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Protection of the atmosphere*

Report of the Secretary-General

Contents

* The present report was prepared by the World Meteorological Organization and the United Nations Environment Programme as task managers for chapter 9 of Agenda 21, with contributions from other United Nations agencies and international organizations. The report is a brief factual overview, which intends to inform the Commission on Sustainable Development on key developments in the subject area.

01-27457 (E) 230301
0127457

Introduction

1. The purpose of the present report is to provide a succinct summary of factual material relating to the protection of the atmosphere. The summary is based primarily on the in-depth review of the ninth session of the Commission on Sustainable Development, supplemented by more recent material that has come available from the work of the Intergovernmental Panel on Climate Change (IPCC) established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). There have been several distinct tendencies in atmospheric conditions during the decade of the 1990s and since the United Nations Conference on Environment and Development held at Rio that have continued from previous decades.

I. Global atmospheric trends

2. The Earth's climate has been relatively stable since the last ice age, with global temperature changes of less than 1º Celsius (C) over a century during the past 10,000 years. During this time, modern society has evolved and, in most cases, successfully adapted to the prevailing local climate and its natural variability. However, the Earth's climate is now changing. The Earth's surface temperature[1] during the twentieth century was clearly warmer than during any other century for the last thousand years, that is to say, the climate of the twentieth century was clearly atypical. According to IPCC, the Earth's atmosphere near the surface warmed overall by between 0.4º and 0.8º C over the past 100 years, with air over land areas warming more than the ocean surface, and with the last two decades of the twentieth century being the hottest in that century. Recent research by WMO shows that the 10 warmest years have all occurred since 1983, with 8 of these having occurred since 1990. As a new century begins, the global mean temperature is 0.6° C above the estimate for the start of the twentieth century. The year 2000 continued the run of warm years in spite of the persistent cooling influence of the tropical Pacific La Niña event and was the twenty-second consecutive year with the global mean surface air temperature above the 1961-1990 normal.

3. In addition to the direct evidence from temperature records of global-scale warming of the atmosphere near the Earth's surface, there is substantiation from increasing sea level (owing partly at least to thermal expansion), the retreat of many of the world's glaciers, and the thinning of Arctic sea ice.

4. Increases in temperature will change the distribution of vectors for malaria and other tropical diseases, and adversely influence agricultural patterns in already vulnerable parts of the world. Rises in sea level will place low-lying countries at risk for severe flooding, cholera and other waterborne diseases. In addition, extreme weather events are expected to increase in frequency and/or severity, and have important health impacts, with the burden falling disproportionately on the poor.

A. Global and regional precipitation

5. There is evidence that precipitation patterns are changing in systematic ways with large areas of the world's continents experiencing extended upward and downward trends. Precipitation increased by 0.5-1 per cent per decade in the twentieth century over most mid and high latitudes of the northern hemisphere continents and also over much of Australia and South America, except for the west coast of both continents. Rainfall decreased during the twentieth century over much of the tropical and subtropical land areas north of the equator, including Africa, East Asia and the Americas, although it has recovered in some areas during recent years. In Western Europe, Southern Africa and parts of Central Asia, there appear to be no distinct trends.

B. Global-scale greenhouse gas concentrations

6. The atmospheric concentrations of greenhouse gases have increased because of human activities, primarily owing to the combustion of fossil fuels (coal, oil and gas), deforestation and agricultural practices.

7. The concentration of atmospheric carbon dioxide (CO_2) has now risen to over 360 parts per million from a pre-industrial level of about 270 parts per million. Changes in the ratio of carbon isotopes in atmospheric CO_2 confirm that the increase is a consequence of human activities. CO_2 has an effective lifetime in the atmosphere of about 100 years, so that its global mean concentration responds only very slowly to changes in emissions. This means that about one third of the CO_2

resulting from human activities in the recent past will still be present in 100 years' time. Anthropogenic CO_2, then, is making the largest direct additional contribution to radiative forcing at present and is likely to do so for some time into the future. Stabilization of CO_2 emissions at current values could slow the consequent projected climate change but still leave atmospheric concentrations rising. Emission reductions of about 60-70 per cent would be needed to prevent CO_2 concentrations from rising further.

8. In addition to the higher concentration of CO_2 in the atmosphere (about 30 per cent), the concentration of methane has more than doubled, while that of nitrous oxide (N_2O) has increased by about 15 per cent. Methane and N_2O also act as greenhouse gases. The burning of fossil fuels has, in addition, caused the atmospheric concentrations of sulphate aerosols to increase in some regions, primarily in the northern hemisphere. However, while greenhouse gases tend to warm the atmosphere near the Earth's surface, aerosols can result in cooling.

C. Global stratospheric ozone concentrations

9. The combined abundance of ozone-depleting chlorine compounds in the stratosphere has apparently peaked and is now slowly declining. Chlorine is no longer increasing because the total consumption of chlorofluorocarbons (CFCs) worldwide had decreased dramatically from about 1.1 million tons in 1986 to 156,000 tons by 1998. The parties to the Vienna Convention for the Protection of the Ozone Layer[2] have phased out 85 per cent of the production of those chemicals that destroy the ozone layer. The remaining 15 per cent is mainly produced and consumed in developing countries which have until 2010 to phase out most of the major ozone depleting substances. By July 2000, 176 countries had ratified the Vienna Convention and 175 countries the Montreal Protocol on Substances that Deplete the Ozone Layer.[3]

10. Although total chlorine is declining, total bromine is increasing according to the Scientific Assessment Panel of the Montreal Protocol. Bromine is much more effective than chlorine at destroying ozone.

11. One measure of the success of the Montreal Protocol and its subsequent Amendments and Adjustments is that without the Montreal Protocol, by the year 2050, the amount of ozone depleting chemicals in the atmosphere would have been five times greater. Ozone depletion would have risen to 50 per cent in the northern hemisphere mid latitudes and 70 per cent in southern hemisphere mid latitudes, about 10 times worse than current levels. The result would have been a doubling of ultraviolet radiation of relative short wavelengths (UVB) reaching the Earth in northern hemisphere mid latitudes and a quadrupling in the southern hemisphere. The implications for human health would have been very serious: 19 million additional cases of non-melanoma skin cancer, 1.5 million more cases of melanoma and 129 million more cases of eye cataracts.

12. The severe destruction of stratospheric ozone over the Antarctic continent (the "ozone hole") was first detected in the mid-1980s using ground-based measurements from stations operating under the WMO Global Atmosphere Watch network. The stratosphere contains 90 per cent of total atmospheric ozone. The seasonal occurrence of the Antarctic ozone hole (during southern hemisphere springtime) has continued up to the present time. Its formation requires stratospheric temperatures below -78º C, which allow the formation of polar stratospheric clouds, levels of chlorine above about 2 parts per billion by volume and sunlight to activate the ozone destroying chemistry of chlorine. The chlorine loading (currently at 4 parts per billion by volume) is a direct result of the use of CFCs as refrigerants, insulators, cleaning agents and propellants in spray cans.

13. At its maximum each year, the ozone hole can cover an area greater than 20 million square kilometres with almost total destruction of the stratospheric ozone at times in some locations within the hole. The Vienna Convention came into force in 1985, and together with its Montreal Protocol (1987) and the subsequent Amendments thereto, has effectively curtailed the release of CFCs into the atmosphere. Because CFCs have such long lifetimes however, the chlorine associated with them is not expected to decline below the critical 2 parts per billion by volume in the stratosphere until mid-century. It is expected, therefore, that the low springtime Antarctic ozone levels will occur for some time.

14. Fortunately for most of humanity, this extreme loss of atmospheric ozone, with its attendant increase in harmful ultraviolet radiation reaching the Earth's surface, occurs over largely uninhabited areas. Its

effect on marine ecosystems is unknown at this point, but studies are under way in various countries to determine any impacts.

15. Ozone depleting substances, which include CFCs, are being replaced by hydrofluorocarbons (HFCs) and, to a lesser extent, by perfluorocarbons (PFCs); and consequently, concentrations of the latter substances in the atmosphere are increasing. HFCs and PFCs have significant global warming potential and the Kyoto Protocol[4] to the United Nations Framework Convention on Climate Change[5] has included HFCs and PFCs in a basket of six gases whose emissions are to be reduced by industrialized countries. The global warming potentials of substitutes for ozone depleting substances have been evaluated by the Scientific Assessment Panel of the Montreal Protocol and IPCC. Options for reducing global warming contributions by substitutes for ozone depleting substances have been evaluated by the Technology and Economic Assessment Panel of the Montreal Protocol and IPCC. Both Assessment Panels of the Montreal Protocol are working closely with IPCC to address the problem of HFCs and PFCs in the context of the two Protocols.

II. Regional air pollution

16. Large-scale regional air pollution is found principally in eastern North America and Europe and increasingly in East Asia. Although naturally occurring episodes of regional "pollution" can be caused by lightning-initiated forest and grassland fires, the chronic regional pollution that is so much a matter of concern is often the consequence of human activities.

17. In the three regions mentioned, a combination of intense industrialization, large population numbers and density, and the ubiquitous automobile results in high pollution levels over large areas. Sulphur, nitrogen oxides, heavy metals and organic compounds are among the principal pollutants. Sulphur and nitrogen, carried aloft by air currents, can lead to the formation of acid rain which may fall to Earth hundreds and thousands of kilometres from their source regions. Acid rain is thought to have contributed to the disappearance of fish from thousands of lakes in both Europe and North America and to extensive damage to forests.

18. Substantial progress in reducing regional air pollution has been achieved in North America and Europe where a number of international agreements are now in place limiting emissions of sulphur, nitrogen oxides, volatile organic compounds, heavy metals and persistent organic pollutants. These have resulted in significant reductions with, for example, in Europe, sulphur emissions having fallen from more than 40 million tons to 22 million tons per year between 1990 and 1998.

19. More recently, regional pollution has become an important issue in many developing countries. In a number of regions, agreements have been adopted to address the problem. They include East and South-East Asia, southern South America and Southern Africa. Nevertheless, because of rapid industrialization and urbanization, the situation is most acute in East Asia and particularly so in South-East Asia, which is also affected by extensive, episodic biomass burning events.

20. Each ecosystem reacts differently to the same input of acid rain and other pollutants. Sensitivity maps showing the most susceptible ecosystems indicate that, in 1990, there were few areas at risk in East and South-East Asia. However, deposition scenarios for 2025 indicate that large areas will be at risk by that date.

III. Urban air pollution

21. The urban environment is where an increasing share of the world's population lives. According to the United Nations,[6] 4.9 billion inhabitants out of 8.1 billion are predicted to live in cities by 2030. This compares with 2.9 billion out of 6.1 billion at the present time. With increased urbanization comes increased urban air pollution associated with the transportation, energy and industrial sectors. In some of the world's major cities, for example, Los Angeles, Mexico City and Beijing, local topography and climate exacerbate levels of urban pollution. Urban pollution characteristics vary enormously spatially, temporally and between individual cities.

22. Common pollutants in urban areas are non-methane hydrocarbons (NMHCs), nitrogen oxides, sulphur dioxide and various types of particulate matter. Urban smog, common in many cities, is a result of the action of sunlight on NMHCs and oxides of nitrogen, and the same process also produces harmful levels of ozone. Pollution is harmful to human health and the built environment. For instance, many world heritage sites located in cities are subject to pollution damage,

and increased incidence of diseases and deaths may result from exposure to increased levels of air pollution (for example, small particulates less than 2.5 microns in diameter). The fact that outdoor air pollution levels also interact with indoor air pollution levels is a particular problem where biomass and coal are used for domestic cooking and heating.

23. Many developed-country cities and some developing-country cities now have monitoring systems that provide air quality information. In some cities, the authorities can enact control measures such as restricting traffic or ordering certain industries to reduce operations to lower pollution levels. To assist city authorities, the World Health Organization (WHO) has produced air quality guidelines based on health studies and WMO is working with national meteorological services to improve urban air pollution forecasting.

IV. Issues for further consideration

24. In view of the recent findings of IPCC in its Third Assessment Report that there is evidence of substantial vulnerabilities to the projected climatic changes, particularly for the poor populations and populations in coastal areas, there is a need to draw greater attention to the adaptive capacity and vulnerabilities of populations, natural systems and regions, and to the links between climate change and sustainable development and equity.

25. Overarching issues such as capacity-building, education and training, and raising public awareness, need to be taken into careful consideration, as well as the increased need for assessments of climate and environmental change and quantitative methods for comparative assessment and decision support analyses.

Notes

[1] The Earth's "surface temperature" is generally taken as that of the air at about 2 metres above the surface. The temperature of the land surface itself can vary significantly with respect to the adjacent air temperature at any given time. The temperatures used to derive the mean surface air temperature over land are typically the local daily maximum temperature and minimum temperature. Over the Earth's oceans, temperatures of the sea surface, as measured from ships and buoys, have been typically used. The temperature of the sea surface can also vary with respect to the adjacent air temperature but generally by not as much as over land. The impact of using the surface temperature of the sea instead of the maritime air temperature to determine the trend in the mean global surface air temperature record is currently under investigation but is expected to be small.

[2] United Nations, *Treaty Series*, vol. 1513, No. 26164.

[3] Ibid., vol. 1522, No. 26369.

[4] Framework Convention on Climate Change/CP/1997/7/Add.1, decision 1/CP.3, annex.

[5] A/AC.237/18 (Part II)/Add.1 and Corr.1, annex I.

[6] "World Urbanization Prospects: The 1999 Revision: key findings", prepared by the Population Division, Department of Economic and Social Affairs of the United Nations Secretariat.