Environmental Effects Assessment Panel
Summary of Progress and emerging issues

37th Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer

31 October - 7 November 2025, Nairobi, Kenya

Environmental effects of stratospheric ozone depletion, UV radiation, and interactions with climate change

EEAP Co-chairs:
Janet F. Bornman (Australia)
Paul Barnes (United States)

Environmental Effects Assessment Panel
2026 Terms of Reference

‘...to pay particular attention to the most recent scientific information, including **solar radiation modification scenarios, forward-looking projections and scenarios**, and to assess the **effects of changes in the ozone layer and ultraviolet radiation and their interaction with the climate system on**:

(a) Human health;

(b) The biosphere, biodiversity, ... the ecosystem;

(c) Ecosystem services, agriculture and materials, microplastics.

...to assess the effects and accumulation of **breakdown products from controlled substances and their alternatives**, in particular any substances that are very persistent in the environment, such as perfluoro- and polyfluoroalkyl substances, including trifluoroacetic acid, in ground and surface waters and in other relevant sinks.’

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EEAP scientific Updates & other material since 2022 that contribute to the 2026 Quadrennial Assessment

2024: Biodiversity linkages between EEAP & the Convention on Biodiversity & Global Biodiversity Framework associated with relevant SDGs

Translation of the 2022 Q&As

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EEAP Quadrennial Assessment Chapters

1	Changes in the ozone layer & ultraviolet radiation and their interaction with the climate system, *Germar Bernhard, Alkis Bais*
2	Potential consequences of stratospheric aerosol injection, *L. Revell, G. Chiodo*
3	UV radiation-induced effects on the troposphere, *S. Madronich, M. S Andersen*
4	Per- and Polyfluorinated Alkyl Substances (PFAS) related to the Montreal Protocol: Definitions, Relevance, & Implications, *M. S Andersen, TEAP & SAP contributors*
5	Chemistry, fate, & toxicology of replacements for ozone-depleting substances & their degradation products, *M. S Andersen, Sasha Madronich*
6	Terrestrial ecosystems, *T.M. Robson, S. Robinson*
7	Aquatic ecosystems, *P. Neale, S. Hylander*
8	Synthetic & natural materials in the environment, *L. Zhu, K. Pandey*
9	Fate of plastic in the environment, *R. Busquet, A. Andrady*
10	Interactive effects of ultraviolet radiation & climate change on human health, *R. Neale, C. Olsen*

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Schedule: EEAP Quadrennial Assessment

2025	
Feb-Apr	♦ **Chapter outlines**, Panel reviewing of drafts
Apr	Science Assessment Panel (SAP) meeting, 16-17 April, York, UK; EEAP focus: Effects of UV radiation, ozone depletion, climate change; Stratospheric aerosol injection; PFAS
May-Aug	♦ **Extended Outlines**; internal Panel review; Draft External Reviewer list; Drafts shared with SAP, TEAP
29 Aug-3 Sep	**EEAP meeting 0** ♦ Chapters: agreement on content for subsequent drafts ♦ Strategic Planning for 2026 Quadrennial year ♦ Format: Executive Summary, Q&As, graphics, tables ♦ Representatives from SAP & TEAP joined online, 3 Sep
Sep-Dec	♦ Preparation of chapters, **Draft 1**; Suggestions & drafting of Q&A

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Schedule: EEAP Quadrennial Assessment

2026	
Jan-Mar	♦ **Draft 1 preparation continued**
Mar	**EEAP Quadrennial meeting 1** **Draft 1** feedback, overview of graphics in preparation for Draft 2; Q&A content, graphics; Executive Summary framework
Mar-Apr	♦ **Chapter Draft 2** for Internal Panel review ♦ **Executive summary Draft 1** for Internal Panel review
Apr	♦ **Revised Draft 2** of Executive Summary; and Highlights page(s)
May	♦ **Chapter Draft 3, Draft 2 Executive Summary** for External rev.
Jun	♦ Comments received back from External reviewers
Jul-Aug	♦ Response to External reviewer comments; Chapters revised
Sep	**EEAP Quadrennial meeting 2;** 2 days with invited reviewers
Oct-Dec	Final revisions Dec: Quadrennial Assessment sent to Ozone Secretariat
Feb 2027	Q&A completed and sent to Ozone Secretariat

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EMERGING ISSUES

UV radiation, ozone and climate

Examples of factors potentially affecting stratospheric ozone (ozone reduction; delaying ozone recovery), UV radiation, and climate

PROJECTIONS:

Nuclear war

Regional

4-year large increases in UV radiation, UVI > 35 in the tropics

3-year UVI > 45 in southern polar regions (summer)

UVI in the tropics (Southern Hemisphere) > 25

Global-scale larger increases in UV radiation due to 15 years reduction in total column ozone (75% globally)

Halogen emissions (e.g., fluorine, chlorine, bromine & smoke particle chemistry) resulting in large ozone losses leading to large increases in surface UV radiation, serious risks to life on Earth

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EMERGING ISSUES

UV radiation, ozone and climate

PROJECTIONS:

Supersonic aircraft

Similar concerns for increased UV radiation and its cascading effects projected from emissions of water vapour and nitrogen oxides on the ozone layer (extent depends on several variables)

Satellite/rocket launches

Increases in UV radiation are projected from the negative impact of enduring launches

Nitrous oxide

Emitted mainly from agricultural practices; most significant ODS

Projected action for strong reduction in nitrous oxide could avoid: 0.2–0.8% cataract cases and a 2-10% increase in skin cancers by 2080–2090 (depending on latitude)

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EMERGING ISSUES and MAIN FOCUS AREAS

Stratospheric Aerosol Injection (SAI)

Injection of aerosols (e.g., sulfate from SO_2) or their precursors into the stratosphere; becomes distributed globally

Main focus areas

- Modelling and SAI scenarios: changes in UV radiation & climate
- Terrestrial ecosystems: changes in temperature, diffuse/direct & total radiation, and in precipitation could result in increased photosynthesis in the tropics, but decreases at high latitudes; global carbon uptake by plants could increase
- Marine ecosystems: reduced solar radiation could impair productivity, hunting by visual predators, disrupt reproductive cues
- SAI effects: compounded by climate changes from SAI (e.g. changes to clouds, precipitation, wildfires)
- Decreased air quality & possible negative effects on human health

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EMERGING ISSUES and MAIN FOCUS AREAS

Per- and Polyfluorinated Alkyl Substances (PFAS)

Decision XXXV/3: Parties requested SAP, EEAP, & TEAP, to assess the relevance of PFAS in the context of the Montreal Protocol,

"...in particular breakdown products of controlled substances and their alternatives that are very persistent, such as per- and polyfluorinated alkyl substances, including trifluoroacetic acid" (TFA)

PFAS chemicals are not new - entered the market since late 1940s

Certain substances and alternatives under the Montreal Protocol can be classified as PFAS and/or degrade to give PFAS

What are the concerns? Certain PFAS are persistent, bioaccumulative, toxic, and/or threaten global ecosystems and human health, **BUT** this does not hold true for all PFAS

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EMERGING ISSUES and MAIN FOCUS AREAS

Per- and Polyfluorinated Alkyl Substances (PFAS)

EEAP, together with SAP and TEAP, is addressing the confusion regarding PFAS

- No universally-adopted definition of PFAS
- All definitions of PFAS include compounds with an extremely wide range of physical, chemical, biological, and toxicological properties

Therefore, not possible to make general PFAS statements on:

potential effects on humans, other animals,

ecosystems or the fate of PFAS in the environment

An introductory text, coordinated by EEAP member, Mads Sulbæk Andersen, is being developed jointly by the three Assessment Panels to address the misconceptions and to increase understanding

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EMERGING ISSUES and MAIN FOCUS AREAS

Per- and Polyfluorinated Alkyl Substances (PFAS)

EEAP focus

- Measurements, amounts, and estimates of PFAS, relevant to the Montreal Protocol, in flowing water, fresh-water lakes, *endorheic lakes, and ocean waters
- Atmospheric degradation pathways for Montreal-P-relevant PFAS, including precursors to TFA, *PFPrA, and *PFBA *(very persistent)*
- Main EEAP Quadrennial Assessment report: is assessing environmental & human health risks of TFA, PFPrA, & PFBA for future projected increases in Montreal Protocol-related precursors

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*Endorheic lakes, no natural water outflow; inflow from rivers, rain

*PFPrA, perfluoropropanoic acid; *PFBA, perfluorobutanoic acid

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EMERGING ISSUES and MAIN FOCUS AREAS

Per- and Polyfluorinated Alkyl Substances (PFAS)

Not all PFAS definitions include TFA and its salts, nor some of the controlled substances under the Montreal Protocol

Trifluoroacetic acid (TFA), a breakdown product of several compounds relevant to the Montreal Protocol, including:

- hydrofluorocarbons (HFCs)
- hydrochlorofluorocarbons (HCFCs)
- hydrofluoroolefins (HFOs)
- pesticides, pharmaceuticals

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EMERGING ISSUES and MAIN FOCUS AREAS

Per- and Polyfluorinated Alkyl Substances (PFAS)

We identified gases controlled under the Montreal Protocol and their known persistent breakdown products that can be classified as PFAS under at least 1 of 3 broadly-used definitions as examples

Commonly used definitions of PFAS

Buck et al. (2011)

OECD (2018) and (2021)

US EPA (2024)

In the 3-Panel Introductory document, we do not assess the merits of the different definitions but acknowledge that differences exist

Outcome: nearly one third of gases controlled under the Montreal Protocol can be classified as PFAS

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Per- and Polyfluorinated Alkyl Substances (PFAS)

Where to find more information on PFAS relevant to the Montreal P?

- The 3-Panel introductory document is proposed to be included in the TEAP 2026 Progress Report
- The 3 Panels propose a side event on this topic at the 2026 OEWG for interested Parties
- Also, the 3 Panels plan on including this document together with additional information on PFAS in their 2026 Quadrennial Assessments

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