New Amendments Restrict More Ozone-Depleting Substances

A new set of amendments to the Montreal Protocol took effect on January 1, 2001, and will further restrict the production of chemicals known to destroy ozone. The new amendments require member countries to cease producing hydrofluorocarbons (HCFCs), often used as a substitute for chlorofluorocarbons (CFCs) previously banned.

Since the Montreal Protocol was first signed in 1987, the number of member countries has expanded from 24 to 175. The regulations controlling the production of ozone-depleting substances have been strengthened through amendments over time. The newest amendments, besides halting production of HCFCs, ban the production, consumption, and international trade of bromochloromethane, a chemical primarily used to extinguish fires. The amendments also require countries to report any use of methyl bromide, used mainly in pesticides.

More information on the amounts of ozone-depleting substances in the atmosphere can be found in December 2000 issue of UV Network News. The implications for ozone recovery are discussed in the October 2000 issue and references therein. Information on the Montreal Protocol is available from the following sites:

United Nations Environmental Programme: http://www.unep.ch/ozone/montreal.shtml.

Center for International Earth Science Information Network: http://www.ciesin.org/TG/PI/POLICY/montpro.html.

Some Recent Publications on UV Effects

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- Any comments or contributions are welcome. -

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/ard/prime/index.htm

In this issue…

Last issue

The present issue marks the last monthly installment of *UV Network News*. We hope you have found the material provided over the past year to be useful and informative. Although we will no longer be publishing regularly, we will post updated information to the web, probably on a quarterly basis.

UV and Ozone Measurements at Denali – Effects of Climate Change

Denali National Park is well-positioned as a site for measuring changes in UV radiation and ozone at high latitudes. The Brewer instrument at Denali is located at 63 degrees, 43 minutes latitude, very near to the Arctic Circle at 66 degrees, 32 minutes latitude.

The Arctic has often been defined simply as the region north of the Arctic Circle. In reality, the Arctic region can be defined in many different ways, based on physical, geographical, or ecological characteristics. Some of these definitions use temperature isotherms, permafrost presence, water bodies, or mountain ranges to bound the Arctic region. Whichever definition is chosen, the Arctic is home to several unique species of animals, including the polar bear, walrus, and musk ox. The Arctic is also inhabited by humans, including diverse Native communities as well as a strong European presence.

The Arctic is an area of significant ozone depletion and corresponding increased ultraviolet radiation levels. These factors, especially when combined with other environmental stressors, pose a serious threat to the region's fragile ecosystems.

The recovery of ozone levels in the Arctic region is closely intertwined with predictions of global change. Current chemical and dynamics models indicate that climate change due to increased carbon dioxide will warm the troposphere, but will cool the stratosphere. In the Arctic, this cooling could be responsible for increased ozone destruction, due to the formation of polar stratospheric clouds.

Polar stratospheric clouds (PSCs) form from ice-phase water at high, stratospheric altitudes. When atmospheric temperatures drop below 200 K, suspensions of sulfate particles, called aerosols, become supercooled and freeze. At temperatures below 195 K, nitric acid ice condenses on the frozen aerosols to form Type-1 polar stratospheric clouds. At temperatures below 190 K, ice-phase water can condense on the particles, forming Type-2 polar stratospheric clouds. These PSCs contribute significantly to ozone chemistry.

Traditionally, PSCs in the Northern Hemisphere have been fewer and shorter-lived than their counterparts in the Southern Hemisphere. Colder stratospheric temperatures at both poles, however, could increase the number and life span of PSCs, especially in the north, where temperatures currently hover just above the critical 190 to 195 K values. Polar stratospheric clouds provide surfaces on which ozone-depleting reactions can occur, and can therefore accelerate ozone destruction. Stratospheric cooling due to global change can therefore result in an increased likelihood of larger and longer-lasting ozone holes in the Antarctic and the formation of an ozone hole over the Arctic (Dameris et al. 1998).

These changes in ozone in polar regions differ significantly from the expected changes over the rest of the globe, where stratospheric temperatures do not reach the cold polar thresholds. The delay in recovery at polar regions means a longer term, and perhaps more severe, threat of ecosystem damage due to increased UV. The EPA/UGA monitoring site at Denali, as well as other UV network sites throughout the Arctic, can help quantify the doses of UV radiation received. These measurements will help to assess the role and recovery of ozone levels in Arctic.

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World Meteorological Organization, Scientific assessment of ozone depletion: 1998, WMO, Report No. 44, 1999.

UV Transmittance through Ice and Snow

In winter months, many ecosystems, particularly those at high latitudes, may be covered with either ice or snow. In regions such as the Arctic, the snow and ice cover can be long-lasting and thick enough to block large portions of UV radiation. However, the amount of UV able to penetrate the ice and snow cover can be significant.

Studies indicate that ice cover reduces only some of solar radiation transmitted to the underlying environment. The shorter UV-B wavelengths, generally the most biologically harmful, are attenuated more than either UV-A or visible radiation. The transmittance depends on the age of the ice: fresh, thin sea ice transmits roughly 20% of UV radiation, while cold first-year ice transmits less than 2%. Different layers within the ice, from very white interior ice to almost clear surface ice, also have different UV extinction coefficients (Grenfell and Maykut 1977).

Determining the amount of UV radiation reaching organisms under an ice or snow cover is difficult. The problem is further complicated by the temporal and spatial variability in the physical, and therefore optical, properties of the ice and snow. Perovich (1993) indicates that even a modest snow cover of about 0.15 m can reduce UV levels to the ground or water below by nearly two orders of magnitude.

When passing through a snow or ice layer, UV wavelengths tend to be more strongly attenuated than visible radiation. These wavelength differences can affect the relative amounts of photosynthetically active radiation (PAR) and UV received beneath the layer. The presence of snow or ice cover does not only reduce UV-B levels; it also changes the ratio of UV to PAR. Perovich (1993) reports that as a snow or ice layer gets thicker, the UV/PAR ratio decreases from 1.0 at the surface to 0.2 under 1.2 meters of ice and snow. This reduction in the UV/PAR ratio implies that ice cover could act to protect under-ice or snow organisms. Changes in UV transmittance and in the UV/PAR ratio are important to consider when determining possible biological impacts of UV.

Above the ice or snow, an opposite effect plays out with significant amounts of UV-B reflected. New dry snow can reflect over 94 percent of the erythemal UV. New wet snow reflects over 79 percent. The amounts reflected by old dry snow and old wet snow, respectively, are 82 percent and 74 percent. Organisms above the snow cover are therefore at serious risk for UV exposure.

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