west virginia department of environmental protection

Appendix E-2a

Regional Haze Modeling for Southwestern VISTAS II Regional Haze Analysis Project 2011el and 2028el CAMx Benchmarking Report

Benchmark Runs #1 and #2

August 17, 2020

West Virginia Division of Air Quality
601 57th Street, SE
Charleston, WV 25304

Promoting a healthy environment.

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Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project
2011el and 2028el CAMx Benchmarking Report

Task 6 Benchmark Report #1
Covering Benchmark Runs #1 and #2

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1.0 EPA 2011 AND 2028 BASE CASE CONFIRMATION

Alpine has executed two confirmation runs, one for the 2011el base year and one for the 2028el base case, to confirm the contract team's ability to replicate EPA's results and to ensure that the EPA data, models, and scripts operated in a consistent manner as EPA's procedure.

The data for this analysis are paired in space and time, meaning that each plot represents a comparison of the two simulations at the same monitor on the same day. Although there is some variability between the two runs, the runs are not expected to be exactly the same due to numerical differences that arises from the different computing architectures used for the U.S. EPA and Alpine simulations. The numerics in photochemical grid models are very complex and it is typical to get slightly different model concentrations based on the version of the computer and compilers. When comparing simulations, it is critical to isolate the changes in concentrations to the changes in the model inputs, and not on the computing details (i.e., compiler version, computer architecture, parallelization options). This is especially problematic when looking at particulate matter, since the particulate treatments have multiple pathways, and small concentration differences can lead to different pathways through the code and different concentrations.

Sources of the difference can come from the options used in CAMx compilation, the version of the compiler, the compiler vendor, and how the model calculation is split onto different processors (parallelization).

2.0 DIFFERENCES BETWEEN EPA AND VISTAS SIMULATIONS

EPA ran the 2011v6.3el platform on EPA's supercomputer with the model configured to use four (4) processor nodes with 16 processors per node. The use of multiple processor nodes with multiple processors per node is efficient on the EPA supercomputer due to the low latency interconnect between the nodes. On more typical computer clusters with the nodes interconnected with Ethernet, like the Alpine cluster and most likely the State and stakeholder clusters, the latency between nodes is sufficiently high that it is inefficient to spread processing between nodes. Our experience with the EPA platform has shown that on an Ethernet connected cluster with 12 Intel XEON processors per node and hyperthreading enabled it is most efficient to use a single node configured with 10 Message Passing Interface (MPI) instances, each with two OpenMP threads.

EPA used the Intel FORTRAN compiler. Alpine, and the CAMx developers, use the Portland Group (PGI) FORTRAN compiler. The PGI compiler has been the standard compiler for CAMx applications for many years and it's anticipated this compiler will be more widely used by the States and stakeholders. The version of CAMx 6.32 EPA distributed with the 2011el platform will be recompiled on the Alpine computer system and used for the confirmation.

EPA ran the model in two time segments. The first segment, typically used only for PM applications, runs from December 22, 2010 through April 30, 2011. The second segment runs from April 21, 2011 through December 31, 2011. The VISTAS confirmation run used the same two segments. December 22-31, 2010 and the April portion of the second segment are spin-ups and are not analyzed due to overlap with the first segment.

3.0 CONFIRMATION METHODOLOGY

The comparison of simulations on the Alpine computer cluster and the EPA computer are based on hourly differences in ozone, particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), organic carbon (OC), Particulate Nitrate, and Particulate Sulfate. The metrics for comparison are the absolute difference (Equation 1) and percent difference (Equation 2) defined as:

(Equation 1) $$\left(C_{vistas} - C_{epa}\right)$$

(Equation 2) $$\frac{\left(C_{vistas} - C_{epa}\right)}{\left(C_{epa}\right)}$$

where: C_{epa} is the concentration at each grid cell hour for the EPA simulation and C_{vistas} is the concentration at each grid cell hour for the simulation on the Alpine computers.

The results are presented for the hours with the largest difference between the EPA and VISTAS simulations. A table presents the hours with the top 10 positive and negative absolute differences. Spatial maps are presented for the hours with the top 10 highest positive and negative differences. To provide context for the differences, the concentration maps are also presented for each of the hours of high difference. On each spatial plot 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.

Hourly animations have also been prepared and are available on the VISTAS II project ftp site. Where appropriate, this report also reports and interprets on the animations.

4.0 CAMX 6.32 2011EL COMPARISON

This section presents comparisons of the 2011el simulations using CAMx 6.32 performed on the Alpine and EPA computer systems.

4.1 Ozone

Ozone results for the top 10 positive and negative hours are presented in tabular format in Table 4-1. The maximum positive difference is 3.13 ppb falling to 2.01 ppb for the 10th high. The maximum negative difference is -2.65 ppb falling to -1.79 for the 10th high. The highest differences are occurring on relatively low ozone hours with concentrations ranging from 30 ppb to 51 ppb for the EPA simulation. The maximum positive and negative percent differences are both 7.4%.

The top ten positive impact hours are presented in Figures 4-1 through 4-10 and the top ten negative impact hours are presented in Figures 4-11 through 4-20. The locations of the impacts are very localized and have seemingly no spatial pattern. On the hours with the maximum impacts the overwhelming number of grid cells have impacts less than 0.01 ppb.

Scatterplots of the daily average ozone concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-21. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a near perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0001 ppb and an R2 of 1.0000.

Examination of the animations show that the differences appear suddenly over very limited areas, then the areas of difference disperse and travel downwind and become less than the 0.01 ppb plotting threshold typically within six (6) hours of forming.

Table 4-1. Comparison of 2011el CAMx 6.32 Simulation Ozone Concentrations (ppb) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (ppb)	Percent Difference	Column	Row
Maximum Positive									
2011	7	14	22	45.15	42.02	3.13	7.4%	292	77
2011	8	18	23	53.60	50.83	2.77	5.5%	286	152
2011	8	19	0	45.25	42.64	2.61	6.1%	286	152
2011	7	6	23	48.49	45.90	2.59	5.6%	197	156
2011	8	30	14	32.28	29.96	2.33	7.8%	110	217
2011	8	7	16	37.14	34.94	2.20	6.3%	257	103
2011	8	27	12	34.34	32.22	2.13	6.6%	295	143
2011	8	23	22	44.30	42.22	2.08	4.9%	323	47
2011	8	8	23	39.44	37.43	2.01	5.4%	217	184
2011	7	7	0	43.63	41.62	2.01	4.8%	197	156
Maximum Negative									
2011	8	16	0	33.32	35.96	-2.65	-7.4%	251	134
2011	7	15	21	48.71	51.16	-2.44	-4.8%	224	159
2011	8	15	23	36.83	39.27	-2.44	-6.2%	251	134
2011	6	18	22	33.70	36.07	-2.37	-6.6%	196	187
2011	6	26	22	34.14	36.40	-2.26	-6.2%	206	183
2011	7	7	16	39.38	41.34	-1.97	-4.8%	216	180
2011	8	11	18	35.28	37.21	-1.92	-5.2%	332	28
2011	3	30	10	42.23	44.13	-1.90	-4.3%	117	19
2011	7	16	19	48.28	50.08	-1.80	-3.6%	196	189
2011	6	18	23	32.77	34.57	-1.79	-5.2%	196	187

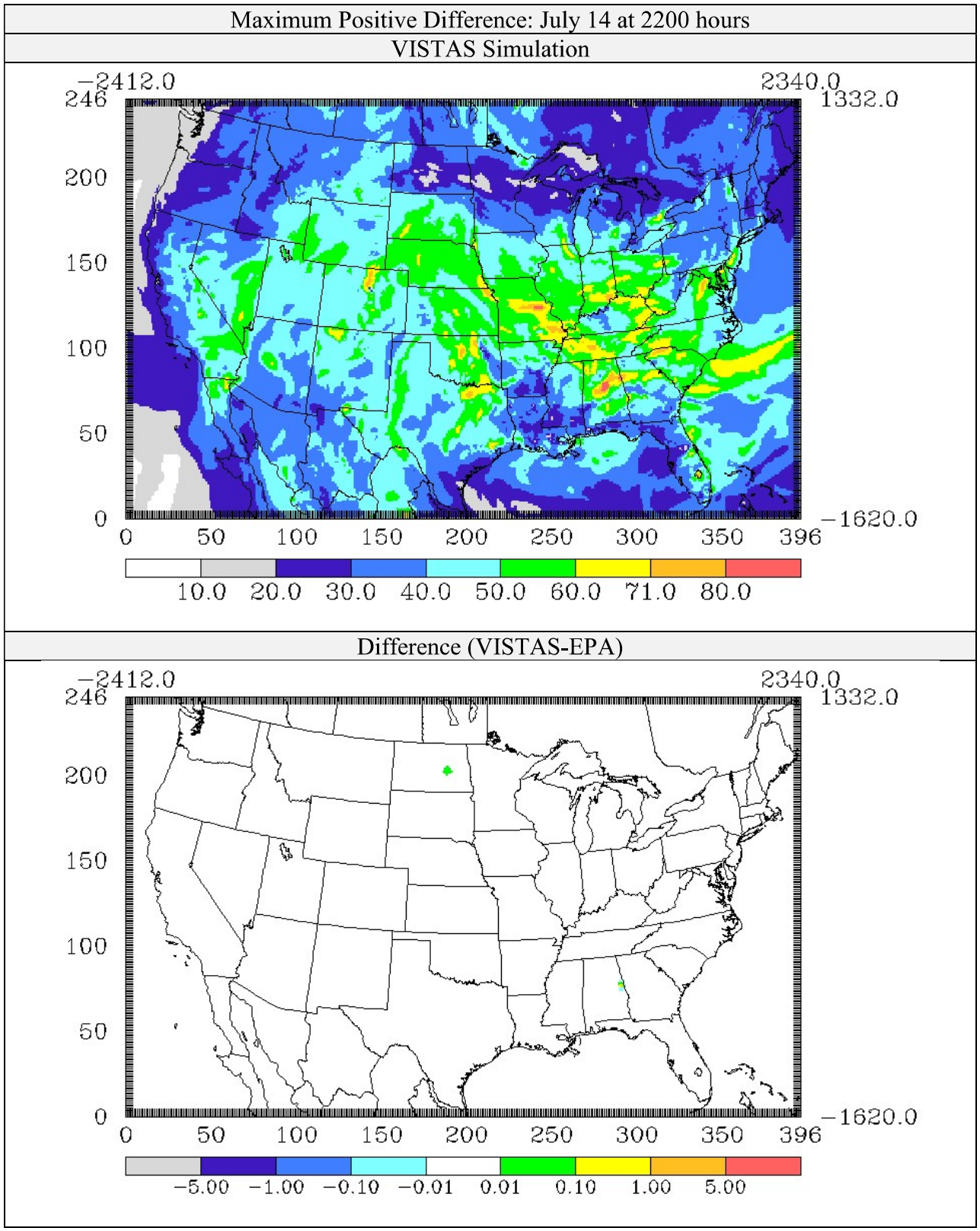

Figure 4-1: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)

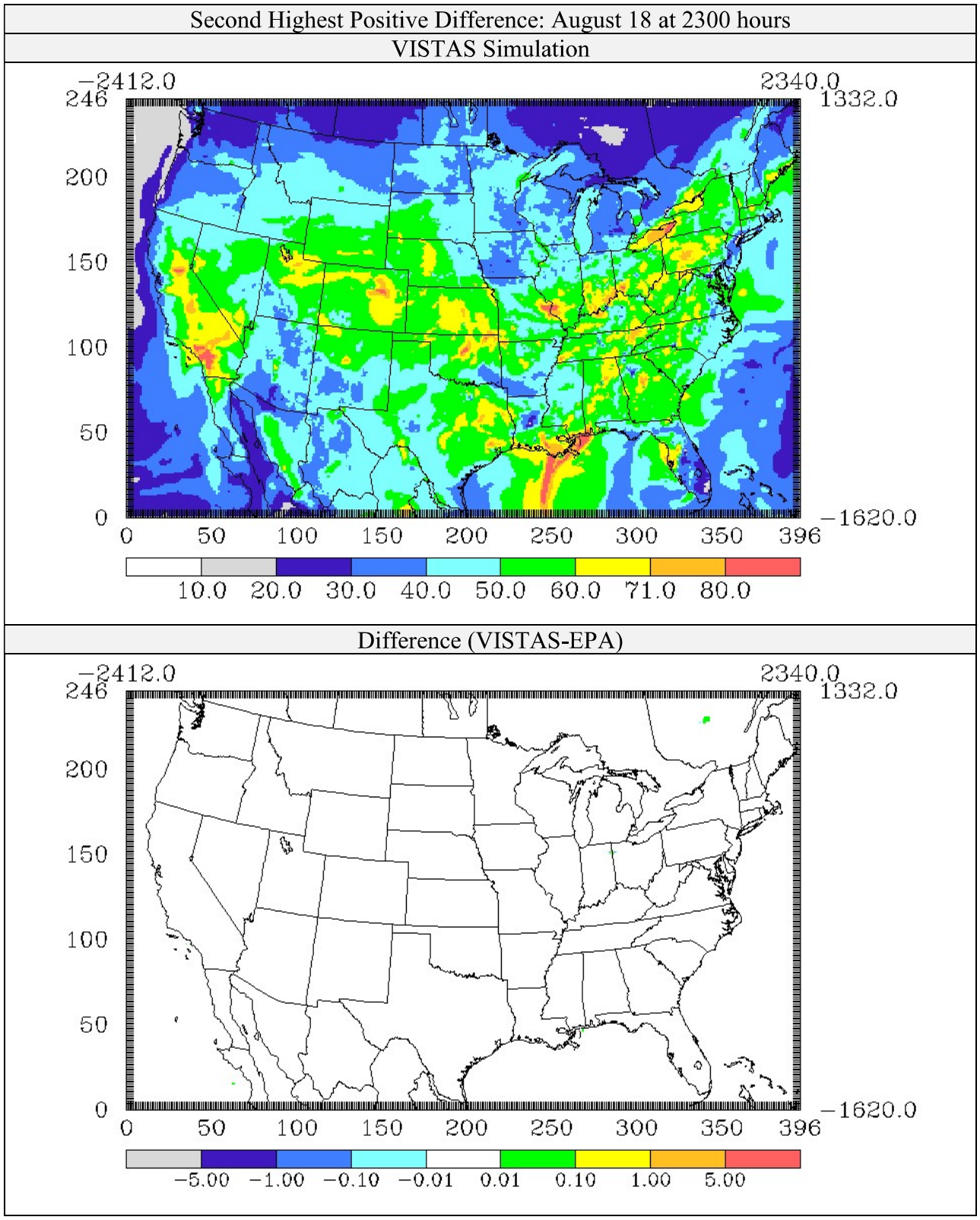

Figure 4-2: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)

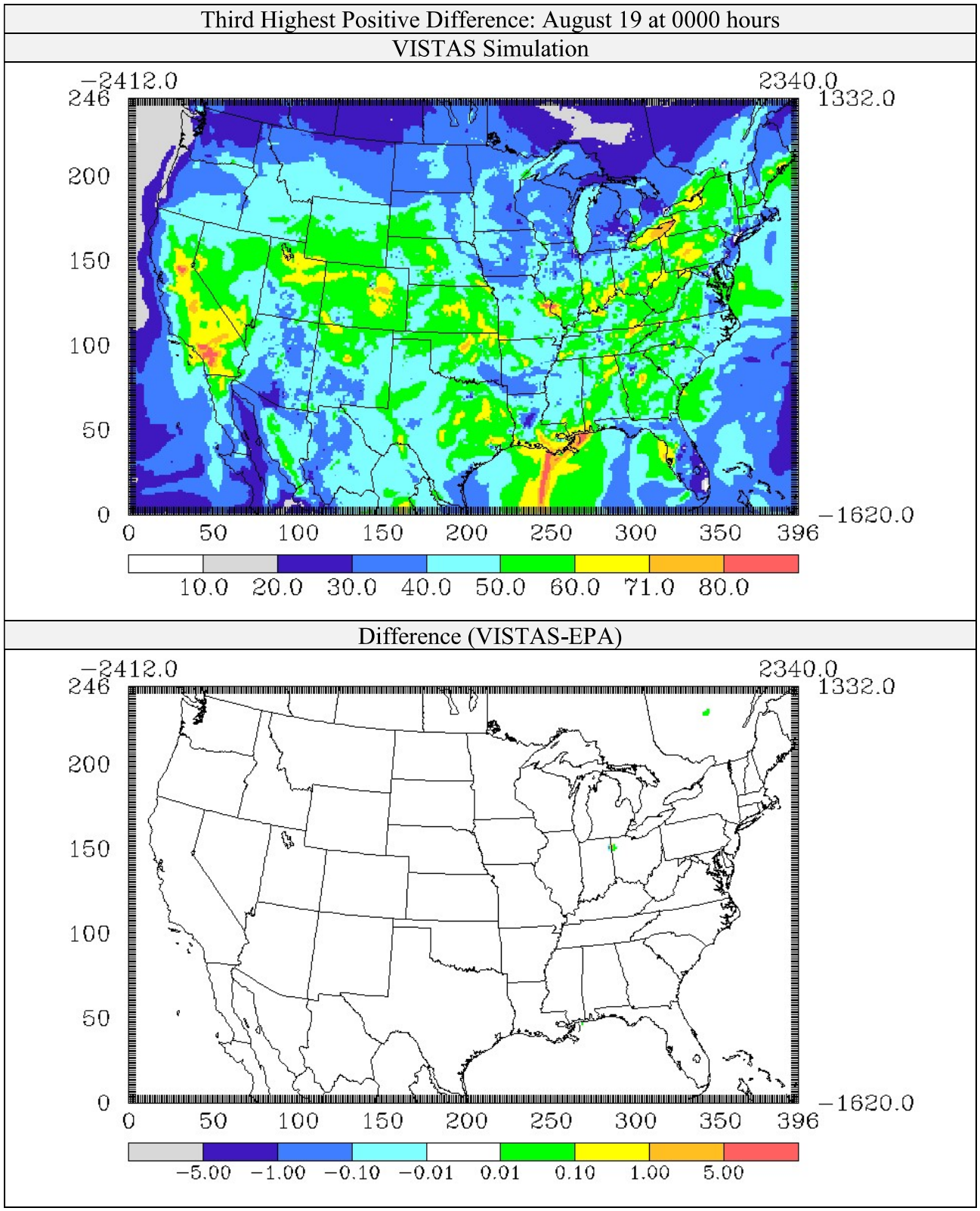

Figure 4-3: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)

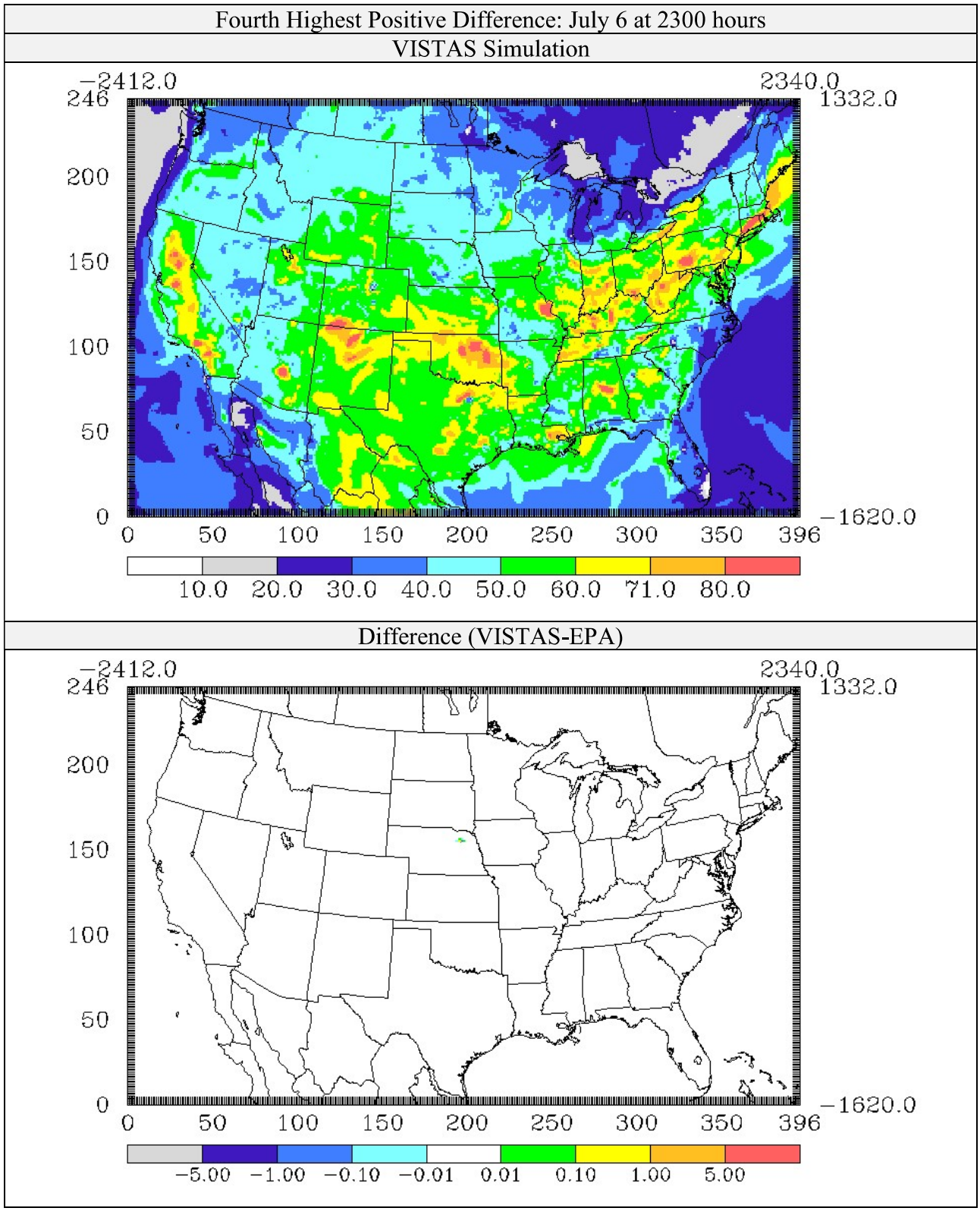

Figure 4-4: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)

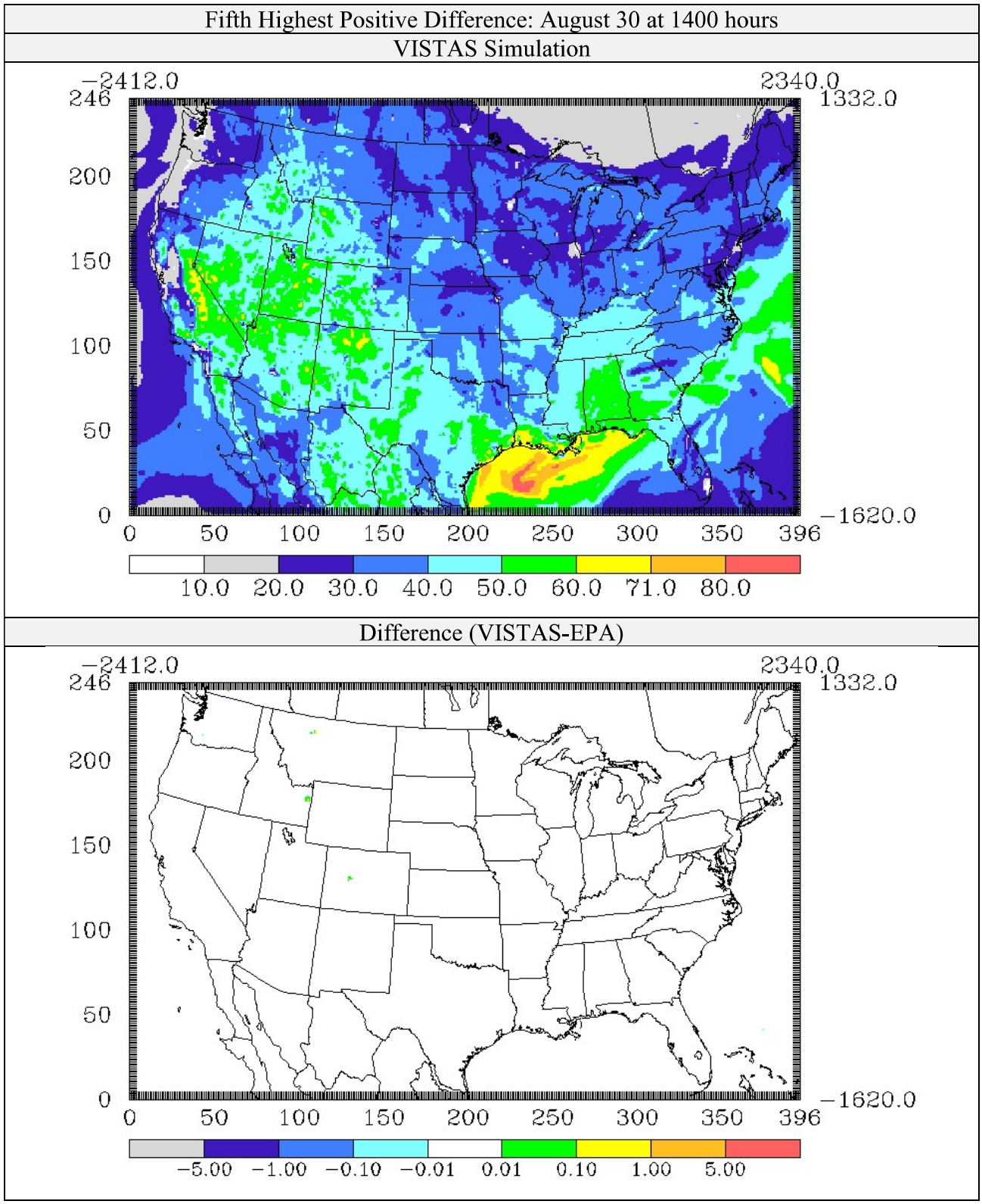

Figure 4-5: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)

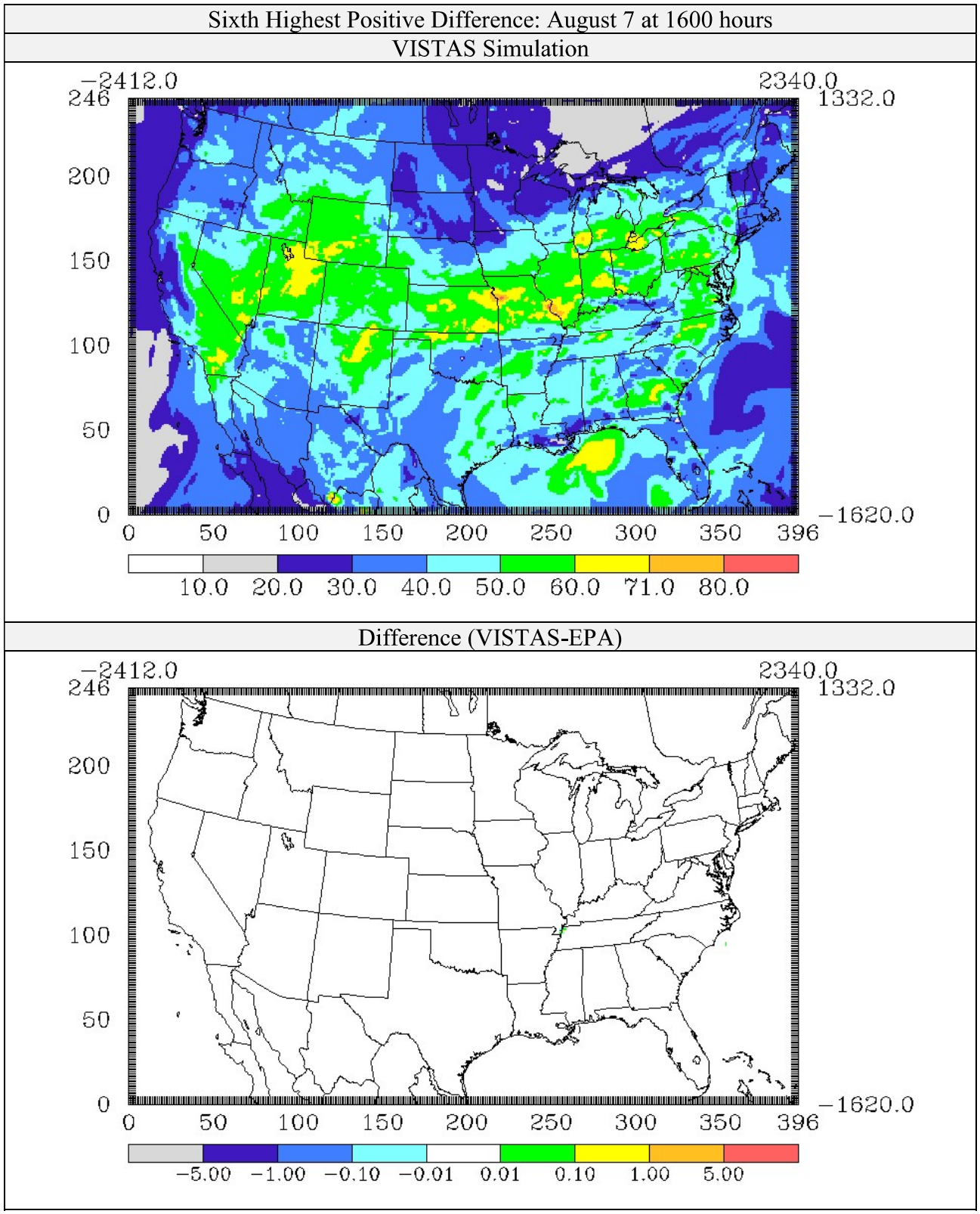

Figure 4-6: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)

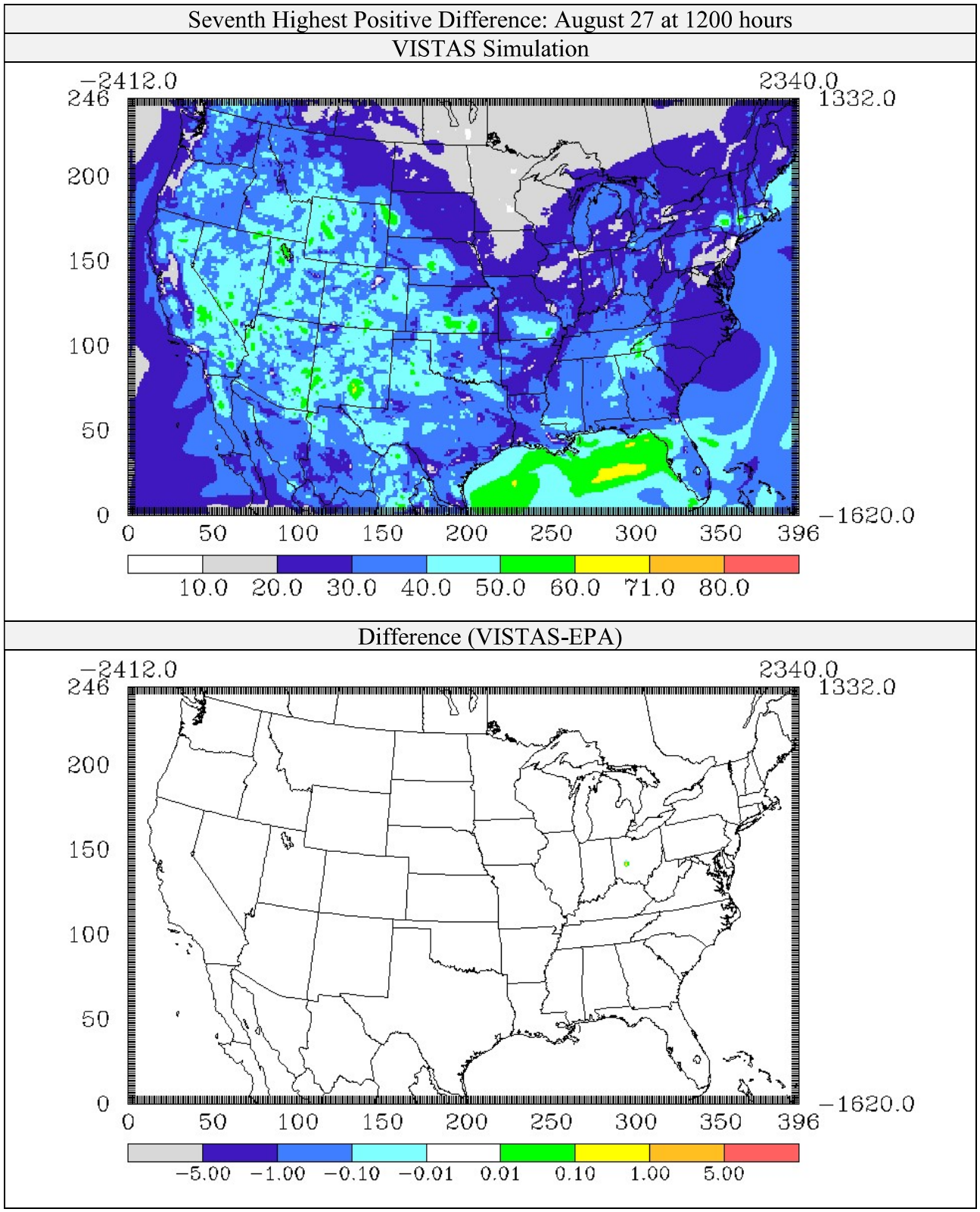

Figure 4-7: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)

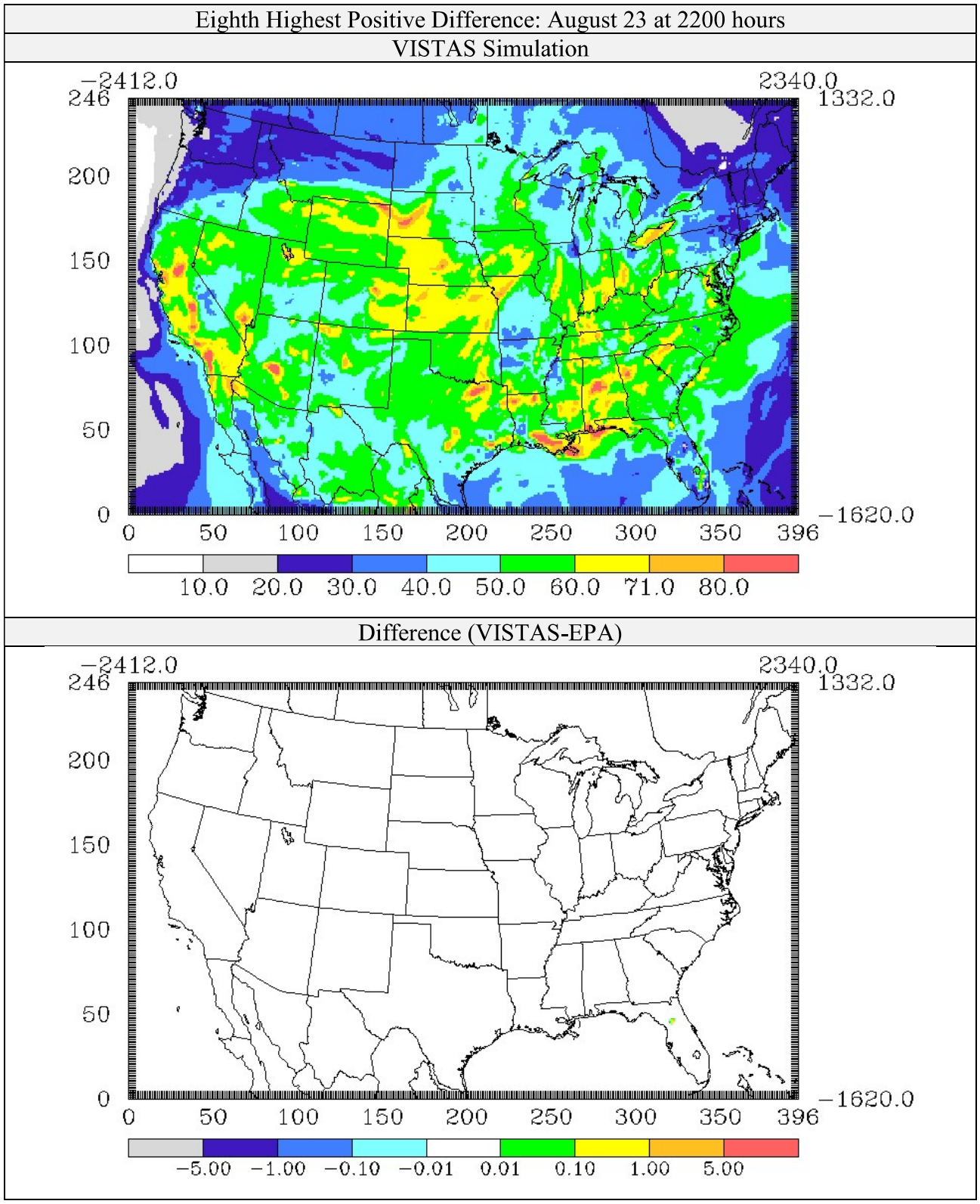

Figure 4-8: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)

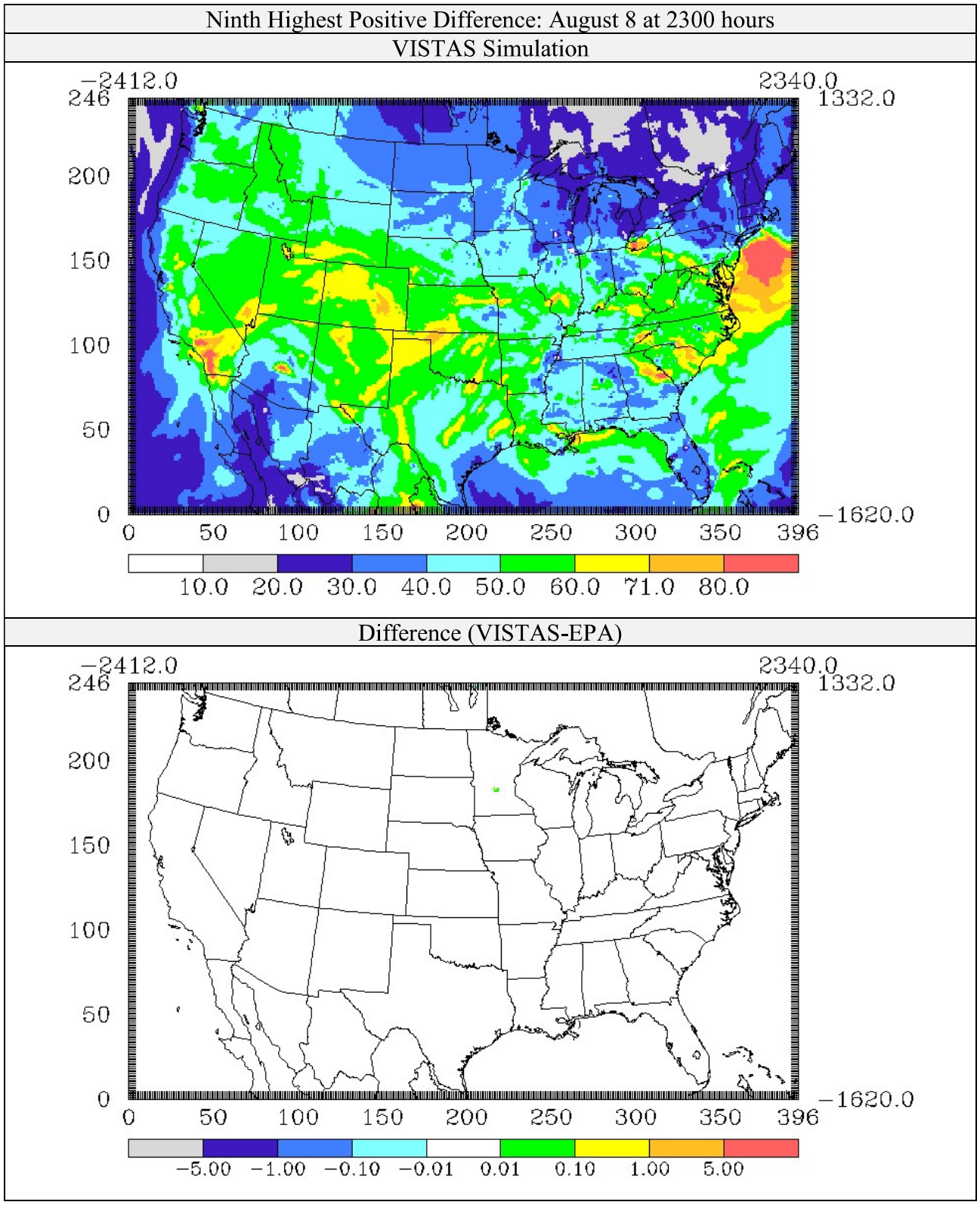

Figure 4-9: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)

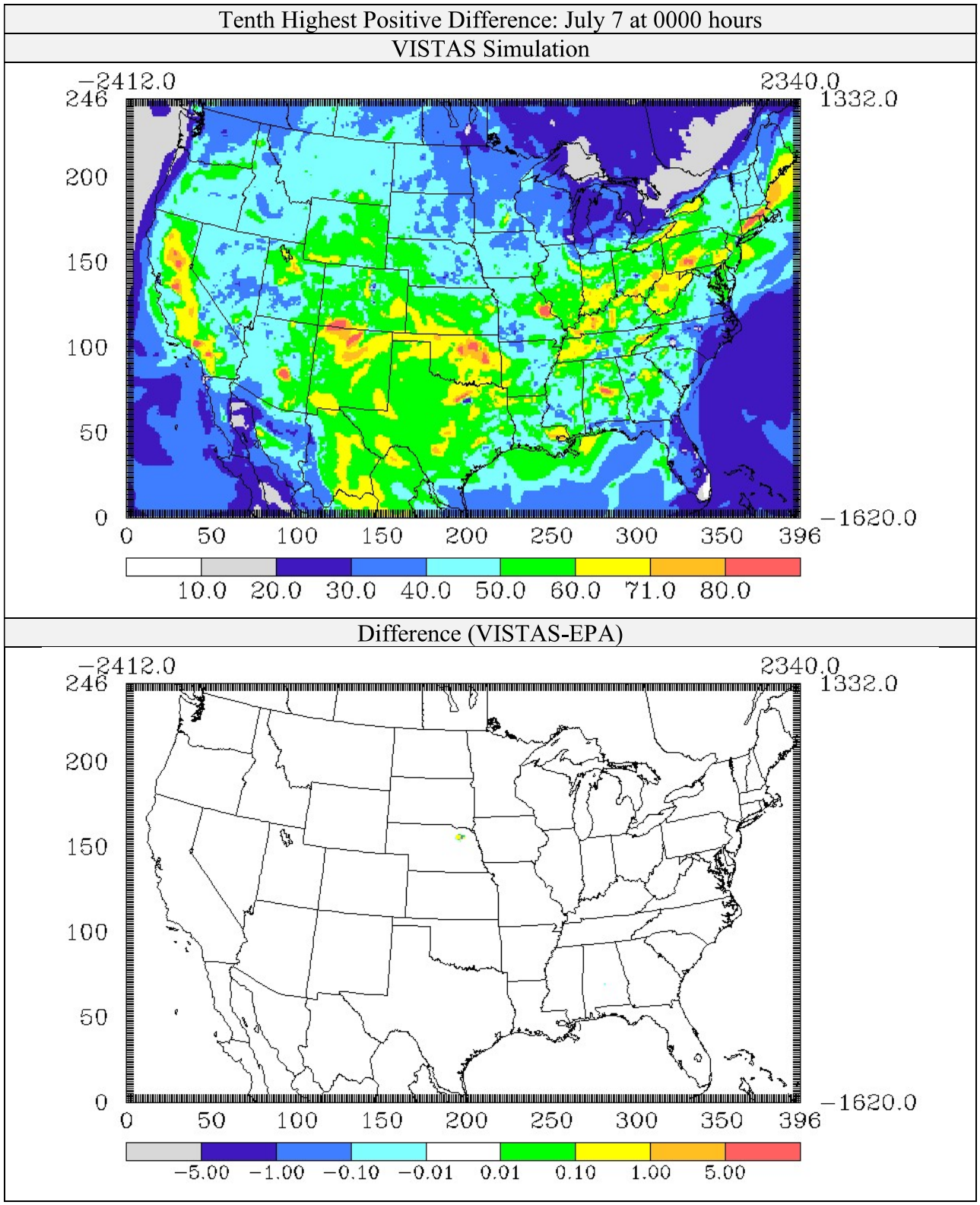

Figure 4-10: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)

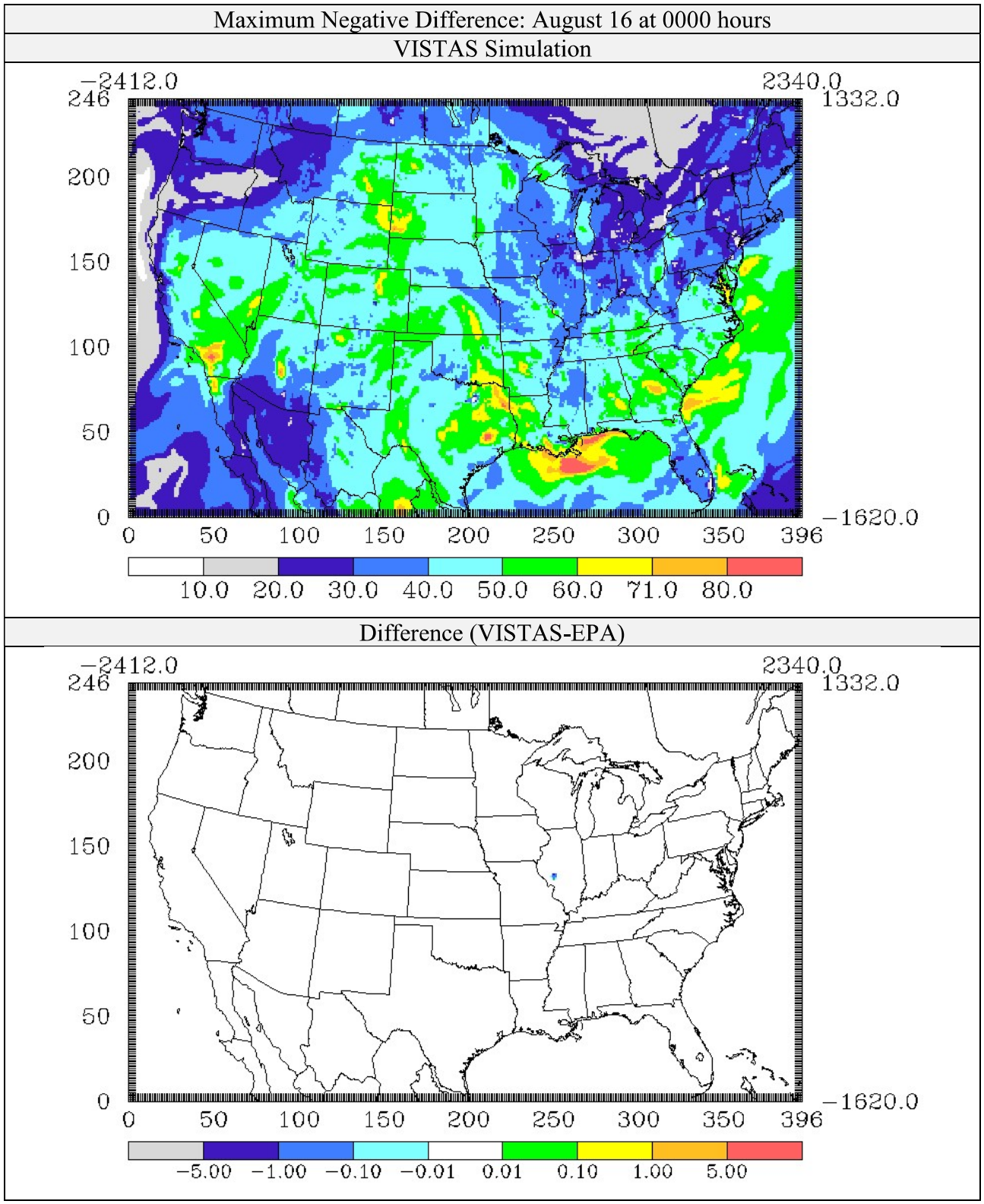

Figure 4-11: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)

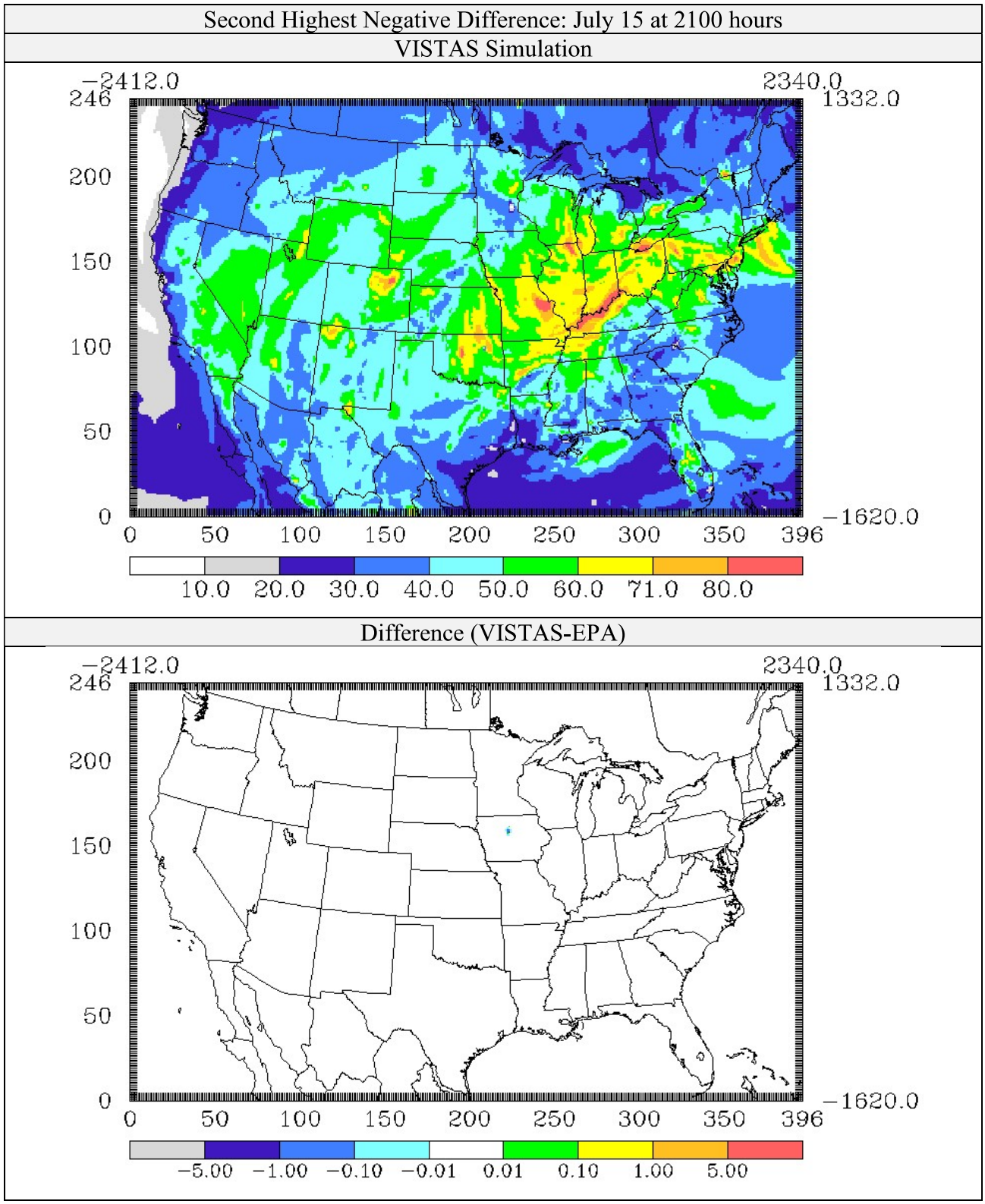

Figure 4-12: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)

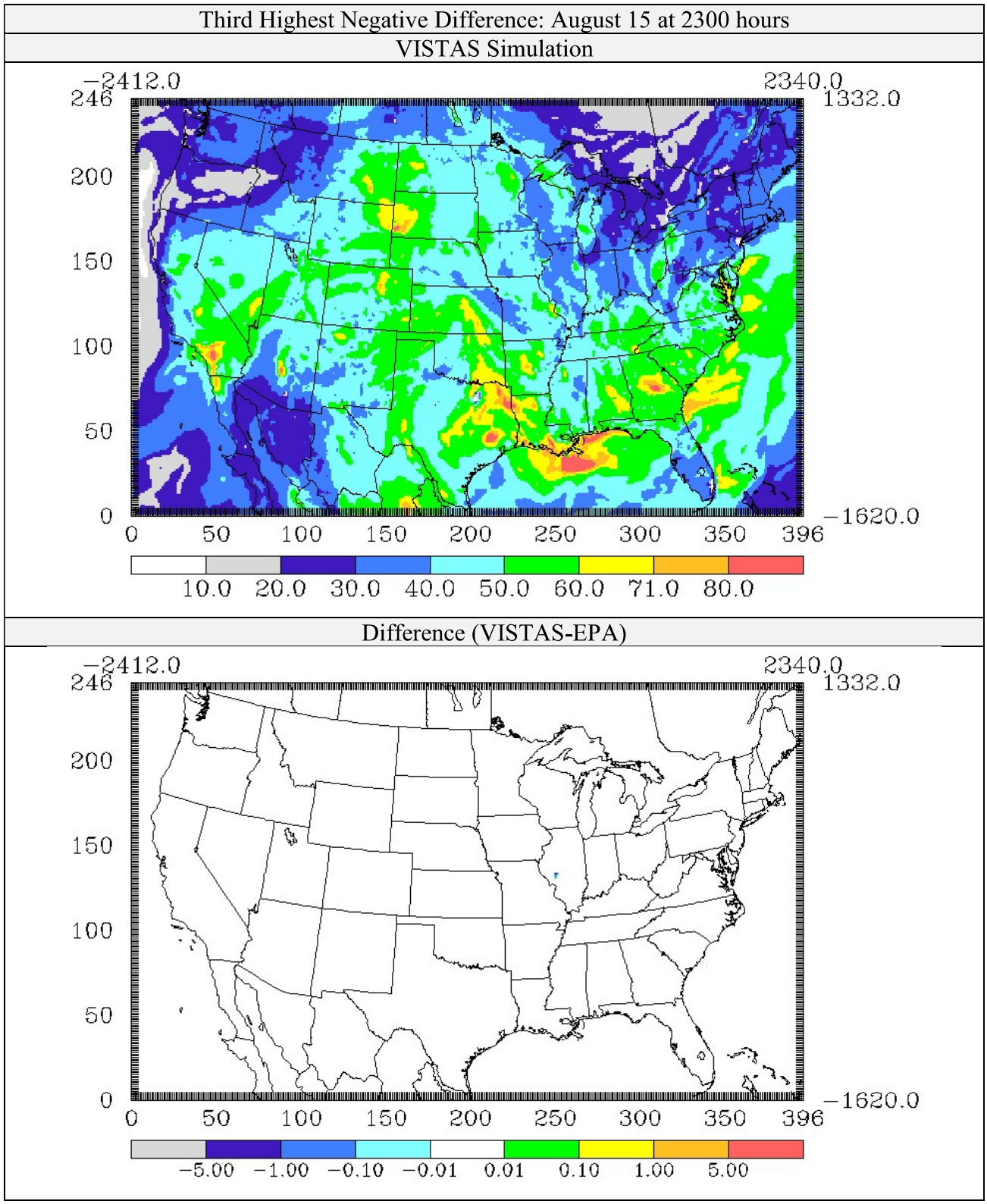

Figure 4-13: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)

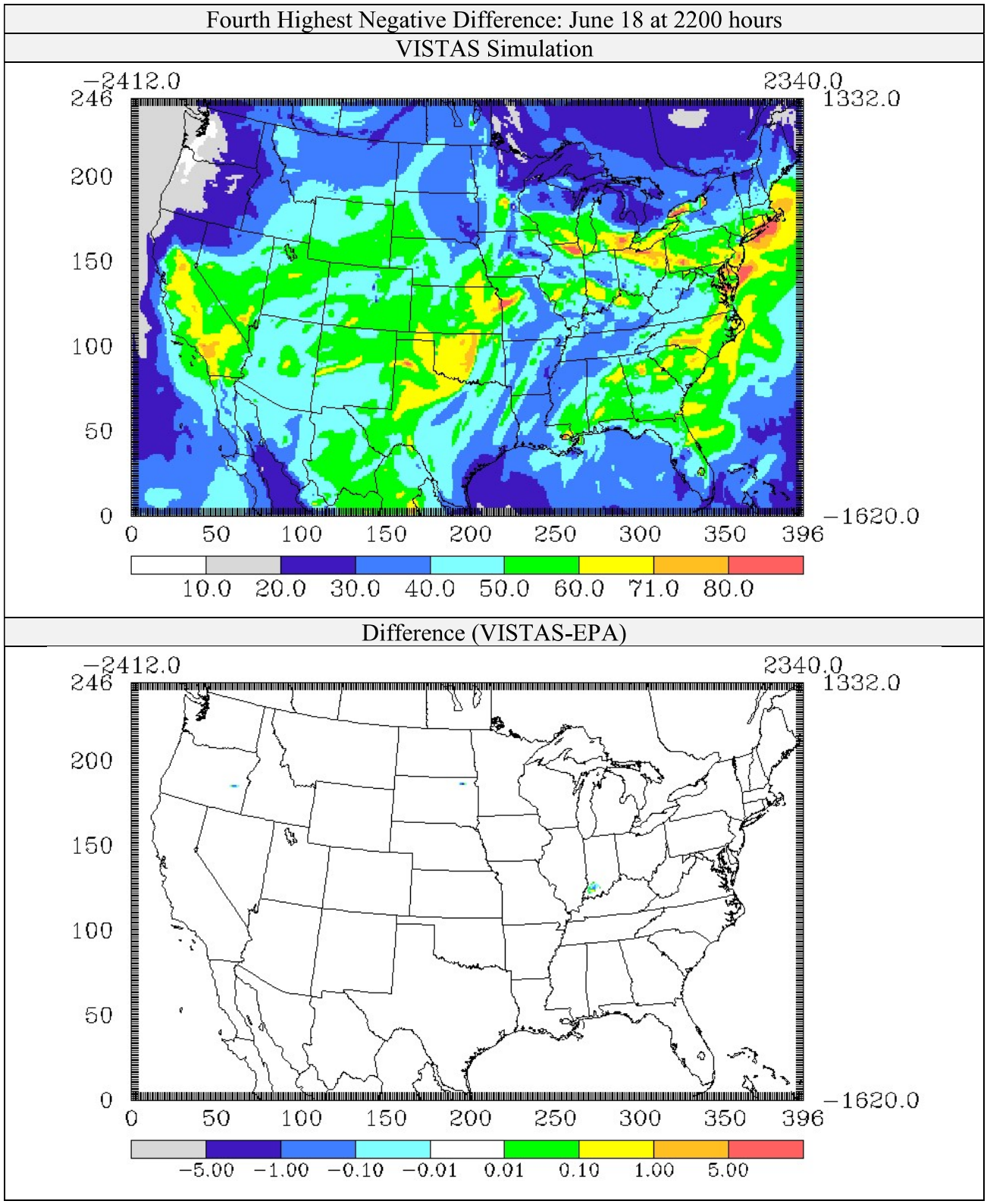

Figure 4-14: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)

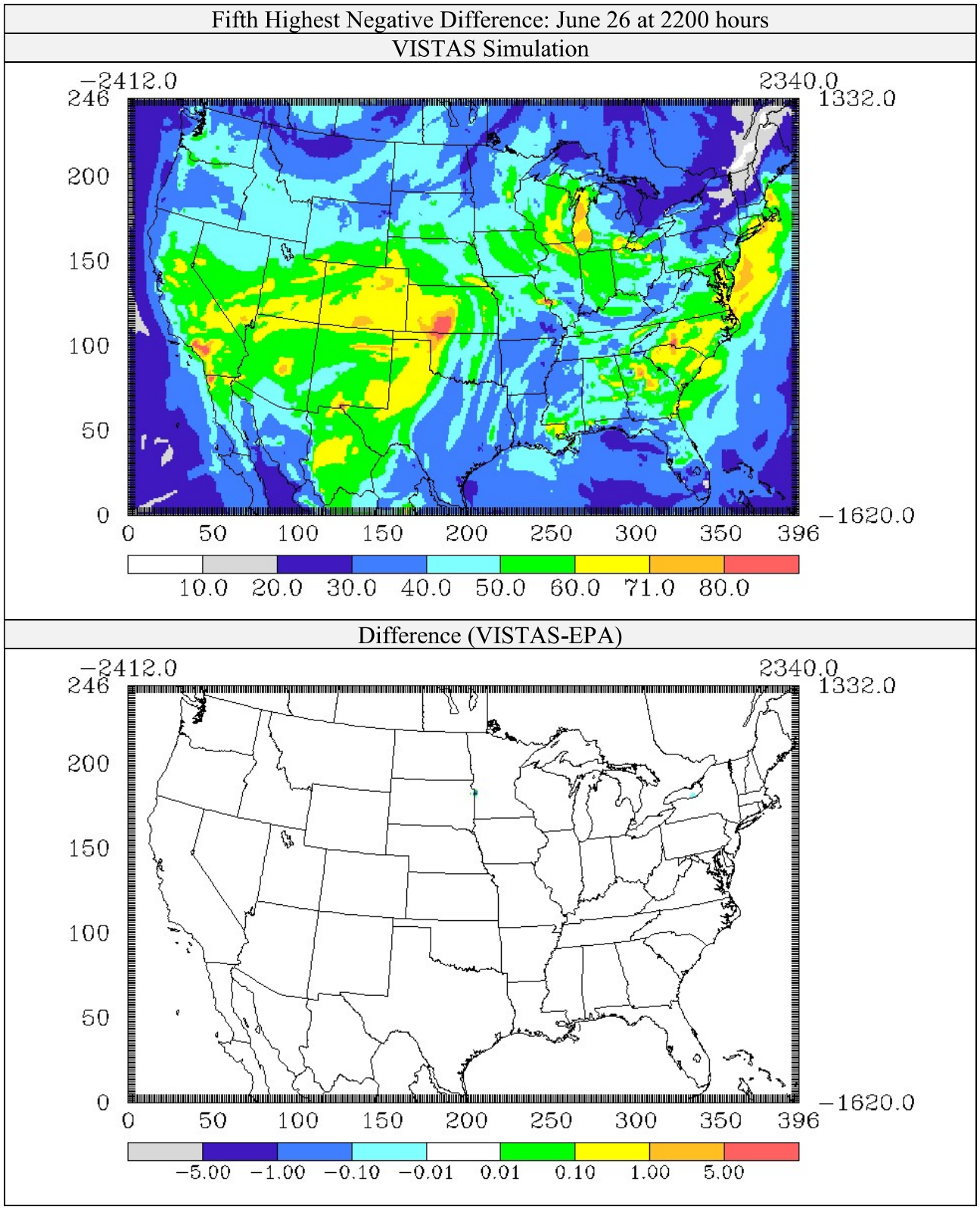

Figure 4-15: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)

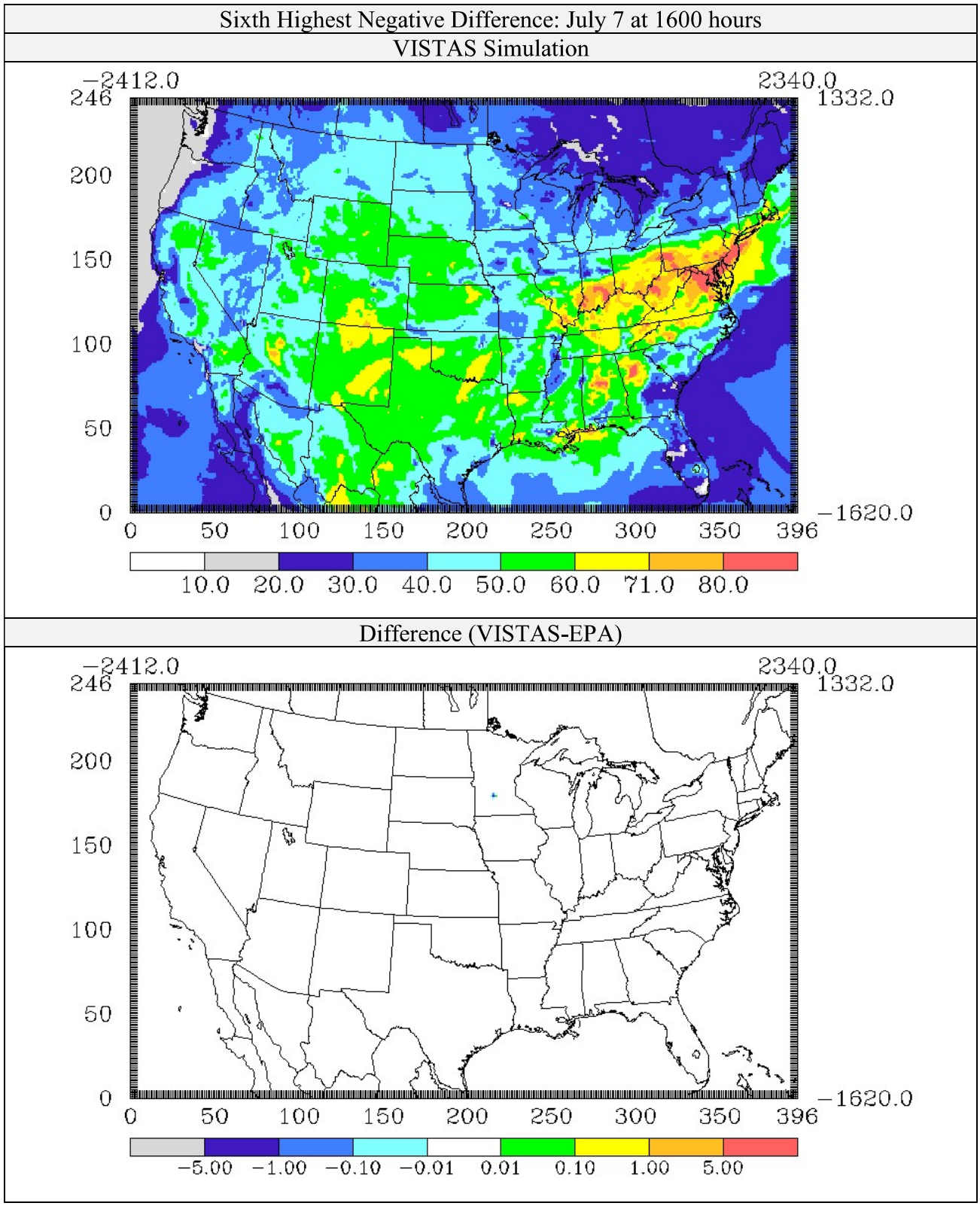

Figure 4-16: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)

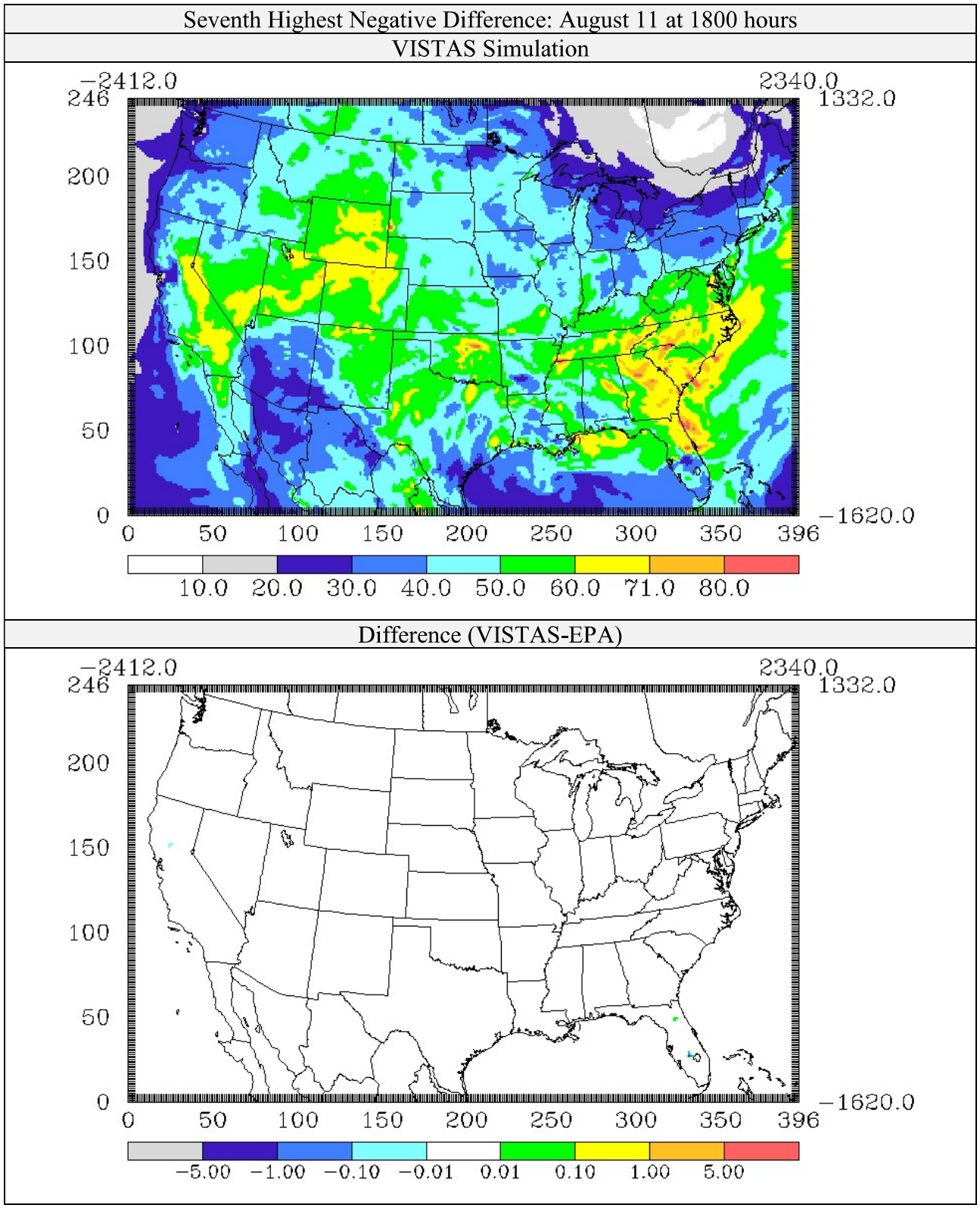

Figure 4-17: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)

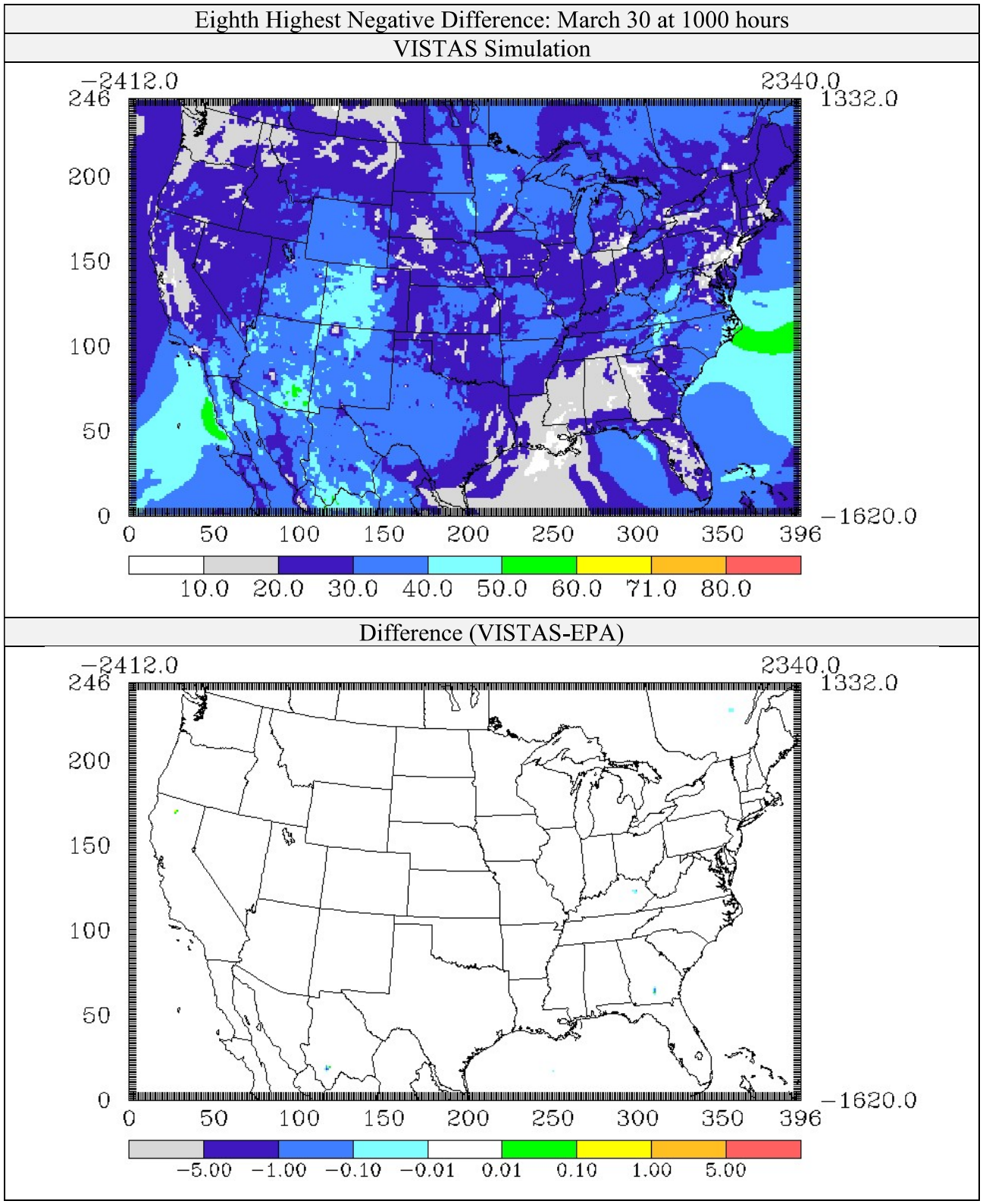

Figure 4-18: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)

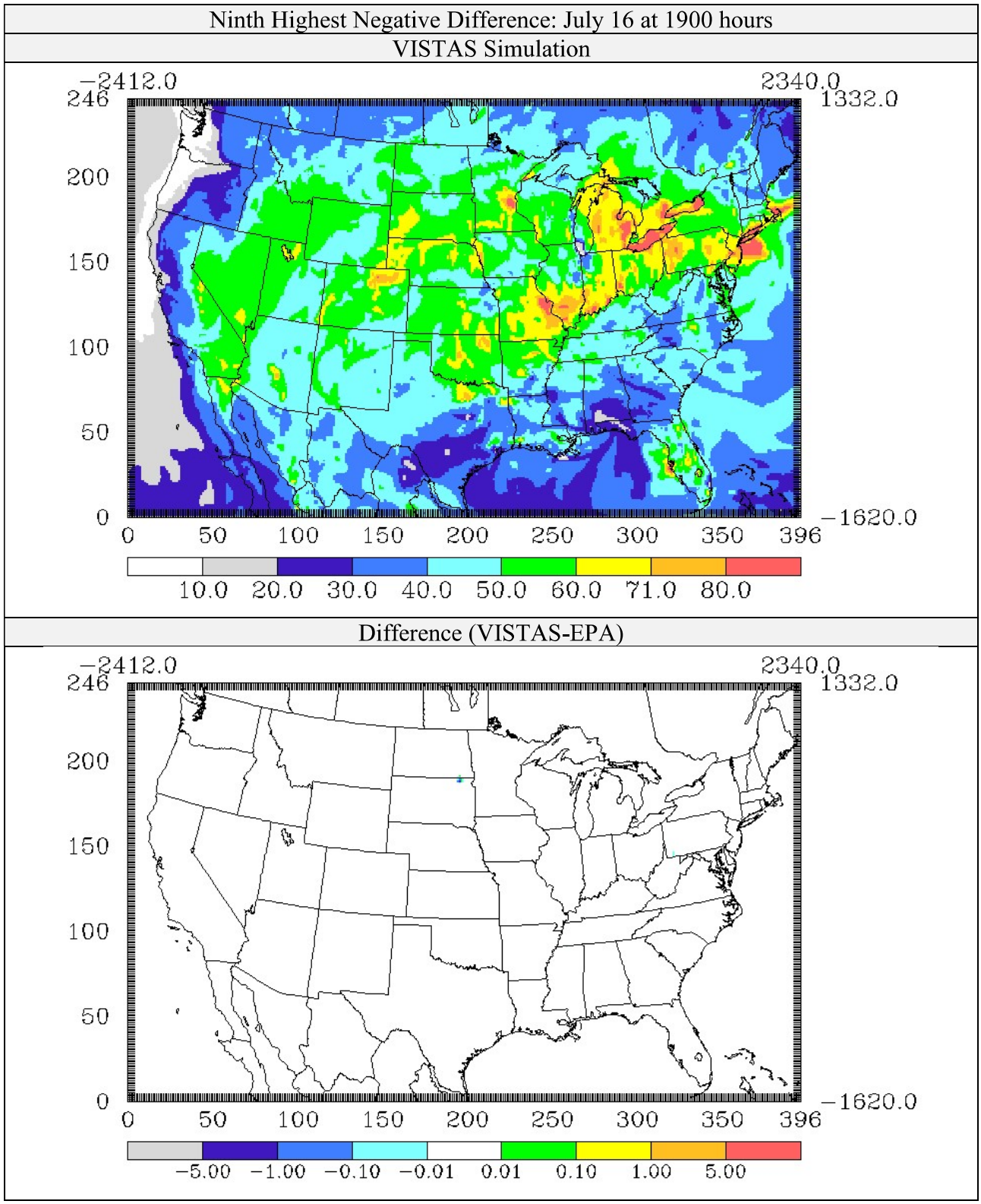

Figure 4-19: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)

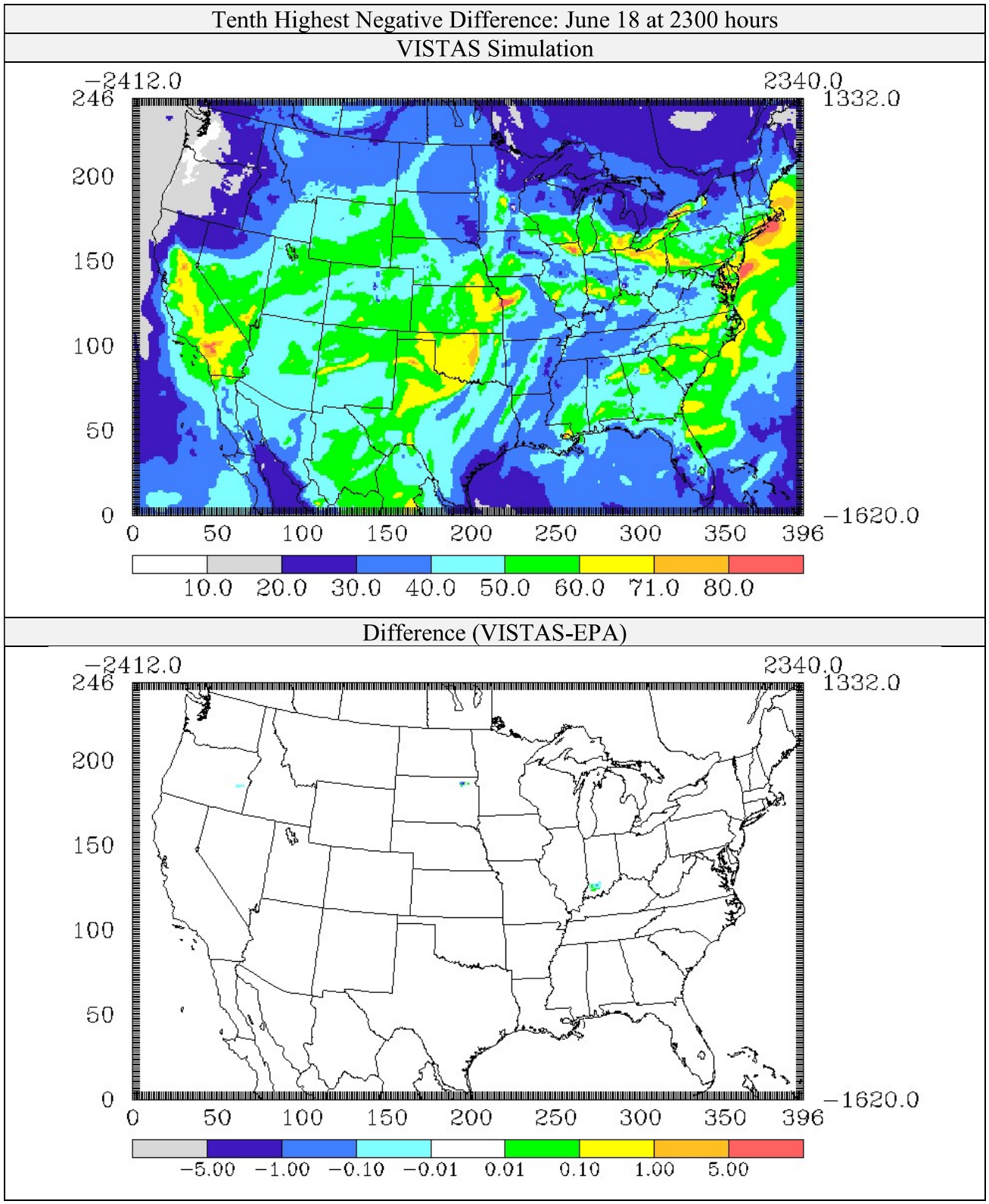

Figure 4-20: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Negative Difference)

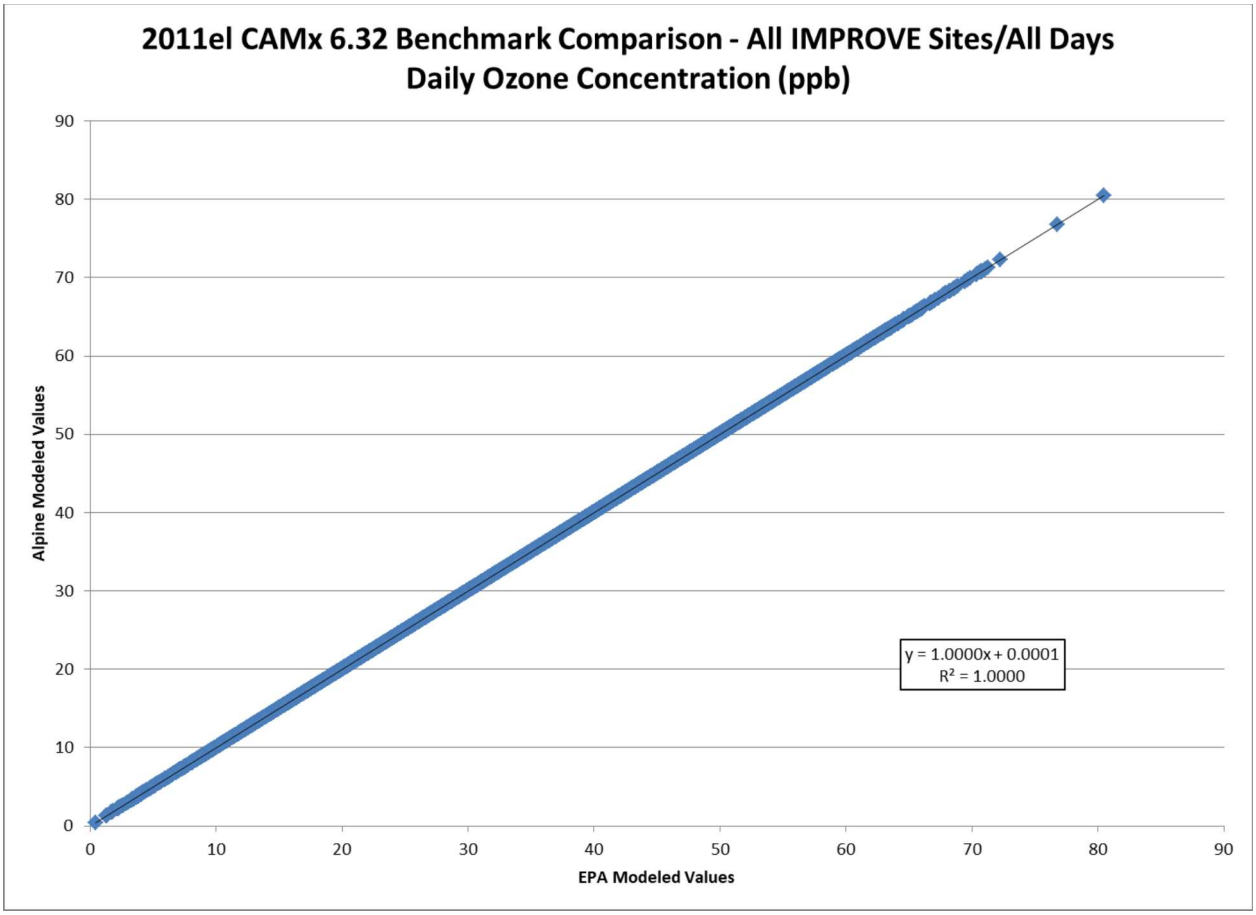

Figure 4-21: Scatterplot Comparing 24-hour Average Predicted Ozone Concentrations (ppb) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2011el Simulations Performed by EPA and VISTAS (Alpine).

4.2 $PM_{2.5}$

$PM_{2.5}$ results for the top 10 positive and negative hours are presented in tabular format in Table 4-2. The maximum positive difference is 6.73 μg/m^3 falling to 2.21 μg/m^3 for the 10th high. The maximum negative difference is -5.41 μg/m^3 falling to -1.97 μg/m^3 for the 10th high. The maximum positive percent difference from these days is 44.5% and negative percent difference of -31.7%, both on low $PM_{2.5}$ concentration days.

The top 10 positive impact hours are presented in Figures 4-22 through 4-31 and the top 10 negative impact hours are presented in Figures 4-32 through 4-41. The locations of the impacts are again localized and tending to occur in Canada near the relatively high concentration entering the domain through the northern boundary. Comparison with the Nitrate results in Section 4.4 shows that on many days the principal difference in the $PM_{2.5}$ concentrations is a result of the differences in the Nitrate predictions.

Scatterplots of the daily average $PM_{2.5}$ concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-42. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Examination of the animations shows that the majority of the differences are occurring in Canada and the Northern U.S. with the differences occurring in the areas of relatively high $PM_{2.5}$. We speculate that the differences are primarily from the difference in the Particulate Nitrate and most likely from different pathways being taken in the ISOROPIA algorithm.

Table 4-2. Comparison of 2011el CAMx 6.32 Simulation $PM_{2.5}$ Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	1	3	4	34.86	28.13	6.73	23.93%	156	236
2011	1	3	5	32.54	26.77	5.77	21.56%	156	236
2011	1	3	6	34.49	29.16	5.33	18.28%	156	235
2011	1	27	7	14.19	9.82	4.37	44.52%	349	244
2011	1	3	3	31.52	28.34	3.17	11.20%	156	236
2011	1	27	11	11.67	8.91	2.76	30.91%	349	243
2011	1	27	6	11.37	8.71	2.66	30.59%	343	244
2011	1	14	9	14.03	11.54	2.49	21.60%	164	222
2011	1	27	4	11.82	9.56	2.26	23.63%	343	244
2011	1	3	21	21.51	19.29	2.21	11.47%	164	236
Maximum Negative									
2011	1	14	6	20.84	26.26	-5.41	-20.62%	120	243
2011	1	27	8	8.56	12.22	-3.67	-30.01%	350	243
2011	1	15	9	14.60	17.96	-3.36	-18.70%	126	220
2011	1	27	11	8.58	11.77	-3.19	-27.10%	342	245
2011	1	27	12	6.20	9.08	-2.88	-31.69%	342	243
2011	1	27	5	7.89	10.74	-2.85	-26.53%	342	244
2011	1	3	10	38.42	40.87	-2.45	-5.99%	155	235
2011	1	14	2	27.61	29.94	-2.32	-7.76%	134	242
2011	1	3	4	28.64	30.77	-2.13	-6.93%	157	237
2011	1	3	6	27.75	29.72	-1.97	-6.61%	159	234

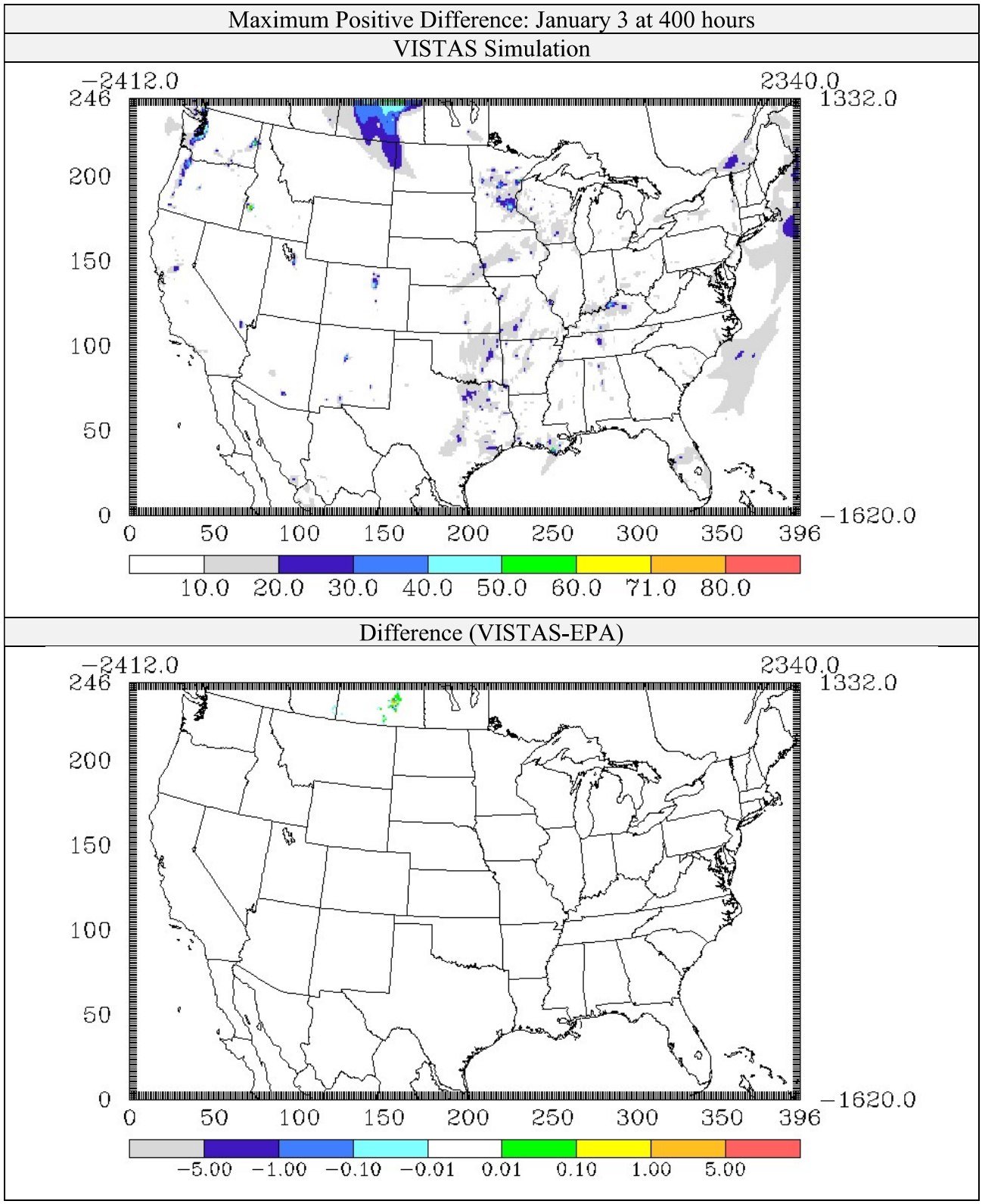

Figure 4-22: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)

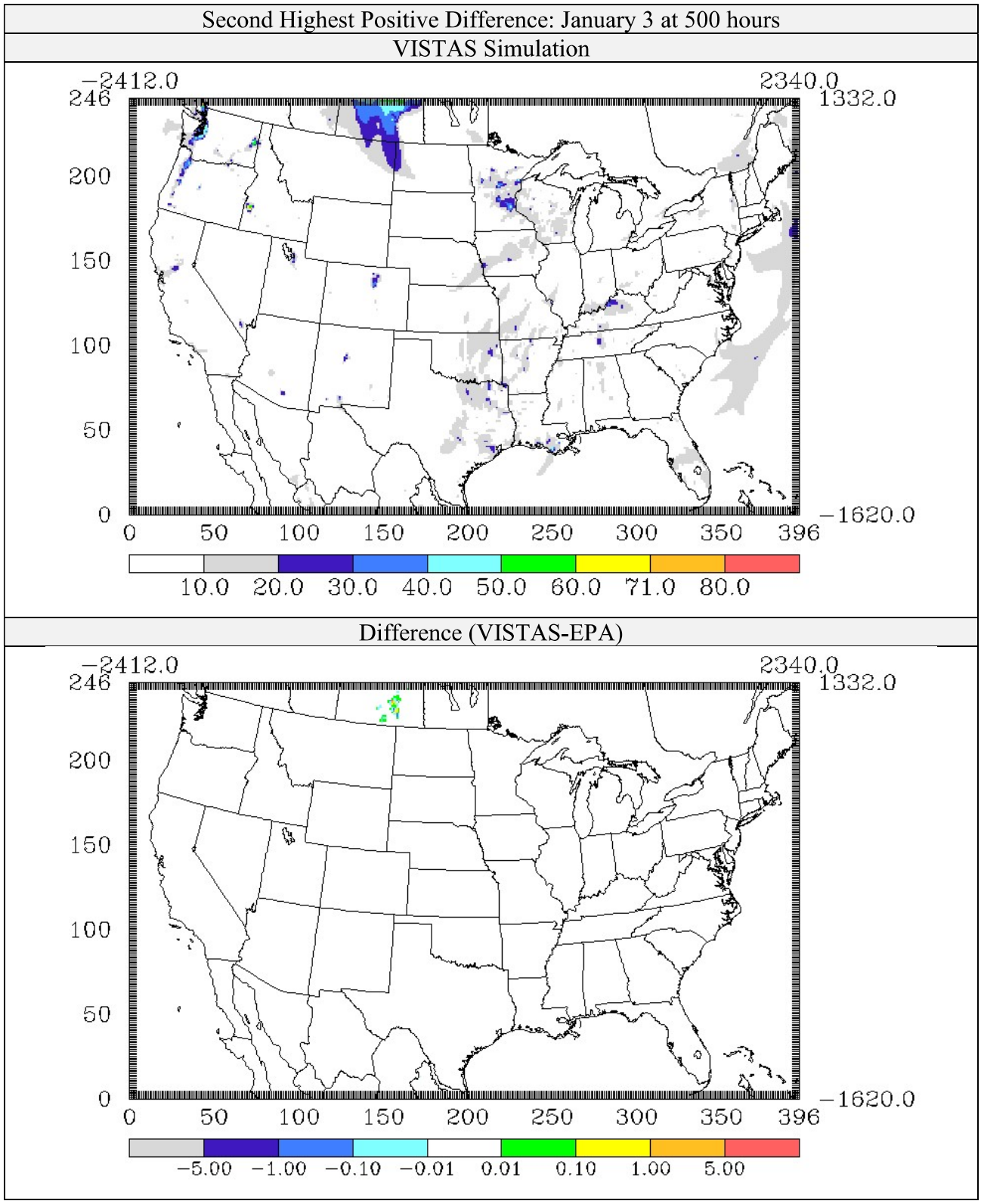

Figure 4-23: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)

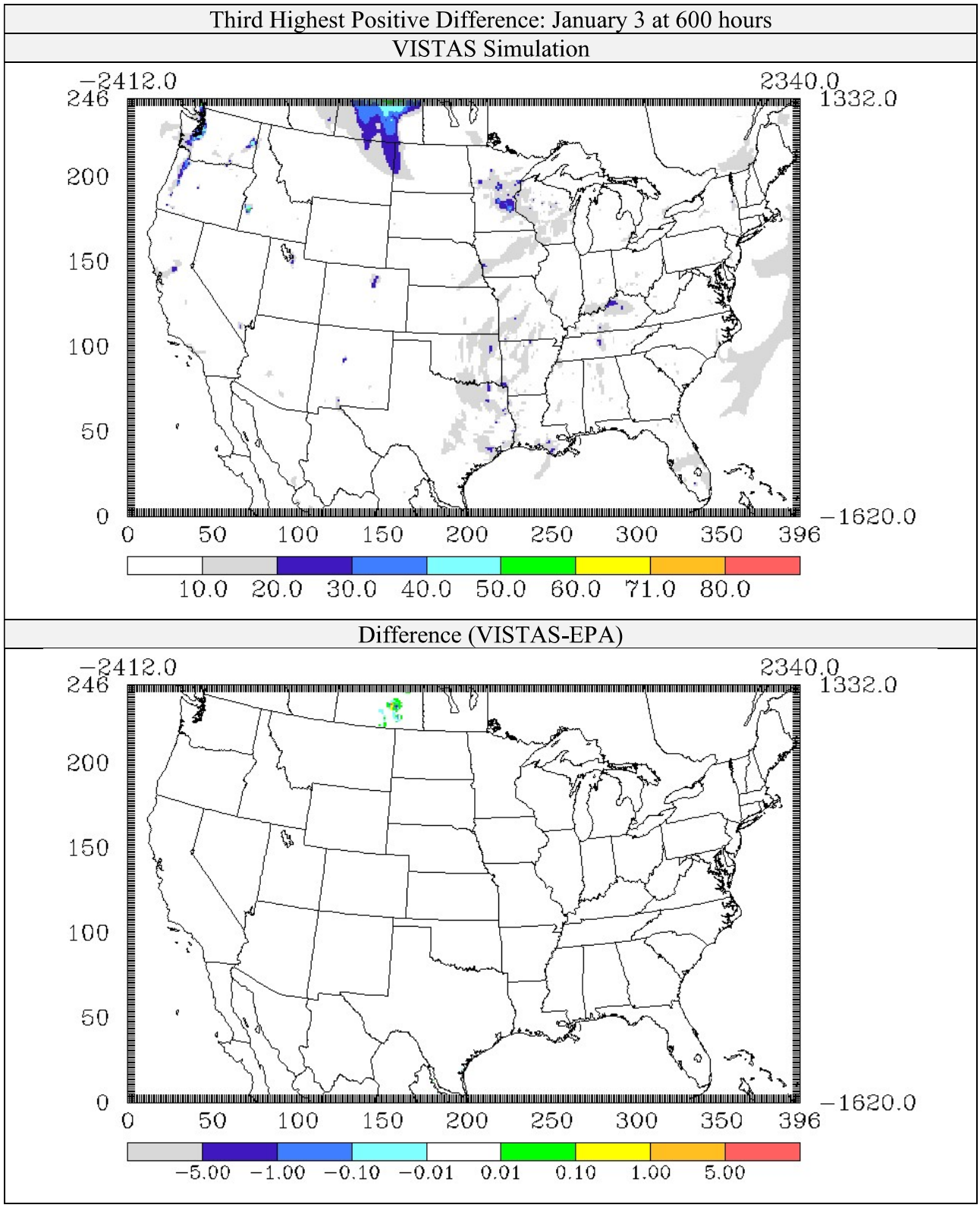

Figure 4-24: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)

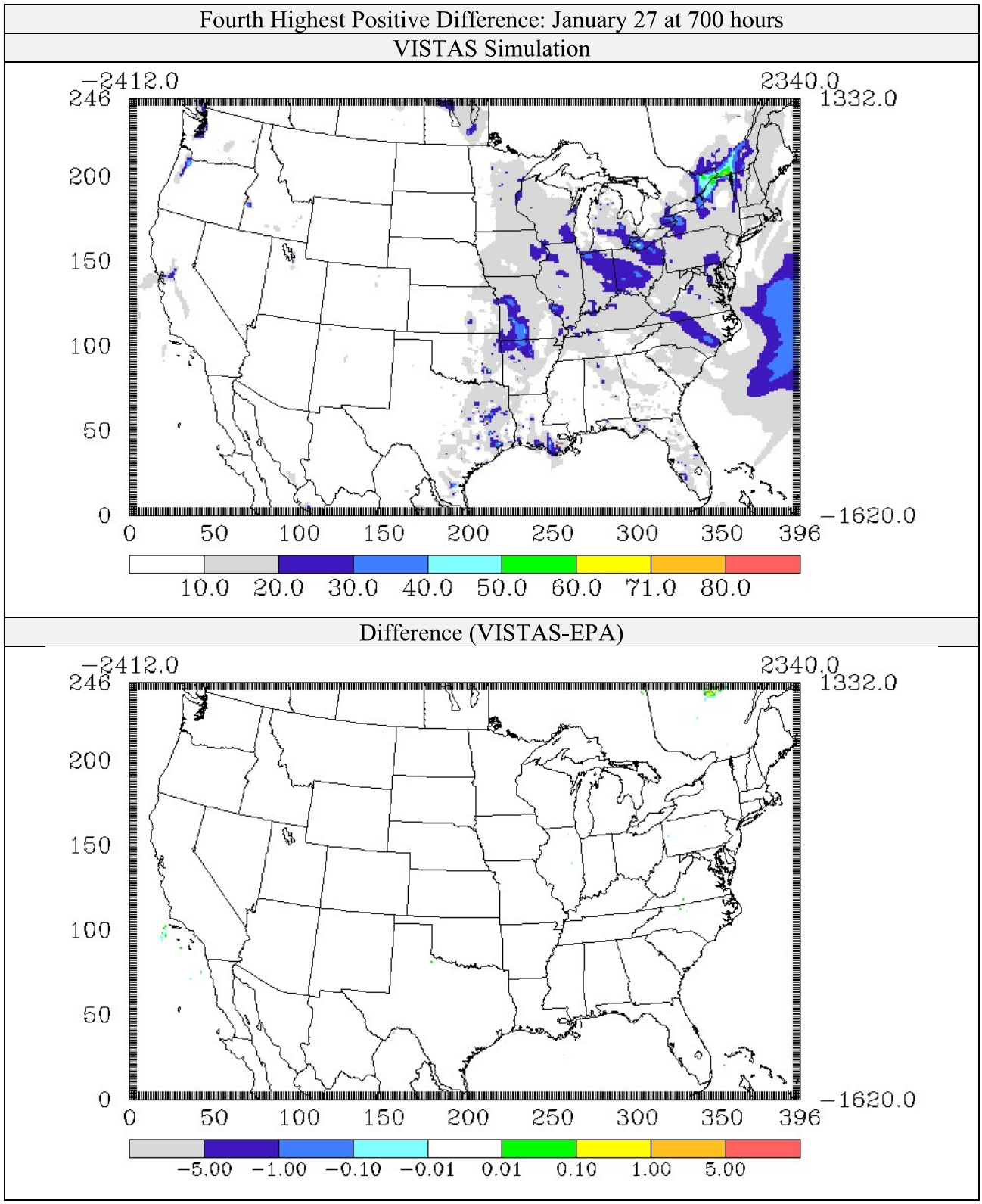

Figure 4-25: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)

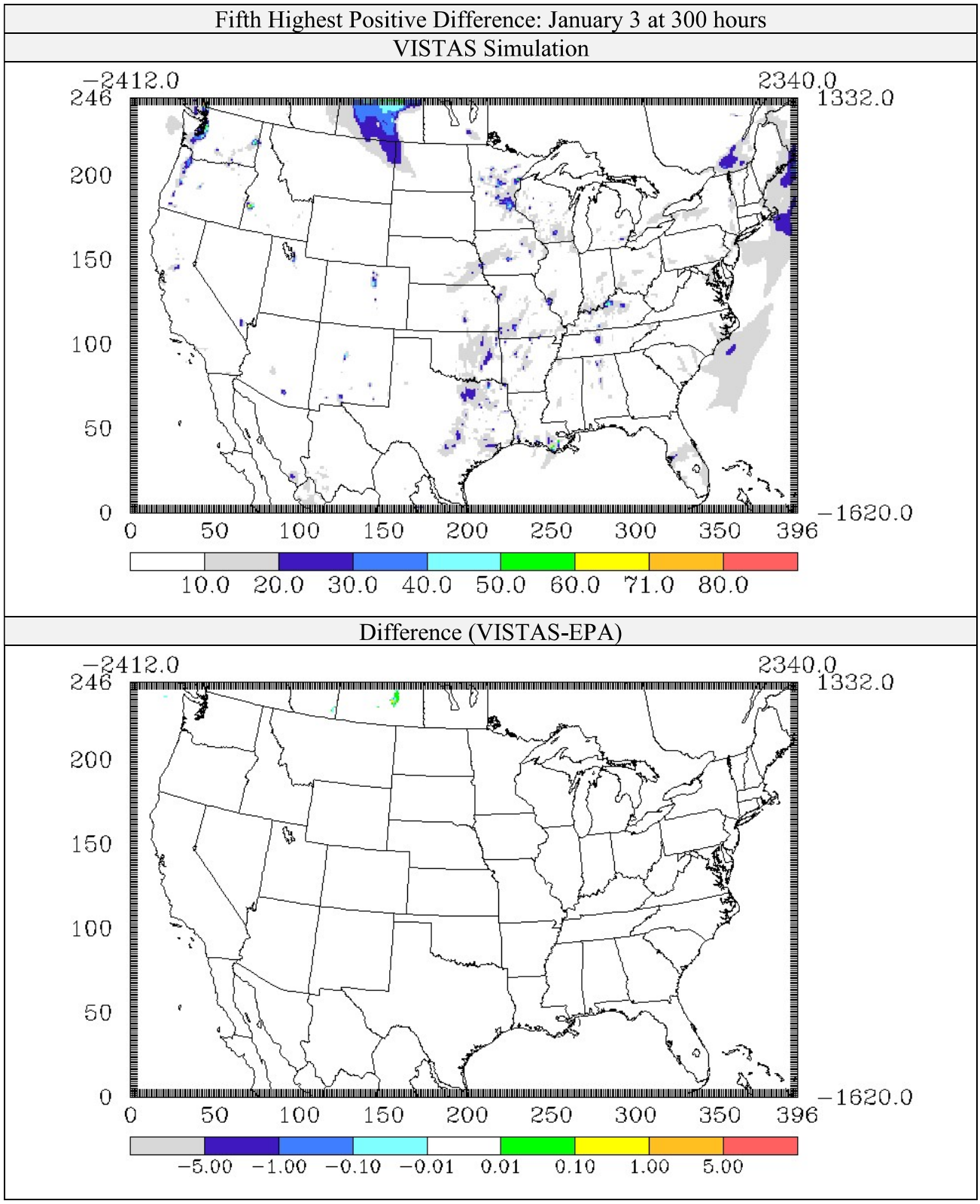

Figure 4-26: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)

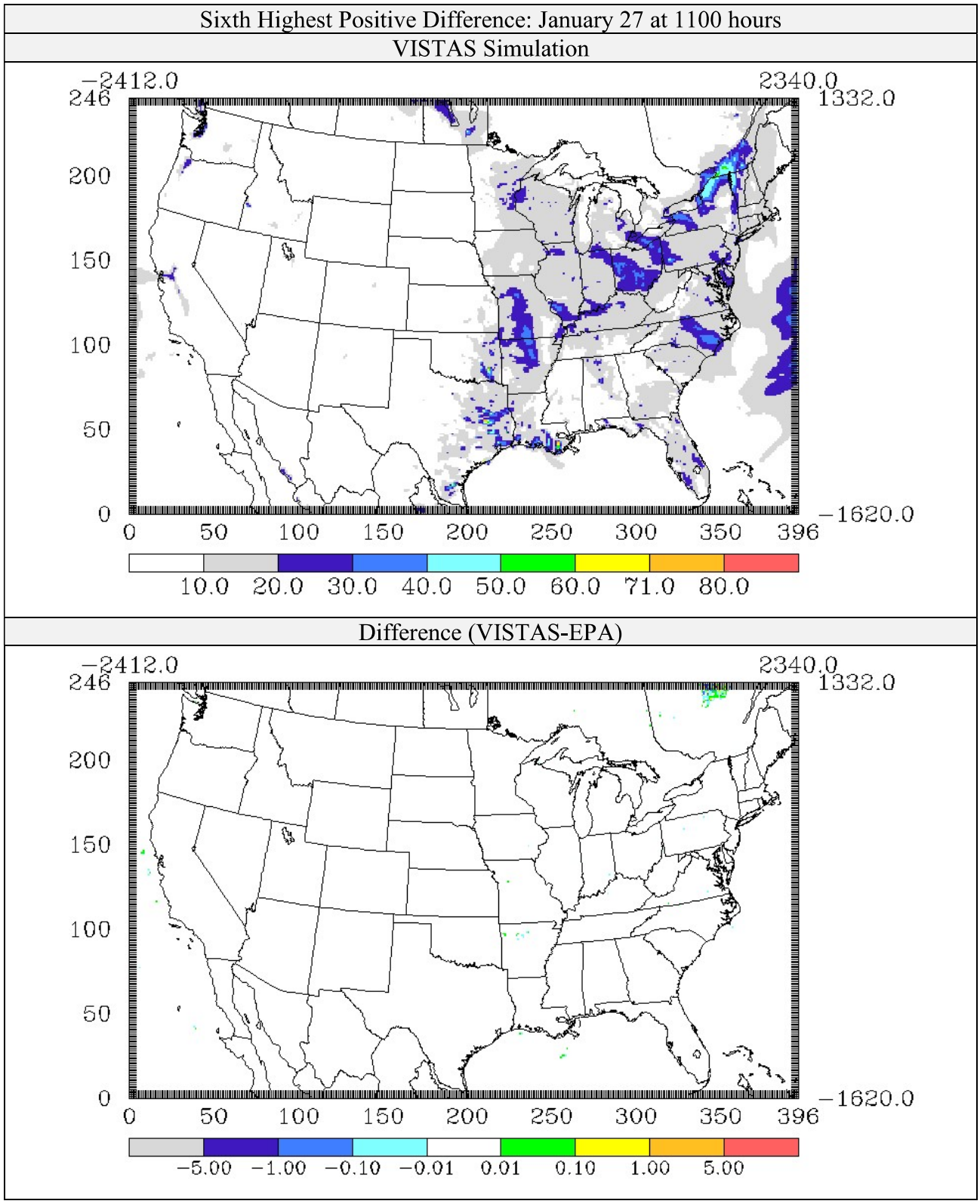

Figure 4-27: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)

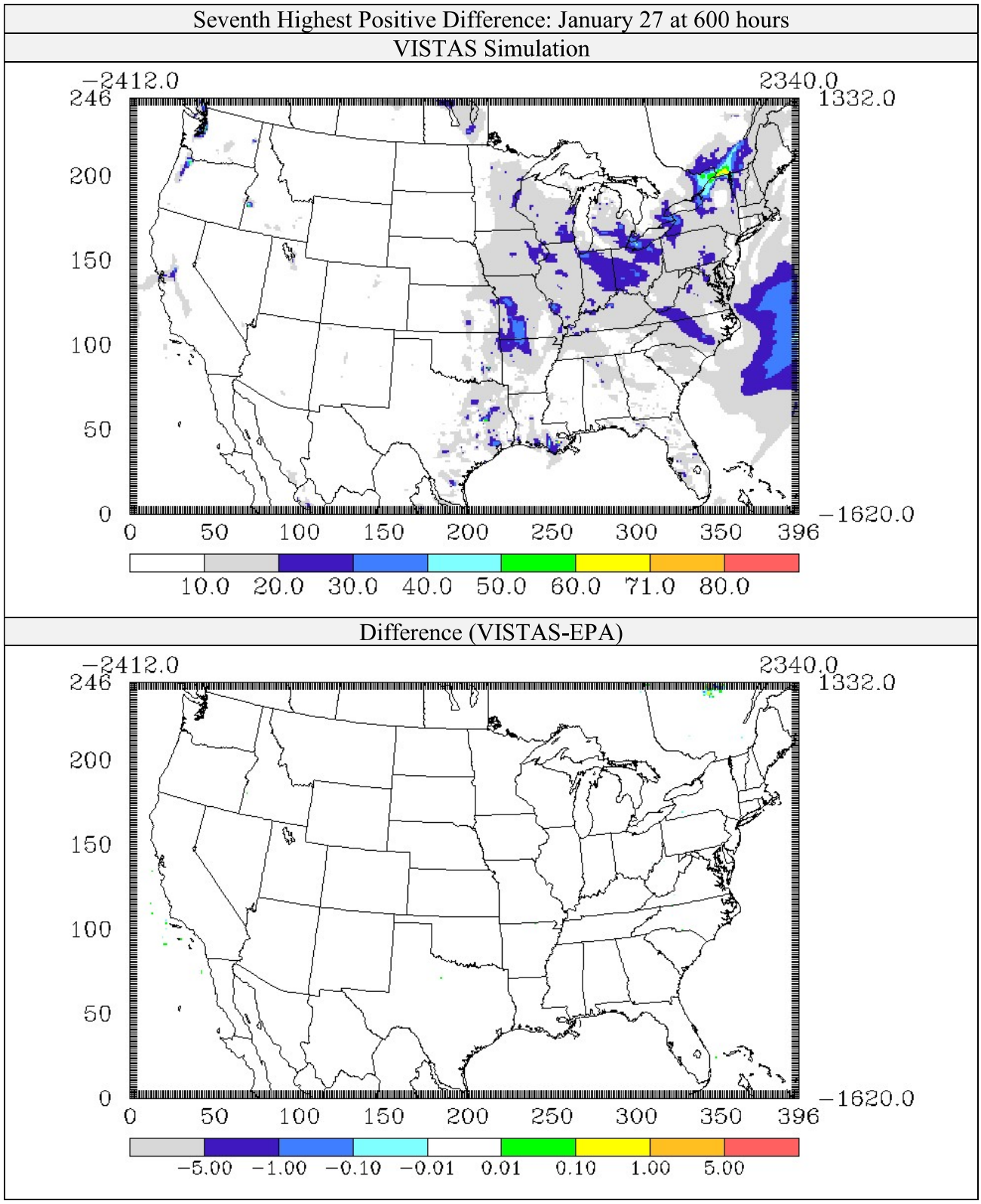

Figure 4-28: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)

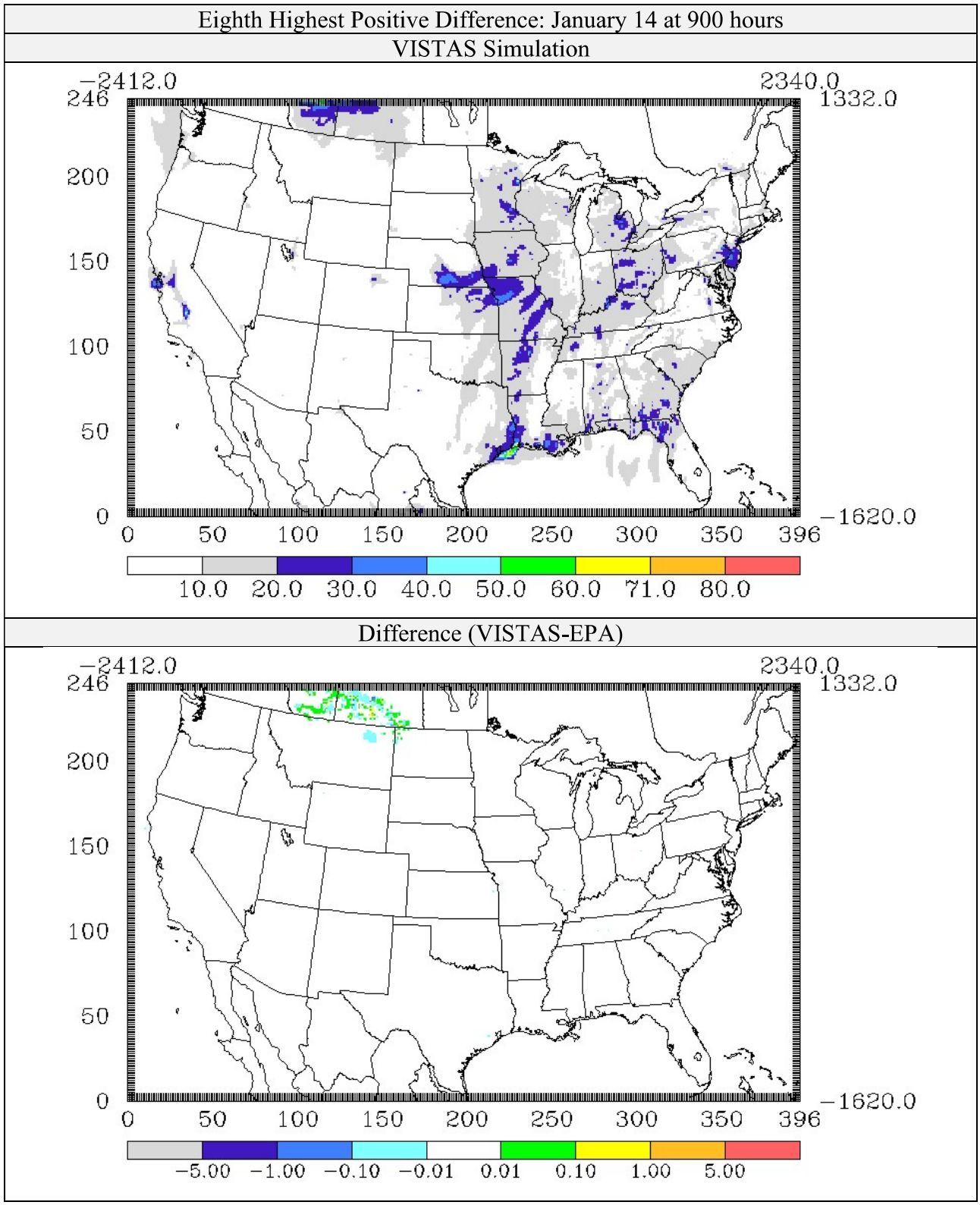

Figure 4-29: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)

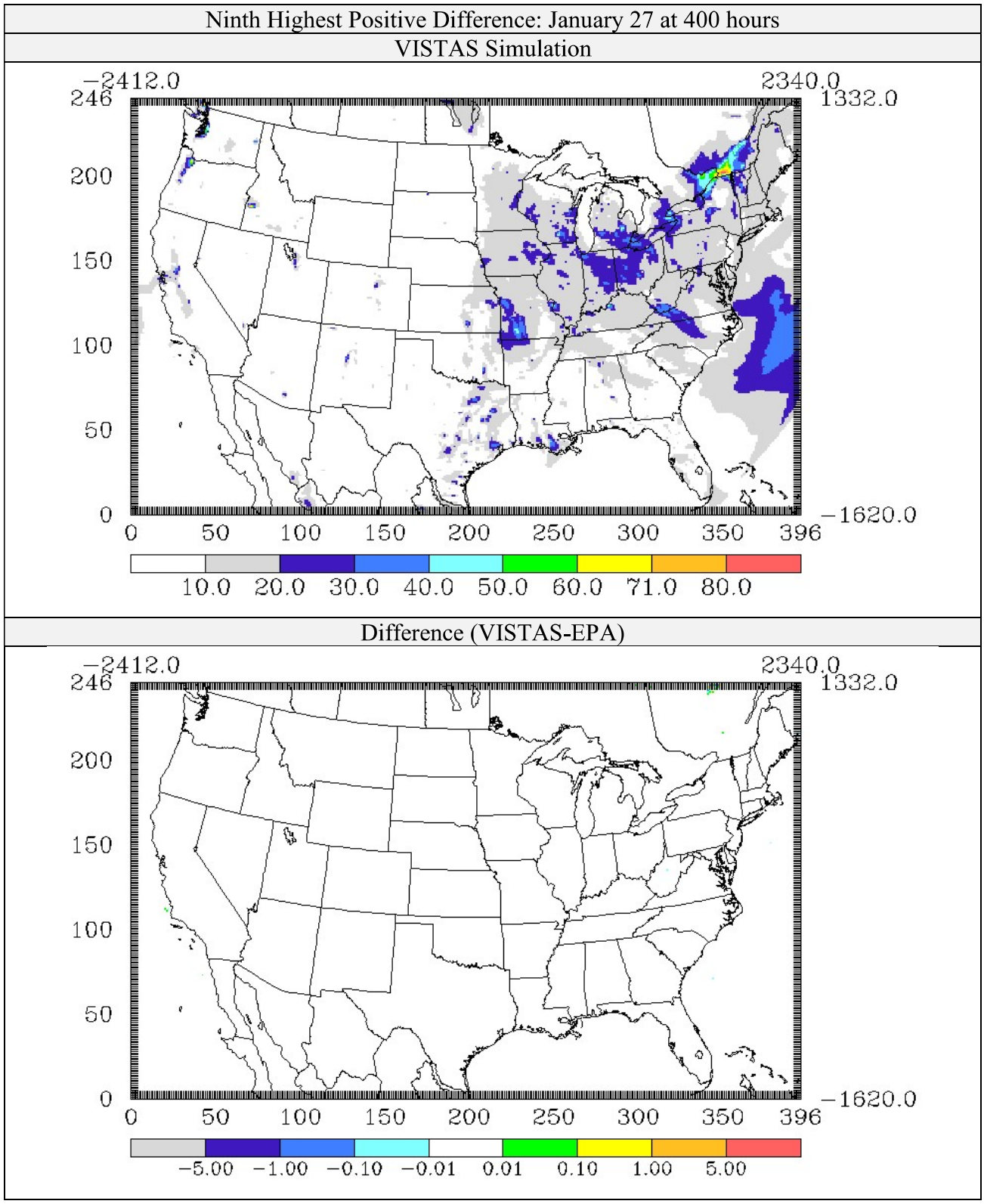

Figure 4-30: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)

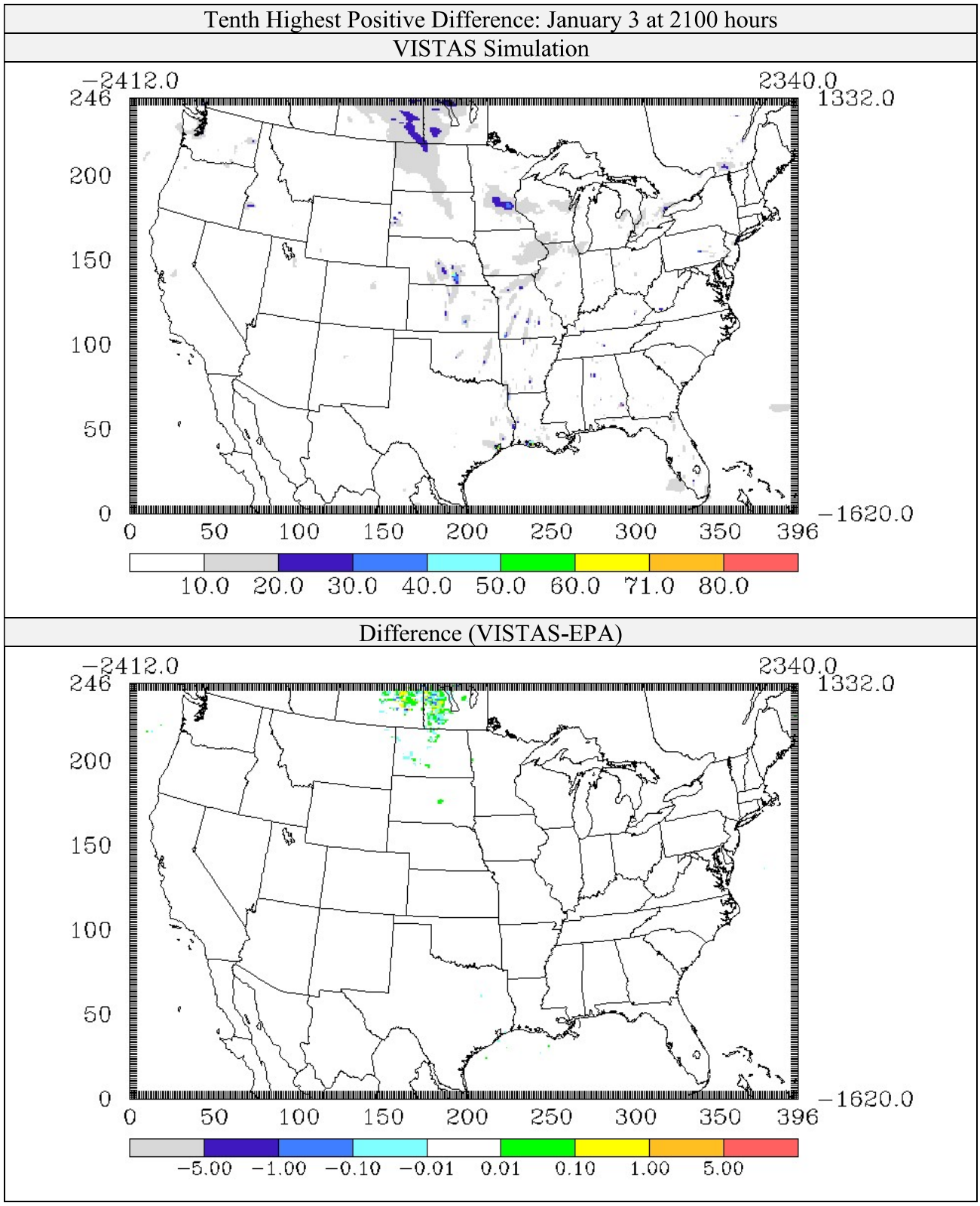

Figure 4-31: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)

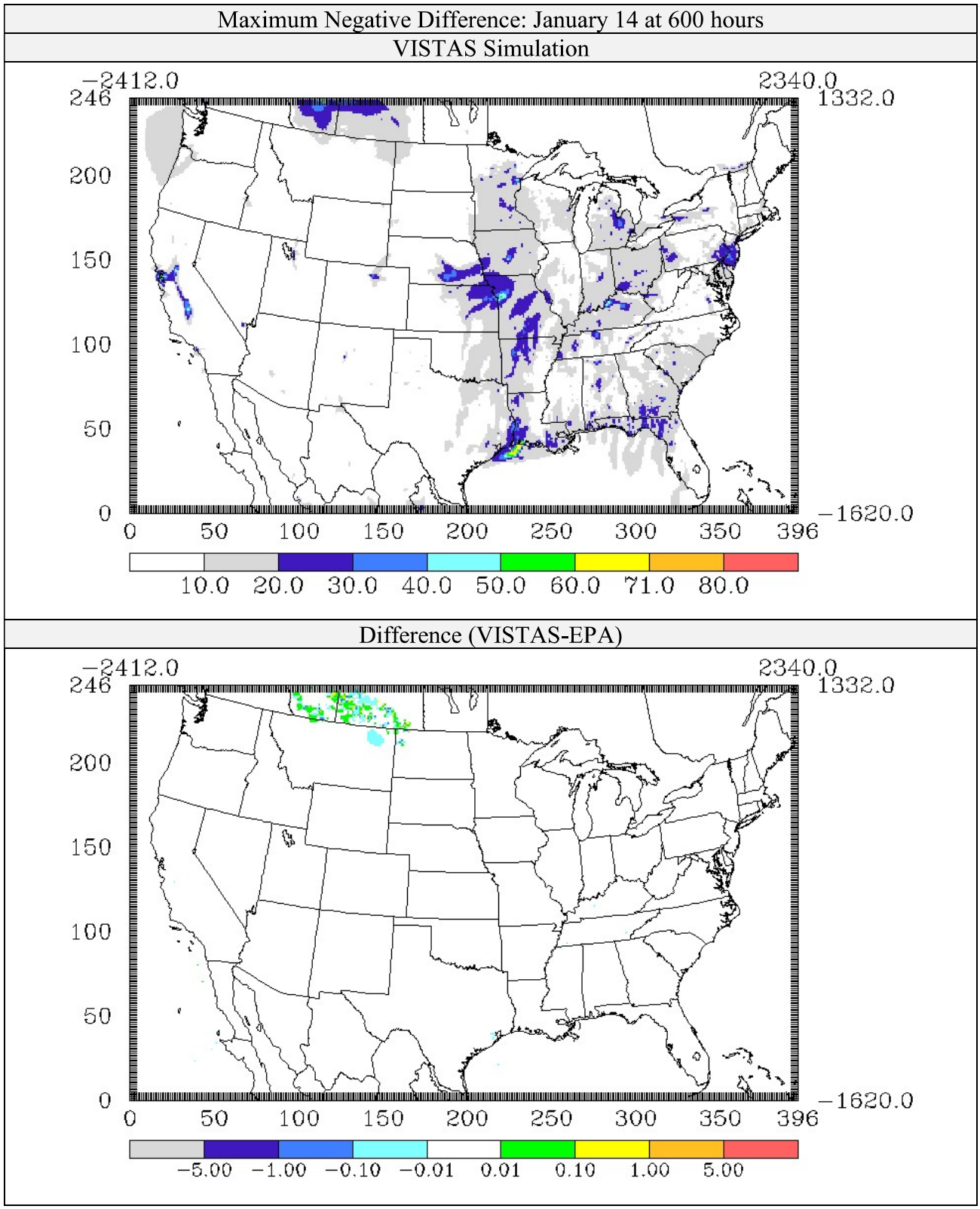

Figure 4-32: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)

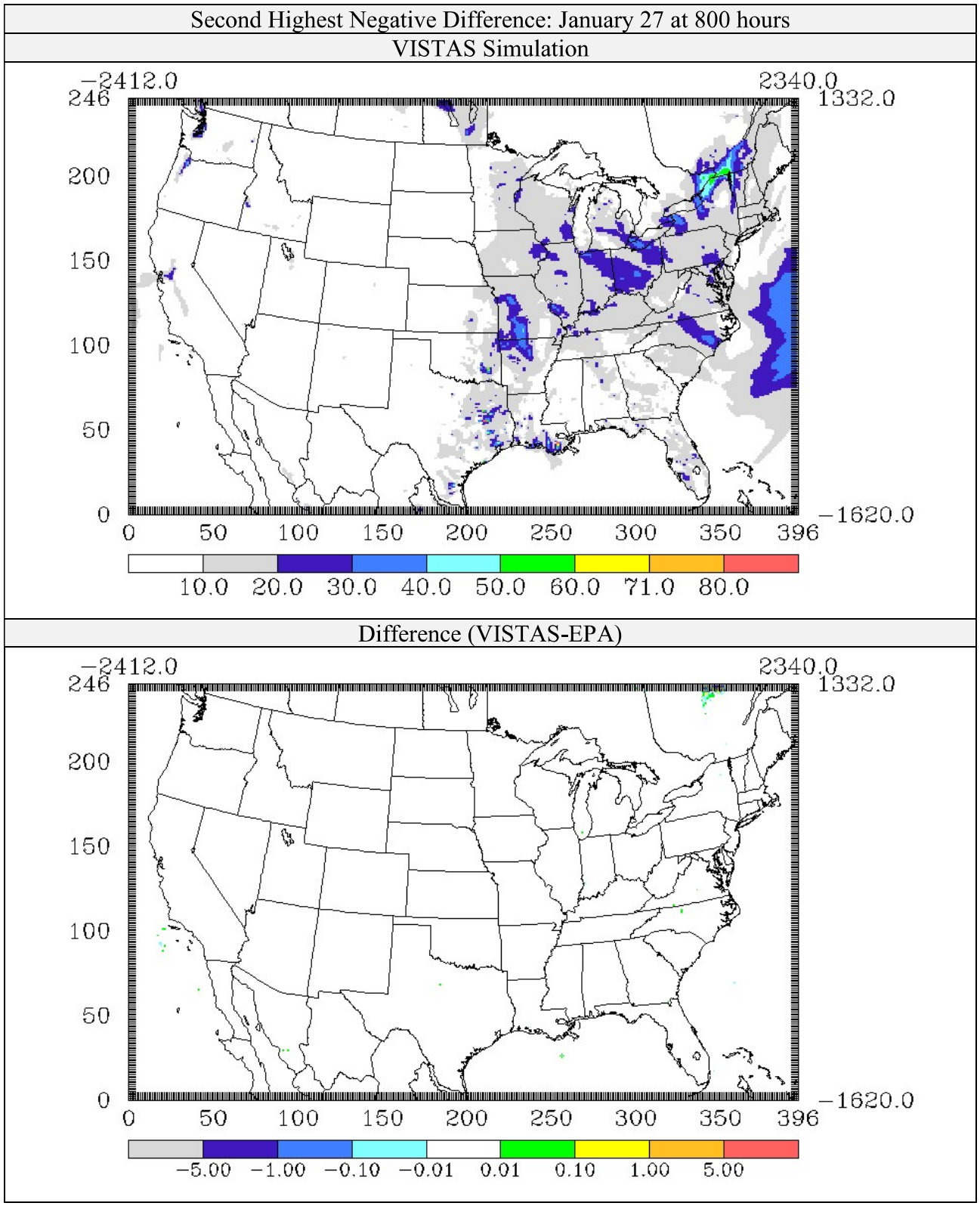

Figure 4-33: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)

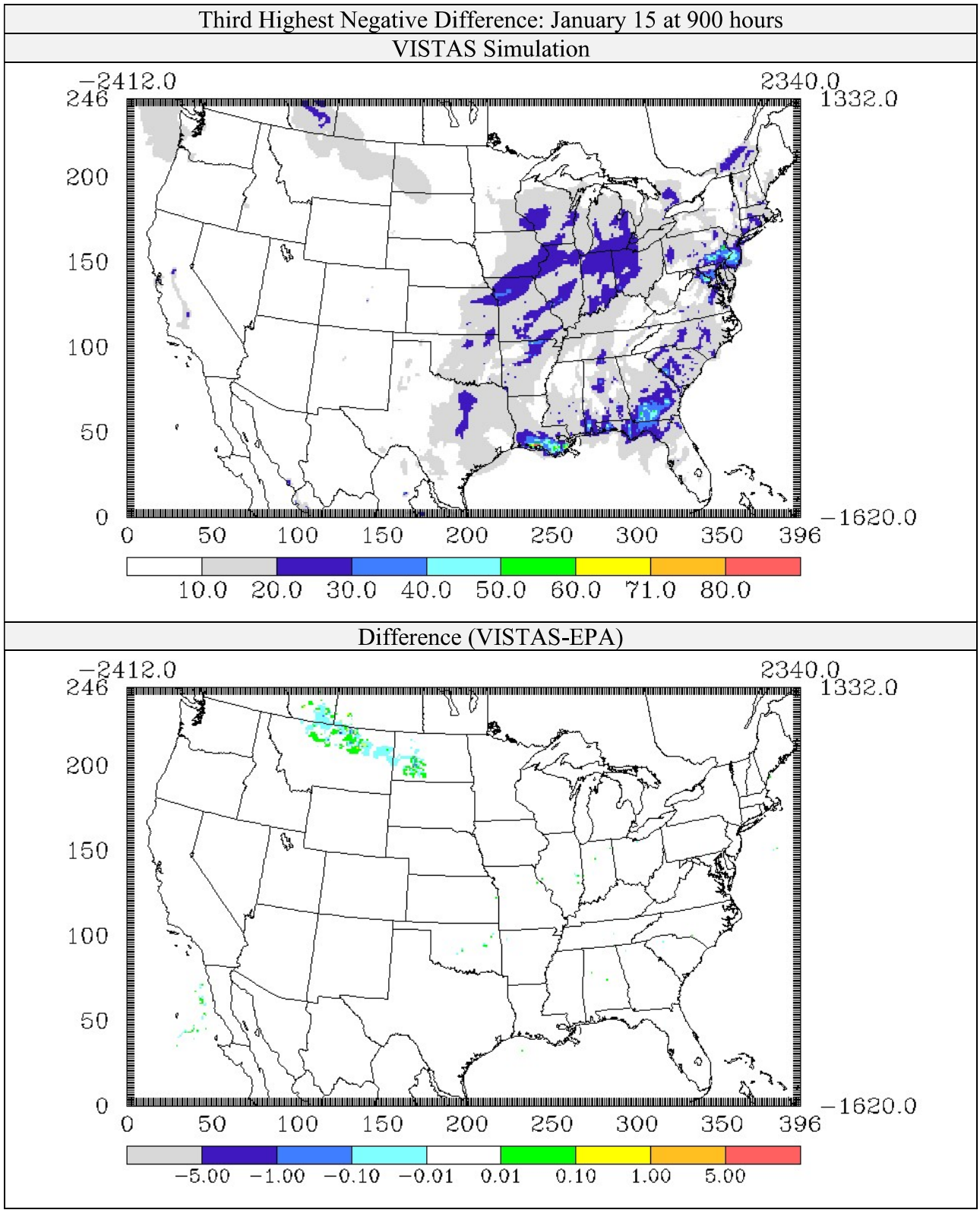

Figure 4-34: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)

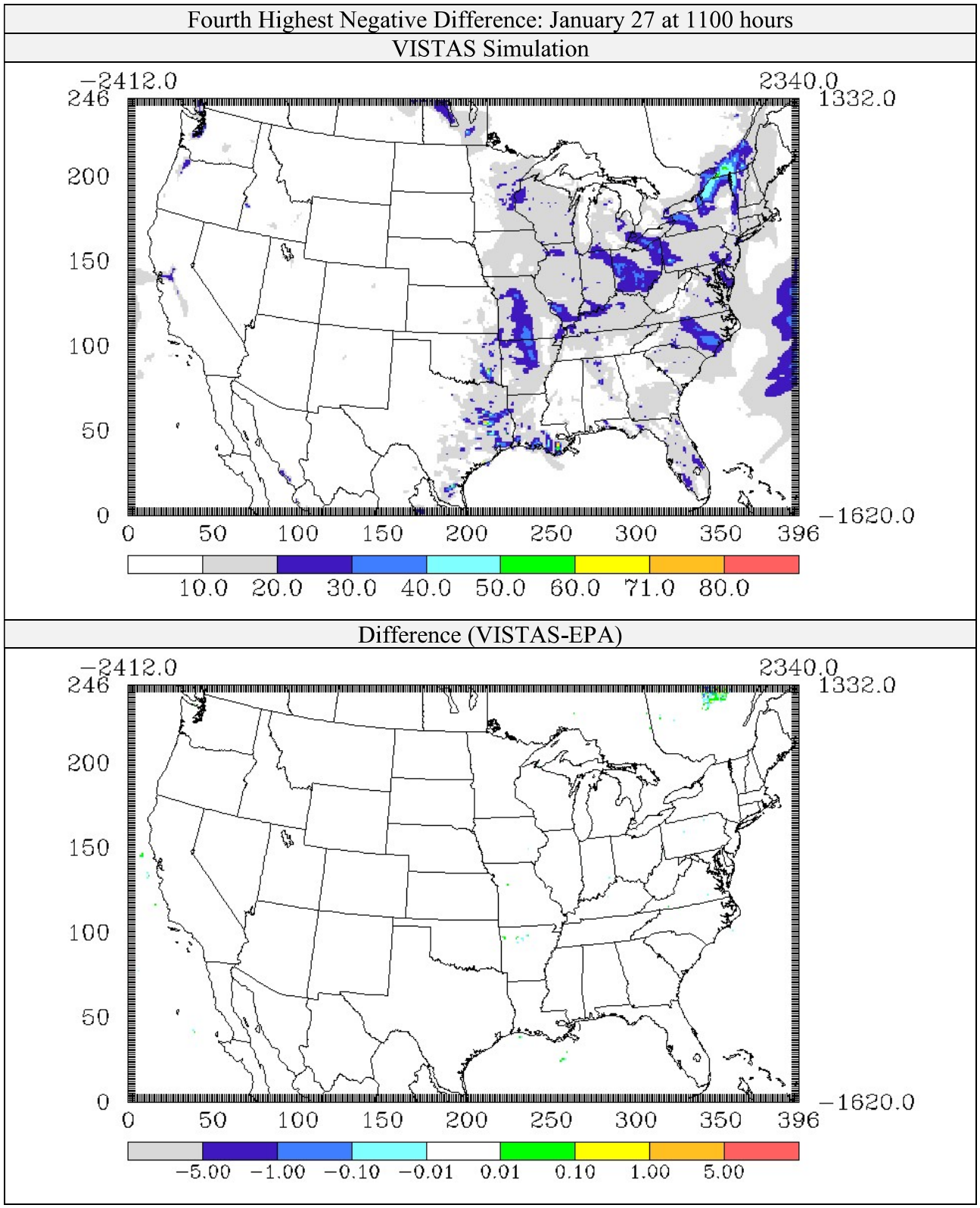

Figure 4-35: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)

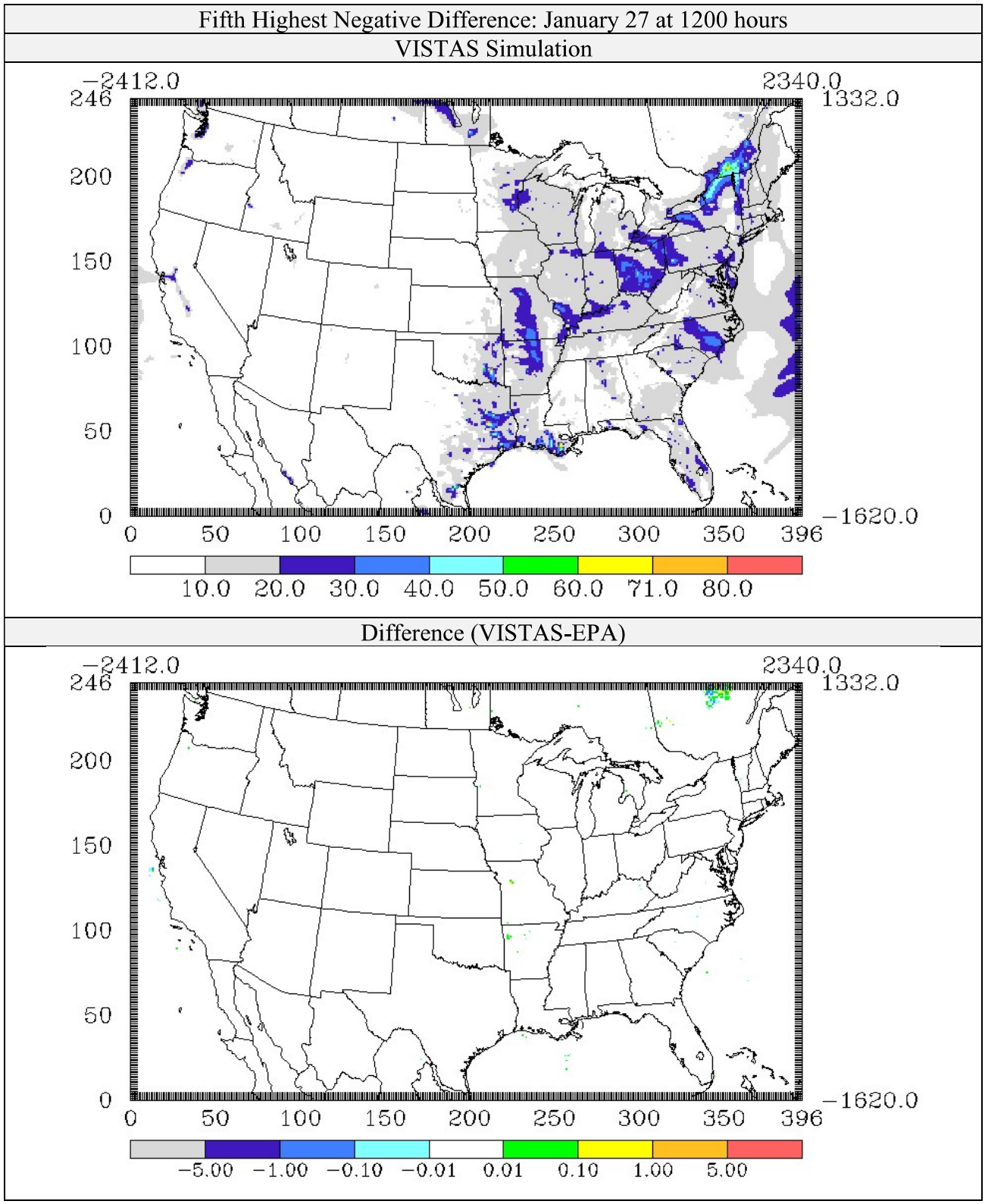

Figure 4-36: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)

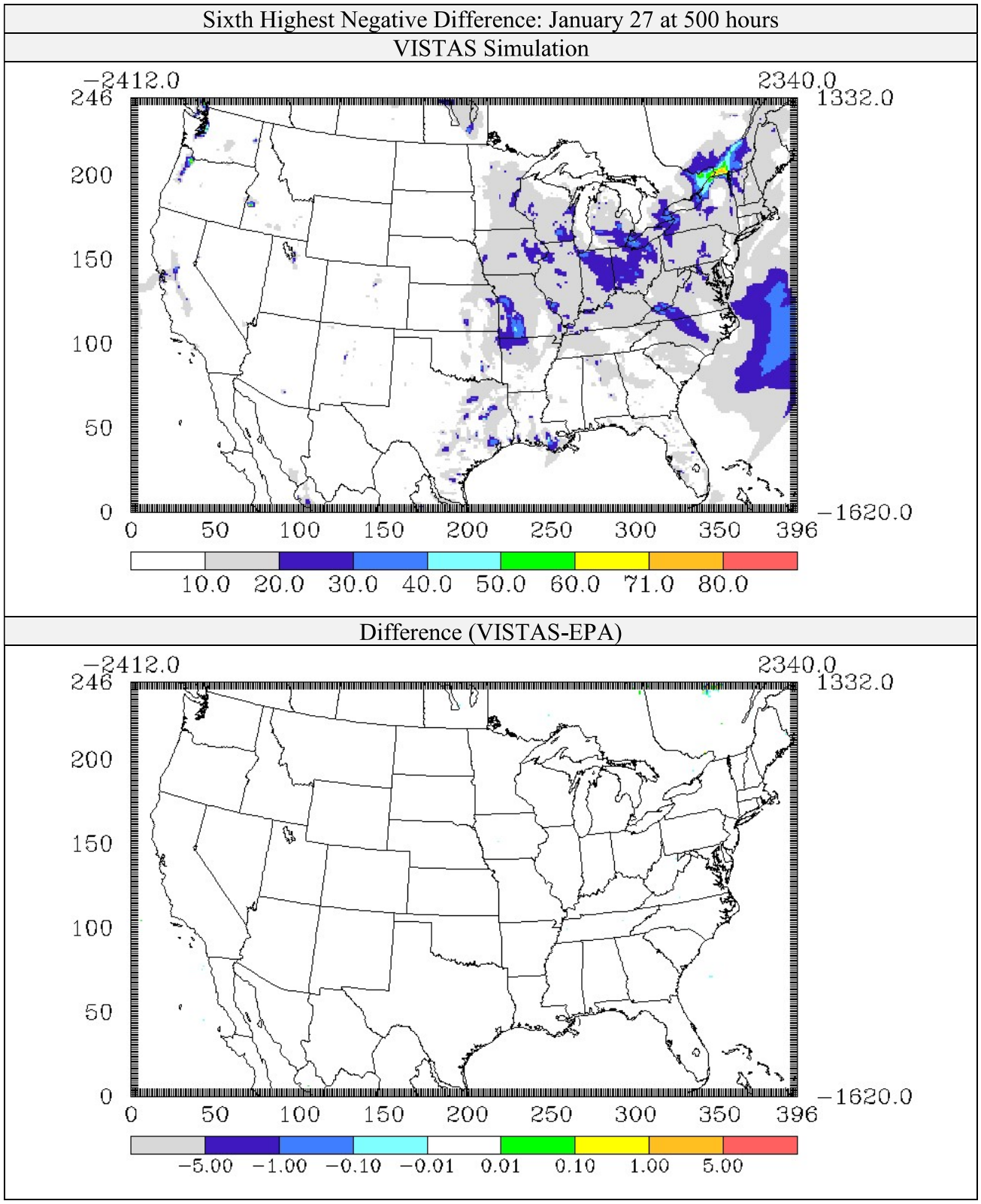

Figure 4-37: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)

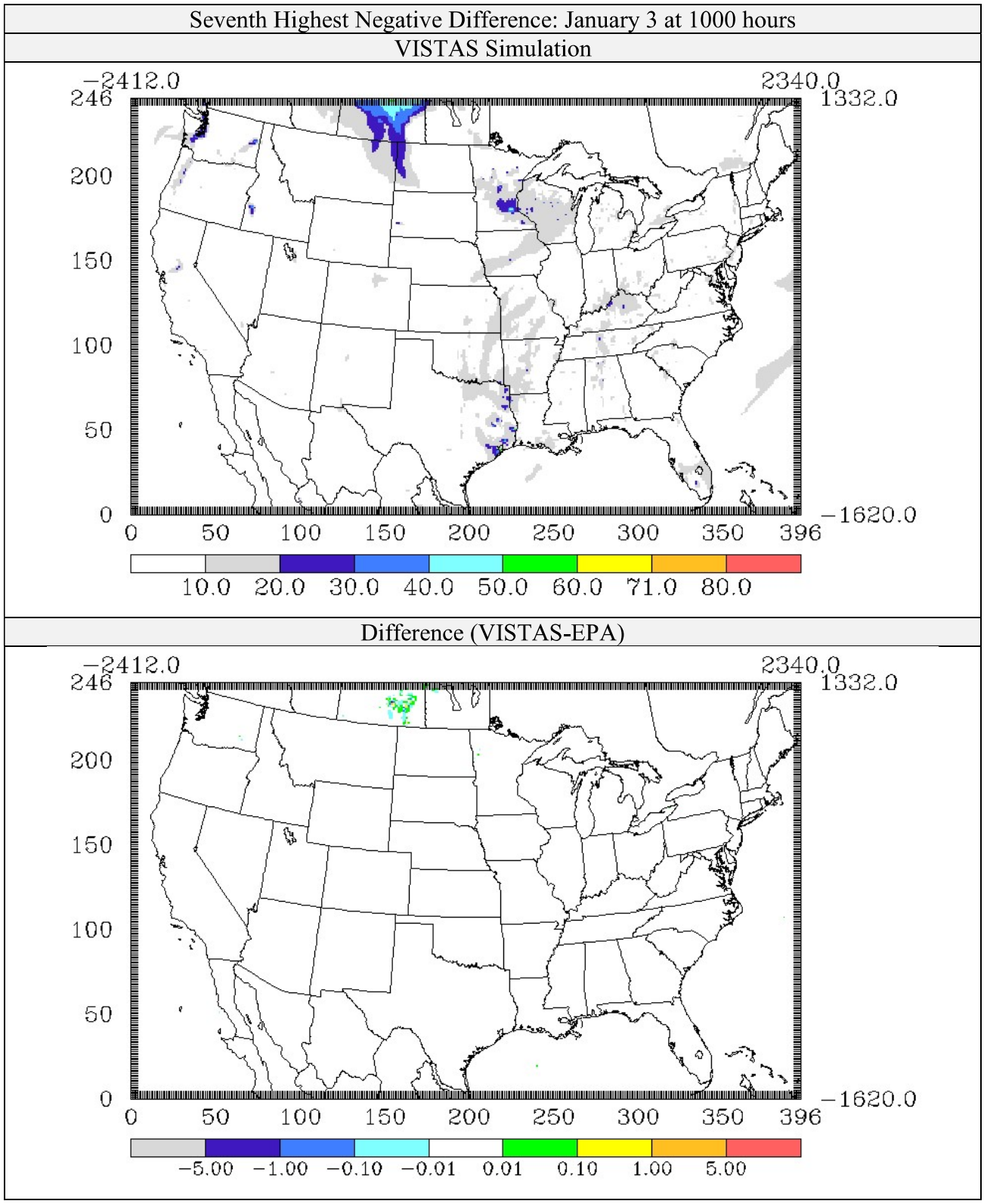

Figure 4-38: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)

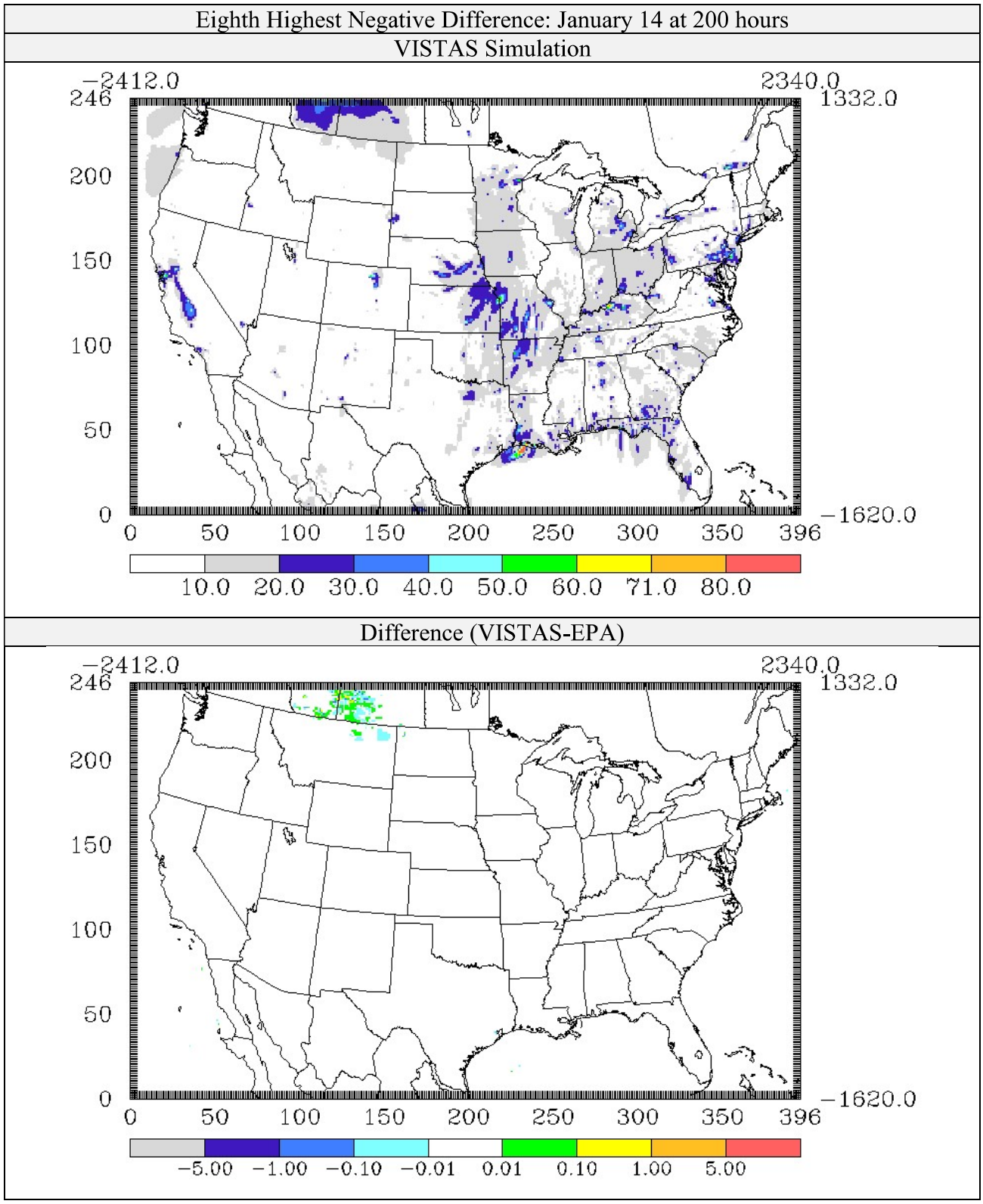

Figure 4-39: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)

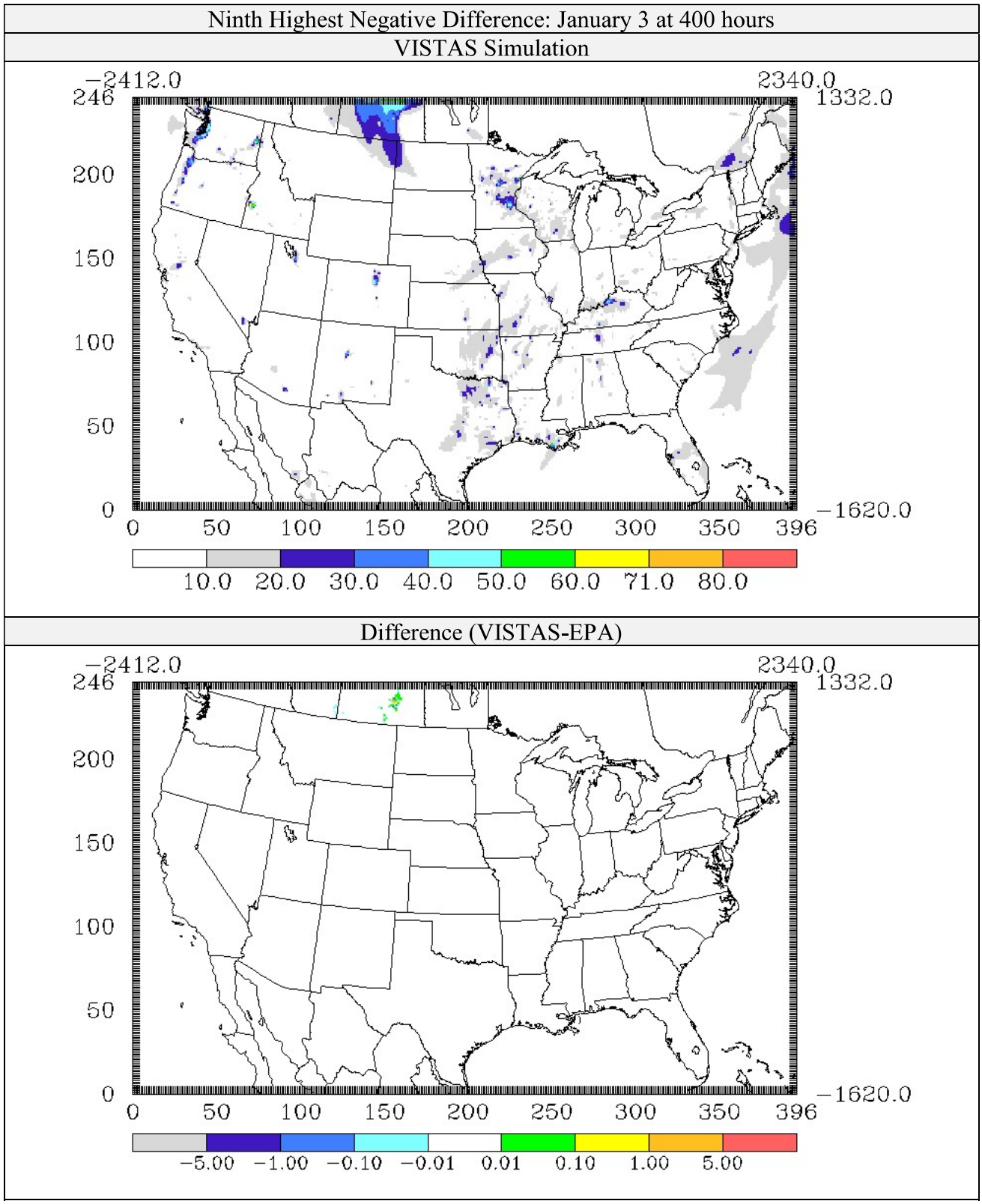

Figure 4-40: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)

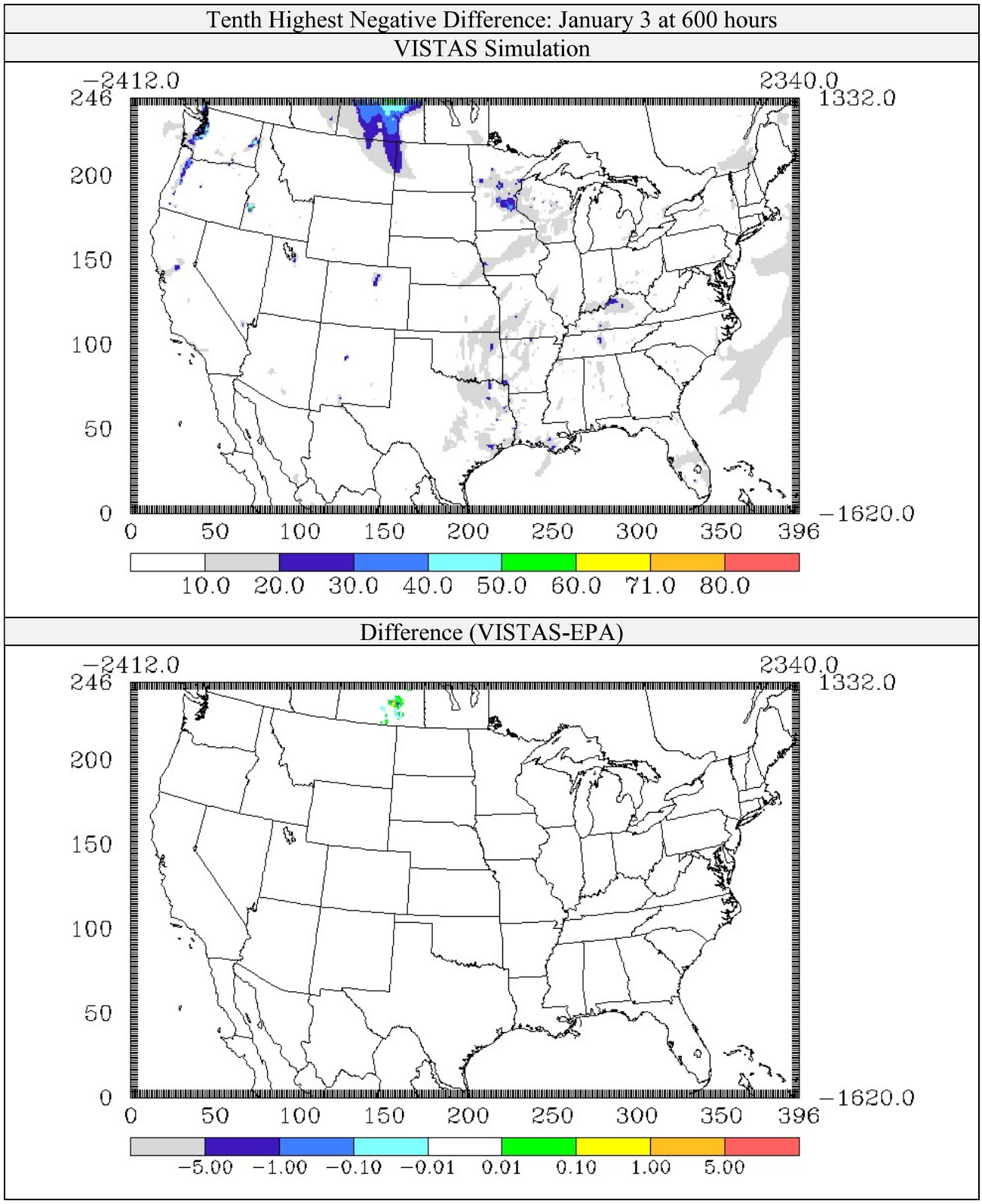

Figure 4-41: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Negative Difference)

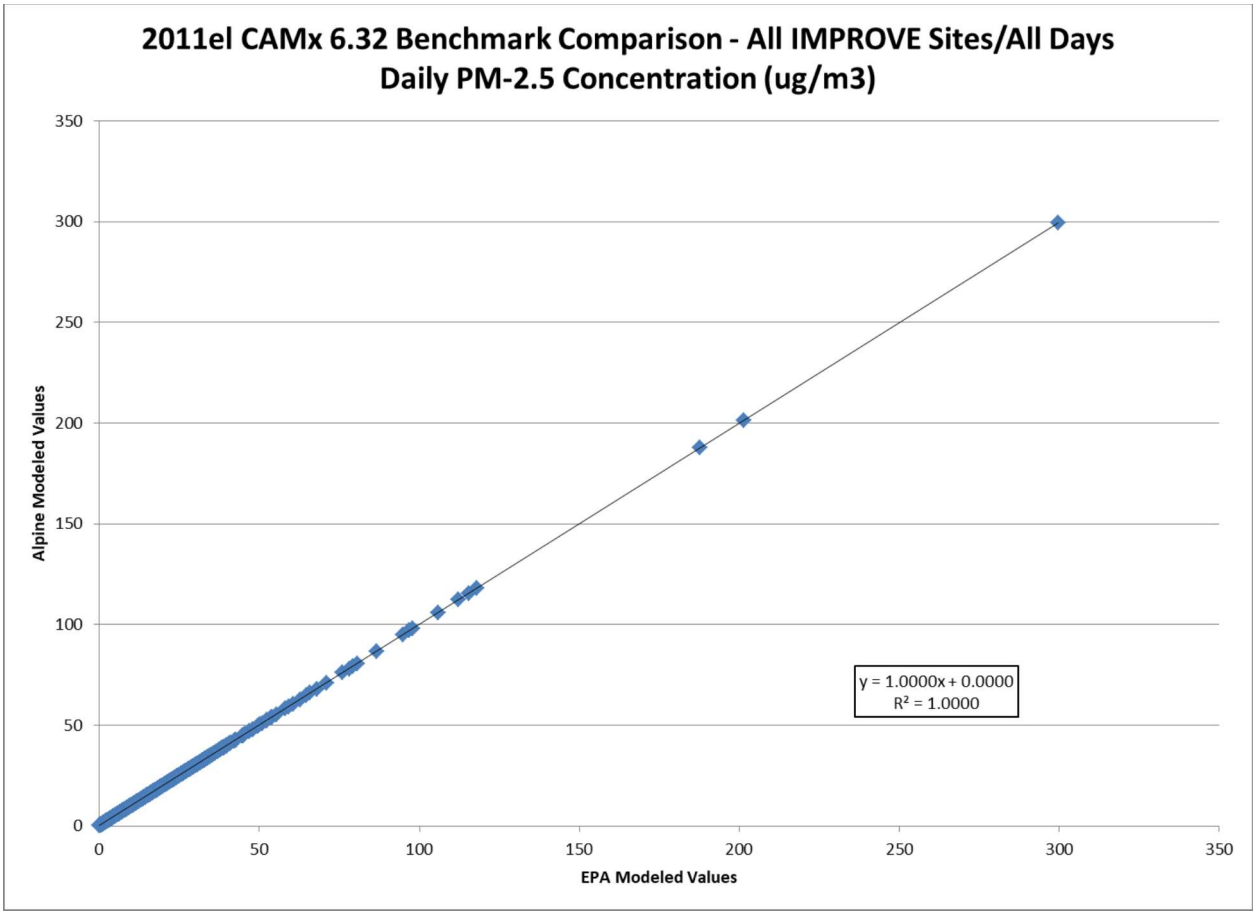

Figure 4-42: Scatterplot Comparing 24-hour Average Predicted $PM_{2.5}$ Concentrations ($\mu g/m^3$) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2011el Simulations Performed by EPA and VISTAS (Alpine).

4.3 Sulfate

Sulfate results for the top 10 positive and negative hours are presented in tabular format in Table 4-3. The maximum positive difference is 0.31 µg/m^3 falling to 0.19 µg/m^3 for the 10th high. The maximum negative difference is -0.40 µg/m^3 falling to -0.14 µg/m^3 for the 10th high. The maximum positive percent difference from these days is 15.09% and negative percent difference of -18.5%.

The top 10 positive impact hours are presented in Figures 4-43 through 4-52 and the top 10 negative impact hours are presented in Figures 4-53 through 4-62. The locations of the impacts are considerably more localized than the nitrate differences, and are not occurring in any systematic location, but are tending to occur in the colder months. The area of the differences does not appear to be correlated with areas of high sulfate concentrations.

Scatterplots of the daily average sulfate concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-63. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Table 4-3. Comparison of 2011el CAMx 6.32 Simulation Sulfate Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	12	31	16	14.98	14.67	0.31	2.12%	247	47
2011	11	29	15	4.91	4.60	0.31	6.74%	206	155
2011	1	10	3	2.20	1.91	0.29	15.09%	259	174
2011	12	31	15	14.06	13.78	0.28	2.06%	247	47
2011	12	14	22	6.46	6.18	0.28	4.54%	282	175
2011	4	9	9	6.40	6.14	0.26	4.21%	156	210
2011	4	8	2	7.66	7.41	0.25	3.31%	172	229
2011	11	29	16	4.44	4.22	0.23	5.36%	206	153
2011	4	9	10	6.46	6.23	0.22	3.57%	156	209
2011	4	9	8	6.19	6.00	0.19	3.19%	156	211
Maximum Negative									
2011	12	6	0	5.65	6.05	-0.40	-6.55%	364	164
2011	12	14	22	5.28	5.63	-0.35	-6.22%	282	173
2011	12	6	1	5.48	5.77	-0.30	-5.13%	364	164
2011	2	6	17	3.72	3.95	-0.23	-5.79%	211	140
2011	5	28	7	2.39	2.61	-0.22	-8.39%	336	186
2011	2	6	16	3.11	3.29	-0.17	-5.29%	211	141
2011	5	14	7	0.64	0.79	-0.15	-18.53%	354	236
2011	12	18	11	3.06	3.21	-0.14	-4.51%	282	115
2011	12	29	16	4.24	4.38	-0.14	-3.28%	209	194
2011	12	30	11	2.82	2.95	-0.14	-4.68%	313	178

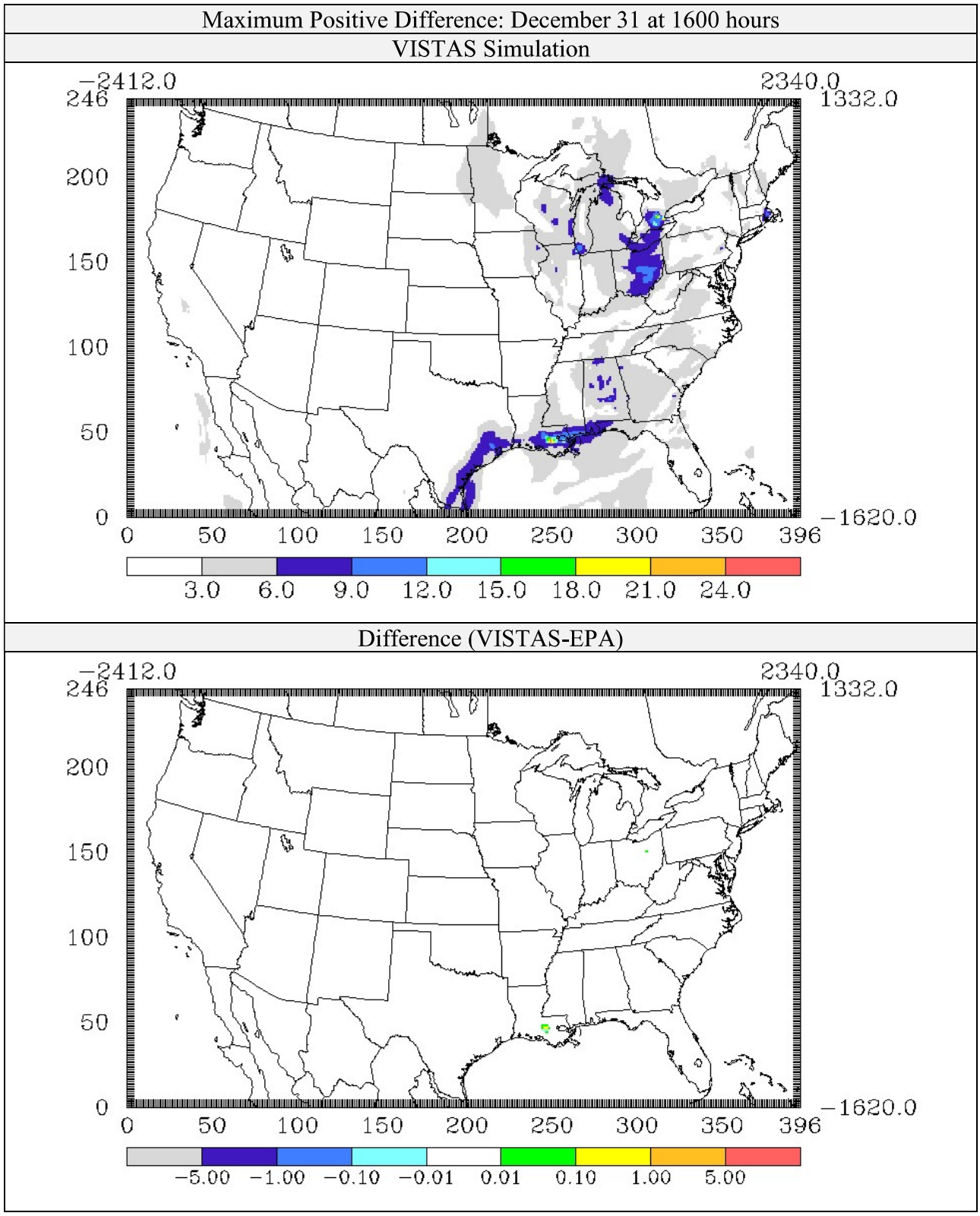

Figure 4-43: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)

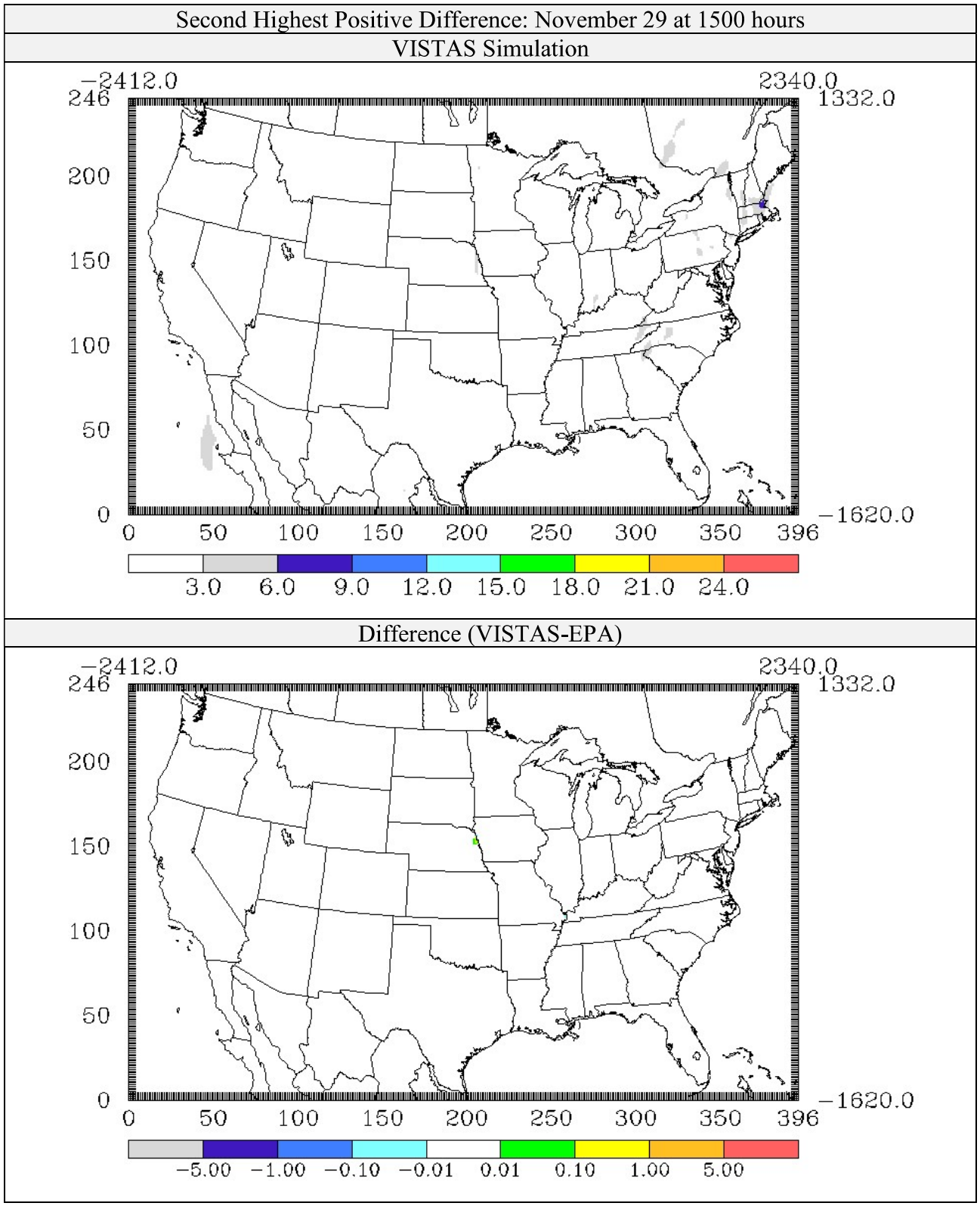

Figure 4-44: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)

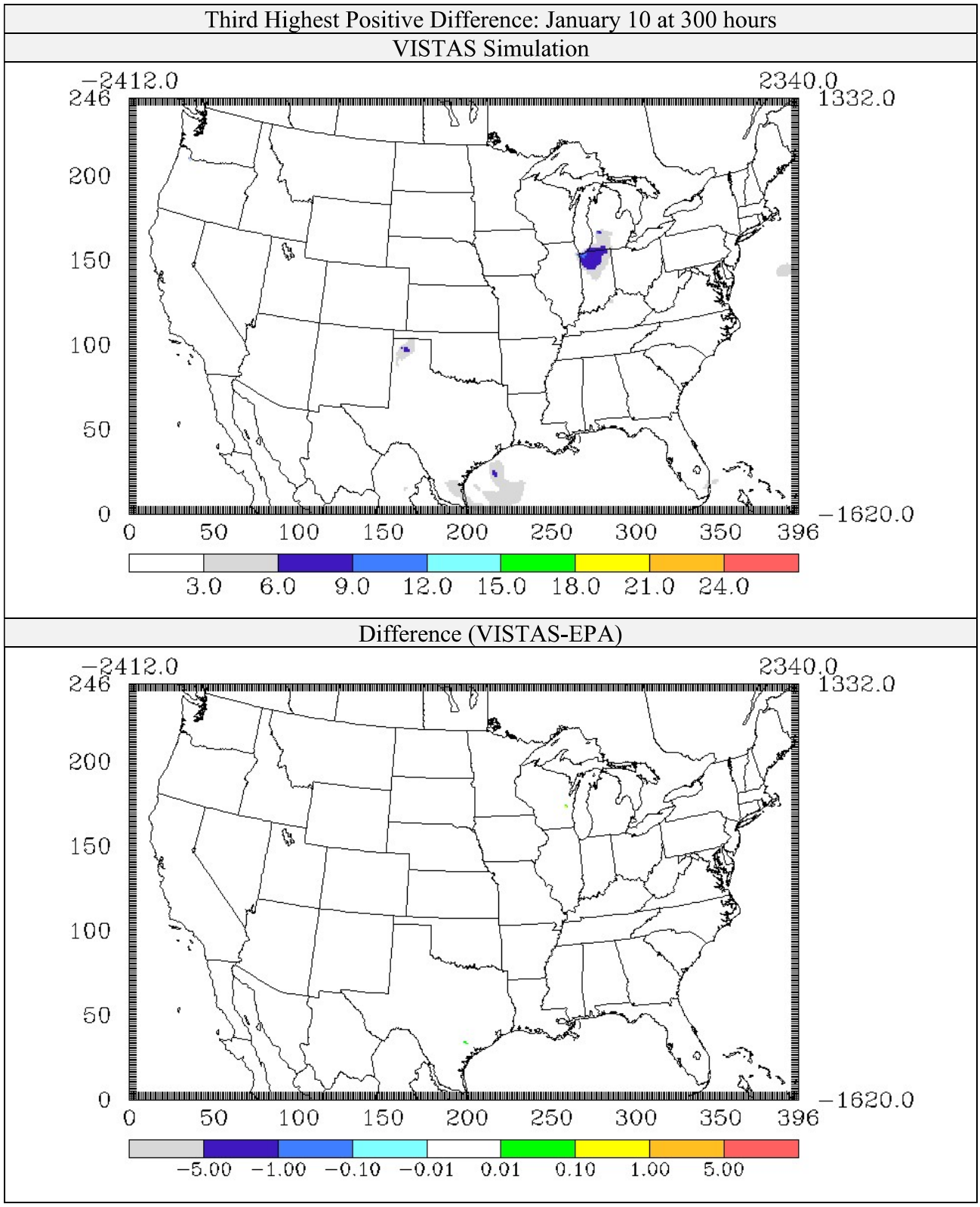

Figure 4-45: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)

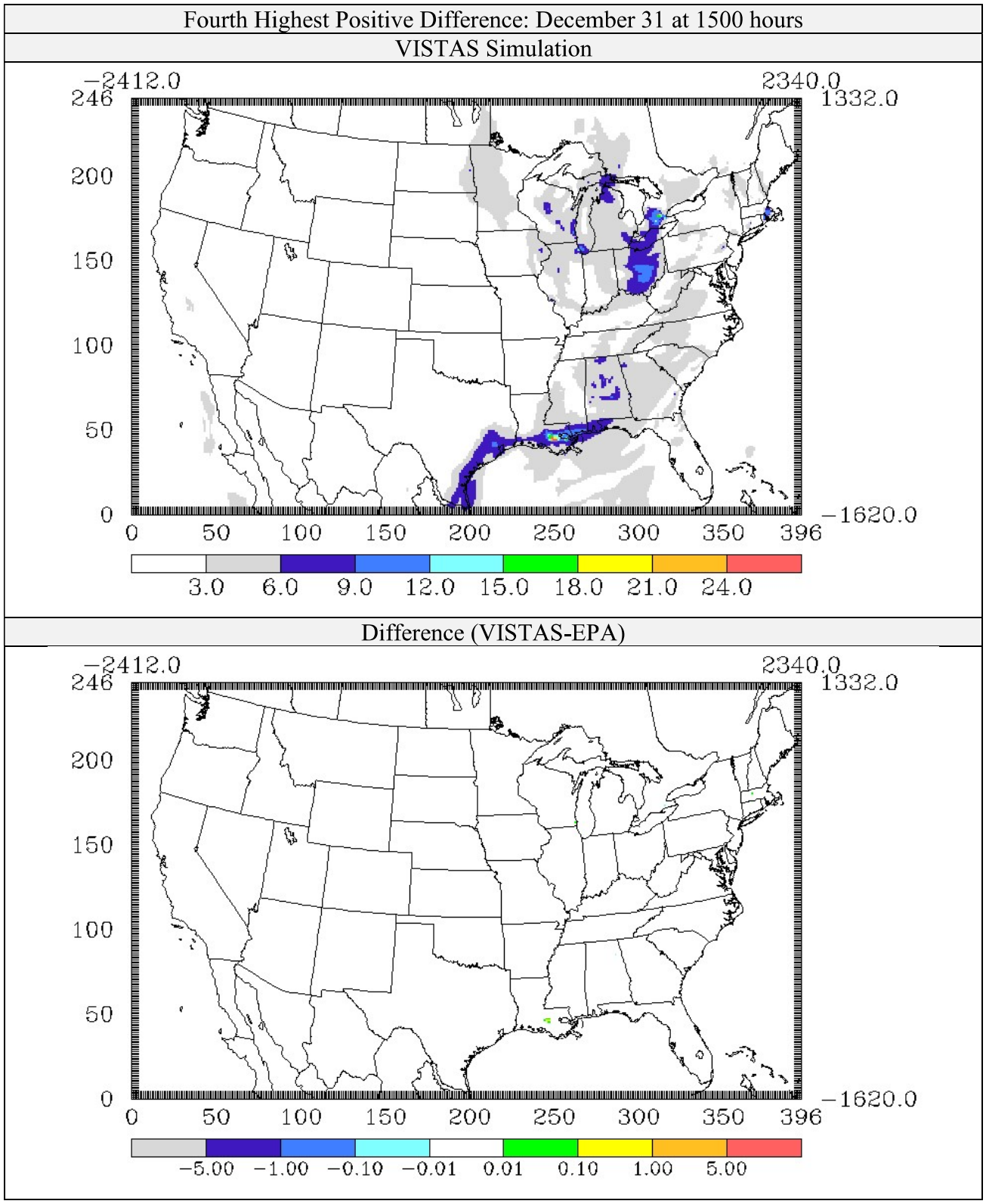

Figure 4-46: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)

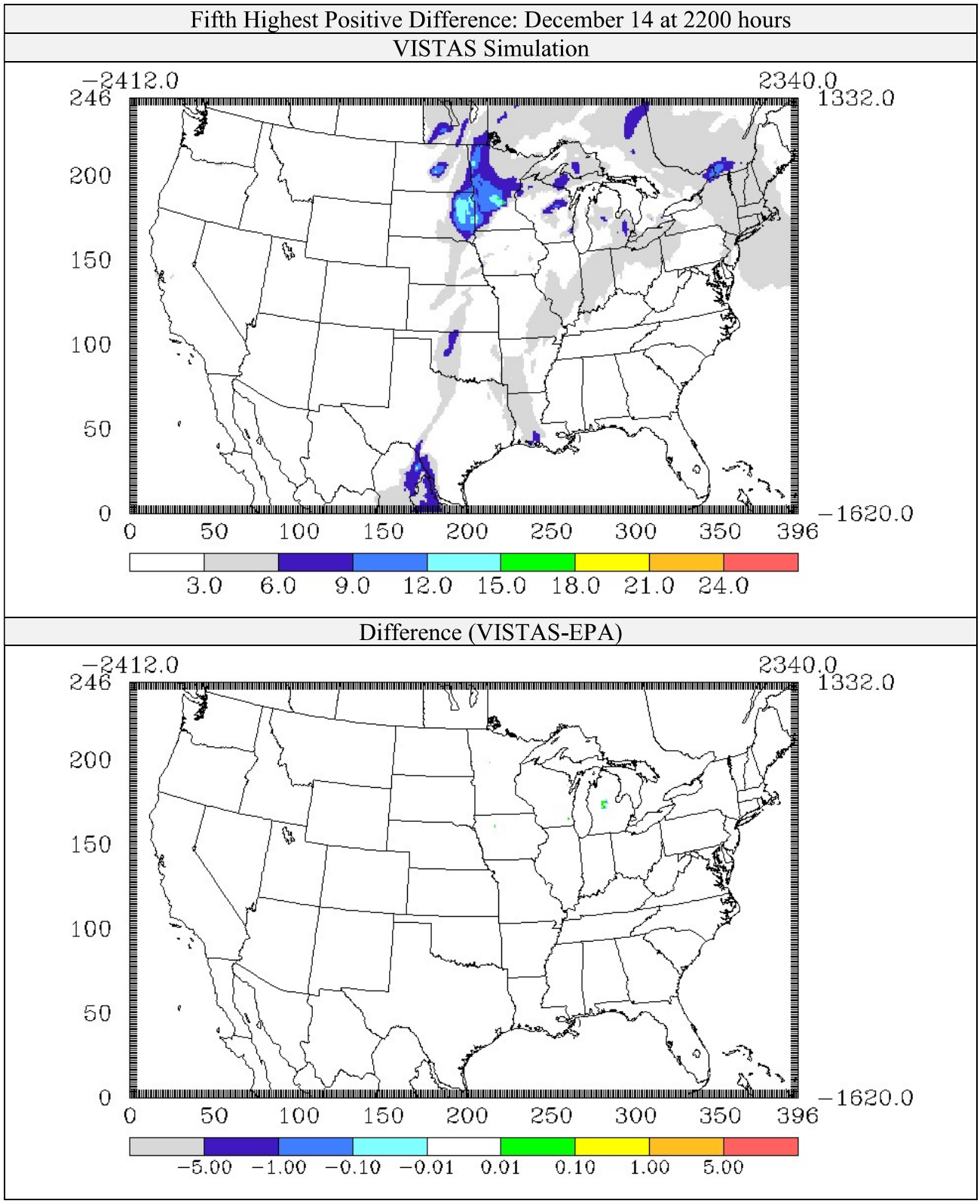

Figure 4-47: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)

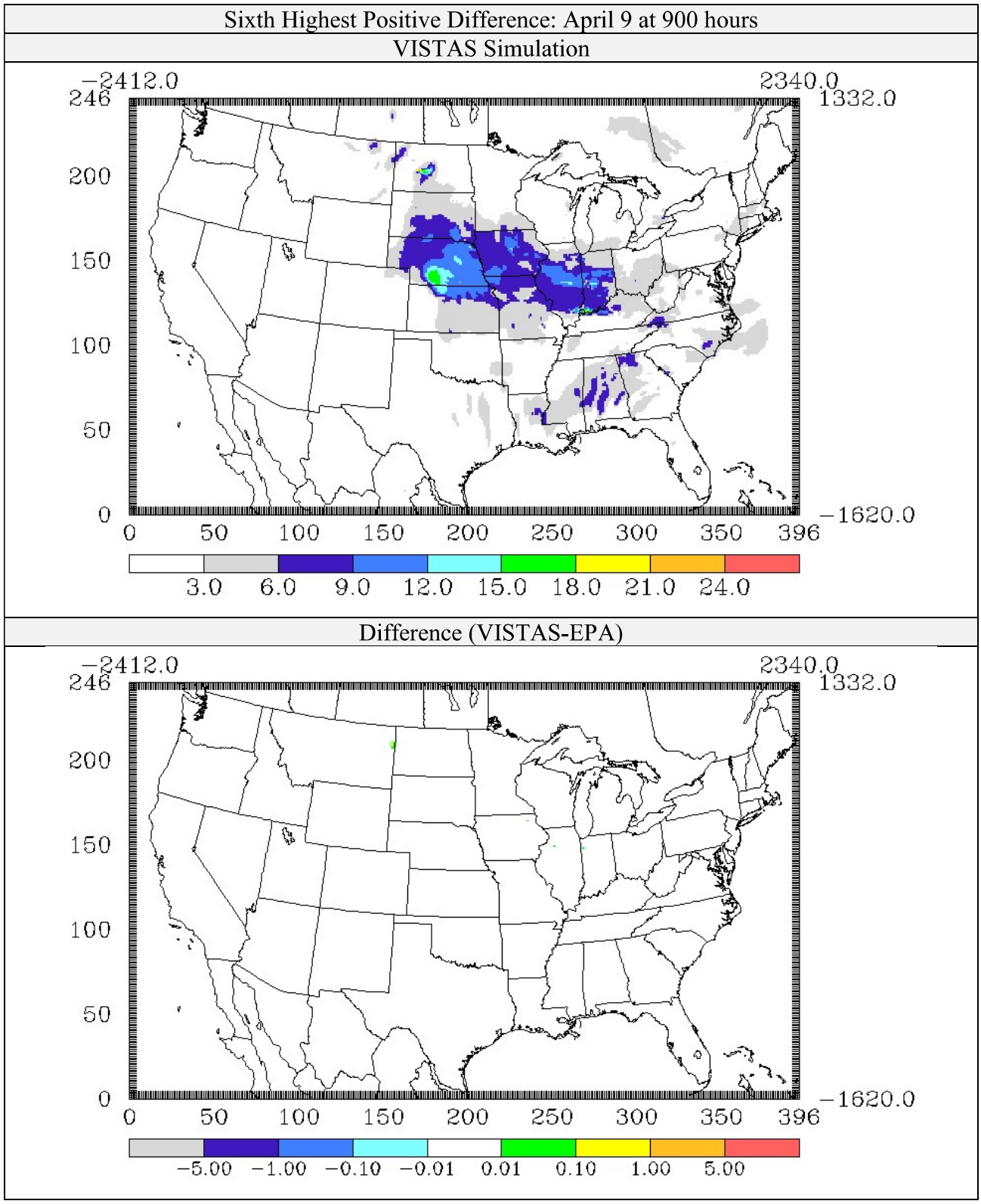

Figure 4-48: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)

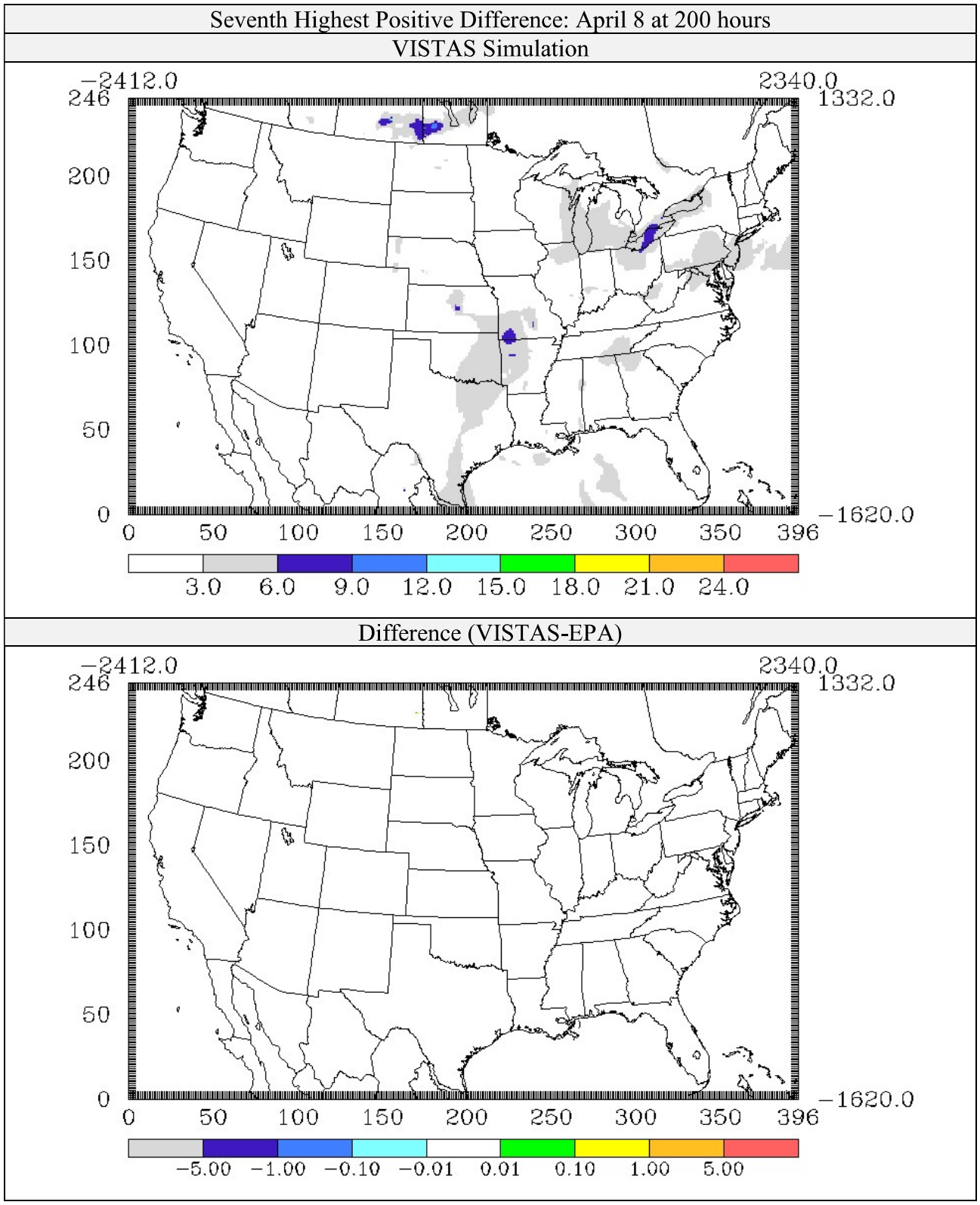

Figure 4-49: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)

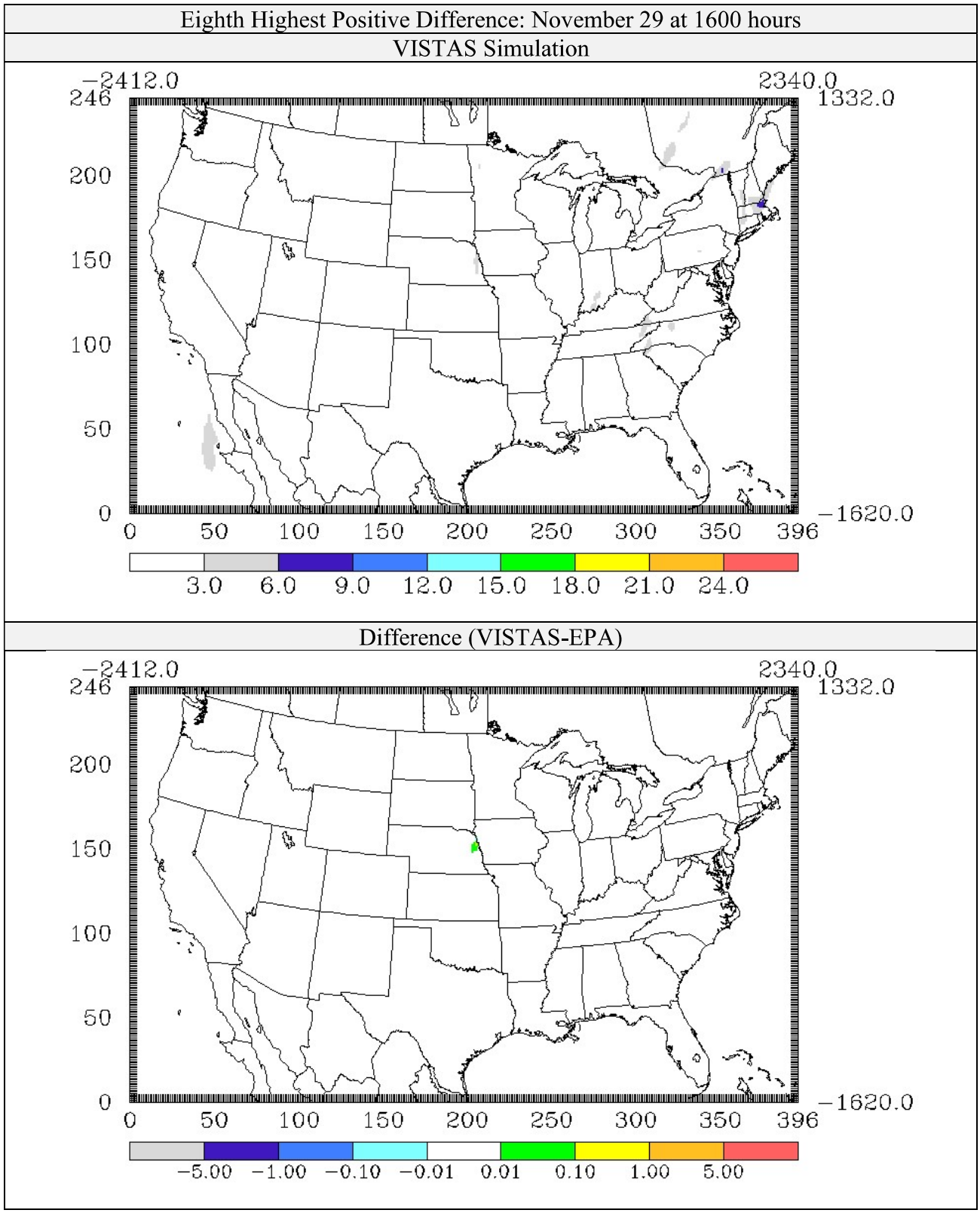

Figure 4-50: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)

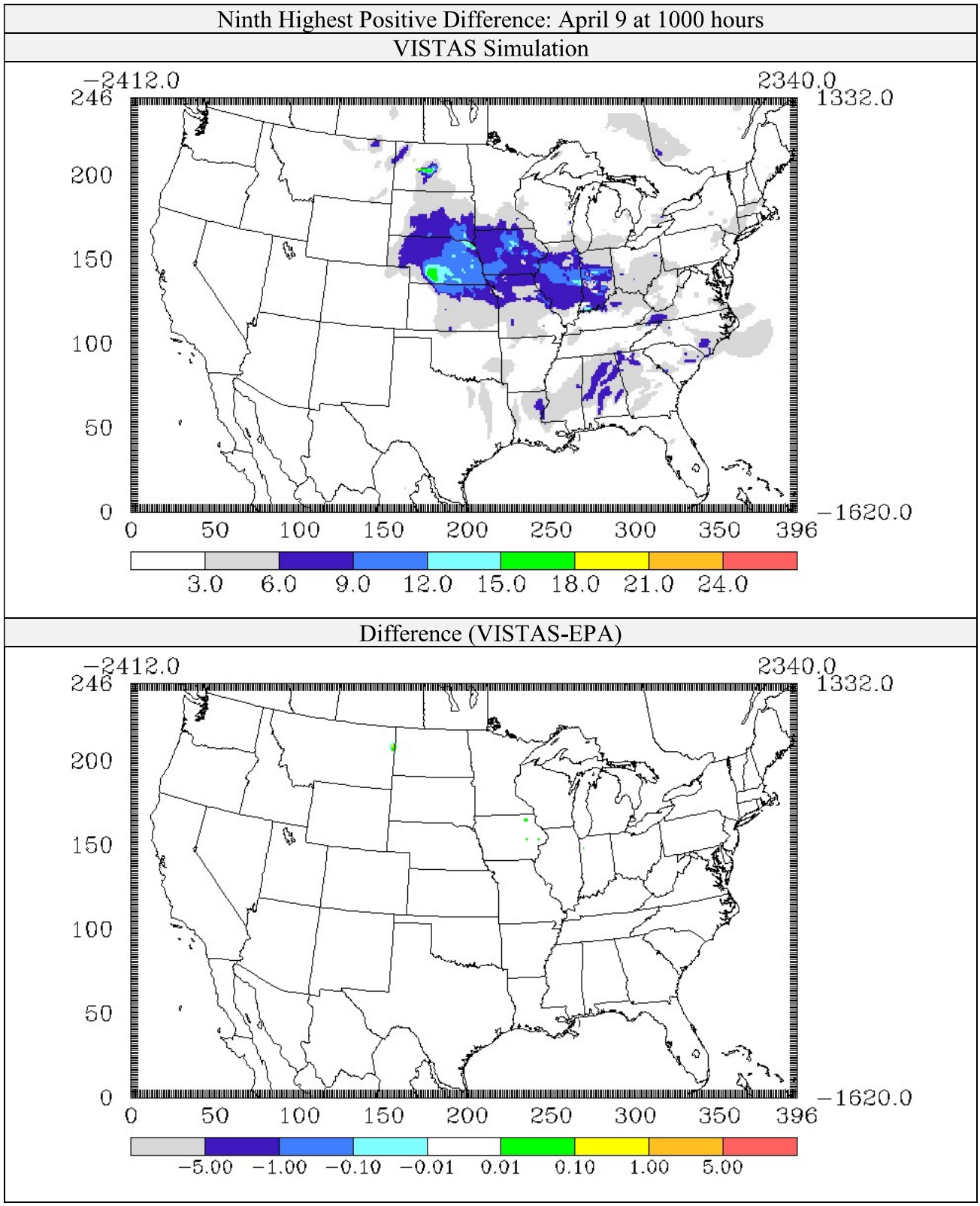

Figure 4-51: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)

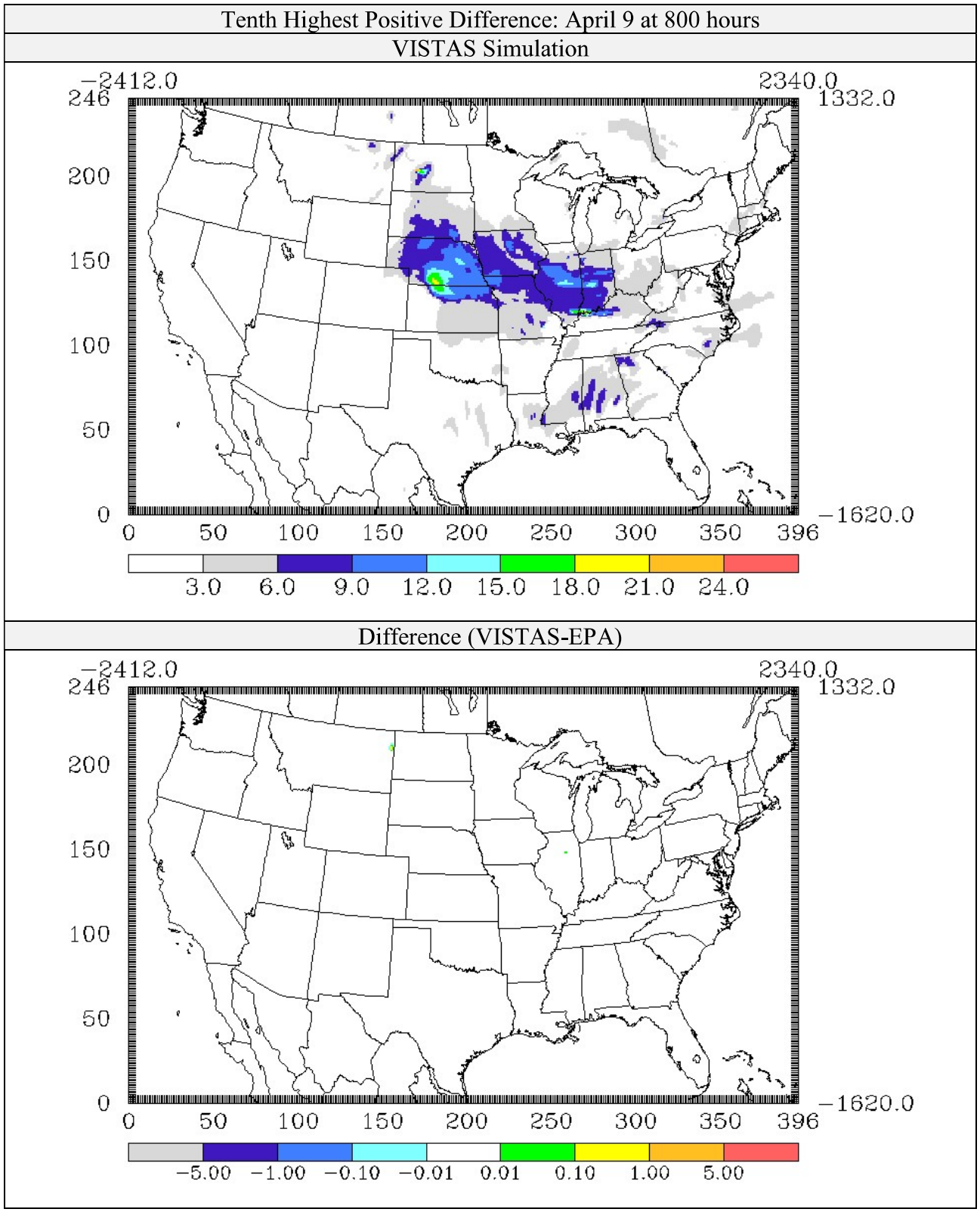

Figure 4-52: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)

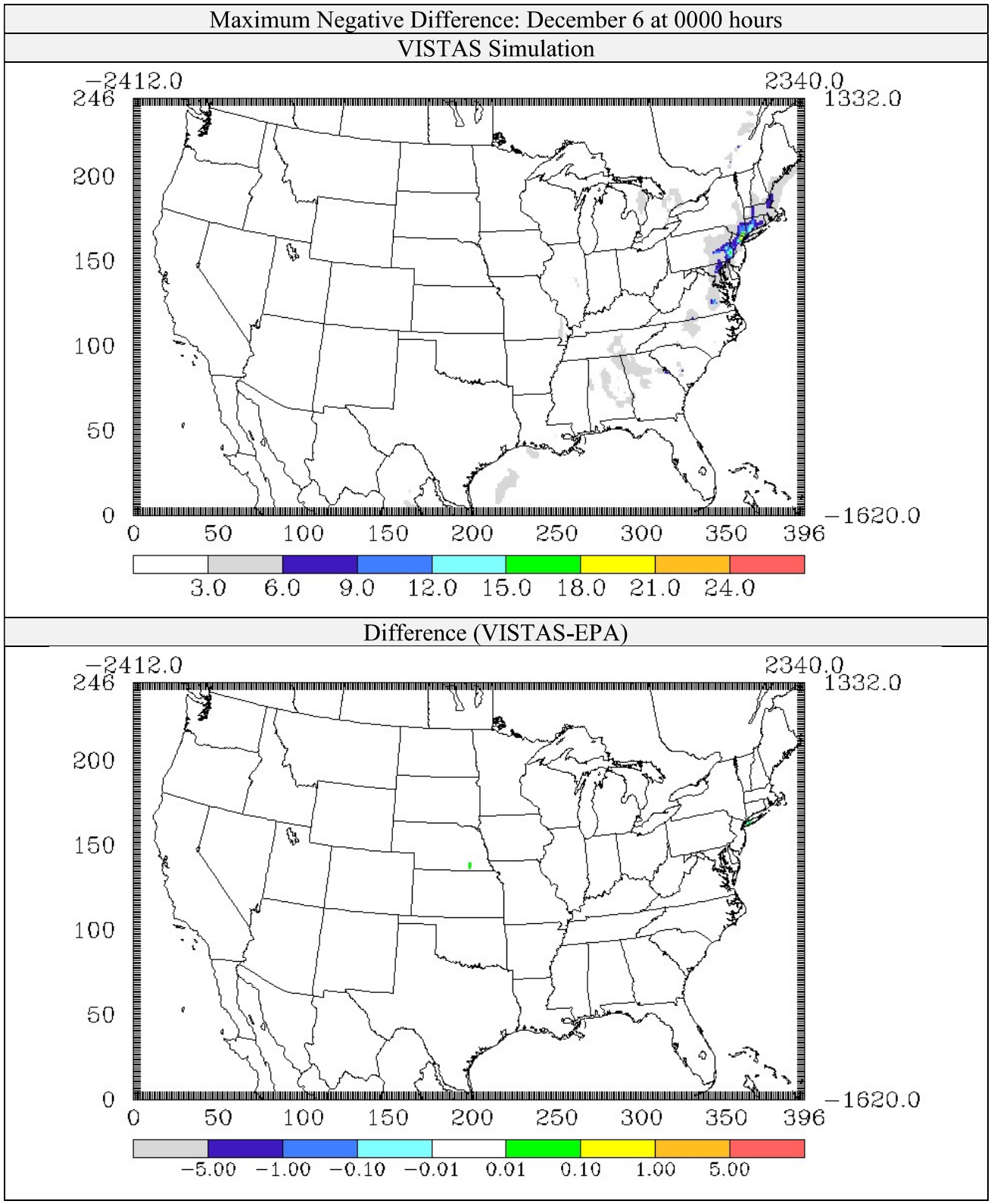

Figure 4-53: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)

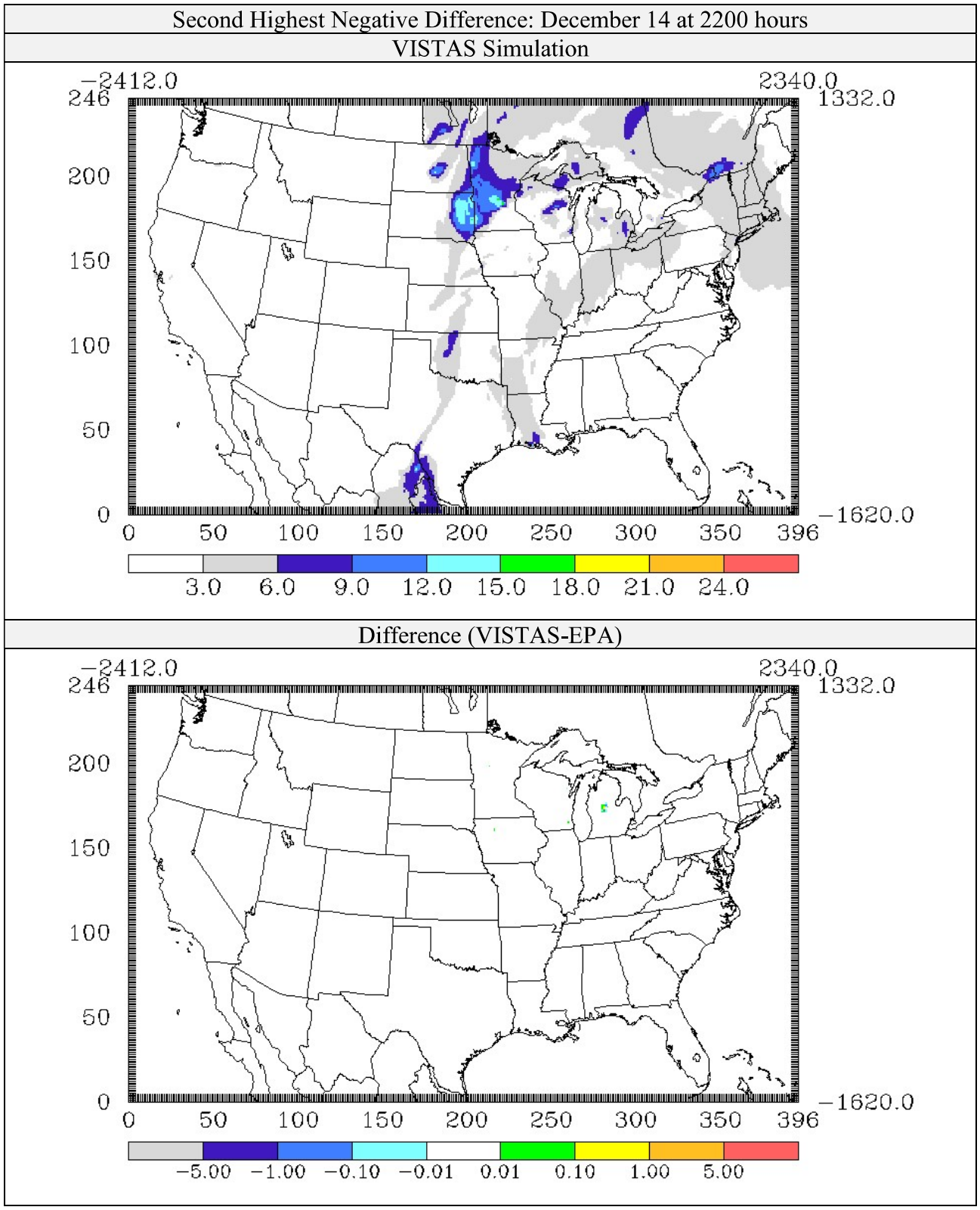

Figure 4-54: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)

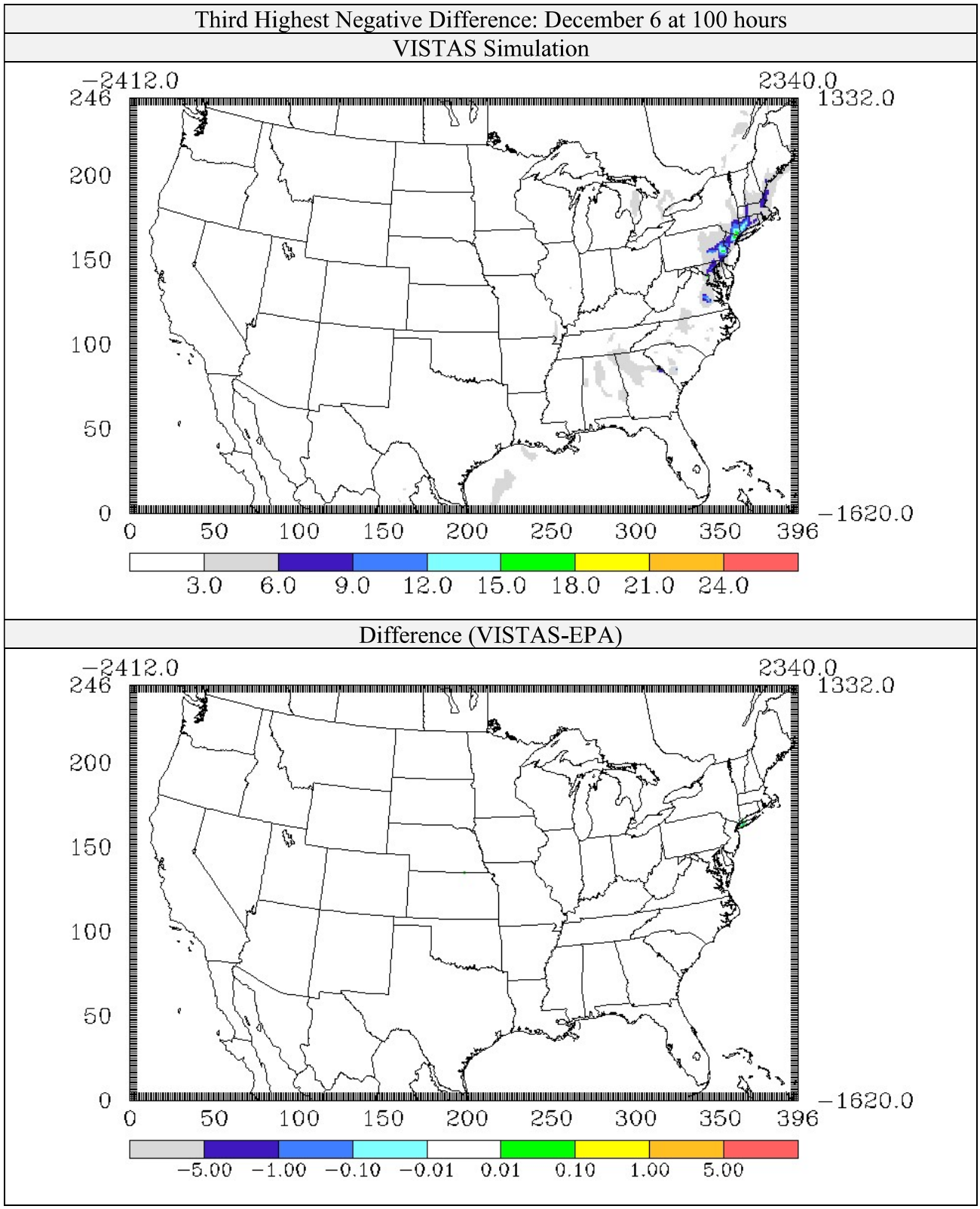

Figure 4-55: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)

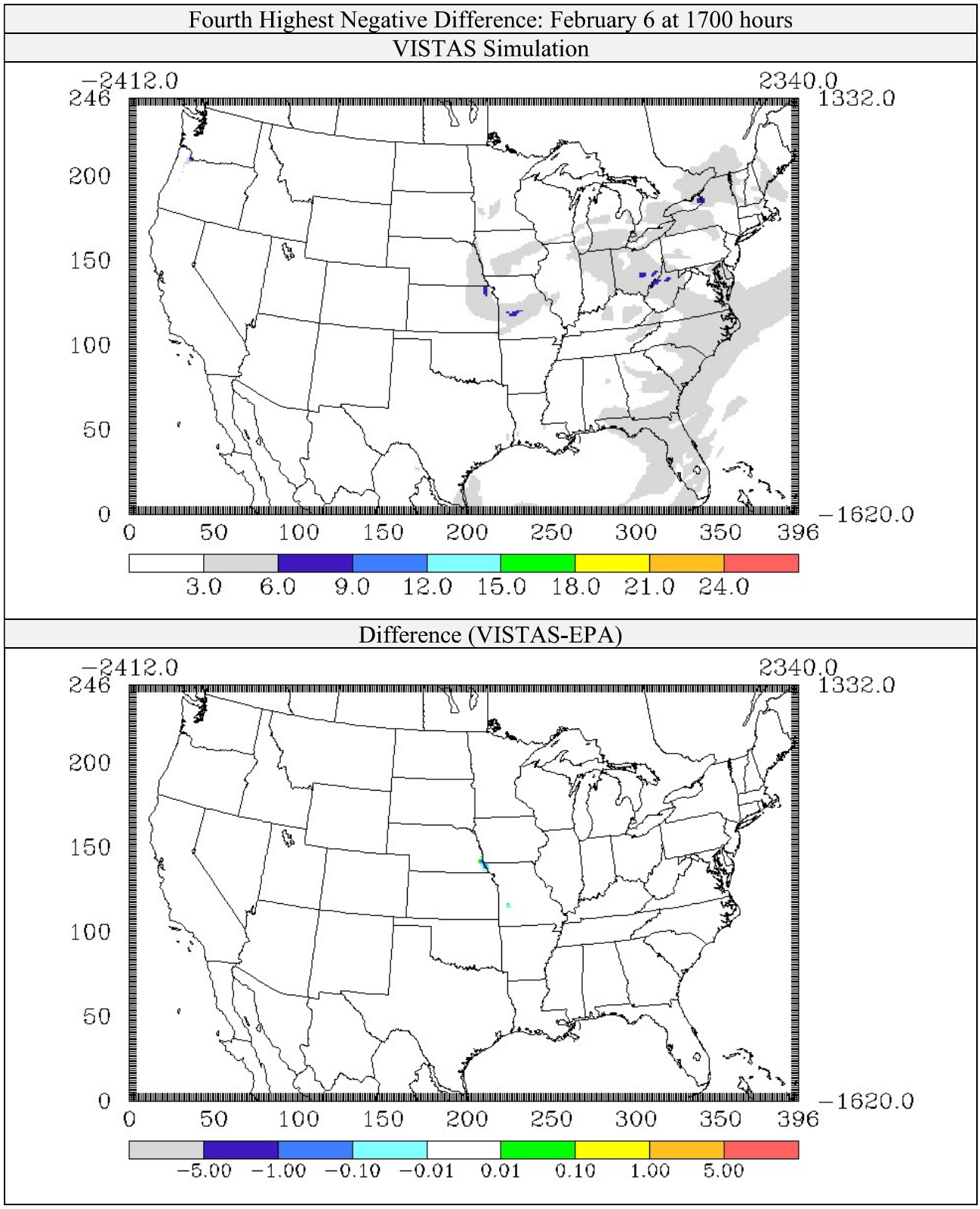

Figure 4-56: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)

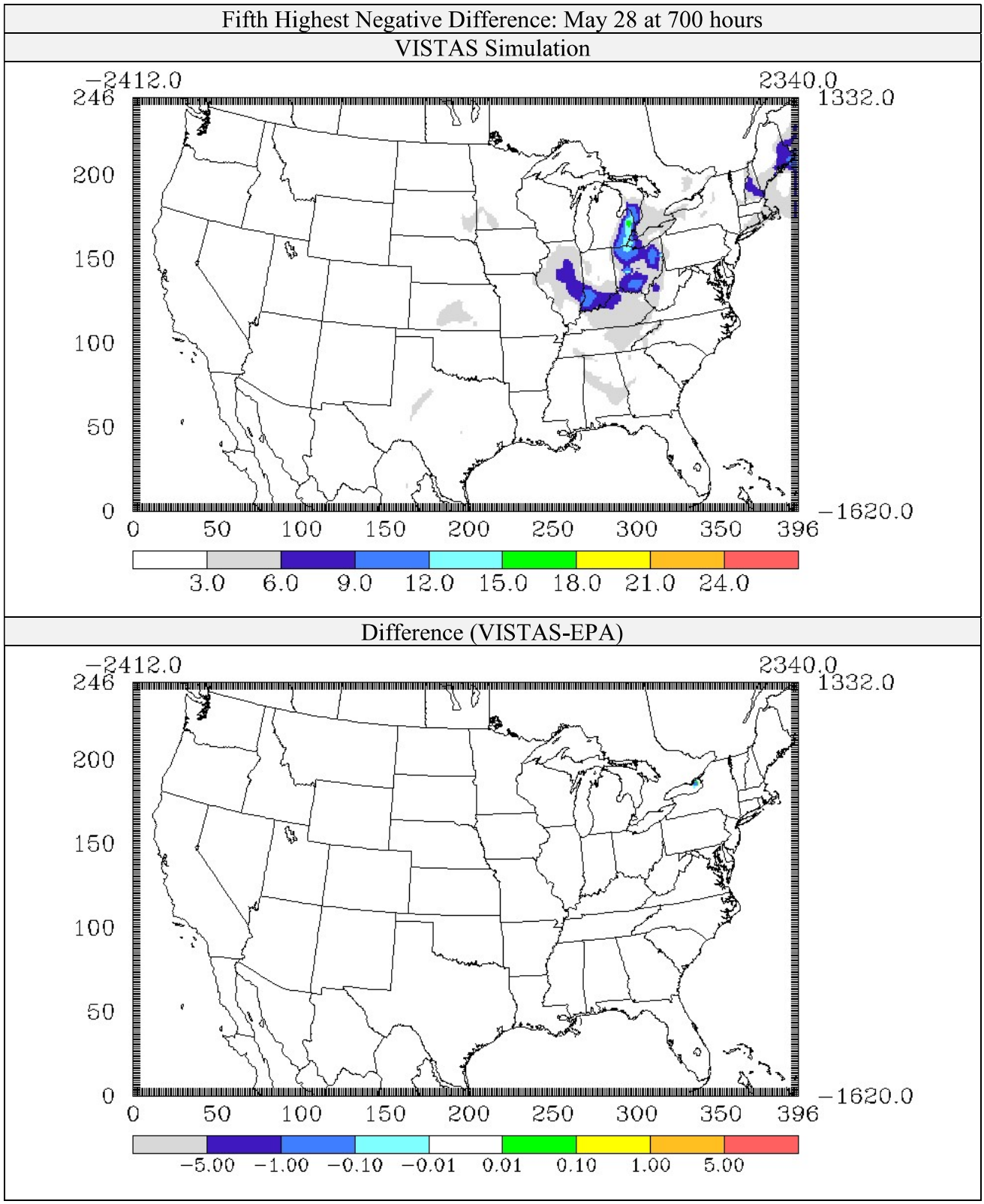

Figure 4-57: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)

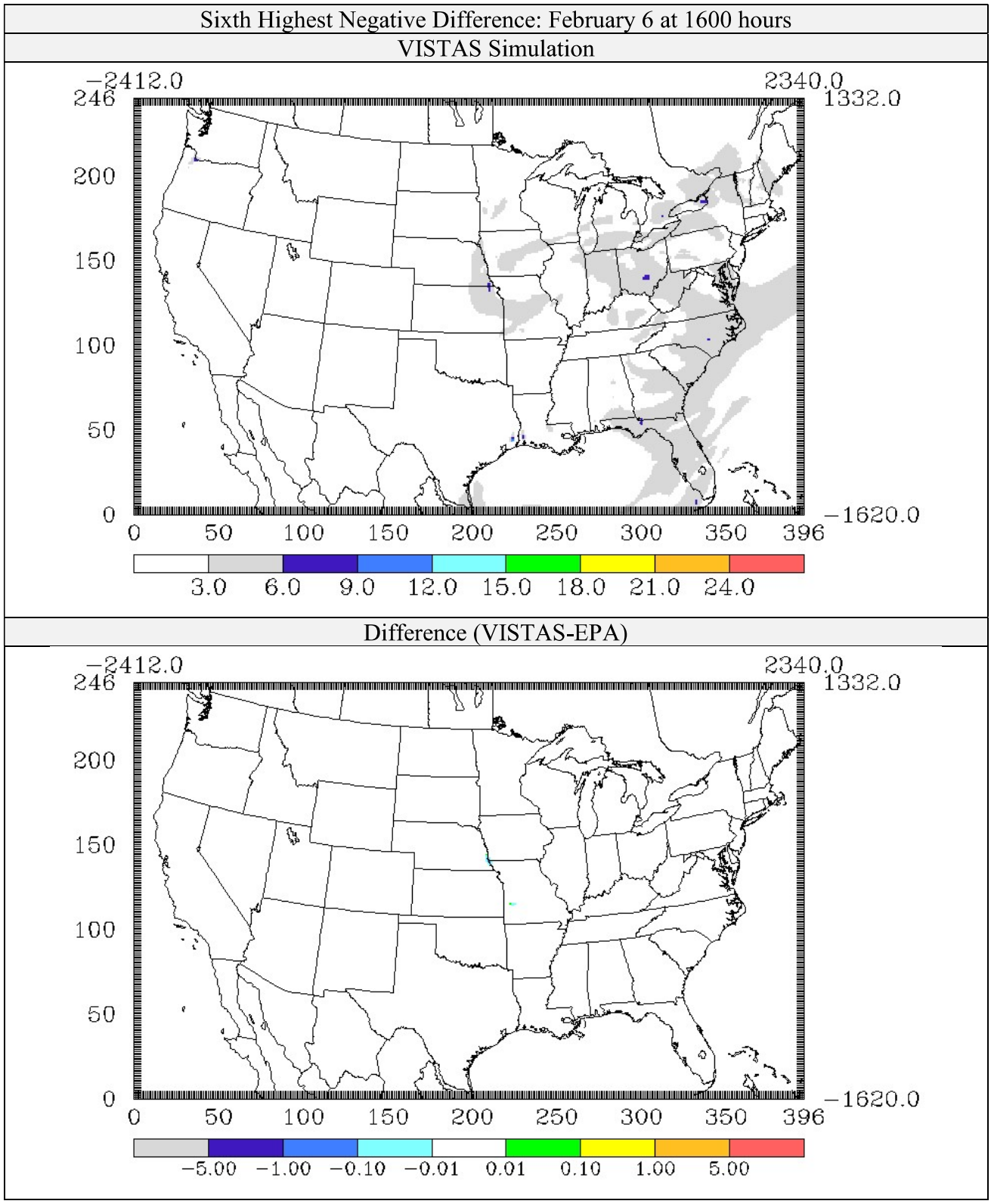

Figure 4-58: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)

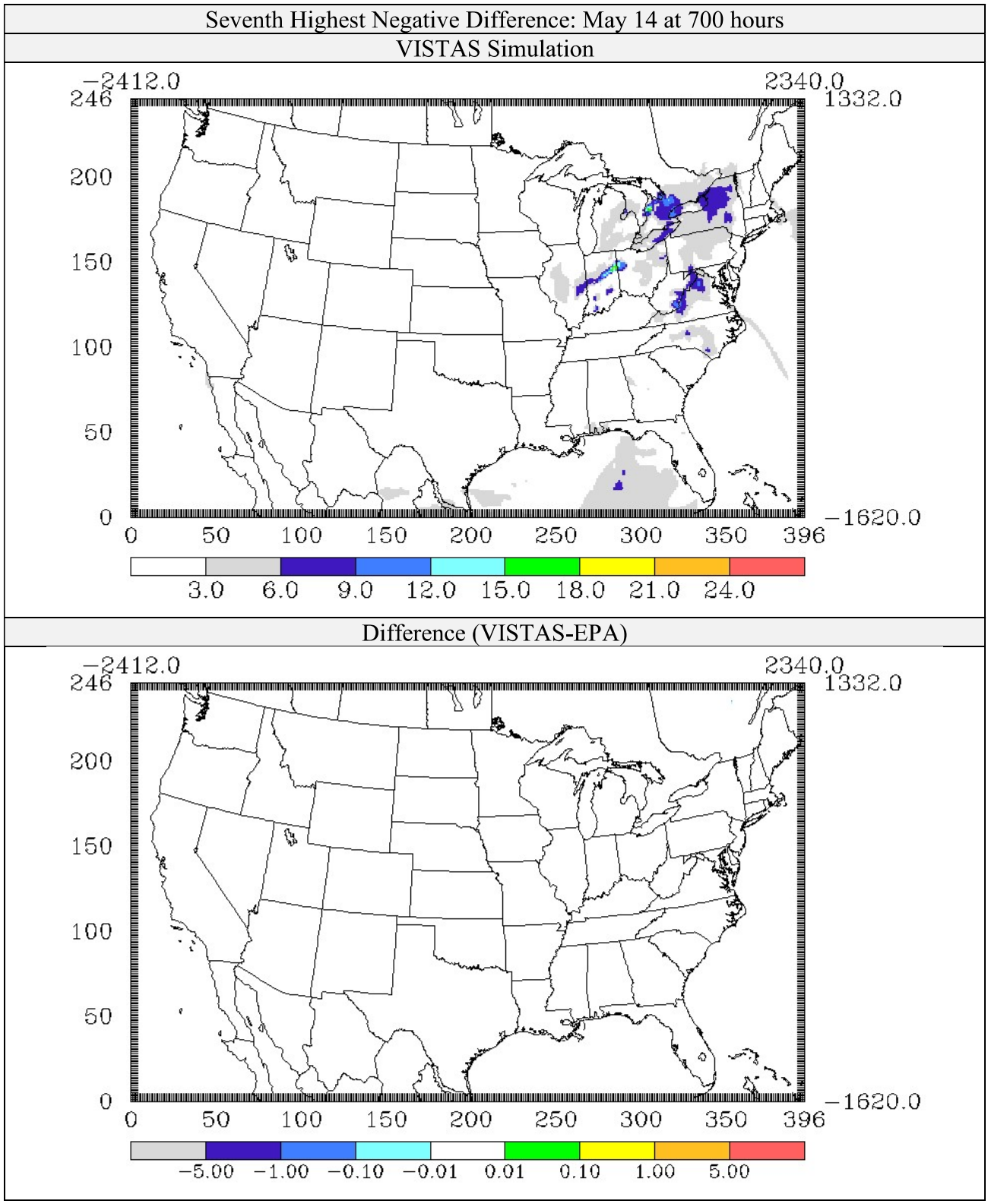

Figure 4-59: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)

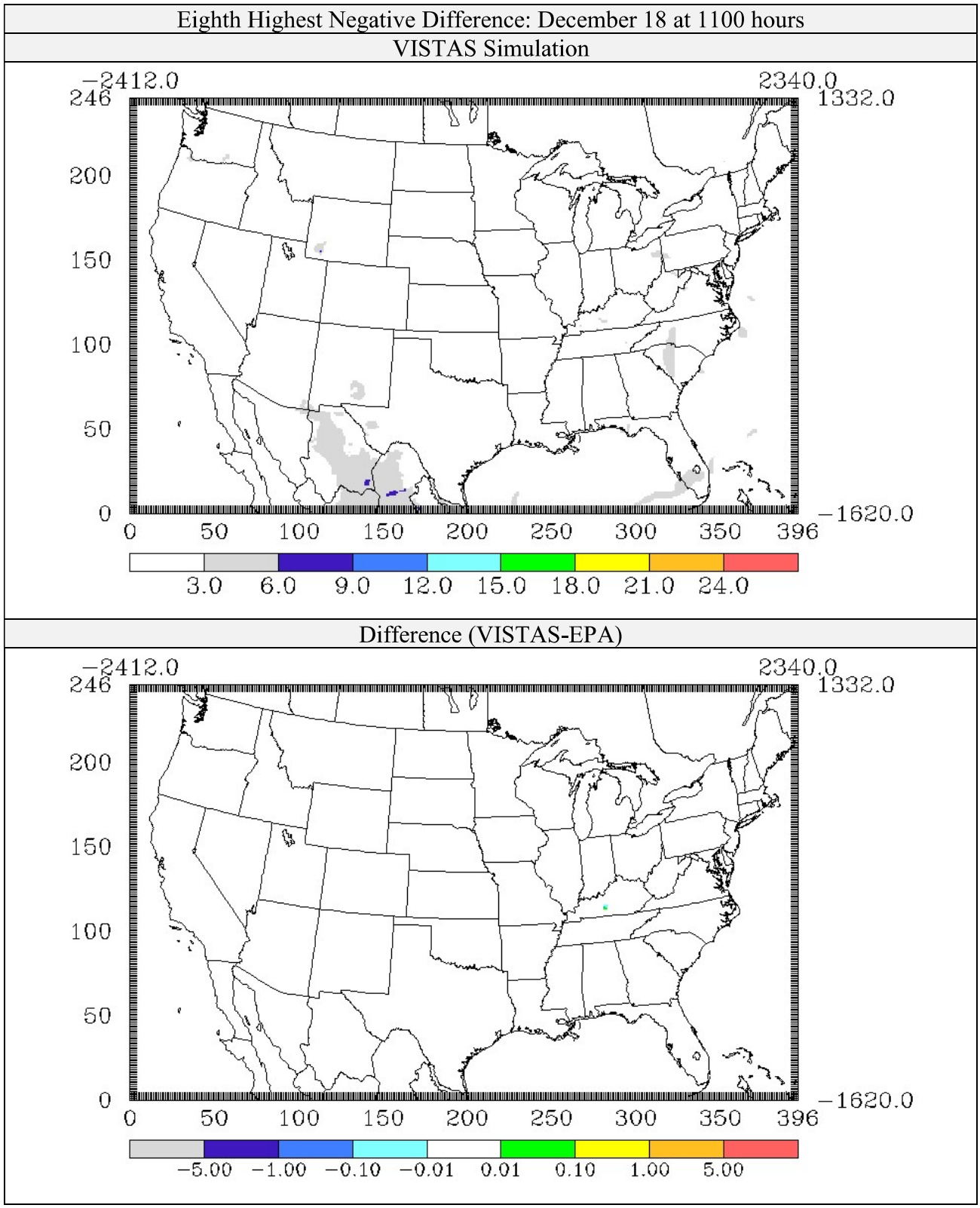

Figure 4-60: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)

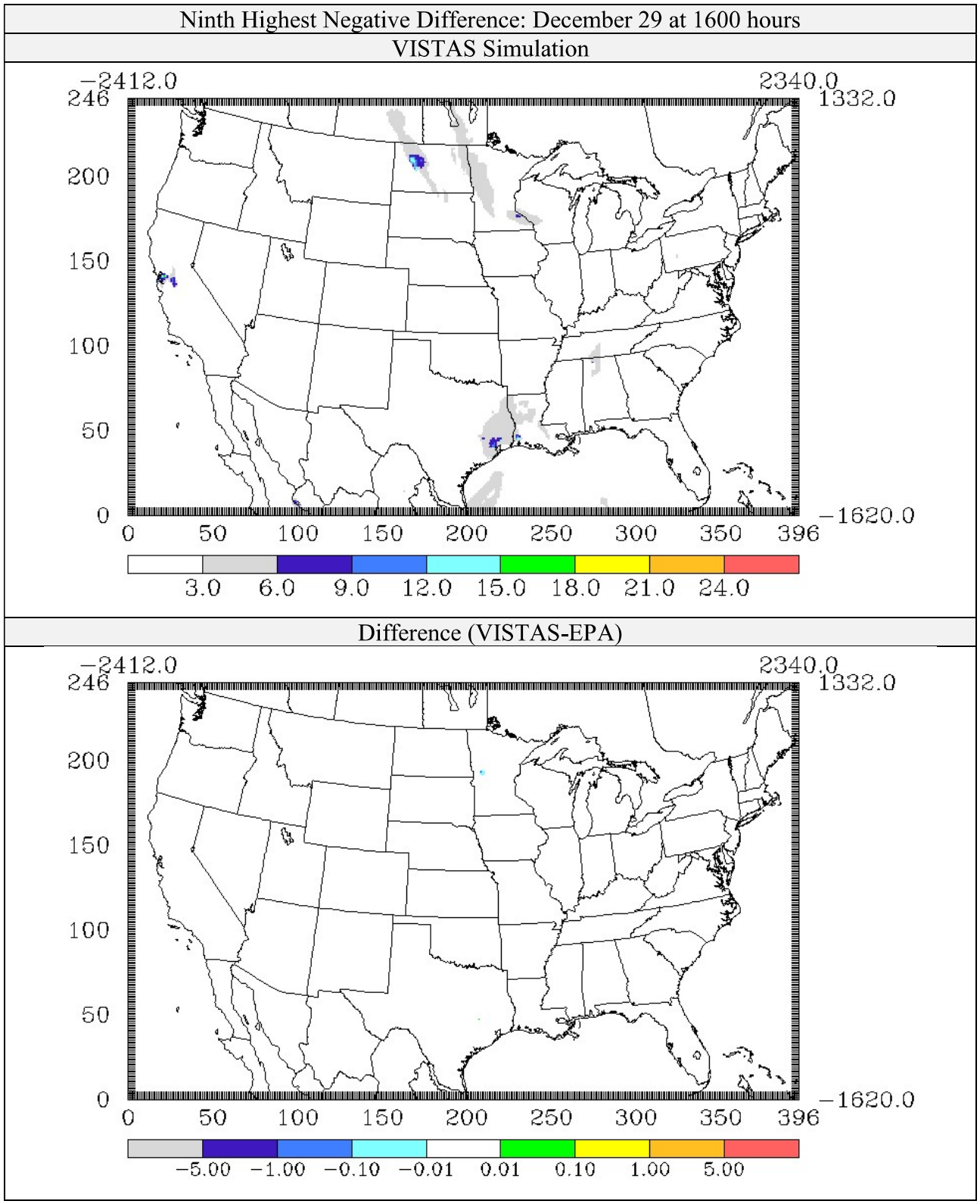

Figure 4-61: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)

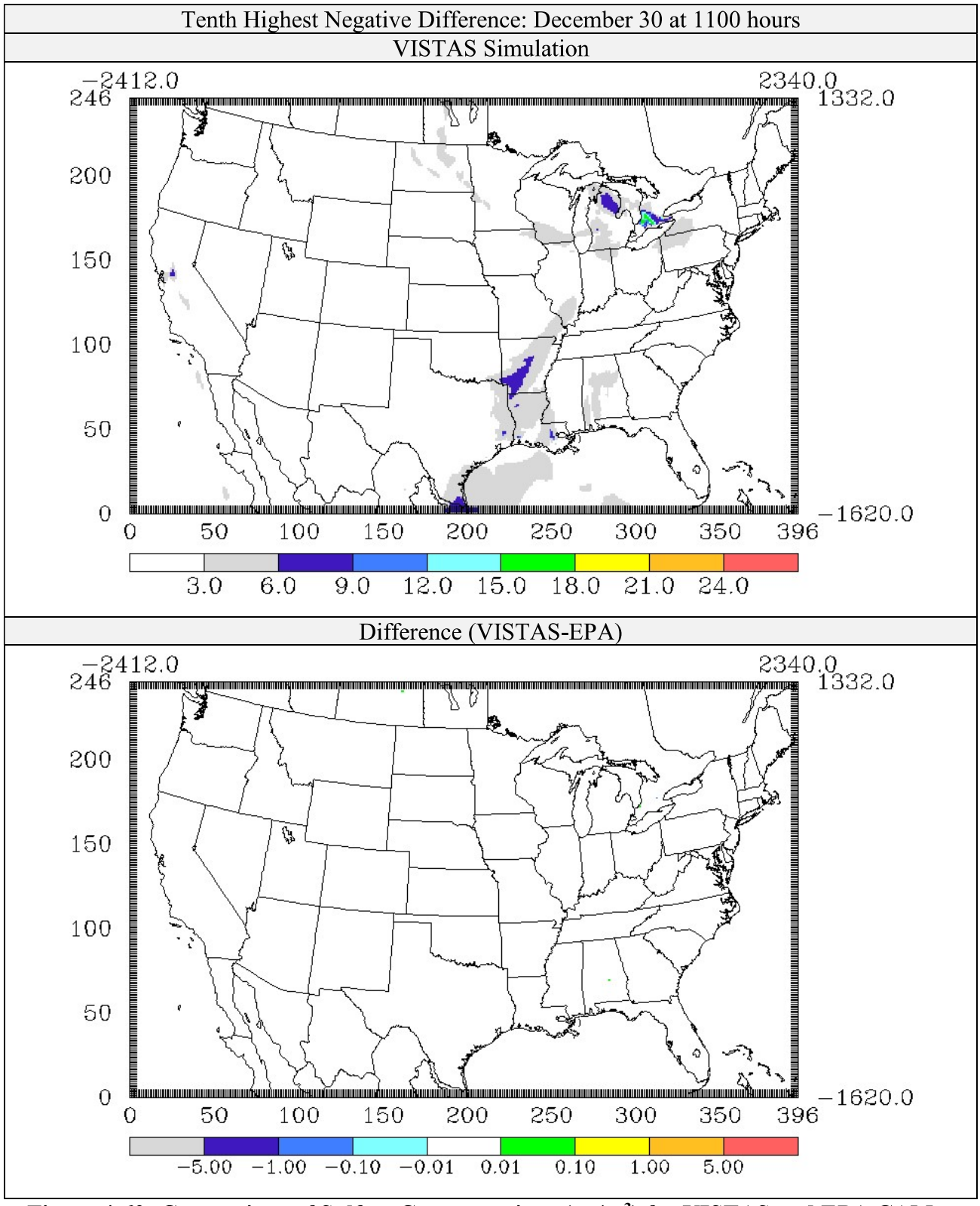

Figure 4-62: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Negative Difference)

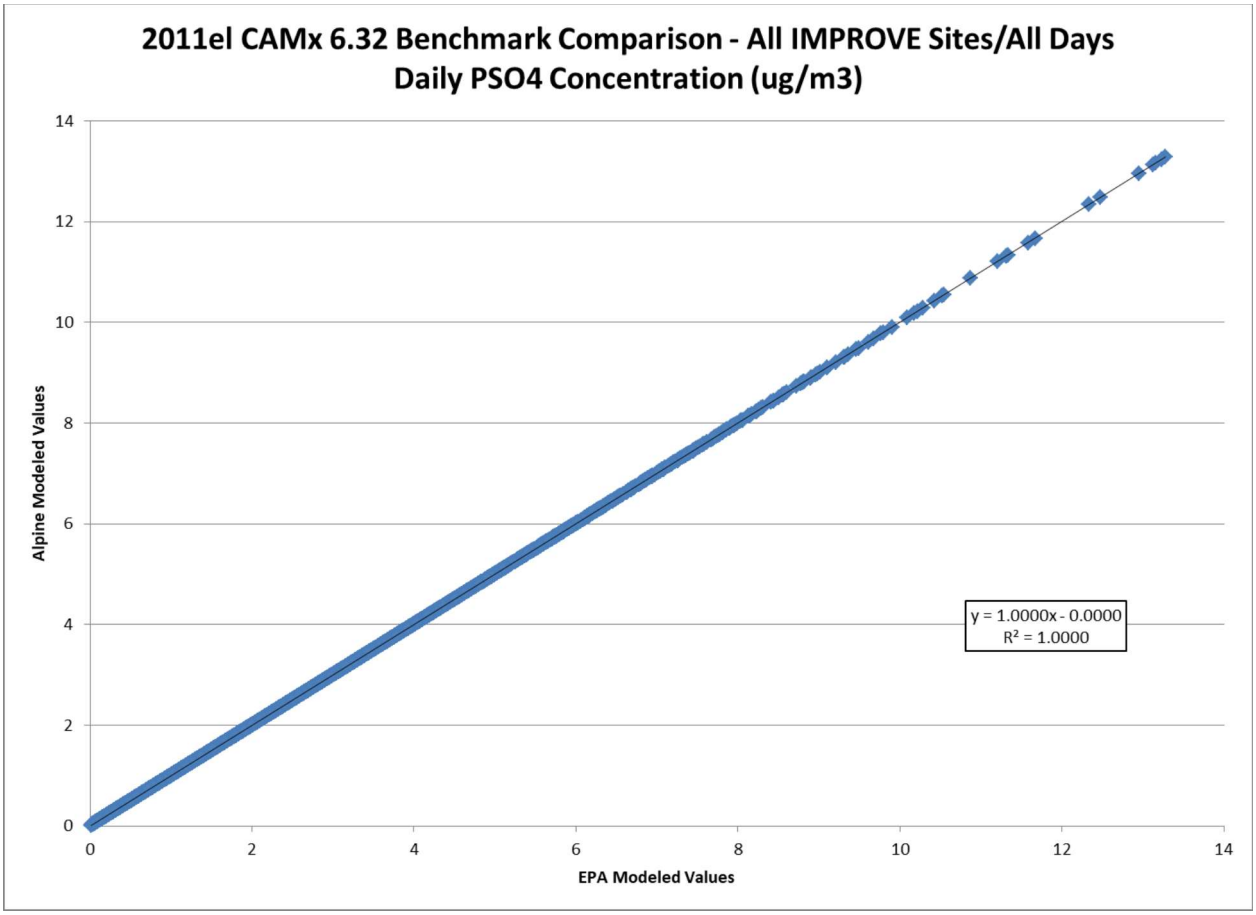

Figure 4-63: Scatterplot Comparing 24-hour Average Predicted Sulfate Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2011el Simulations Performed by EPA and VISTAS (Alpine).

4.4 Nitrate

Nitrate results for the top 10 positive and negative hours are presented in tabular format in Table 4-4. The maximum positive difference is 5.34 µg/m^3 falling to 1.93 µg/m^3 for the 10th high. The maximum negative difference is -4.20 µg/m^3 falling to -1.65 µg/m^3 for the 10th high. The maximum positive percent difference from these days is 110.0% and negative percent difference of -54.5%, both on low Nitrate concentration days.

The top 10 positive impact hours are presented in Figures 4-64 through 4-73 and the top 10 negative impact hours are presented in Figures 4-74 through 4-83. As was discussed in Section 4.2 for the $PM_{2.5}$ concentrations, the differences are tending to occur in January along the northern border in Canada.

Scatterplots of the daily average nitrate concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-84. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Examination of the animations shows that the majority of the differences are occurring in Canada and the Northern U.S. with the differences occurring in the areas of relatively high $PM_{2.5}$. We speculate that the differences are primarily from the difference in the Particulate Nitrate and most likely from different pathways being taken in the ISOROPIA algorithm.

Table 4-4. Comparison of 2011el CAMx 6.32 Simulation Nitrate Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	1	3	4	24.70	19.36	5.34	27.60%	156	236
2011	1	3	5	22.87	18.32	4.55	24.84%	156	236
2011	1	27	7	8.33	3.97	4.36	110.03%	349	244
2011	1	3	6	23.13	18.99	4.15	21.84%	156	235
2011	1	27	11	6.60	3.95	2.65	66.94%	349	243
2011	1	3	3	21.99	19.49	2.50	12.85%	156	236
2011	1	27	6	5.72	3.22	2.50	77.54%	343	244
2011	1	27	4	8.79	6.61	2.18	33.08%	344	245
2011	5	19	13	6.83	4.90	1.94	39.59%	314	168
2011	1	14	9	8.78	6.84	1.93	28.24%	164	222
Maximum Negative									
2011	1	14	6	14.35	18.55	-4.20	-22.62%	120	243
2011	1	27	8	2.99	6.64	-3.64	-54.92%	350	243
2011	1	27	11	3.82	6.97	-3.15	-45.21%	342	245
2011	1	27	12	2.25	4.96	-2.70	-54.54%	342	243
2011	1	27	5	2.53	5.17	-2.64	-51.13%	342	244
2011	1	15	9	9.50	12.11	-2.60	-21.51%	126	220
2011	1	3	10	25.95	27.85	-1.90	-6.83%	155	235
2011	1	27	9	4.37	6.21	-1.84	-29.60%	342	244
2011	1	14	2	19.31	21.10	-1.79	-8.50%	134	242
2011	1	3	4	19.76	21.41	-1.65	-7.72%	157	237

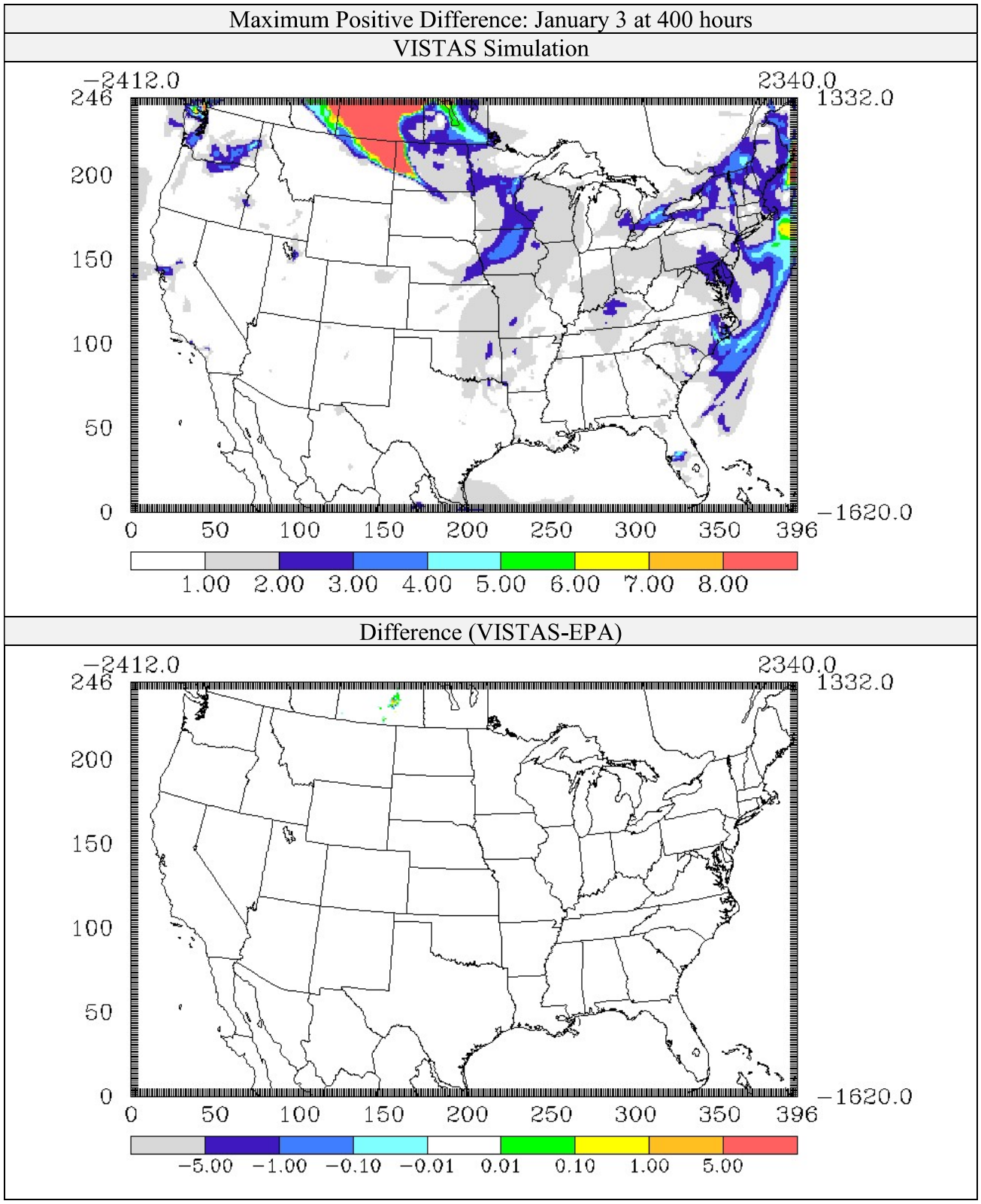

Figure 4-64: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)

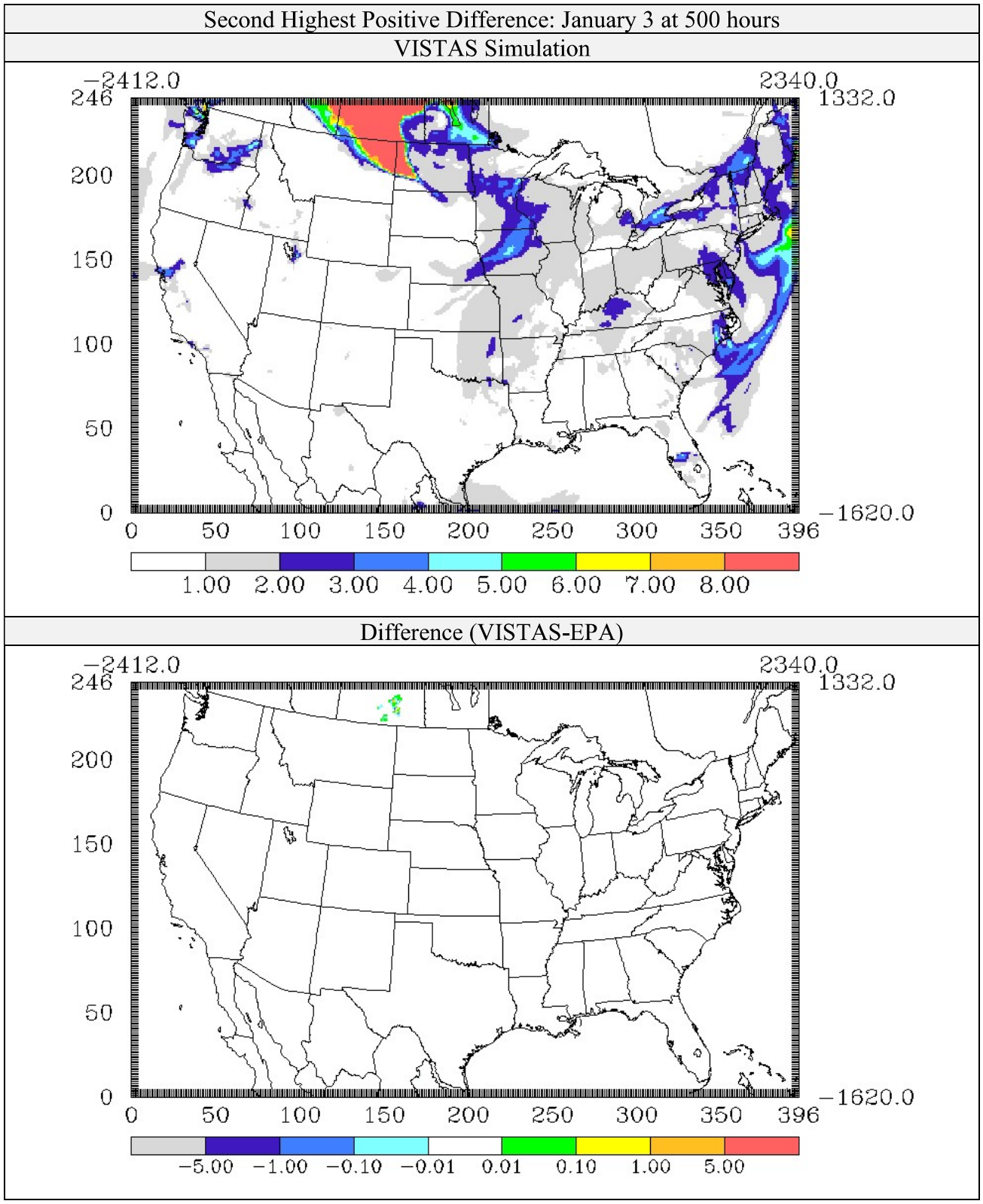

Figure 4-65: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)

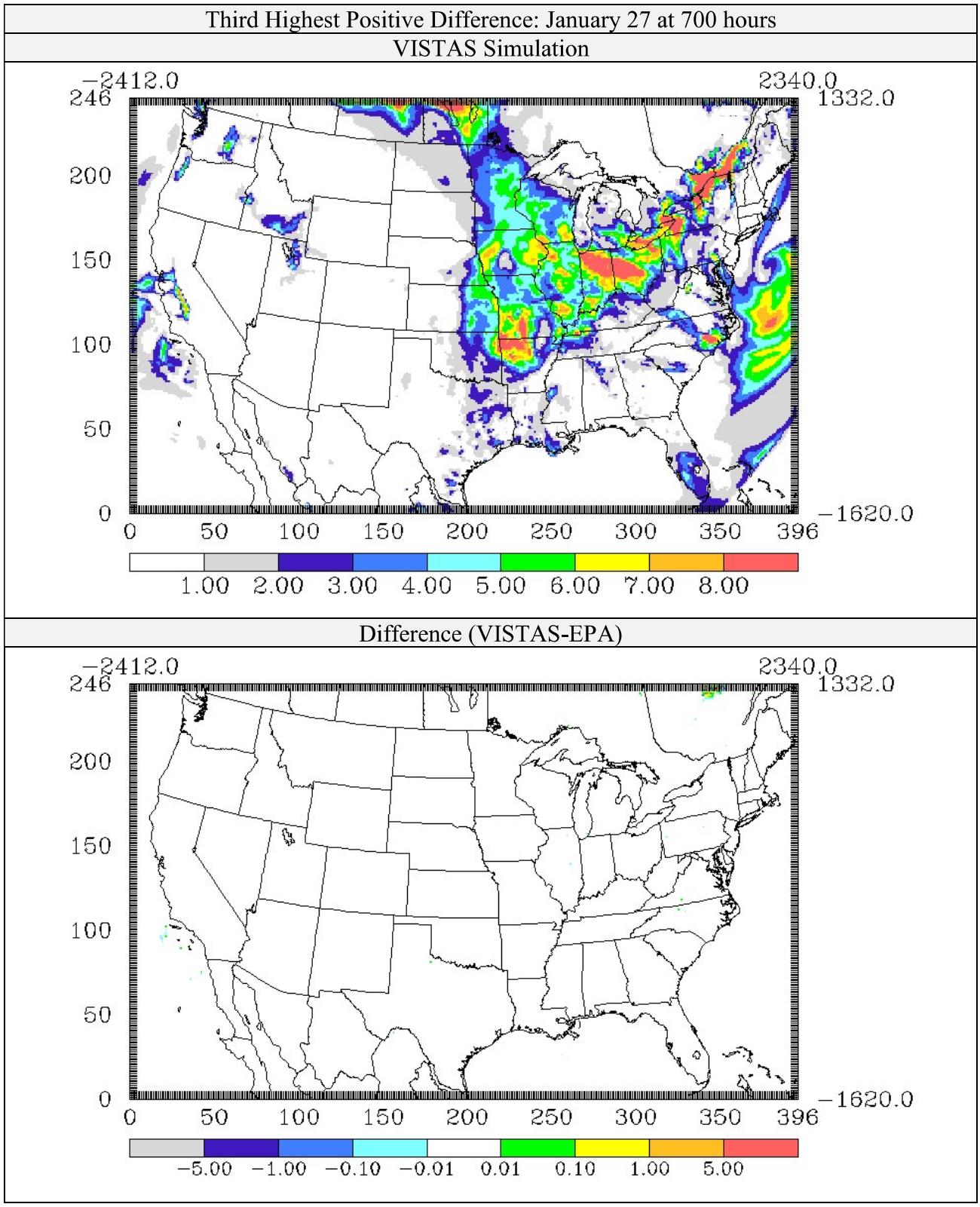

Figure 4-66: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)

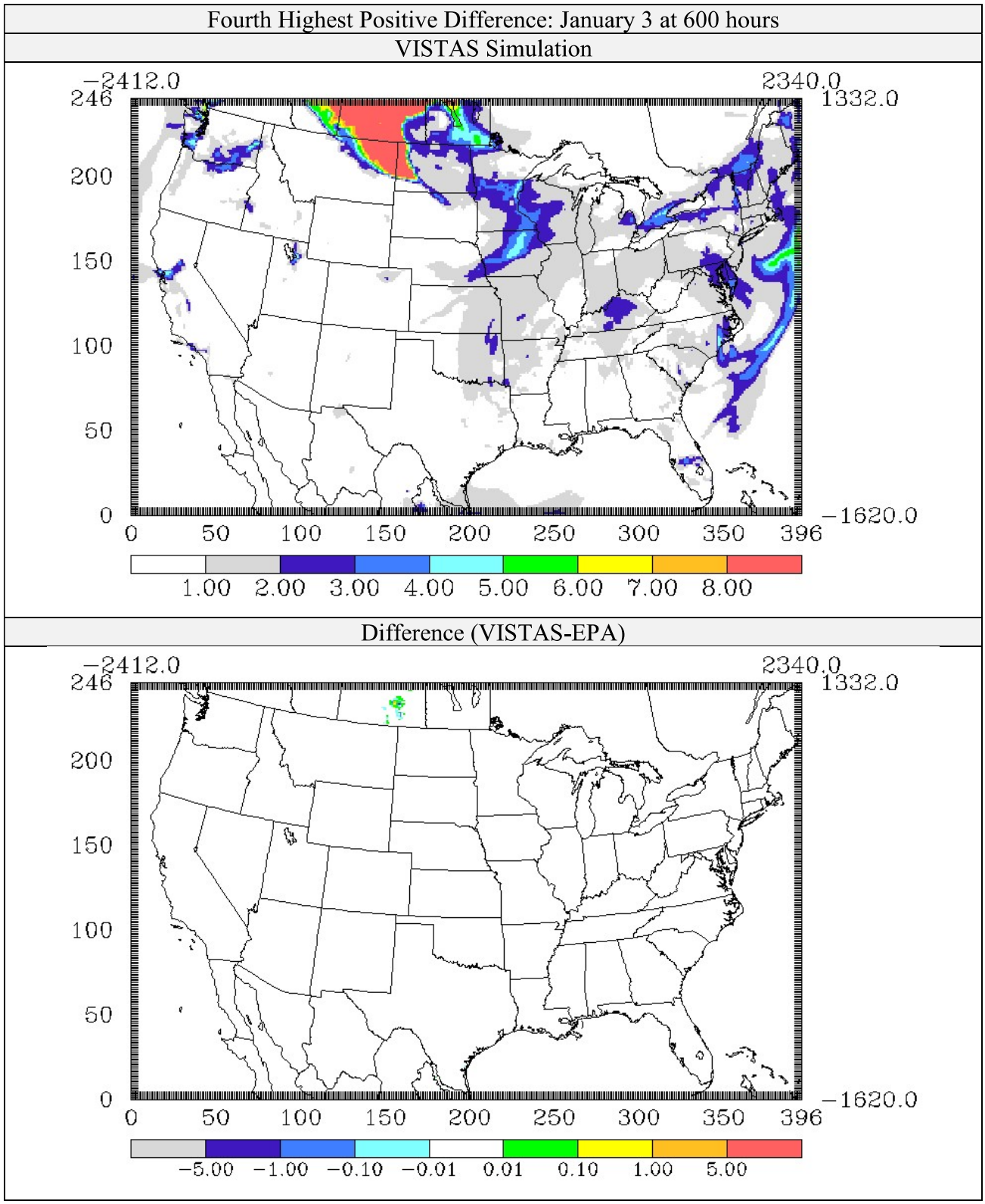

Figure 4-67: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)

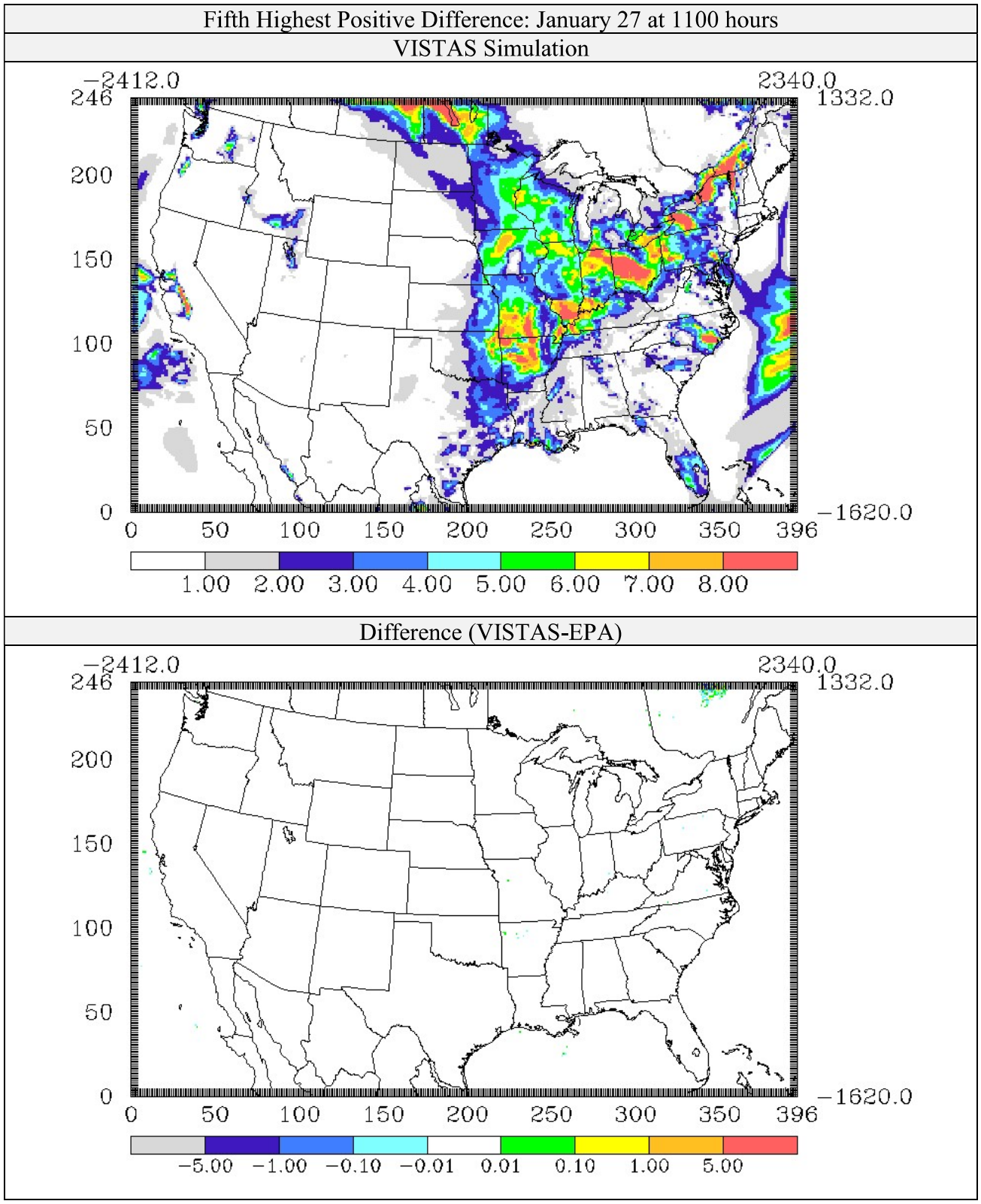

Figure 4-68: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)

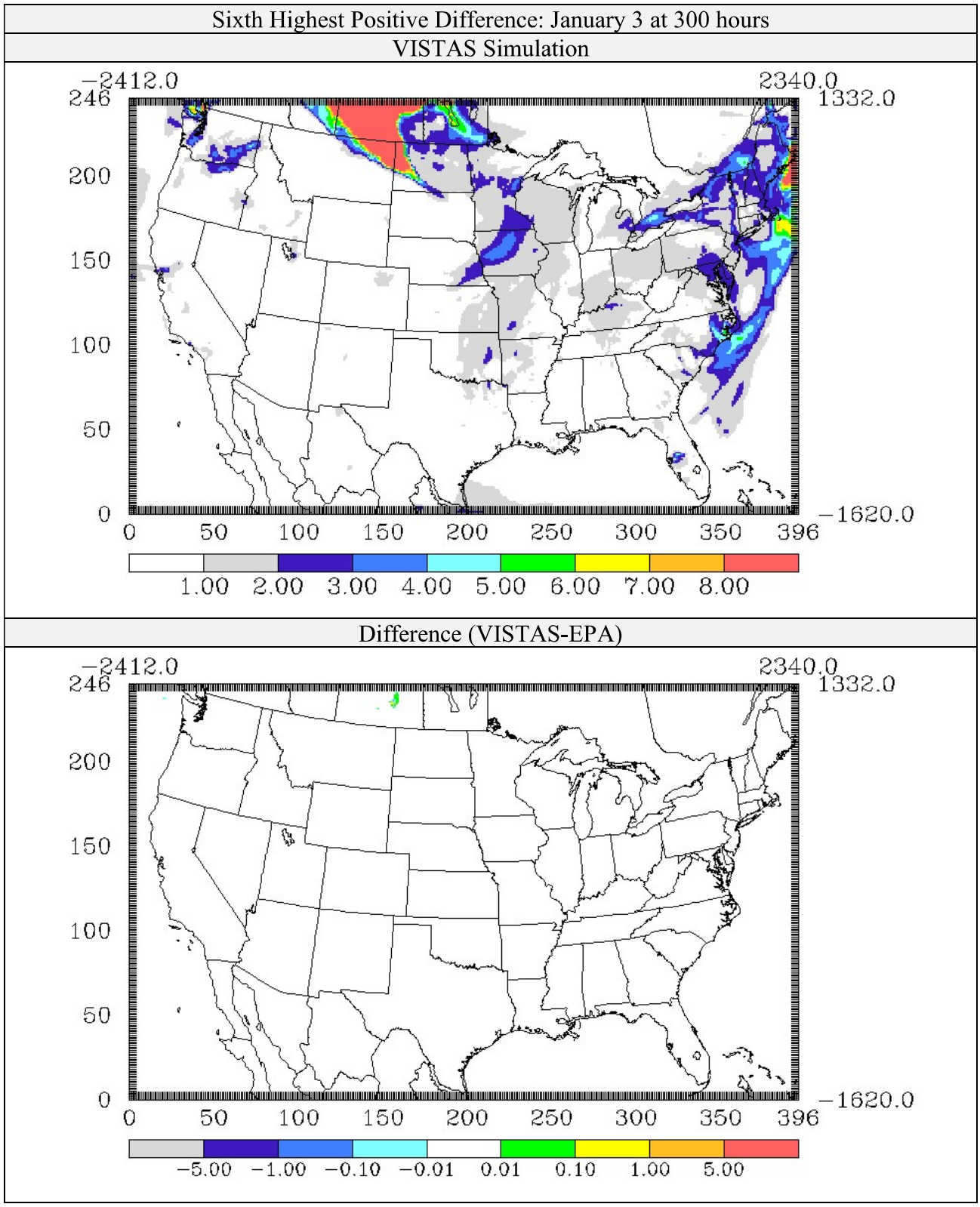

Figure 4-69: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)

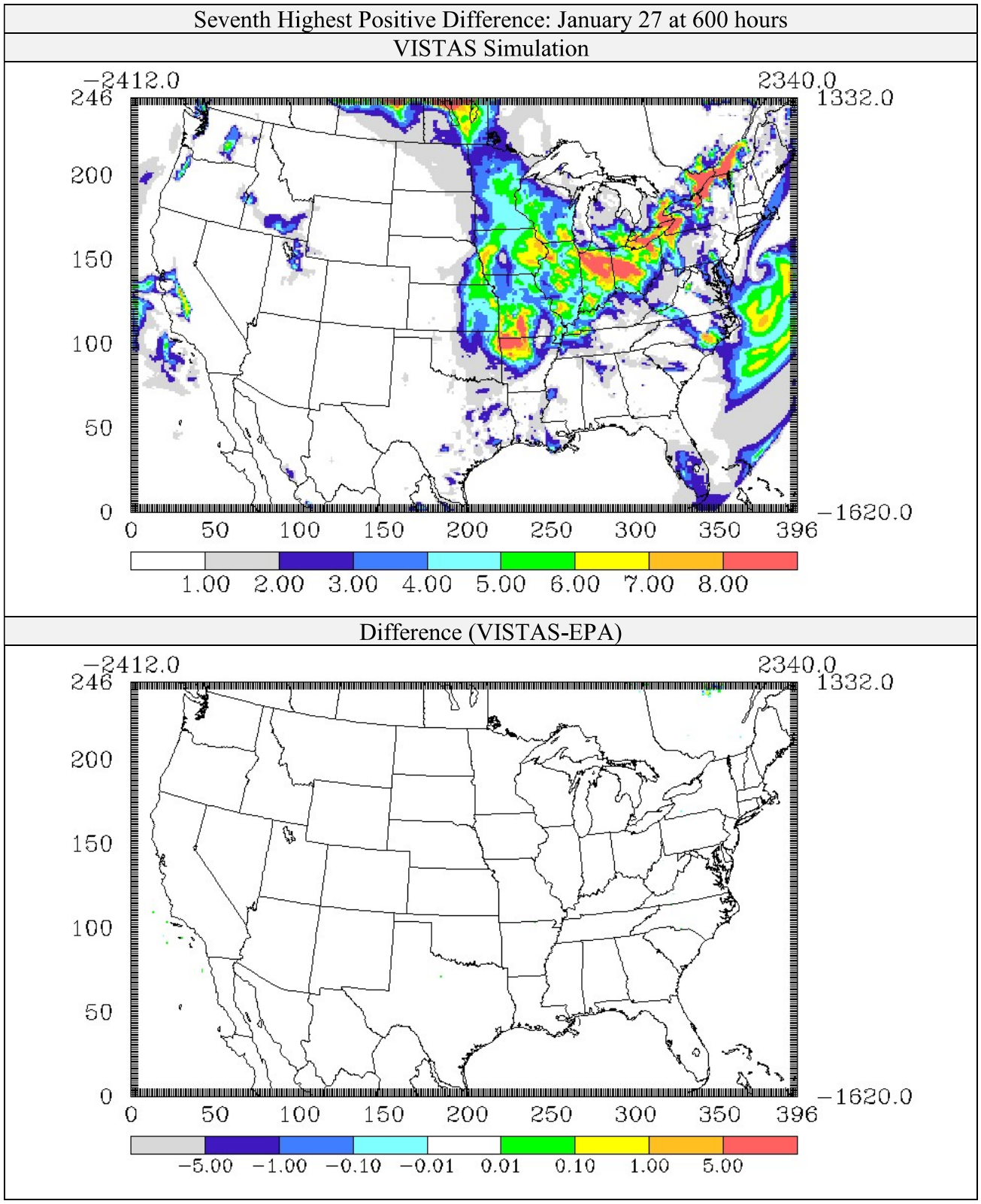

Figure 4-70: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)

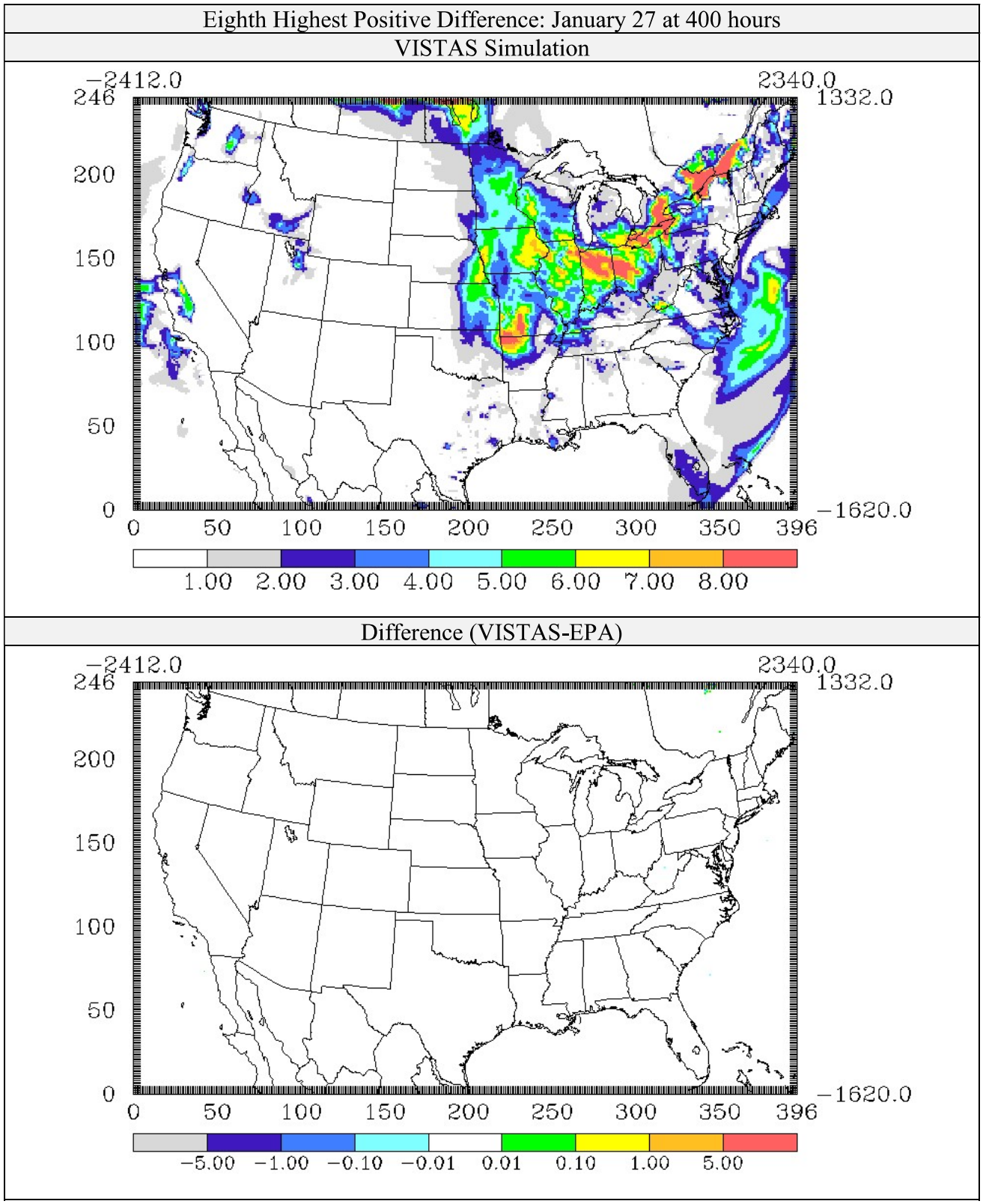

Figure 4-71: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)

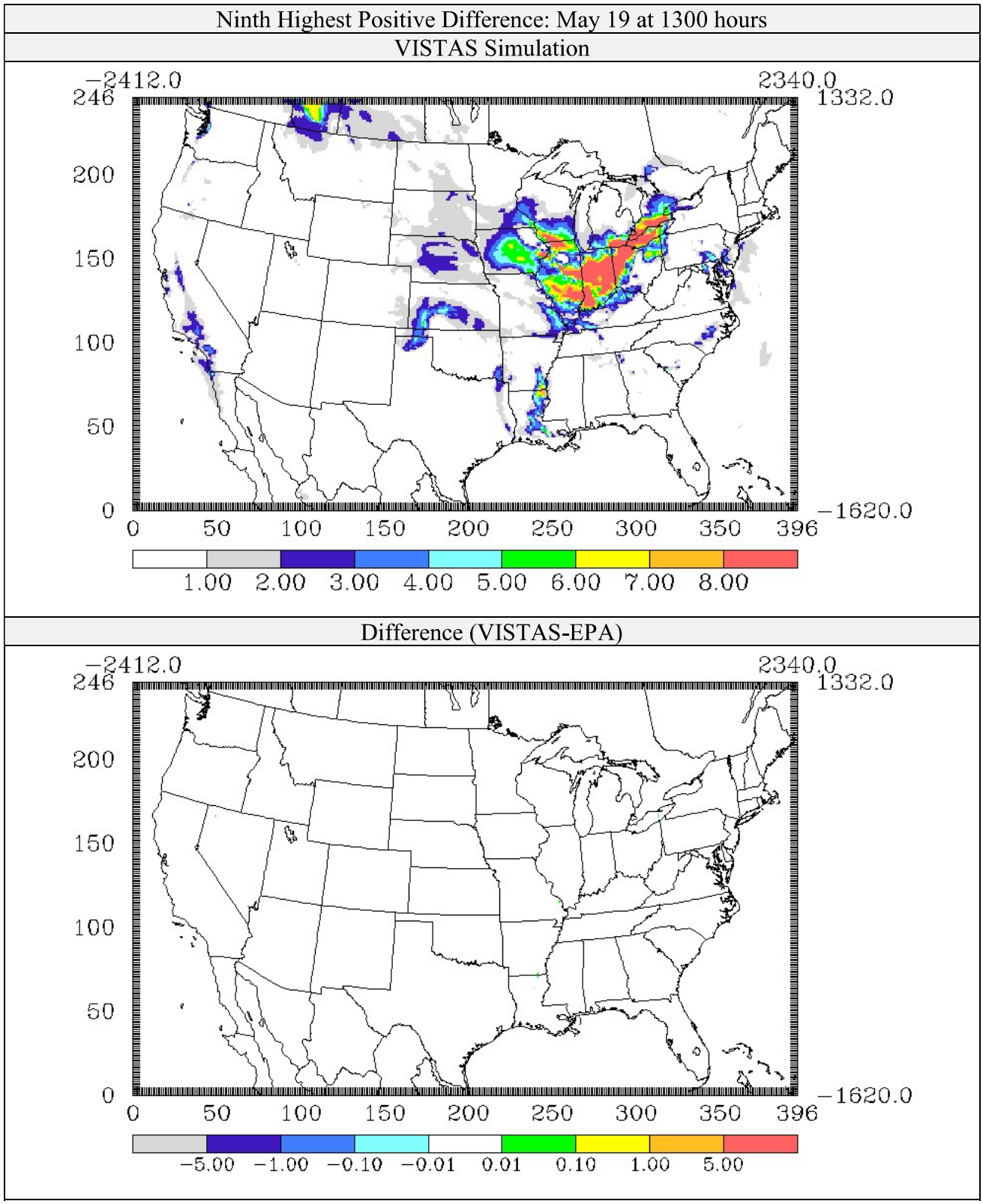

Figure 4-72: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)

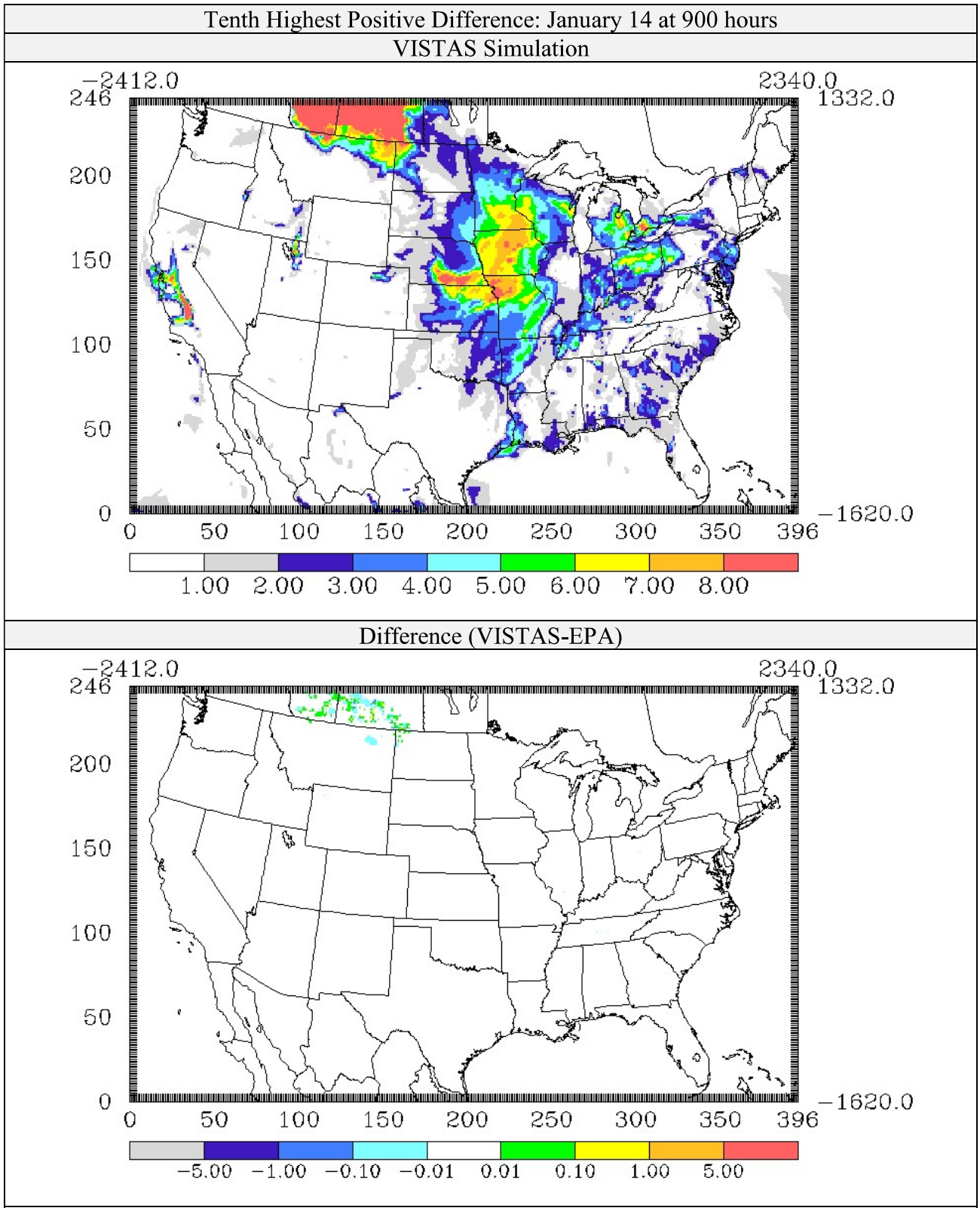

Figure 4-73: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)

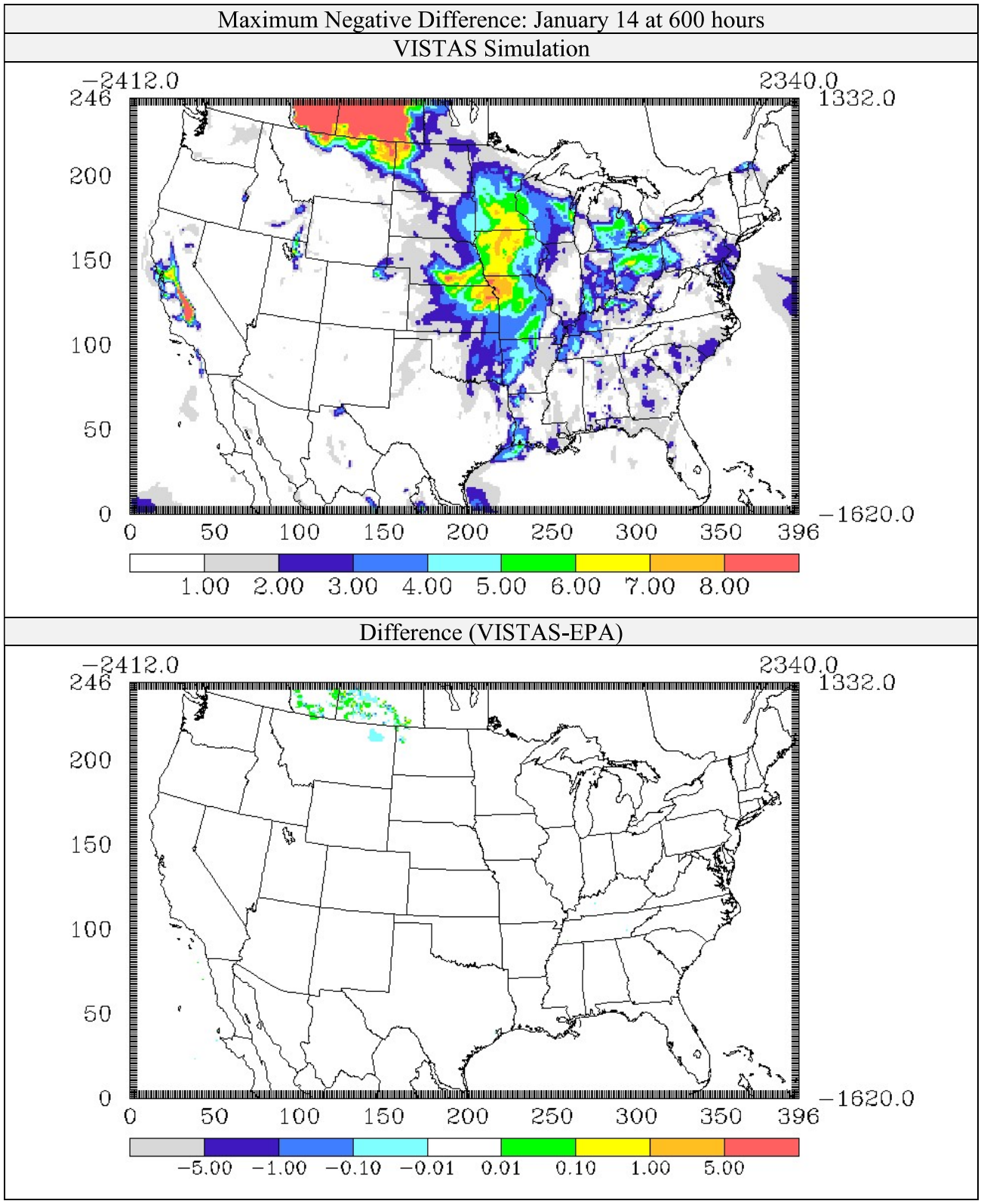

Figure 4-74: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)

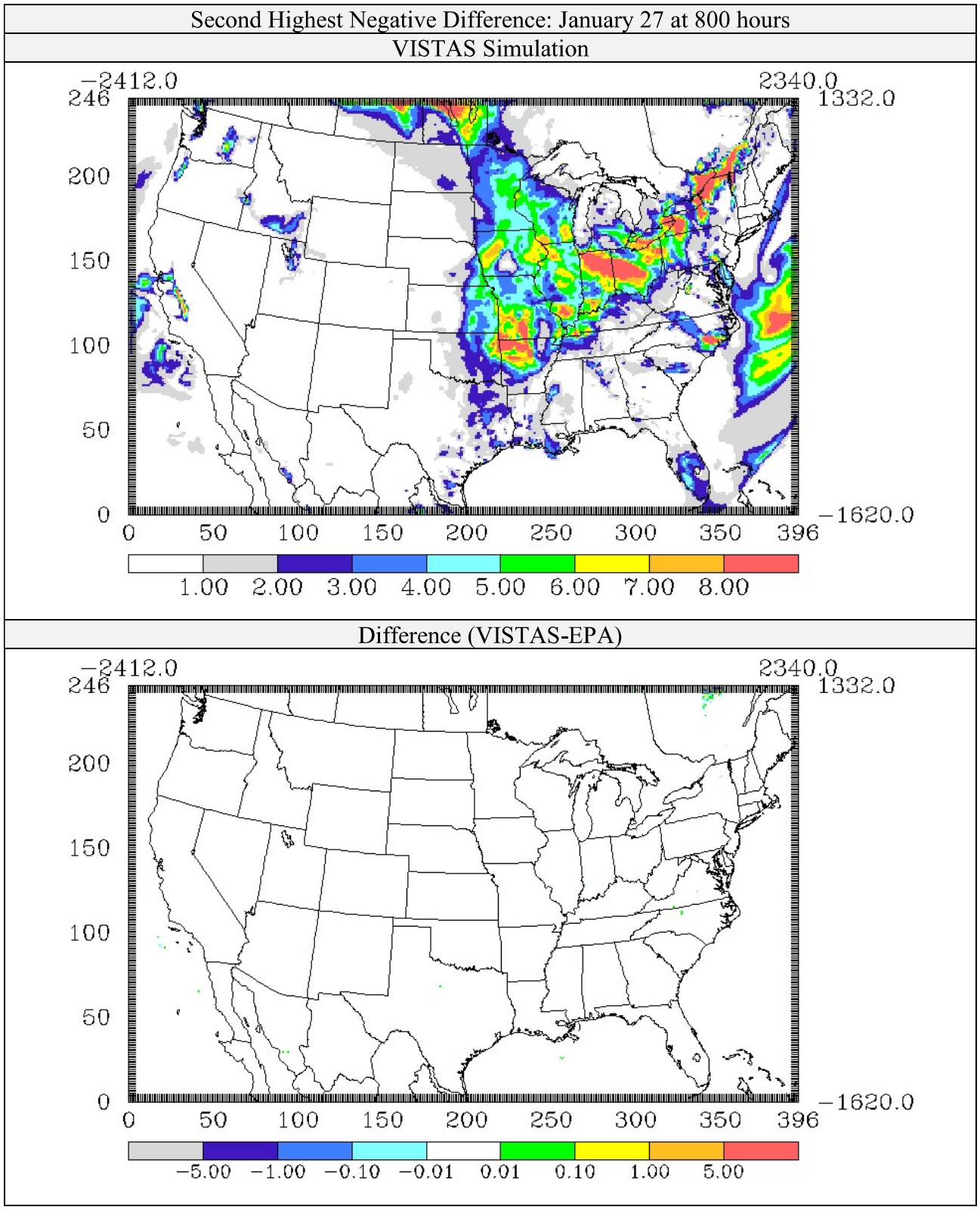

Figure 4-75: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)

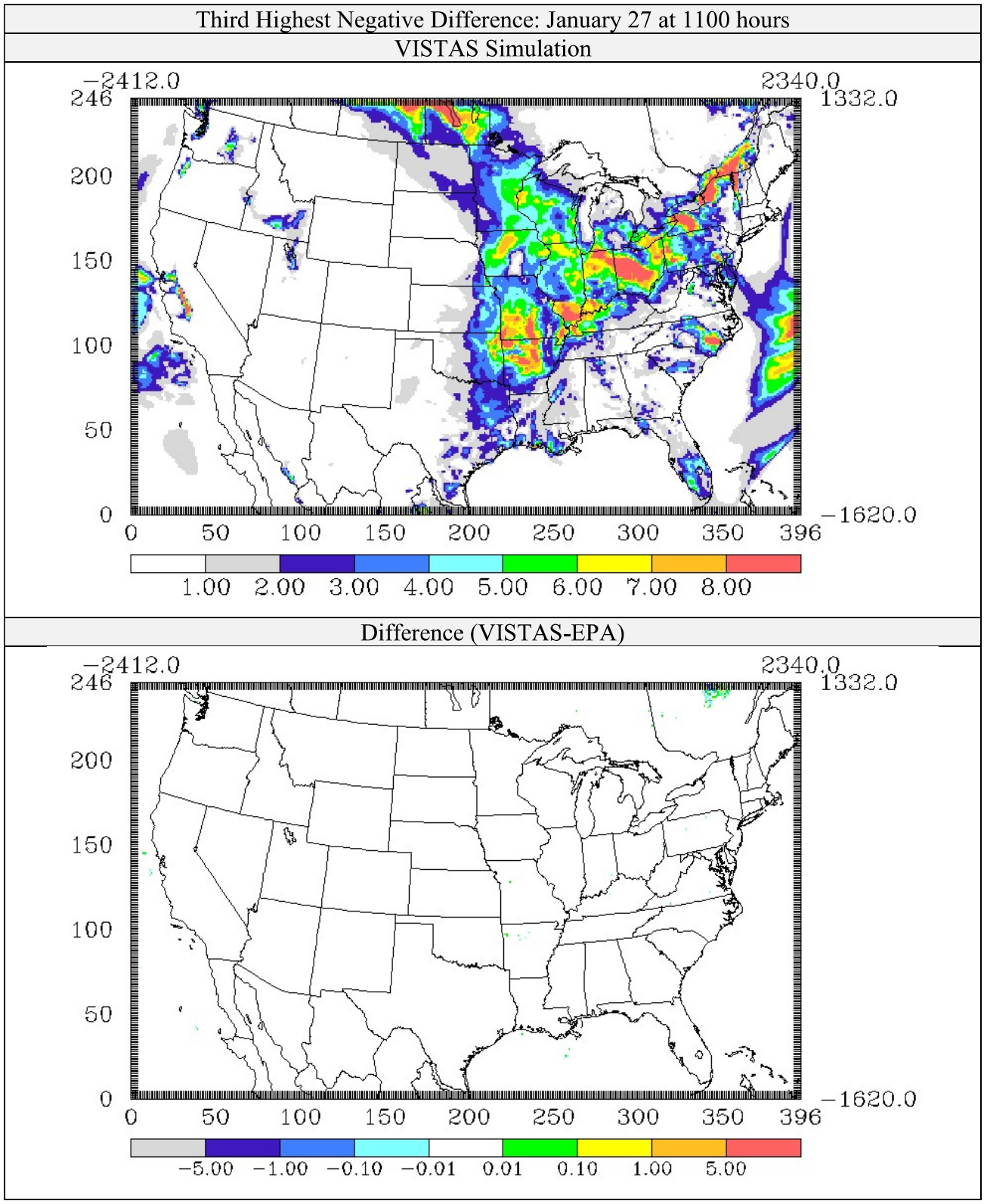

Figure 4-76: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)

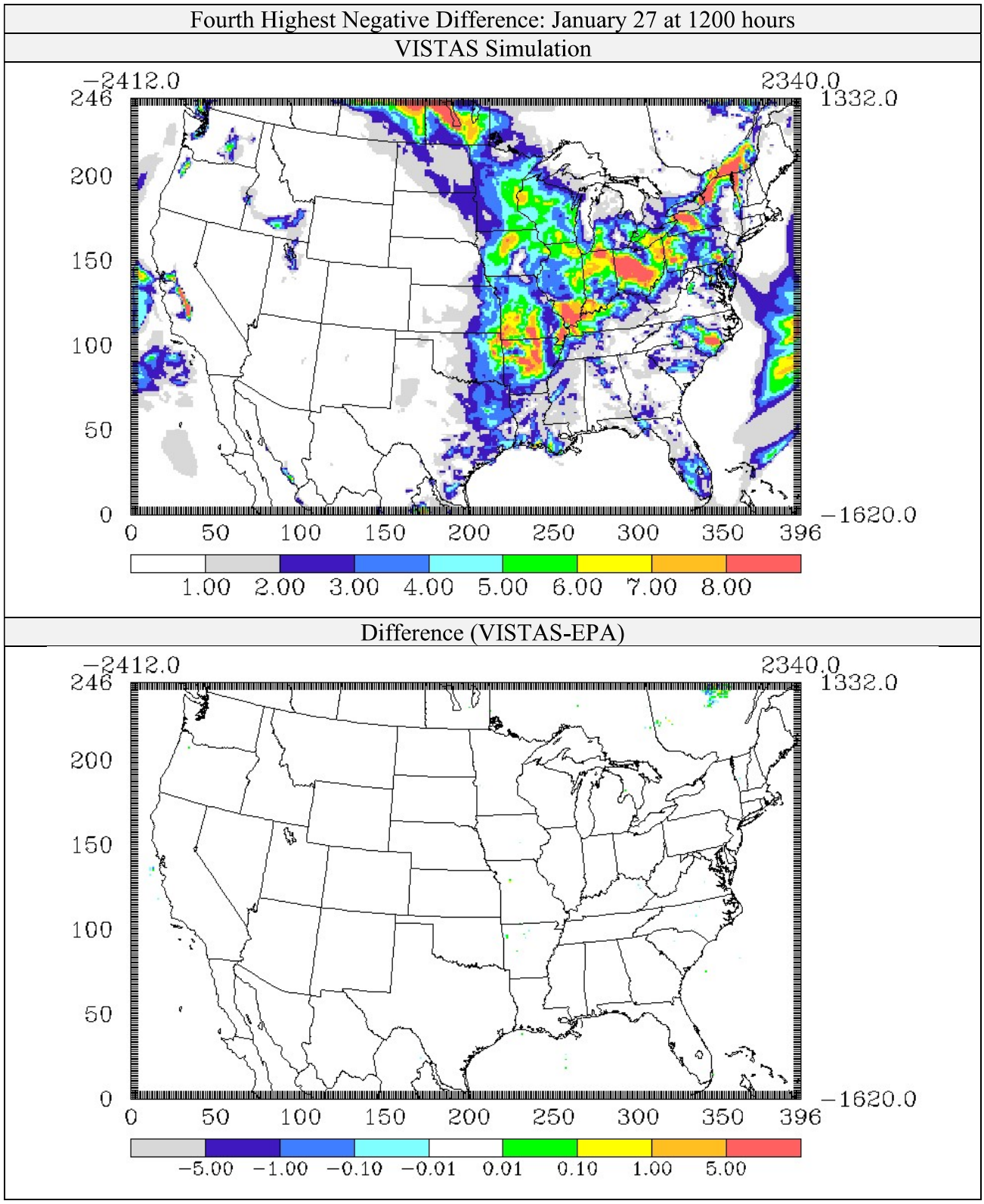

Figure 4-77: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)

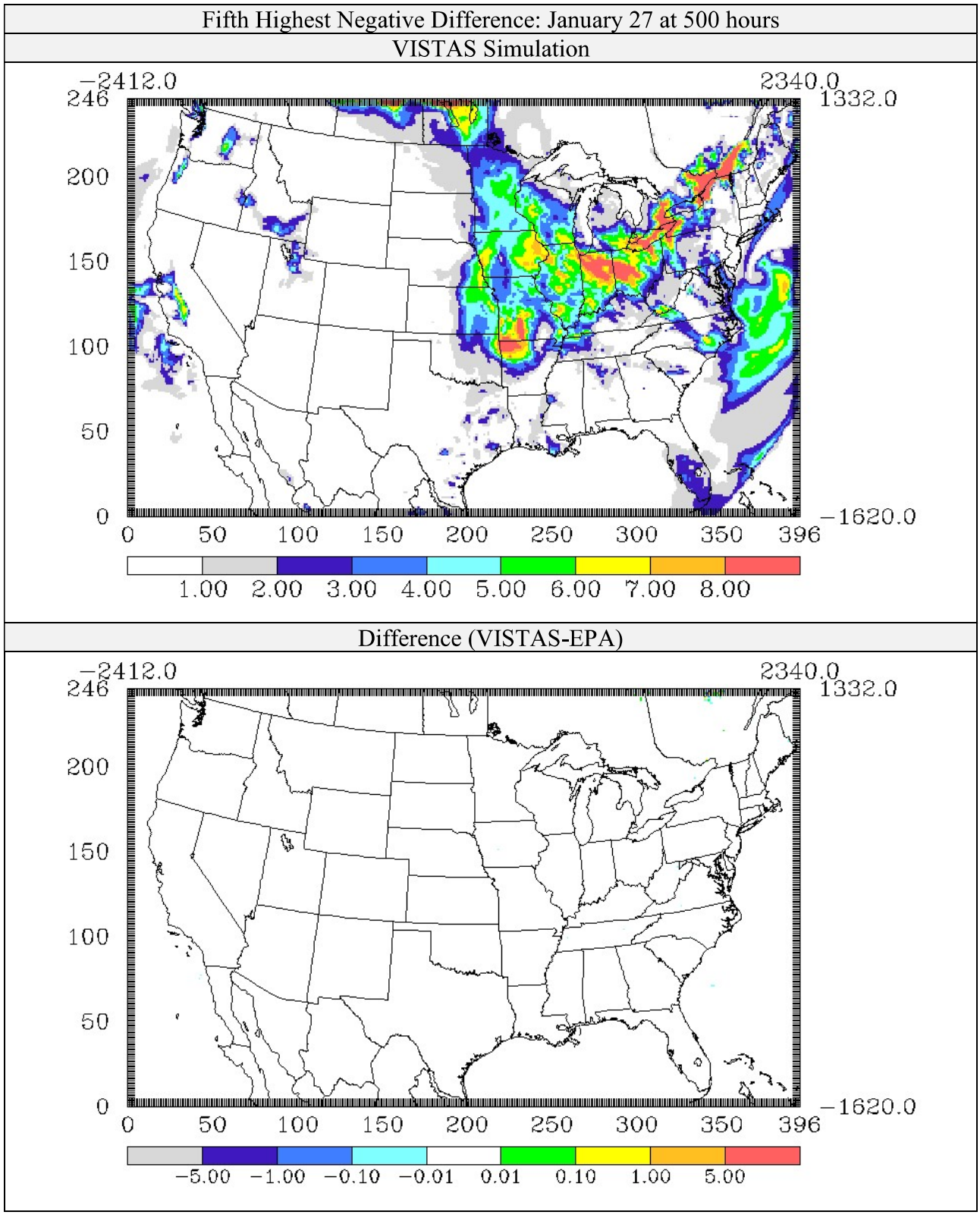

Figure 4-78: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)

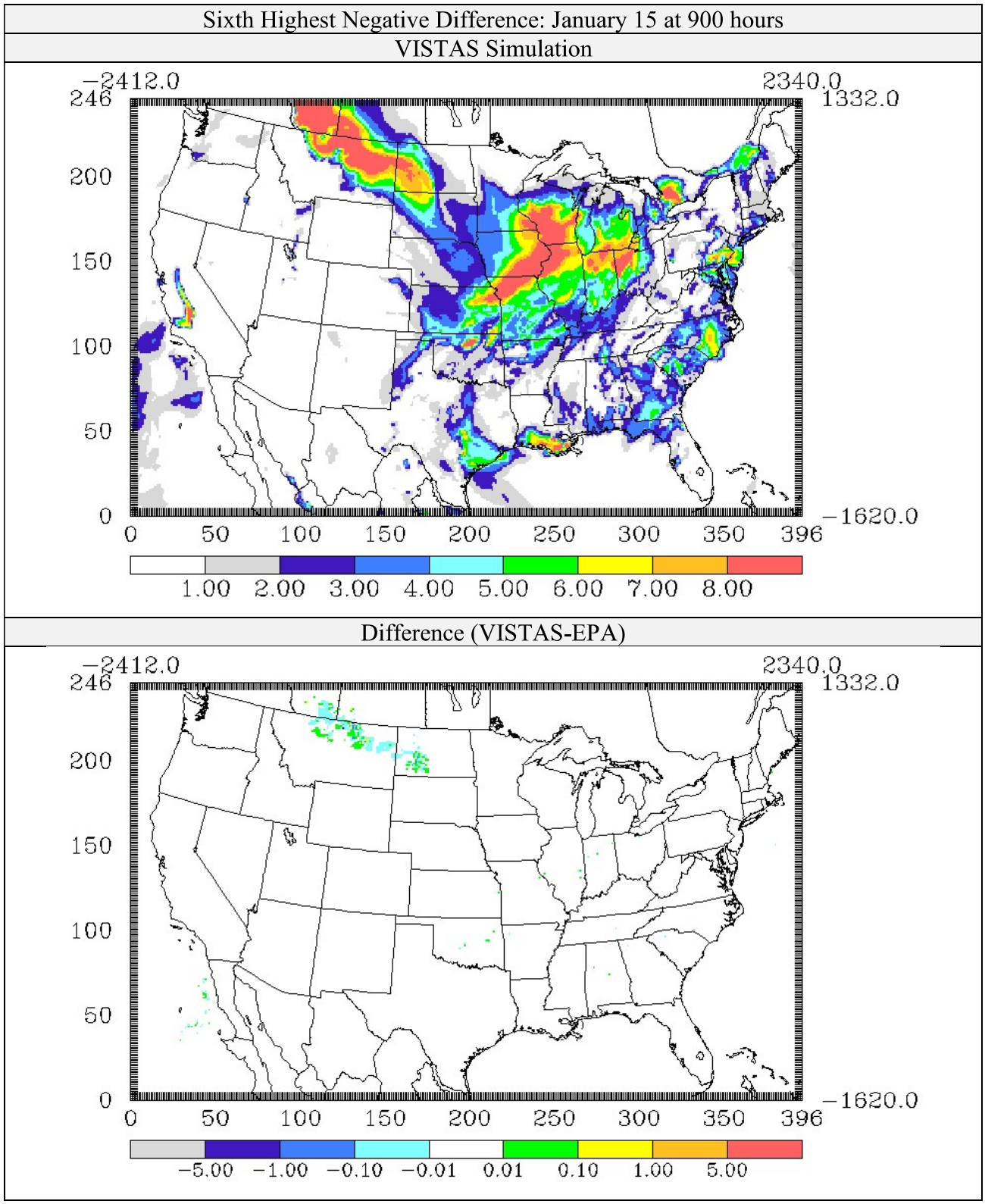

Figure 4-79: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)

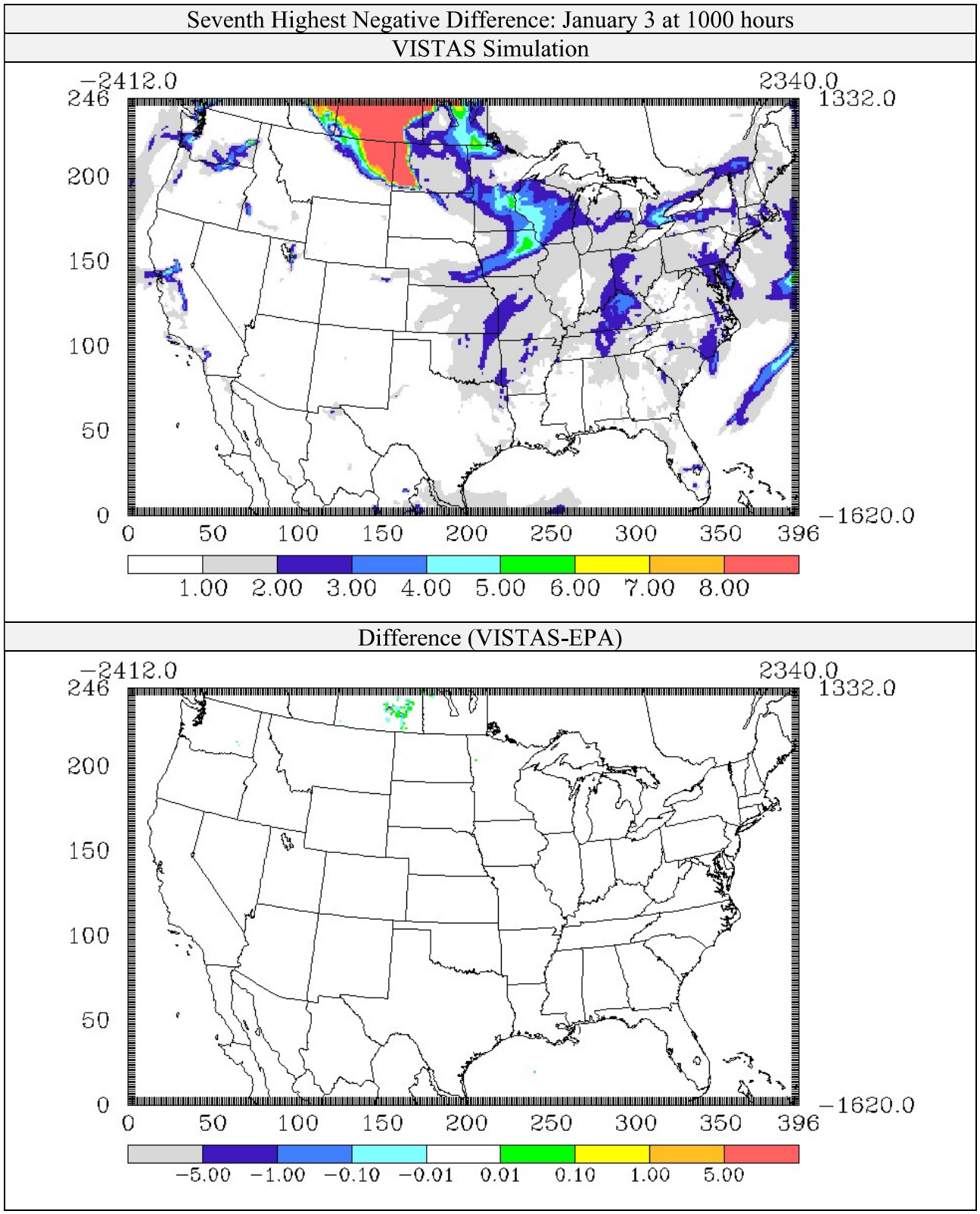

Figure 4-80: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)

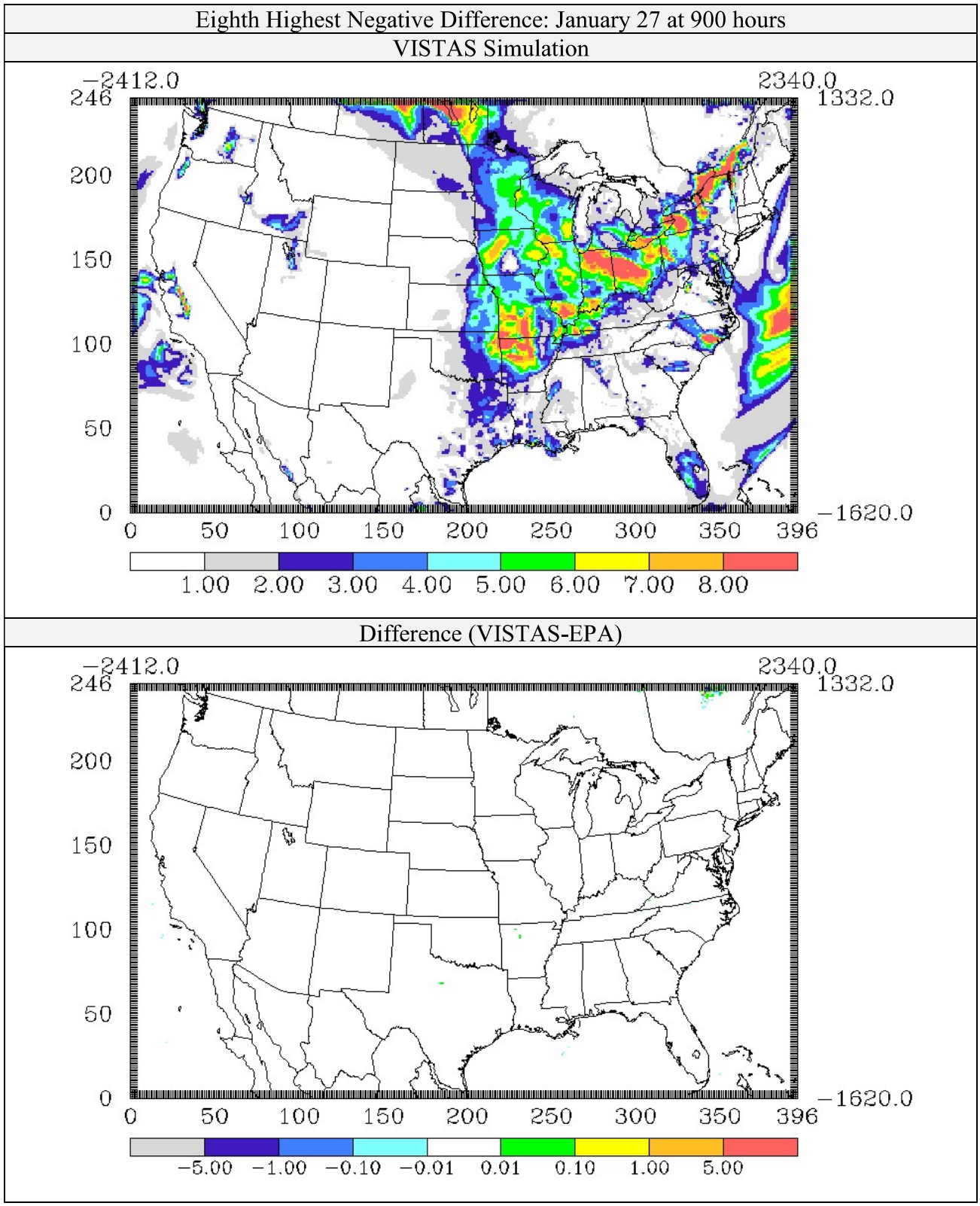

Figure 4-81: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)

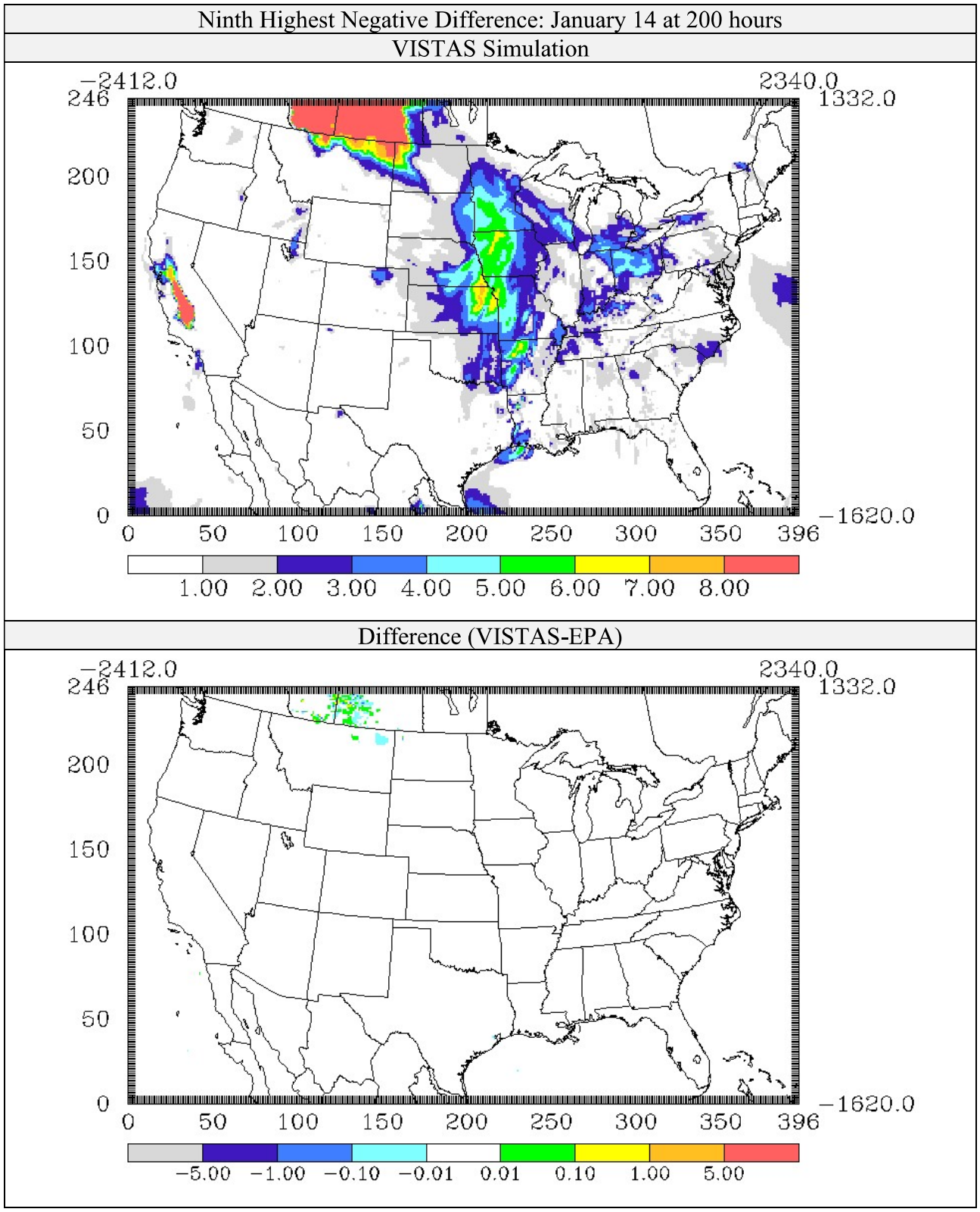

Figure 4-82: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)

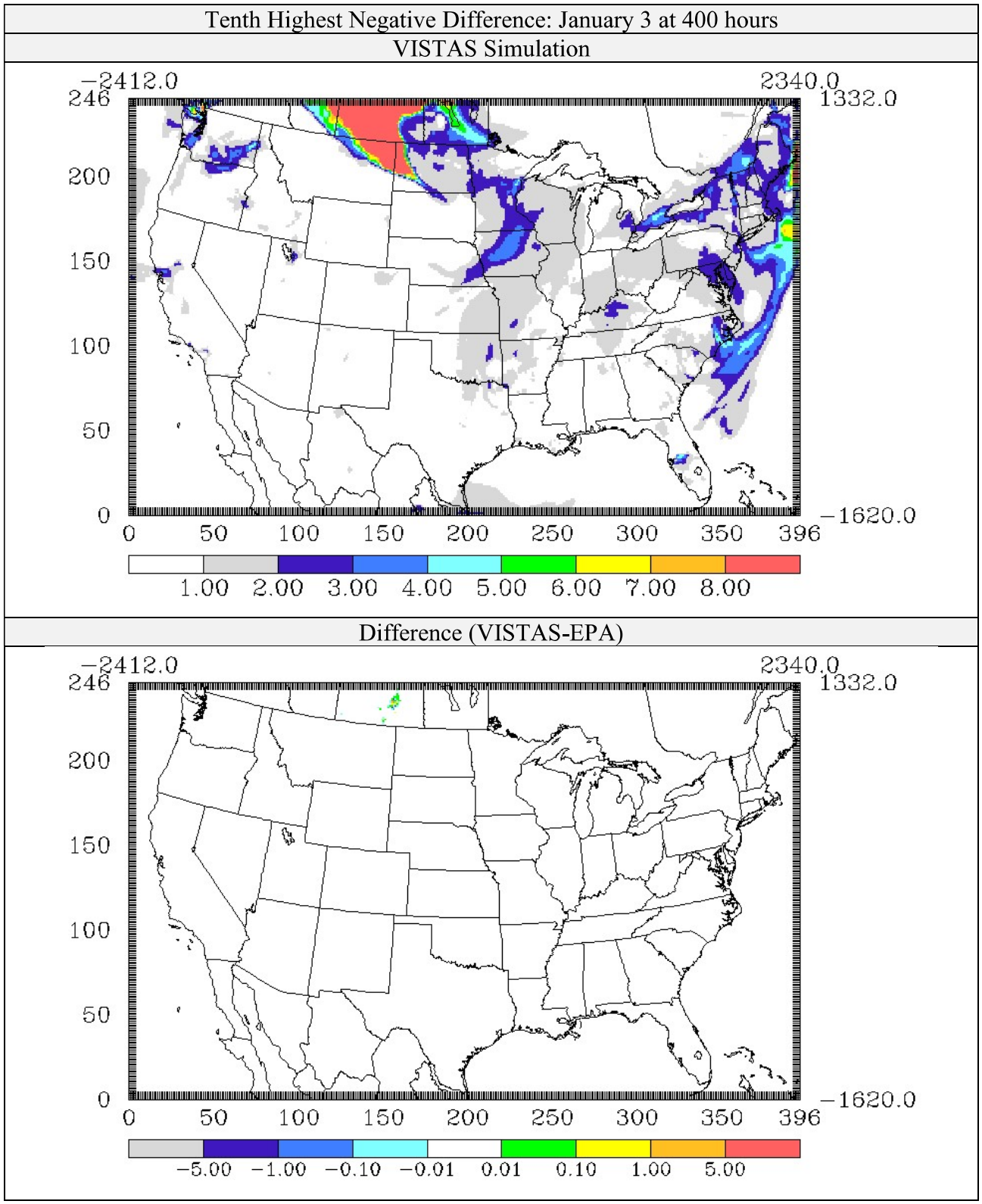

Figure 4-83: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Negative Difference)

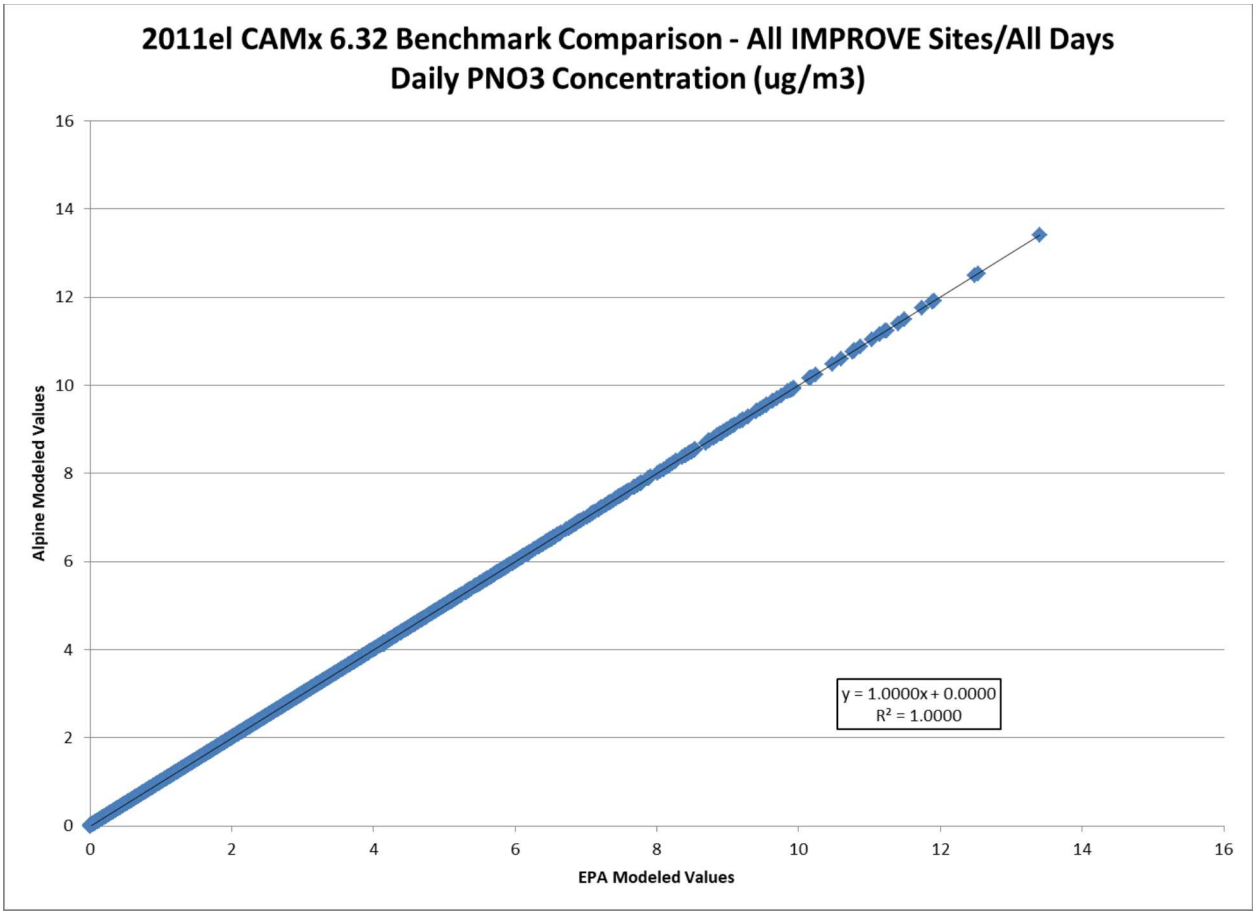

Figure 4-84: Scatterplot Comparing 24-hour Average Predicted Nitrate Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2011el Simulations Performed by EPA and VISTAS (Alpine).

4.5 Organic Carbon (OC)

Organic Carbon (OC) results for the top 10 positive and negative hours are presented in tabular format in Table 4-5. The maximum positive difference is 0.18 $\mu g/m^3$ falling to 0.09 $\mu g/m^3$ for the 10th high. The maximum negative difference is -0.33 $\mu g/m^3$ falling to -0.08 $\mu g/m^3$ for the 10th high. The maximum positive percent difference from these days is 1.28% and negative percent difference of -2.89%.

The top 10 positive impact hours are presented in Figures 4-85 through 4-94 and the top 10 negative impact hours are presented in Figures 4-95 through 4-104. The locations of the impacts are extremely localized.

Scatterplots of the daily average OC concentrations in local standard time at the IMPROVE monitors are presented in Figure 4-105. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Table 4-5. Comparison of 2011el CAMx 6.32 Simulation Organic Carbon Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	6	26	12	17.32	17.13	0.18	1.08%	288	74
2011	5	20	12	11.46	11.32	0.14	1.23%	286	84
2011	8	26	12	10.82	10.69	0.14	1.28%	295	57
2011	5	20	13	10.89	10.77	0.12	1.16%	286	84
2011	12	15	17	25.91	25.80	0.12	0.45%	143	115
2011	7	14	22	5.30	5.19	0.11	2.03%	292	77
2011	6	26	13	12.40	12.31	0.10	0.79%	288	74
2011	7	26	12	10.30	10.21	0.09	0.93%	236	95
2011	8	26	13	7.69	7.60	0.09	1.23%	295	57
2011	8	23	22	7.38	7.29	0.09	1.28%	323	47
Maximum Negative									
2011	12	20	9	10.97	11.30	-0.33	-2.89%	313	89
2011	12	20	8	11.31	11.59	-0.28	-2.39%	313	89
2011	5	21	0	8.28	8.39	-0.11	-1.37%	331	95
2011	12	20	10	11.20	11.31	-0.11	-0.96%	313	89
2011	2	14	23	18.47	18.58	-0.11	-0.57%	271	69
2011	2	14	22	16.07	16.17	-0.10	-0.65%	271	69
2011	8	4	14	13.21	13.31	-0.10	-0.75%	213	89
2011	7	19	12	7.28	7.37	-0.09	-1.22%	253	100
2011	8	1	0	8.21	8.29	-0.08	-1.01%	261	70
2011	7	15	13	5.29	5.38	-0.08	-1.56%	314	98

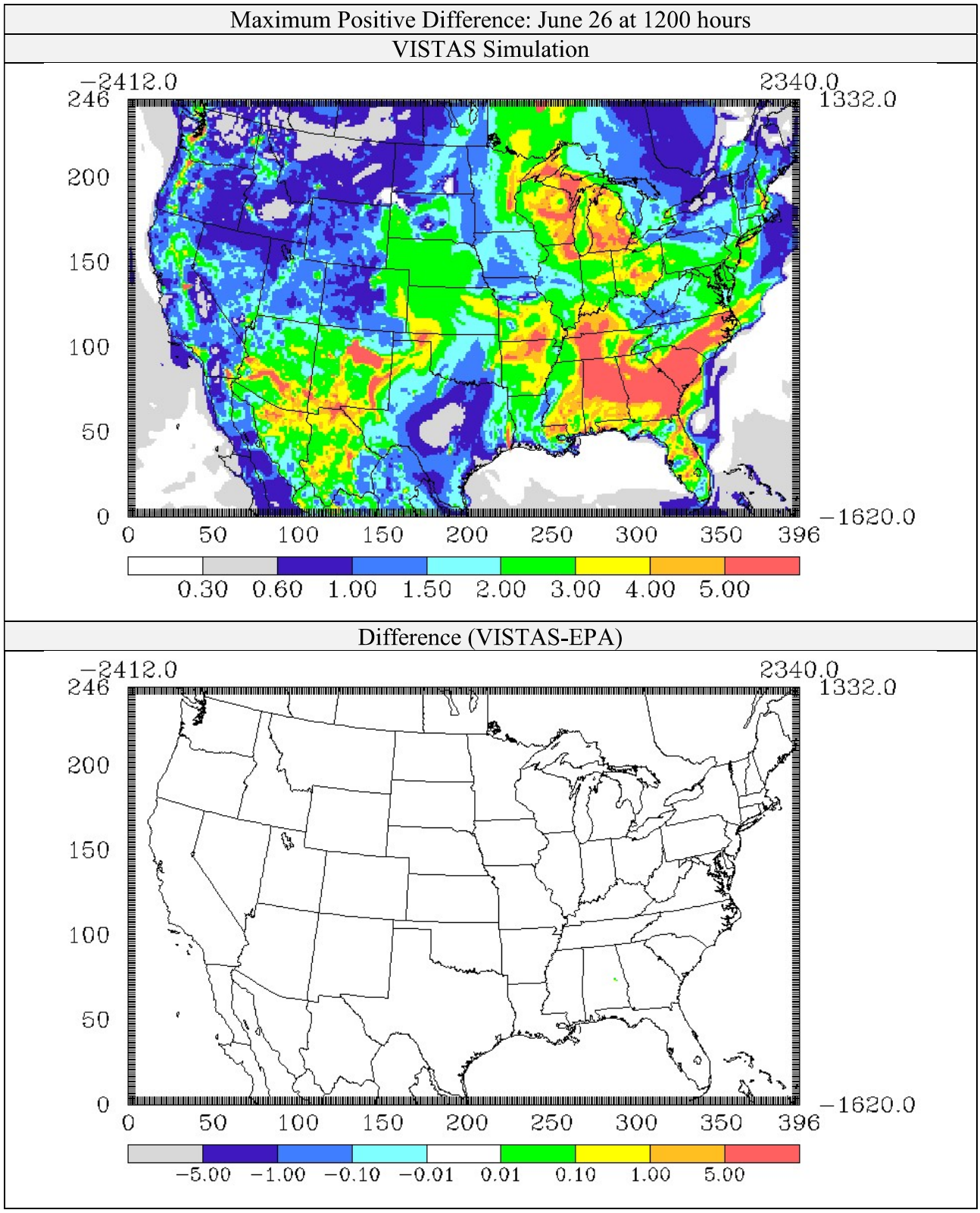

Figure 4-85: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)

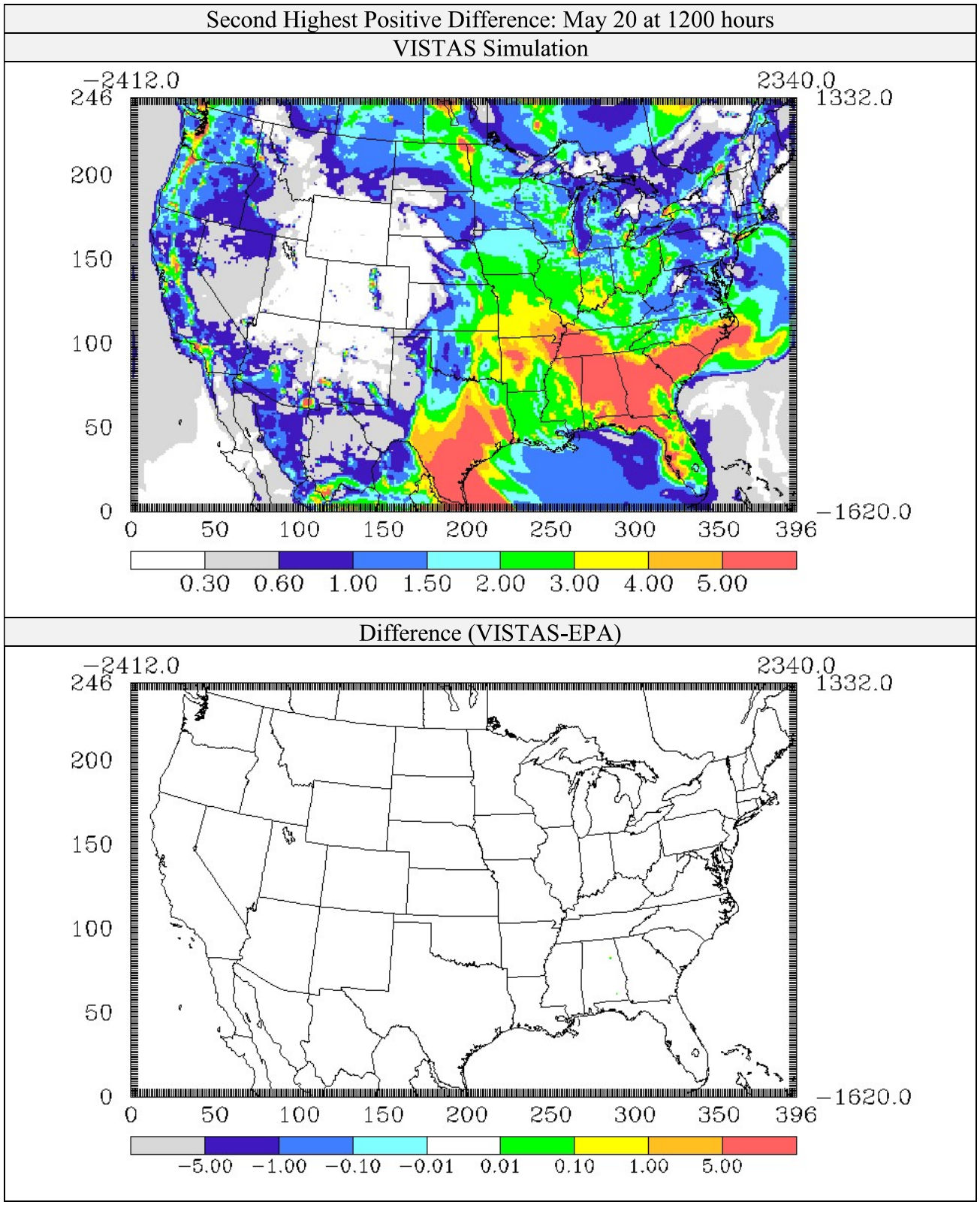

Figure 4-86: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)

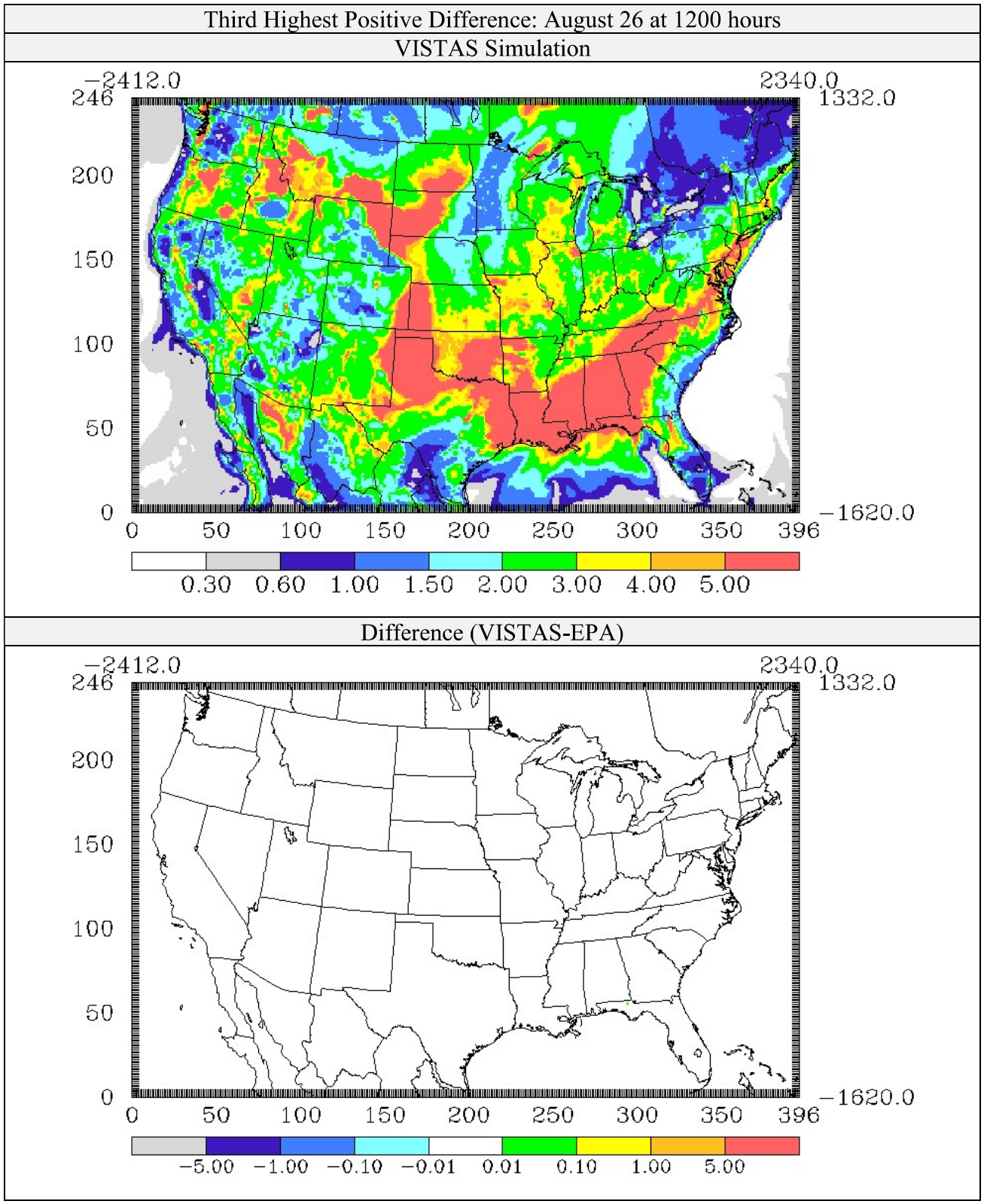

Figure 4-87: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)

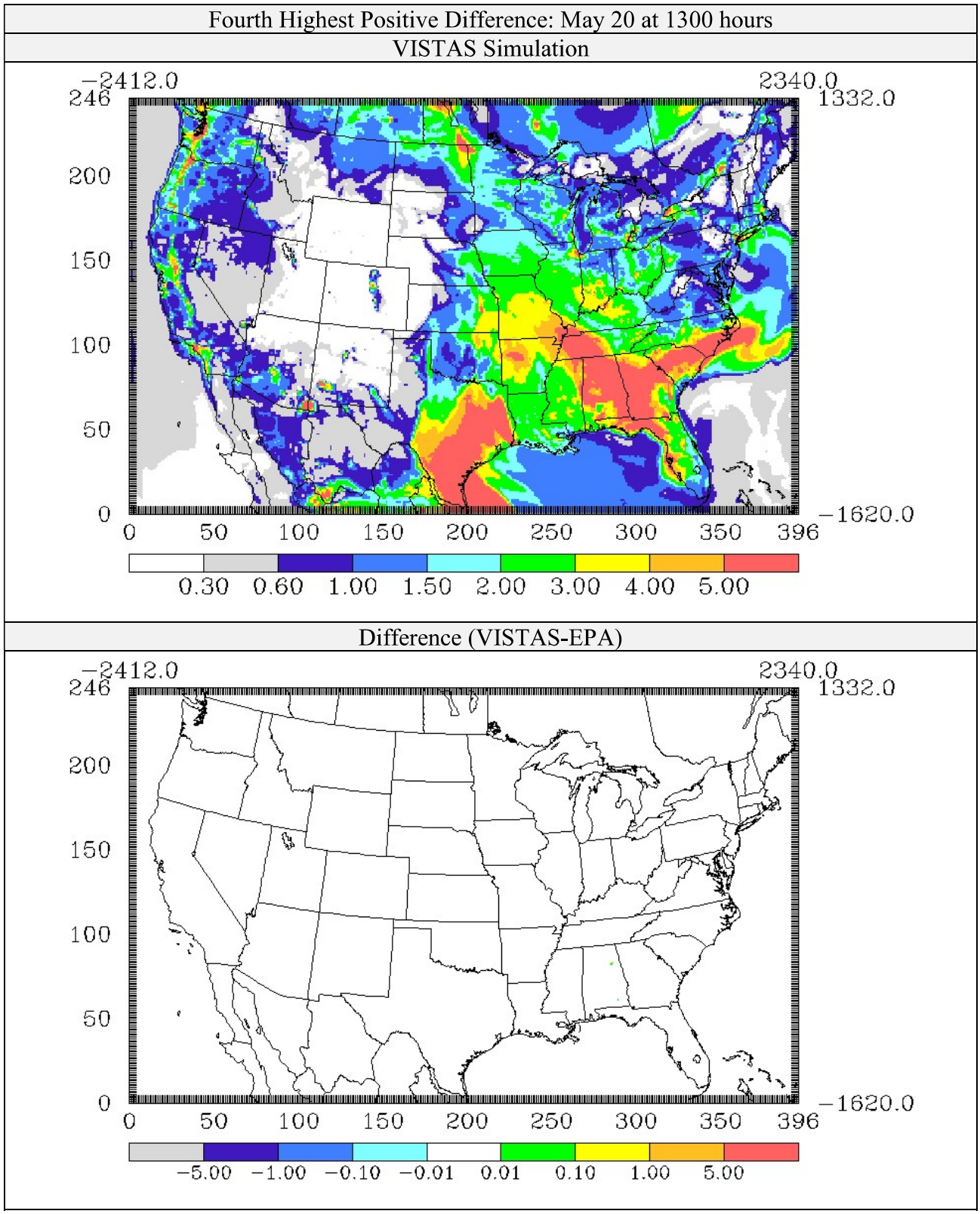

Figure 4-88: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)

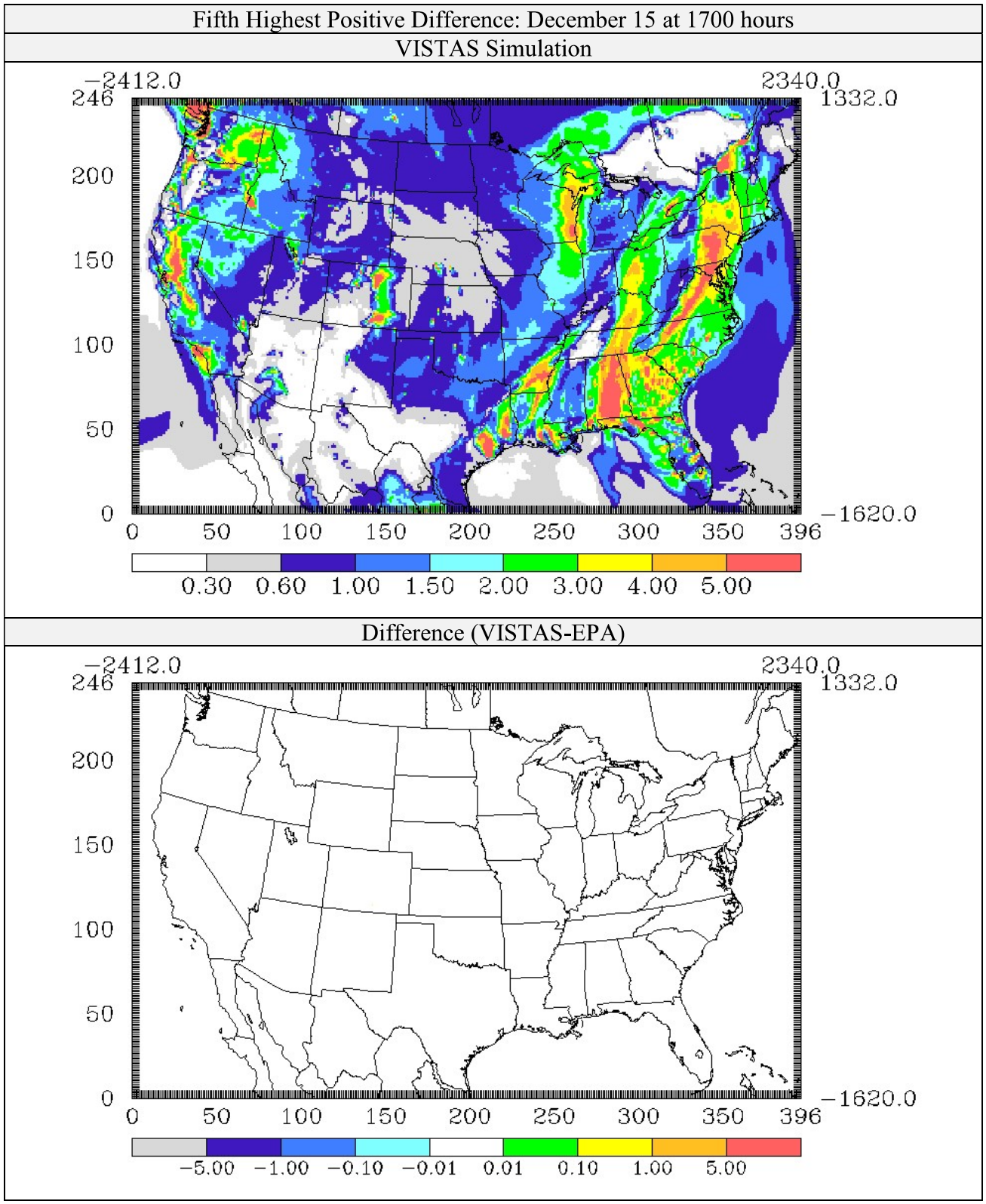

Figure 4-89: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)

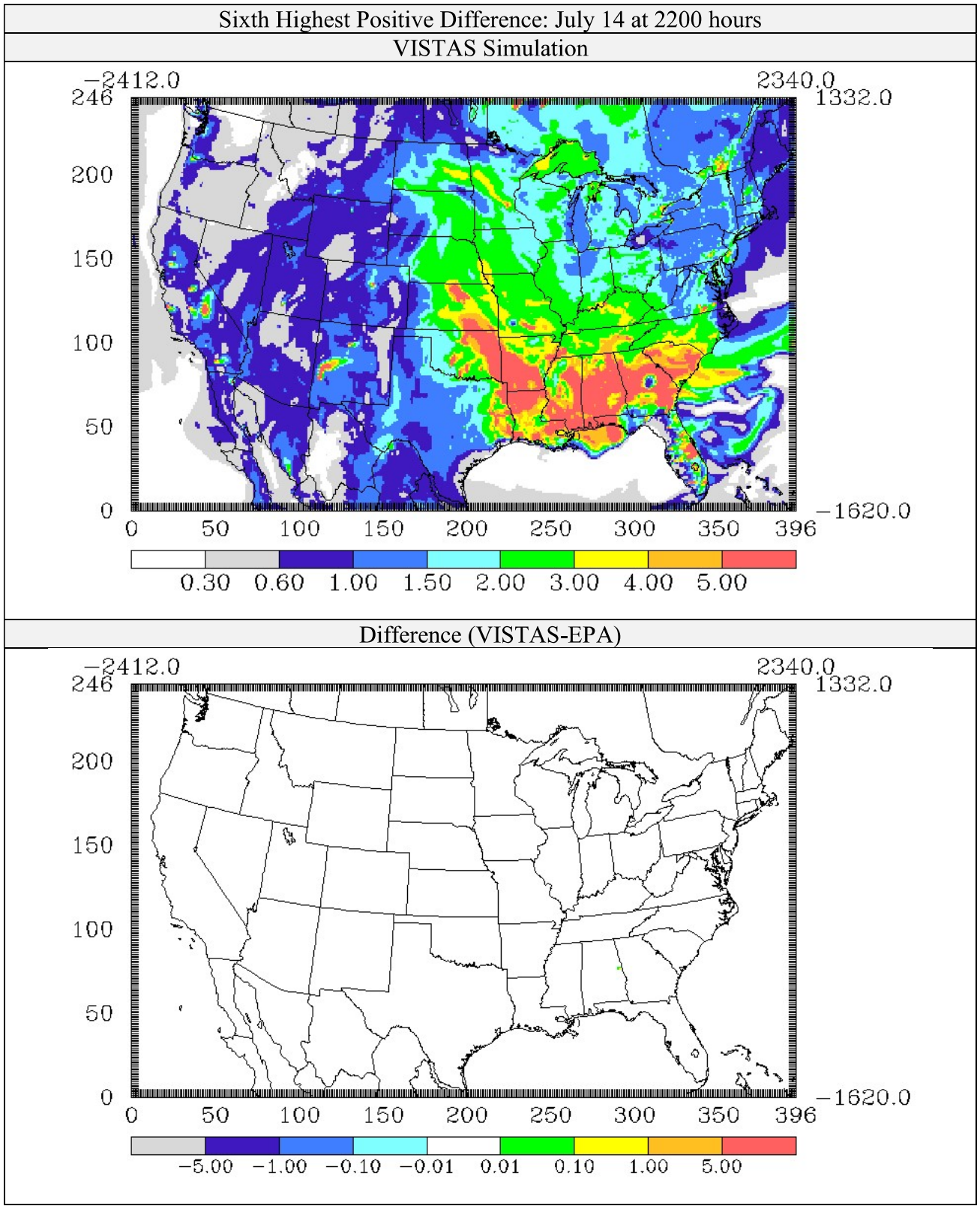

Figure 4-90: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)

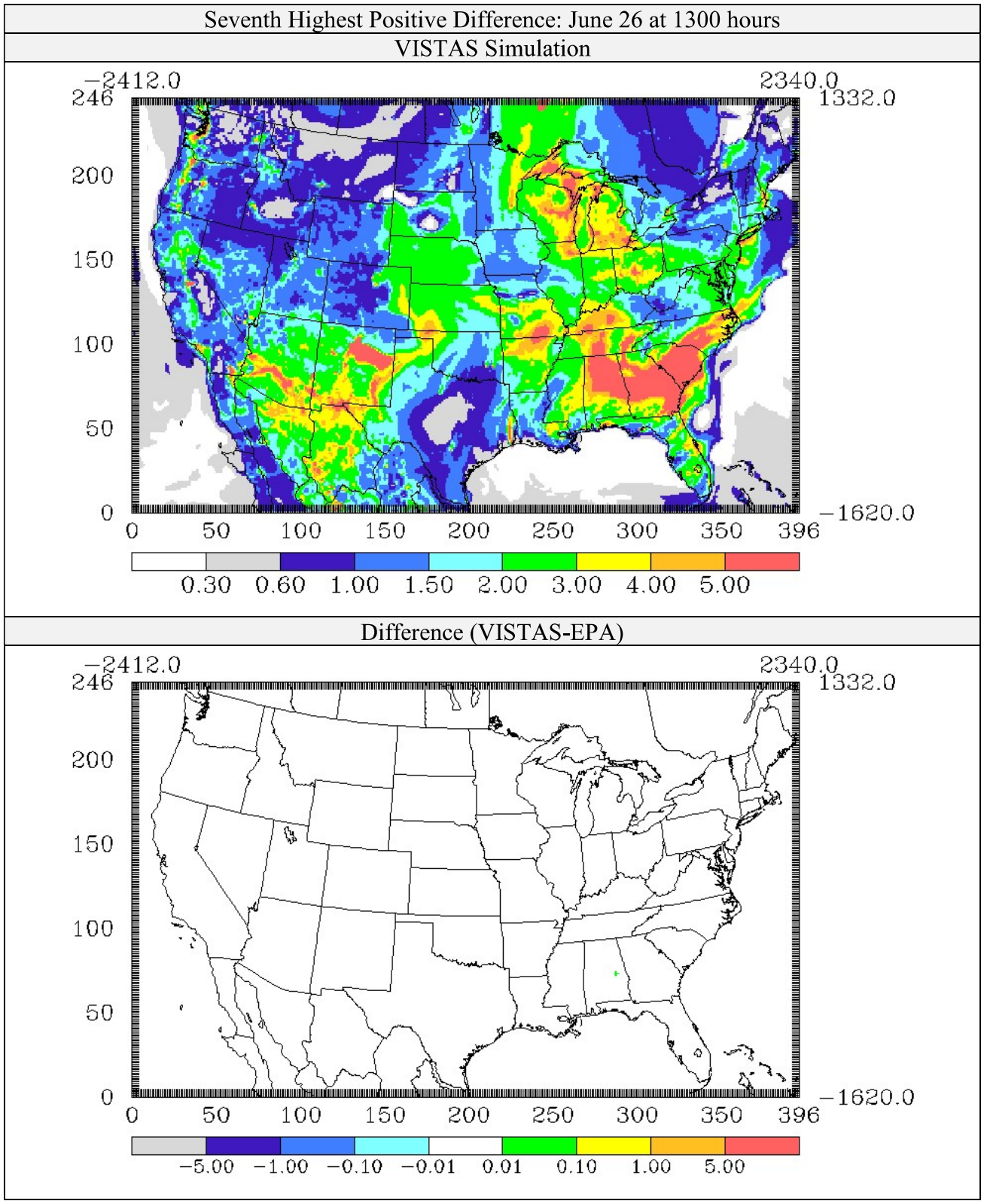

Figure 4-91: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)

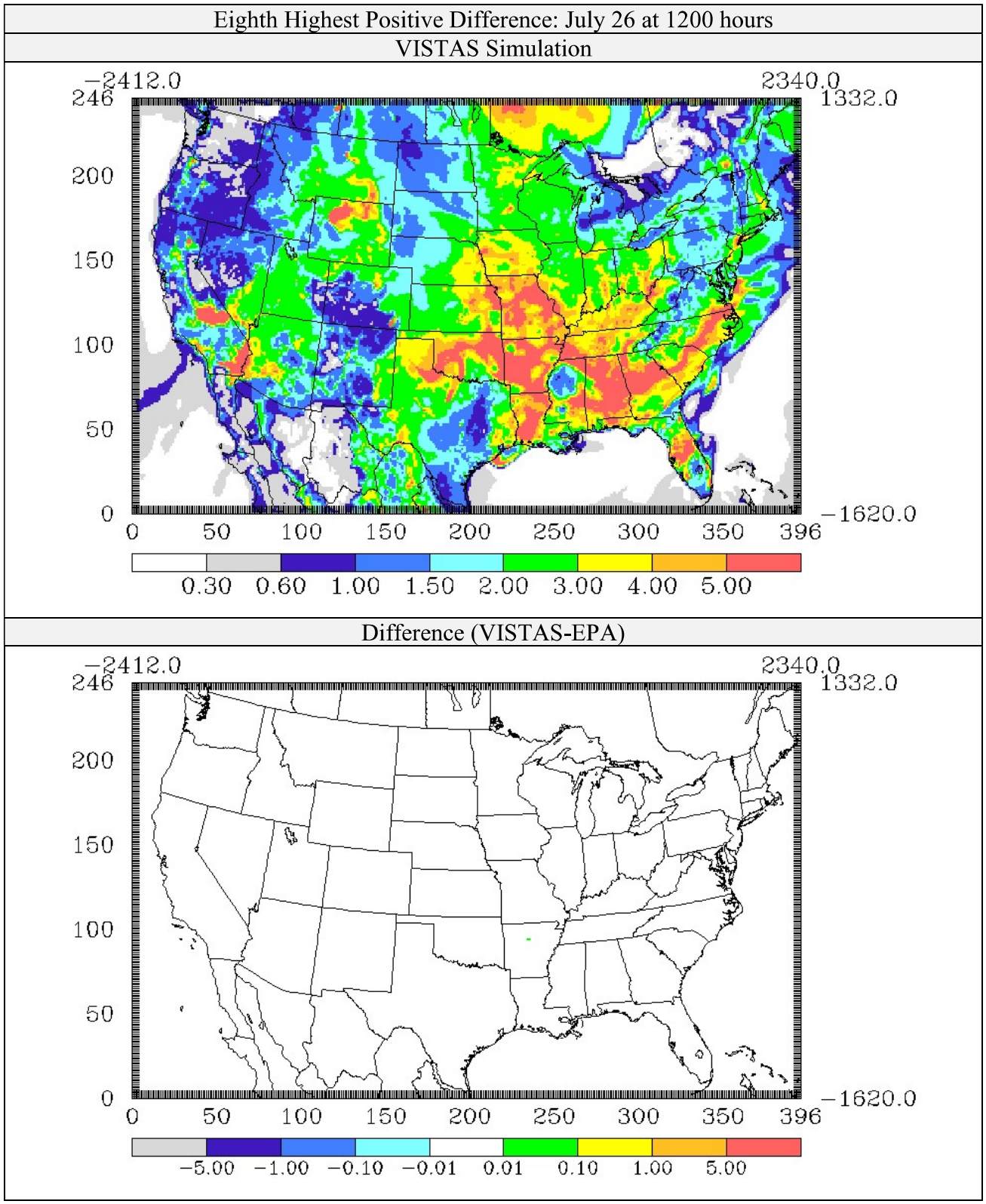

Figure 4-92: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)

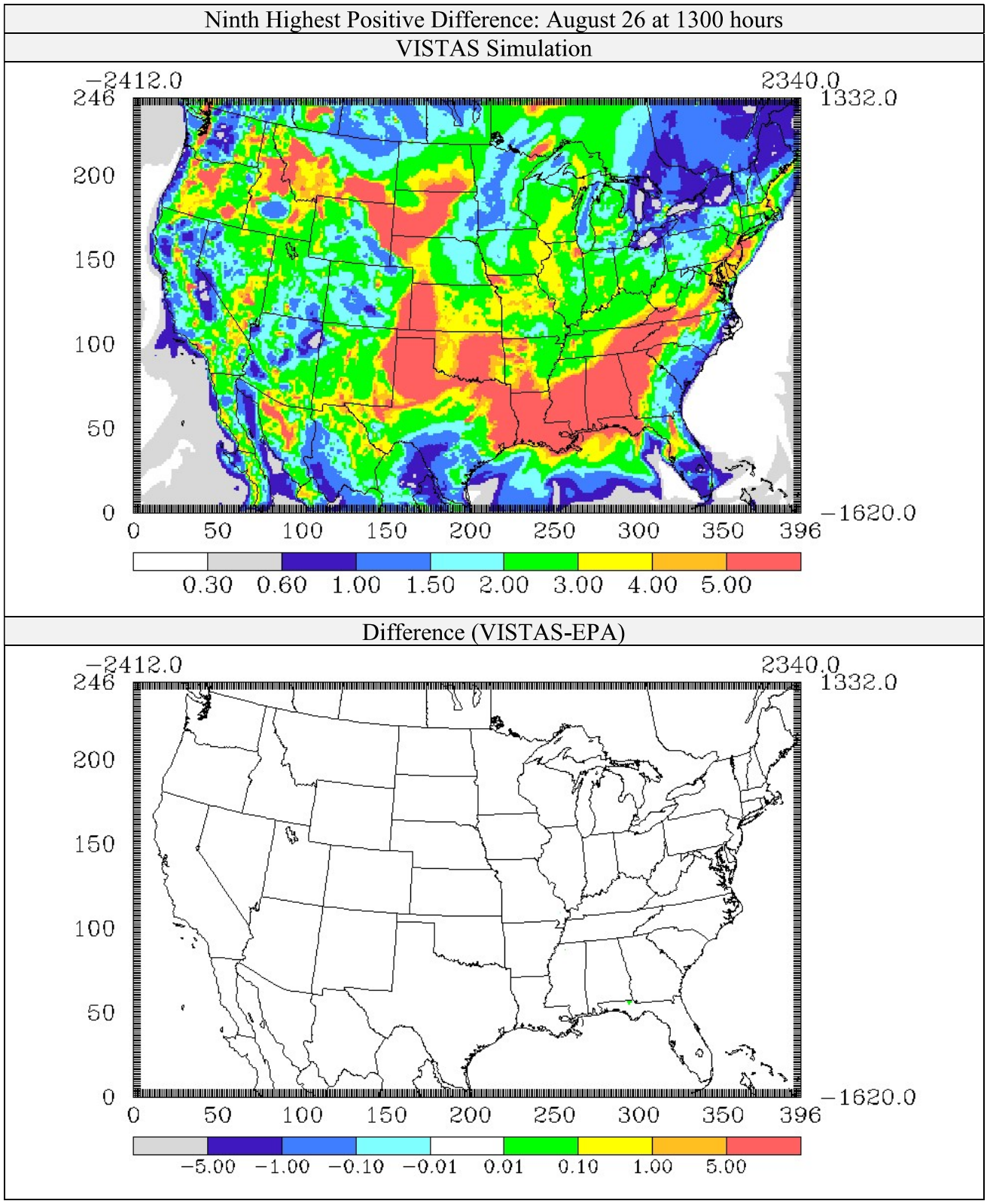

Figure 4-93: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)

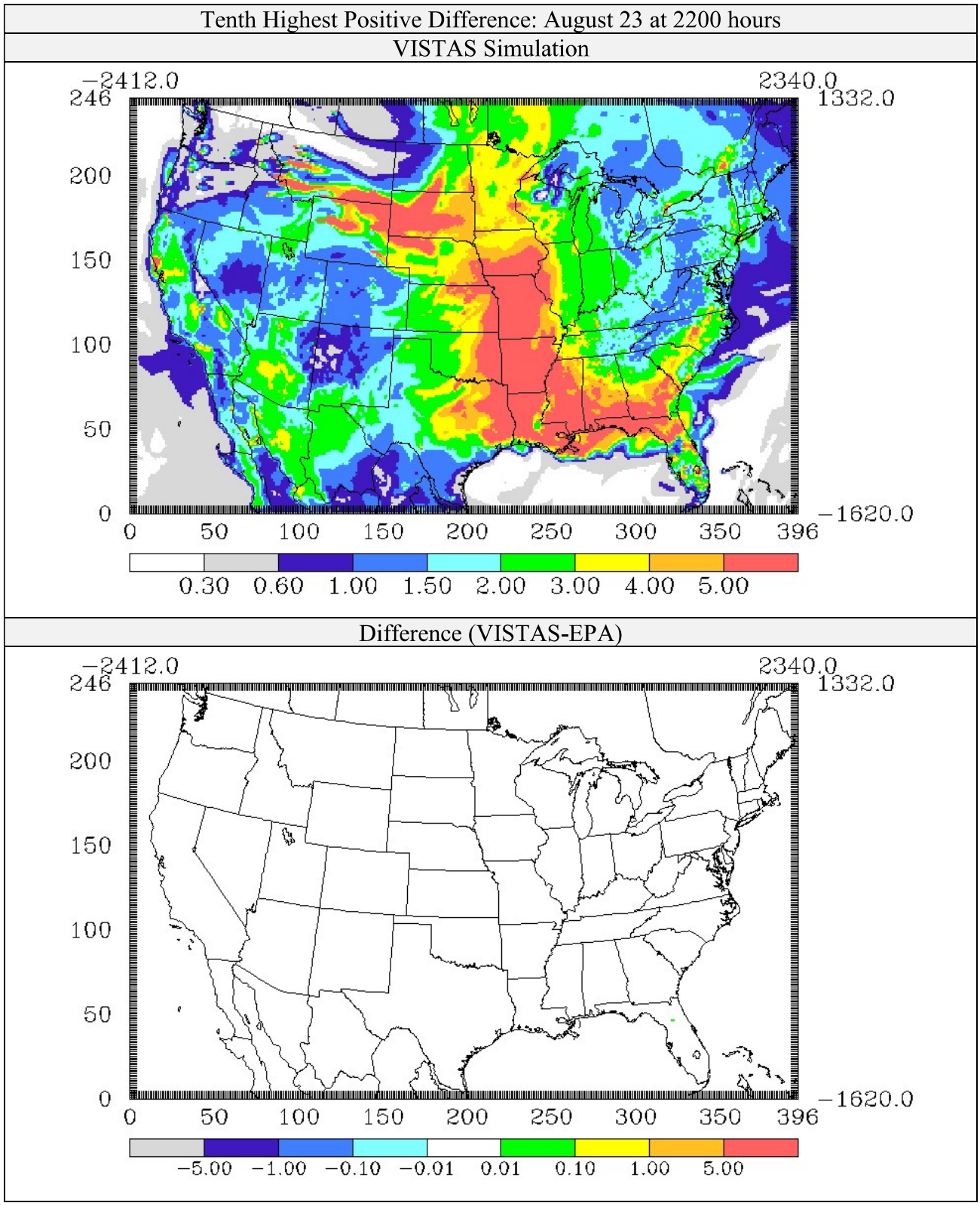

Figure 4-94: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)

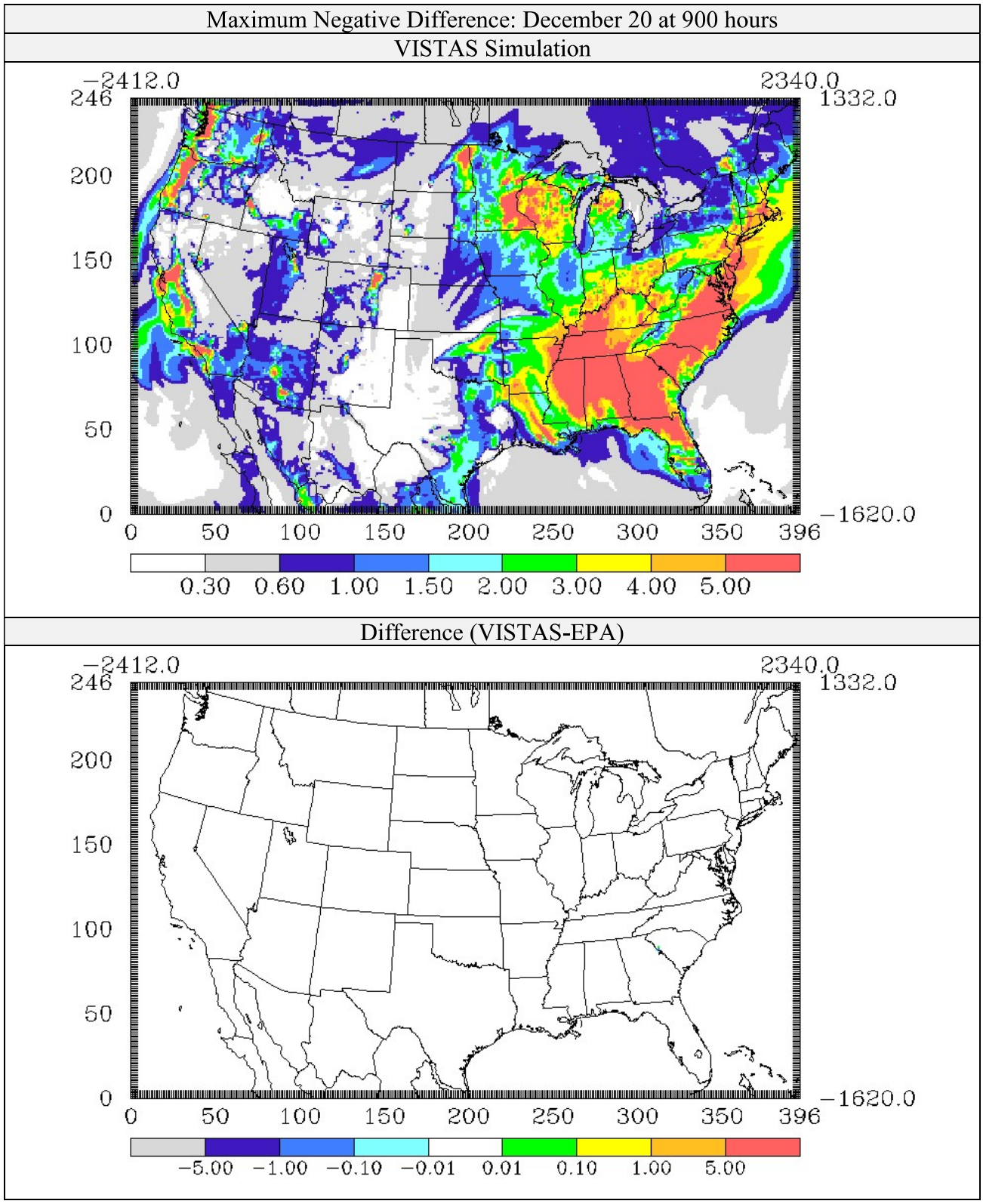

Figure 4-95: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)

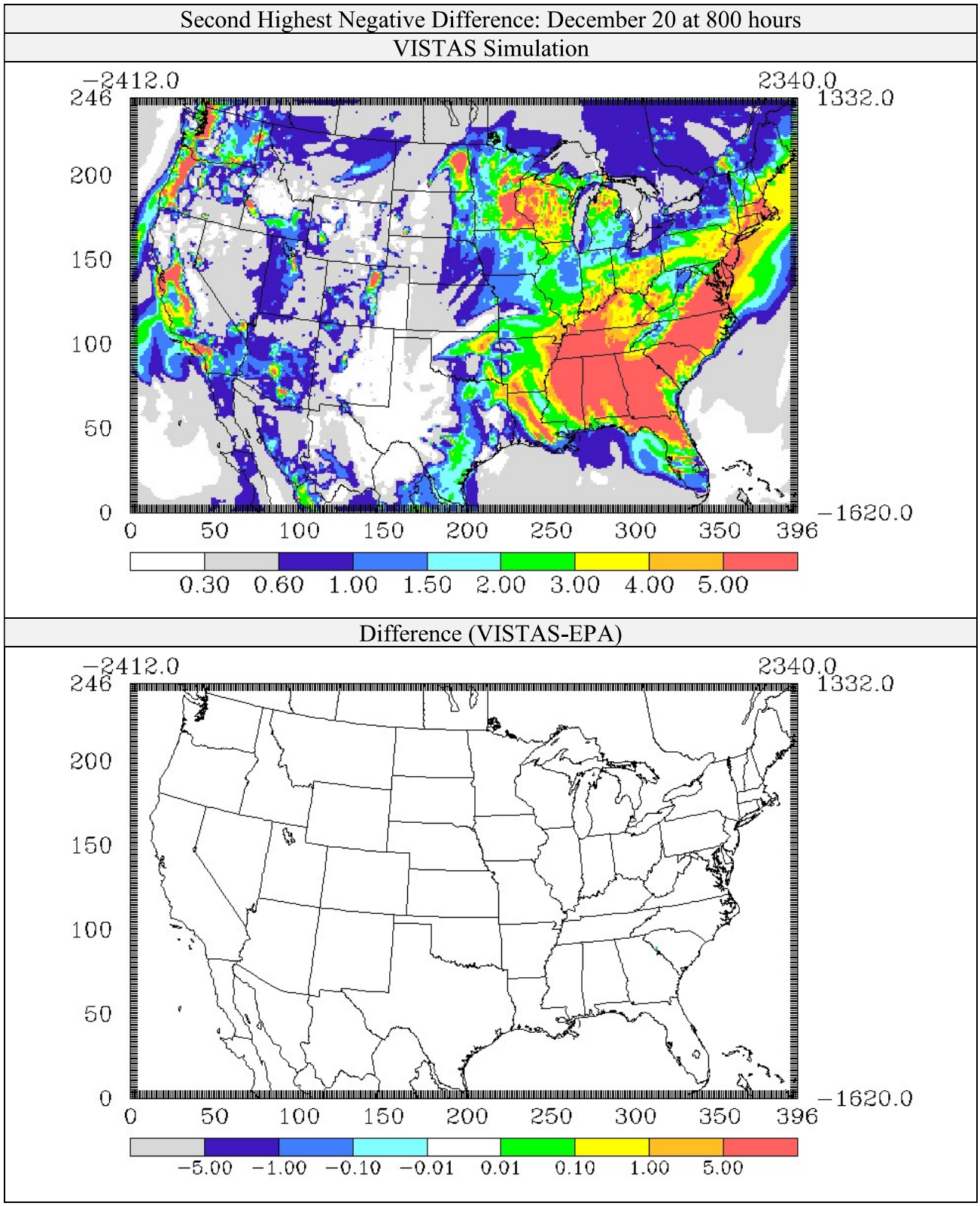

Figure 4-96: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)

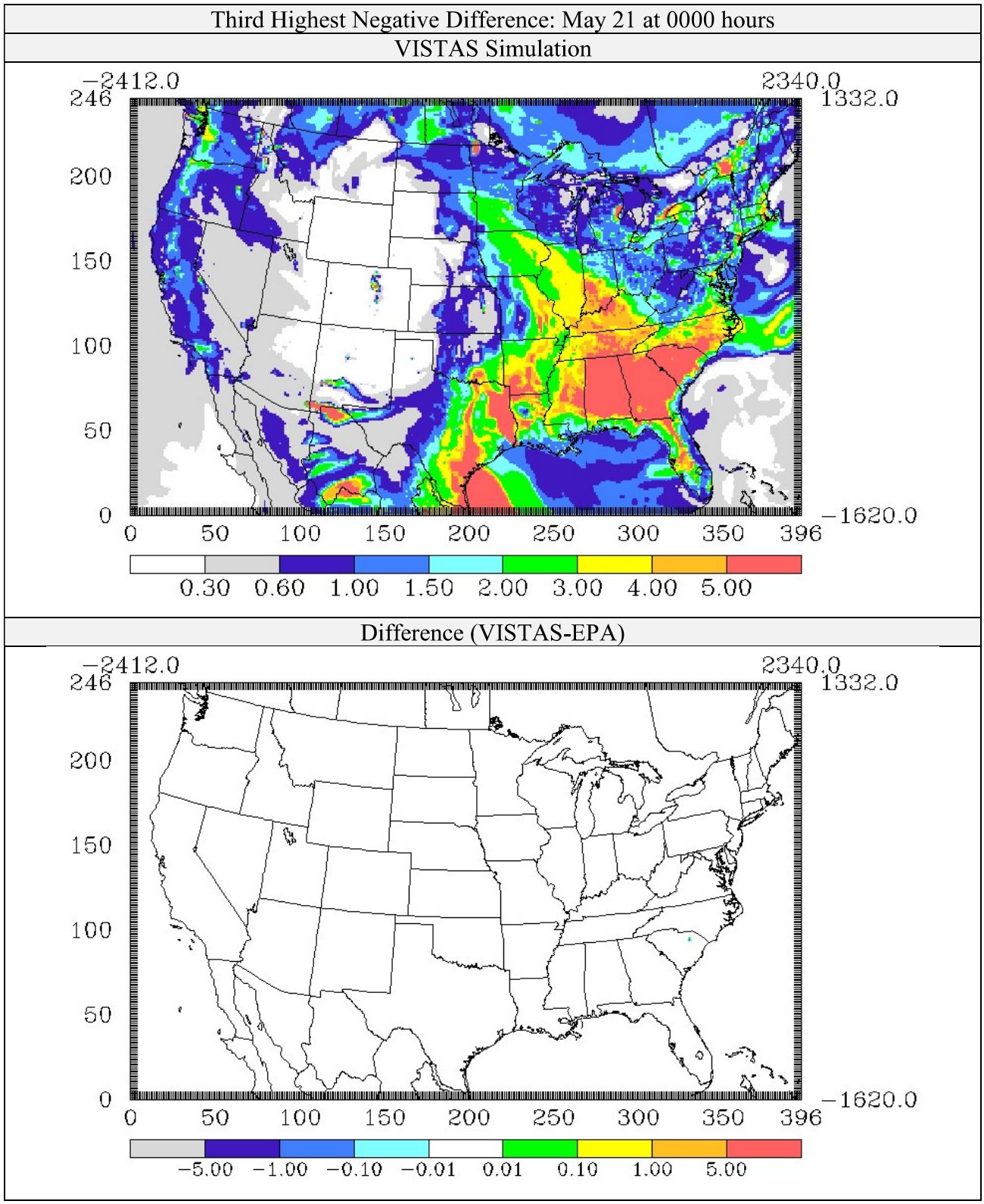

Figure 4-97: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)

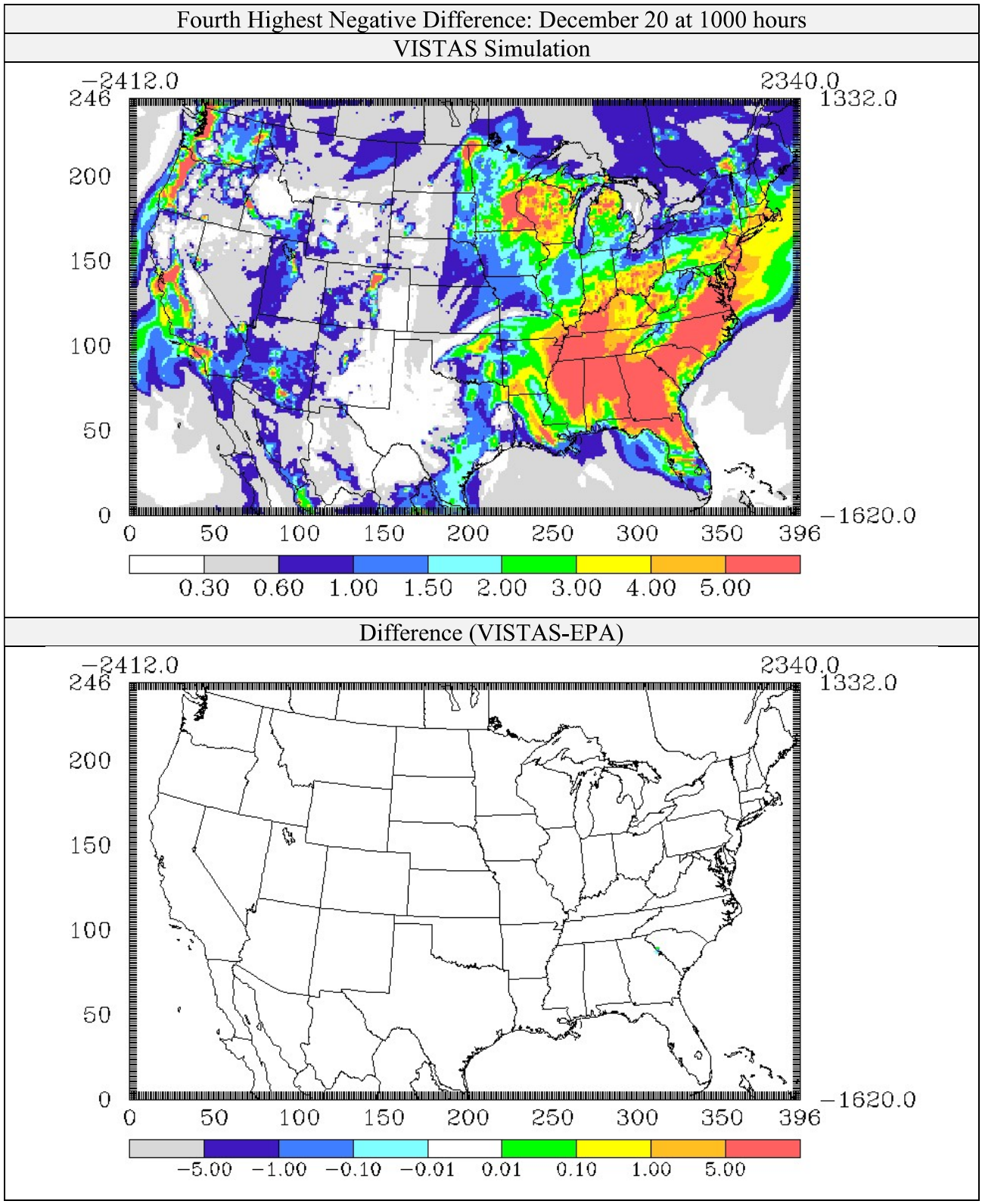

Figure 4-98: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)

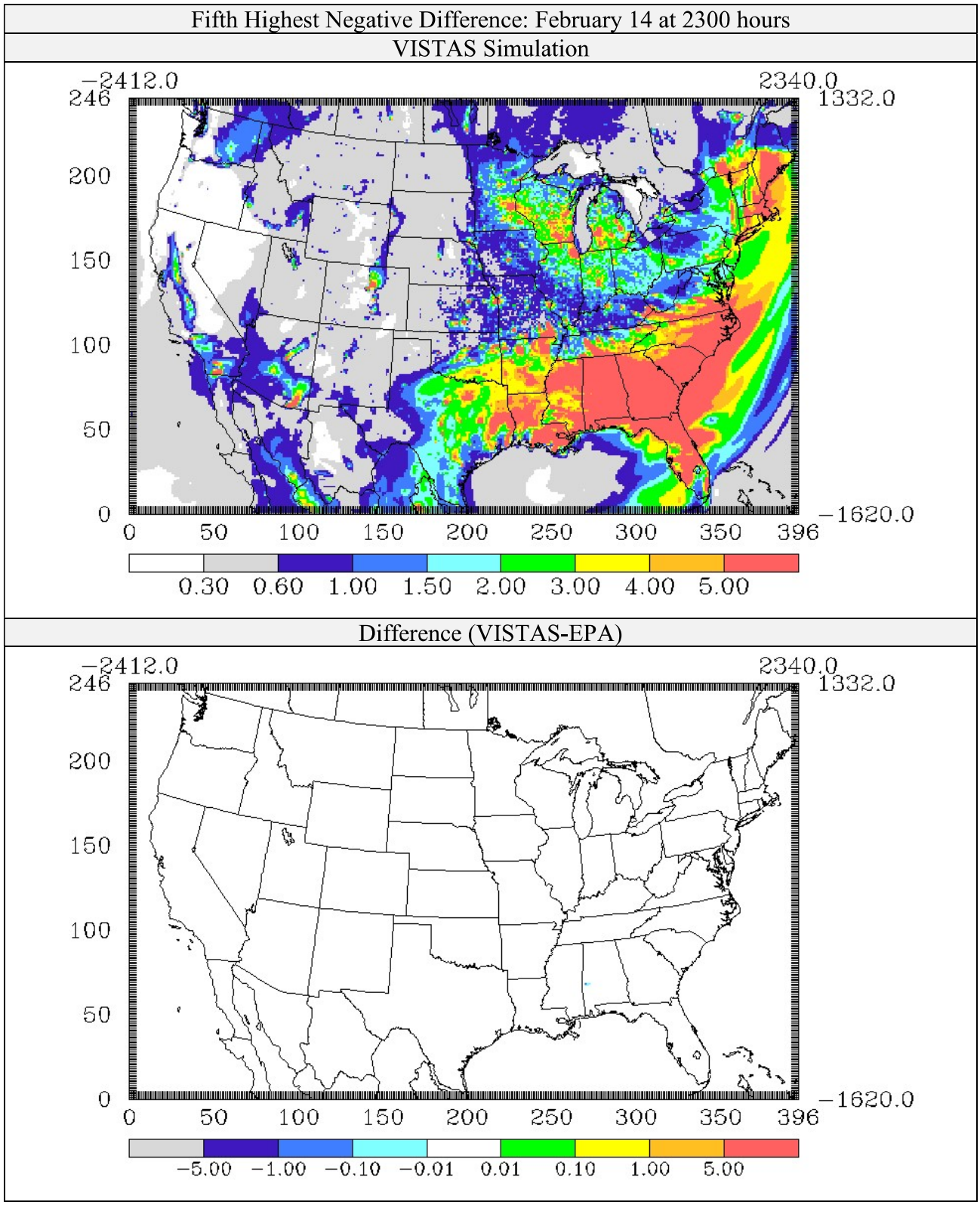

Figure 4-99: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)

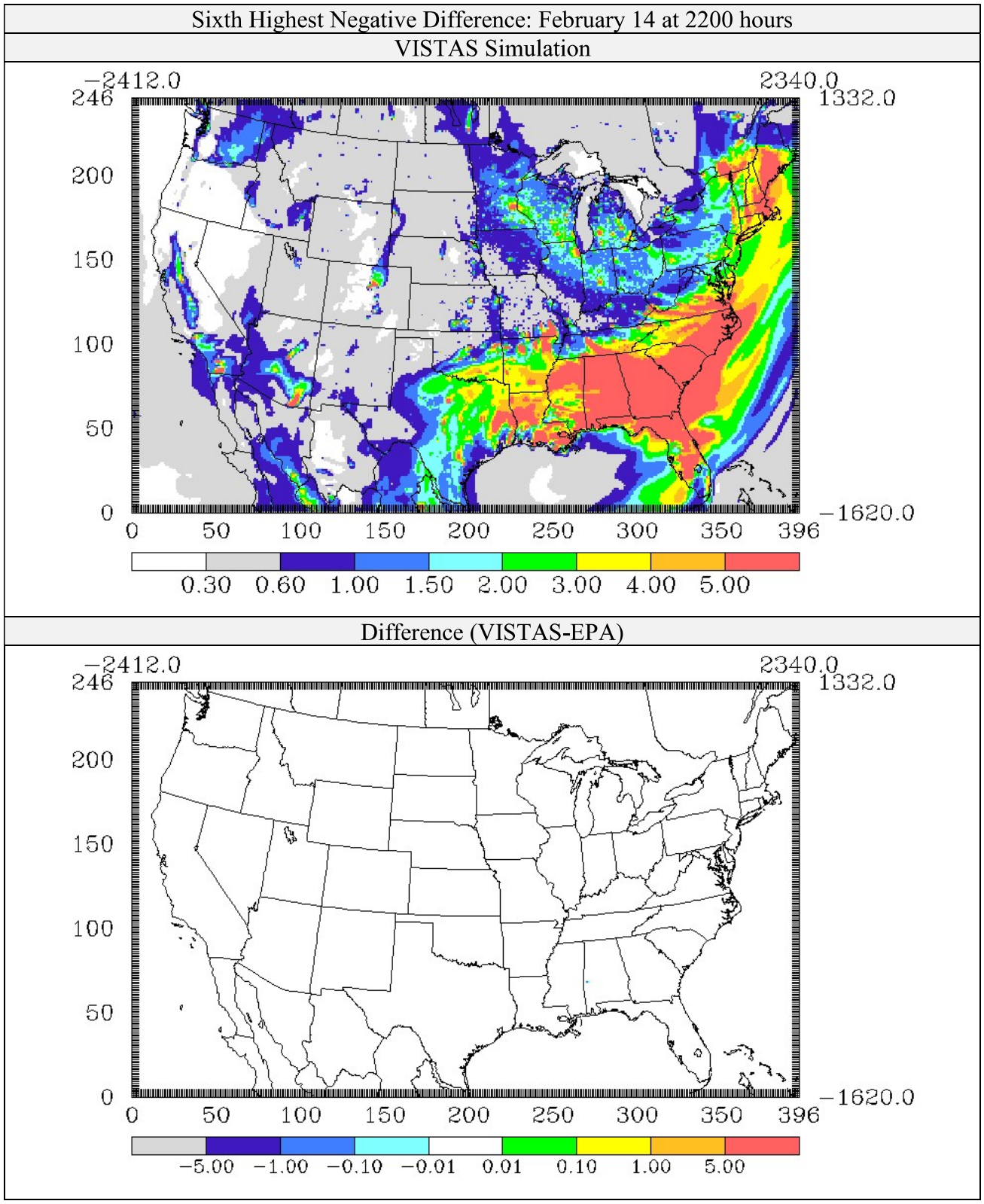

Figure 4-100: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)

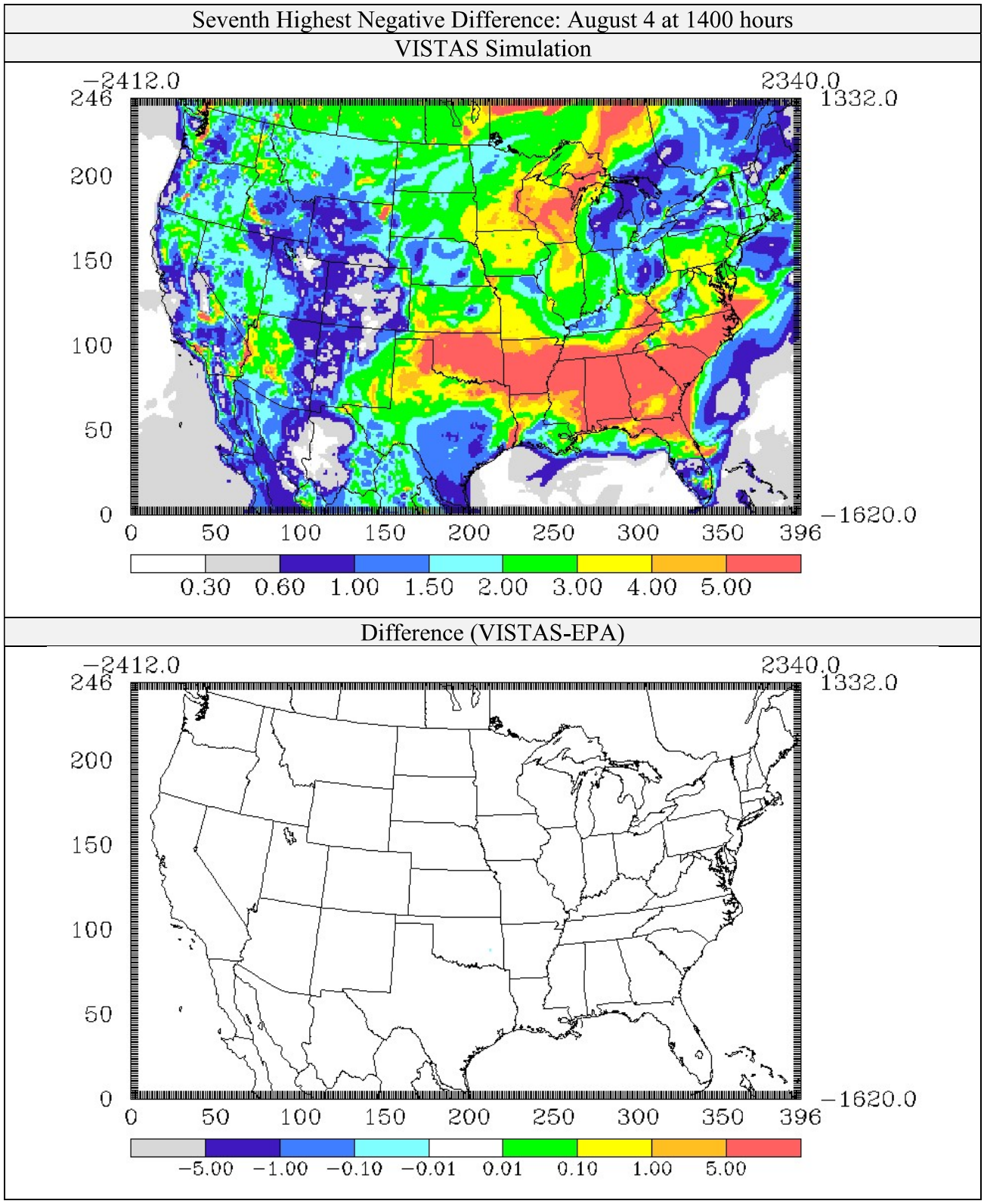

Figure 4-101: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)

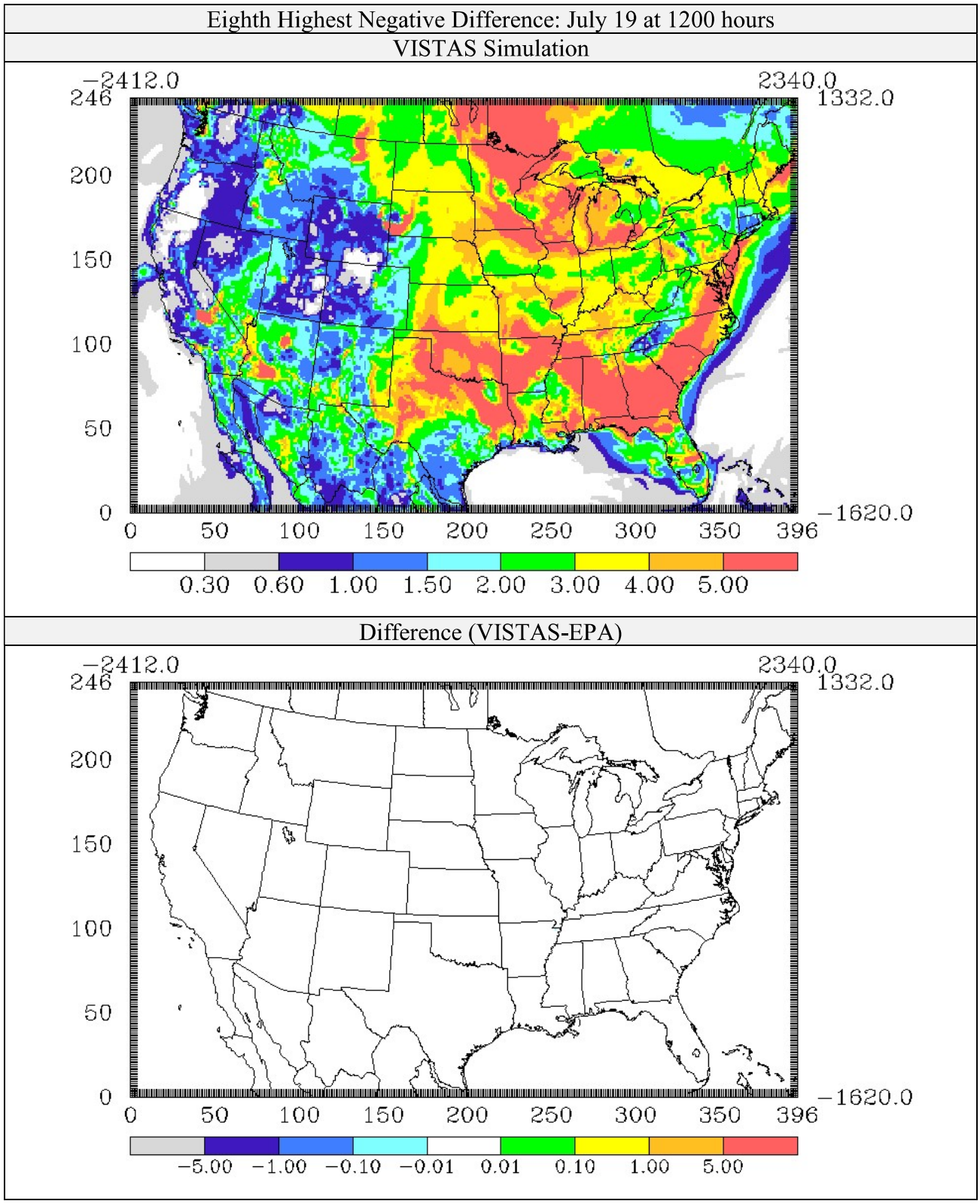

Figure 4-102: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)

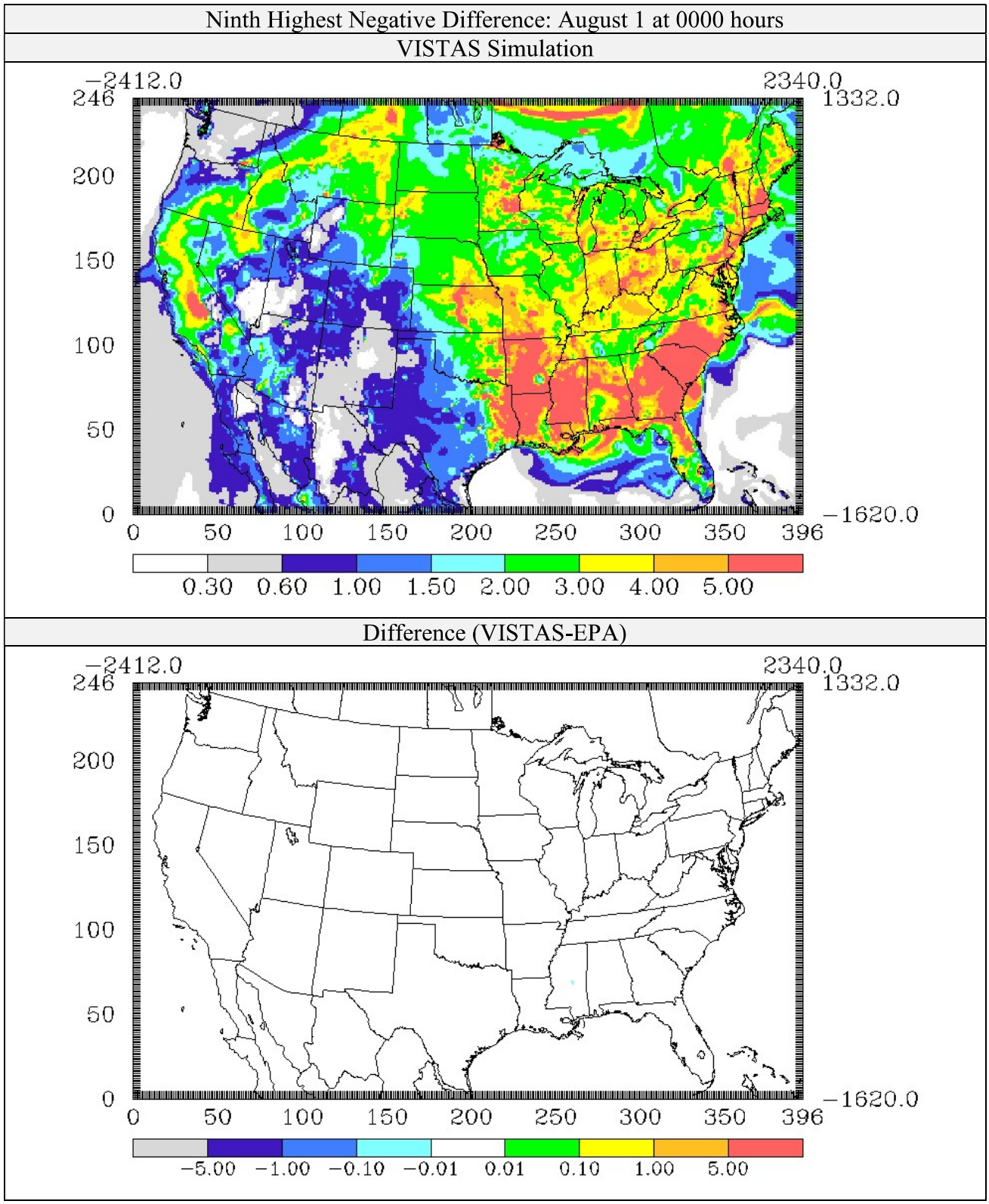

Figure 4-103: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)

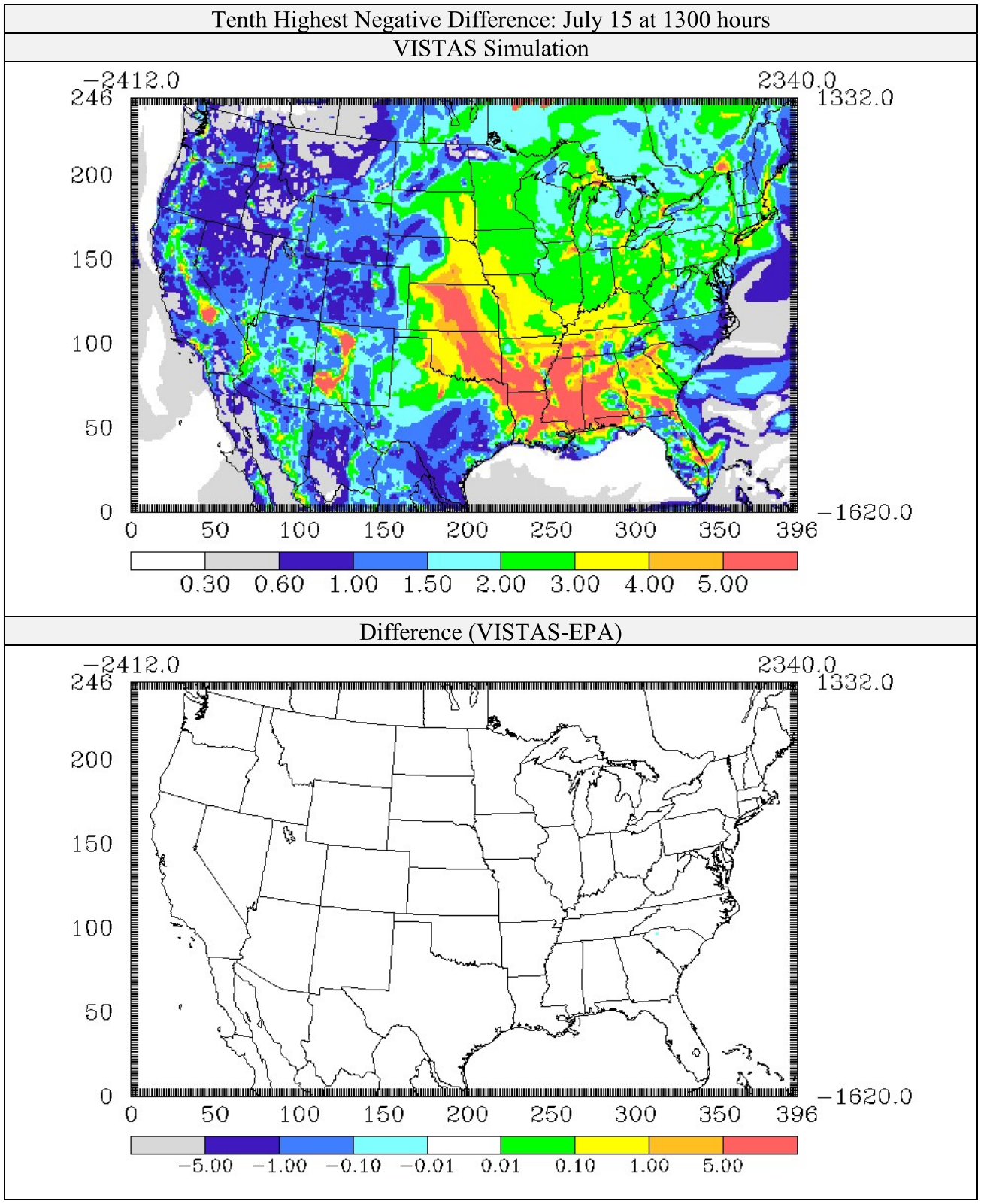

Figure 4-104: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Negative Difference)

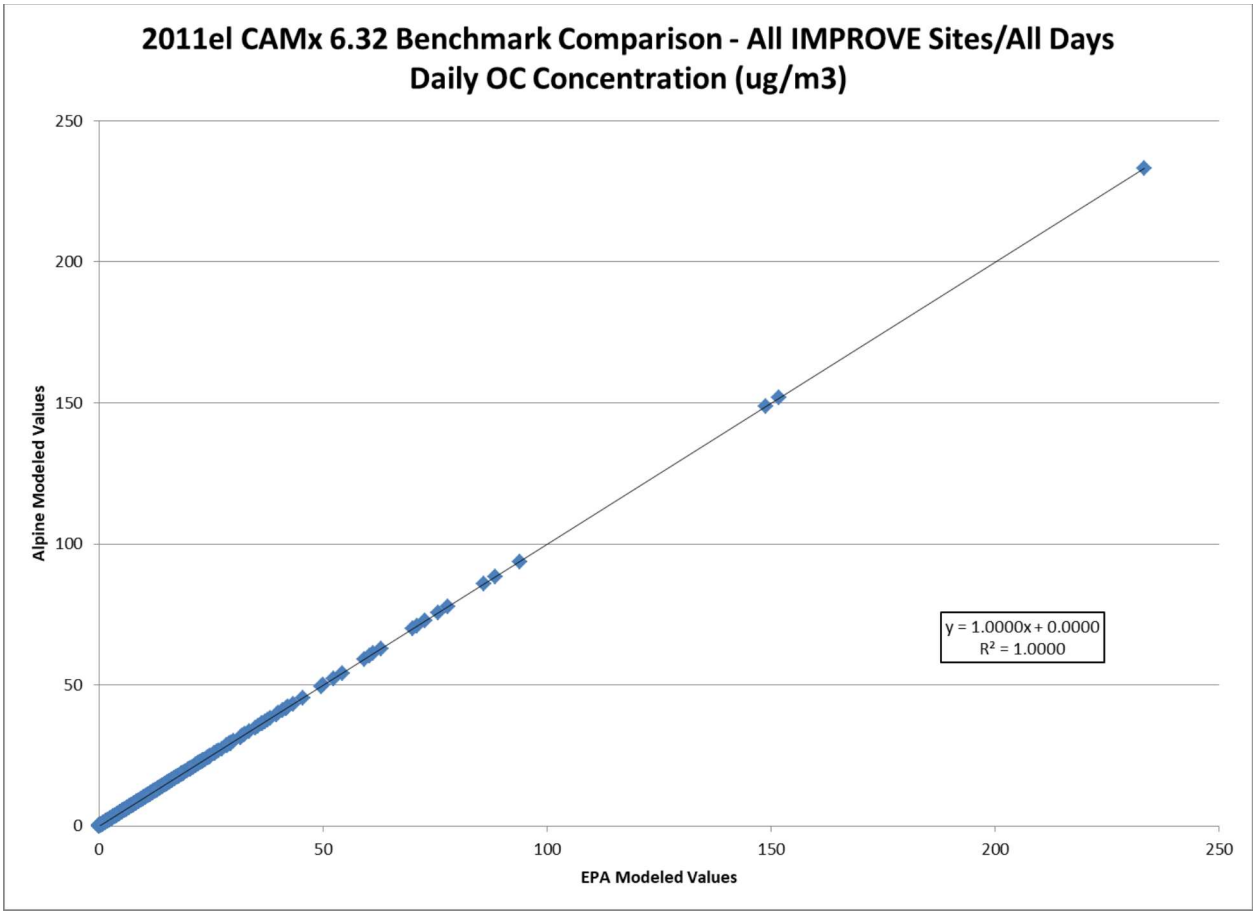

Figure 4-105: Scatterplot Comparing 24-hour Average Predicted Organic Carbon Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2011el Simulations Performed by EPA and VISTAS (Alpine).

5.0 CAMX 6.32 2028EL COMPARISON

This section presents comparisons of the 2028el simulations using CAMx 6.32 performed on the Alpine and EPA computer systems.

5.1 Ozone

Ozone results for the top 10 positive and negative hours are presented in tabular format in Table 5-1. The maximum positive difference is 2.24 ppb falling to 1.74 ppb for the 10th high. The maximum negative difference is -2.25 ppb falling to -1.60 ppb for the 10th high. The highest differences are occurring on relatively low ozone hours with concentrations ranging from 30 ppb to 50 ppb for the EPA simulation. The maximum positive percent difference is 7.8% and the maximum negative percent difference is -6.6%

The top ten positive impact hours are presented in Figures 5-1 through 5-10 and the top ten negative impact hours are presented in Figures 5-11 through 5-20. The locations of the impacts are very localized. On the hours with the maximum impacts the overwhelming number of grid cells have impacts less than 0.01 ppb.

Scatterplots of the daily average ozone concentrations in local standard time at the IMPROVE monitors are presented in Figure 5-21. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

The hours of the maximum differences, and the spatial patterns on those hours, are very similar between the 2011el (Section 4.1) and 2028el. This is not surprising given that the simulations differ only in the anthropogenic emissions inventories.

Table 5-1. Comparison of 2028el CAMx 6.32 Simulation Ozone Concentrations (ppb) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (ppb)	Percent Difference	Column	Row
Maximum Positive									
2011	7	6	23	42.43	40.19	2.24	5.58%	197	156
2011	8	18	23	44.64	42.43	2.21	5.21%	286	152
2011	7	14	22	31.20	29.06	2.13	7.34%	292	77
2011	8	30	14	28.50	26.43	2.06	7.81%	110	217
2011	8	27	12	29.93	28.01	1.92	6.85%	295	143
2011	9	11	23	52.26	50.35	1.91	3.79%	167	218
2011	8	19	0	38.39	36.52	1.87	5.12%	286	152
2011	8	8	23	35.67	33.85	1.82	5.39%	217	184
2011	8	7	16	30.17	28.38	1.80	6.33%	257	103
2011	7	7	0	38.27	36.52	1.74	4.78%	197	156
Maximum Negative									
2011	8	16	0	27.88	30.14	-2.25	-7.47%	251	134
2011	6	18	22	30.88	33.06	-2.18	-6.59%	196	187
2011	8	15	23	30.96	33.06	-2.10	-6.34%	251	134
2011	7	15	21	38.77	40.69	-1.92	-4.73%	224	159
2011	3	30	10	42.39	44.30	-1.91	-4.30%	117	19
2011	6	26	22	27.84	29.67	-1.83	-6.17%	206	183
2011	7	7	16	35.85	37.67	-1.82	-4.84%	216	180
2011	8	11	18	31.40	33.11	-1.72	-5.19%	332	28
2011	6	18	23	30.11	31.76	-1.65	-5.19%	196	187
2011	7	16	19	43.39	45.00	-1.60	-3.57%	196	189

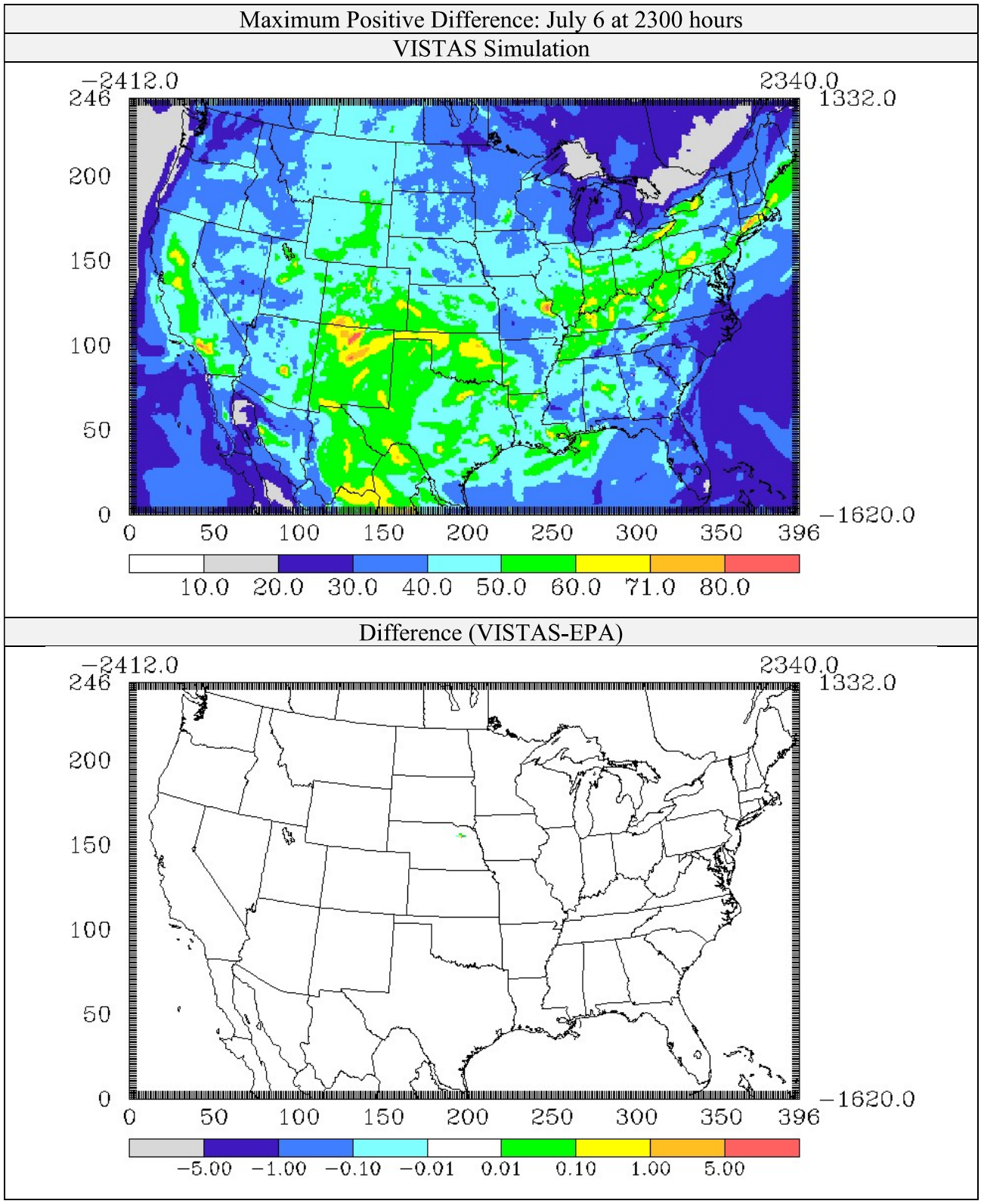

Figure 5-1: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)

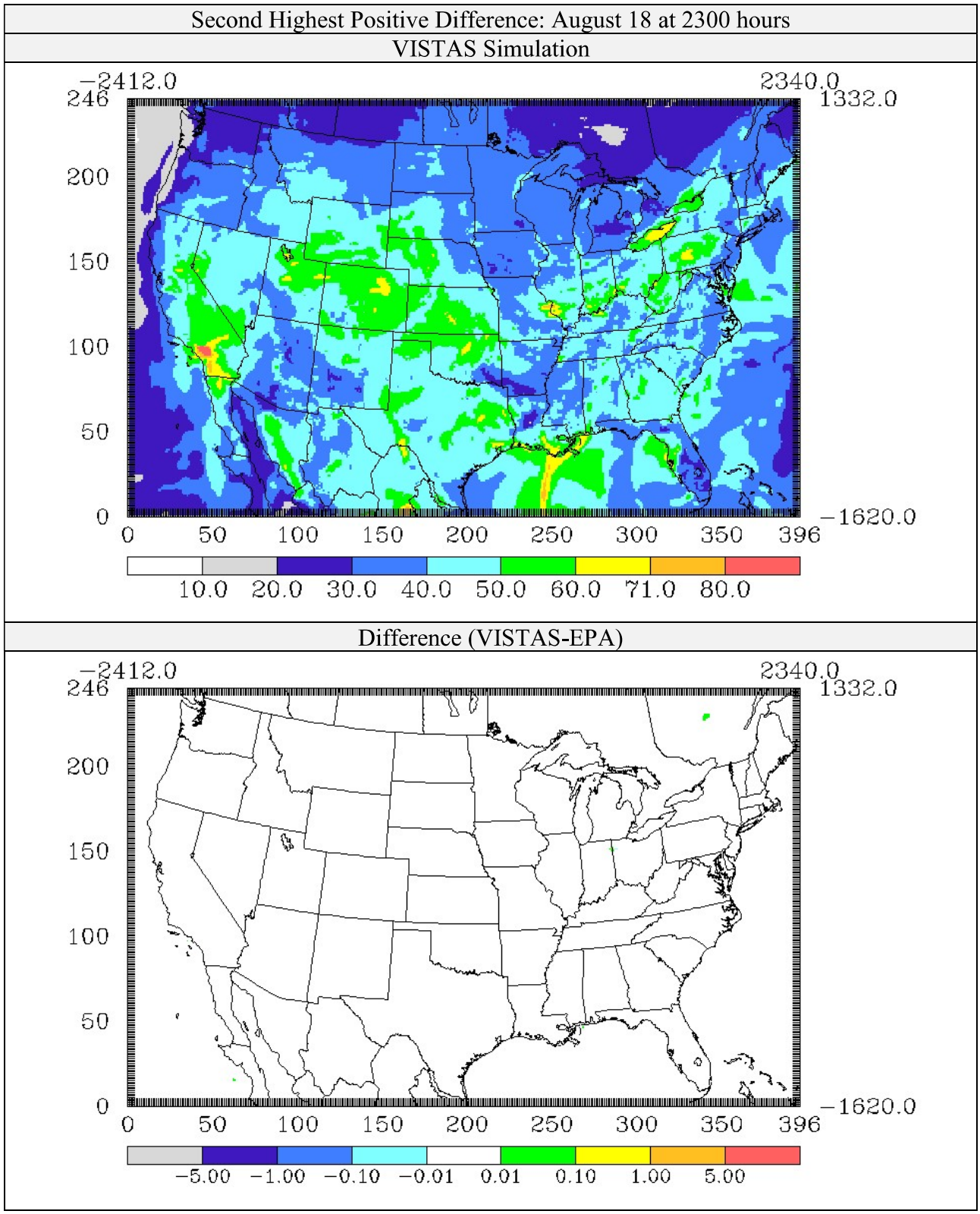

Figure 5-2: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)

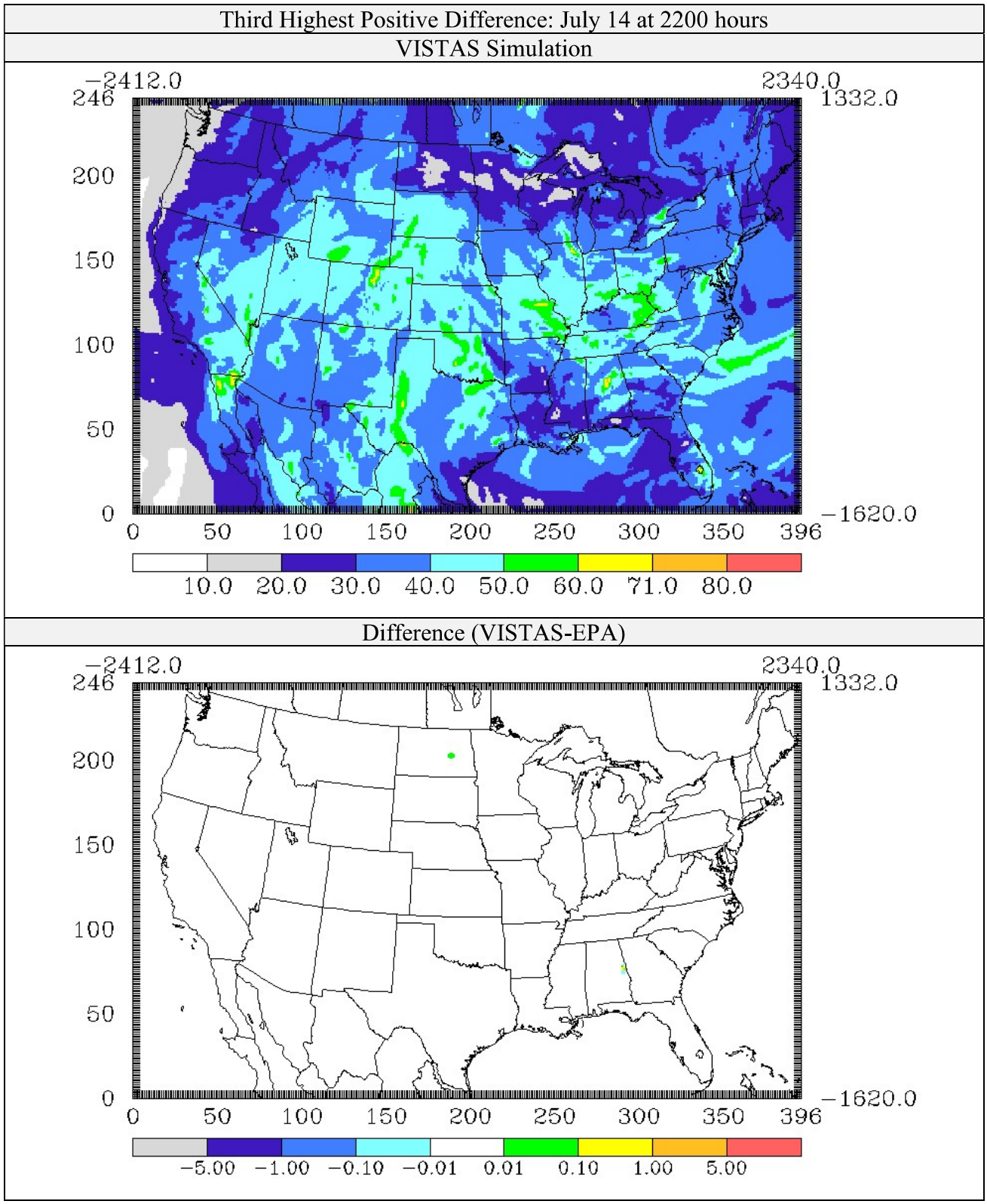

Figure 5-3: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)

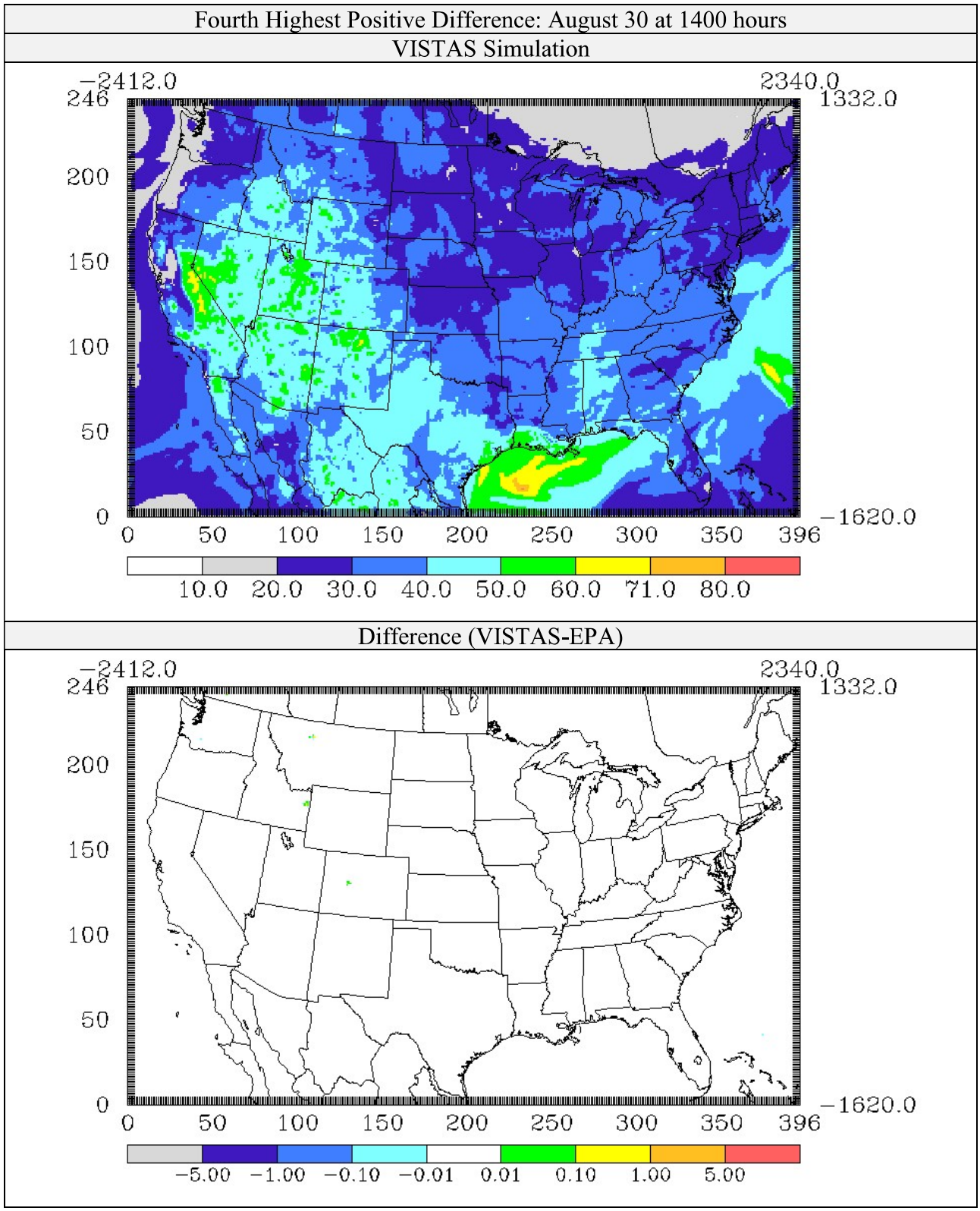

Figure 5-4: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

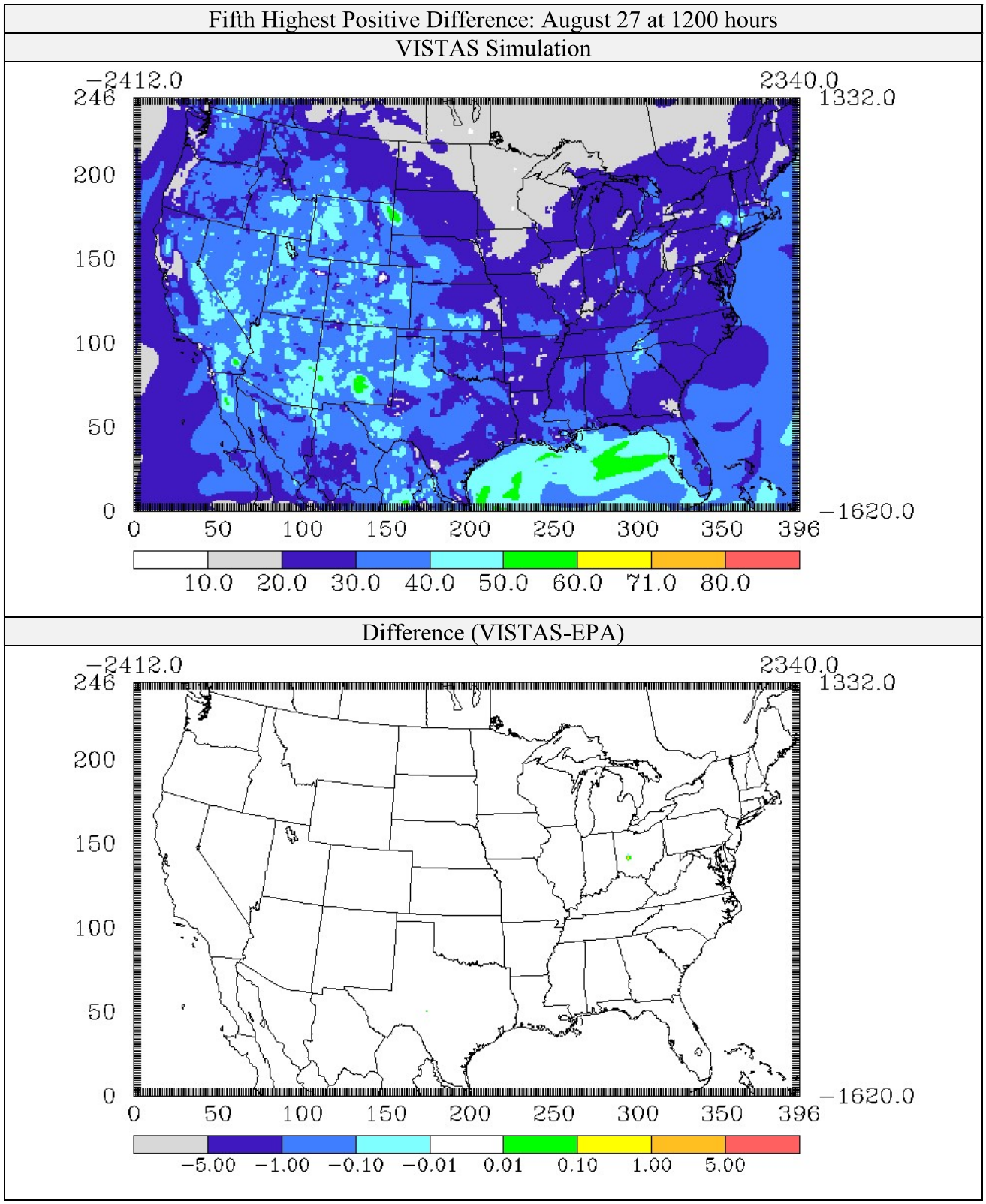

Figure 5-5: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

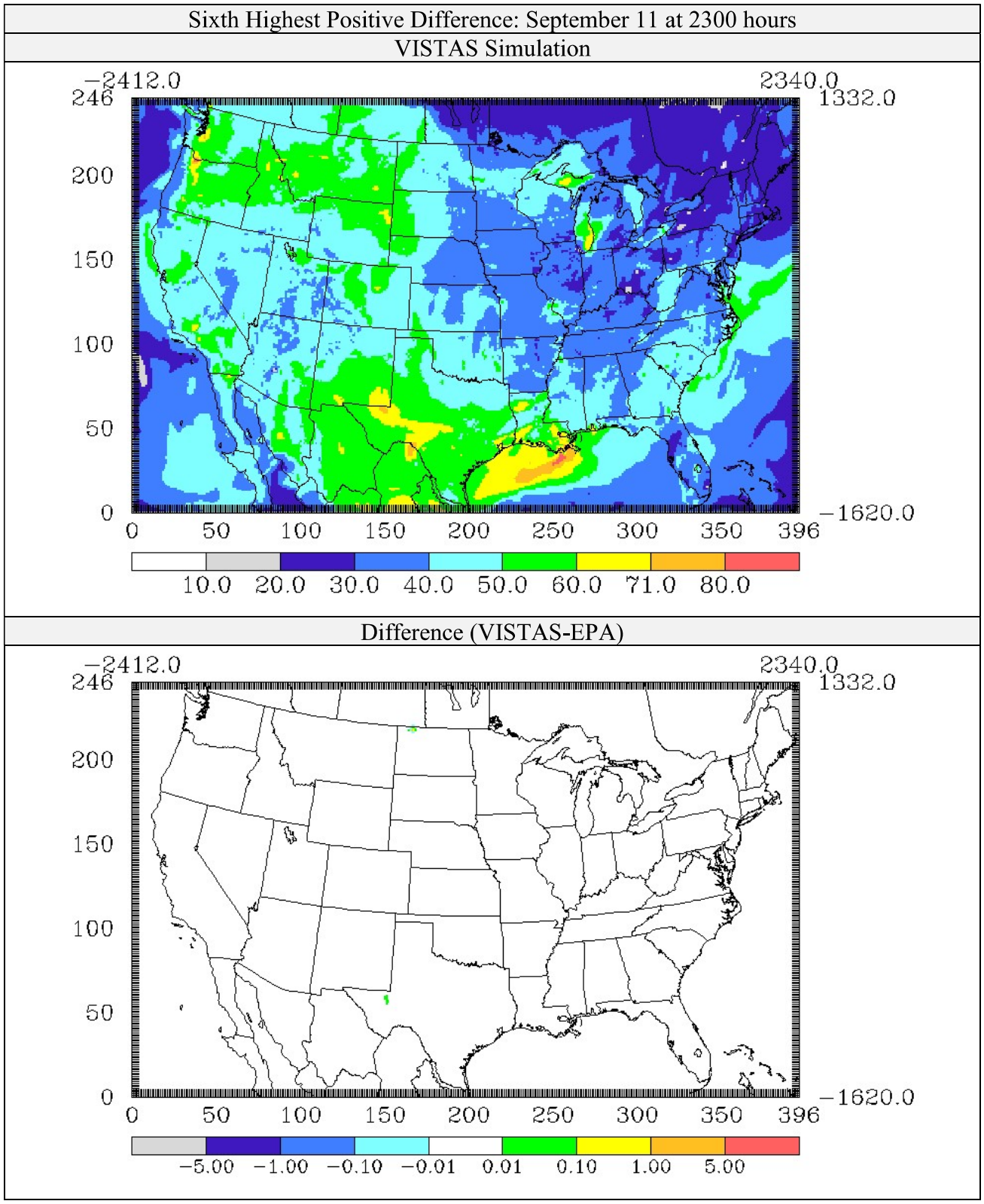

Figure 5-6: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)

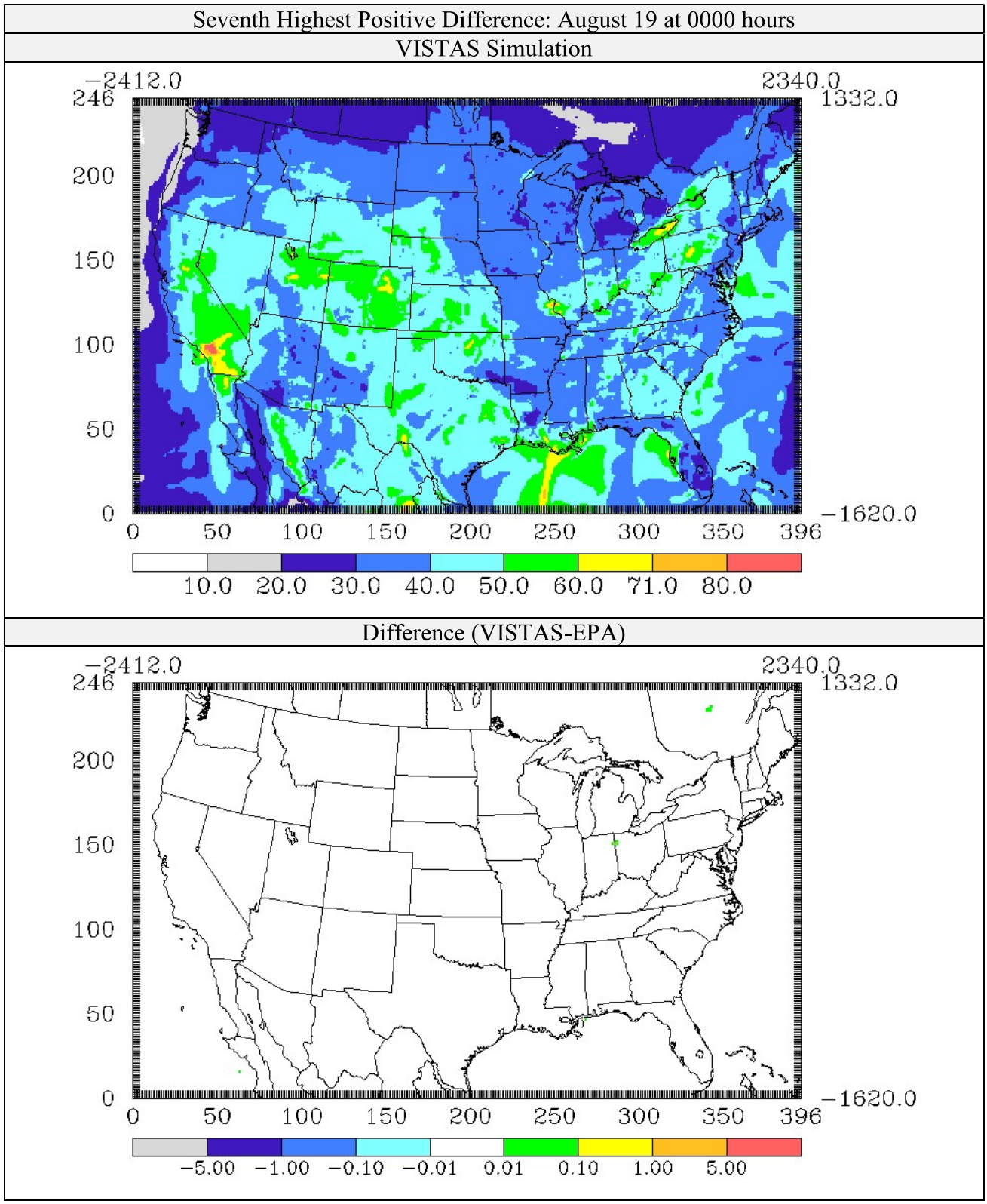

Figure 5-7: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)

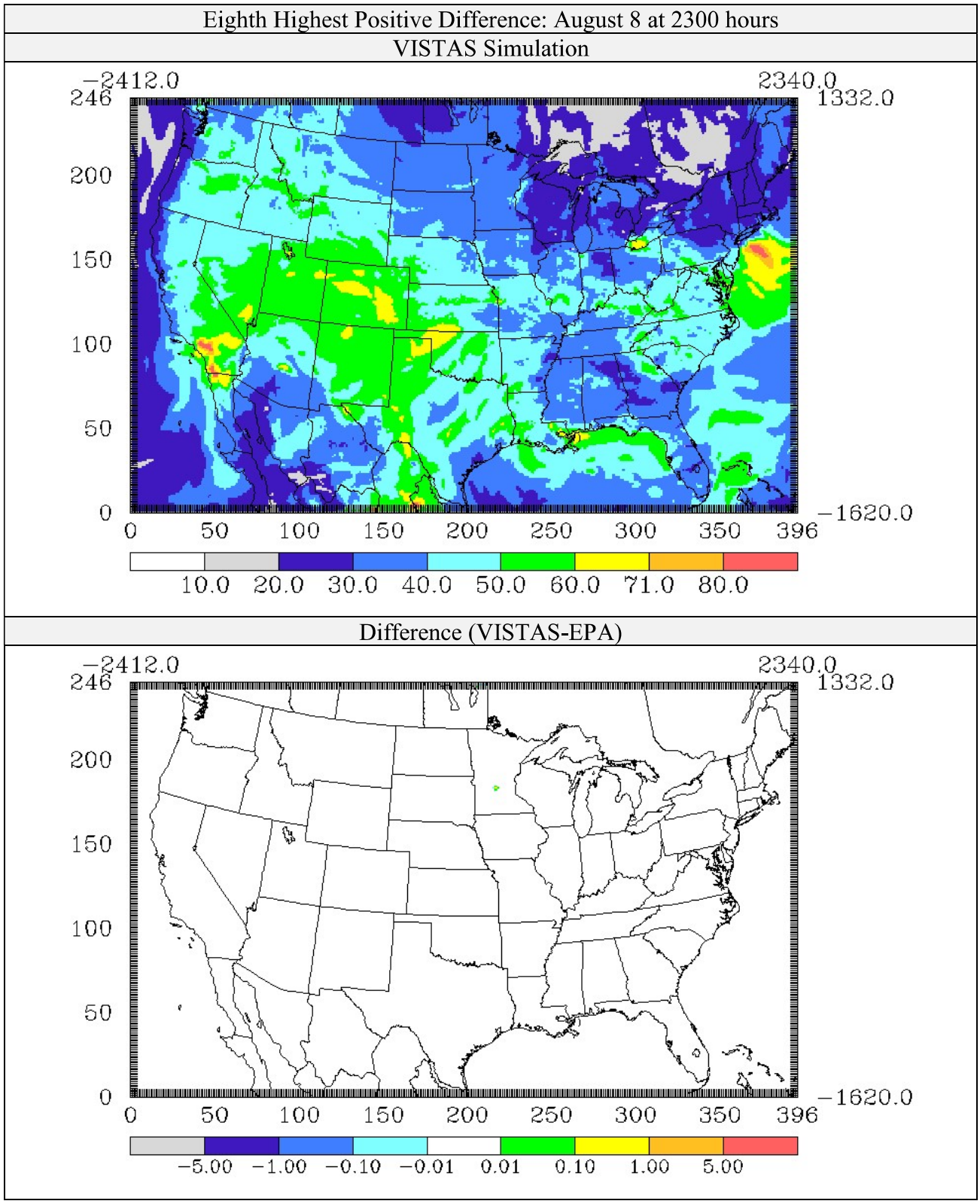

Figure 5-8: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)

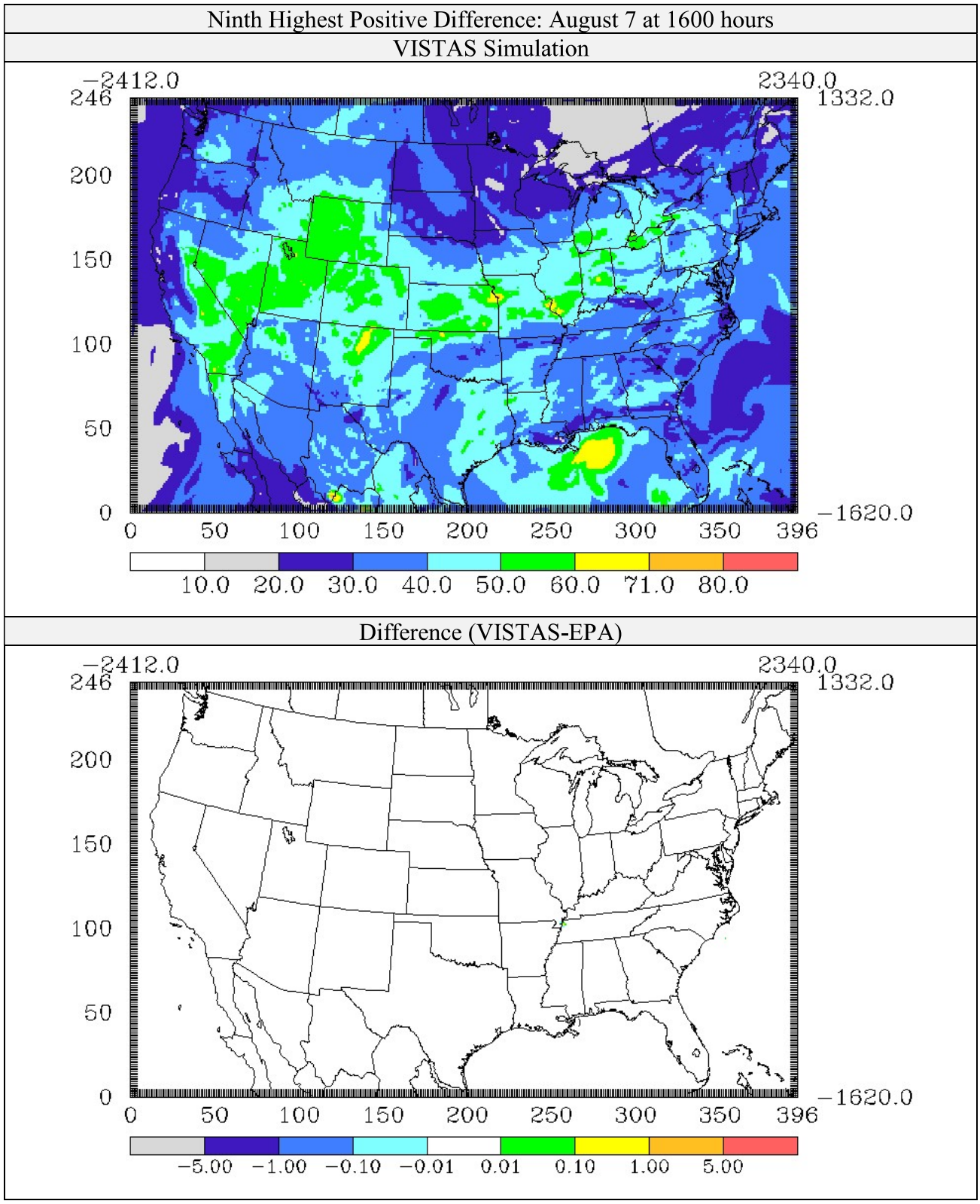

Figure 5-9: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)

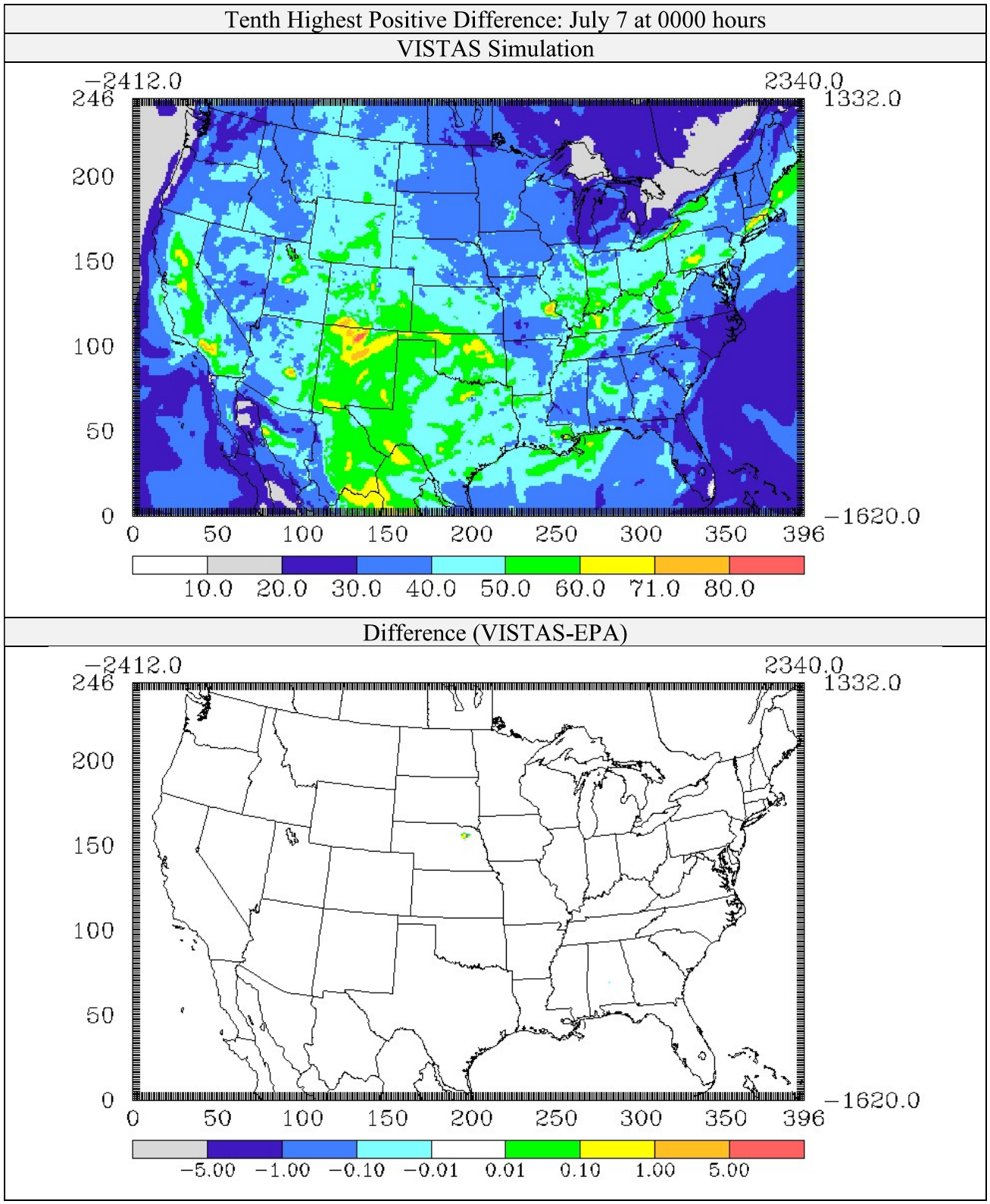

Figure 5-10: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)

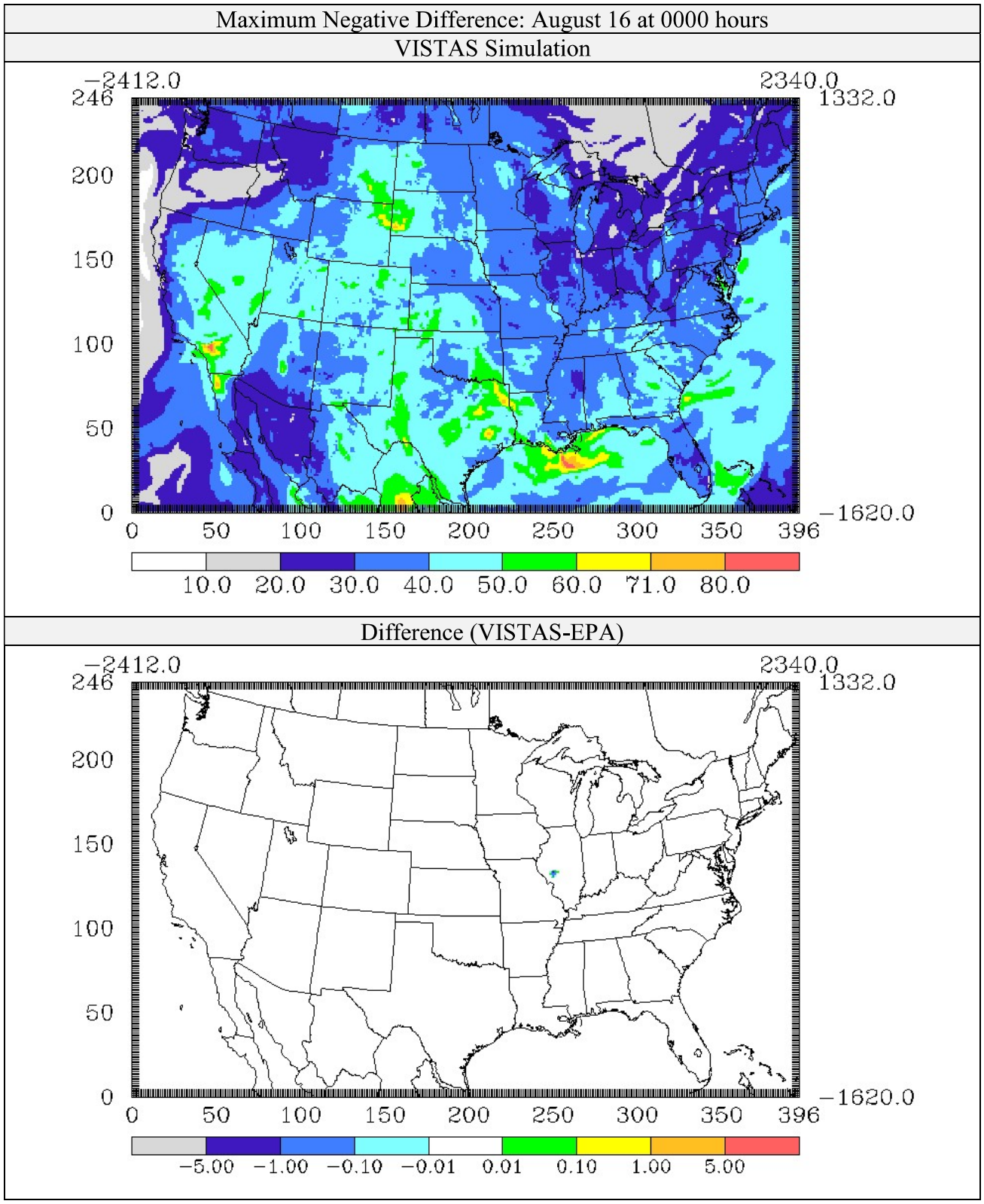

Figure 5-11: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)

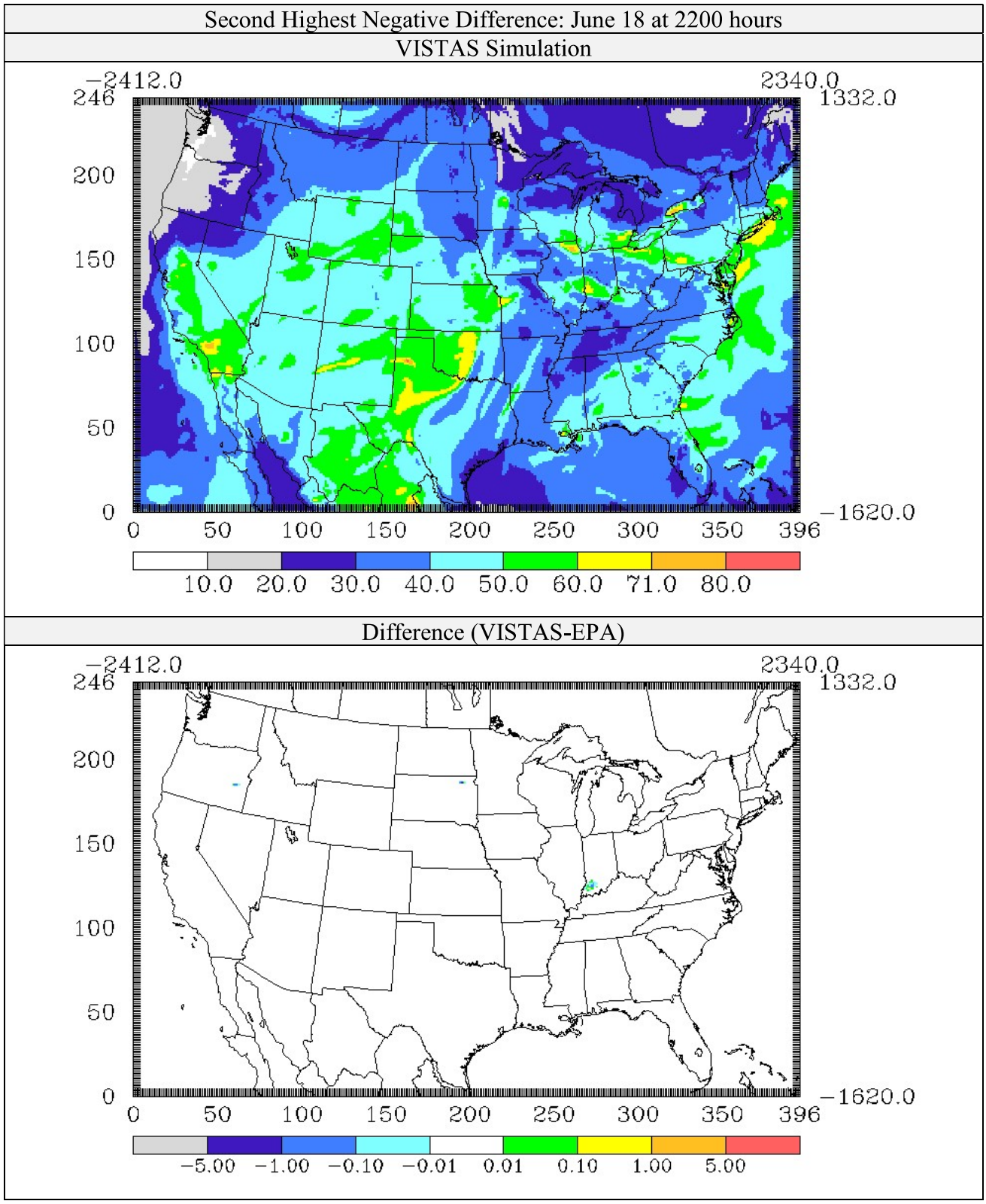

Figure 5-12: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)

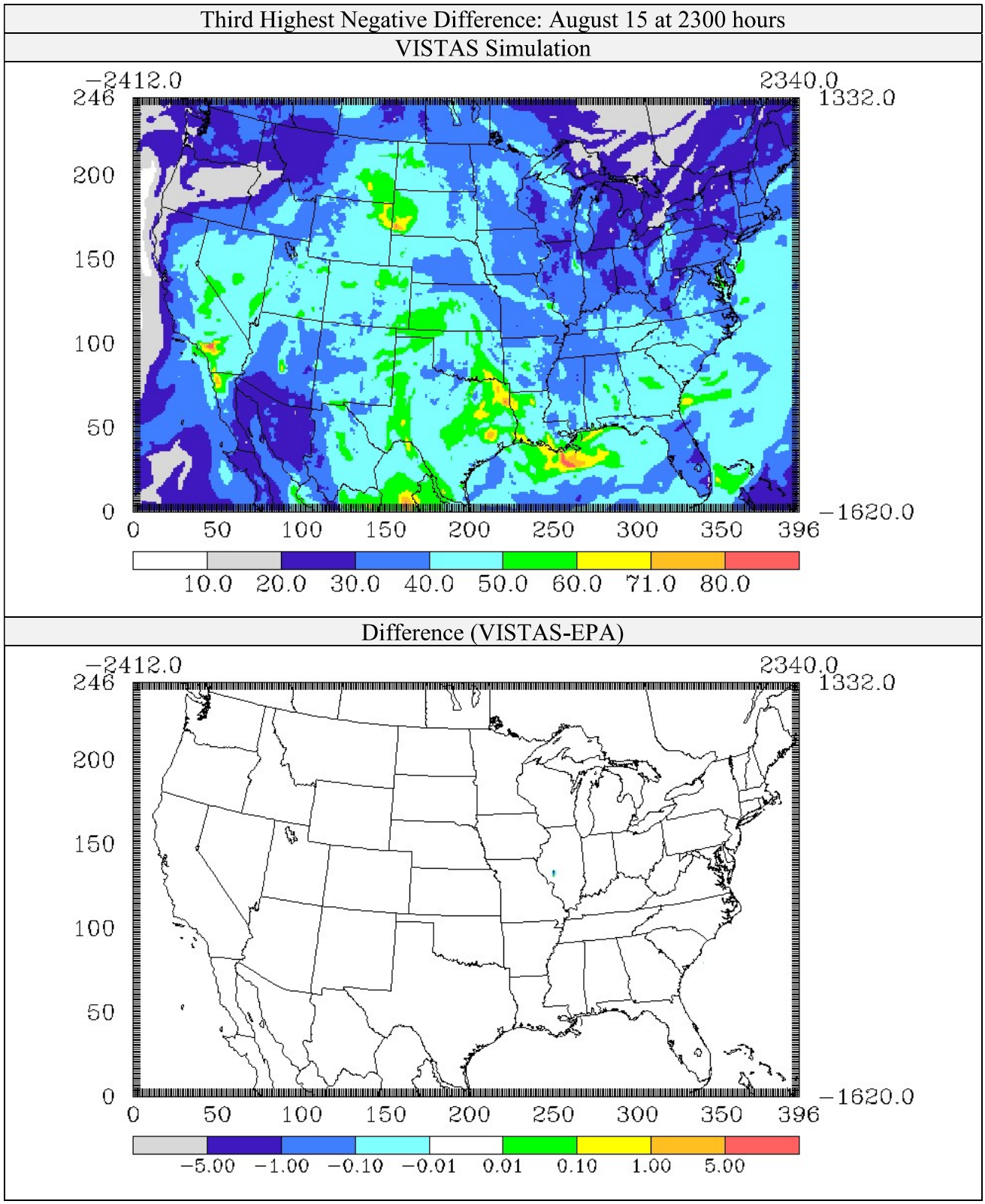

Figure 5-13: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)

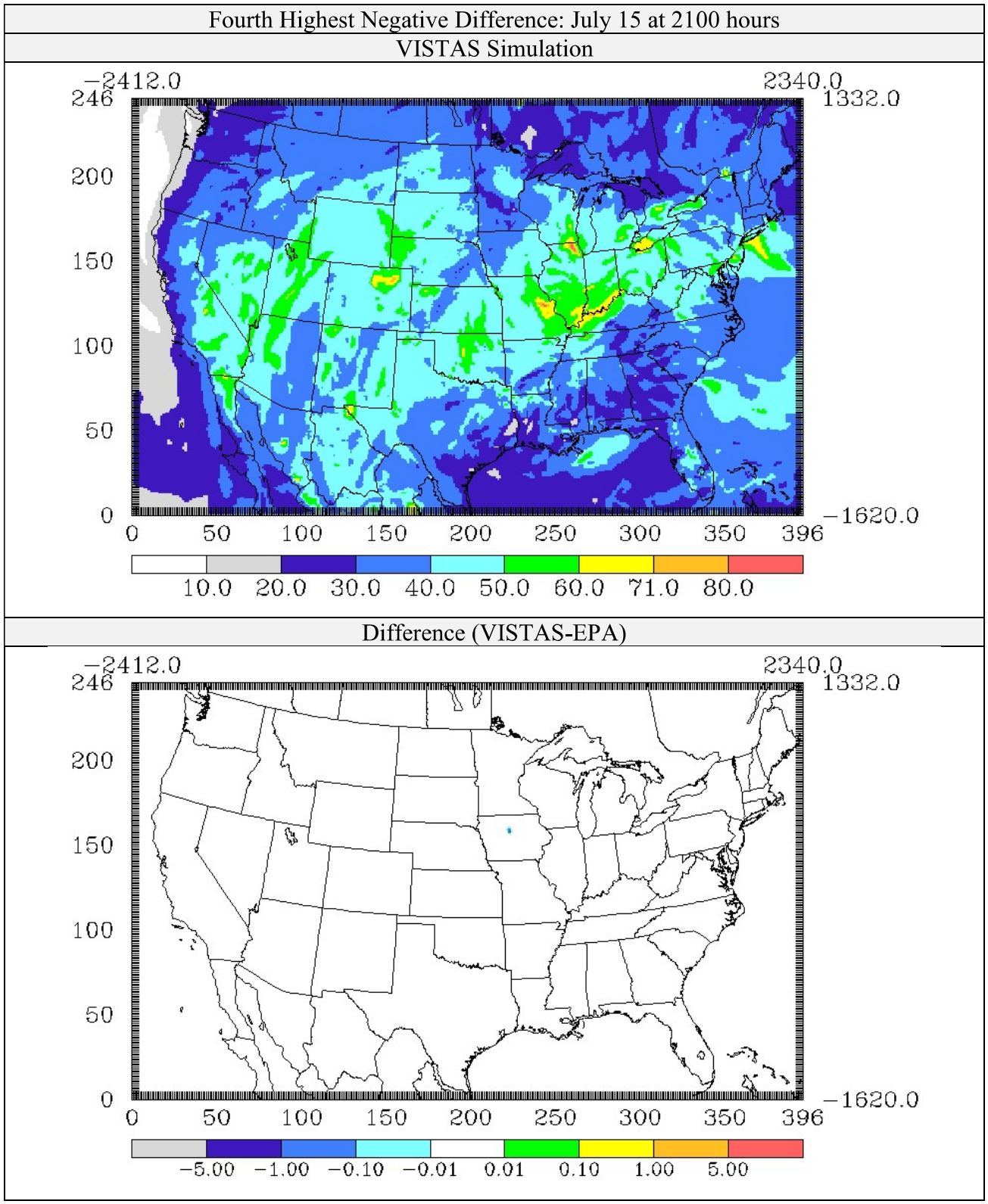

Figure 5-14: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)

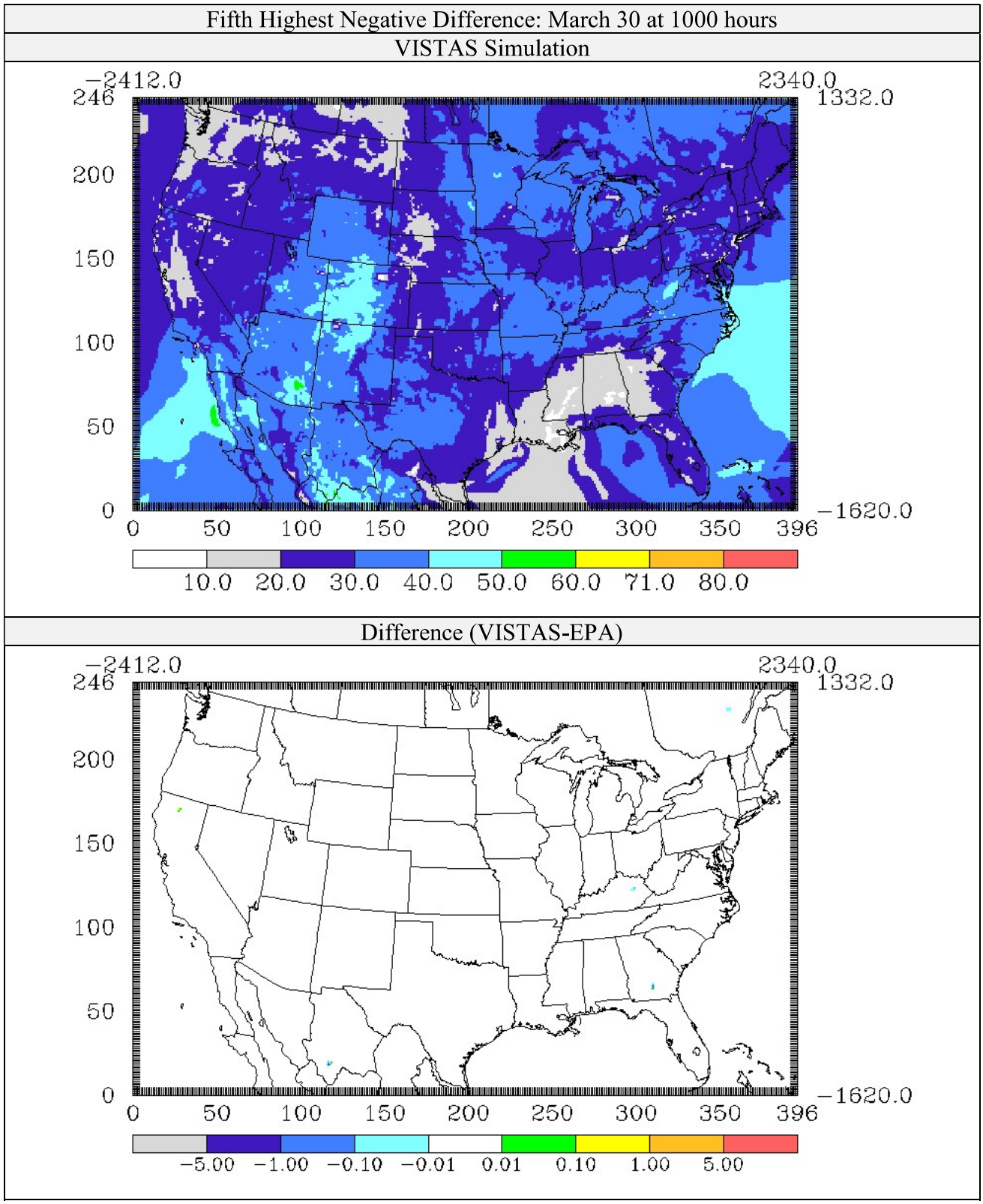

Figure 5-15: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)

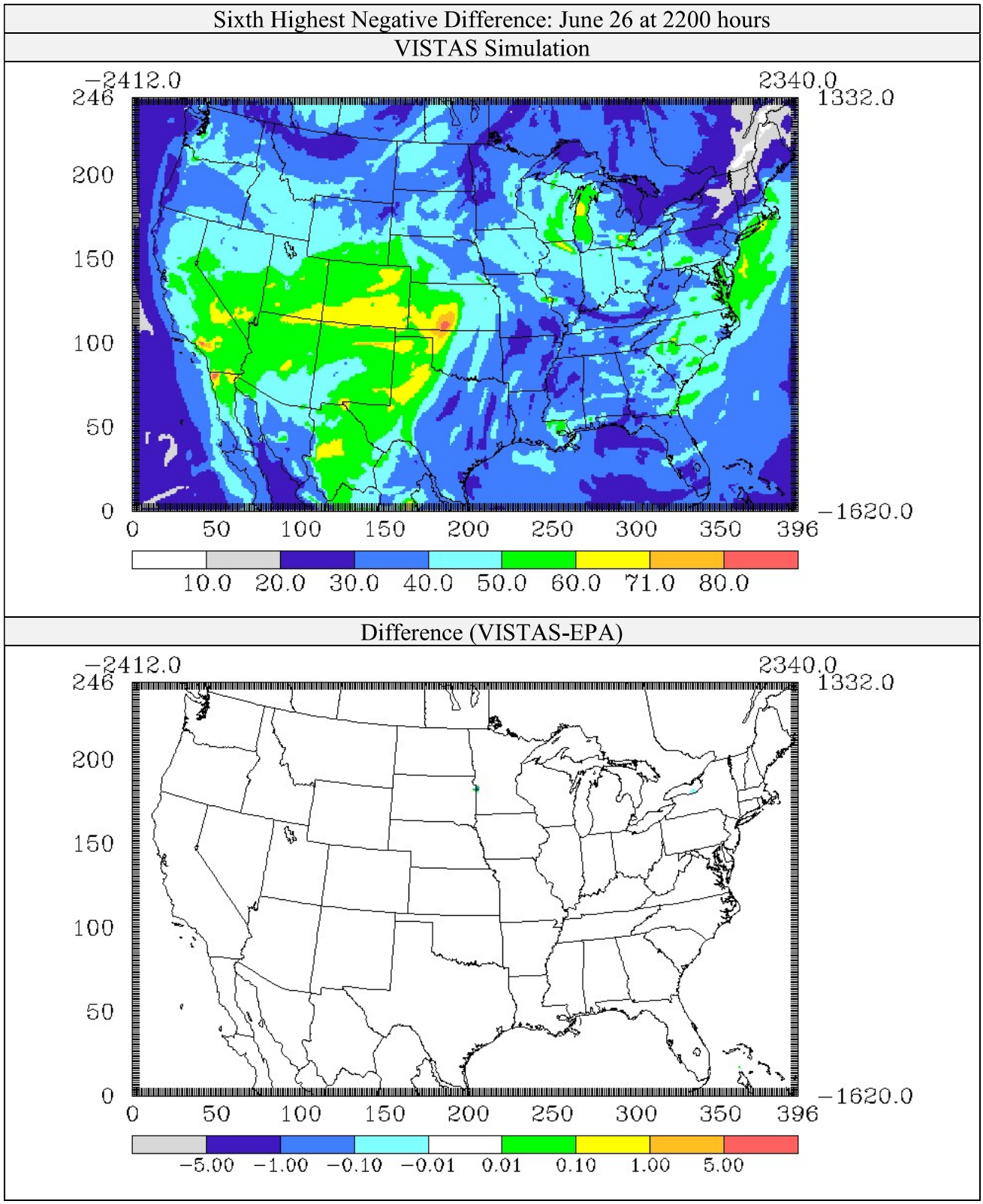

Figure 5-16: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)

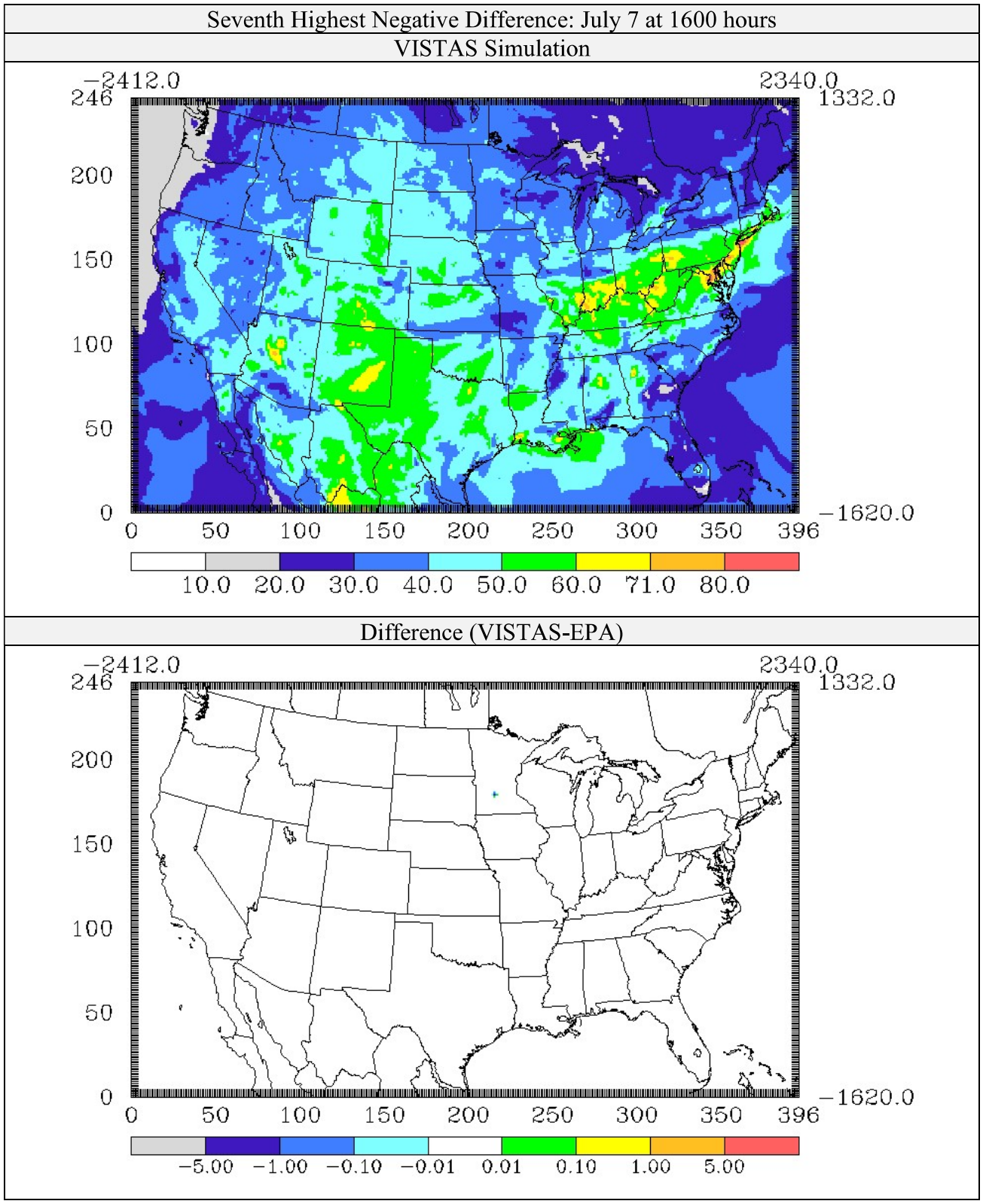

Figure 5-17: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)

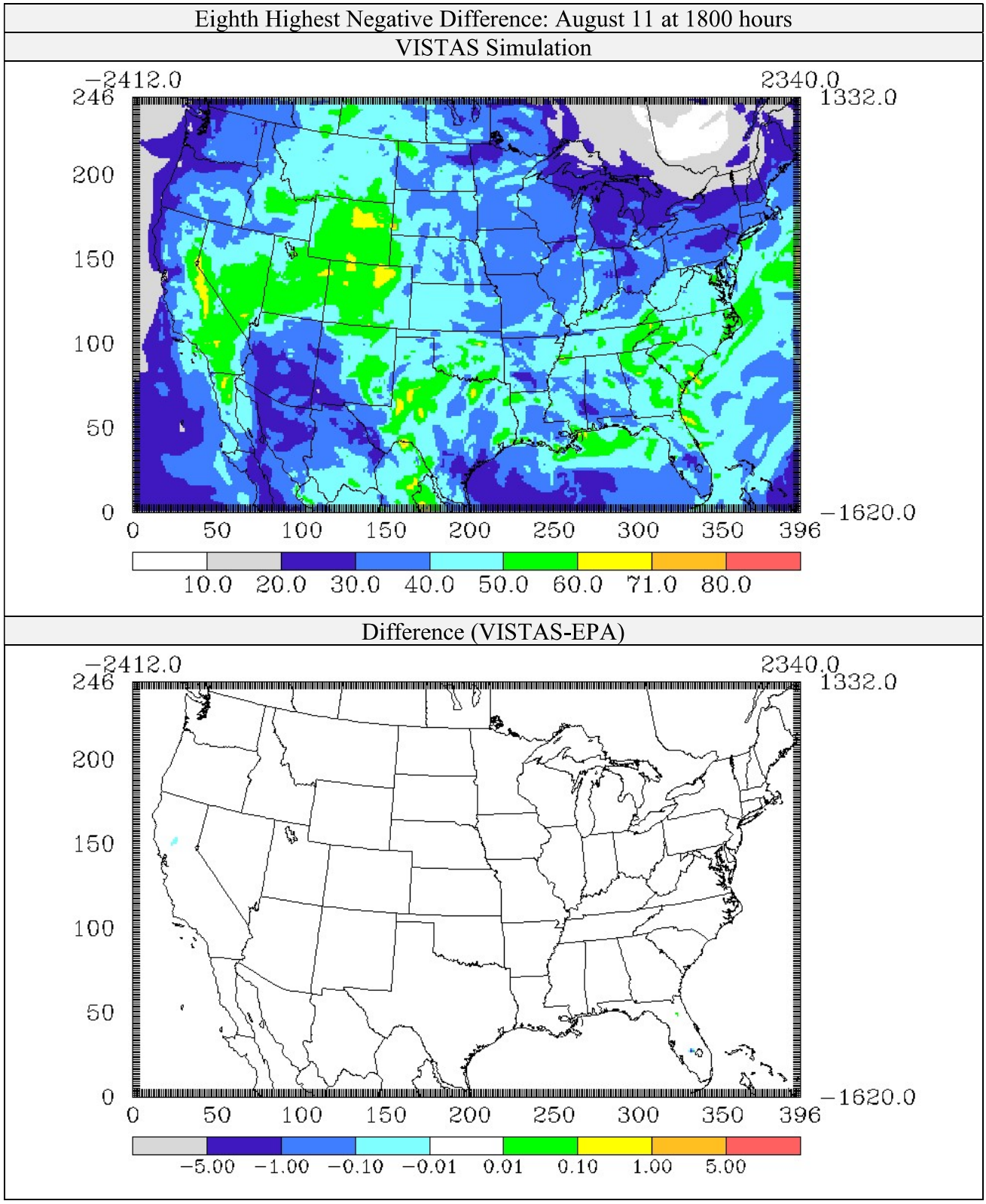

Figure 5-18: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)

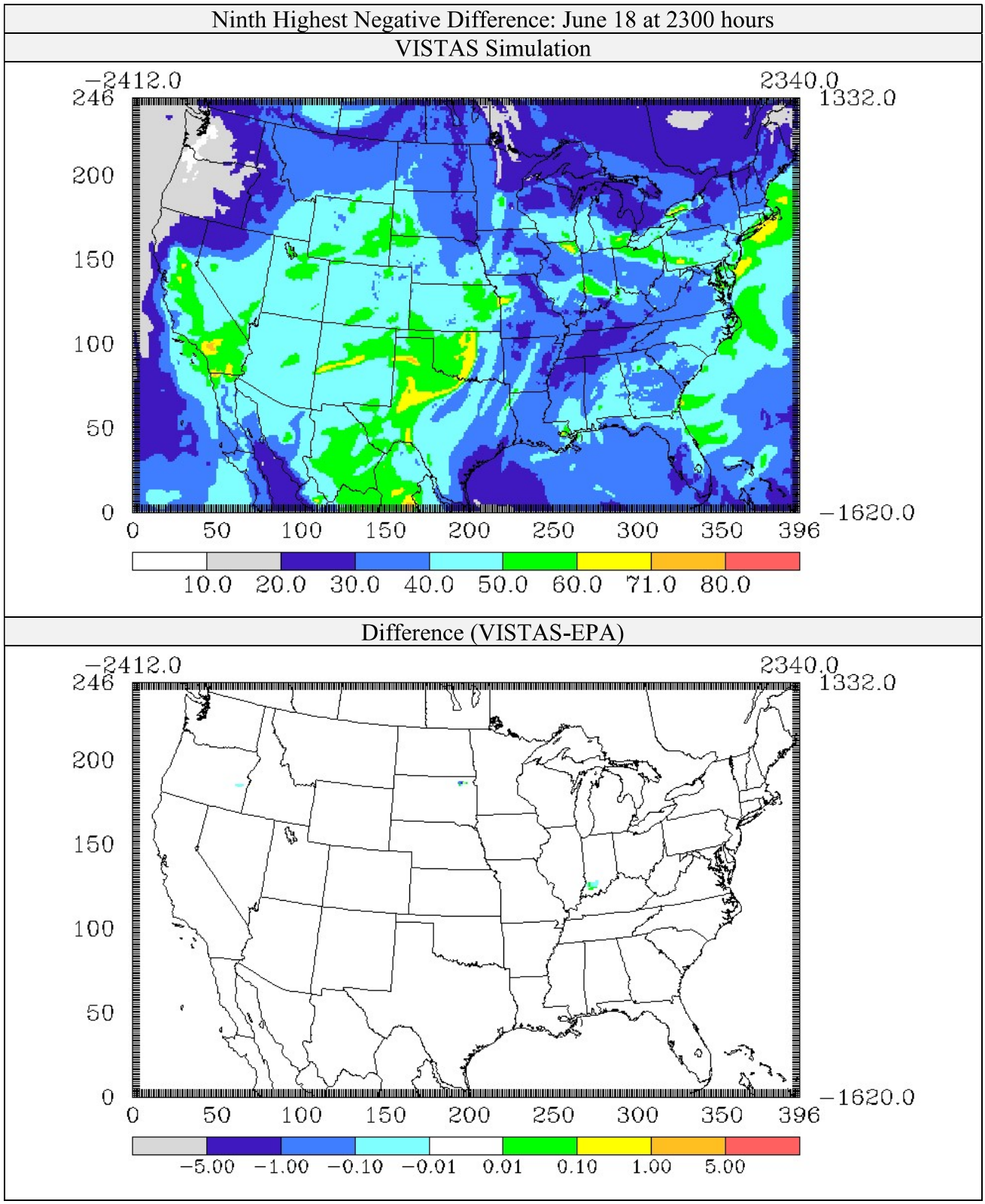

Figure 5-19: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)

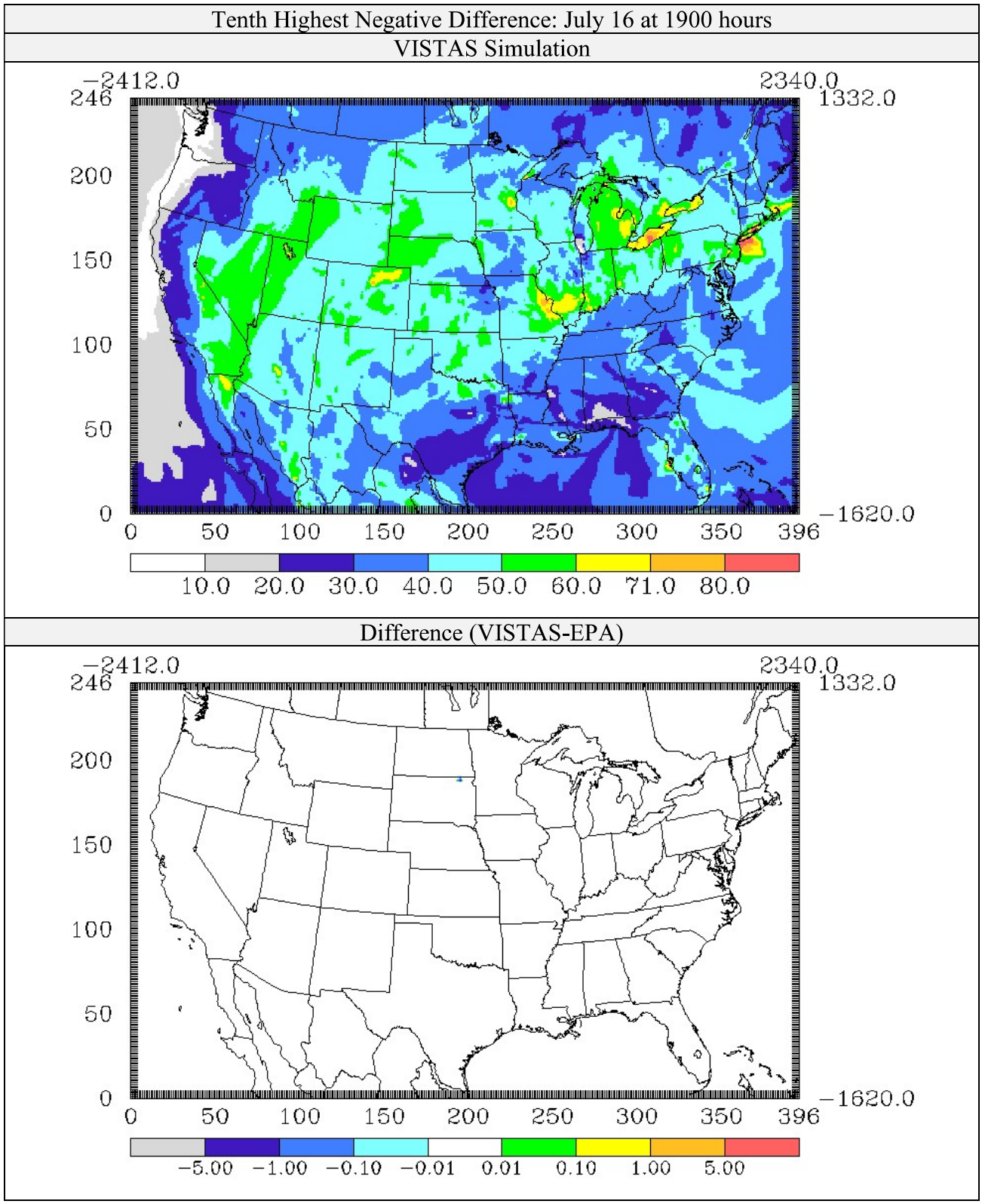

Figure 5-20: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Negative Difference)

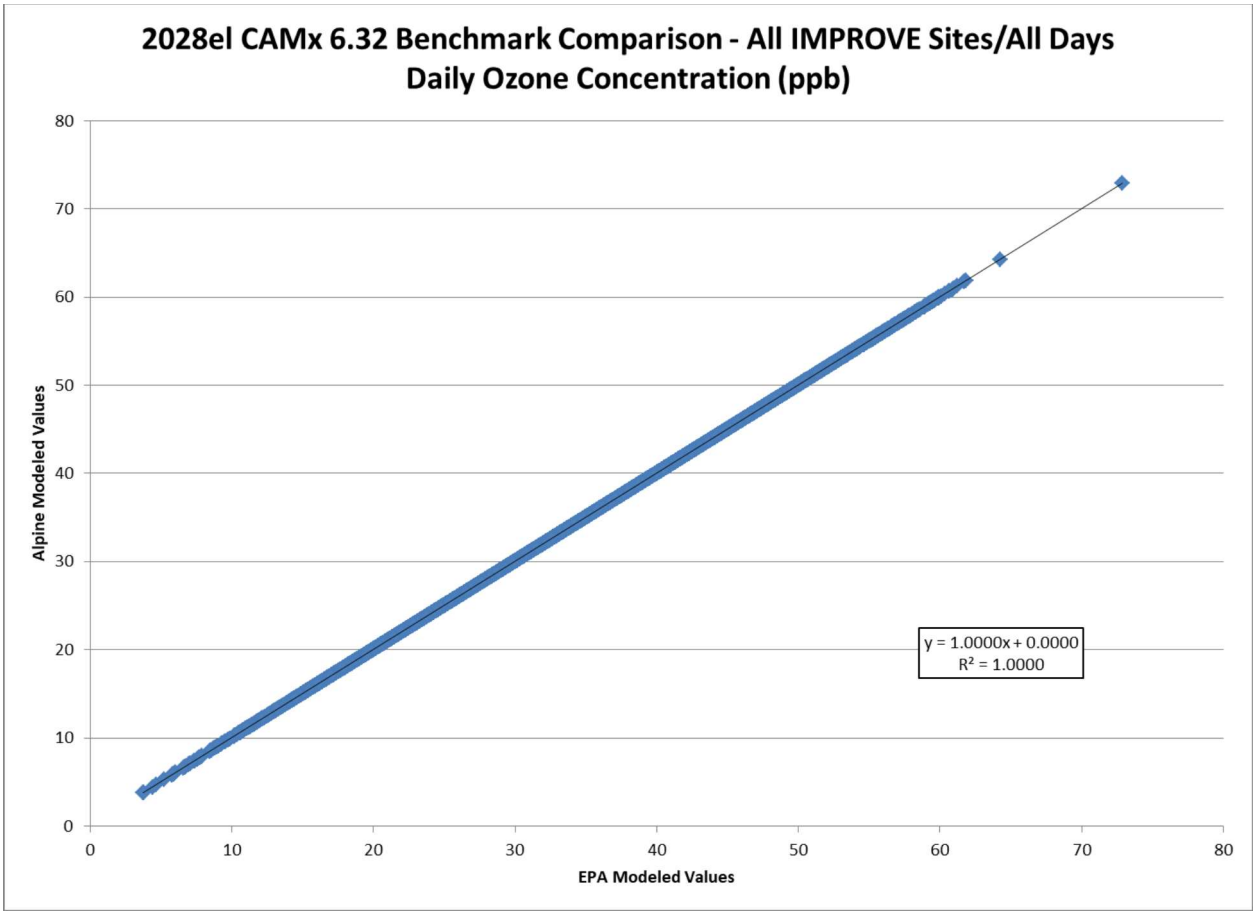

Figure 5-21: Scatterplot Comparing 24-hour Average Predicted Ozone Concentrations (ppb) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2028el Simulations Performed by EPA and VISTAS (Alpine).

5.2 $PM_{2.5}$

$PM_{2.5}$ results for the top 10 positive and negative hours are presented in tabular format in Table 5-2. The maximum positive difference is 5.15 μg/m^3 falling to 2.84 μg/m^3 for the 10th high. The maximum negative difference is -4.61 μg/m^3 falling to -2.45 μg/m^3 for the 10th high. The maximum positive percent difference from these days is 48.4% and negative percent difference of -32.9%, both on low $PM_{2.5}$ concentration days.

The top 10 positive impact hours are presented in Figures 5-22 through 5-31 and the top 10 negative impact hours are presented in Figures 5-32 through 5-41. The locations of the impacts are again localized and tending to occur in Canada near the relatively high concentration entering the domain through the northern boundary. Comparison with the nitrate results in Section 5.4 shows that on many days the principal difference in the $PM_{2.5}$ concentrations is a result of the differences in the nitrate predictions.

Scatterplots of the daily average $PM_{2.5}$ concentrations in local standard time at the IMPROVE monitors are presented in Figure 5-42. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Examination of the animations shows that the majority of the differences are occurring in Canada and the Northern U.S. with the differences occurring in the areas of relatively high $PM_{2.5}$. We speculate that the differences are primarily from the difference in the Nitrate and most likely from different pathways being taken in the ISOROPIA algorithm.

Table 5-2. Comparison of 2028el CAMx 6.32 Simulation $PM_{2.5}$ Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	1	3	4	35.87	30.72	5.15	16.77%	155	237
2011	1	3	12	37.94	33.42	4.53	13.54%	159	237
2011	1	27	7	13.15	8.86	4.29	48.41%	346	245
2011	1	27	9	13.30	9.65	3.65	37.86%	347	245
2011	1	14	6	20.06	16.88	3.17	18.80%	148	237
2011	1	27	12	11.44	8.32	3.12	37.47%	343	245
2011	1	14	4	34.11	31.05	3.07	9.88%	123	244
2011	1	14	9	22.40	19.36	3.04	15.70%	144	240
2011	1	14	2	33.74	30.85	2.89	9.35%	132	243
2011	1	15	13	14.87	12.03	2.84	23.63%	125	222
Maximum Negative									
2011	1	27	8	9.38	13.98	-4.61	-32.95%	348	245
2011	1	3	7	33.90	37.85	-3.95	-10.44%	155	235
2011	1	27	5	9.70	13.65	-3.95	-28.92%	345	245
2011	1	27	11	6.80	9.98	-3.18	-31.88%	343	244
2011	1	27	9	8.93	12.11	-3.18	-26.23%	348	244
2011	1	27	10	7.21	10.27	-3.06	-29.78%	343	245
2011	1	27	12	7.26	10.21	-2.96	-28.95%	342	244
2011	1	3	21	16.59	19.10	-2.51	-13.15%	164	231
2011	1	14	3	24.38	26.86	-2.48	-9.24%	137	242
2011	1	27	3	11.37	13.82	-2.45	-17.75%	343	245

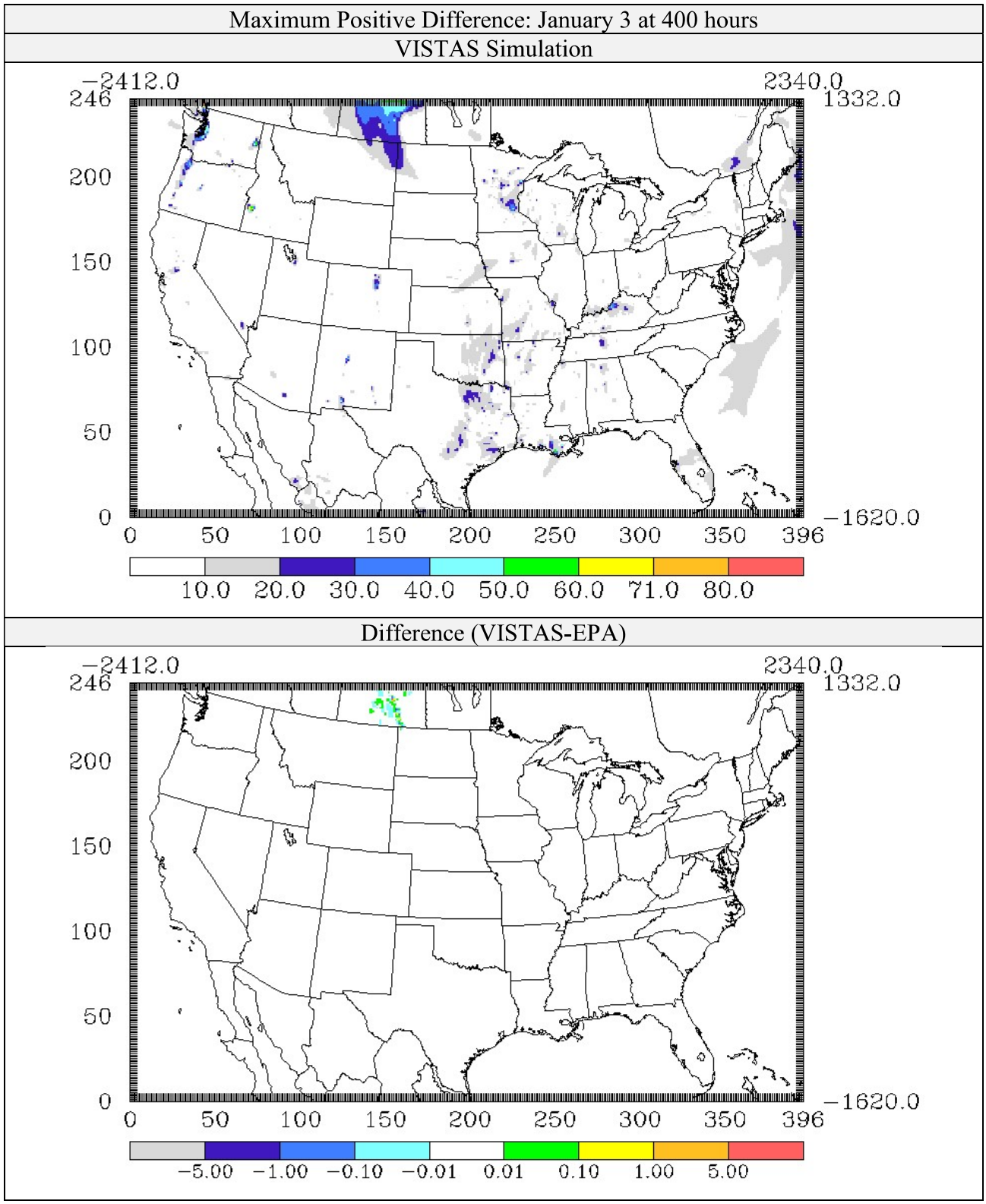

Figure 5-22: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)

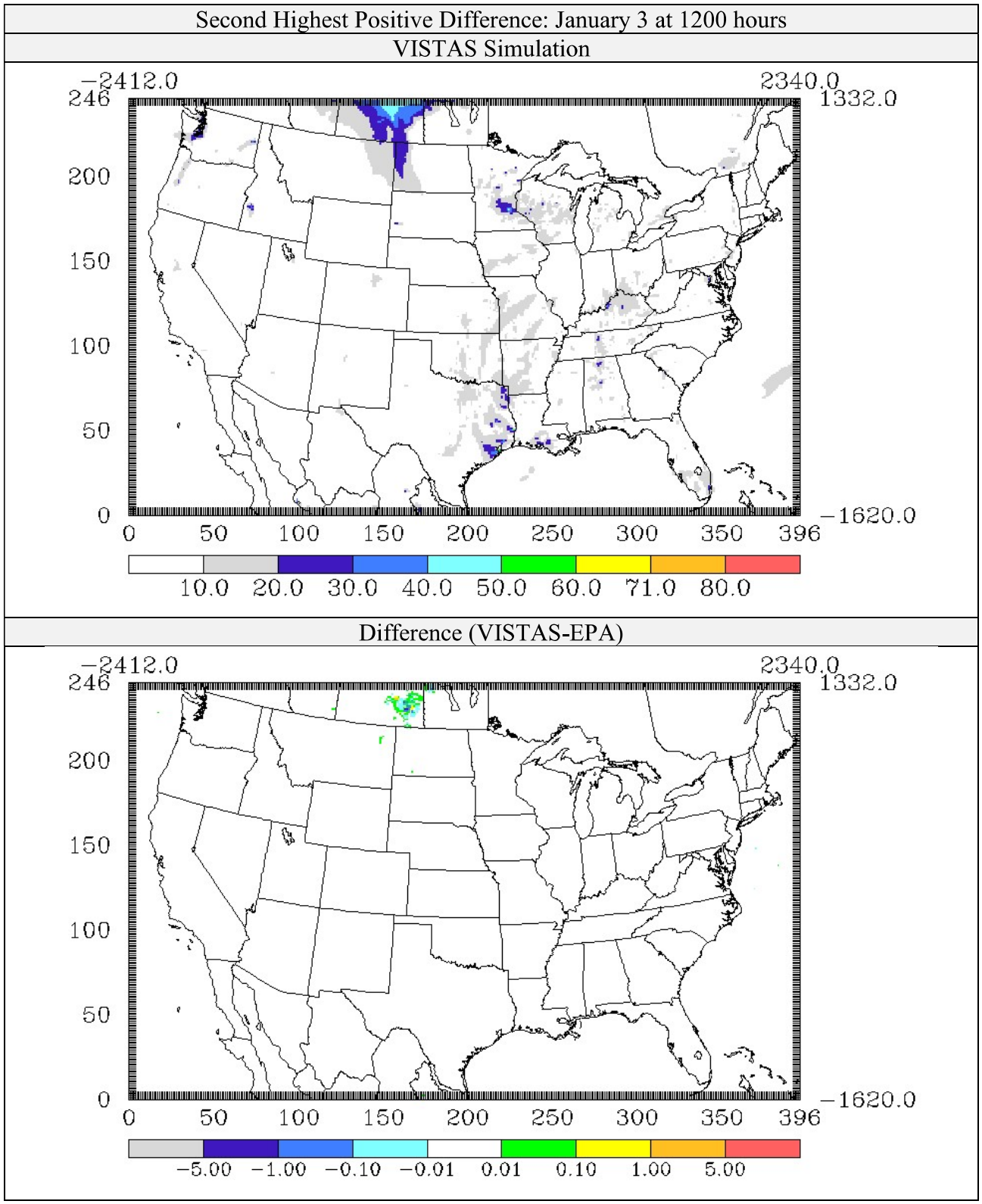

Figure 5-23: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)

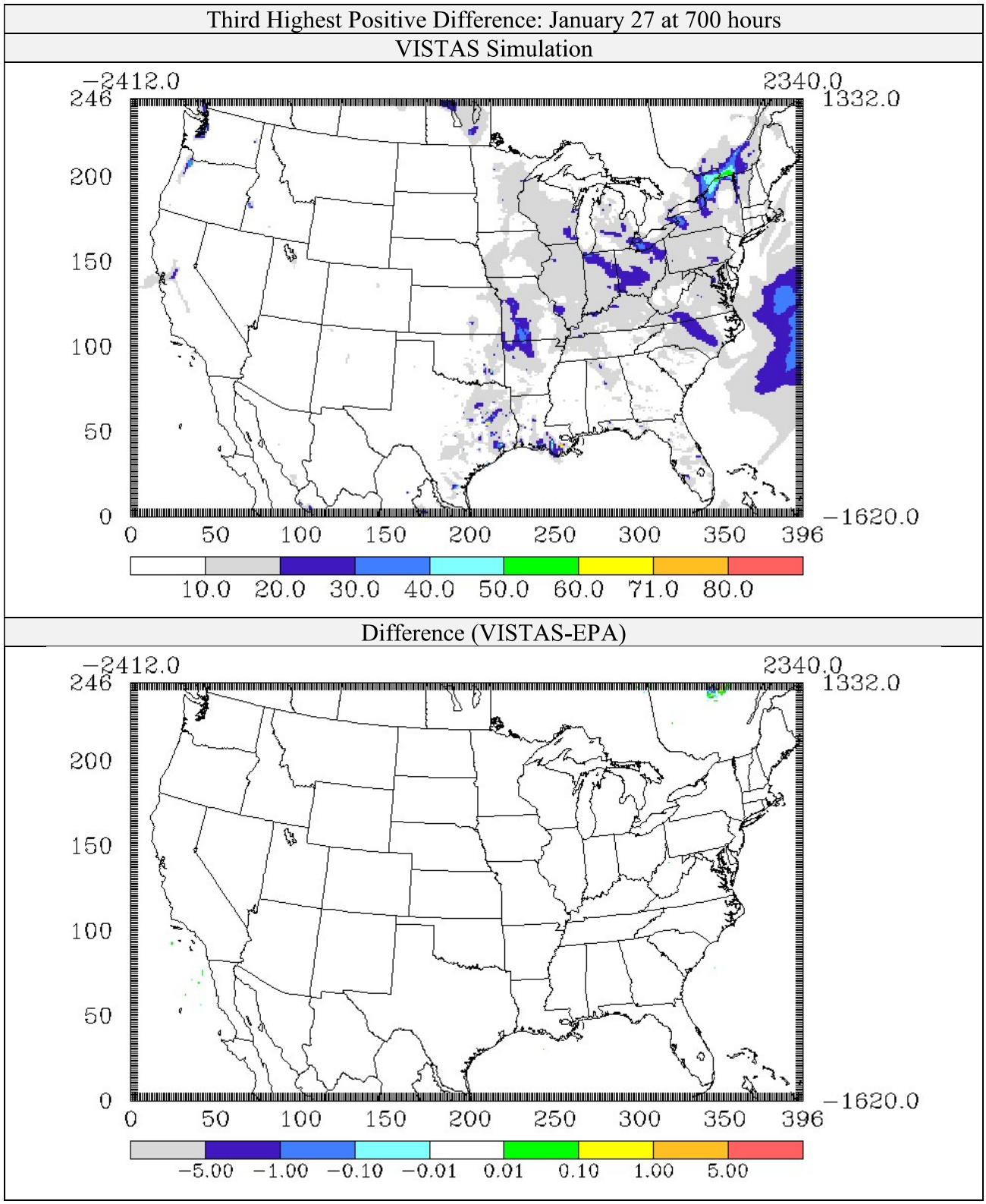

Figure 5-24: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)

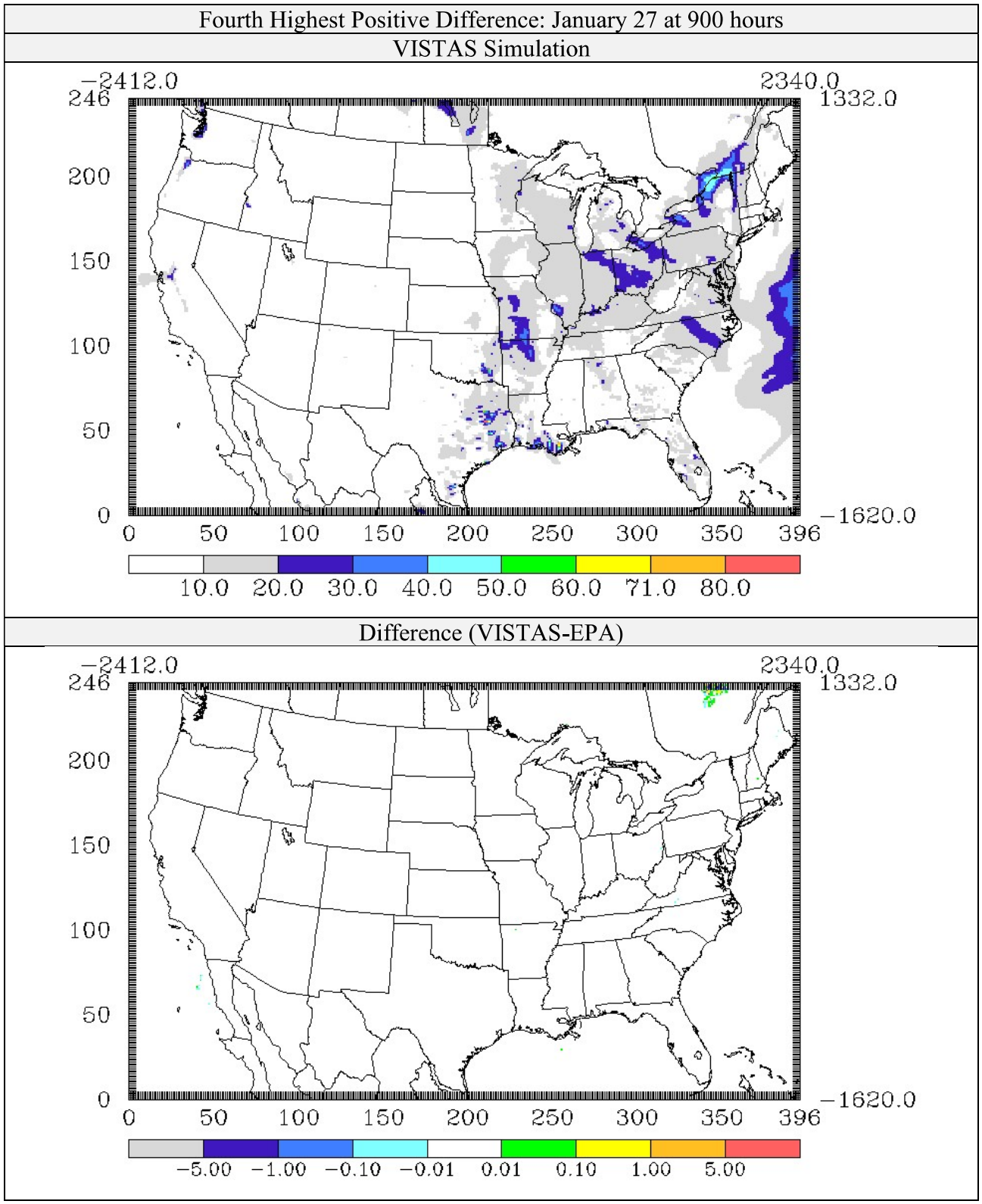

Figure 5-25: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

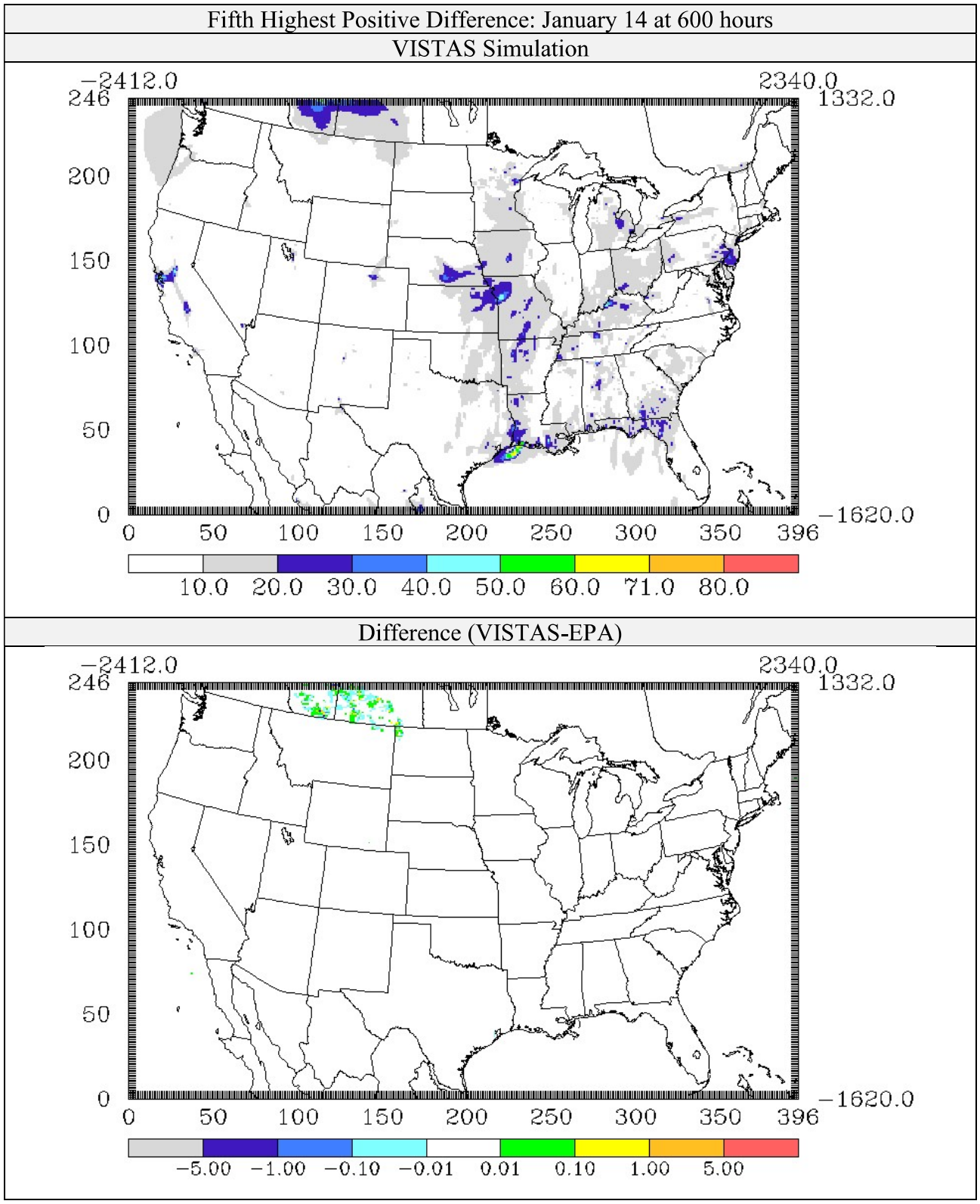

Figure 5-26: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)

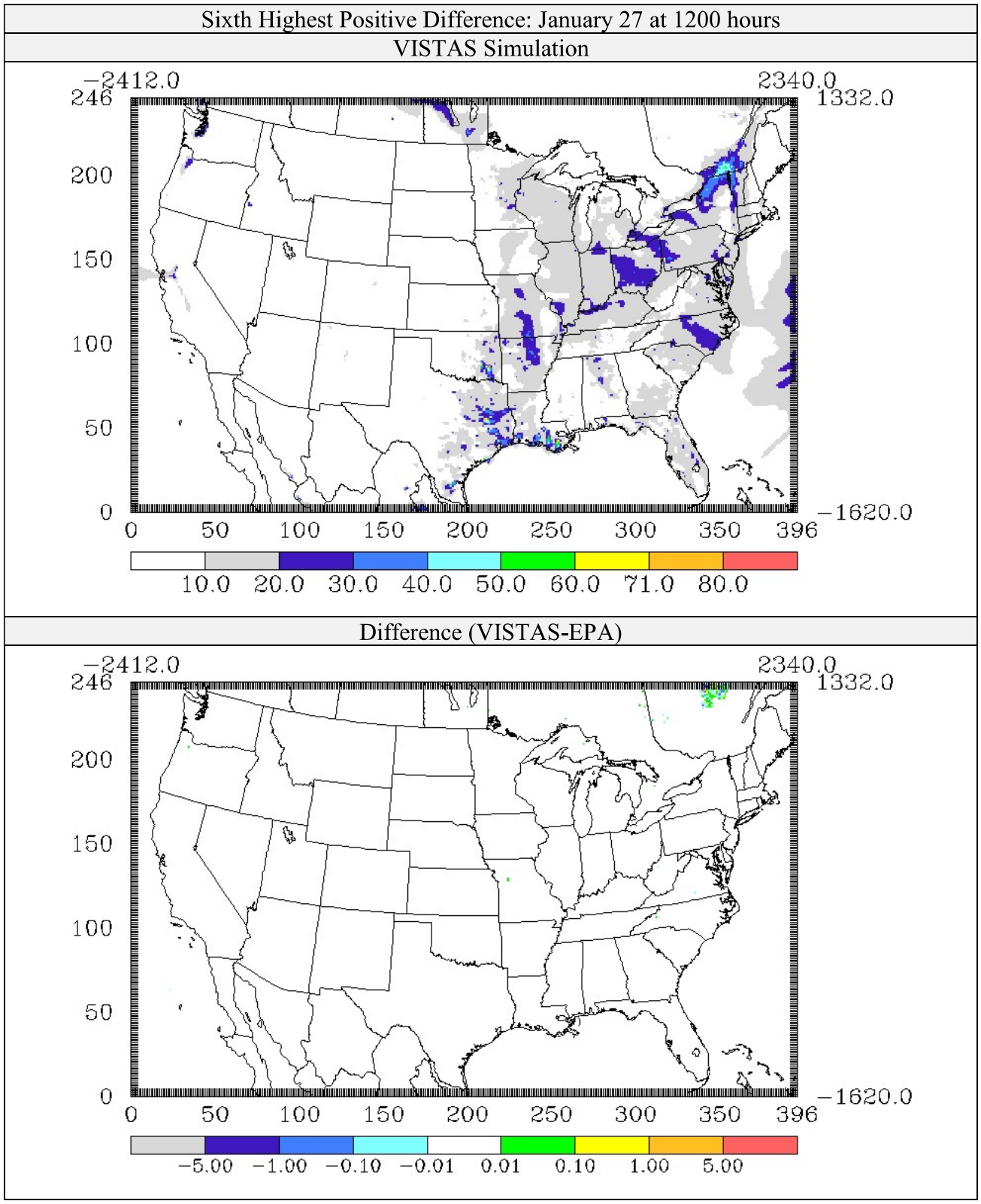

Figure 5-27: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)

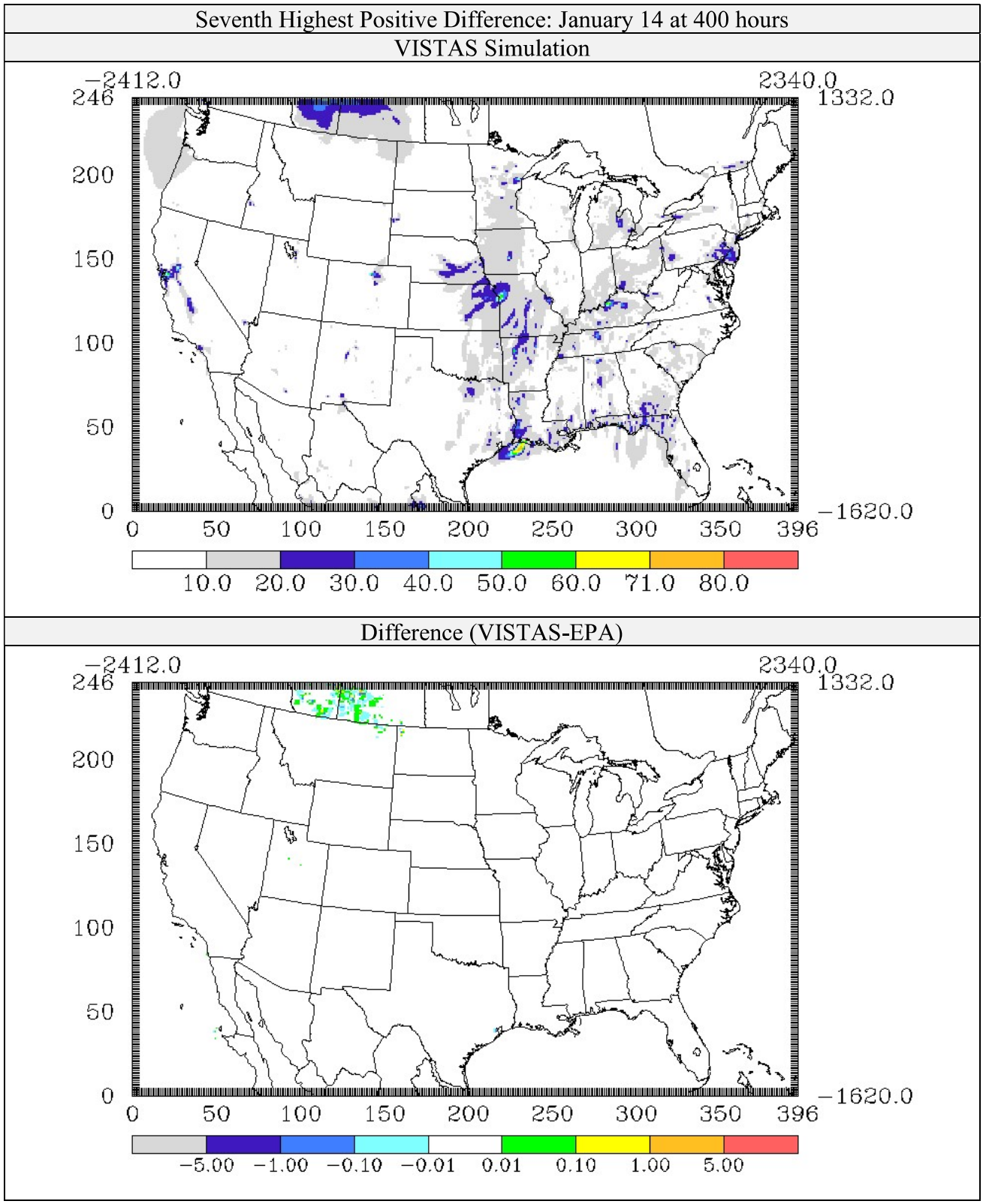

Figure 5-28: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)

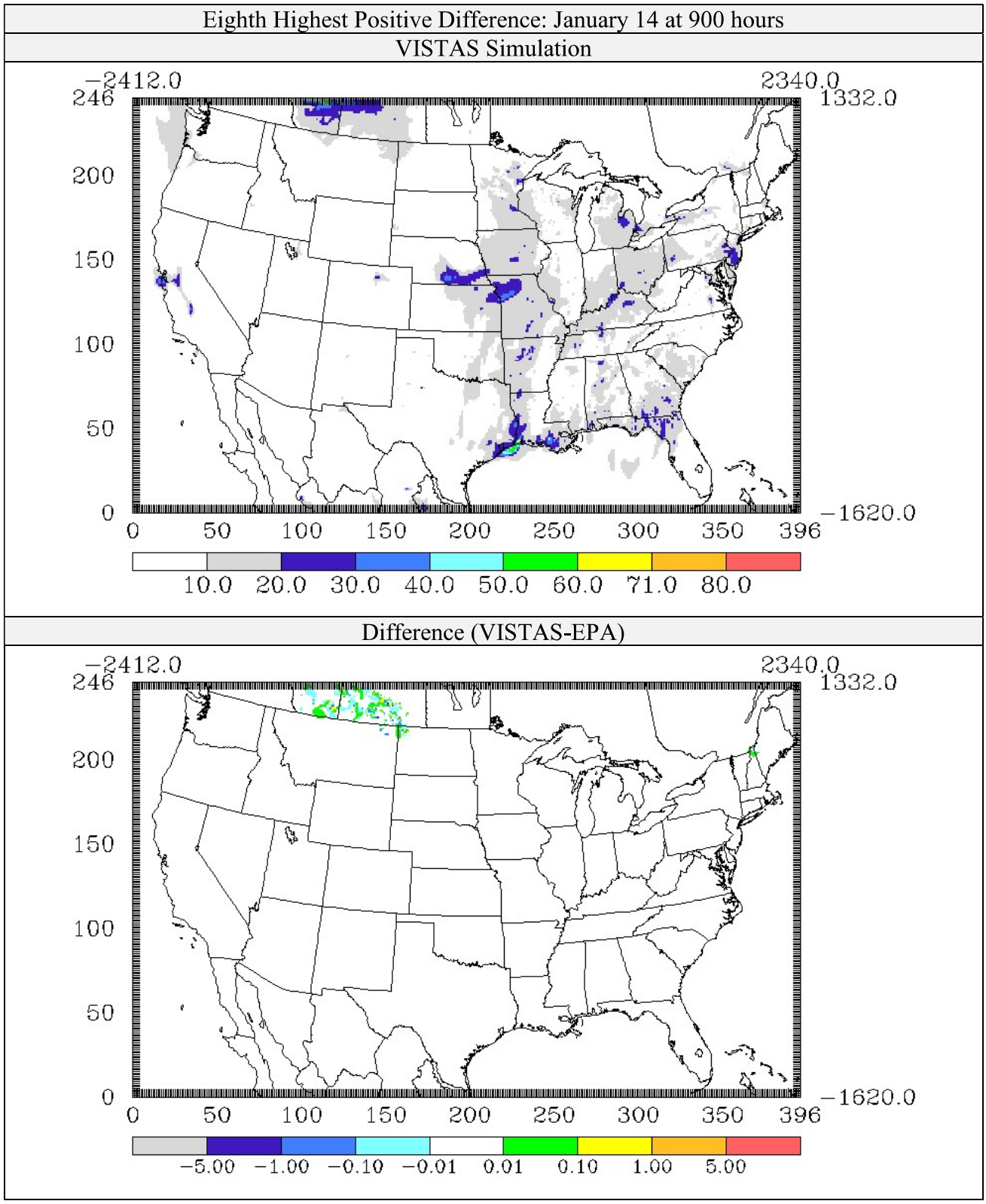

Figure 5-29: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)

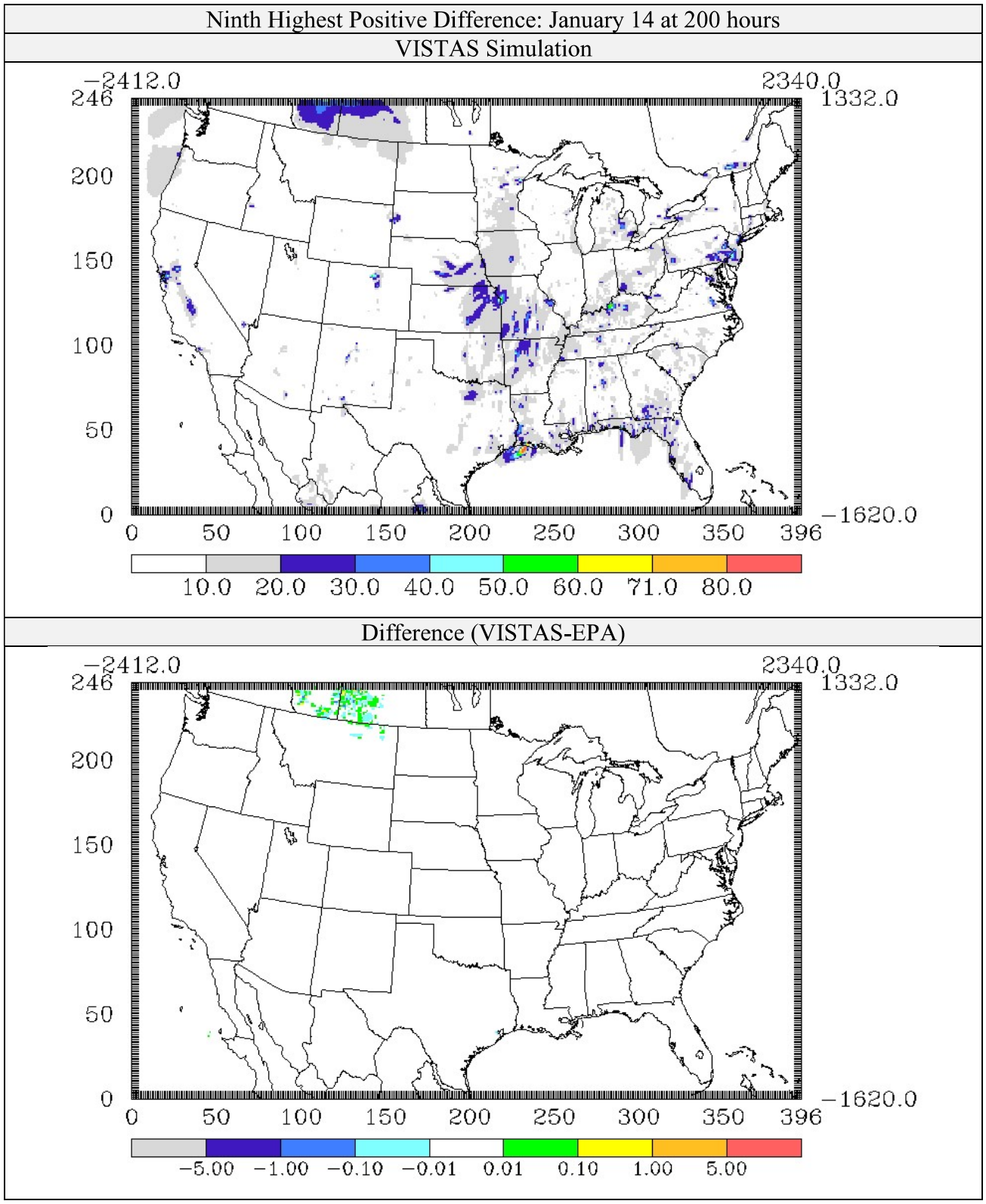

Figure 5-30: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)

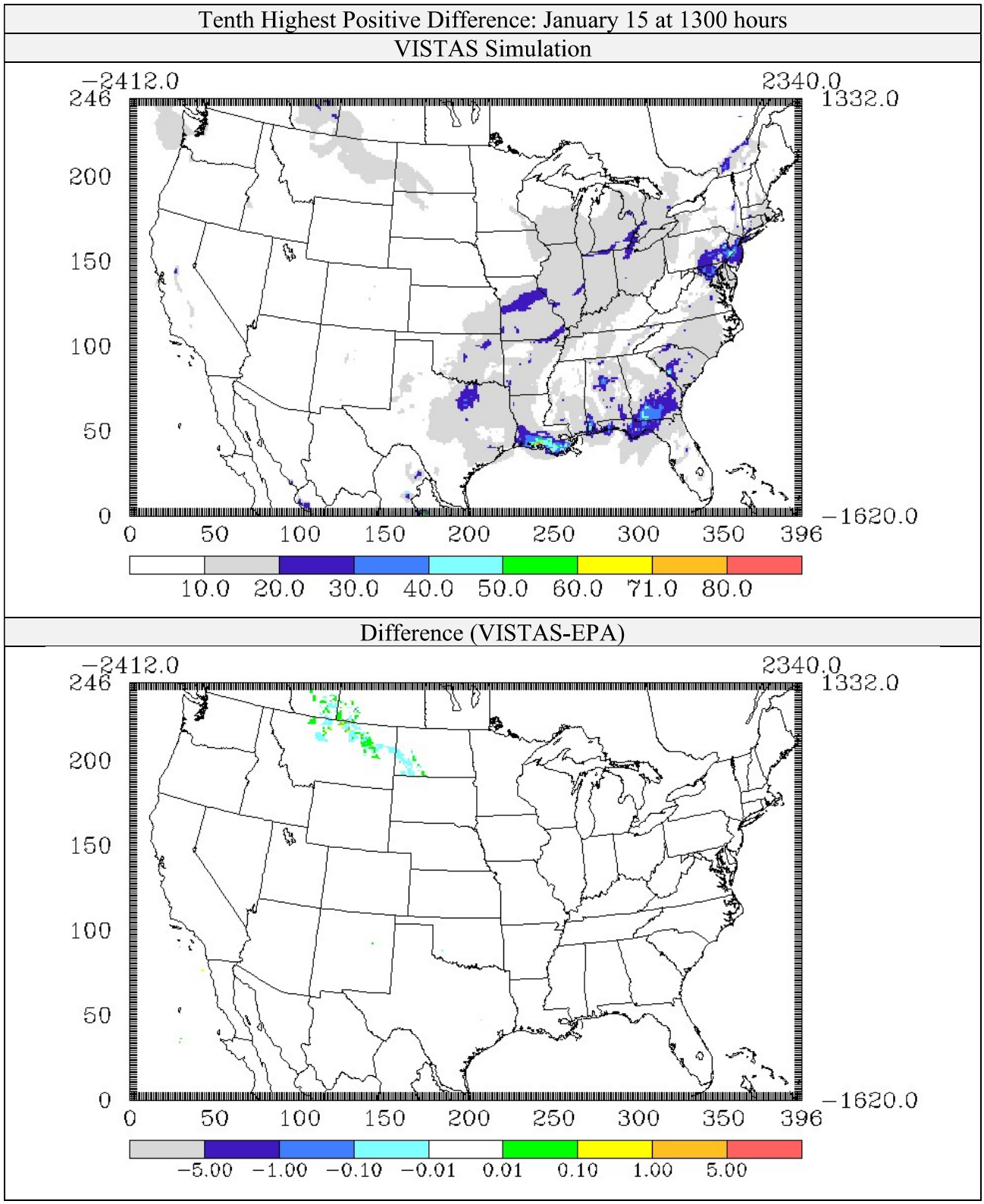

Figure 5-31: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)

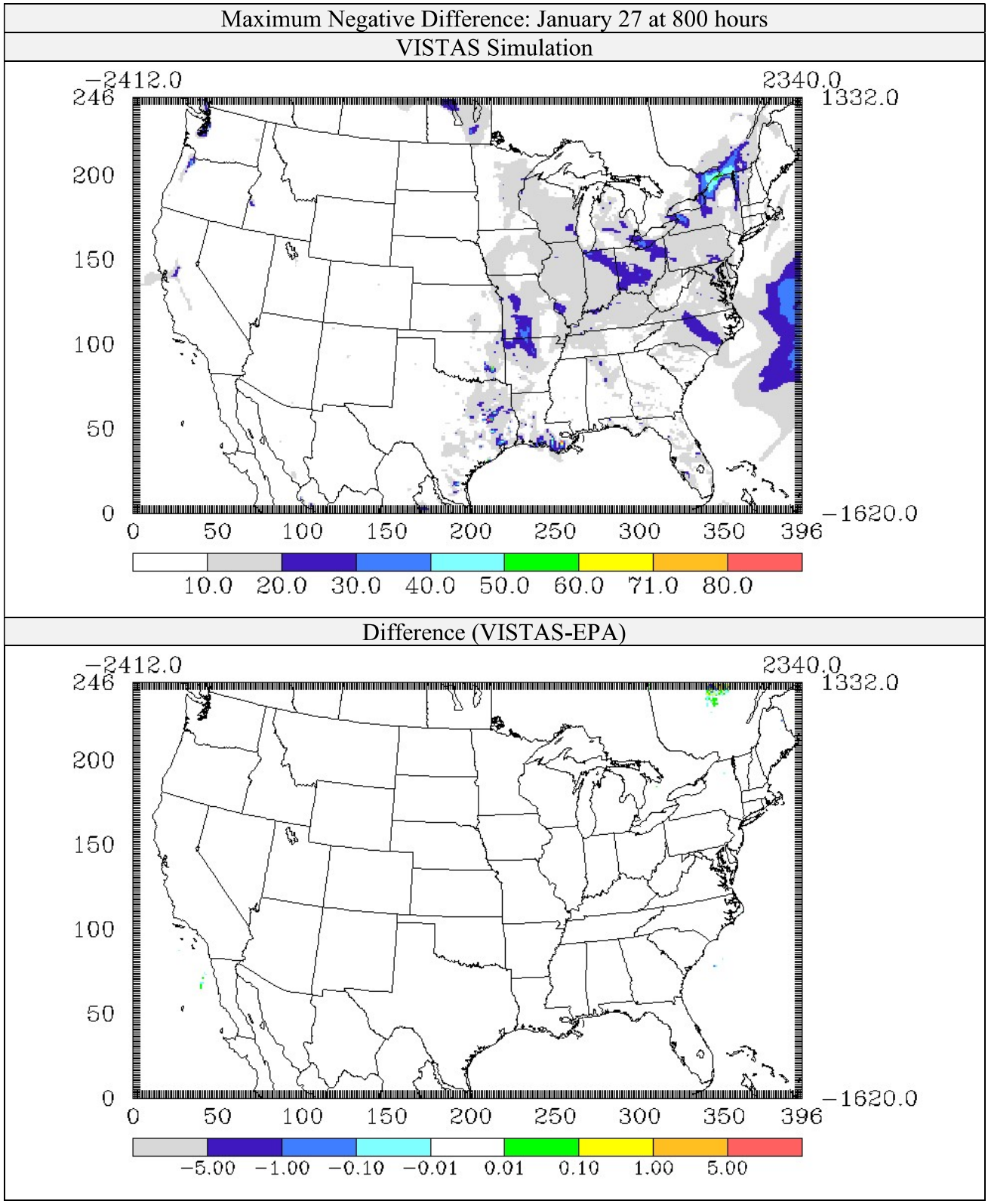

Figure 5-32: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)

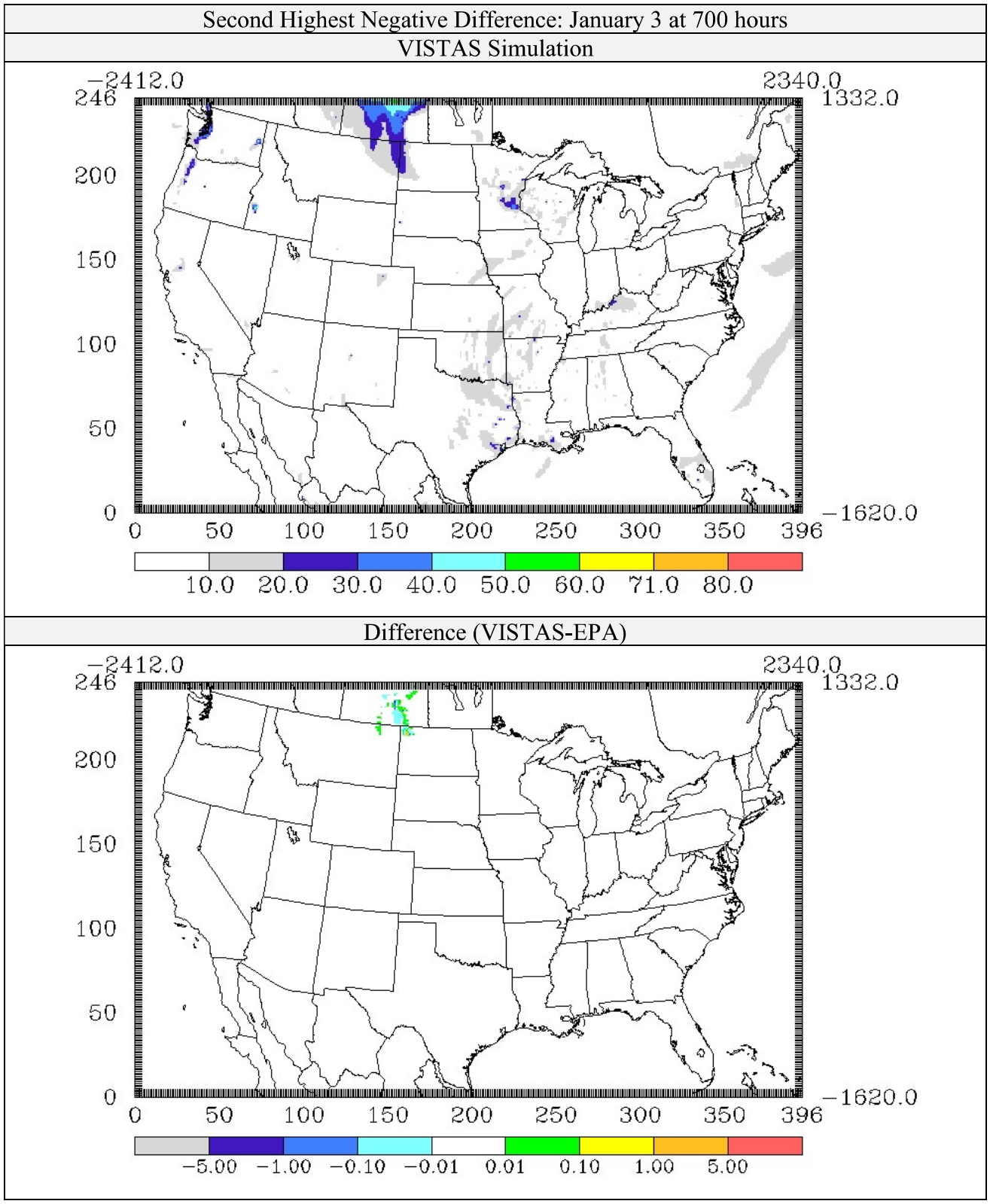

Figure 5-33: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)

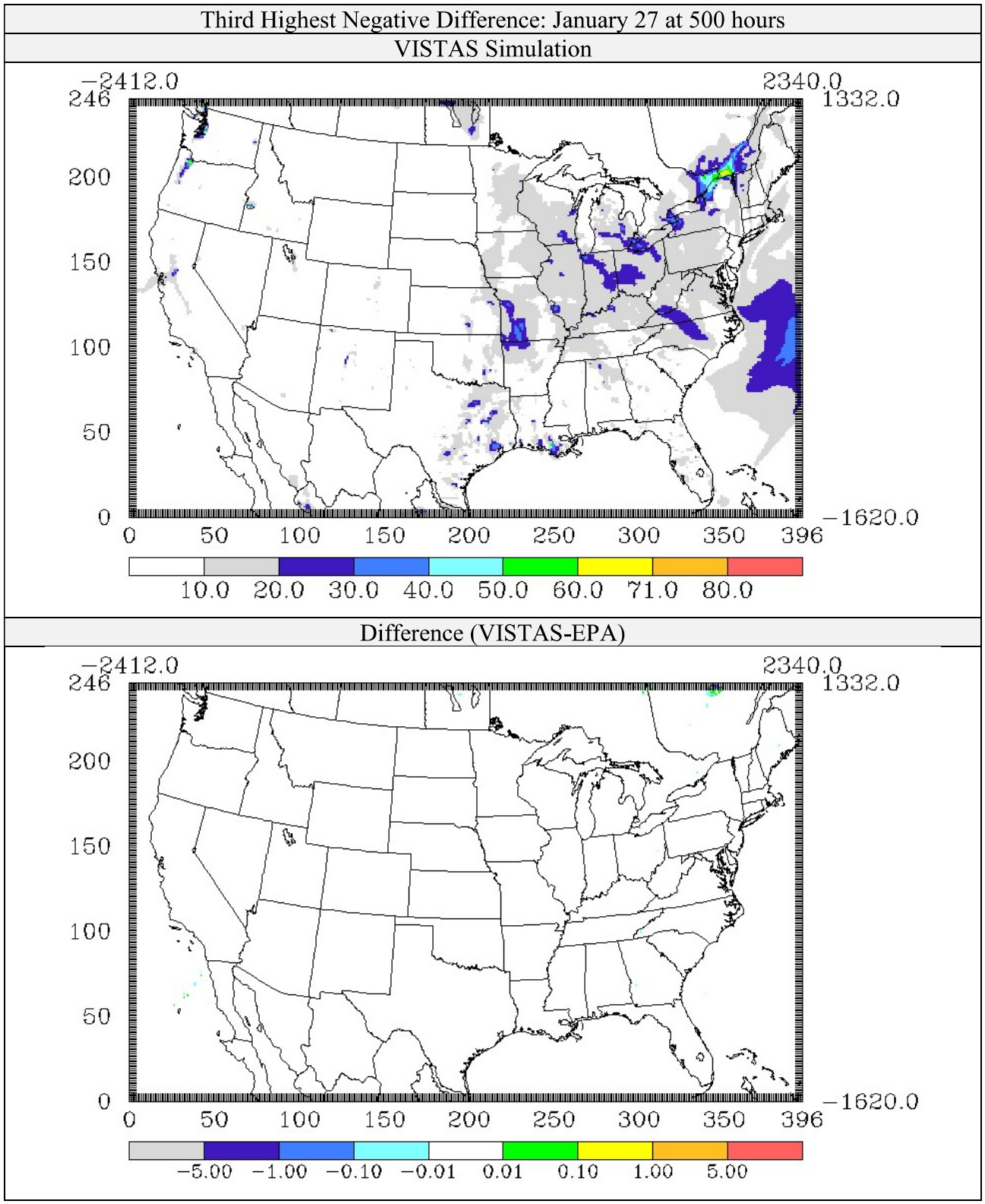

Figure 5-34: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)

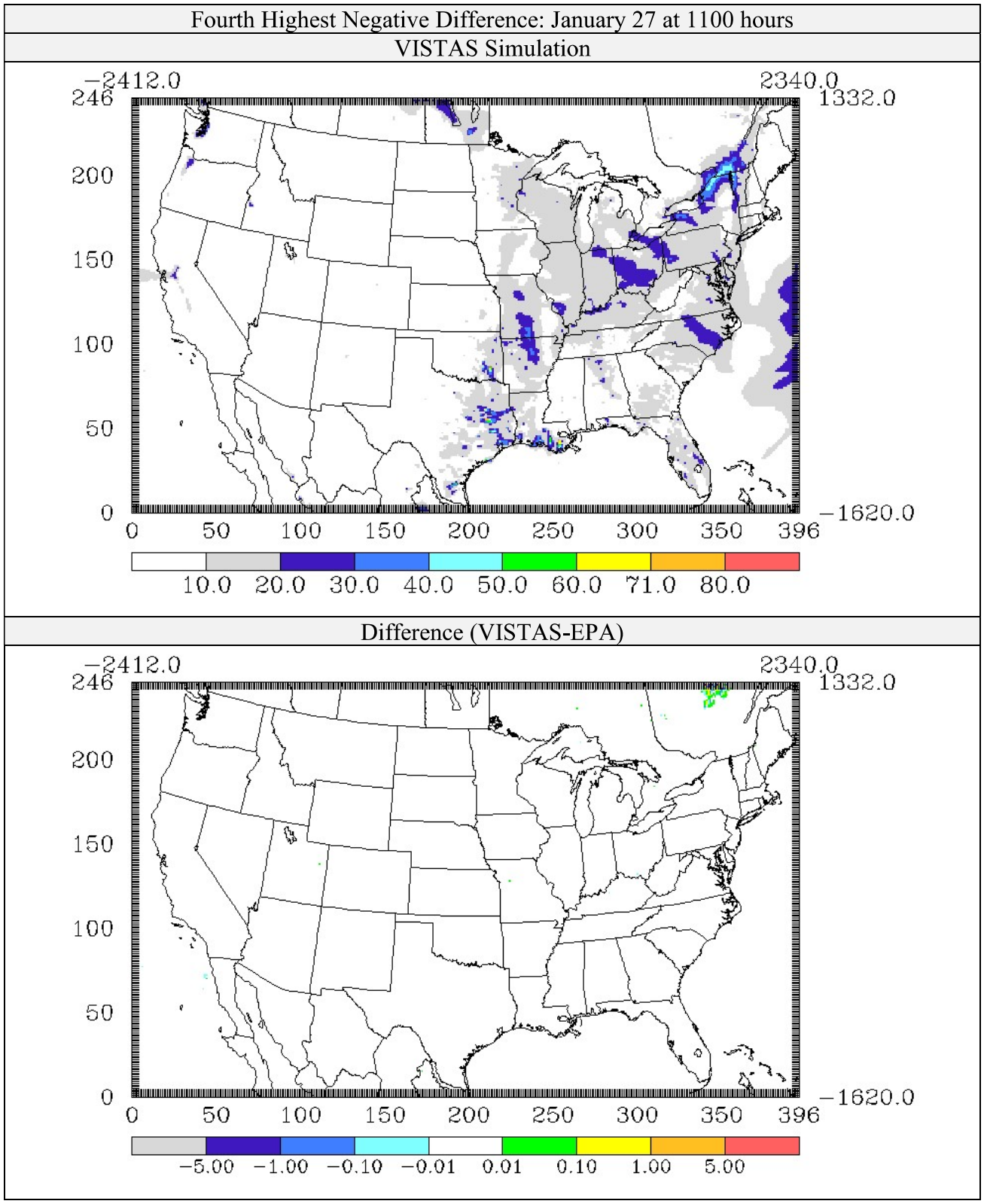

Figure 5-35: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)

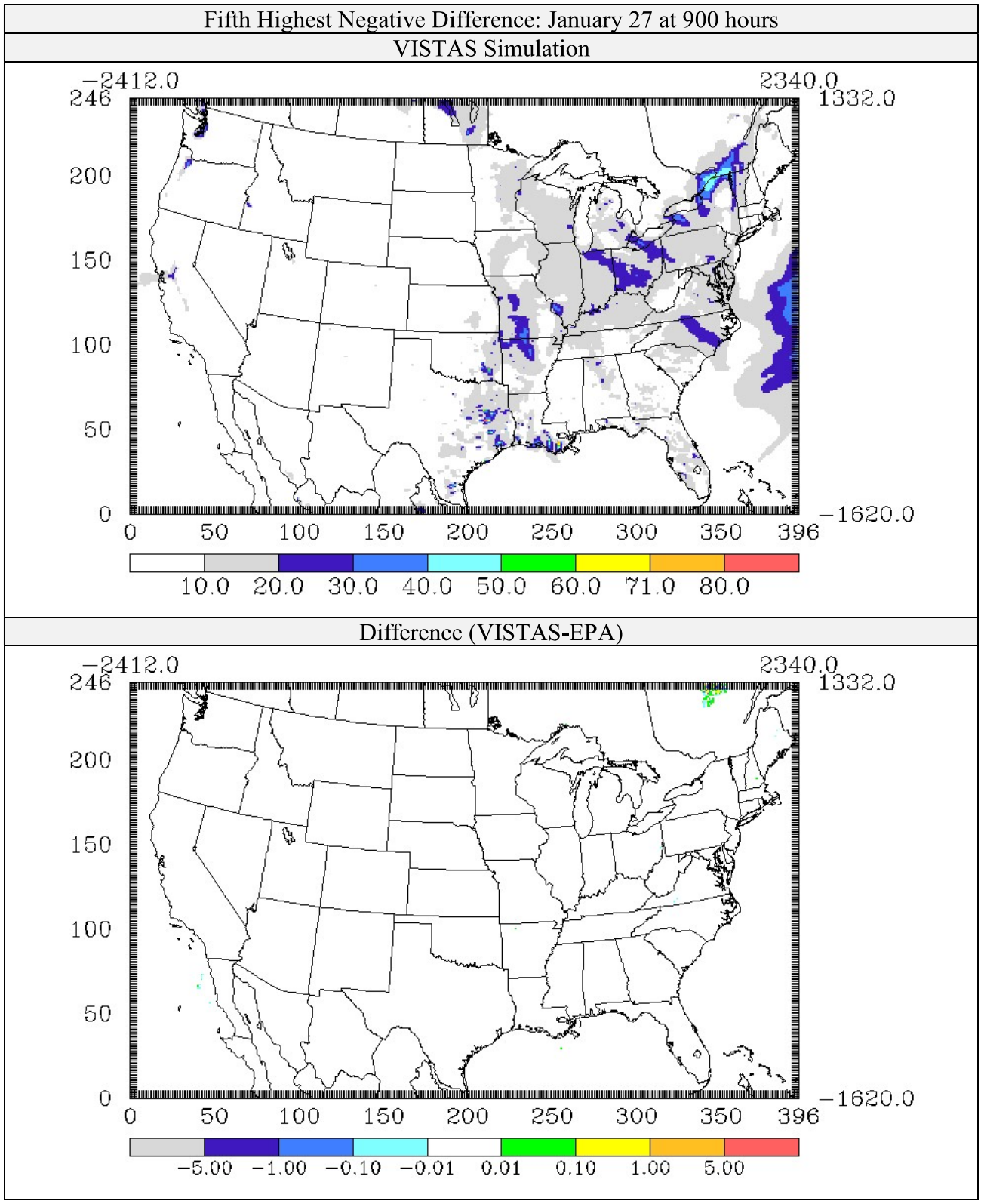

Figure 5-36: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)

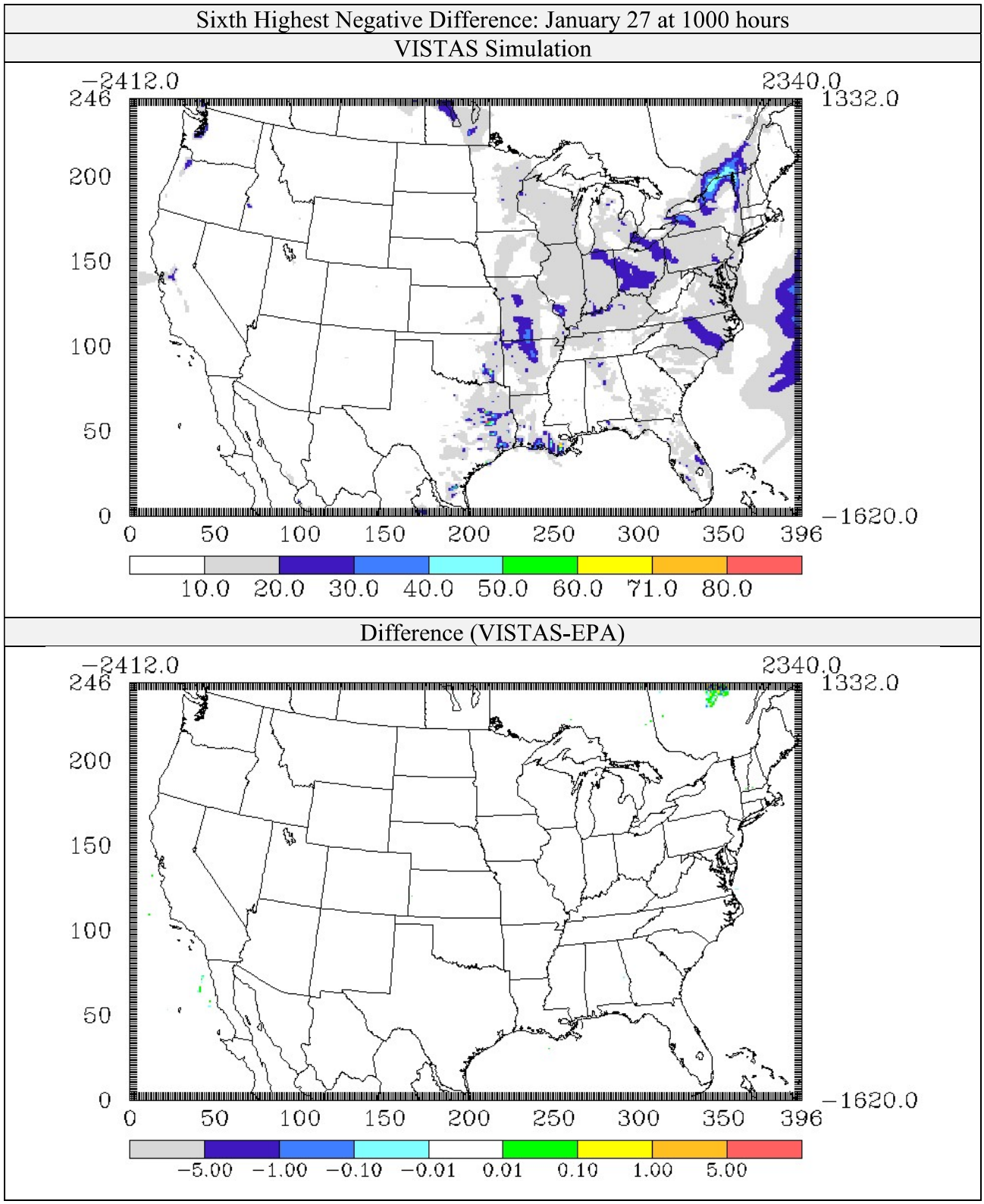

Figure 5-37: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)

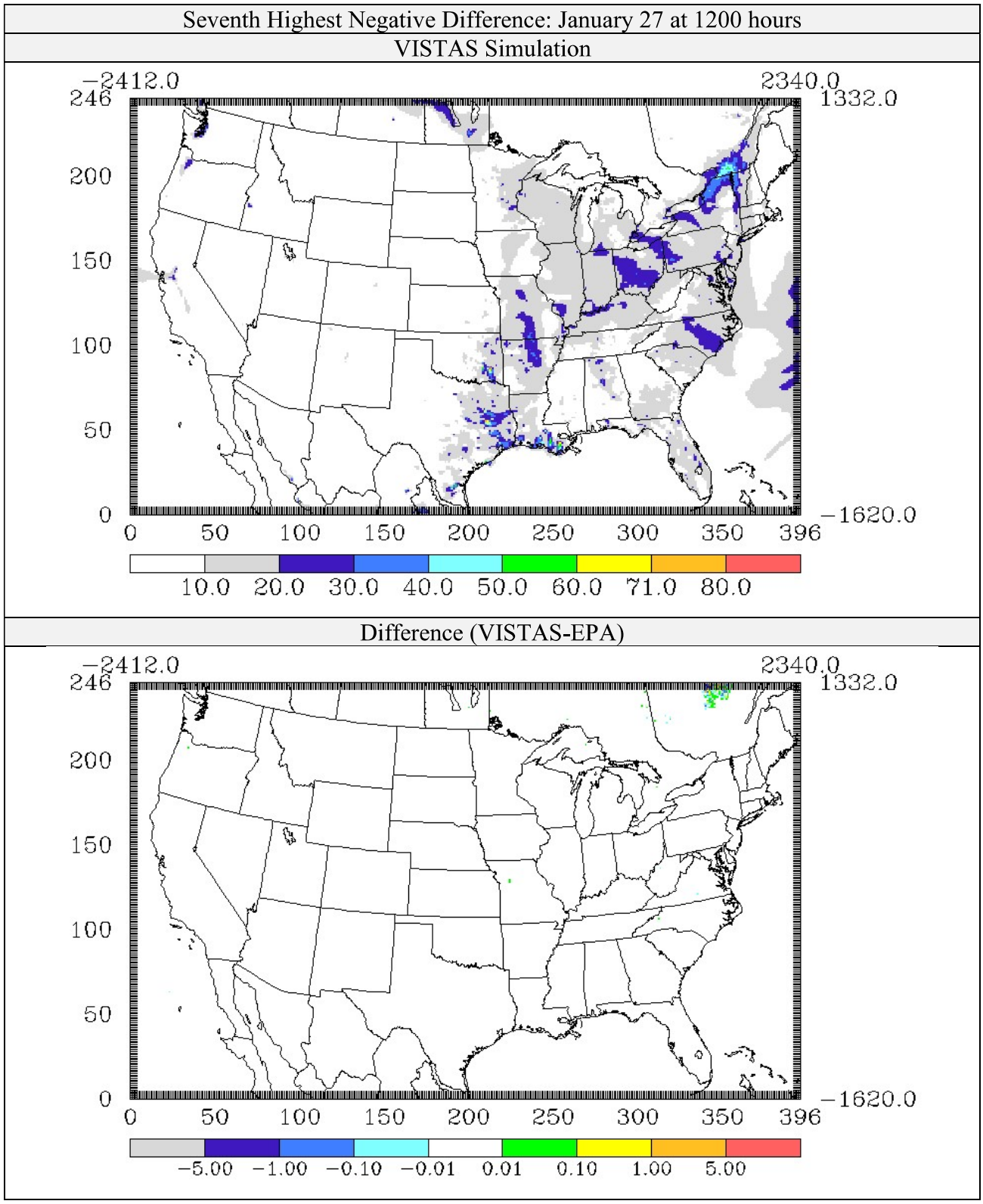

Figure 5-38: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)

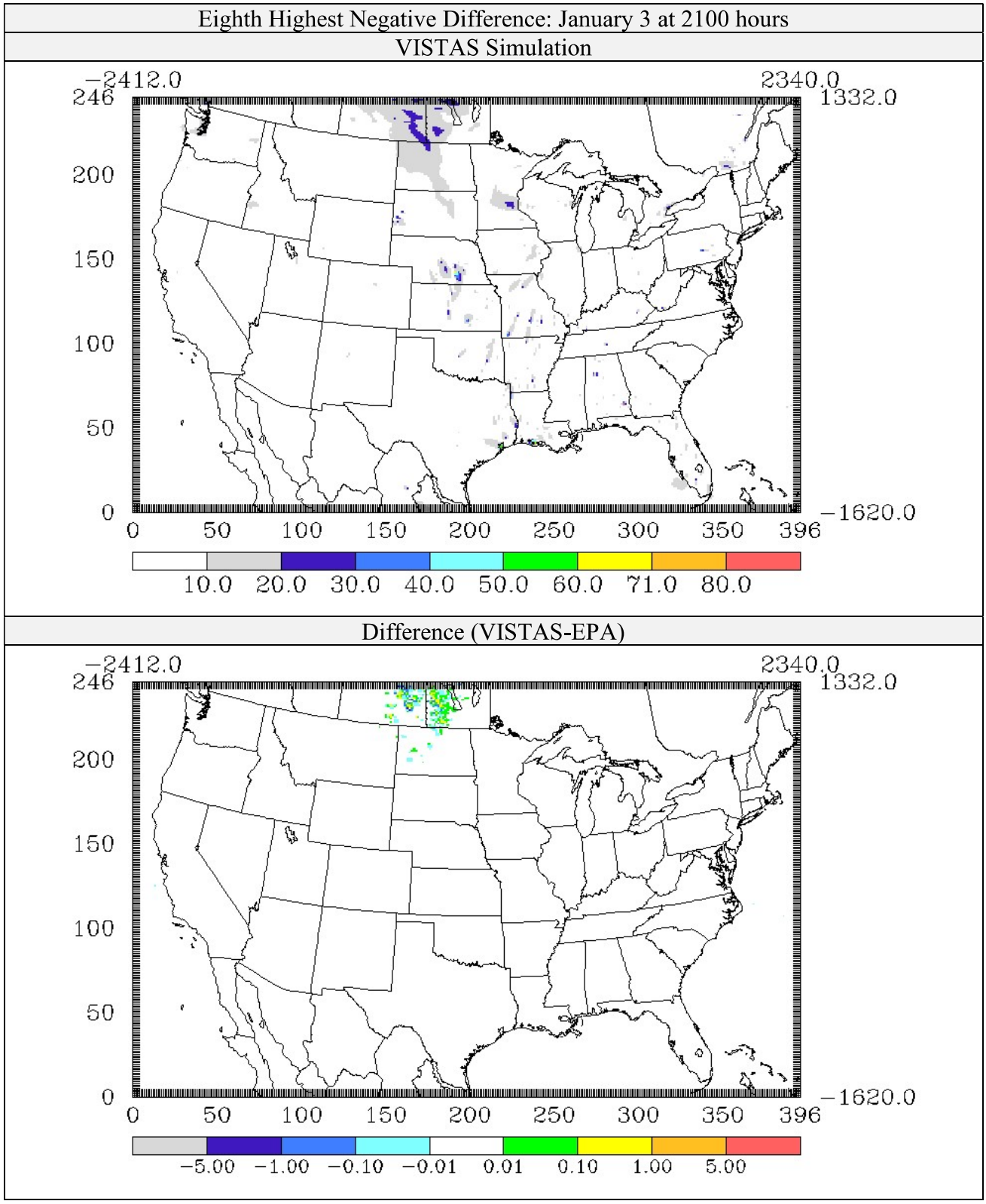

Figure 5-39: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)

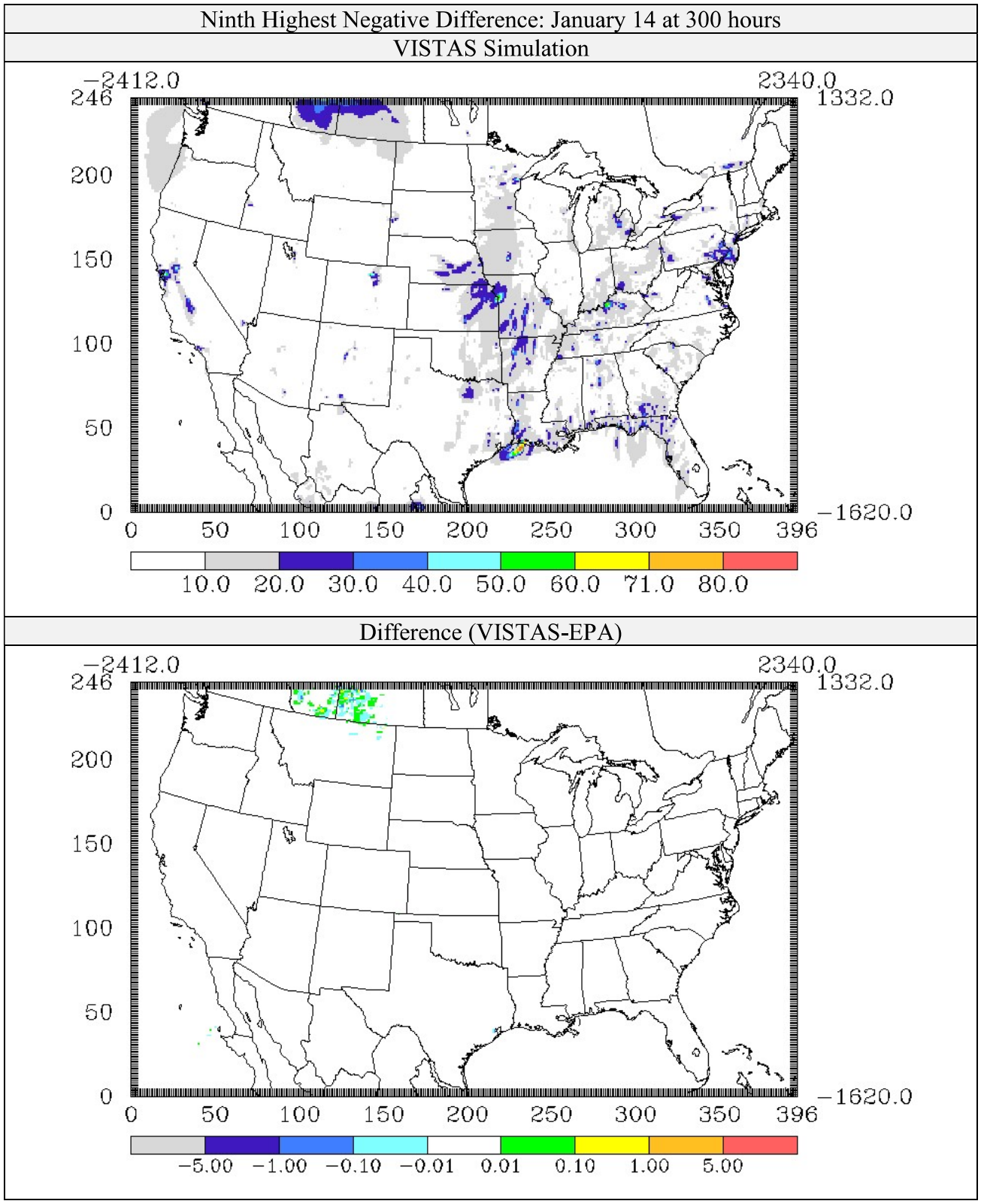

Figure 5-40: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)

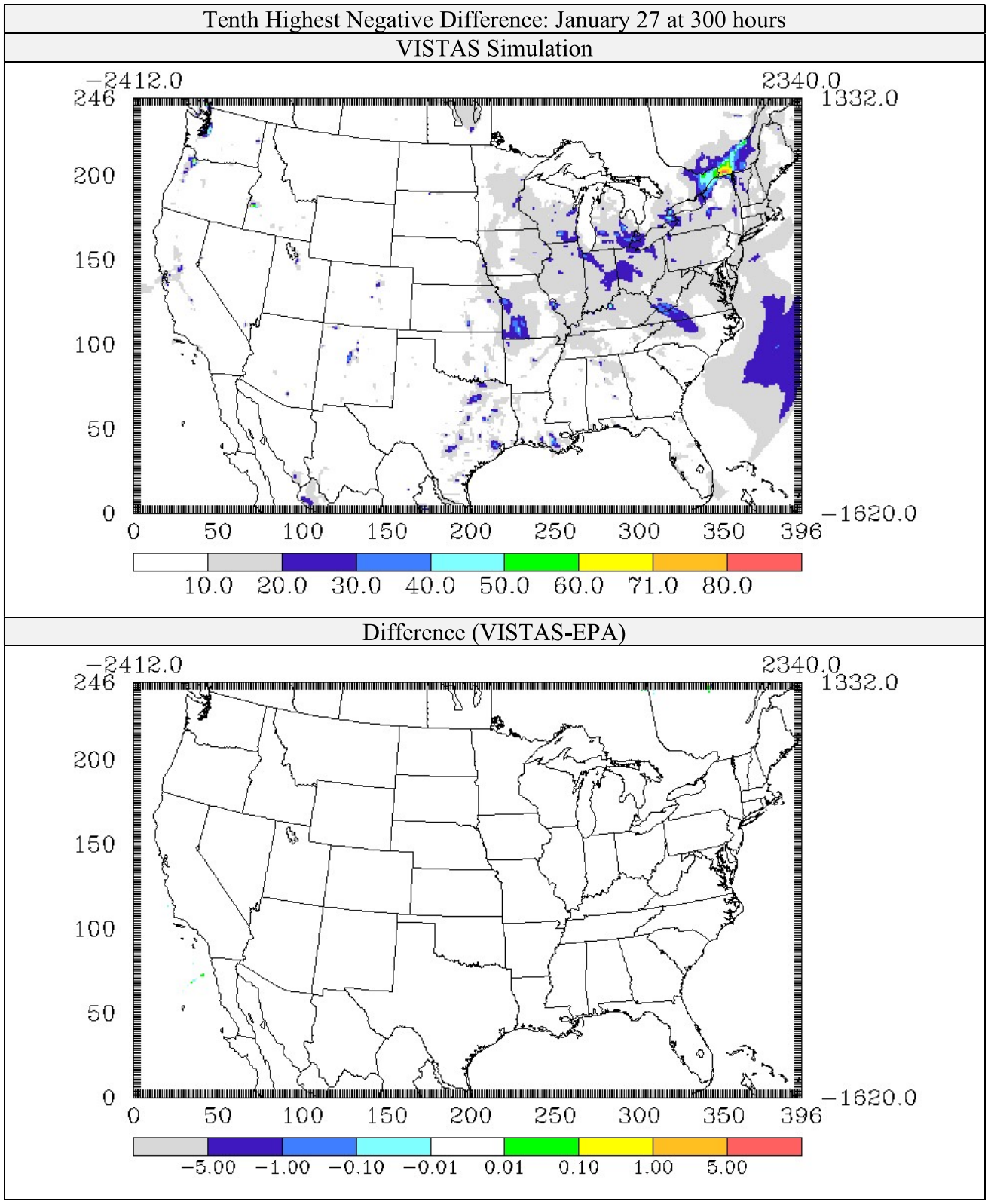

Figure 5-41: Comparison of $PM_{2.5}$ Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Negative Difference)

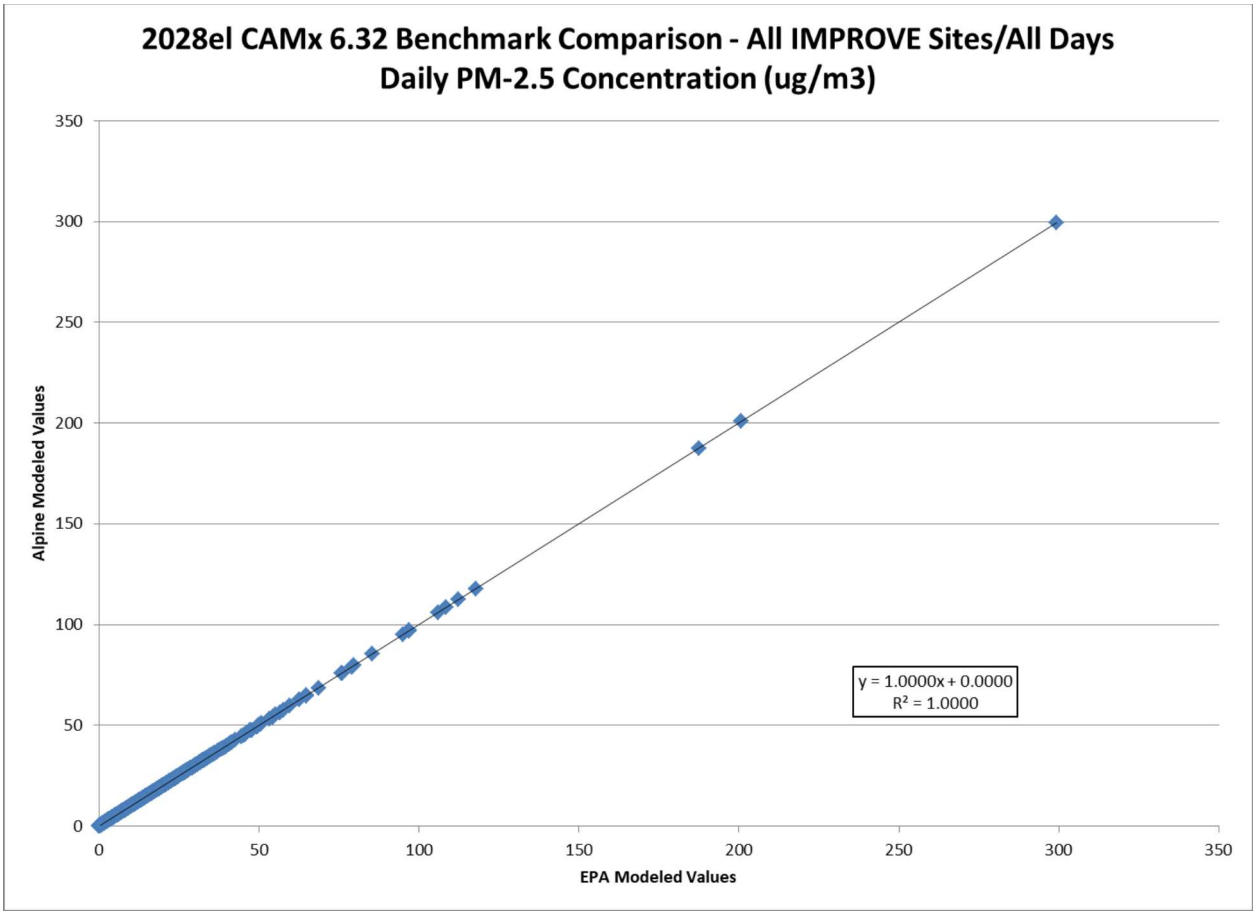

Figure 5-42: Scatterplot Comparing 24-hour Average Predicted $PM_{2.5}$ Concentrations ($\mu g/m^3$) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2028el Simulations Performed by EPA and VISTAS (Alpine).

5.3 Sulfate

Sulfate results for the top 10 positive and negative hours are presented in tabular format in Table 5-3. The maximum positive difference is 0.31 μg/m^3 falling to 0.17 μg/m^3 for the 10th high. The maximum negative difference is -0.14 μg/m^3 falling to -0.08 μg/m^3 for the 10th high. The maximum positive percent difference from these days is 17.8% and negative percent difference of -6.8%.

The top 10 positive impact hours are presented in Figures 5-43 through 5-52 and the top 10 negative impact hours are presented in Figures 5-53 through 5-62. The locations of the impacts are considerably more localized than the $PM_{2.5}$ differences, and are not occurring in any systematic location, but are tending to occur in the colder months. The area of the differences does not appear to be correlated with areas of high Sulfate concentrations.

Scatterplots of the daily average sulfate concentrations in local standard time at the IMPROVE monitors are presented in Figure 5-63. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Table 5-3. Comparison of 2028el CAMx 6.32 Simulation Sulfate Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	1	26	11	2.08	1.77	0.31	17.80%	209	205
2011	12	13	11	4.75	4.45	0.30	6.79%	170	116
2011	11	23	13	3.43	3.17	0.26	8.23%	215	100
2011	1	26	12	2.31	2.06	0.25	11.99%	209	205
2011	3	16	9	5.22	5.00	0.22	4.49%	227	181
2011	11	23	12	3.27	3.06	0.22	7.12%	215	100
2011	3	5	14	3.45	3.24	0.20	6.27%	183	161
2011	1	26	10	1.92	1.73	0.19	10.81%	209	205
2011	3	5	15	3.63	3.45	0.18	5.31%	183	161
2011	3	8	5	3.33	3.16	0.17	5.39%	112	241
Maximum Negative									
2011	1	26	9	4.01	4.15	-0.14	-3.26%	375	181
2011	3	20	13	7.25	7.38	-0.13	-1.74%	359	212
2011	12	26	10	1.74	1.87	-0.13	-6.78%	292	115
2011	5	11	12	2.09	2.19	-0.11	-4.80%	274	135
2011	2	17	4	2.68	2.78	-0.10	-3.72%	147	215
2011	4	13	23	3.38	3.48	-0.10	-2.88%	360	162
2011	2	15	14	3.96	4.06	-0.09	-2.31%	246	156
2011	1	18	12	3.62	3.71	-0.09	-2.31%	303	71
2011	2	15	13	4.16	4.24	-0.08	-1.96%	246	156
2011	12	18	11	2.68	2.76	-0.08	-3.00%	282	115

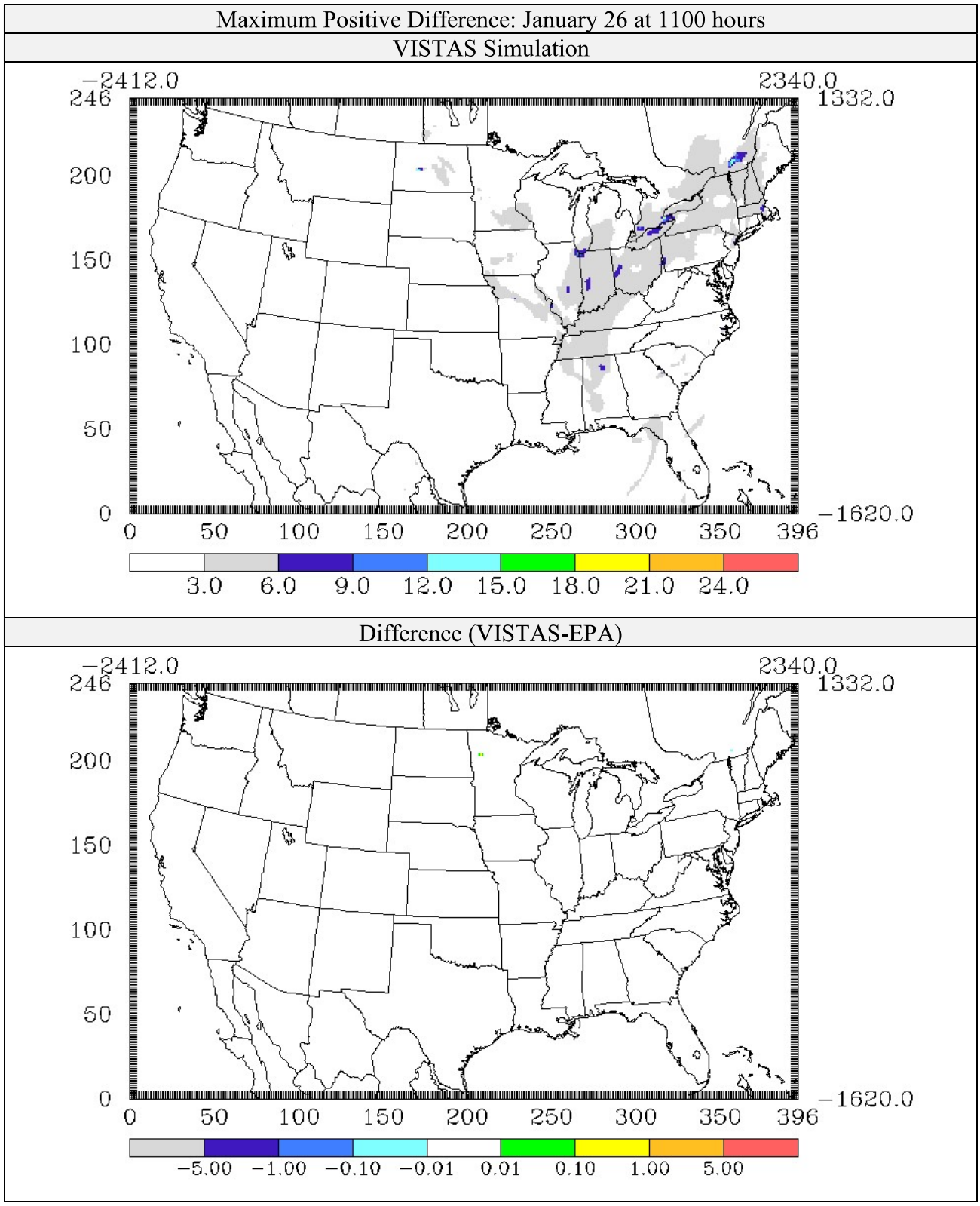

Figure 5-43: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)

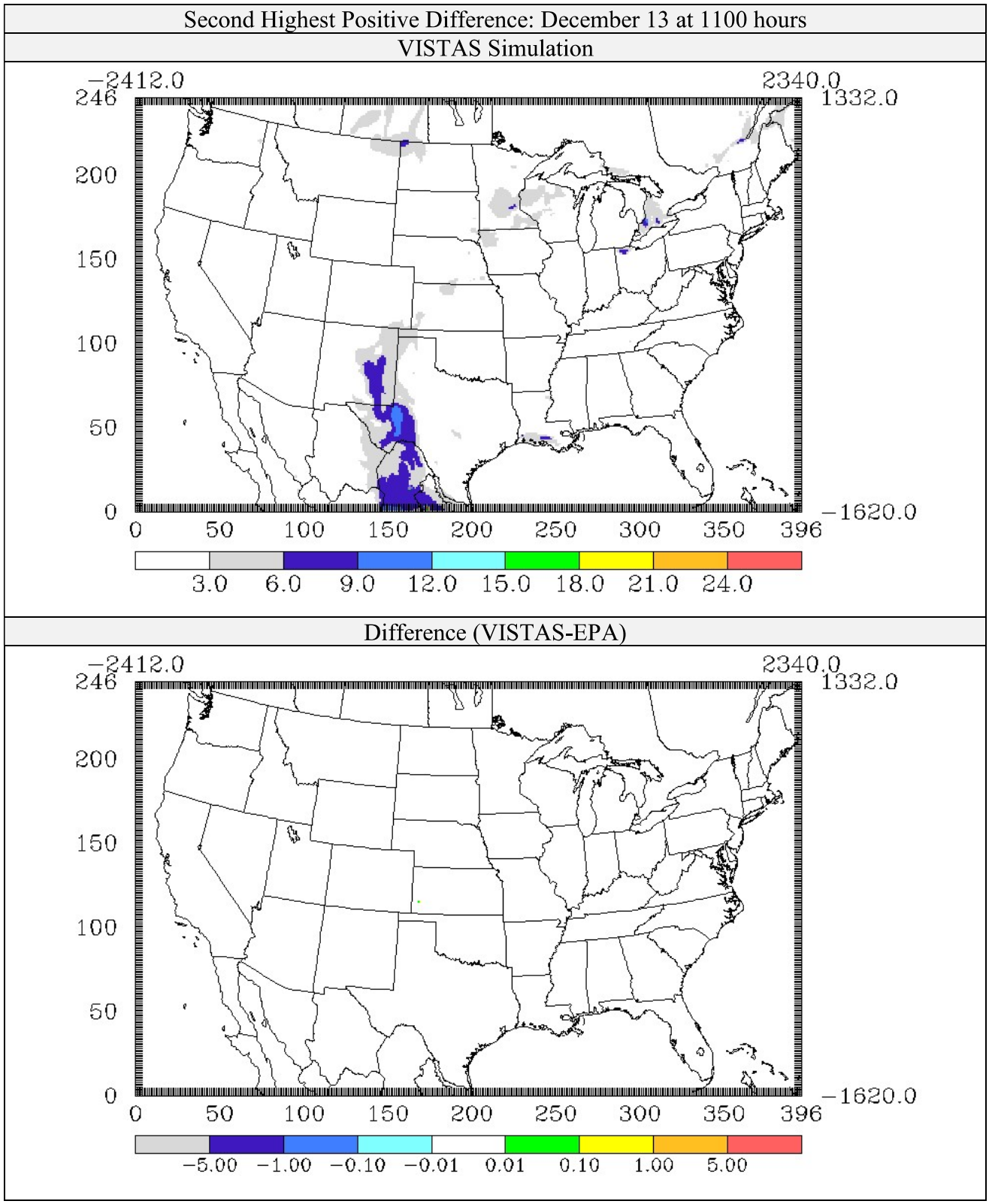

Figure 5-44: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)

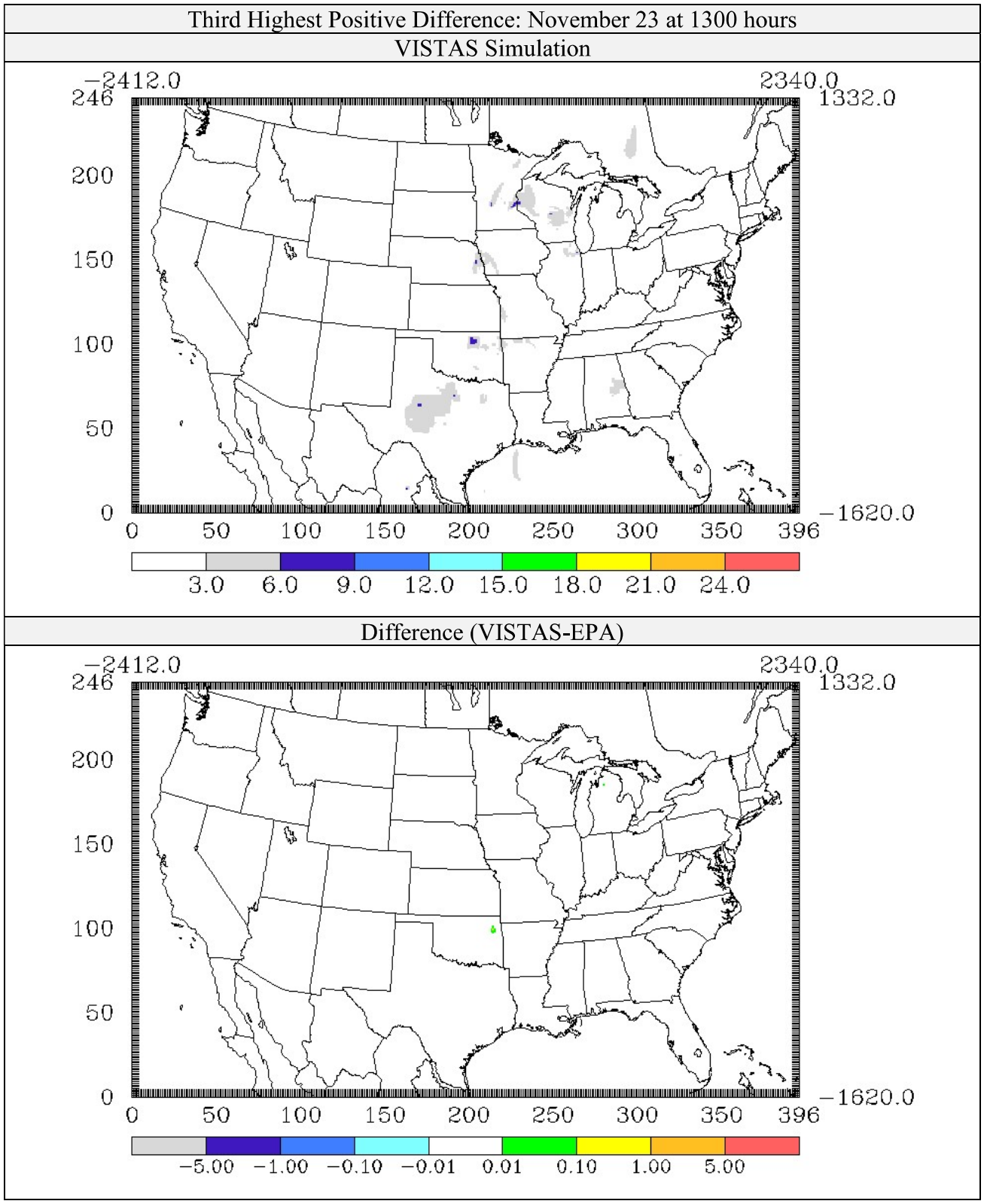

Figure 5-45: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)

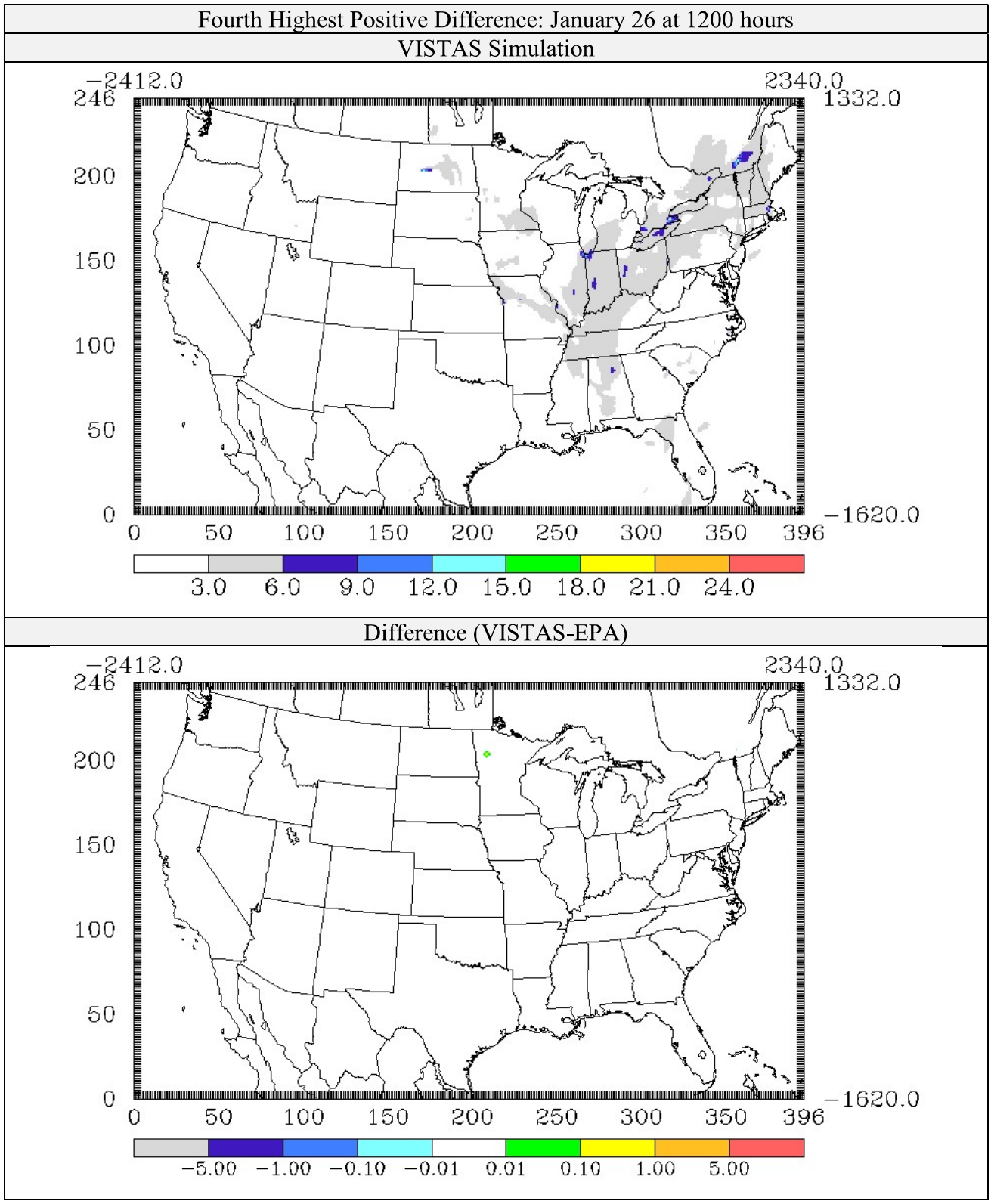

Figure 5-46: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

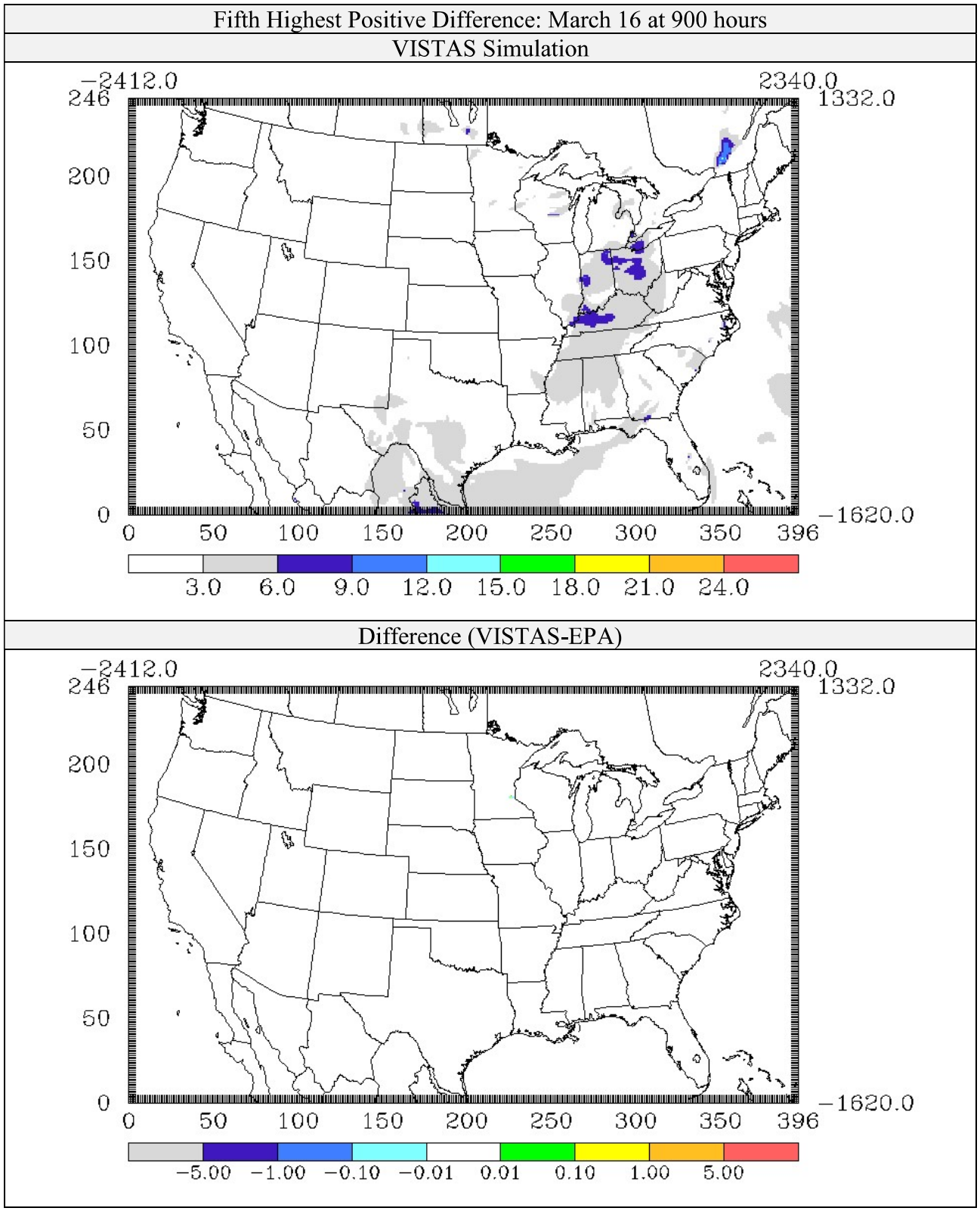

Figure 5-47: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)

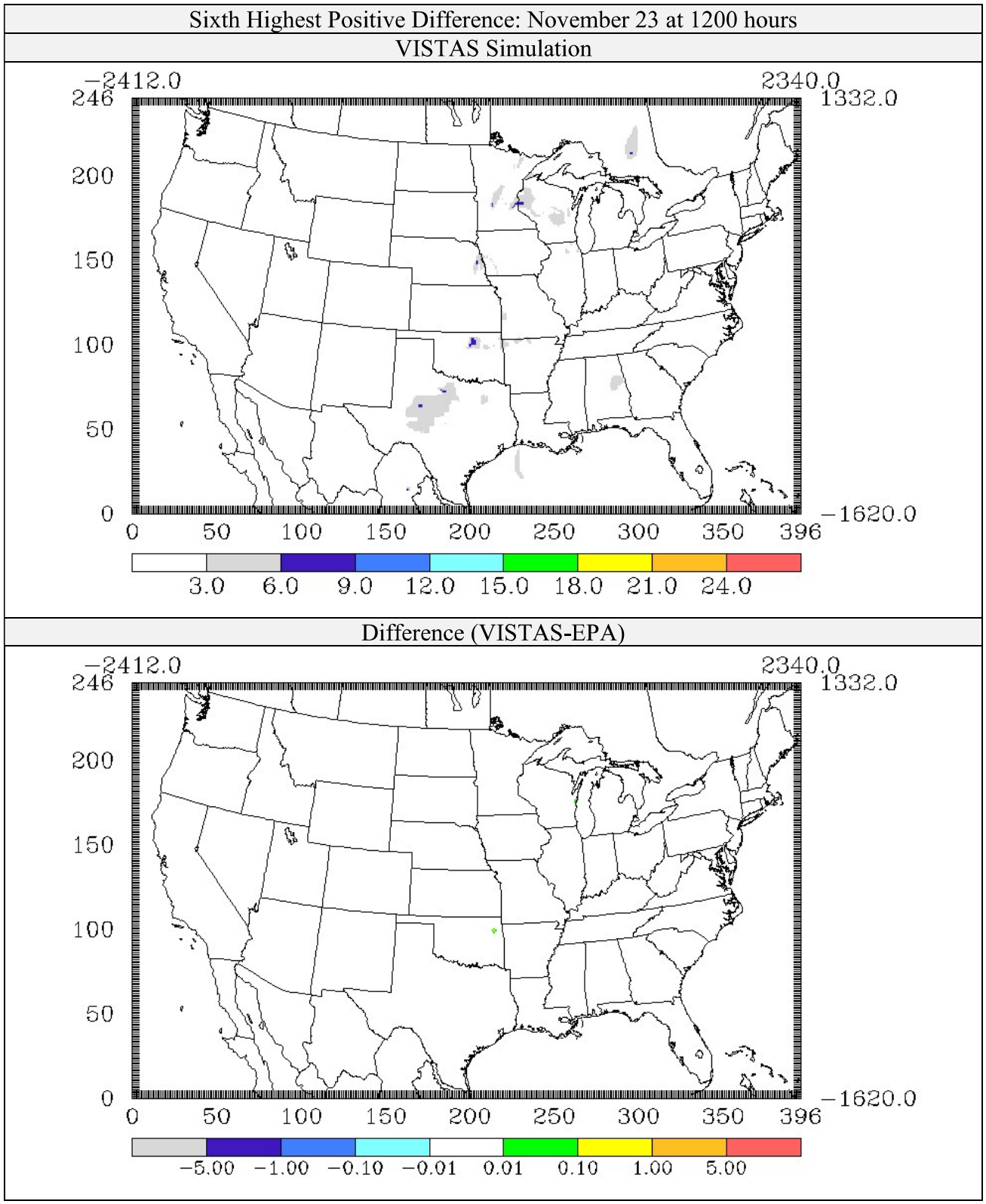

Figure 5-48: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)

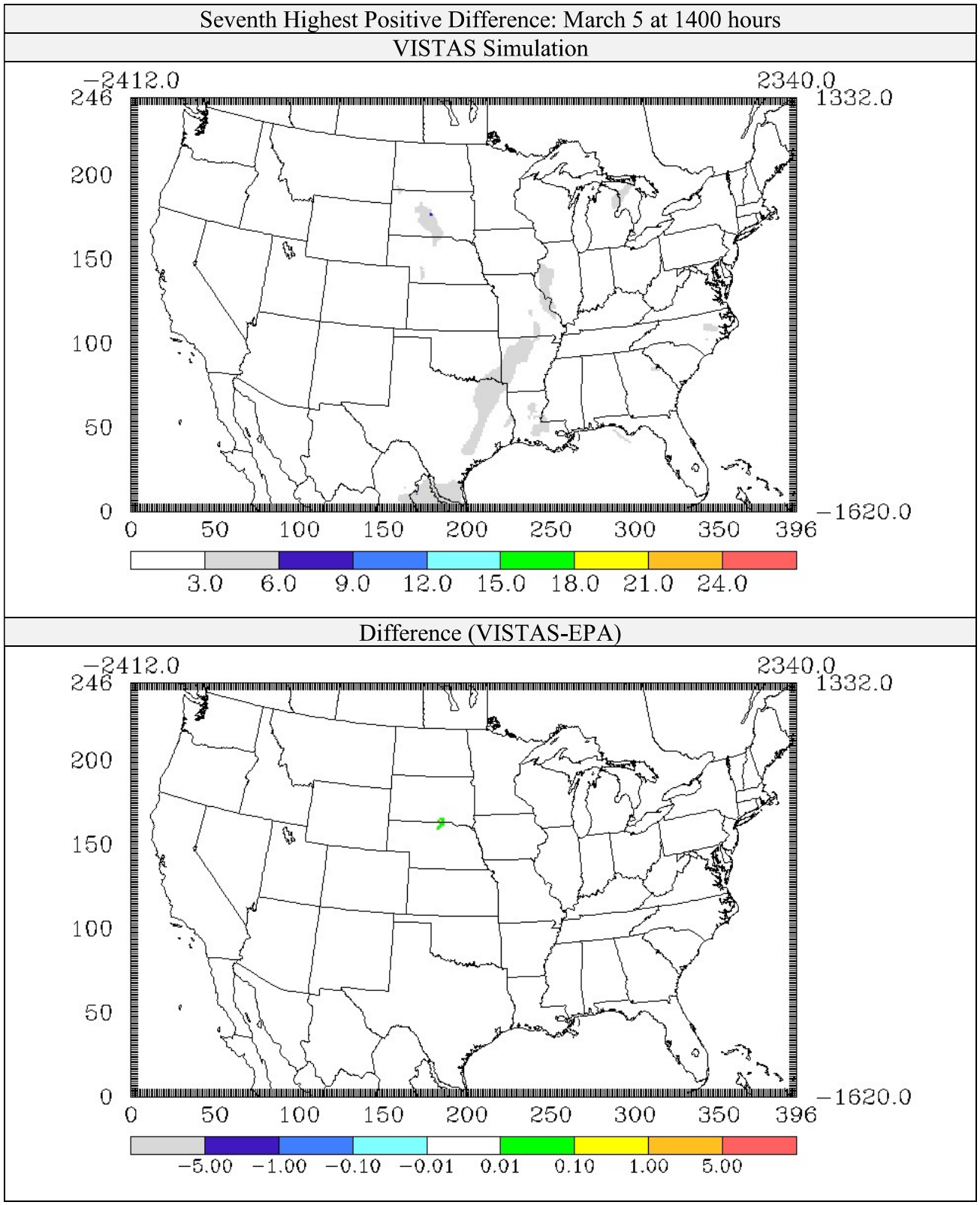

Figure 5-49: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)

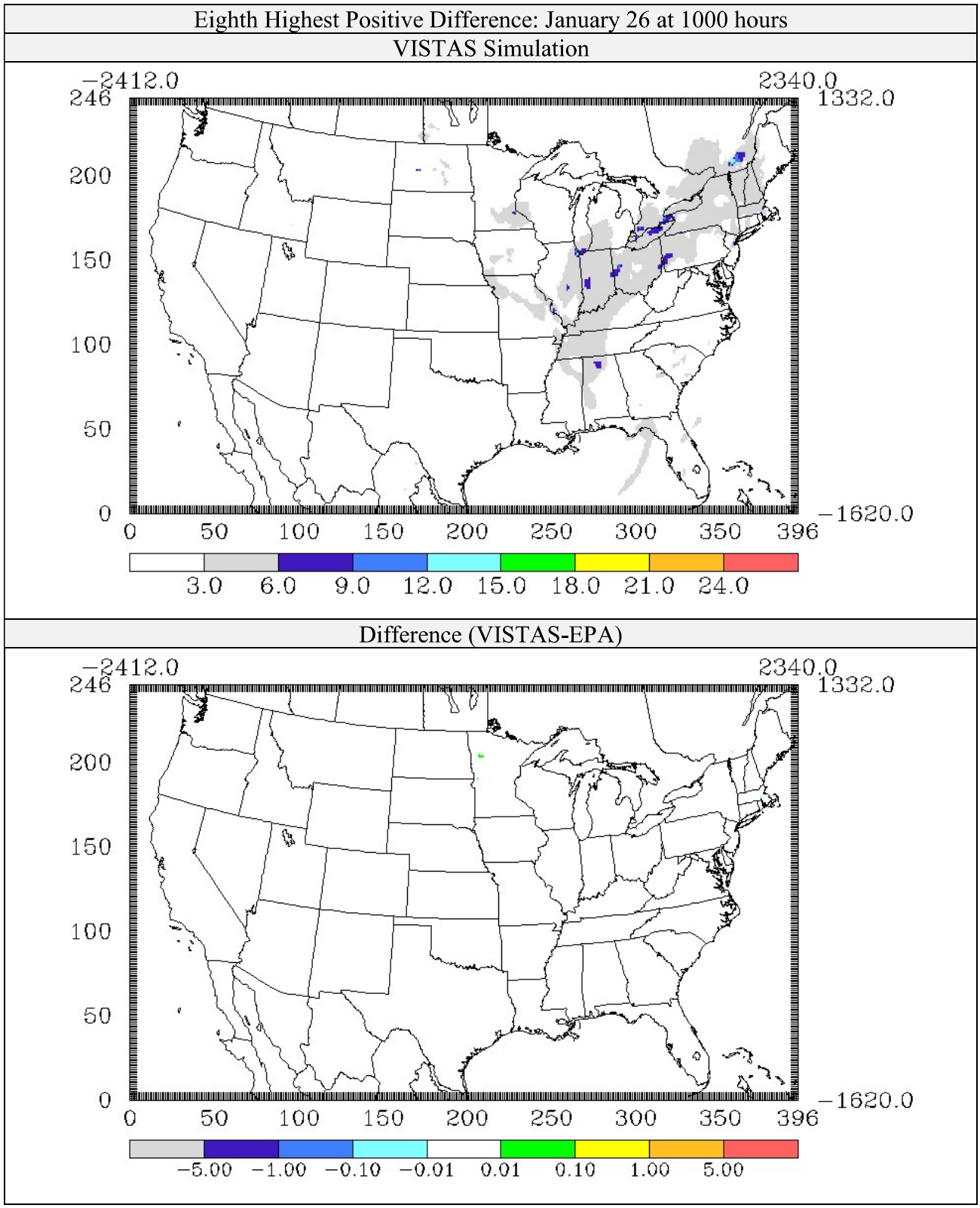

Figure 5-50: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)

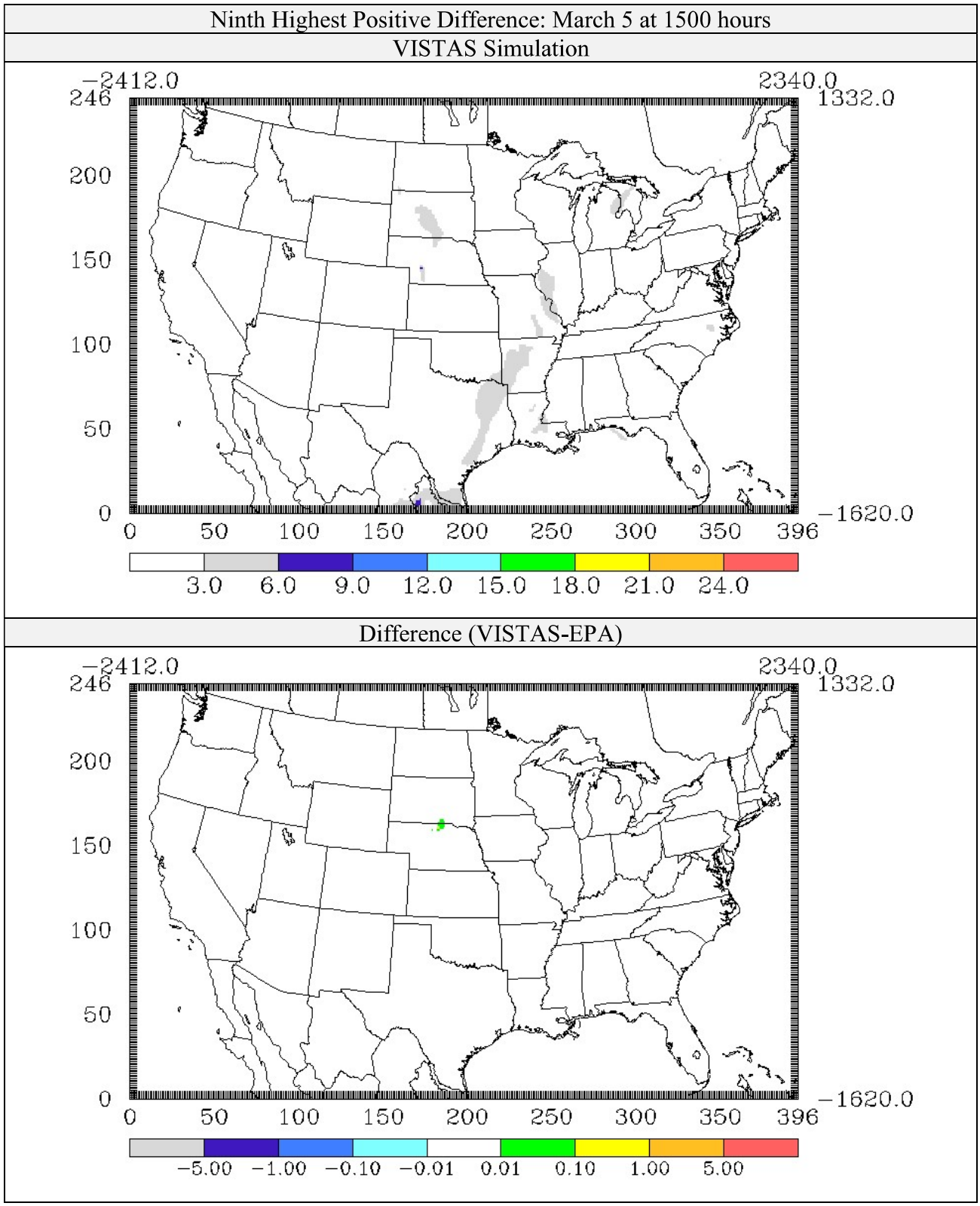

Figure 5-51: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)

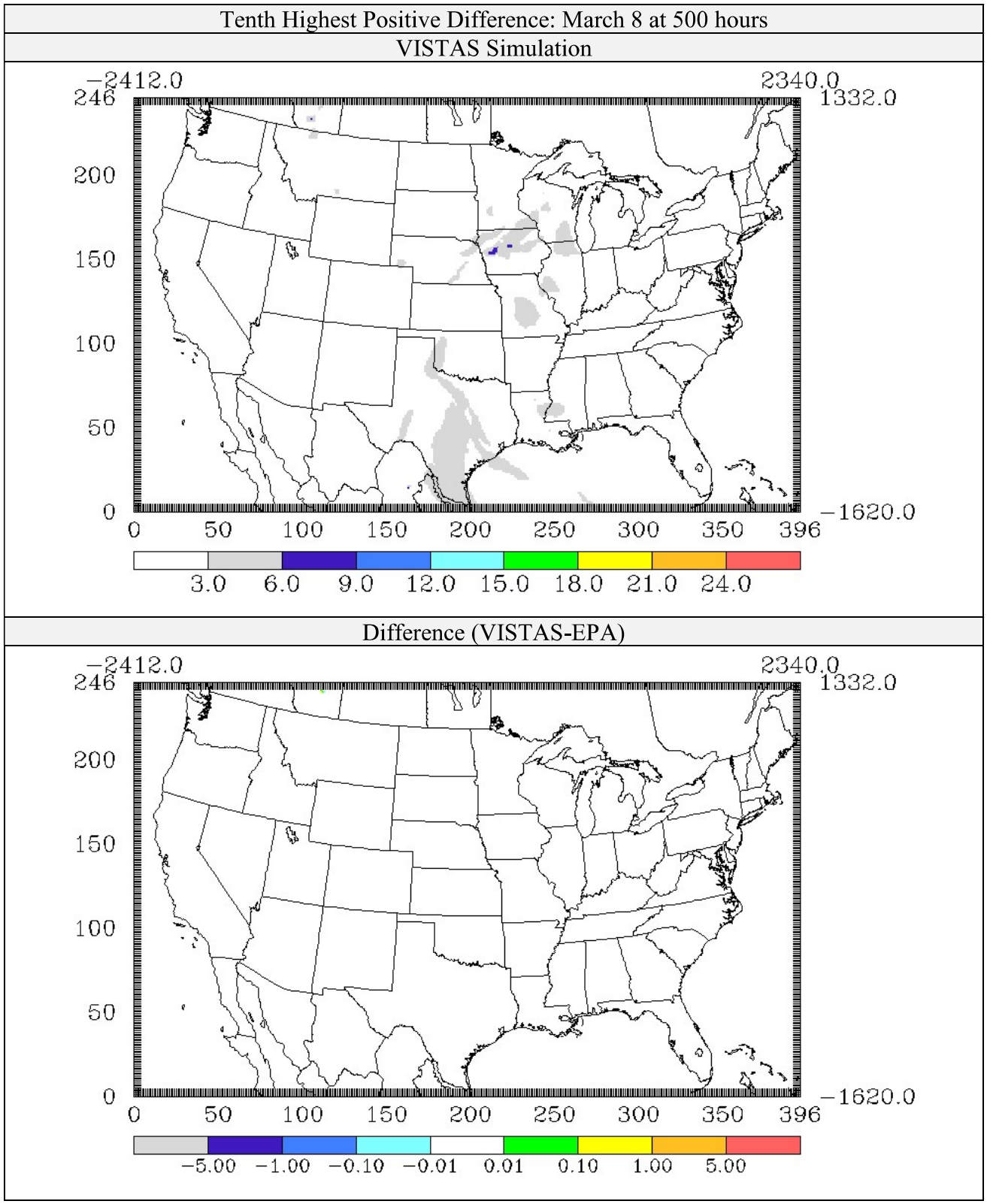

Figure 5-52: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)

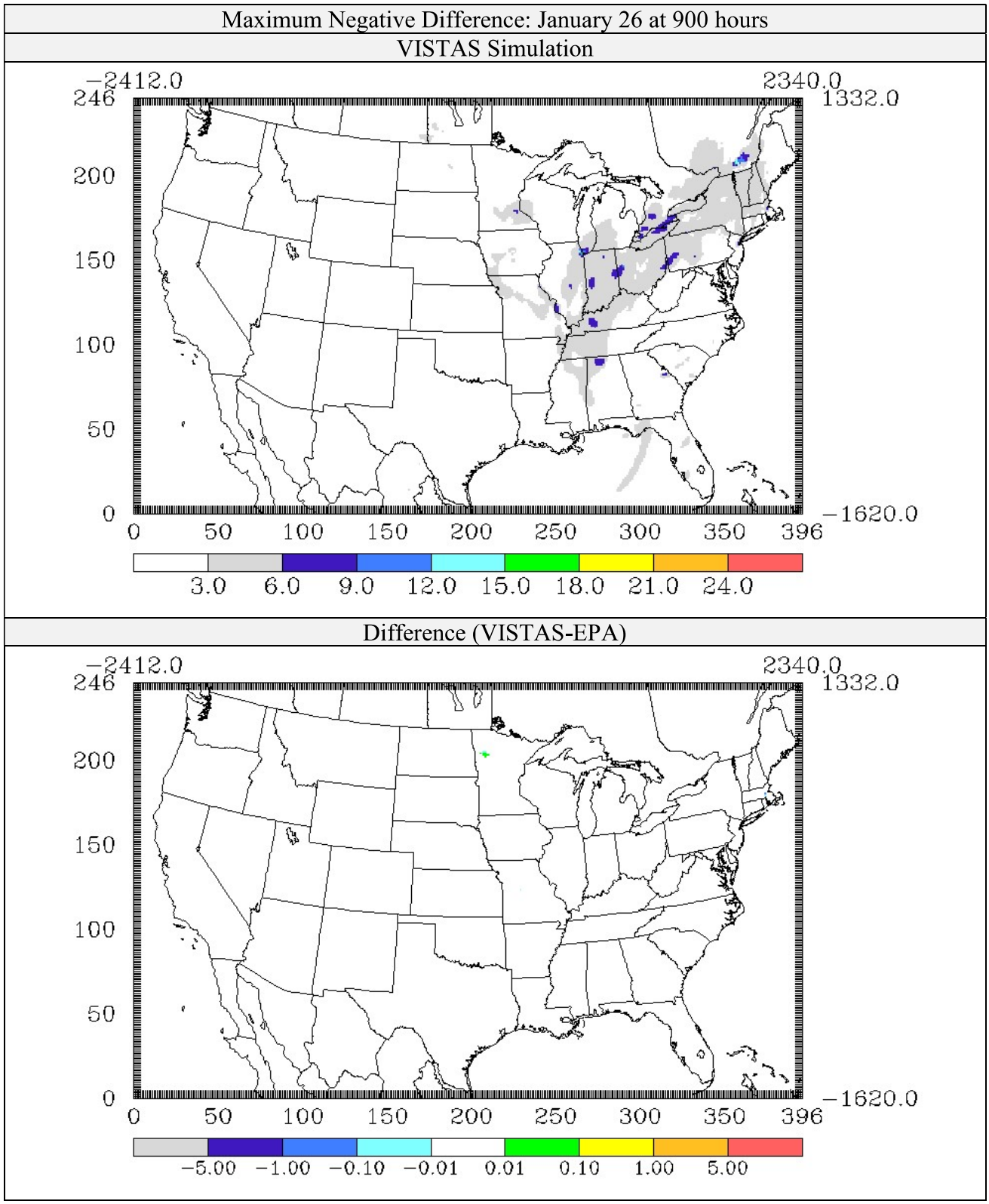

Figure 5-53: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)

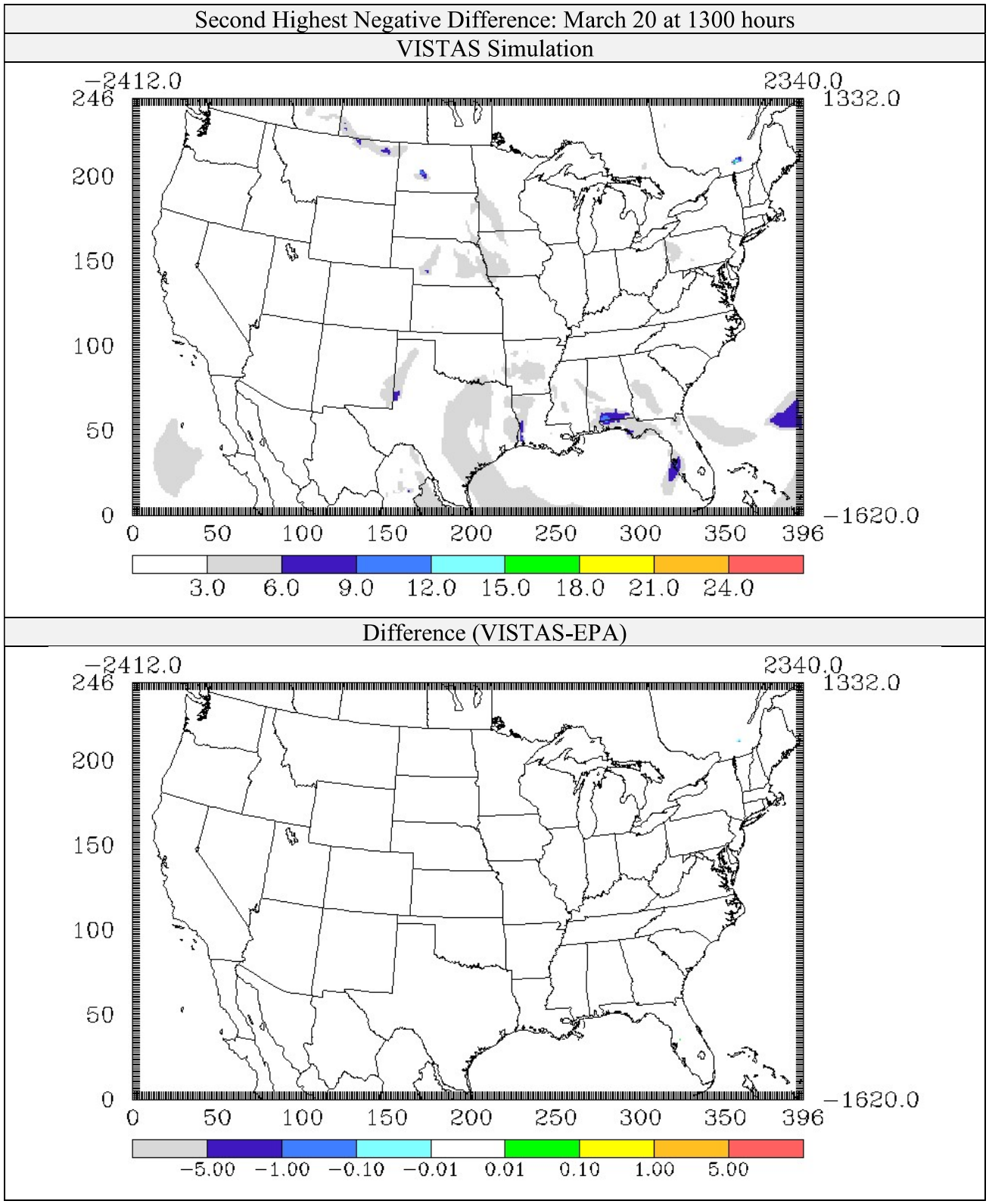

Figure 5-54: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)

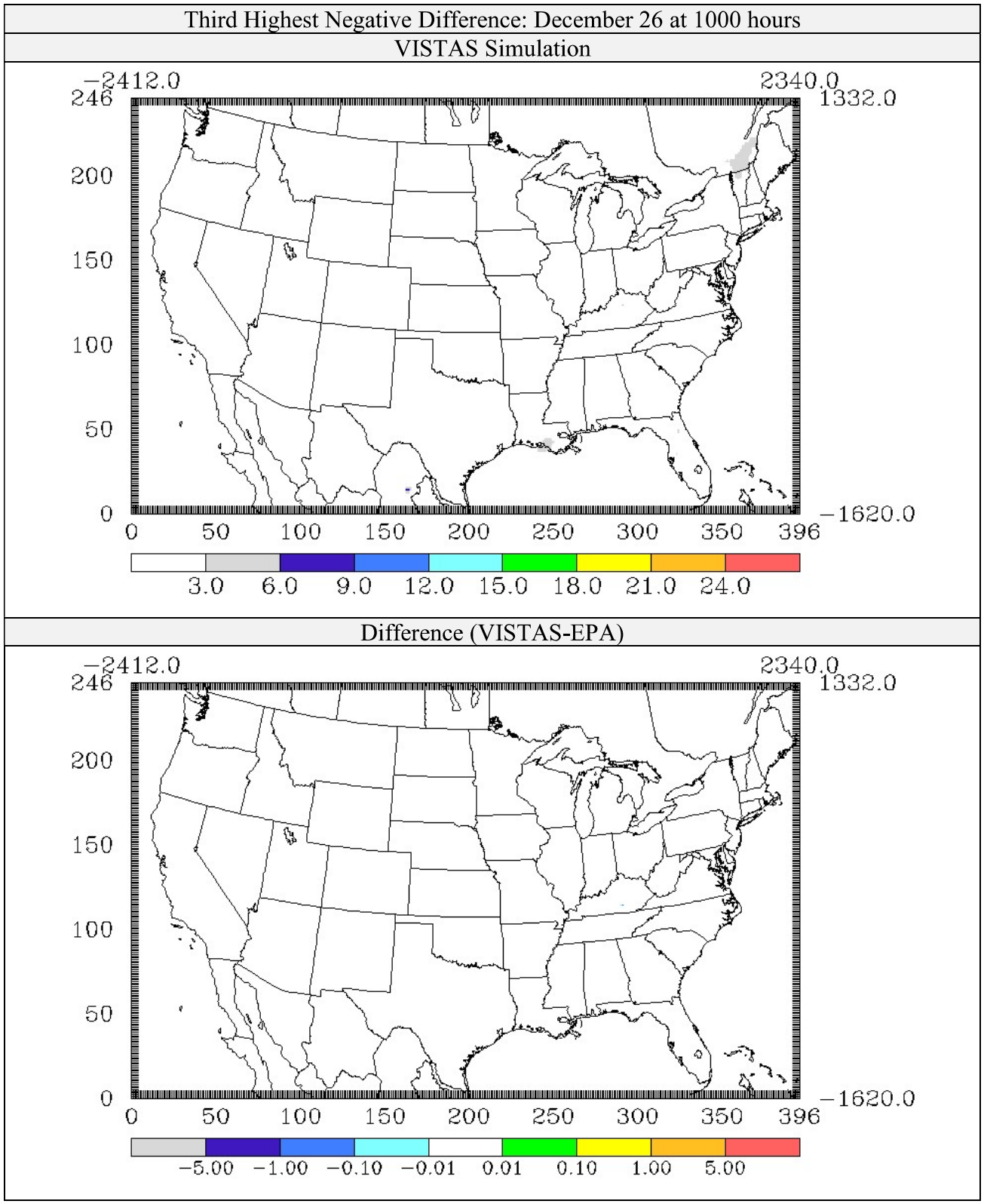

Figure 5-55: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)

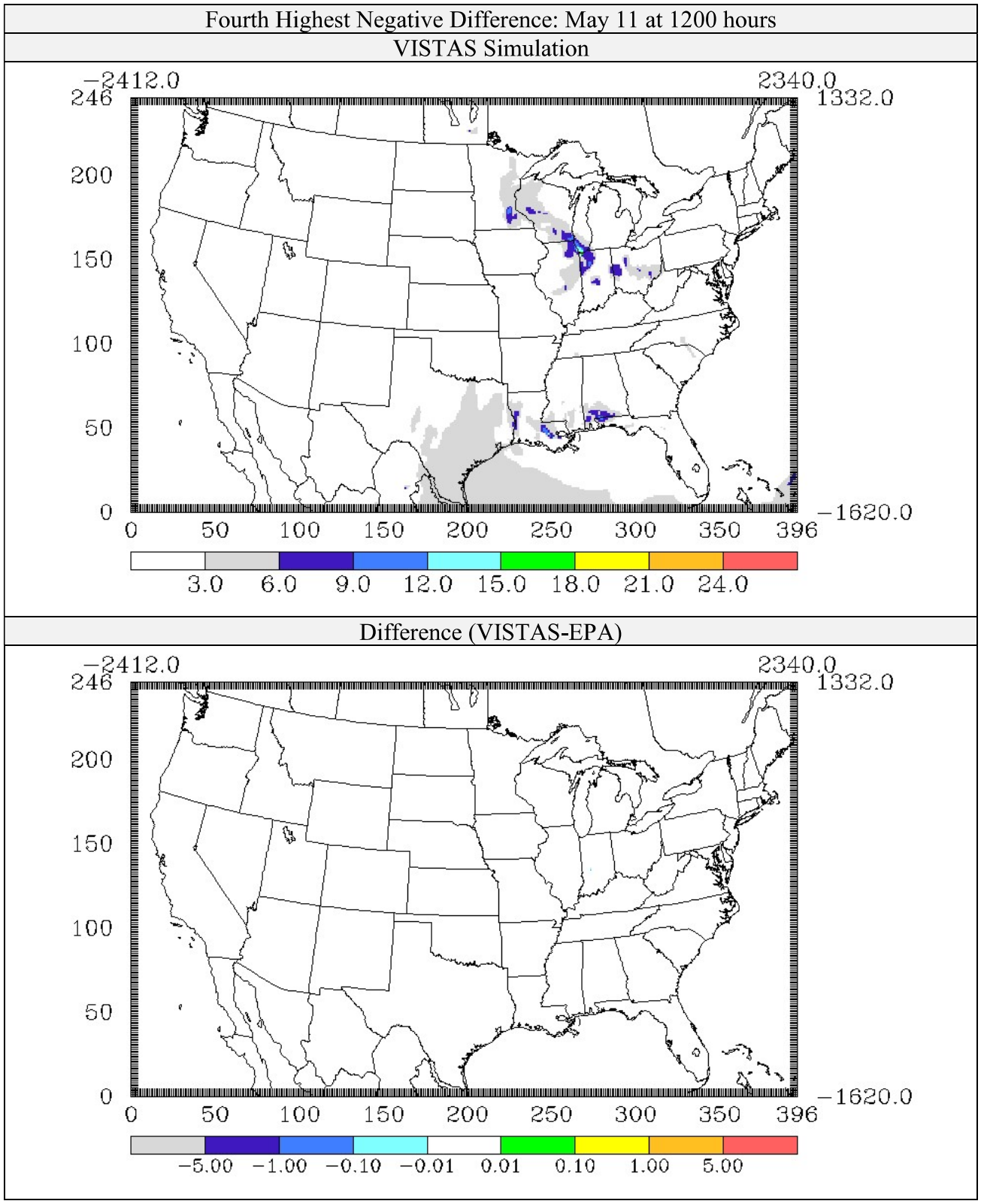

Figure 5-56: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)

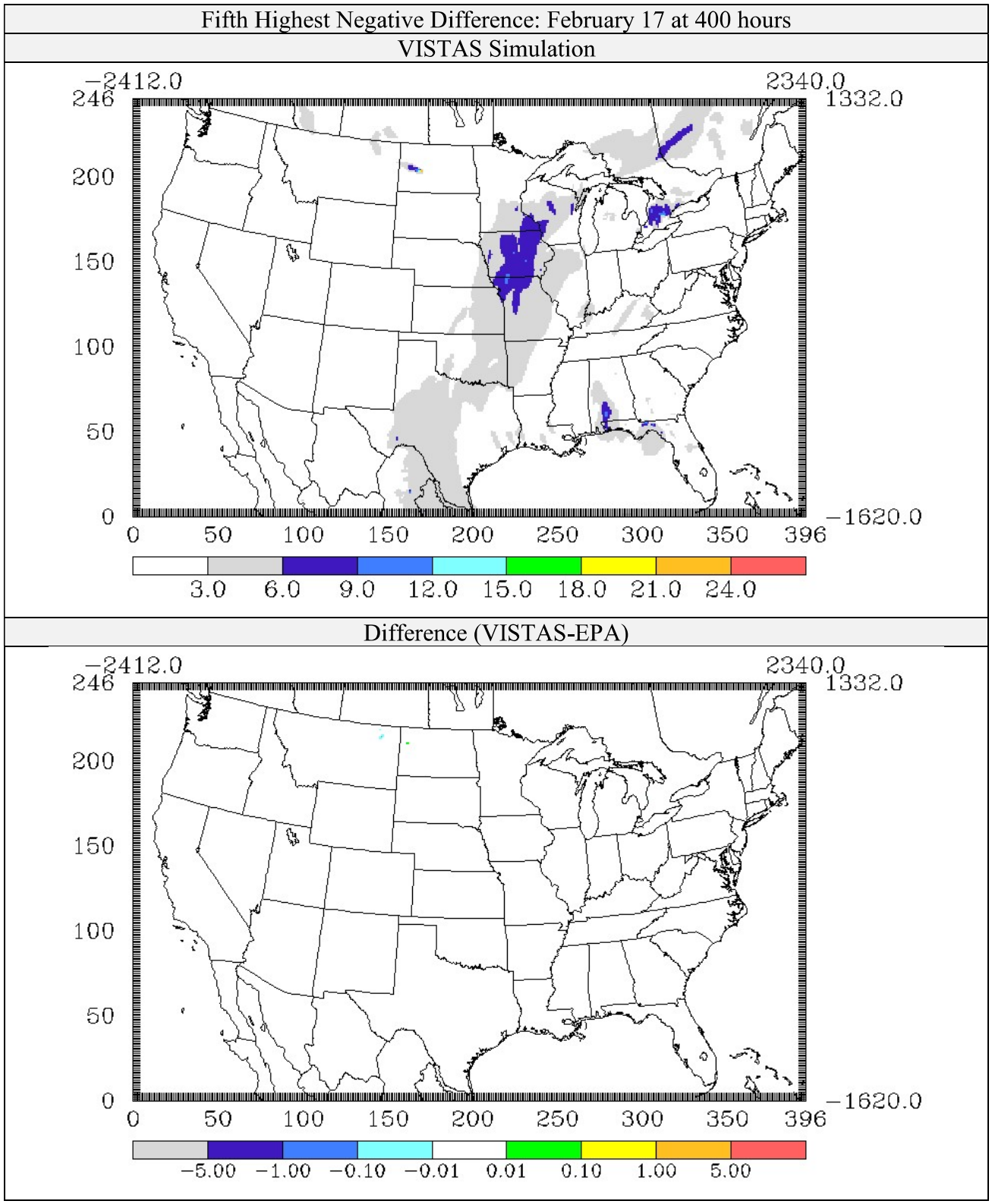

Figure 5-57: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)

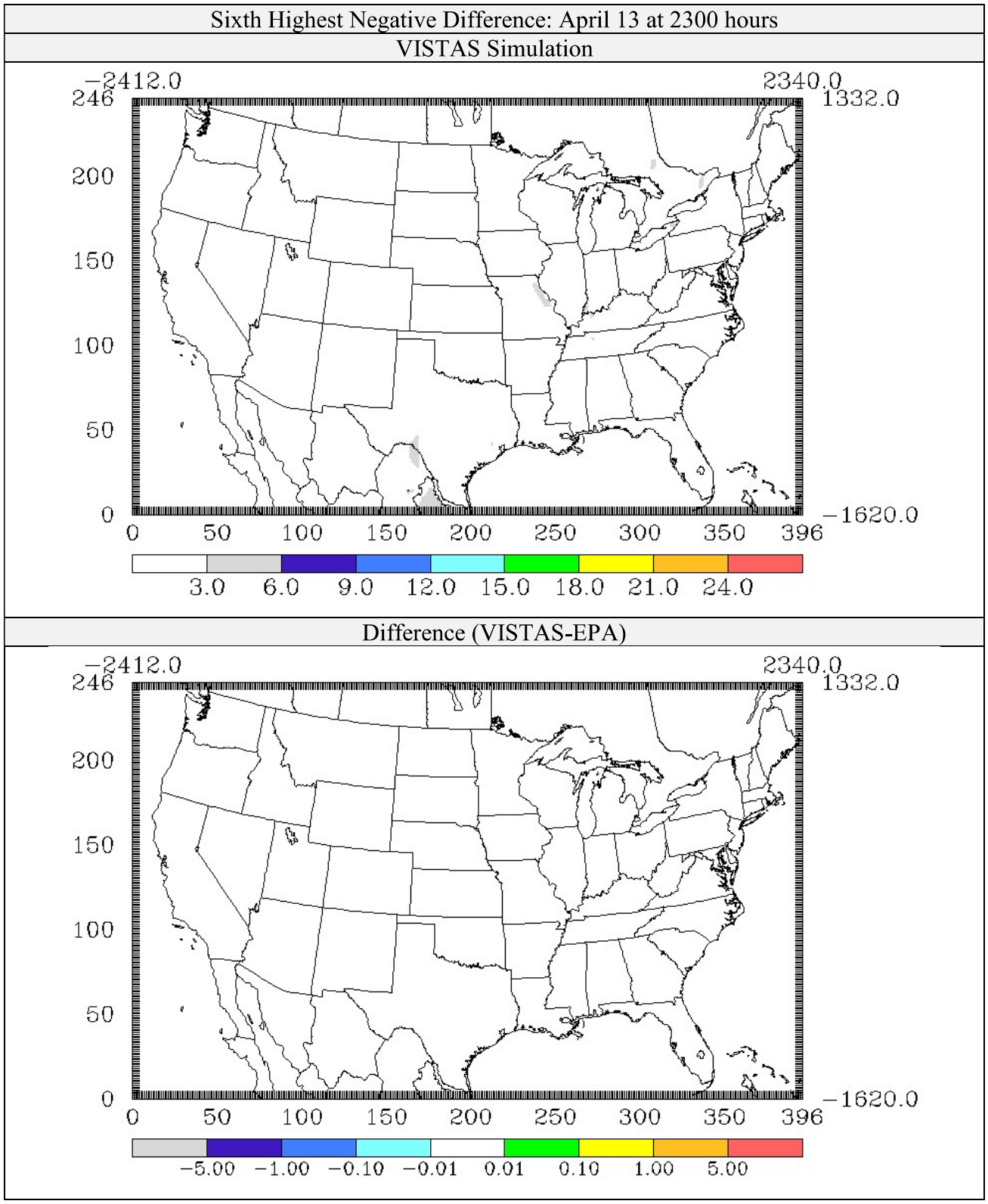

Figure 5-58: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)

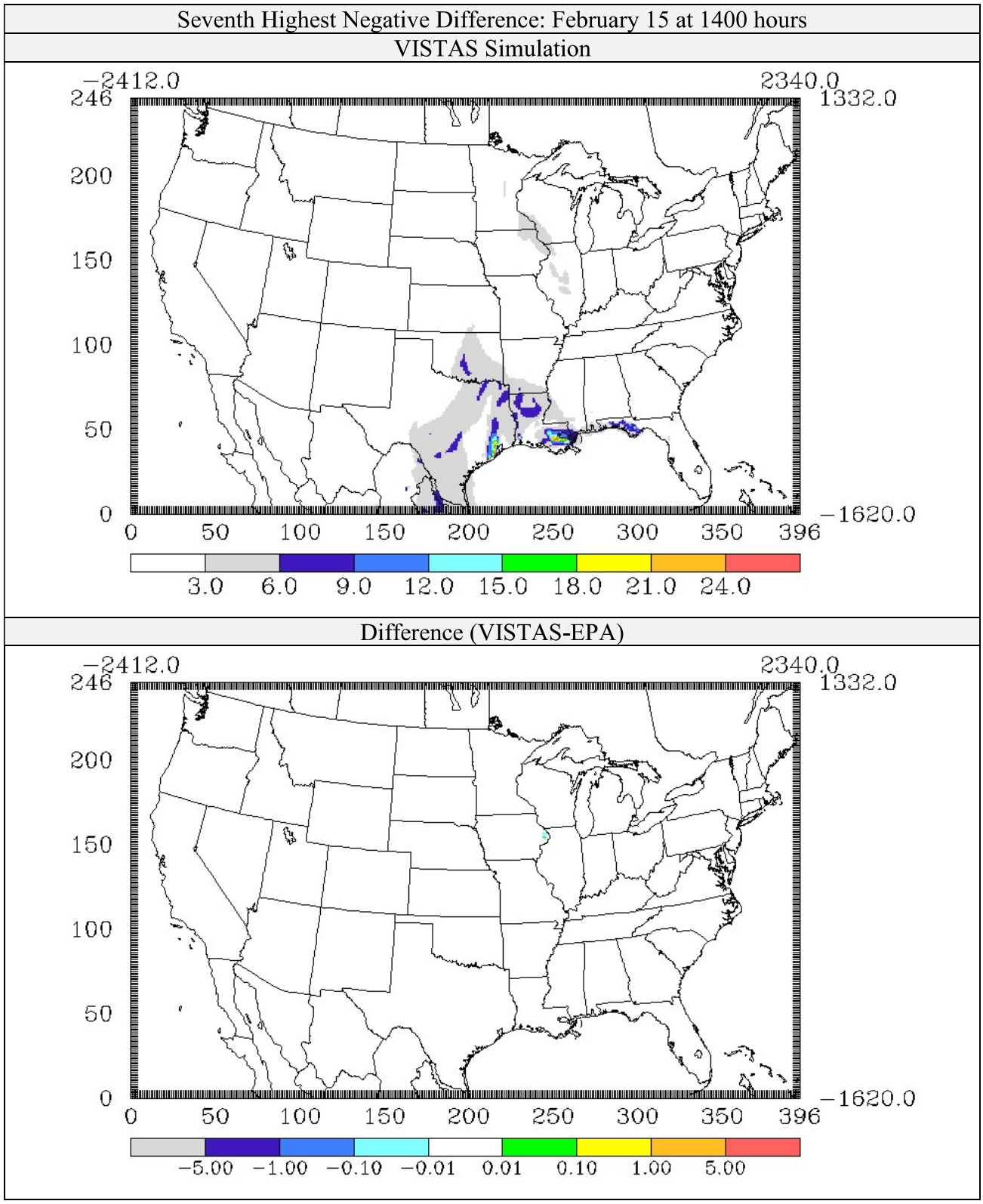

Figure 5-59: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)

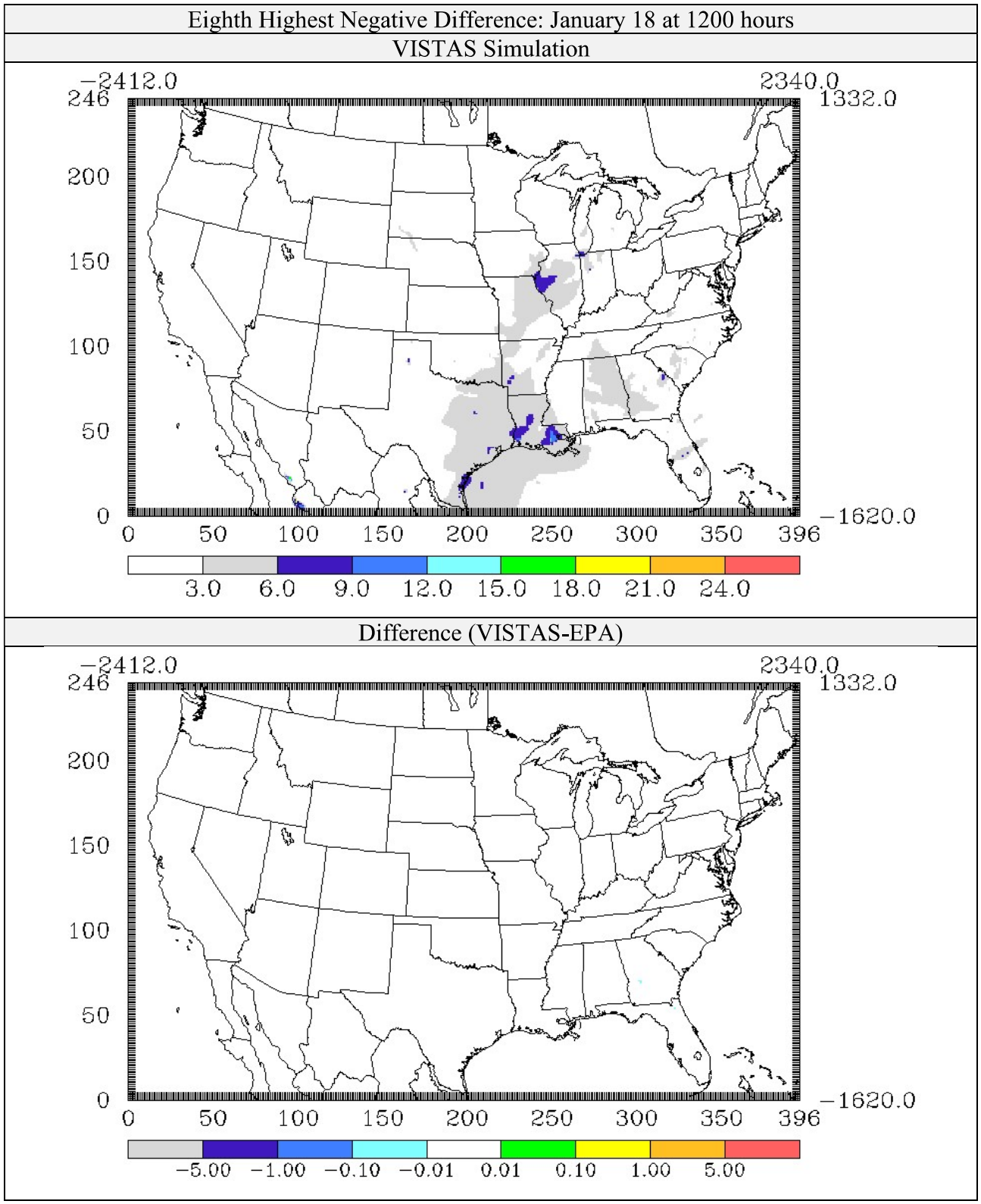

Figure 5-60: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)

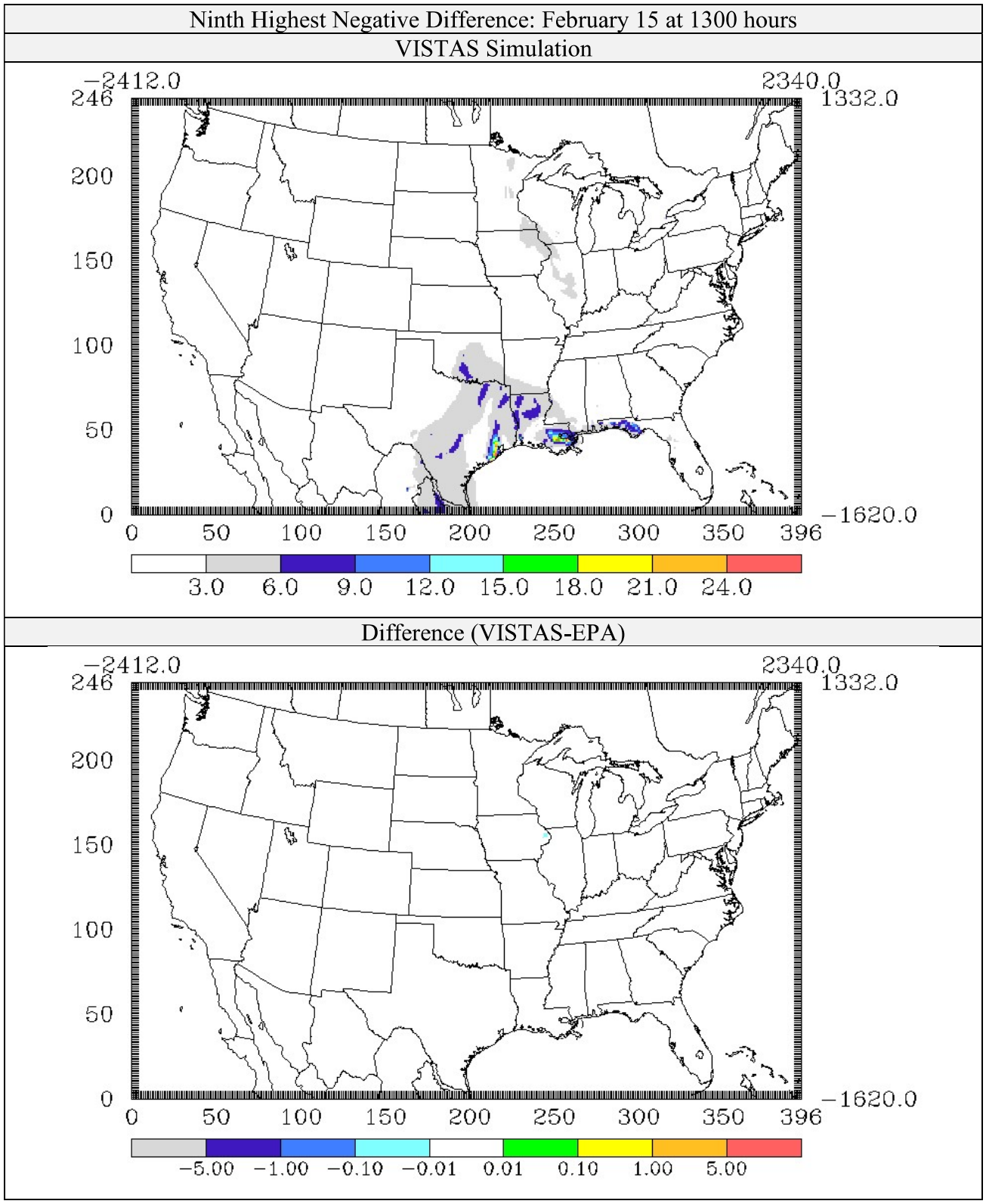

Figure 5-61: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)

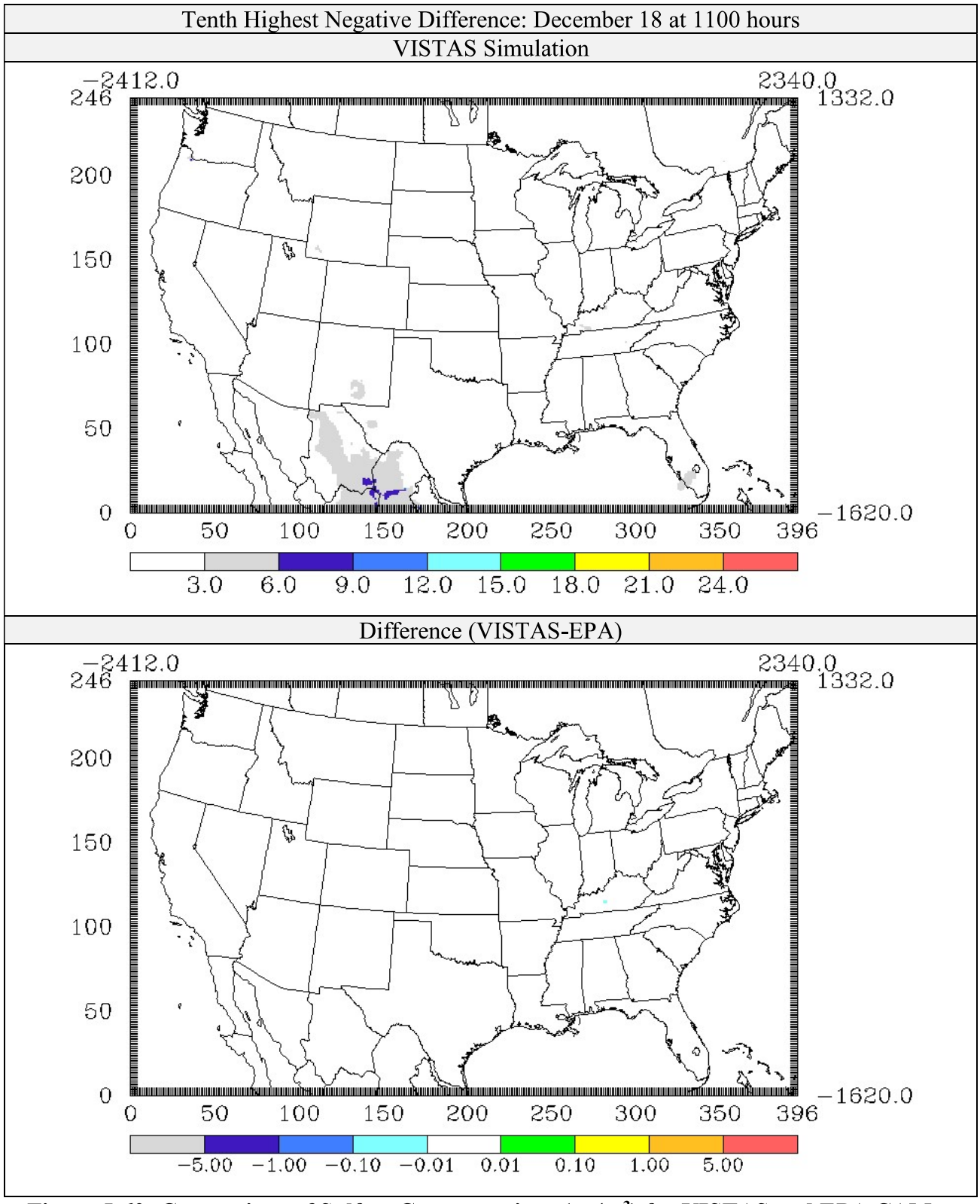

Figure 5-62: Comparison of Sulfate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Negative Difference)

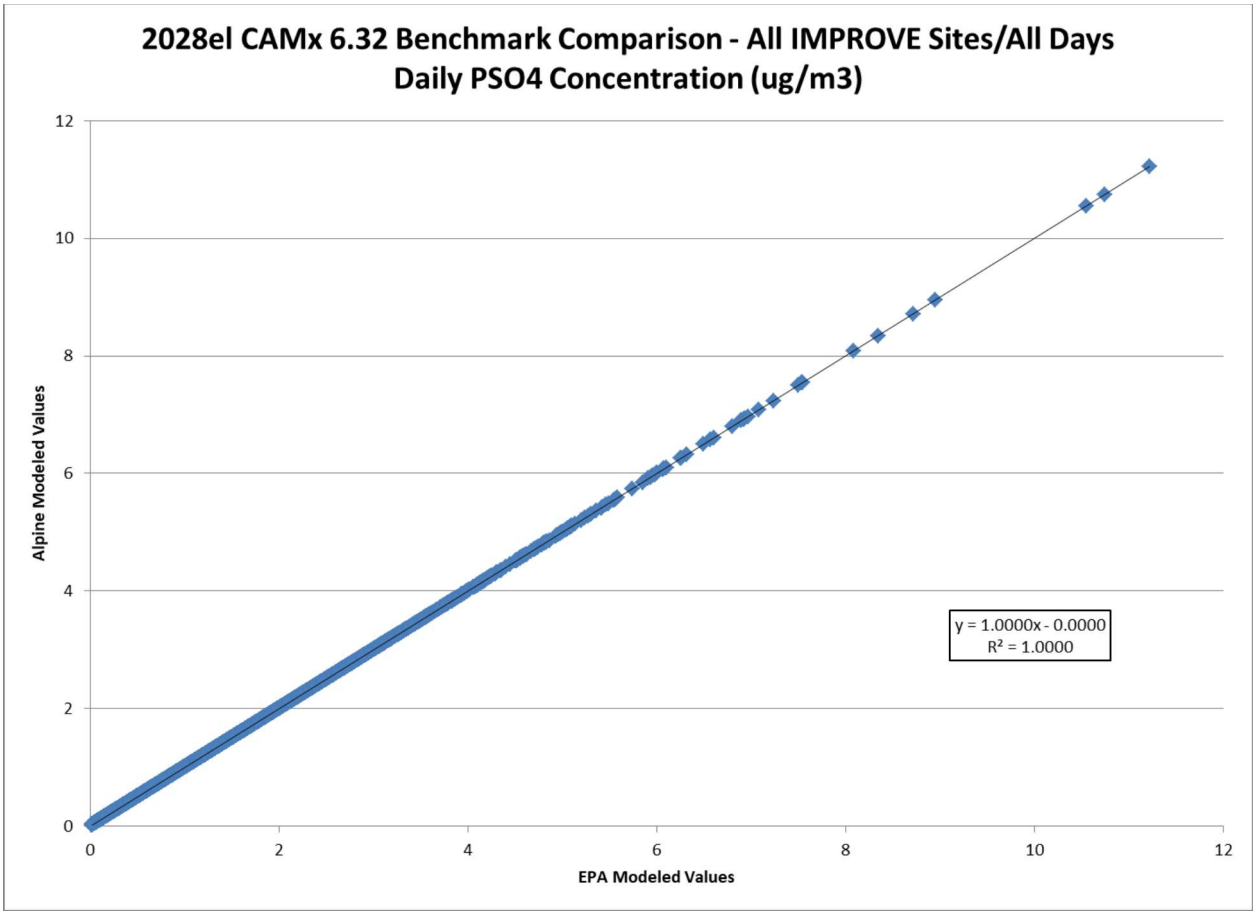

Figure 5-63: Scatterplot Comparing 24-hour Average Predicted Sulfate Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2028el Simulations Performed by EPA and VISTAS (Alpine).

5.4 Nitrate

Nitrate results for the top 10 positive and negative hours are presented in tabular format in Table 5-4. The maximum positive difference is 4.13µg/m^3 falling to 2.23 µg/m^3 for the 10th high. The maximum negative difference is -4.28 µg/m^3 falling to -1.92 µg/m^3 for the 10th high. The maximum positive percent difference from these days is 116% and negative percent difference of -52%, both on low Nitrate concentration days.

The top 10 positive impact hours are presented in Figures 5-64 through 5-73 and the top 10 negative impact hours are presented in Figures 5-74 through 5-83. As was discussed in Section 5.2 for the $PM_{2.5}$ concentrations, the differences are tending to occur in January along the northern border in Canada.

Scatterplots of the daily average nitrate concentrations in local standard time at the IMPROVE monitors are presented in Figure 5-84. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Examination of the animations shows that the majority of the differences are occurring in Canada and the Northern U.S. with the differences occurring in the areas of relatively high $PM_{2.5}$. We speculate that the differences are primarily from the difference in the Particulate Nitrate and most likely from different pathways being taken in the ISOROPIA algorithm.

Table 5-4. Comparison of 2028el CAMx 6.32 Simulation Nitrate Concentrations (µg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (µg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	1	27	7	7.66	3.54	4.13	116.71%	346	245
2011	1	3	4	25.36	21.37	3.99	18.69%	155	237
2011	1	27	9	8.03	4.38	3.65	83.38%	347	245
2011	1	3	12	26.92	23.41	3.51	14.98%	159	237
2011	1	27	12	6.62	3.55	3.08	86.81%	343	245
2011	1	27	11	6.85	4.05	2.80	69.19%	342	245
2011	1	14	6	14.01	11.55	2.46	21.30%	148	237
2011	1	14	4	24.18	21.80	2.37	10.89%	123	244
2011	1	14	9	15.75	13.39	2.36	17.64%	144	240
2011	1	14	2	23.79	21.56	2.23	10.35%	132	243
Maximum Negative									
2011	1	27	8	4.01	8.29	-4.28	-51.60%	348	245
2011	1	27	5	3.91	7.68	-3.77	-49.11%	345	245
2011	1	3	7	23.34	26.41	-3.07	-11.61%	155	235
2011	1	27	9	3.72	6.65	-2.92	-44.00%	348	244
2011	1	27	12	3.03	5.93	-2.89	-48.81%	342	244
2011	1	27	11	2.44	5.14	-2.70	-52.58%	343	244
2011	1	27	10	2.53	5.16	-2.63	-50.89%	343	245
2011	1	27	3	5.12	7.48	-2.35	-31.48%	343	245
2011	1	3	21	10.25	12.20	-1.95	-15.98%	164	231
2011	1	14	3	17.01	18.94	-1.92	-10.15%	137	242

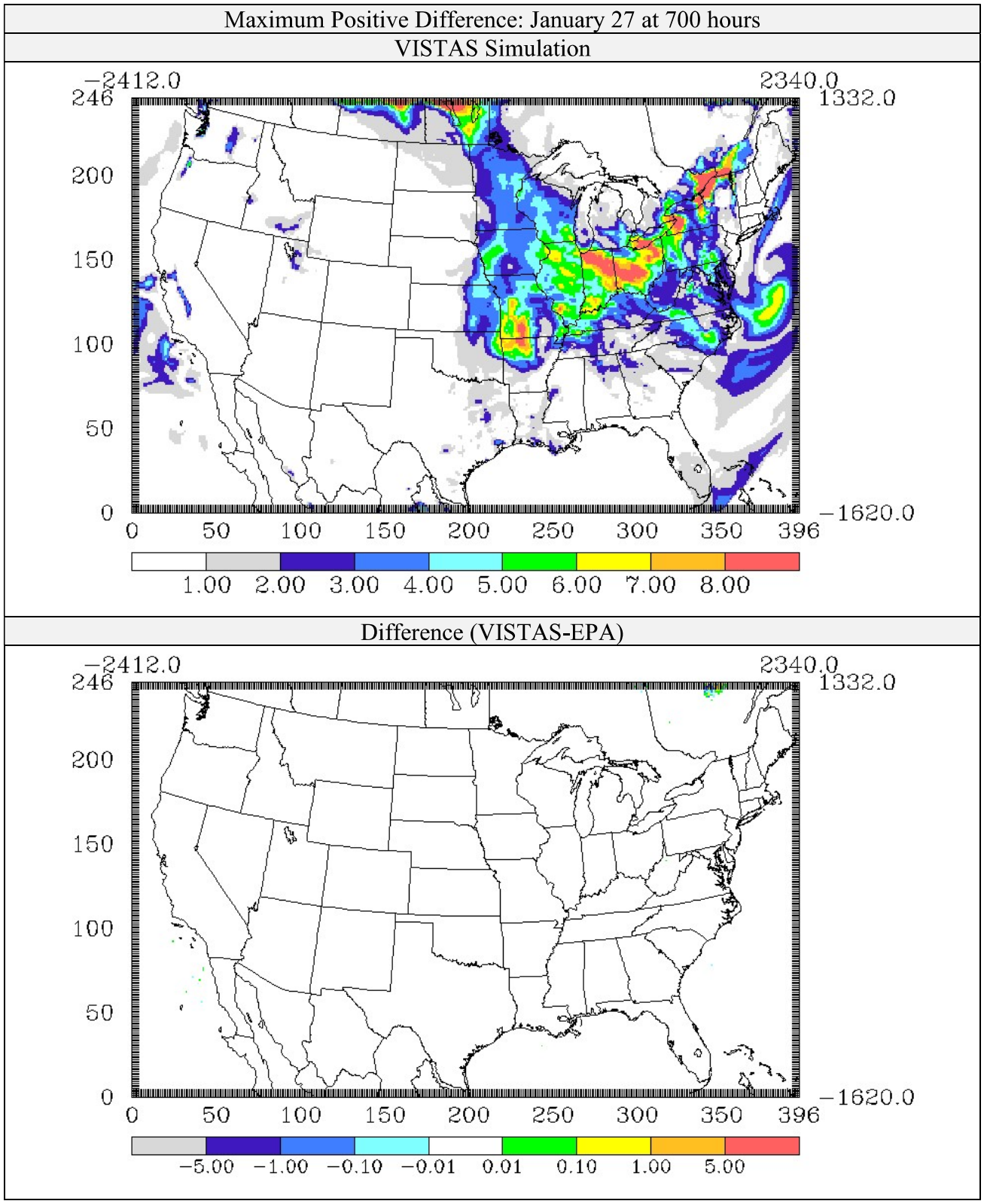

Figure 5-64: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)

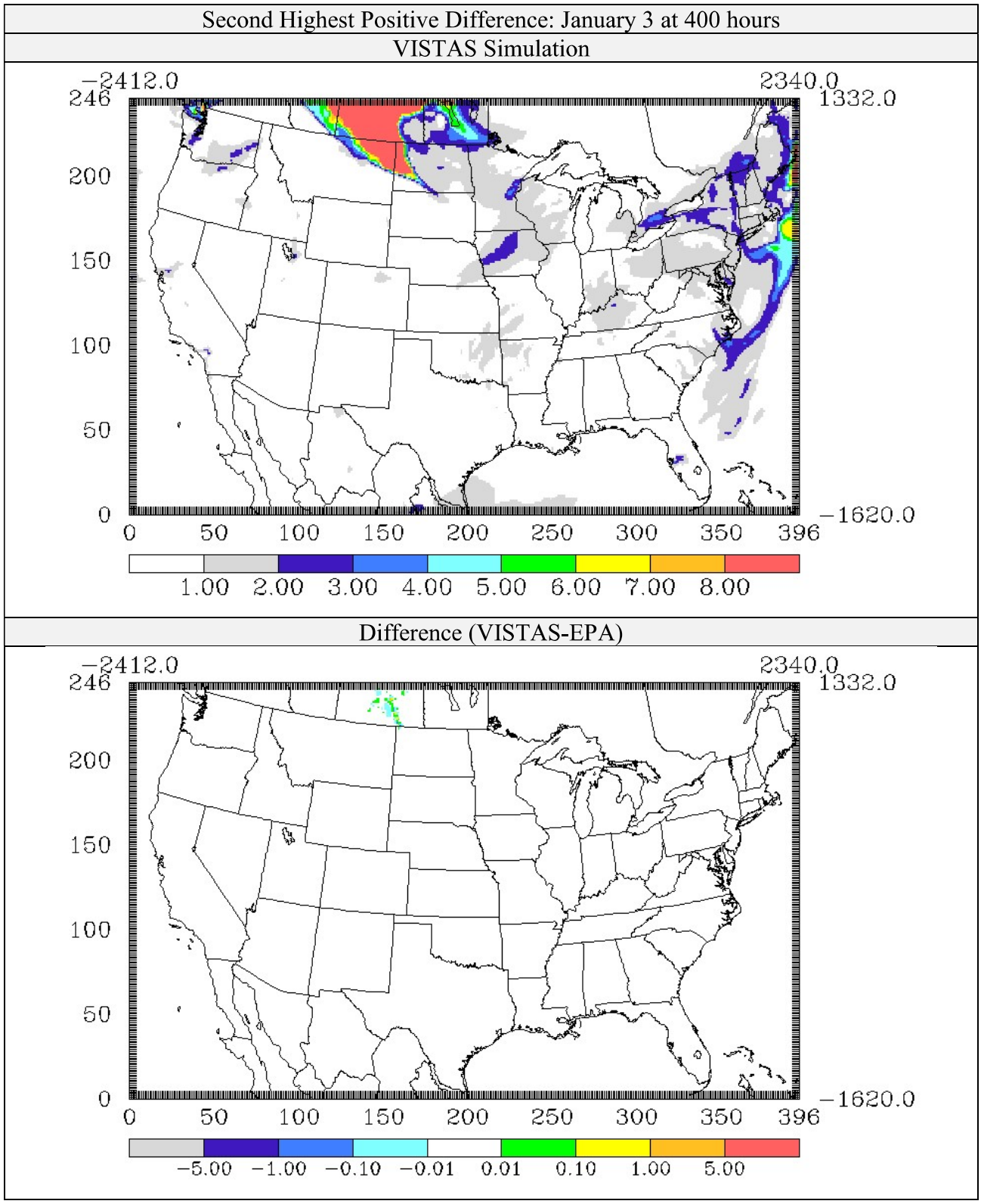

Figure 5-65: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)

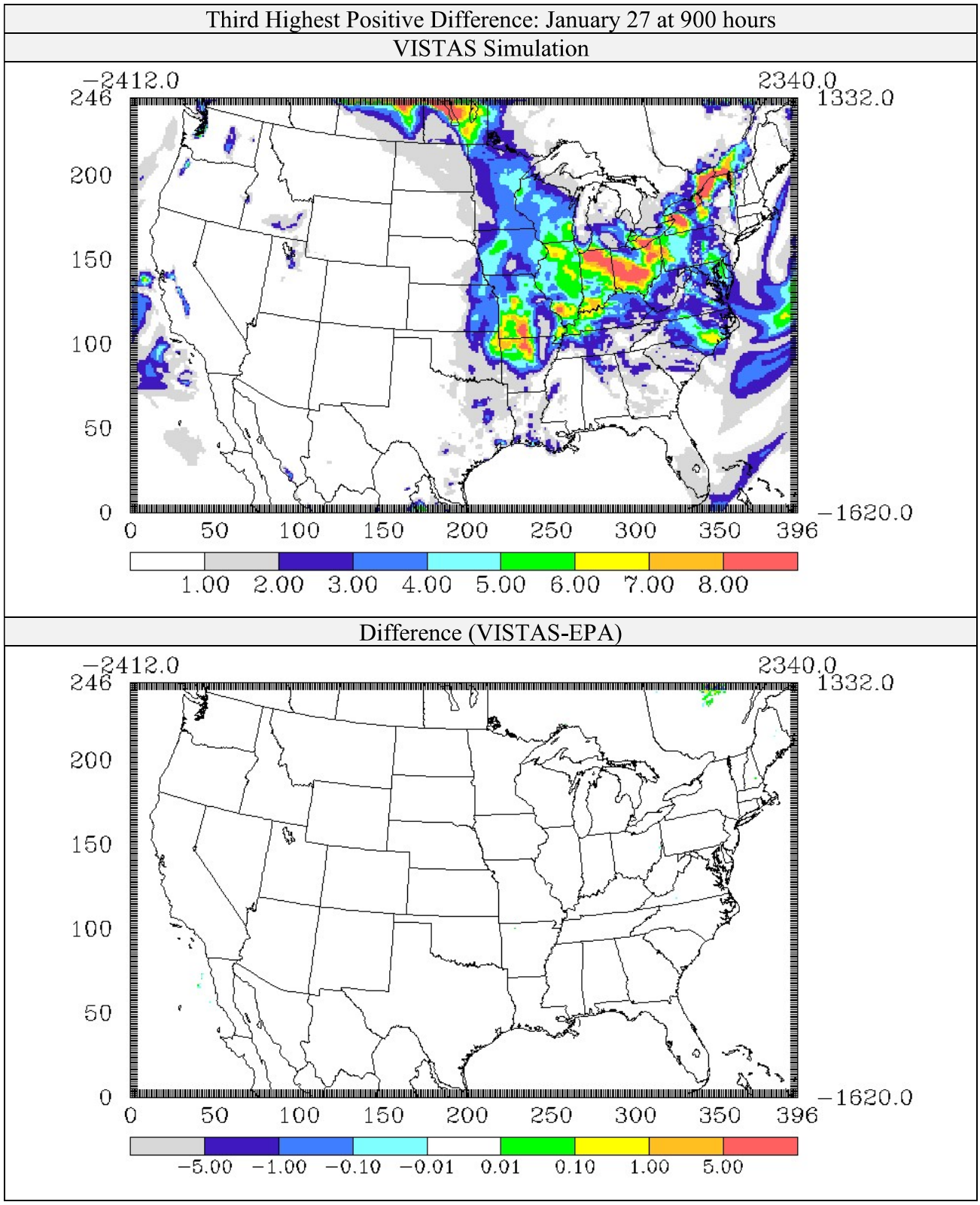

Figure 5-66: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)

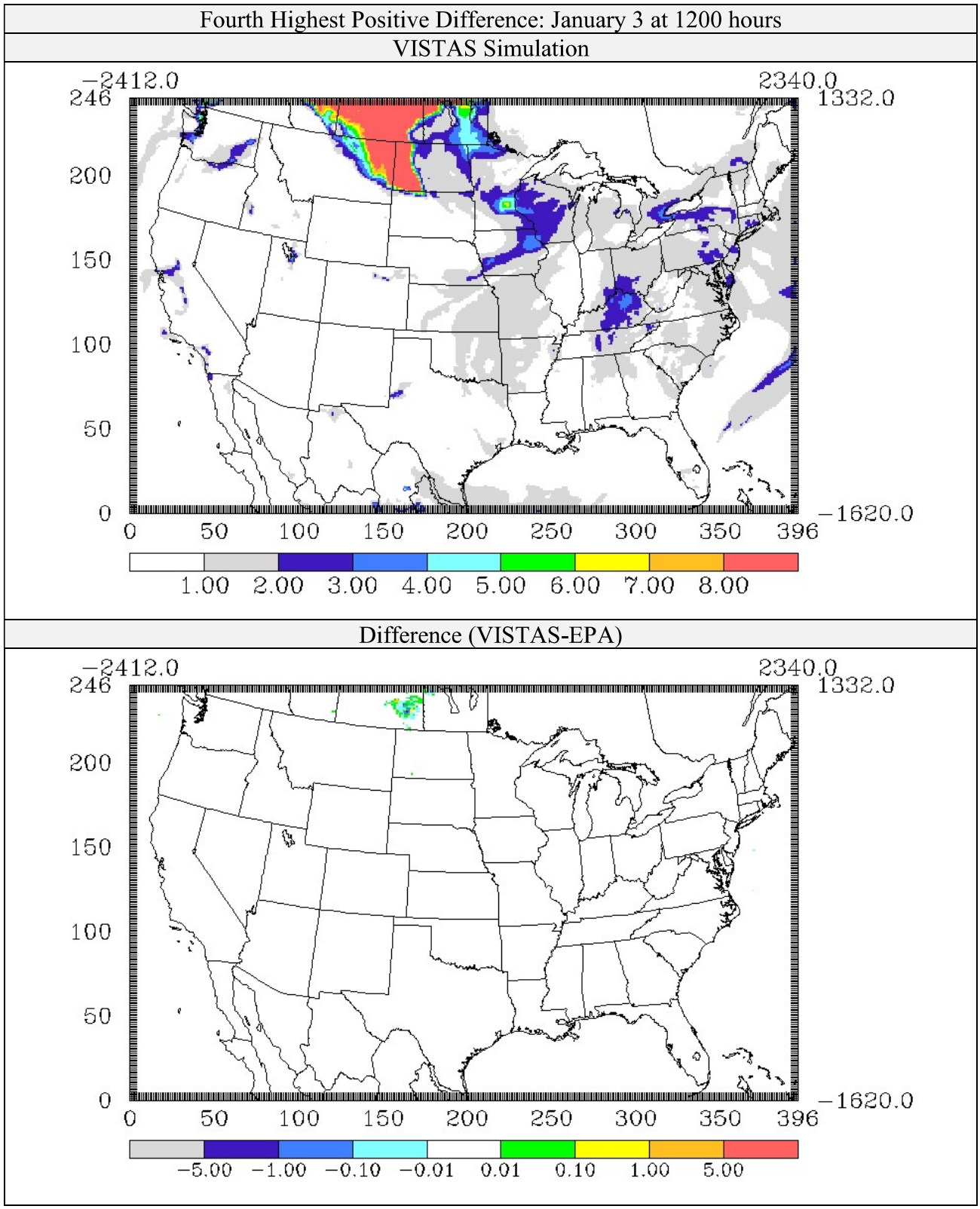

Figure 5-67: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

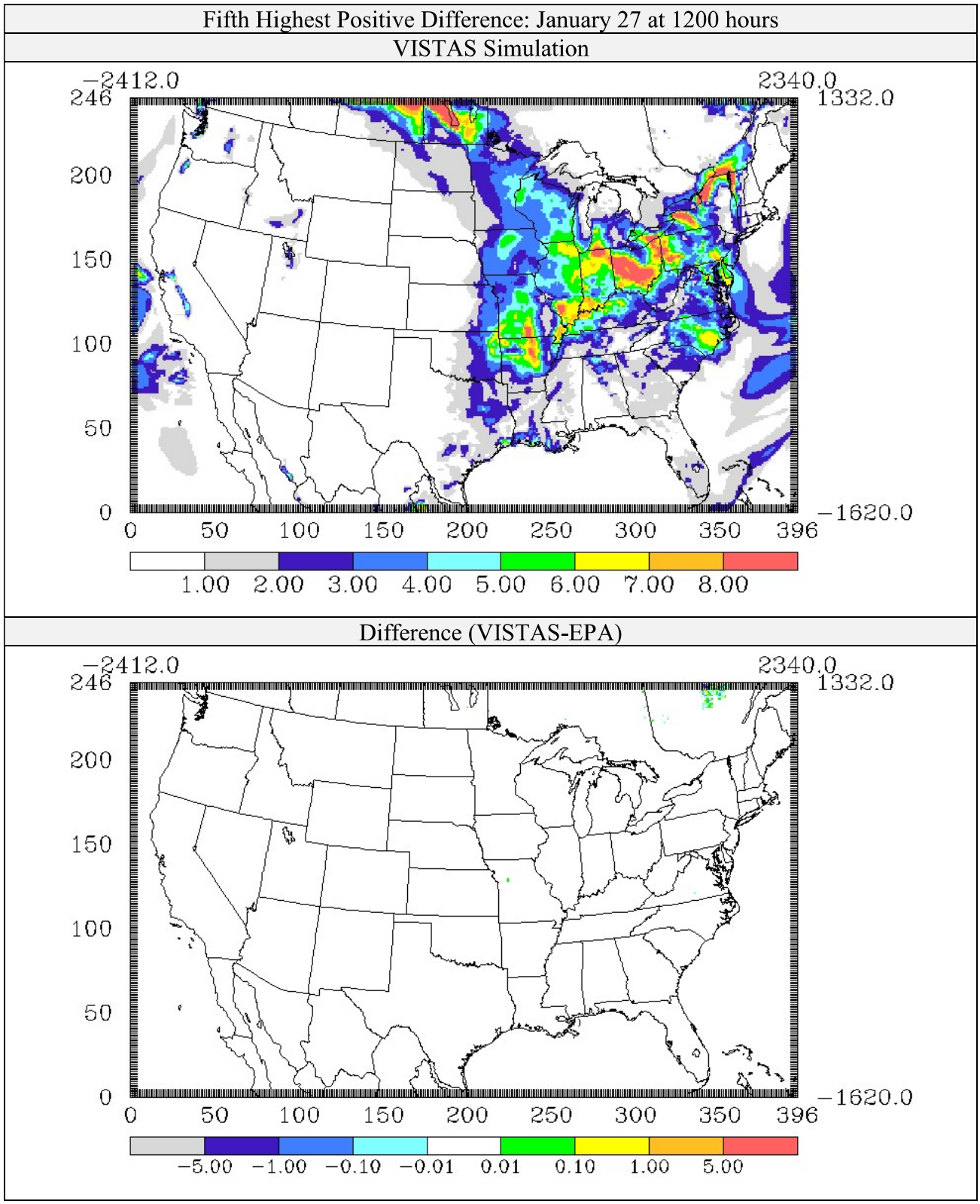

Figure 5-68: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)

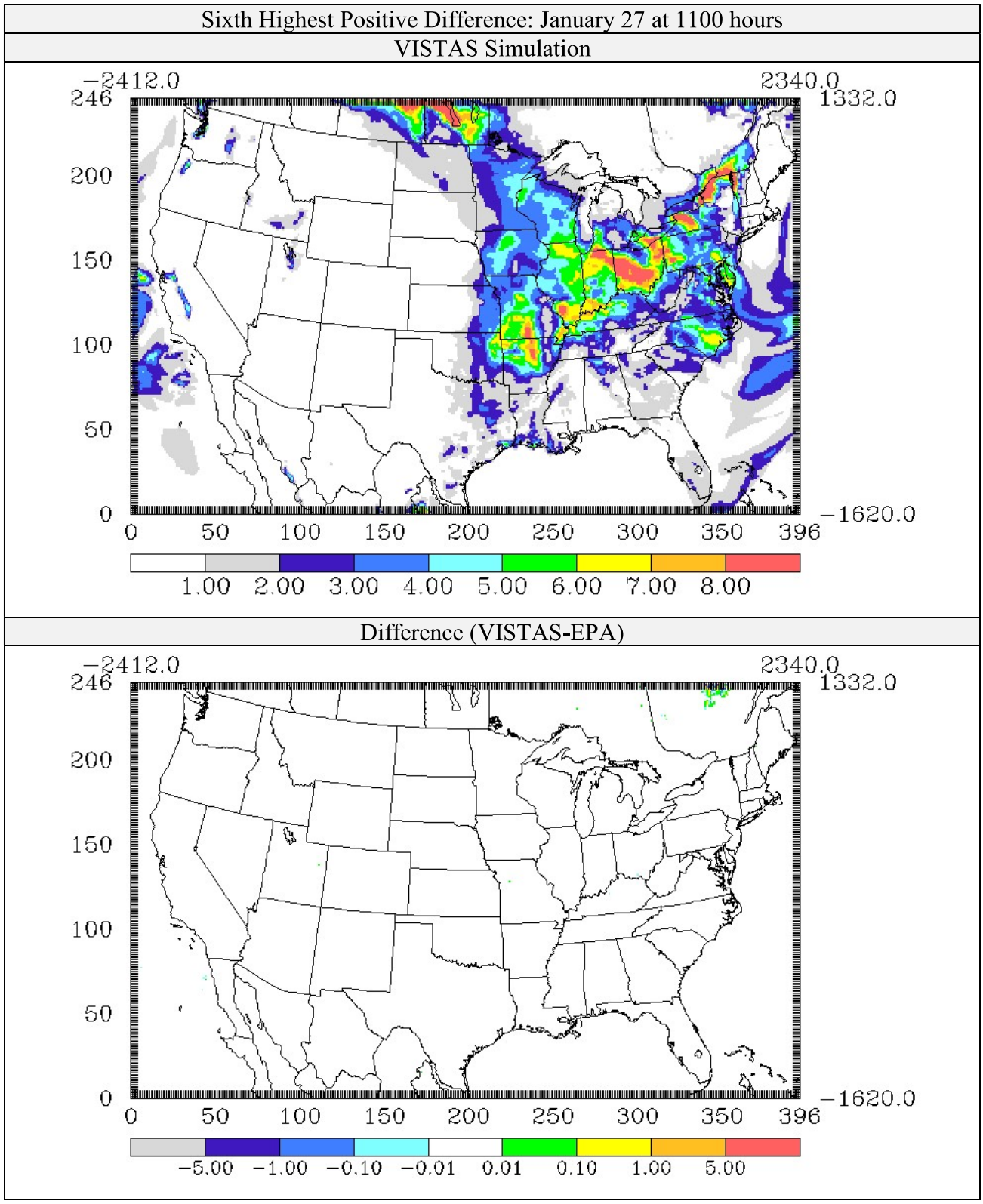

Figure 5-69: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)

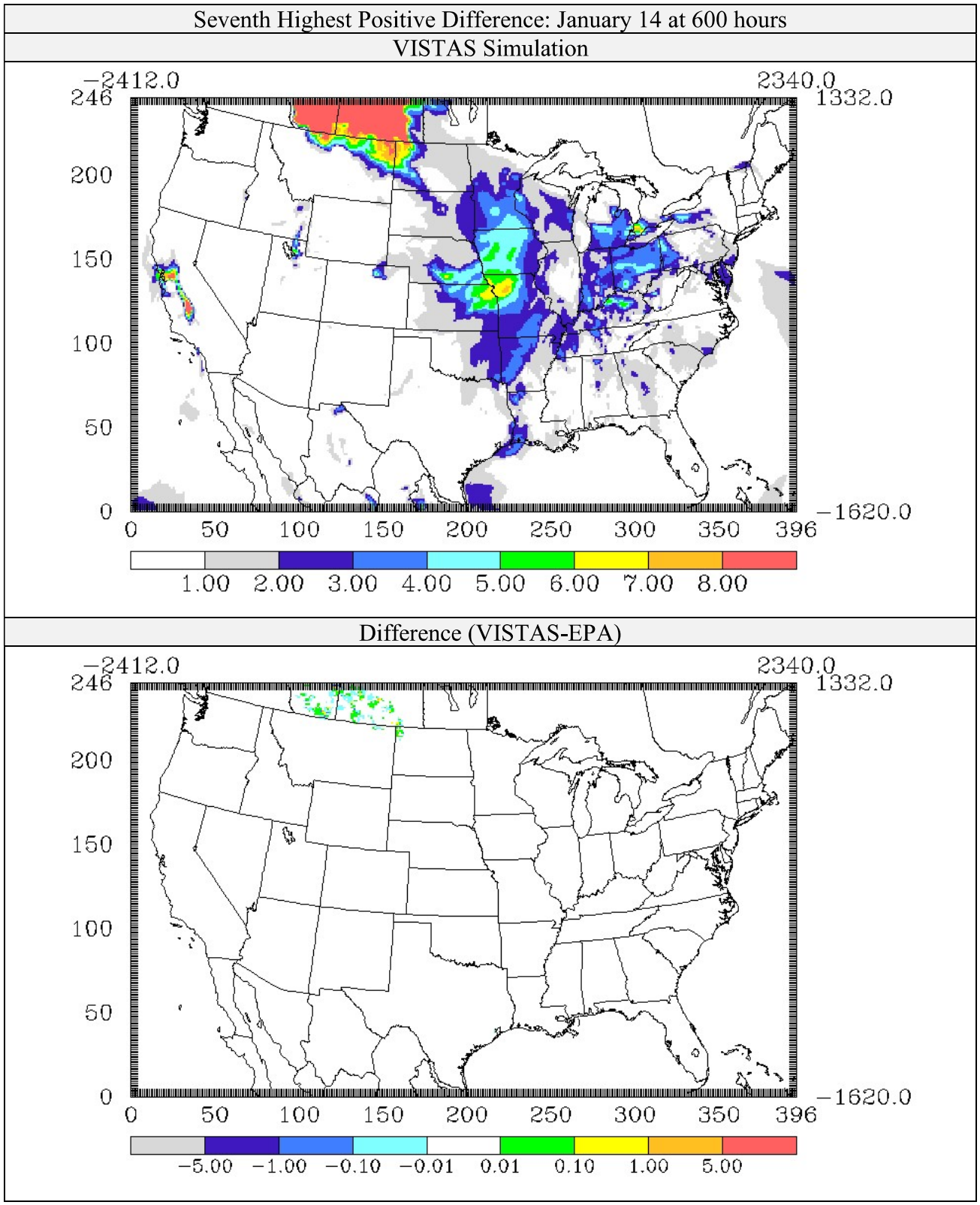

Figure 5-70: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)

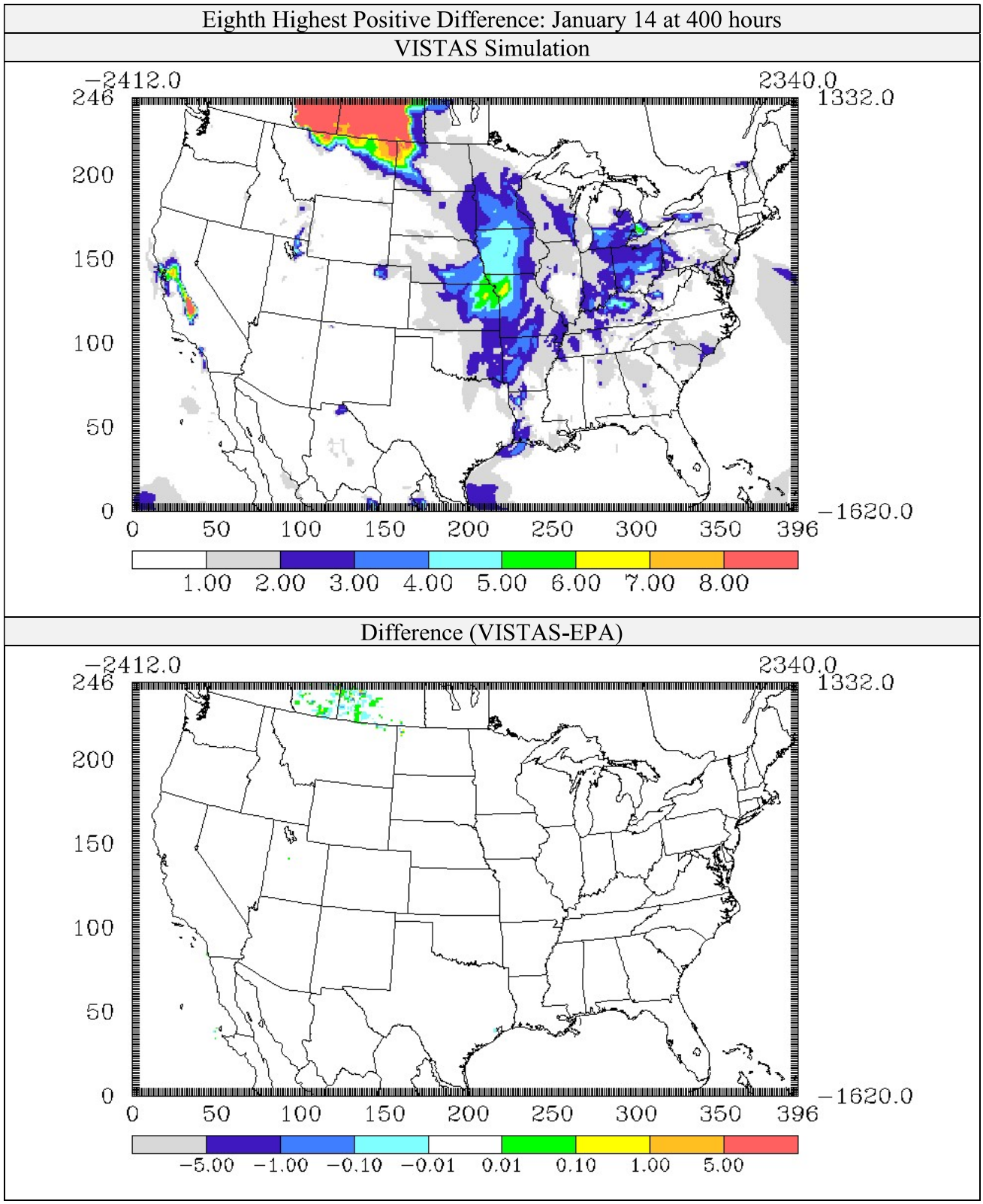

Figure 5-71: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)

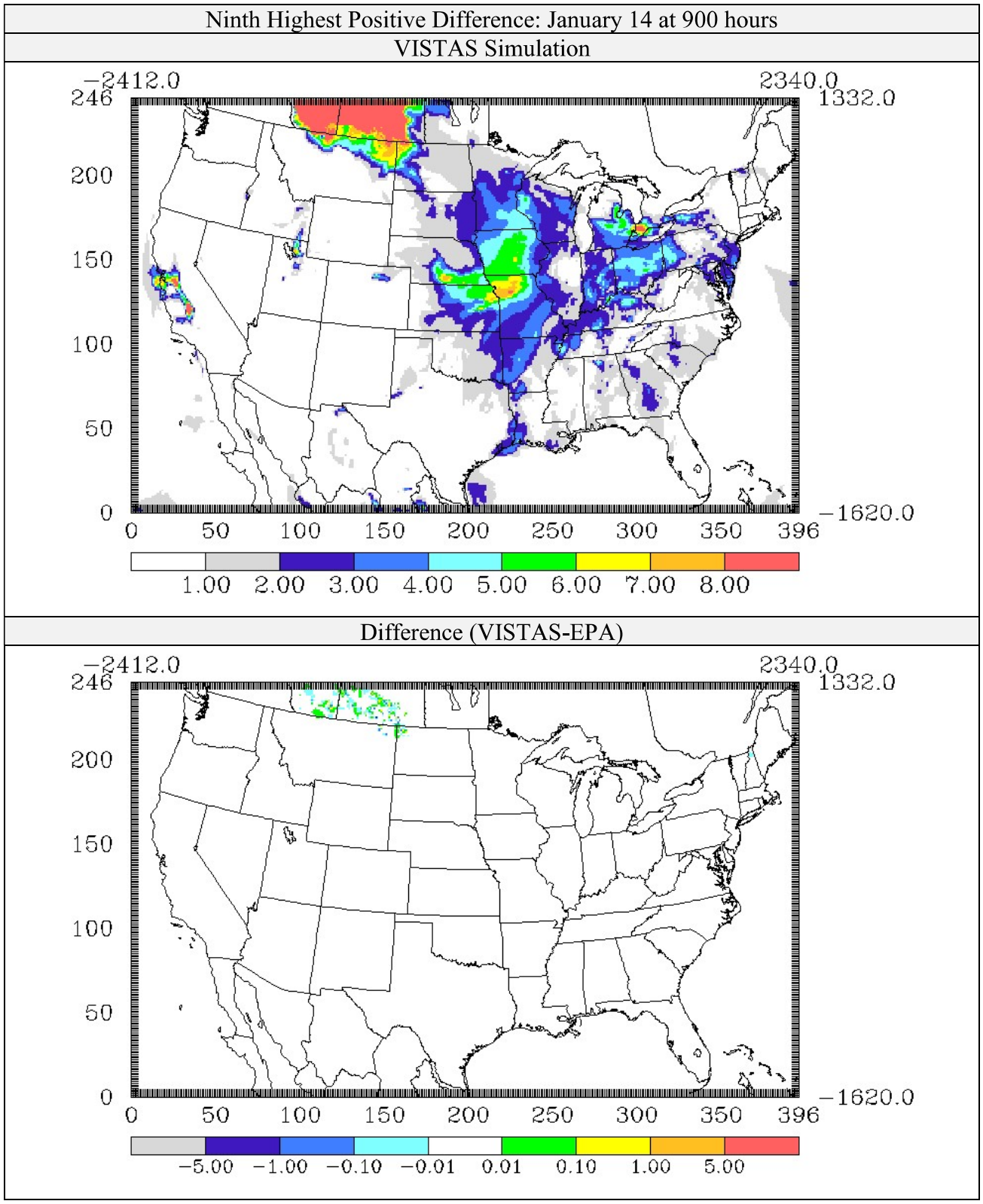

Figure 5-72: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)

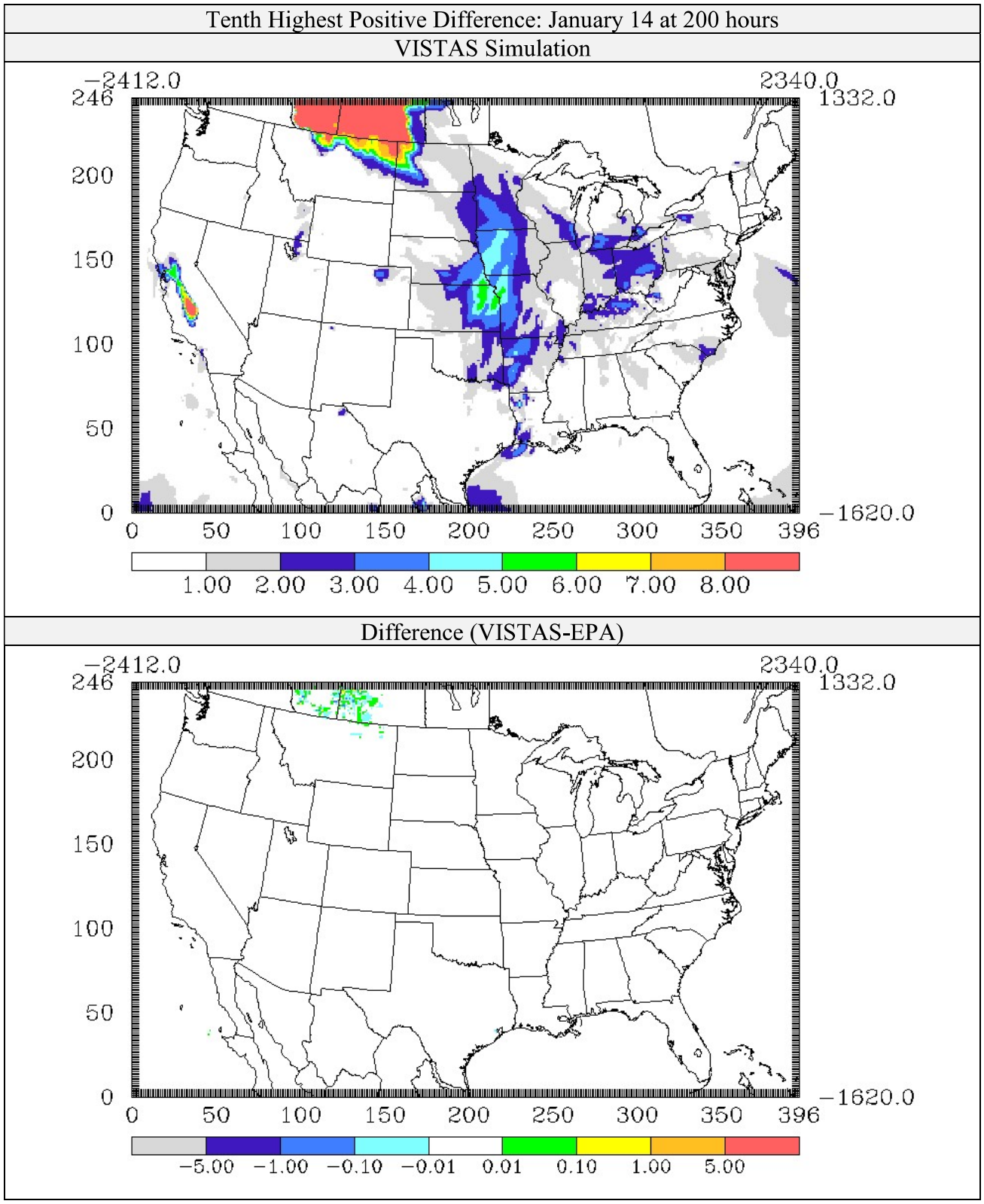

Figure 5-73: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)

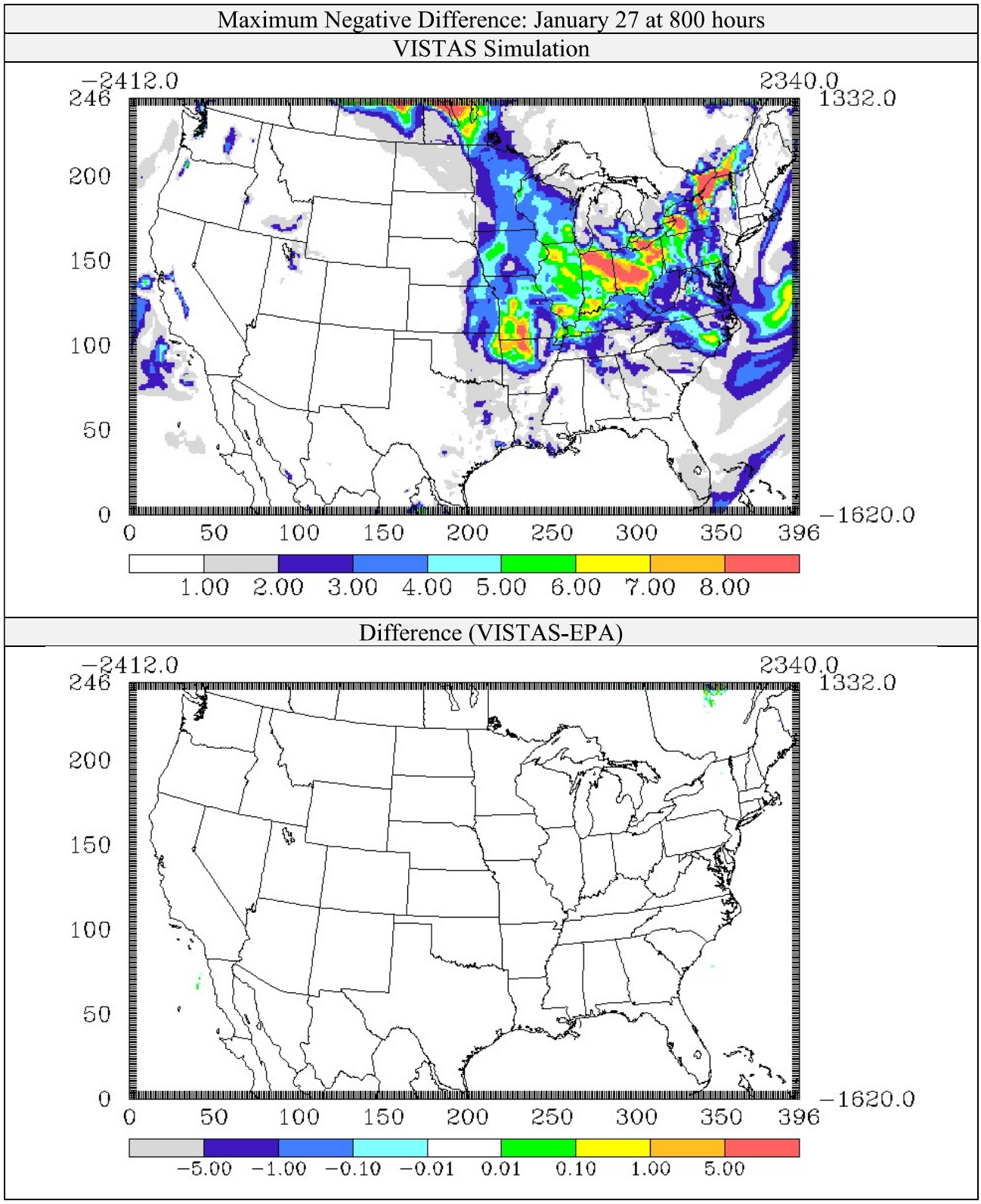

Figure 5-74: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)

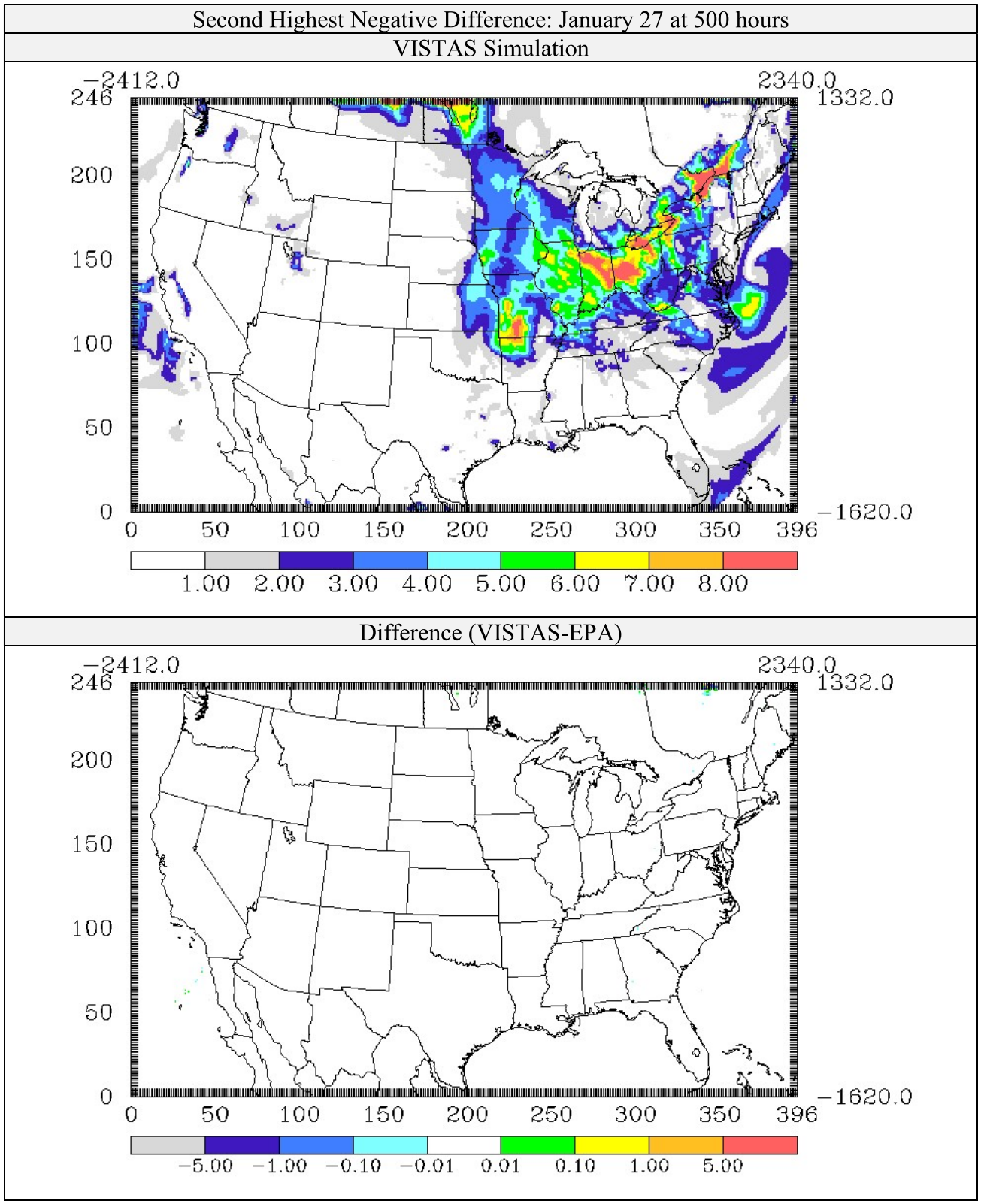

Figure 5-75: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)

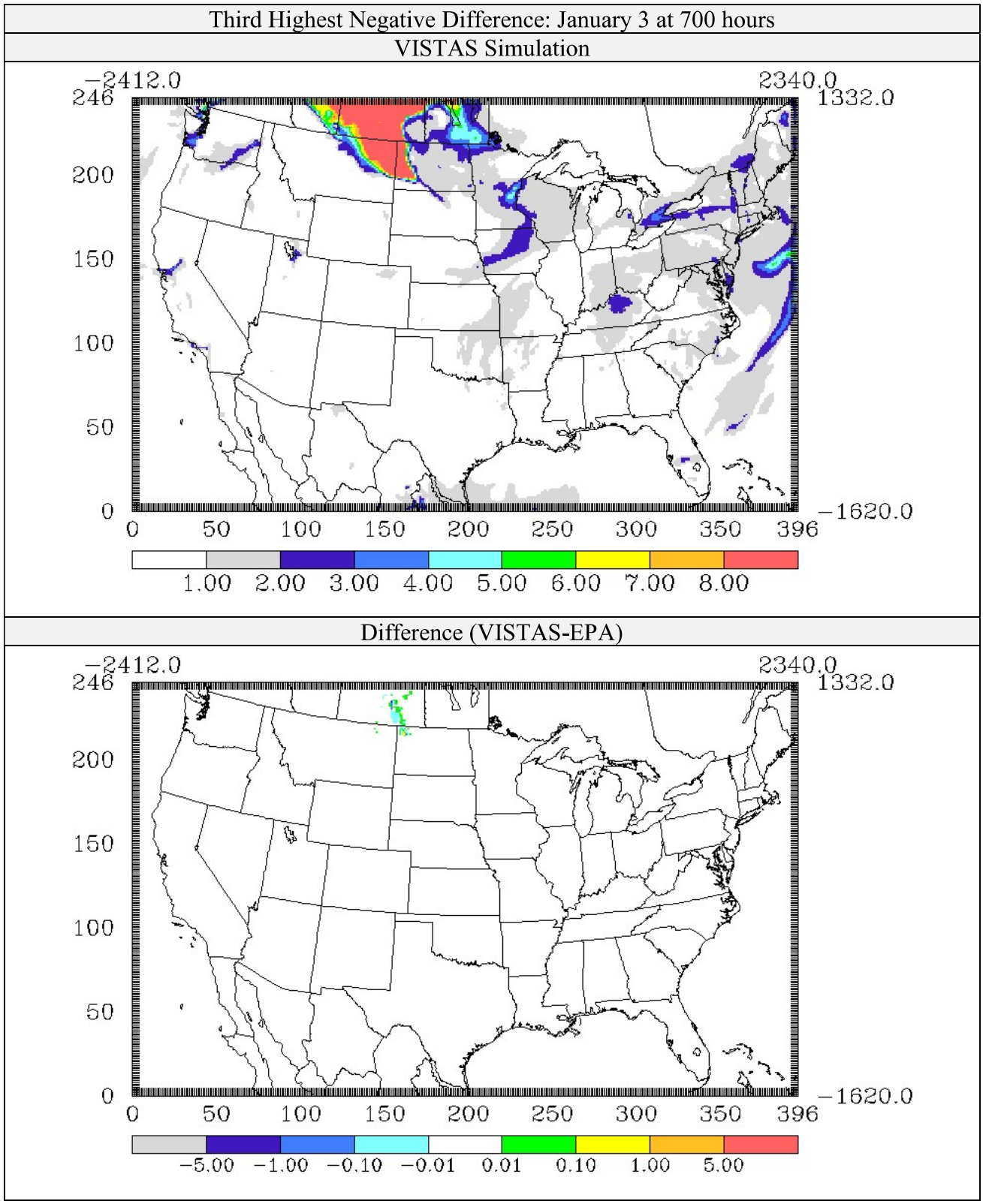

Figure 5-76: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)

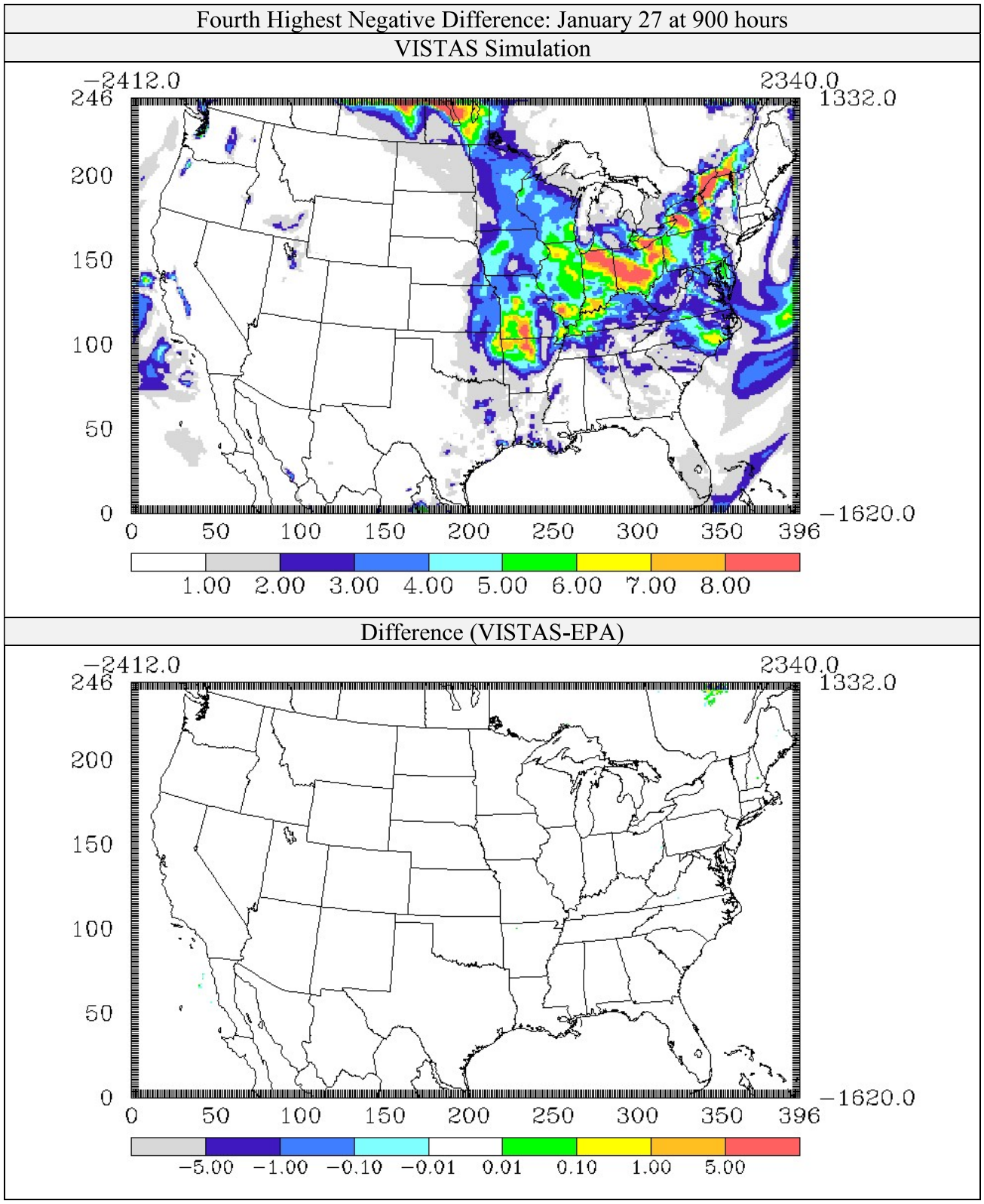

Figure 5-77: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)

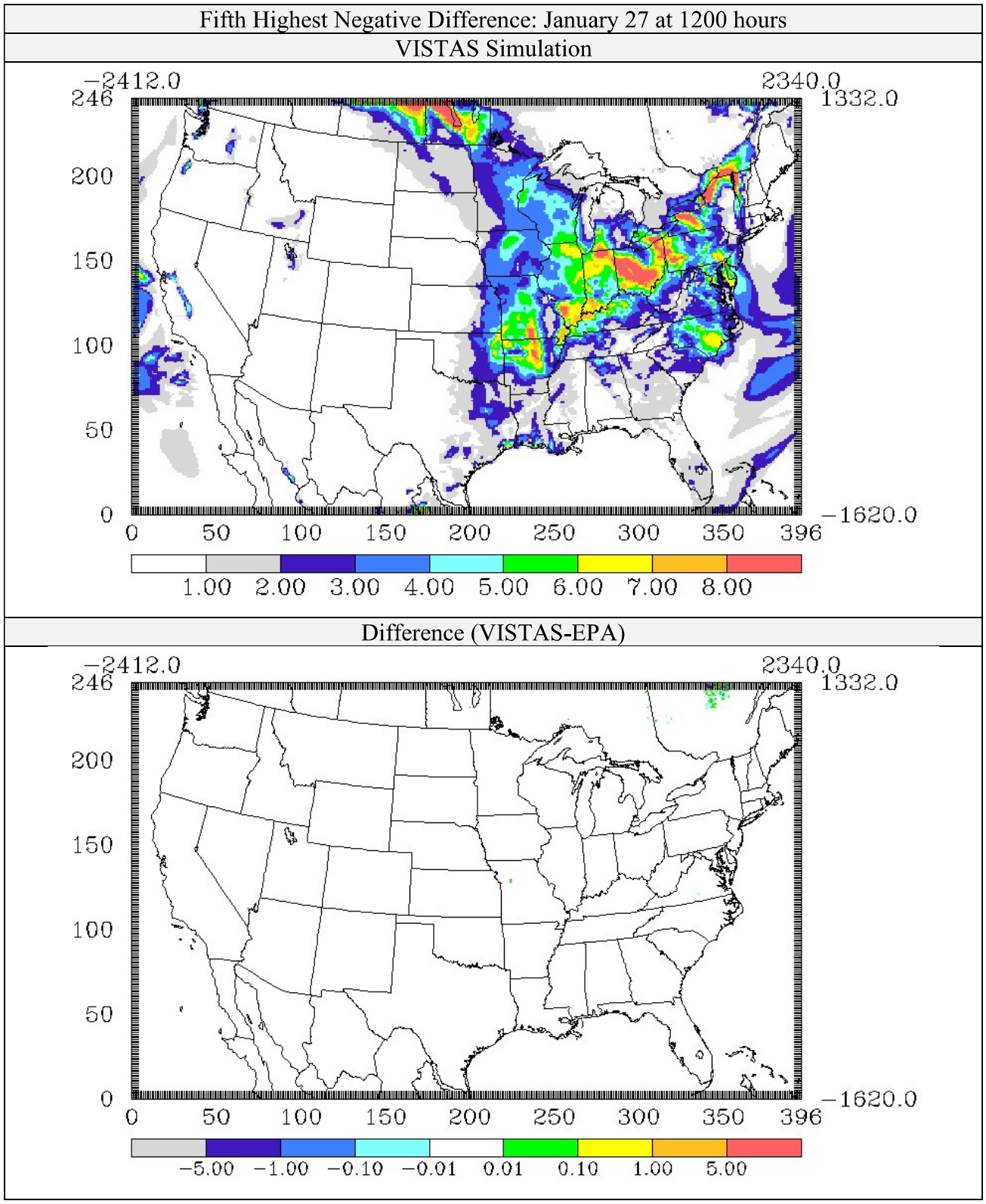

Figure 5-78: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)

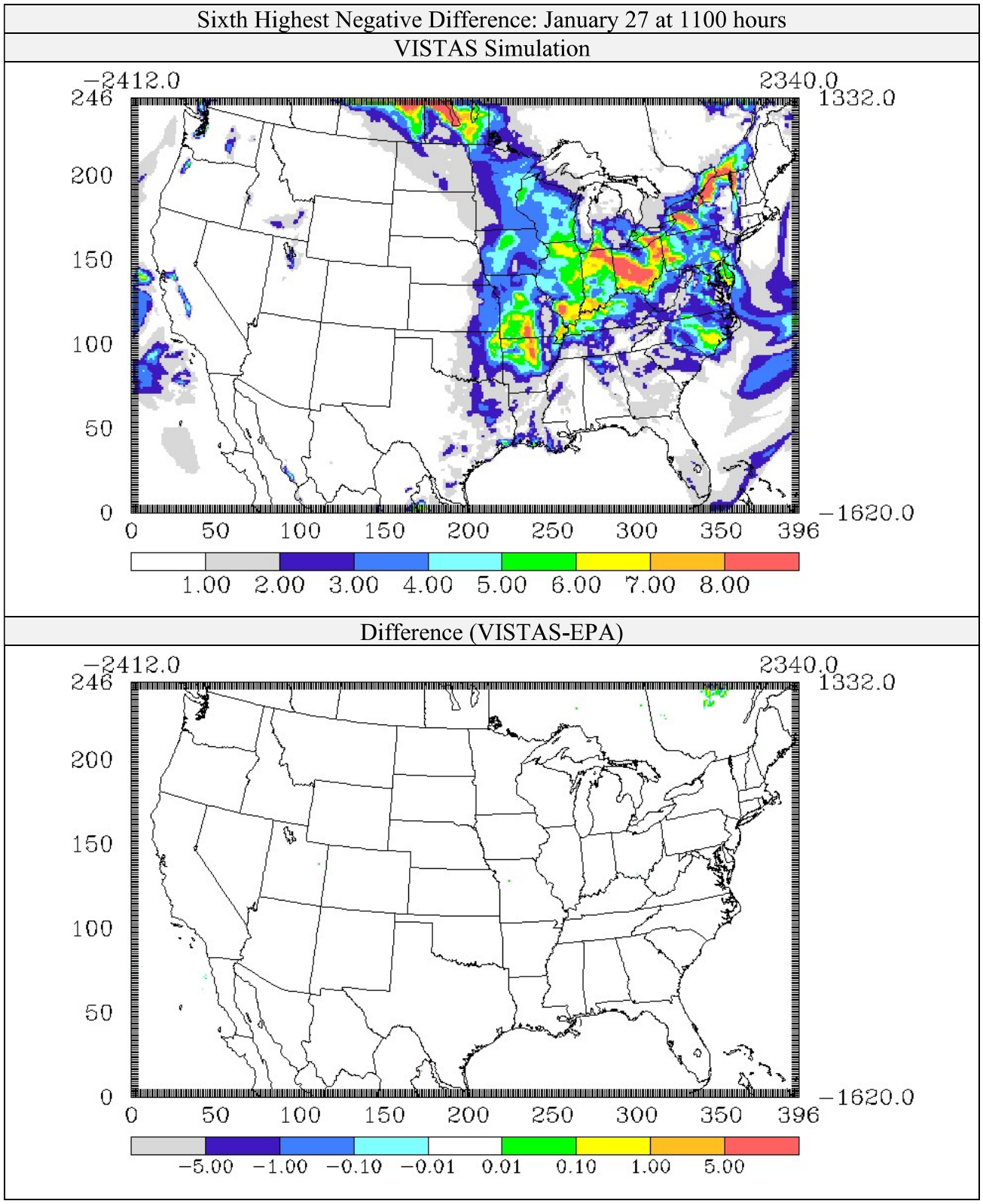

Figure 5-79: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)

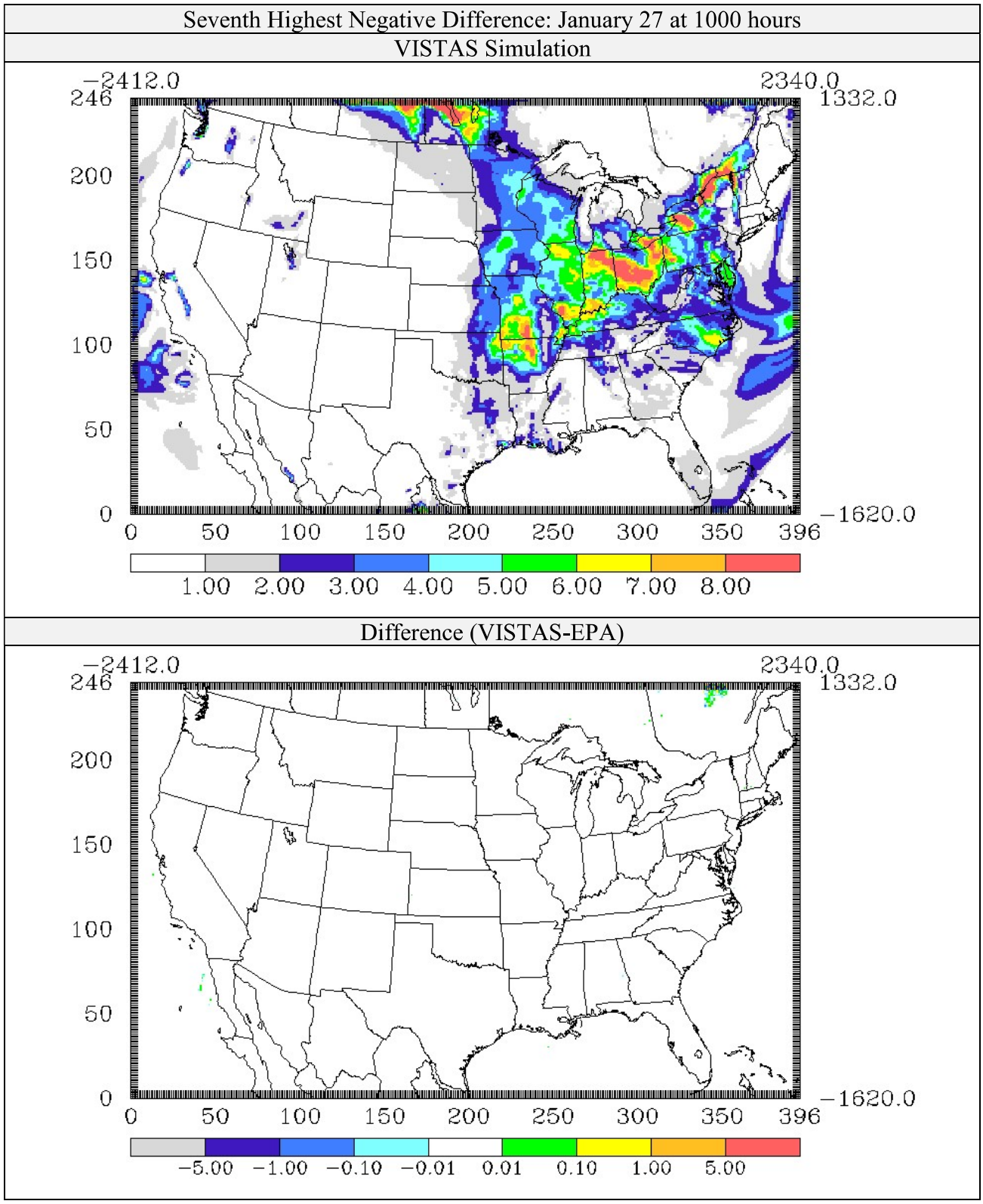

Figure 5-80: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)

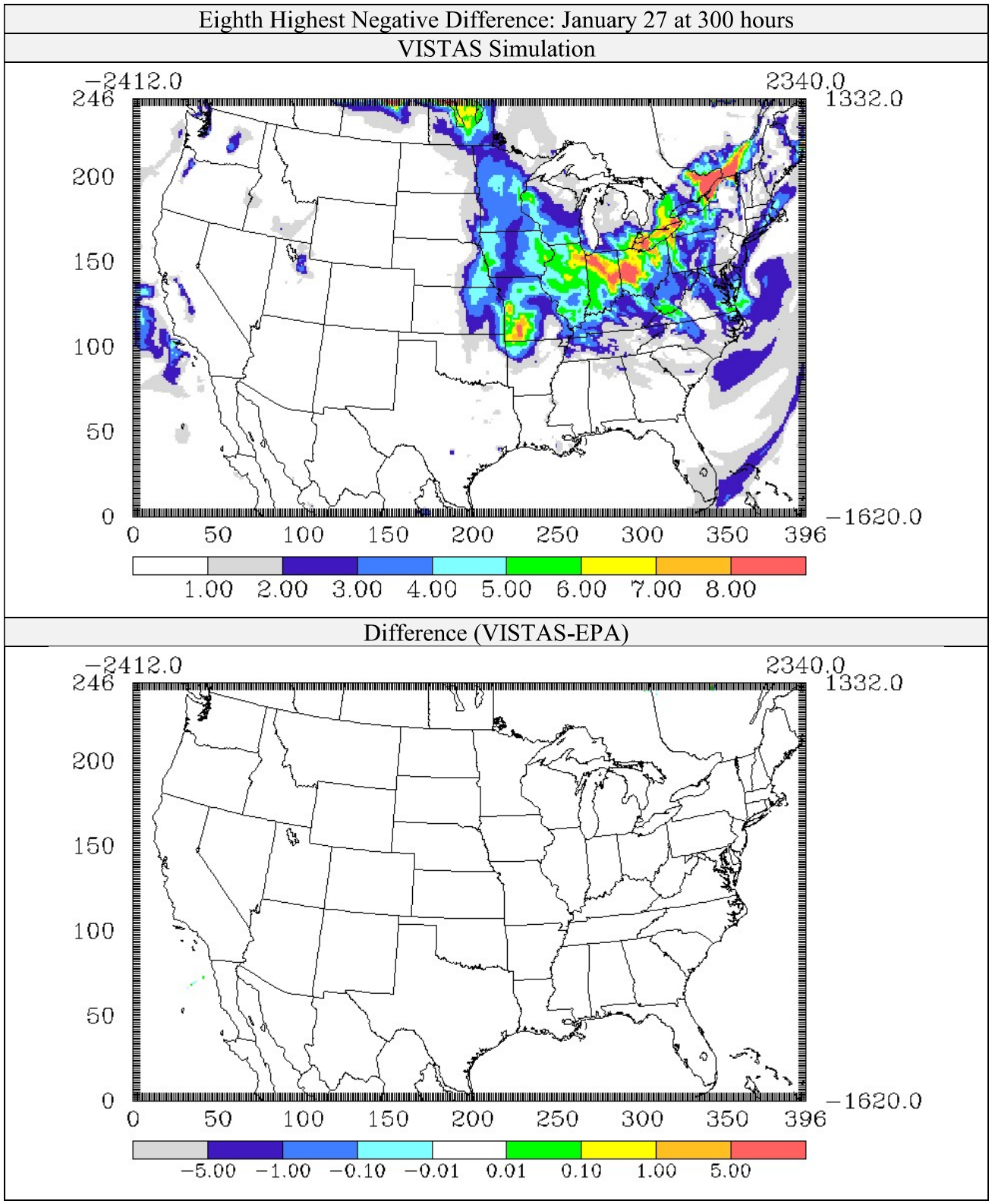

Figure 5-81: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)

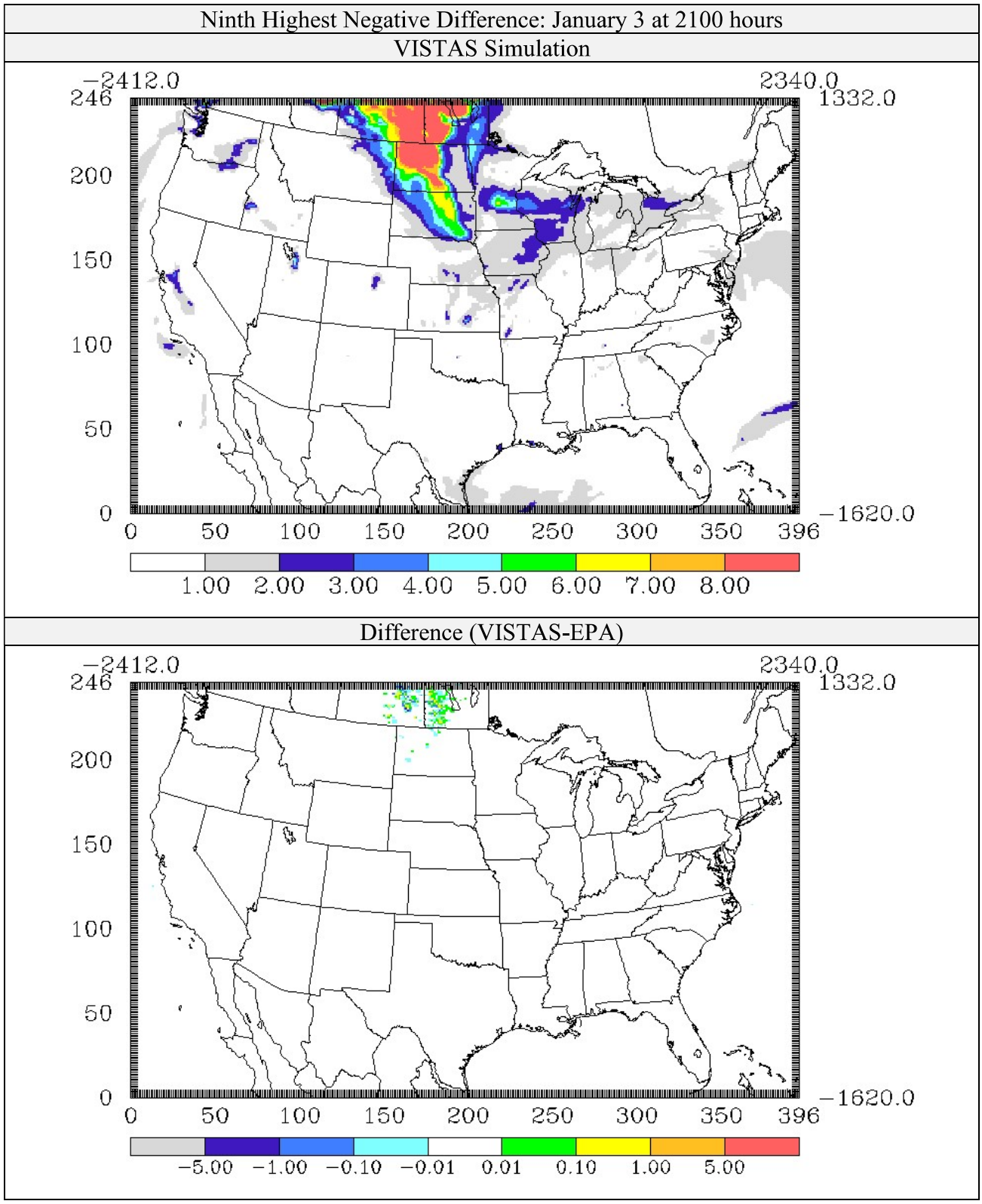

Figure 5-82: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)

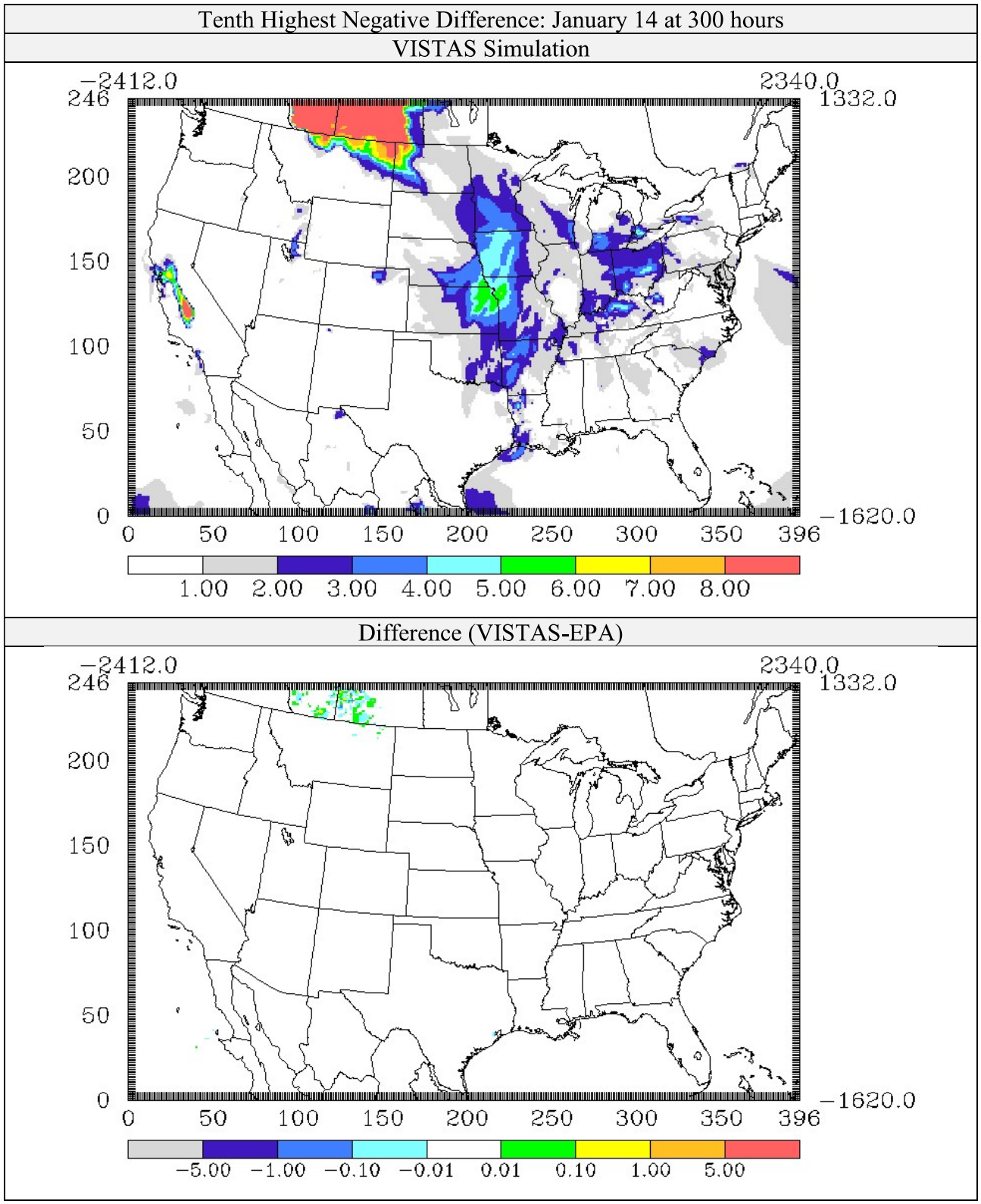

Figure 5-83: Comparison of Nitrate Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Negative Difference)

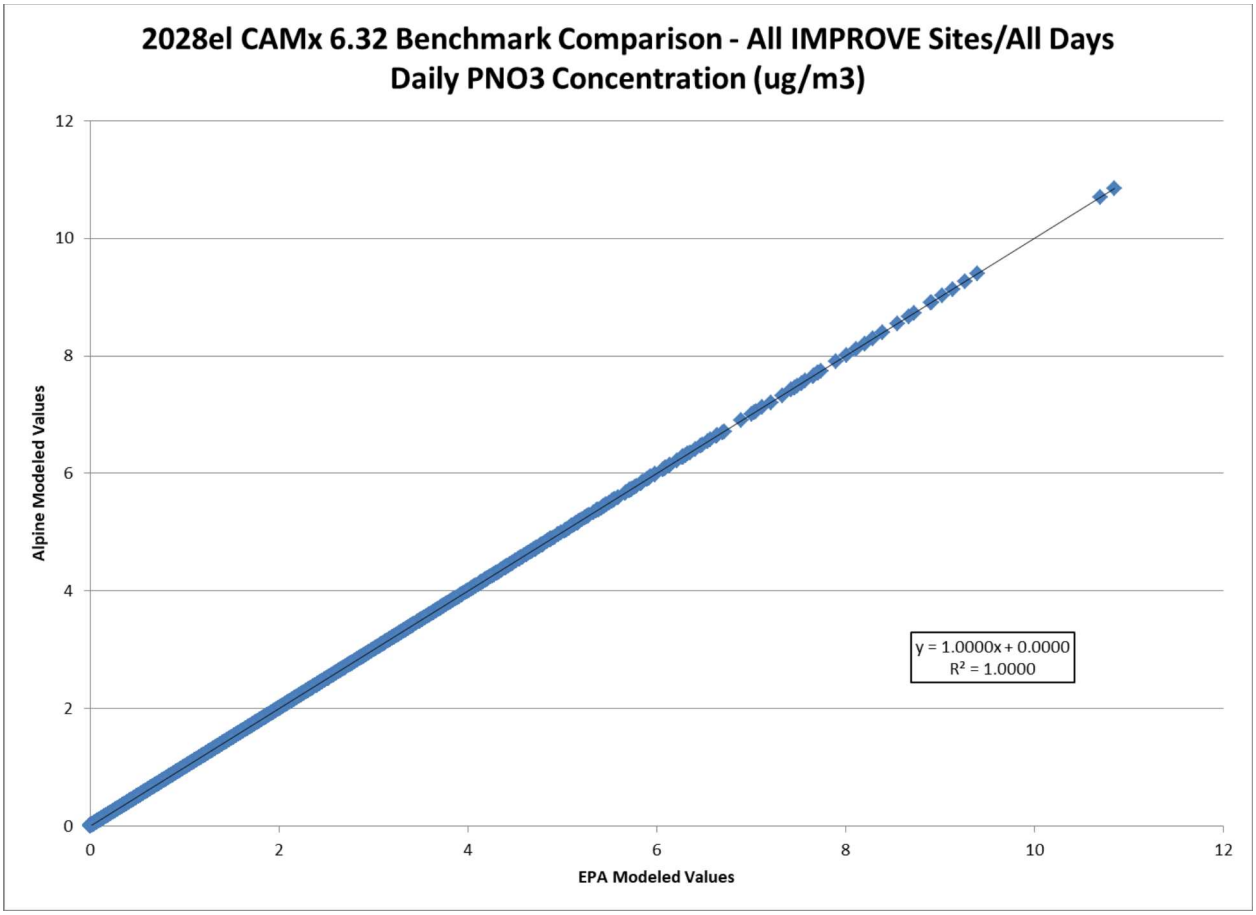

Figure 5-84: Scatterplot Comparing 24-hour Average Predicted Nitrate Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2028el Simulations Performed by EPA and VISTAS (Alpine).

5.5 Organic Carbon (OC)

Organic Carbon (OC) results for the top 10 positive and negative hours are presented in tabular format in Table 5-5. The maximum positive difference is 0.17 $\mu g/m^3$ falling to 0.09 $\mu g/m^3$ for the 10th high. The maximum negative difference is -0.30 $\mu g/m^3$ falling to -0.08 $\mu g/m^3$ for the 10th high. The maximum positive percent difference from these days is 2.11% and negative percent difference of -2.86%.

The top 10 positive impact hours are presented in Figures 5-85 through 5-94 and the top 10 negative impact hours are presented in Figures 5-95 through 5-104. The locations of the impacts are extremely localized.

Scatterplots of the daily average nitrate concentrations in local standard time at the IMPROVE monitors are presented in Figure 5-105. The EPA results are plotted on the x-axis and the VISTAS (Alpine) results are plotted on the y-axis. The data has a perfect degree of correlation with a line of best fit with a slope of 1.0000, an intercept of 0.0000 ppb and an R^2 of 1.0000.

Table 5-5. Comparison of 2028el CAMx 6.32 Simulation Organic Carbon Concentrations (μg/m^3) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

Year	Month	Day	Hour	VISTAS Conc.	EPA Conc.	Difference (μg/m^3)	Percent Difference	Column	Row
Maximum Positive									
2011	6	26	12	16.16	15.99	0.17	1.06%	288	74
2011	5	20	12	11.03	10.90	0.14	1.25%	286	84
2011	8	26	12	10.24	10.11	0.13	1.25%	295	57
2011	5	20	13	10.66	10.54	0.12	1.17%	286	84
2011	12	15	17	25.87	25.76	0.12	0.45%	143	115
2011	7	14	22	4.99	4.89	0.10	2.11%	292	77
2011	8	23	22	7.08	6.98	0.09	1.33%	323	47
2011	6	26	13	11.74	11.65	0.09	0.76%	288	74
2011	7	26	12	9.66	9.57	0.09	0.91%	236	95
2011	8	26	13	7.39	7.30	0.09	1.19%	295	57
Maximum Negative									
2011	12	20	9	10.16	10.46	-0.30	-2.86%	313	89
2011	12	20	8	10.43	10.69	-0.25	-2.37%	313	89
2011	5	21	0	7.46	7.56	-0.11	-1.41%	331	95
2011	12	20	10	10.41	10.51	-0.11	-1.00%	313	89
2011	2	14	22	16.01	16.11	-0.10	-0.65%	271	69
2011	2	14	23	18.33	18.43	-0.10	-0.56%	271	69
2011	8	4	14	13.16	13.26	-0.10	-0.74%	213	89
2011	7	19	12	7.01	7.10	-0.09	-1.28%	253	100
2011	7	15	13	5.01	5.09	-0.08	-1.63%	314	98
2011	10	2	15	8.09	8.17	-0.08	-1.00%	136	181

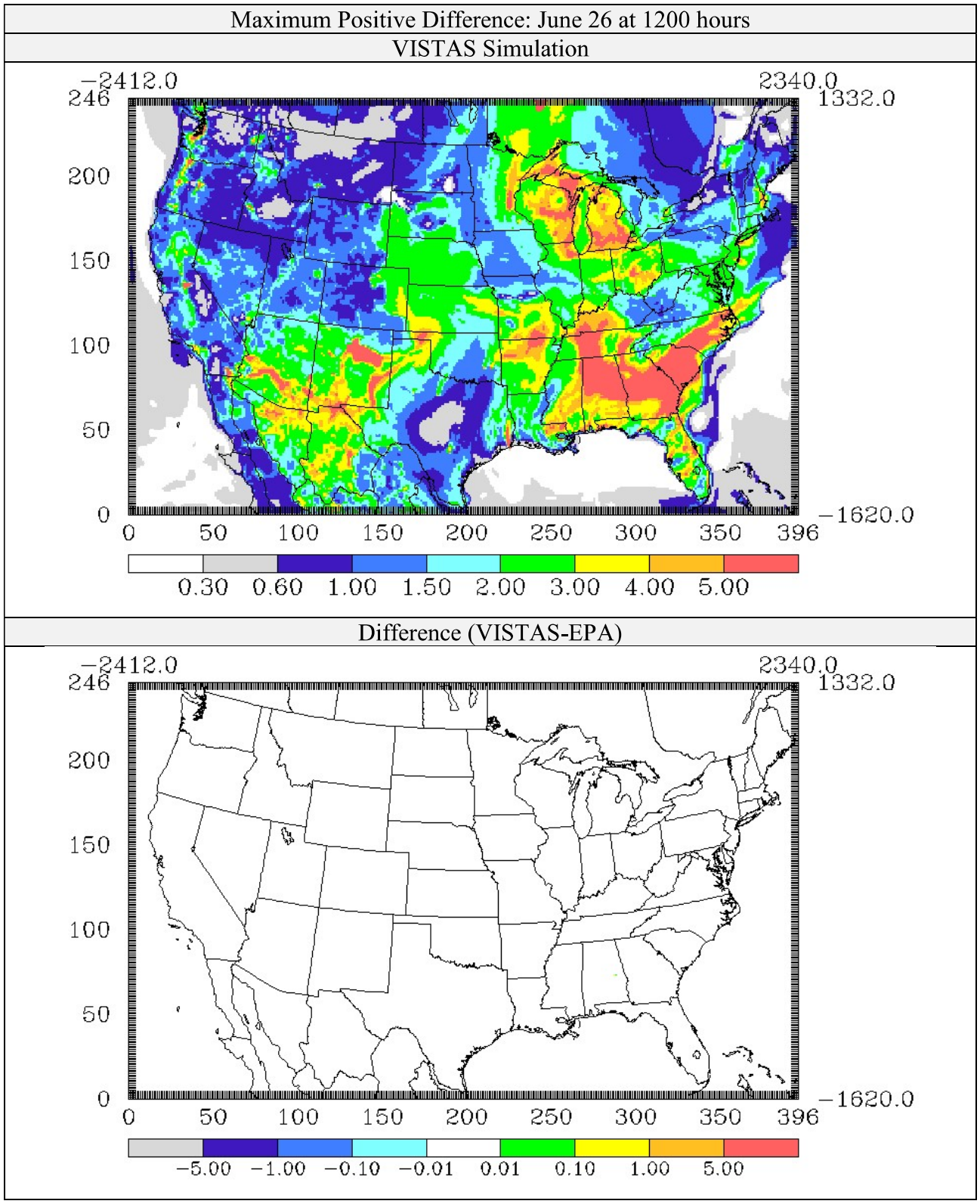

Figure 5-85: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)

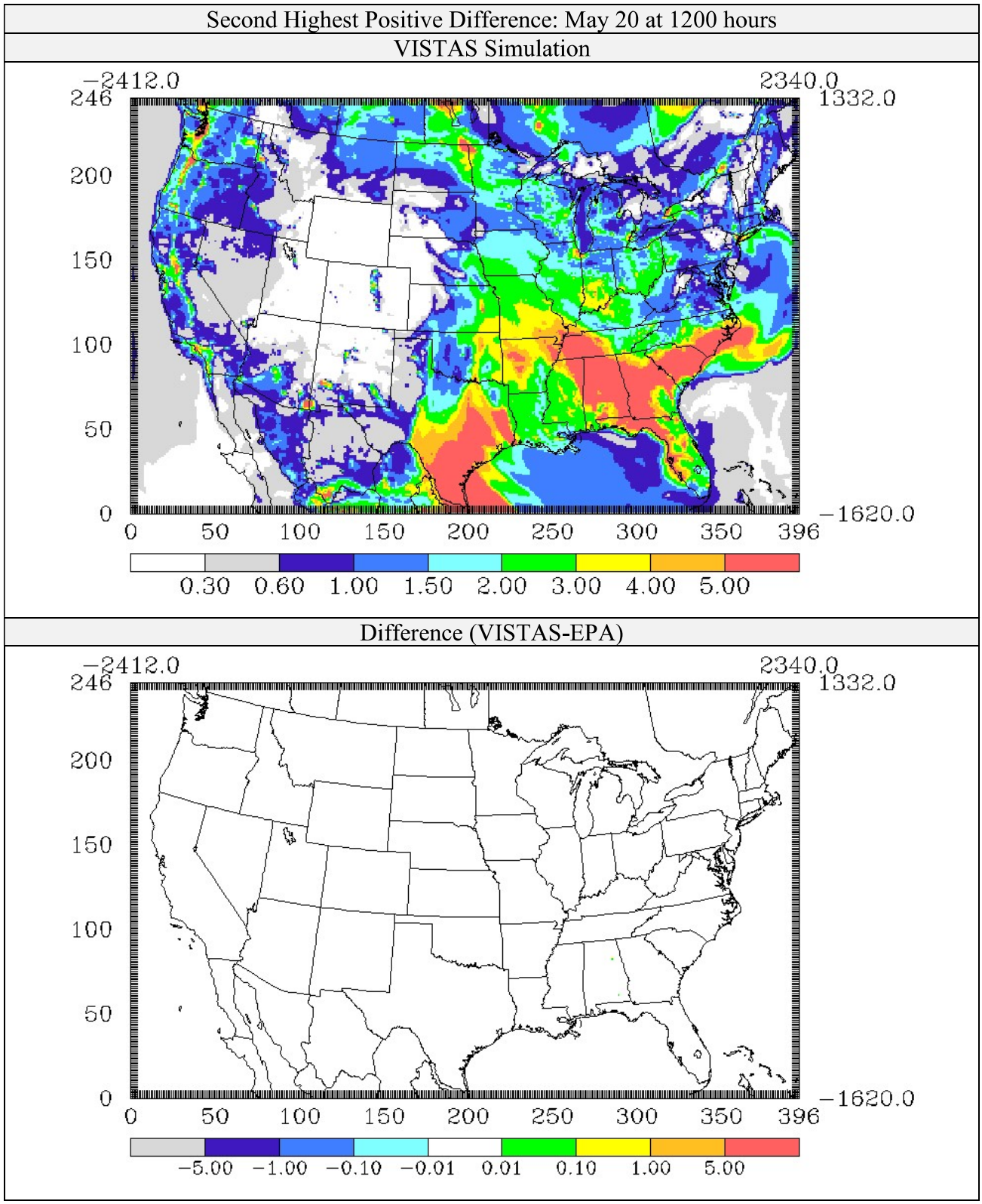

Figure 5-86: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)

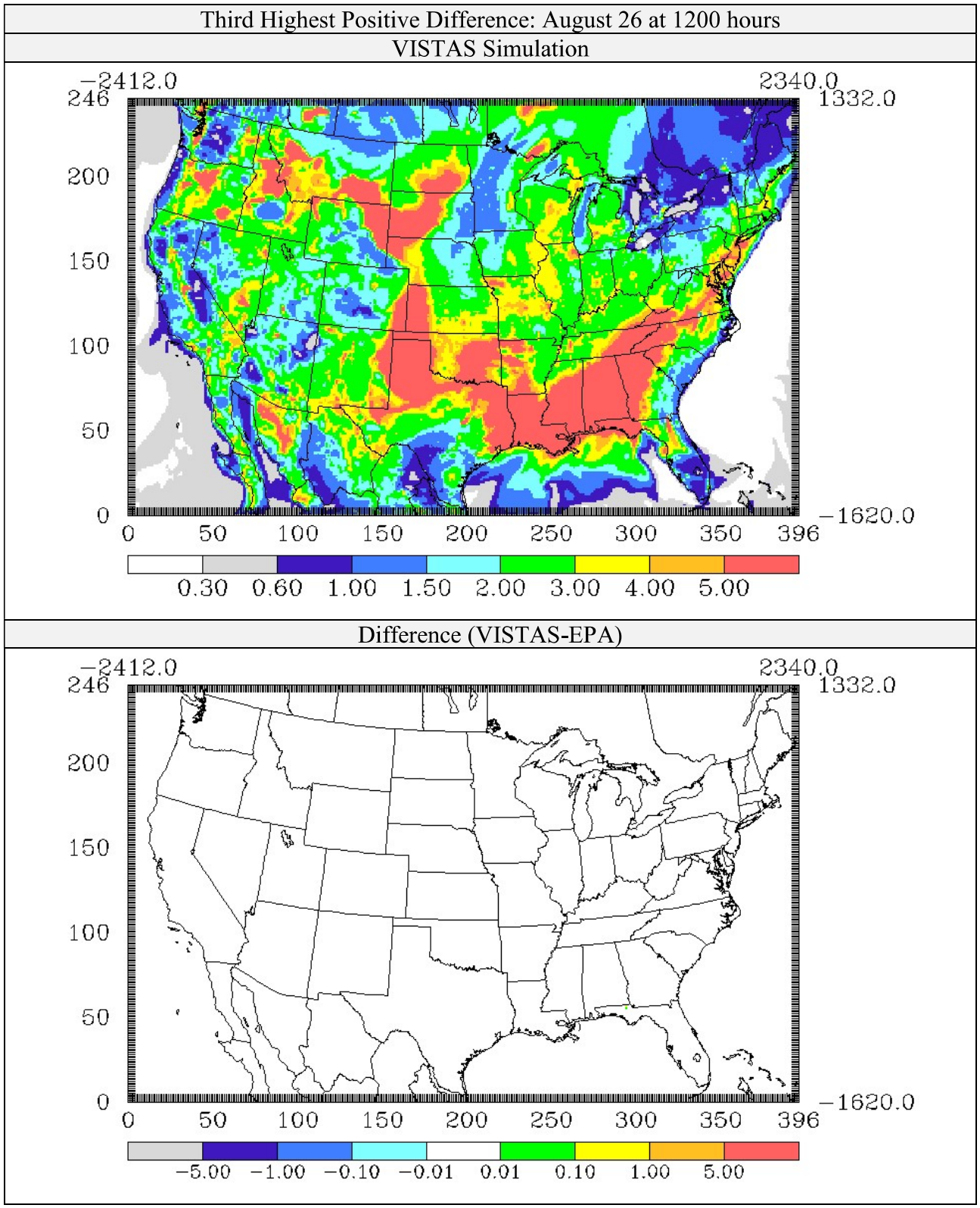

Figure 5-87: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)

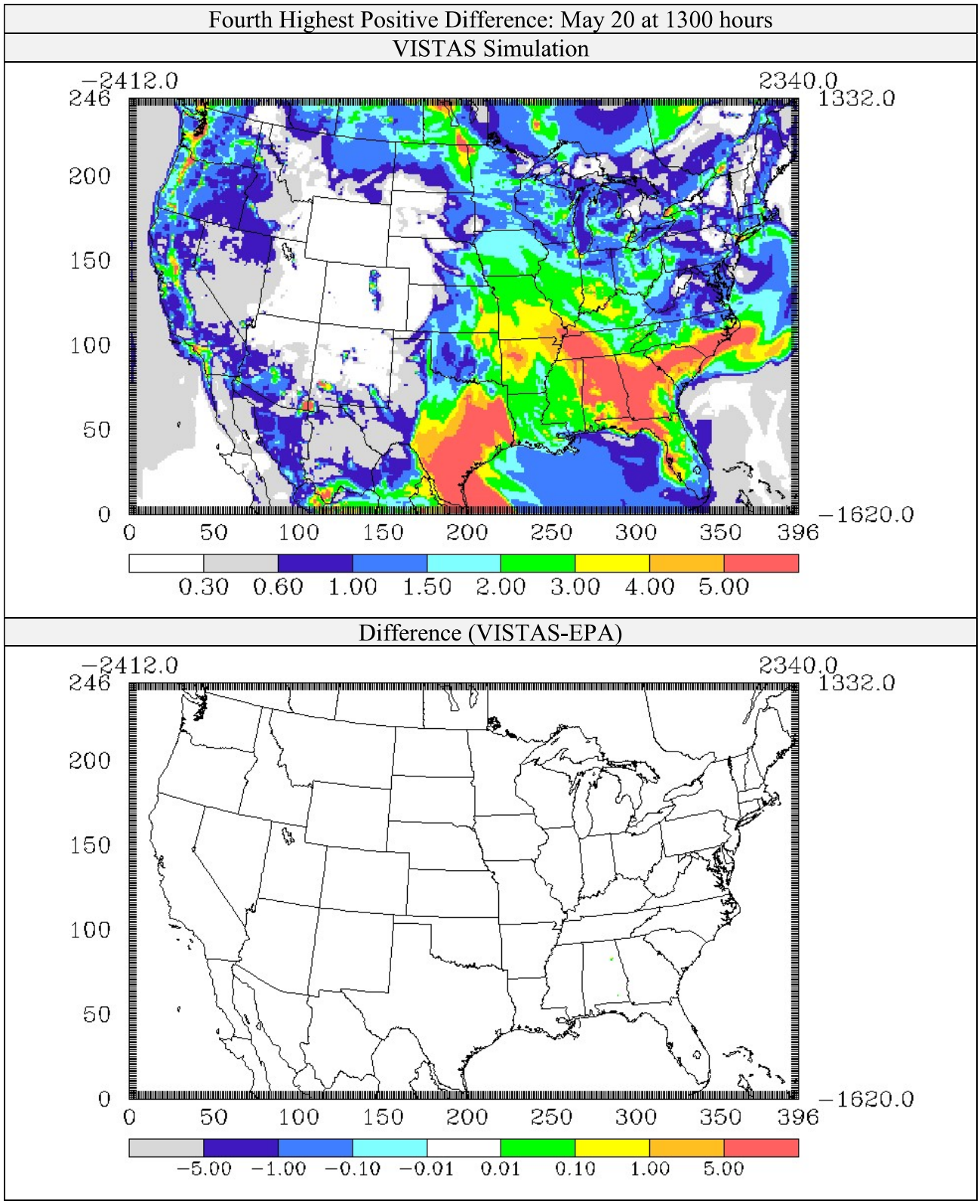

Figure 5-88: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)

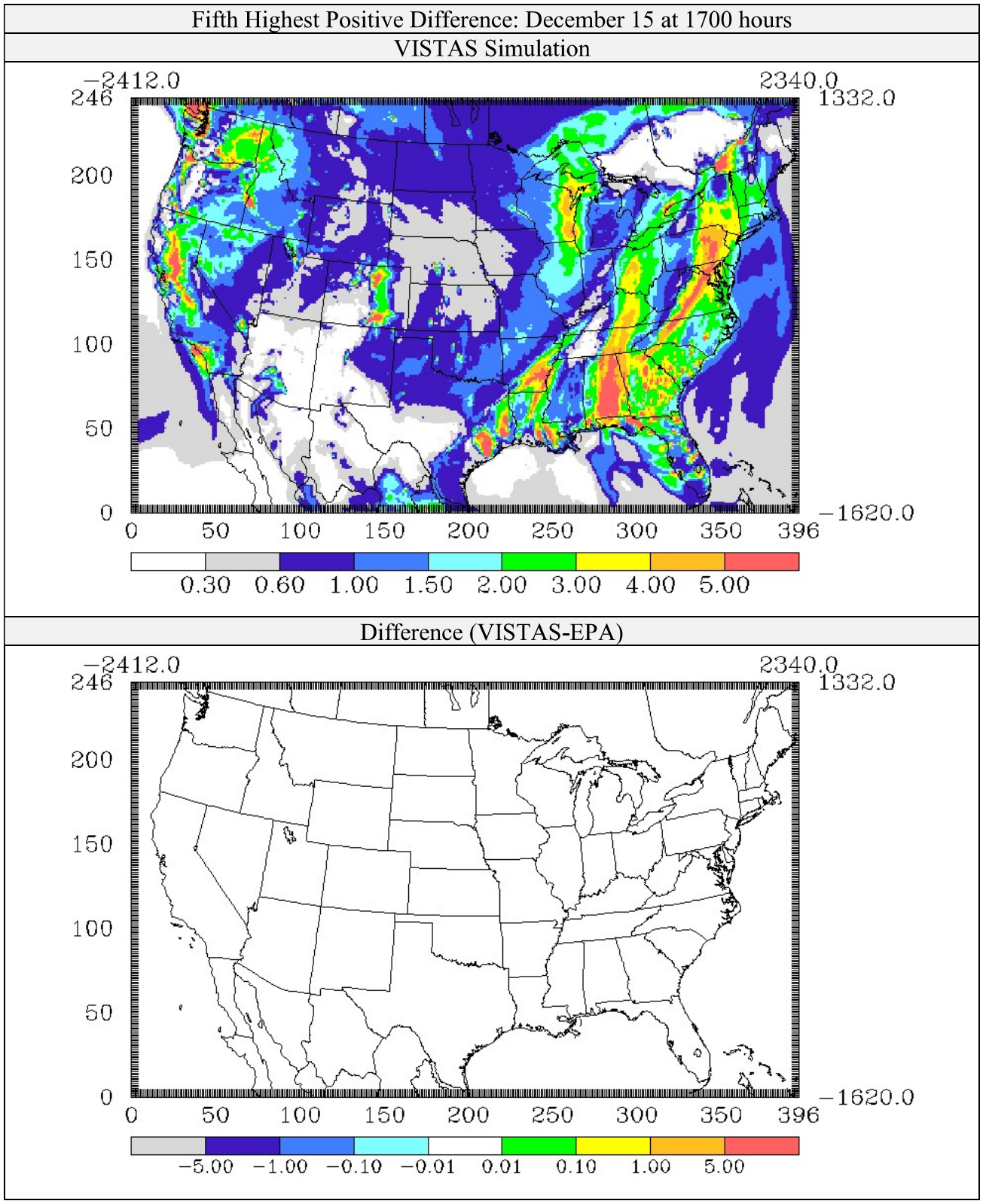

Figure 5-89: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)

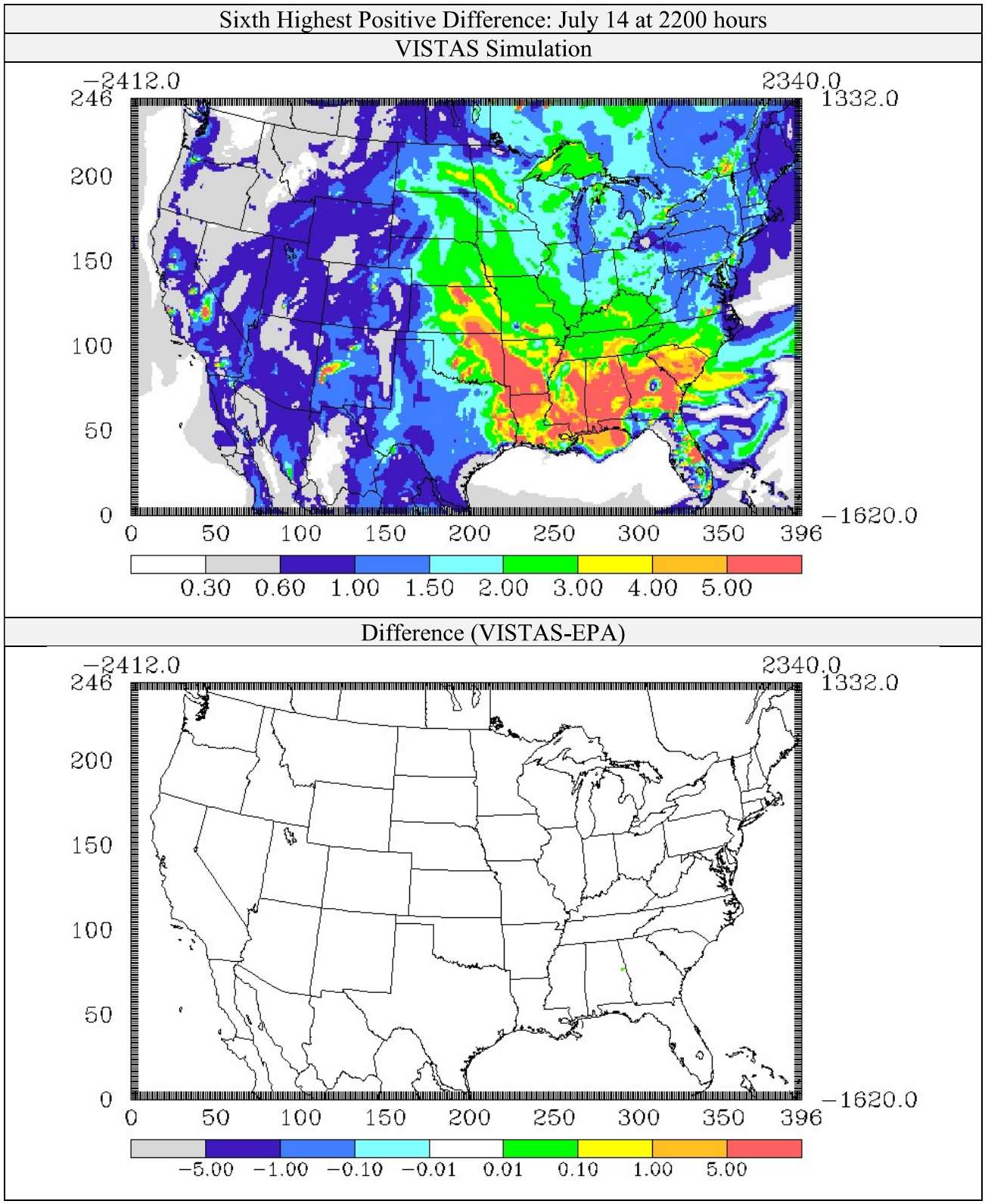

Figure 5-90: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)

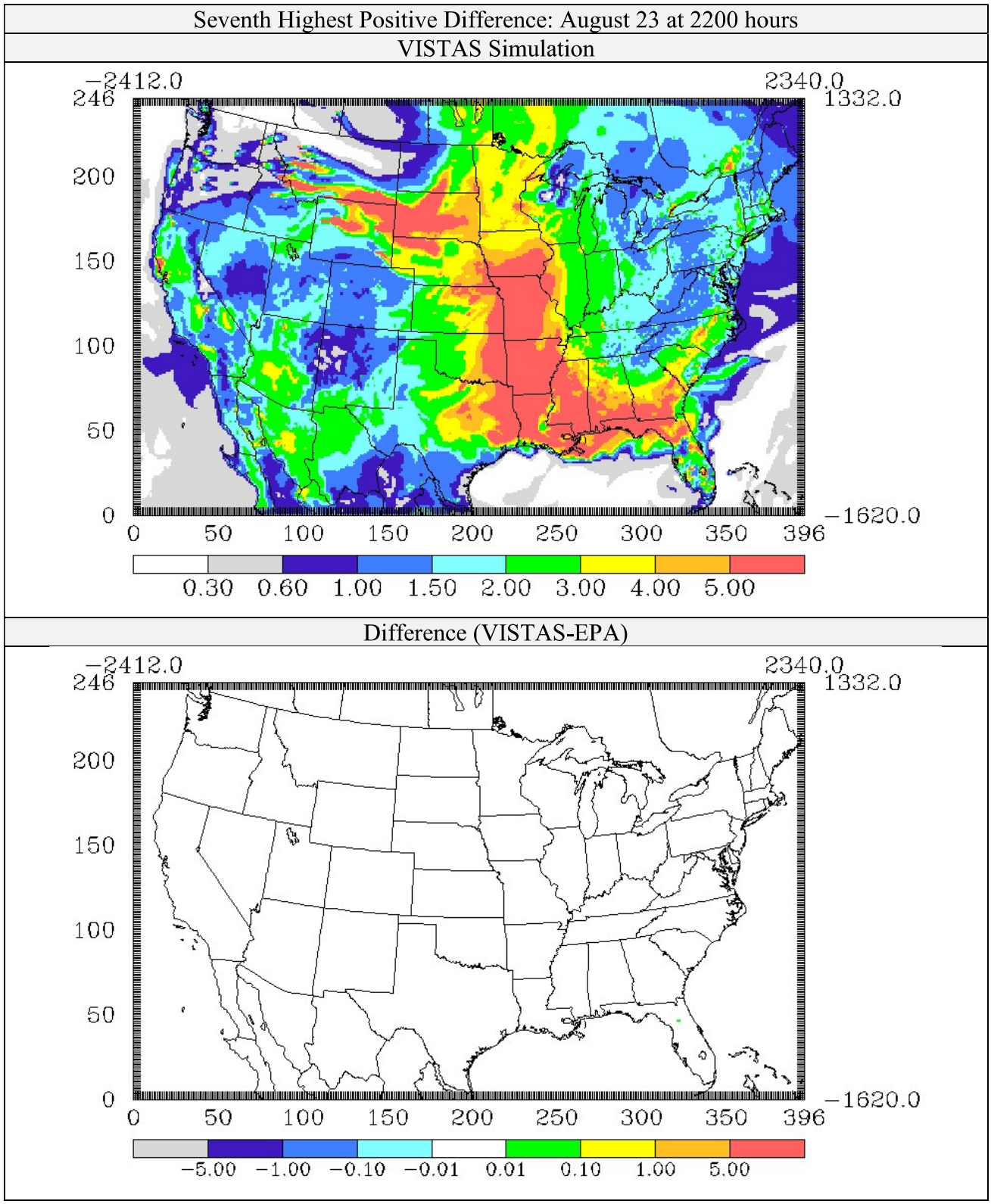

Figure 5-91: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)

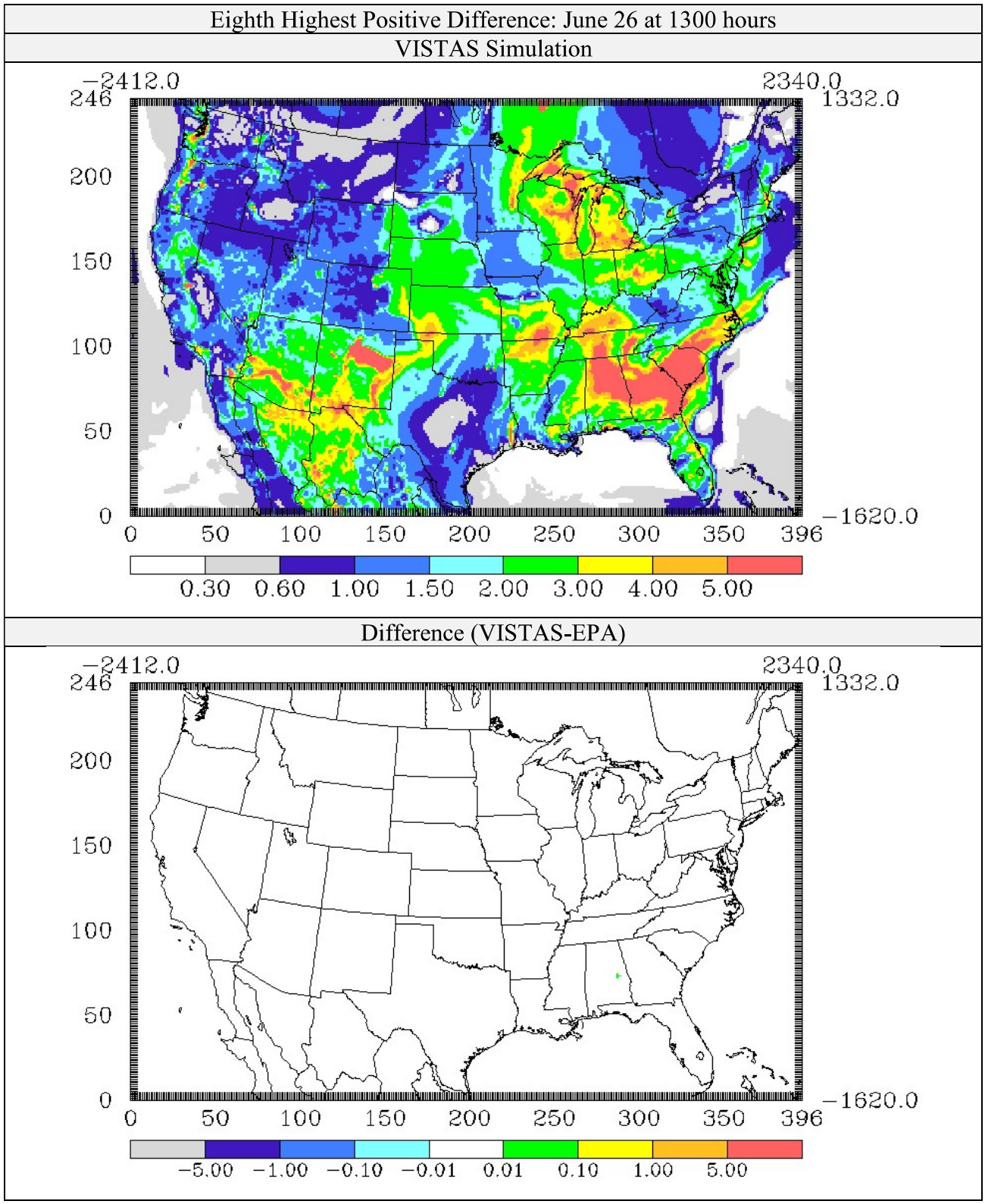

Figure 5-92: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)

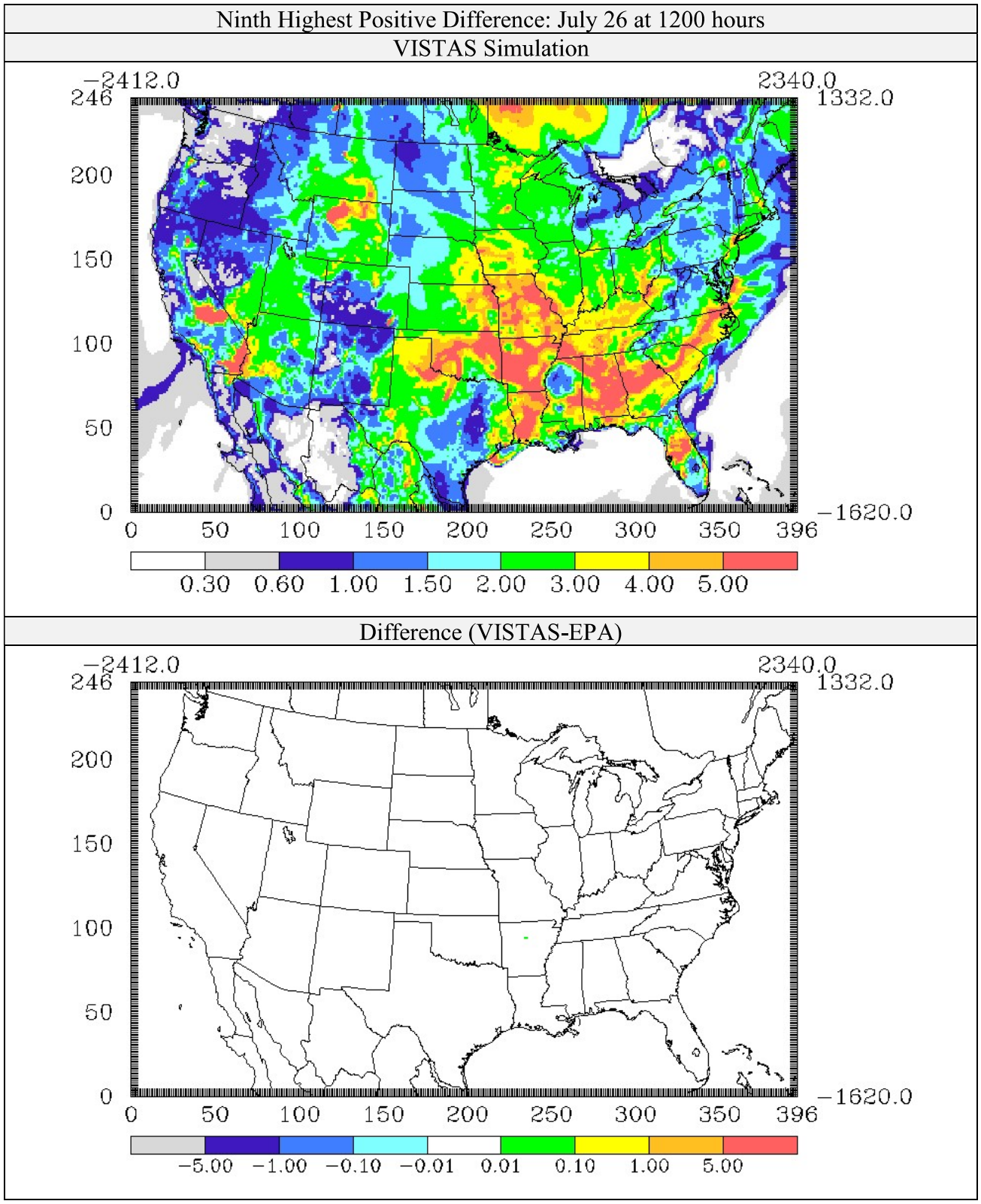

Figure 5-93: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)

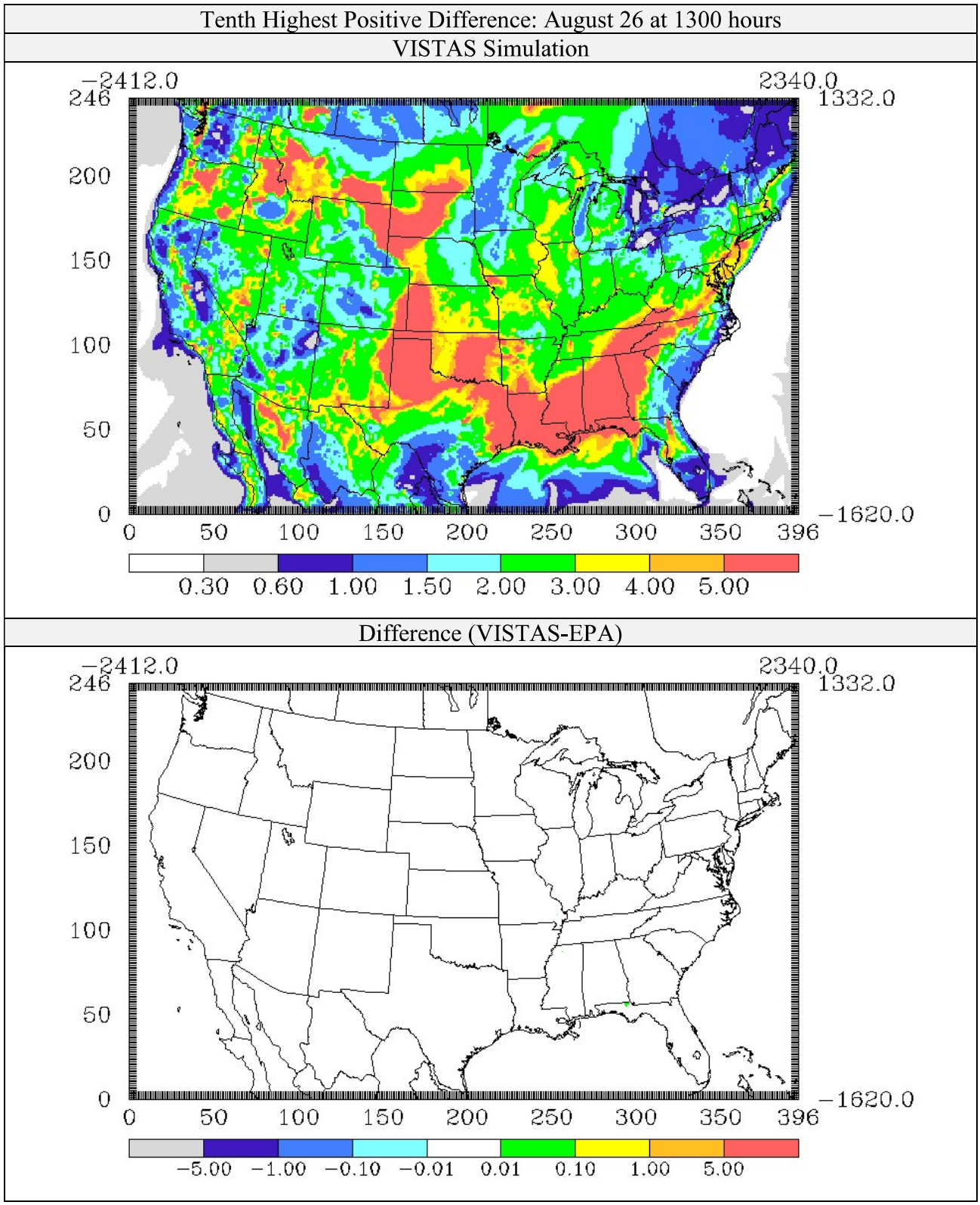

Figure 5-94: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)

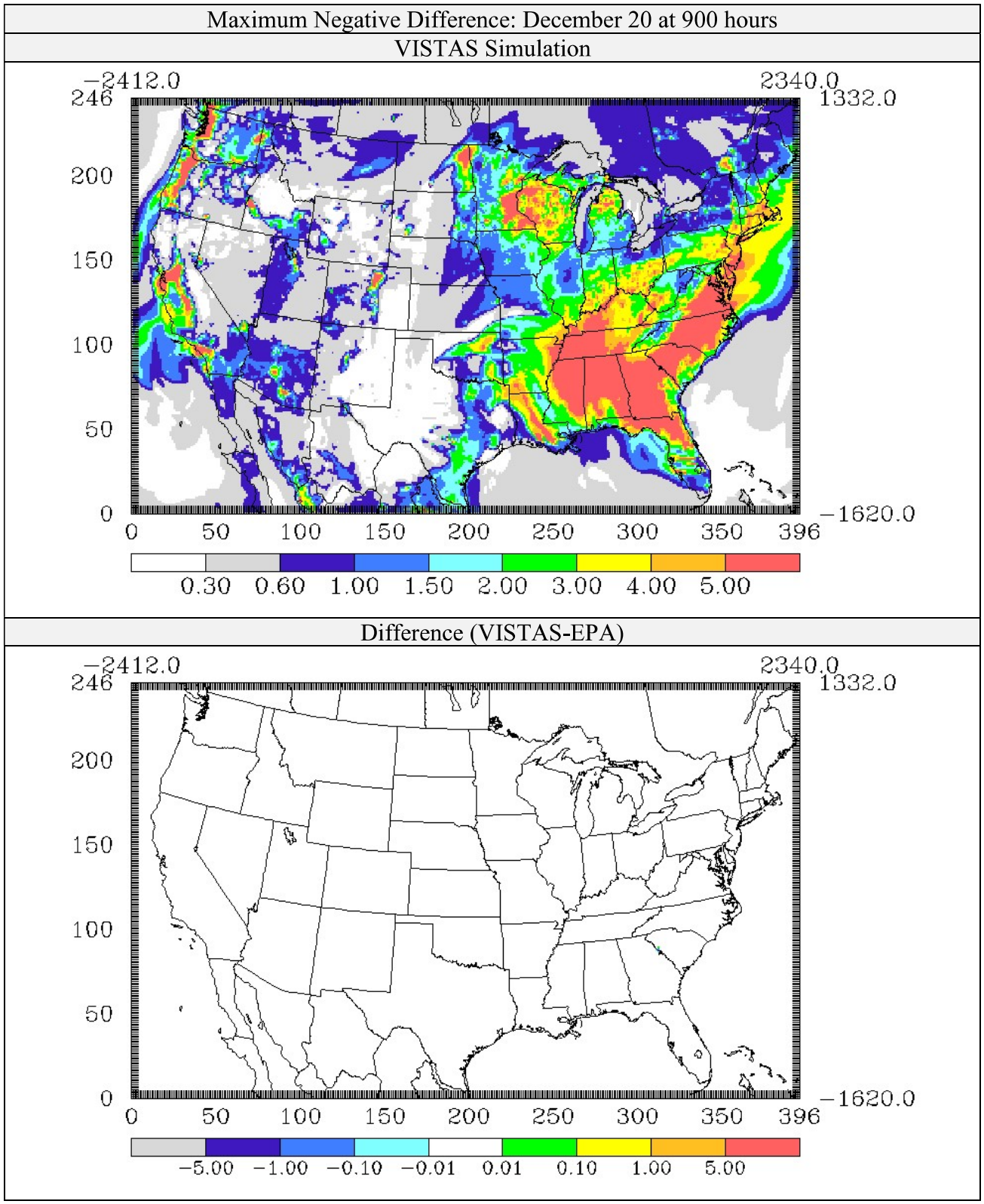

Figure 5-95: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)

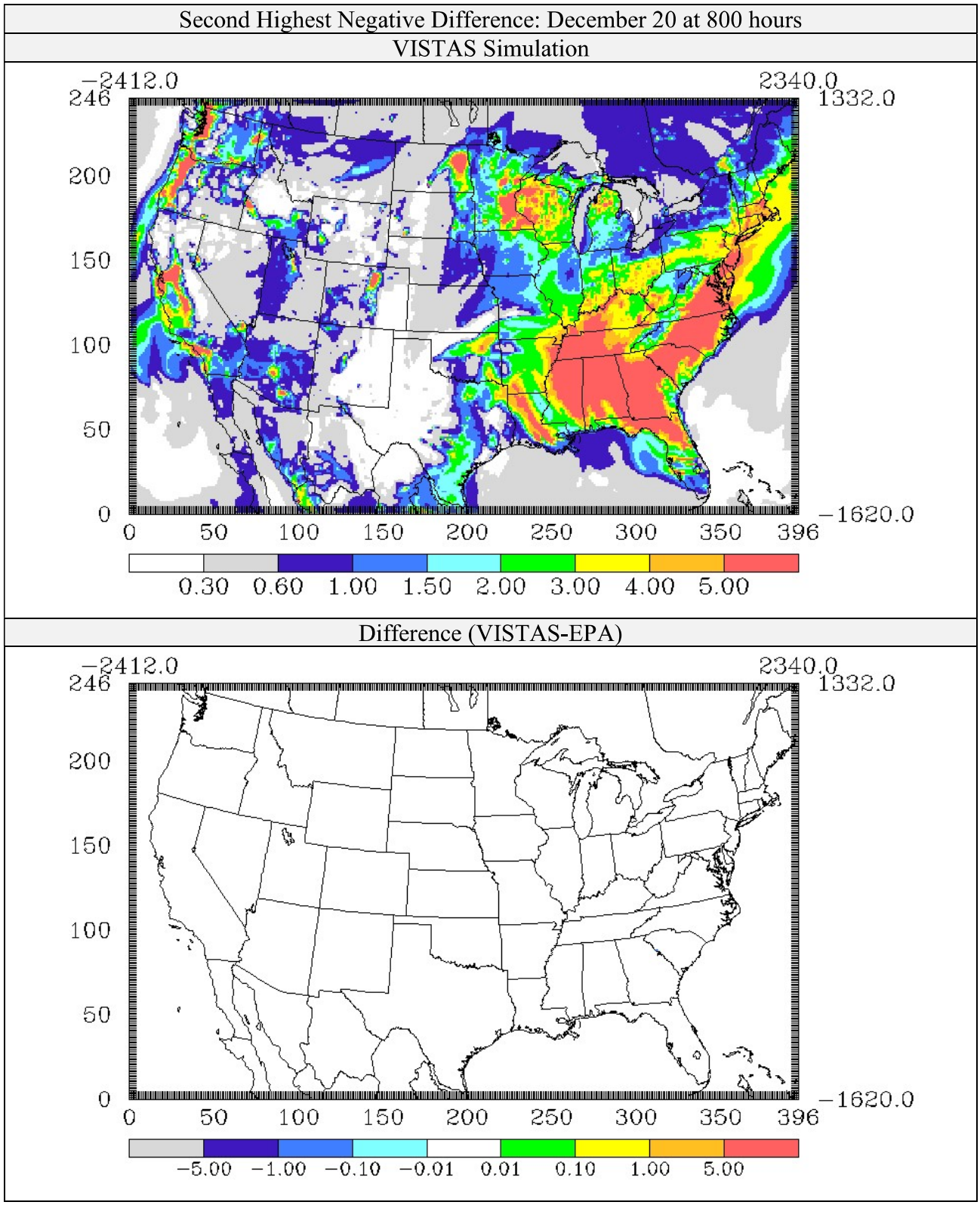

Figure 5-96: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)

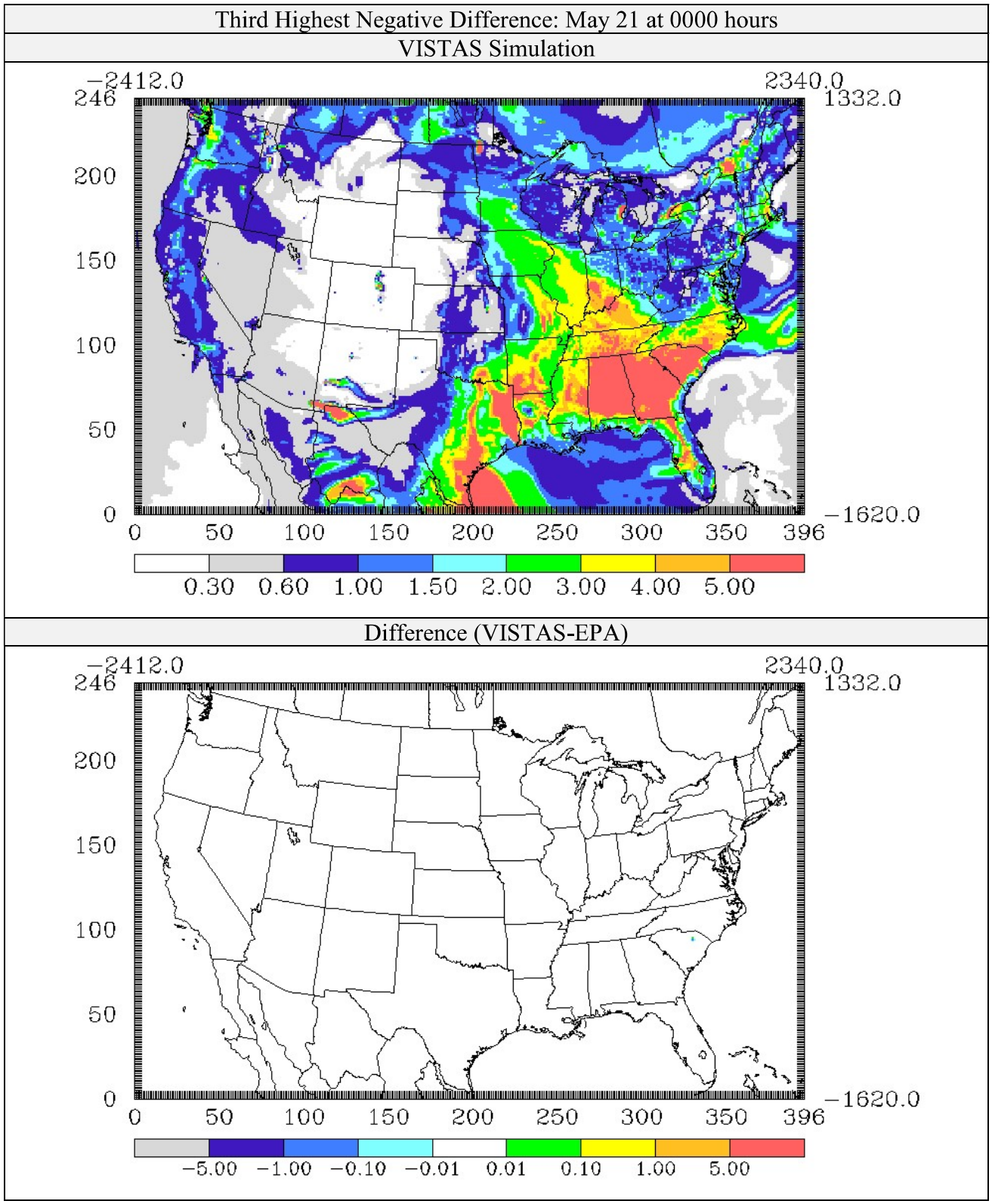

Figure 5-97: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)

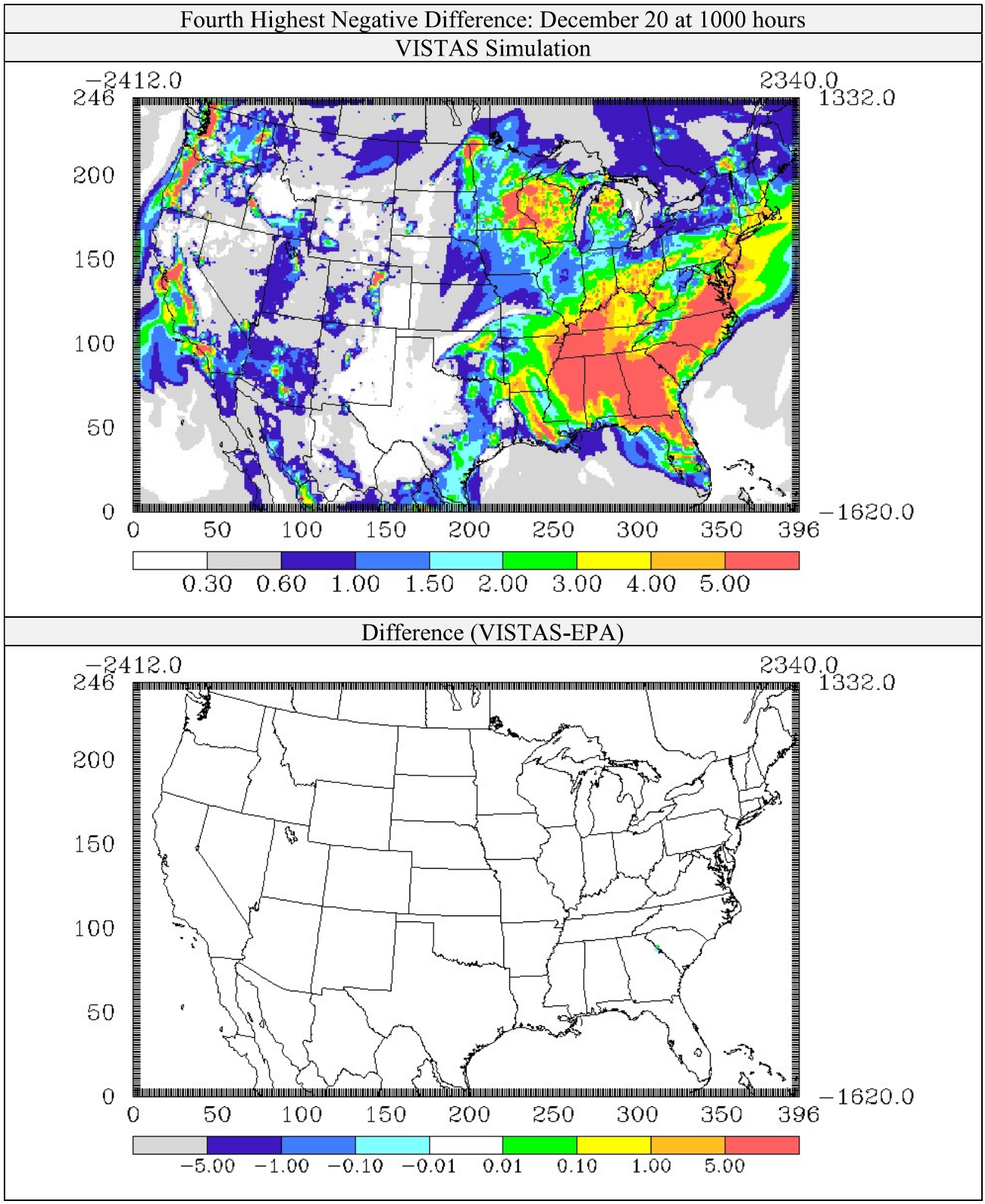

Figure 5-98: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)

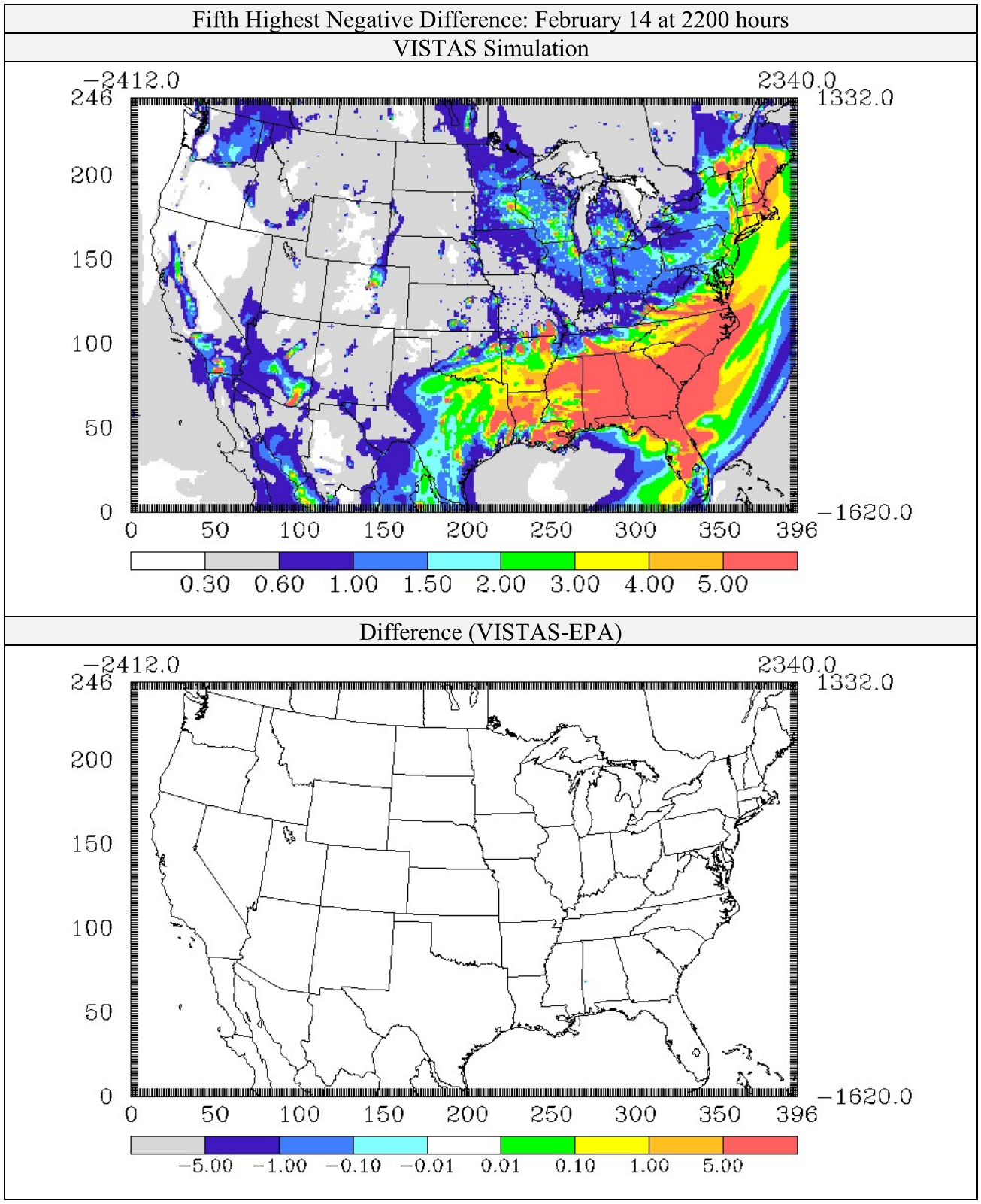

Figure 5-99: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)

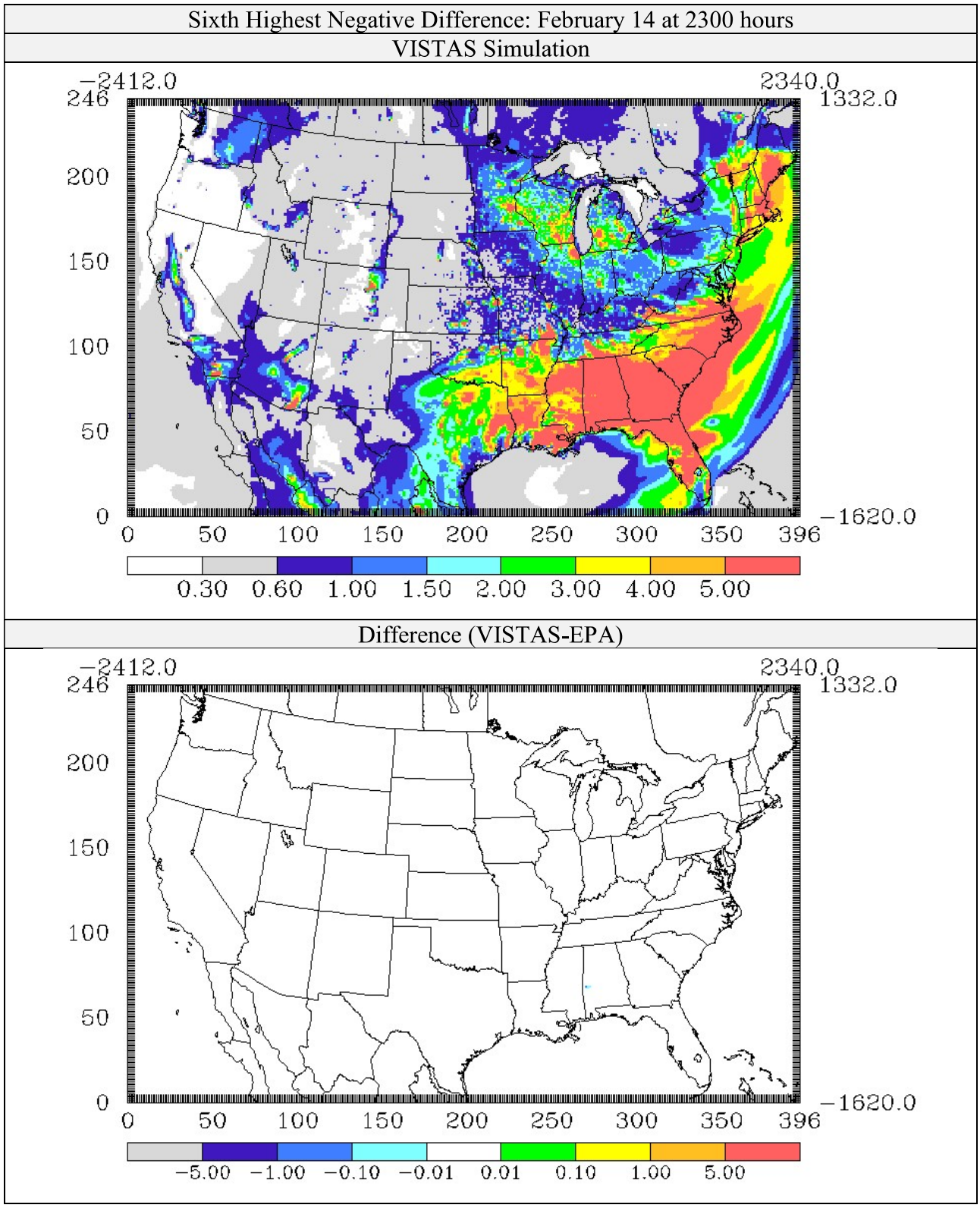

Figure 5-100: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)

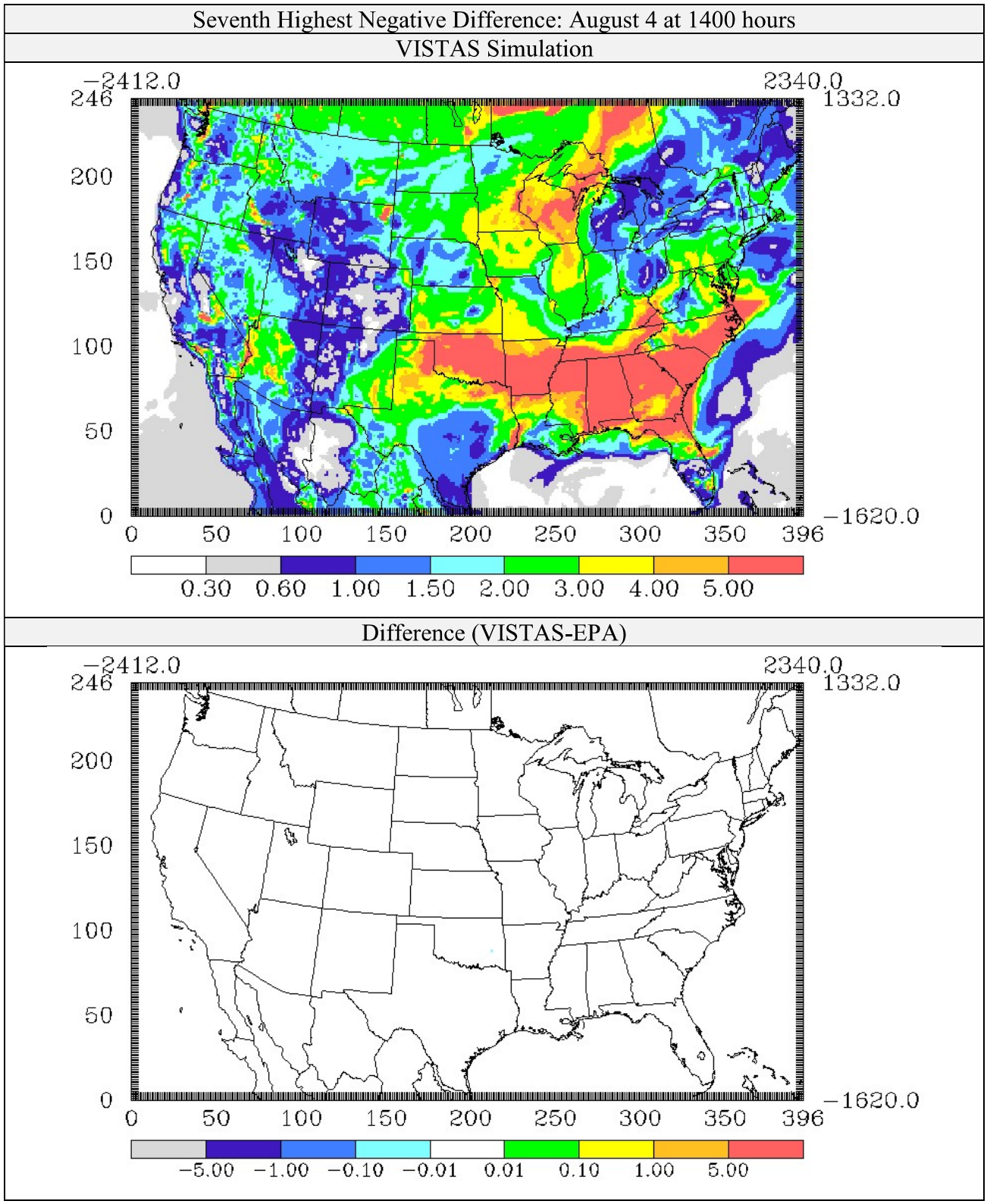

Figure 5-101: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)

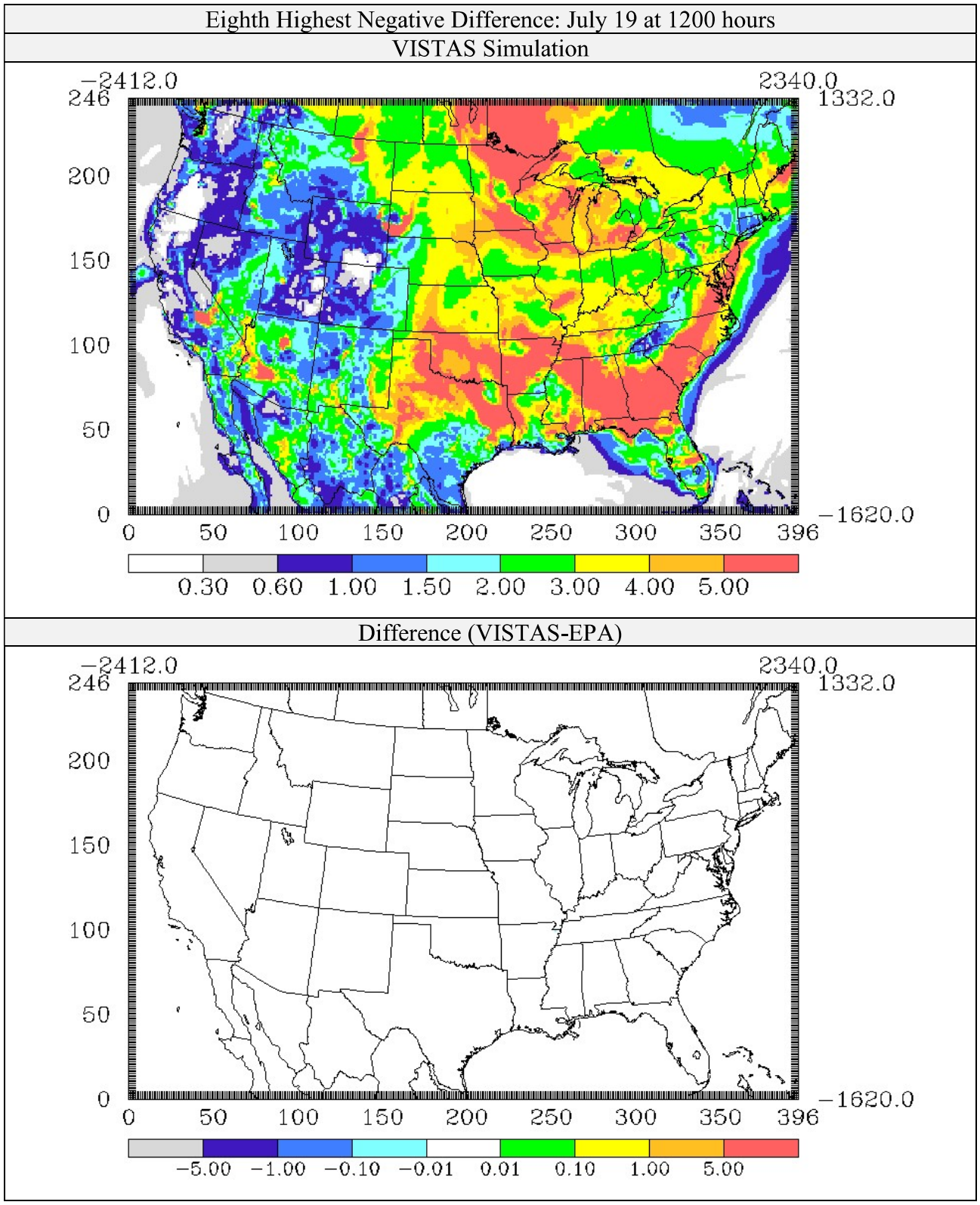

Figure 5-102: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)

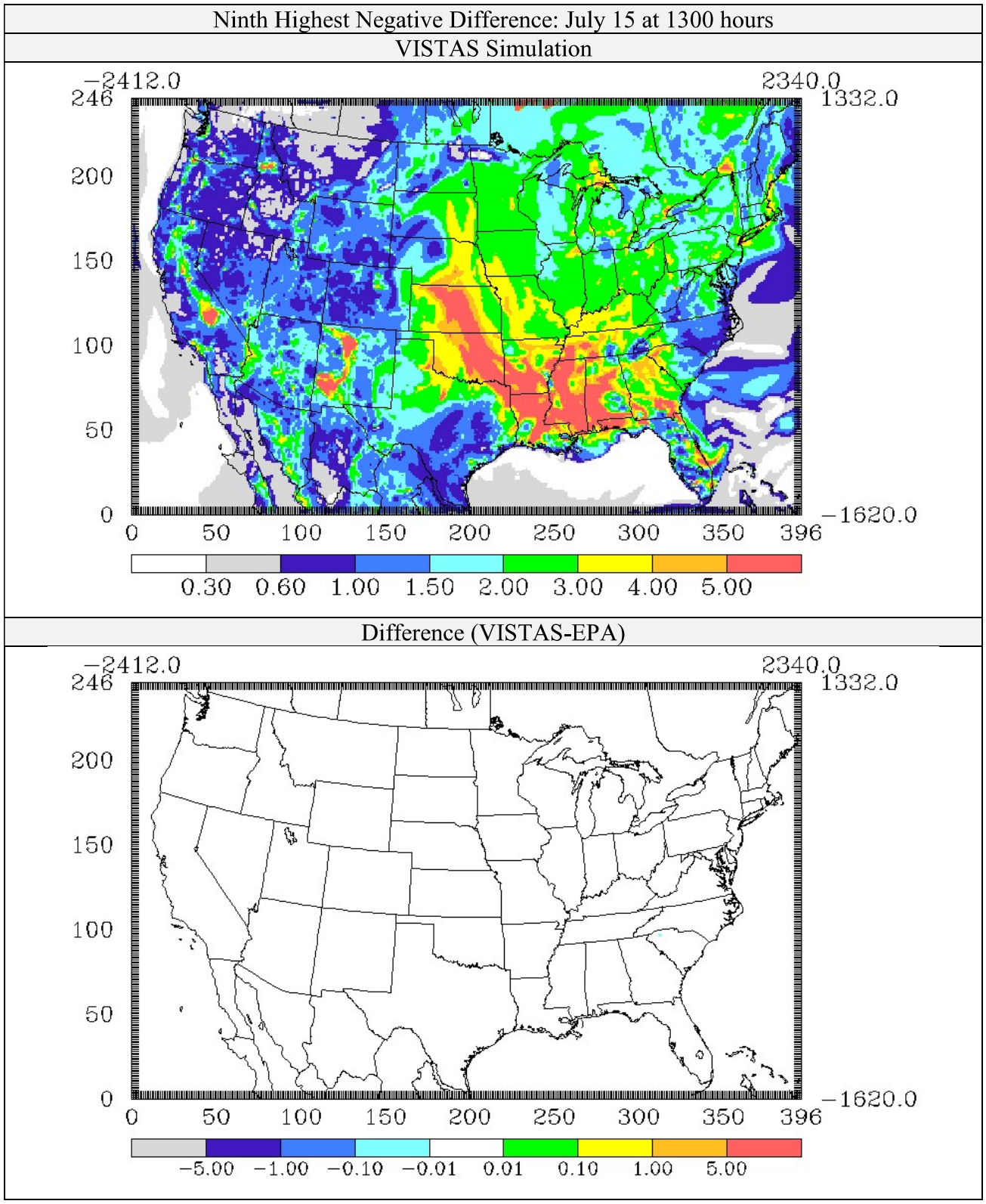

Figure 5-103: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)

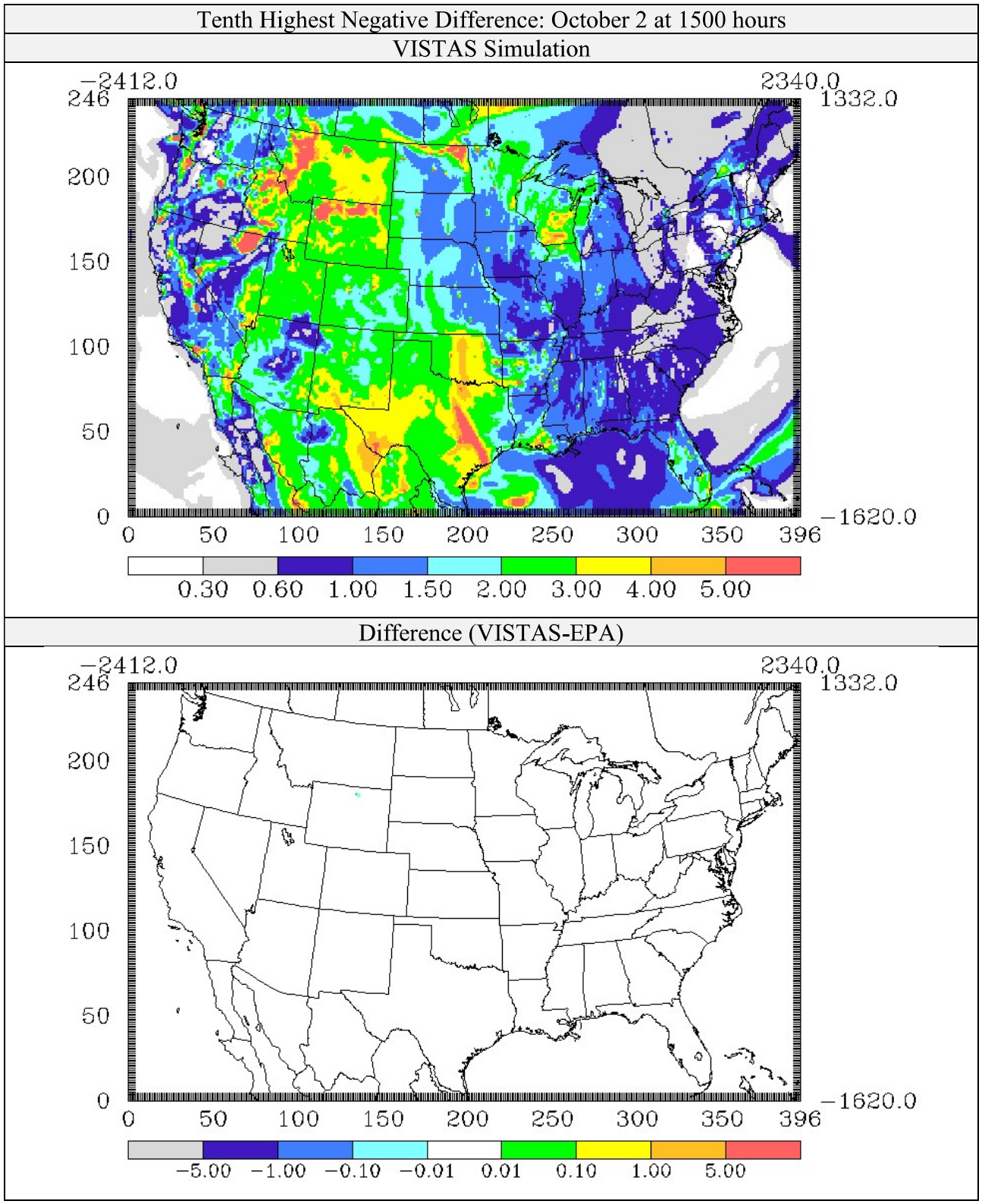

Figure 5-104: Comparison of Organic Carbon Concentrations (µg/m^3) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Negative Difference)

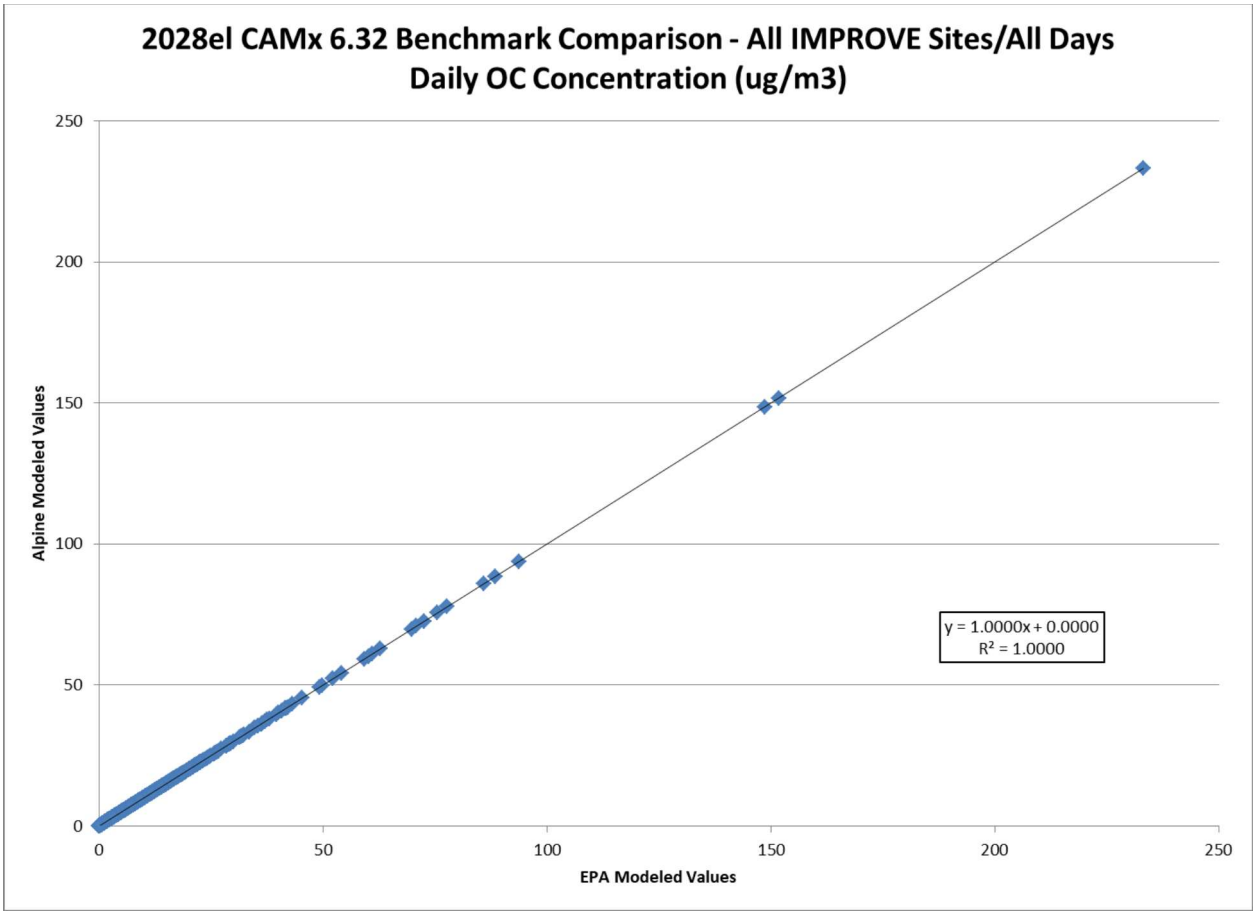

Figure 5-105: Scatterplot Comparing 24-hour Average Predicted Organic Carbon Concentrations (µg/m^3) for All Days at all IMPROVE Monitor Locations for CAMx 6.32 2028el Simulations Performed by EPA and VISTAS (Alpine).

6.0 CONCLUSION

A comparison has been made between 2011el and 2028el CAMx 6.32 simulations performed on the EPA computer and simulations using the same input files and configuration performed on the Alpine Geophysics computer system for the VISTAS project. The comparison was conducted for ozone, $PM_{2.5}$, sulfate, nitrate and organic carbon and included an examination both of hourly gridded concentrations, and at daily average concentrations at the IMPROVE monitors.

The hourly gridded comparison showed limited areas of differences with the location, date and time of the largest differences being similar for both 2011 and 2028, although the magnitude of the differences are slightly different. For ozone the maximum differences occurred suddenly over a limited area and then dispersed over several hours. For particulate species the differences tended to occur near the northern boundary of the domain in areas with high in-flow boundary condition. The majority of the differences in total $PM_{2.5}$ concentrations are due to wintertime nitrate as a result of different pathway being taken in the ISOROPIA algorithm.

A comparison of the daily average concentrations at the IMPROVE monitors showed very near perfect agreement with the EPA results with slopes of 1.0000, intercepts at or very near zero and R^2 of 1.0000. Alpine Geophysics has no reservations that the model is operating in a consistent manner with the simulations performed at EPA.