

Appendix C: Model Performance Evaluation

Ohio EPA conducted model performance analyses using 2012-2014 actual emissions from the General James M. Gavin Plant and the Kyger Creek Station, modeling the impact of these facilities at the location of monitor 39-195-0003. This monitor is located 13 km to the Northeast of the General James M. Gavin plant in Pomeroy, Ohio, and was sited to monitor the combined impact of emissions from the General James M. Gavin and Kyger Creek Station facilities.

Rationale

As outlined in the proposed Appendix W, current non-default/beta (ADJ_U* and LOWWIND3) options have been incorporated into AERMOD to address over-predictions under low-wind/stable conditions. The proposed Appendix W further states, these beta options have been evaluated by EPA and other researchers and are recommended updates to be incorporated into the regulatory default version of the AERMOD modeling system. At the 11th Modeling Conference in Research Triangle Park, NC, August 12, 2015, in the presentation “Proposed Updates to AERMOD Modeling System”¹, U.S. EPA presented multiple field studies for which these beta options have been evaluated and shown to improve model performance as compared to monitor values. Additionally, in the presentation “AERMOD Low Wind Speed Evaluation with Tall-Stack Databases”² improvement over the default options is shown by using the beta options for two separate field studies. The meteorological conditions of one of the studies (Gibson Generating Station in SW Indiana) were such that key hours generally did not exhibit extremely low wind speeds. Even in this study, though results are relatively insensitive to the LOWWIND options, they do still demonstrate slight improvement with the beta options in use. Both presentations conclude that these proposed options should improve AERMOD predictions and should be included as default regulatory options.

Upon conducting initial modeling using current default regulatory options, Ohio EPA found that AERMOD significantly overestimated SO₂ concentrations at monitor 39-195-0003. The computed three-year design value was 41 ppb compared to an actual monitored design value of 30 ppb, without consideration of background concentration in the modeled design value. Ohio EPA identified that a majority (57%) of available meteorological surface data hours from the 2012 to 2014 period modeled for this location fall under stable conditions. Stable hours were computed for each year of the three years, as well as the entire three-year period, as shown in Table 1. Considering the prevalence of stable hours over the modeled time series, as well as the documented ability of the beta options to improve model performance, Ohio EPA conducted further model performance evaluation to determine if inclusion of the beta options could correct the over-prediction of SO₂ concentrations by AERMOD in this scenario.

¹ http://www.epa.gov/ttn/scram/11thmodconf/presentations/1-5_Proposed_Updates_AERMOD_System.pdf

² http://www.epa.gov/ttn/scram/11thmodconf/presentations/2-3_Low_Wind_Speed_Evaluation_Study.pdf

	2012	2013	2014	3-year mean
% stable from total hours	56.6	57.2	57.2	57.0

Table 1: Percentage of hours of non-missing data classified as stable conditions, 2012-2014.

Methodology

Appendix A of Ohio's recommended designation submittal details the modeling approach employed, utilizing the most up-to-date versions of AERMOD and the associated preprocessors available at the time of the modeling analyses. It also details the preparation of meteorological data and generation of appropriate surface and profile files for use with AERMOD, as well as detailing what raw meteorological and SO₂ emissions data were used.

Pursuant of identifying the most appropriate modeling techniques for this source area, Ohio EPA performed modeling over the 2012 to 2014 period with the General James M. Gavin and Kyger Creek sources using AERMOD under two different parameter formulations – one with the beta friction velocity (ADJ_U*) option and beta low wind (LOWWIND3) option enabled (denoted Beta in this document), and one with the default options – no beta options enabled (denoted Default).

To evaluate the validity and performance of the two formulations, Ohio EPA performed a comparison of the modeled values from each formulation at the location of the Pomeroy, OH SO₂ ambient air quality monitor, with the monitor values. For overall model performance, Ohio EPA computed what would be the 3-year design value for SO₂ from 2012 to 2014 for both modeling scenarios for comparison against the actual design value reported for that time period at the monitor location. Additionally, Ohio EPA compared an array of daily maximum thresholds for each of the three years with monitor data.

Design Value Comparison and Results

From the modeling results from the two formulations over the three year modeling period, hourly SO₂ values from a receptor placed at the Pomeroy monitor location were isolated for analysis. From these values, daily maximum values were computed for each day over the three year period and subsequently, the 99th percentile daily maximum value for each of the three years was identified. The mean of these three 99th percentile values is used for the computed Design Value from each modeling formulation, less an acceptable background value. Figure 1 shows the results of this analysis.

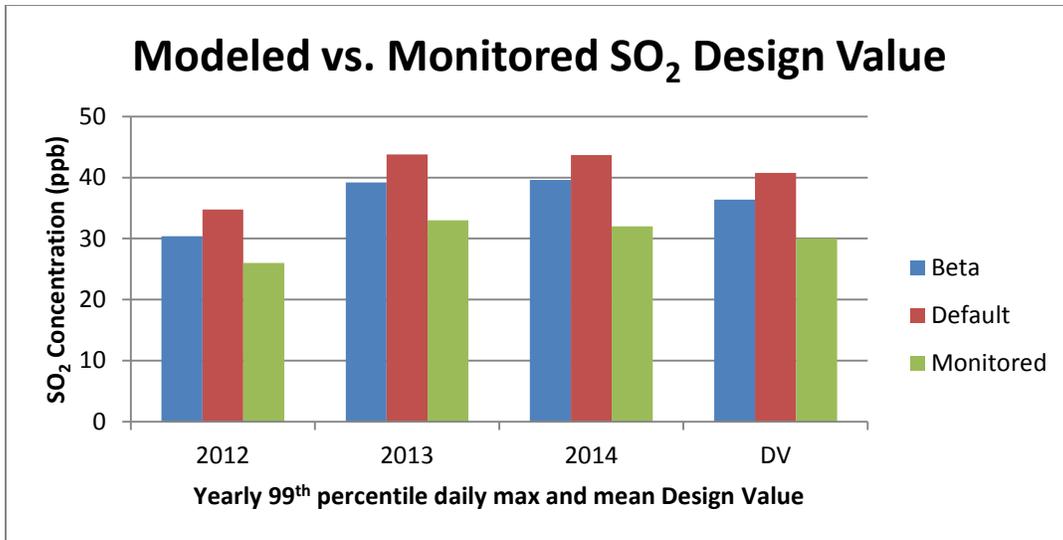


Figure 1: Annual 99th percentile daily max and mean design value for the three year period of SO₂ concentration at monitor 39-195-0003 with modeled design values, with and without beta options, no background.

As shown in Figure 1, both modeling formulations overestimate the monitored SO₂ values at the Pomeroy monitor, even without adding a background SO₂ value to the model results with respect to monitored concentrations. The monitor design value is 30 ppb, and the design value computed from modeling with beta options is 36 ppb. The design value from Default options is 41 ppb. For each yearly 99th percentile daily max value, and in turn the three-year design value, the modeled results with the beta options enabled show closer agreement to the monitor value, representing a substantial improvement in model performance using these beta options.

In-Depth Model Performance

In order to further evaluate the appropriateness of the different model formulations, Ohio EPA performed a more in-depth analysis of not only the design 99th percentile daily maximum values from each year and the resultant design value, but also the computed model results at other percentiles. Utilizing the daily maximum values for the three year period as described in the previous section, the 99th, 90th, 75th, 50th, 25th and 10th percentile daily maximum values for each year were identified for the different model formulations for comparison against monitored values. These results are shown in Figures 2, 3, and 4 for years 2012, 2013, and 2014, respectively. As with the Design Value comparison, background has not been added to the model results.

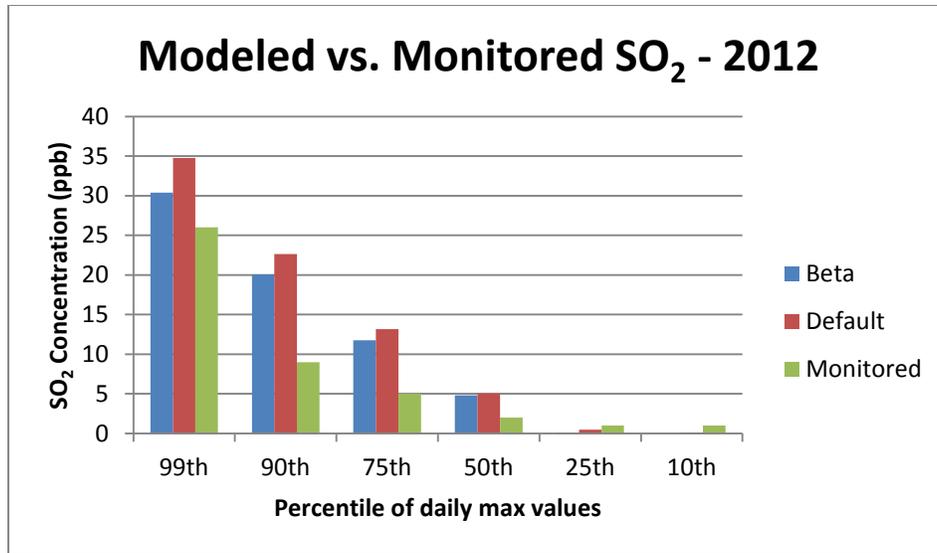


Figure 2: Comparison of SO₂ concentrations between the two model formulations and monitored values over a range of daily maximum thresholds for 2012 at the location of the Pomeroy monitor.

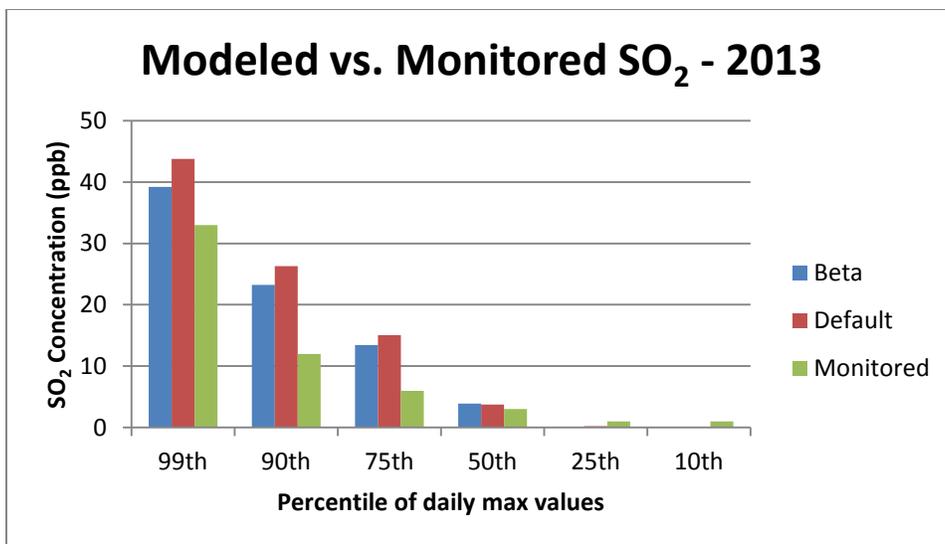


Figure 3: Comparison of SO₂ concentrations between the two model formulations and monitored values over a range of daily maximum thresholds for 2013 at the location of the Pomeroy monitor.

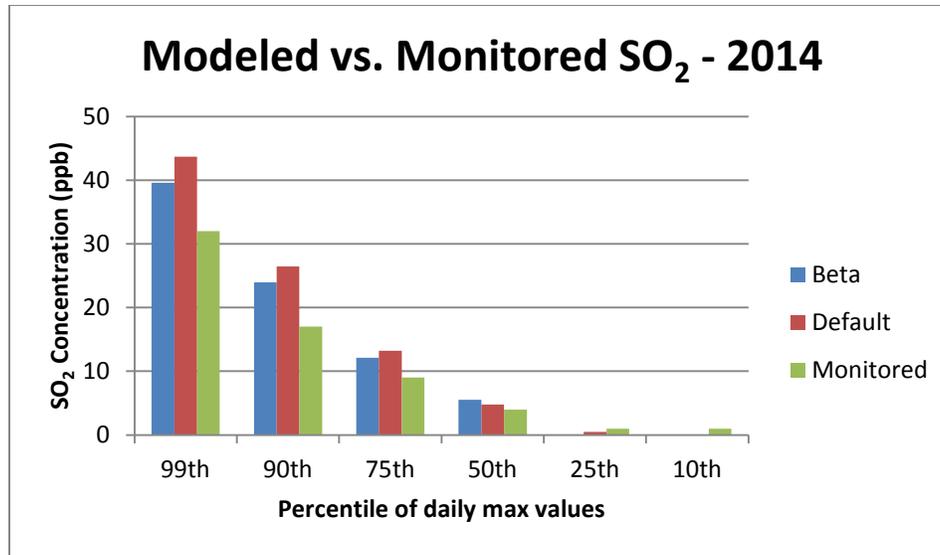


Figure 4: Comparison of SO₂ concentrations between the two model formulations and monitored values over a range of daily maximum thresholds for 2014 at the location of the Pomeroy monitor.

As Figures 2-4 show, both modeling formulations consistently overestimated SO₂ concentrations for all daily maximum values at or above the 50th percentile of daily maximum values, even without an added background concentration. Below the 50th percentile, both model formulations underestimated the monitored values without background, but as the monitored values at the 25th and 10th percentiles are in the 1 ppb range, this underestimation is negligible. With background concentration included, both model formulations overestimate the monitored values at all percentiles. For each year and percentile, then, except for 2013 and 2014 at the 50th percentile, the model formulation with the beta options enabled resulted in SO₂ closer to the monitored values. Even considering the 50th percentile values, the model formulation with beta options enabled was in better agreement with the monitored value for 2012. For every other percentile threshold considered, model performance was consistently and demonstrably improved with the beta options enabled. At the 50th percentile threshold, each of the two model formulations performed better in different years.

Conclusions

Ohio EPA's model performance evaluation conclusively demonstrates that AERMOD performance with respect to monitored values in the General James M. Gavin source area – both when considering elevated SO₂ concentrations which are used for design value calculation, and across a range of daily maximum concentration thresholds – improves with the ADJ_U* and LOWWIND3 options enabled. Additionally, both modeling scenarios consistently overestimate SO₂ concentrations as compared to monitor values in both analyses performed, which indicates that the use of the beta options will still provide conservative estimates of SO₂ concentrations. It should also be

noted that Ohio EPA has, for the purposes of the designation modeling, considered a conservative 10 ppb background concentration. These analyses demonstrate a clear improvement in model performance for this source area by enabling the ADJ_U* and LOWWIND3 options, consistent with previously cited model performance evaluations. Further, Ohio EPA's analysis in this source area provides an additional example of improvements expected by incorporating these beta options as default regulatory options, as suggested in the proposed Appendix W. Ohio EPA concludes, therefore, that enabling the ADJ_U* and LOWWIND3 options was the most appropriate modeling formulation for modeling in this source area.