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EDITORIAL

Environmental effects of stratospheric ozone depletion, UV radiation, and interactions with climate change: 2022 Quadrennial Assessment

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The eight papers in this issue of *Photochemical & Photobiological Sciences* are authored by members and co-authors of the Environmental Effects Assessment Panel (EEAP) of the Montreal Protocol under the United Nations Environment Programme. These papers assess the linkages between stratospheric ozone depletion and UV radiation, and climate change, with respect to the effects on the environment and human health. This Quadrennial Assessment is written primarily for policymakers and governments of the 198 countries that have ratified the Montreal Protocol. The publication of this Quadrennial Assessment, together with our annual updates, makes our findings readily available to the scientific community.

The ozone-depleting substances controlled by the Montreal Protocol have been used in many applications, such as in refrigerants, air conditioners, aerosol propellants, fumigants against pests, in fire extinguishers, and foamed materials. Most of these substances also exhibit high global warming potentials. Thus, the Montreal Protocol, established 35 years ago, is serving a dual purpose in mitigating climate warming and stratospheric ozone depletion by phasing out nearly 99% of these substances. A number of compounds, such as hydrofluorocarbons (HFCs), that were introduced to replace ozone-depleting substances, have also high global warming potentials. Several of these replacements have recently been added to the list of substances controlled by the Montreal Protocol and are being phased down under the Kigali Amendment of the Protocol, thereby further strengthening the additional role of this landmark treaty in reducing climate change. These measures are also helping to advance the technologies towards more environmentally friendly and sustainable refrigerant products.

Because of the Montreal Protocol, the stratospheric ozone layer is projected to slowly recover as the concentrations of ozone-depleting substances continue to decline in the upper atmosphere. However, in the coming decades, the ozone layer will be increasingly influenced by emissions of greenhouse gases and associated global warming. These trends are highly likely to modify the amount of UV radiation reaching the Earth, with implications for ecosystems and human health.

The EEAP is one of three assessment panels (the others being the Science Assessment Panel (SAP), and the Technology and Economic Effects Assessment Panel (TEAP)) that inform the Parties (countries) to the Montreal Protocol. These panels prepare Quadrennial Assessments every 4 years with updates in the intervening years. The EEAP Quadrennial Assessment was written by 48 scientists, and reviewed by 64 expert reviewers from 20 countries. This assessment highlights the contribution of the Montreal Protocol to environmental sustainability, human health and well-being, and aligns with many of the United Nations Sustainable Development Goals. A key highlight of the assessment is that current and future sustainability of the Earth's biosphere is affected by the increased frequency and intensity of extreme climate events, and their interactive effects on solar irradiance.

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Co-Chairs of the Environmental Effects Assessment Panel, United Nations Environment Programme

This Quadrennial Assessment is dedicated to one of the Environmental Effects Assessment Panel's (EEAP) first members, Professor Martyn Caldwell (28 June 1941–24 January 2021), who joined the Panel in 1987. Already a globally respected scientist in the fields of plant physiology, ecology, and photobiology, he contributed his knowledge, innovative approach, and insight to the first EEAP

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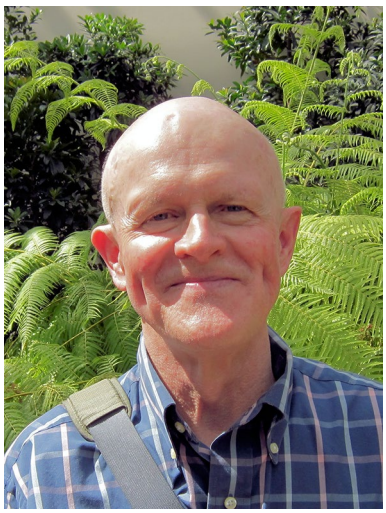
Assessment in 1989 in accordance with the provisions of the Montreal Protocol on Substances that Deplete the Ozone Layer, under the United Nations Environment Programme (UNEP). In that first Assessment, Martyn emphasised the importance of evaluating the ways in which biological systems and the environment were being affected by depletion of stratospheric ozone and associated enhanced UV-B (280–315 nm) radiation at the Earth's surface. In the following quarter century, he made many valuable contributions to the annual and Quadrennial Assessments of the EEAP.[1]



By the time Martyn joined the Panel, he had already published extensively on the effects of UV radiation on plants, and most notably moving out of the laboratory into the natural environment.[2] His 'general plant action spectrum' quantifying the damaging and inhibiting effects of ultraviolet radiation on plants,[3] became a guide for many years and was refined further as the complexities and effects of stratospheric ozone depletion were recognised.[4] Martyn and his co-workers made numerous contributions to technical innovations in research on ultraviolet radiation. Foremost were the methods for providing appropriate UV radiation doses, including a sophisticated modulation system for simulating effects of ozone depletion in the field.[5]

Martyn was, and still is, a lasting inspiration to the Panel and the broader scientific community, laying the photobiological foundations for research on the effects of UV radiation that have informed the Parties to the Montreal Protocol since its inception in 1987.

We were privileged and honoured to have Martyn as a valued Panel member, an outstanding scientist, and dear friend. This quiet, gentle man with many a subtle quip leaves a giant footprint on the pages of plant physiology and photobiology research.

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[1] e.g., Photochemical & Photobiological Sciences 14, 88–107. 2015.

[2] Ecological Monographs 38, 243–268. 1968.

[3] e.g., Photophysiology: Current Topics in Photobiology and Photochemistry, Vol. VI, 131–177. 1971.

[4] Journal of Plant Physiology, 148, 107–114. 1996.

[5] Photochemistry and Photobiology, 37, 479–485. 1983.