THE UNITED STATES NATIONAL SCIENCE FOUNDATION'S UV MONITORING NETWORK FOR POLAR REGIONS: AN OVERVIEW AND RECENT RESULTS

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Abstract

The United States National Science Foundation's Polar Programs UV Monitoring Network was established in 1988 to collect data on the impact of ozone depletion. This network of six sites, ranging from the South Pole, Antarctica, to Barrow, Alaska, acquires routine high spectral resolution measurements of UV-Visible global irradiance in the 280-600 nm range, at 1 nm resolution. The data are distributed on CD-ROMs and can also be accessed via the website www.biospherical.com. Results from the network have been used by various scientists working in diverse fields, including polar biology, UV effects, and atmospheric research.

Volume 8 of network data encompassing the years 1998-1999 has recently been released. Examples from this most current dataset are presented and compared with results of previous years. In December 1998, record-high UV levels were observed at all Antarctic sites and in Ushuaia, Argentina, when the ozone hole started to disperse and ozone-depleted air masses moved towards lower latitudes.

Network overview

The network is equipped with **SUV-100 spectroradiometers** [Booth et al., 1994] featuring

- Fully automated operation; one spectrum is measured every 15 minutes
- A spectral range of **280 - 600 nm**
- A spectral resolution of **1.0 nm** FWHM
- **Built-in irradiance and wavelength standards** to monitor instrument stability.

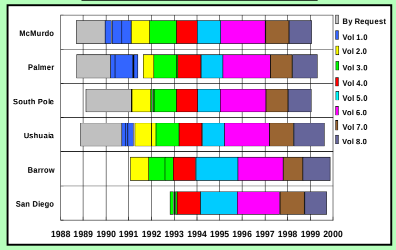
The instruments are operated and calibrated by local site operators using standards that are cross-calibrated yearly. Maintenance is performed annually by staff from Biospherical Instruments. Data from the instruments is transferred from the sites to Biospherical Instruments. After data quality has been checked, data are posted on a weekly basis in graphical form on our website http://www.biospherical.com. The final data is released yearly via CD-ROM or can be downloaded from our website. All data are accompanied by comprehensive reports. Data products include:

- Global spectral irradiance in <= 1 nm intervals
- Biologically weighted irradiance using a wide range of action spectra (e.g. DNA action spectrum proposed by Setlow [1974]).
- Spectral irradiance integrated over various wavelength ranges (e.g. UV-A, UV-B)

Network Sites

Site	Latitude
Antarctica	
McMurdo	77° S
Palmer Station	64° S
South Pole	90° S
South America	
Ushuaia, Argentina	54° S
North America	
San Diego, California	32° N
Barrow, Alaska	71° N

Available Network Data



1998 UV levels at Palmer Station

The size of the "Antarctic ozone hole" is usually defined by the spatial extent of the polar vortex. During October, the region of low stratospheric ozone concentrations is centered at South Pole and shows a sharp boundary at about 65° latitude. When the ozone hole starts to disperse in late November and early December the vortex becomes unstable and packages of ozone depleted air masses can then move towards lower latitudes. **This happened on December 7, 1998, when the center of the ozone hole was close to Palmer Station (**Figure 1). The decrease in ozone caused a clear enhancement in UV (Figure 2). **Daily DNA-weighted UV doses [Setlow, 1994] were 2.9 times higher than the long-term average.** The increase was observed one day later in Ushuaia when the outskirts of the ozone hole passed the tip of South America. The daily DNA-dose measured in Ushuaia on December 8, 1998, was about a factor of two higher than the long-term average.

Our data demonstrate that the ozone hole may have a direct impact on locations far away from Antarctica. Such "low ozone events" cause a rapid change in UV from one day to the next and not all organisms may be able to adapt fast enough. Also public health can be affected (e.g. sunburn) when people are exposed to UV levels that are not typical for their location.

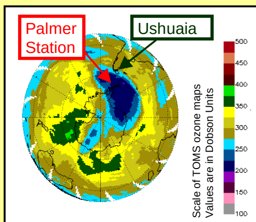


Figure 1: Total column ozone distribution in the southern hemisphere measured by NASA/TOMS on 7-Dec-98. The center of the ozone hole is close to Palmer Station, where 207 DU were measured.

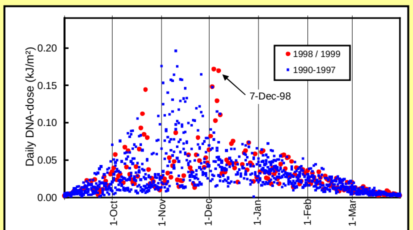


Figure 2: Daily DNA-weighted dose at Palmer Station derived from spectral measurements of the NSF network instrument. UV levels in December 1998 exceeded measurements of previous years of this month.

High levels of ultraviolet radiation observed in November 1998 at Amundsen-Scott South Pole Station

The phenomenon of the "Antarctic ozone hole" usually develops in August and starts to recover in November, with the period of the greatest ozone depletion in October. **The 1998 ozone hole**, however, was unusual in several respects [Uchino et al., 1999]:

- The 1998 ozone hole reached a size of about 26 million km² and **was the largest ever observed** since it first developed in the early 1980s. In addition, the hole showed the highest ozone-mass deficiency ever recorded.
- The minimum total column ozone over South Pole measured by the "Total Ozone Mapping Spectrometer" (TOMS) was 104.6 Dobson Units (DU) on October 6, 1998, which is **close to the all-time low of 86 DU** observed on October 12, 1993.

One reason for the large ozone depletion in 1998 was **unusually low temperatures in the lower stratosphere**, which trigger the formation of Polar Stratospheric Clouds (PSC).

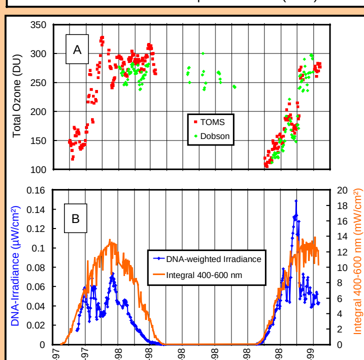


Figure 3: Total column ozone and global irradiance measured over Amundsen-Scott South Pole Station in the 1997/98 and 1998/99 seasons.
A. Total column ozone measured by TOMS and a Dobson spectrometer operated by CMDL/NOAA.
B. DNA-weighted irradiance derived from spectral measurements of the NSF network instrument. The high values in mid- to late November 1998 are quite pronounced and anti-correlate with the drop in total column ozone. Measurements in the visible show no significant increase in the same period.

The 1998 ozone hole started to fill up in mid-October (212.9 DU at South Pole on Nov 17) but **ozone values dropped again after mid-November** reaching 162.3 DU on Nov 27. The final recovery started in early December (270.6 DU on December 6). Due to the extraordinarily low total column ozone in mid- to late-November 1998 and the comparatively high solar elevations prevailing during this part of the year, **high UV levels were observed at South Pole Station between mid-November and December 6** (Figure 1). These **levels clearly exceeded the values of previous years** (Figure 4). Moreover, the 1998 measurements at McMurdo station have also shown the highest UV levels since monitoring began in 1988. This indicates that **the phenomenon also extends to regions with marine life.**

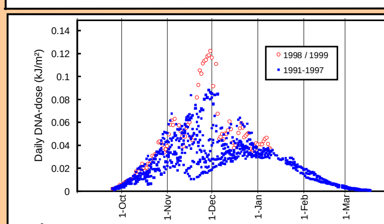


Figure 4: Daily DNA-weighted dose at South Pole derived from spectral measurements of the NSF network instrument. UV levels in November 1998 clearly exceed measurements of previous years.

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