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Protecting the Ozone Layer: Vienna Convention and Montreal Protocol

INTRODUCTION

Life on Earth depends on the existence of a thin shield of a poisonous gas high in the atmosphere: the ozone layer. Ozone is an extremely rare component of the Earth's atmosphere—in every ten million molecules of air, about three are ozone. About 90% is found in the upper atmosphere (the stratosphere) between ten and 50 kilometres, or 6-30 miles above the Earth's surface. The ozone layer absorbs all but a small fraction of the harmful ultraviolet radiation (UV-B) emanating from the sun. It therefore shields plant and animal life from UV-B, which in high doses can be damaging to natural life. The absorption of UV-B by the ozone layer also creates a source of heat, which plays a key role in determining the temperature of the stratosphere.

Ozone is also found near the earth's surface in an area known as the troposphere, where it is referred to as tropospheric ozone. In this region ozone is a pollutant and is one of the constituents of smog and acid rain.

The 1985 Vienna Convention for the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer address stratospheric ozone. This ozone is hereafter referred to as "the ozone layer."

CAUSES AND EFFECTS OF OZONE DEPLETION

Any damage to the ozone layer allows more UV-B radiation to reach the surface of the Earth. Throughout the 1970s and 1980s, scientists began to suspect and then detect an increased thinning of the ozone layer. This was accompanied by increases in UV-B reaching the surface: in 1994 UV-B levels were about 8%-10% higher than 15 years earlier at 45° North and South. This is the latitude of Ottawa (Canada) and Venice (Italy) in the Northern hemisphere; and Dunedin (New Zealand) and Ushuaia (Argentina) in the Southern hemisphere. Higher levels were detected near the poles, particularly in the Southern hemisphere.

Any rise in the amount of UV-B reaching the Earth's surface has potentially harmful effects on human health, animals, plants, micro-organisms, materials and air quality. In humans, long-term exposure to UV-B is associated with the risk of eye damage: a 1% increase in stratospheric ozone depletion is estimated to result in a 0.6%-0.8% rise in the incidence of cataracts, which results in 100,000-150,000 additional cases worldwide. UV-B radiation can cause suppression of immune systems, which is a potentially serious problem in areas where infectious diseases are common. In light-skinned populations, high exposure to UV-B is the key risk factor in the development of skin cancer; experiments suggest that cases increase by 2% for every 1% reduction in stratospheric ozone.

Animals also suffer from increased exposure to UV-B. Marine life is particularly vulnerable to UV-B—this is a matter of concern since more than 3% of the world's animal protein for human consumption comes from the sea. UV-B damages the early developmental stages of fish, shrimp, crab and other water life and reduces the productivity of phytoplankton, the foundation of the aquatic food chain. Plant growth may be reduced by UV-B radiation, which harms crop yields and quality and damages forests. In turn, reductions in the productivity of marine and terrestrial ecosystems can reduce the uptake of carbon dioxide (CO_2) and contribute to global warming.

Synthetic materials such as plastics and rubber, and naturally occurring materials such as wood, are affected by UV-B—the damage caused by excessive exposure ranges from discoloration to loss of mechanical strength. Increases in UV-B exposure may also limit the lifetime of these materials and require more expensive production processes.

Finally, reductions in stratospheric ozone and accompanying increases in UV-B radiation have important effects on the troposphere. The troposphere's chemical reactivity changes and increases both production and destruction of ozone, which at this level is a pollutant and irritates eyes

and lungs. In many areas tropospheric ozone is increasing in concentration as a by-product of the action of sunlight on emissions from vehicle exhausts, industrial solvents, paints and biomass burning. Changes in the concentrations of other oxidants may also affect the atmospheric lifetimes of other important climatic gases, which indicates the possibility of complex and potentially harmful relationships between stratospheric ozone reduction, tropospheric chemistry and climate change. Oxidants are compounds in the atmosphere that have the capability to oxidize other usually stable compounds.

The chemicals that endanger the ozone layer were long considered "miraculous" substances, useful to consumers and industry and harmless to human beings and the environment. From their invention in the late 1920s, the use of these chemicals became widespread, especially after World War II. In the early 1970s concern began to be expressed that the ozone layer might be vulnerable to damage by the release of chemicals known as halocarbons. These are compounds containing chlorine, fluorine, bromine, carbon and hydrogen. Chlorofluorocarbons (CFCs) are stable and non-toxic, cheap to produce, easy to store and highly versatile. They also proved themselves to be an immensely valuable range of industrial chemicals used for refrigeration, air conditioning and blowing foams, and as solvents, sterilants and aerosol propellants. World production of CFCs, concentrated largely in the United States and Western Europe, doubled about every five years since the 1930s (when they started to be used commercially) until 1970.

As scientific knowledge developed, other families of chemicals—halons, carbon tetrachloride, methyl chloroform and methyl bromide—came to be identified as ozone-depleters. Less damaging substitutes, which were developed later, are also gradually being phased out.

The chemicals controlled by the Montreal protocol are:

- Chlorofluorocarbons, which are the most important ozone-depleting chemicals because of the volume used.
- Halons or bromofluorocarbons (BFCs), which are similar to CFCs in structure but contain bromine rather than chlorine and are more dangerous to the ozone layer than CFCs. They are mainly used as fire extinguishing agents.
- Hydrocholofuorocarbons (HCFCs), which are alternatives to CFCs, are used in refrigerators and aerosol sprays. They are related to CFCs but are less ozone-destructive because of an extra hydrogen atom. It makes HCFCs more likely to break down in the lower atmosphere (troposphere). Nonetheless, their overall impact on the ozone layer remains high.
- Methyl bromide, which is used mainly as an agricultural pesticide and fumigant.
- Methyl chloroform and carbon tetrachloride, which are both chemicals containing chlorine. They are used as solvents, mainly for cleaning metals during engineering and manufacturing operations and as a component for producing other chemical compounds.

Observations of stratospheric ozone concentrations since the 1970s have confirmed the evidence of gradual ozone depletion, with seasonal variations. Since 1979, ozone concentrations have fallen by about 4% per decade at mid-latitudes, such as over Argentina, Australia, Europe, China and the United States. The losses are largest during October to November in the Southern hemisphere and during March to April in the Northern hemisphere. In mid-1995, stratospheric ozone concentrations over Europe were 10% to 12% lower than in the mid-1970s. Over North America they were 5% to 10% lower and at times as much as 20% lower in some places. UV-B intensities increased accordingly: 1992-1993 saw the first reported examples of persistent increases over densely-populated regions in the Northern hemisphere. Countries in the tropics, such as Angola, Zambia, Mexico and India, experienced little or no ozone loss.

The Antarctic ozone holes of 1992 and 1993 were the most severe on record, with ozone disappearing completely at altitudes of 14 km to 19 km in October of both years. It is believed that particles from the volcanic eruption at Mount Pinatubo in 1991 accelerated ozone destruction. The 1995 ozone hole lasted the longest, although it was neither the deepest nor the largest on record. It covered an area greater than ten million km^2 (roughly equivalent to the surface area of Europe) for 77 days, compared to 63 days in 1993 and just 25 days in 1985.

Ozone losses above the Arctic have been lower, with a total loss of about 10% to 20% compared to 1979. The recent unexpected recurrence of cold winter temperatures in the stratosphere may itself be due to cumulative ozone destruction, or possibly to climate change. In either case, ozone losses over the Northern hemisphere may be more severe than anticipated in the near future.

The first major statement of scientific concern about ozone depletion from CFCs came in 1974. It was prompted by James Lovelock's discovery of the presence of CFCs in the atmosphere all around the world. Sherwood Rowland and Mario Molina's research paved the way to the now thorough understanding of the processes by which CFCs diffuse up into the stratosphere, are broken apart and destroy ozone molecules.

Although the hypothesis was initially controversial, the extent and growth of CFC use worldwide was enough to trigger calls for urgent action. In March 1977, experts designated by governments, international and non-governmental organizations (NGOs) from 32 countries met in Washington DC to adopt the World Plan of Action on the Ozone Layer. The plan included research into the processes that control ozone concentrations in the stratosphere; the monitoring of ozone and solar radiation; the effect of ozone depletion on human health, ecosystems and the climate; and the development of ways to assess the costs and benefits of control measures. The UN Environment Programme (UNEP), the coordinating agency, was assisted by the Coordinating Committee on the Ozone Layer (CCOL), which was made up of experts from intergovernmental agencies, governments and industry. The CCOL met five times between 1977 and 1982, and its nine assessment reports provided the basis for subsequent international negotiations on protecting the ozone layer.

The main producers of CFCs, the United States and Europe, took steps throughout the late 1970s and early 1980s to reduce the production of CFCs. However, they failed to reduce significantly the emission of ozone-depleting substances (ODS). For this reason, the international community

and scientists continued to push for an international convention on ozone depletion.

In 1981 UNEP's Governing Council established an Ad Hoc Working Group of Legal and Technical Experts for the Elaboration of a Global Framework for the Protection of the Ozone Layer. The group's aim was to secure a general treaty to tackle ozone depletion. The first step of a framework agreement was expected to be relatively easy to achieve. However, differences between those wanting to control the use of CFCs (United States) and those who wanted to put caps on production (the European Union) led to four years of hard work and negotiations before a draft convention was agreed upon.

The Vienna Convention for the Protection of the Ozone Layer was finally ratified in March 1985 by 28 countries. It contained pledges to cooperate in research and monitoring, to share information on CFC production and emissions, and to pass control protocols when warranted. Although the convention contained no commitment to take any action to reduce CFC production and consumption, it was nevertheless an important milestone. Nations agreed in principle to tackle a global environmental problem before its effects were felt or its existence scientifically proven. This was probably the first example of acceptance of the "precautionary principle" in a major international negotiation. The precautionary principle dictates that where an action's exact environmental impact is not yet known or cannot be precisely determined, but is thought to be likely to cause damage, the action should be avoided.

The objective of the convention is to protect human health and the environment against adverse effects resulting, or likely to result, from human activities that modify, or are likely to modify, the ozone layer. The main focus of the convention is cooperation between nations for scientific research and observation, and improvement of world understanding about atmospheric processes.

The Vienna conference also adopted a resolution empowering UNEP to convene negotiations for future protocols to the convention and specified procedures for amendment, which has enabled the convention to evolve as science on ozone depletion has developed. Progress in this second set of negotiations was given a boost by publication of the findings of members of the British Antarctic Survey, led by Dr. Joe Farman, just two months after the Vienna conference. This was the famous "ozone hole" paper, which revealed for the first time the existence of dramatic declines in ozone concentrations over the Antarctic in September through December. In fact, United States satellite observations had already detected this in the late 1970s, but the unexpected findings were discarded since "instrument error" was suspected. Although the cause was still unknown at the time, it was thought that CFCs were responsible for the British Antarctic Survey findings.

By comparison with the protracted negotiations for the Vienna convention, negotiations on the control protocol proceeded quickly and achieved far more than was initially thought possible. On 16 September 1987, 46 countries signed the Montreal Protocol on Substances that Deplete the Ozone Layer.

The Montreal protocol originally required 50% cuts from 1986 levels in both production and consumption of the five main CFCs by 1999, with interim reductions. Production and consumption of the three main halons were frozen at 1986 levels from 1993 on.

Although these reductions could be criticized for being too little (if the ozone depletion hypothesis was believed) or too much (if the hypothesis was not believed), the agreement marked an important political and psychological breakthrough. Once again science validated the negotiators' actions. In March 1988 the report of the Ozone Trends Panel reviewed evidence, especially from the United States Antarctic expeditions in 1986 and 1987, and provided for the first time convincing evidence of the linkage between ozone depletion and CFCs. Opposition to the principle of controls on ozone-depleting substances then collapsed, and industry started to concentrate resources on the development of non-ozone depleting alternatives to CFCs.

The main objective of the Montreal protocol is to protect the ozone layer by taking measures to control total global emissions of substances that deplete it in a way that divides the responsibility equitably among nations. The protocol aims to eliminate the use of ozone-depleting substances altogether by taking into account technical and economic considerations and the particular needs of developing countries.

An important feature of the Montreal protocol is its built-in flexibility, which allows the protocol to develop in light of evolving scientific knowledge and technological changes. Even before it entered into force on 1 January 1989, plans were being made to strengthen its provisions, advance phase-out schedules for the CFCs and halons it specified, and add further ozone-depleting chemicals to the list of substances to control.

Protocols can be adjusted or amended. Adjustments concern substances that are already included in the protocol and are used to reset phase-out schedules. Amendments are used to add new substances to the list of chemicals to be controlled and to alter provisions that do not deal with control measures on substances already included.

The protocol has been subjected to three sets of adjustments to the control measures (agreed at the 1990, 1992 and 1995 Meetings of the Parties) to accelerate the phase-out schedules for ozone-depleting substances. It has also been subject to two amendments. The London Amendment (1990) added methyl chloroform, carbon tetrachloride and a further range of CFCs to the phase-out schedules and established a mechanism for financial and

"The Protocol which resulted from the Vienna Convention became a historic event for three reasons: it was the first global treaty fixing quantified emission reductions in a time frame, it was the first treaty that followed the "precautionary approach," and it was the first environmental treaty under which a formal non-compliance procedure was instituted."

technical assistance to developing country parties. The Copenhagen Amendment (1992) added hydrochlorofluorocarbons, hydrobromofluorocarbons (HBFCs) and methyl bromide to the phase-out schedules and formally created a multilateral fund as the channel for financial transfers to developing countries.

Structure and Governance

The convention and the protocol are international instruments subject to the United Nations Charter and the principles of international law, including the right of states to exploit their own resources and pursue their own environmental policies. The convention and protocol are distinct intergovernmental bodies: the convention is governed by a Conference of the Parties, which meets every three years, and the protocol is governed by a Meeting of the Parties, which meets annually. Every country that ratifies an agreement becomes a party to that agreement; only countries can become parties. Both bodies have designated UNEP to serve as their secretariat, and each operates on a one-country one-vote basis, although they strive to reach decisions by consensus.

The Conference of the Parties and the Meeting of the Parties are responsible for establishing the rules of procedure governing their respective agreements and for generating their own funding. Each forum is open to all interested governments, whether or not they are parties to the agreements, as well to observers from international agencies, the private sector and NGOs. No country can become party to a protocol unless it is, or becomes at the same time, a party to the convention. Only parties to a protocol may participate in decision making concerning that protocol.

Each party reports on its production and consumption of ozone-depleting substances, so that compliance with control measures can be monitored at the Meeting of the Parties. The Meeting of the Parties also hears reports from various technical panels, and on the basis of their recommendations keeps the phase-out schedules under continuous review.

Control Measures on Ozone-Depleting Substances

At the heart of the Montreal protocol lies the control measures it imposes on the production and consumption of ozone-depleting substances. The protocol's main obligation is contained in Article 2 on control measures relating to substances that deplete the ozone layer. These have been tightened over time by agreements reached in London (1990), Copenhagen (1992) and Vienna (1995). In accordance with these schedules, the bulk of ODS—including all the substances specified in the original protocol—were phased out completely in industrialized countries by the end of the 1995. The remaining categories are scheduled for total phase-out by the years 2010 (methyl bromide) and 2030 (HCFCs). However, developing countries have longer phase-out periods: CFCs, halons and carbon tetrachloride are scheduled for total phase-out by 2010, methyl chloroform by 2015, and HCFCs by 2030. The parties have decided on a freeze of methyl bromide in 2002 but have not yet decided on the date of total phase out.

"At a time when global environmental trends appear so daunting, and progress toward reversing them seems so slow, it is reassuring to remember that in responding to the threat of ozone depletion, the international community has largely proved itself up to the task. Though the job is by no means complete, without the Montreal Protocol the world would be facing a catastrophic situation indeed.

Future historians may well view the signing of the Montreal Protocol in 1987 as a defining moment—a point at which it became clear that the very definition of international security was undergoing fundamental change."

Production is defined on a country-by-country basis as total production, minus amounts destroyed and amounts used as chemical feedstock (a chemical used as a raw material to produce other chemicals). Consumption is defined as production plus imports, minus exports. Trade in recycled and used ODS is not included in the calculation of consumption, in order to encourage recovery, reclamation and recycling. "Essential uses" for which no alternatives have been identified are exempt from the controls; the main exemption is currently for CFCs used in metered dose inhalers for asthma suffers.

The protocol includes restrictions on trade with non-parties to the treaty under Article 4. These were designed to both encourage countries to join and prevent production of ODS transferring to non-parties to escape the controls. The parties were required to ban the import of CFCs and halons from non-parties from 1990 on; exports to non-parties were banned from 1993. Imports of goods containing CFCs, such as refrigerators, were also banned from 1993. As new substances have been added to the control schedules, the trade provisions have been gradually extended, although they do not yet cover HCFCs or methyl bromide. The trade restrictions are not applicable against a non-party that is nevertheless in compliance with the control schedules.

Institutions and Procedures

The Meeting of the Parties reviews the control measures at least every four years on the basis of available scientific, environmental, technical and economic information. The Open-Ended Working Group of the Parties meets between full sessions to develop and negotiate recommendations for the full meeting.

The first Meeting of the Parties established advisory panels bringing together experts from science, industry, governments and non-governmental organizations. These currently comprise:

- The Scientific Assessment Panel, which is responsible for reviewing scientific knowledge on ozone depletion;
- The Environmental Effects Assessment Panel, which surveys information on the impact of ozone depletion and UV-B irradiation; and
- The Technology and Economic Assessment Panel (TEAP), which analyzes technical options for the economic costs of controlling the use of ODS, including reviewing applications for essential use exemptions. The TEAP functions largely through subsidiary Technical Options Committees (TOCs), which currently cover economic options, aerosols, foams, halons, methyl bromide, refrigeration and solvents.

The panel reports produced for the Meetings of the Parties have proved crucial in informing the decisions taken there, including adjustments made to the protocol.

The first Meeting of the Parties established separate bureaus for the Vienna convention and the Montreal protocol. The bureaus are composed of the officers elected by the parties for the respective meetings: presidents of the meetings, three vice-presidents and the rapporteurs. The terms of reference of the bureau of the Vienna convention are to review the scientific information on the ozone layer, consider programmes of research, and prepare the agenda for the Conference of the Parties meeting. The bureau of the Montreal protocol should meet at least once between Meetings of the Parties to review the work of any working group, consider other topics on the agenda of the next Meeting of the Parties, and review documents prepared by the Ozone secretariat for the meetings.

Disputes are settled in a three-part process. The complainant and offender must first meet to discuss the matter. If these discussions fail, a third party is invited to mediate. If this is not successful, parties are requested to accept one or both of the following judicial means of dispute settlement: arbitration in accordance with procedures adopted by the Conference of the Parties or submission of the dispute to the International Court of Justice in the Hague (Netherlands). If parties do not accept either of these procedures, the dispute is submitted to an ad hoc conciliation commission, which is created by parties involved and whose recommendations must be accepted in good faith.

The Meeting of the Parties to the Montreal protocol established another subsidiary body, known as the Implementation Committee, which oversees the Non-Compliance Procedure adopted by the parties at their fourth meeting. The Implementation Committee is charged with considering and then reporting to the Meeting of the Parties on cases brought to the attention of the Ozone secretariat by one or more of the parties regarding non-compliance by other parties, or regarding their own non-compliance. The secretariat can also bring to the notice of the Implementation Committee any instances of non-compliance it may find while preparing its reports. Only the Meeting of the Parties can decide when to push for full compliance with the protocol, and it must determine the measures to take to that end. NGOs, which are not party to the Montreal protocol and cannot bring complaints directly, need to work through one of the parties.

The Implementation Committee also recommends courses of action, which might include: providing technical or financial assistance, issuing cautions or suspending the party from the protocol. The committee, which consists of representatives of ten parties with two from each of the five United Nations regions, should meet twice a year. While the provisions of Article 11 of the Vienna convention on settlement of disputes also apply to the Montreal protocol, the Implementation Committee is an additional mechanism to deal specifically with cases of non-compliance with the protocol.

The Ozone secretariat, which is part of UNEP and based in Nairobi (Kenya), provides administrative support for both the Montreal protocol and the Vienna convention. It also periodically publishes the *Handbook for the Ozone Treaties*, which reports on the status of the convention and the protocol.

Developing Countries and the Multilateral Fund

A key feature of the Montreal protocol is its treatment of developing countries. Article 5 permits a developing country with consumption lower than a specified limit (called an "Article 5 country") to delay for ten years its compliance with the control measures set out in Article 2 "in order to meet its basic domestic needs." In 1995 the parties agreed on precise control schedules for the various categories of ODS; most substances were scheduled for phase out by the year 2010. In addition, industrialized countries are obliged to transfer new and "environmentally-benign" technologies to developing countries. The Meetings of the Parties frequently refer to Article 5 and Non-Article 5 countries in order to make the distinction between recipients and donors of funds and technology, as set out in the article.

Article 10 of the protocol provides for a financial mechanism to meet the incremental costs of these countries in phasing out ozone-depleting substances. Accordingly, the parties established a Multilateral Fund as an interim mechanism in 1990, and its final form in 1992. The fund is financed by contributions from non-Article 5 parties on the basis of the United Nations scale of assessment. Decisions are taken by consensus or by vote when necessary, and a minimum two-thirds majority is needed to approve a decision. Funding was set at US$240 million for 1991-1993, and US$510 million for 1994-1996. About 80% of these funds have been collected, with the arrears originating largely from countries with economies in transition (the states of Central and Eastern Europe and the former Soviet Union), which are experiencing severe economic difficulties. In 1996 the Multilateral Fund was replenished at a level of US$540 million for 1997-1999.

The Multilateral Fund has its own secretariat in Montreal and is directed by an Executive Committee. The committee is comprised of representatives of seven Article 5 and seven non-Article 5 countries, which are selected by the annual Meeting of Parties to the protocol. The Multilateral Fund operates through four implementing agencies, each with slightly different roles. They are:

- UNEP's Industry and Environment Programme Activity Centre, which provides clearing-house functions and helps prepare country programmes for low-consuming developing countries;
- The United Nations Development Programme (UNDP), which organizes demonstration and investment projects, technical assistance and feasibility studies;
- The United Nations Industrial Development Organization (UNIDO), which prepares and appraises investment project proposals and implements phase-out schedules at plant level; and
- The World Bank, which disburses almost half of the total funding and concentrates on large-scale phase out and investment projects at plant and country levels.

Each Article 5 country, assisted by one of these agencies, prepares a country programme showing its present and projected use of ODS and identifying opportunities for reduction. The "incremental costs" countries can claim include costs of conversion to alternative technologies and substances, patents, designs and royalties, training, and

"We cannot afford to rest [on] our laurels. The key is having the political will to prevent short-term economic and social interests from undermining the long-term need to protect the ozone layer."

research and development. Recycling controlled substances and modifying or replacing equipment are sometimes also eligible, and the Multilateral Fund's Executive Committee has discretionary powers to include costs other than those listed. The committee approves both the country programmes and subsequent proposals for investment projects and institutional strengthening. By 27 November 1996, a total of US$530 million had been allocated to eliminate a projected 75,000 ODP (ozone-depletion potential) tons of ozone-depleting substances, which is about one-third of the total consumption of developing countries.

The Record of the Ozone Regime

By May 1997, a total of 164 countries had ratified the 1985 Vienna convention and 162 had ratified the 1987 Montreal protocol. By the same time, 115 had ratified the 1990 London Amendment and 66 had ratified the 1992 Copenhagen Amendment. Production and consumption figures for the various controlled substances have changed dramatically since the convention and protocol were first developed. By the end of 1994 (the latest date for which full data is available), production and consumption of the original controlled CFCs and halons had fallen by 93% in industrialized countries, which indicated that a phase out by 1995 was on schedule. Although both production and consumption increased in developing countries, as expected and allowed by the protocol, overall world production declined by about 75% from 1986 (the base year). In general, industrialized countries have found that ending their use of CFCs was much easier than they anticipated. The data for 1995 are now being analyzed and will be submitted to the ninth Meeting of the Parties, to be held in September 1997 in Montreal.

The growth in concentrations of the major ozone-depleting chemical in the atmosphere has clearly slowed. Total organic chlorine (the best measure of the potential for ozone depletion) in the lower atmosphere increased by 60 parts per trillion (ppt) per year, or 1.6% in 1992, compared to 110 ppt/year in 1989. Scientists believe that peak total chlorine and bromine loading in the lower atmosphere may have occurred in 1994-1995; atmospheric concentrations of some CFCs are now falling.

Concentrations in the upper atmosphere, where the ozone layer is located, lag by about three to five years. For this reason, the anticipated peak rate of global ozone depletion will occur in 1998-2000. Compared to the late 1960s, maximum ozone losses are predicted to be 12%-13% at Northern mid-latitudes in their winter and spring, and 6%-7% in their summer and autumn, with about 11% losses in Southern mid-latitudes year-round. Further volcanic eruptions or particularly cold Arctic winters could lead to greater losses in certain years. If the Montreal protocol control regimes for ODS are fully implemented, global ozone levels should gradually recover after the year 2000, and the Antarctic ozone hole should close around the middle of the next century.

In order to commemorate the signing of the Montreal protocol, the United Nations General Assembly has declared 16 September as International Day for the Preservation of the

Alternatives to Ozone-Depleting Substances

This success story of international environmental diplomacy has proved possible because science and industry, stimulated by the clear objectives of the Montreal protocol, have been able to develop and commercialize alternatives to ozone-depleting chemicals. These alternatives take the form of replacement substances, as well as alternative or "not-in-kind" technologies.

Not-in-kind substitutes have proved particularly important in the electronics sector. The foam-blowing sector has made use of water, carbon dioxide and hydrocarbons, as well as HCFCs. The refrigeration and air-conditioning sector has largely used HCFCs as alternatives, but more and more new equipment is using non-ozone depleting hydrofluorocarbons (HFCs), ammonia (the chemical used in the very first refrigerators) or hydrocarbons; an example of this is the "greenfreeze" domestic refrigerator promoted by Greenpeace. Stockpiling or "banking," in which CFCs have been produced before phase out for use afterwards, has helped to extend the development and testing period.

Companies and organizations that manufacture firefighting equipment have also used banking to provide extra time to develop substitutes for halons in extinguishing agents. Other agents, such as carbon dioxide, water, foam and dry powder are now widely used. Alternative approaches, such as good fire prevention practices, use of fire-resistant materials and appropriate designs for buildings have reduced significantly the need for halon systems, and total phase out was achieved by the end of 1993.

Phase-out efforts in industrialized countries are concentrating on HCFCs and methyl bromide. Parties to the Montreal protocol must ensure that HCFCs are used only as direct replacements for other ODS where more environmentally-suitable alternatives are not available. HCFCs were critical in meeting the early CFC phase-out goals, but are considered less important for new equipment available in the medium- and long-term.

The phase out of methyl bromide is a more difficult issue. This is partly because it concerns a different set of producers and consumers to those involved in fluorocarbons and because alternatives are less available. Their major use is in agriculture, mainly for fumigation to control pests and weeds (such treatment is often required by importers). UNEP's Methyl Bromide Technical Options Committee has identified technically-feasible alternatives for 90% of methyl bromide use—though opinions diverge on the possible speed and costs of phase out. In any case, many countries have already subjected the chemical to controls because of concerns about toxicity. In 1995 the parties agreed on a control schedule, with ultimate phase out by 2010. Use for quarantine and pre-shipment purposes is exempted from the controls, and the possibility remains of a further "critical agricultural use" exemption after total phase out.

New Challenges

The 1995 Vienna meeting marked the end of the initial phase of the ozone regime, which concentrated on identifying ozone-depleting substances, agreeing on control measures, and phasing out substances in industrialized countries. Attention is now turning to issues of implementation in developing countries and countries with economies in transition.

The ozone regime now faces its first cases of non-compliance by some Eastern European and former Soviet states. For example, the Russian Federation says it needs until the year 2000 to phase out CFCs due to its economic difficulties. Resources are available for phase out of ODS in these transition economies from the Global Environment Facility (GEF), which was created in 1991 to provide finance for environmentally-sustainable development. So far, the GEF has approved US$110 million worth of ozone-related projects.

The second new problem is the growth of illegal trade, which usually follows any decision to ban the use of a substance. In areas where CFC replacements (or the costs of new technology) have proved more expensive than the original, a black market has developed. The problem is most acute in the United States, where a CFC excise tax introduced to encourage phase out has created incentives for the illegal import of CFCs. However, United States authorities have responded vigorously to the problem and have indicted several individuals on counts of smuggling CFCs and evading federal excise taxes. The European Union has also put in place regulations to control the illegal trade.

Relation with Other Environmental Conventions

The parties to the Montreal protocol and the parties to the 1992 Basel Convention On the Control of Transboundary Movements of Hazardous Wastes and Their Disposal have agreed on a shared interpretation of the convention regarding transboundary movement of used ozone-depleting substances. The Basel convention classifies these as hazardous wastes.

Ozone-depleting substances controlled by the Montreal protocol are greenhouse gases, even though their global warming effect is cancelled out by the opposite effect of stratospheric ozone depletion. Thus, phasing out these substances serves the goals of both conventions. However, some of the ozone-safe substitutes developed to replace the CFCs have turned out to be greenhouse gases. The secretariats of the Montreal protocol and the climate change convention are working together to ensure coordinated responses to these problems.

Non-governmental organizations have played an essential part in the international negotiations on ozone layer protection. They monitor the implementation process of the Vienna convention and the Montreal protocol, develop information campaigns to raise public awareness on ozone issues, and pressure governments, particularly CFC and HCFC producers, to cut production of ozone-depleting substances more quickly. The International NGO Alliance for Ozone Layer Protection provides an informal network for NGOs working on these issues. Friends of the Earth (FoE) in North America and the Pesticide Action Network in the United States provide some secretariat services for the international alliance on a volunteer basis. They send out information updates and coordinate NGO ozone-related work. The demands of the alliance include:

- an accelerated phase-out pace of ODS for industrialized countries and a phase-out commitment for developing countries, to be funded by the multilateral fund;
- a significant increase in the amount of funds contributed to the Multilateral Fund to enable rapid phase outs of ozone-depleting substances in Article 5 countries and more cost-effective use of these funds;
- strong action by parties to address the growing problem of illegal trade in CFCs, stronger government action to crack down on illegal smuggling and implement and enforce measures of prevention, efforts to end the use of ozone-depleting substances, and recovering existing stocks of CFCs and other ozone-depleters for safe destruction;
- phase out HCFCs under a tighter timeline than set out in the agreements and develop environmentally sustainable alternatives;
- a broader context for the debate on ozone depletion to include its economic, environmental, health-related and social costs;
- assurance that controlled substances are not replaced by substances that pose other environmental threats; and
- transition strategies to end the essential use exemption for CFC-metered dose inhalers as alternatives become available.

Both FoE-USA and Greenpeace UK have published a series of background materials on the subject. FoE, Greenpeace and the World Wildlife Fund (WWF) have been asked on several occasions to help the industrial community and governments, including the United Kingdom and Brazil, to develop phase-out initiatives on CFCs. NGOs also organize regular conferences on ozone-safe technologies and other scientific and industrial ozone-related issues, meetings with industry to promote ozone-safe technologies, and training workshops for the control of ozone-depleting substances. NGOs from Article 5 countries, including groups from Benin, Chile, Colombia, Ghana, Kenya and Togo, have been actively involved at Montreal protocol meetings, have worked to phase out methyl bromide, and have pressed for adequate funding under the Multilateral Fund.

At the last Meeting of the Parties in Costa Rica in November 1996, NGOs said there was not enough transparency during the negotiations on the Multilateral Fund. They felt that a more formal mechanism should be put in place to inform and update NGOs on progress and developments at these meetings. They also called for more representation on Technical Options Committees and adequate funding from UNEP for participation for Article 5 countries.

Under the rules of procedure of the convention and the protocol, NGOs (both environmental and industrial) are granted observer status at every Meeting of the Parties and are allowed to make interventions at plenary sessions. However, only parties to the ozone treaties (representatives of governments of the states that have ratified those treaties) can propose amendments and adjustments to the ozone treaties or propose decisions for the Meeting of the Parties to adopt.

FURTHER READING

Handbook for the Montreal Protocol on Substances That Deplete the Ozone Layer*, fourth edition, Ozone Secretariat, UNEP, Nairobi, Kenya, 1996.*

Action on Ozone*, UNEP, Nairobi, Kenya, 1996.*

OzonAction*, a newsletter dedicated to ozone layer protection*

The Montreal protocol is widely regarded as one of the most effective existing international environmental treaties. It has proved to be a flexible but robust regime, which evolves over time in response to new developments in science and technology. Thus, the Meeting of the Parties in Vienna in December 1995 agreed on a third major set of revisions to the control schedules established in 1987. CFC production levels under the original agreement were to have been 80% of 1986 levels; they should now have been phased out completely in industrialized countries, except for small essential uses. Production of halons, which was to have been held at existing levels under the original agreement, ceased at the end of 1993 in these countries. Other chemicals not considered to be ozone-depleting substances a decade ago have been brought under the coverage of the agreements, and their own control schedules progressively tightened.

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Perhaps the most important feature of the ozone regime is the way in which it has brought together an array of different participants in pursuit of a common end. The flexibility built into the protocol in the form of its review process for targets and amendments has allowed continuous evolution to respond to those changes in both scientific evidence and technological developments.

Any effective international agreement needs to recognize the special needs of developing countries. In the Montreal protocol, this has taken the form of the provision of financial assistance and technology transfer, decision-making procedures that give special weight to Article 5 countries, and the ten-year grace period before implementation of the phase-out schedules.

Industry, responding to the stimulus provided by the control measures, has developed alternatives more rapidly and cheaply than first thought possible, and it has participated in debates over further phase out. Environmental NGOs and the media are the essential channels of communication, and increasing environmental education helps to maintain pressure for further measures. Participants in the negotiations on reducing ozone depletion agree that NGOs play an important role in the continuing evolution of this work and in raising public awareness.

Finally, the leadership and vision of the original negotiators in Vienna and Montreal resulted in a treaty that worked: it halted and turned back the progressive deterioration of the Earth's protective ozone layer. The same leadership and vision will still be needed as the international community turns its attention to meeting the new challenges faced by the international ozone regime in restoring the stratospheric ozone layer.

The 15th Open-Ended Working Group Meeting was held from 3-6 June in Nairobi. The main issues discussed at the meeting were:

- methyl bromide and in particular critical use exemptions, trade with non-parties, emergency uses and fixing a date for its phase out by the developing countries;
- production controls on HCFCs and advancing the phase-out date by developed countries; and
- establishing national licensing systems for import and export of ODS to curb illegal trade.

Based on deliberations that took place at the meeting, a consolidated text of proposed adjustments and amendments to the Montreal protocol and a consolidated text of draft decisions was prepared and forwarded to the Ninth Meeting of the Parties.

The Ninth Meeting of the Parties to the Montreal Protocol is scheduled for 15-17 September 1997 in Montreal.

This issue of E&D File *was compiled by Abigail Noko and David Kupecek for the United Nations Non-Governmental Liaison Service (NGLS). The* E&D File *is produced for NGOs and others interested in sustainable development issues and is not an official record. For more information or additional copies write to: NGLS, Palais des Nations, CH-1211 Geneva 10, Switzerland, fax +41-22/788 7366, e-mail <ngls@unctad.org> or NGLS, Room FF-346, United Nations, New York NY 10017, United States, fax +1-212/963 8712, e-mail <ngls@undp.org>.*

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