1. Introduction and Executive Summary

In the fall of 1987, responding to the serious ozone depletion reported in Antarctica, the Division of Polar Programs of the National Science Foundation called for the establishment of an Ultraviolet (UV) Monitoring System in Antarctica. Now in its 12th year, this network is the first automated, longest operating, high-resolution UV scanning spectroradiometer network in the world. It has been operationally successful in the harshest environments of Antarctica and the Arctic and is continuously returning data to researchers studying the effects of UV radiation on terrestrial and marine biological systems. In addition, this data is being used by atmospheric scientists investigating the influence of atmospheric constituents like ozone and clouds on UV levels at the ground. These studies helped to quantify the impact of ozone depletion, to analyze the variability of UV radiation on time-scales from hours to years, and to develop and verify models describing the transfer of solar radiation through the atmosphere.

Spectroradiometers (type SUV-100, manufactured by Biospherical Instruments Inc.) were installed in four locations between February and November 1988; a fifth instrument was installed at Barrow, Alaska in December 1990. The San Diego system, installed in November 1992, is a multi-purpose system used for collecting solar irradiance data, training site operators, evaluating and testing engineering improvements, and comparing measurements of other types of UV instrumentation. The following table lists the positions and the period of data referred to in this report for these sites.

Table 1.1. NSF spectroradiometer installation sites.

ID #	Site	Longitude	Latitude	Established	Normal Season
1	McMurdo, Antarctica	166º40'E	77º51'S	March 1988	August – April
2	Palmer, Antarctica	64º03'W	64º46'S	May 1988	Year-round
3	South Pole, Antarctica	0	90º00'S	February 1988	September - March
4	Ushuaia, Argentina*	68º19'W	54º49'S	November 1988	Year-round
5	San Diego, California**	117º11'W	32º45'N	November 1992	Year-round
6	Barrow, Alaska***	156º47'W	71º18'N	December 1990	January – November

*CADIC: Centro Austral de Investigaciones Cientificas, Argentina
**Biospherical Instruments Inc.
***UIC/NARL: Ukpeagvik Inupiat Corporation (formerly) Naval Arctic Research Laboratory

The SUV-100 spectroradiometers are based on a temperature-stabilized, scanning double monochromator coupled to a photomultiplier tube (PMT) detector. The system is optimized for operation in the UV. A vacuum-formed Teflon® diffuser serves as an all-weather irradiance collector and is conductively heated by the system to minimize ice and snow buildup. The instrument has internal wavelength and irradiance calibration lamps for daily automatic calibrations at programmed intervals. Data acquisition system and control instrumentation accompanies the instrument. Starting in mid-1996, Pentium® microprocessor-based personal computers (PC), using the Windows NT® operating system, were put into use for system control and data collection. For additional information on system hardware see Chapter 2 of this report.

Measurements of global spectral irradiance between 280 and 605 nm are conducted quarter-hourly when the sun is above the horizon. Peripheral data from pyranometers, broadband UV detectors, and other sensors controlling critical system parameters (temperatures, monochromator position, etc.) are also collected. At sites inside the Arctic or Antarctic circles, instrument operation is on a reduced scan schedule during the winter darkness.

Data from the network is categorized into three levels. **Level 1** data is unprocessed, uncalibrated data in binary form, which is not distributed. **Level 2** data is produced on a weekly basis by applying preliminary irradiance and a wavelength calibrations to "raw" Level 1 data. Possible changes in instrument responsivity are corrected during data processing and the data is further screened and corrected for drifts, instrumental malfunctions, and other events that may affect the accuracy. Level 2 data are available in near real time for approved NSF-sponsored researchers. A subset of the dataset is also published on the Biospherical Instruments website, showing weekly updated graphs of UV irradiance in several wavelength bands.

Level 2 data are provisional; investigators are cautioned to check with Biospherical Instruments before any final conclusions or publications are made using these data, as they are subject to revision. **Level 3** data are "final" data that are distributed on CD-ROM and made available via the Biospherical Instruments website. In order to produce Level 3 data, information collected during annual visits to the network sites has been used, including comparisons of the Standards of Spectral Irradiance (maintained on site to calibrate the instruments), with independent standards, which are checked frequently by standards laboratories. Level 3 data have final corrections applied and have successfully passed a well-defined quality control procedure. Level 3 data are generally available to any interested researcher. An online data request form is available on the Biospherical Instruments Inc website www.biospherical.com.

This report describes Volume 8 of Level 3 data from the NSF Polar Programs UV Radiation Monitoring Network, encompassing the years 1998 and 1999. The published data set includes:

- Solar global irradiance spectra in full spectral resolution between 280 and 605 nm. Each spectrum is stored in a separate file in ASCII comma separated value (CSV) format.

- Databases in ASCII format providing measurements of global spectral irradiance at selected wavelengths, which were extracted from the full-resolution irradiance spectra. These databases provide an easy way to analyze time series over extended time periods.

- Databases with spectral integrals (e.g., UV-B and UV-A) and weighted spectral irradiances ("dose rates"). A total of six biological action spectra have been implemented, including the CIE action spectrum for erythema (McKinlay and Diffey, 1987) and Setlow's action spectrum for DNA damage (Setlow, 1994).

- Ancillary measurements with pyranometers (Eppley PSP) and broadband UV-A sensors.

- Databases with system parameters, which are helpful for quality control.

Over the years, this network of instruments has provided data for the support of several research programs, the details of which may be found in the following references: Anderson et al. (1993); Benavides et al. (1994); Booth et al. (1988, 1990, 1991, 1992, 1993, 1994, 1997); Cullen et al. (1992); Day et al. (1998); Díaz et al. (1990, 1991, 1994, 1996); Frederick et al. (1988, 1991, 1993, 1994, 1998); Gurney (1998); Holm-Hansen et al. (1993, 1994, 1997, 1998); Karentz et al. (1990, 1991, 1992, 1994, 1995, 1997); Lewis (1997); Lubin and Frederick (1989, 1991, 1992); Lubin et al. (1989, 1992, 1995); Madronich (1993, 1994); Malloy (1997); Ricchiazzi et al. (1995, 1996); Rowland (1989, 1996); Seckmeyer et al. (1995); Smith et al. (1989,1991,1992); Stamnes (1993); Stamnes et al. (1990,1991, 1992); and Thompson et al. (1997).

The balance of this report describes much of the preceding information in detail, and serves as a guide to researchers using the various databases and high-resolution data products resulting from the project. The report is structured as follows: Section 2 provides a more detailed description of the SUV-100 Spectroradiometer. In Section 3, each of the network sites is described, including the prevailing atmospheric conditions. Section 4 discusses system operation and data analysis, including types and schedule of spectral measurements, as well as calibration and data processing methods. Section 5 discusses the calibration standards used to process Volume 8 data and gives the results of the quality control procedures applied. Section 6 describes in detail the contents and format of the published data, including the database structure. Section 7 provides examples of network data for each of the sites. Here Volume 8 data is contrasted with UV measurements of previous years, focusing on noontime UV levels, and daily doses.