High-resolution ultraviolet spectral irradiance monitoring program in polar regions—Six years (and growing) of data available to polar researchers in ozone and ultraviolet related studies

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The Antarctic Ultraviolet Spectroradiometer Monitoring Network was established by the U.S. National Science Foundation (NSF) in 1988 in response to predictions of increased ultraviolet (UV) radiation in the polar regions. The network consists of several automated, high-resolution spectroradiometers placed in strategic locations in the Antarctic and the Arctic (table 1) and a new operational site in San Diego, which is also used for training and testing. The network is the first automated, high-resolution UV scanning spectroradiometer network installed in the world. It has been largely successful at being operated in the harshest environments of the Antarctic and the Arctic and is currently returning data to researchers studying the effects of ozone depletion on terrestrial and marine biological systems, in addition to being used to develop and verify models of atmospheric light transmission. Over the past 5 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: Booth, Weiler, and Penhale (1988); Booth et al. (1990, 1992, in press); Booth and Madronich (in press); Diaz et al. (1990); Diaz, Lucas, and Smolskaia (1991); Frederick et al. (1993), Lubin and Frederick (1989, 1990a, 1990b, 1991); Lubin et al. (1989, in press); Madronich (1993); Smith and Baker (1989); Smith et al., (1990, 1991, 1992), Stamnes (1993); Stamnes, Slusser, and Boden (1991); and Stamnes et al. (1990, in press).

Spectroradiometers (SUV-100, Biospherical Instruments, Inc.,) were installed in four locations between February and November 1988, and a fifth instrument was installed at Barrow, Alaska, in December 1990. Table 1 lists the positions and the period of data referred to in this report for these sites.

The SUV-100 spectroradiometer is based on a temperature-stabilized scanning double-monochromator coupled to a photomultiplier tube detector. The system is optimized for operation in the UV. A vacuum-formed Teflon diffuser serves as an all-weather irradiance collector and is heated by the system to minimize ice and snow buildup. The instrument has wavelength and intensity calibration lamps for automatic calibrations at programmed intervals (typically two to four times per day). A data-acquisition system accompanies the instrument, and an IBM-compatible computer is used to control the system and log the data. For details, see Booth et al. (1992).

UV-B, frequently defined as the integral of the spectral irradiance between 290 and 320 nanometers, is a common measure of UV irradiance that is potentially harmful to bio-

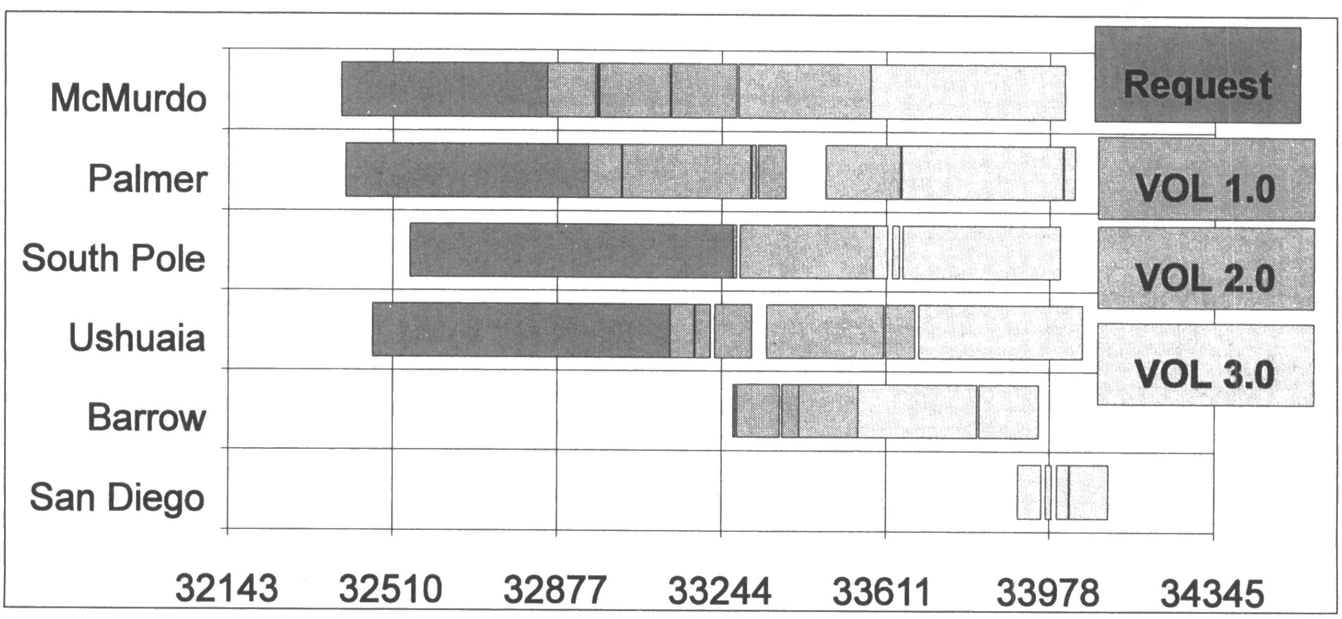

Figure 1. Available data on volumes 1 through 3 of the published CD-ROMs. On special request, data obtained before publishing volume 1 may also be obtained. Contact the authors for more information.

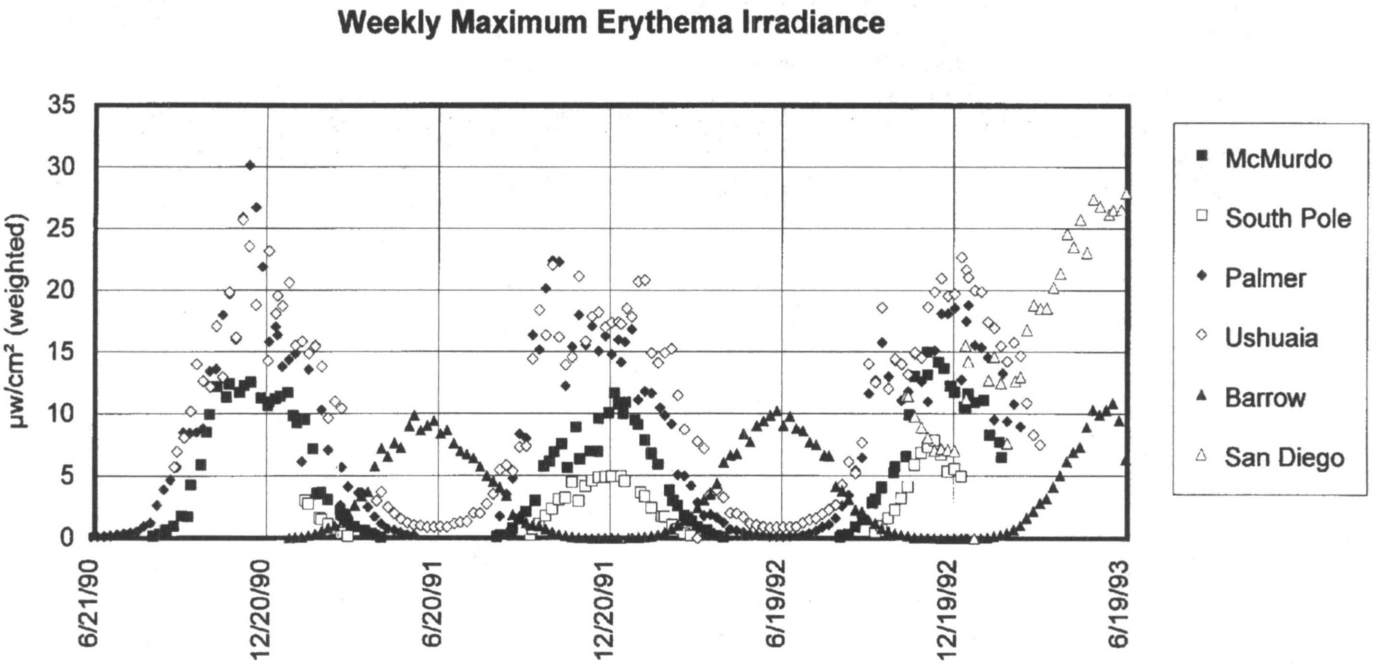

Figure 2. Weekly maximum erythemally weighted (McKinlay and Diffey 1987) UV irradiance recorded at the six UV monitoring sites. Northern and Southern Hemisphere data show the expected seasonal differences. For this data set, Palmer Station shows the highest exposure, occurring when traces of ozone-depleted air persisted until nearly midsummer.

logical systems. Other measures that express the biological impact of UV irradiance include a variety of dose weightings such as Setlow's (1974) action spectra for DNA damage and the Commission Internationale de l'Eclairage–sanctioned action spectra for human erythema as presented by McKinlay and Diffey (1987). The weekly maximum recorded levels of these three measures of UV are tabulated in table 2. The time of year in which the maximum level occurs depends upon a combination of the solar zenith angle, cloud cover, and ozone concentration. Antarctic maxima do not occur when the ozone is most fully depleted, which normally happens in late September or early October, because the Sun is low in the sky at that time. Since these data represent instantaneous maxima of irradiance, they contain data where partially cloudy conditions cause irradiance levels higher than those that would occur if there were clear skies. For example, due to reflections from clouds, the maxima occurring in San Diego on 20 May 1993 were a few percent higher than the irradiance levels observed on the summer solstice. This also accounted for the 5 January 1990 elevated readings in Ushuaia that were very slightly higher than the readings of 30 November 1990. Data from the network are available on CD ROMs published

Table 1. Locations of the sites and the time periods when data are available from each

ID	Site	Longitude	Latitude	Established	Normal (daylight) season
1	McMurdo Station, Antarctica	166.40°E	77.51°S	March 1988	August–April
2	Palmer Station, Antarctica	64.03°W	64.46°S	May 1988	Year round
3	South Pole, Antarctica	0	90.00°S	February 1988	September–March
4	Ushuaia, Argentina[a]	68.00°W	54.59°S	November 1988	Year round
5	San Diego, California	117.12°W	32.46°N	October 1992	Year round (except for during the occasional testing and training activities)
6	Barrow, Alaska[b]	156.47°W	71.18°N	December 1990	January–November

[a]CADIC: Centro Austral de Investigaciones Cientificas, Argentina.
[b]UIC/NARL: Ukpeagvik Inupiat Corporation/(formerly) Naval Arctic Research Laboratory.

Table 2. Maxima determine by examination of the data sets from the three CD-ROMs listed in figure 1. The peak values in each case are in bold.

Site	Erythema			UV-B			Setlow		
	Maxima	Date[a]	SZA[b]	Maxima	Date	SZA	Maxima	Date	SZA
South Pole	7.83	11/29/92	68.5	129.4	12/03/92	67.8	0.111	11/29/92	68.5
McMurdo	14.96	11/19/92	58.5	222.5	11/19/92	58.5	0.256	11/19/92	58.5
Barrow	10.36	05/17/92	52.2	178.9	05/17/92	52.2	**0.138**	**07/02/92**	**48.5**
Palmer	**30.1**	**12/05/90**	**42.0**	382.7	12/02/90	44.0	0.656	12/02/90	42.0
Ushuaia	26.9	01/05/90	32.9	**384.6**	**01/05/90**	**32.9**	0.572	11/30/90	33.3
San Diego	28.18	05/20/93	16.2	376.9	05/20/93	16.2	0.566	05/20/93	16.2

[a]All dates are month-day-year.
[b]Solar zenith angle.

annually. Figure 1 shows the time periods for which data are available from the six sites.

Figure 2 presents the time course of erythemally weighted irradiance for the six sites. The data for the Northern and Southern Hemispheres show the expected seasonal patterns. For this data set, Palmer Station shows the highest exposure, occurring when traces of ozone-depleted air persisted until nearly midsummer. Note that approximately one-half of a year's worth of data (including the summer solstice) from San Diego was available for this analysis because this is the newest site.

The need for the rapid establishment of the UV monitoring program was established by Peter Wilkniss, former Director, Office of Polar Programs, National Science Foundation. We thank a variety of contributors to this effort including Sue Weiler, John Gress, Susana Diaz, David Norton, Dan Endres, Chris Churylo, Tanya Mestechkina, John Tusson IV, and David Neuschuler. Data from the NSF UV spectroradiometer network are available to researchers on CD-ROM, as shown in figure 1. Consult the authors at Biospherical Instruments, Inc., 5340 Riley Street, San Diego, CA 92110 for details.

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People and place: The antarctic environmental relationship

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Anecdotal evidence, drawn from both contemporary and historical sources, has shown that strong emotional bonds to antarctic sites may develop during the course of one's stay. The exact structure of these bonds and the factors that go into determining their valance have not been investigated in the past. Building on prior research into personality factors of the polar sojourner (Suedfeld, Palinkas, and Steel 1992) and extending an interpersonal relationship model forwarded by Sternberg (1986, 1988), an "environmental relationship" model was tested during the 1992 austral summer. Implementing a newly developed interview technique, this model examined three factors thought to underpin the environmental relationship: passion for a place, environmental intimacy (trust, depth of knowledge, self-identity), and commitment to the site. Preliminary results indicate that all three factors are present, in varying degrees, in the Antarcticans' relationship with their worksite. Further analysis is currently under way to determine the ways in which these factors are related to each other and to the differential effects of the summer and winter seasons.

In related work, initiated in the austral summer of 1991, the Polar Psychology Project Battery of personality scales was administered to personnel during the winter fly-in and main season of 1992. Results based on these data have confirmed the findings reported earlier (Suedfeld et al. 1992). Analysis is under way on eight separate scales, testing for evidence of telic dominance, environmental preference, coping strategies, and other factors. This research is being coupled with data gathered during extensive "exit interviews," conducted during the winter fly-in season of 1992, to build a more complete understanding of the polar experience.

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