



vital  
**ozone**  
graphics

A graphic of the Earth's ozone layer, showing a cross-section of the atmosphere. The ozone layer is depicted as a yellow and red ring surrounding the Earth. The Earth is shown in red and white, with a white outline of the continents. The graphic is set against a background of a blue sky with white clouds.

resource kit for journalists

UNEP DTIE OzonAction    UNEP/GRID-Arendal



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vital ozone graphics website:

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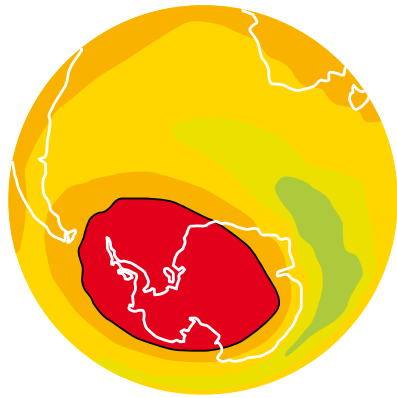
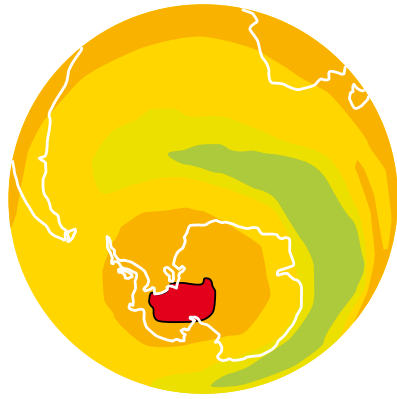
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## a note for journalists

*Vital Ozone Graphics* is designed to be a practical tool for journalists who are interested in developing stories related to ozone depletion and the Montreal Protocol. Besides providing a basic introduction to the subject, this publication is meant to encourage you to seek further information from expert sources and to provide you with ready-made visual images that can be incorporated into your article.

All of the graphics you see in this publication are available online free of charge at [www.vitalgraphics.net/ozone](http://www.vitalgraphics.net/ozone). The graphics can be downloaded in different formats and resolutions, and are designed in such a way that they can easily be translated into local languages.

The on-line version also features additional materials such as story ideas, contacts, a comprehensive glossary and more links to information related to the ozone hole. Please choose what's relevant to you.

UNEP DTIE OzonAction and UNEP/GRID-Arendal would appreciate receiving a copy of any material using these graphics. Please send an e-mail to [ozonaction@unep.fr](mailto:ozonaction@unep.fr) and [ozone@grida.no](mailto:ozone@grida.no).

### \*\* NEWS FLASH \*\*

ON 1 JULY 2007, CHINA, THE WORLD'S LARGEST PRODUCER OF CHLOROFLUOROCARBONS (CFC) AND HALON, SHUT DOWN FIVE OF ITS SIX REMAINING PLANTS, PUTTING THE COUNTRY TWO AND A HALF YEARS AHEAD OF THE MONTREAL PROTOCOL'S 2010 DEADLINE FOR PHASE-OUT OF THE TWO OZONE DEPLETING CHEMICALS. THE REMAINING PRODUCTION OF SOME 500 TONNES PER YEAR IS BEING KEPT STRICTLY TO PRODUCE CFCs FOR METERED-DOSE INHALERS, USED IN THE TREATMENT OF ASTHMA AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE.

NEW STUDIES CONFIRM THE TREMENDOUS CONTRIBUTION OF THE MONTREAL PROTOCOL TO MITIGATING CLIMATE CHANGE. BY PHASING OUT CFCs, HCFCs AND OTHER CHEMICALS UNDER THE MONTREAL PROTOCOL, MORE THAN 5 GIGA TONS EQUIVALENT OF CO<sub>2</sub> HAVE ALREADY BEEN ELIMINATED -- REPRESENTING MORE THAN 25% OF THE WORLD'S GREENHOUSE GASES EMISSIONS COMPARED TO 1990. THIS SURPASSES THE KYOTO PROTOCOL'S TARGET OF REDUCING GHGS BY 5 TIMES.

THE MILLENNIUM DEVELOPMENT GOALS REPORT 2007, ISSUED BY THE HIGHEST LEVEL OF THE UNITED NATIONS SYSTEM, HIGHLIGHTS THE CONTRIBUTION OF THE MONTREAL PROTOCOL TO ENSURING ENVIRONMENTAL SUSTAINABILITY, ONE OF 8 TIME-BOUND AND MEASURABLE GOALS AGREED TO BY ALL 191 UNITED NATIONS MEMBER STATES. IT CONFIRMS THAT THE GLOBAL EFFORT TO ELIMINATE OZONE-DEPLETING SUBSTANCES IS WORKING, THOUGH DAMAGE TO THE OZONE LAYER WILL PERSIST FOR SOME TIME.

**\*\* LATEST ACHIEVEMENT DATA \*\***

BY THE END OF 2005, 191 PARTIES TO THE MONTREAL PROTOCOL HAD OVERALL ACHIEVED A 95% REDUCTION IN THEIR CONSUMPTION OF OZONE DEPLETING SUBSTANCES COMPARED TO THE BASELINE LEVELS ESTABLISHED BY THE MONTREAL PROTOCOL.

THE PHASE OUT IN DEVELOPED COUNTRIES (NON-ARTICLE 5) IS 99.2% AND THAT IN DEVELOPING COUNTRIES (ARTICLE 5) IS 80%.

THE REMAINING PHASE OUT IS 88,000 ODP TONNES OF ANNUAL CONSUMPTION OF WHICH 76,000 ODP TONNES IS IN ARTICLE 5 COUNTRIES.

THE REMAINING PHASE OUT OF ODS IN NON-ARTICLE 5 COUNTRIES IS MOSTLY HCFCS AND METHYL BROMIDE.

THE MULTILATERAL FUND ESTABLISHED TO PROVIDE FINANCIAL AND TECHNICAL ASSISTANCE TO DEVELOPING COUNTRIES (ARTICLE 5) HAS BEEN THE MOST SUCCESSFUL UNITED NATIONS FUND TO DATE. IT HAS BEEN CONTRIBUTED REGULARLY BY THE NON-ARTICLE 5 COUNTRIES TO THE EXTENT OF MORE THAN 85% OF THEIR PLEDGES. IT HAS SO FAR ALLOCATED US\$ 2.2 BILLION TO PROJECTS AND ACTIVITIES IN ARTICLE 5 COUNTRIES. ANOTHER US\$ 170 MILLION HAVE BEEN PROVIDED BY THE GLOBAL ENVIRONMENT FACILITY (GEF) FOR COUNTRIES WITH ECONOMIES IN TRANSITION.

THERE HAS BEEN AN UNPRECEDENTED COLLABORATION BETWEEN MULTILATERAL FUND IMPLEMENTING AGENCIES, I.E. UNDP, UNEP, UNIDO, WORLD BANK, TO ASSIST DEVELOPING COUNTRIES. THOSE AGENCIES HAVE PRODUCED A BOOKLET WITH THE TITLE "PARTNERSHIPS CHANGING THE WORLD".

# f o r e w o r d

## foreword

On 16 September 1987, the treaty known as the Montreal Protocol on Substances that Deplete the Ozone Layer was signed into existence by a group of concerned countries that felt compelled to take action to solve an alarming international environmental crisis: the depletion of the Earth's protective ozone layer. Since that humble beginning two decades ago, this treaty has taken root, grown and finally blossomed into what has been described as "Perhaps the single most successful international environmental agreement to date". It has become an outstanding example of developing and developed country partnership, a clear demonstration of how global environmental problems can be managed when all countries make determined efforts to implement internationally-agreed frameworks. But why has it worked so well, how has it impacted our lives, what work lies before us, and what lessons we can learn from it?

The story of the Montreal Protocol is really a collective of hundreds of compelling and newsworthy individual stories which are waiting for the right voice. There are cautionary tales of the need to avoid environmental problems at the start. There are inspiring stories of partnership, innovation and countries working together for the common good. There are stories of hope, of humanity being able to successfully reverse a seemingly insurmountable environmental problem while balancing economic and societal needs. Beyond numbers and statistics, the Montreal Protocol is above all a story with a human face, showing how the consequences of a global environmental issue can affect us as individuals – our health, our families our occupations, our communities – and how we as individuals can be part of the solution.

This year, the 20th anniversary of this landmark agreement, affords us all the opportunity to investigate these stories. Each country and region, their institutions and individuals, have all made major contributions to the protection of the ozone layer, and their stories must be told. We want to enlist the help of journalists in telling this story, and through this publication, we are trying to assist in these broad communications efforts.

This *Vital Ozone Graphics*, the youngest product in a series of Vital Graphics on environmental issues, provides journalists with the essential visuals, facts, figures and contacts

they need to start developing their own ozone story ideas. The graphics and figures can be used in articles ready-made. We want the information in this publication and the associated web site to inform and inspire journalists to go out and investigate this story and to tell the ozone tale – the good and the bad – to readers, viewers or listeners.

*Vital Ozone Graphics* was produced jointly by the Ozone-Action Branch of UNEP's Division on Technology, Industry and Economics (DTIE) and UNEP/GRID-Arendal, as part of an initiative to engage journalists on the ozone story, with support provided by the Multilateral Fund for the Implementation of the Montreal Protocol.

While specifically targeted at members of the media, we believe that anyone interested in learning about the Montreal Protocol and ozone layer depletion will find this publication to be an interesting and insightful reference.

I hope the reading of the coming pages is not only enjoyable, but will stimulate the creative juices of the media and trigger broader coverage of the ozone protection efforts in newspapers and on radio, TV and the Internet across around globe.

**Achim Steiner,**  
United Nations Under-Secretary General  
Executive Director, United Nations Environment Programme



# the hole

## a damaged uv shield

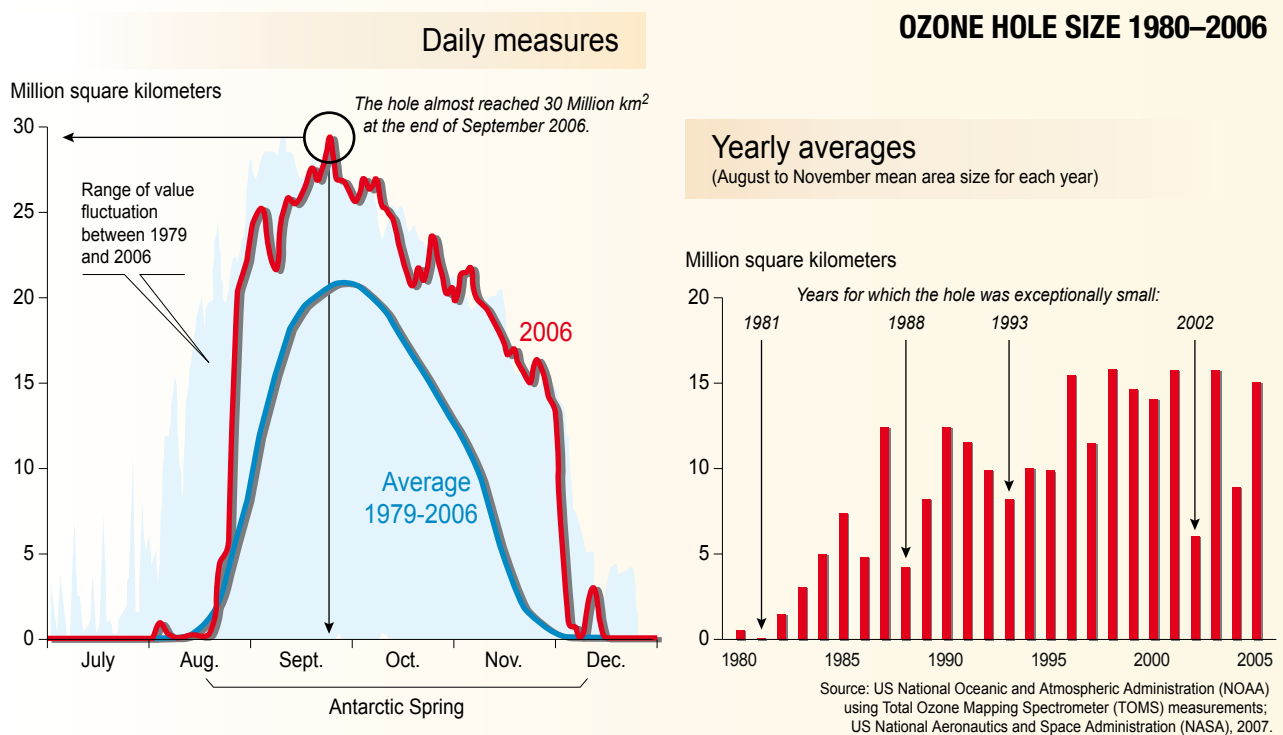
Hovering some 10 to 16 kilometres above the planet's surface, the ozone layer filters out dangerous ultraviolet (UV) radiation from the sun, thus protecting life on Earth. Scientists believe that the ozone layer was formed about 400 million years ago, essentially remaining undisturbed for most of that time. In 1974, two chemists from the University of California startled the world community with the discovery that emissions of man-made chlorofluorocarbons (CFCs), a widely used group of industrial chemicals, might be threatening the ozone layer.

The scientists, Sherwood Rowland and Mario Molina, postulated that when CFCs reach the stratosphere, UV radiation from the sun causes these chemically-stable substances to decompose, leading to the release of chlorine atoms. Once freed from their bonds, the chlorine atoms initiate a chain reaction that destroys substantial amounts of ozone in the stratosphere. The scientists estimated that a single chlorine atom could destroy as many as 100,000 ozone molecules.

The theory of ozone depletion was confirmed by many scientists over the years. In 1985 ground-based measurements by the British Antarctic Survey recorded massive ozone loss (commonly known as the "ozone hole") over the Antarctic, providing further confirmation of the discovery. These results were later confirmed by satellite measurements.

The discovery of the "ozone hole" alarmed the general public and governments and paved the way for the adoption in 1987 of the treaty now known as the Montreal Protocol on Substances that Deplete the Ozone Layer. Thanks to the Protocol's rapid progress in phasing out the most dangerous ozone-depleting substances, the ozone layer is expected to return to its pre-1980s state by 2060–75, more than 70 years after the international community agreed to take action. The Montreal Protocol has been cited as "perhaps the single most successful international environmental agreement to date" and an example of how the international community can successfully cooperate to solve seemingly intractable global environmental challenges.

The ozone layer over the Antarctic has been thinning steadily since the ozone loss predicted in the 1970s was first observed

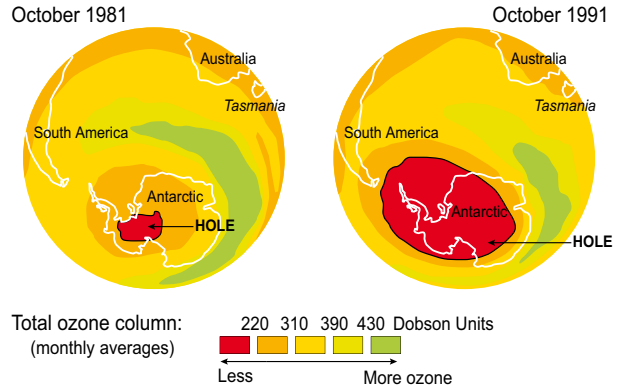


The extent of ozone depletion for any given period depends on complex interaction between chemical and climatic factors such as temperature and wind. The unusually high levels of depletion in 1988, 1993 and 2002 were due to early warming of the polar stratosphere caused by air disturbances originating in mid-latitudes, rather than by major changes in the amount of reactive chlorine and bromine in the Antarctic stratosphere.

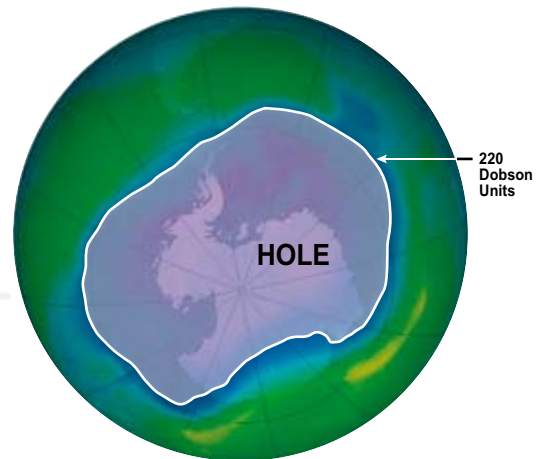


in 1985. The area of land below the ozone-depleted atmosphere increased steadily to encompass more than 20 million square kilometres in the early 1990s, and has varied between 20 and 29 million square kilometres since then. Despite progress achieved under the Montreal Protocol, the ozone “hole” over the Antarctic was larger than ever in September 2006. This was due to particularly cold temperatures in the stratosphere, but also to the chemical stability of ozone-depleting substances – it takes about 40 years for them to break down. While the problem is worst in the polar areas, particularly over the South Pole because of the extremely low atmospheric temperature and the presence of stratospheric clouds, the ozone layer is thinning all over the world outside of the tropics. During the Arctic spring the ozone layer over the North Pole has thinned by as much as 30 per cent. Depletion over Europe and other high latitudes has varied from 5 to 30 per cent.

### THE ANTARCTIC HOLE



September 24, 2006



From September 21-30, 2006, the average area of the ozone hole was the largest ever observed.

Source: US National Oceanic and Atmospheric Administration (NOAA) using Total Ozone Mapping Spectrometer (TOMS) measurements; US National Aeronautics and Space Administration (NASA), 2007.

**story ideas**

#1a. Knowing that ozone depletion will not return to pre-1980 levels until 2060 or 2070, what do scientists anticipate will be the impacts on human health?

#1b. Scientists have been conducting research in Antarctica for years. Have any studied the effects that the “ozone hole” has had/is having on the ecology of Antarctica?

#1c. Arctic warming is being described as attributable to climate change. To what extent is ozone depletion a contributing factor? What impacts do scientists working in the Arctic think that ozone depletion in the Arctic may be having on Arctic biodiversity? Or on residents of, e.g., Greenland?

### stratospheric ozone, tropospheric ozone and the ozone “hole”

Ozone forms a layer in the stratosphere, thinnest in the tropics and denser towards the poles. The amount of ozone above a point on the earth’s surface is measured in Dobson units (DU) – it is typically ~260 DU near the tropics and higher elsewhere, though there are large seasonal fluctuations. Ozone is created when ultraviolet radiation (sunlight) strikes the stratosphere, dissociating (or “splitting”) oxygen molecules (O<sub>2</sub>) into atomic oxygen (O). The atomic oxygen quickly combines with oxygen molecules to form ozone (O<sub>3</sub>).

The ozone hole is defined as the surface of the Earth covered by the area in which the ozone concentration is less than 220-Dobson units (DU). The largest area

observed in recent years covered 25 million square kilometres, which is nearly twice the area of the Antarctic. The lowest average values for the total amount of ozone inside the hole in late September dropped below 100 DU.

At ground level, ozone is a health hazard – it is a major constituent of photochemical smog. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents as well as natural sources emit NO<sub>x</sub> and volatile organic compounds (VOCs) that help form ozone. Ground-level ozone is the primary constituent of smog. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air.

# the culprits 1

## ozone depleting substances

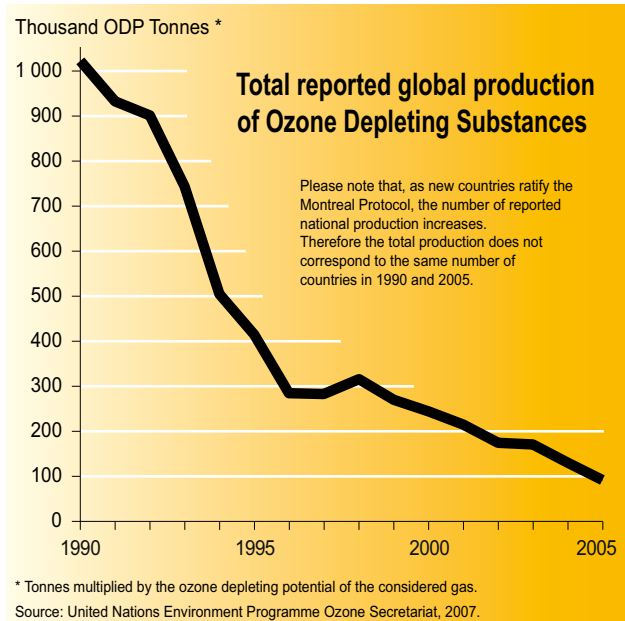
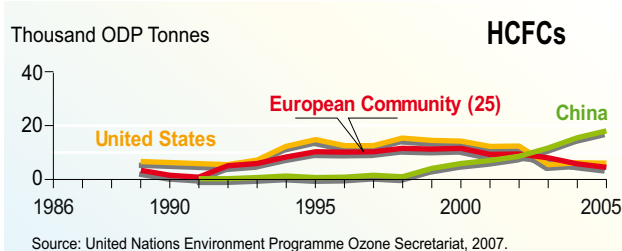
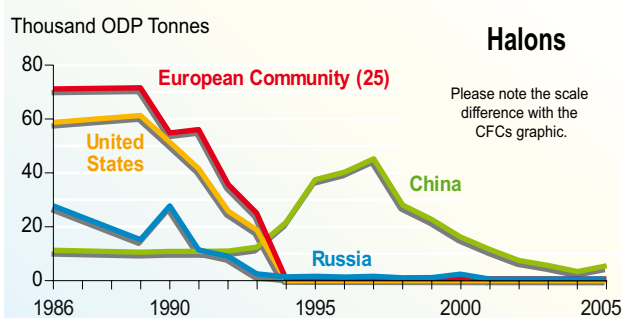
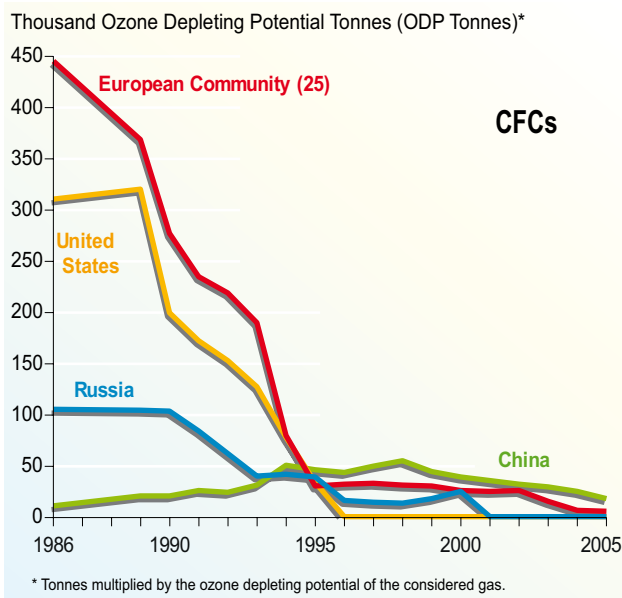
When they were discovered in the 1920s, CFCs and other ozone depleting substances (ODS) were “wonder” chemicals. They were neither flammable nor toxic, were stable for long periods and ideally suited for countless applications. By 1973, when scientists discovered that ODS could destroy ozone molecules and damage the shield protecting our atmosphere, they had become an integral part of modern life.

We would get up in the morning from a mattress containing CFCs and turn on a CFC-cooled air conditioner. The hot water in the bathroom was supplied by a heater insulated with CFC-containing foam, and the aerosol cans

containing deodorant and hair spray used CFC propellants. Feeling hungry we would open the fridge, also insulated with CFCs. Methyl bromide had been used to grow those tempting strawberries, not to mention many other foodstuffs consumed every day. Nor would there be any escape in the car, with CFCs nesting in the safety foam in the dashboard and steering wheel. At work it was much the same, with halons used extensively for fire protection in offices and business premises, as well as in data centres and power stations. Ozone depleting solvents were used in dry cleaning, and to clean metal parts in almost all electronic devices, refrigerating equipment and cars. They also played a part in tasks such as laminating wood for desks, bookshelves and cupboards.

Since the discovery of their destructive nature, other substances have gradually replaced ODS. In some cases it is difficult to find and costly to produce replacements, which may have undesirable side-effects or may not be applicable for every use. Experts and the public need to remain vigilant to ensure replacements do not cause adverse health effects, safety concerns, or other environmental damage (for example global warming). As is often the case, the last mile on the road to complete elimination is the most difficult one.

### PRODUCTION OF MAIN ODS GASES



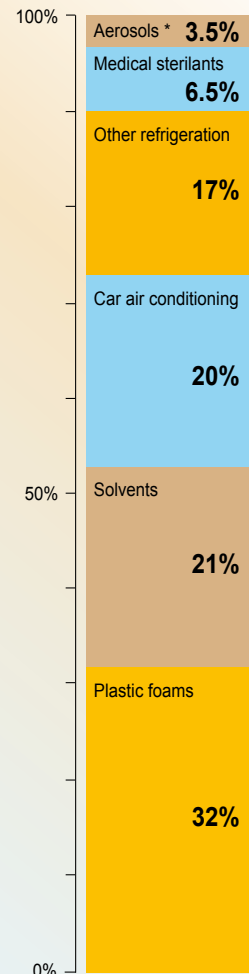
ODS can escape during use (for example when used in aerosol sprays), or are released at the end of the lifetime of a equipment if proper care is not taken during its disposal. They can be captured, recycled and re-used if proper procedures are followed by servicing technicians and equipment owners. Disposing of ODS is possible, though it is relatively costly and laborious. These chemicals must be destroyed using one of the destruction processes approved by the Parties to the Montreal Protocol.

Most commonly used ozone depleting substances and their replacements			
Substance	Characteristics	Uses	Alternatives
Chlorofluorocarbons (CFCs)	Long lived, non toxic, non corrosive, and non flammable. They are also versatile. Depending on the type of CFC, they remain in the atmosphere from between 50 to 1700 years.	Refrigerants, cleaning solvents, manufacture of aerosol sprays, blowing agents for plastic foam.	<i>Hydrofluorocarbons</i> (HFCs) do not deplete stratospheric ozone, but they are greenhouse gases. <i>Hydrochlorofluorocarbons</i> (HCFCs) do also deplete the ozone layer, but to a much lesser extent. They are being phased out as well. Hydrocarbons are ozone- and climate friendly substances, they are however toxic and flammable, which limits their applications.
Halons	Atmospheric lifetime of 65 years.	Mobile fire extinguishers, Fire suppression systems in places such as computer rooms and airplanes, explosion protection.	
Carbon Tetrachloride		Industrial cleaning solvent, feedstock. As its use as a feedstock results in the chemical being destroyed and not emitted, this use is not controlled by the Montreal Protocol.	
Methyl chloroform (CHCl <sub>3</sub> )	Toxic. Takes about 5.4 years to break down.	Industrial solvent for cleaning, inks, correction fluid.	
Methyl bromide (CH <sub>3</sub> Br)	Takes about 0.7 years to break down.	Fumigant used to kill soil-borne pests and diseases in crops prior to planting and as disinfectants in commodities such as stored grains or agricultural commodities awaiting export.	Soil solarisation: a plastic cover of a certain thickness on the soil has a pasteurizing effect on the soil. Good results of eliminating harmful pests from the soil are also achieved by mixing residues from certain plant species (marigold – tagetes) varieties. The organic material breaking down in the soil is toxic for certain pests. The method of heating the soil for 30 minutes with steam is expensive and energy-intensive and thus not a real alternative. Soil-less cultures are another option as well as the breeding of pest-resistant varieties.
Hydrochlorofluorocarbons (HCFCs)	Transitional CFC replacements HCFCs deplete stratospheric ozone, but to a much lesser extent than CFCs; however, they are greenhouse gases.	Refrigerants, solvents, blowing agents for plastic foam manufacture, and fire extinguishers.	

Source: US EPA 2006

### CFC END USES IN THE US IN 1987

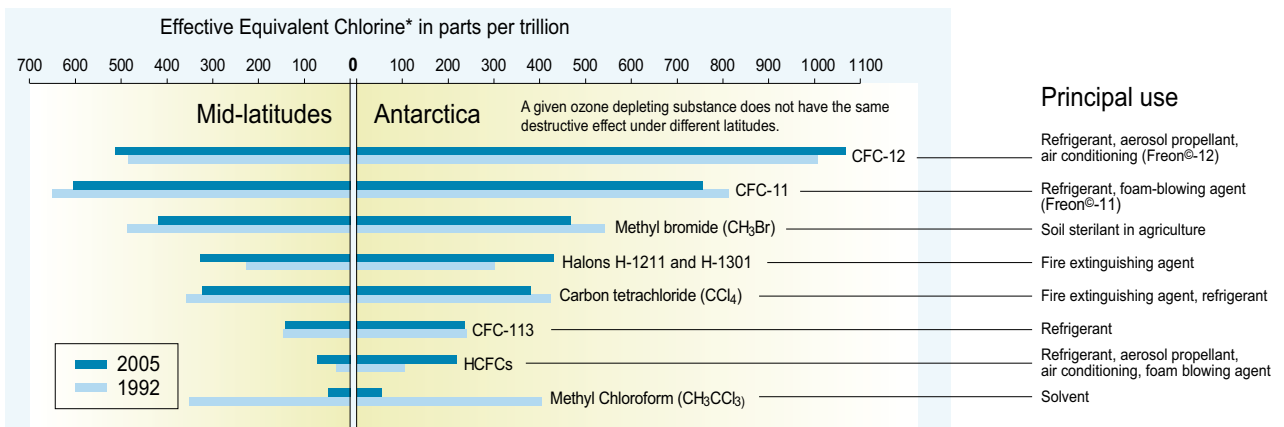
In percentage of all CFC uses



\* Note that CFCs in aerosols were banned in the US in 1978.

Source: US Environmental Protection Agency, 1992 (cited by WRI 1996).

### DESTRUCTIVE POTENTIAL OF OZONE DEPLETING SUBSTANCES



\* Chlorine and bromine are the molecules responsible for ozone depletion. "Effective chlorine" is a way to measure the destructive potential of all ODS gases emitted in the stratosphere.

Between 1992 and 2005, the destructive potential of methyl chloroform has substantially decreased.

Source: David J. Hofmann, Stephen A. Montzka, *The NOAA ozone depleting gas index*, 2006.

# the culprits 2

## higher temperatures, polar stratospheric clouds and a changing climate

For a long time, depletion of the ozone layer and climate change were treated by legal agreements as two separate problems. But now the causes and effects of these two global environmental threats are seen by scientists, policy makers and the private sector as being inextricably linked, as indeed are the solutions to the problems.

Ozone depletion and climate change are linked in many ways, through their effects on physical and chemical processes in the atmosphere, as well as interaction between the atmosphere and the rest of the global ecosystem. Changes in temperature and other natural and human-induced climatic factors such as cloud cover, winds and precipitation impact directly and indirectly on the scale of the chemical reactions that fuel destruction of the ozone in the stratosphere. Recent research indicates that climate change by 2030 may surpass CFCs as the main cause of overall ozone loss.

On the other hand the fact that ozone absorbs solar radiation means it counts as a greenhouse gas (GHG), much as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O)

and halogen source gases. Stratospheric ozone depletion and increases in global ozone near the Earth's surface (tropospheric ozone) in recent decades contribute to climate change. The 2006 report by the Environmental Effects Assessment Panel takes this into account, focusing its assessment on interaction with climate change (see references for full report).

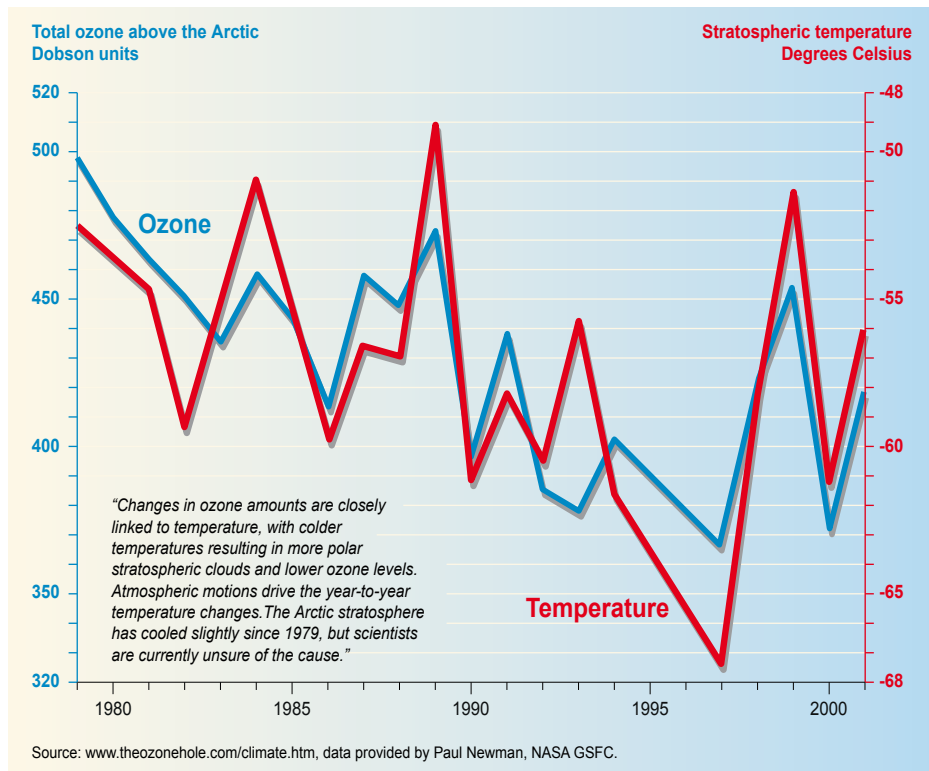
Above all the evidence suggests that continued intense cooperation is needed between Parties to the Montreal and Kyoto Protocols for both of these international agreements to succeed, and for a sustainable future. The situation calls for joint responsibility, coordinated policies and integrated solutions that support the objectives of both treaties.

### story ideas

#3a. Climate change story: Just as we appear to be making progress turning back ozone depletion, scientists believe increasingly that climate change is itself a driver of ozone depletion and in fact may surpass CFCs as the leading cause of ozone depletion by 2030.

#3b. Climate change story (different spin): Increased warming in certain parts of the world threatens to increase demand for refrigerants, which would further deplete the ozone layer and further accelerate climate change.

## ARCTIC OZONE DEPLETION AND STRATOSPHERIC TEMPERATURE



This graph shows total ozone and stratospheric temperatures over the Arctic since 1979. Changes in ozone amounts closely follow temperature, with colder temperatures resulting in more polar stratospheric clouds that intensify ozone destruction. See also [www.vitalgraphics.net/ozone](http://www.vitalgraphics.net/ozone): (questions on the scientific assessment 2006 update, figure Q18–1–20) Radiative forcing of climate change from atmospheric gas changes.

### major links between ozone depletion and climate change

Many of the man-made ozone depleting chemicals (e.g. CFCs and HCFCs) and their replacements (e.g. HFCs) are potent greenhouse gases.

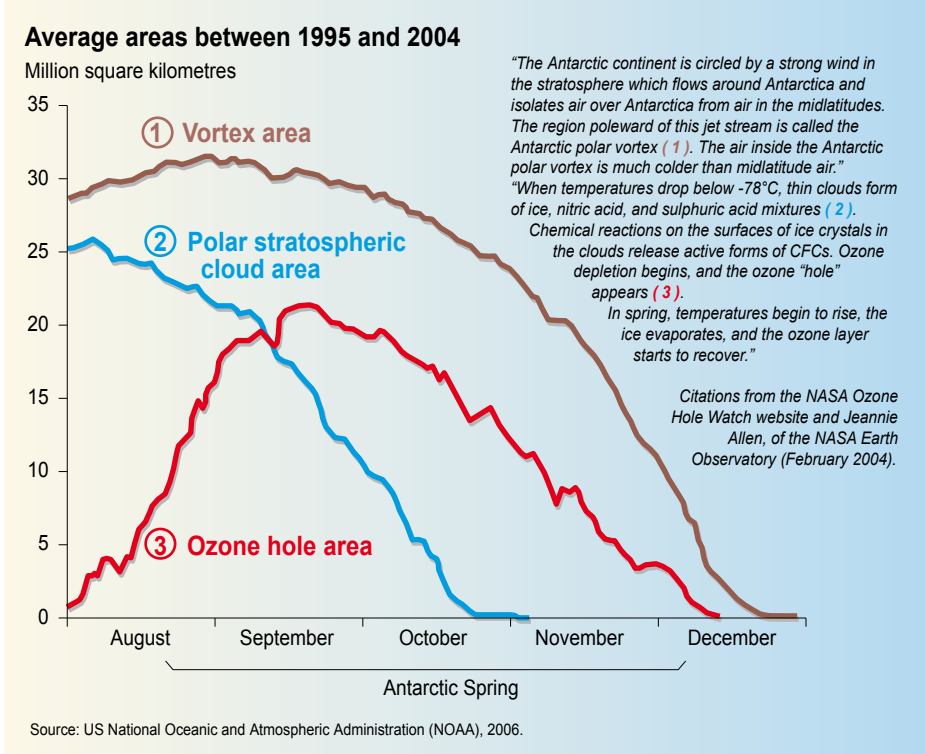
The build-up of GHGs, including ODS and their replacements, is known to enhance warming of the lower atmosphere, called the troposphere (where weather systems occur) and is also expected, on balance, to lead to cooling of the stratosphere.

Stratospheric cooling creates a more favourable environment for the formation of polar stratospheric clouds, which are a key factor in the development of polar ozone holes. Cooling of the stratosphere due to the build-up of GHGs and associated climate change is therefore likely to exacerbate destruction of the ozone layer.

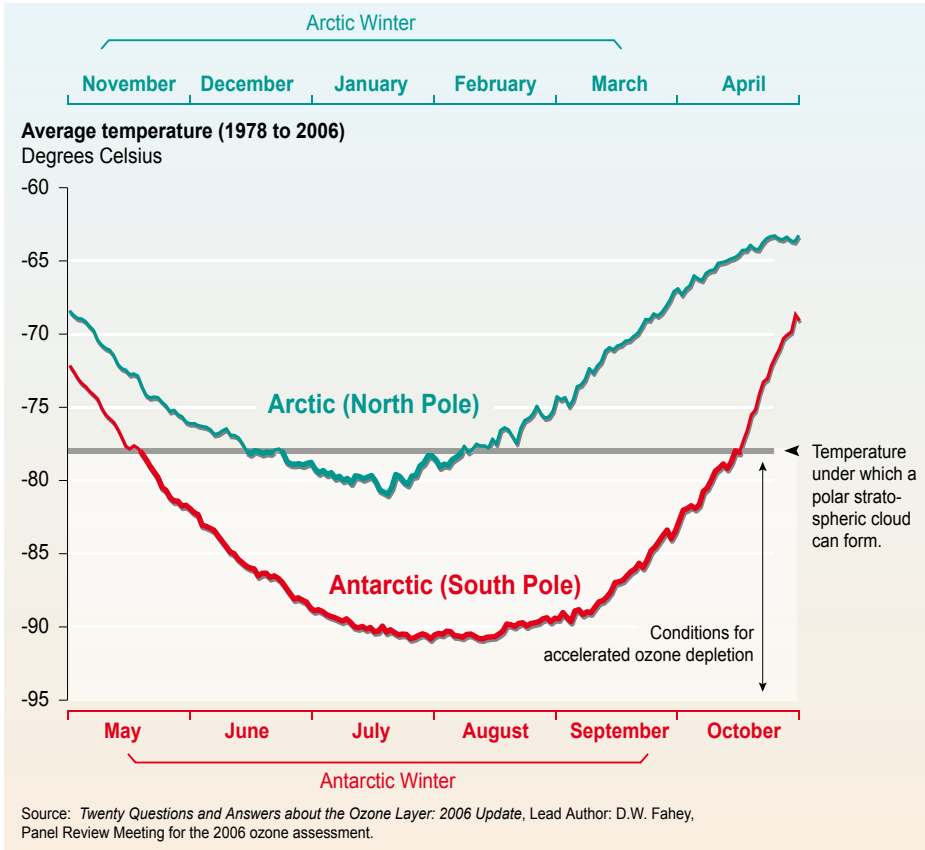
The troposphere and stratosphere are not independent of one another. Changes in the circulation and chemistry of one can affect the other. Changes in the troposphere associated with climate change may affect functions in the stratosphere. Similarly changes in the stratosphere due to ozone depletion can affect functions in the troposphere in intricate ways that make it difficult to predict the cumulative effects.

Source: EIA (2006). Turning up the Heat

## THE "HOLE": A RESULT OF SPECIAL WEATHER CONDITIONS OVER THE POLE REPEATED EVERY SPRING

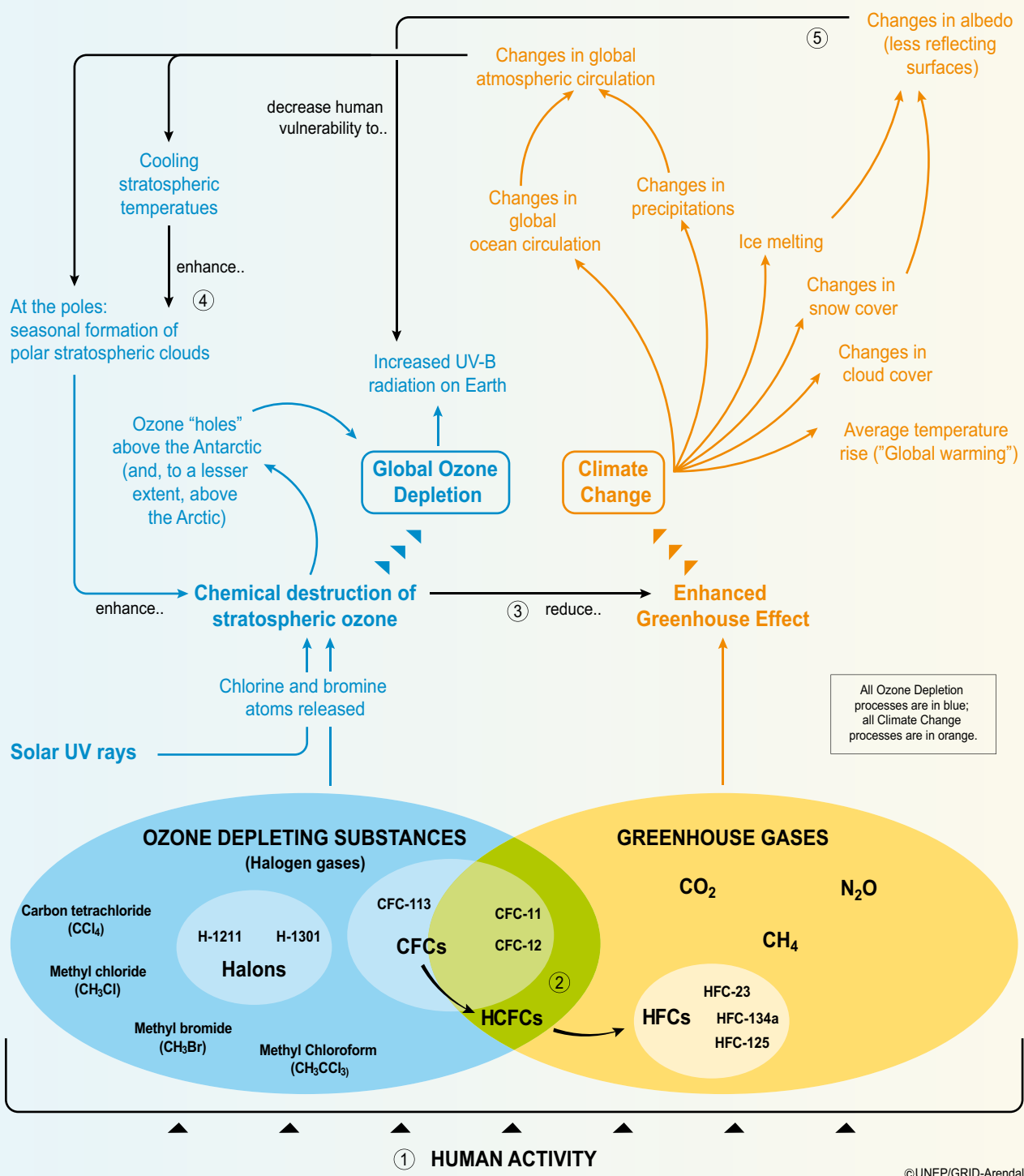


## THE COLDER ANTARCTIC WINTER DRIVES FORMATION OF THE HOLE IN THE SOUTH





## OZONE DEPLETION AND CLIMATE CHANGE



Ozone depletion and climate change are two distinct problems but as they both modify global cycles, they cannot be totally separated. There are still many uncertainties concerning the relations between the two processes. Several links have been identified, in particular:

- ① Both processes are due to human-induced emissions.
- ② Many ozone depleting substances are also greenhouse gases, like CFC-11 and CFC12. HFCs, promoted to substitute CFCs, are sometimes stronger greenhouse gases than the CFCs they are replacing, but do not deplete the ozone layer. This fact is taken into account in the negotiations and decisions in both the Montreal and the Kyoto Protocol.
- ③ Ozone itself is a greenhouse gas. Therefore, its destruction in the stratosphere indirectly helps to cool the climate, but only to a small extent.
- ④ The global change in atmospheric circulation could be the cause of the recently observed cooling of stratospheric temperature. These low temperatures drive the formation of polar stratospheric clouds above the poles in the winter, greatly enhancing chemical ozone destruction and the formation of the "hole".
- ⑤ Human vulnerability to UV-B radiation is related to the albedo. The global warming context reduces white surfaces that are more likely to harm us.



# consequences and effects 1

## uv radiation and human health

We need the sun: psychologically, because sunlight warms our hearts; physically, because our body needs it to produce vitamin D, essential to the healthy development of our bones. Yet increased doses of ultraviolet rays penetrating the ozone layer and reaching the surface of the Earth can do a lot of harm to plants, animals and humans.

Over thousands of years humans have adapted to varying intensities of sunlight by developing different skin colours. The twin role played by the skin – protection from excessive UV radiation and absorption of enough sunlight to trigger the production of vitamin D – means that people living in the lower latitudes, close to the Equator, with intense UV radiation, have developed darker skin to protect them from the damaging effects of UV radiation. In contrast, those living in the higher latitudes, closer to the poles, have developed fair skin to maximize vitamin D production.

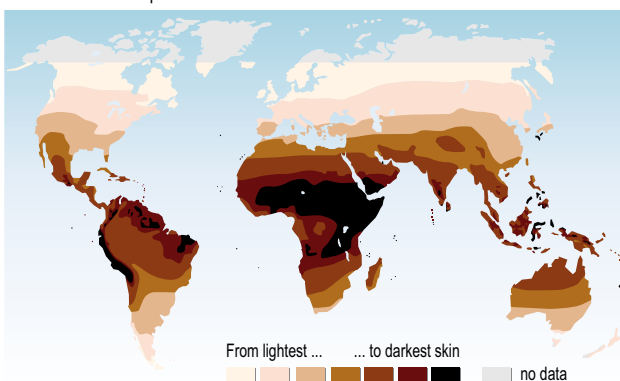
### who is most at risk?

In the last few hundred years however, there has been rapid human migration out of the areas in which we evolved. Our skin colour is no longer necessarily suited to the environment in which we live. Fair skinned populations who have migrated to the tropics have suffered a rapid rise in the incidence of skin cancers.

Behavioural and cultural changes in the 20th century have meant that many of us are now exposed to more UV radiation than ever before. But it may also result in inad-

### Skin colour map (indigenous people)

Predicted from multiple environmental factors



Source: Chaplin G.®, *Geographic Distribution of Environmental Factors Influencing Human Skin Coloration*, *American Journal of Physical Anthropology* 125:292–302, 2004; map updated in 2007.

### story ideas

#4a. Could break the issue down to look at specific health issues, e.g., eyes.

#4b. Could potentially break the issue down regionally and look at health threats from ozone from an environmental justice perspective in, say, Africa. Africa produces no ODSs, consumes few and bears disproportionate health risks as a high percentage of its populations are trying to cope with HIV.

#4c. Are some races or ethnicities particularly vulnerable? Potentially interesting, if there is recent and underreported science in this area.

equate exposure to the sun which damages our health in other ways.

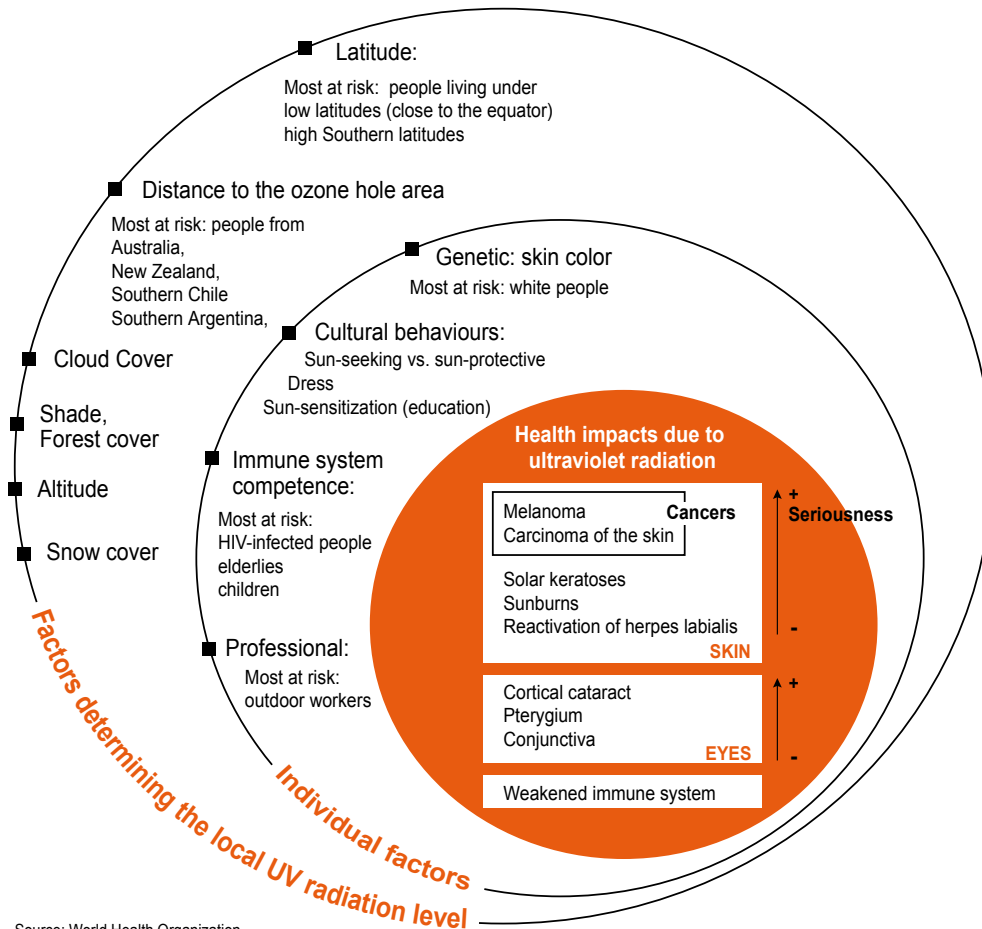
Many people from the higher latitudes grill their skin intensely in the sun during their short summer holidays, but only get minimal exposure to the sun for the rest of the year. Such intermittent exposure to sunlight seems to be a risk factor. On the other hand populations with darker skin pigmentation regularly exposed to similar or even higher UV rays are less prone to skin damage.

### what damage is done?

The most widely recognised damage occurs to the skin. The direct effects are sun burn, chronic skin damage (photo-aging) and an increased risk of developing various types of skin cancer. Models predict that a 10 per cent decrease in the ozone in the stratosphere could cause an additional 300,000 non-melanoma and 4,500 (more dangerous) melanoma skin cancers worldwide annually.

At an indirect level UV-B radiation damages certain cells that act as a shield protecting us from intruding carriers

### VULNERABILITIES



Source: World Health Organization, Global burden of disease from solar ultraviolet radiation, 2006.

of disease. In other words it weakens our immune system. For people whose immune system has already been weakened, in particular by HIV-Aids, the effect is aggravated, with more acute infections and a higher risk of dormant viruses (such as cold sores) erupting again.

UV radiation penetrates furthest into our bodies through our eyes, which are particularly vulnerable. Conditions such as snow blindness and cataracts, which blur the lens and lead to blindness, may cause long-term damage to our eyesight. Every year some 16 million people in the world suffer from blindness due to a loss of transparency in the lens. The World Health Organisation (WHO) estimates that up to 20 per cent of cataracts may be caused by overexposure to UV radiation and could

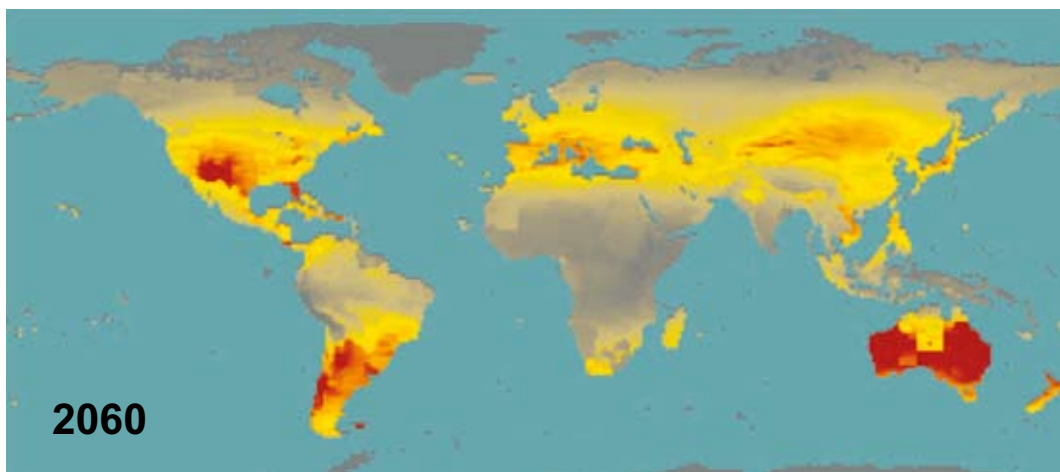
therefore be avoided. The risk of UV radiation-related damage to the eye and immune system is independent of skin type.

#### no reason for reduced attention

Simple counter-measures (see chapter 9) can control the direct negative effects of UV radiation on our health. But that is no reason to reduce our efforts to reverse destruction of the ozone layer. It is difficult to foresee the indirect effects such profound changes in the atmosphere may have on our living conditions. Changes to plants or animals might affect mankind through the food chain, and the influence of ozone depleting substances on climate change might indirectly affect our ability to secure food production.

### Number of extra skin cancer cases related to UV radiation

Per million inhabitants per year  
0 30 60 90 120 220



Source: Dutch National Institute for Public Health and the Environment (RIVM), Laboratory for Radiation Research ([www.rivm.nl/milieustoffen/straling/zomethema\\_uv/](http://www.rivm.nl/milieustoffen/straling/zomethema_uv/)), 2007.

# consequences and effects 2

## uv radiation and ecosystems

We are particularly concerned by the potential impact of increased UV radiation on plants and animals, simply because they form the basis of our food supply. Significant changes in the health or growth of plants and animals may reduce the amount of available food.

Whereas scientists seem to agree that for any individual species, changes may be observed in an organism's growth capacity, it is much trickier to make observations and forecasts for an entire ecosystem. The task is complicated by the fact that we cannot single out UV radiation and separate it from other changes in atmospheric conditions, such as higher temperatures and CO<sub>2</sub> concentrations, or water availability.

UV radiation might affect certain species but also insects and pests, thus counter-balancing the direct negative effects of increased UV radiation. Similarly it might change their ability to compete with other species. In the long term UV-resistant plants may prevail over more vulnerable ones.

Excessive exposure to UV radiation can cause cancers in mammals, much as humans, and damage their eyesight. Fur protects most animals from over-exposure to harmful rays. But radiation may nevertheless damage their nose, paws and skin around the muzzle.

Experiments on food crops have shown lower yields for several key crops such as rice, soy beans and sorghum. The plants minimize their exposure to UV by limiting the surface area of foliage, which in turn impairs growth. However the observed drop in yield does not seem serious enough for scientists to sound the alarm.

### aquatic wildlife is particularly vulnerable

Phytoplankton are at the start of the aquatic food chain, which account for 30 per cent of the world's intake of ani-

**story ideas**

#5a. If there are case studies/science linking UV/ozone depletion to declines in fisheries or plants on which specific local communities or regions depend, stories could focus on the impacts of UV on local livelihoods (fisheries, farming), food security, etc.

#5b. If the impact on phytoplankton is well established, stories could focus on this link and the fate of fisheries, which are already in profound decline.

mal protein. Phytoplankton productivity is restricted to the upper layer of the water where sufficient light is available. However, even at current levels, solar UV-B radiation limits reproduction and growth. A small increase in UV-B exposure could significantly reduce the size of plankton populations, which affects the environment in two ways. With less organic matter in the upper layers of the water, UV radiation can penetrate deeper into the water and affect more complex plants and animals living there. Solar UV radiation directly damages fish, shrimp, crab, amphibians and other animals during their early development. Pollution of the water by toxic substances may heighten the adverse effects of UV radiation, working its way up the food chain. Furthermore less plankton means less food for the animals that prey on them and a reduction in fish stocks, already depleted by overfishing.

## EFFECTS OF ENHANCED UV-B RADIATIONS ON CROPS

Possible changes in plant characteristics	Consequences	Selected sensitive crops
<ul style="list-style-type: none"> <li>■ Reduced <b>photosynthesis</b></li> <li>■ Reduced <b>water-use efficiency</b></li> <li>■ Enhanced <b>drought stress sensitivity</b></li> <li>■ Reduced <b>leaf area</b></li> <li>■ Reduced <b>leaf conductance</b></li> <li>■ Modified <b>flowering</b> (either inhibited or stimulated)</li> <li>■ Reduced <b>dry matter production</b></li> </ul>	<ul style="list-style-type: none"> <li>Enhanced plant fragility</li> <li>Growth limitation</li> <li>Yield reduction</li> </ul>	<ul style="list-style-type: none"> <li>Rice</li> <li>Oats</li> <li>Sorghum</li> <li>Soybeans</li> <li>Beans</li> </ul>

NB: Summary conclusions from artificial exposure studies. Source: modified from Krupa and Kickert (1989) by Runeckles and Krupa (1994) in: Fakhri Bazzaz, Wim Sombroek, *Global Climate Change and Agricultural Production*, FAO, Rome, 1996.

# mobilization 1

## successful environmental diplomacy

The Montreal Protocol on Substances that Deplete the Ozone Layer ranks as one of the great success stories of international environmental diplomacy, and a story that is still unfolding. The protocol, along with its processor the Vienna Convention, is the international response to the problem of ozone depletion agreed in September 1987 following intergovernmental negotiations stretching back to 1981. Following the confirmation of the ozone destruction theory with the discovery of the Antarctic ozone hole in late 1985, Governments finally recognised the need for stronger measures to reduce consumption and production of various CFCs and halons. The Montreal Protocol came into force on 1 January 1989.

It is widely believed that without the protocol, ozone depletion would have risen to around 50 per cent in the northern hemisphere and 70 per cent in the southern mid-latitudes by 2050. This would have resulted in twice as much UV-B reaching the Earth in the northern mid-latitudes and four times as much in the south. The implications of this would have been horrendous: 19 million more cases of non melanoma cancer, 1.5 million cases of melanoma cancer, and 130 million more cases of eye cataracts.

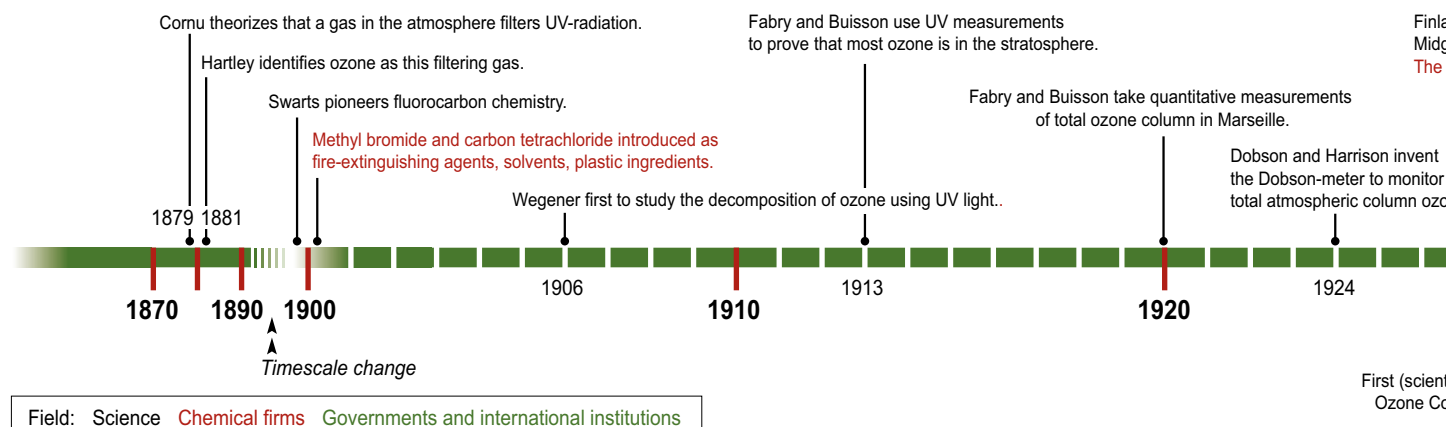
Instead, atmospheric and stratospheric levels of key ozone depleting substances are going down, and it is believed that with full implementation of all of the provisions of the Protocol, the ozone layer should return to pre-1986 levels by 2065.

### story ideas

#6a. Would be good to frame the Protocol's success story as a refreshingly positive "climate" story. Key issues: the threat faced, the countries came together and positive changes (whatever they were) began to occur. A feeling for the political dynamics behind its success would be important.

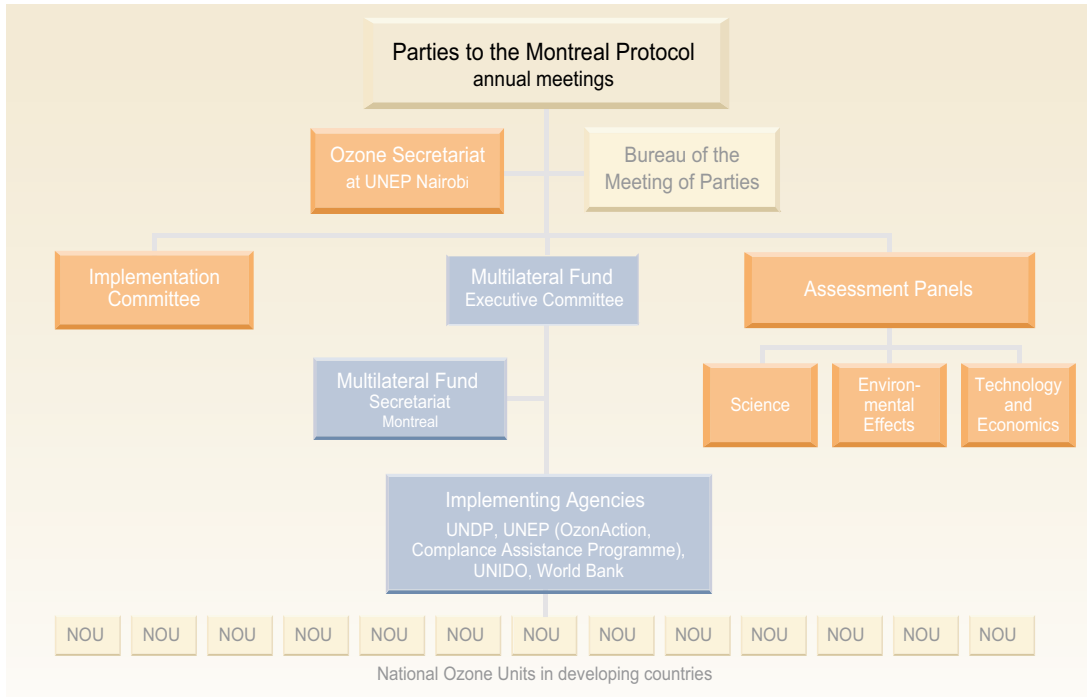
#6b. Geographical focus: to look at how different countries responded. What did your country do in response to the Protocol and what happened as a result in the country, against the backdrop of the global progress that has occurred.

### THE OZONE INTERNATIONAL AWAKENING





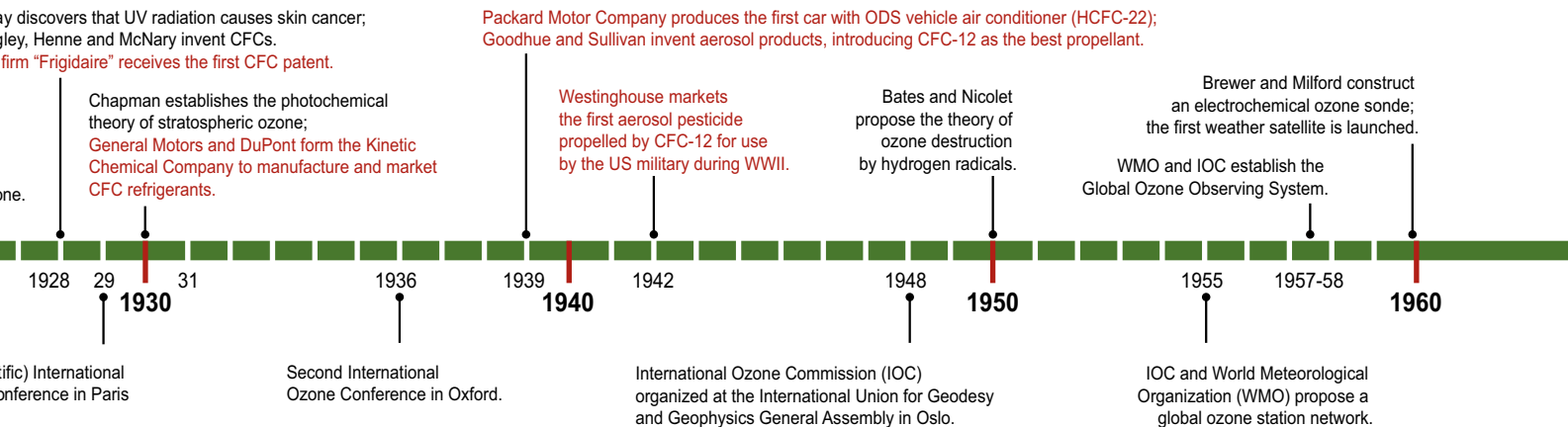
# THE OZONE PROTECTION LANDSCAPE



Source: Ozone Secretariat, Fund Secretariat, OzonAction 2007.

The Protocol can be summarized in seven key features:

1. It requires each of the 191 countries and the European Union that ratified the protocol (called “Parties”) and its amendments to almost completely eliminate production and consumption of nearly 100 chemicals that have ozone depleting properties, in accordance with agreed timelines;
2. The protocol requires each of the Parties to report annually on their production, imports and exports of each of the chemicals they have undertaken to phase out;
3. An Implementation Committee made up of ten Parties from different geographical regions reviews data reports submitted by Parties, assesses their compliance status, and makes recommendations to a meeting of the Parties regarding countries in non-compliance;
4. The protocol includes trade provisions that prevent Parties from trading in ODS and some products containing ODS with non-Parties, and also provisions for trade between Parties;
5. The protocol includes an adjustment provision that enables Parties to respond to developing science and accelerate the phase-out of agreed ODS without going through the lengthy formal process of national ratification. It has been adjusted five times to accelerate the phase-out schedule, which is in itself a remarkable achievement;
6. Developing countries are allowed a “grace period” of 10 to 16 years beyond the dates established for industrialized countries to comply with the control provisions of the protocol;
7. In 1990 the Parties established the Multilateral Fund for the Implementation of the Montreal Protocol to help developing countries meet their compliance obligations under the treaty (see following chapter).

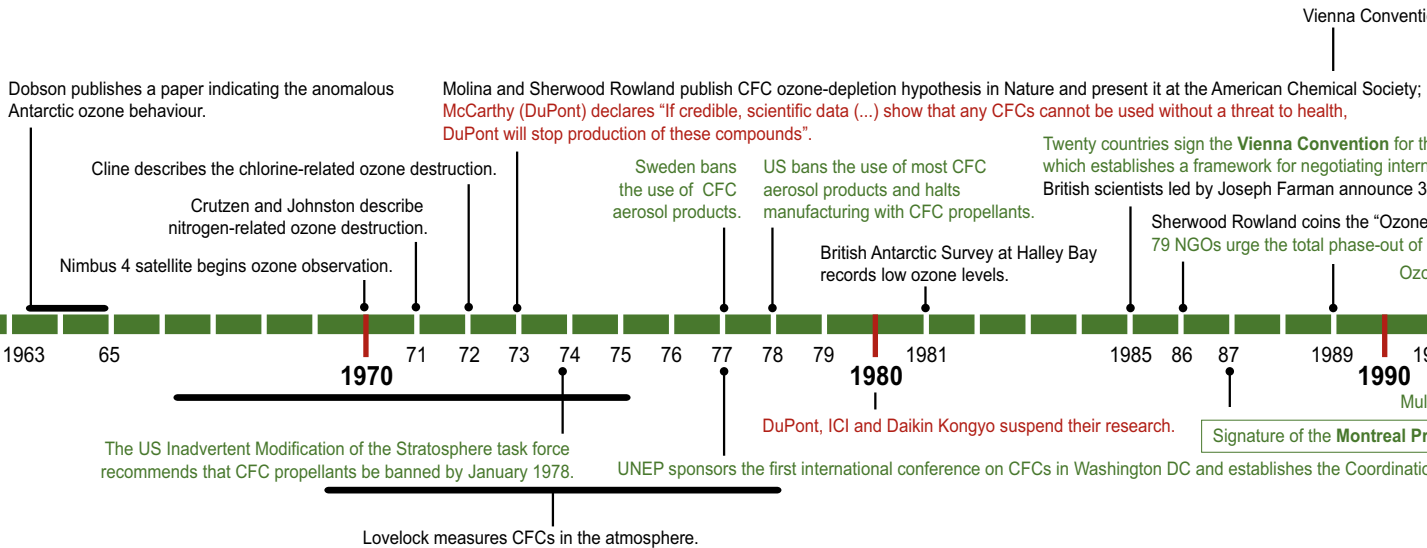
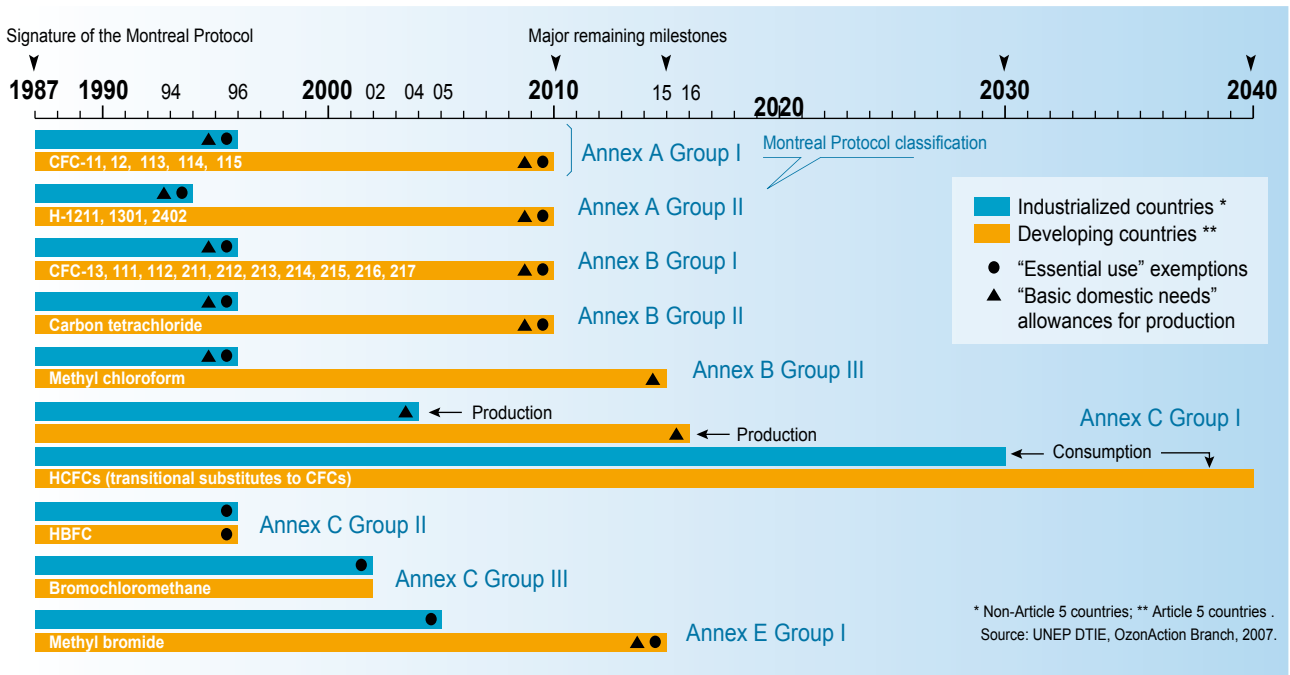


tion, Progress report, April 2007; Sharon L. Roan, Ozone crisis, 1989.

# mobilization 1

successful environmental  
diplomacy

## Deadlines of production and consumption of ozone depleting substances defined in the Montreal protocol phase-outs





## the climate–ozone connection

It is important to realise that there are collateral benefits to the implementation of the Montreal Protocol. The ODS phase out has already provided, and is continuing to provide, significant climate protection benefits. The Montreal Protocol is in a very real sense a “climate protection” treaty too.

In addition to destroying the ozone layer, most ODS are potent greenhouse gases. The GWP of CFCs, halons and HCFCs are thousands of times more than the most commonly-known greenhouse gas, carbon dioxide. These chemicals directly contribute to climate change if they are emitted to the atmosphere. They also contribute indirectly to climate change through the use of electricity to power appliances that use ODS.

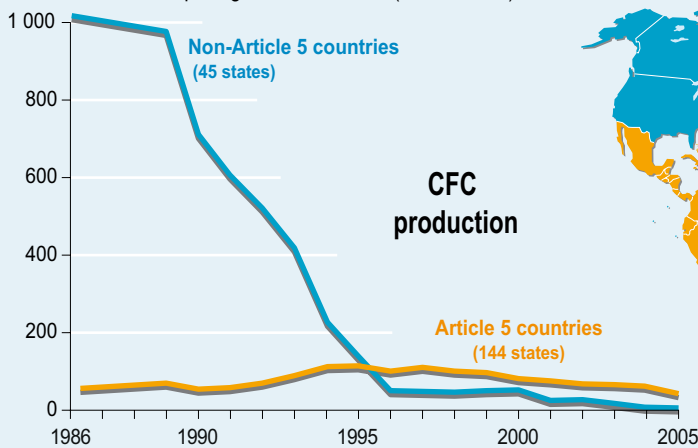
This climate benefit of the Montreal Protocol is an “untold story” for most of the media and it is an interesting topic from many angles. Only recently have scientific papers appeared. A recent study by Velders et al. (see references) has confirmed the tremendous contribution

of the Montreal Protocol to mitigating climate change. By phasing out CFCs, HCFCs and other chemicals under the Montreal Protocol, more than 5 giga tons equivalent of CO<sub>2</sub> have already been eliminated – representing more than 25% of the world’s greenhouse gases emissions compared to 1990. This surpasses the Kyoto Protocol’s target of reducing GHGs by 5 times.

All countries can claim “climate credits” by their phase out of ODS under the Montreal Protocol, and some are beginning to document this contribution. For example, according to the US Environmental Protection Agency, phasing out ODS has already reduced greenhouse gas emissions equivalent to the carbon dioxide emissions associated with the following three scenarios lumped together: generating enough electricity to power every US home for more than 13 years; saving forests covering an area more than twice the size of Florida from deforestation; and saving more than 4,500 million million (trillion) litres of petrol – enough to make 4.8 thousand million round trips from New York to Los Angeles by car.

## COMMON BUT DIFFERENTIATED RESPONSIBILITIES

Thousand Ozone Depleting Potential Tonnes (ODP Tonnes)\*



\* Tonnes multiplied by the ozone depleting potential of the considered gas.

Source: United Nations Environment Programme Ozone Secretariat

on and Montreal Protocol enter into force; first meeting of the Parties in May.

the Protection of the Ozone Layer,

national regulations on ozone-depleting substances; 0-40% depletion of Antarctic ozone since 1977.

“Hole” term; CFCs.

one Secretariat established

Phase-out deadline concerning most CFCs, Carbon tetrachloride and Methyl chloroform for industrialized countries.

Largest ozone hole on record over Antarctic.

Final deadline for HCFCs, the last ODS substances to be phased-out in the Montreal Protocol.

1991

ilateral Fund established

1996

2000

2006

2040

Around 2070:

Total recovery of the Antarctic “ozone hole”.

protocol on Substances that deplete the ozone layer.

on Committee on the Ozone Layer.

Timescale change

# mobilization 2

## pledging funds

### for patching the hole

The international consensus on the need to preserve the ozone layer is reflected in the establishment of a Multilateral Fund (MLF) to support projects to eliminate ozone depleting substances. Between 1991 and March 2007 the MLF received contributions of about US\$ 2,200 million from 49 developed countries (according to the United Nations scale of assessment).

To date expenditures of US\$ 2,164 million have been approved to support some 5,500 projects in 144 "Article 5" Parties, out of the 191 Parties to the protocol. National Ozone Units (NOUs) have been established in 140 countries as government focal points for implementation of this multilateral environmental agreement. Projects supported by the MLF and completed through 2005 have eliminated the consumption of 190,625 ozone depletion potential (ODP) tonnes and have phased out production of more than 116,197 ODP tonnes.

Financial and technical assistance is provided in the form of grants or concessional loans and delivered through four

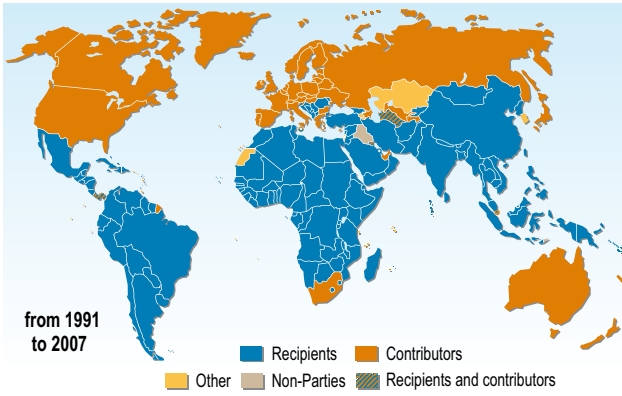
implementing agencies: United Nation Environment Programme (UNEP), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO) and The World Bank. Up to 20 per cent of the contributions can be delivered through the Parties' bilateral agencies in the form of eligible projects and activities. Funds are used for activities including the closure of ODS production plants and industrial conversion, technical assistance, information dissemination, training and capacity building of personnel aimed at phasing out the ODS used in a broad range of industrial sectors. The MLF Secretariat is based in Montreal, Canada.

### challenges ahead

Although the Montreal Protocol has made considerable progress in the global drive to protect the ozone layer, the work is far from complete. There are still several issues that Parties to the protocol need to address before we can be sure the ozone layer is safe for present and future generations:

- Momentum towards achieving a total phase-out must be sustained. All scientific analysis predicting the recovery of the ozone layer relies on the assumption of full compliance with the phase-out agreed. Between the beginning of 2007 and the end of 2009, developing countries will have to, for example, eliminate the last 15% of their production and consumption of CFCs and carbon tetrachloride. Experience shows that this last fraction will be the hardest to phase out, particularly because the majority of the remaining CFCs are
- to service millions of refrigerators and air conditioners;
- Illegal trade continues and needs to be dealt with to ensure that continued legal ODS uses are not diverted to illegal uses;
- Effective control mechanisms for new chemicals threatening the ozone layer are essential;
- Continued monitoring of the ozone layer is needed to ensure the healing process is taking its expected course.
- Control of "essential uses", "critical uses" and "basic domestic needs" exemptions: These exemptions are a way of escape for countries to avoid the phase-out of ODSs if not properly controlled – to the extent that it might eventually have an impact on the recovery of the hole.

All recipient and contributor countries of the Multilateral Fund



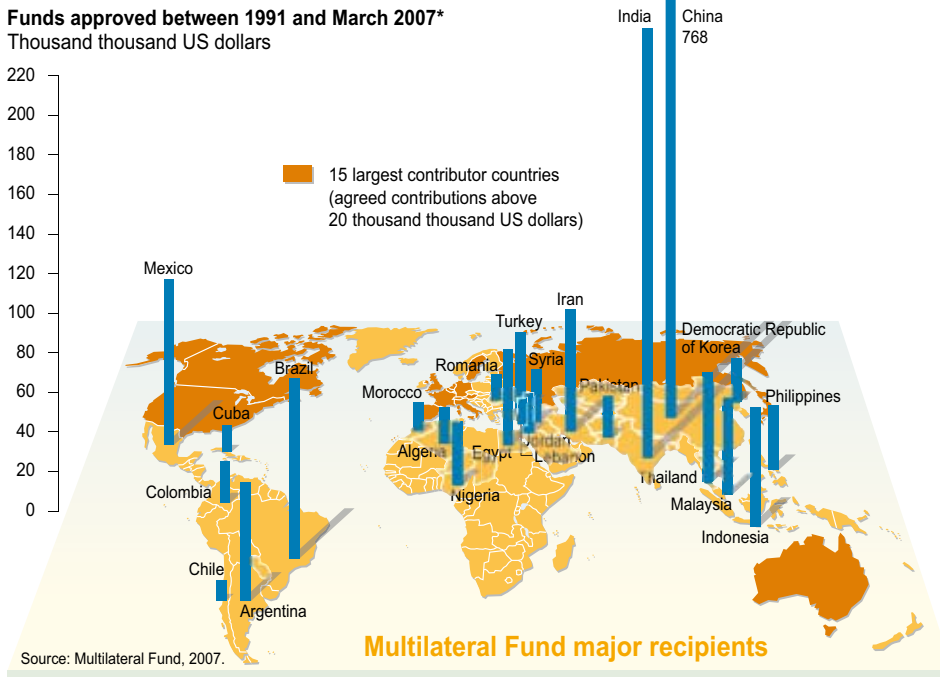
Countries receive funds according to their compliance needs. That is, they receive funds to phase-out specific amounts of ODS production and consumption (see table below for agreed production and consumption amounts). Hence, ODS producer countries and high consumers receive more funds since they have greater needs. However all developing countries who are Parties to the Montreal Protocol have received assistance. Naturally, larger countries with higher population will also have a greater need for ODS, and therefore will also have a bigger share of phase out to tackle.

ODP tonnes approved for phase-out

Country*	Consumption	Production	Total
China	109,618	123,328	232,946
India	23,777	29,014	52,791
Mexico	4,479	12,355	16,834
Brazil	12,462	0	12,462
Indonesia	10,888	0	10,888
Thailand	7,285	0	7,285
Argentina	3,847	2,746	6,593
Malaysia	6,554	0	6,554
Iran	6,532	0	6,532
Korea, DPR	3,237	1,750	4,987
Turkey	4,495	0	4,495
Nigeria	4,384	0	4,384
Egypt	4,311	0	4,311
Syria	3,397	0	3,397
Philippines	3,321	0	3,321
Algeria	2,435	0	2,435
Pakistan	2,295	0	2,295
Jordan	2,223	0	2,223
Colombia	1,861	0	1,861
Romania	1,579	5	1,584
Lebanon	1,541	0	1,541
Chile	1,082	0	1,082
Morocco	1,014	0	1,014
Cuba	422	0	422

\*Only countries receiving more than ten thousand thousand US dollars are shown

Funds approved between 1991 and March 2007\*  
Thousand thousand US dollars



story ideas

- How has implementation of this treaty impacted on small & medium sized enterprises?
- Have jobs been created or lost as a result of the phase out?
- How has ozone protection affected businesses bottom line?
- How has ozone protection affected consumers' pocketbook?
- What companies have benefited from the technology change, which ones have lost?

# mobilization 3

## learning from the montreal protocol

**What was the secret to success of the Montreal Protocol? What were the key drivers that made it possible to convince the companies producing ODS to look for alternatives? How did their business develop? Can we draw parallels to the processes in industry and the international community in facing the challenges of CO<sub>2</sub> reduction in the 21st century?**

In March 1988, DuPont, the world's largest CFC producer, with 25 percent of the market share, made a startling announcement: it would stop manufacturing CFCs. Although the company took only a modest financial risk – less than 2 percent of its annual earnings came from these products – the decision had profound repercussions in the chemical and CFC-producing industry.

At the time, the Montreal Protocol had been signed by 46 countries but had not yet entered into force. That same month, however, the ozone trends panel published the first report demonstrating that the predictions made by scientists had been substantially accurate, and that there was a measurable decrease in thickness of the ozone layer throughout the atmosphere.

DuPont, long a fierce opponent of the ozone depletion theory, had begun its turnaround two years earlier, in 1986, when it and the Alliance for Responsible CFC Policy, a key industry group, announced their agreement to support global limits on CFC production. DuPont's dramatic decision to halt CFC production signalled that the beginning of the end had truly arrived.

The DuPont story illustrates the success of the Montreal Protocol process. A number of key ingredients have contributed to this success.

Strong science framed the ozone issue from the start and has been a key pillar of the Protocol's continuing success. The Protocol called for a review of best available science, environmental, technical and economic information every four years. To aid their decision-making, the Parties established a number of formal expert assessment panels.

Political consensus was pursued and achieved. The largest developed nations, such as the U.S. and members of the European Community, were in accord about the need to commit to addressing ozone depletion in a multi-lateral framework. Industry was assured that a reasonable timeframe for effecting a transition would be granted. Provisions in the Protocol restricting trade with non-Parties contributed to the Protocol's near universal participation.

At the same time, the Protocol had important elements of flexibility. The concept of differentiated responsibilities between Parties made achievement of the Protocol's goals more reachable. While the countries agreed to meet specific numerical reduction targets in agreed timeframes, the

Protocol is silent on the manner in which those reductions are to be met. This has allowed Parties to meet targets through the implementation approaches that best suited their capacities. Similarly, an "adjustment" provision enables the Parties to use new science to adjust controls on previously agreed ozone depleting substances without waiting for multi-year national ratification process.

In cases of non-compliance a regionally balanced Implementation Committee has evolved an extremely successful system for equitable treatment of all Parties. Most important to developing countries was the notion that costs should be borne principally by the developed countries that had caused most of the problem. This was addressed by the 1990 London Amendment to the Protocol, which included provisions establishing a Multilateral Fund. The Parties were provided with undiluted control over the Fund's policies. The balanced membership of developed and developing countries on the Executive Committee signaled a large departure from the historic donor-driven nature of funding entities and carried forward the Protocol's spirit of equality. The Fund evolved into a key driver of success, as the Parties allocated vast sums to ensure compliance.

Important lessons have been learned along the way. The extent of reductions necessary to protect the ozone layer were originally underestimated, requiring further adjustments subsequently. Also underestimated was the ability of industry, faced with the prospect of prohibition, to adapt to change and convert to non-ozone depleting substances. Prognoses were systematically more pessimistic, the costs for industry estimated much higher than they turned out in reality. For example, in 1987, halons were considered so indispensable that the Parties could only agree to freeze their production and consumption at historic levels. Only five years later, however, the Parties agreed to phase them out completely in developed countries by 1994, because industry stepped up to meet the challenges presented by the phaseout.

The successes and lessons of the Montreal Protocol are instructive in the context of global climate change discussions. A clear lesson is that a multilateral agreement with strong, science-based and legally binding limits is essential. Faced with bright-line goals governments and industries can adapt, and, history shows, far more readily than might be initially anticipated or argued. Equally important are provisions that create incentives for compliance, funding for less developed countries and a sense of common commitment and equity.

story ideas

#8a. To what extent are ODSs still prevalent throughout the world? How long will it take after the final phase-out before there are no CFC-containing products? What are the biggest challenges to reaching this point, keeping in mind that CFCs can remain in the stratosphere for decades if not hundreds of years even after they have been removed from use entirely? What does it mean for ozone depletion, climate change? In other words, a story about how long it will take the world to eliminate a very hazardous and destructive group of substances, even when best efforts are being made and success is being achieved. Where are most of the world's ODSs coming from - who is producing them, who is consuming them and who is being affected - in other words, exploring possible

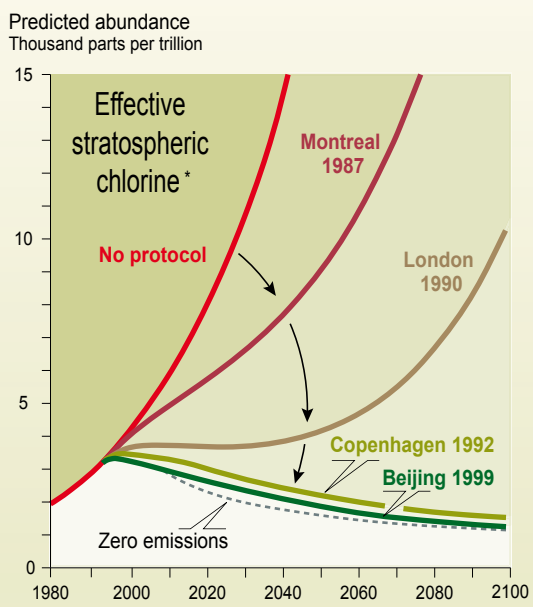
global inequities along the lines of climate change imbalance (US and Europe producing 40% of CO<sub>2</sub>?). Ties in with story #4c.

#8b. Similarly, are new threats to the ozone layer emerging from accelerated economic growth in the BRIC (Brasil, Russia, India, China) countries?

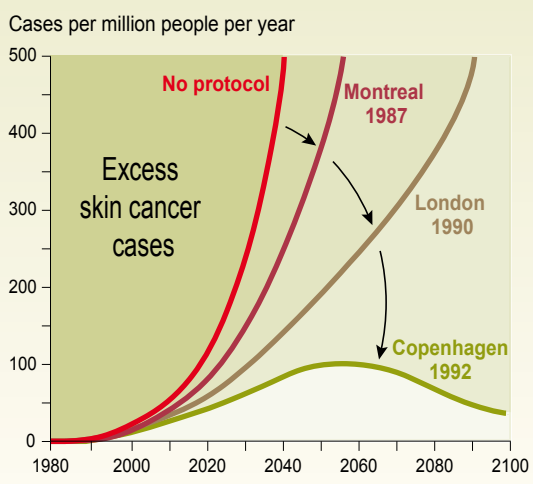
#8c. Methyl bromide is still in use for crops: one banned substance that is still poisoning the environment and poisoning consumers.

#8d. To what extent are international aid agencies buying and exporting ODS-containing technologies, such as refrigerators, air conditioners, crop fumigants - to disaster recover areas around the world - e.g., for purposes of reconstructing houses in the wake of the Indian Ocean tsunami.

EFFECTS OF THE MONTREAL PROTOCOL AMENDMENT AND THEIR PHASE-OUT SCHEDULES



\* Chlorine and bromine are the molecules responsible for ozone depletion. "Effective chlorine" is a way to measure the destructive potential of all ODS gases emitted in the stratosphere.



Source: *Twenty Questions and Answers about the Ozone Layer: 2006 Update*, Lead Author: D.W. Fahey, Panel Review Meeting for the 2006 ozone assessment.

protocol achievements

There are currently a hundred and ninety-one Parties to this treaty, demonstrating a greater degree of global participation than almost any other agreement managed by the UN. By 2005 these countries had collectively phased out more than 95% of the production and consumption of the chemicals controlled by the protocol.

With the assistance of the Multilateral Fund, by December 2005 developing countries have phased out more than 190,625 tonnes of consumption and 116,197 tonnes of production of ozone depleting substances. That represents more than 70 per cent of the total for developing countries. Furthermore plans have already been agreed to reduce more than 80 per cent of the remainder.

Global observations have verified that stratospheric levels of key ODS are going down, and with implementation of the protocol's provisions, the ozone layer should return to pre-1986 levels by 2065. During the phase-out process many developed and developing countries have met their phase-out targets well before the allotted deadline.

In terms of health benefits, controls implemented under the Montreal Protocol have enabled the global community to avoid millions of fatal skin cancers, and tens of millions of non-fatal skin cancers and cataracts. According to United States estimates, by 2165 more than 6.3 million US skin cancer deaths will have been avoided and that efforts to protect the ozone layer will produce an estimated US\$ 4,200 million million health benefit for 1990-2165.

The protocol has also yielded substantial climate benefits. Because ODS also contribute to global warming, cutbacks have resulted in a net reduction in global warming gases of more than 20 gigatonnes of CO<sub>2</sub> equivalents. These reductions make the Montreal Protocol one of the world's prime contributors to the fight against global warming.



# mobilization 4

## sun protection and sensitization projects

These days most children know they have to protect their skin from damage by the sun. This is the result of successful communication and information campaigns in schools and the media all over the world.

The increased UV radiation reaching our planet through the diminishing ozone layer can have a widespread, dramatic effect on our health. But the remedy is comparatively easy, using sun screen or proper clothing to protect our skin, and sunglasses for our eyes. It is consequently all the more important to educate people widely so that they adopt these simple measures.

Sun-safe programmes have been introduced in virtually every country where the risk to the population has increased.

Particular credit is due to the UV index (UVI), an international public awareness initiative led by the World Health Organization (WHO) that encourages consistent reporting on news and weather bulletins about the levels of UV radiation received at the local level. Newspapers in many countries now publish a UVI forecast using a standard graphic format.

Awareness campaigns accompanying the index provide people with a clear indication of the necessary protective measures. Initiatives may take various forms: the Australian authorities, for instance, issue awards to local authorities providing the most shade for their citizens. Successful campaigns clearly distinguish between different target audiences, such as schoolchildren, farmers and outdoor workers.

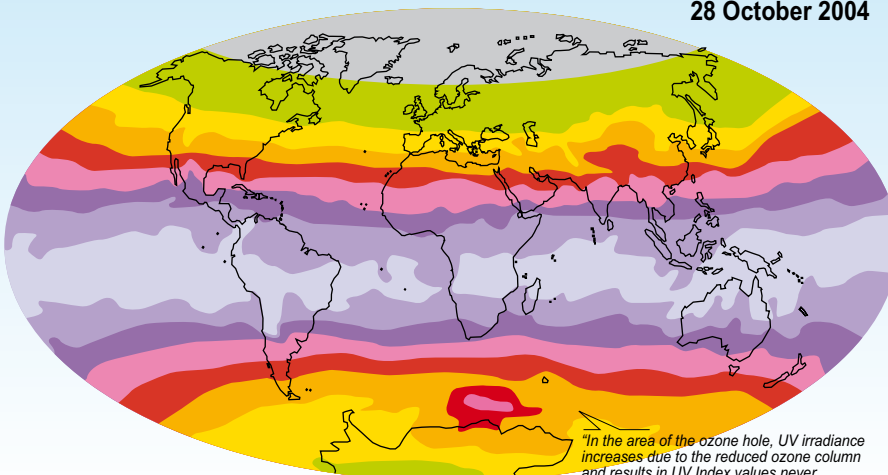
To raise the awareness of children from an early age regarding the potentially damaging effects of the sun's rays and appropriate protective measures, educational media use cartoon characters such as Ozzy Ozone (UNEP/Barbados), Sid Seagull (Australia) and Top, l'Imprudente (Switzerland).

Another important reason why people began to pay attention to skin protection is because awareness of the dangerous consequences of not covering up, i.e., skin cancer, grew steadily. The media readily broadcasted the alarming study results the reported fast rising incidence of melanoma and other types of skin cancer.

And why have governments made such widespread efforts to raise public awareness of the dangers associated with excessive exposure to UV radiation? Apart from their sincere concern for public health, there is a clear financial incentive. For example, skin cancer costs the Australian health service about US\$ 245 million a year, the largest amount for any cancer. The risk of Australians suffering from melanoma is four times higher than for their US, Canadian or UK counterparts. Based on the observed increased incidence in skin cancers and models taking into account projections of further ozone loss in the future, the government calculated that savings on medical spending would likely far exceed the cost of an awareness-building campaign.

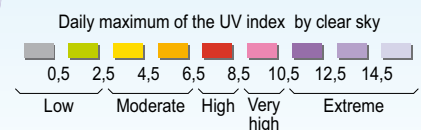
### THE GLOBAL SOLAR UV INDEX

28 October 2004



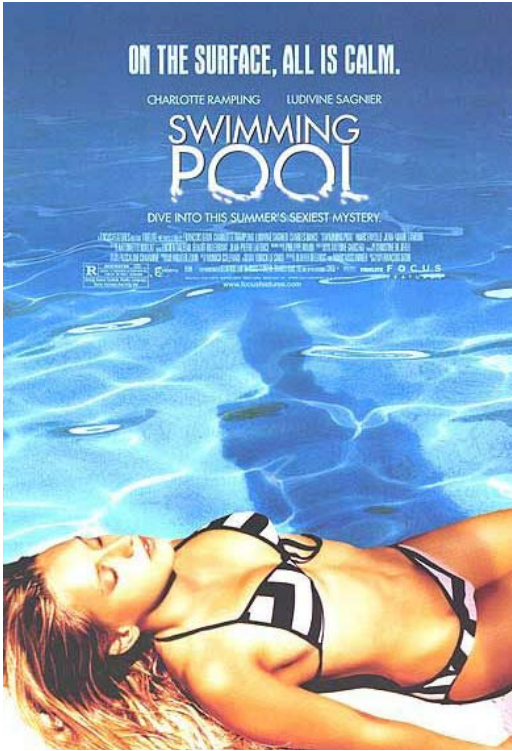
"The Global Solar UV Index (UVI) is a simple measurement of the UV radiation level at the Earth's surface. It has been designed to indicate the potential for adverse health effects and to encourage people to protect themselves. The higher the Index value, the greater the potential for damage to the skin and eye, and the less time it takes for harm to occur.

In countries close to the equator, the UVI can be as much as 20. Summertime values in northern latitudes rarely exceed 8."



Source: GMES, 2006; INTERSUN, 2007.

INTERSUN, the Global UV project, is a collaborative project between WHO, UNEP, WMO, the International Agency on Cancer Research (IARC) and the International Commission on Non-ionizing Radiation Protection (ICNIRP).



Poster for the movie "Swimming Pool", directed by François Ozon (Copyright©2003 Fidélité/France 2 Cinéma/Gimages Films/Foz).

story ideas

- #7a. Could shoehorn ozone education into a broader feature piece about the growth of environmental education worldwide, how children are agents of change in the family, and how behavior changes as a result - more skin cream, more recycling, (UN Decade on Sustainable Development) etc.
- #7b. What are the keys to success for UV protection programmes?
- #7c. What are the reasons for such intensive coverage of UV protection programmes in many countries?



# side effects

## illegal trade in ozone depleting substances

The final phase-out dates are in sight for CFCs and other substances that harm the ozone layer – but smuggling operations threaten the continued recovery of the Earth’s atmosphere. When worldwide trade restrictions or bans are placed on any commodity – drugs, guns, endangered species or whatever – a black market soon emerges. ODS are no exception.

In the mid-1990s, when CFCs were phased-out in industrialized countries (non-Article 5 countries), illegal trade in those chemicals emerged. By 1996 this trade had reached alarming proportions, accounting for as much as 12–20% of global trade in ODS. It was once quoted in the US as being second in value only to cocaine. A 2006 estimate indicated that CFCs alone accounted for 7,000 to 14,000 tonnes of this trade, valued at US\$ 25 to US\$ 60 million.

Alternatives can often be no more expensive than ODS, but the problem arises because equipment must often be retrofitted, sometimes even completely replaced, to use the new chemicals. This maintains the incentive for illegal trade, and it will most likely remain attractive until all ODS-using equipment is finally replaced with newer technology that works with ODS alternatives.

### EXAMPLES OF ODS SMUGGLING PATTERNS IN ASIA AND THE PACIFIC



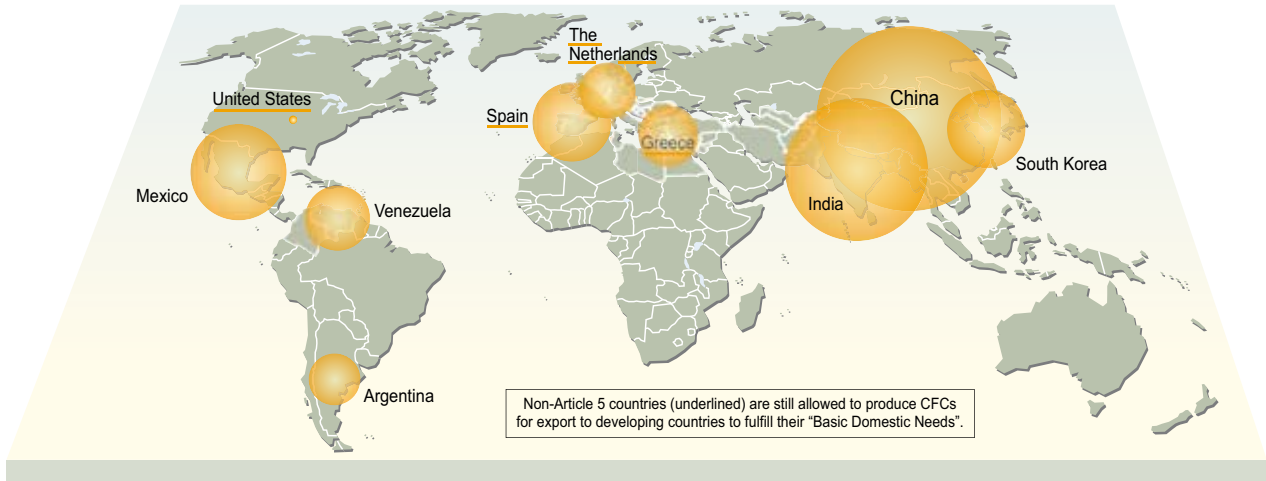
#### story ideas

#10a. Climate criminals. Most people know nothing about black market trading in ODSs. Well-organized packets of material, providing as much hard data as possible, whatever country-specific info a writer wants and a sense of the good and bad aspects of the global response, if any, would make a good story.

#10b. Who are the local authorities responsible for interdicting international shipments of ODSs, and how do they do their business? Similarly, who are the dealers and buyers? Good opportunities for local angles interviews.

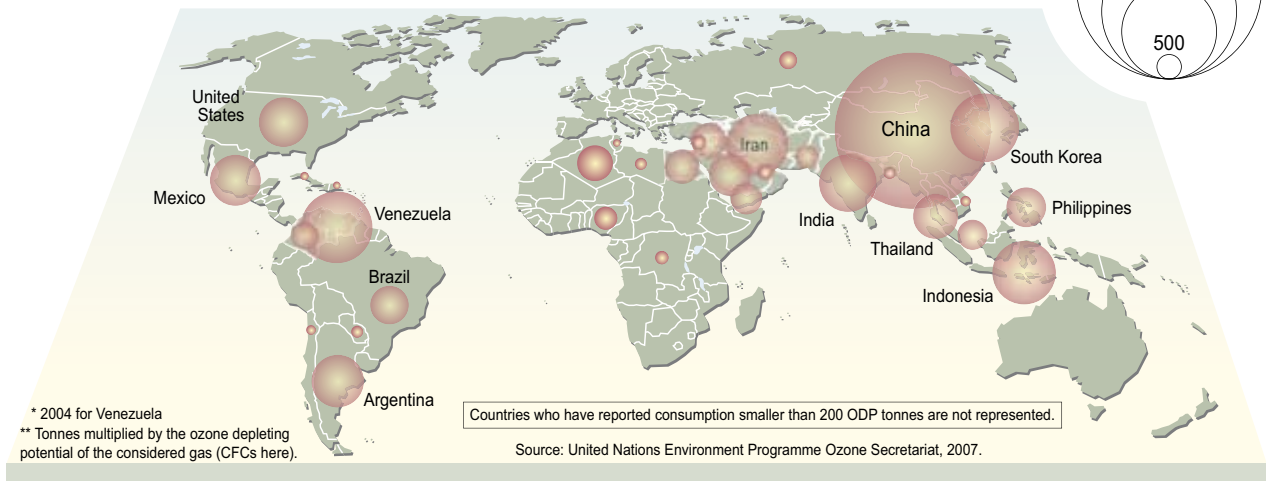
## CFC Production in 2005

as reported to the Ozone Secretariat by Parties of the Montreal Protocol.



## CFC Consumption in 2005\*

as reported to the Ozone Secretariat by Parties of the Montreal Protocol.



### green customs initiative

Much effort has been devoted to training custom officers. The complexities surrounding the movement of illegal imports, as well as the scientific nature of ODS chemicals make it all the easier to deceive ill informed customs officers or Ozone Officers. At room temperature, most ODS are colourless, odourless gases, so chemical analysis is needed to determine precisely what substances are present. Smugglers have taken advantage of this fact and devised highly effective schemes, involving false labels on containers and misdeclarations on documents, diverting ODS to other countries, concealing illegal canisters behind legal ones and disguising virgin ODS to appear recycled.

The importance of skilled customs officers has become apparent not just for the Montreal Protocol, but also in the context of other Multilateral Environmental Agreements such as the Basel Convention (hazardous waste) and CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora).

### protocol patching needed?

By the early 1990s it was clear that businesses and consumers would have to replace or adapt millions of appliances and pieces of equipment. Many measures could, at least in theory, have reduced the likelihood of illegal trade.

Though unintentional, some aspects of the Montreal Protocol contribute to illegal trade. One obvious point is that the Protocol does not require all countries to follow the same phase-out schedule. The Montreal Protocol allows continued production of CFCs in developing countries for up to 10 years after production ceased in developed countries. This creates considerable potential for illegal trade. Demand for CFCs for continued in developed countries after the phase-out in 1995 due to the need to service existing CFC-based equipment.

Critics have also claimed that the Protocol was slow to respond when the problem of illegal trade became apparent, and that the actions taken were insufficient to fully address the problem.

Illegal imports to developing countries continue to be a problem. The phase-out of ODS is about to become more crucial for developing countries as the date they have pledged for completion in 2010 approaches. Illegal trade in CFCs and other ODS is expected to grow as a complete ban approaches.

By mapping the holes in the Montreal Protocol, we may learn lessons on how to deal with this and other environmental challenges.

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# recommended websites

## general

The ozone hole tour (educational website by the University of Cambridge): [www.atm.ch.cam.ac.uk/tour/index.html](http://www.atm.ch.cam.ac.uk/tour/index.html)

Ozone protection website of the European Commission: <http://ec.europa.eu/environment/ozone>

U.S. Environment Protection Agency's Ozone website: [www.epa.gov/ozone](http://www.epa.gov/ozone)

Ozone information by a private NGO: [www.theozonehole.com](http://www.theozonehole.com)

## 01 the hole

Earth System Research Laboratory of NOAA: Ozone measurements: [www.esrl.noaa.gov/gmd/about/ozone.html](http://www.esrl.noaa.gov/gmd/about/ozone.html)

The International Ozone Commission: <http://ioc.atmos.uiuc.edu/about.html>

Near real-time ozone column predictions and measurements (European Space Agency): [www.temis.nl/protocols/O3total.html](http://www.temis.nl/protocols/O3total.html)

British Antarctic Survey Ozone Bulletin: [www.antarctica.ac.uk/met/jds/ozone](http://www.antarctica.ac.uk/met/jds/ozone)

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US National Aeronautics and Space Administration (NASA), Ozone Hole Watch: <http://ozonewatch.gsfc.nasa.gov/facts/hole.html>

US National Aeronautics and Space Administration (NASA), Earth Observatory (data and images): <http://earthobservatory.nasa.gov/Observatory/Datasets/ozone.toms.html>

## 02 the culprits 1: ozone depleting substances

UNEP/DTIE OzonAction, Trade names of chemical products containing ozone depleting substances and their alternatives database: [www.uneptie.org/ozonaction/information/tradenames/main.asp](http://www.uneptie.org/ozonaction/information/tradenames/main.asp)

UNEP/DTIE OzonAction, Montreal Protocol Control Measures by Substance (phase-out schedules): [www.uneptie.org/ozonaction/information/tradenames/trade\\_schedule\\_main.asp](http://www.uneptie.org/ozonaction/information/tradenames/trade_schedule_main.asp)

## 03 the culprits 2: temperatures, polar stratospheric clouds and a changing climate

US National Oceanic and Atmospheric Administration (NOAA) Polar Stratosphere and Ozone Depletion page: [www.cpc.ncep.noaa.gov/products/stratosphere/polar/polar.shtml](http://www.cpc.ncep.noaa.gov/products/stratosphere/polar/polar.shtml)

## 04 the effects 1: uv radiation and human health

Question and answers on effects of UV radiation on human health: [www.who.int/uv/faq/uvhealthfac/en/index.html](http://www.who.int/uv/faq/uvhealthfac/en/index.html)

International Agency for Research on Cancer (databases): [www-dep.iarc.fr](http://www-dep.iarc.fr)

International Agency for Research on Cancer (IARC), CANCER-Mondial databases: [www-dep.iarc.fr](http://www-dep.iarc.fr)

## 06 and 07 the montreal protocol and the multilateral fund

OzonAction Programme [www.unep.fr/ozonaction](http://www.unep.fr/ozonaction)

The Multilateral Fund (Funding mechanism to ensure compliance with MP) [www.multilateralfund.org](http://www.multilateralfund.org)

United Nations Development Programme (UNDP) ozone – related activities: [www.undp.org/chemicals/montrealprotocol.htm](http://www.undp.org/chemicals/montrealprotocol.htm)

United Nations Industrial Development Organization (UNIDO) ozone protection activities: [www.unido.org/doc/18265](http://www.unido.org/doc/18265)

World Bank ODS phase out projects <http://go.worldbank.org/K5RY1P1670>

Ozone Secretariat (the secretariat coordinating the implementation of the Vienna Convention and Montreal Protocol) [www.unep.fr/ozone](http://www.unep.fr/ozone)

Montreal Protocol ratification status: [http://ozone.unep.org/Ratification\\_status](http://ozone.unep.org/Ratification_status)

Assessment Panels providing scientific background for the Montreal Protocol: [http://ozone.unep.org/Assessment\\_Panels](http://ozone.unep.org/Assessment_Panels)

Frequently Asked Questions about the Montreal Protocol [http://ozone.unep.org/Frequently\\_Asked\\_Questions](http://ozone.unep.org/Frequently_Asked_Questions)

World Meteorological Organization ozone website: [www.wmo.ch/web/arep/ozone.html](http://www.wmo.ch/web/arep/ozone.html)

## 08 mobilization 2: sun protection campaigns

World Health Organization Intersun programme: [www.who.int/uv/intersunprogramme/en](http://www.who.int/uv/intersunprogramme/en)

Australia's UV protection site: [www.sunsmart.com.au](http://www.sunsmart.com.au)

## 10 side effects: illegal trade

Environmental Investigation Agency (NGO specialised in detecting environment-related crime) [www.eia-international.org](http://www.eia-international.org) and [http://www.eia-international.org/campaigns/global\\_environment](http://www.eia-international.org/campaigns/global_environment)

Green Customs: [www.greencustoms.org](http://www.greencustoms.org)

Interpol : [www.interpol.int](http://www.interpol.int)

Workshop of Experts from Parties on Illegal Trade in ODS: [http://ozone.unep.org/Meeting\\_Documents/illegal-trade/index.asp](http://ozone.unep.org/Meeting_Documents/illegal-trade/index.asp)







On 16 September 1987, the treaty known as the Montreal Protocol on Substances that Deplete the Ozone Layer was signed by a group of concerned countries that felt compelled to take action to solve an alarming international environmental crisis: the depletion of the Earth's protective ozone layer. Since that humble beginning, this treaty has taken root and grown into what has been described as "perhaps the single most successful international environmental agreement to date".

The year 2007 marks the 20th anniversary of this landmark agreement, and affords us the opportunity to investigate the Montreal Protocol's hundreds of compelling individual stories.

The Vital Ozone Graphics and the associated web site provides journalists with essential visuals, facts, figures and contacts they need to start developing their own ozone story ideas. It is intended to inform and inspire journalists to further investigate and then tell the ozone tale.

Vital Ozone Graphics was produced jointly by the OzonAction Branch of UNEP's Division on Technology, Industry and Economics (DTIE) and UNEP/GRID-Arendal with support provided by the Multilateral Fund for the Implementation of the Montreal Protocol.

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