Report No. NPS D-262

Annual Data Summary

BIG BEND NATIONAL PARK

2002

National Park Service
Gaseous Air Pollutant Monitoring Network

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

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

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

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

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

or

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

ACKNOWLEDGEMENTS

The National Park Service Air Resources Division (ARD) recognizes the level of effort required by individual park units, site operators, auditors, cooperating state and local agencies, and ARD contractors. ARD sincerely appreciates the contributions of all participants in assisting with the collection, validation, and reporting of these air quality and meteorological data.

At Big Bend National Park, the ARD specifically recognizes John Forsythe 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	Big Bend National Park	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
	2.4	Dry Deposition Data Summary	2-27
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 Rose	2-21
Ozone Precision Check Data Summary	2-22
Summary of Selected Meteorological Data	2-24
Quarterly Wind Roses	2-25
Annual Wind Rose	2-26
Quarterly and Annual Average Concentrations	2-28
Weekly Concentrations Report	2-29
Three Year Comparison of Maximum and Average Concentrations	2-30
Average Particulate Nitrate Concentrations	2-31
Nitric Acid Concentrations	2-32

LIST OF FIGURES AND TABLES (Continued)

	Page
Average Total Nitrate Concentrations	2-33
Average Ammonium Concentrations	2-34
Average Particulate Sulfate Concentrations	2-35
Average Sulfur Dioxide Concentrations	2-36
SO_4/SO_2 Ratio	2-37

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.

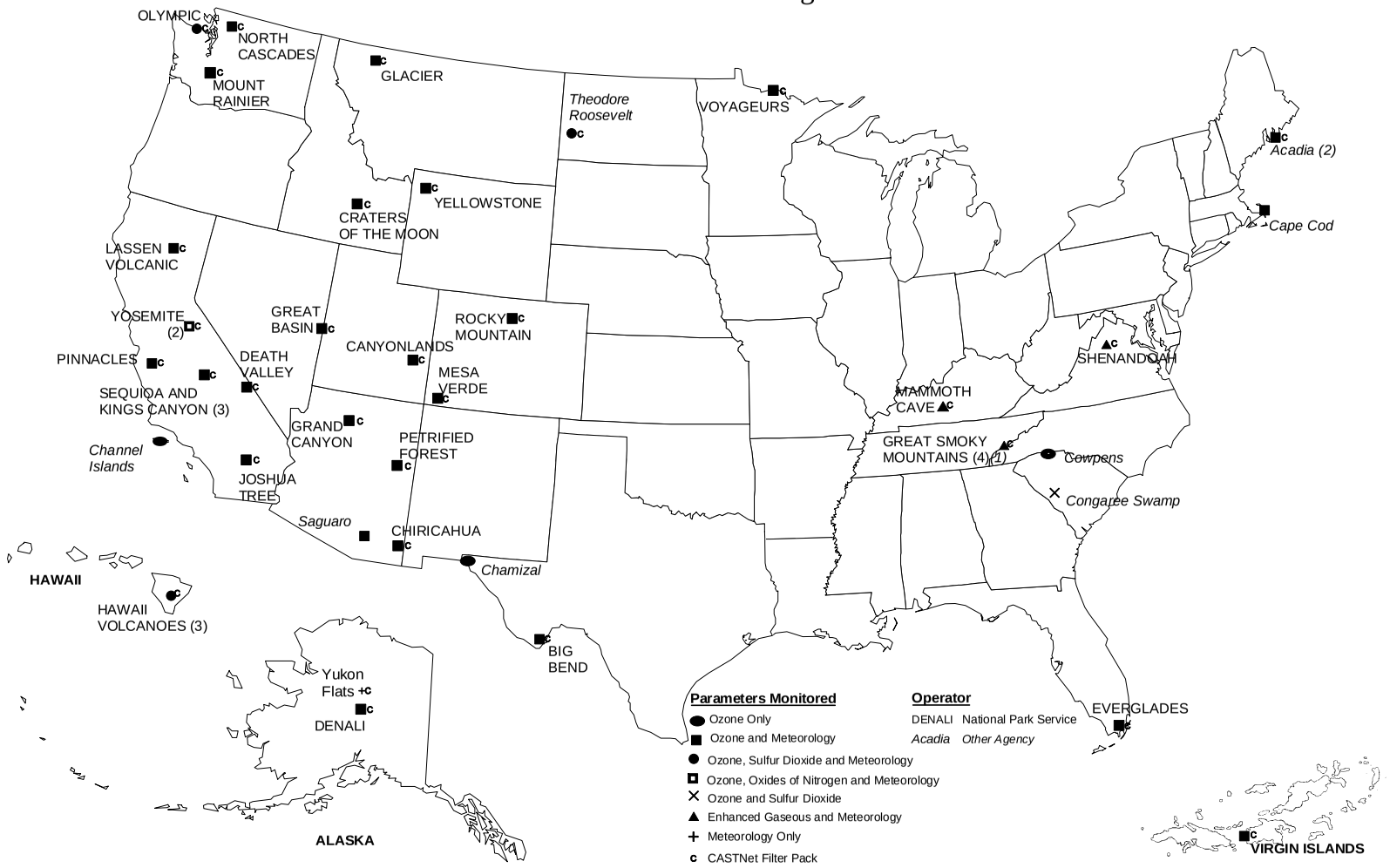
Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The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

Big Bend National Park, a Class I area, is located in southwest Texas. The Rio Grande defines the park's southern boundary for over 100 miles. Its location and site specifications are presented on the following page.

Big Bend National Park was authorized by an act of Congress in 1935 which provided that "...lands...as necessary for recreational park purposes...are hereby established, dedicated, and set apart as a public park for the benefit and enjoyment of the people..." The act also stipulated that the provisions of the National Park Service Organic Act of 1916 apply "...which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The park was formally established in 1944. In 1976, it was designated a Biosphere Reserve.

The park is a nationally significant example of the finest and most scenic Chihuahuan Desert and mountain topography in the United States. It is a land of dramatic contrasts--of lofty, wooded peaks, and river swept floodplains--dominated by great expanses of desertscape, containing spectacular geologic features and other impressive landforms.

Complementing the distinctive topography is an unusual array of plant and animal life, corresponding in diversity to the multitude of habitat types provided by the broad elevation range. Over 1000 species of plants, 60 of mammals, 350 of birds, and 40 of reptiles are known to inhabit the area, including many that are endangered and threatened.

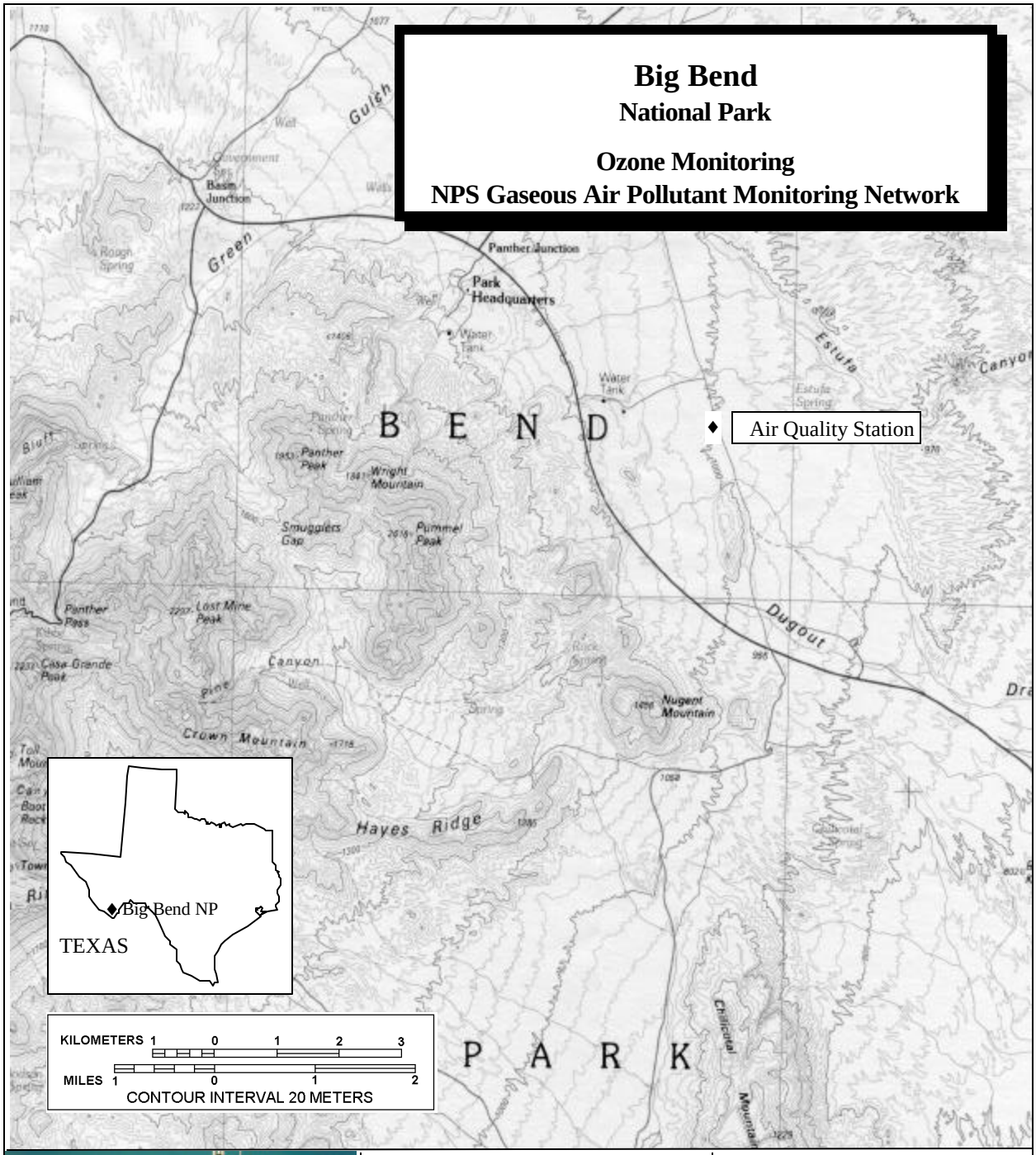
The Chisos Mountains visually dominate the central portion of the park. They are the southernmost mountain mass in the United States, and are the only mountain range totally contained within a unit of the National Park System.

For 107 miles, the Rio Grande defines the southern boundary of the park. The ribbon of shoreline and floodplain vegetation provides a contrast to the harsh desert adjoining the river. Three great canyons sever three limestone mesas within the sweeping arc of this river. Viewed from their rims or from the river, these canyons are among the most outstanding features in the park.

Throughout much of the park, visitors are aware of the presence of the northern frontier of Mexico. From the South Rim in the Chisos Mountains, a 200-mile sweep of American and Mexican terrain may be viewed. The entire region, on both sides of the Rio Grande, is rich in history and cultural interest.

Big Bend
National Park

Ozone Monitoring
NPS Gaseous Air Pollutant Monitoring Network



SITE IDENTIFCATION	
Site Abbreviation:	BIBE
AIRS ID NO.:	48-043-0101

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

MAP INFORMATION	
Mean Elevation:	1052 m
Longitude:	103° 10' 38"W
Latitude:	29° 18' 8"N
UTM Zone:	13
Easting:	667040 m
Northing:	3242668 m
Map Reference:	Chisos Mountains 29103-A1 1:100,000

2.0 DATA SUMMARY

2.1 OVERVIEW

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

Data Collection Statistics
Big Bend National Park

Final Validation

01/01/2002 - 12/31/2002

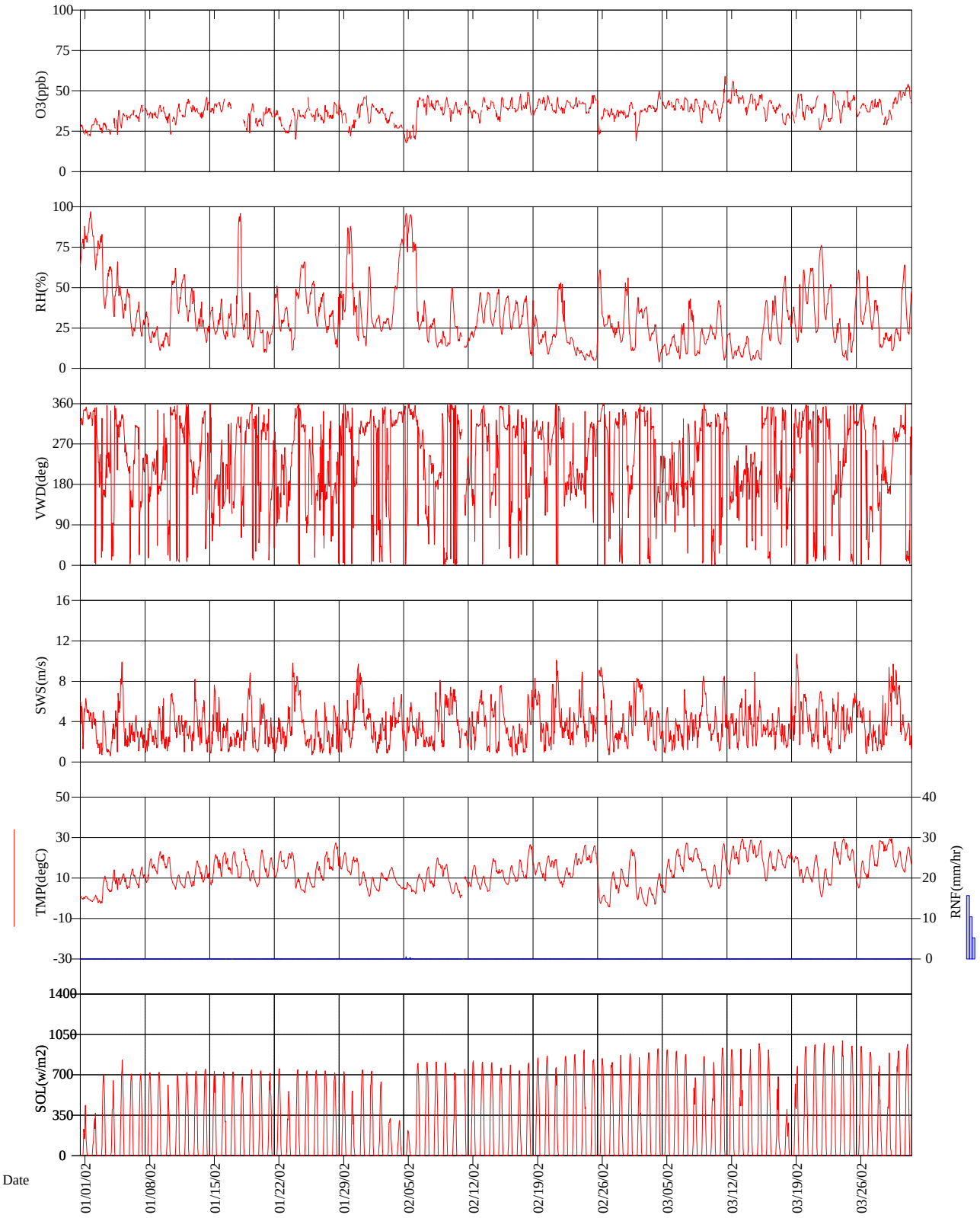
Parameter	Interval	Par Code	Data Recovery			Valid Data	
			No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	hourly	O3	8760	7901	90.2	7883	90.0
Scalar Wind Speed	hourly	SWS	8760	8692	99.2	8005	91.4
Vector Wind Speed	hourly	VWS	8760	8692	99.2	8005	91.4
Vector Wind Direction	hourly	VWD	8760	8692	99.2	8005	91.4
Standard Deviation for Wind Direction	hourly	SDWD	8760	8692	99.2	8005	91.4
Ambient Temperature (aspirated)	hourly	TMP	8760	8688	99.2	8671	99.0
Delta Temperature	hourly	DTP	8760	8688	99.2	8671	99.0
Relative Humidity	hourly	RH	8760	8699	99.3	8699	99.3
Precipitation	hourly	RNF	8760	8644	98.7	8644	98.7
Wetness Sensor	hourly	WET	8760	8656	98.8	8618	98.4
Solar Radiation	hourly	SOL	8760	8689	99.2	8689	99.2
Filter Pack Flow Rate	hourly	FLOW	8760	8699	99.3	8699	99.3

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

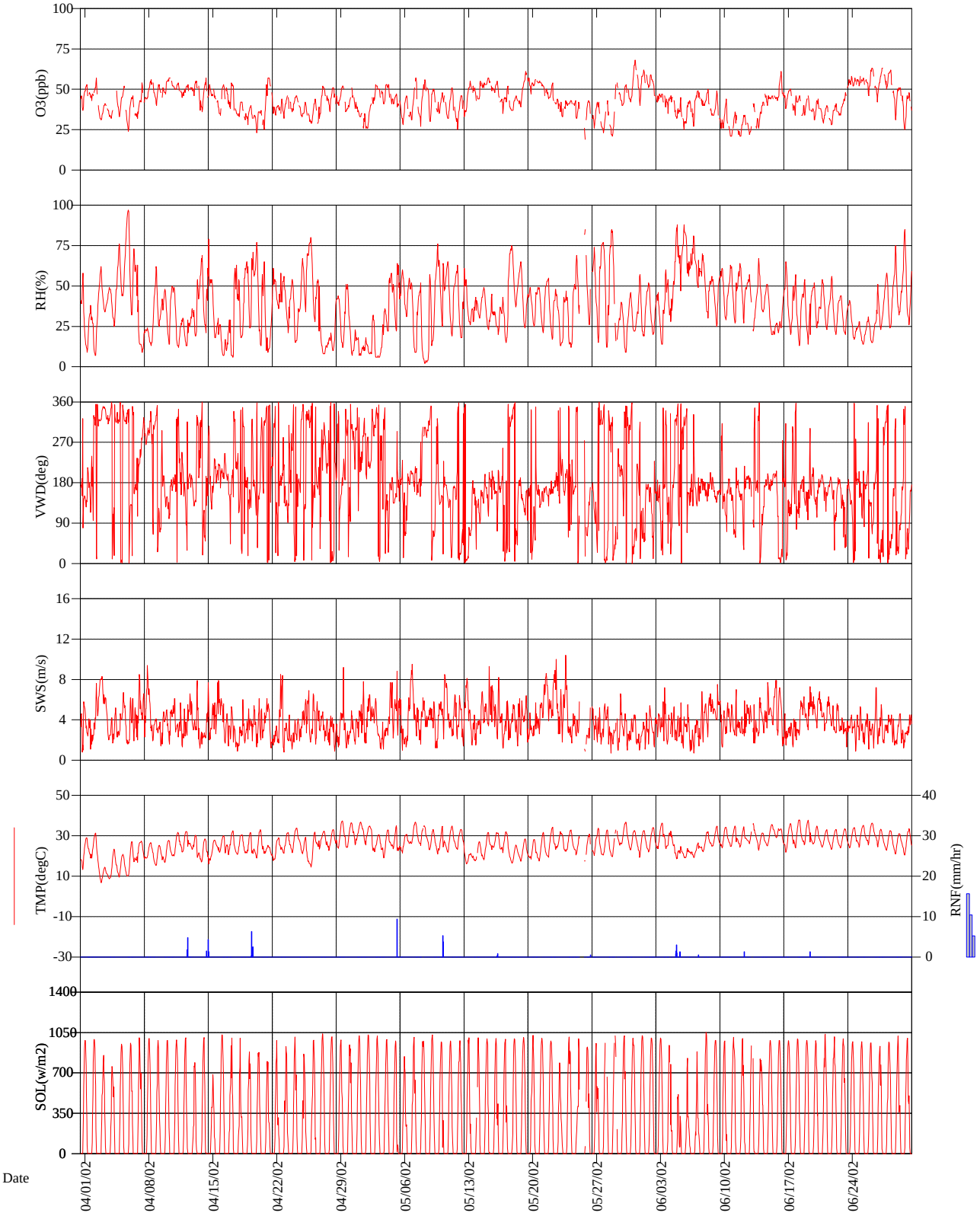
Big Bend National Park



Final Validation

First Quarter 2002

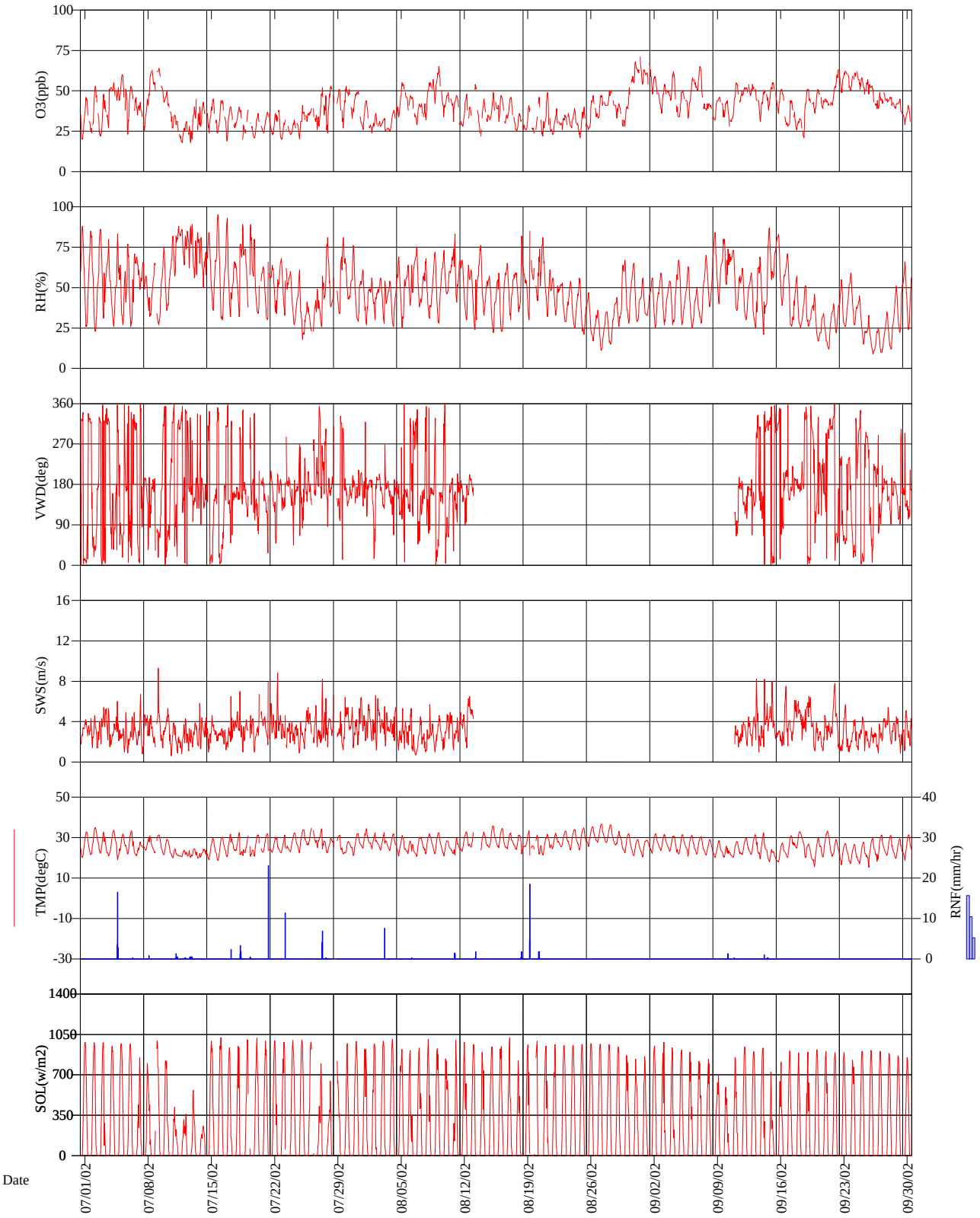
Big Bend National Park



Final Validation

Second Quarter 2002

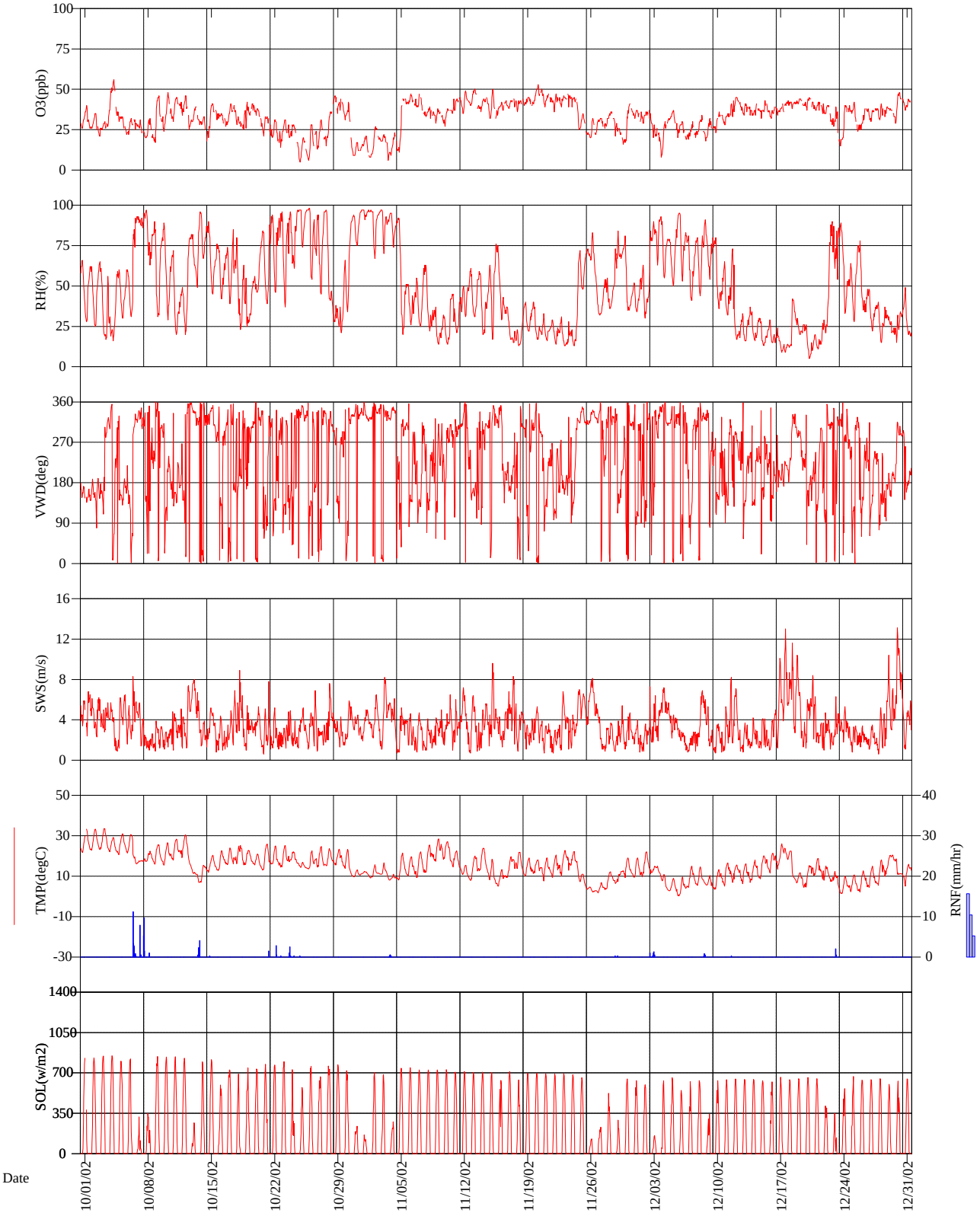
Big Bend National Park



Final Validation

Third Quarter 2002

Big Bend National Park



Final Validation

Fourth Quarter 2002

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Big Bend National Park

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	47	49	59	57	68	63	64	71	67	56	53	48	71	71
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
AVERAGE DAILY MAXIMUM	40	43	46	50	51	49	46	46	53	37	41	39	49	45
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(31)	(153)	(365)
MAXIMUM DAILY MEAN	41	43	50	53	54	56	59	61	60	44	46	42	61	61
NO. OF DAYS	(27)	(27)	(31)	(29)	(29)	(30)	(29)	(30)	(30)	(31)	(30)	(31)	(148)	(354)
AVERAGE DAILY MEAN	34	38	40	43	43	42	36	38	46	30	35	34	41	38
NO. OF DAYS	(27)	(27)	(31)	(29)	(29)	(30)	(29)	(30)	(30)	(31)	(30)	(31)	(148)	(354)
MAX PEAK:MIN RATIO	1.950	2.300	2.000	2.280	2.571	1.920	2.520	2.227	2.429	4.667	4.000	3.750	2.571	4.667
NO. OF DAYS	(27)	(27)	(31)	(29)	(29)	(30)	(29)	(30)	(30)	(31)	(30)	(31)	(148)	(354)
AVERAGE PEAK:MIN RATIO	1.415	1.342	1.378	1.446	1.515	1.470	1.853	1.591	1.446	1.903	1.646	1.507	1.573	1.545
NO. OF DAYS	(27)	(27)	(31)	(29)	(29)	(30)	(29)	(30)	(30)	(31)	(30)	(31)	(148)	(354)
MAX 9AM-4PM AVERAGE	42	46	52	54	57	59	62	65	61	51	50	45	65	65
NO. OF DAYS	(29)	(27)	(31)	(29)	(30)	(29)	(30)	(30)	(30)	(31)	(29)	(31)	(149)	(356)
MONTHLY 9AM-4PM AVERAGE	36	39	42	45	45	45	40	40	49	32	36	34	44	40
NO. OF DAYS	(29)	(27)	(31)	(29)	(30)	(29)	(30)	(30)	(30)	(31)	(29)	(31)	(149)	(356)
MAX 7AM-7PM AVERAGE	43	45	51	54	57	58	61	63	61	50	49	43	63	63
NO. OF DAYS	(27)	(27)	(31)	(29)	(31)	(30)	(30)	(30)	(30)	(31)	(30)	(31)	(151)	(357)
MONTHLY 7AM-7PM AVERAGE	35	39	41	45	44	44	39	40	48	31	36	34	43	40
NO. OF DAYS	(27)	(27)	(31)	(29)	(31)	(30)	(30)	(30)	(30)	(31)	(30)	(31)	(151)	(357)
MONTHLY MEAN	34	38	40	43	43	42	36	38	46	30	35	34	41	38
NO. OF HOURS	(636)	(605)	(680)	(647)	(660)	(653)	(657)	(666)	(659)	(686)	(654)	(680)	(3295)	(7883)
SUM0 EXPOSURE INDEX	21815	22947	27286	27732	28489	27659	23913	25160	30279	20297	22660	23045	135500	301282
NO. OF HOURS	(636)	(605)	(680)	(647)	(660)	(653)	(657)	(666)	(659)	(686)	(654)	(680)	(3295)	(7883)
SUM60 EXPOSURE INDEX	-	-	-	-	577	1473	985	1270	2910	-	-	-	7215	7215
NO. OF HOURS	(0)	(0)	(0)	(0)	(9)	(24)	(16)	(20)	(47)	(0)	(0)	(0)	(116)	(116)
SUM80 EXPOSURE INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
W126 EXPOSURE INDEX	488	793	1261	2045	2450	2615	1443	1644	3623	434	849	560	11775	18205
NO. OF HOURS	(636)	(605)	(680)	(647)	(660)	(653)	(657)	(666)	(659)	(686)	(654)	(680)	(3295)	(7883)

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

* Statistics defined in the Quick Look subsection of the Glossary

Frequency Distribution

Big Bend National Park

Monitoring Season: 01/01/02 - 12/31/02[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	97	7883	0.017	0.035	0.041	0.045	0.049	0.056	0.061	0.066	0.071	0.068	0.0451	0.0442	1.22

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)

Big Bend National Park

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	.029	T	.042	F	.043	F	.053	M	.042	W	.062	S	.046	M	.044	T	.067	S	.040	T	.021	F	.038	S
2	.033	W	.039	S	.038	S	.057	T	.045	T	.059	S	.053	T	.036	F	.066	M	.035	W	.027	S	.037	M
3	.030	T	.037	S	.041	S	.041	W	.053	F	.047	M	.048	W	.033	S	.054	T	.030	T	.022	S	.035	T
4		F	.029	M	.050	M		T	.053	S	.046	T	.055	T	.040	S	.062	W	.056	F	.023	M	.030	W
5	.038	S	.027	T	.044	T	.052	F	.047	S	.045	W	.060	F	.055	M	.050	T	.036	S	.044	T	.037	T
6	.038	S	.046	W	.045	W	.046	S	.046	M	.043	T	.053	S	.047	T	.058	F	.032	S	.047	W	.030	F
7	.041	M	.047	T	.046	T	.054	S	.057	T	.049	F	.046	S	.042	W	.065	S	.031	M	.047	T	.030	S
8	.039	T	.044	F	.045	F	.056	M	.056	W	.050	S	.063	M	.055	T	.042	S	.032	T	.039	F	.034	S
9	.041	W	.046	S	.044	S	.053	T	.050	T	.049	S	.064	T	.065	F	.046	M	.046	W	.038	S	.032	M
10	.040	T	.043	S	.044	S	.057	W	.048	F	.044	M	.052	W	.049	S	.044	T	.048	T	.038	S	.036	T
11	.042	F		M	.059	M	.055	T	.051	S	.036	T	.037	T	.047	S	.055	W	.045	F	.044	M	.035	W
12	.045	S	.040	T	.056	T	.053	F	.046	S	.034	W	.031	F	.048	M	.054	T	.046	S	.049	T	.045	T
13	.041	S	.046	W	.051	W	.055	S	.055	M	.041	T	.045	S		T	.054	F	.039	S	.050	W	.042	F
14	.046	M	.044	T	.048	T	.057	S	.055	T	.047	F	.043	S	.045	W	.050	S	.033	M	.045	T	.041	S
15	.042	T	.046	F	.048	F	.053	M	.057	W	.046	S	.045	M	.049	T	.055	S	.041	T	.050	F	.043	S
16		W	.046	S	.044	S	.053	T	.055	T	.061	S	.044	T	.047	F	.051	M	.037	W	.042	S	.039	M
17		T	.048	S	.042	S	.054	W	.052	F	.050	M	.040	W	.046	S	.044	T	.041	T	.044	S	.041	T
18		F	.049	M	.037	M	.042	T	.046	S	.046	T	.040	T	.036	S	.037	W	.040	F	.044	M	.043	W
19	.042	S	.045	T	.048	T	.040	F	.061	S	.046	W		F	.041	M	.051	T	.042	S	.045	T	.044	T
20	.037	S	.047	W	.048	W	.037	S	.057	M	.044	T	.036	S	.046	T	.051	F	.041	S	.053	W	.045	F
21	.040	M	.046	T	.047	T	.057	S	.055	T	.040	F	.037	S	.049	W	.045	S	.033	M	.050	T	.042	S
22	.038	T	.044	F	.042	F	.045	M	.054	W	.041	S	.038	M	.039	T	.063	S	.031	T	.047	F	.041	S
23	.038	W	.046	S	.050	S	.046	T	.044	T	.051	S	.036	T	.035	F	.062	M	.031	W	.047	S	.039	M
24	.039	T	.043	S	.049	S	.046	W	.043	F	.058	M	.032	W	.039	S	.062	T	.028	T	.046	S	.040	T
25	.046	F	.047	M	.050	M	.042	T		S	.058	T	.041	T	.040	S	.060	W	.020	F	.040	M	.042	W
26	.039	S	.044	T	.042	T	.044	F	.043	S	.063	W		F	.047	M	.057	T	.028	S	.032	T	.038	T
27	.041	S	.039	W	.044	W	.052	S	.042	M	.063	T	.052	S	.047	T	.049	F	.031	S	.032	W	.038	F
28	.043	M	.038	T	.045	T	.051	S	.043	T	.062	F	.053	S	.050	W	.048	S	.041	M	.036	T	.041	S
29	.044	T			.039	F	.052	M	.054	W	.051	S	.051	M	.042	T	.045	S	.046	T	.032	F	.039	S
30	.036	W			.050	S	.051	T	.053	T	.048	S	.053	T	.055	F	.041	M	.042	W	.041	S	.048	M
31	.047	T			.054	S			.068	F			.050	W	.071	S			.017	T				
Valid Days	27		27		31		29		30		30		29		30		30		31		30		30	
Maximum	.047		.049		.059		.057		.068		.063		.064		.071		.067		.056		.053		.048	
Violations	0		0		0		0		0		0		0		0		0		0		0		0	

7861 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])	
90.0 % Possible	7 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

Big Bend National Park

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

Ozone Season: January through December

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	62	88%	No	65	65	62	62	62

Ozone Analyzer

10 Highest Daily 1-Hour Average Maximum Concentrations
Big Bend National Park

Final Validation
01/01/2002 - 12/31/2002

Value	Date	Hour	Concentration (ppb)
Ozone Analyzer			
1	08/31/2002	23	71
2	05/31/2002	17	68*
3	09/01/2002	0	67*
4	09/02/2002	0	66
5	08/09/2002	16	65
6	09/07/2002	13	65*
7	07/09/2002	17	64
8	06/26/2002	15	63*
9	06/27/2002	18	63*
10	07/08/2002	23	63**

* 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

Big Bend National Park

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
Big Bend National Park

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).

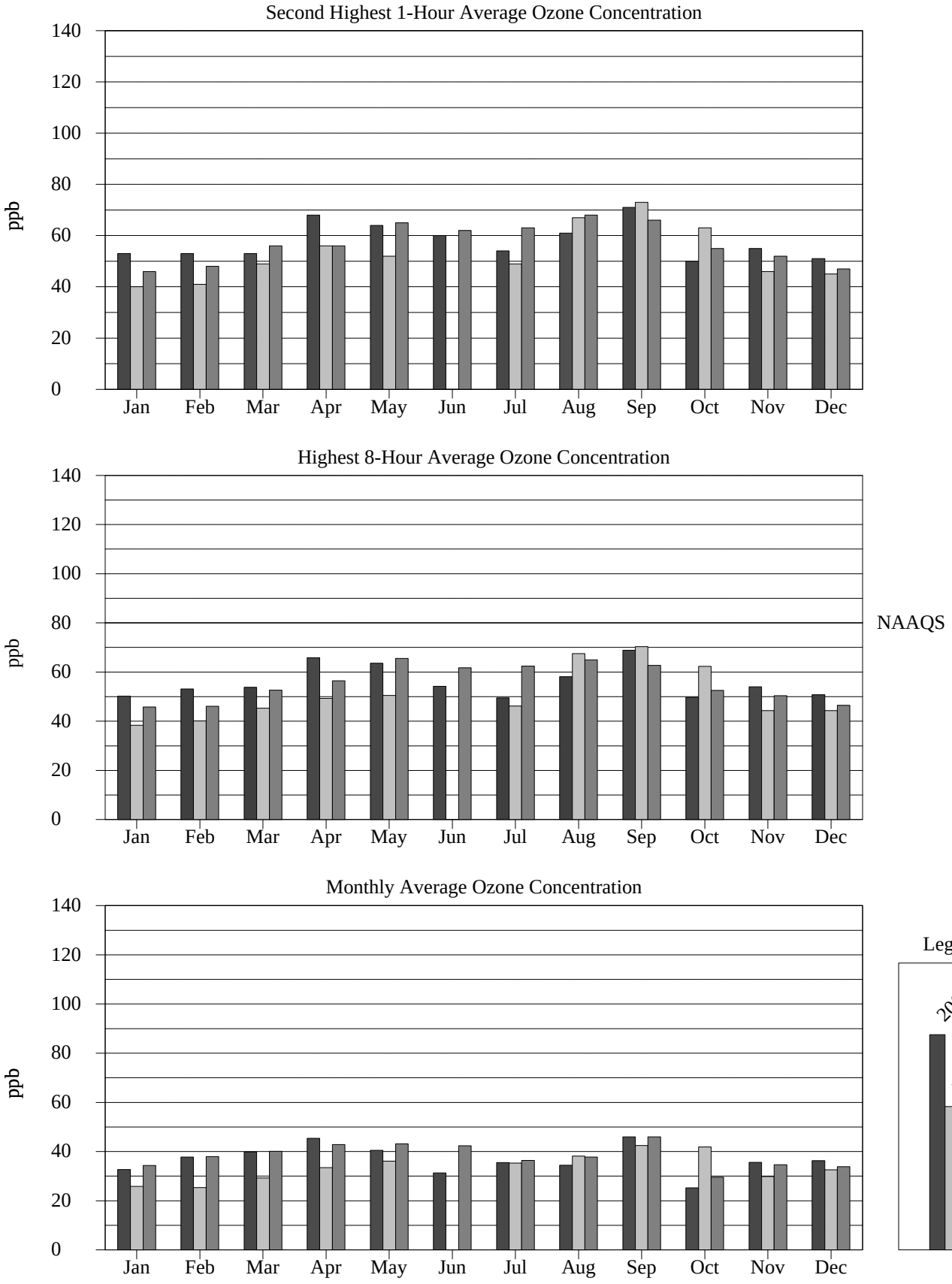
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

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

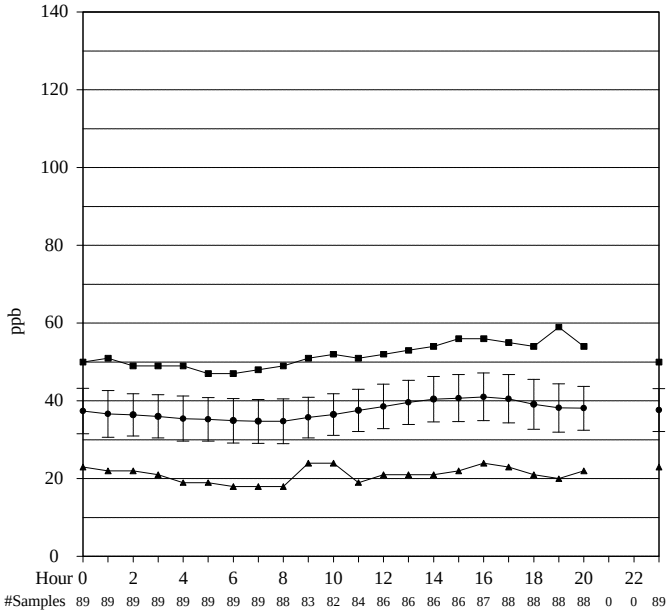
Annual Sum60 Exposure Index			
Site	Rank	Sum60	Count
SEKI-LK	1	204306	2639
SEKI-AS	2	196849	2529
SEKI-LP	3	193795	2491
JOTR-YV	4	175177	2398
GRSM-CM	5	169849	2320
YOSE-TD	6	164764	2298
GRSM-LR	7	131936	1794
GRSM-CD	8	130649	1793
GRSM-PK	9	118538	1656
DEVA-PV	10	106174	1586
GRCA-AS	11	104360	1584
ROMO-LP	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
Highest 8-Hour Average Ozone Concentration
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
NAAQS
Legend
2000
2001
2002

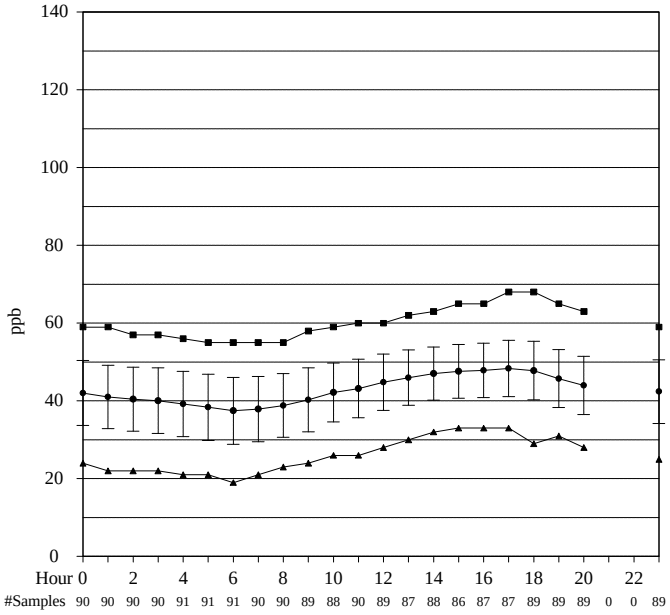
NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK

2002 Second Highest 1-Hour Ozone Concentrations

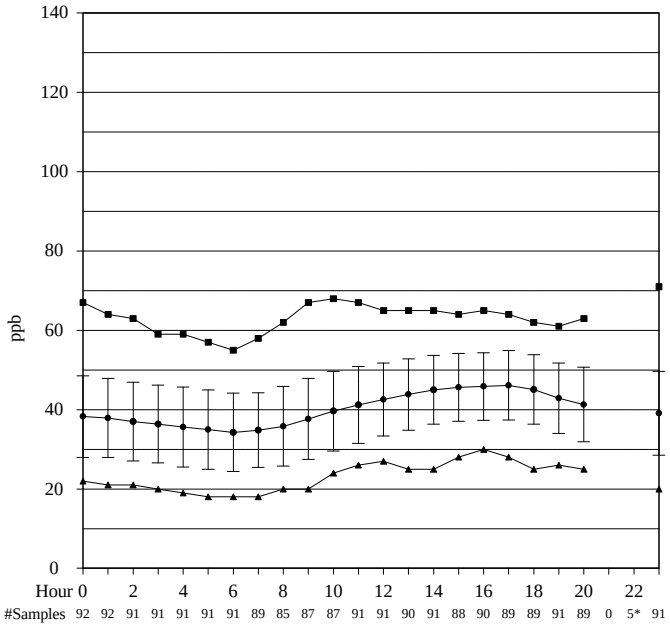
FIRST QUARTER (JAN-MAR)



SECOND QUARTER (APR-JUN)

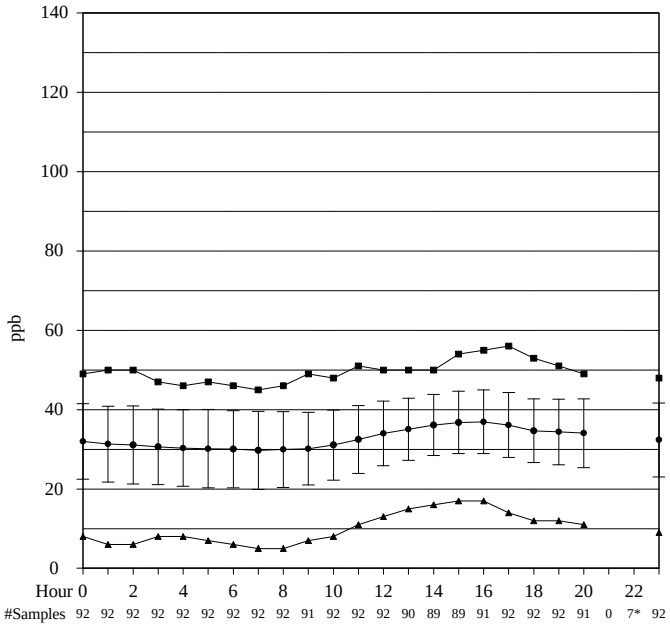


THIRD QUARTER (JUL-SEP)

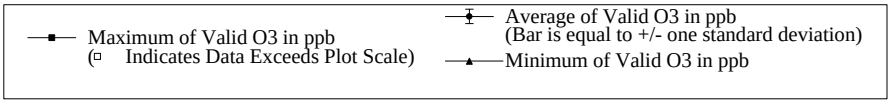


* Number of samples < 20% of maximum available hours during period

FOURTH QUARTER (OCT-DEC)



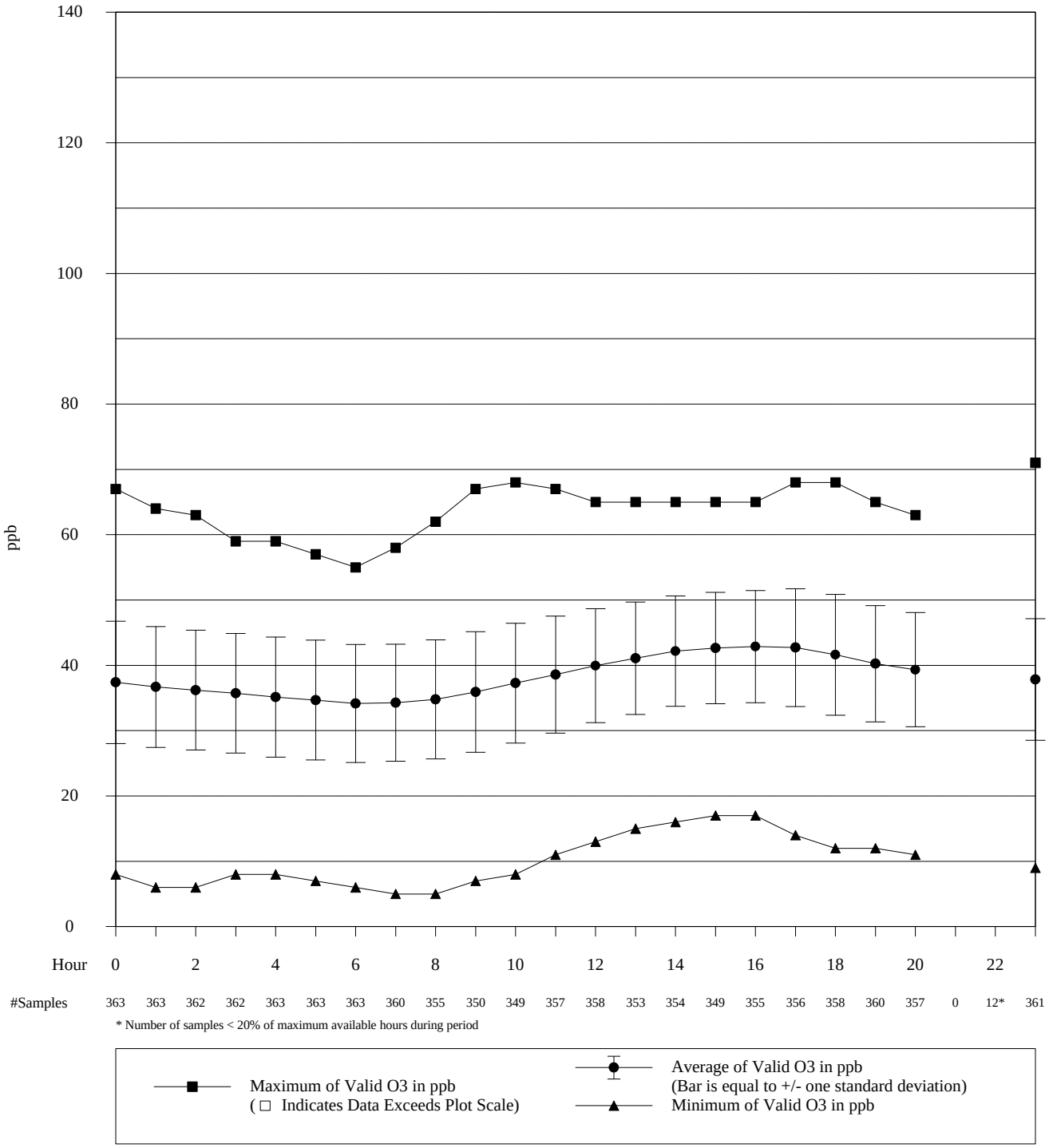
* Number of samples < 20% of maximum available hours during period



Big Bend National Park
K-Bar Ranch Road

Annual Diurnal
Ozone Plot

2002

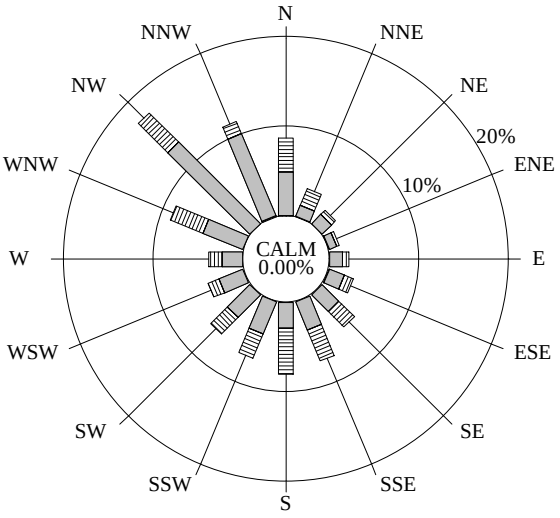


Final Validation

04-18-2003

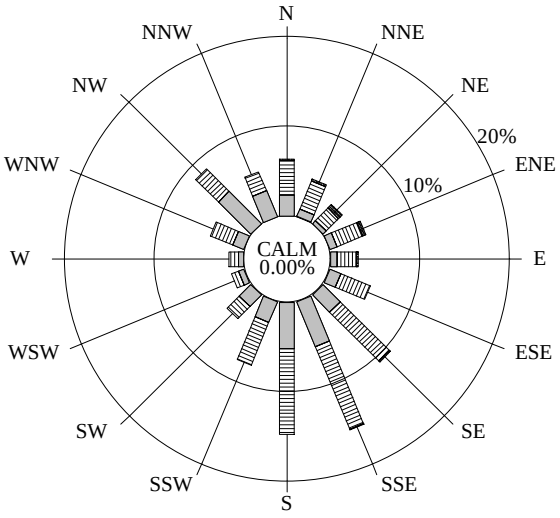
Big Bend National Park Quarterly Ozone Pollutant Rose 2002

FIRST QUARTER (JAN-MAR)



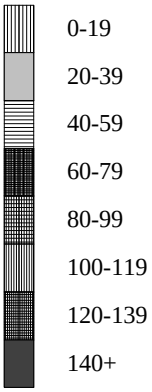
89.2% Collected 88.9% Valid
2160 Possible /1926 Collected /1921 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)

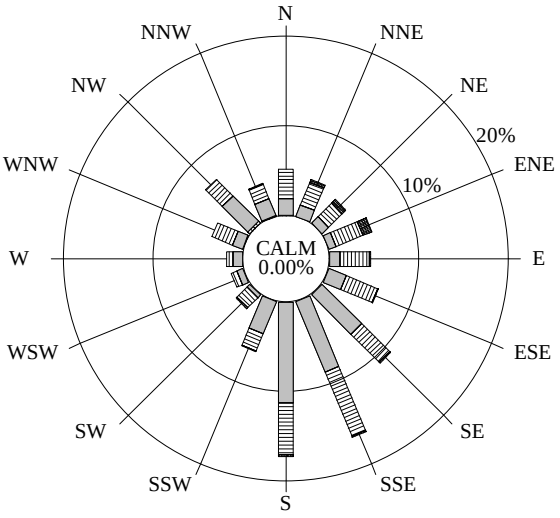


90.1% Collected 89.7% Valid
2184 Possible /1967 Collected /1958 Valid
(includes WS and WD)

Ozone (ppb)

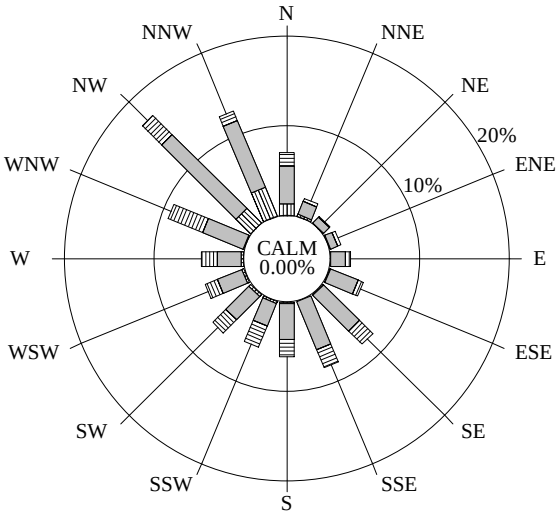


THIRD QUARTER (JUL-SEP)



89.9% Collected 61.5% Valid
2208 Possible /1985 Collected /1358 Valid
(includes WS and WD)

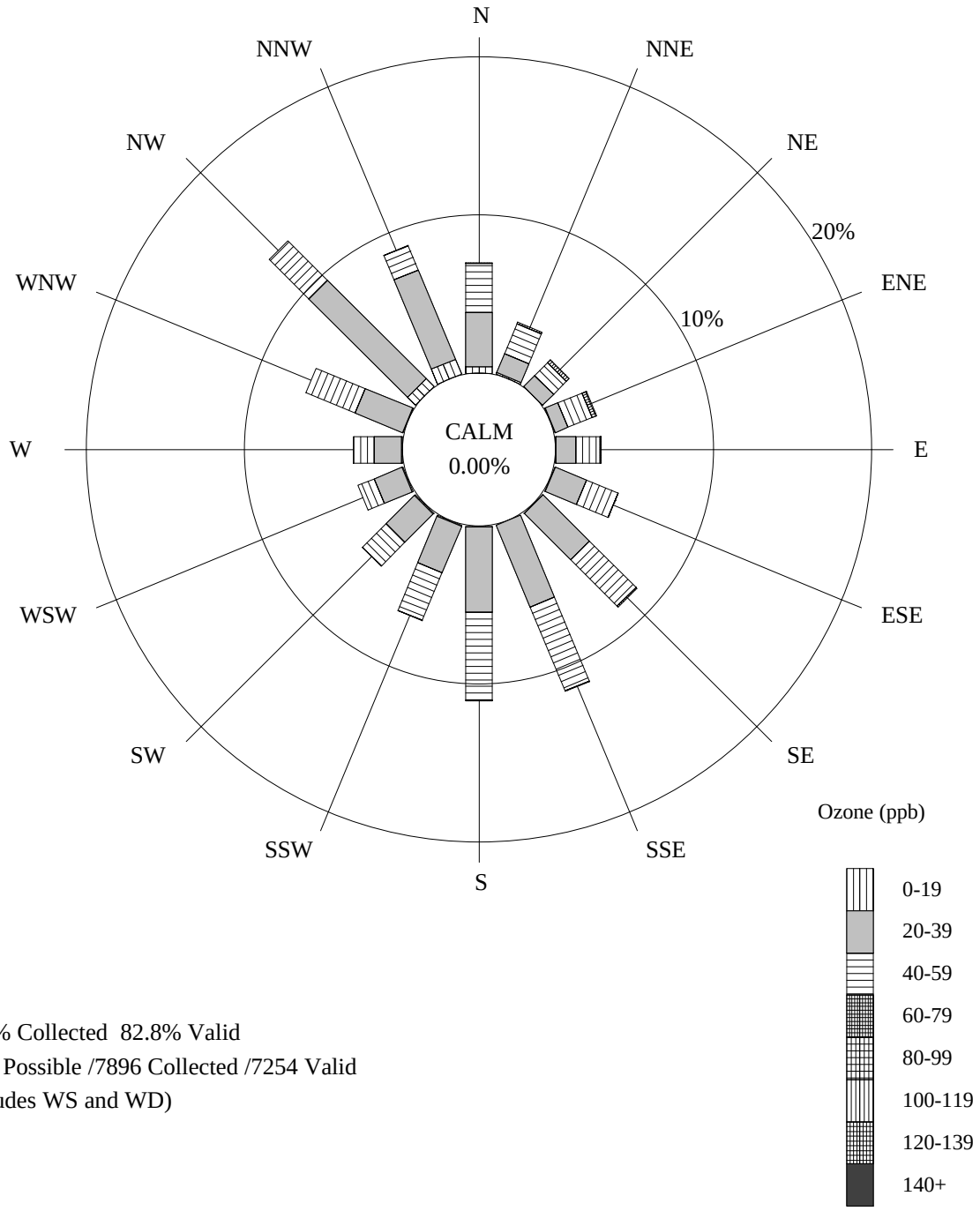
FOURTH QUARTER (OCT-DEC)



91.4% Collected 91.3% Valid
2208 Possible /2018 Collected /2017 Valid
(includes WS and WD)

Final Validation

04-18-2003



90.1% Collected 82.8% Valid
8760 Possible /7896 Collected /7254 Valid
(includes WS and WD)

Ozone Analyzer Precision Check Summary
Big Bend National Park

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	88	-3.62	-8.37	1.13
2	67	-8.19	-10.61	-5.77
3	70	-2.97	-9.26	3.32
4	13	0.72	-1.46	2.89

[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

Big Bend National Park

Final Validation

01/01/2002 - 12/31/2002

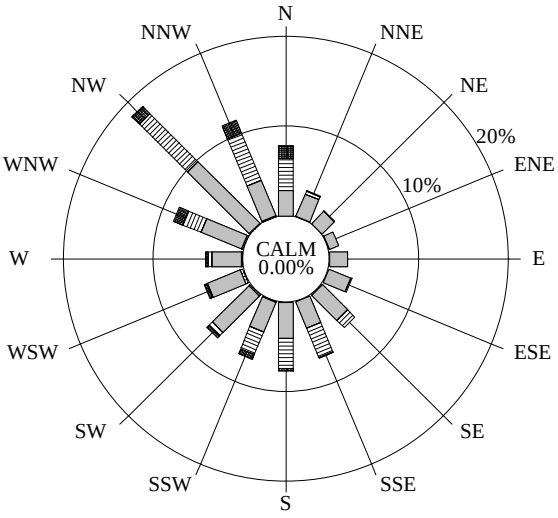
Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	3.6	m/s	8005	1.7
Maximum	13.1	m/s		
Percent calm = 0.00				
AMBIENT TEMPERATURE				
Average	20.0	degC	8671	8.4
Maximum	37.9	degC		
Minimum	-4.2	degC		
RELATIVE HUMIDITY				
Average	42	percent	8699	21
Maximum	98	percent		
Minimum	2	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	2.1	mm/hr	124	3.6
Maximum non-zero rate	23.1	mm/hr		
Minimum non-zero rate	.3	mm/hr		
Accumulated during period	263.1	mm		
SOLAR RADIATION				
Average Daily Total	17,377,554	joules/m2day	346	5,521,688
Maximum Daily Total	27,235,200	joules/m2day		
Minimum Daily Total	2,278,400	joules/m2day		

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

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

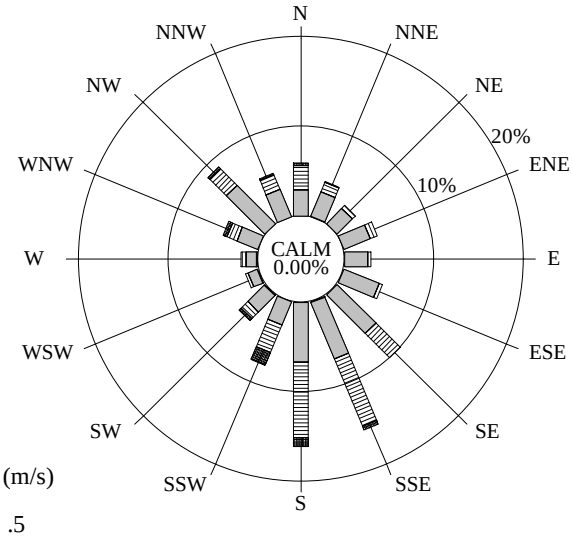
NA indicates instrument not available.

FIRST QUARTER (JAN-MAR)



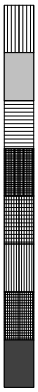
99.7% Collected 99.7% Valid
2160 Possible /2153 Collected /2153 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



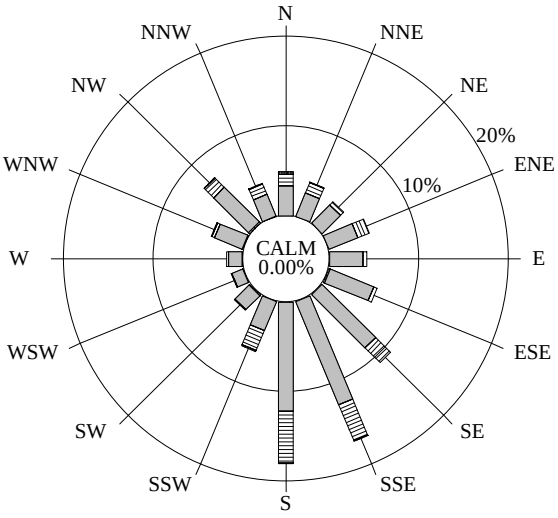
98.8% Collected 98.8% Valid
2184 Possible /2158 Collected /2158 Valid
(includes WS and WD)

Scalar Wind Speed (m/s)



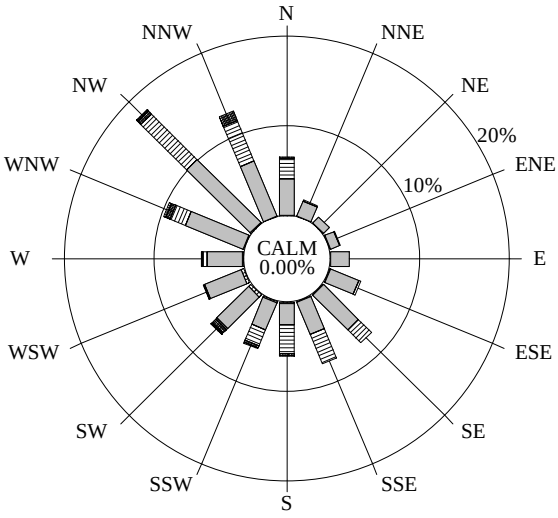
CALM < .5
0.5-0.9
1.0-3.9
4.0-6.9
7.0-9.9
10.0-12.9
13.0-15.9
16.0-18.9
19.0+

THIRD QUARTER (JUL-SEP)



98.6% Collected 67.4% Valid
2208 Possible /2176 Collected /1489 Valid
(includes WS and WD)

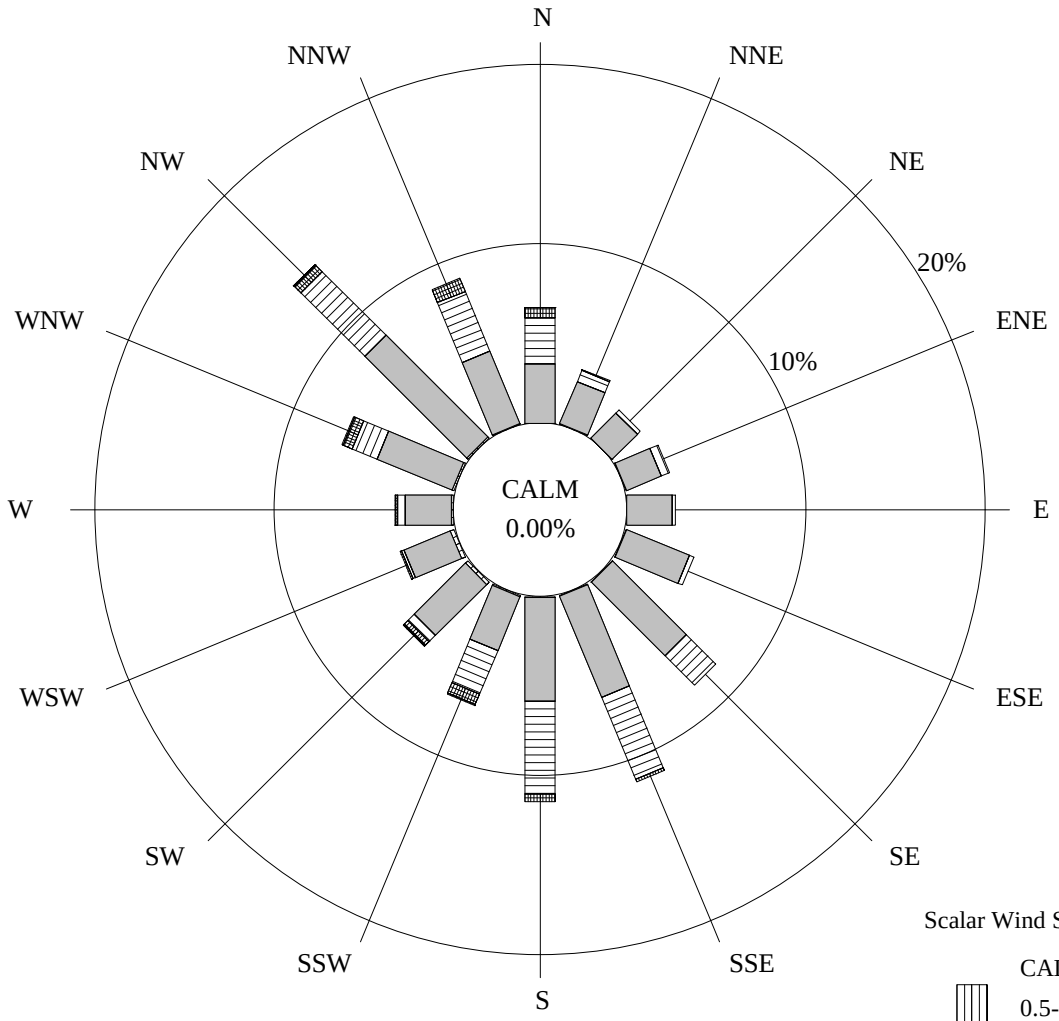
FOURTH QUARTER (OCT-DEC)



99.9% Collected 99.9% Valid
2208 Possible /2205 Collected /2205 Valid
(includes WS and WD)

Final Validation

04-18-2003



99.2% Collected 91.4% Valid
8760 Possible /8692 Collected /8005 Valid
(includes WS and WD)

2.4 DRY DEPOSITION DATA SUMMARY

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

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

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

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

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

CASTNet Dry Deposition Monitoring
Quarterly and Annual Average Concentrations
Big Bend National Park
1/1/02 - 12/31/02

Quarter	No.Valid Samples	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4 /SO_2 Ratio
1	13	0.530	0.597	1.118	0.484	1.349	0.821	1.643
2	13	0.825	0.779	1.591	0.883	2.917	0.698	4.179
3	13	0.499	0.930	1.415	0.812	3.092	0.680	4.549
4	13	0.306	0.636	0.932	0.488	1.459	0.612	2.385
Annual Average		0.540	0.735	1.264	0.667	2.204	0.703	3.137
Standard Deviation		0.315	0.283	0.393	0.285	1.170	0.319	

Data Recovery Table			
Total No. Filters	No. Invalidated	Data Capture	No. Valid Hours
52	0	100.0%	8831.0

CASTNet Dry Deposition Monitoring Weekly Concentrations Report
Big Bend National Park
1/1/02 - 12/31/02

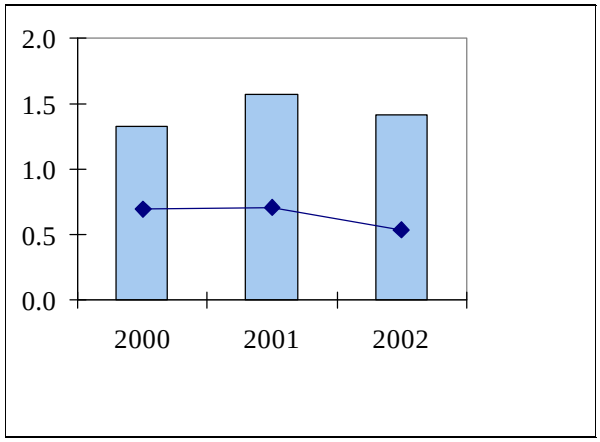
On Date	Off Date	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
12/18/01	01/01/02	0.685	0.534	1.211	0.309	0.771	1.137	0.678
01/01/02	01/08/02	0.144	1.070	1.197	0.571	1.432	0.686	2.088
01/08/02	01/15/02	0.289	0.723	1.001	0.284	0.723	1.034	0.699
01/15/02	01/22/02	0.549	0.633	1.172	0.653	1.932	0.991	1.951
01/22/02	01/29/02	0.617	0.481	1.090	0.667	1.939	0.891	2.177
01/29/02	02/05/02	1.071	0.453	1.517	0.718	1.993	0.785	2.539
02/05/02	02/12/02	0.223	0.691	0.903	0.317	0.685	0.387	1.769
02/12/02	02/19/02	0.587	0.932	1.504	0.430	1.269	1.384	0.917
02/19/02	02/26/02	0.371	0.315	0.681	0.248	0.563	0.341	1.650
02/26/02	03/05/02	0.679	0.252	0.927	0.531	1.554	0.853	1.822
03/05/02	03/12/02	0.516	0.458	0.967	0.453	1.495	1.145	1.306
03/12/02	03/19/02	0.510	0.361	0.865	0.385	1.242	0.471	2.637
03/19/02	03/26/02	0.650	0.860	1.496	0.724	1.941	0.573	3.386
03/26/02	04/02/02	0.523	0.586	1.100	0.687	1.967	0.560	3.509
04/02/02	04/09/02	1.127	1.127	2.236	1.063	3.865	1.426	2.710
04/09/02	04/16/02	0.427	0.869	1.282	0.685	2.058	0.698	2.950
04/16/02	04/23/02	0.891	0.585	1.467	1.042	3.602	0.618	5.828
04/23/02	04/30/02	0.989	0.793	1.769	1.178	3.700	1.190	3.109
04/30/02	05/07/02	0.848	0.635	1.473	0.869	2.890	0.639	4.522
05/07/02	05/14/02	1.410	0.534	1.935	1.008	3.703	0.682	5.432
05/14/02	05/21/02	0.515	1.010	1.509	0.776	2.028	0.517	3.921
05/21/02	05/28/02	0.959	0.853	1.798	0.999	3.529	0.662	5.329
05/28/02	06/04/02	0.591	1.041	1.616	0.921	2.816	0.723	3.897
06/04/02	06/11/02	0.392	0.824	1.203	0.726	2.469	0.243	10.152
06/11/02	06/18/02	0.989	0.744	1.721	0.819	2.718	0.795	3.418
06/18/02	06/25/02	1.064	0.524	1.579	0.708	2.573	0.319	8.068
06/25/02	07/02/02	0.712	1.036	1.731	0.848	3.102	1.079	2.875
07/02/02	07/09/02	0.849	1.178	2.008	1.031	4.225	1.498	2.821
07/09/02	07/16/02	0.102	0.886	0.974	0.721	2.680	0.308	8.693
07/16/02	07/23/02	0.529	0.590	1.110	0.638	2.444	0.413	5.913
07/23/02	07/30/02	0.462	0.543	0.997	0.380	1.374	0.355	3.871
07/30/02	08/06/02	0.732	0.587	1.310	0.575	2.246	0.679	3.310
08/06/02	08/13/02	0.281	1.292	1.552	1.126	4.090	0.453	9.018
08/13/02	08/20/02	0.898	0.694	1.581	0.730	3.050	0.403	7.572
08/20/02	08/27/02	0.731	0.507	1.231	0.460	1.740	0.327	5.316
08/27/02	09/03/02	0.472	1.348	1.799	1.377	5.966	1.283	4.648
09/03/02	09/10/02	0.258	1.269	1.507	0.945	3.525	0.563	6.259
09/10/02	09/17/02	0.185	1.232	1.398	1.278	4.439	0.542	8.188
09/17/02	09/24/02	0.276	0.930	1.191	0.452	1.317	0.932	1.413
09/24/02	10/01/02	0.282	0.998	1.264	0.868	2.263	0.683	3.313
10/01/02	10/08/02	0.379	0.526	0.897	0.786	2.933	0.483	6.079
10/08/02	10/15/02	0.231	0.652	0.873	0.491	1.376	0.281	4.891
10/15/02	10/22/02	0.236	0.698	0.922	0.686	2.227	0.678	3.284
10/22/02	10/29/02	0.036	0.492	0.520	0.520	1.566	0.331	4.730
10/29/02	11/05/02	0.033	0.518	0.543	0.268	0.839	0.255	3.289
11/05/02	11/12/02	0.227	0.369	0.590	0.320	1.037	0.646	1.606
11/12/02	11/19/02	0.357	0.717	1.063	0.345	0.916	0.870	1.053
11/19/02	11/26/02	0.713	0.668	1.370	0.405	1.073	0.868	1.237
11/26/02	12/03/02	0.521	0.883	1.390	0.578	1.678	0.852	1.970
12/03/02	12/10/02	0.200	1.101	1.284	0.532	1.436	0.669	2.146
12/10/02	12/17/02	0.105	0.418	0.517	0.233	0.613	0.468	1.310
12/17/02	12/24/02	0.662	0.225	0.884	0.318	1.011	0.870	1.162

Big Bend National Park

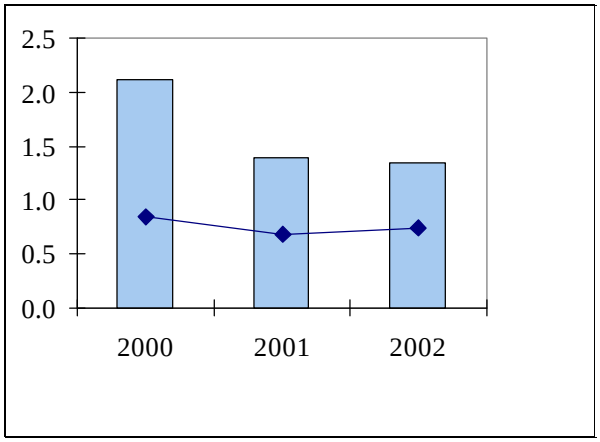
CASTNet Dry Deposition Monitoring

Three Year Comparison of Maximum and Average Concentrations

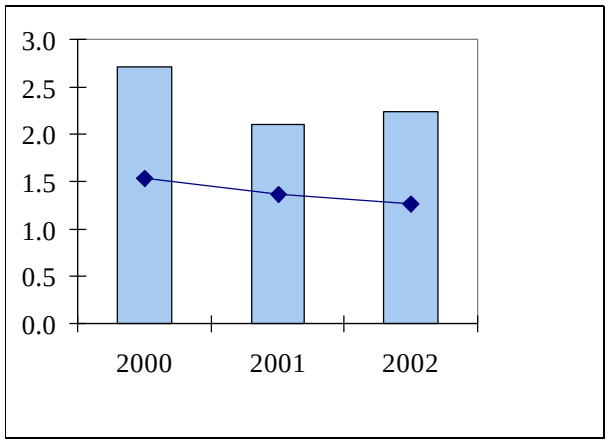
p-NO3



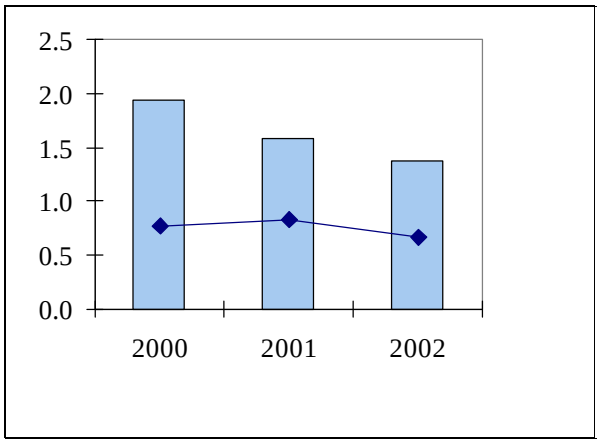
HNO3



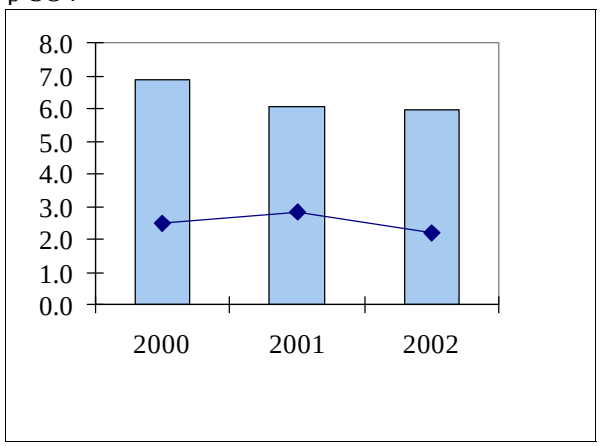
Total NO3



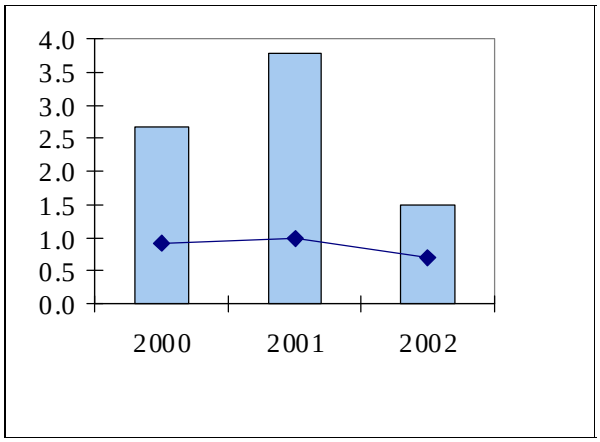
NH4

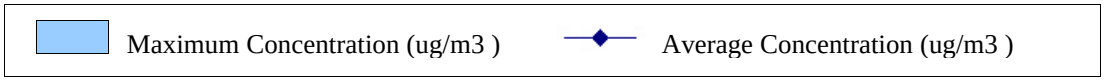


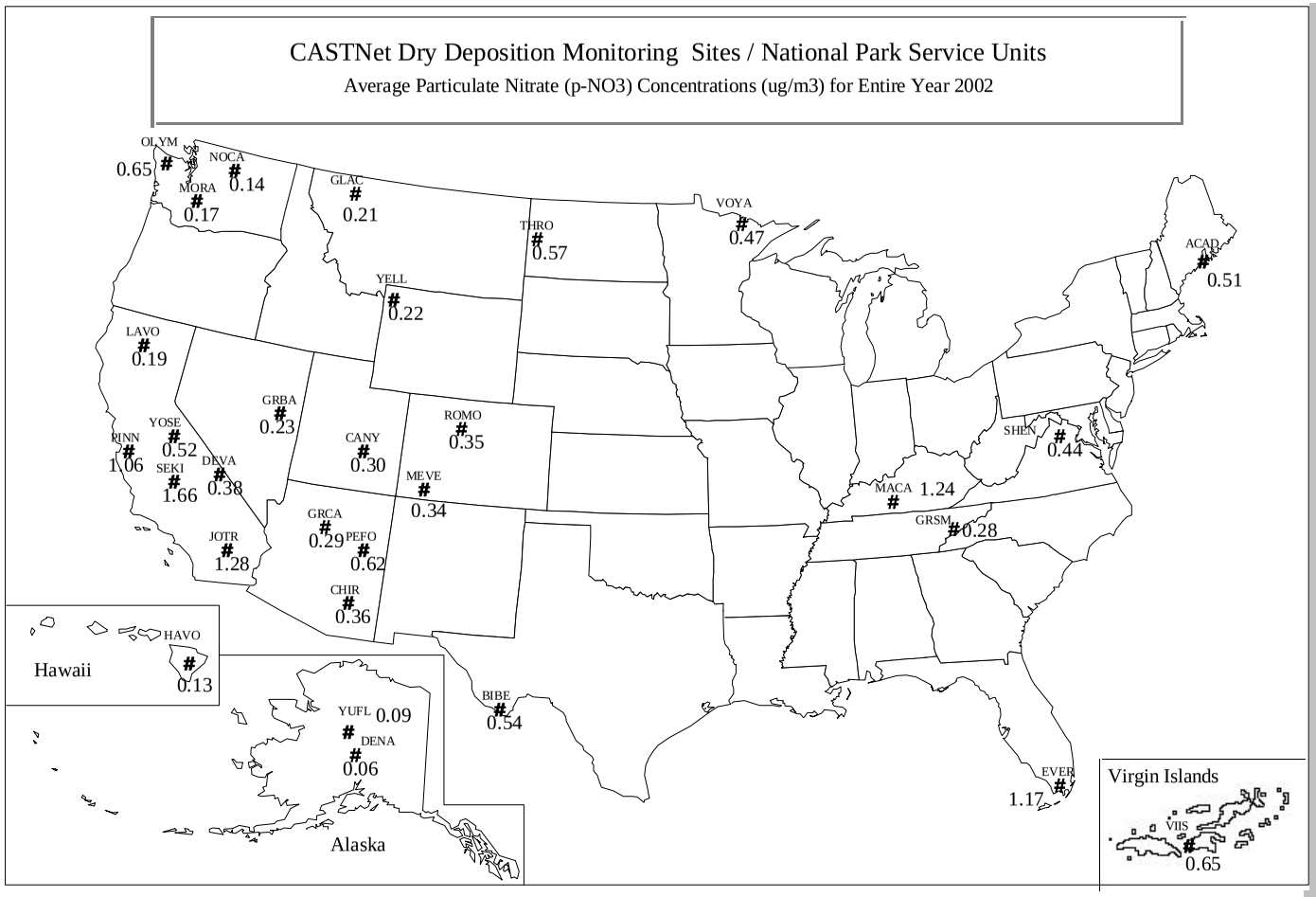
p-SO4



SO2

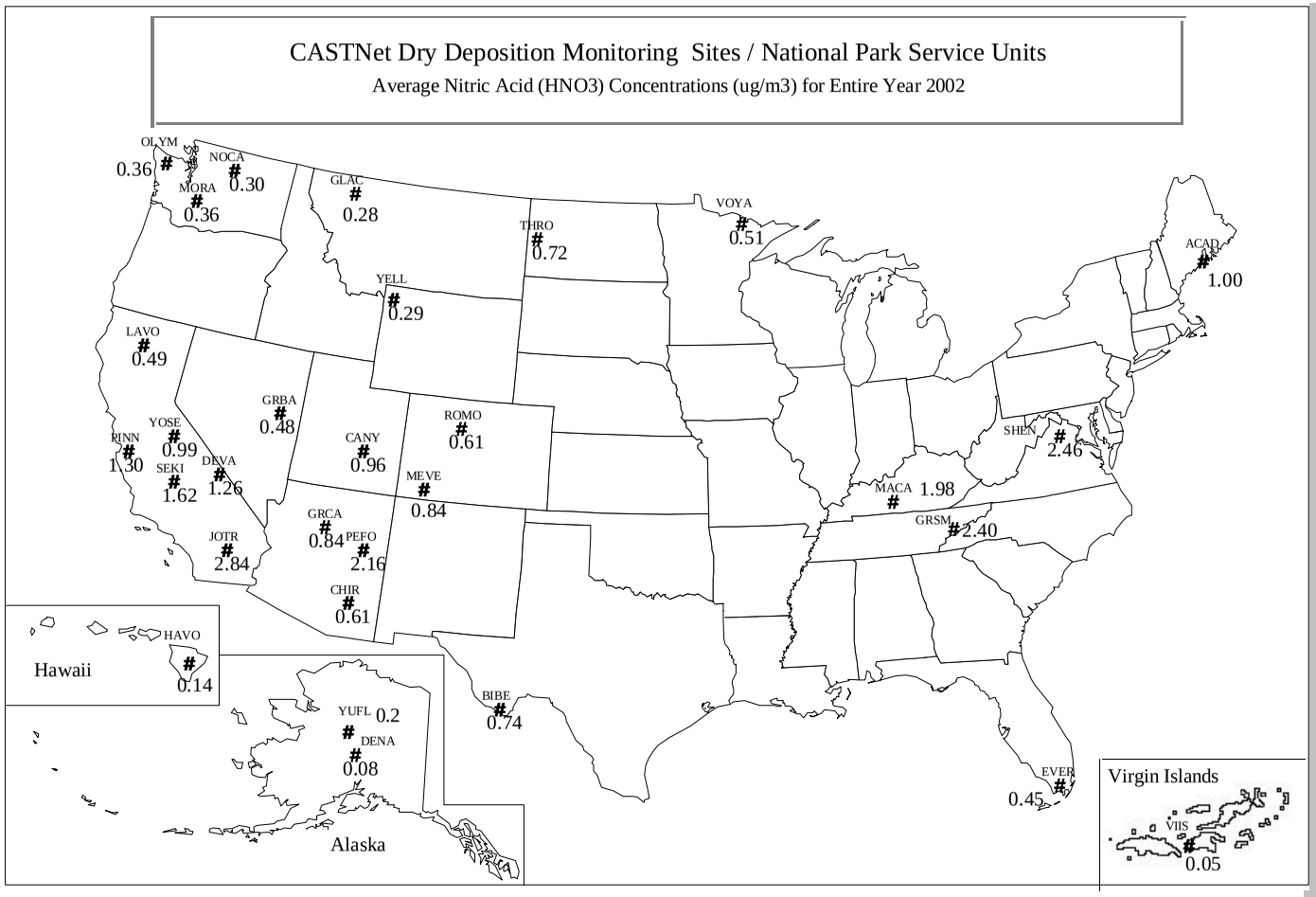






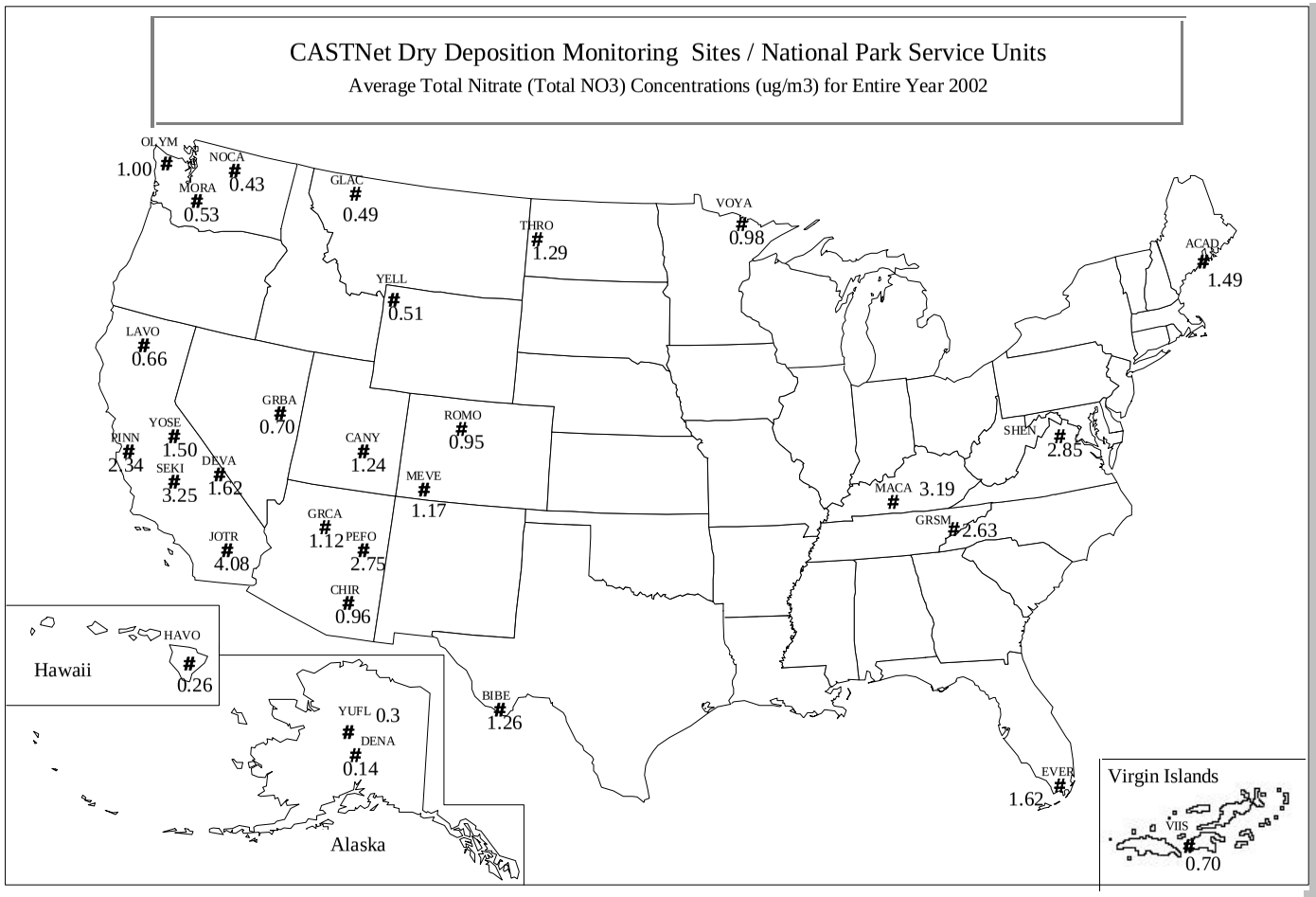
Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



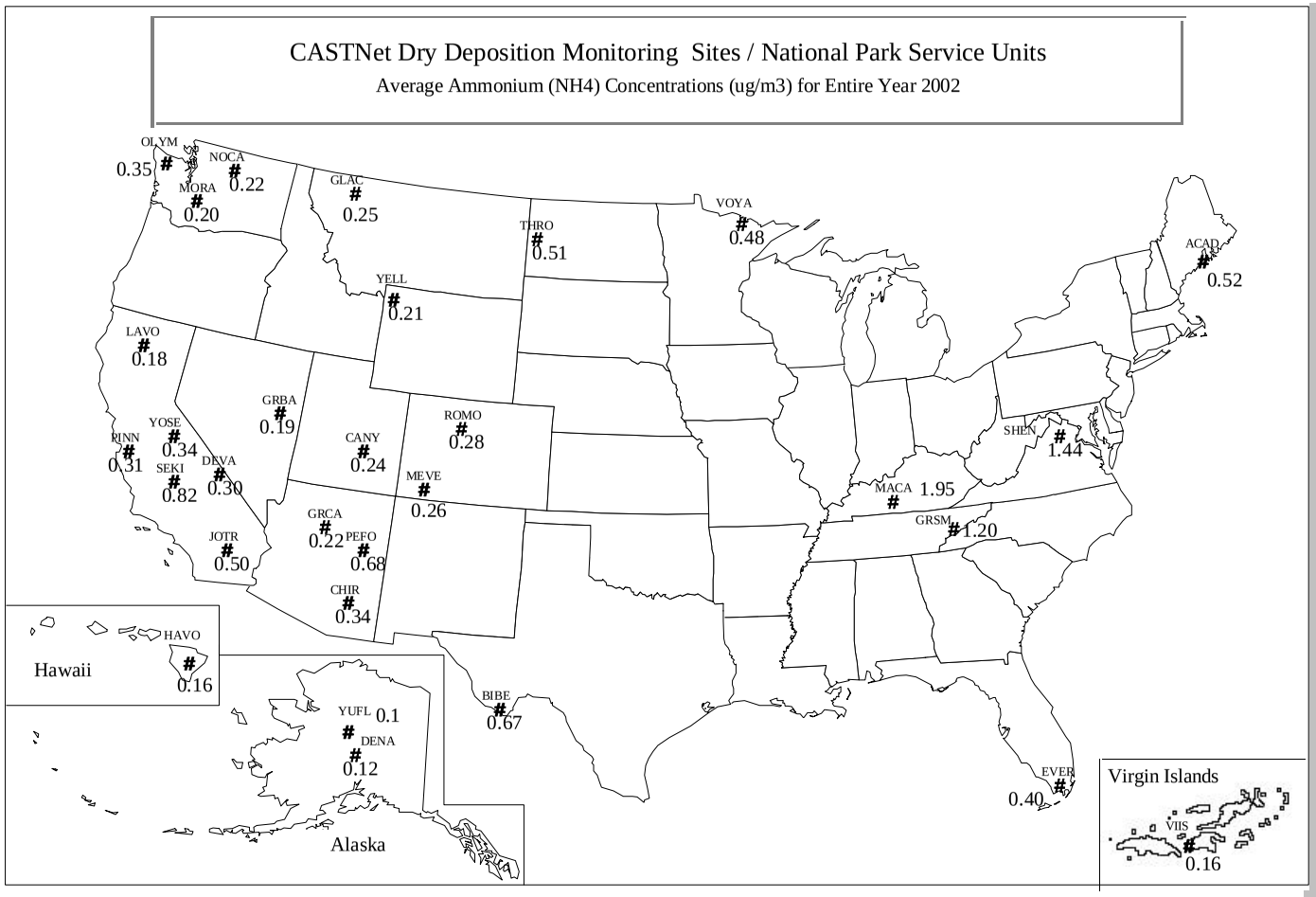
Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



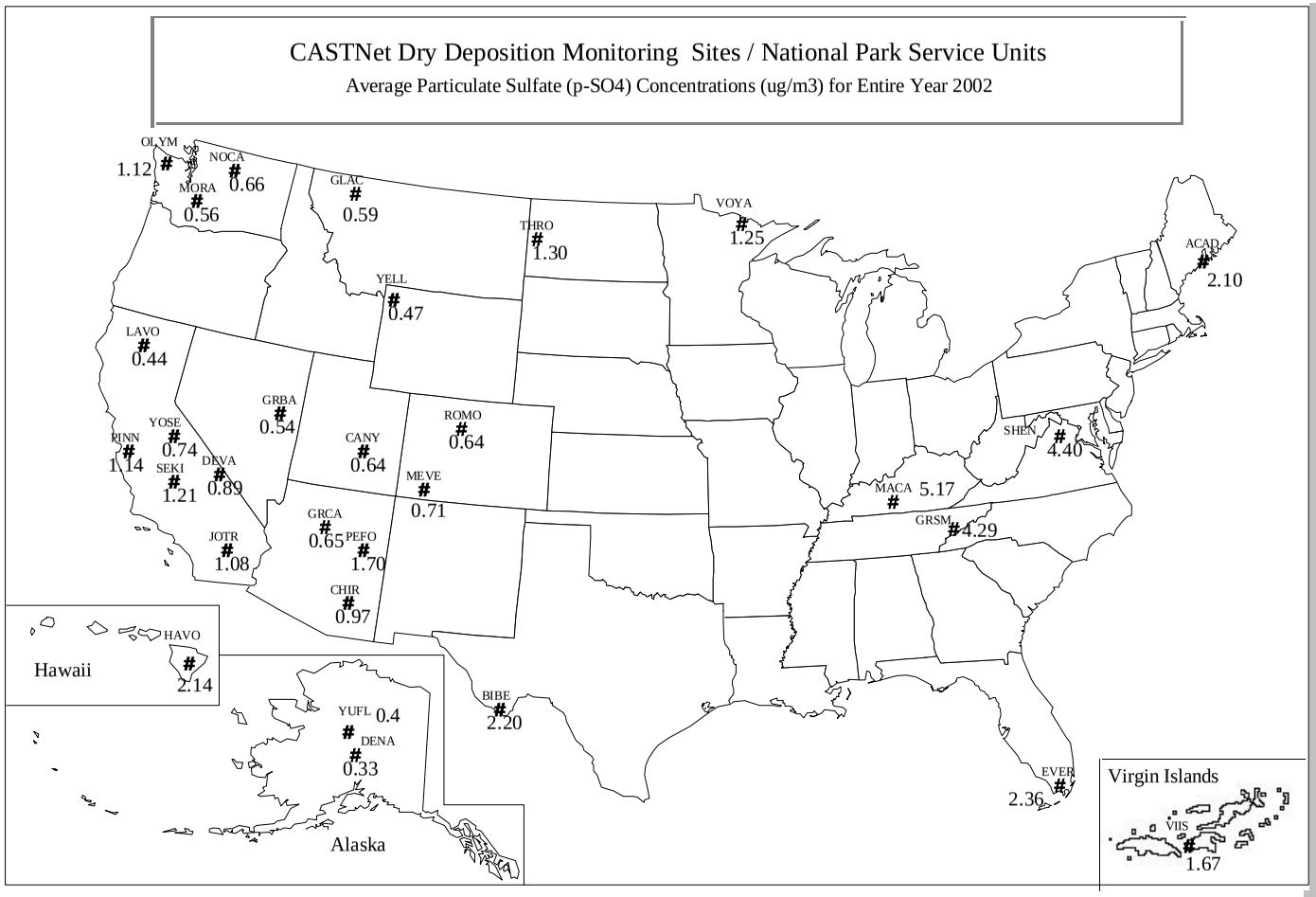
Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



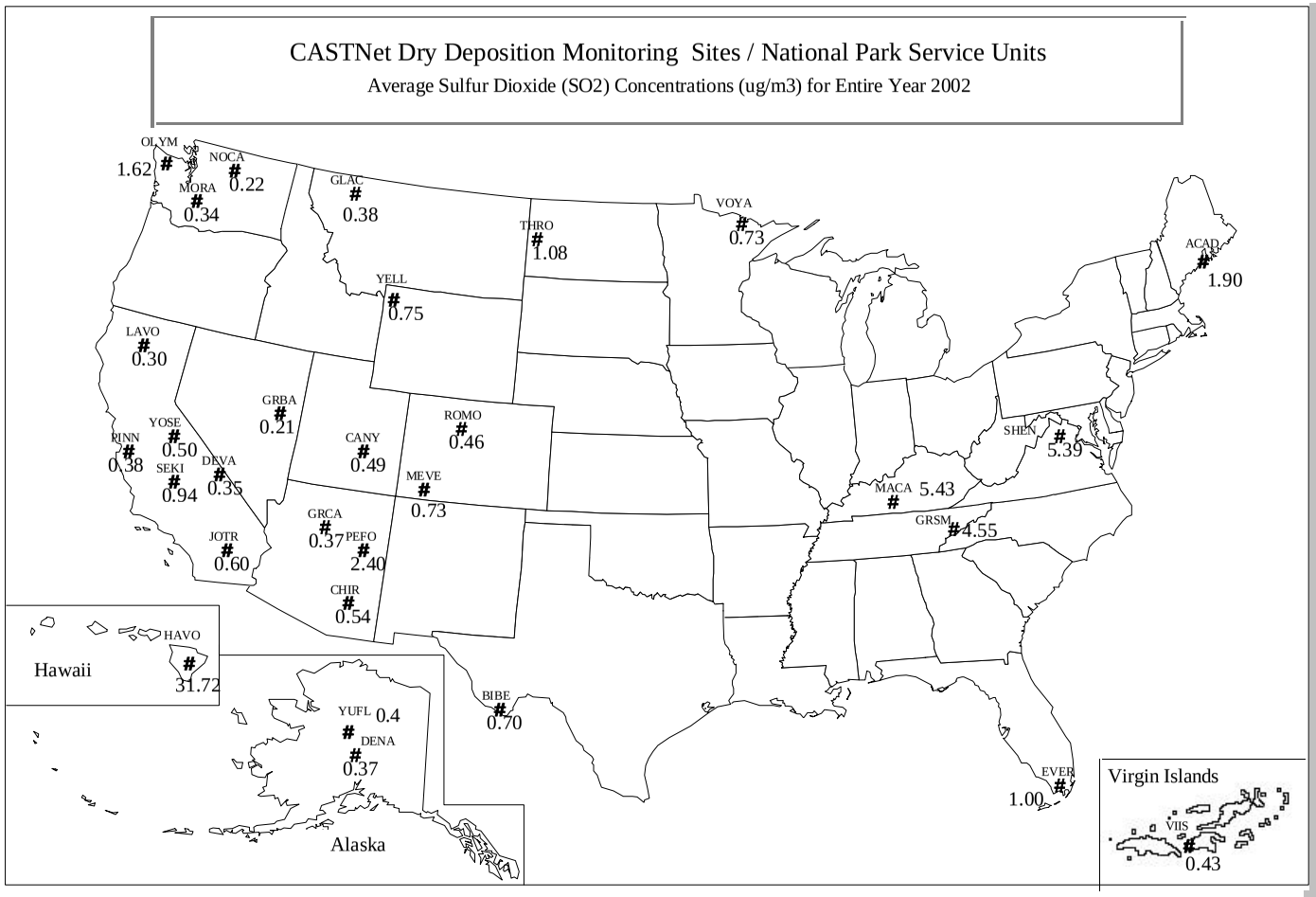
Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



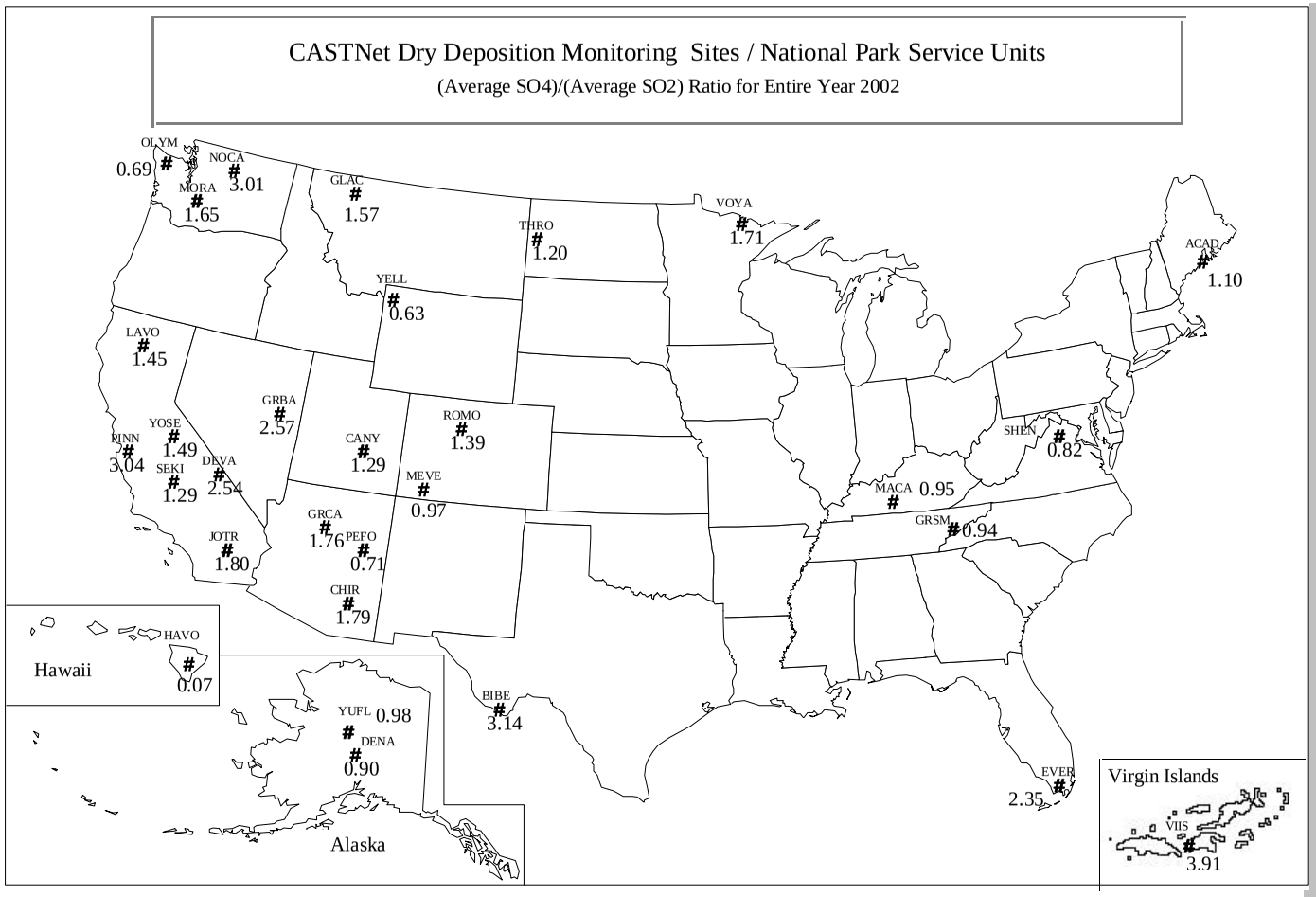
Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR



Key:

ACAD	Acadia NP
BIBE	Big Bend NP
CANY	Canyonlands NP
CHIR	Chiricahua NM
DENA	Denali NP
DEVA	Death Valley NP
EVER	Everglades NP
GLAC	Glacier NP
GRBA	Great Basin NP
GRCA	Grand Canyon NP
GRSM	Great Smokies NP
HAVO	Havaii Volcanos NP
JOTR	Joshua Tree NP
LAVO	Lassen Volcanic NP
MACA	Mammoth Cave NP
MEVE	Mesa Verde NP
MORA	Mount Rainier NP
NOCA	North Cascades NP
OLYM	Olympic NP
PEFO	Petrified Forest NP
PINN	Pinnacles NM
ROMO	Rocky Mountain NP
SEKI	Sequoia NP
SHEN	Shenandoah NP
THRO	Th. Roosevelt NP
VIIS	Virgin Islands NP
VOYA	Voyageurs NP
YELL	Yellowstone NP
YOSE	Yosemite NP
YUFL	Yukon Flats NWR

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.

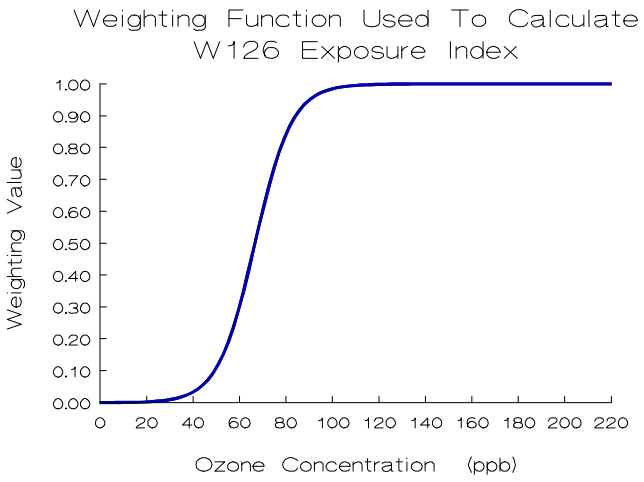
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to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

---

* 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