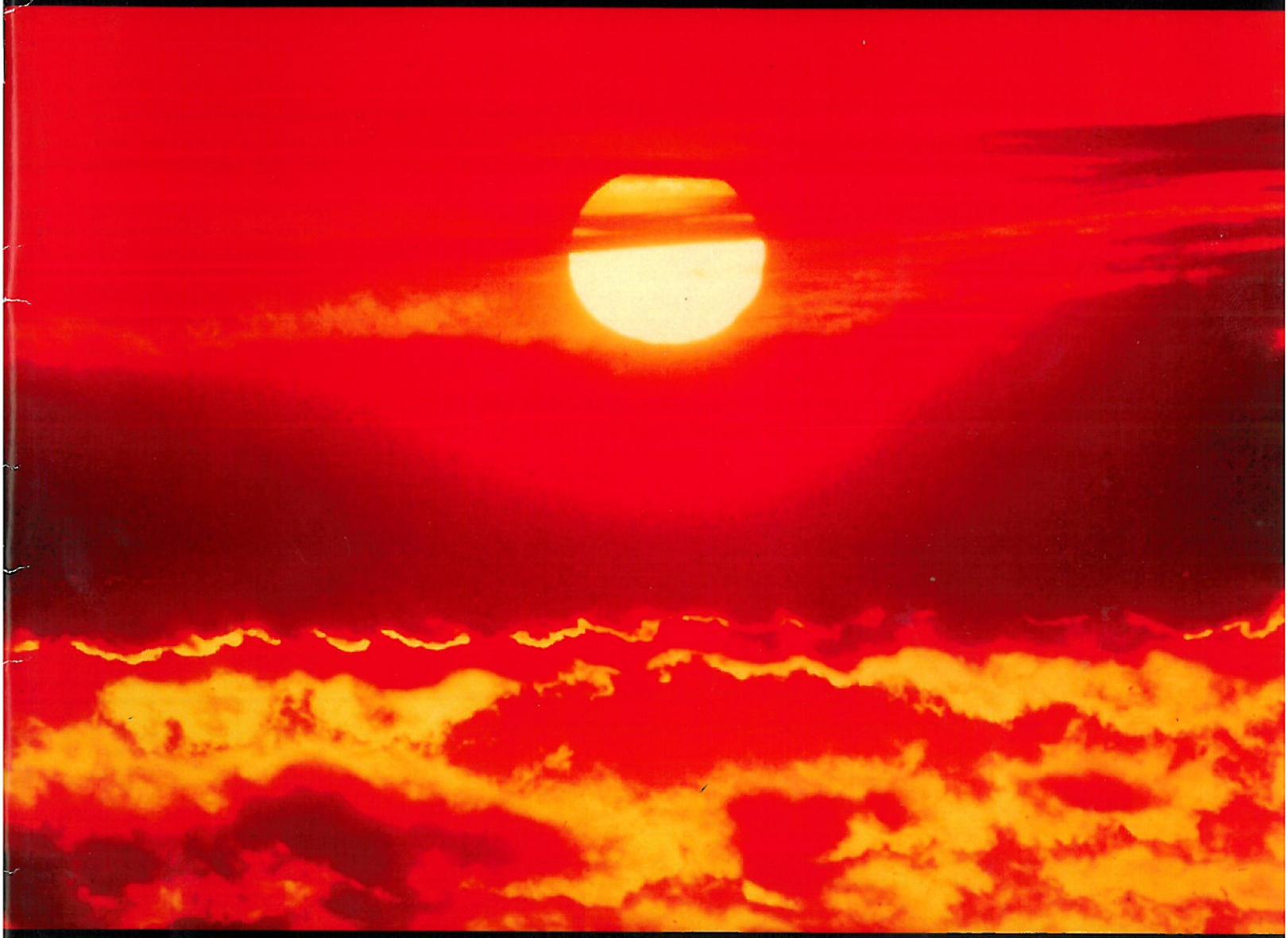
Turning Up the Heat

Linkages between ozone layer depletion and climate change: The urgent case of HCFCs and HFCs



environmental **investigation** agency

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INTRODUCTION


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The world's leading scientists have confirmed that global climate change and stratospheric ozone layer depletion are inextricably linked. The latest studies predict that the major relationships between the two will cause ozone depletion to exacerbate climate change and climate change to exacerbate ozone depletion, with grave and potentially irreversible consequences for people and ecosystems.[1]

The Earth's ozone layer is currently in its most fragile state in recorded history, leaving the Earth exposed to unprecedented levels of harmful ultraviolet radiation. The hole in the ozone layer over the Antarctic has reappeared each austral spring since its initial discovery, and has generally grown larger and lasted longer each year. The 2005 ozone hole was one of the deepest and largest ever recorded, nearly equaling the all-time record set in 2000.[2] While significant progress has been made to reduce the atmospheric concentration of ozone layer destroying chemicals, there is no definitive evidence demonstrating that the ozone layer has started to recover. The most recent prediction by NASA delays recovery until 2068, nearly 20 years later than previous estimates.[3]

Meanwhile, we are also witnessing alarming changes caused by rising global temperatures. In 2002, a 3,350 square kilometer floating ice shelf in Antarctica, that has existed since the last Ice Age 12,000 years ago, collapsed due to record temperatures.[4] The number of Category 4 and 5 hurricanes has doubled in the last 35 years[5], and the flow of ice from glaciers in Greenland has more than doubled over the past decade.[6] Last month, a report commissioned by the US Congress confirmed what the world's leading scientists have known for years: the Earth was warmer in the late 20th Century than it had been in the last 400 or possibly 1,000 years, humans are largely responsible for this change, and it is only getting hotter.[7]

While good progress has been made to address both ozone depletion and climate change, these two issues have generally been treated as separate problems with separate solutions. This has resulted in outdated and uncoordinated policy responses. Of particular importance, and the focus of this report, is the unchecked and excessive production of certain HCFCs (hydrochlorofluorocarbons) and their by-product, HFCs (hydrofluorocarbons), which have global warming potentials (GWP) ranging from 1,000 to over 10,000 times that of carbon dioxide, respectively.[8]

HCFCs were introduced under the Montreal Protocol on Substances that Deplete the Ozone Layer as ozone-layer-safe replacements for CFCs (chlorofluorocarbons), once it was determined that CFCs were largely responsible for depletion of the ozone layer. The problem is that some of these chemicals, notably HCFC-22 and its HFC-23 by-product, contribute significantly to global warming.

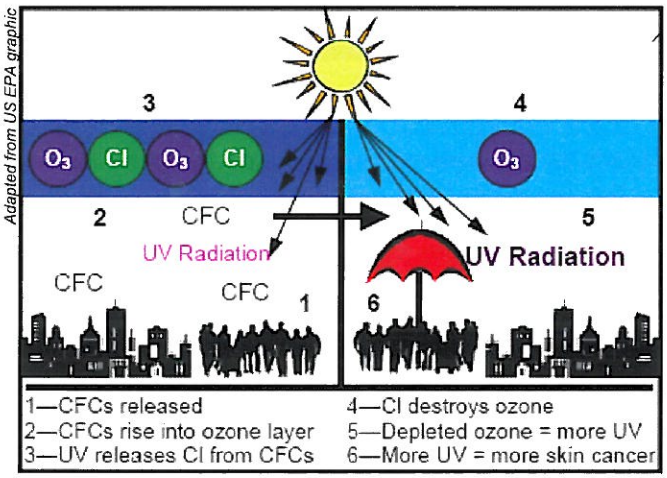
With countries such as China and India set to produce millions of metric tons (mt) of HCFCs over the next 10-20 years, and with phase outs decades off, failure to address this policy shortfall will radically undermine the international community's efforts to address climate change. **If the Montreal Protocol continues on its present course, HCFC and HFC emissions in 2015 are predicted to have over twice the impact on the climate than the required greenhouse gas reductions under the Kyoto Protocol.**

It is now abundantly clear that ozone depletion and climate change are not only inextricably linked in terms of their causes and mechanics, but also in their solutions. The good news is that by addressing HCFCs and HFCs jointly, the Parties to the Montreal and Kyoto Protocols have an opportunity to make a significant contribution to the global effort to stop climate change through international cooperation. This would be an extraordinary achievement, and particularly appropriate as the Montreal Protocol enters its 20th anniversary as a model multilateral environmental agreement. If, however, both conventions fail to address the HCFC and HFC issues together, it will be a shameful example of sheer avoidance or inter-convention squabbling over "jurisdiction."

OZONE LAYER DEPLETION

What is ozone depletion?

Life on Earth depends on the protection provided by the ozone layer. This thin layer of ozone molecules screens out nearly 99% of harmful ultraviolet (UV) radiation from the sun.[9] Humans have severely depleted the ozone layer by releasing high quantities of chemicals that contain bromine, chlorine and other ozone-depleting substances (ODS) into the atmosphere.[10] These chemicals react with sunlight in the upper atmosphere, or stratosphere, to destroy ozone, thus thinning the protective layer and allowing greater amounts of UV radiation to reach the Earth's surface.[10]



Evidence of ozone depletion: the Antarctic ozone hole

In 1985, scientists discovered severe thinning of the ozone layer over Antarctica due to human emissions of bromine and chlorine.[10] Satellite measurements have confirmed that an Antarctic ozone hole has reappeared each austral spring since its initial discovery. Although there is some variation from year to year, the ozone hole has generally grown larger and lasted longer each year. The 2005 ozone hole measured approximately 10 million square miles (25 million square kilometers) and was larger than the size of North America — nearly equaling the all-time record set in 2000.[2]

In 2005, the tip of South America and the Falkland Islands were also affected by the edges of the ozone hole between August and September.[11] During these periods, ozone values dropped to more than 20% below the normal value for that time of year.[11] By the end of September, ozone levels were down by over 30%.[11] The region was also affected by severe ozone depletion from October 7 to 10, when ozone amounts dropped 50% below normal levels.[11]

The specter of an Arctic ozone hole

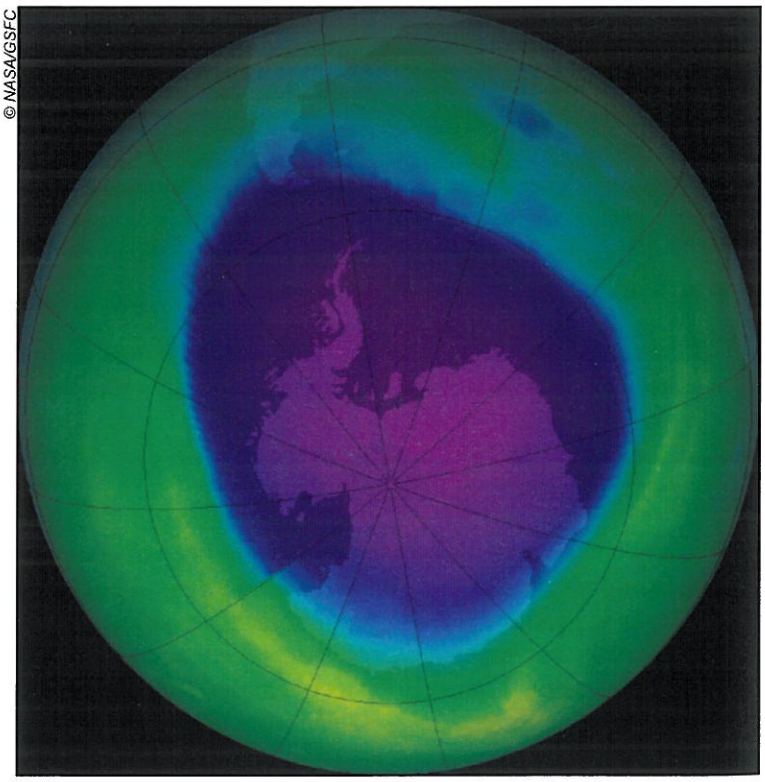
Scientists recently were shocked to observe severe ozone loss over the Northern Hemisphere and now warn of the possible development of an Arctic ozone hole.

In the winter of 2004-2005, the scientific journal *Nature* reported "the biggest ozone losses ever recorded over the Arctic."[12] Researchers observed a 30% reduction in the ozone layer during the winter/early spring and measured a 50% reduction in ozone at an altitude of 18km.[13] This follows measurements from the 1999-2000 winter, when the Arctic ozone layer lost over half of its ozone.[14]

Global ozone layer depletion

Ozone layer thinning is not confined to polar regions; it is a global problem with serious worldwide implications. Current global average ozone levels are approximately 3% below pre-1980 levels.[15] In mid-latitudes, where most of the world's population lives, the ozone layer has thinned between 3%-6% from pre-1980 levels.[15]

According to a recent report by European scientists, stratospheric ozone amounts over mainland Europe started to decline in the 1970s with larger decreases (between 5%-10%) occurring during the winter and spring seasons.[16] They also report that biologically active UV radiation has increased at the ground, in line with the reduced ozone amounts.[16]



The 2005 Antarctic Ozone Hole.


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Cases of pediatric melanoma in the US more than doubled between 1982 and 2002, according to the US National Cancer Institute.[21]

In addition, measurements from five sites within the continental United States (Bismarck, North Dakota; Caribou, Maine; Boulder, Colorado; Wallops Island, Virginia; and Nashville, Tennessee) show a thinning trend in the ozone layer nationwide since the late 1960s.[17]

The human and environmental impacts of ozone depletion

Thinning of the ozone layer results in increases in the quantities of harmful UV radiation that reach the surface of the Earth.[18]

One of the most serious health effects of overexposure to UV radiation is skin cancer. Currently, an estimated 66,000 deaths occur annually from all forms of skin cancer.[19] In the United States, skin cancer kills one person every hour and one in five will develop skin cancer in their lifetime.[19] There has been a dramatic increase in two types of non-melanoma skin cancer in people under 40, according to researchers at the Mayo Clinic.[20] The most likely causes: the fact that young people seek tans and depletion of the ozone layer.[20]

Children are at particular risk from conditions related to overexposure to UV radiation, according to the World Health Organization and the United Nations Environment Programme.[21] Statistics from the US National Cancer Institute indicate that skin cancer is on the rise in children: cases of pediatric melanoma in the U.S. more than doubled between 1982 and 2002.[21]

Recent scientific research indicates that UV radiation is much more harmful to the eye and vision than had previously been suspected.[22] One of the only effective preventative measures for cataract is to decrease exposure to biologically damaging UV radiation.[23] In December 2005, scientists from the Wilmer Eye Institute at the Johns Hopkins School of Medicine, the Joint Global Change Research Institute and the Institute for Global Risk Research estimated that with 5-10% ozone depletion, there will be 167,000-830,000 additional cases of cortical cataract by 2050.[24]

Increased UV radiation from ozone depletion damages DNA in living systems, and increased exposure is likely to affect the immune system and reduce resistance to infection. Zooplankton and phytoplankton, the foundation of the ocean food chain, lack protection from UV-B radiation and thus are particularly sensitive to the effects of ozone depletion.[25]

UV-B radiation can adversely affect the early developmental stages of aquatic organisms, decrease reproductive capacity and impair larval development.[25] Studies of plant species—including trees and agricultural crops—show that some are sensitive to increased UV radiation levels, which can result in reduced plant height, changes in tissue composition and reductions in foliage area.[26]

CLIMATE CHANGE

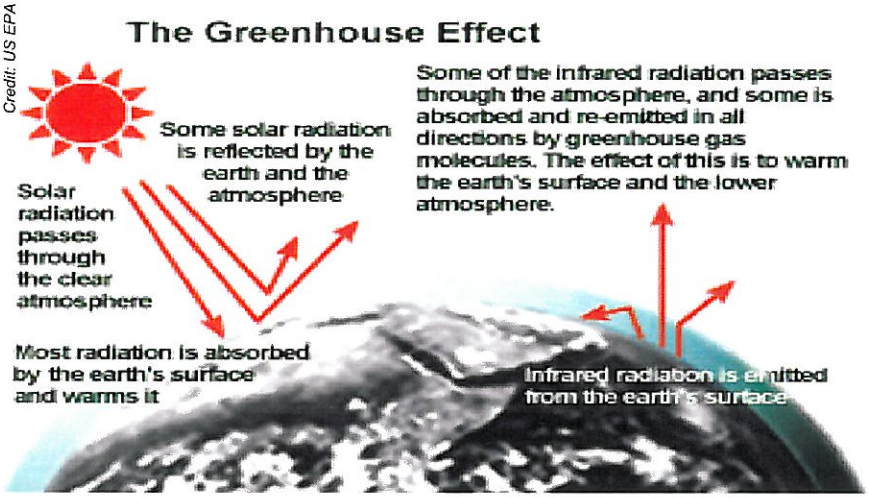
What is climate change?

Energy from the sun drives the Earth's weather and climate. Most of this energy is absorbed by the Earth's surface, causing it to warm, and some is re-emitted back to space.[27] Atmospheric greenhouse gases (GHGs), such as water vapor and carbon dioxide, trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse.[27] This natural "greenhouse effect" maintains the temperature and climate on Earth to support life as we know it.[27]

Earth's temperature on the rise

However, due to the buildup of GHGs from human activities, including industrial processes, fossil fuel combustion and deforestation, the Earth is warming at an unprecedented rate.

Temperatures at the Earth's surface increased by an estimated 1.4°F (0.8°C) between 1900 and 2005.[28] The Earth was warmer in the late 20th century than it had been in the last 400 or possibly 1,000 years.[7] The year 2005 was most likely one of the two warmest years on record since 1850.[29] Scientists expect that the average global surface temperature could rise 1-4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century.[27]



Credit: US EPA

The effects of climate change

Climate change will bring with it myriad harmful effects. These can include increased mortality due to heat, injuries caused by extreme weather such as floods or hurricanes, changes in the distribution of disease, increased threats to food security, the displacement of significant quantities of people due to rising sea levels and changes in weather and agricultural patterns—to name just a few.

Alarming signs of climate change:

- The glaciers of Greenland are melting twice as fast as they were five years ago and the ice sheets of Antarctica—the world's largest reservoir of fresh water—are also shrinking, according to a February 2006 report by NASA's Jet Propulsion Laboratory and the University of Kansas;[6]
- A World Health Organization (WHO) report in 2000 found that warming had caused malaria to spread from three districts in western Kenya to 13 and led to epidemics of the disease in Rwanda and Tanzania;[30]
- Argentina's Upsala Glacier was once the biggest in South America, but it is now disappearing at a rate of 200 meters per year;[31]
- The WHO concluded in 2005 that climate change already is claiming more than 150,000 lives each year, with causes ranging from heat waves to respiratory illness;[30]
- Global warming accounted for around half of the extra hurricane-fueling warmth in the waters of the tropical North Atlantic in 2005, while natural cycles were only a minor factor;[32]


Credit: NOAA

If global warming continues unabated:

- Global sea levels could rise by more than 20 feet with the loss of shelf ice in Greenland and Antarctica, devastating coastal areas worldwide;[33]
- The Arctic Ocean could be ice free in summer by 2050;[34] and
- More than 35% of all species on Earth could be driven to extinction by 2050.[35]

Summary: What is the difference between ozone depletion and climate change?

Climate change generally refers to changes in global weather conditions over a long term timescale. It can be caused by natural processes, such as a change in the sun's strength, as well as by human activities—in particular man-made emissions of GHGs that build up in the atmosphere and alter its chemical composition.[36]

GHGs trap heat in the lower atmosphere, called the troposphere. Atmospheric concentrations of GHGs have grown dramatically since pre-industrial times, due largely to fossil fuel use and permanent forest loss.[36] Temperature, circulation patterns, precipitations levels and storm events have, and will continue to be, affected by these changes.

Ozone depletion refers to the deterioration of the Earth's ozone layer located in the upper atmosphere—known as the stratosphere. Chemicals (such as CFCs, halons and methyl bromide) destroy ozone in the stratosphere, thus impairing the ozone layer's ability to shield UV radiation from the Earth's surface. The result is that the ozone layer becomes noticeably thinner and weaker, particularly in the polar regions. Any loss of ozone allows more UV radiation to reach the earth's surface. This has significant impacts on human and environmental health, notably increased incidence of skin cancer and cataracts.



Credit: NASA

Linkages between ozone depletion and climate change

Although ozone depletion and climate change are in many ways distinct problems, they are linked through complex atmospheric processes and feedback mechanisms. The human activities that contribute to climate change and ozone depletion affect the same atmosphere. Increasingly, scientists believe the net result of these interactions is the intensification of both ozone depletion and climate change.

The most obvious linkage between ozone depletion and climate change is the fact that some ODS, such as CFCs, and their replacements (notably HCFCs and HFCs), are also powerful GHGs.[37] However, ozone depletion and climate change are linked in many other ways, particularly through their effects on physical and chemical processes in the atmosphere, as well as interactions between the atmosphere and the rest of the global ecosystem.[37]

Major Linkages:

- Many of the manmade ozone-depleting chemicals (CFCs) and their replacements (HCFCs and HFCs) are also potent greenhouse gases.[8]
- The buildup 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 a cooling of the stratosphere.[36]
- Stratospheric cooling creates a more favorable environment for the formation of polar stratospheric clouds, which are a key factor in the development of polar ozone holes.[37] Thus, cooling of the stratosphere due to the buildup of GHGs and associated climate change, is likely to exacerbate destruction of the ozone layer.
- The troposphere and stratosphere are not independent of each other. Changes in the circulation and chemistry of one can affect the other.[37] Thus changes in the troposphere associated with climate change can affect functions in the stratosphere. In the same way, changes in the stratosphere due to ozone depletion can affect functions in the troposphere.

"Good" Ozone versus "Bad" Ozone[37]

- Ozone gas in the stratosphere, is beneficial in that it screens out harmful radiation.[9]
- Ozone gas at ground level—in the form of smog—is bad because it is directly harmful to human health.
- Ground level ozone is produced through reactions that rely on energy from the sun. As the ozone layer thins and more UV radiation reaches the Earth's surface, more ozone smog can be produced.

The Hydroxyl Radical: The Atmosphere's Vacuum[37]

- OH, the hydroxyl radical, reacts with many pollutants to effectively remove them from the atmosphere. It is produced through the sun-driven breakdown of ozone in the presence of water.[37]
- OH can remove the greenhouse gas methane, as well as HCFCs and HFCs, which both destroy the ozone layer and contribute to global warming.[37]
- Recent evidence suggests that a significant decline in OH concentrations occurred during the 1990s and that further declines can be expected.[37]
- Decreased or slowed removal of methane, HCFCs and HFCs, due to increased OH concentrations, would delay recovery of the ozone layer and intensify climate change.[37]

THE MONTREAL PROTOCOL

The Montreal Protocol on Substances that Deplete the Ozone Layer, a landmark agreement that was established in 1987, sets legally binding controls on the national production and consumption of ODS, with complete phase out as the final goal. Amendments to the Protocol were added at meetings in London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997), and Beijing (1999).

Widely considered the most successful international environmental agreement, the Montreal Protocol has done much to protect both the ozone layer and the global climate system. For example, atmospheric chlorine levels (the element in CFCs that depletes the ozone layer) are now decreasing due to Montreal Protocol controls on CFCs and other ODS.

Many ODS and their substitutes are also known to be significant GHGs. These include: CFCs, HCFCs, HFCs and PFCs. However, regulatory control over these substances is split between the Montreal Protocol and the Kyoto Protocol. The Montreal Protocol has control over CFCs and HCFCs, whereas HFCs and PFCs are within the purview of the Kyoto Protocol. Given the overlap, both in the causes and effects of ozone depletion and climate change, and in the policy responses, it has become increasingly obvious that coordination between these two treaties is imperative.



Credit: United Nations Environment Programme

TABLE 1: Summary of Montreal Protocol Control Measures[49]

Ozone Depleting Substances	Developed Countries	Developing Countries
Chlorofluorocarbons (CFCs)	Phased out end of 1995 [a]	Total phase out by 2010
Halons	Phased out end of 1993	Total phase out by 2010
Carbon tetrachloride	Phased out end of 1995 [a]	Total phase out by 2010
Methyl chloroform	Phased out end of 1995 [a]	Total phase out by 2015
Hydrochlorofluorocarbons (HCFCs)	Freeze from beginning of 1996 [b]; 35% reduction by 2004; 65% reduction by 2010; 90% reduction by 2015; Total phase out by 2020 [c]	Freeze in 2016 at 2015 base level; Total phase out by 2040
Hydrobromofluorocarbons (HBFCs)	Phased out end of 1995	Phased out end of 1995
Methyl bromide	Freeze in 1995 at 1991 base level [d]; 25% reduction by 1999; 50% reduction by 2001; 70% reduction by 2000; Total phase out by 2005	Freeze in 2002 at average 1995-1998 base level; 20% reduction by 2005 [e]; Total phase out by 2015

a With the exception of a very small number of internationally agreed essential uses that are considered critical to human health and/or laboratory and analytical procedures.

b Based on 1989 HCFC consumption with an extra allowance (ODP weighted) equal to 2.8% of 1989 CFC consumption.

c Up to 0.5% of base level consumption can be used until 2030 for servicing existing equipment.

d All reductions include an exemption for pre-shipment and quarantine uses.

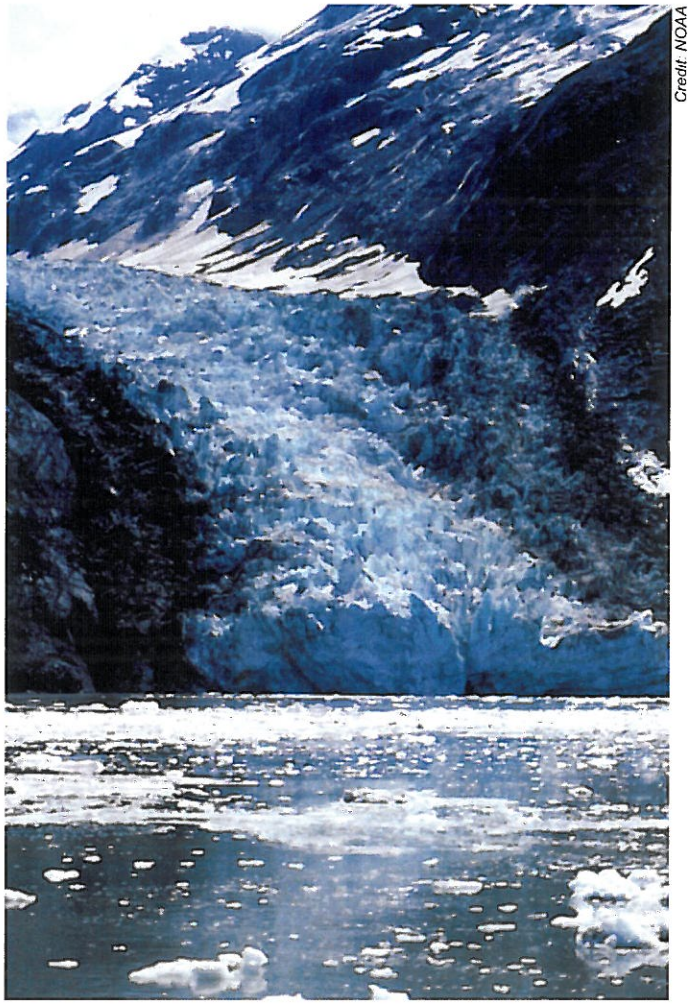
e Review in 2003 to decide on interim further reductions beyond 2005.

THE KYOTO PROTOCOL

The Kyoto Protocol is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratified it have agreed to reduce their emissions of carbon dioxide and five other GHGs (methane, nitrous oxide, sulfur hexafluoride, HFCs, and PFCs) through emissions trading. It is important to note that although HFCs and PFCs are replacements for some ozone-depleting substances, because of their high GWP, they are regulated under the Kyoto Protocol. They are therefore not regulated under the Montreal Protocol.

The Protocol aims to reduce the collective emissions of developed country GHGs by 5.2% from 1990 levels. This amounts to about 950 million mt of carbon dioxide equivalent (CO2-eq) emissions of GHGs. The goal is to lower overall emissions of the six GHGs—calculated as an average over the five-year period of 2008-12. National targets range from 8% reductions for the European Union and some others to 7% for the US (which has yet to ratify the treaty), 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.[38]

One mechanism for decreasing emissions under the Kyoto Protocol is emissions trading through the Clean Development Mechanism (CDM). The CDM enables companies in developed countries to receive credits for investing in emissions-reducing technology in developing countries. The intention is to encourage investment in clean technologies, such as wind and solar power and to reduce global emissions overall.



Credit: NOAA

TABLE 2: Greenhouse Gases Trapped Between Treaties

Gas	Global Warming Potential (relative to CO2)	Relationship to Montreal Protocol	Relationship to Kyoto Protocol
HCFC-22	1,700	Controlled under the Montreal Protocol, but promoted and funded as an alternative to CFCs.	Not regulated despite its global warming impact.
HFC-23	11,700	Not regulated, but produced as a byproduct of HCFC-22, which is regulated under the Montreal Protocol.	Controlled for its global warming impact. Carbon Emissions Reduction credits can be earned for destruction of this chemical.
HFC-134a	1,300	Not regulated. Promoted as an alternative due to its low ozone depleting potential and despite its high global warming impact.	Controlled for its global warming impact.



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The expected impact of HCFC-22 production, and its associated by-product HFC-23, is alarming: approximately one billion metric tons of CO2-equivalence in 2015, or about the same amount as the total required reductions under the Kyoto Protocol.[39]

THE URGENT ISSUE OF HCFCs AND HFCs UNDER THE MONTREAL PROTOCOL

The Montreal Protocol has an important influence on chemicals that affect global warming. These include both controlled substances and non-controlled substances that have been introduced and encouraged as alternatives to ODS. Some actions, such as the phase out of CFCs, were positive steps for both the ozone layer and climate, and should be applauded. Such achievements, however, should not be used as an excuse for inaction or bad decision-making today. Currently, there are serious problems on the horizon that require immediate attention. Chief among these is the predicted, and already partially documented, exponential rise in HCFC-22 production and its by-product HFC-23—both potent global warming gases.

Adoption of HCFC-22 encouraged by the Montreal Protocol

HCFC-22 (or R-22) has a GWP of 1700,[8] which means that one metric ton of HCFC is 1700 times more effective at warming the atmosphere than one metric ton of carbon dioxide.

HCFC-22 is widely used in refrigeration, air conditioning and some foaming agents as a replacement for CFC-12. As a readily available technology with a relatively low ozone depleting potential, the use of HCFC-22 has been encouraged by the Parties to the Montreal Protocol. The Multilateral Fund for the Implementation of the Montreal Protocol (MLF) has financed multiple projects to convert factories using CFC-12 to HCFC-22. The encouragement by the Montreal Protocol to use HCFC-22 has led to the increases in the production of this chemical observed today.

The decision to "push" HCFC-22 is doubly harmful because HFC-23 (or R-23) is manufactured as a by-product of HCFC-22 production. HFC-23 has an extremely high GWP of 11,700.[8] The expected impact of HCFC-22 production, and its associated by-product HFC-23, is alarming: approximately one billion mt of CO2-eq in 2015, or about the same amount as the total required reductions under the Kyoto Protocol.[39]

Slow phase out

HCFC-22 is controlled by the Montreal Protocol, but it currently enjoys an extremely long phase out schedule. Developed countries are effectively required to achieve a total phase out by 2020, while developing countries have until 2040, with a freeze in 2016 at 2015 levels. Current TEAP (the technical and economic expert body of the Montreal Protocol) predictions indicate a troubling increase in production and consumption of HCFC-22 and HCFC-22 containing technologies.[39] This is despite many Parties having recognized its harmful effects.

The European Community has banned the import of products that contain HCFC-22. The US, however, allows such imports and is currently being flooded with HCFC-22 products from China—between 5 and 6 million air conditioning units per year (each containing about 2.5 kilos of HCFCs).[40] The lifetime of these units is about 15 years, which suggests that the US may have to maintain an HCFC bank or continue to produce HCFCs beyond the effective phase out date of 2020.[40]

SKYROCKETING HCFC-22 PRODUCTION

China is chief among those currently gearing up to feed the massive US market for HCFC-dependent technologies, as well as its domestic and other markets. Industry observers estimate that China exports over 14.8 million air conditioning units per year.[41] Rapid growth in air conditioner production in China continues to increase China's use of HCFC-22.[42]

TEAP recently reported that there are currently 21 million window air-conditioners produced in China, which represents 50% of the world market. In the last 5 years, China has become the largest producer of air-conditioning units in the world, of which 90% are currently produced with HCFC-22. This production is currently making the US and the majority of developing countries around the world increasingly dependent on HCFC-22 and creating unnecessary difficulties for the already excessively lax phase out schedule.[42]

While US production of HCFCs and HCFC-dependent equipment is set to end in 2010, there are as yet no parallel measures to restrict imports of HCFC equipment. While stopping US production may serve to phase out the US domestic HCFC industry, it may do little to end HCFC production globally or to wean the US market off HCFCs if imports are allowed to continue to stream in to the United States.

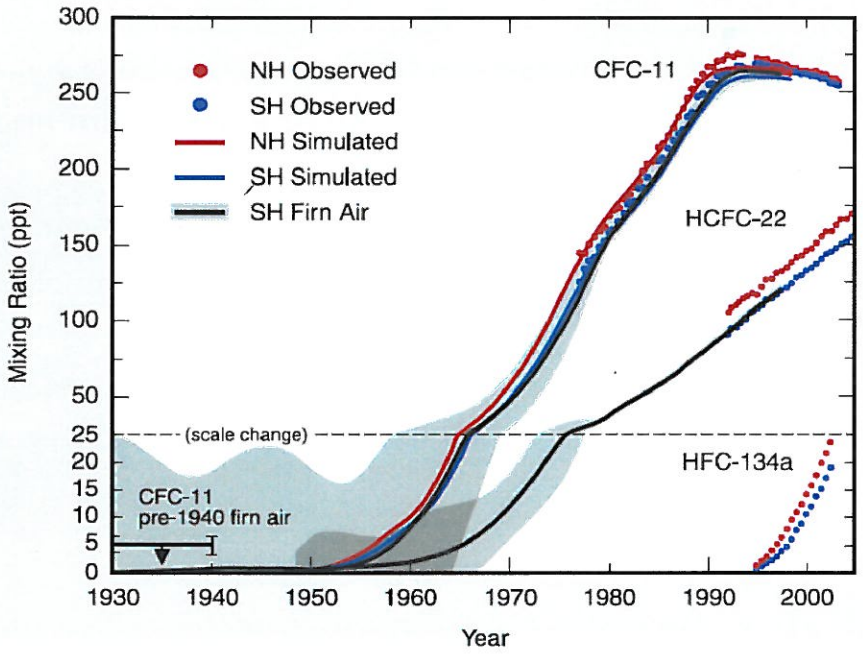
The Multilateral Fund and the need for assistance in speeding up the HCFC-22 phase out

Unfortunately, just as markets around the world are becoming more dependent on HCFC-22, the primary means of weaning them off such technology has been shut off by the Montreal Protocol. The Multilateral Fund, designed to help developing countries cope with phase out plans, has followed a policy of refusing to fund projects to phase out HCFC-22 in industries that have already received funding.[43] The intent of this policy may have been to dissuade countries from seeking funding for conversion to HCFC-22 in the first place and to promote the adoption of "final solutions" (i.e. gases that neither deplete the ozone layer nor contribute to global warming). However, the practical effect in these cases is that the MLF has created a problem of increasing HCFC use that it is now unwilling or unable to fix.

Figure 1 (which was recently jointly produced by the technical bodies of the Montreal and Kyoto Protocols) depicts estimated global tropospheric concentrations of HCFC-22. Experts in the Montreal Protocol now say that, due to the reaction of Chinese producers to the US and other markets, production of HCFCs is expected to increase far beyond the 160,000 mt prediction made at the time.[44] Any increases in production predictions would mean that the impacts on global warming estimated in the following section are an underestimate.

FIGURE 1: MEASURED ATMOSPHERIC HCFC CONCENTRATIONS

Figure TS-3. Estimated global tropospheric mixing ratios (ppt) for CFC-11, HCFC-22 and HFC-134a shown separately for the Northern and Southern Hemisphere. Red and blue symbols show measurements from the AGAGE (Advanced Global Atmospheric Gases Experiment) and CMDL (Climate Monitoring and Diagnostics Laboratory) networks, while red and blue lines show simulated CFC-11 concentrations based on estimates of emissions and atmospheric lifetimes. Black lines and the shaded area show estimates and uncertainty bands for CFC-11 and HCFC-22 derived by synthesis inversion of Antarctic firn air measurements and *in situ* Cape Grim atmospheric measurements. The thick black horizontal line with arrow and error bars shows a separate upper bound estimate of pre-1940 CFC-11 concentrations based on South Pole firn air measurements. Note that the gases shown here are used in different applications and are presented for illustrative purposes only. [Figure 1.8]



Credit: Technical Summary IPCC/TEAP Special Report

THE CLIMATE IMPACT OF HCFCs AND HFCs

The IPCC/TEAP report predicts that under a business-as-usual scenario, the annual emissions of HCFCs in 2015 will be 828 million mt of CO2-eq.[42] The vast majority of this is expected to be due to HCFC-22. Under the same scenario, HFC emissions are predicted to increase from 0.4 Gigatons CO2-eq per year (2002) to about 1.2 billion mt of CO2-eq per year by 2015.[42] According to the report, the three-fold increase "is the result of increased application of HFCs in refrigeration, SAC and MAC sectors and due to byproduct emissions of HFC-23 from increased HCFC-22 production."[42]

HCFC and HFC emissions, therefore, are predicted to be about 2 billion mt of carbon equivalence in 2015 under the business-as-usual scenario. This amounts to over double the required reductions to be achieved under the Kyoto Protocol by 2012.[45]

Subsequent to the release of the IPCC/TEAP report, new estimates of HCFC-22 production, now and in the future, were made by the technical experts. Increases in HCFC-22 production impact the climate in two ways: directly and via the production of its HFC-23 by-product. **Depending on where the new estimates for HCFC-22 production fall within the range of uncertainty currently discussed, they could add on the order of another 1 billion tons of CO2-eq above and beyond the current projections in the IPCC/TEAP report.** The majority of that impact would come directly from HCFC-22 emissions, not the HFC-23 by-product.

It is therefore extremely important to improve the estimates of current and future production of HCFC-22.

Bad information now threatens to cause massive problems for the future of the phase out. Unreported production, stockpiling and trade of HCFCs will conspire to block the take-up of alternatives, and hamper phase out. HFC banks have started to build up and are projected to reach about 5 billion tons CO2-eq in 2015.[46]

To avoid a massive climate contribution by HCFC-22 production, it is imperative to immediately improve understanding and monitoring of the production, trade and 'banking' of HCFCs and HCFC-containing equipment.


Ezra Clark/EIA

Kyoto's Clean Development Mechanism and "perverse incentives"

Under the Kyoto Protocol, the Clean Development Mechanism enables companies in countries that are party to the Protocol to purchase Certificates of Emissions Reduction (CER) credits for each mt of CO2-eq greenhouse gas eliminated through emissions reductions by another company located in a developing country that is also Party to the Protocol.[40] The purpose of the CDM is to encourage investment in renewable energy and "clean" technologies, such as wind and solar power.[40] The price of CERs for most projects is $5.00-$15.00 per mt of CO2 reduction.[40] The cost of destroying the HFC-23, however, is very low (around $0.20 per mt), allowing for extremely high profits.[47]

There are only a few dozen (20-30) HCFC-22 production plants in the world. While some of these plants, particularly those in industrialized countries, destroy HFCs; often those in developing countries do not. Industry observers have suggested that an entirely new HCFC-22 production facility could be financed on the basis of expected profits from the sale of HFC-23 destruction credits.[48] Therefore, the CDM financing of HFC-23 production is expected to create a perverse incentive for significant increases in production of HCFC-22.

CONCLUSIONS AND RECOMMENDATIONS

Given the increasingly fragile condition of the Earth's atmosphere and the tremendous uncertainty associated with the exacerbating effects of ozone depletion and climate change, the Environmental Investigation Agency urgently recommends that the Parties to the Montreal and Kyoto Protocols take joint responsibility for their roles in safeguarding the ozone layer and the global climate by taking the following precautionary actions:

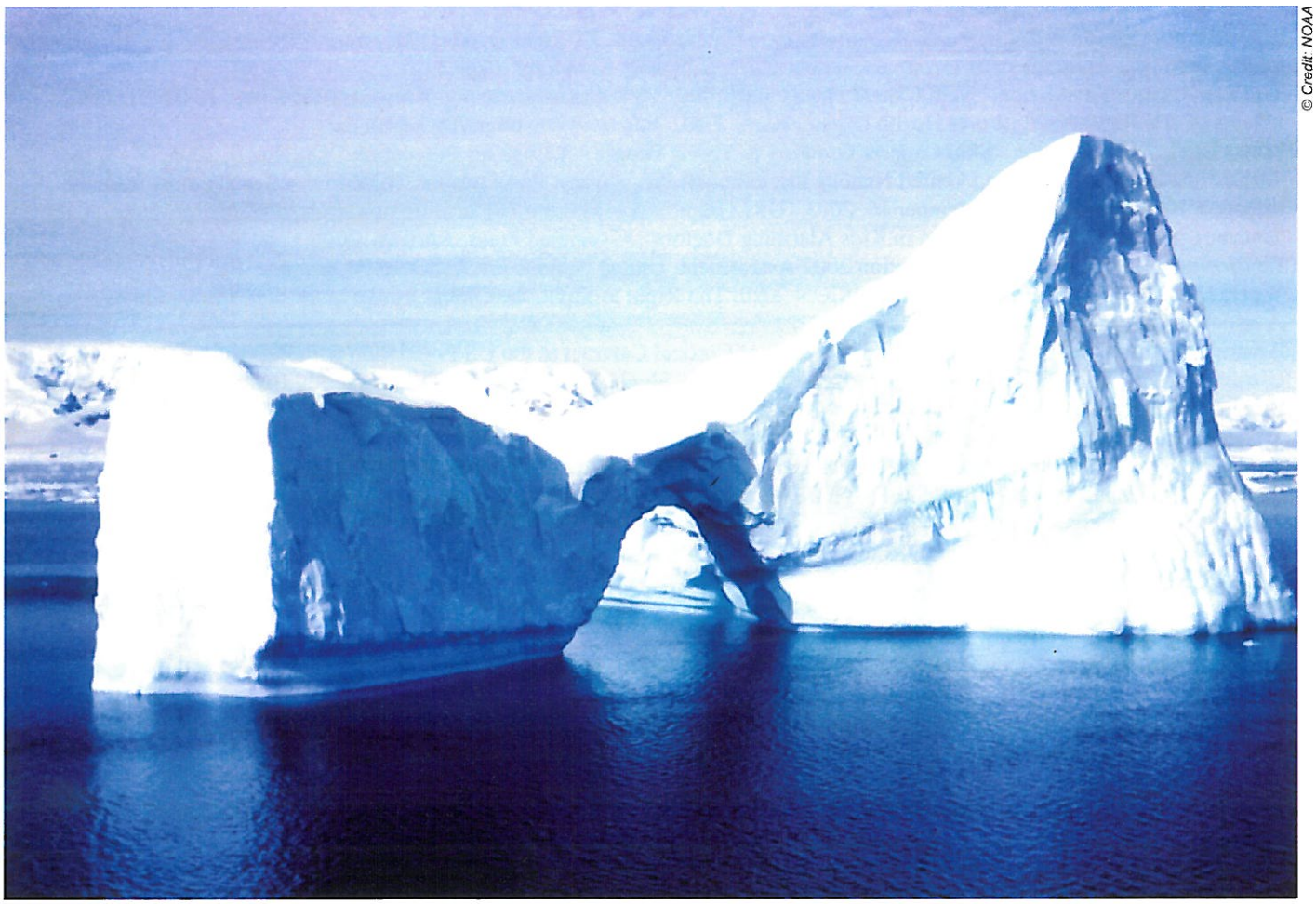
1. Accelerate the Montreal Protocol phase out of HCFC-22.

2. Direct the Multilateral Fund to support an accelerated phase out of HCFC-22 by Article 5 countries and development of alternatives, regardless of past funding projects relating to the phase out of CFCs.

3. Encourage national-level prohibitions on importation of HCFCs and HCFC-containing equipment into developed countries that have not already done so, such as the United States.

4. Encourage the development of additional domestic legislation in developed countries to implement the phase out of HCFC-22, including bans on production, consumption, sale and trade of HCFCs and HCFC-containing equipment.

5. Improve coordination between the Montreal Protocol and the Kyoto Protocol to eradicate and prevent perverse incentives to increase HCFC-22 production as a result of the Clean Development Mechanism.



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The Environmental Investigation Agency, a non-profit NGO based in Washington, DC and London, is committed to investigating and exposing environmental crime, and to promoting lasting solutions. EIA has been actively tracking the global illegal trade in ozone-depleting substances (ODS) since the mid-1990s to provide information to the Montreal Protocol and other relevant bodies, as well as to training and regional cooperation workshops.

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environmental **investigation** agency

US
PO box 53343
Washington DC 20009,
USA
USinfo@eia-international.org
Tel (+1) 202 483 6621

UK
62-63 Upper Street,
London, N1 0NY,
UK
UKinfo@eia-international.org
Tel (+44) 20 7354 7960

www.eia-international.org