UV Network News

Volume 1, Issue 9

This and past issues available online at http://www.srrb.noaa.gov/UV/

October 2000

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/ard/prime/index.htm

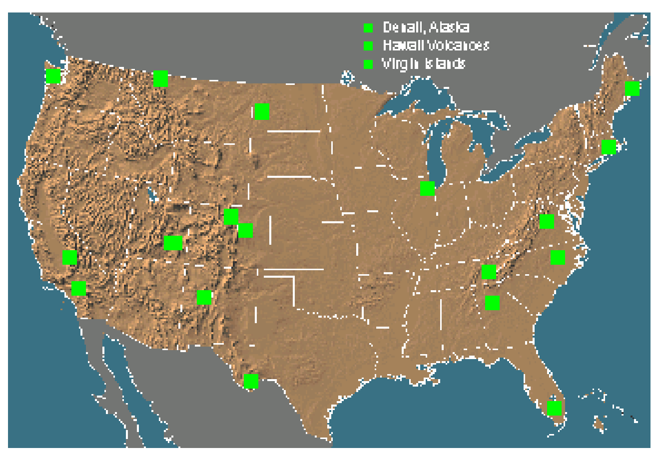
In this issue…

The concentrations of ozone-depleting substances in the lower atmosphere are decreasing. What does this mean for ozone recovery?

Researchers are studying the effects of UV-B and changes in nitrogen deposition in the arid soils of Canyonlands.

Plants have special enzymes to repair DNA damage caused by UV.

UV Monitoring Sites



EPA and U. Georgia monitor UV in 7 urban sites and 14 national parks, from Denali, Alaska, to the Virgin Islands. The sites are indicated by the green squares on the map above.

The Future of Ozone

In 1999, Montzka et al. reported that ozone-depleting substances in the lower atmosphere have been observed to decrease. But changes in climate, namely a cooling of the stratosphere, complicate predictions of ozone recovery. The question of when, and to what extent, the ozone layer will recover remains open.

The WMO 1998 Assessment anticipates that CFC-induced ozone depletion will be ameliorated by the middle of the twenty-first century. Such recovery requires full compliance with the Montreal Protocol and its amendments. This legislation is directly responsible for the decrease in tropospheric concentrations of chlorine- and bromine-containing compounds over the last five years. Because it takes three to six years for these compounds to mix from the troposphere to the stratosphere, stratospheric abundances of these compounds should slowly begin to level off.

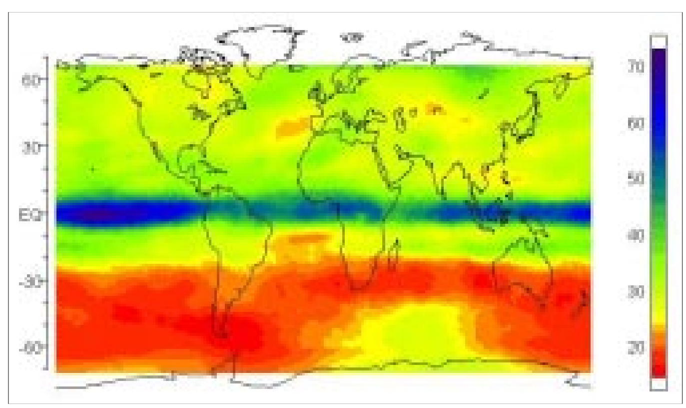
In general, the ozone layer is anticipated to soon begin a gradual recovery. The recovery rates are expected to be nearly linear and to vary geographically, with the largest recovery rates occurring in the polar regions (Jackman et al., 1996; WMO, 1999). The recovery may also vary with altitude, with some altitudes showing greater recovery rates than others.

The models used in the WMO 1998 Assessment (1999) showed roughly no variation in recovery with season. Stratospheric temperature plays an important part in ozone formation and destruction, however, and the effects of overall climate change further complicate recovery.

Chemical models able to account for the effects of climate change suggest that the chemical composition of the atmosphere will not return to pre-CFC conditions (Dameris et al., 1998). These models predict a stratospheric cooling of up to –2ºC for all seasons. These cooler temperatures will slow the rebuilding of ozone, particularly in the polar regions, and could actually enhance ozone depletion relative to 1991 (Dameris et al., 1998).

These results are similar to those of Shindell et al. (1998) whose model predicts a clearly enhanced ozone depletion in 2010-19 relative to 1990-99. The enhanced depletion was due primarily to inclusion of increasing greenhouse gases and corresponding climate effects in the model.

Detecting ozone recovery is plagued with problems of its own, due in part to the natural variability associated with ozone amounts. The figure below shows the time to detect a recovery in total column ozone amounts based on past variability in the data and expected trends. The results indicate that it may be 15-45 years before recovery of total column ozone amounts can be detected.



Years to detect predicted trends in total column ozone, from Weatherhead et al. (2000).

References:

Dameris et al., Geophys Res Lett, 1998;
Jackman et al., J Geophys Res, 1996;
Montzka et al., Nature, 1999;
Shindell et al., Nature, 1998;
Weatherhead et al., J Geophys Res, 2000.
WMO, 1999.

UV stressor and nitrogen deposition impacts at Canyonlands National Park

Principal Investigator:
Jayne Belnap, USGS Biological Resources Division, Canyonlands National Park
jayne_belnap@nps.gov

The availability of nitrogen is important in determining plant growth. Plants require nitrogen to produce proteins, nucleic acids, and other organic molecules. The nitrogen must come from the soil, and in arid regions, is derived from the soil crust. These crusts, often called crytobiotic crusts, can represent up to 70% of the living soil cover.

Researchers at Canyonlands National Park are studying the effects of increased UV-B, nitrogen deposition, and land-use changes on the crytobiotic crusts. These stressors are likely to affect the integrity and sustainability of arid ecosystems by directly impacting plant productivity.

The direct impacts of the stressors will be quantified through a series of nitrogen deposition and UV augmentation experiments at Canyonlands National Park. The park is home to several decades-long research efforts dedicated to understanding the response of arid ecosystems to anthropogenic change.

The research will provide a scientific basis for assessing arid ecosystems' response to increased UV-B, anthropogenic nitrogen deposition, land-use change. The results from Canyonlands can then be used as a reference for changes at 65 national park units (including Denali, Big Bend, and Grand Canyon), and 300 million acres of federal land.

Variations in Surface Albedo

Winter is approaching and many PRIMENet sites will be receiving their first snowfalls of the season. Snow cover dramatically affects the amount of radiation, both visible and UV, reflected from the surface. The surface reflectivity is known as albedo, and is extremely important for studies of UV exposure.

Albedo is defined as the ratio of reflected radiation to incident radiation — essentially, it gives the percentage of radiation that is reflected. Average values for total solar radiation and erythemic UV radiation albedos over various surfaces are summarized below. The values are taken from Blumthaler and Ambach[1].

	Average albedo (%)	
Surface	**Total solar**	**Erythemic UV**
Glacier ice	10.5	7.8
Water	9.1	4.8
Open field	11.5	2.2
Grassland	20.7	1.3
Limestone	26.2	11.2
New dry snow	87.0	94.4
New wet snow	74.5	79.2
Old dry snow	79.2	82.2
Old wet snow	72.4	74.4

Note that the percentage of UV reflected by snow is higher than the amount of visible reflected. The high reflectivity of snow cover means a considerable wintertime risk for damage from UV rays for many animal species. For humans, the risk is particularly great to the neck, nose, and face. Both humans and other animals face potential eye damage as a result of reflected UV.

[1]Blumthaler, M. and W. Ambach, Solar UVB-albedo of various surface, *Photochem. Photobiol.*, 48,1, 85-88, 1988.

UV Protection for Plants

Plants have natural gene "menders" to fix damage done by UV rays. Without certain specialized enzymes, plants would suffer serious damage from sun exposure.

Plant physiologist Edwin Fiscus, who works in the U.S. Department of Agriculture's Agricultural Research Service, and geneticist Anne Britt of the University of California at Davis have found that plants have both general repair enzymes and at least two kinds of specialized enzymes. These enzymes can repair genes that have been damaged by UV rays.

UV radiation harms plants by disrupting the sequence of chemical bases —adenine, guanine, cytosine, and thymine— that make up DNA. If too much of this code of life is damaged, the plant will eventually die. General repair enzymes can help correct the code by excising the damaged sequences and rebuilding them. Other specialized enzymes can repair specific kinds of damage, usually quite efficiently and accurately.

Britt says these specialized enzymes are also interesting in that they are activated by light. The very cause of the UV damage is also what triggers its repair.

More information is available from:

"Enzymes give plants UV protection," Agricultural Research, 1998. Online at http://www.ars.usda.gov/is/AR/archive/oct98/enzy1098.htm.

Fiscus, E.L., USDA-ARS Air Quality-Plant Growth and Development Research Unit, Rayleigh, NC.

Recent Papers on UV and Ecosystem Effects

Ankley, G., J. Tietge, S. Degitz, Effects of laboratory ultraviolet radiation and natural sunlight on survival and development of *Rana pipiens*, Canadian Journal of Zoology, 2000.

Biscof, K., D. Hanelt, C. Wiencke, Effects of ultraviolet radiation on photosynthesis and related enzyme reactions of marine macroalgae, Planta: An international journal of plant biology, 2000.

Broomhall, S., W. Osborne, R. Cunningham, Comparative effects of ambient ultraviolet-B radiation on two sympatric species of Austrialian frogs, Conservation Biology, 2000.

Mazza, C., D. Battista, C. Ballare, The effects of solar ultraviolet-B radiation on the growth and yield of barley are accompanied by increased DNA damage and antioxidant responses, Plant, Cell, and Environment, 2000.

Mousseau, L., M. Gosselin, B. Mostajir, Effects of ultraviolet-B radiation on simultaneous carbon and nitrogen transport rates by estuarine phytoplankton during a week-long mesocosm study, Marine Ecology Progess Series, 2000.

Paul, N., Stratospheric ozone depletion, UV-B radiation, and crop disease, Environmental Pollution, 2000.

UV Network News is a monthly newsletter for persons involved in UV monitoring and research. The newsletter is produced by the Cooperative Institute for Research in Environmental Sciences at the University of Colorado and the Surface Radiation Research Branch of NOAA's Air Resouces Laboratory. Support is provided by the National Park Service and PRIMENet. Editor: Amy Stevermer, amy@srrb.noaa.gov; Supervising Editor: Betsy Weatherhead, betsy@srrb.noaa.gov.

- Any comments or contributions are welcome. -