Report No. NPS D-420

# Annual Data Summary

# GLACIER NATIONAL PARK

# 2002

## National Park Service
## Gaseous Air Pollutant Monitoring Network

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At Glacier National Park, the ARD specifically recognizes Lindy Key, Mary Hamisevicz, Bill Michels, and Ann Fagre for performing the technical and administrative skills required to help produce the data presented within this report.

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# 1.0 INTRODUCTION

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

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

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

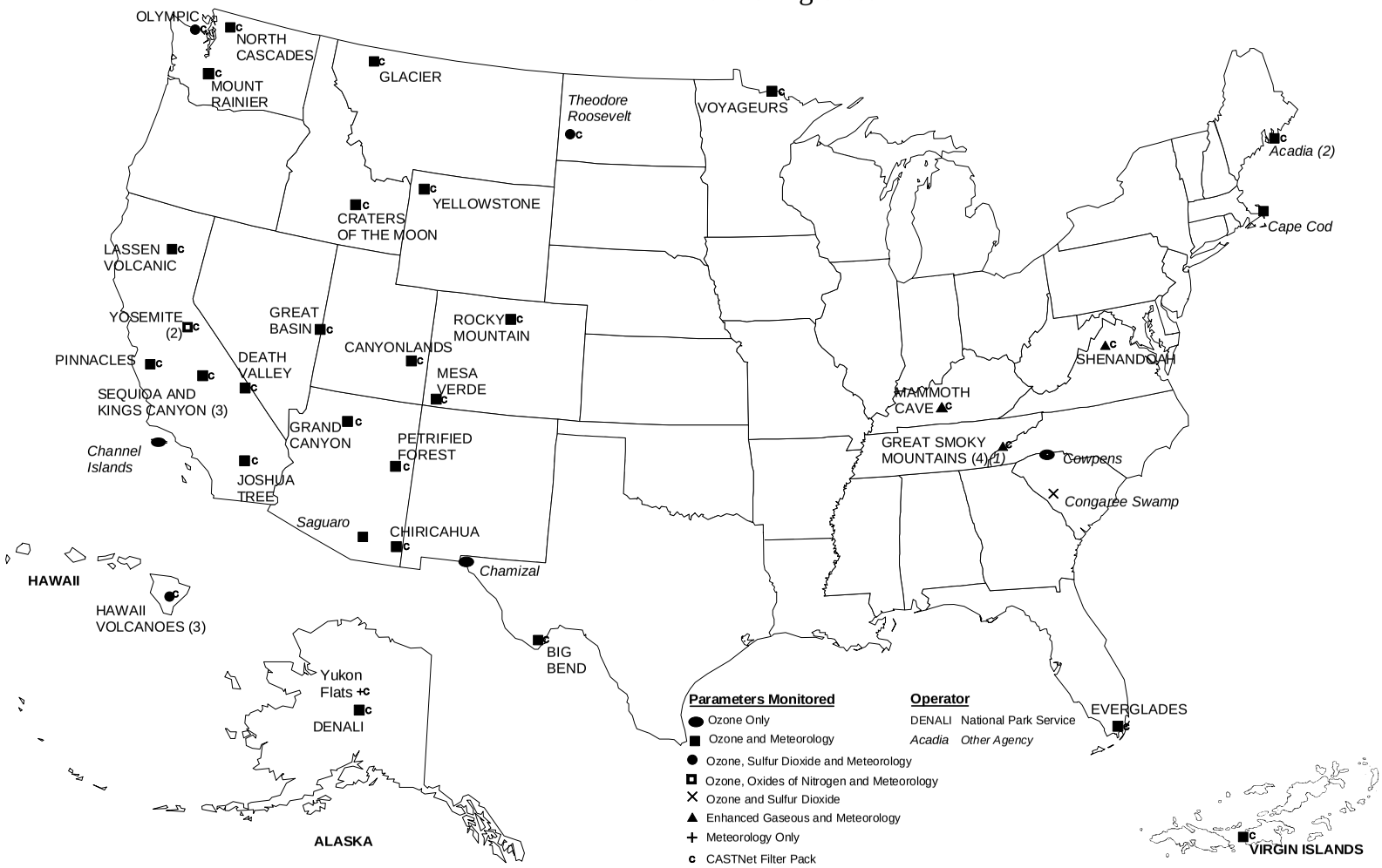
Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The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

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

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

# NATIONAL PARK SERVICE
# GASEOUS POLLUTANT MONITORING NETWORK

## 2002 Monitoring Sites



## 1.2 GLACIER NATIONAL PARK

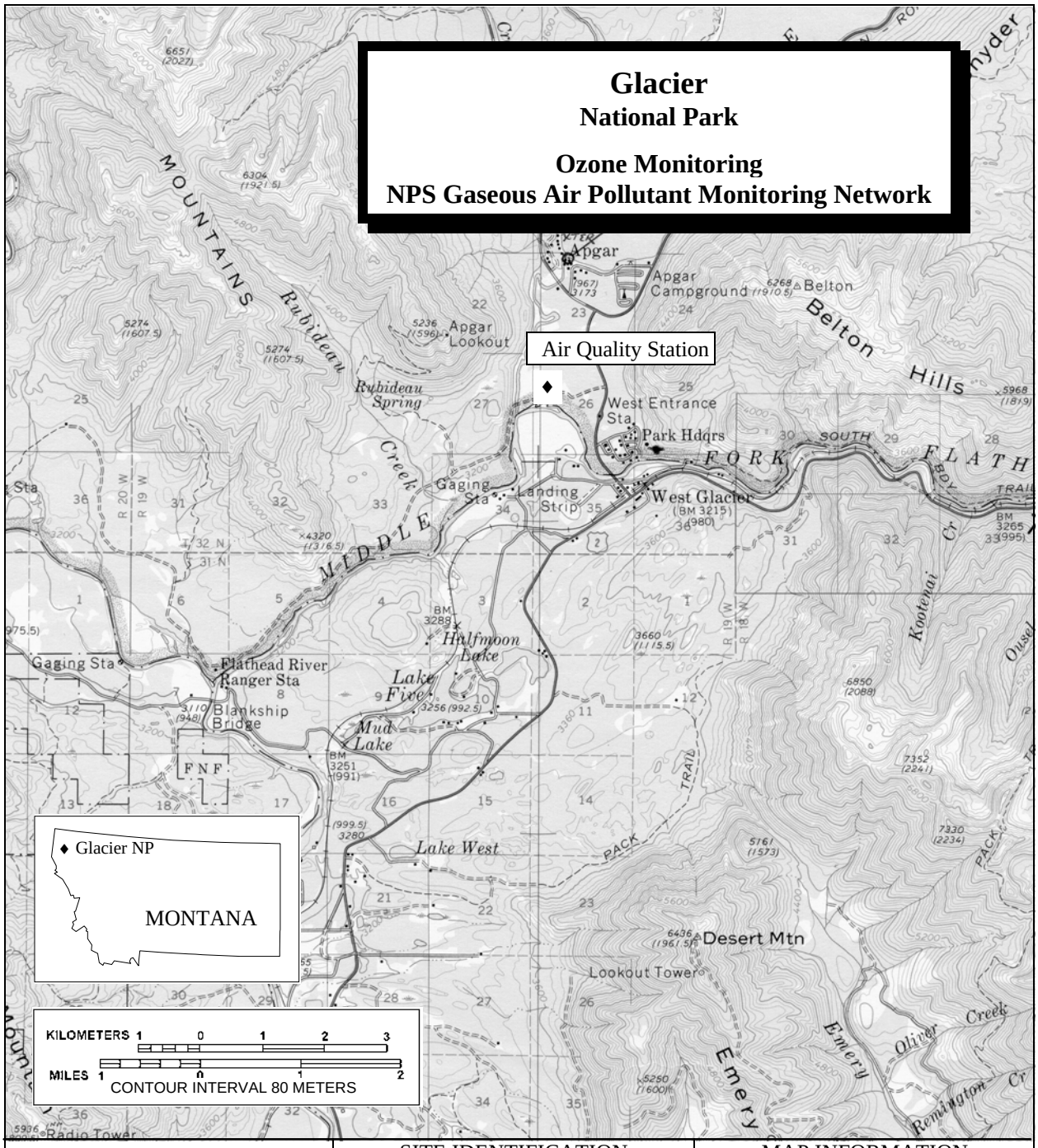
Glacier National Park, a Class I area, is located in northwest Montana in the Northern Rocky Mountains Province. Its location and site specifications are presented on the following page.

Glacier National Park was established by Congress on May 11, 1910. The park was designated a Biosphere Reserve in 1976.

The park, over 1,000,000 acres in size, has precipitous peaks ranging above 10,000 feet. This ruggedly beautiful land includes nearly 50 glaciers, numerous glacier-fed lakes and streams, a wide variety of wildflowers, and wildlife including grizzly bears and grey wolves.

# Glacier
## National Park

## Ozone Monitoring
## NPS Gaseous Air Pollutant Monitoring Network




| SITE IDENTIFICATION | | MAP INFORMATION | |
|---|---|---|---|
| Site Abbreviation: | GLAC | Mean Elevation: | 976 m |
| AIRS ID NO.: | 30-029-8001 | Longitude: | 113° 59' 44"W |
| | | Latitude: | 48° 30' 37"N |
| | | UTM Zone: | 12 |
| | | Easting: | 278763 m |
| | | Northing: | 5377133 m |
| | | Map Reference: | Glacier Natl. Park 1968 N4813-W11310 1:100,000 |

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

# 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
Glacier National Park

Final Validation

01/01/2002 - 12/31/2002

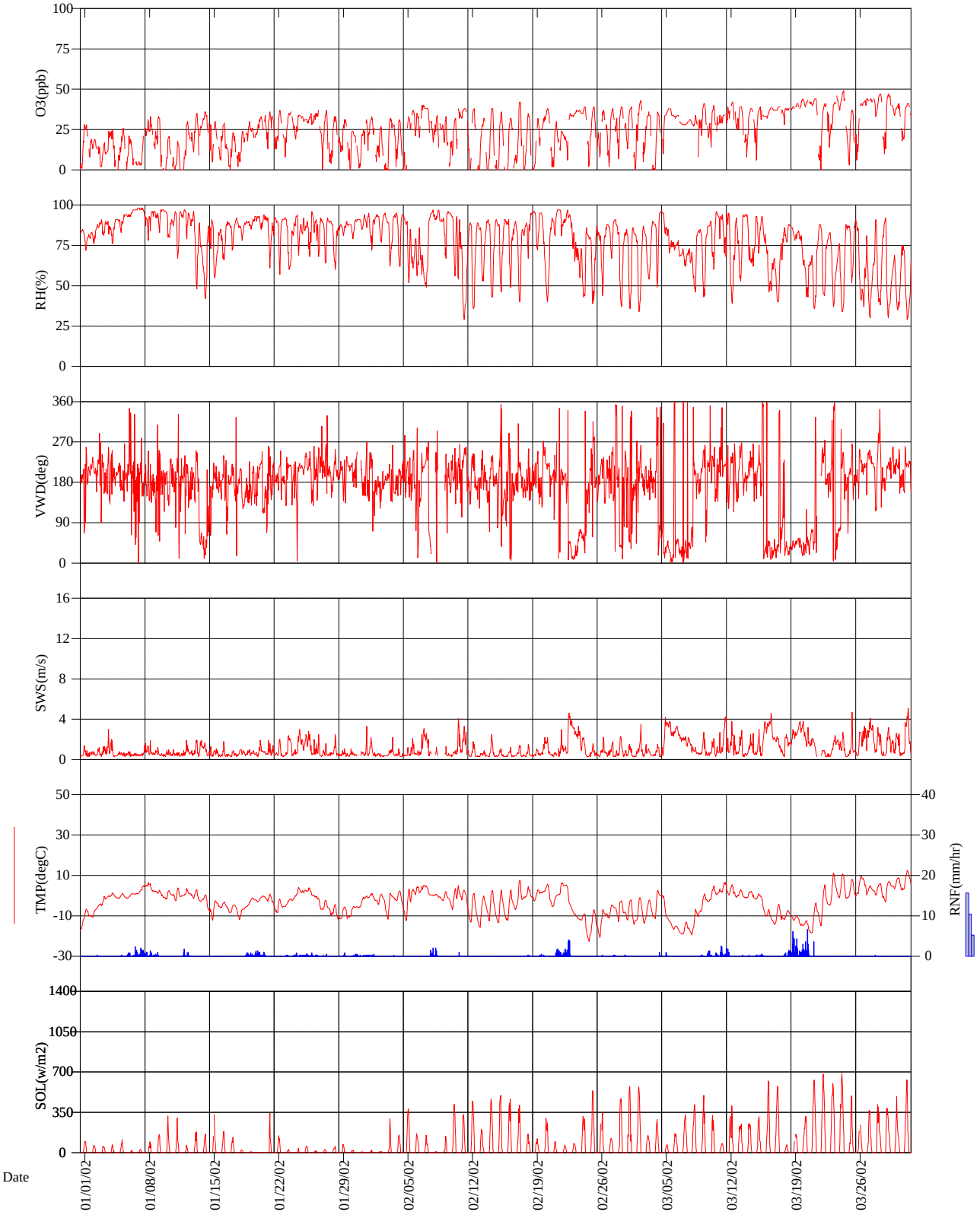
| Parameter | Interval | Par Code | Data Recovery | | | Valid Data | |
|---|---|---|---|---|---|---|---|
| | | | No. Possible | No. Collected | % Collected | No. Valid | % Valid |
| Ozone Analyzer | hourly | O3 | 8760 | 7944 | 90.7 | 7925 | 90.5 |
| Scalar Wind Speed | hourly | SWS | 8760 | 8664 | 98.9 | 8664 | 98.9 |
| Vector Wind Speed | hourly | VWS | 8760 | 8664 | 98.9 | 8664 | 98.9 |
| Vector Wind Direction | hourly | VWD | 8760 | 8664 | 98.9 | 8664 | 98.9 |
| Standard Deviation for Wind Direction | hourly | SDWD | 8760 | 8664 | 98.9 | 8664 | 98.9 |
| Ambient Temperature (aspirated) | hourly | TMP | 8760 | 8759 | 100.0 | 8759 | 100.0 |
| Delta Temperature | hourly | DTP | 8760 | 8759 | 100.0 | 8759 | 100.0 |
| Relative Humidity | hourly | RH | 8760 | 8760 | 100.0 | 8760 | 100.0 |
| Precipitation | hourly | RNF | 8760 | 8701 | 99.3 | 8701 | 99.3 |
| Wetness Sensor | hourly | WET | 8760 | 8360 | 95.4 | 8193 | 93.5 |
| Solar Radiation | hourly | SOL | 8760 | 8736 | 99.7 | 8520 | 97.3 |
| Filter Pack Flow Rate | hourly | FLOW | 8760 | 8759 | 100.0 | 8759 | 100.0 |

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 |

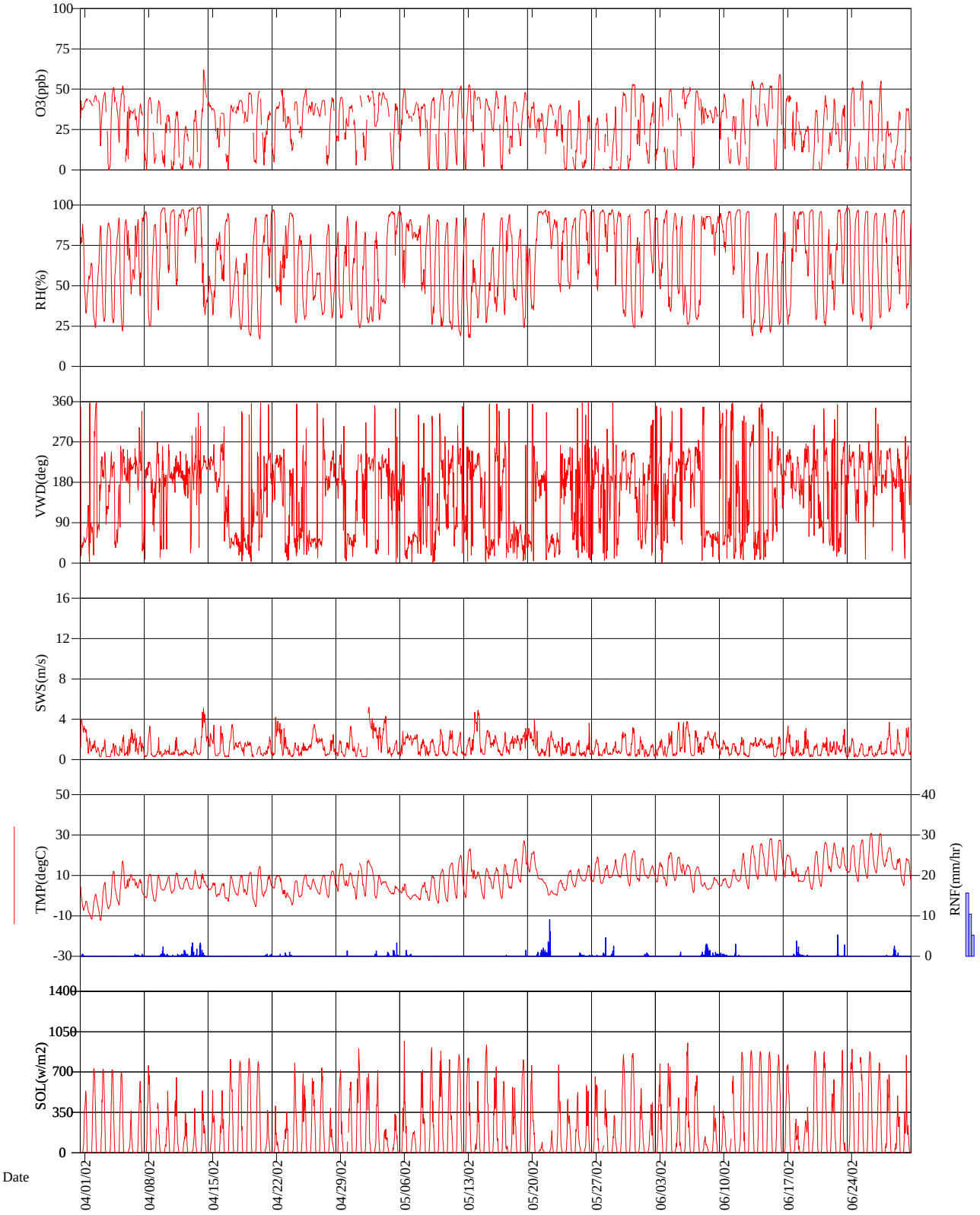
Glacier National Park




Final Validation

First Quarter 2002

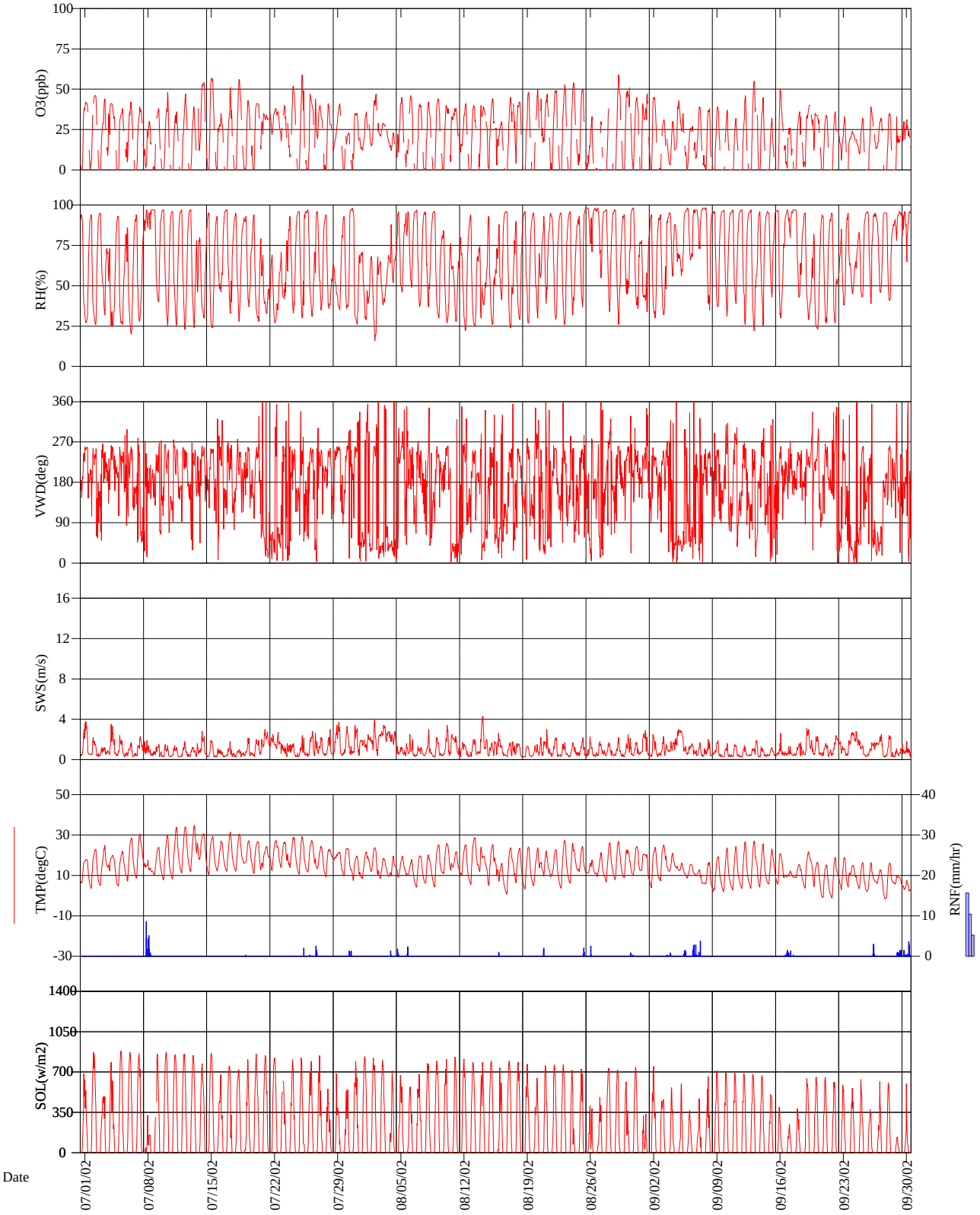
Glacier National Park




Final Validation

Second Quarter 2002

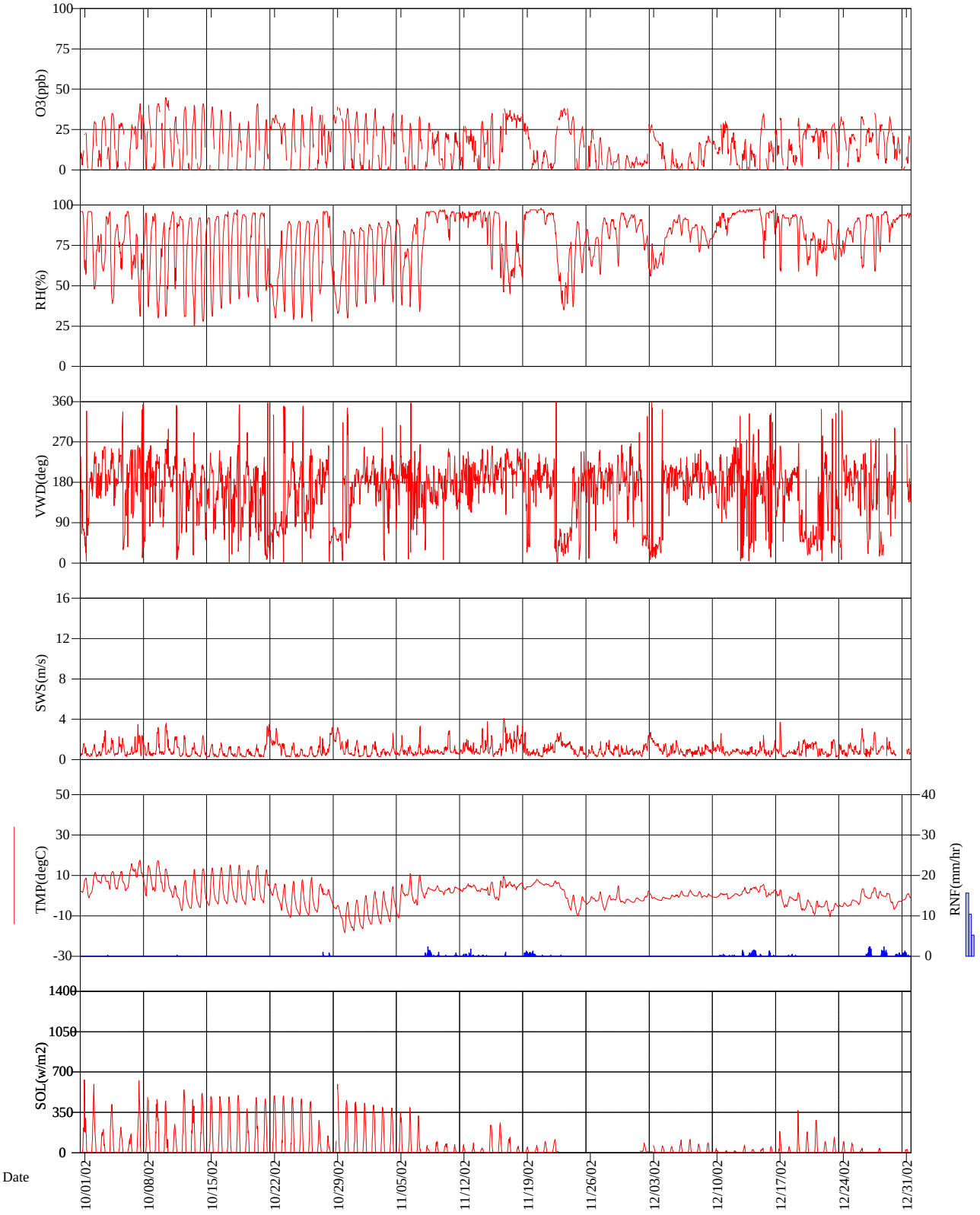
Glacier National Park




Final Validation

Third Quarter 2002

Glacier National Park




Final Validation

Fourth Quarter 2002

## 2.2 OZONE DATA SUMMARY

# Ozone Quick Look Annual Summary Statistics
## Glacier 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 | 37 | 42 | 49 | 62 | 53 | 59 | 59 | 59 | 55 | 45 | 38 | 35 | 59 | 62 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (31) | (30) | (31) | (31) | (30) | (31) | (30) | (31) | (153) | (365) |
| AVERAGE DAILY MAXIMUM | 29 | 35 | 40 | 43 | 44 | 45 | 43 | 43 | 37 | 35 | 27 | 24 | 42 | 37 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (31) | (30) | (31) | (31) | (30) | (31) | (30) | (31) | (153) | (365) |
| MAXIMUM DAILY MEAN | 32 | 37 | 43 | 43 | 42 | 45 | 36 | 31 | 29 | 34 | 35 | 24 | 45 | 45 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (30) | (30) | (31) | (29) | (30) | (31) | (30) | (31) | (150) | (362) |
| AVERAGE DAILY MEAN | 19 | 23 | 32 | 30 | 28 | 27 | 23 | 23 | 18 | 17 | 14 | 14 | 24 | 22 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (30) | (30) | (31) | (29) | (30) | (31) | (30) | (31) | (150) | (362) |
| MAX PEAK:MIN RATIO | 33.000 | 31.000 | 12.333 | 62.000 | 22.000 | 51.000 | 8.400 | 30.000 | 26.000 | 45.000 | 8.000 | 16.000 | 51.000 | 62.000 |
| NO. OF DAYS | (21) | (19) | (27) | (25) | (16) | (18) | (9) | (12) | (8) | (7) | (5) | (17) | (63) | (184) |
| AVERAGE PEAK:MIN RATIO | 6.687 | 8.932 | 3.067 | 9.014 | 4.976 | 12.054 | 4.380 | 9.432 | 10.577 | 16.408 | 3.451 | 7.517 | 8.473 | 7.674 |
| NO. OF DAYS | (21) | (19) | (27) | (25) | (16) | (18) | (9) | (12) | (8) | (7) | (5) | (17) | (63) | (184) |
| MAX 9AM-4PM AVERAGE | 34 | 38 | 45 | 51 | 51 | 50 | 52 | 43 | 41 | 40 | 36 | 29 | 52 | 52 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (29) | (30) | (31) | (29) | (30) | (29) | (29) | (31) | (149) | (358) |
| MONTHLY 9AM-4PM AVERAGE | 24 | 29 | 37 | 38 | 39 | 38 | 36 | 35 | 29 | 27 | 20 | 17 | 35 | 31 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (29) | (30) | (31) | (29) | (30) | (29) | (29) | (31) | (149) | (358) |
| MAX 7AM-7PM AVERAGE | 34 | 37 | 44 | 48 | 47 | 47 | 45 | 38 | 37 | 36 | 36 | 27 | 47 | 48 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (30) | (30) | (31) | (29) | (30) | (31) | (30) | (31) | (150) | (362) |
| MONTHLY 7AM-7PM AVERAGE | 22 | 27 | 35 | 36 | 35 | 35 | 32 | 32 | 25 | 23 | 17 | 15 | 32 | 28 |
| NO. OF DAYS | (31) | (28) | (31) | (30) | (30) | (30) | (31) | (29) | (30) | (31) | (30) | (31) | (150) | (362) |
| MONTHLY MEAN | 19 | 23 | 32 | 30 | 28 | 27 | 23 | 23 | 18 | 17 | 14 | 13 | 24 | 22 |
| NO. OF HOURS | (680) | (610) | (674) | (650) | (662) | (652) | (674) | (666) | (657) | (676) | (653) | (671) | (3311) | (7925) |
| SUM0 EXPOSURE INDEX | 13055 | 13777 | 21724 | 19759 | 18653 | 17471 | 15613 | 15027 | 12016 | 11529 | 9062 | 9014 | 78780 | 176700 |
| NO. OF HOURS | (680) | (610) | (674) | (650) | (662) | (652) | (674) | (666) | (657) | (676) | (653) | (671) | (3311) | (7925) |
| SUM60 EXPOSURE INDEX | - | - | - | 124 | - | - | - | - | - | - | - | - | - | 124 |
| NO. OF HOURS | (0) | (0) | (0) | (2) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (2) |
| SUM80 EXPOSURE INDEX | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| NO. OF HOURS | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) | (0) |
| W126 EXPOSURE INDEX | 95 | 178 | 564 | 718 | 722 | 801 | 542 | 483 | 205 | 143 | 71 | 40 | 2753 | 4563 |
| NO. OF HOURS | (680) | (610) | (674) | (650) | (662) | (652) | (674) | (666) | (657) | (676) | (653) | (671) | (3311) | (7925) |

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

* Statistics defined in the Quick Look subsection of the Glossary

Final Validation

7/15/2003

## Frequency Distribution

## Glacier National Park

## Monitoring Season: 06/01/02 - 09/30/02[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 | 98 | 2649 | 0.023 | 0.031 | 0.038 | 0.042 | 0.046 | 0.053 | 0.055 | 0.059 | 0.059 | 0.059 | 0.0419 | 0.0410 | 1.23 |

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)

## Glacier 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 | .028 | T | .033 | F | .039 | F | .044 | M | | W | .047 | S | .042 | M | .036 | T | .047 | S | .023 | T | .035 | F | .008 | S |
| 2 | .019 | W | .027 | S | .043 | S | .046 | T | .048 | T | .042 | S | .046 | T | .047 | F | .045 | M | .030 | W | .038 | S | .028 | M |
| 3 | .017 | T | .032 | S | .036 | S | .048 | W | .049 | F | .045 | M | .044 | W | .029 | S | .031 | T | .033 | T | .027 | S | .028 | T |
| 4 | .025 | F | .031 | M | .036 | M | .051 | T | .048 | S | .050 | T | .041 | T | .023 | S | .030 | W | .035 | F | .035 | M | .017 | W |
| 5 | .026 | S | .034 | T | .038 | T | .052 | F | .041 | S | .044 | W | .038 | F | .045 | M | .043 | T | .029 | S | .034 | T | .013 | T |
| 6 | .021 | S | .037 | W | .037 | W | .039 | S | .050 | M | .051 | T | .042 | S | .046 | T | .027 | F | .028 | S | .029 | W | .005 | F |
| 7 | .026 | M | .040 | T | .030 | T | .041 | S | .042 | T | .049 | F | .039 | S | .041 | W | .039 | S | .041 | M | .033 | T | .011 | S |
| 8 | .033 | T | .034 | F | .034 | F | .045 | M | .041 | W | .041 | S | .030 | M | .042 | T | .038 | S | .040 | T | .029 | F | .017 | S |
| 9 | .033 | W | .033 | S | .041 | S | .043 | T | .045 | T | .039 | S | .038 | T | .044 | F | .039 | M | .041 | W | .024 | S | .021 | M |
| 10 | .021 | T | .038 | S | .040 | S | .034 | W | .050 | F | .047 | M | .048 | W | .040 | S | .037 | T | .045 | T | .023 | S | .028 | T |
| 11 | .018 | F | .038 | M | .035 | M | .036 | T | .049 | S | .033 | T | .036 | T | .038 | S | .032 | W | .033 | F | .023 | M | .030 | W |
| 12 | .030 | S | .038 | T | .042 | T | .027 | F | .052 | S | .044 | W | .047 | F | .041 | M | .046 | T | .039 | S | .027 | T | .023 | T |
| 13 | .035 | S | .032 | W | .039 | W | .037 | S | .053 | M | .055 | T | .043 | S | .040 | T | .055 | F | .040 | S | .025 | W | .019 | F |
| 14 | .036 | M | .038 | T | .038 | T | .062 | S | .049 | T | .054 | F | .054 | S | .040 | W | .045 | S | .041 | M | .030 | T | .016 | S |
| 15 | .030 | T | .036 | F | .039 | F | .042 | M | .044 | W | .052 | S | .057 | M | .044 | T | .032 | S | .039 | T | .035 | F | .035 | S |
| 16 | .029 | W | .032 | S | .039 | S | .035 | T | .049 | T | .059 | S | .035 | T | .030 | F | .050 | M | .037 | W | .038 | S | .024 | M |
| 17 | .023 | T | .042 | S | .039 | S | .040 | W | .046 | F | .046 | M | .051 | W | .045 | S | .026 | T | .036 | T | .037 | S | .032 | T |
| 18 | .024 | F | .035 | M | .038 | M | .043 | T | .042 | S | .042 | T | .056 | T | .042 | S | .036 | W | .029 | F | .035 | M | .019 | W |
| 19 | .030 | S | .032 | T | .041 | T | .048 | F | .048 | S | .027 | W | .043 | F | .048 | M | .040 | T | .030 | S | .034 | T | .032 | T |
| 20 | .033 | S | .038 | W | .044 | W | .049 | S | .042 | M | .037 | T | .041 | S | .050 | T | .035 | F | .041 | S | .012 | W | .029 | F |
| 21 | .036 | M | .030 | T | .044 | T | .036 | S | .035 | T | .046 | F | .036 | S | .047 | W | .034 | S | .031 | M | .012 | T | .026 | S |
| 22 | .037 | T | .031 | F | .041 | F | .049 | M | .041 | W | .044 | S | .038 | M | .049 | T | .036 | S | .034 | T | .031 | F | .025 | S |
| 23 | .036 | W | .037 | S | .046 | S | .050 | T | .040 | T | .040 | S | .040 | T | .053 | F | .033 | M | .029 | W | .038 | S | .029 | M |
| 24 | .034 | T | .039 | S | .049 | S | .042 | W | .037 | F | .051 | M | .052 | W | .054 | S | .024 | T | .038 | T | .033 | S | .033 | T |
| 25 | .033 | F | .039 | M | .037 | M | .050 | T | .043 | S | .055 | T | .059 | T | .050 | S | .032 | W | .034 | F | .027 | M | .022 | W |
| 26 | .037 | S | .037 | T | .042 | T | .042 | F | .034 | S | .043 | W | .047 | F | .033 | M | .039 | T | .039 | S | .025 | T | .033 | T |
| 27 | .037 | S | .038 | W | .044 | W | .043 | S | .032 | M | .055 | T | .044 | S | | T | .032 | F | .034 | S | .020 | W | .035 | F |
| 28 | .033 | M | .039 | T | .047 | T | .045 | S | .035 | T | .030 | F | .041 | S | | W | .035 | S | .031 | M | .014 | T | .035 | S |
| 29 | .031 | T | | | .047 | F | .045 | M | .039 | W | .036 | S | .041 | M | .059 | T | .033 | S | .039 | T | .010 | F | .033 | S |
| 30 | .024 | W | | | .041 | S | .040 | T | .048 | T | .038 | S | .023 | T | .051 | F | .031 | M | .038 | W | .009 | S | .021 | M |
| 31 | .029 | T | | | .041 | S | | | .053 | F | | | .035 | W | .045 | S | | | .036 | T | | | | |
| Valid Days | 31 | | 28 | | 31 | | 30 | | 30 | | 30 | | 31 | | 29 | | 30 | | 31 | | 30 | | 30 | |
| Maximum | .037 | | .042 | | .049 | | .062 | | .053 | | .059 | | .059 | | .059 | | .055 | | .045 | | .038 | | .035 | |
| Violations | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |

| | | |
|---|---|---|
| 7905 Total Samples | 0 Daily-maxima exceeding the standard of .12 ppm (starred[*]) | |
| 90.5 % Possible | 1 Missing days assumed to be less than the standard | |
| 361 Valid daily maxima | 0 Daily maximas exceed the alert level of .200 ppm | Concentrations in parts per million (ppm) |

Final Validation

4/22/03

Glacier National Park

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

Ozone Season: June 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 | 49 | 95% | Yes | 54 | 53 | 52 | 52 | 52 |

| Ozone Analyzer<br>10 Highest Daily 1-Hour Average Maximum Concentrations<br>Glacier National Park<br><br>Final Validation<br>01/01/2002 - 12/31/2002 | | | |
|---|---|---|---|
| Value | Date | Hour | Concentration (ppb) |
| Ozone Analyzer | | | |
| 1 | 04/14/2002 | 12 | 62* |
| 2 | 06/16/2002 | 14 | 59* |
| 3 | 07/25/2002 | 14 | 59 |
| 4 | 08/29/2002 | 15 | 59 |
| 5 | 07/15/2002 | 13 | 57 |
| 6 | 07/18/2002 | 14 | 56* |
| 7 | 06/13/2002 | 15 | 55 |
| 8 | 06/25/2002 | 16 | 55 |
| 9 | 06/27/2002 | 17 | 55 |
| 10 | 09/13/2002 | 15 | 55* |

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

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

Glacier 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<br>Glacier National Park<br><br>01/01/2002 - 12/31/2002<br>FINAL VALIDATION | | | | |
|---|---|---|---|---|
| Site | Date | Start and End Time of Daily Maximum 8-Hour Average > 84 ppb (hr) | Daily Maximum 8-Hour Average (ppb) | Number of 8-Hour Averages > 84 ppb During the Day |
| | No values exceeded 84 ppb during this period | | | |
| | 0 | Days with 8-hour average concentrations > 84 ppb | | |

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

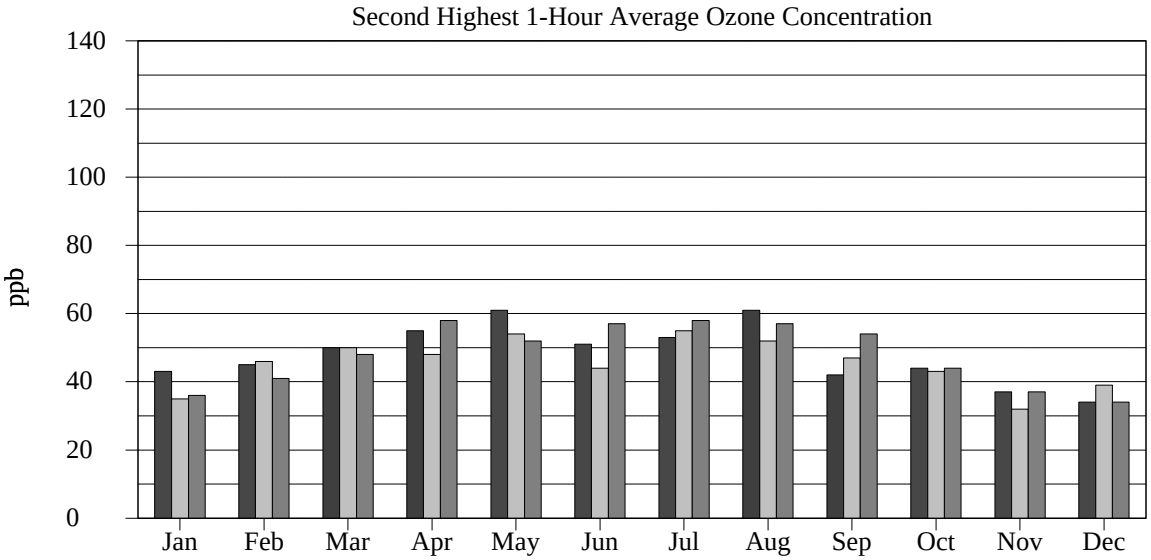
# Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

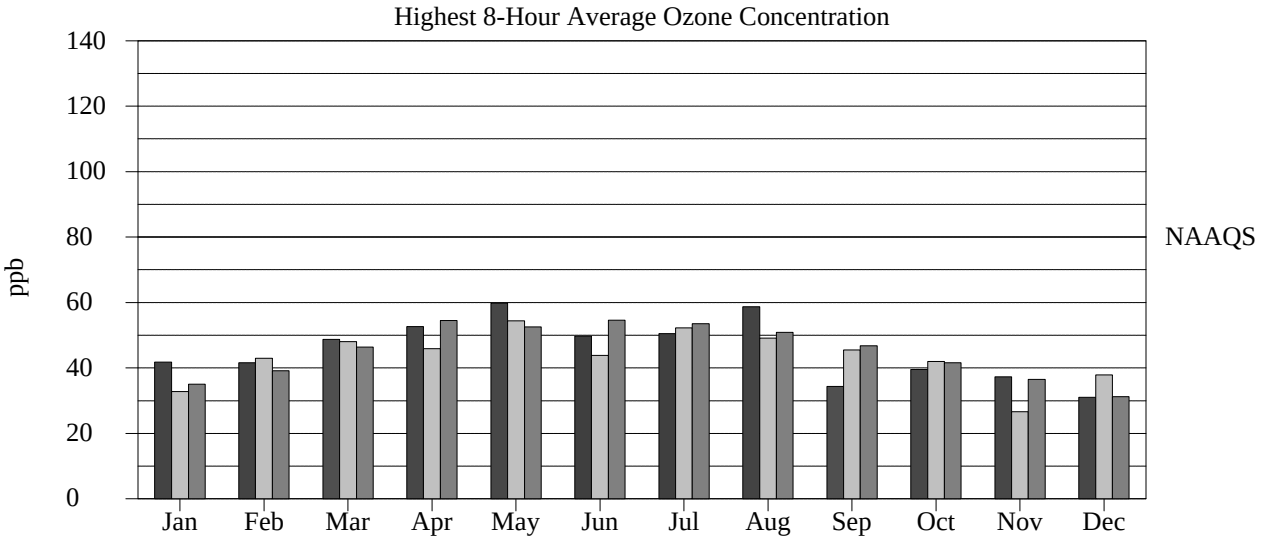
01/01/2002 - 12/31/2002

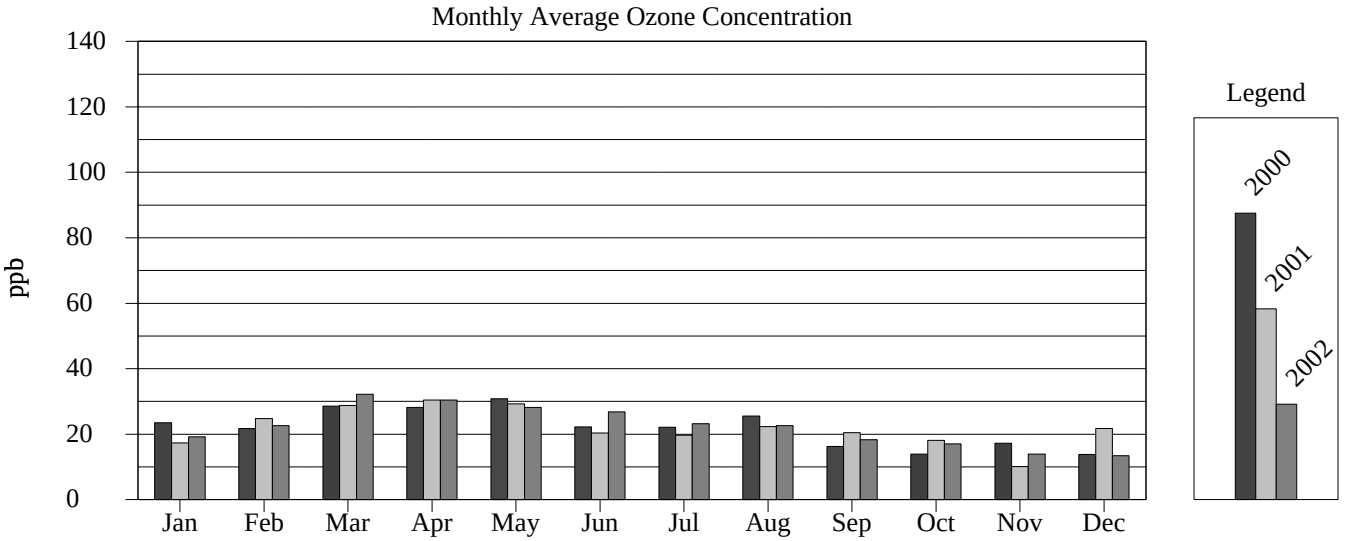
| Second Highest 1-Hour Average Concentration | | |
|---|---|---|
| Site | Rank | Concentration (ppb) |
| ACAD-CM | 1 | 127 |
| CHAM-XX | 2 | 127 |
| JOTR-YV | 3 | 127 |
| SEKI-LK | 4 | 126 |
| SEKI-AS | 5 | 124 |
| SEKI-LP | 6 | 124 |
| GRSM-LR | 7 | 122 |
| CACO-XX | 8 | 118 |
| COWP-XX | 9 | 118 |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

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

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


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

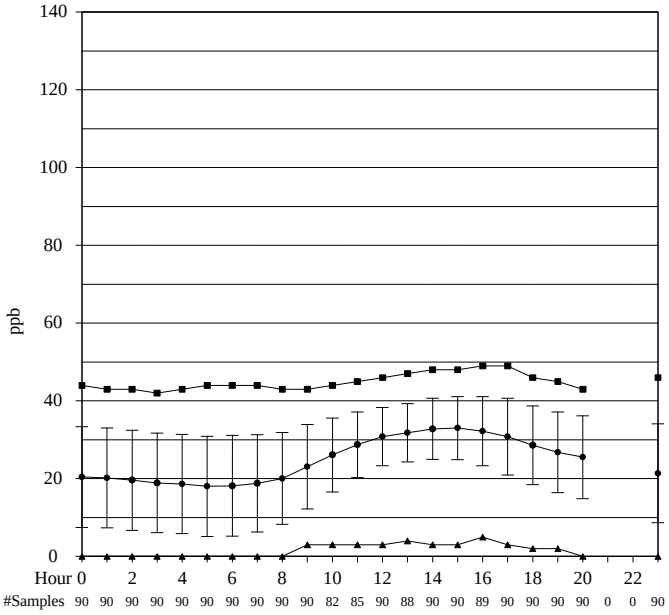

Highest 8-Hour Average Ozone Concentration
ppb
140
120
100
80
60
40
20
0
NAAQS
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


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

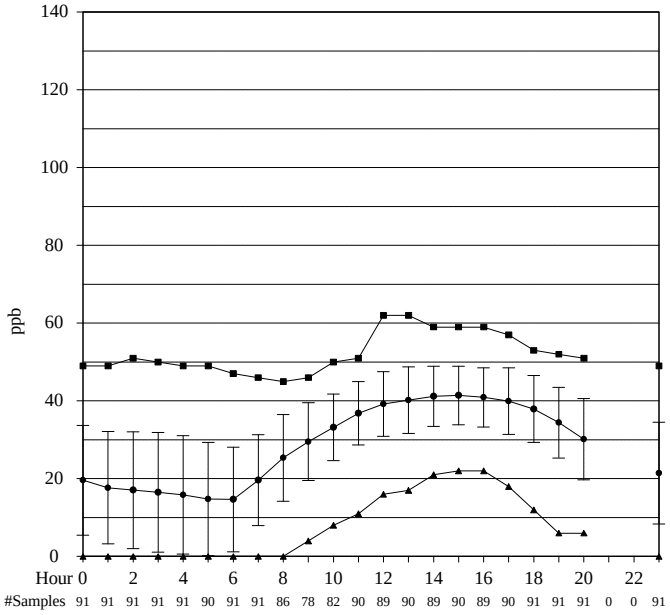
# NATIONAL PARK SERVICE
# GASEOUS POLLUTANT MONITORING NETWORK

## 2002 Second Highest 1-Hour Ozone Concentrations

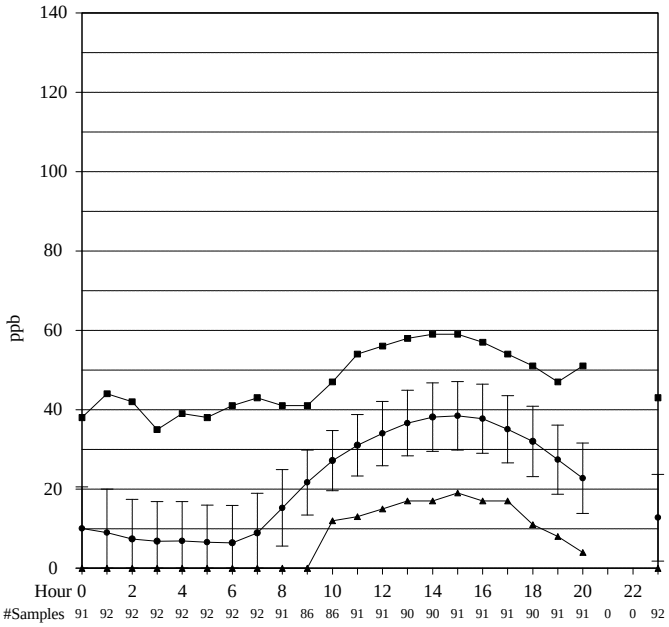
FIRST QUARTER (JAN-MAR)



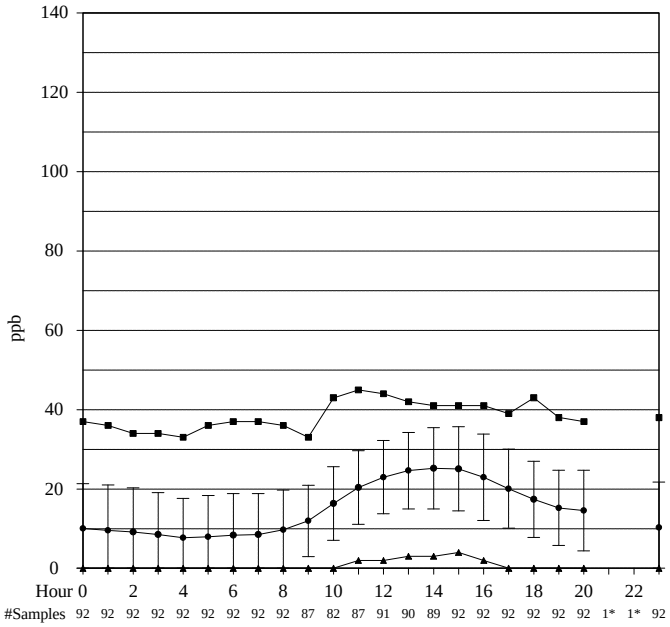

SECOND QUARTER (APR-JUN)




THIRD QUARTER (JUL-SEP)




FOURTH QUARTER (OCT-DEC)




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

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

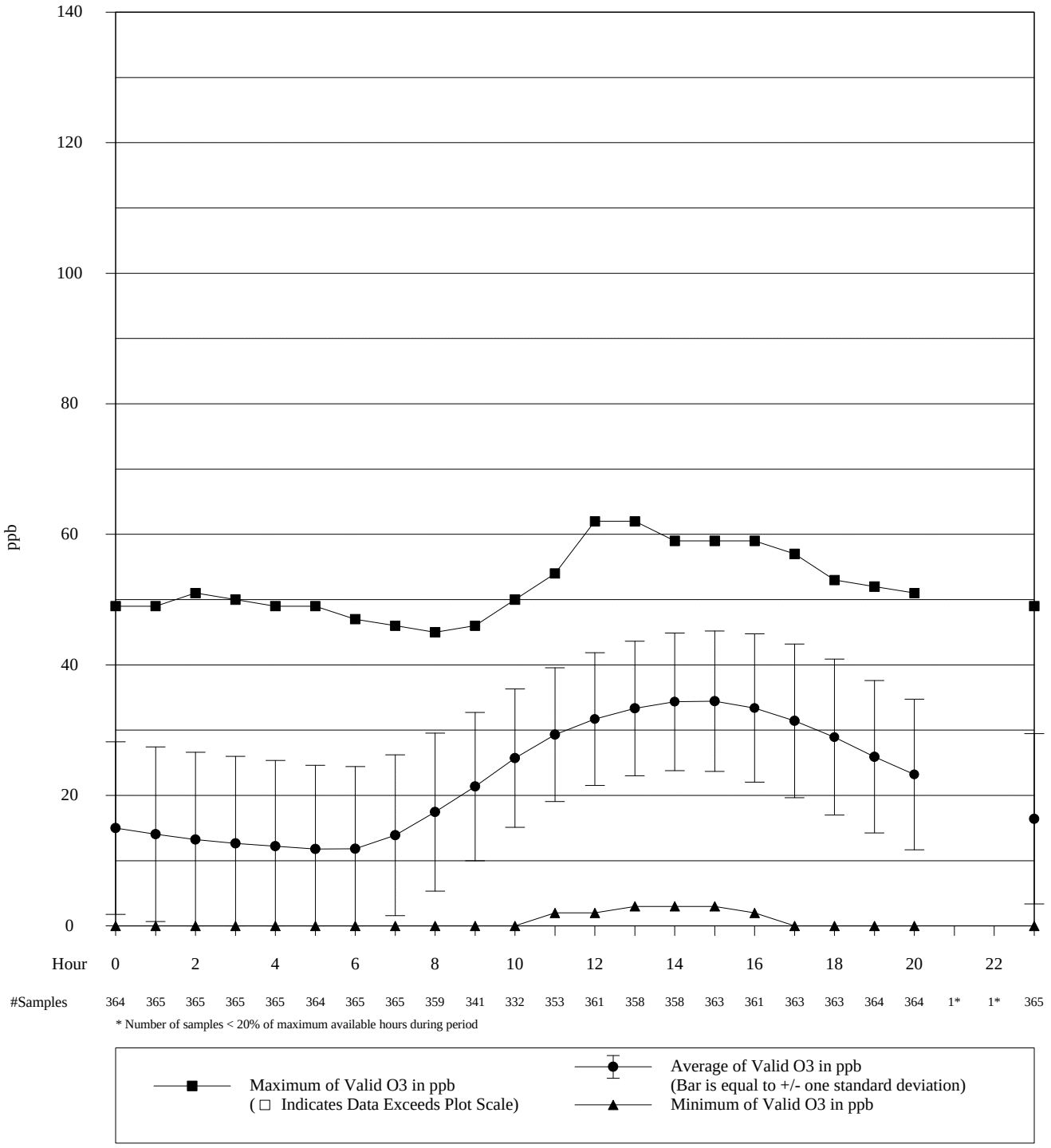
Average of Valid O3 in ppb
(Bar is equal to +/- one standard deviation)

Minimum of Valid O3 in ppb

Glacier National Park
Near West Glacier Horse Stables

Annual Diurnal
Ozone Plot

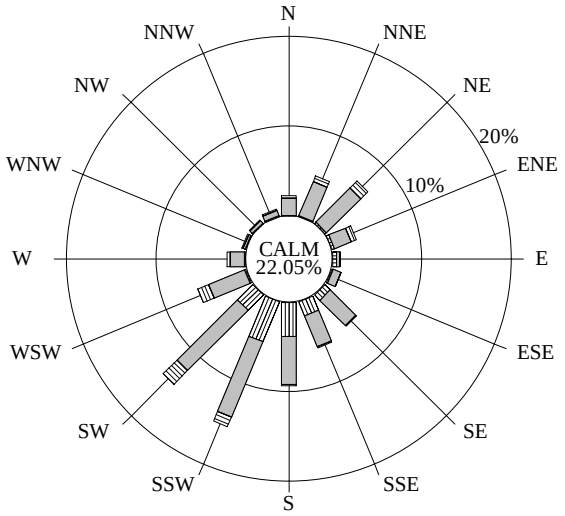
2002




Final Validation

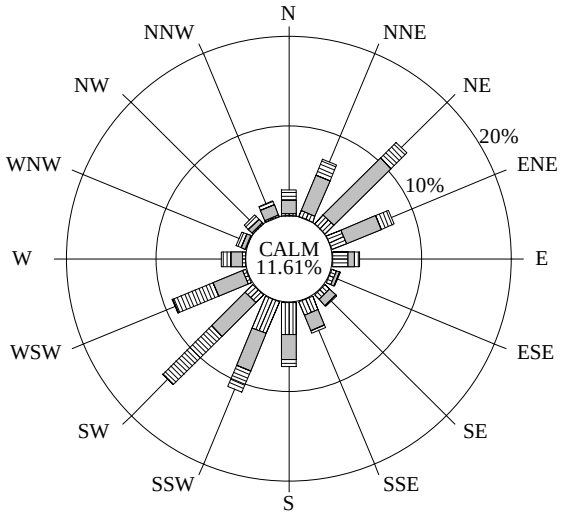
04-18-2003

FIRST QUARTER (JAN-MAR)



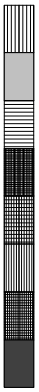

88.8% Collected 88.8% Valid
2160 Possible /1919 Collected /1918 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



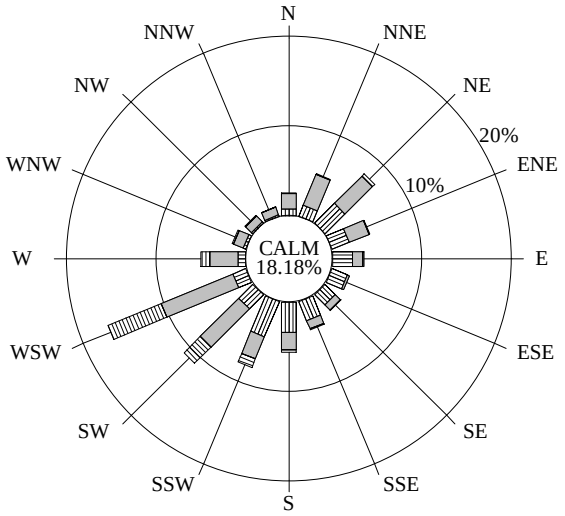

89.7% Collected 89.6% Valid
2184 Possible /1960 Collected /1956 Valid
(includes WS and WD)

Ozone (ppb)



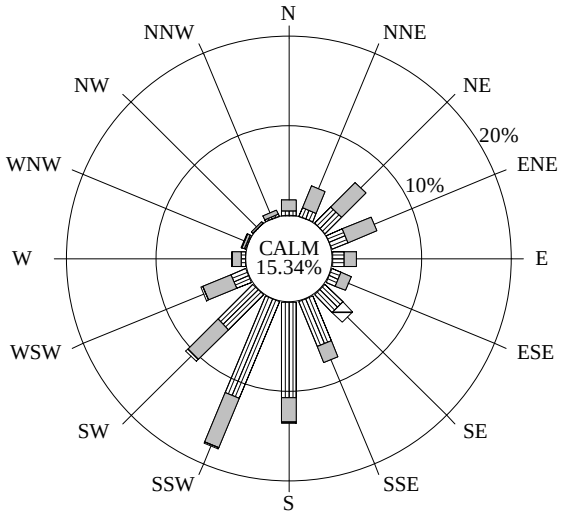
0-19
20-39
40-59
60-79
80-99
100-119
120-139
140+

THIRD QUARTER (JUL-SEP)

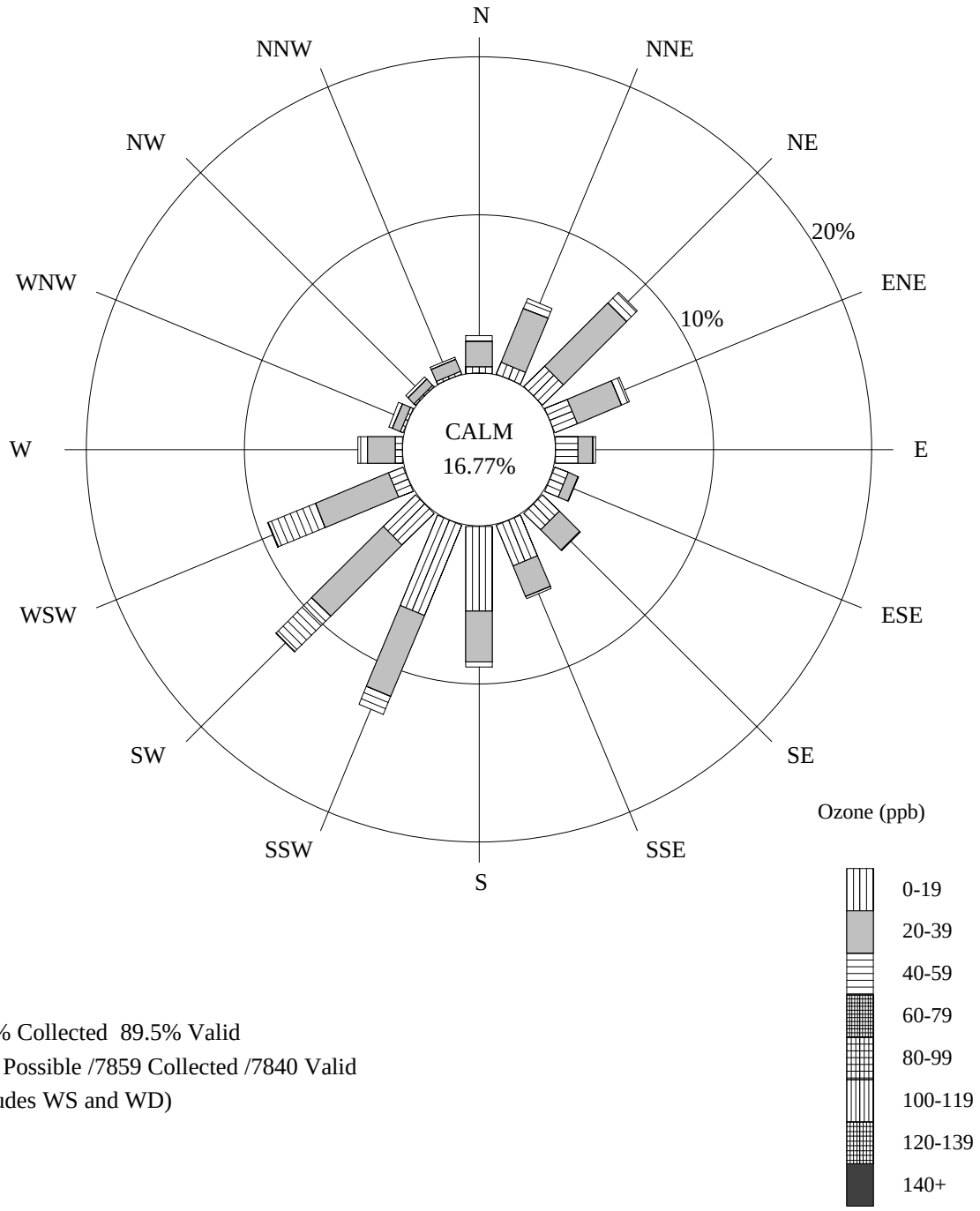



91.0% Collected 90.4% Valid
2208 Possible /2009 Collected /1997 Valid
(includes WS and WD)

FOURTH QUARTER (OCT-DEC)




89.3% Collected 89.2% Valid
2208 Possible /1971 Collected /1969 Valid
(includes WS and WD)




89.7% Collected 89.5% Valid
8760 Possible /7859 Collected /7840 Valid
(includes WS and WD)

# Ozone Analyzer Precision Check Summary
## Glacier 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 | 90 | -3.76 | -5.30 | -2.21 |
| 2 | 91 | -1.73 | -6.85 | 3.39 |
| 3 | 92 | -1.08 | -3.03 | 0.87 |
| 4 | 89 | -1.60 | -4.79 | 1.59 |

[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

Glacier National Park

Final Validation

01/01/2002 - 12/31/2002

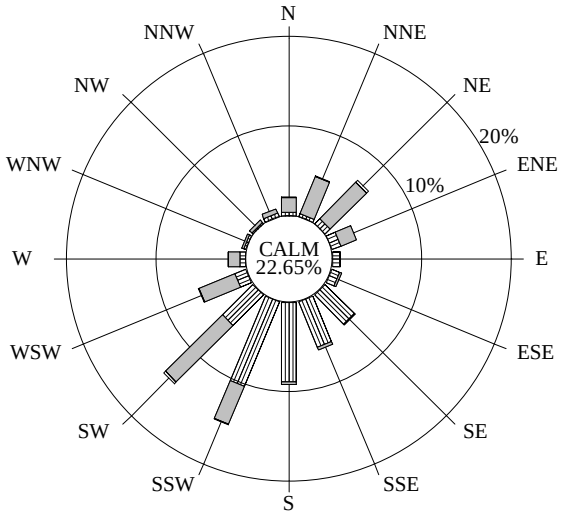
| Parameter | Value | Units | Number | Std Dev |
|---|---|---|---|---|
| SCALAR WIND SPEED | | | | |
| Average | 1.1 | m/s | 8664 | 0.8 |
| Maximum | 5.2 | m/s | | |
| Percent calm = 17.49 | | | | |
| | | | | |
| AMBIENT TEMPERATURE | | | | |
| Average | 5.2 | degC | 8759 | 9.6 |
| Maximum | 34.8 | degC | | |
| Minimum | -22.7 | degC | | |
| | | | | |
| RELATIVE HUMIDITY | | | | |
| Average | 72 | percent | 8760 | 21 |
| Maximum | 99 | percent | | |
| Minimum | 16 | percent | | |
| | | | | |
| PRECIPITATION (Rainfall or Snow melt) | | | | |
| Average non-zero rate | .8 | mm/hr | 873 | .9 |
| Maximum non-zero rate | 9.1 | mm/hr | | |
| Minimum non-zero rate | .3 | mm/hr | | |
| Accumulated during period | 722.6 | mm | | |
| | | | | |
| SOLAR RADIATION | | | | |
| Average Daily Total | 9,622,334 | joules/m2day | 338 | 7,269,519 |
| Maximum Daily Total | 24,905,600 | joules/m2day | | |
| Minimum Daily Total | 99,200 | joules/m2day | | |

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

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

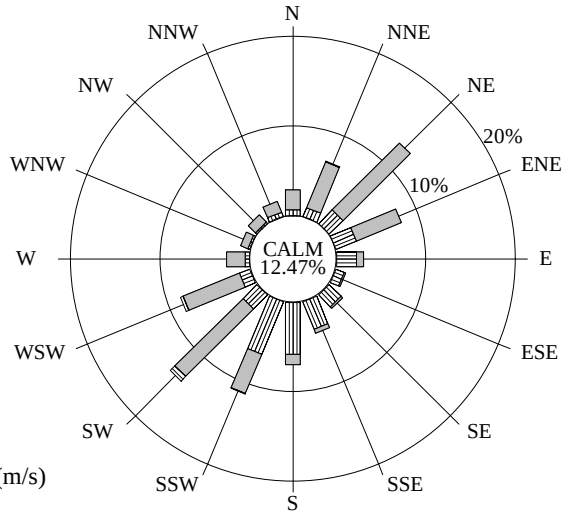
NA indicates instrument not available.

FIRST QUARTER (JAN-MAR)



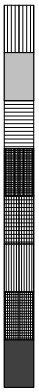

97.7% Collected 97.7% Valid
2160 Possible /2110 Collected /2110 Valid
(includes WS and WD)

SECOND QUARTER (APR-JUN)



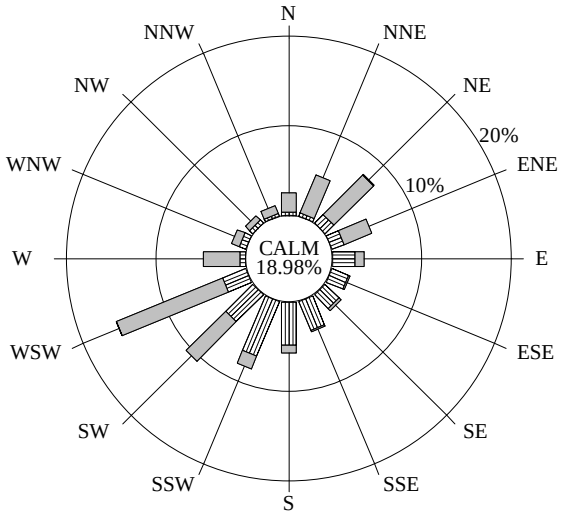

99.5% Collected 99.5% Valid
2184 Possible /2173 Collected /2173 Valid
(includes WS and WD)

Scalar Wind Speed (m/s)



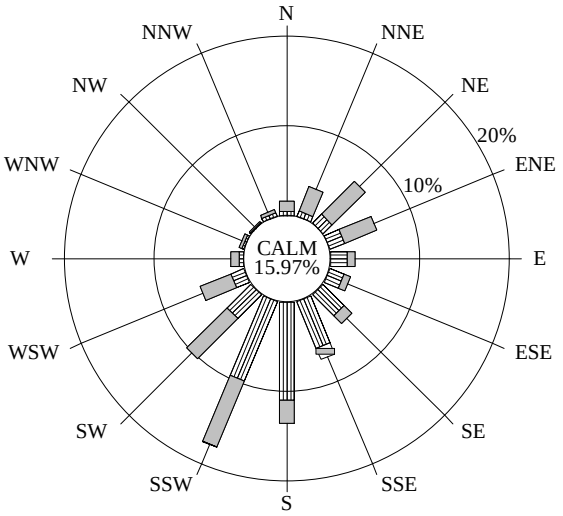
CALM < .5
0.5-0.9
1.0-3.9
4.0-6.9
7.0-9.9
10.0-12.9
13.0-15.9
16.0-18.9
19.0+

THIRD QUARTER (JUL-SEP)




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

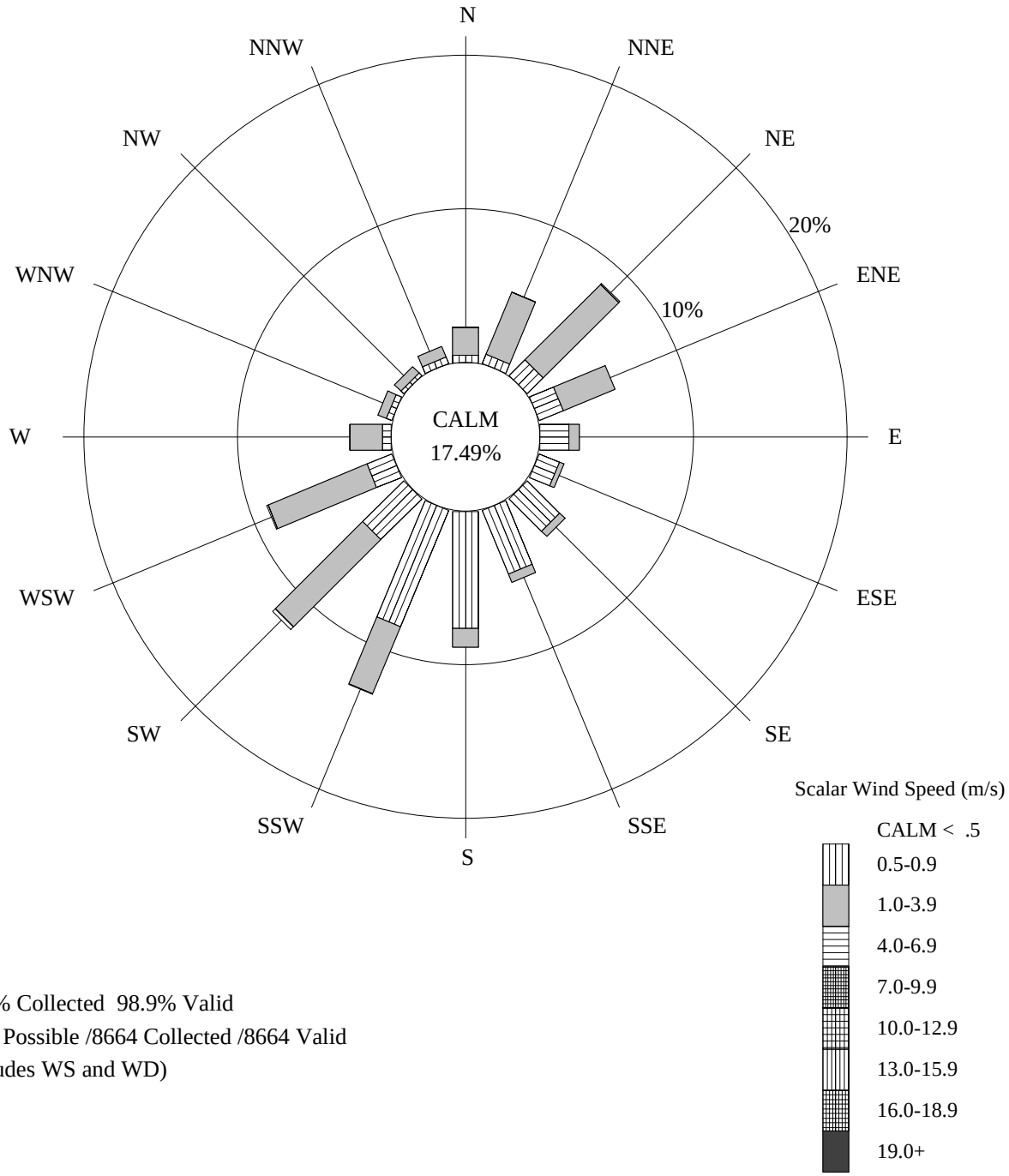
FOURTH QUARTER (OCT-DEC)




98.4% Collected 98.4% Valid
2208 Possible /2173 Collected /2173 Valid
(includes WS and WD)

Final Validation

04-18-2003




98.9% Collected 98.9% Valid
8760 Possible /8664 Collected /8664 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
Glacier 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 | 0.260 | 0.355 | 0.610 | 0.261 | 0.614 | 0.464 | 1.322 |
| 2 | 13 | 0.118 | 0.269 | 0.382 | 0.263 | 0.719 | 0.273 | 2.629 |
| 3 | 13 | 0.094 | 0.290 | 0.379 | 0.184 | 0.466 | 0.319 | 1.460 |
| 4 | 14 | 0.357 | 0.220 | 0.574 | 0.289 | 0.581 | 0.451 | 1.289 |
| Annual Average | | 0.210 | 0.282 | 0.488 | 0.250 | 0.595 | 0.378 | 1.572 |
| Standard Deviation | | 0.239 | 0.149 | 0.275 | 0.155 | 0.339 | 0.227 | |

Data Recovery Table

| Total No. Filters | No. Invalidated | Data Capture | No. Valid Hours |
|---|---|---|---|
| 53 | 0 | 100.0% | 8869.0 |

# CASTNet Dry Deposition Monitoring Weekly Concentrations Report
## Glacier National Park
## 1/1/02 - 12/31/02

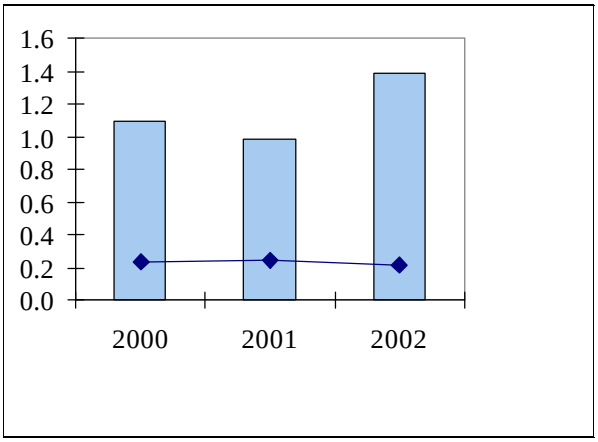
| On Date | Off Date | p-$NO_3$ (ug/m$^3$) | $HNO_3$ (ug/m$^3$) | Total $NO_3$ (ug/m$^3$) | $NH_4$ (ug/m$^3$) | p-$SO_4$ (ug/m$^3$) | $SO_2$ (ug/m$^3$) | $SO_4/SO_2$ Ratio |
|---|---|---|---|---|---|---|---|---|
| 12/26/01 | 01/02/02 | 0.181 | 0.302 | 0.478 | 0.317 | 0.709 | 0.474 | 1.497 |
| 01/02/02 | 01/08/02 | 0.777 | 0.177 | 0.951 | 0.301 | 0.293 | 0.108 | 2.715 |
| 01/08/02 | 01/15/02 | 0.083 | 0.118 | 0.199 | 0.088 | 0.204 | 0.151 | 1.347 |
| 01/15/02 | 01/22/02 | 0.379 | 0.162 | 0.539 | 0.179 | 0.348 | 0.212 | 1.638 |
| 01/22/02 | 01/29/02 | 0.078 | 0.152 | 0.228 | 0.071 | 0.144 | 0.243 | 0.595 |
| 01/29/02 | 02/05/02 | 0.363 | 0.295 | 0.653 | 0.201 | 0.343 | 0.181 | 1.889 |
| 02/05/02 | 02/12/02 | 0.084 | 0.277 | 0.357 | 0.105 | 0.314 | 0.265 | 1.189 |
| 02/12/02 | 02/19/02 | 0.292 | 0.331 | 0.618 | 0.140 | 0.371 | 0.255 | 1.452 |
| 02/19/02 | 02/26/02 | 0.039 | 0.249 | 0.283 | 0.185 | 0.533 | 0.446 | 1.194 |
| 02/26/02 | 03/05/02 | 0.294 | 0.436 | 0.723 | 0.397 | 0.921 | 0.429 | 2.147 |
| 03/05/02 | 03/12/02 | 0.360 | 0.502 | 0.854 | 0.345 | 0.805 | 1.105 | 0.728 |
| 03/12/02 | 03/19/02 | 0.316 | 0.477 | 0.786 | 0.510 | 1.314 | 1.050 | 1.252 |
| 03/19/02 | 03/26/02 | 0.140 | 1.136 | 1.258 | 0.553 | 1.683 | 1.117 | 1.507 |
| 03/26/02 | 04/02/02 | 0.134 | 0.274 | 0.404 | 0.257 | 0.697 | 0.362 | 1.927 |
| 04/02/02 | 04/09/02 | 0.139 | 0.456 | 0.587 | 0.435 | 1.308 | 0.375 | 3.491 |
| 04/09/02 | 04/16/02 | 0.078 | 0.197 | 0.272 | 0.081 | 0.293 | 0.182 | 1.608 |
| 04/16/02 | 04/23/02 | 0.140 | 0.283 | 0.419 | 0.404 | 1.146 | 0.235 | 4.884 |
| 04/23/02 | 04/30/02 | 0.155 | 0.281 | 0.432 | 0.363 | 0.968 | 0.322 | 3.003 |
| 04/30/02 | 05/07/02 | 0.233 | 0.164 | 0.395 | 0.221 | 0.656 | 0.292 | 2.251 |
| 05/07/02 | 05/14/02 | 0.074 | 0.344 | 0.412 | 0.328 | 0.840 | 0.268 | 3.133 |
| 05/14/02 | 05/21/02 | 0.159 | 0.240 | 0.395 | 0.296 | 0.718 | 0.220 | 3.263 |
| 05/21/02 | 05/28/02 | 0.077 | 0.258 | 0.331 | 0.248 | 0.615 | 0.169 | 3.637 |
| 05/28/02 | 06/04/02 | 0.113 | 0.217 | 0.327 | 0.194 | 0.574 | 0.232 | 2.475 |
| 06/04/02 | 06/11/02 | 0.084 | 0.149 | 0.231 | 0.124 | 0.319 | 0.231 | 1.384 |
| 06/11/02 | 06/18/02 | 0.084 | 0.340 | 0.419 | 0.315 | 0.821 | 0.383 | 2.140 |
| 06/18/02 | 06/25/02 | 0.058 | 0.292 | 0.346 | 0.160 | 0.390 | 0.285 | 1.370 |
| 06/25/02 | 07/02/02 | 0.101 | 0.284 | 0.381 | 0.164 | 0.429 | 0.288 | 1.489 |
| 07/02/02 | 07/09/02 | 0.139 | 0.259 | 0.393 | 0.092 | 0.445 | 0.252 | 1.765 |
| 07/09/02 | 07/16/02 | 0.103 | 0.449 | 0.545 | 0.157 | 0.409 | 0.302 | 1.354 |
| 07/16/02 | 07/23/02 | 0.143 | 0.346 | 0.483 | 0.284 | 0.625 | 0.415 | 1.507 |
| 07/23/02 | 07/30/02 | 0.128 | 0.316 | 0.439 | 0.324 | 0.474 | 0.449 | 1.056 |
| 07/30/02 | 08/06/02 | 0.089 | 0.208 | 0.294 | 0.224 | 0.543 | 0.227 | 2.397 |
| 08/06/02 | 08/13/02 | 0.058 | 0.298 | 0.351 | 0.174 | 0.395 | 0.395 | 1.001 |
| 08/13/02 | 08/20/02 | 0.082 | 0.248 | 0.326 | 0.134 | 0.301 | 0.334 | 0.900 |
| 08/20/02 | 08/27/02 | 0.080 | 0.296 | 0.371 | 0.103 | 0.403 | 0.230 | 1.754 |
| 08/27/02 | 09/03/02 | 0.047 | 0.298 | 0.340 | 0.207 | 0.559 | 0.320 | 1.748 |
| 09/03/02 | 09/10/02 | 0.058 | 0.174 | 0.229 | 0.151 | 0.411 | 0.161 | 2.552 |
| 09/10/02 | 09/17/02 | 0.107 | 0.365 | 0.466 | 0.201 | 0.642 | 0.338 | 1.899 |
| 09/17/02 | 09/24/02 | 0.087 | 0.224 | 0.308 | 0.180 | 0.420 | 0.439 | 0.957 |
| 09/24/02 | 10/01/02 | 0.082 | 0.157 | 0.236 | 0.151 | 0.382 | 0.287 | 1.332 |
| 10/01/02 | 10/08/02 | 0.074 | 0.250 | 0.320 | 0.152 | 0.334 | 0.249 | 1.343 |
| 10/08/02 | 10/15/02 | 0.118 | 0.223 | 0.338 | 0.200 | 0.504 | 0.363 | 1.389 |
| 10/15/02 | 10/22/02 | 0.074 | 0.291 | 0.360 | 0.151 | 0.431 | 0.463 | 0.930 |
| 10/22/02 | 10/29/02 | 0.232 | 0.227 | 0.456 | 0.388 | 0.937 | 0.453 | 2.067 |
| 10/29/02 | 11/05/02 | 0.754 | 0.212 | 0.963 | 0.467 | 0.740 | 0.574 | 1.288 |
| 11/05/02 | 11/12/02 | 0.504 | 0.253 | 0.753 | 0.192 | 0.421 | 0.576 | 0.731 |
| 11/12/02 | 11/19/02 | 0.182 | 0.274 | 0.451 | 0.163 | 0.414 | 0.471 | 0.880 |
| 11/19/02 | 11/26/02 | 0.212 | 0.224 | 0.432 | 0.210 | 0.403 | 0.401 | 1.003 |
| 11/26/02 | 12/03/02 | 0.764 | 0.272 | 1.031 | 0.654 | 1.368 | 0.655 | 2.088 |
| 12/03/02 | 12/10/02 | 1.381 | 0.251 | 1.628 | 0.880 | 1.312 | 0.956 | 1.372 |
| 12/10/02 | 12/17/02 | 0.294 | 0.117 | 0.409 | 0.175 | 0.280 | 0.258 | 1.084 |
| 12/17/02 | 12/24/02 | 0.100 | 0.131 | 0.230 | 0.088 | 0.201 | 0.310 | 0.650 |
| 12/24/02 | 12/31/02 | 0.226 | 0.204 | 0.427 | 0.171 | 0.412 | 0.295 | 1.396 |

Glacier National Park

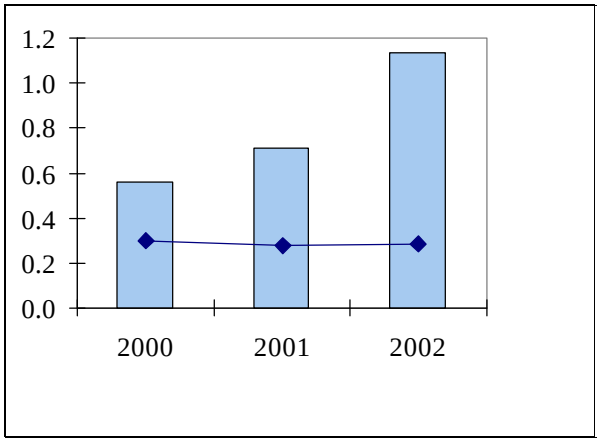
CASTNet Dry Deposition Monitoring

Three Year Comparison of Maximum and Average Concentrations

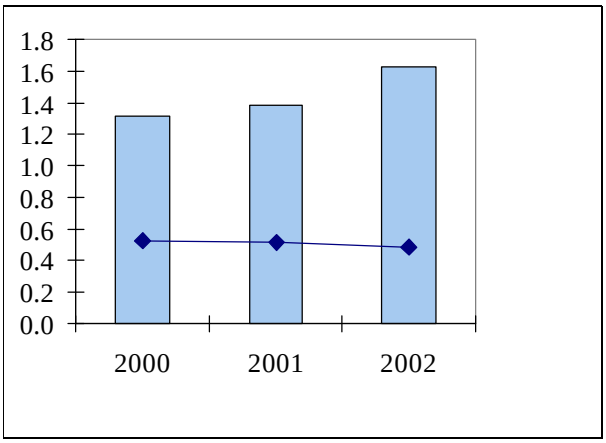
p-NO3



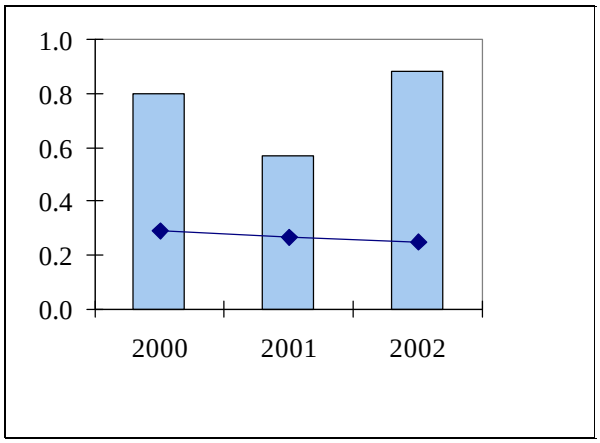

HNO3



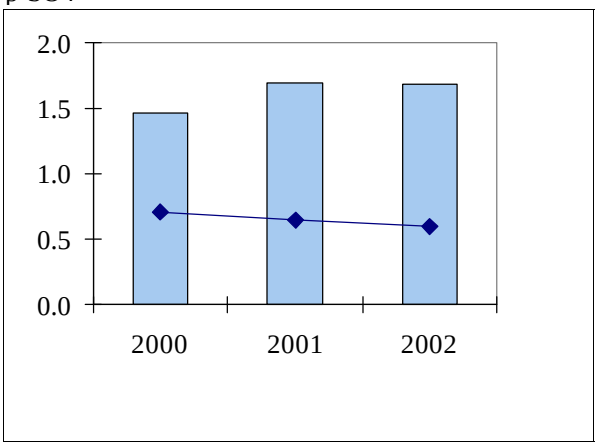

Total NO3



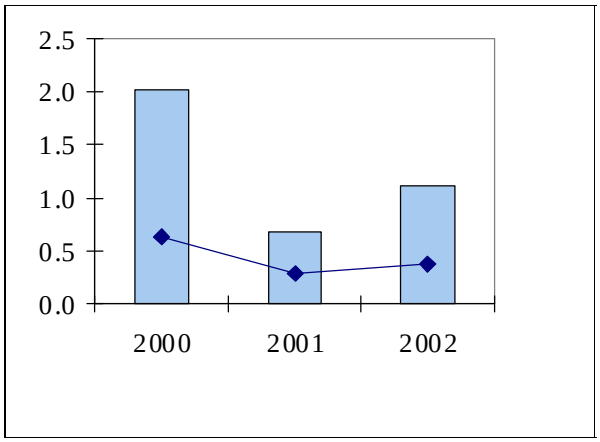

NH4



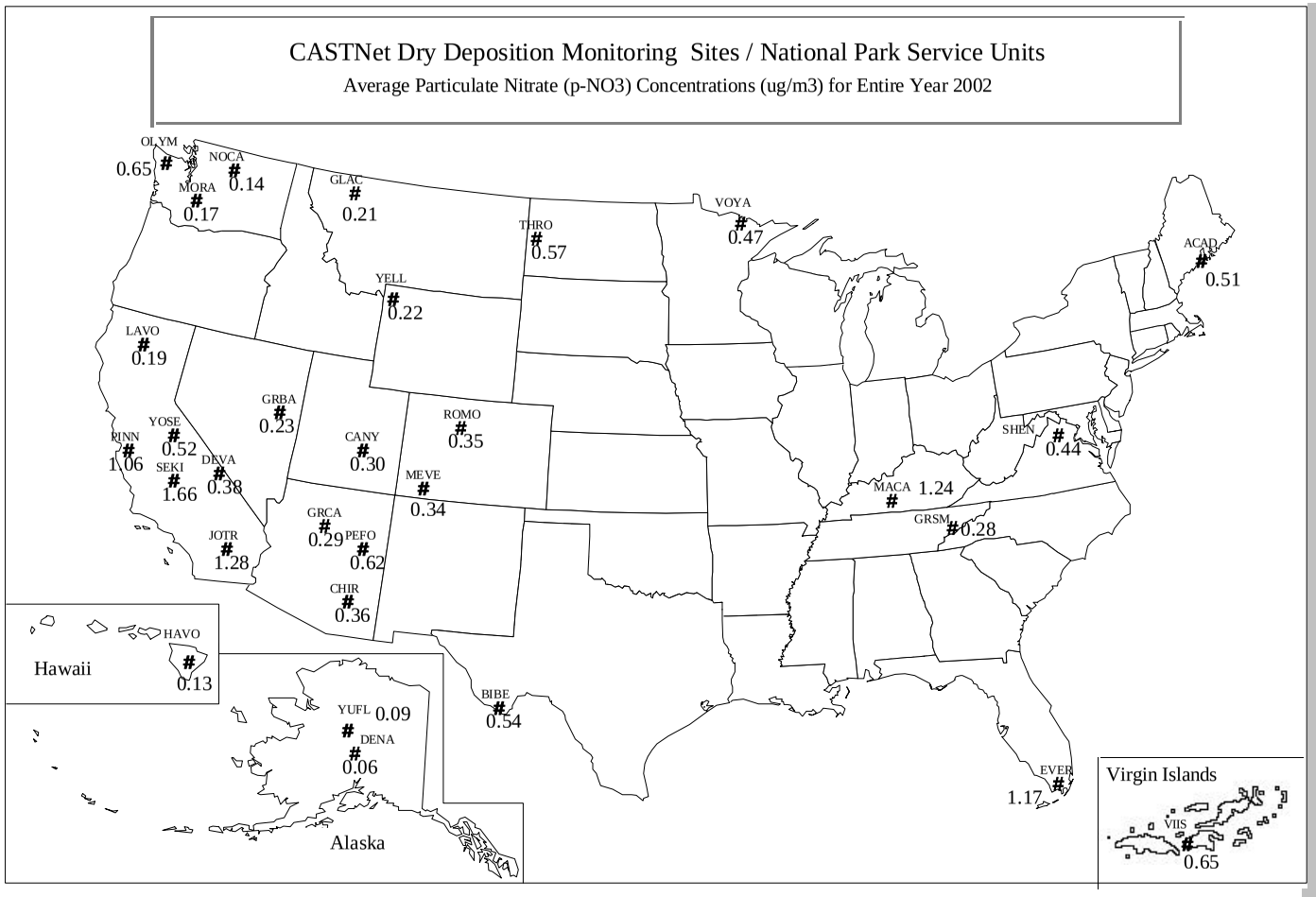

p-SO4




SO2




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




Key:

| | |
|---|---|
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| BIBE | Big Bend NP |
| CANY | Canyonlands NP |
| CHIR | Chiricahua NM |
| DENA | Denali NP |
| DEVA | Death Valley NP |
| EVER | Everglades NP |
| GLAC | Glacier NP |
| GRBA | Great Basin NP |
| GRCA | Grand Canyon NP |
| GRSM | Great Smokies NP |
| HAVO | Havaii Volcanos NP |
| JOTR | Joshua Tree NP |
| LAVO | Lassen Volcanic NP |
| MACA | Mammoth Cave NP |
| MEVE | Mesa Verde NP |
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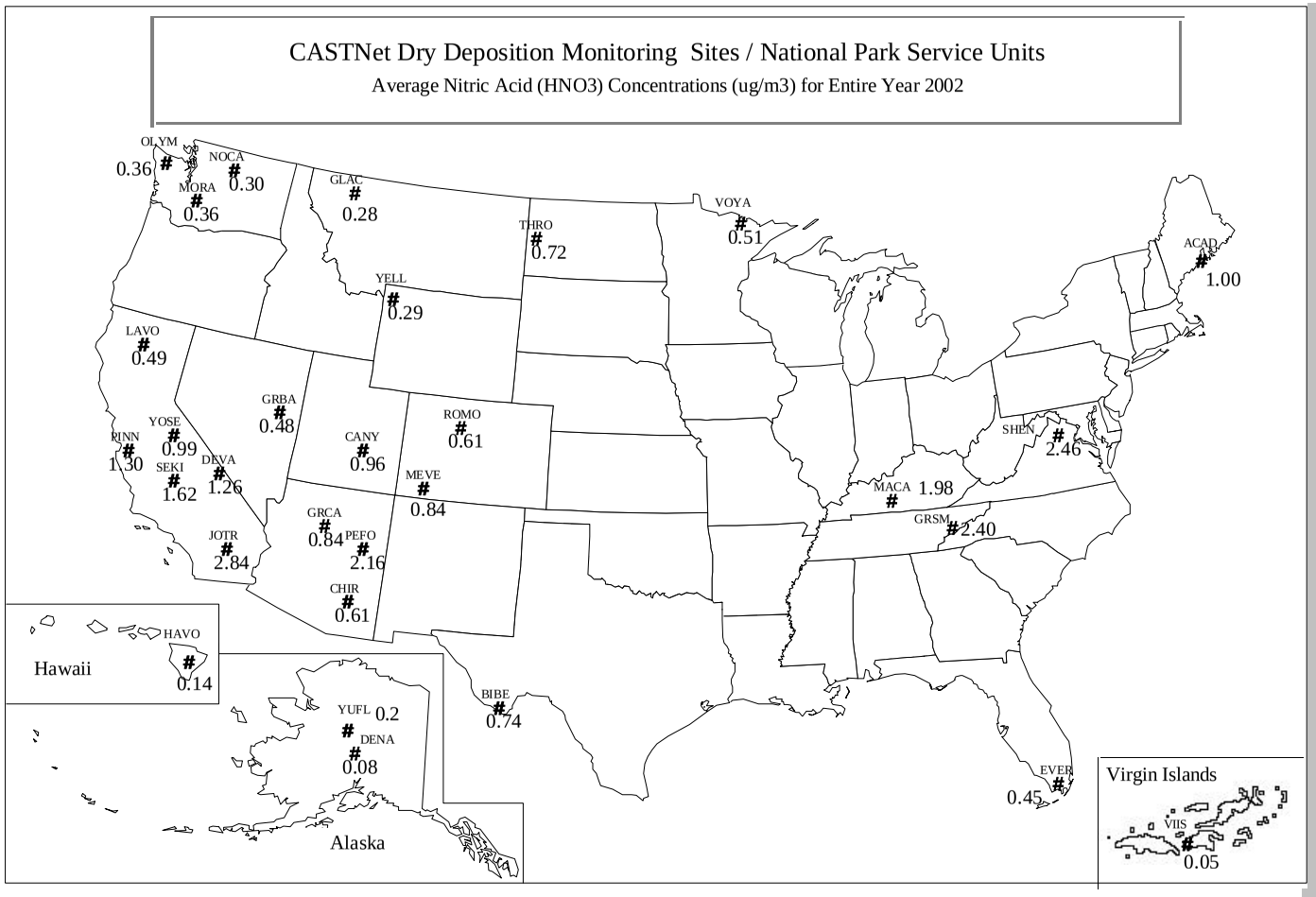


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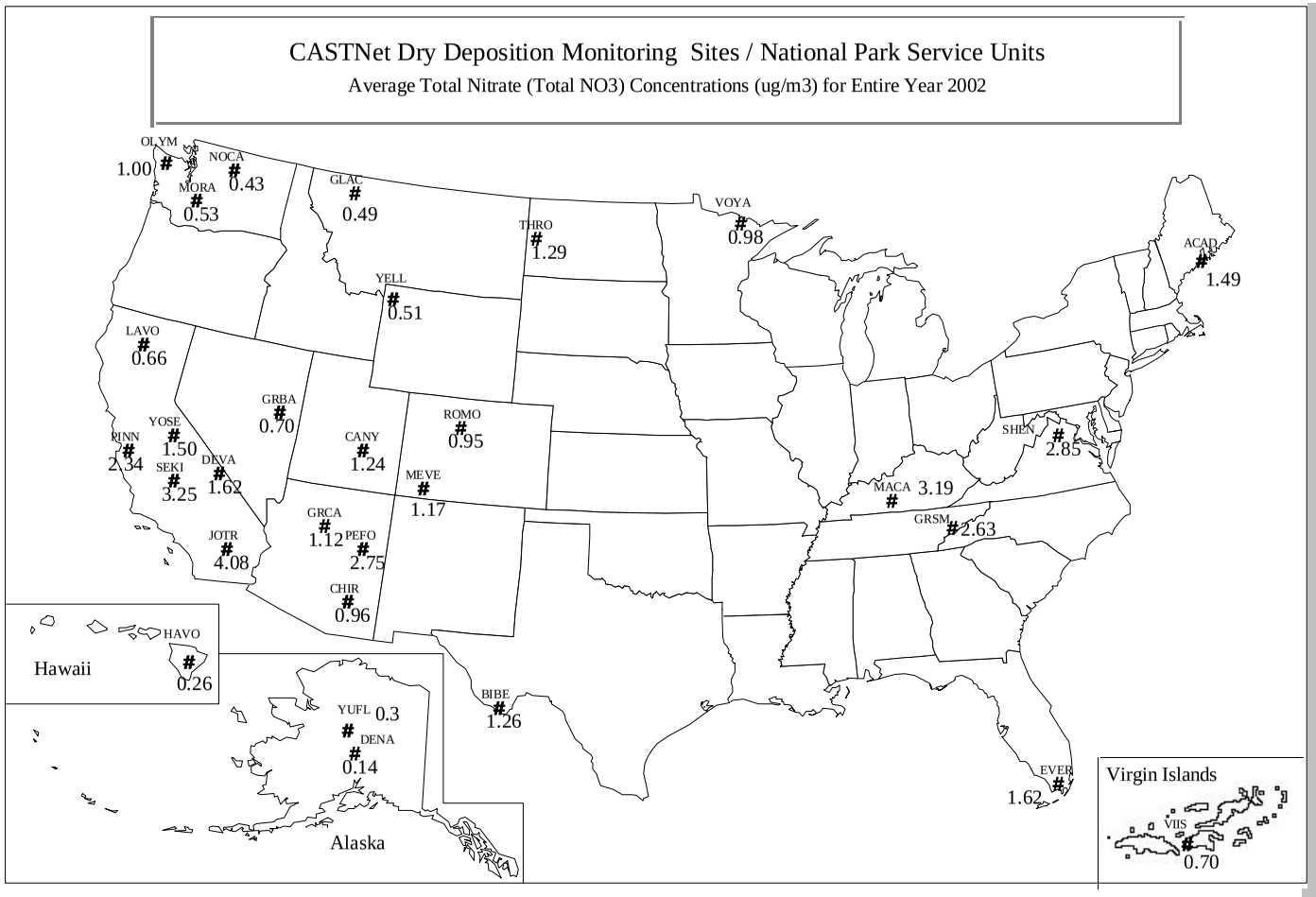


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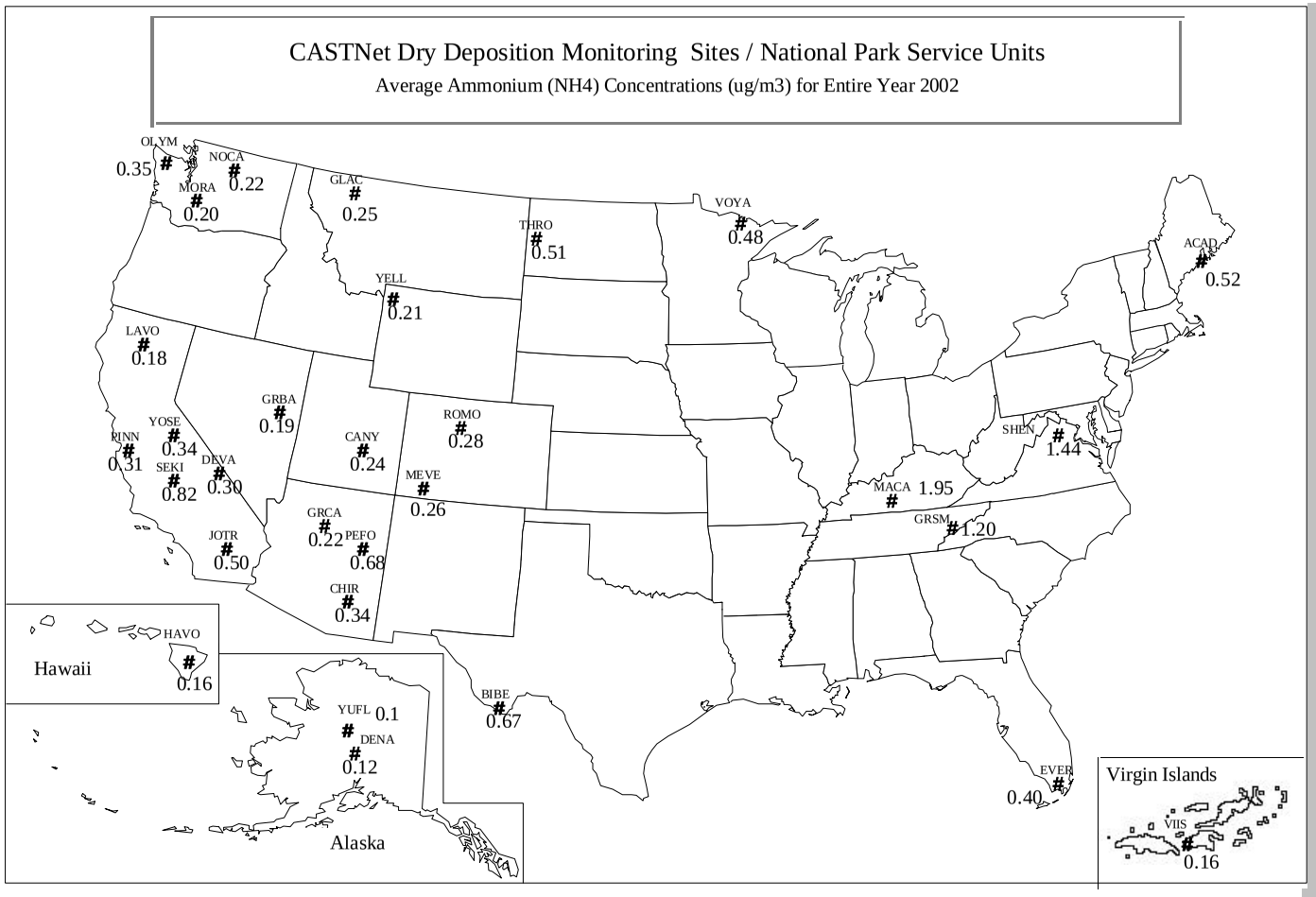


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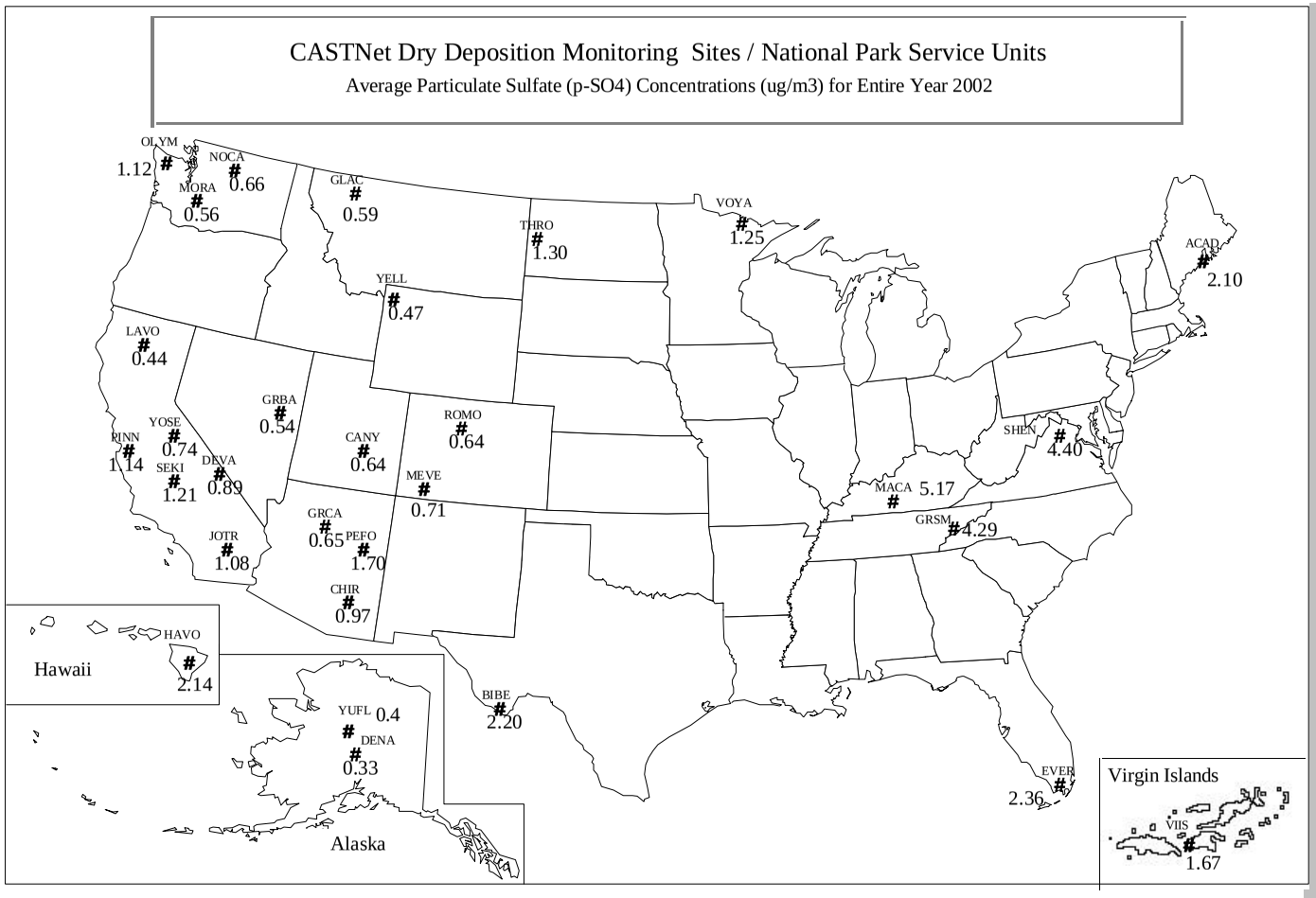


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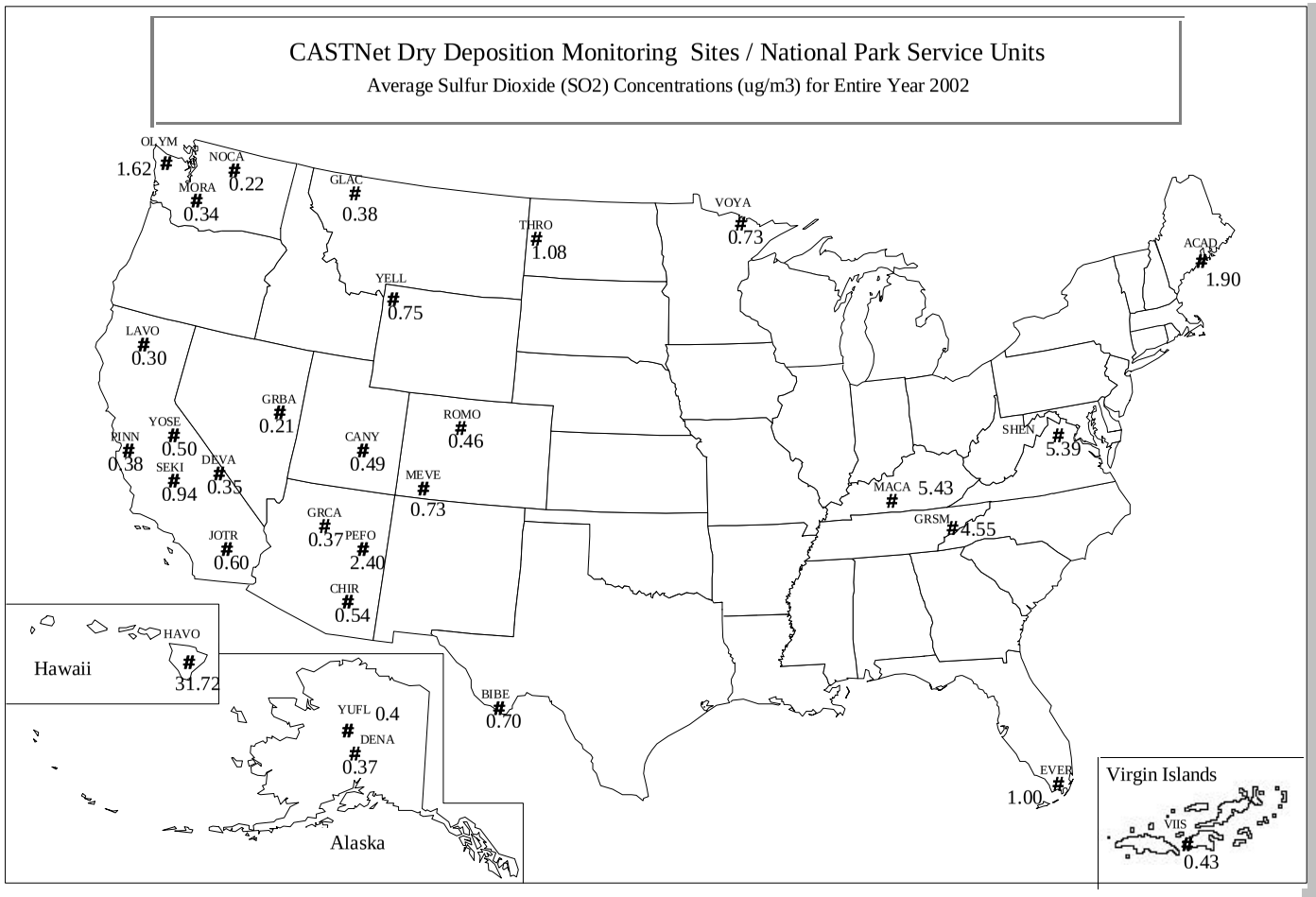


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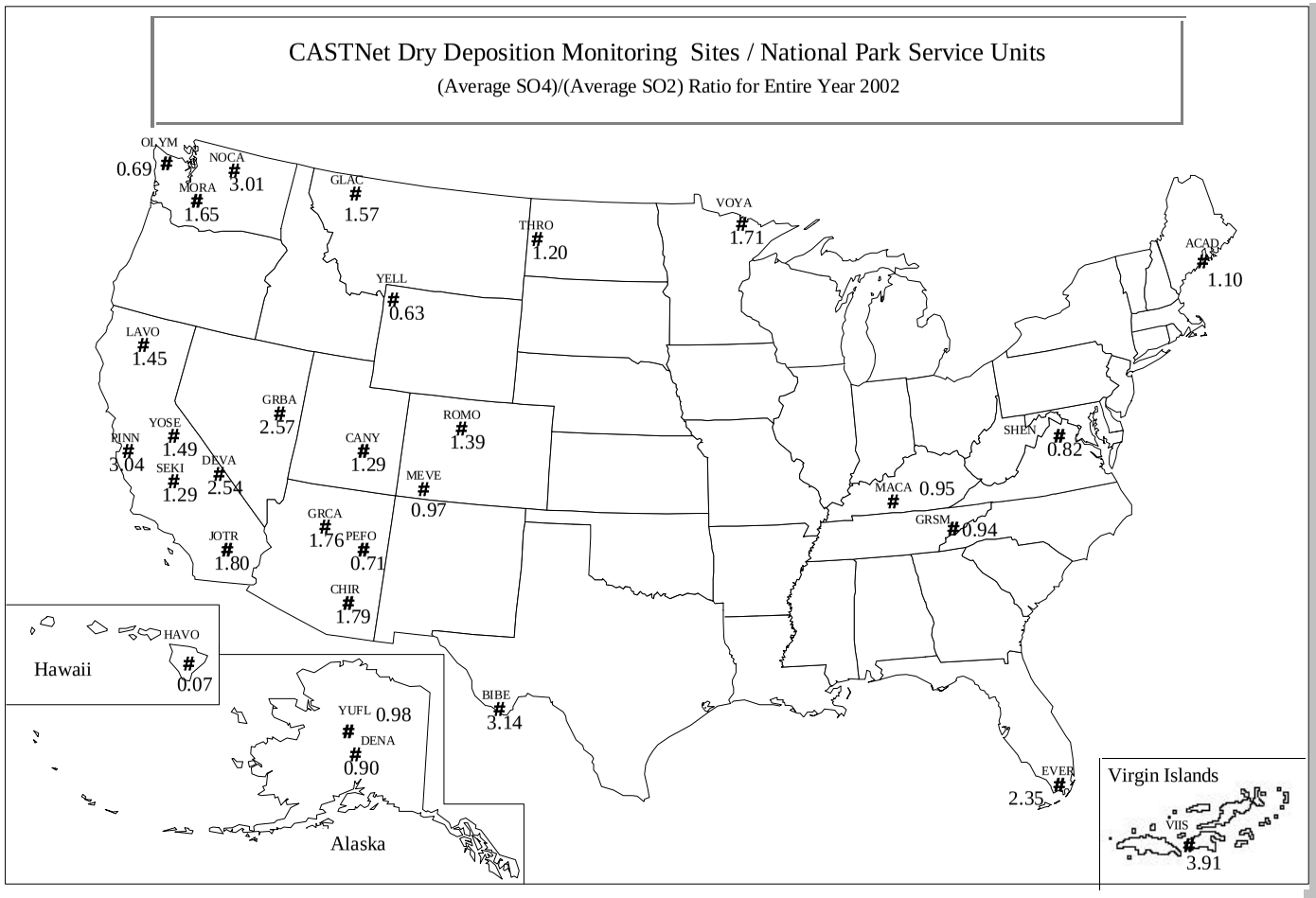


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| SHEN | Shenandoah NP |
| THRO | Th. Roosevelt NP |
| VIIS | Virgin Islands NP |
| VOYA | Voyageurs NP |
| YELL | Yellowstone NP |
| YOSE | Yosemite NP |
| YUFL | Yukon Flats NWR |

## 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.

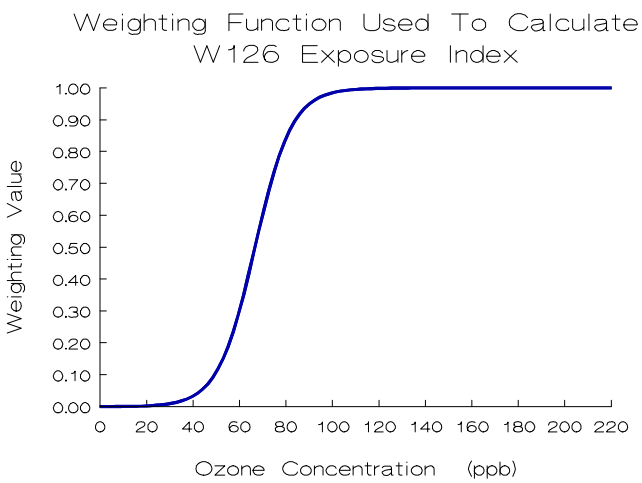
(13) **SUM60 Exposure Index**. The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to 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 <u>not</u> averages (e.g., maxima and exposures) whenever the number of valid observations is less than 75% of the total possible.

## References

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

## 4.2 AIR QUALITY GLOSSARY

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

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

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

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

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

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

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

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

**Ambient Air:** Air that is accessible to the public.

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

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

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

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

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

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

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

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

**Monitoring:** Measurement of air pollution.

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

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

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

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

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

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## 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