Report No. NPS D-246

Annual Data Summary

ACADIA NATIONAL PARK

2000

National Park Service
Gaseous Air Pollutant Monitoring Network

AIR RESOURCES DIVISION
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Annual Data Summary

ACADIA NATIONAL PARK
Cadillac Mountain

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At Acadia National Park the ARD specifically recognizes Bob Breen and Bill Gawley for performing the technical and administrative skills required to help provide the data presented within this report.

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1.0 INTRODUCTION

1.1 THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING NETWORK

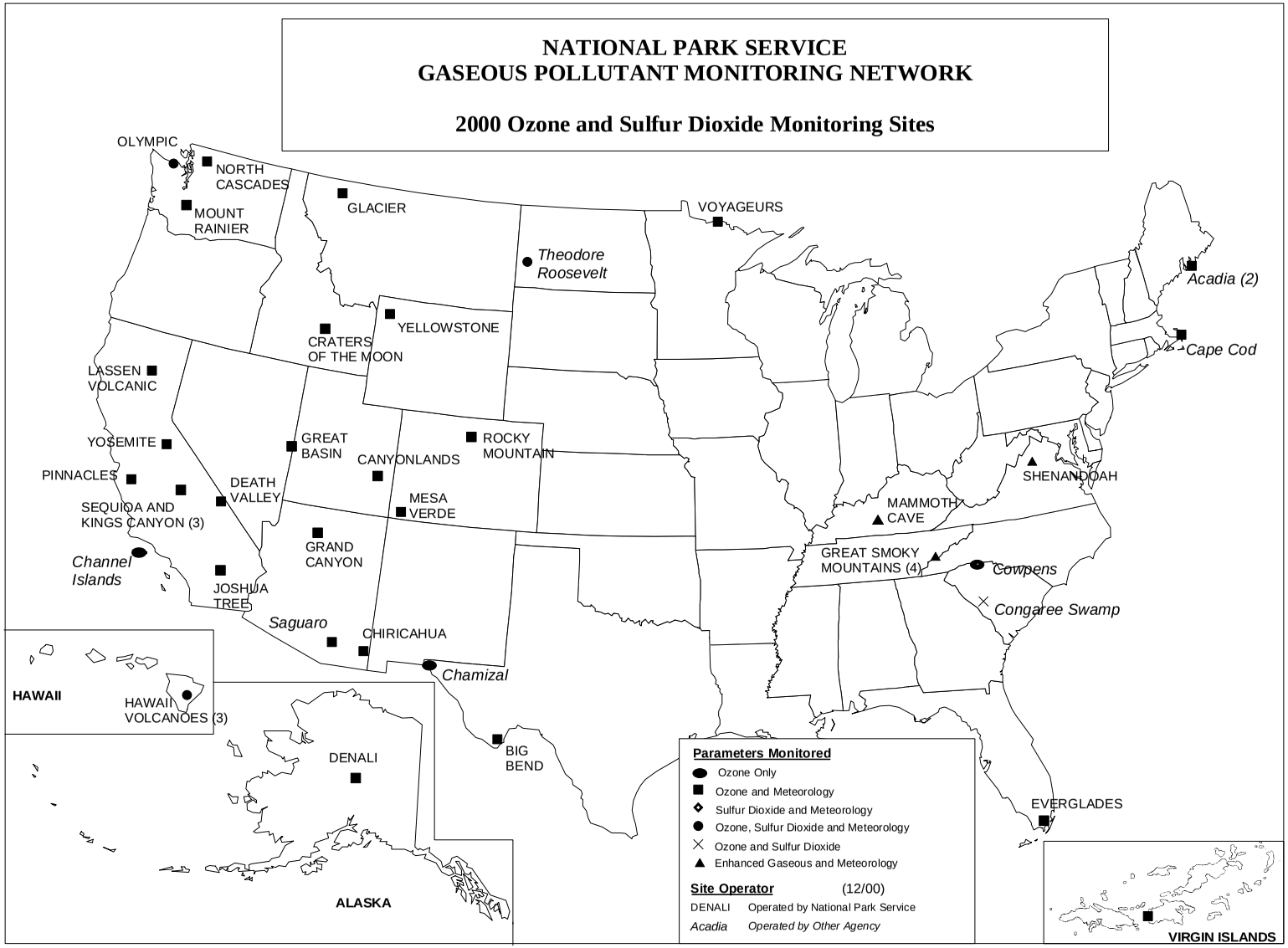
Gaseous air pollutants, including ozone and sulfur dioxide, are of concern to the National Park Service (NPS). Pollutants like these can affect park unit biological resources as well as the health of park unit residents and visitors. The NPS established a gaseous pollutant monitoring program for several 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 Network site locations and measured parameters collected in this reporting year are shown on the map on the following page. During this reporting period, 40 monitoring sites in 35 units of the National Park System had some combination of ozone, sulfur dioxide, meteorological, and 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 PC-compatible diskette containing a digital copy of all data collected during the year and data summary products included in this report is available. Individual reports are generated for each site where monitoring was conducted in the national park network.


NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
2000 Ozone and Sulfur Dioxide Monitoring Sites
OLYMPIC
NORTH CASCADES
MOUNT RAINIER
GLACIER
VOYAGEURS
Theodore Roosevelt
Acadia (2)
Cape Cod
YELLOWSTONE
CRATERS OF THE MOON
LASSEN VOLCANIC
YOSEMITE
GREAT BASIN
ROCKY MOUNTAIN
CANYONLANDS
PINNACLES
DEATH VALLEY
SEQUOIA AND KINGS CANYON (3)
MESA VERDE
SHENANDOAH
MAMMOTH CAVE
GREAT SMOKY MOUNTAINS (4)
Cowpens
Congaree Swamp
Channel Islands
GRAND CANYON
JOSHUA TREE
Saguaro
CHIRICAHUA
Chamizal
BIG BEND
EVERGLADES
HAWAII
HAWAII VOLCANOES (3)
DENALI
ALASKA
VIRGIN ISLANDS
Parameters Monitored
Ozone Only
Ozone and Meteorology
Sulfur Dioxide and Meteorology
Ozone, Sulfur Dioxide and Meteorology
Ozone and Sulfur Dioxide
Enhanced Gaseous and Meteorology
Site Operator (12/00)
DENALI Operated by National Park Service
Acadia Operated by Other Agency

1.2 ACADIA NATIONAL PARK

Acadia National Park, a Class I area, is located along the coast of Maine in Knox and Hancock Counties. Its location and site specifications are presented on the next page.

The mandate from the United States Congress states Acadia National Park was established "...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 a manner and by such means as will leave them unimpaired for the enjoyment of the future generations." The purpose of Acadia is to perpetuate the historical traditions and natural history of a portion of the Maine coastline and to offer visitors an increased awareness of their American heritage.

Sieur de Monts National Monument was established by Presidential Proclamation in 1916. In 1919, the name was changed to Lafayette National Park and again in 1929 to Acadia National Park.

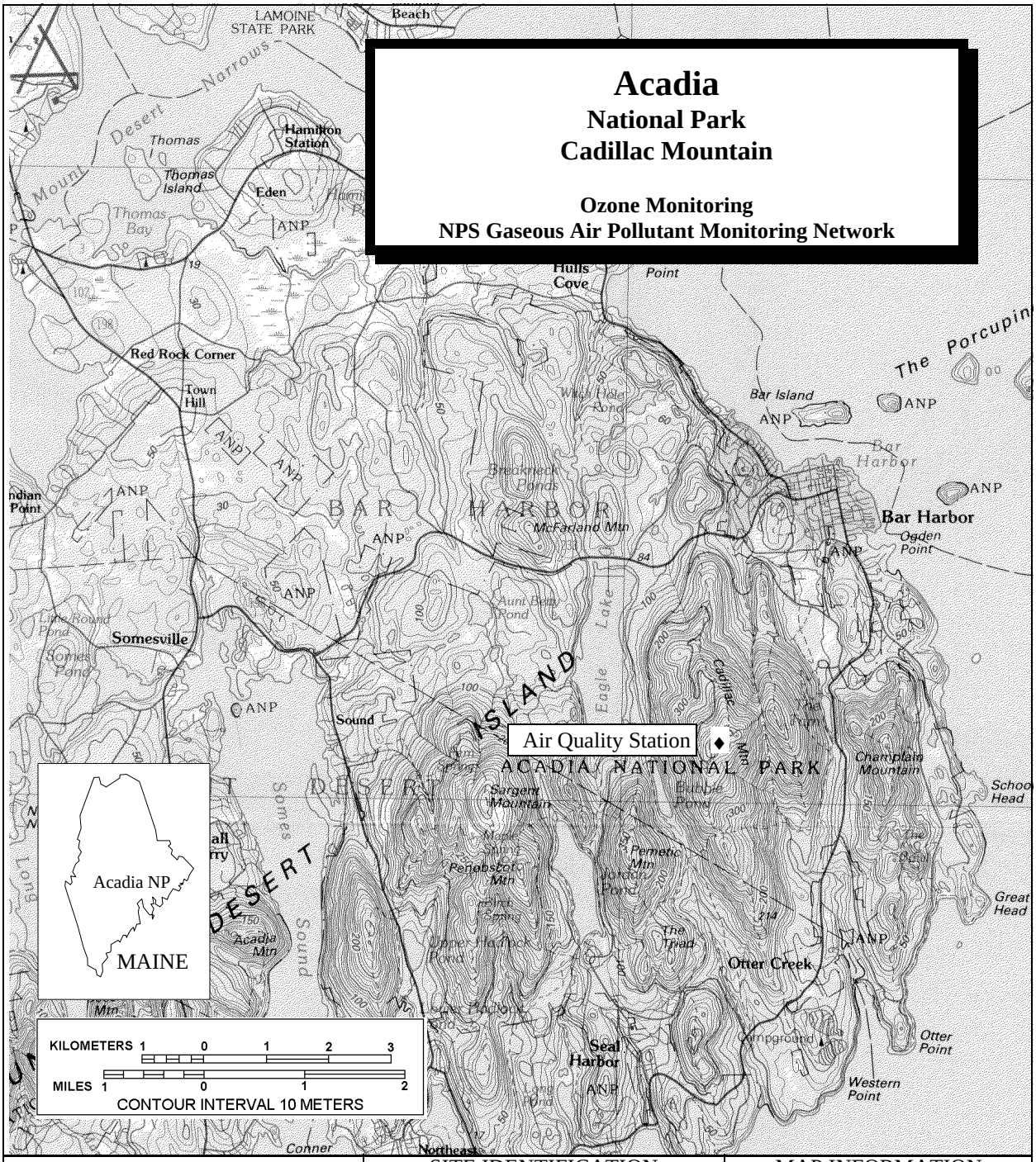
Acadia National Park conserves panoramas and scenic vistas of mountains, rocky coasts, islands and the ocean in a combination that is unequalled along the Atlantic coast. When viewed from seaside cliffs, islands along the coast spread out to the horizon. Behind the rocky shore, the rounded summits of glaciated mountains rise to 1,530 feet. Throughout the mountains are small clear lakes surrounded by spruce, fir and hardwoods. A major concern is residential and commercial development on private lands which threatens to encroach on park vistas offering views of forests, cliffs, and oceans.

The forests of Mount Desert Island have a special quality. The northern coniferous and temperate deciduous forests meet and overlap, bringing to the island an exceptional variety of trees, shrubs and herbaceous plant life. About 1,500 species of plants are found in Acadia, but the majority of these cannot be considered common. For example, scrub oak is only found on Acadia Mountain and a few nearby mountain slopes.

Recent research has found a number of native plants including broad-leaf aster (*Aster macrophyllus*), spreading dogbane (*Androsaemifolium*), black cherry (*Prunus serotina*), and white ash (*Fraxinus americana*) to be sensitive to ambient levels of ozone. Field surveys have confirmed the presence of foliar injury to some of these species growing under natural conditions at Acadia. Other research has indicated a positive correlation between ozone concentration and reduced tree-ring growth in several white pine stands in the park. There have also been a number of other biotic and abiotic agents identified that impact park vegetation including spruce budworm, gypsy moths, insects, and a fungus that produces needle injury to white pine.

Approximately 50 species of mammals and 327 species of birds have been reported in Acadia National Park, as well as amphibians and reptiles. The dominant mammals include raccoon, mink, skunk, red fox, harbor seal, beaver, snowshoe hare, white-tailed deer and harbor porpoise.

In addition to the issue of surrounding growth and development which encroaches primarily on water and visual resources, there are a number of air pollution related concerns. Acid deposition, ozone, mercury and other toxins including PCB's have all been identified as impacts to Acadia's flora, fauna, and hydrogeochemical resources.



SITE IDENTIFICATION	MAP INFORMATION
Site Abbreviation: ACAD-CM AIRS ID NO.: 29-009-0102	Mean Elevation: 466 m Longitude: 68°13'40”W Latitude: 44°20'50”N UTM Zone: 19 Easting: 561551m Northing: 4910512m Map Reference: Bar Harbor 44068-A1 1:100,000

INSTRUMENTATION

O_3 Analyzer	Wind Direction
Relative Humidity	Temperature
Wind Speed	

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
Acadia National Park
Cadillac Mountain

Final Data

04/01/00 - 09/30/00

Parameter	Par Code	Data Recovery			Valid Data	
		No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	O3	4377	4111	93.9	4070	93.0
Scalar Wind Speed	SWS	4384	3923	89.5	3836	87.5
Vector Wind Speed	VWS	4384	3923	89.5	3836	87.5
Vector Wind Direction	VWD	4384	3923	89.5	3836	87.5
Scalar Wind Direction	SWD	4384	3923	89.5	3836	87.5
Standard Deviation for Wind Direction	SDWD	4384	3921	89.4	3836	87.5
Ambient Temperature (aspirated)	TMP	4384	4332	98.8	4254	97.0
Relative Humidity	RH	4384	4332	98.8	4254	97.0

Notes: All statistics are for hourly averages.

The number collected does not include normal maintenance or events beyond the control of the network.

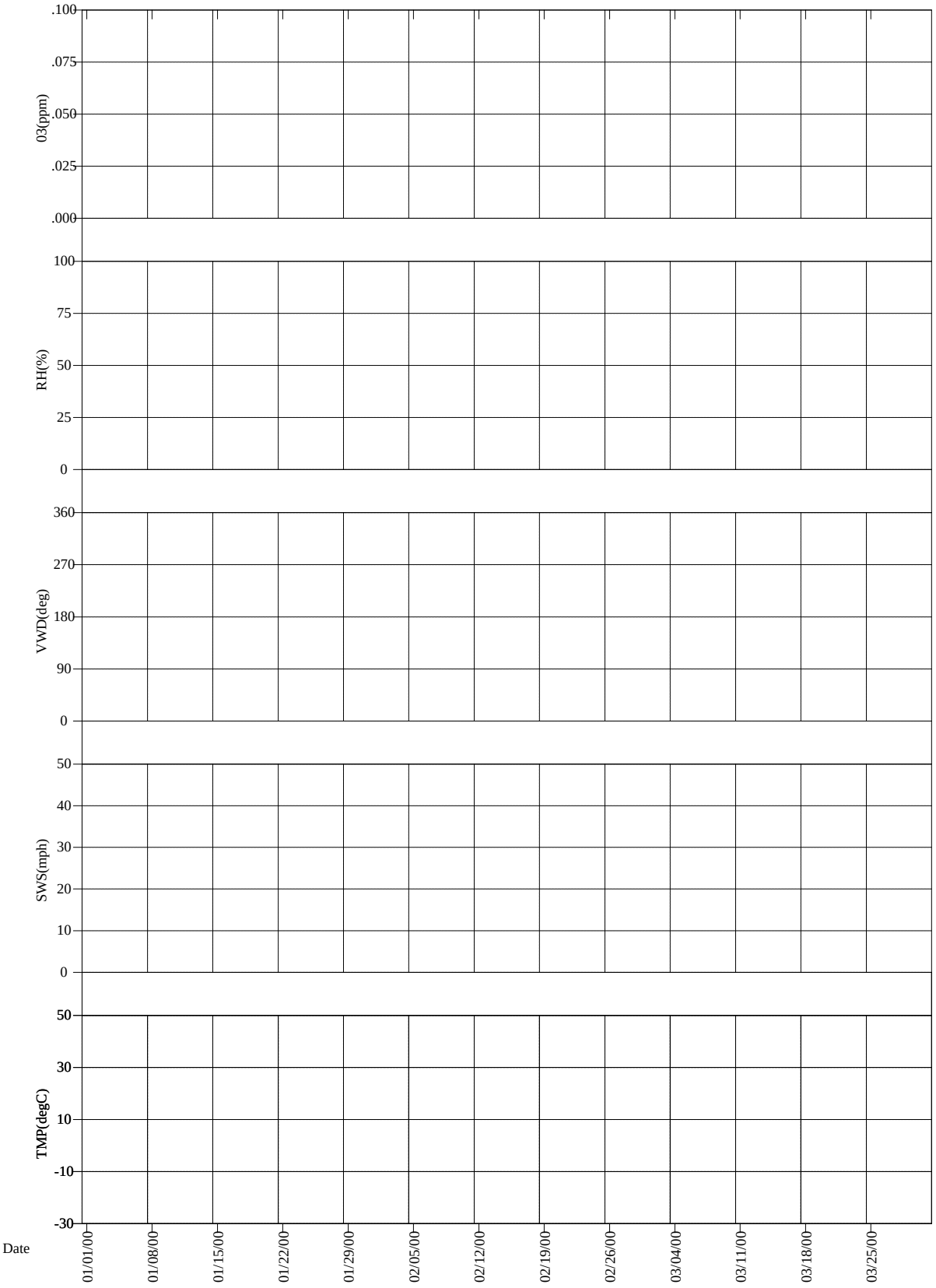
The percent valid is calculated against the number possible.

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.

NPS 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

Acadia National Park - Cadillac Mountain

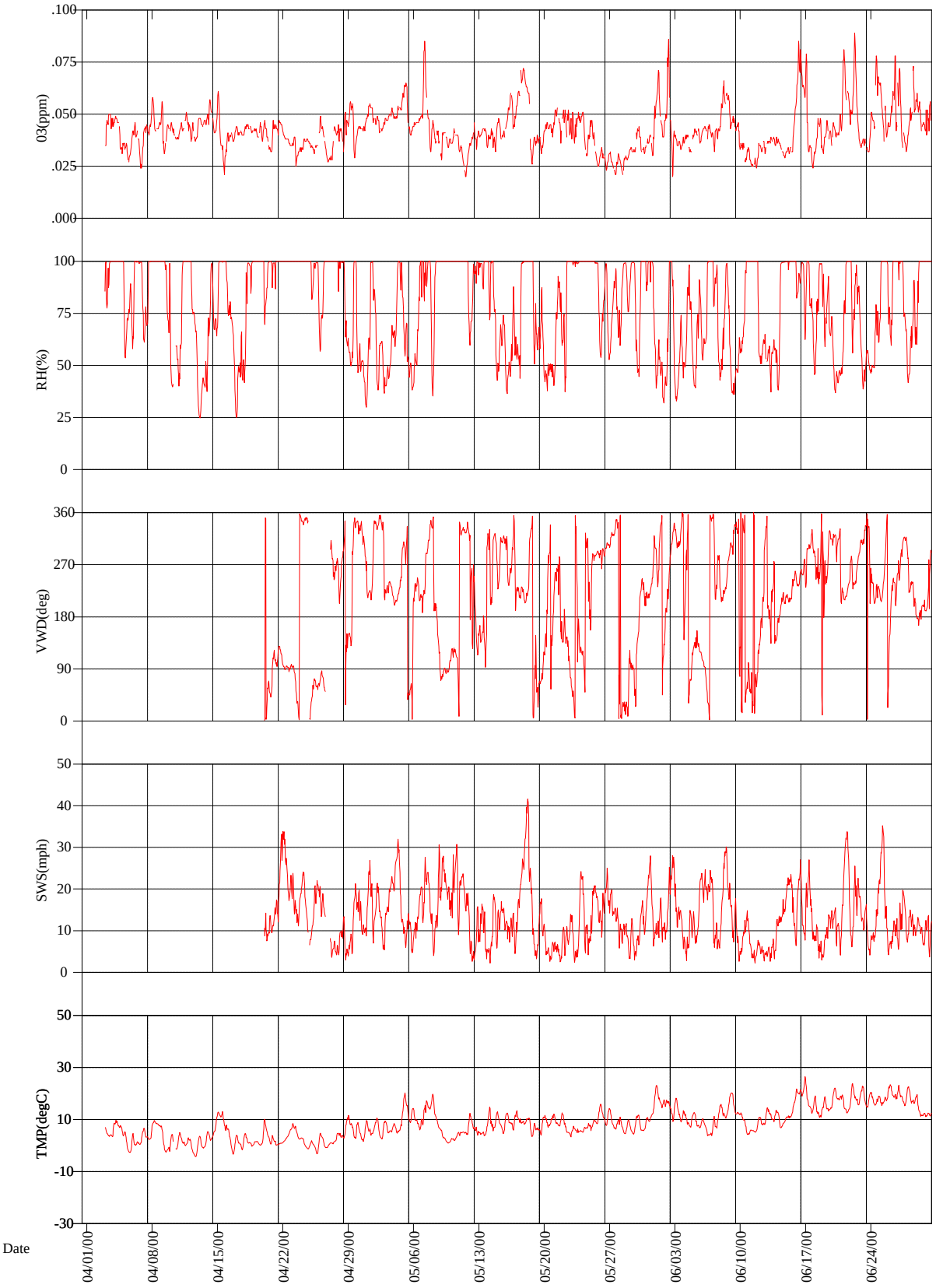


Final Validation

First Quarter 2000

acad-cm.stk - acad-cm.dat 05-17-2001

Acadia National Park - Cadillac Mountain

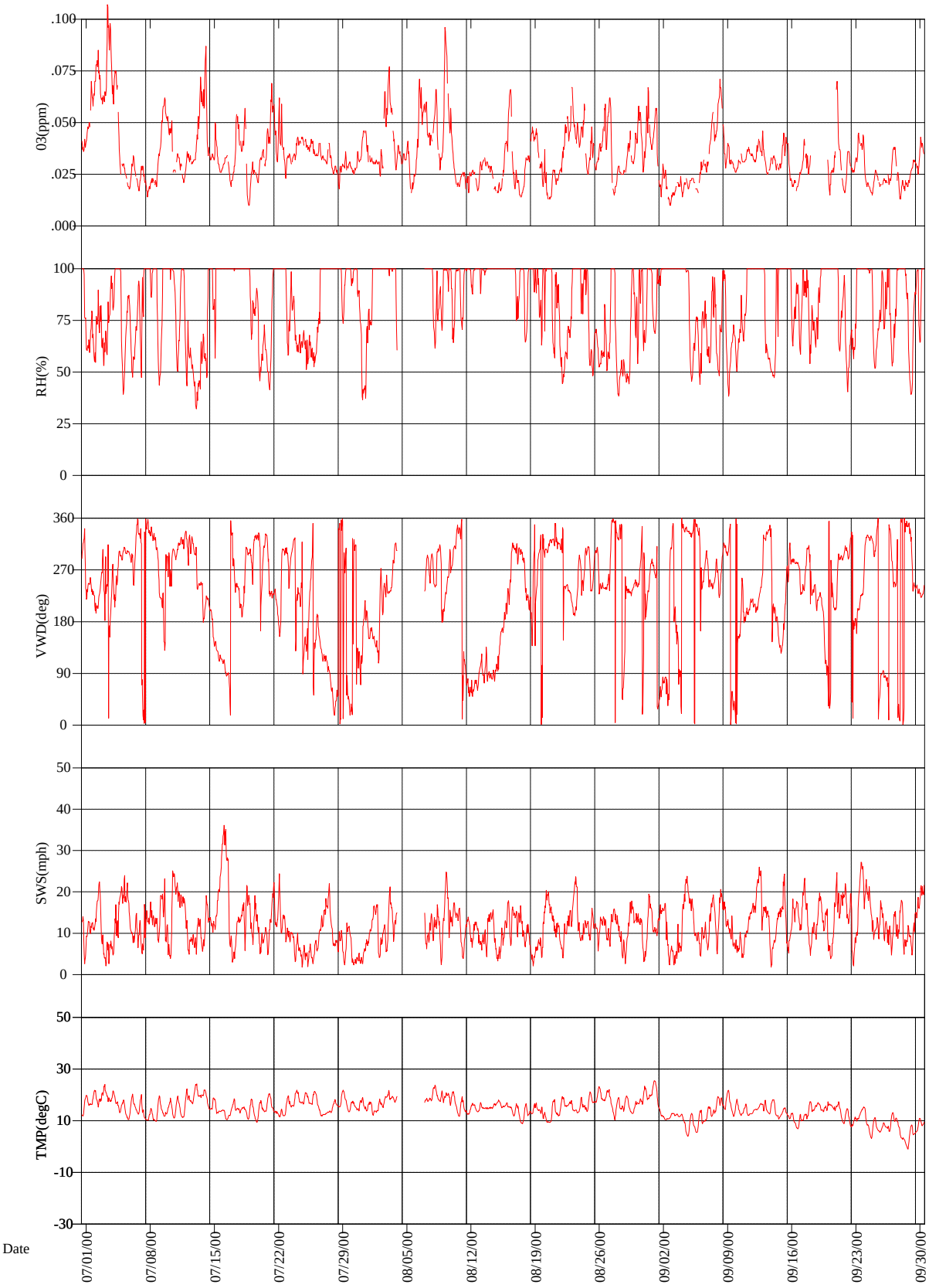


Final Validation

Second Quarter 2000

acad-cm.stk - acad-cm.dat 05-17-2001

Acadia National Park - Cadillac Mountain

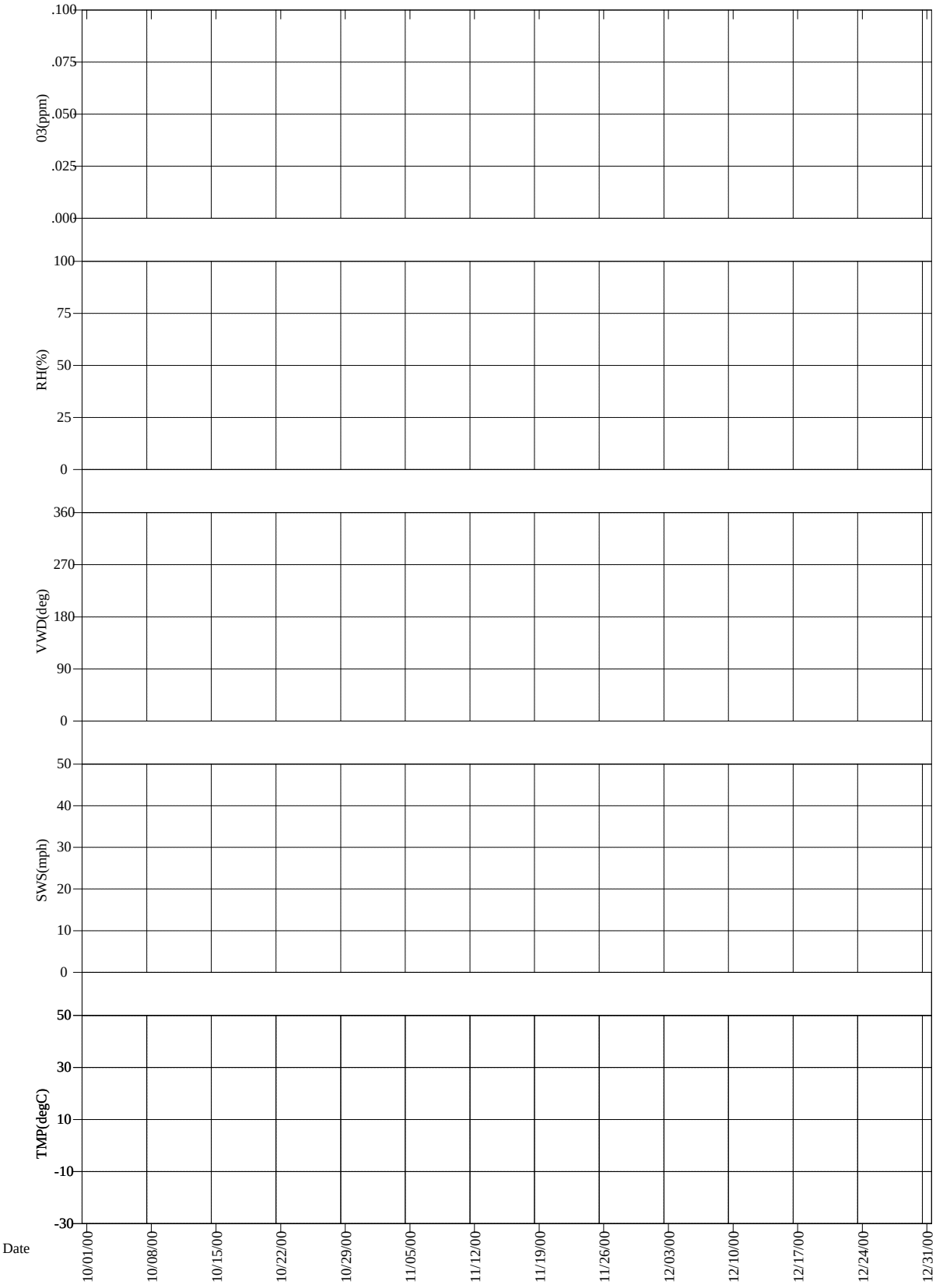


Final Validation

Third Quarter 2000

acad-cm.stk - acad-cm.dat 05-17-2001

Acadia National Park - Cadillac Mountain



Final Validation

Fourth Quarter 2000

acad-cm.stk - acad-cm.dat 05-17-2001

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Acadia National Park
Cadillac Mountain
04/01/00 - 09/30/00

STATISTIC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAY-SEP	ANNUAL
DAILY 1-HR MAXIMUM				61	85	89	107	96	71				107	107
NO. OF DAYS				(28)	(31)	(30)	(31)	(31)	(29)				(152)	(180)
AVERAGE DAILY MAXIMUM				48	49	57	51	49	39				49	49
NO. OF DAYS				(28)	(31)	(30)	(31)	(31)	(29)				(152)	(180)
MAXIMUM DAILY MEAN				49	65	61	76	60	55				76	76
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(27)				(150)	(177)
AVERAGE DAILY MEAN				41	42	44	38	36	30				38	39
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(27)				(150)	(177)
MAX PEAK:MIN RATIO				1.952	2.050	2.656	3.100	4.438	2.692				4.438	4.438
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(27)				(150)	(177)
AVERAGE PEAK:MIN RATIO				1.439	1.437	1.701	1.825	2.114	1.817				1.778	1.726
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(27)				(150)	(177)
MAX 9AM-4PM AVERAGE				53	66	66	71	67	60				71	71
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(28)				(151)	(178)
MONTHLY 9AM-4PM AVERAGE				42	43	45	38	37	31				39	40
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(28)				(151)	(178)
MAX 7AM-7PM AVERAGE				50	65	62	72	63	59				72	72
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(28)				(151)	(178)
MONTHLY 7AM-7PM AVERAGE				41	43	45	38	37	30				39	39
NO. OF DAYS				(27)	(31)	(30)	(31)	(31)	(28)				(151)	(178)
MONTHLY MEAN				41	42	45	38	36	30				38	39
NO. OF HOURS				(631)	(702)	(686)	(708)	(704)	(639)				(3439)	(4070)
SUM0 EXPOSURE INDEX				25653	29431	30542	27079	25191	18859				131102	156755
NO. OF HOURS				(631)	(702)	(686)	(708)	(704)	(639)				(3439)	(4070)
SUM60 EXPOSURE INDEX				61	2847	6160	6321	3041	909				19278	19339
NO. OF HOURS				(1)	(43)	(89)	(88)	(44)	(14)				(278)	(279)
SUM80 EXPOSURE INDEX				-	326	753	1622	616	-				3317	3317
NO. OF HOURS				(0)	(4)	(9)	(18)	(7)	(0)				(38)	(38)
W126 EXPOSURE INDEX				1375	3080	5280	4886	2959	857				17062	18437
NO. OF HOURS				(631)	(702)	(686)	(708)	(704)	(639)				(3439)	(4070)

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

5/24/2001

Frequency Distribution
Ozone Analyzer

Acadia National Park
Cadillac Mountain
Monitoring Season: 04/01/00 - 09/30/00[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	98	4070	0.019	0.032	0.040	0.046	0.054	0.071	0.085	0.098	0.107	0.098	0.0489	0.0465	1.38

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)

Acadia National Park
Cadillac Mountain
04/01/00 - 09/30/00

Day	Jan-00	Feb-00	Mar-00	Apr-00		May-00		Jun-00		Jul-00		Aug-00		Sep-00		Oct-00	Nov-00	Dec-00
1					S	.055	M	.071	T	.050	S	.046	T	.057	F			
2					S	.053	T	.086	F	.085	S	.037	W	.030	S			
3				.050	M	.050	W	.047	S	.107	M	.077	T	.019	S			
4				.050	T	.054	T	.040	S	.098	T	.046	F	.024	M			
5				.044	W	.065	F	.043	M	.055	W	.041	S	.023	T			
6				.046	T	.046	S	.044	T	.034	T	.071	S	.032	W			
7				.045	F	.085	S	.045	W	.029	F	.067	M	.055	T			
8				.058	S	.052	M	.066	T	.023	S	.066	T	.071	F			
9				.056	S	.042	T	.060	F	.058	S	.096	W	.049	S			
10				.046	M	.043	W	.046	S	.062	M	.064	T	.032	S			
11				.046	T	.040	T	.034	S	.035	T	.026	F	.038	M			
12				.051	W	.041	F	.036	M	.036	W	.027	S	.042	T			
13				.048	T	.046	S	.039	T	.067	T	.032	S	.046	W			
14				.057	F	.043	S	.039	W	.087	F	.033	M	.034	T			
15				.061	S	.048	M	.034	T	.050	S	.023	T	.045	F			
16				.041	S	.060	T	.085	F	.034	S	.066	W	.040	S			
17				.044	M	.061	W	.079	S	.054	M	.036	T	.042	S			
18				.045	T	.072	T	.048	S	.057	T	.034	F		M			
19				.044	W	.040	F	.048	M	.031	W	.048	S		T			
20				.047	T	.046	S	.046	T	.037	T	.037	S	.032	W			
21				.047	F	.053	S	.081	W	.069	F	.027	M	.070	T			
22				.047	S	.052	M	.089	T	.062	S	.049	T	.036	F			
23				.039	S	.052	T	.054	F	.038	S	.067	W	.045	S			
24				.038	M	.051	W	.051	S	.043	M	.059	T	.044	S			
25				.038	T	.047	T	.078	S	.043	T	.048	F	.027	M			
26				.049	W	.034	F	.061	M	.042	W	.047	S	.023	T			
27				.037	T	.032	S	.078	T	.040	T	.062	S	.038	W			
28				.045	F	.031	S	.053	W	.040	F	.029	M	.026	T			
29				.056	S	.034	M	.073	T	.036	S	.046	T	.032	F			
30				.055	S	.044	T	.056	F	.031	S	.058	W	.043	S			
31						.040	W			.046	M	.067	T					
Valid Days	0	0	0	28		31		30		31		31		28		0	0	0
Maximum	.000	.000	.000	.061		.085		.089		.107		.096		.071		.000	.000	.000
Violations	0	0	0	0		0		0		0		0		0		0	0	0

4070 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])	
92.8 % Possible	0 Missing days assumed to be less than the standard	
179 Valid daily maxima	0 Daily maximas exceed the alert level of .200 ppm	Concentrations in parts per million (ppm)

Final Validation

5/24/2001

Acadia National Park
Cadillac Mountain
2000 Attainment Status With U.S. Environmental Protection Agency (EPA)
PRIMARY Ozone National Ambient Air Quality Standard

Ozone Season: April through September

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)
2000	86	92%	Yes	97	86	78	76	75

Ozone Analyzer 10 Highest Daily 1-Hour Average Maximum Concentrations Acadia National Park Cadillac Mountain Final Validation 01/01/2000 - 12/31/2000			
Value	Date	Hour	Concentration (ppm)
Ozone Analyzer			
1	07/03/2000	20	0.107*
2	07/04/2000	3	0.098*
3	08/09/2000	16	0.096*
4	06/22/2000	18	0.089*
5	07/14/2000	14	0.087*
6	06/02/2000	20	0.086
7	05/07/2000	17	0.085*
8	06/16/2000	18	0.085*
9	07/02/2000	20	0.085
10	06/21/2000	15	0.081**

* 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

Acadia National Park
Cadillac Mountain

01/01/2000 - 12/31/2000
FINAL VALIDATION

Site	Date	Beginning Hour	No. Hours		Max (ppb)
			≥ 100 ppb	>124 ppb	
ACAD-CM	07/03/00	20	2	0	107
		Total	2	0	107

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 Acadia National Park Cadillac Mountain 01/01/2000 - 12/31/2000 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
ACAD-CM	07/03/00	20 - 03	97	8
ACAD-CM	07/04/00	00 - 07	88	2
ACAD-CM	08/09/00	16 - 23	86	3
	3	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).

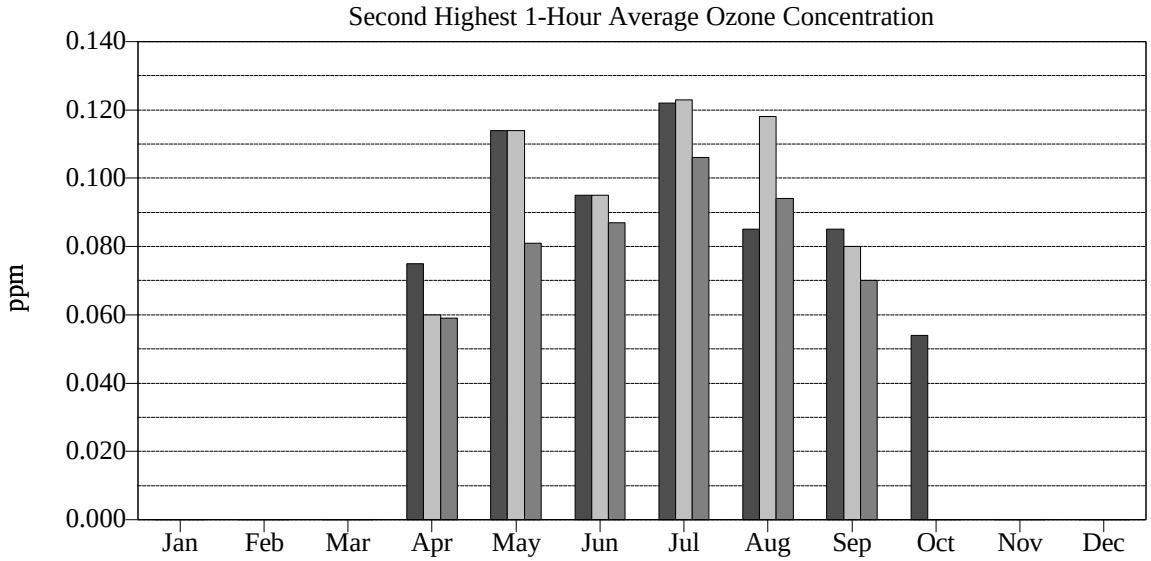
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

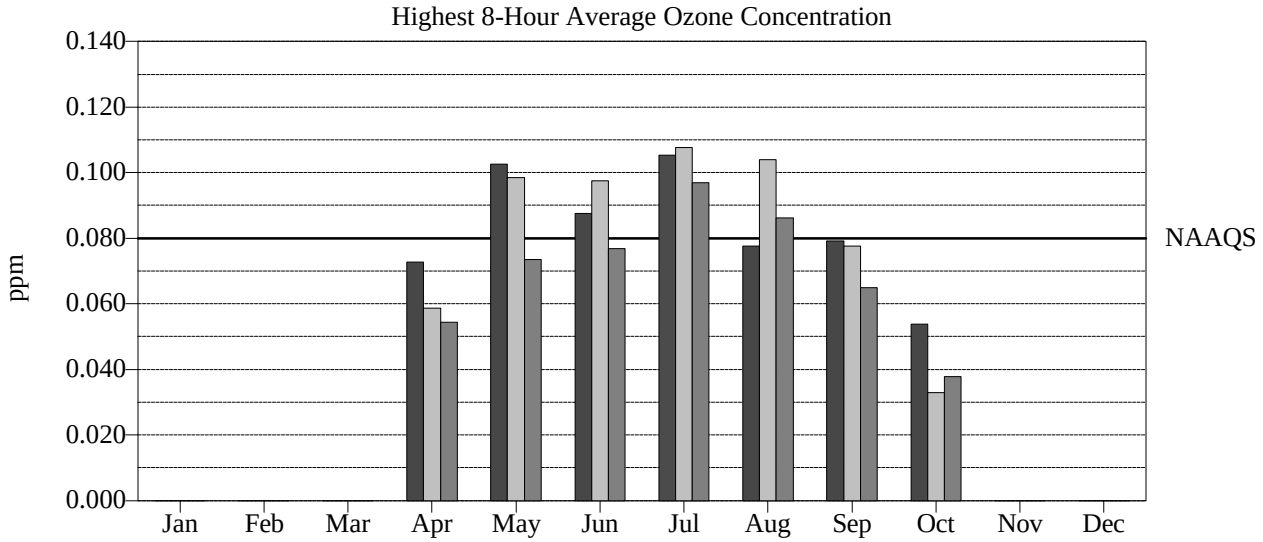
01/01/2000 - 12/31/2000

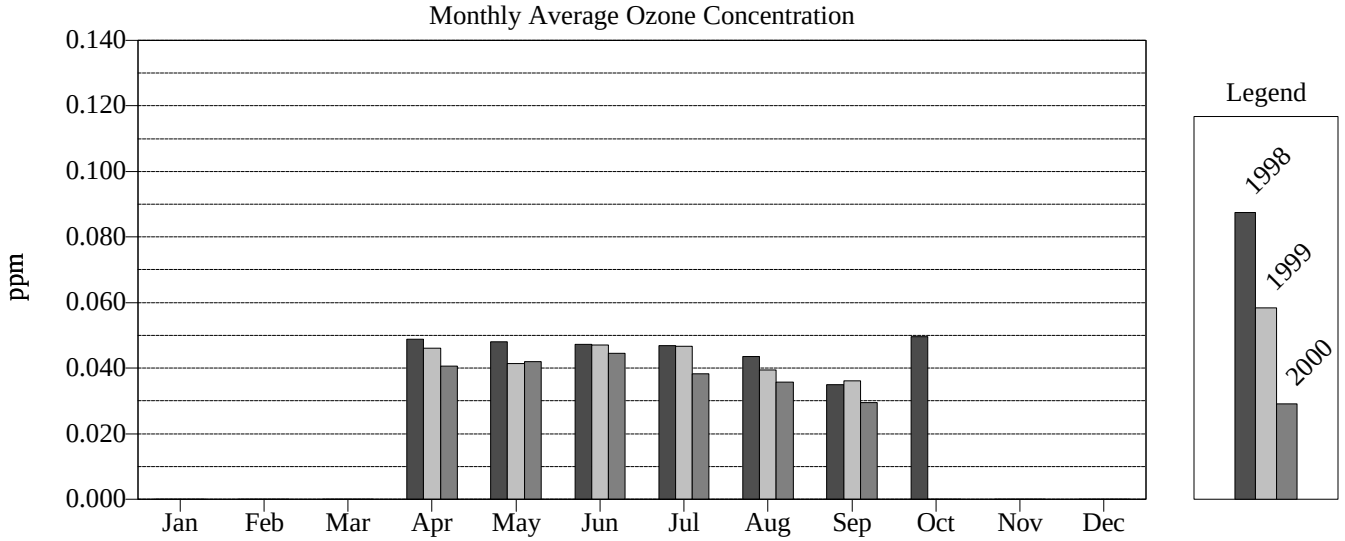
Second Highest 1-Hour Average Concentration		
Site	Rank	Concentration (ppb)
CACO-XX	1	139
JOTR-YV	2	123
GRSM-CD	3	122
YOSE-TD	4	118
SEKI-AS	5	117
COWP-XX	6	115
GRSM-CM	7	114
SEKI-LP	8	114
CHAM-XX	9	111
GRSM-LR	10	110
MACA-HM	11	108
ACAD-CM	12	106
SEKI-LK	13	104
COSW-BL	14	98
GRSM-CC	15	97
ROMO-LP	16	97
PINN-ES	17	96
SHEN-BM	18	95
CHIS-XX	19	92
LAVO-ML	20	88
MEVE-MY	21	88
DEVA-PV	22	87
ACAD-MH	23	85
SAGU-PC	24	84
GRBA-MY	25	82
CANY-IS	26	81
GRCA-AS	27	81
VOYA-SB	28	79
CHIR-ES	29	77
CRMO-VC	30	77
EVER-BC	31	76
YELL-WT	32	73
MORA-TW	33	72
BIBE-KB	34	71
THRO-VC	35	65
GLAC-WG	36	61
OLYM-VC	37	58
VIIS-LP	38	58
NOCA-MM	39	56
HAVO-TH	40	50
DENA-HQ	41	47

4th Highest 8-hour Average Concentration		
Site	Rank	Concentration (ppb)
SEKI-AS	1	105
SEKI-LP	2	101
GRSM-CD	3	100
GRSM-CM	4	96
GRSM-LR	5	96
JOTR-YV	6	96
SEKI-LK	7	90
COWP-XX	8	88
MACA-HM	9	88
YOSE-TD	10	87
CACO-XX	11	83
GRSM-CC	12	81
CHAM-XX	13	80
SHEN-BM	14	80
DEVA-PV	15	79
PINN-ES	16	78
ROMO-LP	17	78
GRBA-MY	18	77
ACAD-CM	19	76
CANY-IS	20	76
LAVO-ML	21	74
COSW-BL	22	73
MEVE-MY	23	73
SAGU-PC	24	72
CHIR-ES	25	71
GRCA-AS	26	71
ACAD-MH	27	70
CRMO-VC	28	66
EVER-BC	29	66
CHIS-XX	30	65
VOYA-SB	31	65
YELL-WT	32	65
BIBE-KB	33	64
THRO-VC	34	59
MORA-TW	35	57
GLAC-WG	36	56
VIIS-LP	37	49
NOCA-MM	38	48
OLYM-VC	39	47
DENA-HQ	40	44
HAVO-TH	41	43

Annual Sum60 Exposure Index			
Site	Rank	Sum60	Count
GRSM-CD	1	195667	2756
GRSM-CM	2	178087	2517
SEKI-LP	3	144383	1894
GRSM-LR	4	138346	1981
JOTR-YV	5	121960	1685
YOSE-TD	6	98751	1433
SEKI-AS	7	91473	1149
SEKI-LK	8	89676	1263
DEVA-PV	9	79510	1207
SHEN-BM	10	73844	1093
ROMO-LP	11	65673	984
GRBA-MY	12	64706	993
GRCA-AS	13	63983	1003
CANY-IS	14	61642	949
COWP-XX	15	57188	803
MEVE-MY	16	55431	851
MACA-HM	17	48907	710
GRSM-CC	18	44635	653
CHIR-ES	19	43204	672
PINN-ES	20	39070	569
LAVO-ML	21	32335	490
CACO-XX	22	30948	440
CHAM-XX	23	30889	439
SAGU-PC	24	26476	400
COSW-BL	25	25769	380
CRMO-VC	26	23165	364
ACAD-CM	27	19339	279
YELL-WT	28	17033	271
ACAD-MH	29	12712	192
EVER-BC	30	8725	133
VOYA-SB	31	7241	112
CHIS-XX	32	5906	89
BIBE-KB	33	5842	92
THRO-VC	34	2348	38
MORA-TW	35	1327	21
GLAC-WG	36	666	11
VIIS-LP	37	64	1
OLYM-VC	38	61	1
DENA-HQ	39	0	0
HAVO-TH	40	0	0
NOCA-MM	41	0	0

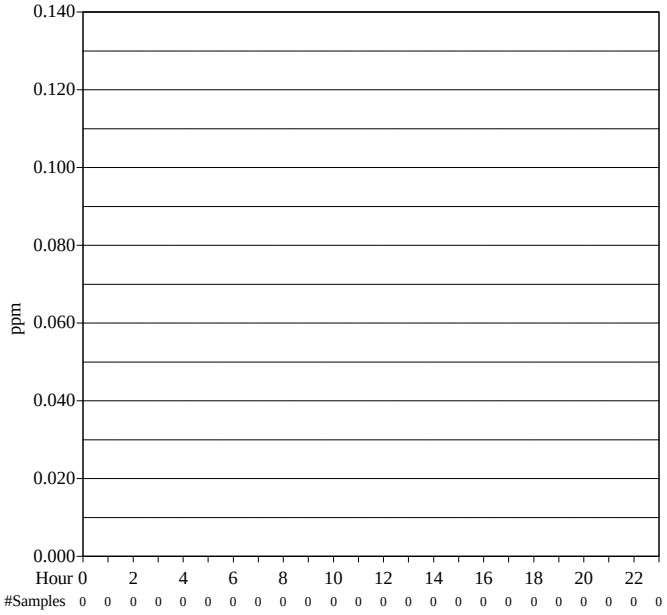

Second Highest 1-Hour Average Ozone Concentration
ppm
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Highest 8-Hour Average Ozone Concentration
ppm
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
NAAQS
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

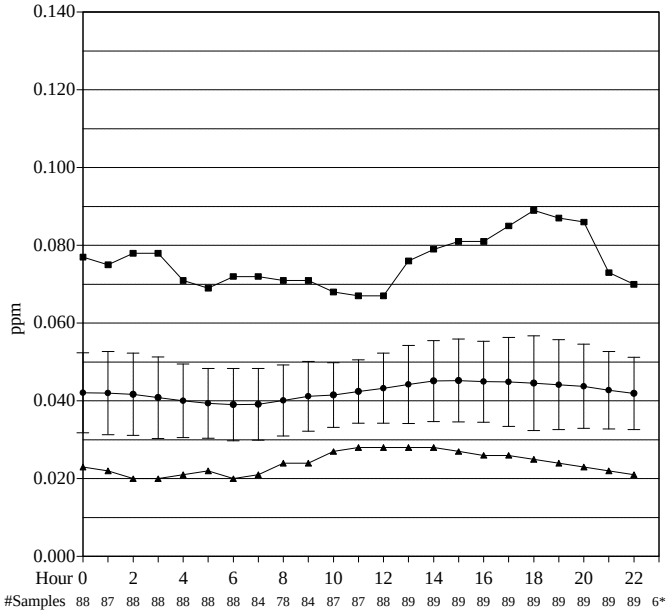

Monthly Average Ozone Concentration
ppm
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Legend
1998
1999
2000

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
2000 Second Highest 1-Hour Ozone Concentrations
OLYMPIC
58
56
72
NORTH CASCADES
MOUNT RAINIER
61
GLACIER
VOYAGEURS
79
65
Theodore Roosevelt
Acadia
106
139
Cape Cod
77
CRATERS OF THE MOON
73
YELLOWSTONE
LASSEN VOLCANIC
88
YOSEMITE
118
PINNACLES
96
117
DEATH VALLEY
87
82
GREAT BASIN
CANYONLANDS
81
97
ROCKY MOUNTAIN
SEQUOIA AND KINGS CANYON
92
Channel Islands
123
81
GRAND CANYON
88
MESA VERDE
MAMMOTH CAVE
108
95
SHENANDOAH
GREAT SMOKY MOUNTAINS
122
115
Cowpens
98
Congaree Swamp
JOSHUA TREE
Saguaro
84
77
CHIRICAHUA
111
Chamizal
71
BIG BEND
HAWAII
50
HAWAII VOLCANOES
DENALI
47
ALASKA
EVERGLADES
76
58
VIRGIN ISLANDS

FIRST QUARTER (JAN-MAR)

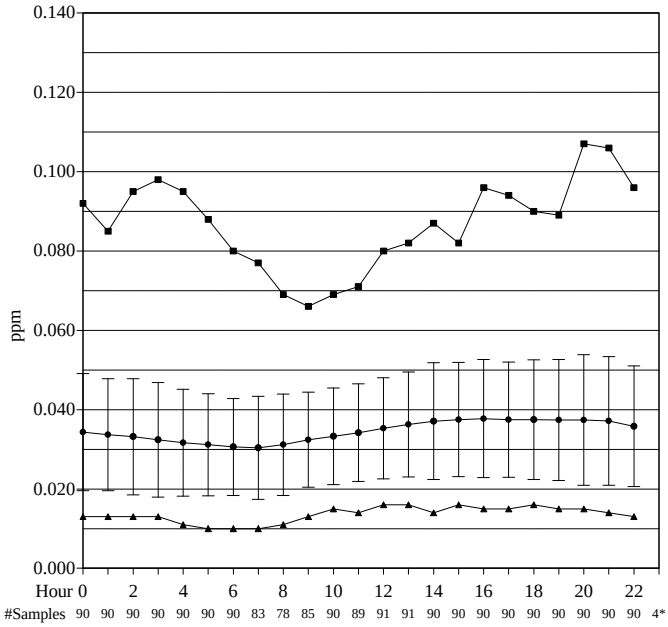


SECOND QUARTER (APR-JUN)



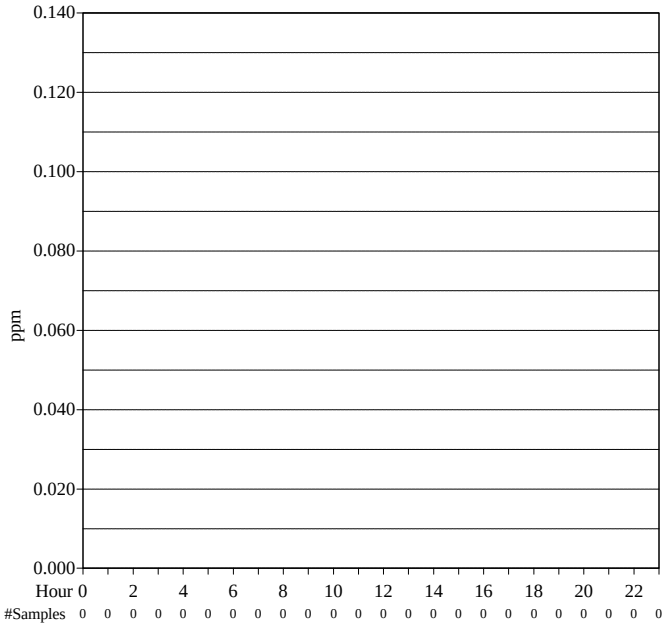
* Number of samples < 20% of maximum available hours during period

THIRD QUARTER (JUL-SEP)



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

FOURTH QUARTER (OCT-DEC)



Maximum of Valid O3 in ppm
(▫ Indicates Data Exceeds Plot Scale)

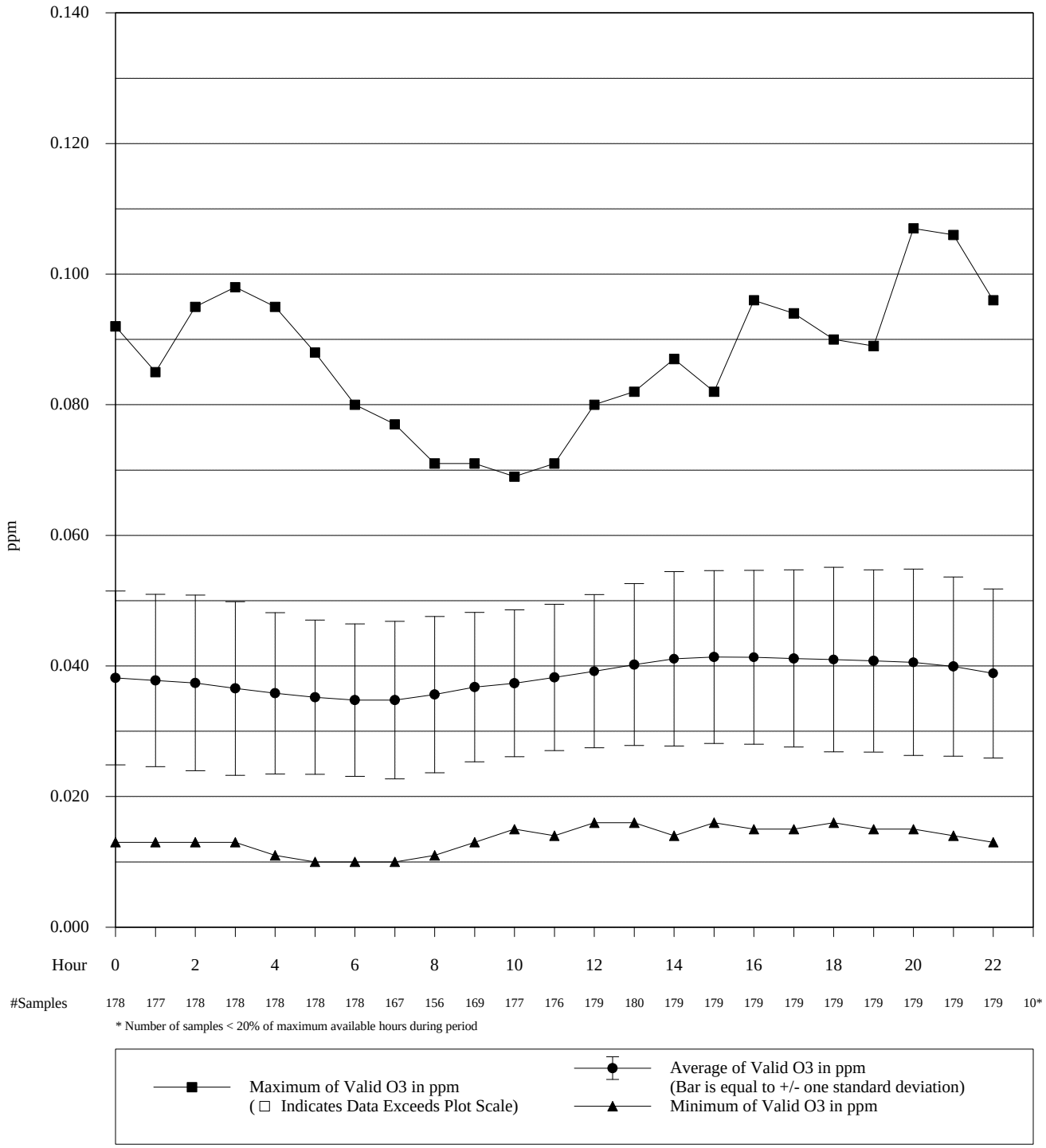
Average of Valid O3 in ppm
(Bar is equal to +/- one standard deviation)

Minimum of Valid O3 in ppm

Acadia National Park
Cadillac Mountain

Annual Diurnal
Ozone Plot

2000



Final Validation

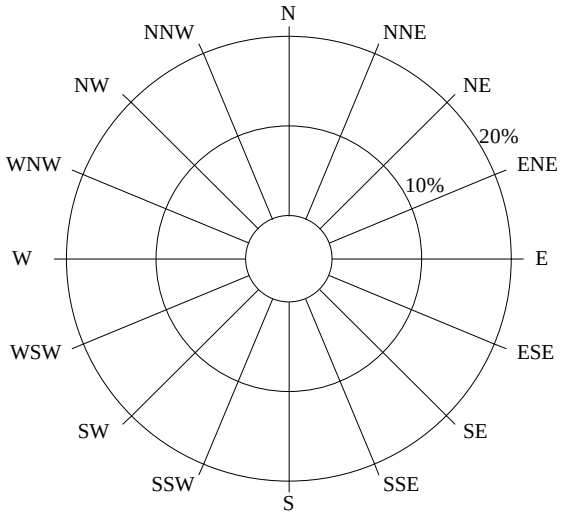
05-24-2001

Acadia National Park
Cadillac Mountain

Quarterly Ozone
Pollutant Rose

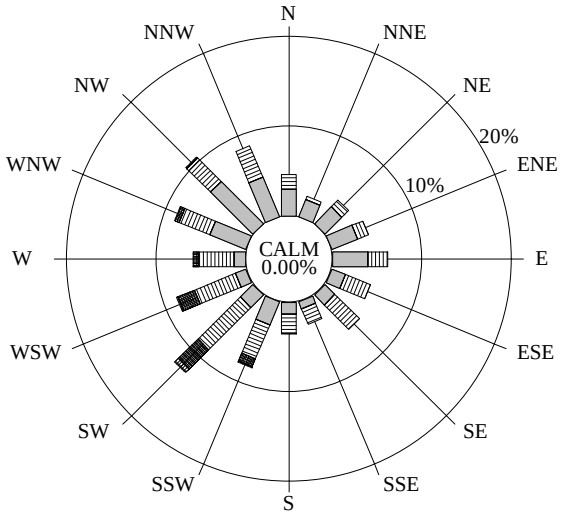
2000

FIRST QUARTER (JAN-MAR)



100.0% Collected 0.0% Valid
2184 Possible /2184 Collected /0 Valid

SECOND QUARTER (APR-JUN)

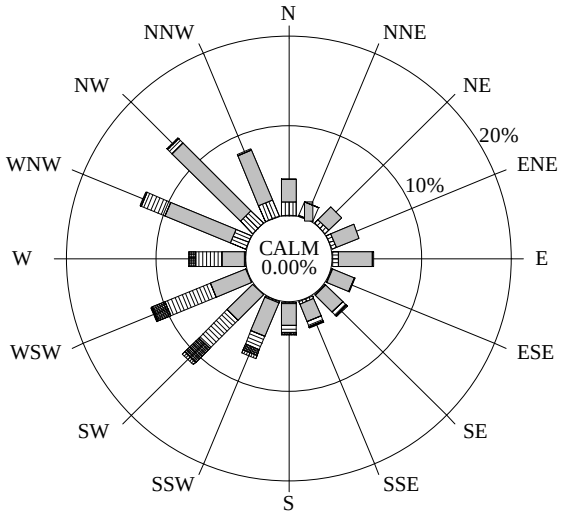


100.0% Collected 73.9% Valid
2184 Possible /2184 Collected /1615 Valid

Ozone (ppm)

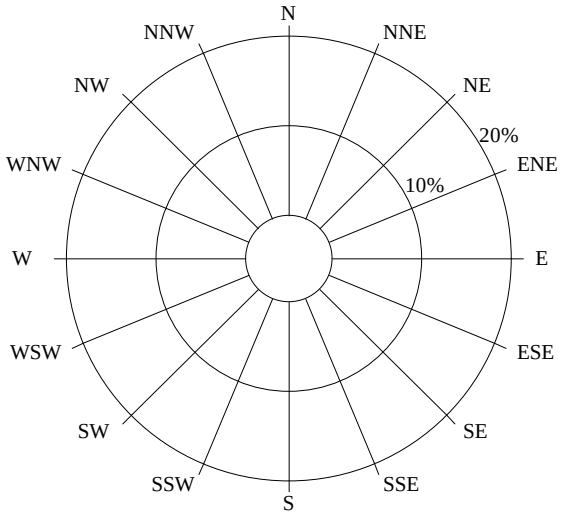
0.000-0.019
0.020-0.039
0.040-0.059
0.060-0.079
0.080-0.099
0.100-0.119
0.120-0.139
0.140+

THIRD QUARTER (JUL-SEP)

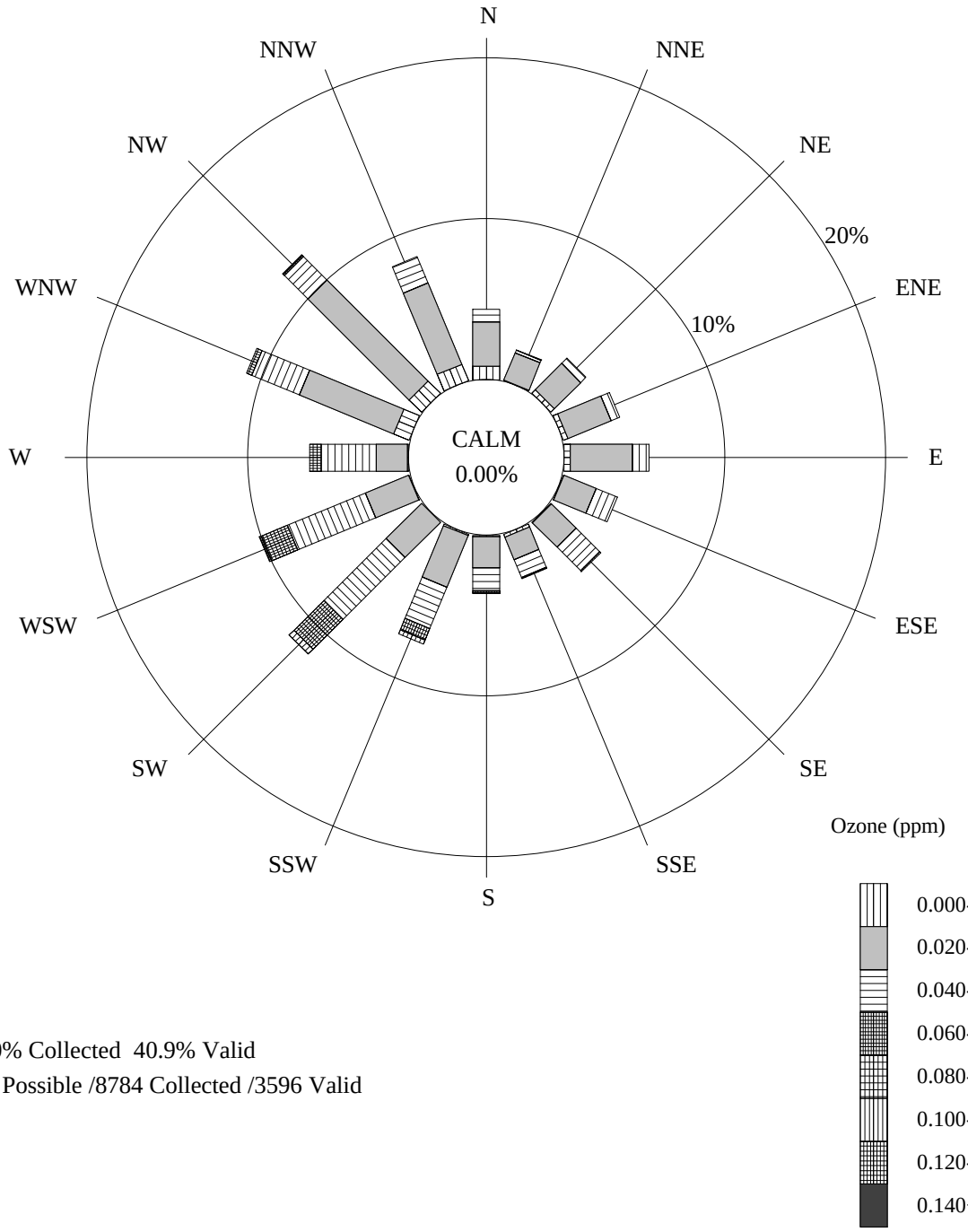


100.0% Collected 89.7% Valid
2208 Possible /2208 Collected /1981 Valid

FOURTH QUARTER (OCT-DEC)



100.0% Collected 0.0% Valid
2208 Possible /2208 Collected /0 Valid



100.0% Collected 40.9% Valid
8784 Possible /8784 Collected /3596 Valid

Ozone Precision Check Summary

Acadia National Park
Cadillac Mountain

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 (between 0.08 and 0.10 ppm for ozone and sulfur dioxide) 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 01/01/2000 - 12/31/2000				
Calendar Quarter	Number of Precision Checks	Average Percent Difference [1] [2]	Lower 95% Probability Limit [3]	Upper 95% Probability Limit [3]
1	0			
2	10	0.40	-2.69	3.49
3	6	0.00	-1.24	1.24
4	0			

[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

Acadia National Park

Cadillac Mountain

Final Validation

01/01/2000 - 12/31/2000

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	5.7	m/s	3836	2.7
Maximum	18.6	m/s		
Percent calm = 0.00				
AMBIENT TEMPERATURE				
Average	11.6	degC	4254	5.9
Maximum	26.5	degC		
Minimum	-4.3	degC		
RELATIVE HUMIDITY				
Average	81	percent	4254	21
Maximum	100	percent		
Minimum	25	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	NA			
Maximum Daily Total				
Minimum Daily Total				

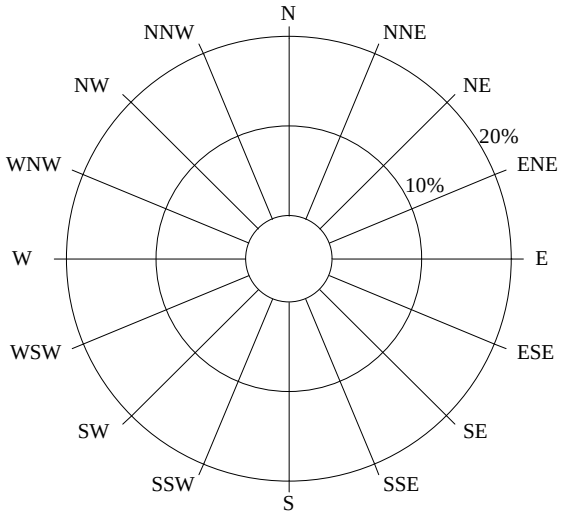
Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

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.

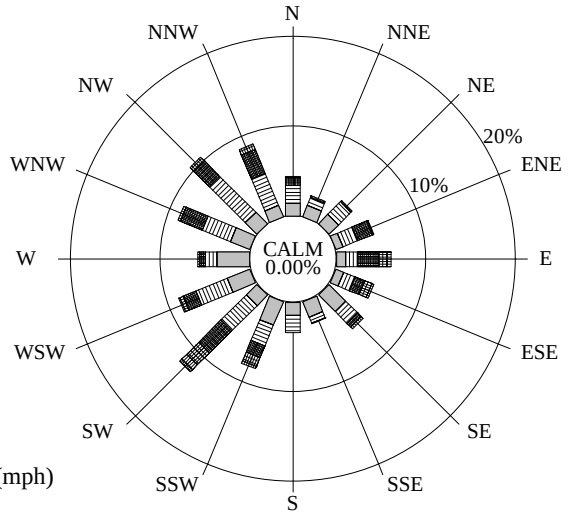
Acadia National Park Quarterly Wind Rose 2000
Cadillac Mountain

FIRST QUARTER (JAN-MAR)



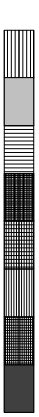
100.0% Collected 0.0% Valid
2184 Possible /2184 Collected /0 Valid

SECOND QUARTER (APR-JUN)



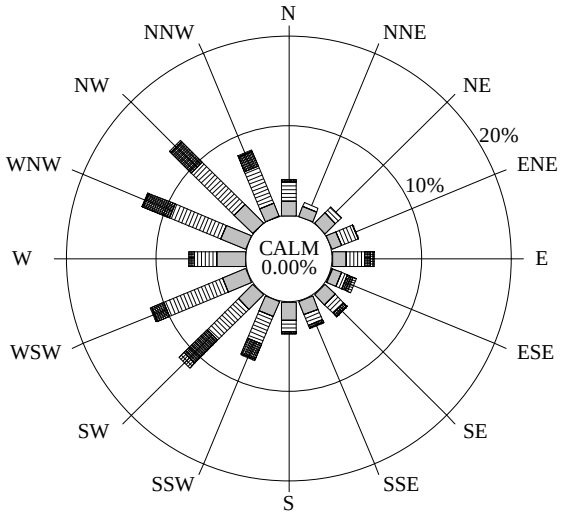
100.0% Collected 77.8% Valid
2184 Possible /2184 Collected /1700 Valid

Scalar Wind Speed (mph)



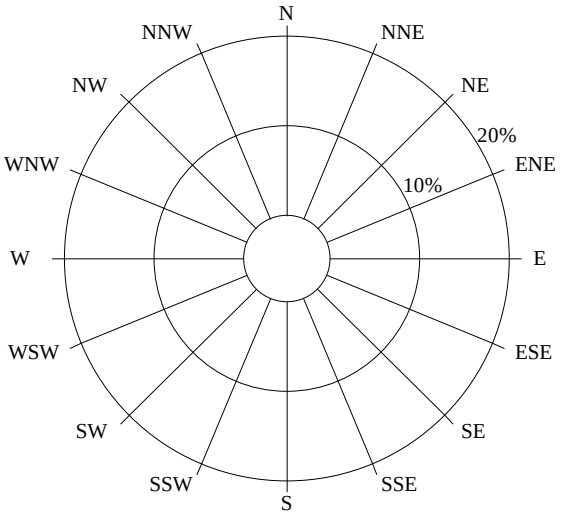
CALM < 1
1.0-1.9
2.0-8.9
9.0-15.9
16.0-22.9
23.0-29.9
30.0-36.9
37.0-43.9
44.0+

THIRD QUARTER (JUL-SEP)



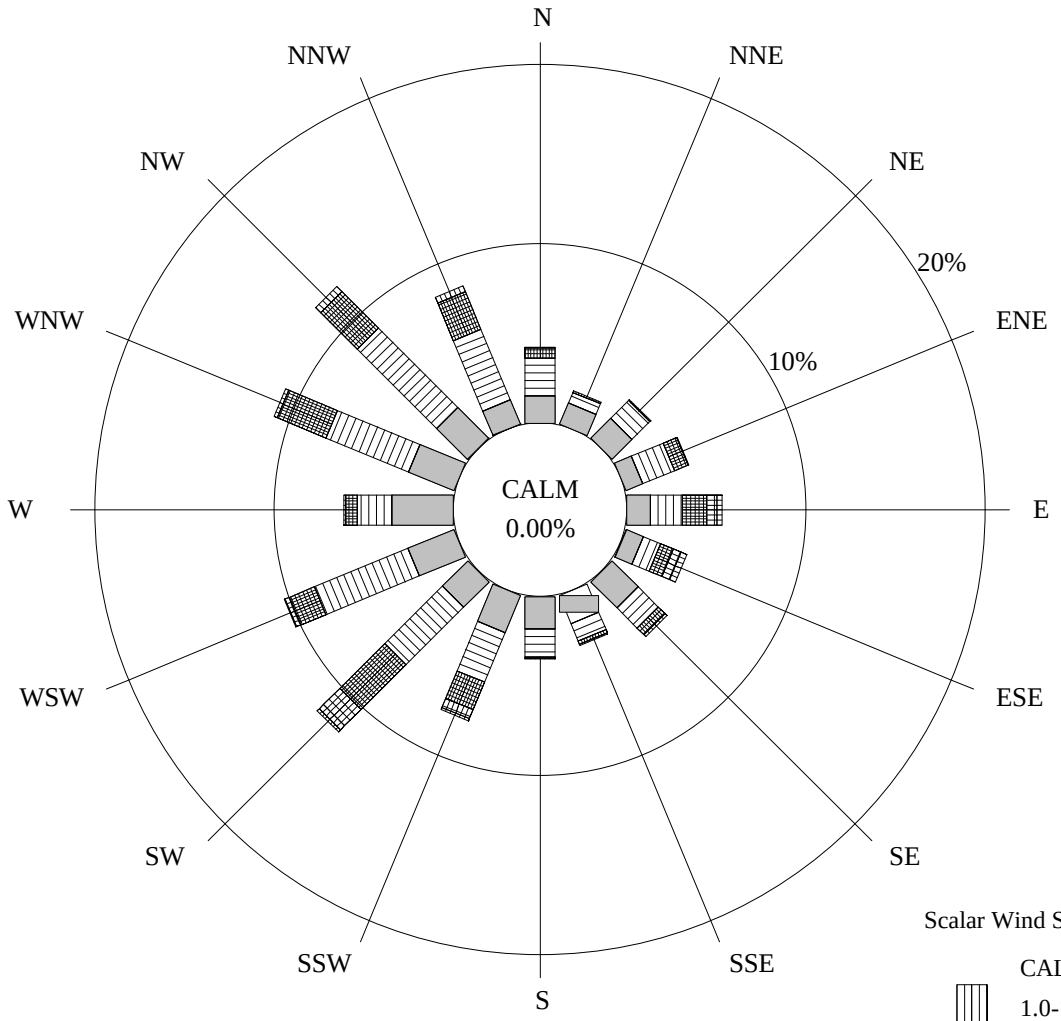
100.0% Collected 96.7% Valid
2208 Possible /2208 Collected /2136 Valid

FOURTH QUARTER (OCT-DEC)



100.0% Collected 0.0% Valid
2208 Possible /2208 Collected /0 Valid

Final Validation 05-22-2001



Scalar Wind Speed (mph)

- CALM < 1
- 1.0-1.9
- 2.0-8.9
- 9.0-15.9
- 16.0-22.9
- 23.0-29.9
- 30.0-36.9
- 37.0-43.9
- 44.0+

100.0% Collected 43.7% Valid
8784 Possible /8784 Collected /3836 Valid

3.0 NATIONAL PARK SERVICE AIR RESOURCES DIVISION DATA SOURCES

3.1 GUIDE TO ATTACHED DATA DISKS

Data disks containing ASCII files of the validated hourly data, as shown in the following table are available. Please return the enclosed postcard or contact the address below. These data may be imported into other programs to perform additional data processing and analysis. The data format of each file is included within each file. The second table describes the validation codes used in the data tables to indicate why data are missing or invalid. Wind and pollutant frequency distribution tables in ASCII format are also included on the diskette if available for this site.

Data users should acknowledge the National Park Service Air Resources Division whenever using these data or any portion of this report.

3.2 OTHER SOURCES FOR RETRIEVING NATIONAL PARK SERVICE GASEOUS POLLUTANT DATA

The data contained in this report may also be obtained from the following sources:

- National Park Service AIRWeb (http://www.aqd.nps.gov/natnet/ard) - available after last quarter 2000
- 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

Data Disk Contents Summary	
File Name (s)	Description
Hourly	
ssssyy.DAT	All Validated Air Quality Data
ssssyymm.ppp	Monthly Data Summary Tables
ssssAN95.Rpp	Annual Wind and Pollutant Frequency Distribution
ssssQ195.Rpp	Quarter 1 Wind and Pollutant Frequency Distribution
ssssQ295.Rpp	Quarter 2 Wind and Pollutant Frequency Distribution
ssssQ395.Rpp	Quarter 3 Wind and Pollutant Frequency Distribution
ssssQ495.Rpp	Quarter 4 Wind and Pollutant Frequency Distribution
Where: ssss = site code yy = year mm = month ppp = air quality data parameter code AN = Annual Qn = Quarter 1-4 R = Wind Frequency distribution table	

CASTNet Weekly Species Summary Data	
File Name (s)	Description
CASTNet	
ssssCNyr.ASC	Weekly averages
Where: ssss = site code CN = CASTNet yr = year asc = ascii file	

NPS IMC and AIRS Invalid Data Codes			
NPS IMC VAL CODE	REASON	AIRS CODE	AIRS REASON
TO	Sample time out of limits	9973	Sample time out of limits
IW	Instrument warmup	9978	Voided by operator
OE	Operator error	9978	
BM	Begin monitoring	9979	Miscellaneous void
TL	Station temp low	9979	
OS	Off scale	9979	
EM	End monitoring	9979	
LI	Local interference	9979	
TH	Station temp high	9979	
IM	Instrument malfunction	9980	Machine malfunction
IN	Interference	9981	Bad weather
RF	Recording system failure	9983	Collection error
NA	No data	9987	Monitoring waived
PF	Power failure	9988	Power Failure
PC	Precision check	9990	Precision Check
ZS	Instrument zero/span check	9991	QC Control Points (Zero/Span)
SA	System audit	9992	QC Audit
PA	Performance audit	9992	
MT	Maintenance	9993	Maintenance/Routine Repairs
OR	Out for repair	9993	
CA	Calibration	9995	Multipoint calibration
SC	Station check	9998	Precision/zero/span

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.

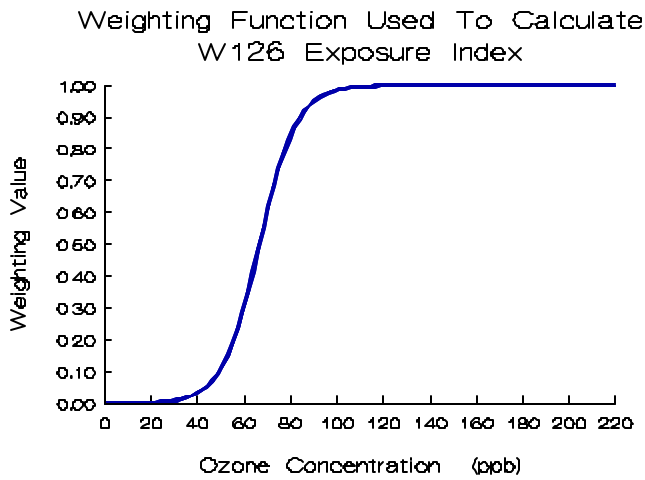
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to 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 not 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	2.237	mph
	mph	0.4470	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