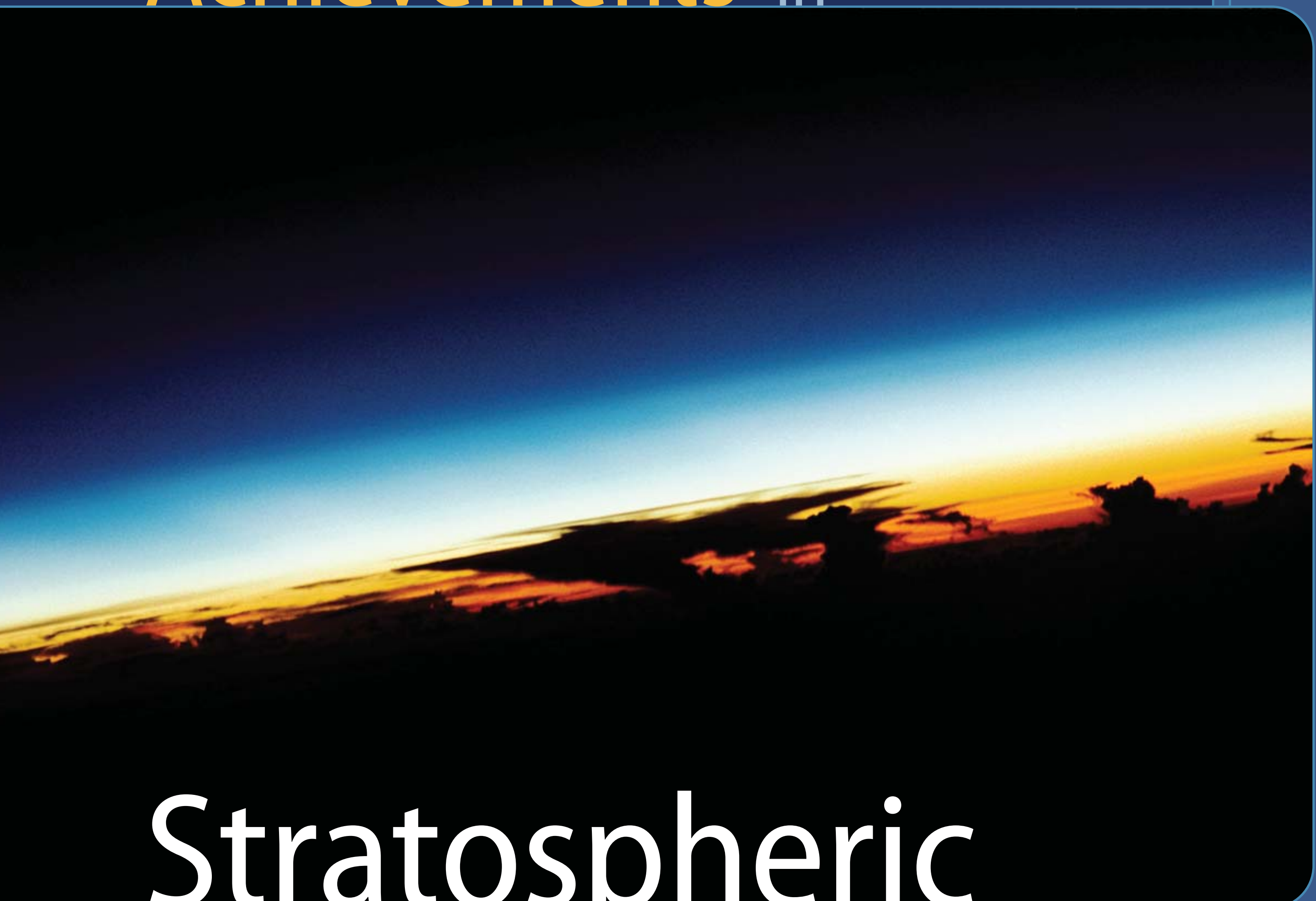
Achievements in



Stratospheric Ozone Protection

PROGRESS REPORT

Contents

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Achievements in Stratospheric Ozone Protection

PROGRESS REPORT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

About This Report

Countries around the world are phasing out the production and use of chemicals that destroy ozone in the Earth's upper atmosphere. The United States has already phased out production of those substances having the greatest potential to deplete the ozone layer. At the same time, we have ensured that businesses and consumers have alternatives that are safer for the ozone layer than the chemicals they replace. These vital measures are helping to protect human health and the global environment.

With our many partners, the U.S. Environmental Protection Agency (EPA) is proud to have been part of a broad coalition that developed and implemented flexible, innovative, and effective approaches to ensure stratospheric ozone layer protection. These partnerships have fundamentally changed the way we do business, spurring the development of new technologies that not only protect the ozone layer but, in many cases, also save energy and reduce emissions of greenhouse gases. Together, we continue to look for alternatives and technologies that are as ozone- and climate-friendly as possible.

This report covers the important and substantial achievements of the people, programs, and organizations that are working to protect the Earth's ozone layer. As impressive as these accomplishments are, our work is not done. Even though we have reduced or eliminated the use of many ozone-depleting substances, some still remain. Additionally, since ozone-depleting substances persist in the air for long periods of time, the past use of these substances continues to affect the ozone layer today. We must also continue to ensure that the alternatives being brought to the market support the country's long-term environmental goals in a cost-effective manner.

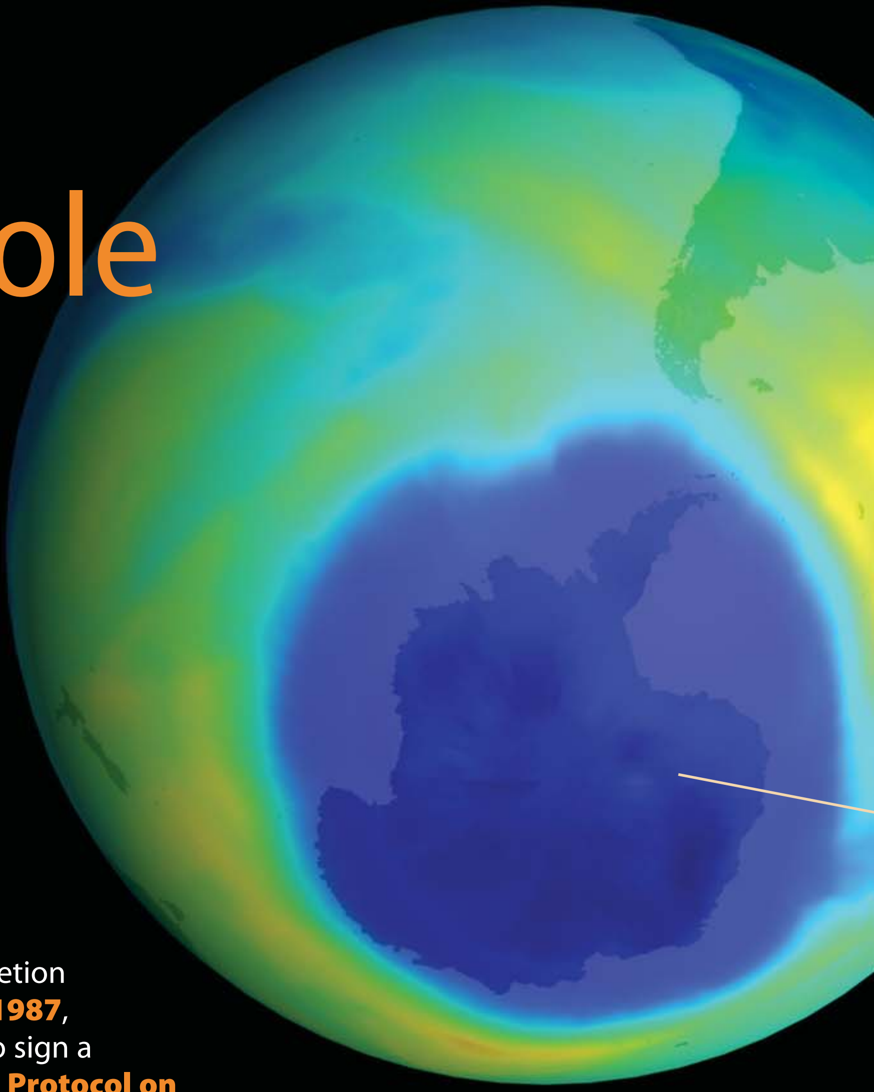
"Those of us who have been fighting for the ozone layer since the early 1980s look back in amazement at what has been accomplished. Most of us consider our work on ozone as the most important part of our lives."

—Dr. Iwona Rummel-Bulska,
United Nations Environment Programme

A C H I E V E

OVER THE PAST SEVERAL DECADES, EPA'S STRATOSPHERIC PROTECTION DIVISION AND ITS PARTNERS HAVE MADE SIGNIFICANT STRIDES TO PROTECT THE EARTH'S STRATOSPHERIC OZONE LAYER, THE ENVIRONMENT, AND PEOPLE'S HEALTH.

Healing the Ozone Hole

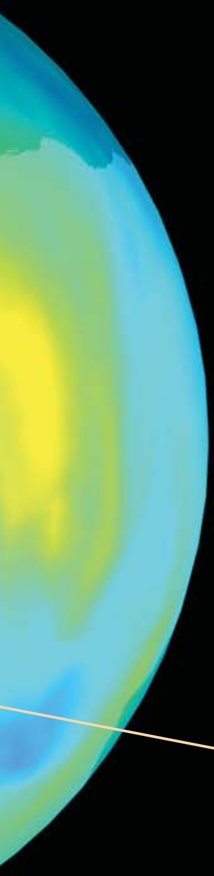


The ozone layer acts like a shield in the upper atmosphere (the stratosphere), to protect life on Earth from harmful ultraviolet (UV) radiation. In **1974**, scientists discovered that emissions of chlorofluorocarbons, or CFCs, were depleting ozone in the stratosphere. CFCs were a common aerosol propellant in spray cans and were also used as refrigerants, solvents, and foam-blowing agents.

In the **1980s**, scientists observed a thinning of the ozone layer over Antarctica, and people began thinking of it as an "ozone hole." Additional research has shown that ozone depletion occurs over every continent.

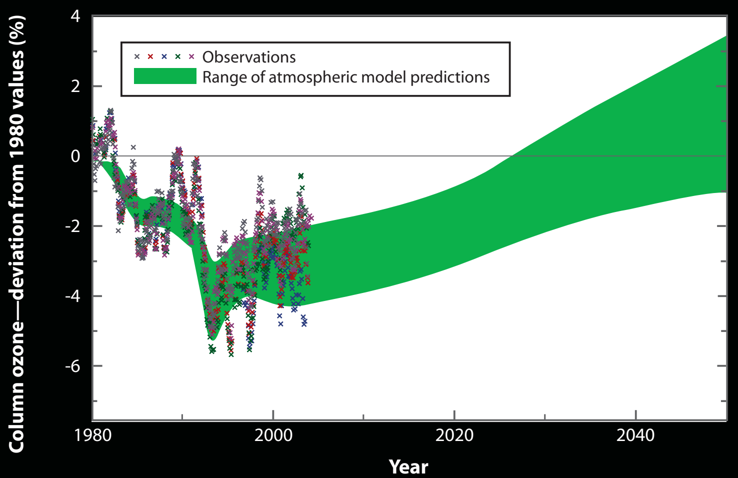
As our scientific knowledge about ozone depletion grew, so too did the response to the issue. In **1987**, leaders from many countries came together to sign a landmark environmental treaty, the **Montreal Protocol on Substances That Deplete the Ozone Layer**. Today, more than 190 countries—including the United States—have ratified the treaty. These countries are committed to taking action to reduce the production and use of CFCs and other ozone-depleting substances to protect the ozone layer. Countries are phasing out the production and consumption of ozone-depleting substances in groups, focusing on those chemicals with the most ozone-depleting potential first, followed by those that pose the next greatest ozone-depletion risk (in this document, these chemicals are referred to as "first-generation" and "second-generation" substances, respectively).

M E N T S



Sustained recovery of the ozone layer will require worldwide phase-out of ozone-depleting substances.

Global Ozone Depletion and Recovery



Source: Intergovernmental Panel on Climate Change/Technology and Economic Assessment Panel. Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. (Cambridge: Cambridge University Press, 2005.) Figure SPM-3.

The ozone layer has not grown thinner since 1998 over most of the world, and it appears to be recovering because of reduced emissions of ozone-depleting substances. Antarctic ozone is projected to return to pre-1980 levels by 2060 to 2075.

OZONE: GOOD UP HIGH, BAD NEARBY

Ozone is a gas that occurs both in the Earth's upper atmosphere (the stratosphere) and at ground level. Ozone can be "good" or "bad" for people's health and the environment, depending on its location in the atmosphere.

"Good" ozone is produced naturally in the stratosphere and is "good" because it blocks harmful UV radiation from reaching the Earth's surface where it can harm people and ecosystems.

"Bad" ozone is an air pollutant found at ground level and is "bad" because it is harmful to breathe and can damage crops, trees, and other vegetation. Ground-level ozone is a main component of urban smog.

For more information, see: <www.epa.gov/oar/oaqps/gooduphigh>.

Saving Lives

We care about ozone depletion because a thinner ozone layer allows more UV radiation to reach the Earth's surface. Overexposure to UV radiation can cause a range of health effects, including skin damage (skin cancers and premature aging), eye damage (including cataracts), and suppression of the immune system. Researchers believe that overexposure to UV radiation is contributing to an increase in melanoma, the most fatal of all skin cancers.

* U.S. Environmental Protection Agency, Office of Air and Radiation. November 1999. The Benefits and Costs of the Clean Air Act, 1990-2010. EPA 4W-R-99-001. www.epa.gov/air/sect812/prospective1.html.

Protecting the Planet

UV radiation can damage sensitive crops, such as soybeans, and reduce crop yields. Some scientists believe that marine phytoplankton, which serve as the base of the ocean food chain, are already under stress from UV radiation. This stress could have profound effects on the food chain and on food productivity.

Additionally, since most ozone-depleting substances are also potent greenhouse gases, replacing these substances with alternatives that are safer for the ozone layer can also reduce greenhouse gas emissions and slow climate change.

Phasing out ozone-depleting substances has already reduced greenhouse gas emissions by more than 8,900 million metric tons of carbon equivalent (MMTCE) per year*—equivalent to the cumulative carbon dioxide emissions associated with…

Generating enough electricity to **power every U.S. home** for more than 13 years…

And

Preserving 89 million acres of forests from deforestation—more than twice the size of Florida…

And

Saving more than **1.2 trillion gallons of gas**—enough to make 4.8 billion round trips from New York to Los Angeles by car.‡

* U.S. Environmental Protection Agency, Stratospheric Protection Division, Allowance Tracking System, 1989-1995.

‡ Calculations made using U.S. Climate Technology Cooperation Gateway tool at www.usctcgateway.net.

Everyone Benefits

Protecting the ozone layer has enormous benefits for the United States.

Because stratospheric ozone depletion is a global issue, people in other countries also benefit from the investments we make in technology and sound science to protect the ozone layer. In turn, we benefit from the accomplishments of other nations.

Every dollar invested in ozone protection provides
$20 of societal health benefits in the United States.*

Efforts to protect the stratospheric
ozone layer will produce an estimated

$4.2 trillion in societal health benefits

in the United States over the period 1990 to 2165.*

* U.S. Environmental Protection Agency, Office of Air and Radiation. November 1999. The Benefits and Costs of the Clean Air Act, 1990-2010. EPA 4W-R-99-001. www.epa.gov/air/sect812/prospective1.html.

Then: Ozone-Depleting Substances Were All Around Us...

Now: More Ozone-Friendly Products, Better Processes, and New Equipment Are In Use

All parts of our daily lives have been touched by ozone-depleting substances. Prior to the 1980s, CFCs and other ozone-depleting substances were pervasive in modern life. But thanks to the work of individuals, businesses, organizations, and governments around the world, substitutes that are safer for the ozone layer continue to be developed for many ozone-depleting substances. The phaseout of ozone-depleting substances has also made a substantial contribution toward the reduction in greenhouse gas emissions since their global warming potential is very high.

Computers

Then: Solvents containing CFCs and methyl chloroform were used to clean circuit boards during their production.

Now: Some companies have eliminated the need to clean circuit boards during their production. Others use water or have temporarily switched to HCFCs.

Polystyrene Cups and Packing Peanuts

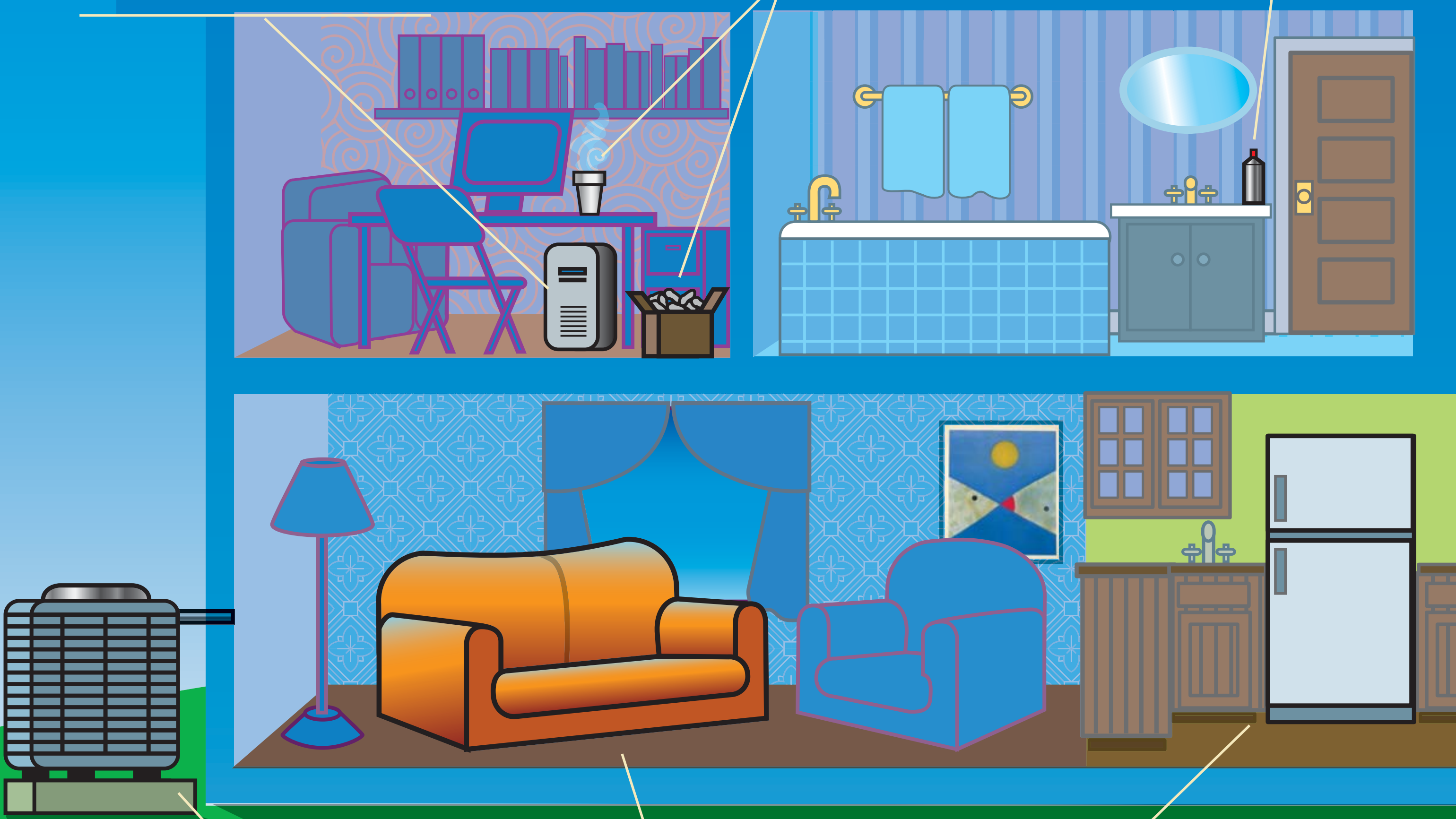
Then: Some polystyrene cups and foam packing "peanuts" were made using CFCs.

Now: These products are made with materials that do not deplete the ozone layer.

Aerosol Cans

Then: CFCs were the propellant used in various spray cans.

Now: Pumps and alternative propellants using hydrocarbons are being used.



Central Air Conditioners

Then: CFCs were used as the coolant in household air conditioners.

Now: HCFCs and HFCs have replaced CFCs.

Furniture

Then: Foam-blowing agents containing CFCs were used in furniture making.

Now: Water-blown foam is being used.

Refrigerators

Then: CFCs were used in refrigerator coolants and foam insulation.

Now: HFCs have replaced CFCs, and substitutes are on the horizon that will have reduced greenhouse gas impacts.

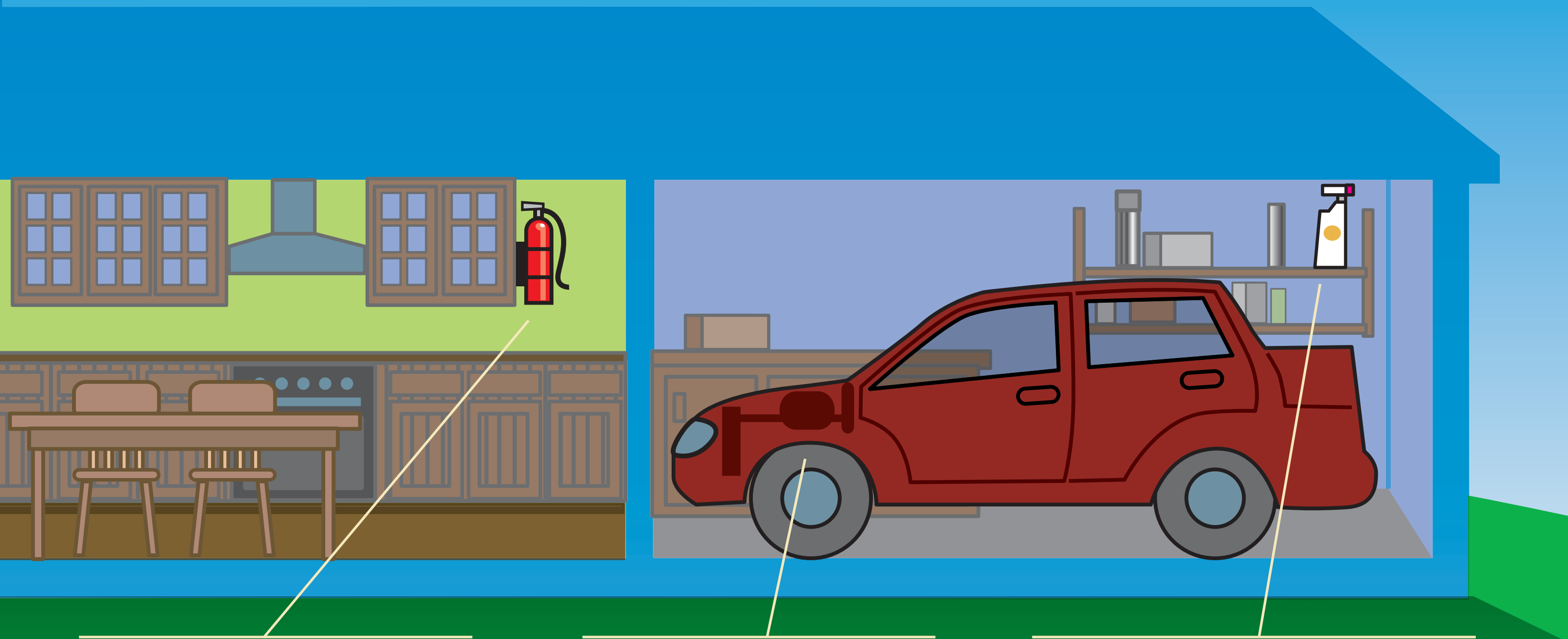
Common Ozone-Depleting Substances and Some Alternatives‡

Substance	Uses	Ozone-Depleting Potential*	Global Warming Potential**
Chlorofluorocarbons (CFCs)	Refrigerants, cleaning solvents, aerosol propellants, and blowing agents for plastic foam manufacture.	0.6 – 1.0	4,680 – 10,720
Halons	Fire extinguishers/fire suppression systems, explosion protection.	3 – 10	1,620 – 7,030
Carbon tetrachloride (CCl_4)	Production of CFCs (feedstock), solvent/diluents, fire extinguishers.	1.1	1,380
Methyl chloroform ($CHCl_3$)	Industrial solvent for cleaning, inks, correction fluid.	0.1	144
Methyl bromide (CH_3Br)	Fumigant used to control soil-borne pests and diseases in crops prior to planting and in commodities such as stored grains. Fumigants are substances that give off fumes; they are often used as disinfectants or to kill pests.	0.6	5
Hydrochlorofluorocarbons (HCFCs)	Transitional CFC replacements used as refrigerants, solvents, blowing agents for plastic foam manufacture, and fire extinguishers. HCFCs deplete stratospheric ozone, but to a much lesser extent than CFCs; however, they are greenhouse gases.	0.01 – 0.5	76 – 2,270
Hydrofluorocarbons (HFCs)	CFC replacements used as refrigerants, aerosol propellants, solvents, and fire extinguishers. HFCs do not deplete stratospheric ozone, but they are greenhouse gases.	0	122 – 14,130

‡ This is a limited list and does not represent all of the alternatives approved by EPA's Significant New Alternatives Policy (SNAP) program. For a complete list, see: www.epa.gov/ozone/snap/lists/index.html.

* Ozone-depleting potential (ODP) is the ratio of the impact on ozone caused by a chemical compared to the impact of a similar mass of CFC-11. The ODP of CFC-11 is 1.0.

** Global warming potential (GWP) is the ratio of the warming caused by a substance compared to the warming caused by a similar mass of carbon dioxide. The GWP of carbon dioxide is 1.0.



Fire Extinguishers

Then: Halons were commonly used in hand-held fire extinguishers.

Now: Conventional dry chemicals, which don't deplete the ozone layer, and water have replaced halons. HFCs are also used.

Car Air Conditioners

Then: CFCs were used as the coolant in automobile air conditioners.

Now: HFCs have replaced CFCs.

Degreasers

Then: CFCs or methyl chloroform were used in many solvents for degreasing.

Now: Water-soluble compounds and hydrocarbon degreasers that do not deplete the ozone layer are available for many applications.

The Technology Revolution

In the 1980s, only a few businesses and government organizations were optimistic that technology could be developed to meet the challenge of effectively eliminating the use of ozone-depleting substances. But over the next two decades, the reductions of these substances, called for in the Montreal Protocol, galvanized a global technology revolution.

Corporate Leaders

Companies around the world invested in unprecedented research and development to find ways to eliminate the use of ozone-depleting substances. Creating effective product substitutes or rethinking processes that had been in place for decades was no trivial task. Many factors had to be considered and thoroughly evaluated.

Some businesses took a traditional path—retrofitting equipment, re-engineering products or processes, or finding in-kind replacements. Others found an opportunity to invent completely new technologies or products. These efforts required major corporate investment to develop new technologies, test them, and speed their deployment to the marketplace.

Today, technology is being developed and deployed that protects the ozone layer while saving energy and preventing greenhouse gas emissions.

There are hundreds of examples of important achievements in ozone layer protection. The following are just a few stories from some technology leaders. Many other organizations also made significant achievements in their fields.

SC JOHNSON ELIMINATES USE OF CFCs IN AEROSOLS

SC Johnson
A Family Company

One of the first instances of U.S. corporate leadership for protection of the ozone layer occurred on June 18, 1975, twelve years before the Montreal Protocol, when SC Johnson announced its plan for a corporate elimination of CFCs used as aerosol product propellants. Its announcement was also well ahead of the announcement by the federal government that most CFC-based aerosol products for consumers would be banned in the United States. SC Johnson demonstrated that hydrocarbon propellants were more economical and that its customers preferred products that were more protective of the ozone layer. By March 1978, when EPA banned CFCs as propellants in cosmetic products, consumers had already virtually halted the purchase of cosmetic products that contained CFCs.

DUPONT™ LEADS WITH SOUND SCIENCE

DU PONT®

For more than two decades, DuPont™ has provided industrial leadership in the protection of stratospheric ozone. In the 1970s, the company's management made a business decision to invest in good science and conduct its own atmospheric modeling to help decipher the evidence that CFCs were affecting stratospheric ozone. By the time the Montreal Protocol was signed, DuPont™ had already led the chemical industry by abandoning CFCs and developing alternatives. The company helped to form the international Programme for Alternative Fluorocarbon Toxicity Testing (PAFT), through which it invited producers to examine the environmental impacts of the potential new alternatives.

"The unprecedented progress we have seen in ozone layer protection was a direct result of cooperation among governments, industry, environmental organizations, and scientists worldwide. Industry's innovations sped CFC phaseout while providing essential services such as air conditioning and refrigeration. We are very optimistic that the same spirit of cooperation can carry forward to other environmental issues such as global climate change."

—Thierry Vanlancker, Director,
DuPont™ Fluorochemicals

Partnerships for Progress

Private and public leaders around the world collaborated to develop and test new technologies to eliminate the need for ozone-depleting substances. These organizations and individuals broke down many technical, institutional, and financial barriers, paving the way for the commercialization and standardization of new materials, products, and processes. In addition, corporate leadership played a key role in the negotiation of the Montreal Protocol phaseout schedules. As a result of this leadership, phaseout targets were more easily achieved.

> "The industry accepted the challenge to protect the ozone layer and managed the transition to new technologies while preserving the significant societal benefits offered by fluorocarbon technologies. The result has been good for the environment, consumers, and the participating industries. The success is unprecedented."
>
> — Kevin Fay
> Former Executive Director
> Alliance for Responsible Atmospheric Policy

Multi-Industry Coalition

The Alliance for Responsible Atmospheric Policy, one of the first multi-industry environmental coalitions, was formed in 1980 to address the issue of stratospheric ozone depletion. It represents industry sectors that rely on fluorocarbons (such as CFCs, HCFCs, and HFCs). In 1986, the Alliance called for a global solution to address ozone depletion. In 1992, the Alliance requested the phaseout schedule for CFCs and certain HCFCs be accelerated. The Alliance continues to be a leading industry voice in ozone protection and climate change issues.

Fire Protection

The fire protection sector played a key role in the U.S. transition from first-generation ozone-depleting substances to a variety of similar substitutes (such as HFCs and inert gases) and alternatives (including water, aerosols, and foam) as fire protection agents. Early collaboration by industry, government, and the military to research, develop, and test the alternatives allowed the sector to achieve its dual goals of

1) fire protection to save property and lives and 2) environmental protection for many—and often challenging—applications. Leadership in the revision of national and international industry standards have ensured the adoption of the alternatives and continued worldwide progress away from halons. The sector has also taken steps to reduce emissions of halons during system testing and servicing, and of HFCs used as halon alternatives.

Four fire protection industry organizations developed a Voluntary Code of Practice that encourages its members to follow government regulations and industry standards; limit the use of HFCs for testing and training; and minimize emissions from false discharges and during storage, handling, and transport. The organizations that developed the code are the Fire Equipment Manufacturers' Association (FEMA), the Fire Suppression Systems Association (FSSA), the Halon Alternatives Research Corporation (HARC), and the National Association of Fire Equipment Distributors (NAFED®).

As part of the Voluntary Code of Practice, the sector also created a program known as the HFC Emissions Estimating Program to collect data about HFC emissions from fire protection applications. This program is helping the industry set benchmarks to minimize unnecessary greenhouse gas emissions and document the progress being made.

ARI Air-Conditioning and Refrigeration Institute

Air Conditioning and Refrigeration

AHAM association of home appliance manufacturers

EPA and the air-conditioning and refrigeration sector have worked closely to find acceptable substitutes for the use of CFCs as coolants in household and car air conditioners and commercial refrigeration systems. In 2006, EPA and the Air-Conditioning and Refrigeration Institute joined forces to minimize the use of HCFCs and HFCs in the manufacture of more than 8 million residential and commercial air-conditioning units and refrigeration systems annually. HCFCs are far less damaging to the ozone layer than CFCs, and HFCs are not ozone-depleting substances. However, both HCFCs and HFCs are greenhouse gases. EPA and the Association of Home Appliance Manufacturers took this into account and agreed to work together to significantly reduce HFC emissions during the manufacturing of 12 million refrigerator-freezers in the United States and more than 60 million worldwide each year.

The partnerships plan to reduce HCFCs and HFCs emissions during all stages of production, including delivery, storage, transfer of refrigerants and system charging, testing, and refrigerant recovery. The guidelines provide a framework for protecting the global environment beyond current mandates through advanced technologies.

Motor Vehicle Air Conditioning

SAE International

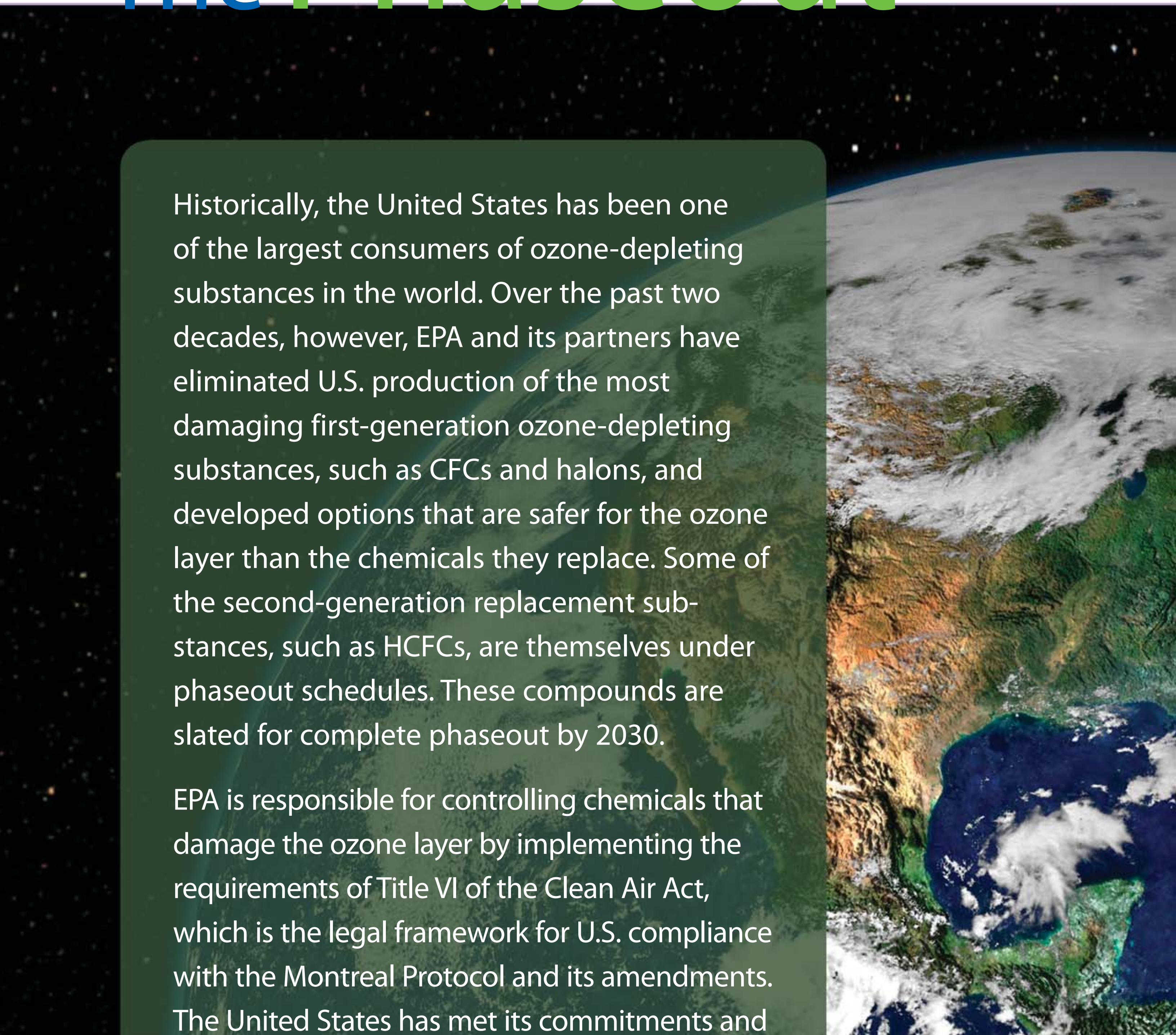
DELPHI

MACS MOBILE AIR CONDITIONING SOCIETY WORLDWIDE

Prior to 1994, most air-conditioning systems used in cars and other vehicles required CFC refrigerants. While vehicles manufactured in 1995 and later do not use CFCs in their air-conditioning systems, many older cars still require them for servicing. Industry partners have developed procedures to retrofit cars to use alternative refrigerants, such as HFC-134a, and to reduce the amount of refrigerant leaked into the air during servicing.

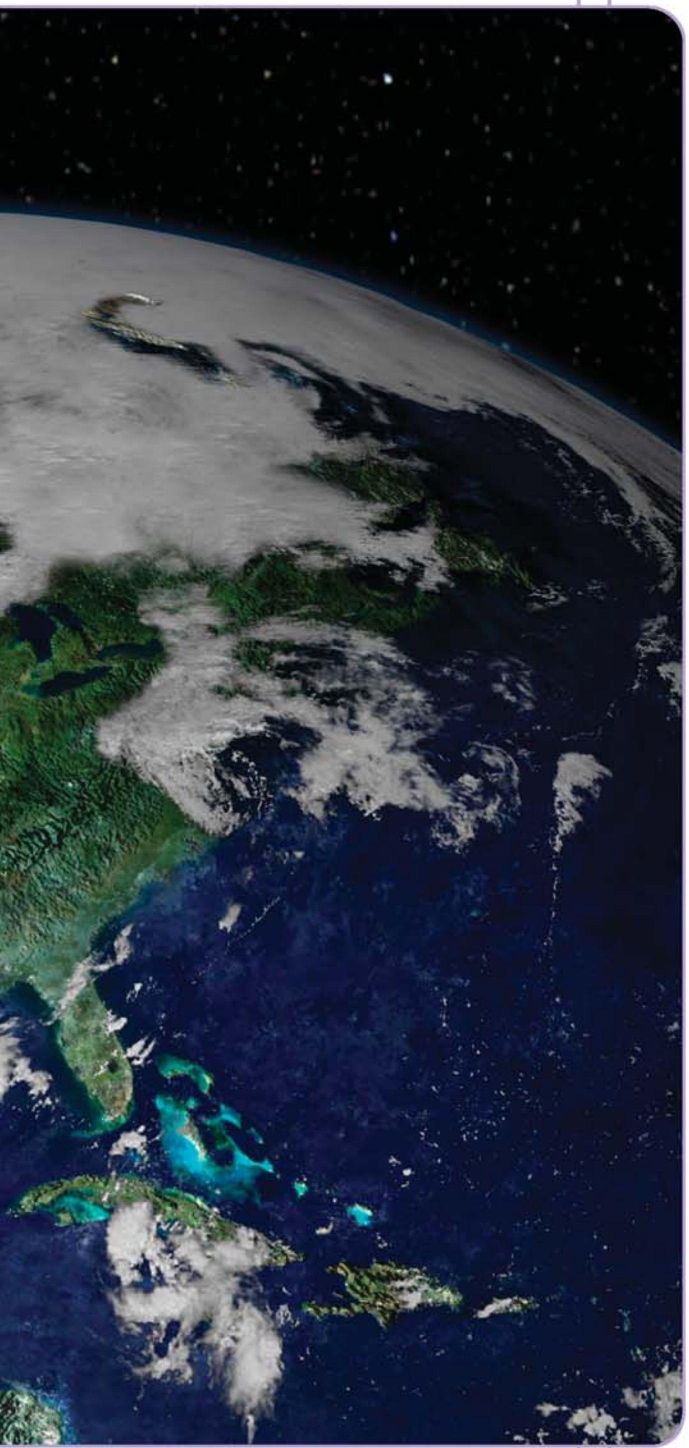
SAE International™, Delphi, and the Mobile Air Conditioning Society (MACS), together with EPA, established a precedent-setting servicing procedure using new technology that allows for onsite recovery and recycling of motor vehicle air-conditioning refrigerant. The procedure prevents millions of pounds of refrigerant from being released to the environment and enables it to be reused, thereby reducing the need for new refrigerant. Automobile manufacturers worldwide have approved this process and allowed it to be covered under vehicle warranties. It has also been adopted for HFC-134a refrigerant, which is used in modern car air-conditioning systems.

The Phaseout



Historically, the United States has been one of the largest consumers of ozone-depleting substances in the world. Over the past two decades, however, EPA and its partners have eliminated U.S. production of the most damaging first-generation ozone-depleting substances, such as CFCs and halons, and developed options that are safer for the ozone layer than the chemicals they replace. Some of the second-generation replacement substances, such as HCFCs, are themselves under phaseout schedules. These compounds are slated for complete phaseout by 2030.

EPA is responsible for controlling chemicals that damage the ozone layer by implementing the requirements of Title VI of the Clean Air Act, which is the legal framework for U.S. compliance with the Montreal Protocol and its amendments. The United States has met its commitments and deadlines under both the Montreal Protocol and Clean Air Act. We could not have achieved these results without the collaboration of our partners from all sectors of our economy.



U.S. Production of First-Generation Ozone-Depleting Substances Phased Out on Schedule

Chemical Group	Production Phaseout Dates	Deadline Met
Halons	January 1, 1994	✓
Chlorofluorocarbons (CFCs)	January 1, 1996	✓
Carbon tetrachloride	January 1, 1996	✓
Hydrobromofluorocarbons (HBFCs)	January 1, 1996	✓
Methyl chloroform	January 1, 1996	✓
Chlorobromomethane	August 18, 2003	✓
Methyl bromide	January 1, 2005	✓

U.S. Production of Second-Generation Ozone-Depleting Substances Phaseout on Schedule

Chemical Group	Production Phaseout Dates	Deadline Met
Hydrochlorofluoro-carbons (HCFCs)	Cut production 35 percent by January 1, 2004	✓ **(One year ahead of schedule)**
	Cut production 65 percent by January 1, 2010 Cut production 90 percent by January 1, 2015 Cut production 99.5 percent by January 1, 2020 Complete phaseout by January 1, 2030	**On track to meet all future requirements**

Spurring Action

The Natural Resources Defense Council (NRDC) played a key role in spurring international treaty talks, domestic regulatory action, and adoption of Clean Air Act provisions targeting ozone-depleting substances. In 1986, NRDC made the first proposal to phase out CFCs and halons over a 10-year period. The environmental community, government, and industry collaborated in developing practical, sector-by-sector schedules for phasing out ozone-depleting chemicals and introducing safer alternatives. As a result, industrialized countries ended halon production by 1994 and nearly all CFC production by 1996. Today, developing countries are also well on the way to eliminating these chemicals.

> "Many people thought that the phase-out of CFCs would be very hard. Yet when countries agreed to the Montreal Protocol, companies found new solutions, discovered business opportunities, and saved money. There's a lesson here for global warming: It will not be as hard as many people think."
>
> —David D. Doniger,
> Policy Director, Climate Center
> Natural Resources Defense Council

Achieving Goals Through Flexibility

Because eliminating or replacing some ozone-depleting substances has presented technical and other challenges, EPA has used flexibility and innovative strategies to achieve the phaseout targets set forth in the Montreal Protocol and the Clean Air Act. For example, EPA has:

- Granted **exemptions** allowed under law for devices or applications for which immediate full-scale replacement is not feasible, such as critical uses of methyl bromide, used to control pests in agriculture and food storage, and essential uses of CFCs for medical devices, such as metered dose inhalers.
- Supported careful management of existing **inventories** of ozone-depleting substances and encouraged their proper destruction.
- Established **tradable permits** for import and production of ozone-depleting substances. The system provides flexibility while also ensuring that the phaseout

schedules for these substances are met. The system also allows imports of ozone-depleting substances to encourage their proper destruction and to reduce the ultimate amount of harmful materials released to the atmosphere.

- Supported efforts to **reclaim and recycle** ozone-depleting substances to reduce emissions while meeting the needs of critical users as they transition to alternatives.

EPA's SNAP Program

The foundation for EPA's regulatory efforts to adopt more ozone-friendly substances is its Significant New Alternatives Policy (SNAP) program. The program was established in 1994 to ensure a smooth transition to safer, practical, and economically feasible alternatives across multiple industrial, consumer, and military sectors.

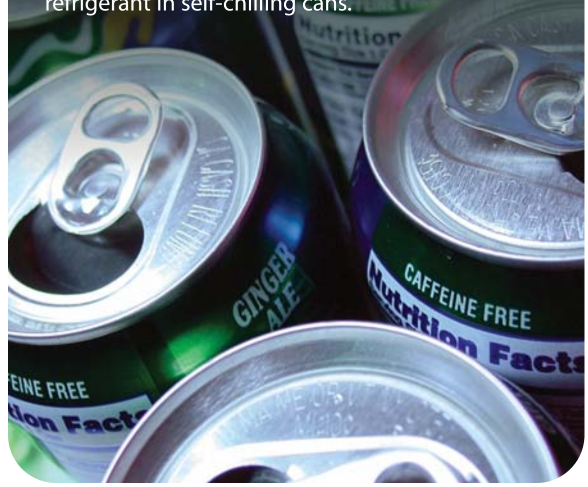
The SNAP program provides a regulatory framework for EPA to evaluate the health and environmental impacts of alternatives to ozone-depleting substances that companies develop. Under the program, EPA reviews alternatives for a variety of end uses, such as refrigeration, air conditioning, insulation foam, and fire suppression. Based on this evaluation, EPA determines which substitutes are acceptable, which are acceptable with conditions, and which are unacceptable.

Through the SNAP program, EPA has approved more than 300 alternatives for more than 60 industrial, commercial, and consumer end uses.

SELF-CHILLING CANS

Most technology applications reviewed by the SNAP program have broad and immediate market implications. These applications include mobile and stationary air conditioning, domestic and commercial refrigeration, fire suppression, solvent cleaning, and aerosols, to name a few. The SNAP program also reviews new technologies with potentially large market penetration, such as a portable, self-chilling can that would allow consumers to drink cold beverages any time and any place. To work, the coolant must be directly vented to the environment; however, the Clean Air Act prohibits intentional venting of refrigeration devices except where the refrigerants used are found to be safe for the environment. EPA worked to make sure that this new technology could remain viable by allowing the use of recycled carbon dioxide in self-chilling cans, and in 2001 disallowing the use of two HFCs. As a result, emissions equivalent to 8 million tons of carbon per year were avoided, which is roughly equivalent to the emissions associated with burning more than 68 million barrels of oil.

*Note: This figure assumes 1 percent of the beverage can industry had adopted HFC-134a as the refrigerant in self-chilling cans.



Partners in Ozone Protection

Many organizations are playing a pivotal role in protecting the stratospheric ozone layer—both in the past efforts they made to eliminate use of first-generation ozone-depleting substances and in their current undertakings to reduce their use of second-generation ozone-depleting substances. Leadership, investment, and innovation are the keys to these important achievements.

STRATOSPHERIC OZONE PROTECTION AWARDS

Since 1990, EPA has recognized outstanding achievement in ozone layer protection. Nearly 500 organizations, teams, and individuals from 40 countries have received Stratospheric Ozone Protection Awards for their exceptional leadership, personal dedication, and technical achievements.

Replacing Halons in Fire Protection

Before the U.S. production of halons ceased in January 1994, these chemicals were extensively used as fire extinguishing agents because they were effective and safe, and left no agent residues. Most halon-based fire extinguishing applications can now be replaced with other means of fire protection, particularly for new installations. However, halons are still employed for some essential uses, such as on civil aircraft, legacy military systems, and other important, existing installations. The halons necessary for these essential uses must be derived from existing supplies.

NFPA®
NATIONAL FIRE PROTECTION ASSN.

The **National Fire Protection Association (NFPA®)** develops voluntary standards for the fire protection industry that are adopted as industry practices in the United States and around the world. The association has developed U.S. standards for important halon replacement technologies and worked to change testing procedures and streamline the acceptance criteria for alternatives. The standards have been instrumental in supporting adoption of halon replacement agents worldwide. In addition, NFPA® has organized conferences internationally to promote the elimination of halon emissions caused by testing, training, leaks, and accidental discharges. It has also worked closely with the fire protection industry to approve a nonchemical pressure test for fire extinguishers in place of discharge testing—thereby preventing significant emissions of ozone-depleting substances.

HARC

The **Halon Alternatives Research Corporation (HARC)** was originally founded as a U.S. government partnership with industry to develop halon alternatives. It has since evolved into an industry-led effort. HARC members include the major chemical manufacturers, equipment suppliers, and servicing companies in the fire protection industry. In addition to serving as a clearinghouse and facilitating organization for research on halon alternatives, HARC has been a leader in establishing the mechanisms by which recycled halons are internationally traded in order to meet essential uses. It implemented a comprehensive halon recycling and banking program and helped to focus global attention on the need for proper recycling of halons.

PROTECTING PATIENTS AND THE PLANET

As originally designed, metered dose inhalers used CFCs to deliver vital medication (such as albuterol) to asthma sufferers. Thanks to the availability of alternative albuterol therapies, in 2005, the U.S. Food and Drug Administration removed CFC-based metered dose inhalers containing albuterol from the list of essential and exempted medical devices. As a result, hundreds of thousands of metered dose inhalers sold each year will be CFC-free. The switch is expected to result in a reduction of the consumption of CFCs by 850 metric tons per year.

3M

3M developed the world's first safe and effective alternative to CFC-driven asthma inhalers—a technology that had remained unchanged for some 40 years. Collaborating with more than seven different companies, 3M redesigned virtually all of the inhaler's components and helped to reformulate numerous drugs to use CFC-free technology. The company has also worked worldwide to educate patients and physicians on how ozone layer protection and patients' safety can go hand-in-hand. 3M set the stage for the ultimate, substantive phaseout of CFCs in metered dose inhalers with no impact on patient safety.

Improving Commercial Refrigeration

Refrigeration and air conditioning typically use a compressed refrigerant to cool and/or dehumidify. CFCs were once used pervasively in refrigeration applications but have since been replaced by HCFCs—a transitional substitute—HFCs, or, in some cases, hydrocarbons.

Raley's® Family of Fine Stores is a pioneer among grocery store chains in transitioning the coolants in its refrigeration systems to ozone-friendly alternatives. Raley's® is already using HFCs for all major remodels and new store construction and has successfully converted more than 70 percent of its inventory to HFCs. Raley's® is also pioneering a spirit of cooperation among grocers by sharing its technical expertise with its competitors. This exchange of information will reduce refrigerant emissions from grocery stores as they convert to alternatives and build new stores that do not rely on ozone-depleting refrigerants.

The Coca-Cola Company has committed to using refrigeration equipment that contains no ozone-depleting substances and to spreading the ozone protection message worldwide. Since Coca-Cola is one of the world's largest multinational corporations, these efforts are having far-reaching results. In 1994, the company stopped purchasing refrigeration equipment containing CFCs. All of the company's new vending machines and dispensing equipment use more ozone-friendly alternatives. Additionally, Coca-Cola requires the capture of all refrigerants during maintenance of these machines. The company also created an Ozone Protection Seminar for its worldwide operations, which are based in both developed and developing nations. At EPA's request, the company created a generic version of the seminar, which EPA and the World Health Organization use as a training program in developing countries. Coca-Cola has also made the program available to other companies and organizations to encourage adoption of similar environmental practices.

TRANSFORMING SOLVENT USE IN ELECTRONICS MANUFACTURING

The phaseout of ozone-depleting substances launched a global change in the way solvent users clean metal parts, deflux wiring assemblies on printed circuit boards, and remove contaminants from precision mechanical parts and assemblies. In the 1980s, two first-generation ozone-depleting substances, CFC-113 and methyl chloroform, were used extensively as solvents in industrial cleaning operations. The solvent cleaning industry conducted far-reaching research and development to reduce the demand for solvents in the first place, find appropriate ozone-friendly chemical substitutes (such as HFCs and HCFCs), and replace existing cleaning methods with substitute technologies, including aqueous cleaning and no-clean technologies.

In 1988, **AT&T®** and **Petroferm** jointly announced that AT&T® was using a naturally derived Petroferm product to deflux electronic circuit assemblies. The announcement signaled that CFCs were no longer essential for sophisticated electronics manufacturing. AT&T® also set the first aggressive phaseout goal for ozone-depleting substances of any electronics manufacturer: 50 percent reduction by 1991 and complete elimination by 1994.

Another company, **Motorola**, also took great strides to completely eliminate the use of all ozone-depleting substances from its manufacturing processes. Motorola accomplished this goal in 1993.

> "…Eliminating the use of ozone-depleting substances was one of the most challenging technological problems ever faced, but the efforts of mankind worldwide prevailed and solutions were found."
>
> — Robert G. Holcomb, Corporate Director, Environmental Affairs, Motorola

New Technologies in Pest Management

Methyl bromide is a first-generation ozone-depleting substance, and it has long been used in agriculture and food storage to effectively control a wide variety of pests in the United States and other countries. The U.S. phaseout of methyl bromide took effect on January 1, 2005, except for allowable exemptions.

In 1993, before the phaseout of methyl bromide, the General Mills-owned **Pillsbury Company®** made the decision to eliminate as much pesticide use as possible. In just four years, the company completely eliminated its use of methyl bromide. To provide customers with safe food products, General Mills continues to use heat treatment and other non-methyl bromide materials, as well as integrated pest management programs, in high-volume flour mills and food processing plants.

Dow AgroSciences™ developed alternatives to methyl bromide that can be economic and effective. Since 1998, the company has developed alternatives that approach methyl bromide's ability to control pests and disease. These products are being used successfully on a wide variety of crops around the world. Dow AgroSciences™ has also developed new uses for sulfuryl fluoride (a pest control tool in the building fumigation industry for more than 40 years) that can replace methyl bromide in some food processing, grain milling, and stored commodity applications.

Sound Science Underscores Achievements

The National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) have been key players in advancing the world's understanding of stratospheric ozone depletion and trends.

NASA maintains satellites in various Earth orbits and conducts research to acquire a long-term, comprehensive set of environmental measurements about the Earth. NASA has also been instrumental in assessing the effects of worldwide aviation on the global atmosphere. In addition to its data gathering efforts, NASA has reduced the use of ozone-depleting substances in its space program by more than 96 percent—from more than 3.5 million pounds in 1991 to less than 150,000 pounds in 2004. To achieve such significant reductions, NASA invested years of focused effort and resources to research, test, develop, qualify, and implement important technological advances for mission-critical uses of ozone-depleting substances.

NOAA determines the extent of depletion over Antarctica (the ozone hole), makes ground-based measurements of ozone in the atmosphere, and monitors the gases responsible for depleting stratospheric ozone. Its global network of research stations and scientists continues to play an important role in monitoring and tracking the recovery of the ozone layer.

Military Leadership in Ozone Protection

The U.S. military has led the way in the technology revolution. Since 1990, the U.S. Department of Defense (DoD) has reduced its overall usage of first-generation ozone-depleting substances from more than 16.5 million pounds to less than half a million pounds in 2005, a 97 percent reduction. The Armed Services and defense agencies have been key players in discovering, testing, and implementing important alternatives to ozone-depleting substances. This work has served as a foundation and model for technology changes and advancement in the global marketplace.

Fire Suppression Alternatives

DoD spearheaded efforts to identify more ozone-friendly alternatives to halons used for fire suppression in aircraft engines. Five different DoD aircraft are using HFCs instead of halons, including three fighter aircraft and two helicopters. DoD also developed solid propellant inert gas generators, similar to the inflation devices used for automobile airbags, as alternatives for halons in aircraft dry bay fire suppression applications.

HFC Refrigerants on Vessels

In 1993, DoD began converting its ship and watercraft air-conditioning and refrigeration systems to those that use more ozone-friendly alternatives. More than 400 vessels now use alternative refrigerants such as HFCs. The switch is not only protecting the ozone layer but also reducing greenhouse gas emissions. When complete, the project will result in annual greenhouse gas emission reductions equivalent to the emissions from more than 5,000 automobiles per year.

PROTECTING SOLDIERS ON THE BATTLEFIELD

DoD was the first in the world to design an effective alternative to the halon systems used in ground combat vehicles to suppress explosions in crew compartments. The new halon-free systems have been used successfully in Iraq and Afghanistan, and all new ground combat vehicles are expected to be outfitted with this alternative system.

Promoting Sun Safety

Because it will not be possible to see the full effect of efforts to restore the Earth's protective ozone layer for at least another 50 years, EPA is also working to protect public health from UV radiation. EPA's SunWise Program promotes sun safety in schools and communities around the country. Sun safety can include a variety of measures, such as wearing sunglasses, hats, and other protective clothing; applying sunscreen; and planning outdoor activities around the UV Index to avoid overexposure to the sun as UV levels get higher.

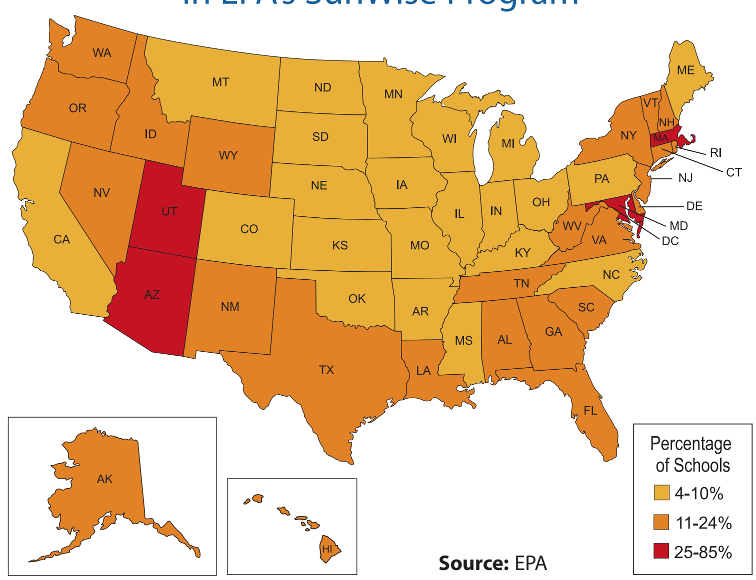
The UV Index provides a daily forecast of the expected risk of overexposure. The Index predicts UV intensity levels on a scale of 1 to 11+, where 1 indicates a low risk of overexposure and 11+ signifies an extreme risk.

EPA's SunWise Program

EPA launched the SunWise Program in 2000 to teach the public about the risks of overexposure to UV radiation. SunWise started out as a school-based program for kindergarten through eighth grade students and has grown to include a number of informal education, sports, community, and nonprofit organizations. By forming partnerships with these groups, SunWise pursues a more comprehensive approach to teaching children and their caregivers about sun safety.

SunWise continues to expand its reach. By the end of 2006, the program had registered more than 13,700 partner schools involving more than 17,000 educators in all 50 states. In addition, 1,500 partner organizations, such as science museums, children's museums, and camps, have partnered with SunWise.

Percentage of K-8 Schools Participating in EPA's SunWise Program



Source: EPA

SUNWISE IN ARIZONA

In Arizona, lessons about using sunscreen, covering up, and wearing sunglasses now join reading and writing as part of the standard curriculum. In 2005, Arizona became the first state to mandate the use of SunWise educational materials in every K-8 public and charter school. Arizona children are at a high risk of developing skin cancer because of the amount of time that they spend outdoors all year and the intense level of UV radiation in the state. Teachers are encouraged to spend five to 10 hours on sun safety education each year.

Recognizing Leaders in Sun Safety

The SunWise Recognition Program recognizes elementary and middle school educators and administrators and other organizations showing exemplary and enthusiastic commitment to sun safety education.

The **Shining Star Award** recognizes partner schools and educators that have shown a lasting commitment to sun safety education, either by adapting the program in new and effective ways, discovering unique ways to share the SunWise message more broadly, or implementing the program in multiple classrooms or grade levels.

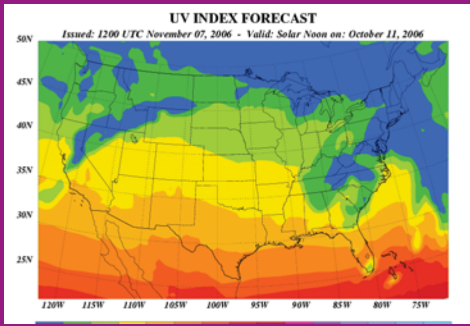
The **Helios Leadership Award** is given to SunWise partners that meet all of the eligibility criteria for the Shining Star Award and that have shown outstanding leadership in school-based sun safety education by either 1) instituting a policy to address sun safety that can serve as a model for other schools/districts, 2) erecting a shade structure, or 3) addressing the issue of sun safety in a way that distinguishes them from Shining Star Schools.

PARTNERING FOR SUN PROTECTION

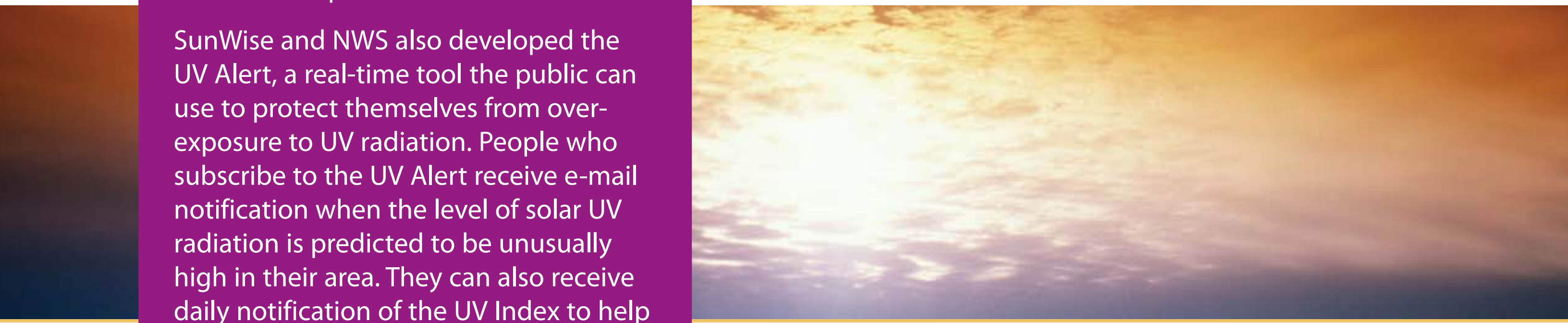
Together with a pair of experts—the National Weather Service (NWS) and the American Meteorological Society (AMS)—SunWise developed a tool kit to help meteorologists educate children about UV radiation and sun protection.

SunWise and NWS also developed the UV Alert, a real-time tool the public can use to protect themselves from overexposure to UV radiation. People who subscribe to the UV Alert receive e-mail notification when the level of solar UV radiation is predicted to be unusually high in their area. They can also receive daily notification of the UV Index to help them plan their outdoor activities.

For more information about the UV Alert, visit <www.epa.gov/sunwise/uvalert.html>



Screenshot of the UV Index Forecast, prepared daily by the National Weather Service.



Shining Star Award Winners

McWane Science Center

In Birmingham, Alabama, the McWane Science Center is teaching thousands of visitors about sun safety. The hands-on, interactive science center and aquarium is one of the many informal learning centers across the nation that is teaming up with SunWise. Led by the efforts of Jan Mattingly, the center has hosted teacher and museum training workshops and created family event days so the entire community can learn about sun safety.

Helios Leadership Award Winners

Kyrene de la Colina Elementary School

Stephanie Smith and Kyrene de la Colina Elementary School in Phoenix, Arizona, have spread the SunWise message in a number of creative ways. Each year, students conduct the "Hats on Heads" activity—keeping track of how many children are wearing hats outdoors throughout the year. The Arizona Commission on the Arts also awarded the school the state's first sun safety grant and provided a playwright who helps children write creative plays about sun safety. Ms. Smith and the school also raised funds for the building of two shade structures on the school property.

Sea Gate Elementary School

In their six years of collaboration, Teryl Brzeski and Sea Gate Elementary School in Naples, Florida, have achieved great things in sun safety. Ms. Brzeski has helped convince the School Board in Collier County, where Sea Gate is located, to devote more than $2 million for shade structures to cover playgrounds at all of its 22 elementary schools—the first project of its kind in the country. She also has worked to provide 1,200 hats and 600 pairs of sunglasses for students.

The SHADE® Foundation of America

The SHADE® Foundation of America has been a SunWise partner since 2003. It has helped spread the message of sun safety to schools across the country and fund shade structures for a number of organizations. With EPA, the foundation also sponsors an annual national poster contest for children in kindergarten through eighth grade. Posters submitted to the contest are original, creative, and suggest ways to prevent skin cancer and raise sun safety awareness. In 2006, the winner got to throw out the first pitch at a Red Sox game at Fenway Park in Boston. More than 40,000 students have participated in the annual contest since its inception in 2003.

Holy Cross Lutheran School

Carlos Olivo and Holy Cross Lutheran School in Dallas, Texas, have developed a SunWise school policy involving the entire school and local health advisors. The policy teaches children to apply sunscreen properly and encourages them to wear hats, sunglasses, and protective clothing. The school has constructed one shade structure and started work to install a second one.

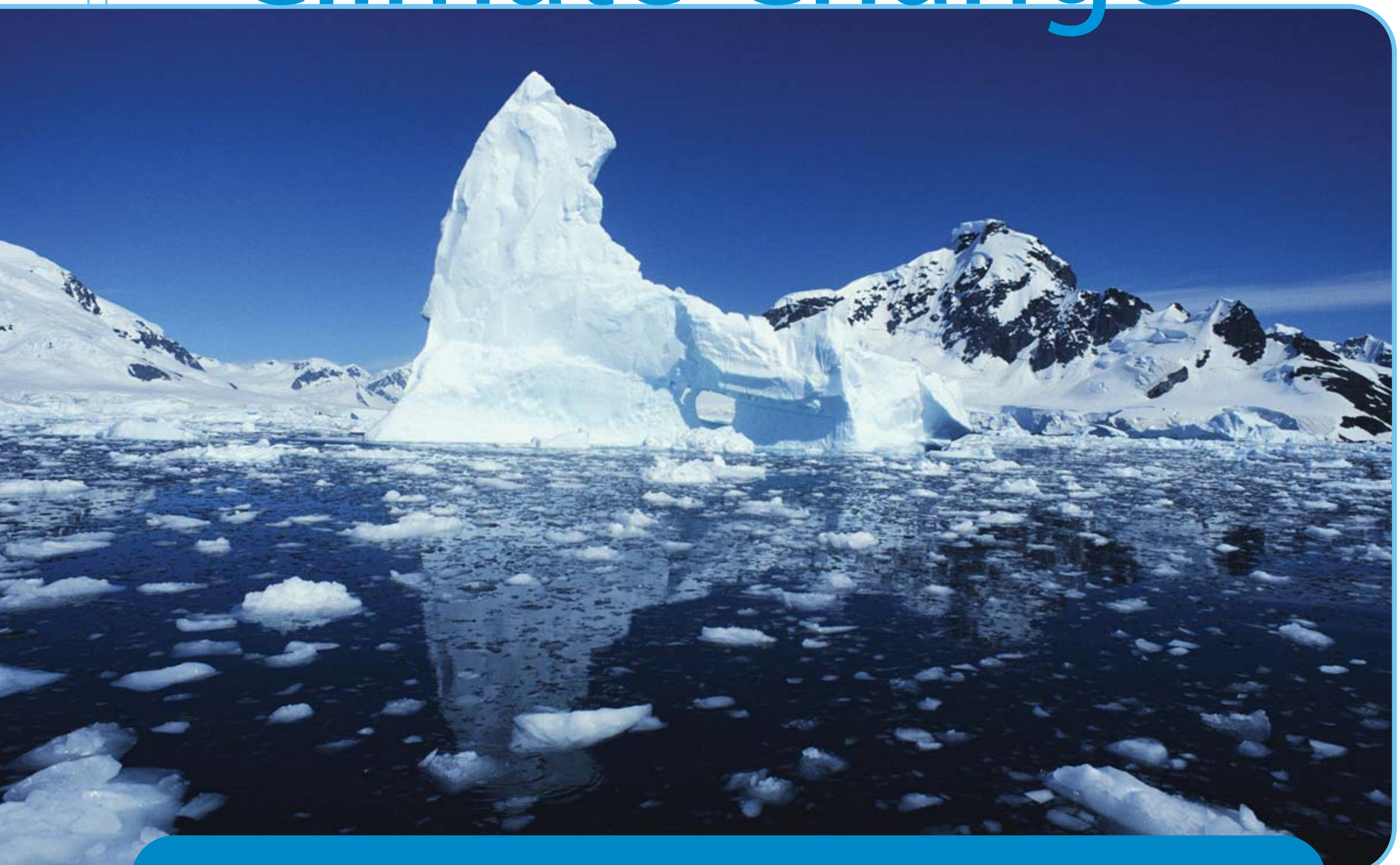
Evansville Cancer Center

Robin Lawrence-Broesch of the Evansville Cancer Center in Indiana has done a remarkable job of spreading the SunWise message to her community. She has conducted more than 50 presentations that have reached more than 10,000 students. She organized a "Pool Patrol" program that distributed free sunscreen and demonstrated the importance of sun safety using the SunWise UV-sensitive Frisbee. She also arranged free skin cancer screenings at the center and was featured in local media for her sun safety work.

Paul Gross, WDIV-TV

Paul Gross of WDIV-TV in Detroit, Michigan, is one of the many meteorologists across the country using the SunWise Program to teach his community about UV radiation and sun safety. On a TV spot featuring the UV Index, Mr. Gross used the SunWise Frisbee and UV meter to demonstrate the effect of UV radiation. He also travels to local schools promoting sun safety and utilizes SunWise activities with students and their teachers.

The Impact of Ozone-Depleting Substances on Climate Change



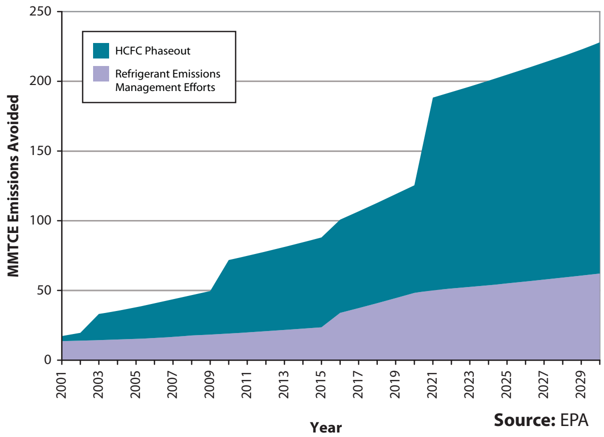
ENERGY EFFICIENCY CO-BENEFITS

The search for alternatives for ozone-depleting substances has also led to opportunities to enhance energy efficiency. For example, to avoid potential efficiency losses in some refrigeration applications, EPA has worked extensively with automobile and equipment manufacturers and the supermarket industry to transition to alternative refrigerants that not only protect the stratospheric ozone layer, but that also contribute to better energy efficiency. This transition has improved cooling performance and enhanced fuel efficiency, leading to a reduced demand for fossil fuel combustion and reduced emissions and concentrations of greenhouse gases.

Phasing out ozone-depleting substances in order to protect the ozone layer directly benefits the Earth's climate in two ways. First, because most ozone-depleting substances are also potent greenhouse gases, phasing out these substances directly reduces greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) noted that the global decline in emissions of ozone-depleting substances has substantial climate benefits. The combined emissions of CFCs, HCFCs, and HFCs have fallen from about 33 percent of the annual carbon dioxide emissions from fossil fuel combustion around 1990 to about 10 percent around 2000.*

The U.S. phaseout of CFCs and halons will result in substantial reductions in greenhouse gas emissions over the period 1990 to 2010, as well as additional reductions from the phaseout of HCFCs over the period 2000 to 2030.

Projected Greenhouse Gas Emissions Avoided Through HCFC Phaseout and Management of Refrigerant Emissions



This graph illustrates the projected annual greenhouse gas emissions (measured in million metric tons of carbon equivalent) that will be avoided as a result of both the U.S. phaseout of HCFCs and the improved management of refrigerant emissions.

Second, when substitute materials are introduced, the equipment in which they are used is usually upgraded. This means that the equipment is often less leaky and more energy efficient. Less leakage reduces direct emissions of the substitute materials to the environment. Greater energy efficiency requires less power production, which in turn reduces the greenhouse gases emitted during fossil fuel combustion.

The International Perspective

EPA's work to achieve climate co-benefits extends globally as well. For example, EPA and the U.S. Department of Energy's National Renewable Energy Laboratory have partnered with The Energy and Resources Institute (TERI) in India to quantify fuel consumption due to car air-conditioning use in India. In Europe and the United States, car air conditioning systems are responsible for 4 to 6 percent of total car fuel use. In India, that figure can be as high as 20 to 30 percent of total car fuel consumption due to India's climatic conditions and the predominance of smaller engine vehicles. TERI is examining various regulatory and voluntary options that the government of India can exercise to improve engine efficiency and reduce emissions of ozone-depleting substances and greenhouse gases.

* Intergovernmental Panel on Climate Change/Technology and Economic Assessment Panel. Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. (Cambridge: Cambridge University Press, 2005.) Figure SPM-3.

CURRENT AND FUTURE CLIMATE CHANGE

For over the past 200 years, the burning of fossil fuels, such as coal and oil, and deforestation have caused the concentrations of heat-trapping "greenhouse gases" to increase significantly in our atmosphere. These gases prevent heat from escaping to space, somewhat like the glass panels of a greenhouse.

Greenhouse gases are necessary to life as we know it, because they keep the planet's surface warmer than it otherwise would be. But, as the concentrations of these gases continue to increase in the atmosphere, the Earth's temperature is climbing above past levels. According to NOAA and NASA data, the Earth's average surface temperature has increased by about 1.2 to 1.4ºF since 1900. The warmest global average temperatures on record have all occurred within the past 15 years, with the warmest two years being 1998 and 2005. Most of the warming in recent decades is likely the result of human activities. Other aspects of the climate are also changing, such as rainfall patterns, snow and ice cover, and sea level.

If greenhouse gases continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 2.5 to 10.4ºF above 1990 levels by the end of this century. Scientists are certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of greenhouse gases will change the planet's climate. But they are not sure by how much it will change, at what rate it will change, or what the exact effects will be.

A Walk Through History

Science

1928
Scientists synthesize CFCs.

1973
Scientists detect CFCs in atmosphere.

1974
Nobel prize winners Molina and Rowland discover that CFCs can break down stratospheric ozone.

1975
Scientists discover that bromine, used in fire-retarding halons and agricultural fumigants, is a potent ozone-depleting substance.

1985
British Antarctic Survey team discovers Antarctic ozone hole (7.3 million square miles), marking the first evidence of stratospheric ozone depletion.

Scientific research reveals stratospheric ozone layer depletion has adverse environmental and human health effects.

1991
International scientists agree that CFCs are depleting the stratospheric ozone layer in the northern and southern hemispheres.

Action

1975
SC Johnson announces corporate phaseout of CFCs as aerosol product propellants.

1976
United Nations Environment Programme (UNEP) calls for an international conference to discuss an international response to the ozone issue.

1978
U.S. bans non-essential uses of CFCs as a propellant in some aerosols (e.g., hair sprays, deodorants, antiperspirants). Canada, Norway, and Sweden follow with a similar ban.

1981
UNEP develops a global convention to protect the ozone layer.

1987
Twenty-four countries sign the Montreal Protocol on Substances That Deplete the Ozone Layer.

1989
All developed countries that are parties to the Montreal Protocol freeze production and consumption of CFCs at 1986 levels.

1990
Clean Air Act Amendments, including Title VI for Stratospheric Ozone Protection, signed into law.

1992
U.S. announces an accelerated CFC phaseout date of December 31, 1995, in response to new scientific information about ozone depletion.

1993
DuPont™ announces that it will halt its production of CFCs by the end of 1994.

1994
U.S. eliminates production and import of halons.

1996
U.S. eliminates production and import of CFCs, carbon tetrachloride, trichloroethane, and hydrobromofluorocarbons.

2000

Japan Meteorological Agency reports the hole in the stratospheric ozone layer over the Antarctic is at its largest to date—more than twice the size of Antarctica.

2002

All developing countries that are parties to the Montreal Protocol freeze methyl bromide production at 1995–1998 average level.

2004

All developed countries reduce consumption of HCFCs by 35 percent from baseline levels.

2006

The ozone hole is reported to be the biggest ever, exceeding that of 2000.

2010

All developed countries reduce consumption of HCFCs by 65 percent from baseline levels.

2015

All developed countries reduce consumption of HCFCs by 90 percent from baseline levels.

2030

All developed countries scheduled to complete the phaseout of ozone depleting substances.

2040

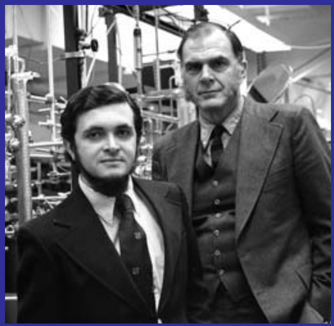
All developing countries that are parties to the Montreal Protocol scheduled to completely phase out HCFCs.

2060-2075

Earliest timeframe projected for the ozone layer to recover.*

* Executive Summary, WMO/UNEP Scientific Assessment of Ozone Depletion: 2006, Scientific Assessment Panel of the Montreal Protocol on Substances that Deplete the Ozone Layer, August 18, 2006. p. 7.

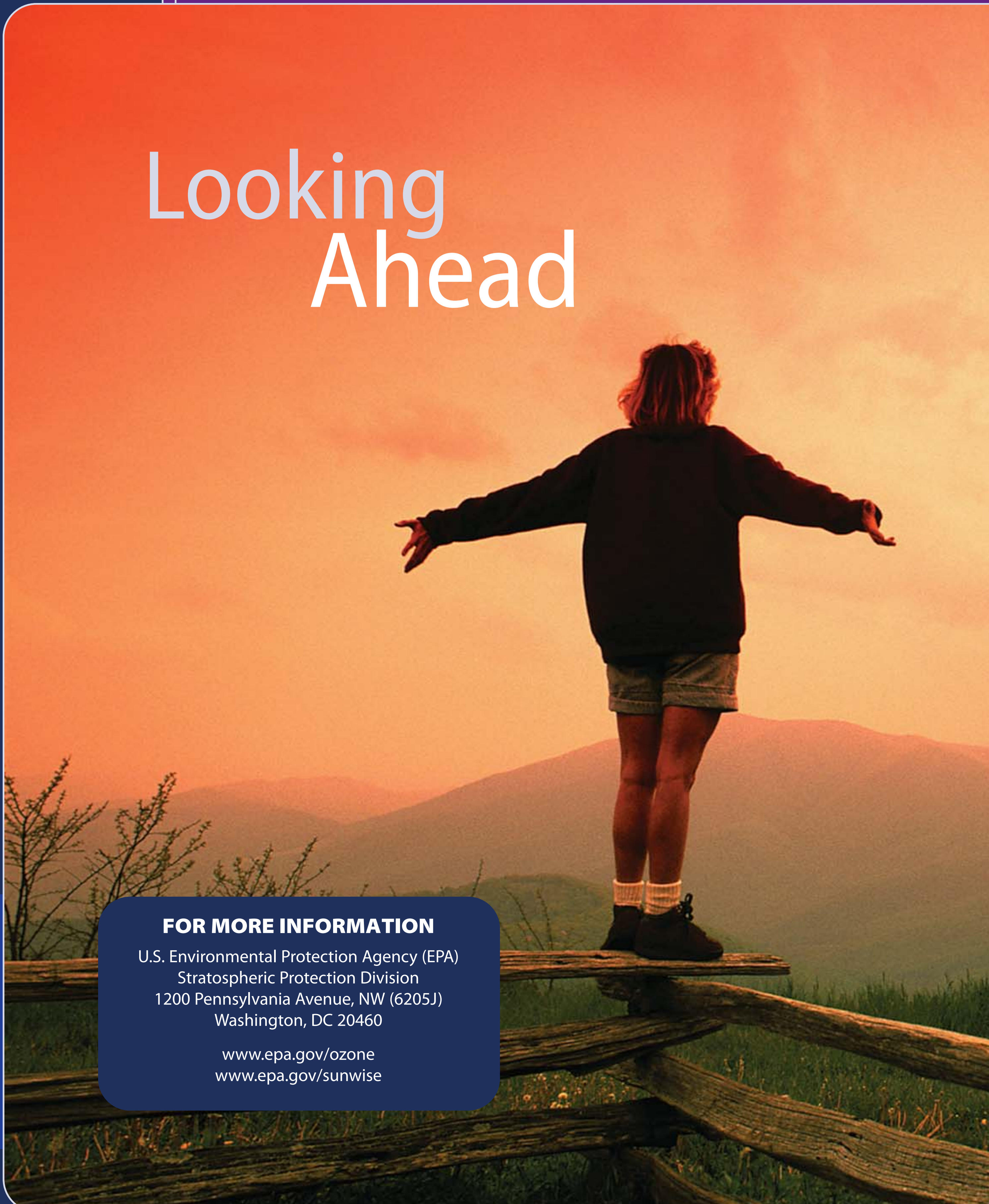
COLLABORATORS IN ATMOSPHERIC CHEMISTRY



In the 1970s, chemists Sherwood Rowland and Mario Molina discovered that CFCs contribute to ozone depletion. The two collaborators theorized that CFC gases react with solar radiation and decompose in the stratosphere, releasing chlorine atoms that are able to destroy large numbers of ozone molecules.

Their research was first published in *Nature* magazine in 1974. The National Academy of Sciences concurred with their findings in 1976, and in 1978 CFC-based aerosols were banned in the United States. Further validation of their work came in 1985 with the discovery of the ozone hole over Antarctica. In 1995, the two chemists shared the Nobel Prize for Chemistry with Paul Crutzen, a Dutch chemist who demonstrated that chemical compounds of nitrogen oxides accelerate the destruction of stratospheric ozone.

Looking Ahead



FOR MORE INFORMATION

U.S. Environmental Protection Agency (EPA)
Stratospheric Protection Division
1200 Pennsylvania Avenue, NW (6205J)
Washington, DC 20460

www.epa.gov/ozone
www.epa.gov/sunwise

Although EPA and its partners have achieved excellent results, our job is not done. Healing the ozone layer will take many years—and require a concerted worldwide effort—to accomplish.

In our work to expedite the recovery of the ozone layer, EPA plans to:

- Complete the phaseout of ozone-depleting substances.
- Continue educating the public, especially children, on how to protect themselves from excess exposure to UV radiation through the SunWise program.
- Continue to implement smart, flexible approaches.
- Continue to foster domestic and international partnerships to protect the ozone layer.
- Encourage the development of products, technologies, and initiatives that reap co-benefits in climate change and energy efficiency.

We've demonstrated that we can successfully meet the global challenge of ozone layer protection, and we will continue to work with our partners to make the environment safer for all generations.

United States Environmental Protection Agency
Office of Air and Radiation
1200 Pennsylvania Avenue, NW (6205J)
Washington, DC 20460

www.epa.gov/ozone
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