

**Annual Data Summary  
THEODORE ROOSEVELT 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 Theodore Roosevelt National Park, ARD specifically recognizes Dan Harmon and the North Dakota Department of Health Division of Environmental Engineering for performing the technical and administrative skills required to help produce the data presented within this report.

## TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1.0	INTRODUCTION	1-1
1.1	The National Park Service Gaseous Pollutant Monitoring Network	1-1
1.2	Theodore Roosevelt National Park	1-3
2.0	DATA SUMMARY	2-1
2.1	Overview	2-1
2.2	Ozone Data Summary	2-7
2.2	Sulfur Dioxide Summary	2-23
2.4	Meteorological Data Summary	2-35
2.5	Dry Deposition Data Summary	2-39
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

		<u>Page</u>
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)

	<u>Page</u>
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 $\geq$ 100 ppb and $>$ 124 ppb	2-13
Episodes with 8-Hour Ozone Concentrations $>$ 84 ppb	2-14
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, Maximum 8-Hour Average Concentrations, and Annual Sum60 Exposure Index for All NPS Monitoring Sites	2-15
Plot of Maximum Ozone Concentration Comparison for Three Years	2-16
Map of National Park Service Gaseous Pollutant Monitoring Network, Second Highest Hourly Ozone Concentration	2-17
Quarterly Diurnal Ozone Plots	2-18
Annual Diurnal Ozone Plot	2-19
Quarterly Ozone Pollutant Roses	2-20
Annual Ozone Pollutant Roses	2-21
Ozone Precision Check Data Summary	2-22
Sulfur Dioxide Daily 1-Hour Maximum Concentrations and National Ambient Air Quality Standards Comparison	2-24
Sulfur Dioxide Standards, 1-Hour Maximum	2-25
Sulfur Dioxide Standards, 24-Hour Block Average	2-26
Sulfur Dioxide Standards, Maximum of 3-Hour Block Average	2-27
Sulfur Dioxide Yearly Frequency Distribution	2-28
Maximum Sulfur Dioxide Concentration Comparisons for Three Years	2-29
Quarterly Diurnal Sulfur Dioxide Plots	2-30
Annual Diurnal Sulfur Dioxide Plots	2-31

## LIST OF FIGURES AND TABLES (Continued)

	<u>Page</u>
Quarterly Sulfur Dioxide Pollutant Roses	2-32
Annual Sulfur Dioxide Pollutant Roses	2-33
Sulfur Dioxide Precision Check Data Summary	2-34
Summary of Selected Meteorological Data	2-36
Quarterly Wind Roses	2-37
Annual Wind Roses	2-38
Quarterly and Annual Average Concentrations	2-40
Weekly Concentrations Report	2-41
Three Year Comparison of Maximum and Average Concentrations	2-42
Average Particulate Nitrate Concentrations	2-43
Nitric Acid Concentrations	2-44
Average Total Nitrate Concentrations	2-45
Average Ammonium Concentrations	2-46
Average Particulate Sulfate Concentrations	2-47
Average Sulfur Dioxide Concentrations	2-48
SO <sub>4</sub> /SO <sub>2</sub> Ratio	2-49

## **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.

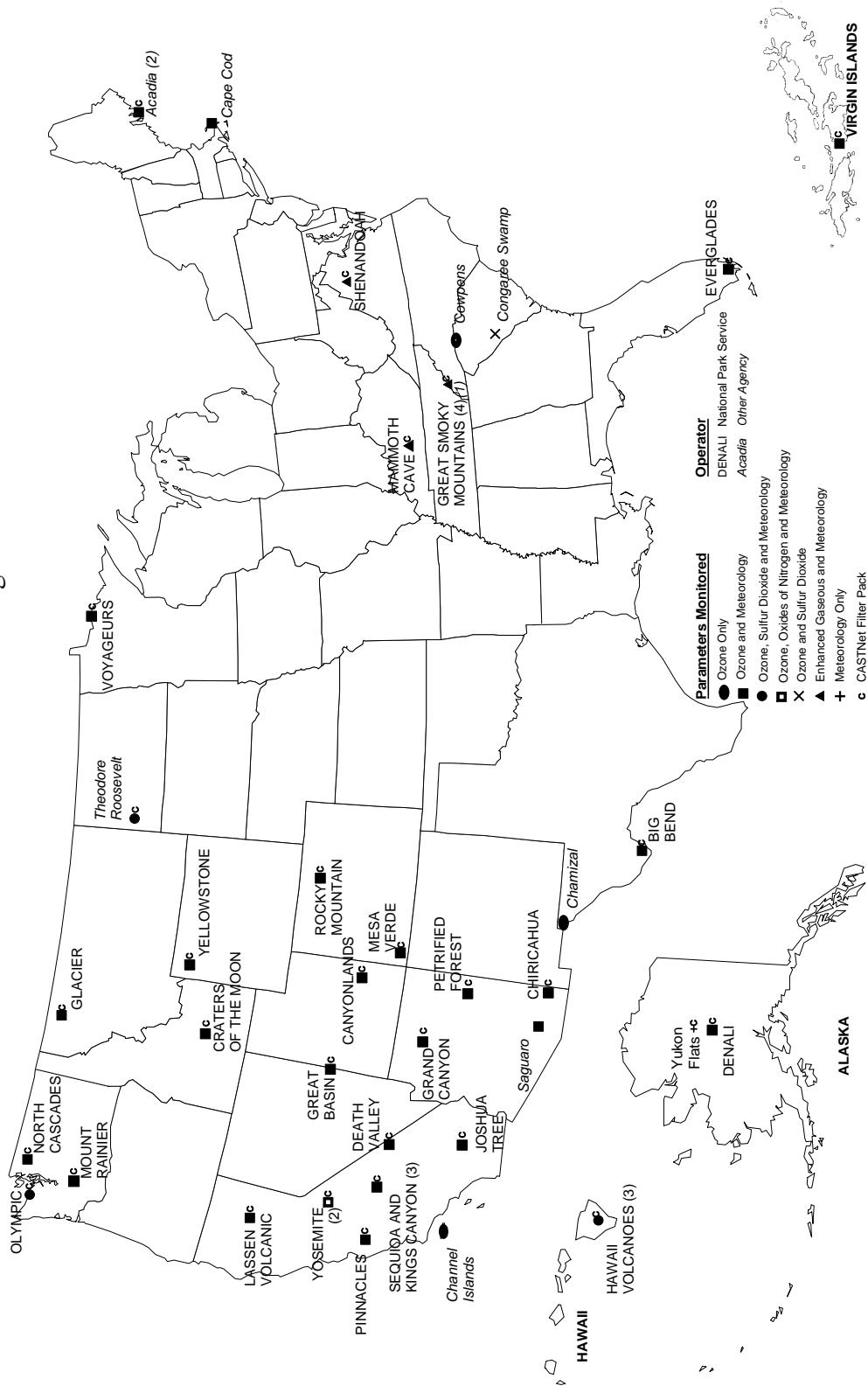
Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The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

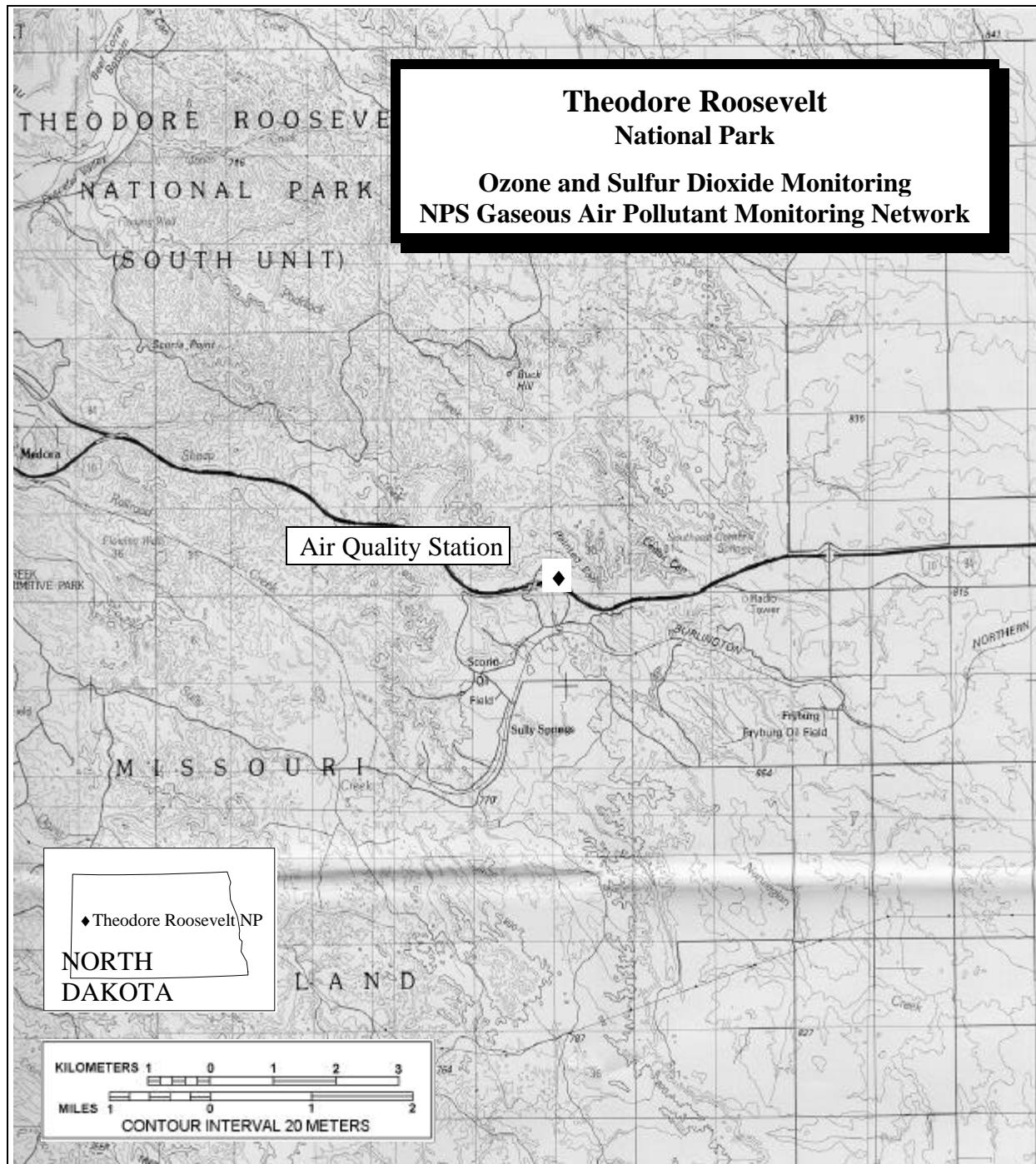


## **1.2 THEODORE ROOSEVELT NATIONAL PARK**

Theodore Roosevelt National Park, a Class I area, is located in the upper Missouri Basin of western North Dakota. Its location and site specifications are presented on the following page.

Theodore Roosevelt National Park was established by Congress on April 25, 1947. Nearly 30,000 acres of the park were designated a wilderness in 1978.

The park, over 70,000 acres in size, includes scenic badlands along the Little Missouri River and part of Theodore Roosevelt's Elkhorn Ranch.



SITE IDENTIFICATION		MAP INFORMATION	
Site Abbreviation:	THRO	Mean Elevation:	850 m
AIRS ID NO.:	38-007-0002	Longitude:	103° 22' 40"W
INSTRUMENTATION		Latitude:	46° 53' 41"N
O <sub>3</sub> Analyzer	Wind Speed	UTM Zone:	13
SO <sub>2</sub> Analyzer	Wind Direction	Easting:	623573 m
Calibrator	Solar Radiation	Northing:	5194521 m
Temperature	Precipitation	Map Reference:	Belfield 1980 47103-E1 1:100,000
Delta Temperature	Relative Humidity		
Wetness	Filter Pack		

## **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**  
**Theodore Roosevelt National Park**  
**Visitor Center**

**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	8712	99.5	8711	99.4
Sulfur Dioxide Analyzer	hourly	SO2	8760	8705	99.4	8703	99.3
Scalar Wind Speed	hourly	SWS	8760	8533	97.4	8532	97.4
Vector Wind Speed	hourly	VWS	8760	8533	97.4	8532	97.4
Vector Wind Direction	hourly	VWD	8760	8533	97.4	8532	97.4
Standard Deviation for Wind Direction	hourly	SDWD	8760	8533	97.4	8532	97.4
Ambient Temperature (aspirated)	hourly	TMP	8760	8530	97.4	8529	97.4
Delta Temperature	hourly	DTP	8760	8530	97.4	8529	97.4
Relative Humidity	hourly	RH	8760	8530	97.4	8529	97.4
Precipitation	hourly	RNF	8760	8478	96.8	8477	96.8
Wetness Sensor	hourly	WET	8760	8514	97.2	8513	97.2
Solar Radiation	hourly	SOL	8760	8530	97.4	8529	97.4
Filter Pack Flow Rate	hourly	FLOW	8760	8535	97.4	8534	97.4

Notes: The percent valid is calculated against the number possible.

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

Performance Goals:

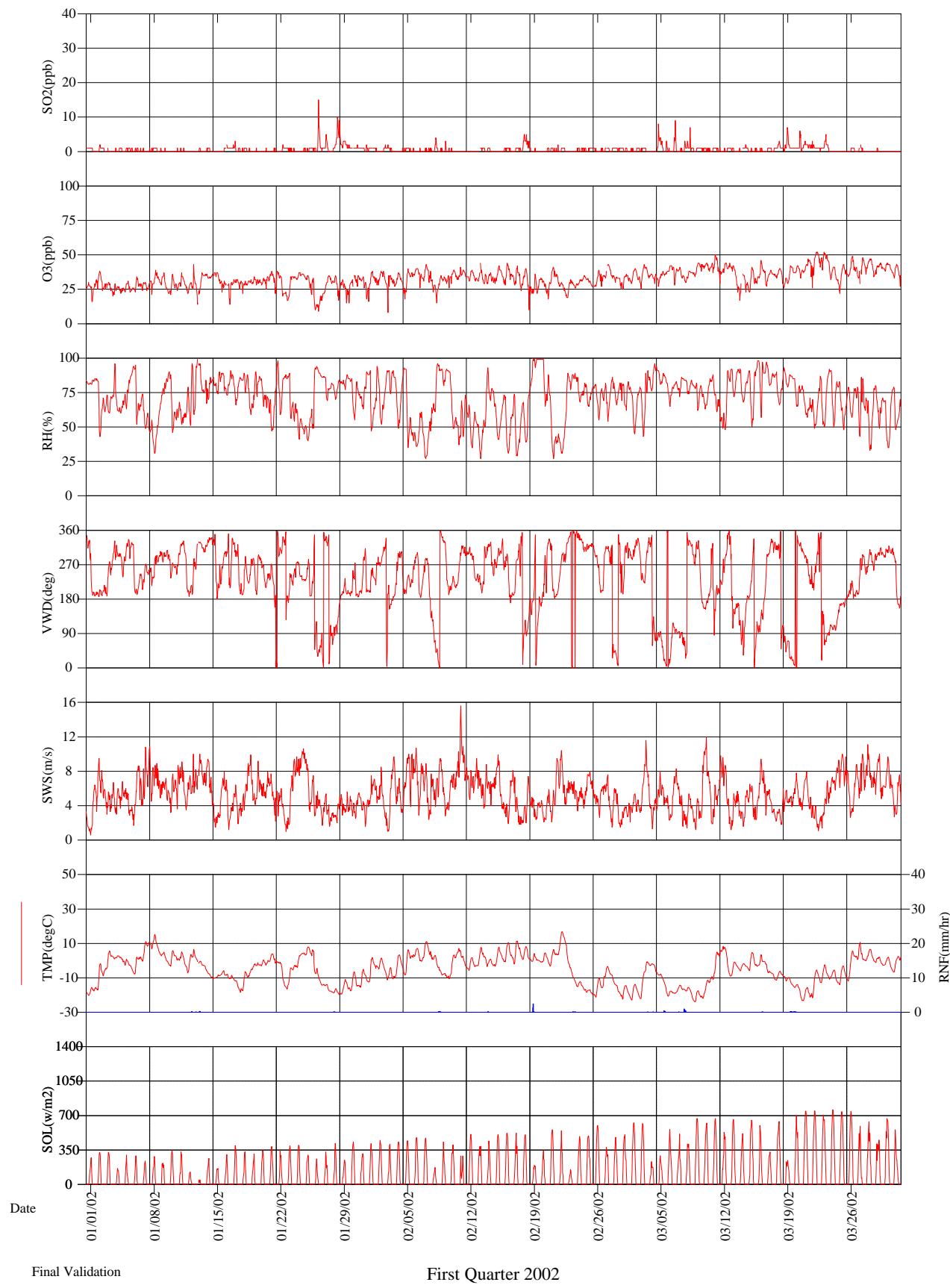
**Quarterly Criteria:**

- 100% of sites, >= 85% valid data capture
- 90% of sites, >= 90% valid data capture
- 80% of sites, >= 95% valid data capture

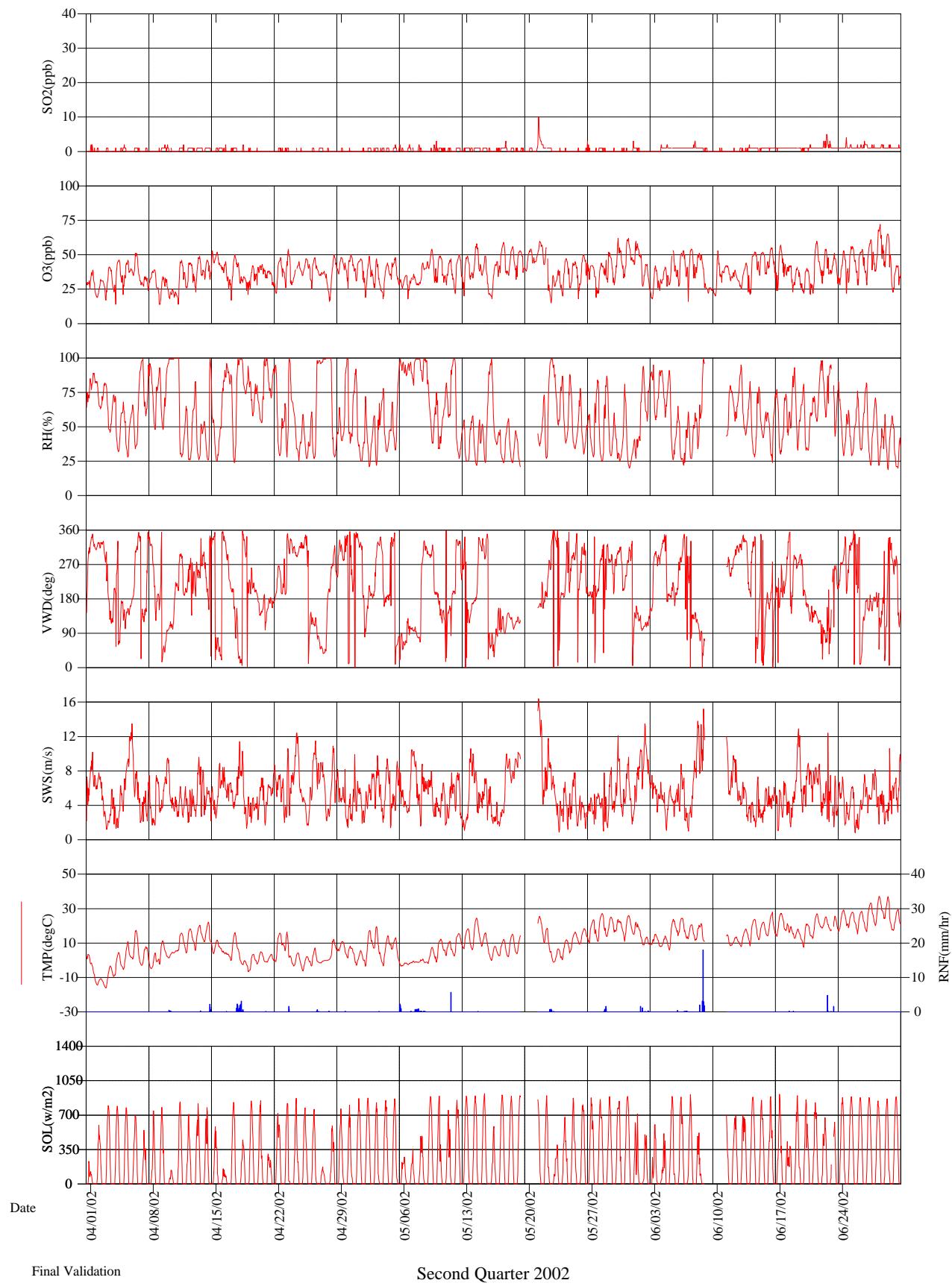
**Monthly Criteria:**

- 100% of sites, >= 60% valid data capture
- 90% of sites, >= 75% valid data capture
- 80% of sites, >= 85% valid data capture

### Theodore Roosevelt National Park



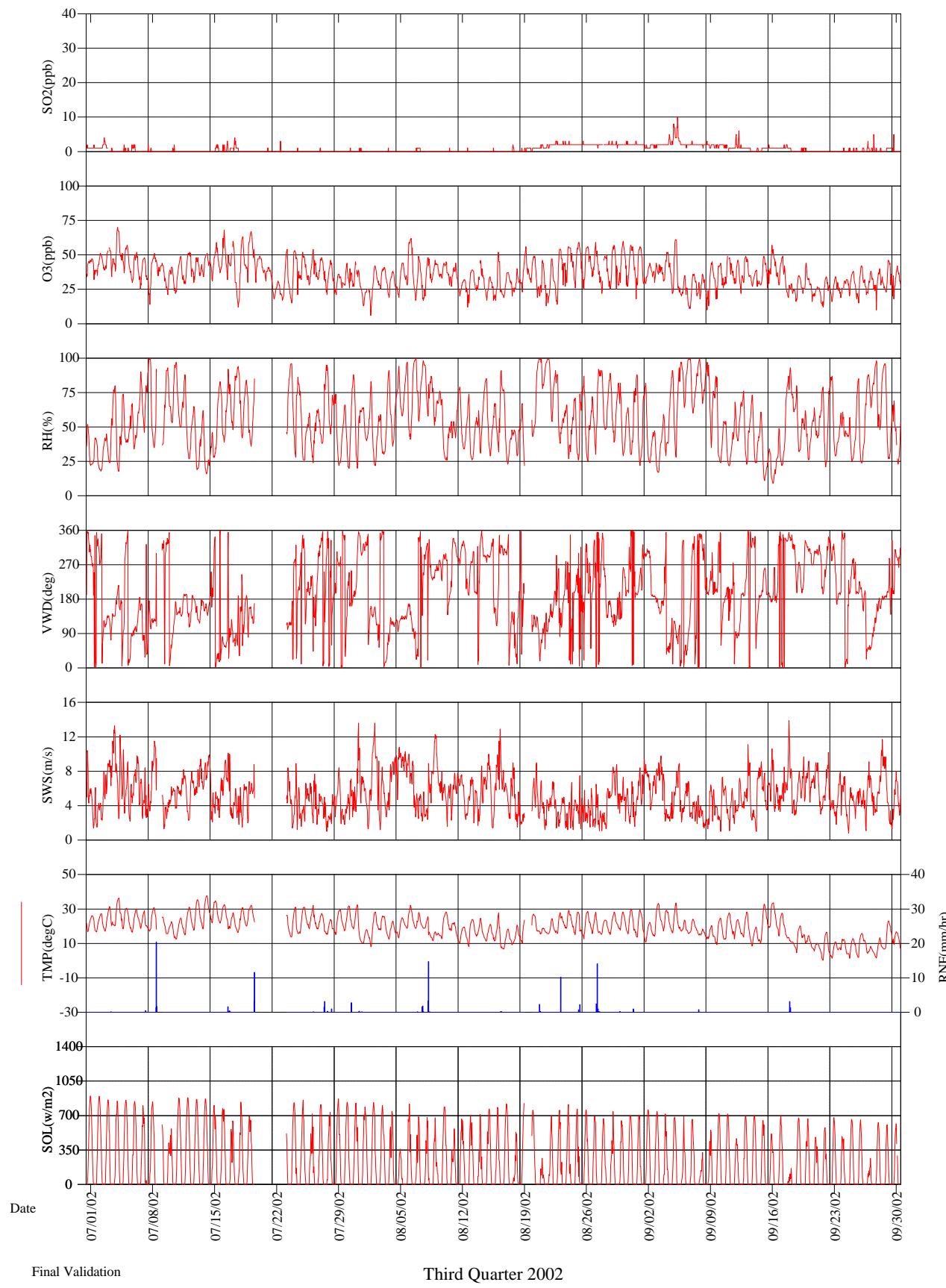
### Theodore Roosevelt National Park



Final Validation

Second Quarter 2002

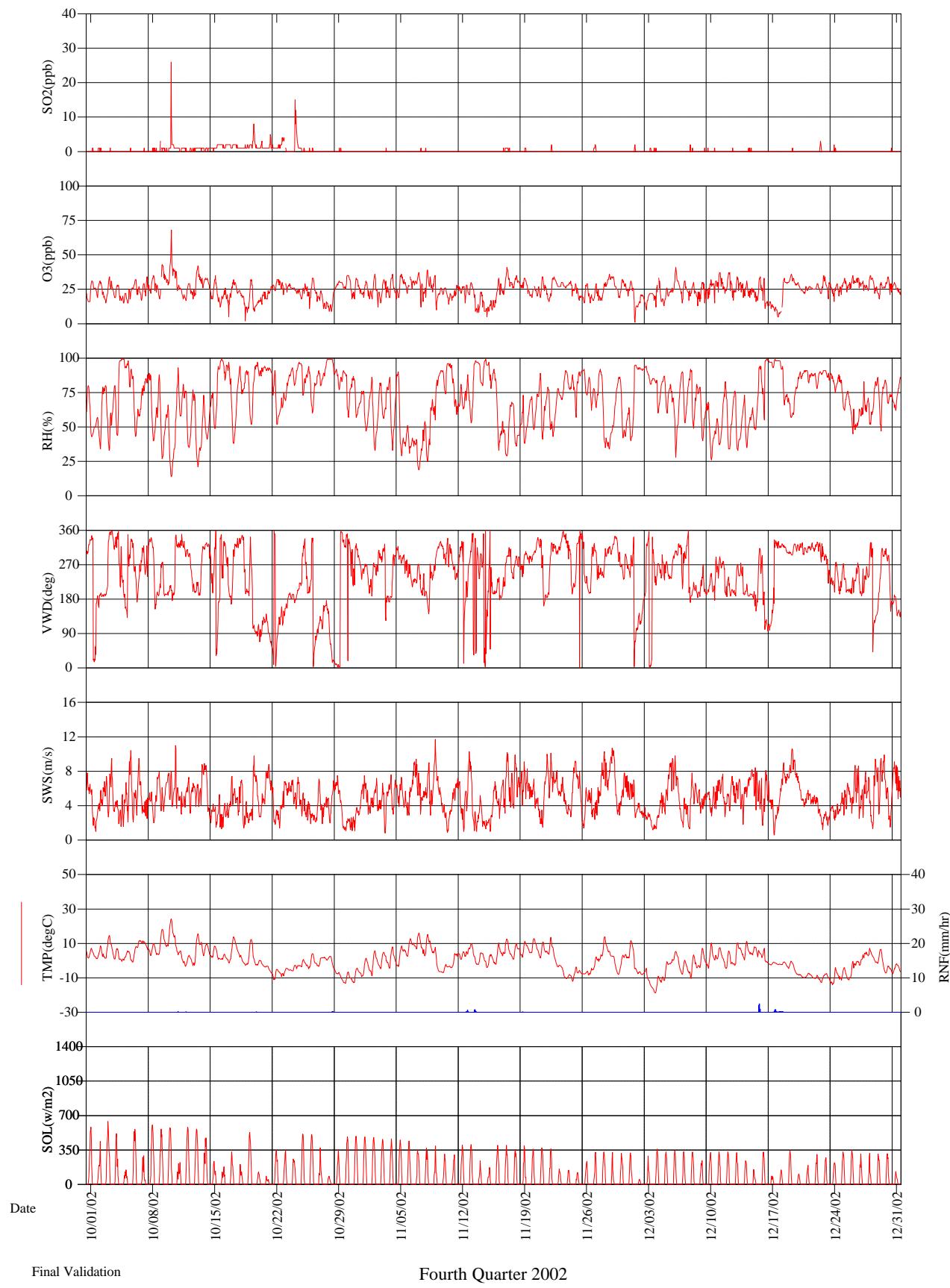
### Theodore Roosevelt National Park



Final Validation

Third Quarter 2002

### Theodore Roosevelt National Park



Final Validation

Fourth Quarter 2002

## **2.2 OZONE DATA SUMMARY**

Ozone Quick Look Annual Summary Statistics  
 Theodore Roosevelt National Park  
**Visitor Center**

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	43	44	52	54	62	72	70	62	61	68	41	41	72	72
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
AVERAGE DAILY MAXIMUM	35	38	43	44	49	51	51	47	42	32	32	31	48	41
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
MAXIMUM/DAILY MEAN	35	37	47	52	54	53	46	43	39	31	32	54	54	54
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
AVERAGE DAILY MEAN	29	32	38	36	39	40	40	35	32	24	25	25	37	33
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
MAX PEAK:MIN RATIO	3,667	4,375	2,118	3,286	3,667	3,375	5,250	7,000	4,500	12,500	3,500	31,000	7,000	31,000
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
AVERAGE PEAK:MIN RATIO	1,745	1,756	1,489	1,935	2,013	1,956	2,037	2,449	2,204	2,443	2,071	3,004	2,133	2,095
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
MAX 9AM-4PM AVERAGE	36	40	49	49	60	64	63	57	55	47	37	34	64	64
NO. OF DAYS	(31)	(28)	(30)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(364)
MONTHLY 9AM-4PM AVERAGE	30	35	40	40	45	47	47	43	38	27	28	26	44	37
NO. OF DAYS	(31)	(28)	(30)	(31)	(30)	(31)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(364)
MAX 7AM-7PM AVERAGE	35	39	48	48	56	61	60	53	50	42	35	33	61	61
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
MONTHLY 7AM-7PM AVERAGE	29	34	39	39	43	44	45	40	36	26	26	26	42	36
NO. OF DAYS	(31)	(28)	(31)	(30)	(31)	(30)	(31)	(30)	(31)	(30)	(30)	(31)	(153)	(365)
MONTHLY MEAN	29	32	38	36	39	40	40	35	32	24	25	25	37	33
NO. OF HOURS	(738)	(669)	(738)	(717)	(741)	(716)	(739)	(741)	(716)	(741)	(717)	(738)	(3653)	(8711)
SUM0 EXPOSURE INDEX	21262	21552	27833	25587	29037	28631	29472	26181	23071	18093	17727	18243	136392	286689
NO. OF HOURS	(738)	(669)	(738)	(717)	(741)	(716)	(739)	(741)	(716)	(741)	(717)	(738)	(3653)	(8711)
SUM60 EXPOSURE INDEX	-	-	-	-	426	1411	1550	244	243	130	-	-	3874	4004
NO. OF HOURS	(0)	(0)	(0)	(7)	(22)	(24)	(4)	(4)	(2)	(0)	(0)	(0)	(61)	(63)
SUM80 EXPOSURE INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
W126 EXPOSURE INDEX	237	361	972	921	1909	2380	2362	1536	780	213	137	138	8966	11946
NO. OF HOURS	(738)	(669)	(738)	(717)	(741)	(716)	(739)	(741)	(716)	(741)	(717)	(738)	(3653)	(8711)

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

\* Statistics defined in the Quick Look subsection of the Glossary

4/21/03

Frequency Distribution										
Theodore Roosevelt National Park Visitor Center										
Monitoring Season: 05/01/02 - 09/30/02 <sup>1</sup>										
Averaging Period	Min.	Percentile <sup>5</sup>	Max.	2nd	Arith.	Geo.	Geo.	Geo.	Geo.	Geo.
% Obs. <sup>3</sup>	# Obs. <sup>2</sup>	Obs. <sup>4</sup>	10	30	50	70	90	95	99	Mean
1-Hour	100	3653	0.027	0.036	0.044	0.049	0.053	0.060	0.062	0.070
Concentrations in parts per million (ppm)										
1-Hour	100	3653	0.027	0.036	0.044	0.049	0.053	0.060	0.062	0.070

<sup>1</sup>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.

<sup>2</sup>The number of observations (# Obs.) includes all valid observations recorded within the Monitoring Season.

<sup>3</sup>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..

<sup>4</sup>The minimum observation value (Min. Obs.) is the minimum daily maximum recorded during the Monitoring Season.

<sup>5</sup>The percentiles and other statistics are derived from the daily maximums.

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

Theodore Roosevelt National Park

**Visitor Center**

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	.030 T	.038 F	.036 F	.039 M	.047 W	.060 S	.047 M	.027 T	.056 S	.031 T	.031 F	.031 S
2	.038 W	.038 S	.040 S	.032 T	.049 T	.050 S	.051 T	.042 F	.044 M	.031 W	.036 S	.021 M
3	.030 T	.035 S	.043 S	.041 W	.047 F	.042 M	.055 W	.041 S	.044 T	.034 T	.032 S	.022 T
4	.029 F	.037 M	.037 M	.046 T	.044 S	.041 T	.070 T	.038 S	.052 W	.028 F	.036 M	.033 W
5	.031 S	.040 T	.038 T	.046 F	.048 S	.053 W	.057 F	.044 M	.061 T	.025 S	.036 T	.026 T
6	.034 S	.040 W	.042 W	.051 S	.035 M	.053 T	.052 S	.062 T	.035 F	.032 S	.034 W	.041 F
7	.030 M	.043 T	.041 T	.034 S	.036 T	.054 F	.048 S	.049 W	.036 S	.034 M	.037 T	.031 S
8	.039 T	.038 F	.038 F	.039 M	.044 W	.051 S	.051 M	.048 T	.036 S	.035 T	.039 F	.030 S
9	.037 W	.035 S	.044 S	.034 T	.054 T	.037 S	.044 T	.046 F	.045 M	.043 W	.035 S	.030 M
10	.036 T	.039 S	.044 S	.032 W	.049 F	.053 M	.041 W	.045 S	.044 T	.068 T	.026 S	.032 T
11	.037 F	.041 M	.050 M	.046 T	.047 S	.042 T	.049 T	.044 S	.049 W	.039 F	.028 M	.037 W
12	.043 S	.039 T	.044 T	.044 F	.050 S	.039 W	.052 F	.032 M	.046 T	.029 S	.028 T	.037 T
13	.037 S	.044 W	.044 W	.049 S	.049 M	.044 T	.048 S	.039 T	.049 F	.042 S	.030 W	.034 F
14	.036 M	.037 T	.037 T	.046 S	.058 T	.052 F	.051 S	.046 W	.039 S	.033 M	.023 T	.031 S
15	.037 T	.042 F	.041 F	.053 M	.049 W	.052 S	.059 M	.034 T	.049 S	.035 T	.017 F	.030 S
16	.031 W	.044 S	.046 S	.045 T	.045 T	.055 S	.068 T	.052 F	.057 M	.026 W	.033 S	.034 M
17	.032 T	.042 S	.039 S	.050 W	.059 F	.057 M	.060 W	.037 S	.049 T	.032 T	.041 S	.016 T
18	.031 F	.040 M	.040 M	.044 T	.056 S	.043 T	.063 T	.040 S	.030 W	.025 F	.035 M	.033 W
19	.034 S	.036 T	.042 T	.042 F	.053 S	.041 W	.067 F	.056 M	.035 T	.032 S	.033 T	.036 T
20	.033 S	.033 W	.042 W	.043 S	.054 M	.040 T	.049 S	.049 T	.044 F	.021 S	.027 W	.030 F
21	.038 M	.041 T	.047 T	.038 S	.060 T	.060 F	.041 S	.046 W	.027 S	.027 M	.034 T	.027 S
22	.038 T	.035 F	.052 F	.048 M	.055 W	.054 S	.031 M	.047 T	.034 S	.032 T	.034 F	.029 S
23	.034 W	.032 S	.052 S	.054 T	.039 T	.051 S	.054 T	.054 F	.034 M	.030 W	.031 S	.035 M
24	.037 T	.034 S	.045 S	.045 W	.047 F	.053 M	.053 W	.056 S	.032 T	.028 T	.031 S	.029 T
25	.036 F	.035 M	.043 M	.047 T	.045 S	.056 T	.052 T	.059 S	.038 W	.029 F	.029 M	.033 W
26	.033 S	.039 T	.049 T	.048 F	.050 S	.054 W	.054 F	.056 M	.042 T	.033 S	.029 T	.035 T
27	.035 S	.043 W	.048 W	.038 S	.043 M	.061 T	.048 S	.059 T	.038 F	.024 S	.029 W	.033 F
28	.035 M	.035 T	.047 T	.050 S	.044 T	.072 F	.046 S	.050 W	.040 S	.023 M	.032 T	.035 S
29	.032 T	.044 F	.048 M	.052 W	.065 S	.036 M	.057 T	.046 S	.031 T	.036 F	.030 S	
30	.035 W	.044 S	.050 T	.062 T	.042 S	.044 T	.060 F	.042 M	.035 W	.032 S	.034 M	
31	.035 T	.043 S	.054	.062 F	.062 F	.045 W	.057 S	.033 T	.031 T	.030 S	.034 M	
Valid Days	31	28	30	30	31	30	31	31	30	31	30	30
Maximum	.043	.044	.052	.054	.062	.072	.070	.062	.061	.068	.041	.041
Violations	0	0	0	0	0	0	0	0	0	0	0	0

8689 Total Samples  
99.5 % Possible  
363 Valid daily maxima  
Final Validation

0 Daily-maxima exceeding the standard of .12 ppm (starred[\*])

1 Missing days assumed to be less than the standard  
0 Daily maxima exceed the alert level of .200 ppm

Concentrations in parts per million (ppm)  
4/22/03

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

Ozone Season: May 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)
2002	59	100%	Yes	67	66	63	62	59

**Ozone Analyzer**  
**10 Highest Daily 1-Hour Average Maximum Concentrations**  
**Theodore Roosevelt National Park**  
**Visitor Center**  
**Final Validation**  
**01/01/2002 - 12/31/2002**

Value	Date	Hour	Concentration (ppb)
<b>Ozone Analyzer</b>			
1	06/28/2002	17	72
2	07/04/2002	13	70
3	07/16/2002	14	68
4	10/10/2002	15	68
5	07/19/2002	15	67
6	06/29/2002	12	65*
7	07/18/2002	16	63*
8	05/30/2002	10	62
9	05/31/2002	14	62
10	08/06/2002	17	62**

\* 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

Theodore Roosevelt National Park  
Visitor Center

01/01/2002 - 12/31/2002

FINAL VALIDATION

Site	Date	Beginning Hour	No. Hours		Max (ppb)
			≥ 100 ppb	>124 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/m<sup>3</sup> exceeds the standard.) (40 CFR 50.9 with reference to Appendix D and H.)

**Episodes with 8-Hour Average Ozone Concentrations > 84 ppb**

**Theodore Roosevelt National Park  
Visitor Center**

**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<sup>3</sup>).

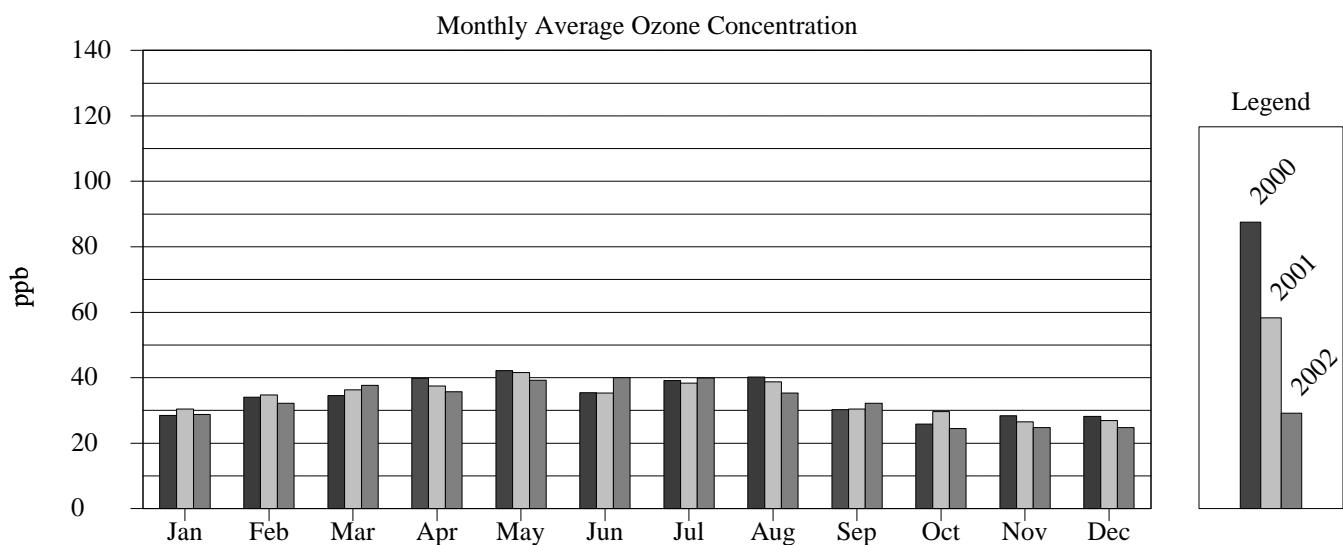
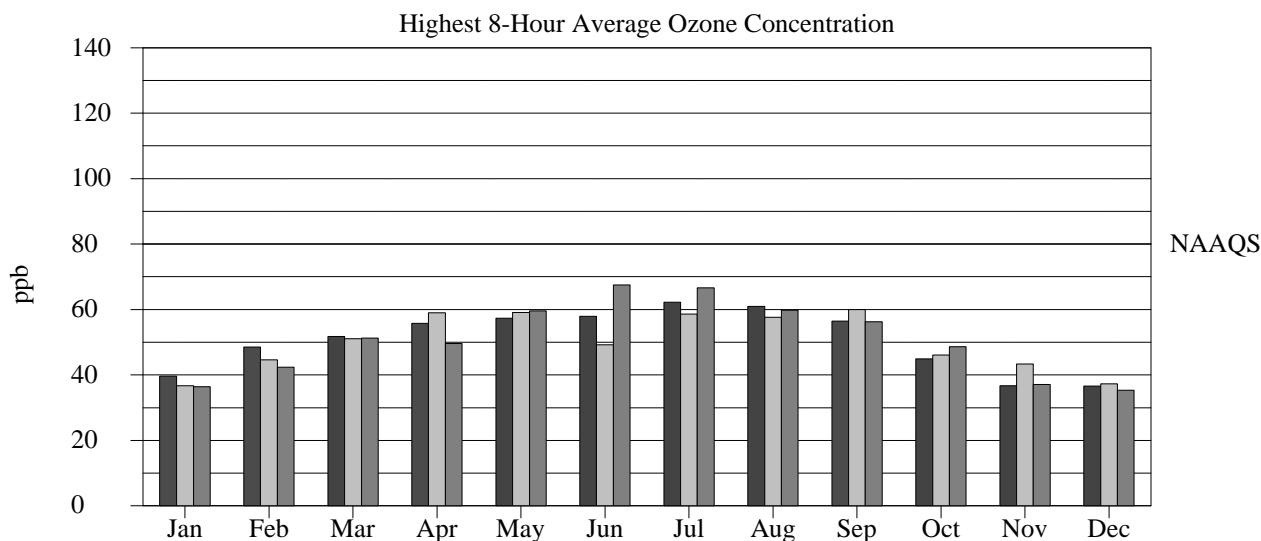
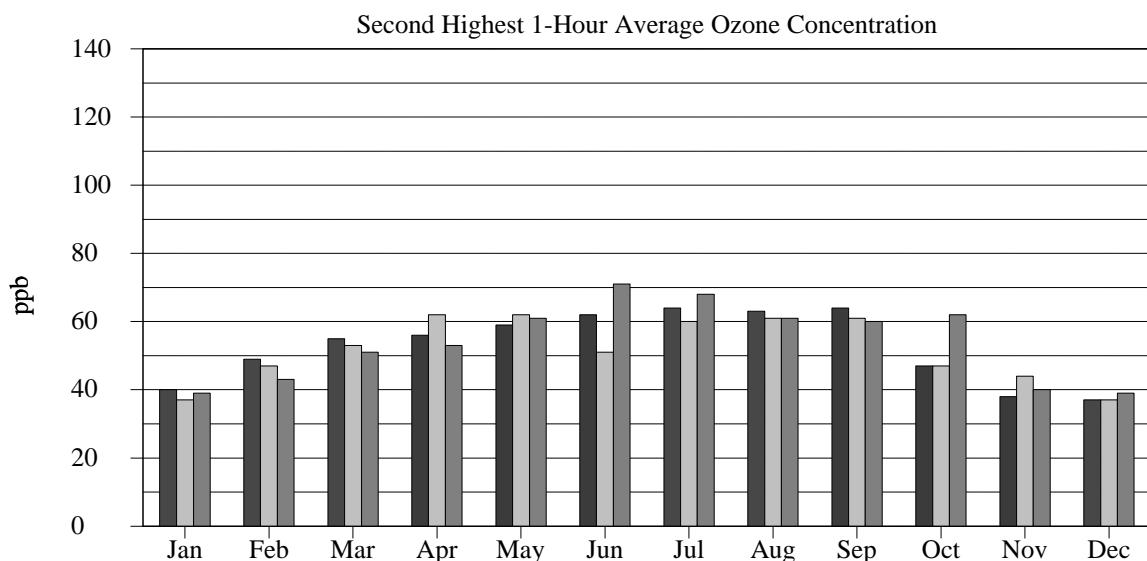
**Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest  
8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites**

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

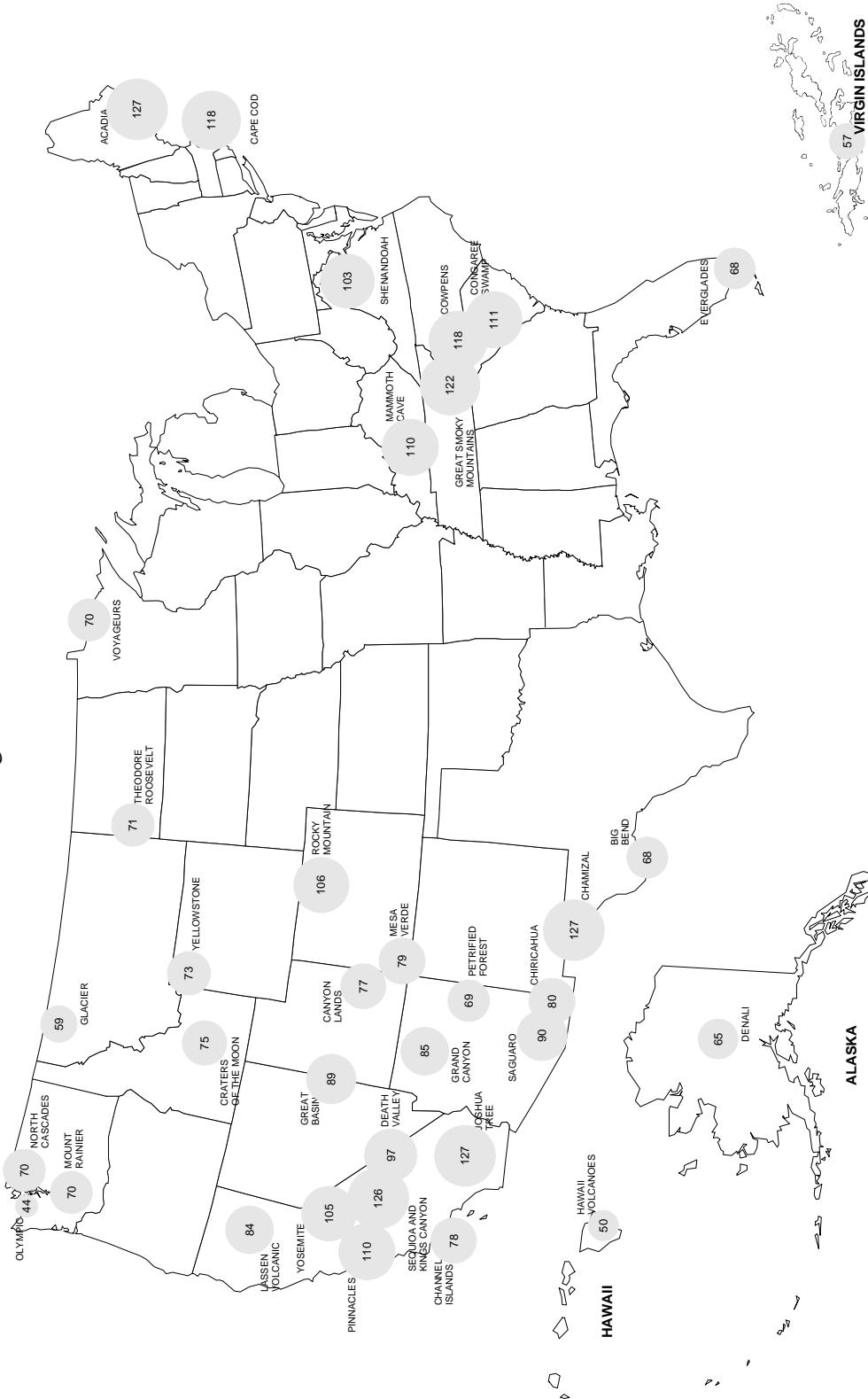
4th Highest 8-hour Average Concentration		
Site	Rank	Concentration (ppb)
SEKI-LP	1	109
SEKI-LK	2	108
JOTR-YV	3	107
SEKI-AS	4	107
GRSM-CM	5	103
GRSM-LR	6	102
GRSM-CD	7	101
ACAD-CM	8	100
GRSM-PK	9	94
CACO-XX	10	93
COWP-XX	11	93
YOSE-TD	12	93
ACAD-MH	13	89
CHAM-XX	14	89
ROMO-LP	15	87
PINN-ES	16	86
SHEN-BM	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



NATIONAL PARK SERVICE  
GASEOUS POLLUTANT MONITORING NETWORK

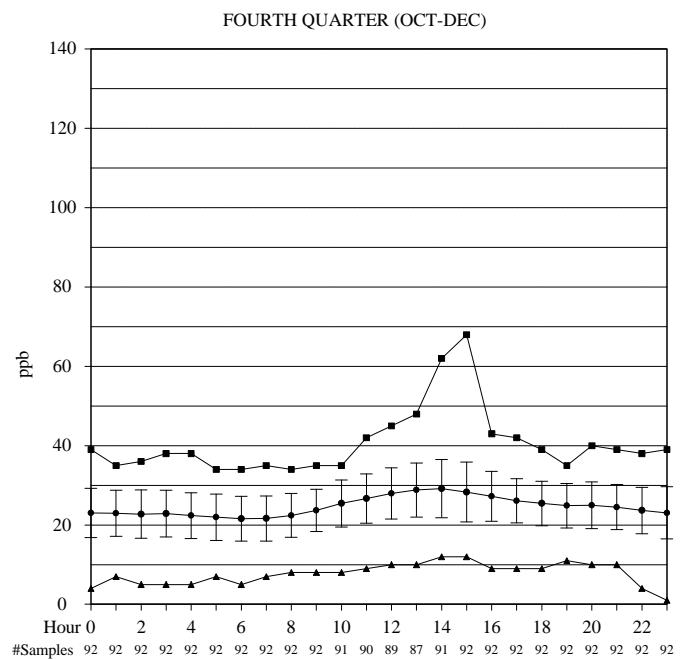
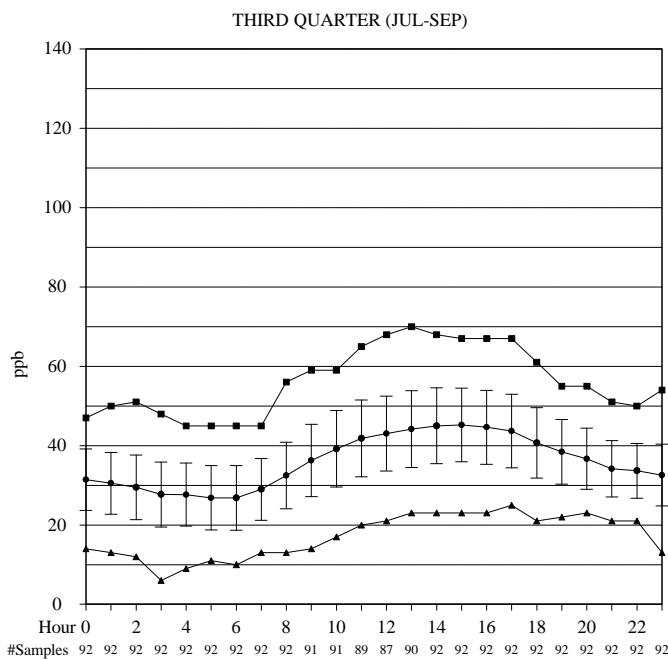
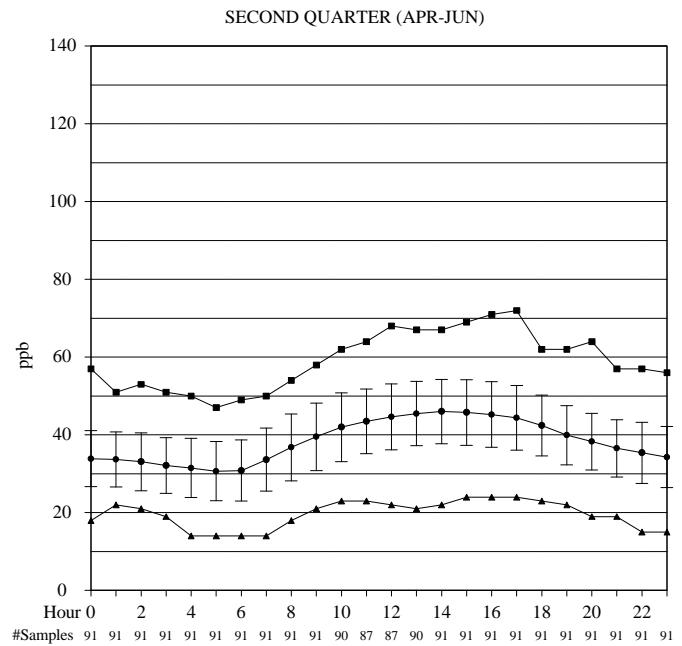
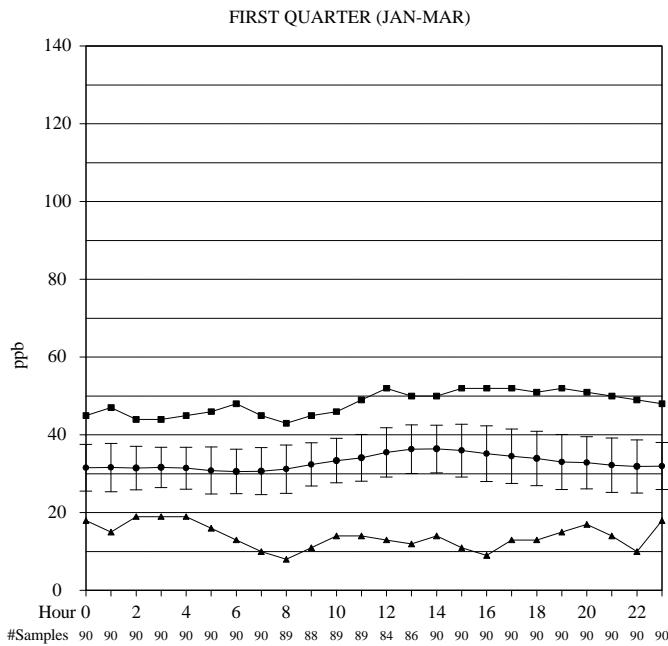
2002 Second Highest 1-Hour Ozone Concentrations



Theodore Roosevelt  
National Park  
Visitor Center

Quarterly Diurnal  
Ozone Plots

2002

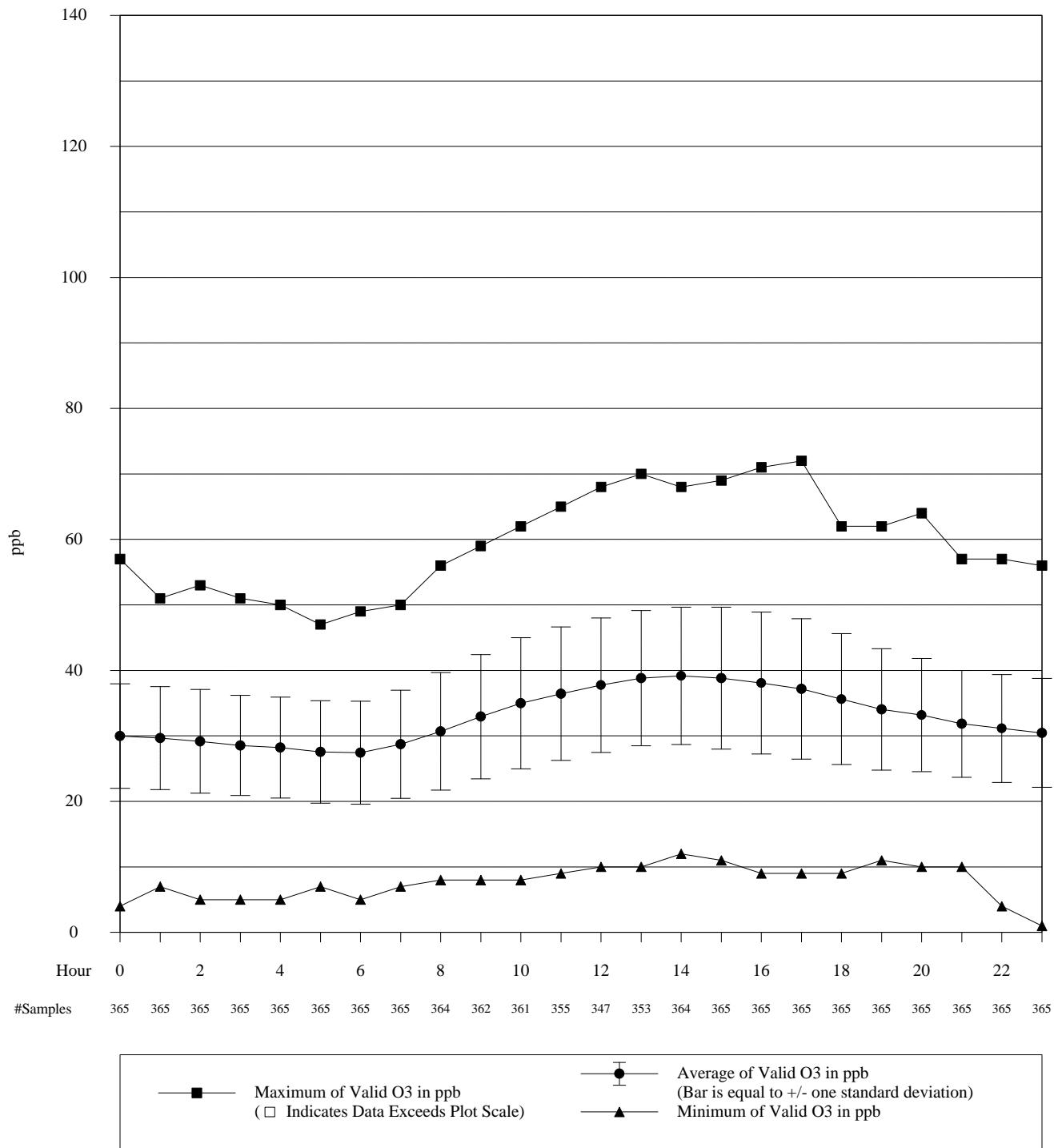


—■— Maximum of Valid O <sub>3</sub> in ppb	—□— Average of Valid O <sub>3</sub> in ppb (Bar is equal to +/- one standard deviation)
(□ Indicates Data Exceeds Plot Scale)	—▲— Minimum of Valid O <sub>3</sub> in ppb

Theodore Roosevelt  
National Park  
Visitor Center

Annual Diurnal  
Ozone Plot

2002

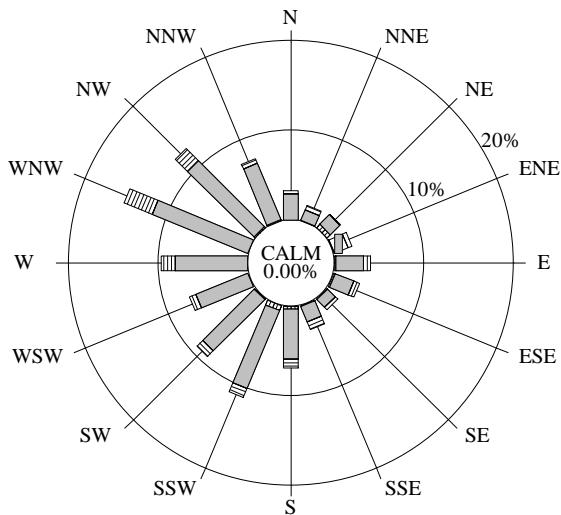


Theodore Roosevelt  
National Park  
Visitor Center

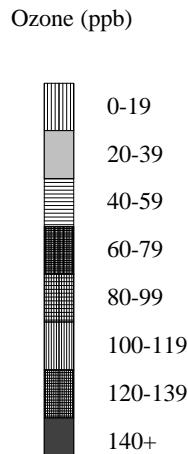
Quarterly Ozone  
Pollutant Rose

2002

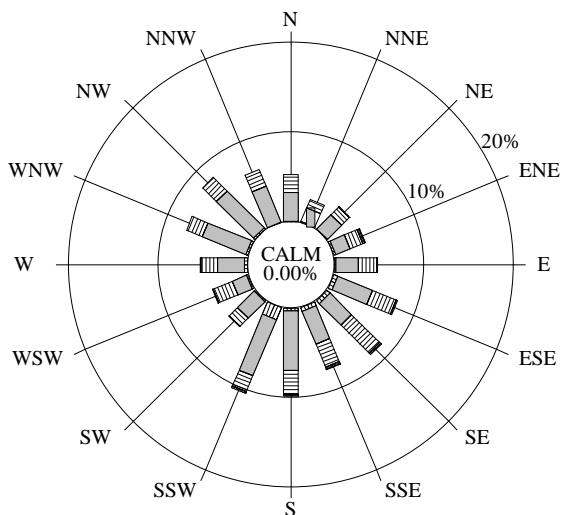
FIRST QUARTER (JAN-MAR)



99.3% Collected 99.3% Valid  
2160 Possible /2144 Collected /2144 Valid  
(includes WS and WD)



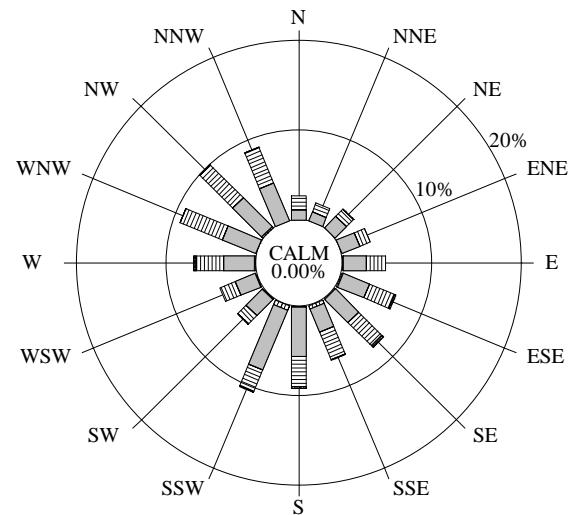
THIRD QUARTER (JUL-SEP)



94.1% Collected 94.0% Valid  
2208 Possible /2077 Collected /2076 Valid  
(includes WS and WD)

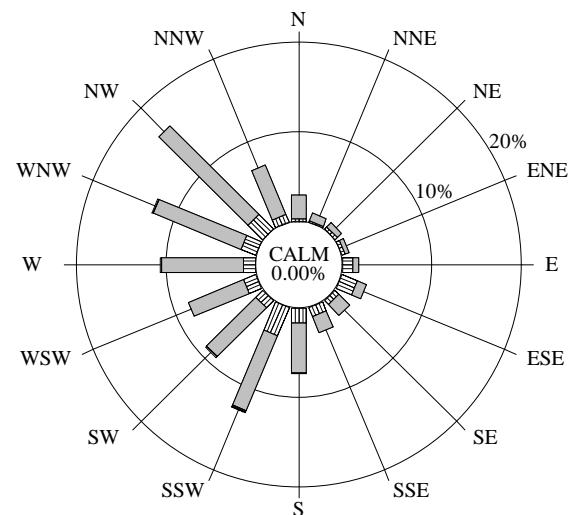
Final Validation

SECOND QUARTER (APR-JUN)



94.7% Collected 94.7% Valid  
2184 Possible /2068 Collected /2068 Valid  
(includes WS and WD)

FOURTH QUARTER (OCT-DEC)



99.5% Collected 99.5% Valid  
2208 Possible /2197 Collected /2196 Valid  
(includes WS and WD)

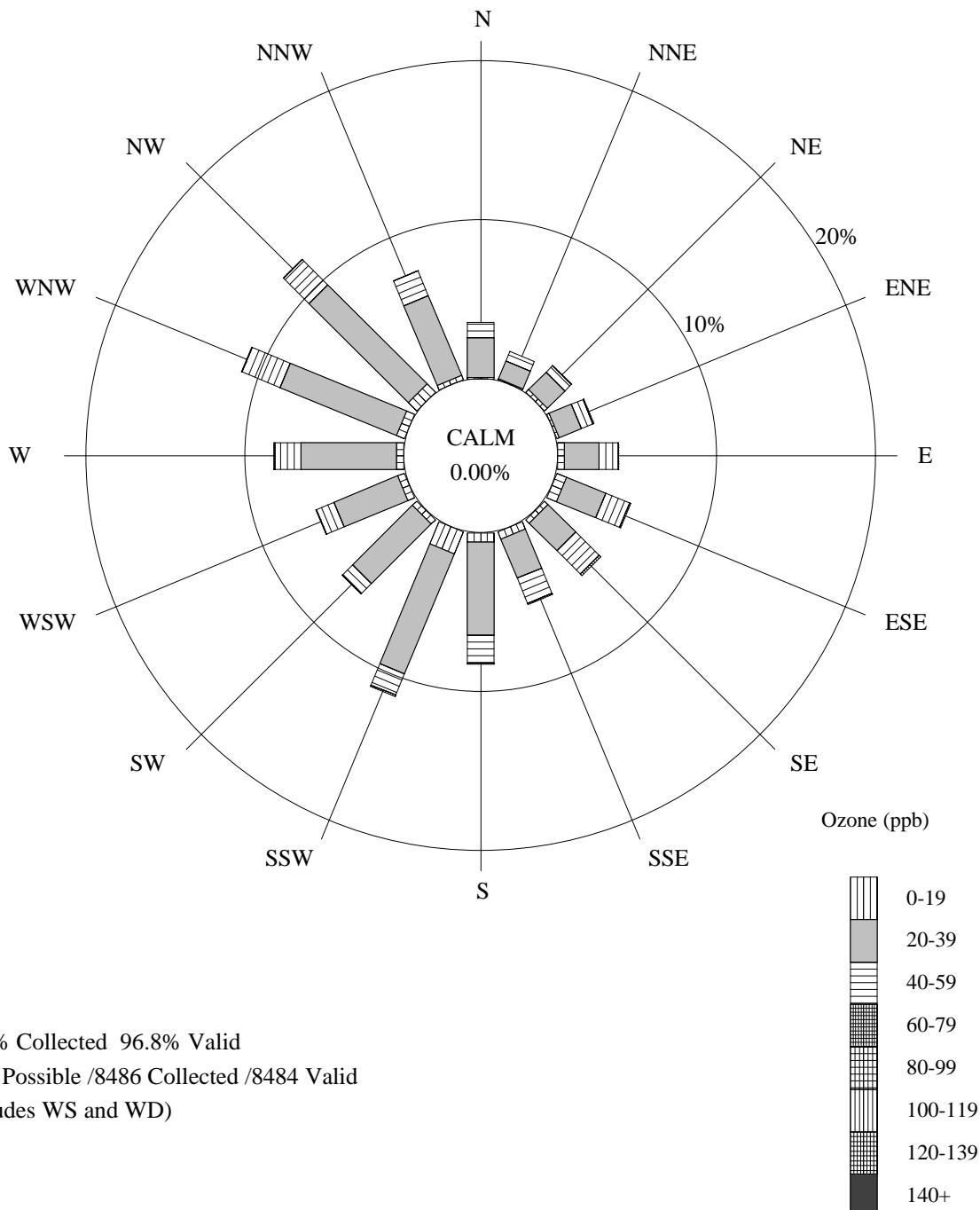
2-20

04-18-2003

Theodore Roosevelt  
National Park  
Visitor Center

Annual Ozone  
Pollutant Rose

2002



## Ozone Analyzer Precision Check Summary

### Theodore Roosevelt National Park Visitor Center

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.<sup>1</sup> 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<sup>2</sup> of all the individual precision check percent differences for the quarter, and the upper and lower 95% probability limits<sup>3</sup> 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 <sup>1 2</sup>	Lower 95% Probability Limit <sup>3</sup>	Upper 95% Probability Limit <sup>3</sup>
1	7	-1.07	-4.05	1.91
2	6	3.13	1.08	5.17
3	7	1.94	-4.16	8.03
4	7	-1.96	-6.41	2.48

<sup>1</sup> Percent Difference=  $\frac{\text{analyzer} - \text{transfer std}}{\text{transfer std}}$  X 100.

<sup>2</sup> Average Percent Difference is the mean of all individual precision check percent differences during the quarter.

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

## **2.3 SULFUR DIOXIDE DATA SUMMARY**

**Sulfur Dioxide**  
**Five Highest Daily 1-Hour Averages, 3-Hour Block Averages,  
 and 24-Hour Block Averages**

Theodore Roosevelt National Park

Visitor Center

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

Rank	Date	Hour	Concentration (ppb)
<b>Highest Daily 1-Hour Averages</b>			
1	10/10/02	14	26.0
2	01/26/02	16	15.0
3	10/24/02	14	15.0
4	01/28/02	18	10.0
5	05/21/02	13	10.0 **
<b>Highest 3-Hour Block Averages</b>			
1	01/26/02	15-17	10.0
2	10/24/02	15-17	9.7
3	10/10/02	12-14	9.3
4	01/28/02	18-20	8.7
5	05/21/02	12-14	8.7
<b>Highest 24-Hour Block Averages</b>			
1	09/05/02	00-23	4.8
2	01/28/02	00-23	2.8
3	10/24/02	00-23	2.6
4	01/29/02	00-23	2.5
5	05/21/02	00-23	2.4

\*\* This value was also recorded on one or more days later in the period.

Note: The primary and secondary ambient air standards for SO<sub>2</sub> are:

Annual Primary Standard - 0.03 ppm; annual arithmetic mean not to be exceeded.

(A value greater than .03 ppm, 34 ppb, or 80 µg/m<sup>3</sup> exceeds the standard.)

24-Hour Primary Standard - 0.14 ppm; not to be exceeded more than once per year.

(A value greater than .14 ppm, 144 ppb, or 365 µg/m<sup>3</sup> exceeds the standard.)

3-Hour Secondary Standard - 0.5 ppm); not to be exceeded more than once per year.

(A value greater than .5 ppm, 549 ppb, or 1300 µg/m<sup>3</sup> exceeds the standard.)

(40 CFR 50.4 and 50.5 with reference to Appendix A.)

**Sulfur Dioxide Standards Report and  
Daily Maximum 1-Hour Average (ppm)**  
**Theodore Roosevelt National Park - Visitor Center**  
**01/01/2002 - 12/31/2002**

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Obs	Max
1	0.001	0.001	0.001	0.002	0.001	0.003	0.002	0.001	0.003	0.001	0.001	0.002	12	0.003
2	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	12	0.002
3	0.001	0.002	0.001	0.001	0.001	0.001	0.004	0.001	0.002	0.001	0.001	0.001	12	0.004
4	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.005	0.001	0.001	0.001	12	0.005
5	0.001	0.001	0.008	0.002	0.001	0.002	0.001	0.010	0.001	0.001	0.001	0.001	12	0.010
6	0.001	0.001	0.004	0.001	0.002	0.001	0.002	0.001	0.003	0.001	0.001	0.001	12	0.004
7	0.001	0.001	0.009	0.001	0.002	0.002	0.001	0.001	0.003	0.001	0.001	0.001	12	0.009
8	0.001	0.004	0.007	0.001	0.002	0.003	0.002	0.001	0.002	0.001	0.001	0.002	12	0.007
9	0.001	0.003	0.001	0.002	0.001	0.001	0.001	0.001	0.003	0.003	0.001	0.001	12	0.003
10	0.001	0.001	0.001	0.002	0.003	0.001	0.002	0.001	0.002	0.026	0.001	0.001	12	0.026
11	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	12	0.002
12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.006	0.001	0.001	0.001	12	0.006
13	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	12	0.001
14	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	12	0.002
15	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	12	0.002
16	0.002	0.001	0.001	0.002	0.001	0.001	0.003	0.001	0.002	0.002	0.001	0.001	12	0.003
17	0.003	0.001	0.001	0.001	0.003	0.001	0.004	0.001	0.002	0.002	0.001	0.001	12	0.004
18	0.001	0.005	0.003	0.002	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	12	0.005
19	0.001	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.008	0.001	0.001	0.001	12	0.008
20	0.001	0.001	0.006	0.001	0.001	0.002	0.001	0.001	0.005	0.001	0.001	0.001	12	0.006
21	0.001	0.001	0.003	0.001	0.010	0.001	0.001	0.002	0.001	0.005	0.001	0.001	12	0.010
22	0.002	0.003	0.001	0.002	0.005	0.003	0.002	0.001	0.002	0.002	0.003	0.003	12	0.005
23	0.001	0.001	0.005	0.001	0.001	0.003	0.001	0.003	0.001	0.004	0.001	0.001	12	0.005
24	0.001	0.001	0.001	0.001	0.004	0.001	0.003	0.001	0.015	0.001	0.001	0.002	12	0.015
25	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	12	0.002
26	0.015	0.001	0.001	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.001	0.001	12	0.015
27	0.005	0.001	0.002	0.001	0.003	0.002	0.001	0.002	0.005	0.001	0.002	0.001	12	0.005
28	0.010	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	12	0.010
29	0.008	0.001	0.001	0.001	0.002	0.001	0.003	0.001	0.001	0.001	0.001	0.001	11	0.008
30	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.005	0.001	0.001	0.001	0.001	11	0.005
31	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.003	0.001	0.001	0.001	7	0.003
Number	31	28	31	30	31	30	31	31	30	31	30	31	31	31
Maximum	0.015	0.005	0.009	0.002	0.010	0.005	0.004	0.003	0.010	0.026	0.002	0.003		
Mean	0.0023	0.0014	0.0025	0.0012	0.0017	0.0018	0.0015	0.0015	0.0024	0.0031	0.0011	0.0012		Annual Maximum: 0.026
Annual Observations:	365													

Sulfur Dioxide Standards Report and Daily Maximum 24-Hour Average (ppm)												
Theodore Roosevelt National Park - Visitor Center												
01/01/2002 - 12/31/2002												
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
3	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.002
4	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
5	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.005
6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
7	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
8	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.001	0.003
11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
13	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
14	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
15	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
16	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002
17	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002
18	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
19	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002
20	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002
21	0.001	0.001	0.002	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.003
22	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.002
23	0.001	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.002
24	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.003	0.001	0.003
25	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002
26	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.003
27	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002
28	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.003
29	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002
30	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001
31	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002
Number	31	28	31	30	31	30	31	30	31	30	31	31
Maximum	0.003	0.002	0.002	0.001	0.003	0.002	0.002	0.005	0.003	0.003	0.001	0.001
Mean	0.0012	0.0010	0.0012	0.0010	0.0011	0.0010	0.0010	0.0013	0.0014	0.0013	0.0010	0.0010
Annual Observations: 365										Annual Mean: .0011	Annual Max: .0015	Annual Maximum: .0005
<b>0 Bolded Values Exceed Primary Standard of 0.145</b>												

**Sulfur Dioxide Standards Report and  
Daily Maximum 3-Hour Average (ppm)**  
**Theodore Roosevelt National Park - Visitor Center**  
**01/01/2002 - 12/31/2002**

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Obs	Max
1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	12	0.002
2	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	12	0.002
3	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.002	0.001	0.001	0.001	12	0.003
4	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	12	0.004
5	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.008	0.001	0.001	0.001	12	0.008
6	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	12	0.003
7	0.001	0.001	0.006	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	12	0.006
8	0.001	0.002	0.003	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	0.001	12	0.003
9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	12	0.002
10	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.009	0.001	0.001	12	0.009
11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	12	0.001
12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	12	0.003
13	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	12	0.001
14	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	12	0.001
15	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	12	0.002
16	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	12	0.002
17	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.002	0.001	0.001	12	0.003
18	0.001	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	12	0.004
19	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001	0.006	0.001	0.001	0.001	12	0.006
20	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	12	0.003
21	0.001	0.001	0.002	0.001	0.008	0.001	0.001	0.002	0.001	0.003	0.001	0.001	12	0.008
22	0.001	0.001	0.001	0.001	0.004	0.001	0.002	0.001	0.001	0.001	0.001	0.002	12	0.004
23	0.001	0.001	0.003	0.001	0.001	0.002	0.001	0.002	0.001	0.003	0.001	0.001	12	0.003
24	0.001	0.001	0.001	0.001	0.003	0.001	0.002	0.001	0.009	0.001	0.001	0.001	12	0.009
25	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	12	0.002
26	0.010	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	12	0.010
27	0.004	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.001	12	0.004
28	0.008	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001	12	0.008
29	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	11	0.005
30	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.001	11	0.002
31	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	7	0.002
Number	31	28	31	30	31	30	31	31	30	31	30	31	31	
Maximum	0.010	0.004	0.006	0.001	0.008	0.004	0.003	0.002	0.008	0.009	0.001	0.002		
Mean	0.0018	0.0011	0.0016	0.0010	0.0012	0.0013	0.0012	0.0014	0.0018	0.0020	0.0010	0.0010		
Annual Observations:	365													
														Annual Maximum: 0.010
														<b>0 Bolded Values Exceed Secondary Standard of 0.55</b>

Frequency Distribution										
Sulfur Dioxide Analyzer										
Theodore Roosevelt National Park - Visitor's Center										
Monitoring Season: 01/01/2002 - 12/31/2002 <sup>1</sup>										
Percentile <sup>4</sup>										
BLK AVG % Obs. <sup>2</sup> # Obs. <sup>3</sup>										
1-Hour										
99.4	8703	.001	.001	.001	.001	.002	.003	.004	.026	.015
24-Hour	365	.001	.001	.001	.002	.002	.003	.005	.003	.001
3-Hour	2880	.001	.001	.001	.001	.002	.002	.003	.010	.009
Concentrations in parts per million (ppm).										

<sup>1</sup> 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.

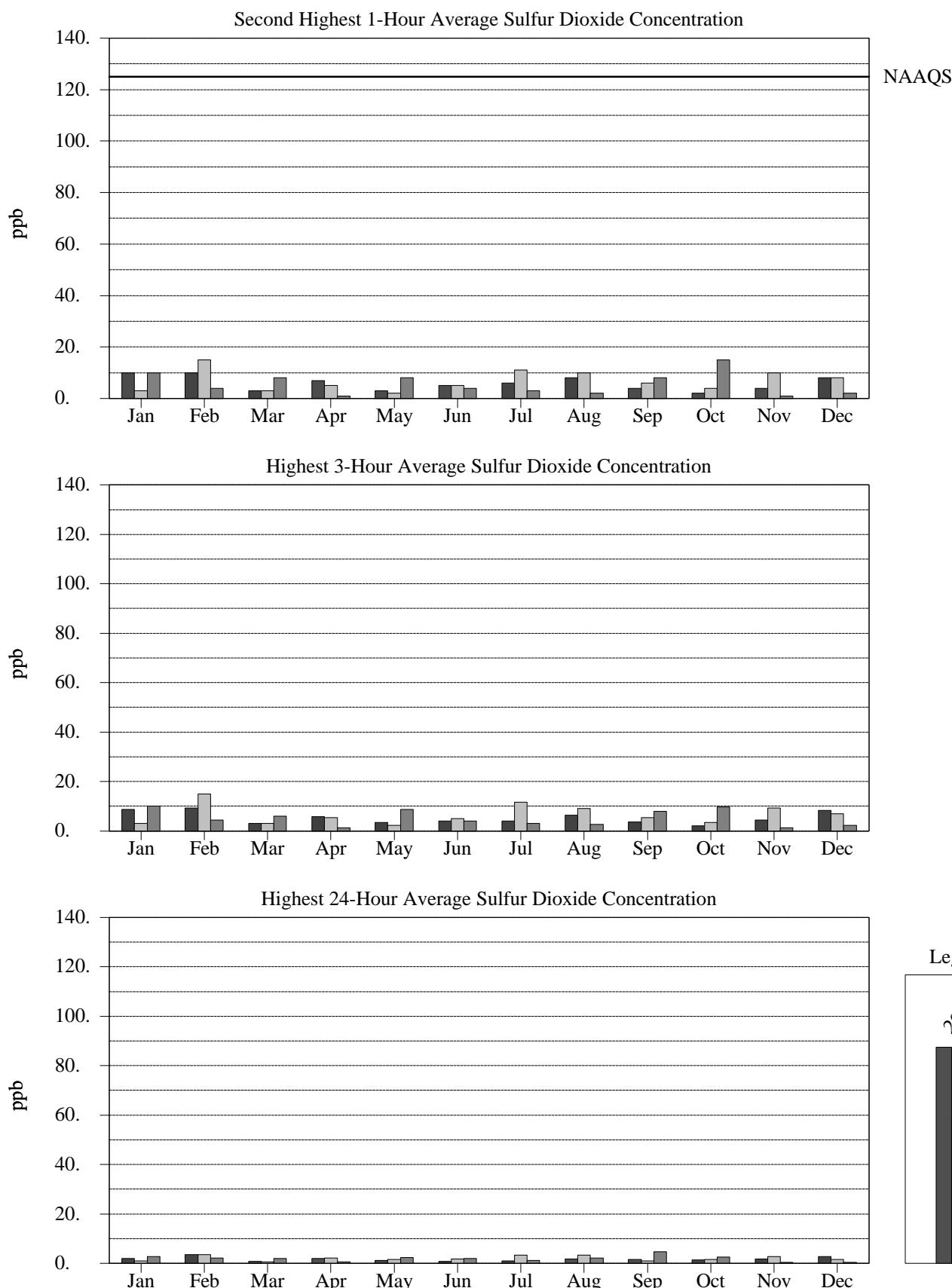
<sup>2</sup> The percent of valid observations (% Obs.) is the percentage of valid days to the number of possible monitoring days during the Monitoring Season.

<sup>3</sup> The number of observations (# Obs.) includes all valid observations recorded within the Monitoring Season.

<sup>4</sup> A valid day is defined as a day with 9 or more valid observations between 9:00 a.m. and 9:00 p.m..

<sup>5</sup> The percentiles and other statistics are derived from the daily maximums.

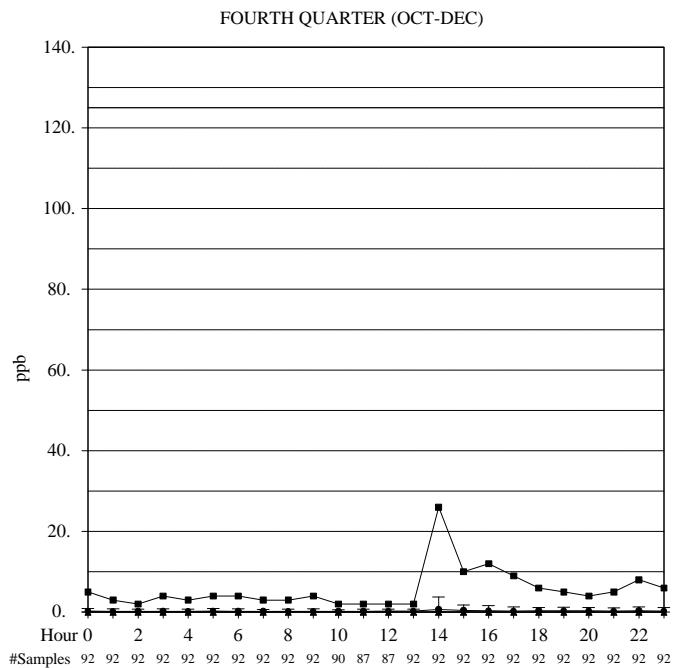
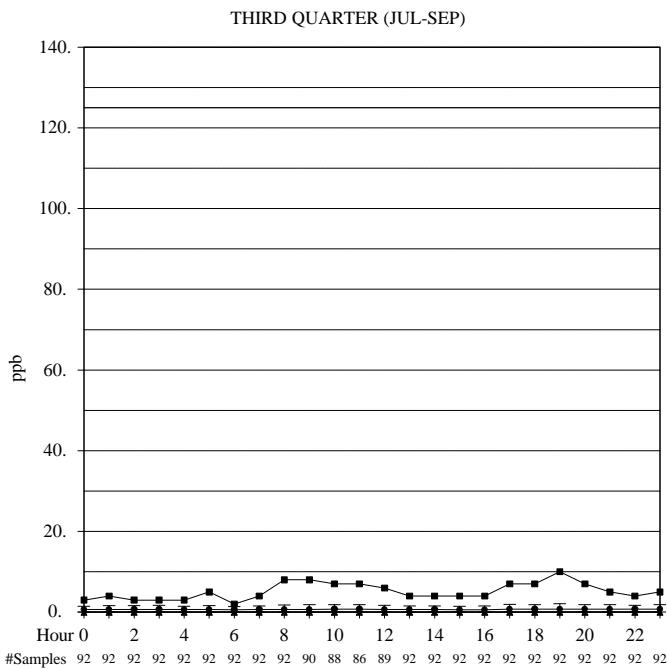
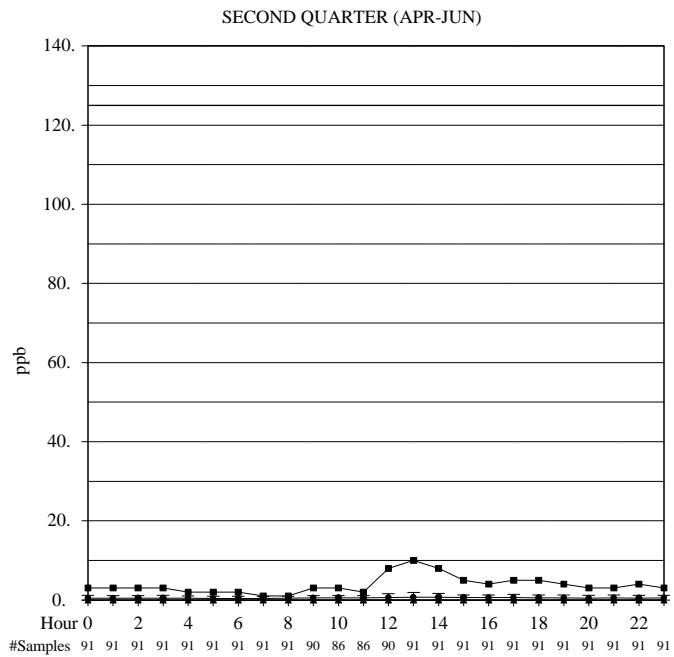
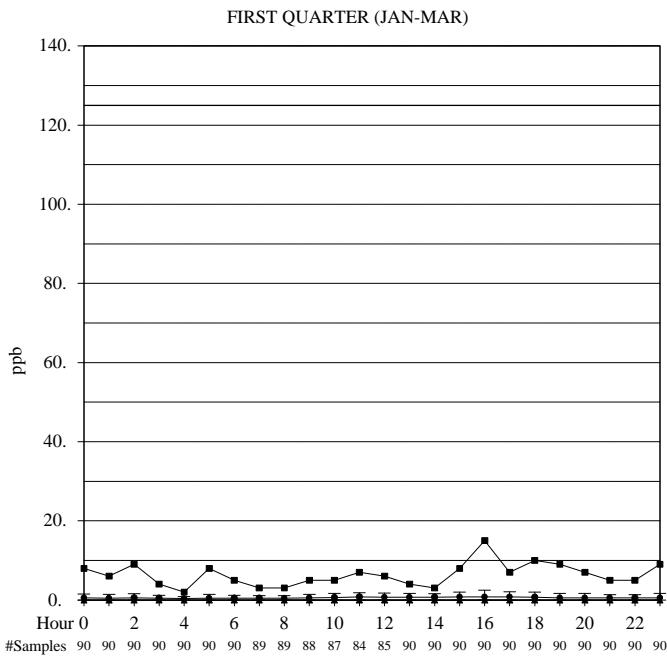
<sup>5</sup> The minimum observation value (Min. Obs.) is the minimum daily maximum recorded during the Monitoring Season.



Theodore Roosevelt  
National Park  
Visitor Center

Quarterly Diurnal  
Sulfur Dioxide Plots

2002

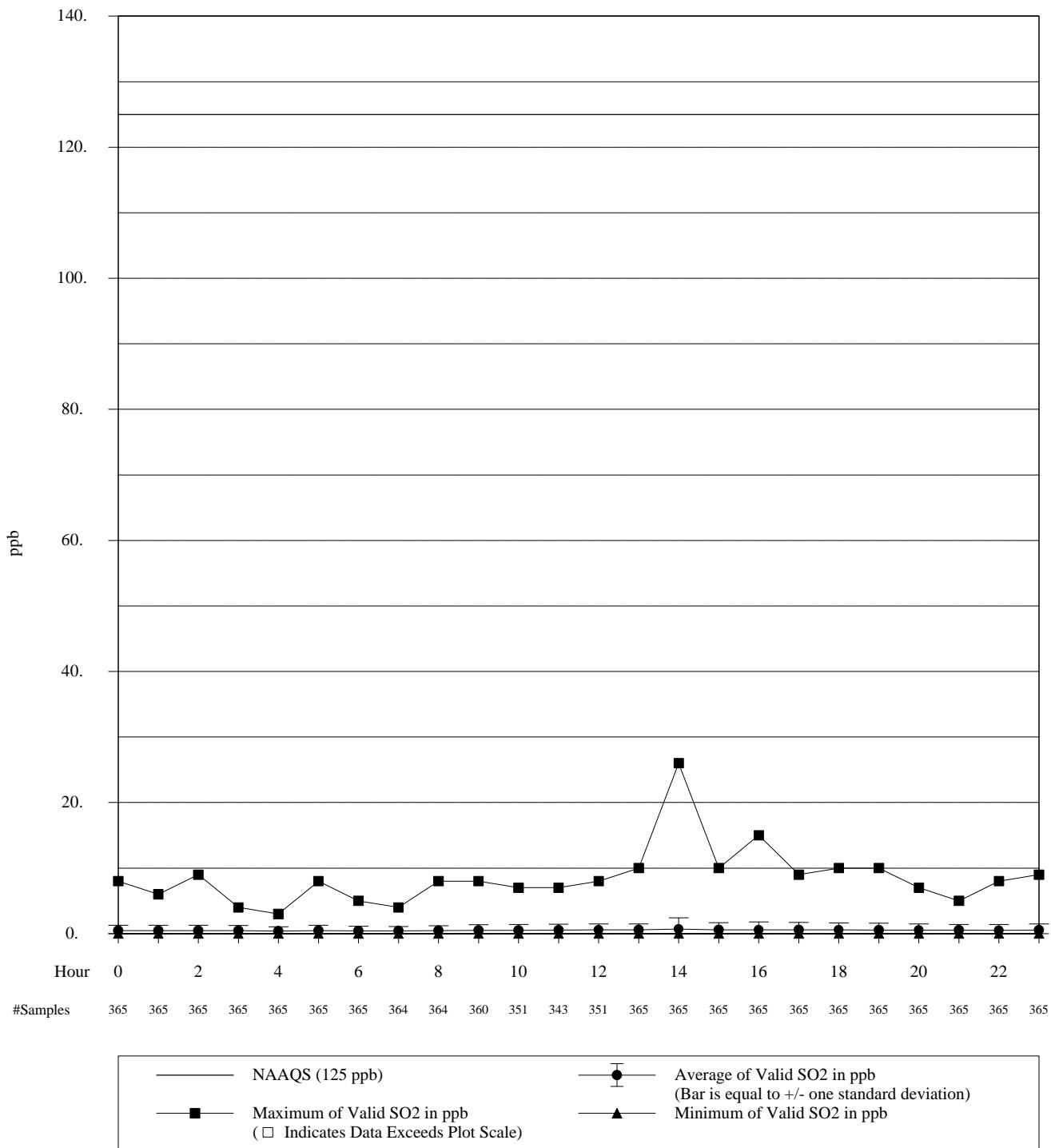


— NAAQS (125 ppb)	— Average of Valid SO <sub>2</sub> in ppb (Bar is equal to +/- one standard deviation)
■ Maximum of Valid SO <sub>2</sub> in ppb (□ Indicates Data Exceeds Plot Scale)	▲ Minimum of Valid SO <sub>2</sub> in ppb

Theodore Roosevelt  
National Park  
Visitor Center

Annual Diurnal  
Sulfur Dioxide Plot

2002

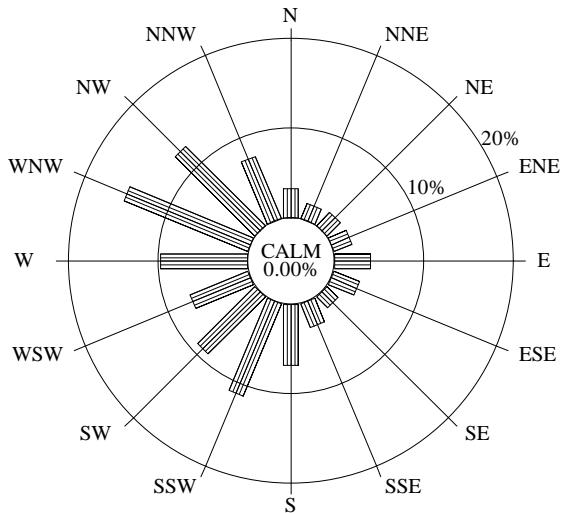


Theodore Roosevelt  
National Park  
Visitor Center

Quarterly Sulfur Dioxide  
Pollutant Rose

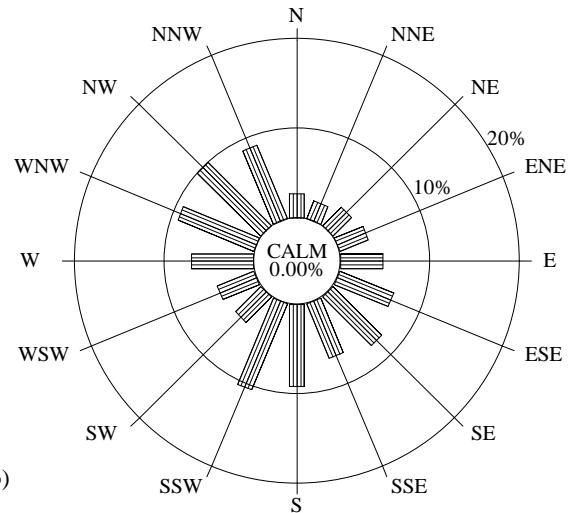
2002

FIRST QUARTER (JAN-MAR)



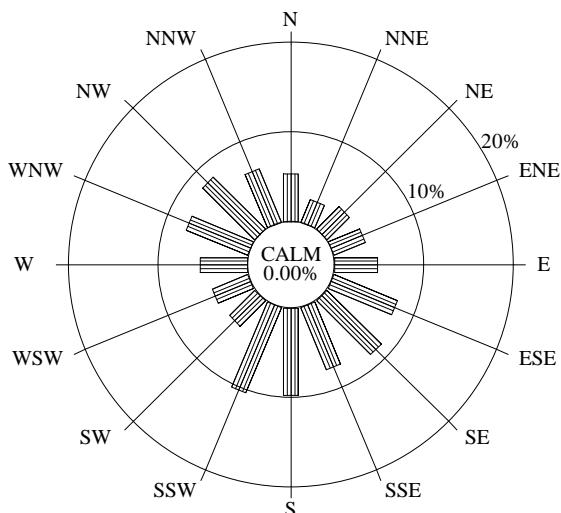
99.1% Collected 99.1% Valid  
2160 Possible /2141 Collected /2141 Valid  
(includes WS and WD)

SECOND QUARTER (APR-JUN)



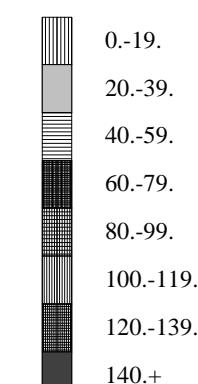
94.6% Collected 94.6% Valid  
2184 Possible /2066 Collected /2066 Valid  
(includes WS and WD)

THIRD QUARTER (JUL-SEP)

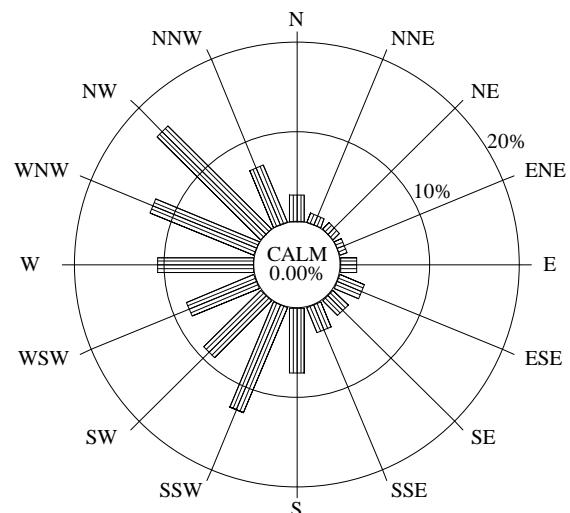


94.0% Collected 93.9% Valid  
2208 Possible /2076 Collected /2073 Valid  
(includes WS and WD)

Final Validation



FOURTH QUARTER (OCT-DEC)

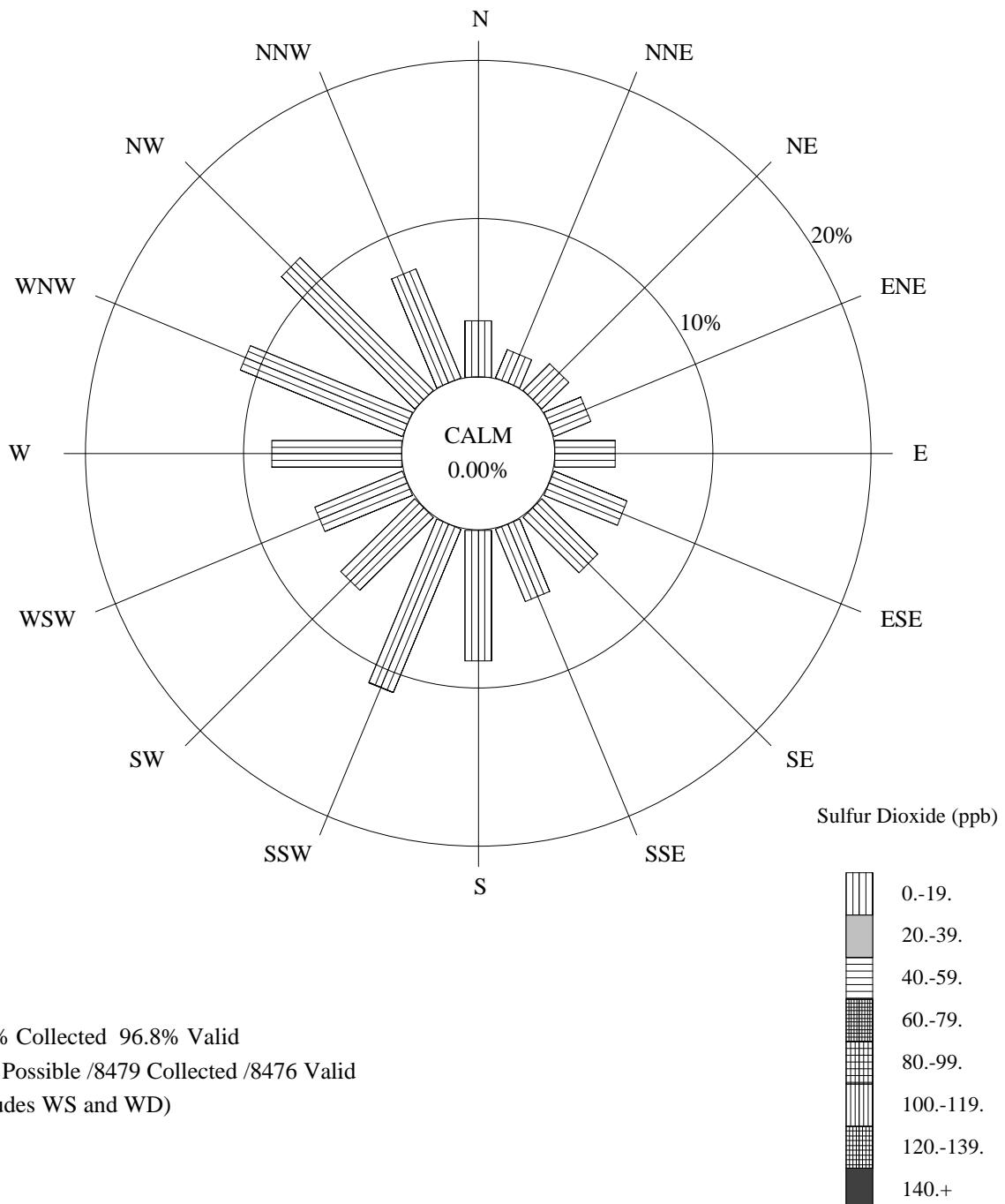


99.5% Collected 99.5% Valid  
2208 Possible /2196 Collected /2196 Valid  
(includes WS and WD)

Theodore Roosevelt  
National Park  
Visitor Center

Annual Sulfur Dioxide  
Pollutant Rose

2002



**Sulfur Dioxide Analyzer Precision Check Summary**  
**Theodore Roosevelt National Park**  
**Visitor Center**

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.<sup>1</sup> 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<sup>2</sup> of all the individual precision check percent differences for the quarter, and the upper and lower 95% probability limits<sup>3</sup> 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 <sup>1 2</sup>	Lower 95% Probability Limit <sup>3</sup>	Upper 95% Probability Limit <sup>3</sup>
1	7	1.59	0.42	2.75
2	6	-0.19	-1.07	0.70
3	7	-1.23	-5.05	2.59
4	7	-3.49	-4.32	-2.67

<sup>1</sup> Percent Difference=  $\frac{\text{analyzer} - \text{transfer std}}{\text{transfer std}}$  X 100.

<sup>2</sup> Average Percent Difference is the mean of all individual precision check percent differences during the quarter.

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

## **2.4 METEOROLOGICAL DATA SUMMARY**

## Summary of Selected Meteorological Data

Theodore Roosevelt National Park

Visitor Center

Final Validation

01/01/2002 - 12/31/2002

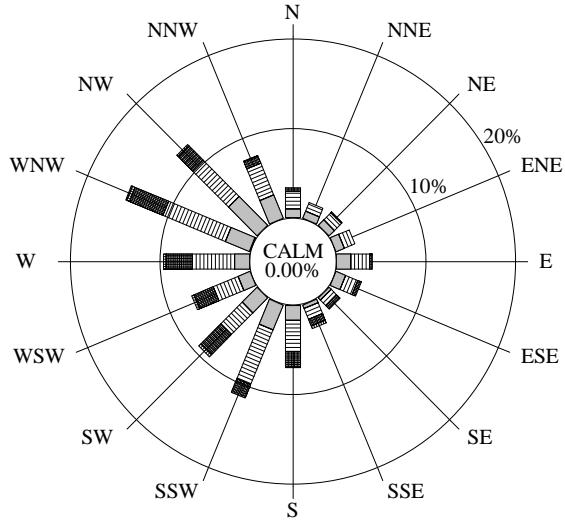
Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	5.3	m/s	8532	2.2
Maximum	16.4	m/s		
Percent calm = 0.00				
AMBIENT TEMPERATURE				
Average	5.9	degC	8529	12.3
Maximum	37.7	degC		
Minimum	-23.9	degC		
RELATIVE HUMIDITY				
Average	64	percent	8529	21
Maximum	100	percent		
Minimum	9	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	.9	mm/hr	254	2.4
Maximum non-zero rate	20.4	mm/hr		
Minimum non-zero rate	.1	mm/hr		
Accumulated during period	239.9	mm		
SOLAR RADIATION				
Average Daily Total	11,953,715	joules/m <sup>2</sup> day	349	7,069,719
Maximum Daily Total	26,662,400	joules/m <sup>2</sup> day		
Minimum Daily Total	716,800	joules/m <sup>2</sup> day		

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.

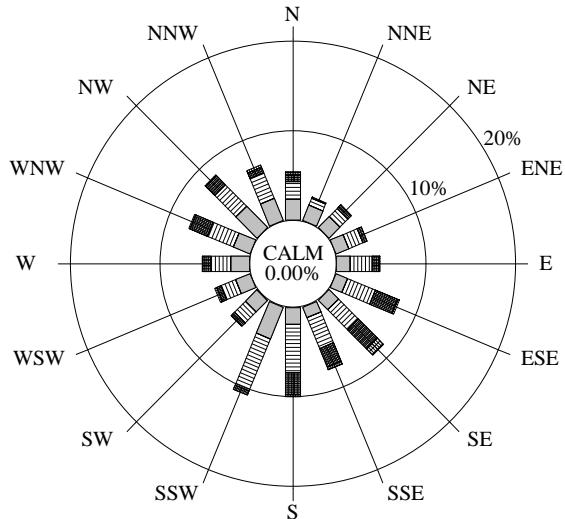
NA indicates instrument not available.

Theodore Roosevelt  
National Park  
Visitor Center  
FIRST QUARTER (JAN-MAR)



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

THIRD QUARTER (JUL-SEP)



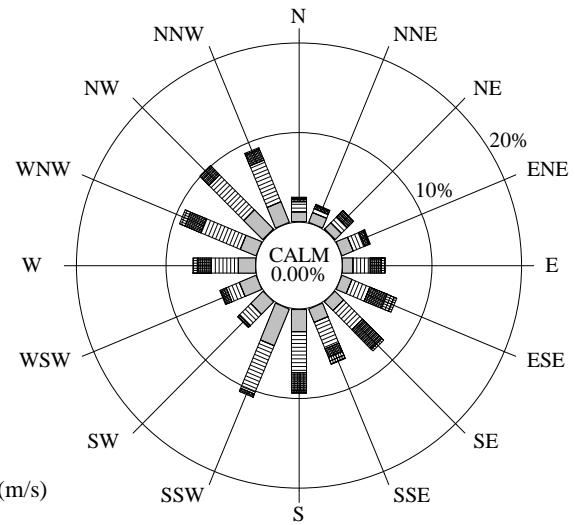
94.6% Collected 94.6% Valid  
2208 Possible /2089 Collected /2088 Valid  
(includes WS and WD)

Final Validation

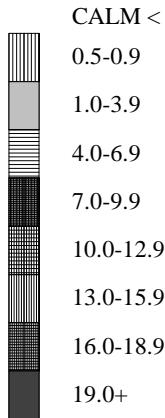
Quarterly Wind Rose

2002

SECOND QUARTER (APR-JUN)

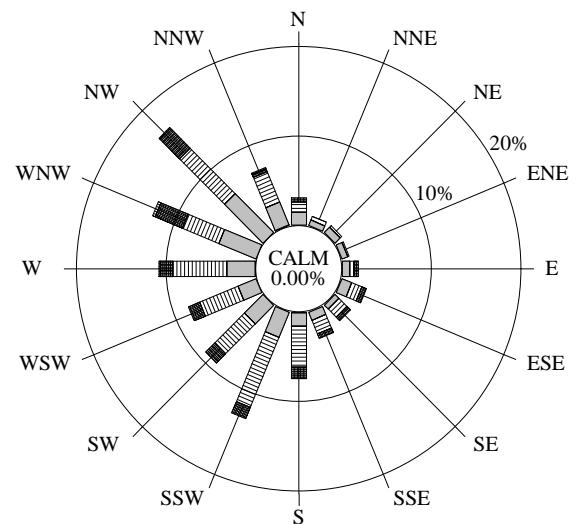


Scalar Wind Speed (m/s)



95.1% Collected 95.1% Valid  
2184 Possible /2078 Collected /2078 Valid  
(includes WS and WD)

FOURTH QUARTER (OCT-DEC)

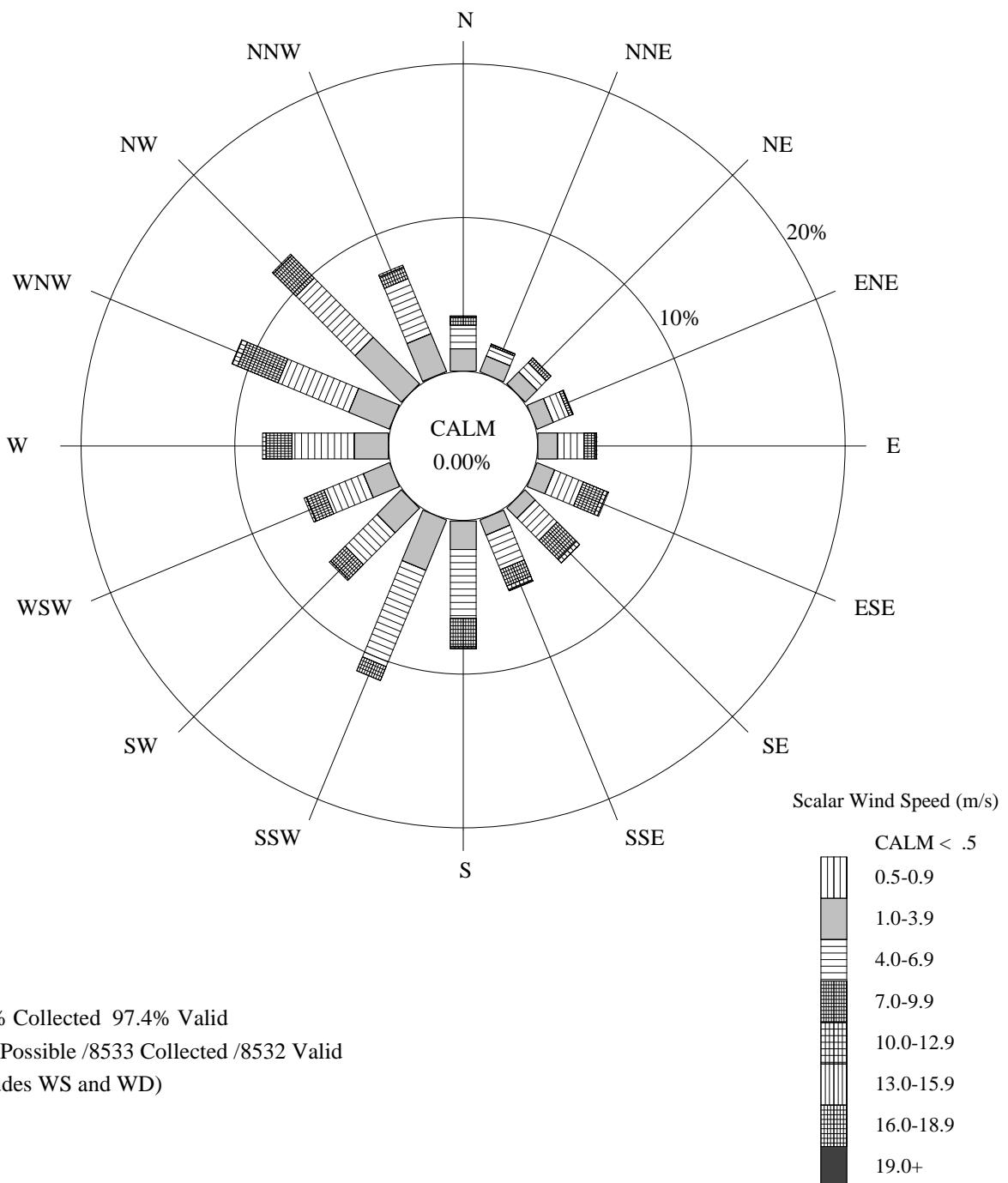


100.0% Collected 100.0% Valid  
2208 Possible /2208 Collected /2208 Valid  
(includes WS and WD)

Theodore Roosevelt  
National Park  
Visitor Center

Annual Wind Rose

2002



## **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 ( $\text{SO}_4^{2-}$ ), particulate nitrate ( $\text{NO}_3^-$ ), particulate ammonium ( $\text{NH}_4^+$ ), sulfur dioxide ( $\text{SO}_2$ ), and nitric acid ( $\text{HNO}_3$ ). In some cases, the positive ions  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$  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**  
**Theodore Roosevelt National Park**  
**1/1/02 - 12/31/02**

Quarter	No. Valid Samples	p-NO <sub>3</sub> (ug/m <sup>3</sup> )	HNO <sub>3</sub> (ug/m <sup>3</sup> )	Total NO <sub>3</sub> (ug/m <sup>3</sup> )	NH <sub>4</sub> (ug/m <sup>3</sup> )	p-SO <sub>4</sub> (ug/m <sup>3</sup> )	SO <sub>2</sub> (ug/m <sup>3</sup> )	SO <sub>4</sub> /SO <sub>2</sub> Ratio
1	13	0.705	0.463	1.161	0.556	1.227	1.589	0.772
2	13	0.511	0.759	1.258	0.536	1.446	0.733	1.974
3	13	0.265	1.298	1.542	0.447	1.511	1.018	1.484
4	14	0.801	0.393	1.188	0.502	1.020	0.971	1.051
Annual Average		0.575	0.722	1.286	0.510	1.296	1.076	1.205
Standard Deviation		0.431	0.524	0.566	0.311	0.679	0.609	

Data Recovery Table			
Total No. Filters	No. Invalidated	Data Capture	No. Valid Hours
53	0	100.0%	8645.0

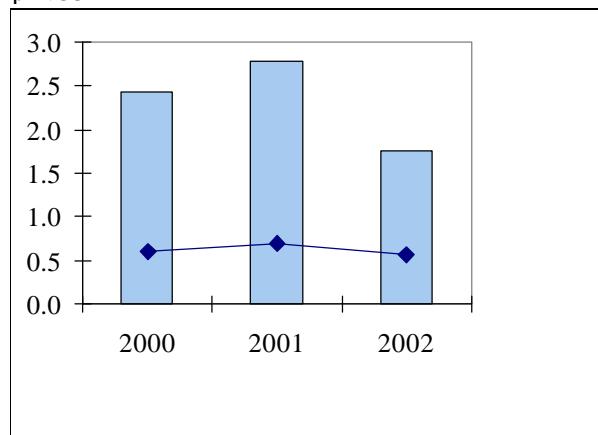
**CASTNet Dry Deposition Monitoring Weekly Concentrations Report**  
**Theodore Roosevelt National Park**

1/1/02 - 12/31/02

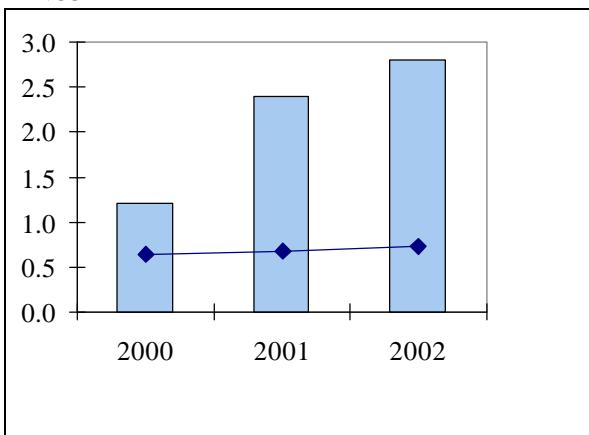
On Date	Off Date	p-NO <sub>3</sub> (ug/m <sup>3</sup> )	HNO <sub>3</sub> (ug/m <sup>3</sup> )	Total NO <sub>3</sub> (ug/m <sup>3</sup> )	NH <sub>4</sub> (ug/m <sup>3</sup> )	p-SO <sub>4</sub> (ug/m <sup>3</sup> )	SO <sub>2</sub> (ug/m <sup>3</sup> )	SO <sub>4</sub> /SO <sub>2</sub> Ratio
12/26/01	01/02/02	0.556	0.445	0.994	0.377	0.925	1.538	0.601
01/02/02	01/08/02	0.238	0.376	0.608	0.101	0.311	0.883	0.352
01/08/02	01/14/02	0.289	0.218	0.504	0.150	0.430	0.550	0.782
01/14/02	01/22/02	0.508	0.361	0.863	0.281	0.522	0.817	0.640
01/22/02	01/29/02	1.432	0.382	1.807	1.380	2.945	3.500	0.841
01/29/02	02/05/02	0.938	0.567	1.496	0.479	0.719	1.537	0.468
02/05/02	02/13/02	0.363	0.383	0.739	0.331	0.801	0.920	0.870
02/13/02	02/19/02	0.611	0.473	1.077	0.259	0.550	1.521	0.361
02/19/02	02/27/02	0.522	0.408	0.924	0.306	0.775	0.959	0.808
02/27/02	03/05/02	0.655	0.492	1.139	0.589	1.386	1.771	0.783
03/05/02	03/12/02	0.732	0.565	1.289	0.648	1.515	2.577	0.588
03/12/02	03/19/02	1.570	0.334	1.899	1.486	3.004	1.373	2.189
03/19/02	03/26/02	0.751	1.016	1.751	0.834	2.074	2.710	0.765
03/26/02	04/02/02	0.493	0.393	0.880	0.498	1.015	0.741	1.369
04/02/02	04/08/02	1.731	0.508	2.231	1.239	2.530	0.906	2.792
04/08/02	04/16/02	0.476	0.701	1.166	0.460	1.218	0.524	2.326
04/16/02	04/23/02	0.288	0.447	0.728	0.436	1.175	0.609	1.930
04/23/02	04/30/02	0.375	0.466	0.834	0.469	1.573	0.610	2.577
04/30/02	05/07/02	0.694	0.264	0.954	0.571	1.672	0.885	1.890
05/07/02	05/15/02	0.297	0.945	1.227	0.506	1.806	0.682	2.650
05/15/02	05/21/02	0.972	1.377	2.328	0.818	2.001	1.074	1.862
05/21/02	05/28/02	0.300	0.482	0.774	0.407	1.059	0.486	2.178
05/28/02	06/04/02	0.439	0.642	1.071	0.358	0.912	0.603	1.512
06/04/02	06/11/02	0.150	1.192	1.324	0.280	1.216	0.663	1.833
06/11/02	06/18/02	0.097	0.910	0.993	0.473	1.235	0.636	1.941
06/18/02	06/25/02	0.336	1.538	1.849	0.460	1.393	1.104	1.261
06/25/02	07/02/02	0.259	1.821	2.051	0.470	1.521	1.020	1.490
07/02/02	07/09/02	0.220	1.652	1.846	0.251	1.365	1.160	1.177
07/09/02	07/16/02	0.274	1.130	1.386	0.492	1.412	1.014	1.392
07/16/02	07/23/02	0.682	2.809	3.446	1.042	3.145	2.523	1.246
07/23/02	07/30/02	0.158	1.051	1.193	0.266	0.721	0.753	0.957
07/30/02	08/06/02	0.348	0.762	1.097	0.283	1.100	0.624	1.762
08/06/02	08/13/02	0.081	1.412	1.470	0.837	2.487	0.552	4.510
08/13/02	08/20/02	0.201	0.600	0.791	0.297	0.997	0.919	1.085
08/20/02	08/27/02	0.206	1.631	1.811	0.457	1.394	0.663	2.103
08/27/02	09/03/02	0.201	1.159	1.342	0.415	1.158	0.787	1.472
09/03/02	09/10/02	0.302	1.536	1.813	0.421	2.380	1.441	1.651
09/10/02	09/17/02	0.307	1.006	1.297	0.304	0.976	1.181	0.826
09/17/02	09/24/02	0.202	0.312	0.510	0.271	0.993	0.599	1.659
09/24/02	10/01/02	0.197	0.755	0.940	0.389	1.148	0.935	1.227
10/01/02	10/08/02	0.156	0.293	0.445	0.247	0.770	0.563	1.367
10/08/02	10/15/02	0.193	0.411	0.597	0.261	0.764	1.204	0.635
10/15/02	10/22/02	0.875	0.387	1.256	0.735	1.400	1.328	1.054
10/22/02	10/29/02	1.756	0.313	2.064	1.061	1.500	0.778	1.927
10/29/02	11/05/02	1.010	0.591	1.592	0.606	1.058	1.039	1.019
11/05/02	11/12/02	0.651	0.281	0.927	0.310	0.771	0.610	1.265
11/12/02	11/18/02	1.299	0.638	1.927	1.066	2.100	0.810	2.594
11/18/02	11/26/02	0.427	0.217	0.640	0.300	0.637	0.532	1.197
11/26/02	12/03/02	1.148	0.330	1.473	0.756	1.717	0.980	1.752
12/03/02	12/10/02	0.943	0.454	1.390	0.353	0.727	1.673	0.435
12/10/02	12/17/02	0.599	0.222	0.818	0.097	0.418	0.763	0.547
12/17/02	12/24/02	1.317	0.227	1.540	0.552	0.689	1.302	0.529
12/24/02	12/31/02	0.643	0.389	1.025	0.288	0.579	1.072	0.540

Theodore Roosevelt National Park  
 CASTNet Dry Deposition Monitoring  
 Three Year Comparison of Maximum and Average Concentrations

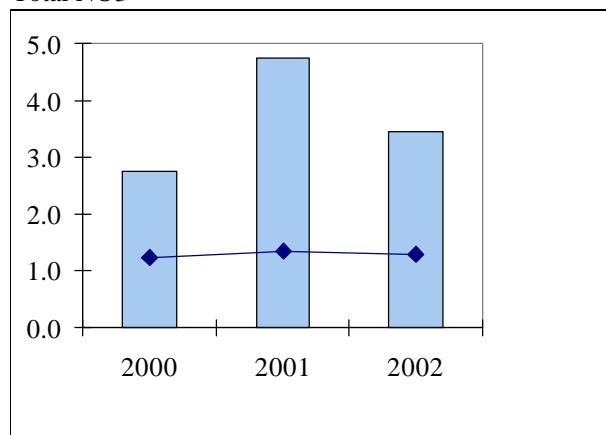
p-NO<sub>3</sub>



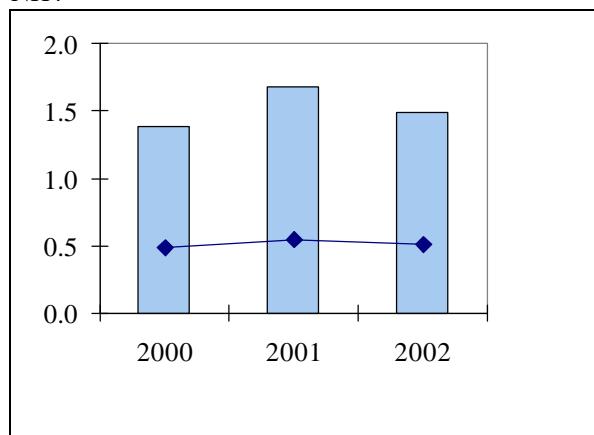
HNO<sub>3</sub>



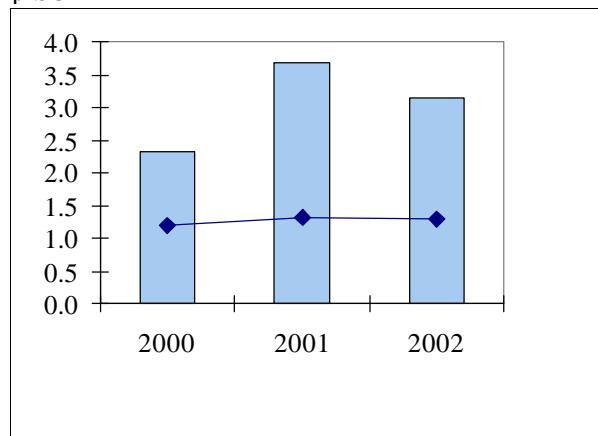
Total NO<sub>3</sub>



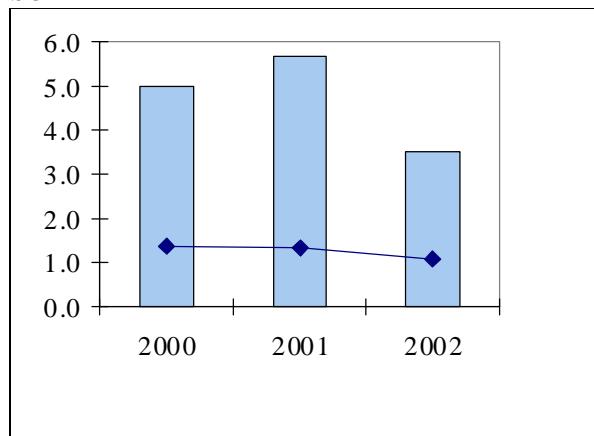
NH<sub>4</sub>



p-SO<sub>4</sub>



SO<sub>2</sub>

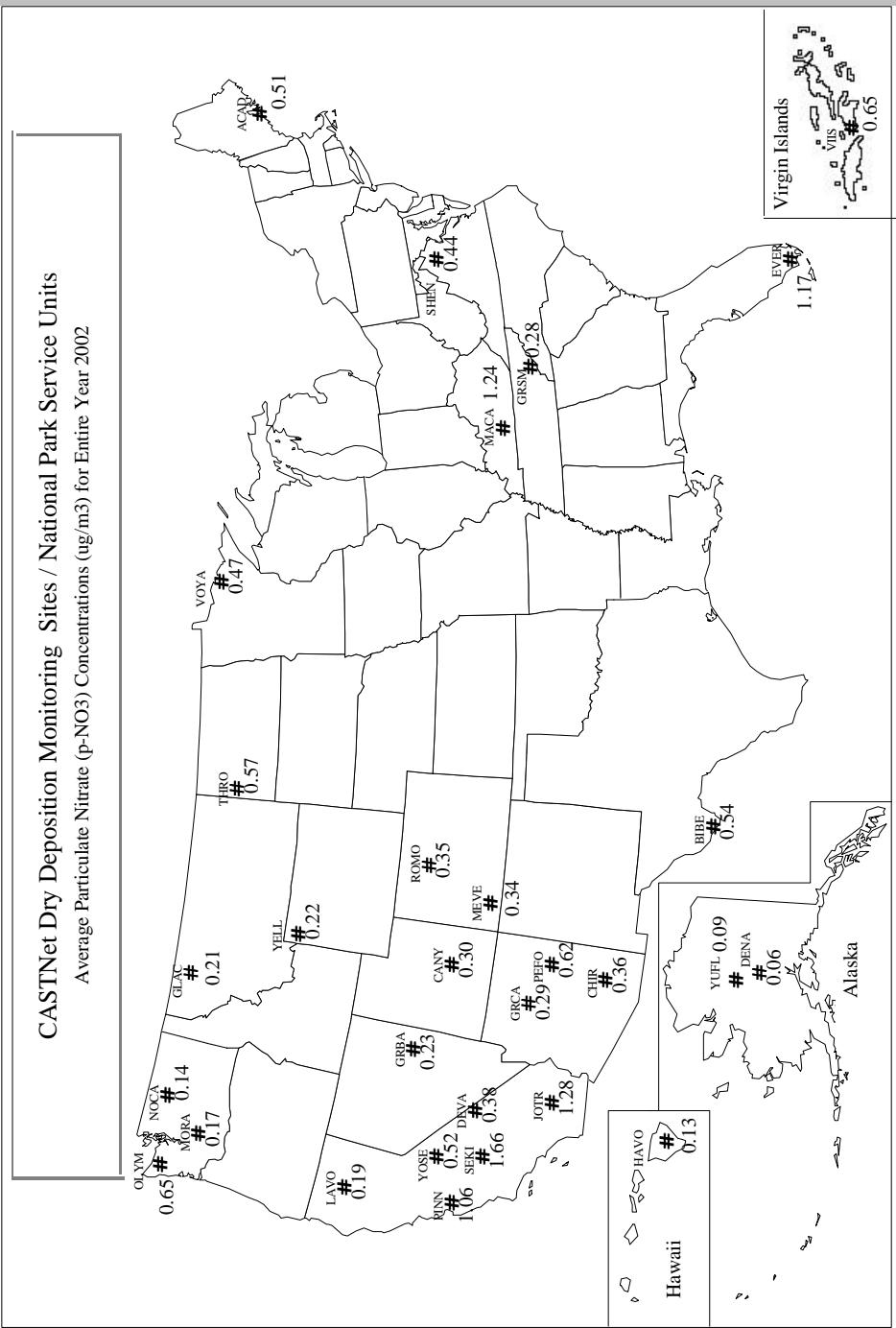


Maximum Concentration (ug/m<sup>3</sup>)

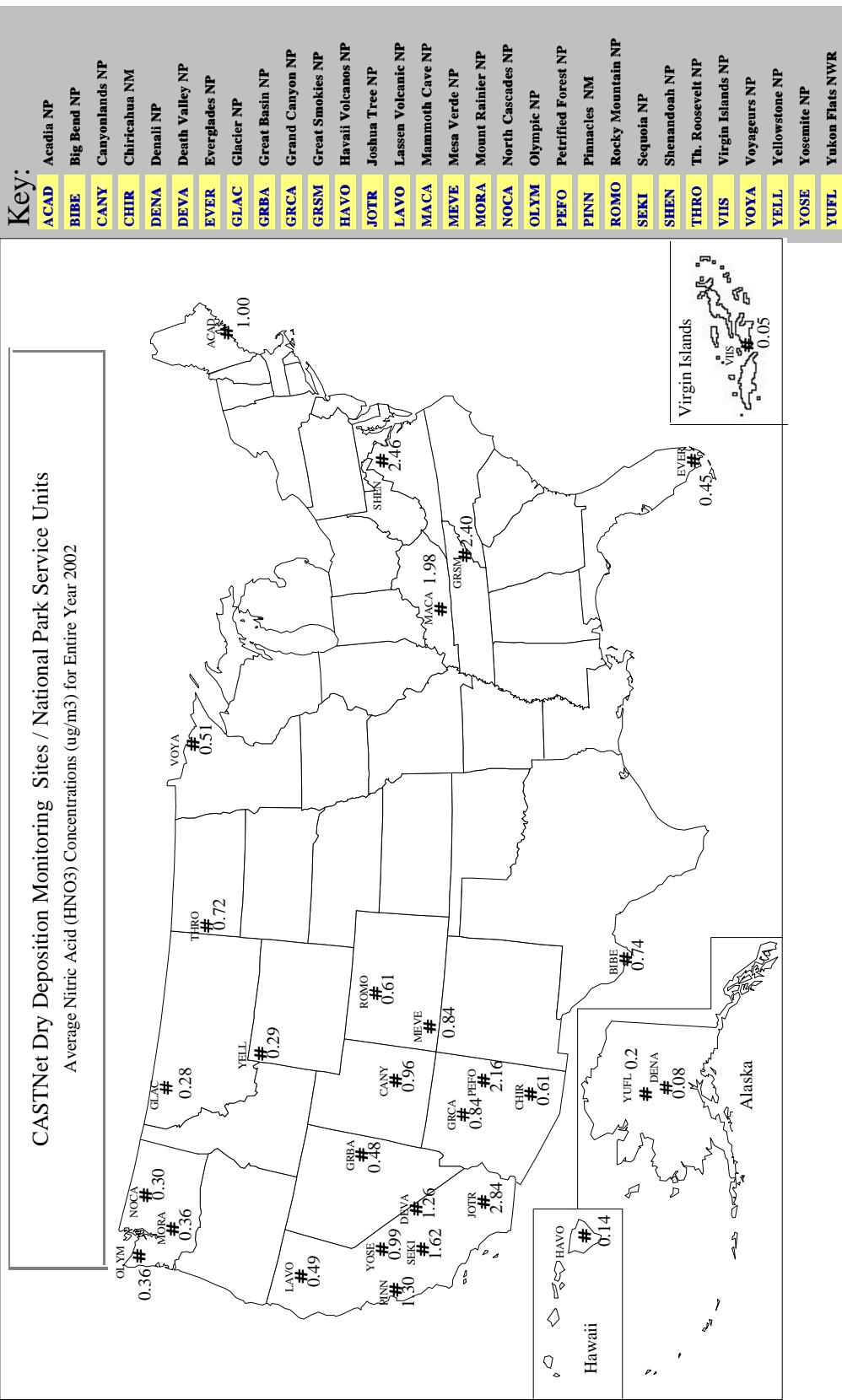


Average Concentration (ug/m<sup>3</sup>)

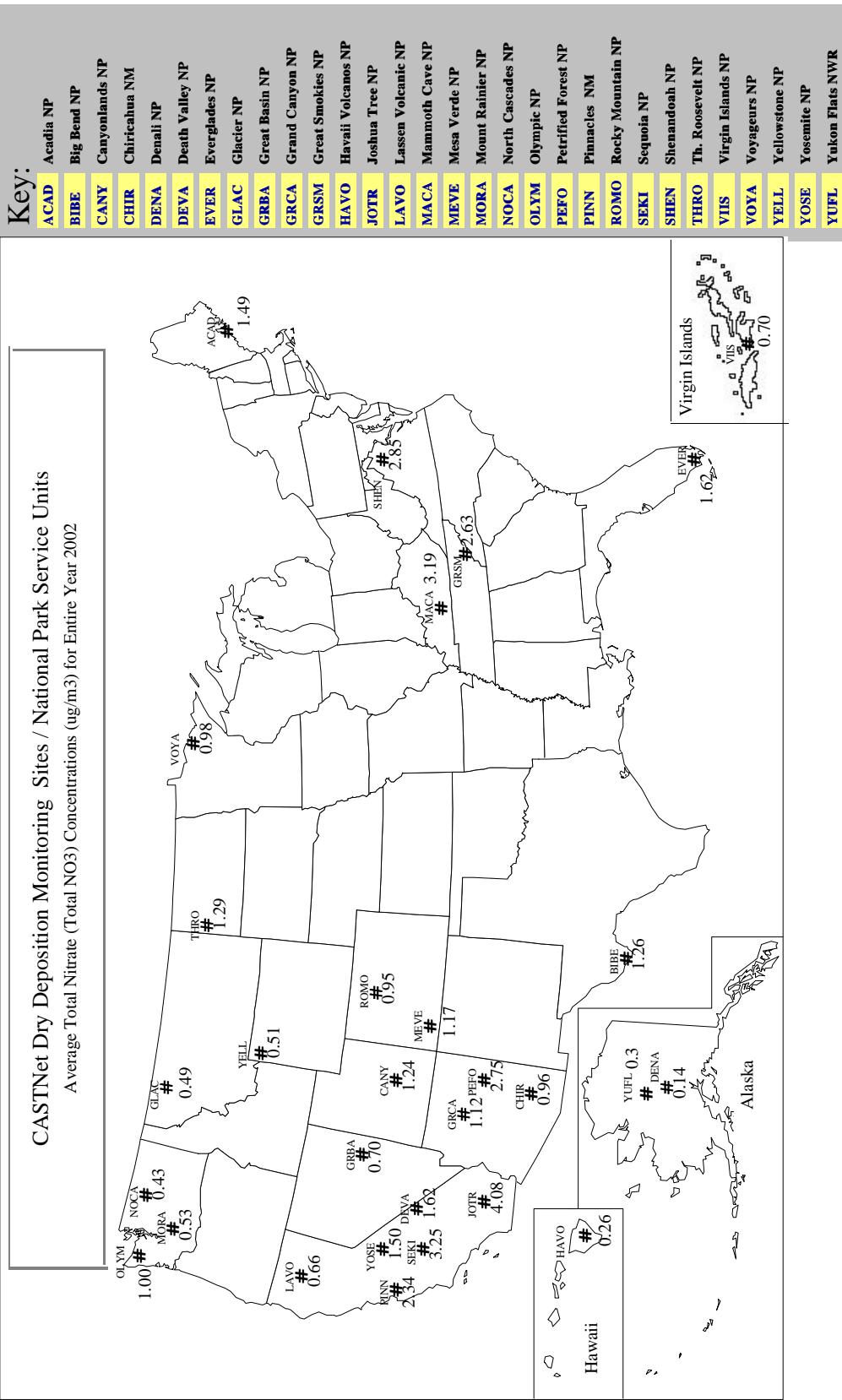
**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Particulate Nitrate ( $\text{p-NO}_3$ ) Concentrations ( $\mu\text{g/m}^3$ ) for Entire Year 2002



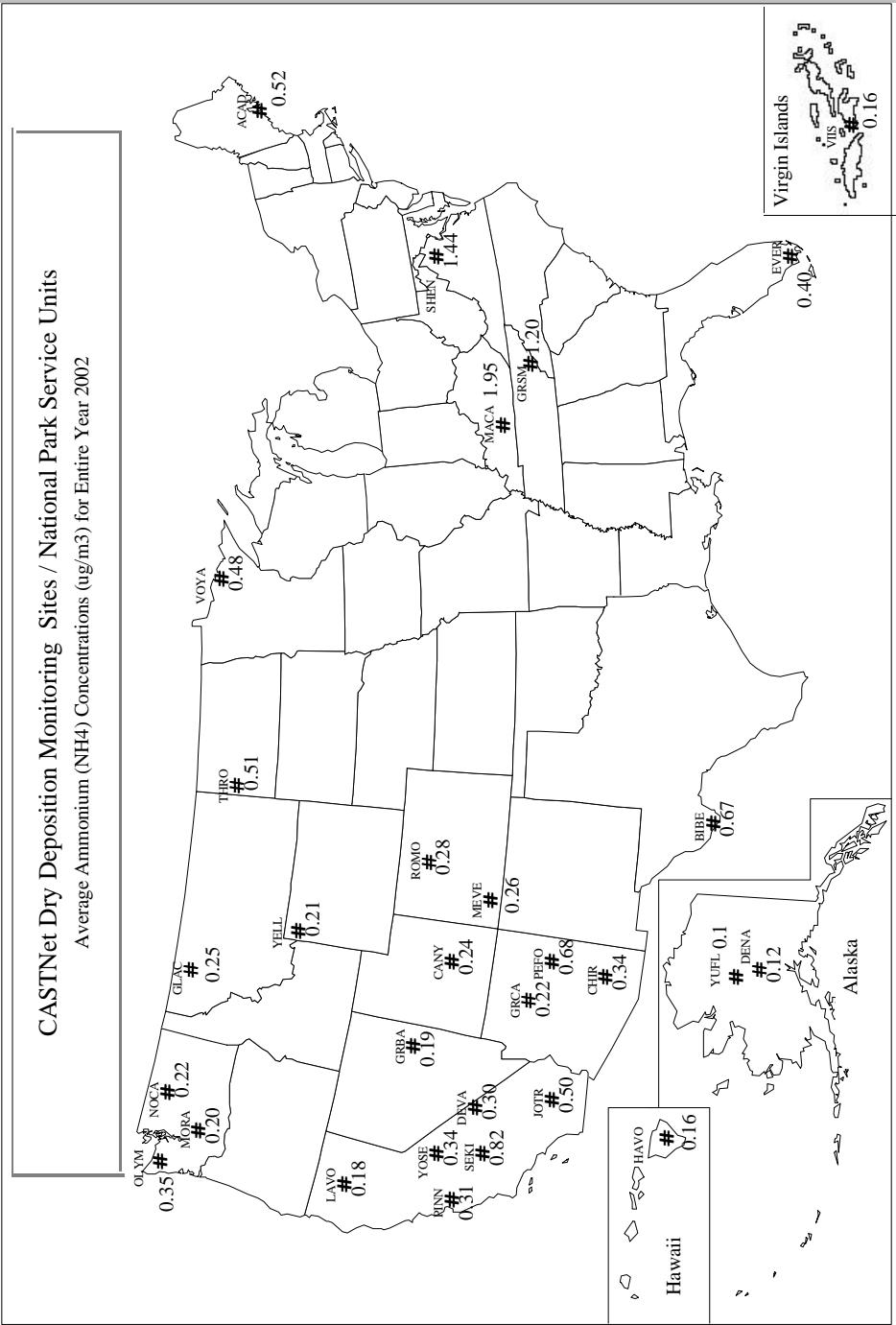
**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Nitric Acid (HNO<sub>3</sub>) Concentrations (ug/m<sup>3</sup>) for Entire Year 2002



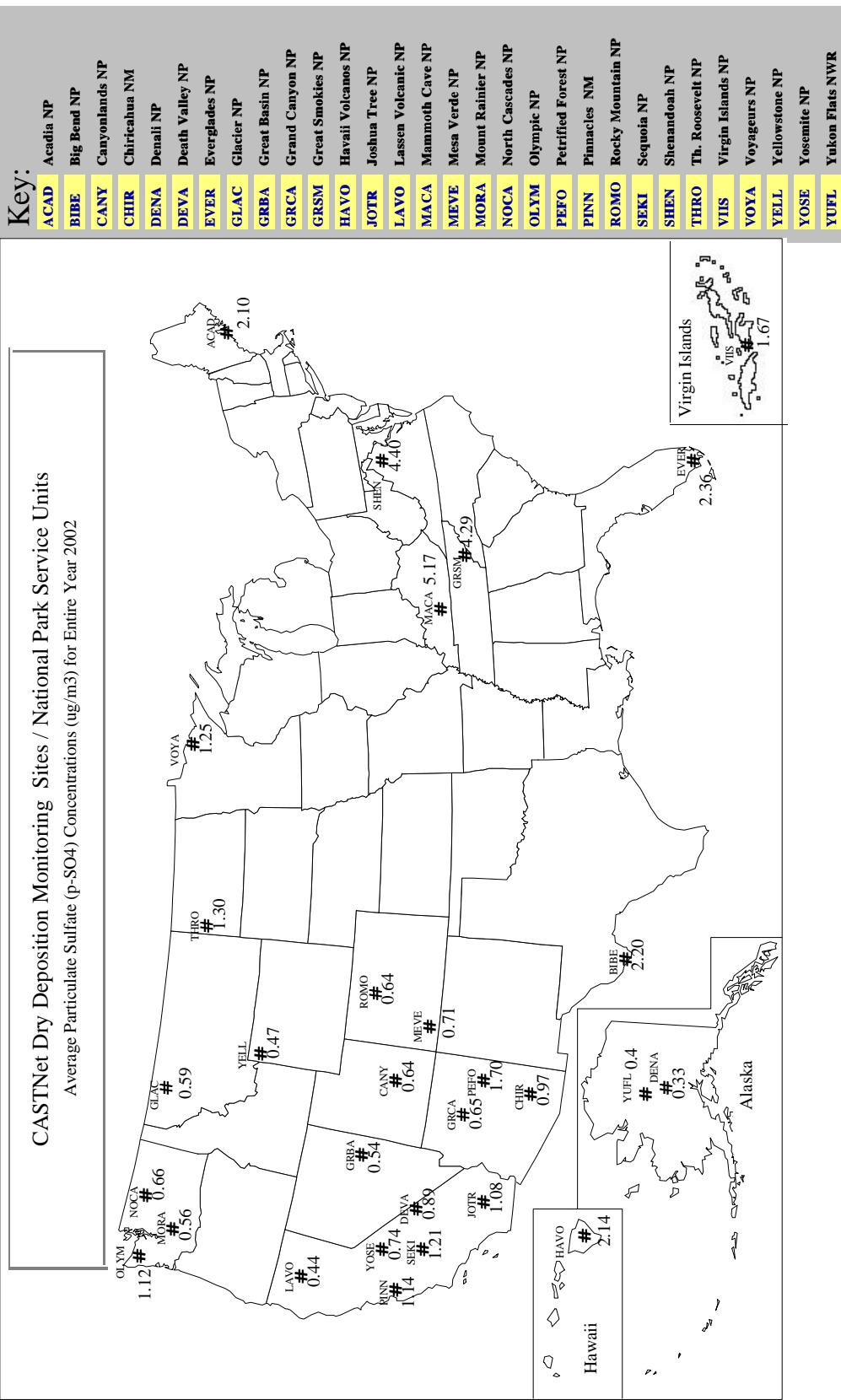
**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Total Nitrate (Total NO<sub>3</sub>) Concentrations ( $\mu\text{g}/\text{m}^3$ ) for Entire Year 2002



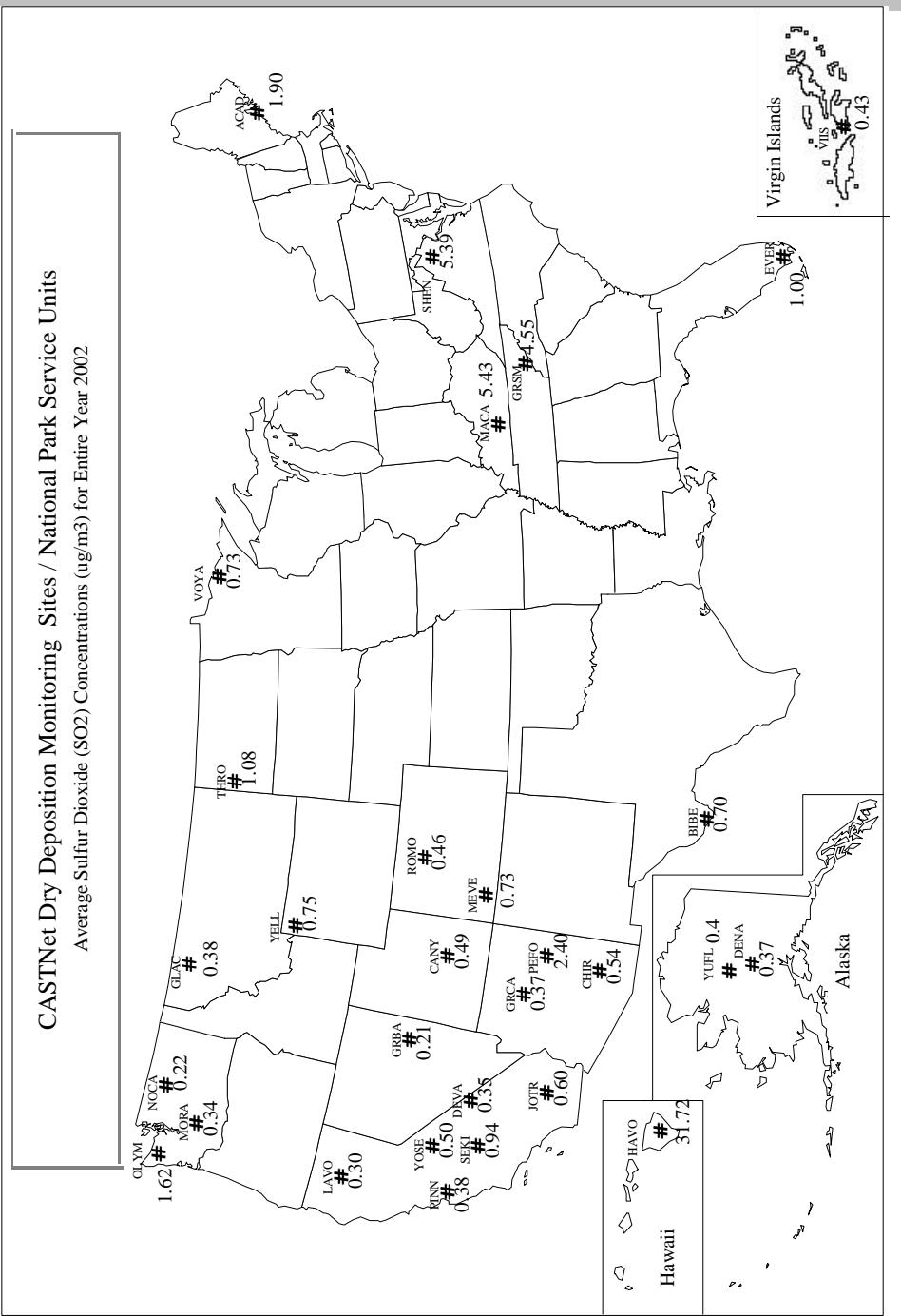
**CASTnet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Ammonium ( $\text{NH}_4$ ) Concentrations ( $\mu\text{g}/\text{m}^3$ ) for Entire Year 2002



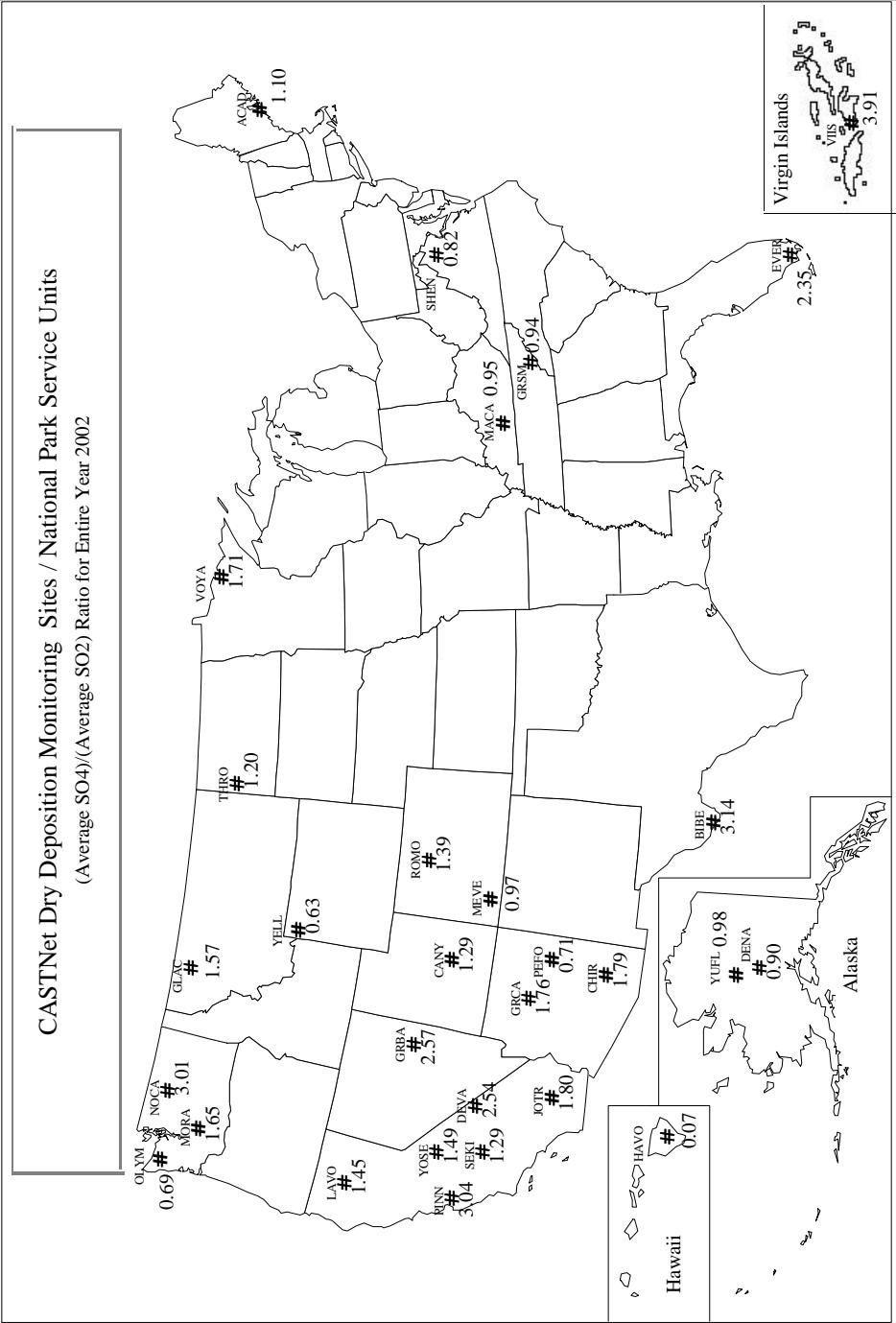
**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Particulate Sulfate ( $\text{p-SO}_4$ ) Concentrations ( $\mu\text{g/m}^3$ ) for Entire Year 2002



**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 Average Sulfur Dioxide (SO<sub>2</sub>) Concentrations ( $\mu\text{g}/\text{m}^3$ ) for Entire Year 2002



**CASTNet Dry Deposition Monitoring Sites / National Park Service Units**  
 (Average SO<sub>4</sub>)/(Average SO<sub>2</sub>) Ratio for Entire Year 2002



### **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](mailto: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

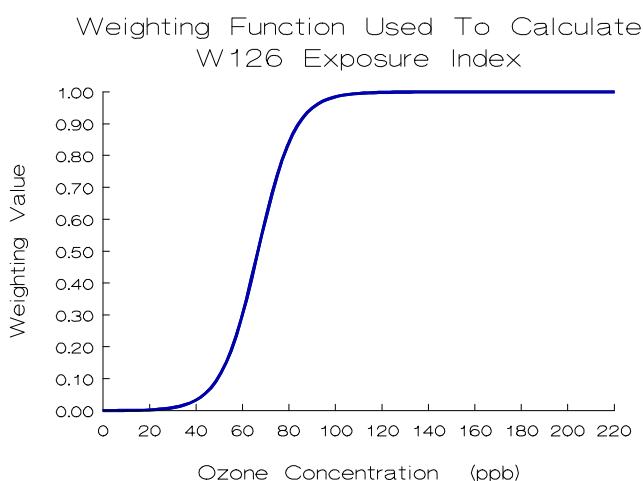
The National Park Service Quick Look Annual Summary Statistics Table (Page 2-8) provides ozone summary statistics for various indices computed on a monthly basis for an entire year. Growing season (generically defined to be May 1 - September 30) and annual statistics are also presented under the "MAY-SEP" 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<sup>1</sup> is:

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

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 ( $\text{SO}_2$ ,  $\text{NO}_2$ ,  $\text{PM}_{10}$ ,  $\text{Pb}$ ,  $\text{CO}$ ,  $\text{O}_3$ ).

**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 ( $\text{O}_3$ ):** 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 ( $\text{SO}_2$ ):** 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	$\mu\text{g}/\text{m}^3$ Ozone (at 25°C)
	ppm	2615	$\mu\text{g}/\text{m}^3$ Sulfur Dioxide (at 25°C)
	ppb	0.001	ppm
	ppb	1.960	$\mu\text{g}/\text{m}^3$ Ozone (at 25°C)
	ppb	2.615	$\mu\text{g}/\text{m}^3$ Sulfur Dioxide (at 25°C)
	$\mu\text{g}/\text{m}^3$ Ozone (25°C)	0.0005102	ppm
	$\mu\text{g}/\text{m}^3$ Ozone (25°C)	0.5102	ppb
	$\mu\text{g}/\text{m}^3$ Sulfur Dioxide (25°C)	0.0003824	ppm
	$\mu\text{g}/\text{m}^3$ Sulfur Dioxide (25°C)	0.3824	ppb
Wind Speed	m/s	2.05	mph
	mph	0.489	m/s
Solar Radiation	ly/min	697	$\text{w}/\text{m}^2$
	$\text{w}/\text{m}^2$	0.00143	ly/min
Precipitation	mm/hr	0.0394	in/hr
	in/hr	25.4	mm/hr
Temperature	$^\circ\text{C} + 17.78$	1.8	$^\circ\text{F}$
	$^\circ\text{F} - 32$	5/9	$^\circ\text{C}$

Where:

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