Update Report of the Environmental Effects Assessment Panel

29th Meeting of the Parties to the United Nations Montreal Protocol
20-24 November 2017
Montreal, Canada

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Nigel Paul (UK)
Min Shao (China)
EEAP to consider

... effects on human health and the environment of changes in the ozone layer and in ultraviolet radiation, together with future projections and scenarios for those variables, taking into account those factors stipulated in Article 3 of the Vienna Convention for the Protection of the Ozone Layer.
Environmental Effects Assessment Panel

CHANGES IN STRATOSPHERIC OZONE

UV-B EXPOSURE

OZONE-RELATED CHANGES IN CLIMATE

EFFECTS OF ODS REPLACEMENTS

HUMAN HEALTH

CONSTRUCTION MATERIALS

AIR & WATER CHEMISTRY

TERRESTRIAL AND AQUATIC ECOSYSTEMS (including crops and fisheries)

EFFECTS ON PEOPLE AND ENVIRONMENT
The success of the Montreal Protocol has prevented very large increases in skin cancers by UV-B radiation.

Estimates by end of the century, in the USA alone: 275-330 million cases of skin cancer prevented for people born between 1980 and 2100
The success of the Montreal Protocol has prevented very large increases in skin cancers by UV-B radiation.

However, the incidence of skin cancers continues to increase globally, likely a result of individual’s choices about sun exposure. Such choices are influenced by climate change.

The economic costs of skin cancers are increasingly significant. In Australia diagnosis and treatment costs are estimated at USD 206 million per year for malignant melanoma, and USD 530 million per year for keratinocyte skin cancers.
Human health: eye disease

The success of the Montreal Protocol has prevented very large increases in the incidence of cataracts, a major cause of blindness world-wide.

It has been estimated that by 2100, just in the USA, the Montreal Protocol has prevented more than 20 million additional cataract cases.

Melanomas of the eye are rare, but some forms are increasing in parallel with skin cancers, and recent evidence suggests that this is related to exposure to solar UV radiation.
New studies are improving understanding of the beneficial effects of UV-B radiation on human health.

The beneficial effects of UV-B-induced synthesis of vitamin D in the skin are best studied, but other mechanisms may also be involved.

Exposure to high UV radiation increases vitamin D but also causes considerable DNA damage in the skin.

By contrast, regular low doses of solar UV radiation increases vitamin D without accumulation of DNA damage, and this may be the optimum approach to improving vitamin D status while minimising the damaging effects of UV-B radiation on health.
Effects of ozone depletion on ecosystems

CHANGES IN STRATOSPHERIC OZONE

Increases in UV radiation have been reported as a result of the Arctic ozone depletions that occurred in winter 2010/11 and 2015/16.

Longer term UV radiation measurements over Europe confirm a signal of ozone depletion combined with the effects of other factors.

UV-B EXPOSURE

HUMAN HEALTH
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EFFECTS ON PEOPLE AND ENVIRONMENT
Effects of ozone depletion on ecosystems: interactions

SOUTHERN HEMISPHERE STRATOSPHERIC OZONE DEPLETION

ATMOSPHERIC CIRCULATION PATTERNS

REGIONAL CLIMATE

CLOUD

RAINFALL

TEMPERATURE

WIND

UV-B EXPOSURE

HUMAN HEALTH

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EFFECTS ON PEOPLE AND ENVIRONMENT
Effects of ozone depletion on ecosystems: interactions

Changes in wind patterns, precipitation and temperature have been associated with ozone depletion over the Antarctic and, more recently, the Arctic.

- Increased forest fires, damage to freshwater ecosystems
- Increases in microbial productivity, plant growth rates, carbon accumulation in moss communities
- Increased rainfall affecting freshwater ecosystems but benefitting crop production
- Positive effects on some mammals and birds on sub-Antarctic Islands
Effects of ozone depletion on ecosystems: interactions

Changes in stratospheric ozone

- UV-B exposure

Climate change
- Cloud
- Rainfall
- Temperature
- Wind

Terrestrial ecosystems
- Changes timing of crop ripening and stress tolerance
- Modifies food crop quality (positive or negative)
- Plant migrations occur (higher latitudes & elevations)
- May disrupt plant species, communities and habitats
TERRESTRIAL ECOSYSTEMS

UV radiation breaks down dead plant material in dryland ecosystems - contributing to emissions of carbon dioxide.

Increased exposure of permafrost soils exposes organic matter to UV radiation, leading to emissions of methane and carbon dioxide.
Effects of ozone depletion on ecosystems: interactions

TERRESTRIAL ECOSYSTEMS AT HIGH LATITUDES

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AQUATIC ECOSYSTEMS AT HIGH LATITUDES

Increased run-off from the land increases inputs of coloured organic materials to aquatic ecosystems.

These materials may be broken down by UV radiation, increasing emissions of carbon dioxide, but may also protect aquatic organisms from UV damage and stimulate aquatic productivity.
The available evidence remains that concentrations of trifluoroacetic acid (TFA) in the environment now, or with modelled future use of HFCs and HFOs, are greatly below concentrations damaging to organisms.

There have been no new publications in the last year on the potential effects of TFA on human health or the environment.

New reports have confirmed that a wide range of man-made chemicals can degrade to produce TFA. These include several widely-used pharmaceuticals and pesticides.

The relative magnitude of these different sources of TFA remains unclear.
Thirty years of research stimulated by the Montreal Protocol has highlighted the multiple and diverse effects of solar UV radiation in the environment.

Solar UV radiation, especially UV-B radiation, degrades plastic litter, creating a brittle surface layer. The surface breaks up into microscale plastic fragments = microplastics.

Microplastics in seawater can concentrate pollutants, contaminating fish and seafood.
<table>
<thead>
<tr>
<th>Schedule</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment framework; scientific update drafts</td>
<td>September 2017</td>
</tr>
<tr>
<td>Scientific update finalised</td>
<td>December 2017</td>
</tr>
<tr>
<td>Reviewer lists compiled</td>
<td>January 2018</td>
</tr>
<tr>
<td>Draft 1 completed</td>
<td>January 2018</td>
</tr>
<tr>
<td>EEAP meeting</td>
<td>February 2018</td>
</tr>
<tr>
<td>Draft 2 revised</td>
<td>February 2018</td>
</tr>
<tr>
<td>Internal reviews; draft revised</td>
<td>May 2018</td>
</tr>
<tr>
<td>External reviewing</td>
<td>May – June 2018</td>
</tr>
<tr>
<td>Draft revised</td>
<td>August 2018</td>
</tr>
<tr>
<td>EEAP Reviewer meeting and revisions</td>
<td>September 2018</td>
</tr>
<tr>
<td>Final Assessment completed</td>
<td>November 2018</td>
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</tbody>
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