Analysis of 1-Hour SO_2 NAAQS Exceedances in Savannah and Rome

Submitted to:
Jimmy Johnston
Program Manager 2
Planning & Support Program

Submitted by:
Data & Modeling Unit
Planning & Support Program

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EXECUTIVE SUMMARY

On June 2, 2010, U.S. EPA strengthened that National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) by adopting a new 1-hour standard of 75 parts per billion (ppb)[1], effective August 23, 2010. EPD has identified three ambient monitors that were recording 1-hour values in excess of the standard. These monitors are: Savannah – Lathrop & Augusta, Savannah – East President Street, and Rome – Coosa Elementary. In order to identify the probable cause of these high readings, EPD conducted a set of analyses. These analyses included the following steps:

1) identification of nearby SO2 sources and Q/d (emissions/distance) analysis;
2) back trajectory analysis on SO2 exceedance days, and
3) AERMOD modeling to quantify source contributions to SO2 exceedances.

The AERMOD modeling was conducted using emissions and stack data requested by EPD and received from the SO_2 sources in March and May, 2013, respectively. Following this request, additional exceedances were measured by the Savannah - Lathrop & Augusta monitor and by the Rome monitor. Additional back trajectory analyses were conducted on the exceedances that were measured prior to November, 2013.

Based on these analyses, it appears that SO2 emissions from Southern States Phosphate & Fertilizer caused or contributed to the SO2 NAAQS exceedances at the Savannah - E. President monitor; SO2 emissions from International Paper – Savannah Mill caused or contributed to the SO2 NAAQS exceedances at the Savannah - Lathrop & Augusta monitor; and SO2 emissions from International Paper – Rome Linerboard (formerly Temple Inland – Rome) and to a lesser degree Plant Hammond caused or contributed to the SO2 NAAQS exceedences at the Rome - Coosa Elementary School monitor.

Unofficial data indicates that the 3-year design value for Savannah – Lathrop & Augusta has violated the NAAQS.

INTRODUCTION

Two SO_2 monitors in Savannah (E. President and Lathrop & Augusta) and one SO_2 monitor in Rome (Coosa Elementary School) measured multiple exceedances of the 1-hour SO_2 NAAQS (75 ppb) from 2011 to 2013. Based on unofficial data through November, 2013, the 3-year design value for the Savannah Lathrop & Augusta monitor is now 80 ppb, which is a violation of the NAAQS. Although there were multiple exceedances of the 1-hour SO_2 NAAQS at the Savannah - E. President and Rome – Coosa Elementary monitors, the three year design value remained below the NAAQS at these two sites. The purpose of this analysis is to help identify

[1] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

which sources contributed to the 1-hour SO_2 exceedances. This document will focus primarily on SO_2 exceedances in 2011, 2012, and early 2013, but also includes some data for exceedances in later 2013. A meteorology analysis of the September exceedances at Lathrop & Augusta is included in Appendix A. Appendix B discusses three days in Savannah where the winds were north-northeast (NNE), but SO_2 remained low.

Table 1 identifies the 1-hour SO_2 exceedances that were included as part of these analyses. The technical analysis includes:

1) identification of nearby SO_2 sources and Q/d (emissions/distance) analysis;
2) back trajectory analysis on SO_2 exceedance days; and
3) AERMOD modeling to quantify source contributions to SO_2 exceedances.

Table 1. Exceedances of the 1-hour SO2 NAAQS included in analyses.

Site	Date	Time of Peak SO2	SO2 Peak (ppb)
E. President (13-051-0021)	2/13/2011	9:00	93.0
	10/20/2012	9:00	87.3
	11/23/2012	9:00	96.6
	11/24/2012	2:00	77.9
	12/19/2012	10:00	79.3
	1/21/2013	10:00	96.0
Lathrop & Augusta (13-051-1002)	5/5/2011	6:00	75.8
	11/24/2011	8:00	94.8
	12/2/2011	10:00	94.2
	10/26/2012	8:00	111.7
	11/17/2012	9:00	127.6
	12/14/2012	7:00	87.1
	9/27/13	8:00	117.5
	9/28/13	8:00	92.7
	9/29/13	8:00	142.1
	10/8/13	9:00	101.1
	11/5/13	10:00	76.3
	11/13/13	7:00	79.9
	11/24/13	7:00	76.6
	11/30/13	12:00	77.3
Coosa Elementary School (13-115-0003)	2/25/2011	0:00	96.0
	4/3/2011	18:00	153.1
	4/4/2011	15:00	115.6
	4/25/2011	16:00	76.3
	11/13/2011	13:00	161.8

Site	Date	Time of Peak SO2	SO2 Peak (ppb)
Coosa Elementary School (13-115-0003)	11/14/2011	12:00	81.4
	2/13/2012	12:00	75.9
	2/23/2012	14:00	133.5
	2/29/2012	21:00	160.6
	3/2/2012	11:00	95.6
	12/6/2013	11:00	88.0

IDENTIFICATION OF NEARBY SO_2 SOURCES

The 2011 NEI was used to identify all point sources within 50 kilometer (km) of each monitor (Table 2, Table 3 and Table 4). The SO_2 emissions were identified in tons per year (Q) and the distance from each point source to the associated SO_2 monitor was calculated in km (d). Next, Q/d, cumulative Q/d, and percent of the cumulative Q/d were calculated for each source. Sources that had a Q/d $\geq$ 20 were identified for further analysis (identified with bold). Sources that had a Q/d < 20 were no longer included in the analysis. The sources that were identified for further analysis accounted for more than 99% of the cumulative Q/d.

Table 2. Point sources within 50 km of Savannah - E. President SO_2 monitor.

AIRS NO.	Facility Name	**SO2 (TPY)**	Distance [km]	**Q/d**	Cumulative Q/d	Percent Cum Q/d
05100077	**Southern States Phosphate & Fertilizer**	**1211.44**	**1.48**	**819.27**	**819.27**	**43.9%**
05100007	**International Paper - Savannah**	**4232.78**	**7.83**	**540.52**	**1359.79**	**72.9%**
05100006	**Ga Power Company - Plant Kraft**	**2806.00**	**12.70**	**221.01**	**1580.80**	**84.8%**
10300007	**Georgia-Pacific Consumer Products LP (Savannah River Mill)**	**3724.79**	**32.41**	**114.92**	**1695.72**	**91.0%**
05100008	**Savannah Acid Plant LLC**	**120.00**	**2.49**	**48.17**	**1743.89**	**93.5%**
05100010	**Weyerhaeuser Company**	**605.44**	**14.53**	**41.67**	**1785.57**	**95.8%**
05100110	**Imperial-Savannah, L.P.**	**502.26**	**12.40**	**40.51**	**1826.08**	**98.0%**
10300003	**Ga Power Co Plt McIntosh**	**691.81**	**33.70**	**20.53**	**1846.60**	**99.1%**
05100076	Colonial Terminals, Inc.	82.15	6.58	12.48	1859.09	99.7%
05100148	Arizona Chemical Corporation	31.32	7.66	4.09	1863.17	99.9%
10300014	Ga Power Company - McIntosh Combined Cycle Facility	18.07	33.69	0.54	1863.71	100.0%
17900001	Interstate Paper LLC	11.52	49.74	0.23	1863.94	100.0%
10300012	Effingham County Power, LLC	4.70	33.20	0.14	1864.08	100.0%
05100003	Southern LNG Company, L.L.C. - Elba Island LNG Terminal - (Kinder Morgan , Inc.)	0.45	4.36	0.10	1864.19	100.0%
10300004	Simpson Lumber Company, LLC	1.65	33.28	0.05	1864.24	100.0%
05100012	NuStar Asphalt Refining, LLC	0.16	8.71	0.02	1864.25	100.0%
05100046	Gulfstream Aerospace Corp	0.08	15.74	0.00	1864.26	100.0%
05100017	Ga Power Company - Plant Boulevard	0.02	7.76	0.00	1864.26	100.0%

Table 3. Point sources within 50 km of Savannah - Lathrop & Augusta SO_2 monitor.

AIRS NO.	Facility Name	SO2 (TPY)	Distance [km]	Q/d	Cumulative Q/d	Percent Cum Q/d
05100007	**International Paper - Savannah**	**4232.78**	**1.83**	**2312.05**	**2312.05**	**69.5%**
05100006	**Ga Power Company - Plant Kraft**	**2806.00**	**6.61**	**424.80**	**2736.85**	**82.3%**
05100077	**Southern States Phosphate & Fertilizer**	**1211.44**	**6.59**	**183.91**	**2920.76**	**87.8%**
10300007	**Georgia-Pacific Consumer Products LP (Savannah River Mill)**	**3724.79**	**27.51**	**135.40**	**3056.16**	**91.9%**
05100110	**Imperial-Savannah, L.P.**	**502.26**	**6.12**	**82.13**	**3138.29**	**94.4%**
05100010	**Weyerhaeuser Company**	**605.44**	**8.02**	**75.46**	**3213.74**	**96.6%**
05100076	**Colonial Terminals, Inc.**	**82.15**	**1.77**	**46.38**	**3260.12**	**98.0%**
05100148	**Arizona Chemical Corporation**	**31.32**	**1.11**	**28.16**	**3288.27**	**98.9%**
10300003	**Ga Power Co Plt McIntosh**	**691.81**	**29.63**	**23.35**	**3311.62**	**99.6%**
05100008	Savannah Acid Plant LLC	120.00	9.78	12.27	3323.89	100.0%
10300014	Ga Power Company - McIntosh Combined Cycle Facility	18.07	29.62	0.61	3324.50	100.0%
17900001	Interstate Paper LLC	11.52	46.78	0.25	3324.75	100.0%
10300012	Effingham County Power, LLC	4.70	26.70	0.18	3324.93	100.0%
05100012	NuStar Asphalt Refining, LLC	0.16	2.14	0.07	3325.00	100.0%
10300004	Simpson Lumber Company, LLC	1.65	25.24	0.07	3325.06	100.0%
17900011	SNF - Riceboro	3.12	47.96	0.07	3325.13	100.0%
05100003	Southern LNG Company, L.L.C. - Elba Island LNG Terminal - (Kinder Morgan , Inc.)	0.45	11.90	0.04	3325.17	100.0%
05100046	Gulfstream Aerospace Corp	0.08	8.15	0.01	3325.18	100.0%
05100017	Ga Power Company - Plant Boulevard	0.02	6.16	0.00	3325.18	100.0%

Table 4. Point sources within 50 km of Rome - Coosa Elementary School SO_2 monitor.

AIRS NO.	Facility Name	SO2 (TPY)	Distance [km]	Q/d	Cumulative Q/d	Percent Cum Q/d
11500021	**International Paper – Rome Linerboard (was Temple Inland – Rome)**	**2,202.81**	**0.77**	**2,854.92**	**2,854.92**	**70.5%**
11500003	**Ga Power Company - Plant Hammond**	**2,174.44**	**2.20**	**988.38**	**3,843.29**	**94.9%**
01500011	**Ga Power Company - Plant Bowen**	**5,888.85**	**40.15**	**146.69**	**3,989.98**	**98.5%**
11500105	**General Shale Brick, Inc. - Plant 40**	**102.78**	**1.80**	**57.04**	**4,047.02**	**99.9%**
01500032	Gerdau Ameristeel US Inc.	92.12	48.74	1.89	4,048.91	100.0%
05500001	Mount Vernon Mills	32.90	31.66	1.04	4,049.95	100.0%
01500061	Anheuser-Busch Inc	5.72	49.86	0.11	4,050.07	100.0%
11500077	Ball Container LLC Rome Can Plant	0.08	21.81	0.00	4,050.07	100.0%
11500095	Packaging Products Corporation, LLC	0.02	14.96	0.00	4,050.07	100.0%

The 2008 SO_2 emissions at the Port of Savannah were obtained from the environmental impact statement report for the Savannah Harbor Expansion Project (U.S. Army Corps of Engineers, Environmental Impact Statement Appendix K: Air Emission Inventory and Assessment Savannah Harbor Expansion Project, 2012) and are shown in Table 5. These emissions were estimated by evaluating the air emissions from all cargo-carrying vessels and landside cargo handling equipment at both the Georgia Port Authority (GPA) and privately-operated terminals at the port. In total, 1,177.5 tons of SO_2 were emitted at the Port of Savannah, with 557.6 tons from the Garden City Terminal, 300.7 tons from the Elba Island LNG Terminal, and 278.7 tons from the Ocean Terminal and non-GPA Terminals. Since the SO_2 emissions from these sources were smaller than the SO2 emissions from point sources that were closer to the monitors, no additional analysis was performed for these sources.

Table 5. SO2 emissions in the Port of Savannah by sources (tons/year)

Source	SO2 Emissions (TPY)
Garden City Terminal	557.6
Ocean Terminal and non-GPA Terminals	278.7
Elba Island LNG Terminal	300.7
Shifts	27.3
Maintenance Dredging	12.4
Tourist Boats	0.9
Total	**1,177.5**

Due to the close proximity of the SO_2 monitors in Savannah, multiple sources are included in both Table 3 (E. President) and Table 4 (Lathrop & Augusta). The Q/d analysis for Savannah indicates that Southern States Phosphate & Fertilizer (43.9%) and International Paper (29.0%) have the largest contribution to the E. President SO_2 monitor (72.9% of the cumulative Q/d) and International Paper has the largest contribution to the Lathrop & Augusta SO_2 monitor (69.5% of the cumulative Q/d). The Q/d analysis for Rome indicates that International Paper – Rome Linerboard has the largest contribution to the Coosa Elementary School SO_2 monitor (70.5% of the cumulative Q/d).

BACK TRAJECTORY ANALYSIS

Table 6 shows the date and time for each 1-hour SO_2 exceedance prior to mid-December, 2013, along with the relevant meteorological information. To aid in identifying sources contributing to each exceedance, 1-hour average wind analysis and 1-minute high resolution back trajectory analysis were conducted.

Table 6. Days that exceeded the 1-hour SO_2 NAAQS and relevant meteorological data.

Site	Date	Time of SO2 Peak	Wind Speed (m/s)	Wind Direction (Deg)
Savannah - E. President (13-051-0021)	2/13/2011	9:00	0.5	253
	10/20/2012	9:00	2.7	271
	11/23/2012	9:00	2.7	258
	11/24/2012	2:00	2.7	268
	12/19/2012	10:00	2.6	21
	1/21/2013	10:00	2.7	354
Savannah - Lathrop & Augusta (13-051-1002)	5/5/2011	6:00	1.9	11
	11/24/2011	8:00	2.9	27
	12/2/2011	10:00	1.8	33
	10/26/2012	8:00	2.5	30
	11/17/2012	9:00	3.6	40
	12/14/2012	7:00	2.5	23
	9/27/13	8:00	3.0	35
	9/28/13	8:00	2.9	36
	9/29/13	8:00	2.1	31
	10/8/13	9:00	3.5	35
	11/5/13	10:00	2.2	26
	11/13/13	7:00	3.1	36
	11/24/13	7:00	3.2	35
	11/30/13	12:00	1.9	28
Rome - Coosa Elementary School* (13-115-0003)	2/25/2011	0:00	5.1	210
	4/3/2011	18:00	5.7	180
	4/4/2011	15:00	8.0	190
	4/25/2011	16:00	no data	no data
	11/13/2011	13:00	no data	no data
	11/14/2011	12:00	no data	no data
	2/13/2012	12:00	Calm	Calm
	2/23/2012	14:00	5.1	200
	2/29/2012	21:00	2.1	200
	3/2/2012	11:00	3.6	230
	12/6/2013	11:00	no data	no data

* Wind data from R.B. Russell Airport Automated Surface Observing Station

For the 1-hour wind analysis, the average wind speed and wind direction data in Table 6 was used to determine the origin of the air mass leading to the exceedance. Figure 1 shows the 1-hour wind analysis plot for the Savannah - E. President monitor. Then, the plot was imported to ArcGIS to overlay the 1-hour wind analysis plot on a map (see Figure 2) to help examine the relationship between major SO_2 sources and each SO_2 exceedance.

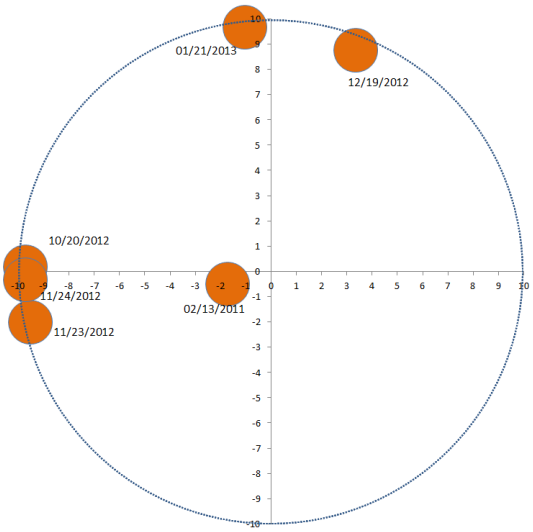

Figure 1. 1-hour wind analysis plot for Savannah - E. President monitor. The units of the x-axis and y-axis are kilometers (km).

Figure 2. Example of 1-hour wind analysis plot overlaid on GIS map. The radius of the circle in the figure is 10 km.

Figure 2 shows the result of 1-hour wind analysis for Savannah - E. President monitor. High SO_2 incidences on 02/1311, 10/20/12, 11/23/12, and 11/24/12 and are associated with sources at the west side of the monitor while other exceedances on 12/19/12 and 01/21/13 are associated with sources at the north/northeast side of the monitor. Four possible major contributors were Southern States Phosphate & Fertilizer, BASF Corporation – Savannah Operations, Georgia-

Pacific Gypsum LCC – Savannah Plant, and Savannah Acid Plant, LLC. Because SO_2 emissions from BASF Corporation – Savannah Operations and Georgia-Pacific Gypsum LCC – Savannah Plant were zero on those days, these two sources were ruled out.

Next, 1-minute high resolution back trajectory analyses were performed with 1-minute wind data (WS and WD) and 1-minute SO_2 concentration data provided by the Ambient Monitoring Program staff. The back-trajectory analysis begins when the first measured 1-minute SO_2 concentration exceeds 75 ppb at each monitor location. Then, 1-minute wind speed and wind direction measurements at the SO2 monitor site were used to calculate back trajectories. Back trajectories were developed for every minute the SO_2 monitor exceeded 75 ppb. The extent of back-trajectory calculation was set to a 3 km radius from the monitoring site. All of the back trajectories were superimposed on a GIS map to help identify sources that may have been contributing to the exceedances.

Figure 3 through Figure 8 show the results of 1-minute high resolution back-trajectory analyses done for each SO_2 exceedance day. In most cases, the trajectories show directional consistency. Based on an analysis of the 1-hour wind analysis plot and the 1-minute high resolution back-trajectory plots, it appears that SO2 emissions from Southern States Phosphate & Fertilizer caused or contributed to many of the SO_2 NAAQS exceedances at the Savannah - E. President monitor.

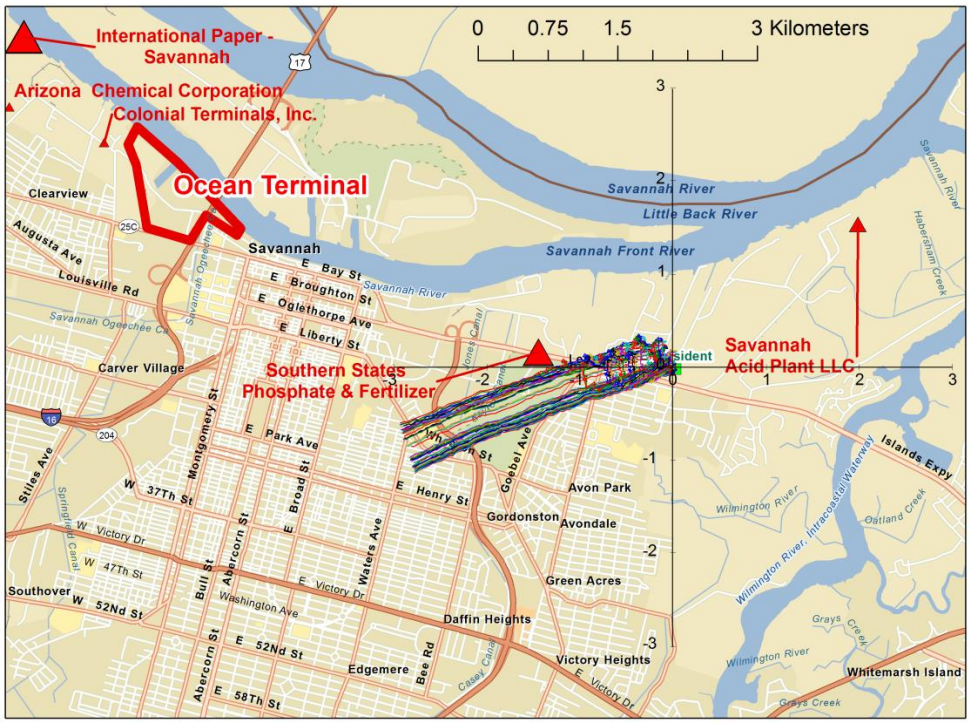

Figure 3. High resolution back trajectory for Savannah - E. President monitor on 02/13/11.

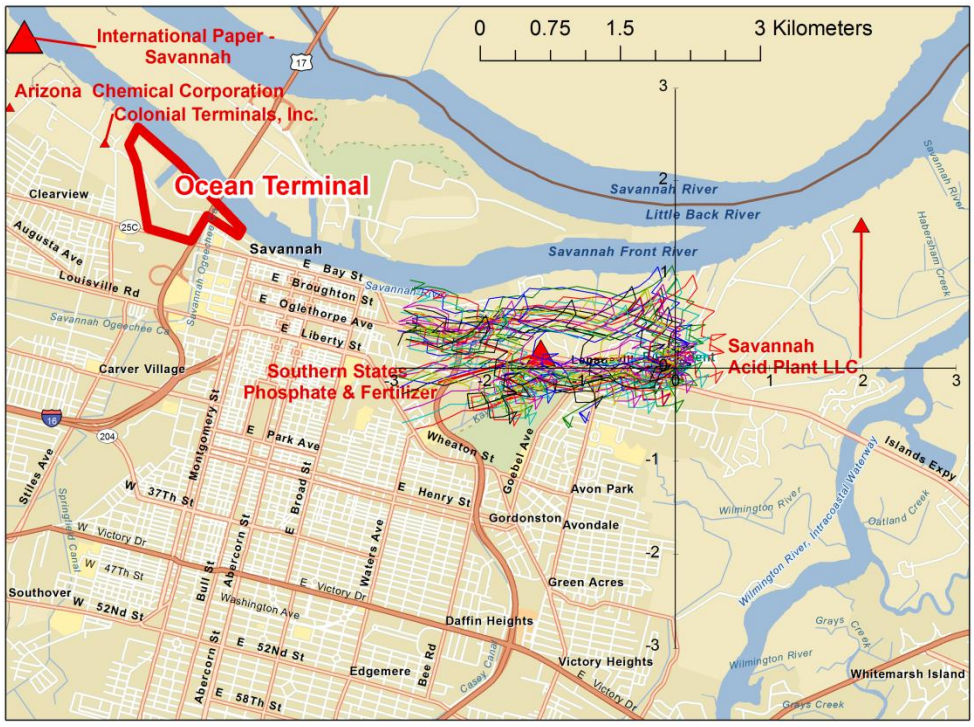

Figure 4. High resolution back trajectory for Savannah - E. President monitor on 10/20/12.

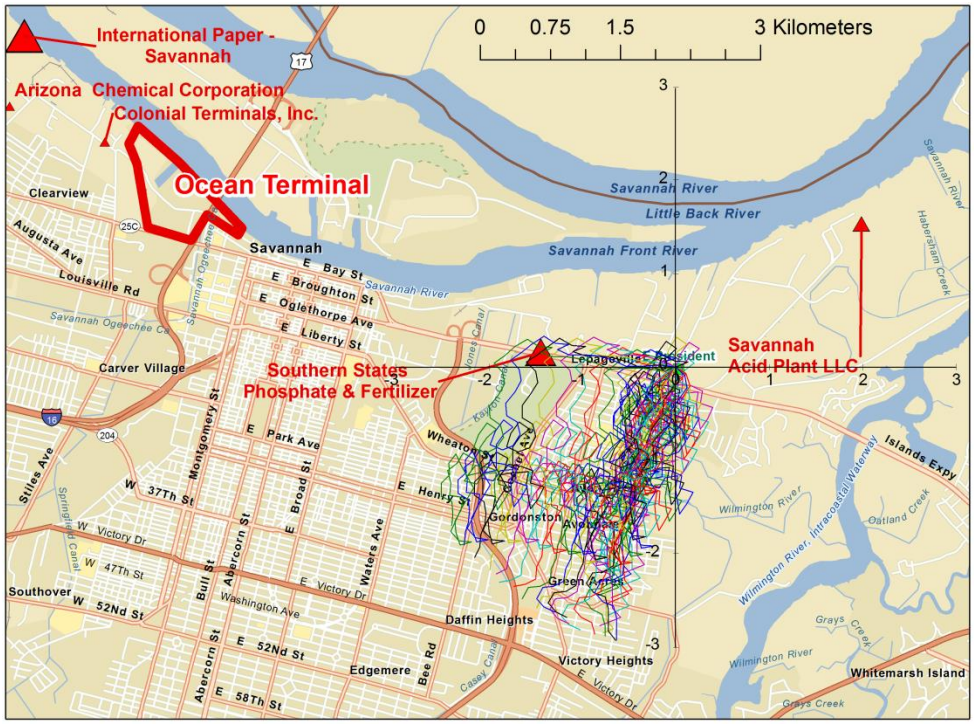

Figure 5. High resolution back trajectory for Savannah - E. President monitor on 11/23/12.

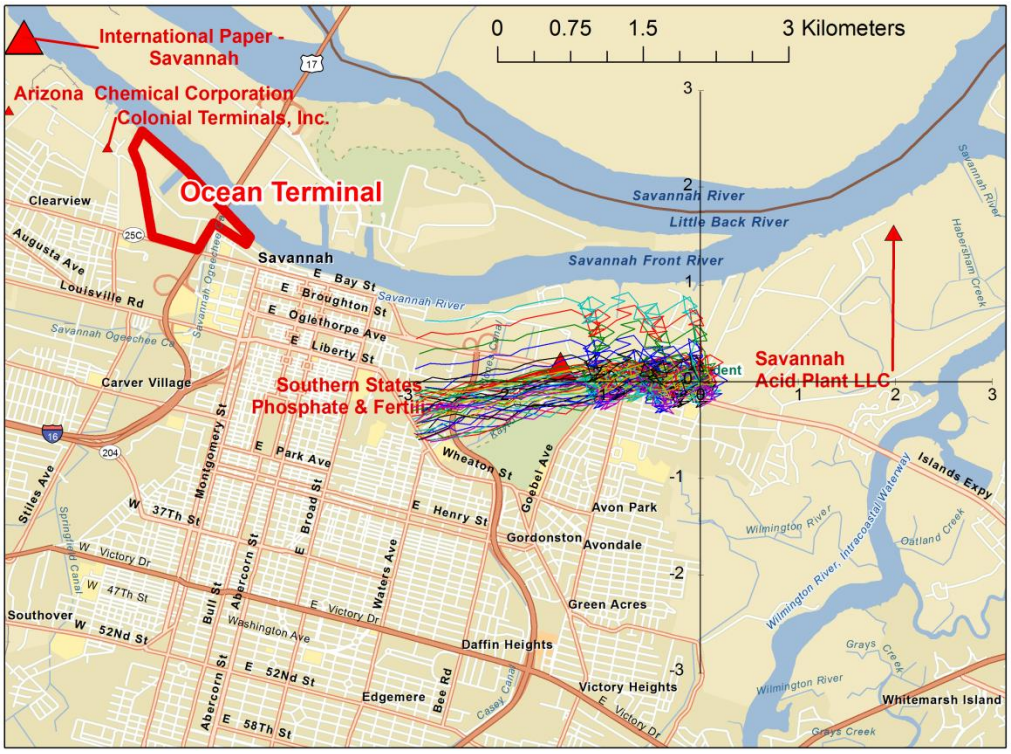

Figure 6. High resolution back trajectory for Savannah - E. President monitor on 11/24/12.

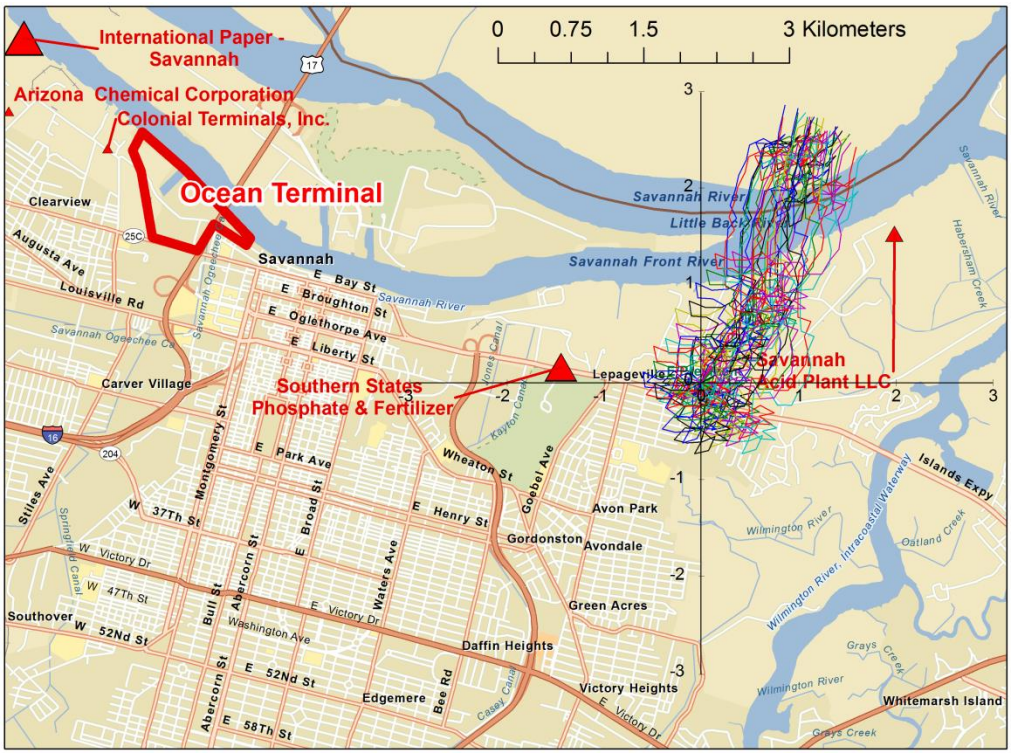

Figure 7. High resolution back trajectory for Savannah - E. President monitor on 12/19/12.

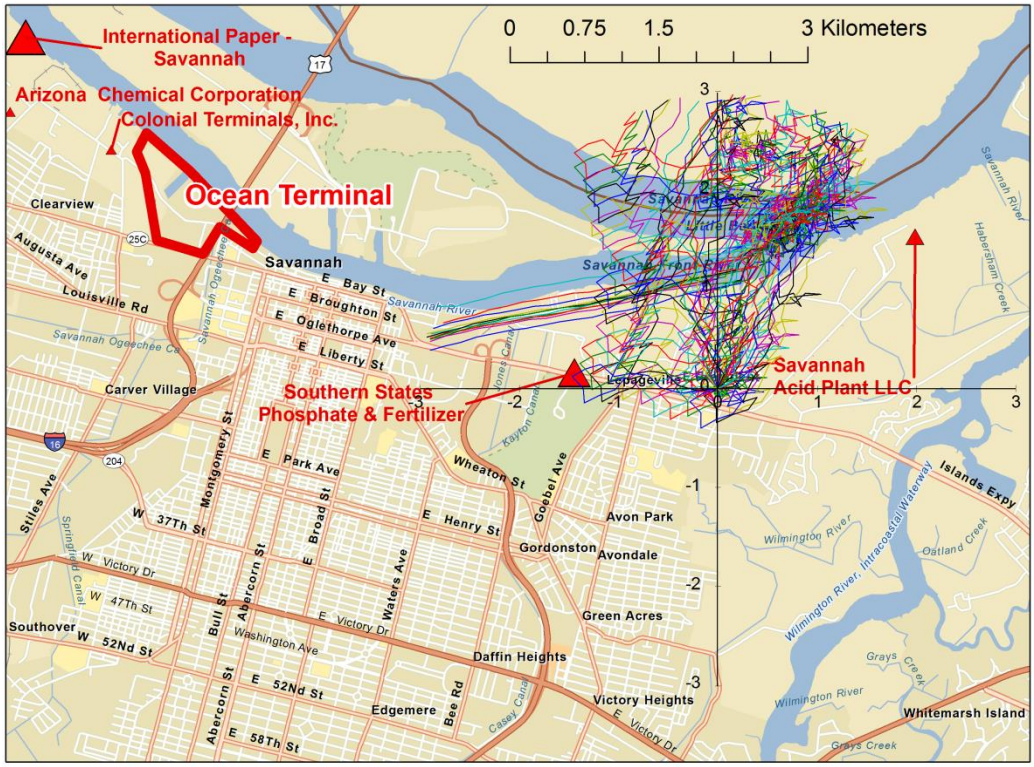

Figure 8. High resolution back trajectory for Savannah - E. President monitor on 01/21/13.

Figure 9 shows the result of 1-hour wind analysis for Savannah - Lathrop & Augusta monitor. All of the SO2 exceedances were associated with sources on the northeast side of the monitor. Two possible contributors were Arizona Chemical Corporation and International Paper - Savannah. Next, 1-minute high resolution back trajectory analyses were conducted for the days with SO2 exceedances (Figure 10 through Figure 15). According to the 2011 NEI, annual SO2 emission from International Paper were 4232.78 TPY compared to 31.32 TPY from Arizona Chemical Corporation. Based on the wind trajectory analysis and NEI 2011 emissions, it appears that the SO2 emissions from International Paper – Savannah Mill may be responsible for many of the SO2 NAAQS exceedances at the Savannah - Lathrop & Augusta monitor.

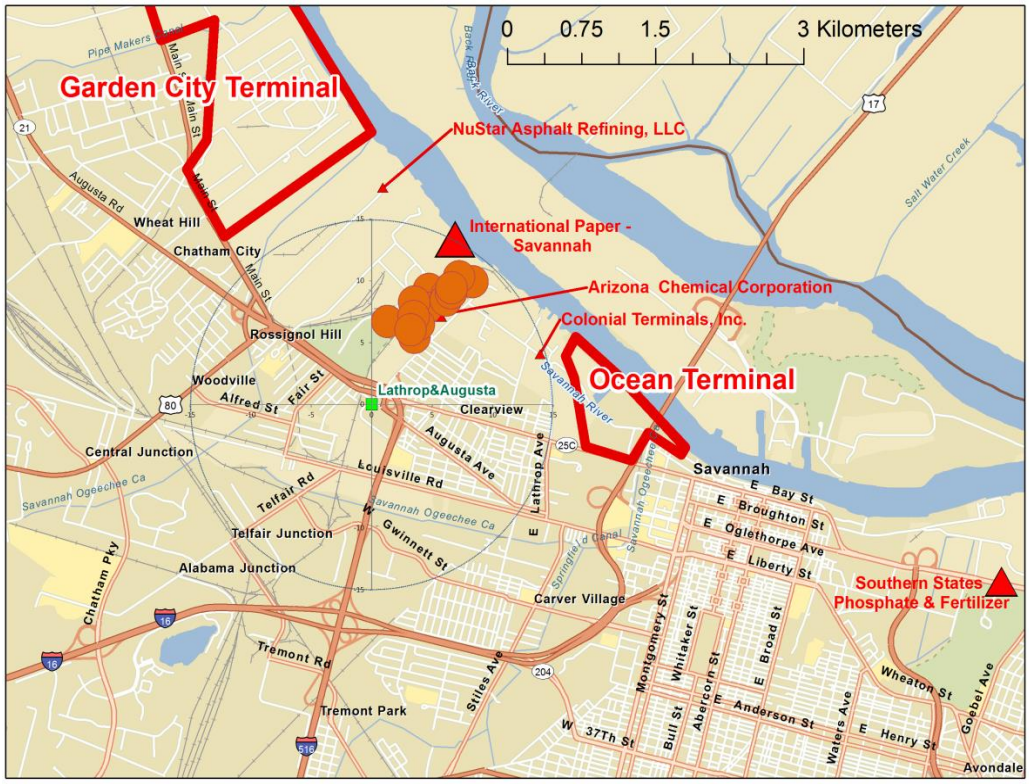

Figure 9. 1-hour wind analysis for Savannah - Lathrop & Augusta monitor. The radius of the circle in the figure is 15 km.

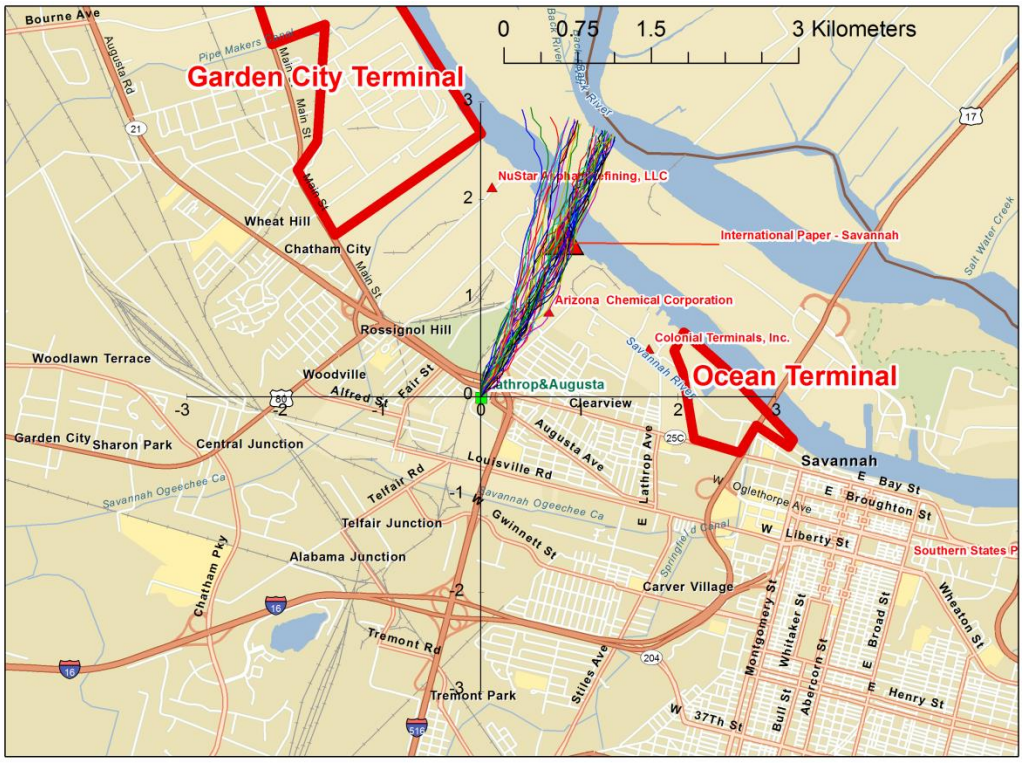

Figure 10. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 05/05/11.

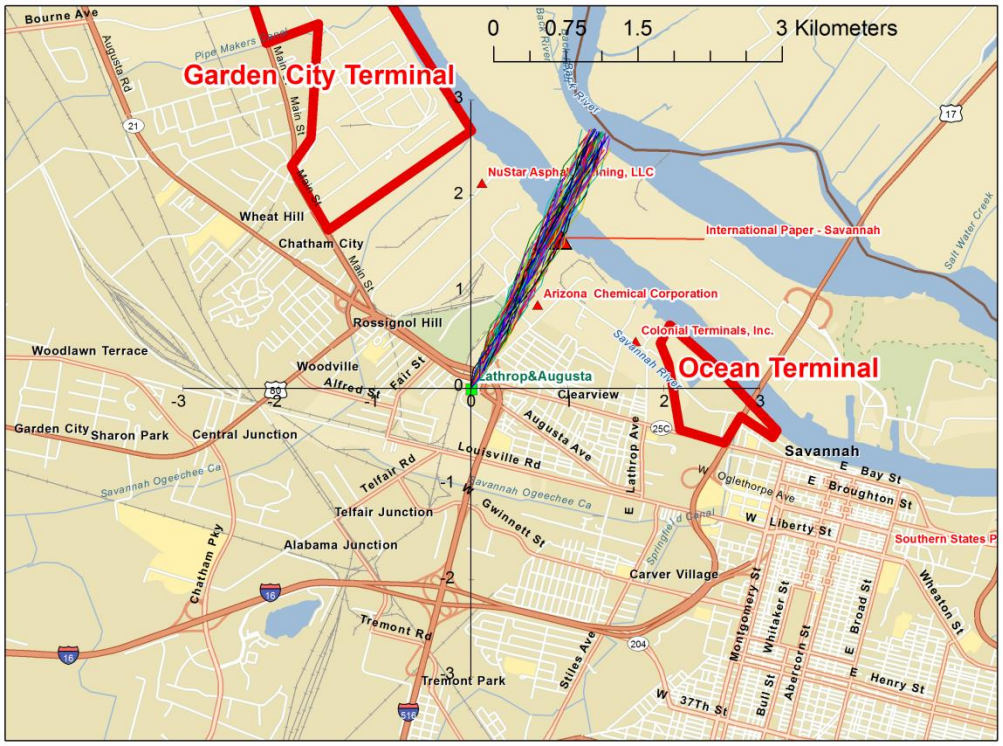

Figure 11. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 11/24/11.

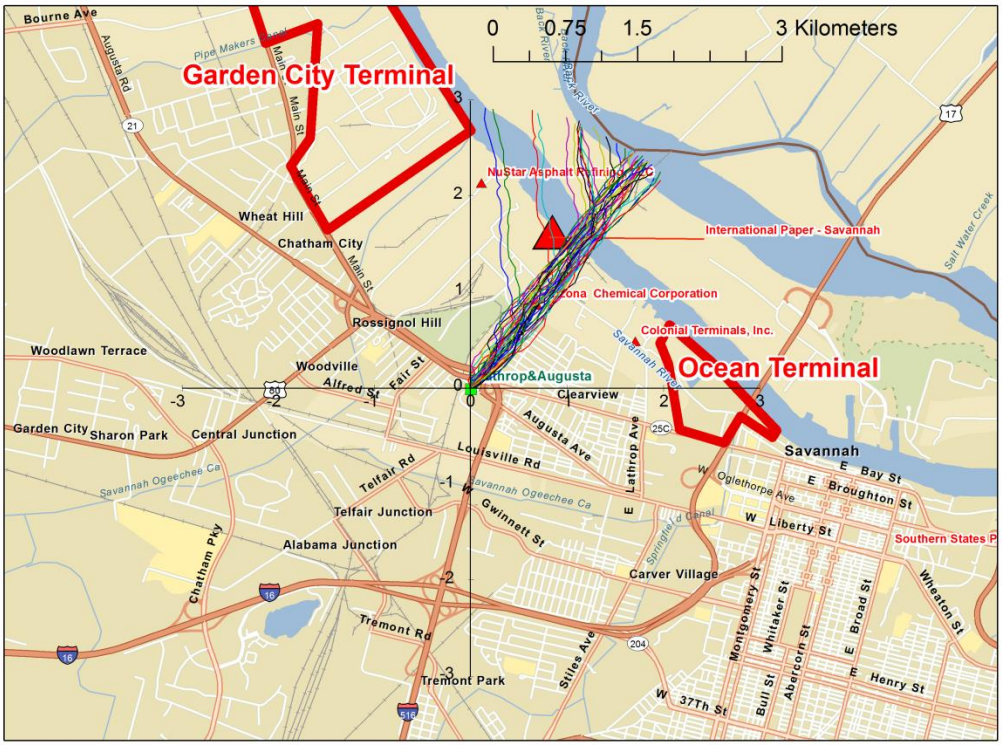

Figure 12. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 12/02/11.

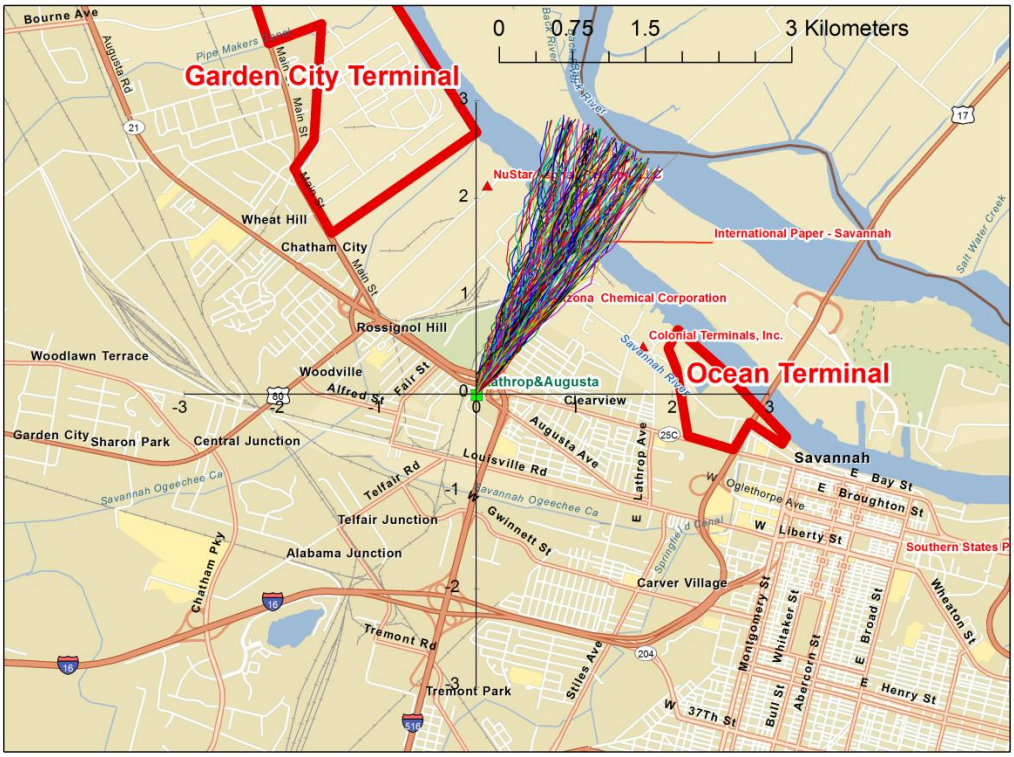

Figure 13. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 10/26/12.

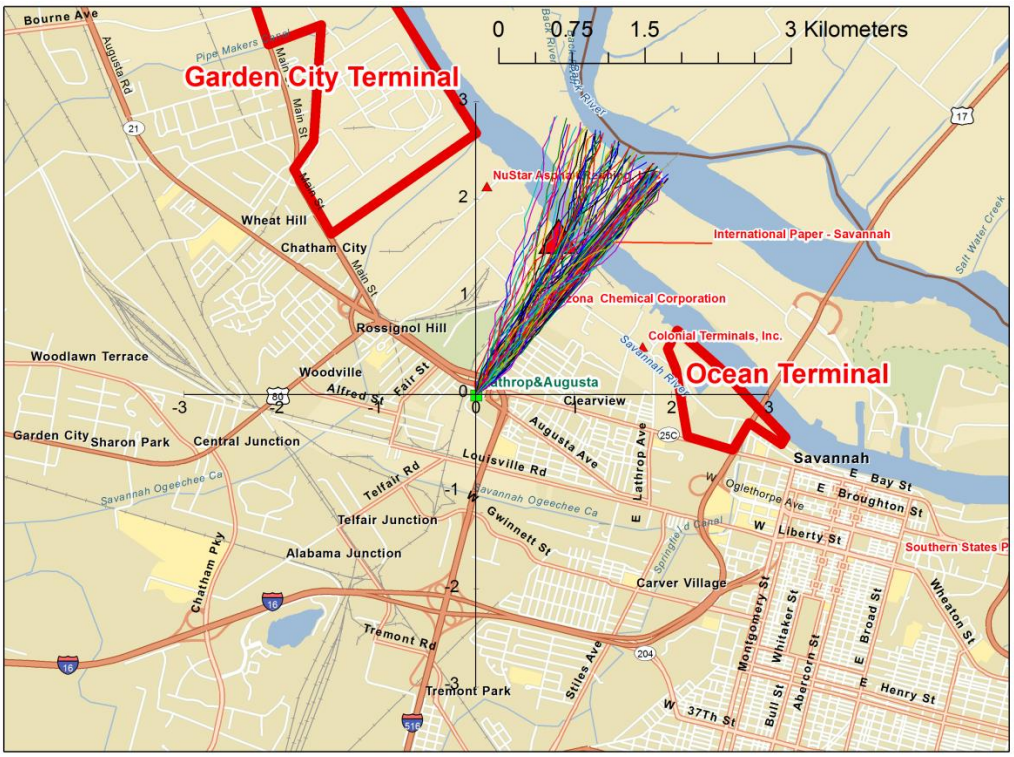

Figure 14. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 11/17/12.

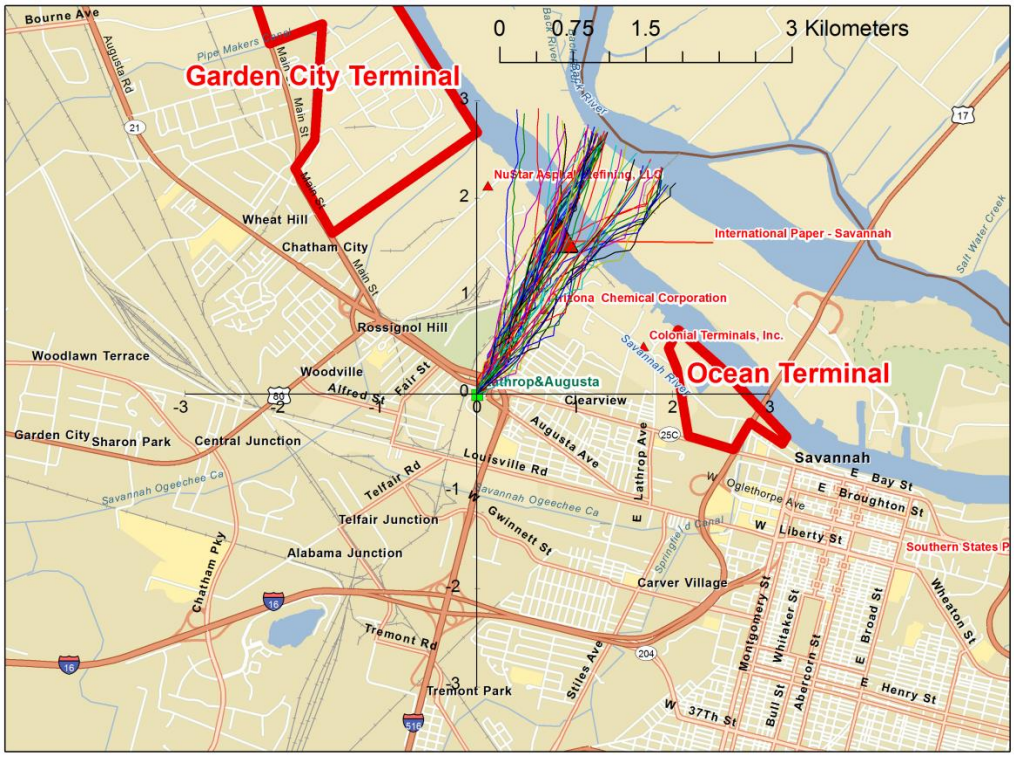

Figure 15. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 12/14/12.

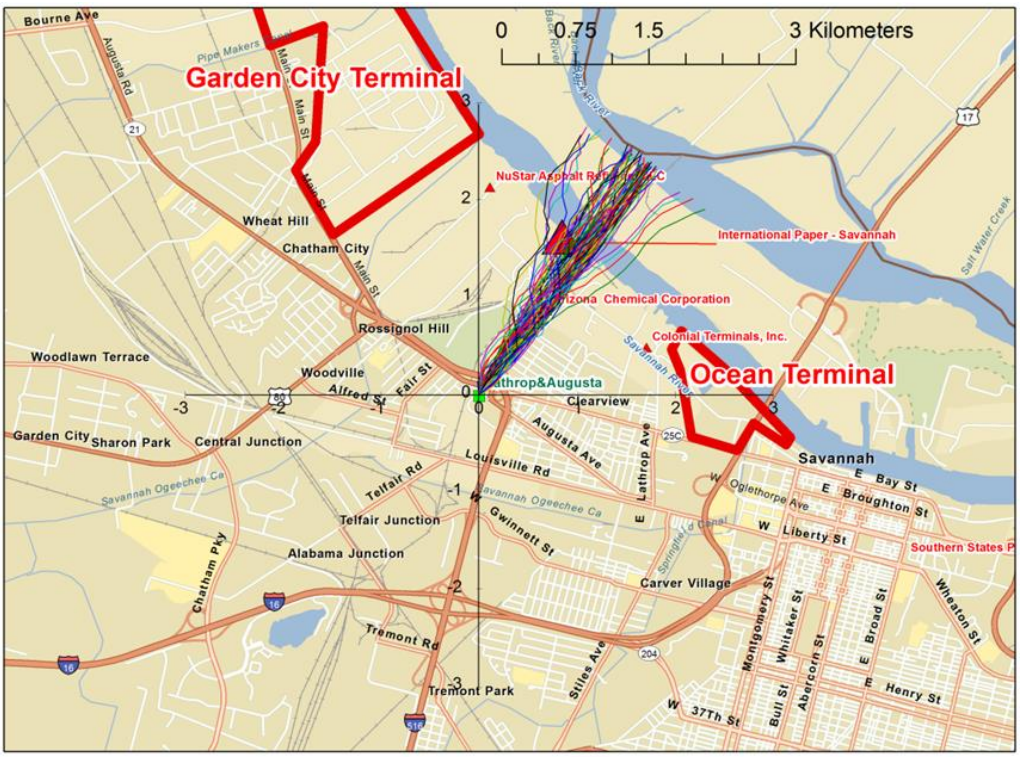

Figure 16. High resolution back trajectory for Lathrop & Augusta monitor on 09/27/13.

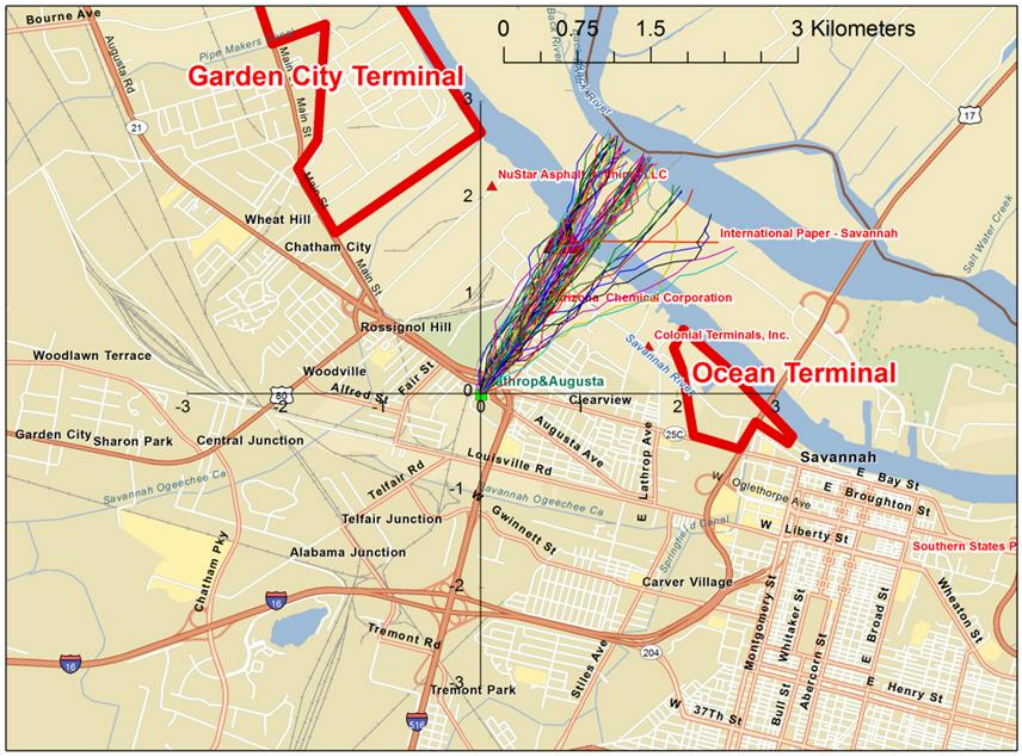

Figure 17. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 09/28/13.

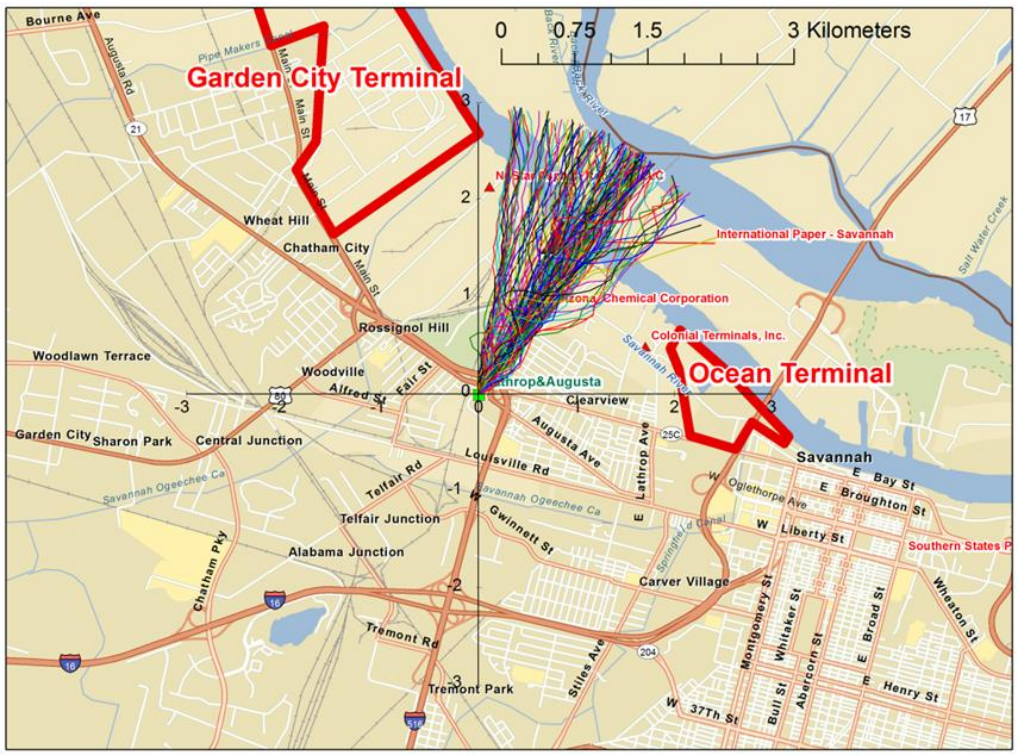

Figure 18. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 09/29/13.

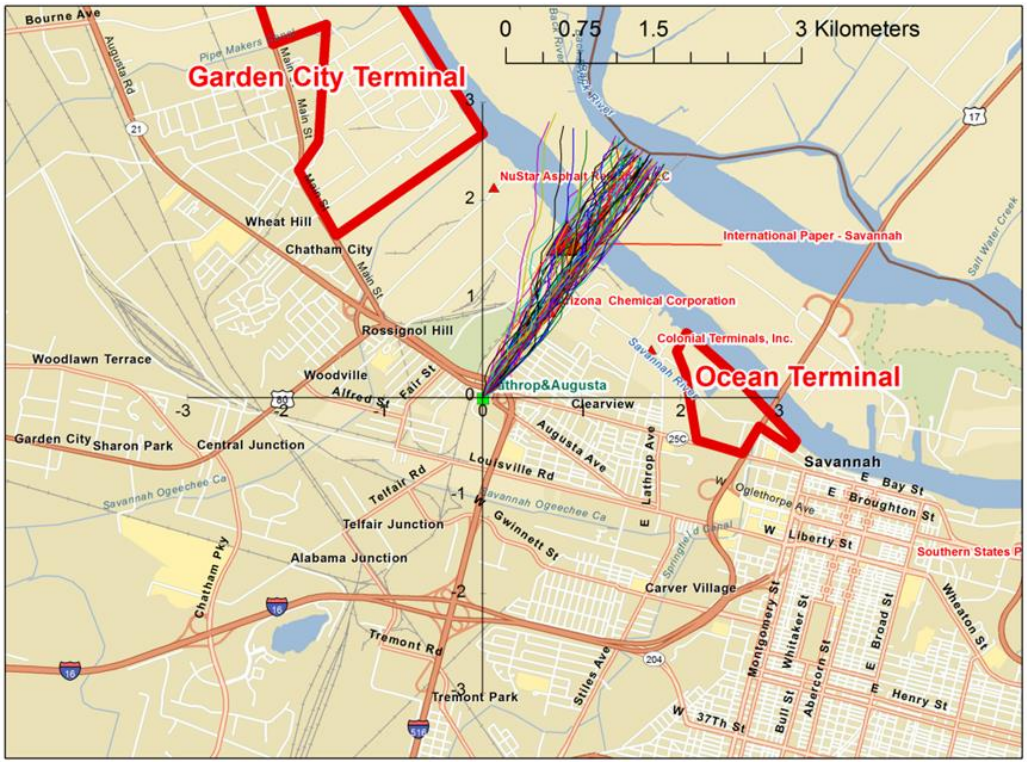

Figure 19. High resolution back trajectory for Savannah - Lathrop & Augusta monitor on 10/08/13.

Figure 20 shows the result of 1-hour wind analysis for the Rome - Coosa Elementary School monitor. All of the SO2 exceedances were associated with sources at the south/southwest side of the monitor. The two possible contributors were Plant Hammond and International Paper – Rome Linerboard. Compared to the Savannah monitors, the wind speed is much faster resulting in less horizontal dispersion. Based on the wind directions and the magnitude of wind speed, it appears that the SO2 emissions from International Paper – Rome Linerboard caused or contributed to many of the SO2 NAAQS exceedances at the Coosa Elementary School monitor. There is one day that the SO2 emissions from Plant Hammond may have caused or contributed to a SO2 NAAQS exceedance. 1-minute high resolution back trajectory analyses cannot be conducted for the Coosa Elementary Monitor since EPD does not operate a meteorology station at this site.

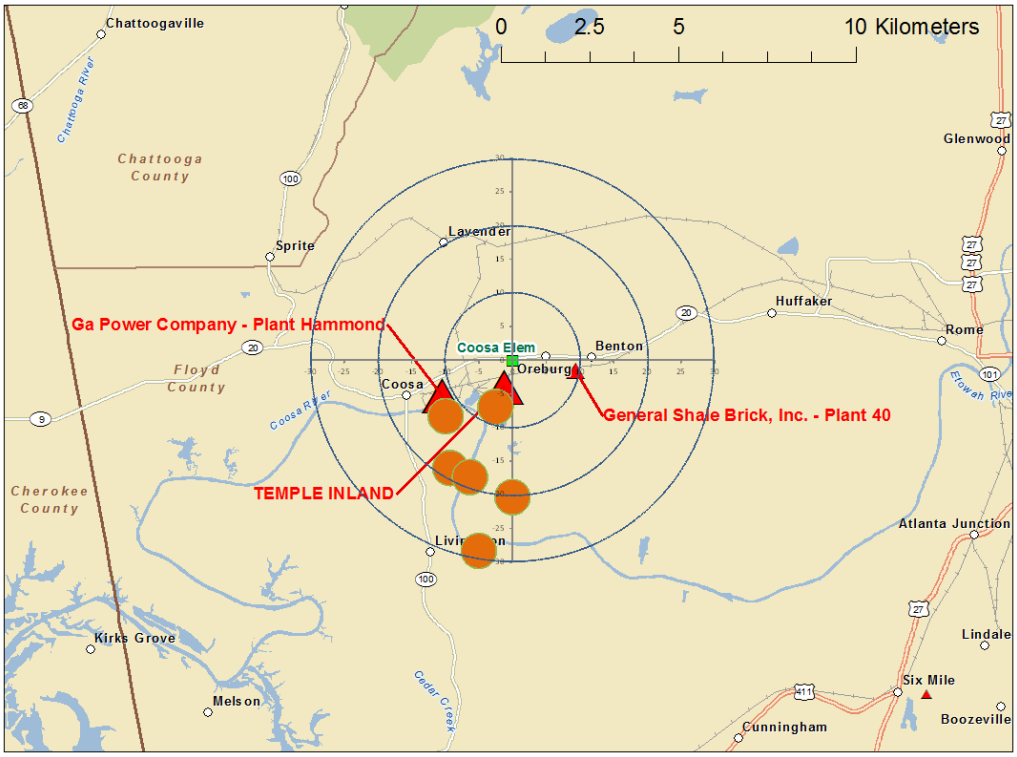

Figure 20. 1-hour wind analysis for Rome Coosa Elementary monitor. The radius of the circle in the figure is 30 km.

AERMOD MODELING ANALYSIS

AERMOD runs were performed to help quantify the contributions from each source to the 1-hour SO2 exceedances prior to September, 2013. In order to use the most accurate SO2 emissions available, letters were sent to each facility included in the analysis requesting hourly emission data for specific exceedance days. The letters requested that:

- Southern States Phosphate & Fertilizer, International Paper - Savannah Mill, Georgia Power Company (Plant Kraft), Georgia-Pacific Consumer Products LP (Savannah River Mill), Weyerhaeuser Company, Imperial-Savannah, L.P., and Georgia Power Company (Plant McIntosh) submit hourly SO2 emissions for 02/13/11, 05/05/11, 11/24/11, 12/02/11, 10/20/12, 10/26/12, 11/17/12, 11/23/12, 11/24/12, 12/14/12, 12/19/12, and 01/21/13;
- Savannah Acid Plant LLC submit hourly SO2 emissions for 02/13/11, 10/20/12, 11/23/12, 11/24/12, 12/19/12, and 01/21/13;
- Colonial Terminals, Inc. and Arizona Chemical Corporation submit hourly SO2 emissions for 05/05/11, 11/24/11, 12/02/11, 10/26/12, 11/17/12, and 12/14/12; and
- –International Paper – Rome Linerboard, Georgia Power Company (Plant Hammond), Georgia Power Company (Plant Bowen), and General Shale Brick, Inc. (Plant 40) submit hourly SO2 emissions for 02/25/11, 02/03/11, 02/04/11, 04/25/11, 11/13/11, 11/14/11, 02/13/12, 02/23/12, and 02/29/12.

In addition, the letter requested SO2 emissions for one day prior to the requested date. All facilities provided data (see Appendix C). However, some data were more detailed than others. While some facilities could provide hourly SO2 emissions, others could only provide a single SO2 emission rate for each day. The SO2 emission files, stack temperature, and stack velocity were converted into AERMOD format for each facility for the days that data was requested. The SO2 emissions on the other days were set equal to zero.

Meteorological data was created for each monitoring site using AERMETv12345 for the period 2011-2012. The Savannah- E. President and Savannah - Lathrop & Augusta monitoring locations both contain on-site meteorological measurements for wind speed and wind direction. The other required meteorological fields were extracted from the Savannah International Airport ASOS site (SAV) and the Charleston, SC station (CHS) for upper air measurements. The Rome - Coosa Elementary School site used surface meteorological fields from the R.B. Russell Airport ASOS site (RMG) in Rome and upper air observations from Peachtree City station (FFC). The meteorological data were processed using the latest version of AERSURFACEv13016 for both airport and site surface characteristics and using AERMINUTEv11325 for the 1-minute ASOS wind observations. Receptor elevations and hill heights required by AERMOD were determined using the AERMAPv11103 terrain preprocessor. Terrain elevations from the USGS 30m DEM were used for AERMAP processing.

Each modeling domain contained a 1-km by 1-km array of receptors (11 x 11) with 100 meter spacing with the center receptor placed at the monitor location. AERMODv12345 was run for 2011 and 2012 for each modeling domain. Modeled SO2 concentrations at the receptor corresponding to the monitor location were compared against SO2 measurements on the days that contained SO2 exceedances. In addition, the maximum SO2 concentration from the 1-km by 1-km array of receptors surrounding the monitor location were compared against SO2 measurements on the days that contained SO2 exceedances. The maximum SO2 concentration was used to identify plumes that may have missed to receptor corresponding to the monitor location due to slight differences in the observed wind direction. Next, the contribution from each source was evaluated to help identify which sources were contributing to the SO2 exceedances. Since AERMOD outputs SO2 concentrations in $\mu g/m^3$, the SO2 observations were converted from ppb to $\mu g/m^3$ by multiplying by 2.62 (e.g., 75 ppb = 196.5 $\mu g/m^3$).

Generally, U.S. EPA requires 5 years of meteorological data to be used and does not require SO2 observations and SO2 model results to be paired in time and space since AERMOD models a distribution of steady-state concentrations. It should be noted that this AERMOD analysis generally pairs the SO2 observations and SO2 model results in time and space on exceedance days, an analysis for which AERMOD was not designed. Therefore, matching of all measured and modeled concentrations should not be expected.

Savannah - E. President (13-051-0021)

Figure 21 contains the AERMOD receptor array used to model impacts at the Savannah - E. President (13-051-0021) monitor. Figure 22 contains a time series plot comparing AERMOD SO2 results at the monitoring site receptor, AERMOD SO2 results for the maximum receptor in the array, and the SO2 observations. Figure 23 contains a Q-Q plot (unpaired in time) for the SO2 concentrations at the monitoring site receptor and the maximum receptor in the array. Figure 21 contains the hourly SO2 source contributions from each facility at the receptor corresponding to the monitor location. Figure 25 contains the maximum hourly SO2 source contributions from the array of receptors for each facility. Figure 26 contains a summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding the monitor location.

In general, AERMOD tends to under predict the SO2 peaks when using the monitoring site receptor. However, the model performance is improved for the higher SO2 values when using the maximum receptor in the array surrounding the monitoring site. Based on the model results, it appears that the SO2 emissions from Southern States Phosphate & Fertilizer caused or contributed to many of the SO2 NAAQS exceedances at the Savannah - E. President monitor.

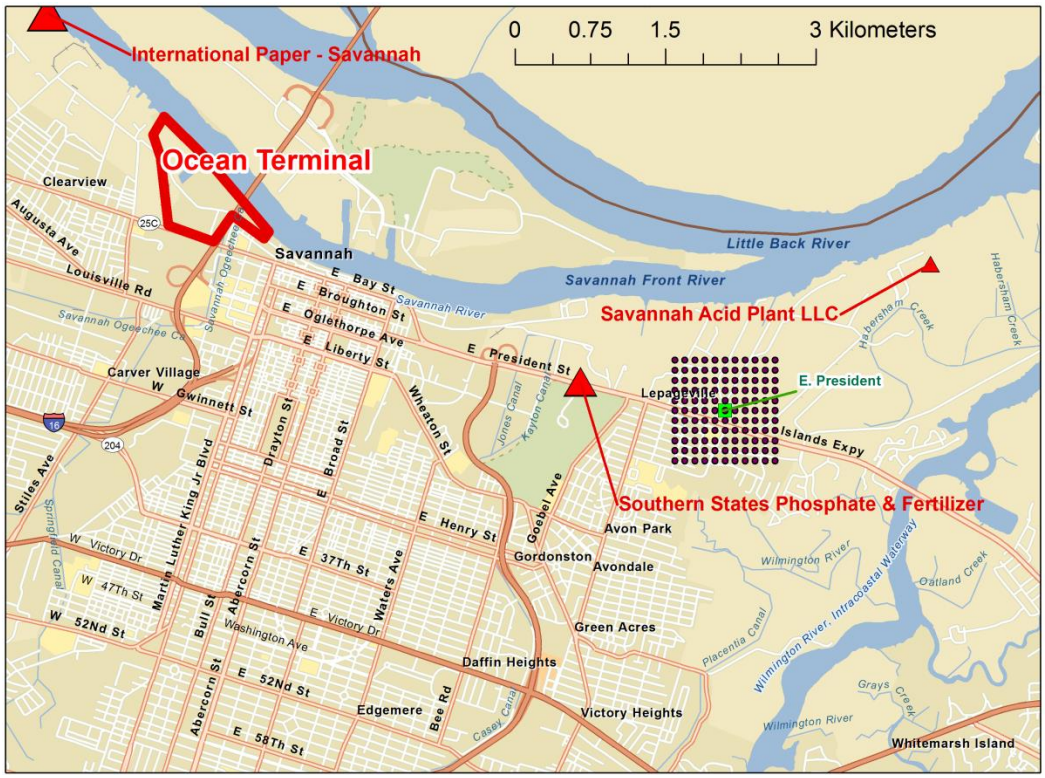

Figure 21. AERMOD receptor array for Savannah - E. President (13-051-0021) monitor.

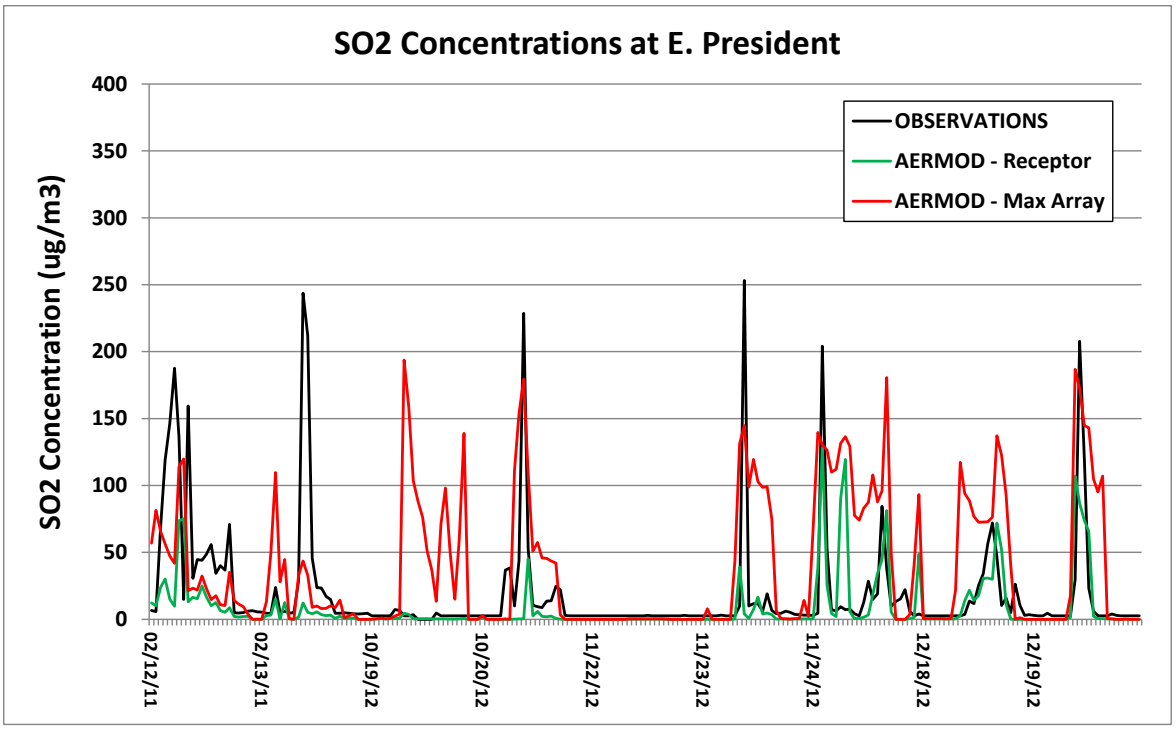

Figure 22. AERMOD SO2 results at the Savannah - E. President monitoring site receptor (green), AERMOD SO2 results for the maximum receptor in the array (red), and the SO2 observations (black).

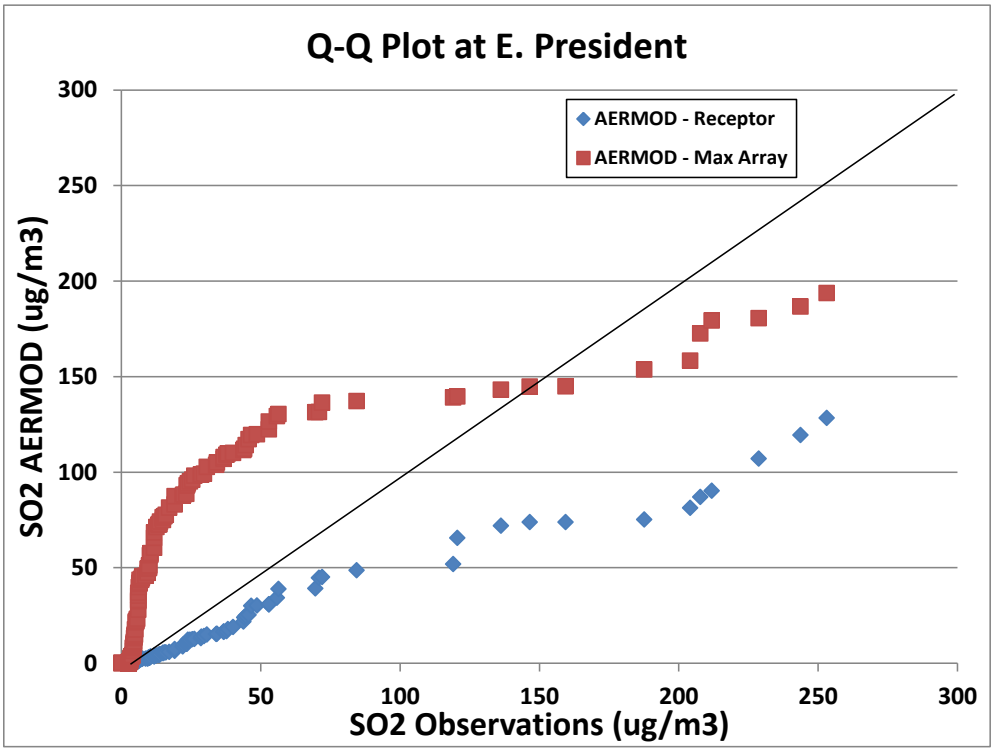

Figure 23. Q-Q plot (unpaired in time) for the SO2 concentrations at the Savannah - E. President monitoring site receptor and the maximum receptor in the array.

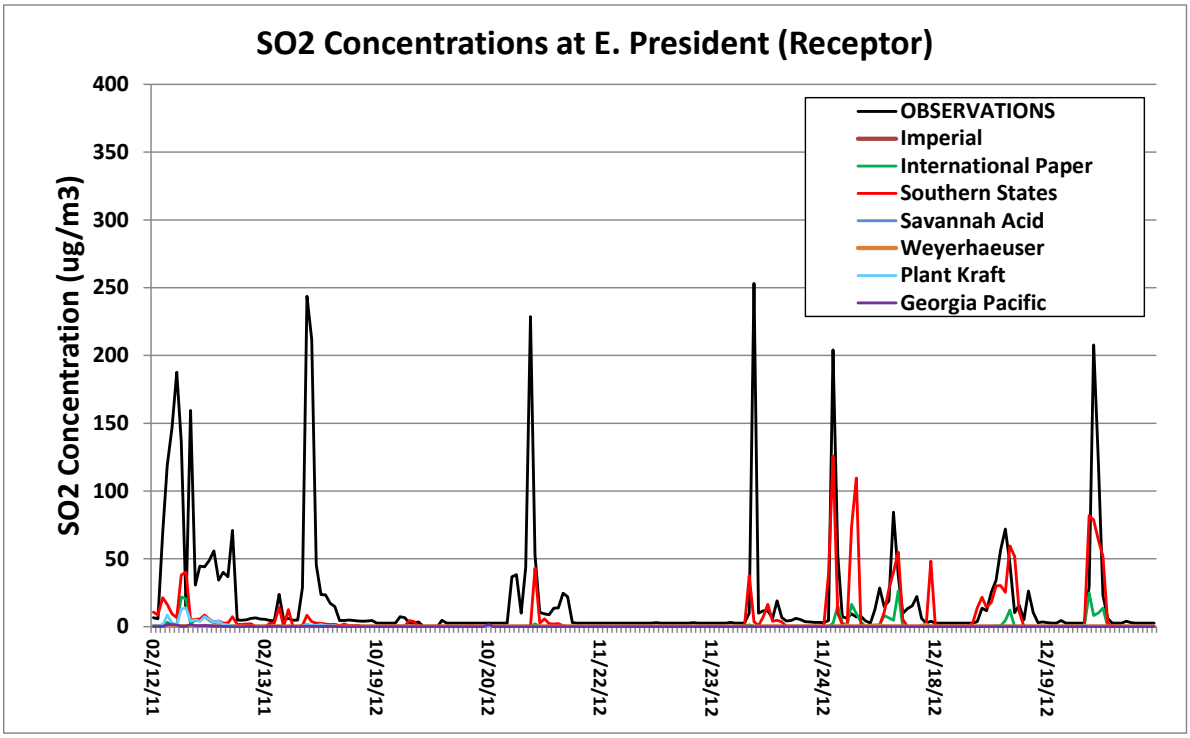

Figure 24. Hourly SO2 source contributions from each facility at the receptor corresponding to the Savannah - E. President monitor location.

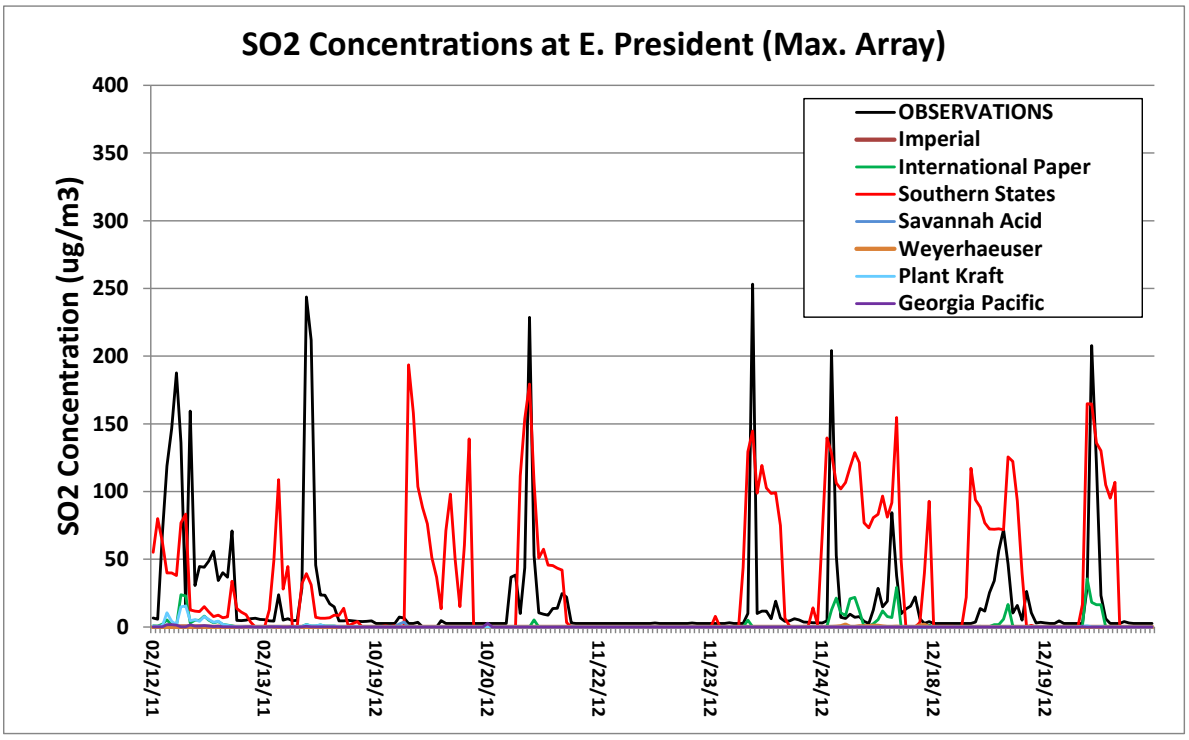

Figure 25. Maximum hourly SO2 source contributions from each facility from the array of receptors surrounding the Savannah - E. President monitor.

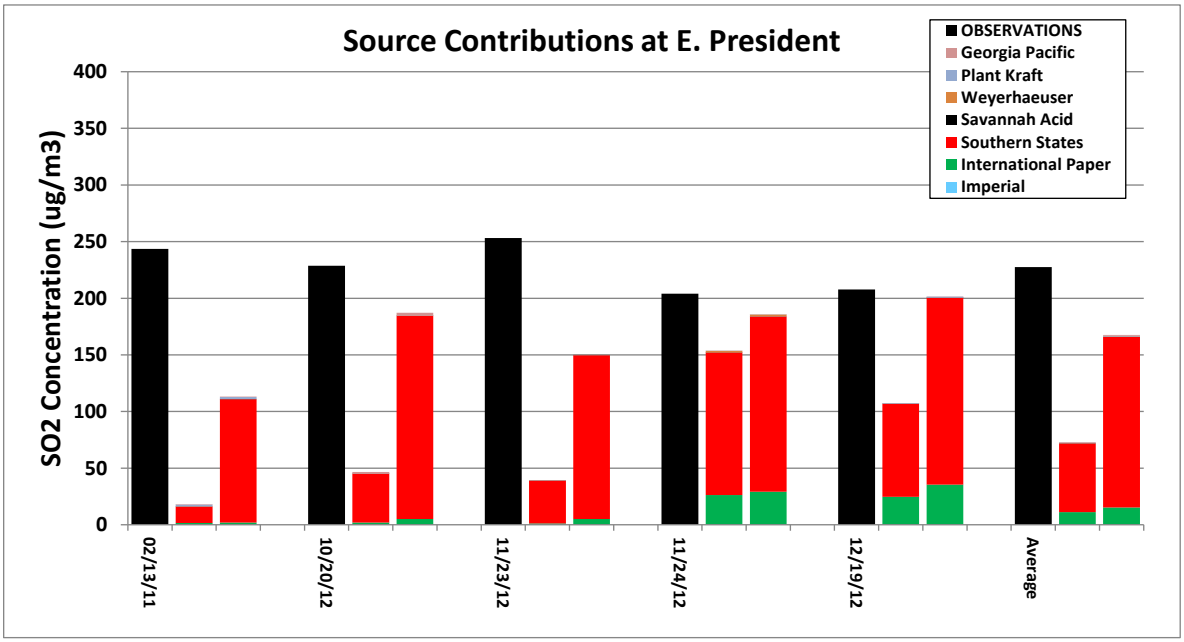

Figure 26. Bar chart summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the Savannah - E. President monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding the Savannah - E. President monitor location.

Savannah - Lathrop & Augusta (13-051-1002)

Figure 27 contains the AERMOD receptor array used to model impacts at the Savannah - Lathrop & Augusta (13-051-1002) monitor. Figure 28 contains a time series plot comparing AERMOD SO2 results at the monitoring site receptor, AERMOD SO2 results for the maximum receptor in the array, and the SO2 observations. Figure 29 contains a Q-Q plot (unpaired in time) for the SO2 concentrations at the monitoring site receptor and the maximum receptor in the array. Figure 30 contains the hourly SO2 source contributions from each facility at the receptor corresponding to the monitor location. Figure 31 contains the maximum hourly SO2 source contributions from the array of receptors for each facility. Figure 32 contains a summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding the monitor location.

In general, AERMOD tends to under predict the SO2 peaks when using the monitoring site receptor as well as when using the maximum receptor in the array surrounding the monitoring site. Based on the model results, it appears that that the SO2 emissions from International Paper – Savannah Mill caused or contributed to many of the SO2 NAAQS exceedances observed at the Savannah - Lathrop & Augusta monitor. Although Figure 32 indicates impacts from Plant Kraft

on 12/02/11, it can be seen in Figure 30 and Figure 31 that the Plant Kraft impacts occur prior to the observed SO2 exceedance on that day.

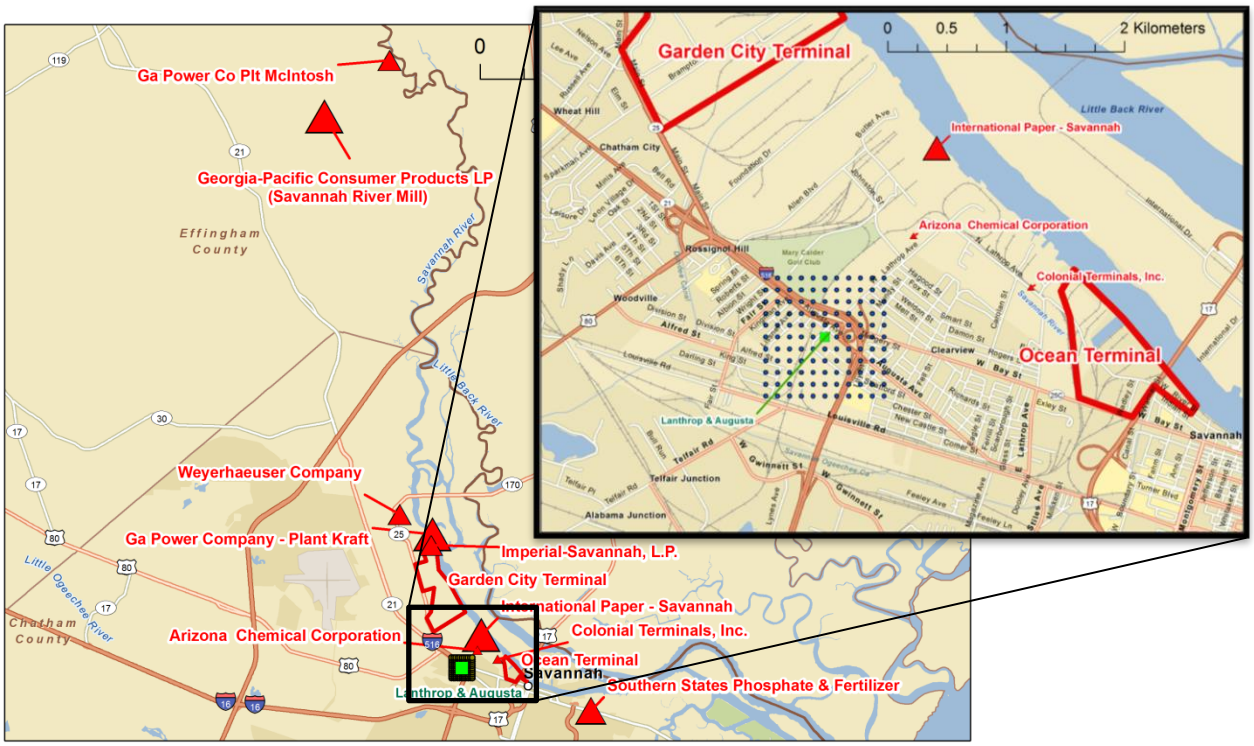

Figure 27. AERMOD receptor array for Savannah - Lathrop & Augusta (13-051-1002) monitor.

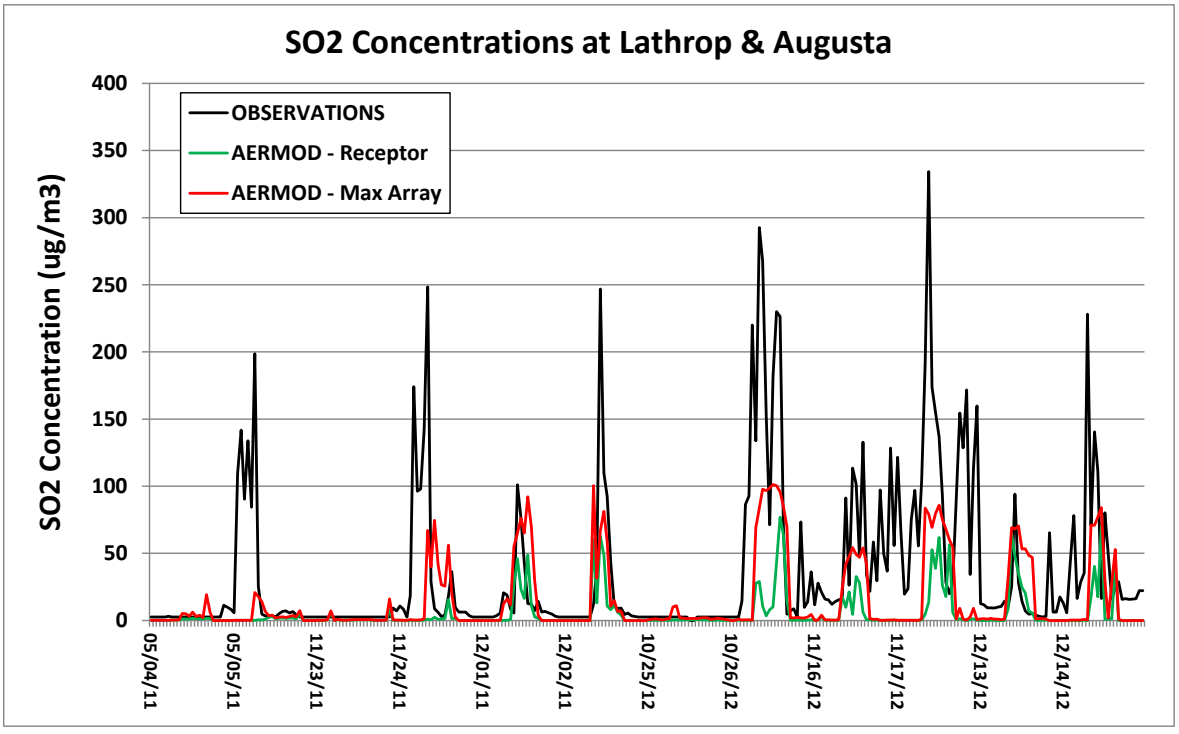

Figure 28. AERMOD SO2 results at the Savannah - Lathrop & Augusta monitor site receptor (green), AERMOD SO2 results for the maximum receptor in the array (red), and the SO2 observations (black).

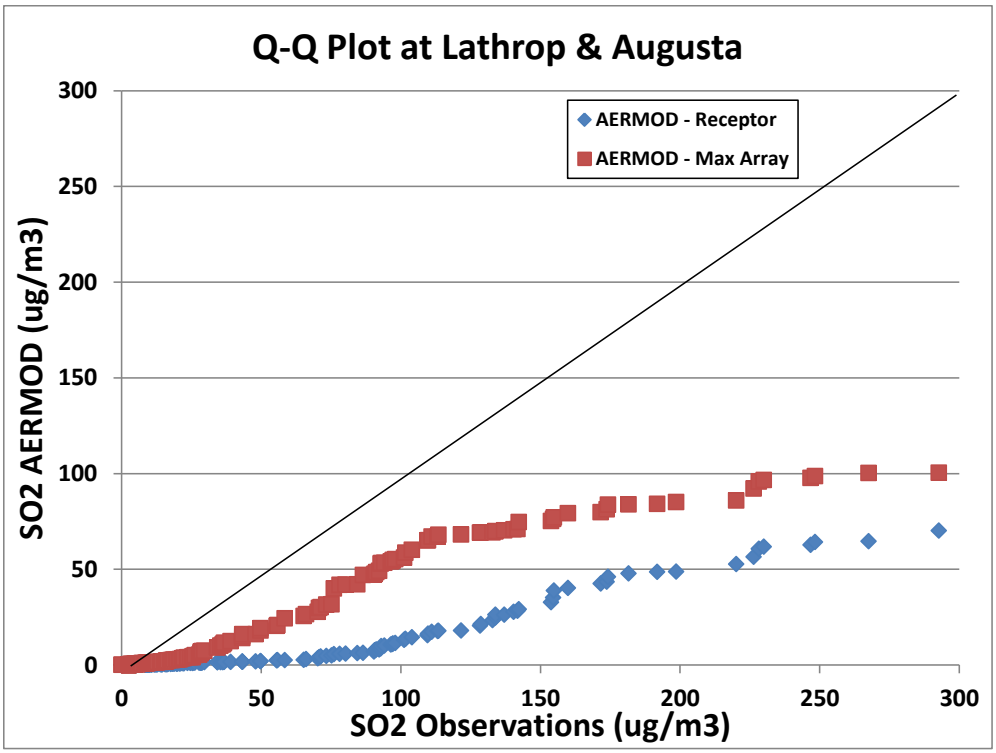

Figure 29. Q-Q plot (unpaired in time) for the SO2 concentrations at the Savannah - Lathrop & Augusta monitoring site receptor and the maximum receptor in the array.

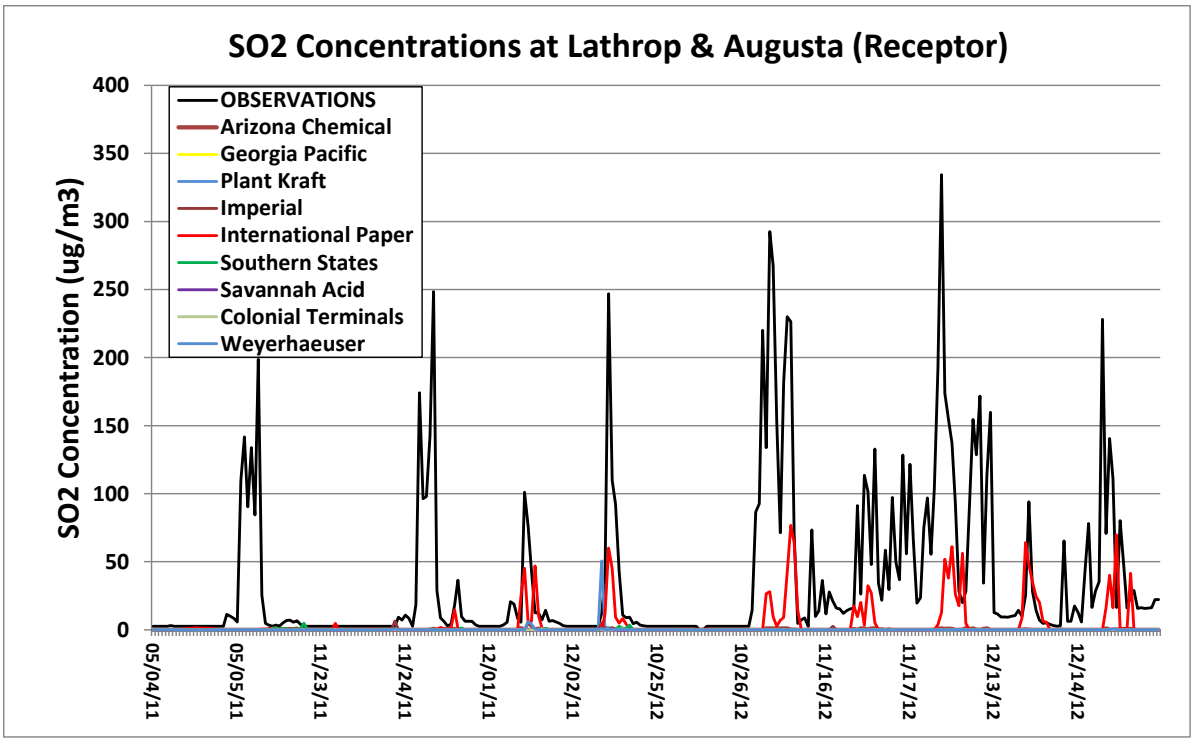

Figure 30. Hourly SO2 source contributions from each facility at the receptor corresponding to the Savannah - Lathrop & Augusta monitor location.

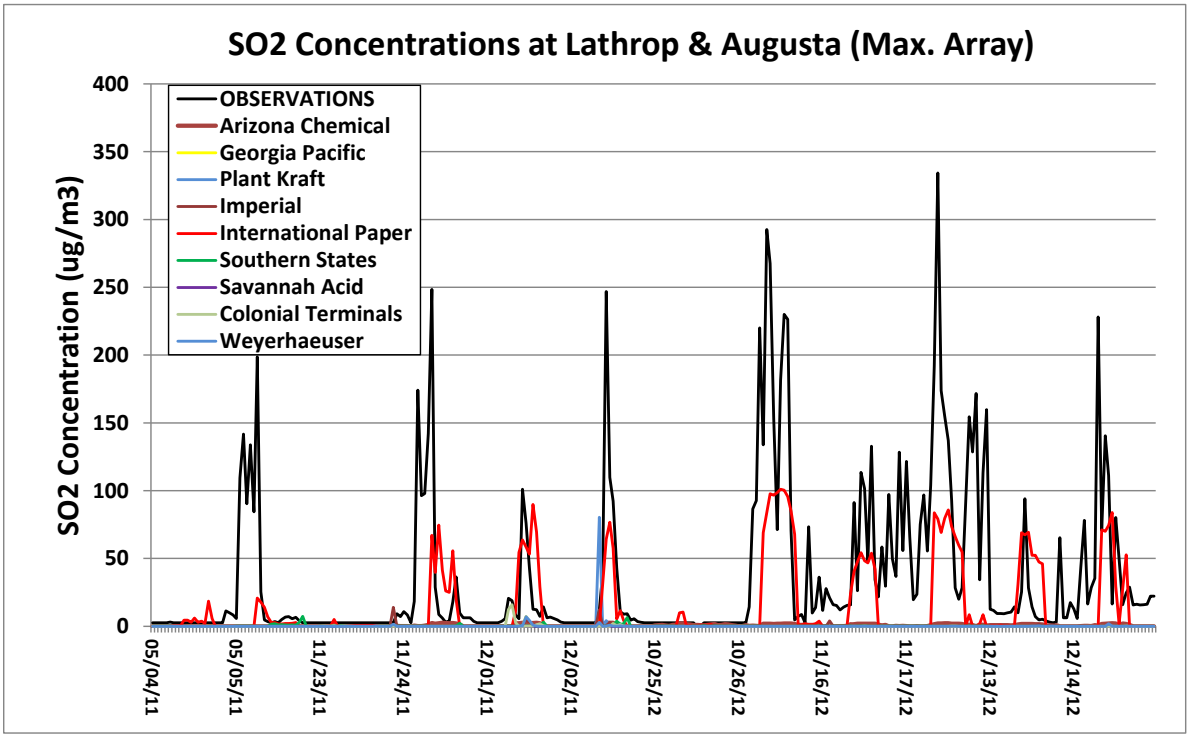

Figure 31. Maximum hourly SO2 source contributions from each facility from the array of receptors surrounding the Savannah - Lathrop & Augusta monitor.

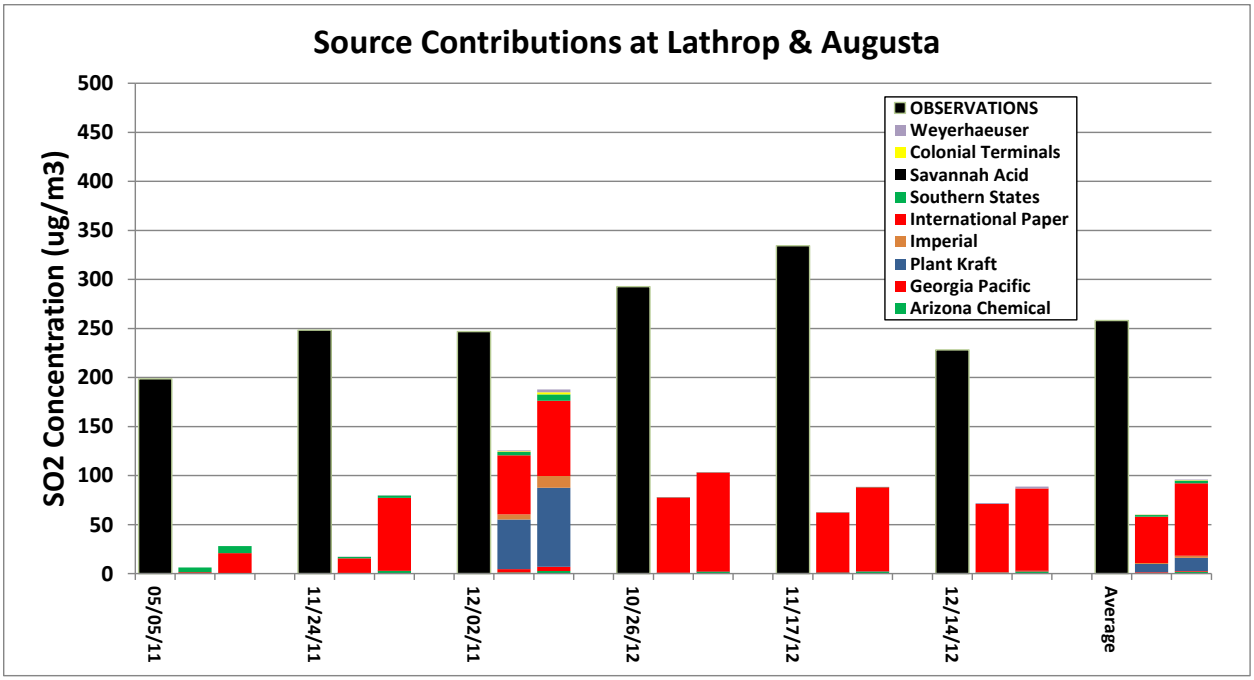

Figure 32. Bar chart summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the Savannah - Lathrop & Augusta monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding Savannah - Lathrop & Augusta monitor location.

Rome - Coosa Elementary School (13-115-0003)

Figure 33 contains the AERMOD receptor array used to model impacts at the Rome - Coosa Elementary School (13-115-0003) monitor. Figure 34 contains a time series plot comparing AERMOD SO2 results at the monitoring site receptor, AERMOD SO2 results for the maximum receptor in the array, and the SO2 observations. Figure 51 contains a Q-Q plot (unpaired in time) for the SO2 concentrations at the monitoring site receptor and the maximum receptor in the array. Figure 36 contains the hourly SO2 source contributions from each facility at the receptor corresponding to the monitor location. Figure 37 contains the maximum hourly SO2 source contributions from the array of receptors for each facility. Figure 38 contains a summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding the monitor location.

In general, AERMOD tends to slightly under predict the SO2 peaks when using the monitoring site receptor. However, the model tends to over predict the SO2 peaks when using the maximum receptor in the array surrounding the monitoring site. Based on the model results, it appears that the SO2 emissions from International Paper – Rome Linerboard and to a lesser degree Plant Hammond caused or contributed to many of the SO2 NAAQS exceedances at the Rome - Coosa Elementary School monitor.

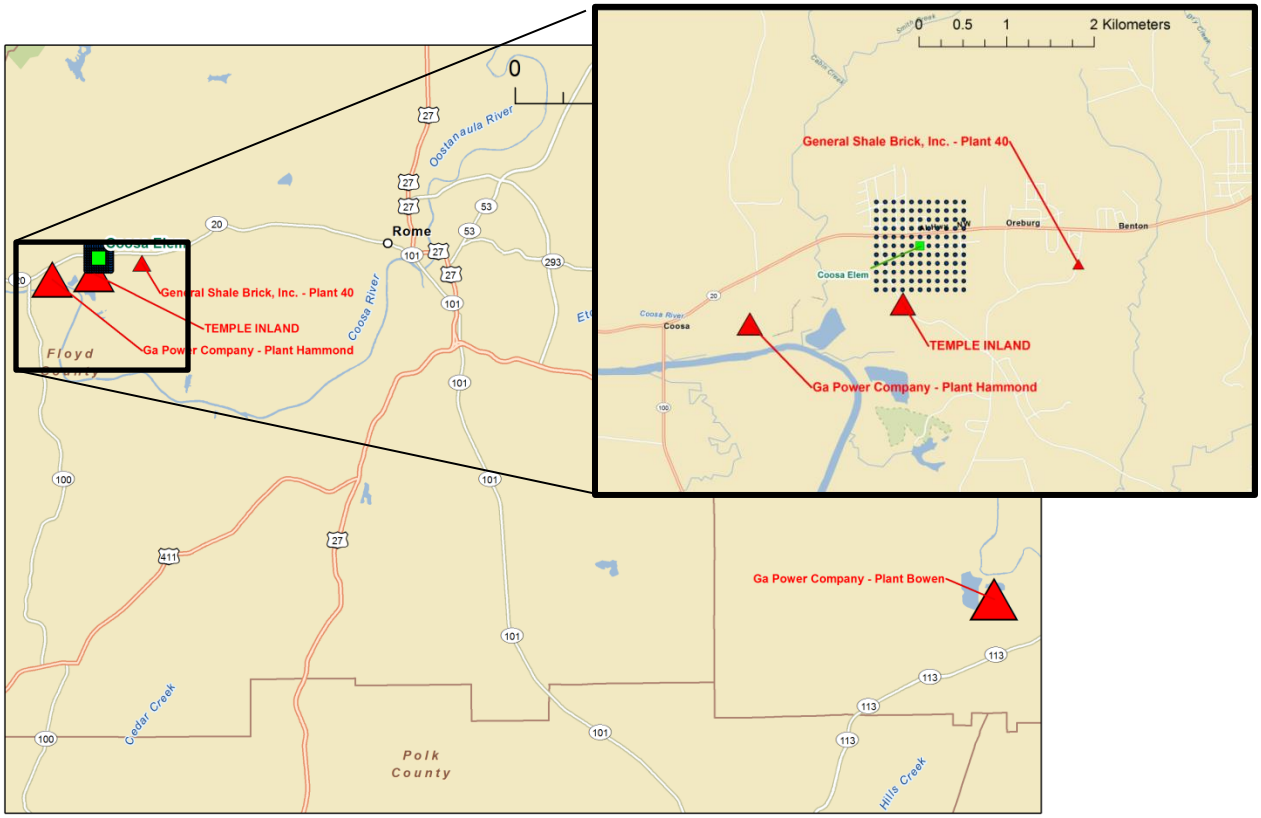

Figure 33. AERMOD receptor array for Rome - Coosa Elementary School (13-115-0003) monitor.

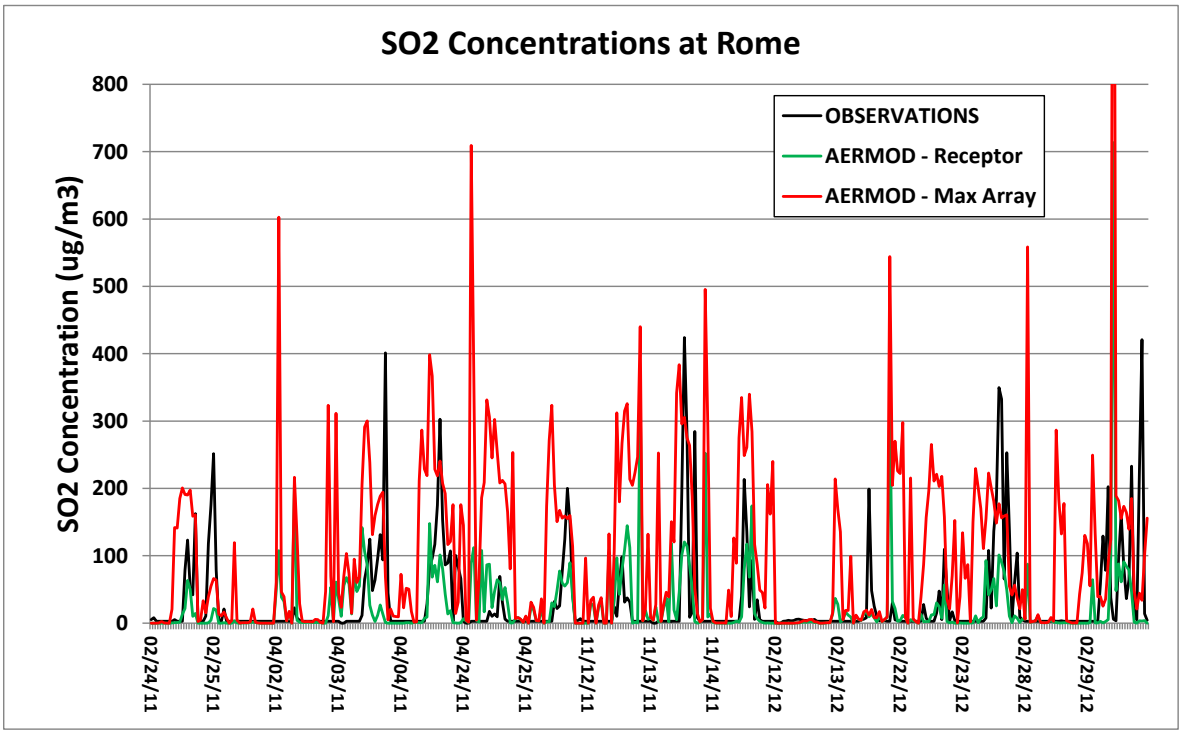

Figure 34. AERMOD SO2 results at the Rome – Coosa Elementary monitoring site receptor

(green), AERMOD SO2 results for the maximum receptor in the array (red), and the SO2 observations (black).

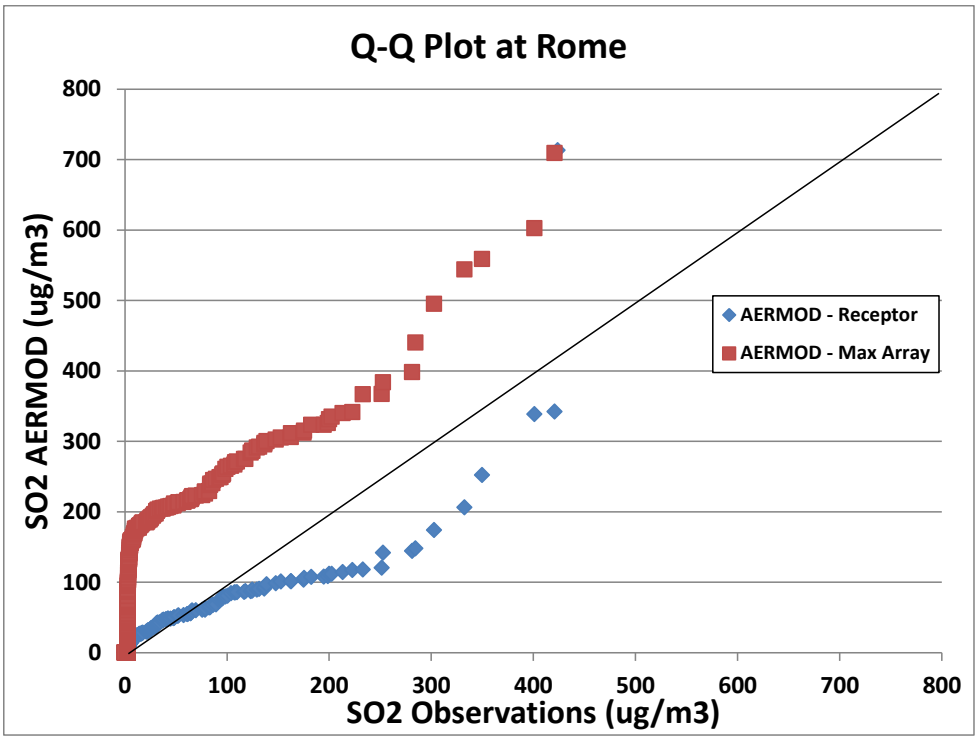

Figure 35. Q-Q plot (unpaired in time) for the SO2 concentrations at the Rome – Coosa Elementary monitoring site receptor and the maximum receptor in the array.

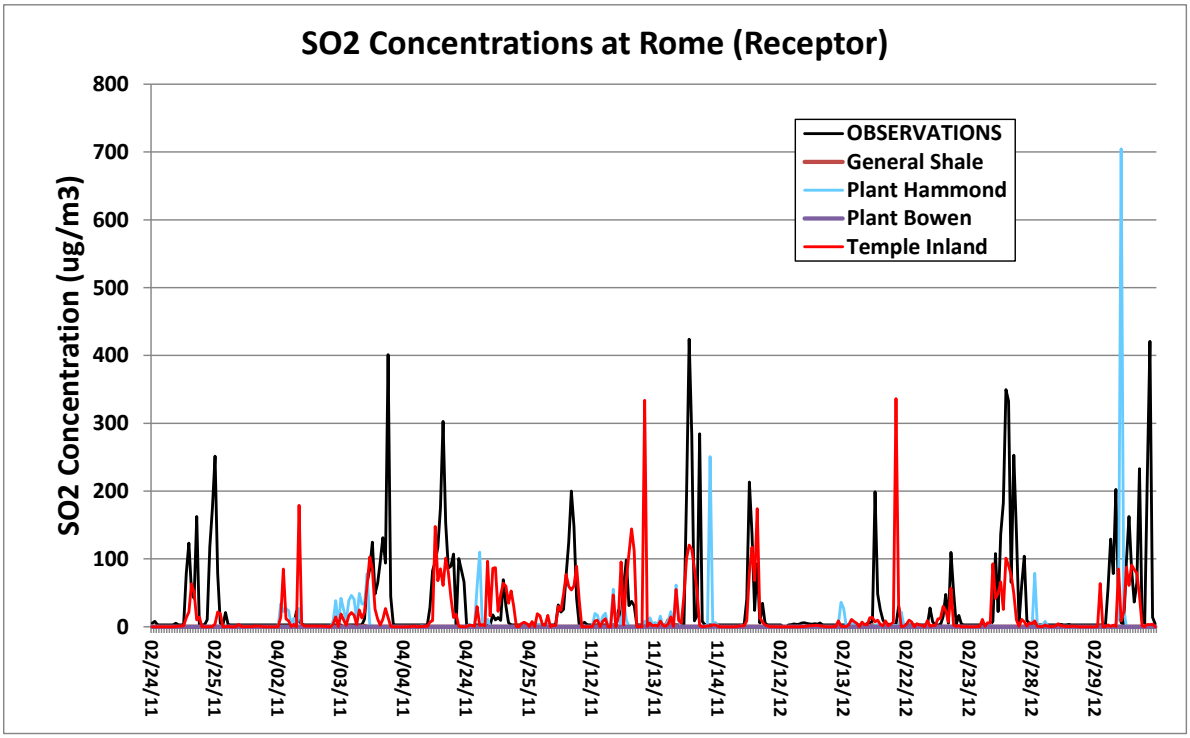

Figure 36. Hourly SO2 source contributions from each facility at the receptor corresponding to the Rome – Coosa Elementary monitor location.

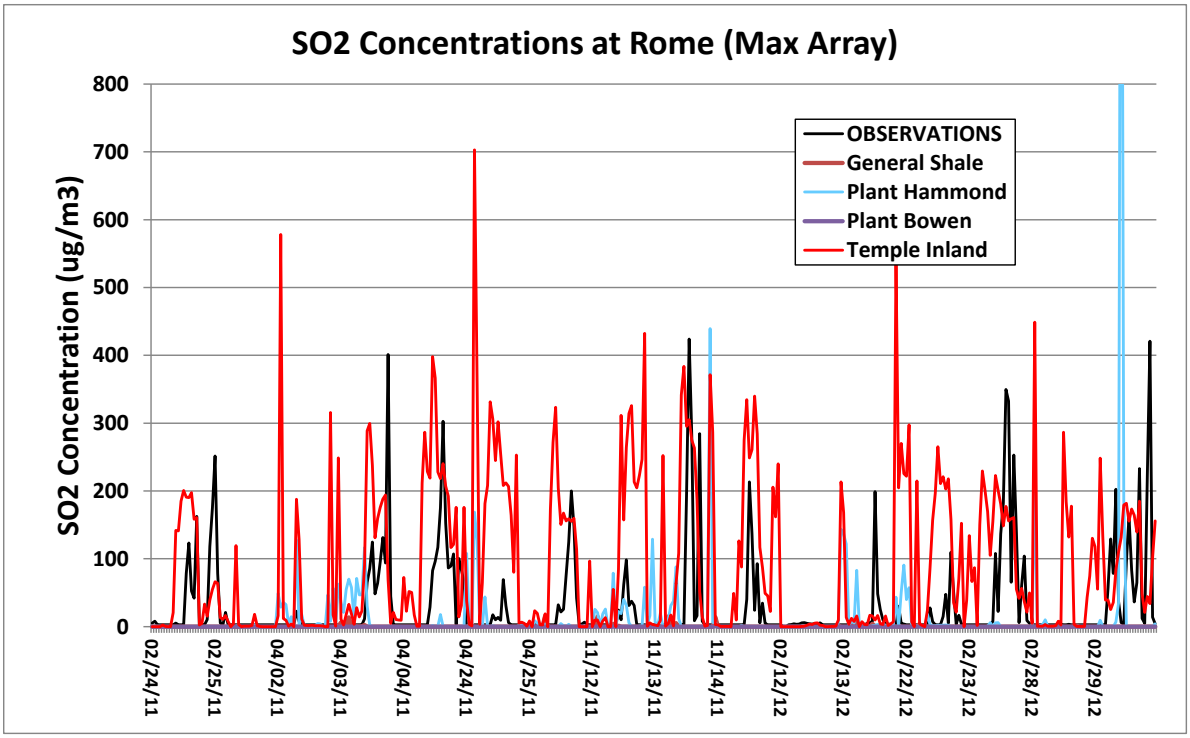

Figure 37. Maximum hourly SO2 source contributions from each facility from the array of receptors surrounding the Rome – Coosa Elementary monitor.

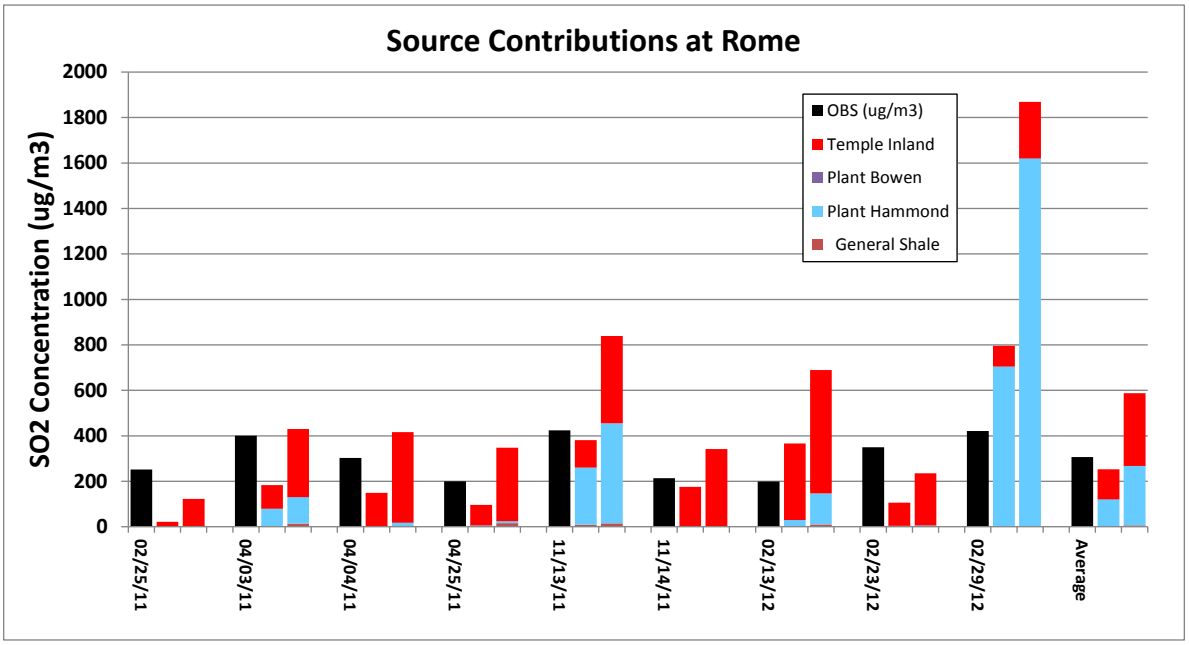

Figure 38. Bar chart summary of the daily maximum observation, daily maximum source contributions from each facility at the receptor corresponding to the Rome – Coosa Elementary

monitor location, and the daily maximum source contributions from each facility from the array of receptor surrounding the Rome – Coosa Elementary monitor location.

CONCLUSIONS

Technical analyses were performed to help identify SO2 emission sources that contributed to SO2 exceedances in Rome and Savannah. These analyses included:

1) identification of nearby SO2 sources and Q/d (emissions/distance) analysis;
2) back trajectory analysis on SO2 exceedance days, and
3) AERMOD modeling to quantify source contributions to SO2 exceedances.

Based on these analyses, it appears that the SO2 emissions from Southern States Phosphate & Fertilizer caused or contributed to the SO2 NAAQS exceedances at the Savannah - E. President monitor; the SO2 emissions from International Paper – Savannah Mill caused or contributed to the SO2 NAAQS exceedances at the Savannah - Lathrop & Augusta monitor; and the SO2 emissions from International Paper – Rome Linerboard and to a lesser degree Plant Hammond caused or contributed to the SO2 NAAQS exceedances at the Rome - Coosa Elementary School monitor.