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MEMORANDUM

Date: June 30, 2025

To: New Mexico Environmental Department, Air Quality Bureau

From: Marco Rodriguez, Pradeepa Vennam, Jung Chien, Jeremiah Johnson, and Ralph Morris

Subject: Preliminary CAMx 2022 4 km Ozone Model Performance Evaluation Using New WRF 2022 4 km Meteorological Inputs

INTRODUCTION

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. Figure 1 shows the trend in ozone Design Values (DV) at the Carlsbad City and Carlsbad Caverns sites in Eddy County and Hobbs site in Lea County in the Permian Basin in southeast New Mexico. Although the Permian Basin 2014-2016 ozone DVs were below the 70 ppb 2015 ozone National Ambient Air Quality Standard (NAAQS) when nonattainment area (NAA) designations were made, since then the observed ozone DV at the Carlsbad sites have exceeded the 2015 NAAQS and even the 75 ppb 2008 ozone NAAQS (e.g., 2020-2022 ozone DV of 77 ppb at the two Carlsbad sites).

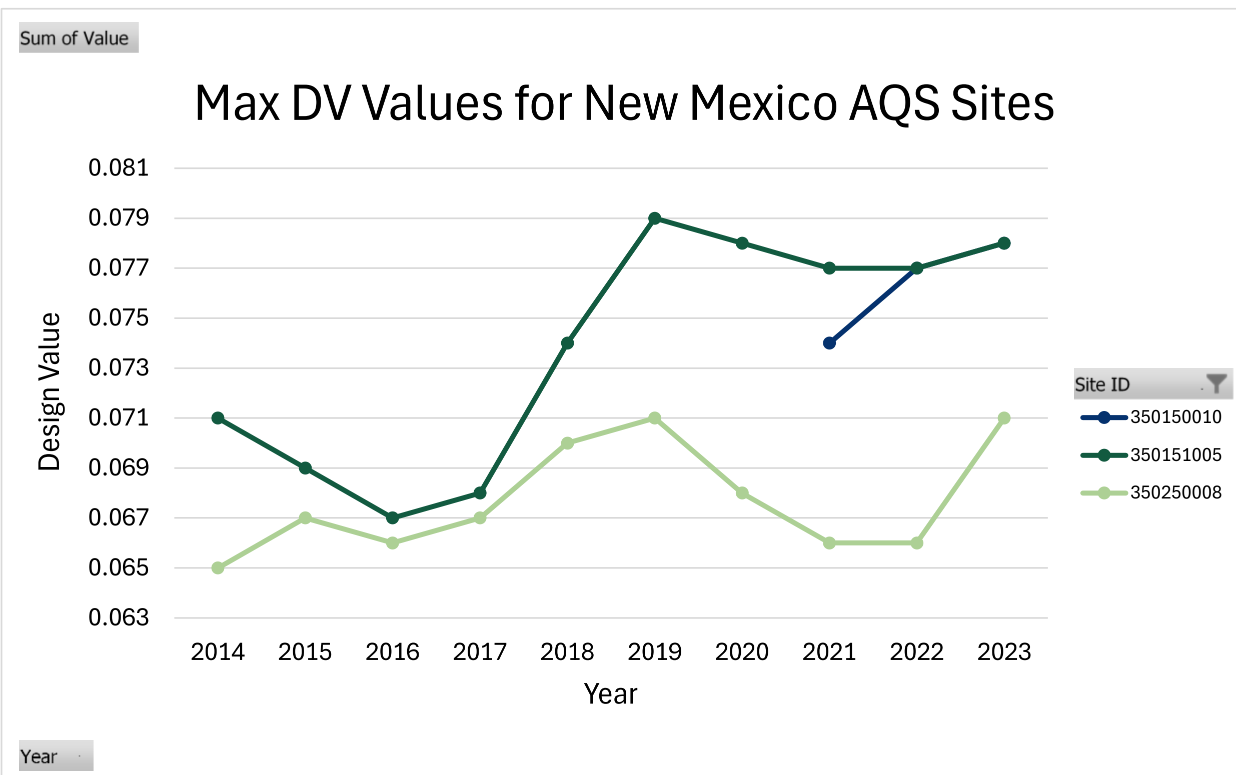

Figure 1. Ozone DV trends for 2014-2023 at the Carlsbad Caverns (350150010) and Carlsbad City (350151005) monitors in Eddy County and the Hobbs (350250008) monitor in Lea County.

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2026 Permian Ozone Source Apportionment Modeling Study

To better understand the causes of elevated ozone concentrations in the Permian Basin, Ramboll is conducting ozone source apportionment modeling for the NMED/AQB in two Tasks following the procedures in a Work Plan developed in April 2025 (Ramboll, 2025a):

- Task 1 conducted 2026 ozone source apportionment modeling of oil and gas emissions in the Permian Basin, and other major Source Sectors, using the existing National Emissions Collaborative (NEC) 2022 Emissions Modeling Platform (EMP) 2022 version 1 (2022v1) 12 km CAMx modeling platform (Ramboll,.2025b).

- Task 2 is developing a more refined CAMx 2022 12/4 km modeling platform with the 4 km domain focused on New Mexico and the Permian Basin. Task 2 will then perform future year ozone source apportionment modeling using the refined CAMx 2022 12/4 km modeling platform.

The work is being performed in two phases. Phase I was conducted in FY2024-2025 and completed by June 30, 2025. Phase I consisted of all of Task 1 that is documented in a report on the CAMx 2022v1 12 km base case modeling and model performance evaluation, and 2026v1 12 km ozone source apportionment modeling (Ramboll, 2025b). Also during Phase I, Ramboll partially developed the refined CAMx summer 2022 12/4 km modeling platform by conducting summer 2002 12/4 km WRF meteorological modeling (Ramboll, 2025c) and preliminary CAMX 2022 12/4 km modeling (this document).

Phase II will be performed in FY2025-2026 starting after June 30, 2025 and will perform the remainder of the Task 2 work effort including completion of the CAMx 2022 12/4 km modeling platform development and performing future year CAMx 12/4 km ozone source apportionment modeling.

Purpose

The WRF summer 12/4 km meteorological modeling produced good meteorological model performance when compared to observed surface meteorological observations (Ramboll, 2025c). However, that may not mean that it will produce better CAMx ozone model performance when the WRF 4 km data are used as CAMx meteorological inputs. In this Memorandum, we present a preliminary model performance evaluation of the CAMx 2022 12/4 km ozone model performance using the new WRF 2022 4 km meteorological inputs covering New Mexico and adjacent areas.

CAMX 2022 12/4 KM MODELING DATABASE

Figure 2 displays the 2022 EMP 36/12 km modeling domains used in EPA's 2022v1 12 km modeling platform that was used in the Phase I Task 1 CAMx 2022v1 12 km base case and model performance evaluation and CAMx 2026v1 12 km ozone source apportionment modeling (Ramboll, 2025b). The WRF 2022 12/4 km meteorological modeling (Ramboll, 2025c) was used to develop CAMx 2022 12/4 km meteorological inputs. The 2022 EMP 2022v1 12 km emission inputs were used as inputs (EPA, 2025) and the CAMx flexi-nest feature interpolated the 2022v1 12 km emission inputs to the 4 km New Mexico domain. Thus, the preliminary CAMx 2022 12/4 km modeling used new WRF 2022 12/4 meteorological inputs for the 12/4 km domains, but the same 2022v1 12 km emission inputs from the 2022 EMP as the 2022v1 12 km CAMx database used in Task 1. Figure 3 displays the 4 km New Mexico domain and locations of ozone monitoring sites used in the preliminary CAMx 2022 12/4 km modeling platform.

Figure 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).

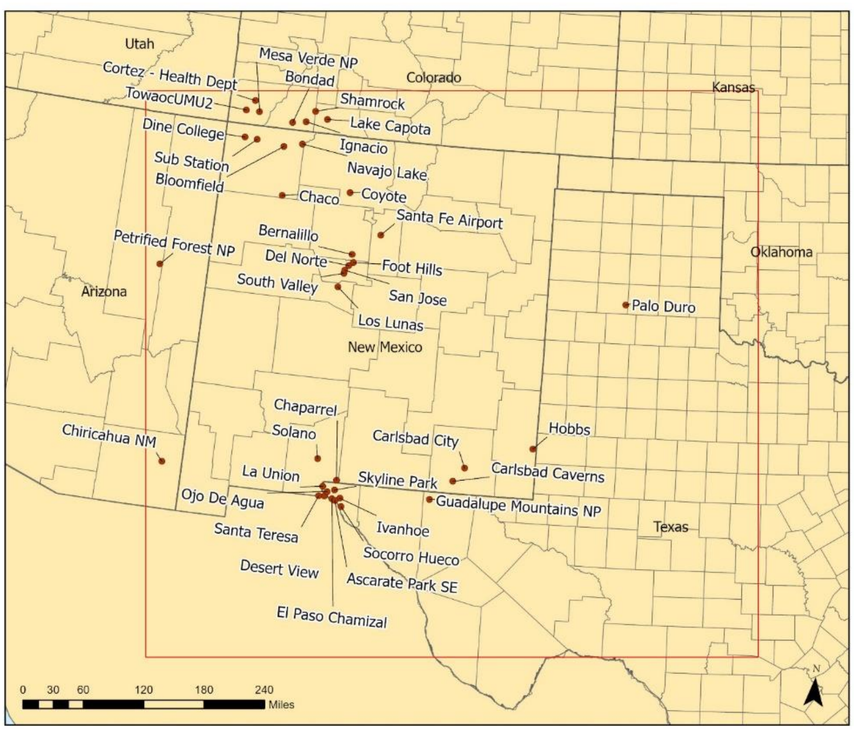

Figure 3. CAMx 4 km New Mexico domain used in the preliminary CAMx 2022 12/4 km modeling platform and locations of ozone monitoring sites operating in 2022 in the New Mexico 4 km domain.

OZONE MODEL PERFORMANCE EVALUATION

CAMx was run for the summer 2022 using the new 12/4 km WRF meteorological inputs and the 2022 EMP 2022v1 12 km emission inputs with the emission for the 4 km domain interpolated from the 12 km domain. The CAMx 2022 12/4 km ozone model performance at sites in the New Mexico 4 km domain (Figure 3) were compared to the CAMx 2022v1 12 km ozone model performance (Ramboll, 2025b). The CAMx 2022 12/4 km and CAMx 2022v1 12 km ozone model performance were evaluated for the same May 10 – October 15, 2022 period so the performance statistics could be compared, thus the CAMx 2022v1 12 km ozone performance statistical metrics in this Memorandum differ slightly from those presented in Ramboll (2025b) that used a longer simulation period in order for the CAMx 12/4 km and CAMx 2022v1 12 km ozone model performance comparisons are made using the same observed ozone time period.

Model Performance Evaluation Approach

The Atmospheric Model Evaluation Tool (AMET) was used to evaluate the CAMx preliminary 2022 12/4 km and CAMx EPA 2022v1 12 km base case simulations following the same procedures as in Ramboll (2025b). AMET comes with the standard AQS monitoring data. The focus of the model evaluation was on ozone concentrations within New Mexico.

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 4 km domain (Figure 3).
- Time series plots of predicted and observed hourly ozone time series for six episodes as follows:
    - May 14 – 16, 2022;
    - May 25 – 30, 2022;
    - June 8 – 11, 2022;
    - June 30 – July 3, 2022;
    - July 13 – 15, 2022; and
    - August 12 – 14, 2022.

When comparing the CAMx preliminary 2022 12/4 km and CAMx EPA 2022v1 12 km modeling platforms ozone model performance using the above graphical performance displays in the sections below, the CAMx preliminary 2022 12/4 km ozone displays are in the left panels and the CAMx EPA 2022v1 12 km platform ozone displays are in the right panels of the figures.

<u>Model Performance Goals and Criteria</u>

Emery et al., (2017) developed 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 compared 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 1 (for completeness we also include the PM performance goals and criteria).

Table 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:

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

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.

Ozone Model Performance Across the 4 km New Mexico Domain

Figure 4 compares the NMB performance statistics across sites in the 4 km New Mexico domain for Maximum Daily Average 8-hour (MDA8) ozone concentrations during May 10 – October 15, 2022 period and the CAMx preliminary 2022 12/4 km modeling platform and the EPA CAMx 2022v1 12 km modeling platform. The NMB in Figure 4 are colored grey of they achieve the ≤±5% bias Performance Goal and two shades of brighter yellow (overestimation) or green (underestimation) if the NMB falls between the bias Performance Goal and Criterion (≤±15%). The NMB MDA8 ozone performance for the two CAMx simulations are similar, but the CAMx 4 km MDA8 ozone NMB performance is noticeably better at the southern New Mexico sites with lower bias for sites in the Permian Basin as well as in southeast Dona Ana County. For both CAMx 4 km and 12 km simulations, the MDA8 ozone NME achieves the error Performance Criterion at all sites and error Performance Goal at most sites in New Mexico (not shown).

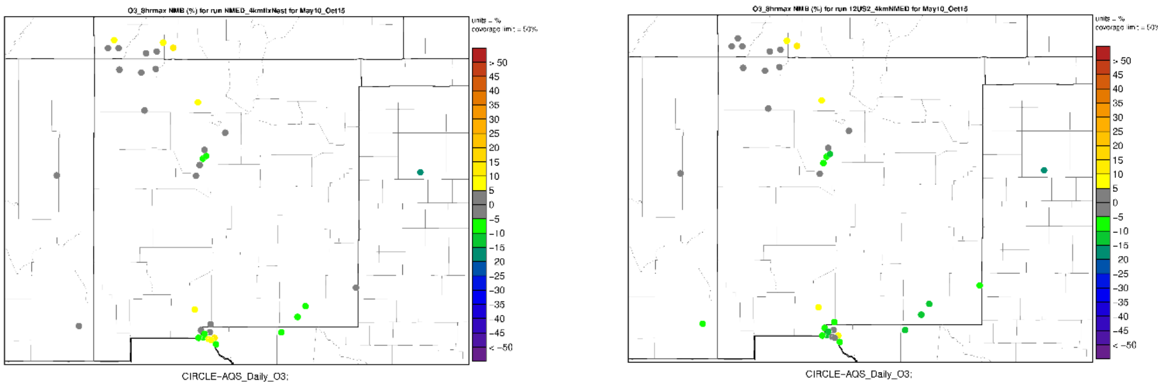

Figure 4. MDA8 ozone NMB performance statistics for the preliminary CAMx 2022 12/4 modeling platform (left) and EPA CAMx 2022v1 12 km modeling platform (right).

Figure 5 compares the spatial distribution of the hourly ozone NMB performance statistics and the CAMx 4 km and 12 km modeling results. Again the CAMx 2022 4 km simulation is exhibiting lower bias at the southern New Mexico sites than the CAMx 2022v1 12 km results (e.g., Carlsbad City site is now achieving the bias Performance Goal using the 4 km meteorological inputs).

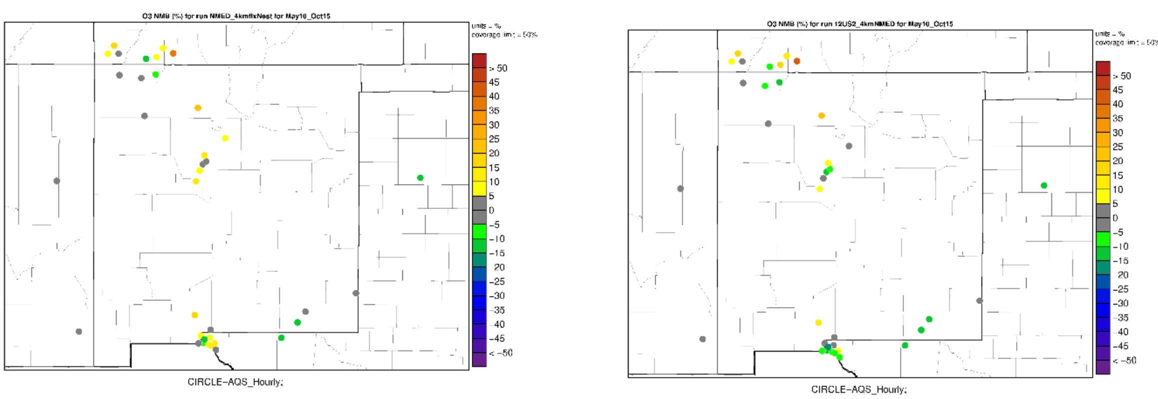

Figure 5. Hourly ozone NMB performance statistics for the preliminary CAMx 2022 12/4 modeling platform (left) and EPA CAMx 2022v1 12 km modeling platform (right).

Ozone Model Performance in the Permian Basin

Figure 6 displays scatter plots and performance statistics for MDA8 ozone concentrations at Permian Basin sites and the CAMx preliminary 2022 12/4 km and EPA 2022v1 12 km modeling platforms. The CAMx 4 km MDA8 ozone performance at Carlsbad City using the new 4 km meteorological inputs is much better with lower bias (-5.9% vs. -11.5%) and error (10.4% vs. 13.8%) than when the 2022v1 12 km meteorology is used (Figure 6, top panels). There is also improved MDA8 ozone performance using the 4 km meteorology at Carlsbad Caverns (Figure 6, middle panels) for bias (-9.3% vs. -13.3%) and error (12.1% vs. 14.7%) although not as pronounced as at Carlsbad City. At Hobbs, the CAMx MDA8 ozone concentration scatter plot is tighter around the 1:1 line of perfect agreement using the 4 km meteorological inputs with NMB (-3.4%) that achieves the bias Performance Goal while the CAMx 2022v1 12 km NMB does not (-7.4%).

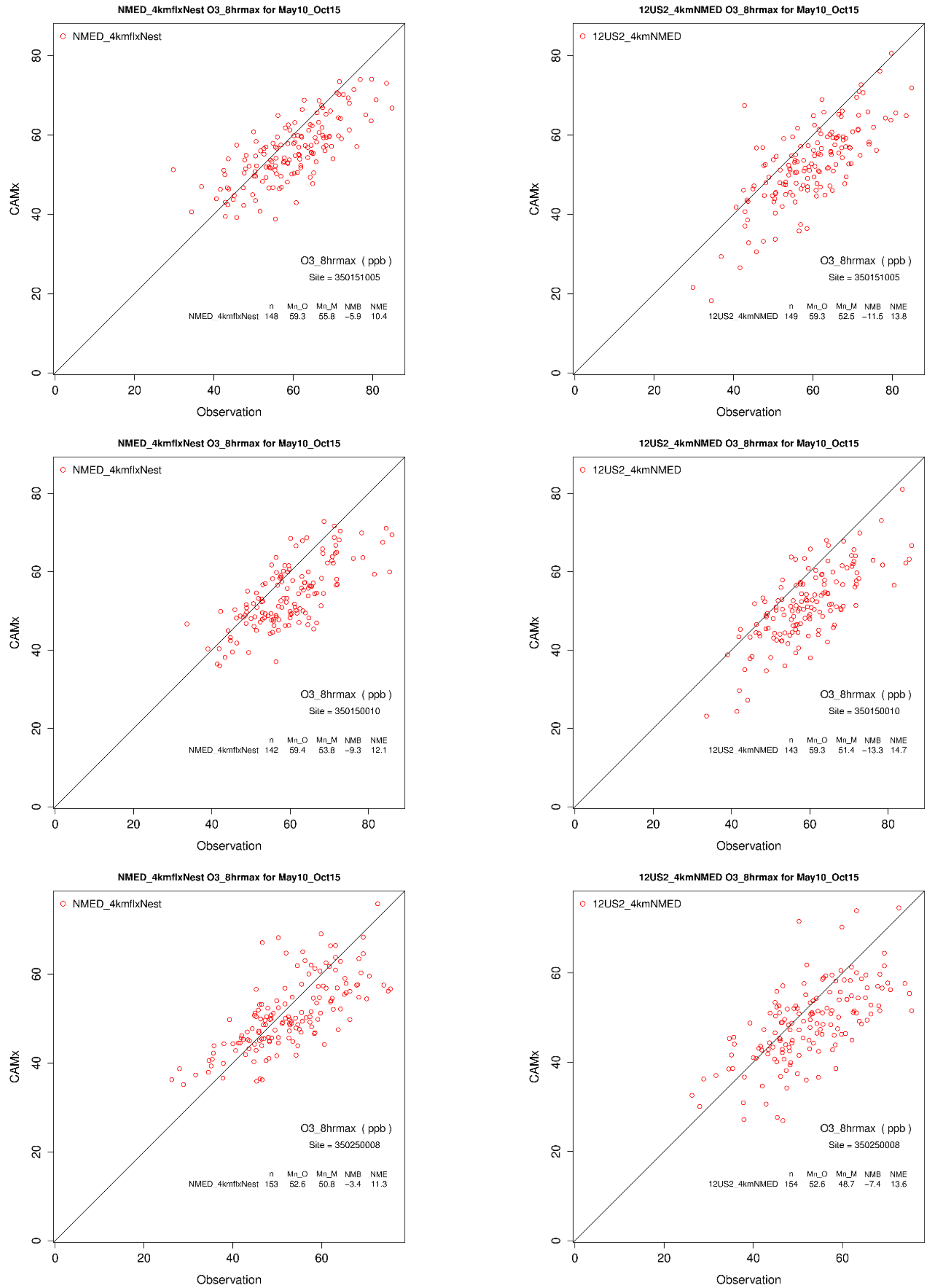

Figure 6. Scatter plots and performance statistics for MDA8 ozone concentrations at Carlsbad City (350151005; top); Carlsbad Caverns (350150010, middle) and Hobbs (350250008) and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

Comparison of the CAMx preliminary 2022 12/4 km and EPA 2022v1 12 km modeling platform hourly ozone scatter plots and model performance statistics for Permian Basin sites are given in Figure 7. The CAMx 4 km hourly ozone performance at Carlsbad City is much better than the 2022v1 12 km with the scatter plot more tightly clustered around the 1:1 line of perfect agreement and NMB (-2.9%) that achieves the bias Performance Goal while the CAMx 2022v1 12 km NMB (-13.9%) does not due to a to large underestimation bias (Figure 7, top panels). At Carlsbad Caverns, the hourly ozone NMB for both the CAMx 4 km simulation (-10.1%) and 2022v1 12 km simulation (-13.7%) exhibit an underestimation bias with a slight improvement using the 4 km meteorological inputs (Figure 7, middle panels). At Hobbs, the hourly ozone NMB achieve the bias Performance Goal for both the CAMx 2022 12/4 km (+2.5%) and 2022v1 12 km (-1.7%) simulations with slight improvement in NME (15.6% vs. 16.8%) when the 4 km meteorological inputs are used (Figure 7, bottom panels).

Figures 8 and 9 present predicted and observed hourly ozone time series at the Carlsbad City, Carlsbad Caverns and Hobbs monitoring sites for six episode periods during the May – August 2022 modeling period and the CAMx preliminary 2022 12/4 km and EPA 2022v1 12 km modeling platforms. The CAMx 4 km and 12 km hourly ozone performance for the May 14-16 episode is similar with one model exhibiting slight improvements in ozone performance on one day and the other model on another day.

During the May 25-30 episode, the CAMx 4 km simulation produces slightly higher afternoon hourly ozone peaks than the CAMx 12 km simulation resulting in slightly improved hourly ozone performance. The CAMx 4 km hourly ozone at Carlsbad City on May 25 is able to reproduce an observed second afternoon shoulder hourly ozone peak better than the CAMx 12 km simulation.

For the June 30 to July 3 episode, the CAMx 4 km simulation is exhibiting much improved ozone performance on June 30 and July 2, some degradation in model performance on July 1, and marginal improvement on July 3 compared to the CAMx 2022v1 12 km simulation.

For the July 8-11 episode, the CAMx 12 km run is performing better than the CAMx 4 km run on July 8, worse on July 9, and much better at Carlsbad Caverns on July 11.

For the July 13-15 and August 12-14, the CAMx 2022v1 12 km simulation had an ozone underestimation bias that is improved somewhat in the CAMx 2022 12/4 km simulation, although there still is an underestimation bias.

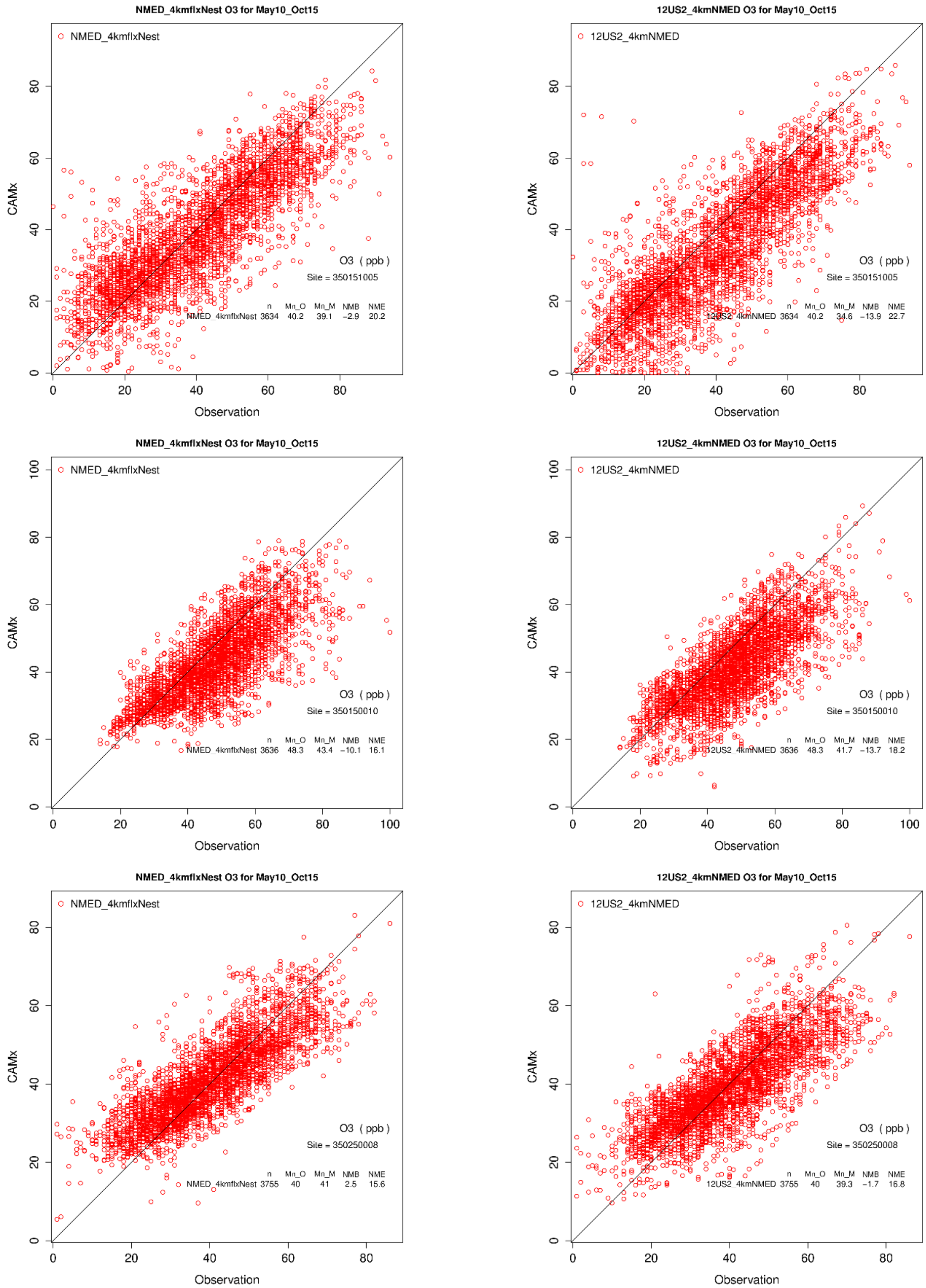

Figure 7. Scatter plots and performance statistics for hourly ozone concentrations at Carlsbad City (350151005; top); Carlsbad Caverns (350150010, middle) and Hobbs (350250008) and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

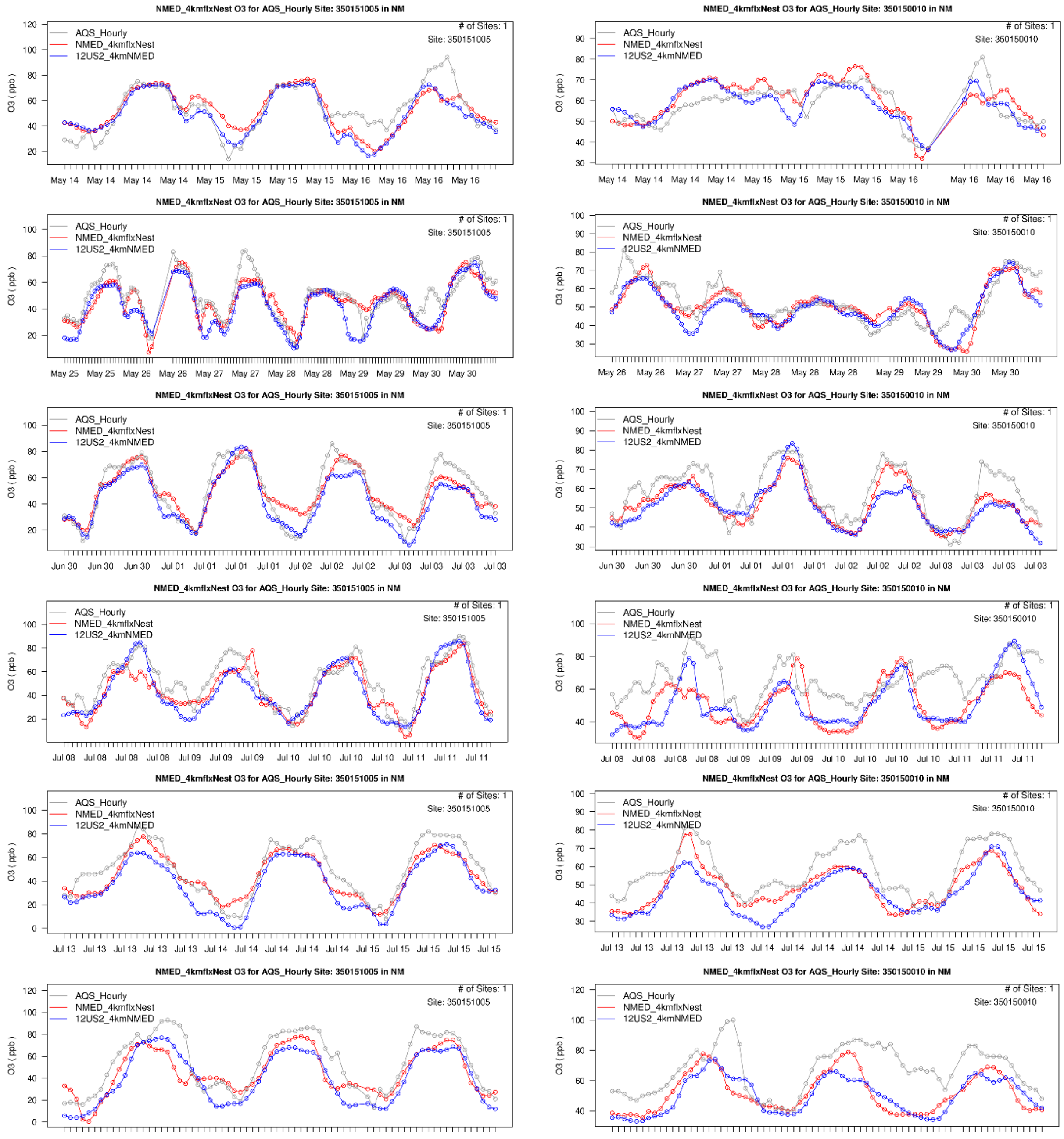

Figure 8. Time series of predicted and observed hourly ozone concentration at the Permian Basin Carlsbad City (350151005; left) and Carlsbad Cavern (350150010; right) monitoring sites for six episodes during the summer 2022 and the CAMx preliminary 2022 12/4 km (red) and EPA 2022v1 12 km (blue) base case simulations.

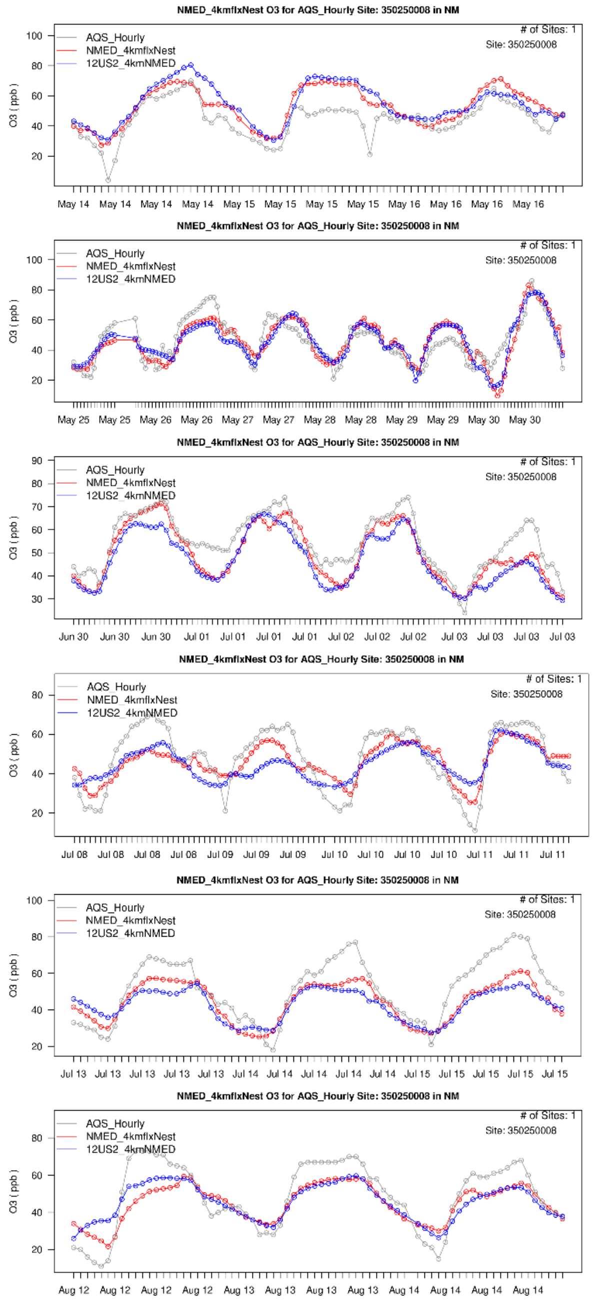

Figure 9. Time series of predicted and observed hourly ozone concentration at the Permian Basin Hobbs (350250008) monitoring site for six episodes during the summer 2022 and the CAMx 2022v1 12 km base case simulation.

Ozone Model Performance in Dona Ana County

The CAMx ozone model performance for Dona Ana County in southern New Mexico adjacent to El Paso, Texas is represented by the Desert View and La Union monitoring sites that record the highest observed ozone concentrations in Dona Ana County. MDA8 ozone scatter plots and performance statistics for these two sites and the CAMx preliminary 2022 12/4 km and EPA 2022v1 12 km simulation are given in Figure 10. MDA8 ozone concentrations are underestimated at Desert View with NMB falling between the Bias Performance Goal and Criterion for both model simulations. The CAMx 4 km simulation exhibits slightly lower NMB (-9.8% vs. -12.5%) and error (12.4% vs. 14.7%) than the CAMx 12 km simulation and the scatter plot is more tightly bunched around the 1:1 line of perfect agreement (Figure 10, top panels). At La Union, the CAMx 4 km simulation NMB (-4.2%) achieves the bias Performance Goal while the CAMx 12 km simulation NMB (-7.5%) does not. Again, the CAMx 4 km simulation has lower error (9.9% vs. 12.1%) and the scatter plot of MDA8 ozone concentrations are more tightly organized around the 1:1 line of perfect agreement.

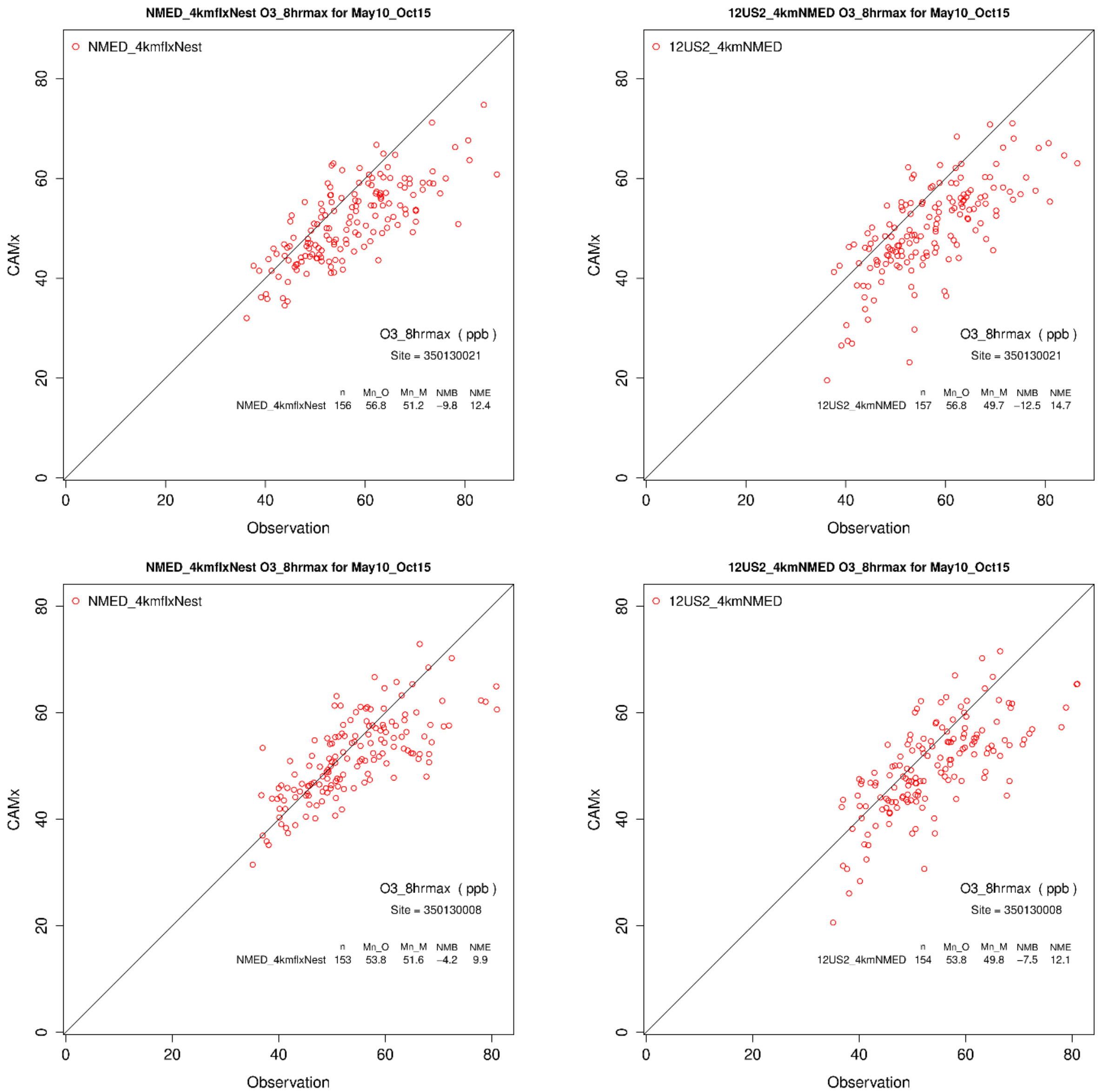

Figure 10. Scatter plots and performance statistics for MDA8 ozone concentrations at Desert View (350130021; top); and La Union (350130008) and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

The hourly ozone scatter plots for Desert View also show slightly better performance by the CAMx 4 km simulation compared to the CAMx 12 km simulation with lower NMB (-9.3% vs. -10.7%) and NME (19.2% vs. 20.9%; Figure 11, top panels). At La Union (Figure 11, bottom panels), both model simulations exhibit an overestimation bias with the CAMx 4 km NMB (+6.8%) failing to achieve the bias Performance Goal while the CAMx 12 km NMB (3.7%) does achieve the bias Performance Goal. However, this overestimation bias is due to the model overestimating the observed nighttime low hourly ozone concentrations that could be due to overdiluting the local NO_X emissions so there is less ozone titration reaction ($NO + O_3 \rightarrow NO_2 + O_2$) in the model than in the real atmosphere near the monitoring site. Even though the CAMx preliminary 2022 12/4 km bas case used a 4 km grid resolution with 4 km meteorological inputs, the emissions inputs were based on the EMP 2022v1 12 km platform so have a coarser grid resolution (12 km). Higher resolution 4 km emissions modeling was not performed and the CAMx internal flexinest feature was used to regrid the 12 km emissions to the 4 km grid cells so the CAMx 2022 12/4 km simulation did not benefit from higher resolution 4 km emissions inputs.

The hourly time series for the six episodes, the Desert View and La Union sites, and the CAMx 2022 12/4 km and CAMx 2022v1 12 km simulations are shown in Figure 12. For the first two episodes in May, the performance of the two models for hourly ozone have very little differences; the CAMx 4 km simulation has marginal improvements on May 25 and 28, while the CAMx 12 km has marginally better performance on May26. However, for the June 30 – July 3 episode, the CAMx 4 km simulations has substantially better hourly ozone model performance for June 30 and July 1, with CAMx 12 km having slightly better on July 2, and the CAMx 4 km and 12 km simulations having comparable hourly ozone model performance on July 3.

With the exception of July 8, the CAMx 12 km simulation is exhibiting slightly better hourly ozone performance than the CAMx 4 km simulation for the July 8-11 episode. The hourly ozone performance for the two model simulations is comparable for the July 13-15 episode. With the exception of August 12, the CAMx 4 km simulations has much better hourly ozone model performance than the CAMx 12 km simulation for the August 12-14 episode with a lower underestimation bias in the observed afternoon ozone levels on August 13 and 14.

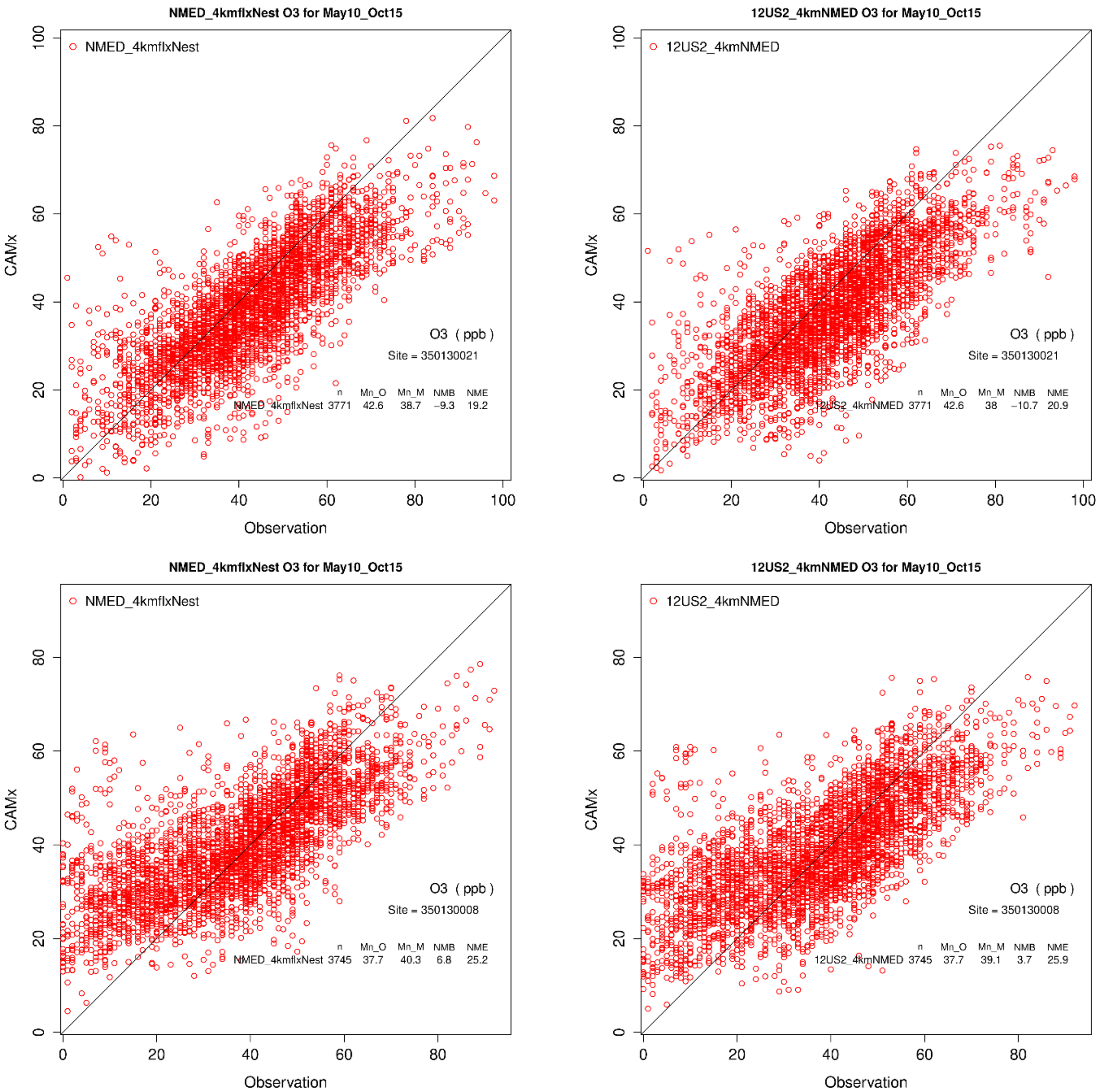

Figure 11. Scatter plots and performance statistics for hourly ozone concentrations at Desert View (350130021; top), and La Union (350130008, bottom) in Dona Ana County and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

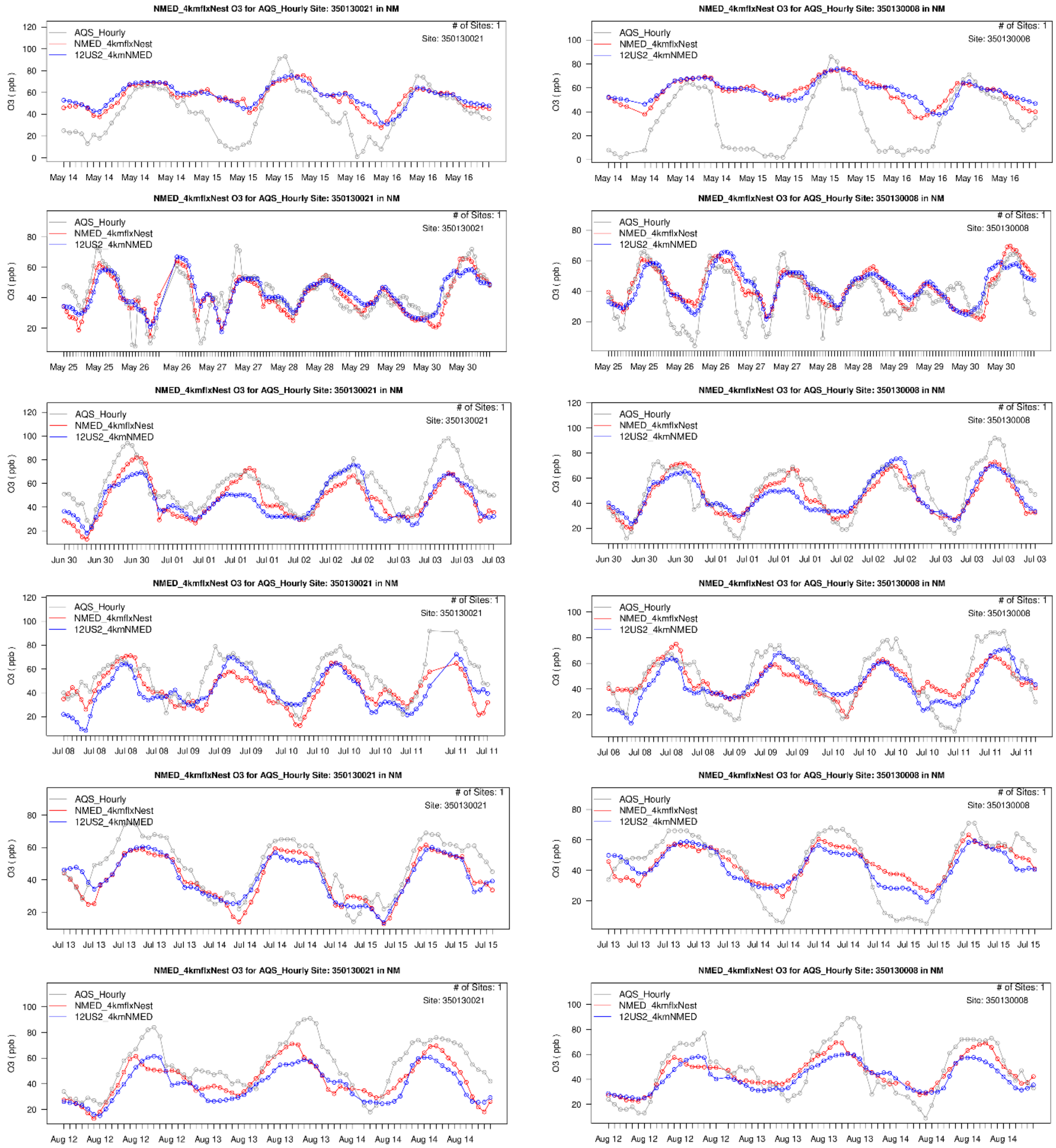

Figure 12. Time series of predicted and observed hourly ozone concentration at the Desert View (350130021; left) and La Union (350130008; right) monitoring sites in Dona Ana County for six episodes during the summer 2022 and the CAMx preliminary 2022 12/4 km (red) and EPA 2022v1 12 km (blue) base case simulations.

Ozone Model Performance in Central New Mexico

As was done in the CAMx 2026v1 ozone source apportionment modeling report (Ramboll, 2025b), the model performance for the Central New Mexico region, which includes Albuquerque, is represented by the Foot Hills site in Bernalillo County and the Bernalillo site in Sandoval County. The MDA8 ozone scatter plots and performance statistics for these two Central New Mexico sites are shown in Figure 13. Both model simulations have an underestimation bias for the Foot Hills site with the CAMx 4 km simulation exhibiting a better NMB (-7.8% vs. -10.3%) and NME (12.7% vs. 13.4%) than the CAMx 12 km simulation. The CAMx 12 km simulations has quite good MDA8 ozone performance statistics at the Bernalillo site with NMB (-3.2%) and NME (10.0%) that achieve the Performance Goal by a wide margin. However, the CAMx 4 km simulation has even better MDA8 ozone performance statistics at the Bernalillo site with near zero NMB (0.5%) and lower NME (8.1%).

Hourly ozone scatter plots and performance statistics for the two Central New Mexico sites are shown in Figure 14. The CAMx 2022 12/4 km simulation is exhibiting better hourly ozone performance at Foot Hills than the CAMx 2022v1 12 km simulation with lower NMB (-4.1% vs. -9.1%) and NME (15.7% vs. 16.8%). Both models have an overestimation bias at the Bernalillo site in Sandoval County due to overestimating the observed nighttime low ozone concentrations with the CAMx 4 km NMB (11.3%) being greater than the CAMX 12 km NMB (8.1%). However, for the highest observed hourly ozone concentrations at Bernalillo site, the CAMx 4 km simulation appears to be performing better as it is more tightly clustered around the 1:1 line of perfect agreement when the observed hourly ozone is above ~40 ppb than the CAMx 12 km simulation (Figure 14, bottom panels).

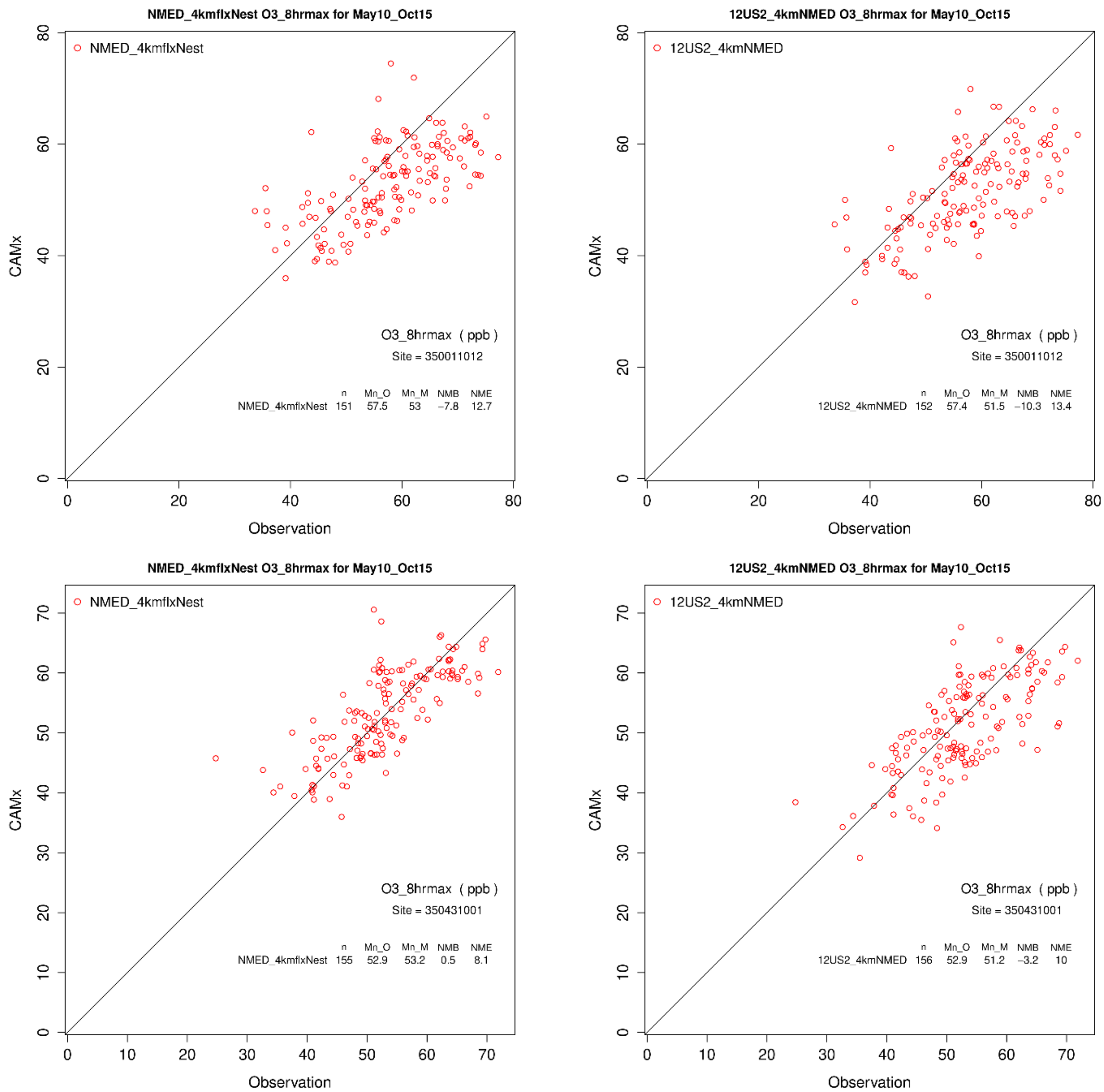

Figure 13. Scatter plots and performance statistics for MDA8 ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and the Bernalillo (350431001) site in Sandoval County in Central New Mexico and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

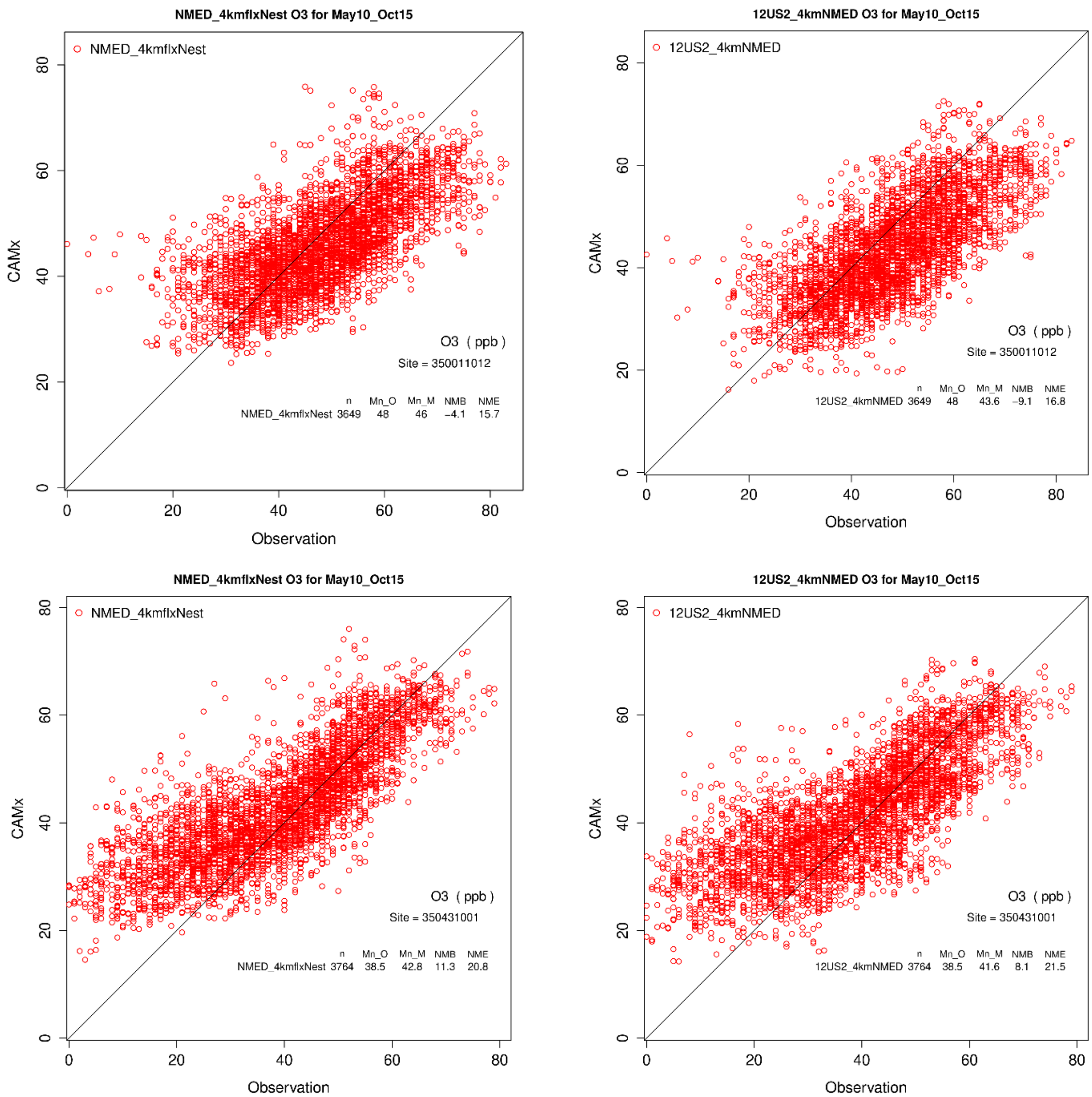

Figure 14. Scatter plots and performance statistics for hourly ozone concentrations at the Foot Hills (350011012) site in Bernalillo County and the Bernalillo (350431001) site in Sandoval County in Central New Mexico and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

Ozone Performance in Northwest New Mexico

The MDA8 ozone scatter plots and performance statistics for the Navajo Lake and Sub Station sites in San Juan County that lie within the South San Juan Basin in Northwest New Mexico are shown in Figure 15. The MDA8 ozone model performance at Navajo Lake is very good for both model simulations with the CAMx 4 km simulation exhibiting slightly better NMB (-0.1% vs. -3.5%) and NME (8.3% vs. 8.9%) than the CAMx 12 km simulation.

The MDA8 ozone results for Sub Station are similar with both models exhibiting very good model performance statistics and CAMx 4 km having slightly better NMB (0.5% vs. -3.3%) and NME (9.0% vs. 9.5%) than the CAMx 12 km simulation.

The hourly ozone scatter plots at Navajo Lake (Figure 16) show that both model simulations underestimate the observed nighttime low ozone concentrations, which could be due to overmixing NO_X emissions in the 12 km grid cell that are not local to the Navajo Lake monitoring site. The CAMx 4 km simulation has slightly better NMB (-8.1% vs. -13.9%) and NME (18.8% vs. 20.8%) hourly ozone performance statistics at Navajo Lake than the CAMx 12 km simulation. (Figure 16, top panels).

At Sub Station, both model simulations exhibit good hourly ozone model performance achieving the bias and error Performance Goals (Figure 15, bottom panels). The Sub Station CAMx 12 km hourly ozone NMB (-1.5%) is slightly better than the CAMx 4 km NMB (2.7%) with the CAMx 12 km NME (14.3%) also being a little lower than the CAMx 4 km NME (14.8%).

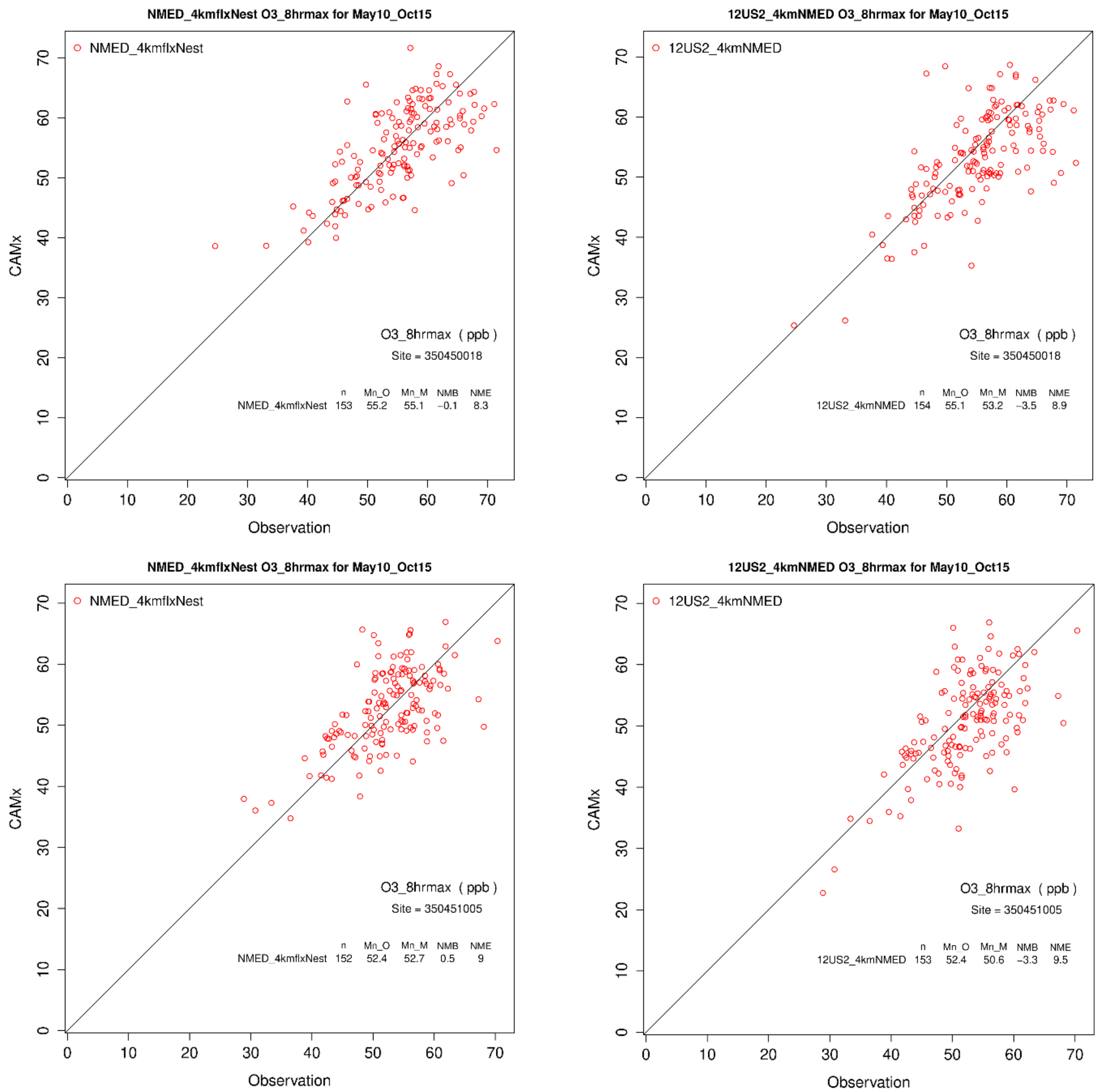

Figure 15. Scatter plots and performance statistics for MDA8 ozone concentrations at the Navajo Lake (350450018, top) and Sub Station (350451005, bottom) in San Juan County and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

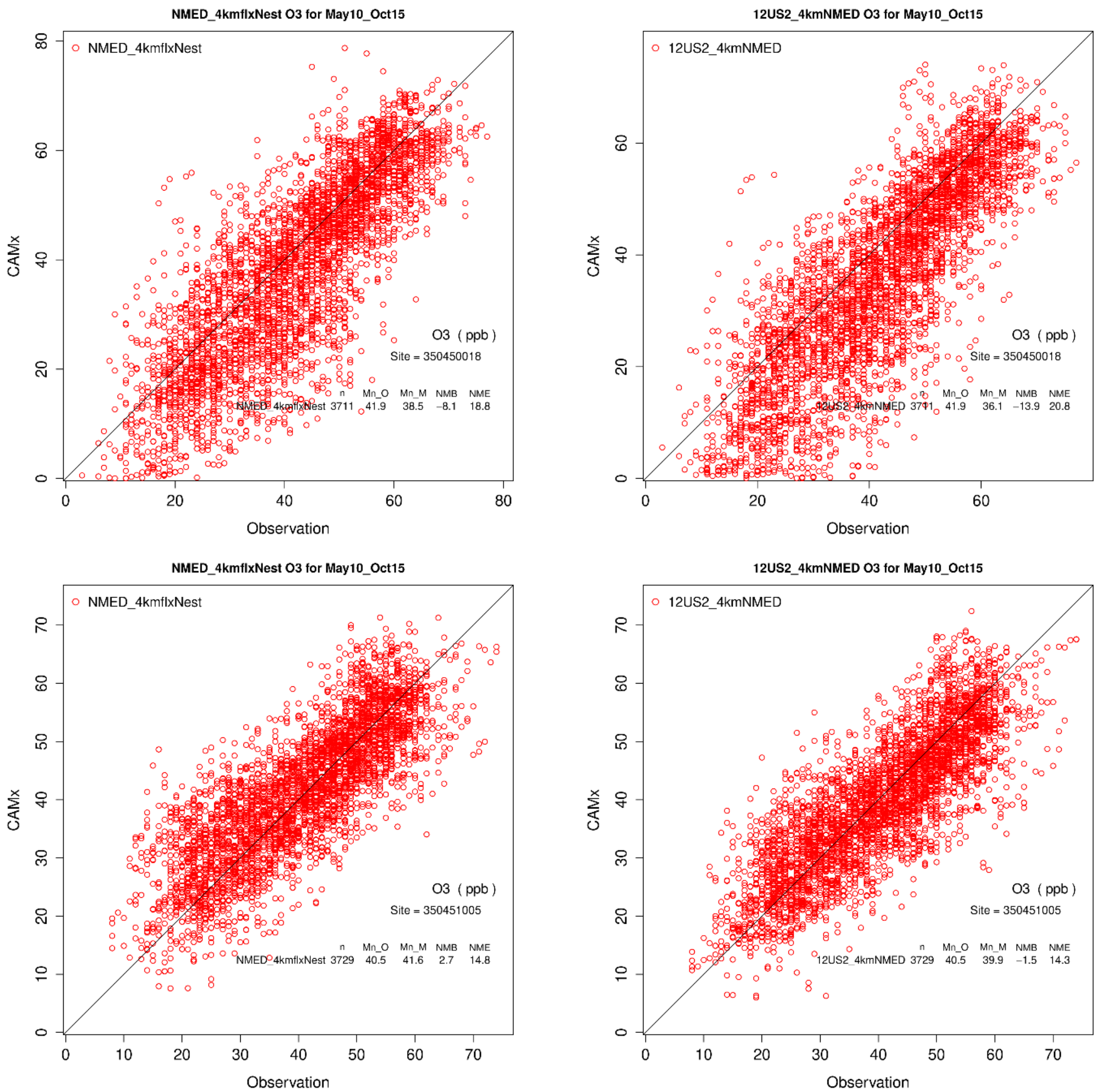

Figure 16. Scatter plots and performance statistics for hourly ozone concentrations at the Navajo Lake (350450018, top) and Sub Station (350451005, bottom) in San Juan County and the CAMx preliminary 2022 12/4 km (left) and EPA 2022v1 12 km (right) modeling platforms.

CONCLUSIONS

Ramboll has conducted CAMx 2022v1 12 km base case modeling and 2026v1 12 km ozone source apportionment modeling using the EPA 2022v1 12 km modeling platform (Ramboll, 2025b). A new WRF summer 2022 12/4 km meteorological model simulation has been conducted, with a 4 km grid resolution domain covering New Mexico and adjacent areas. The WRF 2022 12/4 km simulation showed quite good performance when compared to surface meteorological observations (Ramboll, 2025c). The intent is to use the WRF summer 2022 12/4 km simulations for CAMx meteorological inputs so more refined future year ozone source apportionment can be performed using a 4 km grid resolution for New Mexico. However, just because a WRF simulation showed good model performance when compared to observed surface meteorological variables, it does not necessarily mean this will lead to better ozone model performance when used as meteorological inputs in CAMx. A CAMx summer 2022 12/4 km simulation was conducted using the new WRF 2022 12/4 km meteorological inputs but using the same EPA 2022v1 12 km emission inputs as in the CAMx 2022v1 12 km modeling.

The ozone model performance of the CAMx 2022 12/4 km simulation was mostly comparable to the CAMx 2022v1 12 km simulation. In general, there were slight improvements in the CAMx ozone model performance in the Central and Northwest regions of New Mexico when the new 4 km meteorological inputs. However, the biggest improvement in CAMx ozone performance using the 4 km meteorological inputs occurred at the New Mexico Permian Basin and Dona Ana County sites where the CAMx 2022v1 12 km simulation had an ozone underestimation bias. The CAMx 4 km meteorological inputs partially alleviated the ozone underestimation bias in the CAMx 2022v1 12 km simulation, although this issue remained even when the 4 km meteorological inputs were used.

Thus, the WRF 2022 12/4 km simulations appears to be a sound and appropriate choice for developing a more refined CAMx 2022 12/4 km modeling platform for ozone modeling of New Mexico and it will likely produce improved ozone performance over the current EPA 2022v1 12 km modeling platform, but this will depend in part on developing a more refined and representative set of 2022 4 km emissions inputs.

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