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Analysis of SO_2 Modeling Issues for Ameren Power Plants in the Greater St. Louis Area

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1. Introduction

In 2010, the United States Environmental Protection Agency (EPA) promulgated[1] a stringent National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) with a 1-hour averaging time. EPA's implementation of this new standard has considered both monitoring and modeling approaches, and the agency plans to address large SO_2 sources over the next few years with a hybrid approach that could include a combination of modeling and/or monitoring. In most cases, the use of modeling that does not use actual emission levels as input can lead to a distorted assessment of air quality.

Various environmental groups, including the Sierra Club, have performed modeling exercises for the 1-hour SO_2 NAAQS compliance demonstrations to support their contentions of alleged nonattainment to EPA. One such demonstration[2] involves coal-fired power plants in the St. Louis, Missouri area. The Sierra Club's modeling utilized peak, allowable emission rates that were incorrectly assumed to occur during all hours modeled to demonstrate their contention that SO_2 concentrations would be above the NAAQS by a large margin. They also mischaracterized some of the stack emission parameters and therefore incorrectly modeled the plume rise and dispersion from the Ameren sources. In reality, the Sierra Club modeling significantly overstates emissions from Ameren's facilities as well as their impact on ambient air quality. The Sierra Club modeling does not present credible results, and should be treated as a conservative screening analysis, at best. It is not technically credible for the results of a conservative screening analysis to be treated as a final answer that should be then be publicized as a realistic modeling outcome.

The Sierra Club also asserts that the areas of their incorrectly modeled NAAQS violations result in health risks due to the SO_2 emissions. In rebuttal, we demonstrate that available SO_2 monitoring data indicates otherwise, that concentrations are below the NAAQS. Our analysis reflects that the areas around Meramec, Labadie, and Rush Island are all in compliance with the 1-hour SO_2 NAAQS and that regulatory decisions should not be based on the Sierra Club's inaccurate and misleading modeling efforts.

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[1] 75 FR 35520, Jun 22, 2010.

[2] http://www.epa.gov/region07/air/quality/pdf/aq_2012amnp_mo_comments.pdf. While the Sierra Club has provided regulators and public officials with a report of their findings, the underlying data and modeling inputs have not been made publically available for independent review and verification.

In January 2014, EPA released[3] the SO_2 NAAQS Designations Modeling Technical Assistance Document and the Source-Oriented SO_2 Monitoring Technical Assistance Document (TADs) for public review and comment. EPA developed these documents to assist state, local, and tribal air agencies to characterize ambient SO_2 air quality through modeling or monitoring in areas near emission sources.

The modeling TAD also noted that "other parties" may wish to accelerate the pace of the NAAQS review and submit their own "credible" modeling information without consulting the sources being modeled. However, such modeling information should not be considered "credible" until a source-specific protocol for modeling is submitted and approved by a regulatory agency. This approval should not be granted unless and until the owner or operator of the source has an opportunity to review and comment on the proposed modeling approach so as to ensure accurate and credible assumptions are utilized.

In many cases, such third-party modeling could have the following limitations:

- Input stack information is incorrect;
- Fenceline information is not accurate;
- Actual hourly emissions data is not used, *which is a key issue in the Sierra Club modeling*, as noted below;
- A more accurate version of AERMOD, utilizing updated low wind speed beta options, is not used.

Any of these issues could lead to incorrect and misleading modeling results that would disqualify them as being credible evidence of NAAQS "violations."

[3] Available at http://www.epa.gov/oaqps001/sulfurdioxide/pdfs/SO2ModelingTAD.pdf and http://www.epa.gov/oaqps001/sulfurdioxide/pdfs/SO2MonitoringTAD.pdf.

2. Review of SO_2 NAAQS Compliance for the Ameren Plants

Meramec

Whenever possible, modeling demonstrations to determine NAAQS compliance should be challenged by reviewing available monitoring data. The Sierra Club modeling covers the period of 2006-2010. An SO_2 monitor in the area that was operating during that period is South Broadway, as shown in Figure 1. While this monitor was discontinued after 2010, it is one of the closest to the Meramec plant and can be used to check the modeled results presented by the Sierra Club in their report.

The modeled design concentration at this monitoring location presented by the Sierra Club is about 180 ppb for allowable emissions (from Meramec contributions including a conservative background of about 45 ppb, leaving the Meramec impact portion of the total as about 135 ppb). This should be compared to 2009-2010 South Broadway monitoring (actual) concentrations of only about 35 ppb, which is even lower than the high background concentration assumed by the Sierra Club, obtained from a distant monitor within the city of St. Louis. The 50th percentile monitored value at the South Broadway monitor is about 8 ppb in 2009-2010 (which can be considered as a reasonable background estimate), leaving 27 ppb actually attributable to the measured impact of Meramec and other SO_2 sources. Even assuming that the remaining 27 ppb can be attributed entirely to Meramec and including contributions from other emission sources[4], this comparison (135 vs. 27 ppb) results in at least a factor-of-5 overprediction with Sierra Club's modeling at that location. Application of a factor-of-5 correction factor to Sierra Club's modeling results overall **would have the effect of showing modeled NAAQS *compliance* at virtually all areas in the modeling domain**, and recent EPA modeling updates (AERMET version 14134) for handling low wind speed effects would address elevated areas to the west of the plant.

The Meramec plant has reduced emissions in recent years as they proceed toward more complete use of very low sulfur (Powder River Basin) coal. Figure 2 shows the annual average emissions trend from 2007 – 2012, and the daily SO_2 emissions trend is shown in Figure 3. It is clear from Figure 3 that the trend of the emissions is downward, especially first after 2007 and then again after 2011. The facility-wide allowable emissions modeled by the Sierra Club was about 23,198 lb/hr, but the average emissions during the period 2009-2010 was in the range of 4,000-5,000 lb/hr, which alone accounts for the factor-of-5 overprediction at the South Broadway monitor. Since 2011, the daily average SO_2 emissions have never exceeded 4,000 lb/hr and have averaged less than that level. Accordingly, if the Sierra Club were to redo its modeling with current-day actual hourly SO_2 emissions and appropriate low wind speed options available for AERMOD, they would likely show modeled attainment with the 1-hour SO_2 NAAQS for Meramec.

[4] Area-wide sources (diesel-fueled vehicles) and coal-fired industrial boilers are examples of important sources of SO_2 emissions in St. Louis County and adjacent counties in the greater St. Louis area.

Figure 1: Map Showing Meramec Plant and Area SO_2 Monitor

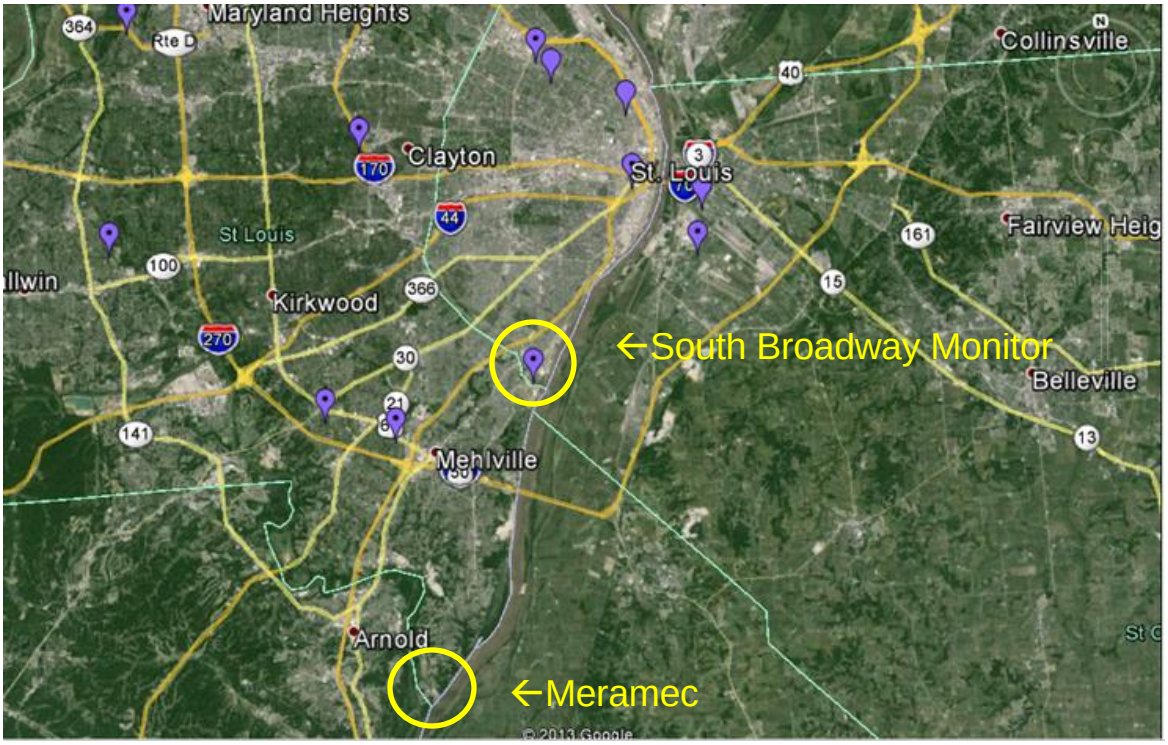


Figure 2: Trend of Annual SO_2 Emissions from Meramec Units

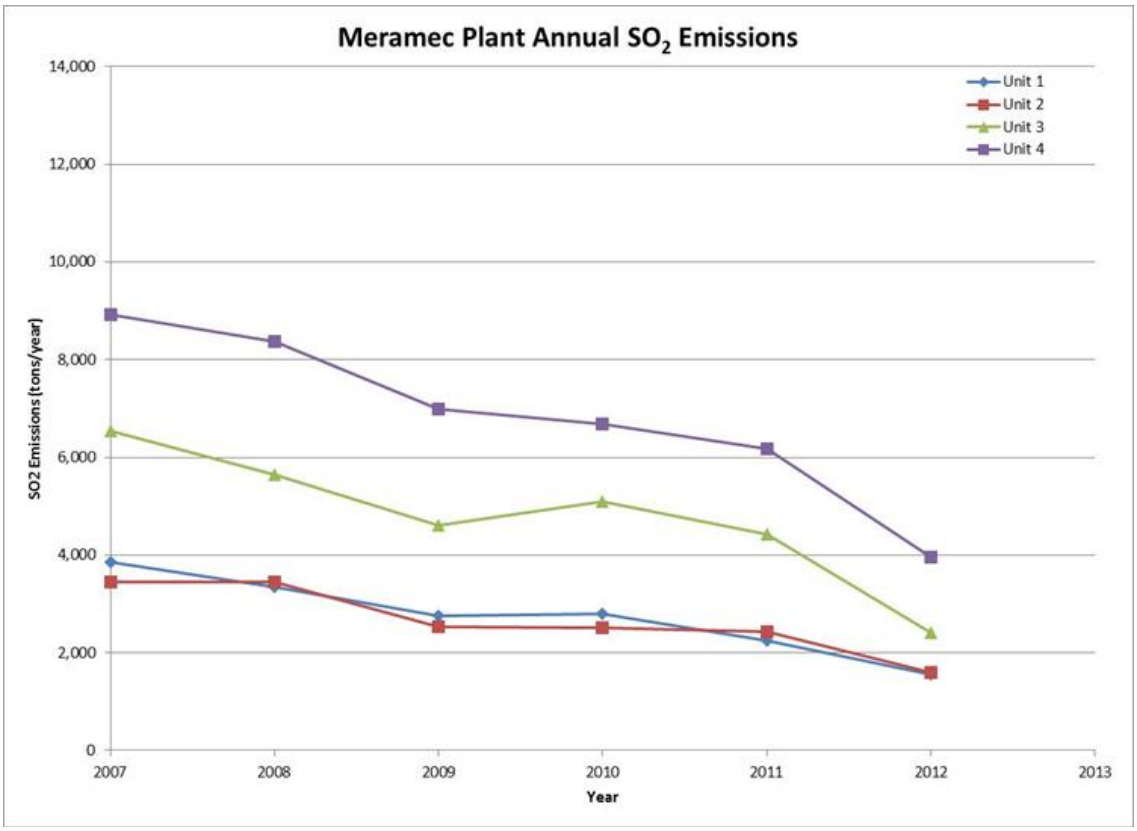
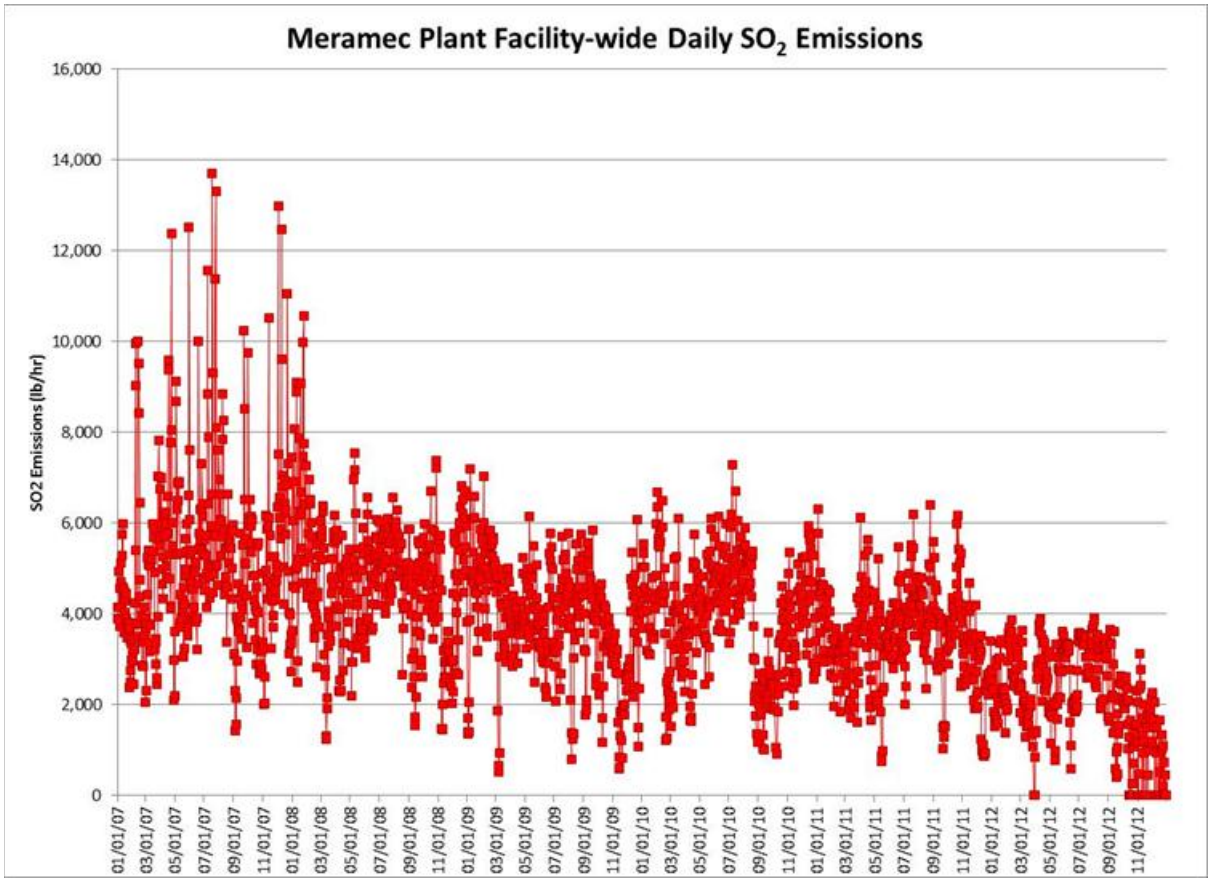


Figure 3: Trend of Daily SO_2 Emissions from Meramec Units



Labadie

An SO_2 monitor close to the plant that was operating during the period of 1987-1998 has its location shown in Figure 4. This monitor was actually moved in December 1994, but its two locations were between 2 and 5 km from the plant in a frequent downwind direction (a southerly wind; see wind rose in Figure 5).

This monitor was well-sited, located in the general area of the maximum observed concentrations from stack emissions of the nature of those from Labadie.

Emissions at Labadie Generating Station decreased by about 75% since monitoring began in 1987 to when it ended in 1998 as shown in Figure 6, coinciding with the switch from higher sulfur coal to Powder River Basin coal in the late 1990s. The 99th percentile 1-hour SO_2 monitored values also decreased in a similar manner during this period. The last year of monitoring data in 1998 shows that the concentrations at the Augusta monitor were well below the 1-hour NAAQS (about 70% of the 75 ppb SO_2 NAAQS). Emissions have been relatively constant since the change to PRB coal, which implies that if a monitor were still in that location today, it would likely show compliance with the NAAQS.

Figure 4: Monitor Locations near Labadie Power Plant

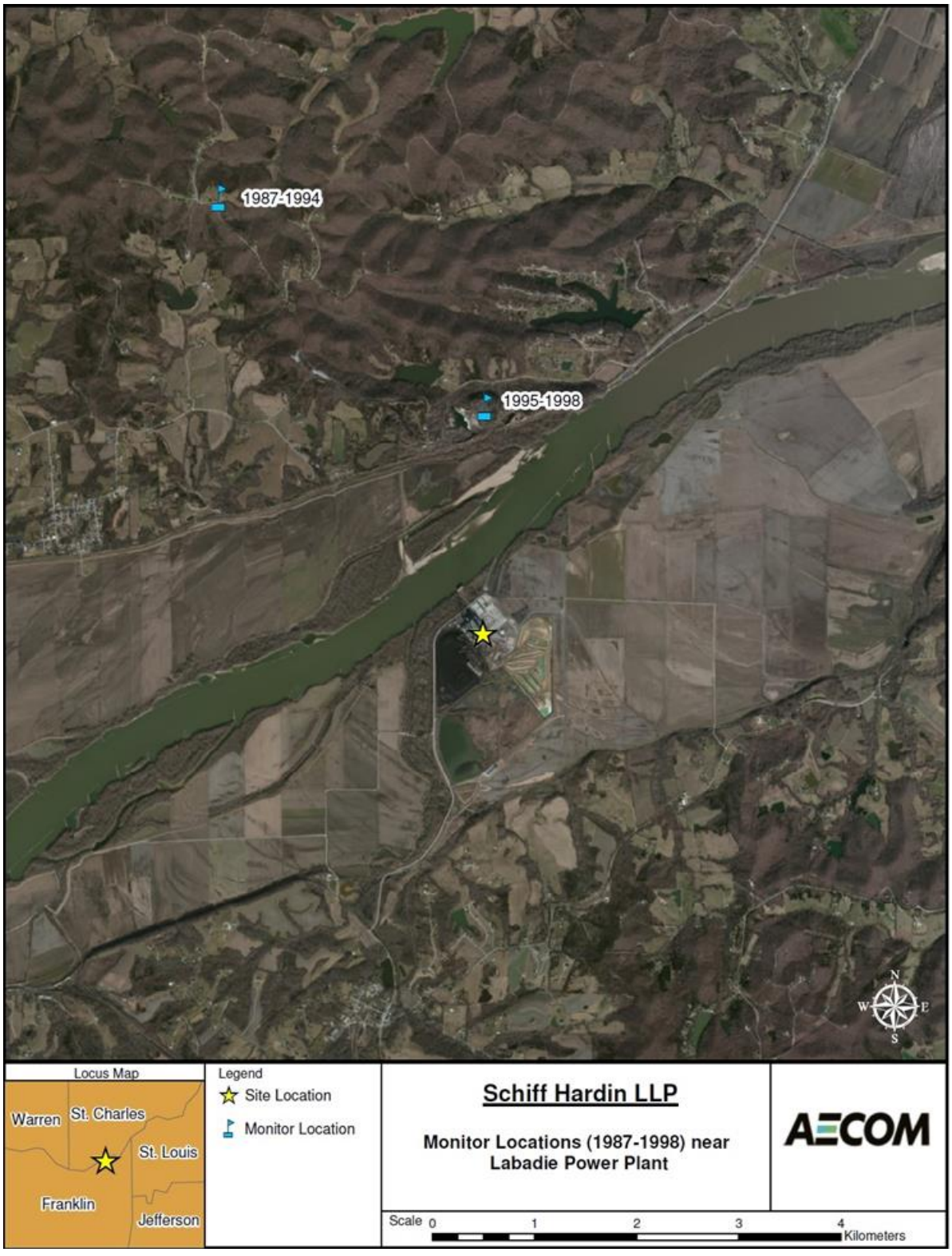


Figure 5: Spirit of Saint Louis Airport Wind Rose (2006-2010)

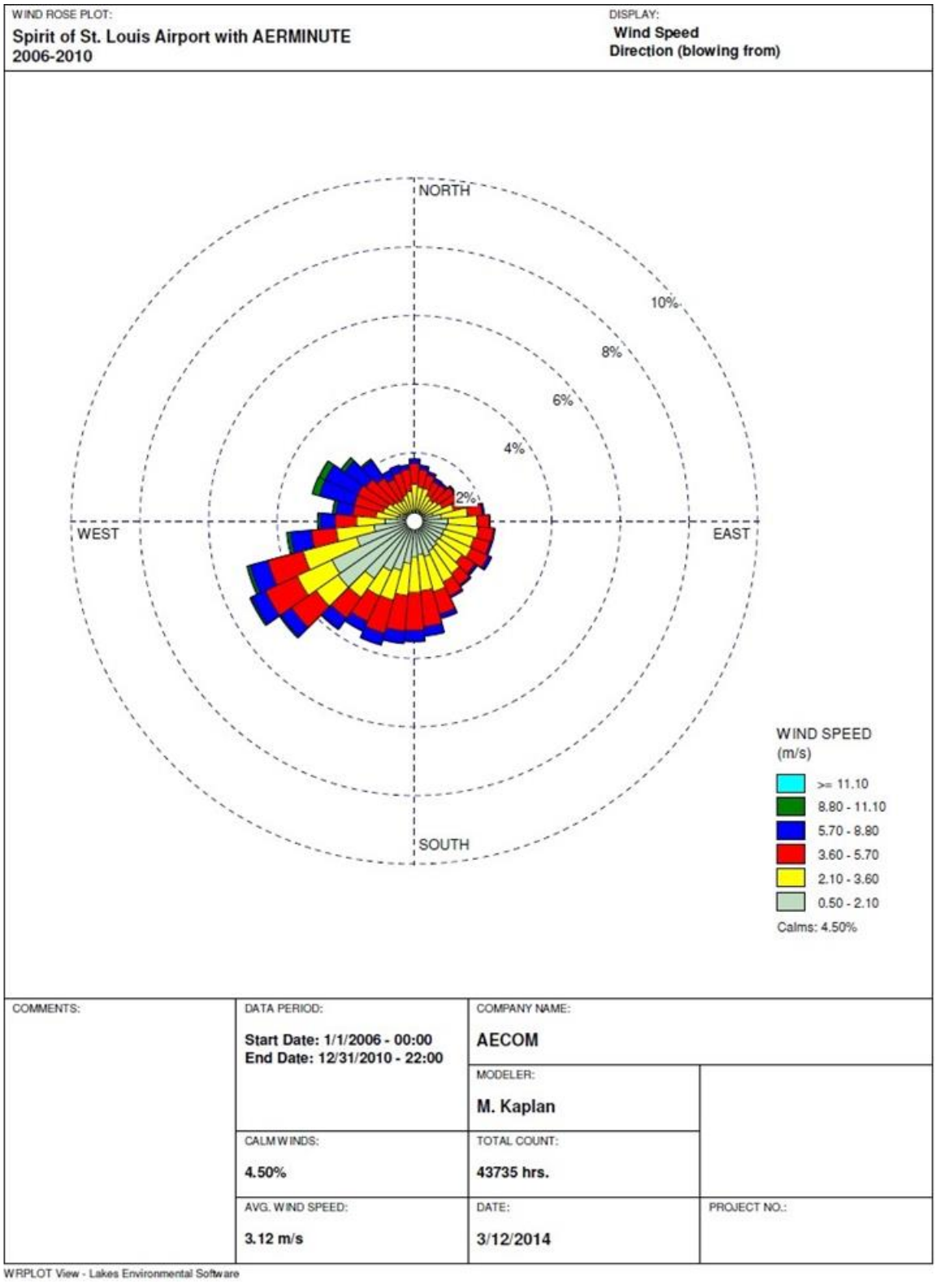
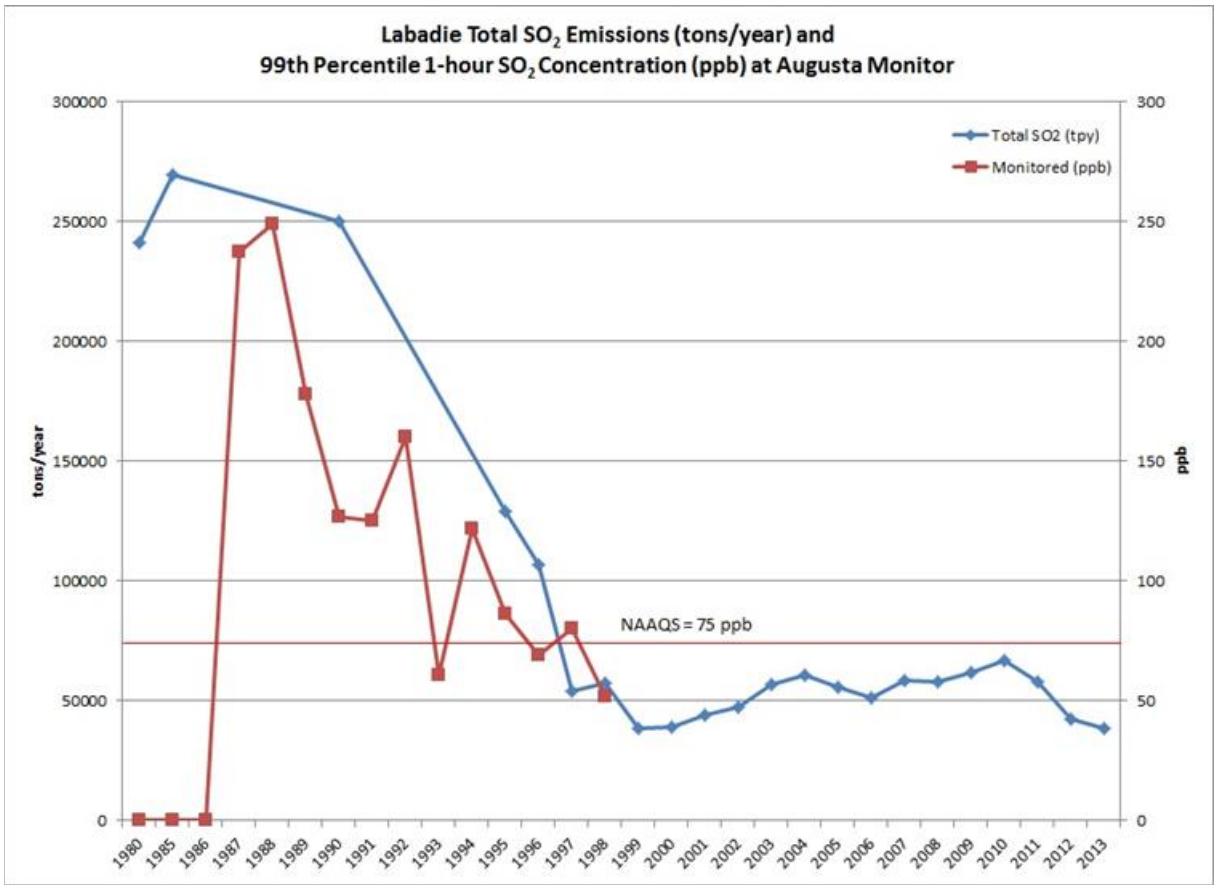


Figure 6: Trend of Annual SO_2 Emissions from Labadie Generating Station



At a minimum, modeling to be used in lieu of monitoring to show NAAQS compliance must use actual hourly emissions data and actual stack heights. However, the Sierra Club's modeling used both allowable emission rates and peak actual emission rates. Both sets of these emission rates are often much higher than actual hourly emissions as shown in Figure 7, and can only be regarded as a conservative screening analysis. If such a conservative modeling analysis were to result in NAAQS compliance, then these results could be presented as clear evidence of NAAQS compliance with a substantial margin. Otherwise, if NAAQS violations are modeled with such a conservative approach, it is prudent to proceed to a refined analysis. Instead, the Sierra Club has inappropriately decided to immediately publish these results as "final" and declare evidence of NAAQS violations. In addition to the conservative emission rates, the Sierra Club did not properly merge the stack exhaust flows from Units 3 and 4 in their modeling. As shown in Figure 8, these units share a common stack. Modeling Units 3 and 4 from the same stack would increase the plume rise and decrease modeled impacts from these units.

Figure 7: Trend of Hourly SO_2 Emissions from Labadie Generating Station (2011-2013)

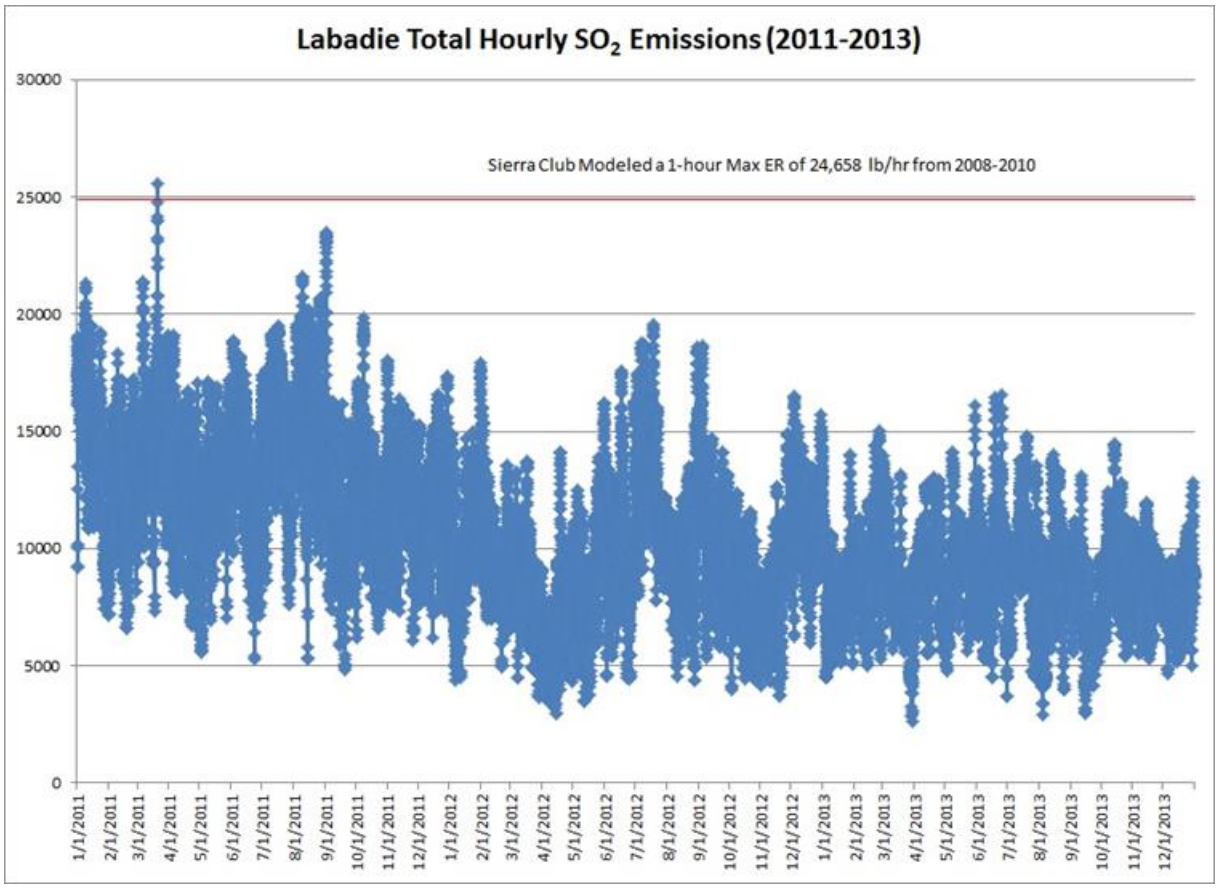


Figure 8: Stacks at Labadie Generating Station

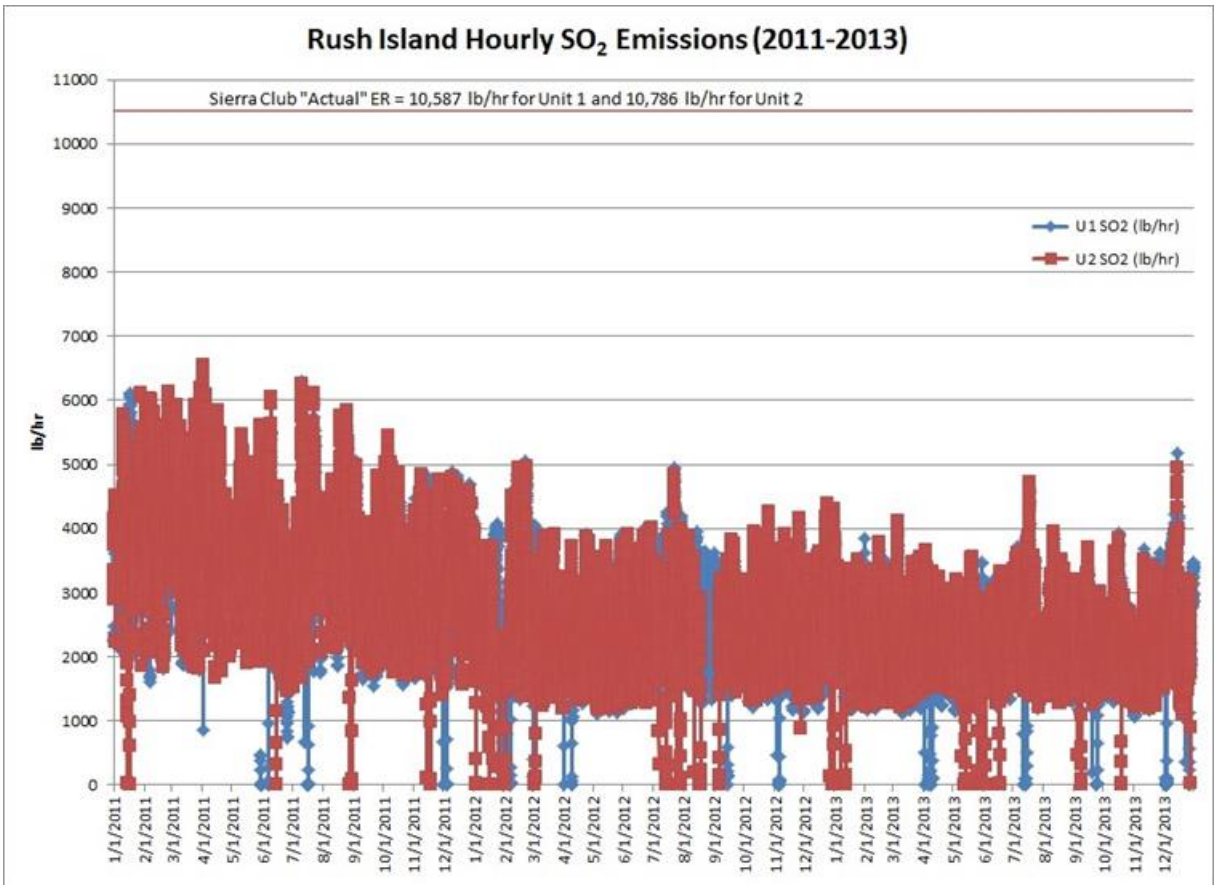
Sierra Club employed the 3-year (2008-2010) 99th percentile average concentration of 44.7 ppb (117 μg/m^3) from the Margaretta monitor in Saint Louis City. This monitor is not representative of background, as it is located in a congested area within 10 kilometers of several steel manufacturing facilities in Illinois and the North Saint Louis waterfront industrial area. AECOM would propose a more representative rural monitor such as the one located in Nilwood, Illinois. The 3-year 99th percentile average concentration for 2008-2010 at this monitor is 17 ppb (44.54 μg/m^3) and for 2011-2013, the average is 7.7 ppb (20.1 μg/m^3). In addition, EPA allows the use of a seasonal hour-of-day background concentration to be added concurrently in AERMOD, which a refined analysis should include.

Rush Island

The Sierra Club employed similar conservative procedures to model the Rush Island Plant. The allowable and highest actual emission rates are considerably higher than the hourly emission rates in 2011-2013 as shown in Figure 9. The same conservatively high ambient background concentration was applied for Rush Island as for Labadie. The two units at Rush Island share a common stack as shown in Figure 10 and were erroneously modeled by the Sierra Club as separate stacks. This resulted in an under-prediction of plume rise and an over-prediction of ground-level concentrations.

The peak modeled AERMOD impacts reported by the Sierra Club occur in higher terrain to the northwest and southwest of the plant. As discussed in the review of the Meramec modeling, AERMOD tends to over-predict in areas of terrain in low wind speed conditions if low wind options available in the recent AERMOD modeling system release (version 14134) are not used. As shown in Table 1, the stack characteristics for Labadie and Rush Island are very similar and the elevated terrain in the vicinity of both facilities is approximately 270 meters.

Figure 9: Trend of Hourly SO_2 Emissions from Rush Island Plant (2011-2013)



Emissions of SO_2 at Rush Island have been consistently about 50-75% relative to that of Labadie since the mid-1990s. Considering the monitor near Labadie showed compliance with the 1-hour SO_2 standard and emissions at Rush Island are lower with similar terrain and stack characteristics, it follows that the area in the vicinity of Rush Island is likely to be in compliance with the SO_2 NAAQS.

For the Herculaneum nonattainment area, emissions from the Doe Run lead smelter were the cause of the high monitored concentrations. This is clearly evident in that since the smelter was shut down at the end of 2013, monitoring data[5] values through mid August 2014 show a peak hourly concentration of 21.7 ppb, which is less than 30% of the NAAQS of 75 ppb, and a 99th percentile peak observation of less than 10 ppb. In contrast, the 99th percentile peak daily 1-hour maximum concentrations for previous years were 146.3, 267.6, and 143.2 ppb for 2011, 2012, 2013, respectively. It is clearly apparent that the shutdown of the smelter has resolved the nonattainment situation at the monitor.

[5] Available from http://www.epa.gov/airdata/ and MDNR.

In light of the recent monitoring evidence at the Herculaneum monitor which strongly indicates that there is no longer a nonattainment issue, the appropriate SO_2 emissions inventory to model for the attainment demonstration would be no emissions for the smelter, and current emissions for the other SO_2 sources in the area. In such a case, the modeling approach described in the SO_2 Data Requirements Rule (use of actual hourly emissions) should apply for the remaining sources in the Herculaneum area.

In summary, we conclude that the areas around Meramec, Labadie, and Rush Island are all in compliance with the 1-hour SO_2 NAAQS.

Table 1: Physical Stack Comparison for Labadie, Rush Island, Bull Run and Kincaid Power Plants

Stack Parameter	Labadie Units 1 & 2	Labadie Units 3 & 4	Rush Island Units 1 & 2	Bull Run	Kincaid
Release Height [m]	213.4	213.4	213.4	244.0	187.0
Gas Exit Temp. [°K]	442.8	437.5	432.4	399.0	416.6
Gas Exit Velocity [m/s]	35.1.	34.7	33.0	18.9	19.8
Inside Diameter [m]	6.2	8.8	8.8	9.0	9.0

Figure 10: Stacks at Rush Island Plant