Figure 6.36: Map of rotated EOF 2 when 2 EOFs are rotated. Values on the map are weighted deviations from the mean sulfate sulfur concentrations at each site in ng/m³.

6.6 Assessment of Quantitative Attribution Techniques

There are a number of receptor oriented models that have been used to attribute primary aerosols to their sources while very few attempts have been made to apportion secondary aerosols using receptor oriented techniques. The chemical mass balance (CMB) model has historically been the most popular receptor oriented model. It essentially uses the relative ratios of natural or man-made tracers at the sources and receptor locations to apportion primary species at one point in time. Tracer mass balance regression (TMBR) on the other hand uses the variation of trace material across time to achieve apportionment of primary or secondary aerosols. Finally, the differential mass balance (DMB) approach uses trace material to establish dispersion factors but calculates the effects of deposition and oxidation explicitly. Assumptions, limitations,and method of calculating uncertainties for each of these model is covered in Appendices 6D, 6B, and 6C. Also presented in Appendix 6A is the recently formulated general mass balance model (GMB). It is an attempt to combine the tracer mass balance regression model, the chemical mass balance model and differential mass balance approach into one umbrella formalism. This formalism allows for a straight forward exploration of assumptions and deviation from assumptions that are required to carry out the apportionment calculations.

Each of the subsequent sections present the attribution calculation along with uncertainty analysis for each of receptor oriented approaches.

6.6.1 Tracer Mass Balance Regression

Tracer mass balance regression (TMBR) is one simplification of the general mass balance model. The equations, assumptions and possible deviations from assumptions associated with TMBR are

presented in Appendix 6B. In TMBR, regression analyses are carried out with total sulfur or sulfate sulfur as the dependent variable and, depending on assumptions, scaled CD_4 (SCD_4), Se, and As as independent variables. (See Appendix 6B for assumptions.)

When attributing a secondary aerosol such as ammonium sulfate the TMBR analysis implicitly assumes that deposition and SO_2 to sulfate conversion rates are constant in both space and time. However during the WHITEX study the sulfur dioxide oxidation rate was strongly dependent on relative humidity. As a first approximation to the oxidation rate RH dependence the independent variables were multiplied by RH. The reader should refer to Appendix 6B for a detailed discussion of this approximation.

If a single unique tracer such as CD_4 is associated with a source, a regression analysis using the aerosol that is to be attributed as the dependent variable and tracer as the independent variable has a fairly simple interpretation. The intercept is the average background concentration while the slope of the regression line multiplied by the tracer is the concentration associated with the source having the unique tracer. On the other hand, if more than one unique tracer is available then the TMBR analysis can be extended to include as many sources as there are unique tracers, provided the number of sources does not exceed the number of data points. The TMBR can also be carried out in the absence of unique tracers. Procedures for this type of analysis are discussed in Appendix 6B.

For purposes of attributing total sulfur or sulfate sulfur to NGS, SCD_4 is considered to be a unique NGS tracer. Furthermore As was found to be below the detectable limit in samples gathered from within the NGS plume (refer to Table 6.3). Therefore As is considered to be a unique tracer for emissions other than NGS and most probably associated with copper smelter emissions. The reader is referred to Section 6.6.3 where a number of copper smelter profiles are exhibited. Finally copper smelter trace element emission profiles usually exhibit relatively small amounts of Se and in some cases Se was below detectable limit. On JD 40 and 41 where back trajectories suggest a copper smelter impact at Hopi Point, ambient Se concentrations were below detectable limits. This suggests that the copper smelter emissions impacting the study area contain small amounts of Se as compared to NGS or other coal fired power plant emissions. Therefore Se can be considered a tracer that is primarily associated with coal fired power plant emissions with possible small contributions associated with other sources. For purposes of the following sulfur attribution analysis Se emissions will be associated with coal fired power plant sulfur.

All regressions were carried out using both ordinary least squares (OLS) regression as well as orthogonal distance regression (ODR). ODR explicitly takes into account the uncertainties in both the dependent and independent variables. Because ODR gives more weight to samples with small uncertainties, for some cases, the OLS and ODR regression coefficients were quite different. Usually the ODR regression coefficients will be greater than the corresponding coefficients obtained with OLS and the intercept will be smaller. The intercepts were forced to be positive in all ODR regressions. At Hopi Point, most of the IMPROVE Se data were below detection limit, therefore, when Se data were needed for Hopi Point, SCISAS Se concentrations were used.

Results for Hopi Point, Grand Canyon

Because the TMBR analysis relies on a constant CD_4/total emission ratio, the CD_4 data gathered at Page, Arizona were scaled to a 2.5 mg/MWe-h ratio. Scaling is valid if the time period over which the CD_4 release rate is constant is long compared to travel time from the source to the receptor or the CD_4 is scaled as a function of NGS air mass age. The rate of change of CD_4/megawatt ratio was on the order of days, and since travel time of NGS emissions from Page, Arizona to the Grand Canyon is variable and can also be on the order of days, the CD_4 ambient concentrations cannot
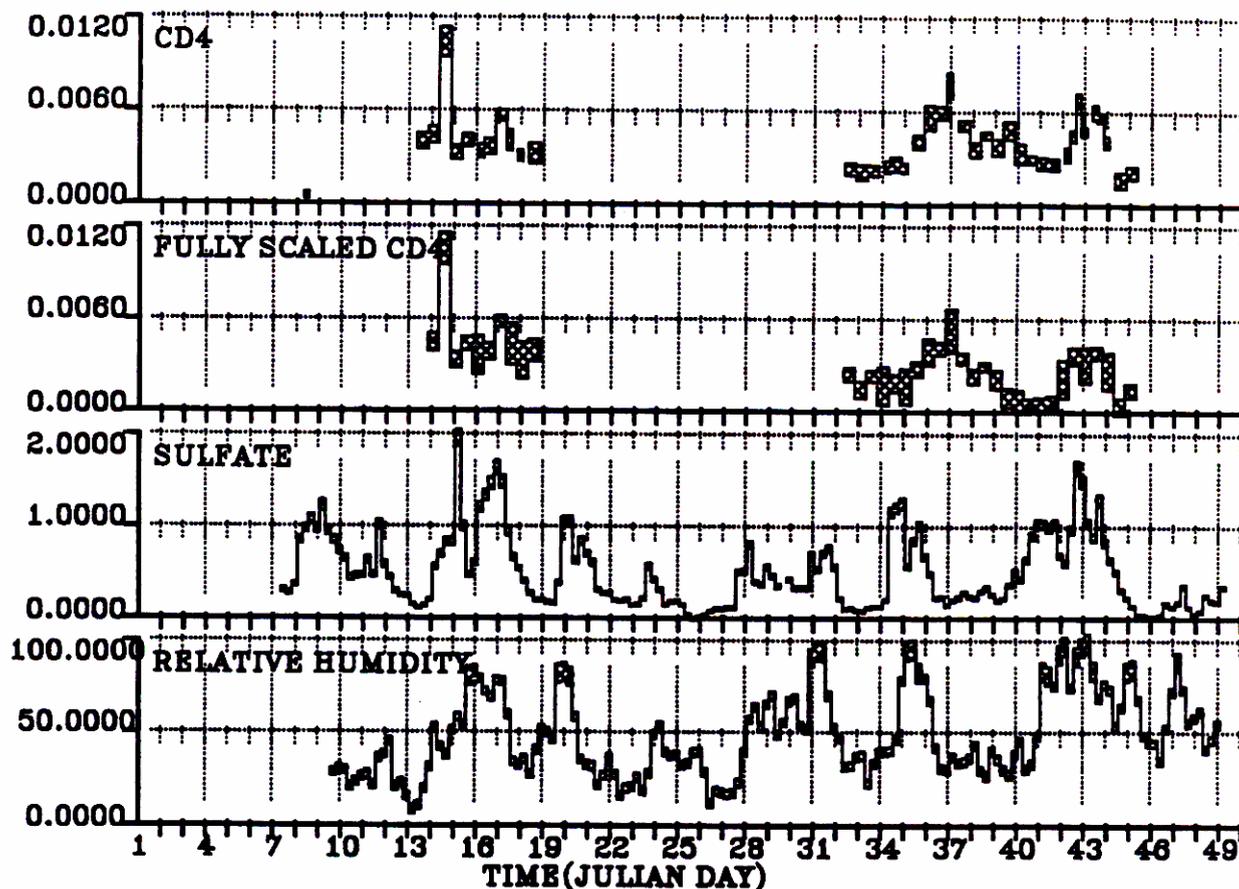
HOPI

Figure 6.37: Unscaled CD_4 (ppt), CD_4 scaled to CD_4 release rate and air mass age (ppt), RH (%) and SO_4 ($\mu g/m^3$) concentrations at Hopi Point.

be directly scaled to the NGS CD_4/megawatt ratio. However, CD_4 data can be scaled using the approximate age of the air mass that carried CD_4 into Grand Canyon. The unscaled CD_4 data, and CD_4 data scaled to CD_4 release rate and air mass age are shown in Figure 6.37. CD_4 data scaled to emission rate and air mass age will be referred to as fully scaled CD_4. Also shown in Figure 6.37 are RH and SO_4 concentrations.

Regression coefficients and intercepts obtained for the TMBR analyses at Hopi Point are listed in Tables 6.23 and 6.24 Regressions were carried out using both total sulfur and sulfate sulfur as the dependent variable. The R^2 values for the regressions using total sulfur are very poor. Even the addition of other trace elements did not raise the R^2 higher than 0.5. The low R^2 could be due to varying SO_2 deposition rates, significant number of ambient SO_2 concentrations below detectable limits, or the existence of sources of SO_2 not associated with measured trace elements.

Table 6.25 gives the results of the ODR and OLS regressions of SCD_4 versus particulate nitrate, organic carbon, and light absorbing carbon. Scatter plots of these data are also shown in Figures

Table 6.23: Results of TMBR regressions for total sulfur at Hopi Point.

Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient
ODR	All	36	0.06	SCD_4	182.19 ± 48.87
				Intercept	0.00 ± 0.14
OLS	All	36	0.06	SCD_4	90.10 ± 63.64
				Intercept	0.35 ± 0.22
ODR	All ex 35.3 *	35	0.30	SCD_4	177.05 ± 40.59
				Intercept	0.00 ± 0.11
OLS	All ex 35.3 *	35	0.30	SCD_4	94.91 ± 25.07
				Intercept	0.23 ± 0.09

* Julian Day 35.3 was an extreme outlying data point (high SO_2 value).

6.38, 6.39, and 6.40. No significant relationships were found between SCD_4 and these variables implying that NGS is not a source of these aerosols.

The first 4 sets of regressions for sulfate sulfur (see Table 6.24) were all done using the tracer or tracer multiplied by RH. Theoretical justification for multiplying the independent variables by RH is presented in Appendix 6B. Multiplication by RH essentially implies a RH dependent SO_2 to SO_4 oxidation rate. Based on the R^2 values, it can be seen that the sulfate sulfur is better explained by using $SCD_4 \times$ RH than by SCD_4 alone. It is also evident that the addition of the As term to the regression greatly improves the fit. Multiplication of As by RH does not make much difference in either the goodness of fit or the average amount of sulfur attributed to copper smelters suggesting that SO_2 from the smelters may have been mostly converted to SO_4 prior to reaching the monitoring site. Note that for all cases the intercept is lower and the coefficients of the tracer and As terms are higher from the ODR regression than from OLS.

If the regressions without an As term are disregarded due to their poorer R^2's, then the sulfur attribution which results from all of the analyses using SCD_4 are quite similar. The sulfate sulfur for all days with CD_4 data was found to be on average 62 ± 4–$73\pm4\%$ due to NGS, 23 ± 2–$30\pm3\%$ from copper smelters, and 0 ± 1–$14\pm2\%$ from other sources. The mean attribution which results from each individual regression are shown in Table 6.24.

The last 4 sets of regressions shown in Table 6.24 are those in which Se concentrations were used rather than scaled tracer concentrations. The first two sets are for days when there were CD_4 data available only. Thus the time periods are the same as those considered in the first 4 sets. If the sulfur which correlates with Se is expected to be sulfur from all power plants, while the sulfur which correlates with SCD_4 is associated with only NGS then, by subtracting the sulfate attributed to NGS from that attributed to all power plants, an estimate of sulfur from other power plants can be obtained. This is summarized in Table 6.26. The differences between the mean sulfur attributed to all power plants and that attributed to NGS only is $5\pm4\%$ for the OLS regressions (with and without As multiplied by RH) and for the ODR regressions in which As is not multiplied by RH. However, for the ODR regressions in which As is multiplied by RH, the mean attribution of sulfur to NGS alone is greater than the mean attribution of sulfur to all power plants by $7\pm4\%$. This is probably an indication that the ODR regressions in which Se data are used are overly influenced by the time periods in which the uncertainties in Se are small.

The final two sets of regressions shown in Table 6.24 were done using Se and As for all days when these data were available – not just the days when CD_4 was analyzed. For these two sets, it

Table 6.24: Results of TMBR regressions for sulfate sulfur at Hopi Point.

Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient	% of sulfur Attributed
ODR	All	36	0.03	SCD_4	75.46 ± 16.99	100±7
	CD_4			Intercept	0.00 ± 0.05	0±4
OLS	All	36	0.03	SCD_4	13.64 ± 12.91	18±4
	CD_4			Intercept	0.18 ± 0.04	82±3
ODR	All	36	0.32	$SCD_4 \times RH$	1.35 ± 0.27	100±7
	CD_4			Intercept	0.00 ± 0.03	0±3
OLS	All	36	0.32	$SCD_4 \times RH$	0.73 ± 0.18	54±4
	CD_4			Intercept	0.10 ± 0.04	46±3
ODR	All	36	0.71	$SCD_4 \times RH$	0.91 ± 0.12	73±4
	CD_4			As	106.41 ± 18.16	27±2
				Intercept	0.00 ± 0.02	0±1
OLS	All	36	0.71	$SCD_4 \times RH$	0.90 ± 0.12	68±4
	CD_4			As	98.57 ± 14.74	23±2
				Intercept	0.02 ± 0.03	9±2
ODR	All	36	0.73	$SCD_4 \times RH$	0.90 ± 0.12	70± 4
*	CD_4			$As \times RH$	2.14 ± 0.36	30±3
				Intercept	0.00 ± 0.02	0±1
OLS	All	36	0.73	$SCD_4 \times RH$	0.83 ± 0.12	62±4
*	CD_4			$As \times RH$	1.81 ± 0.26	24±2
				Intercept	0.03 ± 0.02	14±2
ODR	All	33	0.81	$Se \times RH$	13.68 ± 1.39	78±2
	CD_4			As	92.02 ± 19.53	22±2
				Intercept	0.00 ± 0.01	0±1
OLS	All	33	0.81	$Se \times RH$	12.19 ± 1.40	73±2
	CD_4			As	66.38 ± 11.67	17±2
				Intercept	0.02 ± 0.02	10±2
ODR	All	33	0.76	$Se \times RH$	12.10 ± 1.54	63±2
	CD_4			$As \times RH$	2.61 ± 0.62	34±3
				Intercept	0.01 ± 0.01	3±1
OLS	All	33	0.80	$Se \times RH$	11.10 ± 1.49	67±2
*	CD_4			$As \times RH$	1.22 ± 0.23	18±2
				Intercept	0.03 ± 0.02	15±2
ODR	All	76	0.35	$Se \times RH$	7.69 ± 4.02	20±2
				As	709.09 ± 209.71	80±10
				Intercept	0.00 ± 0.03	1±1
OLS	All	76	0.76	$Se \times RH$	11.57 ± 0.96	62±1
				As	55.09 ± 10.07	13±1
				Intercept	0.04 ± 0.01	26±1
ODR	All	76	0.33	$Se \times RH$	-1.71 ± 11.73	-2±2
				$As \times RH$	32.48 ± 22.61	97±22
				Intercept	0.03 ± 0.04	5±1
OLS	All	76	0.74	$Se \times RH$	10.98 ± 1.03	60±1
*				$As \times RH$	0.99 ± 0.20	13±1
				Intercept	0.04 ± 0.01	26±1

* Results of these regression were used for source apportionment.

Table 6.25: Results of TMBR regressions for nitrate, organic carbon, and elemental carbon at Hopi Point.

| Dependent Variable	Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient
NO_3	ODR	All	36	0.20	SCD_4	34.972 ± 12.004
					Intercept	0.000 ± 0.034
NO_3	OLS	All	36	0.20	SCD_4	38.528 ± 13.281
					Intercept	0.019 ± 0.046
organic carbon	ODR	All	36	0.00	SCD_4	-2.139 ± 19.849
					Intercept	0.090 ± 1.315
organic carbon	OLS	All	36	0.00	SCD_4	-0.433 ± 19.852
					Intercept	0.089 ± 0.069
LAC	ODR	All	36	0.00	SCD_4	1.908 ± 10.737
					Intercept	0.178 ± 4.796
LAC	OLS	All	36	0.00	SCD_4	2.476 ± 10.722
					Intercept	0.177 ± 0.037
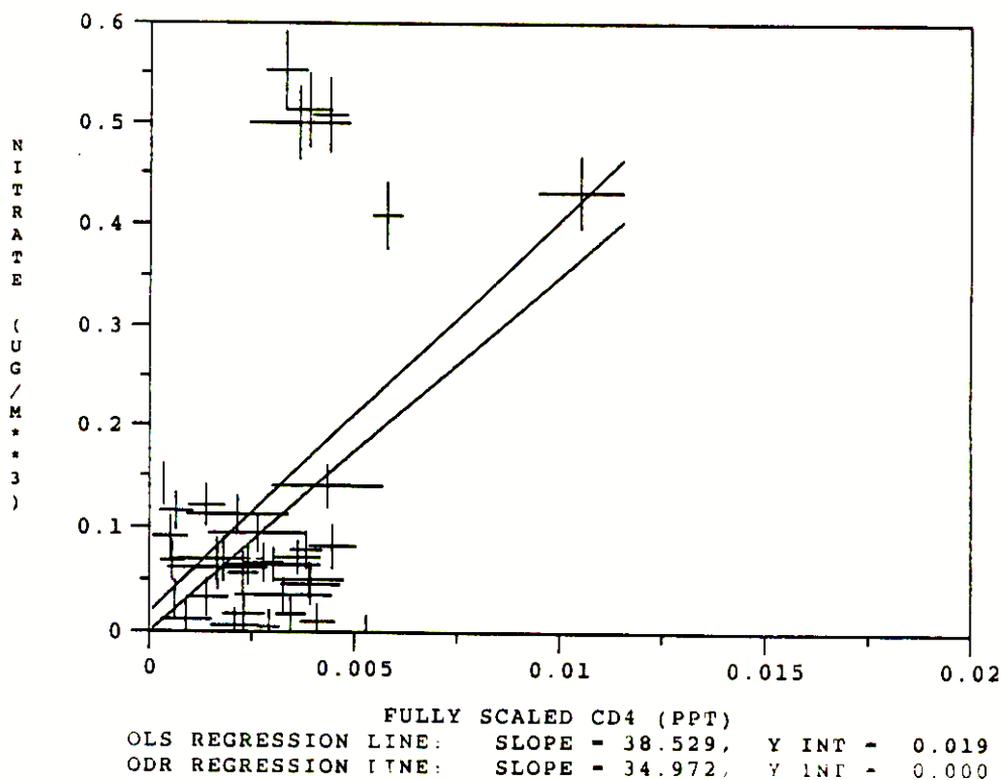
Figure 6.38: Scatter plot of SCD_4 vs particulate nitrate at Hopi Point along with the OLS and ODR regression lines.

FULLY SCALED CD4 (PPT)
OLS REGRESSION LINE: SLOPE = -0.433, Y INT = 0.089
ODR REGRESSION LINE: SLOPE = -2.132, Y INT = 0.090
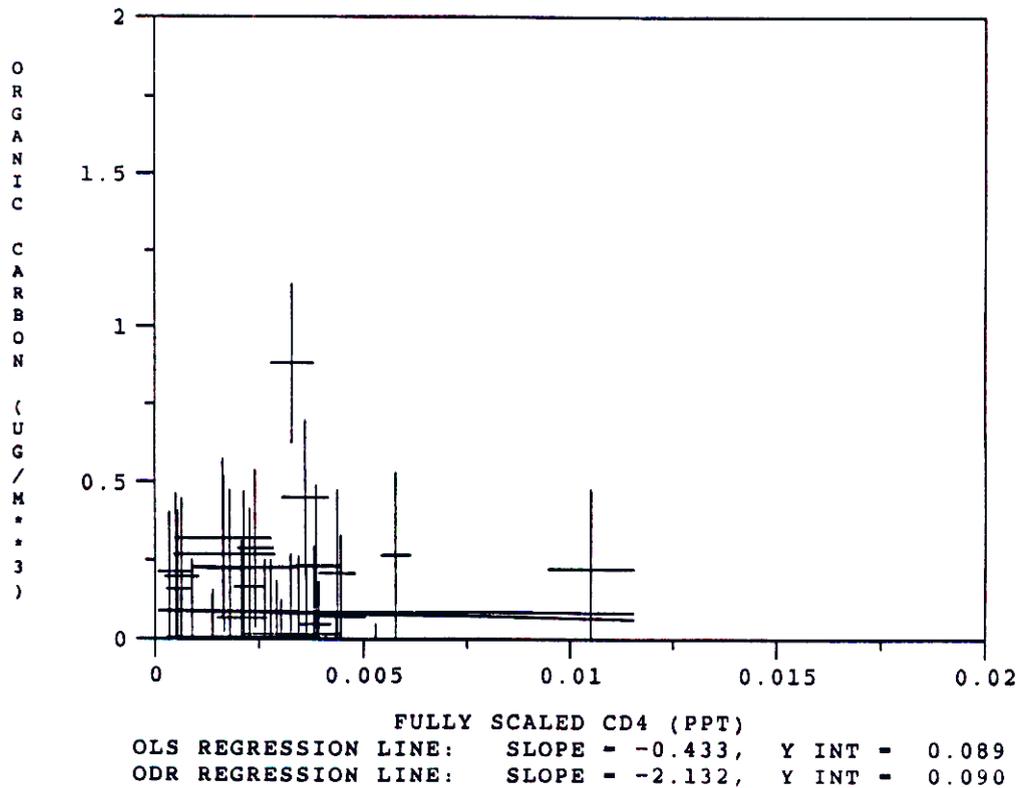
Figure 6.39: Scatter plot of SCD_4 *vs* organic carbon at Hopi Point along with the OLS and ODR regression lines.

Table 6.26: Percent of mean sulfate sulfur at Hopi Point attributed to NGS, all power plants, and power plants other than NGS by TMBR analyses. The $As \times RH$? column refers to whether or not arsenic was multiplied by relative humidity in the TMBR analysis.

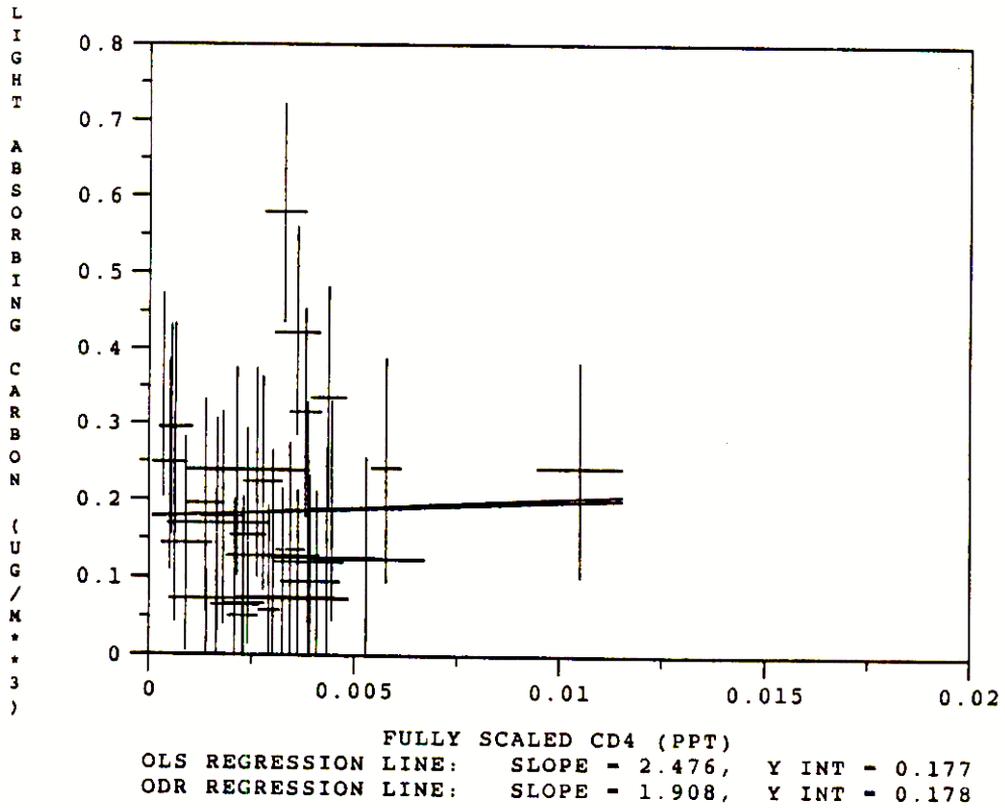| Model	$As \times RH$?	NGS	All	Difference
ODR	No	73±4	78±2	5±4
OLS	No	68±4	73±2	5±4
ODR	Yes	70±4	63±2	-7±4
OLS	Yes	62±4	67±2	5±4

Figure 6.40: Scatter plot of SCD_4 *vs* light absorbing carbon at Hopi Point along with the OLS and ODR regression lines.

can be seen that whether ODR or OLS was used made a large difference in the results. The OLS results are more physically reasonable, as can be seen by the differences in the R^2s and the fact that the Se coefficient is negative for one of the ODR analyses. Also note the large As coefficients for both of the ODR runs. The reason for the difference between the two regression techniques is that the points with the most influence on the ODR regression are those points with the smallest uncertainties. Other points which have larger uncertainties are allowed to fall farther from the "best fit" line. In OLS all points are of equal weight. The uncertainty for SCISAS Se was estimated to be a quadratic sum of half the minimum detection limit plus 7% of the measured concentration which accounts for flow rate error. The ODR regressions using Se appear to be driven mostly by the low concentration data points with the resulting lines being poor fits for the observations which have larger Se concentrations (and uncertainties). The poor fit by the ODR model indicates that either the uncertainties for the low Se concentrations are too small – meaning that the detection limit should be higher, or the uncertainties for the larger concentrations should be smaller – meaning that the 7% flow rate uncertainty may be too large.

For each of the analyses marked by a * in Table 6.24 the source apportionment of sulfur was calculated for every 12-hour time period. TMBR best explained the measured sulfate sulfur when the independent variables used were $SCD_4 \times$ RH, and $As \times$ RH. The ODR results for each time period are shown in Figure 6.41 and Table 6.27 ($\mu g/m^3$ of sulfur attributed to each source for each time period) and Table 6.28 (fraction of sulfur attributed to each source for each time period). The corresponding results using the same variables in OLS are shown in Figure 6.42 and Tables 6.29 and 6.30. Scatter plots of predicted vs measured sulfate sulfur are shown in Figures 6.43 and 6.44.

The source apportionments for only the CD_4 time periods resulting from the OLS regression using $Se \times$ RH to represent all power plants instead of $SCD_4 \times$ RH for NGS only, are shown in Figure 6.45 and Tables 6.31 and 6.32. For the reasons discussed above, the ODR regression in which Se data were used are probably not valid and are not presented. Results for all days are shown in Figure 6.46 and Tables 6.33 and 6.34.

Finally, it is possible, as discussed above, to get an estimate of the sulfate from power plants other than NGS by subtracting the sulfur attributed to NGS from that attributed to all power plants. The day by day results of this calculation are shown in Figure 6.47 and Tables 6.35 and 6.36. Only the OLS results are presented. Other power plant contributions are small except for time periods when copper smelter contributions are predicted to be significant. Apparently meteorological conditions responsible for long range transport of copper smelter emissions are also conducive to transporting sulfates associated with other coal fired power plants. Since the Mohave power plant is in the pathway between southern Arizona copper smelters and Grand Canyon the other power plant sulfur may be associated with its SO_2 emissions.

Figure 6.41: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using ODR regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.

Sulfate Sulfur
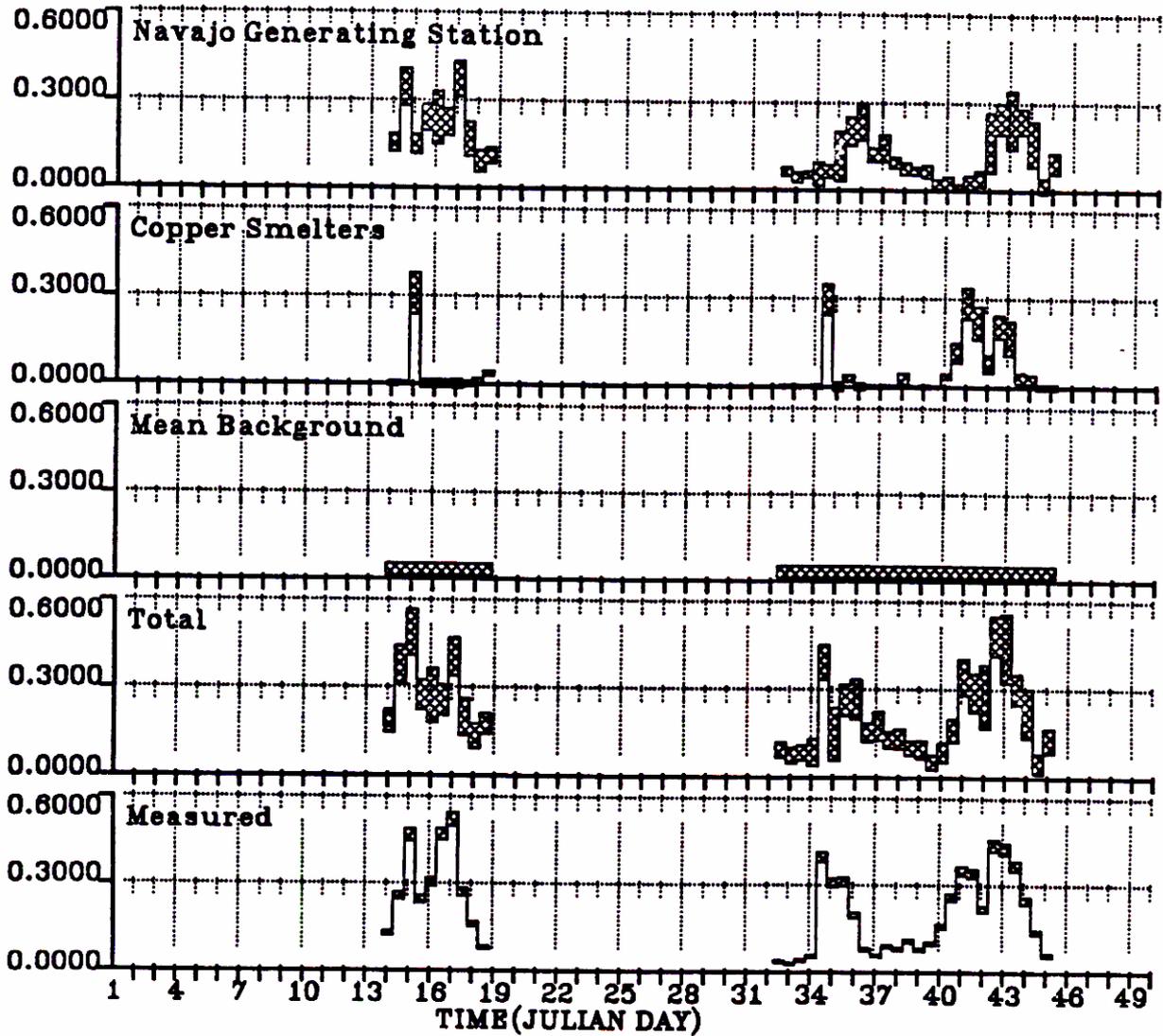
Figure 6.42: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $SCD_4 \times RH$ and $As \times RH$ for days with CD_4.
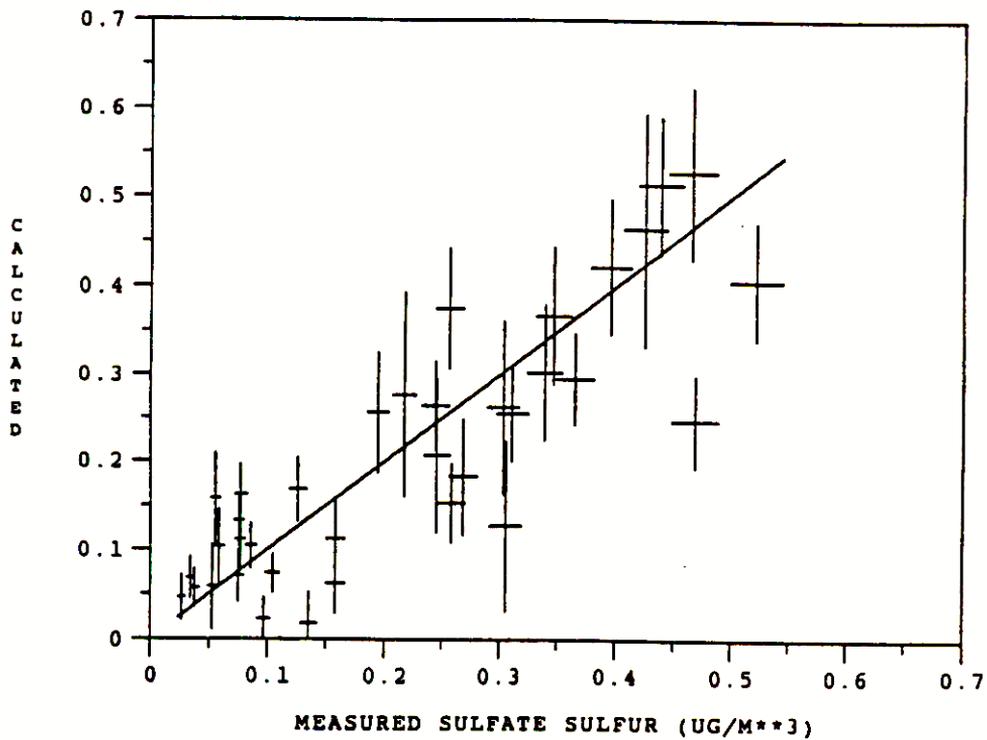
Figure 6.43: Scatter plot of predicted *vs* measured sulfate sulfur ($\mu g/m^3$) at Hopi Point. Results from ODR regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.

Figure 6.44: Scatter plot of predicted *vs* measured sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.
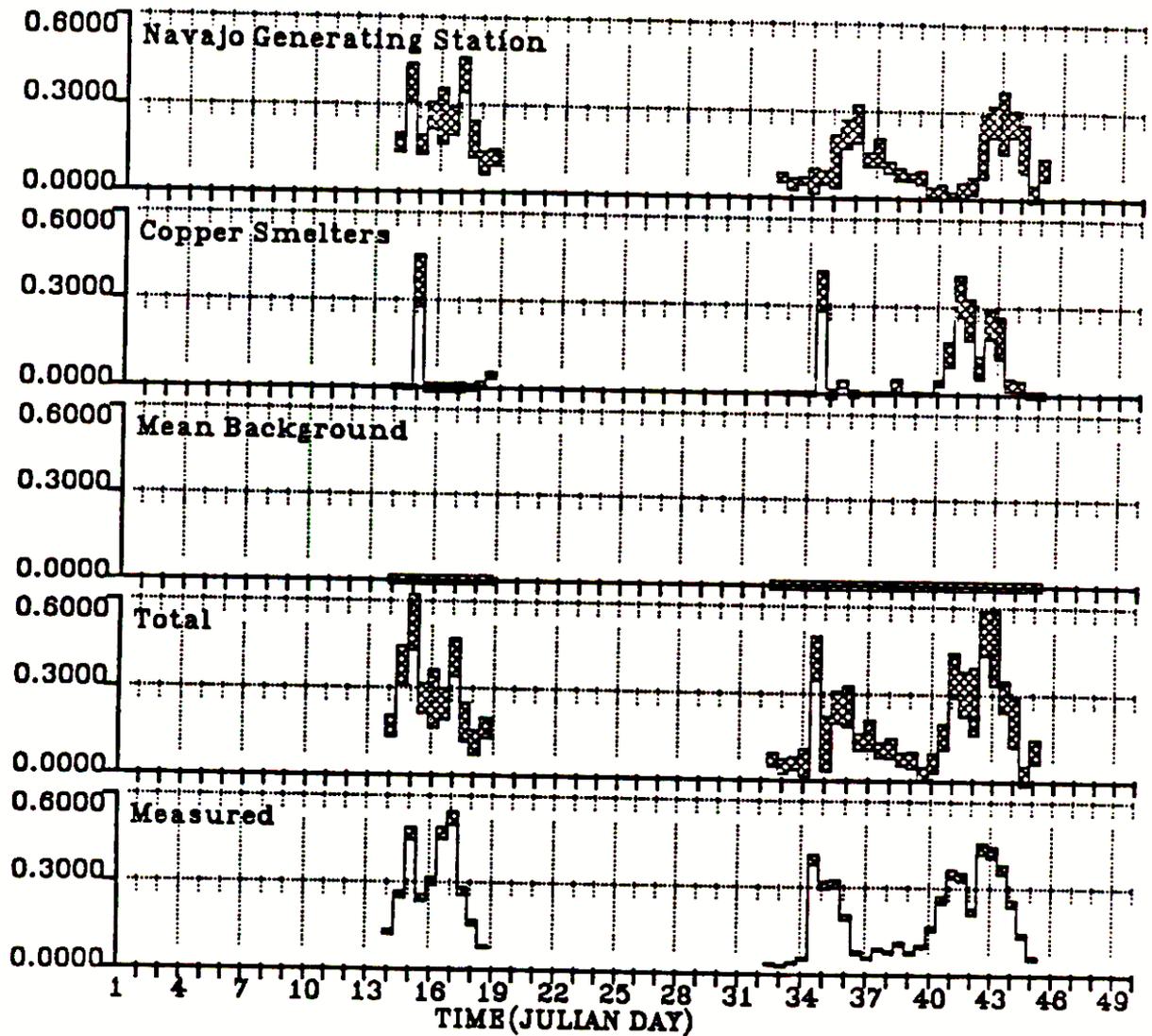
Table 6.27: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using ODR regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.
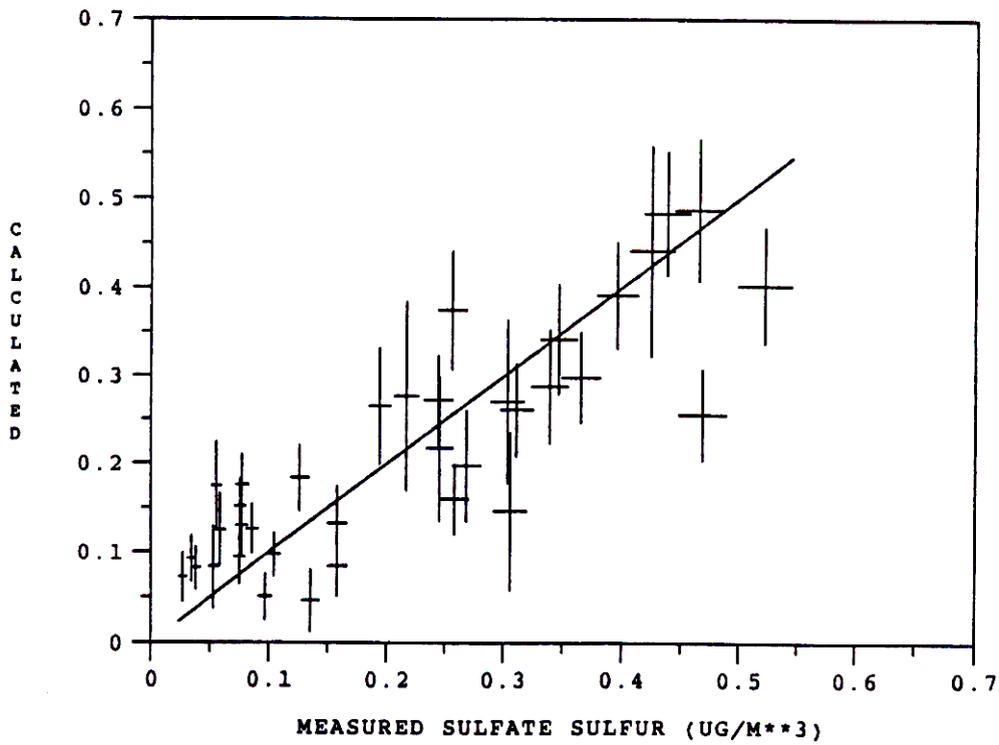
DATE	NGS	Smelters	Background	Total	Measured
13.8	0.168 ± 0.032	0.000 ± 0.007	0.000 ± 0.016	0.168 ± 0.037	0.126 ± 0.007
14.3	0.375 ± 0.065	0.000 ± 0.007	0.000 ± 0.016	0.375 ± 0.067	0.256 ± 0.012
14.8	0.162 ± 0.033	0.364 ± 0.088	0.000 ± 0.016	0.527 ± 0.096	0.465 ± 0.021
15.3	0.264 ± 0.046	0.000 ± 0.015	0.000 ± 0.016	0.264 ± 0.051	0.244 ± 0.012
15.8	0.262 ± 0.096	0.000 ± 0.016	0.000 ± 0.016	0.262 ± 0.099	0.303 ± 0.014
16.3	0.246 ± 0.048	0.000 ± 0.014	0.000 ± 0.016	0.246 ± 0.053	0.469 ± 0.020
16.8	0.406 ± 0.060	0.000 ± 0.017	0.000 ± 0.016	0.406 ± 0.065	0.522 ± 0.023
17.3	0.183 ± 0.063	0.000 ± 0.011	0.000 ± 0.016	0.183 ± 0.066	0.268 ± 0.012
17.8	0.100 ± 0.039	0.013 ± 0.008	0.000 ± 0.016	0.113 ± 0.043	0.158 ± 0.008
18.3	0.120 ± 0.028	0.043 ± 0.011	0.000 ± 0.016	0.162 ± 0.034	0.077 ± 0.005
32.3	0.069 ± 0.016	0.000 ± 0.005	0.000 ± 0.016	0.069 ± 0.023	0.034 ± 0.004
32.8	0.046 ± 0.018	0.000 ± 0.006	0.000 ± 0.016	0.046 ± 0.025	0.027 ± 0.003
33.3	0.057 ± 0.013	0.000 ± 0.005	0.000 ± 0.016	0.057 ± 0.021	0.038 ± 0.004
33.8	0.059 ± 0.044	0.000 ± 0.008	0.000 ± 0.016	0.059 ± 0.048	0.053 ± 0.004
34.3	0.070 ± 0.023	0.351 ± 0.069	0.000 ± 0.016	0.421 ± 0.074	0.396 ± 0.017
34.8	0.127 ± 0.092	0.000 ± 0.017	0.000 ± 0.016	0.127 ± 0.095	0.306 ± 0.014
35.3	0.223 ± 0.050	0.032 ± 0.013	0.000 ± 0.016	0.255 ± 0.054	0.311 ± 0.014
35.8	0.257 ± 0.066	0.000 ± 0.013	0.000 ± 0.016	0.257 ± 0.069	0.194 ± 0.009
36.3	0.133 ± 0.024	0.000 ± 0.005	0.000 ± 0.016	0.133 ± 0.029	0.075 ± 0.005
36.8	0.158 ± 0.048	0.000 ± 0.006	0.000 ± 0.016	0.158 ± 0.051	0.055 ± 0.004
37.3	0.105 ± 0.019	0.000 ± 0.006	0.000 ± 0.016	0.105 ± 0.026	0.086 ± 0.005
37.8	0.082 ± 0.021	0.030 ± 0.022	0.000 ± 0.016	0.111 ± 0.035	0.076 ± 0.005
38.3	0.073 ± 0.013	0.000 ± 0.005	0.000 ± 0.016	0.073 ± 0.021	0.104 ± 0.006
38.8	0.070 ± 0.022	0.000 ± 0.006	0.000 ± 0.016	0.070 ± 0.028	0.075 ± 0.005
39.3	0.023 ± 0.016	0.000 ± 0.004	0.000 ± 0.016	0.023 ± 0.023	0.097 ± 0.005
39.8	0.023 ± 0.027	0.039 ± 0.010	0.000 ± 0.016	0.062 ± 0.033	0.158 ± 0.008
40.3	0.015 ± 0.008	0.137 ± 0.041	0.000 ± 0.016	0.153 ± 0.045	0.258 ± 0.012
40.8	0.029 ± 0.025	0.337 ± 0.071	0.000 ± 0.016	0.367 ± 0.077	0.347 ± 0.015
41.3	0.045 ± 0.029	0.257 ± 0.069	0.000 ± 0.016	0.302 ± 0.077	0.339 ± 0.015
41.8	0.183 ± 0.109	0.093 ± 0.037	0.000 ± 0.016	0.277 ± 0.116	0.217 ± 0.010
42.3	0.270 ± 0.055	0.243 ± 0.050	0.000 ± 0.016	0.513 ± 0.077	0.438 ± 0.019
42.8	0.266 ± 0.108	0.197 ± 0.071	0.000 ± 0.016	0.463 ± 0.130	0.425 ± 0.019
43.3	0.261 ± 0.045	0.034 ± 0.021	0.000 ± 0.016	0.295 ± 0.052	0.365 ± 0.016
43.8	0.177 ± 0.084	0.030 ± 0.017	0.000 ± 0.016	0.207 ± 0.087	0.245 ± 0.011
44.3	0.018 ± 0.028	0.000 ± 0.010	0.000 ± 0.016	0.018 ± 0.034	0.135 ± 0.007
44.8	0.104 ± 0.037	0.000 ± 0.011	0.000 ± 0.016	0.104 ± 0.042	0.058 ± 0.004
MEAN	0.145 ± 0.008	0.061 ± 0.005	0.000 ± 0.003	0.206 ± 0.010	0.217 ± 0.002
FRAC	0.704 ± 0.042	0.296 ± 0.026	0.000 ± 0.013	1.000 ± 0.051	1.049 ± 0.014

Table 6.28: Fractions of sulfate sulfur attributed by TMBR to each source at Hopi Point using ODR regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.

DATE	NGS	Smelters	Background	Total
13.8	1.000 ± 0.290	0.000 ± 0.043	0.000 ± 0.097	1.000 ± 0.309
14.3	1.000 ± 0.249	0.000 ± 0.018	0.000 ± 0.043	1.000 ± 0.253
14.8	0.308 ± 0.085	0.692 ± 0.210	0.000 ± 0.031	1.000 ± 0.228
15.3	1.000 ± 0.259	0.000 ± 0.055	0.000 ± 0.062	1.000 ± 0.272
15.8	1.000 ± 0.526	0.000 ± 0.060	0.000 ± 0.062	1.000 ± 0.533
16.3	1.000 ± 0.291	0.000 ± 0.056	0.000 ± 0.066	1.000 ± 0.304
16.8	1.000 ± 0.217	0.000 ± 0.042	0.000 ± 0.040	1.000 ± 0.225
17.3	1.000 ± 0.496	0.000 ± 0.061	0.000 ± 0.089	1.000 ± 0.507
17.8	0.884 ± 0.483	0.116 ± 0.087	0.000 ± 0.145	1.000 ± 0.512
18.3	0.737 ± 0.233	0.263 ± 0.086	0.000 ± 0.101	1.000 ± 0.268
32.3	1.000 ± 0.413	0.000 ± 0.080	0.000 ± 0.238	1.000 ± 0.484
32.8	1.000 ± 0.676	0.000 ± 0.138	0.000 ± 0.352	1.000 ± 0.774
33.3	1.000 ± 0.430	0.000 ± 0.085	0.000 ± 0.286	1.000 ± 0.523
33.8	1.000 ± 1.106	0.000 ± 0.131	0.000 ± 0.279	1.000 ± 1.148
34.3	0.166 ± 0.063	0.834 ± 0.220	0.000 ± 0.039	1.000 ± 0.232
34.8	1.000 ± 1.044	0.000 ± 0.133	0.000 ± 0.128	1.000 ± 1.060
35.3	0.873 ± 0.269	0.127 ± 0.058	0.000 ± 0.064	1.000 ± 0.283
35.8	1.000 ± 0.372	0.000 ± 0.050	0.000 ± 0.064	1.000 ± 0.381
36.3	1.000 ± 0.283	0.000 ± 0.041	0.000 ± 0.123	1.000 ± 0.311
36.8	1.000 ± 0.448	0.000 ± 0.036	0.000 ± 0.104	1.000 ± 0.461
37.3	1.000 ± 0.303	0.000 ± 0.056	0.000 ± 0.156	1.000 ± 0.345
37.8	0.735 ± 0.299	0.265 ± 0.215	0.000 ± 0.147	1.000 ± 0.396
38.3	1.000 ± 0.338	0.000 ± 0.066	0.000 ± 0.222	1.000 ± 0.410
38.8	1.000 ± 0.513	0.000 ± 0.081	0.000 ± 0.232	1.000 ± 0.569
39.3	1.000 ± 1.243	0.000 ± 0.189	0.000 ± 0.714	1.000 ± 1.446
39.8	0.371 ± 0.473	0.629 ± 0.369	0.000 ± 0.262	1.000 ± 0.655
40.3	0.101 ± 0.062	0.899 ± 0.374	0.000 ± 0.107	1.000 ± 0.394
40.8	0.080 ± 0.071	0.920 ± 0.272	0.000 ± 0.045	1.000 ± 0.285
41.3	0.148 ± 0.103	0.852 ± 0.316	0.000 ± 0.054	1.000 ± 0.337
41.8	0.662 ± 0.482	0.338 ± 0.195	0.000 ± 0.059	1.000 ± 0.523
42.3	0.526 ± 0.134	0.474 ± 0.121	0.000 ± 0.032	1.000 ± 0.183
42.8	0.575 ± 0.284	0.425 ± 0.194	0.000 ± 0.035	1.000 ± 0.346
43.3	0.884 ± 0.219	0.116 ± 0.073	0.000 ± 0.055	1.000 ± 0.237
43.8	0.854 ± 0.544	0.146 ± 0.103	0.000 ± 0.079	1.000 ± 0.559
44.3	1.000 ± 2.471	0.000 ± 0.563	0.000 ± 0.906	1.000 ± 2.691
44.8	1.000 ± 0.533	0.000 ± 0.105	0.000 ± 0.157	1.000 ± 0.565

Table 6.29: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.

DATE	NGS	Smelters	Background	Total	Measured
13.8	0.154 ± 0.031	0.000 ± 0.006	0.030 ± 0.020	0.184 ± 0.037	0.126 ± 0.007
14.3	0.344 ± 0.063	0.000 ± 0.006	0.030 ± 0.020	0.374 ± 0.066	0.256 ± 0.012
14.8	0.149 ± 0.032	0.307 ± 0.069	0.030 ± 0.020	0.486 ± 0.079	0.465 ± 0.021
15.3	0.243 ± 0.044	0.000 ± 0.012	0.030 ± 0.020	0.273 ± 0.050	0.244 ± 0.012
15.8	0.241 ± 0.090	0.000 ± 0.013	0.030 ± 0.020	0.271 ± 0.093	0.303 ± 0.014
16.3	0.226 ± 0.046	0.000 ± 0.012	0.030 ± 0.020	0.256 ± 0.052	0.469 ± 0.020
16.8	0.372 ± 0.059	0.000 ± 0.014	0.030 ± 0.020	0.402 ± 0.064	0.522 ± 0.023
17.3	0.168 ± 0.058	0.000 ± 0.009	0.030 ± 0.020	0.198 ± 0.062	0.268 ± 0.012
17.8	0.091 ± 0.036	0.011 ± 0.007	0.030 ± 0.020	0.132 ± 0.042	0.158 ± 0.008
18.3	0.110 ± 0.027	0.036 ± 0.008	0.030 ± 0.020	0.176 ± 0.034	0.077 ± 0.005
32.3	0.063 ± 0.015	0.000 ± 0.005	0.030 ± 0.020	0.093 ± 0.025	0.034 ± 0.004
32.8	0.043 ± 0.017	0.000 ± 0.005	0.030 ± 0.020	0.073 ± 0.027	0.027 ± 0.003
33.3	0.052 ± 0.012	0.000 ± 0.004	0.030 ± 0.020	0.082 ± 0.024	0.038 ± 0.004
33.8	0.054 ± 0.041	0.000 ± 0.006	0.030 ± 0.020	0.084 ± 0.046	0.053 ± 0.004
34.3	0.064 ± 0.022	0.297 ± 0.051	0.030 ± 0.020	0.391 ± 0.059	0.396 ± 0.017
34.8	0.117 ± 0.085	0.000 ± 0.014	0.030 ± 0.020	0.147 ± 0.089	0.306 ± 0.014
35.3	0.204 ± 0.047	0.027 ± 0.011	0.030 ± 0.020	0.261 ± 0.052	0.311 ± 0.014
35.8	0.236 ± 0.062	0.000 ± 0.011	0.030 ± 0.020	0.266 ± 0.066	0.194 ± 0.009
36.3	0.122 ± 0.023	0.000 ± 0.005	0.030 ± 0.020	0.152 ± 0.031	0.075 ± 0.005
36.8	0.145 ± 0.045	0.000 ± 0.005	0.030 ± 0.020	0.175 ± 0.050	0.055 ± 0.004
37.3	0.096 ± 0.018	0.000 ± 0.005	0.030 ± 0.020	0.126 ± 0.027	0.086 ± 0.005
37.8	0.075 ± 0.020	0.025 ± 0.018	0.030 ± 0.020	0.130 ± 0.034	0.076 ± 0.005
38.3	0.067 ± 0.012	0.000 ± 0.004	0.030 ± 0.020	0.097 ± 0.024	0.104 ± 0.006
38.8	0.065 ± 0.021	0.000 ± 0.005	0.030 ± 0.020	0.095 ± 0.029	0.075 ± 0.005
39.3	0.021 ± 0.015	0.000 ± 0.004	0.030 ± 0.020	0.051 ± 0.025	0.097 ± 0.005
39.8	0.021 ± 0.025	0.033 ± 0.008	0.030 ± 0.020	0.084 ± 0.033	0.158 ± 0.008
40.3	0.014 ± 0.008	0.116 ± 0.033	0.030 ± 0.020	0.160 ± 0.039	0.258 ± 0.012
40.8	0.027 ± 0.023	0.285 ± 0.054	0.030 ± 0.020	0.341 ± 0.062	0.347 ± 0.015
41.3	0.041 ± 0.027	0.217 ± 0.055	0.030 ± 0.020	0.288 ± 0.064	0.339 ± 0.015
41.8	0.168 ± 0.101	0.079 ± 0.030	0.030 ± 0.020	0.277 ± 0.107	0.217 ± 0.010
42.3	0.247 ± 0.053	0.205 ± 0.038	0.030 ± 0.020	0.483 ± 0.068	0.438 ± 0.019
42.8	0.244 ± 0.100	0.166 ± 0.058	0.030 ± 0.020	0.440 ± 0.117	0.425 ± 0.019
43.3	0.240 ± 0.044	0.029 ± 0.017	0.030 ± 0.020	0.298 ± 0.051	0.365 ± 0.016
43.8	0.162 ± 0.078	0.026 ± 0.014	0.030 ± 0.020	0.218 ± 0.082	0.245 ± 0.011
44.3	0.017 ± 0.026	0.000 ± 0.009	0.030 ± 0.020	0.047 ± 0.034	0.135 ± 0.007
44.8	0.095 ± 0.034	0.000 ± 0.009	0.030 ± 0.020	0.125 ± 0.041	0.058 ± 0.004
MEAN	0.133 ± 0.008	0.052 ± 0.004	0.030 ± 0.003	0.215 ± 0.010	0.217 ± 0.002
FRAC	0.620 ± 0.037	0.240 ± 0.020	0.140 ± 0.016	1.000 ± 0.046	1.008 ± 0.013

Table 6.30: Fractions of sulfate sulfur attributed by TMBR to each source at Hopi Point using OLS regression with independent variables $SCD_4 \times$ RH and $As \times$ RH for days with CD_4.

DATE	NGS	Smelters	Background	Total
13.8	0.837 ± 0.238	0.000 ± 0.033	0.163 ± 0.114	1.000 ± 0.266
14.3	0.920 ± 0.234	0.000 ± 0.015	0.080 ± 0.055	1.000 ± 0.241
14.8	0.306 ± 0.082	0.632 ± 0.175	0.062 ± 0.042	1.000 ± 0.198
15.3	0.890 ± 0.231	0.000 ± 0.045	0.110 ± 0.076	1.000 ± 0.248
15.8	0.889 ± 0.450	0.000 ± 0.049	0.111 ± 0.083	1.000 ± 0.460
16.3	0.883 ± 0.254	0.000 ± 0.045	0.117 ± 0.082	1.000 ± 0.271
16.8	0.925 ± 0.209	0.000 ± 0.035	0.075 ± 0.051	1.000 ± 0.218
17.3	0.848 ± 0.398	0.000 ± 0.048	0.152 ± 0.112	1.000 ± 0.416
17.8	0.690 ± 0.350	0.083 ± 0.059	0.227 ± 0.167	1.000 ± 0.392
18.3	0.624 ± 0.194	0.205 ± 0.062	0.171 ± 0.119	1.000 ± 0.236
32.3	0.677 ± 0.246	0.000 ± 0.050	0.323 ± 0.233	1.000 ± 0.343
32.8	0.587 ± 0.320	0.000 ± 0.074	0.413 ± 0.315	1.000 ± 0.455
33.3	0.636 ± 0.232	0.000 ± 0.050	0.364 ± 0.264	1.000 ± 0.356
33.8	0.642 ± 0.597	0.000 ± 0.077	0.358 ± 0.309	1.000 ± 0.677
34.3	0.165 ± 0.061	0.759 ± 0.175	0.077 ± 0.052	1.000 ± 0.192
34.8	0.795 ± 0.754	0.000 ± 0.097	0.205 ± 0.184	1.000 ± 0.782
35.3	0.781 ± 0.239	0.104 ± 0.046	0.115 ± 0.080	1.000 ± 0.256
35.8	0.887 ± 0.322	0.000 ± 0.040	0.113 ± 0.080	1.000 ± 0.334
36.3	0.802 ± 0.221	0.000 ± 0.030	0.198 ± 0.138	1.000 ± 0.262
36.8	0.828 ± 0.350	0.000 ± 0.028	0.172 ± 0.125	1.000 ± 0.373
37.3	0.762 ± 0.220	0.000 ± 0.039	0.238 ± 0.167	1.000 ± 0.279
37.8	0.577 ± 0.216	0.192 ± 0.150	0.231 ± 0.165	1.000 ± 0.310
38.3	0.692 ± 0.212	0.000 ± 0.042	0.308 ± 0.219	1.000 ± 0.307
38.8	0.683 ± 0.306	0.000 ± 0.051	0.317 ± 0.233	1.000 ± 0.388
39.3	0.411 ± 0.356	0.000 ± 0.071	0.589 ± 0.489	1.000 ± 0.609
39.8	0.252 ± 0.308	0.392 ± 0.179	0.356 ± 0.275	1.000 ± 0.450
40.3	0.089 ± 0.052	0.724 ± 0.269	0.187 ± 0.133	1.000 ± 0.305
40.8	0.079 ± 0.070	0.833 ± 0.218	0.088 ± 0.061	1.000 ± 0.237
41.3	0.143 ± 0.098	0.753 ± 0.254	0.104 ± 0.073	1.000 ± 0.282
41.8	0.607 ± 0.432	0.285 ± 0.155	0.108 ± 0.083	1.000 ± 0.467
42.3	0.513 ± 0.131	0.425 ± 0.099	0.062 ± 0.042	1.000 ± 0.170
42.8	0.555 ± 0.271	0.377 ± 0.165	0.068 ± 0.049	1.000 ± 0.321
43.3	0.803 ± 0.201	0.097 ± 0.060	0.101 ± 0.069	1.000 ± 0.221
43.8	0.745 ± 0.455	0.118 ± 0.078	0.138 ± 0.106	1.000 ± 0.473
44.3	0.355 ± 0.618	0.000 ± 0.183	0.645 ± 0.638	1.000 ± 0.907
44.8	0.760 ± 0.367	0.000 ± 0.073	0.240 ± 0.177	1.000 ± 0.414

Figure 6.45: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $Se \times$ RH and $As \times$ RH for days when CD_4 was analyzed.
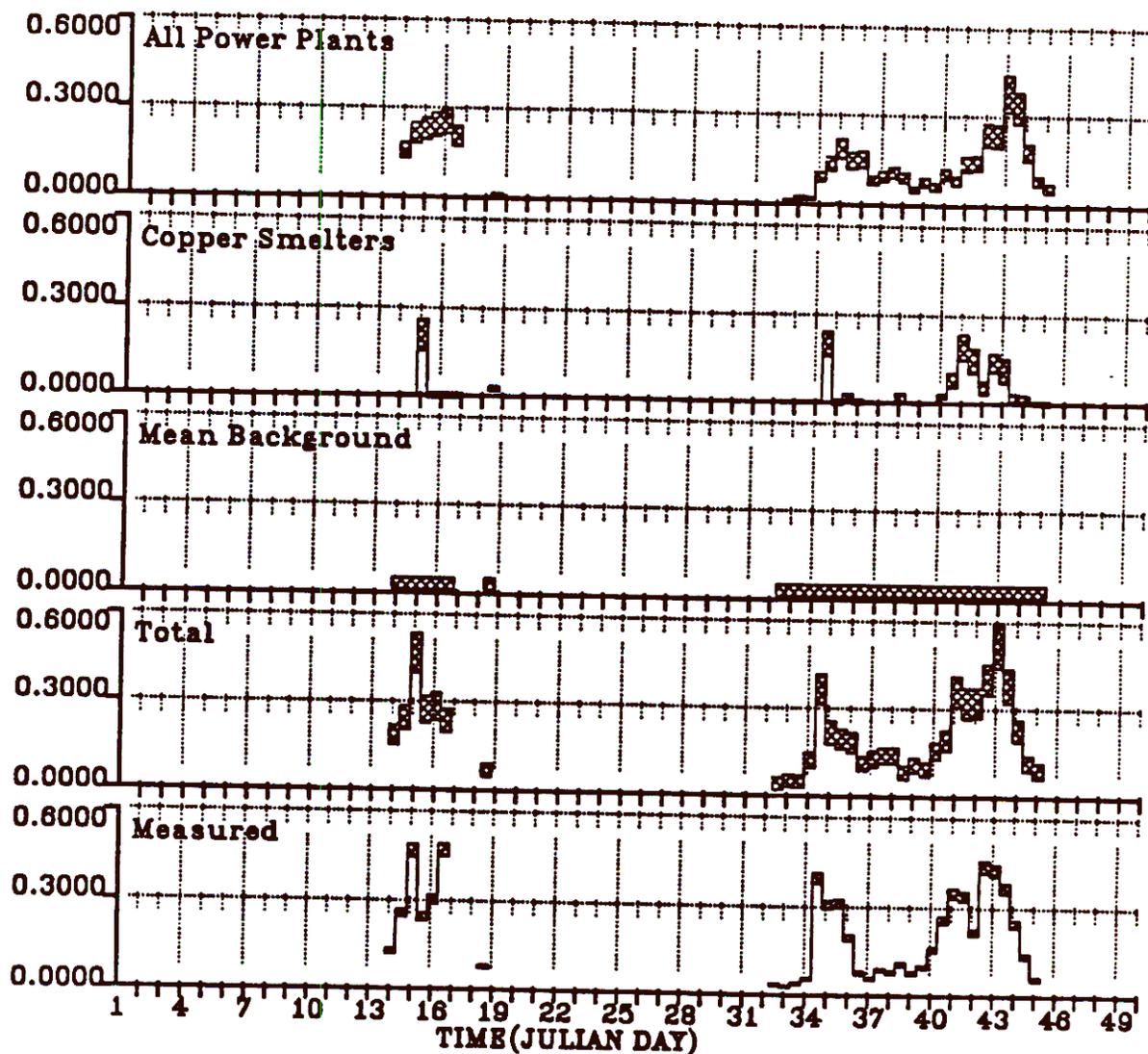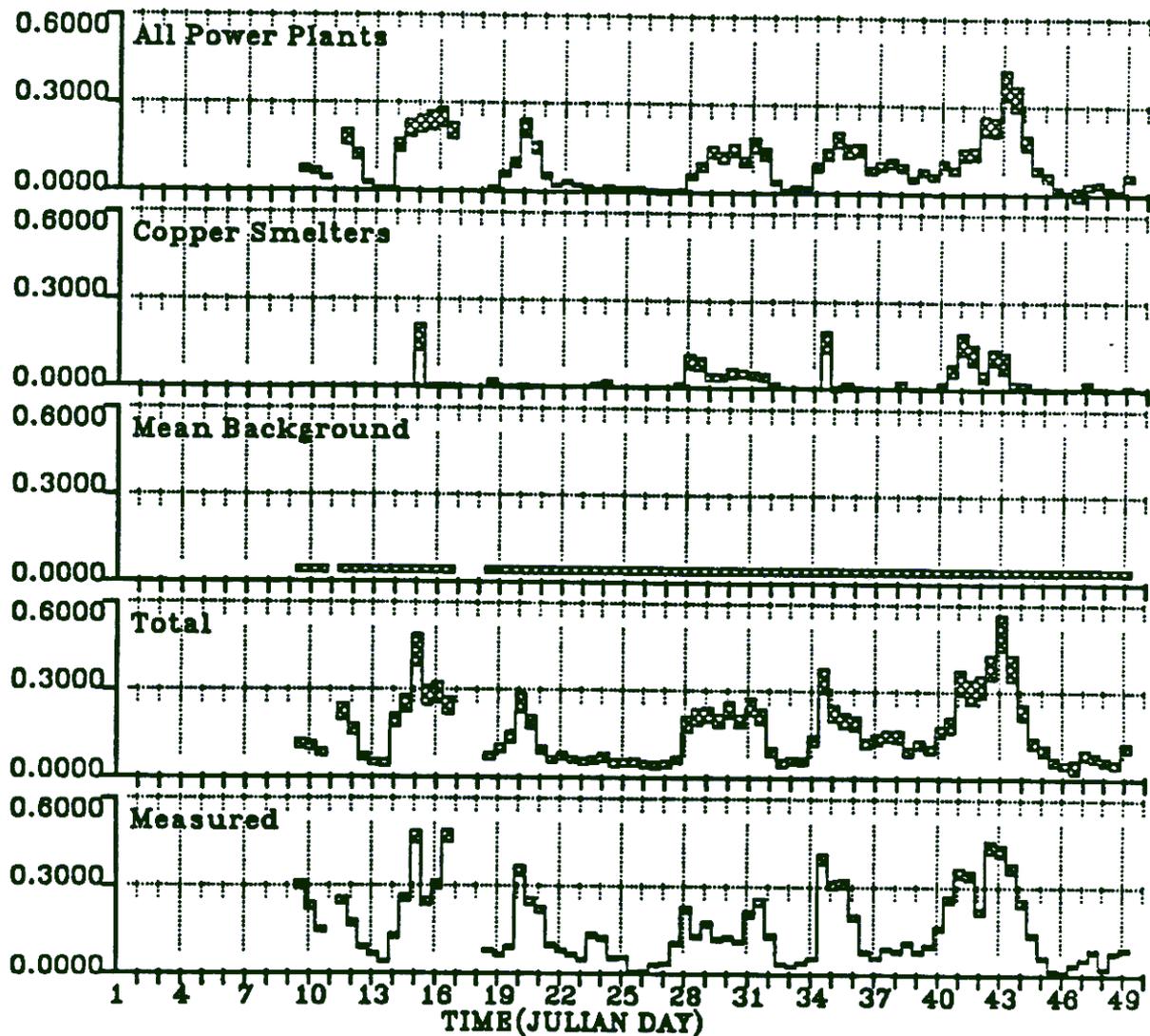
Figure 6.46: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $Se \times$ RH and $As \times$ RH for all days.

Table 6.31: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $Se \times$ RH and $As \times$ RH for days when CD_4 was analyzed.

DATE	All Power Plants	Smelters	Background	Total	Measured
13.8	0.155 ± 0.025	0.000 ± 0.004	0.030 ± 0.020	0.185 ± 0.032	0.126 ± 0.007
14.3	0.214 ± 0.034	0.000 ± 0.004	0.030 ± 0.020	0.244 ± 0.040	0.256 ± 0.012
14.8	0.230 ± 0.036	0.207 ± 0.053	0.030 ± 0.020	0.467 ± 0.067	0.465 ± 0.021
15.3	0.242 ± 0.039	0.000 ± 0.008	0.030 ± 0.020	0.272 ± 0.045	0.244 ± 0.012
15.8	0.253 ± 0.040	0.000 ± 0.009	0.030 ± 0.020	0.283 ± 0.046	0.303 ± 0.014
16.3	0.206 ± 0.032	0.000 ± 0.008	0.030 ± 0.020	0.236 ± 0.039	0.469 ± 0.020
18.3	0.011 ± 0.002	0.024 ± 0.006	0.030 ± 0.020	0.065 ± 0.021	0.077 ± 0.005
32.3	0.009 ± 0.002	0.000 ± 0.003	0.030 ± 0.020	0.039 ± 0.020	0.034 ± 0.004
32.8	0.019 ± 0.003	0.000 ± 0.004	0.030 ± 0.020	0.049 ± 0.021	0.027 ± 0.003
33.3	0.017 ± 0.003	0.000 ± 0.003	0.030 ± 0.020	0.047 ± 0.020	0.038 ± 0.004
33.8	0.090 ± 0.015	0.000 ± 0.004	0.030 ± 0.020	0.120 ± 0.025	0.053 ± 0.004
34.3	0.135 ± 0.021	0.200 ± 0.042	0.030 ± 0.020	0.365 ± 0.052	0.396 ± 0.017
34.8	0.186 ± 0.029	0.000 ± 0.010	0.030 ± 0.020	0.216 ± 0.037	0.306 ± 0.014
35.3	0.146 ± 0.024	0.018 ± 0.008	0.030 ± 0.020	0.194 ± 0.032	0.311 ± 0.014
35.8	0.150 ± 0.024	0.000 ± 0.007	0.030 ± 0.020	0.180 ± 0.032	0.194 ± 0.009
36.3	0.081 ± 0.013	0.000 ± 0.003	0.030 ± 0.020	0.111 ± 0.024	0.075 ± 0.005
36.8	0.094 ± 0.015	0.000 ± 0.003	0.030 ± 0.020	0.124 ± 0.025	0.055 ± 0.004
37.3	0.106 ± 0.017	0.000 ± 0.003	0.030 ± 0.020	0.136 ± 0.027	0.086 ± 0.005
37.8	0.090 ± 0.015	0.017 ± 0.013	0.030 ± 0.020	0.137 ± 0.028	0.076 ± 0.005
38.3	0.051 ± 0.009	0.000 ± 0.003	0.030 ± 0.020	0.081 ± 0.022	0.104 ± 0.006
38.8	0.076 ± 0.012	0.000 ± 0.003	0.030 ± 0.020	0.106 ± 0.024	0.075 ± 0.005
39.3	0.060 ± 0.010	0.000 ± 0.002	0.030 ± 0.020	0.090 ± 0.023	0.097 ± 0.005
39.8	0.103 ± 0.017	0.022 ± 0.006	0.030 ± 0.020	0.156 ± 0.027	0.158 ± 0.008
40.3	0.082 ± 0.014	0.078 ± 0.024	0.030 ± 0.020	0.190 ± 0.034	0.258 ± 0.012
40.8	0.138 ± 0.022	0.192 ± 0.043	0.030 ± 0.020	0.360 ± 0.053	0.347 ± 0.015
41.3	0.143 ± 0.023	0.146 ± 0.041	0.030 ± 0.020	0.319 ± 0.051	0.339 ± 0.015
41.8	0.239 ± 0.039	0.053 ± 0.022	0.030 ± 0.020	0.322 ± 0.049	0.217 ± 0.010
42.3	0.234 ± 0.037	0.138 ± 0.031	0.030 ± 0.020	0.403 ± 0.052	0.438 ± 0.019
42.8	0.378 ± 0.061	0.112 ± 0.041	0.030 ± 0.020	0.520 ± 0.076	0.425 ± 0.019
43.3	0.331 ± 0.052	0.019 ± 0.012	0.030 ± 0.020	0.380 ± 0.057	0.365 ± 0.016
43.8	0.179 ± 0.028	0.017 ± 0.010	0.030 ± 0.020	0.226 ± 0.036	0.245 ± 0.011
44.3	0.083 ± 0.013	0.000 ± 0.006	0.030 ± 0.020	0.113 ± 0.025	0.135 ± 0.007
44.8	0.057 ± 0.010	0.000 ± 0.006	0.030 ± 0.020	0.087 ± 0.023	0.058 ± 0.004
MEAN	0.139 ± 0.005	0.038 ± 0.003	0.030 ± 0.003	0.207 ± 0.007	0.208 ± 0.002
FRAC	0.672 ± 0.023	0.182 ± 0.017	0.145 ± 0.017	1.000 ± 0.033	1.004 ± 0.012

Table 6.32: Fractions of sulfate sulfur attributed to each source by TMBR at Hopi Point using OLS regression with independent variables $Se \times$ RH and $As \times$ RH for days when CD_4 was analyzed.

DATE	All Power Plants	Smelters	Background	Total
13.8	0.838 ± 0.198	0.000 ± 0.022	0.162 ± 0.112	1.000 ± 0.228
14.3	0.877 ± 0.200	0.000 ± 0.016	0.123 ± 0.084	1.000 ± 0.218
14.8	0.493 ± 0.105	0.443 ± 0.130	0.064 ± 0.044	1.000 ± 0.173
15.3	0.890 ± 0.204	0.000 ± 0.031	0.110 ± 0.076	1.000 ± 0.220
15.8	0.894 ± 0.204	0.000 ± 0.032	0.106 ± 0.073	1.000 ± 0.219
16.3	0.873 ± 0.197	0.000 ± 0.033	0.127 ± 0.087	1.000 ± 0.218
18.3	0.162 ± 0.062	0.375 ± 0.157	0.463 ± 0.343	1.000 ± 0.383
32.3	0.239 ± 0.133	0.000 ± 0.079	0.761 ± 0.641	1.000 ± 0.660
32.8	0.385 ± 0.177	0.000 ± 0.075	0.615 ± 0.485	1.000 ± 0.522
33.3	0.357 ± 0.169	0.000 ± 0.059	0.643 ± 0.513	1.000 ± 0.543
33.8	0.751 ± 0.198	0.000 ± 0.036	0.249 ± 0.174	1.000 ± 0.266
34.3	0.370 ± 0.079	0.548 ± 0.140	0.082 ± 0.056	1.000 ± 0.170
34.8	0.861 ± 0.200	0.000 ± 0.045	0.139 ± 0.096	1.000 ± 0.226
35.3	0.751 ± 0.175	0.095 ± 0.042	0.154 ± 0.106	1.000 ± 0.209
35.8	0.833 ± 0.197	0.000 ± 0.040	0.167 ± 0.115	1.000 ± 0.231
36.3	0.729 ± 0.199	0.000 ± 0.028	0.271 ± 0.190	1.000 ± 0.277
36.8	0.759 ± 0.199	0.000 ± 0.026	0.241 ± 0.168	1.000 ± 0.262
37.3	0.780 ± 0.199	0.000 ± 0.025	0.220 ± 0.153	1.000 ± 0.252
37.8	0.658 ± 0.171	0.123 ± 0.096	0.219 ± 0.153	1.000 ± 0.248
38.3	0.628 ± 0.201	0.000 ± 0.034	0.372 ± 0.268	1.000 ± 0.337
38.8	0.718 ± 0.199	0.000 ± 0.031	0.282 ± 0.199	1.000 ± 0.283
39.3	0.668 ± 0.202	0.000 ± 0.027	0.332 ± 0.237	1.000 ± 0.312
39.8	0.664 ± 0.156	0.143 ± 0.046	0.193 ± 0.133	1.000 ± 0.209
40.3	0.432 ± 0.105	0.410 ± 0.146	0.158 ± 0.109	1.000 ± 0.211
40.8	0.384 ± 0.084	0.533 ± 0.143	0.083 ± 0.057	1.000 ± 0.175
41.3	0.447 ± 0.101	0.459 ± 0.149	0.094 ± 0.064	1.000 ± 0.191
41.8	0.742 ± 0.165	0.165 ± 0.071	0.093 ± 0.064	1.000 ± 0.191
42.3	0.582 ± 0.119	0.344 ± 0.089	0.075 ± 0.051	1.000 ± 0.157
42.8	0.727 ± 0.158	0.215 ± 0.086	0.058 ± 0.039	1.000 ± 0.184
43.3	0.870 ± 0.190	0.051 ± 0.032	0.079 ± 0.054	1.000 ± 0.200
43.8	0.791 ± 0.176	0.076 ± 0.045	0.133 ± 0.091	1.000 ± 0.203
44.3	0.734 ± 0.199	0.000 ± 0.051	0.266 ± 0.187	1.000 ± 0.277
44.8	0.657 ± 0.210	0.000 ± 0.071	0.343 ± 0.246	1.000 ± 0.331

Table 6.33: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression with independent variables $Se \times RH$ and $As \times RH$ for all days.

DATE	All Power Plants	Smelters	Background	Total	Measured
9.3	0.071 ± 0.010	0.000 ± 0.003	0.040 ± 0.010	0.111 ± 0.014	0.301 ± 0.014
9.8	0.064 ± 0.009	0.000 ± 0.003	0.040 ± 0.010	0.104 ± 0.014	0.230 ± 0.011
10.3	0.042 ± 0.006	0.000 ± 0.002	0.040 ± 0.010	0.082 ± 0.012	0.148 ± 0.008
11.3	0.181 ± 0.025	0.000 ± 0.003	0.040 ± 0.010	0.221 ± 0.027	0.248 ± 0.012
11.8	0.122 ± 0.016	0.000 ± 0.003	0.040 ± 0.010	0.162 ± 0.019	0.171 ± 0.010
12.3	0.026 ± 0.004	0.000 ± 0.002	0.040 ± 0.010	0.066 ± 0.011	0.089 ± 0.006
12.8	0.007 ± 0.002	0.000 ± 0.001	0.040 ± 0.010	0.047 ± 0.010	0.063 ± 0.005
13.3	0.004 ± 0.001	0.000 ± 0.001	0.040 ± 0.010	0.044 ± 0.010	0.039 ± 0.004
13.8	0.153 ± 0.020	0.000 ± 0.003	0.040 ± 0.010	0.193 ± 0.022	0.126 ± 0.007
14.3	0.212 ± 0.027	0.000 ± 0.003	0.040 ± 0.010	0.252 ± 0.029	0.256 ± 0.012
14.8	0.228 ± 0.028	0.168 ± 0.045	0.040 ± 0.010	0.436 ± 0.054	0.465 ± 0.021
15.3	0.240 ± 0.031	0.000 ± 0.007	0.040 ± 0.010	0.280 ± 0.033	0.244 ± 0.012
15.8	0.250 ± 0.032	0.000 ± 0.007	0.040 ± 0.010	0.290 ± 0.034	0.303 ± 0.014
16.3	0.203 ± 0.025	0.000 ± 0.006	0.040 ± 0.010	0.243 ± 0.028	0.469 ± 0.020
18.3	0.010 ± 0.002	0.020 ± 0.005	0.040 ± 0.010	0.070 ± 0.012	0.077 ± 0.005
18.8	0.057 ± 0.007	0.000 ± 0.004	0.040 ± 0.010	0.097 ± 0.013	0.061 ± 0.005
19.3	0.097 ± 0.013	0.000 ± 0.005	0.040 ± 0.010	0.137 ± 0.017	0.089 ± 0.005
19.8	0.215 ± 0.029	0.000 ± 0.007	0.040 ± 0.010	0.255 ± 0.031	0.350 ± 0.017
20.3	0.149 ± 0.019	0.000 ± 0.004	0.040 ± 0.010	0.189 ± 0.022	0.245 ± 0.011
20.8	0.052 ± 0.007	0.000 ± 0.003	0.040 ± 0.010	0.092 ± 0.013	0.218 ± 0.010
21.3	0.019 ± 0.003	0.000 ± 0.001	0.040 ± 0.010	0.059 ± 0.011	0.096 ± 0.006
21.8	0.032 ± 0.004	0.000 ± 0.003	0.040 ± 0.010	0.072 ± 0.011	0.076 ± 0.005
22.3	0.019 ± 0.003	0.000 ± 0.001	0.040 ± 0.010	0.059 ± 0.011	0.064 ± 0.005
22.8	0.013 ± 0.002	0.000 ± 0.002	0.040 ± 0.010	0.053 ± 0.010	0.046 ± 0.004
23.3	0.007 ± 0.001	0.011 ± 0.005	0.040 ± 0.010	0.057 ± 0.011	0.130 ± 0.007
23.8	0.012 ± 0.003	0.016 ± 0.007	0.040 ± 0.010	0.067 ± 0.013	0.120 ± 0.006
24.3	0.008 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.048 ± 0.011	0.052 ± 0.004
24.8	0.010 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.050 ± 0.011	0.054 ± 0.004
25.3	0.011 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.051 ± 0.011	0.004 ± 0.004
25.8	0.003 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.043 ± 0.010	0.006 ± 0.003
26.3	0.000 ± 0.007	0.000 ± 0.001	0.040 ± 0.010	0.040 ± 0.013	0.029 ± 0.004
26.8	0.005 ± 0.001	0.000 ± 0.001	0.040 ± 0.010	0.045 ± 0.010	0.034 ± 0.004
27.3	0.008 ± 0.002	0.013 ± 0.004	0.040 ± 0.010	0.061 ± 0.011	0.102 ± 0.006
27.8	0.054 ± 0.007	0.090 ± 0.023	0.040 ± 0.010	0.184 ± 0.026	0.219 ± 0.010
28.3	0.087 ± 0.011	0.081 ± 0.021	0.040 ± 0.010	0.209 ± 0.025	0.127 ± 0.006
28.8	0.138 ± 0.017	0.039 ± 0.011	0.040 ± 0.010	0.217 ± 0.023	0.169 ± 0.008
29.3	0.120 ± 0.015	0.036 ± 0.011	0.040 ± 0.010	0.196 ± 0.021	0.117 ± 0.006
29.8	0.144 ± 0.018	0.051 ± 0.017	0.040 ± 0.010	0.234 ± 0.026	0.123 ± 0.006
30.3	0.106 ± 0.013	0.049 ± 0.012	0.040 ± 0.010	0.195 ± 0.020	0.108 ± 0.006
30.8	0.162 ± 0.021	0.043 ± 0.012	0.040 ± 0.010	0.245 ± 0.027	0.205 ± 0.010
31.3	0.133 ± 0.017	0.038 ± 0.011	0.040 ± 0.010	0.211 ± 0.023	0.247 ± 0.011
31.8	0.036 ± 0.005	0.013 ± 0.004	0.040 ± 0.010	0.089 ± 0.012	0.129 ± 0.007
32.3	0.009 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.049 ± 0.010	0.034 ± 0.004
32.8	0.019 ± 0.003	0.000 ± 0.003	0.040 ± 0.010	0.059 ± 0.011	0.027 ± 0.003
33.3	0.016 ± 0.002	0.000 ± 0.002	0.040 ± 0.010	0.056 ± 0.011	0.038 ± 0.004
33.8	0.089 ± 0.012	0.000 ± 0.004	0.040 ± 0.010	0.129 ± 0.016	0.053 ± 0.004
34.3	0.134 ± 0.017	0.162 ± 0.036	0.040 ± 0.010	0.336 ± 0.041	0.396 ± 0.017
34.8	0.184 ± 0.023	0.000 ± 0.008	0.040 ± 0.010	0.224 ± 0.026	0.306 ± 0.014
35.3	0.144 ± 0.019	0.015 ± 0.006	0.040 ± 0.010	0.199 ± 0.022	0.311 ± 0.014
35.8	0.149 ± 0.018	0.000 ± 0.006	0.040 ± 0.010	0.189 ± 0.022	0.194 ± 0.009
36.3	0.080 ± 0.011	0.000 ± 0.003	0.040 ± 0.010	0.120 ± 0.015	0.075 ± 0.005
36.8	0.093 ± 0.012	0.000 ± 0.003	0.040 ± 0.010	0.133 ± 0.016	0.055 ± 0.004
37.3	0.105 ± 0.014	0.000 ± 0.003	0.040 ± 0.010	0.145 ± 0.017	0.086 ± 0.005
37.8	0.089 ± 0.012	0.014 ± 0.010	0.040 ± 0.010	0.143 ± 0.018	0.076 ± 0.005
38.3	0.050 ± 0.007	0.000 ± 0.002	0.040 ± 0.010	0.090 ± 0.012	0.104 ± 0.006
38.8	0.075 ± 0.010	0.000 ± 0.003	0.040 ± 0.010	0.115 ± 0.014	0.075 ± 0.005
39.3	0.060 ± 0.008	0.000 ± 0.002	0.040 ± 0.010	0.100 ± 0.013	0.097 ± 0.005
39.8	0.102 ± 0.013	0.018 ± 0.005	0.040 ± 0.010	0.160 ± 0.017	0.158 ± 0.008
40.3	0.081 ± 0.011	0.063 ± 0.020	0.040 ± 0.010	0.185 ± 0.025	0.258 ± 0.012
40.8	0.137 ± 0.018	0.156 ± 0.037	0.040 ± 0.010	0.332 ± 0.042	0.347 ± 0.015
41.3	0.141 ± 0.018	0.119 ± 0.035	0.040 ± 0.010	0.300 ± 0.040	0.339 ± 0.015
41.8	0.236 ± 0.031	0.043 ± 0.018	0.040 ± 0.010	0.319 ± 0.037	0.217 ± 0.010
42.3	0.232 ± 0.029	0.112 ± 0.026	0.040 ± 0.010	0.384 ± 0.040	0.438 ± 0.019
42.8	0.374 ± 0.048	0.091 ± 0.034	0.040 ± 0.010	0.505 ± 0.060	0.425 ± 0.019
43.3	0.327 ± 0.041	0.016 ± 0.010	0.040 ± 0.010	0.383 ± 0.043	0.365 ± 0.016
43.8	0.177 ± 0.022	0.014 ± 0.008	0.040 ± 0.010	0.231 ± 0.025	0.245 ± 0.011
44.3	0.082 ± 0.010	0.000 ± 0.005	0.040 ± 0.010	0.122 ± 0.015	0.135 ± 0.007
44.8	0.057 ± 0.008	0.000 ± 0.005	0.040 ± 0.010	0.097 ± 0.014	0.058 ± 0.004
45.3	0.018 ± 0.003	0.000 ± 0.004	0.040 ± 0.010	0.058 ± 0.011	0.013 ± 0.004
45.8	0.004 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.044 ± 0.011	0.007 ± 0.004
46.3	0.000 ± 0.022	0.000 ± 0.004	0.040 ± 0.010	0.040 ± 0.025	0.032 ± 0.005
46.8	0.027 ± 0.005	0.015 ± 0.010	0.040 ± 0.010	0.082 ± 0.015	0.050 ± 0.004
47.3	0.032 ± 0.005	0.000 ± 0.006	0.040 ± 0.010	0.072 ± 0.013	0.078 ± 0.005
47.8	0.018 ± 0.003	0.000 ± 0.005	0.040 ± 0.010	0.058 ± 0.012	0.021 ± 0.004
48.3	0.009 ± 0.002	0.000 ± 0.003	0.040 ± 0.010	0.049 ± 0.011	0.074 ± 0.005
48.8	0.059 ± 0.007	0.009 ± 0.004	0.040 ± 0.010	0.108 ± 0.013	0.086 ± 0.005
MEAN	0.091 ± 0.002	0.020 ± 0.001	0.040 ± 0.001	0.151 ± 0.003	0.154 ± 0.001
FRAC	0.603 ± 0.012	0.132 ± 0.009	0.265 ± 0.008	1.000 ± 0.017	1.021 ± 0.008

Table 6.34: Fraction of sulfate sulfur attributed to each source TMBR at Hopi Point using OLS regression with independent variables $Se \times RH$ and $As \times RH$ for all days.

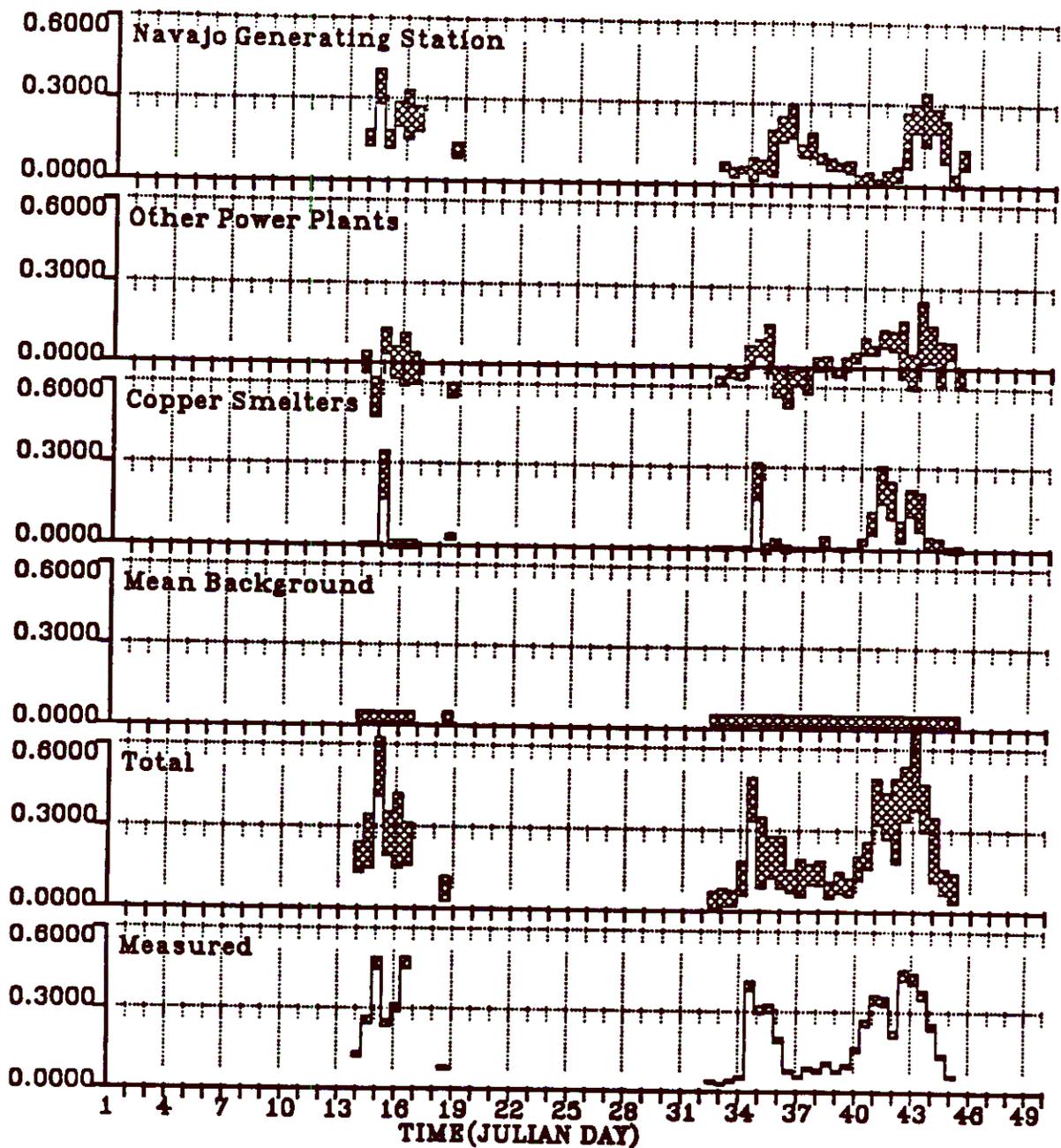| DATE	All Power Plants	Smelters	Background	Total
9.3	0.640 ± 0.121	0.000 ± 0.023	0.360 ± 0.101	1.000 ± 0.160
9.8	0.615 ± 0.116	0.000 ± 0.026	0.385 ± 0.108	1.000 ± 0.161
10.3	0.510 ± 0.108	0.000 ± 0.022	0.490 ± 0.142	1.000 ± 0.179
11.3	0.819 ± 0.149	0.000 ± 0.012	0.181 ± 0.050	1.000 ± 0.158
11.8	0.753 ± 0.132	0.000 ± 0.021	0.247 ± 0.068	1.000 ± 0.150
12.3	0.392 ± 0.068	0.000 ± 0.030	0.608 ± 0.183	1.000 ± 0.205
12.8	0.152 ± 0.047	0.000 ± 0.021	0.848 ± 0.280	1.000 ± 0.285
13.3	0.098 ± 0.031	0.000 ± 0.027	0.902 ± 0.305	1.000 ± 0.308
13.8	0.793 ± 0.136	0.000 ± 0.017	0.207 ± 0.057	1.000 ± 0.149
14.3	0.841 ± 0.145	0.000 ± 0.013	0.159 ± 0.044	1.000 ± 0.152
14.8	0.522 ± 0.091	0.386 ± 0.113	0.092 ± 0.026	1.000 ± 0.148
15.3	0.857 ± 0.150	0.000 ± 0.024	0.143 ± 0.040	1.000 ± 0.157
15.8	0.862 ± 0.150	0.000 ± 0.025	0.138 ± 0.038	1.000 ± 0.156
16.3	0.836 ± 0.139	0.000 ± 0.026	0.164 ± 0.045	1.000 ± 0.148
18.3	0.148 ± 0.036	0.281 ± 0.090	0.570 ± 0.171	1.000 ± 0.196
18.8	0.589 ± 0.109	0.000 ± 0.042	0.411 ± 0.117	1.000 ± 0.165
19.3	0.708 ± 0.127	0.000 ± 0.038	0.292 ± 0.081	1.000 ± 0.156
19.8	0.843 ± 0.152	0.000 ± 0.029	0.157 ± 0.044	1.000 ± 0.161
20.3	0.788 ± 0.135	0.000 ± 0.022	0.212 ± 0.058	1.000 ± 0.148
20.8	0.563 ± 0.109	0.000 ± 0.032	0.437 ± 0.125	1.000 ± 0.168
21.3	0.327 ± 0.076	0.000 ± 0.025	0.673 ± 0.206	1.000 ± 0.221
21.8	0.444 ± 0.092	0.000 ± 0.035	0.556 ± 0.164	1.000 ± 0.191
22.3	0.328 ± 0.080	0.000 ± 0.024	0.672 ± 0.207	1.000 ± 0.223
22.8	0.250 ± 0.065	0.000 ± 0.035	0.750 ± 0.238	1.000 ± 0.249
23.3	0.118 ± 0.033	0.185 ± 0.088	0.696 ± 0.220	1.000 ± 0.239
23.8	0.174 ± 0.050	0.232 ± 0.119	0.594 ± 0.186	1.000 ± 0.226
24.3	0.158 ± 0.053	0.000 ± 0.065	0.842 ± 0.282	1.000 ± 0.294
24.8	0.192 ± 0.056	0.000 ± 0.057	0.808 ± 0.265	1.000 ± 0.277
25.3	0.210 ± 0.059	0.000 ± 0.064	0.790 ± 0.259	1.000 ± 0.273
25.8	0.077 ± 0.040	0.000 ± 0.063	0.923 ± 0.321	1.000 ± 0.330
26.3	0.000 ± 0.185	0.000 ± 0.034	1.000 ± 0.400	1.000 ± 0.442
26.8	0.104 ± 0.033	0.000 ± 0.031	0.896 ± 0.303	1.000 ± 0.306
27.3	0.129 ± 0.034	0.213 ± 0.071	0.658 ± 0.202	1.000 ± 0.217
27.8	0.294 ± 0.057	0.489 ± 0.144	0.218 ± 0.063	1.000 ± 0.167
28.3	0.418 ± 0.073	0.390 ± 0.110	0.192 ± 0.053	1.000 ± 0.142
28.8	0.637 ± 0.104	0.178 ± 0.056	0.185 ± 0.050	1.000 ± 0.128
29.3	0.611 ± 0.102	0.185 ± 0.061	0.204 ± 0.056	1.000 ± 0.131
29.8	0.613 ± 0.102	0.216 ± 0.077	0.171 ± 0.047	1.000 ± 0.136
30.3	0.544 ± 0.090	0.251 ± 0.065	0.205 ± 0.055	1.000 ± 0.124
30.8	0.662 ± 0.113	0.175 ± 0.054	0.163 ± 0.044	1.000 ± 0.133
31.3	0.630 ± 0.105	0.180 ± 0.057	0.189 ± 0.052	1.000 ± 0.130
31.8	0.405 ± 0.077	0.147 ± 0.053	0.448 ± 0.127	1.000 ± 0.158
32.3	0.189 ± 0.054	0.000 ± 0.052	0.811 ± 0.266	1.000 ± 0.276
32.8	0.317 ± 0.076	0.000 ± 0.051	0.683 ± 0.212	1.000 ± 0.231
33.3	0.292 ± 0.070	0.000 ± 0.040	0.708 ± 0.221	1.000 ± 0.235
33.8	0.691 ± 0.122	0.000 ± 0.028	0.309 ± 0.086	1.000 ± 0.152
34.3	0.398 ± 0.070	0.483 ± 0.124	0.119 ± 0.033	1.000 ± 0.146
34.8	0.821 ± 0.141	0.000 ± 0.035	0.179 ± 0.049	1.000 ± 0.154
35.3	0.724 ± 0.126	0.075 ± 0.032	0.201 ± 0.055	1.000 ± 0.141
35.8	0.788 ± 0.133	0.000 ± 0.031	0.212 ± 0.058	1.000 ± 0.149
36.3	0.666 ± 0.120	0.000 ± 0.021	0.334 ± 0.093	1.000 ± 0.154
36.8	0.700 ± 0.125	0.000 ± 0.020	0.300 ± 0.083	1.000 ± 0.152
37.3	0.724 ± 0.129	0.000 ± 0.019	0.276 ± 0.076	1.000 ± 0.151
37.8	0.624 ± 0.114	0.096 ± 0.074	0.280 ± 0.079	1.000 ± 0.157
38.3	0.556 ± 0.109	0.000 ± 0.025	0.444 ± 0.127	1.000 ± 0.169
38.8	0.653 ± 0.119	0.000 ± 0.023	0.347 ± 0.097	1.000 ± 0.155
39.3	0.598 ± 0.114	0.000 ± 0.020	0.402 ± 0.113	1.000 ± 0.162
39.8	0.637 ± 0.106	0.113 ± 0.034	0.250 ± 0.068	1.000 ± 0.131
40.3	0.440 ± 0.084	0.343 ± 0.118	0.217 ± 0.062	1.000 ± 0.158
40.8	0.411 ± 0.075	0.468 ± 0.126	0.120 ± 0.034	1.000 ± 0.150
41.3	0.471 ± 0.087	0.396 ± 0.127	0.133 ± 0.038	1.000 ± 0.159
41.8	0.740 ± 0.130	0.135 ± 0.058	0.125 ± 0.035	1.000 ± 0.146
42.3	0.603 ± 0.099	0.292 ± 0.075	0.104 ± 0.028	1.000 ± 0.127
42.8	0.741 ± 0.130	0.180 ± 0.071	0.079 ± 0.022	1.000 ± 0.150
43.3	0.854 ± 0.144	0.041 ± 0.026	0.105 ± 0.029	1.000 ± 0.149
43.8	0.766 ± 0.126	0.061 ± 0.035	0.173 ± 0.047	1.000 ± 0.139
44.3	0.672 ± 0.120	0.000 ± 0.039	0.328 ± 0.092	1.000 ± 0.156
44.8	0.587 ± 0.121	0.000 ± 0.052	0.413 ± 0.119	1.000 ± 0.178
45.3	0.308 ± 0.080	0.000 ± 0.061	0.692 ± 0.218	1.000 ± 0.240
45.8	0.099 ± 0.051	0.000 ± 0.061	0.901 ± 0.311	1.000 ± 0.321
46.3	0.000 ± 0.551	0.000 ± 0.099	1.000 ± 0.662	1.000 ± 0.867
46.8	0.331 ± 0.088	0.183 ± 0.129	0.486 ± 0.151	1.000 ± 0.217
47.3	0.447 ± 0.102	0.000 ± 0.080	0.553 ± 0.168	1.000 ± 0.212
47.8	0.314 ± 0.083	0.000 ± 0.083	0.686 ± 0.219	1.000 ± 0.248
48.3	0.177 ± 0.058	0.000 ± 0.063	0.823 ± 0.274	1.000 ± 0.287
48.8	0.546 ± 0.094	0.084 ± 0.036	0.370 ± 0.103	1.000 ± 0.144

Figure 6.47: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression.

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Table 6.35: TMBR source apportionment of sulfate sulfur ($\mu g/m^3$) at Hopi Point using OLS regression.

DATE	NGS	Other Power Plants	Smelters	Background	Total	Measured
13.8	0.154 ± 0.031	0.001 ± 0.039	0.000 ± 0.007	0.030 ± 0.020	0.185 ± 0.054	0.126 ± 0.007
14.3	0.344 ± 0.063	-0.130 ± 0.072	0.000 ± 0.007	0.030 ± 0.020	0.244 ± 0.098	0.256 ± 0.012
14.8	0.149 ± 0.032	0.081 ± 0.048	0.257 ± 0.087	0.030 ± 0.020	0.518 ± 0.106	0.465 ± 0.021
15.3	0.243 ± 0.044	0.000 ± 0.059	0.000 ± 0.015	0.030 ± 0.020	0.272 ± 0.078	0.244 ± 0.012
15.8	0.241 ± 0.090	0.012 ± 0.098	0.000 ± 0.016	0.030 ± 0.020	0.283 ± 0.135	0.303 ± 0.014
16.3	0.226 ± 0.046	-0.020 ± 0.056	0.000 ± 0.014	0.030 ± 0.020	0.236 ± 0.077	0.469 ± 0.020
18.3	0.110 ± 0.027	-0.099 ± 0.027	0.030 ± 0.011	0.030 ± 0.020	0.071 ± 0.044	0.077 ± 0.005
32.3	0.063 ± 0.015	-0.053 ± 0.015	0.000 ± 0.006	0.030 ± 0.020	0.039 ± 0.030	0.034 ± 0.004
32.8	0.043 ± 0.017	-0.024 ± 0.017	0.000 ± 0.007	0.030 ± 0.020	0.049 ± 0.032	0.027 ± 0.003
33.3	0.052 ± 0.012	-0.036 ± 0.012	0.000 ± 0.005	0.030 ± 0.020	0.047 ± 0.027	0.038 ± 0.004
33.8	0.054 ± 0.041	0.037 ± 0.043	0.000 ± 0.008	0.030 ± 0.020	0.120 ± 0.063	0.053 ± 0.004
34.3	0.064 ± 0.022	0.071 ± 0.031	0.248 ± 0.067	0.030 ± 0.020	0.413 ± 0.079	0.396 ± 0.017
34.8	0.117 ± 0.085	0.069 ± 0.090	0.000 ± 0.017	0.030 ± 0.020	0.216 ± 0.127	0.306 ± 0.014
35.3	0.204 ± 0.047	-0.058 ± 0.053	0.023 ± 0.013	0.030 ± 0.020	0.199 ± 0.075	0.311 ± 0.014
35.8	0.236 ± 0.062	-0.085 ± 0.066	0.000 ± 0.013	0.030 ± 0.020	0.180 ± 0.094	0.194 ± 0.009
36.3	0.122 ± 0.023	-0.041 ± 0.026	0.000 ± 0.006	0.030 ± 0.020	0.111 ± 0.041	0.075 ± 0.005
36.8	0.145 ± 0.045	-0.050 ± 0.048	0.000 ± 0.006	0.030 ± 0.020	0.124 ± 0.069	0.055 ± 0.004
37.3	0.096 ± 0.018	0.010 ± 0.025	0.000 ± 0.006	0.030 ± 0.020	0.136 ± 0.037	0.086 ± 0.005
37.8	0.075 ± 0.020	0.015 ± 0.025	0.021 ± 0.022	0.030 ± 0.020	0.141 ± 0.044	0.076 ± 0.005
38.3	0.067 ± 0.012	-0.017 ± 0.015	0.000 ± 0.005	0.030 ± 0.020	0.081 ± 0.028	0.104 ± 0.006
38.8	0.065 ± 0.021	0.012 ± 0.024	0.000 ± 0.006	0.030 ± 0.020	0.106 ± 0.038	0.075 ± 0.005
39.3	0.021 ± 0.015	0.039 ± 0.018	0.000 ± 0.004	0.030 ± 0.020	0.090 ± 0.031	0.097 ± 0.005
39.8	0.021 ± 0.025	0.082 ± 0.030	0.028 ± 0.010	0.030 ± 0.020	0.161 ± 0.045	0.158 ± 0.008
40.3	0.014 ± 0.008	0.068 ± 0.016	0.097 ± 0.040	0.030 ± 0.020	0.209 ± 0.048	0.258 ± 0.012
40.8	0.027 ± 0.023	0.111 ± 0.032	0.238 ± 0.069	0.030 ± 0.020	0.406 ± 0.082	0.347 ± 0.015
41.3	0.041 ± 0.027	0.102 ± 0.035	0.182 ± 0.069	0.030 ± 0.020	0.354 ± 0.084	0.339 ± 0.015
41.8	0.168 ± 0.101	0.071 ± 0.108	0.066 ± 0.037	0.030 ± 0.020	0.335 ± 0.153	0.217 ± 0.010
42.3	0.247 ± 0.053	-0.013 ± 0.065	0.172 ± 0.049	0.030 ± 0.020	0.436 ± 0.099	0.438 ± 0.019
42.8	0.244 ± 0.100	0.134 ± 0.117	0.139 ± 0.071	0.030 ± 0.020	0.547 ± 0.171	0.425 ± 0.019
43.3	0.240 ± 0.044	0.091 ± 0.068	0.024 ± 0.021	0.030 ± 0.020	0.385 ± 0.086	0.365 ± 0.016
43.8	0.162 ± 0.078	0.017 ± 0.083	0.021 ± 0.017	0.030 ± 0.020	0.231 ± 0.117	0.245 ± 0.011
44.3	0.017 ± 0.026	0.066 ± 0.029	0.000 ± 0.010	0.030 ± 0.020	0.113 ± 0.045	0.135 ± 0.007
44.8	0.095 ± 0.034	-0.038 ± 0.036	0.000 ± 0.011	0.030 ± 0.020	0.087 ± 0.054	0.058 ± 0.004
MEAN	0.126 ± 0.008	0.013 ± 0.009	0.047 ± 0.006	0.030 ± 0.003	0.216 ± 0.014	0.208 ± 0.002
FRAC	0.585 ± 0.182	0.059 ± 0.047	0.217 ± 0.071	0.139 ± 0.045	1.000 ± 0.093	0.961 ± 0.293

Table 6.36: Fractions of sulfate sulfur attributed to each source by TMBR at Hopi Point using OLS regression.

DATE	NGS	Other Power Plants	Smelters	Background	Total
13.8	0.832 ± 0.296	0.005 ± 0.214	0.000 ± 0.040	0.162 ± 0.118	1.000 ± 0.416
14.3	1.409 ± 0.619	-0.532 ± 0.362	0.000 ± 0.029	0.123 ± 0.095	1.000 ± 0.565
14.8	0.287 ± 0.085	0.157 ± 0.099	0.497 ± 0.197	0.058 ± 0.040	1.000 ± 0.291
15.3	0.890 ± 0.303	0.000 ± 0.217	0.000 ± 0.054	0.110 ± 0.080	1.000 ± 0.405
15.8	0.850 ± 0.516	0.044 ± 0.348	0.000 ± 0.056	0.106 ± 0.087	1.000 ± 0.677
16.3	0.958 ± 0.369	-0.086 ± 0.240	0.000 ± 0.059	0.127 ± 0.094	1.000 ± 0.461
18.3	1.552 ± 1.036	-1.404 ± 0.951	0.427 ± 0.304	0.424 ± 0.387	1.000 ± 0.880
32.3	1.594 ± 1.264	-1.355 ± 1.094	0.000 ± 0.141	0.761 ± 0.766	1.000 ± 1.069
32.8	0.873 ± 0.674	-0.488 ± 0.481	0.000 ± 0.134	0.615 ± 0.577	1.000 ± 0.934
33.3	1.122 ± 0.691	-0.765 ± 0.511	0.000 ± 0.106	0.643 ± 0.565	1.000 ± 0.811
33.8	0.447 ± 0.410	0.304 ± 0.392	0.000 ± 0.065	0.249 ± 0.211	1.000 ± 0.739
34.3	0.156 ± 0.061	0.171 ± 0.081	0.601 ± 0.198	0.073 ± 0.050	1.000 ± 0.271
34.8	0.541 ± 0.507	0.320 ± 0.458	0.000 ± 0.080	0.139 ± 0.124	1.000 ± 0.831
35.3	1.027 ± 0.455	-0.293 ± 0.289	0.115 ± 0.079	0.151 ± 0.116	1.000 ± 0.534
35.8	1.308 ± 0.765	-0.474 ± 0.444	0.000 ± 0.072	0.167 ± 0.141	1.000 ± 0.738
36.3	1.102 ± 0.454	-0.374 ± 0.275	0.000 ± 0.050	0.271 ± 0.207	1.000 ± 0.519
36.8	1.163 ± 0.741	-0.404 ± 0.445	0.000 ± 0.047	0.241 ± 0.209	1.000 ± 0.785
37.3	0.706 ± 0.235	0.074 ± 0.186	0.000 ± 0.044	0.220 ± 0.159	1.000 ± 0.388
37.8	0.533 ± 0.219	0.106 ± 0.179	0.148 ± 0.165	0.213 ± 0.157	1.000 ± 0.440
38.3	0.836 ± 0.332	-0.208 ± 0.201	0.000 ± 0.061	0.372 ± 0.280	1.000 ± 0.497
38.8	0.607 ± 0.294	0.110 ± 0.233	0.000 ± 0.054	0.282 ± 0.214	1.000 ± 0.509
39.3	0.232 ± 0.183	0.435 ± 0.250	0.000 ± 0.049	0.332 ± 0.249	1.000 ± 0.487
39.8	0.132 ± 0.157	0.510 ± 0.232	0.172 ± 0.078	0.186 ± 0.135	1.000 ± 0.392
40.3	0.068 ± 0.040	0.325 ± 0.106	0.464 ± 0.221	0.143 ± 0.101	1.000 ± 0.327
40.8	0.066 ± 0.059	0.274 ± 0.097	0.586 ± 0.207	0.074 ± 0.051	1.000 ± 0.286
41.3	0.116 ± 0.081	0.287 ± 0.120	0.513 ± 0.229	0.085 ± 0.060	1.000 ± 0.336
41.8	0.502 ± 0.379	0.211 ± 0.336	0.197 ± 0.143	0.090 ± 0.073	1.000 ± 0.648
42.3	0.567 ± 0.177	-0.030 ± 0.148	0.394 ± 0.144	0.069 ± 0.048	1.000 ± 0.321
42.8	0.446 ± 0.230	0.245 ± 0.228	0.254 ± 0.152	0.055 ± 0.040	1.000 ± 0.442
43.3	0.623 ± 0.180	0.237 ± 0.185	0.063 ± 0.056	0.078 ± 0.055	1.000 ± 0.316
43.8	0.703 ± 0.491	0.074 ± 0.361	0.093 ± 0.088	0.130 ± 0.109	1.000 ± 0.716
44.3	0.147 ± 0.239	0.587 ± 0.350	0.000 ± 0.091	0.266 ± 0.207	1.000 ± 0.567
44.8	1.089 ± 0.779	-0.432 ± 0.486	0.000 ± 0.127	0.343 ± 0.312	1.000 ± 0.877

Results for Glen Canyon National Recreation Area (Page, Arizona)

An ordinary least square regression (OLS) and orthogonal distance regression (ODR) analyses were carried out with total sulfur and sulfate sulfur as dependent variables and SCD_4, $SCD_4 \times$ RH, As, and $As \times$ RH as independent variables. Furthermore, as in the Hopi Point calculations, Se was substituted for SCD_4 in an attempt to separate out NGS contributions from other coal fired power plants. The analysis was done for time periods when CD_4 was released out of units one and three and for only those time periods for which CD_4 was analyzed. The data were further broken down into two time periods: All data (JD 27.33–45.33) and high sulfate episode data (JD 37.33–45.33). The CD_4 sampling system malfunctioned from JD 44.8–45.08. Therefore data gathered during these time periods were not used in the analysis.

SCD_4 and Se were the only variables found to be significant for either the total or sulfate sulfur regressions implying that within the uncertainty of the analysis sulfur associated with sources that have As a tracer (copper smelters) were not found to contribute. Unlike the Hopi Point analysis, the fit, as indicated by R-square values, was nearly the same for either SCD_4 or $SCD_4 \times$ RH as the independent variable. Furthermore, within the statistical uncertainty of the regressions a systematic difference was not found between using Se or SCD_4 as the independent variable. Therefore an estimation of the difference between sulfur contributions from NGS and other coal fired power plants cannot be made.

A scatter plot of total sulfur ($SO_2/2 + SO_4/3$) vs SCD_4 for all data along with OLS and ODR regression lines are shown in Figure 6.48. Intercepts, slopes, percent sulfur attributed to NGS and associated uncertainties for all and episode total sulfur data are presented in Table 6.37. In most cases R-squares are high indicating strong highly correlated relationships. Most of the measured total sulfur mass concentration fell between 0.0 and 5.0 $\mu g/m^3$. However, Figure 6.48 shows one data point, obtained on JD 42.3, near 15 $\mu g/m^3$. Since one outlying data point can "leverage" a regression analysis both ODR and OLS regressions were carried out with and without the JD 42.3 value. These results are also presented in Table 6.37.

Within the statistical uncertainty of the model ODR results are the same with and without JD 42.3 for both episode and all data. However, OLS results are statistically different depending on whether the JD 42.3 data point is used in the analysis. If the JD 42.3 data point is kept in the OLS analysis, NGS sulfur contribution is predicted to be over 100 percent which is an obvious over prediction. The ODR analysis estimates NGS contribution to total sulfur to be between 82 $\pm$ 6 to 83 $\pm$ 7 percent and 100 $\pm$ 30 to 100 $\pm$ 35 percent depending on whether JD 42.3 is used for the all data and episode data set, respectively. Average background total sulfur is estimated to be between 17 $\pm$ 1 to 18 $\pm$ 1 for all data and 0 $\pm$ 4 to 0 $\pm$ 5 percent for episode data.

Finally the ODR regression line yields an average total sulfur to SCD_4 ratio of approximately 222 while the in plume ratio is 540. Apparently there is significant deposition between NGS and the monitoring site.

A similar analysis was repeated using sulfate sulfur (SSO_4) as the dependent variable. These results are shown in Figures 6.49 and 6.50 and tabularly presented in Table 6.38. Figure 6.49 shows a scatter plot of all data, while Figure 6.50 shows the episode data. The circled data points and the JD 42.3 data point correspond to some of the highest sulfate days found at the Page, Arizona monitoring site and all fall with the time period referred to as the "episode". The circled data points are clearly data points which lie outside any obvious trend between SCD_4 and sulfate sulfur. However, there is some question as to whether JD 42.3 should be included in a regression analysis since it could "leverage" the results. Therefore, a preliminary analysis was done with and without the JD 42.3 data points and without the circled data points. Table 6.38 shows these results.
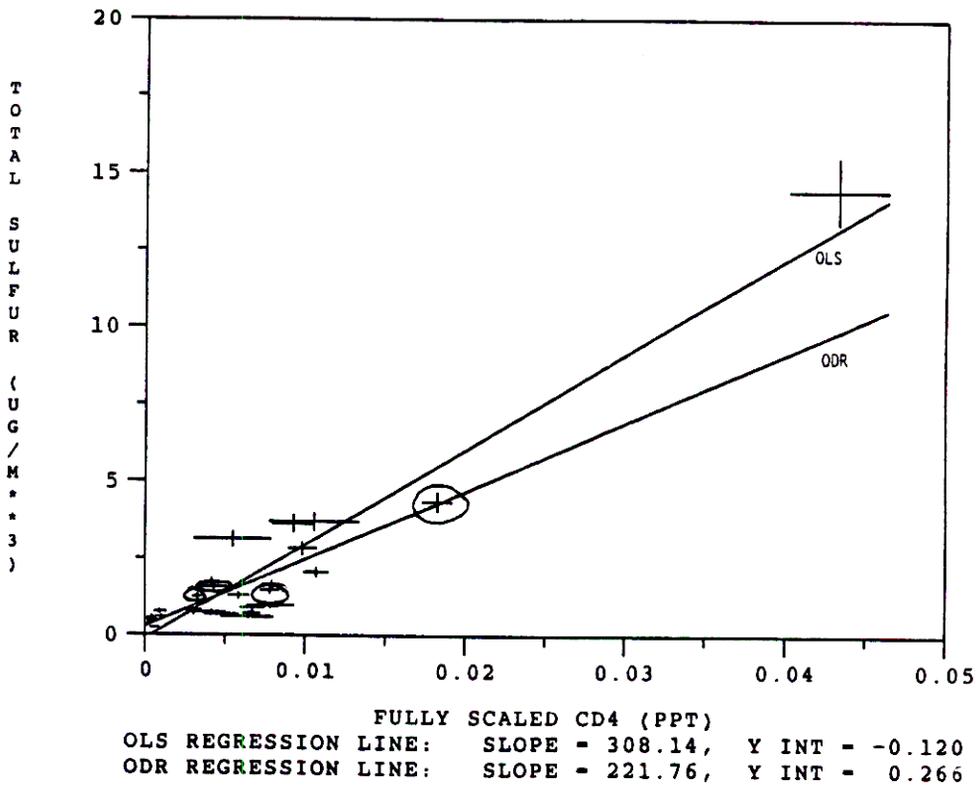
TOTAL SULFUR (UG/M**3)

20

15

10

5

0

0   0.01   0.02   0.03   0.04   0.05

FULLY SCALED CD4 (PPT)

OLS REGRESSION LINE: SLOPE = 308.14,   Y INT = -0.120
ODR REGRESSION LINE: SLOPE = 221.76,   Y INT = 0.266

OLS

ODR

Figure 6.48: Scatter plot of total sulfur vs SCD_4 at Page, along with the OLS and ODR regression lines. The four circled points correspond to time periods JD 42.8–44.3.

Table 6.37: Results of TMBR regressions for total sulfur at Page. "All" days refers to all days when SCD_4 data were available. "Episode" is JD 37.8–45.3.

Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient	% of sulfur Attributed
ODR	All	31	0.91	SCD_4	221.8 ± 24.3	83 ±7
				Intercept	0.27 ± 0.07	17 ±1
OLS	All	31	0.91	SCD_4	308.1 ± 17.9	107 ±9
				Intercept	-0.12 ± 0.18	-9 ±7
ODR	All ex 42.3	30	0.67	SCD_4	209.8 ± 23.9	82 ±6
				Intercept	0.28 ± 0.06	18 ±1
OLS	All ex 42.3	30	0.67	SCD_4	217.4 ± 28.6	83 ± 7
				Intercept	0.27 ± 0.18	17 ±2
ODR	episode	12	0.95	SCD_4	223.4 ± 55.6	100 ±30
				Intercept	0.00 ± 0.36	0 ±4
OLS	episode	12	0.95	SCD_4	344.2 ± 24.0	127±28
				Intercept	-0.77 ± 0.36	-27 ±7
ODR	episode ex 42.3	11	0.66	SCD_4	221.2 ± 66.4	100 ±35
				Intercept	0.00 ± 0.41	0 ±5
OLS	episode ex 42.3	11	0.66	SCD_4	273.3 ± 65.1	110 ±40
				Intercept	-0.27 ± 0.56	-10 ±7
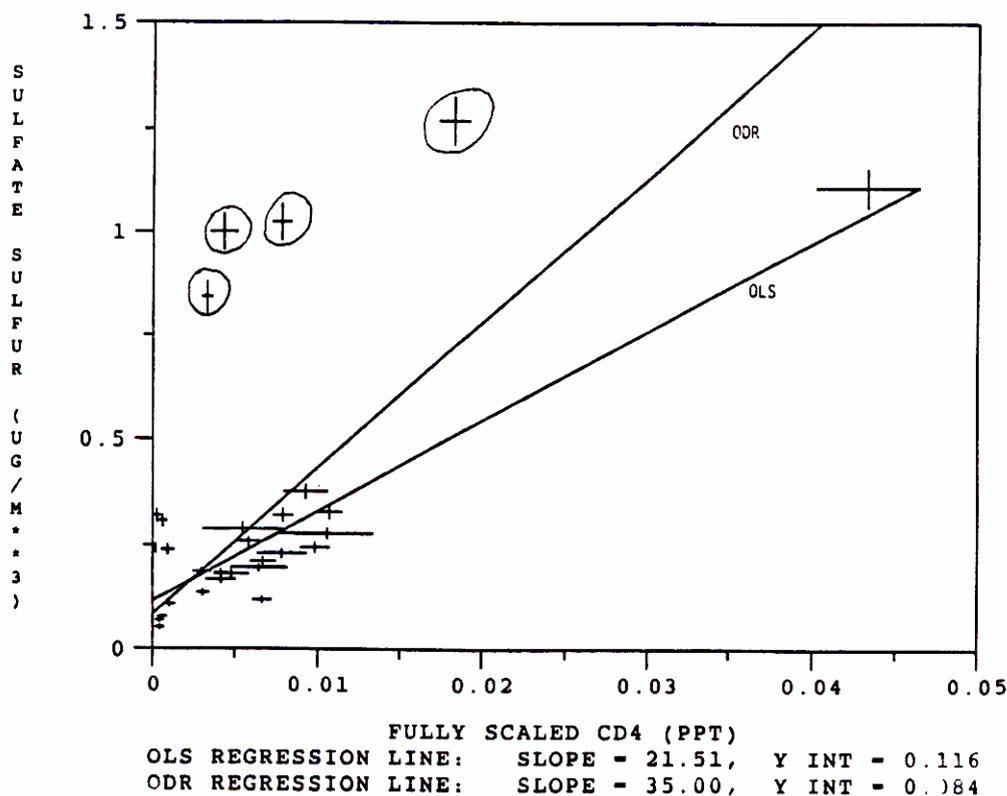
Figure 6.49: Scatter plot of SCD_4 *vs* sulfate sulfur for all times periods with SCD_4 at Page along with OLS and ODR regression lines. The four circled points correspond to time periods JD 42.8–44.3.

The ODR results were nearly identical with and without JD 42.3 as were the OLS results for the episode data.

Figures 6.49 and 6.50 also show the OLS and ODR regression lines with JD 42.3 included but without the circled data points. The four circled data points lie outside the SCD_4 to sulfate sulfur relationship suggested by the regression lines. The enhanced SSO_4/SCD_4 ratio could result from sulfate being transported to the monitoring from other SO_2 sources, from an aged NGS air mass being recirculated to the monitoring site or from accelerated oxidation of NGS emitted SO_2. If the elevated SSO_4 are associated with other SO_2 sources one might expect:

- Similar outliers in the total sulfur *vs* SCD_4 plot

- Wind fields conducive to transport of sulfate into the monitoring site from sulfate sources outside the Lake Powell area

- Spatial concentration gradients showing a gradient in sulfate concentration that implies transport from outside to within the Lake Powell area

- Trace element ratios that are different between JD 42.8–44.3 (four circles data points) and other episode days

- Trace element ratios that are the same between JD 42.8–44.3 (four circled data points) and the suspected source area.

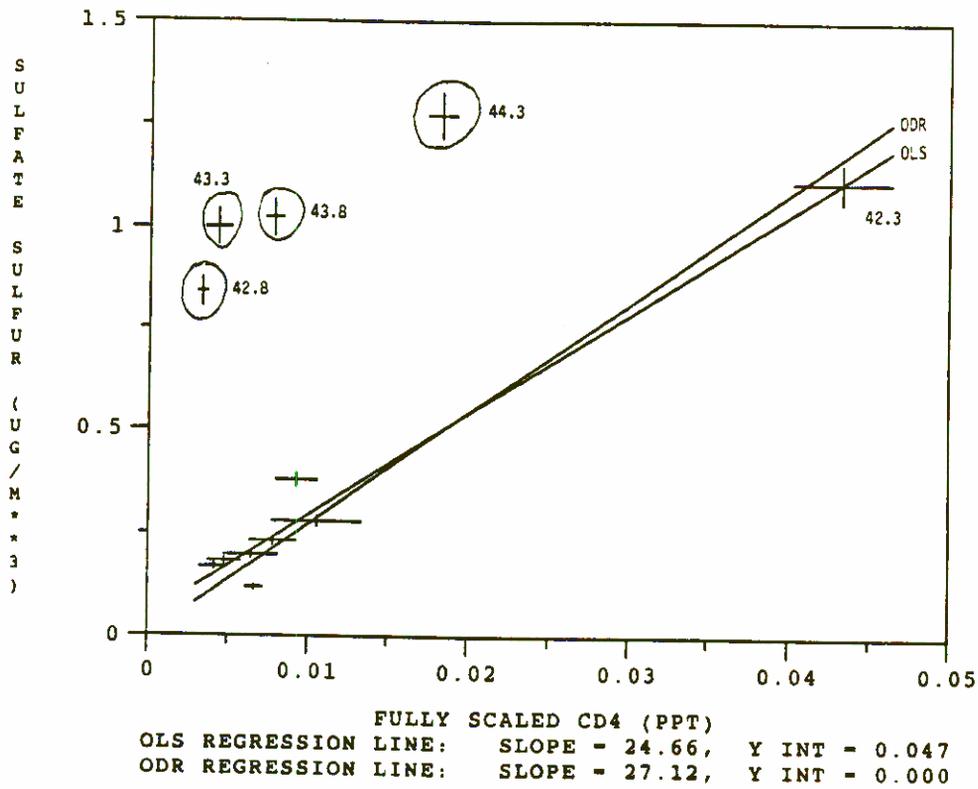Each of these possibilities will be examined separately.

Figure 6.50: Scatter plot of SCD_4 *vs* sulfate sulfur at Page for the high sulfate episode (JD 37.8–45.3) along with OLS and ODR regression lines. The four circled points correspond to time periods JD 42.8–44.3.

Table 6.38: Results of TMBR regressions for sulfate sulfur at Page. JD 42.8–44.3 were not included in any regressions. "All" days refers to all days when SCD_4 was available. "Episode" is JD 37.8–45.3. Source attribution by method 1 assumes the excess sulfur on days 42.8–44.3 is all due to NGS. Method 2 assumes the excess sulfur is due to other sources.

Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient	Method 1 % of sulfur Attributed	Method 2 % of sulfur Attributed
ODR	All	27	0.83	SCD_4	35.00 ± 8.81	75 ±2	62 ± 5
				Intercept	0.084 ± 0.021	25 ±1	38 ± 5
OLS	All	27	0.83	SCD_4	21.51 ± 1.96	66 ±2	38 ± 2
				Intercept	0.116 ± 0.020	34 ±1	62± 2
ODR	All ex 42.3	26	0.30	SCD_4	43.75 ± 13.54	—	—
				Intercept	0.078 ± 0.026	—	—
OLS	All ex 42.3	26	0.30	SCD_4	13.97 ± 4.31	—	—
				Intercept	0.146 ± 0.024	—	—
ODR	episode	8	0.97	SCD_4	27.12 ± 5.70	100 ±3	50 ± 5
				Intercept	0.000 ± 0.046	0 ±2	50 ± 5
OLS	episode	8	0.97	SCD_4	24.66 ± 1.71	92 ±3	46 ± 3
				Intercept	0.047 ± 0.029	8 ±2	54 ± 3
ODR	episode	7	0.53	SCD_4	27.23 ± 12.22	—	—
				Intercept	0.000 ± 0.082	—	—
OLS	episode	7	0.53	SCD_4	26.86 ± 11.33	—	—
				Intercept	0.032 ± 0.083	—	—

The four circled data points in Figure 6.48, a scatter plot of sulfate sulfur vs SCD_4, also correspond to the time periods JD 42.8–44.3. The total sulfur to SCD_4 ratio on those four days is not anomalously different from any other day. Examination of Figure 6.51 shows why. SSO_2 and SCD_4 decreased dramatically on those days while SSO_4 remained somewhat constant. Thus total sulfur to SCD_4 ratio does not change while SSO_4 to SCD_4 ratio deviates significantly from the average SSO_4 to SCD_4 ratio. It is possible that just the right amount of total sulfur was transported too the page monitoring site from other SO_2 sources to match the average total sulfur to SCD_4 ratio. On the other hand it is also possible that an aged NGS air mass recirculated back to the monitoring site or that the SO_2 to SO_4 oxidation rate was higher on those four days. Either possibility would be consistent with the data; however, it seems unlikely that just the right amount of sulfur from other sources would transport into the Page monitoring area to maintain a constant total sulfur to CD_4 ratio.

The SSO_4 spatial concentration gradient on day JD 42.3, shown in Figure 6.23, is consistent with stagnant air mass meteorology. The highest SSO_4 concentration are found at Page and at Green River Utah with decreasing concentrations found as one moves radially from either the Page or Green River monitoring site. The EOF analysis (see Figures 6.34 and 6.36) shows that this spatial concentration pattern increased in intensity starting on JD 40 and continuing through 42.3. After approximately JD 42.8 the spatial gradient field is a combination of spatial concentration patterns represented by both EOF 1 and 2 while on JD 44.3 the spatial gradient field is dominated by EOF 1. Concentration gradient field represented by EOF 1 is shown in Figure 6.35. Figure 6.35
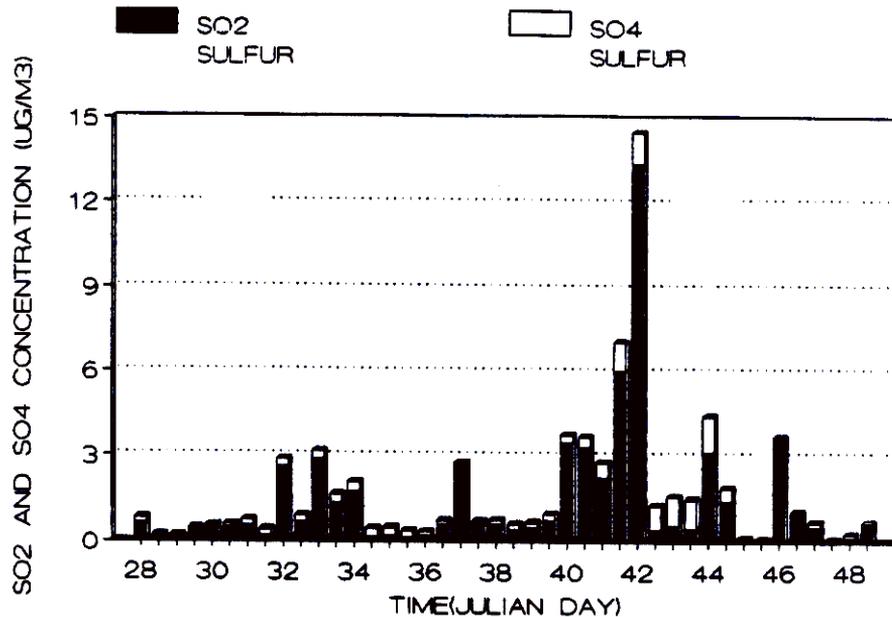
Figure 6.51: Temporal plot showing SO_2 and SO_4 sulfur concentrations in Page, Arizona. The bars are additive. The height of the two bars is the sum of SO_2 and SO_4 sulfur concentrations.

shows a spatial concentration gradient field that has sulfate concentrations nearly constant within the Lake Powell basin but with decreasing concentrations as one moves radially from Lake Powell. This sort of SSO_4 spatial concentration gradient field suggests that the sulfate measured at the Page monitoring site on JD 42.8–44.3 is associated with a local source.

Examination of surface winds, vertical temperature gradients and synoptic meteorology (see Section 6.4) show the time period JD 40–45 to be meteorologically stagnant with highly variable and vertically sheared winds. Meteorological conditions such as these are conducive to buildup of locally generated aerosols. However, starting on JD 42, 300 meter winds suggest a net transport down the Colorado River canyon i.e., flow from the northeast to the southwest. This flow is clearly conducive to transporting NGS emissions into Grand Canyon but it is also could potentially transport sulfates from sources northeast of Page to the Page monitoring site. Thus from a purely meteorological perspective arguments can be made for the elevated SSO_4 found on JD 42.8–44.3 to be locally generated or transported in from the northeast.

Flow from the northeast on JD 42.8–44.3 could be transporting in sulfates from non-NGS sources or NGS sulfate that had "pooled" in the lower Lake Powell basin. If the elevated sulfate on those days is from NGS then the trace element signature should be the same on JD 40.3–42.3 and on the elevated sulfur but low CD_4 days of JD 42.8–44.3. On the other hand if the sulfate is transported in from sources to the northeast around Green River the trace element profile at Page on the elevated sulfate days (JD 42.8–44.3) should match the trace element profile at the northeastern sampling sites. A chemical mass balance (CMB) analysis can be performed to test these hypotheses. The average elemental ratios on JD 40.3–42.3 at the Page and Green River monitoring sites were used as source profiles. The average concentration of aerosol species at Page for the elevated SSO_4 days

(JD 42.8–44.3) was also calculated. A chemical mass balance analysis was then carried out using the Page and Green River profiles as source terms. The analysis is summarized in Table 6.39 a and b. The match between the Page trace element profiles obtained on JD 40.3–42.3 and the four elevated SSO_4 days is quite good (R-square = 0.91 and chi-square = 3.36) implying that the origin of the trace elements during those two time periods is the same. On the other hand the match between Page and Green River trace element profiles is significantly worse with an R-square = 0.70 and chi-square = 12.04. Most trace elements are under predicted by 70-80 percent. Since the trace element profile on days preceeding the four elevated sulfur data points and the elevated sulfur days compares quite favorably and the trace element profile at Green River does not predict the profile associated with the four elevated SSO_4 days, the elevated SSO_4 on JD 42.8–44.3 is most likely to be primarily associated with NGS emissions.

A DMB type analysis (see Section 6.6.2 for details) was carried out to see if it is physically and chemically possible for NGS emissions to be responsible for the sulfate concentrations found on JD 42.8–44.3; i.e., given resonable deposition rates along with dispersion characteristics implied by the ambient CD_4 concentrations can NGS emissions result in sulfate concentrations as high as those observed during those sampling periods. $v_{d,sso_4} = 0.15$ cm/sec and $v_{d,sso_2} = 0.7$ cm/sec were used for sulfate and sulfur dioxide deposition velocities, respectively, while a SO_2 to SO_4 oxidation rate of 1%/hr was used. First the air mass age was varied from 6 to 120 hours. Although increased sulfate is predicted as age increases with a 1%/hr oxidation rate age alone cannot account for the observed sulfate. Only by imposing elevated oxidation rates can the observed sulfate concentrations be achieved. With air mass age equal to 6 hrs and oxidation rates of approximately 10, 10, 5, and 2.5 percent per hour for JD 42.8, 43.3, 43.8, and 44.3, respectively, the predicted NGS sulfate concentrations are near those observed.

The above calculation is not meant to "prove" that the observed SSO_4 concentrations on JD 42.8–44.3 are associated with NGS emissions but only to show that the upper limit of NGS contribution to sulfate imposed by chemical and physical constraints is not less than ambient SSO_4 concentrations.

In the Hopi Point TMBR analysis the RH dependent SO_2 to SO_4 oxidation rate was approximated by multiplying SCD_4 by RH. Although the apparent RH dependent SO_2 to SO_4 oxidation rate cannot be approximated by this simple approximation at Page, Figure 6.52 strongly suggests the dependence is still there. At high RH values SO_4 concentrations are dramatically increased.

In any case, Table 6.38 shows the amount of SSO_4 attributed to NGS, assuming that the four high SSO_4 data points are partially due to imported sulfate. The NGS contribution to SSO_4 on JD 42.8–44.3 is calculated using the regression equations shown in Table 6.38. The NGS contribution to ambient SSO_4 is also calculated assuming all the SSO_4 other than the intercept term is associated with NGS. The ODR analysis attributes 50 ± 5 to 62 ± 5 percent of the SSO_4 to NGS assuming influx of SSO_4 from other sulfate sources on JD 42.8–44.3 while 75 ± 2 to 100 ± 3 percent of the sulfate is attributed to NGS if all sulfate other than the intercept term is assigned to NGS.

Figures 6.53 and 6.54 show temporal plots along with uncertainties of NGS sulfate, other sulfate, total predicted sulfate, and measured sulfate.

Table 6.40 gives the results of the ODR and OLS regressions of SCD_4 versus particulate nitrate, organic carbon, and light absorbing carbon. Scatter plots of these data are also shown in Figures 6.55, 6.56, and 6.57. Although some of the regression coefficients are statistically significant, all of the R^2 values are very small indicating weak relationships between these variables and SCD_4. Day 42.3 which has the highest concentration of SCD_4 appears to be an outlier on the scatter plots of nitrate, organic carbon, and light absorbing carbon vs SCD_4, so the regressions were run with and without this point. The regression coefficients were significantly higher, in most cases, if this point was left out, however, the R^2 values were very poor, both with and without this data point.

Table 6.39: Results of CMB analysis for Page on days 42.8–44.3 using Page and Green River data taken on days 40.3–42.3 as profiles.

(a) Page as Source

Species		I	Meas	Calc	Ratio C/M
MASSC	MASSU	T	7.37678±.68806	.85063±.04891	.12
SO_4C	SO_4U		3.10404±.13265	.88000±.03907	.28
SO_2C	SO_2U		2.28096±.20479	3.35604±.27084	1.47
SCD_4C	SCD_4U		.01102±.00075	.00616±.00038	.56
KC	KU		.02813±.00224	.01674±.00134	.60
MNC	MNU		.03718±.00260	.01989±.00139	.53
FEC	FEU	*	.01283±.00073	.01317±.00070	1.03
NIC	NIU		.00903±.00063	.00646±.00045	.72
CUC	CUU	*	.00058±.00010	.00043±.00008	.74
ZNC	ZNU	*	.00186±.00021	.00136±.00013	.74
ASC	ASU	*	.00116±.00021	.00054±.00010	.47
SEC	SEU	*	.00160±.00023	.00130±.00016	.82
BRC	BRU	*	.00153±.00023	.00103±.00015	.67
PBC	PBU	*	.00265±.00056	.00274±.00031	1.03

(b) Green River as Source

| Species		I	Meas	Calc	Ratio C/M
MASSC	MASSU	T	7.37678±.68806	.30375±.01935	.04
SO_4C	SO_4U		3.10404±.13265	.00000±.00000	.00
SO_2C	SO_2U		2.28096±.20479	.00000±.00000	.00
SCD_4C	SCD_4U		.01102±.00075	.00000±.00000	.00
KC	KU		.02813±.00224	.00606±.00098	.22
MNC	MNU		.03718±.00260	.00019±.00010	.01
FEC	FEU	*	.01283±.00073	.01543±.00080	1.20
NIC	NIU		.00903±.00063	.00077±.00007	.09
CUC	CUU	*	.00058±.00010	.00016±.00004	.27
ZNC	ZNU	*	.00186±.00021	.00075±.00008	.40
ASC	ASU	*	.00116±.00021	.00036±.00008	.31
SEC	SEU	*	.00160±.00023	.00034±.00007	.21
BRC	BRU	*	.00153±.00023	.00052±.00010	.34
RBC	RBU	*	.00000<.00021	.00000<.00008	.30
PBC	PBU	*	.00265±.00056	.00100±.00016	.38
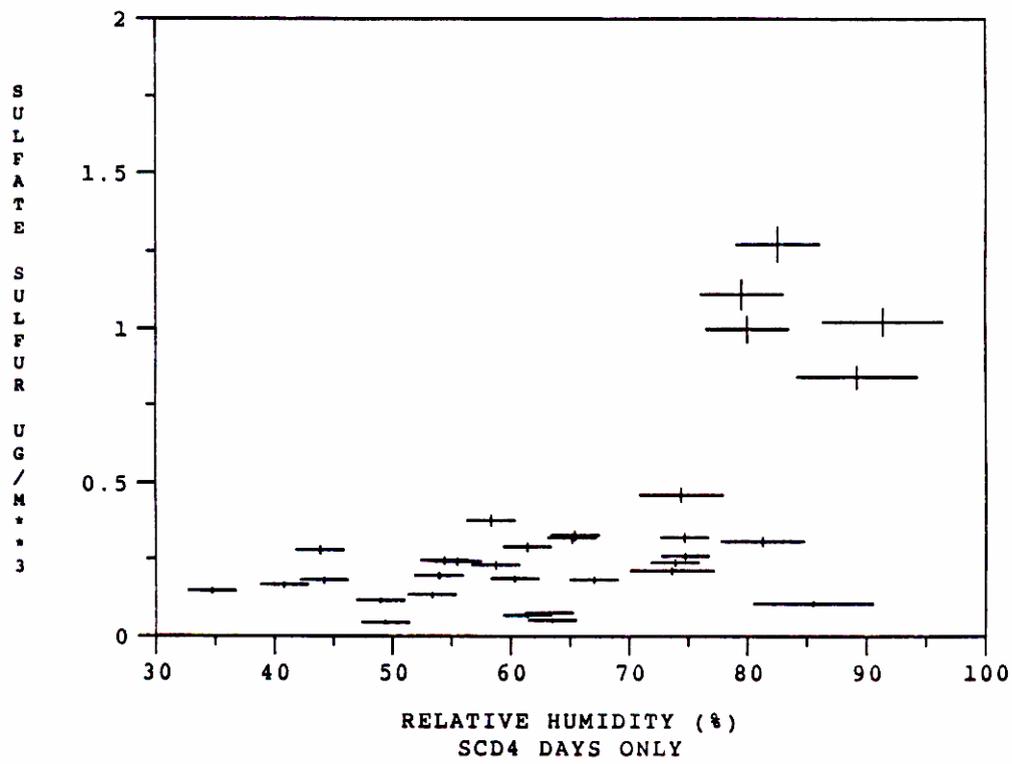
Figure 6.52: Scatterplot of sulfate sulfur *vs* relative humidity at Page for SCD_4 days.
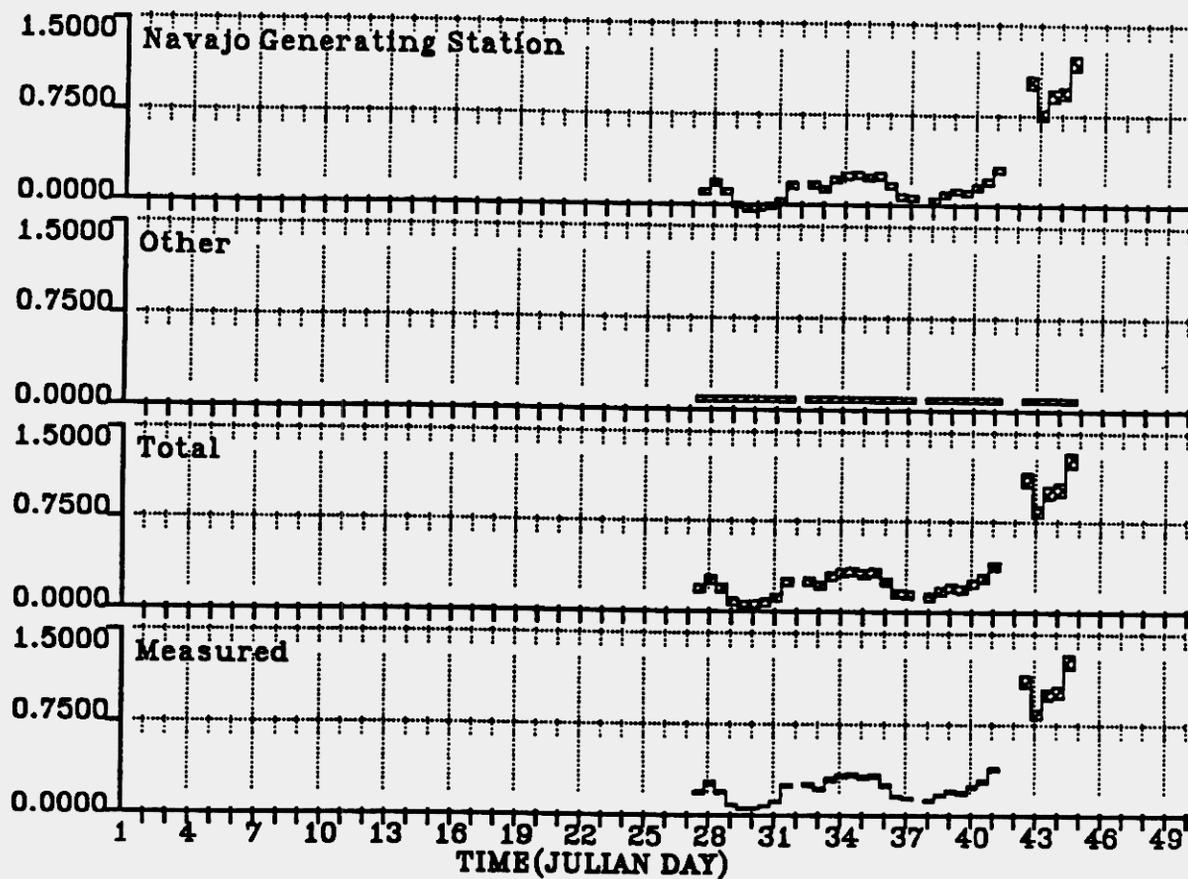
Sulfate Sulfur

Figure 6.53: Temporal plot of source apportionment of sulfate sulfur at Page based on TMBR assuming that all sulfur except the intercept term is due to NGS.
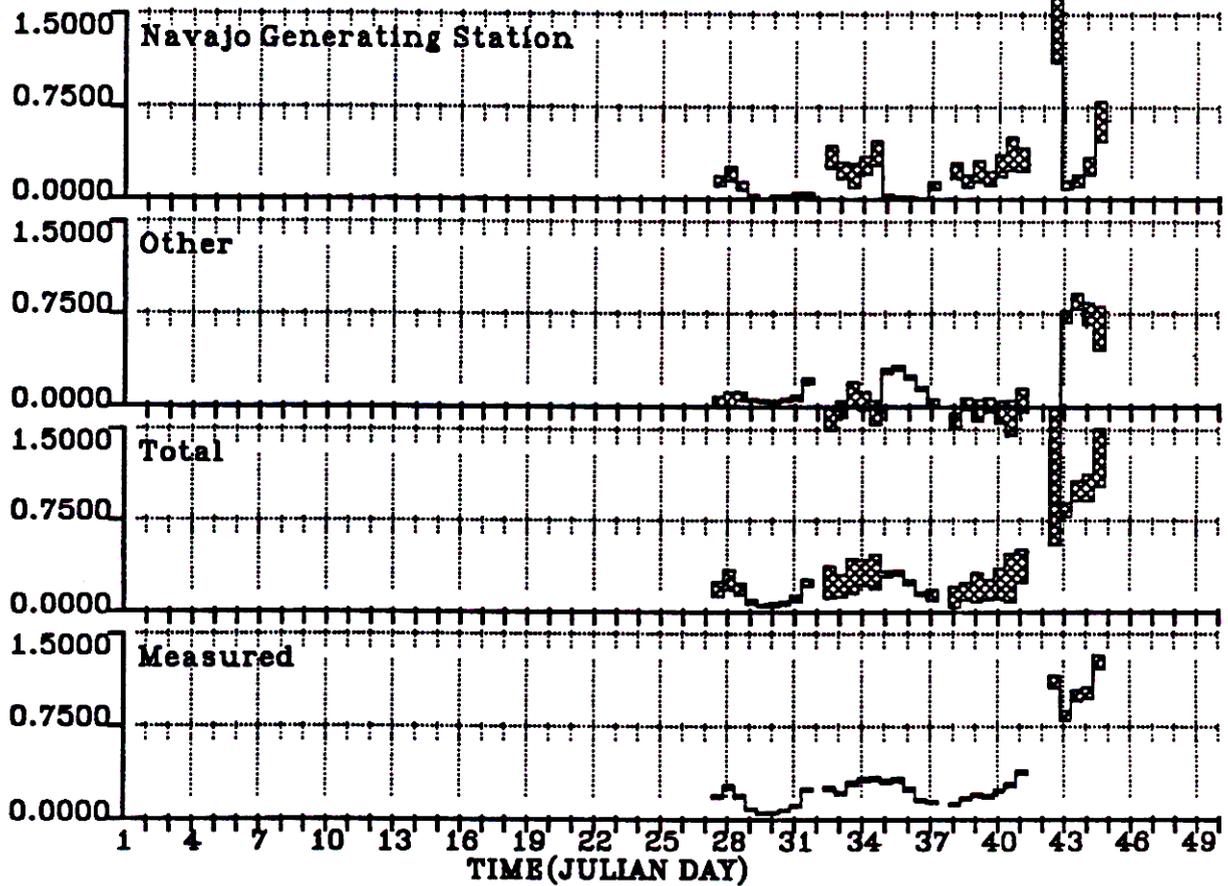
Sulfate Sulfur

Figure 6.54: Temporal plot of source apportionment of sulfate sulfur at Page based on TMBR assuming that all sulfur not associated with SCD_4 is due to other sources.

Table 6.40: Results of TMBR regressions for nitrate, organic carbon, and elemental carbon at Page.

Dependent Variable	Regression Model	Days Used	No. of Obs.	R^2	Independent Variable	Regression Coefficient
NO_3	ODR	All	28	0.00	SCD_4	2.600 ± 3.477
					Intercept	0.185 ± 0.033
NO_3	OLS	All	28	0.00	SCD_4	0.254 ± 5.071
					Intercept	0.279 ± 0.053
NO_3	ODR	All ex 42.3	27	0.01	SCD_4	22.324 ± 8.920
					Intercept	0.136 ± 0.040
NO_3	OLS	All ex 42.3	27	0.01	SCD_4	4.131 ± 10.064
					Intercept	0.262 ± 0.066
organic carbon	ODR	All	31	0.15	SCD_4	39.378 ± 15.457
					Intercept	0.810 ± 0.131
organic carbon	OLS	All	31	0.15	SCD_4	29.092 ± 13.089
					Intercept	0.866 ± 0.130
organic carbon	ODR	All ex 42.3	30	0.36	SCD_4	109.002 ± 22.029
					Intercept	0.557 ± 0.126
organic carbon	OLS	All ex 42.3	30	0.36	SCD_4	86.873 ± 21.928
					Intercept	0.628 ± 0.138
LAC	ODR	All	31	0.03	SCD_4	12.496 ± 9.937
					Intercept	0.496 ± 0.091
LAC	OLS	All	31	0.03	SCD_4	9.396 ± 9.697
					Intercept	0.533 ± 0.096
LAC	ODR	All ex 42.3	30	0.14	SCD_4	53.687 ± 17.465
					Intercept	0.346 ± 0.099
LAC	OLS	All ex 42.3	30	0.14	SCD_4	37.973 ± 17.720
					Intercept	0.415 ± 0.111