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Presentation of the synthesis report of the 2006 assessments of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel

Synthesis report

Note by the Secretariat

The annex to the present note contains a synthesis of the following three reports prepared pursuant to Article 6 of the Montreal Protocol by the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel, respectively: “Scientific Assessment of Ozone Depletion: 2006,” “Environmental Effects of Ozone Depletion and its Interactions with Climate Change: 2006 Assessment,” and “2006 Report of the Technology and Economic Assessment Panel”.

The synthesis is presented as submitted and is issued without formal editing.

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Annex

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SYNTHESIS SUMMARY

The Montreal Protocol is working. There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances in the lower atmosphere and in the stratosphere; some early signs of the expected stratospheric ozone recovery are also evident. However, failure to continue to comply with the Montreal Protocol would delay, or could even prevent, recovery of the ozone layer. Furthermore, if the Parties were to eliminate all emissions of ozone-depleting substances soon after 2006, it would advance by about 15 years (from around 2050 to 2035) the global ozone layer recovery to pre-1980 levels (often used as a benchmark for ozone recovery).

The scientific evidence that elevated surface UV-B radiation is caused by stratospheric ozone layer depletion has been further strengthened during the past 4 years since the previous Assessment.
The increases in UV-B radiation from 1980 to the end of the 20th century have been larger than the long-term natural variability. Elevated UV-B radiation due to reduced stratospheric ozone is expected to persist during at least the next decade. UV-B radiation is known to harm people, other living organisms, and ecosystems. Therefore, the adverse impacts of stratospheric ozone depletion are expected to persist.
The table below indicates the percentage reductions that could be achieved in integrated equivalent effective stratospheric chlorine if the noted actions were taken.

Compound or Compound Group	**All Emissions Eliminated from Production after 2006**	**All Emissions Eliminated from Existing Banks at End of 2006**	**All Emissions Eliminated after 2006**
Chlorofluorocarbons (CFCs)	0.3	11	11
Halons	0.5	14	14
Carbon tetrachloride (CCl_4)	3	-	3
Methyl chloroform (CH_3CCl_3)	0.2	-	0.2
Hydrochlorofluorocarbons (HCFCs)	12	4	16
Methyl bromide (CH_3Br) (anthropogenic)	5	-	5

Adapted from Table 1, Executive Summary of "Scientific Assessment of Ozone Depletion: 2006."

Although the amounts of ozone-depleting substances (ODSs) in the atmosphere are decreasing due to the Montreal Protocol, there are options available to return to the 1980 levels sooner. Options with the largest potential to reduce the equivalent effective stratospheric chlorine are: 1) accelerated phase-out of hydrochlorofluorocarbons (HCFCs) and tighter control of methyl bromide applications and 2) immediate collection and destruction, in order of importance, of halons, chlorofluorocarbons (CFCs), and HCFCs. Technically and economically feasible substitutes are available for almost all ODS applications, including those using HCFCs and methyl bromide. Technically and economically feasible measures are also available to reduce the 3.5 million ODP-tonnes of ODSs currently in the banks from reaching the atmosphere. The phase-out schedules and destruction strategies, as well as their feasibility and benefits could be elaborated.

Key Findings on Science

There is even stronger evidence since the 2002 Assessment that the Montreal Protocol is working. The total combined abundance of ODSs is now declining not only in the lower atmosphere (troposphere), but also in the stratosphere. Now there are clear indications that peak ODS levels were reached in the stratosphere in the late 1990s. The ozone layer outside of polar regions has shown some initial signs of recovery and the decline of stratospheric ozone seen in the 1990s has not continued. Indeed, the global stratosphere (60°S-60°N) has likely already experienced its highest levels of ozone depletion from man-made halocarbons.

Polar ozone loss will remain large and highly variable in the coming decades, and the Antarctic ozone hole will persist longer than previously estimated. Springtime polar depletion continues to be severe in winters when the polar stratosphere is cold, and meteorological variability plays a large role in the yearly extent of ozone depletion over both poles. In the next two decades, the Antarctic ozone hole is not expected to improve significantly. Updated estimates show that with continued compliance to the current control measures of the Protocol, Antarctic ozone will return to previous levels in 2060-2075, 10-25 years later than estimated in the previous Assessment. The projection of this later return is primarily due to a better representation of the time evolution of ozone-depleting gases in the polar regions. According to Chemistry-Climate Models, Arctic ozone levels are expected, on average, to return to pre-1980 levels before 2050, however, these predictions are uncertain. Individual years of anomalously larger or smaller ozone depletion in Antarctica or the Arctic, such as the smaller Antarctic ozone hole of 2002, will continue to arise in the coming decades. These variations are expected during this period when ODS concentrations are roughly constant.

Failure to continue to comply with the Montreal Protocol could delay or even prevent the recovery of the ozone layer. Multiple factors, including ozone-depleting substances and climate change, will affect the future state of the ozone layer. However, the decrease in ODS emissions already achieved by the Montreal Protocol remains the dominant factor in the return of ozone levels to pre-1980 (pre-ozone-hole) values. Assuming continuing compliance with the Protocol, it is estimated that the global ozone levels (60°S-60°N) will recover to the pre-1980 values around 2050. Changes in climate; future levels of the well-mixed greenhouse gases and stratospheric water vapour; and uncertainties in transport, banks, and future emissions will influence if, when, and to what extent ozone will be restored in different regions of the atmosphere. HCFCs and the release of “banked” CFCs will continue to contribute to ozone depletion until roughly the middle of the 21st century. The role of very short-lived halogenated substances is now believed to be more important than previously thought, and ozone depletion could be enhanced by significant anthropogenic production of these substances.

The decline in the abundance of methyl chloroform and methyl bromide contributed the most to the present decline in effective equivalent lower atmospheric (tropospheric) chlorine levels. By 2005, the abundances of the total combined anthropogenic ozone-depleting gases in the troposphere had decreased by 8-9% from the peak value observed in the 1992-1994 time period. The total ~120 parts per trillion (ppt) decline between 2000 and 2004 was due to the following: ~60 ppt decrease of methyl chloroform, ~45 ppt decrease of methyl bromide, ~23 ppt decrease of CFCs, and ~12 ppt increase of HCFCs. Methyl chloroform will soon be insignificant in the stratosphere.

HCFCs continue to increase in the atmosphere. HCFCs accounted for 214 ppt, or 6%, of total tropospheric chlorine in 2004 versus 180 ppt (5%) of total chlorine in 2000. HCFC-22 is the most abundant of the HCFCs and is currently (2000-2004) increasing at a rate of 4.9 ppt/year (3.2%/year). HCFC-141b and HCFC-142b abundances increased by 1.1 ppt/year (7.6%/year) and 0.6 ppt/year (4.5%/year) over this same period. The rates of increase for all three of these HCFC compounds are significantly slower than projected in the 2002 Ozone Assessment.

Total tropospheric bromine from halons and methyl bromide peaked in about 1998 at 16.5 to 17 ppt and has since declined by 0.6-0.9 ppt (3-5%). This observed decrease was solely a result of declines observed for methyl bromide beginning in 1999, when industrial production was reduced. Bromine from halons continues to increase, but at slower rates in recent years (0.1 ppt Br/year in 2003-2004). The decrease in methyl bromide was larger than expected and suggests that anthropogenic methyl bromide contributes more to ozone depletion than previously estimated.

The effectiveness of bromine compared with chlorine for global ozone depletion (on a per-atom basis), typically referred to as α, has been re-evaluated upward from 45 to a value of 60. Therefore, the Ozone Depletion Potentials (ODPs) of brominated compounds have increased proportionately.

Very short-lived halogenated substances are of greater importance to stratospheric ozone depletion than previously estimated. Significant anthropogenic production of such substances could increase ozone depletion.

- The Ozone Depletion Potential of n-propyl bromide is 0.1 for tropical emissions and 0.02-0.03 for emissions in northern midlatitudes. These are unchanged from the previous Assessment.

- The Ozone Depletion Potential of CF_3I is 0.018 for tropical surface emissions, 0.011 for midlatitude surface emissions, and 0.25 for 6-9 km altitude emissions in the tropics. The previous Assessment had an upper limit for surface emissions of 0.008.

Key Findings on Environmental Effects

UV-B radiation influences living organisms, ecosystems, and materials. In human populations it can cause severe damage to the eyes, skin cancers, and suppressions of the immune system. UV-B radiation also has many effects on plants and aquatic organisms. UV-B radiation often changes growth and form of plants, which may lead to changes in competitive balance and consequent changes in species composition. Large decreases in root mass and other below-ground changes occur as a result of UV-B radiation above ground. Climate change factors, such as CO_2 and water availability, interact with UV-B radiation eliciting complex plant responses. In terrestrial ecosystems, UV-B radiation can alter carbon and nutrient cycling, and in aquatic ecosystems, the biological availability and toxicity of metals are changed, leading to bioaccumulation in food webs. The changes in community structure in aquatic ecosystems are more important than effects on overall biomass.

Climate change will influence the exposure of all living organisms to UV-B radiation via changes in cloudiness, precipitation, and ice cover. Other factors associated with climate change, for example, human and animal behaviour, will also determine the amount of UV-B exposure. In addition, there are indications that several reactions to UV-B radiation work more effectively at higher environmental temperatures. For instance, enhanced UV-B radiation together with high temperatures leads to faster degradation of wood and plastics, which has implications for the materials industry. The temperature effect also applies to the induction of nuclear cataract of the eye and non-melanoma skin cancer.

The incidence of squamous cell carcinoma (SCC), basal cell carcinoma (BCC), and melanoma continue to rise, which is partly attributed to increases in UV-B radiation. For example, the incidence of all three types of skin cancer is projected to approximately double in years 2000 to 2015 in The Netherlands and in many other countries with predominantly fair-skinned populations. In children, the incidence of melanoma is still rising and has been positively correlated with environmental UV radiation exposure.

UV-B suppresses some functions of the human immune system. This is a crucial factor in increasing the incidence of skin cancer and may also contribute to viral reactivation and a reduction in vaccine effectiveness.

Key Findings on Technology and Economics

In both Article 5 and non-Article 5 Parties, the developments that have occurred between 2002 and 2006 increase the technical and economic feasibility of:

1. the acceleration of the phase-out of consumption of most ODS;
2. the reduction of the emissions in many applications; and
3. the collection and destruction of ODS contained in foam products, refrigeration, air conditioning and other equipment.

Some of the key findings are summarised as follows:

Chemicals

- Some carbon tetrachloride (CTC) and CFC feedstock and process agent uses exempted by the Protocol could be replaced by HCFCs or by not-in-kind manufacturing processes using non-ozone depleting substances (non-ODSs). Parties may wish to consider periodic assessment of available and emerging alternatives for feedstock and process agent uses with a view to restricting exempted uses.

Foams

- Hydrocarbons are now the largest single class of blowing agents in use globally (36% of the total). HCFCs also continue to have a significant part of the market (22% of the total) --despite phase-out in many non-Article 5 countries-- primarily because of rapid growth in the use of insulating foams in some Article 5 countries to improve the energy performance of new buildings. Hydrofluorocarbons (HFCs) have been introduced into some foam sectors, but price and the application of responsible use criteria have limited their uptake to less than 60,000 tonnes globally (16% of the total).

Halons

- The civil aviation sector continues to be dependent on halons and has not demonstrated further progress through the adoption of alternative technologies in new airframe designs. The sector lacks an agreed technical design strategy to implement alternative methods of fire suppression. The International Civil Aviation Organization (ICAO) may not take up these issues at their 2007 Assembly as previously agreed.
- Adequate supplies of halons 1211, 1301, and 2402 are expected to be available on a global basis; however, they are projected to be unevenly distributed amongst the major regions of the world. These regional imbalances are a growing concern and may need to be addressed by the Parties.

Medical applications

- Global phase-out of CFCs in Metered-Dose Inhalers (MDIs) is achievable by 2010. However, considerable challenges remain in achieving transition to alternatives, particularly in Article 5 countries.
- A relatively large number of companies manufacturing CFC MDIs in Article 5 countries do not yet have the skills or knowledge needed to phase out CFC MDIs. It is critical that technical expertise and funds for technology transfer and equipment are available to ensure that patients in Article 5 countries receive essential inhaled treatment.
- Pharmaceutical-grade CFC production for MDIs may be economically impractical after 2009. If global transition in CFC MDI manufacture is not achieved by 2010, Parties may need to consider the necessity for a final campaign production of pharmaceutical-grade CFCs and the acquisition of remaining stockpile from non-Article 5 countries.

Methyl bromide

- Technical alternatives exist for almost all controlled uses of methyl bromide.
- Phase-out for the remaining methyl bromide uses will be greatly influenced by the registration and the regulatory controls on several key chemical alternatives (including 1,3-dichloropropene, chloropicrin, methyl iodide and sulfuryl fluoride) and by the incentives for non-chemical alternatives and Integrated Pest Management (IPM).
- Full implementation of barrier films in soil fumigation could significantly reduce methyl bromide dosage rates and emissions.
- Increased use of methyl bromide for Quarantine and Pre-shipment (QPS) is offsetting gains made by reductions in controlled uses for soils and other non QPS uses. QPS methyl bromide use is particularly increasing in response to the International Standard for Phytosanitary Measures (ISPM 15) encouraging methyl bromide use on wooden packaging material despite the availability of an authorised alternative to methyl bromide for this use.
- Parties contemplating controls on exempted methyl bromide use may wish to consider economic incentives that encourage minimal use, containment, recovery, and recycling; as well as not-in-kind alternatives and substitutes for the products that are traded.

Refrigeration

- In contrast with non-Article 5 countries, CFCs and HCFCs will continue to be the primary service refrigerants in most Article 5 countries because of long equipment life and the costs of field conversion to alternative refrigerants. Containment and conservation are therefore likely to need increasingly more attention with time.
- Several low Global Warming Potential (GWP) refrigerant candidates (one with an ozone depleting ingredient -- CF_3I) are claimed to provide comparable energy efficiency to HFC-134a in vehicle air conditioning. Development of these low-GWP refrigerants may also have major future consequences for (new) refrigerant choices in other sectors and applications.

Cross-Sectoral Findings

- Technically and economically feasible substitutes are available for almost all applications of HCFCs, although transitional costs remain a barrier for smaller enterprises, particularly in developing countries.
- A considerable portion of the 3.5 million ODP-tonnes of ODS contained in banks is available for collection and destruction at costs that can be justified by benefits in reducing ODS and greenhouse gas emissions.
- Parties contemplating ODS collection and destruction may wish to consider incentives for collection that avoid prolonged use of inefficient equipment, intentional venting or product dumping. In this context, the classification of ODS recovery and destruction activities as carbon offset projects could warrant further investigation.

FOR MORE INFORMATION

The findings above are supported in the three 2006 Assessment Panel Reports, which can be found on the Ozone Secretariat website at the following addresses:

"Scientific Assessment of Ozone Depletion: 2006"
http://ozone.unep.org/Assessment_Panels/SAP/Scientific_Assessment_2006/index.shtml

"Environmental Effects of Ozone Depletion and its Interactions with Climate Change: 2006 Assessment"
http://ozone.unep.org/Assessment_Panels/EEAP/eeap-report2006.pdf

"2006 Report of the Technology and Economic Assessment Panel"
http://ozone/unep.org/Assement_Panels/TEAP/Reports/TEAP_Reports/TEAP_Assessment _2006.pdf