Saving the Ozone Layer: Every Action Counts

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UNEP

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Saving the Ozone Layer: Every Action Counts—the video

A video of *Saving the Ozone Layer: Every Action Counts* is available in three languages and in all the main video formats, making it usable immediately in many countries.

English, French and Spanish versions are available free to developing countries (a charge of US$50 is made to developed countries to cover costs) in the following VHS formats:

* NTSC (North and South America, the Caribbean, the Philippines and Japan);
* SECAM (Francophone countries); and
* PAL (most of the rest of the world).

To support more specialized uses of the video, two other facilities are available. Users may select footage for reuse in other video productions provided permission is first obtained from UNEP IE; and a version of the video is available upon request for users who wish to translate it into other languages.

Finally, a public broadcast version of *Saving the Ozone Layer: Every Action Counts* is available for television transmission, again upon request. Please note that this applies to developing countries only, due to copyright restrictions.

Extra copies of the video and further information are available from UNEP IE's OzonAction Programme. Please state clearly which version you wish to receive and how you plan to use it.

Contents

Introduction

This booklet accompanies *Saving the Ozone Layer: Every Action Counts*, an 18-minute video explaining why the stratospheric ozone layer is threatened, what the implications of ozone depletion are and what we can do to prevent it. The video puts special emphasis on the contribution developing nations can make to the worldwide phase out of ozone-depleting substances. Approved by an international panel of distinguished scientists and technical experts, the video is an up-to-date, uncomplicated introduction to the key scientific and policy issues involved in protecting the ozone layer.

Saving the Ozone Layer: Every Action Counts covers five main topics:

* The ozone layer—what is it, and how does it protect life on Earth?
* The effects of ozone depletion—what are they, and how serious are they?
* The threat to the ozone layer—why are man-made chemicals destroying ozone?
* The international response—what has the international community done to prevent ozone depletion?
* Developing nations and ozone depletion—what role can developing countries play and what are the benefits of phasing out ozone-depleting substances?

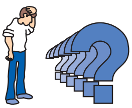
Saving the Ozone Layer: Every Action Counts is aimed at a general audience. Those involved in implementing the Montreal Protocol on Substances that Deplete the Ozone Layer will find it an invaluable awareness-raising and educational tool. A suggested use is to show the video during workshops or seminars for industry or other groups. It can also be shown in public meetings, and to groups of older school children. The video is also suitable for the general public through television broadcasts.

The booklet is designed to help you maximize the effectiveness of the video by providing material that you can use in a presentation before or after a viewing, or in moderating a group discussion.

It presents background information on the themes covered in the video in the form of commonly asked questions and responses, followed by suggested subjects for discussions.

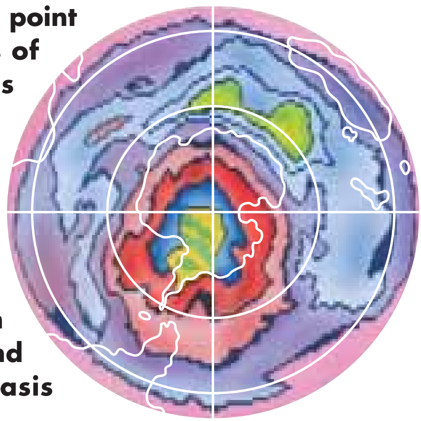
Information resources available from UNEP are listed, together with contacts from whom further documentation can be obtained.

The booklet and video have been produced by UNEP IE's OzonAction Programme in its capacity as an information clearinghouse under the Multilateral Fund of the Montreal Protocol on Substances that Deplete the Ozone Layer. They are part of an 'information kit' designed to assist developing countries to increase awareness on ozone layer depletion and protection. Other materials included in the kit are a handbook for National Ozone Units entitled *Five Steps for Raising Awareness on Ozone Depletion*, a series of posters and a set of overheads and slides.



Saving the Ozone Layer: questions, answers and discussion points

***Saving the Ozone Layer: Every Action Counts* can provide a starting point for more in-depth explanations of key issues, or for discussions. This booklet is designed to support such activities. The following sections present background information on each of the video's main themes, in the form of commonly asked questions and responses to them. For each theme, a series of statements and questions are suggested as a basis for discussions.**



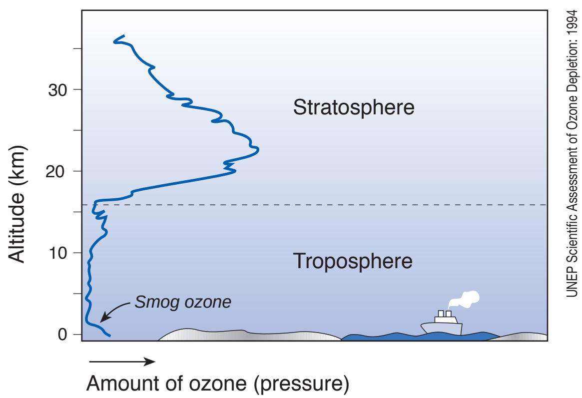
1 The ozone layer and its protective role

Entry and exit times in the video: 00:52–01:52

What is ozone?

Ozone is a tri-atomic form of oxygen—it has three oxygen atoms instead of the normal two. It is formed naturally in the upper levels of the Earth's atmosphere by high-energy ultraviolet radiation from the Sun. The radiation breaks down oxygen molecules, releasing free atoms, some of which bond with other oxygen molecules to form ozone. About 90 per cent of all ozone in the atmosphere is formed in this way, between 15 and 55 kilometres above the Earth's surface—the part of the atmosphere called the stratosphere. Hence, this is known as the 'ozone layer'.

The stratospheric 'ozone layer' contains nine-tenths of ozone



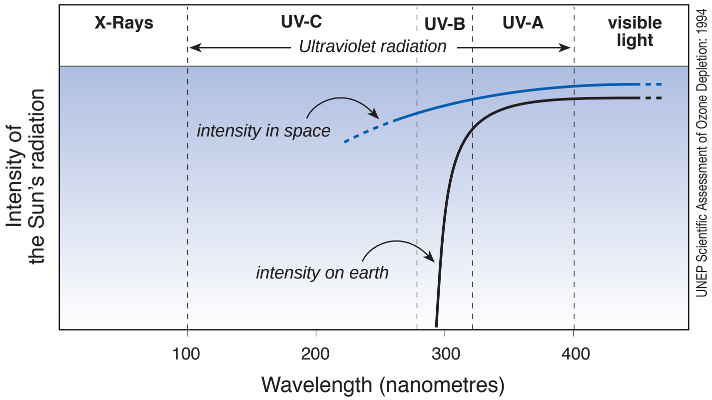
Even in the ozone layer, ozone is present in very small quantities; its maximum concentration, at a height of about 20–25 kilometres, is only ten parts per million.

Ozone is an unstable molecule. High-energy radiation from the Sun not only creates it, but also breaks it down again, recreating molecular oxygen and free oxygen atoms. The concentration of ozone in the atmosphere depends on a dynamic balance between how fast it is created and how fast it is destroyed.

Why is the ozone layer important for life on Earth?

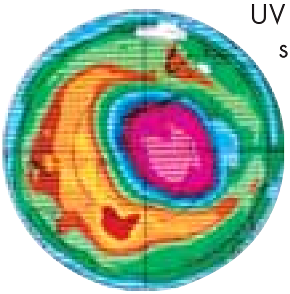
The ozone layer is important because it absorbs ultraviolet (UV) radiation from the Sun, preventing most of it from reaching the Earth's surface. Radiation in the UV spectrum has wavelengths just shorter than those of visible light. UV radiation with wavelengths between 280 and 315 nanometres (a nanometre is one millionth of a millimetre) is called UV-B, and is damaging to almost all forms of life. By absorbing most UV-B radiation before it can reach the Earth's surface, the ozone layer shields the planet from the radiation's harmful effects. Stratospheric ozone also affects the temperature distribution of the atmosphere, thus playing a role in regulating the Earth's climate.

The ozone layer is the Earth's sunscreen



What is the difference between the ozone layer and ground-level ozone?

Ozone is also present in the lower levels of the atmosphere (i.e. the troposphere), but at even lower concentrations than in the stratosphere. Close to the Earth's surface, most of the Sun's high-energy UV radiation has already been filtered out by the stratospheric ozone layer, so the main natural mechanism for ozone formation does not operate at this low level. However, elevated concentrations of ozone at ground level are found in some regions, mainly as the result of pollution. Burning fossil fuels and biomass releases compounds, such as nitrogen oxides and organic com-



pounds, which react with sunlight to form ozone. This ground-level ozone is a component of urban smog and can cause respiratory problems in humans and damage to plants.

There is little connection between ground-level ozone and the stratospheric ozone layer. Whereas stratospheric ozone shields the Earth from the Sun's harmful rays, ground-level ozone is a pollutant. Though the downward movement of ozone-rich air from the stratosphere contributes to ground-level ozone, very little is transported upwards, so ozone formed due to pollution at the Earth's surface cannot replenish the ozone layer. In addition, though ground-level ozone absorbs some ultraviolet radiation, the effect is very limited.

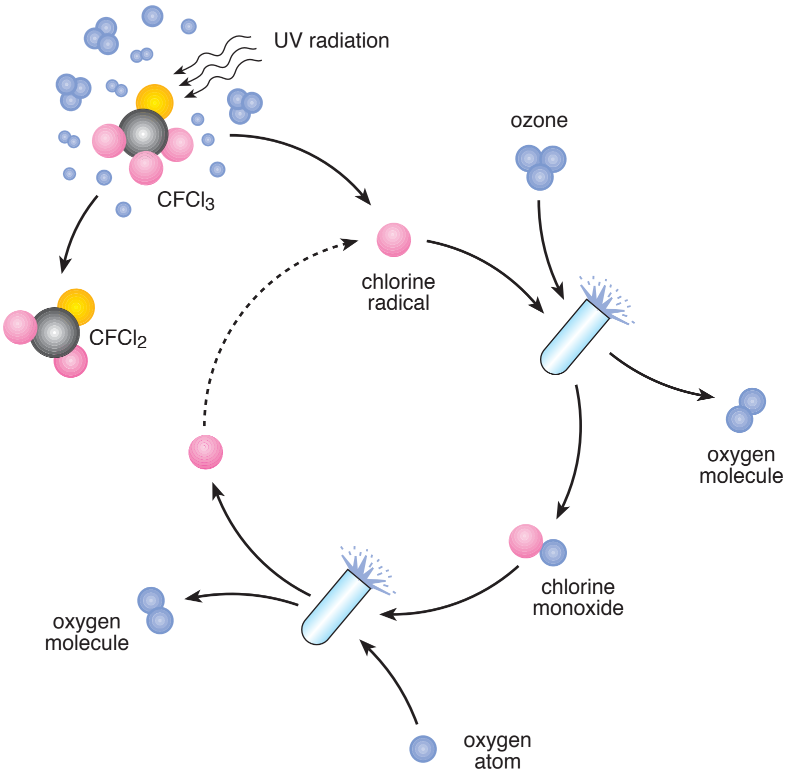
Discussion points

- **The different parts of the atmosphere and the location of the ozone layer**
- **The natural creation and destruction of ozone in the stratosphere**
- **Why ozone depletion will increase the levels of damaging ultraviolet radiation (UV-B) reaching the Earth's surface**
- **The difference between stratospheric and ground-level ozone**

2 The threat to the ozone layer from man-made chemicals

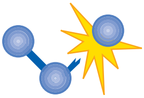
Entry and exit times in the video: 05:10–08:00

A little chlorine can destroy a lot of ozone



Why is the ozone layer threatened?

When released to the air, some very stable man-made chemicals containing chlorine and bromine gradually infiltrate all parts of the atmosphere, including the stratosphere. Though they are stable in the lower atmosphere, the chemicals are broken down in the stratosphere by the high levels of solar UV radiation, freeing extremely reactive



chlorine or bromine atoms. These take part in a complex series of reactions leading to ozone depletion. A simplified version of the main steps in the ozone depletion process follows:

* Free chlorine or bromine atoms react with ozone to form chlorine or bromine monoxide, stealing one oxygen atom and converting the ozone molecule into oxygen.

* Chlorine or bromine monoxide molecules react with free oxygen atoms, giving up their 'stolen' oxygen atom to form more molecular oxygen and free chlorine or bromine atoms.

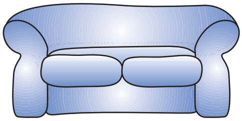
The newly-freed chlorine or bromine atoms start the process afresh by attacking another ozone molecule. In this way, every one of these atoms can destroy thousands of ozone molecules, which is why very low levels of chlorine and bromine (the concentration of chlorine in the stratosphere in 1985 was 2.5 parts per billion) can break down sufficient ozone to deplete significantly the vast ozone layer.

Which chemicals destroy ozone?

A number of man-made chemicals are capable of destroying stratospheric ozone. They all have two features in common: in the lower atmosphere they are remarkably stable, being largely insoluble in water and resistant to physical and biological breakdown; and they contain chlorine or bromine (elements that are extremely reactive when in a free state) and can therefore attack ozone.

For these reasons, ozone-depleting chemicals remain in the air for long periods, and are gradually diffused to all parts of the atmosphere, including the stratosphere. Here they are broken down, by intense high-energy radiation from the Sun, freeing ozone-destroying chlorine or bromine atoms.

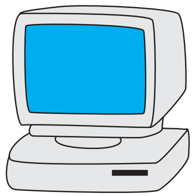
Chlorofluorocarbons (CFCs) are the most important ozone-destroying chemicals. CFCs have been used in many ways since they were first synthesized in 1928. Some examples are: as a refrigerant in refrigerators and air conditioners; as a propellant in aerosol spray cans; as a blowing agent in the manufacture of flexible foams in cushions and mattresses; and as a cleaning agent for printed circuit boards and other equipment. Fifteen CFCs are being phased out.

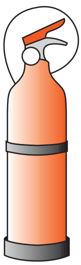


Hydrochlorofluorocarbons (HCFCs) are related to CFCs, and were largely developed as substitutes. Their main uses are as refrigerants and blowing agents. HCFCs are less ozone-destructive than CFCs because their extra hydrogen atom makes them more likely to break down in the lower atmosphere, preventing much of their chlorine from reaching the stratosphere.

Nevertheless, the ozone-depletion potential (ODP) of HCFCs is too high to allow their long-term use. Forty different HCFCs are subject to global controls leading to an eventual phase out of their use.

Two other chlorine-containing chemicals have significant ODPs and are subject to global controls: carbon tetrachloride and methyl chloroform (1,1,1-trichloroethane). Both chemicals have been widely employed as solvents, mainly for cleaning metals during engineering and manufacturing operations.





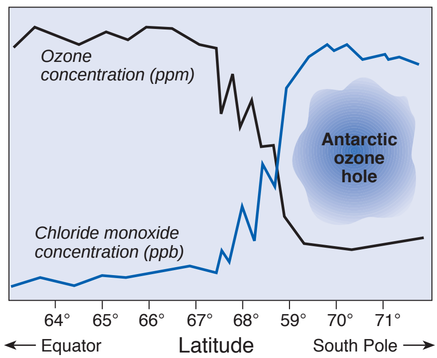
The main bromine-containing chemicals that destroy ozone are called halons. These are bromofluorocarbons (BFCs), the principal use of which has been to extinguish fires. Some halons are potent ozone destroyers—up to ten times more powerful than the most destructive CFCs. Production of three halons ended in developed countries in 1994, and 34 types of halogenated halons (HBFCs) are due to be phased out under the Montreal Protocol.

In recent years, attention has been focused on another bromine-containing chemical with significant potential to destroy ozone—methyl bromide—which is used mainly as an agricultural pesticide. Due to its ozone-depletion potential, the 7th Meeting of the Parties to the Montreal Protocol agreed to phase out methyl bromide by 2010 for developed countries, and a freeze at 2002 for developing countries.

How strong is the evidence that man-made chemicals cause ozone depletion?

The first hypotheses that human activities could damage the ozone layer were published in the early 1970s. For some years afterwards, it remained uncertain whether ozone depletion would actually happen, and if so, whether human activities could be to blame. Initially, some thought that emissions of nitrogen oxides from high-flying supersonic aircraft were the main threat. Others argued that man-made chemicals could make only a tiny difference compared with natural sources of potentially ozone-depleting chemicals, such as volcanoes. Now, though, direct measurement of the stratosphere has proved that chlorine and bromine derived from man-made chemicals are primarily responsible for observed ozone depletion. This conclusion has been further supported by improved scientific understanding of the chemical mechanisms of ozone depletion.

The proof that man-made chemicals destroy ozone: more chlorine monoxide equals less ozone



UNEP Scientific Assessment of Ozone Depletion: 1994

Volcanic eruptions can hasten the rate of ozone depletion, but their effects are relatively short-lived. In 1991, the eruption of Mount Pinatubo in the Philippines injected some 20 million tonnes of sulphur dioxide into the atmosphere, which contributed to record levels of ozone depletion in 1992 and 1993. In the atmosphere, the sulphur dioxide was rapidly converted into sulphuric acid aerosol, increasing the rate of ozone depletion.

However, stratospheric aerosol concentrations fell to less than a fifth of their peak level in less than two years. By comparison, some CFCs can stay in the atmosphere for more than 100 years; the atmospheric lifetime of CFC-115 is 1700 years.

An international panel of around 295 scientists from 26 countries stands firm in its consensus that ozone depletion is caused by chlorine- and bromine-containing man-made chemicals, mainly CFCs and halons.

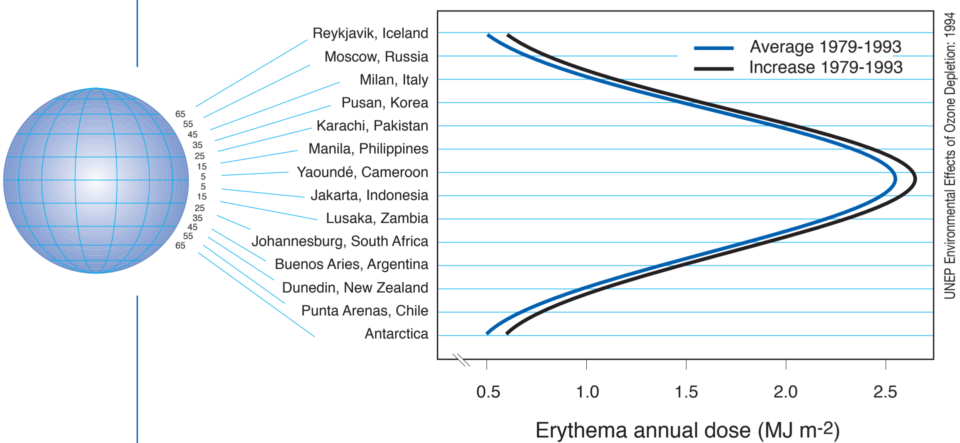
How fast is the ozone layer being depleted?

Extensive measurements of the ozone layer by ground-based instruments began in 1957. Since the late 1970s, scientists have taken increasing numbers of measurements of the ozone layer, using ground-based, balloon-borne and satellite-borne instruments. The measurements have confirmed that ozone levels are falling almost everywhere in the world. Over the period 1979 to 1994, ozone over the midlatitudes (30˚–60˚) of both hemispheres has been depleted at an average rate of 4–5 per cent per decade. Ozone levels fell faster in the 1980s than in the 1970s, suggesting that ozone depletion has accelerated.

Where and when is ozone depletion most severe?

* Depletion varies with latitude. It is lowest over the equator and increases toward the poles. Over the tropics (20˚N–20˚S), measurements have shown no significant trend in the total amount of ozone. For the six months after the eruption of Mount Pinatubo, total ozone fell by 3–4 per cent. Over the Arctic, cumulative ozone depletion of up to 20 per cent is thought to have occurred in some altitudes, while ozone loss over the Antarctic has been even greater (see page 15).

Ultraviolet radiation levels on Earth have already increased around the world

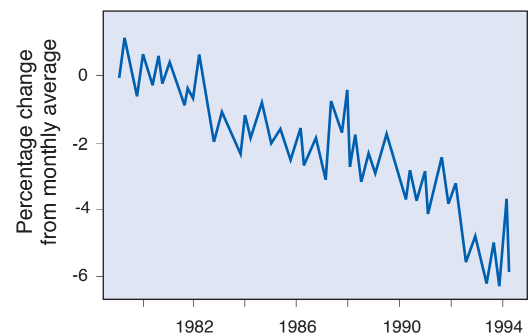


* Depletion varies with season. In Northern Hemisphere midlatitudes over the period 1979–1994, ozone levels fell twice as fast in winter/spring as in summer/autumn. In the Southern

Hemisphere, there is less seasonal variation. Huge seasonal variations in ozone depletion have been recorded over Antarctica.

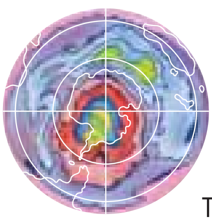
* Depletion varies with altitude. Measurements taken between 1979 and 1991 suggest no significant depletion at any latitude at altitudes of between 25 and 30 km. Measurements made over the same period at 35–45 km suggest depletion of 5–10 per cent per decade, including over the tropics. Below 20 km, there is inconsistency between measurements, with some studies suggesting trends over mid-latitudes as large as 20 per cent depletion per decade.

The global ozone layer has decreased by 6 per cent since 1981



UNEP Scientific Assessment of Ozone Depletion: 1994

Peak global ozone depletion is expected to be felt over the next several years based on extrapolation of current trends. Scientists predict maximum ozone losses over northern mid-latitudes of 12–13 per cent in winter/spring and 6–7 per cent in summer/autumn. The peak over southern mid-latitudes is predicted to be about 11 per cent in all seasons. These estimates give only an indication of what the peak level of ozone depletion might be. In particular, the predictions assume full cooperation with the international effort to phase out ozone-destroying chemicals.



What is the Antarctic 'ozone hole'?

Though ozone depletion generally increases from the tropics to mid-latitudes, much greater ozone depletion has been measured over Antarctica during September and October.

This phenomenon is called the 'ozone hole'. For about two months every southern spring, total ozone declines by up to 60 per cent over most of Antarctica. The existence of the ozone hole first became public knowledge in 1985—an event that played an important role in speeding up the international agreement, the Montreal Protocol, to protect the ozone layer.

The ozone hole is created due to a combination of special factors found only over Antarctica. Each winter, a 'polar vortex' isolates a large mass of the Antarctic stratosphere. During the winter, no sunlight falls on this air and it becomes extremely cold. The low temperatures encourage the growth of ice clouds, which provide a surface for special chemical reactions. Despite the absence of sunlight, 'inactive' chlorine-containing chemicals are converted into 'active' forms, capable of attacking ozone. When the Sun returns in the spring, this process is speeded up, resulting in very fast destruction of ozone until the polar vortex breaks up, dispersing the air towards the equator.

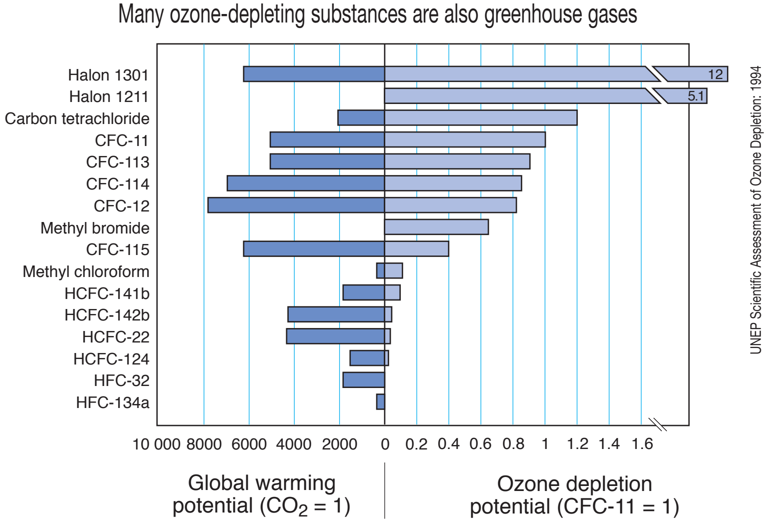
Recent experiments in the Arctic have shown that some of the mechanisms necessary for extremely rapid ozone depletion are present here too. Fortunately, the polar vortex in the Arctic normally breaks up early in the spring (before sunlight has time to destroy large amounts of ozone) before a full-blown ozone hole can be created.

How are ozone depletion and climate change related?

Stratospheric ozone depletion and climate change are both effects of human activities on the global atmosphere. They are distinct environmental problems, but are linked in a number of ways. Some of the main potential interactions are the following:

Ozone-depleting chemicals contribute to global warming

* Ozone-depleting chemicals can have an impact on the Earth's heat balance as well as on the ozone layer because many of them are greenhouse gases. For example, CFCs 11 and 12 (the two main chlorofluorocarbon compounds that destroy ozone) are, respectively, 4000 and 8500 times more powerful greenhouse gases than carbon dioxide (over a period of 100 years). Fluorocarbon chemicals developed as substitutes for CFCs are also powerful greenhouse gases.



Ozone depletion can affect climate

* Ozone is itself a greenhouse gas and the ozone layer plays a role in maintaining the planet's overall temperature balance. Depletion of the ozone layer is currently thought to reduce the greenhouse effect.

* On the other hand, increased exposure of the Earth's surface to UV-B due to ozone depletion could alter the cycling of greenhouse gases, such as carbon dioxide, in ways that could increase global warming. In particular, increased UV-B is likely to suppress primary production in terrestrial plants and marine phytoplankton, so reducing the amount of carbon dioxide they absorb from the atmosphere.

Global warming could aggravate ozone depletion

* Global warming is expected to increase average temperatures in the lower atmosphere—but it could cool the stratosphere. This could increase ozone depletion even with the same concentrations of man-made chemicals reaching the stratosphere because very cold temperatures favour special sorts of reactions that deplete ozone more rapidly.

How are UV radiation levels changing at the Earth's surface?

Direct measurement of UV-B radiation levels is technically complicated. However, there is overwhelming scientific evidence that ozone depletion leads to more UV-B reaching the Earth's surface, and that the amount of increase can be predicted from trends in ozone levels. On this basis, UV-B at mid-latitudes is calculated to have increased by 8–10 per cent over the last 15 years (the calculation is for UV-B radiation at a wavelength of 310 nanometres at latitudes 45° north and south over the period 1979–1994). Calculated increases in UV-B to date are larger at higher latitudes and for shorter wavelengths.

The first persistent increase in UV-B over densely populated areas due to ozone depletion was measured in 1992/93. Several studies found large increases at northern mid and high-latitudes. Measurements at Toronto, Canada, suggested that UV-B at 300 nanometres was 35 per cent higher than four years previously.

Large increases in UV-B have occurred in Antarctica due to the annual ozone hole. In 1992, when ozone depletion was especially severe, UV-B (in the range 298–303 nanometres) at the South Pole was four times higher than in 1991. Surrounding regions have also been affected, because when the polar vortex breaks down in the spring, large quantities of ozone-depleted air drift toward lower latitudes.

At a measurement station in southern Argentina, biologically-weighted levels of UV (a measure taking into account the greater damage caused by shorter wavelengths) were 45 per cent higher in December 1991 than is usual at this latitude. The increase was equivalent to moving the site 20 per cent closer to the equator.

Based on simulation models, peak levels of biologically-weighted UV-B reaching the Earth due to ozone depletion are expected to be significantly higher than measured to date. Relative to 1960, estimated maximum increases for erythema induction and DNA damage at mid-latitudes are shown in the table below. As with the estimates of maximum ozone depletion given above, the figures are subject to uncertainty; and they assume full compliance from all parties in the global effort to phase out ozone-depleting substances.

Estimated maximum seasonal increases in erythema induction and DNA damage (relative to 1960)

	erythema induction	DNA damage
Northern Hemisphere in winter/spring	15–17%	29–32%
Northern Hemisphere in summer/autumn	8–9%	12–15%
Southern Hemisphere in all seasons	15%	25%

UNEP Environmental Effects of Ozone Depletion: 1994

Discussion points

- **What chemical characteristics do ozone-depleting substances have in common?**

- **How are ozone-depleting substances used in your country? Identify uses of CFCs or halons and products that are produced using these substances: in the home, at work and in different industries.**

- **What are the trends in ozone levels in your region?**

- **What are local UV-B levels? Is anyone making continuous measurements of UV-B in your country? How is, or could, this information be used?**

- **How large are your country's emissions of different ozone-depleting substances?**

- **What is the level of knowledge about ozone depletion among different groups of people in your country? Are there any common misunderstandings?**

- **Ozone depletion and climate change. What activities contribute to both? What environmental policies could take both problems into account?**

3 The effects of increased ultraviolet radiation

Entry and exit times in the video: 01:52–05:10

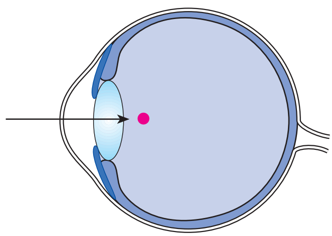
How does UV radiation affect human skin?

One of the most obvious effects of UV-B radiation is sunburn, known technically as erythema. Dark-skinned people are protected from most of this effect by pigment in their skin cells. UV-B can also damage the genetic material in skin cells, which can cause cancers. For fair-skinned people, life-long exposure to high levels of UV-B increases the risk of non-melanoma skin cancers. Researchers have suggested that these kinds of skin cancers are likely to increase by 2 per cent for each 1 per cent decrease of stratospheric ozone. There is also some evidence that increased exposure to UV-B, especially in childhood, can increase the risk of developing more dangerous melanoma skin cancers.

How does UV radiation affect the eye?

In humans, exposure to UV-B from unusual directions can cause snow blindness—actinic keratitis—a painful acute inflammation of the cornea. Chronic exposure can also damage the eye. Enhanced levels of UV-B could lead to more people suffering from cataracts—a clouding of the lens that impairs vision. Cataracts are a leading cause of blindness, even though they can be effectively treated through surgery in regions well provided with medical care.

UV-B radiation can cause cataracts



Health Council of Netherlands report: 1994

How does UV radiation affect the body's defences against disease?

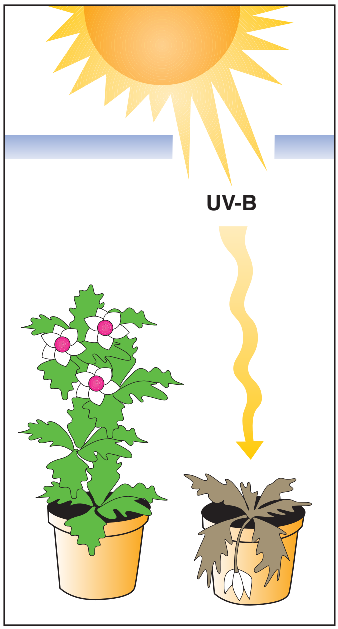
Exposure to UV-B can suppress immune responses in humans and animals. Increased UV-B could therefore reduce human resistance to a number of diseases, including cancers, allergies and some infectious diseases. In areas of the world where infectious diseases are already a major problem, the added stress from increased UV-B could be significant. This is especially true for diseases, such as leishmaniasis, malaria and herpes, against which the body's major defence is in the skin. Exposure to UV-B can also affect the body's ability to respond to vaccinations against diseases.

The effects of UV-B on the immune system are not dependent on skin colour. Dark-skinned and fair-skinned people are equally at risk.

What effect does UV radiation have on plants?

Many species and varieties of plants are sensitive to UV-B, even at present-day levels. Increased exposure could have complex direct and indirect effects, both on crops and natural ecosystems. Experiments have shown that increased exposure to UV-B of crops such as rice and soy beans results in smaller plants and lower yields. Increased UV-B could alter crop plants chemically, potentially reducing nutritional value or increasing toxicity. If further ozone depletion is not prevented, we will have to search for UV-B tolerant crop varieties or breed new ones.

Increased UV-B can harm plants



The implications for natural ecosystems are difficult to predict, but could be significant. UV-B has a number of indirect effects on plants, such as altering plant form, biomass allocation to parts of the plant and production of chemicals that prevent insect attack. Increased UV-B could therefore lead to ecosystem-level effects, such as changes in the competitive balance between plants, animals that eat them and plant pathogens and pests.

What are the effects on marine and aquatic life?

Experiments have shown that increased UV-B harms phytoplankton, zooplankton, juvenile fish and larval crabs and shrimps. Harming these small organisms could threaten the productivity of fisheries. More than 30 per cent of animal protein consumed by humans comes from the sea, and in many developing countries the share is higher. In Antarctic seas, plankton production has already been reduced under the annual ozone hole.

Marine life also plays an important role in global climate because phytoplankton absorb vast quantities of carbon dioxide, the main greenhouse gas. A decrease in phytoplankton production could leave more carbon dioxide in the atmosphere, contributing to global warming.

What are the effects on man-made materials?

Ultraviolet radiation is a primary cause of degradation of some materials, particularly plastics and paints. Increased UV-B will speed up rates of degradation, especially in regions that normally experience high temperatures and strong sunshine.

Discussion points

- **What effects of ozone depletion will be particularly harmful in your country? What regions and groups of people could be hardest hit?**

- **What economic and welfare losses could occur if ozone depletion continues? Consider this question for each of the effects of increased UV-B.**

- **What precautionary measures can be taken today and in the near future?**

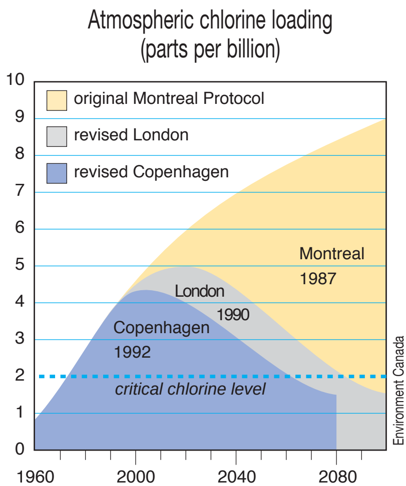
- **What could public information campaigns do to help prevent adverse health or environmental effects?**

4 The international response

Entry and exit times in the video: 08:00–12:39

What has the international community done to combat ozone depletion?
A strong international consensus that the ozone layer needs to be protected has developed over the past decade. The first step towards turning consensus into global action was taken in March 1985, ahead of firm scientific proof that man-made chemicals were damaging the ozone layer. This was the adoption of the Vienna Convention for the Protection of the Ozone Layer. Parties to the Convention agreed to take 'appropriate measures' to safeguard the ozone layer, and anticipated the negotiation of protocols for specific measures.

The need for a protocol arose almost immediately, when the first evidence of the Antarctic ozone hole was published in June 1985. Global negotiations for a protocol were put into top gear, and resulted in adoption in September 1987 of the Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol came into force in January 1989 and is the legal basis for the worldwide effort to safeguard the ozone layer through controls on production, consumption and use of ozone-depleting substances.



By December 1995, 150 countries had ratified the Montreal Protocol, so becoming Parties to it and legally bound by its requirements. About a third are developed and two-thirds are developing countries. The original Montreal Protocol defined measures that parties had to take to limit production and consumption of eight ozone-depleting substances (ODS), known in the language of the Protocol as 'controlled substances'. At meetings held in London and Copenhagen in 1990 and 1992, the controls were strengthened and broadened to cover other chemicals. Instead of merely a reduction in production and consumption of five CFCs and three halons, the Protocol now requires developed countries to phase out 15 CFCs, three halons, 34 HBFCs, carbon tetrachloride and methyl

Latest control measures as of 7th Meeting of the Parties, Vienna, 5–7 December 1995
(Article 5 countries are in bold; non-Article 5 countries are not)

1 July 1989	Freeze of Annex A[1] CFCs
1 January 1992	Freeze of halons
1 January 1993	Annex B CGCs[2] reduced by 20% from 1989 levels Freeze of methyl chloroform
1 January 1994	Annex B CFCs reduced by 75% from 1989 levels Annex A CFCs reduced by 75% from 1986 levels Halons[3] phased out[6]
1 January 1995	Methyl bromide frozen at 1991 levels Carbon tetrachloride reduced by 85% from 1989 levels
1 January 1996	HBFCs[6] phased out Carbon tetrachloride phased out Annex A and B CFCs phased out[6] Methyl chloroform phased out[6] HCFCs[5] frozen at 1989 levels of HCFC + 2.8% of 1989 consumption of CFCs (base level)
1 July 1999	**Freeze of Annex A CFCs at 1995-97 average levels**
1 January 2001	Methyl bromide reduced by 25%
1 January 2002	**Freeze of halons at 1995–97 average levels** **Freeze of methyl bromide at 1995–98 average levels**
1 January 2003	**Annex B CFCs reduced by 20% from 1998–2000 average consumption** **Freeze in methyl chloroform at 1998–2000 average levels**
1 January 2004	HCFCs reduced by 35% below base levels
1 January 2005	**Annex A CFCs reduced by 50% from 1995–97 average levels** **Halons reduced by 50% from 1995–97 average levels** **Carbon tetrachloride reduced by 85% from 1998–2000 average levels** **Methyl chloroform reduced by 30% from 1998–2000 average levels** Methyl bromide reduced by 50%
1 January 2007	**Annex A CFCs reduced by 85% from 1995–97 average levels** **Annex B CFCs reduced by 85% from 1998–2000 average levels**
1 January 2010	HCFCs reduced by 65% Methyl bromide phased out **100% phase out of CFCs, halons and carbon tetrachloride as per the London Amendment** **Methyl chloroform reduced by 70% from 1998–2000 average levels**
1 January 2015	HCFCs reduced by 90% **100% phase out of methyl chloroform**
1 January 2016	**Freeze of HCFCs at base line figure of year 2015 average levels**
1 January 2020	HCFCs phased out with service tail until 2030
1 January 2040	**HCFCs phased out**

[1]Five CFCs in Annex A: CFCs 11, 12, 113, 114, and 115. [2]Ten CFCs in Annex B: CFCs 13, 111, 112, 211, 212, 213, 214, 215, 216 and 217. [3]Halons 1211, 1301 and 2402. [4]34 hydrobromofluorocarbons. [5]34 hydrochlorofluorocarbons. [6]with exemptions for essential uses. Consult the *Handbook on Essential Use Nominations* prepared by the Technology and Economic Assessment Panel, 1994, UNEP, for more information.

chloroform. A longer-term reduction schedule, also leading to complete phase out, has been agreed for 40 HCFCs. The list of controlled substances is now extended to include methyl bromide as agreed at the 7th Meeting of the Parties.

Parties to the Montreal Protocol agreed to reduce and then eliminate the use of ODS before substitutes and alternative technologies were fully available. This has proved a successful strategy. Industries and manufacturers have already developed alternative substances and technologies for almost every former use of ODS. Many countries are already well on their way to a complete phase out of ODS.

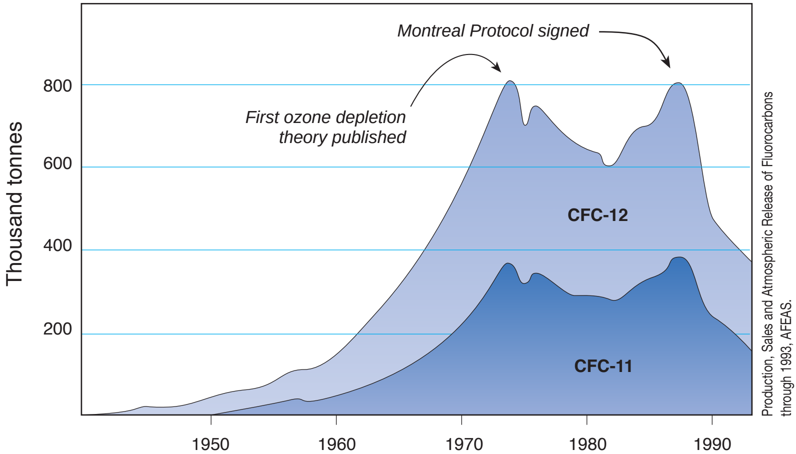
Recognizing developing countries' need for economic development and their relatively low historical use of CFCs, the Montreal Protocol grants developing countries a 'grace period' of ten years more than developed countries to implement the reduction and phase-out measures required by the Protocol. In addition, at their 1990 meeting in London, the Parties created a financial mechanism to provide technical and financial assistance to developing countries' ozone protection programmes. To be eligible to receive support under the financial mechanism, Parties must be developing countries and must consume less than 0.3 kg per capita per annum of controlled substances. More than 100 countries meet these criteria; they are called 'Article 5' countries because their status is defined in Article 5 of the Montreal Protocol.

How are ozone-depleting substances being phased out?

Many alternatives exist in the former applications of ODS, involving both substitute chemicals and alternative technologies. In existing uses of ODS, conservation, recovery, recycling and leak prevention are important routes to near-term reductions in emissions.

In refrigeration and air conditioning, the main alternative to ODS is to use a non-CFC refrigerant, such as a hydrocarbon or ammonia. HCFCs are being used in some applications, but only as stop gaps, or 'transitional substances', since they too are due to be phased out eventually due to their ozone-depletion potential. Some hydrofluorocarbons (HFCs) are also being used. HFCs contain no chlorine and are ozone benign. However, they are potent greenhouse gases.

World production of CFCs 11 and 12 is falling fast



For existing refrigeration and cooling equipment, proper maintenance can reduce leakage considerably. This also cuts costs. Some equipment can be retrofitted for alternative chemicals. CFCs from old refrigerators and air conditioners are increasingly being recovered and recycled before the equipment is disposed of.

In the plastic foam manufacturing industry, CFCs have been used as blowing agents for both rigid (insulating) foams and flexible (structural) foams. Several alternative blowing agents are now in widespread use, including HCFCs, hydrocarbons, methylene chloride, carbon dioxide and water.

Several ODS have been used as cleaning agents, including CFC-113, carbon tetrachloride and methyl chloroform. They are being replaced in a variety of ways.

Alternatives, such as alcohols, terpenes or water, have proved effective for many industrial needs. In the electronics industry, new techniques have made it possible to eliminate cleaning in some operations.

CFCs 11 and 12 have been widely used as propellants in aerosol spray cans. In many countries, this use has already virtually ceased.

Alternative propellants, such as hydrocarbons, have replaced virtually all the former uses of CFCs. In addition, mechanical pumps have been developed that do not need a chemical propellant at all.

Halons for fire fighting are being replaced with other fire-quenching compounds such as water, carbon dioxide or foam. New high-pressure water mists are being developed for oil and gasoline fires. Inert gases, such as argon or nitrogen, are alternatives for applications where the other solutions have serious drawbacks. Halons in existing fire-fighting equipment are increasingly being reclaimed and stored in halon banks to conserve stocks, prevent emissions to the atmosphere and be available for 'essential uses' as agreed under the Montreal Protocol.

What are the benefits to companies of phasing out ozone-depleting substances?

There are two main reasons to convert to ozone-friendly technologies as soon as possible. The first is environmental benefit: the total chlorine and bromine loading in the atmosphere will determine how severe ozone depletion will become and how long it will last. The sooner emissions are stopped, the faster the ozone layer will repair itself. Only if all companies and all countries cooperate in a rapid phase out of ODS can even more severe ozone depletion be avoided.

The second is economic benefit: under the terms of the Montreal Protocol, most production of CFCs and halons will cease in the near future.

Trade restrictions will further limit supplies. What is left on the market will become scarce and expensive. Companies that abandon ODS early could benefit from lower costs. Industries that switch to

Many products are now labelled 'ozone-friendly'

ozone-benign technologies could benefit from consumer demand for ozone-friendly products. Users of ODS-containing equipment, such as air conditioners and refrigeration units, could save costs by preventing leaks, with the advantage that better maintenance also reduces the likelihood of breakdowns.

Discussion points

- **How has your country responded to the Montreal Protocol and its plans for phasing out ODS?**

- **What are some reasons for ratifying the Montreal Protocol and its amendments?**

- **Discuss the role of international cooperation in phasing out ODS. What role has your country played in the international discussion?**

- **Many countries are phasing out ODS faster than required by the Montreal Protocol. List some benefits of such a policy.**

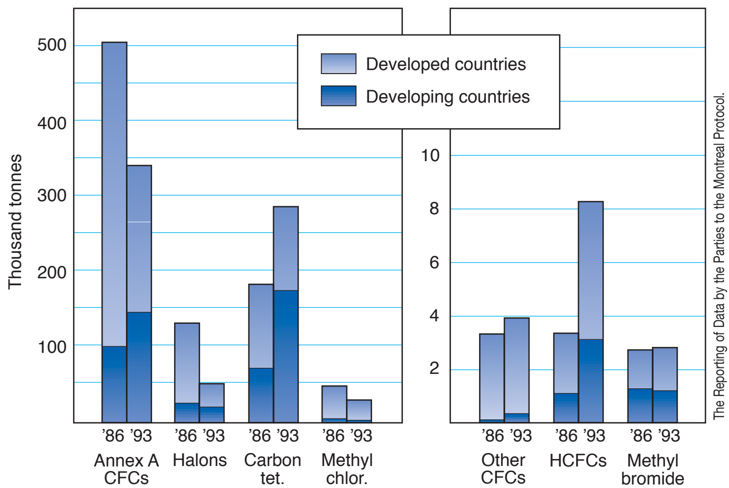
- **What are the risks associated with using 'transitional substances,' such as HCFCs?**

5 Ozone depletion and developing nations

Entry and exit times in the video: 12:39–14:23

What part have developing countries played in ozone depletion?
Historically, developing countries' use of ODS and manufacture or import of ODS-containing equipment has been very limited. In 1986, the developing countries in Asia, Africa and Latin America accounted for only 21 per cent of global consumption of CFCs and halons. Developing countries are responsible for an even smaller proportion of emissions; 90 per cent of CFCs are currently released in latitudes corresponding to North America, Europe and Japan.

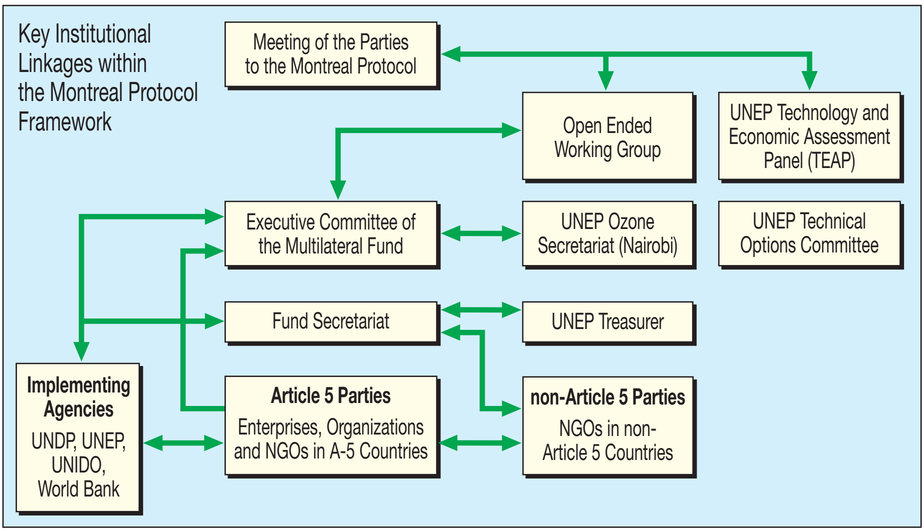
World ODS consumption is falling—but not everywhere



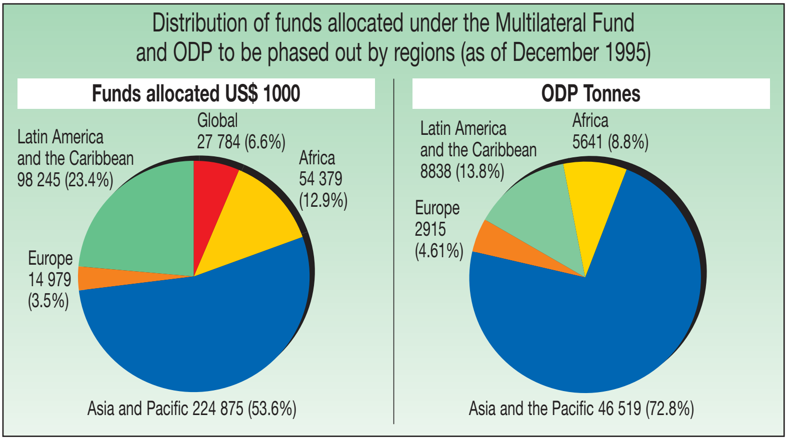
However, as developed countries phase out ODS and others become more industrialized, the developing countries' share of consumption is increasing. Developed countries accounted for 65 per cent in 1986, but only 47 per cent in 1992. Asia's share of consumption rose over the same period from 19 to 30 per cent. The consumption share of eastern Europe increased from 14 to 21 per cent. Trends in the geographical distribution of ODS emissions mean that developing countries' policies on ODS will become increasingly significant for the global environment. Several Article 5 developing countries are rapidly industrializing; at the same time, economic growth in these countries is creating much greater consumer demand for products that use or contain ODS. Two examples are refrigerators and air conditioners. If the new demands are met by ozone-destructive technologies, emissions of CFCs and halons will rise drastically. Increases in population and economic growth in countries such as Brazil, China and India could lead to a doubling of CFC-consumption every five years, and it would soon reach the levels attained by the industrialized nations a few years ago. The demand for ODS in developing countries, if unconstrained, has been calculated at 1 million tonnes in 2010.

How is the international community helping developing countries to phase out ODS?

Parties to the Montreal Protocol have agreed that developing countries need financial and technical assistance to phase out ODS. To meet this need, the Parties have established the Multilateral Fund as part of the financial mechanism which assists Article 5 countries with their reduction and phase-out efforts. Contributions to the Fund are made mainly by industrialized countries.



The Fund provides Article 5 countries with financial assistance in developing and implementing projects and programmes aimed at phasing out ODS. Technical expertise and assistance, information on new technologies, and training and demonstration programmes can also be provided by the Fund. Its budget for 1991–93 was US$240 million, and was increased to US$510 million for the period 1994–96. As of November 1995, the Fund had approved 'country programmes' for more than 64 Article 5 countries which, between them, will phase out a total of 142 000 ODP tonnes when fully implemented.



Multilateral Fund Secretariat

The Multilateral Fund is managed by an Executive Committee, made up of representatives of 14 Parties to the Montreal Protocol, with equal representation from developed and developing countries. The Committee approves project funding and develops guidelines for the administration of the Fund. Four organizations have been designated Implementing Agencies for the Multilateral Fund:

* The United Nations Development Programme (UNDP) assists Parties in investment project planning and preparation, country programmes and institutional strengthening, and runs training and demonstration projects.

* The United Nations Environment Programme (UNEP), through the UNEP IE OzonAction Programme, collects data, provides an information clearinghouse, assists low-volume consuming

countries in the preparation of country programmes and institutional strengthening projects, and offers training and networking assistance.

* The United Nations Industrial Development Organization (UNIDO) runs small- to medium-scale investment projects and country programmes, and offers technical assistance and training for individual factories.

* The World Bank develops and implements investment projects and assists in the preparation of country programmes.

Discussion points

- **Identify the most important uses of ODS in your country, especially any that could grow more important in future.**

- **What are the immediate options for decreasing ODS consumption in different industrial sectors in your country? What are the likely benefits and costs of the options?**

- **What are the long-term options in different industrial sectors in your country? What are the likely benefits and costs of each option?**

- **What are the risks and what is the cost of not taking immediate action in each sector?**

- **What factors (economic, social, educational) will determine the success of ODS phase-out policies?**

- **What are the information needs of specific sectors? How can they be met?**

- **What activities on a national or company level could be eligible for financial assistance through the Multilateral Fund?**

- **What experiences from local efforts in phasing out ODS could be of benefit to others?**

Index to questions

1. The ozone layer and its protective role

2. The threat to the ozone layer from man-made chemicals

3. The effects of increased ultraviolet radiation

4. The international response

5. Ozone depletion and developing nations

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Glossary

Protecting the ozone layer involves many scientific, technological and legal issues. This booklet has introduced a few of them. Some key terms are explained below in more detail. You may find the glossary useful as a point of reference. It may also help you if, during a presentation or discussion on issues raised in *Saving the Ozone Layer: Every Action Counts*, you need a more formal definition of concepts mentioned in the booklet.

Aerosol A suspension of very fine solid or liquid particles in a gas. Aerosol is also used as a common name for spray, or aerosol can, in which a container is filled with a product and a propellant, and pressurized so as to release the product in a fine spray.

Article 5 country A developing country that is a Party to the Montreal Protocol, and whose annual consumption of controlled substances is less than 0.3 kg per capita. Such countries are considered to operate under Article 5 of the Montreal Protocol and are thus called 'Article 5 countries'.

Blowing agent A gas or volatile liquid used to 'blow' plastic foams by forming bubbles or cells.

Cataract Damage to the eye in which the lens is partly or completely clouded, impairing vision and sometimes causing blindness. Exposure to ultraviolet radiation can cause cataracts.

CFCs Chlorofluorocarbons; a family of chemicals that contain chlorine, fluorine and carbon; used as refrigerants, aerosol propellants, cleaning solvents and in the manufacture of foam. One of the main causes of ozone depletion.

Controlled substance Under the Montreal Protocol, any chemical that is subject to control measures, such as a phase-out requirement.

Country programme A national strategy prepared by an Article 5 country to implement the Montreal Protocol and phase out ODS use, identifying, among others, investment projects for funding under the Multilateral Fund.

Erythema Any redness of the skin, such as sunburn, caused by exposure to ultraviolet radiation.

Global warming The theory that greenhouse gases emitted due to human activities will warm the Earth's atmosphere, leading to climate change.

Greenhouse gas A gas that traps heat in the Earth's atmosphere, contributing to the greenhouse effect.

Halocarbons All carbon-based chemicals that contain one or more elements in the halogen group, including fluorine, chlorine and bromine.

Halons Brominated chemicals related to CFCs that are used in fire fighting and have very high ODPs.

HBFCs Hydrobromofluorocarbons; a family of hydrogenated chemicals related to halons, but with lower ODPs.

HCFCs Hydrochlorofluorocarbons; a family of chemicals related to CFCs, which contain hydrogen as well as chlorine, fluorine and carbon. The hydrogen reduces their atmospheric lifetime, making HCFCs less damaging than CFCs in the longer term.

HFCs Hydrofluorocarbons; a family of chemicals related to CFCs, which contain hydrogen, fluorine and carbon, but no chlorine, and therefore do not deplete the ozone layer.

Immune system In humans and animals, the cells and tissues involved in recognizing and attacking foreign substances in the body.

Implementing Agency Under the Montreal Protocol; four international organizations designated to implement the Multilateral Fund. They are UNDP, UNEP, UNIDO and the World Bank.

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Methyl bromide A chemical composed of carbon, hydrogen and bromine, which is used mainly as an agricultural pesticide and fumigant, and has a significant ODP.

Methyl chloroform Also known as 1,1,1-trichloroethane; a chemical composed of carbon, hydrogen and chlorine, which is used as a solvent and blowing agent and has an ODP about a tenth that of CFC-11.

Montreal Protocol The Protocol to the Vienna Convention, signed in 1987, which commits Parties to take concrete measures to protect the ozone layer by freezing, reducing or ending production and consumption of controlled substances.

Multilateral Fund Part of the financial mechanism under the Montreal Protocol; it supports ODS phase-out policies, programmes and investment projects in Article 5 countries.

ODP Ozone-depletion potential; a measure of a substance's ability to destroy stratospheric ozone, based on its atmospheric lifetime, stability, reactivity and content of elements that can attack ozone, such as chlorine and bromine. All ODPs are based on the reference measure of 1 for CFC-11.

ODS Ozone-depleting substance; any chemical that can deplete the ozone layer. Most ODS are controlled substances under the Montreal Protocol.

OzonAction Programme UNEP IE's OzonAction Programme provides assistance to developing country parties under the Montreal Protocol through information exchange, training, networking, country programmes and institutional strengthening projects.

Ozone A gas whose molecules contain three atoms of oxygen, and whose presence in the stratosphere constitutes the ozone layer. Ozone is toxic to humans, animals and plants at high concentrations, and so is a pollutant when it occurs in the lower atmosphere in smog.

Ozone depletion The process by which stratospheric ozone is destroyed by man-made chemicals, leading to a reduction in its concentration.

Ozone layer A thinly scattered layer of ozone molecules found in the stratosphere. The ozone layer filters most ultraviolet radiation from the Sun, preventing it from reaching the Earth.

Ozone Secretariat The secretariat to the Montreal Protocol, provided by UNEP and based in Nairobi, Kenya.

Party A country that signs and/or ratifies an international legal instrument, indicating that it agrees to be bound by the rules set out therein. Parties to the Montreal Protocol are countries that have signed and ratified the Protocol.

Plankton A collective term for the wide variety of plant and animal organisms, often microscopic in size, that float or drift in sea or fresh water; plankton represent the basic level of many feeding relationships.

Phase out The ending of all production and consumption of a chemical controlled under the Montreal Protocol.

Polar vortex A semi-isolated area of cyclonic circulation formed each winter in the polar stratosphere. The southern polar vortex is stronger than the northern one. The vortex increases ozone depletion by trapping very cold air containing aerosols on which ozone-depleting reactions can take place.

Propellant A liquid or gas used in aerosol spray cans to force the product out of the can in a fine spray when the valve is opened.

Refrigerant A heat transfer agent, usually a liquid, used in equipment such as refrigerators, freezers and air conditioners.

Retrofit The upgrading or adjustment of equipment so that it can be used under altered conditions; for example, of refrigeration equipment to be able to use a non-ozone depleting refrigerant in place of a CFC.

Skin cancer A mutation in the skin which can be malignant or benign, and which, in melanoma cancers, involves the production of pigment synthesizing cells called melanocytes.

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Smog The entrapment of pollutants in still air or fog. Photochemical smog occurs where sunlight causes chemical reactions in a smog, one effect of which is the generation of ozone.

Stratosphere A region of the upper atmosphere between the troposphere and the mesosphere, ranging from about 15–55 km above the Earth's surface.

Transitional substance Under the Montreal Protocol; a chemical whose use is permitted as a replacement for ozone-depleting substances, but only temporarily due to the substance's ODP or toxicity.

Troposphere The lowest layer of the Earth's atmosphere, in which all weather happens, which ranges from the surface to about 15 km.

Ultraviolet radiation Radiation from the Sun with wavelengths between visible light and X-rays. UV-B (280–320 nm) is one of three bands of UV radiation, is harmful to life at the Earth's surface, and is mostly absorbed by the ozone layer.

UNDP The United Nations Development Programme; one of the Multilateral Fund's implementing agencies.

UNEP The United Nations Environment Programme. Through the UNEP IE OzonAction Programme, UNEP is one of the Multilateral Fund's implementing agencies.

UNIDO The United Nations Industrial Development Organization; one of the Multilateral Fund's implementing agencies.

Vienna Convention The international agreement made in 1985 to set a framework for global action to protect the ozone layer; the international framework law that supports the Montreal Protocol.

World Bank Formally known as the International Bank for Reconstruction and Development; one of the Multilateral Fund's implementing agencies.

Further information available from UNEP

UNEP can provide a wide range of information on the science of ozone depletion and the technical and policy aspects of the ODS phase-out process. Information resources produced by the UNEP IE OzonAction Programme through its Information Clearinghouse include the following:

* Information campaign materials and public awareness tools—the OzonAction Programme produces a range of information designed to support national efforts to raise awareness about ozone depletion. This includes a handbook for ODS officers on raising national awareness of ozone issues; sets of slides and overheads for use in oral presentations; and a set of three posters that can provide a visual profile to a public awareness campaign.

* The OzonAction Newsletter and special supplements—a quarterly newsletter available in Arabic, Chinese, English, French and Spanish.

* Query response service—a service that researches and responds to developing countries' technical and policy questions (available by fax, phone, e-mail and mail).

* Sector-specific brochures, technology sourcebooks, case studies and information papers; technical publications that provide information on identifying and selecting alternative technologies to protect the ozone layer.

* The OzonAction Information Clearinghouse (OAIC)—a diskette reference tool, updated twice a year, that contains numerous databases on technical and policy issues related to ODS phase out.

* The International Recycled Halon Bank Management Information

Clearinghouse—which provides information about halon banking, recycled halon availability and non-halon alternatives.

* Publications and videos listings—a list of all publications produced or distributed by the OzonAction Programme is available. It is divided into identified needs of developing countries eligible for assistance in phasing out ODS under the Montreal Protocol. An extensive list of videos about ozone depletion and ODS phase out is also available.

The other major information resources produced by UNEP are international reviews of scientific and technical aspects of ozone depletion and the ODS phase-out process, prepared in conjunction with other international organizations. The reports are produced annually by international groups of experts operating under the Montreal Protocol. They offer the most comprehensive, up-to-date, coverage of the science of ozone depletion, its effects and technical options for ODS phaseout. Recent titles in the series include:

* *Scientific Assessment of Ozone Depletion: 1994.*

* *Environmental Effects of Ozone Depletion: 1994 Assessment.*

* *1994 Report of the UNEP Economic Options Committee: 1995 Assessment.*

* *Report of the UNEP Technology and Economics Assessment Panel: 1995 Assessment.*

* *1994 Report of the Technology and Economic Assessment Panel,* including Recommendations on Nominations for Essential Use Production/Consumption Exemptions for Ozone-Depleting Substances.

In addition to the reports covering general scientific and technical issues, a series of reports focus on specific sectors that use ODS:

* *Report of the UNEP Technical Options Committee for Aerosols, Sterilants, Miscellaneous Uses and Carbon Tetrachloride: 1994.*

* *1994 Report of the Flexible and Rigid Foams Technical Options Committee: 1995 Assessment.*

* *Report of the Halon Fire Extinguishing Agents Technical Options Committee: 1994.*

* *1994 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee: 1995 Assessment.*

* *1994 Report of the Methyl Bromide Technical Options Committee: 1995 Assessment.*

* *1994 Report of the Solvents, Coatings and Adhesives Technical Options Committee: 1995 Assessment.*

* *Handbook on Essential Use Nominations: Prepared by the Technology and Economic Assessment Panel: 1994.*

All UNEP Technical Options Committee Reports and Assessment Panel Reports can be obtained from the UNEP IE OzonAction Programme and the UNEP Ozone Secretariat.

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The Video Script

The script to *Saving the Ozone Layer: Every Action Counts* follows, including commentary and interviews. Entry times are shown in minutes and seconds. Suggested uses are as reference for presentations, or to copy and distribute to groups after a showing of the video.

[00:12] Ozone layer depletion, one of the many pressing environmental problems of today; a topic plunged in confusion and myth. But one thing is certain: if we don't stop destroying the ozone layer, everyone is going to feel the impact. Yet even now, some countries are actually stepping up the use of chemicals which are damaging the ozone layer. Why does it matter? And what should we be doing about it? That's what this film is all about.

[00:52] The basis for all life on Earth is the Sun. It gives us life, warmth and energy. But the Sun also has the power to destroy with its invisible ultraviolet rays.

[01:06] What protects us from these rays is a thin veil of gases—our atmosphere. Of this, a tiny fraction is ozone, which is scattered thinly through the stratosphere 15 to 50 kilometres above our Earth. It forms a fragile but effective shield against most ultraviolet radiation.

[01:27] Ozone is a special form of oxygen, which is in a constant state of flux. It breaks down and is regenerated in a natural balance. But now man-made chemicals are destroying ozone faster than it can be replaced. The shield is getting thinner and thinner, allowing more damaging ultraviolet rays to reach the Earth.

[01:52] People who spend much time in the Sun risk suffering from skin cancer, but that's just one of many consequences of a thinning ozone shield. Over time, too much light can harm even healthy eyes and if ozone depletion continues, many more people could suffer from the eye disease, cataract. Many may go blind.

[02:19] Animals might be affected as well. And there's no way to protect livestock that graze outside.

[02:30] Even our bodies' defence against disease may suffer. Imagine this were your child being vaccinated against a disease like tuberculosis. Under a thinning ozone layer, the Sun might make this vaccination less effective. Or the Sun might make the body less able to cope with an invading parasite such as malaria.

[02:55] No skin is strong enough to provide protection against the Sun's negative effects on the immune system. If the destruction of the ozone layer continues everyone will be at risk.

[03:11] What doesn't affect us directly could affect us in other ways, undermining the very basis for national and family security: food.

[03:23] Experiments that simulate ozone depletion have shown that increased ultraviolet radiation can stunt the growth of important food crops, such as these soya beans. Other plants have also been tested and many of them have been proved to be sensitive.

[03:46] Trees are vulnerable, too. Tests carried out on pine trees showed that they grew at half-speed when exposed to ultraviolet light. Slower tree growth could affect forestry. These effects on plants might also upset the balance in natural ecosystems.

[04:05] The first signs are already here. In Antarctica, plankton are being damaged every year when ozone levels are low. Plankton are the basic food in the sea. If there are less of them, it will mean hardship for all marine life and ultimately less fish.

[04:35] Fish are actually subject to a double threat. Not only is their primary food source endangered, but fish and shellfish larvae are very sensitive to ultraviolet radiation, and in shallow coastal waters, this makes them very vulnerable.

[04:52] The future could look this bleak, but disaster is not inevitable. We still have the power to halt the destruction of the ozone layer if we act fast. But first it is vital to understand what is happening in our sky.

[05:10] As far back as the 1970s, scientists sounded warnings that man-made chemicals called chlorofluorocarbons, or CFCs, were spreading through the atmosphere and eating away at the ozone layer. Despite these warnings, the problems were largely ignored. Then came the shock.

[05:25] In the mid 1980s the rate of ozone destruction had speeded up drastically and more than 50 per cent of the ozone layer was gone over the South Pole. This thinning of the ozone layer is commonly referred to as a 'hole', which reappears every southern spring. It now reaches into South America.

[05:54] Initially there was controversy as to what caused the hole, but scientific research has now proved that man-made chemicals containing chlorine and bromine are to blame, particularly CFCs and halons.

[06:13] Halons are found in fire-fighting systems and are so harmful that developed countries ceased production altogether in January 1994. CFCs are found everywhere; in refrigerators and freezers, spray cans, air conditioners, electronic cleaners and foams.

[06:39] CFCs have been widely used because they are such stable chemicals. But when they are released into the atmosphere, this very stability means that they can remain there for decades. Eventually, they will reach the stratosphere. Once there, ultraviolet radiation splits off the chlorine atoms from the CFC molecules and these then react with ozone, breaking it down to form oxygen and chlorine monoxide. The chlorine monoxide later reacts with free oxygen to reform chlorine and the cycle starts again. And again. And again. Each chlorine atom can destroy thousands of ozone molecules.

[07:22] The destruction of ozone is most severe over the Antarctic, because winters are extremely cold and ice clouds form in the stratosphere. The chlorine molecules build up on the ice crystals and, when the Sun returns in the spring, the ozone layer is primed for the destruction.

[07:40] Measurements in the northern hemisphere show that the same chemistry is at play, but due to the milder climate, the situation is not as bad as over Antarctica.

[07:51] Away from the poles, ozone depletion has not been as severe—not yet. But there are definitely enough CFCs in the atmosphere to cause concern.

[08:00] Mr K.M. Sarma, Coordinator, Ozone Secretariat: "The international community has been concerned about this issue since 1972. Many discussions have taken place since then, and in 1985 they expressed their determination to protect the ozone layer through the Vienna Convention. The first concrete step to curb consumption of ozone-depleting chemicals was taken in Montreal in 1987."

[08:27] As the case against CFCs has strengthened, so have the international efforts to get rid of them.

[08:33] Elizabeth Dowdeswell, Executive Director, UNEP: "The Montreal Protocol is a most remarkable global instrument. It's a legal agreement that was reached by developing and developed countries. It's a legal agreement that was reached by environmentalists, industrialists and governments alike. And what it does is commit all of us to take action to preserve the ozone layer. More than 150 countries have signed the agreement now and are taking action to ensure the number of compounds that deplete the ozone layer are covered by the agreement and that the phase out of these substances is accelerated."

[09:16] Worldwide commitment to current international agreements is rapidly reducing the yearly emissions of ozone depleting substances. But the danger isn't over. In developing countries with a growing demand for consumer products, many companies still use ozone-depleting substances.

[09:43] In China, a booming economy combined with a large population has led to the rapid development of the domestic refrigerator market. Estimates show that the demand for refrigerators will increase by 10 per cent in 1995. The negative environmental effects have been recognized, and China is now moving towards ozone-friendly technology.

[10:12] K.M. Sarma: "It's good that the industrialized countries are stopping consumption of CFCs. But that's not enough. There are many countries in the world, like India, China and Brazil, with huge populations—and with growing populations at that—and with economic growth rates of nearly 10 per cent every year. If they continue consuming these CFCs it [their CFC consumption] will double every five years, and soon they will reach a level the industrialized nations attained a few years ago."

[10:43] Every country, company and consumer must take responsibility now for stopping the use of CFCs if the ozone layer is to be saved. And phasing out CFCs actually stands to benefit industry. Already, CFCs are becoming scarce and expensive, so companies are finding that ozone-friendly technology makes economic sense. Trade restrictions in the Montreal Protocol will also limit supplies. Growing consumer pressure adds to the need for a change in direction.

[11:18] The alternatives are already there. In the refrigeration industry, new cooling systems have been developed and CFC-free refrigerators are already on sale.

[11:34] In the insulation industry, harmless blowing agents are used to make CFC-free foams, or foam is replaced by materials such a glass wool. In electronics production, water-based technologies replace harmful cleaners, and alternatives can be used instead of halons to fight fires. Even better would be more adequate fire prevention measures.

[11:58] Maintenance helps prevent emissions. Releases should be avoided while testing systems. Air conditioners in buildings and cars should have leaks plugged, and old equipment has to be taken care of—not dumped.

[12:12] K.M. Sarma: "All of us can do a lot to help; for example, we need not emit the CFCs in existing equipment into the atmosphere. We can instead recover and recycle the same CFCs into other equipment. We can prolong the life of the equipment and also benefit the environment and benefit economically ourselves."

[12:39] According to the Montreal Protocol, developed countries must phase out CFC production by January 1996. Developing nations have a 10-year grace period to give them time to switch technology and to stop the use of these substances. The Protocol has also established the Multilateral Fund to provide technical and financial assistance to these countries.

[13:05] Dr Omar El-Arini, Chief Officer, Multilateral Fund: "The Multilateral Fund was established to assist developing countries to phase out ozone-depleting substances in order to protect the ozone layer."

[13:14] The Fund is made up of contributions from industrialised countries. It provides money for the development and implementation of projects as well as technical expertise and assistance, information on new technologies, training and demonstration programmes.

[13:32] Omar El-Arini: “You actually can have economic benefits by switching from ozone-depleting chemicals to ozone-friendly chemicals, and these economic benefits are immediately realisable—it is not fictitious.”

[13:50] This economic reality alone proved to be a sufficient incentive for Malaysia, which is one of the developing countries committed to phasing out CFCs ahead of the Montreal Protocol.

[14:04] Ismail Ithnin, Department of the Environment, Malaysia: “Malaysia has a vision by the year 2020 of being a developed country. So we believe that the use of ozone-friendly technology is one of the best ways that industry can help the government to achieve this 2020 vision.”

[14:23] Elizabeth Dowdeswell: “Through our networking, through our information sharing, through our transfer of technology, we know that this message is getting through to others around the world. And that’s important. That’s how it should be because for all of us the preservation of the ozone layer is critical, not only to our own health, the environment in which we live and the economies in which we depend, but it’s also important for the future of our children and grandchildren.”

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