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OZONACTION

Special Issue 2009

2010 and then ?

Building on the Montreal Protocol's Success and Facing the Challenges Ahead

Content

Editorial

Achim Steiner

The ozone treaties have in 2009, achieved a series of extraordinary landmarks that will stand the international community in good stead as it works towards a low carbon, resource efficient Green Economy in 2010 and beyond.

With the accession this year of the world's youngest democracy – Timor Leste – the Montreal Protocol will have achieved the unique goal of universal ratification.

It sends a strong and quite remarkable signal of global solidarity not only for addressing ozone depletion, but increasingly for addressing other pressing sustainability issues and challenges: not least climate change.

2010 for example marks the date when developing countries are scheduled to fully and finally phase out chlorofluorocarbons (CFCs) and halons.

CFCs, found in products such as refrigerants, were the prime motivation for global action to protect the Earth's ozone layer as a result of scientific evidence showing their production and consumption were destroying this thin, gassy shield and putting the public at greater risk of skin cancers and cataracts.

We now know that this phase-out has also contributed to buying the world some important breathing space in respect to global warming.

Indeed, a scientific paper in 2007 calculated the climate mitigation benefits of the ozone treaty as totalling an equivalent of 135 billion tonnes of CO_2 since 1990, or a delay in global warming of seven to 12 years.

In that same year governments also agreed to accelerate the freeze and phase-out of CFC replacement substances – hydrochlorofluorocarbons (HCFCs) – explicitly for their climate change impacts.

The maximum benefits here are only likely to occur if this goes hand in hand with the introduction of more energy efficient equipment that can work with substances that have low or zero global warming potential.

The focus is now rapidly shifting to hydrofluorocarbons (HFCs). This year scientists, reporting in the Proceedings of the National Academy of Sciences, suggested that if these became the replacement substances of choice, the climate impacts could be serious.

The scientists argue that HFC use could climb sharply in the coming years as replacements in products such as insulation foams, air conditioning units and refrigeration.

Under a scenario where carbon dioxide emissions are pegged to 450 parts per million, HFCs could equal 9 gigatonnes – equivalent to around 45 per cent of total CO_2 emissions – by 2050 if their growth is unchecked.

Conversely, rapid action to freeze and to cut emissions annually alongside fostering readily available alternatives could see HFC emissions fall to under 1 gigatonne by 2050.

Importantly, governments last year requested the Executive Secretaries of the Montreal Protocol and the UN Framework Convention on Climate Change to cooperate more closely on these issues and this was taken forward in 2009 in the spirit of One UN.

In a financially constrained world, facing a climate-constrained one, governments need to maximize the economic and social benefits of action across the many environmental challenges of our time. This is one of the tenets of UNEP's Green Economy initiative.

It is a tenet that can be taken forward at the 21st Meeting of the Parties to the Montreal Protocol in Egypt this November, just days before the crucial UN climate convention meeting in Copenhagen where the world must Seal the Deal on a comprehensive and far-reaching agreement.

The story of the ozone treaties has been quite remarkable – if governments, civil society and scientists can demonstrate the same commitment to the future as they have done to the past, then many more extraordinary chapters will surely be written. Ones that increasing dovetail with the climate challenge and others ranging from chemicals and waste management to energy efficient technologies, human health and the UN's Millennium Development Goals.

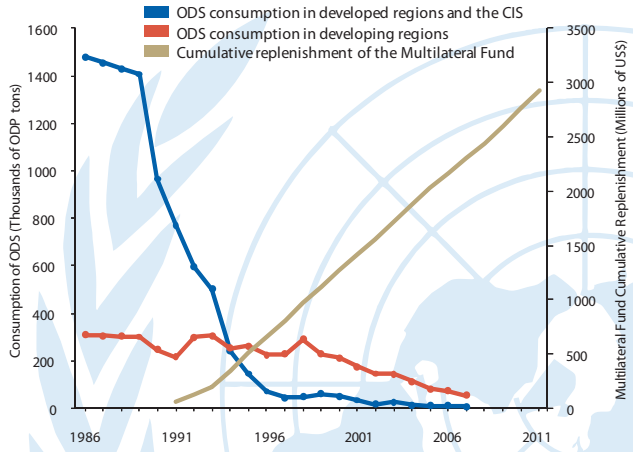
Mr. Achim Steiner
UN Under-Secretary General and Executive Director
United Nations Environment Programme (UNEP)

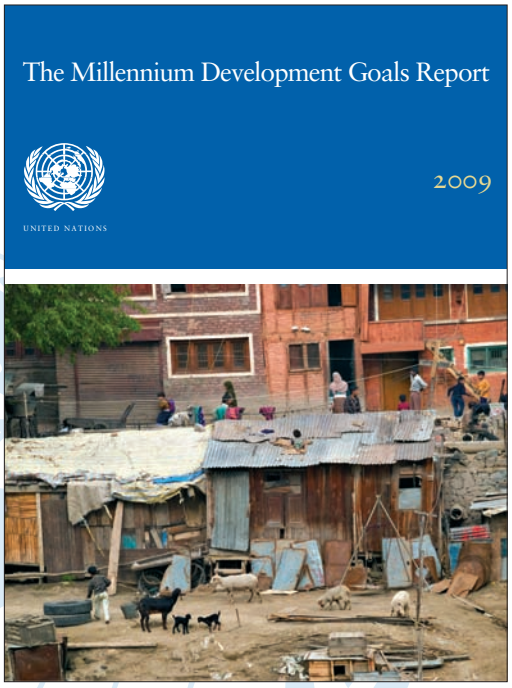
Strong Partnerships and Sound National Policies Lead to Extraordinary Progress in Protecting the Ozone Layer

"… At the global level, the world came together to achieve a 97 per cent reduction in the consumption of substances that deplete the Earth's protective ozone layer, setting a new precedent for international cooperation…"

SHA ZUKANG
UN Under-Secretary-General for Economic and Social Affairs

Consumption of all ozone-depleting substances (ODS), 1986-2007 (thousands of metric tonnes of ozone-depleting potential) and replenishment of the Montreal Protocol Multilateral Fund (millions of US dollars)





From 1986 to 2007, the 195 countries that are currently party to the Montreal Protocol have achieved a 97 per cent reduction in the consumption of substances that deplete the Earth's ozone layer. This extraordinary accomplishment is a prime example of both the integration of sustainable development principles into national policy frameworks (MDG 7) and a global partnership for development (MDG 8).

To date, 177 parties to the Montreal Protocol have put in place national regulations or legislation to promote effective protection of the ozone layer and sustainable compliance with the Protocol. In addition to funding these critical activities, the Montreal Protocol Multilateral Fund has, for the past 19 years, supported national capacity -building and networking of policy makers, customs officials and others. The Fund has also helped transfer essential technologies that have enabled developing countries to 'leapfrog' to new, energy-efficient technologies and export their wares to the global market.

Still, challenges remain. Foremost among them is the phasing out of hydrochlorofluorocarbons while avoiding the use of alternatives with a high potential for global warming. Other serious issues include the management of existing stocks of ozone-depleting substances (including their destruction) and ensuring that illegal trade does not emerge after key substances are phased out. Finally, technologically and economically viable alternatives must still be found for the few critical and essential uses that are currently receiving exemptions by States parties to the Protocol.

Excerpt from The Millennium Development Goals 2009 Report, www.un.org/millenniumgoals

Protecting the Ozone Layer Protects the Climate for Future Generations

Mostafa K. Tolba

U.S. President Barack Obama, Mexico President Felipe Calderon, and Canadian Prime Minister Stephen Harper energized the global climate debate on 10 August when they pledged to "Work together under the Montreal Protocol to phase down the use of HFCs and bring about significant reductions of this potent greenhouse gas." This is exciting because the Montreal Protocol would start fast, set a challenging pace, and would use its proven Multilateral Fund and network offices to support Article 5 Parties in meeting their obligations. It is all the more significant that the science driving this bold declaration was crafted by an interdisciplinary team from our Scientific Assessment Panel (SAP) and Technology and Economic Assessment Panel (see article on page 20).

As the UNEP Executive Director who presided over the creation of the Montreal Protocol and its instructions, I am naturally very proud of what the Parties are doing to protect climate and ozone.

During the past three decades governments, international agencies, and NGOs have developed increasingly effective approaches to transboundary environmental problems. From the traditional, insular stance by which a nation rejected interference in its policies, in the environmental field governments have realized that some problems must be solved through cooperation. One of these problems was the protection of the ozone layer.

In 1981, accumulating scientific information led the UNEP Governing Council to establish an ad hoc working group of legal and technical experts to work out a framework convention on the protection of the ozone layer. The negotiations in the group lasted over three years.

In spite of disagreements during the negotiations, there was a general acknowledgment that, although scientific uncertainties would exist for some time, it was necessary to consider the consequences of awaiting complete certainty, whereas action taken now might prevent irreversible damage to the ozone layer. Not only was cooperation in research, as provided for in the convention, necessary, but the potential risks also made it essential to adopt a protocol to reduce CFC emissions, the major cause of ozone depletion. During the negotiations of the framework convention, a multi-option protocol was advocated that would enable countries in widely differing economic circumstances to accept it while rewarding past actions to reduce CFC use by more affluent nations. Another proposal was to put a limit on production capacity. Neither was accepted by the negotiators to be included in the convention or in a separate protocol.

A plenipotentiary conference convened in Vienna in March 1985 adopted a treaty to protect the ozone layer, committing its signatories only to take appropriate measures to protect human health and the environment from human activities with potentially adverse effects on the ozone layer. No specific control measures were set in the convention.

However, the conference requested UNEP to continue work on a protocol on ozone-depleting substances to be adopted the following year.

Negotiations for the protocol began in 1986 in a changed climate. Scientific information continued to pour in that strengthened the case for an effective protocol, but economic factors had taken on additional importance.

The United States and the 12 – nation European Community emerged as the principle protagonists in the diplomatic process that culminated in the Montreal Protocol. Despite their shared political, economic and environmental values, the United States and EC disagreed over almost every issue at every step along the route to Montreal.

Preparations for negotiation of a Protocol on Substances that Deplete the Ozone Layer (later called the Montreal Protocol) began with the following areas of serious disagreements: the Toronto Group countries (Canada, US, Norway, Sudan, Finland and Australia) advocated a production freeze and major cuts; the EC advocated a cap on production but no cuts; the U.S.S.R. and Japan were reluctant to accept any cuts; developing countries feared that any control measures would impede their development; most industries opposed cuts in CFC production and use; and there were differences over the form of a number of points to be included in the Protocol.

After a marathon of informal negotiations, the control measures issue was resolved by a compromise that would reduce production and consumption of all five CFC types by 50 percent by 1999, using 1986 as the base year. There were a number of small adjustments to be made, and language was found to meet the situation of the U.S.S.R.

When the Protocol was adopted in Montreal, Canada on September 16, 1987, the feeling of triumph was general. This was the first global environmental treaty that dealt with an issue still shrouded in scientific uncertainties, one that posed a threat, not immediately, but in the future, one that potentially affected everyone on earth today and far into the future. It was a monument of collective action. It had the advantages of ease of implementation, flexibility due to its mechanism permitting adjustments to meet scientific, technological, and socioeconomic changes, and the clearly applied principle of common but differentiated responsibility. It was also the first treaty to set for itself, subject to conditions, a date for its own entry into force: January 1, 1989, barely fifteen months after the treaty had been signed. There would follow a number of meetings to finalize its details, but the date – September 16, 1987 – went down as a landmark in the history of international negotiations.

I sincerely believe, as many others believe, that the negotiations for the Vienna Convention and its Montreal Protocol set new standards in international negotiations and that the Montreal Protocol turned out to be the best example of true international co-operation in dealing with a global environmental problem. Surely the Montreal Protocol will do its part in achieving positive results in negotiating a post-Kyoto Protocol for dealing with the problem of climate change.

Dr. Mostafa K. Tolba
President of International Centre for Environment and Development (ICED)
Former UN Under Secretary General and Executive Director United Nations Environment Programme (UNEP)

New Challenges in the Montreal Protocol and Japan's Approach

Masayoshi Mizuno

We need to take new and innovative measures to address emerging challenges in order to continue the success of the Montreal Protocol. Among the challenges we now face are:

(1) Environmentally sound management of the bank of ozone-depleting substances (ODS),

(2) The high global warming effects of the alternative substances to HCFCs.

There is no easy answer to these problems and all Parties seem to be struggling to find solutions. This article briefly describes Japan's current approach, in the hope that this will provide other Parties with some clues as to the best way to proceed.

Advanced technologies are a key part of Japan's approach. To ensure destruction of the ODS bank, our technology has been developed with the aim of achieving the 3R (reduce, reuse, recycle) society. The legislation in Japan obliges users and operators of electric appliances and other types of products to ensure that these products are recycled. Through legislation, we have also created a licensing system for the recycling or destruction of products. With these systems in place, destruction technologies have been developed as a result of initiatives by industry, or with the aid of the government.

Some of the technologies for destruction, such as rotary kiln incinerators, are multi-purpose and can be applied not merely to fluorocarbons but also to other industrial waste. Other technologies are exclusively designed for fluorocarbons and have the capacity to destroy considerable amounts of ODS. The superheated steam reaction, plasma destruction and cement kiln are in the latter category of technologies. It is our hope that knowledge of these technologies will be disseminated and provide solutions to a range of problems in many countries around the world.

After successfully converting to alternatives to HCFCs, Japan is now focusing its efforts on developing practical alternatives to HFCs. Without ready-to-use alternatives to HFCs, it will be difficult in practice to reduce the production or consumption of HFCs even though we are gravely concerned about their serious impact upon global warming. Japan has succeeded in making alternatives to HFCs available with the use of CO_2 or hydrocarbons (HC). Although there are still difficulties in using these alternatives for air-conditioning purposes, the technology has been successful in practice for many other applications.

The second area we are now exploring in search of solutions is the use of bilateral assistance. It is true that much of the past success in protecting the ozone layer has been due to the Multilateral Fund for ODS under the framework of the Montreal Protocol. According to our analysis, the current framework does not have the capability or flexibility to address the two emerging issues. Some people may argue that the current system should be amended immediately in order to deal with the new situation. We partly agree with this view and are actually ready to discuss how the current framework could be adjusted. It must be pointed out, however, that Japan will anyway adopt other approaches without waiting for agreement to be made among all Parties concerned.

Our bilateral framework of aid has been designed with particular focus on the urgent need to address global warming. Even prior to the agreement on the framework beyond 2012, Japan launched an initiative called "Cool Earth Partnership" to provide assistance to the many developing countries who are aiming to achieve both emissions reductions and economic growth. Given that ODS have high global warming effect, our "Cool Earth Partnership" can potentially provide effective solutions for the emerging two issues, destruction of ODS and the alternatives to HCFCs.

A view from Tokyo, Japan

We know that this bilateral aid is not at all an easy solution. The multilateral framework obliges Parties to reduce ODS levels and accordingly provides financial assistance to them in addressing their difficulties in meeting obligations. When it comes to areas without multilateral agreement, it is not until developing countries choose to take action that we can provide financial assistance to them. Japan has a lot of experience in policy discussions with many developing countries. Let us reiterate that we are ready and willing to cooperate with those who agree with us on the urgent need for action.

Mr. Masayoshi Mizuno
Director of Global Environment Division
Ministry of Foreign Affairs, Japan

Meeting the 2010 Commitments: Is Global Compliance a Reality?

Robyn Washbourne

The global challenge of addressing ozone depletion has meant that Parties to the Montreal Protocol have each taken on specific obligations towards the phasing-out of ozone-depleting chemicals. The success of this phase-out to date has made possible the repair of the ozone layer within this century. However, without continued global compliance, achievement of this ultimate goal will be delayed or the opportunity will be lost.

On 1 January 2010, methyl chloroform consumption in Article 5 Parties is scheduled to reduce from 70 per cent to 30 per cent of base level. In addition to this, the global phasing out of CFCs, halons, and carbon tetrachloride production and consumption (apart from essential uses) will also be complete. The sustained action of governments, industry sectors, civil society and the public that has moved the world towards this milestone is something to be proud of. This is a truly environmentally significant achievement that benefits both ozone and climate.

The obligations for Parties to comply with phase-out schedules are measurable criteria. Over the life of the Montreal Protocol there have been challenges of compliance for some Parties, and these have been dealt with under the non-compliance procedure. This seeks to secure an amicable solution to an issue, in a cooperative and consultative process with the Party involved. The Implementation Committee operates the procedure by identifying potential non-compliance and making appropriate recommendations.

The fundamental key to global compliance is that each Party has in place the functioning and effective licensing system that is an obligation under Article 4B. This must be an enforceable working system on the ground that is fully able to police imports and exports of controlled ozone-depleting substances at the border. Global compliance will not be achieved unless all Parties meet this requirement. In addition, Parties will find it difficult to meet the 2010 commitments and any future challenges if this licensing system is not in place or fails in some way.

The Implementation Committee often encounters cases where Parties have experienced difficulties in meeting compliance targets because of a weak or ineffective licensing system. There are also challenges for Parties who have ratified amendments and taken on their compliance obligations later rather than sooner. It is also clear that the last residual uses of ozone-depleting substances are often the most difficult for Parties to phase out.

In spite of this, it is encouraging that Parties are invariably willing to address their compliance situations and find solutions to enable them to regain compliance and meet, or even accelerate, obligations. This determination must continue so that Parties, particularly Article 5 Parties, can address the new compliance challenges in the years ahead. These include:

Setting of HCFC base level

The HCFC consumption data for Article 5 Parties in 2009 and 2010 is the base level against which future compliance will be measured. It will only become apparent after several years whether this has been correctly determined and, if it has not, then the intensive methodology for change decided by the Parties in Decision XV/19 will be required.

HCFC freeze

The HCFC consumption in 2013 will determine the difficulty in meeting the 10 per cent phase-down of HCFCs by 2015. An ability to limit growth in the HCFC sector will prove an advantage in maintaining future compliance. Availability of and transition to alternatives is a critical issue.

Illegal trade

As supply decreases and prices rise, the temptation is for black markets and illegal trade to increase. Again, the importance of a successful licensing system is a key to prevention.

Methyl bromide

The phase-out of non-QPS (quarantine and pre-shipment) methyl bromide has been a challenge for non-Article 5 Parties. Many Article 5 Parties will need to plan carefully for the significant reduction from 80 per cent of base level to zero consumption by 2015.

Conclusion

Ozone depletion remains a global issue. We must continue to stand together to succeed in meeting future challenges as effectively as we have met those of the past. The current sustained effort of all Parties bodes well for future and global compliance. However it is vital that compliance challenges are tackled pro-actively and that the momentum of the phase-out of ozone-depleting substances continues – for the sake of both ozone and climate benefits.

Ms. Robyn Washbourne
Senior Policy Analyst
Environmental Issues, Ministry of Environment, New Zealand

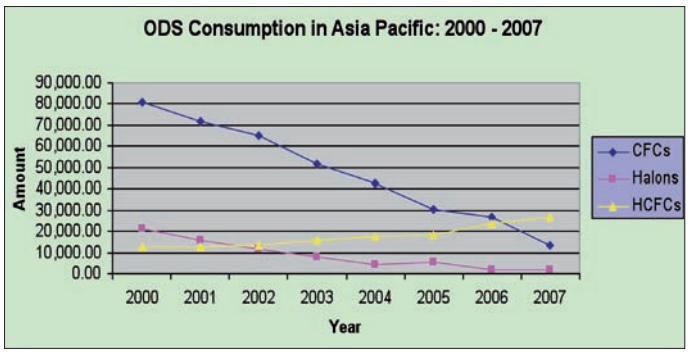
The Final Stretch in Meeting the 2010 Commitments

Atul Bagai, Thanavat Junchaya and Shaofeng Hu

Last leg of the race

In Asia and the Pacific region, CFCs and halons consumption has been reduced by 83.6 per cent and 91.8 per cent respectively from 2000 to 2007. The UNEP DTIE OzonAction CAP team in Asia and the Pacific, through innovative mechanisms, has been assisting Article 5 Parties to achieve Montreal Protocol compliance.

These mechanisms have included: public-private partnerships to address Metered Dose Inhaler (MDI) (Langkawi Declaration) and illegal trade issues (Ulaan Baatar Declaration), Sky Hole Patching, south-south and north-south cooperation, border dialogues mainstreaming ozone issues, and regional awareness initiatives.



The HCFC phase-out is another key challenge for Asia and the Pacific. The region is the main producer and consumer of HCFCs and, moreover, HCFC production has shown a significant increase in the last 10 years. CAP will continue to assist countries to phase out HCFCs to ensure another success for the Montreal Protocol.

Mr. Atul Bagai
Regional Network Coodinator
South Asia

Final Countdown to 2010

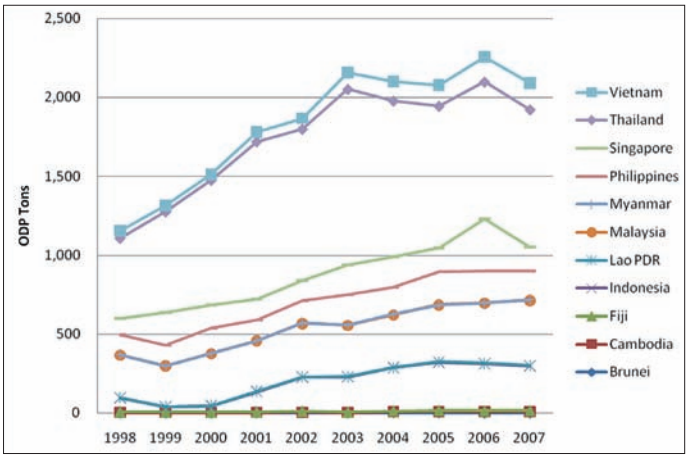
All SEAP Network countries should be able to meet the 2010 commitments with flying colours. Three countries (Fiji, Myanmar and Singapore) have already phased out CFC consumption while the rest have reduced their 2007 consumption beyond the 85 per cent target. Other ODS (halons, CTC and methyl chloroform) have also been drastically reduced or phased out.

However, HCFC consumption has significantly increased. Six out of the top 25 developing countries with the highest consumption of HCFCs are from the SEAP Network: Thailand, Malaysia, Indonesia, Philippines, Vietnam, and Singapore due to their large base of air-conditioning manufacturers.

Mr. Thanavat Junchaya
Regional Network Coordinator
South East Asia

Bringing Pacific Island Countries into the MP mainstream

The Pacific Island Countries (PICs) have unique social, economic and environmental characteristics. Remoteness and lack of a network prior to 2009 have meant these countries have to an extent been left out of the mainstream of the Montreal Protocol (MP). Hence, challenges faced by PICs differ from those of other regions.



Although a small base line has enabled PICs to phase out CFC consumption in the period since 2005, the countries are still very vulnerable to non-compliance. Vigilance is required in monitoring and managing CFC imports in the region.

It is important to build the local capacity and institutional memory of PICs to enable the region to enter the MP mainstream. HCFC phase-out will pose tremendous challenges in terms of establishment of the baseline data, as well as meeting further freezing and reduction targets. Countries need to integrate efforts to face these challenges while mobilizing stakeholders at the national level to support and be involved in the HCFC Phase-out Management Plan (HPMP) development process.

Mr. Shaofeng Hu
Regional Network Coordinator
Pacific Island Countries

Pacific Island

The Final Stretch in Meeting the 2010 Commitments

Jeremy Bazye, Mirian Vega, Abdulelah Alwadaee and Halvart Koeppen

Will Africa make it?

When the Vienna Convention and the Montreal Protocol were adopted in the mid-eighties, only a few African countries had shown interest in the two instruments. The depletion of the ozone layer was perceived as an issue only for the developed world. Slowly but surely, African countries joined the international community in its efforts to get rid of ODS. As an active player and keen observer of the phase-out programmes in the African region, I am confident that this continent with its 53 parties to the Protocol will lead the drive in complying with the requirement to totally phase out the major ODS by the end of the year 2009.

Mr. Jeremy Bazye
Regional Network Coordinator
Africa

African landscape

The urgent need for feasible HCFC alternatives

Over the last few years, West Asia countries have maintained an excellent record of compliance with the Montreal Protocol. Even the few potential non-compliance cases were quickly overcome, thanks to timely help from the Compliance Assistance Programme and the Multilateral Fund. West Asia Member States were also positive players in the international negotiations that led to the historical 2007 Adjustment to speed up phase-out of HCFCs, in spite of deep concerns concerning the availability of reliable alternatives to all HCFC applications, particularly in hot climates.

Now, with the trend towards reducing dependency on high GWP alternatives to ODS, many countries in West Asia are envisaging a hard road towards the achievement of all environmental goals simultaneously. They particularly note the difficulties in locating and promoting long-term feasible alternatives in key applications. Research, policy update, wise selection of technologies and involvement of industry in decision making seem to be the key elements that will help to draft the roadmap for a sustainable shift to environmentally friendly solutions.

Dr. Abdulelah Al-Wadaee
Regional Network Coordinator
West Asia

Latin America and the Caribbean: networking supports compliance

The present success of the Montreal Protocol (MP) is attributable to an active, complex, multilayered and dynamic networking mechanism that brings together national, regional and international resources, expertise and experience. This mechanism is spearheaded by dedicated national institutions contributing to national, and ultimately global, achievements of the MP. To sustain the success of this mechanism, while keeping its core role as a compliance support tool and ensuring continued support for key stakeholders, it is essential to encourage linkages and cross-fertilization into other environmental concerns, for example climate change and chemical management.

Ms. Mirian Vega
Regional Network Coordinator
Latin America and the Carribbean

Strengthening national institutions through regional co-operation

Zero consumption of CFC, halons and CTC from 1 January 2010 cannot be achieved by last minute effort. It is the fruit of years of dedicated work by National Ozone Units and their national partners, with support from their Governments. Overall, ECA network countries show excellent compliance but there is no time to relax and to wait for the year 2011 to assess countries' 2010 compliance. This year's theme for the ECA network is "Strengthening National Institutions through Regional Co-operation". This will highlight the important role of regional networks in strengthening national refrigeration and air-conditioning (RAC) associations and national Customs services. Creation of the ECA Enforcement Network of Customs and Ozone Officers and the involvement of national RAC associations ECA network meetings in 2009 and 2010 will help sustain the achievements and remove barriers to the transfer of ozone and climate-friendly technologies to Article 5 countries in the context of HPMP implementation.

Mr. Halvart Koeppen
Regional Network Coordinator
Europe and Central Asia

ECA Network Meeting, Armenia, May 2009

The Final Stretch in Meeting the 2010 Commitments

Nermin Othman, Makhtumkuli Akmuradov and Jorge Sanchez Segura

Iraq forges ahead despite extreme difficulty

With the help of the Montreal Protocol mechanisms – particularly the Ozone Secretariat, Multilateral Fund, UNEP and UNIDO – Iraq joined the Vienna Convention and Montreal Protocol on 25 June 2008, after great efforts by the Ministry of Environment. In July 2009, the 58th Meeting of Executive Committee praised the efforts of Iraq in preparing a comprehensive plan to phase-out CFCs and halons by 2010, despite many obstacles, and approved a National Phase-out Plan (NPP) for the country.

Having faced extreme political unrest, Iraq is in need of assistance to control environmental deterioration and preserve bio-diversity. Four years ago, during a biodiversity conference in Brazil, I stated that Iraq did not belong to any environmental multilateral agreements, but pledged not to spare any effort, despite our difficulties, to show the new phase of Iraq. We fulfilled our promise and today Iraq has joined many agreements including the Vienna Convention and Montreal Protocol.

This year – 2009 – is an important one in the history of the Montreal Protocol, as it precedes the total phase-out of CFCs, halons and other ODS scheduled for 2010. Meeting this deadline requires the development of rapid action strategies to tackle the twin problems of ozone depletion and climate change.

The proven success of the Montreal Protocol in reducing emission of ODS will place the ozone layer on the road to recovery by the middle of this century, and make a notable contribution to the reduction of global warming.

Accordingly we believe that the Montreal Protocol is indeed the most successful international treaty today, bringing countries together to protect the ozone layer and life on our Mother Earth.

Dr. Nermin Othman Hassan
Minister of Environment, Iraq

Action on ozone in Turkmenistan

Chlorofluorocarbons, developed in the 20th century as refrigerants and used in a wide range of applications, posed a major challenge for the international community when their destructive effect on Earth's ozone layer was discovered.

Two exemplary international agreements – the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer – have shown that unified action by countries can succeed in tackling global environmental threats effectively.

January 1, 2010 marks a new phase in the restoration and preservation of the ozone layer. It is to be expected that during this phase there will be attempts at illegal import of chlorofluorocarbons. In this scenario, it is essential that Customs Officers should work even more closely with the Ozone Unit than they have before.

In Turkmenistan, integrated action from the relevant ministries and departments is focusing on compliance with the country's international obligations, which is coordinated by the Ozone Unit at the Ministry of Nature Protection of Turkmenistan.

Turkmenistan declares with confidence that, in close interaction with the Ozone Secretariat, Implementing Agencies and other countries, it fulfills all the necessary conditions to become a centre of regional cooperation in the field of ozone layer protection.

Mr. Makhtumkuli Akmuradov
Minister of Environment, Turkmenistan

Challenge and opportunity in Colombia

The success of the Montreal Protocol has shown that it is possible to reconcile different interests and divergent views for the common good. Similarly, application of the principle of "Common but Differentiated Responsibilities", whereby developed countries assumed their obligations as the main ODS generators and developing countries made commitments subject to receipt of economic and technological support, has facilitated achievement of the Protocol's aims.

Creation of the Multilateral Fund, as an independent and specific economic instrument for Protocol implementation, and the technical assistance provided through conversion projects have each played a key role in enabling countries such as Colombia to fulfill their commitments.

Also of vital importance was a national strategy for the fulfillment of commitments through the participation of all stakeholders (equipment manufacturers, importers of ODS, associations, state entities, universities and citizens) and the establishment of mechanisms to strengthen the presence of the National Ozone Unit in the regions with increasing ODS consumption

Currently, Colombia faces two main challenges: replacement of old equipment (refrigerators and air-conditioning equipment) using CFCs, and the environmental management of ODS wastes. Meeting these challenges will require support from the Montreal Protocol. There is also a need to integrate action on these issues with action on other national and global programmes. For instance, it is essential to coordinate with policies on climate change, as well as with national post-consumption policies in the sector concerned with the manufacture of electrical appliances.

Mr. Jorge E. Sánchez Segura
Ozone Officer, Colombia

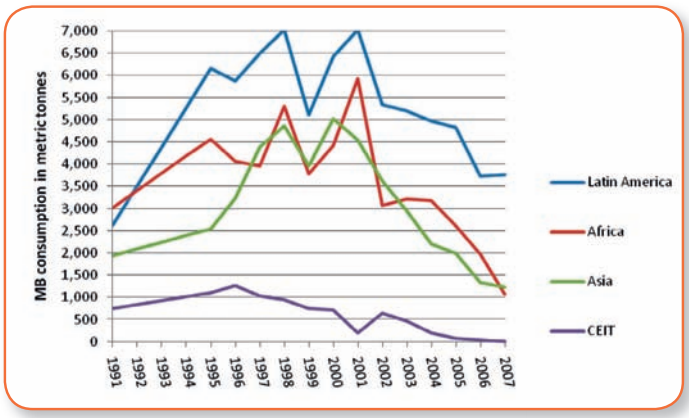
Going, Going, Almost Gone: Methyl Bromide Phase-out in Africa

Melanie Miller, Marta Pizano and David Okioga

Total Article 5 (A5) consumption of methyl bromide (MB) peaked in 1998 at more than 18,100 metric tonnes, but by 2007 it was 6,189 metric tonnes or 39 per cent of the A5 baseline. Total A5 consumption fell by an amazing 1,410 tonnes per year on average between 2003 and 2007. And in 2007, 88 per cent of A5 Parties (129 Parties) reported MB consumption level less than 50 per cent of their national baseline. Only 17 A5 parties consumed more than 50 per cent of national baseline in 2007.

Chart 1 shows the trend in MB consumption in A5 regions in 1991-2007. It shows that Africa has performed very well compared to other regions, having now eliminated 76 per cent of the regional baseline. Consumption in Africa has been reduced from almost 6,000 tonnes in 2001 to about 1,000 tonnes in 2007.

Chart 1: MB consumption in A5 regions, 1991-2007, metric tonnes



Source of data: Data Access Centre on the Ozone Secretariat website

Chart 2 shows that four African countries were among the top 15 MB users in the 1990s. Together these 15 countries accounted for 80 per cent of the A5 baseline consumption. Since then, almost all African countries have made excellent progress. Action in Egypt has been slower; however the Multilateral Fund (MLF) is currently supporting a UNIDO project aimed at phasing out remaining controlled uses except a small one for high moisture dates (10 tonnes).

Major MB uses in Africa differed from country to country but included stored products, and crops such as flowers, tomato, strawberries and tobacco seedbeds. Many alternatives have been adopted successfully in A5 countries, often with assistance from the MLF. Chemical and non-chemical alternatives have proved as effective as MB for controlling soil-borne pests attacking flowers, strawberries, tomatoes, peppers, eggplant and seedbeds. Alternatives include combinations of chemicals such as 1,3-D, chloropicrin, metham sodium and dazomet and non-chemical methods such as substrates, grafting, resistant varieties, biofumigation, and solarisation. The use of substrates in seed trays has become normal practice for tobacco seedling production in many locations. Most often, the combination of alternatives within an Integrated Pest Management (IPM) approach is the best and most sustainable solution. Chart 3 shows examples of MB alternatives that have been widely adopted at commercial level in African countries.

Chart 2: 15 A5 Parties that consumed most MB in the past

Country	National MB consumption (metric tonnes)			MB eliminated from maximum use to 2007	MB eliminated from Baseline to 2007	MLF project
	Maximum use in past (a)	Baseline (1995-98)	2007 (% Baseline)			
China	3,501	1,837	33%	83%	67%	Yes
Morocco	2,702	1,162	38%	84%	62%	Yes
Mexico	2,397	1,885	79%	38%	21%	Yes
Brazil	1,408	1,186	0%	100%	100%	Yes
Zimbabwe	1,365	928	4%	97%	96%	Yes
Guatemala[b]	1,311	668	73%	63%	27%	Yes
South Africa	1,265	1,005	10%	92%	90%	No (c)
Turkey	964	800	0%	100%	100%	Yes
Honduras[b]	852	432	96%	51%	4%	Yes
Argentina	841	686	72%	41%	28%	Yes
Thailand	784	305	67%	74%	33%	Yes
Costa Rica[b]	757	571	69%	48%	31%	Yes
Egypt	720	397	78%	57%	22%	Yes
Chile	497	354	79%	44%	21%	Yes
Lebanon	476	394	8%	94%	92%	Yes
Total of top 15 countries	19,840	12,610	5,284 (42% average)	73% average	58% average	

Countries that consumed more than 470 metric tonnes MB, Ozone Secretariat data
(a) Maximum national MB consumption in the past
(b) Melon producers in these countries increased consumption greatly in recent years Guatemala and Honduras are implementing MLF projects designed to bring compliance
(c) South Africa was invited to prepare a GEF project

Tomato production in Morocco (grafted plants)

In the vegetable sector, grafting has had a significant impact, being rapidly adopted by growers in many countries. For example, 100 per cent of the Moroccan tomato sector is now using grafted plants. When combined with other treatments such as solarisation and/ or alternative fumigants, grafted plants can avoid the need for MB. Production of grafted plants requires training and investment, but provides business and employment opportunities for local nurseries. Resistant rootstocks are becoming increasingly available for vegetables which presented difficulties in the past, such as melons, eggplant and peppers. Initial investment is usually offset by improved yields and quality.

For stored products such as grains, coffee, cocoa, and wooden items, alternatives have also been widely adopted. Examples include phosphine, other fumigants, insecticides and IPM practices, heat treatments, modified atmospheres, and vacuum-hermetic systems, as illustrated in Chart 3.

Tobacco project, Zimbabwe

Chart 3: Main MB alternatives successfully adopted in African countries

Alternatives for use in soils	Examples of countries where alternatives are used
Grafting	• **Morocco:** Tomatoes, peppers • **Egypt:** Peppers, cucumbers, melons • **Libya:** Tomatoes, cucumbers, other
Substrates	• **Morocco:** Green peas • **Egypt:** Strawberries, flowers • **Libya:** Tomatoes, cucumbers, other • **Kenya:** Flowers, sweet peas and other vegetables • **Zimbabwe:** Flowers
Solarisation	• **Morocco:** Tomatoes, cucurbits • **Egypt:** Lettuce, tomato, medicinal plants • **Ghana:** Melons
Biofumigation	• **Ghana:** Melons • **Zambia:** Cut flowers, vegetables
Fumigants, pesticides	• **Kenya:** Metham sodium (spading) – vegetables, flowers • **Zambia:** EDB, metham sodium – tobacco seedlings • **Malawi:** Metham sodium, dazomet – tobacco seedlings • **Morocco:** Metham sodium/ Pic, 1,3-D/Pic – strawberries; 1,3-D – bananas • **Kenya:** Metham sodium, fenamiphos, oxamyl - vegetables
Steam	• **Uganda:** Chrysanthemum cuttings, cut roses • **Zimbabwe:** Cut roses, summer flowers • **Kenya:** Flowers
Seed trays	• **Malawi, Zambia, Zimbabwe:** Tobacco seedlings
Combined options (within an IPM approach)	• **Zambia:** Solarisation + biofumigation – tomatoes, peppers, green peas, others • **Morocco:** solarisation + biofumigation (first production cycle); substrates + nematicides (2nd and 3rd cycles) – green beans; solarisation + 1,3-D/Pic – flowers; solarisation + 1,3-D - bananas • **Egypt:** grafting + solarisation – tomatoes; soil-less plus bio-antagonists – strawberries, flowers • **Zambia:** solarisation + fumigants – cut flowers and vegetables
Post harvest uses	**Examples of countries where alternatives are used**
Phosphine	• **Egypt and Zambia:** commodities and structures • **Senegal:** Peanut seed • **Kenya and Zimbabwe:** Grain • **Many countries:** tobacco
Sulphuryl fluoride	• **Egypt:** commodities and structures • **Mauritius:** Flour mills
Ethyl formate	• **South Africa:** dried fruit
Heat	• **South Africa:** wood pallets, packaging, wooden items
Controlled atmospheres	• **Tunisia:** dates • **Uganda:** sesame seeds
Hermetic storage	• **Ghana, Kenya, Malawi, Sudan, Zambia:** grains • **Ethiopia, Ghana, Cote d'Ivoire, Kenya, Tanzania:** coffee or cocoa beans • **Mozambique:** rice seed
Vacuum- hermetic	• **Several countries:** cocoa beans, coffee beans , maize
Vacuum steam	• **Many countries:** tobacco

The only MB use in Africa for which alternatives have not been identified is high-moisture dates, although alternatives have been found for other types of dates (MBTOC 2002, p.8). Three African countries use MB for high-moisture dates in small quantities: Algeria consumed 3.3 tonnes (43 per cent of baseline), Egypt 10 tonnes (3 per cent of baseline) and Tunisia 11 tonnes (79.5 per cent of baseline) in 2007. Decision XV/12 allows countries that use more than 80 per cent of national MB consumption for high-moisture dates to continue until two years after TEAP finds alternatives. And in April 2008 ExCom authorised a UNIDO demonstration project to identify suitable MB alternatives for this purpose.

Rose production on substrates in Uganda

The projects and actions undertaken in developing countries have provided the following useful lessons:

> Effective alternatives exist for all uses of MB as a soil fumigant. Economic barriers have been overcome in many cases with support from the MLF and efforts by users themselves.

> The ability of users to adapt alternatives to site-specific conditions is essential for theis successful adoption

> Alternatives can be introduced within periods of 2-3 years. In some cases the registration of chemical alternatives has also been carried out within this period.

> Projects succeed when key stakeholders are involved. This includes growers' associations, large enterprises, technical or extension staff, researchers, government officials, importers and others.

MB consumption has been significantly reduced in Africa. Some challenges however remain and must be addressed if the phase out is to be sustainable. For example, cut flower production in a pumice and coco peat substrate in Kenya is cost-effective and allows for pest control that is even better than when using MB. However, it is often necessary to pasteurise the substrate with steam before it can be re-used and this is a costly procedure which can be made economically feasible when used within an IPM approach. Farmers need to learn this technique so they are not inclined to revert to MB. In Zimbabwe, a pine-bark substrate proved successful for producing tobacco seedlings, however steaming before use made this alternative too expensive, restricting it use. Farmers now favour the cost-effective floating trays technology and have adopted it widely. Steam is however still used to treat a limited nursery beds in Zimbabwe and in Kenya.

Grafted watermelon plants at "International Nursery", Morocco

Dr. Melanie Miller
Former Member of Methyl Bromide Technical Options Committee
Director Touchdown consulting

Ms. Marta Pizano
Co-Chair Methyl Bromide Technical Options Committee
Director Hortitecnia

Dr. David M. Okioga
Member of Methyl Bromide Technical Options Committee
Coordinator, Kenya Ozone Office
National Environment Secretariat

Customs and the Montreal Protocol: Success through Cooperation and Coordination

Kunio Mikuriya

565 cartons of R-12 (99.9 per cent pure) were intercepted on 20 May 2009 - ©Indonesian Customs

By its nature, environmental crime is trans-boundary and in many cases involves cross-border criminal syndicates. This requires Customs to vigilantly guard against the illegal trade in ozone-depleting substances (ODS), which often pass through several countries on the way to their final destination. Very often, non-producer countries and free-trade zones are abused as transit points for further distribution of ODS thereby bypassing the Montreal Protocol licensing system. False declarations and mislabelling make it even more difficult for Customs to detect these goods. The task of curbing smuggling in developing countries (which fall within Article 5 of the Protocol) is considerable because the bulk of production and consumption now occurs in these countries due to the fact that their scheduled phase out of ODS is still to be completed.

The World Customs Organization (WCO) has adopted several recommendations on environmental crime; its latest recommendation of June 2008 calls on all WCO Members to continue their efforts to combat environmental crime and to ensure that the environment remains a priority issue for Customs across the globe. This priority was echoed when the WCO dedicated 2009 to the environment under the theme: 'Customs and the Environment: Protecting our Natural Heritage'.

Headings and subheadings for ODS in the Harmonized System – the international goods nomenclature managed by the WCO – have been amended to enable the most traded ODS to be identified and monitored. The WCO Customs Enforcement Network (CEN) has been widely used for information exchange for border environmental enforcement. A new ODS seizure database will be created in the near future as part of the WCO's global national Customs Enforcement Network (nCEN) project. Alerts, analysis of trends and information from other organizations enable the WCO to provide Customs officers with updated situation reports on illegal trafficking, thereby enhancing border enforcement.

'ENVIRONET', the global communication tool launched by the WCO on 5 June 2009, has allowed more than 700 officials from Customs, national competent authorities, the police, and international organizations and their regional networks to exchange real-time information, leading to better cooperation in the fight against environmental crime at the border. In addition, an ODS e-learning program jointly developed by the WCO Secretariat and UNEP will be made available in 2009. This course will benefit Customs officers and other parties involved in controlling the ODS trade or in combating any illegal trade.

At the regional level, the e-learning module 'Customs and ODS' was officially launched in May 2009 by UNEP's Asia Pacific regional office and the WCO Regional Training Centre in New Delhi, India. A further example of close cooperation is that which has existed since 2005 between the WCO Regional Intelligence Liaison Office (RILO) for the Commonwealth of Independent States (CIS) and the Regional Ozone Network for Europe and Central Asia. The WCO Regional Offices for Capacity Building (ROCB) have also been very active in environmental protection by collecting and analysing seizure information, hosting training events, and participating in capacity building initiatives.

The WCO's efforts to strengthen Customs enforcement capabilities through various tools and actions were rewarded when Royal Thai Customs seized 1,140 cylinders of R-12 on 12 May 2008 and successfully foiled an attempt to smuggle 1,115 cylinders (15 metric tonnes) of R-12; another success was when Indonesian Customs successfully intercepted an attempt to import 565 cartons of R-12 (99.9 per cent pure) on 20 May 2009. All these illegal ODS were declared as R-134. These seizures are just the 'tip of the iceberg' with respect to the illegal activity unveiled by Customs administrations worldwide.

In the lead-up to 2010 and beyond, the WCO and its member Customs administrations will step up efforts to combat ODS trafficking. The phase-out of CFCs in developing countries will not mean the end of Customs' work. Criminal syndicates will still attempt to trade, but Customs and its partners must be ready to deal an effective blow to their activities through increased mutual cooperation and coordinated action. WCO's partnership with UNEP and other members of the Green Customs Initiative forms the backbone of our fight to ensure full compliance with the terms of the Montreal Protocol. Together we remain an invincible force against environmental crime.

Mr. Kunio Mikuriya
Secretary General
World Customs Organization

Fluorocarbons Must Go for Good

Gerd Leipold

In 1931, DuPont opened the world's first chlorofluorocarbon (CFC) factory in Deepwater, New Jersey, and launched the world on the perilous road of fluorocarbon chemical dependency.

During the ensuing eight decades, tens of millions of tons of CFCs, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) have been emitted into the atmosphere. This chemical dependency brought upon us the crisis of ozone layer depletion and is a significant contributor to human- induced climate change. Undoubtedly, climate change is the greatest emergency facing humanity today.

CFCs and HCFCs are powerful ozone-depleting substances and together with HFCs are super-greenhouse gases.

Under the Montreal Protocol, 2010 will mark the end of legal production and consumption of CFCs in the world. Meanwhile, HCFC production and consumption will continue till 2020 and 2030 in industrialized and developing countries respectively.

Because CFCs and HCFCs are very potent global warming substances, by reducing CFC emissions, the Montreal Protocol has inadvertently also reduced the emissions of large amounts of greenhouse gases.

However, the Montreal Protocol could have achieved significantly more to protect the climate had CFCs and HCFCs been phased-out at a much faster rate, and equally important, had most of the CFCs not been primarily replaced by HCFCs and HFCs. From a technical point of view, both of those measures were achievable.

There is no doubt that, with sufficient financial support, developing countries could have phased-out CFCs before 2010. Similarly, a global accelerated HCFC phase-out with more ambitious phase-out target dates could have been achieved several years prior to 2007.

Unfortunately, due to the extensive influence of the chemical corporations, governments failed to take such readily available preventative actions.

The fact is that, prior to the signing of the Kyoto Protocol, the Parties to the Montreal Protocol chose to ignore the global warming impacts of CFC replacement substances. Even after Kyoto, the Multilateral Fund primarily sponsored HCFC-and HFC-based projects even though fluorocarbon-free alternative technologies were available for most applications.

Today we face the following daunting facts:

- Developing country HCFC use is larger today than the historical peak use of HCFCs in industrialized countries, and HCFC use is still growing. This means that there will be a massive demand for HFCs should they become the primary replacement for HCFCs.
- Growing HFC emissions could erase the substantial net climate benefits of the phasing out of CFCs and HCFCs under the Montreal Protocol.
- Uncontrolled HFC emissions will cause a large percentage of all anthropogenic forcing (warming) by mid-century. This is because, under some circumstances, they have an equal impact to that of CO_2 emissions – effectively erasing the gains made by efforts to de-carbonize the global energy sector.

Reduction and elimination of HFC use are necessary components of global strategies to reverse climate change. Greenpeace calls for immediate action to ensure overall greenhouse gas emissions peak no later than 2015 and start declining thereafter on a pathway that brings greenhouse gas emissions down to as close to zero as possible by mid-century.

Therefore, there is an urgent need to prevent the massive uptake of HFCs and any new generation of chemicals worldwide as HCFCs are phased out. Such uptake can be avoided through a HFC phase-out regime. This will guide industry in both industrialized and developing countries towards the uptake of presently available technologies using natural refrigerants and insulation foam-blowing agents. It will further guide industry towards intensified research and development of additional HFC-free alternatives.

Fortunately, there is no need for these fluorinated gases. There are environmentally safe, efficient, technologically proven and commercially available alternatives to HCFCs and HFCs in most domestic and commercial applications. These use natural substances, such as hydrocarbons, CO_2, ammonia or water. Typically, systems using natural refrigerants are equal to, or are more energy efficient than those using HFCs, and they are less expensive to operate.

Greenpeace is a strong proponent of the use of natural refrigerants and foam-blowing agents. In 1992, Greenpeace developed and popularized "Greenfreeze", the hydrocarbon-based domestic refrigerator technology. Today there are over 300 million Greenfreeze refrigerators in the world, globally representing nearly half of the annual production of refrigerators.

Greenpeace, together with UNEP, is also an active supporter of Refrigerants, Naturally! a consortium of international corporations committed to phasing out HFCs in point-of-sale applications, such as beverage vending machines and ice-cream freezers.

The United Nations Framework Convention on Climate Change (UNFCCC) and the Montreal Protocol both have important collaborative and complementary roles to play in the phase-out of HFCs.

Greenpeace believes that HFCs should remain within the regulated basket of gases under the UNFCCC and that an HFC phase-out must be incorporated in the Copenhagen agreement. Meanwhile, the Montreal Protocol could act as a key facilitating body for limiting the production and consumption of HFCs around the world. Such a dual approach will combine the political and moral authority of the UNFCCC/Copenhagen process with the vast practical expertise of the Montreal Protocol. It may require an amendment to both Protocols.

Meanwhile the Montreal Protocol has the capacity to take immediate steps to further protect the climate by no longer funding any more HFC projects through the Multilateral Fund.

Governments can act now to avoid the mistakes of the past. They must wean the world off of its current chemical dependency on all fluorocarbons.

Dr. Gerd Leipold
Executive Director, Greenpeace International

The Challenge and Opportunity for Accelerated Phase-out of HCFCs under the Montreal Protocol

Drusilla Hufford

In September 2007, countries gathered in Montreal, Canada to continue their historic collaboration to restore the Earth's stratospheric ozone layer. They had much to celebrate: the meeting marked the 20th anniversary of the signing of the Montreal Protocol. In the decades since, the treaty has become known as the most successful multilateral environmental agreement ever negotiated. Scientists working to support the treaty summarized the achievements in ozone layer protection in their 2006 "Scientific Assessment of Ozone Depletion".[1] Among other findings, the update showed continuing declines in ozone depleting substances (ODS) in the atmosphere, and projected that recovery of the ozone layer at mid-latitudes could occur as early as 2050.

In March 2007, a paper published in the "Proceedings of the National Academy of Sciences"[2] characterized another vital contribution of the Montreal Protocol – protection of the Earth's climate. Climate benefits from the Montreal Protocol were possible because many of the ODS being phased out also have high global warming potentials (GWPs). The paper showed that in 2010, the Montreal Protocol would be responsible for a reduction in carbon equivalents 5-6 times greater than the reductions under the first commitment period of the Kyoto Protocol.

Against this backdrop, a collection of pragmatic idealists proposed a path forward for consideration at the 20th anniversary meeting. This path offered additional opportunities for environmental protection under the Montreal Protocol: more could be accomplished, if potential benefits were clearly articulated and a workable way forward identified. With eight other developed and developing countries, the U.S. put forward a proposal to amend the treaty to speed phase-out of the next major group of ODS due to be controlled, the hydrochlorofluorocarbons (HCFCs).

Discussions were intense and realistic; many were clear-sighted about the challenges presented by the proposals. By 2007, the transition from the first major group of ODS to be controlled, the chlorofluorocarbons (CFCs), was largely complete in the developed world, except for a few remaining essential uses. But even in developed countries, it was not unheard of for large building chillers to rely on CFC stocks for servicing, being nursed many years past their life expectancy to save owners the capital investment that replacement would demand. For developing countries, the challenge was even more daunting. They faced the transition from CFCs in 2010, and in many cases, had not even begun the task of moving to HCFCs.

Despite the formidable challenges, there was a spirit among the 2007 delegates of possibility, hope and commitment to environmental goals. At the meeting, delegates were greeted by a video clip taped in real-time from the U.S. space shuttle. Astronauts wished the delegates success in their efforts to strengthen the Montreal Protocol and described the beauty of our shared planet, with its protective layer of ozone, as seen from space. This helped put into perspective the many obstacles to forward progress. Along with ingenuity and risk-taking, particularly of delegates from developing countries, this spirit propelled the countries of the Montreal Protocol to accept the challenge, and adjust the accord on its 20th anniversary to go even further in protection of both ozone and climate.

Polar bears affected by melting ice sheets

Now countries are moving to the demanding tasks of implementation. At this time, it is useful to remind ourselves of the substantial environmental benefits all countries recognized in choosing to take on new and more stringent commitments. In keeping with the Montreal Protocol's primary goal, substantial gains can be made for ozone layer protection through the 2007 amendment. Successful implementation will reduce HCFC emissions to the atmosphere by 47 per cent, compared to prior commitments over the 30-year period 2010-2040.

Climate benefits of the strengthened HCFC phase-out are even more impressive. U.S. analysis performed before the negotiations estimated that, over the period 2010-2040, the new schedule would reduce climate-damaging emissions between 3,000 – 16,000 millions of metric tonnes of carbon equivalent ($MMTCO_2e$). The mid-range of this estimate, 9,000 $MMTCO_2e$, is equivalent to eliminating climate emissions from nearly half of all U.S. passenger cars every year for the next 30 years.

Why is there a range in potential climate benefits from the HCFC phase-out? Because benefits of the 2007 agreement have yet to be realized, and will depend strongly on two factors. Most important is the availability of alternatives: for HCFCs to be phased out, alternatives must exist. But availability has more dimensions than mere existence: it also must be true that alternatives are within

[1] World Meteorological Organization. Scientific Assessment of Ozone Depletion: 2006. March 2007. Report 50.
[2] National Academy of Science. The Importance of the Montreal Protocol in Protecting Climate. March 2007

economic reach. For this reason, historically the Montreal Protocol has been concerned not only with technical, but also economic feasibility of replacement.

The challenge of finding suitable cost-effective HCFC alternatives

If alternatives exist, but implementation costs are high, then the experience of the CFC phase-out in developed countries has shown the tendency to cling to older technologies and delay needed capital investment. If carried to extreme, this tendency would mean that little of the potential climate benefit of the 2007 agreement could be achieved. Widespread delay in adopting alternatives could even imperil compliance with the new, lower HCFC consumption limits countries have agreed to meet. So alternatives must exist, and be available, for the climate benefits of the 2007 change to be realized.

If alternatives are available, but have high GWPs, substantial benefits for climate may still be realized in the transition. This is because newer equipment tends to be tighter and less prone to leakage, as well as more energy efficient, compared to existing equipment. Recognizing this, underlying text supporting the 2007 agreement makes explicit the importance not only of intrinsic GWP, but also of operating factors that may have equal importance for the long-term climate contribution of alternatives:

> "To agree that the Executive Committee, when developing and applying funding criteria for projects and programmes, … give priority to cost-effective projects and programmes which focus on… (b) Substitutes and alternatives that minimize other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors;…"

Still, high-GWP alternatives inevitably mean some reduction in the overall climate benefit achievable from the switch. Where low-GWP options are available, then adopting them in place of HCFCs can raise the overall climate payoff of the 2007 agreement even more.

This implies important balancing ahead, in which it will be vital to integrate the goals of the Montreal Protocol as an ozone treaty with the world's urgent need to reverse damage to climate. Because alternatives must be available to allow the HCFC transition to proceed, and because HCFCs damage both ozone and climate, the first principle in going forward must be to encourage compliance with and thorough implementation of the 2007 adjustment. Thus, enthusiasm in constraining availability of high-GWP alternatives to HCFCs to serve climate goals must be tempered with a recognition that, without alternatives, the world may remain invested in older, less efficient technology choices that damage both ozone and climate.

Making the most of the opportunities

Technical experts from both the climate and ozone communities have recognized that focusing solely on reducing climate-damaging emissions of HFCs could impede completion of Montreal Protocol tasks. The European Union's 1999 submission to the United Nations Framework Convention on Climate Change stated, "Action taken to reduce HFC emissions should not undermine the efforts to phase out ozone-depleting substances". This recognizes that undermining the smooth completion of the Montreal Protocol's next phase would reduce not just benefits for the ozone layer, but also for climate.

In moving ahead, where technologies exist but rely on high-GWP chemicals, emphasis should be placed on identifying tighter and more efficient equipment to minimize climate damage from the gases being used. Where lower-GWP choices exist, either older materials like ammonia that are getting a second look through approaches like secondary loop cooling, or brand new molecules created specifically for better environmental performance, governments and industries can continue the tradition of innovation that has made the Montreal Protocol so successful by encouraging environmentally safer choices. This will allow the important decision made in 2007 to realize the greatest possible benefits, both for the ozone layer and the Earth's climate system. That way the view of our sparkling planet from space will remain as beautiful for generations to come as it is for our own.

The views presented here are the views of the author and do not necessarily represent the views of the U.S. Environmental Protection Agency, where the author is employed.

Ms. Drusilla Hufford
Director, U.S. Environmental Protection Agency
Stratospheric Protection Program

Progress with HCFC Phase-out: Industry Perspectives from China

Yang Mianmian

China acceeded to the London and Copenhagen Amendments of the Montreal Protocol regarding ozone-depleting substances (ODS) in June 1991 and April 2003 respectively. As the largest producer and consumer of HCFCs, China has been faced with more and more challenges. The Chinese government has fully realized the importance and urgency of protecting the ozone layer and has accelerated the process of reducing the emissions of ODS and greenhouse gases.

According to the paper, "ODS Phase-out of National Programs in China (Revised Version)", the ODS control objective of China was to prohibit completely the production and consumption of chlorofluorocarbons (CFCs) since 1 January, 2010. The refrigeration industry has been prohibited from importing and exporting CFCs as a refrigerant in compressors and related products since 1 March 2006, which is ahead of the original schedule.

The industrial enterprises of China are also making great efforts to phase-out ODS ahead of time, but progress depends on the technical and economical feasibility. The alternative technologies of R-22 have been accelerated in the air-conditioning industry. The majority of household electrical appliance enterprises are carrying out reduction of R-22 refrigerants and actively promoting environment friendly R-410A refrigerant use. Through industrial restructuring and promotion of alternative technology research, the goals of ODS phase-out could be achieved with application of policies, standards and good practice in reducing emissions of HCFCs.

With regard to domestic enterprises, non-CFC substitutes were used firstly in refrigerators and air-conditioners produced by Haier. By the end of 2002, all of Haier's household appliances had achieved freon emission reduction of 2580 metric tonnes, one twentieth of total national emissions reduction. Haier has made great efforts in the cause of protection of the ozone layer and the environment. As the sole white appliance sponsor for the Beijing 2008 Olympic Games, the company supplied nearly 6,000 refrigerators with carbon dioxide as the refrigerant. Carbon dioxide is more environmentally friendly and safer and can save 30 per cent more energy than traditional non-CFC refrigerants. According to the statistical data, Haier has produced a total of about 60 million non-CFC refrigerators, saving 80 billion kWh from 1996 to June 2008.

Haier had the honour of supplying all of the Olympic Games venues with over 60,000 environmental and energy-efficient household appliances, and Haier central air-conditioning systems were installed in the 23 venues. For example, the energy efficiency ratio of Haier multiple air-conditioning units used in the National Stadium can reach 4.29, saving 800,000 kWh per year in electric power through use of an environmentally friendly R-410A refrigerant. The environmental performance of these products is among the best in the world. Haier had substituted 147,238 non-CFC central air-conditioning units in 2008 and will be substituting 38,000 units in 2009.

Haier has issued reports on sustainability in the past four years with strong regard to the company's environmental and social responsibilities. The contribution of Haier to environmental protection and energy conservation has been highly appreciated by scientists and by the industry. Haier will continue to make great efforts in the field of energy saving and emission reduction and will go forward with full confidence.

Ms. Yang Mianmian
President of Haier Group

China's economic growth spreads accessibility to air-conditioning

Maintaining Montreal Protocol Momentum: A View from the EU

Marianne Wenning

International measures to protect the ozone layer in the stratosphere have had remarkable success. Close to universal ratification, the 1987 Montreal Protocol has achieved the phase-out of 95 per cent of controlled ozone-depleting substances (ODS) globally. In the EU, current legislation – generally more ambitious than the Montreal Protocol – helped achieve a 99 per cent phase-out of controlled substances.

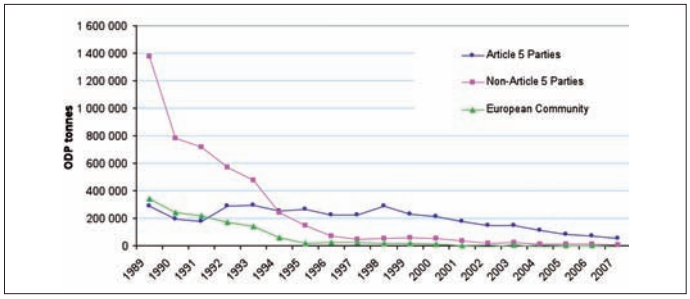


Figure 1: Global ODS Consumption

Beyond protecting the ozone layer, the reduction of ODS also plays a significant role in fighting climate change. ODS have a global warming potential (GWP) up to 14,000 times greater than carbon dioxide. Without the Montreal Protocol global greenhouse gas emissions would be 50 per cent higher than they are today.

Scientists now consider it possible for the ozone layer to be fully restored sometime between 2050 and 2075, but warn that a number of challenges remain. The recent agreement by the Parties to the Protocol to accelerate the phase-out of hydrochlorofluorocarbons (HCFCs) needs to be implemented in a way that maximizes the benefits to the climate. Exemptions such as critical uses, the use of methyl bromide for quarantine and pre-shipment, and new ODS still pose a threat to the ozone layer.

Earlier this year the EU passed a new regulation on substances that deplete the ozone layer, which aligns existing legislation with the new global HCFC phase-out agreement and adapts it to new scientific developments and future challenges.

The new regulation strengthens the measures on the illegal trade and use of ODS in the EU and introduces measures to prevent the dumping of these substances – or obsolete equipment relying on these substances – in developing countries.

The revision also restricts further the use of HCFCs. Production of HCFCs for export will cease by 2020 in incremental steps and caps instead of by the original deadline of 2025.

The revised regulation also mandates the Commission to adopt tougher provisions on ODS trapped – or 'banked'– in products such as insulation foams in buildings. This is in addition to already existing obligations on the recovery and elimination of substances in air conditioners and refrigeration equipment and will allow for better synergies with current and future EU waste legislation.

Measures on methyl bromide will be tightened. All uses of the substance will be banned by March 2010, including those used for quarantine and pre-shipment, in line with the most recent decisions under EU pesticides regulations. In addition, exports of chlorofluorocarbons (CFCs) for the manufacture of metered dose inhalers will be prohibited by 2010 without posing any health risks. The legislation also establishes a list of new substances for which reporting is required, even though they are not yet covered by the Montreal Protocol.

The new legislation should help the ozone layer recover from 2050 onwards and also contribute to EU efforts to mitigate climate change.

To ensure that potential climate benefits of the HCFC phase out are maximized poses a significant challenge. Most hydrofluorocarbons (HFCs), which are popular alternatives for HCFCs in a number of applications, are potent greenhouse gases. Although today HFC emissions represent less than 2 per cent of the total reported greenhouse gases, their share could grow significantly as the HCFC phase-out takes full effect over the coming years.

In 2006, the EU adopted a regulatory framework aimed at reducing emissions of HFCs and other F-Gases. This policy is widely acknowledged as a global model that leads to more responsible management of the substances, tighter systems, lower F-Gas charges and ultimately to substitution by more environmentally friendly technologies. Not coincidentally, the demand for low-GWP alternatives such as ammonia, carbon dioxide and hydrocarbons is growing and more recently, several chemical companies have started investing in new low-GWP alternatives.

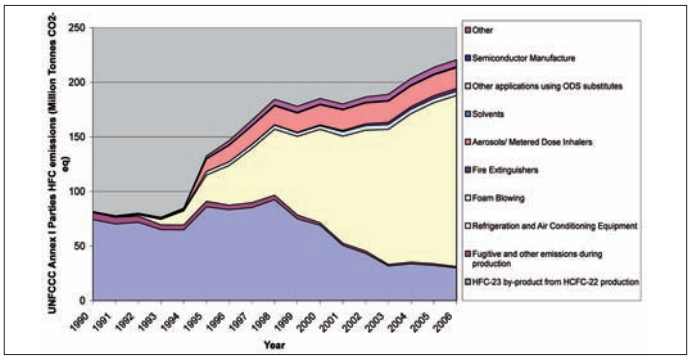


Figure 2: HFC emissions reported by Annex I Parties under UNFCCC

At the same time the EU is very active in international climate negotiations to reach a comprehensive and ambitious climate change agreement in Copenhagen in December 2009. In March 2009, the Council concluded that the Copenhagen agreement should include an international emission reduction arrangement for HFC emissions. While such an arrangement should be governed by the United Nations Framework Convention on Climate Change (UNFCCC), it would also be highly desirable to maximise the synergies with the Montreal Protocol.

On 4 May 2009, The Federated States of Micronesia and Mauritius submitted a proposal to amend the Montreal Protocol to control and phase down HFCs. The EU looks forward to constructive discussions with other Parties on the best way to reach a global agreement.

Ms. Marianne Wenning
Head of Unit ENV C.4 - Industrial Emissions and Protection of the Ozone Layer
Environment Directorate General, European Commission

A Tale of Two Protocols: The Case of Senegal

Ndiaye Cheikh Sylla

Today everybody acknowledges the achievements of the Montreal Protocol. Its success is the result of an effective mechanism based on a network of coordinators and financial support from the Multilateral Fund, on national as well as regional levels.

The fact that, in Senegal, the same department administers both the Kyoto and Montreal Protocols has meant that the Climate Team has benefited from the enthusiasm and support of the Montreal Protocol Unit in carrying out activities and providing information to the public.

It is not surprising that the climate and ozone agreements should often be mistaken one for the other, given the features they have in common.

HCFCs are a good example of common ground between the two initiatives. Senegal, within the framework of reduction of all ODS, is striving for an accelerated phase-out of these substances far ahead of schedule. Accordingly, negotiations are in progress with UNIDO on the one hand, and with UNEP and the World Bank on the other, with the aim of integrating the concerns over climate into the phase-out of HCFCs in the refrigeration sector, particularly for industry. However, achievements resulting from co-operation between the Ozone Secretariat and the Climate Secretariat, and further between the IPCC and the TEAP, remain minor.

It is clear that action on ozone can support action on climate, especially when it comes to gases that are relevant to both problems. Under Kyoto, the African continent has not so far equitably benefited from Clean Development Mechanism (CDM) projects, with only 1.8 per cent of CDM projects out of a total of 31, whereas under Montreal, countries have all the projects they can implement. If phase-out activities for HCFCs are supported by the Global Environment Facility (GEF), or by bilateral cooperation, a very substantial increase in the number of CDM projects could be achieved in response to legitimate demand from Africa, as instituted by the Marrakech Agreement in the implementation of Article 12 of the Kyoto Protocol, (the Clean Development Mechanism.

We thus understand how the Montreal Protocol has the potential to respond to two of the objectives of Kyoto: equity and the reduction of greenhouse gases. In any case, Senegal intends to use this synergy to take up the challenge of effective implementation of both the Montreal and the Kyoto Protocols.

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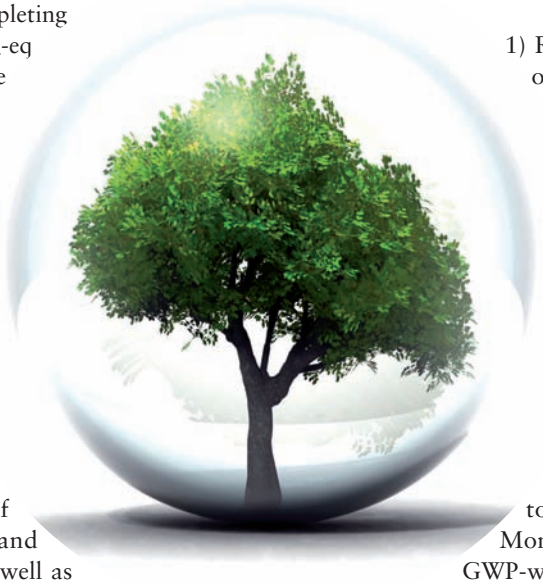
Down the road

How Future HFC Emissions Might Offset Climate Benefits Already Achieved by the Montreal Protocol

Guus J. M. Velders, David W. Fahey, John S. Daniel, Mack McFarland, Stephen O. Andersen

Global production and use of chlorofluorocarbons (CFCs) and halons have decreased significantly as a result of the phase-out schedules of the 1987 Montreal Protocol and its subsequent amendments and adjustments. This has already contributed to protection of both the ozone layer (1) and the climate (2) because the regulated compounds generally have significant ozone-depleting potentials (ODPs) and global warming potentials (GWPs), respectively. The Montreal Protocol will have reduced GWP-weighted emissions from ozone-depleting substances (ODSs) by about 15-18 $GtCO_2$-eq yr^{-1} in 2010 (2), see Figure 1. The climate benefit of these reduced emissions is partially offset by increased emissions of replacement compounds, such as hydrofluorocarbons (HFCs), and by depletion of stratospheric ozone. The net reduction in GWP-weighted emissions is 10-12 $GtCO_2$-eq yr^{-1} in 2010, or about 5-6 times the reduction target of the first commitment period (2008-2012) of the Kyoto Protocol.



As a direct result of the decreased use of CFCs and halons, the use of hydrochlorofluorocarbons (HCFCs) and HFCs as replacements, in developed as well as developing countries, has increased. HCFCs are low-ODP substitutes for high-ODP substances and were classified under the Protocol as "transitional substitutes" for use during the time it took to commercialize new ozone-safe alternatives and replacements. Ultimately, HCFCs will be phased out globally under the Montreal Protocol, leaving much of the application demand for refrigeration, air conditioning (AC), heating and thermal-insulating foam production to be met by HFCs (3). The demand for HCFCs and/or HFCs in many applications is expected to increase in both developed and developing countries, but especially in Asia, in the absence of regulations. HFCs do not deplete the ozone layer but, along with CFCs and HCFCs, are greenhouse gases which contribute to the radiative forcing of climate (3). Thus, the transition away from ozone-depleting substances has implications for future climate. In 2007, partly to further protect future climate, the Parties to the Montreal Protocol decided to accelerate the HCFC phase-out. HCFC consumption in developing countries will be frozen in 2013 and stepwise reduced, with a virtually complete phase-out in 2030. Developed countries have agreed to a virtually complete phase-out in 2020. The HCFC cumulative emissions reduction attributable to the accelerated phase-out is estimated to be 12-15 $GtCO_2$ eq between 2013 and 2050 (4). In adopting the accelerated HCFC phase-out, the Parties agreed to promote the use of HCFC alternatives that minimized the impact on climate.

Recently, new HFC baseline scenarios have been formulated (4), based on growth rates in gross domestic product and population and incorporating recent information on:

1) Reported recent increases in consumption of HCFCs in developing countries of about 20% yr^{-1},
2) Replacement patterns of HCFCs by HFCs as reported in developed countries,
3) Accelerated phase-out schedules of HCFCs in developed and developing countries. The analysis results in significantly larger emissions in 2050 than would be expected based on previous projections.

In Figure 1, past global emissions and future scenarios are shown for ODSs and HFCs for the period 1960-2050 together with an ODS scenario without Montreal Protocol regulations. Total direct-GWP-weighted emissions of ODSs peak in 1988 at 9.4 $GtCO_2$ eq yr^{-1} and decrease after that, whereas HFC emissions monotonically increase, primarily in developing countries, exceeding those of ODSs after about 2020. Total HFC GWP-weighted emissions reach 5.5-8.8 $GtCO_2$ eq yr^{-1} by 2050, slightly less than the peak in ODS emissions. In a business-as-usual scenario, starting in 1987, without Montreal Protocol regulations the GWP-weighted emissions of ODSs reach 15-18 $GtCO_2$ eq yr^{-1} by 2010. So, growth in HFC use and emissions will offset at least part of the climate benefits already achieved by the Montreal Protocol.

The HFC scenario results are put into context by comparing them to projected global CO_2 emissions. Global HFC emissions in 2050 are equivalent to 9-19% (CO_2-eq. basis) of projected global CO_2 emissions in IPCC/SRES business-as-usual scenarios. This percentage increases to 14-23% and 28-45% in comparison to projected CO_2 emissions in stabilization scenarios for 550-ppm and 450-ppm CO_2, respectively. Here, only the direct contribution to climate forcing due to ODS and HFC emissions is considered. Indirect climate forcing associated with halocarbon usage derives from the energy used or saved during the application or product lifetime and energy required to

1. WMO (2007) *Scientific Assessment of Ozone Depletion: 2006* (Global Ozone Research and Monitoring Project - Report No. 50, World Meteorological Organization, Geneva, Switzerland).
2. Velders GJM, Andersen SO, Daniel JS, Fahey DW, McFarland M (2007) The importance of the Montreal Protocol in protecting climate. *Proc Nat Acad Sci* 104:4814-4819.
3. IPCC/TEAP (2005) *Special report: Safeguarding the ozone layer and the global climate system: Issues related to hydrofluorocarbons and perfluorocarbons* (Cambridge Univ Press, New York).
4. Velders GJM, Fahey DW, Daniel JS, McFarland M, Andersen SO (2009) The large contribution of projected HFC emissions to future climate forcing. *Proc Nat Acad Sci.* (in press).
5. IPCC (2007) *Climate Change 2007: The physical science basis* (Cambridge Univ Press, Cambridge, UK and New York).
6. Plattner G-K, et al. (2008) Long-term climate commitments projected with climate-carbon cycle models. *J Climate* 21:2721-2751.

manufacture the product, including the halocarbon it uses. For example, insulating foam products in buildings and appliances reduce energy consumption, whereas refrigeration and AC systems consume energy over their lifetimes. A full evaluation of the total climate forcing resulting from the global transition away from CFCs and HCFCs towards HFCs and other compounds requires consideration of both direct and indirect impacts over all associated halocarbon and not-in-kind application lifecycles.

The views presented here are the views of the authors and do not necessarily represent the views of the organizations where they are employed.

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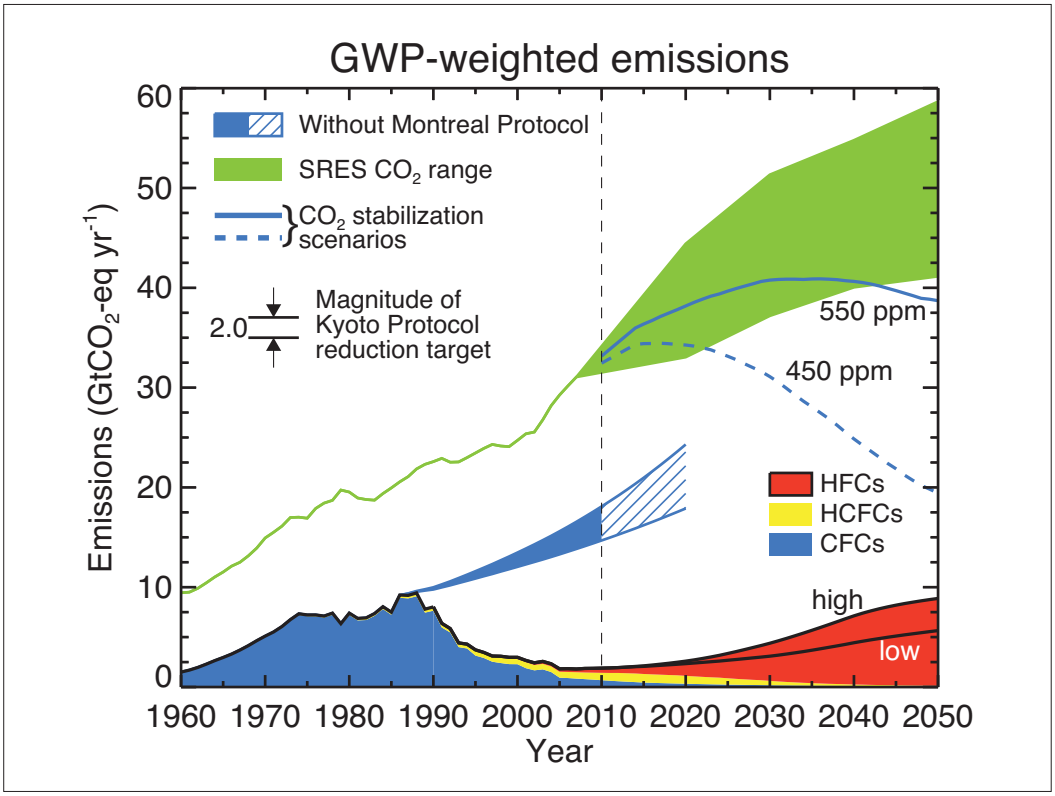

Figure 1. Global CFC, HCFC, HFC, and CO_2 emissions for the period 1960-2050, and global CFC emissions for 1987-2020 following a scenario in which there is no Montreal Protocol regulation (2). The CFC data include all principal ODSs in the Montreal Protocol except HCFCs. The emissions of individual compounds are multiplied by their respective GWPs (direct, 100-year time horizon (5)) to obtain aggregate emissions expressed as equivalent $GtCO_2$ yr^{-1}. The colour-shaded regions show ranges of emissions of CFCs, HCFCs, HFCs, and CO_2 as indicated in the panel legends. The high and low limits of the HFC ranges follow from the differences in gross domestic product and population growth in the underlying IPCC/SRES storylines (4). Shown for reference are emissions for the range of IPCC/SRES CO_2 scenarios and the 450- and 550-ppm CO_2 stabilization scenario (5, 6).
Source: Proceedings of the National Academy of Sciences, 106, June 2009

New Strategies to Leverage the Montreal Protocol to Protect the Climate

Durwood Zaelke and Peter M. Grabiel

The world urgently needs fast-action climate mitigation to avoid the worst impacts of climate change and reduce the risk of passing tipping points for abrupt, irreversible, and catastrophic climate changes. These fast-action strategies must complement mid- and long-term climate strategies under the 1997 Kyoto Protocol and 2009 Copenhagen agreement.

Strengthening the Montreal Protocol to protect the climate system is one of the quickest, cheapest, and most certain means of delivering fast-action climate mitigation. The Montreal Protocol is the world's most successful international environmental agreement and has set the ozone layer on the path to recovery later this century. It is also the most successful climate treaty to date, having already delivered per annum climate protection 5-6 times greater than the expected mitigation under the Kyoto Protocol during the first commitment period (see Velders et al article in this issue).

In 2007, the Parties agreed to accelerate the phase-out of hydrochlorofluorocarbons (HCFCs) in a decision that explicitly recognized the climate benefits of their actions. At the same time it was acknowledged that these climate benefits would only accrue if technologies and substances that replace HCFCs are as climate friendly as possible. To capture the full climate benefits of the HCFC accelerated phase-out, hydrofluorocarbons (HFCs) with a high global warming potential (GWP) must be controlled now and in a manner that is consistent with HCFC regulation under the Montreal Protocol.

In 2008, the Parties took decisions that set the stage for decisions this year to capture even more climate benefits from the Montreal Protocol. These included exploring regulatory options for high-GWP HFCs under the Montreal Protocol and promoting and financing pilot projects to recover and destroy banks of ozone-depleting substances (ODS).

This year, the Federated States of Micronesia and Mauritius submitted a joint proposal to strengthen the Montreal Protocol to protect the climate system by amending the Protocol to phase down high-GWP HFCs and to collect and destroy banks of ODS with support from the Multilateral Fund.

Parties to the Montreal Protocol can avoid the dramatic increase in HFC emissions that is already underway by controlling the production and consumption of HFCs in a way that complements the climate regime controls on emissions. Guus Velders and colleagues predict that an HFC production and consumption phase-down has a climate mitigation potential of up to 8.8 billion tonnes of carbon-dioxide equivalent per year by 2050.

The Montreal Protocol has not yet exercised its existing legal authority to regulate HFCs and recover and destroy ODS banks. The Montreal Protocol was designed to address ODS, but also to ensure broader environmental protection as evidenced in Article 2F(7)(c), and with particular regard to the climate system as referenced in the Preamble and interpreted by numerous decisions of the Parties addressing climate change. Similarly, Article 2(2)(b) of the Vienna Convention for the Protection of the Ozone Layer requires the Parties to prevent adverse effects of their ozone protection policies and specifically lists climate change among the adverse effects to be avoided in Article 1(2). Further responsibility arises because the phase-out of ODS under the Montreal Protocol is responsible for creating the market for HFCs.

In addition to HFCs, approximately 16-17 billion tonnes of carbon-dioxide equivalent of ODS exist in banks in discarded products and equipment. By 2015, up to 3 billion tonnes of carbon-dioxide equivalent will be emitted from the most cost-effective banks alone unless they are recovered and destroyed. The future of the Montreal Protocol will be to holistically regulate the chemicals used in the sectors it regulates from cradle to grave, i.e. from production through consumption to end-of-life.

Both of these climate opportunities require immediate action. Fortunately, the Montreal Protocol already has the expertise, institutions, and an existing on-the-ground network of ozone officers in every developing country prepared for immediate implementation. The Montreal Protocol has to act on its own, when and where it can, while also standing prepared to coordinate with the process under the United Nations Framework Convention on Climate Change (UNFCCC) to expand the opportunities for regulating and financing these efforts.

Countries such as Australia, Japan, and The Netherlands have demonstrated that recovering and destroying ODS banks can be accomplished at very little cost, for example, by generating financing through a levy on imported or virgin production of ODS and HFCs or by taxing new refrigerators and air conditioning units. In Brazil, a groundbreaking refrigerator replacement project, carried out in coordination with Germany and the United Nations Development Programme, has led to the development of a cost-effective means of making available millions of tonnes of ODS banks in refrigerators, while providing better energy efficient appliances to low-income households. In a testament to the power of regulation and the ability of industry to respond to appropriate market signals, the regulation of HFCs in Europe has spurred automakers and chemical manufacturers to develop alternative technologies and substances to replace high-GWP HFCs and now has chemical companies poised to commercialize HFO-1234yf, with a GWP of only 4 to replace HFC-134a with a GWP of over 1400.

These efforts give us only a glimpse of what can be achieved if the Montreal Protocol community leads a coordinated effort to seize these climate mitigation opportunities. Now is the time to act. No international agreement has done more to protect the climate system, and none has the opportunity to do still more as quickly and cheaply as the Montreal Protocol can by regulating HFCs and recovering and destroying ODS banks.

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What If There Had Been No Montreal Protocol?

Paul A. Newman

What is the state of the ozone layer now that the Montreal Protocol is more than 20 years old? Signed in 1987, this landmark international agreement stopped the growth of ozone-destroying substances (ODS), including chlorofluorocarbons (CFCs) and halons.

Figure 1 shows a 'sand chart' from 1960 to the present of the combined chlorine compounds in the troposphere (each compound is multiplied by the number of chlorine atoms). By 1960, the chlorine containing ODSs (mainly carbon tetrachloride, CFC-11 and CFC-12) had already increased chlorine levels by 60 per cent over the natural levels. Molina and Rowland's paper, published in 1974, alerted the public to the threat posed by CFCs to the ozone layer and slightly slowed the rate of increase in chlorine levels. The 1987 landmark Montreal Protocol led to a considerable slowing of CFC production, and by about 1993, the growth of chlorine in our atmosphere had stopped. Over the last 15 years, the total chlorine has slowly decreased by about 10 per cent.

Methyl chloroform (a solvent) has decreased relatively quickly because of its short 5-year atmospheric lifetime, while many other species are only decreasing slowly (for example, CFC-12 has a lifetime of about 100 years). HCFC-22 has gone up about 0.1 ppb since the early 1990s, but should start decreasing soon because of the 2007 regulation of these CFC replacements. In addition to the tropospheric measurements of ODSs, satellite measurements of stratospheric chlorine have also shown a steady decrease. The Montreal Protocol has succeeded in halting the growth of ODSs, and we are now seeing declines in both the troposphere and stratosphere.

So, are we now seeing a return to the ozone levels observed prior to 1980? The answer is a qualified 'yes'! In the upper stratosphere the ozone layer is bouncing back, but in the lower stratosphere there is less certainty. Figure 2 shows the ozone levels from both ground and satellite observations for the northern hemisphere (left panel) and the southern hemisphere (right panel). It is clear that ozone is no longer decreasing in both hemispheres (the 1993-1995 NH low values of ozone resulted from the effects of Mt. Pinatubo).

The Montreal Protocol is a success, but what would have happened if nothing had been done? To test this, we used a computer model and increased CFC levels by 3 per cent per year to the year 2065. By that year, the chlorine and bromine loading of the atmosphere would be 40 times its natural level at about 45 ppb (total chlorine actually peaked in about 1993 just over 3 ppb, see Figure 1). Figure 3 shows globally and annually averaged total ozone levels for these extreme CFC levels (black line). Total ozone would have decreased by two-thirds by 2065. An ozone value of 220 Dobson Units was used to denote the outline of the Antarctic ozone hole. Hence, by about 2040, the ozone hole would have covered the entire Earth resulting in extreme UV values. The lower panel of Figure 3 shows the UV index. By 2065, the UV index would have tripled for the northern mid-latitudes in summer. For light-skinned persons, this would have caused a perceptible sun-burn in about 5 minutes.

The Montreal Protocol has not only been effective in combating ozone depletion, it has also been beneficial for climate change. CFCs and bromine containing halons are very powerful greenhouse gases. The radiative impact of ODS compared to carbon dioxide is measured with the global warming potential (GWP). The GWP is the relative radiative effect of the mass of an ODS compound against the same mass of CO_2. For example, CFC-12 has a GWP of 10,890 for a 100-year time frame. This means that a kilogram of CFC-12 is about 10,890 times more powerful than a kilogram of CO_2. The regulation of ODS by the Montreal Protocol has also provided an enormous climate benefit for the Earth.

In summary, the Montreal Protocol has produced a dual benefit for our atmosphere. Firstly, we have avoided catastrophic ozone loss and the consequent large increases of UV. Secondly, we have reduced greenhouse-gas-forced warming of the Earth. If the nations of the world continue to abide by the Protocol, the ozone layer should return to pre-1980 levels about 2050 in the mid-latitudes and the Antarctic ozone hole should disappear in about 2065.

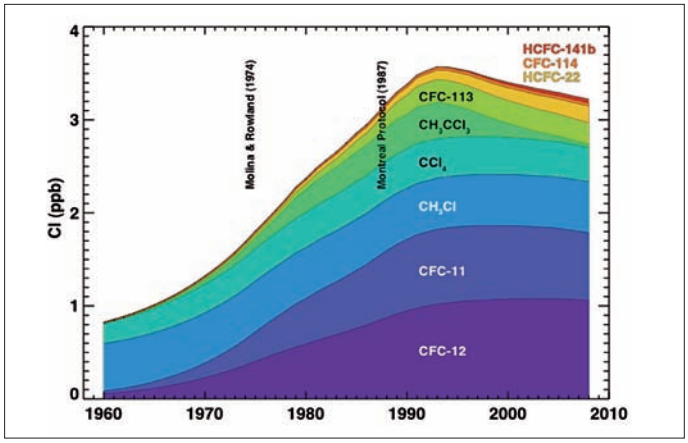

Figure 1. Sand chart of surface total chlorine from 1960 to 2008 for all of the major long-lived species. The individual contributions are shown in the various colours.

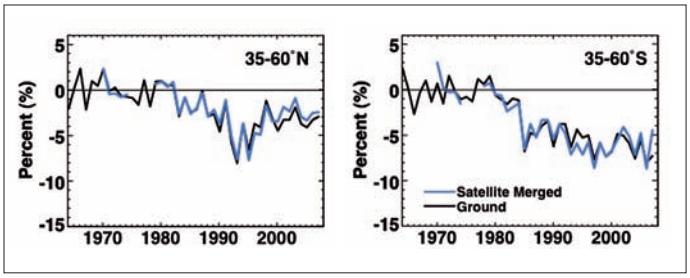

Figure 2. Left: de-seasonalized, annually averaged, area-weighted total ozone deviations from satellite (blue) and ground stations (black) for the (top) northern mid latitudes (35°N to 60°N) and Right: southern mid latitudes (35°S to 60°S). Updated from Fioletov et al. (2002) and WMO (2007).

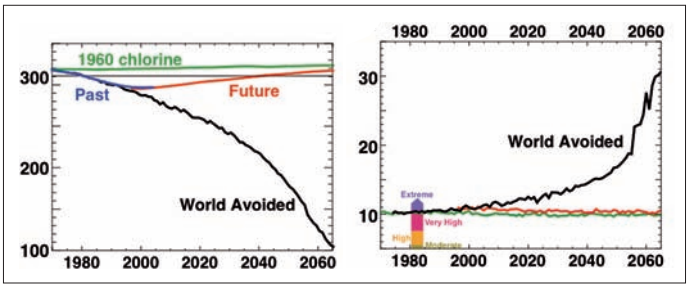

Figure 3. left: Global annual average total ozone versus year for 4 model simulations. The green line shows a simulation with changing greenhouse gases but ODS fixed to 1960 levels. The blue line shows total ozone for the past (observed ODS levels), while the red line shows total ozone for the future (current ODS projections). The black line shows total ozone for a simulation with increases of ODS by 3% per year. Right: UV index for July 2 mid-day conditions in the northern mid-latitudes. The UV index uses the total ozone in the 30-50°N region for the simulations in the top panel. A UV index greater than 10 is considered extreme. Adapted from Newman et al. (2009).

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How Stratospheric Ozone is Measured Around the World

Geir O. Braathen

The Vienna Convention of 1985 on the Protection of the Ozone Layer and its Montreal Protocol of 1987 with subsequent amendments and adjustments have both been successful. The amount of ozone-depleting substances is slowly going down (about 1 per cent per year) after reaching a peak in the late 1990s. Nonetheless, the Antarctic ozone hole of 2006 was the largest on record. This was due to the unusually cold and stable polar vortex in the austral spring of 2006.

This demonstrates that the degree of ozone loss not only depends on the atmospheric burden of ozone depleting halogens but also on the meteorological conditions. It shows the close linkage between ozone depletion and climate change. In order to verify the efficiency of the Montreal Protocol, measurements of the atmospheric burden of ozone depleting substances (ODS) are taken at a number of stations around the globe. It is also necessary to verify that the decrease in ODS results in recovery of the ozone layer, globally and also in the Polar Regions. Several observational networks are in place to measure ozone from the ground and from balloons, and many satellites measure ozone and related chemical species from space.

Measuring total ozone from the ground

The total ozone measurements operated under the umbrella of WMO's Global Atmosphere Watch (GAW) are based on spectrophotometer measurements, using either the sun or the zenith sky as the light source. The Dobson and Brewer spectrophotometer measurements are based on calibrations obtained from so-called Langley plot calibrations, both performed at the Mauna Loa Observatory in Hawaii. The world primary Dobson instrument is operated by the National Oceanic and Atmospheric Administration (NOAA) of the United States, while Environment Canada is responsible for a triad of standard instruments in Toronto, one of which is regularly calibrated by the Langley plot method at the Mauna Loa Observatory at Hawaii. Today, measurements from about 80 Dobson and 50 Brewer instruments are regularly reported to the World Ozone and UV data centre (WOUDC) in Toronto. Figure 1 shows a diagram of how the GAW ozone observing system is organised. Over the last couple of decades a lot of effort has been put into securing the quality of the data and to ensuring that the network provides homogeneous data across the globe. Figure 2 shows how the agreement between different instruments has improved during the last 40 years.

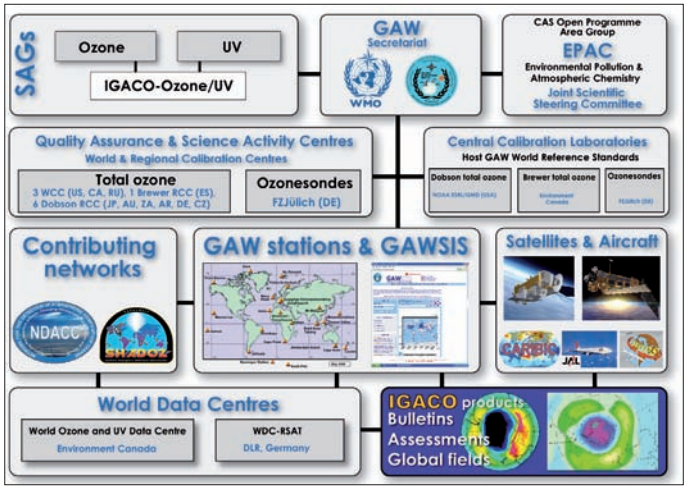

Figure 1. Components of the WMO/GAW ozone global monitoring network, including the contributing NDACC (formerly NDSC) and SHADOZ networks. SAG = Science Advisory Group, RCC= Regional Calibration Centre, WCC = World Calibration Centre.

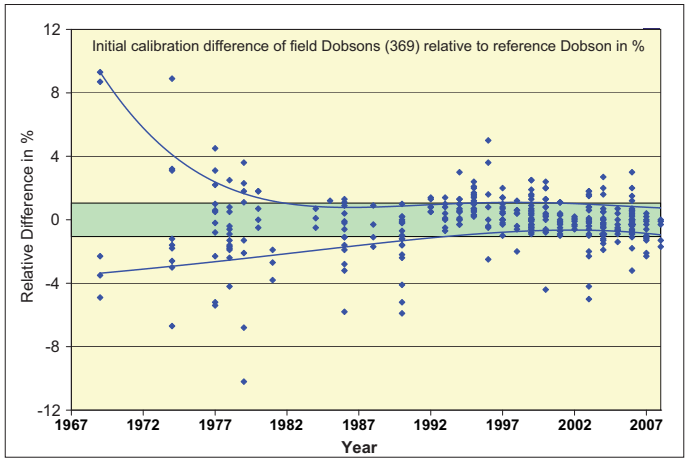

Figure 2. Improvement in data quality of the Dobson spectrophotometer network from 1967 until present. The graph shows the spread among instruments participating at various intercomparison exercises during the last 40 years. The measurements have been taken at the beginning of each intercomparison, i.e. before the participating instruments have been calibrated against the standard instrument. It can be seen that this initial spread has become smaller, especially during the last 20 years.

Profile measurements

Ozone profile measurements with electrochemical sensors carried on small balloons have been performed regularly since the early 1970s. The entire ozonesonde network, combining GAW and the contributing networks SHADOZ (Southern Hemisphere Additional Ozonesondes) and NDACC (Network for the Detection of Atmospheric Composition Change) is shown in Figure 3. Sonde intercomparisons have been carried out several times at the WMO World Calibration Centre for ozonesondes in Jülich, Germany, in order to understand and characterize differences between different makes of sondes and to quantify differences caused by different operating procedures. NDACC and SHADOZ have served to promote additional stations, filling gaps in remote areas that are not otherwise accessed by GAW members. Ozone profiles are also measured with LIDAR (Light Detection and Ranging) instruments. These instruments belong to the NDACC network.

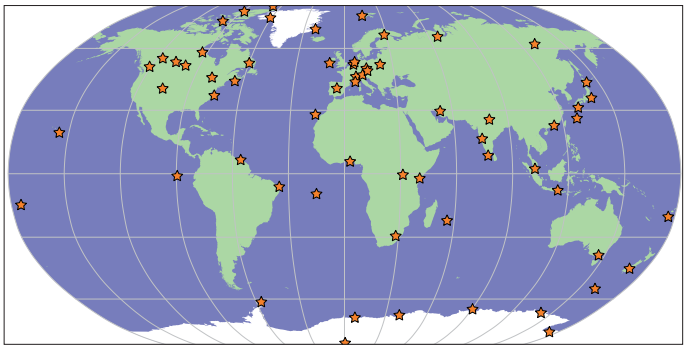

Figure 3. Map of the ozonesonde stations that contribute to the GAW, NDACC and SHADOZ networks.

Measurements from satellites

Satellites give the advantage of a good overview from the regional to the global scale. However, satellite measurements need to be validated against ground based measurements. On the other hand, satellite data are also used to assess the quality of ground-based data. In this way there is a synergy between ground-based networks and satellite observations that benefits both types of measurements. Figure 4 shows a satellite image of active chlorine over Antarctica during the ozone hole season of 2008.

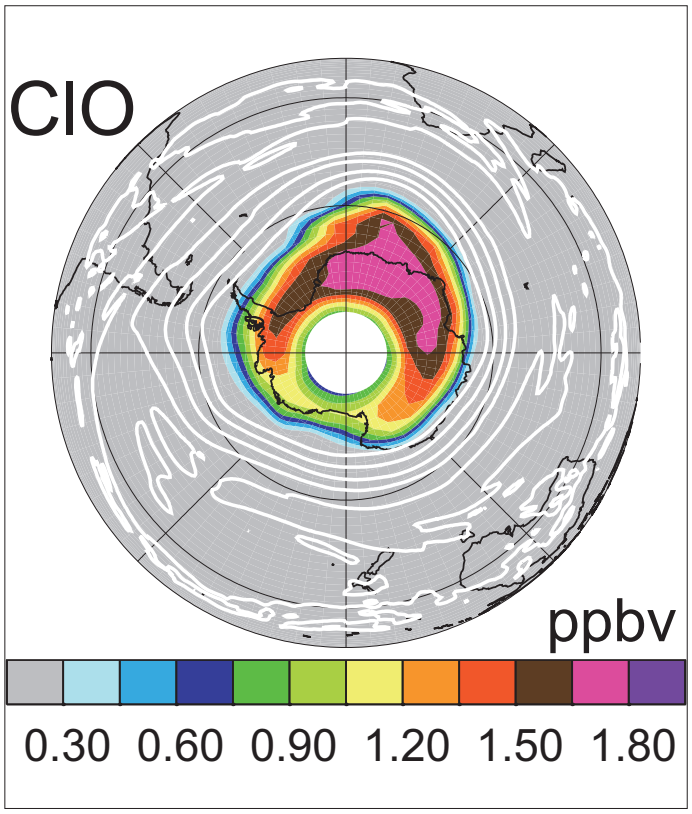

Figure 4. Mixing ratio of ClO, chlorine monoxide on 17 September 2008 at the isentropic level of 490 K (~18 km). The white contours indicate isolines of scaled potential vorticity. The map is made at NASA's Jet Propulsion Laboratory and based on data from the Aura-MLS satellite instrument.

Ozone-depleting substances

Ozone-depleting substances are measured at a number of stations operated by NOAA, the AGAGE (Advanced Global Atmospheric Gases Experiment) network and collaborative sampling stations, such as the SOGE (System for Observations of halogenated Greenhouse gases in Europe) stations in Europe and Asia. Measurements carried out by these networks show directly whether the phase-out of ODS follow the regulations of the Montreal Protocol and they also help to reveal increases in the atmospheric concentration of compounds that might not be covered by the Montreal Protocol. Figure 5 shows the development of the so-called Ozone Depleting Gas Index, a parameter calculated at NOAA in order to show the combined ozone-depleting effect of the ozone-depleting gases.

The Scientific Assessment of Ozone Depletion

Every four years UNEP and WMO collaborate on the production and publication of the "Scientific Assessment of Ozone Depletion". The most recent Assessment was published in 2007 and the next is due early 2011. NOAA also provides invaluable support for these assessments. Several hundred ozone scientists are involved either as authors or reviewers. The Assessment is based on results from peer-reviewed scientific articles. It gives the best available overview of the state of the atmosphere and trends with respect to the ozone layer in all regions of the world as well as the situation regarding ozone-depleting substances. The results are based on observations from the ground, plus those from balloons and aircraft as well as satellites in combination with computer models of the atmosphere.

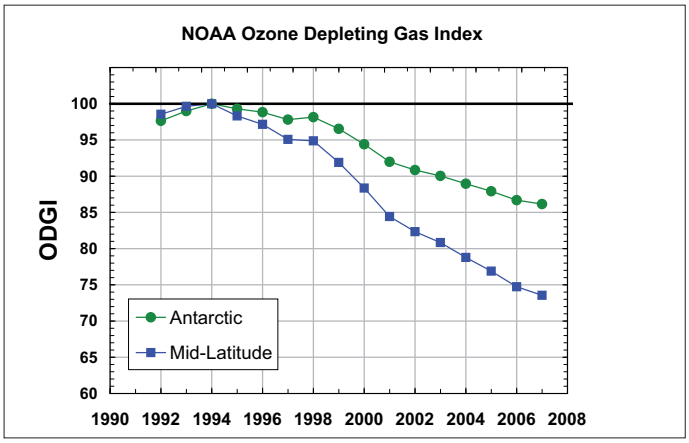

Figure 5. The Ozone Depleting Gas Indices (ODGI) versus time calculated for both Antarctica and mid-latitudes. While the ODGIs represent changes in the troposphere, actual stratospheric changes lag those shown here by 3 years in mid-latitudes and by 6 years above Antarctica, on average. NOAA Earth System Research Laboratory. Stephen A. Montzka, David J. Hofmann

More information

More information on the networks that observe ozone and ozone-depleting gases can be found here:

http://www.woudc.org
http://gaw.empa.ch/gawsis/
http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html
http://www.ndacc.org/
http://agage.eas.gatech.edu/
http://www.esrl.noaa.gov/gmd/hats/
http://www.esrl.noaa.gov/gmd/odgi/

The Scientific Assessment of Ozone Depletion can be found here:
http://www.wmo.int/pages/prog/arep/gaw/ozone_2006/ozone_asst_report.html

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ASHRAE's Comprehensive Approach to Climate Protection

Gordon Holness

With the critical role that fluorocarbons have played in the development of refrigeration, air-conditioning and heating technologies, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has long been engaged in efforts to improve the way these chemicals are used and to limit their impact on the global environment. Additionally, ASHRAE has a storied history in the energy efficiency of buildings, having developed the United States' first standard for the energy efficient design of commercial buildings in the 1970s. The current version of this standard now serves as the U.S. national model energy code.[1]

In recent years, these two areas of expertise have come together as the global community addresses climate change. Energy efficiency reduces the production of greenhouse gases from burning fossil fuels, and efforts to protect the ozone layer have resulted in reduced emissions of substances with high global warming potential. These complementary methods for addressing climate change have led ASHRAE to pursue a comprehensive approach.

As part of this approach, ASHRAE believes that the selection and regulation of refrigerants and the systems utilizing these chemicals should be based on a holistic analysis including consideration of energy efficiency, performance, community and personal safety, economic and societal impacts, and minimization of other environmental impacts – especially global warming potential. ASHRAE has supported the use of both natural refrigerants (including ammonia, carbon dioxide, hydrocarbons and water) and conventional chemicals when appropriate under such an analysis.

Supporting reductions in ODS emissions

In 1989, ASHRAE began development of Guideline 3, "Reducing Emission of Fully Halogenated Chlorofluorocarbon Refrigerants in Refrigeration and Air Conditioning Systems" (now Standard 147). The precursor to Standard 15, "Safety Code for Mechanical Refrigeration", was initially developed in 1930, while another ASHRAE refrigerant-related standard, Standard 34, "Number Designation and Safety Classification of Refrigerants", was initially developed in 1978. Since 1989, periodic updates have reflected changes necessary for new alternative refrigerants.

Since the 1996 ban on CFCs for developed countries, only about 57 per cent of the estimated 85,485 large tonnage CFC chillers in the US and Canada have been replaced or converted to use non-CFC refrigerants. ASHRAE and others in the industry are supporting legislation that would encourage businesses to retire this CFC-based equipment and replace it with more energy efficient equipment. ASHRAE also is involved in the GreenChill Advanced Refrigeration Partnership, a US Environmental Protection Agency (EPA) cooperative alliance with the supermarket industry and other stakeholders. GreenChill promotes the adoption of technologies, strategies, and practices that reduce ODS emissions and greenhouse gases and increase refrigeration system energy efficiency.

Reducing building-related greenhouse gas emissions

In its recent assessment report, the Intergovernmental Panel on Climate Change (IPCC) identified buildings as the sector with the greatest opportunity to mitigate climate change (see Figure 1). ASHRAE continues its efforts to reduce the amount of energy used by buildings and realize some of that potential. The ASHRAE Board of Directors has set a goal of achieving 30 per cent increased efficiency for the commercial building energy standard above the 2004 version by 2010, while working within the existing consensus process. Further efficiency goals have been set to move towards the widespread design and construction of net-zero energy buildings through increased use of renewable sources of energy and greater energy efficiency.

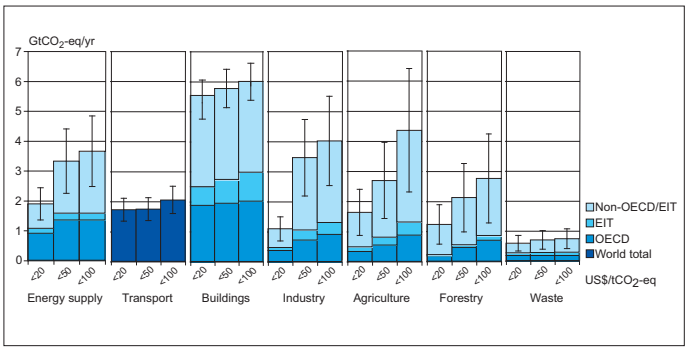

Figure 1: Economic Mitigation Potential by 2030 [2]
Climate Change 2007: Mitigation of Climate Change. Working Group III Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Figure SPM.6. Cambridge University Press.

Around 70 per cent of the buildings projected to exist in 2030 are already built, so to have any impact on energy use and climate change attention must be given to existing buildings. Beyond the replacement of individual mechanical components, an integrated look at the operation and maintenance of buildings is essential. Recognizing this need, ASHRAE has developed a personnel certification programme for Operations and Performance Management and is launching a building energy labelling programme - Building Energy Quotient (bEQ).

The bEQ programme will be a key step in fostering a greater understanding of how buildings perform relative to how they are designed and provide owners and prospective owners with information on energy-saving opportunities.

Through this comprehensive approach to refrigerant management and selection and building energy use, ASHRAE is reducing the impact of buildings on the climate we rely on to live, breathe and raise our families.

Mr. Gordon Holness
P.E., Fellow ASHRAE, Life Member, is the 2009-10 president of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and a consulting engineer, Grosse Pointe Shores Michigan, United States

[1] ANSI/ASHRAE/IESNA Standard 90.1
[2] IPCC Working Group III Contribution to the Summary for Policy Makers; The Fourth Assessment Report (2007).

Maximizing the Climate Benefits from HCFC Phase-out

Suely Carvalho, S. M. Si Ahmed, Rajendra Shende and Steve Gorman

UNDP: An Innovative Approach to Finance

The accelerated phase-out of HCFCs provides a unique opportunity for maximizing both ozone layer and climate benefits. Challenges yet to overcome include the identification of readily available ozone and climate friendly technologies and the required financial resources, as well as the sound management of ODS banks. In response, UNDP is implementing pilot projects to destroy ODS and to validate ozone and climate friendly technologies. These pilot projects tap into various sources of innovative financing, including from the carbon markets.

UNDP stands ready to support countries in identifying, combining and sequencing environmental finance to enable them to deliver significant benefits for both the ozone and climate regimes.

Dr. Suely Carvalho
Chief
Montreal Protocol and Chemicals Unit
Environment and Energy Group
Bureau for Development Policy
United Nations Development Programme

Two Challenges, One Course of Action – UNIDO's Crosscutting Approach to Phasing Out HCFCs

The phase-out of HCFCs is yet another opportunity for the Montreal Protocol programme to venture deliberately into the realm of climate change prevention under the UNFCCC. Undoubtedly, innovative mechanisms combining the goals of the Montreal and Kyoto Protocols will arise from this challenge. There are many viable options for replacing HCFCs but, as it has always done, UNIDO will replace HCFCs with substances with zero ODP and negligible GWP, and will assist Article 5 countries to adopt energy-efficient technologies to further reduce greenhouse gas emissions. UNIDO leads in promoting liquid carbon dioxide blowing technology for flexible polyurethane foam and hydrocarbons technologies in refrigeration.

Mr. S. M. Si Ahmed
Director
Montreal Protocol Branch
United Nations Industrial Development Organization

Standing at a Defining Moment of the Montreal Protocol

On 1 January 2010 the world will wake up to a new reality – one in which production and consumption of CFCs and halons will be assigned to our history books. This is a momentous achievement, but there are still formidable challenges ahead – not least of which is to phase out HCFCs. The HCFC challenge is also an opportunity because it not only benefits the ozone layer but also reduces climate change. Moreover, the energy efficient technologies with low-or non-GWP alternatives will add economic advantage. OzonAction is dedicated to promoting these 'triple gains' through its capacity building and technology support programme. The new business opportunities that will arise in pursuit of HCFC phase-out will contribute to the Green Economy. Indeed this is a good road-sign for those travelling to Copenhagen.

Mr. Rajendra Shende
Head
OzonAction
Division of Technology Industry and Economics
United Nations Environment Programme

Montreal Protocol Operations at the World Bank: Beyond 2010

Article 5 countries that have partnered with the World Bank over the last decade to phase out CFCs, halons, and CTC have made great strides in fulfilling Montreal Protocol obligations. Although such countries have carried out important groundwork, HCFCs will be a greater challenge due to their volume as compared to their ODP, limited proven alternative technologies, the unavoidable upgrade of technology in conversion, and a long phase-out period. The Bank believes that a programmatic approach can turn these challenges to opportunities by allowing countries to take advantage of the environmental and economic co-benefits of HCFC phase-out – in line with Decision XIX/6. Through the concurrent pursuit of energy-efficient and low-GWP alternative technologies with HCFC phase-out, countries will reduce costs to their industry in the long-term while facilitating co-financing and policy-making.

Mr. Steve Gorman
GEF Executive Coordinator and Team Leader
Montreal Protocol/POPs Unit Environment Department
The World Bank

Multilateral Fund for the Implementation of the Montreal Protocol: Empowering Developing Countries to Phase Out HCFCs

Maria Nolan

The freeze on HCFC consumption and production in 2013 and the 10 per cent reduction in 2015 not only represent key objectives towards restoring the ozone layer but, with the right replacement technologies, will also yield significant climate benefits. As never before, the Multilateral Fund (MLF) will be under pressure to empower developing countries to face this dual challenge. Developed and developing country members of the MLF's Executive Committee are working together to provide the technical, policy and financial assistance needed to achieve timely and measurable HCFC reductions in developing countries and buy the world time in the race to mitigate climate change.

Ms. Maria Nolan
Chief Officer
Multilateral Fund Secretariat

ExCom Meeting Delegates, MLF

Ozone Secretariat: Why We Cannot Rest on Our Laurels

Marco Gonzalez

While the history of the Montreal Protocol is replete with examples of successful international cooperation, the year 2010 will mark the culmination of a particularly significant achievement.

Beginning 1 January 2010, widespread use of the most significant ozone-depleting substances – namely, CFCs, halons and carbon tetrachloride – will be completely phased out. Their use will be limited to the less than 1 per cent of cases where the Parties have agreed there are not yet good, cost effective alternatives.

The flag of the United Nations

But challenges remain; for example more ozone-depleting substances still require to be addressed. Further, the Parties to the Montreal Protocol are very cognizant of the fact that some ozone-depleting substances, namely HCFCs, are being replaced by alternatives that include HFCs, which are potent global warming chemicals. Indeed, the ozone–climate protection nexus is quickly becoming a primary challenge in the implementation of the Montreal Protocol.

In 2007, the Parties to the Protocol committed to phase out HCFCs with substitutes that minimized global warming impacts. Let us pledge to continue progress in the phase-out of those harmful chemicals and do our utmost to provide for significant climate change protection while safeguarding the precious ozone layer.

Mr. Marco Gonzalez
Executive Secretary
UNEP Ozone Secretariat

The Montreal Protocol: The First Global Environmental Agreement to Achieve Universal Ratification

A treaty to protect the ozone layer, which shields all life on Earth from deadly levels of ultra violet rays, has scored a first in the history of international environmental agreements.

Today Mr. Xanana Gusmão, the Prime Minister of the young Pacific nation of Timor-Leste, announced that it had ratified the Montreal Protocol making this the first environmental agreement to achieve universal participation by 196 parties.

"Timor-Leste is very pleased to be joining the rest of the world in the fight against the depletion of the ozone layer and the effort towards its recovery. We are proud to be part of this important process to protect the ozone layer and undertake to implement and comply with the Montreal Protocol like all other States that preceded us in this important journey, "Mr. Gusmão said.

The historic announcement, made on the UN's International Day for the Preservation of the Ozone Layer, is the latest in a rapidly evolving list of achievements for the ozone treaties.

The Montreal Protocol, established to phase-out the pollutants that were damaging the planet's protective shield, will in just three months' time have completely retired close to 100 chemicals linked with ozone damage.

Today, as the sun rises in Australasia swiftly onto Timor-Leste before setting on Hawaii, United States – one of the first nations to ratify – countries will be marking not only the recovery of the ozone layer. They will also be celebrating the unique contribution that the Montreal Protocol has, and is continuing to contribute, to combating other key challenges including climate change.

Achim Steiner, UN Under-Secretary General and Executive Director of the UN Environment Programme (UNEP), said:"The ratification by Timor-Leste makes this special day even more special and a signal that when the world fully and wholly unites around an environmental challenge there can be multiple and transformative effects". "Without the Montreal Protocol and its Vienna Convention, atmospheric levels of ozone-depleting substances would have increased tenfold by 2050 which in turn could have led to up to 20 million more cases of skin cancer and 130 million more cases of eye cataracts, not to speak of damage to human immune systems, wildlife and agriculture," he added.

"Today we in addition know that some of the same gases contribute to climate change. By some estimates, the phase-out of ozone-depleting substances has since 1990 contributed a delay in global warming of some seven to 12 years underlining that a dollar spent on ozone has paid handsomely across other environmental challenges," said Mr Steiner.

Marco González, Executive Secretary of the Ozone Secretariat which is hosted by UNEP, said the focus was now switching from the original gases such as chloroflurocarbons (CFCs) to their replacement gases known as HCFCs and HFCs for uses in refrigerators, foams and flame retardants.

In 2007 governments agreed to accelerate the freeze and phase-out hydrochloflurocarbons or HCFCs – explicitly for their climate change impacts.

The maximum benefits here are only likely to occur if this goes hand in hand with the introduction of more energy efficient equipment that can work with substances that have low or zero global warming potential.

The focus is now also rapidly shifting to hydroflurocarbons (HFCs). This year scientists, reporting in the Proceedings of the National Academy of Sciences, suggested that if these became the replacement substances of choice, the climate impacts could be serious.

The scientists argue that HFC use could climb sharply in the coming years in products such as insulation foams air conditioning units and refrigeration as replacements.

Conversely, rapid action to freeze and to cut emissions annually alongside fostering readily available alternatives could see HFC emissions fall to under one Gigatonne by 2050.

"Importantly, governments last year requested the Executive Secretaries of the Montreal Protocol and the UN Framework Convention on Climate Change to cooperate more closely on these issues and this was taken forward in 2009 in the spirit of One UN," said Mr González.

In November in Port Ghalib, Egypt, governments will meet under the Montreal Protocol to chart the future directions for the treaty including its role in combating climate change.

Mr González emphasized that "this historic meeting, hosted by the Government of Egypt, will be the first to bring together the highest number ever of participating States for decision-making under an international treaty."

These discussions will come just days before the key climate meeting in Copenhagen where nations are being urged to Seal the Deal on significant emissions reductions backed by support for adaptation for vulnerable countries and communities.

The story of the ozone layer also underlines that sustainably managing the environment is less costly and time-consuming than repairing damage once it has been done. Even with the swift and decisive action taken by governments under the Montreal Protocol, the Earth's protective shield is likely to take another 40 years to 50 years to fully recover.

Ozone Secretariat, Press Release, on the International Day for the Preservation of the Ozone Layer,
16 September 2009

The Montreal Protocol HCFC Challenge: Opportunity for Another Success

Stephen O. Andersen and K. Madhava Sarma

The historic agreement under the Montreal Protocol in 2007 to accelerate the phase-out of hydrochlorofluorocarbons (HCFCs) marked the first time both developed and developing countries explicitly agreed to accept binding and enforceable commitments to address climate change. The 2007 decisions on recovery and destruction of ODS banks will also contribute to both better protection of the ozone layer and mitigation of climate change.

Accelerating the HCFC phase-out could reduce greenhouse gas (GHG) emissions by 16 billion tonnes of carbon dioxide-equivalent ($GtCO_2e$) through 2040. This climate benefit is possible because, in addition to depleting the ozone layer, HCFCs are also potent GHGs.

HCFCs are used in a variety of applications, including refrigerators and air conditioners, as foam blowing agents, and as chemical solvents. The actual climate benefits of HCFC phase-out will depend on two key factors: the success of replacing HCFCs with zero and low global warming potential (GWP) substitutes and/or prevention of future emissions of these substitutes. The latter can be achieved by provision of robust systems to ensure near-zero emissions and to recover and recycle or destroy used chemicals during service and at equipment end-of-life.

The beauty of an ocean view under a healing ozone layer

Parties could promote faster adoption of low-GWP alternatives to HCFCs by fully financing ozone, climate, and health benefits through the Multilateral Fund and by applying the Montreal Protocol principles to hydrofluorocarbons (HFCs). At present, the plan is that the climate benefits of HFC phase-down should be paid for by the various financial mechanisms of the UNFCCC and Kyoto Protocol or from the voluntary carbon markets and other innovative schemes. Any such funds could pass through the highly effective Multilateral Fund (MLF) to improve effectiveness and avoid redundancies. The demand for HFCs is now intensified with the accelerated phase-out of HCFCs. The success of the Montreal Protocol can be attributed to many of its key principles and these can also be harnessed to encourage countries to control HFCs.

These key principles include the following:

- Adjustment procedures for chemicals already regulated that allow the Parties to adjust control measures by consensus at a Meeting of the Parties (MOP) without having to be ratified by each Government again. These adjustments would take effect in six months after approval by a MOP;
- A dedicated multilateral funding mechanism (MLF) with a democratic decision-making procedure for financing low-GWP/superior Life Cycle Climate Performance (LCCP) options;
- Assured periodical replenishment of the Fund;
- A written indicative list of incremental costs that will be met by the MLF;
- An expanded remit for Country Focal Points and Networks of such focal points plus awareness, education, information, and training programmes;
- Assessment of alternatives and substitutes by the TEAP and its Technical Options Committees, expanded to assess and to report environmental performance – such as LCCP, health and safety;
- A facilitating non-compliance procedure established to emphasize assistance to the Parties and punitive action only in case of willful non-compliance.

These principles would give great incentive to the adoption of low-GWP alternatives to high-GWP HFCs, as they did for the adoption of alternatives to ODS.

Parties, Companies, and Consumers would protect the ozone layer as well as climate more effectively if they did the following:

- Used LCCP as the metric for selecting alternatives to satisfy safety and health criteria.
- Favoured not-in-kind, natural chemicals, and low-GWP HFCs with near-zero emissions.
- Allowed continued HCFC/HFC use only where environmentally superior feasible alternatives are not yet available.
- Demanded near-zero emission, recovery and recycle in service and end-of-life, and ozone and climate offsets through destruction of banked, unusable ODS/HFC to make any continued essential use of ODS and HFCs ozone and climate neutral.

This article conveys the author's perspective and does not necessarily reflect the views of the Technology and Economics Assessment Panel.

Dr. Stephen O. Andersen
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Senior Expert Member

Collecting and Destroying Ozone-Depleting Greenhouse Gases: Lessons From the Military

Anton L. C. Janssen and Robert S. Thien

It is no wonder that Parties to the Montreal Protocol are working to quickly collect and destroy ozone-depleting greenhouse gases. The Technology and Economic Assessment Panel (TEAP) estimates that end-of-life measures across all sectors could recover approximately 300,000 ozone-depleting potential (ODP) metric tonnes of chemicals that have climate forcing of approximately 6 billion tonnes of CO_2-equivalent (CO_2-eq.).

Halon stock facilities, Halon Bank Association, NL

The most accessible portion amounts to almost 200 thousand tonnes of CFCs (equivalent to approximately 2 billion tonnes of CO_2) and almost 500 thousand tonnes of HCFCs (equivalent to approximately 770 million tonnes of CO_2). The combined CO_2-eq. of ozone-depleting refrigerants and foam-blowing agents contained in products and equipment is equal to three years of global Kyoto targets. Action is needed now because ozone-depleting substances (ODS) that leak cannot be recovered from the atmosphere. The TEAP estimates that, without immediate action, by 2015 approximately 90 per cent of the CFCs and 50 per cent of the HCFCs in "reachable" refrigeration and air conditioning products in non-Article 5 Parties, and over 75 per cent in Article 5 (A5) Parties, will have been emitted.

When the Montreal Protocol was signed, military organizations depended on ODS for virtually every aspect of their operations and nearly every weapon system. The challenge of phasing out ODS was daunting, but military bodies around the world have established phase-out programmes for all but mission-critical uses where proven alternatives are not yet available. For these few critical uses, they have perfected ODS banking and destruction of surplus or unusable ODS.

When Parties to the Montreal Protocol collect and destroy ODS, there is a wealth of information available from civilian and military experts to maximize environmental benefits and minimize costs. In 2008, military organizations from the Netherlands, Australia, and the United States offered to support collection and destruction with information sharing and consulting on logistics. The goal is an on-line library of best practices, laboratory techniques, and business strategies, with direct links to companies offering equipment and services for collection and destruction of surplus military ODS. The Ozone Secretariat will act as coordinator with the Basel Convention Secretariat and other conventions to ensure the transport of surplus ODS to countries with authorized critical uses or destruction facilities is correctly permitted.

Military organizations worldwide are cooperating to achieve greater success in ODS management. UNEP Workshops, such as the Sub-Regional Workshop on ODS Phase-out in Military Applications held in Colombo in April 2009, have helped military leaders from developing and developed countries meet to discuss best practices and lessons learnt. One of the key lessons is that military bodies worldwide need to select alternatives to ODS that have low global warming impacts. Military experience in managing, collecting and destroying ozone-depleting greenhouse gases will be a useful model in managing non-CO_2 greenhouse gases.

ODS being repackaged with transfer pump

The comprehensive way forward for collection and destruction of ozone-depleting greenhouse gases will:

- Create incentives to prevent intentional discharge of ODS. Regulations that require owners to pay for destruction can be counterproductive. The more successful approach may be to duplicate and integrate with military lines of command that are pre-eminently structured for including collecting and destroying ODS as part of their logistics management.

- Include ODS banking programmes, in particular halon banking by military organizations or civil/military cooperation, can be managed in a cost- effective manner on a non-profit/non-loss basis for approximately US$ 2/kg. These banking programmes can be a useful model for collection of ODS for redeployment and eventual destruction.

- Facilitate collection and eventual destruction of inventories of ODS regulated in the UN International Maritime Organization Convention on Ship Recycling or regional oriented agreements such as for aircraft recycling, including the military.

- Stretch budgets by accumulating ODS in regional storage facilities until a full shipment can be justified. Ask military and civilian logistical experts to serve as volunteer consultants to national and regional authorities and the Multilateral Fund and its implementing agencies. In some cases, military-ministry partnerships may be able to work with enterprises seeking to properly collect and redeploy or destroy surplus/excess ODS. In some cases it may be more cost effective to bring mobile destruction equipment to the chemicals rather than shipping chemicals to a stationary destruction facility.

- Motivate military organizations to work with public and private carbon trading experts to examine possibilities to reward greenhouse gas destruction based on effective accounting frameworks.

Ing. Anton L.C. Janssen
Netherlands Ministry of Defence

Mr. Robert S. Thien
ODS Program Manager
United States Department of Defense

Next Generation Technology in Mobile Air Conditioning

Stella Papasavva and Kristen Taddonio

When the Montreal Protocol was signed in 1987, there was an urgent need to implement ODS replacements in all sectors, including mobile air conditioning (MAC). HFC-134a was a quickly available alternative to CFC-12, with zero ozone-depletion potential (ODP), 80 per cent lower global warming potential (GWP), low toxicity, and no flammability. Under the Montreal Protocol, the automotive community globally transitioned from CFC-12 to HFC-134a between 1990 and 1994 while significantly reducing refrigerant emissions, increasing fuel efficiency, and improving system reliability. However, HFC-134a is a potent greenhouse gas (GWP = 1,430), and emissions from MAC are growing unsustainably. The Intergovernmental Panel on Climate Change (IPCC) estimates that by 2015, annual refrigerant emissions from MACs will be equal to 250 million metric tonnes of CO_2-eq. Growth of developing economies will make HFC emissions even higher. A second transition under the Montreal Protocol from HFC-134a to a low-GWP refrigerant could be part of the fast-start strategy to avoid the catastrophic human and ecological consequences of climate tipping points. It can also buy time for the climate while the long-term strategy under the new Copenhagen Protocol takes effect.

In response to concerns about the global warming impacts, the European F-Gas Directive will phase out HFC-134a from new cars sold in the EU by 2017. Pending US regulations have incentives that may phase out HFC-134a even faster. Industry is striving to transform all global markets to a single new refrigerant in order to simplify global marketing. Four refrigerants were considered as replacements for the HFC-134a in MAC:

- Hydrocarbons (HC, GWP=5, low toxicity, highly flammable),
- HFC-152a (GWP=122, low toxicity, moderately flammable),
- HFC-1234yf (also called HFO-1234yf, GWP=4, low toxicity, slightly flammable),
- Carbon dioxide (R744, GWP=1, high acute toxicity, non-flammable).

Greenpeace and some German stakeholders prefer natural refrigerant R744, but automakers outside Germany favour HFC-1234yf for its lower system cost, higher reliability, and superior energy efficiency in hot and humid climates where air conditioning is in high demand.

Fuel consumed to operate MAC systems results in indirect greenhouse gas (GHG) emissions in addition to direct refrigerant GHG emissions. Thus, the environmentally superior choice is a refrigerant that has both a low GWP and equal or better energy efficiency than HFC-134a.

To guide the selection of the best MAC alternative, environmental and industry experts developed the GREEN-MAC-LCCP© model to compare refrigerants' life-cycle climate performance (LCCP). LCCP is the most comprehensive life-cycle analytical technique for identifying environmentally superior technology to minimize GHG emissions from refrigeration and air-conditioning applications. It quantifies every aspect of GHG emissions, including direct refrigerant emissions at new system charge, service, accident, and disposal; indirect fuel combustion emissions from air conditioners and vehicle transport; and manufacturing emissions for chemicals and materials used in new systems and parts replacement. This model was initially developed at General Motors in the early 2000s, and it was later perfected by an industry-government partnership. It is now an SAE International Standard and is a completely transparent model. A copy of the model is available on-line at: www.epa.gov/cppd/mac.

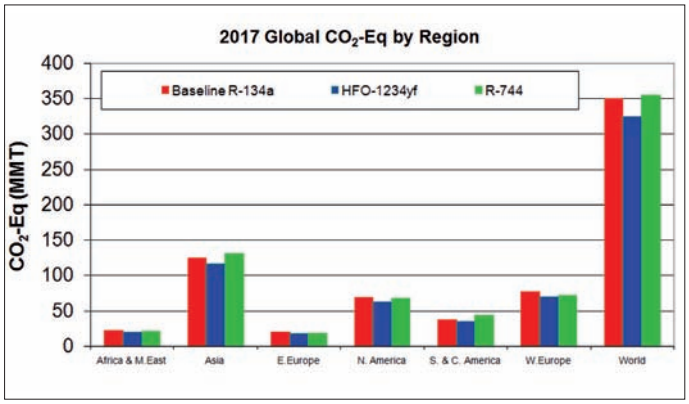


Figure 1. Comparison of LCCP CO_2-eq Emissions of Alternative Refrigerants in 2017 in Various World Regions
The results assume the use of R134a for vehicles in the fleet prior to 2011 and that all new vehicles produced after 2011 have the new refrigerant

The model estimates the LCCP CO_2-eq emissions of the proposed alternative refrigerants.

The model shows that all competing alternatives can be optimized to achieve improved LCCP, but that HFC-1234yf has the best climate performance. HFC-1234yf is a relatively easy alternative to implement in both developed and developing countries because HFC-1234yf systems use similar components and operate at pressures, cooling capacity, and energy efficiency comparable to HFC-134a. HFC-1234yf is already registered by the regulation on Registration, Evaluation, Authorization and Restriction of Chemical substances (REACH-EU) and is pending listing under the Significant New Alternatives Program (SNAP -US).

The authors of GREEN-MAC-LCCP© have offered to adapt the model for appliances, stationary air conditioning and other applications. LCCP modelling can be the basis for picking refrigerant and system technology and can validate project-level carbon payments.

This article conveys the author's perspective and does not necessarily reflect the views of the US EPA.

Dr. Stella Papasavva
GREEN-MAC-LCCP© Chair and
Senior Advisor on Life-Cycle Analysis

Ms. Kristen Taddonio
Manager
US EPA Mobile Air Conditioning Climate Protection Partnership

Remembering the Montreal Protocol beyond 2010…

Rajendra Shende

Beyond 2010, what will be the major triumphs for which the Montreal Protocol is remembered?

The remarkable fact that production and consumption of millions of tonnes of man-made ozone depleting chemicals, which humanity once relied on, was eliminated will without a doubt stand in our memory as its greatest achievement.

Future generations will surely recall the unparalleled tale of determination grit and vigour with which the world community decided to accelerate the phase-out of the remaining ozone depleting chemicals namely HCFCs.

The annals of the history will certainly echo with the message of optimism emanating from the Montreal Protocol on what can be achieved globally when world leaders embrace pragmatism in accepting common but differentiated responsibilities and translating this into action.

That those who acknowledged their responsibility for damaging the ozone layer and thereafter provided funding and technological innovation to address this crisis will indeed be commemorated for years to come.

But is that all?

For me, the Montreal Protocol will be most treasured for reasons entirely unrelated to the ozone layer and ozone depleting substances.

Firstly, the Montreal Protocol has shown that 'multilateralism' can work, and work well, in a sustained manner. Multilateralism was the innovation of the 20th century that arrived along with establishment of the United Nations. The UN's multiparty platform is deployed to resolve and prevent political, social and economic conflicts – with mixed success. The work under the Montreal Protocol, in my view, outshines all past efforts of multilateralism. It is the first treaty that institutionalised democratic mechanisms for achieving environmental benefits in a 'multiparty 'system.

It will also be remembered as the first treaty that has demonstrated that a single focused global environmental accord can deliver a multitude of unintended benefits. The new refrigerators and air conditioning equipment manufactured without CFCs were much more energy efficient compared to those made before 1987. Many of the alternative technologies developed in other areas created 'not-in kind' replacements which entirely avoided the use of any chemicals whatsoever. Implementation of the Montreal Protocol also promoted industrial rationalisation and better efficiency in many countries.

In retrospect, the Protocol will retain its place in history as the instrument which developed, strengthened and nurtured the global, regional and national infrastructure used to implement global accords. The established and practiced mechanisms under the Montreal Protocol such as: democratic decision-making at global level; best practices in capacity building through south-south cooperation and networking at the regional level; and workable mechanisms of technology transfer and policy enforcement could present a 'blueprint' and encouraging example to achieve the goals needed to implement other global accords.

But the best part of the history, yet to be fully written, is that the Montreal Protocol has given us a first glimpse of the 'Green Economy'.

Landscape, India

Back in 1987, a whole suite of new green business emerged embracing ozone-friendly practices in recovery and recycling, and in designing energy efficient appliances. This innovation has continued and green business dealing with the storage, transport and destruction of ozone depleting chemicals will now flourish. Refrigeration and air-conditioning equipment now uses considerably less chemical to achieve the same results as a consequence of better energy and material efficiency – demonstrating the benefits of this 'Green Economy'.

When I travel from mission to mission, from Argentina to Afghanistan, from Bhutan to Bangladesh and from Mexico to Micronesia to provide policy support to these countries, I have come to realise that the Montreal Protocol is about more than simply ozone layer recovery. It is about inter-generational equity. It is about leaving the ozone layer in the same state for our children as we got from our parents.

Mr. Rajendra Shende
Head
OzonAction
Division of Technology, Industry and Economics
United Nations Environment Programme

Memorable Ozone Quotes

" In the last two decades, thanks to an exemplary collaboration in the international community among politics, science and economics, important results have been obtained with positive results for current and future generations. On behalf of all, I hope that this cooperation is intensified so that the common good, development and the safeguarding of creation is promoted, strengthening the alliance between man and the environment."

Pope Benedict XVI. Pope presses environment campaign, urging greater cooperation to fight ozone-depletion. The Associated Press, Castel Gandolfo, Italy, 16 September 2007.

"...let us strengthen our commitment to be in full compliance with the environment treaties and let us hope that the enormous gains that have been made under these agreements are protected. Especially the Montreal Protocol will inspire our collective responsibilities for the conservation of the global environment and life on planet earth."

Major General GA Chandrasiri, Chief of Staff, Sri Lanka Army. Sub-Regional Workshop on ODS Phase-out in Military Applications, Colombo, Sri Lanka, 16 April 2009.

"Preservation of the ozone layer is critical to life on Earth. The Montreal Protocol has led to a dramatic reduction in the production and use of ozone-depleting chemicals, and scientists report that the ozone layer is on its way to recovery. ...It also is critical that the United States support efforts by developing countries to phase out their use of ozone-depleting chemicals."

Bill Clinton, Former President of the United States of America. Statement by the President. The White House, Office of the Press Secretary, 16 September 1999.

"...let us remember that for the preservation of the ozone layer, every year will be a new anniversary of environmental action. Let us be sure that they are causes for celebration and renewal commitment. Ozone projection is not yesterday's problem. It is today's and tomorrow's. For the well-being of future generations the price we pay today is indeed a small price to pay."

Elizabeth Dowdeswell, Former UNEP Executive Director. Ninth Meeting of the Parties, Montreal, Canada, 15 September 1997.

«The road to Copenhagen is not easy. But we have traversed this ground before. We negotiated the Montreal Protocol more than 20 years ago, to protect the ozone layer, and then strengthened it to the point where we've now banned most of the major substances that created the ozone hole over Antarctica. And that is now healing. And we did it with bipartisan support. President Ronald Reagan and Speaker of House Tip O'Neill joined hands to lead the way.»

Al Gore, Former Vice President of the USA. Al Gore Sees the Road to Copenhagen. UN Dispatch, Post on the UN, 28 January 2009.

"Only two years later after the Montreal Protocol was concluded, our country joined the caravan with the support of its rich culture, history and religious belief. To sustain our survival and to create a harmonized and peaceful biosphere for the human community we will have no choice but to understand and to make the best of nature's laws to prevent our further destructive activities and to protect and improve the quality of our environment and its resources. For that, we need active cooperation and incisive involvement of all governments and nations."

Fatemeh Vaez Javadi, Vice President and Head of the Department of Environment, Iran. Ozone Action in Iran, Issue No. 1, Spring 2008.

"Success was huge. The Montreal Protocol was the first multilateral environmental agreement to keep developing nations and industrialized nations within the same treaty by providing different targets for each group."

Elizabeth May, Leader of the Green Party, Canada. The Montreal Protocol. Green Party of Canada, 16 September 2007.

"Now, on the eve of the 20th anniversary of the Montreal Protocol and the 10th anniversary of the Kyoto Protocol, the world recognizes the important linkages between ozone depletion and climate change, but also the fact that the refrigeration industry is the heart of both phenomena. "

Sylvie Lemmet, Director, UNEP Division of Technology, Industry and Economics. Newsletter, Institut International du Froid, No. 31, 2007.

"It is a well known fact that exposure to high levels of ultraviolet radiation can have deleterious effects on a population's health, including increased incidences of skin cancers and cataracts. It is therefore important that countries engage in activities which are ozone friendly to ensure the preservation of the ozone layer."

Hon. Dean Peart, M.P. Minister of Land and Environment. Message of Hon. Minister, Jamaica, International Ozone Day September 2005.

«The ozone layer is slowly being replenished as a direct result of the Montreal Protocol. The Protocol also shows we can find man-made solutions to man-made problems - if we have the political will to take global measures, backed up with action and commitment by nations, individuals and industry.»

John Prescott MP, Former Deputy Prime Minister and First Secretary of State, UK. Natural resources and sustainable development: new responsibilities for businesses and governments. Economic Forum of the Americas, Montreal, June 2006.

"Thanks to the Montreal Protocol on Substances that Deplete the Ozone Layer, we already have an encouraging example showing how global solutions can be found when all countries make determined efforts to implement internationally agreed protocols on global environmental problems. ...We strongly advocate a similar solution for the other global environment problems which lead to global warming and climate change as well."

Hon. Patali Champika Ranawaka, Minister of Environment and Natural Resources of Sri Lanka. Inauguration ceremony at the Sub-Regional Workshop on ODS Phase-out in Military Applications, Colombo, Sri Lanka, 16 April 2009.

"... The Montreal Protocol is a wonderful example how it is possible to seek an alliance between the latest scientific research on the state of the ozone layer and a policy making, taking into an account the social and economic impact on production and consumption sectors in developed and developing countries. This kind of co-operation resulted in stabilizing the ozone hole and in starting of its recovery. The Montreal Protocol with its enforcement, implementation and financial mechanisms could serve as an inspiration for the other global environmental conventions and protocols."

H.E. Mr Václav Klaus, President of the Czech Republic. Extract from his message at the 16th Meeting of the Parties, Prague, Czech Republic, November, 2004.

"It is our hope that the Vienna Convention and the Montreal Protocol will be of concern not only to Northern-hemisphere nations but also to those of the South, and that the latter will embrace these measures and act as full participants in the search for solutions to the economic, social and ecological consequences of ozone layer depletion."

His Excellency Abdoulaye Wade, President of Senegal. OzonAction Newsletter No. 51, December 2005.

"As for what lies beyond 2012, all governments will work together over the next few years to decide on future intergovernmental action on climate change. In this light, it is vital that stakeholders in government, industry and other arenas continue to work together to enlarge the replacement options for ozone-depleting substances in ways that serve the aims of the Montreal Protocol and UNFCCC alike."

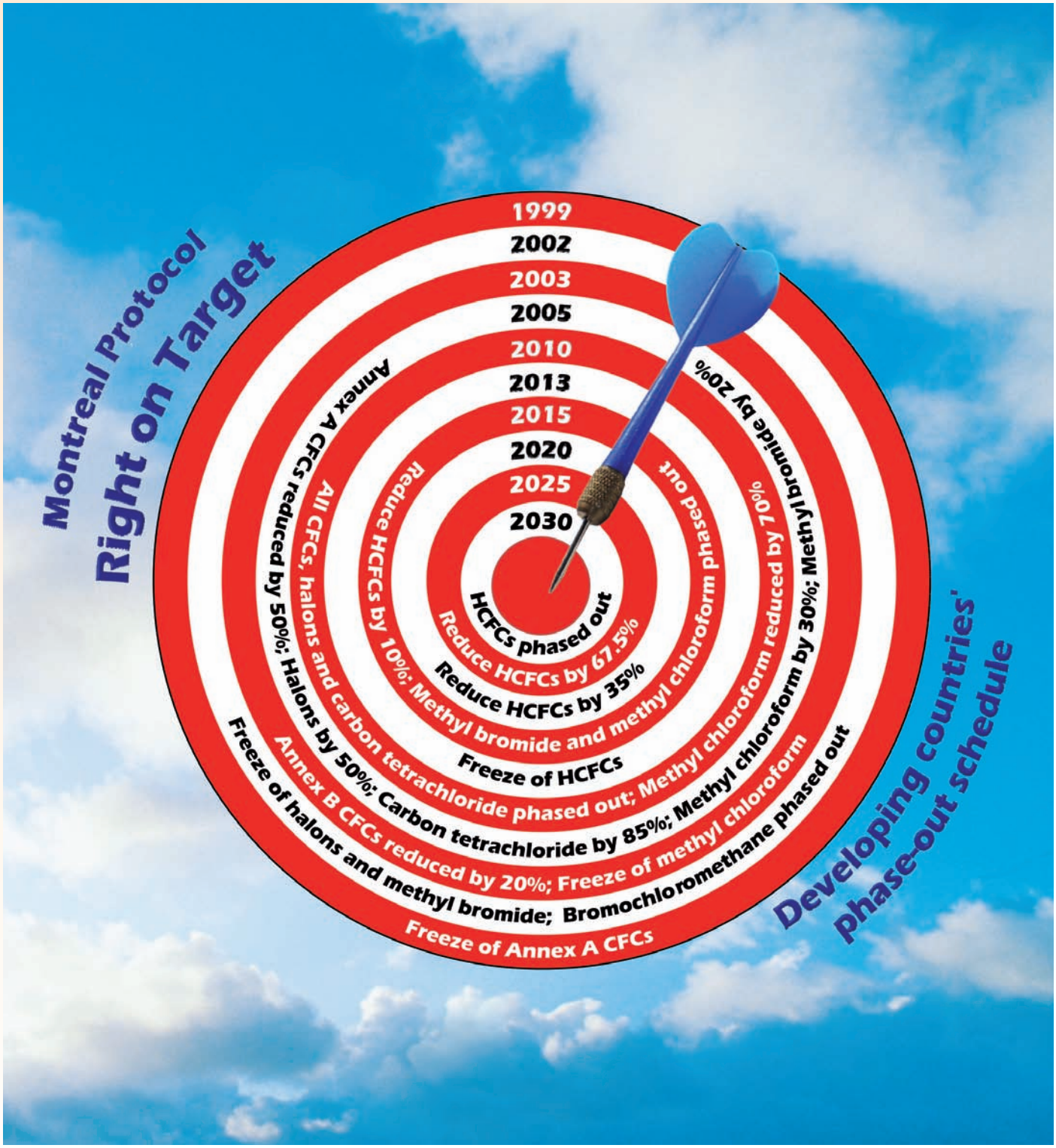
Joke Waller-Hunter (1946-2005), Executive Secretary, United Nations Framework Convention on Climate Change (UNFCCC), in her viewpoint in the 50th issue of the OzonAction Newsletter, September 2005.

"It's important that people are aware of the little things you can do to protect our world, are aware (of ozone) and know what's going on, especially because unlike garbage and other types of pollution, you can't see the ozone layer."

Tata Young, (Thai-American pop star). More than just hot air. The Straits Times, 4 June 2009. Photo by Nirmal Ghosh.

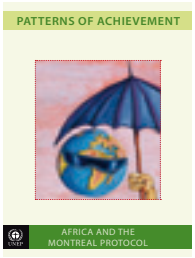
Ozone quotes are available from UNEP DTIE OzonAction website at www.unep.fr/ozonaction/information/quotes/index.asp

Right on Target



On the occasion of the 2009 International Day for the Preservation of the Ozone Layer, the UNEP DTIE OzonAction Programme has produced an animated Computer screen saver on developing countries' phase-out schedule. **"Right on Target"** is a screen saver for PCs using Microsoft Windows™ – available in various languages versions - that you can download from OzonAction website at http://www.unep.fr/ozonaction/information/screensaver/

Publications



Patterns of Achievement Africa and the Montreal Protocol

The African Montreal Protocol experience is not just one success story but several successful cases, wich are highlighted in this publication, each with its specific theme contributing to the wider picture of the success of the Montreal Protocol. We present these achievements here in recognition of Africa's valuable contribution to the Montreal Protocol.

Transition to CFC-free Inhalers Package for National Ozone Units

This awareness package aims to assist National Ozone Units (NOUs) and other key national stakeholders in developing countries to develop appropriate materials to ensure the seamless transition of CFC-Free inhalers in each country.
www.unep.fr/ozonaction/information/mmc/lib_detail.asp?r=5310

Information on Commercially Validated Methyl Bromide Alternative Technologies

AEL Special Edition for 2009 International Ozone Day: In-depth information on Methyl Bromide Alternatives validated at the commercial level in Africa.

Website

Vital Ozone Graphics 2 - Climate link, Resource Kit for Journalists

Provide details on the latest ozone protection issues including ozone-climate interlinkages.

The Montreal Protocol Who's Who

A web portal to honour the visionaries, innovators and implementers who are making the Montreal Protocol a global environmental success story.
www.unep.fr/ozonaction/information/MontrealProtocolWhosWho.htm

HCFC Help Centre

A one-stop web module for information about the management and phase-out of HCFCs.
www.unep.fr/ozonaction/topics/hcfc.asp

A place for journalists to learn more about ozone layer protection and its linkages with climate change.
www.unep.fr/ozonaction/ozone2climate/index.htm

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