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A Statistical Simulation Study to Evaluate the Sensitivity of Deciview Calculations to Missing Data Values and Relative Humidity Factors

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OVERVIEW

Calculation of annual visibility indices for IMPROVE sites poses problems when concentrations of certain aerosols and/or relative humidity values are unavailable due to missing values in the IMPROVE database. At least two different approaches have been used in the past, one by the EPA and the other by Sisler (1996), for overcoming this missing value problem. The visibility index under consideration is *dv*, the annual average deciview for the worst 20% visibility days. This report examines the sensitivity of estimated *dv* values to the choice of a strategy for handling missing values. The report also examines, via statistical simulation studies, the closeness of the estimated *dv* values to the "true values" under different scenarios for the occurrences of missing values. It is found that, when missing values occur infrequently, there doesn't appear to be a practical difference in the estimated *dv* regardless of the method used. However, as the frequency of occurrence of missing values increases, differences due to estimation method becomes noticeable. The report also presents the results of a limited investigation of a proposal currently under consideration by the EPA[•] whereby, for estimating *dv,* missing values are replaced by the 10^{th} percentile of the concentration distribution of the species under consideration. It appears that this is a satisfactory approach for estimating *dv* and also for correctly identifying the worst 20% visibility days for each year.

The report is organized into three chapters. Chapter 1 reports the details of a statistical simulation study to evaluate the sensitivity of deciview calculations to missing data values. The results show that there is little practical difference between the two algorithms being compared when the percentage of missing values for any given specie is low (1% - 6%). A second statistical simulation study was conducted to evaluate the sensitivity of deciview calculations to missing data values with a high level of missing days for nitrate. This was motivated by what actually occurred at selected eastern sites during 1998. The results of this second simulation study are reported in Chapter 2.
It is found that the EPA method not only shows a high degree of variability, but also shows considerable bias. The variability can be attributed to the reduced number of data values available for using the EPA method. The bias, however, is explained by the fact that, in many of the simulated data sets, it is the high extinction days that become missing. As a result, the deciview estimates are systematically lower than the true value.

In all of the simulations discussed in Chapters 1 and 2, we used a constant f(rh) value in calculating deciviews, where the constant value was the annual average f(rh) as supplied by J.Sisler. In a set of case studies, we investigated the effect of using a day-specific or month-specific f(rh) values. Results of these case studies are presented in Chapter 3. It appears that the use of daily f(rh) versus monthly average f(rh) didn't make a practical difference.

[•] The proposal being referred to here was being considered by the EPA at the time the simulation study was carried out.

CHAPTER 1

A Statistical Simulation Study to Evaluate the Sensitivity of Deciview Calculations to Missing Data Values

1.1 Introduction

The EPA is in the process of developing a strategy for assessing improvement in visibility at National Parks, National Monuments, and Class 1 recreation areas, on a periodic basis so as to monitor progress towards attainment of national visibility goals. Any such strategy will be based on an accepted index of annual visibility. One such index under consideration is the average extinction coefficient (measured using the deciview scale -- see Sisler[1]) on 20% of the worst visibility days during the year.

An important question related to any such strategy is how missing data values affect the results of the calculation of annual visibility indices and, in turn, affect the assessment of visibility improvement/degradation.

1.2 Measure of Visibility

Table 1.1 lists the aerosol species that are known to affect visibility along with their abbreviated names used in this report.

Table 1.1 Aerosol species used in the computation of reconstructed extinction.

Species	Abbreviation	Species	Abbreviation
Aluminum	al	Pyrolized Carbon	op
Calcium	ca	PM_{10} (Total Mass)	tm
Iron	fe	$PM_{2.5}$ (Fine Mass)	fm
Silicon	si	Elemental Sulfur	s
Titanium	ti	Organic Carbon 1-4	o1-o4
Ammonium Nitrate Ion	n	Elemental Carbon 1-3	e1-e3

Different approaches are currently used by different investigators• for calculating the annual visibility index. We outline two of the approaches below.

1.2.1 NPS Algorithm:

For the desired time frame (yearly or seasonal), sort the data in decreasing order of fine mass concentrations and select sampling days for which the fine mass concentration is in the

• The U.S. EPA is currently considering an approach different from the approaches being evaluated in this simulation study. Our study was conducted prior to the EPA final draft guidance document for tracking progress became available.

highest 20% of the values for the time period in question. Sampling days for which fine mass concentrations are unavailable are excluded from any calculations. For these top 20% days replace any negative values in the database for the concentrations of the other species with zeros. Next, for each specie, find the average concentration over these top 20% days of the available values (non-missing data values) for that specie. Then calculate the reconstructed extinction using the formula

$$ext = 1000^{-1} * \left[.0031(so4 + no3) f(rh) + .004oc + .001soil + .0006(tm - fm) + .01lac\right]$$

where *soil* represents fine soil, *lac* represents light absorbing carbon, *tm-fm* represents coarse mass, *oc* represents organic carbon, *so4* stands for ammonium sulfate, *no3* stands for ammonium nitrate, and *f(rh)* is a correction factor for relative humidity. These intermediate quantities are computed as follows:

$$soil = 2.2 * al + 1.63 * ca + 2.42 * fe + 2.49 * si + 1.94 * ti .$$
$$lac = e1 + e2 + e3 - op .$$
$$oc = 1.4(o1 + o2 + o3 + o4 + op) .$$
$$so4 = 4.125 * s .$$
$$no3 = 1.29 * n .$$

An annualized $f(rh)$ factor is used in the calculations so that, for any given year, the value of *f(rh)* is a constant.

Lastly, the recalculated extinction coefficient is expressed in the deciview scale (*dv*) by defining

$$dv = 10 * \log_e\left[(ext + 0.01)/0.01\right].$$

The value dv is used as the deciview value characteristic of the year in question.

The reason that reconstructed extinction is used rather than measured extinction is that reconstructed extinction is thought to better represent the effect on visibility of the aerosol particles of concern and it is free of meteorological variables. An annualized *f(rh)* factor is used for the relative humidity correction, rather than a separate value for each sampling day, because of the fact that routine relative humidity measurements are made only at selected sites and even then they are not always available corresponding to every sampling period.

1.2.2 EPA algorithm:

According to the algorithm• used by the EPA, a day is deleted from consideration if the data value for any of the component species required for calculating reconstructed extinction is missing (listwise deletion). If at least 75% of the potential sampling days for a given year have complete information then reconstructed extinction coefficients, and hence deciviews, were calculated for each such day for that year. The highest 20% of the recalculated deciviews for the year were averaged and the resulting value used to calculate a deciview value characteristic of the year in question.

• The EPA is currently considering methods for treating missing values different from what is reported here.

1.2.3 Comments on the two algorithms:

The EPA algorithm computes a daily value for reconstructed extinction and deciview, for each day on which all component data are available, and chooses 20% of the highest extinction days. The method ends up throwing away useful data since even a single missing component results in discarding the entire data record for a sampling day. Sisler's algorithm, on the other hand, attempts to overcome the problem created by missing data by selecting the top 20% of the highest fine mass concentration days and calculates an average deciview from these days. If fine mass is very strongly positively correlated with extinction, this method has the possibility of including more of the data in the calculation of an annual visibility index. Otherwise, this method is likely to introduce a bias.

More recently, for estimating *dv,* the EPA is considering a proposal[•] for replacing a missing value for a species by the 10th percentile from the distribution of available concentrations for that species over a specified time frame. Although the statistical simulation studies reported here do not consider this more recent proposal, results of a small number of case-studies using this new proposal are presented.

1.3 Description of the Data Base

We used 26 sites that have data from the IMPROVE network. These sites all have data available from March 1988 through the end of 1998. A list of these sites is given in Table 1.2.

Table 1.2 A list of sites for which data from the IMPROVE network was analyzed.

ACRONYM	FULL NAME	ACRONYM	FULL NAME
ACAD	Acadia NP	LAVO	Lassen Volcanoes NP
BADL	Badlands NM	MEVE	Mesa Verde NP
BAND	Bandelier NM	MORA	Mount Rainier NP
BRCA	Bryce Canyon NP	PEFO	Petrified Forest NP
BRID	Bridger WA	PINN	Pinnacles NM
CANY	Canyonlands NP	PORE	Point Reyes NS
CHIR	Chiricahua NM	REDW	Redwood NP
CRLA	Crater Lake NP	SAGO	San Gorgonio WA
GLAC	Glacier NP	SHEN	Shenandoah NP
GRCA	Grand Canyon NP	TONT	Tonto WA
GRSA	Great Sand Dunes NM	WEMI	Weminuche WA
GRSM	Great Smoky Mtns NP	YELL	Yellowstone NP
GUMO	Guadalupe Mtns NP	YOSE	Yosemite NP
NP = National Park NM = National Monument WA = Wilderness			

[•] The method for treating missing values currently (Oct, 2001) under consideration by the EPA is different from the method being referred to in this paragraph.

1.4 Preliminary Analysis

We first analyzed the missing data patterns and missing data frequencies for each site. First we determined the total number of days on which data were collected for each year. Second, out of days for which data were collected, for each of the species we determined the number of days with missing data. If, on a given day, the data value for one of the carbon species is missing then the data values for the remaining carbon species are also missing. Most sites had no missing values for any of the constituent species of fine soil; for those sites that did have missing data values the combined total of missing for all constituent species of fine soil was one. The situation was similar for missing values of sulfur. So our further analyses focussed only on missing values for fine mass, total mass, ammonium nitrate and carbon.

Next we did an analysis of the missing values for each species for each season within a year. We found there was no seasonal pattern of missing values at any of the sites. Occasionally, however, for certain sites an entire season's worth of data were missing for selected species.

We next investigated the temporal patterns in the occurrence of missing days for each species of concern. This was done in order to determine whether or not it is reasonable to assume that missing days occurred at random or if any serial correlation structure needed to be built into the simulation study. This was done by examining two-by-two tables of frequencies where the rows are labeled as 'missing' or 'nonmissing' for the current day and the columns are labeled as 'missing' and 'nonmissing' for the following day and calculating a measure of association between the rows and the columns by conducting the Fisher exact test for 2-way tables. We also examined the "run lengths", i.e., the lengths of the sequences of consecutive missing days. We found that at several sites at least one of the four species showed a non-zero serial correlation that was statistically significant. Closer examination of the sequence of missing days showed that in most cases either the number of missing days was small, so any sequence of consecutive missing days had a large influence on the statistical significance of the serial correlation, or there were one or more large sequences of missing days. After carefully weighing these observations, we made the judgment that, for the purposes of our simulation study it was reasonable to assume that missing days occurred in a random fashion. Future simulation studies might consider building in some serial correlation structure when simulating sequences of missing days.

We next investigated the presence or an absence of an association between the occurrences of missing days for the different species. For a given pair of species we constructed a 2 by 2 table whose rows were labeled as 'missing' or 'nonmissing' for one species in the pair and the columns labeled as 'missing' or 'nonmissing' for the other species in the pair. We then used the Fisher exact test for the two by two tables to determine the degree and significance of the association between the pair of species. This was done for each of the six possible pairs of species that could be formed from the four species being investigated. This association analysis was based on all available data. If a statistically significant association was found for a pair of species, then we did further analyses by considering such two by two tables separately for each year. We found that, for most sites there was no association between the species with respect to missing value patterns. In the few cases that we did find a correlation for a pair of the species it was caused by a single year. For the purposes of our simulation study we concluded that it was adequate to consider the missing value patterns among species to be uncorrelated.

Lastly, for each of the four species we calculated the percentage of missing days. In calculating the percentage of missing days, any year of data that our previous analysis showed had an extreme number of missing days was removed. Table 1.4 includes a site by site listing of the number of missing days for each of the four species. The last column is the number of days with missing data for at least one of the four species. The highlighted years are the years that were deleted in the calculation of the percentage of missing days. A summary of the years deleted is given in the second through fifth column of Table 1.3. Table 1.5 includes a site by site listing of the number of valid days by year and by quarter. A valid day is a day when measurements were recorded for each of the four species. The highlighted quarters are those for which less than 75% of the days were declared valid. Table 1.6 includes a site by site listing of the number of days when fine mass was recorded. The highlighted quarters are those for which less than 75% of the days had values for fine mass.

1.5 Statistical Simulation of Missing Data

Based on our preliminary analysis we decided to focus on the four species, *no3, fine mass, total mass* and *carbon,* for their effects on visibility calculations. Recall that if a day was missing one of the carbon species then it was missing all of the carbon species. Our preliminary analysis of the existing data also indicates the missing days for one of the four species can be considered independent of the missing days for other three species. We decided, for this study, to assume that the missing days for the different species were statistically independent of each other and also that, for each species, the missing values occurred randomly during each year.

For each site, two years were selected to use as base years for the simulation. The year runs from January 1st through December 31st . From all the years for which data were available for a given site, two years with the maximum number of complete data records for the four species were selected. See Table 1.3 for a list of the years used. Any missing values were filled in by using the average of the first preceding non-missing value and the first following non-missing value.

Using this “completed” data set, new data sets for a year were generated in the following manner. For each of the four species *no3, fine mass, total mass* and *carbon* a predetermined percentage of days are set to missing. These percentages was determined in the preliminary analysis (see Table 1.3 for the percentages used). The days to be set to missing are determined using a uniform random number generator, independently for each species. For each site/year combination 1000 replicate years of simulated data were generated.

Note that during the simulation, it was possible negative values of course mass were not set to zero. However, this should have little effect on simulation results.

Table 1.3

	Years Deleted				Years	Percentages of Missing Days Used			
		Fine	Total		Used in		Fine	Total	
SITE	**Carbon**	**Mass**	**Mass**	**NO3**	**Simulation**	**Carbon**	**Mass**	**Mass**	**NO3**
ACAD	88,89	91	90,91	98	93,97	1%	3%	4%	4%
BADL	88	---	90	---	93,95	3%	3%	3%	3%
BAND	88	---	88	---	95,98	2%	4%	3%	3%
BRCA	88,89,92	---	---	---	96,97	2%	4%	7%	7%
BRID	88,89	---	90	---	96,97	1%	5%	3%	3%
CANY	88,89	90	---	91	95,98	1%	2%	2%	2%
CHIR	88,89,90	---	90	98	94,96	3%	3%	3%	3%
CRLA	88,91	90,91,98	88,89,90	---	95,97	3%	6%	6%	6%
GLAC	---	---	---	---	92,97	2%	2%	4%	4%
GRCA	88,89,92	91,92	---	---	94,98	2%	5%	4%	4%
GRSA	---	90	---	---	95,97	3%	3%	3%	3%
GRSM	88,89	---	89,91	98	94,95	2%	2%	4%	4%
GUMO	88,95,96	---	---	---	93,94	2%	3%	6%	6%
LAVO	88	90,91	89	92,93	94,97	3%	6%	6%	6%
MEVE	---	91	90	---	93,97	3%	4%	4%	4%
MORA	88	---	89	---	95,97	2%	4%	4%	4%
PEFO	88,89,91,92	---	90	---	93,97	2%	4%	3%	3%
PINN	88,89	---	88,90	98	91,96	1%	3%	2%	2%
PORE	88,89	---	88	92	93,98	3%	3%	2%	2%
REDW	88	---	---	---	95,97	2%	4%	3%	3%
SAGO	88,92	---	88,92	---	94,97	3%	4%	4%	4%
SHEN	---	---	88	98	94,95	3%	3%	4%	4%
TONT	88,89,92	91	92	89	95,96	2%	3%	5%	5%
WEMI	88	---	---	88	93,95	3%	5%	3%	3%
YELL	88	---	---	---	94,96	2%	6%	4%	4%
YOSE	88	---	---	---	92,95	3%	5%	3%	3%

1.6 Results and Comments

Tables 1.7 through 1.11 contain the results from the simulations. We shall refer to the deciview value calculated from the base year as the "true deciview".

Table 1.7 contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the Sisler algorithm. From left to right the columns are the min, 10^{th}, 20^{th}, mean, 80^{th}, 90^{th} and max of the simulated values. The last column is the "true" deciview, i.e., calculated from the base year with no missing data.

Table 1.8 contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the EPA algorithm. From left to right the columns are the min, 10th, 20th, mean, 80th, 90th and max of the simulated values. The last column is the "true" deciview, i.e., calculated from the base year with no missing data.

Tables 1.7 and 1.8 are visually summarized in Figures 1.1 through 1.4. Figure 1.1 presents the results for Eastern sites (ACAD 1993 and 1997; GRSM 1994 and 1995; SHEN 1994 and 1995), Figure 1.2 gives the results for northwest sites (BRID 1996 and 1997; CRLA 1995 and 1997; GLAC 1992 and 1997; MORA 1995 and 1997; WEMI 1993 and 1995; YELL 1994 and 1996), Figure 1.3 gives the results for south central sites (BAND 1995 and 1998; CHIR 1994 and 1996; GRCA 1994 and 1998; GRSA 1995 and 1997; GUMO 1993 and 1994; MEVE 1993 and 1997; PEFO 1993 and 1997; TONT 1995 and 1996), and Figure 1.4 gives the results for southwestern sites (BADL 1993 and 1995; BRCA 1996 and 1997; CANY 1995 and 1998; LAVO 1994 and 1997; PINN 1991 and 1996; PORE 1993 and 1996; REDW 1995 and 1997; SAGO 1994 and 1997; YOSE 1992 and 1995). The vertical axis in these plots represents the estimated value for *dv* and the horizontal axis represents the site-year combination considered in the simulation study along with the method used to estimate *dv*. For instance, the label BAND95EPA along the horizontal axis refers to the results from the simulation study for BAND for the year 1995 using the EPA method for handling missing values (list-wise deletion).

The results from the simulation study are summarized in the form of Box Plots for each site-year-method combination. The bottom and the top extremes of the Box Plot correspond to the minimum and the maximum values observed over 1000 simulated data sets for each site-year. The box itself covers the middle 60% of the distribution (the 20th percentile and the 80th percentile form the bottom and the top of the box) of the estimated *dv* values over the 1000 simulations. The mean value of the distribution of the estimates is also shown by a horizontal line drawn across the box. In addition, the plot shows the 10th and 80th percentiles and the “true value” (“true values” can be computed from the complete data set prior to creating missing values for the simulated year). For convenience of comparisons, results for the EPA method and the NPS (Sisler) method are shown side by side for each site-year combination.

Tables 1.9 and 1.10 contain selected percentiles of the distribution of the error percentages for the NPS algorithm and for the EPA algorithm, respectively. The error percentage is defined as 100*(simulated deciview - true deciview)/true deciview. So a negative error percentage means the estimated deciview was less than the true deciview.

Table 1.11 is a summary of the relevant statistics for each site year combination. The first row has the true deciview, i.e., the deciview value calculated with no missing values in the data. The second row has the summary statistics for the deciview values calculated from the 1000 simulated years using the NPS algorithm. The third row has the summary statistics for the deciview values calculated from the 1000 simulated years using the EPA algorithm. The fourth through the eighth rows contain information on the missing day patterns for the simulated years. The fourth row has the summary statistics for the number of days in each year with a missing value for at least one of the four species. The fifth row contains the number of missing day per year for fine mass. The sixth through eighth rows give, for the other three species, the summary statistics for the number of missing days among the selected top 20% days. The last two rows give the summary statistics for the percentage error in the estimated deciview values for the simulated years, using the NPS method and the EPA method, respectively.

The discrepancy between the NPS method and the EPA method appears to be mainly due to a lack of strong correlation between fine mass and extinction. The EPA method shows a lower variability in the simulated results than the NPS method.

Acknowledgment

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References

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Table 1.4 includes a site by site listing of the number of missing days for each of the four species.

Table 1.4.1 ACAD

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	67	7	67	7	71	3	74	0	15
89	93	6	97	2	94	5	99	0	12
90	100	1	98	3	86	15	101	0	18
91	101	1	89	13	92	10	102	0	17
92	103	0	100	3	97	6	102	1	9
93	102	0	100	2	99	3	102	0	5
94	104	1	103	2	102	3	104	1	7
95	97	2	97	2	97	2	99	0	5
96	101	0	98	3	98	3	99	2	6
97	103	0	102	1	101	2	102	1	4
98	101	2	99	4	101	2	98	5	10

Table 1.4.2 BADL

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	61	15	70	6	73	3	75	1	21
89	91	6	92	5	92	5	97	0	15
90	99	5	96	8	92	12	102	2	24
91	101	2	96	7	99	4	103	0	12
92	100	2	100	2	101	1	102	0	5
93	104	0	103	1	102	2	104	0	3
94	102	3	105	0	102	3	105	0	6
95	103	0	103	0	103	0	103	0	0
96	100	2	102	0	102	0	100	2	4
97	102	3	103	2	103	2	104	1	6
98	102	1	102	1	100	3	100	3	8

Table 1.4.3 BAND

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	75	11	83	3	75	11	84	2	22
89	88	4	86	6	85	7	92	0	13
90	85	1	77	9	80	6	86	0	16
91	80	2	74	8	77	5	82	0	15
92	83	2	82	3	80	5	85	0	8
93	100	0	99	1	98	2	100	0	3
94	95	1	90	6	96	0	95	1	8
95	89	1	90	0	89	1	90	0	2
96	98	1	98	1	99	0	98	1	3
97	104	0	102	2	104	0	102	2	4
98	100	1	101	0	101	0	100	1	2

Table 1.4.4 BRCA

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	57	24	75	6	76	5	76	5	28
89	82	22	100	4	102	2	103	1	26
90	101	1	89	13	93	9	102	0	23
91	99	3	93	9	96	6	100	2	17
92	70	27	86	11	88	9	92	5	46
93	101	0	90	11	98	3	101	0	13
94	100	4	96	8	102	2	104	0	14
95	101	2	102	1	100	3	102	1	7
96	103	0	101	2	102	1	103	0	3
97	105	0	104	1	103	2	105	0	3
98	102	1	100	3	102	1	102	1	6

Table 1.4.5 BRID

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	63	11	69	5	69	5	72	2	17
89	90	10	96	4	99	1	99	1	15
90	96	1	88	9	87	10	97	0	18
91	98	2	96	4	95	5	97	3	13
92	99	2	94	7	97	4	101	0	10
93	95	1	92	4	93	3	96	0	7
94	104	1	100	5	102	3	105	0	9
95	101	0	97	4	99	2	100	1	5
96	100	0	97	3	99	1	99	1	5
97	101	0	99	2	99	2	101	0	4
98	98	2	96	4	97	3	99	1	9

Table 1.4.6 CANY

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	53	24	75	2	75	2	74	3	27
89	68	21	86	3	87	2	89	0	24
90	95	5	90	10	94	6	100	0	18
91	98	1	93	6	97	2	83	16	25
92	93	0	90	3	92	1	93	0	4
93	102	1	101	2	102	1	102	1	5
94	101	0	100	1	97	4	100	1	5
95	88	0	88	0	87	1	88	0	1
96	99	0	99	0	99	0	92	7	7
97	100	0	100	0	100	0	99	1	1
98	102	0	102	0	102	0	102	0	0

Table 1.4.7 CHIR

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	75	9	78	6	79	5	84	0	17
89	66	20	83	3	79	7	83	3	30
90	95	6	95	6	85	16	99	2	25
91	91	2	92	1	91	2	92	1	6
92	96	0	91	5	95	1	96	0	6
93	94	4	97	1	98	0	98	0	5
94	99	0	99	0	96	3	99	0	3
95	91	1	90	2	90	2	91	1	6
96	99	2	101	0	101	0	101	0	2
97	102	1	100	3	101	2	103	0	6
98	98	4	99	3	98	4	91	11	20

Table 1.4.8 CRLA

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	58	18	70	6	57	19	74	2	35
89	63	9	68	4	49	23	70	2	30
90	70	4	62	12	64	10	74	0	25
91	64	22	65	21	81	5	86	0	32
92	100	0	92	8	92	8	100	0	16
93	96	0	90	6	89	7	96	0	11
94	73	2	68	7	71	4	75	0	12
95	100	0	97	3	98	2	100	0	5
96	99	0	93	6	96	3	99	0	7
97	91	2	92	1	91	2	91	2	6
98	96	3	81	18	92	7	97	2	23

Table 1.4.9 GLAC

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	65	9	71	3	70	4	73	1	14
89	93	6	98	1	92	7	98	1	12
90	98	3	100	1	91	10	100	1	14
91	100	1	96	5	100	1	101	0	7
92	103	0	103	0	101	2	103	0	2
93	103	0	100	3	101	2	102	1	5
94	100	0	99	1	97	3	99	1	4
95	102	0	101	1	99	3	102	0	4
96	104	0	103	1	104	0	101	3	4
97	103	1	102	2	103	1	104	0	4
98	104	0	103	1	102	2	98	6	9

Table 1.4.10 GRCA

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	38	44	76	6	80	2	82	0	46
89	72	29	97	4	98	3	96	5	32
90	97	5	93	9	96	6	101	1	18
91	104	0	92	12	101	3	104	0	15
92	65	25	80	10	86	4	89	1	35
93	103	1	96	8	101	3	103	1	13
94	105	0	103	2	101	4	105	0	6
95	98	3	100	1	94	7	101	0	11
96	101	1	99	3	101	1	102	0	5
97	102	0	97	5	98	4	102	0	9
98	69	0	66	3	68	1	69	0	3

Table 1.4.11 GRSA

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	55	8	59	4	62	1	63	0	13
89	96	5	93	8	97	4	101	0	17
90	100	1	88	13	92	9	101	0	23
91	102	2	97	7	98	6	103	1	14
92	102	1	99	4	101	2	102	1	8
93	102	1	102	1	96	7	102	1	10
94	101	4	103	2	105	0	104	1	7
95	103	1	103	1	104	0	104	0	2
96	104	0	103	1	103	1	102	2	4
97	101	2	103	0	102	1	103	0	3
98	100	4	101	3	104	0	104	0	7

Table 1.4.12 GRSM

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	70	11	78	3	77	4	79	2	14
89	82	11	90	3	74	19	89	4	27
90	91	4	92	3	88	7	93	2	11
91	91	1	89	3	76	16	91	1	21
92	100	3	103	0	100	3	103	0	6
93	98	2	100	0	99	1	97	3	6
94	93	2	95	0	94	1	95	0	3
95	104	0	104	0	100	4	104	0	4
96	104	0	104	0	102	2	98	6	8
97	103	1	103	1	97	7	103	1	9
98	101	0	100	1	97	4	84	17	22

Table 1.4.13 GUMO

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	Obs.	Missing	Obs.	Missing	Obs.	Missing	Obs.	Missing	Missing
88	70	15	81	4	75	10	80	5	27
89	90	6	94	2	93	3	95	1	10
90	92	6	92	6	88	10	96	2	21
91	95	1	88	8	81	15	96	0	24
92	102	0	101	1	100	2	101	1	4
93	100	1	100	1	101	0	101	0	2
94	87	0	87	0	87	0	84	3	3
95	72	24	95	1	94	2	93	3	27
96	72	25	96	1	87	10	97	0	35
97	103	1	99	5	103	1	103	1	8
98	102	0	100	2	100	2	99	3	7

Table 1.4.14 LAVO

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	Obs.	Missing	Obs.	Missing	Obs.	Missing	Obs.	Missing	Missing
88	67	13	74	6	77	3	79	1	21
89	92	5	94	3	85	12	97	0	19
90	97	4	90	11	92	9	101	0	21
91	101	3	91	13	96	8	104	0	22
92	98	2	93	7	95	5	52	48	58
93	98	0	94	4	96	2	71	27	28
94	98	2	94	6	96	4	97	3	12
95	89	2	88	3	83	8	89	2	13
96	96	0	91	5	93	3	90	6	14
97	99	1	92	8	97	3	100	0	11
98	90	3	84	9	87	6	93	0	15

Table 1.4.15 MEVE

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	74	6	76	4	77	3	80	0	12
89	96	3	97	2	93	6	99	0	11
90	94	7	96	5	91	10	99	2	20
91	94	1	84	11	89	6	95	0	18
92	97	3	98	2	98	2	98	2	9
93	99	0	93	6	99	0	99	0	6
94	104	1	101	4	102	3	105	0	8
95	99	3	101	1	99	3	100	2	7
96	89	0	85	4	82	7	87	2	13
97	85	0	83	2	81	4	84	1	7
98	97	5	100	2	99	3	101	1	10

Table 1.4.16 MORA

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	66	11	72	5	77	0	77	0	16
89	87	4	88	3	78	13	90	1	20
90	67	3	70	0	62	8	69	1	11
91	97	2	94	5	94	5	96	3	12
92	105	0	102	3	102	3	96	9	12
93	102	0	98	4	100	2	101	1	7
94	102	1	99	4	102	1	103	0	5
95	99	1	98	2	100	0	100	0	3
96	100	3	101	2	100	3	99	4	11
97	102	1	102	1	102	1	103	0	3
98	102	1	98	5	97	6	96	7	18

Table 1.4.17 PEFO

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	68	15	79	4	77	6	83	0	19
89	81	21	100	2	97	5	102	0	27
90	98	2	92	8	85	15	99	1	24
91	92	11	98	5	98	5	103	0	21
92	72	24	93	3	93	3	94	2	30
93	90	0	88	2	89	1	90	0	3
94	94	1	92	3	94	1	95	0	5
95	96	0	93	3	96	0	96	0	3
96	88	1	88	1	87	2	87	2	6
97	87	0	86	1	86	1	86	1	3
98	88	4	92	0	92	0	87	5	9

Table 1.4.18 PINN

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	58	15	70	3	59	14	72	1	28
89	92	9	98	3	97	4	95	6	16
90	99	2	94	7	91	10	101	0	19
91	104	0	104	0	102	2	104	0	2
92	103	0	101	2	100	3	103	0	5
93	103	0	101	2	103	0	103	0	2
94	104	1	101	4	101	4	104	1	10
95	100	2	102	0	99	3	100	2	5
96	98	0	98	0	98	0	97	1	1
97	100	2	101	1	101	1	96	6	10
98	73	0	73	0	73	0	58	15	15

Table 1.4.19 PORE

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	61	14	69	6	68	7	75	0	23
89	87	11	93	5	97	1	94	4	15
90	101	1	95	7	98	4	101	1	12
91	101	1	98	4	101	1	99	3	8
92	99	0	97	2	97	2	89	10	13
93	102	0	102	0	102	0	102	0	0
94	97	7	104	0	104	0	103	1	8
95	82	0	82	0	81	1	81	1	2
96	91	6	95	2	97	0	95	2	9
97	74	2	73	3	75	1	74	2	8
98	80	0	80	0	80	0	78	2	2

Table 1.4.20 REDW

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	65	11	71	5	71	5	74	2	19
89	92	3	89	6	90	5	93	2	12
90	92	2	90	4	89	5	94	0	10
91	101	1	98	4	101	1	102	0	6
92	102	3	101	4	102	3	103	2	11
93	101	0	97	4	99	2	101	0	6
94	100	4	101	3	103	1	104	0	8
95	96	1	97	0	96	1	97	0	2
96	92	0	89	3	91	1	92	0	4
97	93	0	92	1	93	0	91	2	3
98	97	3	98	2	100	0	99	1	6

Table 1.4.21 SAGO

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	40	11	49	2	40	11	51	0	22
89	61	4	63	2	64	1	65	0	6
90	91	1	88	4	86	6	92	0	8
91	98	3	96	5	95	6	101	0	14
92	62	26	86	2	73	15	86	2	45
93	99	3	99	3	100	2	102	0	7
94	75	2	77	0	75	2	77	0	4
95	93	1	93	1	92	2	94	0	3
96	86	2	87	1	85	3	84	4	10
97	78	0	75	3	76	2	78	0	5
98	64	4	63	5	66	2	66	2	13

Table 1.4.22 SHEN

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	63	6	65	4	59	10	69	0	14
89	91	2	88	5	86	7	93	0	13
90	100	0	97	3	94	6	100	0	9
91	98	0	96	2	93	5	98	0	5
92	103	2	105	0	100	5	103	2	8
93	100	4	102	2	102	2	103	1	9
94	102	1	103	0	102	1	102	1	3
95	91	1	90	2	92	0	92	0	3
96	91	2	93	0	90	3	93	0	5
97	91	8	96	3	95	4	96	3	18
98	93	4	94	3	95	2	71	26	33

Table 1.4.23 TONT

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	Obs.	Missing	Obs.	Missing	Obs.	Missing	Obs.	Missing	Missing
88	51	15	60	6	62	4	66	0	21
89	74	16	89	1	87	3	79	11	20
90	84	2	80	6	78	8	86	0	15
91	97	2	86	13	92	7	98	1	19
92	68	22	83	7	65	25	83	7	53
93	85	6	89	2	88	3	88	3	14
94	105	0	103	2	101	4	104	1	7
95	98	0	98	0	98	0	98	0	0
96	98	0	98	0	98	0	98	0	0
97	101	0	101	0	94	7	101	0	7
98	100	2	102	0	100	2	102	0	4

Table 1.4.24 WEMI

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	Obs.	Missing	Obs.	Missing	Obs.	Missing	Obs.	Missing	Missing
88	62	19	74	7	79	2	73	8	25
89	90	6	90	6	88	8	94	2	18
90	88	7	86	9	90	5	94	1	18
91	91	6	87	10	92	5	97	0	18
92	95	1	90	6	94	2	96	0	8
93	95	2	94	3	97	0	97	0	5
94	98	1	96	3	98	1	98	1	5
95	98	2	100	0	99	1	99	1	3
96	88	0	87	1	88	0	84	4	5
97	101	0	99	2	99	2	99	2	5
98	103	0	99	4	102	1	100	3	8

Table 1.4.25 YELL

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	51	15	55	11	63	3	66	0	23
89	83	4	82	5	80	7	86	1	13
90	82	1	74	9	81	2	83	0	12
91	85	0	78	7	80	5	85	0	12
92	90	4	90	4	90	4	94	0	11
93	97	0	94	3	92	5	95	2	10
94	99	0	96	3	97	2	99	0	5
95	94	1	93	2	93	2	94	1	6
96	89	1	90	0	88	2	89	1	4
97	91	2	90	3	90	3	93	0	8
98	76	3	71	8	77	2	79	0	13

Table 1.4.26 YOSE

	Carbon #Days		Fine Mass #Days		Total Mass #Days		NO3 #Days		#Days ζ1
Year	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Obs.**	**Missing**	**Missing**
88	45	11	52	4	55	1	55	1	15
89	89	8	94	3	95	2	96	1	13
90	99	0	91	8	97	2	99	0	10
91	96	0	90	6	92	4	96	0	10
92	104	0	99	5	102	2	104	0	7
93	100	1	96	5	97	4	101	0	9
94	99	0	97	2	95	4	98	1	7
95	97	1	95	3	95	3	97	1	8
96	92	5	93	4	94	3	95	2	10
97	98	4	98	4	100	2	99	3	11
98	97	5	96	6	100	2	101	1	11

Table 1.5 includes a site by site listing of the number of valid days by year and by quarter. A valid day is a day when measurements were recorded for each of the four species. The highlighted quarters are those for which less than 75% of the days were declared valid.

Table 1.5.1 ACAD

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	11	19	23
89	22	17	22	26
90	23	20	21	19
91	22	21	20	22
92	22	23	27	22
93	21	24	26	26
94	24	25	24	25
95	23	25	25	21
96	21	26	26	22
97	26	25	25	23
98	20	22	27	24
99	24	23	17	.

Table 1.5.2 BADL

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	14	14	21
89	18	21	18	24
90	22	19	20	19
91	25	22	23	21
92	23	25	25	24
93	25	26	26	24
94	23	24	25	27
95	25	26	26	26
96	24	26	24	24
97	25	23	26	25
98	23	25	25	22
99	23	23	16	.

Table 1.5.3 BAND

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	7	12	21	24
89	20	23	22	14
90	12	20	17	20
91	21	14	17	15
92	20	18	17	22
93	24	22	25	26
94	19	23	20	26
95	25	14	24	25
96	26	25	25	20
97	26	24	25	25
98	24	26	24	25
99	25	26	17	.

Table 1.5.4 BRCA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	13	18	13
89	7	25	23	23
90	21	19	22	17
91	18	25	22	20
92	4	17	9	21
93	21	26	20	21
94	19	25	24	22
95	22	23	26	25
96	24	26	26	24
97	25	26	25	26
98	20	25	27	25
99	24	18	14	.

Table 1.5.5 BRID

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	2	14	19	22
89	18	20	25	21
90	18	20	20	21
91	19	25	21	22
92	23	24	23	21
93	19	25	19	26
94	24	23	24	25
95	23	24	26	23
96	22	26	25	22
97	24	25	25	23
98	22	25	27	17
99	17	21	17	.

Table 1.5.6 CANY

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	9	21	12
89	5	22	15	23
90	18	22	22	20
91	22	23	13	16
92	25	23	17	24
93	24	24	26	24
94	22	26	24	24
95	21	19	22	25
96	15	26	26	25
97	26	26	23	24
98	25	25	26	26
99	24	24	16	.

Table 1.5.7 CHIR

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	14	19	26
89	22	6	13	15
90	20	22	18	16
91	23	23	18	23
92	20	23	23	24
93	25	22	21	25
94	25	26	22	23
95	19	25	23	19
96	23	24	26	26
97	24	25	23	25
98	23	23	23	13
99	26	26	17	.

Table 1.5.8 CRLA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	12	18	3
89	9	13	9	11
90	13	11	12	13
91	13	21	18	2
92	14	21	27	22
93	19	24	17	25
94	19	12	26	6
95	23	23	27	22
96	23	23	25	21
97	18	26	21	22
98	18	18	22	18
99	15	19	11	.

Table 1.5.9 GLAC

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	7	15	21	17
89	18	22	24	23
90	21	21	24	21
91	22	25	25	22
92	26	24	26	25
93	24	25	26	23
94	24	25	21	26
95	25	21	27	25
96	26	26	23	25
97	24	25	24	27
98	23	25	24	23
99	26	24	16	.

Table 1.5.10 GRCA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	0	0	21	15
89	5	20	23	21
90	20	23	21	20
91	22	22	22	23
92	6	20	9	20
93	22	23	25	21
94	25	22	25	27
95	22	24	19	25
96	24	26	24	23
97	25	23	22	23
98	23	26	17	.
99	.	.	.	.

Table 1.5.11 GRSA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	.	8	20	22
89	23	22	22	17
90	21	21	20	16
91	20	23	25	22
92	21	22	26	26
93	25	25	20	23
94	25	26	23	24
95	23	26	27	26
96	24	26	26	24
97	24	26	25	25
98	24	26	25	22
99	25	24	17	.

Table 1.5.12 GRSM

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	15	21	23
89	12	20	24	10
90	15	22	24	23
91	19	19	15	18
92	23	23	25	26
93	21	25	23	25
94	24	17	25	26
95	24	24	26	26
96	25	24	22	25
97	25	24	25	21
98	20	17	21	21
99	21	21	15	.

Table 1.5.13 GUMO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	5	12	15	26
89	23	22	21	20
90	19	25	9	24
91	15	21	23	13
92	23	23	27	25
93	25	23	26	25
94	24	18	17	25
95	6	12	26	25
96	21	15	18	8
97	23	25	24	24
98	23	25	22	25
99	25	22	16	.

Table 1.5.14 LAVO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	11	20	19
89	14	20	24	20
90	20	23	18	19
91	20	19	21	22
92	19	22	1	0
93	0	20	26	24
94	20	25	25	18
95	13	24	22	19
96	19	23	19	21
97	20	25	26	18
98	17	21	24	16
99	15	22	13	.

Table 1.5.15 MEVE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	13	23	24
89	21	15	26	26
90	23	23	16	19
91	16	19	21	21
92	23	23	26	19
93	20	23	26	24
94	22	25	23	27
95	23	23	25	24
96	26	24	8	18
97	15	24	23	16
98	20	25	26	21
99	24	21	16	.

Table 1.5.16 MORA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	13	22	20
89	19	16	16	20
90	16	16	7	20
91	22	23	19	23
92	19	22	26	26
93	24	23	26	22
94	25	25	24	24
95	25	23	24	25
96	24	23	22	23
97	24	26	25	25
98	18	21	23	23
99	18	23	16	.

Table 1.5.17 PEFO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	19	22	15
89	7	23	23	22
90	18	22	20	16
91	21	23	26	12
92	14	23	10	19
93	25	23	14	25
94	24	18	21	27
95	25	25	22	21
96	23	21	21	18
97	23	22	15	24
98	20	21	20	22
99	26	24	15	.

Table 1.5.18 PINN

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	11	8	17
89	17	20	26	22
90	20	21	17	24
91	24	26	26	26
92	23	24	25	26
93	24	26	26	25
94	20	25	23	27
95	24	23	27	23
96	24	24	24	25
97	22	25	26	19
98	14	11	15	18
99	24	23	17	.

Table 1.5.19 PORE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	13	11	20
89	22	19	20	22
90	23	21	21	25
91	23	25	25	21
92	21	22	23	20
93	24	26	26	26
94	26	24	22	24
95	20	22	23	15
96	21	23	20	24
97	20	12	20	16
98	15	19	23	21
99	17	24	11	.

Table 1.5.20 REDW

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	15	16	18
89	21	21	23	18
90	23	19	21	21
91	24	26	24	22
92	23	23	26	22
93	23	23	26	23
94	22	22	26	26
95	23	26	27	19
96	19	24	24	21
97	19	26	22	23
98	21	25	25	23
99	24	22	15	.

Table 1.5.21 SAGO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	9	12	2
89	20	16	8	15
90	21	21	17	25
91	19	24	24	20
92	9	22	3	9
93	25	23	26	21
94	22	24	12	15
95	22	22	25	22
96	25	23	13	17
97	11	24	21	17
98	17	21	9	8
99	18	26	13	.

Table 1.5.22 SHEN

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	5	16	17	17
89	17	22	17	24
90	23	26	21	21
91	24	23	22	24
92	23	23	25	26
93	25	24	24	22
94	24	25	25	26
95	25	25	20	19
96	20	22	20	26
97	19	22	24	16
98	15	13	14	22
99	17	20	8	.

Table 1.5.23 TONT

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	.	9	18	18
89	23	9	18	20
90	21	22	13	15
91	17	18	22	23
92	12	17	3	5
93	14	20	23	20
94	26	24	21	27
95	25	26	27	20
96	24	26	26	22
97	25	26	24	19
98	22	25	26	25
99	26	24	16	.

Table 1.5.24 WEMI

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	13	19	18
89	12	20	25	21
90	22	18	19	18
91	15	21	22	21
92	15	25	25	23
93	18	24	26	24
94	22	24	25	23
95	21	25	26	25
96	15	24	19	25
97	19	26	26	25
98	20	26	26	23
99	22	22	16	.

Table 1.5.25 YELL

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	5	13	10	15
89	19	18	24	13
90	16	15	23	17
91	13	24	22	14
92	22	17	27	17
93	20	18	26	23
94	25	20	24	25
95	21	19	24	25
96	22	21	20	23
97	21	25	25	14
98	.	19	25	22
99	23	21	17	.

Table 1.5.26 YOSE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	11	12	12
89	20	17	24	23
90	24	26	18	21
91	20	23	20	23
92	22	26	26	23
93	22	24	22	24
94	25	24	16	27
95	18	24	27	21
96	14	26	25	22
97	23	20	24	24
98	18	24	27	22
99	21	24	17	.

Table 1.6 includes a site by site listing of the number of days when fine mass was recorded. The highlighted quarters are those for which less than 75% of the days had values for fine mass.

Table 1.6.1 ACAD

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	17	21	23
89	25	23	23	26
90	25	24	25	24
91	23	22	20	24
92	23	26	27	24
93	24	24	26	26
94	26	25	25	27
95	25	25	25	22
96	23	26	26	23
97	26	26	26	24
98	24	23	27	25
99	25	23	17	.

Table 1.6.2 BADL

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	23	17	22
89	19	23	24	26
90	25	25	22	24
91	25	25	23	23
92	24	26	25	25
93	25	26	26	26
94	26	26	26	27
95	25	26	26	26
96	26	26	26	24
97	26	25	26	26
98	25	25	27	25
99	24	23	16	.

Table 1.6.3 BAND

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	25	24	25
89	21	24	22	19
90	15	20	19	23
91	24	15	19	16
92	21	18	20	23
93	26	22	25	26
94	20	23	20	27
95	25	15	24	26
96	26	26	26	20
97	26	25	26	25
98	25	26	24	26
99	25	26	17	.

Table 1.6.4 BRCA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	24	21	21
89	24	25	26	25
90	23	22	23	21
91	23	25	23	22
92	17	24	23	22
93	22	26	20	22
94	20	25	26	25
95	25	24	27	26
96	24	26	26	25
97	26	26	26	26
98	22	25	27	26
99	25	18	14	.

Table 1.6.5 BRID

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	4	21	20	24
89	21	23	26	26
90	20	21	23	24
91	23	26	23	24
92	24	24	24	22
93	21	26	19	26
94	25	24	25	26
95	23	24	26	24
96	23	26	26	22
97	25	25	25	24
98	24	25	27	20
99	22	21	17	.

Table 1.6.6 CANY

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	22	22	23
89	22	25	15	24
90	18	24	23	25
91	24	24	22	23
92	25	24	17	24
93	25	26	26	24
94	24	26	25	25
95	21	19	22	26
96	21	26	26	26
97	26	26	23	25
98	25	25	26	26
99	25	24	17	.

Table 1.6.7. CHIR

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	23	21	26
89	22	13	22	26
90	24	25	21	25
91	26	24	18	24
92	20	23	24	24
93	25	22	25	25
94	26	26	24	23
95	21	25	24	20
96	23	26	26	26
97	24	26	25	25
98	24	24	25	26
99	26	26	17	.

Table 1.6.8 CRLA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	21	19	21
89	17	21	17	13
90	16	12	15	19
91	17	22	19	7
92	22	21	27	22
93	23	24	18	25
94	21	15	26	6
95	24	24	27	22
96	23	23	26	21
97	22	26	22	22
98	18	19	26	18
99	24	21	15	.

Table 1.6.9 GLAC

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	7	24	21	19
89	21	26	26	25
90	25	25	26	24
91	23	25	25	23
92	26	25	26	26
93	25	25	26	24
94	26	25	22	26
95	25	23	27	26
96	26	26	26	25
97	24	25	26	27
98	25	25	27	26
99	26	24	17	.

Table 1.6.10 GRCA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	22	23	23
89	23	21	27	26
90	23	26	22	22
91	23	22	24	23
92	13	21	25	21
93	23	24	26	23
94	26	24	26	27
95	23	25	27	25
96	25	26	25	23
97	25	25	23	24
98	23	26	17	.
99	.	.	.	.

Table 1.6.11 GRSA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	.	16	20	23
89	23	25	23	22
90	22	23	22	21
91	23	24	25	25
92	22	25	26	26
93	25	26	26	25
94	25	26	26	26
95	24	26	27	26
96	26	26	26	25
97	24	26	26	27
98	25	26	26	24
99	26	25	17	.

Table 1.6.12 GRSM

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	24	22	24
89	22	25	26	17
90	19	23	26	24
91	24	20	20	25
92	24	26	27	26
93	22	26	26	26
94	24	18	26	27
95	25	26	27	26
96	26	26	26	26
97	26	24	26	27
98	23	26	27	24
99	25	25	17	.

Table 1.6.13 GUMO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	23	23	26
89	24	22	26	22
90	26	26	14	26
91	19	23	25	21
92	25	23	27	26
93	25	23	26	26
94	26	18	17	26
95	17	26	27	25
96	23	22	26	25
97	23	26	24	26
98	24	25	26	25
99	25	24	17	.

Table 1.6.14 LAVO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	23	21	21
89	22	25	27	20
90	26	24	18	22
91	25	19	23	24
92	24	22	25	22
93	19	24	26	25
94	23	26	25	20
95	18	26	24	20
96	20	23	26	22
97	22	25	26	19
98	17	22	26	19
99	15	24	17	.

Table 1.6.15 MEVE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	20	23	25
89	22	23	26	26
90	26	25	22	23
91	22	20	21	21
92	25	25	27	21
93	20	23	26	24
94	22	26	26	27
95	25	25	25	26
96	26	26	13	20
97	17	26	23	17
98	22	26	27	25
99	25	25	17	.

Table 1.6.16 MORA

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	21	23	22
89	25	21	19	23
90	23	17	7	23
91	24	23	22	25
92	24	25	27	26
93	24	25	26	23
94	25	25	24	25
95	25	23	24	26
96	25	25	25	26
97	25	26	26	25
98	23	23	27	25
99	21	24	17	.

Table 1.6.17 PEFO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	22	26	23
89	25	25	26	24
90	21	25	24	22
91	23	23	26	26
92	24	26	21	22
93	25	23	14	26
94	24	18	23	27
95	25	25	22	21
96	24	21	23	20
97	23	23	15	25
98	21	21	24	26
99	26	24	15	.

Table 1.6.18 PINN

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	20	19	22
89	24	22	27	25
90	24	25	20	25
91	26	26	26	26
92	24	26	25	26
93	24	26	26	25
94	23	25	26	27
95	24	26	27	25
96	24	24	25	25
97	25	25	26	25
98	21	19	15	18
99	25	23	17	.

Table 1.6.19 PORE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	26	14	21
89	25	22	24	22
90	25	23	22	25
91	24	25	26	23
92	24	26	25	22
93	24	26	26	26
94	26	26	26	26
95	20	22	23	17
96	22	23	26	24
97	22	12	22	17
98	16	20	23	21
99	20	25	11	.

Table 1.6.20 REDW

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	24	19	20
89	24	23	23	19
90	23	22	23	22
91	25	26	24	23
92	24	25	27	25
93	24	23	26	24
94	23	25	26	27
95	24	26	27	20
96	19	24	24	22
97	19	26	23	24
98	23	26	25	24
99	25	23	16	.

Table 1.6.21 SAGO

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	9	12	17	11
89	20	16	10	17
90	21	22	19	26
91	24	26	25	21
92	22	23	20	21
93	26	25	26	22
94	24	24	14	15
95	22	23	25	23
96	26	24	17	20
97	11	25	21	18
98	20	22	12	9
99	20	26	13	.

Table 1.6.22 SHEN

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	6	23	19	17
89	18	26	20	24
90	26	26	22	23
91	25	24	23	24
92	26	26	27	26
93	25	26	25	26
94	25	25	26	27
95	25	25	20	20
96	20	26	21	26
97	23	25	25	23
98	17	26	27	24
99	21	23	9	.

Table 1.6.23 TONT

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	.	17	18	25
89	25	18	22	24
90	24	24	15	17
91	21	18	23	24
92	24	19	16	24
93	20	23	23	23
94	26	25	25	27
95	25	26	27	20
96	24	26	26	22
97	26	26	26	23
98	23	26	27	26
99	26	24	17	.

Table 1.6.24 WEMI

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	8	22	25	19
89	18	23	27	22
90	24	19	23	20
91	19	22	23	23
92	16	25	25	24
93	18	26	26	24
94	23	24	25	24
95	21	26	27	26
96	19	24	19	25
97	21	26	26	26
98	22	26	27	24
99	23	23	16	.

Table 1.6.25 YELL

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	5	21	11	18
89	20	20	26	16
90	17	16	23	18
91	15	25	24	14
92	25	17	27	21
93	24	20	26	24
94	26	20	24	26
95	23	21	24	25
96	22	24	21	23
97	23	26	25	16
98	.	21	26	24
99	23	22	17	.

Table 1.6.26 YOSE

Year	Quarter1	Quarter2	Quarter3	Quarter4
88	7	19	14	12
89	21	25	24	24
90	24	26	19	22
91	22	24	20	24
92	22	26	26	25
93	22	24	24	26
94	26	25	19	27
95	20	26	27	22
96	19	26	26	22
97	25	21	26	26
98	21	25	27	23
99	24	25	17	.

Table 1.7 Selected percentiles of the simulated distribution of estimated annual deciview using the NPS algorithm

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
ACAD	93	23.89	24.43	24.54	24.81	25.09	25.11	25.21	24.62
	97	22.00	22.49	22.59	22.76	22.93	22.95	23.04	22.87
BADL	93	16.38	16.93	17.03	17.17	17.29	17.34	17.77	17.48
	95	16.21	16.90	17.01	17.20	17.38	17.42	17.70	17.43
BAND	95	12.05	12.51	12.60	12.69	12.78	12.80	12.91	12.86
	98	13.36	13.79	13.87	13.99	14.11	14.15	14.29	14.03
BRCA	96	12.61	13.39	13.58	13.70	13.86	13.92	14.17	13.80
	97	11.16	12.97	13.15	13.20	13.42	13.47	13.67	12.99
BRID	96	12.07	12.60	12.80	12.86	12.97	12.98	13.13	12.79
	97	9.37	9.83	9.94	10.05	10.18	10.21	10.34	10.11
CANY	95	10.31	10.70	10.78	10.81	10.86	10.91	11.06	11.27
	98	10.94	11.45	11.56	11.66	11.77	11.79	11.91	12.00
CHIR	94	13.31	13.75	13.85	13.92	14.02	14.05	14.18	14.17
	96	12.88	13.12	13.19	13.26	13.33	13.37	13.56	13.76
CRLA	95	11.58	11.94	12.05	12.18	12.34	12.37	12.53	12.40
	97	10.27	10.76	10.86	10.96	11.06	11.11	11.33	11.38
GLAC	92	19.01	19.57	19.73	19.87	20.01	20.05	20.32	19.73
	97	16.54	17.00	17.14	17.26	17.38	17.42	17.61	17.76
GRCA	94	11.33	11.84	11.96	12.03	12.15	12.19	12.38	12.40
	98	12.38	12.93	13.07	13.20	13.34	13.39	13.58	13.31
GRSA	95	11.11	11.56	11.63	11.70	11.79	11.81	11.94	11.81
	97	11.31	11.74	11.88	11.96	12.06	12.10	12.32	12.30
GRSM	94	27.98	28.49	28.57	28.60	28.66	28.67	28.76	28.57
	95	28.06	28.77	28.94	29.03	29.11	29.13	29.20	28.91
GUMO	93	14.32	14.76	14.87	14.97	15.08	15.11	15.26	15.12
	94	14.93	15.64	15.83	15.98	16.15	16.19	16.48	15.85

Table 1.7 (continued) Selected percentiles of the simulated distribution of estimated annual deciview using the NPS algorithm

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
LAVO	94	12.87	13.37	13.45	13.61	13.76	13.82	14.25	14.22
	97	11.05	11.52	11.64	11.73	11.84	11.87	12.04	12.02
MEVE	93	10.65	11.62	11.76	11.80	11.94	11.98	12.17	11.74
	97	10.45	10.92	11.02	11.15	11.27	11.30	11.47	11.64
MORA	95	20.16	20.93	21.08	21.23	21.38	21.40	21.57	21.77
	97	20.56	20.89	20.98	21.11	21.22	21.27	21.67	21.74
PEFO	93	11.98	12.25	12.31	12.37	12.43	12.46	12.59	12.63
	97	11.47	11.94	12.04	12.14	12.24	12.30	12.52	12.80
PINN	91	19.70	20.34	20.44	20.52	20.63	20.67	20.88	20.56
	96	17.32	17.59	17.65	17.70	17.76	17.79	17.89	17.72
PORE	93	22.02	23.81	24.48	24.66	24.98	25.06	25.47	23.73
	98	18.84	19.99	20.13	20.27	20.41	20.50	20.92	21.18
REDW	95	21.98	22.60	22.69	22.88	23.05	23.08	23.21	23.16
	97	19.52	21.01	21.15	21.29	21.46	21.55	21.99	22.54
SAGO	94	22.77	23.43	23.54	23.68	23.82	23.90	24.32	23.74
	97	19.92	20.51	20.68	20.84	21.02	21.10	21.36	21.68
SHEN	94	29.49	29.98	30.07	30.16	30.24	30.27	30.36	29.96
	95	29.94	30.61	30.78	30.92	31.09	31.10	31.15	30.52
TONT	95	13.88	14.28	14.33	14.40	14.46	14.49	14.64	14.52
	96	13.67	14.24	14.35	14.42	14.52	14.55	14.67	14.53
WEMI	93	11.29	11.59	11.67	11.74	11.80	11.84	12.00	12.00
	95	10.73	11.14	11.22	11.37	11.52	11.55	11.68	11.79
YELL	94	13.42	14.31	14.45	14.67	14.88	14.94	15.17	14.62
	96	13.15	14.41	14.67	14.92	15.19	15.24	15.54	14.95
YOSE	92	16.31	17.32	17.52	17.68	17.85	17.91	18.35	18.01
	95	15.70	17.80	18.05	18.08	18.31	18.35	18.57	17.13

Table 1.8 Selected percentiles of the simulated distribution of estimated annual deciview using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
ACAD	93	23.29	24.05	24.26	24.58	24.93	25.11	25.21	24.62
	97	21.61	22.43	22.60	22.85	23.14	23.24	23.35	22.87
BADL	93	16.35	17.07	17.23	17.46	17.72	17.84	17.91	17.48
	95	15.93	16.98	17.14	17.40	17.70	17.79	17.92	17.43
BAND	95	12.00	12.57	12.67	12.82	12.99	13.05	13.06	12.86
	98	13.17	13.76	13.86	14.04	14.25	14.30	14.41	14.03
BRCA	96	12.54	13.31	13.50	13.79	14.10	14.19	14.42	13.80
	97	11.38	12.21	12.49	12.90	13.27	13.37	13.48	12.99
BRID	96	11.85	12.50	12.58	12.75	12.90	12.94	12.95	12.79
	97	9.48	9.88	9.98	10.14	10.30	10.35	10.44	10.11
CANY	95	10.57	11.05	11.14	11.24	11.37	11.37	11.37	11.27
	98	11.42	11.79	11.86	11.99	12.13	12.14	12.15	12.00
CHIR	94	13.35	13.87	13.99	14.14	14.29	14.33	14.35	14.17
	96	13.22	13.54	13.63	13.76	13.91	13.95	14.03	13.76
CRLA	95	11.38	12.00	12.14	12.34	12.54	12.63	12.77	12.40
	97	10.58	11.04	11.17	11.36	11.58	11.64	11.73	11.38
GLAC	92	18.67	19.24	19.43	19.70	20.01	20.09	20.14	19.73
	97	16.63	17.39	17.56	17.76	18.02	18.06	18.09	17.76
GRCA	94	11.42	12.04	12.17	12.34	12.52	12.58	12.64	12.40
	98	12.19	12.90	13.06	13.25	13.48	13.56	13.56	13.31
GRSA	95	11.23	11.57	11.67	11.79	11.94	11.96	11.97	11.81
	97	11.48	12.01	12.10	12.27	12.44	12.49	12.53	12.30
GRSM	94	27.42	28.13	28.26	28.49	28.74	28.80	28.85	28.57
	95	27.60	28.48	28.61	28.87	29.18	29.25	29.28	28.91
GUMO	93	14.13	14.76	14.91	15.14	15.38	15.47	15.69	15.12
	94	14.64	15.36	15.56	15.84	16.10	16.17	16.33	15.85

Table 1.8 (continued) Selected percentiles of the simulated distribution of estimated annual deciview using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
LAVO	94	13.00	13.84	13.97	14.16	14.36	14.44	14.55	14.22
	97	11.13	11.68	11.78	11.95	12.13	12.19	12.30	12.02
MEVE	93	10.64	11.27	11.59	11.73	11.93	11.99	12.03	11.74
	97	10.84	11.30	11.42	11.59	11.78	11.82	11.92	11.64
MORA	95	20.56	21.33	21.47	21.68	21.92	21.99	22.04	21.77
	97	20.76	21.37	21.51	21.72	21.93	22.00	22.18	21.74
PEFO	93	12.15	12.44	12.51	12.60	12.71	12.72	12.72	12.63
	97	12.30	12.59	12.68	12.80	12.93	12.96	13.00	12.80
PINN	91	19.67	20.26	20.37	20.53	20.73	20.77	20.77	20.56
	96	17.25	17.60	17.66	17.73	17.83	17.84	17.84	17.72
PORE	93	21.41	22.98	23.29	23.77	24.24	24.31	24.36	23.73
	98	20.07	20.71	20.87	21.12	21.36	21.52	21.56	21.18
REDW	95	21.86	22.79	22.94	23.19	23.48	23.55	23.71	23.16
	97	21.44	22.05	22.26	22.48	22.76	22.82	22.83	22.54
SAGO	94	22.11	23.30	23.47	23.74	24.03	24.16	24.19	23.74
	97	20.49	21.30	21.46	21.68	21.90	21.95	22.02	21.68
SHEN	94	28.10	29.44	29.62	29.92	30.24	30.34	30.61	29.96
	95	29.23	29.97	30.21	30.55	30.90	31.03	31.06	30.52
TONT	95	13.89	14.30	14.42	14.53	14.66	14.69	14.72	14.52
	96	13.52	14.27	14.36	14.53	14.72	14.77	14.80	14.53
WEMI	93	11.41	11.79	11.88	12.01	12.16	12.21	12.23	12.00
	95	11.02	11.46	11.57	11.72	11.90	11.95	11.97	11.79
YELL	94	13.35	14.09	14.29	14.59	14.95	15.04	15.10	14.62
	96	13.11	14.35	14.56	14.88	15.25	15.37	15.52	14.95
YOSE	92	16.97	17.61	17.73	17.95	18.19	18.26	18.33	18.01
	95	15.25	16.50	16.89	17.15	17.47	17.55	17.61	17.13

Table 1.9 Selected percentiles of the simulated distribution of percent errors when estimating annual deciview using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
ACAD	93	-2.97	-0.76	-0.32	0.77	1.90	1.98	2.39	24.62
	97	-3.77	-1.66	-1.21	-0.48	0.27	0.36	0.76	22.87
BADL	93	-6.30	-3.14	-2.60	-1.81	-1.09	-0.81	1.65	17.48
	95	-7.00	-3.07	-2.43	-1.35	-0.29	-0.07	1.53	17.43
BAND	95	-6.31	-2.76	-2.03	-1.38	-0.67	-0.47	0.39	12.86
	98	-4.76	-1.68	-1.10	-0.22	0.59	0.87	1.87	14.03
BRCA	96	-8.67	-3.01	-1.64	-0.76	0.43	0.88	2.63	13.80
	97	-14.10	-0.14	1.21	1.57	3.32	3.70	5.20	12.99
BRID	96	-5.57	-1.48	0.08	0.59	1.40	1.54	2.71	12.79
	97	-7.31	-2.76	-1.69	-0.67	0.61	0.91	2.25	10.11
CANY	95	-8.59	-5.09	-4.40	-4.15	-3.66	-3.27	-1.93	11.27
	98	-8.80	-4.59	-3.64	-2.81	-1.88	-1.72	-0.76	12.00
CHIR	94	-6.08	-2.97	-2.27	-1.77	-1.06	-0.85	0.06	14.17
	96	-6.37	-4.62	-4.15	-3.64	-3.09	-2.85	-1.45	13.76
CRLA	95	-6.61	-3.70	-2.86	-1.75	-0.52	-0.27	1.00	12.40
	97	-9.72	-5.41	-4.56	-3.70	-2.78	-2.36	-0.46	11.38
GLAC	92	-3.61	-0.81	0.02	0.71	1.47	1.65	3.02	19.73
	97	-6.87	-4.28	-3.50	-2.85	-2.18	-1.94	-0.84	17.76
GRCA	94	-8.66	-4.54	-3.63	-2.99	-2.05	-1.70	-0.23	12.40
	98	-6.95	-2.81	-1.78	-0.79	0.23	0.63	2.01	13.31
GRSA	95	-5.87	-2.14	-1.52	-0.89	-0.16	0.01	1.11	11.81
	97	-8.00	-4.56	-3.34	-2.77	-1.96	-1.62	0.22	12.30
GRSM	94	-2.08	-0.31	-0.03	0.10	0.31	0.35	0.66	28.57
	95	-2.93	-0.48	0.12	0.40	0.71	0.76	1.01	28.91
GUMO	93	-5.31	-2.39	-1.69	-1.04	-0.30	-0.10	0.92	15.12
	94	-5.81	-1.31	-0.12	0.83	1.90	2.19	4.02	15.85

Table 1.9 (continued) Selected percentiles of the simulated distribution of percent errors when estimating annual deciview using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
LAVO	94	-9.48	-6.01	-5.39	-4.29	-3.24	-2.80	0.17	14.22
	97	-8.09	-4.16	-3.12	-2.39	-1.44	-1.21	0.19	12.02
MEVE	93	-9.21	-0.97	0.24	0.58	1.76	2.08	3.72	11.74
	97	-10.23	-6.20	-5.31	-4.27	-3.23	-2.98	-1.45	11.64
MORA	95	-7.43	-3.88	-3.18	-2.50	-1.79	-1.71	-0.96	21.77
	97	-5.43	-3.92	-3.47	-2.89	-2.40	-2.15	-0.33	21.74
PEFO	93	-5.14	-3.00	-2.57	-2.08	-1.59	-1.35	-0.33	12.63
	97	-10.43	-6.77	-5.97	-5.17	-4.39	-3.92	-2.17	12.80
PINN	91	-4.19	-1.08	-0.59	-0.17	0.33	0.53	1.59	20.56
	96	-2.25	-0.72	-0.38	-0.08	0.21	0.40	0.96	17.72
PORE	93	-7.23	0.33	3.14	3.91	5.23	5.58	7.33	23.73
	98	-11.04	-5.62	-4.98	-4.31	-3.61	-3.20	-1.22	21.18
REDW	95	-5.12	-2.42	-2.05	-1.24	-0.50	-0.35	0.21	23.16
	97	-13.41	-6.80	-6.19	-5.57	-4.81	-4.40	-2.44	22.54
SAGO	94	-4.10	-1.31	-0.84	-0.26	0.34	0.69	2.43	23.74
	97	-8.11	-5.42	-4.64	-3.88	-3.04	-2.71	-1.49	21.68
SHEN	94	-1.57	0.06	0.36	0.67	0.95	1.05	1.32	29.96
	95	-1.91	0.29	0.86	1.30	1.87	1.91	2.08	30.52
TONT	95	-4.42	-1.66	-1.25	-0.82	-0.36	-0.15	0.82	14.52
	96	-5.94	-2.02	-1.27	-0.76	-0.10	0.13	1.00	14.53
WEMI	93	-5.89	-3.37	-2.72	-2.16	-1.61	-1.28	0.02	12.00
	95	-9.00	-5.48	-4.79	-3.53	-2.28	-2.04	-0.89	11.79
YELL	94	-8.19	-2.08	-1.14	0.35	1.77	2.19	3.75	14.62
	96	-12.03	-3.61	-1.87	-0.18	1.63	1.94	3.96	14.95
YOSE	92	-9.43	-3.81	-2.73	-1.84	-0.86	-0.54	1.87	18.01
	95	-8.35	3.90	5.36	5.57	6.88	7.11	8.42	17.13

Table 1.10 Selected percentiles of the simulated distribution of percent errors when estimating annual deciview using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
ACAD	93	-5.41	-2.31	-1.44	-0.15	1.27	1.99	2.39	24.62
	97	-5.50	-1.91	-1.18	-0.08	1.20	1.64	2.12	22.87
BADL	93	-6.51	-2.38	-1.43	-0.11	1.36	2.04	2.46	17.48
	95	-8.59	-2.61	-1.67	-0.15	1.55	2.05	2.81	17.43
BAND	95	-6.75	-2.24	-1.49	-0.33	0.97	1.42	1.52	12.86
	98	-6.09	-1.92	-1.17	0.10	1.59	1.93	2.78	14.03
BRCA	96	-9.17	-3.60	-2.21	-0.11	2.15	2.83	4.44	13.80
	97	-12.43	-5.99	-3.90	-0.68	2.14	2.94	3.75	12.99
BRID	96	-7.30	-2.27	-1.60	-0.29	0.89	1.23	1.24	12.79
	97	-6.24	-2.30	-1.30	0.25	1.86	2.38	3.22	10.11
CANY	95	-6.25	-1.96	-1.17	-0.32	0.84	0.84	0.84	11.27
	98	-4.81	-1.79	-1.19	-0.05	1.06	1.21	1.21	12.00
CHIR	94	-5.81	-2.17	-1.26	-0.24	0.84	1.12	1.27	14.17
	96	-3.90	-1.55	-0.91	0.05	1.12	1.43	1.97	13.76
CRLA	95	-8.23	-3.23	-2.12	-0.52	1.12	1.81	2.93	12.40
	97	-7.02	-2.93	-1.84	-0.14	1.81	2.33	3.06	11.38
GLAC	92	-5.33	-2.45	-1.49	-0.11	1.45	1.84	2.11	19.73
	97	-6.37	-2.08	-1.17	-0.01	1.44	1.66	1.82	17.76
GRCA	94	-7.91	-2.91	-1.92	-0.52	0.94	1.43	1.86	12.40
	98	-8.39	-3.11	-1.90	-0.45	1.27	1.90	1.90	13.31
GRSA	95	-4.92	-2.01	-1.17	-0.12	1.10	1.29	1.39	11.81
	97	-6.62	-2.35	-1.56	-0.22	1.18	1.57	1.89	12.30
GRSM	94	-4.02	-1.57	-1.09	-0.29	0.57	0.80	0.95	28.57
	95	-4.53	-1.50	-1.03	-0.14	0.93	1.19	1.29	28.91
GUMO	93	-6.59	-2.37	-1.43	0.08	1.71	2.30	3.74	15.12
	94	-7.61	-3.04	-1.80	-0.05	1.60	2.02	3.05	15.85

Table 1.10 (continued) Selected percentiles of the simulated distribution of percent errors when estimating annual deciview using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
LAVO	94	-8.60	-2.69	-1.74	-0.45	0.94	1.52	2.34	14.22
	97	-7.41	-2.84	-1.95	-0.53	0.97	1.43	2.33	12.02
MEVE	93	-9.33	-3.94	-1.28	-0.09	1.64	2.17	2.54	11.74
	97	-6.93	-2.97	-1.91	-0.48	1.16	1.52	2.41	11.64
MORA	95	-5.56	-2.02	-1.40	-0.41	0.69	1.00	1.21	21.77
	97	-4.50	-1.69	-1.04	-0.11	0.89	1.22	2.05	21.74
PEFO	93	-3.83	-1.46	-0.94	-0.22	0.62	0.75	0.76	12.63
	97	-3.91	-1.66	-0.98	-0.02	0.98	1.24	1.52	12.80
PINN	91	-4.30	-1.43	-0.91	-0.13	0.83	1.03	1.03	20.56
	96	-2.61	-0.66	-0.32	0.08	0.65	0.71	0.71	17.72
PORE	93	-9.79	-3.17	-1.86	0.14	2.14	2.45	2.63	23.73
	98	-5.23	-2.21	-1.44	-0.29	0.85	1.61	1.82	21.18
REDW	95	-5.63	-1.63	-0.99	0.13	1.34	1.64	2.36	23.16
	97	-4.90	-2.18	-1.25	-0.26	0.94	1.24	1.26	22.54
SAGO	94	-6.88	-1.87	-1.14	-0.01	1.23	1.77	1.88	23.74
	97	-5.50	-1.79	-1.02	-0.03	1.02	1.25	1.54	21.68
SHEN	94	-6.21	-1.74	-1.14	-0.14	0.92	1.26	2.15	29.96
	95	-4.21	-1.81	-1.00	0.10	1.25	1.68	1.76	30.52
TONT	95	-4.29	-1.47	-0.70	0.07	0.96	1.17	1.38	14.52
	96	-6.96	-1.81	-1.16	0.01	1.30	1.65	1.83	14.53
WEMI	93	-4.88	-1.69	-0.99	0.12	1.34	1.77	1.92	12.00
	95	-6.50	-2.75	-1.89	-0.60	0.97	1.40	1.56	11.79
YELL	94	-8.66	-3.58	-2.28	-0.22	2.29	2.89	3.27	14.62
	96	-12.29	-3.98	-2.55	-0.44	2.01	2.82	3.85	14.95
YOSE	92	-5.78	-2.21	-1.53	-0.31	0.99	1.36	1.78	18.01
	95	-10.97	-3.66	-1.40	0.12	1.98	2.46	2.79	17.13

Table 1.11: Summary information from the 1000 simulations for each site-year combination.

Table 1.11.1 ACAD 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	24.62	---	---	---
	Simulated NPS	24.81	0.28	23.89	25.21
	Simulated EPA	24.58	0.40	23.29	25.21
Number of Missing Days for:	Total	15.09	0.88	12	16
	Fine Mass	4	---	---	---
	Carbon	0.40	0.55	0	2
	Total Mass	0.98	0.85	0	4
	NO3	1.02	0.87	0	5
Percent Error	NPS	0.77%	1.13%	-2.97%	2.39%
	EPA	-0.15%	1.61%	-5.41%	2.39%

Table 1.11.2 ACAD 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	22.87	---	---	---
	Simulated NPS	22.76	0.19	22.00	23.04
	Simulated EPA	22.85	0.32	21.61	23.35
Number of Missing Days for:	Total	15.10	0.88	12	16
	Fine Mass	4	---	---	---
	Carbon	0.39	0.56	0	2
	Total Mass	0.97	0.87	0	5
	NO3	0.94	0.85	0	4
Percent Error	NPS	-0.48%	0.85%	-3.77%	0.76%
	EPA	-0.08%	1.39%	-5.50%	2.12%

Table 1.11.3 BADL 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	17.48	---	---	---
	Simulated NPS	17.17	0.17	16.38	17.77
	Simulated EPA	17.46	0.28	16.35	17.91
Number of Missing Days for:	Total	15.09	0.86	12	16
	Fine Mass	4	---	---	---
	Carbon	0.76	0.77	0	4
	Total Mass	0.79	0.80	0	4
	NO3	0.79	0.77	0	3
Percent Error	NPS	-1.81%	0.99%	-6.30%	1.65%
	EPA	-0.11%	1.63%	-6.51%	2.46%

Table 1.11.4 BADL 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	17.43	---	---	---
	Simulated NPS	17.20	0.23	16.21	17.70
	Simulated EPA	17.40	0.33	15.93	17.92
Number of Missing Days for:	Total	15.10	0.87	11	16
	Fine Mass	4	---	---	---
	Carbon	0.79	0.78	0	4
	Total Mass	0.77	0.76	0	3
	NO3	0.78	0.77	0	4
Percent Error	NPS	-1.35%	1.31%	-7.00%	1.53%
	EPA	-0.15%	1.91%	-8.59%	2.81%

Table 1.11.5 BAND 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.86	---	---	---
	Simulated NPS	12.69	0.12	12.05	12.91
	Simulated EPA	12.82	0.18	12.00	13.06
Number of Missing Days for:	Total	11.42	0.70	8	12
	Fine Mass	4	---	---	---
	Carbon	0.41	0.57	0	2
	Total Mass	0.61	0.69	0	3
	NO3	0.63	0.70	0	3
Percent Error	NPS	-1.38%	0.92%	-6.31%	0.39%
	EPA	-0.33%	1.38%	-6.75%	1.52%

Table 1.11.6 BAND 98

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.03	---	---	---
	Simulated NPS	13.99	0.15	13.36	14.29
	Simulated EPA	14.04	0.21	13.17	14.41
Number of Missing Days for:	Total	15.07	0.87	12	16
	Fine Mass	5	---	---	---
	Carbon	0.59	0.68	0	3
	Total Mass	0.78	0.80	0	3
	NO3	0.79	0.77	0	4
Percent Error	NPS	-0.22%	1.05%	-4.76%	1.87%
	EPA	0.10%	1.52%	-6.09%	2.78%

Table 1.11.7 BRCA 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	13.80	---	---	---
	Simulated NPS	13.70	0.25	12.61	14.17
	Simulated EPA	13.79	0.34	12.54	14.42
Number of Missing Days for:	Total	22.08	1.21	17	24
	Fine Mass	5	---	---	---
	Carbon	0.58	0.67	0	3
	Total Mass	1.54	1.04	0	5
	NO3	1.53	1.05	0	5
Percent Error	NPS	-0.76%	1.83%	-8.67%	2.63%
	EPA	-0.11%	2.49%	-9.17%	4.44%

Table 1.11.8 BRCA 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.99	---	---	---
	Simulated NPS	13.20	0.42	11.16	13.67
	Simulated EPA	12.90	0.43	11.38	13.48
Number of Missing Days for:	Total	22.07	1.19	18	24
	Fine Mass	5	---	---	---
	Carbon	0.57	0.66	0	3
	Total Mass	1.57	1.07	0	5
	NO3	1.57	1.09	0	5
Percent Error	NPS	1.57%	3.23%	-14.10%	5.20%
	EPA	-0.68%	3.30%	-12.43%	3.75%

Table 1.11.9 BRID 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.79	---	---	---
	Simulated NPS	12.86	0.16	12.07	13.13
	Simulated EPA	12.75	0.18	11.85	12.95
Number of Missing Days for:	Total	11.53	0.64	9	12
	Fine Mass	5	---	---	---
	Carbon	0.21	0.41	0	1
	Total Mass	0.57	0.68	0	3
	NO3	0.59	0.70	0	3
Percent Error	NPS	0.59%	1.24%	-5.57%	2.71%
	EPA	-0.29%	1.44%	-7.30%	1.24%

Table 1.11.10 BRID 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	10.11	---	---	---
	Simulated NPS	10.05	0.15	9.37	10.34
	Simulated EPA	10.14	0.18	9.48	10.44
Number of Missing Days for:	Total	15.13	0.83	12	16
	Fine Mass	6	---	---	---
	Carbon	0.38	0.55	0	2
	Total Mass	0.73	0.75	0	4
	NO3	0.74	0.75	0	3
Percent Error	NPS	-0.67%	1.51%	-7.31%	2.25%
	EPA	0.25%	1.82%	-6.24%	3.22%

Table 1.12.11 CANY 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.27	---	---	---
	Simulated NPS	10.81	0.09	10.31	11.06
	Simulated EPA	11.24	0.13	10.57	11.37
Number of Missing Days for:	Total	6.80	0.43	5	7
	Fine Mass	2	---	---	---
	Carbon	0.21	0.41	0	1
	Total Mass	0.43	0.58	0	2
	NO3	0.38	0.57	0	2
Percent Error	NPS	-4.15%	0.77%	-8.59%	-1.93%
	EPA	-0.32%	1.16%	-6.25%	0.84%

Table 1.11.12 CANY 98

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.00	---	---	---
	Simulated NPS	11.66	0.15	10.94	11.91
	Simulated EPA	11.99	0.14	11.42	12.15
Number of Missing Days for:	Total	10.54	0.65	8	11
	Fine Mass	3	---	---	---
	Carbon	0.38	0.54	0	2
	Total Mass	0.55	0.66	0	3
	NO3	0.58	0.67	0	3
Percent Error	NPS	-2.81%	1.27%	-8.80%	-0.76%
	EPA	-0.05%	1.20%	-4.81%	1.21%

Table 1.11.13 CHIR 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.17	---	---	---
	Simulated NPS	13.92	0.14	13.31	14.18
	Simulated EPA	14.14	0.18	13.35	14.35
Number of Missing Days for:	Total	11.45	0.72	8	12
	Fine Mass	3	---	---	---
	Carbon	0.60	0.69	0	3
	Total Mass	0.61	0.71	0	3
	NO3	0.62	0.68	0	3
Percent Error	NPS	-1.77%	1.00%	-6.08%	0.06%
	EPA	-0.24%	1.28%	-5.81%	1.27%

Table 1.11.14 CHIR 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	13.76	---	---	---
	Simulated NPS	13.26	0.09	12.88	13.56
	Simulated EPA	13.76	0.16	13.22	14.03
Number of Missing Days for:	Total	15.12	0.86	11	16
	Fine Mass	4	---	---	---
	Carbon	0.79	0.78	0	4
	Total Mass	0.82	0.76	0	4
	NO3	0.79	0.75	0	3
Percent Error	NPS	-3.64%	0.69%	-6.37%	-1.45%
	EPA	0.05%	1.14%	-3.90%	1.97%

Table 1.11.15 CRLA 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.40	---	---	---
	Simulated NPS	12.18	0.17	11.58	12.53
	Simulated EPA	12.34	0.24	11.38	12.77
Number of Missing Days for:	Total	19.44	1.15	15	21
	Fine Mass	6	---	---	---
	Carbon	0.55	0.66	0	3
	Total Mass	1.18	0.99	0	5
	NO3	1.14	0.93	0	4
Percent Error	NPS	-1.75%	1.40%	-6.61%	1.00%
	EPA	-0.52%	1.97%	-8.23%	2.93%

Table 1.11.16 CRLA 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.38	---	---	---
	Simulated NPS	10.96	0.14	10.27	11.33
	Simulated EPA	11.36	0.23	10.58	11.73
Number of Missing Days for:	Total	19.33	1.15	15	21
	Fine Mass	6	---	---	---
	Carbon	0.60	0.71	0	3
	Total Mass	1.14	0.91	0	4
	NO3	1.19	0.94	0	5
Percent Error	NPS	-3.70%	1.25%	-9.72%	-0.46%
	EPA	-0.14%	2.02%	-7.02%	3.06%

Table 1.11.17 GLAC 92

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	19.73	---	---	---
	Simulated NPS	19.87	0.21	19.01	20.32
	Simulated EPA	19.70	0.32	18.67	20.14
Number of Missing Days for:	Total	15.11	0.86	12	16
	Fine Mass	3	---	---	---
	Carbon	0.59	0.68	0	3
	Total Mass	0.95	0.88	0	4
	NO3	0.98	0.87	0	5
Percent Error	NPS	0.71%	1.05%	-3.61%	3.02%
	EPA	-0.11%	1.60%	-5.33%	2.11%

Table 1.11.18 GLAC 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	17.76	---	---	---
	Simulated NPS	17.26	0.17	16.54	17.61
	Simulated EPA	17.76	0.26	16.63	18.09
Number of Missing Days for:	Total	15.12	0.84	11	16
	Fine Mass	3	---	---	---
	Carbon	0.59	0.70	0	3
	Total Mass	0.95	0.86	0	4
	NO3	0.96	0.86	0	4
Percent Error	NPS	-2.85%	0.95%	-6.87%	-0.84%
	EPA	-0.01%	1.46%	-6.37%	1.82%

Table 1.11.19 GRCA 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.40	---	---	---
	Simulated NPS	12.03	0.15	11.33	12.38
	Simulated EPA	12.34	0.20	11.42	12.64
Number of Missing Days for:	Total	17.77	0.99	14	19
	Fine Mass	6	---	---	---
	Carbon	0.58	0.66	0	3
	Total Mass	0.94	0.85	0	4
	NO3	0.94	0.85	0	4
Percent Error	NPS	-2.99%	1.19%	-8.66%	-0.23%
	EPA	-0.52%	1.65%	-7.91%	1.86%

Table 1.11.20 GRCA 98

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	13.31	---	---	---
	Simulated NPS	13.20	0.19	12.38	13.58
	Simulated EPA	13.25	0.25	12.19	13.56
Number of Missing Days for:	Total	11.30	0.75	8	12
	Fine Mass	4	---	---	---
	Carbon	0.38	0.56	0	2
	Total Mass	0.55	0.65	0	3
	NO3	0.58	0.66	0	3
Percent Error	NPS	-0.79%	1.44%	-6.95%	2.01%
	EPA	-0.45%	1.85%	-8.39%	1.90%

Table 1.11.21 GRSA 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.81	---	---	---
	Simulated NPS	11.70	0.11	11.11	11.94
	Simulated EPA	11.79	0.15	11.23	11.97
Number of Missing Days for:	Total	15.09	0.86	12	16
	Fine Mass	4	---	---	---
	Carbon	0.76	0.77	0	4
	Total Mass	0.81	0.79	0	4
	NO3	0.76	0.80	0	3
Percent Error	NPS	-0.89%	0.94%	-5.87%	1.11%
	EPA	-0.12%	1.29%	-4.92%	1.39%

Table 1.11.22 GRSA 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.30	---	---	---
	Simulated NPS	11.96	0.15	11.31	12.32
	Simulated EPA	12.27	0.19	11.48	12.53
Number of Missing Days for:	Total	15.10	0.87	11	16
	Fine Mass	4	---	---	---
	Carbon	0.75	0.75	0	4
	Total Mass	0.79	0.78	0	4
	NO3	0.81	0.82	0	4
Percent Error	NPS	-2.77%	1.21%	-8.00%	0.22%
	EPA	-0.22%	1.55%	-6.62%	1.89%

Table 1.11.23 GRSM 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	28.57	---	---	---
	Simulated NPS	28.60	0.11	27.98	28.76
	Simulated EPA	28.49	0.27	27.42	28.85
Number of Missing Days for:	Total	11.51	0.66	9	12
	Fine Mass	2	---	---	---
	Carbon	0.43	0.57	0	2
	Total Mass	0.83	0.78	0	3
	NO3	0.82	0.79	0	4
Percent Error	NPS	0.10%	0.37%	-2.08%	0.66%
	EPA	-0.29%	0.94%	-4.02%	0.95%

Table 1.11.24 GRSM 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	28.91	---	---	---
	Simulated NPS	29.03	0.15	28.06	29.20
	Simulated EPA	28.87	0.31	27.60	29.28
Number of Missing Days for:	Total	15.12	0.84	11	16
	Fine Mass	3	---	---	---
	Carbon	0.59	0.69	0	3
	Total Mass	1.01	0.89	0	4
	NO3	1.02	0.87	0	4
Percent Error	NPS	0.40%	0.51%	-2.93%	1.01%
	EPA	-0.14%	1.06%	-4.53%	1.29%

Table 1.11.25 GUMO 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	15.12	---	---	---
	Simulated NPS	14.97	0.15	14.32	15.26
	Simulated EPA	15.14	0.27	14.13	15.69
Number of Missing Days for:	Total	19.46	1.11	15	21
	Fine Mass	4	---	---	---
	Carbon	0.58	0.68	0	3
	Total Mass	1.35	0.98	0	4
	NO3	1.38	1.03	0	5
Percent Error	NPS	-1.04%	0.96%	-5.31%	0.92%
	EPA	0.08%	1.81%	-6.59%	3.74%

Table 1.11.26 GUMO 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	15.85	---	---	---
	Simulated NPS	15.98	0.24	14.93	16.48
	Simulated EPA	15.84	0.31	14.64	16.33
Number of Missing Days for:	Total	15.82	0.97	13	17
	Fine Mass	3	---	---	---
	Carbon	0.39	0.56	0	2
	Total Mass	1.17	0.93	0	4
	NO3	1.17	0.93	0	5
Percent Error	NPS	0.83%	1.52%	-5.81%	4.02%
	EPA	-0.05%	1.98%	-7.61%	3.05%

Table 1.11.27 LAVO 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.22	---	---	---
	Simulated NPS	13.61	0.18	12.87	14.25
	Simulated EPA	14.16	0.24	13.00	14.55
Number of Missing Days for:	Total	19.44	1.15	15	21
	Fine Mass	6	---	---	---
	Carbon	0.57	0.67	0	3
	Total Mass	1.09	0.91	0	4
	NO3	1.13	0.93	0	5
Percent Error	NPS	-4.29%	1.29%	-9.48%	0.17%
	EPA	-0.45%	1.66%	-8.60%	2.34%

Table 1.11.28 LAVO 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.02	---	---	---
	Simulated NPS	11.73	0.15	11.05	12.04
	Simulated EPA	11.95	0.21	11.13	12.30
Number of Missing Days for:	Total	19.44	1.15	15	21
	Fine Mass	6.00	---	---	---
	Carbon	0.61	0.68	0	3
	Total Mass	1.18	0.92	0	4
	NO3	1.11	0.94	0	5
Percent Error	NPS	-2.39%	1.23%	-8.09%	0.19%
	EPA	-0.53%	1.71%	-7.41%	2.33%

Table 1.11.29 MEVE 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.74	---	---	---
	Simulated NPS	11.80	0.26	10.65	12.17
	Simulated EPA	11.73	0.27	10.64	12.03
Number of Missing Days for:	Total	14.21	0.82	11	15
	Fine Mass	4	---	---	---
	Carbon	0.57	0.67	0	3
	Total Mass	0.77	0.78	0	3
	NO3	0.77	0.76	0	3
Percent Error	NPS	0.58%	2.19%	-9.21%	3.72%
	EPA	-0.09%	2.30%	-9.33%	2.54%

Table 1.11.30 MEVE 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.64	---	---	---
	Simulated NPS	11.15	0.16	10.45	11.47
	Simulated EPA	11.59	0.21	10.84	11.92
Number of Missing Days for:	Total	14.06	0.86	10	15
	Fine Mass	4	---	---	---
	Carbon	0.60	0.68	0	3
	Total Mass	0.80	0.79	0	3
	NO3	0.80	0.80	0	4
Percent Error	NPS	-4.27%	1.39%	-10.23%	-1.45%
	EPA	-0.48%	1.78%	-6.93%	2.41%

Table 1.11.31 MORA 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	21.77	---	---	---
	Simulated NPS	21.23	0.20	20.16	21.57
	Simulated EPA	21.68	0.26	20.56	22.04
Number of Missing Days for:	Total	13.28	0.79	9	14
	Fine Mass	4	---	---	---
	Carbon	0.40	0.56	0	2
	Total Mass	0.80	0.83	0	4
	NO3	0.80	0.79	0	3
Percent Error	NPS	-2.50%	0.93%	-7.43%	-0.96%
	EPA	-0.41%	1.18%	-5.56%	1.21%

Table 1.11.32 MORA 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	21.74	---	---	---
	Simulated NPS	21.11	0.16	20.56	21.67
	Simulated EPA	21.72	0.25	20.76	22.18
Number of Missing Days for:	Total	16.85	0.96	14	18
	Fine Mass	5	---	---	---
	Carbon	0.57	0.66	0	3
	Total Mass	0.96	0.88	0	4
	NO3	0.97	0.89	0	4
Percent Error	NPS	-2.89%	0.74%	-5.43%	-0.33%
	EPA	-0.11%	1.15%	-4.50%	2.05%

Table 1.11.33 PEFO 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.63	---	---	---
	Simulated NPS	12.37	0.08	11.98	12.59
	Simulated EPA	12.60	0.12	12.15	12.72
Number of Missing Days for:	Total	11.42	0.70	8	12
	Fine Mass	4	---	---	---
	Carbon	0.38	0.55	0	2
	Total Mass	0.59	0.68	0	3
	NO3	0.64	0.70	0	3
Percent Error	NPS	-2.08%	0.67%	-5.14%	-0.33%
	EPA	-0.22%	0.91%	-3.83%	0.76%

Table 1.11.34 PEFO 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.80	---	---	---
	Simulated NPS	12.14	0.15	11.47	12.52
	Simulated EPA	12.80	0.15	12.30	13.00
Number of Missing Days for:	Total	11.40	0.70	9	12
	Fine Mass	4	---	---	---
	Carbon	0.35	0.53	0	2
	Total Mass	0.62	0.69	0	3
	NO3	0.63	0.69	0	3
Percent Error	NPS	-5.17%	1.16%	-10.43%	-2.17%
	EPA	-0.02%	1.14%	-3.91%	1.52%

Table 1.11.35 PINN 91

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	20.56	---	---	---
	Simulated NPS	20.52	0.14	19.70	20.88
	Simulated EPA	20.53	0.20	19.67	20.77
Number of Missing Days for:	Total	11.46	0.68	9	12
	Fine Mass	4	---	---	---
	Carbon	0.41	0.58	0	2
	Total Mass	0.57	0.66	0	3
	NO3	0.54	0.65	0	3
Percent Error	NPS	-0.17%	0.69%	-4.19%	1.59%
	EPA	-0.13%	0.98%	-4.30%	1.03%

Table 1.11.36 PINN 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	17.72	---	---	---
	Simulated NPS	17.70	0.08	17.32	17.89
	Simulated EPA	17.73	0.10	17.25	17.84
Number of Missing Days for:	Total	7.76	0.48	6	8
	Fine Mass	3	---	---	---
	Carbon	0.21	0.40	0	1
	Total Mass	0.39	0.54	0	2
	NO3	0.37	0.55	0	2
Percent Error	NPS	-0.08%	0.45%	-2.25%	0.96%
	EPA	0.08%	0.57%	-2.61%	0.71%

Table 1.11.37 PORE 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	23.73	---	---	---
	Simulated NPS	24.66	0.51	22.02	25.47
	Simulated EPA	23.77	0.53	21.41	24.36
Number of Missing Days for:	Total	13.27	0.79	9	14
	Fine Mass	4	---	---	---
	Carbon	0.79	0.81	0	4
	Total Mass	0.58	0.69	0	3
	NO3	0.60	0.68	0	3
Percent Error	NPS	3.91%	2.16%	-7.23%	7.33%
	EPA	0.14%	2.23%	-9.79%	2.63%

Table 1.11.38 PORE 98

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	21.18	---	---	---
	Simulated NPS	20.27	0.22	18.84	20.92
	Simulated EPA	21.12	0.29	20.07	21.56
Number of Missing Days for:	Total	9.53	0.64	7	10
	Fine Mass	3	---	---	---
	Carbon	0.63	0.68	0	3
	Total Mass	0.41	0.56	0	2
	NO3	0.40	0.57	0	2
Percent Error	NPS	-4.31%	1.05%	-11.04%	-1.22%
	EPA	-0.29%	1.39%	-5.23%	1.82%

Table 1.11.39 REDW 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	23.16	---	---	---
	Simulated NPS	22.88	0.20	21.98	23.21
	Simulated EPA	23.19	0.31	21.86	23.71
Number of Missing Days for:	Total	11.47	0.69	9	12
	Fine Mass	4	---	---	---
	Carbon	0.40	0.56	0	2
	Total Mass	0.57	0.66	0	3
	NO3	0.58	0.69	0	3
Percent Error	NPS	-1.24%	0.87%	-5.12%	0.21%
	EPA	0.13%	1.32%	-5.63%	2.36%

Table 1.11.40 REDW 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	22.54	---	---	---
	Simulated NPS	21.29	0.30	19.52	21.99
	Simulated EPA	22.48	0.29	21.44	22.83
Number of Missing Days for:	Total	11.44	0.69	9	12
	Fine Mass	4	---	---	---
	Carbon	0.36	0.54	0	2
	Total Mass	0.58	0.68	0	3
	NO3	0.57	0.67	0	3
Percent Error	NPS	-5.57%	1.35%	-13.41%	-2.44%
	EPA	-0.26%	1.28%	-4.90%	1.26%

Table 1.11.41 SAGO 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	23.74	---	---	---
	Simulated NPS	23.68	0.19	22.77	24.32
	Simulated EPA	23.74	0.33	22.11	24.19
Number of Missing Days for:	Total	13.92	0.94	11	15
	Fine Mass	4	---	---	---
	Carbon	0.61	0.68	0	3
	Total Mass	0.74	0.74	0	4
	NO3	0.77	0.76	0	4
Percent Error	NPS	-0.26%	0.80%	-4.10%	2.43%
	EPA	-0.01%	1.39%	-6.88%	1.88%

Table 1.11.42 SAGO 97

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	21.68	---	---	---
	Simulated NPS	20.84	0.24	19.92	21.36
	Simulated EPA	21.68	0.27	20.49	22.02
Number of Missing Days for:	Total	13.97	0.91	9	15
	Fine Mass	4	---	---	---
	Carbon	0.57	0.68	0	3
	Total Mass	0.79	0.77	0	4
	NO3	0.74	0.77	0	4
Percent Error	NPS	-3.88%	1.10%	-8.11%	-1.49%
	EPA	-0.03%	1.22%	-5.50%	1.54%

Table 1.11.43 SHEN 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	29.96	---	---	---
	Simulated NPS	30.16	0.13	29.49	30.36
	Simulated EPA	29.92	0.37	28.10	30.61
Number of Missing Days for:	Total	16.85	0.96	13	18
	Fine Mass	4	---	---	---
	Carbon	0.75	0.75	0	4
	Total Mass	0.92	0.85	0	4
	NO3	1.00	0.88	0	4
Percent Error	NPS	0.67%	0.44%	-1.57%	1.32%
	EPA	-0.14%	1.23%	-6.21%	2.15%

Table 1.11.44 SHEN 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	30.52	---	---	---
	Simulated NPS	30.92	0.24	29.94	31.15
	Simulated EPA	30.55	0.39	29.23	31.06
Number of Missing Days for:	Total	13.27	0.80	10	14
	Fine Mass	3	---	---	---
	Carbon	0.61	0.66	0	3
	Total Mass	0.79	0.79	0	4
	NO3	0.83	0.76	0	3
Percent Error	NPS	1.30%	0.79%	-1.91%	2.08%
	EPA	0.10%	1.27%	-4.21%	1.76%

Table 1.11.45 TONT 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.52	---	---	---
	Simulated NPS	14.40	0.10	13.88	14.64
	Simulated EPA	14.53	0.15	13.89	14.72
Number of Missing Days for:	Total	14.19	0.82	10	15
	Fine Mass	3	---	---	---
	Carbon	0.41	0.55	0	2
	Total Mass	0.95	0.87	0	4
	NO3	0.92	0.87	0	4
Percent Error	NPS	-0.82%	0.68%	-4.42%	0.82%
	EPA	0.07%	1.05%	-4.29%	1.38%

Table 1.11.46 TONT 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.53	---	---	---
	Simulated NPS	14.42	0.14	13.67	14.67
	Simulated EPA	14.53	0.20	13.52	14.80
Number of Missing Days for:	Total	14.19	0.82	10	15
	Fine Mass	3	---	---	---
	Carbon	0.38	0.54	0	2
	Total Mass	0.96	0.86	0	4
	NO3	0.98	0.84	0	4
Percent Error	NPS	-0.76%	1.00%	-5.94%	1.00%
	EPA	0.01%	1.41%	-6.96%	1.83%

Table 1.11.47 WEMI 93

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	12.00	---	---	---
	Simulated NPS	11.74	0.10	11.29	12.00
	Simulated EPA	12.01	0.16	11.41	12.23
Number of Missing Days for:	Total	13.25	0.80	10	14
	Fine Mass	5	---	---	---
	Carbon	0.58	0.68	0	3
	Total Mass	0.58	0.68	0	3
	NO3	0.56	0.67	0	3
Percent Error	NPS	-2.16%	0.86%	-5.89%	0.02%
	EPA	0.12%	1.33%	-4.88%	1.92%

Table 1.11.48 WEMI 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	11.79	---	---	---
	Simulated NPS	11.37	0.17	10.73	11.68
	Simulated EPA	11.72	0.19	11.02	11.97
Number of Missing Days for:	Total	13.27	0.78	10	14
	Fine Mass	5	---	---	---
	Carbon	0.57	0.66	0	3
	Total Mass	0.59	0.68	0	3
	NO3	0.60	0.69	0	3
Percent Error	NPS	-3.53%	1.42%	-9.00%	-0.89%
	EPA	-0.60%	1.58%	-6.50%	1.56%

Table 1.11.49 YELL 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.62	---	---	---
	Simulated NPS	14.67	0.26	13.42	15.17
	Simulated EPA	14.59	0.37	13.35	15.10
Number of Missing Days for:	Total	15.11	0.85	12	16
	Fine Mass	6	---	---	---
	Carbon	0.38	0.56	0	2
	Total Mass	0.78	0.76	0	4
	NO3	0.78	0.77	0	3
Percent Error	NPS	0.35%	1.81%	-8.19%	3.75%
	EPA	-0.22%	2.50%	-8.66%	3.27%

Table 1.11.50 YELL 96

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	14.95	---	---	---
	Simulated NPS	14.92	0.34	13.15	15.54
	Simulated EPA	14.88	0.41	13.11	15.52
Number of Missing Days for:	Total	15.05	0.90	12	16
	Fine Mass	6	---	---	---
	Carbon	0.37	0.54	0	2
	Total Mass	0.75	0.75	0	4
	NO3	0.76	0.77	0	4
Percent Error	NPS	-0.18%	2.25%	-12.03%	3.96%
	EPA	-0.44%	2.74%	-12.29%	3.85%

Table 1.11.51 YOSE 92

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	18.01	---	---	---
	Simulated NPS	17.68	0.26	16.31	18.35
	Simulated EPA	17.95	0.25	16.97	18.33
Number of Missing Days for:	Total	16.87	0.96	14	18
	Fine Mass	6	---	---	---
	Carbon	0.78	0.79	0	4
	Total Mass	0.76	0.76	0	4
	NO3	0.73	0.77	0	4
Percent Error	NPS	-1.84%	1.43%	-9.43%	1.87%
	EPA	-0.31%	1.39%	-5.78%	1.78%

Table 1.11.52 YOSE 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	17.13	---	---	---
	Simulated NPS	18.08	0.47	15.70	18.57
	Simulated EPA	17.15	0.41	15.25	17.61
Number of Missing Days for:	Total	13.30	0.74	11	14
	Fine Mass	5	---	---	---
	Carbon	0.61	0.67	0	3
	Total Mass	0.61	0.71	0	3
	NO3	0.55	0.67	0	3
Percent Error	NPS	5.57%	2.72%	-8.35%	8.42%
	EPA	0.12%	2.39%	-10.96%	2.79%

Figure 1.1 Selected percentiles of the simulated distribution of estimated annual deciview

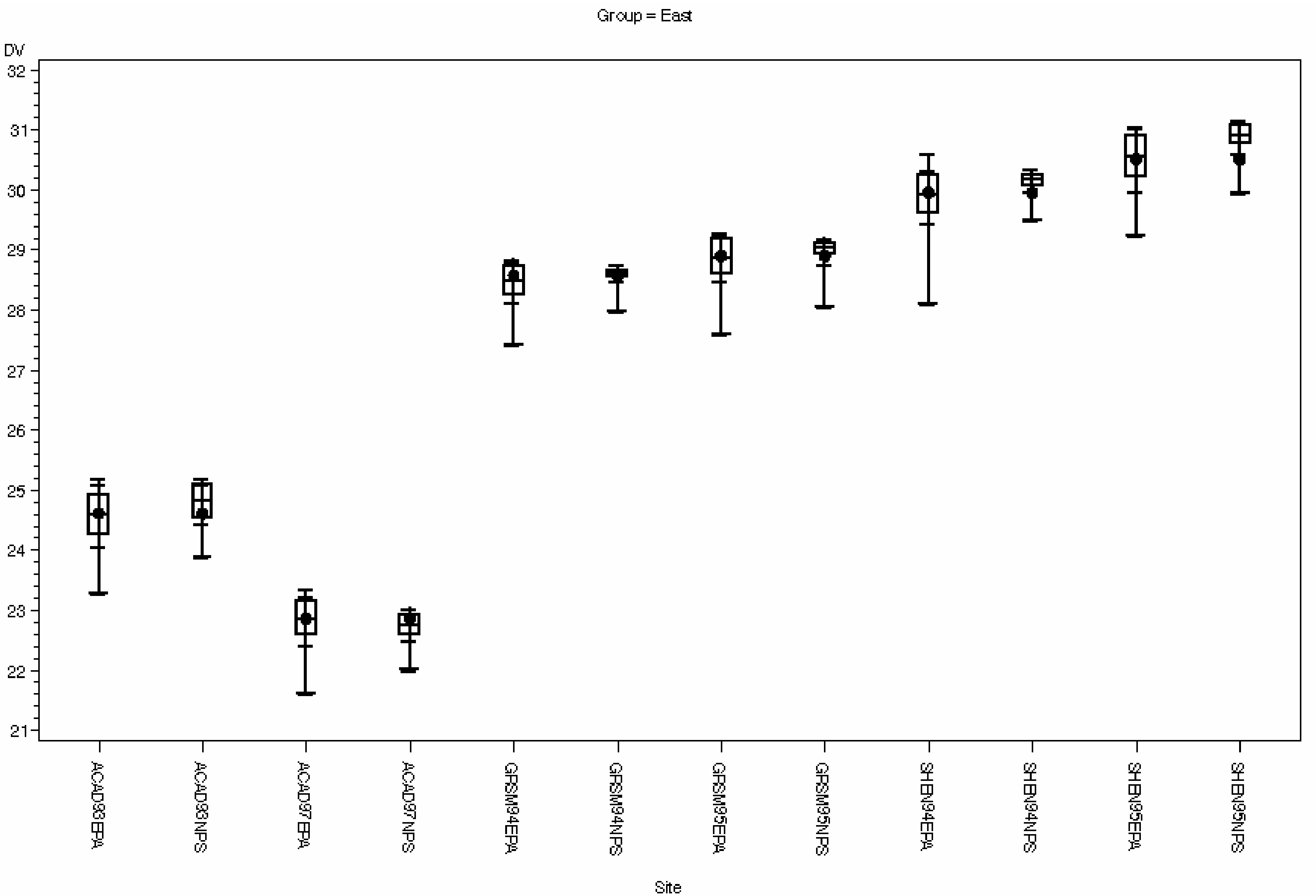


Figure 1.2 Selected percentiles of the simulated distribution of estimated annual deciview

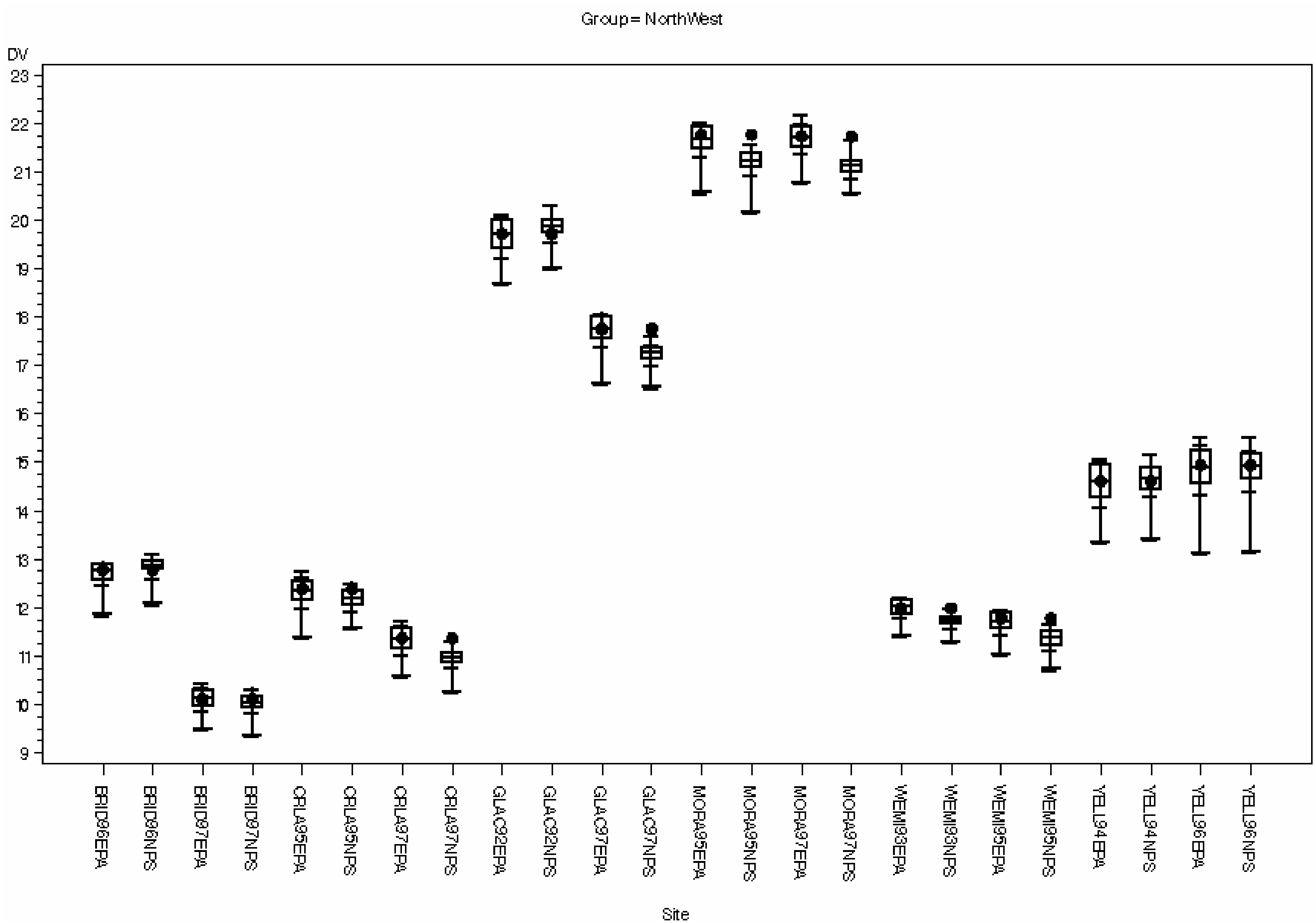


Figure 1.3 Selected percentiles of the simulated distribution of estimated annual deciview

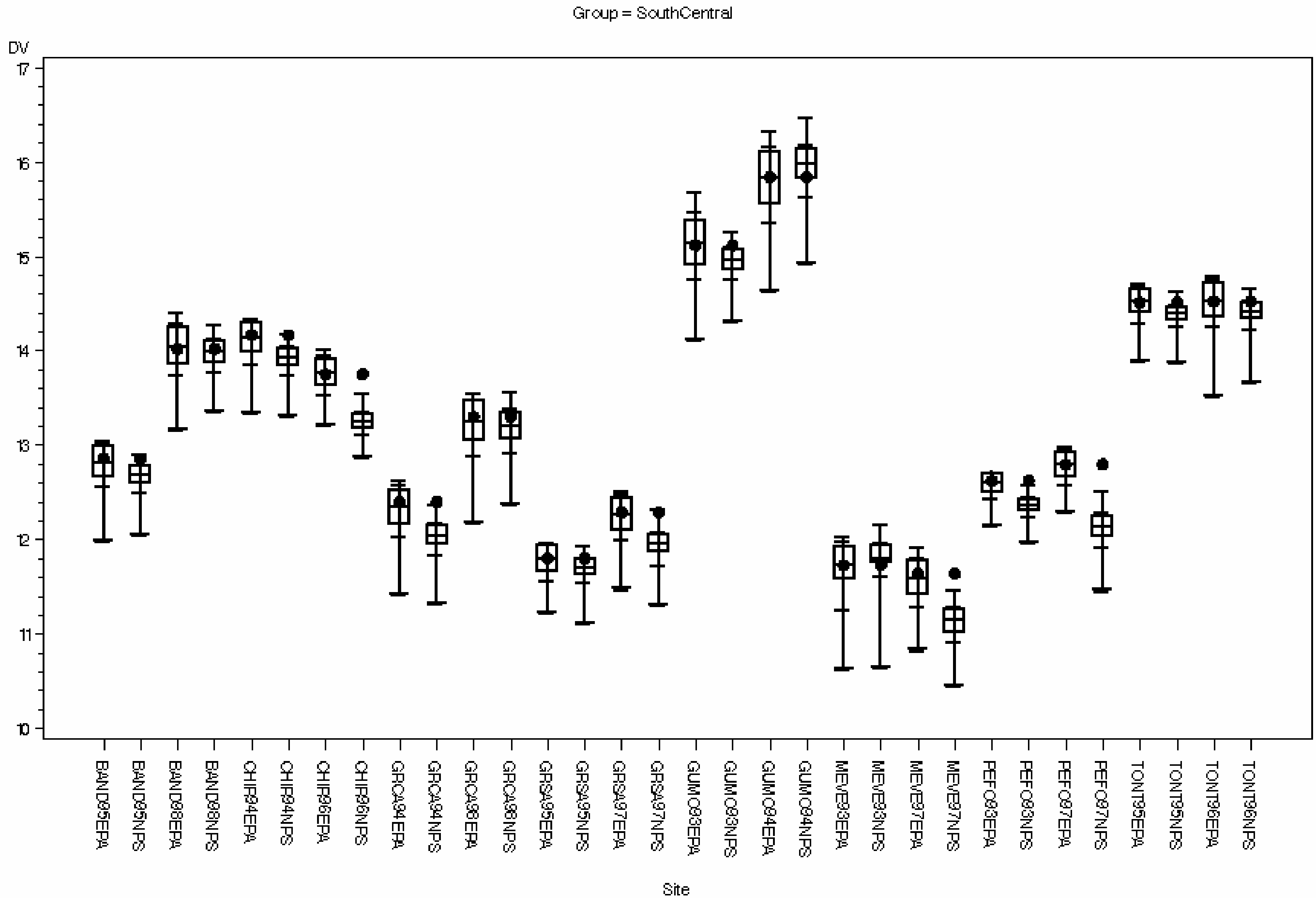
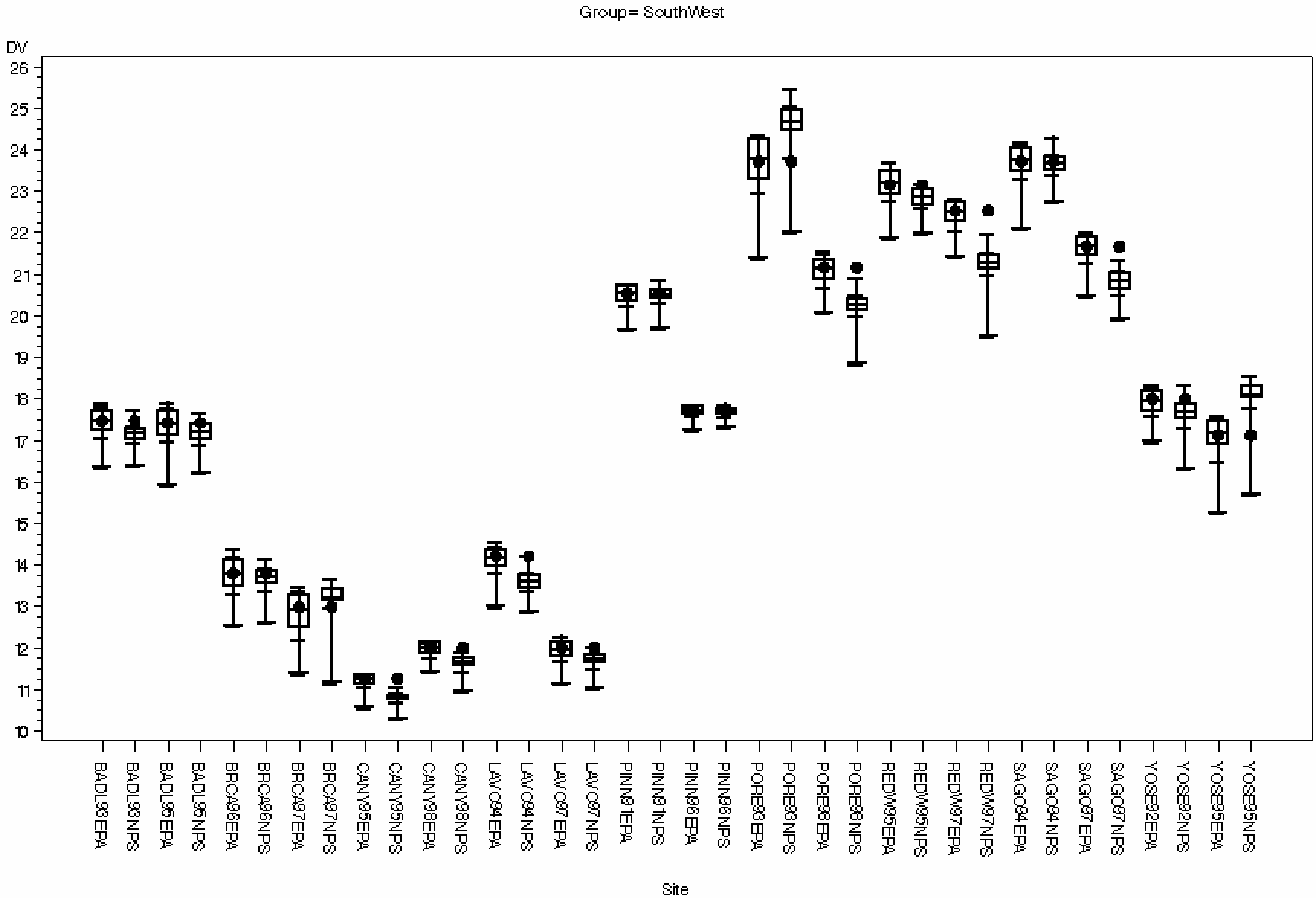


Figure 1.4 Selected percentiles of the simulated distribution of estimated annual deciview



CHAPTER 2

A Statistical Simulation Study to Evaluate the Sensitivity of Deciview Calculations to Missing Data Values With a High Level of Missing Days for Nitrate

2.1 Introduction

The results from the simulation study in Chapter 1 show that there is little practical difference between the two algorithms being compared when the percentage of missing values for any given specie is low (1% - 6%). In this chapter, we consider how these two algorithms perform when the number of missing nitrate values is increased.

2.2 Simulation with High Constant Missing Nitrate Rate

An additional simulation was run for Great Smokies (GRSM) and Shenandoah (SHEN) only, using an increased percentage of missing nitrate values. This was done to investigate the effect of high missing value rates similar to what actually occurred at these sites during 1998. As a matter of fact, the percentage of missing nitrate values for 1998 was 19% for GRSM and 32% for SHEN. For the remaining species, the percentage of days set to missing remained the same as the original simulation. For each site/year combination 1000 replicate years of simulated data were generated and analyzed.

2.3 Simulation with High Constant Missing Nitrate Rate: Results and Comments

Tables 2.1 and 2.2 contain the results from this revised simulation. Table 2.1a contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the NPS algorithm. Table 2.1b contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the EPA algorithm. Figure 2.1 is a visual summary of Tables 2.1a and 2.1b. Tables 2.2a and 2.2b contain selected percentiles of the distribution of the error percentages for the NPS algorithm and for the EPA algorithm, respectively.

Table 2.3 (a--d) is a summary of the relevant statistics for each site year combination.

Both methods show very little bias, i.e., the average value of estimated *dv* over the 1000 simulations is close to the “true value”. However, the EPA method exhibits a high degree of variability in the estimated *dv* values. This is to be expected because, when there are a large number of missing values, fewer samples are available for estimating *dv* when using the EPA method.

2.4 Simulation with Nitrate Missing Value Rate Dependent on Fine Mass Concentration

In this simulation, again for GRSM and SHEN only, where the missing value pattern for nitrates was made to depend on the total fine mass concentration. This was done to mimic the situation that was observed during 1998 when, during high fine mass days, certain problems were encountered with the filters getting clogged, resulting in missing nitrate values. This suggests a "selective missing pattern" where missing values for nitrate tended to occur during high fine mass days. To simulate such a scenario the following scheme was used. For both GRSM and SHEN, if the fine mass concentration was less than or equal to 15,000 ng/m^3 than the missing nitrate rate was 5%. For higher concentrations of fine mass, the missing nitrate rate was set to 55%. For the remaining three species, the percentage of days set to missing remained the same as in simulation study 1. For each site/year combination 1000 replicate years of simulated data were generated.

2.5 Simulation with Nitrate Missing Value Rate Dependent on Fine Mass Concentration: Results and Comments

Tables 2.4 through 2.6 contain the results from this revised simulation. Table 2.4a contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the NPS algorithm. Table 2.4b contains selected percentiles of the distribution of the 1000 deciview values calculated for the simulated years using the EPA algorithm. Figure 2.2 is a visual summary of Tables 2.4a and 2.4b. Tables 2.5a and 2.5b contain selected percentiles of the distribution of the error percentages for the NPS algorithm and for the EPA algorithm, respectively.

Table 2.6 (a--d) is a summary of the relevant statistics for each site year combination.

Note that the EPA method not only shows a high degree of variability, but also shows considerable bias, i.e., the average *dv* based on the 1000 simulations using the EPA method is much smaller than the true value. The variability can be attributed to the reduced number of data values available for using the EPA method. The bias, however, is explained by the fact that, in many of the simulated data sets, it is the high extinction days that become missing. As a result, the estimates of *dv* are systematically lower than the true value.

Table 2.1a Selected percentiles of the simulated distribution of estimated annual deciview (with high percentage of missing nitrate values) using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
GRSM	94	28.00	28.49	28.58	28.61	28.67	28.68	28.81	28.57
	95	28.33	28.78	28.96	29.03	29.12	29.13	29.24	28.91
SHEN	94	29.57	29.96	30.04	30.15	30.25	30.28	30.39	29.96
	95	29.56	30.54	30.77	30.91	31.09	31.11	31.17	30.52

Table 2.1b Selected percentiles of the simulated distribution of estimated annual deciview (with high percentage of missing nitrate values) using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
GRSM	94	26.49	27.89	28.16	28.49	28.88	29.01	29.21	28.57
	95	27.52	28.26	28.48	28.84	29.23	29.40	29.76	28.91
SHEN	94	27.28	28.96	29.31	29.86	30.42	30.68	31.33	29.96
	95	28.19	29.50	29.86	30.50	31.17	31.48	32.24	30.52

Table 2.2a Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with high percentage of missing nitrate values) using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
GRSM	94	-2.00	-0.30	0.01	0.12	0.32	0.37	0.83	28.57
	95	-2.01	-0.44	0.16	0.42	0.73	0.76	1.16	28.91
SHEN	94	-1.31	-0.01	0.28	0.64	0.97	1.06	1.42	29.96
	95	-3.13	0.07	0.83	1.29	1.88	1.94	2.13	30.52

Table 2.2b Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with high percentage of missing nitrate values) using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	True Deciview
GRSM	94	-7.30	-2.40	-1.45	-0.28	1.08	1.53	2.22	28.57
	95	-4.81	-2.26	-1.47	-0.24	1.09	1.69	2.94	28.91
SHEN	94	-8.96	-3.34	-2.18	-0.35	1.55	2.41	4.58	29.96
	95	-7.64	-3.35	-2.15	-0.07	2.13	3.17	5.64	30.52

Table 2.3: Summary information from the 1000 simulations for each site-year combination (with high percentage of missing nitrate values).

Table 2.3a GRSM 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	28.57	---	---	---
	Simulated NPS	28.61	0.10	28.00	28.81
	Simulated EPA	28.49	0.43	26.49	29.21
Number of Missing Days for:	Total	25.17	1.16	20.00	27.00
	Fine Mass	2.00	---	---	---
	Carbon	0.38	0.56	0	2
	Total Mass	0.79	0.79	0	4
	NO3	3.74	1.55	0	9
Percent Error	NPS	0.12	0.35	-2.00	0.83
	EPA	-0.28	1.50	-7.30	2.22

Table 2.3b GRSM 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	28.91	---	---	---
	Simulated NPS	29.03	0.14	28.33	29.24
	Simulated EPA	28.84	0.44	27.52	29.76
Number of Missing Days for:	Total	28.62	1.31	25.00	31.00
	Fine Mass	3.00	---	---	---
	Carbon	0.56	0.67	0	3
	Total Mass	1.06	0.91	0	4
	NO3	4.00	1.54	0	9
Percent Error	NPS	0.42	0.47	-2.01	1.16
	EPA	-0.24	1.51	-4.81	2.94

Table 2.3c SHEN 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	29.96	---	---	---
	Simulated NPS	30.15	0.14	29.57	30.39
	Simulated EPA	29.86	0.68	27.28	31.33
Number of Missing Days for:	Total	41.45	1.60	36.00	46.00
	Fine Mass	4.00	---	---	---
	Carbon	0.78	0.80	0	4
	Total Mass	0.92	0.84	0	4
	NO3	6.39	1.93	1	12
Percent Error	NPS	0.64	0.46	-1.31	1.42
	EPA	-0.35	2.25	-8.96	4.58

Table 2.3d SHEN 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	True	30.52	---	---	---
	Simulated NPS	30.91	0.25	29.56	31.17
	Simulated EPA	30.50	0.75	28.19	32.24
Number of Missing Days for:	Total	36.49	1.41	32.00	40.00
	Fine Mass	3.00	---	---	---
	Carbon	0.55	0.66	0	3
	Total Mass	0.76	0.77	0	3
	NO3	5.86	1.81	1	12
Percent Error	NPS	1.29	0.82	-3.13	2.13
	EPA	-0.07	2.47	-7.64	5.64

Table 2.4a Selected percentiles of the simulated distribution of estimated annual deciview (with missing nitrate rate dependent on fine mass concentration) using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	TRUE Deciview
GRSM	94	28.07	28.47	28.57	28.61	28.67	28.69	28.89	28.57
	95	28.38	28.79	28.96	29.03	29.12	29.13	29.21	28.91
SHEN	94	29.49	29.95	30.04	30.15	30.26	30.29	30.44	29.96
	95	30.01	30.57	30.77	30.91	31.09	31.11	31.18	30.52

Table 2.4b Selected percentiles of the simulated distribution of estimated annual deciview (with missing nitrate rate dependent on fine mass concentration) using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	TRUE Deciview
GRSM	94	23.78	25.57	25.97	26.58	27.24	27.56	28.68	28.57
	95	24.63	26.09	26.39	27.01	27.63	27.96	28.97	28.91
SHEN	94	25.65	27.04	27.38	27.93	28.52	28.84	30.11	29.96
	95	26.35	27.85	28.18	28.80	29.46	29.78	31.14	30.52

Table 2.5a Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with missing nitrate rate dependent on fine mass concentration) using the NPS algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	TRUE Deciview
GRSM	94	-1.75	-0.35	-0.01	0.12	0.34	0.41	1.11	28.57
	95	-1.82	-0.42	0.17	0.43	0.73	0.77	1.03	28.91
SHEN	94	-1.57	-0.05	0.28	0.64	1.00	1.10	1.62	29.96
	95	-1.67	0.18	0.84	1.28	1.87	1.94	2.18	30.52

Table 2.5b Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with missing nitrate rate dependent on fine mass concentration) using the EPA algorithm.

SITE	YEAR	Min	10th Percentile	20th Percentile	Mean	80th Percentile	90th Percentile	Max	TRUE Deciview
GRSM	94	-16.76	-10.51	-9.12	-6.97	-4.66	-3.55	0.36	28.57
	95	-14.82	-9.76	-8.71	-6.57	-4.41	-3.29	0.22	28.91
SHEN	94	-14.38	-9.76	-8.62	-6.79	-4.79	-3.73	0.51	29.96
	95	-13.66	-8.73	-7.67	-5.61	-3.48	-2.42	2.04	30.52

Table 2.6: Summary information from the 1000 simulations for each site-year combination (with missing nitrate rate dependent on fine mass concentration).

Table 2.6a GRSM 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	TRUE	28.57	---	---	---
	Simulated NPS	28.61	0.10	28.07	28.89
	Simulated EPA	26.58	0.76	23.78	28.68
Number of Missing Days for:	Total	24.81	3.04	15	33
	Fine Mass	2.00	---	---	---
	Carbon	0.42	0.57	0	2
	Total Mass	0.74	0.78	0	3
	NO3	10.42	2.15	4	18
Percent Error	NPS	0.12	0.35	-1.75	1.11
	EPA	-6.97	2.67	-16.76	0.36

Table 2.6b GRSM 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	TRUE	28.91	---	---	---
	Simulated NPS	29.03	0.13	28.38	29.21
	Simulated EPA	27.01	0.71	24.63	28.97
Number of Missing Days for:	Total	27.93	3.17	18	38
	Fine Mass	3	---	---	---
	Carbon	0.61	0.69	0	3
	Total Mass	1.00	0.87	0	4
	NO3	11.61	2.14	4	18
Percent Error	NPS	0.43	0.46	-1.82	1.03
	EPA	-6.57	2.46	-14.82	0.22

Table 2.6c SHEN 94

	Variable	Mean	Std Dev	Minimum	Maximum
Data	TRUE	29.96	---	---	---
	Simulated NPS	30.15	0.15	29.49	30.44
	Simulated EPA	27.93	0.71	25.65	30.11
Number of Missing Days for:	Total	27.90	3.05	18	38
	Fine Mass	4	---	---	---
	Carbon	0.80	0.79	0	4
	Total Mass	1.00	0.87	0	4
	NO3	11.00	2.17	5	17
Percent Error	NPS	0.64	0.49	-1.57	1.62
	EPA	-6.79	2.37	-14.38	0.51

Table 2.6d SHEN 95

	Variable	Mean	Std Dev	Minimum	Maximum
Data	TRUE	30.52	---	---	---
	Simulated NPS	30.91	0.24	30.01	31.18
	Simulated EPA	28.80	0.75	26.35	31.14
Number of Missing Days for:	Total	23.07	2.89	14	34
	Fine Mass	3	---	---	---
	Carbon	0.59	0.68	0	3
	Total Mass	0.78	0.78	0	4
	NO3	9.79	2.11	4	16
Percent Error	NPS	1.28	0.79	-1.67	2.18
	EPA	-5.61	2.47	-13.66	2.04

Figure 2.1 Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with high percentage of missing nitrate values).

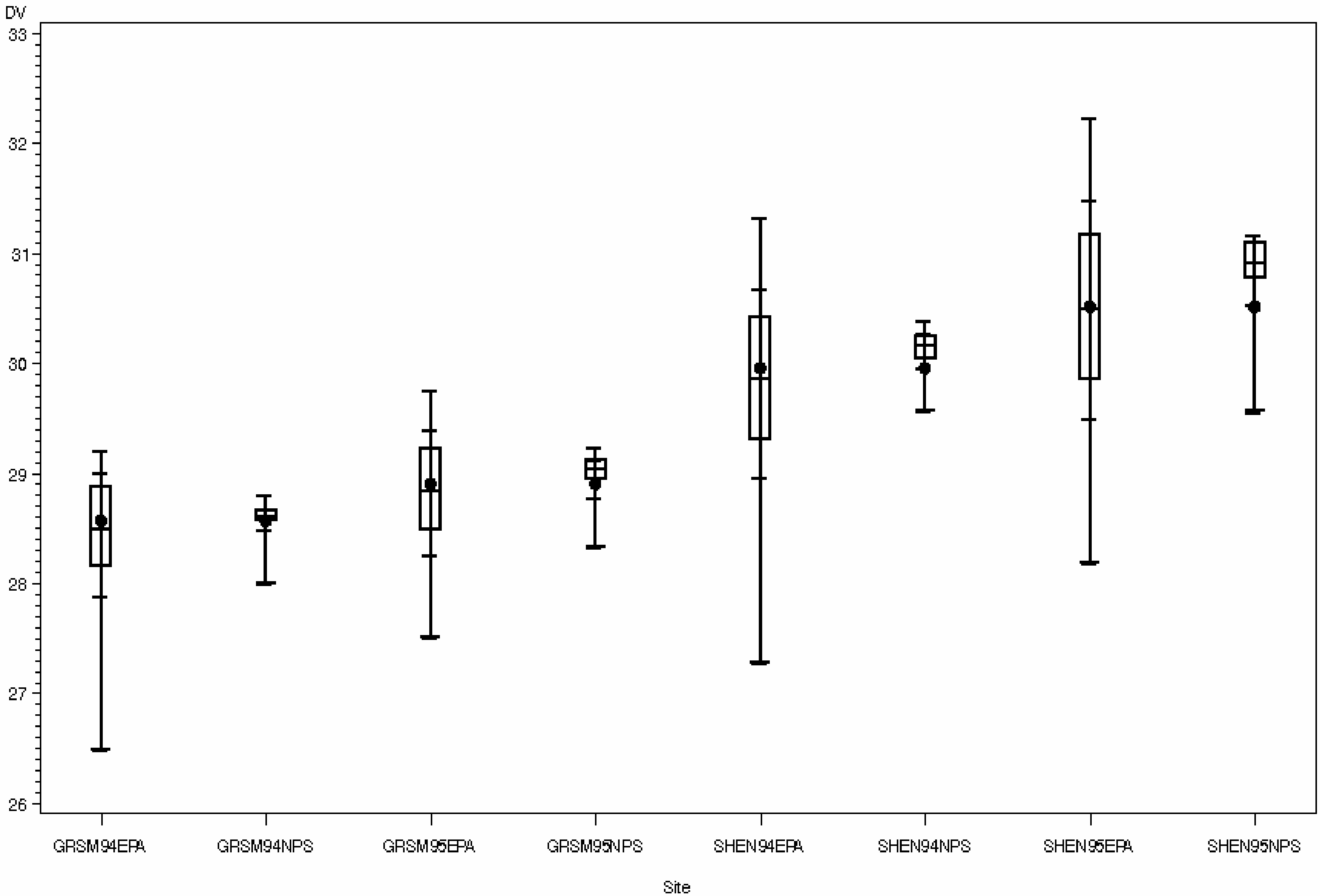
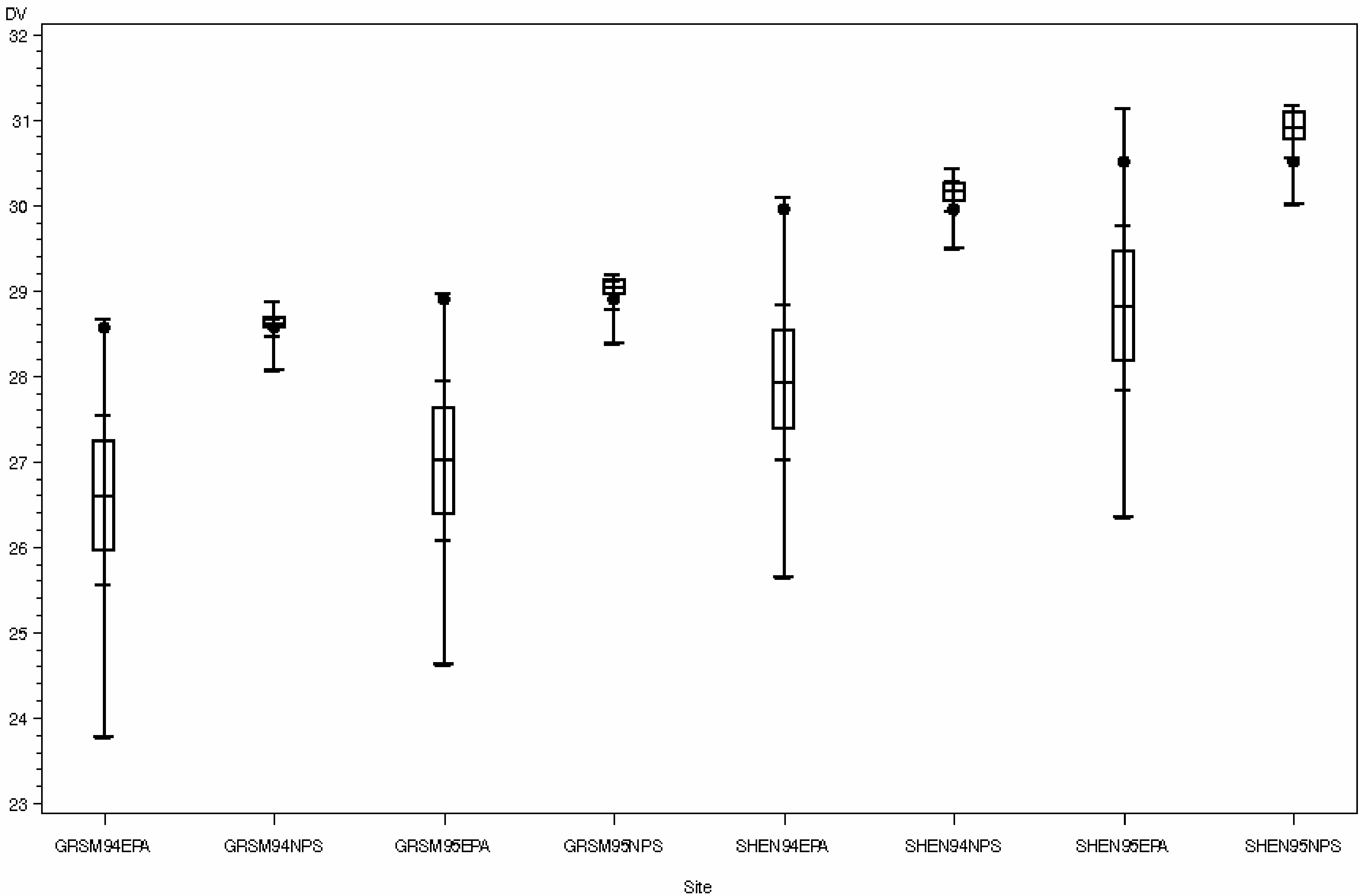


Figure 2.2 Selected percentiles of the simulated distribution of percent errors when estimating the annual deciview (with percentage of missing nitrate values dependent on fine mass concentration).



CHAPTER 3

Investigations on the Effect of Using a Constant f(rh) Value in the Deciview Calculation

3.1 Introduction

In all of the simulations discussed above, we used a constant f(rh) value, where the constant value was the annual average f(rh) as supplied by J.Sisler. In this chapter, we explore the effect of using a day-specific or month-specific f(rh).

3.2 Examination of the Effect of Using a Constant f(rh) Value Versus Daily f(rh) Values

In order to compare the effect of using a day specific f(rh) value versus a constant f(rh) value, the annual deciview index dv was estimated using four different methods. These methods are labeled as follows:

1. Method D: EPA method using <u>daily</u> f(rh).
2. Method A: EPA method using an <u>average</u> annual f(rh) value as provided by Sisler.
3. Method T: EPA method using an average f(rh) value based on the <u>top 20%</u> of deciview days.
4. Method S: <u>Sisler's</u> method using an annual average f(rh) value.

Only site/year combinations from the original simulations for which we had co-located RH data were considered. In addition, only days for which no aerosol values or daily f(rh) were missing were used.

3.3 Examination of the Effect of Using a Constant f(rh) Value Versus Daily f(rh) Values: Results and Comments

Figure 3.1 shows the estimated annual deciview index using the four different methods. Figures 3.2.1 through 3.2.31 show the extinction for the days chosen by each method by site and year (D=1, A=2, T=3, S=4). Note that the negative values for course mass are due to the fact that these values were not replaced with zeroes. This should have little effect on the simulation results.

An examination of the figures reveals that, if we are interested in the annual average worst 20% deciview value, then there is little difference between the four methods. If we are interested in the actual days chosen for inclusion in the top 20%, then the NPS method differed somewhat from the other three methods.

3.4 Examination of the Effect of Using a Constant f(rh) Value Versus Monthly f(rh) Values

For sites which have at least 5 years of coincident aerosol and rh data, a monthly-averaged f(rh) value was computed for each month within each year. The monthly average was computed using the daily f(rh) values for all days of the month (not just aerosol sampling days). If a day did not have at least 16 hourly values for f(rh) it was not used in computing the average. Similarly, if a month had less than 18 daily f(rh) values it was not included in further analyses. The quantities being estimated in this study are the average deciview for the 20% worst days (dv_{worst}) and the average deciview for the 20% best days (dv_{best}).

The problem of missing aerosol values was treated according to a proposal currently under consideration[•] by the EPA. According to this strategy, missing values are handled by substituting the 10th percentile when estimating dv_{worst} and 90th percentiles when estimating dv_{best} (10th and 90th percentiles for the month in question based on all available years of data for that month). Days with missing daily f(rh) values were not included in further analyses.

Using an identical data set, the daily reconstructed extinction and hence the daily deciview was calculated using both daily and monthly f(rh) values. The average of the 20% worst days and 20% best days deciview values were calculated using both methods.

3.5 Examination of the Effect of Using a Constant f(rh) Value Versus Monthly f(rh) Values: Results and Comments

Figures 3.3.1 through 3.3.16 summarize the results by site. It appears that the use of daily f(rh) versus monthly average f(rh) didn't make a practical difference.

• The EPA proposal referred to here was being considered by them at the time the simulation study was conducted.

Figure 3.1 Comparison of annual average worst 20% deciview value using four different methods.

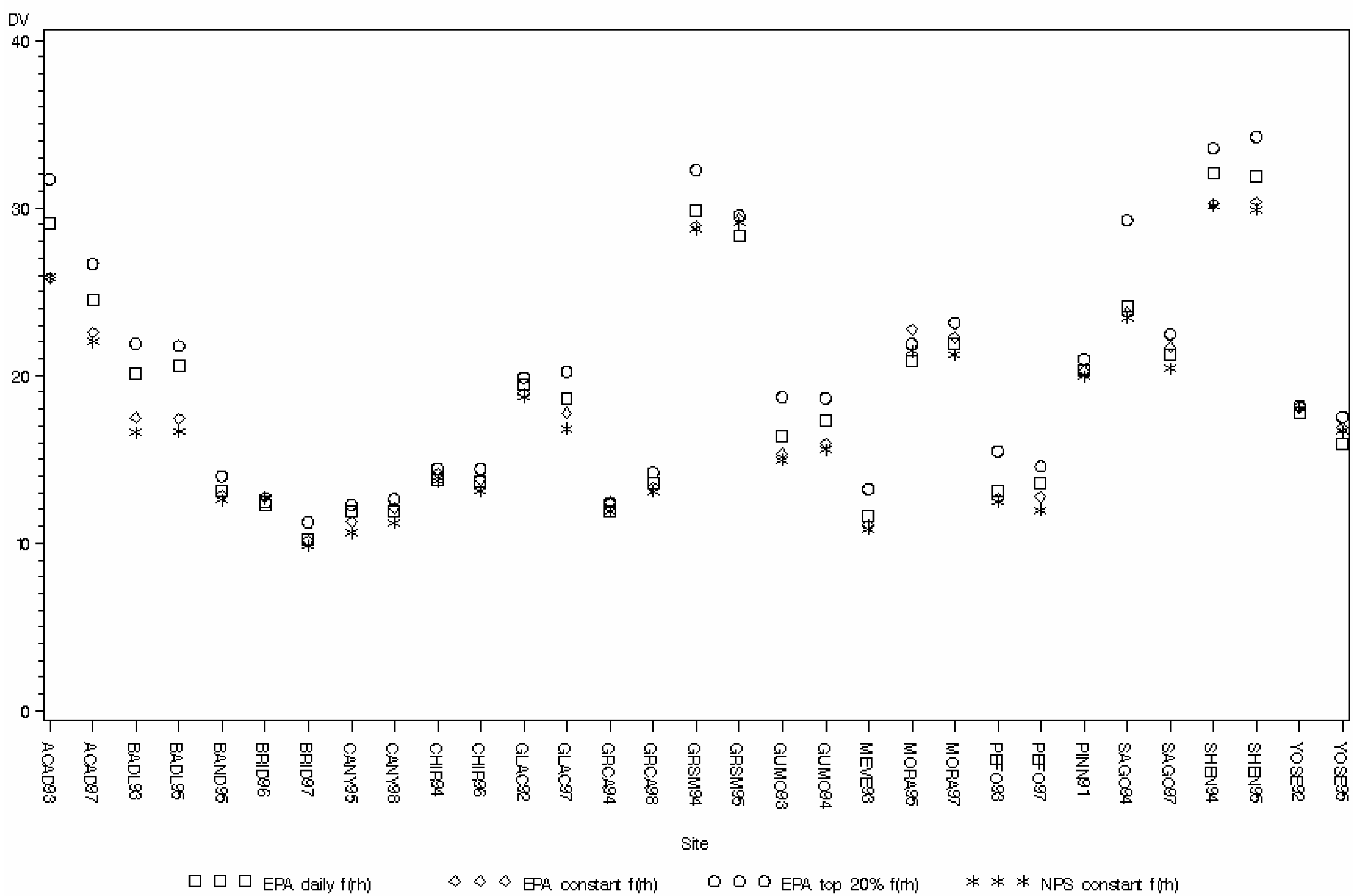


Figure 3.2.1 Extinction Budgets for ACAD 93 for Days Selected to be a Top 20% Day by at least one of the four methods considered

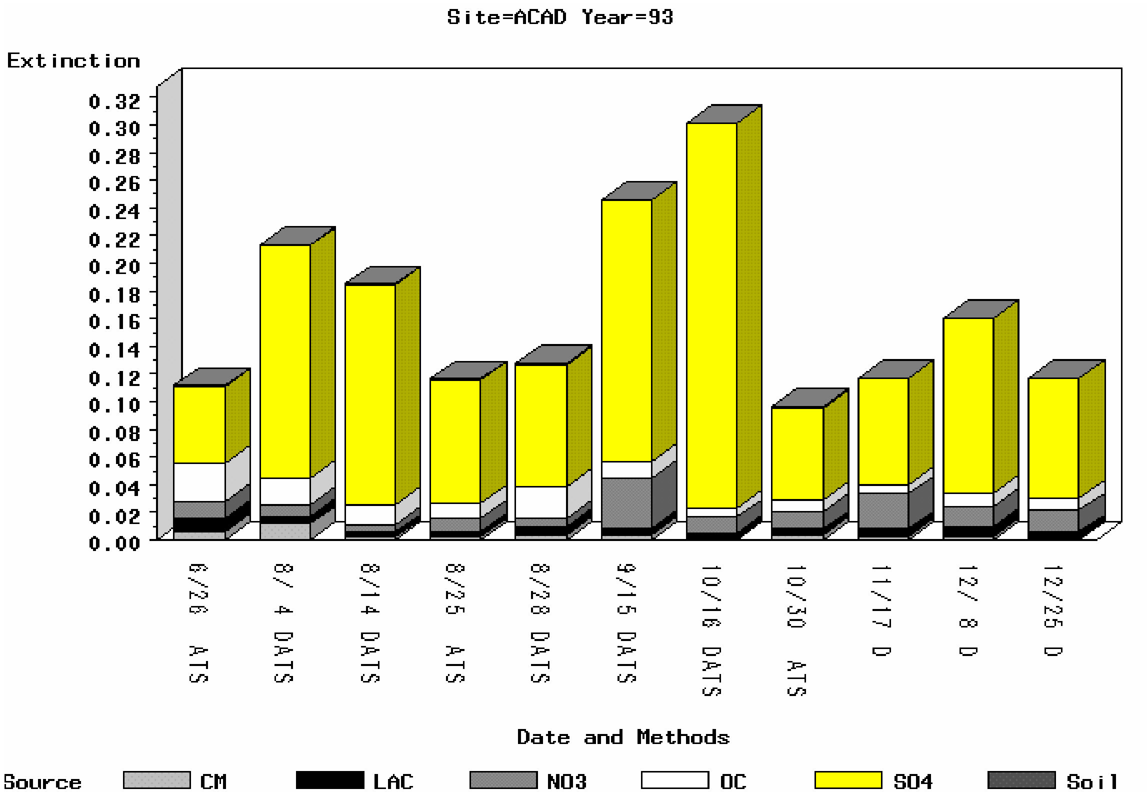


Figure 3.2.2 Extinction Budgets for ACAD 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

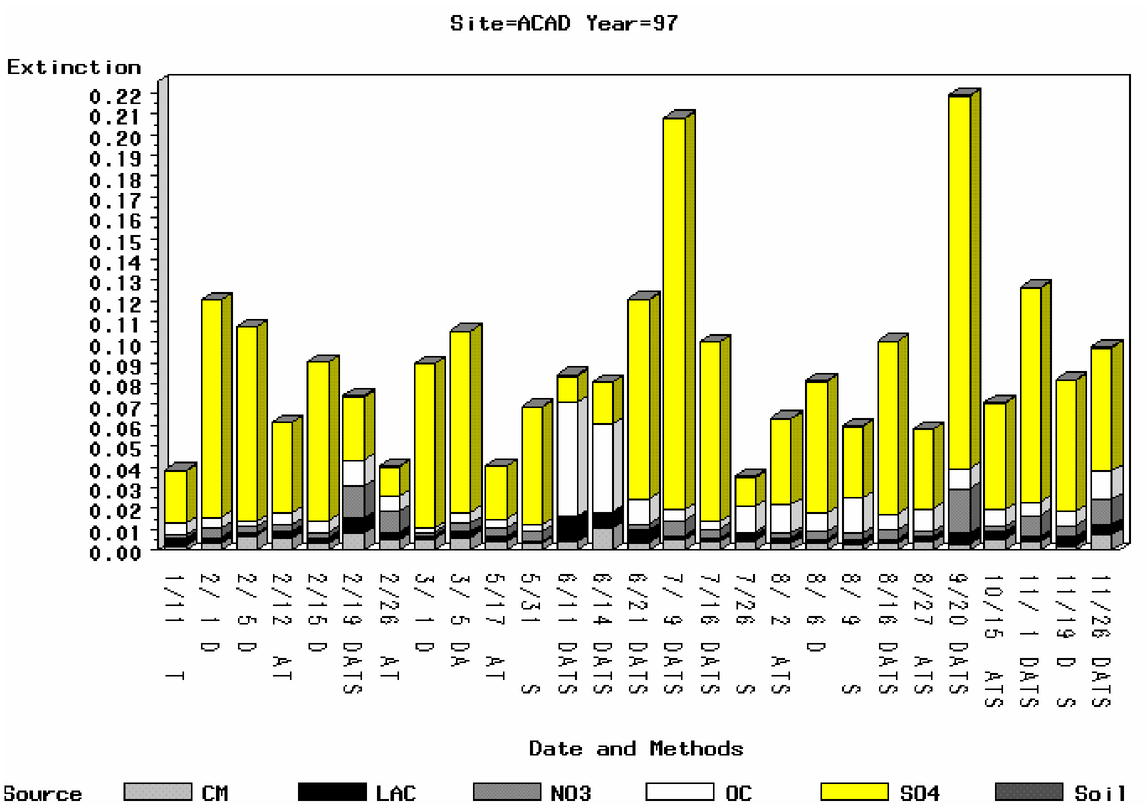


Figure 3.2.3 Extinction Budgets for BADL 93 for Days Selected to be a Top 20% Day by at least one of the four methods considered

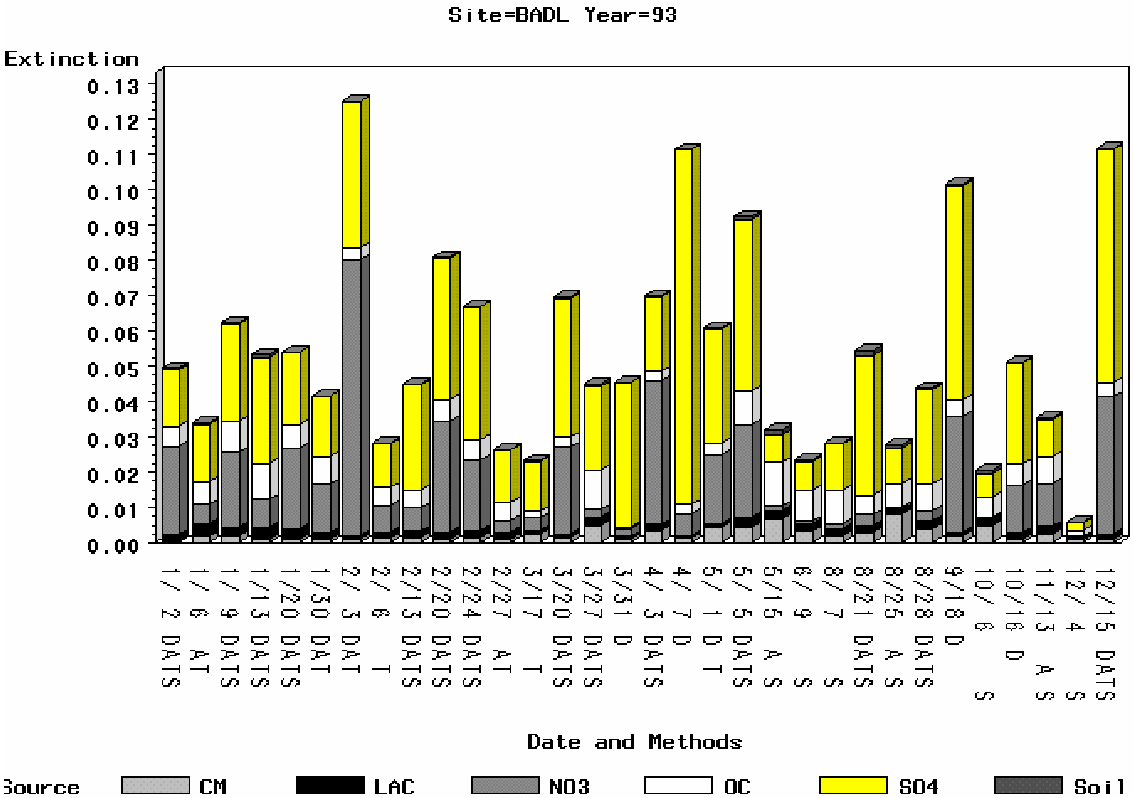


Figure 3.2.4 Extinction Budgets for BADL 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

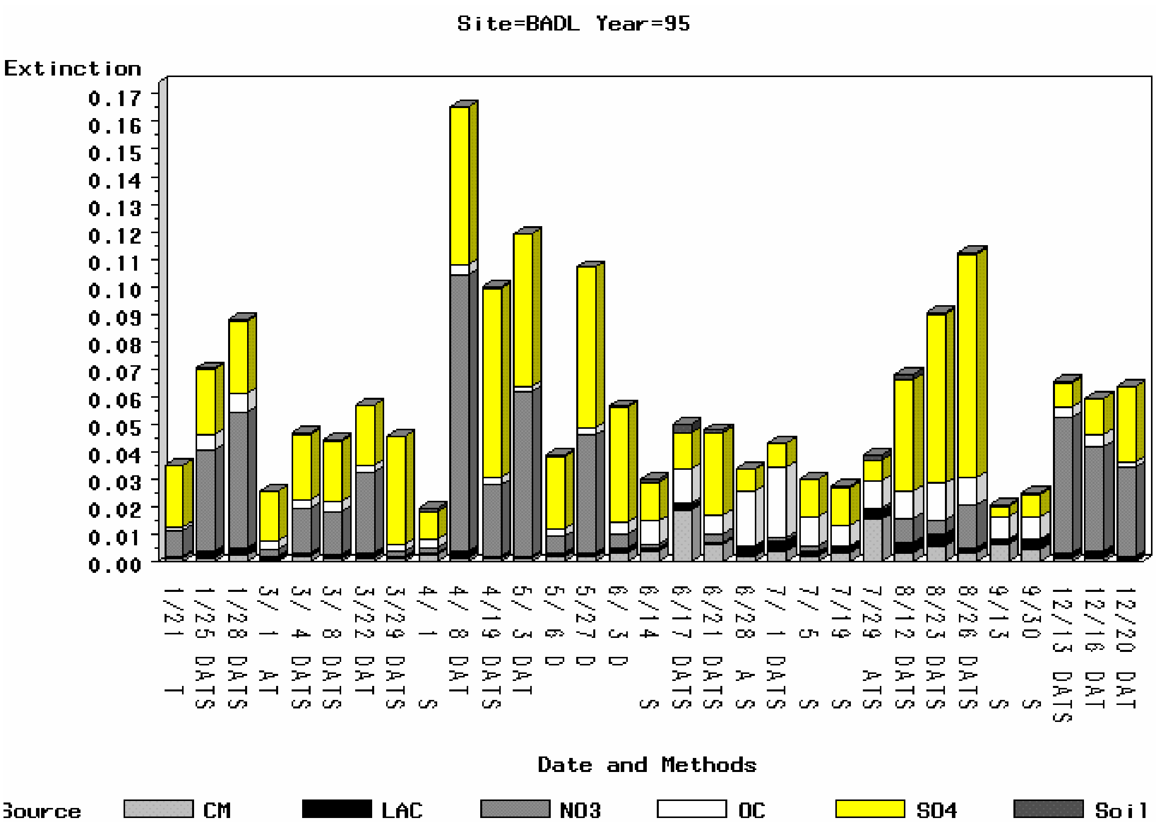


Figure 3.2.5 Extinction Budgets for BAND 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

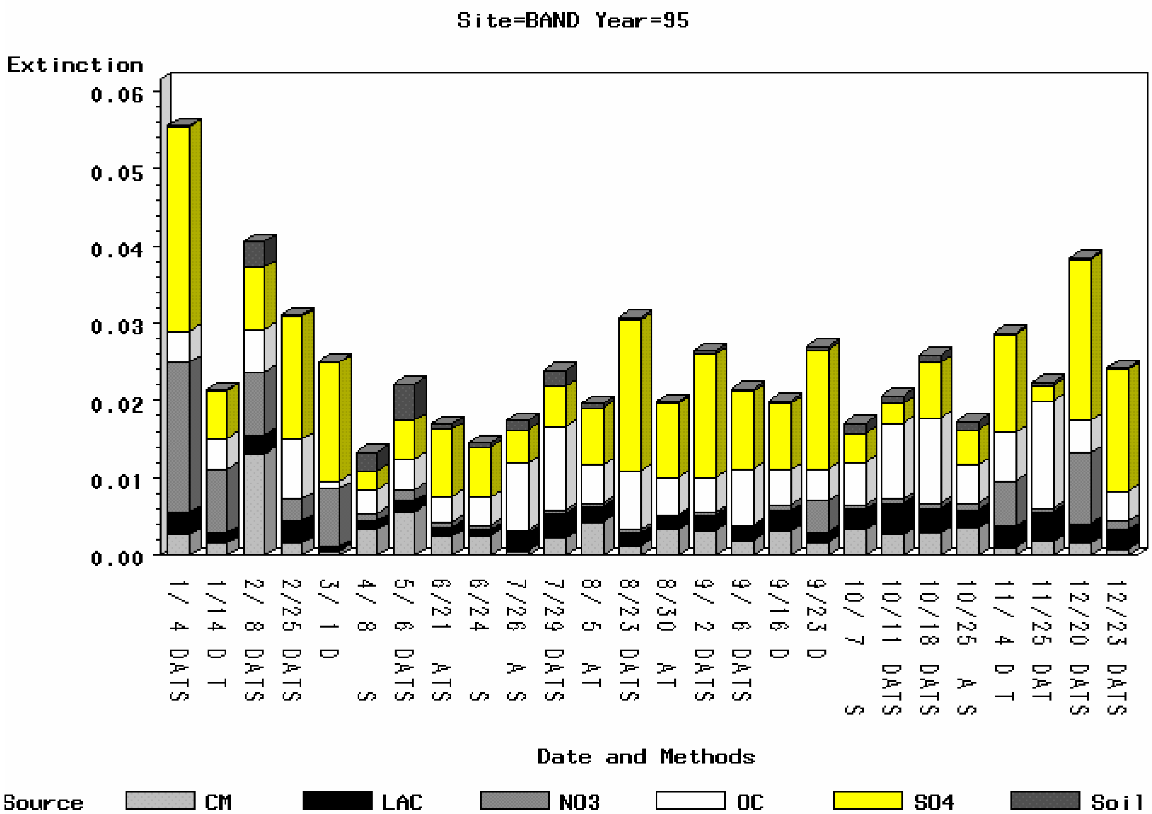


Figure 3.2.6 Extinction Budgets for BRID 96 for Days Selected to be a Top 20% Day by at least one of the four methods considered

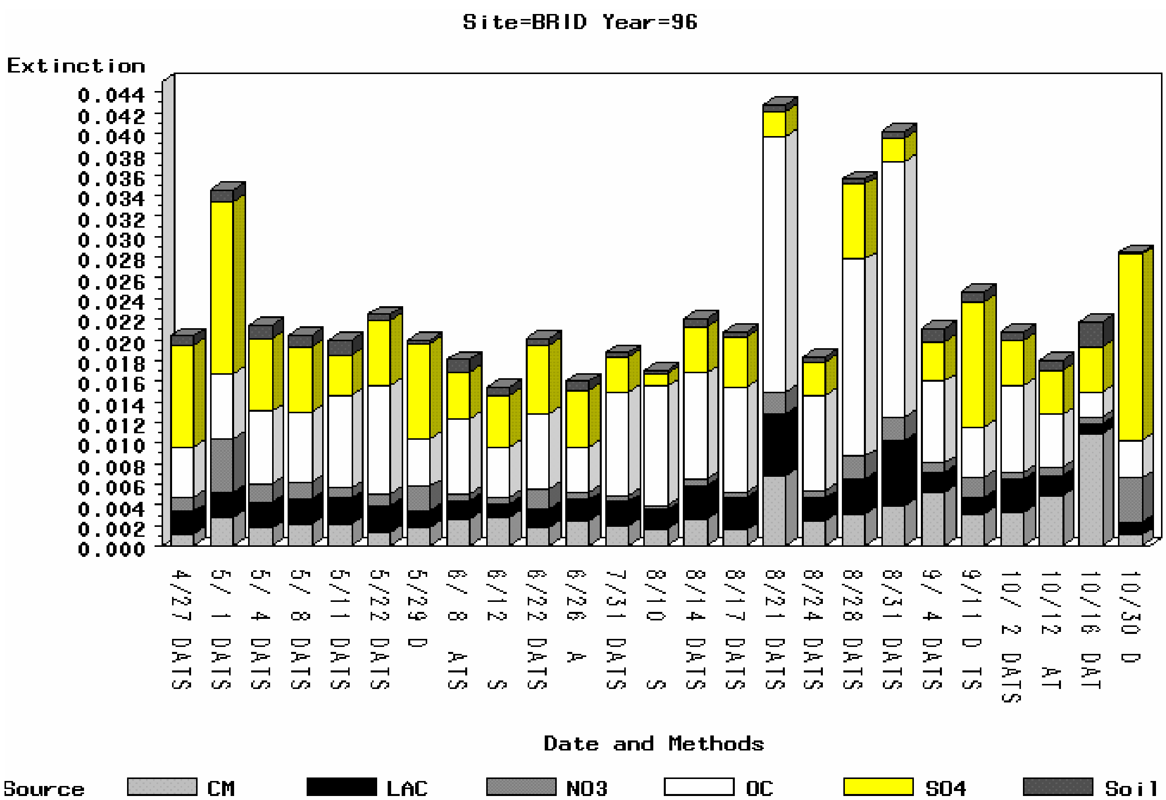


Figure 3.2.7 Extinction Budgets for BRID 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

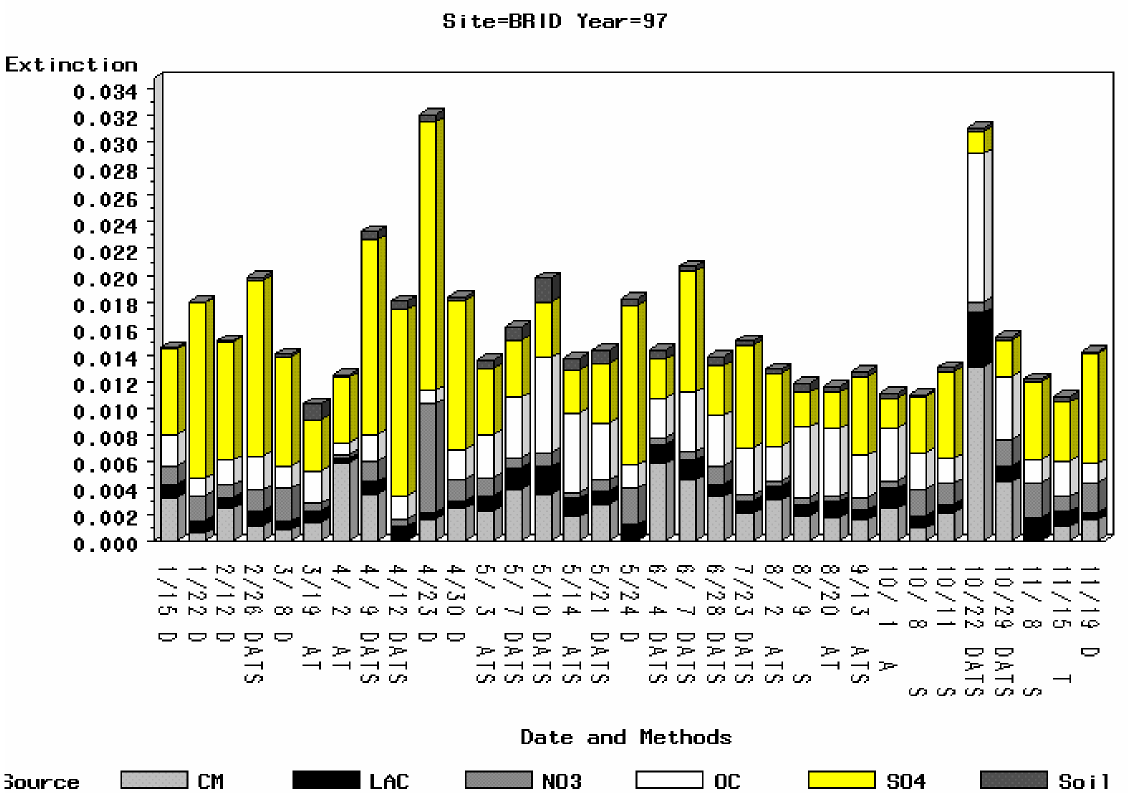


Figure 3.2.8 Extinction Budgets for CANY 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

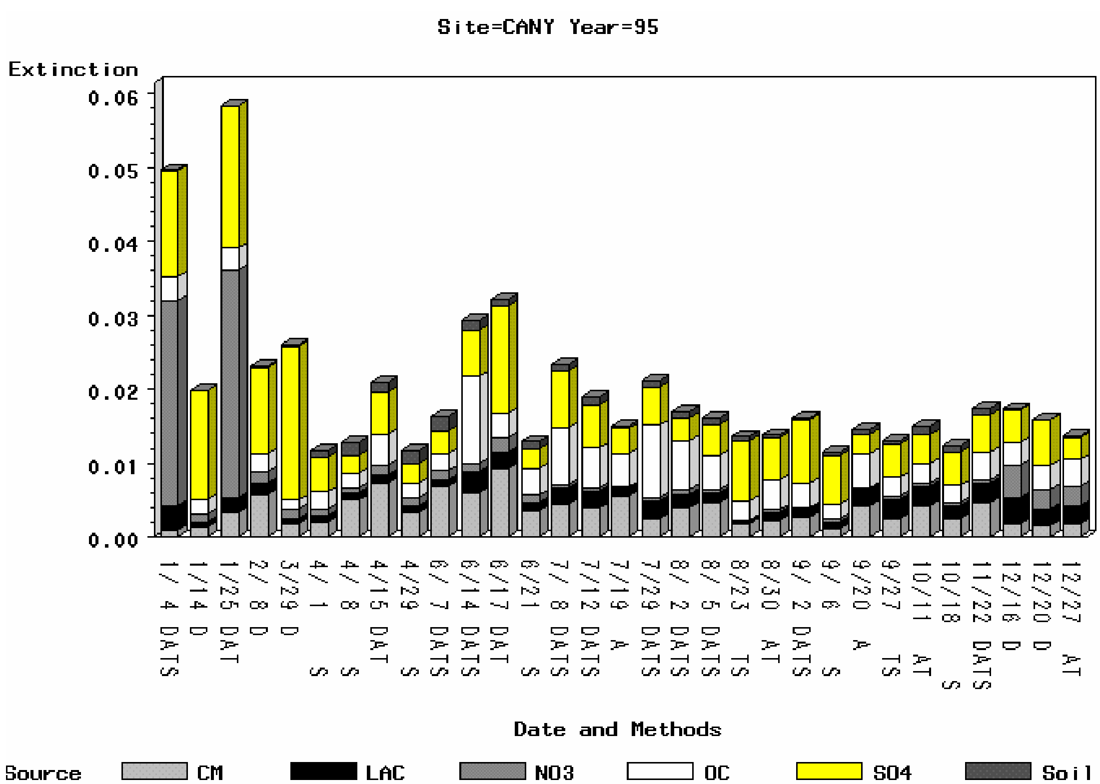


Figure 3.2.9 Extinction Budgets for CANY 98 for Days Selected to be a Top 20% Day by at least one of the four methods considered

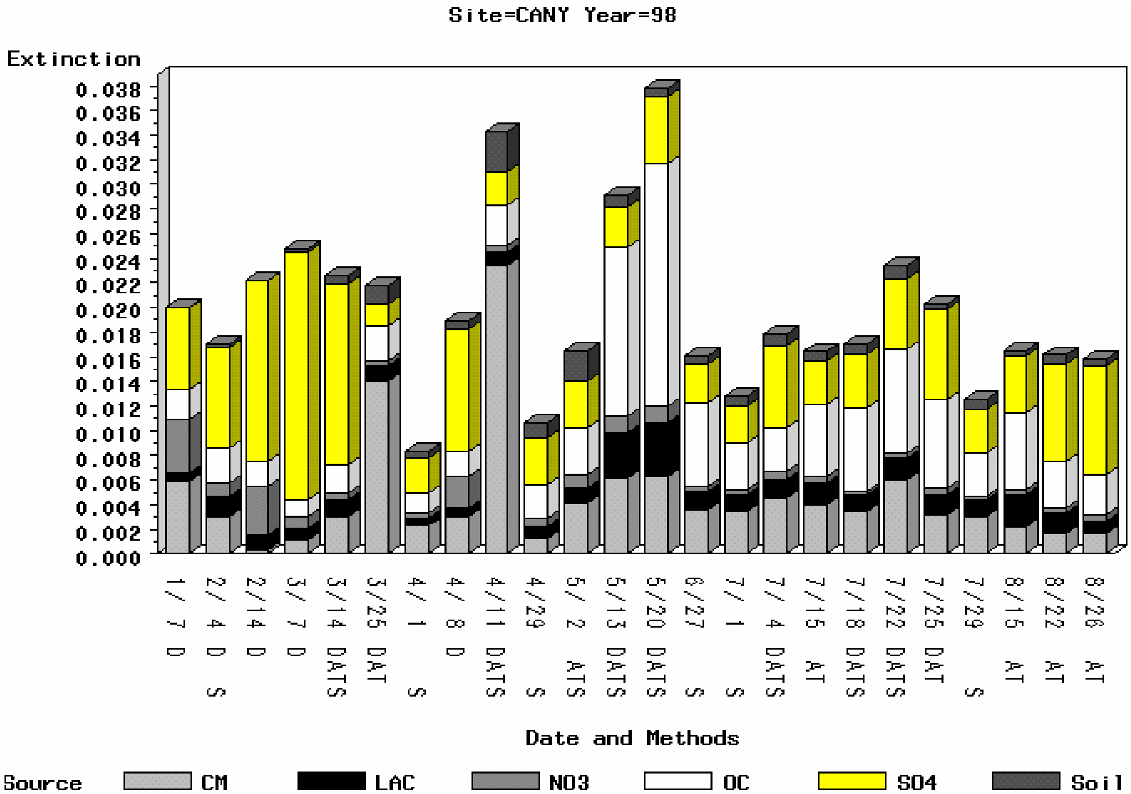


Figure 3.2.10 Extinction Budgets for CHIR 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

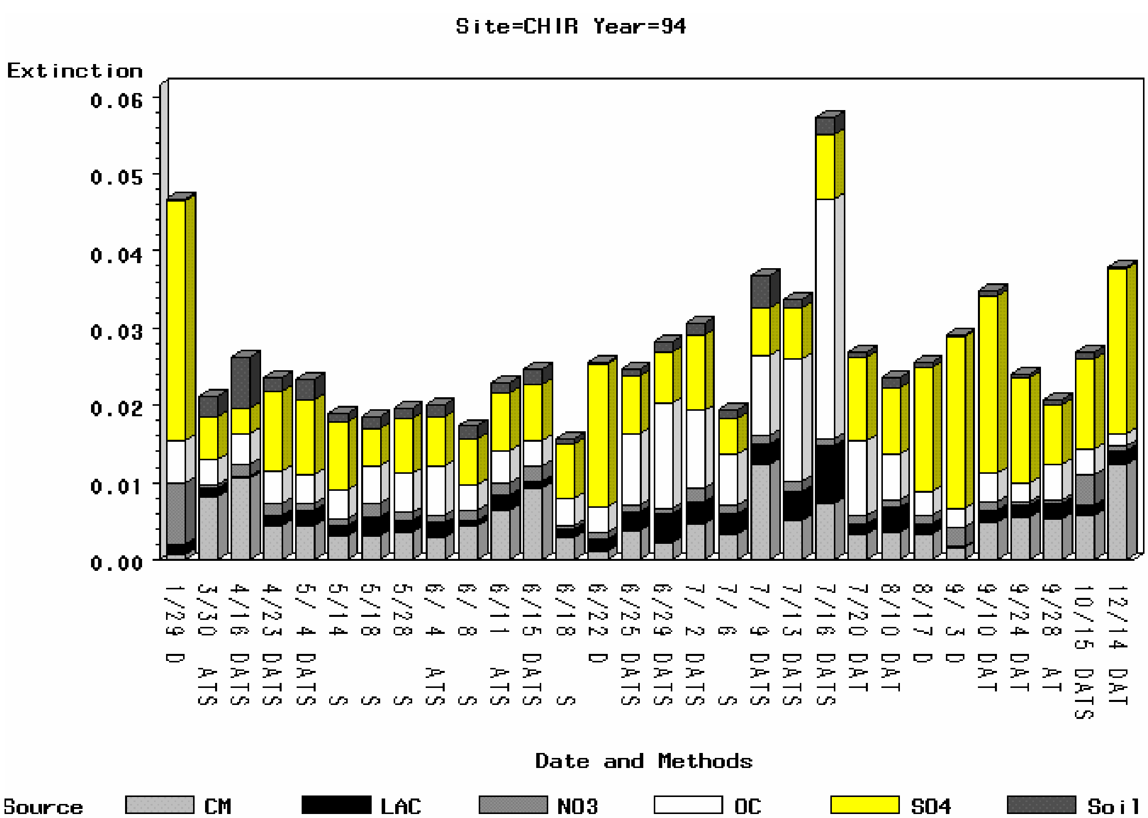


Figure 3.2.11 Extinction Budgets for CHIR 96 for Days Selected to be a Top 20% Day by at least one of the four methods considered

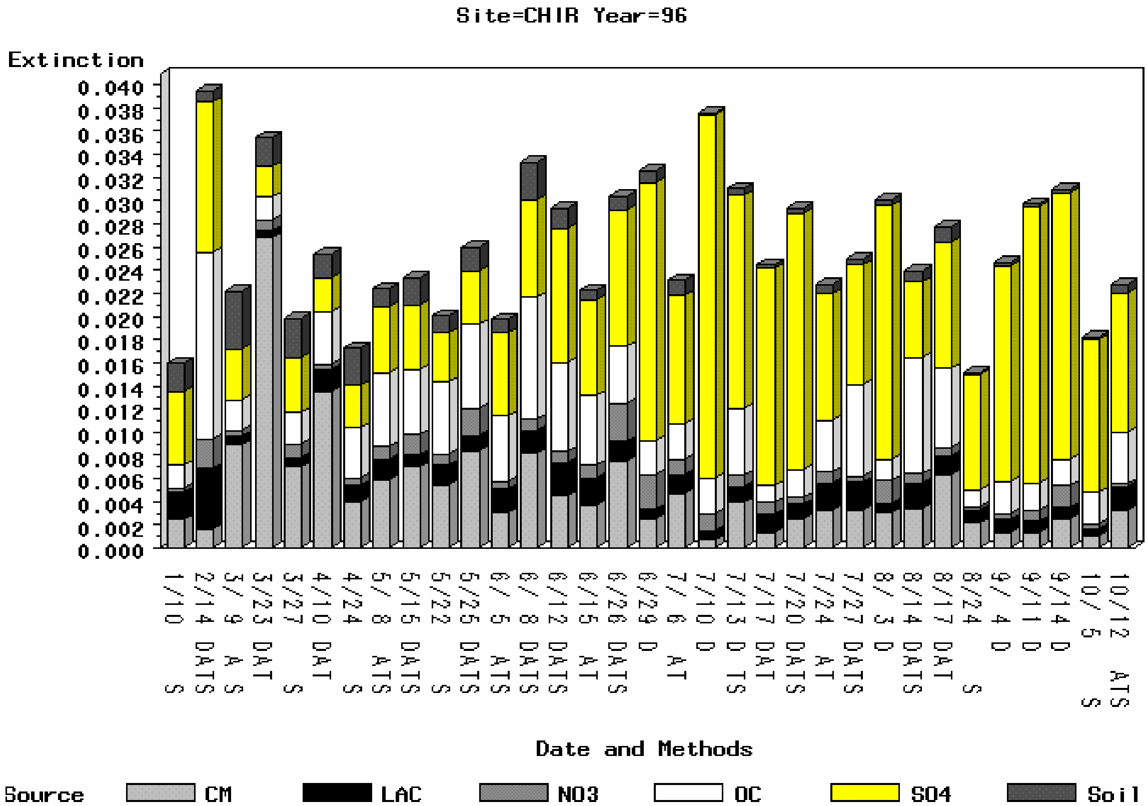


Figure 3.2.12 Extinction Budgets for GLAC 92 for Days Selected to be a Top 20% Day by at least one of the four methods considered

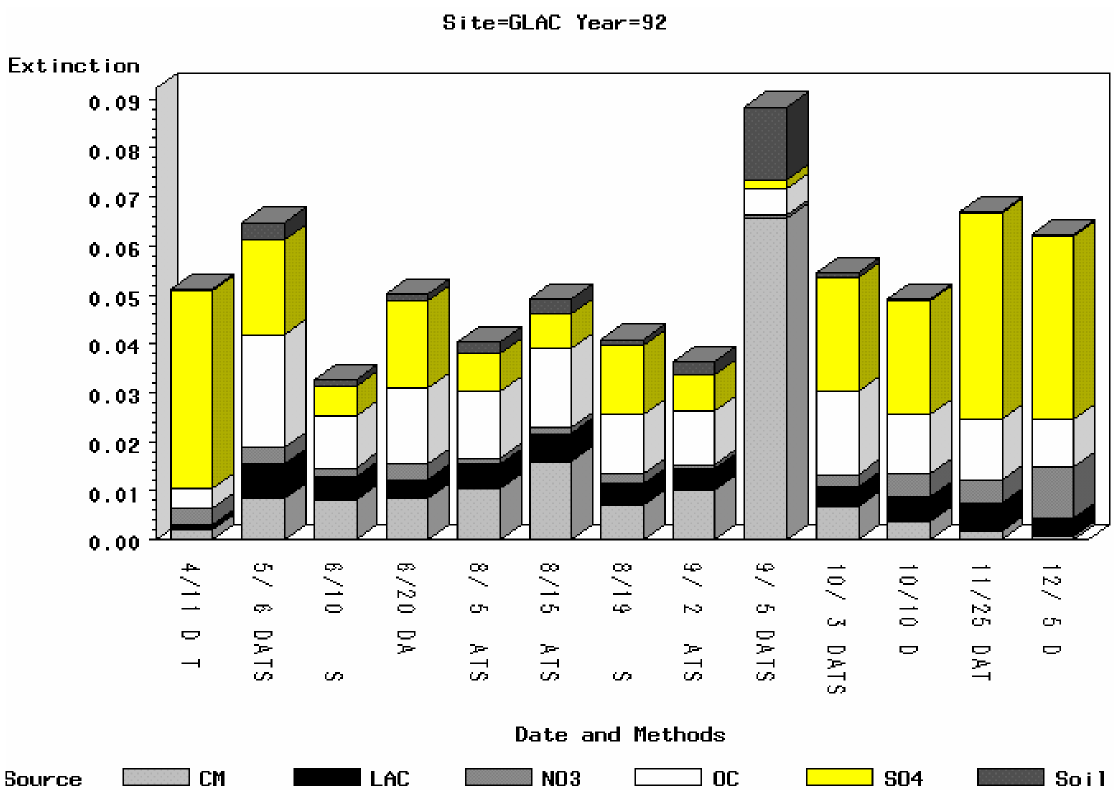


Figure 3.2.13 Extinction Budgets for GLAC 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

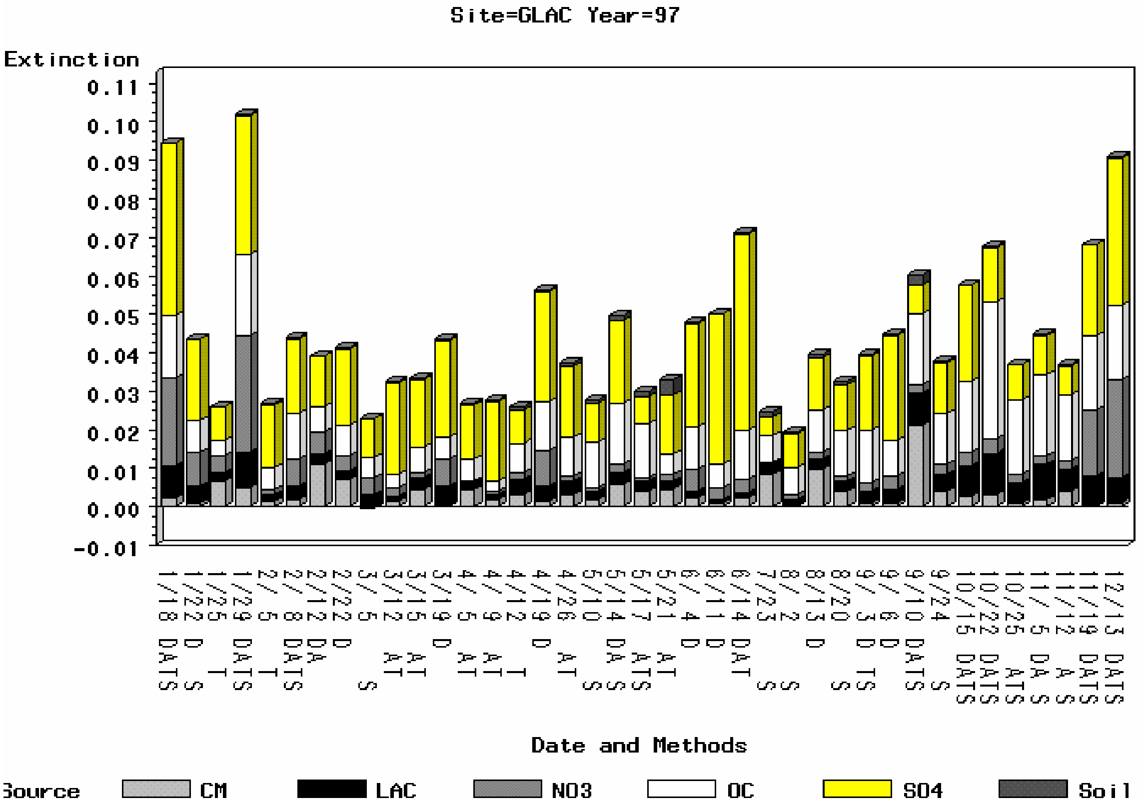


Figure 3.2.14 Extinction Budgets for GRCA 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

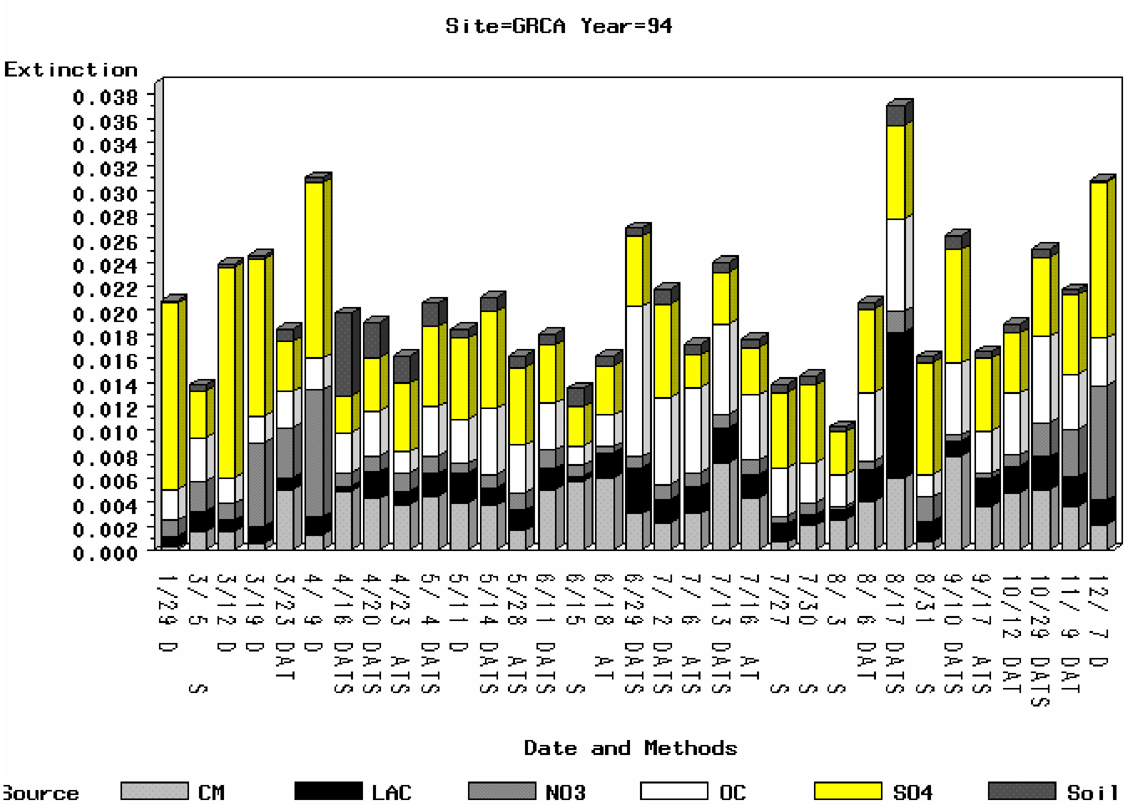


Figure 3.2.15 Extinction Budgets for GRCA 98 for Days Selected to be a Top 20% Day by at least one of the four methods considered

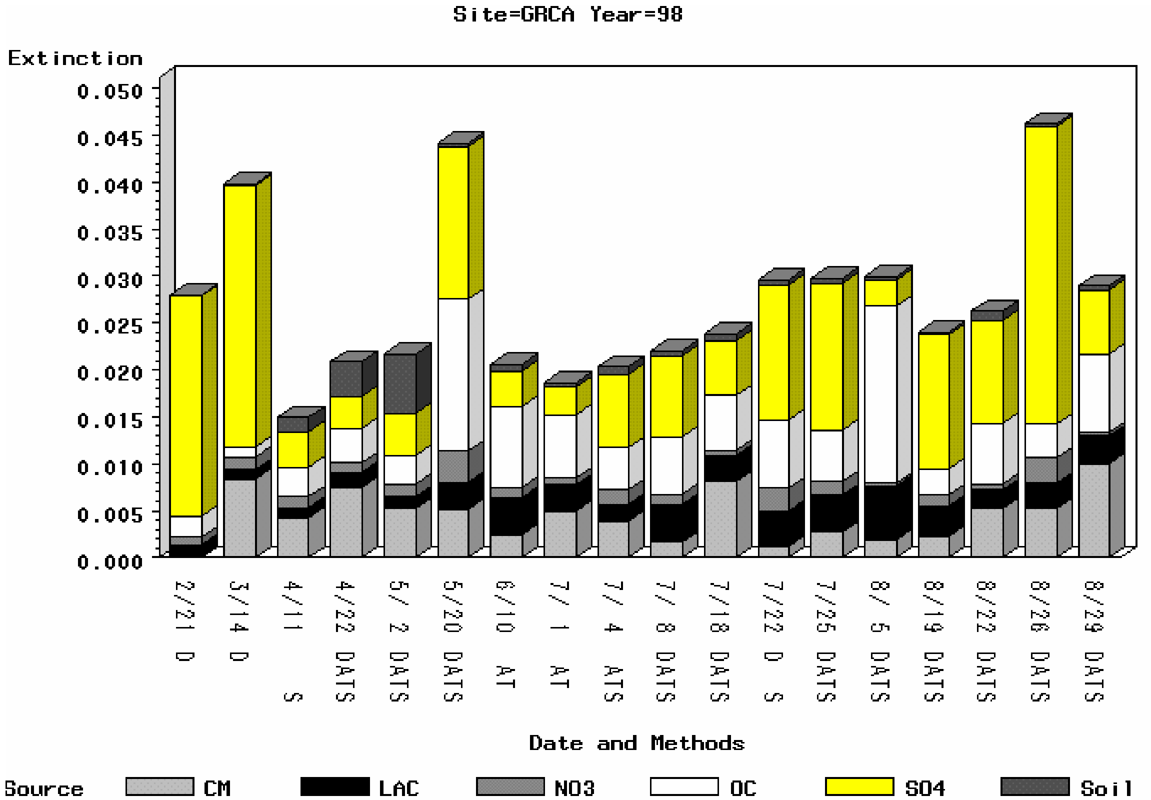


Figure 3.2.16 Extinction Budgets for GRSM 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

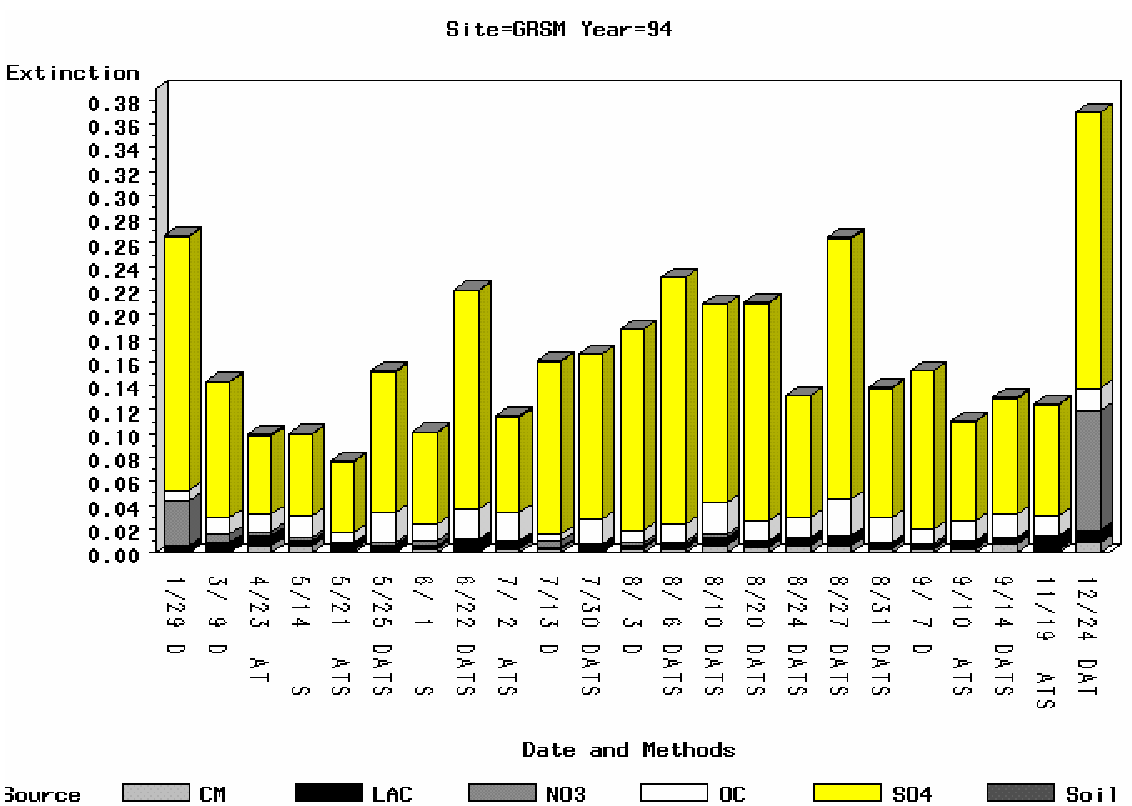


Figure 3.2.17 Extinction Budgets for GRSM 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

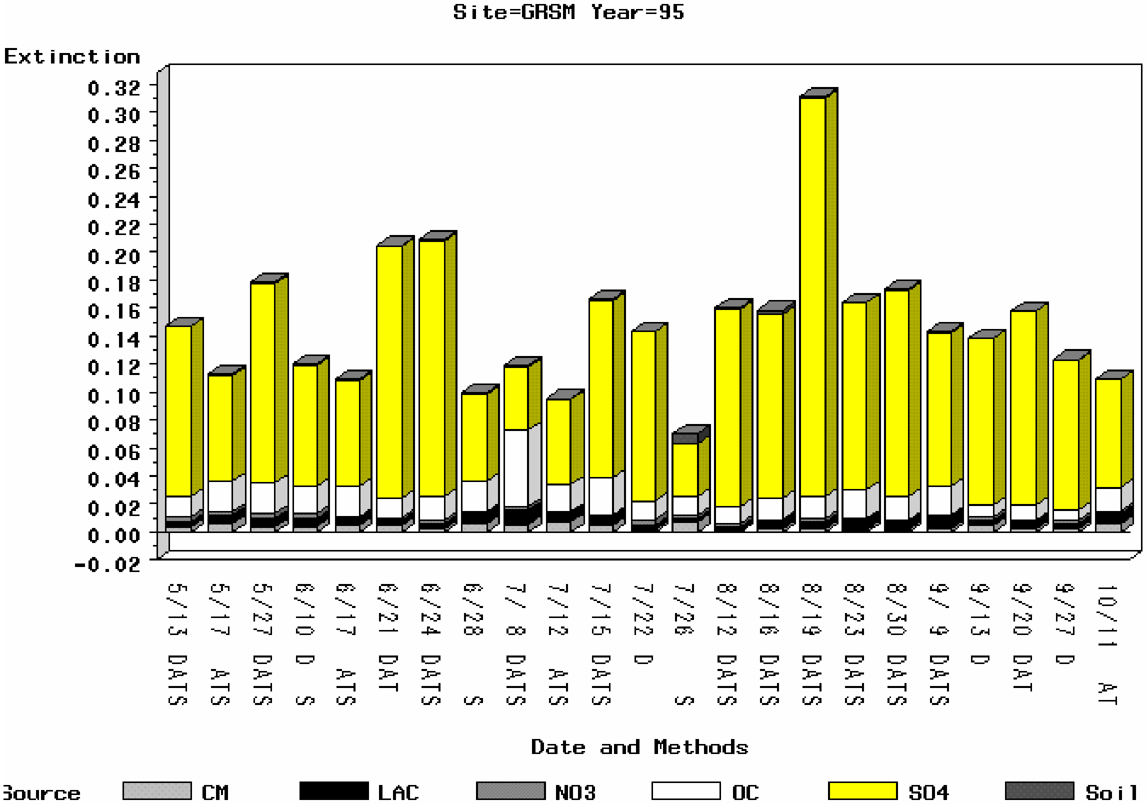


Figure 3.2.18 Extinction Budgets for GUMO 93 for Days Selected to be a Top 20% Day by at least one of the four methods considered

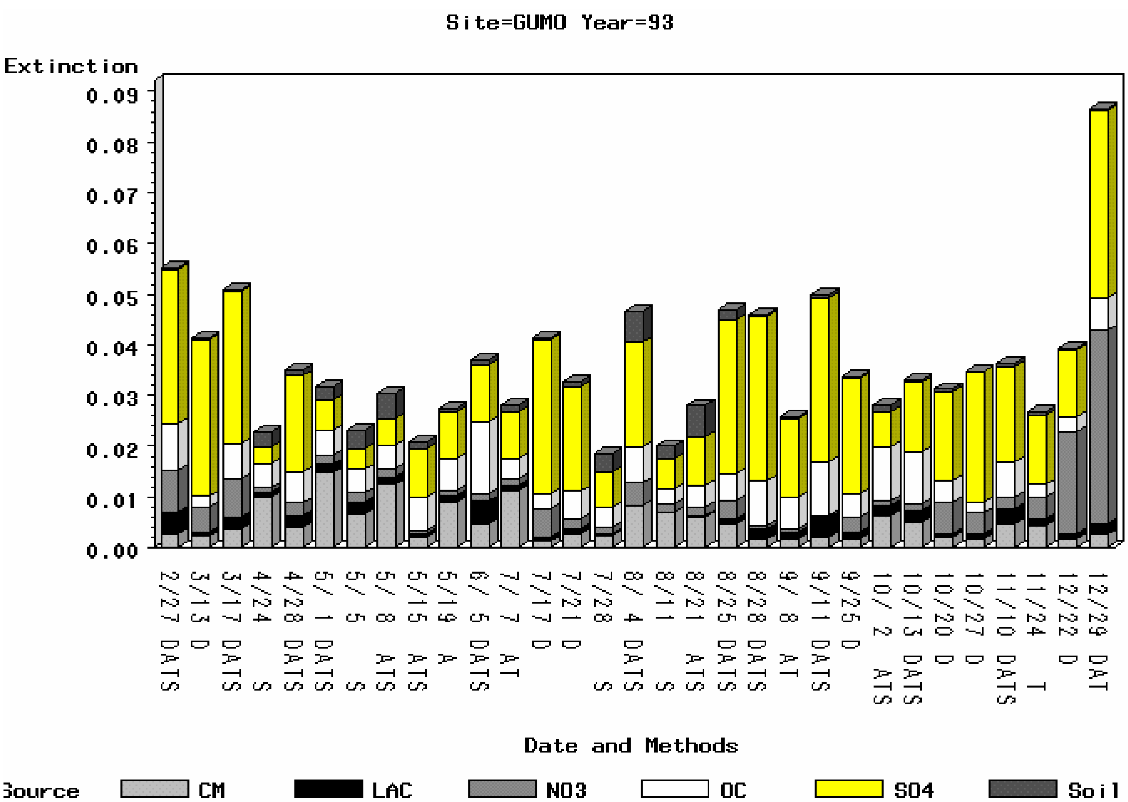


Figure 3.2.19 Extinction Budgets for GUMO 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

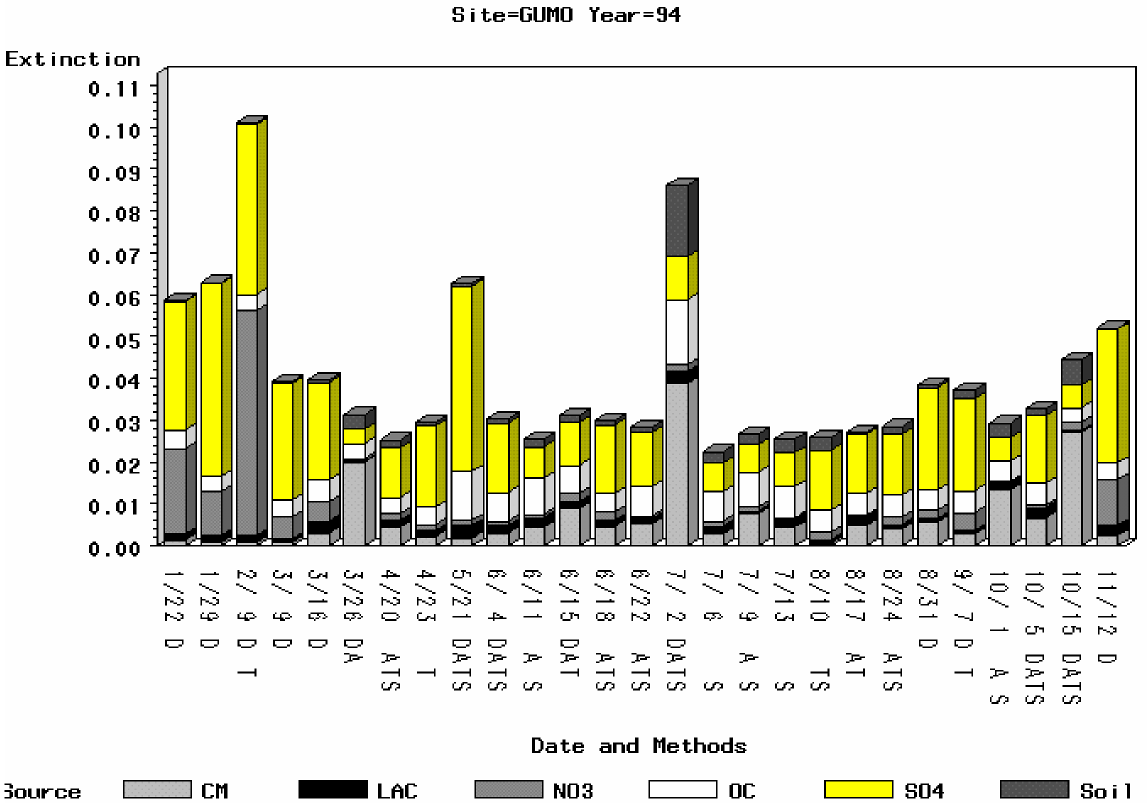


Figure 3.2.20 Extinction Budgets for MEVE 93 for Days Selected to be a Top 20% Day by at least one of the four methods considered

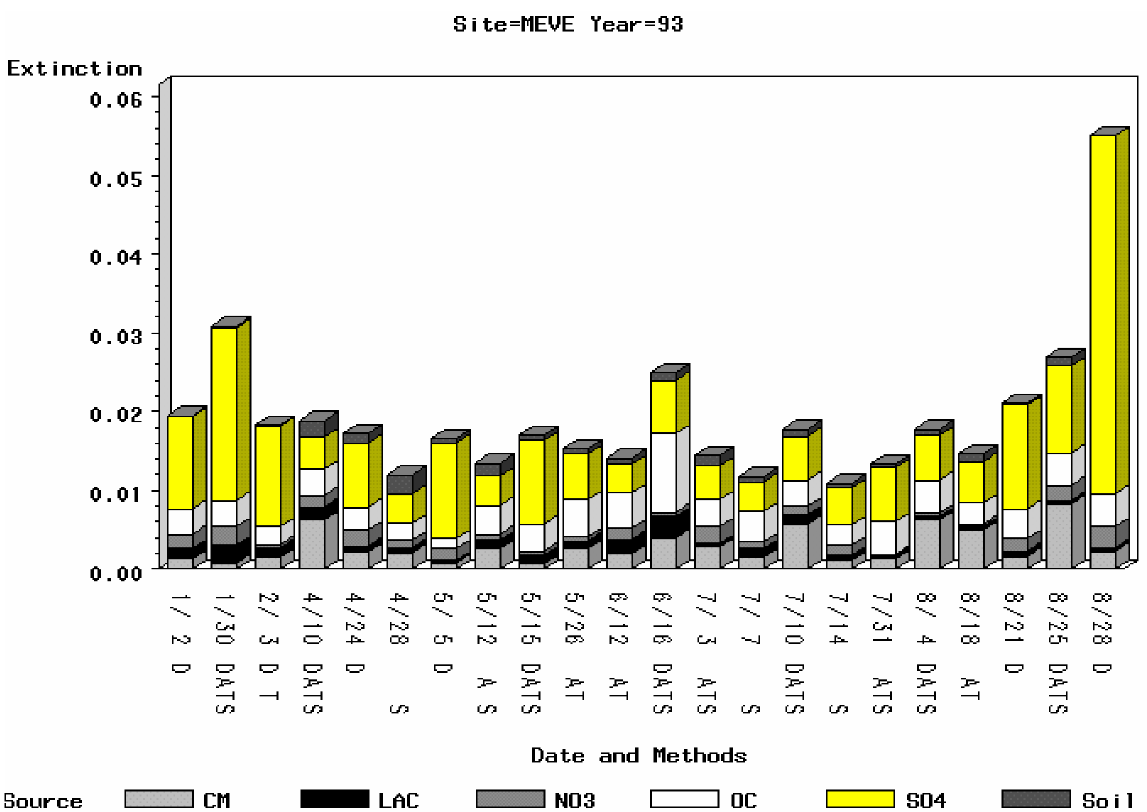


Figure 3.2.21 Extinction Budgets for MORA 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

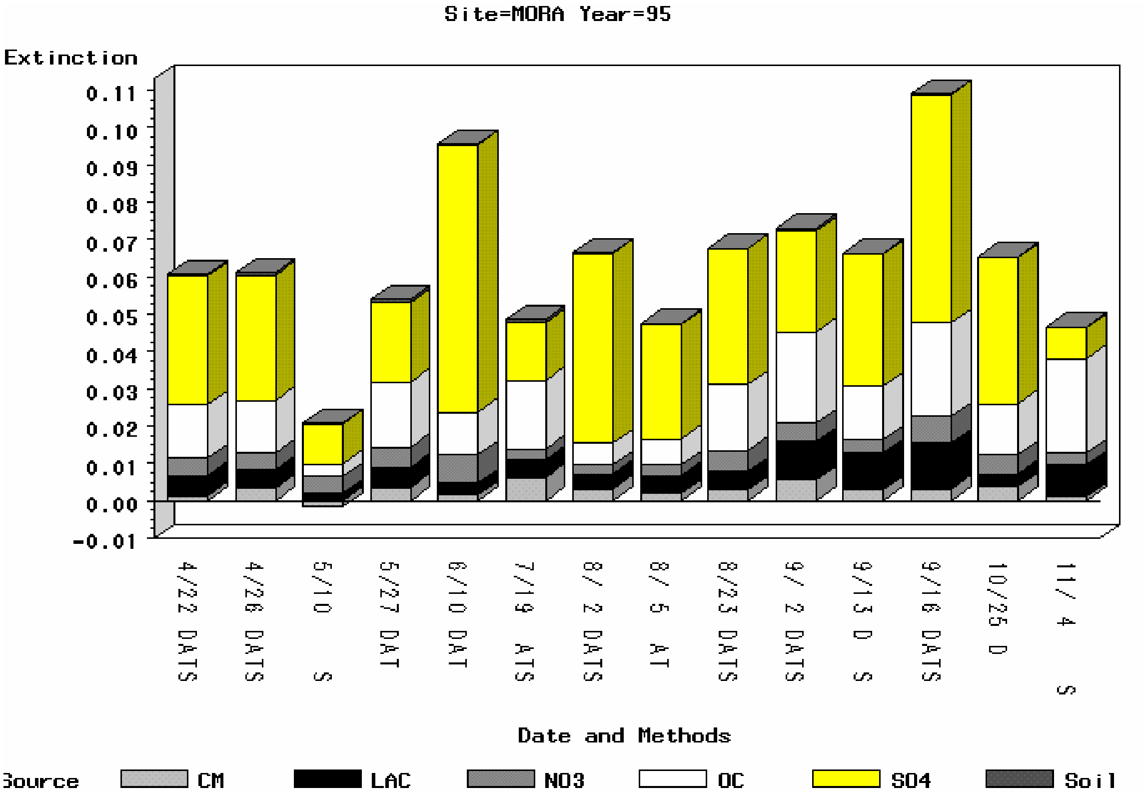


Figure 3.2.22 Extinction Budgets for MORA 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

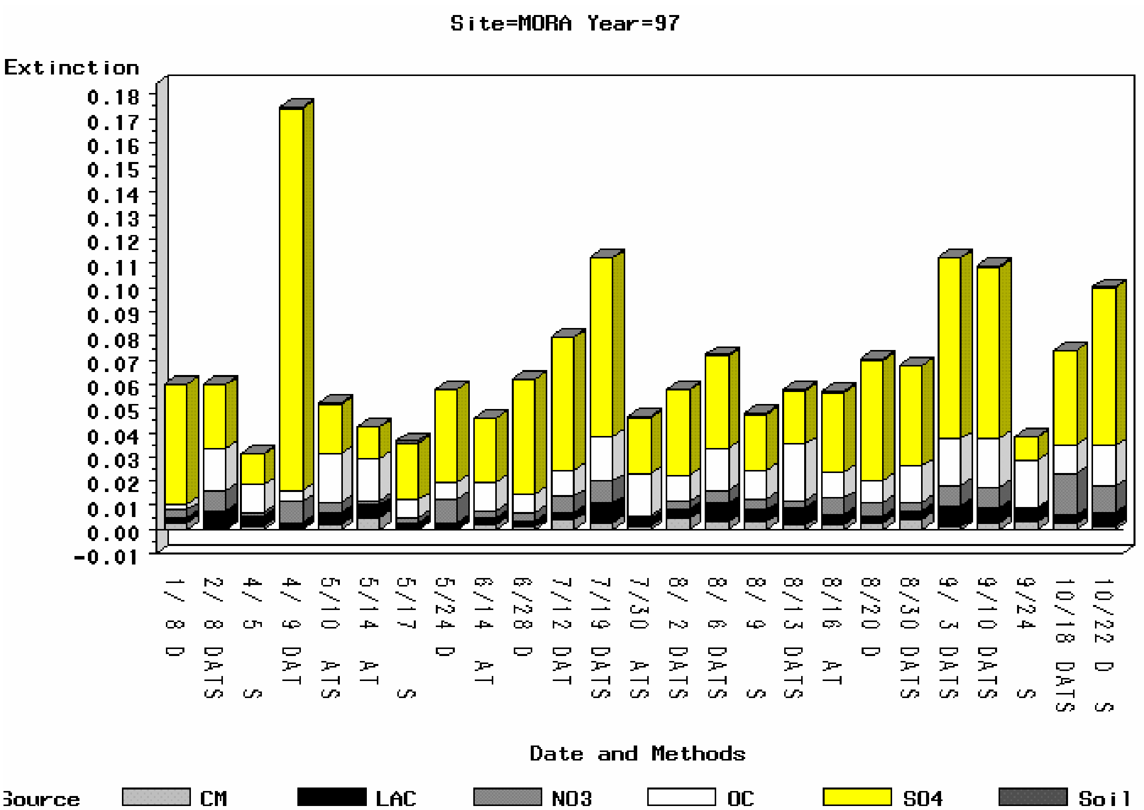


Figure 3.2.23 Extinction Budgets for PEFO 93 for Days Selected to be a Top 20% Day by at least one of the four methods considered

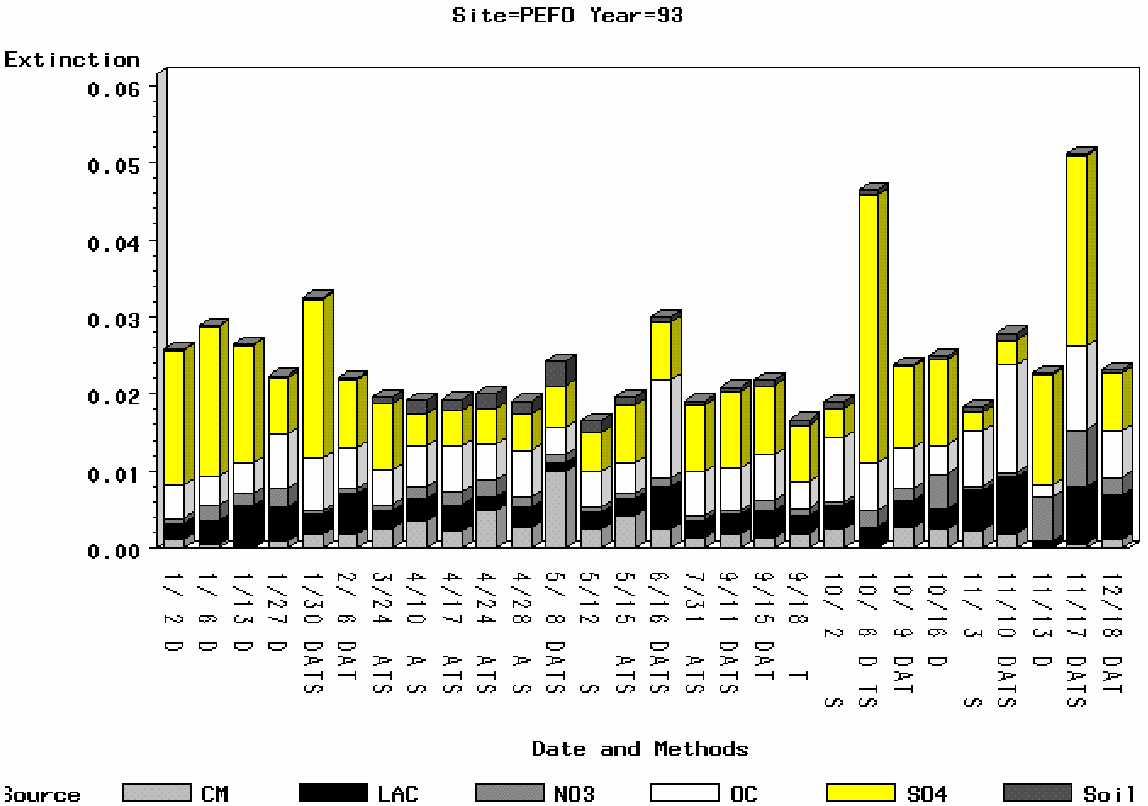


Figure 3.2.24 Extinction Budgets for PEFO 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

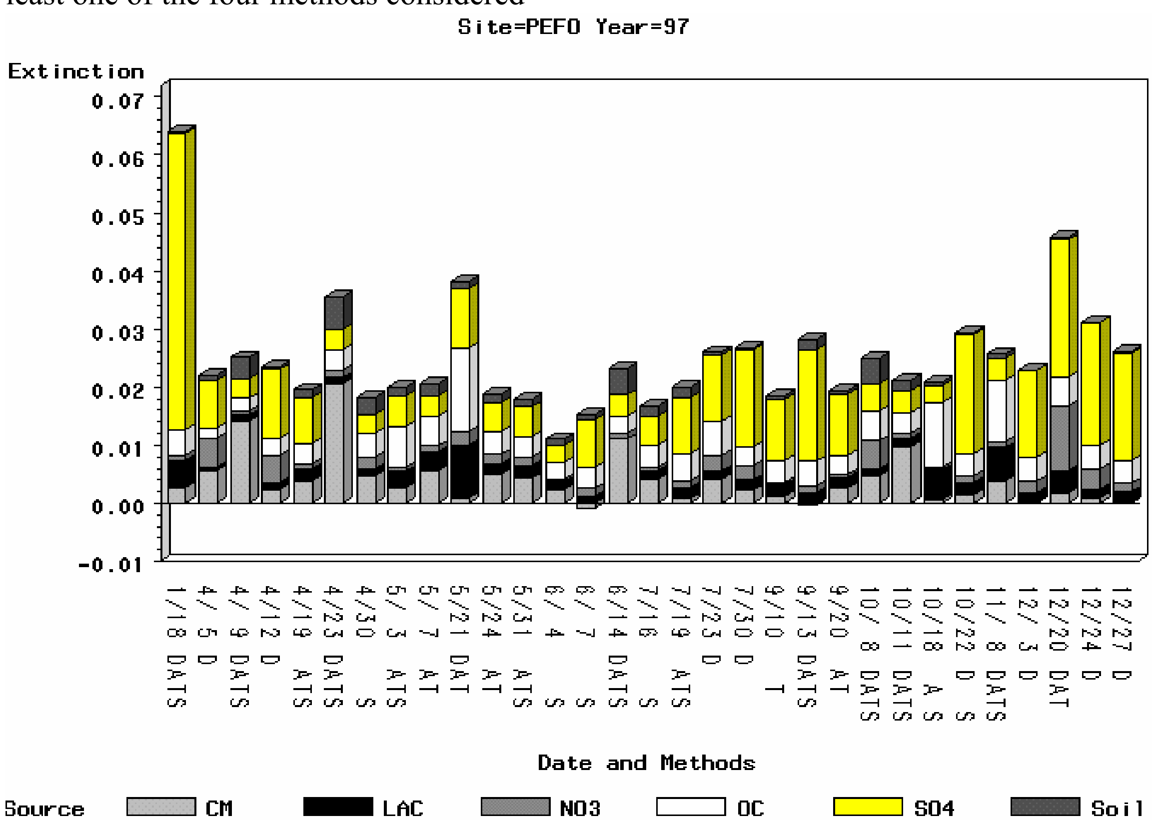


Figure 3.2.25 Extinction Budgets for PINN 91 for Days Selected to be a Top 20% Day by at least one of the four methods considered

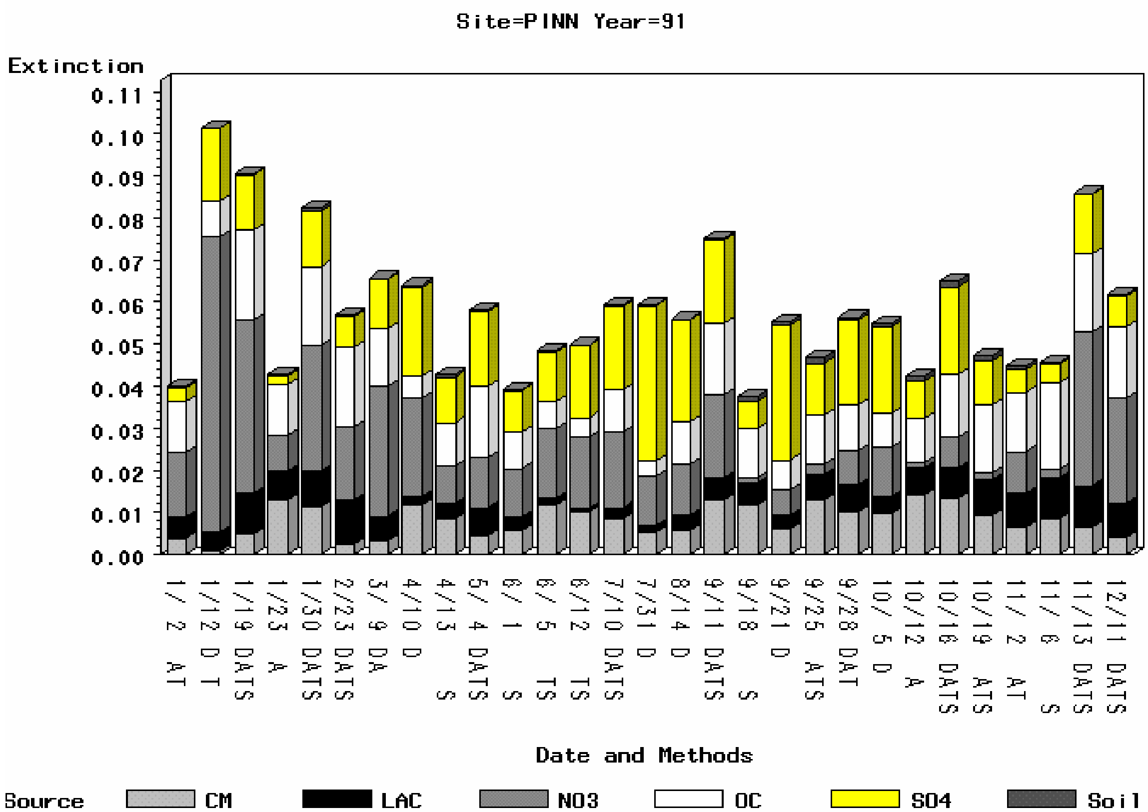


Figure 3.2.26 Extinction Budgets for SAGO 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

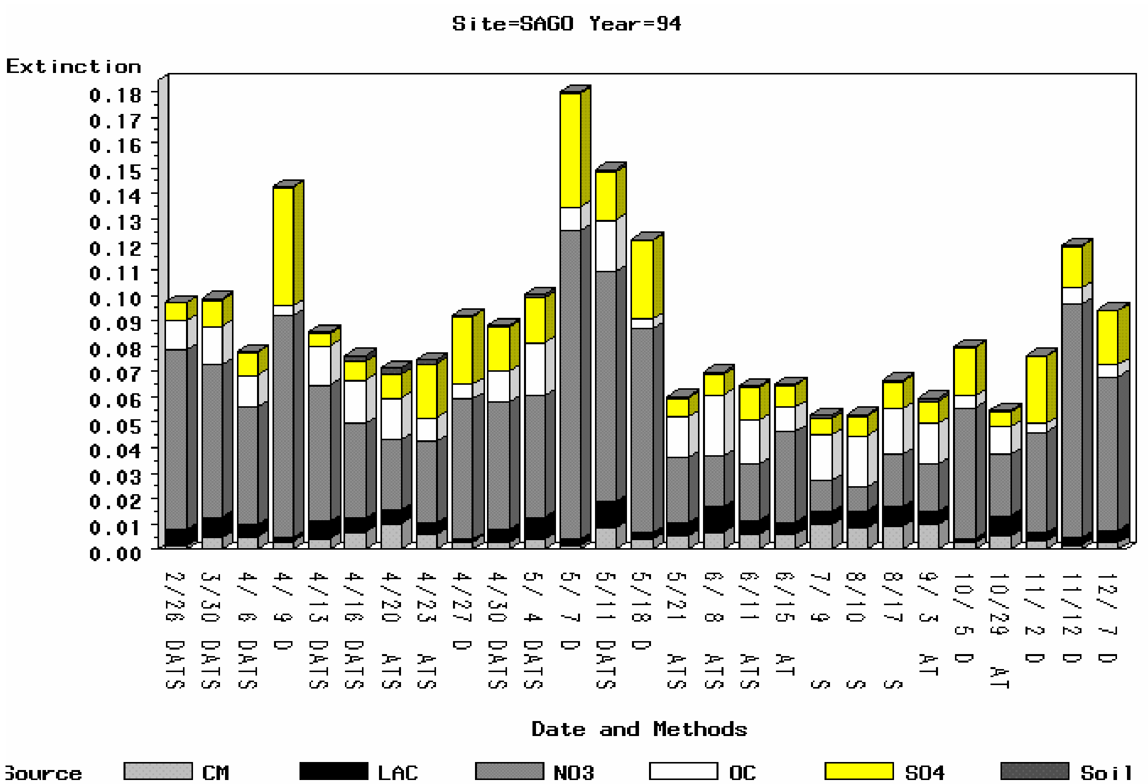


Figure 3.2.27 Extinction Budgets for SAGO 97 for Days Selected to be a Top 20% Day by at least one of the four methods considered

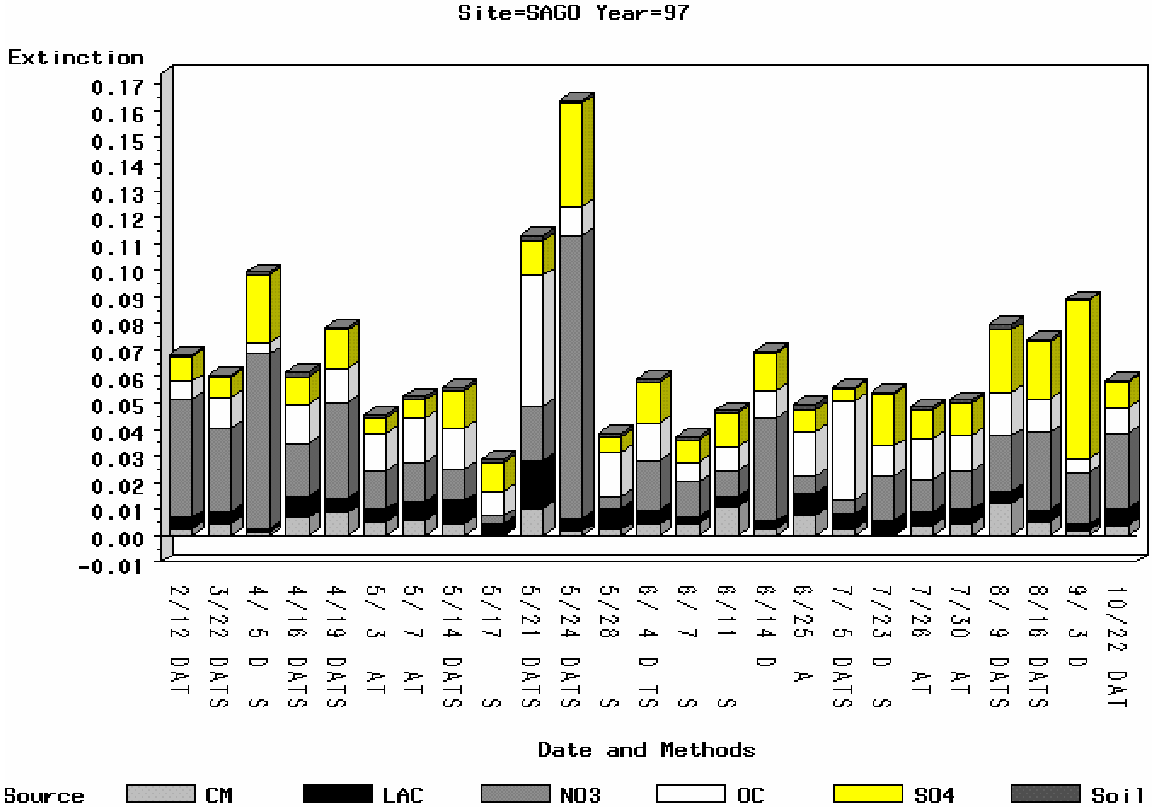


Figure 3.2.28 Extinction Budgets for SHEN 94 for Days Selected to be a Top 20% Day by at least one of the four methods considered

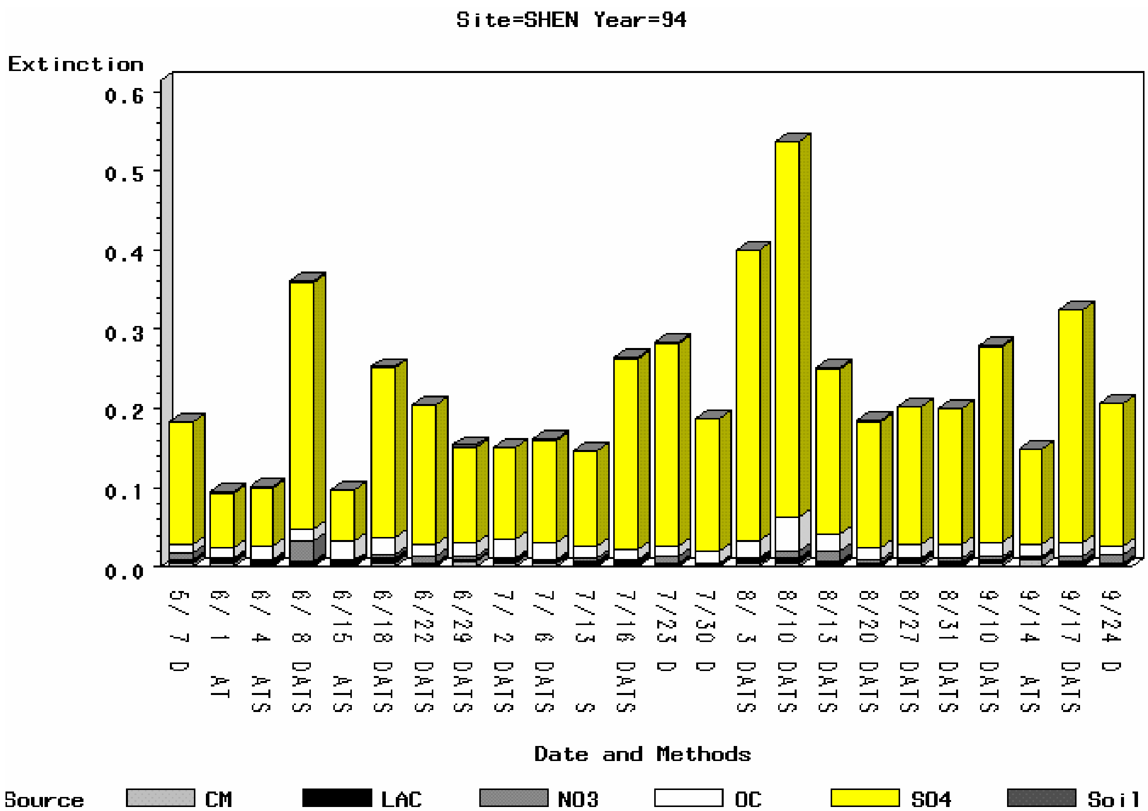


Figure 3.2.29 Extinction Budgets for SHEN 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

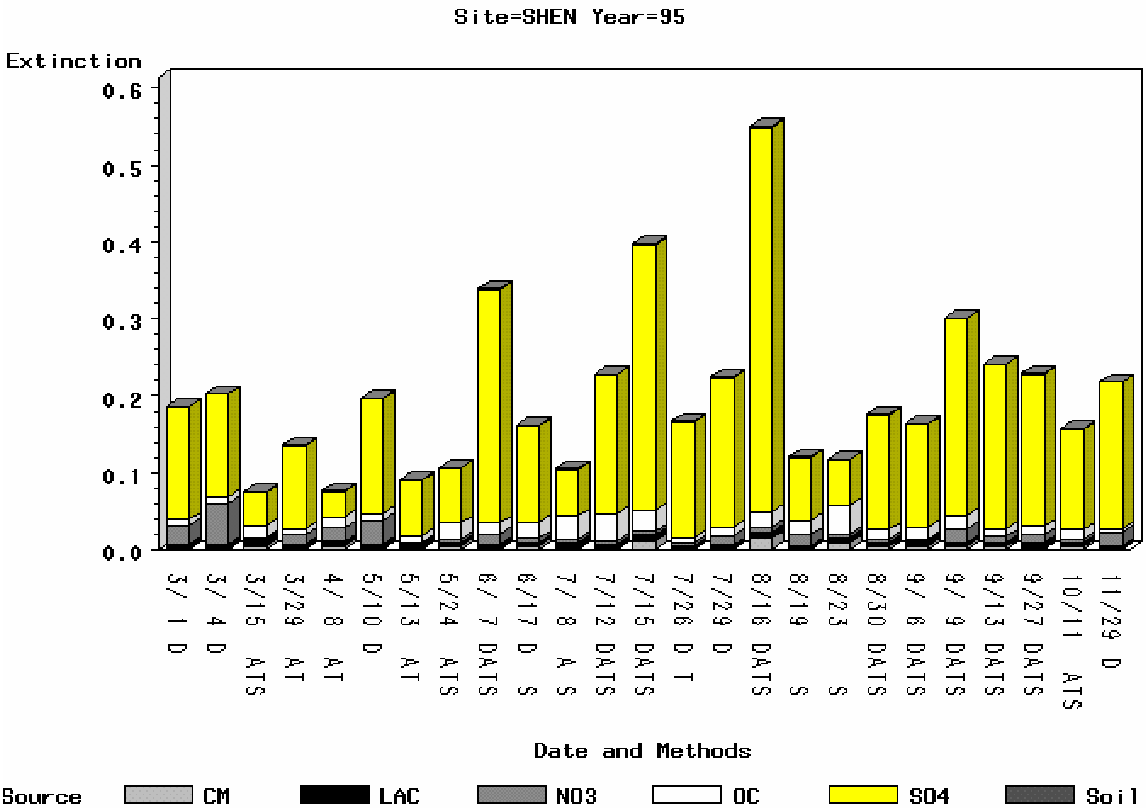


Figure 3.2.30 Extinction Budgets for YOSE 92 for Days Selected to be a Top 20% Day by at least one of the four methods considered

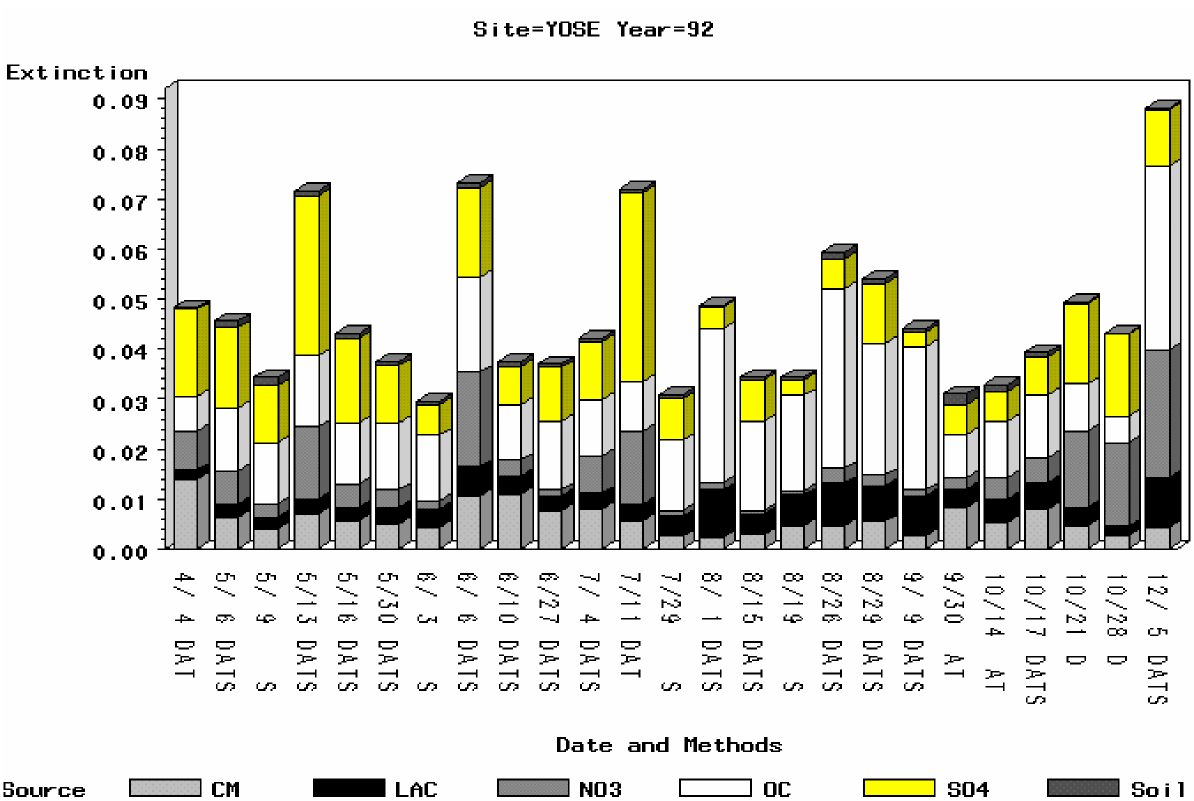


Figure 3.2.31 Extinction Budgets for YOSE 95 for Days Selected to be a Top 20% Day by at least one of the four methods considered

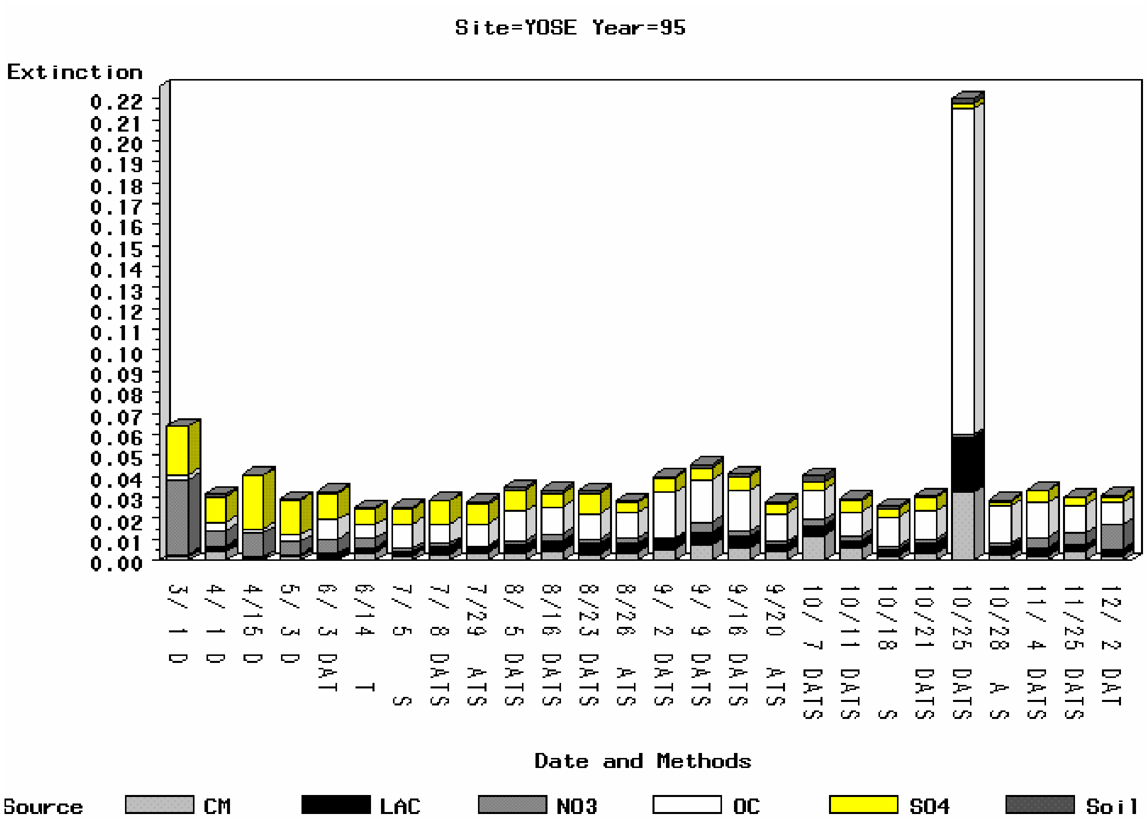


Figure 3.3.1 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **BADL**.

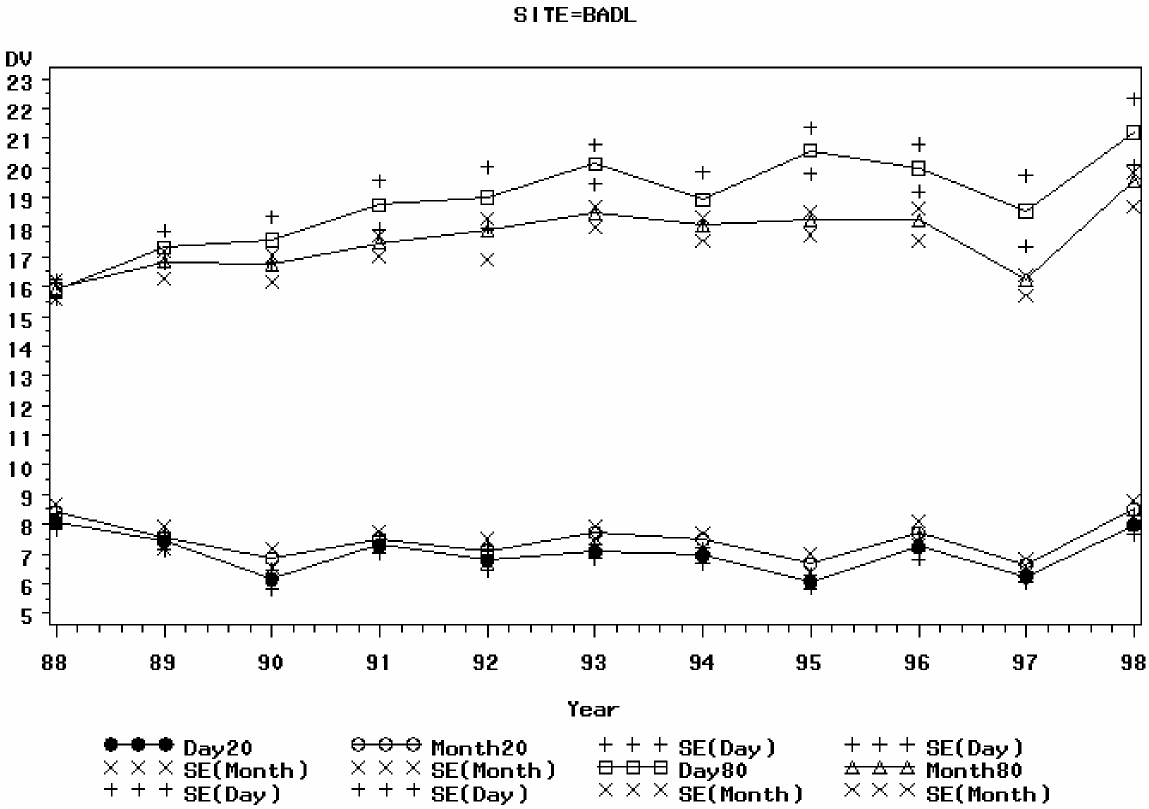


Figure 3.3.2 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **BAND**.

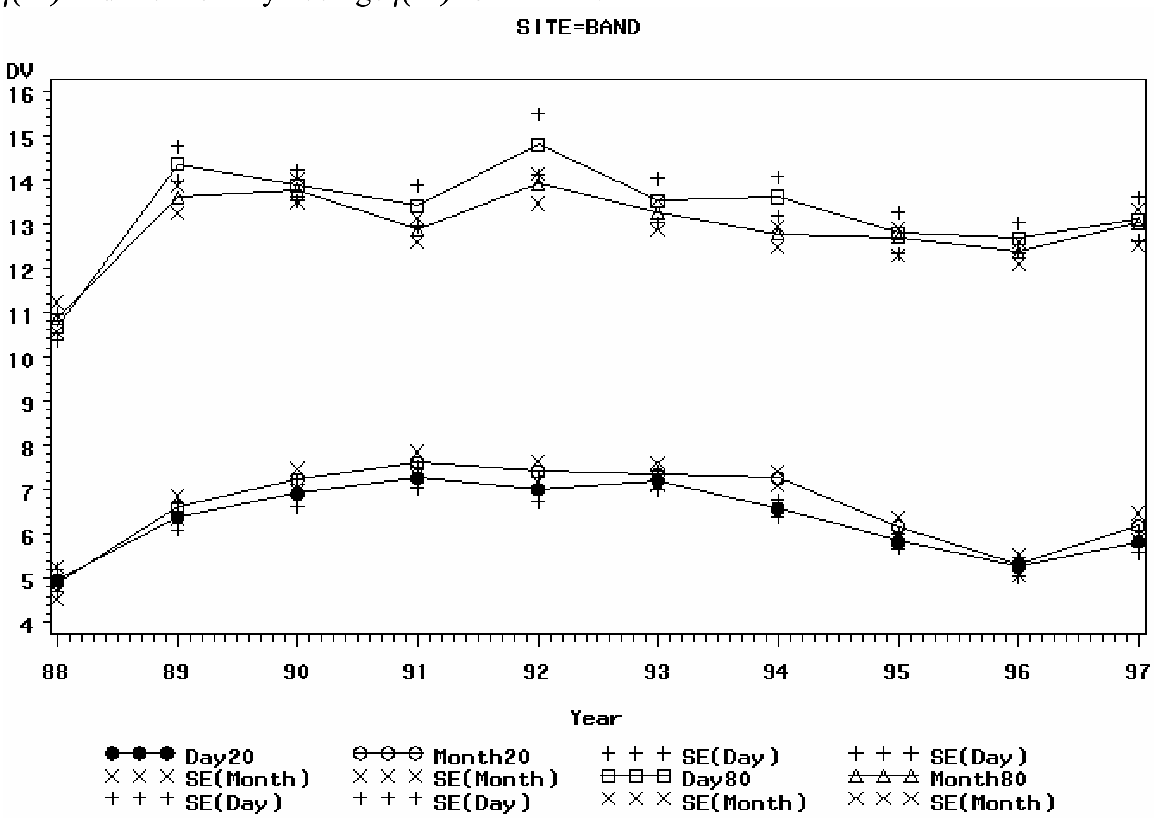


Figure 3.3.3 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **BRID**.

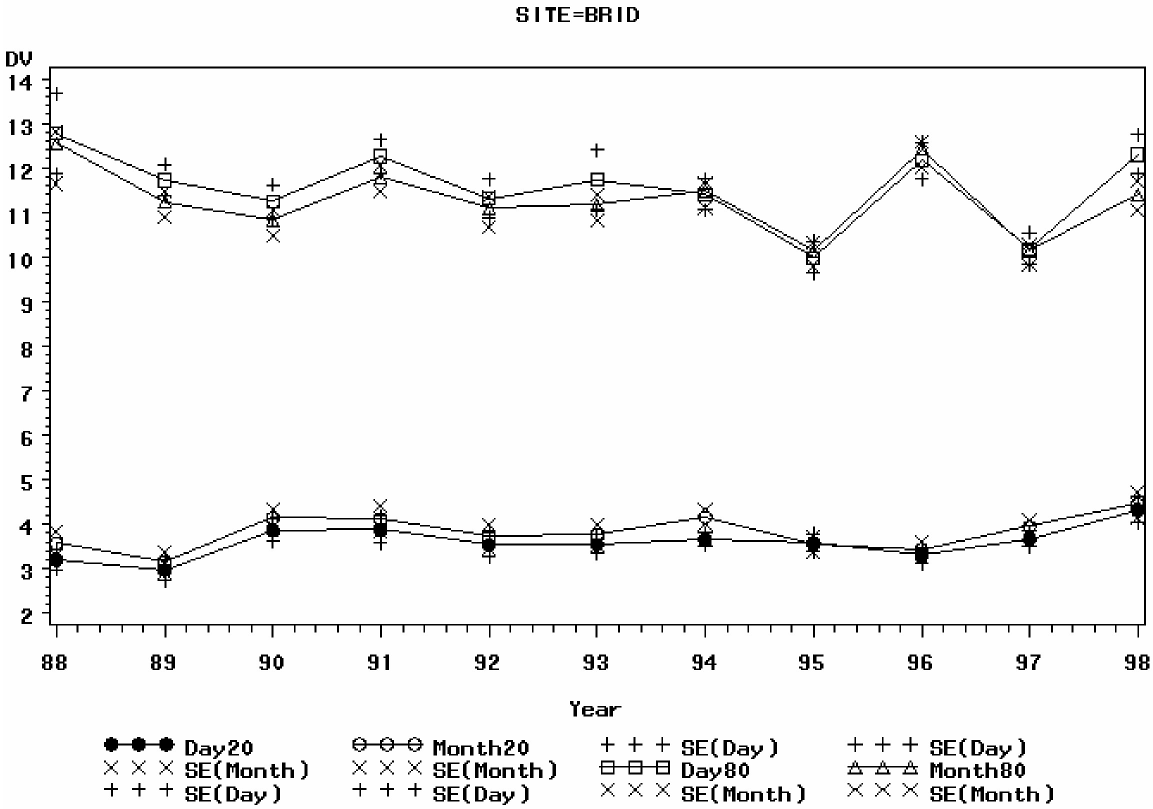


Figure 3.3.4 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **CANY**.

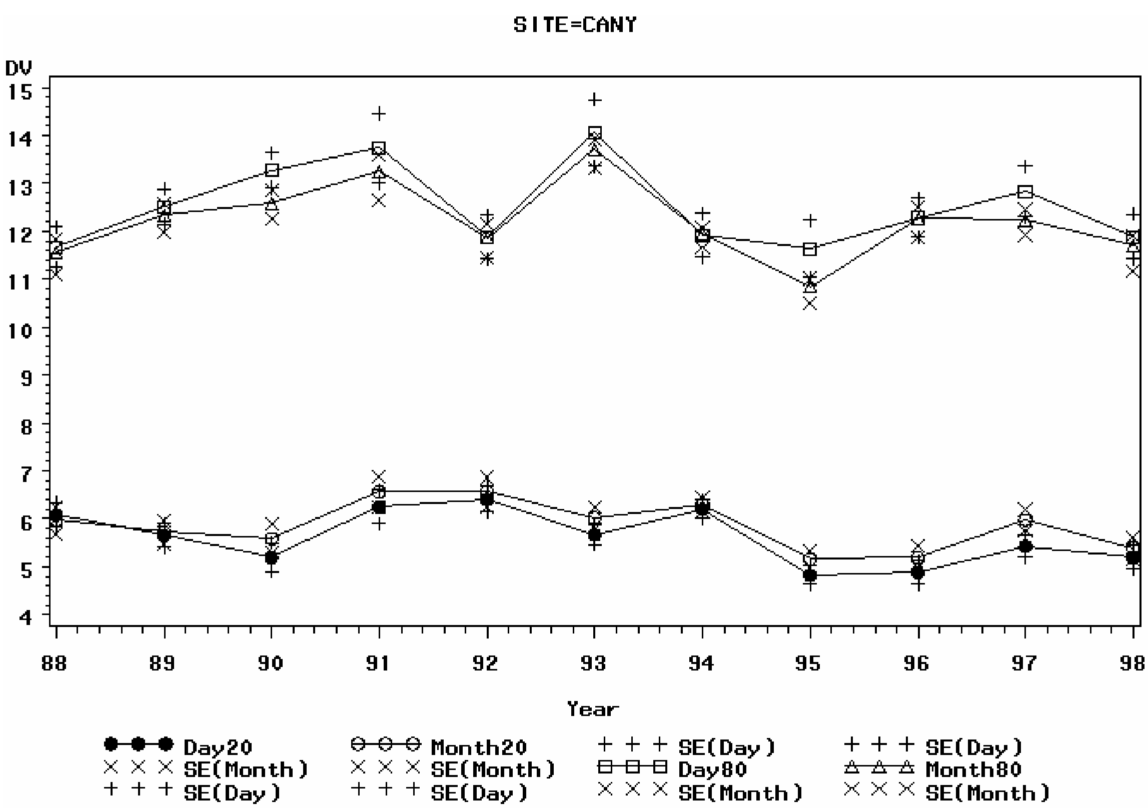


Figure 3.3.5 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **CHIR**.

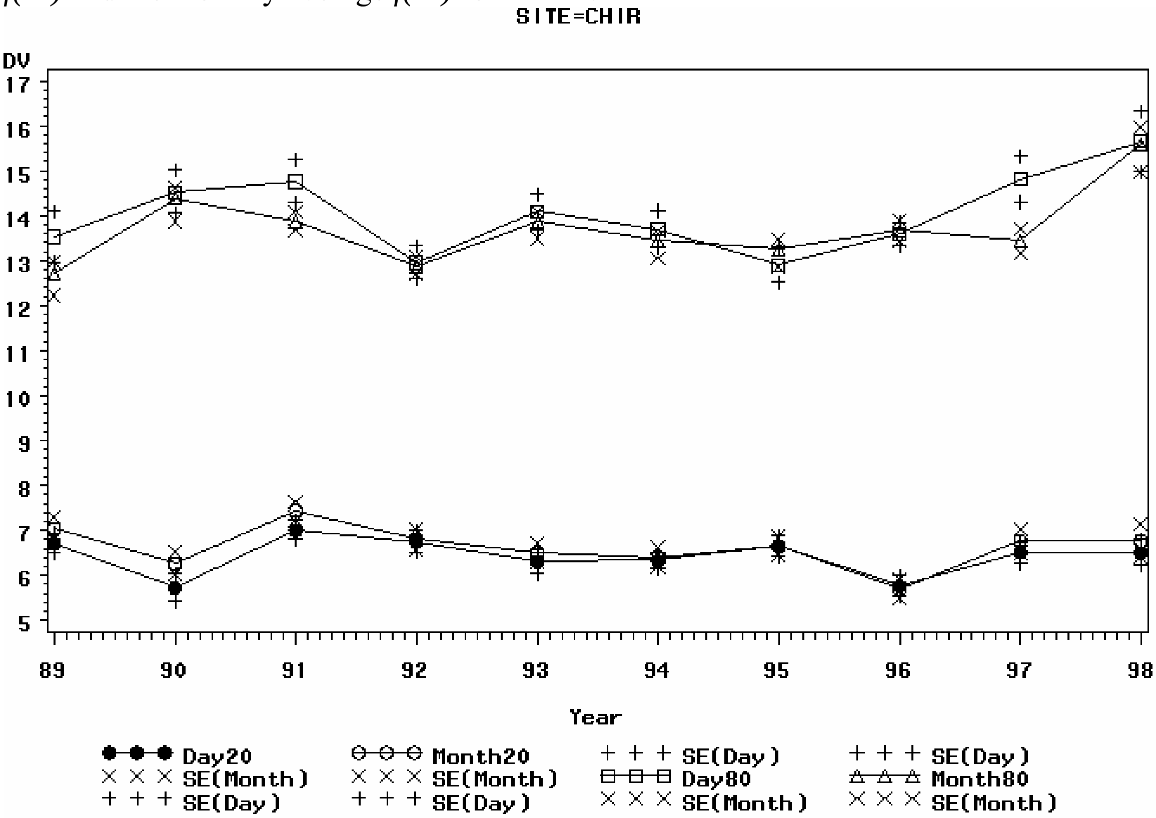


Figure 3.3.6 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **GLAC**.

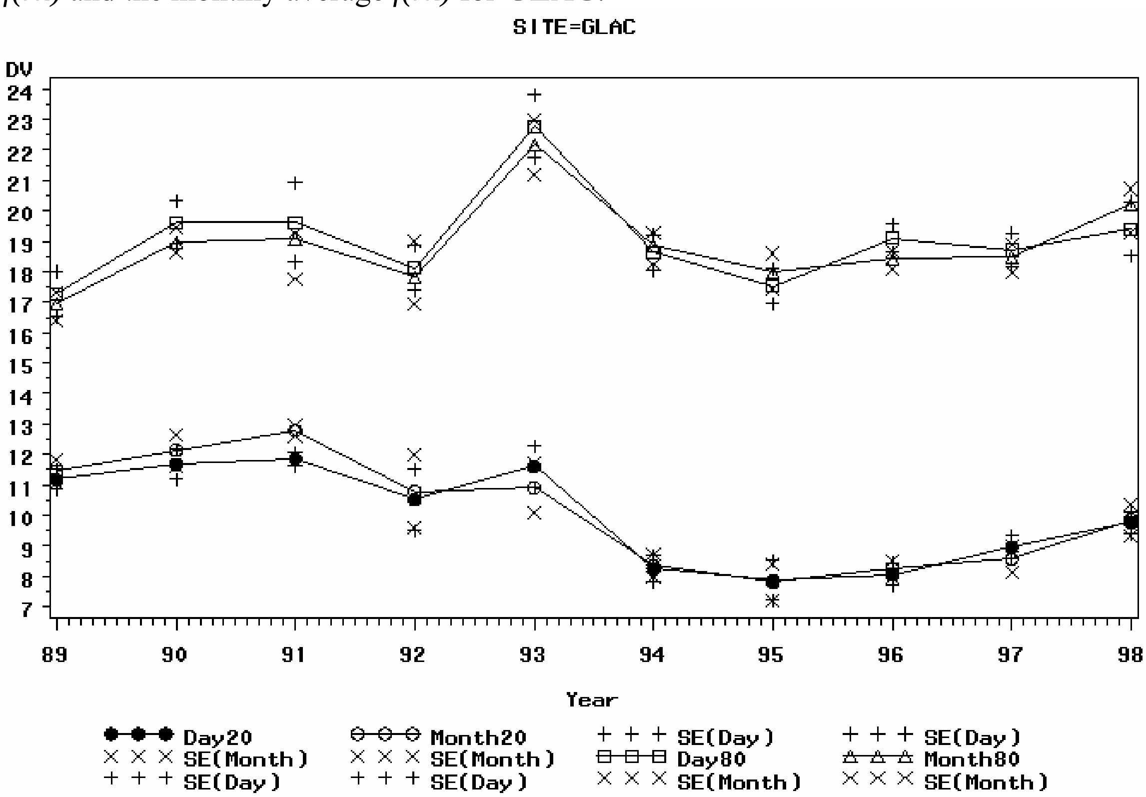


Figure 3.3.7 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **GRCA**.

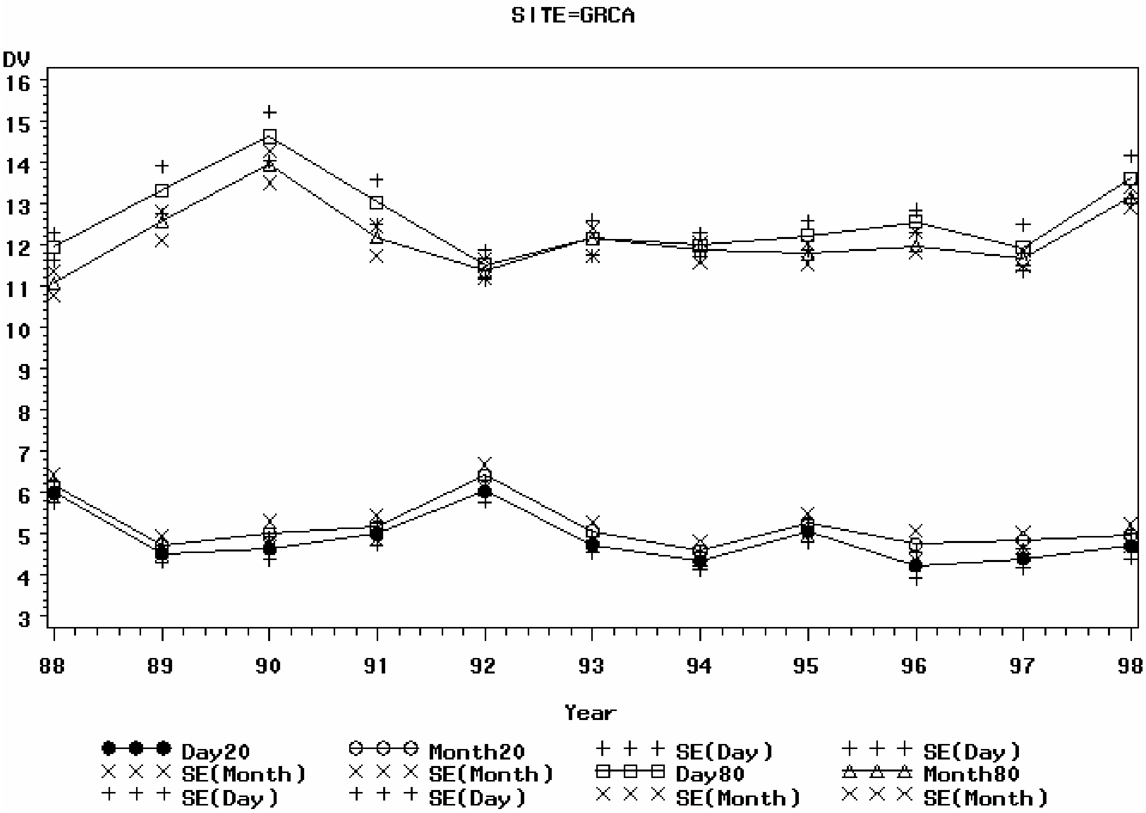


Figure 3.3.8 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **GRSM**.

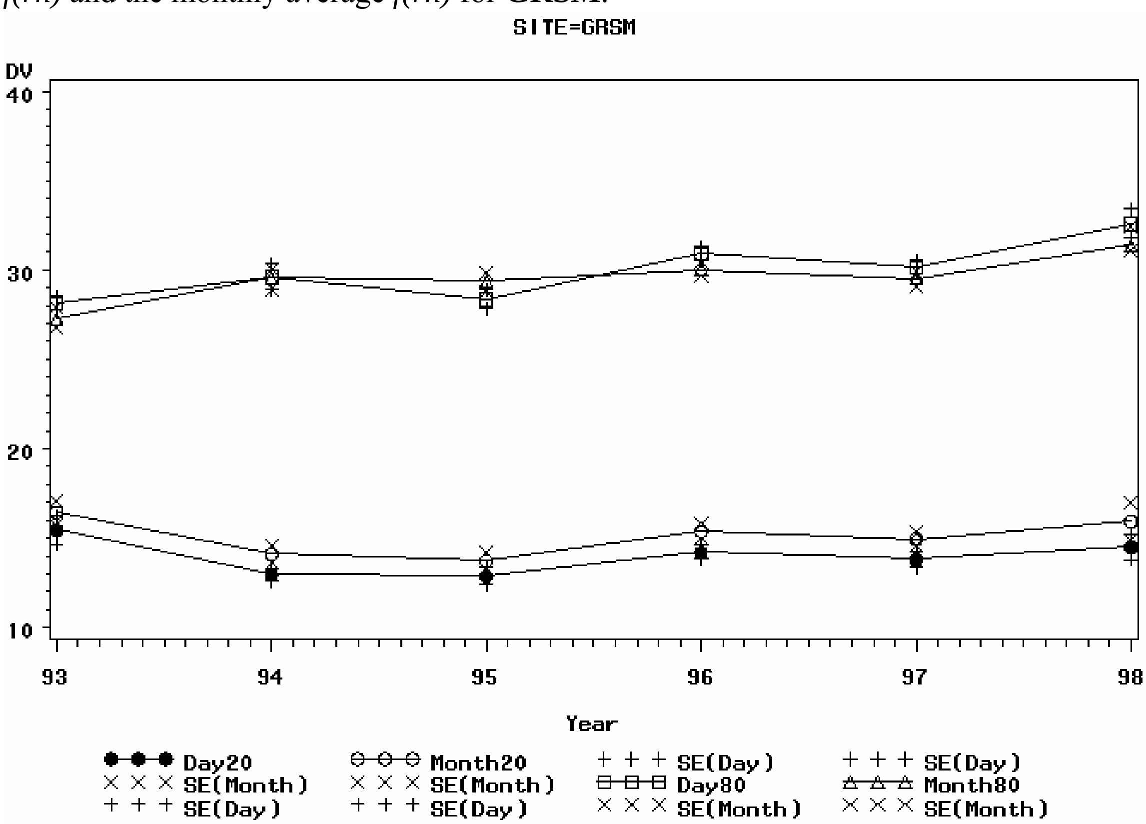


Figure 3.3.9 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **GUMO**.

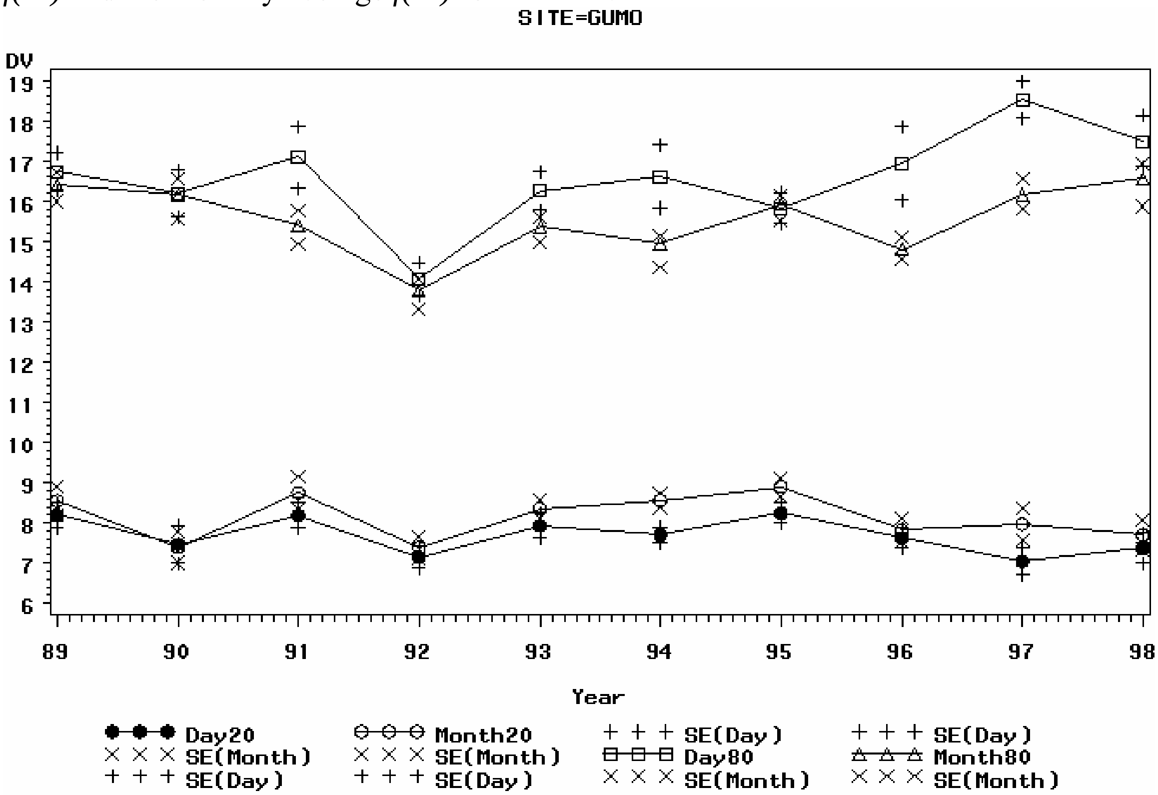


Figure 3.3.10 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **MEVE**.

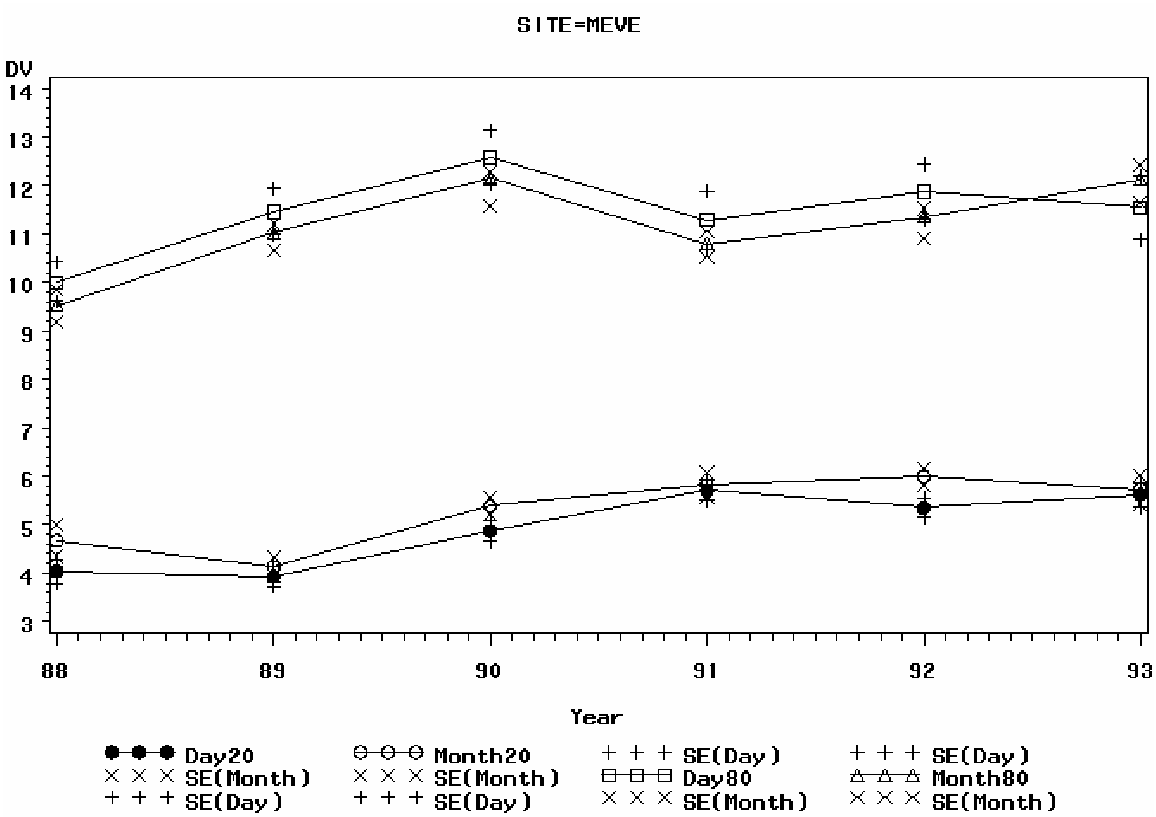


Figure 3.3.11 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **MORA**.

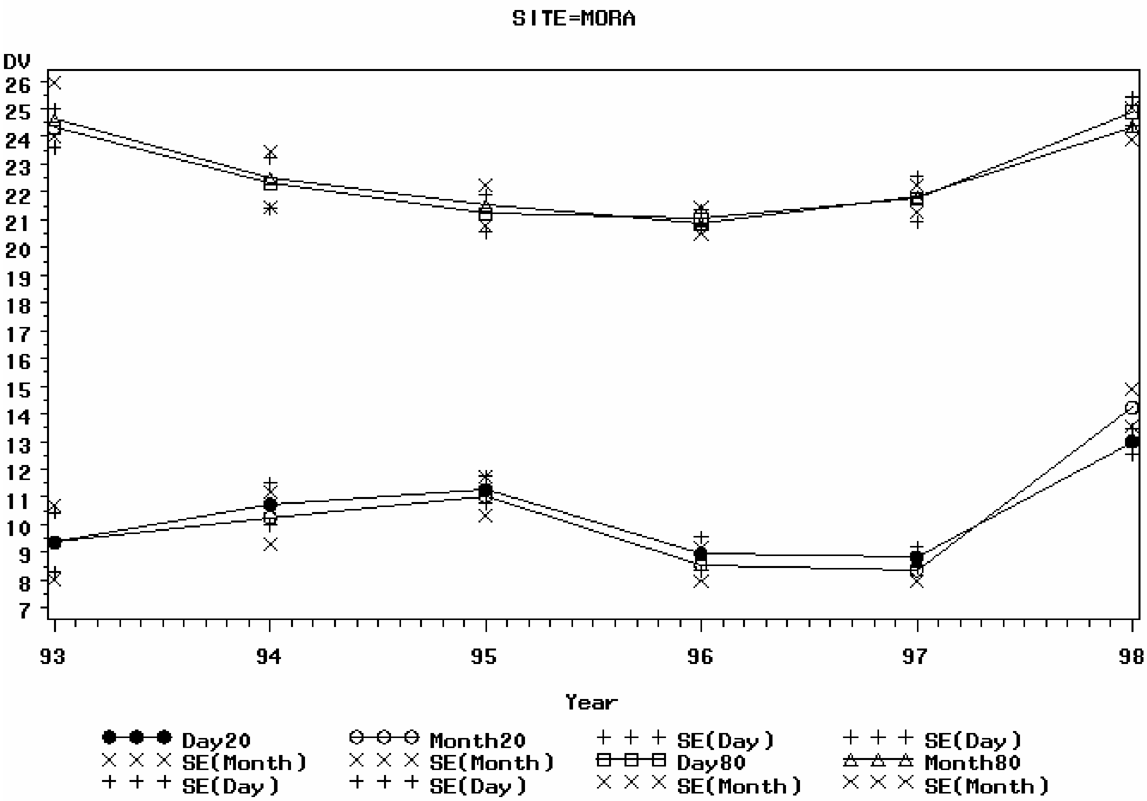


Figure 3.3.12 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **PEFO**.

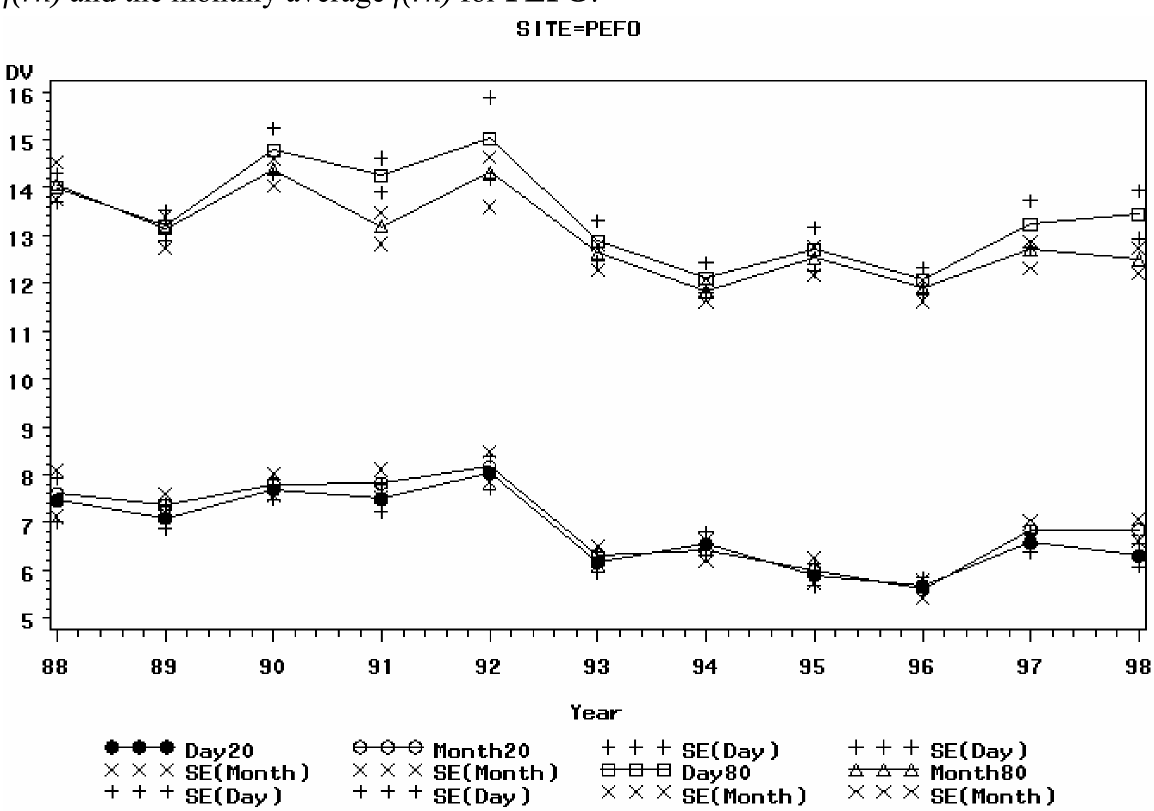


Figure 3.3.13 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **PINN**.

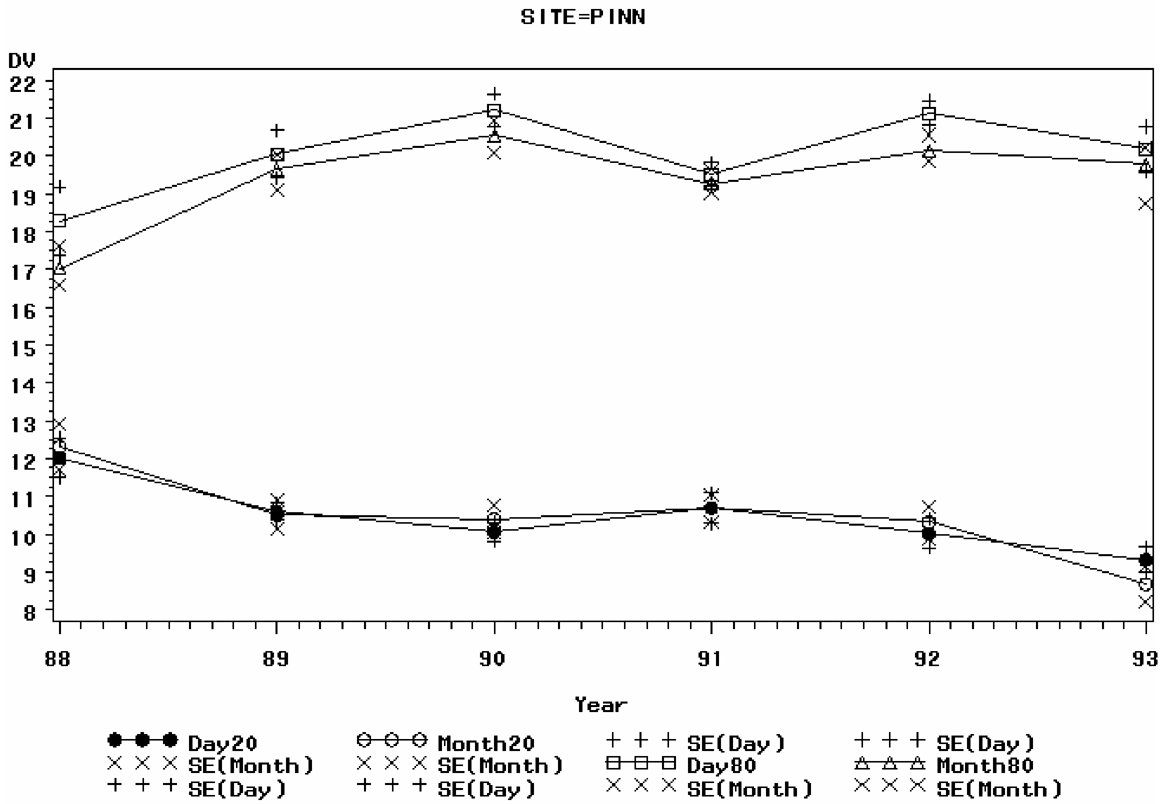


Figure 3.3.14 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **SAGO**.

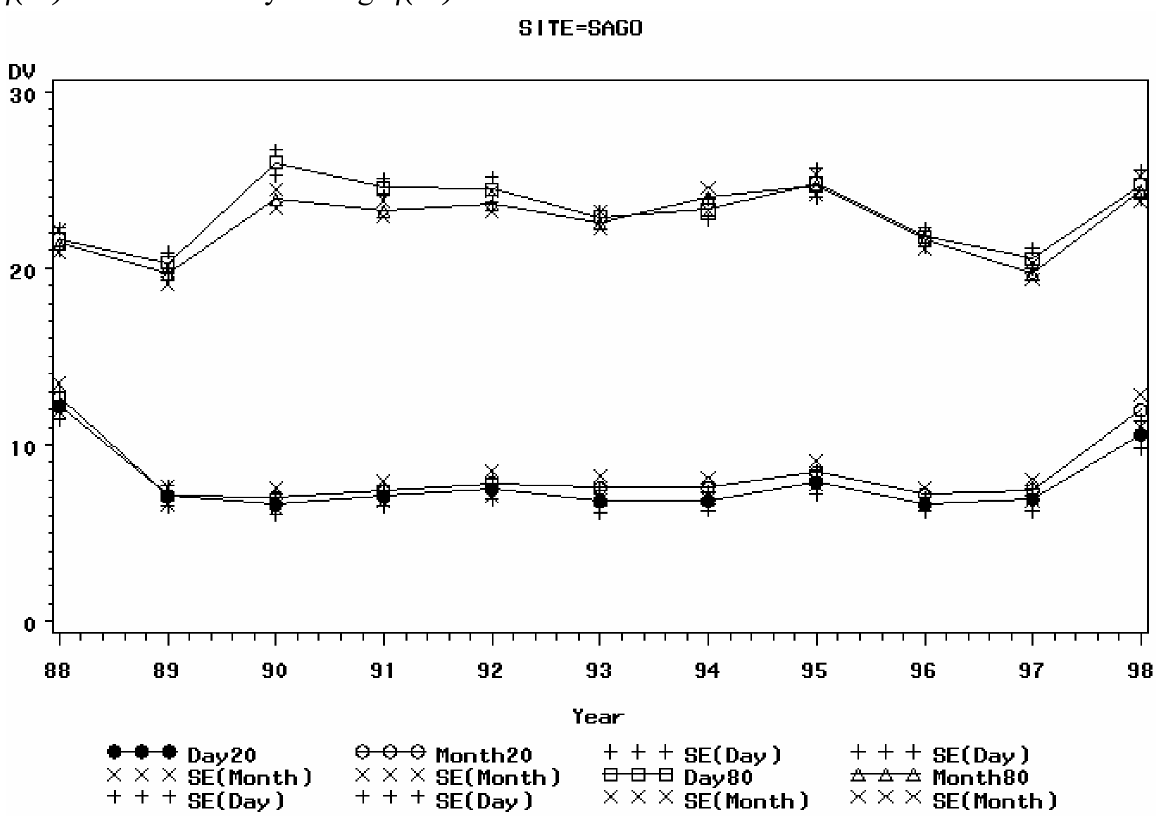


Figure 3.3.15 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **SHEN**.

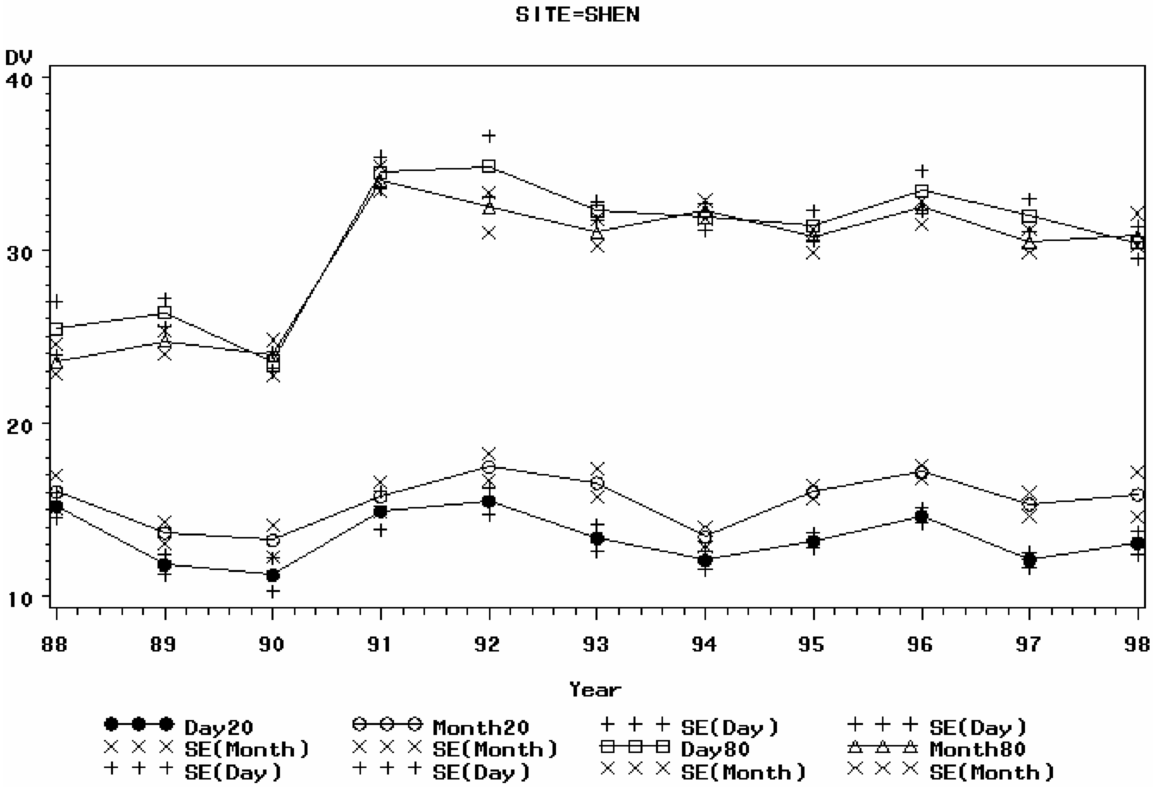


Figure 3.3.16 Estimates of dv_{worst} (lower pair of lines) dv_{best} (upper pair of lines) using constant *f(rh)* and the monthly average *f(rh)* for **YOSE**.