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Co-ordinating Committee on the
Ozone Layer
Eighth Session
Bilthoven 19-21 November 1986

Report of the Second Part of the Eighth Session
Effects of ozone layer modification

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1. Opening of the session:

The second part of the eighth session of the Co-ordinating Committee on the Ozone Layer (CCOL) was convened in Bilthoven, Netherlands, at the kind invitation of the Government of the Netherlands. The purpose of the meeting was to review the impacts of ozone layer modification on man and his environment.

The first part of the eighth session of the CCOL took place in Nairobi, Kenya from 24 to 28 February 1986. At that meeting, an assessment of ozone layer modification was made by members. The report of the session is published by UNEP as document UNEP/CCOL/VIII.

The resumed eighth session of the CCOL was opened at 10.30 a.m. on Wednesday 19 November 1986 at the National Institute of Public Health and Environmental Hygiene, Netherlands by Dr. Jacob Swager of the Netherlands Ministry of Housing, Physical Planning and Environment. He welcomed members to the meeting on behalf of his Government, his Ministry and the Institute and noted this was the second time the Netherlands had hosted a session of the CCOL. He confirmed the major interest in environmental matters in the Netherlands and stated that the ozone layer issue was one of particular current concern in his country. Dr. Swager referred to the work of the CCOL in supporting Governments in the development of the Vienna Convention for the Protection of the Ozone Layer and in the subsequent search for a protocol on the control of chlorofluorocarbons through the provision of relevant scientific and technical information and said that CCOL had played a significant role in the success achieved.

In reply, Mr. Peter Usher of the United Nations Environment Programme, and acting chairman in the absence of Dr. Michael Gwynne who was unable to be present, explained the purpose of the meeting which was to provide a scientific assessment of the effects of ozone layer modification for use by the Vienna Group. The Vienna group, an Ad Hoc group of legal and technical experts, is to be convened from 1 to 5 December 1986, in Geneva, to develop a protocol on the control of chlorofluorocarbons to the Vienna Convention for the Protection of the Ozone Layer.

He said that the assessment would be based on national research results provided by members but also drew attention to the reports of an International Conference on Effects of Change in Stratospheric Ozone and Global Climate, which had been jointly convened by UNEP and the United States Environmental Protection Agency in June 1986 in Washington, D.C. He also informed the Committee of other UNEP activities during the year designed to support the Vienna Group in its task. These included the holding of the first part of the eighth session of the CCOL at Nairobi in February; an Ad Hoc meeting of some CCOL participants in August which produced a Policy Support Document drawing attention to some of the issues that the Vienna Group need taken into account in developing a protocol; and a two-part workshop on the control of chlorofluorocarbons, held in Rome in May and in September in Leesburg. He also informed the CCOL of UNEPs aim to achieve agreed targets by 1992 which include the development of a legal instrument to limit the extent of future climate change.

Mr. Usher concluded by warmly thanking the Government of the Netherlands for its generous support to UNEP which enabled the meeting to be held.

2. Organization of work:

The meeting was informed of the availability of a document containing a draft assessment of effects of ozone layer change, prepared for UNEP by experts selected from participants in the UNEP/EPA International Conference on Effects of Changes in Stratospheric Ozone and Global Climate. The chairman asked that this document be considered as a working document in developing a summary assessment of effects suitable for use by the Vienna Group. It was also suggested, that, if possible, the draft assessment should, after amendment, be adopted as the CCOL assessment. The chairman also noted that a set of recommendations for further research should also be made.

Following discussions, it was felt that the draft assessment prepared by UNEP needed further consideration before adoption and it was agreed to circulate the document among CCOL member countries and organizations with a view to allowing its more detailed consideration before adoption.

It was decided to concentrate on developing a short assessment statement for use by the Vienna Group and three working groups, for health effects; for effects on agriculture and terrestrial and marine ecosystems; and for climatic effects, effects on urban pollution and materials and for UV-B flux, were established for this purpose.

Some members regretted that the draft assessment and other documents were not precirculated to members and also complained that an invitation to the meeting had not been received. The chairman said that invitations had been cabled to all members on 1 July 1986 and said that an investigation would be undertaken to determine why the invitations had not been received. He regretted that it had not been possible to circulate the draft assessment prior to the meeting and he himself had only received the draft assessment that day due to unexpected delays in its compilation. He noted that the primary input to the assessment would be research results reported by members and that the effects related documentation provided for the meeting was more extensive than that tabled at any previous CCOL meeting.

3. Adoption of the agenda:

The following agenda was adopted by the meeting:

1. Opening of the meeting.

2. Organization of work.

3. Adoption of agenda.

4. Presentation by members of ongoing and planned research activities and of recent research results.

5. Assessment of effects of ozone layer modification.

6. Recommendations.

7. Any other business.

8. Closure of the meeting.

4. Attendance:

The meeting was attended by experts designated by the following countries; United Nations bodies and specialized agencies; and inter-governmental and non-governmental organizations:

Member states:

Canada, Federal Republic of Germany, France, Italy, Netherlands, Norway, Sweden, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland and United States of America.

United Nations bodies and specialized agencies:

World Meteorological Organization
United Nations Environment Programme

Inter-governmental organizations:

The Organization for Economic Co-operation and Development

Non-Governmental organizations:

Chemical Manufacturers Association
International Council of Scientific Unions

A full list of participants appears on Annex I.

Documentation for the meeting appears as Annex 2.

5. Reports by members of ongoing and planned research programmes and recent research results:

Members reported on activities being conducted in their countries and by their organizations concerned with effects of ozone layer modification.

The reports submitted by members are attached as annex III to this report.

6. Assessment of ozone layer modification:

Presentations were made to the Committee by experts on aspects of effects of ozone layer modification not previously considered by the CCOL. These were photochemical smog and impacts of UV-B on plastic and rubber materials. Also, Mr. John Hoffmann, one of the organizers of UNEP/EPA International Conference on Effects of Changes in Stratospheric Ozone and Global Climate, provided the CCOL with a brief overview of some of the more significant results to emerge from that conference.

The Committee then separated into its three working groups and prepared an assessment statement of effects of ozone layer modifications. The full text of the statement agreed by the Committee is as follows:

Assessment Statement on Effects of Ozone Layer Modification

Radiation at ultraviolet wavelengths between 280 nm and 320 nm is commonly referred to as ultraviolet-B (UV-B) radiation. Solar UV-B radiation which reaches the ground depends on many physical parameters such as the amount of atmospheric ozone, solar zenith angle, ground albedo, altitude and atmospheric scattering.

Monitoring of ground level UV-B radiation is just as important as monitoring ozone because UV-B radiation at the lower atmosphere directly affects several biological and photochemical reactions. UV-B radiation is measured by photodetectors which are sensitive at wavelengths weighted to approximate the eurythmically active spectrum. The intensity of this weighted UV-B flux falling on a horizontal surface is measured. Ground level UV-B radiation is measured by a ground based network. Satellites do not measure ground level UV-B from space.

A reduction in total column ozone would result in an increase in radiation reaching the troposphere and the earth's surface, particularly at the shorter wavelengths were radiation is more damaging to humans, plants, animals, and materials and exacerbates air pollution. For example, a 1% depletion in total column ozone would increase DNA damaging UV-B radiation by 2%.

In this document, reference to UV-B indicates information derived solely from the evaluation of UV-B induced effects; reference to ozone or ozone depletion indicates information based on predictions of changes in UV-B flux resulting from changes in total column ozone.

There is a direct relationship between exposure to UV-B radiation and the incidence of non-melanoma skin cancer. A 1% decrease of total column ozone would lead to a 2% increase of carcinogenically effective UV-B irradiance. With unchanged exposure habits, this would result in an average increase of the incidence rates of basal cell carcinoma by about 4% and of squamous cell carcinomas by about 6%.

Non-melanoma skin cancers occur in people of all skin types, the incidence is highest in light-skinned people. Most non-melanoma skin cancers can be cured. Somewhat less than 1% result in death.

Melanoma, though less frequent, is a more serious form of skin malignancy. Between 25% and 40% of all melanoma cases result in death. The evidence supporting the relationship between malignant melanoma and sunlight is more circumstantial than the evidence that supports the relationship between sunlight and non-melanoma skin cancers. The evidence comes from a variety of studies, and is not accepted by a few scientists. Of the components of sunlight, UV-B is the most likely waveband for producing melanomas. In the United States, epidemiological studies indicate that a 1% ozone depletion could increase incidences of melanoma by about 2%, assuming the relationship between UV-B and melanoma is causal. Similar projections of increase in skin melanoma are not available from most countries.

It is generally accepted that exposure to UV-B is associated with accelerated skin aging, consequently total column ozone depletion is likely to accelerate this effect.

Recent research indicates that UV-B radiation alters several responses of the immunological system. The doses of UV-B radiation causing these immunological changes are much smaller than those which are associated with an increased incidence of tumors. Some experimental results indicate that infectious diseases with a cutaneous component could be exacerbated by the increased UV-B radiation associated with ozone depletion. Herpes and the tropical skin disease leishmaniasis are two such diseases for which some evidence exists. Some evidence supports the hypothesis that melanoma of the eye could be increased by sunlight and these might possibly be induced by UV-B radiation. Studies on animals and epidemiological data support the conclusion that UV-B radiation is one of the causes of cataracts. Epidemiological studies support the conclusion that a 1% total column ozone depletion would result in between 0.2% and 0.6% increase in cataract prevalence.

The relationship among ozone depletion, UV-B radiation, and biological effect varies temporally, spatially, and by biological process. In many cases there is a greater percentage change in biological response than the percentage change in total column ozone.

A 10% decrease in total column ozone would produce a level of biologically effective UV-B radiation in temperate latitudes equivalent to radiation levels currently found in the tropics.

Based on limited results from field and laboratory experiments:

- Increases in UV-B radiation reduce yield in certain agricultural crops, and alter competition among plants. Knowledge of biological mechanisms associated with increases in UV-B radiation has aided the interpretation of current field studies.

- Many soybean varieties are sensitive to increased UV-B radiation. One particular variety showed a yield loss of up to 25% following exposure to UV-B radiation simulating a 20% ozone reduction.

- Many plants, including some economically important crops such as soybean, cabbage and squash, are more susceptible to UV-B radiation than others. Differential UV sensitivity may be due to differences in adaptive mechanisms.

- UV-B radiation alters the reproductive capacity of some plants.

- UV-B radiation affects the quality of harvestable products.

- Reduced vigor in UV-B sensitive plants could render them more susceptible to pest or disease damage and thus result in reductions in crop yield.

- Increased UV-B radiation affects competition among plant species. In conjunction with other stresses, increased UV-B radiation also could alter ecosystems in ways not yet understood.

- The effectiveness of UV-B radiation can be greatly modified by other environmental factors, such as water and mineral stresses.

UV-B radiation damages larval stages of fish, shrimp and crab, as well as other zooplankton and plants essential to marine food webs, including those comprising commercial fisheries.

Solar UV-B radiation has important ecological effects. Sunlight-exposed organisms sacrifice potential resources to avoid UV-B radiation damage. Thus, even small increases in UV-B radiation would be likely to further injure the marine species currently under the most stress.

Current ambient levels of UV-B radiation reduce the survival of many aquatic microorganisms by decreasing their reproductive capacity and restricting their ability to move into favourable environments. Therefore, increased levels of exposure would further reduce the population size.

A decrease in total column ozone could shorten the season in which zooplankton can feed near the surface causing a mismatch in timing between food availability and food requirements.

Studies show an 8% loss of the larval anchovy population for a 9% total ozone column reduction.

Exposure of a marine community to UV-B radiation stress results in a decrease of species diversity, and therefore in a reduction of ecosystem resilience and flexibility.

The use of plastics/rubber materials in building and in other outdoor applications shows a consistent increase worldwide. This is true of developing countries as well, where plastics represent an inexpensive substitute for conventional materials. Ultraviolet radiation (particularly UV-B), in general, leads to changes in physical and mechanical properties of plastics, often severely shortening the service-life outdoors.

The extent of such degradation depends on the spectral sensitivity, dose-response relationship and the amount of light-stabilizer (chemical additives used to protect the material from light-induced degradation) incorporated into the polymer formulation.

The increased degradation of a given type of plastic material as a result of incremental UV-B radiation increase cannot be reliably estimated at the present time. This is due to the lack of relevant experimental data on the plastics compositions commonly used in outdoor applications. Preliminary estimates, however, show the degradation of materials involved is likely to be substantial.

In the event of UV radiation level increase, the plastics/rubber industry may act in several ways to mitigate the damage. Increasing the levels of currently used conventional light stabilizers is likely to be an initial strategy. A preliminary case study of rigid PVC plastics show that the conventional stabilizer technology can be used only to a limited extent under such conditions. Such a strategy will involve increased production costs and is likely to diminish in effectiveness with increasing UV light-levels.

As UV-B radiation increase due to total column ozone depletion will be felt to varying extents in different geographical regions, the strategies adopted to increase the protection of outdoor plastics may differ from region to region.

Most trace gases which have been so far identified as having an impact on ozone chemistry, also exhibit, greenhouse properties. The observed increasing concentrations in such gases is expected to lead to substantial increases in global mean surface temperature during the next century and beyond. A major effect of such a warming would be a rise in the mean sea level.

Redistribution of total column ozone could also contribute to a global warming. Steps to control any one of the trace gases capable of interacting with ozone could reduce, but not eliminate, a rise in sea level. The major contribution by the other greenhouse gases would remain.

The initial causes of sea level rise should be thermal expansion and alpine ice melting. Prediction of sea level rise is uncertain, but a warming in the range of 1.5°C to 4.5°C is estimated to lead to a rise of between 20 cm and 140 cm. Sea level rise will inundate and erode coastal land, increase flooding and produce saltwater intrusion into freshwater areas. Wetlands and river deltas will be adversely affected. Regions of the world that have low topographic relief, are storm-prone and/or have concentrations of human populations and economic activity are especially vulnerable to sea level rise. Typically, coastal areas tend to have high concentrations of populations and economic activity.

Preliminary studies suggest that adverse consequences could be substantially reduced by anticipatory coastal planning.

In a recently published modeling study and in one experimental study it was suggested that the decrease in total column ozone will influence the photochemistry of urban pollutants and could cause increases of ground level ozone. As a result, and also because peak concentrations would tend to occur closer to the emission sources (where population densities are also typically large), more people could be exposed to excessive ozone concentrations.

The study also predicted that, under certain conditions, hydrogen peroxide formation is extremely sensitive to increased UV-B radiation. Some acidification processes are known to be influenced by the hydrogen peroxide. More investigations of these potential effects are necessary.

Global warming can be expected to alter urban photochemical effects of increased total column ozone. One study has shown that most of the expected chemical enhancement stems from a thermal shift in the balance between urban ozone and peroxyacetyl nitrate (PAN), a cooxidant formed in urban atmospheres along with urban ozone.

The Committee requested that the above statement be transmitted to the Vienna Group for its use during its first meeting from 1-5 December 1986 to develop a protocol on the control of chlorofluorocarbons.

7. <u>Recommendations:</u>

The Committee also agreed the following set of recommendations for future research on effects of ozone layer modification, of UV-B flux and of climate change.

1. Governments and organizations that are determined to protect man and the environment against adverse effects resulting from modification of the ozone layer and who are also aware of the need for future research, should critically examine their current levels of funding, especially in the area of effects research. Current uncertainties about effects are largely attributable to a lack of adequate funding of qualified researchers.

2. Steps should be taken to develop national and international foci to organise and co-ordinate effects research.

3. Trends of UV-B radiation should be studied and correlated to ozone trends. Such comparative studies could be used to test models and assumptions that predict an increase of UV-B radiation with a decrease of total column ozone.

4. UV-B radiation should be considered as a climatological parameter. Maps of UV-B radiation as a function of season should be generated.

5. More detailed measurements of the wavelength dependence of UV-B radiation should be made. Various biological and photochemical reactions are sensitive to different regions of the UV-B spectrum and detailed wavelength dependence information (about 1 nm resolution) would be beneficial to analyse a particular application.

6. Effort should be made to improve the standardizing of instrumental calibrations.

7. Conduct experiments and epidemiological studies to better establish the nature of the relationship between UV-B and melanoma, particularly with regard to quantification.

8. Determine the extent to which possible increases in UV-B and associated immunosuppression could increase the incidence and morbidity of infectious diseases.

9. Conduct experiments to better define action spectra and dose-response relationships in human health effects.

Recommended studies needed to help achieve the above include:

- Develop improved ground-level UV-B measuring devices, including personal dosimeters, and monitor trends in exposures for sufficient and adequate time periods. Also, develop and implement Epidemiologic case-control and field studies which include such measurements and may lead to improved quantification of the potential harmful health effects of projected ozone depletion.

- Develop and implement biochemical (photobiological) epidemiologic studies of elements in human skin (such as urocanic acid), involved in UV-B sensitization responses, including immunologic suppression.

- Improve quantitative projections of adverse health effects, incorporating further quantitative investigations of immunological changes and biological dosimetry into mathematical models of photocarcinogenesis.

10. The number of field experiments for impacts on agriculture should be increased. Most of the studies to-date have been conducted in controlled environments that cannot simulate time responses in actual conditions.

11. Broaden the geographic focus of studies to include the tropical and poleward latitudes.

12. Study more plants and natural ecosystems. Little or no data exist for component of most terrestrial ecosystems, including forests, grasslands and wetlands.

13. Increase the effort given to better understanding of the effects of multiple stresses and of competitive balance. One way to help accomplish this is to use an experimental design employing natural solar radiation and ozone filters.

14. Develop more accurate action spectra data. Recent progress in developing such action spectra on intact plants under polychromatic radiation is encouraging.

15. Continue studies on the mechanisms by which UV-B radiation act on biological molecules, cells, species and ecosystems.

16. Conduct further studies on mechanisms of biological responses to UV-B radiation in order to lay a foundation for plant breeding and other actions to mitigate the effects of a UV-B increase.

17. Determine whether the effects of increased levels of UV-B radiation may be augmented when considered in conjunction with future changes in global climate.

18. Determine the effect of UV-B radiation on the photodegradation of herbicides, pesticides, and similar agricultural chemicals.

19. Establish the effect of, UV-B stress to aquatic microorganisms on commercial fisheries.

20. Define the relationships among vertical position data of aquatic organisms, attenuation of UV-B radiation in the water column, and the UV-B sensitivity of the organism.

21. Determine the proximity of current levels of UV-B exposure to the threshold of effect for aquatic organisms.

22. Increase the promotion of research on mechanistic, kinetic and other aspects of light-induced degradation of key plastic materials, particularly under increased UV light conditions. This research should generate the required data to enable reliable assessment of damage to key polymers.

23. Set up long-term weathering studies in different geographical regions to study the effects of naturally occurring variations in UV content of sunlight.

24. In conjunction with the above, carry out a detailed study of relevant specific formulations of plastic products, the types of plastic technologies and the nature of plastic/rubber industry in those regions most affected by possible ozone depletion. A detailed study of the materials usage in these high-risk regions will allow a realistic assessment of the socio-economic impacts of ozone depletion.

25. Undertake investigations of surface coating, painting and other means of controlling photodegradation including a study of environmental impact of such technologies.

26. Determine past and present-day changes in sea level more precisely. This could be aided by establishing sea level stations in strategic locations, including the Southern Hemisphere and mid-ocean locations where data are currently sparse and by conducting regional studies to differentiate the effects of tectonic, oceanographic and isostatic factors on regional/local sea levels. An up-dating compilation and analysis of existing tidal gauge and other observations is needed for various regions.

27. Determine the relative contribution of the thermal expansion of the ocean to sea level rise. High-quality observations of ocean salinity and temperature are needed (including sub-surface measurements for which historical data are scanty) in order to monitor long-term changes, to improve understanding of vertical mixing, and to develop and validate ocean models.

28. Refine numerical models of the ocean's circulation. Such a model could simulate long-term changes in the ocean for estimating the long-term effects of global warming on mean sea level.

29. Conduct integrated regional studies of the environmental and socio-economic consequences of sea level rise on vulnerable coastal locations. These would include the effects of climatic change and sea level rise on climatic extremes like storm surges, as well as the chronic effects of slow inundation, salinization, erosion and so on. Priority should be given to densely-populated, major river deltas of the world where vast resources and large numbers of people could potentially be affected.

30. New, supplemental and confirmational studies on urban ozone effects are needed. Currently, only one study on the subject has been published.

31. Increases in hydrogen peroxide need to be elucidated, especially if hydrogen peroxide from urban sources increases significantly as predicted by recent studies. In particular, the role played by hydrogen peroxide generated from urban areas needs to be defined.

32. Studies of the effects on global tropospheric chemistry should be undertaken in view of the expected increase in the formation of such species as hydrogen peroxide on a global scale induced by increased UV-B radiation.

33. Undertake studies of the many supplemental interactions on air pollution effects from increased UV-B radiation. Such interactions that have yet to be addressed stem from climate changes (important to precursor emissions rates, frequency of episodes and local meteorology) and the day to day carry-over of pollutants in multiple-day episodes.

34. Actual estimates of potential population exposure increases need to be made.

35. Improve spectral resolution in present and predicted solar UV-B fluxes as to make more accurate predictions of air pollution effects.

8. Any other business and closure of the meeting:

There being no other business, the acting chairman thanked on behalf of the Committee, the hosts, the Government of the Netherlands and the National Institute of Public Health and Environment Hygiene for their generous support which had contributed to the successful holding of the meeting.

He wished participants a safe return home and declared the meeting closed at 2.00 p.m. on Friday 21 November 1986.

Participant' List | Annex 1

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Annex 2

Documentation:

1. Draft agenda	UNEP/CCOL/8/7
2. Draft annotated agenda	UNEP/CCOL/8/8
3. Report of the seventh session of the Co-ordinating Committee on the Ozone Layer	UNEP/CCOL/VII
4. Report of the first part of the eighth session of the Co-ordinating Committee on the Ozone Layer	UNEP/CCOL/VIII
5. Report of the first part of the Workshop on the control of chlorofluorocarbons	UNEP/WG.151/Background 1
6. Report of the second part of the Workshop on the control of chlorofluorocarbons	UNEP/WG.151/Background 2
7. UNEP Policy Support Document	UNEP/WG.151/Background 4
8. Draft assessment report to the UNEP Co-ordinating Committee on the Ozone Layer on Effects of Stratospheric modifications and Climate Change	
9. Atmospheric Ozone 1985 (3 volumes)	WMO No. 16
10. Effects of Changes in Stratospheric Ozone and Global Climate: Volume 1 Overview Volume 2 Stratospheric Volume 3 Climate Change Volume 4 Sea Level Rise	
11. Report of the International Confernce on the Assessment of the Role of Carbon Dioxide and of other Greenhouse Gases in Climate Variations and Associated Impacts	WMO No. 661
12. Effects of UV-B on Biological Systems. Report of a research programme sponsored by the Ministry of Research and Technology (FRG)	
