UV Network News

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Welcome! to *UV Network News*, a newsletter for those involved with the UV-monitoring network operated by the U.S. Environmental Protection Agency (EPA), the University of Georgia's (UGA) National UV Monitoring Center (NUVMC), and the National Park Service (NPS). UV Network News is distributed monthly to provide up-to-date information on UV radiation and effects and on measurement efforts at EPA/UGA and other monitoring sites.

About the EPA/UGA UV network:

EPA, UGA, and NPS operate a network of Brewer spectrophotometers at locations throughout the U.S. Fourteen of the monitoring sites are located in national parks in conjunction with PRIMENet (Park Research and Intensive Monitoring of Ecosystems Network) measurement efforts. An additional seven sites are located in urban areas. Together, these sites comprise the largest spectral-UV network in the world.

The network data are used for a variety of scientific studies including assessments of the effects of UV on frog populations and other ecosystems, verification of the NOAA/EPA UV Index for predicting human exposure levels, and for monitoring changes to the global environment. The data are available to interested parties via the following web sites:

EPA's Ultraviolet Monitoring Program, UV-Net
http://www.epa.gov/uvnet/

The National UV Monitoring Center home page
http://oz.physast.uga.edu/

The National Park Service PRIMENet page
http://www2.nature.nps.gov/

In this issue…

PRIMENet Annual Meeting Announcement

The 4th Annual PRIMENet meeting will be held November 7-9, 2000, at Skyland in Shenandoah National Park. For suggestions of agenda topics or for more information, contact Kathy Tonnessen at (406) 243-4449. Christi Gordon of Shenandoah is hosting this year's meeting, which will include a field trip. Also, November 7 is Election Day, so don't forget to vote via absentee ballot before leaving for the meeting.

For information on additional upcoming meetings, visit the UV Radiation page at http://www.srrb.noaa.gov/UV/.

Summer Sun Sampler: What is a MED?

The skin-reddening (erythemal) potential of UV radiation is described by the Minimal Erythemal Dose (MED). One MED is defined as the effective UV dose (in J/m^2) that causes a perceptible reddening of previously unexposed human skin. Because certain skin types are more sensitive than others to UV, one MED can vary from a weighted value of 200 to 500 J/m^2. Within a skin type, the value of one MED can also vary by individual. MED estimates, such as from handheld meters, can be combined with the UV Index to calculate a person's maximum unprotected time in the sun before receiving a sunburn. For UV Index values of 6 or greater, this time can be as short as 10 to 20 minutes.

EPA/UGA PRIMENet UV Monitoring presented at Japan meetings

The Quadrennial Ozone Symposium was held in Sapporo, Japan, on July 3-8, 2000. This international meeting convenes every four years and is attended by hundreds of ozone and UV researchers from countries worldwide. This year, the Ozone Symposium was followed by a Brewer Users' Meeting in Tokyo. Both meetings were well attended by the UV monitoring community, including researchers from the National UV Monitoring Center (NUVMC) at the University of Georgia (UGA).

The NUVMC operates the 21 Brewer instruments that compose the EPA/UGA network, including the 14 instruments presently located at national park sites. Dr. John Rives of NUVMC attended the Brewer Users' Meeting and presented many results from the Brewer network, including new findings related to temperature corrections for the Brewer UV irradiance measurements.

Summary: The temperature dependence of the spectral, or wavelength, response of the Brewer instruments is forced by fluctuations in the ambient temperatures at each of the monitoring sites. These fluctuations can span a temperature range of over 50°C, resulting in seasonal variations of up to 20 percent in the UV irradiance. Until now, the data have not been corrected for these biases. To correct for these variations, a 50W lamp from UGA will be sent to each of the Brewer sites so that site operators can determine the temperature dependence for their specific instruments. The method is discussed in the excerpted abstract below.

Temperature dependence of the spectral response for the MKIV Brewers in the EPA/UGA network.

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The temperature dependence of the spectral response for wavelengths less than 325 nm has been described previously for a single Brewer. It is one of the major limitations of the Brewer's accuracy as an absolute solar UV irradiance instrument. While the Brewer is the dominant instrument worldwide for these measurements, the instrument temperature fluctuates with the ambient temperature at various sites. This fluctuation results in a predicted seasonal variation in the UV irradiance of up to 20 percent, well beyond the goal of +/- 3 percent.

This paper describes a method, using 50W Brewer calibration lamps operating in a constant current mode, which allows the local operator at each site to obtain the instrument's temperature dependence.

Initial Laboratory Measurements

Early measurements in the laboratory of the temperature coefficient of the Brewer response for three instruments demonstrated the need to correct for the temperature dependence. The response was measured with a calibrated 1000W FEL lamp operating in a constant temperature environment and at constant current while the temperature of the Brewer was adjusted from –18°C to +42ºC in a separate temperature controlled atmosphere. Best fits to the data yielded temperature coefficients at 306 nm of –0.17 percent, -0.22 percent, and –0.37 percent per °C for the three Brewers. In addition, a wavelength dependence of the response was observed.

Method of Field Determination of Brewer Temperature Dependence

Because it is impractical and costly to return each network Brewer to NUVMC in order to measure the temperature coefficients in the manner discussed above, a plan has been developed to obtain the coefficients at each site using the 50W lamps.

The operator performs XL scans throughout the day as the ambient temperature varies in its diurnal cycle. The lamp is maintained at constant current using a highly regulated DC power source whose current output is kept constant by monitoring the voltage across a low resistance standard resistor in series with the lamp. Both the resistor and the voltmeter will have extremely low temperature coefficients. The only contributions to the temperature dependence of the signal will be from the Brewer and from the 50W lamp.

Once the temperature dependence of the radiance of the 50W lamps is known, the temperature coefficient of the Brewer response can be isolated. XL scans were taken on the same Brewer under two conditions: (1) using a 1000W FEL lamp maintained at constant ambient temperature while the Brewer temperature was varied in a controlled environment and (2) using a 50W lamp where both the lamp and Brewer were in the same fluctuating ambient temperature conditions on the roof.

The slope of the line showing photomultiplier counts as a function of temperature determines the temperature coefficient for a particular wavelength. The temperature coefficient of Brewer 114 as a function of λ is shown in Fig. 1 (indicated by symbols). The $NiSO_4$ filter, which is removed above 325nm, is the main source of the wavelength dependence. In addition, the photomultiplier tube makes an additional contribution of about -0.2%/^{0}C. Using the 50W lamp, a slightly shifted temperature coefficient is obtained (thin solid line).

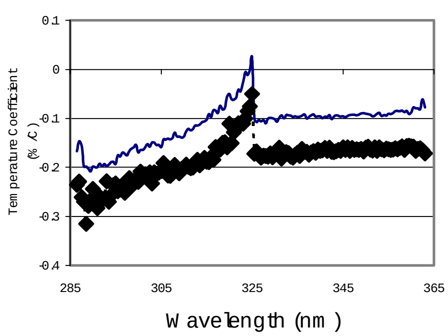

Figure 1. Temperature dependence for Br 114.

The difference yields the wavelength independent temperature coefficient of the 50W lamp radiance (0.07%/°C). It is estimated that at least 70 percent of the temperature dependent contribution to the measured absolute UV irradiance can be corrected using this method.

References:

[1]F. Cappellani and C. Kochler, J. Geophys. Res. 105, 4829 (1999).

New UV Effects Research

Ian Davidson and Malcolm Shick of the School of Marine Sciences at the University of Maine are conducting a collaborative research project titled Nitrogen Limitation and Ultraviolet Stress in Marine Macroalgae. The project examines how several species of macroalgae, or sea weed, respond to simultaneous nitrogen limitation and UV light stress. Researchers will study the impacts of UV light on nitrogen metabolism and the ability of these macroalgae to recover from stress caused by exposure to UV light when nitrogen is either limited or abundant. The results will improve understanding of how these species respond to combinations of important environmental factors.

PRIMENet UV Data and UV Impacts

PRIMENet UV monitoring and the applications of the data were presented at a faculty workshop on Ozone Depletion, UV Radiation, and Health Effects. The workshop was hosted by the Desert Research Institute and the Science and Public Policy Institute with the goal of entraining two– and four-year college faculty and students in UV impacts research. William Grant of NASA's Langley Research Center reported recent findings correlating UV exposure with vitamin D production and various cancer types. More on Dr. Grant's work, which utilizes EPA/UGA network UV measurements, will be available in a forthcoming issue of *UV Network News*.

← For a full version of the temperature dependence abstract, visit http://www.srrb.noaa.gov/UV/textfiles/uga_ab.html.

UV Effects on Aquatic Systems

UV radiation can harm a variety of aquatic organisms, including bacteria, phytoplankton, zooplankton, insect larvae, and even amphibians, fish, and other aquatic vertebrates. Researchers have placed increased emphasis on understanding these effects, as the quality, abundance, and distribution of both freshwater and marine resources can be critical to the survival of human populations and other ecosystems.

Interest in the effects of UV on marine and freshwater ecosystems has heightened due to possible implications for the world's food supply. UV radiation affects phytoplankton and other primary producers. Certain zooplankton are especially sensitive to in situ UV levels. Changes in UV penetration might therefore cause shifts in zooplankton biodiversity rather than straightforward declines in zooplankton biomass. These effects can ripple all the way up the food chain, eventually impacting human food supply. The impacts can be widespread. In the Bering Sea region, for example, sea edge communities contribute 40-50% of the total marine productivity. These shallow waters can be extremely permeable to damaging UV rays.

Water by itself does not strongly absorb UV radiation, and in the clearest ocean waters 1% of the surface UV radiation can penetrate as much as 40 meters. Attenuation depths in freshwater ecosystems can be significantly less, as UV is absorbed by concentrations of dissolved organic carbon (DOC).

Dissolved organic carbon (DOC) is derived primarily from terrestrial ecosystems as the degradation products of living organisms. The amount of DOC can strongly influence UV attenuation. Models suggest that approximately 90% of the variations in UV attenuation across various lakes is explainable by DOC concentrations alone. For instance, in lakes in the western and northwestern U.S. and in Newfoundland, the 1% attenuation depth tends to be 4 meters or greater. In the upper Midwest and Florida, 75% of lakes have 1% attenuation depths of 0.5 meters or less.

The amount of UV radiation that is attenuated is hyperbolically related to DOC concentrations. Very small decreases in DOC concentrations can cause large increases in the amount of UV that penetrates to certain water depths. Changes in DOC can mean extreme variability in terms of future changes in underwater UV levels and are likely to have a greater impact than changes associated with ozone depletion.

The potential ecosystem impacts are likely to be influenced by confounding environmental factors. Acid precipitation, harmful in itself, can reduce DOC concentrations and lead to an increase in underwater UV. High elevations where UV is highest usually correspond to naturally low levels of DOC.

References:

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- Any comments or contributions are welcome. -