

Chapter 9

THE NON-CARBON AND NON-UNFCCC AGENDAS

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I. INTRODUCTION

Since 1992, policymakers have attempted to address climate change through the climate change regime. They have negotiated two major treaties with near universal participation, as well as the Cancun Agreements and Durban Package as the starting point for a post-Kyoto Protocol climate change regime. Negotiations under the new Ad Hoc Working Group on the Durban Platform for Enhanced Action may result in a new international agreement. Or maybe not. Meanwhile, climate change and its associated impacts continue to outpace the predictions of models. Seas are rising, glaciers are melting, temperatures are increasing, and species are shifting ranges all faster than scientists thought they would. Moreover, emissions of carbon dioxide (CO₂) continue to rise. Despite pledges to reduce or limit CO₂ emissions, those emissions have doubled since the 1970s and are expected to climb by 50 percent by 2050 without new policies. Virginie Marchal et al., *Climate Change*, in OECD ENVIRONMENTAL OUTLOOK TO 2050: THE CONSEQUENCES OF INACTION 72, 76 (March 2012). Current pledges are on course for a temperature rise by the end of the century of 3.7-5.6°C above pre-industrial levels, rather than the 2°C goal of the climate change regime. *Id.* at 84.

No one has advocated for building a climate change regime that does not involve CO₂. Indeed, any effort to combat climate change requires steep reductions in CO₂ emissions. Nonetheless, as the window of opportunity for achieving the 2°C goal closes, governments and environmentalists are looking to new approaches to address climate change. In particular, close attention is being given to short-lived climate forcers. These substances — black carbon (frequently referred to as BC), tropospheric ozone (O₃), methane (CH₄), and some hydrofluorocarbons (HFCs) — are responsible for about 40 percent of warming, but they have significantly shorter lifetimes than CO₂ — days to about a decade as opposed to 100 to 1,000 years or more for CO₂, which is responsible for 55 to 60 percent of warming. Reduction of these short-lived climate forcers thus provides an opportunity to mitigate climate change significantly in the short term while the climate change regime determines how to address CO₂ in the longer term. Similarly, some governments and environmentalists believe that the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) could be used to limit emissions of human-made greenhouse gases (GHGs) in the same way it has successfully reduced production and consumption of ozone depleting substances such as chlorofluorocarbons (CFCs). In short, governments and people are looking to get beyond CO₂.

Are other treaties allowed to regulate GHGs? If so, how should those treaty regimes interact, if at all, with the climate change regime? In general, international law is ill-equipped to deal with overlapping jurisdictions, gaps in the law, or unintended consequences that require policy trade-offs between regimes. International environmental law comprises a relatively ad hoc set of treaties, each aimed at a different environmental issue. To make matters worse, no one institution is in charge of international environmental law to referee any jurisdictional dispute. While questions regarding the climate regime will be addressed by the climate Secretariat in Bonn or the Conference of the Parties, neither entity is authorized to interpret other environmental regimes or to make decisions binding on the Parties of other regimes. The Vienna Convention on the Law of Treaties provides general guidance on interpreting treaties that may be referenced in a potential conflict, but it provides little specific guidance to ensure a balanced and well-reasoned outcome. Moreover, no overarching international environmental agreement sets forth either procedures or principles for resolving conflicts between environmental regimes. Nor does the United Nations Environment Programme or any other institution have the authority to ensure policy coherence among the environmental regimes.

As you read about the activities of these other regimes, ask yourself the following questions:

- What role should these regimes have in mitigation or adaptation to climate change? Should they engage in climate change mitigation or should they restrict their activities to adaptation? Or should these regimes step aside completely and leave the business of climate change to the UNFCCC and Kyoto Protocol?
- How should multilateral environmental regimes structure their cooperation on overlapping issues, given that each regime is limited in authority to issues that fall within the substantive scope of their respective treaties?

- Who should answer these questions and by what rules?

II. USING THE OZONE REGIME TO CONTROL HUMAN-MADE GHGS

Ozone (O₃) is a reactive gas composed of three weakly bound oxygen atoms. It exists in two layers of the atmosphere. In the stratosphere, a distance of 12 to 50 kilometers above the earth's surface, ozone shields the earth from harmful levels of high-energy ultraviolet (UV-B) radiation from the sun. About 90 percent of ozone molecules exist in the stratosphere. In the troposphere, from ground level to 10 to 15 kilometers above the earth's surface, ozone is a significant greenhouse gas and human health pollutant. Tropospheric ozone is also a short-lived climate forcer. It is discussed in Section III.B.

Although depletion of stratospheric ozone is not a climate change issue, many of the substances that cause ozone depletion are also greenhouse gases. Moreover, the multilateral regime to stop ozone depletion may offer opportunities to reduce emissions of non-CO₂ GHGs. These issues are addressed in the remainder of this section.

A. Introduction to Ozone Depletion and the Montreal Protocol

Ozone depletion and climate change are frequently confused. For most purposes they should be considered two completely separate environmental issues. They involve different chemical processes, have mostly different causes, and result in different threats to human health and the environment. Ozone depletion is itself a major environmental threat, but one that is being addressed effectively through the Montreal Protocol regime. However, many GHGs are powerful ozone depleting substances and many ozone depleting substances (ODSs) are also powerful GHGs.

Moreover, as we explore in this section, the effectiveness of the Montreal Protocol in significantly reducing concentrations of ODSs in the atmosphere has led many to wonder whether the Montreal Protocol might be a better forum for reducing emissions of human-made GHGs, such as hydrofluorocarbons (HFCs), as well as other gases currently not covered by the UNFCCC or the Kyoto Protocol. The following excerpt provides a brief overview of ozone depletion and the Montreal Protocol regime.

DAVID HUNTER, JAMES SALZMAN & DURWOOD ZAELKE,
INTERNATIONAL ENVIRONMENTAL LAW & POLICY
5–6 (4th ed. 2011)

Like greenhouse gases, stratospheric concentrations of ozone have maintained relatively constant levels through natural, homeostatic processes. By interfering with these processes, chlorofluorocarbons (CFCs) and certain other widely used synthetic chemicals can destroy stratospheric ozone more quickly than natural processes can replenish it. CFCs and similar chemicals, used as refrigerants, aerosols and other common applications, migrate into the upper

atmosphere, where they are broken down by high-energy radiation. As these compounds break down, they release chlorine and bromine ions. These ions, in turn, catalyze a reaction that breaks down ozone molecules. The chlorine and bromine ions are not destroyed in this reaction, and each ion can destroy thousands of ozone molecules. Beginning in the 1940s, global use of CFCs and other ozone depleting substances expanded dramatically, with a corresponding increase in atmospheric chlorine and bromine.

In Antarctica, where the greatest losses have occurred, up to 60% of stratospheric ozone is depleted each September, resulting in an “ozone hole” larger than the entire United States. A similar but smaller hole also opens annually above the Arctic. The thinning of the ozone layer is not confined to the poles, however. Unprecedented levels of ozone depletion were measured through the 1990s over Europe, North America, Australia, and New Zealand, with as much as a 10% decline over northern middle latitudes, and 35% over parts of Siberia.

The increased amounts of UV-B radiation striking the Earth’s surface endanger human health, agriculture and the environment. Rates of skin cancer, for example, may increase by 2% for every 1% loss in ozone coverage. A 10% reduction of atmospheric ozone could result in an additional 300,000 cases of skin cancer and up to 1.75 million additional cases of cataracts *each year*. UV-B exposure also suppresses the body’s immune response system, making it more vulnerable to certain diseases. Under laboratory conditions, increased radiation at the levels expected from ozone depletion inhibits the growth of many plants, including important commercial species such as soybeans, cotton, and certain trees. It may also cause developmental abnormalities in fish, shellfish and amphibians, threatening hundreds of species. Such exposure also reduces the productivity of phytoplankton, the base of the ocean’s food web. Reductions in this fundamental food source could dramatically affect the ocean biodiversity.

In 1985, the international community adopted a framework convention — the Vienna Convention on Ozone Depletion — which set in motion a series of increasingly restrictive steps to phase out global production and consumption of ODSs. The Vienna Convention itself established the institutions and general purpose of the regime, but it was the landmark Montreal Protocol that introduced targets and timetables for reducing production and consumption of ODSs. Beginning with just 8 ODSs, including 5 CFCs, the Montreal Protocol was amended and adjusted several times to include near total phase-outs for 96 ODSs. By the end of 2009, the Montreal Protocol Parties had reduced consumption of 98 percent of all of the chemicals controlled by the Protocol. For example, global consumption of CFCs, the most used ozone-depleting substance, has dropped from 1.1 million tons in 1986 to about 35,000 tons in 2006. UNEP, *BACKGROUND: BASIC FACTS AND DATA ON THE SCIENCE AND POLITICS OF OZONE PROTECTION* 6 (Sept. 9, 2010). Atmospheric concentrations of ozone-depleting substances appear to have peaked in the late 1990s, and stratospheric ozone levels are beginning to increase. The United Nations Environment Program (UNEP) now predicts that the ozone layer will recover to its pre-1980 levels before 2050, although such a recovery may be delayed until roughly 2075 for the ozone hole over Antarctica. Without the Protocol, UNEP predicted that levels of ozone-depleting substances would have been five times higher than they are today and surface UV-B radiation levels would have doubled at mid-latitudes in the northern hemisphere.

The Montreal Protocol regime is widely viewed as the most effective environmental treaty regime and was the explicit model for the international negotiations over climate change. Consider in this regard the following comments from U.S. ozone negotiator Richard Benedick, written on the eve of the United Nations Conference on Environment and Development in 1992.

The current debate about greenhouse warming conveys a distinct sense of *déjà vu*. The world again confronts a classic situation: weighing the risks of action and inaction in the face of uncertainties. Short-term costs loom large; long-term dangers seem remote . . . The Antarctic ozone hole is an example of what scientists call a nonlinear response; that is, the ozone layer kept absorbing ever more chlorine from man-made sources without revealing any problem, until the concentrations reached a breaking point, and collapse ensued. With respect to greenhouse warming, scientists warn that the billions of tons of carbon dioxide and other gases being emitted by modern industrial economies constitute an unpredictable experiment on the atmosphere. Are we approaching other unknown thresholds?

Richard Benedick, *Essay: A Case of Déjà Vu*, 266 SCI. AM. 160 (April 1992).

Had the production and use of CFCs and other ODSs been permitted to grow, irreparable damage to the ozone layer would have occurred. Instead, with significant scientific uncertainty as to whether ODSs were causing ozone depletion, the international community acted based on the best available science to begin regulating the production and consumption of ODSs.

Beginning in 1985, even before the Antarctic ozone hole had been discovered, governments adopted the Montreal Protocol and agreed to halve their consumption of five CFCs and freeze consumption of three halons. Through a series of adjustments and amendments to the Montreal Protocol's annexes, in which ODSs and their reductions schedules are listed, the Parties have agreed to phase-out consumption of 96 ODSs. In each case, the Parties have established a specific date for the phase out, frequently with intermediate reduction targets before the final phase-out date.

The phase-out schedules are, of course, the core feature of the Montreal Protocol. Yet, the Montreal Protocol's success is based on other provisions that enticed Parties to join and comply with it. For example, the Protocol barred trade in listed ODSs, including products containing ODSs, with non-Parties. Given the importance of many ODSs for refrigeration and medicines (metered dose inhalers, e.g.), countries found it in their interest to participate in the Montreal Protocol in order to obtain the benefits of ODS trade — at least until the final phase-out date for a particular substance. Finally, the Montreal Protocol granted developing countries grace periods for implementing the phase-out schedules. The Montreal Protocol also developed a compliance regime based on facilitating compliance rather than punishing non-compliance. Only after a period of time of noncompliance in which capacity-building efforts and other attempts to facilitate compliance have failed will the Parties adopt punitive measures, such as cutting off access to the Protocol's Multilateral Fund, which provides hundreds of millions of dollars each

triennium to developing countries for projects to combat ozone depletion.

Another key feature leading to the Montreal Protocol's success is its voting structure. Once an ODS is listed in the Protocol's annexes, the Parties may "adjust" the control measures for that substance through a vote of two-thirds of the Parties representing simple majorities of both developing and developed countries. This voting structure allows the Parties to respond quickly to new scientific information without the need for ratification by a Party's legislature. The triple majority vote also ensures widespread acceptance of the adjustment. In contrast to the adjustment process, the addition of new ODSs to the annexes requires a two-thirds majority vote of the Parties and ratification by two-thirds of the Parties. Despite this more cumbersome process for amendments, the Montreal Protocol has been amended four times, with the vast majority of Parties ratifying each of the amendments.

B. The UNFCCC's Treatment of Ozone Depleting Substances

Despite the value of understanding climate change and ozone depletion as separate problems, they do overlap in important ways. Both CFCs, the main cause of ozone depletion, and ozone are greenhouse gases. Thus, the addition of CFCs to the atmosphere adds directly to global warming, but in destroying ozone it leads to global cooling. The two effects partly cancel each other out, but overall the warming impact of CFCs is now thought to be considerably greater than the cooling impact of ozone depletion. Complicating the situation further is that the substitutes allowed for CFCs under the Montreal Protocol regime are more potent GHGs than CFCs, and the production of CFC substitutes may create by-products that are more potent GHGs than CFCs themselves. Thus, as countries have expanded their production of HCFCs, a CFC substitute, their impact on climate change has increased as well.

Not surprisingly, the complex relationship between ODSs and GHGs has resulted in a complicated relationship within international law. Although the climate and ozone regimes generally recognize the importance of having a mutually reinforcing set of policies, the two regimes still act largely independently of one another and, at least until recently, have not taken explicit steps to address one another's goals.

During the negotiations of the UNFCCC, the Parties disagreed as to how to treat CFCs and other ODSs controlled under the Montreal Protocol. The United States sought to include CFCs, but other countries opposed their inclusion because CFCs were already scheduled to be phased out under the Protocol. Opponents thought that including CFCs would give industrialized countries credit for something they had already agreed to do and would allow certain countries (particularly the United States) to increase substantially their emissions of other GHGs. To some extent, this argument became less important, at least with respect to CFC reductions, when the IPCC reported that ozone itself was a GHG. Thus, the climate cooling effects of eliminating CFCs would cancel out the climate warming effects of increasing stratospheric ozone levels.

Given this new evidence, the United States and others allowed the UNFCCC to exempt substances regulated under the Montreal Protocol. Thus, in Article 4 of the UNFCCC, the

various commitments of developed countries repeatedly exempt greenhouse gases “not controlled by the Montreal Protocol.” Similar language is found throughout the Kyoto Protocol, and the six greenhouse gases specifically listed in Annex A to the Kyoto Protocol do not include CFCs, HCFCs, or any other substance specifically controlled by the Montreal Protocol.

Thus, the general approach of the Kyoto Protocol was to keep its market-based approach to the regulation of greenhouse gases separate from the control of ozone-depleting substances under the Montreal Protocol. Countries that had made or will make significant reductions in their ODSs would not be able to gain credit for this under the Kyoto Protocol’s cap-and-trade system.

Although the Kyoto Protocol’s approach clarified the overall relationship between the two regimes to some extent, important difficulties in coordination have emerged over time. Most prominently, hydrochlorofluorocarbons (HCFCs), a group of chemicals that have lower ozone depleting potential than CFCs but which are very potent GHGs, have been a preferred substitute for CFCs. HCFC-22, for example, has an ozone depleting potential of 0.055 but a global warming potential (GWP) of 1,800. Moreover, the manufacture of some HCFCs results in byproducts — including HFCs — that are regulated *only* under the Kyoto Protocol. For example, the production of HCFC-22 results in emissions of trifluoromethane (“HFC-23”), an unwanted by-product with a GWP of 11,700 and an atmospheric lifetime of 264 years. The creation of substitutes consistent with the Montreal Protocol has thus led to the production of several new, extremely potent GHGs. For example, “[t]he combined climate emissions of HCFC-22, with a GWP of 1,780, and its HFC-23 byproduct, with GWP of 11,700, are projected to reach 1 GtCO₂eq. by 2015 — roughly equal to the emissions reductions presently required under the Kyoto Protocol.” Donald Kaniaru et al., *Strengthening the Montreal Protocol: Insurance against Abrupt Climate Change*, 7 SUST. DEV. L & POL’Y 3, 4–5 (Winter 2007).

Several factors influence a projected increase in HCFC production. First, the Montreal Protocol itself created unintended consequences by creating different ODS phase-out schedules for developed and developing countries and incentivizing the creation of less potent, but still harmful, ODS substitutes. Taking advantage of the system, ODS manufacturers in developed countries could transfer inexpensive old technology to manufacturers in developing countries, which could use the outdated technology until the developing countries’ phase-out deadlines come due. Second, the Kyoto Protocol’s Clean Development Mechanism (CDM) provides even more incentives for developed countries to partly meet their Kyoto Protocol commitments by investing in the destruction of HFCs produced as by-products at HCFC manufacturing facilities in developing countries. Together, the two treaties established perverse incentives for developing countries to increase their production of unneeded ODSs.

Under the CDM, Parties or their investors have obtained certified emissions reductions (CERs) by capturing and destroying HFC-23 emissions at facilities producing HCFC-22. These HFC-23 CDM projects have become notorious because of the low cost of HFC-23 destruction compared to the value of CERs on the global carbon market. In one case, investors paid about \$500 million for equipment to destroy HFC-23 as part of a CDM deal, even though the equipment only cost \$5 million. Keith Bradsher, *Outsize Profits, and Questions, in Effort to Cut Warming Gases*, N.Y. TIMES, Dec. 21, 2006. On average, the cost of destroying HFC-23 is less

than \$0.20 per ton of CO₂eq. TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL (TEAP), RESPONSE TO DECISION XVIII/12: REPORT OF THE TASK FORCE ON HFCF ISSUES (WITH PARTICULAR FOCUS ON THE IMPACT OF THE CLEAN DEVELOPMENT MECHANISM) AND EMISSIONS REDUCTION BENEFITS ARISING FROM EARLIER HCFC PHASE-OUT AND OTHER PRACTICAL MATTERS § 3.2.1 (Aug. 2007); *see also* Chapter 7 (concerning HFC destruction projects and the CDM). When the CERs generated from these projects are sold in the carbon market, however, they can earn as much as 10 times more than it costs to destroy the gas, and revenues from CDM HFC-23 destruction projects “could easily exceed the revenue from HCFC-22 sales” *Id.* at § 3.2.5.1.

Due to this perverse incentive, CDM investors unsurprisingly flocked to HFC-23 destruction projects, with HFC-23 destruction projects accounting for 67 percent of CERs contracted for in 2005 and 34 percent in 2006. KARAN CAPOOR & PHILIPPE AMBROSI, STATE AND TRENDS OF THE CARBON MARKET 2007, 27–28 (2007). The 19 registered CDM HFC-23 abatement projects (out of close to 3,000 registered projects) have delivered 414,363,373 issued carbon credits as of June 30, 2012, representing almost half of the 958,978,229 total CERs issued. CDM, *CDM Issuance Registry Report: Issued CERs as at 30 June 2012* (2012) (available at <http://cdm.unfccc.int/Registry/index.html>). By one estimate, the sale of CERs from HFC-23 projects would fetch €4.7 billion (\$6.4 billion) by 2012 even though the cost of capturing and destroying the gas is only €100 million (\$150 million). Economist.com, *Perverse Incentives*, Apr. 23, 2007.

Due to this incentive created by the CDM, it appears that some projects produced unnecessary HCFC-22 primarily to produce HFC-23 to generate additional CERs. Moreover, technological reviews showed that HCFC-22 generating plants produced abnormally high percentages of HFC-23 when they were operating under CDM. These issues became difficult to ignore after the NGO CDM Watch, using information submitted by the operators of the HFC-23 destruction projects, petitioned the CDM’s Executive Board to revise the criteria for issuing CERs from HFC-23 destruction projects.

REVISION TO AM0001 TO ADDRESS METHODOLOGICAL ISSUES, F-CDM-AM-Rev ver 01, 3–10 (Mar. 2010)

1) Adequacy of the HFC-23/HCFC-22 ratio used for emission reduction calculations

A key parameter for the calculation of emission reductions is the quantity of HFC-23 that would be generated in the baseline per quantity of HCFC-22 produced (the HFC-23/HCFC-22 ratio). AM0001 requires using the lower value between 3% and the lowest annual HFC-23/HCFC-22 ratio observed in a three year historical period between 2000 and 2004. In the absence of historical data, a default value of 1.5% shall be used.

The current version of the methodology implicitly assumes that the plants would continue to operate during all crediting periods (i.e. up to 2030) at or above a historically observed HFC-23/HCFC-22 ratio. In contrast to more recently approved methodologies, the current version of AM0001 assumes that no autonomous technological improvement would take place over time.

However, a detailed evaluation of data from registered projects shows now that this assumption is problematic and that the methodology should be revised in this respect. Evidence from registered projects and information from literature suggests that the plants would – without the incentives from the CDM – likely operate at a lower HFC-23/HCFC-22 ratio than they actually do. This is explained in detail in the following.

Our quantitative evaluation is based on information reported in [Project Design Documents (PDDs)] and monitoring reports. The analysis covers 19 registered projects of which 17 have issued CERs by 10 February 2010 and 163 monitoring reports which contained information on HFC-23 generation and HCFC-22 production and for which CERs were issued by 10 February 2010. Our evaluation revealed the following findings:

- a) Some plants achieved already quite low HFC-23/HCFC-22 ratios between 2000 and 2004
- b) Most plants are operated exactly at or just above the cut-off HFC-23/HCFC-22 ratio established in the PDD
- c) Plants are operated at a significantly lower HFC-23/HCFC-22 ratio during periods when no CERs can be claimed compared to periods when CERs can be generated
- d) The HFC-23/HCFC-22 ratio does not seem constant but apparently tends to decrease over time

These findings are illustrated in the following in more detail.

- a) Some plants achieved already quite low HFC-23/HCFC-22 ratios between 2002 and 2004*

The HFC-23/HCFC-22 ratio varies significantly among plants. 18 out of 19 projects document the historical HFC-23/HCFC-22 ratios in their PDDs. The historical values documented in PDDs for the period 2000 to 2004 vary between 1.64% (project 1105 in 2003) and 5.44% (project 0193 in 2003). The weighted average historical HFC-23/HCFC-22 rate for all 18 projects and all years was 3.21%, the mean 3.15%.

This shows that the IPCC default value of 3%, which is used in the methodology as a cut-off value, represents a reasonable average estimate but that the variations among plants are considerable. Apparently, some plants managed to reduce the HFC-23/HCFC-22 significantly without any incentives from the CDM or any forms of regulations. For example:

- the Changshu Haike plant in China (UNFCCC Reference number 1105) operated at a ratio of 1.87% in 2002, 1.64 % in 2003 and 1.84% in 2004;
- the Shandong Dongyue plant in China (UNFCCC Reference number 232) operated at a ratio of 2.59% in 2002, 2.47% in 2003 and 2.37% in 2004;
- the Quimobásicos plant in Mexico (UNFCCC Reference number 151) operated at a ratio of 2.46% in 2002, 2.53% in 2003 and 2.44% in 2004.

This illustrates that significantly lower HFC-23/HCFC-22 ratios than the default value of 3% have been achieved in the past without any incentives from the CDM. Indeed, McCulloch and

Lindley (2007) explain that “significant reduction in HFC-23 formation can be achieved by adjusting process operating conditions”. The fact that the HFC-23/HCFC-22 ratio varies considerably among plants and that some plants achieved significantly lower values than others questions to what extent historical data is a reliable proxy for how the plants would be operated in the future, in particular if the historical data is not only used for one crediting period but for three crediting periods.

b) Most plants are operated exactly at or just above the cut-off HFC-23/HCFC-22 ratio established in the PDD

The monitoring reports of all registered projects were evaluated to assess at which HFC-23/HCFC-22 ratios the plants are operated. This includes 17 projects for which CERs were issued 10 February 2010. The evaluation revealed the following:

Whereas the HFC-23/HCFC-22 ratio varied for many projects significantly in the historical period between 2000 and 2004, many plants operate during the crediting period at relatively constant HFC-23/HCFC-22 ratios. Most plants operate in a manner that the cut-off HFC-23/HCFC-22 ratio established in the PDD is always just met or slightly exceeded. Figure shows this for the two plant (projects 0232 and 0306). A very similar plant operation can be observed in the case of the projects 11, 193, 232, 306, 549, 550, 767, 807, 838, 868 and 1194. A possible explanation is that the plants are intentionally operated in a manner that ensures that the cut-off value established in the PDD is always exceeded. Such a behaviour would be economically rationale, as the CDM provides very strong economic incentives not to lower the HFC-23/HCFC-22 ratio below the cut-off value. This suggests that most plant operators are aware of the strong economic incentives from the CDM to keep the HFC-23/HCFC-22 ratio above the maximum value established in the PDD. It would be statistically very unlikely that all these plants operate by chance at a HFC-23/HCFC-22 ratio just above the cut-off value, given that the variation in the HFC-23/HCFC-22 rate over time was for most plants much larger in the period from 2000 to 2004.

In the case of few other plants, the HFC-23/HCFC-22 ratio is more variable. For these plants the HFC-23/HCFC-22 ratio is sometimes above and sometimes below the cut-off value established in the PDD. This applies to projects 1, 3 and 115. A possible explanation is that these project participants are not aware of the economic incentives from the CDM to operate the plant at a higher HFC-23/HCFC-22 ratio or that they do not wish to intentionally increase their HFC-23 emissions in order to maximize their CER revenues.

One plant (project 449) operated during its first monitoring report at a lower HFC-23/HCFC-22 ratio than the cut-off value established in the PDD and increased during all subsequent monitoring reports its HFC-23/HCFC-22 ratio above the cut-off value established in the PDD. This is shown in Figure 2. This raises the question whether these project participants initially achieved lower HFC-23/HCFC-22 ratios than established in the PDD but then got aware of the strong economic incentives from the CDM and intentionally increased the HFC-23/HCFC-22 ratio in subsequent monitoring periods.

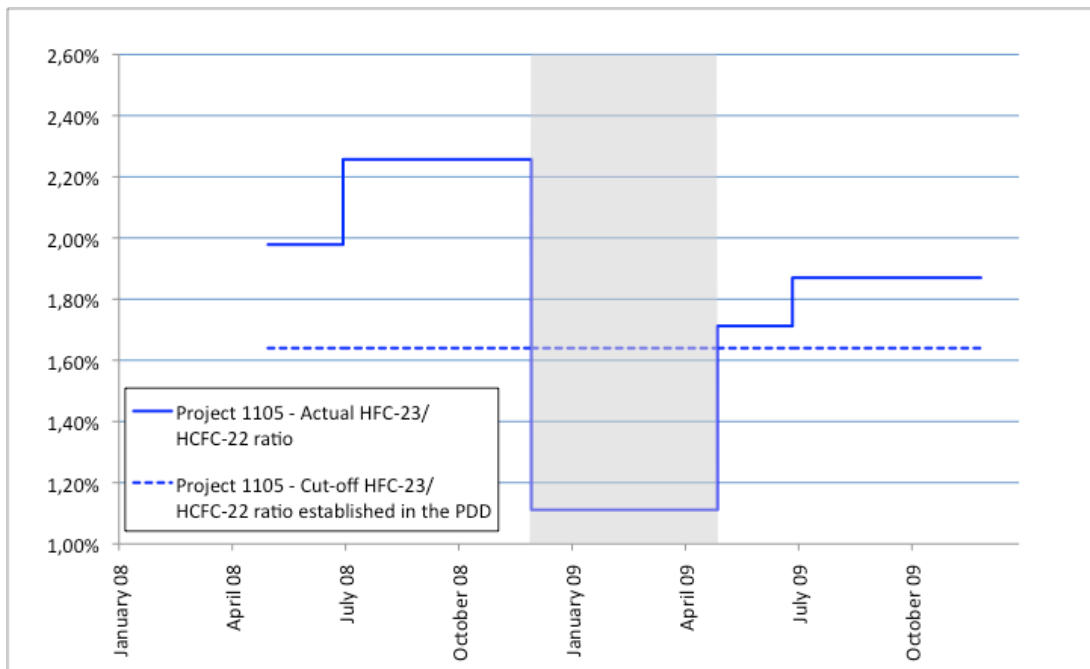
c) Plants are operated at a significantly lower HFC-23/HCFC-22 ratio during periods when no CERs can be claimed compared to periods when CERs can be generated

The most interesting result from the evaluation of data from registered projects is an assessment of the few monitoring periods where project participants could not claim CERs. In the case of two out of 162 monitoring reports no CERs were issued for the entire monitoring period because the maximum eligible amount of HCFC-22 production for that year was already reached by the plant in the previous monitoring period. During these monitoring periods, the project participants could not claim CERs — whatever the HFC-23/HCFC-22 ratio. Thus, during these periods the CDM did not provide any incentives to operate the plant in any particular manner.

Figure 3 and Figure 4 [eds. note: omitted] show the HFC-23/HCFC-22 ratio over time for the two projects which faced this situation (projects 0151 and 1105). The periods in which no CERs could be claimed are marked in grey.

The figures show that in both cases the plants were operated during these periods at a significantly lower HFC-23/HCFC-22 ratio than during the periods when CERs could be claimed. In both cases, the HFC-23/HCFC-22 is in the periods in which no CERs could be claimed significantly below the cut-off HFC-23/HCFC-22 ratio established in the PDD. This provides strong evidence that it is likely that the plants would in the absence of the incentives from the CDM be operated at significantly lower HFC-23/HCFC-22 ratios than the cut-off ratio established in the PDD. Apparently, the CDM provides perverse incentives to operate the plants at artificially high HFC-23/HCFC-22 ratios in order to generate more CERs. The fact that most plants operate just at or slightly above the cut-off HFC-23/HCFC-22 ratio established in the PDD, as shown above under b), supports this explanation.

Figure 3: HFC-23/HCFC-22 ratio during the crediting period for project 11051



2) Adequacy of the cap on historical HCFC-22 production

The current version of the methodology introduced a cap on the amount of HCFC-22 production for which HFC-23 destruction can be credited. The cap is based on the maximum historical HCFC-22 production in the most recent three years within the period from 2000 and 2004, including an equivalent amount of CFC production. The cap aims to prevent perverse incentives that, as a result of the incentives from the CDM, more HCFC-22 is produced than would be produced without the CDM. In addressing this objective, the methodology implicitly assumes that HCFC-22 production (including an equivalent CFC production) will in the absence of the CDM stay at historical levels or grow but not drop below historical levels.

The evaluation of data from registered projects questions whether the potential perverse incentives are avoided through the cap. Table 1 illustrates the actual HCFC-22 production during the first years of the crediting period in relation to the maximum eligible amount of HCFC-22 production for which HFC-23 destruction can be credited.

Table 1: Actual HCFC-22 production during the crediting period in relation to the maximum eligible amount of HCFC-22 production

Project	Year 1	Year 2	Year 3	Year 4	Year 5
11	109%	110%	106%		
115	72%	94%	96%	100%	101%
151	100%	101%	107%		
193	105%	102%	104%		
232	102%	101%	101%		

306	125%	120%			
499	101%	99%			
549	101%	113%	159%		
550	100%	109%	119%		
767	101%	101%			
807	69%	94%			
838	101%	103%			
868	105%	109%			
1105	148%				
1194	100%	101%			

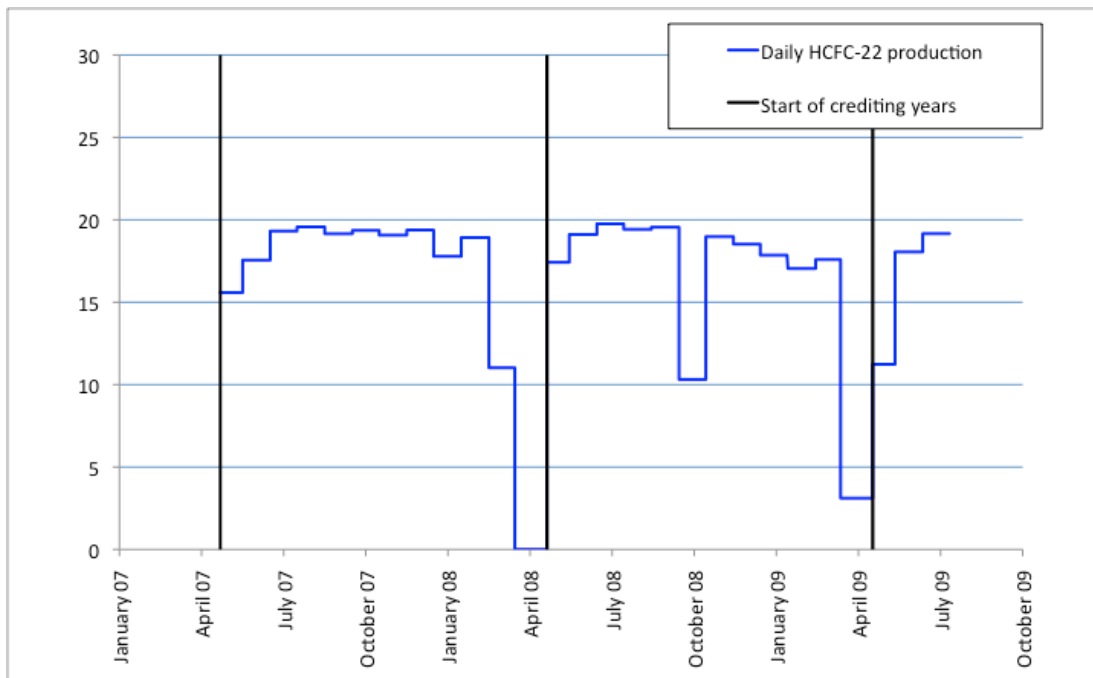
The data shows the following:

1. Two plants (projects 115 and 807) produced during several years less HCFC-22 than can be credited. This means that the implicit assumption that production of HCFC-22 will always be above historical levels appears not adequate. These project participants could have increased their production, if technically feasible, to the eligible amount (100%) and could have even vented the HCFC-22, given that CER revenues are usually higher than HCFC-22 production costs. These project participants may not have wished to intentionally increase their HCFC-22 production in order to maximize their profit or they may not have been aware of the strong economic incentives from the CDM to do so. However, they could have done so — the cap would not have been effective in preventing this.

2. The amount of HCFC-22 produced in a year of the crediting period very frequently just matches or exceeds the amount eligible for crediting (the number is 100% or few percentages above 100%). This shows that a number of plants are constantly producing each year the amount of HCFC-22 which is eligible for crediting. It is very unlikely that such behaviour could be observed by chance. Apparently, the amount of HCFC-22 produced is in the case of several plants determined by the CDM rules and not by other factors, such as market demand.

3. Some plants heavily reduced or even stopped their HCFC-22 production once the amount of HCFC-22 that is eligible for crediting was reached and started production again when the new crediting year started. This is illustrated for the project 767 in Figure 6 below. The plant had a relatively constant HCFC-22 production of about 15-20 tons per day until the HCFC-22 amount eligible for crediting was reached. From that point onwards, the production was reduced or the plant was even shut down (in April 2008). Production was then taken up again with the first day of the next year of the crediting period (1 May of each year). Apparently, the plant operators had no incentives to produce HCFC-22 during times where no CERs could be gained from generating and destroying HFC-23. This questions whether all of the HCFC-22 produced by the plant is produced for the market or whether a lower amount of HCFC-22 would have been produced in the absence of the CDM.

Figure 6: Daily HCFC-22 production during the crediting period for project 767 (tons per day)



The development of the price for HCFC-22 in China, the most important market for HCFC-22, is another indicator that the production of HCFC-22 could be driven by CDM rules. According to the CHEAA appliance magazine (2009), the price dropped in 2008 from 15,000 RMB/ton to 8000 RMB/ton, the lowest price in history. Apparently, this price drop can only partly be explained through normal market effects, such as seasonal variations. The magazine reports that the prices for raw materials, such as chloroform and hydrogen fluoride increased which increased the production costs. According to the magazine, two factories stated that the production was not profitable at all with the low prices. Although market prices are driven by many factors, this information suggests that the CDM may have been an important factor for the prices of HCFC-22.

In light of the submission from CDM-Watch, the CDM Executive Board suspended methodology AM0001 so that no additional HFC-23 destruction projects can be registered. During the same meeting, however, it also approved the issuance of CERs to 16 of the HFC destruction projects. CDM Executive Board, *Report of the Fifty-Eighth Meeting*, CDM-EB-58, paras. 28, 78 (Nov. 26, 2010). At the request of the Executive Board, the CDM's Methodology Panel prepared revisions to AM0001. After reviewing the available information, the Methodology Panel recommended that the waste ratio be dropped from 3.0 percent to either 1.0 percent or 1.4 percent. It also recommended that the quantity of HCFC-22 that is eligible for crediting be based on the *average* instead of the *maximum* historical HCFC-22 production level. CDM Methodologies Panel, *Report of the 49th Meeting of the Methodologies Panel*, Information Note on the revision of AM0001, Annex 13 (May 2011). The Executive Board adopted these recommendations when it approved the revised methodology in November 2011. CDM Executive Board, *Report of the Sixty-Fifth Meeting*, Report Version 01.1, CDM-EB-65, para. 86(a) (Nov. 25, 2011).

As a result of this decision of the CDM Executive Board, the Kyoto Protocol regime will continue to provide subsidies for the growth of the HCFC industry in developing countries. This problem created by the interplay of the climate and ozone regimes could have been solved by the Kyoto Protocol Parties — they could have barred or otherwise restricted the issuance of CERs for HFC destruction projects. As we see in the next section, the Parties to the Montreal Protocol have stepped in to take the necessary steps.

QUESTIONS AND DISCUSSION

1. The issues addressed by CDM-Watch in its Revision Request to methodology AM0001 related to waste ratios and other factors concerning the operation once a project is approved and operational. Methodology AM0001, like other methodologies, also includes eligibility criteria to determine whether projects can even participate in the CDM. In May 2005, the CDM Executive Board modified its approved baseline methodology for determining CERs for HFC-23 projects. It decided to apply the methodology only to HFC-23 waste streams from an *existing* HCFC-22 production facility with at least three years of operating history between the beginning of the year 2000 and the end of the year 2004 where the project activity occurs and where no regulation requires the destruction of the total amount of HFC-23 waste. CDM Executive Board, *Revision to Approved Baseline Methodology AM0001: Incineration of HFC 23 Waste Streams*, AM0001/Version 03 (May 13, 2005). The current methodology includes the following conditions:

- At least one HCFC-22 reaction unit at the project activity site has an operating history of at least three years between 1 January 2000 and 31 December 2004 and has been in operation from 2005 until the start of the project activity;
- The HFC-23 decomposition and, if applicable, any temporary storage of HFC-23, occurs only at the project activity site (i.e. no off-site transport occurs);
- No regulation requires the decomposition of the total amount of HFC-23 generated;
- Prior to the implementation of the project activity, no HFC-23 decomposition facility was installed at the project activity site and all HFC-23 generated at the project activity site was released to the atmosphere.

CDM Executive Board, *Approved Baseline and Monitoring Methodology AM0001: Decomposition of Fluoroform (HFC-23) Waste Streams*, AM0001 / Version 06.0.0 (Nov. 25, 2011). Are these conditions for approval of a CDM HFC-23 destruction project sufficient? What additional conditions would you impose?

2. For some specific projects, such as the HFC Decomposition Project in Ulsan, the Executive Board has not been able to agree on whether to issue CERs. CDM Executive Board, *Report of the Fifty-Ninth Meeting*, CDM-EB-59, para. 47 (Feb. 18, 2011). After several

meetings, the Executive Board finally renewed the crediting period for this project for another seven years after the project participants voluntarily agreed to revise the monitoring plan for the project to lower its waste factor, provided that the Executive Board adopts a revised methodology with a lower waste ratio. CDM Executive Board, *Report of the Sixty-Fifth Meeting*, CDM-EB-65, para. 67 (Nov. 25, 2011).

C. The Montreal Protocol Regime's Treatment of Greenhouse Gases

Although the focus of the Montreal Protocol regime has always been on avoiding ozone depletion, it has incidentally had an enormous positive impact on reducing global warming. Indeed, the Montreal Protocol has already led to the reduction of substances having a total global warming impact equivalent to 135 gigatons (Gt) of CO₂, or roughly 11 GtCO₂eq per year — more than five times the reductions of 2 GtCO₂eq per year from the Kyoto Protocol's first commitment period. See Guus J. M. Velders et al., *The Importance of the Montreal Protocol in Protecting Climate*, 104 PROC. NAT'L ACAD. SCI. 4814–19 (Mar. 20, 2007); UNEP, HFCs: A CRITICAL LINK IN PROTECTING CLIMATE AND THE OZONE LAYER: A SYNTHESIS REPORT 19 (2011). This means that the Montreal Protocol, alone, has slowed global warming by twelve years. If voluntary and domestic measures preceding the Montreal Protocol are taken into account, the effort to avoid ozone depletion has slowed global warming by an astonishing 41 years. Velders et al., at 4817. The significant impact of the Montreal Protocol is partly due to the fact that it has been curtailing global warming substances for decades, but it also reflects the effective nature of the Protocol's regulatory and technology-forcing approach in changing State behavior.

Even as early as the 1987 Montreal Protocol, the Parties emphasized that they were “conscious of the potential climatic effects of emissions of [ODSs].” See Montreal Protocol, Preamble, para. 4. Throughout the next two decades, the Montreal Protocol Parties would periodically affirm the need to consider the full environmental (presumably including climatic) effects of the substances they were regulating.

1. The HCFC Challenge

In establishing the control measures for HCFCs, Article 2F(7) of the Montreal Protocol noted that in addition to reducing ozone depletion, the decision to use HCFCs should meet other “environmental, safety and economic considerations.” Subsequently, the Parties would direct their technical bodies to consider such factors as “energy efficiency, total global warming impact, potential flammability, and toxicity” in evaluating substances under the regime. See *Decision VI/13: Assessment Panels*, Report of the Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, UNEP/OzL.Pro.6/7 (Oct. 1994). Finally, sparked by increasing concern over climate change, the Parties to the Montreal Protocol in 2007 clarified further their intention to build greater policy coherence between their efforts to reverse ozone depletion and climate change. They decided:

9. To encourage Parties to promote the selection of alternatives to HCFCs that

minimize environmental impacts, in particular impacts on climate, as well as meeting other health, safety and economic considerations; . . .

11. To agree that the Executive Committee, when developing and applying funding criteria for projects and programmes, and taking into account paragraph 6, give priority to cost-effective projects and programmes which focus on, *inter alia*: . . .

(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[.]

Decision XIX/6: Adjustments to the Montreal Protocol with Regard to Annex C, Group I, Substances (Hydrochlorofluorocarbons), Report of the Nineteenth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, UNEP/OzL.Pro.19/7 (Sept. 2007). Although this formal agreement to consider climate impacts was important, more important was the specific action the Parties took to accelerate the phase-out of HCFCs.

Under the 2007 Adjustments, production of HCFCs is to be frozen in 2013 at the average production level in 2009–2010. The phase-out of HCFCs would then be accelerated in both developed and developing countries. Developed countries agreed to a slightly more accelerated phase-out of HCFCs than previously agreed, culminating with the complete phase-out in 2020. Interim goals for developed countries are 75 percent by 2010 and 90 percent by 2015. Developing countries also agreed to a step-by-step phase-out on their way to a total phase-out in 2030. After freezing production and consumption in 2013, developing countries would reduce their HCFC production and consumption by 10 percent by 2015, 35 percent by 2020, and 67.5 percent by 2025. Developing countries will be eligible for up to a 2.5 percent “servicing” exemption, which will allow some grandfathered, capital-intensive equipment to continue to operate on HCFCs through 2040. The Parties also agreed that additional funding would be made available under the Multilateral Fund to assist developing countries in meeting the incremental costs of accelerating the phase-out of HCFCs. *Decision XIX/6: Adjustments to the Montreal Protocol with Regard to Annex C, Group I, Substances (Hydrochlorofluorocarbons)* (Sept. 2007). The differences between the “before” and “after” status of HCFCs is shown in the following table:

Table 10-1: The Acceleration of HCFCs

	Original Schedule	2007 Acceleration
Developed Countries	65% reduction by 2010	75% reduction by 2010
	90% reduction by 2015	90% reduction by 2015
	Phase-out by 2020	Total phase-out by 2020
	0.5% service tail	Service tail ends 2030
Developing Countries	Freeze production in 2016	Freeze production in 2013
		10% reduction by 2015

		35% reduction by 2020
		67.5% reduction by 2025
		97.5% reduction by 2030
	Total Phase-out by 2040	2.5% service tail ends 2040

As the table suggests, the key difference is that the developing country Parties agreed to a gradual reduction with interim phase-out targets as opposed to waiting until 2040 for the ban to kick in. This eliminates significant quantities of HCFCs along the way and reduces the risk that the 2040 ban would present an “all-or-nothing” compliance challenge, where countries might pretend to be reducing HCFC use along the way and simply wait until 2040 to disclose their noncompliance.

The Montreal Protocol’s acceleration of the phase-out of HCFCs is one of the most meaningful international steps yet taken to combat climate change. It will have a significant role in reducing greenhouse gas emissions and, just as importantly, provides hope that the international community will step up to meet the climate challenge. Consider the following excerpt describing the importance of the HCFC accelerated phase-out.

Last September’s historic agreement under the Montreal Protocol 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. This is particularly significant because the decision was taken by consensus by all 191 Parties to the Protocol — all but five countries recognized by the United Nations. Accelerating the HCFC phase-out could reduce emissions by 16 billion tons of carbon dioxide-equivalent (“GtCO₂e”) through 2040. In terms of radiative forcing, this will delay climate change by up to 1.5 years. . . . Thus, from September 2007 both Montreal and Kyoto can be considered climate protection treaties.

Donald Kaniaru, Rajendra Shende, & Durwood Zaelke, *Landmark Agreement to Strengthen Montreal Protocol Provides Powerful Climate Mitigation*, SUSTAINABLE DEV. L. & POL’Y 46, 46 (Winter 2008).

2. Can the Montreal Protocol Regulate GHGs?

The success of the Montreal Protocol from a climate change perspective and the more rapid phase-out of HCFCs, many of which are both ODSs and GHGs, have led to discussions about whether the Montreal Protocol could regulate GHGs that are not ODSs. HFCs, for example, are substitutes for HCFCs particularly in refrigeration and air conditioning. Demand for HFCs is soaring in developing countries. Research estimates that HFC emissions will grow to about 5.5 to 8.8 GtCO₂eq by 2050, which is equivalent to 9 to 19 percent of projected CO₂ emissions in 2050 under business-as-usual scenarios. Guus J. M. Velders et al., *The Large Contribution of Projected HFC Emissions to Future Climate Forcing*, 106 PROC. NAT’L ACAD. SCI. 10952 (July 7, 2009).

In 2010, 90 Montreal Protocol Parties signed a declaration recognizing that the projected increase in the use of HFCs poses a major challenge for the world's climate system and declared their intent to pursue further action to transition the world to environmentally sound alternatives to ODSs. In 2011, Canada, Mexico, and the United States proposed an amendment to the Montreal Protocol that called on Parties to reduce their consumption and production of 20 HFCs. Developed countries would reduce their consumption of HFCs to 15 percent of baseline levels by 2033 and developing countries would reduce their consumption to 15 percent of baseline levels by 2043. The U.S. Environmental Protection Agency estimated that this proposal would reduce 98 GtCO₂eq by 2050. Canada, Mexico, & United States, "Text of HFC Phasedown Amendment Proposal" (2011); Canada, Mexico, & United States, "Summary Points: North American HFC Submission to the Montreal Protocol" 2 (2011). The Federated States of Micronesia submitted a similar proposal. The Federated States of Micronesia, "Proposed Amendment to Control HFCs under the Montreal Protocol" (2011).

Can the Montreal Protocol regulate substances that are not ODSs? Most agree that this is indeed possible. Article 1 of the Montreal Protocol defines "controlled substance" to mean

a substance in Annex A, Annex B, Annex C or Annex E to this Protocol, whether existing alone or in a mixture. It includes the isomers of any such substance, except as specified in the relevant Annex, but excludes any controlled substance or mixture which is in a manufactured product other than a container used for the transportation or storage of that substance.

In other words, a "controlled substance" is not an "ozone depleting substance" but rather a substance included in one of the Protocol's annexes. Moreover, Article 3 requires the Parties to ensure that their "calculated level of consumption of the controlled substances" included in a particular annex meets a specific target by a specific date. Nowhere does the Montreal Protocol appear to limit its scope to ODSs. In fact, the Ozone Secretariat, in a response to questions about the proposal from Canada, Mexico, and the United States, referred to as the "North American Proposal," agreed that either the Vienna Convention or the Montreal Protocol could be amended to include a phase-down in HFCs:

Article 2(2)(b) of the Vienna Convention includes language that applies to the Vienna Convention and the Montreal Protocol, and states that "Parties shall . . . co-operate in harmonizing appropriate policies" associated with controlling ozone-depleting substances. One way the Parties may cooperate in "harmonizing their policies" with regard to phasing out CFCs and HCFCs is to specify how that transition should be accomplished — for example, by specifying which CFC and HCFC alternatives the Parties will, or will not, move to. Since HFCs are the primary alternative to CFCs and HCFCs, the Parties may agree to "harmonize their policies" in moving away from CFCs and HCFCs, past HFCs, and into other alternatives.

Note by the Secretariat, *Frequently Asked Questions on the North American HFC Amendment*

Proposal, UNEP/OzL.Pro.23/INF/5 (Nov. 15, 2011). Despite these assurances from the Ozone Secretariat, the Montreal Protocol Parties debated at length whether the Montreal Protocol could address HFCs.

**REPORT OF THE COMBINED NINTH MEETING OF THE
CONFERENCE OF THE PARTIES TO THE VIENNA CONVENTION ON
THE PROTECTION OF THE OZONE LAYER AND THE TWENTY-
THIRD MEETING OF THE PARTIES TO THE MONTREAL PROTOCOL
ON SUBSTANCES THAT DEplete THE OZONE LAYER**

UNEP/OzL.Conv.9/7-UNEP/OzL.Pro.23/11 (Dec. 8, 2011)

106. Introducing the proposed amendment, the representative of the United States of America highlighted a recent UNEP report describing clear links between ozone-related issues and climate change. Noting that HFCs were being introduced almost exclusively as an alternative to ozone-depleting substances, he said that the parties must immediately address an environmental harm resulting directly from the implementation of the Protocol and that preventing harm would be more cost-effective than repairing the damage after it had materialized.

107. He said that parties had a responsibility under the Vienna Convention to manage the phase-out of ozone-depleting substances in a manner that minimized adverse effects on the environment and that the current forum was perfectly placed to discuss HFCs produced and consumed as alternatives to ozone-depleting substances. In outlining the substance of the proposed amendment, he said that it was important to send a clear signal to industry to develop and commercialize substances with low global-warming potential in both developed and developing countries. Substantial benefits might accrue from adopting the amendment, including a cumulative 98 gigatonne reduction in the production of HFCs by 2050. The proposed amendment did not alter or affect obligations under the United Nations Framework Convention on Climate Change but rather promoted harmonization and coherence of policies among multilateral environmental agreements. He also explained that since HFCs were the primary alternative to CFCs and HCFCs, which were subject to phase-out under the Montreal Protocol, the parties might agree, in accordance with paragraph 2(b) of Article 2 of the Vienna Convention, to harmonize their policies in moving to other alternatives under the Montreal Protocol. Concluding, he noted that opposition to the proposed amendment had already been voiced on technical, economic and legal grounds. He said, however, that the way forward involved dialogue to find common ground, and he requested that a formal contact group should be established.

108. The representative of Canada . . . recalled that the parties to the Montreal Protocol had a long history of considering the impact of their actions and decisions on climate change, citing several decisions taken under the Protocol to that effect . . .

109. The representative of Mexico said that it was important for parties to the Montreal Protocol to make decisions based on scientific evidence and emphasized that his country had considered the evidence in deciding to support the proposed amendment and was acting on that

basis alone. The financial mechanism under the Montreal Protocol had shown unparalleled success in reducing production and consumption of harmful gases and it would be appropriate to extend that process to HFCs. He affirmed that there was a moral and ethical basis for taking action based on clear scientific data and urged that parties should engage in cooperative dialogue about the proposed amendment. . . .

111. There was agreement that in phasing out ozone-depleting substances it was preferable to adopt alternatives with low or zero global-warming potential rather than high global-warming potential. There was disagreement, however, on whether HFCs could be considered under the Montreal Protocol. Some representatives said that, because HFCs were not associated with ozone depletion, there was no legal basis for further discussion of the proposed amendments. Other representatives expressed support for further discussion of the amendments, noting that the Montreal Protocol and the Vienna Convention stipulated that protection of the ozone layer must be conducted with minimal effects on the environment and that the current rapid growth in HFC production was a direct result of actions undertaken under the Montreal Protocol.

112. Many representatives from parties vulnerable to the effects of climate change, particularly small island developing States and States in Africa, emphasized that the risks posed by and harm caused by climate change were already occurring and increasing, with disastrous effects for their populations. Several representatives said that it was contradictory to argue that actions taken under the Montreal Protocol might exacerbate climate change but that parties were barred from recognizing and responding to the consequences of those actions under the Montreal Protocol and must instead seek relief under a different international agreement having largely the same parties.

113. Some representatives said that both proposed amendments respected the principle of common but differentiated responsibilities, as they provided different timescales for phasing down HFCs for parties operating under paragraph 1 of Article 5 and those not so operating. One representative added that the Montreal Protocol had been one of the first multilateral environmental agreements to implement the principle, in particular in creating the Multilateral Fund and adopting worldwide implementation of ozone-depleting substance phase-out schedules. Another representative, however, said that . . . including HFCs in the Montreal Protocol would impose new obligations on all parties to the ozone regime that would not be consistent with the Kyoto Protocol, which only imposed the obligation of reducing HFCs on developed countries. In accordance with the principles of equity and common but differentiated responsibilities, developing countries, in contrast to developed countries, should deal with HFCs through voluntary, nationally appropriate actions supported by international financial, technological and capacity-building support. He urged parties to retain their focus on approaches that would be agreeable to all parties, instead of diverting efforts to questionable approaches such as the proposed amendments. Proponents of the amendments suggested that such concerns could be resolved through dialogue in a formal contact group.

114. Some representatives said that the Montreal Protocol provided the infrastructure for addressing the production and consumption of HFCs, particularly through the Multilateral Fund, the OzonAction information clearing-house and other technical assistance mechanisms. Those

representatives argued that the Montreal Protocol therefore provided a proper and effective framework for considerations of HFCs. Other representatives, however, said that the acknowledged success of the Montreal Protocol was grounded in its clear focus on ozone depletion. That success might be put at risk if its focus were diluted by encompassing other environmental issues. They said that the Framework Convention on Climate Change and its Kyoto Protocol were the appropriate multilateral environmental agreements for considering greenhouse gases such as HFCs. Some representatives further suggested that the Multilateral Fund could provide incentives for countries operating under paragraph 1 of Article 5 to use alternatives with low global-warming potential but that the Montreal Protocol could go no further in addressing HFCs in the absence of a request from the Framework Convention on Climate Change.

115. In response, representatives supporting establishment of a formal contact group to discuss the issues further noted that the priorities of the Framework Convention on Climate Change and the Kyoto Protocol were much broader in their overall scope, that negotiations under those agreements were much more complex, and that robust efforts to introduce consideration of HFCs in that context had so far failed. Moreover, those agreements addressed emissions but not consumption and production of greenhouse gases, including HFCs. They argued that the Montreal Protocol was therefore better positioned to examine consumption and production of HFCs, which had been promoted under its aegis. One representative also said that he supported a formal contact group but if one could not be created would also support informal negotiations to help advance the discussion of the amendments.

QUESTIONS AND DISCUSSION

1. The Montreal Protocol Parties adopted neither the North American proposal nor the proposal of the Federated States of Micronesia. Both proposals were submitted again for the next meeting of the Parties in 2012. *See* Proposed Amendment to the Montreal Protocol Submitted by Canada, Mexico and the United States of America, UNEP/OzL.Pro.WG.1/32/6 (May, 11, 2012), Proposed Amendment to the Montreal Protocol, UNEP/OzL.Pro.WG.1/32/5 (May, 11, 2012). While the Parties did not adopt the amendments, they did direct the Protocol's Scientific Assessment Panel to offer clarifications and updates with respect to (1) scientific observations of HFCs, (2) total global predictions over time relative to baseline data, (3) future radiative forcing, and (4) atmospheric lifetime of HFCs. *Report of the Twenty-Fourth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer*, UNEP/OzL.Pro.24/10, paras. 126–54 (Nov. 22, 2012).

2. Advocates for using the Montreal Protocol for HFCs draw a connection between HFCs and ODSs by explaining that HFCs are substitutes for HCFCs. But is such a connection even necessary from a legal perspective? Could the Montreal Protocol Parties establish control measures for the human-made GHGs included in Annex A of the Kyoto Protocol, such as perfluorocarbons and sulfur hexafluoride (SF₆), even though these substances are not ODSs? If there are no legal obstacles to doing so, *should* the Montreal Protocol Parties do so when another legal regime has explicit authority to regulate those substances? What about nitrogen trifluoride

(NF₃), a GHG that is a frequent substitute for PFCs and SF₆ with a global warming potential of roughly 17,000, but which has no relationship to ozone depletion? The Kyoto Protocol Parties added NF₃ to the list of regulated greenhouse gases for the second commitment period.

3. Durwood Zaelke and his colleagues at the Institute for Governance & Sustainable Development have been the most effective advocates for using the Montreal Protocol to achieve climate benefits. They note that the Montreal Protocol offers several advantages that will allow it reduce production and consumption of HFCs faster and in a more cost-effective way than the climate change regime:

The orderly and transparent phase-out schedule for the chemicals the Montreal Protocol targets has allowed markets to innovate and adjust, often resulting in significant cost and technical efficiencies. Past transitions from CFCs to HCFCs have helped drive technological innovation to create substitutes, and improved manufacturing processes and equipment. In many cases this innovation has produced gains in energy efficiency, reduced leakage or other technological improvements. The phase-out of CFCs is estimated to have spurred up to 60% improvement in energy efficiency of domestic refrigerators, and technology transfer to developing countries as part of the HCFC phase-out is expected to reduce energy consumption of room air conditioning units by 10–40%. As a backstop, the Montreal Protocol's 'essential use' and 'critical use' exemptions allow for continued use when environmentally acceptable options are not yet available.

The Montreal Protocol has also supported national ozone officers in every developing country, which are organized into regional networks. These experienced officers are well prepared to implement the HFC phasedown schedules and to efficiently and cost effectively utilize the funding made available through the MLF. Further, the Montreal Protocol has several successful scientific and technical bodies with decades of experience working closely with industry: the Scientific Assessment Panel, the Environmental Effects Assessment Panel, the Technology and Economic Assessment Panel (TEAP) and the Technical Options Committees. These bodies produce real-time, policy-relevant reports based on their familiarity with technology, both commercially available and in-development, in every relevant sector.

Durwood Zaelke, et al., *Strengthening Ambition for Climate Mitigation: The Role of the Montreal Protocol in Reducing Short-lived Climate Pollutants*, 21 RECIEL 231, 239–40 (2012). Zaelke, et al. note the important technology innovations resulting from the Montreal Protocol's phase-outs. Others have also acknowledged the Montreal Protocol's important "technology forcing" provisions:

[The Montreal Protocol] did not merely prescribe "best available technology" to replace CFCs. Rather the designers of the treaty mandated a timetable for deep cuts in consumption of these useful chemicals with full knowledge that the technology "did not yet exist to achieve those cuts." The treaty furnished an

unmistakable market signal that made it worthwhile for companies to invest in research into new chemicals and processes they had previously eschewed . . . I suspect we would find the same forces at work if we would focus on reducing dependence on fossil fuels in the current international negotiations on a climate treaty.

Richard Benedick, *Essay: A Case of Déjà Vu*, 266 SCI. AM. 160 (Apr. 1992). Are you convinced that the Montreal Protocol Parties should step in and establish phase-out schedules for HFCs and other human-made greenhouse gases? Do you agree with the view that clear standards like the phase-outs in the Montreal Protocol create a strong market signal for technological innovation? If clear legal standards, including prohibitions, provide market incentives and economic opportunities, why does the climate regime rely so heavily on the market-based cap-and-trade approach? What are the major advantages and disadvantages between the approaches taken by the ozone and climate regimes? Which do you think has the greatest potential to drive technological innovation?

4. How could coordination be improved further between the ozone and climate regimes? In the future, how should the Montreal Protocol address substances that both destroy the ozone layer and contribute to climate change? Industry argues that industrial gases, such as HFCs, should not be regulated solely under the Montreal Protocol, because inclusion of those gases in the Kyoto Protocol expands the supply of credits in the trading system, broadens its flexibility, and reduces overall compliance costs. Is the Montreal Protocol's regulatory approach incompatible with the market trading system of the Kyoto Protocol? If so, which do you prefer? What steps can be taken in the climate regime to better reflect the approach taken in the Montreal Protocol?

5. Reducing ODS Banks. Another existing gap in the Montreal Protocol that has significant climate change implications is the treatment of existing "banks" of ozone depleting substances:

The Montreal Protocol does not place any controls on emissions from "banks" and provides minimal incentives for their recovery and destruction. Banks are defined as the chemicals contained in equipment and products or stored in tanks. Large amounts of CFCs and other ODS substitutes such as HCFCs and HFCs (not an ODS but a GHG) currently exist in refrigerators, air conditioners, insulating foams, and chemical stockpiles, where they can leak. When equipment reaches the end of its useful life, the chemicals inside are usually released into the atmosphere.

With limited incentives for recovery and destruction of ODS banks, most of the CFCs in banks will be emitted into the atmosphere over the next decade, with detrimental impacts for both the ozone layer and the climate. In addition to contributing to the expected delay in ozone recovery, emissions from CFC banks by 2015 could equal approximately 7.4 GtCO₂-eq. yr⁻¹ — more than seven times the size of the emissions reductions initially targeted by the Kyoto Protocol.

Kaniaru et al., *Strengthening the Montreal Protocol*, *supra*, at 5–6. How would you recommend governments address these banks? Which regime would be more effective — the regulatory approach of the Montreal Protocol or the market incentives of the Kyoto Protocol? In November 2008, the Montreal Protocol Parties began to address this gap by launching initial pilot projects, cost-benefit analyses, and other consultations to promote the destruction of ODSs in stockpiles and discarded products such as refrigerators. As the following summary indicates, the opportunities and challenges of recovering or destroying these ODS banks are many:

A window of opportunity to recover ozone-depleting substances existed until 2020, in particular to consider banks of CFCs in parties operating under paragraph 1 of Article 5 [eds. note: developing countries]. While the recovery of ozone-depleting substances would be profitable in the short term, the issue of financing merited further discussion. Financing through voluntary and compliance carbon markets had great potential, but ensuring their efficacy and integrity would be important. There was also great potential for participation by the private sector; it would have to be determined to what extent activities would require the assistance of Governments. While providing incentives for collection and recovery could be important, they had not been found to be essential. Energy efficiency strategies should also be pursued and synergies sought in the management of various chemicals with a view to using projects and infrastructure to dispose of ozone-depleting substances at the same time as other chemicals, such as persistent organic pollutants. Countries with large-scale economies and experience of or programmes for the destruction or substitution of refrigerants had many more options to pursue in dealing with stocks of ozone-depleting substances than did smaller countries. Medium- and low-volume-consuming countries might therefore wish to consider aggregating their stockpiles of ozone-depleting substances for destruction, and some pilot projects in that area had been implemented. . . . Finally, decision makers should ensure that projects were sustainable.

UNEP, *Draft Report of the Seminar on the Environmentally Sound Management of Banks of Ozone-Depleting Substances (Decision XXI/2)*, UNEP/OzL.Pro/Seminar.1/1/2, para. 41 (Aug. 3, 2010).

6. Improving Energy Efficiency of ODS Alternative Technologies. The Montreal Protocol Parties' general decision to consider energy efficiency and other non-ozone environmental impacts paves the way for the Parties to address the climate change implications of future decisions they make. This is an important step in improving the coherence of global environmental governance generally and of the climate-ozone connection more specifically. It should allow the Montreal Protocol regime to address each substance in terms of its combined impacts on ozone and climate, using an integrated life-cycle analysis. Such an analysis would consider a chemical's ozone depleting potential, its global warming potential, the energy efficiency of the equipment in which it is used, and the potential for leaks and containment thereof. From this broader perspective, it may make sense for overall environmental purposes to exempt certain HCFCs from accelerated phase-out, perhaps in exchange for corresponding

offsets (i.e., destruction of an equal or even greater amount of ODSs), at least until an overall environmentally superior alternative emerges. See STEPHEN O. ANDERSEN & DURWOOD ZAELEKE, *INDUSTRY GENIUS: INVENTIONS AND PEOPLE PROTECTING THE CLIMATE AND FRAGILE OZONE LAYER* 168–69 (2003) (discussing the climate benefits from exempting HCFC-123 for use in low-pressure chillers where its leakage is near zero and its energy efficiency is superior to other refrigerants). See also Environmental Investigation Agency, *Turning Up the Heat: Linkages between Ozone Layer Depletion and Climate Change: The Urgent Case of HCFCs and HFCs* (2006).

III. REGULATING SHORT-LIVED CLIMATE FORCERS

Perhaps the greatest opportunity for addressing climate change in the short term is for governments to act aggressively on short-lived climate forcings — black carbon, methane, tropospheric ozone, and HFCs (although some HFCs have a long atmospheric lifetime, the average lifetime mix of HFCs weighted by use is just 15 years). These three substances, together with industrial gases such as CFCs and HFCs, account for roughly 40 percent of current climate change.

The role of short-lived climate forcings in climate change is underscored by reviewing the effects of these substances on radiative forcing in light of the goal of the climate change regime to maintain temperatures at no more than 2°C above pre-industrial levels. (As discussed in Chapter 1, absorbed solar energy is exactly balanced by radiation emitted to space by the Earth and atmosphere when the climate system is in equilibrium. Factors that disturb this balance, and thus potentially alter the climate, are called radiative forcing agents.). The 2°C goal translates to radiative forcing of less than or equal to 2.5 watts per meter squared (Wm^{-2}). Veerabhadran Ramanathan & Yangyang Xu, *The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues*, 107 PROC. NAT'L ACAD. SCI. 8055 (May 4, 2010).

The 2.5 Wm^{-2} requirement poses serious challenges since anthropogenic emissions of GHGs as of 2005 already trap 3 Wm^{-2} ; absorption of CO_2 by oceans and emissions of other substances that cool the earth by reflecting light back into space have kept the effect of anthropogenic emissions below 2.5 Wm^{-2} . See Table 10-2. Nonetheless, the oceans are reaching their capacity to absorb CO_2 , GHG emissions, particularly CO_2 emissions, continue to grow, and emissions of some cooling gases, such as sulfate aerosols, will decline when emissions of CO_2 decline. These factors place several constraints on mitigation options. Moreover, because of the long atmospheric lifetime of CO_2 , we must look elsewhere to meet the 2°C goal in a relevant timeframe to avoid unmanageable impacts of climate change. Short-lived climate forcings provide that opportunity.

Table 10–2: Radiative Forcing (RF) of Climate Forcers in 2005 (in Wm^{-2})

Long-lived Climate Forcers	RF
CO_2	1.66
HFCs, PFCs, SF_6	0.017

N ₂ O	0.16
CFCs, HCFCs and other Montreal Protocol Gases	0.32
Short-lived Climate Forcers	
Black Carbon	0.90
Tropospheric Ozone	0.35
CH ₄	0.48
Subtotal	3.878
Other	
SO ₂ /NO _x mix	- 2.1
Land surface changes due to deforestation	- 0.2
Total	1.578

Sources: P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS: CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 131–32 (2007); Veerabhadran Ramanathan & Yangyang Xu, *The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues*, 107 PROC. NAT'L ACAD. SCI. 8055, 8056 (May 4, 2010) (for black carbon).

A. An Introduction to Short-lived Climate Forcers

Three short-lived climate forcers — black carbon, tropospheric ozone, and methane — are frequently considered together because of their chemical links. For example, measures to reduce CH₄ have a large impact on global and regional warming because CH₄ is a GHG itself and a precursor to O₃, a powerful GHG. Measures to reduce black carbon will also reduce concentrations of O₃ (largely through reductions in emissions of carbon monoxide, a precursor gas of O₃).

1. Black Carbon

Black carbon, or soot, is a component of fine particle pollution emitted from diesel engines, residential stoves, agricultural and forest fires, and some industrial facilities. Black carbon is created when there is insufficient oxygen to yield a complete conversion of a fuel into CO₂ and water (incomplete combustion). Black carbon particles are small, typically smaller than a micrometer, but nonetheless have a large impact on climate change. In the atmosphere, black carbon absorbs solar radiation, which heats the surrounding air. It also causes warming when it is deposited on snow and ice, again, where it absorbs solar radiation and accelerates the melting of the snow and ice. It can also alter cloud formation by warming surrounding air and burning off low-level stratus and cumulus clouds. That allows more solar radiation to reach the earth's surface. Scientists estimate that the contribution of one gram of black carbon to climate change over a period of 100 years is 100 to 2,000 times greater than one gram of CO₂, even though its lifetime is only 3 to 8 days. When mixed with water soluble aerosols, however, it can create greater cloud cover that reflects more solar radiation back into the atmosphere and cool the earth. For this reason, the precise global warming impact of black carbon is still uncertain. Mario

Molina et al., *Reducing Abrupt Climate Change Risk Using the Montreal Protocol and Other Regulatory Actions to Complement Cuts in CO₂ Emissions*, 106 PROC. NAT'L ACAD. SCI. 20618-19 (2009); Note by the Executive Director, *Summary for Decision Makers of the Integrated Assessment of Black Carbon and Tropospheric Ozone*, UNEP/GC.26/INF/20, 6 (Feb. 17, 2011).

Black carbon may indirectly contribute to global warming in other ways. For example, because black carbon accelerates melting of snow and ice in the Arctic by absorbing solar radiation (sunlight), it contributes to longer ice-free Arctic conditions conducive to opening new Arctic navigation routes and new oil production facilities. Both of these activities will increase GHG emissions, including emission and deposition of black carbon. Erika Rosenthal & Robert Watson, *Multilateral Efforts to Reduce Black Carbon Emissions: A Lifeline for the Warming Arctic?*, 20 REV. EUR. COMM. & INT. ENV'T L. 3, 4 (2011).

Black carbon is the second largest warming agent, trailing only CO₂, and, while its effects are felt nearly everywhere, its effects are felt the most in the Arctic and other areas of snow and ice. Indeed, the Arctic is warming more than twice as fast as the rest of the planet, and black carbon is a major contributor.

Shindell and Faluvegi estimate that BC may be responsible for ~0.5–1.4°C of the 1.9°C warming observed in the Arctic from 1890 to 2007. Quinn et al. suggest that BC from northern Eurasia, North America, and Asia may be the greatest absolute impact on the Arctic, and that reducing emissions from local source regions could mitigate Arctic warming on a more immediate time scale than CO₂ reductions. Hansen and Nazernko estimate that reducing BC emissions to restore snow albedo “would have the double benefit of reducing global warming and raising the global temperature level at which dangerous anthropogenic interference occurs.”

In the Himalayan region, Ramathan and Carmichael estimate that solar heating from BC at high elevations may be as important as CO₂ for melting snow and ice, and their model simulations indicate that approximately 0.6°C of the 1°C warming in the Tibetan Himalayas since the 1950s may be due to atmospheric BC. Flanner et al estimate that BC and copollutants may be responsible for nearly as much total springtime snowmelt in Eurasia as anthropogenic CO₂, and that eliminating these emissions could restore up to 25% of the ice cover lost since preindustrial times. This large warming trend is the proposed causal factor for the accelerating retreat of Himalayan-Tibetan glaciers, which threaten fresh water supplies and food security in China and India.

Molina et al., at 20619.

Black carbon derives almost exclusively from two major sources: the use of fossil fuels and biomass burning. The use of fossil fuels, particularly diesel, contributes about 35 percent of black carbon emissions worldwide. The remaining 65 percent are associated with the burning of biomass from forest fires, man-made fires for clearing cropland, and the use of organic fuels for

cooking, heating, and small-scale industry. Jessica Seddon Wallack & Veerabhadran Ramanathan, *The Other Climate Changers: Why Black Carbon and Ozone Also Matter*, 88 FOREIGN AFFAIRS 105, 107 (Sept./Oct. 2009).

QUESTIONS AND DISCUSSION

1. Some basic technological fixes exist to reduce black carbon. For example, regenerative filters for diesel vehicles reduce black carbon emissions by up to 99 percent. S. Biswas et al., *Chemical Speciation of PM Emissions from Heavy-Duty Diesel Vehicles Equipped with Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) Retrofits*, 43 ATMOS. ENV'T 1917 (2009). According to one estimate, retrofitting one million semitrailer trucks with these filters between 2012 and 2030 would provide the total equivalent carbon dioxide reduction of 96 million metric tons — equivalent to eliminating the annual emissions of 21 million cars or 1.8 million diesel semitrailer trucks. L. BRUCE HILL, THE CARBON DIOXIDE-EQUIVALENT BENEFITS OF REDUCING BLACK CARBON EMISSIONS FROM U.S. CLASS 8 TRUCKS USING DIESEL PARTICULATE FILTERS: A PRELIMINARY ANALYSIS 4 (rev. Sept 10, 2009).

Addressing biomass cooking will be more challenging. Biomass cooking, which emits black carbon as well as methane and carbon monoxide, both of which produce ozone and thus amplify warming, is used by an estimated three billion people in the developing world. Despite China's rapid economic growth, approximately 80 percent of Chinese households rely on solid fuels like wood or dung to meet their energy needs. The benefits of replacing traditional biomass cooking with BC-free stoves in specific regions would be significant: it could reduce BC-caused warming by 70 to 80 percent over South Asia and by 20 to 40 percent over East Asia. Molina et al., at 20619.

2. The reduction of black carbon will have significant co-benefits, particularly for public health:

Black carbon makes up a varying fraction of particulate pollution — a known health hazard and a traditional, regulated air pollutant in Europe, the United States and other countries. PM_{2.5} fine particulate pollution (smaller than 2.5 microns) is linked to many significant health impacts, including increased morbidity and mortality from cardiovascular and respiratory illness and lung cancer. The United States Environmental Protection Agency has concluded that although uncertainties remain, diesel soot is 'likely to be carcinogenic to humans by inhalation.' Initial studies in the Netherlands and the United States suggest that black carbon's small *particle* size (1 micron or less) reaches deeper into the lungs and may present greater acute affects than PM_{2.5}.

Indoor and outdoor air pollution from PM_{2.5} is a major contributor to morbidity and mortality throughout the developing world. Black carbon contributes to the thick blankets of hazy pollution known as atmospheric brown clouds that hang over major urban areas around the world. The World Health

Organization (WHO) estimates that indoor air pollution alone, principally from traditional cookstoves, causes 1.9 million premature deaths annually, mostly women and children. Most of the health benefits of black carbon mitigation are local, accruing to the citizens of the country that takes action — a powerful motivator for national action.

Rosenthal & Watson, at 5.

3. The Global Alliance for Clean Cookstoves is a public-private partnership comprising more than 300 public and private partners and 35 countries that seeks to “save lives, improve livelihoods, empower women, and combat climate change by creating a thriving global market for clean and efficient household cooking solutions.” It has set a goal to foster the adoption of clean cookstoves and fuels in 100 million households by 2020. For more information, see The Global Alliance for Clean Cookstoves, at <http://www.cleancookstoves.org/the-alliance>; U.S. Dep’t of State, Global Alliance for Clean Cookstoves, at <http://www.state.gov/s/partnerships/cleancookstoves/index.htm>.

2. Tropospheric Ozone

As noted in the introduction to Section II, tropospheric ozone (O₃) is a significant greenhouse gas and human health pollutant. Ozone is not emitted directly but is formed when CH₄, nitrogen oxides (NO_x —nitric oxide (NO) and nitrogen dioxide (NO₂)), volatile organic compounds (VOCs), and carbon monoxide (CO) react with sunlight. Large increases in these ozone precursor gases have increased tropospheric ozone concentrations globally by roughly 30 percent from preindustrial levels; in the northern hemisphere, ozone concentrations have more than doubled. The contribution of tropospheric ozone to global warming, even though its atmospheric lifetime is only 4 to 18 days, is about 20 percent of that caused by CO₂. Molina et al. at 20619; ROYAL SOCIETY, GROUND-LEVEL OZONE IN THE 21ST CENTURY: FUTURE TRENDS, IMPACTS AND POLICY IMPLICATIONS 1 (2008).

Emissions of ozone precursor gases arise from a wide variety of natural and anthropogenic sources:

Energy generation, transport, agriculture, industrial processes, biomass burning and land use changes such as deforestation are significant sources of O₃ precursor gases. Socioeconomic and environmental factors are therefore important drivers of O₃ pollution as they affect either the production of natural and anthropogenic O₃ precursor emissions, or O₃ production or destruction rates. Underpinning these drivers are population growth and economic development as they lead to increases in demand for resources such as land and fossil fuels, and polluting activities such as energy production, agriculture and transport. The world’s population is expected to reach 9.2 billion in 2050 and increased urbanisation, particularly in rapidly developing countries, and the associated growth in transport, industrial infrastructure and energy use, are expected to lead

to a rapid increase in O₃ pollution unless regulatory controls and new technologies are implemented.

ROYAL SOCIETY, GROUND-LEVEL OZONE IN THE 21ST CENTURY: FUTURE TRENDS, IMPACTS AND POLICY IMPLICATIONS 3 (2008).

Breathing ozone can cause a range of human health problems, including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma, as well as reduce lung function and inflame the linings of the lungs. Repeated exposure to ozone may permanently scar lung tissue. Environmental Protection Agency, Ground-level Ozone, Health Effects, at <http://www.epa.gov/groundlevelozone/health.html>.

Ozone is also toxic to plants. UNEP and the World Meteorological Organization (WMO) estimate that measures to control emissions of CH₄ to reduce tropospheric ozone concentrations could avoid the loss of about 25 million tons of rice, maize, soybean, and wheat annually. UNEP & WMO, INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS 16 (2011). The Royal Society put this damage from ozone in monetary terms: It estimated that ozone in 2000 caused \$14 to \$26 billion in crop damage, a figure “significantly higher than present day losses to crops projected to occur as a result of climate change.” ROYAL SOCIETY, at 77.

3. Methane

Methane is a GHG in its own right with an atmospheric life of 12 years, but it is also a precursor for ozone. Methane has the second largest radiative forcing of the GHGs after CO₂ (see Table 10-3). The IPCC has reported that present atmospheric concentrations of CH₄ “are unprecedented in at least the last 650,000 years,” with concentrations rising from 715 parts per billion in 1970 to 1,774 in 2005. Forster et al., at 140, 143. These increases in methane result from agriculture, including rice cultivation and the keeping of ruminant livestock, coal mining, oil and gas production and distribution, biomass burning, and municipal waste landfills.

QUESTIONS AND DISCUSSION

1. As with reducing emissions of other short-lived climate forcers, reducing emissions of methane will have significant co-benefits for human health and air quality. For some methane sources, emission control measures for methane also reduce other co-emitted substances such as VOCs that contribute to the formation of tropospheric ozone, as well as air toxics, such as benzene, carbon tetrachloride and chloroform.

2. In 2004, 14 governments, including the United States, launched the Methane to Markets Partnership to advance cost-effective, near-term methane recovery and use as a clean energy source. The Initiative focused on methane recovery and use opportunities in the agriculture (animal waste management), coal mine, landfill, and oil and gas system sectors. The Partnership,

renamed the Global Methane Initiative in 2010, now includes 38 additional governments, the European Commission, the Asian Development Bank, and the Inter-American Development Bank, as well as NGO participants, that have collaborated on more than 300 projects around the world that have reduced methane emissions by approximately 40 million MtCO₂eq. When fully implemented, these projects are expected to reduce emissions by more than 60 million MtCO₂eq per year while also providing new sources of clean energy, supporting technology transfer, stimulating local economic growth, and providing public health and environmental benefits. Participating governments are also asked to develop actions plans in order to coordinate methane reduction efforts, and developed countries will provide coordinated assistance to developing country partners. For more on the Global Methane Initiative, see <http://www.globalmethane.org>.

B. Multilateral Efforts to Mitigate Short-lived Climate Forcers

Governments have treated abatement of black carbon and tropospheric ozone primarily as local human health issues to be addressed at the national level. Many countries, including the United States and the member States of the European Union have taken measures to limit emissions of these substances. Moreover, technologies exist for making drastic emission reductions of these substances. For example, black carbon can be reduced by as much as 50 percent with existing technologies. With a 50 percent reduction in black carbon, it may be possible “to offset the warming effects of one to two decades’ worth of carbon dioxide emissions.” Wallack & Ramanathan, at 105, 108.

UNEP and the WMO recently compiled a list of measures (see Table 10-3), already employed in many countries, and estimated that widespread implementation of measures to reduce methane, NO_x, carbon monoxide and nonmethane volatile organic compounds emissions, the principal precursors of black carbon and/or tropospheric ozone, would reduce future warming by 0.5°C, as well as avoid, each year, 2.4 million premature deaths and the loss of 52 million tons of maize, rice, soybean, and wheat. Put another way, implementation of these measures would reduce warming by half during the 2030s relative to not implementing these measures. In contrast, even aggressively reducing CO₂ emissions “does little to mitigate warming over the next 20–30 years” although it clearly leads to long-term climate benefits. UNEP & WMO, INTEGRATED ASSESSMENT OF BLACK CARBON AND TROPOSPHERIC OZONE: SUMMARY FOR DECISION MAKERS 3, 10–11 (2011).

Adoption of the near-term emission control measures described in this Assessment, together with measures to reduce CO₂ emissions, would greatly improve the chances of keeping Earth’s temperature increase to less than 2°C relative to pre-industrial levels (Figure 3). With the CO₂ measures alone, warming exceeds 2°C before 2050. Even with both the CO₂ measures and CH₄ measures envisioned under the same IEA 450 Scenario, warming exceeds 2°C in the 2060s. However, the combination of CO₂, CH₄, and BC measures holds the temperature increase below 2°C until around 2070. While CO₂ emission reductions even larger than those in the CO₂ measures scenario would of course mitigate more warming, actual CO₂ emissions over the past decade have consistently exceeded the most

pessimistic emission scenarios of the IPCC. Thus, it seems unlikely that reductions more stringent than those in the CO₂ measures scenario will take place during the next 20 years.

Examining the more stringent UNFCCC 1.5°C threshold, the CO₂ measures scenario exceeds this by 2030, whereas the near-term measures proposed in the Assessment delay that exceedance until after 2040. Again, while substantially deeper early reductions in CO₂ emissions than those in the CO₂ measures scenario could also delay the crossing of the 1.5°C temperature threshold, such reductions would undoubtedly be even more difficult to achieve. However, adoption of the Assessment’s near-term measures (CH₄ + BC) along with the CO₂ reductions would provide a substantial chance of keeping the Earth’s temperature increase below 1.5°C for the next 30 years.

UNEP & WMO, at 12–13.

Table 10–3. Measures that improve climate change mitigation and air quality and have a large emission reduction potential

Measure ¹	Sector
CH₄ Measures	
Extended pre-mine degasification and recovery and oxidation of CH ₄ from ventilation air from coal mines	Extraction and transport of fossil fuel
Extended recovery and utilization, rather than venting, of associated gas and improved control of unintended fugitive emissions from the production of oil and natural gas	
Reduced gas leakage from long-distance transmission pipelines	
Separation and treatment of biodegradable municipal waste through recycling, composting and anaerobic digestion as well as landfill gas collection with combustion/utilization	Waste management
Upgrading primary wastewater treatment to secondary/tertiary treatment with gas recovery and overflow control	
Control of CH ₄ emissions from livestock, mainly through farm-scale anaerobic digestion of manure from cattle and pigs	Agriculture
Intermittent aeration of continuously flooded rice paddies	
BC measures (affecting BC and other co-emitted compounds)	
Diesel particle filters for road and off-road vehicles	Transport
Elimination of high-emitting vehicles in road and off-road transport	
Replacing coal by coal briquettes in cooking and heating stoves	Residential
Pellet stoves and boilers, using fuel made from recycled wood waste or sawdust, to replace current wood-burning technologies in the residential sector in industrialized countries	
Introduction of clean-burning biomass stoves for cooking and heating in developing countries ^{2,3}	

Substitution of clean-burning cookstoves using modern fuels for traditional biomass cookstoves in developing countries ^{2,3}	
Replacing traditional brick kilns with vertical shaft kilns and Hoffman kilns	Industry
Replacing traditional coke ovens with modern recovery ovens, including the improvement of end-of-pipe abatement measures in developing countries	
Ban of open field burning of agricultural waste ²	Agriculture

¹ There are measures other than those identified in the table that could be implemented. For example, electric cars would have a similar impact to diesel particulate filters but these have not yet been widely introduced; forest fire controls could also be important but are not included due to the difficulty in establishing the proportion of fires that are anthropogenic.

² Motivated in part by its effect on health and regional climate, including areas of ice and snow.

³ For cookstoves, given their importance for BC emissions, two alternative measures are included.

UNEP & WMO, at 9.

Even if these technologies already exist, that does not mean that each country will eagerly require the use of these technologies. As with reduction of CO₂ emissions, countries may believe that implementation of these measures in the absence of an international agreement will put their industries at a competitive disadvantage. The transboundary nature of tropospheric ozone and its precursor gases as well as the established global warming effects of these substances also suggest that an international agreement might produce more profound climate benefits than a country-by-country approach.

To date, no international agreement has the scope to address these short-lived climate forcers comprehensively. However, given the nature of the pledges in the Cancun Agreements, some UNFCCC Parties may elect to reduce emissions of short-lived climate forcers. Recall, for example, that Annex I Parties did not specify which GHGs they would reduce and that the Cancun Agreements do not limit mitigation efforts to the six gases included in Annex A of the Kyoto Protocol. *See* Chapter 6, Section III.B. The UNFCCC Parties could also agree as part of the Durban Platform to focus on short-lived climate forcers.

In the meantime, bilateral and regional agreements and institutions could be used to reduce emissions of short-lived climate forcers. The most prominent regional effort is the Convention on Long Range Transboundary Air Pollution, which has taken action to reduce NO_x emissions and other precursors of ozone and black carbon, although it has done so more out of concern for human health and acid rain than climate change. The International Maritime Organization and the Arctic Council also provide opportunities for addressing short-lived climate forcers on a regional or international scale.

1. The Convention on Long Range Transboundary Air Pollution

Mainly as a response to the public outcry against the detrimental impacts of acid rain in Europe, caused primarily by emissions of sulfur dioxide (SO₂) and nitrogen oxides (NO_x) that mix with water and precipitate out of the atmosphere as acids, the members of the United

Nations Economic Commission for Europe negotiated the Convention on Long Range Transboundary Air Pollution (CLRTAP). Signed in 1979 and entered into force in 1983, CLRTAP was the first regional environmental convention and has been instrumental in reducing key harmful pollutants in both Europe and North America.

CLRTAP began by requiring Parties to develop “the best available technology which is economically feasible and low- and non-waste technology” to reduce emissions of air pollutants. Since then, the Parties have negotiated eight protocols that require Parties to adopt technology-based standards, specific numerical pollution targets, and specified policy responses to protect human and environmental health from pollutants such as SO₂, NO_x, persistent organic pollutants, volatile organic compounds, ammonia, and toxic heavy metals.

Like the Montreal Protocol, CLRTAP is responsible for a number of significant accomplishments in the region:

- Between 1990 and 2006, SO₂ levels have dropped by 70% within the European Union, and by 36% in the United States;
- Between 1990 and 2006, NO_x levels have dropped by 35% within the European Union, and by 23% in the United States;
- Between 1990 and 2006, ammonia (NH₃) levels have dropped by 20% in the European Union;
- Between 1990 and 2006, non-methane volatile organic compounds have decreased by 41% in the European Union;
- Between 1990 and 2006, primary particulate matter (PM 10) has declined by 28% in the European Union.

UNECE, UNECE’s Convention on Long-range Transboundary Air Pollution Celebrates 30th Anniversary, *at* <http://www.unece.org/env/lrtap/30anniversary.html>.

CLRTAP’s protocol-based approach has made it an ideal vehicle for responding to new scientific information and new challenges. As you read excerpts from three of CLRTAP’s protocols — the Sofia Protocol, Geneva Protocol, and Gothenburg Protocol — consider the various approaches used and whether any of the approaches offer possibilities for use on a global scale.

**PROTOCOL TO THE 1979 CONVENTION ON LONG-RANGE
TRANSBOUNDARY AIR POLLUTION CONCERNING THE CONTROL
OF EMISSIONS OF NITROGEN OXIDES OR THEIR TRANSBOUNDARY
FLUXES (SOFIA PROTOCOL)**

UNECE, signed Oct. 31, 1987, entered into force Feb. 14, 1991

Article 2 — Basic Obligations

1. The Parties shall, as soon as possible and as a first step, take effective measures to control and/or reduce their national annual emissions of nitrogen oxides or their transboundary fluxes so that these, at the latest by 31 December 1994, do not exceed their national annual emissions of nitrogen oxides or transboundary fluxes of such emissions for the calendar year 1987 or any previous year to be specified upon signature of, or accession to, the Protocol, provided that in addition, with respect to any Party specifying such a previous year, its national average annual transboundary fluxes or national average annual emissions of nitrogen oxides for the period from 1 January 1987 to 1 January 1996 do not exceed its transboundary fluxes or national emissions for the calendar year 1987.

2. Furthermore, the Parties shall in particular, and no later than two years after the date of entry into force of the present Protocol:

(a) Apply national emissions standards to major new stationary sources and/or source categories, and to substantially modified stationary sources in major source categories, based on the best available technologies which are economically feasible, taking into consideration the Technical Annex;

(b) Apply national emission standards to new mobile sources in all major source categories based on the best available technologies which are economically feasible, taking into consideration the Technical Annex and the relevant decisions taken within the framework of the Inland Transport Committee of the Commission; and

(c) Introduce pollution control measures for major existing stationary sources, taking into consideration the Technical Annex and the characteristics of the plant, its age and its rate of utilization and the need to avoid undue operational disruption.

3. (a) The Parties shall, as a second step, commence negotiations, no later than six months after the date of entry into force of the present Protocol, on further steps to reduce national annual emissions of nitrogen oxides or transboundary fluxes of such emissions, taking into account the best available scientific and technological developments, internationally accepted critical loads and other elements resulting from the work programme undertaken under article 6;

(b) To this end, the Parties shall cooperate in order to establish:

(i) Critical loads;

(ii) Reductions in national annual emissions of nitrogen oxides or transboundary fluxes of such emissions as required to achieve agreed objectives based on critical loads; and

(iii) Measures and a timetable commencing no later than 1 January 1996 for achieving such reductions.

The subsequent Geneva Protocol on the Control of Emissions of Volatile Organic Compounds or Their Transboundary Fluxes tackled the second major class of air pollutants responsible for the formation of tropospheric ozone — volatile organic compounds (VOCs). Rather than setting targets and timetables, this Protocol, among other things, specifies three options for emission reduction targets that a country must choose upon signature or ratification of the Protocol.

**PROTOCOL TO THE 1979 CONVENTION ON LONG-RANGE
TRANSBOUNDARY AIR POLLUTION CONCERNING THE CONTROL
OF EMISSIONS OF VOLATILE ORGANIC COMPOUNDS OR THEIR
TRANSBOUNDARY FLUXES (GENEVA PROTOCOL)**

UNECE, signed Nov. 18, 1991, entered into force Sept. 29, 1997

Article 2 — Basic Obligations

1. The Parties shall control and reduce their emissions of VOCs in order to reduce their transboundary fluxes and the fluxes of the resulting secondary photochemical oxidant products so as to protect human health and the environment from adverse effects.

2. Each Party shall, in order to meet the requirements of paragraph 1 above, control and reduce its national annual emissions of VOCs or their transboundary fluxes in any one of the following ways to be specified upon signature:

(a) It shall, as soon as possible and as a first step, take effective measures to reduce its national annual emissions of VOCs by at least 30 per cent by the year 1999, using 1988 levels as a basis or any other annual level during the period 1984 to 1990, which it may specify upon signature of or accession to the present Protocol; or

(b) Where its annual emissions contribute to tropospheric ozone concentrations in areas under the jurisdiction of one or more other Parties, and such emissions originate only from areas under its jurisdiction that are specified as TOMAs in annex I, it shall, as soon as possible and as a first step, take effective measures to:

(i) Reduce its annual emissions of VOCs from the areas so specified by at least 30 per cent by the year 1999, using 1988 levels as a basis or any other annual level during the period 1984-1990, which it may specify upon signature of or accession to the present Protocol; and

(ii) Ensure that its total national annual emissions of VOCs by the year 1999 do not exceed the 1988 levels; or

(c) Where its national annual emissions of VOCs were in 1988 lower than 500,000 tonnes and 20 kg/inhabitant and 5 tonnes/km², it shall, as soon as possible and as a first step, take effective measures to ensure at least that at the latest by the year 1999 its national annual emissions of VOCs do not exceed the 1988 levels.

3. (a) Furthermore, no later than two years after the date of entry into force of the present Protocol, each Party shall:

(i) Apply appropriate national or international emission standards to new stationary sources based on the best available technologies which are economically feasible, taking into consideration annex II;

(ii) Apply national or international measures to products that contain solvents and promote the use of products that are low in or do not contain VOCs, taking into consideration annex II, including the labelling of products specifying their VOC content;

(iii) Apply appropriate national or international emission standards to new mobile sources based on the best available technologies which are economically feasible, taking into consideration annex III; and

(iv) Foster public participation in emission control programmes through public announcements, encouraging the best use of all modes of transportation and promoting traffic management schemes.

(b) Furthermore, no later than five years after the date of entry into force of the present Protocol, in those areas in which national or international tropospheric ozone standards are exceeded or where transboundary fluxes originate or are expected to originate, each Party shall:

(i) Apply the best available technologies that are economically feasible to existing stationary sources in major source categories, taking into consideration annex II;

(ii) Apply techniques to reduce VOC emissions from petrol distribution and motor vehicle refuelling operations, and to reduce volatility of petrol, taking into consideration annexes II and III.

* * *

5. In implementing the present Protocol, and in particular any product substitution measures, Parties shall take appropriate steps to ensure that toxic and carcinogenic VOCs, and those that harm the stratospheric ozone layer, are not substituted for other VOCs.

6. The Parties shall, as a second step, commence negotiations, no later than six months after the date of entry into force of the present Protocol, on further steps to reduce national annual emissions of volatile organic compounds or transboundary fluxes of such emissions and their resulting secondary photochemical oxidant products, taking into account the best available

scientific and technological developments, scientifically determined critical levels and internationally accepted target levels, the role of nitrogen oxides in the formation of photochemical oxidants and other elements resulting from the work programme undertaken under article 5.

7. To this end, the Parties shall cooperate in order to establish:

(a) More detailed information on the individual VOCs and their POCP values;

(b) Critical levels for photochemical oxidants;

(c) Reductions in national annual emissions or transboundary fluxes of VOCs and their resulting secondary photochemical oxidant products, especially as required to achieve agreed objectives based on critical levels;

(d) Control strategies, such as economic instruments, to obtain overall cost-effectiveness to achieve agreed objectives;

(e) Measures and a timetable commencing no later than 1 January 2000 for achieving such reductions.

8. In the course of these negotiations, the Parties shall consider whether it would be appropriate for the purposes specified in paragraph 1 to supplement such further steps with measures to reduce methane.

Not satisfied that the Geneva Protocol adequately addressed concerns relating to tropospheric ozone, the CLRTAP Parties negotiated the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. The Gothenburg Protocol sets emission limits for four pollutants: sulfur, NO_x, VOCs, and ammonia. Despite other CLRTAP protocols addressing these substances, the Parties innovated yet again. As you read the obligations of the Protocol, consider the role of Tropospheric Ozone Management Areas (“TOMAs”), Cooperative Programmes for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe (“EMEPs”), and pollutant emissions management areas (“PEMAs”).

Annex II establishes emissions limits for sulfur, NO_x, VOCs, and ammonia. CLRTAP Parties whose emissions have a more severe environmental or health impact and whose emissions are relatively cheap to reduce must make the biggest cuts. Germany, for example, must reduce its NO_x emissions by 60 percent whereas Armenia, Croatia, and Greece are not required to reduce their emissions at all; Cyprus can even grow its emissions by 28 percent. Once fully implemented, the Protocol is expected to reduce Europe’s sulfur emissions by at least 63 percent, its NO_x emissions by 41 percent, its VOC emissions by 40 percent, and its ammonia emissions by 17 percent compared to 1990.

The Protocol also takes a sectoral approach by setting limit values for specific emission sources (e.g. combustion plant, electricity production, dry cleaning, cars and trucks). *See* Annexes IV, V, and VI. For example, any new or existing wood and plastic lamination facility must limit its consumption of solvent to less than 5 milligrams per year and emissions of nonmethane-VOCs to 30g/m². Annex VI, Table 3.

**PROTOCOL TO THE 1979 CONVENTION ON LONG-RANGE
TRANSBOUNDARY AIR POLLUTION TO ABATE ACIDIFICATION,
EUTROPHICATION AND GROUND-LEVEL OZONE (GOTHENBURG
PROTOCOL)**

UNECE, signed Nov. 30, 1999, entered into force May 17, 2005

Article 3 — Basic Obligations

1. Each Party having an emission ceiling in any table in annex II shall reduce and maintain the reduction in its annual emissions in accordance with that ceiling and the timescales specified in that annex. Each Party shall, as a minimum, control its annual emissions of polluting compounds in accordance with the obligations in annex II.

2. Each Party shall apply the limit values specified in annexes IV, V and VI to each new stationary source within a stationary source category as identified in those annexes, no later than the timescales specified in annex VII. As an alternative, a Party may apply different emission reduction strategies that achieve equivalent overall emission levels for all source categories together.

3. Each Party shall, in so far as it is technically and economically feasible and taking into consideration the costs and advantages, apply the limit values specified in annexes IV, V and VI to each existing stationary source within a stationary source category as identified in those annexes, no later than the timescales specified in annex VII. As an alternative, a Party may apply different emission reduction strategies that achieve equivalent overall emission levels for all source categories together or, for Parties outside the geographical scope of EMEP, that are necessary to achieve national or regional goals for acidification abatement and to meet national air quality standards.

4. Limit values for new and existing boilers and process heaters with a rated thermal input exceeding 50 MWth and new heavy-duty vehicles shall be evaluated by the Parties at a session of the Executive Body with a view to amending annexes IV, V and VIII no later than two years after the date of entry into force of the present Protocol.

5. Each Party shall apply the limit values for the fuels and new mobile sources identified in annex VIII, no later than the timescales specified in annex VII.

6. Each Party should apply best available techniques to mobile sources and to each new or existing stationary source, taking into account guidance documents I to V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto.

7. Each Party shall take appropriate measures based, *inter alia*, on scientific and economic criteria to reduce emissions of volatile organic compounds associated with the use of products not included in annex VI or VIII. The Parties shall, no later than at the second session of the Executive Body after the entry into force of the present Protocol, consider with a view to adopting an annex on products, including criteria for the selection of such products, limit values for the volatile organic compound content of products not included in annex VI or VIII, as well as timescales for the application of the limit values.

8. Each Party shall, subject to paragraph 10:

- (a) Apply, as a minimum, the ammonia control measures specified in annex IX; and
- (b) Apply, where it considers it appropriate, best available techniques for preventing and reducing ammonia emissions, as listed in guidance document V adopted by the Executive Body at its seventeenth session (decision 1999/1) and any amendments thereto.

9. Paragraph 10 shall apply to any Party:

- (a) Whose total land area is greater than 2 million square kilometres;
- (b) Whose annual emissions of sulphur, nitrogen oxides, ammonia and/or volatile organic compounds contributing to acidification, eutrophication or ozone formation in areas under the jurisdiction of one or more other Parties originate predominantly from within an area under its jurisdiction that is listed as a PEMA in annex III, and which has presented documentation in accordance with subparagraph (c) to this effect;
- (c) Which has submitted upon signature, ratification, acceptance or approval of, or accession to, the present Protocol a description of the geographical scope of one or more PEMAs for one or more pollutants, with supporting documentation, for inclusion in annex III; and
- (d) Which has specified upon signature, ratification, acceptance or approval of, or accession to, the present Protocol its intention to act in accordance with this paragraph.

10. A Party to which this paragraph applies shall:

- (a) If within the geographical scope of EMEP, be required to comply with the provisions of this article and annex II only within the relevant PEMA for each pollutant for which a PEMA within its jurisdiction is included in annex III; or
- (b) If not within the geographical scope of EMEP, be required to comply with the provisions of paragraphs 1, 2, 3, 5, 6 and 7 and annex II, only within the relevant PEMA for

each pollutant (nitrogen oxides, sulphur and/or volatile organic compounds) for which a PEMA within its jurisdiction is included in annex III, and shall not be required to comply with paragraph 8 anywhere within its jurisdiction.

11. Canada and the United States of America shall, upon their ratification, acceptance or approval of, or accession to, the present Protocol, submit to the Executive Body their respective emission reduction commitments with respect to sulphur, nitrogen oxides and volatile organic compounds for automatic incorporation into annex II.

12. The Parties shall, subject to the outcome of the first review provided for under article 10, paragraph 2, and no later than one year after completion of that review, commence negotiations on further obligations to reduce emissions.

QUESTIONS AND DISCUSSION

1. The 25 Parties to the Sofia Protocol have collectively reduced NO_x emissions 9 percent compared to 1987 and 19 of the Parties have met or exceeded their targets to stabilize emissions at 1987 levels (or 1978 levels for the United States because it had taken earlier efforts to reduce NO_x emissions). What strategies does the Sofia Protocol use to achieve these reductions? Which strategies would be new to the climate change regime? Do you think they are feasible to employ at a global level? Why or why not?

2. Most of the Geneva Protocol's 24 Parties opted to reduce VOC emissions by 30 percent by 1999 (Austria, Belgium, Estonia, Finland, France, Germany, Netherlands, Portugal, Spain, Sweden and the United Kingdom with 1988 as base year, Denmark with 1985 as base year, Liechtenstein, Switzerland and the United States with a 1984 base year, and Czech Republic, Italy, Luxembourg, Monaco and Slovakia with 1990 as base year). Norway and Canada chose to adopt the same 30 percent reduction within a TOMA specified in an annex to the Protocol and ensure that by 1999 total national emissions did not exceed 1988 levels. Bulgaria, Greece, and Hungary, whose emissions in 1988 did not exceed certain specified levels, opted to stabilize emissions at that 1999 level. Why might this menu approach provide a useful model for reducing emissions of short-lived climate forcers within the climate change regime? Would you alter the menu of options for the climate change regime?

3. Under the Gothenburg Protocol, Parties may establish PEMAs, provided that the area has the characteristics described in Article 3.9 above and is designated in Annex III of the Protocol. Only Russia has designated a PEMA. Why do you think only one PEMA has been designated? Do you think the PEMA concept would be valuable for use in the climate change regime? What other aspects of the Gothenburg Protocol provide valuable models for the climate change regime?

4. The Gothenburg Protocol, if fully implemented, is expected to have a wide range of positive environmental and human health benefits:

[T]he area in Europe with excessive levels of acidification will shrink from 93 million hectares in 1990 to 15 million hectares. That with excessive levels of eutrophication will fall from 165 million hectares in 1990 to 108 million hectares. The number of days with excessive ozone levels will be halved. Consequently, it is estimated that life-years lost as a result of the chronic effects of ozone exposure will be about 2,300,000 lower in 2010 than in 1990, and there will be approximately 47,500 fewer premature deaths resulting from ozone and particulate matter in the air. The exposure of vegetation to excessive ozone levels will be 44% down on 1990.

UNECE, The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, at http://www.unece.org/env/lrtap/multi_h1.html.

5. The Gothenburg Protocol will soon be revised to include additional pollutants. In particular, the Protocol’s Executive Body decided in 2010 to consider the inclusion of black carbon in the Protocol’s revision. The Parties directed a working group to prepare text for developing national emission inventories, ambient monitoring and source measurements as well as technical annexes that include measures to reduce BC emissions and abatement techniques for significant source categories of BC as a component of particulate matter. Decision 2010/2, *Implications of the Reports of the Task Force on Hemispheric Transport of Air Pollution and the Ad Hoc Expert Group on Black Carbon*, ECE/EB.AIR/106/Add.1, para. 4 (2010). In light of the sources of black carbon mentioned in Section III.A.1 above, what kind of mitigation measures do you think might work best? Do previous approaches under the CLRTAP provide useful guidance?

2. The International Maritime Organization

Land-based emissions of short-lived climate forcers and precursor gases clearly predominate, but emissions from international aviation and shipping are growing. The International Maritime Organization (IMO) estimates that ships emitted 1,046 million tonnes of CO₂ in 2007, 3.3 percent of global emissions in that year. Mid-range emissions scenarios indicate that these emissions could grow, in the absence of policies, by 200 percent to 300 percent by 2050 as a result of the growth in world trade. IMO, SECOND IMO GHG STUDY 2009 1 (2009).

CO₂ is the most important GHG emitted by ships, but ships also emit CH₄, NO_x, and HFCs, as well as black carbon and ozone precursor gases such as CO and nonmethane VOCs.

Table 10–4: Summary of GHG Emissions from Shipping during 2007

	International Shipping (million tonnes)	Total Shipping	
		Million tonnes	CO ₂ equivalent
CO ₂	870	1050	1050
CH ₄	Not determined*	0.24	6
N ₂ O	0.02	0.03	9
HFC	Not determined*	0.0004	≤ 6

* A split into domestic and international emissions is not possible.

Id. at § 1.10.

IMO's report estimates that ships have reduced emissions of CFCs by 735 tonnes (98 percent) and HCFCs by 10,900 tonnes (78 percent), but emissions of HFCs have increased by 415 tonnes (315 percent) because they are being used as a substitute for CFCs and HCFCs. IMO also reports reductions in emissions of NO_x and possibly in VOCs:

1.14 Where emissions of NO_x are concerned, a reduction in emissions of about 12–14% per tonne of fuel consumed has been identified for regulated (Tier I) engines as compared to pre-regulation (Tier 0) engines. In 2007, about 40% of the installed engine power of the world fleet had been built since 1 January 2000 and was thus assumed to be Tier I-compliant. The net reduction in international emissions of NO_x from shipping in 2007 was thus about 6% compared to a no-regulation baseline. However, NO_x emissions from international shipping are estimated to have increased from 16 million tonnes in 2000 to 20 million tonnes in 2007.

1.16 A reduction in emissions of VOC has not been quantified. The most tangible result of implementing regulation 15 in MARPOL Annex VI is the introduction of standardized VOC return pipes, through which tankers can discharge VOC to shore during loading. Most tankers now have this capability, although the frequency of their use is variable.

Id.

Shipping may actually have a net positive effect on climate change due to emissions of sulfates that reflect solar radiation back into the atmosphere and indirect effects of shipping emissions that cause the formation of additional low-level clouds, increasing the albedo of the planet and cooling the earth's surface. The global average net negative RF from shipping may be as high as -110 mWm^{-2} . *Id.* at § 8.30. However, this calculation does not include the positive RF that might occur from the interaction of black carbon with snow, something that has not yet been fully quantified. The negative RF may also be misleading due to the low emissions of short-lived climate forcers relative to CO₂: “the persistence and accumulation of CO₂ is such that its warming effect may ultimately overwhelm any cooling effects.” *Id.* at § 8.38. In addition, the use of a global average masks important regional differences. At the poles, for example, shipping results in a positive RF of 0.3 to 0.5 Wm^{-2} but a negative RF of more than -0.2 Wm^{-2} at 30° North latitude. *Id.* at § 8.43. Moreover, sulfates, which may have a cooling effect in the atmosphere, cause acidification of natural ecosystems and freshwater bodies when deposited through precipitation. *Id.* at § 8.52.

The regulation of international shipping comprises a maze of 41 conventions and protocols under the auspices of the IMO. The one most relevant for reducing GHGs and other pollutants from ships is the International Convention for the Prevention of Pollution from Ships, Nov. 2,

1973, 1983 U.N.T.S. 184 (entered into force Oct. 2, 1983), and a separately negotiated Protocol to it. Feb. 17, 1978, 1983 U.N.T.S. 62 (entered into force Oct. 2, 1983). Together, these two agreements are known as MARPOL 73/78 (short for MARine POLLution), or even more simply as MARPOL. MARPOL establishes regulations to control various forms of pollution from ships, including oil, noxious liquid substances, sewage, and garbage. Annex VI of MARPOL prohibits the deliberate release of HCFCs and the installation of any new equipment containing ozone depleting substances, although HCFCs may be used until 2020. It also requires Parties to use certain procedures for the control of VOCs from tankers, but it does not establish specific emissions limits. MARPOL CONSOLIDATED EDITION 2006, Annex VI, Regulations 12, 15 (2006).

In addition, Annex VI limits NO_x emissions based on the ship construction date and the engine's rated speed. The strictest standards apply only to specified ships while operating in Emission Control Areas (ECA) — areas “where the adoption of special mandatory measures for emissions from ships is required to prevent, reduce and control air pollution from NO_x or SO_x and particulate matter or all three types of emissions and their attendant adverse impacts on human health and the environment.” IMO, Resolution MEPC.176(58), MEPC 58/23/Add.1, para. 8 (Oct. 17, 2008). Despite a definition that suggests ECAs are areas where air quality problems are acute, the North American ECA includes all waters out to 200 nautical miles off the east and west coasts and into the Gulf of Mexico, as well as around the Hawaiian Islands. It also covers Canadian waters out to 200 nautical miles. EPA, Designation of North American Emission Control Area to Reduce Emissions from Ships: Regulatory Announcement, EPA-420-F-10-015, 1 (Mar. 2010). Other ECAs exist in the Baltic Sea, North Sea, and around Puerto Rico and the U.S. Virgin Islands.

In 2011, the IMO amended MARPOL Annex VI to mandate energy efficiency requirements. The new amendments introduce two new mandatory mechanisms intended to improve the energy efficiency of ships: the Energy Efficiency Design Index (EEDI) for new ships or ships that have undergone a major conversion, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. The EEDI is a performance-based mechanism that requires a minimum energy efficiency, as measured in CO₂ emissions, per capacity mile (e.g., tonne mile) for different ship types (e.g., tankers, container ships). The new MARPOL requirements are targets. Thus, ship designers and builders may choose from a variety of technologies and designs to satisfy the EEDI requirements. Resolution MEPC.203(62), Regulations 20, 21 (adopted July 15, 2011); *see also* Resolution MEPC.212(63), *2012 Guidelines on the Method of Calculation of the Attained Energy Efficiency Design Index (EEDI) for New Ships* (adopted Mar. 2, 2012).

The SEEMP establishes a mechanism for operators to improve the energy efficiency of ships by providing an approach for monitoring ship and fleet efficiency performance over time. As with other environmental management systems (e.g., ISO 14001), the SEEMP provides an approach for the ship owner and operator at each stage of the operation of the ship to review and consider operational practices and technology upgrades to improve the energy efficiency of a ship. Resolution MEPC.203(62), at Regulation 22; Resolution MEPC.213(63), *2012 Guidelines for the Development of a Ship Energy Efficiency Management Plan (SEEMP)* (adopted Mar. 2, 2012).

These regulations, which entered into force on January 1, 2013, apply to all ships of and above 400 gross tonnage and are expected to reduce CO₂ emissions from ships significantly. By one estimate, they will reduce CO₂ emissions by 151.5 million tonnes annually by 2020 and 330 million tonnes annually by 2030. Emission reductions increase in later years as older ships are replaced with newer ones. Compared to a business-as-usual scenario, these emissions reductions are between 13 percent and 23 percent; however, because international shipping is expected to grow, overall CO₂ emissions from shipping will continue to increase. These emission reductions will also translate into fuel savings of US\$50 billion in 2020 and \$200 billion in 2030. ZABI BAZARI & TORI LONGVA, ASSESSMENT OF IMO MANDATED ENERGY EFFICIENCY MEASURES FOR INTERNATIONAL SHIPPING 4–6 (Oct. 31, 2011).

QUESTIONS AND DISCUSSION

1. As in the debate regarding the applicability of the Montreal Protocol to GHGs, some IMO Parties have suggested that any IMO measures to reduce GHG emissions should only be applicable to UNFCCC Annex I Parties, in accordance with the principle of “common but differentiated responsibilities” (CBDR) and that reduction of emissions related to international shipping should be voluntary for developing countries. Other IMO Parties point to the global nature of the IMO’s mandate and the obligation of all Parties to protect the marine and atmospheric environment from all sources of ship pollution. These Parties claim that any IMO measures to reduce GHG emissions should apply to all ships, irrespective of which country’s flag the ship flies. *See* IMO, SECOND IMO GHG STUDY 2009, at paras. 2.42–.44. What do you think — should the UNFCCC’s principle of CBDR carry over to other international agreements and institutions?

2. According to the U.S. Environmental Protection Agency, ships complying with ECA standards will reduce their emissions of NO_x, sulfur oxides (SO_x), and fine particulate matter (PM_{2.5}). In 2020, emissions from these ships operating in the ECA are expected to be reduced annually by 320,000 tons for NO_x, 90,000 tons for PM_{2.5}, and 920,000 tons for SO_x, which is 23 percent, 74 percent, and 86 percent, respectively, below predicted levels in 2020 absent the ECA. EPA, Designation of North American Emission Control Area to Reduce Emissions from Ships: Regulatory Announcement, EPA-420-F-10-015, 1 (Mar. 2010). If ECAs yield these significant benefits, why not apply these standards to all marine areas?

3. As the price of distillate fuel increases and the new IMO GHG regulations come into effect, liquefied natural gas (LNG) is expected to become the fuel of choice for ships. This switch to LNG to reduce CO₂ emissions, however, illustrates the technical challenges of mitigating GHG emissions.

Key drivers for this expected development [to LNG] are the low emissions of nitrogen oxides (NO_x), SO_x and particulate matter (PM) from LNG-fuelled ships. Also, LNG contains more hydrogen and less carbon than diesel fuels; hence emissions of CO₂ are reduced. Unfortunately, increased emissions of methane (CH₄) reduce the net effect to about 15% reduction of CO₂ equivalents. . . . The

most important technical challenge is finding the necessary space for storage of the fuel on board the ship and the availability of LNG in the bunkering ports. Therefore, LNG is primarily interesting in a regional shipping context, where the ship's range is less of an issue and the next port of bunkering is more predictable. LNG could also become an interesting fuel for tankers, since there is considerable space available for the LNG fuel tanks on deck. LNG-fuelled ships would be particularly attractive in NO_x emission control areas, since they can meet Tier III emission levels [eds note: the most stringent emissions limits] without after-treatment of the exhaust gases.

IMO, SECOND IMO GHG STUDY 2009, at para. A2.79. Similarly, efforts to reduce NO_x emissions by modifying the engine's combustion process tend to increase emissions of CO₂ and particulate matter. As noted above, however, other strategies such as fuel switching can reduce NO_x emissions by approximately 90 percent while also reducing CO₂ emissions. *Id.* at paras. A2.99–.100.

3. The International Civil Aviation Organization

Aviation emissions also contribute to climate change. Aviation contributes an estimated two percent of CO₂ emissions, with about one percent from international aviation. In addition, aviation emissions contribute an estimated two percent of global NO_x emissions, which models predict will increase tropospheric ozone levels by three to six percent. Aircraft are estimated to contribute about 3.5 percent of the total radiative forcing. This percentage, which excludes the effects of possible changes in the formation of cirrus clouds, is projected to grow. So, too, are CO₂ emissions from aviation. Despite improvements in jet engines that have made new engines 70 percent more fuel efficient than those produced 40 years ago and 20 percent more fuel efficient than 10 years ago, CO₂ emissions nearly doubled between 1990 and 2006 with the rate of growth of CO₂ emissions at two percent per year, although expected growth in passengers and flights may increase this rate to more than three percent unless further action is taken. INTERNATIONAL CIVIL AVIATION ORGANIZATION, REPORT OF THE GROUP ON INTERNATIONAL AVIATION AND CLIMATE CHANGE (GIACC), para. 1.1 (June 1, 2009) (“GIACC REPORT”); UNFCCC, FCCC/SBSTA/2010/MISC.5, Information Relevant to Emissions from Fuel Used for International Aviation and Maritime Transport, Submission by the International Civil Aviation Organization (ICAO), para. 4.4 (May 20, 2010); A.S. Grossman et al., *Potential Climate Change from Aviation*, para. 6.6.1, in IPCC, AVIATION AND THE GLOBAL ATMOSPHERE (IPCC Special Reports, 2000); U. Schumann et al., *Pollution from Aircraft Emissions in the North Atlantic Flight Corridor: Overview on the POLINAT Projects*, 105 J. GEOPHYSICAL RES. 3605, 3626 (2000).

While Parties must account for emissions from domestic flights, the International Civil Aviation Organization (ICAO), established under the 1944 Convention on International Civil Aviation, has authority to regulate, among other things, emissions from international aviation. ICAO's governing Council has not imposed mandatory obligations on ICAO Parties to mitigate CO₂ emissions from aircraft. It has, however, approved an annual improvement in fuel efficiency

of 2 percent between 2013 and 2020 and an aspirational global fuel efficiency improvement rate of 2 percent per year from 2021 to 2050. Declaration by the High-level Meeting on International Aviation and Climate Change (HLM-ENV/09), para. 2 (Oct. 2009). If these goals are met, cumulative fuel efficiency from aviation would improve about 60 percent from 2005 levels. GIACC REPORT, at para. 3.7.1.

In addition, ICAO's policymaking body, the Assembly, has requested the Council "to monitor and develop its knowledge of, in cooperation with other relevant international bodies such as WHO, the effects of aviation emissions of particulate matter, nitrogen oxides and other gases on human welfare and health, and to disseminate information in this regard." It further encourages the ICAO Parties to "to limit or reduce international aviation emissions affecting local air quality through voluntary measures." Resolution A36-22, *Consolidated Statement of Continuing ICAO Policies and Practices related to Environmental Protection*, Appendix H, Aviation Impact on Local Air Quality, paras. 1, 5.

QUESTIONS AND DISCUSSION

1. ICAO has been criticized for its failure to more aggressively address GHG emissions. Because of ICAO's slow pace, the EU included the aviation sector in its Emissions Trading Scheme. The U.S. airline industry unsuccessfully challenged the ETS as violating the Convention on International Civil Aviation before the Court of Justice of the European Union. *Air Transport Association of America and others v. Secretary of State for Energy and Climate Change*, C-366/10 (Dec. 21, 2011). They are now urging the United States to challenge these provisions of the ETS using the Convention's dispute settlement processes.

2. Article 2(2) of the Kyoto Protocol directs Annex I Parties to pursue limitations or reductions of GHG emissions from aviation and marine bunker fuels, "working through the International Civil Aviation Organization and the International Maritime Organization." Yet, the UNFCCC Parties have, since 1995, sought to address the issue of the allocation and control of emissions from international bunker fuels. Decision 4/CP.1, *Methodological Issues*, para. 1(f) (1995). Under the auspices of the Ad-Hoc Working Group on Long-Term Cooperative Action under the Convention, the Parties had attempting to negotiate sectoral agreements on aviation and marine bunker fuels. Given the specialized knowledge concerning ship design and operations of those participating in the IMO, and the existence of a treaty specifically related to ship emissions, should the UNFCCC Parties defer to the IMO with respect to GHG emissions from ships?

4. *The Arctic Council*

As discussed in Chapter 1, Section III.A, the Arctic is warming faster than other parts of the world, mainly due to the loss of ice and snow. Black carbon, tropospheric ozone, and methane may contribute to Arctic warming as much as CO₂, although uncertainty regarding the magnitude of their effects remains. The deposition of black carbon on ice and snow also has a greater per

unit effect than elsewhere. Also, sources of black carbon within the Arctic from shipping and gas flaring are likely to have a large forcing per unit of emission. P.K. QUINN ET AL., *THE IMPACT OF BLACK CARBON ON ARCTIC CLIMATE* 60 (Arctic Monitoring and Assessment Programme (AMAP) Technical Report No. 4 (2011)); AMAP, *AMAP 2009: UPDATE ON SELECTED CLIMATE ISSUES OF CONCERN* v (2009).

This warming is having a profound impact on the Arctic. The Arctic land area covered by snow in early summer has reduced by 18 percent since 1966. The southern limit of the permafrost has shifted northward by 30 to 80 km in Russia between 1970 and 2005, and by 130 km during the past 50 years in Quebec. Net loss of mass from the Greenland Ice Sheet has increased from an estimated 50 Gt per year between 1995 and 2000 to approximately 200 Gt per year between 2004 and 2008. Similarly, Arctic sea-ice decline has been faster during the past ten years than in the previous 20 years — and faster than the IPCC estimated in its 2007 Fourth Assessment Report. The area of sea ice persisting in summer (polar pack ice) has been at or near record low levels every year since 2001 and is now about one third smaller than the average summer sea-ice cover from 1979 to 2000. New studies show that average sea-ice thickness is decreasing. These impacts are likely to increase, because average Arctic autumn-winter temperatures are projected to increase by between 3 and 6°C by 2080, even using scenarios in which GHG emissions are lower than they have been for the past ten years. AMAP, *SNOW, WATER, ICE AND PERMAFROST IN THE ARCTIC (SWIPA): CLIMATE CHANGE AND THE CRYOSPHERE* vii-viii (2011)

Given these climate effects on the Arctic, the Arctic Council has begun to address climate change issues within its authority. The Arctic Council is a high-level intergovernmental forum to promote cooperation, coordination, and interaction among the Arctic States — Canada, Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russian Federation, Sweden, and the United States of America — on common Arctic issues, particularly sustainable development and environmental protection in the Arctic.

As with other institutions, the Arctic Council's climate change agenda has progressed over time as the effects of climate change have become clearer. In 2009, the Arctic Council recognized “that reductions of emissions [of short-lived climate forcers] have the potential to slow the rate of Arctic snow, sea ice and sheet ice melting in the near-term” and “the urgent need for an effective global response that will address the challenge of climate change.” It also created a task force on short-lived climate forcers to identify existing and new measures to reduce emissions of these forcers and recommend further immediate actions to be taken. Arctic Council, *Tromsø Declaration* (Apr. 29, 2009). Based on the reports of the task force and others, the Arctic Council encouraged Parties to reduce emissions of black carbon, directed the task force to continue its work on short-lived climate forcers, and established a Short-Lived Climate Forcer Contaminants project steering group to undertake demonstration projects to reduce emissions of black carbon and other short-lived climate forcers. Arctic Council, *Nuuk Declaration* (May 12, 2011).

The Arctic Council has also begun to address adaptation, by establishing the Adaptation of Actions for a Changing Arctic (AACA). The AACA will enable more informed, timely and

responsive policy and decision-making related to adaptation action in a rapidly changing Arctic. Arctic Council, *Adaptation of Actions for a Changing Arctic*, DMM02 (May, 15 2012).

The Task force on Short-Lived Climate Forcers unveiled a number of recommendations at the 2011 Arctic Council meeting. These recommendations focused on black carbon, acknowledging that this is where the Arctic Council members could have the greatest impact. To provide the bases for its recommendations, the task force first identified the largest sources of Arctic regional emissions of black carbon: land-based transportation (primarily on-road and off-road diesel vehicles), open biomass burning (agricultural burning, prescribed forest burning, and wildfires), and residential heating. Marine shipping constitutes a potentially significant source, especially in the Arctic due to its projected increase over time and its proximity to snow and ice. Gas flaring is a source that requires special attention to improve the understanding of its size and importance. The task force then characterized many of its recommendations as “no regrets” measures because of corresponding health co-benefits associated with black carbon reductions, including reductions in premature deaths and avoided health care costs.

**ARCTIC COUNCIL TASK FORCE ON SHORT-LIVED CLIMATE
FORCERS, PROGRESS REPORT AND RECOMMENDATIONS FOR
MINISTERS**
5–9 (2011)

[Measures to reduce black carbon from transportation] — all of which have strong health co-benefits — could include the following:

- accelerated implementation of ultralow sulphur diesel (ULSD) requirements for both on- and off-road diesel fuels (an important prerequisite to black carbon reductions), accompanied by emissions controls to reduce diesel PM;
- development and implementation of particulate emission standards enforcing use of particulate traps for new engines of on- and off-road vehicles, mobile machinery, locomotives, and certain marine vessels where such standards may not be in place;
- retrofitting of existing older and high-emitting vehicles and equipment with particle filters through regulation or voluntary subsidy programs;
- retirement or replacement of the dirtiest existing sources (especially those not easily fitted with filters) through regulation or financial incentives; guidelines for early retirement or scrappage programs should ensure that the original engine is either destroyed or, when possible, returned to the manufacturer to be remanufactured to cleaner emission standards;
- coordinated campaigns for better enforcement of new standards, more stringent inspection requirements, and encouragement of better maintenance practices;

- introduction or expansion of “green zones” that ban or require special fees for vehicles with high particle emissions; and
- reducing truck and off-road idling through regulation, education, or rest stop electrification; additional vehicle efficiency programs; addition of auxiliary power units on non-road equipment; and use of smart transportation algorithms.

* * *

The following measures offer potential for reductions of black carbon emissions in [the residential heating] sector:

- implementation of stringent black carbon emissions standards or stricter PM standards, regulations, and inspection regimes for stoves and boilers;
- development of point-of-manufacture certification programs for stoves and boilers meeting emissions and performance standards;
- voluntary old stove/boiler change-out programs and incentives for newer models that emit less black carbon;
- increased combustion efficiency;
- boiler retrofits, for example, with accumulator tanks; and
- operator education campaigns (best fuels and burning techniques).

* * *

Options for reducing black carbon from agricultural burning, prescribed forest burning, and wildfires include the following:

- technical assistance (seminars, exchanges) and micro-financing assistance to foresters and farmers to encourage the use of no-burn methods, such as either conservation tillage or soil incorporation;
- demonstration projects and exchange of information to show the efficacy of no-burn methods, both bilaterally and as exchanges between national and sub-national governments of Arctic Council nations or organizations, and through joint Council projects;
- development of fire management programs and strategies aimed at preventing accidental wildfires and avoiding unnecessary application of fire in land management (information campaigns aimed at decreasing such fires may represent a relatively low-cost way to decrease black carbon emissions);

- for controlled burns where necessary in forestry or agriculture, use of more efficient and controlled burning techniques or measures to control the timing of burns, and mechanical removal of material before the burn for possible use in energy or biochar production;
- expansion of resources for fire monitoring, fire management decision support, and fire response.

* * *

The Arctic Council nations comprise 90% of current shipping activities in the region; they therefore have a unique ability to influence the development of future black carbon emissions from this sector by enacting early voluntary measures and engaging in international regulatory regimes such as the IMO:

- voluntary measures by all eight Arctic Council nations to decrease black carbon emissions and encouragement of vessels (especially cruise ships) flagged in non-Arctic Council nations and operating in the Arctic to adopt these measures as well;
- support by all eight Arctic nations of the current IMO submission on black carbon by Norway, Sweden and the United States, which raised the importance of black carbon emissions from shipping on the Arctic climate and identified a range of technical and operational measures (e.g., speed reduction, improved engine tuning, energy efficiency enhancements, better fuel injection, or use of diesel particulate filters);
- adoption by all eight Arctic Council nations of the proposed amendment of MARPOL Annex VI to establish an Energy Efficiency Design Index for new ships; and
- ongoing provision of new scientific and technical developments to the IMO by AMAP and other Arctic Council working groups, and vice versa.

* * *

Oil and gas activities also constitute a very large Arctic source of methane emissions, and such studies could determine methane emissions and leakage in parallel to work on black carbon:

- funding immediate work on in-field measurements and scientific and technical analysis, in concert with the private sector, aimed at filling current information gaps;
- obtaining better black carbon emissions data, as well as location and other basic information on gas flaring practices;
- providing information on best practices and regulatory options from the energy industry where there has been progress in reducing flaring (e.g., Canadian provinces such as Alberta);

- ensuring coordination with other international efforts addressing venting and flaring, such as the Global Gas Flaring Reduction Partnership and Global Methane Initiative.

In 2013, the Arctic Council agreed to monitor black carbon emissions in the region. The ministers attending the meeting not only noted the key role that the Arctic council can play in mitigating black carbon, but also the important role of the CLRTAP:

Ministers emphasized the importance of emission inventories for black carbon to identify emission trends and mitigation opportunities. They concurred that each Arctic State should periodically produce national emission inventories for black carbon in line with the guidelines that are to be agreed upon under the Convention on Long Range Transboundary Air Pollution (CLRTAP). Inventories should be submitted to CLRTAP and shared within the Arctic Council, with the ambition to have submissions starting from February 15 2015.

Ministers concluded that decisive action on black carbon and other SLCPs is needed, and encouraged coordination and support for international and global efforts to address emissions. Ministers encouraged the Arctic Council to consider establishing a process at the Kiruna Ministerial meeting aiming for an instrument or other arrangements to enhance efforts to reduce emissions of black carbon from the Arctic States for review and appropriate decision at the next Ministerial meeting in 2015. Measures to address black carbon (and in some cases other SLCPs) that the Arctic States may wish to consider include: national action plans to be submitted to, and compiled by, the Arctic Council; a common vision for emission reductions; promotion of best mitigation practices and technologies available for relevant pollution sources in the Arctic States and the polar region; promotion of collaborative measures with the private sector; and consideration of benchmarks or targets.

CHAIR'S CONCLUSIONS FROM THE ARCTIC ENVIRONMENT MINISTERS MEETING, ARCTIC CHANGE – GLOBAL EFFECTS 2–3 (Jukkasjärvi, Sweden, Feb. 5–6, 2013)

QUESTIONS AND DISCUSSION

1. The Arctic Council has recognized that it is uniquely positioned to address short-lived climate forcers as they relate to the Arctic. Yet, it has to date only recommended voluntary actions. Why do you think that is so? If the Arctic Council continues to recommend voluntary measures, is it nevertheless a useful forum for addressing climate change? What other steps should it take?

2. The United States has contributed US\$5 million towards the reduction of black carbon in the Russian Arctic, some of which will be funneled through the Arctic Council. In February 2012, the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants Foundation

Partners, which includes the United States, Bangladesh, Canada, Ghana, Mexico, and Sweden, together with the UN Environment Programme committed more than \$15 million to get the coalition up and running, with the United States contributing an additional \$12 million. In May 2012, the G-8 joined the coalition. Camp David Declaration, para. 14 (May 18-19, 2012).

IV. BIODIVERSITY-RELATED TREATIES

Many efforts of environmentalists to draw attention to climate change have focused on biodiversity-related conventions, because of the important two-way links between climate change and biodiversity. For example, while biodiversity is threatened by climate change, it can also reduce the impacts of climate change. Forests and other habitats have great capacity to store carbon, while deforestation and other land use practices currently release about 20 percent of the world's anthropogenic emissions of carbon dioxide. The conservation of mangroves and other coastal ecosystems helps retard storm surges that can flood coastal areas. More generally, ecosystems that are more biodiverse are more resilient to disturbances, which are expected to increase in frequency and intensity due to climate change.

As reported by the Intergovernmental Panel on Climate Change (IPCC), climate change is already forcing species to adapt by shifting to different habitats, changing life cycles, or developing new physical traits. The Secretariat to the Convention on Biological Diversity (CBD) provides the following examples of climate impacts on biodiversity:

- Rising temperatures have caused coral bleaching — massive die offs — of coral reef communities from Australia to the Caribbean.
- The Common Murre has advanced breeding by 24 days per decade over the past 50 years due to rising temperatures.
- Polar bear populations face dwindling access to food sources as Arctic ice melts.

The question for species is whether they can adapt quickly enough to these types of changes. For some species, changes in temperatures are likely to have irrevocable impacts. Some estimates suggest that as many as one million species may become extinct due to climate change. The extinct Golden Toad and Gastric Brooding Frog have already been labeled as the first victims of climate change. See CBD Secretariat, *The International Day for Biological Diversity: Biodiversity and Climate Change: 22 May 2007*, available at <http://www.cbd.int/ibd/2007/>.

Some biodiversity-related conventions have begun to recognize the need to link biodiversity conservation and climate change. For example, Decision VIII/30 of the CBD encourages Parties and other governments to integrate biodiversity considerations into all relevant national policies, programs, and plans in response to climate change, and encourages governments and relevant organizations to develop rapid assessment tools for the design and implementation of biodiversity conservation and sustainable use activities that contribute to adaptation to climate change. The International Tropical Timber Organization (ITTO) decided to study the

implications of climate change for tropical forests and the contribution of tropical forests to the mitigation of the effects of climate change. To that end, it will “assist members in formulating and implementing an integrated forest sector response to climate change.” Decision 2(XLVII), ITTO Biennial Work Programme for the Years 2012–2013 ITTC(XLVII)/17, 28 (Nov. 19, 2011). While these agreements have not yet taken any specific action to address climate change, others, such as the World Heritage Convention, have or are actively contemplating it.

A. The World Heritage Convention

The Convention Concerning the Protection of the World Cultural and Natural Heritage, more commonly called the World Heritage Convention, directs the convention’s Parties to protect areas representing “universal outstanding heritage” that are part of “the world [natural and cultural] heritage of mankind as a whole.” Convention Concerning the Protection of the World Cultural and Natural Heritage, Nov. 16, 1972, 27 U.S.T. 37, 1037 U.N.T.S. 151 (entered into force Dec. 17, 1975). To date, the World Heritage Convention’s 189 Parties have placed 962 properties on the World Heritage List. These sites include 745 cultural, 188 natural, and 29 mixed properties in 157 countries. UNESCO, *World Heritage List*, available at <http://whc.unesco.org/en/list>.

The sites included in the World Heritage List are among the world’s most important cultural sites, such as the Taj Mahal, as well as natural sites that constitute “superlative natural . . . formations,” “the most important ecosystems,” and “the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value from the point of view of science or conservation still survive.” *Operational Guidelines for the Implementation of the World Heritage Convention*, para. 77 WHC. 05/2 (Feb. 2, 2005), available at <http://whc.unesco.org/en/guidelines> [hereinafter WHC Operational Guidelines]. Because of the importance of these sites, the World Heritage Convention directs each Party to do its “utmost” to protect and conserve the sites within its borders. It also requires governments to “endeavor, in so far as possible, and as appropriate for each country,” to establish services and training for the protection, conservation and presentation of cultural and natural heritage, and to take the appropriate legal, scientific, technical, administrative and financial measures necessary for the identification, protection, conservation, presentation, and rehabilitation of this heritage. Each Party is also precluded from taking “any deliberate measures” that might directly or indirectly damage listed sites. *World Heritage Convention*, at arts. 4–6.

With these obligations in mind, and using special procedures to list sites as “in danger” if they are threatened by “serious and specific dangers,” environmental lawyers from around the world coordinated efforts to petition the World Heritage Committee to list six World Heritage Sites as in danger due to climate change. See *Climate Justice*, available at <http://www.climatelaw.org>. Seeking to list sites where the effects of climate change were best understood, these lawyers petitioned to list sites with bleaching coral reefs (e.g., the Great Barrier Reef in Australia) and shrinking glaciers (e.g., Sagarmatha National Park in Nepal and Waterton-Glacier International Peace Park). Glacier National Park, the U.S. portion of Waterton-Glacier International Peace Park, once boasted approximately 150 glaciers, but only 25 remain, and the remaining glaciers may vanish entirely by 2020.

Seeking to compel broad-based action to mitigate climate change, the Waterton-Glacier petitioners did not ask for corrective actions relating to the park itself, such as removal of automobiles from the park in favor of buses to reduce carbon dioxide emissions or the creation of wildlife corridors so that species could migrate as their habitat changed. Instead, they recommended the following nationwide corrective actions:

Because electricity generation accounts for thirty-nine percent of all carbon dioxide emissions, a program of corrective measures should include a plan to reduce reliance on coal to produce electricity through the promotion of alternative energy sources, like wind power. In addition, a significant corrective measure could be regulation of emissions from coal-fired power plants; this could be achieved efficiently and economically with a cap-and-trade program for carbon dioxide emissions. Moreover, a program of corrective measures could achieve significant progress toward reducing greenhouse gas emissions if it included transportation sector reductions, including increases in fuel efficiency standards, regulation of tail-pipe emissions, and increased reliance on non-petroleum-based fuels, like ethanol and biodiesel. Finally, the World Heritage Committee could also include programs aimed at achieving greater energy efficiency through appliance efficiency standards.

Petition to the World Heritage Committee Requesting Inclusion of Waterton-Glacier International Peace Park on the List of World Heritage in Danger as a Result of Climate Change and for Protective Measures and Actions, viii (Feb. 16, 2006).

To date, the World Heritage Committee has not acted on any of the climate-related petitions. The petitions did, however, trigger a process to consider how the World Heritage Committee and the Convention's Parties should address climate change. The World Heritage Committee first initiated an assessment of the impacts of climate change on World Heritage Sites and concluded that climate change was already affecting many World Heritage Sites. Decision 29 COM 7B.a.Rev (2005), *available at* <http://whc.unesco.org/archive/2005/whc05-29com-22e.pdf>. The Committee then organized a meeting specifically to discuss the impacts of climate change on World Heritage Sites. That meeting led to the development of a report on predicting and managing the effects of climate change on World Heritage and a strategy to assist the Parties to implement appropriate management responses, which the World Heritage Committee endorsed at its 2006 annual meeting. World Heritage Committee, *The Impacts of Climate Change on World Heritage Properties*, WHC-06/30.COM/7.1 (including May Cassar et al., *Predicting and Managing the Effects of Climate Change on World Heritage*, at Annex 4).

The World Heritage Committee made very clear, however, that the "UNFCCC is the instrument through which mitigation strategies at the global and State Parties level is being addressed," not the World Heritage Convention. World Heritage Committee, *The Impacts of Climate Change on World Heritage Properties*, WHC-06/30.COM/7.1, para. 13 (2006). Nonetheless, Parties must consider "site-level monitoring, mitigation and adaptation measures, where appropriate." World Heritage Committee, *Draft of the Policy Document on the Impacts of*

Climate Change on World Heritage Properties, WHC-07/31.COM/7.1, at 4 (June 2007) (emphasis added). Possible adaptation strategies available to Parties could include enlarging existing protected areas, creating buffer zones of natural habitat around protected areas, and restoration of natural habitat, among others. *Predicting and Managing the Effects of Climate Change on World Heritage*, at 56, Box 11. Site-level mitigation activities could include conservation for carbon sequestration and reducing vehicular emissions within the site.

QUESTIONS AND DISCUSSION

1. In their petitions, environmentalists argued that the World Heritage Committee and governments had a duty to mitigate climate change. Professor Erica Thorson, the lead attorney on the Waterton-Glacier petition, writes:

The obligations imposed by Articles 4, 5, and 6 of the WHC require that State Parties engage in an aggressive climate-change mitigation strategy because they mandate the protection of World Heritage sites and the “outstanding universal values” therein. Articles 4 and 5 call for State Parties to act aggressively to protect world heritage within their territories, and Article 6 obliges all State Parties to forgo actions that might damage World Heritage sites. Together, these provisions require that all State Parties engage in an aggressive climate change mitigation strategy entailing sharp reductions in greenhouse gas emissions.

Many World Heritage sites will never be preserved for transmission to future generations unless the State Parties, led by the World Heritage Committee, act more proactively than merely supporting site-specific mitigation. For example, any climate-change mitigation occurring within Glacier National Park’s boundaries, while commendable, is inevitably inadequate to address the devastating consequences of climate change within the park. Even a total ban on greenhouse gas emissions within the park would not slow, and could never reverse, the climate change effects on glacial melt within the Park. Yet this type of mitigation is all that the Joint Report and the Strategy suggest should occur — a wholly inadequate response to the threat of climate change because it will not protect the outstanding universal values of the Park. The World Heritage Committee’s weak approach may be politically palatable, especially to State Parties like the United States, but it falls far short of the type of mitigation required to protect World Heritage sites.

Erica J. Thorson, *On Thin Ice: The Failure of the United States and the World Heritage Committee to Take Climate Change Mitigation Pursuant to the World Heritage Convention Seriously*, 38 ENVTL. L. 139, 170–71 (2008). Do you agree with Professor Thorson or the view of the World Heritage Committee on whether the Parties must mitigate climate change? Are the Parties to the World Heritage Convention required to take action beyond site-level adaptation and mitigation? Even if the World Heritage Convention requires the Parties to mitigate climate change, is it the appropriate treaty for doing so?

2. In a series of case studies, the World Heritage Committee summarized some possible adaptation strategies for World Heritage Sites affected by climate change. For example, Australia has increased the percentage of no-take areas from 5 percent to 33 percent, which should improve the resilience of biodiversity within the Great Barrier Reef Marine Park. State and federal officials are also collaborating to improve water quality. For Sagarmatha National Park in the Himalayas of Nepal, the case study noted that 50 percent of the park includes high altitude ice, glaciers, snow, and rocks. With rising temperatures, glaciers are melting and causing the rapid expansion of glacial lakes, which have unstable banks. The retention of glaciers and glacial lakes is essential, because mountain glaciers account for half of the freshwater used by humankind, and the glaciers of Sagarmatha are no exception. Moreover, the banks of these glacial lakes in Sagarmatha (and elsewhere) have burst, leading to “Glacial Lake Outburst Floods” (GLOFs). GLOFs in Sagarmatha have already destroyed power stations and houses and killed at least 20 people. The Imja Lake in Sagarmatha is considered “one of the largest and most threatening lakes” needing preventive action. To respond to these and other threats caused by climate change, the case study suggests an early warning system to notify people downstream in case of a GLOF. It also suggests that artificially draining a lake could avoid a GLOF. Augustin Colette et al., *Case Studies on Climate Change and World Heritage* (2007). Do any of these facts and possible adaptation strategies lead you to reconsider your responses to the questions posed in note 1, above?

3. The International Environmental Law Project of Lewis & Clark Law School, the author of the petition to list Waterton-Glacier International Peace Park as “in Danger due to Climate Change,” has provided links to a variety of sources concerning shrinking glaciers, including time-lapse photography of Glacier National Park’s vanishing glaciers. See <http://law.lclark.edu/live/news/4473-ielp-petitions-international-committee-to-list>. Information concerning the other petitions can be found on the website of the Climate Justice Programme, <http://www.climatelaw.org>.

B. The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is the most comprehensive treaty aimed at conserving biological diversity. United Nations Convention on Biological Diversity, June 5, 1992, S. TREATY DOC. 20 (1993), *reprinted in* 311.L.M. 818 (entered into force Dec. 29, 1993). It establishes three laudable and reinforcing goals: (1) the conservation of biological diversity, (2) the sustainable use of components of biological diversity, and (3) the equitable sharing of benefits from the use of genetic resources. To achieve these goals, the CBD establishes general obligations to, *inter alia*, develop national biodiversity conservation strategies, protect threatened species, establish protected areas, and integrate conservation and sustainable use into relevant sectoral policies. Like the World Heritage Convention, the CBD leaves implementation of these obligations to national governments. For example, the CBD does not require Parties to establish a certain number of protected areas or adopt any particular policy for the conservation and sustainable use of biodiversity. The CBD specifically recognizes that differing economic circumstances and biodiversity endowments will lead the Parties to different biodiversity

conservation strategies.

Recognizing the important linkages between biodiversity and climate change, the CBD Parties have begun developing recommendations for addressing these linkages. In 2000, at their fifth meeting, the Parties to the CBD called for collaboration with the appropriate bodies of the UNFCCC and the IPCC to understand better the impact of climate change on forest biological diversity, marine and coastal biodiversity, and other habitats. The Parties also directed the CBD's scientific body, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), to consider the impact of climate change on these habitats. Those recommendations led to the establishment of an Ad Hoc Technical Expert Group on Biological Diversity and Climate Change to analyze possible adverse impacts on biological diversity of measures taken under the climate change regime, identify factors influencing biodiversity's capacity to mitigate climate change and contribute to adaptation and the likely effects of climate change on that capacity, and identify options for future work on climate change that also contribute to the conservation and sustainable use of biological diversity. SBBSTA, Recommendation VI/7, para. 1. Relying on the IPCC's Third Assessment Report and other documents, the Ad Hoc Technical Expert Group documented the effects of climate change on biodiversity and described tools, such as criteria and indicators and environmental impact assessment, for integrating climate change into biodiversity conservation planning. UNEP/CBD/SBSTTA/9/INF/12.

This report, while not necessarily breaking new ground, placed climate change impacts squarely in the context of biodiversity conservation planning. The expert group noted that the "protection, restoration or establishment of biologically diverse ecosystems that provide important goods and services may constitute important adaptation measures to supplement existing goods and services, in anticipation of increased pressures or demand, or to compensate for likely losses." *Id.* at para. 198. The protection or restoration of mangroves, for example, may protect coastal areas from sea level rise and extreme weather events.

Subsequent to the report, the Parties have adopted two decisions that encourage the Parties to integrate biodiversity conservation into climate change adaptation. The decisions further encourage Parties to develop assessment tools for the design and implementation of biodiversity conservation and sustainable use activities that contribute to adaptation to climate change. They also commit the CBD Parties to work closely with the Ramsar Convention on Wetlands, the Convention on Migratory Species, the World Heritage Convention, and the UN Convention to Combat Desertification to support the preparation of adaptation activities and plans; these activities may include assistance in the areas of financial resources, technology transfer, education and outreach, capacity-building, research and systemic observation, and harmonized reporting. In addition, the CBD, through a new Ad Hoc Technical Expert Group on Biodiversity and Climate Change, has placed itself in the position to provide biodiversity-related information to the climate change regime. Decision VIII/30, *Biodiversity and Climate Change: Guidance to Promote Synergy among Activities for Biodiversity Conservation, Mitigating or Adapting to Climate Change and Combating Land Degradation* (2006); Decision IX/16, *Biodiversity and Climate Change* (2008).

QUESTIONS AND DISCUSSION

1. *Invasive Species.* The CBD provides the general framework for international efforts to control invasive species. Invasive species are those plants, animals, and microbes not native to a region that, when introduced either accidentally or intentionally, out-compete native species for available resources, reproduce prolifically, and dominate regions and ecosystems. Because they often arrive in new areas unaccompanied by their native predators, invasive species can be difficult to control. The resulting damage can have broad economic impacts and threaten human health and well-being. The introduction of invasive species has escalated in recent years, largely due to increased international trade and travel. But climate change, too, can create conditions favoring introduced species over native species. Left unchecked, many climate-aided invasive species have the potential to transform entire ecosystems, as native species and those that depend on them for food, shelter, and habitat disappear. The CBD Parties have recognized “the critical importance of regional collaboration to address the threat of invasive alien species, particularly as a means to enhance ecosystem resilience in the face of climate change.” At the same time, the use of non-native species may be useful for climate change adaptation. For example, fast growing species may help stabilize coastlines from erosion due to rising seas and tidal surges. As a result, the Parties have directed the CBD Secretariat to compile information on the management of invasive species, “reconciling the need for adaptation of biodiversity and ecosystems to climate change as well as the need to prevent and minimize the risks of existing and potential invasive alien species.” Decision X/38, *Invasive Alien Species*, paras. 4, 9(a) (2010). How should countries balance the importance of biodiversity with the need to adapt to climate change impacts?

2. *Genetically Modified Organisms.* In 2000, the CBD Parties signed the Cartagena Protocol on Biosafety, creating an international regime for importing and exporting genetically modified organisms (GMOs). May 15, 2000, 2226 U.N.T.S. 208 (entered into force Sept. 11, 2003). The Protocol establishes an elaborate notification and prior informed consent procedure for living modified organisms intended to be released into the environment (for example, seeds or live fish), but requires only labeling of bulk commodities of GMOs. See Cartagena Protocol on Biosafety to the Convention on Biological Diversity, *adopted* Jan. 29, 2000, *reprinted in* 31 I.L.M. 1257 (2000). The Cartagena Protocol does not explicitly address climate change, but climate change is expected to increase the use and distribution of GMOs. Many agricultural companies are developing drought- or heat-resistant crops to increase yields in a warmer planet. Although many people hope this will soften the potential food security issues raised by climate change, others are concerned that the risks of GMO crops are not well understood. Managing those risks in the future will fall in part to the Parties to the Biosafety Protocol.

3. *Ocean Fertilization.* The CBD Parties have also expressed their concern about the potential impacts of iron fertilization as a step to mitigate climate change. See Chapter 19, Section IV.D (describing steps to address ocean fertilization under the CBD as well as the London Dumping Convention.)

4. Other biodiversity-related conventions have opportunities to take climate change into account in their decisionmaking processes. Consider the following:

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Mar. 3, 1973, 27 U.N.T.S. 243 (entered into force July 1, 1975), regulates international trade in specimens of species of conservation concern. Prior to trade in protected species, the CITES Parties must issue permits and make certain scientific and management findings as a condition of trade in “specimens” — readily recognizable parts and derivatives — of the protected species. CITES, arts. III, IV. The most important permit finding generally and for climate change purposes specifically is the requirement that the export will not be detrimental to the survival of the species. This biological finding, known as the “non-detriment finding,” must be made prior to any export of a CITES specimen. The non-detriment finding is crucial for ensuring that trade does not undermine the conservation status of species in the wild. The impacts of climate change clearly affect a species’ survival by altering a species’ distribution, population trends, and other biological and ecological factors affecting the species. How should the Parties evaluate climate change impacts when making a non-detriment finding? For example, if a specific export of a polar bear skin will not be detrimental to the survival of the species, but climate change is considered to be a key factor threatening the very survival of polar bears, should the trade in a single polar bear skin be allowed?

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Feb. 2, 1971, 11 I.L.M. 969 (1972) (entered into force Dec. 21, 1975), provides the framework for the conservation and wise use of wetlands included in the Ramsar List of Wetlands of International Importance. The Parties must promote the conservation of the wetlands included in the List and the wise use of all wetlands in their territory. They must also establish wetland nature reserves for waterfowl. Ramsar Convention, arts. 2–4. Because draining and drying certain types of wetlands, particularly boreal peatlands and tropical peat swamps, releases both carbon dioxide and methane, the conservation and restoration of these wetlands will avoid the release of these GHGs and provide other important ecological services. The Parties’ most recent climate change resolution urges Parties to manage wetlands so as to increase their resilience to, and reduce the impacts of, climate change. Ramsar, Resolution X.24, *Climate Change and Wetlands* (2008). It further urges Parties to reduce the degradation, promote restoration, and improve management practices of peatlands and other wetland types that are significant GHG sinks. Among other things, this resolution encourages additional studies relating to wetlands’ role in mitigating and adapting to climate change and instructs the Ramsar scientific body and the Ramsar Secretariat to collaborate with other international institutions addressing climate change. Separately, Ramsar has developed a mechanism for financing delivery of carbon offsets to reduce or offset greenhouse gas emissions through wetland restoration projects. Danone Fund for Nature, *Achieving Carbon Offsets through Mangroves and Other Wetlands: November 2009 Expert Workshop Meeting Report* (2010). None of these activities requires specific action on the Parties. As such, what is their value?

The Convention on the Conservation of Migratory Species of Wild Animals (CMS), June 23, 1979, 1519 U.N.T.S. 26342 (entered into force Nov. 1, 1983), focuses solely on the conservation of migratory species. It requires Parties to “endeavour” to conserve and, where feasible, restore essential habitat of endangered migratory species — those species “in danger of extinction throughout all or a significant portion of [their] range” — included in Appendix I.

Party Range States (i.e., those Parties where a species occurs) must also endeavour to prevent or mitigate obstacles to the migration of the species, and “to the extent feasible,” reduce factors leading to endangerment. Range States also “shall prohibit” the “taking,” including the “capturing” and “harassing,” of Appendix I species, subject to some exceptions. It also establishes a process for creating specific agreements for the conservation of species or groups of species listed in Appendix II. A species in Appendix II either has an “unfavourable conservation status” which requires international conservation and management or “a conservation status which could significantly benefit” from international cooperation. Thus, unlike species in Appendix I, CMS Parties have no conservation obligations regarding species included only in Appendix II until they conclude a separate agreement specifically addressing that species.

A 2011 resolution recommends a broad range of activities to protect migratory species from the impacts of climate change, including the preparation of single-species Action Plans. Resolution 10.19, *Migratory Species Conservation in Light of Climate Change* (2011). The ability to craft species-specific or taxon-specific action plans or agreements for migratory species provides both a unique opportunity to tailor conservation approaches to address the effects of climate change on those species and a daunting challenge. A 2005 report underscores this challenge. The report found, for example, that 84 percent of bird species protected by CMS are threatened to some degree by climate change. Even if those species are affected by the same vector, such as changes in water supplies or alterations in habitat, each may require a separate set of conservation measures to help adapt to climate change. Where one species needs year-round glacial melt for the breeding of prey species, another needs an ice pack from which to hunt. In considering these issues, the report made the following recommendations for addressing the effects of climate change on migratory species. In making its recommendations, the authors distinguished between what they called “broad-front” migrants — those species that “migrate in short hops, stopping frequently on route, and often have geographically diffuse migration routes (most bats, insects, passerine birds and marine animals)”; and “leap migrants” — those species that “migrate in long-haul journeys stopping at only a few, usually discrete, sites, such as wetlands, often in large numbers; the primary example of these would be migrating shorebirds and waterfowl.”

6.3. For leap migrants, maintenance of a coherent network of stopover sites will be required. Currently there is a lack of even some of the most basic syntheses of information that are required for conservation action. **There is an urgent need to collate information on migratory stopover sites to identify coherent migratory networks.** This would provide a strategic, international overview and enable clear identification of site protection priorities for leap migrants. Much of this information is available for birds, so this could be achieved relatively straightforwardly for the key flyways. The same consideration may also apply to other taxonomic groups.

6.4. For broad-front terrestrial migrants, the creation of suitable migratory habitat, such as wildlife-friendly field margins, hedgerows, small copses and ponds [has] potential to allow migrants to adapt to climate change. Where these are absent, populations may not be able to adapt sufficiently

and hence will suffer negative impacts. . . .

ROBERT A. ROBINSON, ET AL., CLIMATE CHANGE AND MIGRATORY SPECIES, 25–28 (2005). The report also recommends the creation of trans-boundary habitat corridors and the designation of marine protected areas for the prey of marine mammals at key sites. However, because the locations of such areas are likely to change over time “[t]here will need to be a degree of flexibility in the establishment of protected areas for marine mammals . . . to take account of the potential for shifts in the range of species with climate change.” *Id.* at para. 6.6.

Given the species-specific nature of climate change threats to migratory species, what kind of measures would you recommend to conserve such species? Does the flexibility to negotiate separate agreements under CMS provide the best opportunity for developing adaptation strategies for migratory species?

5. One of the key challenges for international environmental governance is how to increase policy coordination among the many different environmental Secretariats and institutions with overlapping or interconnected missions. This is particularly important for developing countries that do not have the capacity and resources to address a growing number of obligations under an increasingly large number of conventions. What steps would you recommend that the Secretariats take to improve coordination? Are there steps that can be taken to consolidate reporting and other requirements to reduce the burden on developing countries? *See, e.g.*, Conference of the Parties to the Convention on Biological Diversity, *Decision IX/16, Biodiversity and Climate Change*, Annex II: Indicative List of Activities by Parties to Promote Synergies Among the Rio Conventions (2008).

V. THE UN CONVENTION ON THE LAW OF THE SEA

The UN Convention on the Law of the Sea (UNCLOS), Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 16, 1994), provides the basic legal and institutional framework for ocean governance. As already noted in Chapter 1, climate change is having substantial impacts on ocean ecology. The top layers of the oceans appear to be warming, sea levels are rising, and ocean salinity in some areas may be changing. In addition, increased concentrations of greenhouse gases are turning the oceans measurably more acidic. The net results are that climate change threatens the future of coral reefs as well as the productivity of the ocean’s basic food pyramid (zooplanktons, planktons and algae). At the same time, the oceans collectively are the largest carbon sink and reservoir on the planet, although evidence is mounting that the ability of the oceans to sequester carbon from the atmosphere is slowing.

UNCLOS resolved ongoing disputes concerning jurisdiction over marine areas by establishing a series of jurisdictional zones, moving outward from a baseline that in general reflects a nation’s coast line. The ports of a coastal State are regarded as *internal waters* and, with few exceptions relating to inspections and enforcement, ports are subject to the full range of the coastal State’s national authority. UNCLOS, art. 11. Within a country’s *territorial seas*, an area extending to twelve nautical miles offshore, the coastal State exercises almost complete

authority, subject to the right of innocent passage (i.e., the right to freedom of navigation in the territorial sea). *Id.* art. 3. In the *contiguous zone*, 12 to 24 nautical miles offshore, the coastal State's sovereignty is more limited, though it may enforce its customs, fiscal, immigration or sanitary laws and regulations. *Id.* art. 33. From the boundary of the territorial sea (generally 12 miles) up to 200 nautical miles is the *exclusive economic zone* (EEZ). Within the EEZ, coastal States have the sovereign right to explore, exploit, conserve and manage the natural resources, both mineral and living. *Id.* arts. 56–57. Beyond the EEZ, more than 200 nautical miles off the coast, lie the *high seas*, an area beyond national jurisdictions that are part of the global commons.

In establishing these zones and imposing a number of environmental protection and conservation obligations, UNCLOS embodies a fundamental shift away from the historical “freedom of the seas” approach, under which few rules restricted activities such as fishing or pollution, to a regime based on “rights and responsibilities.” Restrictions, for example to fish sustainably or to limit ocean dumping, are now a central part of the law of the sea, as are obligations “to protect and preserve the marine environment,” even in waters beyond national jurisdiction. UNCLOS, art. 192. To implement this obligation to protect and preserve the marine environment, UNCLOS elaborates a number of more concrete obligations.

Article 194 **Monitoring of the risks or effects of pollution**

1. States shall take all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection.

2. States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention....

5. The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life.

Article 204 **Monitoring of the risks or effects of pollution**

1. States shall, consistent with the rights of other States, endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyse, by recognized scientific methods, the risks or effects of pollution of the marine environment.

2. In particular, States shall keep under surveillance the effects of any activities which they permit or in which they engage in order to determine whether these activities are likely to pollute the marine environment. * * *

Article 206
Assessment of potential effects of activities

When States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments. . . .

Article 207
Pollution from land-based sources

1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures.

2. States shall take other measures as may be necessary to prevent, reduce and control such pollution. . . .

4. States, acting especially through competent international organizations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources, taking into account characteristic regional features, the economic capacity of developing States and their need for economic development. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.

QUESTIONS AND DISCUSSION

Review the description in Chapter 1 of ocean acidification caused by increasing concentrations of carbon dioxide in the atmosphere. Do the general provisions of the Law of the Sea Convention provide any legal basis for addressing the emission of greenhouse gases? Assuming that climate change is causing substantial impacts on ocean ecology, do the general environmental principles excerpted above in UNCLOS provide any arguments for bringing climate change claims? *See, e.g., William C.G. Burns, Potential Causes of Action for Climate Change Damages in International Fora: The Law of the Sea Convention, 2 INT'L J. OF SUST. DEVT. L. & POL'Y 27 (2006).*

