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
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Charleston, WV 25304
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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)** \( C_{vistas} - C_{epa} \)

- **(Equation 2)** \( \frac{(C_{vistas} - C_{epa})}{C_{epa}} \)

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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (ppb)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>7</td>
<td>14</td>
<td>22</td>
<td>45.15</td>
<td>42.02</td>
<td>3.13</td>
<td>7.4%</td>
<td>292</td>
<td>77</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>18</td>
<td>23</td>
<td>53.60</td>
<td>50.83</td>
<td>2.77</td>
<td>5.5%</td>
<td>286</td>
<td>152</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>19</td>
<td>0</td>
<td>45.25</td>
<td>42.64</td>
<td>2.61</td>
<td>6.1%</td>
<td>286</td>
<td>152</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>6</td>
<td>23</td>
<td>48.49</td>
<td>45.90</td>
<td>2.59</td>
<td>5.6%</td>
<td>197</td>
<td>156</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>30</td>
<td>14</td>
<td>32.28</td>
<td>29.96</td>
<td>2.33</td>
<td>7.8%</td>
<td>110</td>
<td>217</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>7</td>
<td>16</td>
<td>37.14</td>
<td>34.94</td>
<td>2.20</td>
<td>6.3%</td>
<td>257</td>
<td>103</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>27</td>
<td>12</td>
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<td>6.6%</td>
<td>295</td>
<td>143</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>23</td>
<td>22</td>
<td>44.30</td>
<td>42.22</td>
<td>2.08</td>
<td>4.9%</td>
<td>323</td>
<td>47</td>
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<tr>
<td>2011</td>
<td>8</td>
<td>8</td>
<td>23</td>
<td>39.44</td>
<td>37.43</td>
<td>2.01</td>
<td>5.4%</td>
<td>217</td>
<td>184</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>7</td>
<td>0</td>
<td>43.63</td>
<td>41.62</td>
<td>2.01</td>
<td>4.8%</td>
<td>197</td>
<td>156</td>
</tr>
</tbody>
</table>

**Maximum Negative**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (ppb)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8</td>
<td>16</td>
<td>0</td>
<td>33.32</td>
<td>35.96</td>
<td>-2.65</td>
<td>-7.4%</td>
<td>251</td>
<td>134</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>15</td>
<td>21</td>
<td>48.71</td>
<td>51.16</td>
<td>-2.44</td>
<td>-4.8%</td>
<td>224</td>
<td>159</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>15</td>
<td>23</td>
<td>36.83</td>
<td>39.27</td>
<td>-2.44</td>
<td>-6.2%</td>
<td>251</td>
<td>134</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>18</td>
<td>22</td>
<td>33.70</td>
<td>36.07</td>
<td>-2.37</td>
<td>-6.6%</td>
<td>196</td>
<td>187</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>26</td>
<td>22</td>
<td>34.14</td>
<td>36.40</td>
<td>-2.26</td>
<td>-6.2%</td>
<td>206</td>
<td>183</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>7</td>
<td>16</td>
<td>39.38</td>
<td>41.34</td>
<td>-1.97</td>
<td>-4.8%</td>
<td>216</td>
<td>180</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>11</td>
<td>18</td>
<td>35.28</td>
<td>37.21</td>
<td>-1.92</td>
<td>-5.2%</td>
<td>332</td>
<td>28</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>30</td>
<td>10</td>
<td>42.23</td>
<td>44.13</td>
<td>-1.90</td>
<td>-4.3%</td>
<td>117</td>
<td>19</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>16</td>
<td>19</td>
<td>48.28</td>
<td>50.08</td>
<td>-1.80</td>
<td>-3.6%</td>
<td>196</td>
<td>189</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>18</td>
<td>23</td>
<td>32.77</td>
<td>34.57</td>
<td>-1.79</td>
<td>-5.2%</td>
<td>196</td>
<td>187</td>
</tr>
</tbody>
</table>
Maximum Positive Difference: July 14 at 2200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-1: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)
Second Highest Positive Difference: August 18 at 2300 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-2: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)
Third Highest Positive Difference: August 19 at 0000 hours

**VISTAS Simulation**

![VISTAS Simulation](image)

**Difference (VISTAS-EPA)**

![Difference (VISTAS-EPA)](image)

**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)
Fifth Highest Positive Difference: August 30 at 1400 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-5: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)
Sixth Highest Positive Difference: August 7 at 1600 hours

VISTAS Simulation

Figure 4-6: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)
Seventh Highest Positive Difference: August 27 at 1200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-7: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)
Eighth Highest Positive Difference: August 23 at 2200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-8: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: August 8 at 2300 hours

VISTAS Simulation

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)
Second Highest Negative Difference: July 15 at 2100 hours

VISTAS Simulation

Figure 4-12: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: August 15 at 2300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-13: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)
Fourth Highest Negative Difference: June 18 at 2200 hours

VISTAS Simulation

![Map of VISTAS Simulation](image)

Difference (VISTAS-EPA)

![Map of Difference (VISTAS-EPA)](image)

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)
Seventh Highest Negative Difference: August 11 at 1800 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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)
Ninth Highest Negative Difference: July 16 at 1900 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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 10$^{th}$ high. The maximum negative difference is -5.41 µg/m$^3$ falling to -1.97 µg/m$^3$ for the 10$^{th}$ 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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m$^3$)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
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<tbody>
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<td>1</td>
<td>3</td>
<td>4</td>
<td>34.86</td>
<td>28.13</td>
<td>6.73</td>
<td>23.93%</td>
<td>156</td>
<td>236</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>32.54</td>
<td>26.77</td>
<td>5.77</td>
<td>21.56%</td>
<td>156</td>
<td>236</td>
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<td>3</td>
<td>6</td>
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<td>18.28%</td>
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<td>2011</td>
<td>1</td>
<td>27</td>
<td>7</td>
<td>14.19</td>
<td>9.82</td>
<td>4.37</td>
<td>44.52%</td>
<td>349</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
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<td>3</td>
<td>3</td>
<td>31.52</td>
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<td>11.20%</td>
<td>156</td>
<td>236</td>
</tr>
<tr>
<td>2011</td>
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<td>27</td>
<td>11</td>
<td>11.67</td>
<td>8.91</td>
<td>2.76</td>
<td>30.91%</td>
<td>349</td>
<td>243</td>
</tr>
<tr>
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<td>27</td>
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<td>11.37</td>
<td>8.71</td>
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<td>30.59%</td>
<td>343</td>
<td>244</td>
</tr>
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<td>14</td>
<td>9</td>
<td>14.03</td>
<td>11.54</td>
<td>2.49</td>
<td>21.60%</td>
<td>164</td>
<td>222</td>
</tr>
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<td>27</td>
<td>4</td>
<td>11.82</td>
<td>9.56</td>
<td>2.26</td>
<td>23.63%</td>
<td>343</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
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<td>3</td>
<td>21</td>
<td>21.51</td>
<td>19.29</td>
<td>2.21</td>
<td>11.47%</td>
<td>164</td>
<td>236</td>
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Maximum Negative

<table>
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<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m$^3$)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>14</td>
<td>6</td>
<td>20.84</td>
<td>26.26</td>
<td>-5.41</td>
<td>-20.62%</td>
<td>120</td>
<td>243</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>8</td>
<td>8.56</td>
<td>12.22</td>
<td>-3.67</td>
<td>-30.01%</td>
<td>350</td>
<td>243</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>15</td>
<td>9</td>
<td>14.60</td>
<td>17.96</td>
<td>-3.36</td>
<td>-18.70%</td>
<td>126</td>
<td>220</td>
</tr>
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<td>2011</td>
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<td>27</td>
<td>11</td>
<td>8.58</td>
<td>11.77</td>
<td>-3.19</td>
<td>-27.10%</td>
<td>342</td>
<td>245</td>
</tr>
<tr>
<td>2011</td>
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<td>27</td>
<td>12</td>
<td>6.20</td>
<td>9.08</td>
<td>-2.88</td>
<td>-31.69%</td>
<td>342</td>
<td>243</td>
</tr>
<tr>
<td>2011</td>
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<td>27</td>
<td>5</td>
<td>7.89</td>
<td>10.74</td>
<td>-2.85</td>
<td>-26.53%</td>
<td>342</td>
<td>244</td>
</tr>
<tr>
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<td>3</td>
<td>10</td>
<td>38.42</td>
<td>40.87</td>
<td>-2.45</td>
<td>-5.99%</td>
<td>155</td>
<td>235</td>
</tr>
<tr>
<td>2011</td>
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<td>14</td>
<td>2</td>
<td>27.61</td>
<td>29.94</td>
<td>-2.32</td>
<td>-7.76%</td>
<td>134</td>
<td>242</td>
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<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>28.64</td>
<td>30.77</td>
<td>-2.13</td>
<td>-6.93%</td>
<td>157</td>
<td>237</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>27.75</td>
<td>29.72</td>
<td>-1.97</td>
<td>-6.61%</td>
<td>159</td>
<td>234</td>
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</tbody>
</table>
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 ($\mu$g/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 ($\mu$g/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)
Eighth Highest Positive Difference: January 14 at 900 hours
VISTAS Simulation

Difference (VISTAS-EPA)

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 ($\mu$g/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)
Maximum Negative Difference: January 14 at 600 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-32: Comparison of PM2.5 Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)
Second Highest Negative Difference: January 27 at 800 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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 ($\mu$g/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)
Fifth Highest Negative Difference: January 27 at 1200 hours
VISTAS Simulation

Difference (VISTAS-EPA)

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 ($\mu g/m^3$) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: January 3 at 1000 hours

VISTAS Simulation

Figure 4-38: Comparison of PM$_{2.5}$ Concentrations ($\mu$g/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)
Ninth Highest Negative Difference: January 3 at 400 hours
VISTAS Simulation

Figure 4-40: Comparison of PM$_{2.5}$ Concentrations ($\mu$g/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/m³ falling to 0.19 µg/m³ for the 10th high. The maximum negative difference is -0.40 µg/m³ falling to -0.14 µg/m³ 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 R² of 1.0000.
Table 4-3. Comparison of 2011el CAMx 6.32 Simulation Sulfate Concentrations (µg/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
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<tbody>
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<td>Maximum Positive</td>
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<td>15</td>
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<td>6.74%</td>
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<td>15.09%</td>
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<td>2.06%</td>
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<td>47</td>
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<td>4.54%</td>
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<td>175</td>
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<td>9</td>
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<td>4.21%</td>
<td>156</td>
<td>210</td>
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<td>6.23</td>
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<td>3.57%</td>
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<td>8</td>
<td>6.19</td>
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<td>-6.22%</td>
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<td>3.21</td>
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<td>115</td>
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<tr>
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<td>29</td>
<td>16</td>
<td>4.24</td>
<td>4.38</td>
<td>-0.14</td>
<td>-3.28%</td>
<td>209</td>
<td>194</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>30</td>
<td>11</td>
<td>2.82</td>
<td>2.95</td>
<td>-0.14</td>
<td>-4.68%</td>
<td>313</td>
<td>178</td>
</tr>
</tbody>
</table>
Figure 4-43: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)
Second Highest Positive Difference: November 29 at 1500 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-44: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)
Figure 4-45: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)
Fourth Highest Positive Difference: December 31 at 1500 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-46: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)
Figure 4-47: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)
Sixth Highest Positive Difference: April 9 at 900 hours

VISTAS Simulation

Figure 4-48: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)
Figure 4-49: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)
Figure 4-50: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: April 9 at 1000 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-51: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)
Figure 4-52: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)
Figure 4-53: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)
Second Highest Negative Difference: December 14 at 2200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-54: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: December 6 at 100 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-55: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)
Figure 4-56: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)
Fifth Highest Negative Difference: May 28 at 700 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-57: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)
Figure 4-58: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: May 14 at 700 hours
VISTAS Simulation

Figure 4-59: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)
Figure 4-60: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)
Figure 4-61: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)
Figure 4-62: Comparison of Sulfate Concentrations (µg/m³) 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/m³) 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/m³ falling to 1.93 μg/m³ for the 10th high. The maximum negative difference is -4.20 μg/m³ falling to -1.65 μg/m³ 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/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>24.70</td>
<td>19.36</td>
<td>5.34</td>
<td>27.60%</td>
<td>156</td>
<td>236</td>
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<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>22.87</td>
<td>18.32</td>
<td>4.55</td>
<td>24.84%</td>
<td>156</td>
<td>236</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>7</td>
<td>8.33</td>
<td>3.97</td>
<td>4.36</td>
<td>110.03%</td>
<td>349</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>23.13</td>
<td>18.99</td>
<td>4.15</td>
<td>21.84%</td>
<td>156</td>
<td>235</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>11</td>
<td>6.60</td>
<td>3.95</td>
<td>2.65</td>
<td>66.94%</td>
<td>349</td>
<td>243</td>
</tr>
<tr>
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<td>3</td>
<td>3</td>
<td>21.99</td>
<td>19.49</td>
<td>2.50</td>
<td>12.85%</td>
<td>156</td>
<td>236</td>
</tr>
<tr>
<td>2011</td>
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<td>27</td>
<td>6</td>
<td>5.72</td>
<td>3.22</td>
<td>2.50</td>
<td>77.54%</td>
<td>343</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>4</td>
<td>8.79</td>
<td>6.61</td>
<td>2.18</td>
<td>33.08%</td>
<td>344</td>
<td>245</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>19</td>
<td>13</td>
<td>6.83</td>
<td>4.90</td>
<td>1.94</td>
<td>39.59%</td>
<td>314</td>
<td>168</td>
</tr>
<tr>
<td>2011</td>
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<td>14</td>
<td>9</td>
<td>8.78</td>
<td>6.84</td>
<td>1.93</td>
<td>28.24%</td>
<td>164</td>
<td>222</td>
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</table>

**Maximum Negative**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>14</td>
<td>6</td>
<td>14.35</td>
<td>18.55</td>
<td>-4.20</td>
<td>-22.62%</td>
<td>120</td>
<td>243</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>8</td>
<td>2.99</td>
<td>6.64</td>
<td>-3.64</td>
<td>-54.92%</td>
<td>350</td>
<td>243</td>
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<td>27</td>
<td>11</td>
<td>3.82</td>
<td>6.97</td>
<td>-3.15</td>
<td>-45.21%</td>
<td>342</td>
<td>245</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>12</td>
<td>2.25</td>
<td>4.96</td>
<td>-2.70</td>
<td>-54.54%</td>
<td>342</td>
<td>243</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>5</td>
<td>2.53</td>
<td>5.17</td>
<td>-2.64</td>
<td>-51.13%</td>
<td>342</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>15</td>
<td>9</td>
<td>9.50</td>
<td>12.11</td>
<td>-2.60</td>
<td>-21.51%</td>
<td>126</td>
<td>220</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>25.95</td>
<td>27.85</td>
<td>-1.90</td>
<td>-6.83%</td>
<td>155</td>
<td>235</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>27</td>
<td>9</td>
<td>4.37</td>
<td>6.21</td>
<td>-1.84</td>
<td>-29.60%</td>
<td>342</td>
<td>244</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>14</td>
<td>2</td>
<td>19.31</td>
<td>21.10</td>
<td>-1.79</td>
<td>-8.50%</td>
<td>134</td>
<td>242</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>19.76</td>
<td>21.41</td>
<td>-1.65</td>
<td>-7.72%</td>
<td>157</td>
<td>237</td>
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</tbody>
</table>
Figure 4-64: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)
Second Highest Positive Difference: January 3 at 500 hours

VISTAS Simulation

Figure 4-65: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)
Third Highest Positive Difference: January 27 at 700 hours

VISTAS Simulation

Figure 4-66: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)
Figure 4-67: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)
Fifth Highest Positive Difference: January 27 at 1100 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-68: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)
Figure 4-69: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)
Figure 4-70: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)
Figure 4-71: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: May 19 at 1300 hours

VISTAS Simulation

Figure 4-72: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)
Tenth Highest Positive Difference: January 14 at 900 hours

VISTAS Simulation

Figure 4-73: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)
Figure 4-74: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)
Figure 4-75: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: January 27 at 1100 hours
VISTAS Simulation

Figure 4-76: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)
Fourth Highest Negative Difference: January 27 at 1200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-77: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)
Figure 4-78: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)
Figure 4-79: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: January 3 at 1000 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-80: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)
Eighth Highest Negative Difference: January 27 at 900 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-81: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)
Figure 4-82: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)
Tenth Highest Negative Difference: January 3 at 400 hours

VISTAS Simulation

Figure 4-83: Comparison of Nitrate Concentrations ($\mu$g/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/m³) 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 μg/m³ falling to 0.09 μg/m³ for the 10th high. The maximum negative difference is -0.33 μg/m³ falling to -0.08 μg/m³ 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 R² of 1.0000.
Table 4-5. Comparison of 2011el CAMx 6.32 Simulation Organic Carbon Concentrations (μg/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (μg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>6</td>
<td>26</td>
<td>12</td>
<td>17.32</td>
<td>17.13</td>
<td>0.18</td>
<td>1.08%</td>
<td>288</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>20</td>
<td>12</td>
<td>11.46</td>
<td>11.32</td>
<td>0.14</td>
<td>1.23%</td>
<td>286</td>
<td>84</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>26</td>
<td>12</td>
<td>10.82</td>
<td>10.69</td>
<td>0.14</td>
<td>1.28%</td>
<td>295</td>
<td>57</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>20</td>
<td>13</td>
<td>10.89</td>
<td>10.77</td>
<td>0.12</td>
<td>1.16%</td>
<td>286</td>
<td>84</td>
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<td>17</td>
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<td>25.80</td>
<td>0.12</td>
<td>0.45%</td>
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<td>115</td>
</tr>
<tr>
<td>2011</td>
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<td>14</td>
<td>22</td>
<td>5.30</td>
<td>5.19</td>
<td>0.11</td>
<td>2.03%</td>
<td>292</td>
<td>77</td>
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<tr>
<td>2011</td>
<td>6</td>
<td>26</td>
<td>13</td>
<td>12.40</td>
<td>12.31</td>
<td>0.10</td>
<td>0.79%</td>
<td>288</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>26</td>
<td>12</td>
<td>10.30</td>
<td>10.21</td>
<td>0.09</td>
<td>0.93%</td>
<td>236</td>
<td>95</td>
</tr>
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<td>2011</td>
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<td>26</td>
<td>13</td>
<td>7.69</td>
<td>7.60</td>
<td>0.09</td>
<td>1.23%</td>
<td>295</td>
<td>57</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>23</td>
<td>22</td>
<td>7.38</td>
<td>7.29</td>
<td>0.09</td>
<td>1.28%</td>
<td>323</td>
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Maximum Negative

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (μg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>12</td>
<td>20</td>
<td>9</td>
<td>10.97</td>
<td>11.30</td>
<td>-0.33</td>
<td>-2.89%</td>
<td>313</td>
<td>89</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>20</td>
<td>8</td>
<td>11.31</td>
<td>11.59</td>
<td>-0.28</td>
<td>-2.39%</td>
<td>313</td>
<td>89</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>21</td>
<td>0</td>
<td>8.28</td>
<td>8.39</td>
<td>-0.11</td>
<td>-1.37%</td>
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<td>95</td>
</tr>
<tr>
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<td>20</td>
<td>10</td>
<td>11.20</td>
<td>11.31</td>
<td>-0.11</td>
<td>-0.96%</td>
<td>313</td>
<td>89</td>
</tr>
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<td>23</td>
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<td>-0.57%</td>
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<td>69</td>
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<td>22</td>
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<td>-0.65%</td>
<td>271</td>
<td>69</td>
</tr>
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<td>13.31</td>
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<td>-0.75%</td>
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<td>89</td>
</tr>
<tr>
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<td>19</td>
<td>12</td>
<td>7.28</td>
<td>7.37</td>
<td>-0.09</td>
<td>-1.22%</td>
<td>253</td>
<td>100</td>
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<td>-1.01%</td>
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<td>70</td>
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<tr>
<td>2011</td>
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<td>15</td>
<td>13</td>
<td>5.29</td>
<td>5.38</td>
<td>-0.08</td>
<td>-1.56%</td>
<td>314</td>
<td>98</td>
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</tbody>
</table>
Figure 4-85: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Positive Difference)
Figure 4-86: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Positive Difference)
Figure 4-87: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Positive Difference)
Fourth Highest Positive Difference: May 20 at 1300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-88: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Positive Difference)
Figure 4-89: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Positive Difference)
Figure 4-90: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Positive Difference)
Figure 4-91: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Positive Difference)
Figure 4-92: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: August 26 at 1300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 4-93: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Positive Difference)
Figure 4-94: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Tenth Highest Positive Difference)
Figure 4-95: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Maximum Negative Difference)
Figure 4-96: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: May 21 at 0000 hours
VISTAS Simulation

Figure 4-97: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Third Highest Negative Difference)
Figure 4-98: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fourth Highest Negative Difference)
Figure 4-99: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Fifth Highest Negative Difference)
Figure 4-100: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Sixth Highest Negative Difference)
Figure 4-101: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Seventh Highest Negative Difference)
Figure 4-102: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Eighth Highest Negative Difference)
Figure 4-103: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2011el Simulations (Ninth Highest Negative Difference)
Figure 4-104: Comparison of Organic Carbon Concentrations (µg/m³) 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/m³) 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.

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<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (ppb)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>2.24</td>
<td>5.58%</td>
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<td>156</td>
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<td>2011</td>
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<td>18</td>
<td>23</td>
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<td>42.43</td>
<td>2.21</td>
<td>5.21%</td>
<td>286</td>
<td>152</td>
</tr>
<tr>
<td>2011</td>
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<td>14</td>
<td>22</td>
<td>31.20</td>
<td>29.06</td>
<td>2.13</td>
<td>7.34%</td>
<td>292</td>
<td>77</td>
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<td>14</td>
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<td>7.81%</td>
<td>110</td>
<td>217</td>
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<td>28.01</td>
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<td>143</td>
</tr>
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<td>218</td>
</tr>
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<td>36.52</td>
<td>1.87</td>
<td>5.12%</td>
<td>286</td>
<td>152</td>
</tr>
<tr>
<td>2011</td>
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<td>8</td>
<td>23</td>
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<td>33.85</td>
<td>1.82</td>
<td>5.39%</td>
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<td>184</td>
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<tr>
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<td>16</td>
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<td>6.33%</td>
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<td>7</td>
<td>0</td>
<td>38.27</td>
<td>36.52</td>
<td>1.74</td>
<td>4.78%</td>
<td>197</td>
<td>156</td>
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<tr>
<td><strong>Maximum Negative</strong></td>
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<td></td>
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</tr>
<tr>
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<td>-7.47%</td>
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<td>134</td>
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<td>22</td>
<td>30.88</td>
<td>33.06</td>
<td>-2.18</td>
<td>-6.59%</td>
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<td>187</td>
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<td>8</td>
<td>15</td>
<td>23</td>
<td>30.96</td>
<td>33.06</td>
<td>-2.10</td>
<td>-6.34%</td>
<td>251</td>
<td>134</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>15</td>
<td>21</td>
<td>38.77</td>
<td>40.69</td>
<td>-1.92</td>
<td>-4.73%</td>
<td>224</td>
<td>159</td>
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<tr>
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<td>3</td>
<td>30</td>
<td>10</td>
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<td>-1.91</td>
<td>-4.30%</td>
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<td>19</td>
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<td>-6.17%</td>
<td>206</td>
<td>183</td>
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<tr>
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<td>7</td>
<td>7</td>
<td>16</td>
<td>35.85</td>
<td>37.67</td>
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<td>216</td>
<td>180</td>
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<tr>
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<td>11</td>
<td>18</td>
<td>31.40</td>
<td>33.11</td>
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<td>-5.19%</td>
<td>332</td>
<td>28</td>
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<td>18</td>
<td>23</td>
<td>30.11</td>
<td>31.76</td>
<td>-1.65</td>
<td>-5.19%</td>
<td>196</td>
<td>187</td>
</tr>
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<td>19</td>
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<td>45.00</td>
<td>-1.60</td>
<td>-3.57%</td>
<td>196</td>
<td>189</td>
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</tbody>
</table>
Figure 5-1: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)
Second Highest Positive Difference: August 18 at 2300 hours

VISTAS Simulation

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)
Fourth Highest Positive Difference: August 30 at 1400 hours

VISTAS Simulation

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 2028sl Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: August 7 at 1600 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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)
Third Highest Negative Difference: August 15 at 2300 hours

VISTAS Simulation

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)
Sixth Highest Negative Difference: June 26 at 2200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-16: Comparison of Ozone Concentrations (ppb) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: July 7 at 1600 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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 $10^{th}$ high. The maximum negative difference is -4.61 μg/m$^3$ falling to -2.45 μg/m$^3$ for the $10^{th}$ 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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m$^3$)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
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<td>3</td>
<td>4</td>
<td>35.87</td>
<td>30.72</td>
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<td>16.77%</td>
<td>155</td>
<td>237</td>
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<td>3</td>
<td>12</td>
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<td>33.42</td>
<td>4.53</td>
<td>13.54%</td>
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<td>237</td>
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<td>27</td>
<td>7</td>
<td>13.15</td>
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<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m$^3$)</th>
<th>Percent Difference</th>
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<td>-28.92%</td>
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<td>245</td>
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<td>11</td>
<td>6.80</td>
<td>9.98</td>
<td>-3.18</td>
<td>-31.88%</td>
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<td>8.93</td>
<td>12.11</td>
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</table>
Figure 5-22: Comparison of PM$_{2.5}$ Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)
Figure 5-23: Comparison of PM$_{2.5}$ Concentrations ($\mu$g/m$^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)
Figure 5-24: Comparison of PM$_{2.5}$ Concentrations ($\mu$g/m$^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)
Fourth Highest Positive Difference: January 27 at 900 hours

VISTAS Simulation

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)
Fifth Highest Positive Difference: January 14 at 600 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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)
Sixth Highest Positive Difference: January 27 at 1200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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)
Seventh Highest Positive Difference: January 14 at 400 hours
VISTAS Simulation

Difference (VISTAS-EPA)

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 ($\mu g/m^3$) 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 ($\mu$g/m$^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)
Second Highest Negative Difference: January 3 at 700 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-33: Comparison of PM$_{2.5}$ Concentrations ($\mu g/m^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: January 27 at 500 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-34: Comparison of PM$_{2.5}$ Concentrations ($\mu g/m^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)
Figure 5-35: Comparison of PM$_{2.5}$ Concentrations ($\mu g/m^3$) 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)
Sixth Highest Negative Difference: January 27 at 1000 hours

VISTAS Simulation

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 ($\mu g/m^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)
Figure 5-39: Comparison of PM$_{2.5}$ Concentrations ($\mu g/m^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)
Ninth Highest Negative Difference: January 14 at 300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

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 ($\mu g/m^3$) 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 (µg/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/m³ falling to 0.17 µg/m³ for the 10th high. The maximum negative difference is -0.14 µg/m³ falling to -0.08 µg/m³ 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/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>26</td>
<td>11</td>
<td>2.08</td>
<td>1.77</td>
<td>0.31</td>
<td>17.80%</td>
<td>209</td>
<td>205</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>13</td>
<td>11</td>
<td>4.75</td>
<td>4.45</td>
<td>0.30</td>
<td>6.79%</td>
<td>170</td>
<td>116</td>
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<td>23</td>
<td>13</td>
<td>3.43</td>
<td>3.17</td>
<td>0.26</td>
<td>8.23%</td>
<td>215</td>
<td>100</td>
</tr>
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<td>26</td>
<td>12</td>
<td>2.31</td>
<td>2.06</td>
<td>0.25</td>
<td>11.99%</td>
<td>209</td>
<td>205</td>
</tr>
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<td>9</td>
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<td>0.22</td>
<td>4.49%</td>
<td>227</td>
<td>181</td>
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<tr>
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<td>23</td>
<td>12</td>
<td>3.27</td>
<td>3.06</td>
<td>0.22</td>
<td>7.12%</td>
<td>215</td>
<td>100</td>
</tr>
<tr>
<td>2011</td>
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<td>5</td>
<td>14</td>
<td>3.45</td>
<td>3.24</td>
<td>0.20</td>
<td>6.27%</td>
<td>183</td>
<td>161</td>
</tr>
<tr>
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<td>1.73</td>
<td>0.19</td>
<td>10.81%</td>
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<td>205</td>
</tr>
<tr>
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<td>15</td>
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<td>3.45</td>
<td>0.18</td>
<td>5.31%</td>
<td>183</td>
<td>161</td>
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<td>8</td>
<td>5</td>
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<td>3.16</td>
<td>0.17</td>
<td>5.39%</td>
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Maximum Negative

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<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>26</td>
<td>9</td>
<td>4.01</td>
<td>4.15</td>
<td>-0.14</td>
<td>-3.26%</td>
<td>375</td>
<td>181</td>
</tr>
<tr>
<td>2011</td>
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<td>20</td>
<td>13</td>
<td>7.25</td>
<td>7.38</td>
<td>-0.13</td>
<td>-1.74%</td>
<td>359</td>
<td>212</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>26</td>
<td>10</td>
<td>1.74</td>
<td>1.87</td>
<td>-0.13</td>
<td>-6.78%</td>
<td>292</td>
<td>115</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>11</td>
<td>12</td>
<td>2.09</td>
<td>2.19</td>
<td>-0.11</td>
<td>-4.80%</td>
<td>274</td>
<td>135</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>17</td>
<td>4</td>
<td>2.68</td>
<td>2.78</td>
<td>-0.10</td>
<td>-3.72%</td>
<td>147</td>
<td>215</td>
</tr>
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<td>2011</td>
<td>4</td>
<td>13</td>
<td>23</td>
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<td>3.48</td>
<td>-0.10</td>
<td>-2.88%</td>
<td>360</td>
<td>162</td>
</tr>
<tr>
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<td>15</td>
<td>14</td>
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<td>4.06</td>
<td>-0.09</td>
<td>-2.31%</td>
<td>246</td>
<td>156</td>
</tr>
<tr>
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<td>18</td>
<td>12</td>
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<td>3.71</td>
<td>-0.09</td>
<td>-2.31%</td>
<td>303</td>
<td>71</td>
</tr>
<tr>
<td>2011</td>
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<td>15</td>
<td>13</td>
<td>4.16</td>
<td>4.24</td>
<td>-0.08</td>
<td>-1.96%</td>
<td>246</td>
<td>156</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>18</td>
<td>11</td>
<td>2.68</td>
<td>2.76</td>
<td>-0.08</td>
<td>-3.00%</td>
<td>282</td>
<td>115</td>
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</tbody>
</table>
Figure 5-43: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)
Figure 5-44: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)
Figure 5-45: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)
Fourth Highest Positive Difference: January 26 at 1200 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-46: Comparison of Sulfate Concentrations (µg/m³) 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/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)
Figure 5-49: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)
Figure 5-50: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: March 5 at 1500 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-51: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)
Figure 5-52: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)
Figure 5-53: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)
Second Highest Negative Difference: March 20 at 1300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-54: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: December 26 at 1000 hours

VISTAS Simulation

Figure 5-55: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)
Fourth Highest Negative Difference: May 11 at 1200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-56: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)
Figure 5-57: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)
Sixth Highest Negative Difference: April 13 at 2300 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-58: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)
Figure 5-59: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)
Figure 5-60: Comparison of Sulfate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)
Ninth Highest Negative Difference: February 15 at 1300 hours

VISTAS Simulation

Figure 5-61: Comparison of Sulfate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)
Tenth Highest Negative Difference: December 18 at 1100 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-62: Comparison of Sulfate Concentrations (μg/m³) 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/m³) 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/m³ falling to 2.23 µg/m³ for the 10th high. The maximum negative difference is -4.28 µg/m³ falling to -1.92 µg/m³ 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/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
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<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>27</td>
<td>7</td>
<td>7.66</td>
<td>3.54</td>
<td>4.13</td>
<td>116.71%</td>
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<td>245</td>
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<td>4</td>
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<td>3.99</td>
<td>18.69%</td>
<td>155</td>
<td>237</td>
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<tr>
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<td>27</td>
<td>9</td>
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<td>83.38%</td>
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<td>12</td>
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<td>10.35%</td>
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<th>Year</th>
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<td>-44.00%</td>
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<td>244</td>
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<td>-50.89%</td>
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<td>-31.48%</td>
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<td>3</td>
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<td>12.20</td>
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<td>-15.98%</td>
<td>164</td>
<td>231</td>
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<td>1</td>
<td>14</td>
<td>3</td>
<td>17.01</td>
<td>18.94</td>
<td>-1.92</td>
<td>-10.15%</td>
<td>137</td>
<td>242</td>
</tr>
</tbody>
</table>
Figure 5-64: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)
Second Highest Positive Difference: January 3 at 400 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-65: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)
Figure 5-66: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)
Fourth Highest Positive Difference: January 3 at 1200 hours

VISTAS Simulation

Figure 5-67: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)
Figure 5-68: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)
Figure 5-69: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)
Figure 5-70: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)
Figure 5-71: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)
Figure 5-72: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)
Figure 5-73: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)
Maximum Negative Difference: January 27 at 800 hours

VISTAS Simulation

Figure 5-74: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)
Figure 5-75: Comparison of Nitrate Concentrations ($\mu$g/m$^3$) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)
Figure 5-76: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)
Fourth Highest Negative Difference: January 27 at 900 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-77: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)
Fifth Highest Negative Difference: January 27 at 1200 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-78: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)
Sixth Highest Negative Difference: January 27 at 1100 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-79: Comparison of Nitrate Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: January 27 at 1000 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-80: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)
Eighth Highest Negative Difference: January 27 at 300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-81: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)
Figure 5-82: Comparison of Nitrate Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)
Figure 5-83: Comparison of Nitrate Concentrations (μg/m³) 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/m³) 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 µg/m³ falling to 0.09 µg/m³ for the 10\textsuperscript{th} high. The maximum negative difference is -0.30 µg/m³ falling to -0.08 µg/m³ for the 10\textsuperscript{th} 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/m³) Run on VISTAS and EPA Computer Systems. Hours with the Top 10 Maximum Positive and Maximum Negative Differences are Shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
<th>VISTAS Conc.</th>
<th>EPA Conc.</th>
<th>Difference (µg/m³)</th>
<th>Percent Difference</th>
<th>Column</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>26</td>
<td>12</td>
<td>16.16</td>
<td>15.99</td>
<td>0.17</td>
<td>1.06%</td>
<td>288</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>20</td>
<td>12</td>
<td>11.03</td>
<td>10.90</td>
<td>0.14</td>
<td>1.25%</td>
<td>286</td>
<td>84</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>26</td>
<td>12</td>
<td>10.24</td>
<td>10.11</td>
<td>0.13</td>
<td>1.25%</td>
<td>295</td>
<td>57</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>20</td>
<td>13</td>
<td>10.66</td>
<td>10.54</td>
<td>0.12</td>
<td>1.17%</td>
<td>286</td>
<td>84</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>15</td>
<td>17</td>
<td>25.87</td>
<td>25.76</td>
<td>0.12</td>
<td>0.45%</td>
<td>143</td>
<td>115</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>22</td>
<td>22</td>
<td>4.99</td>
<td>4.89</td>
<td>0.10</td>
<td>2.11%</td>
<td>292</td>
<td>77</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>23</td>
<td>22</td>
<td>7.08</td>
<td>6.98</td>
<td>0.09</td>
<td>1.33%</td>
<td>323</td>
<td>47</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>26</td>
<td>13</td>
<td>11.74</td>
<td>11.65</td>
<td>0.09</td>
<td>0.76%</td>
<td>288</td>
<td>74</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>26</td>
<td>12</td>
<td>9.66</td>
<td>9.57</td>
<td>0.09</td>
<td>0.91%</td>
<td>236</td>
<td>95</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>26</td>
<td>13</td>
<td>7.39</td>
<td>7.30</td>
<td>0.09</td>
<td>1.19%</td>
<td>295</td>
<td>57</td>
</tr>
<tr>
<td>Maximum Negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2011</td>
<td>12</td>
<td>20</td>
<td>9</td>
<td>10.16</td>
<td>10.46</td>
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<td>-2.86%</td>
<td>313</td>
<td>89</td>
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<tr>
<td>2011</td>
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<td>20</td>
<td>8</td>
<td>10.43</td>
<td>10.69</td>
<td>-0.25</td>
<td>-2.37%</td>
<td>313</td>
<td>89</td>
</tr>
<tr>
<td>2011</td>
<td>5</td>
<td>21</td>
<td>0</td>
<td>7.46</td>
<td>7.56</td>
<td>-0.11</td>
<td>-1.41%</td>
<td>331</td>
<td>95</td>
</tr>
<tr>
<td>2011</td>
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<td>20</td>
<td>10</td>
<td>10.41</td>
<td>10.51</td>
<td>-0.11</td>
<td>-1.00%</td>
<td>313</td>
<td>89</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>22</td>
<td>22</td>
<td>16.01</td>
<td>16.11</td>
<td>-0.10</td>
<td>-0.65%</td>
<td>271</td>
<td>69</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>23</td>
<td>18.33</td>
<td>18.43</td>
<td>-0.10</td>
<td>-0.56%</td>
<td>271</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>14</td>
<td>13.16</td>
<td>13.26</td>
<td>-0.10</td>
<td>-0.74%</td>
<td>213</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>19</td>
<td>12</td>
<td>7.01</td>
<td>7.10</td>
<td>-0.09</td>
<td>-1.28%</td>
<td>253</td>
<td>100</td>
</tr>
<tr>
<td>2011</td>
<td>7</td>
<td>15</td>
<td>13</td>
<td>5.01</td>
<td>5.09</td>
<td>-0.08</td>
<td>-1.63%</td>
<td>314</td>
<td>98</td>
</tr>
<tr>
<td>2011</td>
<td>10</td>
<td>2</td>
<td>15</td>
<td>8.09</td>
<td>8.17</td>
<td>-0.08</td>
<td>-1.00%</td>
<td>136</td>
<td>181</td>
</tr>
</tbody>
</table>
Maximum Positive Difference: June 26 at 1200 hours

VISTAS Simulation

Figure 5-85: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Positive Difference)
**Figure 5-86:** Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Positive Difference)
Figure 5-87: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Positive Difference)
Figure 5-88: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Positive Difference)
Fifth Highest Positive Difference: December 15 at 1700 hours
VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-89: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Positive Difference)
Figure 5-90: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Positive Difference)
Seventh Highest Positive Difference: August 23 at 2200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-91: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Positive Difference)
Eighth Highest Positive Difference: June 26 at 1300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-92: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Positive Difference)
Ninth Highest Positive Difference: July 26 at 1200 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-93: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Positive Difference)
Tenth Highest Positive Difference: August 26 at 1300 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-94: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Tenth Highest Positive Difference)
Figure 5-95: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Maximum Negative Difference)
Figure 5-96: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Second Highest Negative Difference)
Third Highest Negative Difference: May 21 at 0000 hours
VISTAS Simulation

Figure 5-97: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Third Highest Negative Difference)
Fourth Highest Negative Difference: December 20 at 1000 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-98: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fourth Highest Negative Difference)
Figure 5-99: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Fifth Highest Negative Difference)
Figure 5-100: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Sixth Highest Negative Difference)
Seventh Highest Negative Difference: August 4 at 1400 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-101: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Seventh Highest Negative Difference)
Figure 5-102: Comparison of Organic Carbon Concentrations (μg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Eighth Highest Negative Difference)
Ninth Highest Negative Difference: July 15 at 1300 hours

VISTAS Simulation

Figure 5-103: Comparison of Organic Carbon Concentrations (µg/m³) for VISTAS and EPA CAMx 6.32 2028el Simulations (Ninth Highest Negative Difference)
Tenth Highest Negative Difference: October 2 at 1500 hours

VISTAS Simulation

Difference (VISTAS-EPA)

Figure 5-104: Comparison of Organic Carbon Concentrations ($\mu$g/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/m³) 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.