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Ad Hoc Working Group of Legal and  
Technical Experts for the Elaboration  
of a Protocol on the control of  
chlorofluorocarbons to the Vienna  
Convention for the Protection of the  
Ozone Layer (Vienna Group)

Executive Summary of the Assessment  
of Ozone Layer Modification - February 1986

Submitted by

UNEP Co-ordinating Committee  
on the Ozone Layer

EXECUTIVE SUMMARY

The ozone layer protects the biosphere from the harmful effects of solar ultraviolet radiation, controls the structure of the stratosphere and influences the Earth's climate.

There is now compelling observational evidence for increases in the concentrations of most atmospheric trace gases which control ozone. These increases are likely due to man's activities. The gases include methane, nitrous oxide, chlorofluorocarbons (CFCs) 11 and 12, carbon tetrachloride, methyl chloroform and other halocarbons.

These gases are the precursors to the hydrogen, nitrogen and chlorine oxides which catalyse the destruction of ozone in the stratosphere by a series of chemical reactions. The reactions involving these oxides are highly coupled and the species interact with one another. Consequently, the effect of individual trace gases on ozone cannot be considered in isolation. Carbon monoxide and carbon dioxide, which are also increasing, can affect ozone indirectly.

The annual statistics on CFCs 11 and 12, produced for the companies reporting to the Chemical Manufacturers Association (CMA), show that in 1984 the production of CFCs 11 and 12 was 312 and 382 kilo-tonnes respectively. These figures represent increases of 7.1% and 7.5% for CFCs 11 and 12 compared with 1983. The 1984 production is close to that reported in 1977. The production figures for countries not reporting to CMA are unavailable.

Mathematical models of the atmosphere which include projected continuation of the currently observed increases in nitrous oxide, methane and carbon dioxide predict decreases of less than 3% in the global average total ozone in the next 70 years, if the sustained rate of increase of CFCs 11 and 12 release is less than 1.5% per year. Even when predicted changes in total ozone are small, a significant vertical and latitudinal redistribution of ozone is predicted, which alters stratospheric structure. Typical predictions suggest that ozone at 40 km would be depleted by 30-70% and that the total ozone

changes would be about 4 times larger at the pole than at the equator. For a sustained chlorofluorocarbon emission growth rate of 3%/year the predicted global average ozone depletion is 10% over 70 years and increases rapidly thereafter. A 3% growth rate implies doubling of chlorofluorocarbon production every 25 years. Also, since many of the gases have very long atmospheric residence times, once changes in ozone have occurred it will take tens to hundreds of years for ozone to return to its original level.

Identification of changes in global ozone which may have already taken place is crucial. The search for a global ozone trend involves looking for small secular changes amidst large natural variations that may occur on many time scales. Statistical methods for analysis of data for ozone trends have been developed. These analyses have so far shown no significant trend in total ozone; model predictions for the same period are consistent with this, when changes in all the trace gases are taken into account.

Stratospheric ozone trend estimates have also been made using the altitude profile data for ozone measured at a network of stations. These estimates indicate a significant decrease in the middle and upper stratosphere of 2-3% for the period 1970 to 1980. The results are sensitive to the inclusion of a correction accounting for stratospheric aerosol effects. Calculations using atmospheric models are qualitatively consistent with the corrected trend.

Important new observational evidence for a regional total ozone change has recently been reported. The October values of total ozone in the Antarctic have decreased by approximately 40% since 1957, most of this has occurred since the mid-1970s. At present, the cause of this has not been established and therefore the implications of these observations for possible future global ozone change are not known.

The predictions of atmospheric change rely on mathematical models. A primary test of the models is their ability to simulate the features of the present atmosphere, which are being observed in some detail in the current measurement programmes. Most of the key stratospheric constituents have been observed. Disagreements between observations and simulations of key species do appear which place limits on our confidence in the predictive capability of the models. However, in general, there is agreement between observed

concentrations and their simulations. An accurate estimate of future changes in precursor gas concentrations is of vital importance for reliable predictions of ozone change. Ultimately, however, our predictive capability will be tested by measurement of the changes taking place in the atmosphere. This will require careful measurement of critical species to be carried out over long periods.

The observed increases of the chlorofluorocarbons, of methane and of nitrous oxide also have direct implications for the Earth's radiative balance through an enhancement of the greenhouse effect. These gases absorb infrared radiation in a part of the spectrum in which the atmosphere is otherwise transparent. The calculated cumulative effect of the increase in all trace gases for the period 1850-1980 is a warming in the range of 0.3-1K. At present, changes in carbon dioxide and in other trace gases are thought to be contributing about equally to greenhouse warming. Estimates indicate that the greenhouse warming predicted to occur in the next 50 years should be about twice that calculated for the previous 130 years.

In summary, there continues to be concern that both the total amount and the vertical distribution of atmospheric ozone, the temperature structure, and climate, will be modified by changes in the atmospheric concentrations of several trace substances, specifically chlorofluorocarbons, carbon dioxide, methane and nitrous oxide. Thus the two issues of ozone modification and climate change should be considered together.

Footnote:

The Co-ordinating Committee on the Ozone Layer, at its eighth session, did not discuss the relationship between changing concentrations of total column ozone and solar UV-B flux at the earth's surface. The CCOL noted the importance of this relationship in view of the risk to human health and the environment should UV-B incidence increase. The subject will be considered at the UNEP/EPA Conference on Health and Environmental Effects of Ozone Modification and Climate Change in June 1986 and will be included in the CCOL Assessment of Effects of Ozone Layer Modification to be undertaken in August 1986.

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