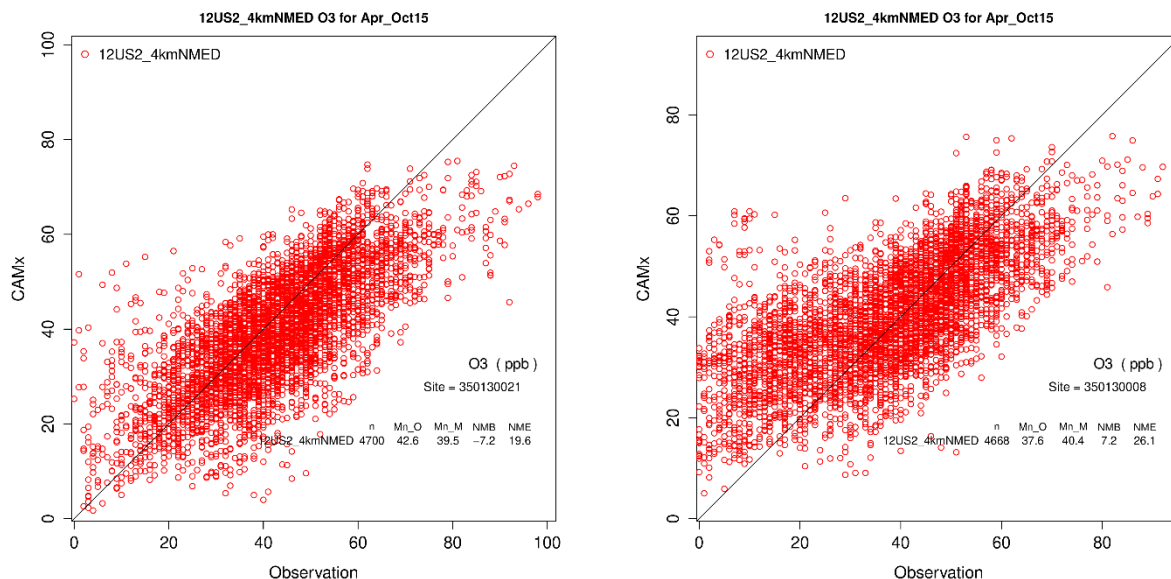


Figure 2-13. Scatter plots of predicted and observed hourly ozone concentrations at the Desert View (350130021) and La Union (35013008) Dona Ana County monitoring sites in southern New Mexico.

The time series of predicted and observed hourly ozone concentrations at Desert View and La Union and the 6 selected episodes are shown in Figure 2-14. For the May 14-16 episode, the model fails to predict the diurnal trends of the observed hourly ozone concentrations with higher nighttime ozone than observed for unknown reasons as the model does a better job replicating the observed night low hourly ozone for the other episodes. For the first four episodes during May through July 11, the model reproduces the observed diurnal hourly ozone concentration well on some days, whereas on others the model fails to reproduce the observed afternoon hourly ozone peaks. For the last two episodes in July and August, the model underestimates the observed daytime hourly ozone concentrations with the underestimation greater at Desert View than at La Union.

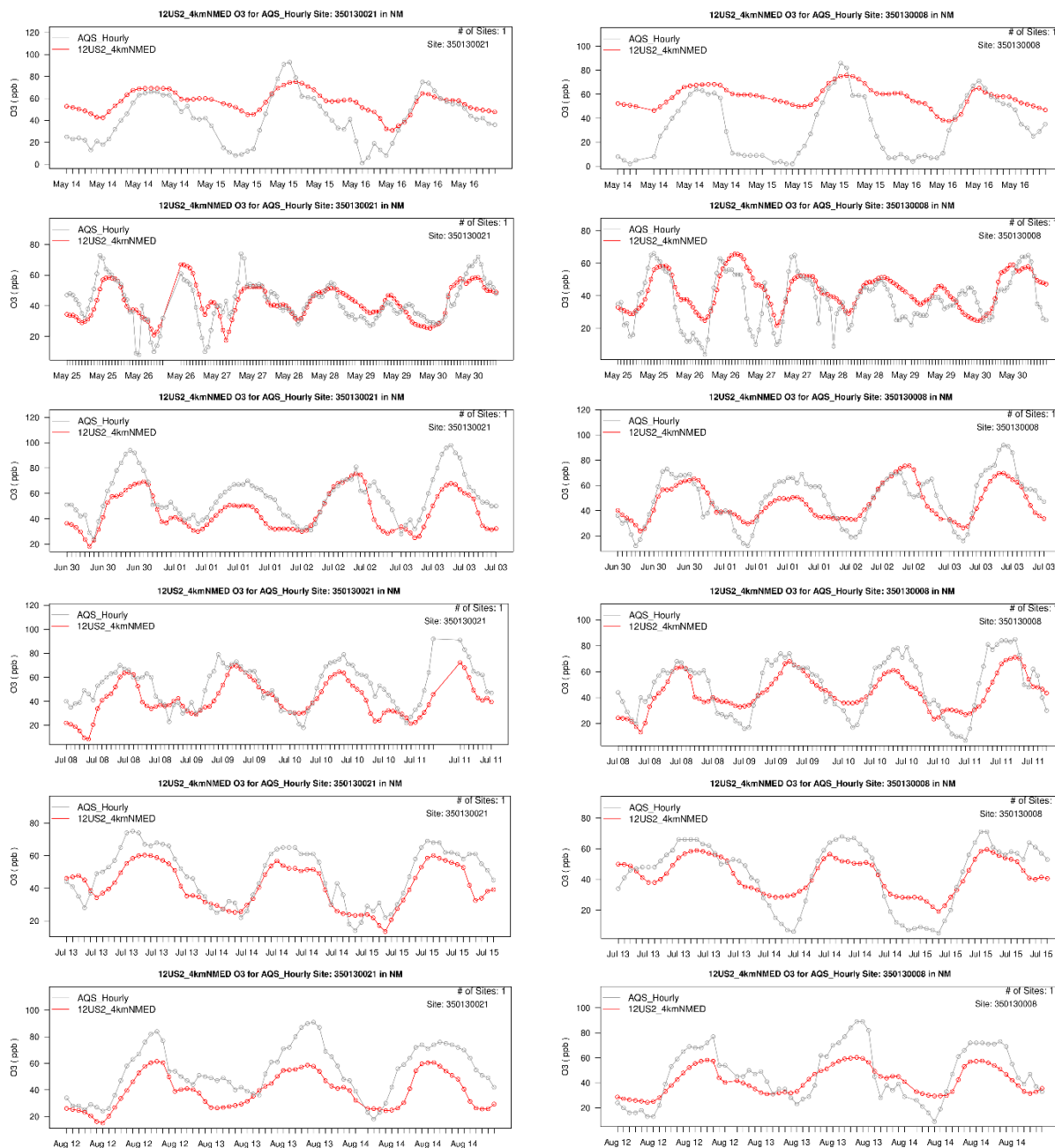


Figure 2-14. Time series of predicted and observed hourly ozone concentration at the Dona Ana County Desert View (350130021) and La Union (350130008) monitoring sites for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

2.7 Ozone Model Performance in El Paso, Texas

There are five ozone monitoring sites operating in El Paso, Texas during 2022. The MDA8 ozone NMB at the El Paso sites ranges from -8.6% to +4.9% (Table 2-2). Below we show examples of the ozone model performance at the Ojo De Agua (481411021) and Socorro Hueco (481410057) ozone sites that have some of the highest ozone, as well as being westerly and easterly sites in El Paso. Scatter plots and time series plots for the two example El Paso sites are shown in, respectively, Figures 2-15 and 2-16. The MDA8 ozone performance at Ojo De Agua (-9% NMB) is similar to Desert View, which is not surprising given their close proximity (see Figure 2-1). However, the MDA8 ozone performance at Socorro Hueco and the other sites in El Paso is much better with lower bias and also not exhibiting the large degradation in model performance at the end of June that continues into July and August as seen at the Ojo De Agua and sites in southern Dona Ana County (Figure 2-16).

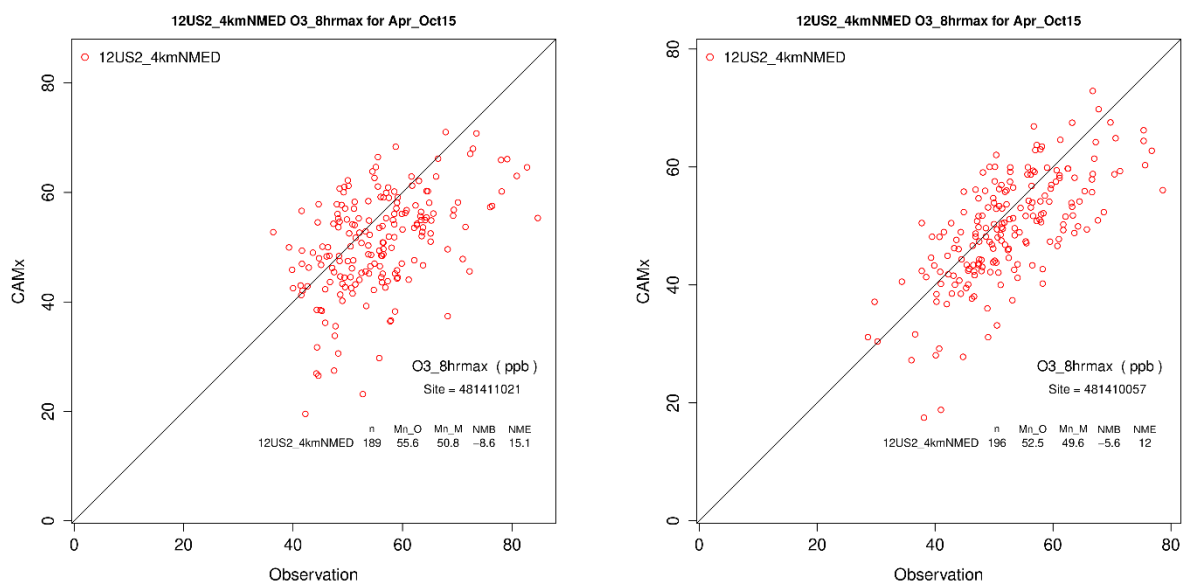


Figure 2-15. Scatter plots of predicted and observed MDA8 ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.

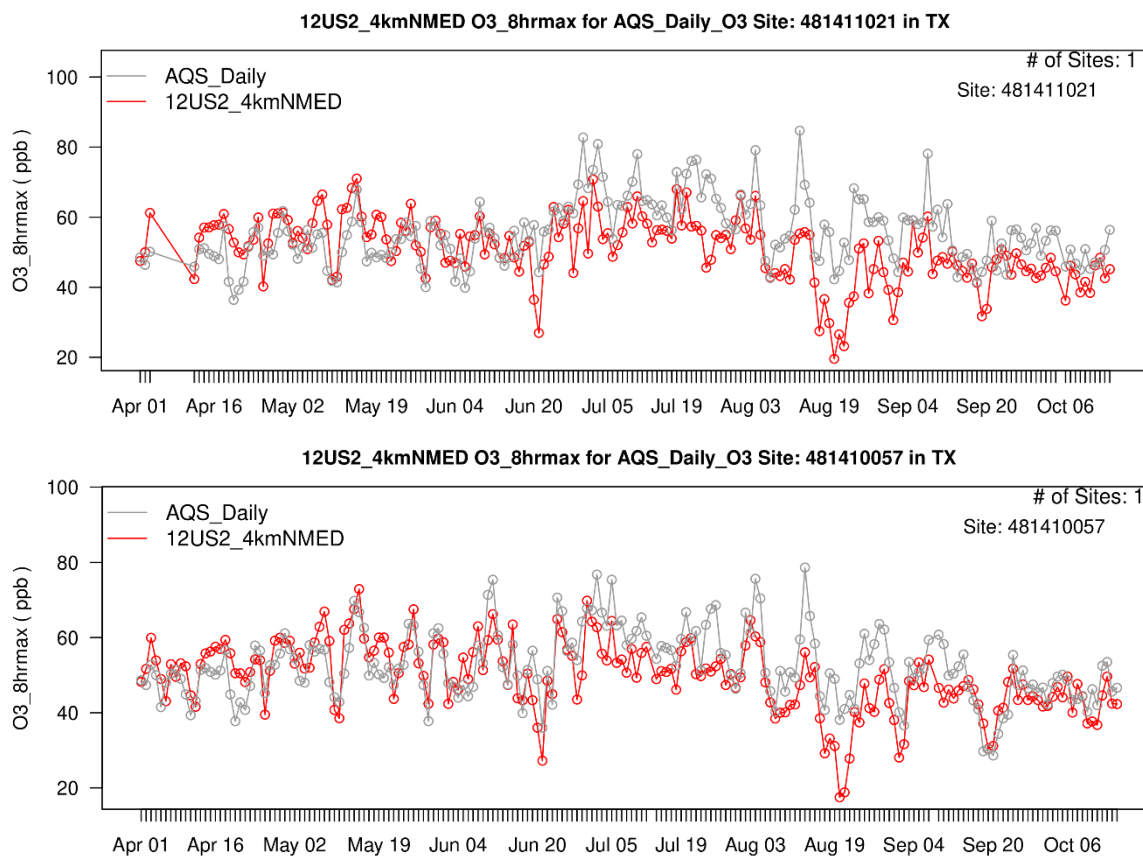


Figure 2-16. Time series of predicted and observed MDA8 ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.

The hourly ozone scatter plots for the two example El Paso monitoring sites are shown in Figure 2-17 with Ojo De Agua having a NMB of -14% and Socorro Hueco a NMB of -5%. The hourly ozone underestimation at Ojo De Agua is apparent in the scatter plot with the 1:1 line passing through the upper part of the scatter. At Socorro Hueco, the 1:1 line passes through the center of the hourly ozone scatter plot with the scatter plot exhibiting lots of scatter at the lower observed and predicted ozone concentrations (< 40 ppb) suggesting that the model has difficulty to estimate the nighttime lower hourly ozone concentrations.

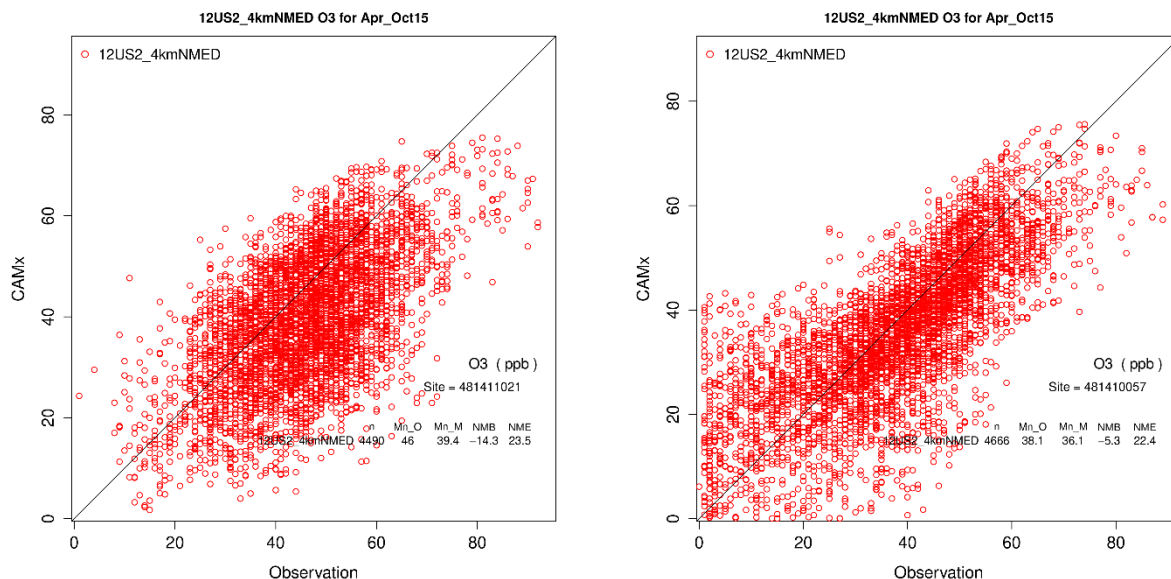


Figure 2-17. Scatter plots of predicted and observed hourly ozone concentrations at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas.

The time series of predicted and observed hourly ozone concentrations at the two example El Paso sites confirm much better ozone performance at the Socorro Hueco site compared to Ojo De Agua site (Figure 2-18). Whereas the Ojo De Agua site exhibits a larger ozone underestimation that almost becomes systematic starting in late June and through July and August, at Socorro Hueco the model mostly matches the observed hourly ozone well until August. In fact, the model hourly ozone performance for the first four episodes is very good and its ability to reproduce the observed variations in hourly ozone during the May 25 – 30 episode is remarkably good.

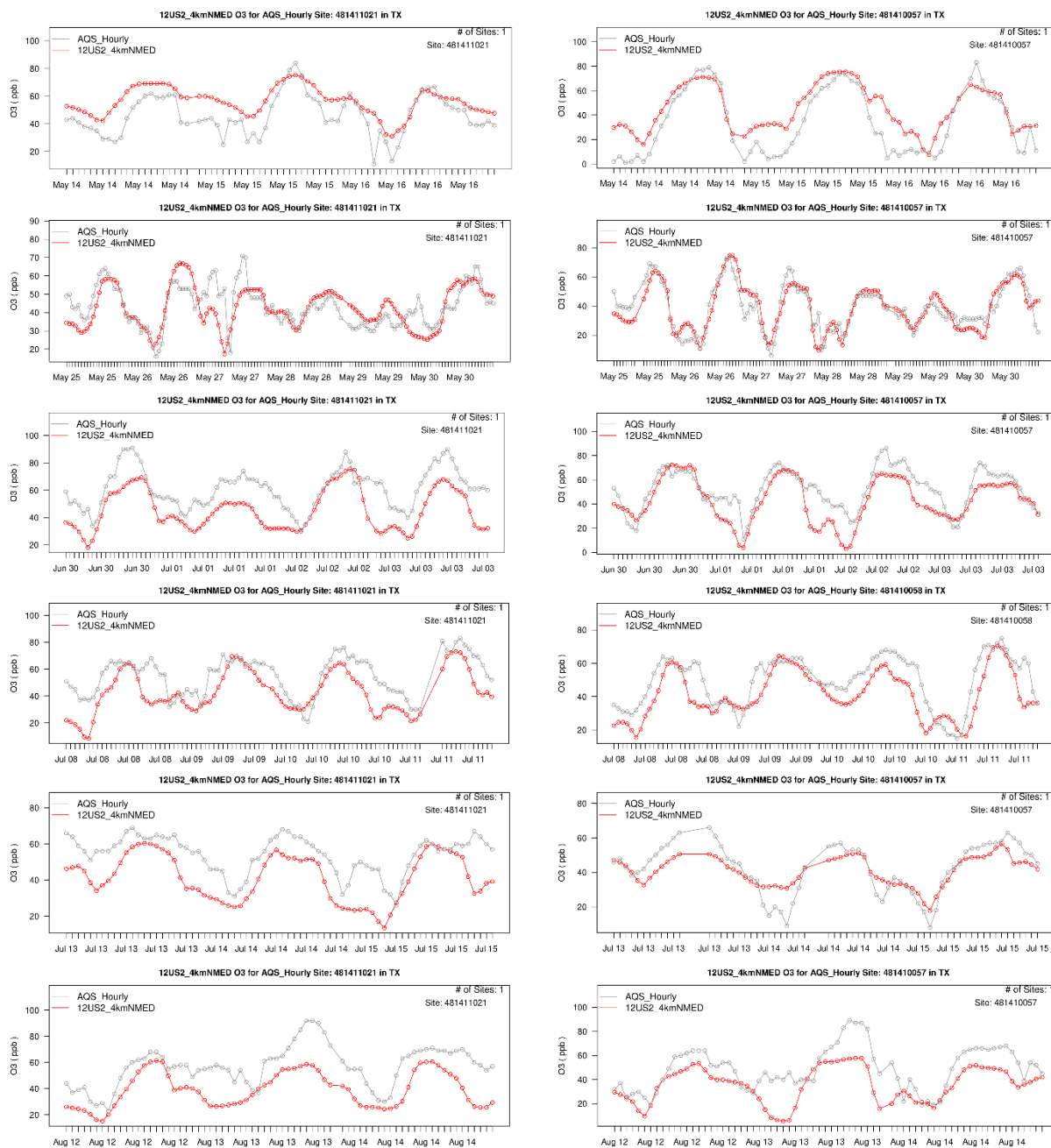


Figure 2-18. Time series of predicted and observed hourly ozone concentration at the Ojo De Agua (481411021) and Socorro Hueco (481410057) monitoring sites in El Paso, Texas for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

2.8 Ozone Model Performance in Central New Mexico

There are six sites in the Central New Mexico region, three in Bernalillo County and one each in Sandoval, Santa Fe and Valencia Counties. Based on performance statistics, the ozone model performance is slightly better at the six Central New Mexico sites than at the southern (Dona Ana County) and southeastern (Permian Basin) New Mexico sites with the MDA8 ozone NMB ranging from -9.0% to +1.2% (Table 2-2) and hourly ozone NMB ranging from -8.8% to +9.6% (Table 2-3) all achieving the bias Performance Criterion and some sites even achieving the bias Performance Goal. The Foot Hills site in Bernalillo County and the Bernalillo site in Sandoval County sites are used as an example of model performance for Central New Mexico as they had the highest 2021-2023 ozone Design Values (72 and 69 ppb; Figure 2-19) of the Central New Mexico sites.

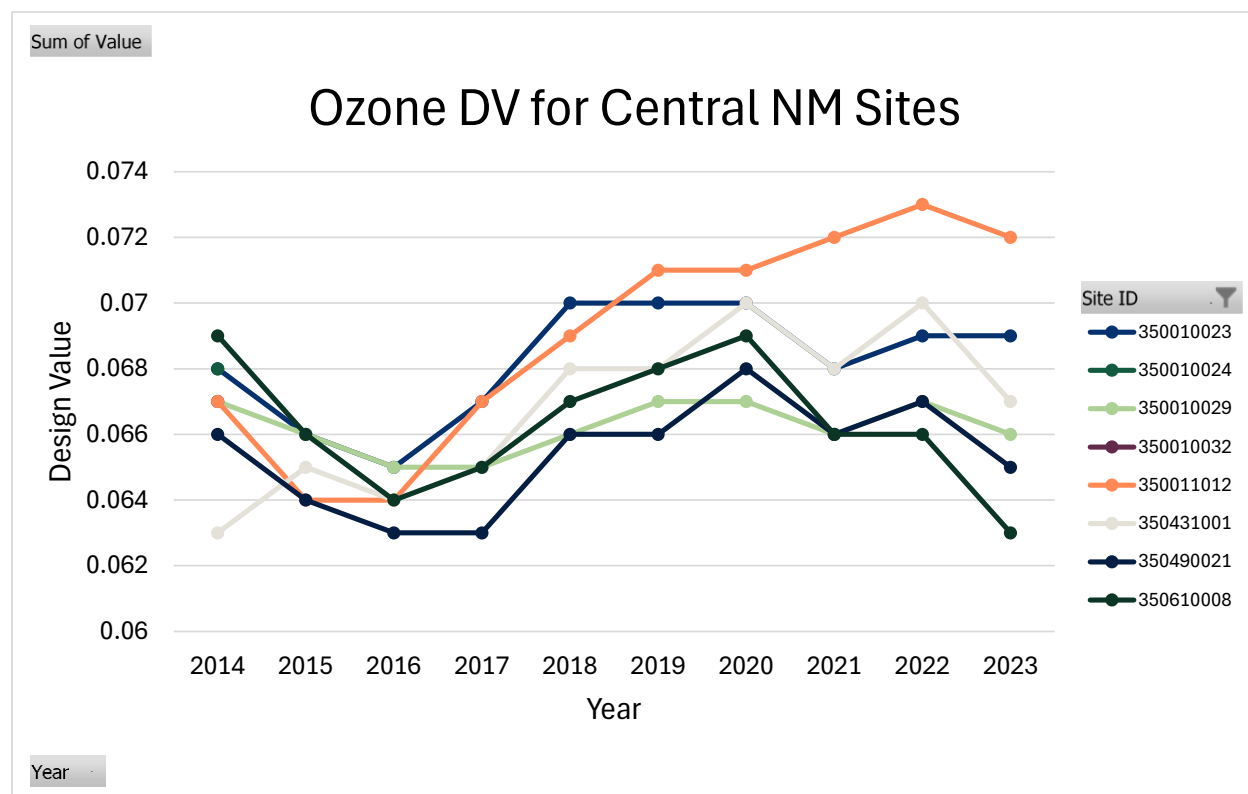


Figure 2-19. Ozone Design Value trends from 2014 to 2023 for sites located in Central New Mexico: Del Norte (350010023), South Valley (350010029) and Foot Hills (350011012) in Bernalillo County; Bernalillo (350431001) in Sandoval County; Santa Fe (350490021) in Santa Fe County; and Los Lunas (350610008) in Valencia County.

Scatter plots of predicted and observed MDA8 ozone concentrations at the Foot Hills and Bernalillo sites are shown in Figure 2-20. Although the range of the modeled MDA8 ozone concentrations are similar (approximately 40 to 70 ppb), there is higher observed MDA8 ozone at Foot Hills resulting in an underestimation bias (-9%), whereas there is little bias at Bernalillo (-2%).

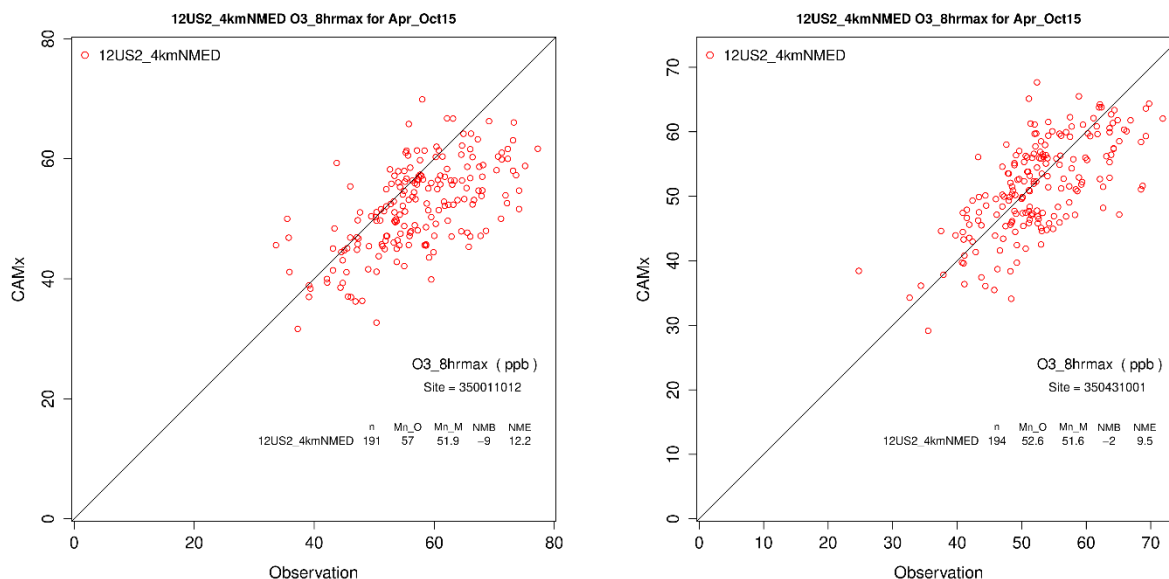


Figure 2-20. Scatter plots of predicted and observed MDA8 ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.

The time series of predicted and observed MDA8 ozone at Foot Hills and Bernalillo are shown in Figure 2-21. At Foot Hills, there is good agreement in MDA8 ozone during April, May and June even replicating very low observed ozone around June 20. However, after this low ozone period, the observed MDA8 ozone concentrations are mostly underestimated in late June and into July and August at the Foot Hills site with better performance in September. Although there is some underestimation of the observed high MDA8 ozone days in July and August at the Bernalillo site in Sandoval County, the ozone underestimation is less severe than that seen at Foot hills.

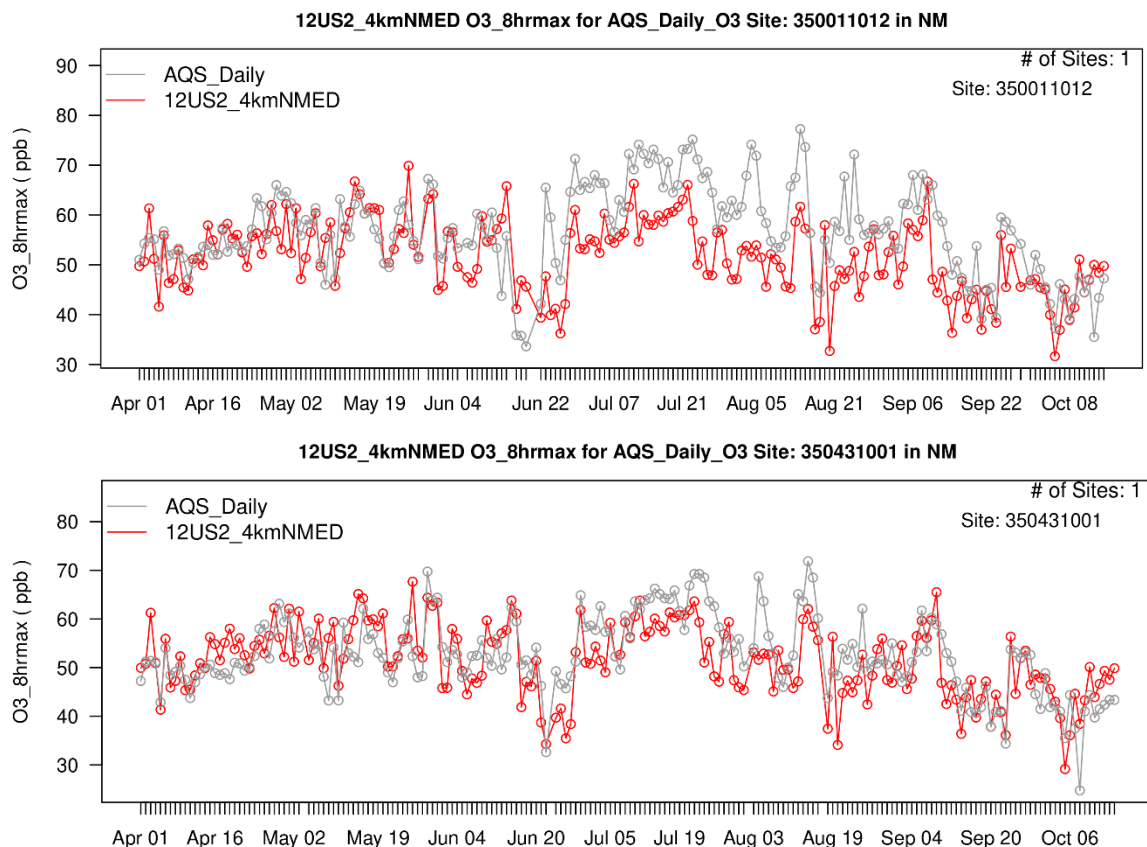


Figure 2-21. Time series of predicted and observed MDA8 ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.

The hourly ozone scatter plot at Foot Hills site shows an ozone underestimation tendency with a NMB of -9%, the same as for MDA8 ozone (Figure 2-22). Better hourly ozone performance is seen at the Bernalillo site that has a NMB of 9% due to an overestimation of the lower observed hourly ozone concentrations; the observed hourly ozone has many values below 20 ppb while the modeled values rarely go below 20 ppb. For both Central New Mexico sites, when the observed hourly ozone is above 70 ppb the modeled hourly ozone is rarely above 60 ppb.

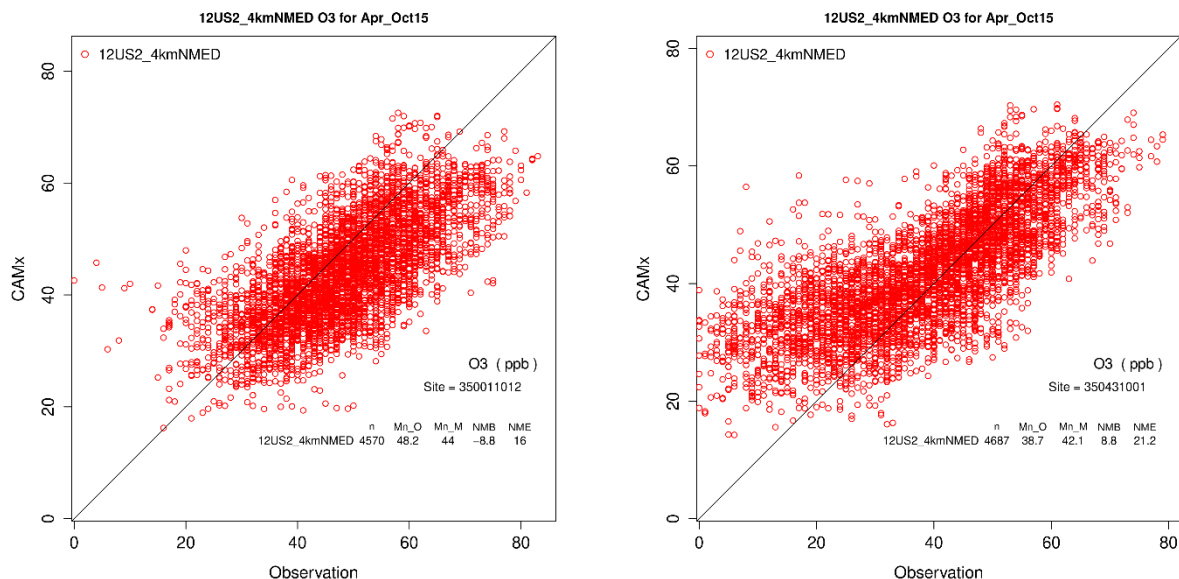


Figure 2-22. Scatter plots of predicted and observed hourly ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico.

The time series of predicted and observed hourly ozone concentrations at the Foot Hills and Bernalillo Central New Mexico sites are shown in Figure 2-23. The model does a reasonable job reproducing the afternoon hourly ozone at the two sites for the May 14-16 first episode, however like the other monitoring sites it overstates the nighttime low ozone. The overestimation of the nighttime low ozone concentrations is an issue for the other episodes at the Bernalillo site, which was also indicated in the hourly ozone scatter plot (Figure 2-22, right panel). The observed hourly ozone is reproduced well by the model for the second episode (May 25-30) at both Central New Mexico sites. For the remainder of the four episodes in July and August, the observed afternoon hourly ozone at the Foot Hills site is underestimated, whereas the hourly ozone at the Bernalillo site is reproduced well on most days.

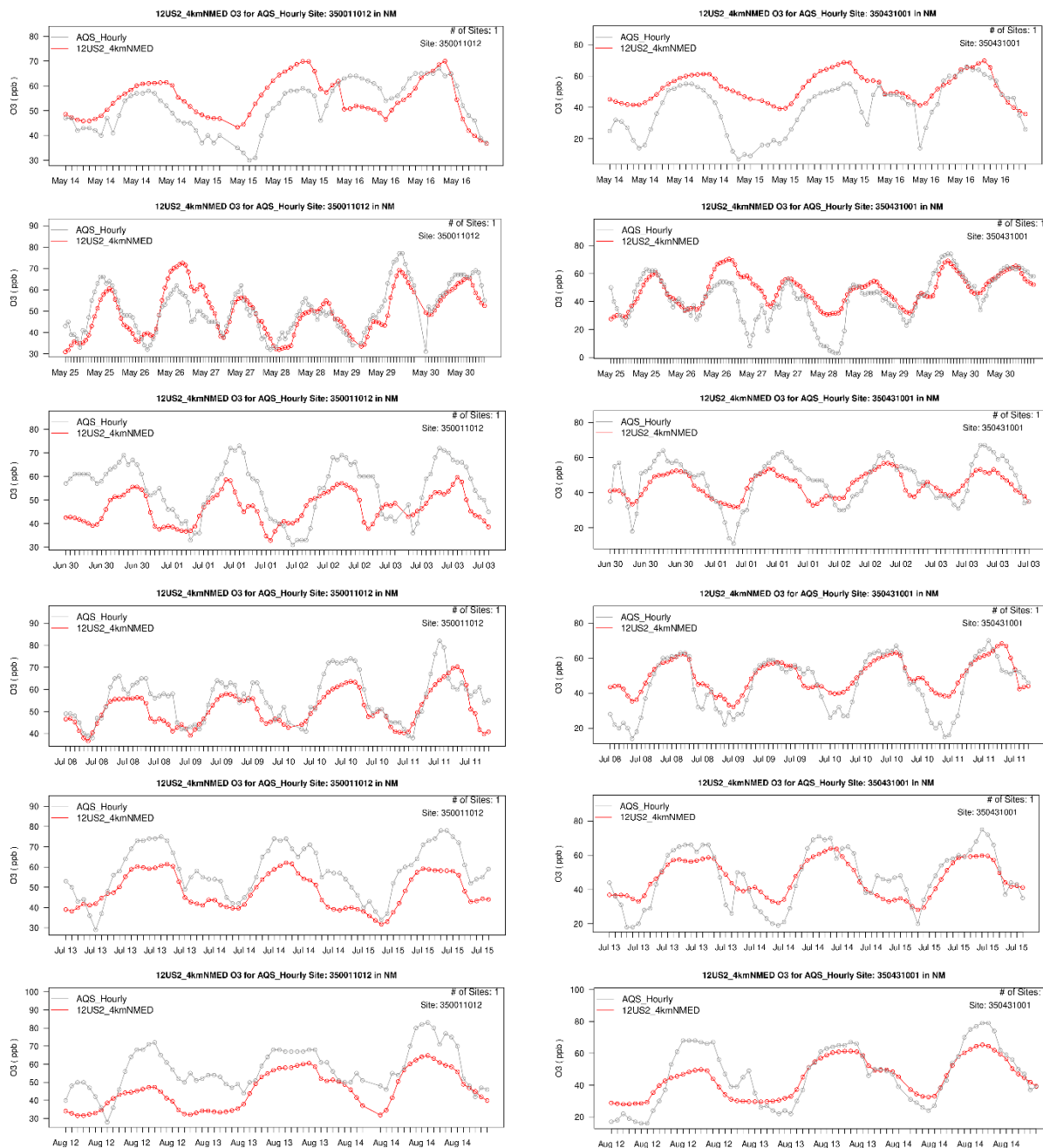


Figure 2-23. Time series of predicted and observed hourly ozone concentration at the Foot Hills (350011012) site in Bernalillo County and Bernalillo (350431001) site in Sandoval County in Central New Mexico for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

2.9 Ozone Model Performance in the South San Juan Basin in Northwest New Mexico

There are five ozone monitoring sites in the South San Juan Basin in Northwest New Mexico region, four in San Juan County and one in Rio Arriba County. Figure 2-25 displays the 2014 to 2023 ozone Design Value trends at the five Northwest New Mexico sites. The highest ozone Design Value occurs at the Navajo Lake site with 2022 and 2023 Design Values of 70 ppb that is just below the 2025 ozone NAAQS. The next highest ozone Design Value is 67 ppb that occurs at the Chaco and Sub Station sites. We use the ozone model performance for the Navajo Lake and Sub Station sites to illustrate ozone performance in Northwest New Mexico.

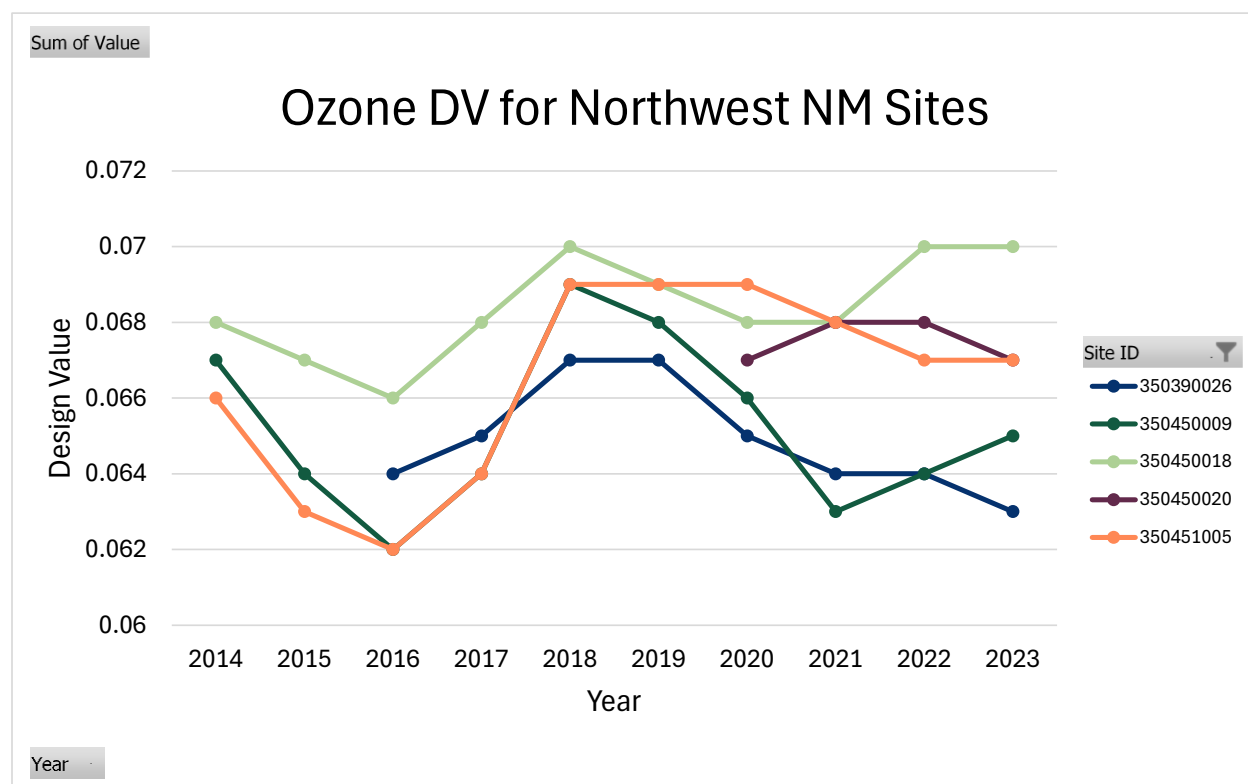


Figure 2-24. Ozone Design Values (DV; ppm) for sites in the South San Juan Basin in Northwest New Mexico: Coyote (350390026), Bloomfield (350450009), Navajo Lake (350450018), Chaco (350450020) and Sub Station (350451005).

Except for the Coyote site in Rio Arriba County that had a 9% NMB, the MDA8 ozone NMB and NME at other sites in Northwest New Mexico achieved the bias Performance Goal (Table 2-2). Again, except for the ozone overestimation bias at Coyote all the San Juan County sites hourly ozone NMB achieve the Performance Criteria with half achieving the bias Performance Goal.

Although data point show considerable spread, the 1:1 line of perfect agreement runs through the middle of the MDA8 ozone scatter plots (Figure 2-25) for Navajo Lake and Sub Station resulting in low bias (-3% and -4%) and error (8.8% and 9.2%) that achieve the Performance Goals. The time series plots (Figure 2-26) show much better agreement between the modeled and observed MDA8 ozone concentrations at the Northwest New Mexico sites than in southern New Mexico. There is much better agreement across most of

the summer 2022 modeling period, although the model does underestimate the observed MDA8 ozone in late July and early August. The highest observed MDA8 ozone at Sub Station occurs in mid-July that is also the highest modeled MDA8 ozone at this site, confirming good model performance.

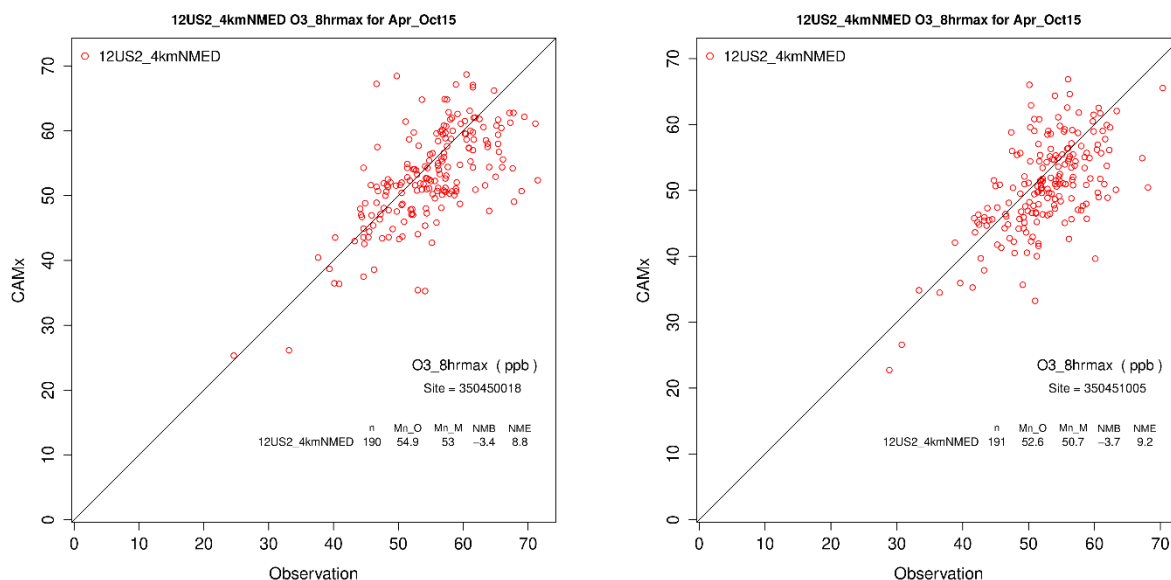


Figure 2-25. Scatter plots of predicted and observed MDA8 ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.

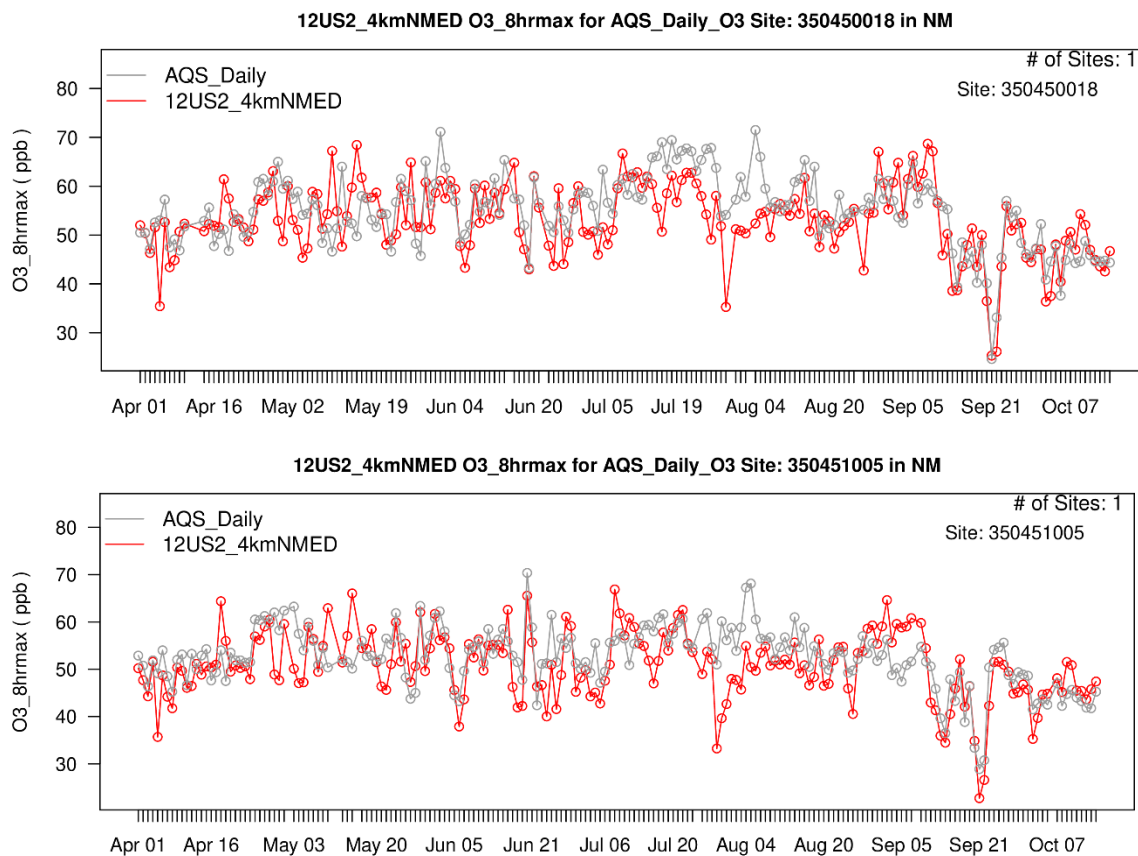


Figure 2-26. Time series of predicted and observed MDA8 ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.

The hourly ozone scatter and time series plots for Navajo Lake and Sub Station are shown in Figures 2-27 and 2-28, respectively. Except for the underestimation of the observed lower nighttime ozone at Navajo Lake resulting in a NMB (-14%) and NME (21%) that falls between the Performance Goal and Criterion, there is good agreement with the observed hourly ozone at the two Northwest New Mexico sites. As seen for MDA8 ozone, at Sub Station, the hourly ozone NMB (-3%) and NME (14%) achieves the Performance Goals. Unlike the southern New Mexico sites that had worsening ozone model performance in July and August, these two sites exhibit skill in predicting the day-to-day and diurnal variation of the observed hourly ozone concentrations throughout the summer 2022 modeling period.

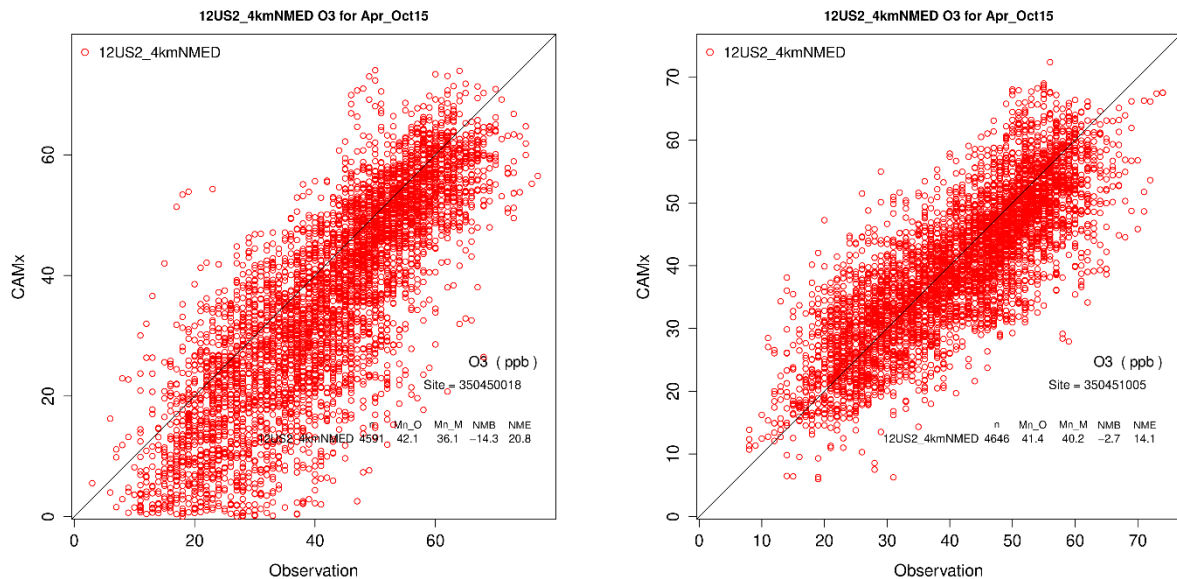


Figure 2-27. Scatter plots of predicted and observed hourly ozone concentrations at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico.

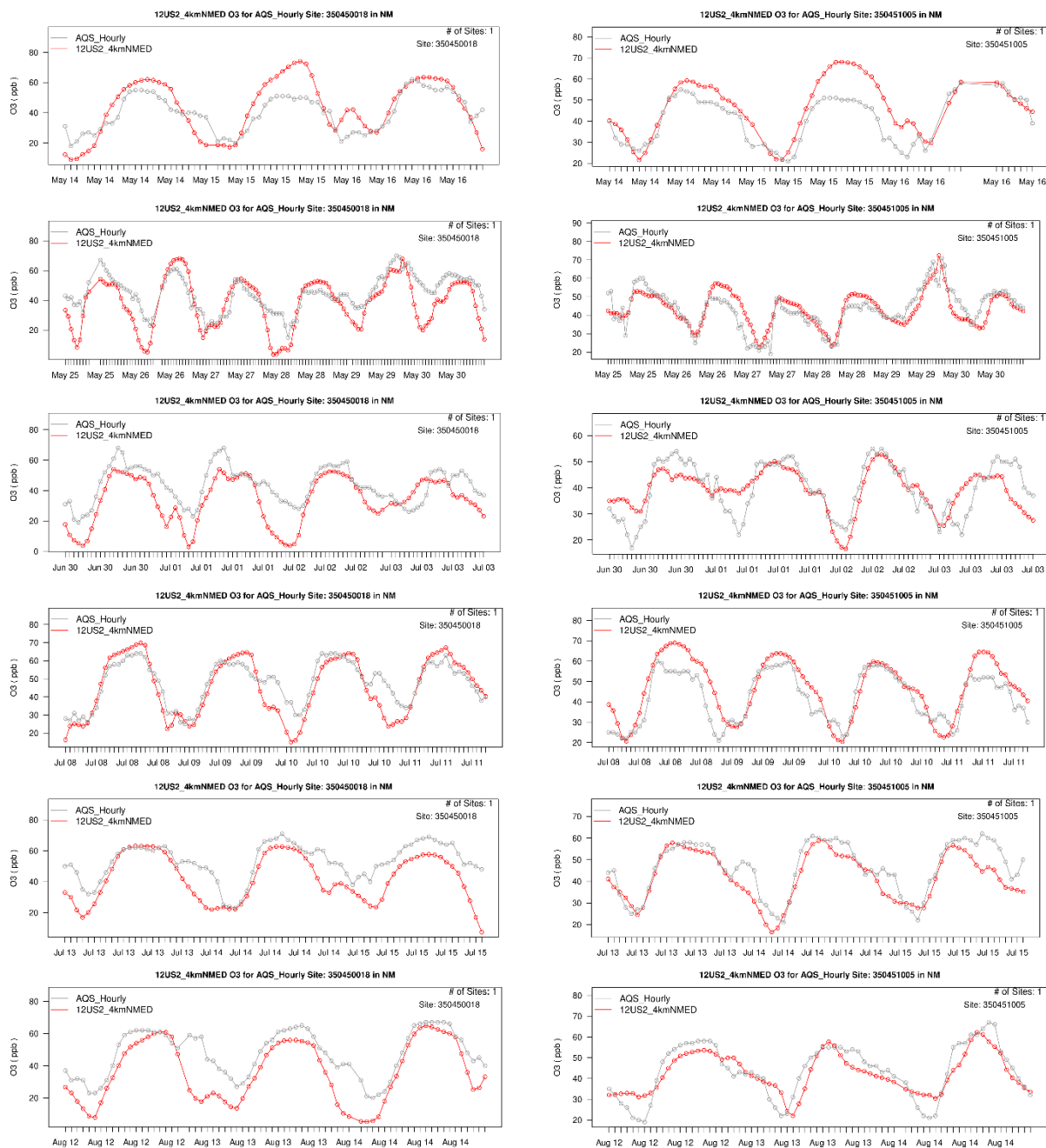


Figure 2-28. Time series of predicted and observed hourly ozone concentration at the Navajo Lake (350450018) and Sub Station (350451005) sites in San Juan County in Northwest New Mexico for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

2.10 NO_x Model Performance

The main source of Oxides of nitrogen (NO_x) emissions are combustion sources, although there are also some soil NO_x emissions. NO_x is emitted primarily (80-90%) as nitric oxide (NO) with the remainder being mainly nitrogen dioxide (NO₂). NO can be converted quickly to NO₂ through the ozone titration reaction ($\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$) and can also be converted to NO₂ by photochemical reactions involving Volatile Organic Compounds (VOC). Ozone is formed when sunlight causes NO₂ photolysis into NO and O, and then oxygen (O) atom combines with oxygen molecule (O₂) to form ozone (O₃).

Photochemical Grid Models (PGMs) generally do not reproduce observed NO_x concentrations well due to it being a primary emitted pollutant and the grid cell averaging used in PGMs, which in this study is too coarse with the 12 km grid resolution used. If NO_x sources are located near the monitor, CAMx will underestimate the observed NO_x concentrations due to the instantaneous mixing of the NO_x emissions in a 12 km by 12 km grid cell (7.5 miles squared or 35,500 acres). As most of the NO_x is emitted as NO, the model is especially expected to underestimate the highest observed NO concentrations. This NO underestimation is further enhanced by the fast conversion of NO to NO₂ due to the mixing of the NO and ozone in the grid cell, whereas in the real atmosphere the ozone titration reaction will take longer as it is diffusion limited (i.e., NO + O₃ reaction is limited by the rate of mixing of the primary emitted NO emissions with the background ozone concentrations). We expect the model to perform better for NO₂ than NO and NO_x (NO_x = NO + NO₂). Evaluating primary emitted pollutants, such as NO_x, with observations matched by time and location is always a challenge, which is why dispersion models (e.g., AERMOD) are typically evaluated unmatched in time.

Figure 2-29 display scatter plots of predicted and observed hourly NO, NO₂ and NO_x concentrations matched by time and location for the Carlsbad City and Hobbs monitoring sites located in the Permian Basin. As expected, NO is generally underestimated by the model (NMB of -46% and -56%; Figure 2-29 top panels). It is encouraging that the range of the predicted and observed NO concentrations at Carlsbad City is similar (0 to 15 ppb), while at Hobbs, except for some outliers, the modeled range (0-2 ppb) is about half of the observed range (0-4 ppb).

The modeled NO₂ at Carlsbad City (average 9 ppb) is almost double what was observed (average 5 ppb) resulting in a large overestimation bias (NMB of 80%; Figure 2-29, left middle panel). At Hobbs, however, the observed average ozone (2.9 ppb) matches the model well (3.0 ppb) resulting in low bias (NMB of 4%), but there is high variance resulting in a large error (NME of 68%). At the Carlsbad City monitor, the average observed NO_x concentrations 6.3 ppb is overestimated by the model (9.6%) by approximately 50% that is reflected in the NMB (53%). The NO_x performance at Hobbs is similar to NO₂ as the NO concentrations are lower with nearly identical average NO₂ concentrations (3.2-3.3 ppb) and low NMB (-3%).

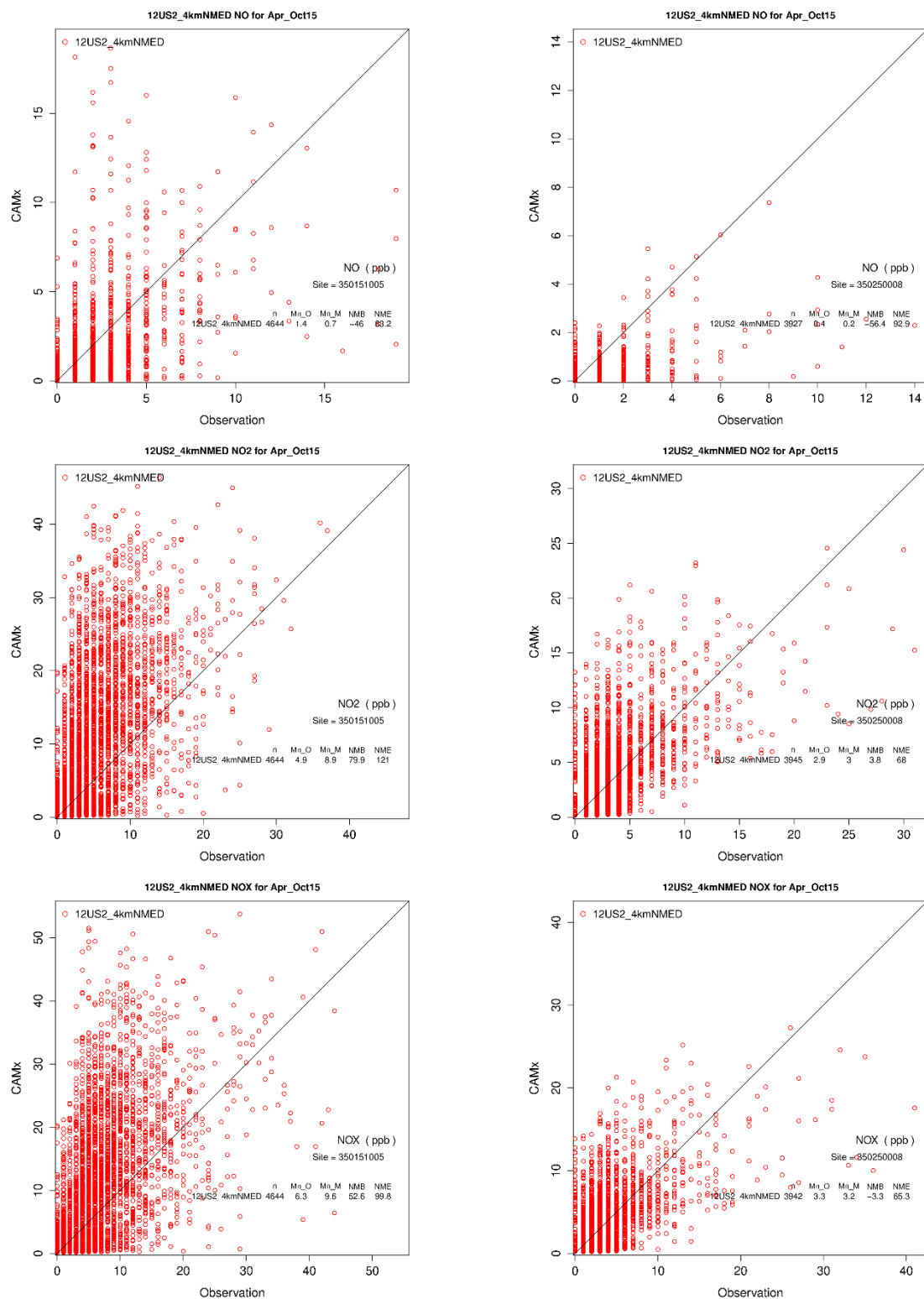


Figure 2-29. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO₂ (middle) and NO_x (bottom) concentrations at the Carlsbad City (350151005; left) and Hobbs (350250008; right) monitoring site in the Permian Basin.

There are two sites in Dona Ana County in southern New Mexico that measured NO_x in 2022: Santa Teresa and Desert View. The top panels in Figure 2-30 displays the hourly NO scatter plots and performance statistics at the two Dona Ana County sites. At Santa Teresa, the averaged modeled NO concentration (0.5 ppb) is less than half of the observed value (1.1 ppb) resulting in an underestimate NMB of -59%. A vast majority of the observed hourly NO concentrations are below 10 ppb while the modeled hourly NO concentrations are almost all below 7 ppb. At Desert View, the average observed NO concentrations (1.4 ppb) is almost 5 times greater than the modeled value (0.3 ppb) The model underestimates most of the higher NO concentrations, likely due to the 12 km grid resolution diluting nearby NO_x sources (e.g., I-10 mobile emissions).

The hourly NO₂ performance (Figure 2-30, middle panels) at Santa Teresa is good with the average observed and modeled NO₂ concentrations being comparable (7.2 and 6.2 ppb), a low bias (NMB of -5%) and most of the predicted and observed hourly NO₂ concentrations below 30 ppb. On average, the predicted average NO₂ concentration at Desert View is -20% below the average observed value and most of the predicted and observed hourly NO₂ concentrations are between 0 and 20 ppb.

The hourly NO_x performance at the two Dona Ana sites reflect the combination of the NO and NO₂ performance. The model fails to reproduce the highest observed hourly NO_x concentrations due to over dilution across the 12 km grid cell with most of the observed and modeled hourly NO_x concentrations at both sites being below 30 ppb.

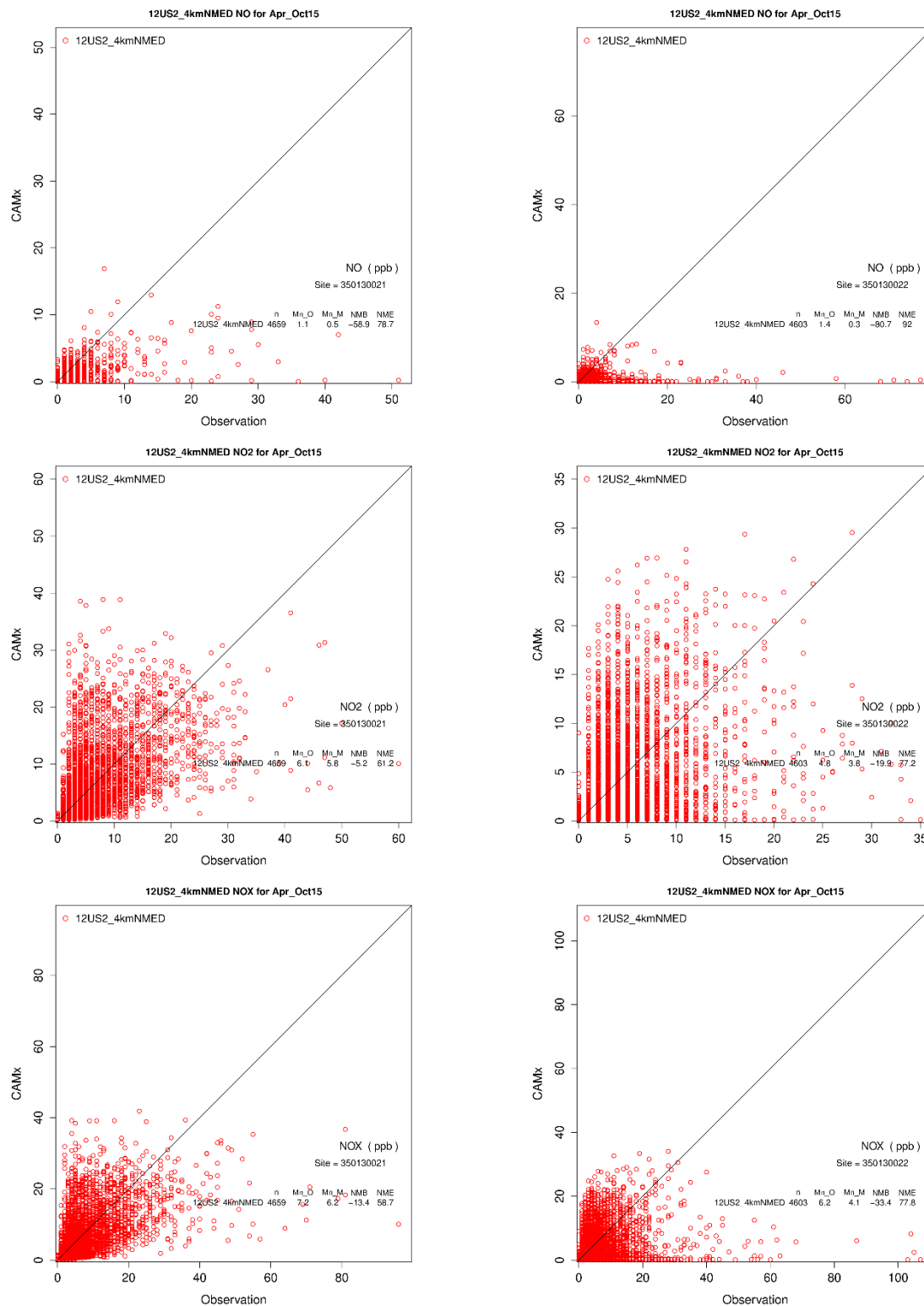


Figure 2-30. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO₂ (middle) and NO_x (bottom) concentrations at the Santa Teresa (350130021; left) and Desert View (35025008; right) monitoring sites in Dona Ana County.

The NO, NO₂ and NO_x scatter plots for the Del Norte and South Valley monitoring sites in Bernalillo County are shown in the top panels of Figure 2-31. The modeled average hourly NO concentration at Del Norte (0.7 ppb) is almost double the measured average value (0.4 ppb) resulting in a NMB overestimation bias of +80%. In contrast, the observed average hourly NO concentration at South Valley (1.4 ppb) is over an order magnitude of the average modeled value (0.1 ppb) resulting in an NMB of -91%. There is an observed hourly NO value at South Valley of over 250 ppb that defines the scale of the scatter plot making it difficult to interpret.

At Del Norte, the NO₂ performance (Figure 2-31, middle panels) is reasonable with the modeled average hourly NO₂ concentrations (6.4 ppb) is above the observed value (5.3 ppb) resulting in a NMB overestimation bias of +20%. There is a large (NMB of -63%) underestimation of the average observed hourly NO₂ concentration (5 ppb) at South Valley. The NO_x performance is similar to NO and NO₂ with reasonably good agreement at Del Norte (NMB of 16%) and large underestimation at South Valley (NMB of -70%).

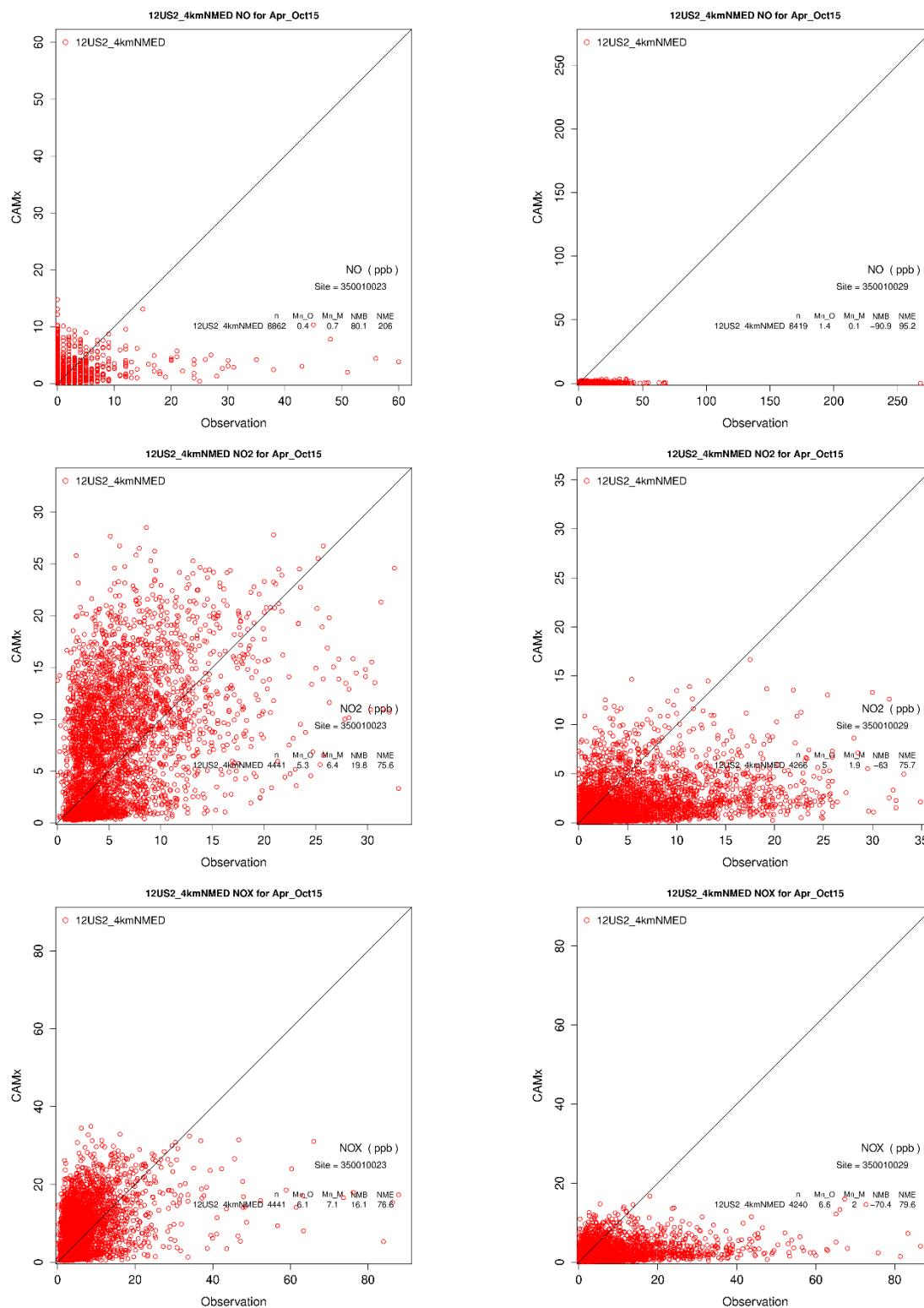


Figure 2-31. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO₂ (middle) and NO_x (bottom) concentrations at the Del Norte (350010023; left) and South Valley (350010029) monitoring sites in Bernalillo County in Central New Mexico.

In 2022, NO_x measurements were collected at the Broomfield, Navajo Lake and Chaco monitoring sites in San Juan County. The scatter plots of hourly NO, NO₂ and NO_x concentrations at the Broomfield and Navajo Lake sites are shown in Figure 2-32. Although the model is underestimating the observed hourly NO concentrations at the Broomfield site (NMB of -20%), it is overestimated at the Navajo Lake site (NMB of 86%). NO₂ and NO_x are overestimated at both San Juan sites with the overestimation being approximately a factor of 2 at the Navajo Lake site. The overstated modeled NO_x concentrations at Navajo Lake helps explain why the modeled nighttime hourly ozone at Navajo Lake is lower than observed (see Figures 2-27 and 2-28).

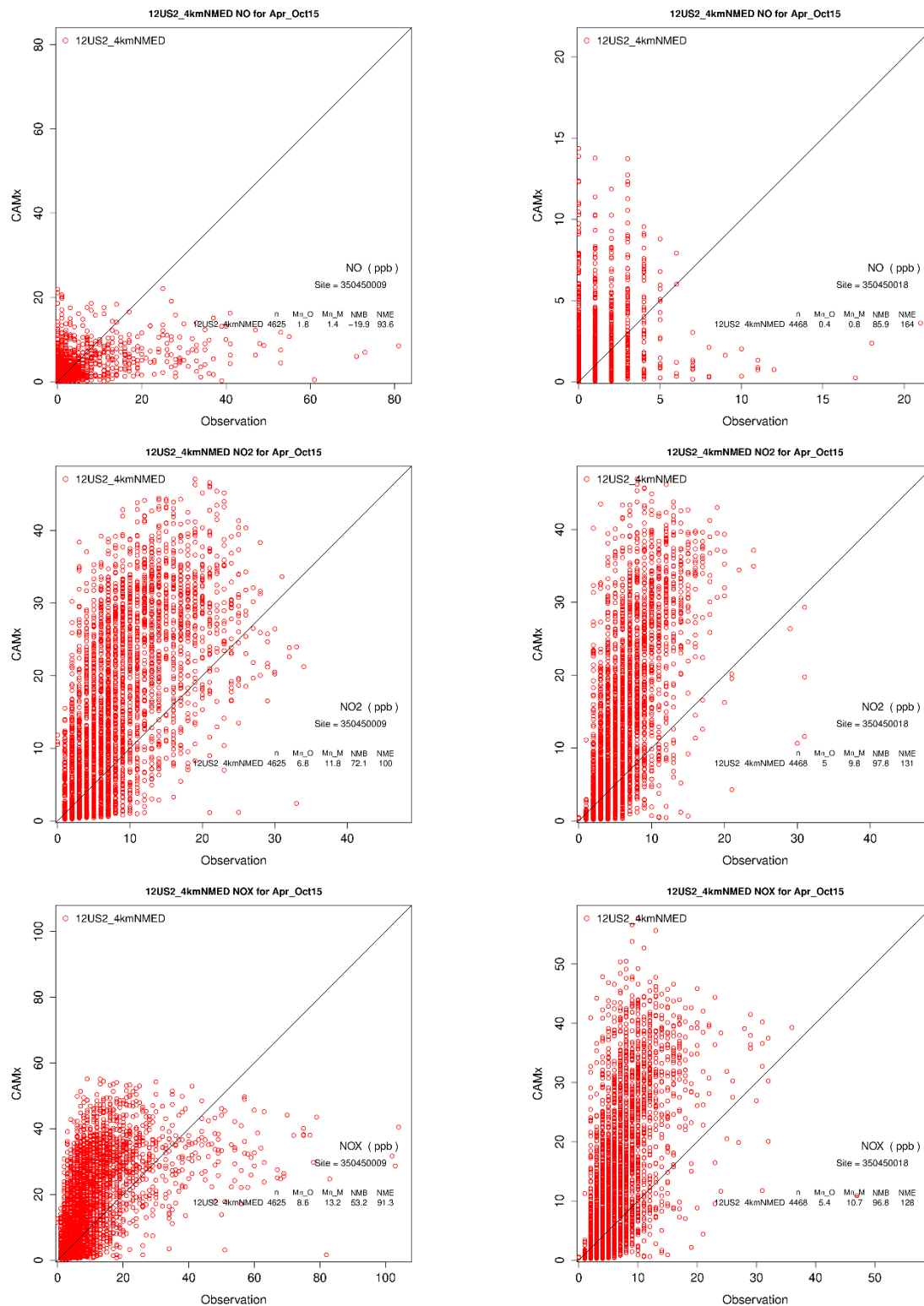


Figure 2-32. CAMx 2022v1 12 km scatter plots for hourly NO (top), NO₂ (middle) and NO_x (bottom) concentrations at the Broomfield (350450009; left) and Navajo Lake (350450018) monitoring sites in San Juan County in Northwest New Mexico.

2.11 Evaluation for Days Used in Estimation of Future Year Ozone Design Value Projections

To make 2026 future year ozone Design Value (DVF_{2026}) projections, EPA guidance (EPA, 2018) recommends using modeling results for the 10 highest modeled MDA8 ozone days near a monitor to scale the observed base year ozone Design Value (DVB). The model-derived scaling factors are called Relative Response Factors (RRFs) and are the ratio of the modeled 2026 to modeled 2022 MDA8 ozone concentrations averaged over the top 10 2022 MDA8 ozone days near the monitor:

$$RRF = \Sigma \text{Model-Ozone}_{2026} / \Sigma \text{Model-Ozone}_{2022}$$

The observed base year DVB is the average of three-years of Design Values centered on the 2022 base modeling year (i.e., 2020-2024):

$$DVB_{2020-2024} = (DV_{2020-2022} + DV_{2021-2023} + DV_{2022-2024}) / 3$$

$$DVF_{2026} = RRF \times DVB_{2020-2024}$$

Thus, it is important to analyze the CAMx 2022v1 12 km base case model performance on the 10 highest modeled 2022 MDA8 ozone days as those are the days whose modeled ozone are used to make the 2026 ozone DVF projections. Thus, in this section we examine the CAMx MDA8 ozone model performance at the monitor for the 10 highest 2022v1 modeled ozone days at five key sites in New Mexico.

2.11.1 Highest Modeled MDA8 Ozone Performance at Permian Basin Sites

Table 2-4 lists the 20 highest modeled MDA8 ozone concentrations at the Carlsbad Caverns monitor in Eddy County for the CAMx 2022v1 12 km base case with observed MDA8 ozone concentrations and corresponding bias. The observed MDA8 ozone concentrations are colored bright yellow if they are one of the top 10 observed MDA8 ozone at Carlsbad Cavern site and colored a duller shade of yellow if they rank 11 to 20 (i.e., the yellow shaded observations are the top 20 2022 observed MDA8 ozone concentrations). The percent bias is colored green if it achieves the bias Performance Goal, yellow if it falls between the Performance Goal and Criterion, and red if it fails to achieve the Performance Criterion. Ideally, it is desirable for the 10 highest modeled 2022 MDA8 ozone days to overlap with the 20 highest observed MDA8 ozone days and achieve the bias Performance Criterion with some days also achieving the Performance Goal.

For the Carlsbad Caverns site and the 10 highest modeled 2022 MDA8 ozone days, half (5 days) are also top 20 observed 2022 MDA8 ozone days (4 of those days are also top 10 observed ozone days) with the bias achieving the Performance Criterion on 8 of the 10 days. Even though there is concern with the model underestimating the observed ozone concentrations at Carlsbad Caverns during July and August 2022, the use of the highest modeled 2022 MDA8 ozone days in the RRF projection factors ends up not using the days with large ozone underestimation bias and selects better ozone performing days for developing the 2026 ozone DVF RRF projection factors.

Table 2-4. 20 highest modeled MDA8 ozone days at the Carlsbad Cavern monitor and comparison with observed MDA8 ozone.

350150010	Obs	Mod	Bias	Bias%
7/11/2022	83.6	81.0	-2.6	-3.1%
7/1/2022	78.3	73.1	-5.2	-6.6%
5/8/2022	62.9	72.8	9.9	15.8%
5/30/2022	72.8	69.9	-2.9	-4.0%
5/14/2022	64.3	68.0	3.8	5.8%
5/15/2022	68.6	67.8	-0.8	-1.2%
6/8/2022	64.8	66.7	2.0	3.1%
8/12/2022	86.0	66.7	-19.3	-22.5%
5/19/2022	60.1	65.8	5.7	9.5%
7/10/2022	71.3	65.6	-5.6	-7.9%
5/7/2022	61.8	65.5	3.8	6.1%
6/27/2022	70.6	64.1	-6.5	-9.2%
5/26/2022	71.6	64.0	-7.6	-10.6%
5/13/2022	55.3	63.8	8.5	15.4%
5/20/2022	58.6	63.4	4.8	8.1%
7/8/2022	85.4	63.2	-22.2	-26.0%
5/12/2022	56.4	63.2	6.8	12.0%
7/15/2022	76.1	62.9	-13.2	-17.3%
6/25/2022	64.6	62.8	-1.9	-2.9%
8/24/2022	71.3	62.6	-8.6	-12.1%

The comparison of the predicted and observed MDA8 ozone concentrations for the top 20 modeled MDA8 ozone days at the Carlsbad City site in Eddy County is shown in Table 2-5. Six of the top 10 modeled MDA8 ozone days overlap with top 20 observed MDA8 ozone days and a majority of the days (6 out of 10) have very low bias (NMB from -2.7% to 1.0%) that achieves the bias Performance Goal. Of the remaining four days that don't achieve the Performance Goal, two days have NMB that falls between the Performance Goal and Criterion and two days have NMB that fail to achieve the Performance Criterion. The August 12 day NMB (-15.3%) is just barely outside the Performance Criterion and actually has a modeled MDA8 ozone value that exceeds the 2015 ozone NAAQS, so is a good day to use in the 2026 ozone DVF projection. However, the June 8 day has a large overestimation bias (NMB of 58%). In the past we have removed days that fail to achieve the Performance Criterion by a wide margin and substituted the next highest modeled ozone day that achieves the Performance Criterion in the ozone DVF projections. Replacing poorer performance days with better performing days in the RRF used in the DVF projection procedure for just one or two days of the 10 days would not make much of a difference in the future year projected ozone DVF.

Table 2-5. 20 highest modeled MDA8 ozone days at the Carlsbad City monitor and comparison with observed MDA8 ozone.

350110050	Obs	Mod	Bias	Bias%
7/11/2022	79.8	80.6	0.8	1.0%
7/1/2022	76.9	76.1	-0.8	-1.0%
5/8/2022	65.1	73.1	8.0	12.3%
7/8/2022	72.1	72.7	0.5	0.7%
8/12/2022	84.9	71.9	-13.0	-15.3%
5/15/2022	71.6	71.0	-0.7	-0.9%
5/30/2022	72.6	70.6	-2.0	-2.7%
5/14/2022	71.0	69.5	-1.5	-2.2%
9/6/2022	62.3	68.9	6.7	10.7%
6/8/2022	42.8	67.4	24.7	57.7%
5/7/2022	64.9	66.3	1.4	2.1%
7/10/2022	67.4	66.0	-1.4	-2.0%
5/26/2022	73.8	65.8	-8.0	-10.8%
5/19/2022	62.8	65.8	3.0	4.8%
8/14/2022	80.9	65.5	-15.3	-19.0%
7/17/2022	66.5	65.2	-1.3	-1.9%
6/30/2022	71.5	65.0	-6.5	-9.2%
8/13/2022	83.5	64.9	-18.6	-22.3%
5/13/2022	60.1	64.8	4.7	7.8%
7/16/2022	67.1	64.7	-2.4	-3.6%

Although the Hobbs site in Lea County exhibited better ozone model performance statistics than the two Eddy County sites, for the 10 highest modeled 2022 MDA8 ozone days the performance is worse. For the Hobbs 10 highest 2020 modeled MDA8 ozone days, 6 of the days have NMB that fails to achieve the bias Performance Criterion due to overestimation bias greater than 15% (Table 2-6). Only 3 of the top 10 modeled 2022 MDA8 ozone days overlap with the top 20 observed MDA8 ozone days. The model estimates four ozone exceedance days at Hobbs during 2022, but only one of those (May 30) is confirmed by the observations. There is a larger drop of in MDA8 concentrations in the model than observed (e.g., 10th highest modeled MDA8 ozone is 61.5 ppb versus 68.4 ppb observed).

Table 2-6. 20 highest modeled MDA8 ozone days at the Hobbs monitor and comparison with observed MDA8 ozone.

350250008	Obs	Mod	Bias	Bias%
5/30/2022	72.6	74.6	2.0	2.7%
5/8/2022	58.6	74.5	15.8	27.0%
5/14/2022	63.1	73.9	10.8	17.1%
5/15/2022	50.3	71.6	21.3	42.4%
5/19/2022	59.9	70.3	10.4	17.4%
5/7/2022	59.3	68.7	9.4	15.9%
7/1/2022	69.4	64.4	-5.0	-7.1%
5/20/2022	52.0	61.8	9.8	18.8%
6/30/2022	69.4	61.6	-7.8	-11.2%
5/9/2022	54.6	61.5	6.9	12.7%
5/13/2022	62.0	61.3	-0.7	-1.1%
4/3/2022	59.1	61.2	2.1	3.5%
4/28/2022	53.5	61.0	7.5	14.0%
5/27/2022	59.6	60.6	0.9	1.6%
4/15/2022	52.8	60.4	7.7	14.5%
6/7/2022	63.1	60.0	-3.1	-4.9%
7/2/2022	68.4	59.7	-8.7	-12.7%
7/11/2022	65.3	59.5	-5.7	-8.7%
5/17/2022	57.6	59.5	1.9	3.3%
6/5/2022	56.3	59.4	3.1	5.5%

2.11.1 Highest Modeled MDA8 Ozone Performance at Southern New Mexico Sites

Tables 2-7 and 2-8 compare the predicted and observed MDA8 ozone concentrations for the top 20 modeled 2022 MDA8 ozone days at Desert View and La Union monitoring sites respectively. At Desert View, there is good overlap between the 10 highest modeled 2022 MDA8 ozone days and the top 20 observed ozone days (7 out of 10), but the modeled MDA8 ozone is much lower on some of the days such that three of the top 10 modeled ozone days fail to achieve the bias Performance Criterion due to underprediction bias greater than - 15%.

Only 3 of the top 10 modeled 2022 MDA8 ozone days overlap with observed top 10 modeled days at the La Union site and four days fail to achieve the bias Performance Criterion, 2 due to over- and 2 due to under-prediction.

Table 2-7. 20 highest modeled MDA8 ozone days at the Desert View monitor and comparison with observed MDA8 ozone.

350130021	Obs	Mod	Bias	Bias%
5/15/2022	73.4	71.0	-2.3	-3.2%
7/2/2022	68.9	70.8	1.9	2.8%
5/14/2022	62.3	68.4	6.1	9.8%
7/19/2022	73.6	68.0	-5.6	-7.7%
7/21/2022	80.6	67.0	-13.6	-16.8%
5/8/2022	59.5	66.5	7.0	11.7%
8/1/2022	71.5	66.2	-5.3	-7.4%
8/4/2022	78.6	66.1	-12.5	-16.0%
5/7/2022	60.3	64.6	4.4	7.3%
6/30/2022	83.8	64.6	-19.2	-22.9%
7/3/2022	86.4	63.0	-23.4	-27.0%
6/24/2022	63.1	62.9	-0.2	-0.3%
7/9/2022	70.1	62.9	-7.2	-10.3%
5/13/2022	58.9	62.7	3.8	6.4%
5/12/2022	52.5	62.2	9.7	18.5%
6/27/2022	62.0	62.1	0.1	0.2%
4/30/2022	66.6	61.2	-5.4	-8.1%
4/3/2022	54.8	61.2	6.5	11.8%
4/29/2022	60.1	61.1	1.0	1.6%
4/28/2022	54.0	61.0	7.0	13.0%

Table 2-8. 20 highest modeled MDA8 ozone days at the La Union monitor and comparison with observed MDA8 ozone.

350130008	Obs	Mod	Bias	Bias%
5/15/2022	66.5	71.6	5.1	7.6%
7/2/2022	63.1	70.3	7.1	11.3%
5/14/2022	58.0	67.0	9.0	15.5%
7/19/2022	65.1	66.8	1.7	2.5%
5/8/2022	56.6	66.0	9.4	16.6%
7/11/2022	81.0	65.4	-15.6	-19.2%
7/3/2022	80.9	65.4	-15.5	-19.2%
8/1/2022	63.6	64.6	1.0	1.5%
5/7/2022	57.1	64.1	6.9	12.2%
5/26/2022	56.4	63.0	6.6	11.7%
6/9/2022	66.3	62.4	-3.8	-5.8%
6/24/2022	60.3	62.3	2.0	3.3%
5/12/2022	51.6	62.2	10.6	20.5%
5/13/2022	55.4	62.0	6.6	11.9%
6/30/2022	68.1	61.8	-6.3	-9.2%
7/9/2022	68.8	61.7	-7.0	-10.2%
4/30/2022	63.5	61.6	-1.9	-3.0%
4/18/2022	58.5	61.6	3.1	5.2%
6/27/2022	59.1	61.2	2.1	3.5%
4/3/2022	52.5	61.2	8.7	16.5%

3.0 2026 Ozone Design Value Projections using the 2022 EMP CAMx 12 km Modeling Platform

In Section 2.11 the EPA recommended procedures for making 2026 projected ozone Design Value (DVF) projections was described following EPA’s ozone modeling guidance (EPA, 2018). These procedures use the relative changes CAMx 2022 and 2026 ozone modeling results near the monitor to scale the observed 2020-2024 base year ozone Design Value (DVB) to project 2026 ozone Design Value (DVF):

$$RRF = \Sigma \text{Model-Ozone}_{2026} / \Sigma \text{Model-Ozone}_{2022}$$

$$DVB_{2020-2024} = (DV_{2020-2022} + DV_{2021-2023} + DV_{2022-2024}) / 3$$

$$DVF_{2026} = RRF \times DVB_{2020-2024}$$

EPA has codified their recommended future year ozone DVF projection approach in the Speciated Modeled Attainment Test – Community Edition (SMAT-CE). SMAT-CE was used with the CAMx 2022v1 and 2026v1 12 km modeling results and observed 2020-2024 base year ozone DVB to make projected 2026 ozone DVFs at the monitoring sites. SMAT-CE also has an Unmonitored Area Analysis (UAA) that interpolates the 2020-2024 ozone DVB across the domain and makes 2026 ozone DVF projections in each grid cell.

3.1 2026 Ozone DVF Projections at Monitoring Sites

Table 3-1 displays the 2020-2024 base year ozone DVB and projected 2026 ozone DVF at monitoring sites in and near New Mexico. The ozone DVB/DVF are colored: (1) red if they exceed the 75 ppb 2008 ozone NAAQS; and (2) yellow if they exceed the 70 ppb 2015 ozone NAAQS but are below the 2008 ozone NAAQS. The Carlsbad Caverns site is a special case as SMAT-CE initially did not make any 2026 ozone DVF projection for this site because it only had three years of valid DVs during the 2020-2024 5-year DVB period. We forced SMAT-CE to make a 2026 ozone DVF projection at Carlsbad Caverns using a 3-year DVB so it is colored blue in Table 3-1 and not considered in our analysis below. There are five sites in New Mexico with 2020-2024 ozone DVBS exceeding the 2015 ozone NAAQS with three of them also exceeding the 2008 ozone NAAQS: Carlsbad City (78.0 ppb); La Union (76.0 ppb); Desert View (77.3 ppb), Santa Teresa (73.5 ppb), and Foot Hills (72.3 ppb).

Of the five New Mexico sites with a 2020-2024 DVB exceeding the 2015 ozone NAAQS, two have projected 2026 ozone DVFs that attain the 2015 NAAQS (Santa Teresa and Foot Hills). For the remaining three New Mexico sites whose 2020-2024 ozone DVB was above the 75 ppb 2008 ozone NAAQS, their projected 2026 ozone DVFs are below the 2008 but still above the 2015 ozone NAAQS: Carlsbad City (71.8 ppb), La Union (74.8 ppb) and Desert View (75.5 ppb). The reduction (i.e., DVF-DVB) in the ozone DV at Carlsbad City (6.2 ppb) is much greater than the other sites in New Mexico (typically approximately -2 ppb ±1 ppb). This is because of the relatively larger contribution of emissions from O&G Source Sector to ozone at Carlsbad City than other sites and the greater reduction in the O&G Source Sector NO_x (-30%) and VOC (-43%) emissions between 2022 and 2026 than the total anthropogenic NO_x (-22%) and VOC (-1%) emissions reduction between 2020 and

2026 of the other combined anthropogenic Source Sectors (Table 1-1) estimated by the 2022 EMP 2022v1 emissions platform.

Table 3-1. Current year 2020-2024 ozone Design Values (DVB) and future year projected 2026 ozone Design Values (DVF) for monitoring sites in New Mexico and adjacent to New Mexico using the 2022 EMP CAMx 12 km 2022v1 and 2026v1 modeling results.

Region	ID	Name	State	County	DVB (ppb)	DVF (ppb)	RRF	ppb	days
NM-PB	350151005	Carlsbad City	NM	Eddy	78.0	71.8	0.9210	70	10
NM-PB	350150010	Carlsbad Caverns	NM	Eddy	78.3	72.4	0.9255	68	10
NM-PB	350250008	Hobbs	NM	Lea	69.7	67.5	0.9687	62	10
NM-S	350130008	La Union	NM	Dona Ana	76.0	74.8	0.9854	66	10
NM-S	350130017	Sunland Park	NM	Dona Ana	-7.0	-9.0	0.9779	66	10
NM-S	350130020	Chaparral	NM	Dona Ana	70.3	69.0	0.9823	65	10
NM-S	350130021	Desert View	NM	Dona Ana	77.3	75.5	0.9779	66	10
NM-S	350130022	Santa Teresa	NM	Dona Ana	73.5	70.6	0.9609	66	10
NM-S	350130023	Solano	NM	Dona Ana	67.3	66.5	0.9890	64	10
TX-EP	481410029	Ivanhoe	TX	El Paso	64.3	63.5	0.9888	66	10
TX-EP	481410044	El Paso Chamizal	TX	El Paso	69.0	68.1	0.9876	67	10
TX-EP	481410055	Ascarate Park SE	TX	El Paso	70.0	69.1	0.9876	67	10
TX-EP	481410057	Socorro Hueco	TX	El Paso	71.7	70.9	0.9902	66	10
TX-EP	481410058	Skyline Park	TX	El Paso	70.3	69.3	0.9871	67	10
NM-Cen	350010023	Del Norte	NM	Bernalillo	69.7	68.2	0.9793	63	10
NM-Cen	350010029	South Valley	NM	Bernalillo	66.0	64.6	0.9803	64	10
NM-Cen	350011012	Foot Hills	NM	Bernalillo	72.3	70.7	0.9780	64	10
NM-Cen	350431001	Bernalillo	NM	Sandoval	68.3	66.8	0.9781	64	10
NM-Cen	350490021	Santa Fe	NM	Santa Fe	66.0	65.0	0.9860	62	10
NM-Cen	350610008	Los Lunas	NM	Valencia	64.7	63.5	0.9824	62	10
NM-SSJ	350390026	Coyote	NM	Rio Arriba	63.3	61.5	0.9724	62	10
NM-SSJ	350450009	Bloomfield	NM	San Juan	65.3	63.6	0.9747	64	10
NM-SSJ	350450018	Navajo Lake	NM	San Juan	69.3	67.6	0.9765	65	10
NM-SSJ	350450020	Chaco	NM	San Juan	67.0	65.3	0.9752	62	10
NM-SSJ	350451005	Sub Station	NM	San Juan	67.0	64.8	0.9684	62	10
CO-NSJ	80671004	Shamrock	CO	La Plata	64.0	62.8	0.9826	66	10
CO-NSJ	80677001	Ignacio	CO	La Plata	66.3	64.7	0.9769	66	10
CO-NSJ	80677003	Bondad	CO	La Plata	66.0	64.7	0.9810	66	10
CO-NSJ	80830006	Cortez	CO	Montezuma	62.3	61.1	0.9823	62	10
CO-NSJ	80830101	Mesa Verde NP	CO	Montezuma	64.7	63.5	0.9818	62	10
AZ-Misc	40038001	Chiricahua NM	AZ	Cochise	66.3	65.8	0.9934	62	10
AZ-Misc	40170119	Petrified Forest	AZ	Navajo	65.0	62.9	0.9680	62	10
TX-Misc	483819991	Palo Duro	TX	Randall	68.3	67.7	0.9916	60	5

3.2 2026 Ozone DVF Projections Across New Mexico

The SMAT-CE Unmonitored Area Analysis (UAA) was used to make 2026 ozone DVF projections across New Mexico and nearby areas. We generated displays of the spatial distribution of the 2026 ozone DVF across the New Mexico analysis domain.

The SMAT-CE UAA interpolates the observed 2020-2024 ozone DVB at the monitoring sites across the domain. There are two options for making the UAA interpolation, a Gradient Adjusted (GA) approach that uses the CAMx 2022 ozone concentration gradients in the spatial interpolation and an approach that does not use the modeled ozone concentration gradients (nonGA).

Figure 3-1 displays the spatial distribution of the 2020-2024 ozone DVB across the New Mexico analysis domain using the SMAT-CE UAA with and without using the modeled 2022 ozone concentrations gradients in the UAA spatial interpolation of the 2020-2024 ozone DVB. When using modeled 2022 ozone concentrations gradients in the spatial interpolation (Figure 3-1, top), the SMAT-CE UAA estimates a maximum 2020-2024 ozone DVB of 79.2 ppb in southern Lea County with DVB exceeding the 70 ppb 2015 ozone NAAQS in southern Lea and Eddy Counties, western El Paso and southeast Dona Ana Counties (Sunland Park) and in Sierra County with a couple grid cells in adjacent counties. The SMAT-CE UAA with GA interpolation shows that the DVB ozone exceedances in Sierra County are from enhanced modeled 2022 ozone concentrations due to emissions from the Black wildfire and using the ozone concentration gradients in the UAA spatial interpolation procedure.

When SMAT-CE UAA uses a spatial interpolation procedure without accounting for modeled 2022 concentration gradients (Figure 3-1, bottom), the maximum 2020-2024 ozone DVB is 77.6 ppb and occurs in Eddy County, New Mexico. SMAT-CE UAA with nonGA 2020-2024 ozone DVB exceed the 2015 ozone NAAQS in southern Dona Ana County, most western El Paso, all Eddy County and Culberson County, Texas and extends into Mexico. Since there are no ozone DVB at monitors in Mexico in SMAT-CE, the elevated ozone DVB at the New Mexico Dona Ana, Eddy and Lea Counties and in El Paso, Texas are extrapolated into Mexico when SMAT-CE UAA with the nonGA interpolation options is used.

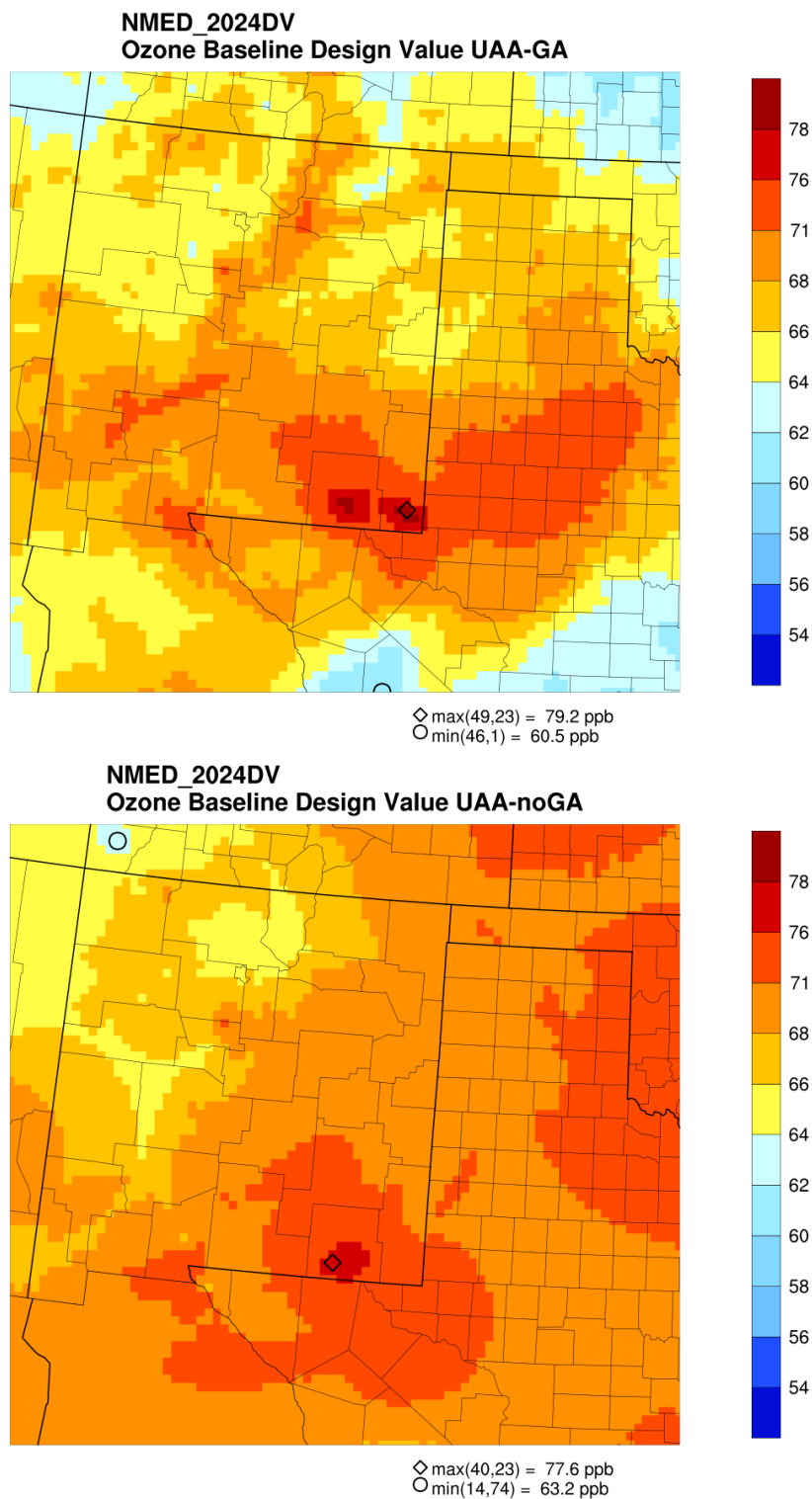


Figure 3-1. Spatial distribution of the 2020-2024 base year ozone Design Value (DVB) using the SMAT-CE UAA interpolation procedure with (UAA-GA; top) and without (UAA-nonGA; bottom) using the modeled 2022 ozone concentration gradients in the 2020-2024 ozone DVB spatial interpolation.

The spatial distribution of the projected 2026 ozone DVF across New Mexico using the SMAT-CE UAA with and without using concentration gradients in the DVB interpolation are shown in Figure 3-2. When the modeled ozone gradients are used (Figure 3-2, top), the maximum 2026 ozone DVB is 75.3 ppb and occurs in southern Lea County. 2026 ozone DVF over the 2015 ozone NAAQS occur in southern Lea and Eddy Counties, western El Paso and southeastern Dona Ana County as well as at the location of the Black wildfire in Sierra County and two adjacent counties. There are no areas for the 2026 ozone DVF that exceed the 2015 ozone NAAQS and for the 2008 NAAQS the area of exceedances is smaller compared to the DVB UAA GA interpolation plots (Figures 3-1 and 3-2, top panels).

When not using the UAA gradient adjusted interpolation procedure, most of the area that exceeded the 2015 ozone NAAQS for the DVB, is reduced to just the most southerly grid cells in Eddy and Lea counties in New Mexico and only half of the grid cells in Culberson County, Texas (Figures 3-1 and 3-2, bottom panels). There are still areas in west Texas and Mexico with 2026 ozone DVF that exceed the 2015 ozone NAAQS, but these may just be artifacts of SMAT-CE not having monitoring sites in Mexico.

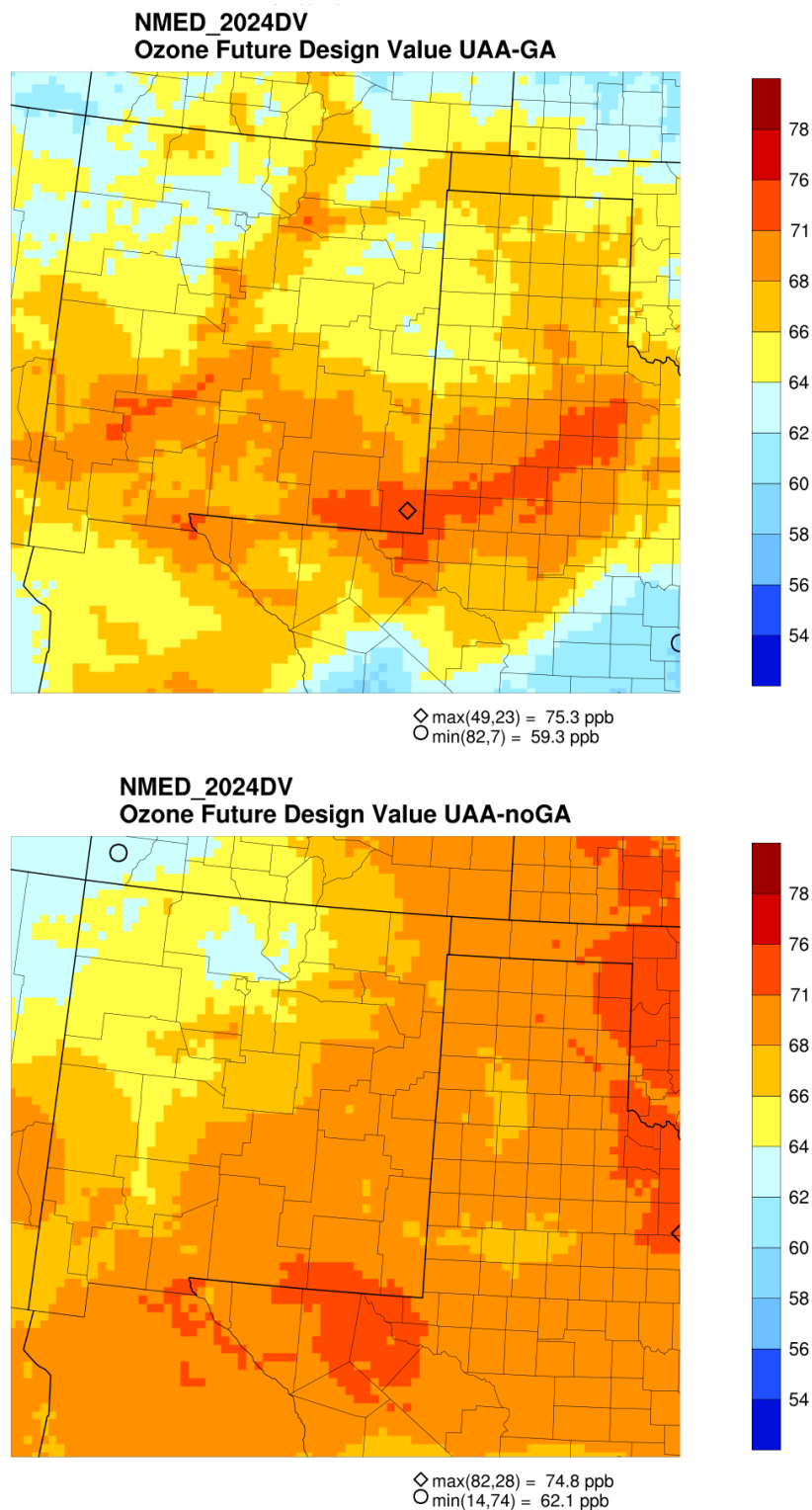


Figure 3-2. Spatial distribution of the projected 2026 future year ozone Design Value (DVF) using the SMAT-CE UAA interpolation procedure with (UAA-GA; top) and without (UAA-nonGA; bottom) using the modeled 2022 ozone concentration gradients.

3.3 2026 Ozone Projection Conclusions

There are six monitoring sites in the New Mexico analysis domains with 2020-2024 ozone DVB that exceed the 70 ppb 2015 ozone NAAQS with three of the sites also exceeding the 75 ppb 2008 ozone NAAQS. The three sites that are below the 2008 but above the 2015 ozone NAAQS are projected to have 2026 ozone DVFs below the 70 ppb 2015 ozone NAAQS. However, the three sites with 2020-2024 ozone DVB above the 2008 ozone NAAQS have projected 2026 ozone DVF that are below the 2008 NAAQS but above the 2015 NAAQS are: Carlsbad (71.8 ppb), La Union (74.8 ppb) and Desert View (75.5 ppb).

The SMAT-CE Unmonitored Area Analysis suggests there may be areas with projected 2026 DVF that still exceed the 2015 ozone NAAQS in southern Eddy and Lea Counties, in southeast Dona Ana County and in eastern El Paso County.

4.0 2026 OZONE SOURCE APPORTIONMENT MODELING APPROACH

A CAMx 2026v1 12 km ozone source apportionment simulation was performed for the modeling period April 16 to August 15, 2022. CAMx includes the Ozone Source Apportionment Technology (OSAT) Probing Tool that apportions ozone formed in the model to user-defined Source Group's NO_x and VOC emissions. At each model integration time step and in each grid cell, OSAT determines whether the ozone formed is more sensitive to NO_x or VOC concentrations and the ozone formed is allocated to Source Groups based on the relative contribution of the most sensitive precursor (i.e., either NO_x or VOC). For each Source Group, OSAT uses 10 reactive tracers (tagged species) to track ozone formed under more NO_x-sensitive (O3N) or VOC-sensitive (O3V) conditions from the Source Group's NO_x and VOC emissions.

The Anthropogenic Precursor Culpability Assessment (APCA) variant of the CAMx ozone source apportionment Probing Tool differs from OSAT in that it only assigns ozone formed to the Natural Source Category (e.g., biogenic emissions) when the ozone formed is due to photochemistry between the Natural NO_x and Natural VOC emissions. When ozone is formed due to photochemical reactions between Natural VOC and Anthropogenic NO_x under VOC-sensitive ozone formation conditions, a case OSAT would assign the ozone formed to the Natural Source Group, APCA redirects the ozone formed to the Anthropogenic Source Group(s). The APCA version of the CAMx ozone source apportionment Probing Tool is believed to provide more control strategy relevant information as natural emissions cannot be controlled. As used in the EPA transport rules and past New Mexico ozone source apportionment modeling, the APCA version of the CAMx ozone source apportionment Probing Tool was used in this study's CAMx 2026v1 12 km ozone source apportionment modeling.

The user-defined Source Groups are usually defined as the combination between Source Regions and Source Categories, which is the approach used in this CAMx 2026v1 12 km APCA ozone source apportionment modeling.

4.1.1 Definition of Source Regions

The CAMx 2026v1 12 km APCA ozone source apportionment modeling used six (6) Source Regions as follows (Figure 4-1):

1. Permian Basin portion of NM
2. Remainder NM
3. Permian Basin portion of TX
4. Remainder TX
5. Mexico
6. Remainder 12 km domain.

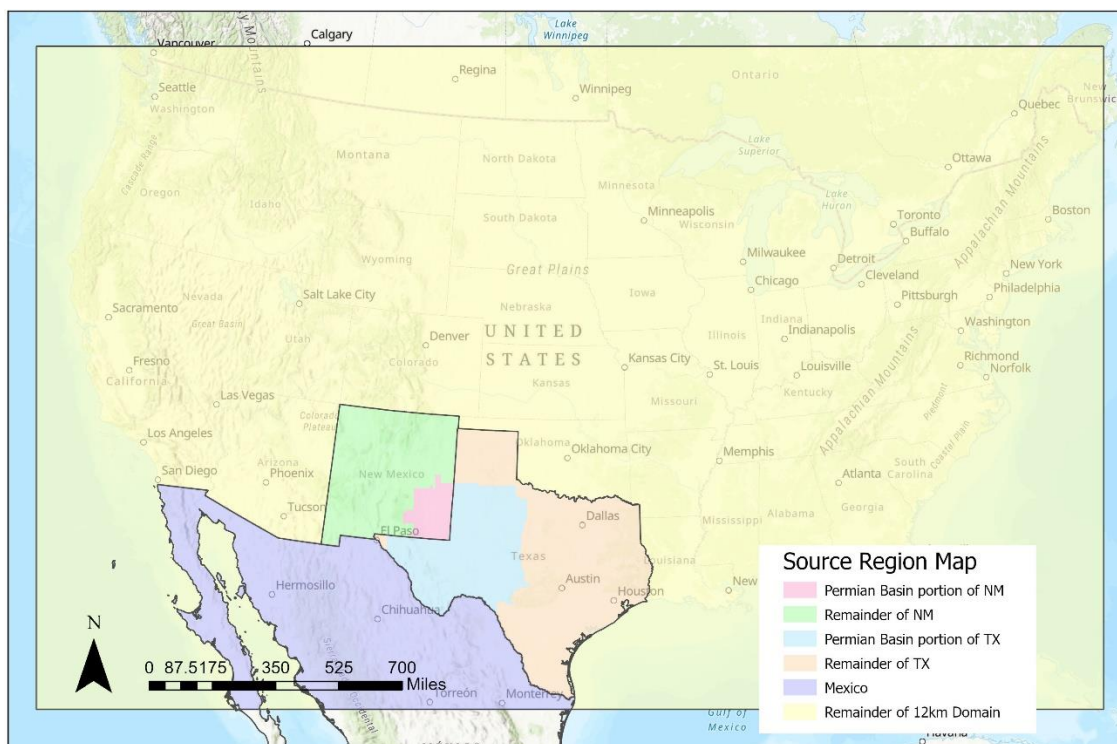


Figure 4-1. Six Source Regions used in the CAMx 2026v1 12 km APCA ozone source apportionment simulation using the 2022 EMP CAMx 2022v1 12 km modeling platform.

4.1.2 Definitions of Source Categories

The Source Categories used in the CAMx 2026v1 12 km APCA ozone source apportionment modeling were limited to the pre-merged model-ready 2026v1 12 km emissions distributed in the 2022 EMP 2022v1 12 km platform provided by EPA. We used nine (9) Source Categories in the CAMx 2026v1 12 km APCA ozone source apportionment modeling as follows:

1. Natural (biogenic, lightning NO_x [LNO_x], and oceanic [sea salt and dimethyl sulfide])
2. Fires (U.S. wildfires, wildland prescribed burns and agricultural burning and other [Mexico/Canada] fires)
3. Oil and gas point sources (surrogate for midstream O&G)
4. Oil and gas non-point sources (surrogate for upstream O&G)
5. EGU point
6. Non-EGU point
7. On-road mobile
8. Non-road mobile
9. Remainder anthropogenic (e.g., non-point sector).

4.1.3 Definition of Source Groups

With 6 Source Regions, 9 Source Categories, and Initial Concentrations (IC) and Boundary Conditions (BC) always having to be considered in an APCA ozone source apportionment simulation, this combination results in ozone contributions for 56 Source Groups ($56 = 6 \times 9 + 2$).

4.2 CAMx 2026 VOC/NO_x Emission Sensitivity Modeling

The CAMx 2026 12 km APCA ozone source apportionment modeling provides an estimate of the contributions of emissions from Source Groups to ozone concentrations under the 2026v1 emissions and 2022 12 km WRF meteorological conditions but may not provide a reliable estimate of the ozone response when VOC and/or NO_x emissions are changed. To assess an ozone response to emission changes requires a sensitivity method, not a source apportionment method. Knowing the ozone sensitivity to VOC and NO_x emission reductions is important when considering alternative control measures for sources like O&G that emit both ozone precursors and may have quite different control measures for VOC versus NO_x emissions. Thus, five 2026 brute force (BF) VOC/NO_x emission sensitivity simulations were conducted mainly to assess their efficacy in reducing ozone concentrations as follows:

1. NM 20% anthropogenic NO_x reduction.
2. NM 20% anthropogenic VOC reduction.
3. NM 20% Permian Basin O&G NO_x reduction.
4. NM 20% Permian Basin O&G VOC reduction.
5. NM 20% Permian Basin O&G NO_x and VOC increase.

Spatial displays of the differences in projected 2026 ozone DVFs from the BF emission reduction sensitivity tests were generated and are discussed in Chapter 7.

5.0 CONTRIBUTIONS TO PROJECTED 2026 OZONE DESIGN VALUES ACROSS NEW MEXICO

The SMAT-CE Unmonitored Area Analysis (UAA) was used with the CAMx 2026v1 12 km APCA ozone source apportionment modeling results to estimate the contributions of Source Groups to projected 2026 future year ozone Design Values (DVs) across the New Mexico domain. SMAT-CE UAA was first used with the CAMx 2022 and 2026 standard model results to make 2026 ozone DVF projections as shown in Figure 3-2. SMAT-CE UAA was then applied using the CAMx 2026 modeling results with the Source Group's ozone contributions removed to obtain 2026 ozone DVFs without the Source Group's ozone contributions. The differences in the 2026 ozone DVFs with and without the Source Group's ozone contributions are then displayed to obtain the Source Group's contributions to the 2026 ozone DVFs across the New Mexico analysis domain.

5.1 Contributions of Total New Mexico Anthropogenic Emissions to 2026 Ozone DVFs

Figure 5-1 displays the contributions of total New Mexico anthropogenic emissions to the projected 2026 ozone DVF in the New Mexico analysis domain using the SMAT-CE UAA with the DVV interpolation based on the modeled 2022 ozone concentration gradients. Although the spatial distribution of the UAA 2020-2024 ozone DVV (Figure 3-1) and 2026 ozone DVF (Figure 3-2) are quite different with (GA) and without (nonGA) using the gradient adjustment in the UAA DVV spatial interpolation, when looking at the contributions of Source Sectors to the 2026 ozone DVF, the difference plots are essentially identical whether the UAA GA or nonGA spatial interpolation is used. Thus, in the remainder of this report we use the UAA with the GA interpolation.

The largest contribution of New Mexico anthropogenic emissions to the 2026 ozone DVF is 9.0 ppb and occurs near the Carlsbad City monitoring site in Eddy County that is within the Permian Basin. Within the Permian Basin, NM anthropogenic emission contributes 4 ppb or more to the 2026 ozone DVF across Eddy and Lea Counties and most of Chaves County. NM anthropogenic emissions contribute over 4 ppb to 2026 ozone DVFs along the border of Bernalillo and Sandoval Counties in Central NM, and in San Juan and Rio Arriba Counties in northwest NM.

Figure 5-2 displays the contributions of all emissions in New Mexico to the 2026 ozone DVFs across New Mexico including both anthropogenic emissions (as in Figure 5-1) and natural emissions, such as biogenic sources and fires. The addition of natural sources increases the ozone contribution across New Mexico when compared to only the New Mexico anthropogenic emissions (Figure 5-1). For example, the peak ozone contribution near Carlsbad in southern Eddy County is increased from 9.0 ppb with NM anthropogenic emissions alone to 9.8 ppb when natural emissions are also included.

Emissions from fires can have a large contribution to the 2026 ozone DVF. The effects on the projected 2026 ozone DVFs due to the two biggest wildfires in New Mexico in 2022 are evident in Figure 5-2:

- The Calf Canyon/Hermits Peak fire burned approximately 340,000 acres and was the largest 2022 wildfire in the contiguous U.S. and largest wildfire in New Mexico history. It is estimated to contribute over 8 ppb to the 2026 ozone DVF in Mora

County in northeastern New Mexico with ozone contributions due to fire emissions spreading downwind into northwest Texas and western Oklahoma.

- The Black fire burned approximately 325,000 acres in 2022 and contributed over 8 ppb to the 2026 ozone DVF in four grid cells in Sierra County in southwest New Mexico with ozone contributions from the fire emissions occurring downwind into Socorro County.

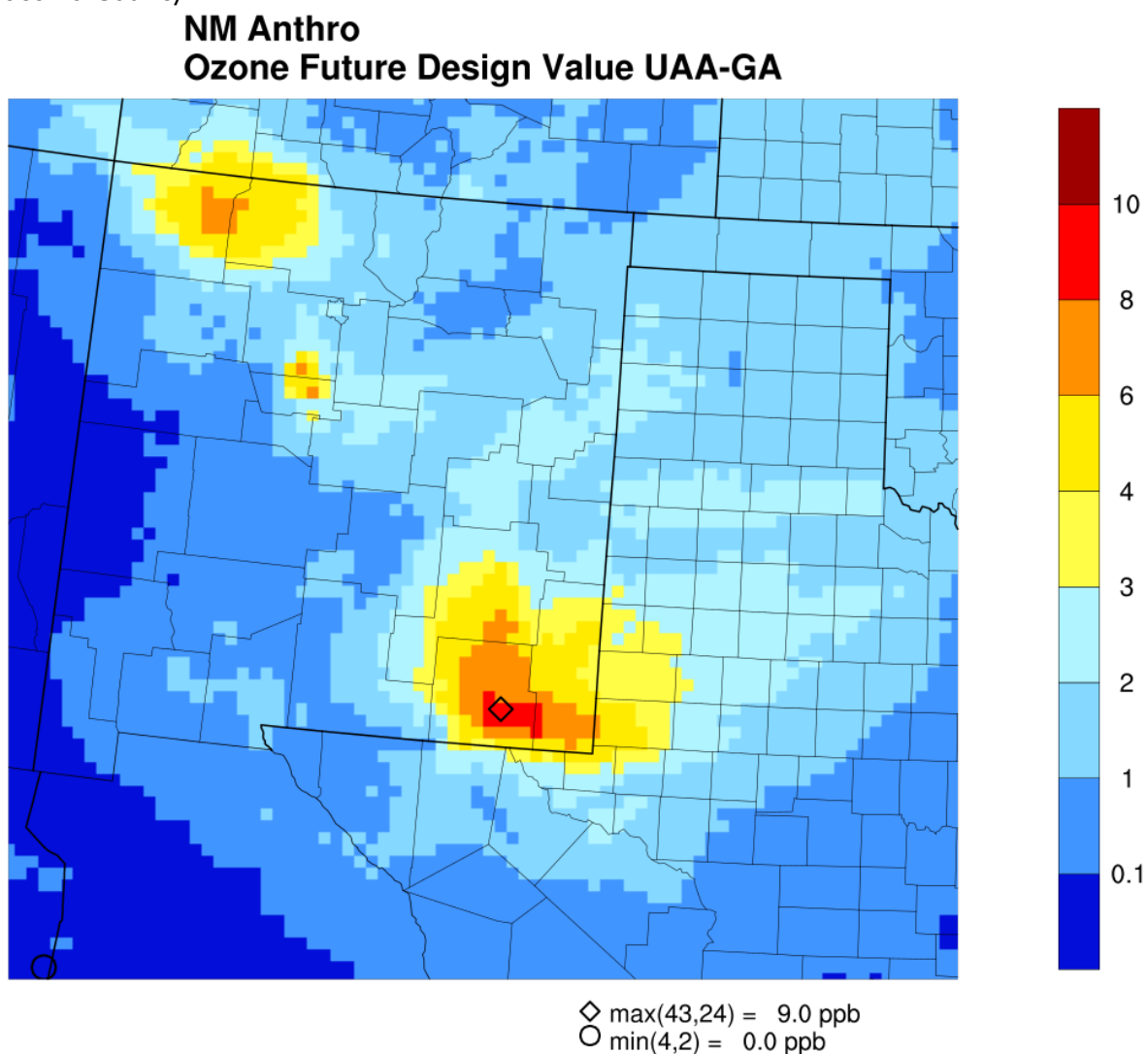


Figure 5-1. Contributions of New Mexico Anthropogenic emissions to the projected 2026 ozone DVFs across New Mexico.

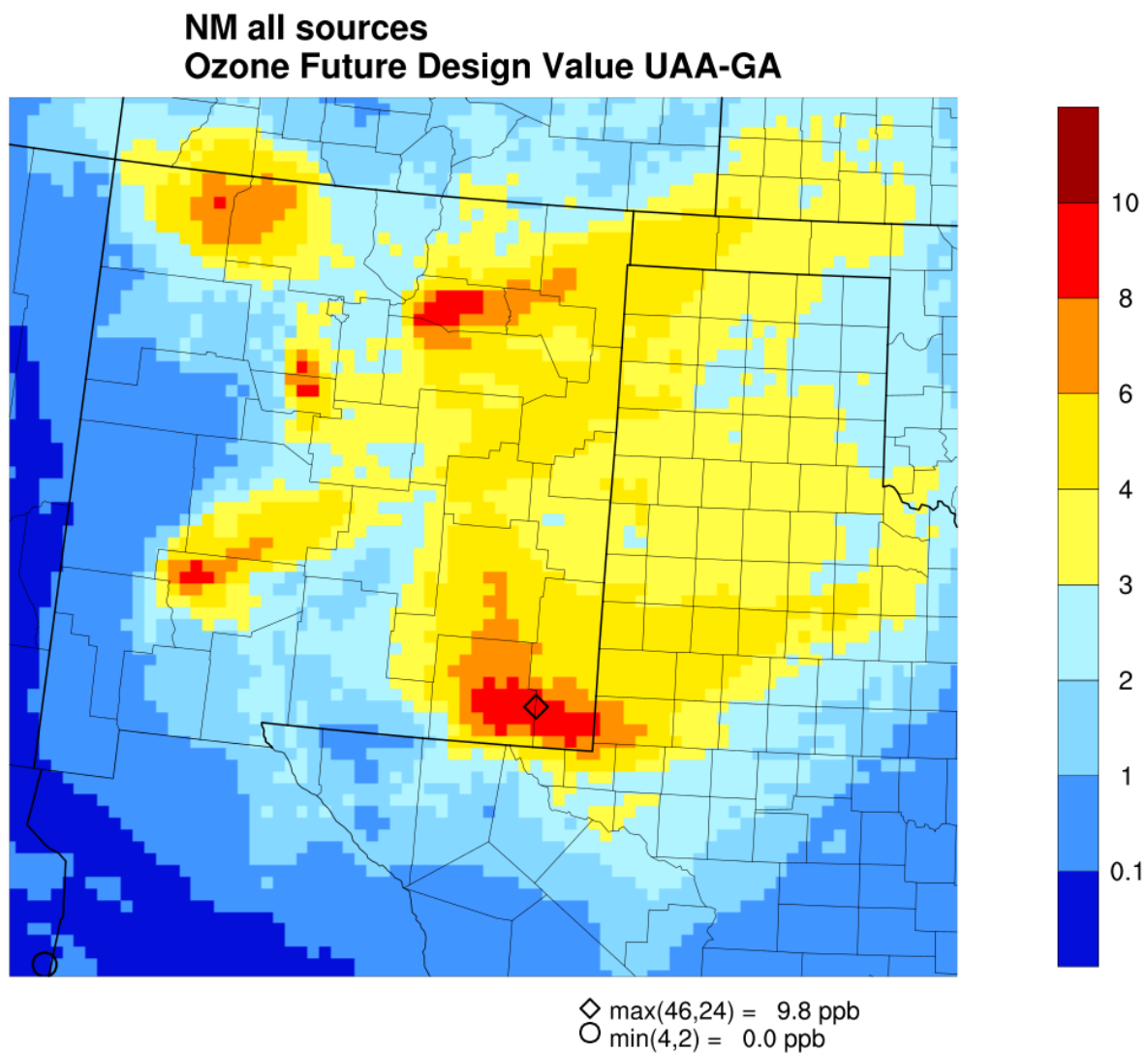


Figure 5-2. Contributions of New Mexico All Sources (anthropogenic and natural) emissions to the projected 2026 ozone DVF's across New Mexico and adjacent areas.

5.2 Contributions of Permian Basin Oil and Gas Emissions to 2026 Ozone DVFs

Figure 5-3 displays the contributions of New Mexico's (NM) Permian Basin (PB) oil and gas (O&G) emissions to the 2026 ozone DVFs with the top two panels showing the low-level (area) O&G and elevated (point) O&G contributions and the bottom panel the total (area plus point) NM PB O&G emissions contribution. The NM PB O&G has a maximum contribution to the 2026 ozone DVF of 8.5 ppb at the same location near Carlsbad in Eddy County as the maximum contribution due to all NM anthropogenic emissions (Figure 5-1). The maximum NM anthropogenic emissions contribution to 2026 ozone DVF is 9.0 ppb of which 8.5 ppb is due to NM PB O&G emissions, which is 94% of the maximum NM anthropogenic emissions contribution to 2026 ozone DVF. NM PB low-level (area) contributes slightly more (maximum 4.8 ppb) than elevated (point; maximum 3.8 ppb) O&G emissions.

Figure 5-4 shows the contribution of Permian Basin O&G emissions in New Mexico and Texas to 2026 ozone DVFs across the New Mexico analysis domain. The largest ozone contribution of all Permian Basin O&G emissions is 12.0 ppb near Carlsbad City in southern Eddy County of which 9.0 ppb (75%) is due to New Mexico and 3.0 ppb (25%) due to Texas PB O&G emissions. Total PB O&G emissions contribute more than 6 ppb to the 2026 ozone DVFs across Eddy and Lea Counties in New Mexico and into Andrews and Martin Counties in Texas.

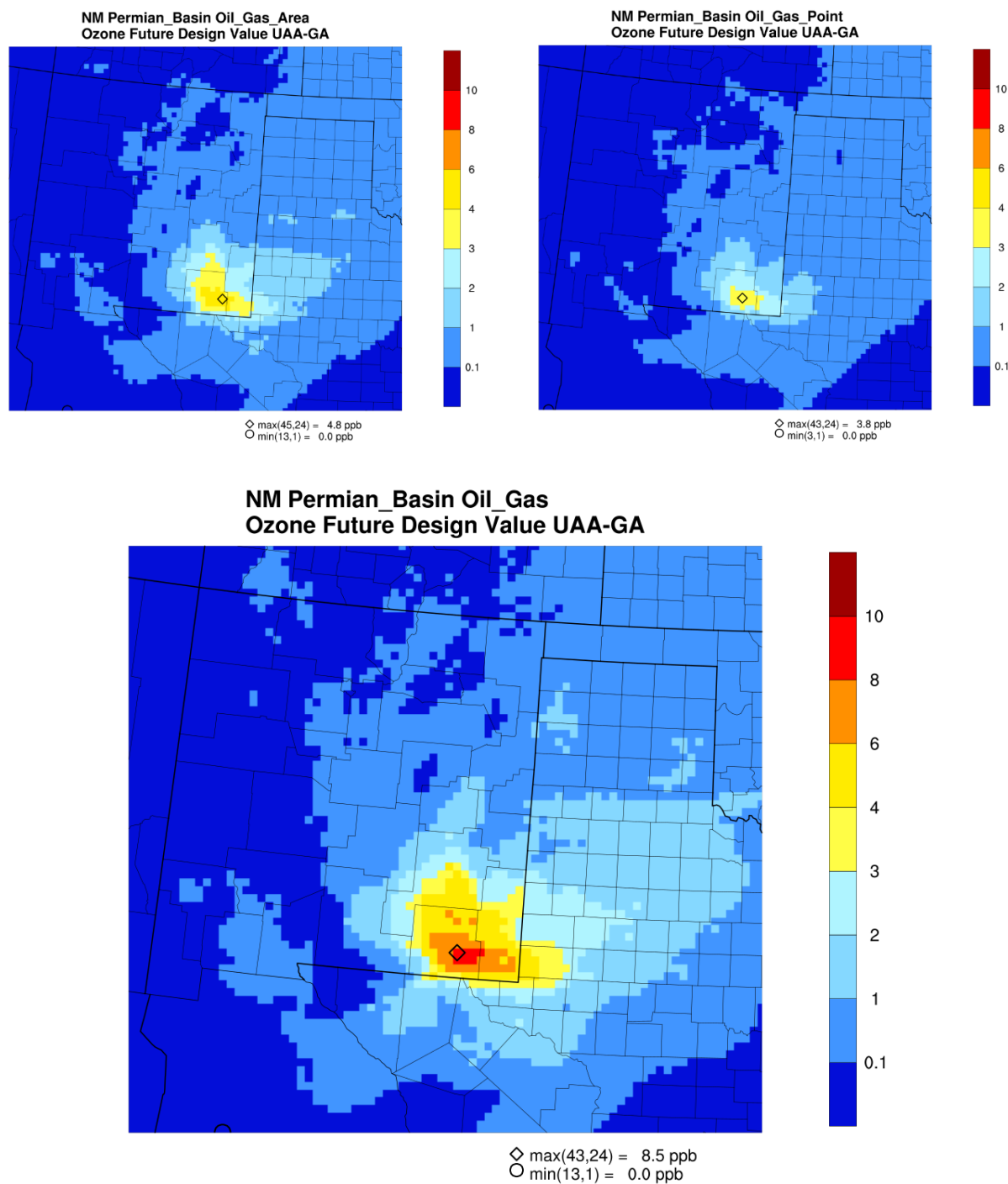
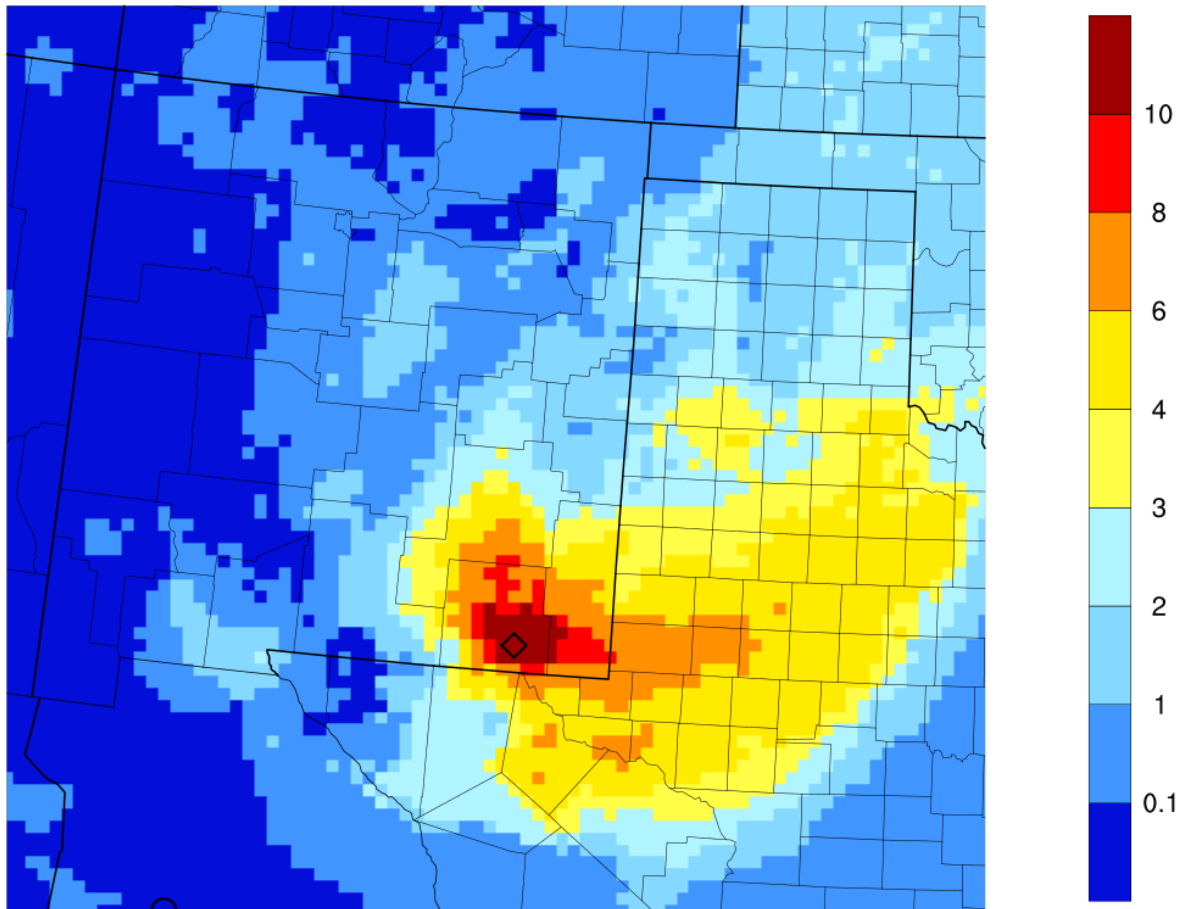


Figure 5-3. Contributions of New Mexico Permian Bason Oil and Gas emissions to 2026 ozone DVFs for: low-level (area) O&G emissions (top left); elevated (point) O&G emissions (top right); and total (area + point) O&G emissions (bottom).

NM_TX Permian_Basin Oil_Gas Ozone Future Design Value UAA-GA



◇ max(43,23) = 12.0 ppb
○ min(14,1) = 0.0 ppb

Figure 5-4. Contributions of New Mexico and Texas Permian Basin Oil and Gas emissions to 2026 ozone DVFs.

5.3 Anthropogenic Emissions Contributions to 2026 Ozone DVF

The contributions of anthropogenic emissions from New Mexico, Texas, Mexico and the remainder of the domain to 2026 ozone DVFs are shown in Figure 5-5. The New Mexico anthropogenic emission contributions to the 2026 ozone DVF was shown previously in Figure 5-1 and has a maximum contribution of 9.0 ppb near Carlsbad. Texas anthropogenic emissions contribute over 4 ppb to the 2026 ozone DVF in Eddy County and the Sunland Park area in southern Dona Ana County.

The largest contribution to 2026 ozone DVFs from Mexican anthropogenic emissions is 10.4 ppb and occurs in Mexico, near Ciudad Juarez, over the border with Texas and New Mexico next to western El Paso and the Sunland Park area in southeastern Dona Ana County. Mexico anthropogenic emissions contributions to 2026 ozone DVFs exceeding 8 ppb occur in the Sunland Park area in southeast Dona Ana County, New Mexico and in El Paso, Texas. The Mexican anthropogenic emission contributions to Eddy and Lea Counties, New Mexico are in the 1 to 3 ppb range.

The remainder of the anthropogenic emissions in the modeling domain (i.e., U.S. states except NM and TX, Canada and offshore) contribute 1 to 3 ppb to the southern New Mexico and Permian Basin Counties with isolated grid cells with contributions in the 3 to 4 ppb range in Eddy County.

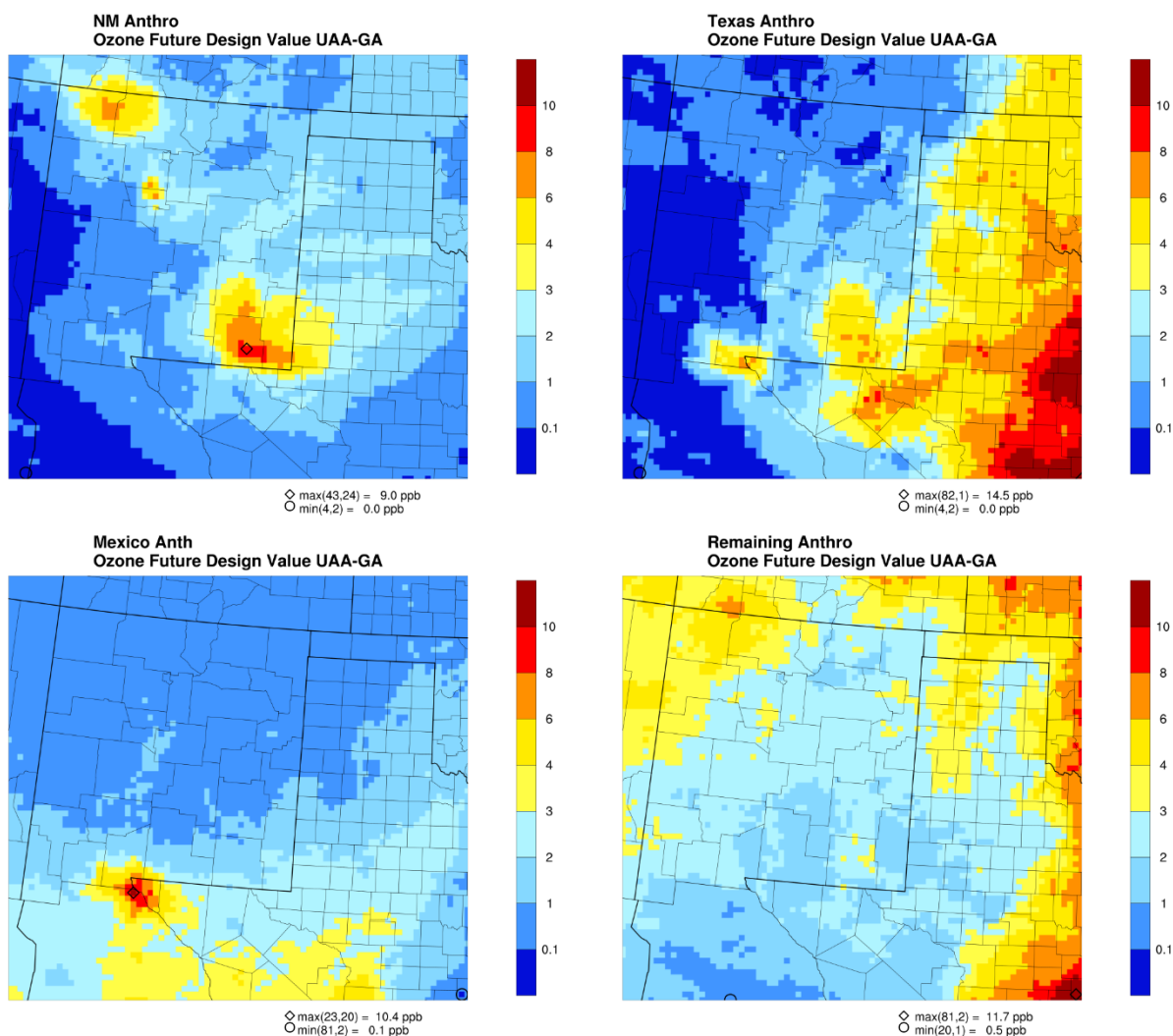


Figure 5-5. Contributions of anthropogenic emissions in New Mexico (top left), Texas (top right), Mexico (bottom left) and remainder of the domain (bottom right; i.e., not NM, TX or Mexico) to 2026 ozone DVFs.

5.4 Effects of No New Mexico Permian Basin O&G Emissions on 2026 Ozone DVF

Figure 5-6 displays the 2026 ozone DVFs using all emissions and with the ozone due to the New Mexico Permian Basin oil and gas emissions removed. When NM PB O&G 2026 emissions are removed, there are no projected 2026 ozone DVF exceedances (Figure 5-6 bottom panel). However, the 2026 ozone DVF ozone exceedances in western El Paso and southeastern Dona Ana County remain even when the 2026 ozone due to the NMPB oil and gas emissions are removed. There are also areas of SMAT-CE UAA 2026 ozone DVF exceedance areas in Sierra and Mora Counties at the locations where wildfires occurred in 2022, but this is likely just an artifact of the UAA spatial interpolation using modeled 2022 ozone concentrations gradients (UAA GA).

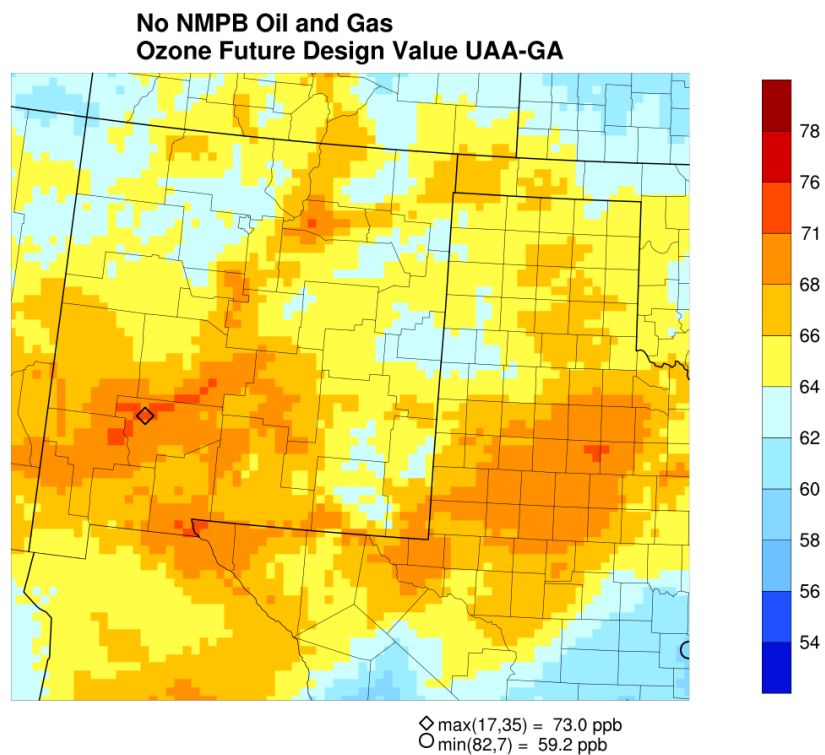
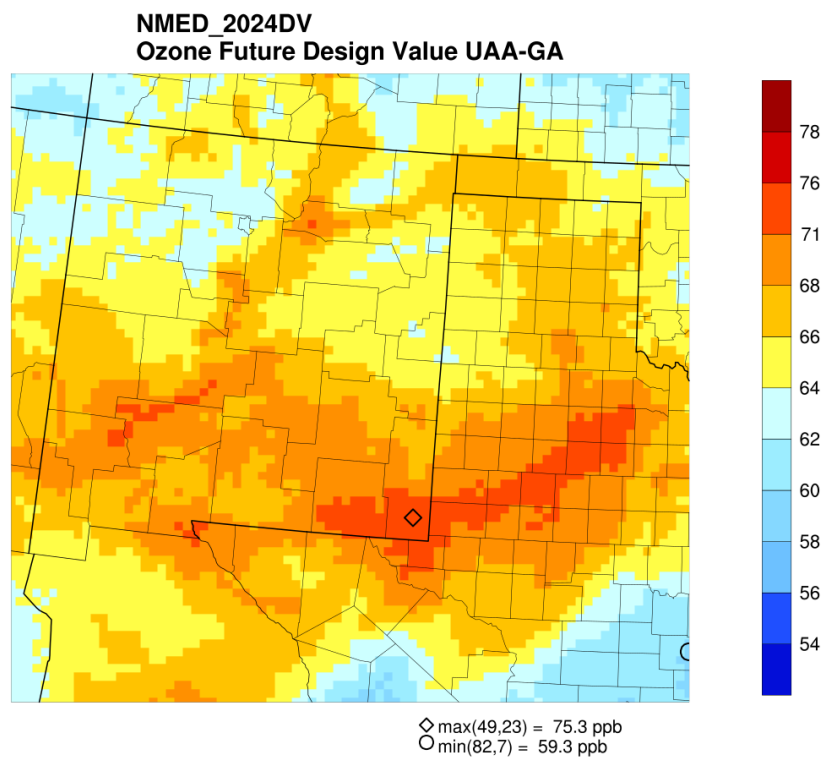


Figure 5-6. Projected 2026 ozone DVFs using SMAT-CE UAA with all emissions (top) and with the contributions of New Mexico Permian Basin O&G emissions removed (bottom).

5.5 Effects of No Mexico Anthropogenic Emissions on 2026 Ozone DVF

Figure 5-7 displays the SMAT-CE UAA projected 2026 ozone DVFs across the New Mexico analysis domain when ozone contributions due to 2026 Mexico anthropogenic emissions within the CAMx 12 km domain are removed using the 2026 APCA ozone source apportionment results. The maximum 2026 ozone DVF of 75.3 ppb occurs in the Permian Basin (Lea County) and is reduced to 73.1 ppb when the contributions of Mexican anthropogenic emissions in the 12 km domain are removed (bottom Figure 5-7). The areas in southeast Dona Ana County, New Mexico and western El Paso County, Texas where the 2026 ozone DVF exceeds the 70 ppb ozone NAAQS attain it when the ozone contributions from anthropogenic emissions from Mexico in the 12 km domain are removed.

Including Carlsbad Caverns, there were four sites in New Mexico with 2020-2024 ozone DVB that exceeded the 70 ppb 2015 ozone NAAQS: Carlsbad City (78.0 ppb), Carlsbad Caverns (78.3 ppb), Desert View (75.5 ppb), and La Union (76.0 ppb). When the ozone contribution due to 2026 Mexico anthropogenic emissions within the 12 km CONUS domain are eliminated, the projected 2026 ozone DVF at all four sites are below the 2015 ozone NAAQS: Carlsbad City (70.2 ppb), Carlsbad Caverns (70.9 ppb), Desert View (64.9 ppb), and La Union (65.1 ppb).

These results indicate that the Dona Ana County, New Mexico and El Paso County, Texas could demonstrate they would attain the 2015 ozone NAAQS in 2026 if not for international anthropogenic emissions as would be needed for a Section 179B demonstration. Note that the results presented here are a fraction of the total international anthropogenic emissions ozone contribution as it just eliminated the in-domain Mexico anthropogenic emissions ozone contribution and the ozone contributions due to Mexico anthropogenic emissions outside the CAMx 12 km domain as well as international anthropogenic emissions from other non-U.S. sources are still present in the modeling results shown in Figure 5-7. The projected 2026 ozone DVFs without all international anthropogenic emissions would be lower than shown in Figure 5-7 and if the ozone contributions of all international anthropogenic emissions were removed the SMAT-CE UAA would likely estimate that the peak 2026 ozone DVF of 73.1 ppb in the Permian Basin may also be below the 2015 NAAQS.

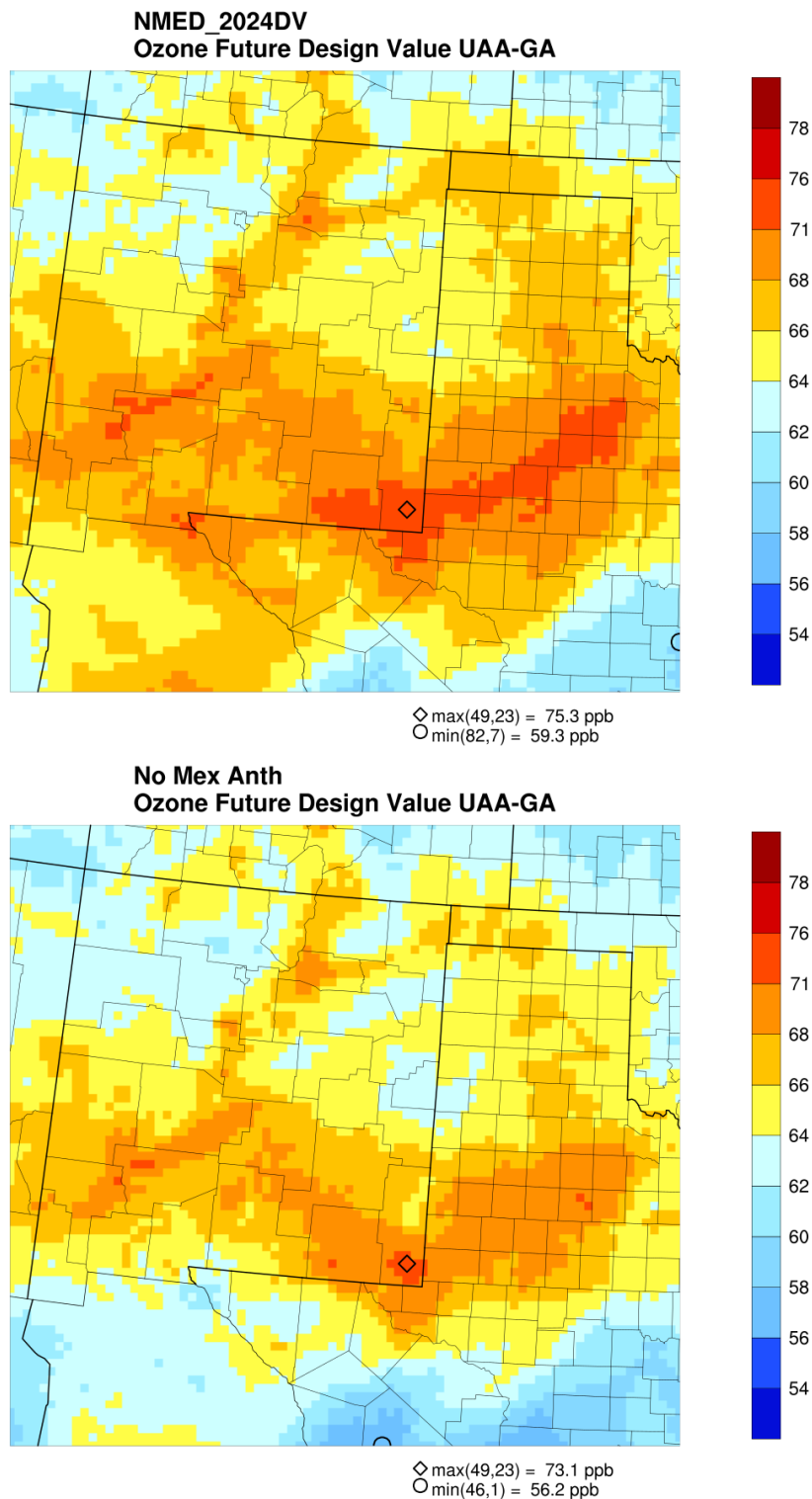


Figure 5-7. Projected 2026 ozone DVFs using SMAT-CE UAA with all emissions (top) and without the contributions of anthropogenic emissions from Mexico in the 12 km domain (bottom).

6.0 CONTRIBUTIONS TO 2026 MDA8 OZONE CONCENTRATIONS AT MONITORING SITES

The CAMx 2026 APCA ozone source apportionment contributions to MDA8 ozone were extracted at the monitoring sites and processed into an Excel Dashboard so that the Source Groups ozone contributions to MDA8 ozone concentrations at the monitors can be displayed for a day or groups of days. The MDA8 ozone Dashboard allows the user to investigate into the Source Region and Source Category ozone contributions of interest to 2026 MDA8 ozone concentrations at all New Mexico sites. Below we discuss some example results from the 2026 MDA8 ozone Dashboard that represent just a small fraction of the information available within the Dashboard.

6.1 2026 Ozone Contributions at the Carlsbad City Site in Eddy County

Figure 6-1 displays the MDA8 ozone Dashboard for the Carlsbad City monitoring site, and the 10 days used by SMAT-CE to estimate 2026 future year ozone Design Value (DVF) projections. Thus, the 2026 ozone contributions can be viewed as the contribution to the projected 2026 ozone DVF calculated by SMAT-CE.

There are three control panels on the left side of the Dashboard as follows:

Site ID: Controls which site the MDA8 ozone contributions will be displayed (selected Carlsbad City in Figure 6-1).

Regions: Controls which of the six Source Regions plus Boundary Conditions (BCs) MDA8 ozone concentrations will be displayed (all regions are selected in Figure 6-1):

- NMPB – the New Mexico portion of the Permian Basin.
- NMRem – the remainder of New Mexico (i.e., all of New Mexico except the Permian Basin).
- TXPM – the Texas portion of the Permian Basin.
- TXRem – the remainder of Texas (i.e., all of Texas except the Permian Basin).
- MEX – Mexico.
- RemDom – Remainder of the CAMx 36/2/4 km domain (i.e., Canada, Offshore and all U.S. states but New Mexico and Texas).
- BCD – Boundary Conditions (BCs; assumed concentrations around the boundaries of the most outer 36 km modeling domain that were defined by a 2022 simulation of the Hemispheric CMAQ chemistry model).

Source Categories: The nine Source Categories plus BCs that MDA8 ozone contributions can be displayed (all Source Categories are selected in Figure 6-1, which is the typical configuration, although anthropogenic emission displays excluding NAT and FIR are also frequently used):

- NAT – Natural emissions that includes biogenic VOC and NO_x, lightning NO_x and oceanic emissions.
- FIR – Open land fires that includes wildfires, prescribed burns and agricultural burning.
- EGU – Electrical Generating Unit point sources.
- NEGU – Non-EGU point sources.
- OGA – Low-level (area) oil and gas emissions.
- OGP – Elevated (point) oil and gas emissions.
- ONRD – On-road mobile sources.

- NONRD – Non-Road mobile sources.
- Area – Remaining low-level (area) emissions (e.g., non-point).
- BCD – Boundary Conditions.

The 7 control panels along the top of the Dashboard control which days the MDA8 ozone contributions will be displayed. For displaying the 10 SMAT-CE days, as in Figure 6-1, the third top control panel SMAT is set to Yes and the final three control panels (Top 10 Days, Over 60, Over 65 and Over 70) are set to both Yes and No so no SMAT days are excluded, and the Dashboard will fill in the Month and Day of Month control panels with the 10 SMAT days.

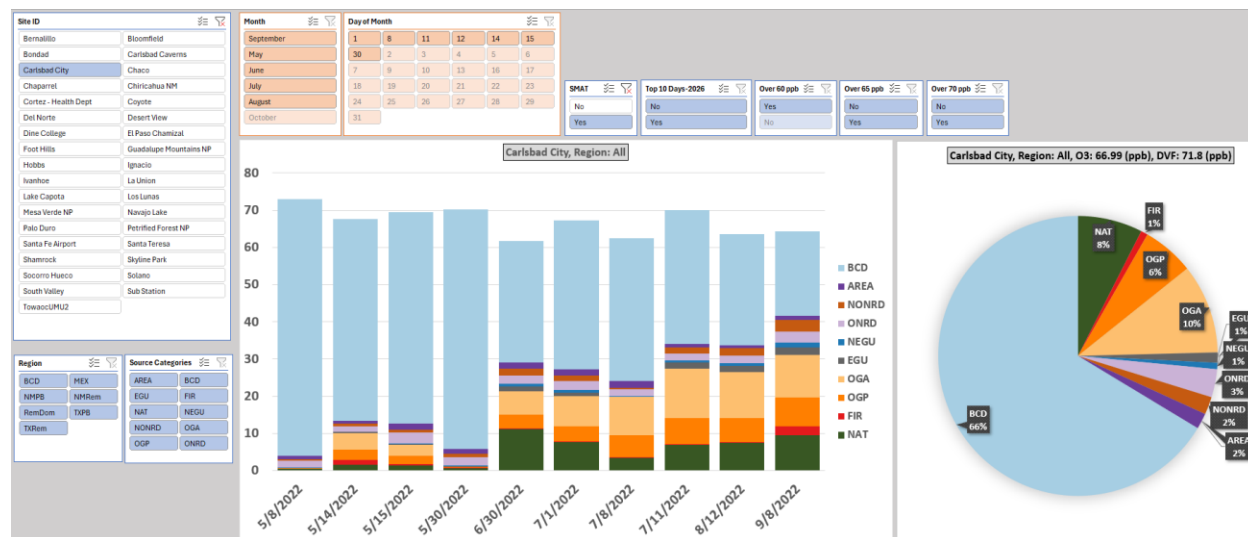


Figure 6-1. MDA8 Ozone Dashboard that displays Source Category and Source Region contributions to 2026 MDA8 ozone concentrations at Carlsbad City monitoring site on the 10 days used by SMAT-CE to make 2026 ozone DVF projections.

In Figure 6-1, the 2026 MDA8 ozone contributions for the 10 SMAT days are displayed as Stacked Bar Charts of Source Category ozone contributions. The Pie Chart displays the average ozone contributions across the 10 SMAT days for the 9 Source Categories and BC for the selected Source Regions (all regions are selected in Figure 6-1).

The Pie Chart in Figure 6-1 shows that 66% of the 2026 modeled MDA8 ozone averaged across the 10 SMAT days at Carlsbad City comes from BCs. Of the remaining 34%, almost half (16%; broken out as 6% OGP and 10% OGA) comes from oil and gas emissions and approximately a quarter are from natural emissions (8%). The Pie Chart also has two important pieces of information in its header label, the projected 2026 ozone DVF (71.8 ppb) and the average MDA8 ozone across the days selected (66.99 ppb averaged across the 10 SMAT days at Carlsbad City in this case).

The 10 days of Stacked Bar Charts show larger BC ozone contributions at Carlsbad City for SMAT days in May than SMAT days later in the summer. This issue could be explored by clicking on the May month to get one display and then the other months to get the pie charts of ozone contributions across the 4 May SMAT days and 6 non-May SMAT days as shown in Figure 6-2. These pie charts show that BCs contribute 87% of the ozone averaged across the four May SMAT days and 51% averaged across the 6 non-May July SMAT days.

These results suggest evaluation of control strategies should focus on the non-May days when BCs do not overwhelm the ozone contributions of in-domain anthropogenic emissions.

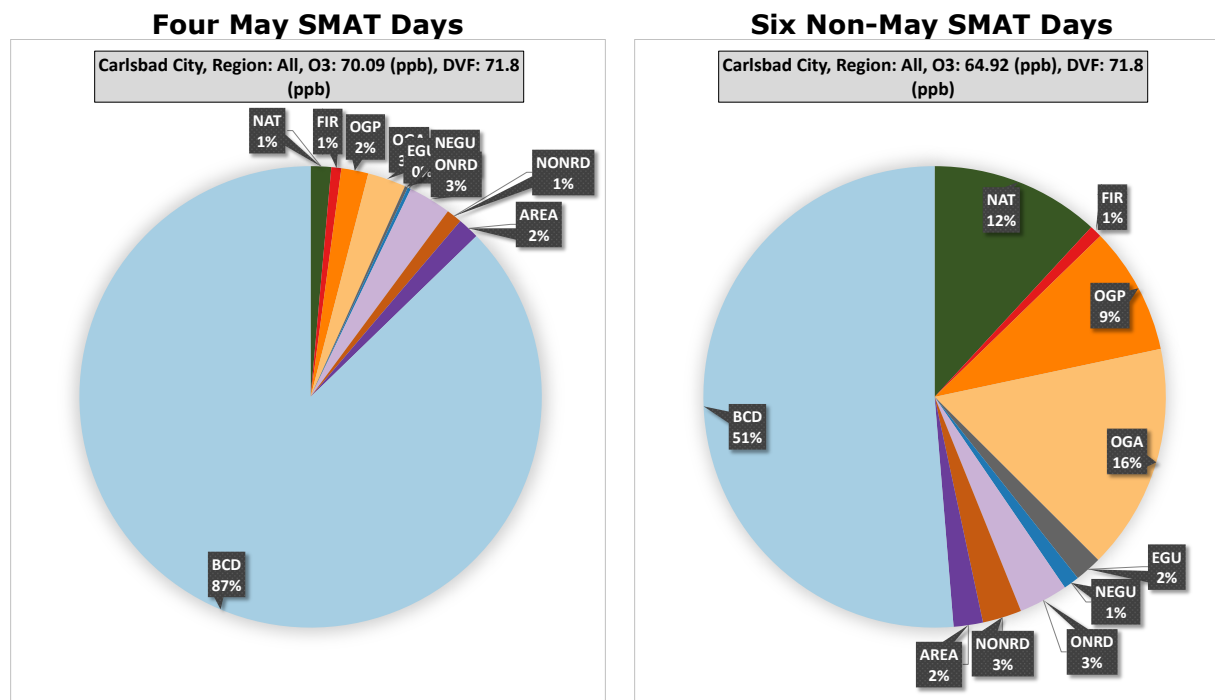


Figure 6-2. Pie charts of 2026 ozone contributions at Carlsbad City averaged across the 4 May (left) and 6 Non-May (right) SMAT days.

To examine Source Category ozone contributions by Source Region for the 10 SMAT days, each Source Region button can be separately selecting starting with the all 10 SMAT days configuration (i.e., as in Figure 6-1) with the resultant Dashboard pie charts shown in Figure 6-3:

- The NMPB Source Region contributes 7.42 ppb to the 2026 MDA8 ozone averaged over the 10 SMAT days (66.99 ppb) so represents 11% of the ozone contribution. Of the 7.42 ppb ozone contributions from the NMPB Source Region, a vast majority (93%) comes from oil and gas emissions split 51% area (OGA) and 42% point (OGP) source oil and gas emissions.
- The NMRem Source Region only contributes 0.55 ppb (0.8%) to the average of the 2026 MDA8 ozone concentrations across the 10 SMAT days at Carlsbad City with over half of that contribution due to natural and fire sources.
- The Texas portion of the Permian Basin (TXPB) contributes 4.17 ppb (6.2%) to the average of the 2026 MDA8 ozone across the 10 SMAT days at Carlsbad City that is 40% lower than the NMPB contribution (7.42 ppb and 11%). A majority (68%) of the TXPB ozone contributions is due to oil and gas sources.
- The remainder of Texas (TXRem) contributes 3.485 ppb (5.2%) of the 2026 MDA8 ozone averaged across the 10 SMAT days at Carlsbad City of which 39% is due to natural emissions and 18% due to oil and gas emissions that are not from the Permian Basin (e.g., Eagle Ford Basin).

- In domain emissions from Mexico (MEX) contributes 2.01 ppb (3.0%) to the average 2026 MDA8 ozone across the 10 SMAT days at Carlsbad City of which 1.5 ppb (2.3%) is due to Mexican anthropogenic emissions. Note that the projected 2026 ozone DVF at Carlsbad City was 71.8 ppb that is ~1.0% above the 70 ppb 2015 ozone NAAQS. The removal of the 2.3% in-domain Mexico anthropogenic emissions ozone contribution from the Carlsbad City 2026 ozone DVF is sufficient to bring the 2026 ozone DVF down to below the 2015 ozone NAAQS.

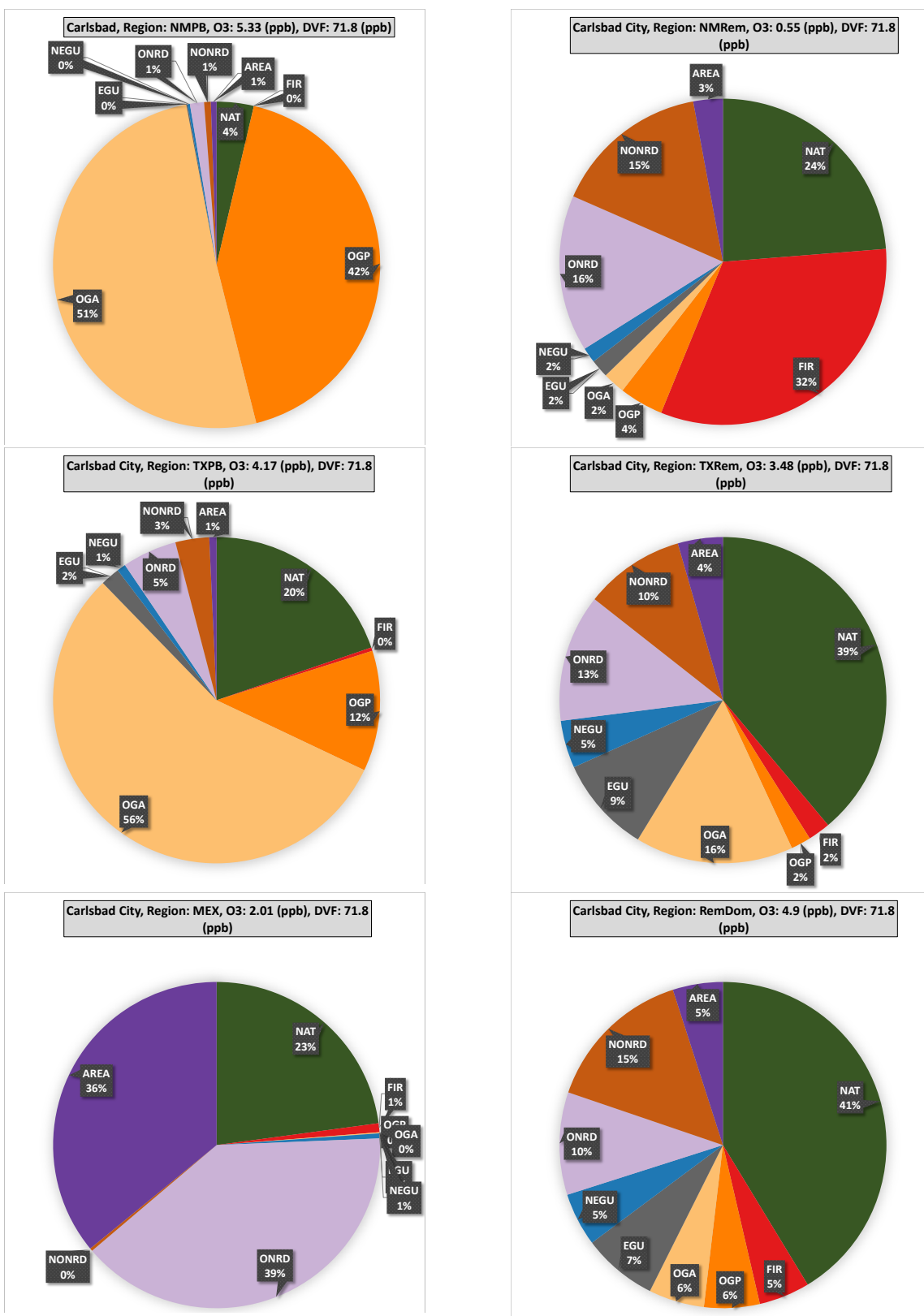


Figure 6-3. Contributions of Source Regions to the average of the 2026 MDA8 ozone concentrations on the 10 SMAT days at Carlsbad City.

There are 24 days during summer 2022 when the modeled 2026 MDA8 ozone is greater than 60 ppb with 13 of those days occurring in May and the other 11 days in later months. Figure 6-4 displays the Source Category contributions on the 11 non-May days with 2026 MDA8 ozone greater than 60 ppb at Carlsbad City. BCs contribute about half (52%) of the average of the ozone on these days; this is in contrast to the BCs contributing 83% across the average of the 13 May days at Carlsbad City with 2026 MDA8 ozone greater than 60 ppb. Of the 63 ppb average across 11 non-May days with 2026 MDA8 ozone greater than 60 ppb, 21 ppb (36%) is due to anthropogenic emissions. Of the 21 ppb anthropogenic emissions contribution, 9 ppb (40%) is from the NMPB Source Region that is mainly (94%) due to oil and gas emissions, 5 ppb (23%) is from the TXPB Source Region that is also mainly (84%) due to oil and gas with TXRem (4 ppb), RemDom (3 ppb) and Mex (1 ppb) rounding out the rest of the anthropogenic emissions contribution.

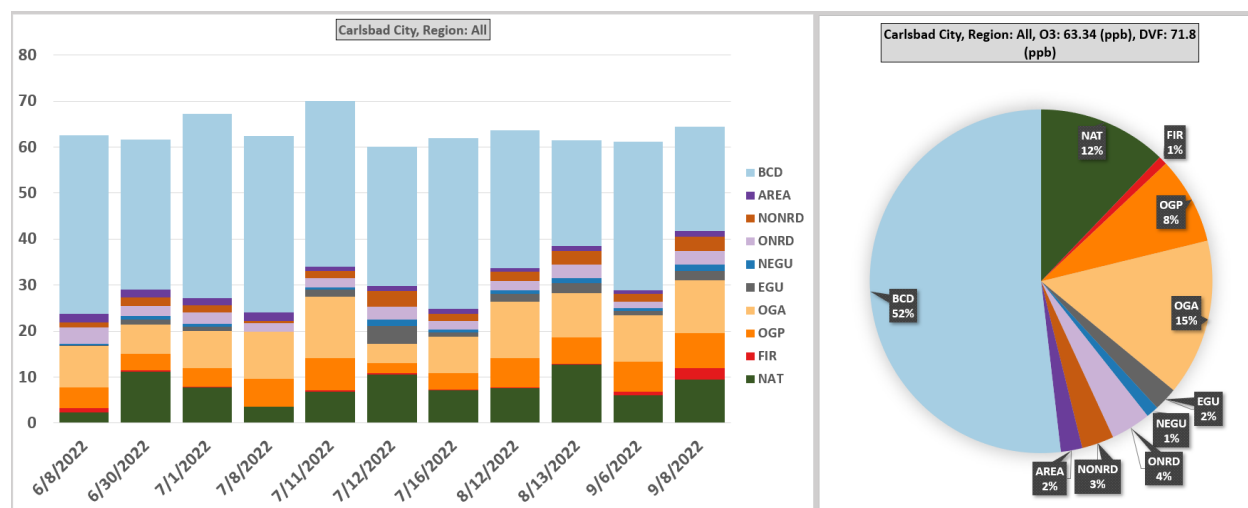


Figure 6-4. Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb at the Carlsbad City monitoring site during June, July, August and September.

6.2 2026 Ozone Contributions at the Hobbs Monitor in Lea County

Figure 6-5 displays the ozone contributions to the 2026 MDA8 ozone on the 10 SMAT days at the Hobbs monitoring site in Lea County. The 10 SMAT days at Hobbs are mainly days from May 2020 when contributions from BCs (outside 36 km domain) contribute the vast majority (70-90%) to the MDA8 ozone at Hobbs resulting in an 80% average BC contribution.

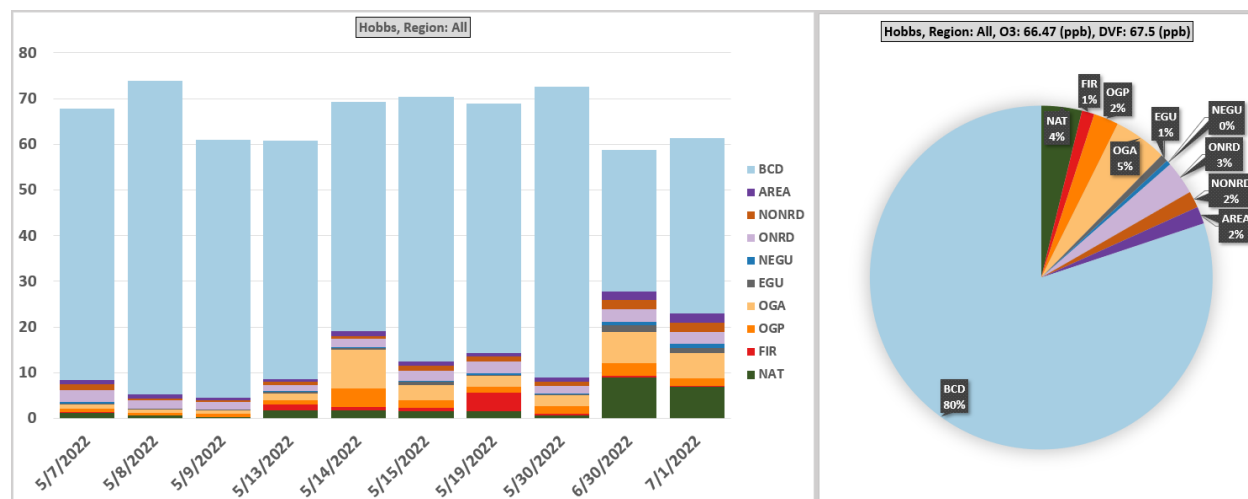


Figure 6-5. Contributions to the 2026 MDA8 ozone concentrations at Hobbs for the 10 SMAT days.

Figure 6-5 displays the monthly average contributions to 2026 MDA8 ozone concentrations at Hobbs for May, June, July and August. May has a much higher BC contribution (79%) than the other three months (60-65%) with May having almost half the oil and gas contributions (7%) as the other three months (12-13%).

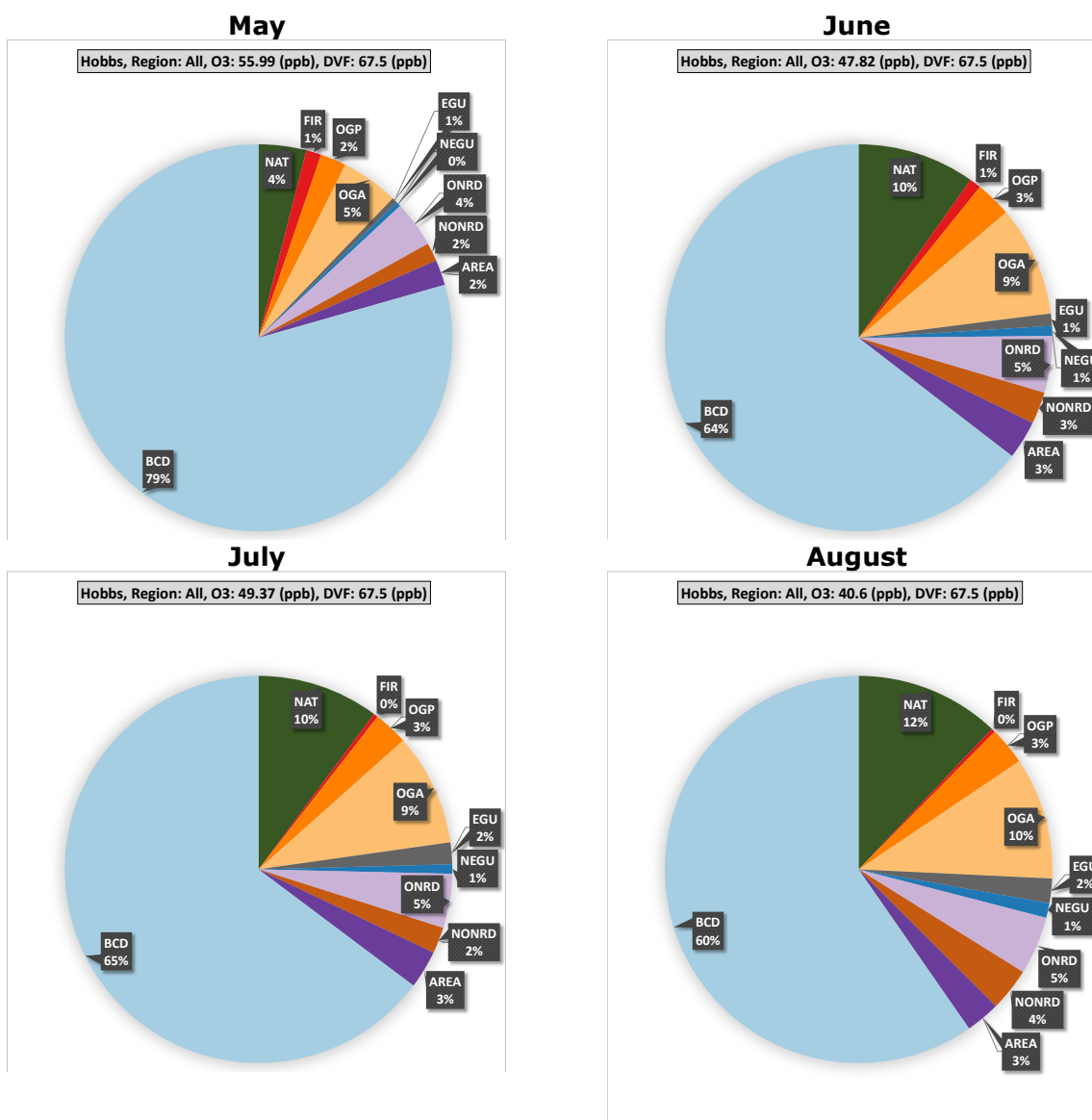


Figure 6-6. Contributions to monthly average MDA8 ozone concentrations at Hobbs.

6.3 2026 Ozone Contributions at the Desert View Monitor in Dona Ana County

Figure 6-7 displays the ozone contributions to the 2026 MDA8 ozone for the 10 SMAT days at Desert View in Dona Ana County with Figure 6-8 displaying the contributions by Source Region. BCs are the largest contributor (66%) driven in part by low in-domain contributions on the three May days (10 ppb or less) versus the non-May days (15-40 ppb). New Mexico has a small (2 ppb or 3%) contribution of which approximately half is due to natural emissions. Texas has a 7 ppb (11%) contribution and Mexico's contribution is 10 ppb (15%) of which 8.2 ppb is due to Mexican Anthropogenic emissions. The removal of the ozone contributions of the in-domain Mexico anthropogenic emissions is sufficient to reduce the projected 2026 ozone DVF (75.5 ppb) at Desert View to below the 70 ppb 2015 ozone NAAQS.

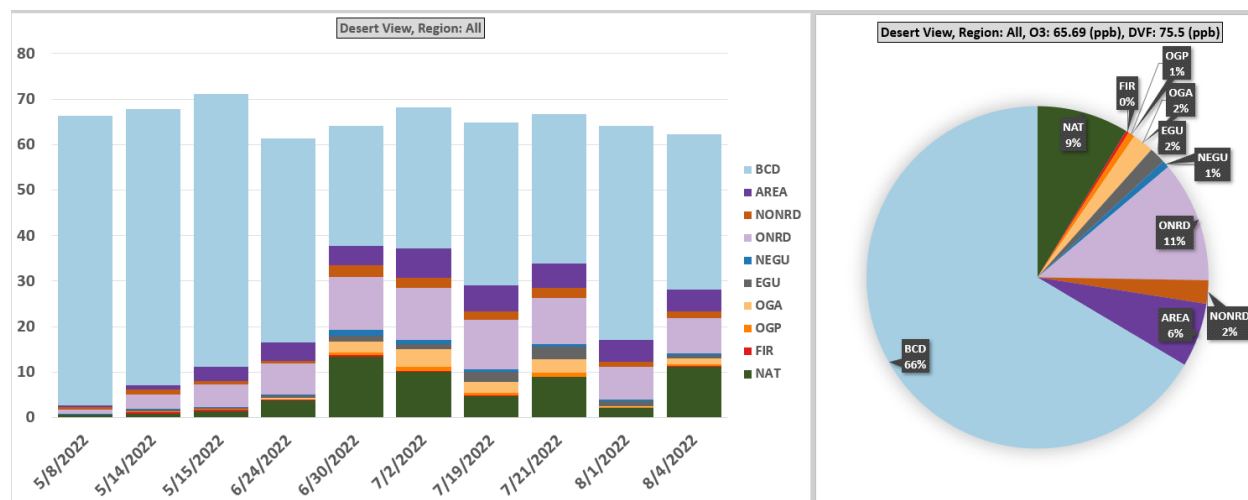


Figure 6-7. Contributions to the 2026 MDA8 ozone concentrations at Desert View for the 10 SMAT days.

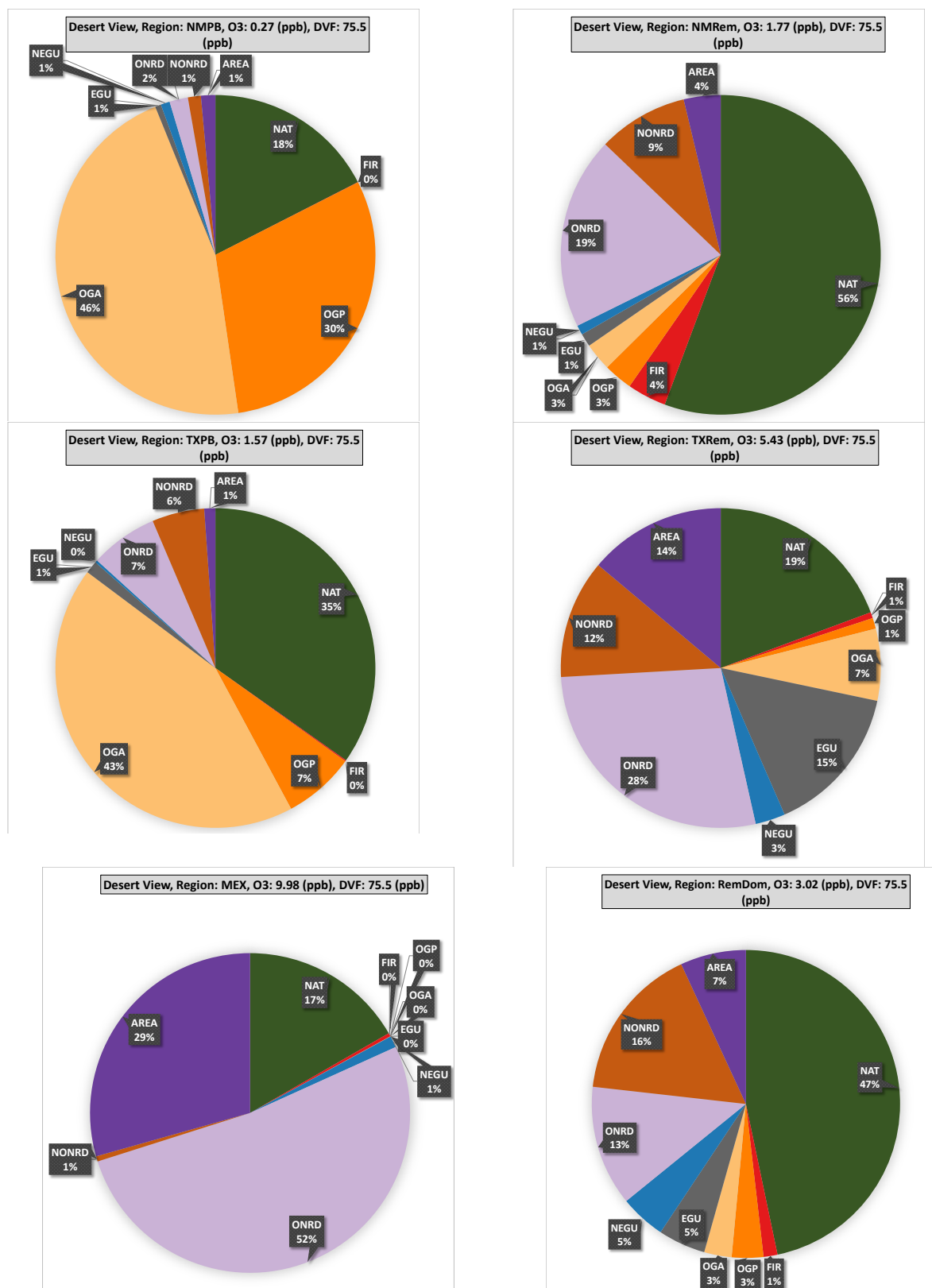


Figure 6-8. Contributions of Source Regions to the average of the 2026 MDA8 ozone concentrations on the 10 SMAT days at Desert View.

6.4 2026 Ozone Contributions at the Foot Hills Monitor in Bernalillo County

Figure 6-9 displays the contributions of Source Categories and Regions to 2026 MDA8 ozone concentrations at the Foot Hills monitor for the four days in July that the modeled 2026 MDA8 ozone exceeds 60 ppb. With BCs contributing 54% that leaves 46% (~29 ppb) due to in-domains sources. Natural plus Fire being 18% resulting in 28% (~18 ppb) of the average of the MDA8 ozone in July above 60 ppb at Foot Hills being due to anthropogenic emissions. Unlike the Permian Basin and southern New Mexico sites, New Mexico (Figure 6-9, middle left) is a major contributor to the total in-domain ozone (15.14 ppb or 52%) and total in-domain anthropogenic ozone (10.3 ppb or 57%). Texas (3.9 ppb or 13%), Mexico (1.7 ppb or 6%) and remainder domain (8.2 ppb or 28%) make up the rest of the 29 ppb total in-domain ozone contribution at Foot Hills.

6.5 2026 Ozone Contributions at the Navajo Lake Monitor in San Juan County

Figure 6-10 is similar to Figure 6-9 only for eight days in July in which the modeled 2026 MDA8 ozone exceeds 60 ppb at the Navajo Lake receptor in San Juan County. BCs contribute on average 59% leaving 41% (25 ppb) due to in-domain sources of which 27% (17 ppb) is due to in-domain anthropogenic emissions. Of the 25 ppb in-domain contribution, New Mexico (12.6 ppb 50%) and remainder domain (8.3 ppb or 33%) are the two largest contributors with Texas (2.8 ppb or 11%) and Mexico (1.7 ppb or 7%) having smaller contributions.

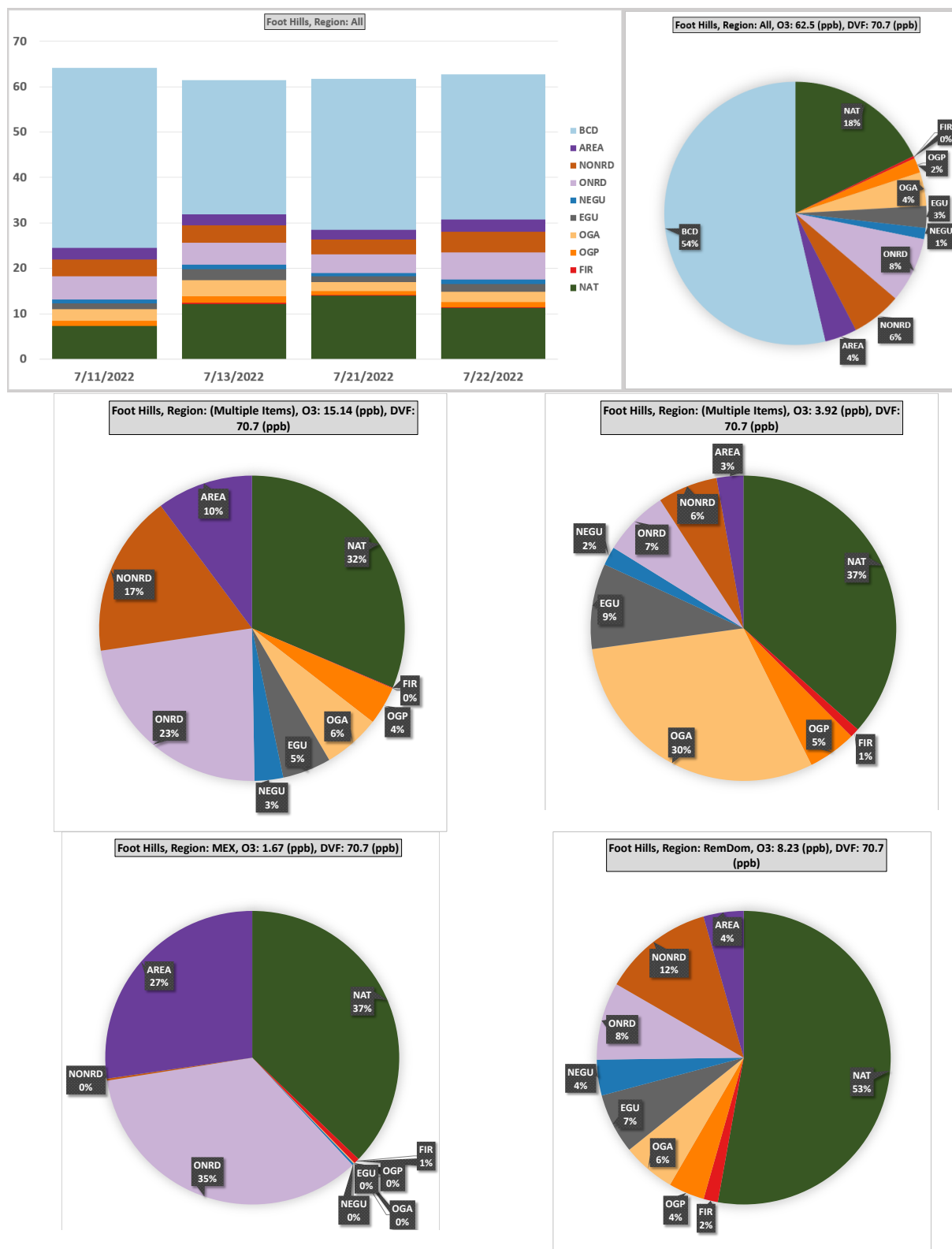


Figure 6-9. Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb in July at the Foot Hills monitoring site: New Mexico (middle left), Texas (middle right), Mexico (bottom left) and Remainder Domains (bottom right).

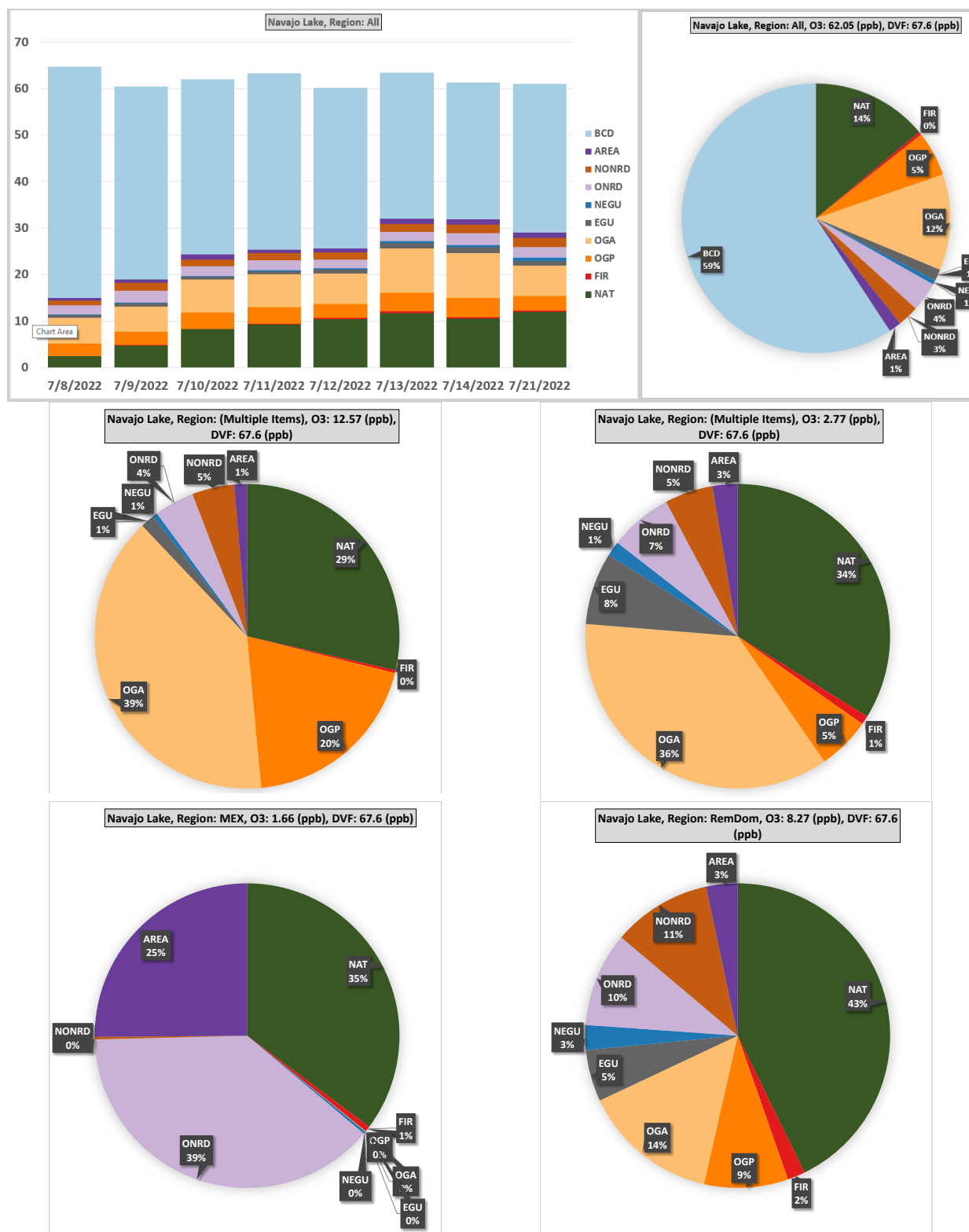


Figure 6-10. Ozone contributions to 2026 MDA8 ozone concentrations greater than 60 ppb in July at the Navajo Lake monitoring site: New Mexico (middle left), Texas (middle right), Mexico (bottom left) and Remainder of Domain (bottom right).

6.6 Conclusions 2026 Ozone Source Apportionment at New Mexico Monitoring Sites

This Chapter presented a few examples of contributions of Source Categories and Source Regions to modeled MDA8 ozone concentrations at several sites in New Mexico using the 2026 MDA8 ozone Dashboard viewing tool. The results confirm the Conceptual Model of elevated ozone concentrations in that a majority of the ozone in New Mexico on high ozone days is due to international transport from outside of North America (i.e., the BCs). The contribution of the BCs is particularly high in May producing some of the highest modeled MDA8 ozone concentrations. As the SMAT-CE tool used to make future year ozone DVF projections uses the 10 highest modeled 2022 MDA8 ozone days, it tends to use many days from the May period when BCs dominate the ozone contributions and there are small ozone contributions from in-domain anthropogenic emissions. This results in little change in current year ozone DVB to future year ozone DVFs since the BCs remain unchanged between 2022 and 2026. When evaluating emissions control strategies it is important to examine changes in high ozone during June-August away from the May period that is dominated by BCs.

Although the 2026 ozone source apportionment modeling only modeled the in-domain portion of anthropogenic emissions from Mexico, when the ozone contribution due to the in-domain anthropogenic emissions from Mexico are removed, all projected 2026 ozone DVFs that were above the 70 ppb ozone NAAQS are below the 2015 NAAQS. Thus, the removal of ozone contributions from all international anthropogenic emission sources would result in further reductions in ozone Design Values.

7.0 ANALYSIS OF 2026 APCA OZONE APPORTIONMENT O3N AND O3V TRACERS

The CAMx OSAT/APCA ozone source apportionment Probing Tool includes an indication of when ozone is formed under more NO_x-sensitive and VOC-sensitive conditions that is separately tracked by the, respectively, O3N and O3V reactive tracers. However, it is an imperfect measure of how much ozone is formed under NO_x-sensitive or VOC-sensitive conditions for which a sensitivity method is needed or Process Analysis. The APCA ozone source apportionment tool has the added issue of only assigning ozone formed to the natural Source Category when it natural NO_x reacting with natural VOCs; when ozone formed due to biogenic VOC reacting with anthropogenic NO_x under VOC-sensitive conditions APCA assigns the ozone formed to the anthropogenic Source Group(s) as it is believed that will provide more control strategy relevant information. Thus, APCA has a bias toward assigning more ozone formed to the O3N than O3V tracers. With these caveats in mind, the CAMx 2026 APCA ozone source apportionment O3N and O3V tracers were examined for high 2026 MDA8 ozone days at several New Mexico sites in the following sections.

7.1 2026 MDA8 Ozone O3N/O3V Contributions at Carlsbad City

Figure 7-1 is from the O3N/O3V Dashboard that displays the contributions to the 2026 MDA8 ozone on days in which the modeled 2026 ozone is greater than 60 ppb during June – September at Carlsbad City monitoring site. The operation of the O3N/O3V Dashboard is similar to the 2026 MDA8 ozone Dashboard only there is no BC contributions since it is not known whether BC ozone is formed under more NO_x-sensitive or VOC-sensitive conditions. Approximately 90% of the in-domain ozone formed for high 2026 MDA8 ozone days reside in the O3N tracers. These results suggest that ozone formation at Carlsbad City is more NO_x-sensitive than VOC-sensitive although the relative amounts of sensitivity cannot be determined using the O3N and O3V tracers given the caveats described in the beginning of this Chapter.

Figure 7-2 displays the Source Category anthropogenic emissions contribution to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Carlsbad City by Source Region. Of the 22.27 ppb anthropogenic emissions contribution at Carlsbad City, 8.98 ppb (40%) is from the NMPB Source Region whose O3N/O3V are approximately split 89%/11%. However, of the 11% O3V from the NMPB, it is all from oil and gas sources. The TXPB Source Region anthropogenic emissions contribute 4.9 ppb with O3N/O3V split 85%/15%. The remaining part of Texas (TXRem) contributes 3.7 ppb split 96%/4% between O3N/O3V. However, the remainder Texas (TXRem) and remainder domain (RemDom) contribute, respectively, 3.7 and 3.4 ppb and have O3N/O3V split 96%/4%.

As noted above, the O3N ozone contributions are much greater than O3V for elevated 2026 MDA8 ozone at Carlsbad City suggesting NO_x controls may be more beneficial than VOC controls for reducing ozone at Carlsbad City. However, the relative larger O3V due to oil and gas emissions in the Permian Basin suggest that VOC controls on oil and gas sources in the both the New Mexico and Texas portions of the Permian Basin would also be beneficial for reducing ozone concentrations.

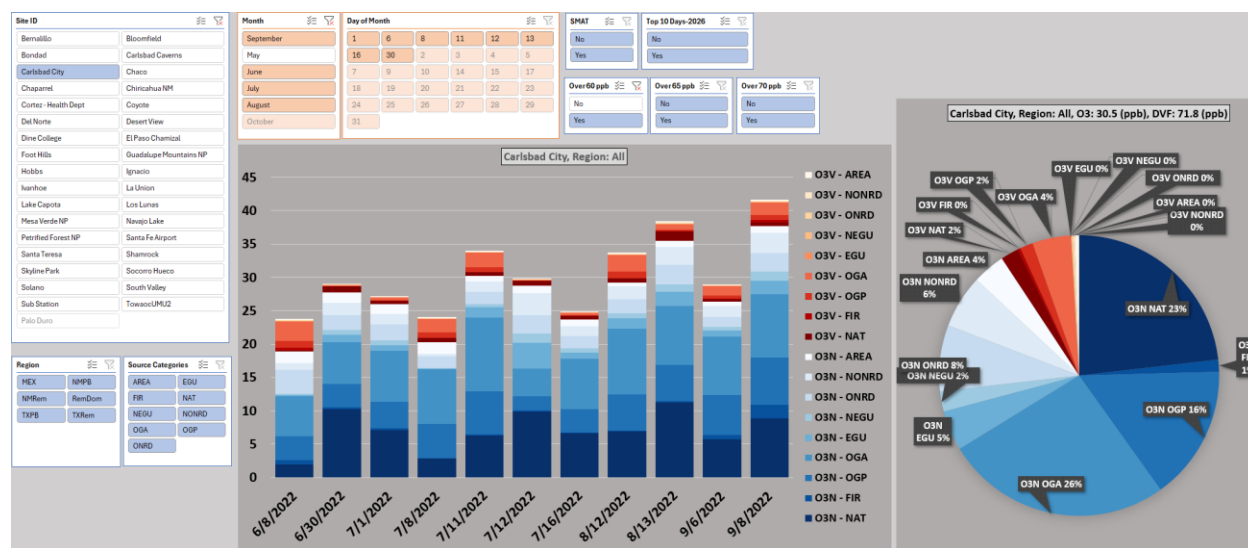


Figure 7-1. O3N and O3V contributions to the 2026 MDA8 ozone concentrations at Carlsbad City on days the modeled 2026 MDA8 ozone is greater than 60 ppb in June – September.

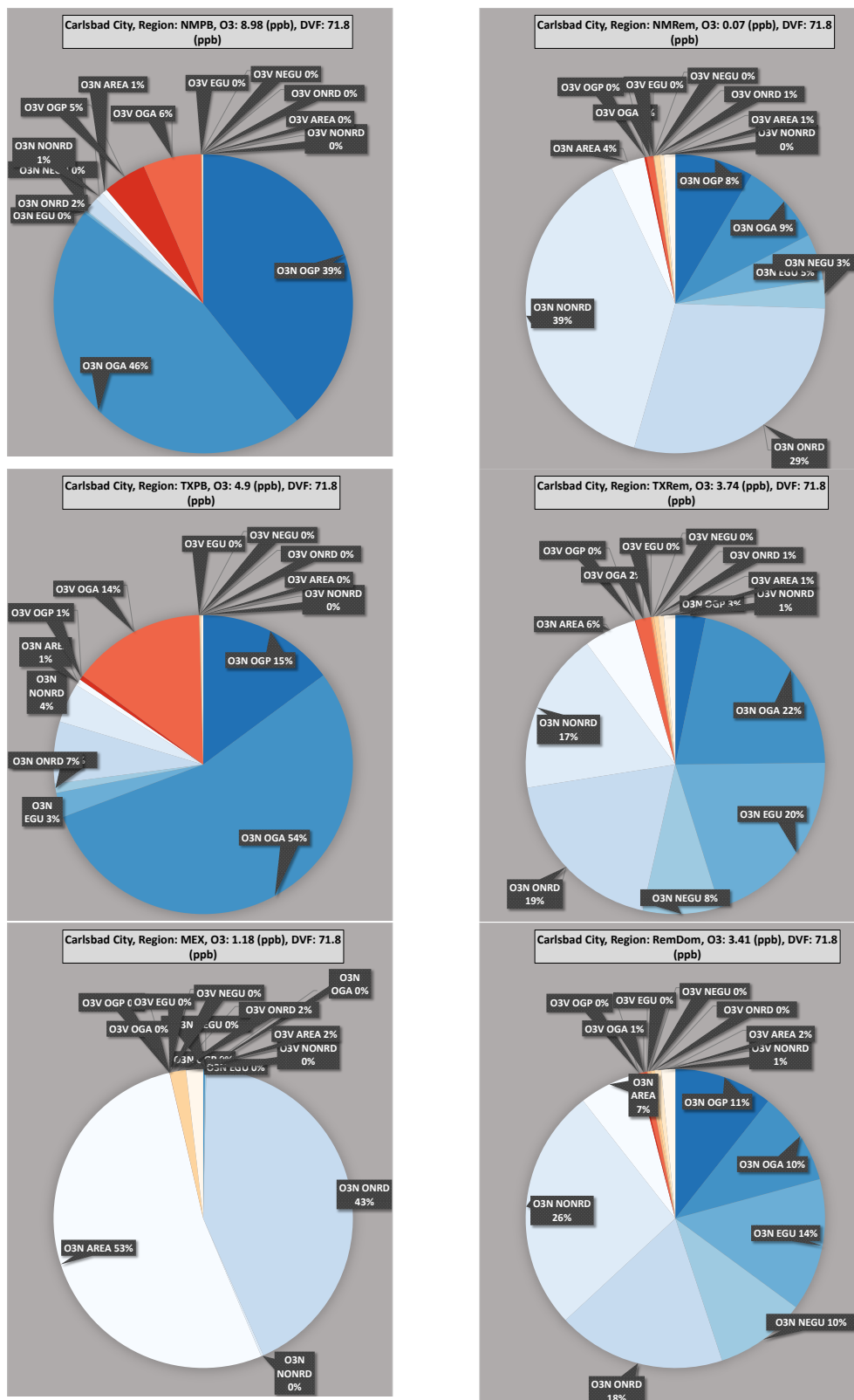


Figure 7-2. O3N/O3V contributions by Source Regions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Carlsbad City.

7.2 2026 MDA8 Ozone O3N/O3V Contributions at Desert View and El Paso

There are 12 days at Desert View with 2026 MDA8 ozone greater than 60 ppb during June – September with the anthropogenic emissions Source Category contributions to their average shown in the left panel of Figure 7-3. There is a lot more ozone contributions from O3V tracers at Desert View than at the Permian Basin sites, likely due to being more urban-oriented so having higher density NO_x emissions. The O3N/O3V split at Desert View is 72%/28% with a majority (61%) of the O3V due to On-Road Mobile Source Category. Even so, the On-Road Mobile O3N is over 2.5x the O3V.

The right panel of Figure 7-3 is similar to the left panel only for the 2026 MDA8 ozone for June – September days greater than 60 ppb at the Socorro Hueco monitoring site in El Paso, Texas. The O3N/O3V is split 75%/25% with On-Road Mobile contributing approximately half of both the O3N and O3V tracers.

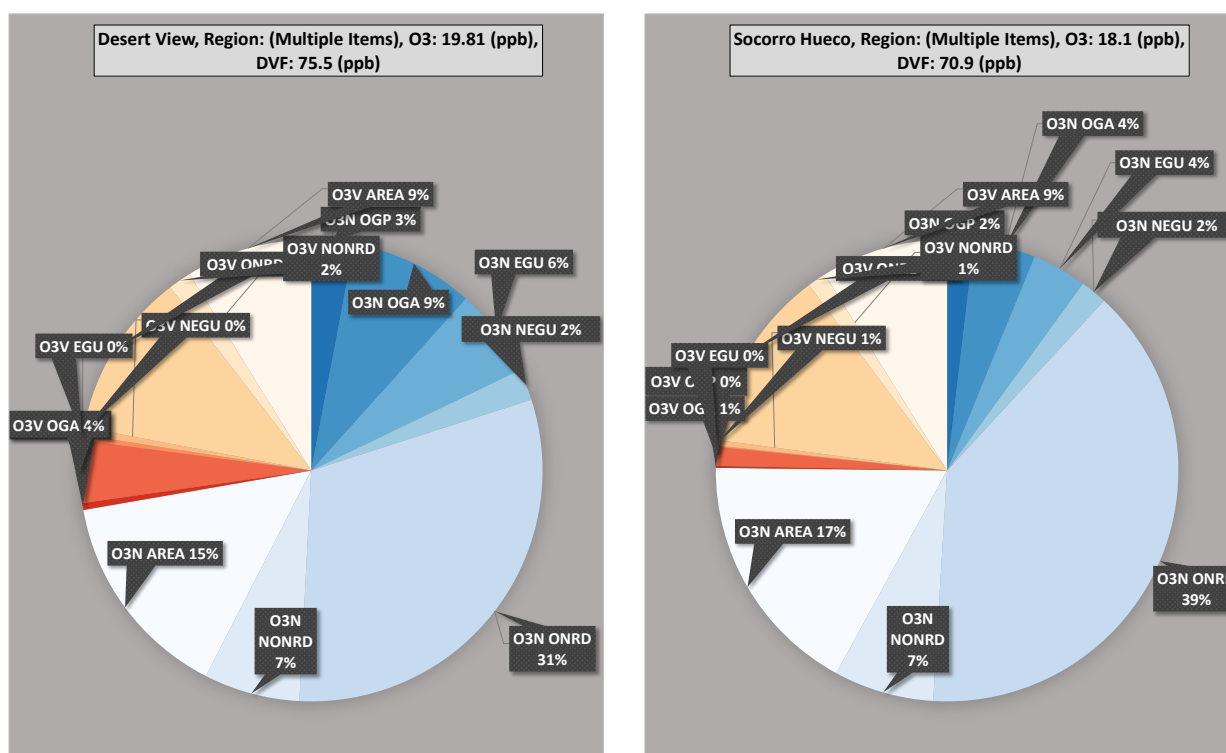


Figure 7-3. Anthropogenic emissions Source Category O3N/O3V contributions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Desert View in Dona County (left) and Socorro Hueco in El Paso County (right).

7.3 2026 MDA8 Ozone O3N/O3V Contributions at Foot Hills and Navajo Lake

Figure 7-4 displays the O3N/O3V contributions to the average of the 2026 MDA8 ozone concentrations greater than 60 ppb for the 6 days at Foot Hills and 18 days at Navajo Lake. At both sites, the O3N/O3V split is approximately 90%/10% with a majority of the 2026 MDA8 ozone at Foot Hills due mobile source O3N and a majority at Navajo Lake due to oil and gas O3N.

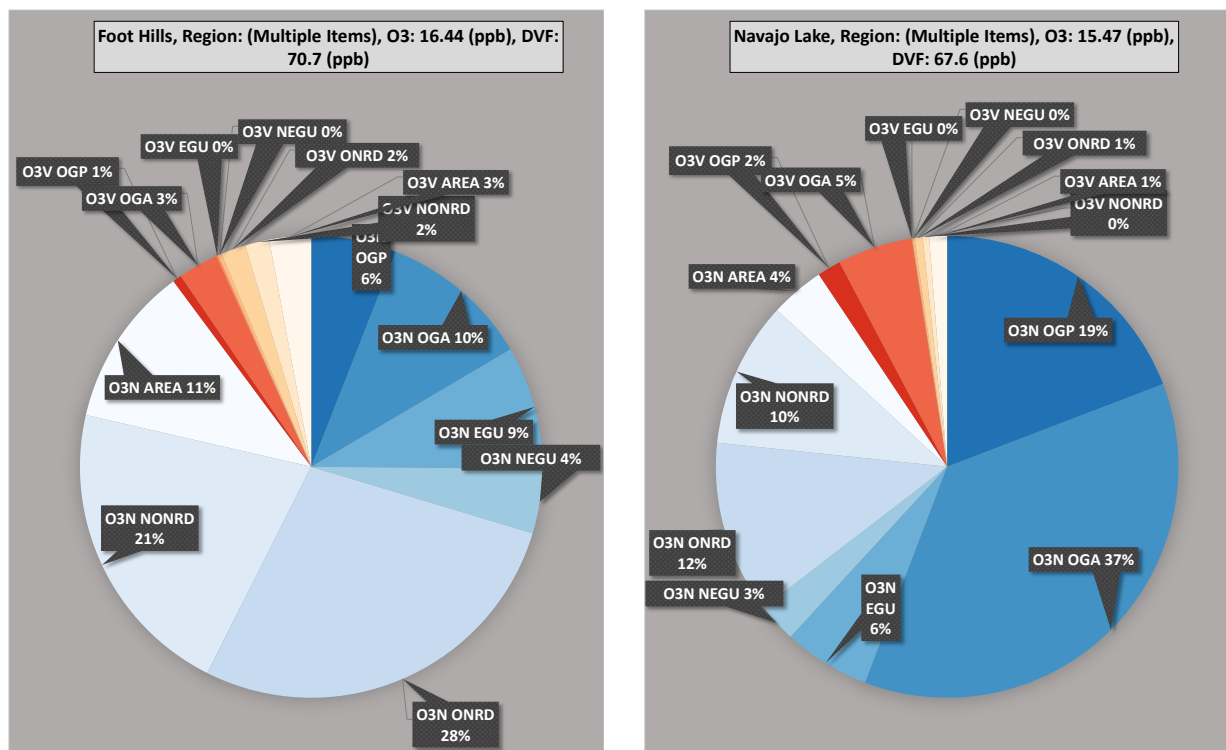


Figure 7-4. Anthropogenic emissions Source Category O3N/O3V contributions to the average of the 2026 MDA8 ozone greater than 60 ppb during June – September at Foot Hills in Bernalillo County (left) and Navajo Lake in San Juan County (right).

8.0 RESULTS OF THE 2026 BRUTE FORCE EMISSION REDUCTION SENSITIVITY TESTS

Five Brute Force (BF) CAMx 2026 12 km emission reduction sensitivity tests were conducted mainly to explore the relative sensitivity of 2026 ozone formation in New Mexico to NO_x versus VOC emission reductions:

1. NM 20% anthropogenic NO_x reduction.
2. NM 20% anthropogenic VOC reduction.
3. NM 20% Permian Basin O&G NO_x reduction.
4. NM 20% Permian Basin O&G VOC reduction.
5. NM 20% Permian Basin O&G NO_x and VOC increase.

The fifth sensitivity test was run to examine the sensitivity of the 2026 ozone levels to uncertainties in the 2026 oil and gas emission projections in the New Mexico portion of the Permian Basin. As given in Table 1-1, the 2022 EMP assumed between 2022 and 2026 that New Mexico oil and gas NO_x and VOC emissions would be reduced by, respectively, -30% and -57%. The fifth sensitivity test examines the sensitivity of the 2026 ozone levels if not all of the emissions reductions in oil and gas emissions between 2022 and 2026 are obtained in the Permian Basin.

The CAMx 2026v1 12 km BF simulations were run a little differently than the CAMx 2026v1 12 km APCA ozone source apportionment simulations. The CAMx 2026 APCA ozone source apportionment simulation was computationally extensive obtaining separate ozone contributions for 56 Source Groups, whereas the five CAMx 2026 BF standard model runs obtained sensitivity results for five Source Groups. Consequently, the CAMx 2026 APCA run used a faster computer with more CPUs and produced slightly different 2026 ozone results than the CAMx 2026 BF runs. Thus, we were internally consistent across the two sets of 2026 modeling results, but did not mix the CAMx APCA and BF modeling results.

Spatial displays of the differences in projected 2026 ozone DVFs and MDA8 ozone concentrations for the BF emission reduction sensitivity tests were generated and are discussed below.

8.1 Sensitivity of 2026 Ozone DVF to NO_x and VOC Emissions

The sensitivity of estimated 2026 ozone DVF levels to total anthropogenic and Permian Basin oil and gas emissions was analyzed by taking the differences in the SMAT-CE UAA 2026 DVFs for the base case minus each of the sensitivity cases.

Figure 8-1 displays the projected 2026 ozone DVFs using the CAMx 2026 12 km BF base case modeling results. Figure 8-2 displays the differences in 2026 ozone DVFs between the base case and the 20% emissions reduction in New Mexico anthropogenic NO_x (sens1) or VOC (sens2). The 20% NO_x reduction is producing greater ozone reductions than the 20% VOC reductions even though New Mexico anthropogenic VOC emissions are 80% higher (1.76x) the anthropogenic NO_x emissions (Table 1-1). For example, the largest 2026 ozone DVF decrease for the 20% NO_x reduction scenario is -1.2 ppb near Carlsbad in Eddy County

that is 4 times the largest ozone decrease due to the 20% VOC reduction scenario (-0.3 ppb) that also occurs in Eddy County east of Carlsbad.

Similar results are seen for the New Mexico Permian Basin Oil and Gas 20% NO_x or VOC emissions reductions scenarios with the 20% NO_x reduction producing much larger decreases in the 2026 ozone DVF than the 20% VOC reduction. The largest ozone reduction due to the NMPB O&G 20% NO_x reduction is -1.0 ppb that is over 3 times greater than the highest ozone reductions due to the 20% VOC control (-0.3 ppb).

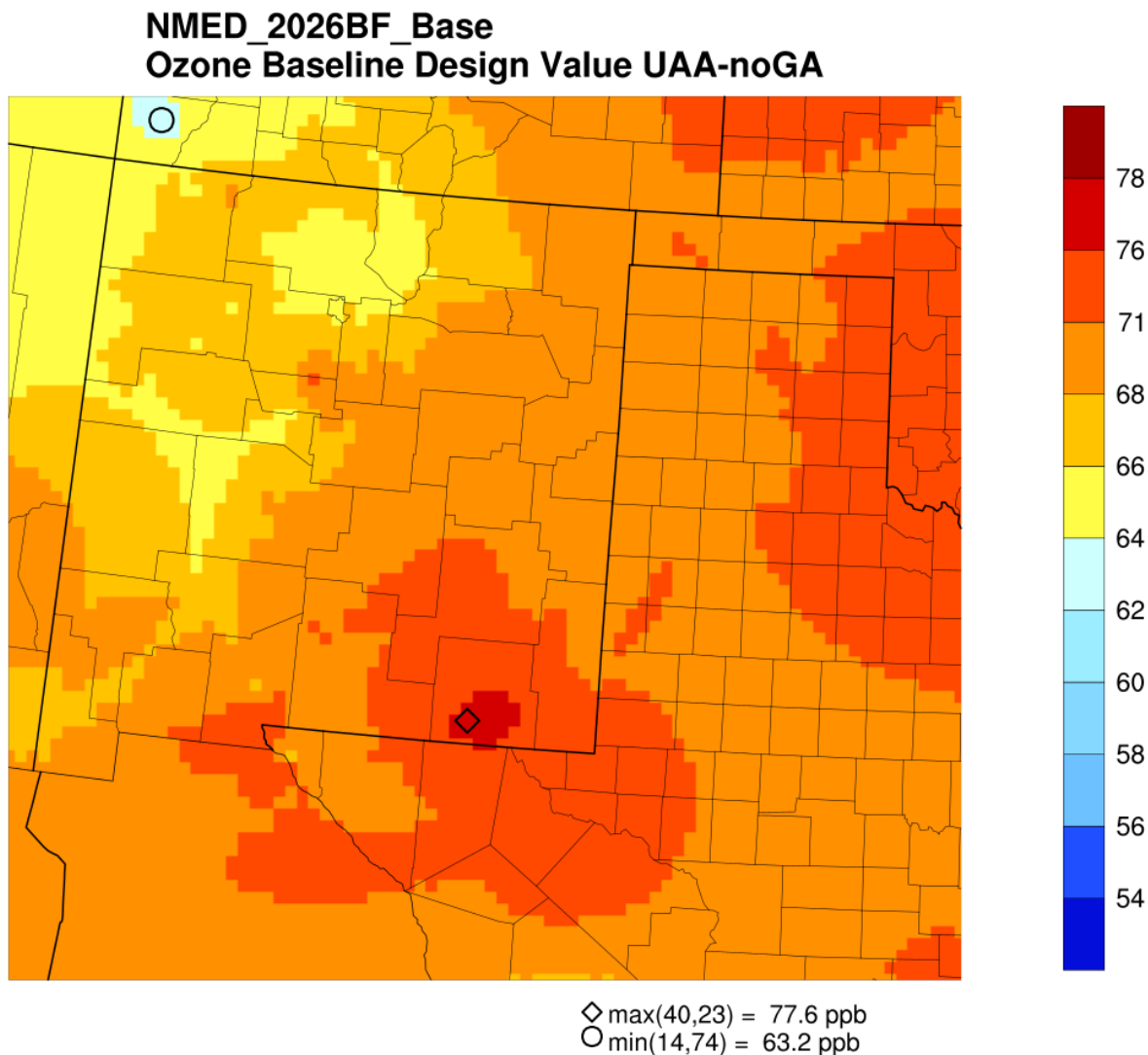


Figure 8-1. Projected 2026 ozone DVF for the BF CAMx 2026v1 12 km base case simulation.

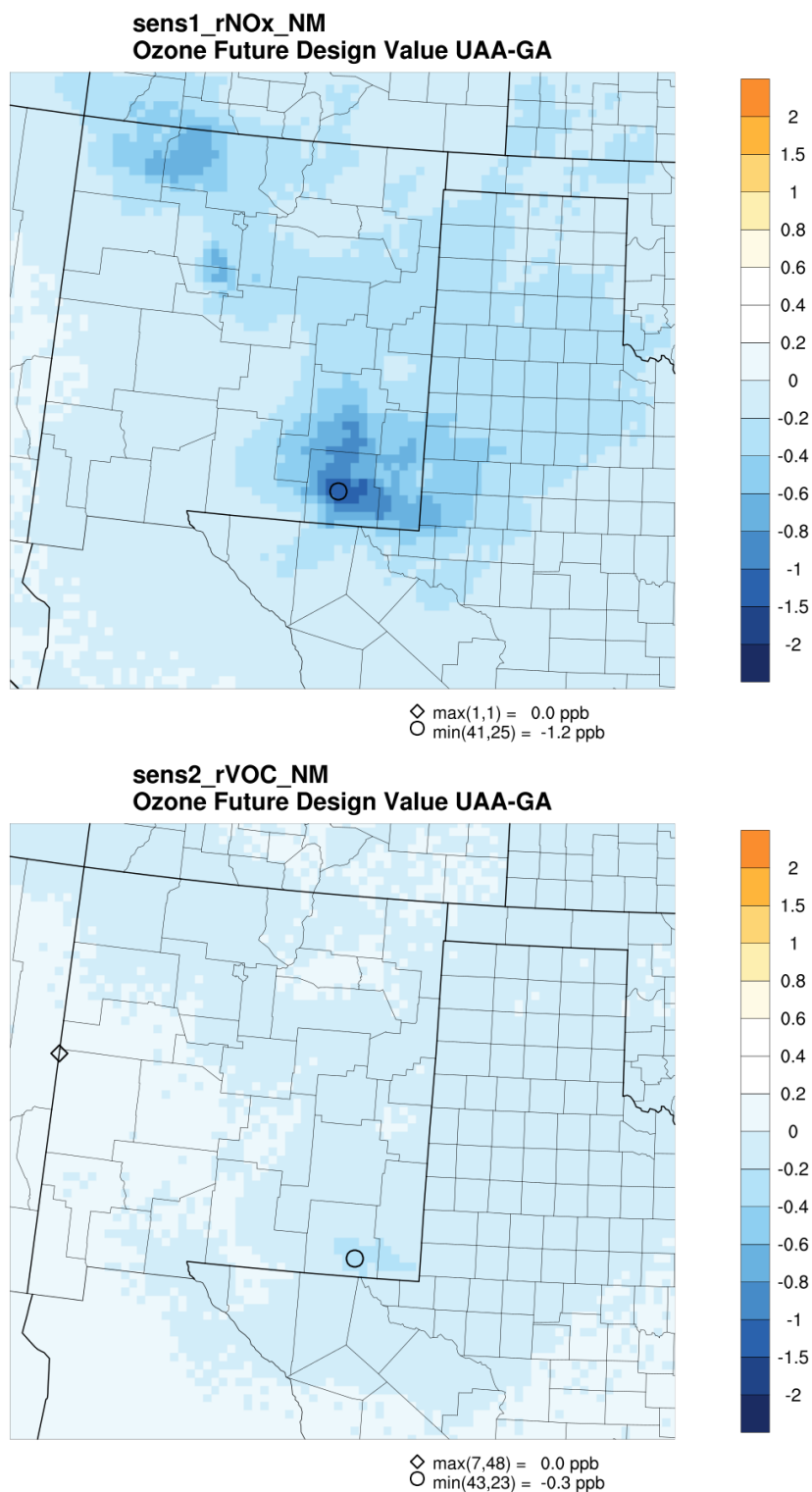


Figure 8-2. Differences in 2026 ozone DVFs between the 2026v1 base case and the 20% New Mexico NO_x (top) and VOC (bottom) BF anthropogenic emissions reduction sensitivity simulation.

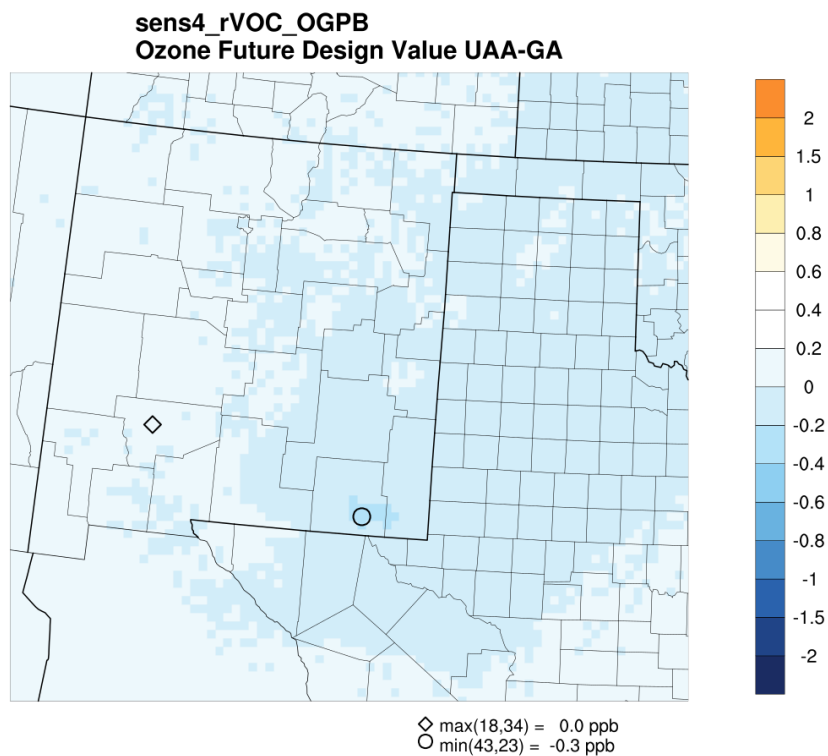
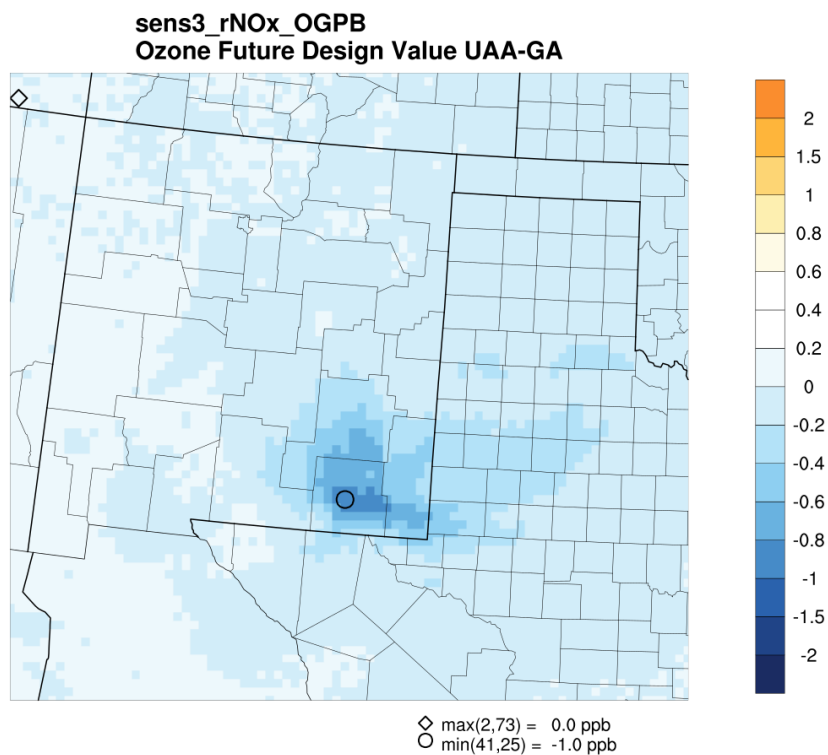


Figure 8-3. Differences in 2026 ozone DVFs between the 2026v1 base case and the 20% New Mexico Permian Basin Oil and Gas NO_x (top) and VOC (bottom) BF anthropogenic emissions reduction sensitivity simulation.

8.2 Sensitivity of 2026 MDA8 Ozone to NO_x and VOC Emission Reductions

The effects of the 20% NO_x or VOC reduction in New Mexico anthropogenic emissions on 2026 MDA8 ozone concentrations was examined with six example days presented in Figures 8-4 through 8-6. Each one of these figures presents three panels of results for two days with the top panel being the MDA8 ozone concentrations, the middle panel the changes in MDA8 ozone due to 20% NM anthropogenic NO_x emission reductions and the bottom panel the changes in MDA8 ozone due to 20% NM anthropogenic VOC emission reductions.

On June 30 (Figure 8-4, left panels), there is elevated 2026 MDA8 ozone in western El Paso and the Permian Basin. The 20% NO_x reduction reduces MDA8 ozone across most of New Mexico with a maximum reduction of 1.3 ppb in the Permian Basin. The 20% VOC reduction results in much lower MDA8 ozone reductions with a maximum reduction of 0.1 ppb in the San Juan Basin.

The highest MDA8 ozone on July 1 is centered on Eddy County which is near where the highest MDA8 ozone reductions occurs (-1.1 ppb) due to the 20% NO_x reductions (Figure 8-4, right panels). The 20% NO_x emissions reduction increases MDA8 ozone on the border of northwest NM and southwest CO near the Four Corners and San Juan Power Plants, which is also where the largest ozone decreases due to the 20% VOC reductions occur (-0.2 ppb).

On July 3 (Figure 8-5, right panels) the highest 2026 MDA8 ozone occurs near Albuquerque where the 20% NO_x reduction decreases ozone but the 20% VOC reduction has no noticeable effect. The maximum 2026 MDA8 ozone decrease due to the 20% NO_x reduction is -1.0 ppb in the Permian Basin that is also where the maximum MDA8 ozone decrease occurs for the 20% VOC reduction (-0.3 ppb).

A peak MDA8 ozone above the 2015 NAAQS is estimated to occur in southern Eddy County in the Permian Basin on July 11 (Figure 8-5, right panels) which is where a maximum ozone decreases of -2.1 ppb and -0.5 ppb occur due to the 20% reduction in, respectively, NO_x and VOC emissions. In addition to the Permian Basin, noticeable reductions in 2026 MDA8 ozone are estimated to occur due to the 20% VOC emissions reduction in Albuquerque and the San Juan Basin on July 11.

Higher ozone is estimated to occur in southeast Dona Ana County on August 1 where the 20% NO_x reduction decreases ozone but 20% VOC reduction has little effect (Figure 8-6, left panels). The 20% NO_x emissions reductions results in +0.2 ppb increase in 2026 MDA8 ozone in northwest New Mexico near the two coal-fired EGUs where the maximum ozone reductions of -0.3 ppb occurs due to the 20% VOC reduction. The largest decrease in MDA8 ozone on August 1 due to the 20% NO_x reduction is -1.1 ppb and occurs in the Permian Basin where much smaller but noticeable ozone reductions are seen from the 20% VOC reduction.

On September 8 elevated 2026 MDA8 ozone concentrations are estimated to occur in the San Juan and Permian Basins and in southeastern Dona Ana County (Figure 8-6, right panels). Both the 20% NO_x and 20% VOC reduction sensitivity tests reduce the elevated ozone in the San Juan and Permian Basins with maximum ozone decreases of -2.0 and -0.6 ppb, respectively. In southeastern Dona County the 20% NO_x reduction has mixed effects with some ozone decreases but also a maximum ozone increase of +0.2 ppb, while the 20% VOC reductions has no noticeable effects on ozone.

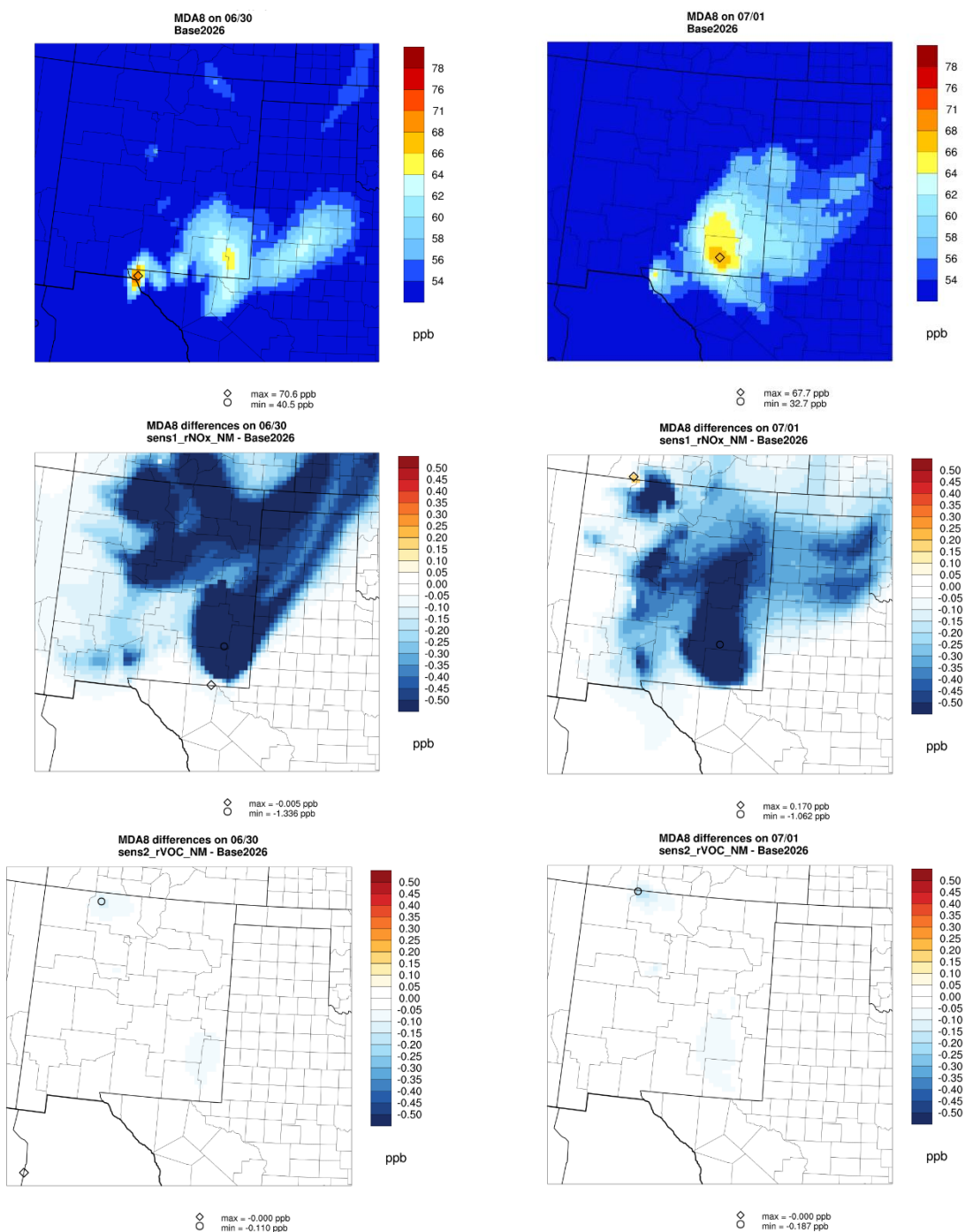


Figure 8-4. 2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NOX (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on June 30 (left) and July 1 (right).

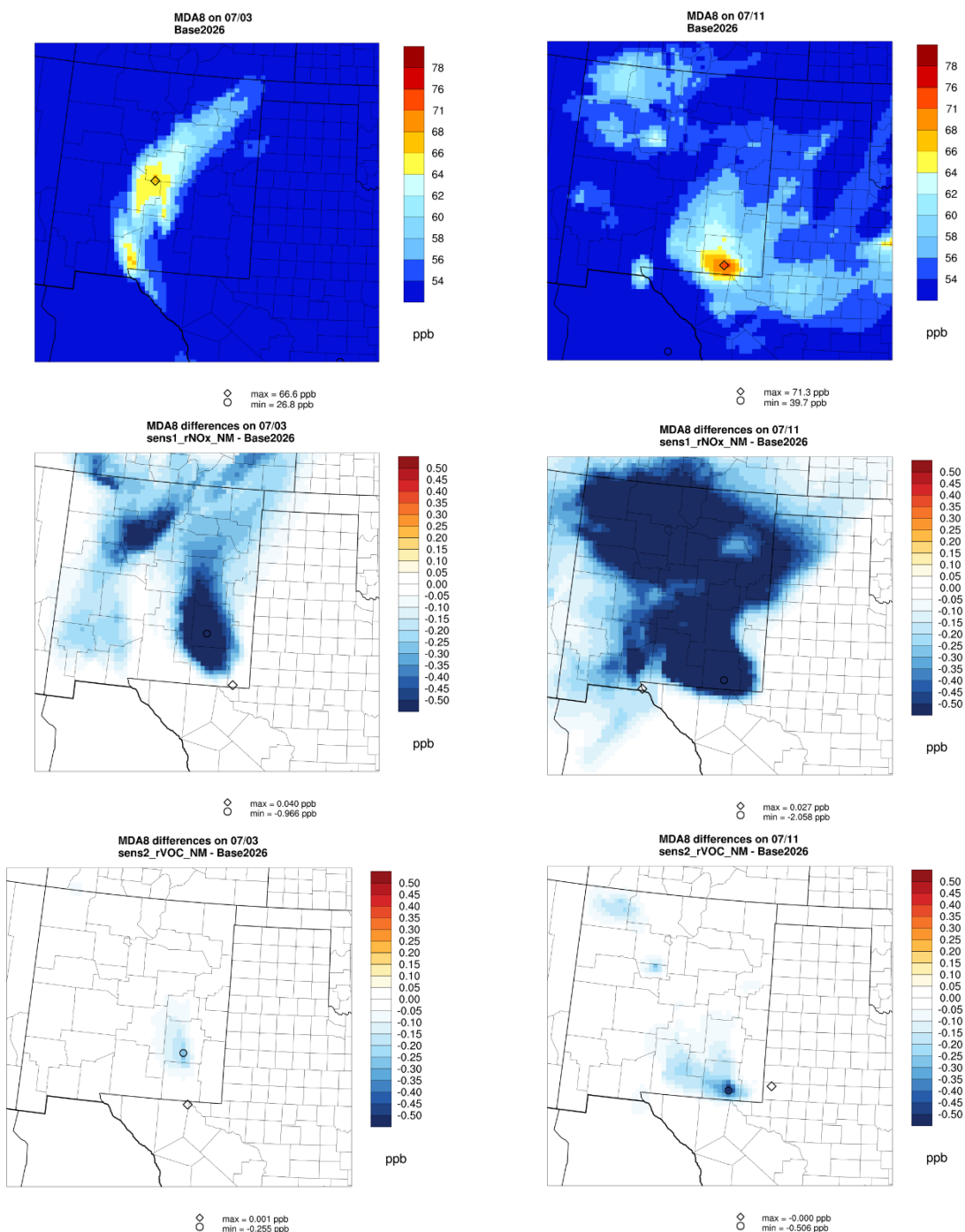


Figure 8-5. 2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NO_x (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on July 3 (left) and July 11 (right).

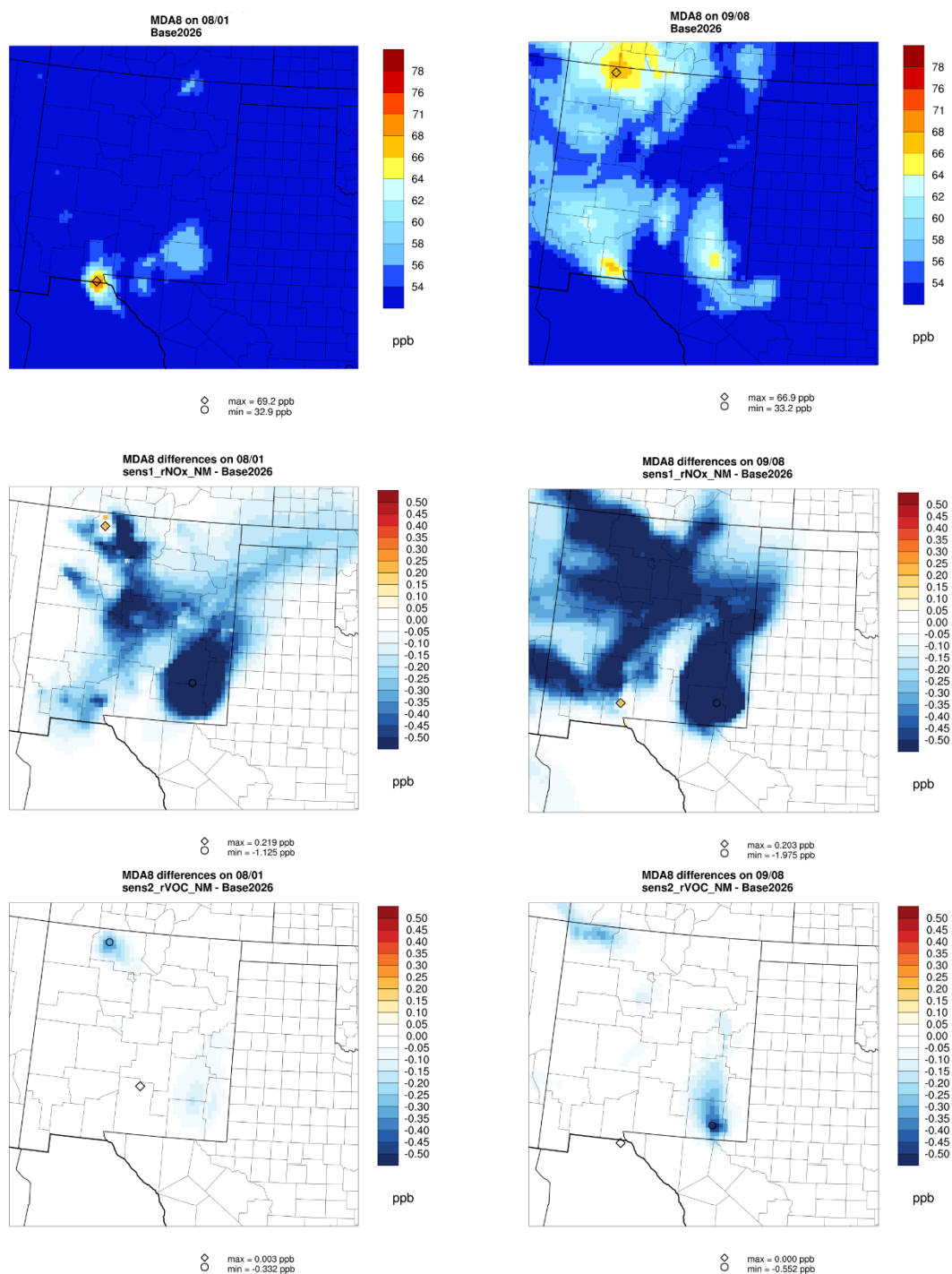


Figure 8-6. 2026 MDA8 ozone concentrations for the CAMx 2028 BF base case (top) and reductions in MDA8 ozone for the 20% NO_x (middle) and VOC (bottom) New Mexico anthropogenic emissions reductions on August 1 (left) and September 8 (right).

8.3 Effects of Increases in Permian Basin O&G Emissions

Figure 8-7 displays the SMAT-CE UAA GA spatial distribution of the increases in the 2026 ozone DVF due to increasing the Permian Basin O&G NO_x and VOC emissions by 20%. The increases in the 2026 ozone DVF are pretty much limited to the Permian Basin with a maximum increase of 1.1 ppb that occurs at approximately the same location (near Carlsbad) as the 77.6 ppb maximum 2026 ozone DVF in the CAMx 2026 BF base case simulation (Figure 8-1).

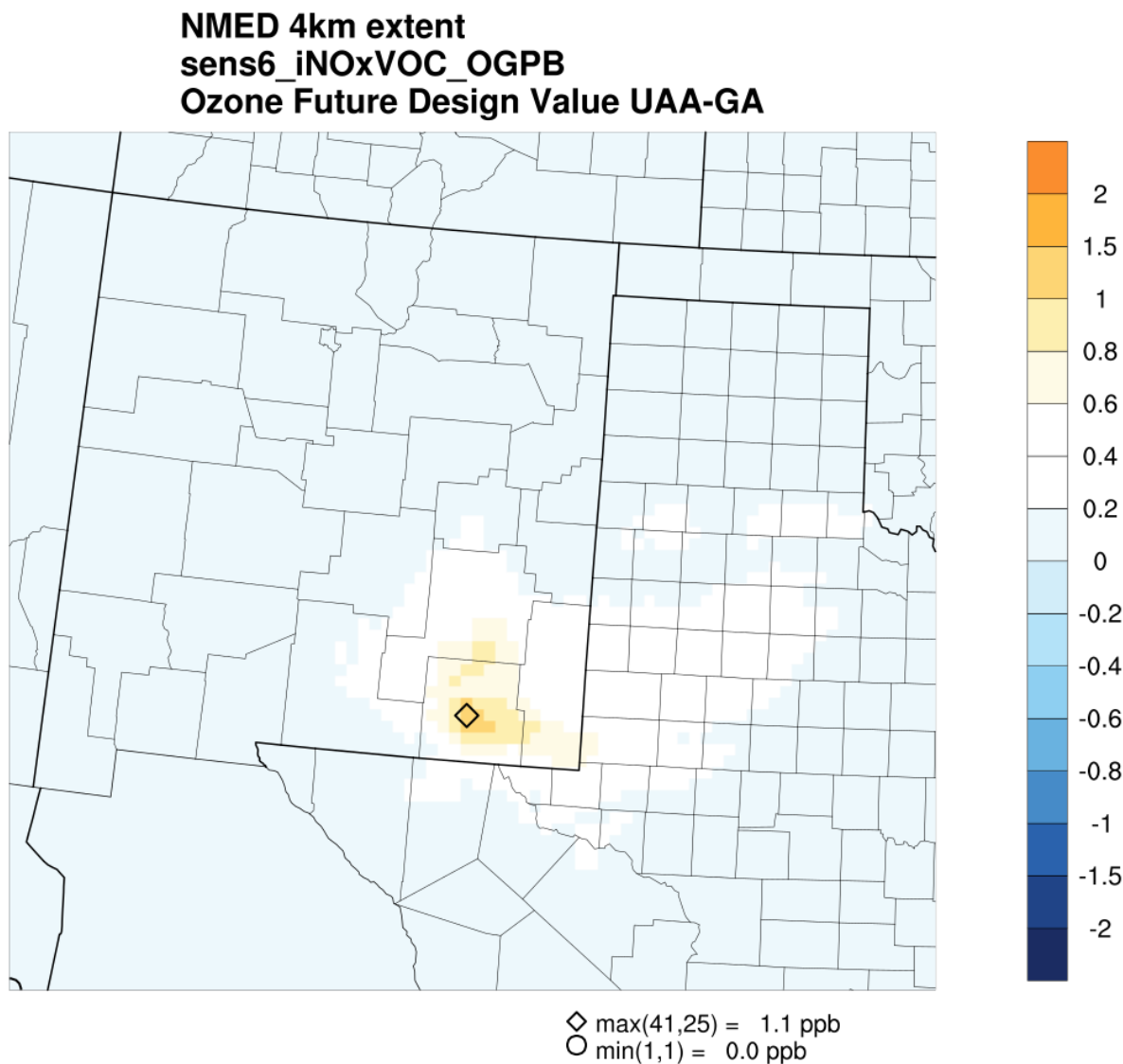


Figure 8-7. Increases in the 2026 ozone DVF due to a 20% increase in the New Mexico Permian Basin 2026 oil and gas NO_x and VOC emissions.

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