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Measuring Ultraviolet Radiation in National Park System Units (updated)

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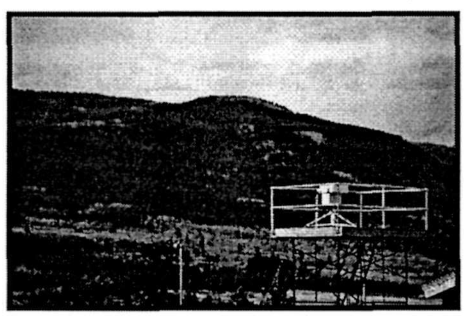
Background

In September 1996, the National Park Service and the U.S. Environmental Protection Agency (EPA) signed an interagency agreement to cooperate on a program of long-term monitoring of environmental stressors in National Park System (NPS) units[1] and research the effects of the stresses on ecosystems. Fourteen NPS units are included in the *Park Research and Intensive Monitoring of Ecosystems Network* (PRIMENet): Acadia, Big Bend, Canyonlands, Everglades, Denali, Glacier, Great Smoky Mountains, Hawaii Volcanoes, Olympic, Rocky Mountain, Sequoia-Kings Canyon, Shenandoah, Theodore Roosevelt, and Virgin Islands national parks. These parks are representative of major ecosystem types and were chosen because of their status as Class-1[2] air quality parks.

In these parks, the National Park Service is sponsoring the monitoring of air quality including ozone, wet and dry deposition, visibility, and meteorology. EPA added UV-B monitors in these parks to determine changes in irradiance that may be affecting human health and ecosystem processes.



Ultraviolet radiation monitor in Glacier National Park, Montana

[1] National parks and other entities of the National Park Service such as national monuments, national rivers, wild and scenic riverways, national scenic trails, and others are called *units* and collectively constitute the *National Park System.*

[2] A classification established by the U.S. Congress to implement the prevention of significant deterioration of air quality in specific areas, including national parks larger than 24.3 km^2 (6000 acres).

Why Monitor UV?

In 1985, the scientific community discovered the stratospheric ozone hole over the Antarctic through which more damaging UV-B reach the surface of the earth. Ozone thinning has been detected throughout the globe, and seasonal depressions in this protective shield are most severe at the poles. Stratospheric ozone depletion is the result of anthropogenic air pollutants known as chloroflurorcarbons (CFCs), which cause catalytic reactions in the stratosphere that destroy ozone molecules. In 1987, the major polluting nations signed the *Montreal Protocol on Substances that Deplete the Ozone Layer*, which called for phasing out such chemicals as freon, a particularly harmful CFC.

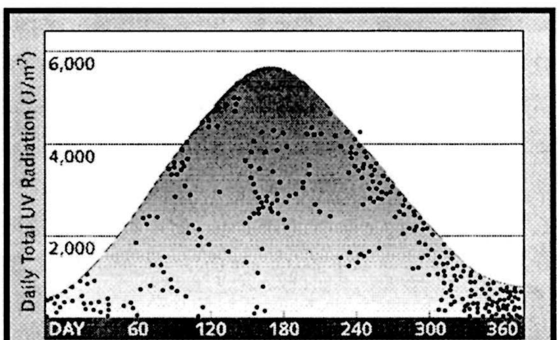
Because of the long lifetimes of CFCs in the upper atmosphere, scientists are not certain when the ozone thinning will be reversed. The actual exposure of humans and ecosystems to this form of solar radiation must be determined to understand which systems are being damaged. To chart the changes from the CFC control programs, researchers must also monitor the seasonal variability in both the UV-B reaching the surface and in the total column ozone that filters out UV.

Effects of UV-B on biological systems include:

- an increase in human skin cancers and cataracts
- damage to phytoplankton and reduction in growth of fishes, molluscs, and crustaceans
- damage to DNA and photosynthesis in plants
- possible effects on animals including benthic invertebrates and amphibians.

UV Monitoring

Each of the fourteen PRIMENet sites will be equipped with a Brewer spectrophotometer, an instrument designed to measure different wavelengths of light, and the focus will be on the ultraviolet spectra (UV-B radiation is in the 300-320 nm range of light). These instruments track the sun as they monitor the variation in solar irradiance throughout the day. They also record other data such as total column ozone and ambient concentration of gases. These data are then used to calculate the dose of UV at the surface of the Earth. Because of the influence of sun angle, clouds, and other forms of air pollution, the seasonal variation in UV-B detected at the surface is large. Therefore, it will take many years of monitoring to detect trends in the incidence of UV-B.



Seasonal Variation in UV Radiation

The fourteen NPS units complement a larger Brewer network in the United States that includes eight monitors located in cities. These monitoring devices have also been deployed in Canada and on other continents to allow global assessment of the status of the stratospheric ozone layer.

Partnerships

The two major contributors to this long-term research and monitoring program are the Natural Resource Program Center of the National Park Service and the Office of Research and Development of EPA. In PRIMENet sites, the two agencies are cooperating with researchers from other organizations, including the Biological Resources Division of the U.S. Geological Survey, the USDA Forest Service, and universities to conduct research needed to tie atmospheric stressors to ecosystem responses. They are also working with the National Oceanic and Atmospheric Administration and the U.S. Department of Agriculture to develop quality-assurance methods and to compare UV instruments.

Program Status

By the end of Fiscal Year 1999, all 14 UV-B monitors will be operating in NPS units. This cooperative monitoring program is being complemented by process-level ecological research on the effects of UV on arid-land terrestrial processes and amphibian populations. The annual PRIMENet meeting of park staff, researchers, and EPA liaisons was held in November. Participants discussed new research on contaminants and amphibian populations in PRIMENet parks.

Current information about the program is available at http://www.nature. nps.gov/ard

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