Report No. NPS D-73

Annual Data Summary

CRATERS OF THE MOON NATIONAL MONUMENT

2002

National Park Service Gaseous Air Pollutant Monitoring Network

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At Craters of the Moon National Monument, the ARD specifically recognizes Mike Muntz and John Apel for performing the technical and administrative skills required to help produce the data presented within this report.

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
1.1	The National Park Service Gaseous Pollutant Monitoring Network	1-1
1.2	Craters of the Moon National Monument	1-3
2.0	DATA SUMMARY	2-1
2.1	Overview	2-1
2.2	Ozone Data Summary	2-7
2.3	Meteorological Data Summary	2-23
3.0	NATIONAL PARK SERVICE AIR RESOURCES DIVISION DATA SOURCES	3-1
4.0	GLOSSARY	4-1
4.1	Definitions and Computational Procedures for National Park Service Quick Look Annual Summary Statistics Table	4-1
4.2	Air Quality Glossary	4-4
4.3	Glossary of Units	4-6

LIST OF FIGURES AND TABLES

	Page
Map of National Park Service Gaseous Pollutant Monitoring Network Ozone and Sulfur Dioxide Monitoring Sites	1-2
Site Specifications	1-4
Data Collection Statistics	2-2
First Quarter Data Stackplot	2-3
Second Quarter Data Stackplot	2-4
Third Quarter Data Stackplot	2-5
Fourth Quarter Data Stackplot	2-6
Ozone Quick Look Annual Summary Statistics	2-8
Ozone Annual Frequency Distribution	2-9

LIST OF FIGURES AND TABLES (Continued)

	Page
Ozone Daily 1-Hour Maximum Concentrations and National Ambient Air Quality Standards Comparison	2-10
Attainment Status with EPA Proposed Primary Ozone Standards	2-11
Ten Highest 1-Hour Average Ozone Concentrations	2-12
Episodes with 1-Hour Ozone Concentrations $\geq$ 100ppb and > 124 ppb	2-13
Episodes with 8-Hour Ozone Concentrations >84 ppb	2-14
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, Maximum 8-Hour Average Concentrations, and Annual Sum60 Exposure Index for All NPS Monitoring Sites	2-15
Plot of Maximum Ozone Concentration Comparison for Three Years	2-16
Map of National Park Service Gaseous Pollutant Monitoring Network, Second Highest Hourly Ozone Concentration	2-17
Quarterly Diurnal Ozone Plots	2-18
Annual Diurnal Ozone Plot	2-19
Quarterly Ozone Pollutant Roses	2-20
Annual Ozone Pollutant Roses	2-21
Ozone Precision Check Data Summary	2-22
Summary of Selected Meteorological Data	2-24
Quarterly Wind Roses	2-25
Annual Wind Roses	2-26

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.

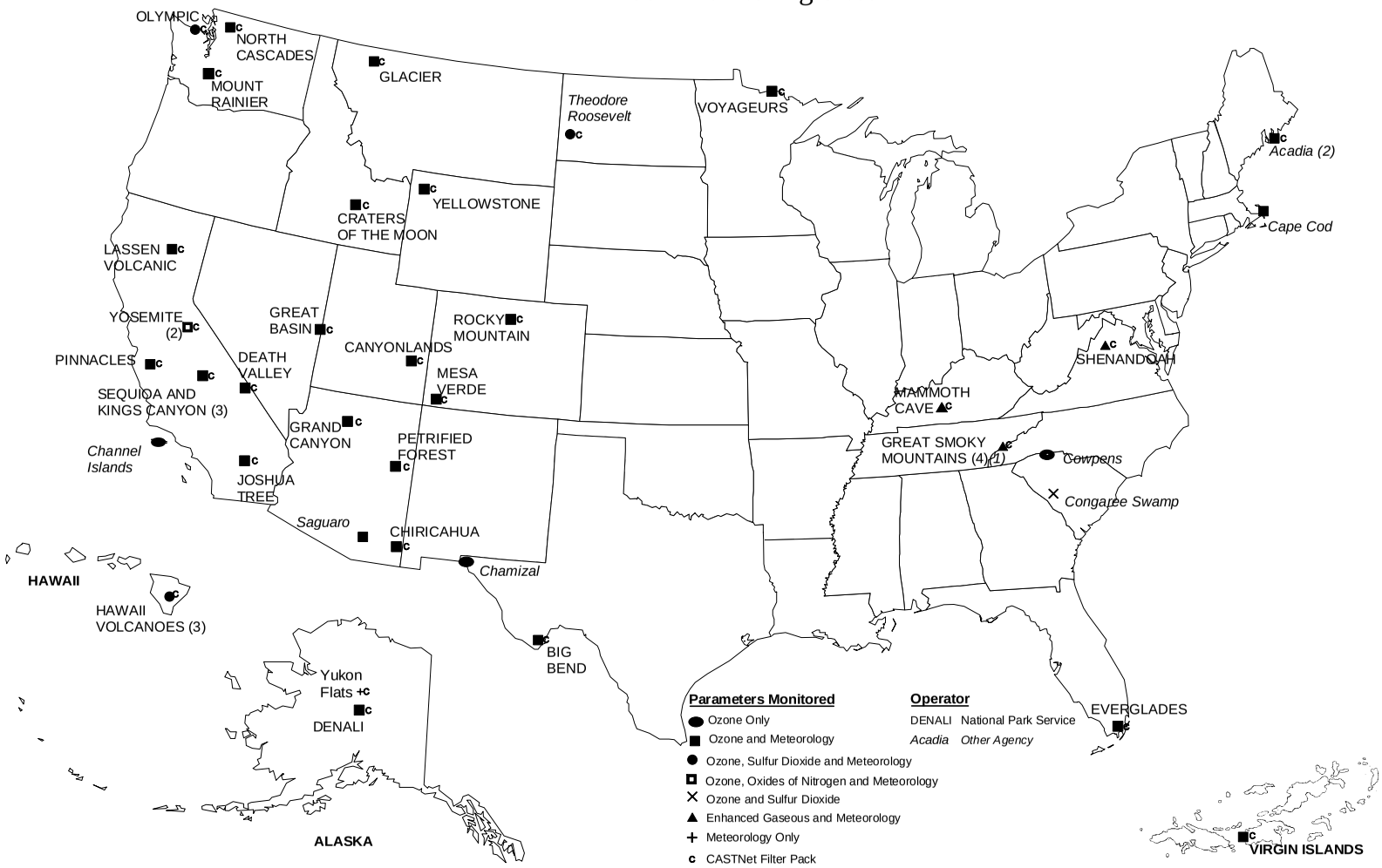
Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The 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 CRATERS OF THE MOON NATIONAL MONUMENT

Craters of the Moon National Monument, a Class I area, is located in southern Idaho about 60 miles northwest of Pocatello. Its location and site specifications are presented on the following page.

Craters of the Moon National Monument was established by presidential proclamation in 1924. It occupies approximately 54,000 acres in the eastern Snake River Plain, which crosses southern Idaho as a broad arc of low topographic relief, contrasting with the mountainous terrain of the rest of the state.

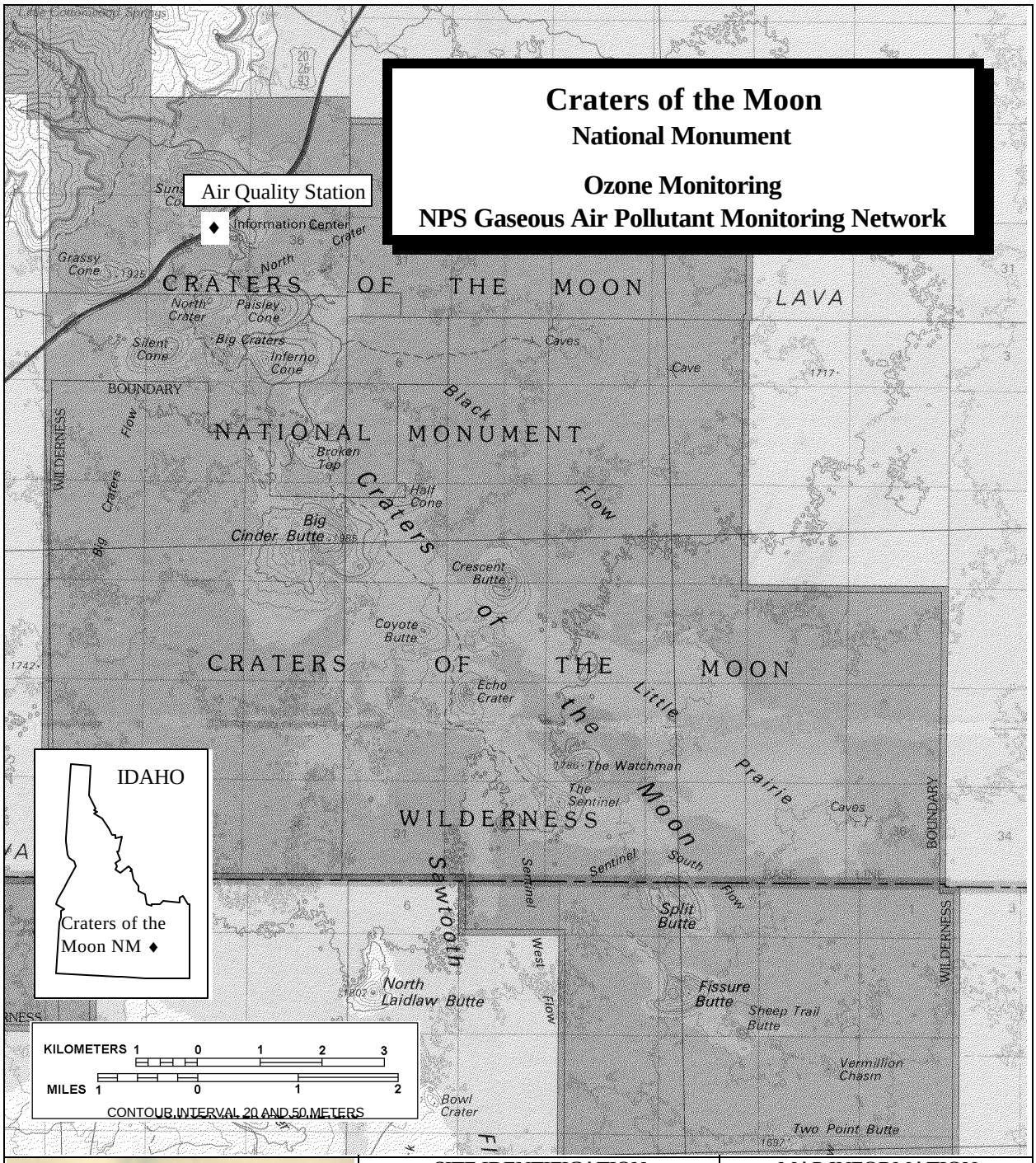
The significance of the monument is the relatively young age of the lava flows and the diversity of volcanic features in a small geographic area. The monument contains part of one of the four rift sets that make up the Great Rift, a volcanic rift zone that extends for 60 miles from the Pioneer Mountains south nearly to the Snake River. Visitors to the monument can see some of the most spectacular and diverse features along the Great Rift, including vast basaltic lava flows and associated volcanic products from eruptions that occurred between 15,000 and 2,100 years ago. Features include two types of lava flow, cinder cones, rafted blocks, fissure cracks, vents, spatter cones, lava tubes, and tree molds.

The monument's fauna and particularly its flora reflect the influence of the geologic setting. Plant succession is well illustrated among the different aged lava flows. Limber pine grows at a lower altitude in the monument than throughout the rest of its range. Three subspecies of small mammals were first described from this area and are found only in the vicinity of lava flows of the Great Rift.

The northern end of the monument includes a small portion of the foothills of the Pioneer Mountains. The north unit (4,125 acres) is a different environment from the volcanic area to the south: it is a sagebrush-grassland shrub steppe with stands of Douglas-fir and quaking aspen. Riparian areas surround the small watercourses that arise from springs in the foothills.

Approximately 81 percent of the monument (43,243 acres) was designated wilderness on October 23, 1970. This wilderness area was designated a Class I area in the Clean Air Act, as amended in 1977. The rest of the monument is designated as a class II area, however, the entire monument is managed as a class I area.

Visibility and scenery are notable air quality related values at Craters of the Moon.



SITE IDENTIFICATION	
Site Abbreviation:	CRMO
AIRS ID NO.:	16-023-0101

INSTRUMENTATION	
O_3 Analyzer	Relative Humidity
Calibrator	Temperature
Wind Speed	Solar Radiation
Wind Direction	

MAP INFORMATION	
Mean Elevation:	1815 m
Longitude:	113° 33' 44"W
Latitude:	43° 27' 38"N
UTM Zone:	12
Easting:	292714 m
Northing:	4814934 m
Map Reference:	Craters of the Moon N4300-W11300 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
Craters of the Moon National Monument

Final Validation

01/01/2002 - 12/31/2002

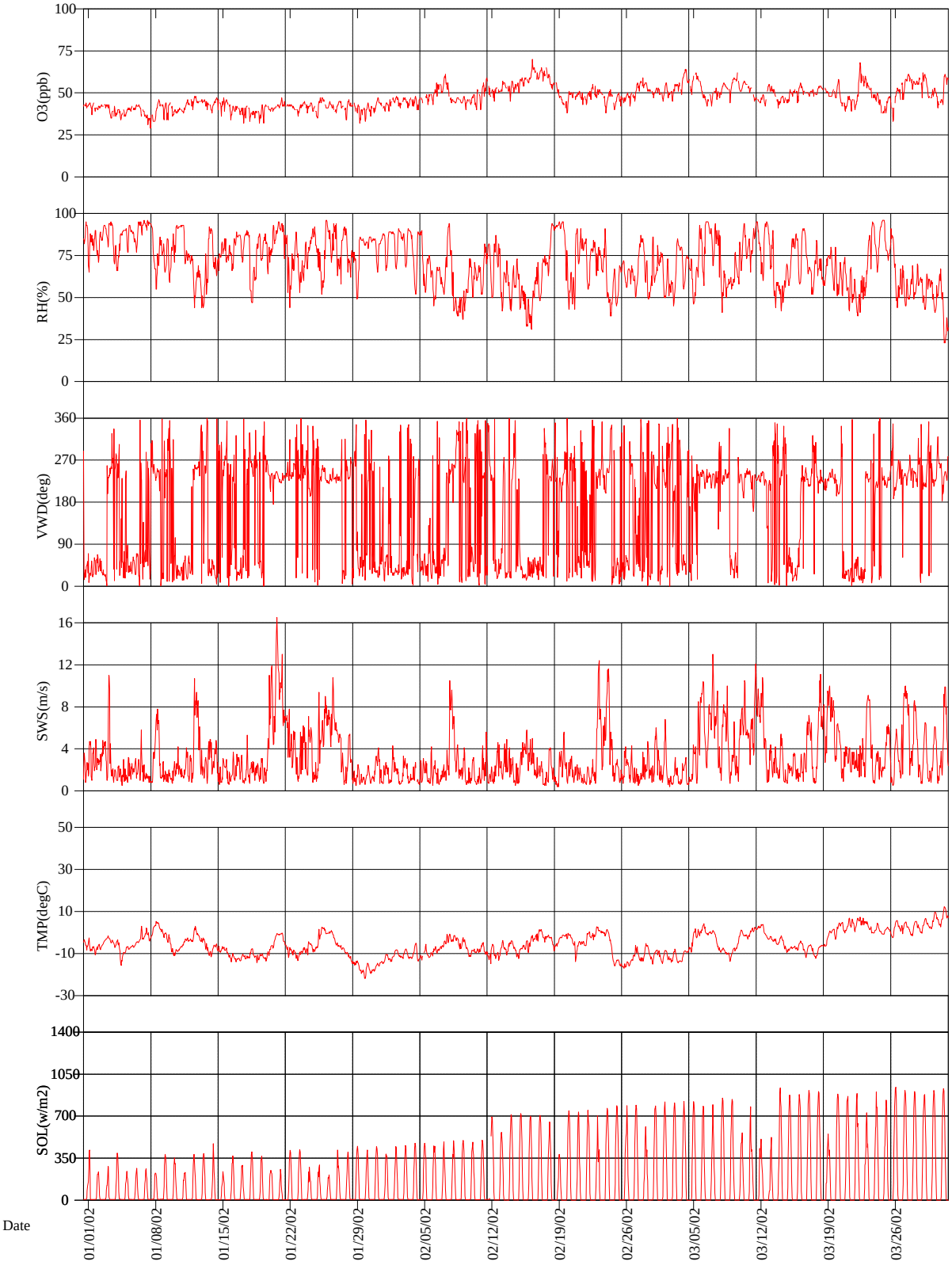
Parameter	Interval	Par Code	Data Recovery			Valid Data	
			No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	hourly	O3	8760	8006	91.4	7846	89.6
Scalar Wind Speed	hourly	SWS	8760	8752	99.9	8752	99.9
Vector Wind Speed	hourly	VWS	8760	8752	99.9	8752	99.9
Vector Wind Direction	hourly	VWD	8760	8752	99.9	8752	99.9
Standard Deviation for Wind Direction	hourly	SDWD	8760	8752	99.9	8752	99.9
Ambient Temperature (aspirated)	hourly	TMP	8760	8748	99.9	8748	99.9
Relative Humidity	hourly	RH	8760	8755	99.9	8755	99.9
Solar Radiation	hourly	SOL	8760	8750	99.9	8083	92.3

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:	Monthly Criteria:
100% of sites, >= 85% valid data capture	100% of sites, >= 60% valid data capture
90% of sites, >= 90% valid data capture	90% of sites, >= 75% valid data capture
80% of sites, >= 95% valid data capture	80% of sites, >= 85% valid data capture

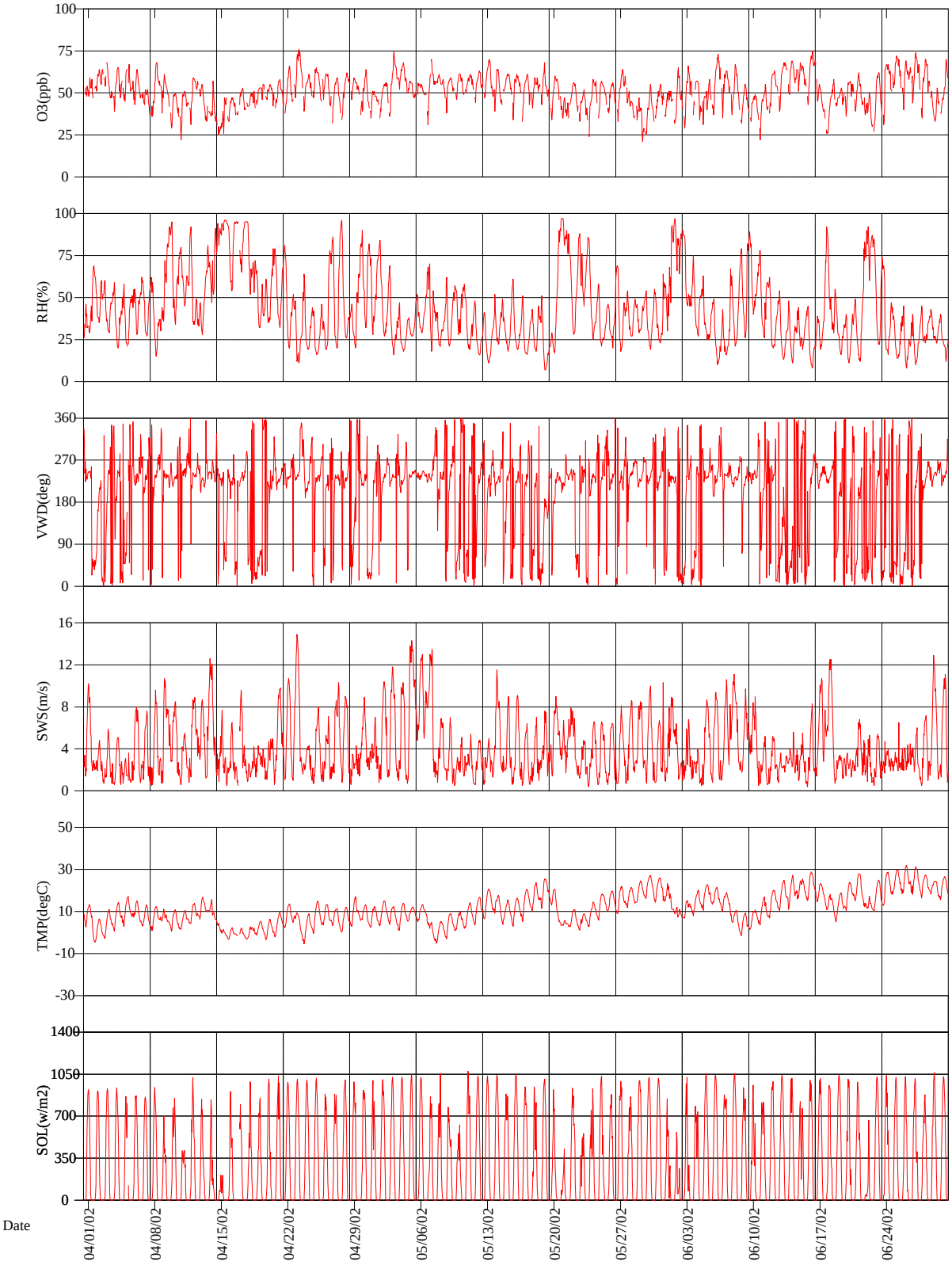
Craters of the Moon National Monument



Final Validation

First Quarter 2002

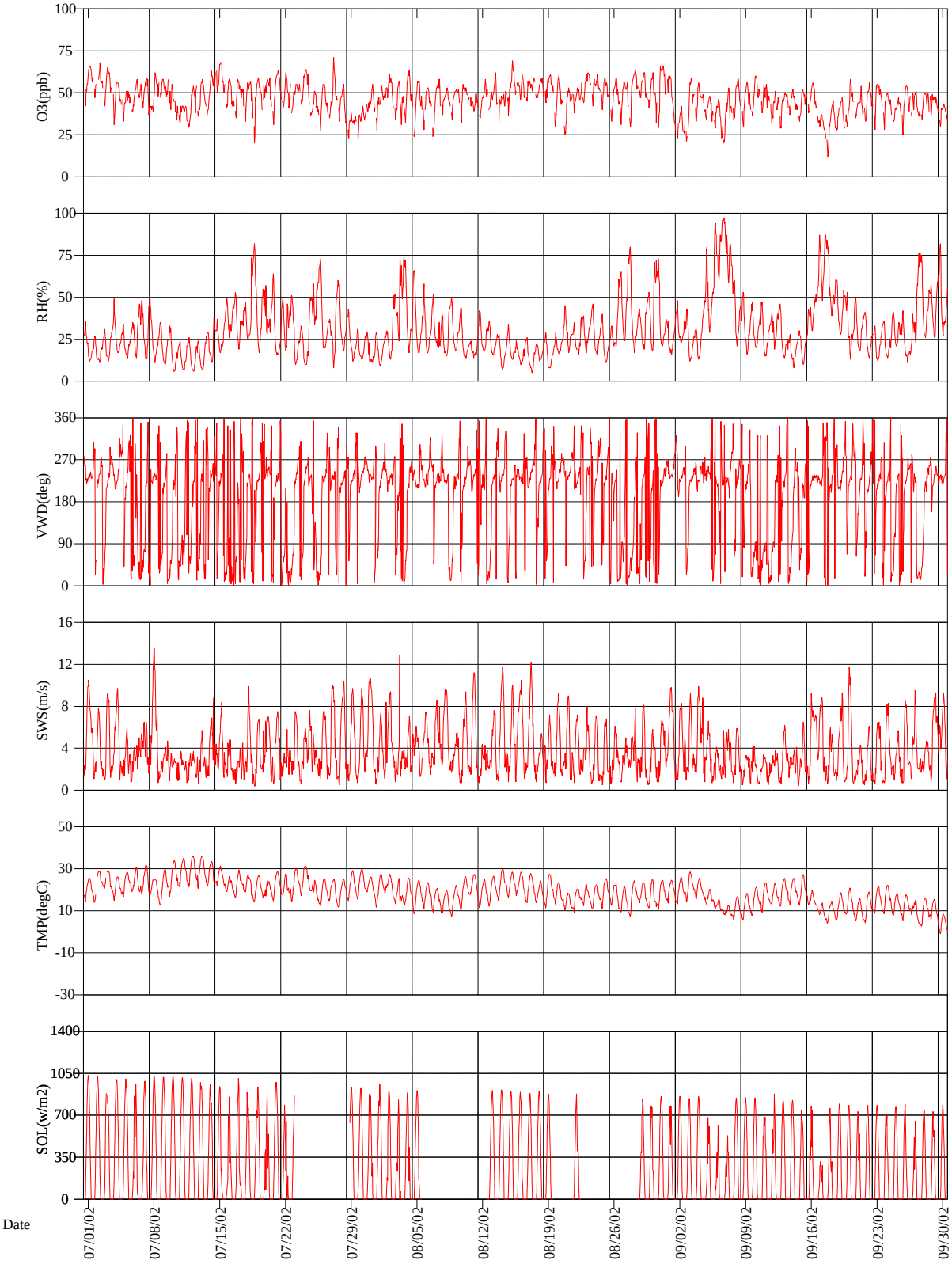
Craters of the Moon National Monument



Final Validation

Second Quarter 2002

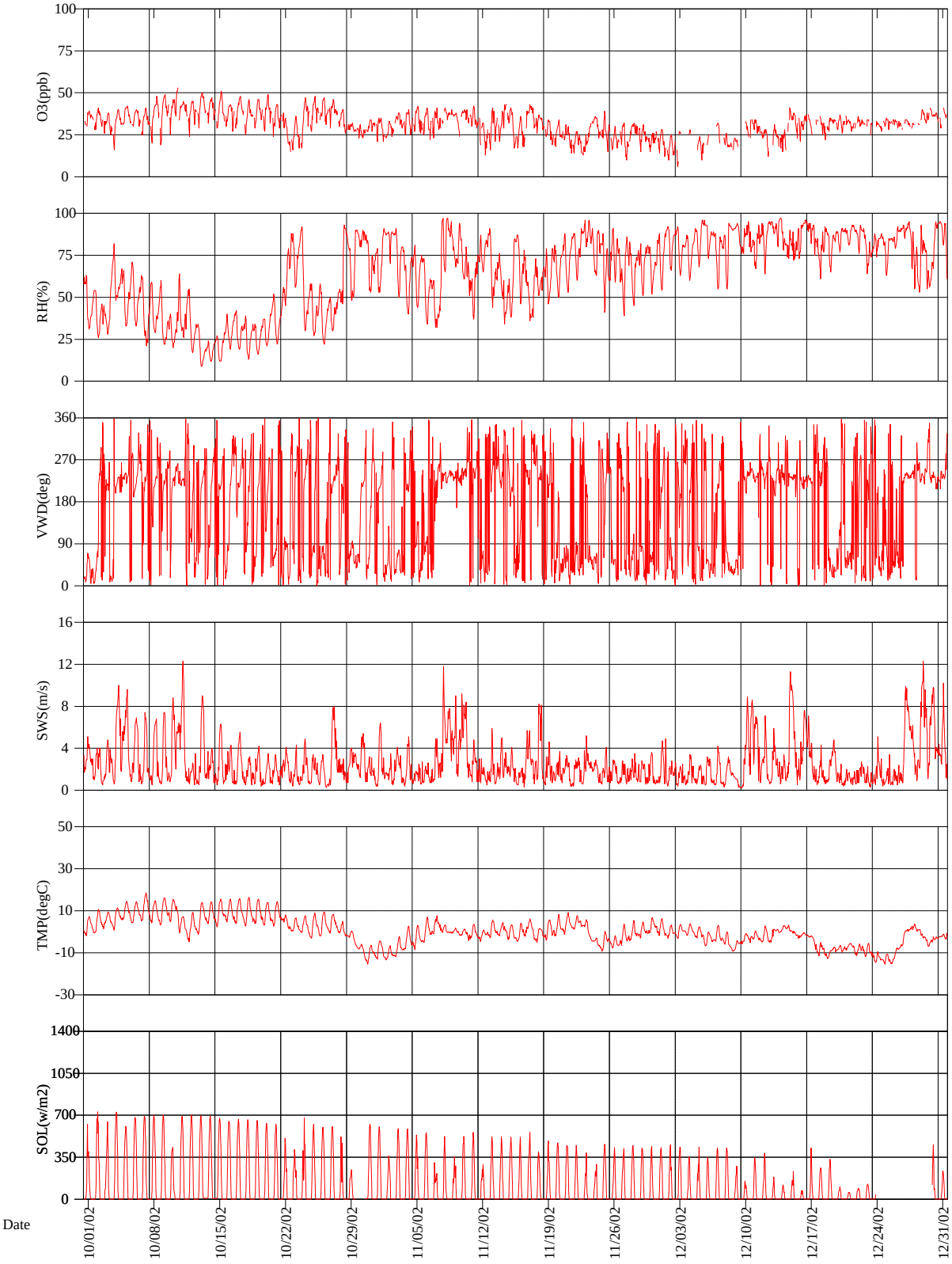
Craters of the Moon National Monument



Final Validation

Third Quarter 2002

Craters of the Moon National Monument



Final Validation

Fourth Quarter 2002

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Craters of the Moon National Monument

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	48	70	68	76	75	75	71	69	60	53	43	41	75	76
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
AVERAGE DAILY MAXIMUM	44	55	56	59	60	63	58	58	52	44	36	33	58	51
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MAXIMUM DAILY MEAN	45	61	58	63	61	63	60	55	50	42	37	37	63	63
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(18)	(152)	(350)
AVERAGE DAILY MEAN	41	50	51	50	51	52	48	49	43	36	29	29	48	45
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(18)	(152)	(350)
MAX PEAK:MIN RATIO	1.394	1.475	1.700	2.318	2.417	2.500	2.950	2.417	3.750	2.765	3.200	2.500	3.750	3.750
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(18)	(152)	(350)
AVERAGE PEAK:MIN RATIO	1.234	1.231	1.261	1.585	1.635	1.782	1.661	1.696	1.804	1.748	1.916	1.585	1.715	1.597
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(18)	(152)	(350)
MAX 9AM-4PM AVERAGE	46	62	61	69	65	68	64	63	56	46	40	36	68	69
NO. OF DAYS	(31)	(27)	(29)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(26)	(152)	(356)
MONTHLY 9AM-4PM AVERAGE	41	50	51	54	55	56	52	52	46	39	33	30	52	47
NO. OF DAYS	(31)	(27)	(29)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(26)	(152)	(356)
MAX 7AM-7PM AVERAGE	45	61	60	67	63	66	62	60	54	45	40	37	66	67
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(23)	(152)	(355)
MONTHLY 7AM-7PM AVERAGE	41	50	51	52	54	54	50	51	45	38	31	29	51	46
NO. OF DAYS	(31)	(27)	(31)	(30)	(31)	(30)	(30)	(31)	(30)	(31)	(30)	(23)	(152)	(355)
MONTHLY MEAN	41	50	51	50	51	52	48	49	43	36	29	29	48	44
NO. OF HOURS	(678)	(608)	(671)	(654)	(681)	(657)	(679)	(681)	(659)	(681)	(657)	(540)	(3357)	(7846)
SUM0 EXPOSURE INDEX	27770	30287	34071	32716	34601	33954	32723	33453	28029	24385	19246	15513	162760	346748
NO. OF HOURS	(678)	(608)	(671)	(654)	(681)	(657)	(679)	(681)	(659)	(681)	(657)	(540)	(3357)	(7846)
SUM60 EXPOSURE INDEX	-	2256	2211	5304	5684	11528	3666	3297	240	-	-	-	24415	34186
NO. OF HOURS	(0)	(36)	(36)	(83)	(90)	(177)	(58)	(53)	(4)	(0)	(0)	(0)	(382)	(537)
SUM80 EXPOSURE INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
W126 EXPOSURE INDEX	1158	4150	4942	5650	6230	7872	4848	4905	2178	770	283	194	26033	43180
NO. OF HOURS	(678)	(608)	(671)	(654)	(681)	(657)	(679)	(681)	(659)	(681)	(657)	(540)	(3357)	(7846)

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

* Statistics defined in the Quick Look subsection of the Glossary

Final Validation

4/21/03

Frequency Distribution

Craters of the Moon National Monument

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	4692	0.031	0.045	0.052	0.057	0.061	0.068	0.070	0.075	0.076	0.075	0.0562	0.0555	1.18

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)

Craters of the Moon National Monument

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	.044	T	.046	F	.053	F	.059	M	.051	W	.051	S	.066	M	.054	T	.060	S	.039	T	.035	F	.028	S
2	.044	W	.048	S	.056	S	.064	T	.056	T	.065	S		T	.061	F	.042	M	.041	W	.033	S	.025	M
3	.043	T	.047	S	.055	S	.068	W	.075	F	.066	M	.065	W	.057	S	.059	T	.038	T	.038	S		T
4	.042	F	.048	M	.064	M	.065	T	.068	S	.057	T	.056	T	.063	S	.056	W	.040	F	.040	M		W
5	.041	S		T	.062	T	.067	F	.057	S	.058	W	.051	F	.057	M	.048	T	.042	S	.042	T	.024	T
6	.043	S	.056	W	.058	W	.064	S	.056	M	.073	T	.058	S	.053	T	.046	F	.040	S	.041	W		F
7	.040	M	.061	T	.053	T	.052	S	.070	T	.065	F	.059	S	.058	W	.053	S	.041	M	.041	T	.032	S
8	.046	T	.051	F	.056	F	.068	M	.061	W	.067	S	.062	M	.053	T	.059	S	.048	T	.041	F	.026	S
9	.044	W	.048	S	.059	S	.061	T	.059	T	.055	S	.058	T	.052	F	.056	M	.049	W	.040	S		M
10	.044	T	.049	S	.062	S	.050	W	.061	F	.049	M	.058	W	.055	S	.060	T	.051	T	.040	S		T
11	.046	F	.059	M	.055	M	.051	T	.061	S	.055	T	.042	T	.050	S	.055	W	.053	F	.042	M	.034	W
12	.048	S	.058	T	.049	T	.059	F	.063	S	.063	W	.054	F	.058	M	.051	T	.045	S	.035	T	.030	T
13	.046	S	.057	W	.055	W	.057	S	.070	M	.068	T	.058	S	.062	T	.050	F	.050	S	.041	W	.031	F
14	.047	M	.057	T	.048	T	.057	S	.064	T	.069	F	.063	S	.051	W	.052	S	.047	M	.043	T	.028	S
15	.047	T	.059	F	.052	F	.047	M	.061	W	.068	S	.068	M	.069	T	.052	S	.051	T	.043	F	.041	S
16	.044	W	.070	S	.056	S	.047	T	.061	T	.075	S	.058	T	.061	F	.056	M	.043	W	.036	S	.037	M
17	.042	T	.065	S	.052	S	.053	W	.061	F	.070	M	.058	W	.059	S	.042	T	.048	T	.043	S		T
18	.042	F	.065	M	.054	M	.051	T	.059	S	.058	T	.057	T	.059	S	.045	W	.046	F	.037	M	.036	W
19	.043	S	.056	T	.053	T	.055	F	.068	S	.054	W	.059	F	.061	M	.047	T	.046	S	.034	T	.035	T
20	.042	S	.051	W	.058	W	.055	S	.060	M	.057	T	.059	S	.061	T	.058	F	.049	S	.034	W	.037	F
21	.047	M	.051	T	.048	T	.058	S	.052	T	.062	F	.063	S	.053	W	.054	S	.043	M	.031	T	.036	S
22	.043	T	.053	F	.068	F	.066	M	.056	W	.050	S	.062	M	.053	T	.056	S	.038	T	.027	F	.036	S
23	.044	W	.055	S	.060	S	.076	T	.052	T	.062	S	.055	T	.062	F	.055	M	.036	W	.030	S		M
24	.045	T	.052	S	.050	S	.061	W	.058	F	.067	M	.064	W	.061	S	.050	T	.047	T	.036	S	.033	T
25	.047	F	.050	M	.048	M	.065	T	.057	S	.072	T	.051	T	.059	S	.047	W	.048	F	.039	M	.035	W
26	.046	S	.050	T	.053	T	.061	F	.056	S	.069	W	.055	F	.059	M	.054	T	.047	S	.030	T	.034	T
27	.045	S	.056	W	.061	W	.059	S	.064	M	.074	T	.071	S	.057	T	.051	F	.046	S	.032	W	.034	F
28	.046	M	.059	T	.059	T	.062	S	.060	T	.070	F	.055	S	.064	W	.050	S	.040	M	.032	T		S
29	.044	T			.062	F	.059	M	.047	W	.057	S	.038	M	.062	T	.049	S	.032	T	.031	F	.040	S
30	.044	W			.053	S	.064	T	.055	T	.070	S	.042	T	.062	F	.043	M	.031	W	.026	S	.041	M
31	.047	T			.061	S			.055	F			.055	W	.066	S			.034	T				
Valid Days	31		27		31		30		31		30		30		31		30		31		30		22	
Maximum	.048		.070		.068		.076		.075		.075		.071		.069		.060		.053		.043		.041	
Violations	0		0		0		0		0		0		0		0		0		0		0		0	

7829 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])	
89.6 % Possible	6 Missing days assumed to be less than the standard	
354 Valid daily maxima	0 Daily maximas exceed the alert level of .200 ppm	Concentrations in parts per million (ppm)

Final Validation

4/22/03

Craters of the Moon National Monument

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	63	82%	No	72	71	69	69	68

Ozone Analyzer 10 Highest Daily 1-Hour Average Maximum Concentrations Craters of the Moon National Monument Final Validation 01/01/2002 - 12/31/2002			
Value	Date	Hour	Concentration (ppb)
Ozone Analyzer			
1	04/23/2002	16	76
2	05/03/2002	16	75
3	06/16/2002	17	75
4	06/27/2002	14	74
5	06/06/2002	19	73
6	06/25/2002	13	72*
7	07/27/2002	15	71
8	02/16/2002	17	70
9	05/07/2002	15	70
10	05/13/2002	16	70**

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

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

Craters of the Moon National Monument

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

Site	Date	Beginning Hour	No. Hours ≥ 100 ppb	No. Hours >124 ppb	Max (ppb)
	No values greater than or equal 100 ppb during this period				
		Total	0	0	

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
Craters of the Moon National Monument

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
	No values exceeded 84 ppb during this period			
	0	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).

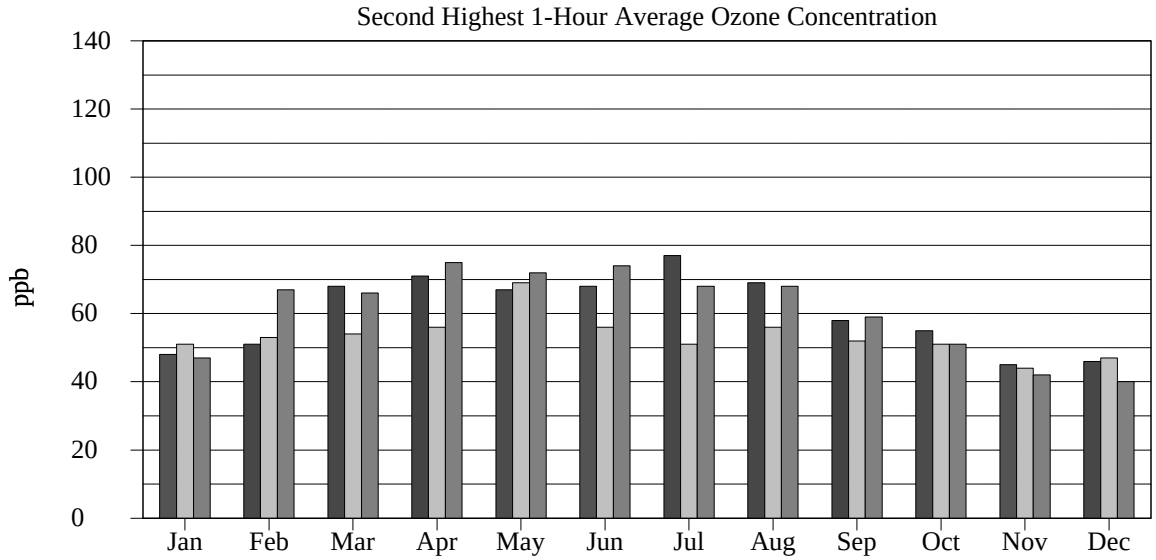
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

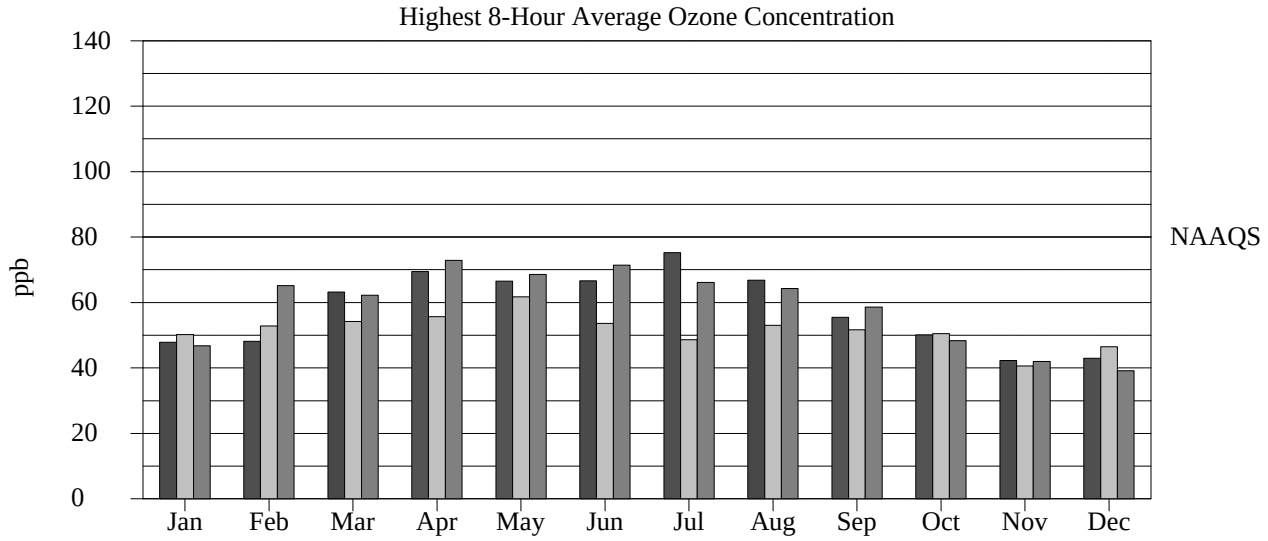
01/01/2002 - 12/31/2002

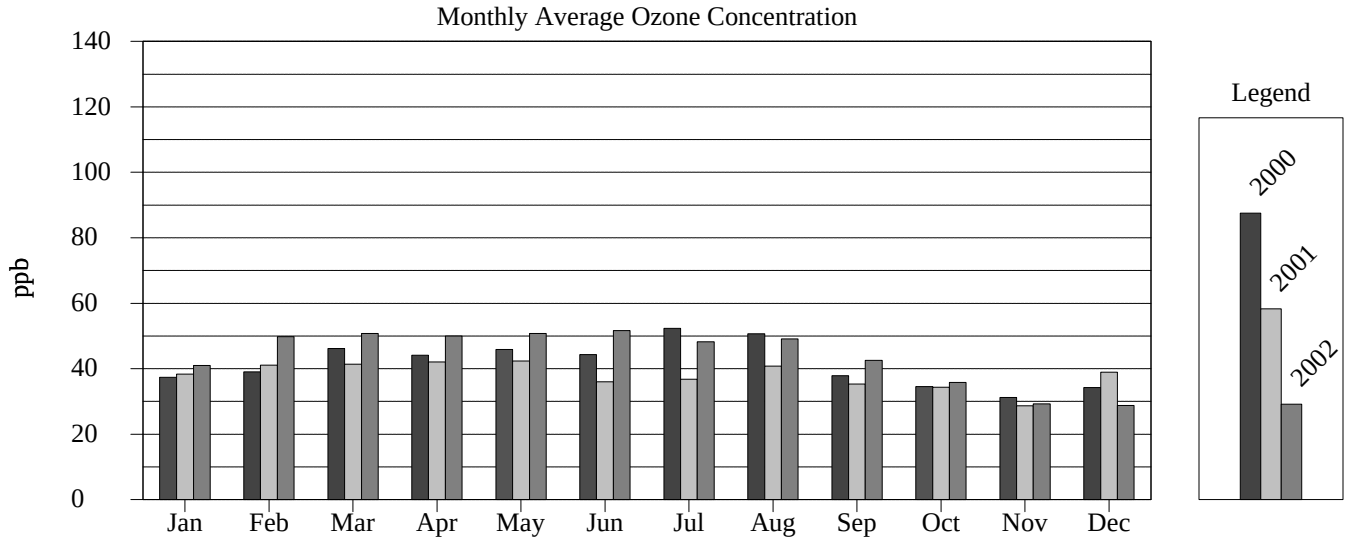
Second Highest 1-Hour Average Concentration		
Site	Rank	Concentration (ppb)
ACAD-CM	1	127
CHAM-XX	2	127
JOTR-YV	3	127
SEKI-LK	4	126
SEKI-AS	5	124
SEKI-LP	6	124
GRSM-LR	7	122
CACO-XX	8	118
COWP-XX	9	118
ACAD-MH	10	117
GRSM-CM	11	117
GRSM-CD	12	115
COSW-BL	13	111
MACA-HM	14	110
PINN-ES	15	110
GRSM-CC	16	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

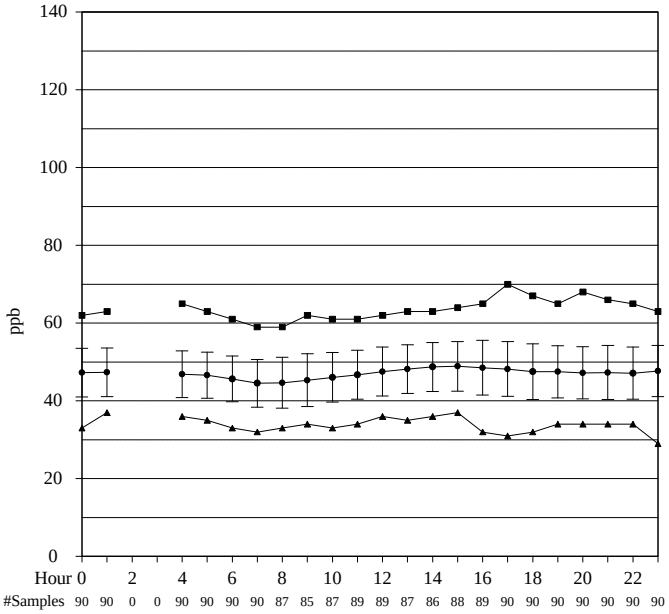

Highest 8-Hour Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
NAAQS
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


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

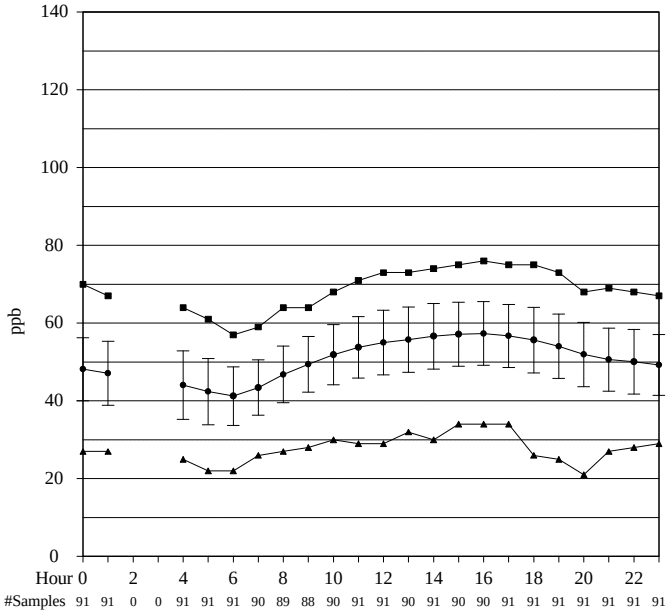
NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK

2002 Second Highest 1-Hour Ozone Concentrations

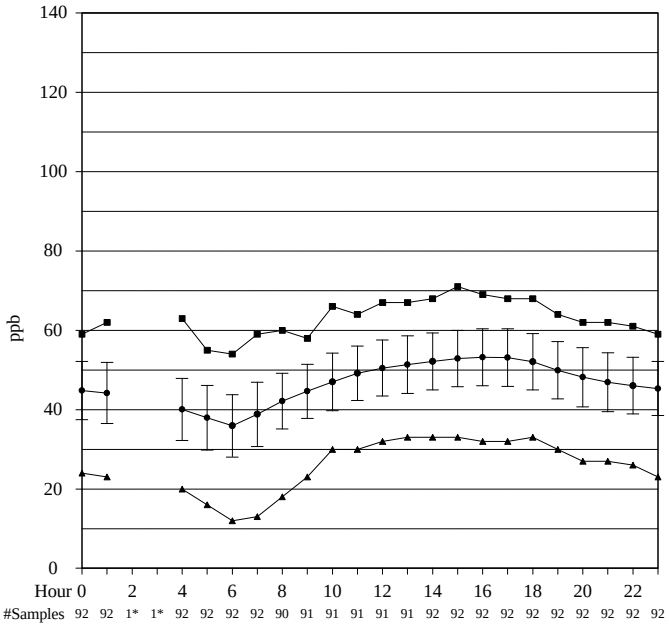
FIRST QUARTER (JAN-MAR)



SECOND QUARTER (APR-JUN)

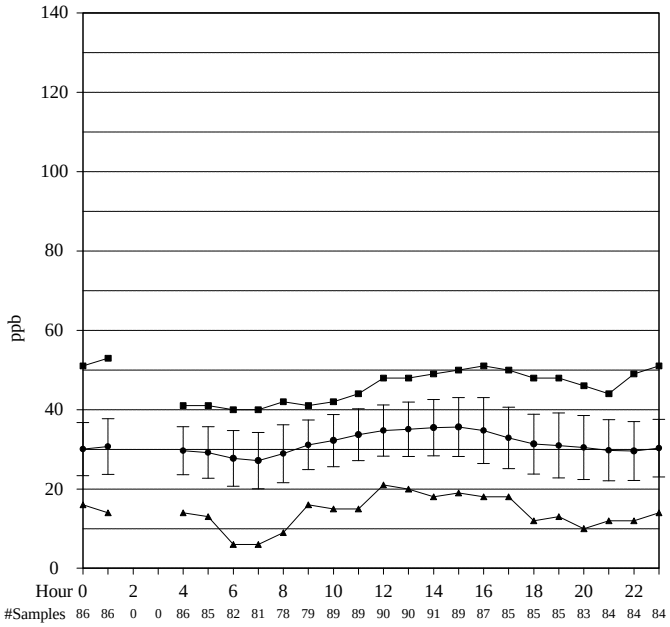


THIRD QUARTER (JUL-SEP)



* 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)

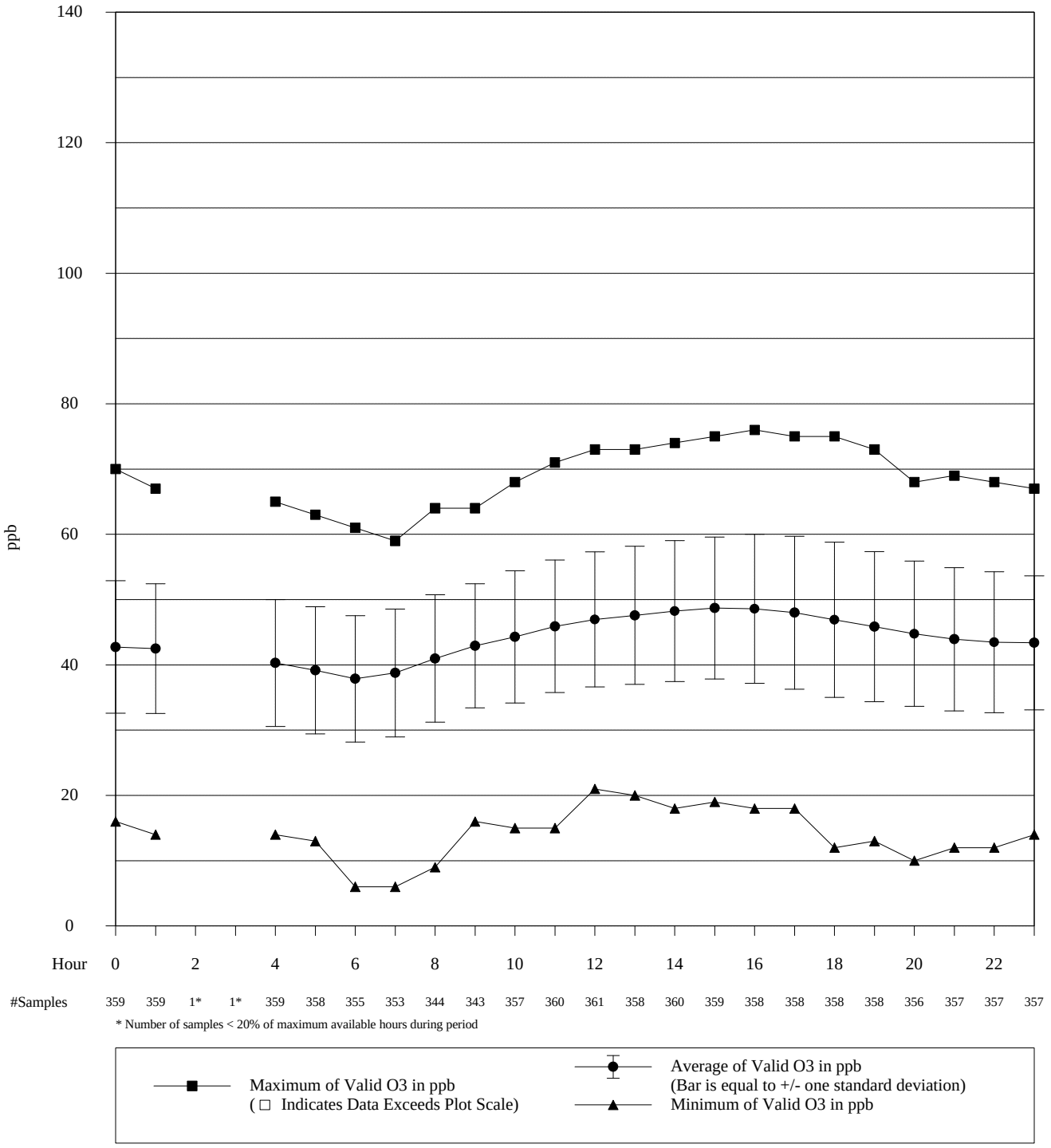
Average of Valid O3 in ppb
(Bar is equal to +/- one standard deviation)

Minimum of Valid O3 in ppb

Craters of the
Moon National Monument
Visitor Center

Annual Diurnal
Ozone Plot

2002



Final Validation

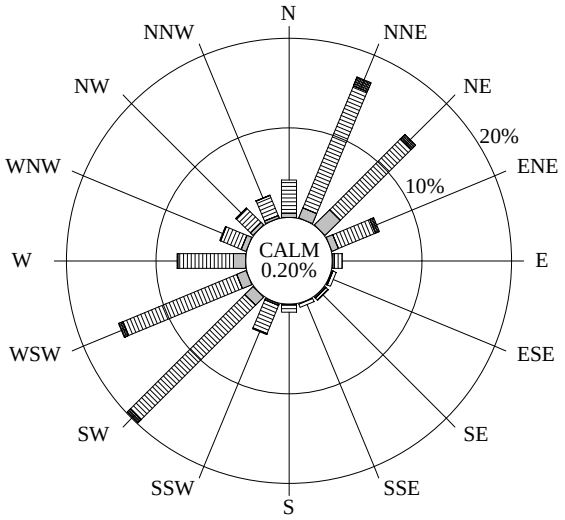
04-18-2003

Craters of the Moon National Monument

Quarterly Ozone Pollutant Rose

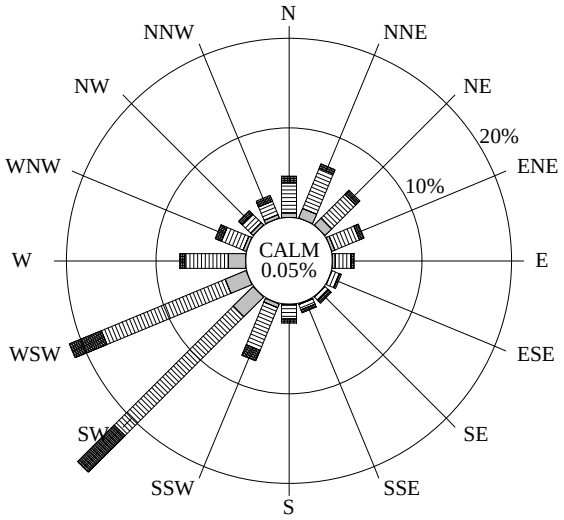
2002

FIRST QUARTER (JAN-MAR)



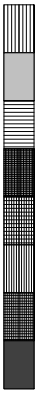
90.6% Collected 90.5% Valid
2160 Possible /1958 Collected /1955 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



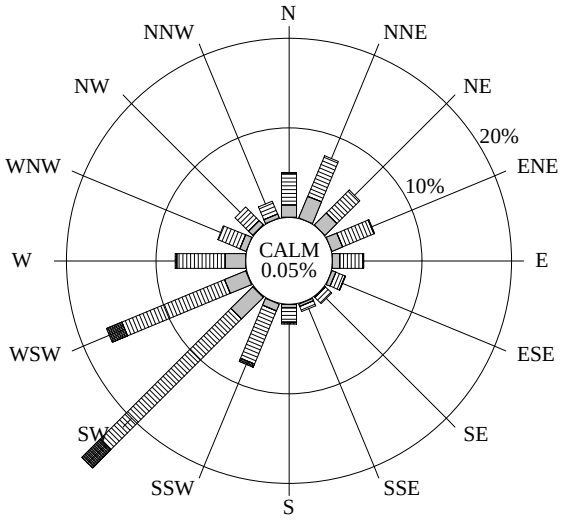
91.3% Collected 91.2% Valid
2184 Possible /1994 Collected /1992 Valid
(includes WS and WD)

Ozone (ppb)



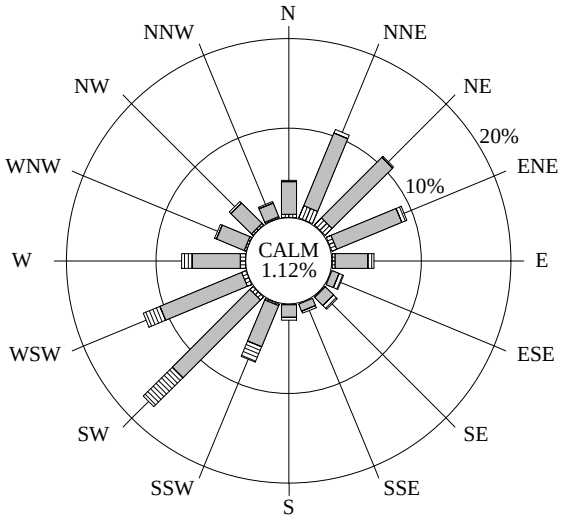
0-19
20-39
40-59
60-79
80-99
100-119
120-139
140+

THIRD QUARTER (JUL-SEP)

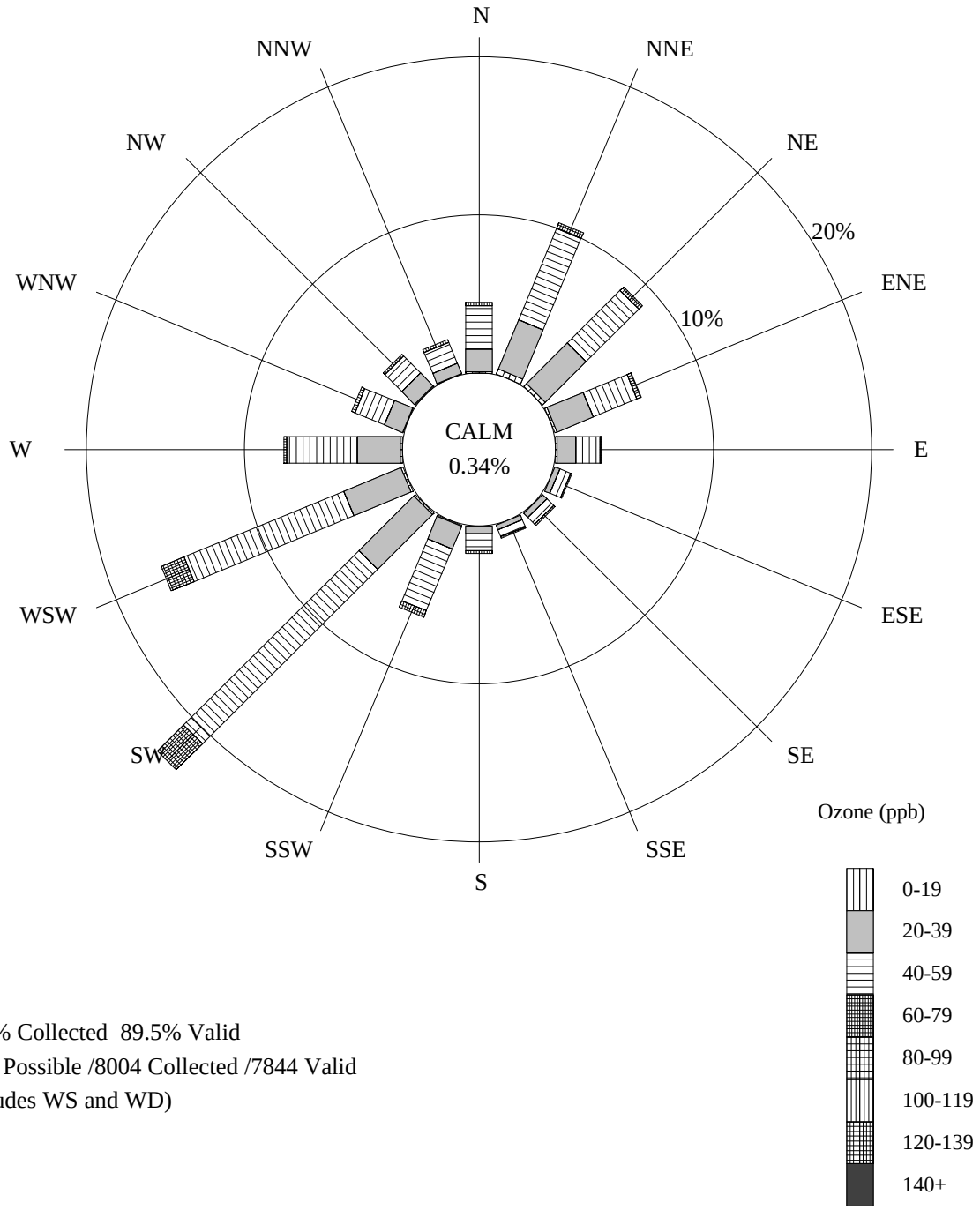


91.4% Collected 91.4% Valid
2208 Possible /2019 Collected /2019 Valid
(includes WS and WD)

FOURTH QUARTER (OCT-DEC)



92.1% Collected 85.1% Valid
2208 Possible /2033 Collected /1878 Valid
(includes WS and WD)



91.4% Collected 89.5% Valid
8760 Possible /8004 Collected /7844 Valid
(includes WS and WD)

Ozone Analyzer Precision Check Summary
Craters of the Moon National Monument

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	12	2.35	-5.69	10.39
2	11	7.75	5.56	9.93
3	13	-0.96	-6.09	4.17
4	13	-5.72	-8.39	-3.04

[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

Craters of the Moon National Monument

Final Validation

01/01/2002 - 12/31/2002

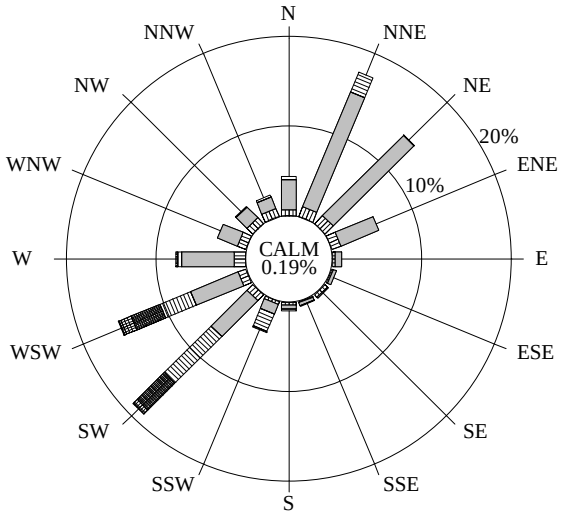
Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	3.4	m/s	8752	2.6
Maximum	16.5	m/s		
Percent calm = 0.49				
AMBIENT TEMPERATURE				
Average	6.2	degC	8748	11.5
Maximum	36.2	degC		
Minimum	-21.8	degC		
RELATIVE HUMIDITY				
Average	53	percent	8755	25
Maximum	97	percent		
Minimum	5	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	NA			
Maximum non-zero rate				
Minimum non-zero rate				
Accumulated during period				
SOLAR RADIATION				
Average Daily Total	15,654,081	joules/m2day	331	7,790,318
Maximum Daily Total	29,910,400	joules/m2day		
Minimum Daily Total	1,139,200	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.

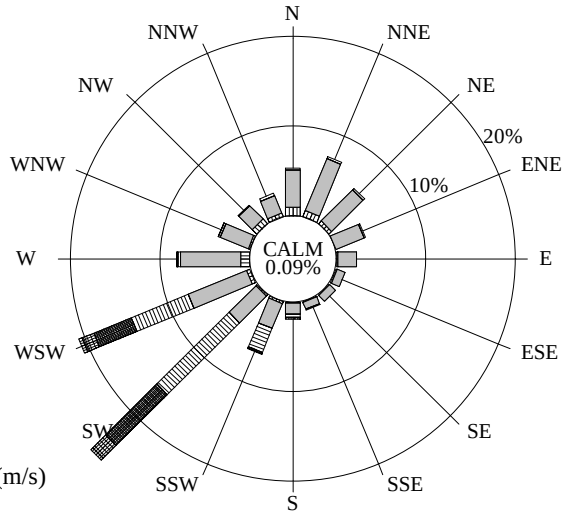
NA indicates instrument not available.

FIRST QUARTER (JAN-MAR)



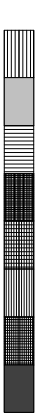
99.9% Collected 99.9% Valid
2160 Possible /2158 Collected /2158 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



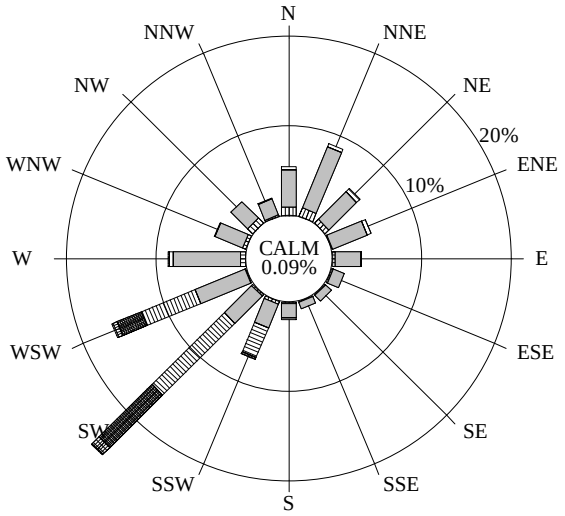
99.8% Collected 99.8% Valid
2184 Possible /2179 Collected /2179 Valid
(includes WS and WD)

Scalar Wind Speed (m/s)



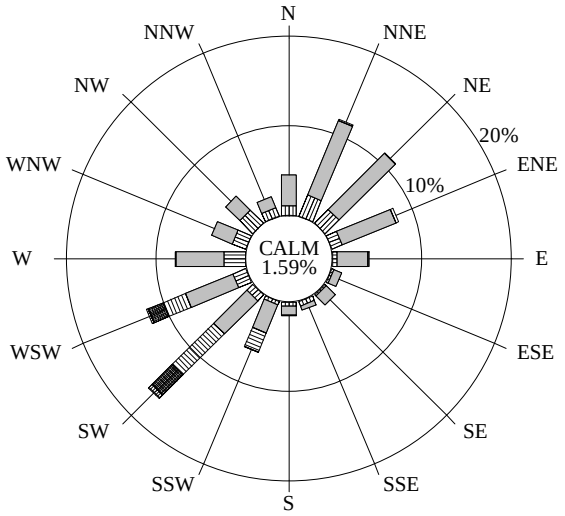
CALM < .5
0.5-0.9
1.0-3.9
4.0-6.9
7.0-9.9
10.0-12.9
13.0-15.9
16.0-18.9
19.0+

THIRD QUARTER (JUL-SEP)



100.0% Collected 100.0% Valid
2208 Possible /2207 Collected /2207 Valid
(includes WS and WD)

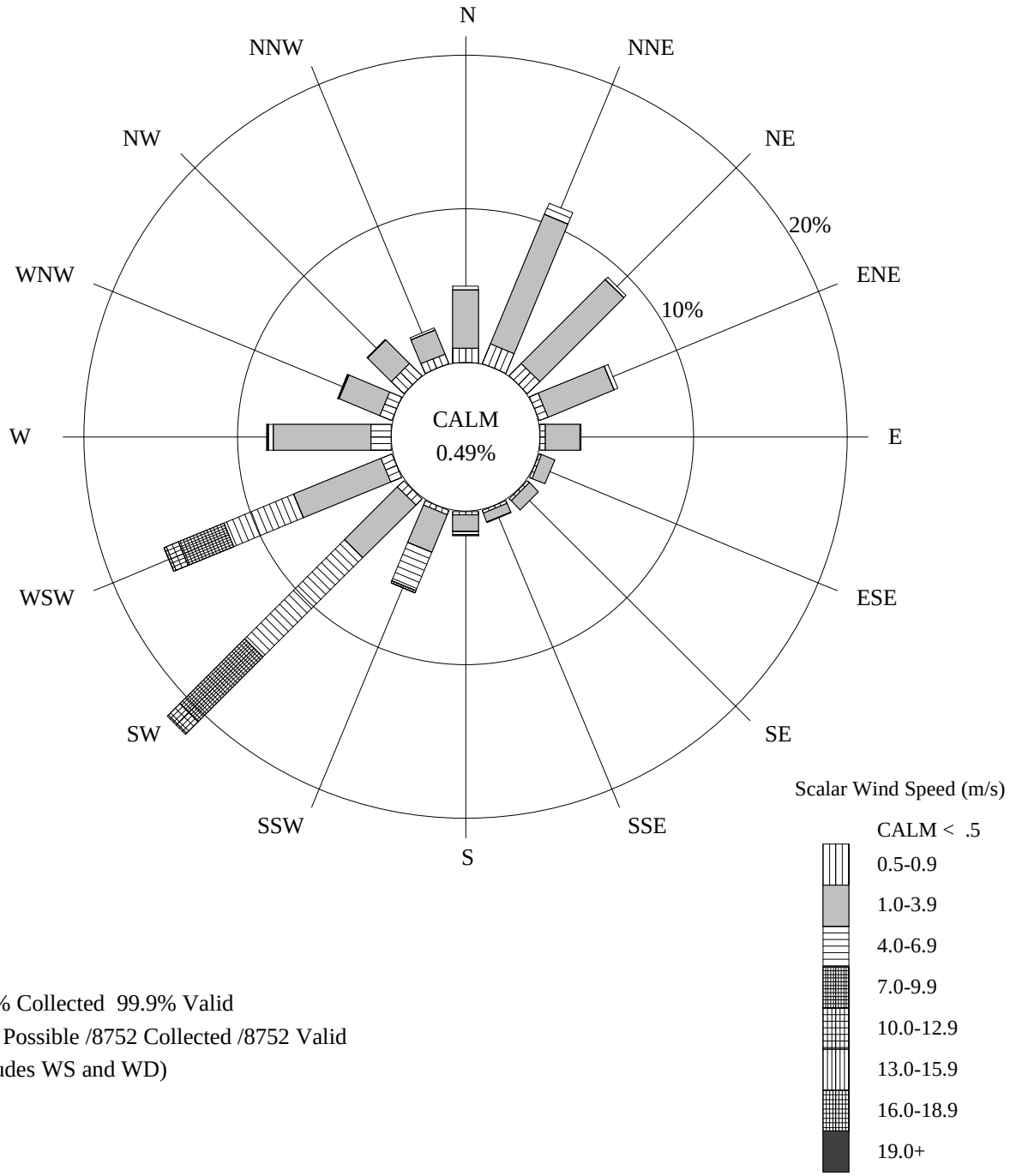
FOURTH QUARTER (OCT-DEC)



100.0% Collected 100.0% Valid
2208 Possible /2208 Collected /2208 Valid
(includes WS and WD)

Final Validation

04-18-2003



99.9% Collected 99.9% Valid
8760 Possible /8752 Collected /8752 Valid
(includes WS and WD)

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.

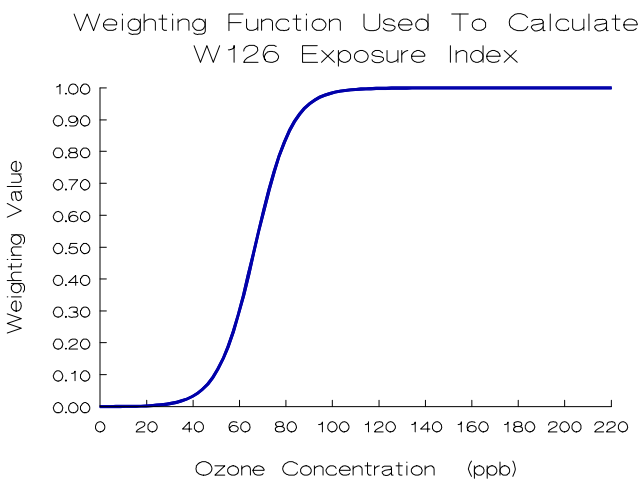
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to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