Report No. NPS D-118

Annual Data Summary

MAMMOTH CAVE NATIONAL PARK

2002

National Park Service
Gaseous Air Pollutant Monitoring Network

AIR RESOURCES DIVISION
RESEARCH AND MONITORING BRANCH
12795 West Alameda Parkway
P.O. Box 25287
Lakewood, Colorado 80225
Telephone: (303) 969-2820
Fax: (303) 969-2822

This Annual Data Summary was prepared under NPS Contract C2350010840 by:

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: (970) 484-7941
Fax: (970) 484-3423

For additional copies of this report or reports for other NPS units, contact:

National Park Service Air Resources Division
Information Management Center
c/o Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: (970) 484-7941
Fax: (970) 484-3423
E-Mail: AIR-IMC@AIR-RESOURCE.COM

or

National Park Service
Air Resources Division
P.O. Box 25287
Lakewood, Colorado 80225-02587
Telephone: (303) 969-2130
E-Mail: AQ_INFO@AQD.NPS.GOV

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At Mammoth Cave National Park, the ARD specifically recognizes Bob Carson for performing the technical and administrative skills required to help produce the data presented within this report.

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1.0 INTRODUCTION

1.1 THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING PROGRAM (GPMP)

Gaseous air pollutants, including ozone and sulfur dioxide, are of concern to the National Park Service (NPS). Pollutants like these can affect park unit biological resources as well as the health of park unit residents and visitors. The NPS established a gaseous pollutant monitoring program for several pollutants linked to effects on NPS resources. This program was designed to meet certain resource management objectives.

The primary objective of this monitoring program is to establish the status and trends of park unit air quality conditions and to determine if a park unit is exceeding the National Ambient Air Quality Standards established by the U.S. Environmental Protection Agency (EPA) to protect public health and welfare. In addition, such monitoring is designed to detect changes or trends in pollution levels over time. A monitoring station may also be established if there is documented biological injury due to air pollution in a park unit. Information on ambient air pollution levels is an important part of research on effects of air pollutants on NPS resources, and can help confirm suspected causes of observed effects.

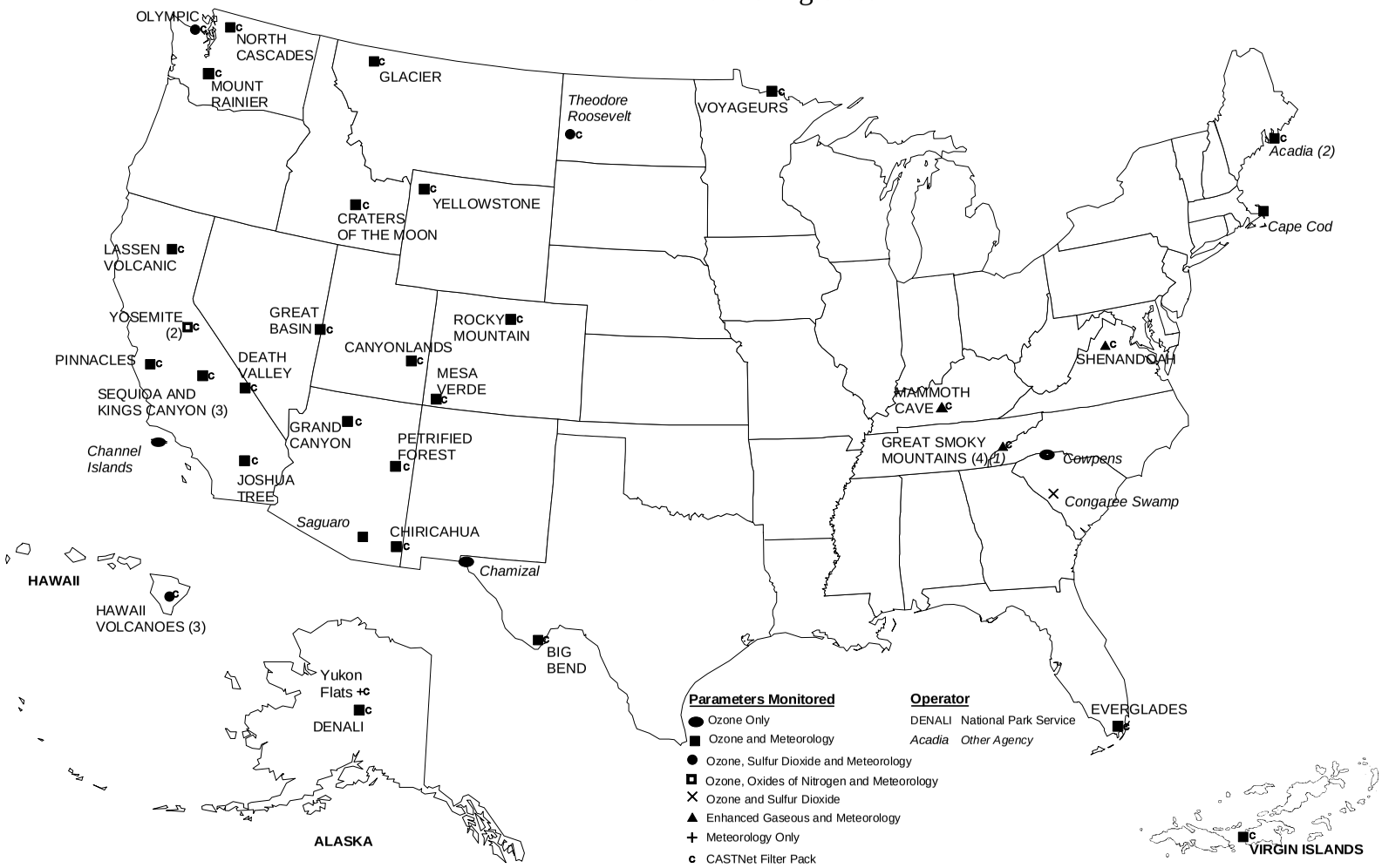
Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The Clean Air Act gives federal land managers and superintendents an affirmative responsibility to protect air quality related values in Class I areas and to assess whether new sources will have an adverse impact on park unit resources and values. Information on air quality levels in NPS units can also be used to evaluate the performance of atmospheric models that simulate how pollutants are transported into park units and predict impacts on the park unit caused by air pollution sources.

The National Park Service Gaseous Pollutant Monitoring Program site locations and measured parameters collected in this reporting year are shown on the map on the following page. During this reporting period, 47 monitoring sites in 37 units of the National Park System had some combination of ozone, sulfur dioxide, nitrogen, meteorological, and Clean Air Status and Trends Network (CASTNet) dry deposition monitoring. Monitoring methods and quality assurance procedures used in the national park network meet the applicable 40 CFR Part 58 EPA requirements. This allows for the direct comparison of NPS collected data with that collected by the EPA, and state and local air pollution control agencies. Data collected by this network are incorporated in the EPA Aerometric Information Retrieval System (AIRS) database which is a national database of all air quality data collected throughout the country. These data are also stored in the NPS Air Resources Division’s Information Management Center (IMC) that allows for easy access and analysis of data.

This report includes a variety of data summaries for data collected at an individual monitoring site at a national park unit during this reporting period. These summaries highlight the average range and frequency of the data collected during the year. A digital copy of all data collected during the year and data summary products are available; see Section 3.0 for information on obtaining these data. Individual reports are generated for each site where monitoring was conducted in the national park network.

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK

2002 Monitoring Sites



1.2 MAMMOTH CAVE NATIONAL PARK

Mammoth Cave National Park, a Class I area, is located in west central Kentucky. It is noted primarily for its subsurface features which include the largest and longest limestone cave system in the world. This system encompasses more than 300 miles of known subterranean passages. Its location and site specifications are presented on the following page.

The park is the centerpiece of one of the greatest cave regions in the world. The area, with its multitude of limestone caves, underground rivers, springs, and sinkholes, is known as a karst landscape.

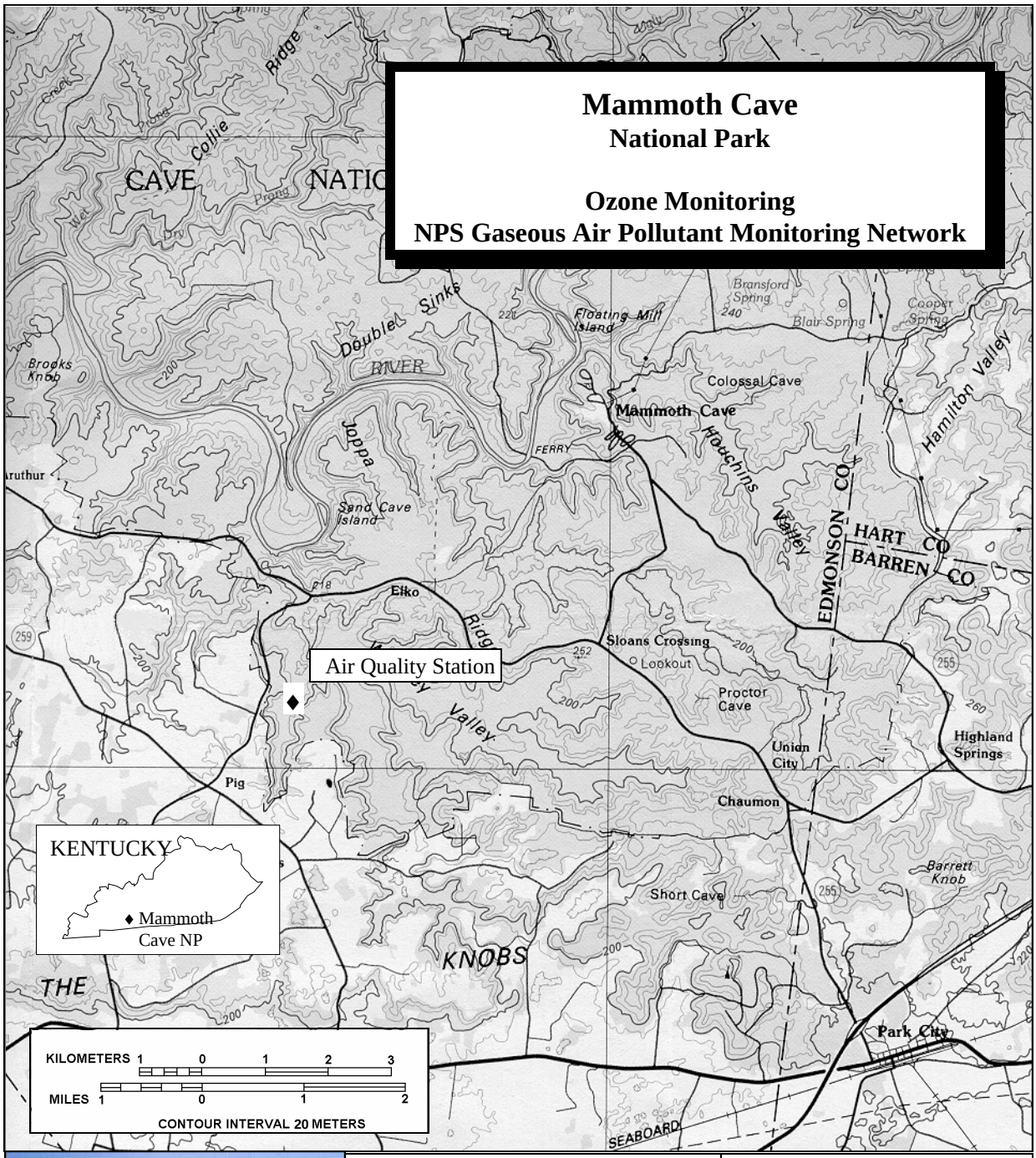
An act to provide for the establishment of Mammoth Cave National Park was approved in 1926 "for the benefit and enjoyment of the people." The law creating the park also referenced the 1916 National Park Service Organic Act which stated that the fundamental purpose of national parks is "...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The dominant vegetation consists of oaks and hickories on the slopes, and of sycamore, elm, and ash along the river banks. However, botanists have identified 84 species of trees, 28 species of shrubs and vines, 29 species of ferns and over 200 species of flowering herbs. There are two areas of forest growth that apparently have never been logged and these areas contain fairly extensive stands of mature white oak, black oak, tulip tree, beech, and maple.

Over 40 species of mammals are found within the park, but the major forms are deer, raccoon, opossum, gray squirrel, rabbit, woodchuck, muskrat, red fox and bat. There are also over 100 species of fish, over 200 of birds, 18 of reptiles, and 15 of amphibians. Many of the cave animals are blind, or nearly so, and some lack skin pigments as a result of living in the total blackness of the cave.

Park lands are rich in cultural resources. Pre-Columbian Indians went into the cave passages to chip minerals off the walls and ceilings. Chipmarks, blackened ceilings from torch smoke, sandals and other clothing artifacts, and mummified remains of Indians have been found in cave passages.

Air quality is being degraded by pollutants such as ozone originating outside the park.



SITE IDENTIFICATION	
Site Abbreviation:	MACA
AIRS ID NO.:	21-061-0501

INSTRUMENTATION	
O_3 Analyzer	SO_2 Analyzer
Calibrator	Temperature
Wind Speed	Solar Radiation
Wind Direction	Precipitation
Relative Humidity	Barometer
Wetness	Delta Temperature
	Filter Pack

MAP INFORMATION	
Mean Elevation:	243 m
Longitude:	86° 08' 52"W
Latitude:	37° 07' 55"N
UTM Zone:	16
Easting:	575696 m
Northing:	4109640 m
Map Reference:	Beaver Dam 37086-A1 1:100,000

2.0 DATA SUMMARY

2.1 OVERVIEW

Based on the site specifications during this annual reporting period, data summaries and statistics are provided in this section.

Data Collection Statistics
Mammoth Cave National Park
Houchin Meadow

Final Validation

01/01/2002 - 12/31/2002

Parameter	Interval	Par Code	Data Recovery			Valid Data	
			No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	hourly	O3	8760	8346	95.3	8305	94.8
Scalar Wind Speed	hourly	SWS	8760	8734	99.7	8722	99.6
Vector Wind Speed	hourly	VWS	8760	8707	99.4	8644	98.7
Vector Wind Direction	hourly	VWD	8760	8707	99.4	8644	98.7
Standard Deviation for Wind Direction	hourly	SDWD	8760	8707	99.4	8644	98.7
Ambient Temperature (aspirated)	hourly	TMP	8760	8730	99.7	8714	99.5
Delta Temperature	hourly	DTP	3672	3662	99.7	3662	99.7
Relative Humidity	hourly	RH	8760	8743	99.8	8742	99.8
Precipitation	hourly	RNF	8760	8697	99.3	8696	99.3
Wetness Sensor	hourly	WET	3672	3661	99.7	3661	99.7
Solar Radiation	hourly	SOL	8760	8737	99.7	8573	97.9
Barometric Pressure	hourly	BAR	8760	8742	99.8	8742	99.8
Filter Pack Flow Rate	hourly	FLOW	3672	3663	99.8	3663	99.8

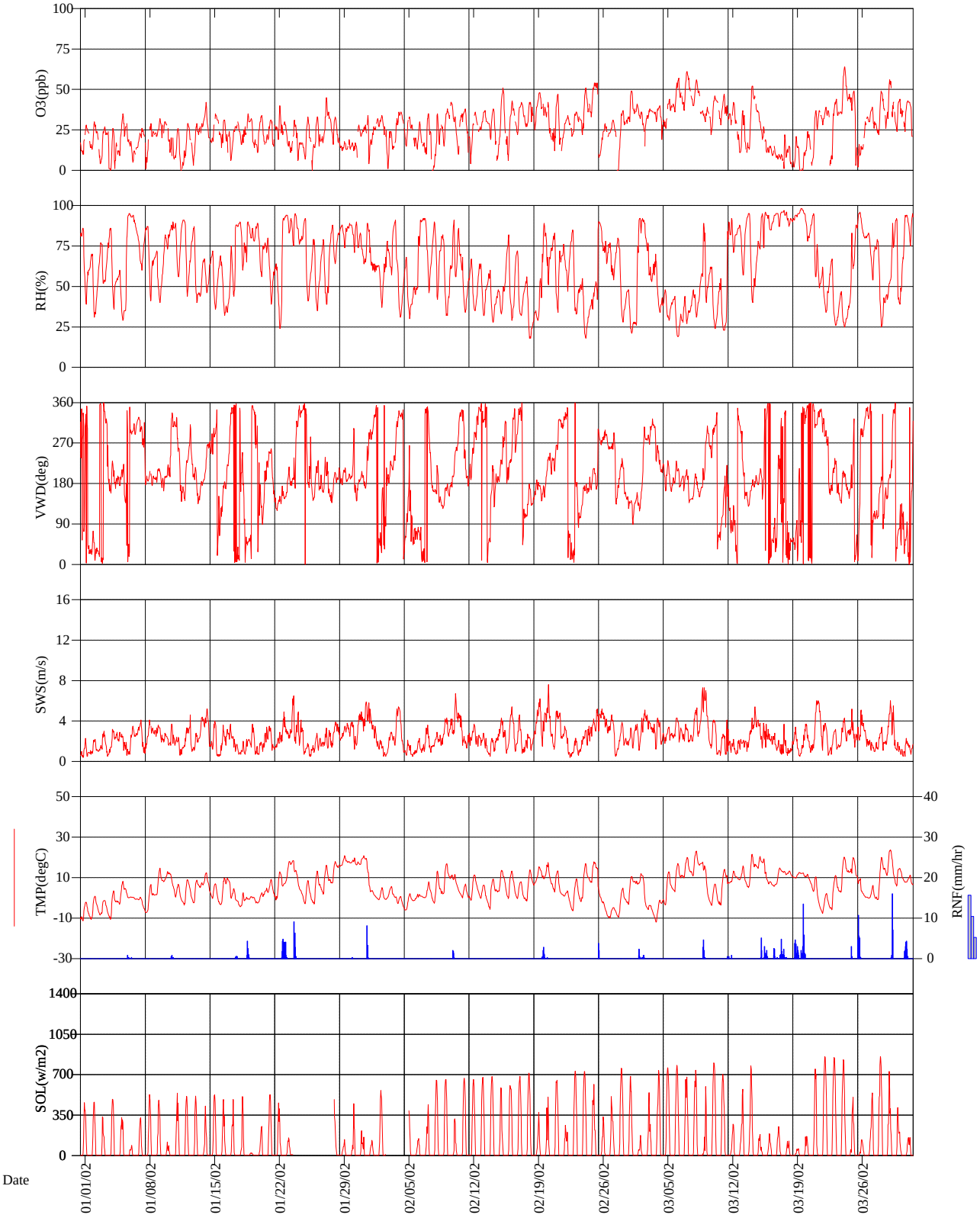
Notes: The percent valid is calculated against the number possible.
Automatic zeros and spans are performed daily on most ambient gas analyzers, therefore, no ambient data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically can not be greater than 95.8.

Performance Goals:

Quarterly Criteria:
100% of sites, >= 85% valid data capture
90% of sites, >= 90% valid data capture
80% of sites, >= 95% valid data capture

Monthly Criteria:
100% of sites, >= 60% valid data capture
90% of sites, >= 75% valid data capture
80% of sites, >= 85% valid data capture

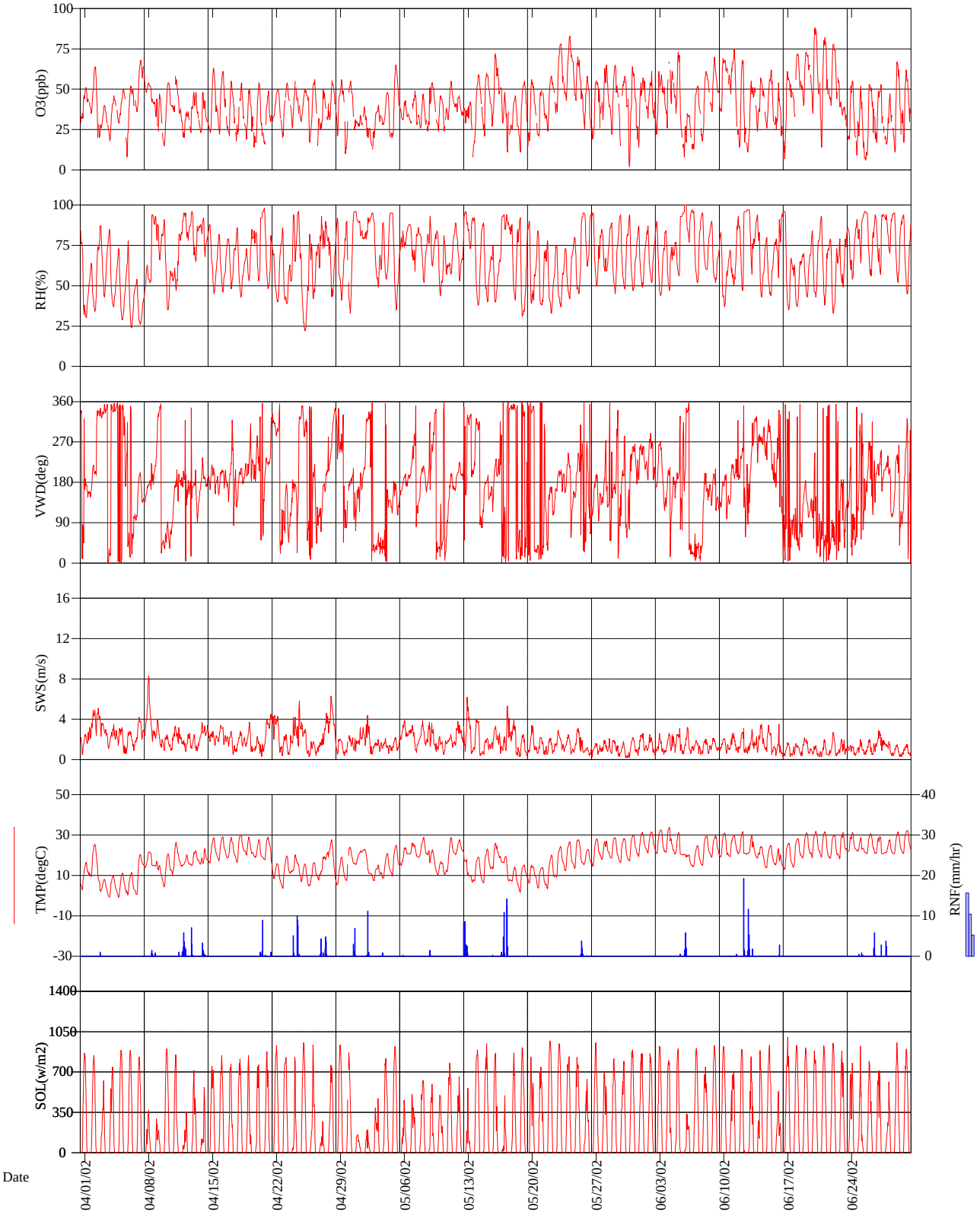
Mammoth Cave National Park - Houchin Meadow



Final Validation

First Quarter 2002

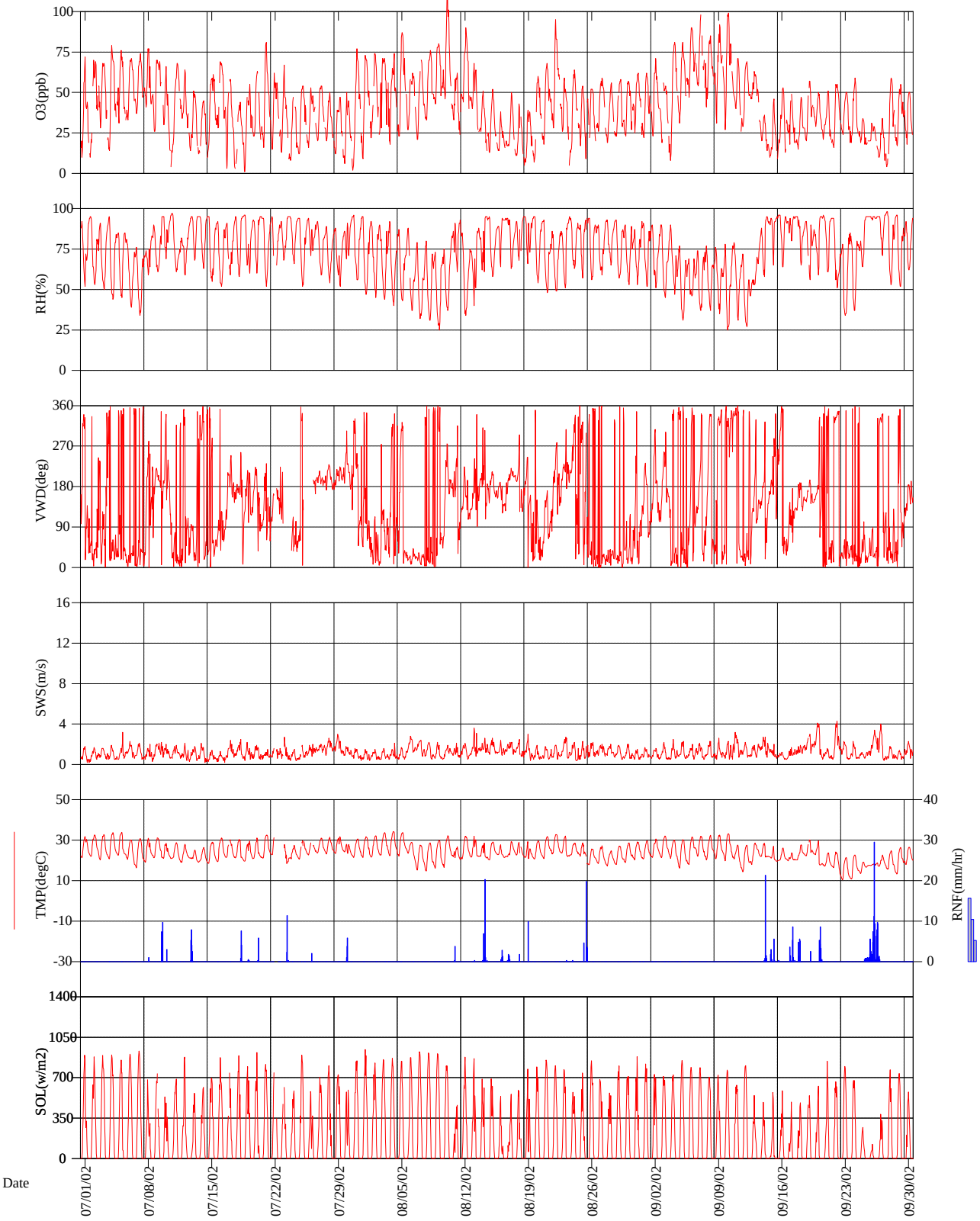
Mammoth Cave National Park - Houchin Meadow



Final Validation

Second Quarter 2002

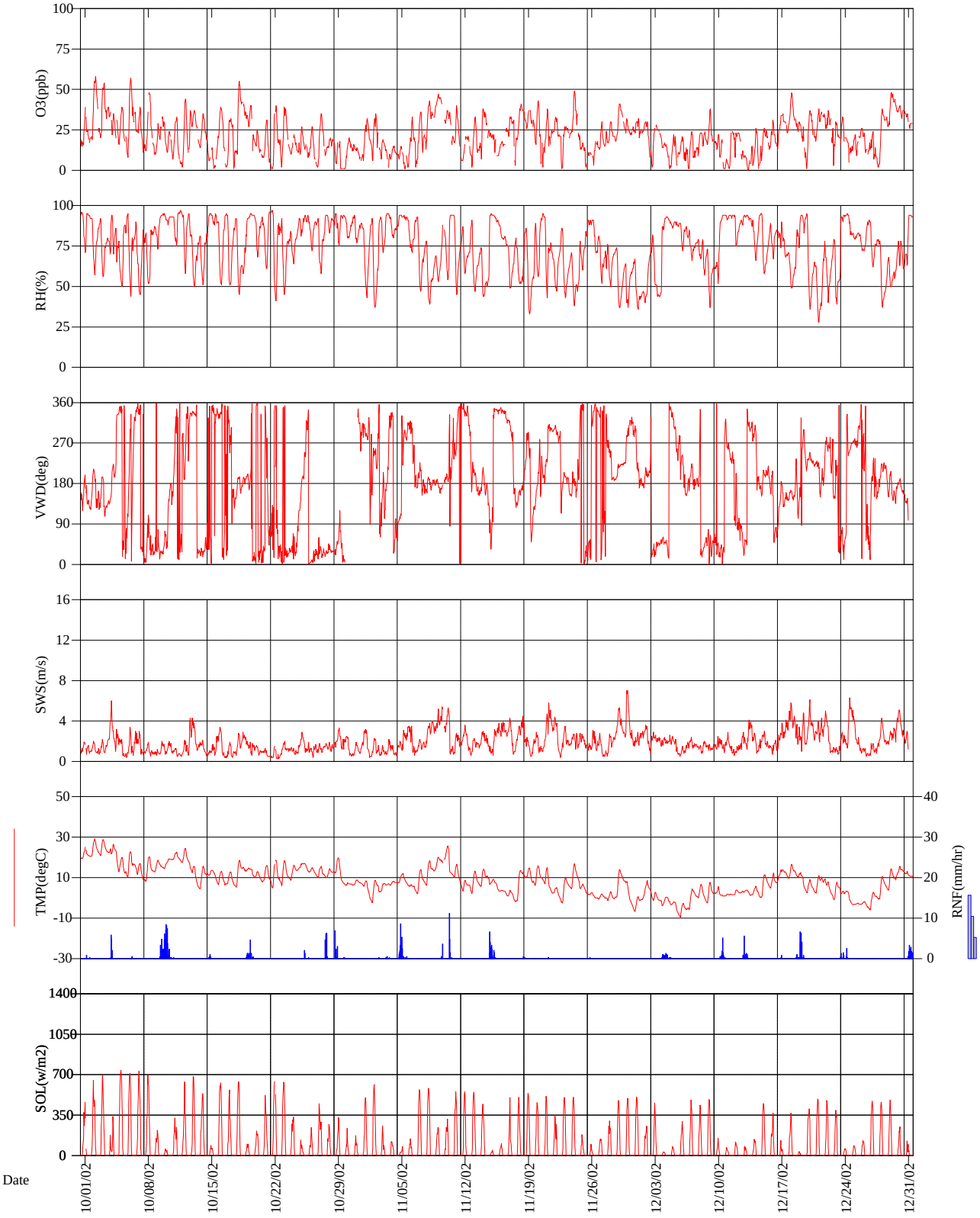
Mammoth Cave National Park - Houchin Meadow



Final Validation

Third Quarter 2002

Mammoth Cave National Park - Houchin Meadow



Final Validation

Fourth Quarter 2002

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Mammoth Cave National Park
Houchin Meadow
01/01/2002 - 12/31/2002

STATISTIC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAY-SEP	ANNUAL
DAILY 1-HR MAXIMUM	45	54	64	68	83	88	81	114	99	58	49	48	114	114
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
AVERAGE DAILY MAXIMUM	31	39	41	53	55	63	63	65	61	35	32	30	61	47
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MAXIMUM DAILY MEAN	30	46	50	53	63	63	55	73	70	37	41	38	73	73
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
AVERAGE DAILY MEAN	21	28	31	39	41	43	40	43	42	22	22	21	42	33
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MAX PEAK:MIN RATIO	29.000	25.000	22.000	6.500	32.000	8.833	55.000	12.800	14.750	40.000	27.000	37.000	55.000	55.000
NO. OF DAYS	(28)	(26)	(29)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(30)	(153)	(357)
AVERAGE PEAK:MIN RATIO	5.070	4.252	4.452	2.667	3.606	3.689	8.045	3.862	3.440	9.324	7.101	7.940	4.541	5.313
NO. OF DAYS	(28)	(26)	(29)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(30)	(153)	(357)
MAX 9AM-4PM AVERAGE	36	52	58	62	75	84	71	98	90	50	45	42	98	98
NO. OF DAYS	(30)	(28)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(31)	(152)	(363)
MONTHLY 9AM-4PM AVERAGE	24	33	36	47	50	56	56	58	54	29	27	25	55	41
NO. OF DAYS	(30)	(28)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(31)	(152)	(363)
MAX 7AM-7PM AVERAGE	33	50	54	59	71	74	64	86	78	45	44	41	86	86
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MONTHLY 7AM-7PM AVERAGE	22	31	34	44	47	51	50	52	49	25	25	23	50	38
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MONTHLY MEAN	21	28	31	39	41	43	40	43	42	22	22	21	42	33
NO. OF HOURS	(705)	(641)	(709)	(681)	(706)	(685)	(697)	(703)	(682)	(705)	(682)	(709)	(3473)	(8305)
SUM0 EXPOSURE INDEX	14565	17801	22014	26300	28756	29549	27787	30296	28470	15225	14880	14741	144858	270384
NO. OF HOURS	(705)	(641)	(709)	(681)	(706)	(685)	(697)	(703)	(682)	(705)	(682)	(709)	(3473)	(8305)
SUM60 EXPOSURE INDEX	-	-	433	1263	4187	7981	7441	9216	9254	-	-	-	38079	39775
NO. OF HOURS	(0)	(0)	(7)	(20)	(62)	(117)	(110)	(128)	(127)	(0)	(0)	(0)	(544)	(571)
SUM80 EXPOSURE INDEX	-	-	-	-	327	833	161	2163	2873	-	-	-	6357	6357
NO. OF HOURS	(0)	(0)	(0)	(0)	(4)	(10)	(2)	(24)	(33)	(0)	(0)	(0)	(73)	(73)
W126 EXPOSURE INDEX	95	411	1082	2075	4050	6301	5515	7653	7540	375	192	167	31060	35457
NO. OF HOURS	(705)	(641)	(709)	(681)	(706)	(685)	(697)	(703)	(682)	(705)	(682)	(709)	(3473)	(8305)

Concentrations in parts per billion (ppb)
Exposures in parts per billion-hours (ppb-hr)

* Statistics defined in the Quick Look subsection of the Glossary

Frequency Distribution

Mammoth Cave National Park
Houchin Meadow
Monitoring Season: 04/01/02 - 10/31/02[1]

Averaging Period	% Obs.[3]	# Obs.[2]	Min. Obs.[4]	Percentile[5] 10	30	50	70	90	95	99	Max. Obs.	2nd Max.	Arith. Mean	Geo. Mean	Geo. Stdv.
1-Hour	100	4859	0.016	0.036	0.050	0.055	0.063	0.076	0.083	0.098	0.114	0.099	0.0564	0.0539	1.37

Concentrations in parts per million (ppm)

[1] Records for this report are selected in accordance with the AIRS Geo-Common file criteria. These criteria are based on the state-specific Monitoring Season defined in AIRS.

[2] The number of observations (# Obs.) includes all valid observations recorded within the Monitoring Season.

[3] The percent of valid observations (% Obs.) is the percentage of valid days to the number of possible monitoring days during the Monitoring Season. A valid day is defined as a day with 9 or more valid observations between 9:00 a.m. and 9:00 p.m..

[4] The minimum observation value (Min. Obs.) is the minimum daily maximum recorded during the Monitoring Season.

[5] The percentiles and other statistics are derived from the daily maximums.

Ozone Standards Report and
Daily Maximum 1-Hour Concentrations (ppm)

Mammoth Cave National Park

Houchin Meadow

01/01/2002 - 12/31/2002

Day	Jan-02		Feb-02		Mar-02		Apr-02		May-02		Jun-02		Jul-02		Aug-02		Sep-02		Oct-02		Nov-02		Dec-02	
1	.028	T	.034	F	.049	F	.051	M	.034	W	.057	S	.072	M	.073	T	.062	S	.039	T	.032	F	.032	S
2	.030	W	.034	S	.041	S	.064	T	.039	T	.061	S	.070	T	.074	F	.071	M	.058	W	.035	S	.030	M
3	.027	T	.025	S	.038	S	.040	W	.040	F	.061	M	.068	W	.071	S	.056	T	.054	T	.019	S	.028	T
4	.026	F	.036	M	.040	M	.046	T	.048	S	.067	T	.079	T	.074	S	.081	W	.039	F	.015	M	.023	W
5	.035	S	.033	T	.044	T	.050	F	.065	S	.073	W	.076	F	.087	M	.081	T	.039	S	.015	T	.022	T
6	.029	S	.030	W	.057	W	.052	S	.043	M	.035	T	.071	S	.062	T	.090	F	.057	S	.033	W	.021	F
7	.026	M	.035	T	.061	T	.068	S	.049	T	.052	F	.074	S	.070	W	.098	S	.039	M	.036	T	.024	S
8	.029	T	.035	F	.056	F	.059	M	.047	W	.061	S	.077	M	.076	T	.085	S	.048	T	.043	F	.023	S
9	.032	W	.038	S	.039	S	.047	T	.054	T	.070	S	.070	T	.080	F	.092	M	.029	W	.047	S	.038	M
10	.030	T	.042	S	.046	S	.054	W	.046	F	.069	M	.066	W	.114	S	.099	T	.033	T	.038	S	.022	T
11	.026	F	.038	M	.047	M	.058	T	.055	S	.075	T	.068	T	.062	S	.071	W	.033	F	.040	M	.023	W
12	.029	S	.036	T	.042	T	.038	F	.046	S	.068	W	.064	F	.090	M	.069	T	.044	S	.021	T	.024	T
13	.029	S	.037	W	.037	W	.048	S	.042	M	.055	T	.051	S	.068	T	.063	F	.037	S	.033	W	.012	F
14	.042	M	.038	T	.052	T	.048	S	.059	T	.057	F	.045	S	.051	W	.036	S	.035	M	.038	T	.026	S
15	.035	T	.051	F	.041	F	.063	M	.060	W	.062	S	.061	M	.052	T	.046	S	.020	T	.025	F	.026	S
16	.031	W	.043	S	.019	S	.061	T	.072	T	.054	S	.069	T	.038	F	.053	M	.039	W	.018	S	.031	M
17	.028	T	.042	S	.015	S	.055	W	.051	F	.061	M	.058	W	.050	S	.049	T	.032	T	.033	S	.035	T
18	.030	F	.042	M	.022	M	.054	T	.046	S	.072	T	.044	T	.043	S	.047	W	.055	F	.041	M	.048	W
19	.035	S	.048	T	.021	T	.050	F	.055	S	.073	W	.055	F	.039	M	.057	T	.041	S	.037	T	.032	T
20	.034	S	.042	W	.024	W	.054	S	.056	M	.088	T	.063	S	.060	T	.050	F	.025	S	.043	W	.037	F
21	.031	M	.047	T	.037	T	.049	S	.049	T	.082	F	.081	S	.068	W	.051	S	.031	M	.038	T	.038	S
22	.040	T	.034	F	.039	F	.050	M	.058	W	.078	S	.062	M	.095	T	.055	S	.040	T	.033	F	.037	S
23	.030	W	.036	S	.044	S	.054	T	.078	T	.057	S	.067	T	.059	F	.050	M	.039	W	.027	S	.030	M
24	.031	T	.051	S	.064	S	.055	W	.083	F	.055	M		W	.064	S	.059	T	.022	T	.049	S	.033	T
25	.033	F	.054	M	.049	M	.050	T	.070	S	.052	T	.054	T	.054	S	.034	W	.027	F	.023	M	.022	W
26	.033	S	.029	T	.030	T	.056	F	.058	S	.053	W	.053	F	.052	M	.031	T	.027	S	.018	T	.026	T
27	.045	S	.031	W	.039	W	.050	S	.055	M	.053	T	.054	S	.059	T	.034	F	.035	S	.030	W	.024	F
28	.033	M	.037	T	.049	T	.055	S	.065	T	.047	F	.050	S	.056	W	.059	S	.020	M	.030	T	.038	S
29	.018	T			.056	F	.056	M	.065	W	.067	S	.047	M	.058	T	.055	S	.018	T	.041	F	.048	S
30	.019	W			.044	S	.055	T	.058	T	.062	S	.050	T	.057	F	.050	M	.020	W	.032	S	.044	M
31	.028	T			.043	S			.064	F			.077	W	.062	S			.016	T				
Valid Days	31		28		31		30		31		30		30		31		30		31		30		30	
Maximum	.045		.054		.064		.068		.083		.088		.081		.114		.099		.058		.049		.048	
Violations	0		0		0		0		0		0		0		0		0		0		0		0	

8283 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])	
94.8 % Possible	1 Missing days assumed to be less than the standard	
363 Valid daily maxima	0 Daily maximas exceed the alert level of .200 ppm	Concentrations in parts per million (ppm)

Final Validation

4/22/03

Mammoth Cave National Park
Houchin Meadow
2002 Attainment Status With U.S. Environmental Protection Agency (EPA)
PRIMARY Ozone National Ambient Air Quality Standard

Ozone Season: April through October

The primary National Ambient Air Quality Standard for ozone is designed to protect human health. The level of the primary ozone standard promulgated by the EPA on July 18, 1997 is 0.08 parts per million (ppm) [80 parts per billion, (ppb)], daily maximum 8-hour average. The primary ozone standard is met at an ambient monitoring site when the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to 0.08 ppm. This standard is not met when the 3-year average is greater than 0.08 ppm. Using the EPA's rounding convention, a computed 3-year average ozone concentration of 0.085 ppm (85 ppb) is the smallest value that is greater than the level of the 0.08 ppm standard.

The primary standard requires 90 percent data completeness, on average, during the 3-year period, with no single year within the period having less than 75 percent data completeness. This data completeness requirement would have to be satisfied in order to determine that the standard has been met at a monitoring site. However, calendar years with less than 75 percent data completeness are included in the computation if the annual fourth-highest daily maximum 8-hour concentration is greater than the level of the standard. A site could be found not to have met the standard with less than complete data. The percent data completeness is the percent of valid ozone monitoring days. A day is valid if valid 8-hour averages are available for at least 75 percent of possible hours in the day (i.e., at least 18 of the 24 averages). An 8-hour average is considered valid if at least 75 percent (or 6) of the hourly averages for the 8-hour period are available.

The table below lists the 3-year average fourth-highest daily maximum 8-hour ozone concentration based on data collected during the reported year and the two previous years. This is the number to compare to the level of the new primary standard. The 3-year average data completeness percent and the reported year highest five daily maximum 8-hour averages are also tabulated. A 'No' in the Data Comp % Met? column indicates EPA data completeness requirement was not met for the three-year period.

Year	3-Year Avg 4th High Daily Max 8-hr Ozone (ppb)	3-Year Avg Data Complete %	Data Complete % Met?	Annual 1st High Daily Max 8-hr Ozone (ppb)	Annual 2nd High Daily Max 8-hr Ozone (ppb)	Annual 3rd High Daily Max 8-hr Ozone (ppb)	Annual 4th High Daily Max 8-hr Ozone (ppb)	Annual 5th High Daily Max 8-hr Ozone (ppb)
2002	84	99%	Yes	100	91	86	85	83

Ozone Analyzer 10 Highest Daily 1-Hour Average Maximum Concentrations Mammoth Cave National Park Houchin Meadow Final Validation 01/01/2002 - 12/31/2002			
Value	Date	Hour	Concentration (ppb)
Ozone Analyzer			
1	08/10/2002	13	114
2	09/10/2002	14	99*
3	09/07/2002	13	98
4	08/22/2002	12	95
5	09/09/2002	15	92
6	08/12/2002	14	90
7	09/06/2002	12	90*
8	06/20/2002	11	88
9	08/05/2002	13	87
10	09/08/2002	15	85

* This value was also recorded during one or more hours later in the day.

Episodes with 1-Hour Ozone Concentrations
≥ 100 ppb and > 124 ppb

Mammoth Cave National Park
Houchin Meadow

01/01/2002 - 12/31/2002
FINAL VALIDATION

Site	Date	Beginning Hour	No. Hours ≥ 100 ppb	No. Hours >124 ppb	Max (ppb)
MACA-HM	08/10/02	11	4	0	114
MACA-HM	08/10/02	16	1	0	101
		Total	5	0	114

Note: The primary and secondary national ambient air standard for ozone that applied in 1996 is 0.12 ppm over a one hour period not to be exceeded more than once per year. (A value greater than .12 ppm, 124 ppb, or 235 ug/m³ exceeds the standard.) (40 CFR 50.9 with reference to Appendix D and H.)

Episodes with 8-Hour Average Ozone Concentrations > 84 ppb Mammoth Cave National Park Houchin Meadow 01/01/2002 - 12/31/2002 FINAL VALIDATION				
Site	Date	Start and End Time of Daily Maximum 8-Hour Average > 84 ppb (hr)	Daily Maximum 8-Hour Average (ppb)	Number of 8-Hour Averages > 84 ppb During the Day
MACA-HM	08/10/02	10 - 17	100	6
MACA-HM	09/06/02	10 - 17	85	1
MACA-HM	09/07/02	09 - 16	86	2
MACA-HM	09/10/02	10 - 17	91	5
	4	Days with 8-hour average concentrations > 84 ppb		

Note: This table presents episodes of high ozone based on running 8-hour averages. In 1997, the EPA published new primary and secondary national ambient air quality standards for ozone based on 8-hour average ozone concentrations. Attainment of the new primary standard is reached if the annual fourth highest daily maximum 8-hour ozone concentration, averaged over three years, does not exceed 0.08 ppm (84 ppb or 157 ug/m^3).

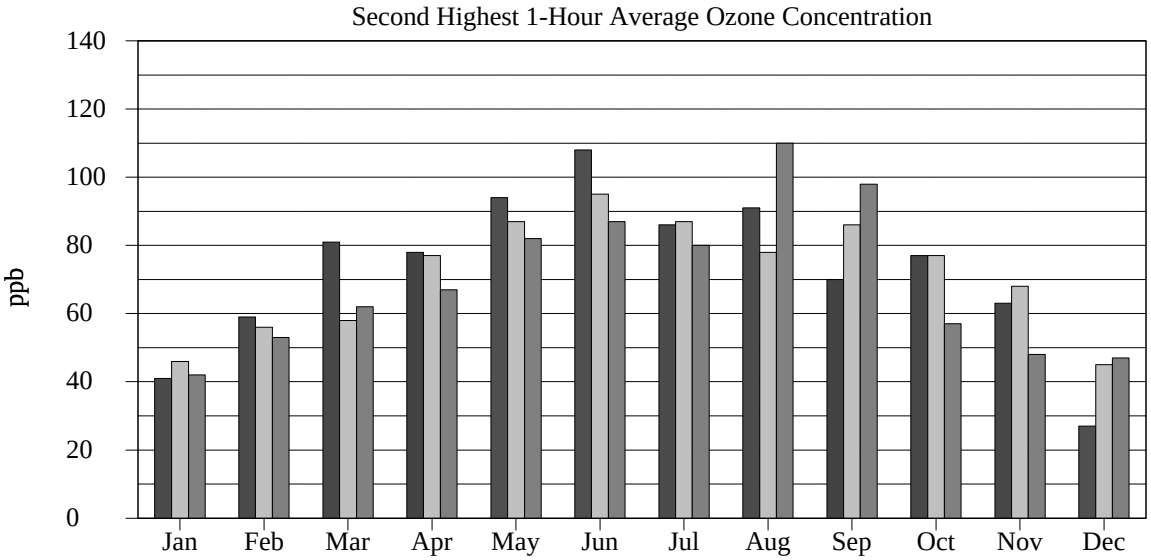
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

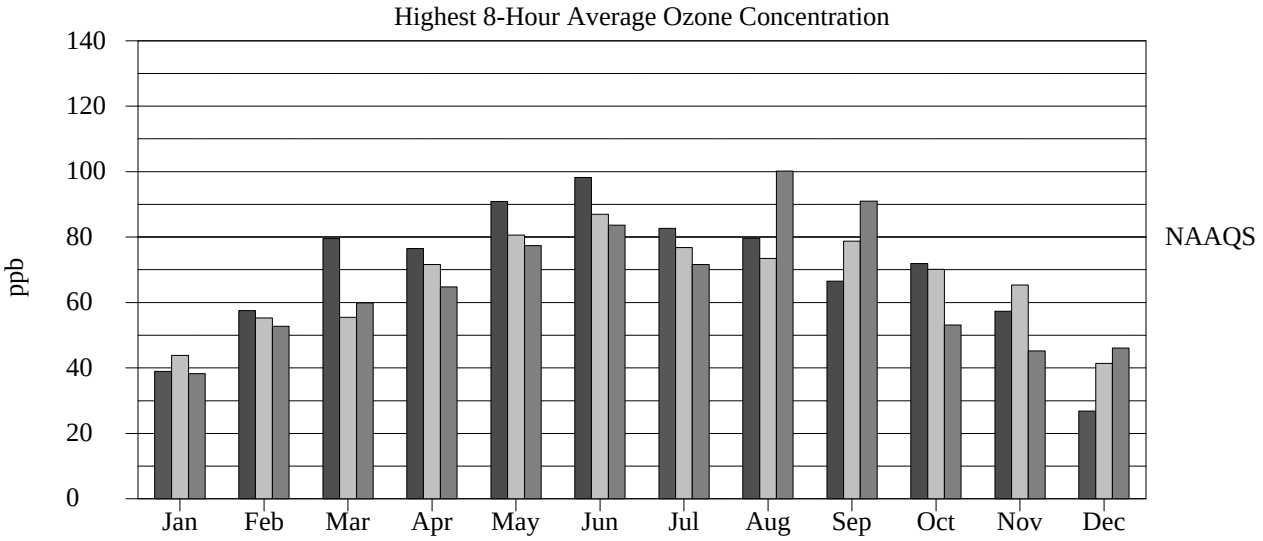
01/01/2002 - 12/31/2002

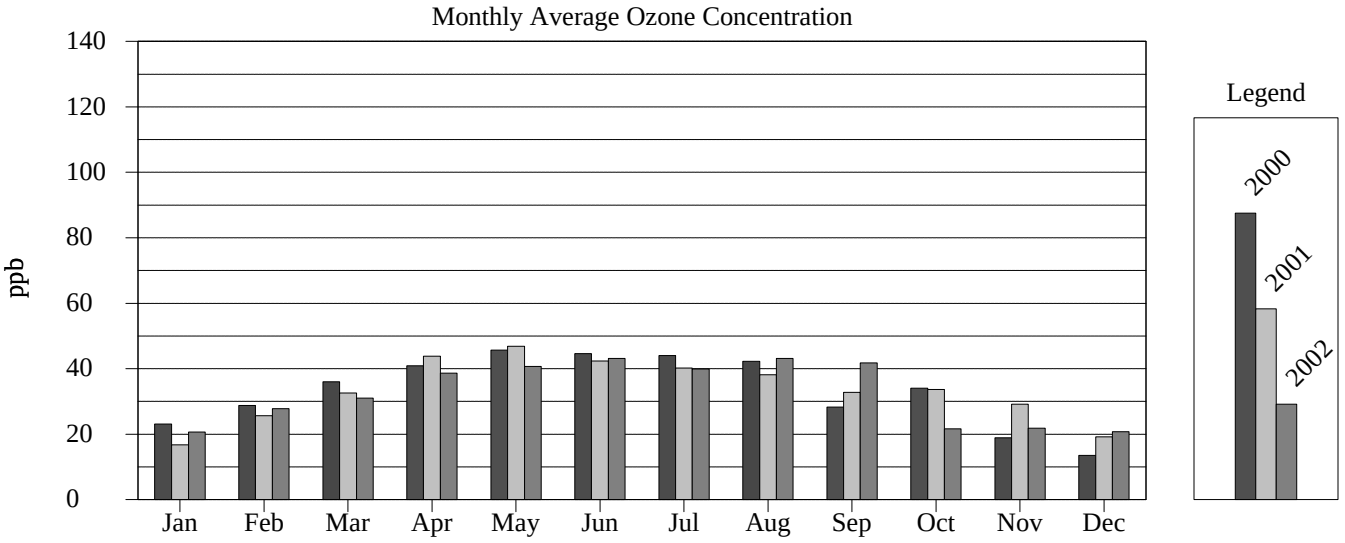
Second Highest 1-Hour Average Concentration		
Site	Rank	Concentration (ppb)
ACAD-CM	1	127
CHAM-XX	2	127
JOTR-YV	3	127
SEKI-LK	4	126
SEKI-AS	5	124
SEKI-LP	6	124
GRSM-LR	7	122
CACO-XX	8	118
COWP-XX	9	118
ACAD-MH	10	117
GRSM-CM	11	117
GRSM-CD	12	115
COSW-BL	13	111
MACA-HM	14	110
PINN-ES	15	110
GRSM-CC	16	108
ROMO-LP	17	106
GRSM-PK	18	105
YOSE-TD	19	105
SHEN-BM	20	103
DEVA-PV	21	97
SAGU-PC	22	90
GRBA-MY	23	89
GRCA-AS	24	85
LAVO-ML	25	84
CHIR-ES	26	80
YOSE-MR	27	80
MEVE-MY	28	79
CHIS-XX	29	78
CANY-IS	30	77
CRMO-VC	31	75
YELL-WT	32	73
THRO-VC	33	71
MORA-TW	34	70
NOCA-MM	35	70
VOYA-SB	36	70
PEFO-HB	37	69
BIBE-KB	38	68
EVER-BC	39	68
DENA-HQ	40	65
GLAC-WG	41	59
VIIS-LP	42	57
HAVO-TH	43	50
OLYM-VC	44	44

4th Highest 8-hour Average Concentration		
Site	Rank	Concentration (ppb)
SEKI-LP	1	109
SEKI-LK	2	108
JOTR-YV	3	107
SEKI-AS	4	107
GRSM-CM	5	103
GRSM-LR	6	102
GRSM-CD	7	101
ACAD-CM	8	100
GRSM-PK	9	94
CACO-XX	10	93
COWP-XX	11	93
YOSE-TD	12	93
ACAD-MH	13	89
CHAM-XX	14	89
ROMO-LP	15	87
PINN-ES	16	86
SHEN-BM	17	86
MACA-HM	18	85
DEVA-PV	19	83
COSW-BL	20	82
GRSM-CC	21	82
GRCA-AS	22	79
SAGU-PC	23	77
LAVO-ML	24	75
GRBA-MY	25	74
CANY-IS	26	72
YOSE-MR	27	72
MEVE-MY	28	70
CHIR-ES	29	69
CRMO-VC	30	69
CHIS-XX	31	66
YELL-WT	32	66
VOYA-SB	33	65
BIBE-KB	34	62
THRO-VC	35	62
EVER-BC	36	57
DENA-HQ	37	55
PEFO-HB	38	55
GLAC-WG	39	52
MORA-TW	40	52
VIIS-LP	41	48
NOCA-MM	42	46
HAVO-TH	43	42
OLYM-VC	44	39

Annual Sum60 Exposure Index			
Site	Rank	Sum60	Count
SEKI-LK	1	204306	2639
SEKI-AS	2	196849	2529
SEKI-LP	3	193795	2491
JOTR-YV	4	175177	2398
GRSM-CM	5	169849	2320
YOSE-TD	6	164764	2298
GRSM-LR	7	131936	1794
GRSM-CD	8	130649	1793
GRSM-PK	9	118538	1656
DEVA-PV	10	106174	1586
GRCA-AS	11	104360	1584
ROMO-LP	12	95145	1403
SHEN-BM	13	88006	1273
CANY-IS	14	68738	1068
COWP-XX	15	66858	924
PINN-ES	16	54322	767
MEVE-MY	17	49400	771
GRSM-CC	18	42779	611
CACO-XX	19	39974	546
MACA-HM	20	39775	571
ACAD-CM	21	39360	529
SAGU-PC	22	35867	540
COSW-BL	23	34655	491
CHAM-XX	24	34216	482
CRMO-VC	25	34186	537
CHIR-ES	26	32418	503
GRBA-MY	27	30461	466
YELL-WT	28	29522	470
ACAD-MH	29	26476	362
LAVO-ML	30	26432	394
YOSE-MR	31	22272	334
VOYA-SB	32	7405	116
BIBE-KB	33	7215	116
CHIS-XX	34	6974	106
THRO-VC	35	4004	63
DENA-HQ	36	996	16
PEFO-HB	37	951	15
EVER-BC	38	833	13
MORA-TW	39	453	7
NOCA-MM	40	267	4
GLAC-WG	41	124	2
HAVO-TH	42	0	0
OLYM-VC	43	0	0
VIIS-LP	44	0	0


Second Highest 1-Hour Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Highest 8-Hour Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
NAAQS


Monthly Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Legend
2000
2001
2002

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK

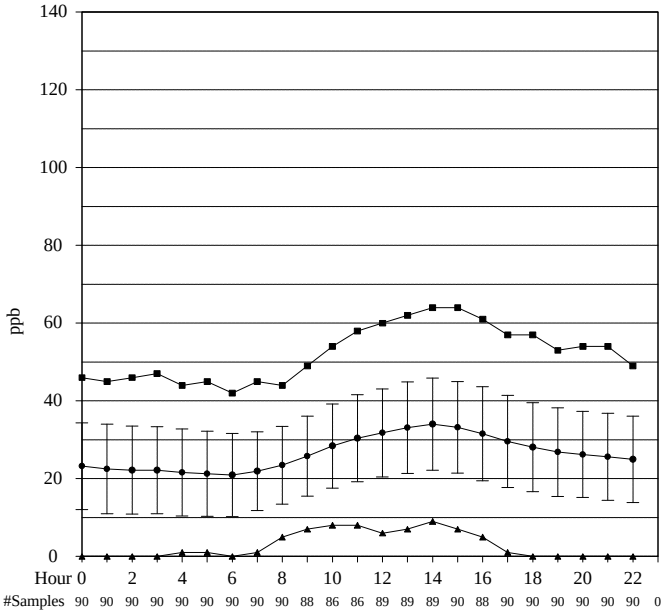
2002 Second Highest 1-Hour Ozone Concentrations

Mammoth Cave
National Park
Houchin Meadow

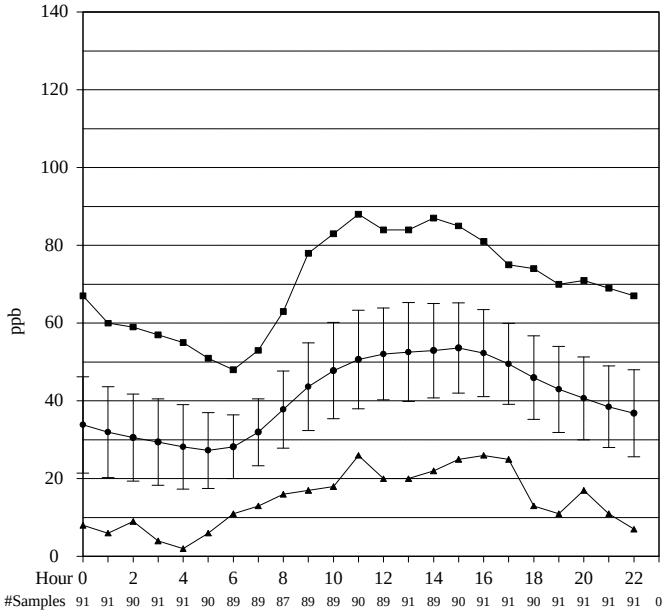
Quarterly Diurnal
Ozone Plots

2002

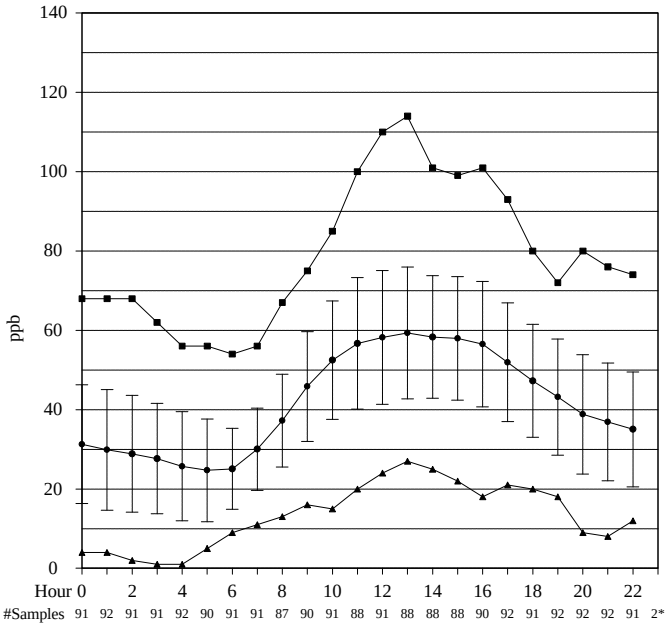
FIRST QUARTER (JAN-MAR)



SECOND QUARTER (APR-JUN)

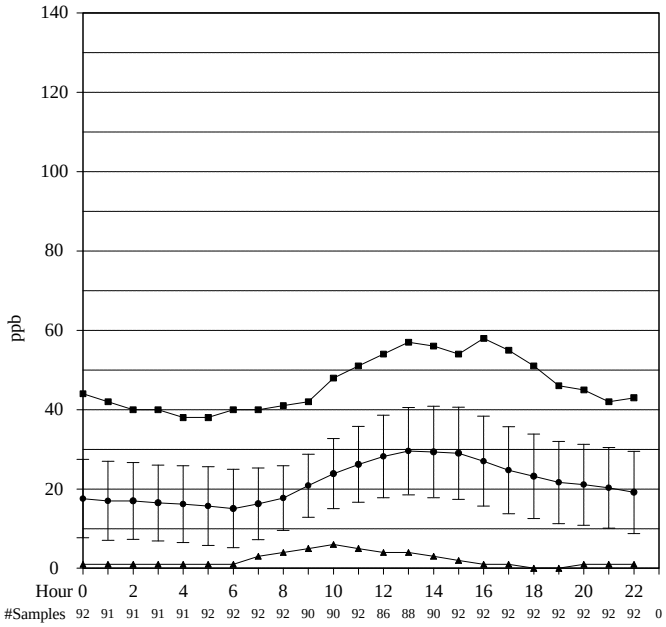


THIRD QUARTER (JUL-SEP)



* Number of samples < 20% of maximum available hours during period

FOURTH QUARTER (OCT-DEC)



Maximum of Valid O3 in ppb
(□ Indicates Data Exceeds Plot Scale)

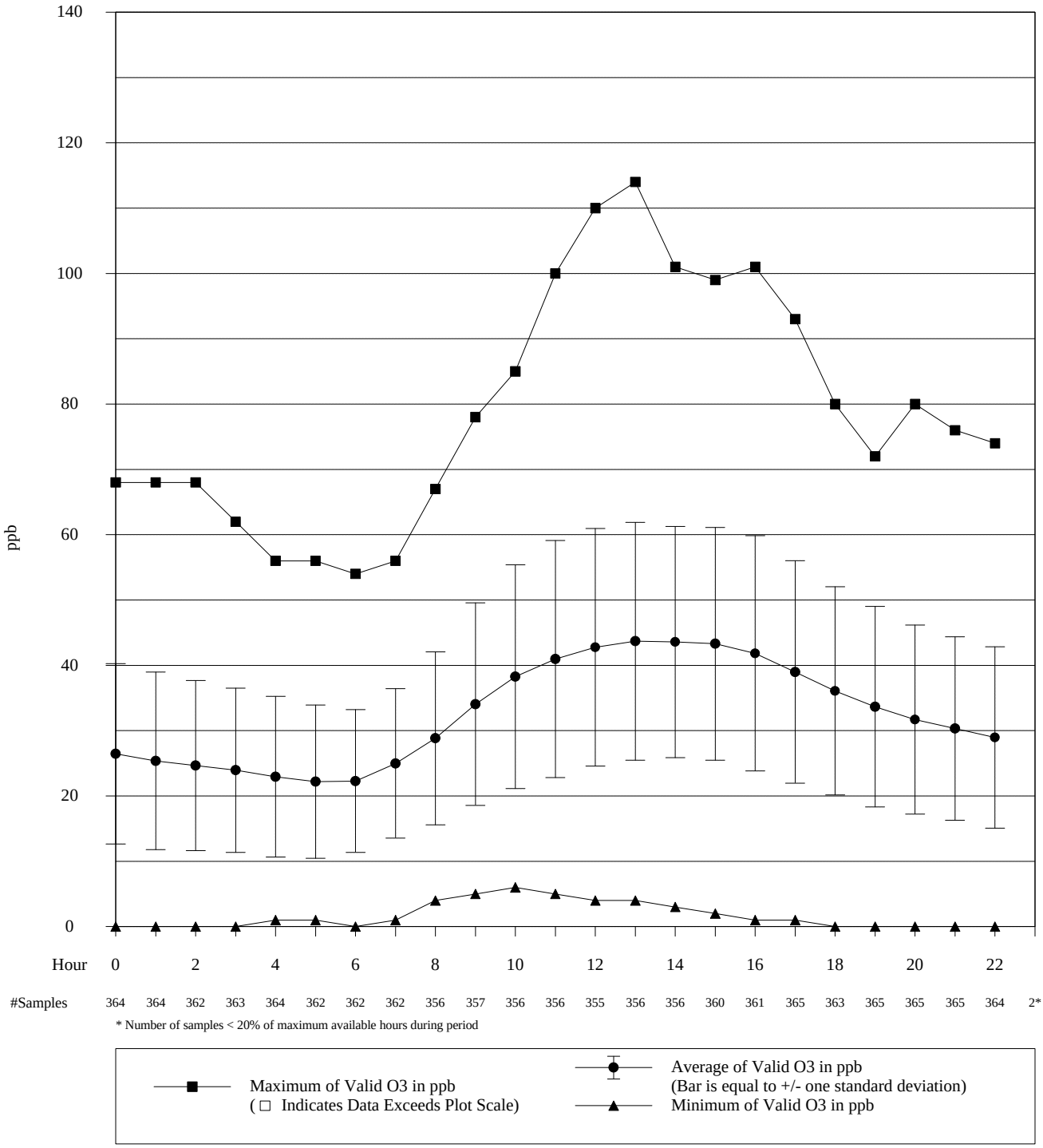
Average of Valid O3 in ppb
(Bar is equal to +/- one standard deviation)

Minimum of Valid O3 in ppb

Mammoth Cave
National Park
Houchin Meadow

Annual Diurnal
Ozone Plot

2002



Final Validation

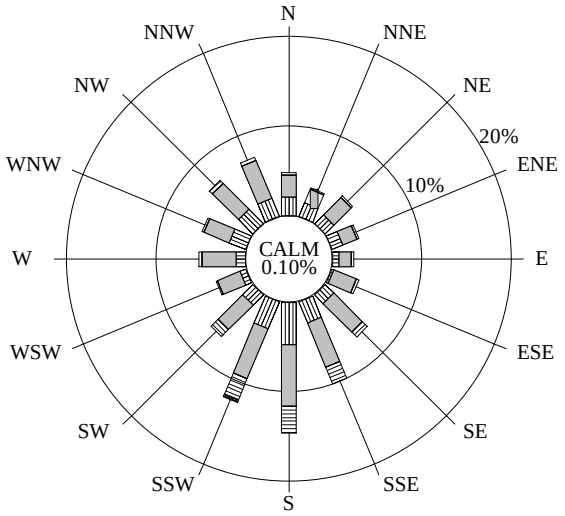
04-18-2003

Mammoth Cave National Park Houchin Meadow

Quarterly Ozone Pollutant Rose

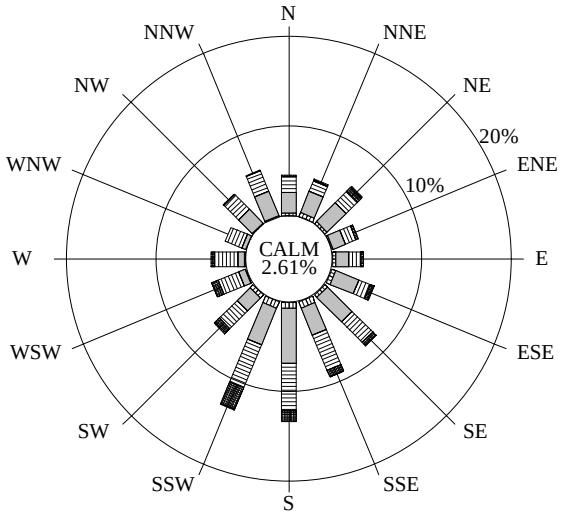
2002

FIRST QUARTER (JAN-MAR)



95.1% Collected 95.0% Valid
2160 Possible /2055 Collected /2053 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)

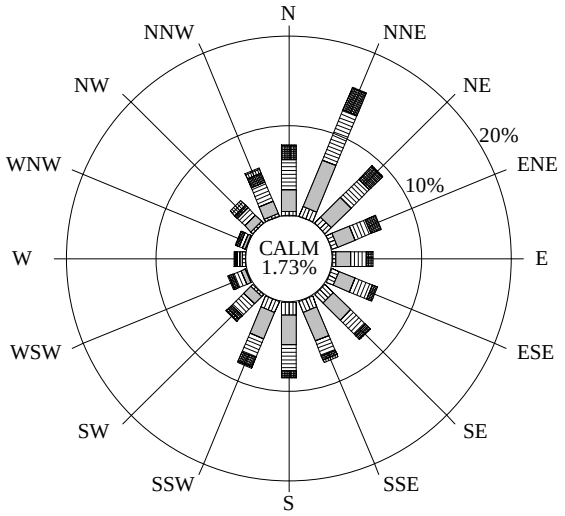


95.4% Collected 94.9% Valid
2184 Possible /2083 Collected /2072 Valid
(includes WS and WD)

Ozone (ppb)

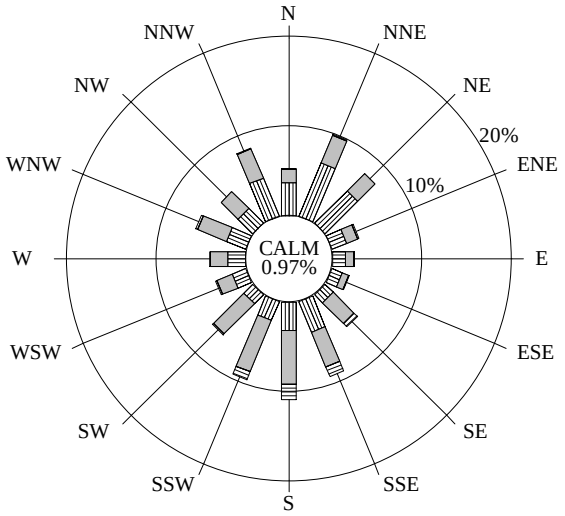
0-19
20-39
40-59
60-79
80-99
100-119
120-139
140+

THIRD QUARTER (JUL-SEP)



93.3% Collected 91.8% Valid
2208 Possible /2059 Collected /2028 Valid
(includes WS and WD)

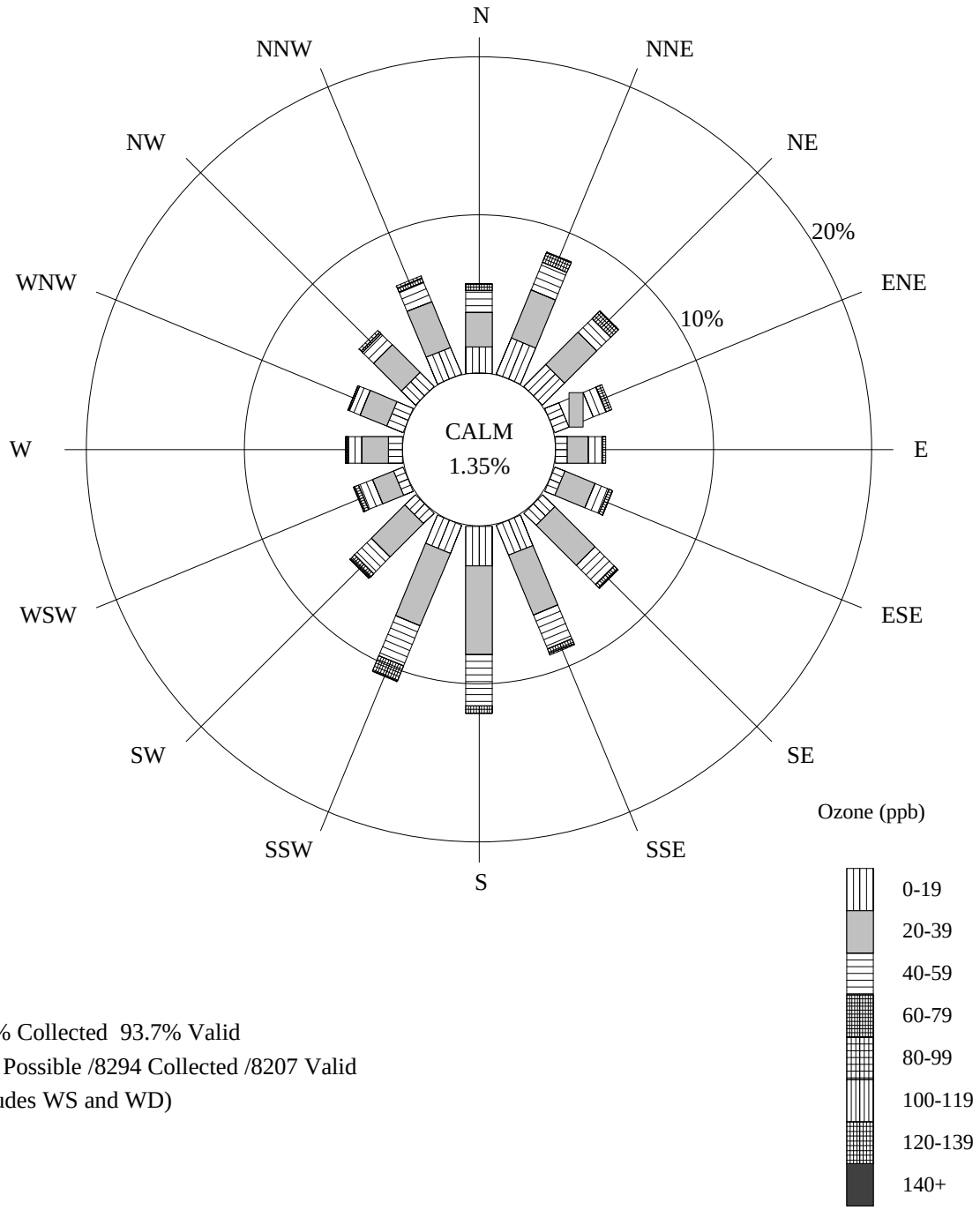
FOURTH QUARTER (OCT-DEC)



95.0% Collected 93.0% Valid
2208 Possible /2097 Collected /2054 Valid
(includes WS and WD)

Final Validation

07-11-2003



94.7% Collected 93.7% Valid
8760 Possible /8294 Collected /8207 Valid
(includes WS and WD)

Ozone Analyzer Precision Check Summary

Mammoth Cave National Park
Houchin Meadow

Precision checks are required by the Environmental Protection Agency (EPA) of all monitoring instruments collecting data which are to be submitted to the EPA Aerometric Information Retrieval System (AIRS). A precision check is performed by challenging the pollutant analyzer with a known concentration of gas from the pollutant transfer standard. This precision check must be performed at least every 14 days of monitoring operation. The percent difference between the analyzer and the transfer standard is then calculated.[1] According to NPS Standard Operating Procedures, the pollutant analyzer must respond within 10% of the transfer standard. The table below gives the number of precision checks performed during each quarter, the average[2] of all the individual precision check percent differences for the quarter, and the upper and lower 95% probability limits[3] for precision checks. The probability limits represent the interval having a 95% chance of containing the true average percent difference. The quarterly average percent difference and probability limits should ideally be within +/- 10%.

Final Validation 01/01/2002 - 12/31/2002				
Calendar Quarter	Number of Precision Checks	Average Percent Difference [1] [2]	Lower 95% Probability Limit [3]	Upper 95% Probability Limit [3]
1	90	1.13	0.00	2.27
2	91	1.09	-0.55	2.73
3	87	0.52	-3.66	4.71
4	92	0.08	-1.69	1.85

[1] Percent Difference= $\frac{\text{analyzer - transfer std}}{\text{transfer std}}$ X 100.

[2] Average Percent Difference is the mean of all individual precision check percent differences during the quarter.

[3] Upper/Lower 95% Probability Limits=(Average Percent Difference) +/- (1.96)(Standard Deviation of precision check percent differences in the quarter.)

2.3 METEOROLOGICAL DATA SUMMARY

Summary of Selected Meteorological Data

Mammoth Cave National Park

Houchin Meadow

Final Validation

01/01/2002 - 12/31/2002

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	1.8	m/s	8722	1.1
Maximum	8.3	m/s		
Percent calm = 1.46				
AMBIENT TEMPERATURE				
Average	14.2	degC	8714	9.9
Maximum	34.3	degC		
Minimum	-12.0	degC		
RELATIVE HUMIDITY				
Average	70	percent	8742	18
Maximum	100	percent		
Minimum	18	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	2.3	mm/hr	618	3.1
Maximum non-zero rate	29.5	mm/hr		
Minimum non-zero rate	.3	mm/hr		
Accumulated during period	1403.2	mm		
SOLAR RADIATION				
Average Daily Total	12,343,676	joules/m2day	346	6,950,377
Maximum Daily Total	25,740,800	joules/m2day		
Minimum Daily Total	662,400	joules/m2day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

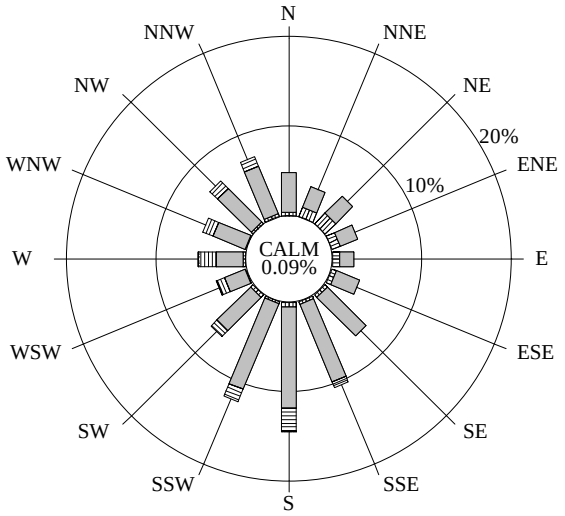
NA indicates instrument not available.

Mammoth Cave National Park
Houchin Meadow

Quarterly Wind Rose

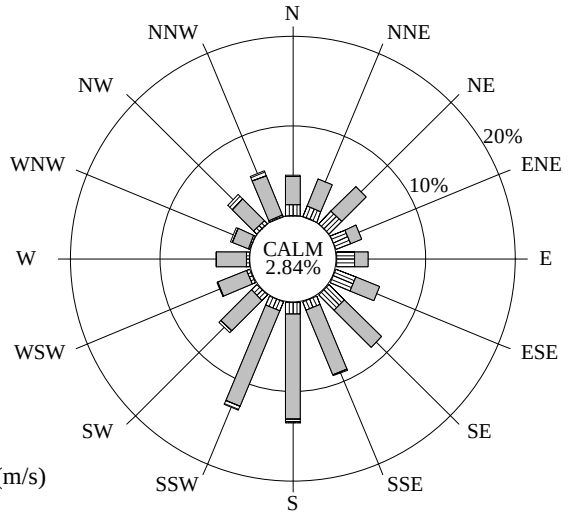
2002

FIRST QUARTER (JAN-MAR)



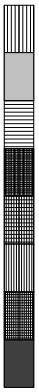
99.9% Collected 99.9% Valid
2160 Possible /2158 Collected /2158 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



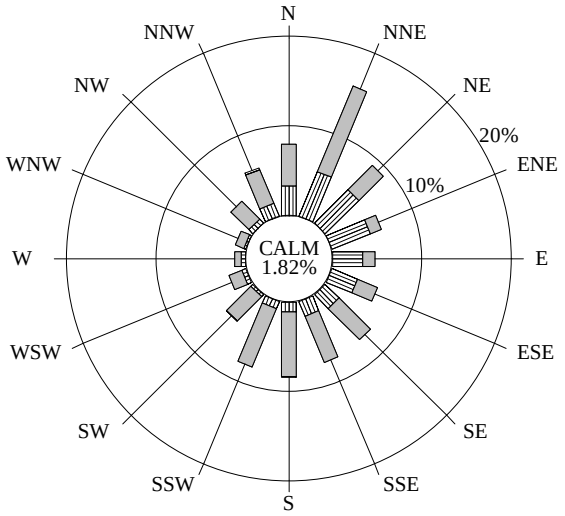
100.0% Collected 100.0% Valid
2184 Possible /2183 Collected /2183 Valid
(includes WS and WD)

Scalar Wind Speed (m/s)



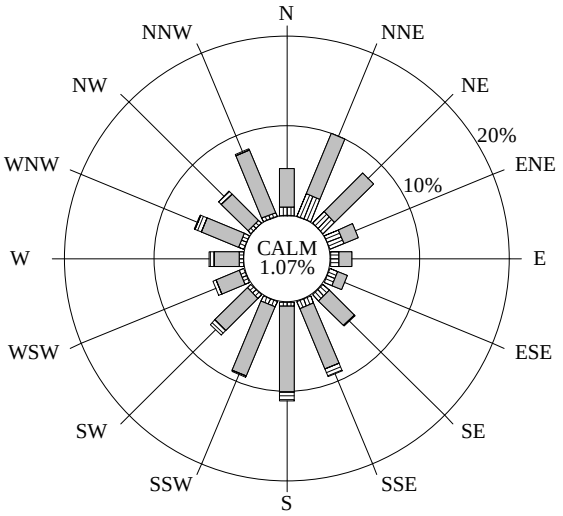
CALM < .5
0.5-0.9
1.0-3.9
4.0-6.9
7.0-9.9
10.0-12.9
13.0-15.9
16.0-18.9
19.0+

THIRD QUARTER (JUL-SEP)



98.1% Collected 97.2% Valid
2208 Possible /2165 Collected /2146 Valid
(includes WS and WD)

FOURTH QUARTER (OCT-DEC)



99.7% Collected 97.7% Valid
2208 Possible /2201 Collected /2157 Valid
(includes WS and WD)

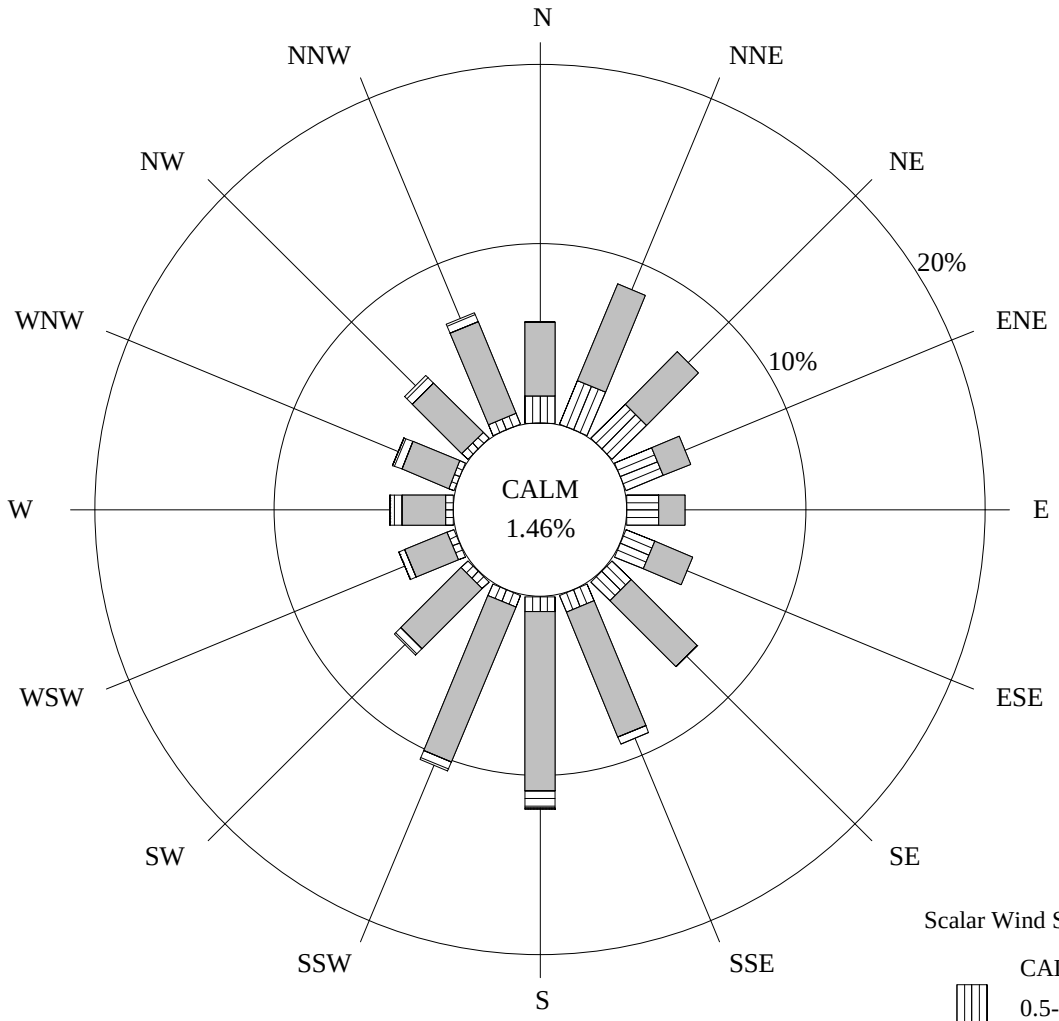
Final Validation

07-11-2003

Mammoth Cave
National Park
Houchin Meadow

Annual Wind Rose

2002



Scalar Wind Speed (m/s)

- CALM < .5
- 0.5-0.9
- 1.0-3.9
- 4.0-6.9
- 7.0-9.9
- 10.0-12.9
- 13.0-15.9
- 16.0-18.9
- 19.0+

99.4% Collected 98.7% Valid
8760 Possible /8707 Collected /8644 Valid
(includes WS and WD)

2.4 DRY DEPOSITION DATA SUMMARY

Clean Air Status and Trends Network (CASTNet)
Dry Deposition Monitoring

In 1995, the National Park Service (NPS) and the Environmental Protection Agency (EPA) entered a partnership to jointly measure dry deposition in park units, mostly in the West. A portion of the 2000, 2001, and 2002 data collected from this partnership is presented in this section. These data are presented using local conditions. Data presented in reports prior to 2002 are based on standard conditions.

Atmospheric deposition of acidic species takes two pathways: wet deposition and dry deposition. Wet deposition is the result of precipitation events (rain, snow, or fog) that remove particles and gases from the atmosphere. Dry deposition is less event driven, but still involves the transfer of particles and gases from the atmosphere to surfaces and plants. Wet deposition has been well documented for many years. In the national parks, the National Acidic Deposition Program (NADP) measures and reports wet deposition (see the web site at http://nadp.sws.uiuc.edu for further information). Dry deposition is much harder to measure and a smaller network of monitoring stations is involved. The method used to measure dry deposition is sometimes called the "inferential method" because air quality concentration data are combined with meteorological measurements and land use functions to compute deposition velocities. The CASTNet program provides long-term estimates of total acidic deposition by adding dry deposition values to wet deposition values.

This annual summary report presents the air quality concentration portion of the dry deposition inferential method, which is the only currently available data set. These data were compiled from the analyses of filters collected by CASTNet deposition filter pack systems in the parks. The filter pack analyses yielded weekly average concentrations of particulate sulfate (SO_4^{2-}), particulate nitrate (NO_3^-), particulate ammonium (NH_4^+), sulfur dioxide (SO_2), and nitric acid (HNO_3). In some cases, the positive ions Na^+, K^+, Ca^{2+}, and Mg^{2+} were also measured from the filter samples. These concentration data for the individual ionic species are presented as annual bar charts and summarized by quarter and by year in this report. Concentration data can be used to compare sites and to indicate the amount of acidic species available for deposition. As with the continuous analyzer data, the filter pack concentration data are included on a computer diskette that accompanies this report.

Estimated dry deposition values derived from EPA modeling will be reported at a later time to complete the inferential analyses. When available, these modeling results will be posted on the NPS Air Resources Division Internet web site at http://www.aqd.nps.gov/ard1 or on the EPA CASTNet site. Initial CASTNet results have shown that dry deposition can be a significant portion of total acidic deposition.

CASTNet Dry Deposition Monitoring Annual Summary Report Mammoth Cave National Park 1/1/2002 -12/31/2002								
Quarter	# Valid Sample	p-NO3 (ug/m3)	HNO3 (ug/m3)	Total NO3 (ug/m3)	NH4 (ug/m3)	p-SO4 (ug/m3)	SO2 (ug/m3)	SO4/SO2 Ratio
3	9	0.265	2.208	2.437	2.469	7.690	3.226	2.384
4	14	1.870	1.841	3.682	1.623	3.549	6.854	0.518
Annual Average		1.242	1.985	3.195	1.954	5.169	5.434	0.951
Standard Deviation		1.409	0.572	1.470	0.786	2.859	3.884	

Data Recovery Table			
Total # Filters	# Invalidated	% Data Capture	# Valid Hours
23	0	100.0%	3828.0

5/28/2003

CASTNet Dry Deposition Monitoring Weekly Concentrations Report
Mammoth Cave National Park
1/1/02 - 12/31/02

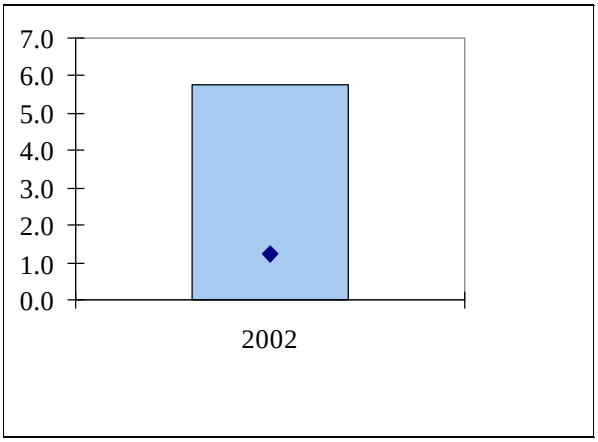
On Date	Off Date	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
07/24/02	07/30/02	0.333	1.653	1.960	2.168	6.594	1.823	3.616
07/30/02	08/06/02	0.118	2.807	2.880	3.846	12.988	3.901	3.330
08/06/02	08/13/02	0.255	2.727	2.939	2.783	7.946	4.556	1.744
08/13/02	08/20/02	0.247	1.157	1.385	0.690	2.397	1.312	1.828
08/20/02	08/27/02	0.124	2.438	2.524	2.436	7.696	2.878	2.674
08/27/02	09/03/02	0.245	2.044	2.257	2.705	8.052	2.090	3.853
09/03/02	09/10/02	0.458	3.237	3.643	3.204	9.932	6.475	1.534
09/10/02	09/17/02	0.501	2.040	2.509	2.295	7.323	3.702	1.978
09/17/02	09/24/02	0.099	1.770	1.841	2.094	6.283	2.298	2.734
09/24/02	10/01/02	0.162	1.902	2.034	2.095	6.037	3.068	1.968
10/01/02	10/08/02	0.438	1.708	2.118	1.229	3.855	3.843	1.003
10/08/02	10/15/02	0.390	1.078	1.451	1.229	3.362	2.464	1.365
10/15/02	10/22/02	1.248	1.563	2.787	1.123	2.861	3.408	0.839
10/22/02	10/29/02	0.898	2.428	3.288	2.534	6.482	6.741	0.962
10/29/02	11/05/02	2.026	1.044	3.053	1.658	3.085	6.411	0.481
11/05/02	11/12/02	0.821	1.968	2.758	1.112	3.173	5.506	0.576
11/12/02	11/19/02	1.460	2.453	3.874	1.272	2.713	5.616	0.483
11/19/02	11/26/02	3.310	1.569	4.854	1.907	3.116	8.288	0.376
11/26/02	12/03/02	2.788	1.509	4.273	1.279	2.258	7.068	0.320
12/03/02	12/10/02	5.768	2.072	7.807	2.375	3.177	19.871	0.160
12/10/02	12/17/02	2.989	2.704	5.650	2.342	4.338	9.346	0.464
12/17/02	12/24/02	1.613	1.771	3.356	1.034	2.167	5.953	0.364
12/24/02	12/31/02	2.269	2.001	4.239	1.528	3.057	8.368	0.365

Mammoth Cave National Park

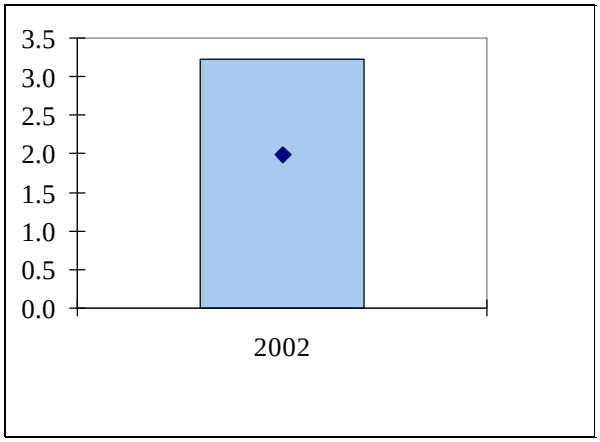
CASTNet Dry Deposition Monitoring

Three Year Comparison of Maximum and Average Concentrations

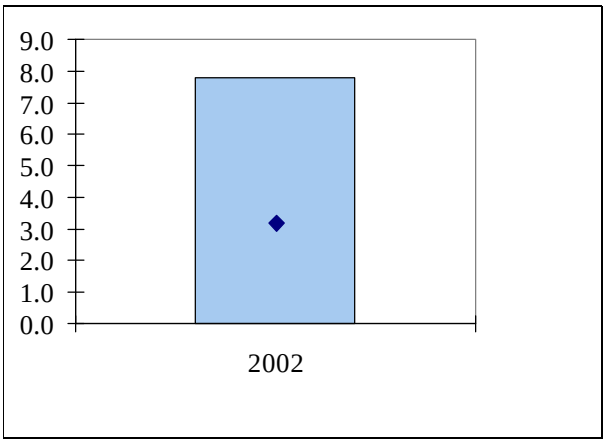
p-NO3



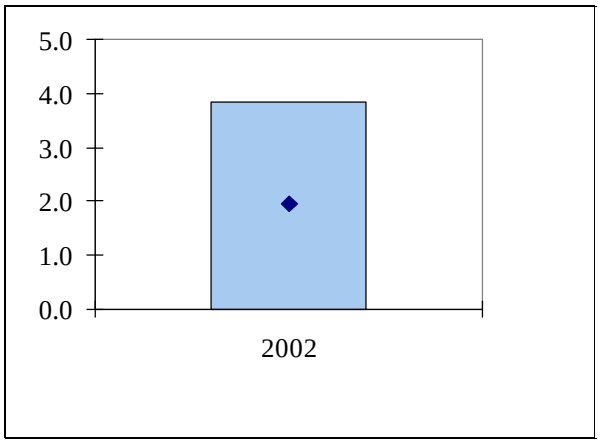
HNO3



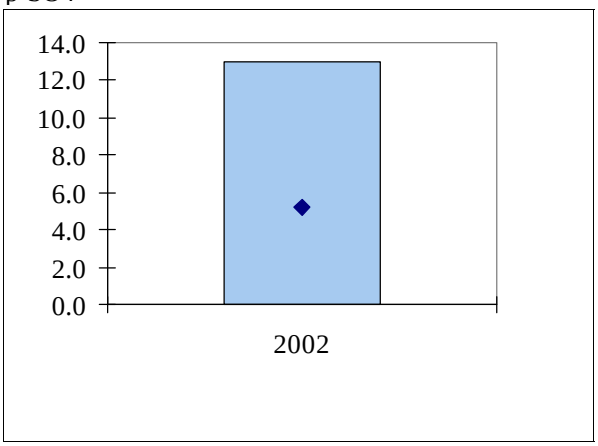
Total NO3



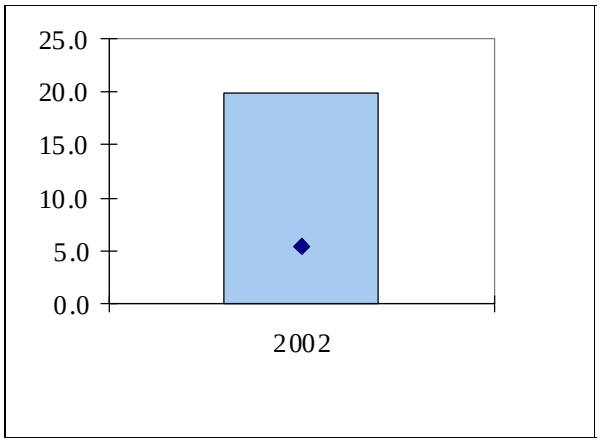
NH4



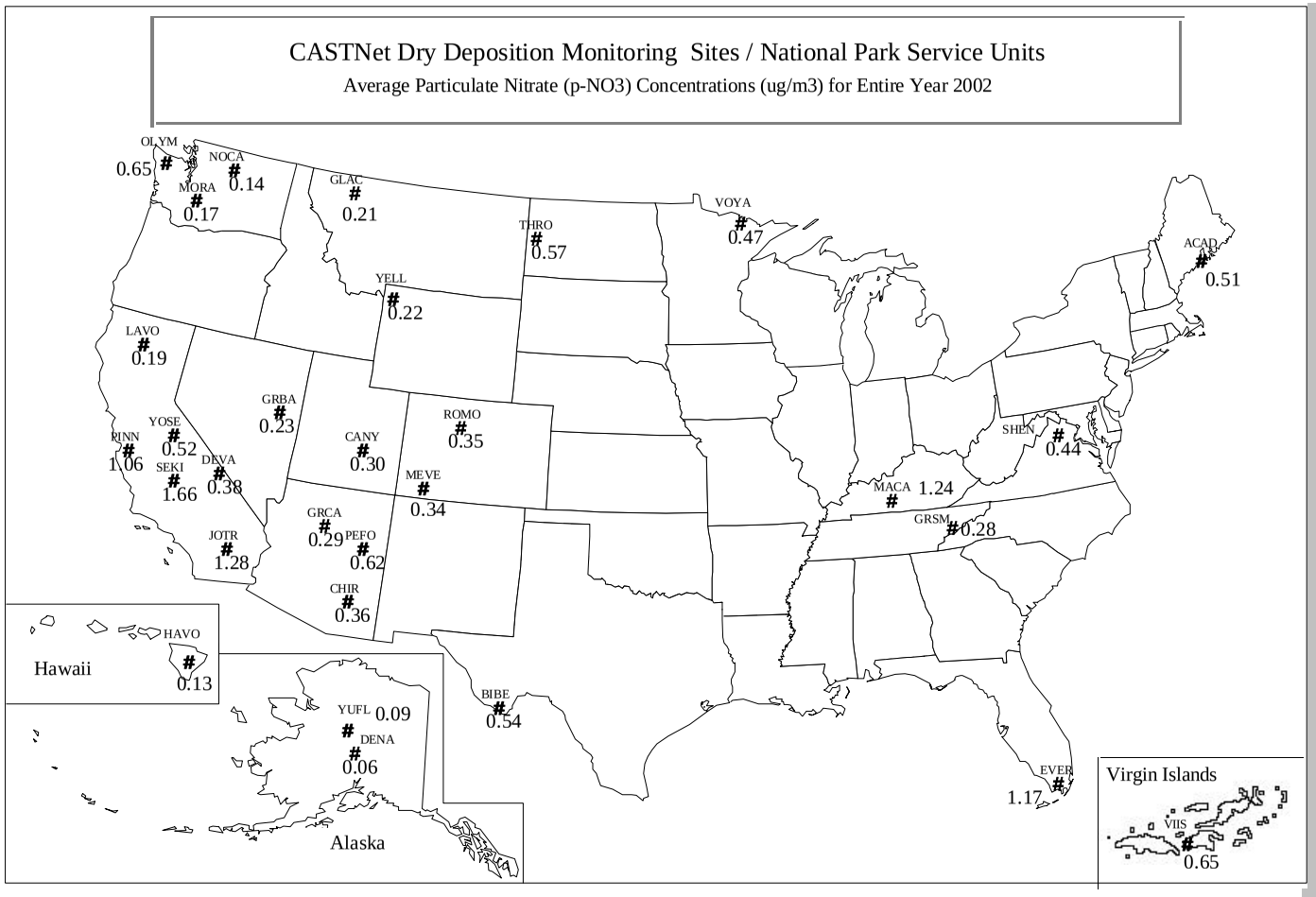
p-SO4



SO2



Maximum Concentration (ug/m3) Average Concentration (ug/m3)



Key:

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BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
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THRO	Th. Roosevelt NP
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YELL	Yellowstone NP
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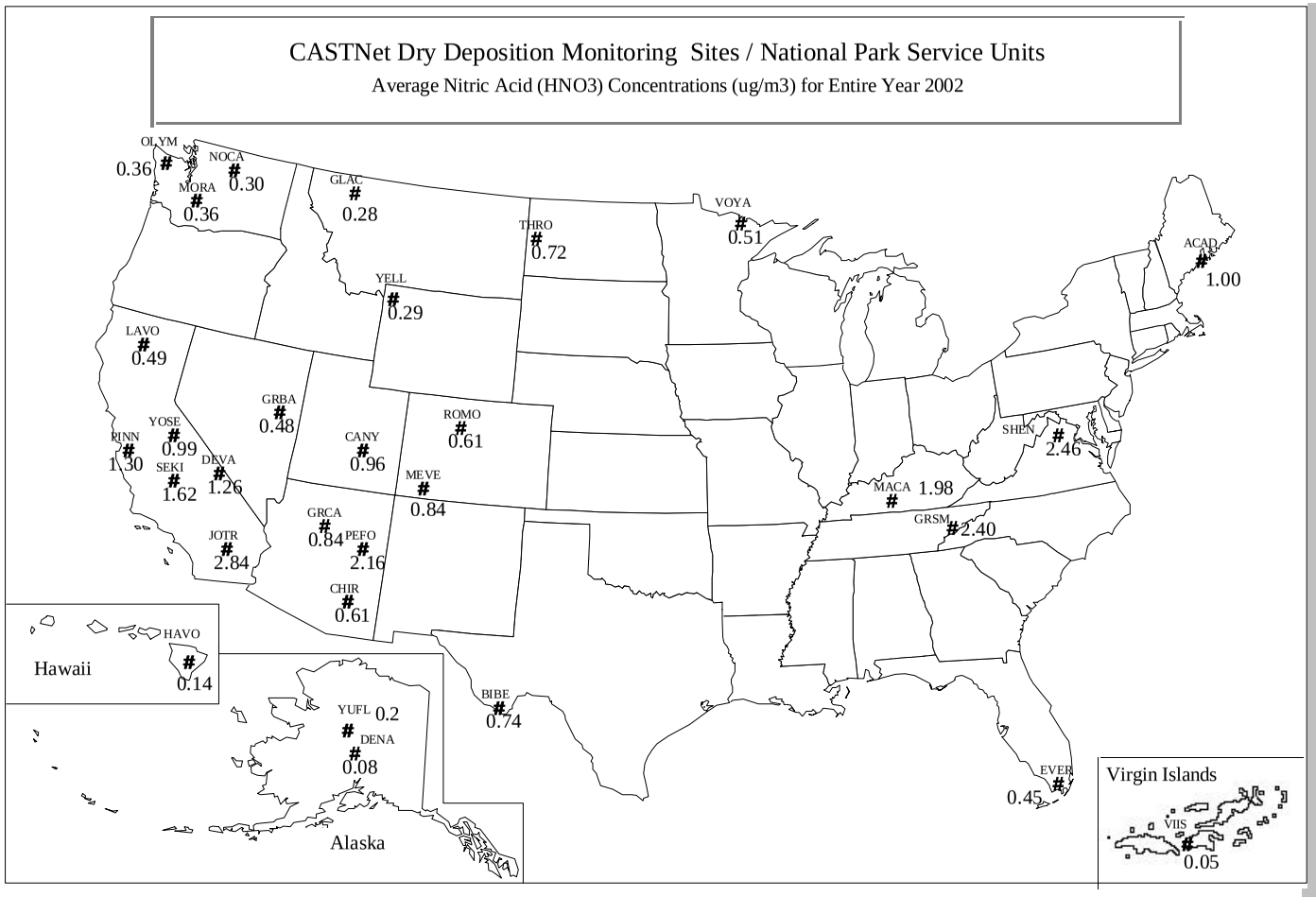
YUFL	Yukon Flats NWR



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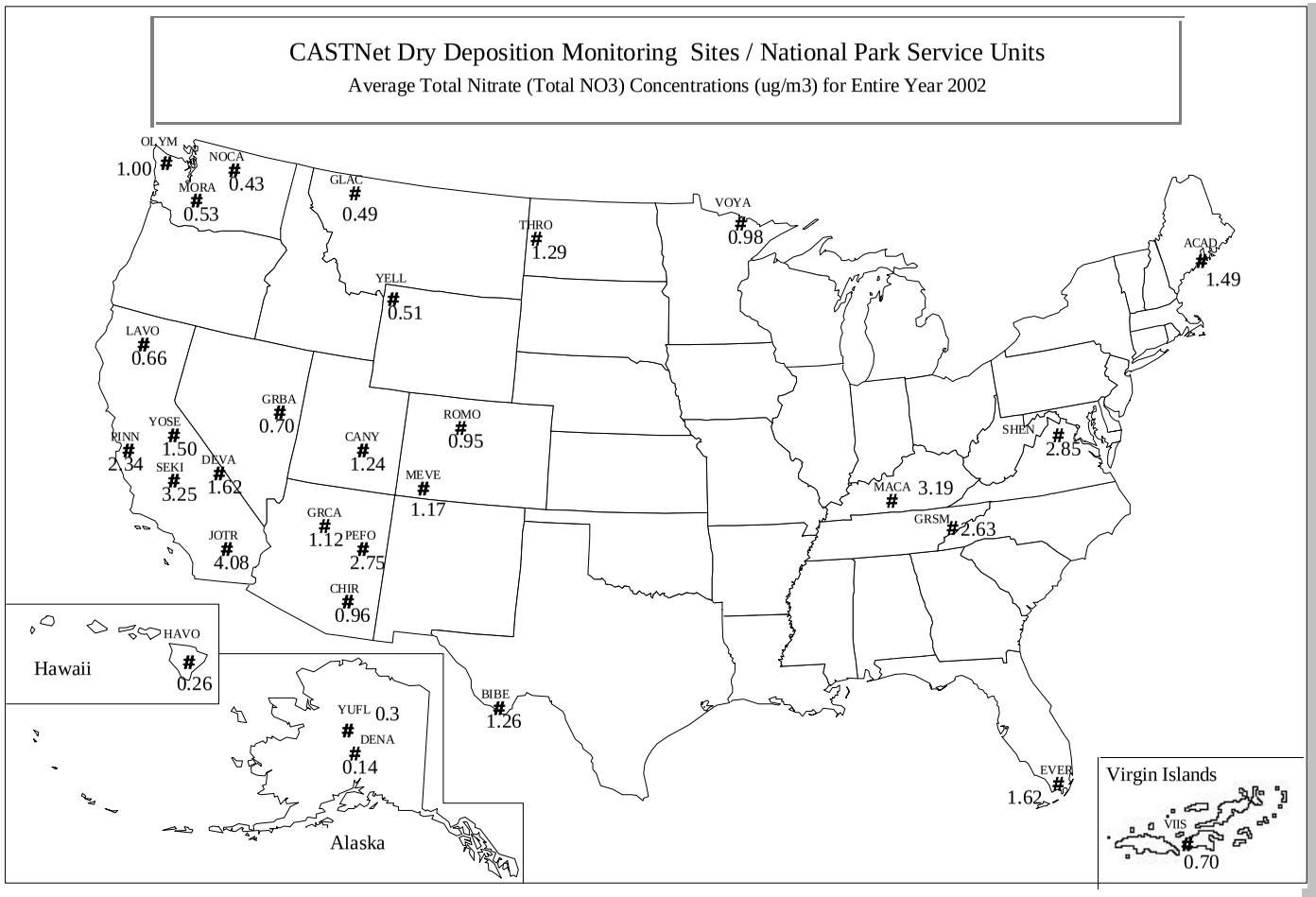

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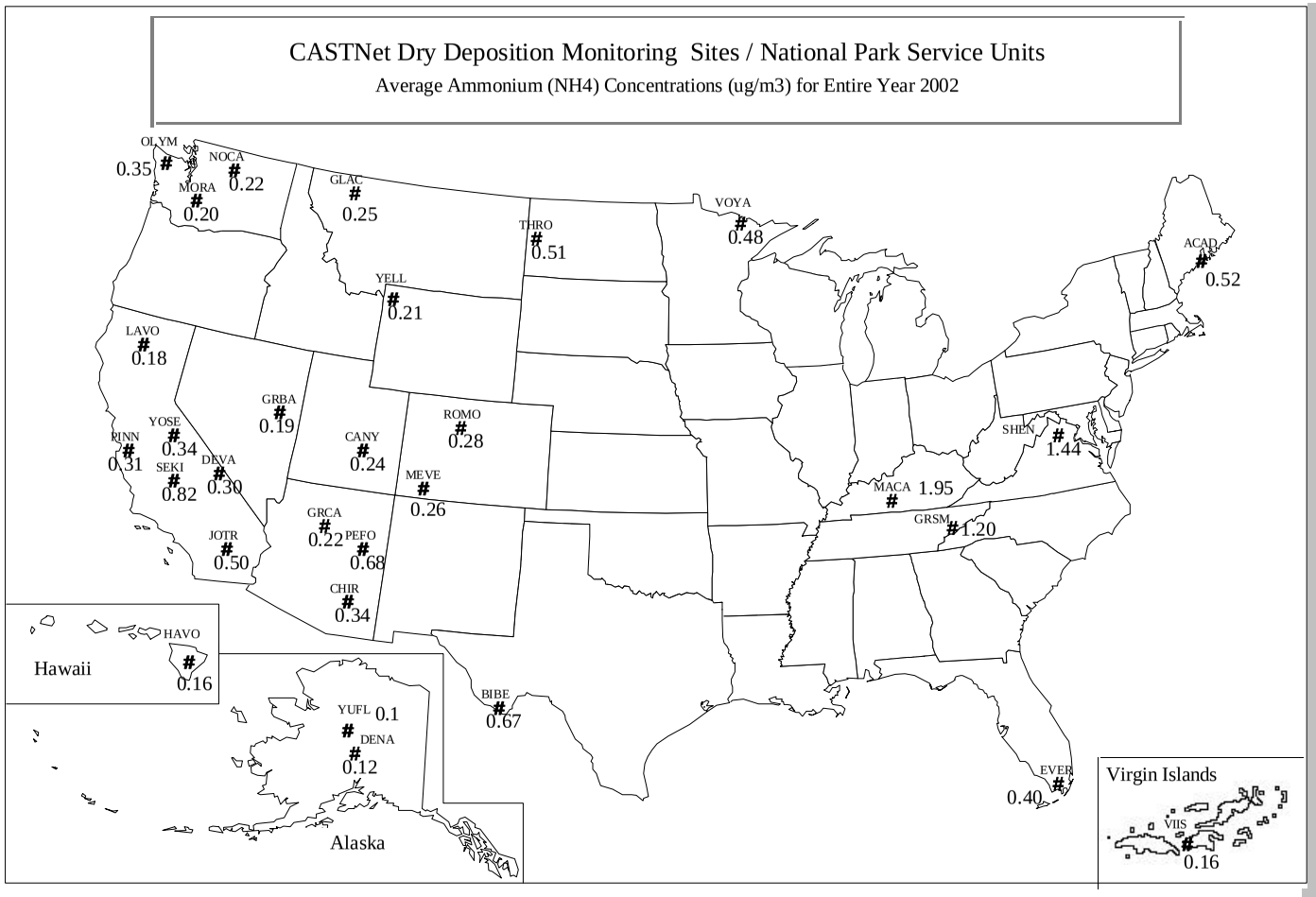

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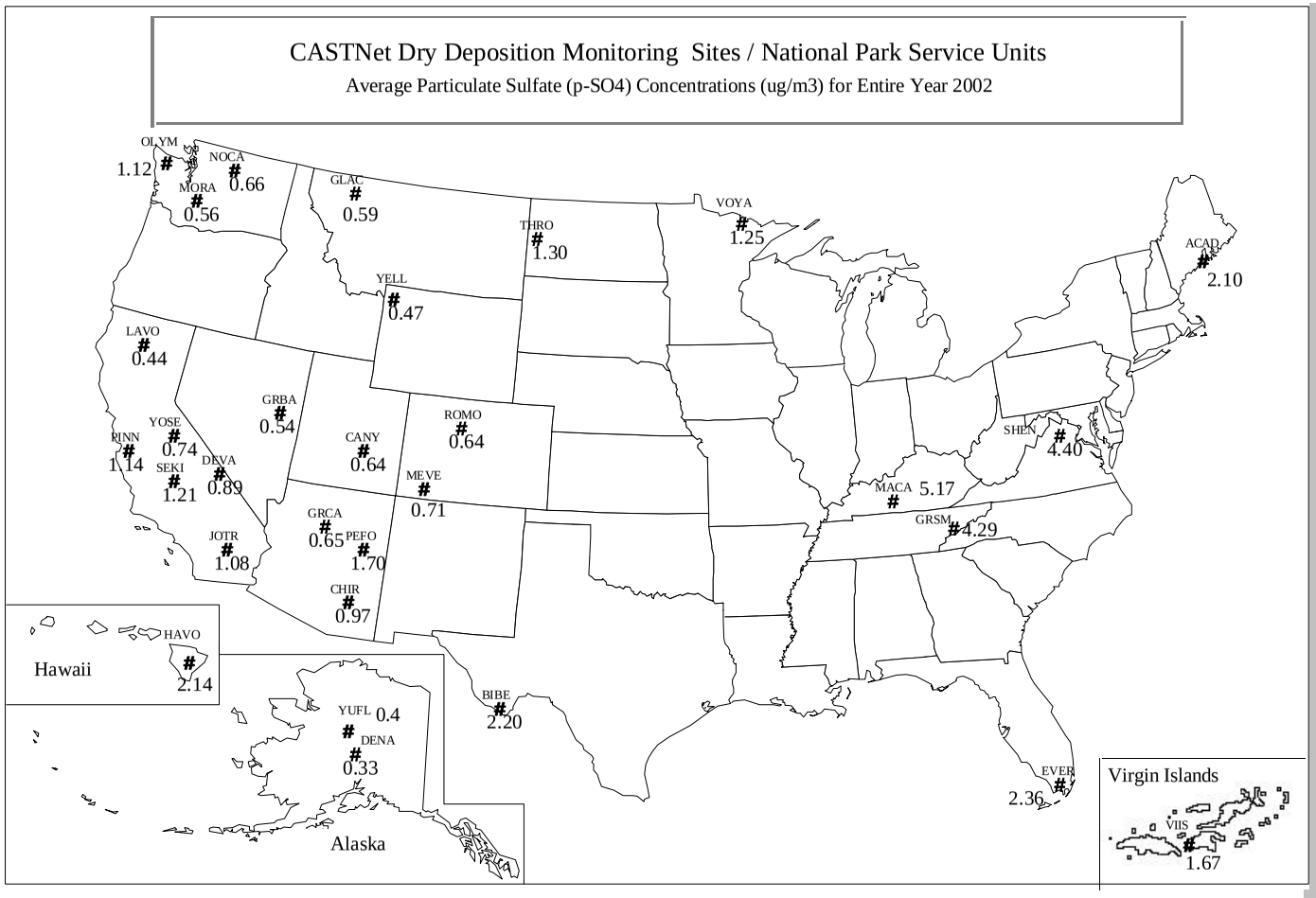

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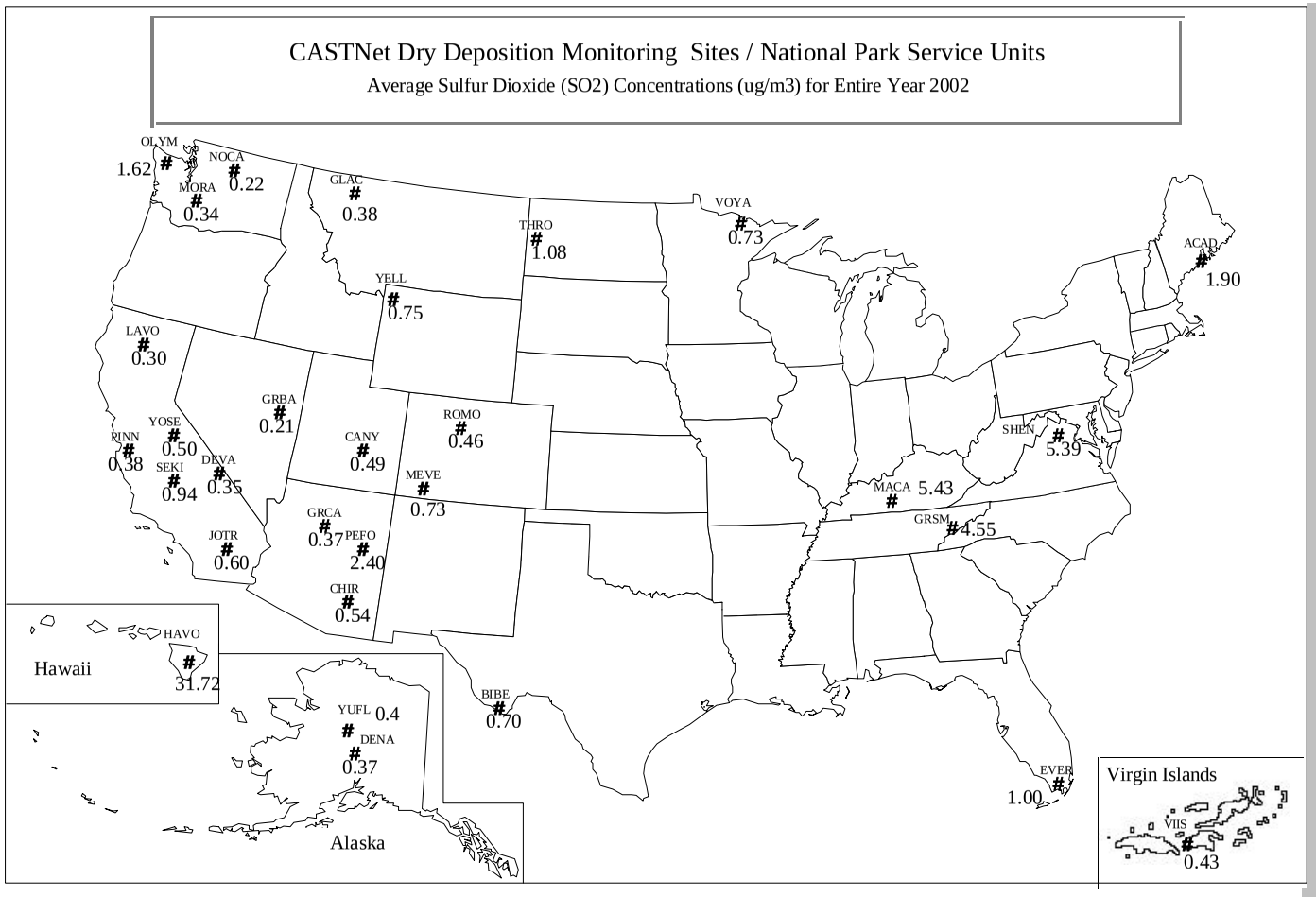

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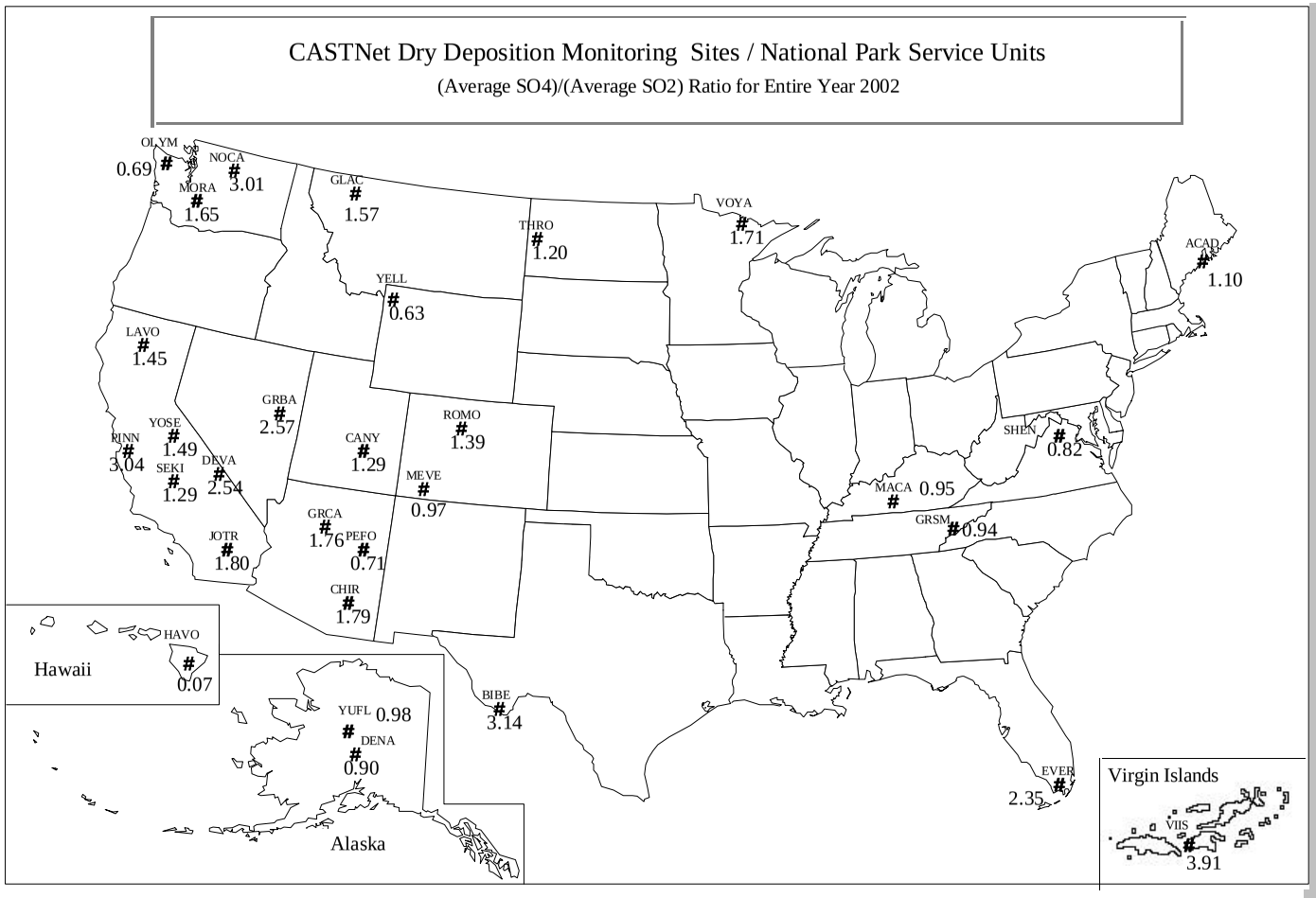

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3.0 NATIONAL PARK SERVICE AIR RESOURCES DIVISION DATA SOURCES

Meteorological and hourly gaseous data contained in this report may be obtained from the following sources:

- National Park Service AIRWeb (http://www.aqd.nps.gov/natnet/ard)
- EPA AIRS database
- Data requests directed to:

NPS Air Resources Division
Information Management Center
c/o Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: (970) 484-7941
Fax: (970) 484-3423
E-Mail: AIR-IMC@AIR-RESOURCE.COM

CASTNet concentration data may be obtained from the following Web site:

http://www.epa.gov/castnet/data.html

4.0 GLOSSARY

4.1 DEFINITIONS AND COMPUTATIONAL PROCEDURES FOR NATIONAL PARK SERVICE QUICK LOOK ANNUAL SUMMARY STATISTICS REPORT

The National Park Service Quick Look Annual Summary Statistics Table (Page 2-8) provides ozone summary statistics for various indices computed on a monthly basis for an entire year. Growing season (generically defined to be May 1 - September 30) and annual statistics are also presented under the "MAY-SEP" and "ANNUAL" columns, respectively. All concentrations are expressed in the units of parts per billion (PPB) and exposures in parts per billion-hours (PPB-HR). The definitions for each of the statistics appearing on the Quick Look Annual Summary Table are given below.

(1) **Daily 1-Hr Maximum**. The maximum 1-hour average concentration recorded during each month, the growing season or the year regardless of the number of valid hourly observations recorded during a given day. The number in parentheses below this statistic, (N), indicates the number of days in the month, growing season, or year with valid data.

(2) **Average Daily Maximum**. The average of all Daily 1-Hr Maxima during the month regardless of the number of Daily 1-Hr Maxima recorded during the month. For the "MAY-SEP" column the average of all the Daily Maxima recorded during the growing season is given. For the "ANNUAL" column the average of all the Daily Maxima is given. N is as in (1) above.

(3) **Maximum Daily Mean**. The maximum of the valid daily means computed for each month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). A valid daily mean is one for which 75% of the observations are available for each day, i.e., 18 hours. N is the number of days during each month, growing season, and year with at least 18 observations.

(4) **Average Daily Mean**. The average of all valid daily means for the month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). N is as in (3) above.

(5) **Max Peak:Min Ratio**. The ratio of the Daily 1-Hr Maximum to the Daily 1-Hr Minimum. A ratio is computed only if a valid Daily Mean is computed and if the Daily 1-Hr Minimum is not equal to zero. N is the number of days with a valid Peak:Min ratio.

(6) **Average Peak:Min Ratio**. The average of all Peak:Min ratios for the month, growing season, or year. N is as in (5) above.

(7) **Max 9AM-4PM Average**. The maximum of all valid 9AM-4PM Averages computed for the month, growing season, or year. A valid 9AM-4PM Average is one which has 75% of the observations available during that time period (i.e., 6 hours. N is the number of days with valid averages.)

(8) **Monthly 9AM-4PM Average**. The average of all valid 9AM-4PM Averages for the month, growing season, or year. N is as in (7) above.

(9) **Max 7AM-7PM Average**. The maximum of all valid 7AM-7PM Averages computed for the month, growing season, or year. A valid 7AM-7PM Average is one which has 75% of the observations available during that time period, i.e., 9 hours. N is the number of days with valid averages.

(10) **Monthly 7AM-7PM Average**. The average of all valid 7AM-7PM averages for the month, growing season, or year. N is as in (9) above.

(11) **Monthly Mean**. The average of all 1-Hr ozone concentrations recorded during the month, growing season, or year. A mean is computed regardless of the number of hours with valid data. N is the number of hours with valid observations.

(12) **SUM0 Exposure Index**. The monthly sum of all hourly ozone concentrations. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours with valid observations and is the same N as in (11) above.

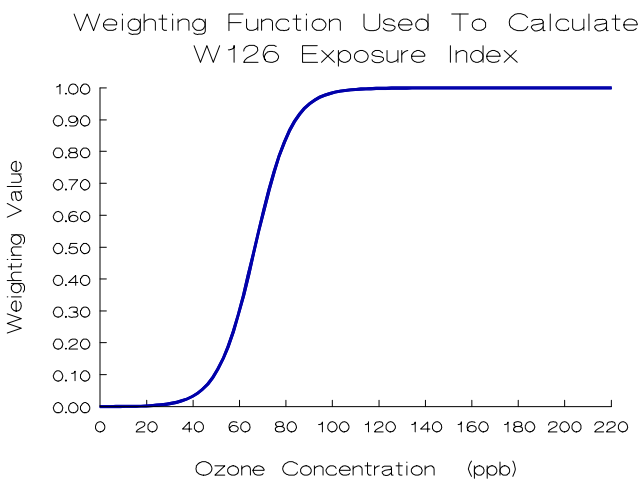
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 60 PPB during the month, growing season, or year.

(14) **SUM80 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 80 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 80 PPB during the month, growing season, or year.

(15) **W126 Exposure Index**. The monthly sum of all hourly ozone concentrations where each concentration is weighted by a function that gives greater emphasis to the higher hourly concentrations while still including the lower ones. This weighting function provides a weighting value that is unique for each hourly ozone concentration. The weighting function, as described by Lefohn, Laurence, and Kohut[1] is:

$$w_i = \frac{1}{1 + 4403 \exp(-.126 c_i)}$$

where



w_i = weighting value for hourly concentration *i*, and
c_i = hourly concentration *i* in PPB.

The graph of weighting value versus ozone concentration, in the figure to the left, illustrates the greater weights given to higher hourly ozone concentrations.

Each hour's weighting value is multiplied by its corresponding hourly concentration. This product is summed over all the valid hours in each month to calculate the monthly W126 exposure.

Thus, the monthly W126 exposure is:

$$W126 = \sum_{i=1}^{n} w_i c_i$$

where

W126	= monthly W126 exposure index,
w_i	= weighting value for hourly concentration *i*,
c_i	= hourly concentration *i* in PPB, and
n	= number of hours in the month with valid ozone concentrations.

The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. The exposure units are PPB-HR.

Because each hour contributes to this exposure index, N is the number of hours with valid observations and is the same N as in (11) and (12) above.

The U.S. Environmental Protection Agency usually considers air quality statistics, such as a mean, to be "valid" (i.e., representative of the parameter being estimated for the time interval in question) only if 75% or more of the total possible observations have been measured during that time interval. Therefore, one should exercise caution when comparing these statistics between months and sites, particularly those that are <u>not</u> averages (e.g., maxima and exposures) whenever the number of valid observations is less than 75% of the total possible.

References

1. Lefohn, A.S., J. A. Laurence, and R. J. Kohut. 1988. A Comparison of Indices That Describe the Relationship Between Exposure to Ozone and Reduction in the Yield of Agricultural Crops. *Atmospheric Environment* 22, 1229-1240.

4.2 AIR QUALITY GLOSSARY

Acid Deposition: Air pollution produced when acid chemicals are incorporated into rain, snow, fog, or mist.

Aerometric Information Retrieval System (AIRS): A computer-based database of U.S. air pollution information administered by the EPA Office of Air Quality Planning and Standards (U.S. Environmental Protection Agency).

AIRWeb: Air Resources Web, an air quality information retrieval system for U.S. parks and wildlife refuges developed by the Air Resources Division of the National Park Service and the Air Quality Branch of the Fish and Wildlife Service.

Air Pollutant: An unwanted chemical or other material found in the air.

Air Pollution: Degradation of air quality resulting from unwanted chemicals or other materials occurring in the air.

Air Quality: The properties and degree of purity of air to which people and natural and heritage resources are exposed (in the context of national parks).

Air Pollution Control Permitting Process: Process by which facilities are permitted to emit specified types and quantities of air pollutants.

Air Quality Related Values (AQRVs): Values including visibility, flora, fauna, cultural and historical resources, odor, soil, water, and virtually all resources that are dependent upon and affected by air quality. "These values include visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality." *(43 Fed. Reg. 15016)*

Ambient Air: Air that is accessible to the public.

Class I: Areas of the country set aside under the Clean Air Act to receive the most stringent degree of air quality protection.

Class II: Areas of the country protected under the Clean Air Act but identified for somewhat less stringent protection from air pollution damage than Class I, except in specified cases.

Clean Air Act: Originally passed in 1963, our current national air pollution control program is based on the 1970 version of the law. Substantial revisions were made by the 1990 Clean Air Act Amendments.

Continuous Sampling Device: An air analyzer that measures air quality components continuously.

Criteria: Information on health and/or environmental effects of pollution (in the context of criteria air pollutants).

Criteria Air Pollutant: A group of very common air pollutants regulated by EPA on the basis of criteria and for which a National Ambient Air Quality Standard is established (SO_2, NO_2, PM_{10}, Pb, CO, O_3).

Emissions: Release of pollutants into the air from a source.

Environmental Protection Agency (EPA): The federal agency responsible for regulating air quality.

Monitoring: Measurement of air pollution.

National Ambient Air Quality Standards (NAAQS): Permissible levels of criteria air pollutant established to protect public health and welfare.

Ozone (O_3): A criteria air pollutant that is a strong oxidizing agent, reactive with many other compounds and surfaces, and a health hazard in high concentrations. Ozone is formed by nitrogen oxides and organic compounds reacting in sunlight.

Source: Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources; sources that move are mobile sources.

Sulfur Dioxide (SO_2): A criteria air pollutant that is a gas produced by burning coal and some industrial processes.

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* Recent updates to this glossary may be found on the NPSARD AIRWeb - http://www.aqd.nps.gov/natnet/ard/glossary.htm.

4.3 GLOSSARY OF AIR QUALITY UNITS

Units Conversion Table			
Parameter Type	Multiply	By	To Obtain
Pollutant	ppm	1000	ppb
	ppm	1960	$\mu g/m^3$ Ozone (at 25°C)
	ppm	2615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	ppb	0.001	ppm
	ppb	1.960	$\mu g/m^3$ Ozone (at 25°C)
	ppb	2.615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	$\mu g/m^3$ Ozone (25°C)	0.0005102	ppm
	$\mu g/m^3$ Ozone (25°C)	0.5102	ppb
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.0003824	ppm
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.3824	ppb
Wind Speed	m/s	2.05	mph
	mph	0.489	m/s
Solar Radiation	ly/min	697	w/m^2
	w/m^2	0.00143	ly/min
Precipitation	mm/hr	0.0394	in/hr
	in/hr	25.4	mm/hr
Temperature	°C + 17.78	1.8	°F
	°F - 32	5/9	°C

Where:
ppm = parts per million
ppb = parts per billion
$\mu g/m^3$ = micrograms per cubic meter (at 25°C)
m/s = meters per second
mps = miles per hour
ly/min = langleys per minute
w/m^2 = watts per square meter
mm/hr = millimeters per hour
in/hr = inches per hour
°C = degrees centigrade
°F = degrees fahrenheit