Page

Figure 6.72: Time plot of predicted upper limit of NGS contribution to total sulfur at Page (540 × SCD_4) and measured total sulfur.

6.7 Attribution of Visibility Impairment

The apportionment of light extinction was carried by first estimating the contribution of each chemical species to light extinction using consensus literature values for the extinction efficiencies of each species. These are summarized in Table 6.45. The fs(RH) and fn(RH) terms shown in the Table refer to functions describing the dependence of the sulfate and nitrate, scattering efficiencies on relative humidity. Most efficiencies are based on a literature review by Trijonis and Pitchford.[74] The coarse mass efficiency was adjusted to account for the size range 2.5–15 μm of the WHITEX coarse mass data rather than the 2.5–10 μm data in their study. Similarly, the organic efficiency was scaled by 1.5/1.4 to account for the different scaling ratios used to convert organic carbon to organics. The nitrate efficiency is based on Tang et al.[75] for a mass median diameter of 0.98 μm and a highly polydisperse size distribution. Figure 6.73 shows these functions graphically. The fn(RH) and fs(RH) functions are based on those described by Tang et al.[75]

For purposes of error propagation, all efficiencies in Table 6.45 were assumed to have an uncertainty of 10%. The uncertainty in the RH functions was calculated based on the uncertainties in the RH measurements, which are 2% for RH 0–80 % and 5% for RH 80–100 %. As can be seen in Figure 6.73 when the RH is above 80%, the relatively large uncertainty in the RH causes a large uncertainty in the RH functions. Although uncertainties are calculated for both NGS sulfate and other sulfate, the uncertainties for these components are not independent. For example, if RH was over estimated, the contributions due to NGS sulfate and other sulfate would both be over estimated.

The NGS contribution to light extinction was estimated by determining the NGS sulfate sulfur concentration for each time period based on the TMBR results. The sulfate sulfur due to other sources was then determined by subtracting NGS sulfur from the measured sulfate sulfur concentration. NGS sulfur could also be determined by DMB, and as discussed in Section 6.6.4, the results would be similar.

Table 6.45: Consensus literature light extinction efficiencies in m^2/g.

Chemical Species	Extinction Efficiency
sulfates	$2.55 \times fs(RH)$
nitrates	$1.1 \times fn(RH)$
organics	4.0
absorbing carbon	9.0
coarse mass	0.45
fine soil	1.25

Relative Scattering Efficiencies
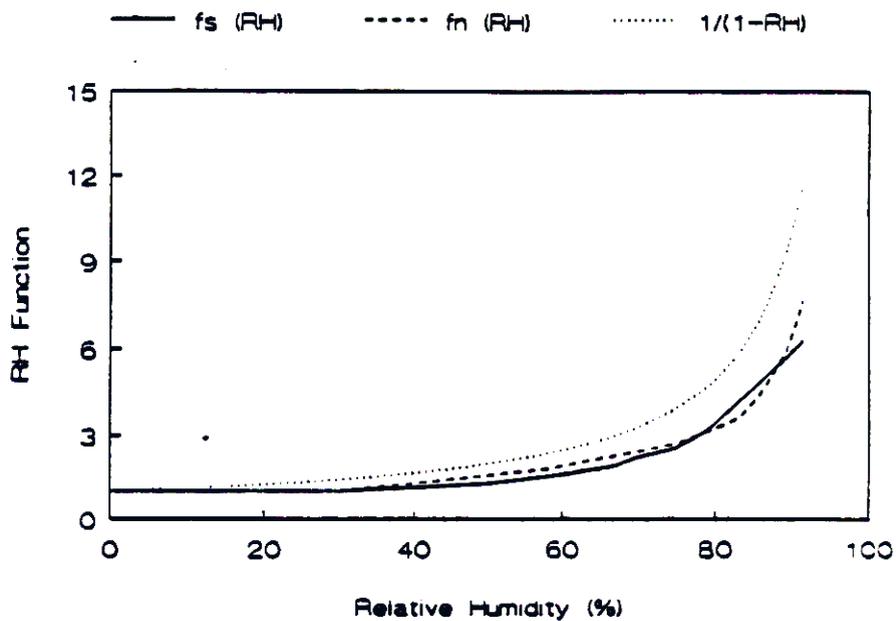
fs (RH) ----- fn (RH) .... 1/(1-RH)

Figure 6.73: Relative light scattering coefficients for ammonium sulfate and ammonium nitrate aerosols.

To calculate light extinction due to NGS sulfate for each time period, the concentrations are multiplied by the scattering efficiency shown in Table 6.45 and by 4.125 to scale the sulfur to ammonium sulfate. Extinction due to other sulfur is calculated in the same way. Scattering and absorption due to other chemical species are similarly calculated by multiplying the respective concentrations by the appropriate efficiencies. The fraction due to each species is determined by dividing the extinction due to each species by the total.

6.7.1 Results for Hopi Point

For Hopi Point, the NGS sulfur was determined by using the results of TMBR shown in Tables 6.27 and 6.28 and Figure 6.41. The apportionment of light extinction based on this source apportionment of sulfate sulfur is shown in Figure 6.74 and Table 6.46 which give the light extinction in 1/Km for each time period due to each species, and Table 6.47 which shows the fraction of extinction due to each species for each time period. The mean apportionment of light extinction at Hopi Point based on this calculation is 42% ± 13% NGS sulfate, 21% ± 2% sulfate from other sources, 27% ± 6% due to carbonaceous material, 7% ± 3% natural (scattering due to fine soil plus coarse mass) and 4% ± 0.4% nitrates.

6.7.2 Results for Page

At Page the existence of 4 "outlying" data points on the SCD_4 vs sulfate sulfur scatter plot meant that the TMBR analyses were carried out using two different assumptions about what caused these points to be outliers. The first assumption (method 1) assumed that the excess sulfur (above the regression line) during these time periods was due to NGS, the second assumption (method 2) was that the excess sulfur was due to some other "background" source. See Section 6.6.1 for more details on the calculations.

The apportionment of light extinction was carried out using the results of both of these TMBR analyses. See Figure 6.53 for the results of the TMBR analyses using method 1 and Figure 6.54 for results of method 2. The apportionment of light extinction using method 1 are shown in Figure 6.75 and Tables 6.48 and 6.49. The mean fraction of the extinction due to each chemical species based on method 1 are 38 % ± 14 % NGS sulfate, 8 % ± 2% sulfate from other sources, 45% ± 2% carbonaceous, 5% ± 1% natural (fine soil + coarse mass), and 4% ± 2% nitrate.

The results of the apportionment of light extinction when TMBR results for method 2 (excess sulfate to other sources) are used are shown in Figure 6.76 and Tables 6.50 and 6.51. The mean fractions of non-Rayleigh light extinction attributed to each species for this case are 23% ± 8% NGS sulfate, 22% ± 2% other sulfate, 45% ± 3% carbonaceous, 5% ± 1% natural, 4% ± 2% nitrate.
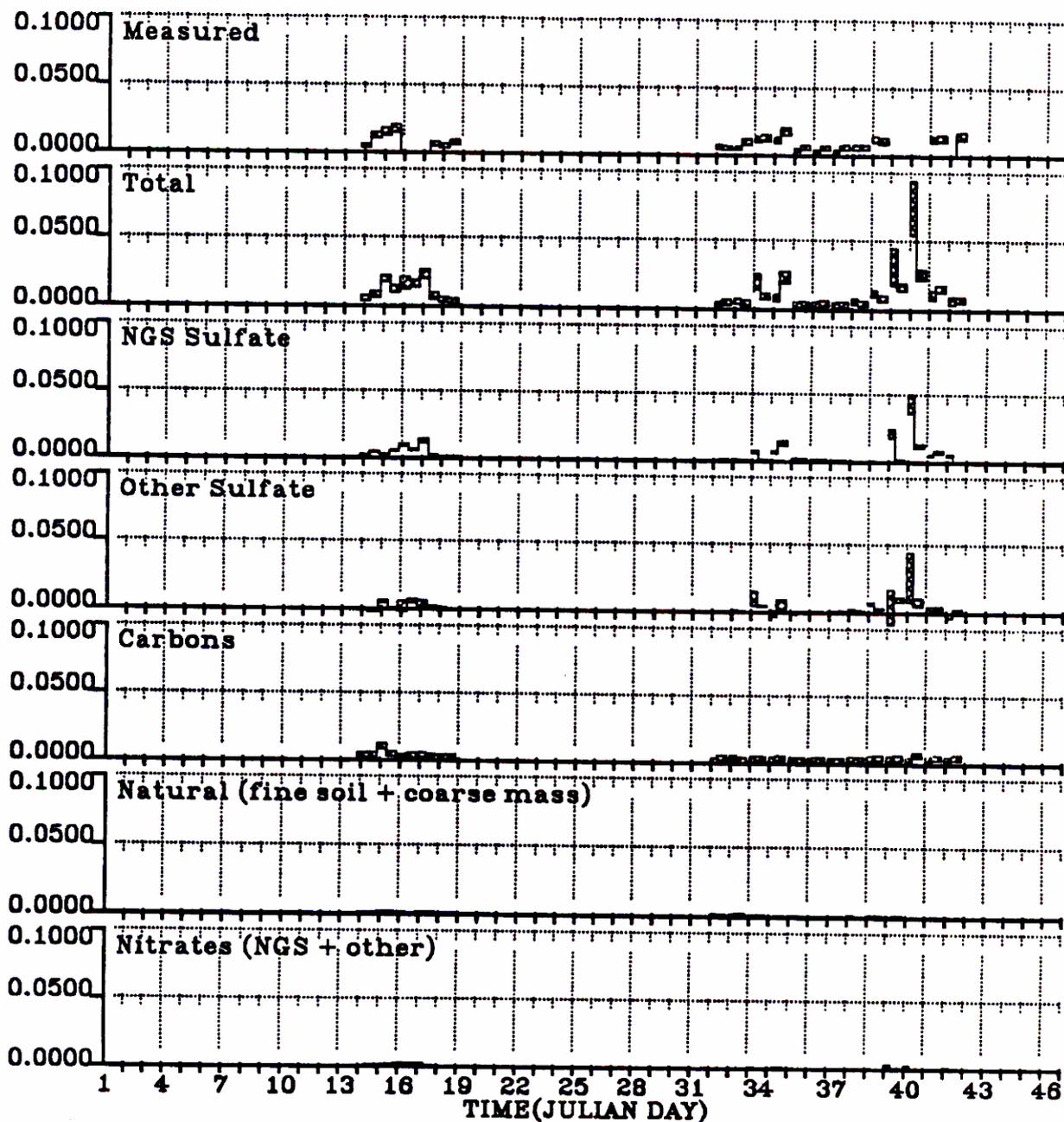
Hopi Point

Figure 6.74: Apportionment of non-Rayleigh light extinction at Hopi Point based on the results of the TMBR model and literature extinction efficiencies.

Table 6.46: Apportionment of non-Rayleigh light extinction (1/Km) at Hopi Point based on TMBR results for sulfate sulfur and literature extinction efficiencies.

Date	Measured	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
13.8	0.00430± 0.00138	0.00534± 0.00200	0.00206± 0.00021	-0.00051 ±0.00041	0.00314± 0.00194	0.00050± 0.00015	0.00016± 0.00004
14.3	0.01200± 0.00215	0.00806± 0.00214	0.00449± 0.00045	-0.00143 ±0.00080	0.00360± 0.00192	0.00062± 0.00019	0.00079± 0.00010
14.8	0.01490± 0.00244	0.01953± 0.00222	0.00245± 0.00025	0.00457 ±0.00075	0.01016± 0.00205	0.00100± 0.00026	0.00135± 0.00017
15.3	0.01730± 0.00268	0.01229± 0.00232	0.00538± 0.00055	-0.00042 ±0.00097	0.00449± 0.00200	0.00116± 0.00030	0.00167± 0.00023
15.8	·±·	0.01654± 0.00419	0.00957± 0.00105	0.00148 ±0.00356	0.00207± 0.00190	0.00106± 0.00030	0.00235± 0.00036
16.3	·±·	0.01621± 0.00246	0.00592± 0.00060	0.00535 ±0.00137	0.00312± 0.00194	·±·	0.00182± 0.00023
16.8	·±·	0.02311± 0.00319	0.01285± 0.00133	0.00367 ±0.00207	0.00367± 0.00200	0.00114± 0.00026	0.00177± 0.00025
17.3	0.00630± 0.00158	0.00736± 0.00213	0.00239± 0.00024	0.00111 ±0.00084	0.00256± 0.00193	0.00100± 0.00023	0.00030± 0.00005
17.8	0.00475± 0.00143	0.00457± 0.00197	0.00110± 0.00011	0.00065 ±0.00044	0.00209± 0.00191	0.00067± 0.00016	0.00006± 0.00003
18.3	0.00740± 0.00169	0.00362± 0.00190	0.00133± 0.00013	-0.00047 ±0.00032	0.00224± 0.00186	0.00045± 0.00012	0.00007± 0.00003
32.3	0.00515± 0.00147	0.00474± 0.00191	0.00074± 0.00007	-0.00037 ±0.00018	0.00300± 0.00189	0.00128± 0.00016	0.00010± 0.00003
32.8	0.00575± 0.00152	0.00307± 0.00188	0.00054± 0.00005	-0.00023 ±0.00022	0.00113± 0.00185	0.00158± 0.00019	0.00006± 0.00003
33.3	0.00980± 0.00193	0.00418± 0.00188	0.00060± 0.00006	-0.00020 ±0.00014	0.00184± 0.00186	0.00186± 0.00021	0.00008± 0.00003
33.8	0.00515± 0.00147	0.00526± 0.00195	0.00070± 0.00007	-0.00007 ±0.00053	0.00304± 0.00186	0.00148± 0.00024	0.00011± 0.00004
34.3	0.01300± 0.00225	0.00937± 0.00197	0.00088± 0.00009	0.00407 ±0.00055	0.00299± 0.00187	0.00129± 0.00026	0.00014± 0.00004
34.8	0.01200± 0.00215	0.01975± 0.00544	0.00672± 0.00073	0.00943 ±0.00504	0.00245± 0.00190	0.00069± 0.00019	0.00046± 0.00016
35.3	0.01750± 0.00270	0.02311± 0.00397	0.01325± 0.00150	0.00525 ±0.00314	0.00342± 0.00190	0.00064± 0.00016	0.00055± 0.00021
35.8	0.01140± 0.00209	0.00822± 0.00259	0.00664± 0.00067	-0.00163 ±0.00173	0.00241± 0.00180	0.00061± 0.00014	0.00019± 0.00007
36.3	0.00570± 0.00152	0.00342± 0.00188	0.00152± 0.00015	-0.00066 ±0.00028	0.00205± 0.00185	0.00049± 0.00012	0.00002± 0.00003
36.8	0.00355± 0.00131	0.00362± 0.00188	0.00173± 0.00017	-0.00112 ±0.00054	0.00244± 0.00179	0.00058± 0.00013	0.00000± 0.00002
37.3	0.00550± 0.00150	0.00428± 0.00191	0.00116± 0.00012	-0.00021 ±0.00022	0.00262± 0.00188	0.00069± 0.00013	0.00000± 0.00003
37.8	0.00300± 0.00125	0.00355± 0.00189	0.00098± 0.00010	-0.00006 ±0.00026	0.00199± 0.00187	0.00062± 0.00013	0.00003± 0.00003
38.3	0.00590± 0.00154	0.00357± 0.00184	0.00077± 0.00008	0.00032 ±0.00015	0.00188± 0.00183	0.00058± 0.00013	0.00003± 0.00003
38.8	0.00320± 0.00127	0.00340± 0.00188	0.00082± 0.00008	0.00005 ±0.00027	0.00196± 0.00185	0.00056± 0.00014	0.00001± 0.00002
39.3	0.00625± 0.00158	0.00429± 0.00189	0.00024± 0.00002	0.00078 ±0.00020	0.00269± 0.00187	0.00057± 0.00014	0.00001± 0.00003
39.8	0.00590± 0.00154	0.00595± 0.00189	0.00028± 0.00003	0.00165 ±0.00038	0.00297± 0.00184	0.00099± 0.00021	0.00006± 0.00003
40.3	0.01075± 0.00203	0.00823± 0.00193	0.00017± 0.00002	0.00260 ±0.00030	0.00404± 0.00189	0.00132± 0.00025	0.00010± 0.00003
40.8	0.01185± 0.00213	0.01190± 0.00209	0.00058± 0.00006	0.00623 ±0.00086	0.00363± 0.00189	0.00118± 0.00025	0.00029± 0.00007
41.3	·±·	0.01664± 0.00241	0.00144± 0.00016	0.00944 ±0.00146	0.00405± 0.00189	0.00121± 0.00026	0.00051± 0.00011
41.8	·±·	0.03105± 0.01311	0.02099± 0.00314	0.00381 ±0.01255	0.00352± 0.00185	0.00052± 0.00024	0.00220± 0.00100
42.3	·±·	0.02584± 0.00355	0.01179± 0.00132	0.00735 ±0.00269	0.00633± 0.00190	·±·	0.00037± 0.00009
42.8	·±·	0.07421± 0.01979	0.04355± 0.00700	0.02589 ±0.01840	0.00253± 0.00186	0.00029± 0.00022	0.00195± 0.00067
43.3	0.01280± 0.00223	0.01532± 0.00249	0.00743± 0.00077	0.00296 ±0.00140	0.00423± 0.00189	0.00037± 0.00021	0.00032± 0.00008
43.8	0.01250± 0.00220	0.01079± 0.00299	0.00472± 0.00048	0.00183 ±0.00228	0.00352± 0.00186	0.00035± 0.00018	0.00036± 0.00008
44.3	0.01475± 0.00243	0.00729± 0.00192	0.00029± 0.00003	0.00192 ±0.00052	0.00440± 0.00184	0.00031± 0.00017	0.00037± 0.00006
44.8	·±·	0.00686± 0.00260	0.00475± 0.00057	-0.00208 ±0.00170	0.00314± 0.00187	0.00040± 0.00012	0.00066± 0.00015
Mean	0.00887± 0.00036	0.01207± 0.00078	0.00502± 0.00157	0.00253 ±0.00023	0.00321± 0.00067	0.00083± 0.00033	0.00054± 0.000032
Frac	0.73482± 0.05569	1.00000± 0.09084	0.41612± 0.13319	0.20930 ±0.02338	0.26559± 0.05792	0.06837± 0.02793	0.04451± 0.003923

Table 6.47: Fractions of non-Rayleigh light extinction due to each species at Hopi Point based on TMBR and literature extinction efficiencies.

| Date	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
13.8	1.000 ± 0.530	0.386 ± 0.150	-0.096 ± 0.085	0.588 ± 0.425	0.094 ± 0.045	0.030 ± 0.013
14.3	1.000 ± 0.375	0.557 ± 0.158	-0.177 ± 0.110	0.447 ± 0.266	0.077 ± 0.031	0.098 ± 0.029
14.8	1.000 ± 0.161	0.125 ± 0.019	0.234 ± 0.047	0.520 ± 0.120	0.051 ± 0.015	0.069 ± 0.012
15.3	1.000 ± 0.267	0.438 ± 0.094	-0.034 ± 0.079	0.365 ± 0.177	0.094 ± 0.030	0.136 ± 0.032
15.8	1.000 ± 0.358	0.579 ± 0.160	0.089 ± 0.216	0.125 ± 0.119	0.064 ± 0.024	0.142 ± 0.042
16.3	1.000 ± 0.215	0.365 ± 0.067	0.330 ± 0.098	0.192 ± 0.123	. ± .	0.112 ± 0.022
16.8	1.000 ± 0.195	0.556 ± 0.096	0.159 ± 0.092	0.159 ± 0.089	0.049 ± 0.013	0.077 ± 0.015
17.3	1.000 ± 0.409	0.325 ± 0.099	0.151 ± 0.122	0.348 ± 0.281	0.136 ± 0.050	0.041 ± 0.014
17.8	1.000 ± 0.610	0.241 ± 0.107	0.142 ± 0.114	0.457 ± 0.462	0.147 ± 0.072	0.013 ± 0.009
18.3	1.000 ± 0.742	0.367 ± 0.196	-0.130 ± 0.112	0.619 ± 0.608	0.124 ± 0.073	0.019 ± 0.013
32.3	1.000 ± 0.570	0.156 ± 0.065	-0.078 ± 0.049	0.633 ± 0.473	0.270 ± 0.114	0.021 ± 0.011
32.8	1.000 ± 0.866	0.176 ± 0.109	-0.075 ± 0.085	0.368 ± 0.643	0.515 ± 0.321	0.020 ± 0.015
33.3	1.000 ± 0.636	0.144 ± 0.066	-0.048 ± 0.040	0.440 ± 0.487	0.445 ± 0.206	0.019 ± 0.011
33.8	1.000 ± 0.524	0.133 ± 0.051	-0.013 ± 0.101	0.578 ± 0.413	0.281 ± 0.114	0.021 ± 0.011
34.3	1.000 ± 0.297	0.094 ± 0.022	0.434 ± 0.109	0.319 ± 0.211	0.138 ± 0.040	0.015 ± 0.005
34.8	1.000 ± 0.390	0.340 ± 0.101	0.477 ± 0.287	0.124 ± 0.102	0.035 ± 0.014	0.023 ± 0.010
35.3	1.000 ± 0.243	0.573 ± 0.118	0.227 ± 0.141	0.148 ± 0.086	0.028 ± 0.008	0.024 ± 0.010
35.8	1.000 ± 0.446	0.808 ± 0.267	-0.198 ± 0.220	0.293 ± 0.238	0.074 ± 0.029	0.023 ± 0.011
36.3	1.000 ± 0.777	0.444 ± 0.248	-0.193 ± 0.134	0.599 ± 0.633	0.143 ± 0.086	0.006 ± 0.009
36.8	1.000 ± 0.734	0.478 ± 0.253	-0.309 ± 0.219	0.674 ± 0.606	0.160 ± 0.091	0.000 ± 0.006
37.3	1.000 ± 0.631	0.271 ± 0.124	-0.049 ± 0.056	0.612 ± 0.517	0.161 ± 0.078	0.007 ± 0.008
37.8	1.000 ± 0.753	0.276 ± 0.150	-0.017 ± 0.074	0.561 ± 0.605	0.175 ± 0.100	0.008 ± 0.010
38.3	1.000 ± 0.729	0.216 ± 0.113	0.090 ± 0.062	0.527 ± 0.580	0.162 ± 0.091	0.003 ± 0.006
38.8	1.000 ± 0.782	0.241 ± 0.135	0.015 ± 0.080	0.576 ± 0.631	0.165 ± 0.100	0.003 ± 0.009
39.3	1.000 ± 0.623	0.056 ± 0.025	0.182 ± 0.093	0.627 ± 0.516	0.133 ± 0.067	0.005 ± 0.005
39.8	1.000 ± 0.449	0.047 ± 0.016	0.277 ± 0.109	0.499 ± 0.348	0.166 ± 0.064	0.010 ± 0.006
40.3	1.000 ± 0.332	0.021 ± 0.005	0.316 ± 0.083	0.491 ± 0.257	0.160 ± 0.048	0.012 ± 0.005
40.8	1.000 ± 0.248	0.049 ± 0.010	0.524 ± 0.117	0.305 ± 0.168	0.099 ± 0.027	0.024 ± 0.007
41.3	1.000 ± 0.205	0.087 ± 0.016	0.567 ± 0.120	0.243 ± 0.119	0.073 ± 0.019	0.031 ± 0.008
41.8	1.000 ± 0.597	0.676 ± 0.303	0.123 ± 0.407	0.113 ± 0.076	0.017 ± 0.010	0.071 ± 0.044
42.3	1.000 ± 0.194	0.456 ± 0.081	0.284 ± 0.111	0.245 ± 0.081	. ± .	0.014 ± 0.004
42.8	1.000 ± 0.377	0.587 ± 0.183	0.349 ± 0.265	0.034 ± 0.027	0.004 ± 0.003	0.026 ± 0.011
43.3	1.000 ± 0.230	0.485 ± 0.093	0.193 ± 0.097	0.276 ± 0.131	0.024 ± 0.014	0.021 ± 0.006
43.8	1.000 ± 0.392	0.437 ± 0.129	0.170 ± 0.216	0.326 ± 0.195	0.032 ± 0.019	0.033 ± 0.012
44.3	1.000 ± 0.372	0.040 ± 0.011	0.263 ± 0.099	0.604 ± 0.298	0.043 ± 0.026	0.051 ± 0.016
44.8	1.000 ± 0.536	0.692 ± 0.275	-0.303 ± 0.273	0.458 ± 0.323	0.058 ± 0.028	0.096 ± 0.043

Page Method 1
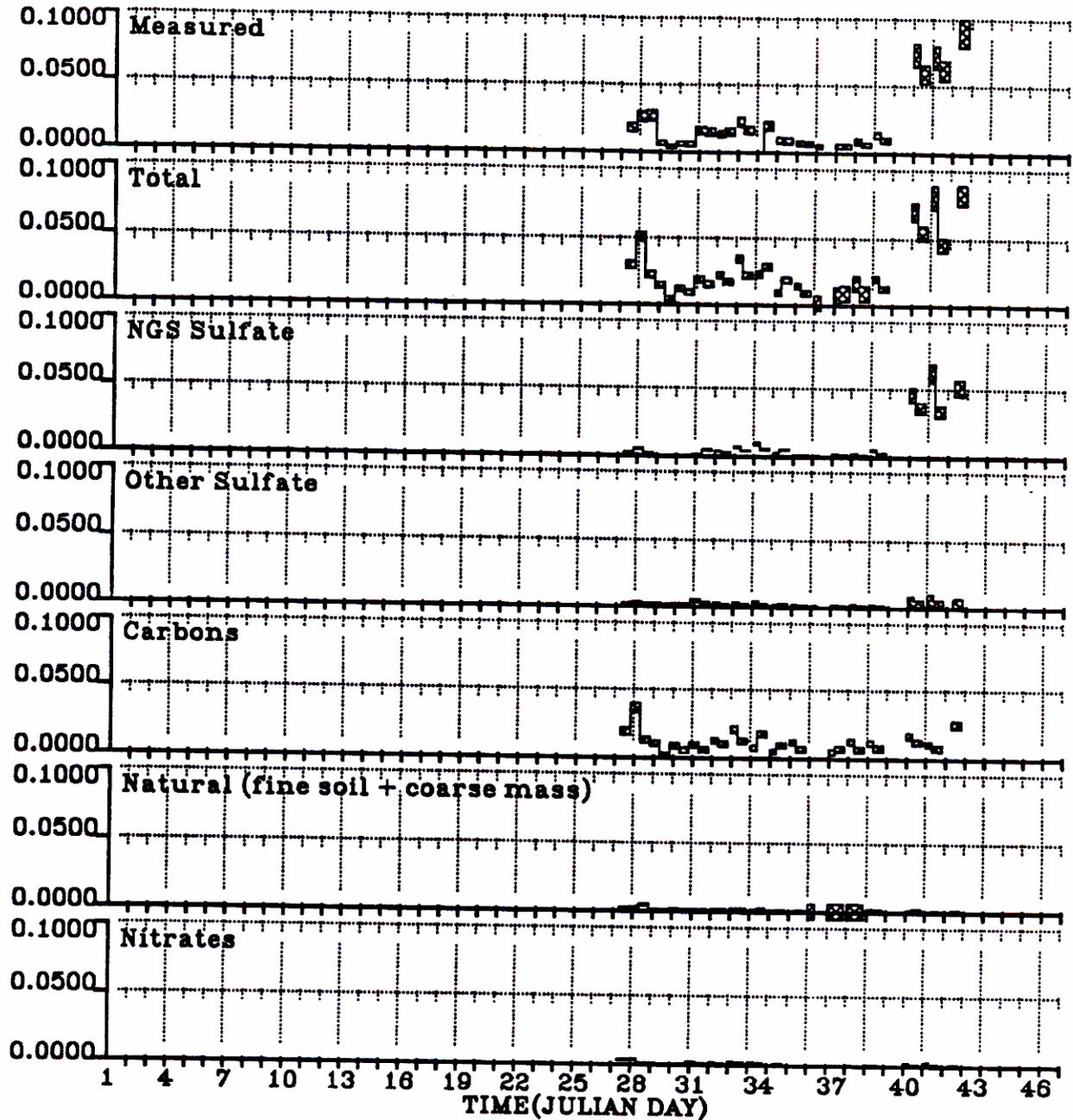
Figure 6.75: Apportionment of light extinction at Page based on the results of the TMBR model method 1 (excess sulfate to NGS) and literature extinction efficiencies.

Table 6.48: Non-Rayleigh light extinction (1/Km) attributed to each chemical species at Page. Results are based on the TMBR analysis which attributes the excess sulfate to NGS (method 1) and literature extinction efficiencies.

Date	Measured	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
27.3	0.01780± 0.00281	0.02944± 0.00277	0.00206± 0.00021	0.00171± 0.00053	0.01886± 0.00264	0.00227± 0.00044	0.00298± 0.00037
27.8	0.02600± 0.00363	0.05041± 0.00339	0.00476± 0.00048	0.00227± 0.00075	0.03589± 0.00318	0.00228± 0.00057	0.00342± 0.00042
28.3	0.02695± 0.00372	0.02247± 0.00223	0.00177± 0.00018	0.00144± 0.00044	0.01263± 0.00206	0.00450± 0.00068	0.00103± 0.00014
28.8	0.00650± 0.00168	0.01416± 0.00201	-0.00011± 0.00001	0.00156± 0.00043	0.01008± 0.00195	0.00109± 0.00022	0.00051± 0.00008
29.3	0.00395± 0.00143	0.00407± 0.00181	-0.00051± 0.00005	0.00113± 0.00031	0.00152± 0.00177	0.00091± 0.00015	0.00020± 0.00005
29.8	0.00625± 0.00165	0.01182± 0.00194	-0.00059± 0.00006	0.00157± 0.00044	0.00828± 0.00187	0.00152± 0.00027	0.00023± 0.00007
30.3	0.00600± 0.00163	0.00937± 0.00190	-0.00026± 0.00003	0.00148± 0.00042	0.00515± 0.00183	0.00141± 0.00023	0.00057± 0.00009
30.8	0.01570± 0.00260	0.01863± 0.00233	0.00125± 0.00015	0.00429± 0.00127	0.00906± 0.00189	0.00105± 0.00024	0.00163± 0.00038
31.3	0.01480± 0.00251	0.01538± 0.00205	0.00410± 0.00041	0.00222± 0.00073	0.00579± 0.00185	0.00108± 0.00025	0.00116± 0.00016
32.3	0.01495± 0.00252	0.01714± 0.00201	0.00245± 0.00025	0.00127± 0.00042	0.00992± 0.00191	0.00153± 0.00034	0.00081± 0.00011
32.8	0.01345± 0.00238	0.02218± 0.00218	0.00340± 0.00035	0.00220± 0.00070	0.01238± 0.00200	0.00154± 0.00034	0.00146± 0.00020
33.3	0.01645± 0.00268	0.02205± 0.00217	0.00363± 0.00037	0.00148± 0.00051	0.01243± 0.00202	0.00160± 0.00040	0.00152± 0.00020
33.8	0.02220± 0.00325	0.03451± 0.00259	0.00640± 0.00064	0.00226± 0.00082	0.02063± 0.00230	0.00161± 0.00047	0.00209± 0.00026
34.3	0.01935± 0.00296	0.02855± 0.00238	0.00482± 0.00049	0.00165± 0.00060	0.01741± 0.00220	0.00187± 0.00046	0.00134± 0.00018
34.8	.±	0.02297± 0.00246	0.00895± 0.00100	0.00335± 0.00120	0.00710± 0.00186	0.00113± 0.00029	0.00169± 0.00027
35.3	0.00860± 0.00189	0.01845± 0.00204	0.00461± 0.00046	0.00164± 0.00059	0.00933± 0.00187	0.00092± 0.00024	0.00081± 0.00012
35.8	0.00885± 0.00192	0.00923± 0.00187	0.00245± 0.00025	0.00130± 0.00042	0.00479± 0.00179	0.00068± 0.00021	.±
36.3	0.00660± 0.00169	0.00870± 0.00185	0.00072± 0.00007	0.00094± 0.00028	0.00638± 0.00181	0.00066± 0.00019	.±
36.8	0.00720± 0.00175	0.01427± 0.00198	0.00078± 0.00008	0.00124± 0.00036	0.01168± 0.00193	0.00057± 0.00021	.±
37.8	0.00450± 0.00148	0.00181± 0.00544	0.00046± 0.00005	0.00113± 0.00033	.±	0.00022± 0.00543	.±
38.3	0.00515± 0.00154	0.00885± 0.00573	0.00102± 0.00010	0.00102± 0.00031	0.00647± 0.00184	0.00023± 0.00542	0.00010± 0.00004
38.8	0.00485± 0.00151	0.00764± 0.00575	0.00169± 0.00017	0.00125± 0.00038	0.00431± 0.00183	0.00024± 0.00544	0.00015± 0.00005
39.3	0.00620± 0.00165	0.00894± 0.00574	0.00125± 0.00013	0.00107± 0.00033	0.00622± 0.00186	0.00025± 0.00542	0.00016± 0.00005
39.8	0.00860± 0.00189	0.01644± 0.00580	0.00243± 0.00024	0.00139± 0.00045	0.01207± 0.00196	0.00028± 0.00544	0.00027± 0.00006
40.3	0.00955± 0.00199	0.01264± 0.00195	0.00247± 0.00025	0.00106± 0.00036	0.00727± 0.00188	0.00157± 0.00032	0.00027± 0.00005
40.8	0.01310± 0.00234	0.01977± 0.00209	0.00482± 0.00048	0.00138± 0.00053	0.01135± 0.00192	0.00175± 0.00036	0.00047± 0.00008
42.3	0.05895± 0.00692	0.05446± 0.00515	0.03631± 0.00397	0.00297± 0.00251	0.01211± 0.00204	0.00196± 0.00053	0.00111± 0.00019
42.8	0.07355± 0.00839	0.07035± 0.00660	0.04601± 0.00519	0.00510± 0.00340	0.01647± 0.00212	0.00093± 0.00046	0.00184± 0.00055
43.3	0.06150± 0.00718	0.04557± 0.00480	0.03356± 0.00369	0.00307± 0.00237	0.00743± 0.00190	0.00065± 0.00042	0.00086± 0.00016
43.8	0.07175± 0.00820	0.08056± 0.00844	0.06236± 0.00691	0.00557± 0.00438	0.01060± 0.00193	0.00015± 0.00052	0.00188± 0.00063
44.3	0.08970± 0.01000	0.08236± 0.00722	0.05142± 0.00578	0.00364± 0.00347	0.02508± 0.00254	0.00117± 0.00050	0.00106± 0.00018
Mean	0.02163± 0.00072	0.02526± 0.00071	0.00950± 0.00344	0.00205± 0.00038	0.01129± 0.00027	0.00121± 0.00036	0.00110± 0.00046
Frac	0.85628± 0.03733	1.00000± 0.03965	0.37600± 0.13666	0.08127± 0.01531	0.44686± 0.01637	0.04803± 0.01433	0.04342± 0.01807

Table 6.49: Fraction of non-Rayleigh light extinction attributed to each chemical species at Page. Results are based on the TMBR analysis which attributes the excess sulfate to NGS (method 1) and literature extinction efficiencies.

| Date	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
27.3	1.000 ± 0.133	0.070 ± 0.010	0.058 ± 0.019	0.641 ± 0.108	0.077 ± 0.017	0.101 ± 0.016
27.8	1.000 ± 0.095	0.094 ± 0.011	0.045 ± 0.015	0.712 ± 0.079	0.045 ± 0.012	0.068 ± 0.009
28.3	1.000 ± 0.140	0.079 ± 0.011	0.064 ± 0.021	0.562 ± 0.107	0.200 ± 0.036	0.046 ± 0.008
28.8	1.000 ± 0.201	-0.008 ± 0.001	0.110 ± 0.034	0.712 ± 0.171	0.077 ± 0.019	0.036 ± 0.008
29.3	1.000 ± 0.629	-0.125 ± 0.057	0.278 ± 0.145	0.373 ± 0.466	0.224 ± 0.106	0.049 ± 0.025
29.8	1.000 ± 0.232	-0.050 ± 0.010	0.133 ± 0.043	0.701 ± 0.196	0.129 ± 0.031	0.019 ± 0.007
30.3	1.000 ± 0.287	-0.028 ± 0.006	0.158 ± 0.055	0.550 ± 0.225	0.150 ± 0.039	0.061 ± 0.016
30.8	1.000 ± 0.177	0.067 ± 0.012	0.230 ± 0.074	0.486 ± 0.118	0.056 ± 0.015	0.087 ± 0.023
31.3	1.000 ± 0.189	0.267 ± 0.044	0.144 ± 0.051	0.376 ± 0.130	0.070 ± 0.019	0.075 ± 0.014
32.3	1.000 ± 0.166	0.143 ± 0.022	0.074 ± 0.026	0.579 ± 0.130	0.089 ± 0.022	0.047 ± 0.008
32.8	1.000 ± 0.139	0.153 ± 0.022	0.099 ± 0.033	0.558 ± 0.106	0.069 ± 0.017	0.066 ± 0.011
33.3	1.000 ± 0.139	0.165 ± 0.023	0.067 ± 0.024	0.564 ± 0.107	0.073 ± 0.019	0.069 ± 0.011
33.8	1.000 ± 0.106	0.185 ± 0.023	0.065 ± 0.024	0.598 ± 0.080	0.047 ± 0.014	0.061 ± 0.009
34.3	1.000 ± 0.118	0.169 ± 0.022	0.058 ± 0.022	0.610 ± 0.092	0.065 ± 0.017	0.047 ± 0.007
34.8	1.000 ± 0.151	0.390 ± 0.060	0.146 ± 0.055	0.309 ± 0.087	0.049 ± 0.014	0.074 ± 0.014
35.3	1.000 ± 0.156	0.250 ± 0.037	0.089 ± 0.033	0.506 ± 0.116	0.050 ± 0.014	0.044 ± 0.008
35.8	1.000 ± 0.287	0.265 ± 0.060	0.141 ± 0.054	0.519 ± 0.221	0.074 ± 0.027	. ± .
36.3	1.000 ± 0.301	0.083 ± 0.019	0.108 ± 0.040	0.733 ± 0.260	0.076 ± 0.027	. ± .
36.8	1.000 ± 0.196	0.055 ± 0.009	0.087 ± 0.028	0.819 ± 0.177	0.040 ± 0.016	. ± .
37.8	1.000 ± 4.250	0.254 ± 0.764	0.624 ± 1.885	. ± .	0.122 ± 3.022	. ± .
38.3	1.000 ± 0.916	0.115 ± 0.075	0.115 ± 0.082	0.731 ± 0.517	0.026 ± 0.613	0.011 ± 0.009
38.8	1.000 ± 1.064	0.221 ± 0.168	0.164 ± 0.133	0.564 ± 0.487	0.031 ± 0.712	0.020 ± 0.016
39.3	1.000 ± 0.908	0.140 ± 0.091	0.120 ± 0.085	0.696 ± 0.493	0.028 ± 0.607	0.018 ± 0.013
39.8	1.000 ± 0.499	0.148 ± 0.054	0.085 ± 0.040	0.734 ± 0.285	0.017 ± 0.331	0.016 ± 0.007
40.3	1.000 ± 0.218	0.195 ± 0.036	0.084 ± 0.031	0.575 ± 0.173	0.124 ± 0.032	0.021 ± 0.005
40.8	1.000 ± 0.150	0.244 ± 0.035	0.070 ± 0.028	0.574 ± 0.115	0.089 ± 0.020	0.024 ± 0.005
42.3	1.000 ± 0.134	0.667 ± 0.096	0.055 ± 0.046	0.222 ± 0.043	0.036 ± 0.010	0.020 ± 0.004
42.8	1.000 ± 0.133	0.654 ± 0.096	0.072 ± 0.049	0.234 ± 0.037	0.013 ± 0.007	0.026 ± 0.008
43.3	1.000 ± 0.149	0.736 ± 0.112	0.067 ± 0.052	0.163 ± 0.045	0.014 ± 0.009	0.019 ± 0.004
43.8	1.000 ± 0.148	0.774 ± 0.118	0.069 ± 0.055	0.132 ± 0.028	0.002 ± 0.006	0.023 ± 0.008
44.3	1.000 ± 0.124	0.624 ± 0.089	0.044 ± 0.042	0.305 ± 0.041	0.014 ± 0.006	0.013 ± 0.002
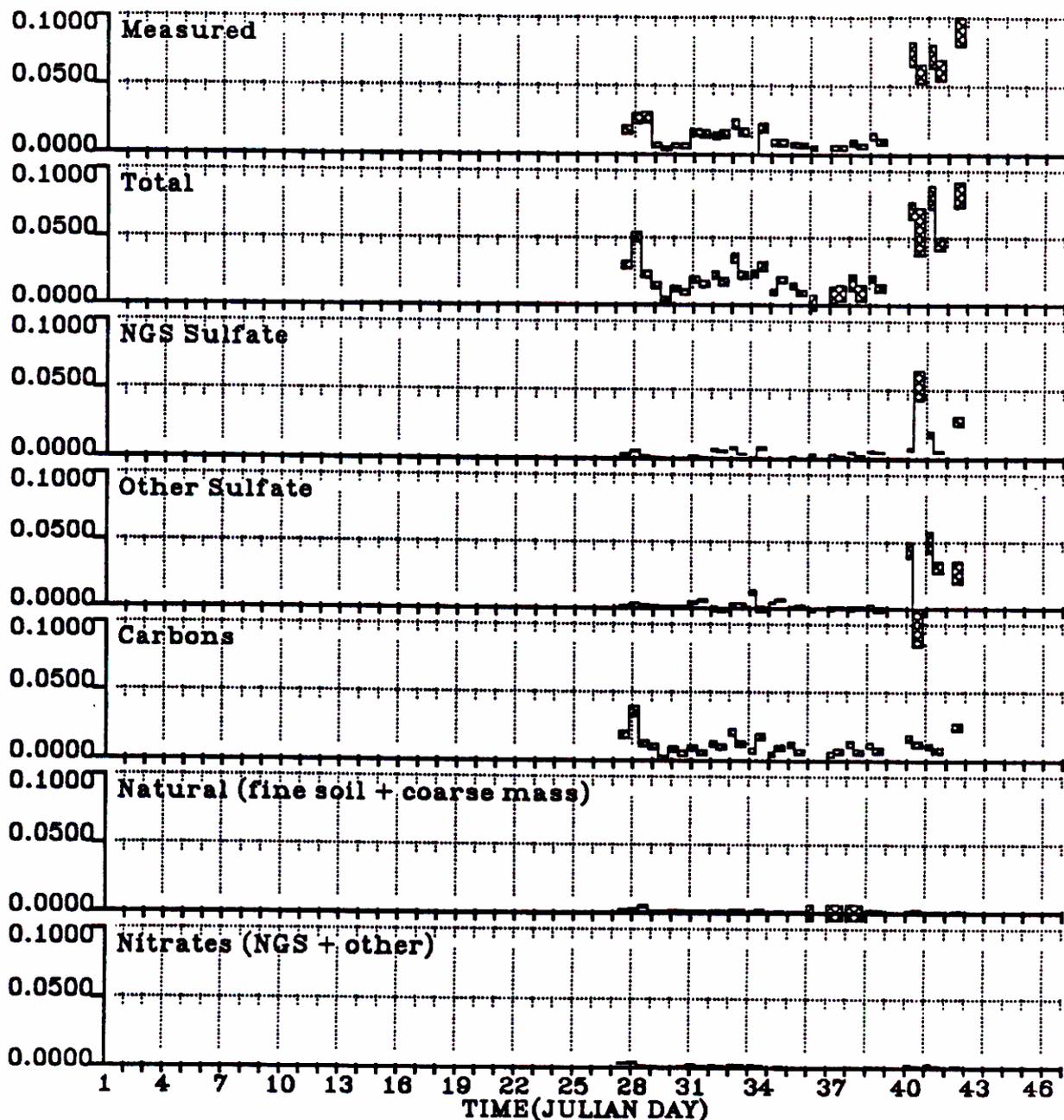
Figure 6.76: Apportionment of non-Rayleigh light extinction at Page based on the results of the TMBR model method 2 (excess sulfate to sources other than NGS) and literature extinction efficiencies.

Table 6.50: Non-Rayleigh light extinction (1/Km) attributed to each chemical species at Page. Results are based on the TMBR analysis which attributes the excess sulfate to other sources (method 2) and literature extinction efficiencies.

Date	Measured	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
27.3	0.01780± 0.00281	0.02944± 0.00285	0.00296± 0.00030	0.00081± 0.00082	0.01886± 0.00264	0.00227± 0.00044	0.00298± 0.00037
27.8	0.02600± 0.00363	0.05041± 0.00366	0.00550± 0.00055	0.00152± 0.00156	0.03589± 0.00318	0.00228± 0.00057	0.00342± 0.00042
28.3	0.02695± 0.00372	0.02247± 0.00227	0.00179± 0.00018	0.00142± 0.00059	0.01263± 0.00206	0.00450± 0.00068	0.00103± 0.00014
28.8	0.00650± 0.00168	0.01416± 0.00198	0.00038± 0.00004	0.00107± 0.00024	0.01008± 0.00195	0.00109± 0.00022	0.00051± 0.00008
29.3	0.00395± 0.00143	0.00407± 0.00179	0.00000± 0.00000	0.00062± 0.00013	0.00152± 0.00177	0.00091± 0.00015	0.00020± 0.00005
29.8	0.00625± 0.00165	0.01182± 0.00190	0.00028± 0.00003	0.00070± 0.00020	0.00828± 0.00187	0.00152± 0.00027	0.00023± 0.00007
30.3	0.00600± 0.00163	0.00937± 0.00187	0.00026± 0.00003	0.00097± 0.00021	0.00515± 0.00183	0.00141± 0.00023	0.00057± 0.00009
30.8	0.01570± 0.00260	0.01863± 0.00217	0.00179± 0.00021	0.00375± 0.00094	0.00906± 0.00189	0.00105± 0.00024	0.00163± 0.00038
31.3	0.01480± 0.00251	0.01538± 0.00202	0.00084± 0.00008	0.00548± 0.00075	0.00579± 0.00185	0.00108± 0.00025	0.00116± 0.00016
32.3	0.01495± 0.00252	0.01714± 0.00246	0.00519± 0.00052	-0.00147± 0.00140	0.00992± 0.00191	0.00153± 0.00034	0.00081± 0.00011
32.8	0.01345± 0.00238	0.02218± 0.00274	0.00614± 0.00063	-0.00054± 0.00171	0.01238± 0.00200	0.00154± 0.00034	0.00146± 0.00020
33.3	0.01645± 0.00268	0.02205± 0.00273	0.00337± 0.00034	0.00174± 0.00175	0.01243± 0.00202	0.00160± 0.00040	0.00152± 0.00020
33.8	0.02220± 0.00325	0.03451± 0.00319	0.00744± 0.00075	0.00123± 0.00199	0.02063± 0.00230	0.00161± 0.00047	0.00209± 0.00026
34.3	0.01935± 0.00296	0.02855± 0.00307	0.00734± 0.00074	-0.00088± 0.00194	0.01741± 0.00220	0.00187± 0.00046	0.00134± 0.00018
34.8	·±·	0.02297± 0.00239	0.00084± 0.00009	0.01146± 0.00145	0.00710± 0.00186	0.00113± 0.00029	0.00169± 0.00027
35.3	0.00860± 0.00189	0.01845± 0.00202	0.00017± 0.00002	0.00608± 0.00069	0.00933± 0.00187	0.00092± 0.00024	0.00081± 0.00012
35.8	0.00885± 0.00192	0.00923± 0.00186	0.00009± 0.00001	0.00366± 0.00043	0.00479± 0.00179	0.00068± 0.00021	·±·
36.3	0.00660± 0.00169	0.00870± 0.00184	0.00000± 0.00000	0.00166± 0.00021	0.00638± 0.00181	0.00066± 0.00019	·±·
36.8	0.00720± 0.00175	0.01427± 0.00200	0.00156± 0.00016	0.00045± 0.00046	0.01168± 0.00193	0.00057± 0.00021	·±·
37.8	0.00450± 0.00148	0.00181± 0.00551	0.00312± 0.00031	-0.00153± 0.00084	·±·	0.00022± 0.00543	·±·
38.3	0.00515± 0.00154	0.00885± 0.00576	0.00176± 0.00018	0.00028± 0.00060	0.00647± 0.00184	0.00023± 0.00542	0.00010± 0.00004
38.8	0.00485± 0.00151	0.00764± 0.00588	0.00337± 0.00034	-0.00042± 0.00124	0.00431± 0.00183	0.00024± 0.00544	0.00015± 0.00005
39.3	0.00620± 0.00165	0.00894± 0.00578	0.00212± 0.00021	0.00020± 0.00072	0.00622± 0.00186	0.00025± 0.00542	0.00016± 0.00005
39.8	0.00860± 0.00189	0.01644± 0.00597	0.00453± 0.00045	-0.00071± 0.00145	0.01207± 0.00196	0.00028± 0.00544	0.00027± 0.00006
40.3	0.00955± 0.00199	0.01264± 0.00262	0.00467± 0.00047	-0.00114± 0.00174	0.00727± 0.00188	0.00157± 0.00032	0.00027± 0.00005
40.8	0.01310± 0.00234	0.01977± 0.00257	0.00532± 0.00053	0.00088± 0.00157	0.01135± 0.00192	0.00175± 0.00036	0.00047± 0.00008
42.3	0.05895± 0.00692	0.05446± 0.01772	0.05349± 0.01037	-0.01422± 0.01421	0.01211± 0.00204	0.00196± 0.00053	0.00111± 0.00019
42.8	0.07355± 0.00839	0.07035± 0.00622	0.00696± 0.00079	0.04414± 0.00575	0.01647± 0.00212	0.00093± 0.00046	0.00184± 0.00055
43.3	0.06150± 0.00718	0.04557± 0.00462	0.00547± 0.00060	0.03116± 0.00415	0.00743± 0.00190	0.00065± 0.00042	0.00086± 0.00016
43.8	0.07175± 0.00820	0.08056± 0.00835	0.01803± 0.00200	0.04990± 0.00783	0.01060± 0.00193	0.00015± 0.00052	0.00188± 0.00063
44.3	0.08970± 0.01000	0.08236± 0.00904	0.02763± 0.00310	0.02743± 0.00808	0.02508± 0.00254	0.00117± 0.00050	0.00106± 0.00018
Mean	0.02163± 0.00072	0.02526± 0.00092	0.00588± 0.00213	0.00567± 0.00036	0.01129± 0.00068	0.00121± 0.00036	0.00110± 0.00046
Frac	0.85628± 0.04236	1.00000± 0.05161	0.23291± 0.08476	0.22434± 0.01648	0.44686± 0.03139	0.04803± 0.01437	0.04342± 0.01810

Table 6.51: Fraction of non-Rayleigh light extinction attributed to each chemical species at Page. Results are based on the TMBR analysis which attributes the excess sulfate to other sources (method 2) and literature extinction efficiencies.

Date	Total	NGS sulfate	Other sulfate	Carbonaceous	Natural	Nitrate
27.3	1.000 ± 0.137	0.101 ± 0.014	0.028 ± 0.028	0.641 ± 0.109	0.077 ± 0.017	0.101 ± 0.016
27.8	1.000 ± 0.103	0.109 ± 0.013	0.030 ± 0.031	0.712 ± 0.082	0.045 ± 0.012	0.068 ± 0.010
28.3	1.000 ± 0.143	0.080 ± 0.011	0.063 ± 0.027	0.562 ± 0.108	0.200 ± 0.036	0.046 ± 0.008
28.8	1.000 ± 0.198	0.027 ± 0.005	0.076 ± 0.020	0.712 ± 0.170	0.077 ± 0.019	0.036 ± 0.008
29.3	1.000 ± 0.622	0.000 ± 0.000	0.152 ± 0.074	0.373 ± 0.465	0.224 ± 0.105	0.049 ± 0.025
29.8	1.000 ± 0.227	0.024 ± 0.005	0.059 ± 0.019	0.701 ± 0.194	0.129 ± 0.031	0.019 ± 0.007
30.3	1.000 ± 0.282	0.028 ± 0.006	0.104 ± 0.030	0.550 ± 0.224	0.150 ± 0.039	0.061 ± 0.015
30.8	1.000 ± 0.165	0.096 ± 0.016	0.201 ± 0.056	0.486 ± 0.116	0.056 ± 0.014	0.087 ± 0.023
31.3	1.000 ± 0.186	0.055 ± 0.009	0.356 ± 0.068	0.376 ± 0.130	0.070 ± 0.019	0.075 ± 0.014
32.3	1.000 ± 0.203	0.303 ± 0.053	-0.086 ± 0.083	0.579 ± 0.139	0.089 ± 0.024	0.047 ± 0.009
32.8	1.000 ± 0.175	0.277 ± 0.044	-0.024 ± 0.077	0.558 ± 0.114	0.069 ± 0.018	0.066 ± 0.012
33.3	1.000 ± 0.175	0.153 ± 0.024	0.079 ± 0.080	0.564 ± 0.115	0.073 ± 0.020	0.069 ± 0.012
33.8	1.000 ± 0.131	0.216 ± 0.029	0.036 ± 0.058	0.598 ± 0.087	0.047 ± 0.014	0.061 ± 0.009
34.3	1.000 ± 0.152	0.257 ± 0.038	-0.031 ± 0.068	0.610 ± 0.101	0.065 ± 0.018	0.047 ± 0.008
34.8	1.000 ± 0.147	0.037 ± 0.005	0.499 ± 0.082	0.309 ± 0.087	0.049 ± 0.014	0.074 ± 0.014
35.3	1.000 ± 0.155	0.009 ± 0.001	0.330 ± 0.052	0.506 ± 0.115	0.050 ± 0.014	0.044 ± 0.008
35.8	1.000 ± 0.285	0.010 ± 0.002	0.397 ± 0.092	0.519 ± 0.220	0.074 ± 0.027	. ± .
36.3	1.000 ± 0.299	0.000 ± 0.000	0.191 ± 0.047	0.733 ± 0.259	0.076 ± 0.027	. ± .
36.8	1.000 ± 0.198	0.109 ± 0.019	0.032 ± 0.033	0.819 ± 0.177	0.040 ± 0.016	. ± .
37.8	1.000 ± 4.305	1.724 ± 5.250	-0.845 ± 2.615	. ± .	0.122 ± 3.023	. ± .
38.3	1.000 ± 0.920	0.199 ± 0.131	0.032 ± 0.071	0.731 ± 0.519	0.026 ± 0.613	0.011 ± 0.009
38.8	1.000 ± 1.088	0.441 ± 0.342	-0.055 ± 0.168	0.564 ± 0.496	0.031 ± 0.712	0.020 ± 0.016
39.3	1.000 ± 0.914	0.237 ± 0.155	0.022 ± 0.082	0.696 ± 0.496	0.028 ± 0.607	0.018 ± 0.013
39.8	1.000 ± 0.514	0.276 ± 0.104	-0.043 ± 0.090	0.734 ± 0.292	0.017 ± 0.331	0.016 ± 0.007
40.3	1.000 ± 0.293	0.369 ± 0.085	-0.090 ± 0.139	0.575 ± 0.191	0.124 ± 0.036	0.021 ± 0.006
40.8	1.000 ± 0.184	0.269 ± 0.044	0.045 ± 0.080	0.574 ± 0.122	0.089 ± 0.022	0.024 ± 0.005
42.3	1.000 ± 0.460	0.982 ± 0.372	-0.261 ± 0.274	0.222 ± 0.081	0.036 ± 0.015	0.020 ± 0.007
42.8	1.000 ± 0.125	0.099 ± 0.014	0.627 ± 0.099	0.234 ± 0.037	0.013 ± 0.007	0.026 ± 0.008
43.3	1.000 ± 0.143	0.120 ± 0.018	0.684 ± 0.114	0.163 ± 0.045	0.014 ± 0.009	0.019 ± 0.004
43.8	1.000 ± 0.147	0.224 ± 0.034	0.619 ± 0.116	0.132 ± 0.028	0.002 ± 0.006	0.023 ± 0.008
44.3	1.000 ± 0.155	0.335 ± 0.053	0.333 ± 0.105	0.305 ± 0.045	0.014 ± 0.006	0.013 ± 0.003