UV Network News

Volume 1, Issue 4 | *This and past issues available online at http://www.srrb.noaa.gov/UV/* | May 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) 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/NPS and other monitoring sites.

About the EPA/NPS UV network:

EPA 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...

May is Melanoma Awareness Month! Some Melanoma Resources...

National Assocation of Physicians for the Environment (NAPE) website
→ http://napenet.org/uvfacts.html

National Cancer Institute "Atlas of Cancer Mortality in the U.S., 1950-1994"
→ http://www.nci.nih.gov/atlas/

What's New in Dermatology listserv
→ subscribe at http://www.dermopedia.com

MelanomaNet
→ http://www.derm-infonet.com/melanomanet/

Ozone in the Stratosphere

Most of the oxygen in our atmosphere is molecular oxygen consisting of two oxygen atoms (O_2). This molecular oxygen is the oxygen that we breathe. Molecular oxygen is millions of times for more common than ozone in the atmosphere, yet ozone plays a vital role.

Ozone is a molecule consisting of three oxygen atoms (O_3). Most of the ozone in the atmosphere is located in the stratosphere, concentrated in a layer between about 20 to 30 kilometers above the Earth's surface. Ozone is an effective absorber of UV radiation, preventing it from reaching the earth's surface where it can cause damage to plants and animals.

Ozone's ability to absorb UV radiation contributes greatly to its own production and destruction. In the upper atmosphere, ultraviolet radiation from sunlight breaks apart molecular oxygen (O_2). The free oxygen atoms then react in the presence of a mediator molecule, M, to form ozone:

$$O_2 + UV \rightarrow O + O$$
$$2(O + O_2 + M \rightarrow O_3 + M)$$

Net reaction: $3O_2 \rightarrow 2O_3$ (1)

Ultraviolet radiation also breaks apart ozone, freeing oxygen atoms. These atoms can quickly recombine with molecular oxygen to form more ozone, or can combine with ozone to again produce molecular oxygen.

$$O_3 + UV \rightarrow O + O_2$$
$$O + O_3 \rightarrow O_2 + O_2$$

Net reaction: $2O_3 \rightarrow 3O_2$ (2)

Ozone is continously produced and destroyed so that the overall amount in the stratosphere is typically in balance. Even in the stratosphere, ozone amounts can vary substantially from place to place. These variations are due to winds and other factors that can move ozone around or interfere with the destruction or production processes.

The amount of ozone over a particular place is usually expressed as a total column amount. The total column ozone represents the number of molecules present in an imaginary tube 1 cm on a side, stretching from the surface to the top of the atmosphere. Total column ozone is measured in terms of Dobson Units (DU), named after George Dobson, a pioneer in the study of ozone. On average, every point on the globe is covered by at least 250 DU of ozone. Total column amounts are smallest over the equator, and largest over the poles, except during the winter-spring season over the poles, when severe depletion has been observed to occur.

The depletion of ozone over the poles, and also over much of the rest of the world, has thrust the issue into the forefront of science and public policy. The WMO Scientific Assessment of Ozone Depletion: 1998 contains extensive information on this issue. Every few years, an International Ozone Symposium is also held addressing the scientific and political aspects of stratospheric ozone.

You can read more about stratospheric ozone on NASA's web site: http://www.nas.nasa.gov/Services/Education/Resources/TeacherWork/Ozone/Ozone.homepage.html.

Daily measurements of total column ozone over the place you live are available from the Total Ozone Mapping Spectrometer (TOMS) home page: http://toms.gsfc.nasa.gov.

Ozone in the Troposphere

"This most excellent canopy, the air, look you, this brave o'erhanging firmament, this majestic roof fretted with golden fire, why, it appears no other thing to me than a foul and pestilent congregation of vapours." William Shakespeare, *Hamlet*, Act 2

One component of that foul and pestilent congregation of vapours could well have been ozone, which, while of benefit in the stratosphere, can be toxic in the lower atmosphere.

The first measurements of tropospheric ozone date back to the late 1800s and were obtained using an ozonometer. The ozonometer was developed by Christian Schonbein, who first identified ozone in the laboratory in the 1830s. Ozonometer records near Paris, France, show the ozone concentration to be about 10 parts per billion by volume (ppbv) from 1876-1907, far less than the 100-200 ppbv values typical of polluted air today.

In the 1800s, tropospheric ozone was recognized as a primarily urban factor. But it was not until some decades later that the processes of ozone formation were actually discovered. In 1952, Aire Haagen-Smit, a scientist working in Los Angeles, suggested that ozone forms in air containing hydrocarbons and nitrogen oxides. Haagen-Smit's experiments ultimately led him to the development of the theory of photochemical smog formation.

Photochemical smog forms when reactive hydrocarbons and nitrogen oxide, both present in car exhaust, combine with the hydroxol radical to produce ozone, nitrogen dioxide, and a second type of hydrocarbon. In urban areas, the amount of ozone produced in this way can become very high, especially by late afternoon when pollutants have been accumulating all day.

While ozone in the troposphere can block UV radiation from reaching the surface, it is primarily considered a pollutant with several toxic effects. Lower-atmosphere ozone has been linked to damage of human lungs, causing cancer and even death. It has also been linked to decreases in plant production and to increased wear on rubber and other materials.

Recent reports indicate that smog and the accompanying haze and air quality problems are more than just an urban phenomena. Ultraviolet radiation from sunlight can react with terpenes and other hydrocarbons formed naturally by plants and trees. These reactions can produce photochemical smog in the national parks and other areas.

One key objective of the National Park Service PRIMENet program is to address the effects of ozone and other photochemical smog ingredients on park habitats. To meet this objective, the NPS is monitoring air quality, including tropospheric ozone concentrations, at 14 sites, from Denali National Park in Alaska to Acadia National Park in Maine to the Virgin Islands National Park. The measurements are shared with the U.S. Geological Survey, the U.S. Department of Agriculture, and several universities for use in tying atmospheric changes to ecosystem responses.

More information is available from the following resources.

PRIMENet research and monitoring:
http://www2.nature.nps.gov/ard/prime/index.htm

NPS air quality research:
http://www2.nature.nps.gov/pubedhp.html

Less Ozone, More UV

Much of the attention devoted to UV stems, of course, from concerns about ozone depletion. Ozone losses have been observed in a number of places, from both ground-based and satellite measurements. As shown in Figure 1, the depletion values vary with latitude, from little to no depletion in areas of the tropics, to about 6 to 8 percent depletion at mid-latitudes. Depletion in the polar regions tends to be on the order of 40 percent, with springtime losses in the southern hemisphere measuring as much as 60 percent.

Correspondingly, the largest changes in UV dose have occurred in and near Antarctica, where the springtime biologically damaging UV levels can exceed those measured in San Diego, California. These levels occur despite the fact that the sun is much higher above the horizon in San Diego than in Antarctica.

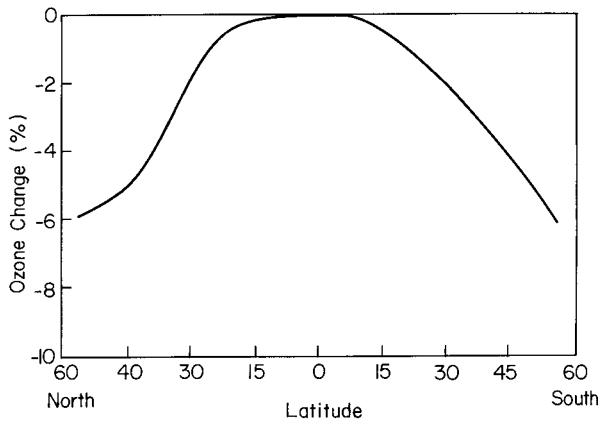

Figure 1. Schematic of the North-to-South Ozone Depletion: 1979-1997.

Figure 2 shows the percent increase in erythemal UV as a function of ozone decrease. Clear-sky measurements performed at Toronto, Canada; Mauna Loa, Hawaii; Garmisch, Germany; Thessaloniki, Greece; Lauder, New Zealand; and at the South Pole show that ozone decreases lead to increased UV at the surface. The measurements are in good agreement with those expected from calculations (the model curve is shown by the solid line in the figure).

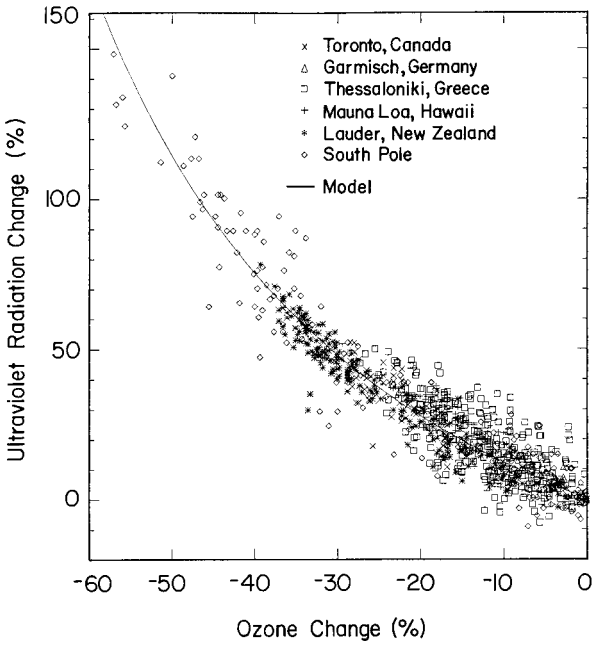

Figure 2. Increases in Erythemal (Sunburning) Ultraviolet Radiation Due to Ozone Decreases.

*Figures from the World Meteorological Organization Scientific Assessment of Ozone Depletion:1998.

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. -