Appendix E-2f

Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2028 Emissions Version V3 and V5 Comparison Report

Benchmark Run #7

September 22, 2020

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Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project

2028 Emissions Version V3 and V5 Comparison Report

Task 6 Benchmark Report #6
Covering Benchmark Run #7

Prepared for:

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Under Contract No. V-2018-03-01

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Final

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Abbreviations/Acronym List

Alpine	Alpine Geophysics, LLC
CAMx	Comprehensive Air Quality Model with Extensions
dv	Deciview
DV	Design Value
EGU	Electric Generating Unit
EPA	Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ERTAC	Eastern Regional Technical Advisory Committee
FLM	Federal Land Manager
FR	Federal Register
IPM	Integrated Planning Model
km	kilometer
$\mu g/m^3$	microgram per cubic meter
NAAQS	National Ambient Air Quality Standard
NO_x	Oxides of nitrogen
OAQPS	Office of Air Quality Planning and Standards
O_3	Ozone
OC	Organic carbon
OSAT	Ozone Source Apportionment Technology
PSAT	Particulate Source Apportionment Technology
PEC	Primary elemental carbon
PM	Particulate matter
$PM_{2.5}$	Fine particle; primary particulate matter less than or equal to 2.5 microns in aerodynamic diameter
PNH4	Particulate ammonium
PNO3	Particulate nitrate
POA	Primary Organic Aerosol
PSAT	Particulate Source Apportionment Technology
PSO4	Particulate sulfate
R^2	Pearson correlation coefficient squared
RADM-AQ	Regional Acid Deposition Model – aqueous chemistry
RHR	Regional Haze Rule
SESARM	Southeastern States Air Resource Managers, Inc.
SIP	State Implementation Plan
SMAT-CE	Software for Model Attainment Test – Community Edition
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SOA	Secondary organic aerosol
SOAP	Secondary organic aerosol partitioning
tpy	Tons per year
U.S.	United States
VISTAS	Visibility Improvement – State and Tribal Association of the Southeast
VOC	Volatile organic compounds

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1.0 INTRODUCTION

1.1 Overview

Southeastern States Air Resource Managers, Inc. (SESARM) has been designated by the United States (U.S.) Environmental Protection Agency (EPA) as the entity responsible for coordinating regional haze evaluations for the ten Southeastern states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. The Eastern Band of Cherokee Indians and the Knox County, Tennessee local air pollution control agency are also participating agencies. These parties are collaborating through the Regional Planning Organization known as Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) in the technical analyses and planning activities associated with visibility and related regional air quality issues. VISTAS analyses will support the VISTAS states in their responsibility to develop, adopt, and implement their State Implementation Plans (SIPs) for regional haze.

The state and local air pollution control agencies in the Southeast are mandated to protect human health and the environment from the impacts of air pollutants. They are responsible for air quality planning and management efforts including the evaluation, development, adoption, and implementation of strategies controlling and managing all criteria air pollutants including fine particles and ozone (O_3) as well as regional haze. This project will focus on regional haze and regional haze precursor emissions. Control of regional haze precursor emissions will have the additional benefit of reducing criteria pollutants as well.

The 1999 Regional Haze Rule (RHR) identified 18 Class I Federal areas (national parks greater than 6,000 acres and wilderness areas greater than 5,000 acres) in the VISTAS region. The 1999 RHR required states to define long-term strategies to improve visibility in Federal Class I national parks and wilderness areas. States were required to establish baseline visibility conditions for the period 2000-2004, natural visibility conditions in the absence of anthropogenic influences, and an expected rate of progress to reduce emissions and incrementally improve visibility to natural conditions by 2064. The original RHR required states to improve visibility on the 20% most impaired days and protect visibility on the 20% least impaired days.[1] The RHR

[1] RHR summary data is available at: http://vista.cira.colostate.edu/Improve/rhr-summary-data/

requires states to evaluate progress toward visibility improvement goals every five years and submit revised SIPs every ten years.

EPA finalized revisions to various requirements of the RHR in January 2017 (82 FR 3078) that were designed to strengthen, streamline, and clarify certain aspects of the agency's regional haze program including:

A. Strengthening the Federal Land Manager (FLM) consultation requirements to ensure that issues and concerns are brought forward early in the planning process.

B. Updating the SIP submittal deadlines for the second planning period from July 31, 2018 to July 31, 2021 to ensure that they align where applicable with other state obligations under the Clean Air Act. The end date for the second planning period remains 2028; that is, the focus of state planning will be to establish reasonable progress goals for each Class I area against which progress will be measured during the second planning period. This extension will allow states to incorporate planning for other Federal programs while conducting their regional haze planning. These other programs include: the Mercury and Air Toxics Standards, the 2010 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standards (NAAQS); the 2012 annual fine particle ($PM_{2.5}$) NAAQS; and the 2008 and 2015 ozone NAAQS.

C. Adjusting interim progress report submission deadlines so that second and subsequent progress reports will be due by: January 31, 2025; July 31, 2033; and every ten years thereafter. This means that one progress report will be required midway through each planning period.

D. Removing the requirement for progress reports to take the form of SIP revisions. States will be required to consult with FLMs and obtain public comment on their progress reports before submission to the EPA. EPA will be reviewing but not formally approving or disapproving these progress reports.

The RHR defines "clearest days" as the 20% of monitored days in a calendar year with the lowest deciview (dv) index values. "Most impaired days" are defined as the 20% of monitored days in a calendar year with the highest amounts of anthropogenic visibility impairment. The long-term strategy and the reasonable progress goals must provide for an improvement in visibility for the most impaired days since the baseline period and ensure no degradation in visibility for the clearest days since the baseline period.

1.2 Emissions Update

Since the completion of the original round of emissions inventory development, emissions processing, modeling, and Particulate Source Apportionment Technology (PSAT), SESARM concluded that the 2028 point electric generating unit (EGU) and non-EGU emissions needed to be reviewed and updated for selected sources. These include data review from:

- Point source emissions updates identified in the Area of Influence report;
- Updated EGU emissions developed by the Eastern Regional Technical Advisory Committee (ERTAC);
- EPA's 2028 point source emissions based on the 2016 modeling platform; and
- Additional facility emission updates after PSAT analysis.

Specific updates related to development of the 2028 emissions inventory updates are presented in the Task 2 and Task 3 updated reports.[2,3]

1.3 2028elv3 and 2028elv5 CAMx 6.40 Comparison

Under subcontract to Eastern Research Group, Inc, (ERG), Alpine Geophysics, LLC (Alpine) has executed two air quality simulations for the 2028el projection year modeling platform using CAMx 6.40. We note that CAMx 6.50 has now been released, however that model release was too late to be included with sufficient certainty in the VISTAS II project schedule.

This comparison is to document the differences in model estimates between CAMx 6.40 2028elv3 and 2028elv5 as is discussed in the VISTAS II Modeling Protocol.[4]

2 Southeastern States Air Resource Managers, Inc. "Southeastern VISTAS II Regional Haze Analysis Project - Task 2 and Task 11.3 Emission Inventory Updates Report." Prepared by Eastern Research Group, Inc. under Contract V-2018-03-01. Final. September 2020.

3 Southeastern States Air Resource Managers, Inc. "Conversion of the Task 2B 2028 Point Source Remodeling Files for Emissions Processing with SMOKE, Task 3." Prepared by Alpine Geophysics, LLC and Eastern Research Group, Inc. under Contract V-2018-03-01. Final. September 2020.

4 "Regional Haze Modeling for Southeastern VISTAS II Region Haze Analysis Project, Final Modeling Protocol. Update and Addendum to the Approved Modeling Protocol for Task 6.1 (June 2018)." Prepared for SESARM under Contract No. V-2018-03-01. Prepared by Alpine Geophysics, LLC and Eastern Research Group, Inc. August 31, 2020.

2.0 DIFFERENCES BETWEEN 2028ELV3 AND 2028ELV5 SIMULATIONS

Differences in modeled output concentrations between the 2028elv3 and 2028elv5 CAMx 6.40 simulations were as a result solely of changes to the emissions inventory.

There are notable emissions inventory differences used in the modeling by SESARM compared to EPA's 2028el modeling platform. SESARM updated the 2028 emissions inventory used in this analysis (2028elv5) with changes to both electric generating unit (EGU) and non-EGU point source emissions. Summaries of the emission differences are presented in the updated Task 2 and 3 reports[2,3] for this study, the Alpine Geophysics memo "Task 6 – Benchmark #7 Review and 2028elv3 Reassessment" (Appendix A), and summarized in Section 4.1.

The VISTAS emissions processing was restricted to 2011, however, the CAMx model has a "spin-up" period from December 22 through December 31, 2010 to minimize the influence of the global model-derived initial conditions. For the 2028elv3 simulation the spin-up period for the low level emissions were based on the EPA supplied 2028el emissions for the December 2010 period. The elevated 2028elv3 emissions and the 2028elv5 low level and elevated emissions were copied by day of week from the beginning of 2011. This small difference in emissions handling led to differences in model concentrations during January 1-2, 2011. January 1-2 do not represent any 20% clearest or 20% most anthropogenically impaired days at any Class I area and therefore our results here do not include these days in the 2028elv3 and 2028elv5 modeled value scatterplots.

3.0 CONFIRMATION METHODOLOGY

The presented comparison of model simulations are based on annual and 24-hour $PM_{2.5}$ design values as generated from the output of the two VISTAS12-based simulations; CAMx 6.40 with 2028elv3 and 2028elv5 emissions. This report does not compare hourly concentrations for each PM species as the model version, platform configuration and processing methods, and the underlying projection year emissions inventories differ significantly between the two model runs making it difficult, if not impossible, to determine the cause of any differences seen in concentrations. We also provide a comparison of gridded 12-kilometer (km) annual elevated and low level emissions for the domain. The metric for comparison of the design values are the absolute difference (Equation 1) and percent difference (Equation 2) defined as:

(Equation 1) $$(C_{2028elv5} - C_{2028elv3})$$

(Equation 2) $$\frac{(C_{2028elv5} - C_{2028elv3})}{(C_{2028elv3})}$$

Where $C_{2028elv5}$ is the design value at each FRM monitor for the CAMx simulation with the 2028elv5 emissions and $C_{2028elv3}$ is the design value at each FRM monitor for the CAMx simulation with the 2028elv3 emissions. For the emission comparison plots, only Equation 1 results were calculated for each grid cell and plotted for review.

The results are presented for each FRM monitor in the VISTAS states for each of the two design values. Emission density spatial maps are presented for only the nested VISTAS12 modeling domain that was reprocessed with updated emissions. On each spatial emissions difference plot presented, the maximum positive and negative values, along with the grid cell in which these occur, are presented at the top of the graphic. The coordinates refer to the row and columns of the cell referenced to the cell coordinates on the bottom (column) and left (row) of the graphic.

Scatterplots of the daily average concentrations of ozone and the various calculated PM species in local standard time at the Interagency Monitoring for Protected Visual Environment (IMPROVE) monitors across all modeled days are also presented with the CAMx 2028elv5 results plotted on the x-axis and the CAMx 2028elv3 results plotted on the y-axis.

3.1 CAMx Species Mapping

The CAMx species mapping from version 6.40 of the model is presented in Table 3-1.

Table 3-1. Species Mapping from CAMx into Aggregated Species

Aggregated Species	CAMx 6.40 Species
Ozone	O3
$PM_{2.5}$	PSO4+PNO3+PNH4+SOA1+SOA2+SOA3+SOA4+SOPA+SOPB+POA+PEC +FPRM+FCRS+NA+PCL
Sulfate	PSO4
Nitrate	PNO3
Organic Matter (OM)	SOA1+SOA2+SOA3+SOA4+SOPA+SOPB+POA

4.0 CAMX 2028ELV3 AND 2028ELV5 COMPARISON

This section presents comparisons of the simulations using CAMx 2028elv3 and CAMx 2028elv5 performed on the Alpine computer system. Emissions presented are the post-processed results of the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions tool, including oxides of nitrogen (NO_X), volatile organic compounds (VOC), and speciated $PM_{2.5}$ components (e.g., particulate nitrate (PNO3), particulate sulfate (PSO4), etc.) for elevated and low level sources. Annual and 24-Hour $PM_{2.5}$ design values are the result of running each of the model platforms through the Software for the Modeled Attainment Test - Community Edition (SMAT-CE) tool to generate receptor-level values.

4.1 Emissions

Annual emission summaries have been prepared from the model-ready input files for both elevated and low level sources. Elevated sources include all CEM-based emissions in the modeling platform, non-EGU point sources with explicit latitude and longitude release coordinates and calculated plume rise greater than or equal to twenty (20) meters, emissions from wildfires, and international commercial marine emissions not otherwise associated with specific U.S. states. Low-level sources are comprised of all other anthropogenic source types including non-EGU point sources with a calculated plume rise of less than twenty (20) meters, agricultural and prescribed fires, biogenic and other natural source emissions, and commercial marine emissions associated with sources assigned to specific U.S. states. Results presented include maps of the VISTAS12 domain with annual emissions (tons per year) and emission differences by grid cell and pollutant. Table 4-1 presents summary results by pollutant over the VISTAS12 domain for elevated and low level comparisons. Figures 4-1 through 4-7 present the annual emissions and emission differences for elevated sources by pollutant in the VISTAS12 modeling domain. Figures 4-8 through 4-15 present annual emissions and emission differences for low level sources, by pollutant, in the VISTAS12 modeling domain.

As expected with the changes in modeled emission inventories between the SESARM 2028elv3 and 2028elv5 platforms, we see the changes in elevated (point source) emissions fairly uniformly throughout of the modeling domain. Low-level emission changes are also seen predominantly in the VISTAS states for areas where emission inventory modifications were applied for this analysis with scattered changes elsewhere due to the replacement of first-layer emitting point sources as noted above.

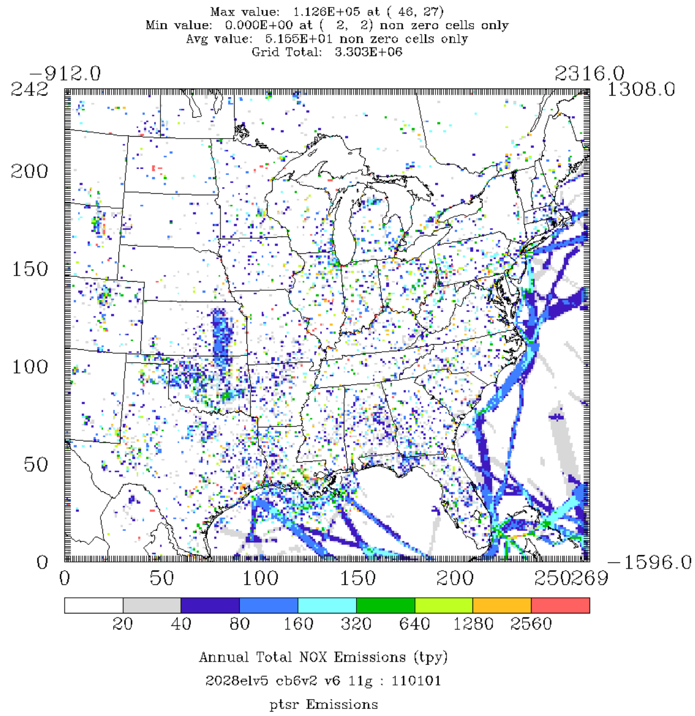
Table 4-1. Comparison of CAMx 6.40 2028elv5 and 2028elv3 Annual Emissions

		2028 Annual Emissions (tons)				
		2028elv5	Elv5-elv3[e]	Domain Wide	Individual Grid Cell	
Source Type	Pollutant	Total Tons	Total Change	% Change	Max Increase	Max Decrease
Elevated	NO_X[a]	3,303,000	-364,300	-11.03%	8,106	-17,730
Elevated	VOC[b]	3,293,000	-8,109	-0.25%	1,194	-2,331
Elevated	SO_2[c]	2,737,000	-918,000	-33.54%	7,247	-53,910
Elevated	PEC	183,300	-4,977	-2.72%	140	-290
Elevated	PNH4[d]	9,808	-208	-2.12%	6	-15
Elevated	PNO3	11,760	-179	-1.52%	22	-16
Elevated	POA	1,208,000	-5,856	-0.48%	180	-406
Elevated	PSO4	62,220	-6,059	-9.74%	165	-445
Low Level	NO_X	5,805,000	-759	-0.01%	61	-157
Low Level	VOC	46,160,000	-6,035	-0.01%	1,147	-1,201
Low Level	SO_2[c]	257,300	2,321	0.90%	2,849	-157
Low Level	PEC	118,400	-52	-0.04%	2	-13
Low Level	PNH4[b]	5,831	-1	-0.02%	0	-1
Low Level	PNO3	3,770	-7	-0.17%	0	-1
Low Level	POA	757,200	-142	-0.02%	2	-36
Low Level	PSO4	150,000	-217	-0.14%	15	-69

[a] NO_X is calculated as the sum of NO plus NO_2
[b] VOC emissions are approximate since calculated from CB6 speciated emissions.
[c] The molecular weight for SO_2 in these totals was 3% higher than the true molecular weight.
[d] PNH4 = Particulate ammonium
[e] Emission differences are discussed in the updated Task 2 and 3 reports[2,3] for this study and the Alpine Geophysics memo "Task 6 – Benchmark #7 Review and 2028elv3 Reassessment" (Appendix A).

Annual NO_X Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

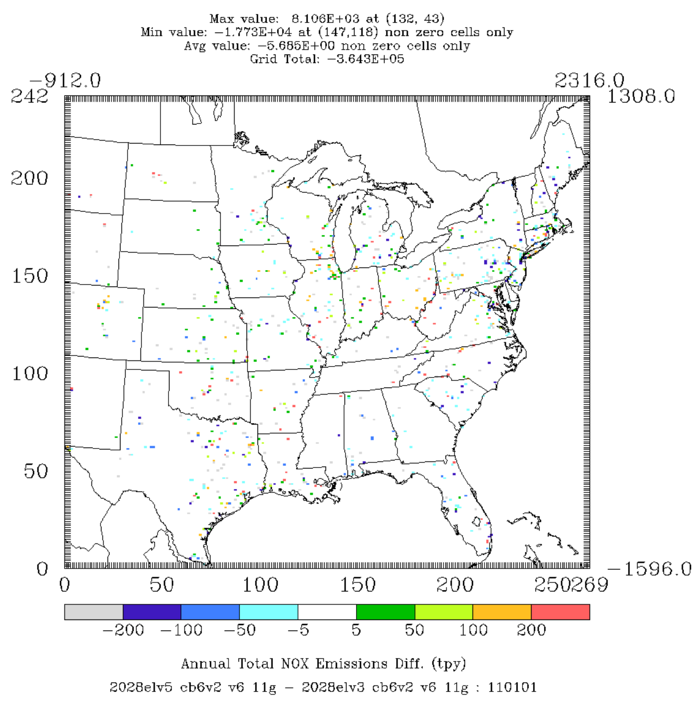
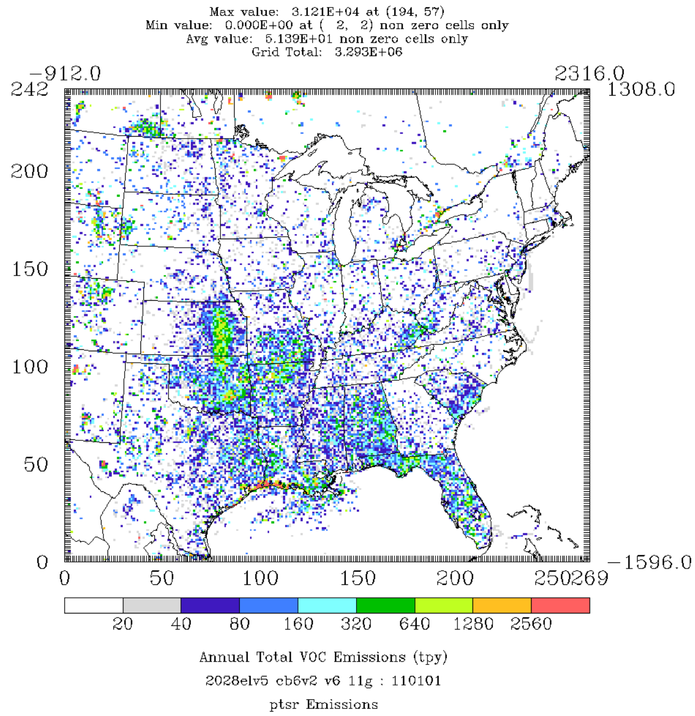


Figure 4-1. Comparison of Elevated NO_X Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual VOC Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

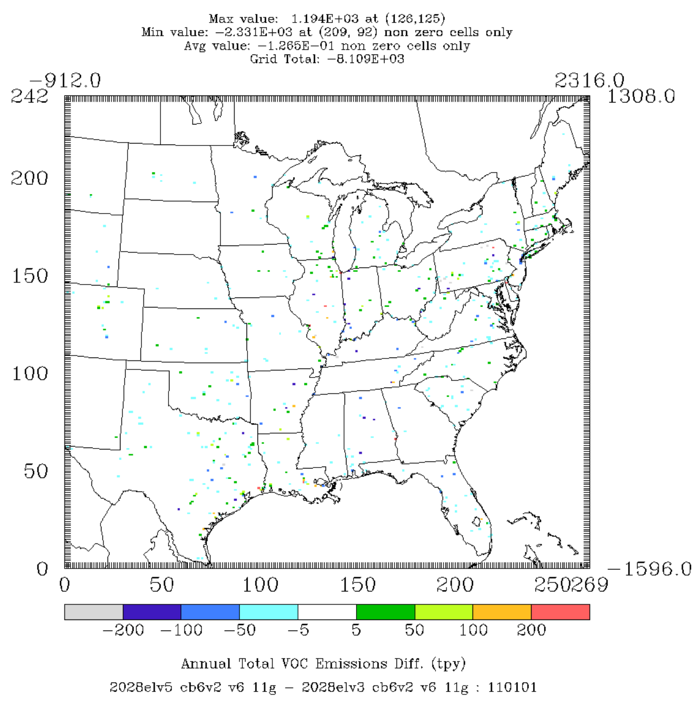
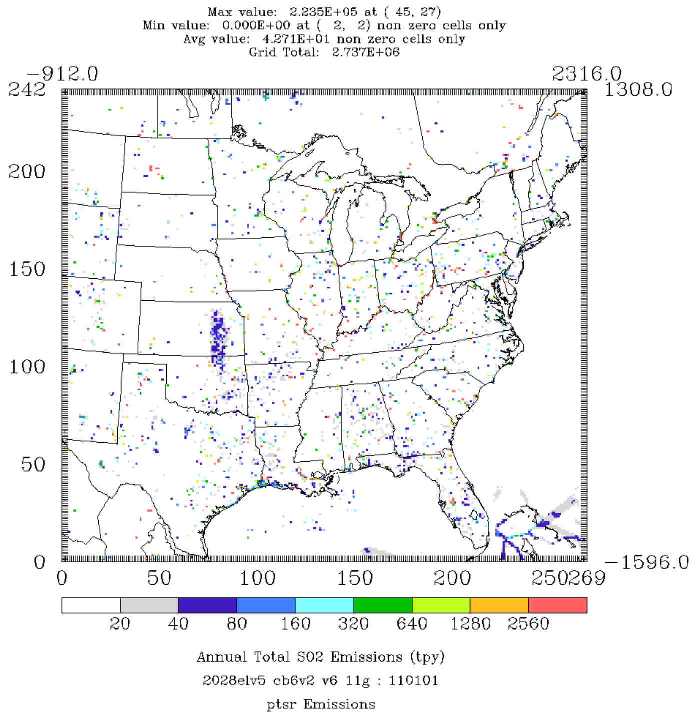


Figure 4-2. Comparison of Elevated VOC Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual SO_2 Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

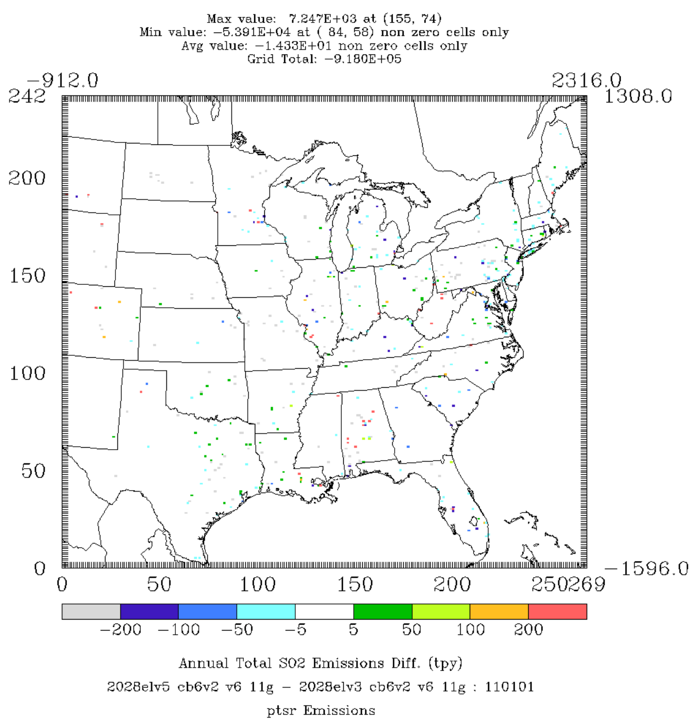


Figure 4-3. Comparison of Elevated SO_2 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

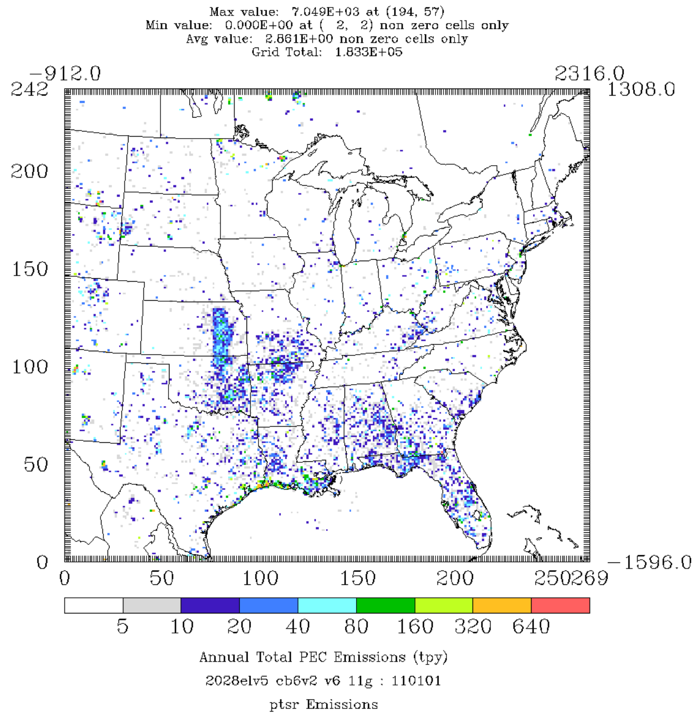
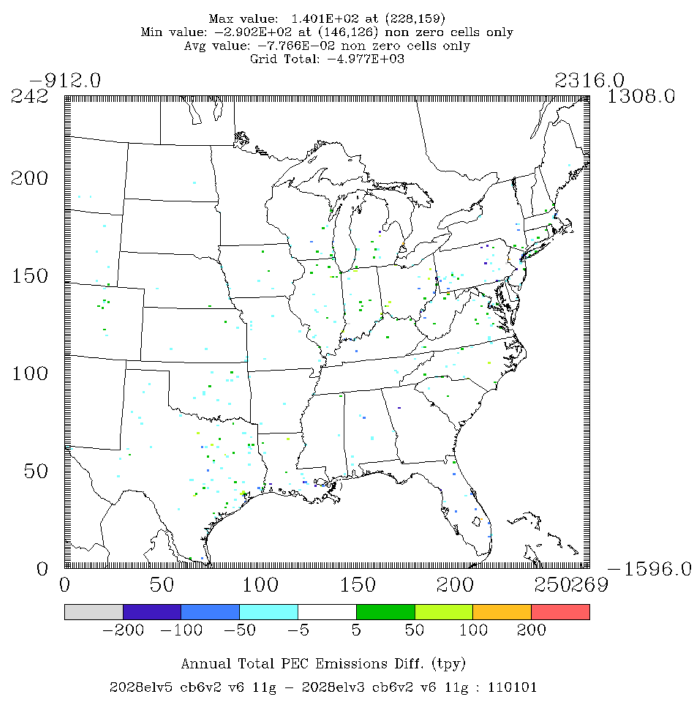
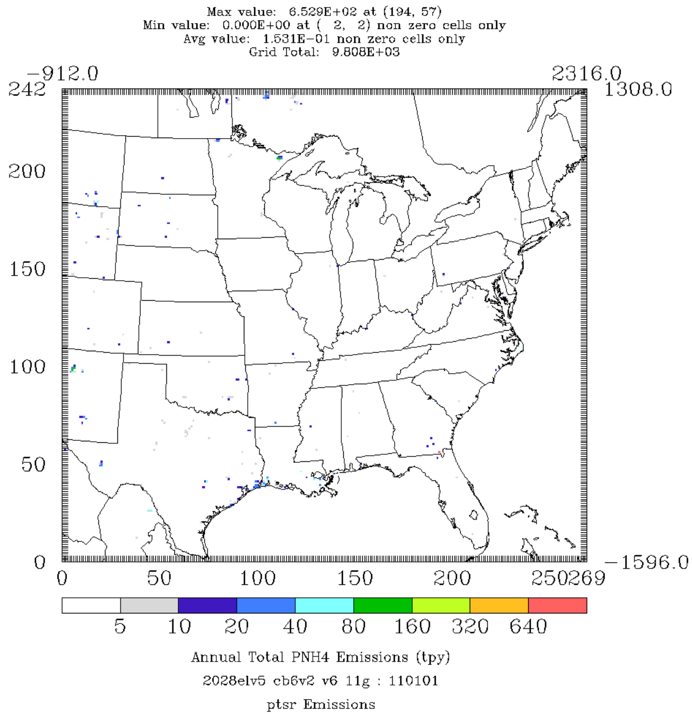
Annual PEC Emissions – Elevated Sources
2028elv5

Difference (2028elv5 – 2028elv3)


Figure 4-3. Comparison of Elevated PEC Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PNH4 Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

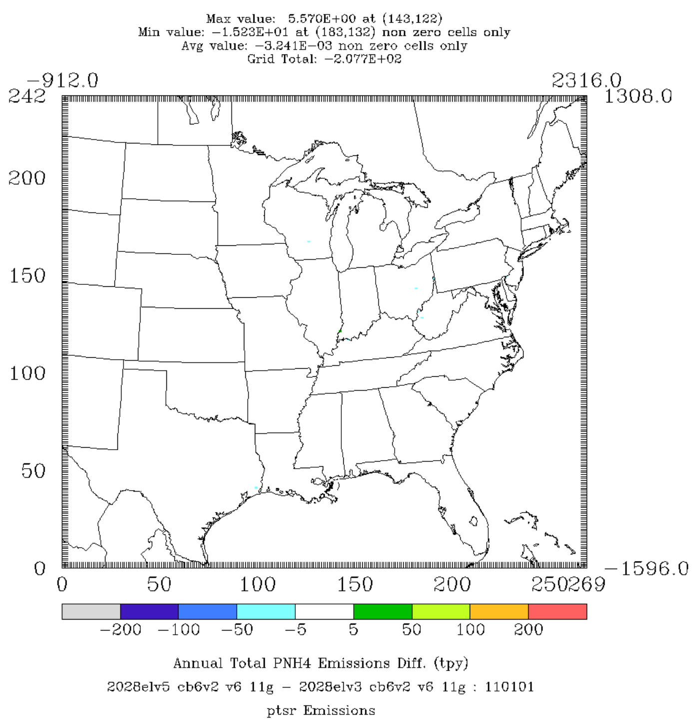
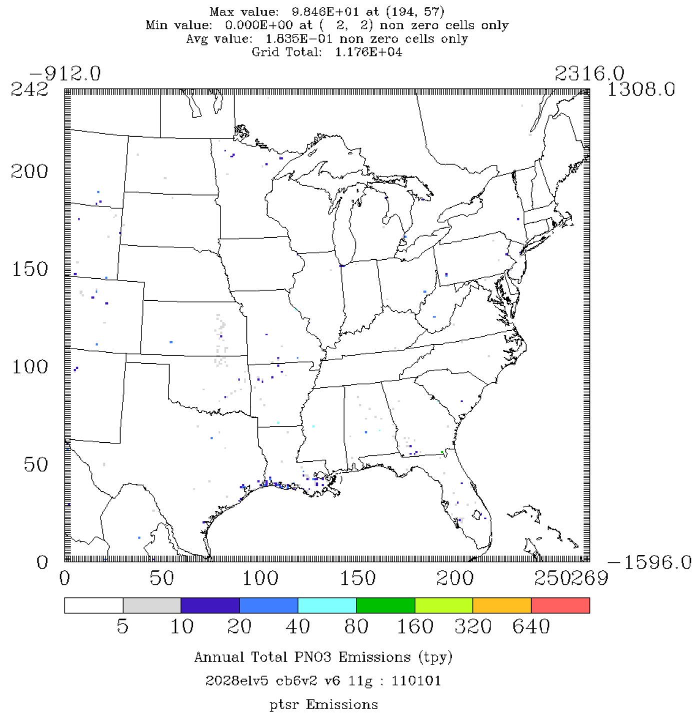


Figure 4-4. Comparison of Elevated PNH4 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PNO3 Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

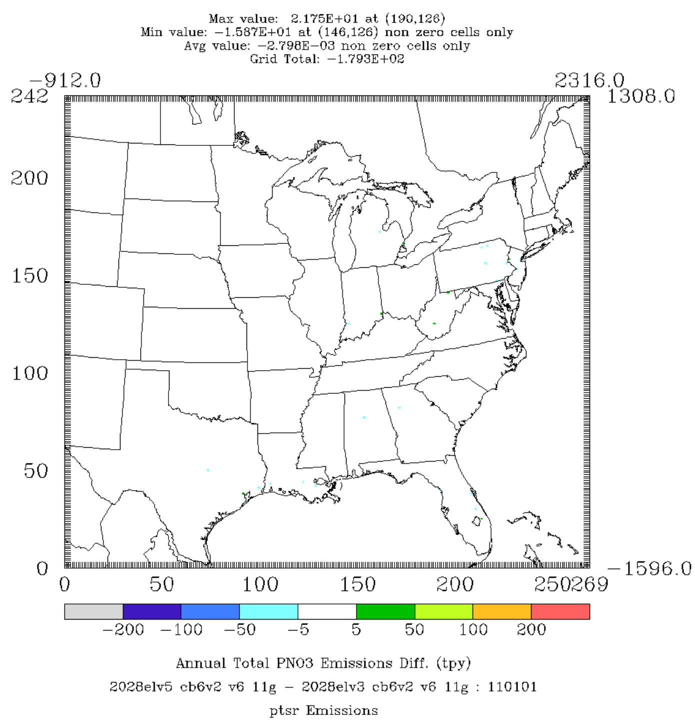
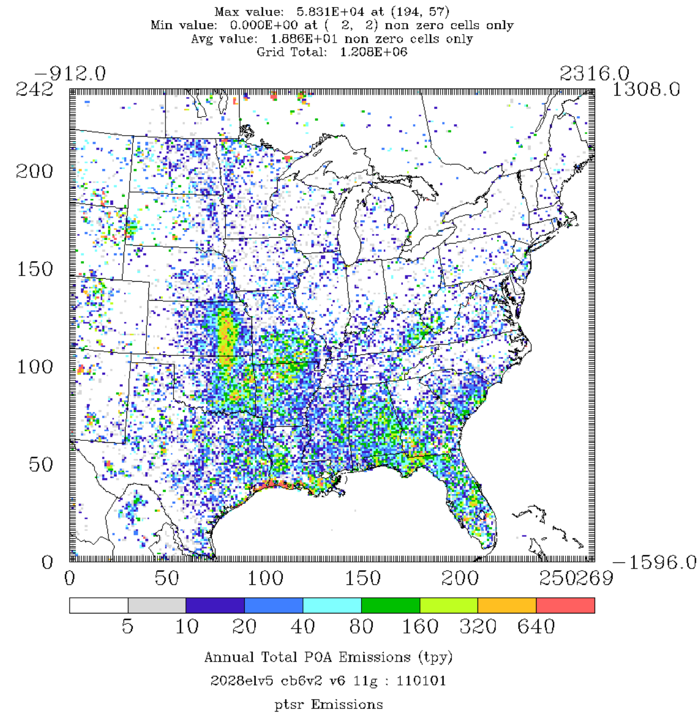


Figure 4-5. Comparison of Elevated PNO3 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual POA Emissions – Elevated Sources
2028elv5



Difference (2028elv5 – 2028elv3)

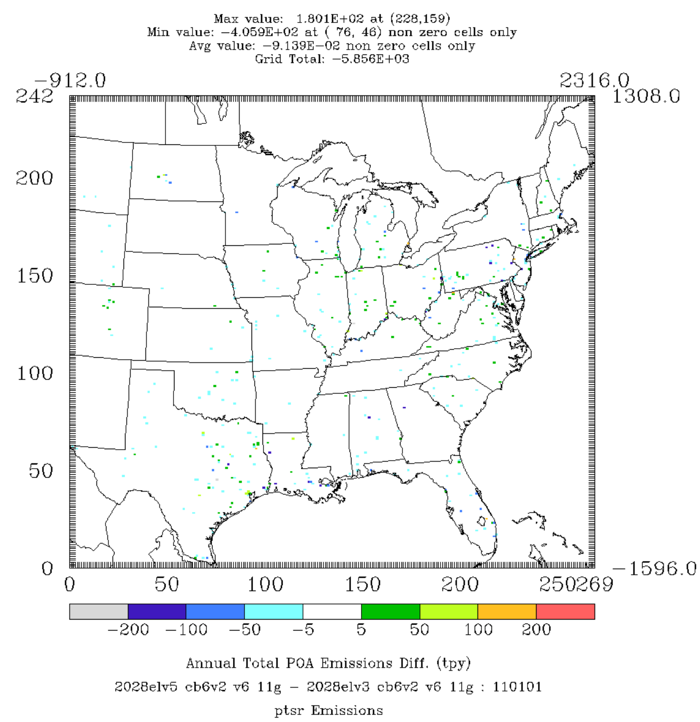
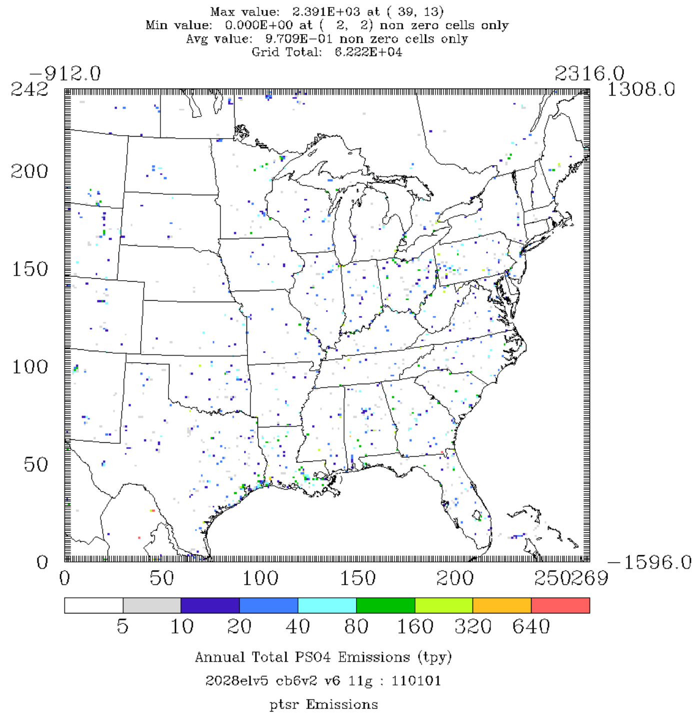


Figure 4-6. Comparison of Elevated POA Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PSO4 Emissions – Elevated Sources

2028elv5



Difference (2028elv5 – 2028elv3)

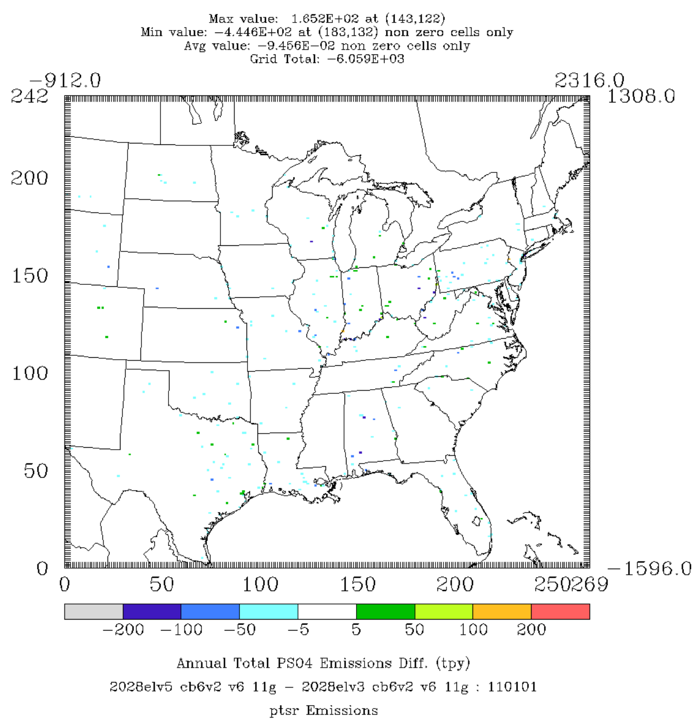
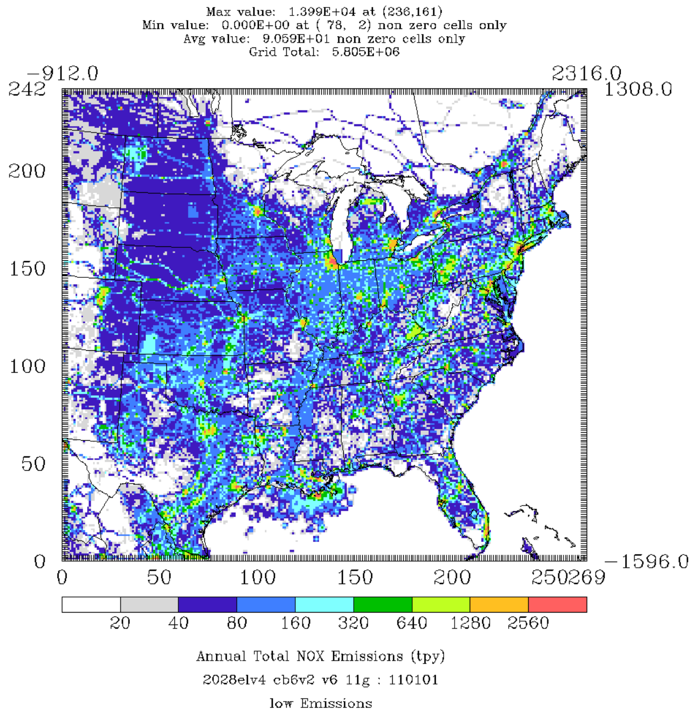


Figure 4-7. Comparison of Elevated PSO4 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual NO_X Emissions – Low Level Sources

2028elv5



Difference (2028elv5 – 2028elv3)

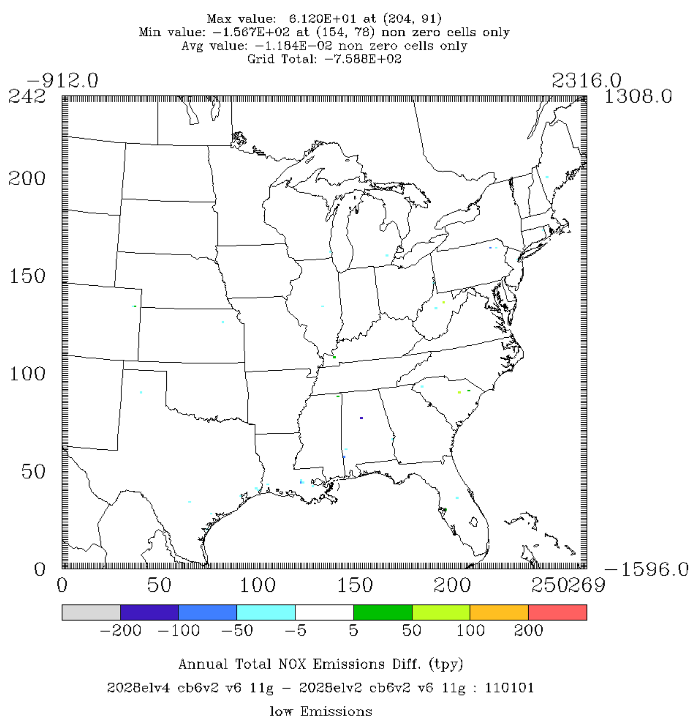
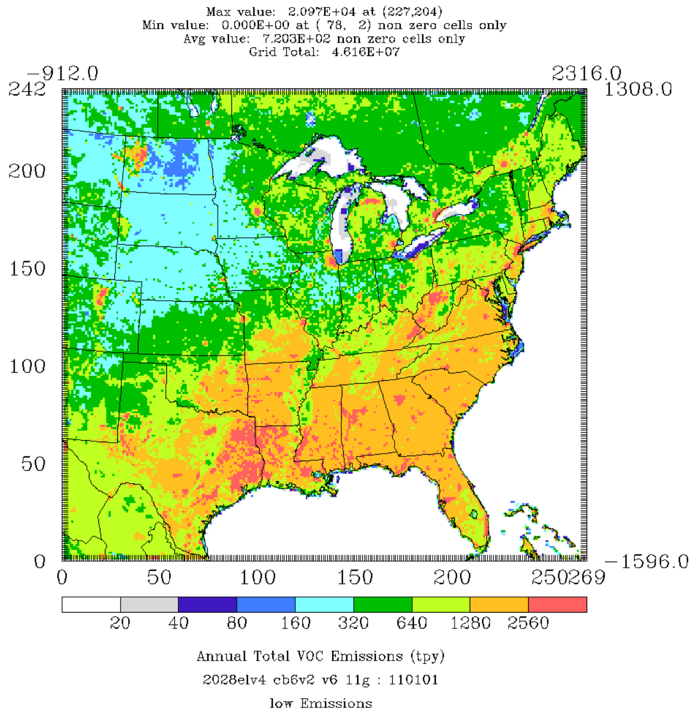


Figure 4-8. Comparison of Low Level NO_X Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual VOC Emissions – Low Level Sources

2028elv5



Difference (2028elv5 – 2028elv3)

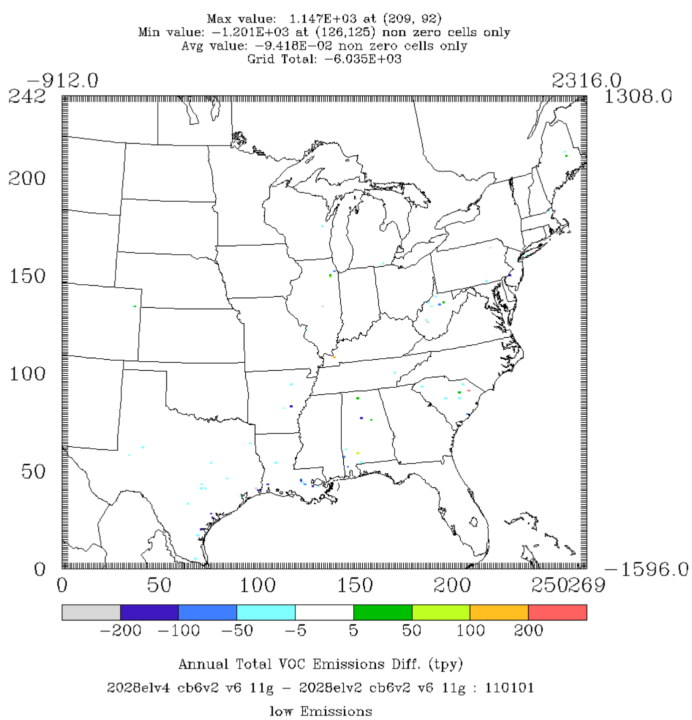
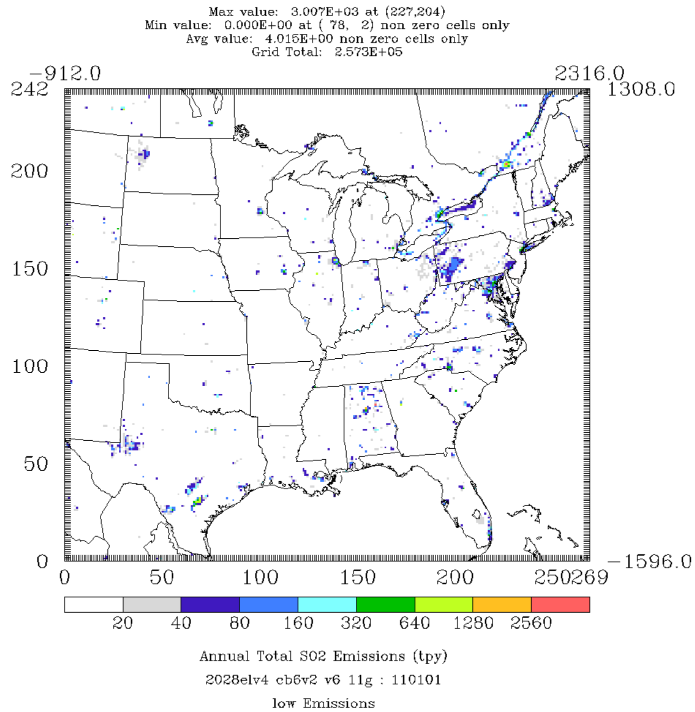


Figure 4-9. Comparison of Low Level VOC Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual SO_2 Emissions – Low Level Sources
2028elv5



Difference (2028elv5 – 2028elv3)

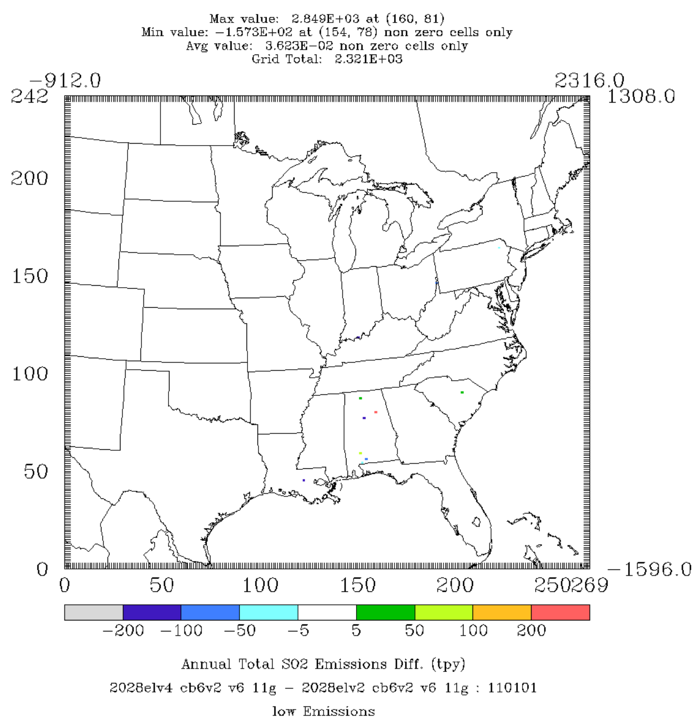
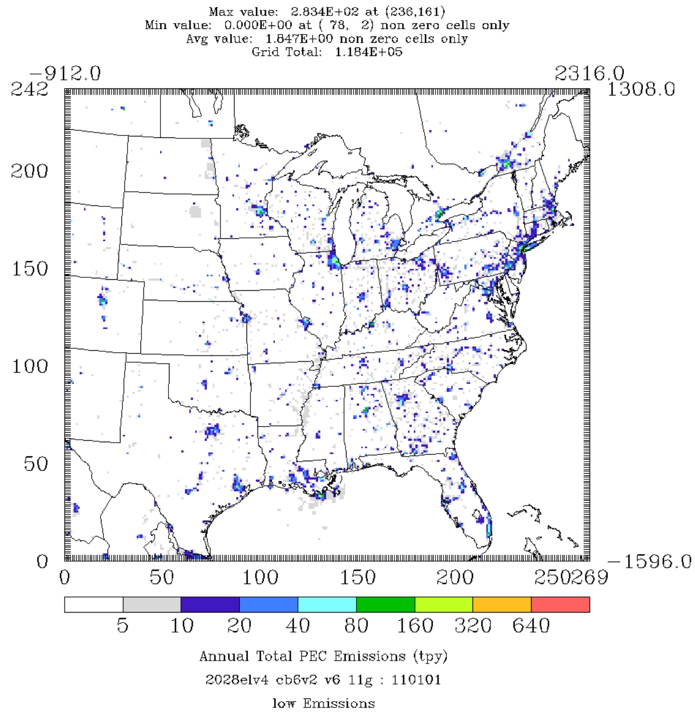


Figure 4-10. Comparison of Low Level SO_2 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PEC Emissions – Low Level Sources
2028elv5



Difference (2028elv5 – 2028elv3)

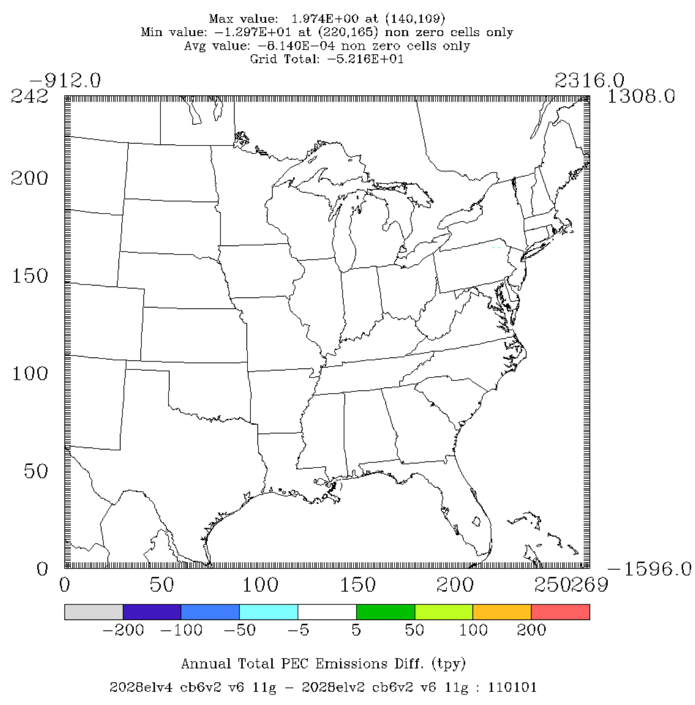
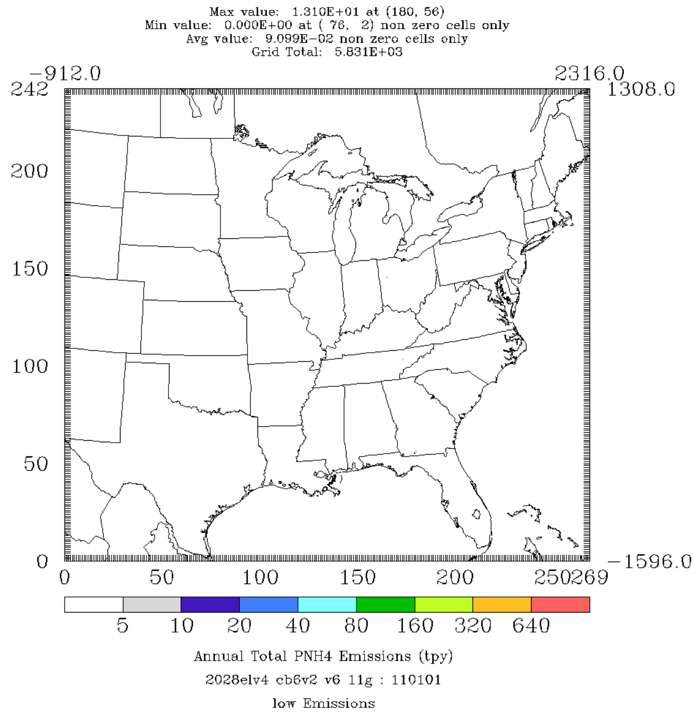


Figure 4-11. Comparison of Low Level PEC Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PNH4 Emissions – Low Level Sources
2028elv5



Difference (2028elv5 – 2028elv3)

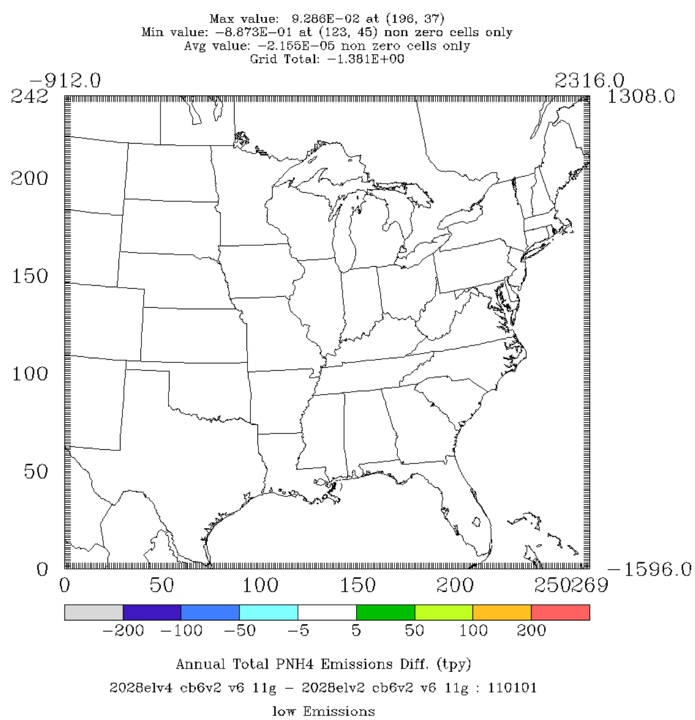
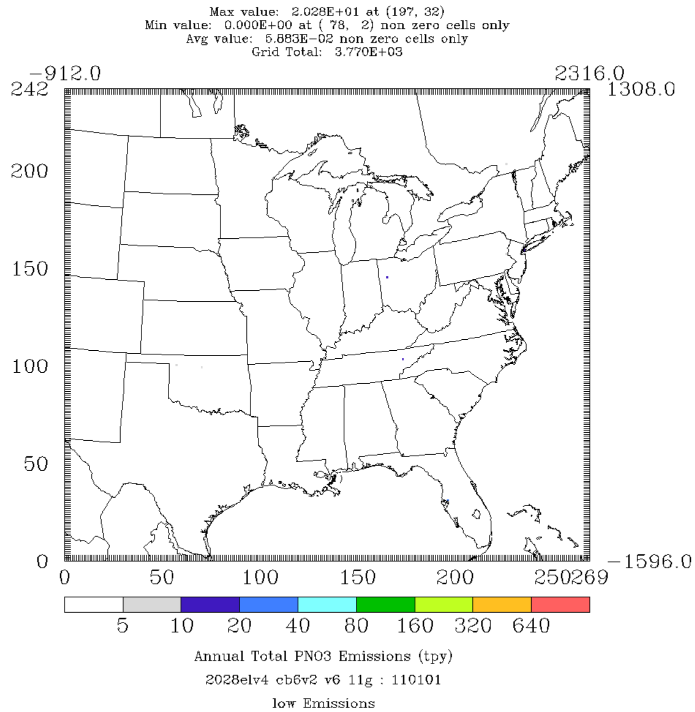


Figure 4-12. Comparison of Low Level PNH4 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PNO3 Emissions – Low Level Sources

2028elv5



Difference (2028elv5 – 2028elv3)

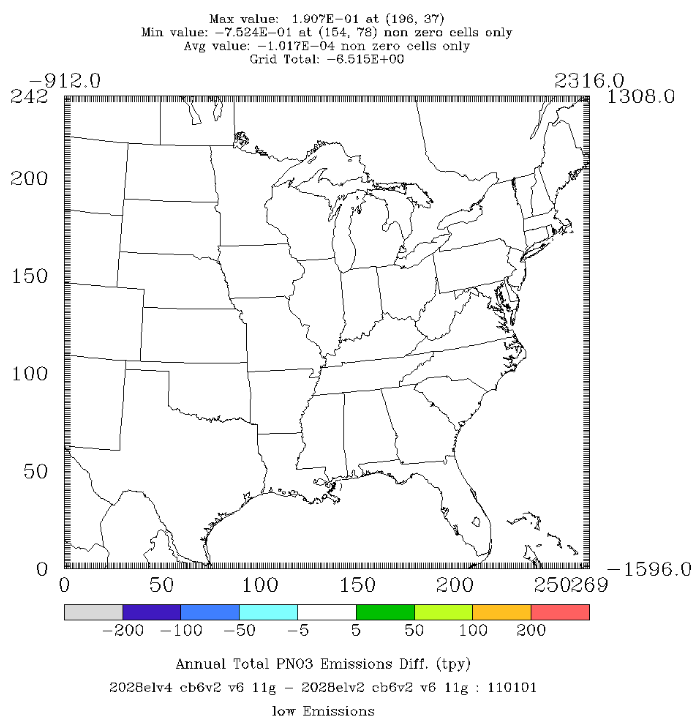
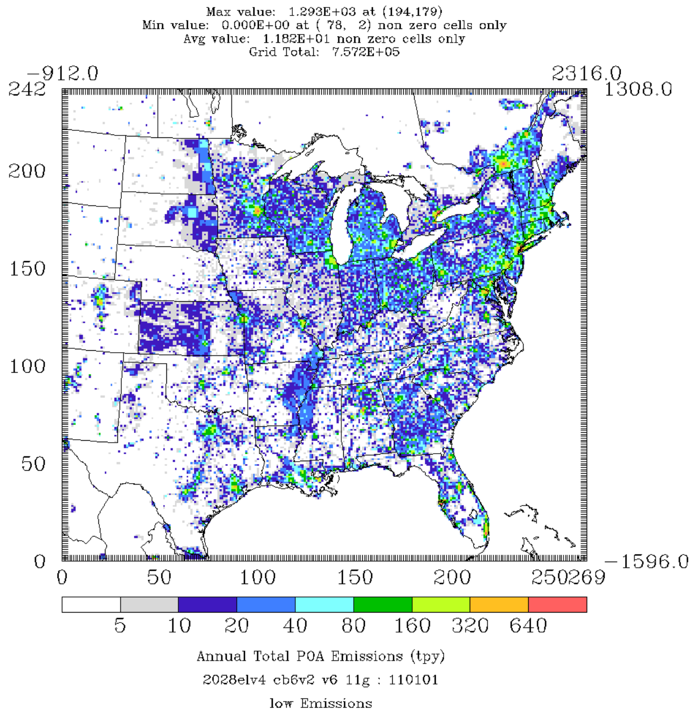


Figure 4-13. Comparison of Low Level PNO3 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual POA Emissions – Low Level Sources
2028elv5



Difference (2028elv5 – 2028elv3)

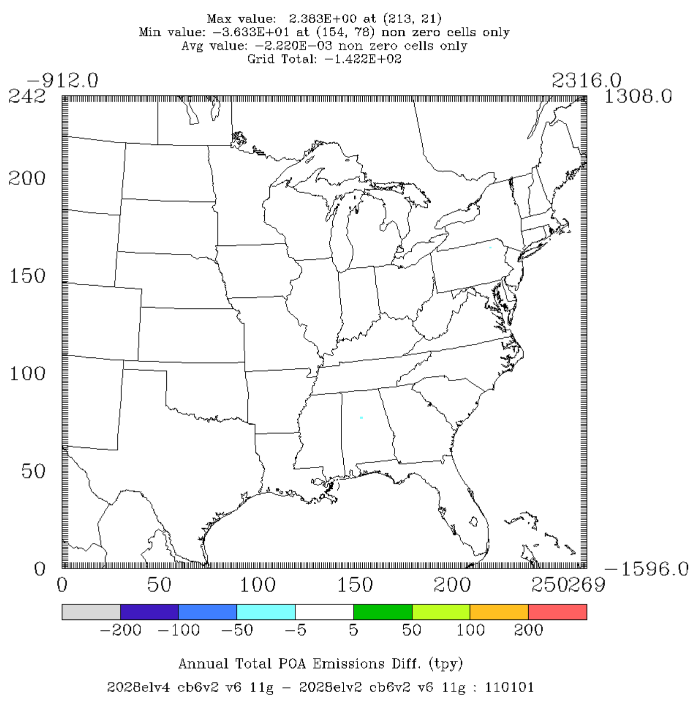
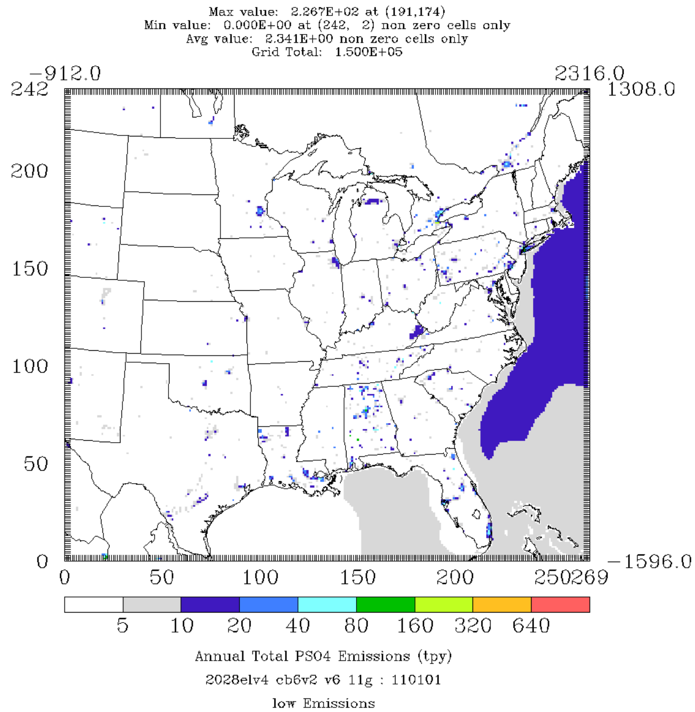


Figure 4-14. Comparison of Low Level POA Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

Annual PSO4 Emissions – Low Level Sources

2028elv5



Difference (2028elv5 – 2028elv3)

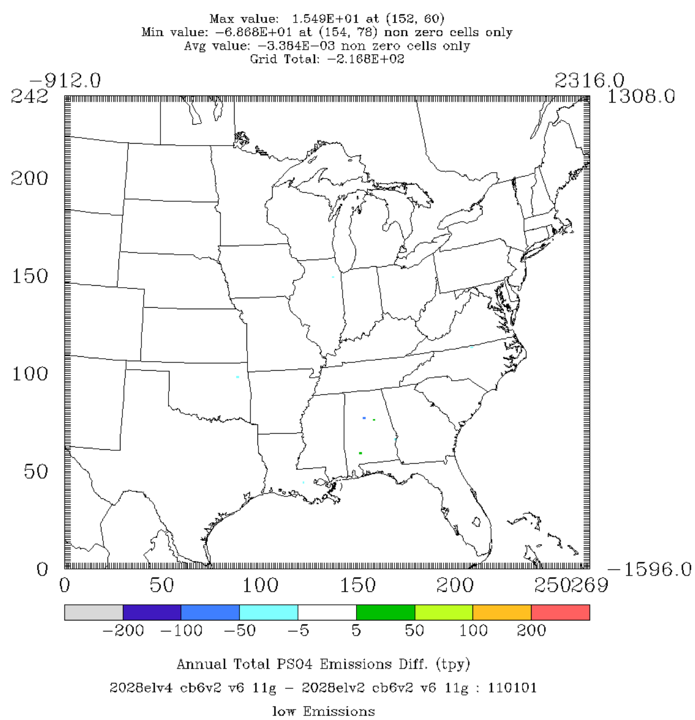


Figure 4-15. Comparison of Low Level PSO4 Emissions (tpy) for CAMx 2028elv5 and 2028elv3 Simulations

4.2 Annual $PM_{2.5}$ Design Value

Annual $PM_{2.5}$ design values were generated using the results of each individual CAMx simulation (version 6.40 with SESARM's 2028elv5 and modeled 2028elv3 emissions platforms) and the SMAT-CE tool. Results for each individual FRM monitor in the VISTAS states are presented in tabular format in Table 4-2 along with the absolute difference and percent difference in design value.

The maximum calculated decrease is 0.67 $\mu g/m^3$ at monitor 211010014 in Henderson, Kentucky (7% decrease between 2028elv3 and 2028elv5). No increases are calculated at any FRM monitor in the VISTAS states because of the move from 2028elv3 to 2028elv5. The average change in annual design value for all monitors in the VISTAS states is a decrease of 0.33 $\mu g/m^3$, with an average annual percent decrease of 4% at these same locations.

Geographic distribution of the 2028elv5 annual $PM_{2.5}$ design values and differences in design values compared to the modeled 2028elv3 simulation are presented in Figure 4-16. In the VISTAS12 domain, the largest annual $PM_{2.5}$ design value decreases are seen in areas consistent with the largest reduction in SO_2 and NO_X emissions between modeled 2028elv3 and 2020elv5. The smallest changes are seen on the boundaries of the VISTAS12 domain, consistent with not reprocessing the larger 12US2 region.

A scatterplot of the annual $PM_{2.5}$ design values for all FRM monitors in the VISTAS12 domain is presented in Figure 4-17. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis. The data have a line of best fit with a slope of 1.0277, an intercept of 0.1346 $\mu g/m^3$and an R^2 of 0.9948. As expected, due to the lower emissions associated with the 2028elv5 platform compared to modeled 2028elv3, new 2028elv5 annual $PM_{2.5}$ design values are lower at all monitors across all concentration ranges.

Table 4-2. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Annual $PM_{2.5}$ Design Values ($\mu g/m^3$) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Annual $PM_{2.5}$ Design Value ($\mu g/m^3$)			
			2028elv3	2028elv5	Difference	Percent Difference
010030010	Alabama	Baldwin	8.06	7.73	-0.33	-4%
010270001	Alabama	Clay	7.92	7.59	-0.33	-4%
010331002	Alabama	Colbert	8.37	8.03	-0.34	-4%
010491003	Alabama	DeKalb	8.52	8.21	-0.31	-4%
010550010	Alabama	Etowah	8.84	8.55	-0.29	-3%
010690003	Alabama	Houston	8.25	7.98	-0.27	-3%
010730023	Alabama	Jefferson	11.17	10.55	-0.62	-6%
010731005	Alabama	Jefferson	9.33	8.89	-0.44	-5%
010731009	Alabama	Jefferson	8.24	7.80	-0.44	-5%
010731010	Alabama	Jefferson	9.56	9.18	-0.38	-4%
010732003	Alabama	Jefferson	10.31	9.68	-0.63	-6%
010732006	Alabama	Jefferson	9.50	8.96	-0.54	-6%
010735002	Alabama	Jefferson	8.97	8.59	-0.38	-4%
010735003	Alabama	Jefferson	8.68	8.22	-0.46	-5%
010890014	Alabama	Madison	9.15	8.84	-0.31	-3%
010970003	Alabama	Mobile	8.17	7.80	-0.37	-5%
010972005	Alabama	Mobile	7.83	7.50	-0.33	-4%
011011002	Alabama	Montgomery	9.58	9.26	-0.32	-3%
011030011	Alabama	Morgan	8.73	8.40	-0.33	-4%
011130001	Alabama	Russell	10.17	9.86	-0.31	-3%
011170006	Alabama	Shelby	8.18	7.79	-0.39	-5%
011210002	Alabama	Talladega	9.14	8.77	-0.37	-4%
011250004	Alabama	Tuscaloosa	8.74	8.36	-0.38	-4%
011270002	Alabama	Walker	9.12	8.68	-0.44	-5%
120990008	Florida	Palm Beach	6.94	6.85	-0.09	-1%
120990009	Florida	Palm Beach	5.85	5.73	-0.12	-2%
130210007	Georgia	Bibb	10.60	10.32	-0.28	-3%
130210012	Georgia	Bibb	7.96	7.69	-0.27	-3%
130510091	Georgia	Chatham	8.54	8.31	-0.23	-3%
130590002	Georgia	Clarke	8.13	7.81	-0.32	-4%
130630091	Georgia	Clayton	9.43	9.11	-0.32	-3%
130670004	Georgia	Cobb	8.73	8.39	-0.34	-4%
130890002	Georgia	DeKalb	8.76	8.44	-0.32	-4%
130950007	Georgia	Dougherty	10.41	10.14	-0.27	-3%
131150003	Georgia	Floyd	9.48	9.13	-0.35	-4%

Table 4-2. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Annual $PM_{2.5}$ Design Values (µg/m^3) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Annual $PM_{2.5}$ Design Value (µg/m^3)			
			2028elv3	2028elv5	Difference	Percent Difference
131210039	Georgia	Fulton	10.36	10.02	-0.34	-3%
131390003	Georgia	Hall	8.07	7.76	-0.31	-4%
131530001	Georgia	Houston	8.55	8.28	-0.27	-3%
132150001	Georgia	Muscogee	10.78	10.47	-0.31	-3%
132450005	Georgia	Richmond	9.27	9.01	-0.26	-3%
132450091	Georgia	Richmond	9.54	9.28	-0.26	-3%
132950002	Georgia	Walker	8.02	7.69	-0.33	-4%
133190001	Georgia	Wilkinson	9.97	9.71	-0.26	-3%
210130002	Kentucky	Bell	8.80	8.45	-0.35	-4%
210190017	Kentucky	Boyd	8.31	7.96	-0.35	-4%
210290006	Kentucky	Bullitt	9.32	8.83	-0.49	-5%
210373002	Kentucky	Campbell	7.61	7.20	-0.41	-5%
210430500	Kentucky	Carter	6.80	6.46	-0.34	-5%
210470006	Kentucky	Christian	8.39	7.91	-0.48	-6%
210590005	Kentucky	Daviess	9.25	8.64	-0.61	-7%
210670012	Kentucky	Fayette	7.97	7.52	-0.45	-6%
210930006	Kentucky	Hardin	8.4	7.90	-0.50	-6%
211010014	Kentucky	Henderson	8.96	8.29	-0.67	-7%
211110067	Kentucky	Jefferson	9.44	8.98	-0.46	-5%
211451004	Kentucky	McCracken	8.84	8.32	-0.52	-6%
211510003	Kentucky	Madison	6.97	6.54	-0.43	-6%
211950002	Kentucky	Pike	8.03	7.69	-0.34	-4%
212270008	Kentucky	Warren	8.83	8.40	-0.43	-5%
280330002	Mississippi	DeSoto	8.36	7.98	-0.38	-5%
280350004	Mississippi	Forrest	9.92	9.51	-0.41	-4%
280430001	Mississippi	Grenada	8.00	7.62	-0.38	-5%
280450003	Mississippi	Hancock	8.23	7.93	-0.30	-4%
280470008	Mississippi	Harrison	7.99	7.69	-0.30	-4%
280490010	Mississippi	Hinds	9.58	9.21	-0.37	-4%
280590006	Mississippi	Jackson	7.90	7.51	-0.39	-5%
280670002	Mississippi	Jones	10.1	9.71	-0.39	-4%
280750003	Mississippi	Lauderdale	9.20	8.79	-0.41	-4%
280810005	Mississippi	Lee	9.36	9.00	-0.36	-4%
370010002	North Carolina	Alamance	7.36	7.03	-0.33	-4%
370210034	North Carolina	Buncombe	6.97	6.65	-0.32	-5%

Table 4-2. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Annual $PM_{2.5}$ Design Values (µg/m^3) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Annual $PM_{2.5}$ Design Value (µg/m^3)			
			2028elv3	2028elv5	Difference	Percent Difference
370330001	North Carolina	Caswell	6.57	6.23	-0.34	-5%
370350004	North Carolina	Catawba	7.98	7.67	-0.31	-4%
370370004	North Carolina	Chatham	6.07	5.74	-0.33	-5%
370510009	North Carolina	Cumberland	7.66	7.37	-0.29	-4%
370570002	North Carolina	Davidson	8.54	8.23	-0.31	-4%
370610002	North Carolina	Duplin	6.48	6.21	-0.27	-4%
370630015	North Carolina	Durham	7.00	6.67	-0.33	-5%
370650004	North Carolina	Edgecombe	6.66	6.35	-0.31	-5%
370670022	North Carolina	Forsyth	7.33	6.97	-0.36	-5%
370670030	North Carolina	Forsyth	7.34	6.99	-0.35	-5%
370710016	North Carolina	Gaston	7.78	7.49	-0.29	-4%
370810013	North Carolina	Guilford	6.97	6.62	-0.35	-5%
370810014	North Carolina	Guilford	7.14	6.78	-0.36	-5%
370870012	North Carolina	Haywood	7.86	7.59	-0.27	-3%
370990006	North Carolina	Jackson	7.15	6.87	-0.28	-4%
371010002	North Carolina	Johnston	6.70	6.40	-0.30	-4%
371070004	North Carolina	Lenoir	6.85	6.57	-0.28	-4%
371110004	North Carolina	McDowell	7.60	7.30	-0.30	-4%
371170001	North Carolina	Martin	6.39	6.08	-0.31	-5%
371190041	North Carolina	Mecklenburg	8.11	7.82	-0.29	-4%
371190042	North Carolina	Mecklenburg	8.45	8.17	-0.28	-3%
371190043	North Carolina	Mecklenburg	7.64	7.34	-0.30	-4%
371210001	North Carolina	Mitchell	7.19	6.91	-0.28	-4%
371230001	North Carolina	Montgomery	6.95	6.66	-0.29	-4%
371290002	North Carolina	New Hanover	5.61	5.37	-0.24	-4%
371470006	North Carolina	Pitt	6.29	6.00	-0.29	-5%
371550005	North Carolina	Robeson	7.51	7.23	-0.28	-4%
371590021	North Carolina	Rowan	7.85	7.55	-0.30	-4%
371730002	North Carolina	Swain	7.50	7.21	-0.29	-4%
371830014	North Carolina	Wake	7.89	7.58	-0.31	-4%
371830020	North Carolina	Wake	7.09	6.78	-0.31	-4%
371890003	North Carolina	Watauga	6.29	5.99	-0.30	-5%
371910005	North Carolina	Wayne	7.40	7.16	-0.24	-3%
450190048	South Carolina	Charleston	7.11	6.88	-0.23	-3%
450190049	South Carolina	Charleston	6.88	6.64	-0.24	-3%

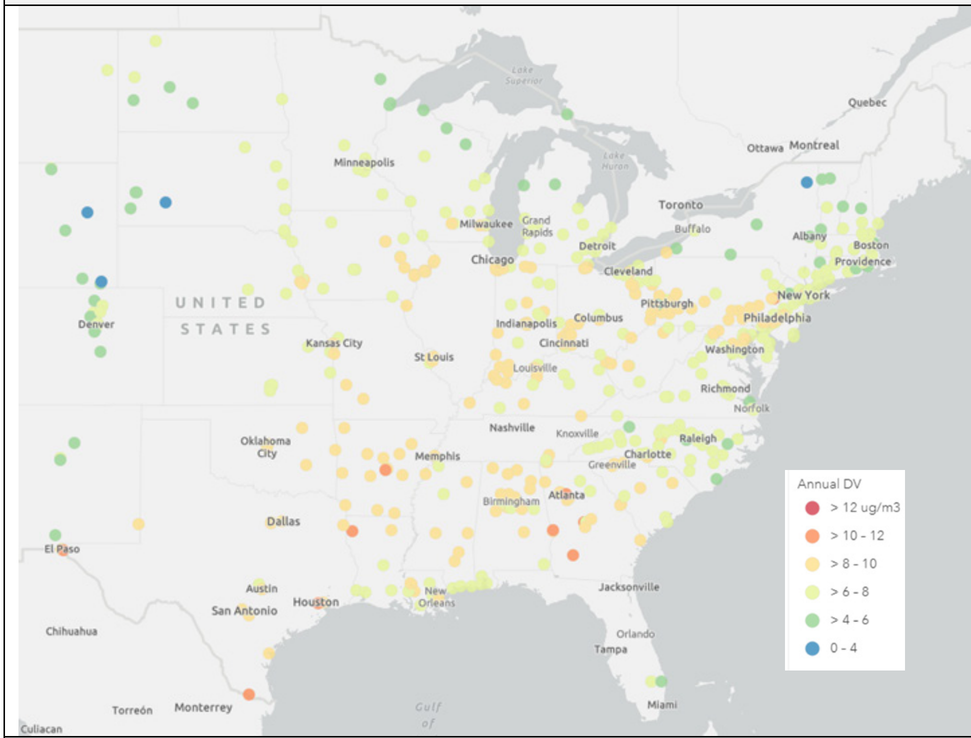
Table 4-2. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Annual $PM_{2.5}$ Design Values (µg/m^3) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Annual $PM_{2.5}$ Design Value (µg/m^3)			
			2028elv3	2028elv5	Difference	Percent Difference
450250001	South Carolina	Chesterfield	7.69	7.41	-0.28	-4%
450370001	South Carolina	Edgefield	8.03	7.76	-0.27	-3%
450410003	South Carolina	Florence	8.65	8.36	-0.29	-3%
450450009	South Carolina	Greenville	8.65	8.31	-0.34	-4%
450450015	South Carolina	Greenville	8.92	8.58	-0.34	-4%
450630008	South Carolina	Lexington	8.64	8.40	-0.24	-3%
450830011	South Carolina	Spartanburg	8.47	8.16	-0.31	-4%
470650031	Tennessee	Hamilton	8.55	8.20	-0.35	-4%
470651011	Tennessee	Hamilton	8.45	8.08	-0.37	-4%
470654002	Tennessee	Hamilton	8.30	7.92	-0.38	-5%
510030001	Virginia	Albemarle	6.67	6.34	-0.33	-5%
510360002	Virginia	Charles	6.57	6.24	-0.33	-5%
510410003	Virginia	Chesterfield	7.44	7.08	-0.36	-5%
510590030	Virginia	Fairfax	7.38	6.99	-0.39	-5%
510690010	Virginia	Frederick	8.19	7.78	-0.41	-5%
510870014	Virginia	Henrico	7.17	6.83	-0.34	-5%
510870015	Virginia	Henrico	6.76	6.41	-0.35	-5%
511071005	Virginia	Loudoun	7.57	7.20	-0.37	-5%
511390004	Virginia	Page	7.13	6.77	-0.36	-5%
511650003	Virginia	Rockingham	7.89	7.55	-0.34	-4%
515200006	Virginia	Bristol City	7.73	7.45	-0.28	-4%
516500008	Virginia	Hampton City	5.93	5.64	-0.29	-5%
516800015	Virginia	Lynchburg City	6.52	6.18	-0.34	-5%
517100024	Virginia	Norfolk City	7.04	6.75	-0.29	-4%
517700015	Virginia	Roanoke City	7.73	7.38	-0.35	-5%
517750011	Virginia	Salem City	7.50	7.15	-0.35	-5%
518100008	Virginia	Virginia Beach City	6.98	6.70	-0.28	-4%
540030003	West Virginia	Berkeley	9.38	8.96	-0.42	-4%
540090005	West Virginia	Brooke	9.59	9.08	-0.51	-5%
540110006	West Virginia	Cabell	9.10	8.74	-0.36	-4%
540291004	West Virginia	Hancock	8.73	8.23	-0.50	-6%
540390010	West Virginia	Kanawha	8.14	7.72	-0.42	-5%
540391005	West Virginia	Kanawha	9.27	8.83	-0.44	-5%
540490006	West Virginia	Marion	9.21	8.81	-0.40	-4%

Table 4-2. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Annual $PM_{2.5}$ Design Values ($\mu g/m^3$) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Annual $PM_{2.5}$ Design Value ($\mu g/m^3$)			
			2028elv3	2028elv5	Difference	Percent Difference
540511002	West Virginia	Marshall	10.03	9.58	-0.45	-4%
540610003	West Virginia	Monongalia	8.08	7.64	-0.44	-5%
540690010	West Virginia	Ohio	8.72	8.22	-0.50	-6%
540810002	West Virginia	Raleigh	6.99	6.61	-0.38	-5%
541071002	West Virginia	Wood	9.12	8.73	-0.39	-4%

Annual $PM_{2.5}$ Design Value – VISTAS12 Domain
CAMx 6.40 2028elv5



Annual $PM_{2.5}$ Design Value Reduction (2028elv3 – 2028elv5)

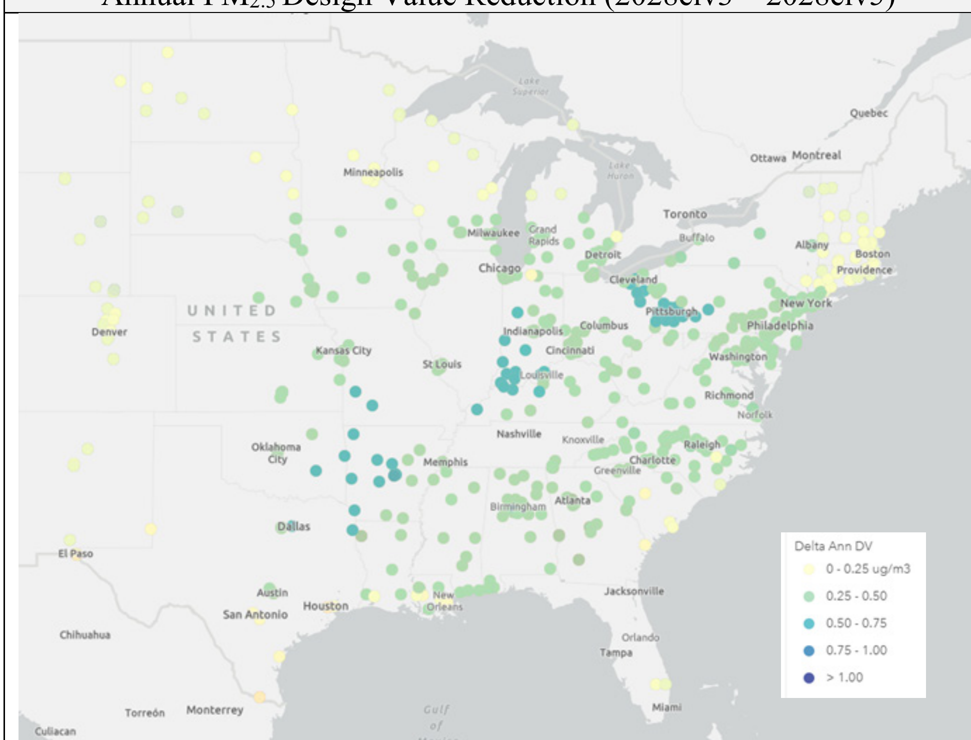


Figure 4-16. Comparison of Annual $PM_{2.5}$ Design Values ($\mu g/m^3$) for CAMx 6.40 2028elv5 and 2028elv3 Simulations

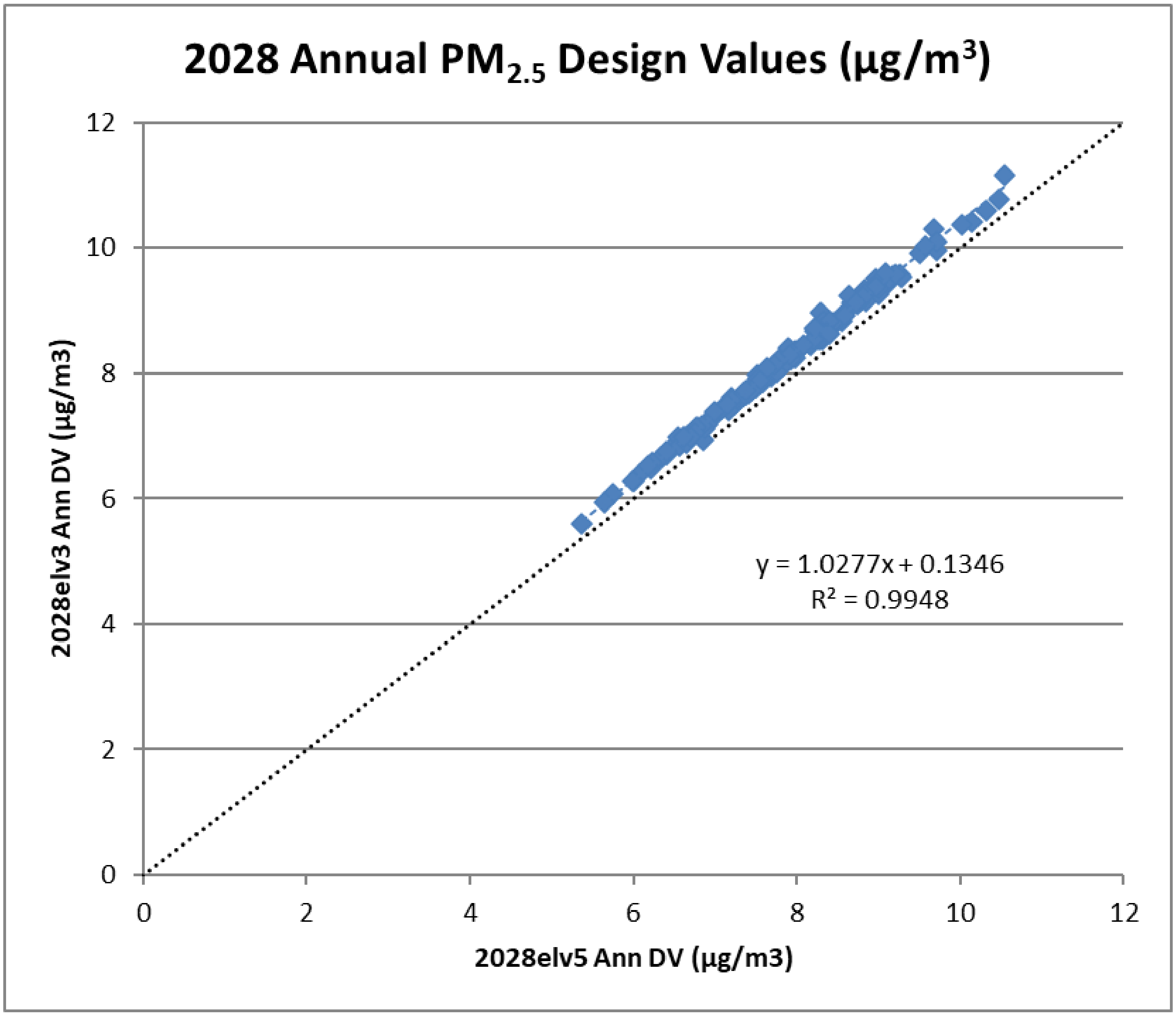


Figure 4-17. Scatterplot Comparing Annual Average Predicted $PM_{2.5}$ Design Values (µg/m^3) at all Monitor Locations for CAMx 6.40 2028elv3 and 2028elv5 Simulations Performed by VISTAS (Alpine)

4.3 24-Hour (Daily) $PM_{2.5}$ Design Value

Daily $PM_{2.5}$ design values were generated using the results of each individual CAMx simulation (version 6.40 with SESARM's 2028 elv5 and modeled 2028elv3 emissions platform) and the SMAT-CE tool. Results for each individual FRM monitor in the VISTAS states are presented in tabular format in Table 4-3 along with the absolute difference and percent difference in design value.

The maximum calculated decrease is 2.4 $\mu g/m^3$ at monitor 010732003 in Jefferson, Alabama (11% decrease going from 2028elv3 to 2028elv5). No increases are calculated at any FRM monitor in the VISTAS states because of the move from 2028elv3 to 2028elv5. The average change in annual design value for all monitors in the VISTAS states is a decrease of 0.7 $\mu g/m^3$, with an average annual percent decrease of 4% at these same locations.

Geographic distribution of the 6.40 2028elv5 daily $PM_{2.5}$ design values and reductions in design values compared to the modeled 2028elv3 simulation are presented in Figure 4-18. Daily $PM_{2.5}$ design values have widespread change throughout the VISTAS12 modeling domain with the smallest daily design value changes seen along the western border of the region.

A scatterplot of the daily $PM_{2.5}$ design values for all FRM monitors in the VISTAS12 domain is presented in Figure 4-19. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the modeled 2028elv3 results are plotted on the y-axis. The data has a slope of 0.9977, an intercept of 0.688 $\mu g/m^3$ and an R^2 of 0.9854. 2028elv5 concentrations are lower compared to modeled 2028elv3 across all concentration ranges which is consistent with the change in emissions between the two platforms.

Table 4-3. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Daily (24-Hour) $PM_{2.5}$ Design Values (µg/m^3) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Daily (24-Hr) $PM_{2.5}$ Design Value (µg/m^3)			
			2028elv3	2028elv5	Difference	Percent Difference
10030010	Alabama	Baldwin	15.9	15.3	-0.6	-4%
10270001	Alabama	Clay	17.2	16.6	-0.6	-3%
10331002	Alabama	Colbert	16.2	15.7	-0.5	-3%
10491003	Alabama	DeKalb	17.1	16.5	-0.6	-4%
10550010	Alabama	Etowah	17.7	17.3	-0.4	-2%
10690003	Alabama	Houston	17.0	16.7	-0.3	-2%
10730023	Alabama	Jefferson	22.9	22.3	-0.6	-3%
10731005	Alabama	Jefferson	17.8	16.9	-0.9	-5%
10731009	Alabama	Jefferson	17.8	16.9	-0.9	-5%
10731010	Alabama	Jefferson	18.3	17.7	-0.6	-3%
10732003	Alabama	Jefferson	21.2	18.8	-2.4	-11%
10732006	Alabama	Jefferson	18.6	17.9	-0.7	-4%
10735002	Alabama	Jefferson	17.4	16.7	-0.7	-4%
10735003	Alabama	Jefferson	17.7	16.9	-0.8	-5%
10890014	Alabama	Madison	18.6	18.1	-0.5	-3%
10970003	Alabama	Mobile	16.1	15.5	-0.6	-4%
10972005	Alabama	Mobile	16.7	16.0	-0.7	-4%
11011002	Alabama	Montgomery	19.9	19.4	-0.5	-3%
11030011	Alabama	Morgan	16.5	15.8	-0.7	-4%
11130001	Alabama	Russell	23.4	23.0	-0.4	-2%
11170006	Alabama	Shelby	15.8	15.1	-0.7	-4%
11210002	Alabama	Talladega	18.5	18.0	-0.5	-3%
11250004	Alabama	Tuscaloosa	19.0	18.4	-0.6	-3%
11270002	Alabama	Walker	17.8	17.0	-0.8	-4%
120990008	Florida	Palm Beach	15.7	15.5	-0.2	-1%
120990009	Florida	Palm Beach	13.6	13.4	-0.2	-1%
130210007	Georgia	Bibb	22.1	21.6	-0.5	-2%
130210012	Georgia	Bibb	17.9	17.5	-0.4	-2%
130510017	Georgia	Chatham	24.3	23.7	-0.6	-2%
130510091	Georgia	Chatham	24.4	23.8	-0.6	-2%
130590002	Georgia	Clarke	17.6	17.1	-0.5	-3%
130670004	Georgia	Cobb	17.1	16.5	-0.6	-4%
130890002	Georgia	DeKalb	17.2	16.7	-0.5	-3%
130950007	Georgia	Dougherty	24.3	24.0	-0.3	-1%
131390003	Georgia	Hall	16.5	15.9	-0.6	-4%

Table 4-3. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Daily (24-Hour) $PM_{2.5}$ Design Values (µg/m³) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Daily (24-Hr) $PM_{2.5}$ Design Value (µg/m³)			
			2028elv3	2028elv5	Difference	Percent Difference
131530001	Georgia	Houston	19.5	19.1	-0.4	-2%
132950002	Georgia	Walker	17.2	16.8	-0.4	-2%
133190001	Georgia	Wilkinson	20.2	19.8	-0.4	-2%
210130002	Kentucky	Bell	20.6	20.2	-0.4	-2%
210190017	Kentucky	Boyd	17.8	17.1	-0.7	-4%
210373002	Kentucky	Campbell	16.0	15.1	-0.9	-6%
210430500	Kentucky	Carter	14.9	14.3	-0.6	-4%
210470006	Kentucky	Christian	15.8	14.7	-1.1	-7%
210590005	Kentucky	Daviess	19.9	18.3	-1.6	-8%
210670012	Kentucky	Fayette	16.2	15.3	-0.9	-6%
210930006	Kentucky	Hardin	17.0	16.1	-0.9	-5%
211010014	Kentucky	Henderson	18.5	16.7	-1.8	-10%
211110067	Kentucky	Jefferson	20.4	19.4	-1.0	-5%
211451004	Kentucky	McCracken	17.0	15.8	-1.2	-7%
211510003	Kentucky	Madison	14.3	13.5	-0.8	-6%
211950002	Kentucky	Pike	18.1	17.4	-0.7	-4%
212270008	Kentucky	Warren	16.3	15.3	-1.0	-6%
280330002	Mississippi	DeSoto	15.9	15.2	-0.7	-4%
280350004	Mississippi	Forrest	19.5	19.0	-0.5	-3%
280430001	Mississippi	Grenada	15.8	14.9	-0.9	-6%
280450003	Mississippi	Hancock	18.3	17.9	-0.4	-2%
280470008	Mississippi	Harrison	15.1	14.8	-0.3	-2%
280490010	Mississippi	Hinds	18.5	17.9	-0.6	-3%
280590006	Mississippi	Jackson	17.6	16.9	-0.7	-4%
280670002	Mississippi	Jones	20.3	19.8	-0.5	-2%
280750003	Mississippi	Lauderdale	18.6	17.9	-0.7	-4%
280810005	Mississippi	Lee	17.4	16.6	-0.8	-5%
370010002	North Carolina	Alamance	15.2	14.6	-0.6	-4%
370210034	North Carolina	Buncombe	13.5	12.9	-0.6	-4%
370330001	North Carolina	Caswell	12.8	12.4	-0.4	-3%
370350004	North Carolina	Catawba	16.4	16.1	-0.3	-2%
370370004	North Carolina	Chatham	13.0	12.3	-0.7	-5%
370510009	North Carolina	Cumberland	17.0	16.6	-0.4	-2%
370570002	North Carolina	Davidson	15.9	15.5	-0.4	-3%
370610002	North Carolina	Duplin	14.4	14.0	-0.4	-3%

Table 4-3. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Daily (24-Hour) $PM_{2.5}$ Design Values (µg/m³) for FRM Monitors in VISTAS States

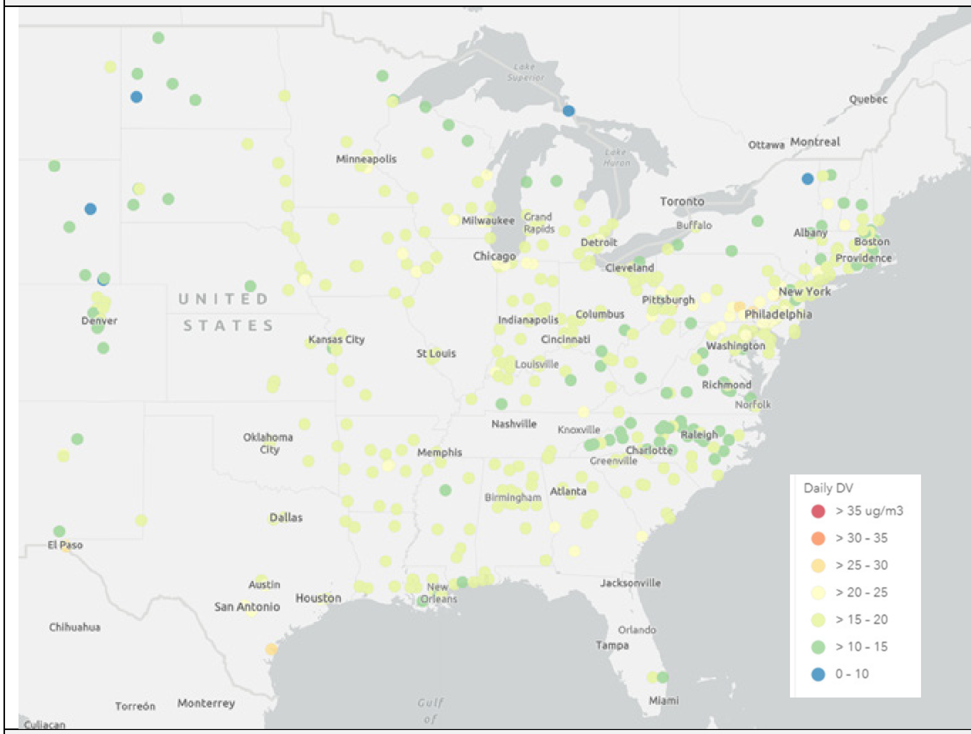
Monitor	State	County	2028 Daily (24-Hr) $PM_{2.5}$ Design Value (µg/m³)			
			2028elv3	2028elv5	Difference	Percent Difference
370630015	North Carolina	Durham	13.9	13.5	-0.4	-3%
370650004	North Carolina	Edgecombe	14.7	14.1	-0.6	-4%
370670022	North Carolina	Forsyth	15.3	14.8	-0.5	-3%
370670030	North Carolina	Forsyth	14.8	14.5	-0.3	-2%
370710016	North Carolina	Gaston	16.4	15.8	-0.6	-4%
370810013	North Carolina	Guilford	16.1	15.6	-0.5	-3%
370810014	North Carolina	Guilford	14.4	13.9	-0.5	-3%
370870012	North Carolina	Haywood	18.8	18.4	-0.4	-2%
370990006	North Carolina	Jackson	13.8	13.4	-0.4	-3%
371010002	North Carolina	Johnston	14.1	13.6	-0.5	-4%
371070004	North Carolina	Lenoir	15.8	15.0	-0.8	-5%
371110004	North Carolina	McDowell	15.4	14.9	-0.5	-3%
371170001	North Carolina	Martin	17.3	16.3	-1.0	-6%
371190041	North Carolina	Mecklenburg	17.5	17.0	-0.5	-3%
371190042	North Carolina	Mecklenburg	17.9	17.4	-0.5	-3%
371190043	North Carolina	Mecklenburg	15.2	14.8	-0.4	-3%
371210001	North Carolina	Mitchell	13.8	13.3	-0.5	-4%
371230001	North Carolina	Montgomery	14.9	14.4	-0.5	-3%
371290002	North Carolina	New Hanover	15.9	15.2	-0.7	-4%
371470006	North Carolina	Pitt	15.4	14.8	-0.6	-4%
371550005	North Carolina	Robeson	16.9	16.3	-0.6	-4%
371590021	North Carolina	Rowan	15.3	14.9	-0.4	-3%
371730002	North Carolina	Swain	15.6	15.0	-0.6	-4%
371830014	North Carolina	Wake	17.4	16.8	-0.6	-3%
371830020	North Carolina	Wake	14.4	13.9	-0.5	-3%
371890003	North Carolina	Watauga	13.0	12.5	-0.5	-4%
371910005	North Carolina	Wayne	15.8	15.4	-0.4	-3%
450190048	South Carolina	Charleston	16.3	15.8	-0.5	-3%
450190049	South Carolina	Charleston	15.9	15.3	-0.6	-4%
450250001	South Carolina	Chesterfield	15.5	15.1	-0.4	-3%
450370001	South Carolina	Edgefield	16.9	16.3	-0.6	-4%
450410003	South Carolina	Florence	18.4	18.0	-0.4	-2%
450450009	South Carolina	Greenville	18.1	17.6	-0.5	-3%
450450015	South Carolina	Greenville	19.3	19.0	-0.3	-2%
450630008	South Carolina	Lexington	19.0	18.6	-0.4	-2%

Table 4-3. Comparison of CAMx 6.40 2028elv3 and 2028elv5 Predicted Daily (24-Hour) $PM_{2.5}$ Design Values (µg/m^3) for FRM Monitors in VISTAS States

Monitor	State	County	2028 Daily (24-Hr) $PM_{2.5}$ Design Value (µg/m^3)			
			2028elv3	2028elv5	Difference	Percent Difference
450790019	South Carolina	Richland	19.4	18.9	-0.5	-3%
450830011	South Carolina	Spartanburg	17.4	16.8	-0.6	-3%
470650031	Tennessee	Hamilton	18.6	18.0	-0.6	-3%
470651011	Tennessee	Hamilton	17.0	16.4	-0.6	-4%
470654002	Tennessee	Hamilton	16.7	16.3	-0.4	-2%
510030001	Virginia	Albemarle	13.8	12.8	-1.0	-7%
510360002	Virginia	Charles	13.9	12.9	-1.0	-7%
510410003	Virginia	Chesterfield	15.5	14.8	-0.7	-5%
510590030	Virginia	Fairfax	18.0	17.3	-0.7	-4%
510690010	Virginia	Frederick	18.6	17.9	-0.7	-4%
510870014	Virginia	Henrico	16.1	15.3	-0.8	-5%
510870015	Virginia	Henrico	14.1	13.1	-1.0	-7%
511071005	Virginia	Loudoun	16.5	16.1	-0.4	-2%
511390004	Virginia	Page	16.1	15.0	-1.1	-7%
511650003	Virginia	Rockingham	17.7	17.2	-0.5	-3%
515200006	Virginia	Bristol City	16.2	15.6	-0.6	-4%
516500008	Virginia	Hampton City	14.9	14.0	-0.9	-6%
516800015	Virginia	Lynchburg City	13.9	13.2	-0.7	-5%
517100024	Virginia	Norfolk City	15.7	14.9	-0.8	-5%
517700015	Virginia	Roanoke City	16.9	16.2	-0.7	-4%
517750011	Virginia	Salem City	15.0	14.4	-0.6	-4%
518100008	Virginia	Virginia Beach City	16.8	16.3	-0.5	-3%
540030003	West Virginia	Berkeley	23.5	22.8	-0.7	-3%
540090005	West Virginia	Brooke	19.2	18.3	-0.9	-5%
540110006	West Virginia	Cabell	18.8	18.0	-0.8	-4%
540291004	West Virginia	Hancock	20.5	19.5	-1.0	-5%
540390010	West Virginia	Kanawha	17.0	16.1	-0.9	-5%
540391005	West Virginia	Kanawha	18.6	17.9	-0.7	-4%
540490006	West Virginia	Marion	19.3	18.6	-0.7	-4%
540511002	West Virginia	Marshall	23.3	22.6	-0.7	-3%
540610003	West Virginia	Monongalia	17.1	16.4	-0.7	-4%
540690010	West Virginia	Ohio	17.9	17.0	-0.9	-5%
540810002	West Virginia	Raleigh	14.3	13.5	-0.8	-6%
541071002	West Virginia	Wood	18.6	17.7	-0.9	-5%

Daily $PM_{2.5}$ Design Value – VISTAS12 Domain

CAMx 6.40 2028elv5



Daily $PM_{2.5}$ Design Value Reduction (2028elv3 – 2028elv5)

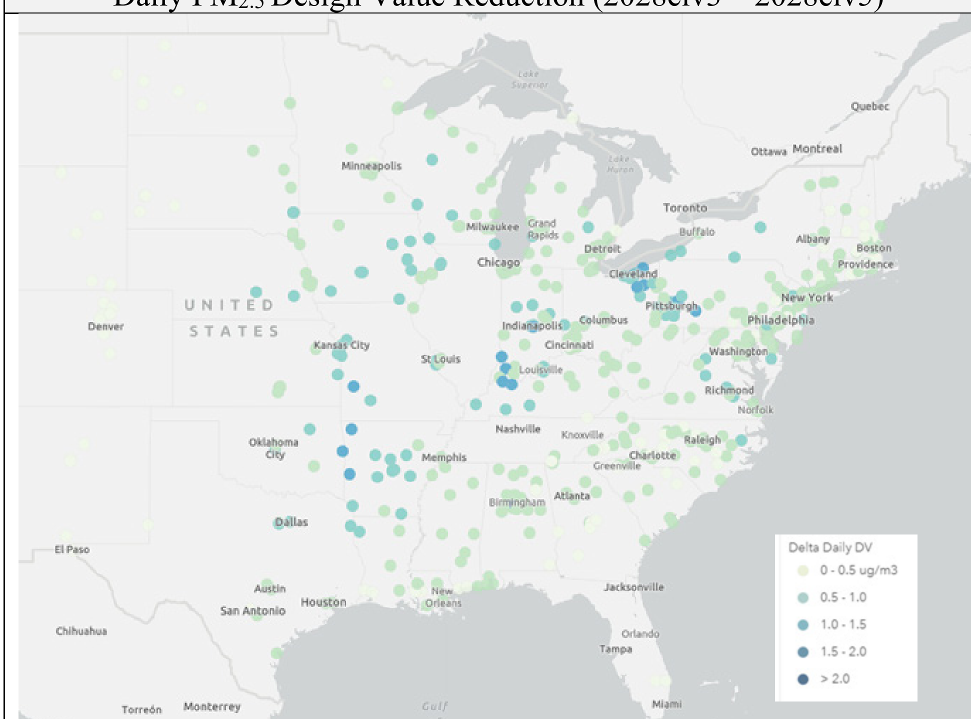


Figure 4-18. Comparison of Daily $PM_{2.5}$ Design Values ($\mu g/m^3$) for CAMx 6.40 2028elv5 and 2028elv3 Simulations

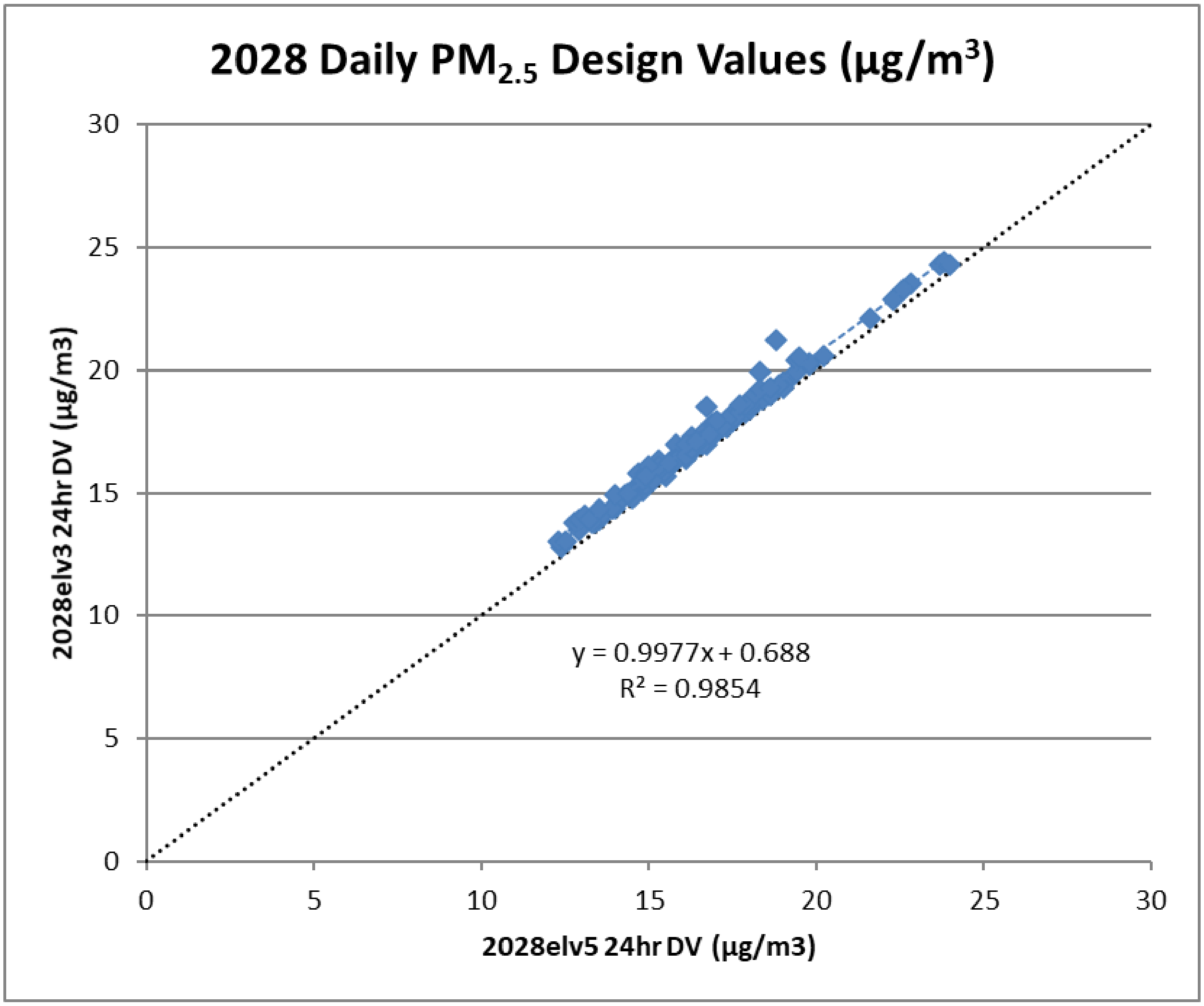


Figure 4-19. Scatterplot Comparing Daily (24-hr) Average Predicted $PM_{2.5}$ Design Values ($\mu g/m^3$) at all Monitor Locations for CAMx 6.40 2028elv3 and 2028elv5 Simulations Performed by VISTAS (Alpine)

4.4 Scatterplots of Ozone and PM Species Concentrations

Scatterplots of the daily average concentrations of ozone and the various calculated PM species in local standard time at the Interagency Monitoring for Protected Visual Environment (IMPROVE) monitors across all modeled days are presented in Figures 4-20 through 4-26. The CAMx 6.40 20282elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis.

Figure 4-20 exhibits concentrations for ozone with a line of best fit with a slope of 1.0147, an intercept of -0.3588 ppb and an R^2 of 0.9986. Results are scattered both above and below the 1:1 line, with marginally higher concentrations estimated by CAMx 6.40 2028elv3 across the concentration range.

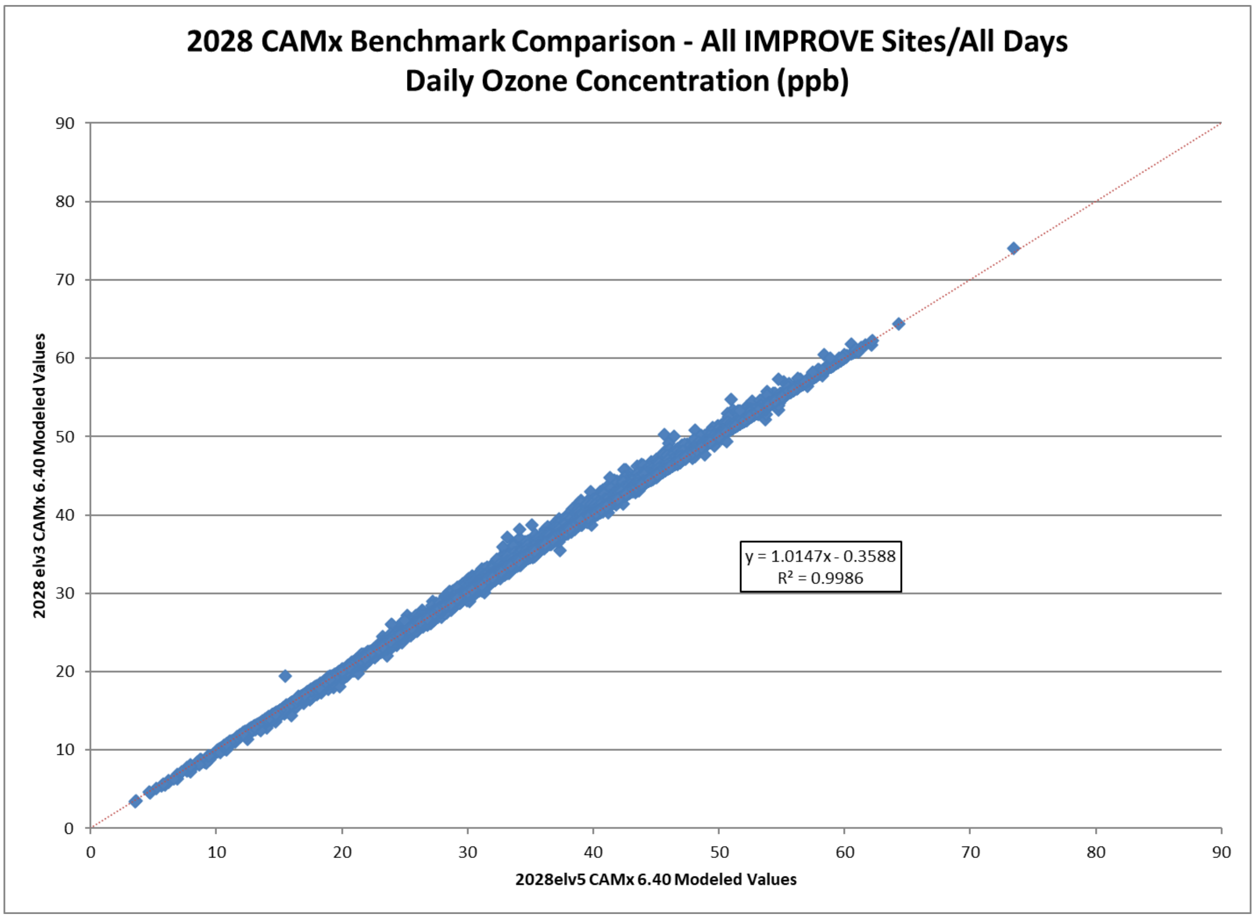


Figure 4-20. Scatterplot Comparing 24-hour Average Predicted Ozone Concentrations (ppb) for All Days at all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine)

Scatterplots of the daily average $PM_{2.5}$ concentrations in local standard time at the IMPROVE monitors are presented in Figures 4-21 and 4-22 with different axis scaling to facilitate analysis over the full range of concentrations. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis. The data has a line of best fit with a slope of 1.0197, an intercept of 0.0652 μg/m^{3}and an R^2 of 0.9978. As expected with the change in emissions, 2028elv5 predicts lower concentrations across most locations in the domain although a few sites at lower concentrations (< 20 μg/m^3) show significantly higher concentrations with 2028elv5. These are largely associated with increased NO_X (and NO_3) emissions from changes made in the 2028elv5 inventory compared to modeled 2028elv3.

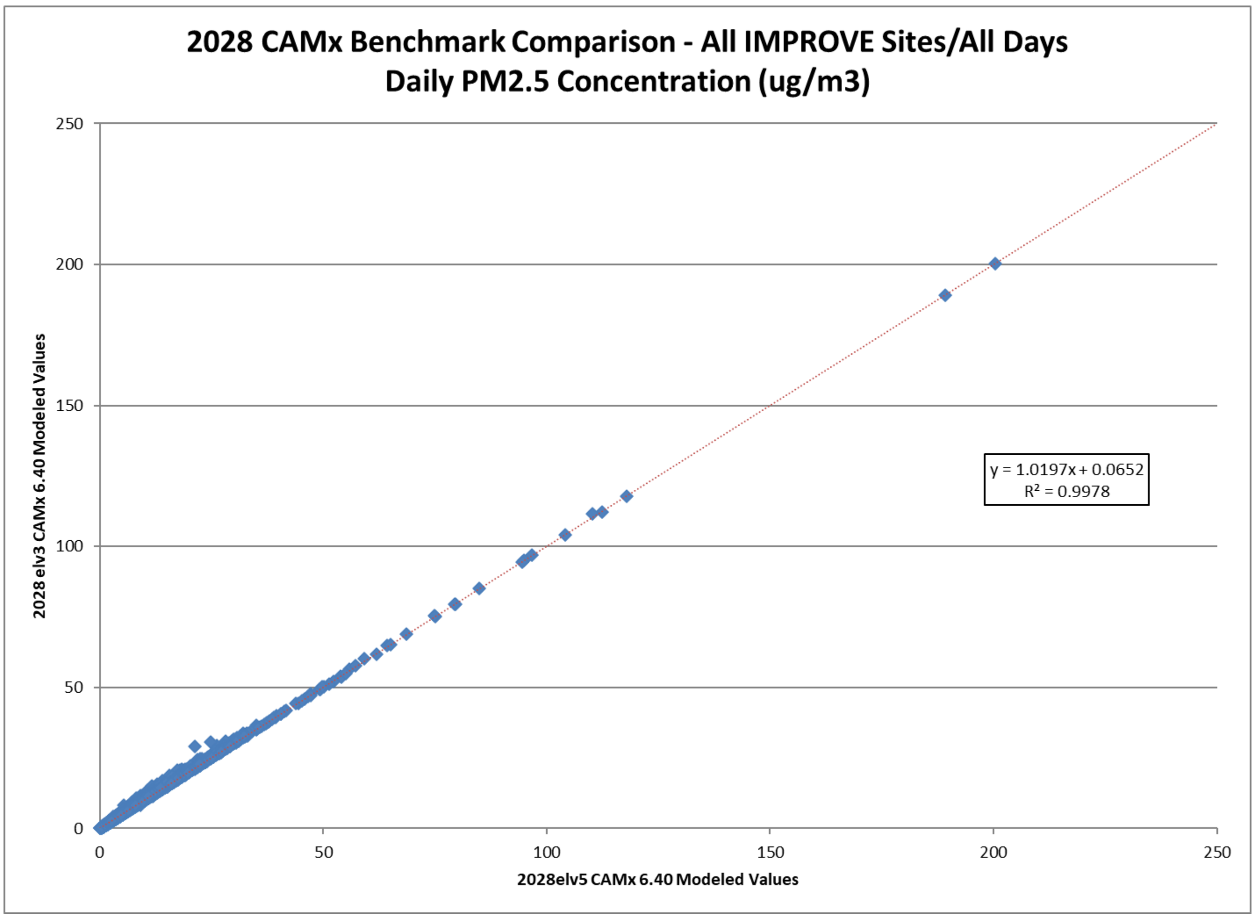


Figure 4-21. Scatterplot Comparing 24-hour Average Predicted $PM_{2.5}$ Concentrations (μg/m^3) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine)

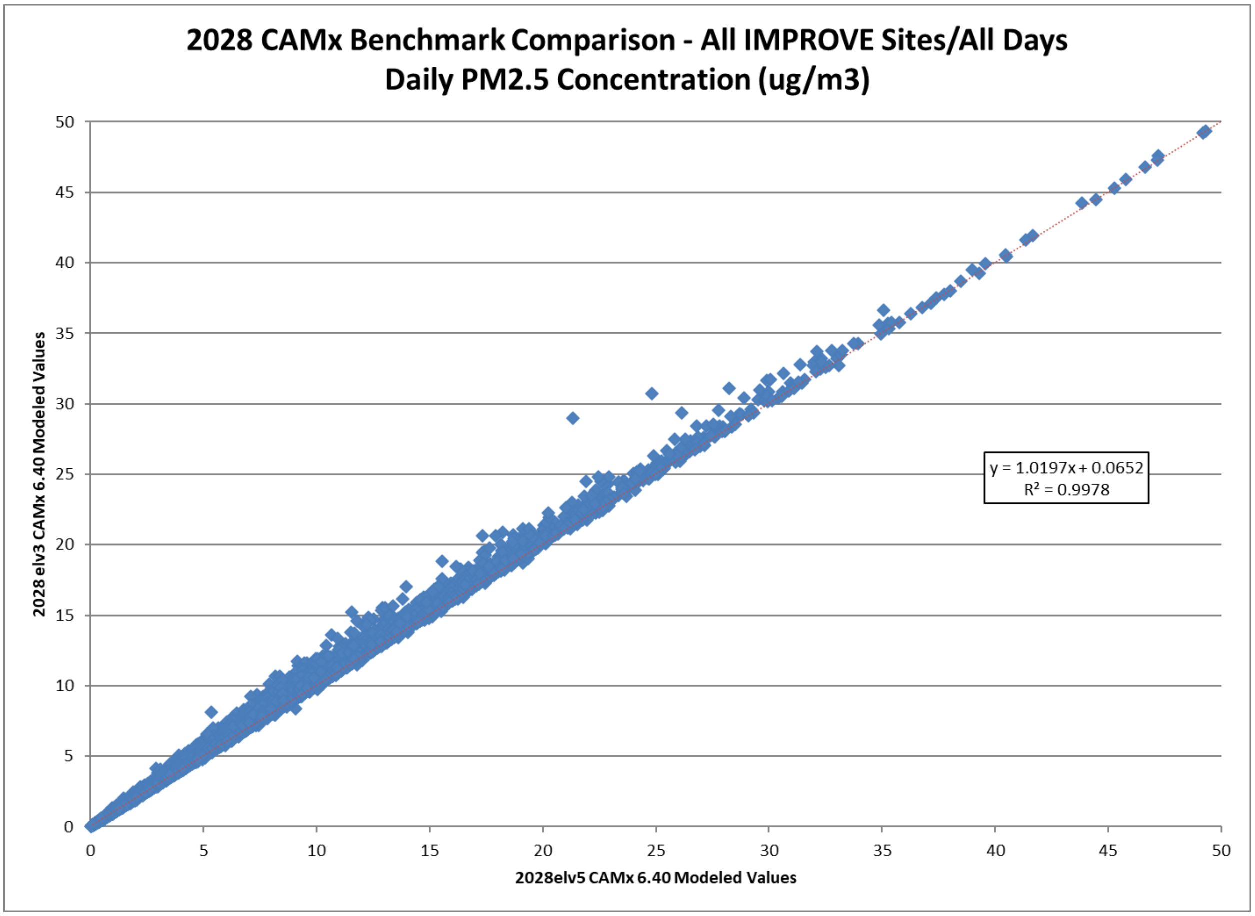


Figure 4-22. Scatterplot Comparing 24-hour Average Predicted $PM_{2.5}$ Concentrations ($\mu g/m^3$) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine); Modified Scale

Scatterplots of the daily average sulfate concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-23. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis. The data have a line of best fit with a slope of 1.156, an intercept of -0.0317 μg/m^3 and an R^2 of 0.9572. As expected with the change in emissions, 2028elv5 predicts lower concentrations across most locations.

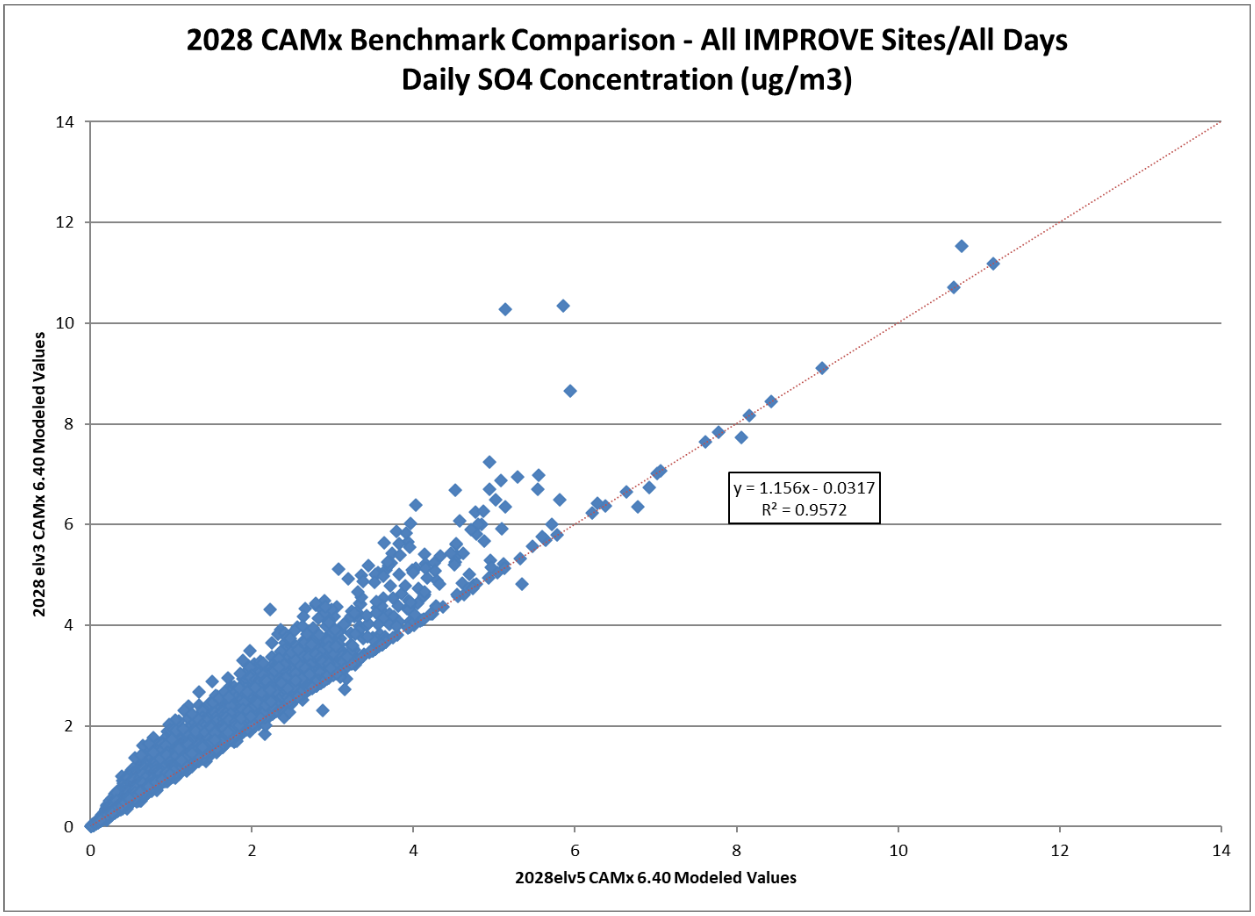


Figure 4-23. Scatterplot Comparing 24-hour Average Predicted Sulfate Concentrations (μg/m^3) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine)

Scatterplots of the daily average nitrate concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-24. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis. The data have a line of best fit with a slope of 1.0141, an intercept of -0.0007 μg/m^3 and an R^2 of 0.9975. As expected with the change in NOx emissions, 2028elv5 predicts lower concentrations across many locations. However, many other locations show higher nitrate concentrations. This is likely due to the decrease in sulfate formation (see Figure 4-23) resulting in more available free ammonia that can be used to form additional ammonium nitrate.

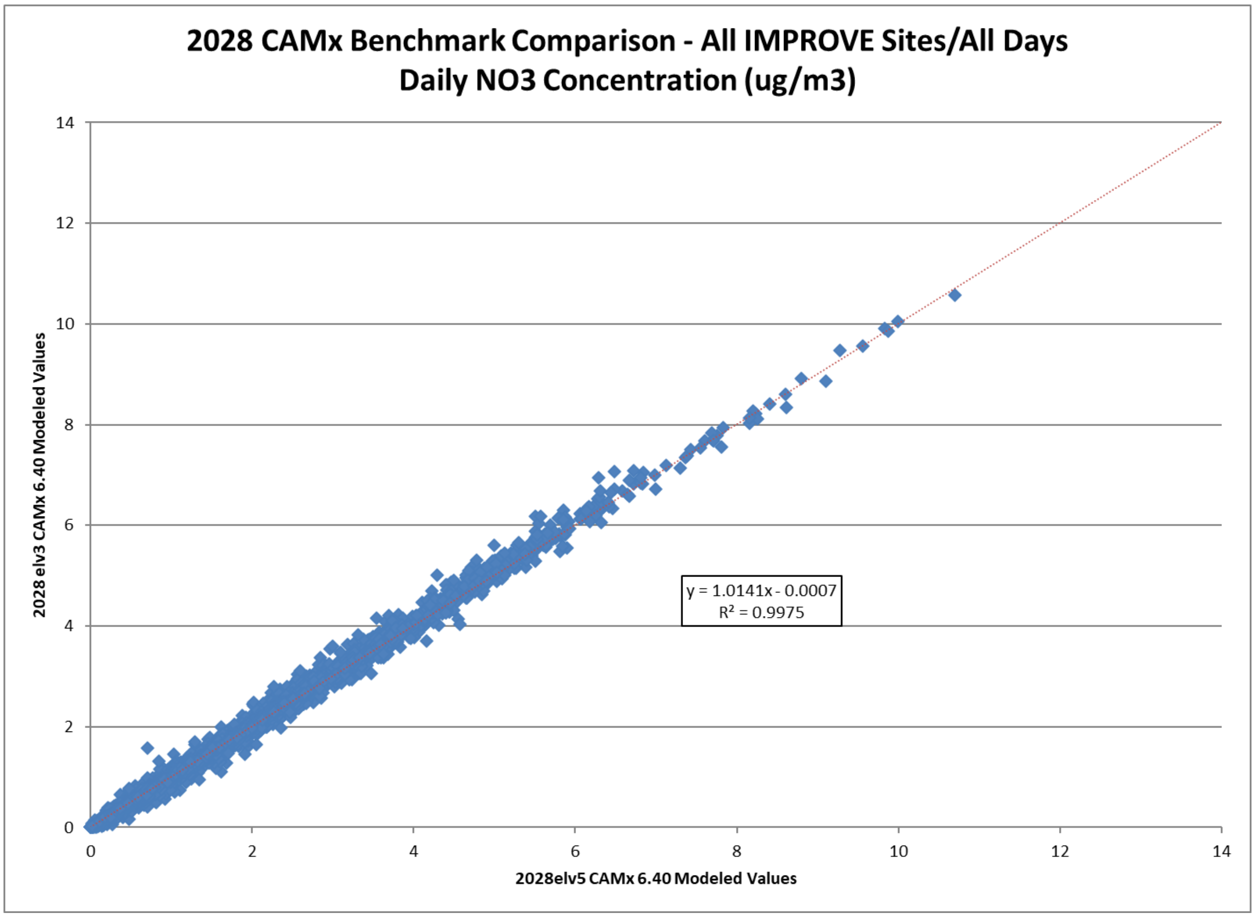


Figure 4-24. Scatterplot Comparing 24-hour Average Predicted Nitrate Concentrations (μg/m^3) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine)

Scatterplots of the daily average organic carbon concentrations in local standard time at the IMPROVE monitors are presented in Figures 4-24 and 4-25 with different axis scaling to facilitate analysis over the full range of concentrations. The CAMx 6.40 2028elv5 results are plotted on the x-axis and the 2028elv3 results are plotted on the y-axis. The data have a line of best fit with a slope of 1.0012, an intercept of 0.0017 ppb and an R^2 of 1.000. The two simulations show nearly identical results for organic carbon.

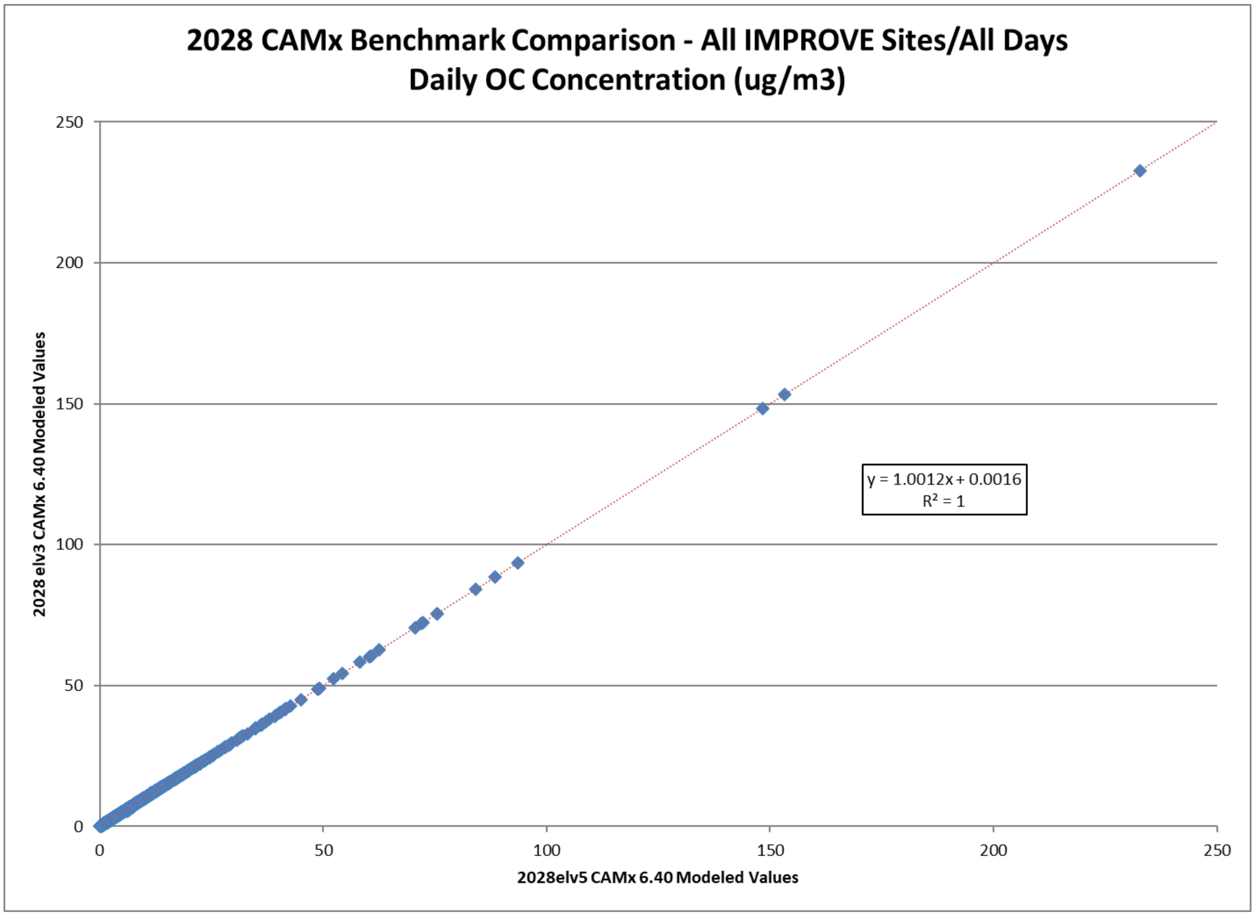


Figure 4-25. Scatterplot Comparing 24-hour Average Predicted Organic Carbon Concentrations (µg/m³) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine)

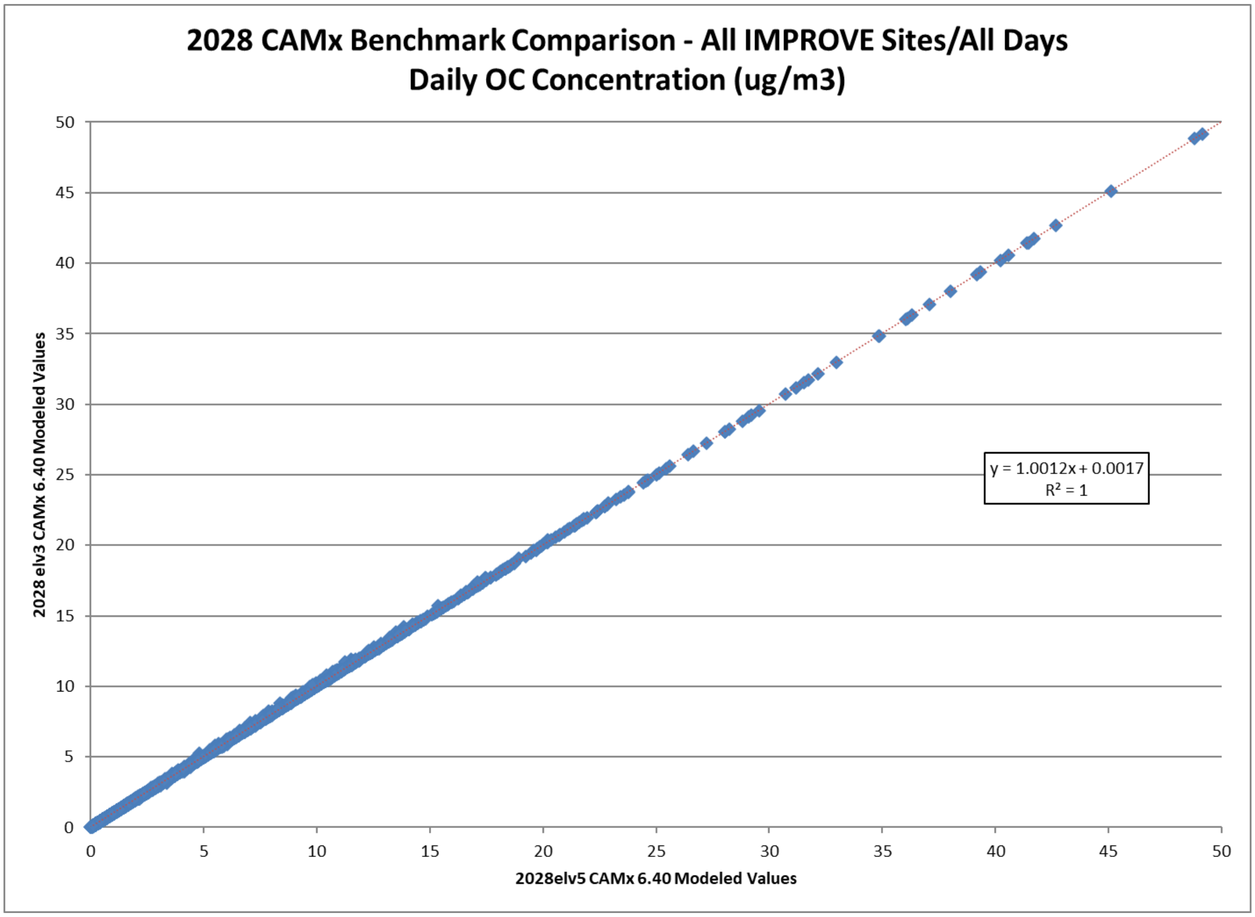


Figure 4-26. Scatterplot Comparing 24-hour Average Predicted Organic Carbon Concentrations (μg/m^3) for All Days all IMPROVE Monitor Locations for CAMx 6.40 2028elv5 and 2028elv3 Simulations Performed by VISTAS (Alpine); Modified Scale

5.0 CONCLUSIONS

A comparison has been made between modeled CAMx 6.40 2028elv5 and 2028elv3 simulations as performed on the Alpine Geophysics computer system. The comparison was conducted for $PM_{2.5}$ and included an examination both of annual emissions for elevated and low level sources and annual and daily future year design values at monitors in the modeling domain.

The annual emissions comparisons showed areas of differences across the domain that are consistent with changes in the modeled 2028 emissions inventories used for this analysis. A comparison of the annual and daily $PM_{2.5}$ design values at the monitors in the VISTAS12 modeling domain showed a systematic decrease for all FRM monitors for both values between the modeled 2028elv3 and 2028elv5 platforms. The greatest change in design values are seen in the central regions of the VISTAS12 modeling domain with smallest change noted along the borders of the domain itself.

A comparison of the daily average concentrations at the IMPROVE monitors showed fairly small differences for ozone between the two simulations with CAMx 6.40 2028elv5 estimating slightly lower values across most of the concentration range. Because of the changes in emissions between the modeled 2028elv3 and 2028elv5 modeling platforms, $PM_{2.5}$ and sulfate generally decreased. Nitrate concentrations showed decreases at some sites and increases at others. Organic carbon concentrations are nearly identical with the modeled 2028elv3 and 2028elv5 emissions.

The comparison of modeled CAMx 6.40 2028elv3 and 2028elv5 showed differences in both annual and daily $PM_{2.5}$ design values as well as in daily concentrations of various $PM_{2.5}$ species. This is to be expected given the changes made in the modeled 2028 projection emission inventory across the modeling domain. Alpine Geophysics does not see any features in the modeling that would preclude the use of the updated emission inventories in CAMx 6.40 2028elv5 platform for use in the VISTAS air quality planning.

Appendix A

Task 6 – Benchmark Run #7 Report Review and 2028 elv3 Reassessment

(see APP_A_ELV3_REASSESSMENT.zip)

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