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DOOMSDAY DÉJÀ VU:

OZONE DEPLETION'S LESSONS FOR GLOBAL WARMING

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EXECUTIVE SUMMARY

The Kyoto Protocol to the United Nations Framework Convention on Climate Change, the international agreement to reduce emissions of so-called greenhouse gases suspected of contributing to global warming, is in many respects an unprecedented endeavor. Never before has so much been asked of the world in the name of preventing an alleged environmental problem.

One issue has attracted comparison – ozone depletion and the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer. Proponents of the Kyoto Protocol often cite the Montreal Protocol as a successful precedent, and hope to emulate, in a global warming context, its worldwide restrictions on chlorofluorocarbons (CFCs) and other compounds suspected of depleting the ozone layer. They argue that the Montreal Protocol:

- represents a successful application of the precautionary principle in that it proactively averted a potential environmental crisis;
- achieved its goals at minimal cost;
- demonstrated that global cooperation and compliance with environmental regulations can be achieved.

Contrary to these assertions, the Montreal Protocol should actually serve as a cautionary tale. With the passage of more than ten years since the Montreal Protocol's enactment, the evidence is now clear that:

- the threat posed by ozone depletion was far less serious and imminent than originally stated, thus the benefits of the Montreal Protocol are considerably lower;
- the costs of implementing the Protocol's provisions have been, and continue to be, substantial;
- global compliance has been inconsistent.

The mistakes of the Montreal Protocol will be even more pronounced if repeated in the Kyoto Protocol. As with ozone depletion, the evidence that global warming poses a genuine threat in need of immediate countermeasures is still quite weak, raising the possibility that the Kyoto Protocol will be another overreaction to an exaggerated environmental concern. But this time, the costs of overreacting will be far higher. While CFCs are an important class of chemicals, carbon dioxide, the chief greenhouse gas, is the ubiquitous by-product of all fossil fuel consumption, which forms the backbone of every healthy economy. Moreover, the difficulties and inequities in globally implementing and enforcing the Montreal Protocol should raise serious doubts that the more ambitious Kyoto Protocol could work as intended.

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INTRODUCTION

The Kyoto Protocol to the United Nations Framework Convention on Climate Change, the international agreement to reduce emissions of greenhouse gases, is in many respects an unprecedented endeavor. The magnitude and complexity of its scientific, economic, and geo-political implications set it apart from previous environmental issues and international treaties. If implemented, the Kyoto Protocol will necessitate substantial reductions in global fossil fuel use, which forms the backbone of every healthy economy. In order to achieve the Protocol's goal of reducing carbon dioxide and other greenhouse emissions, all developed nations would have to accept onerous sacrifices, and cooperate to a degree not seen in any previous undertaking. Stabilizing greenhouse gas emissions in the atmosphere – the Kyoto Protocol's ultimate goal – will impose restrictions worldwide. Never before has so much been asked of the world in the name of preventing an unproven environmental threat.

Proponents of the Kyoto Protocol often cite the Montreal Protocol as a successful model.

There is, however, one issue that has attracted comparison – ozone depletion and the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer. Proponents of the Kyoto Protocol often cite the Montreal Protocol as a successful model. They point to its worldwide restrictions on chlorofluorocarbons (CFCs) and other putative ozone-depleting compounds as the prototype for creating a global policy that proactively addresses an environmental problem, and as a precedent for implementing such a policy in a workable, fair, and economically responsible manner. Vice President Al Gore wrote that "many of the innovations in the Montreal agreement will be directly applicable to the new agreement" to reduce greenhouse emissions.[1] Environmental activists speak of the need to create and implement an international treaty that will "accomplish for global warming what the Montreal Protocol did for ozone depletion."[2] Mustafa Tolba, executive director of the United Nations Environment Programme (UNEP) throughout the proceedings that led to the Montreal Protocol, said "the mechanisms we

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[1] Al Gore, *Earth In The Balance* (New York: Houghton Mifflin Company, 1992), pp. 352-53.
[2] Hilary French, "Learning From The Ozone Experience," in *State of the World 1997* (Washington, D.C.: Worldwatch Institute, 1997), p. 169.

design for the Protocol will – very likely – become the blueprint for the institutional apparatus designed to control greenhouse gases and adaptation to climate change."[3]

The manipulation of the science of global warming, and its translation into policy, is indeed closely following the precedent set by ozone depletion. Once again, a large research bureaucracy has apparently reached a "consensus" that a potential environmental crisis is emerging. Once again, several governments have responded by creating an international treaty, which sets specific targets for restricting the anthropogenic emissions supposedly causing the problem. And, once again, proponents of the treaty are claiming that the benefits far outweigh the economic impacts.

But before policymakers allow the Montreal Protocol to be emulated in a global warming context, it is worthwhile to critically evaluate it, because, in many respects, it should serve as a cautionary tale.

But before policymakers allow the Montreal Protocol to be emulated in a global warming context, it is worthwhile to critically evaluate it, because, in many respects, it should serve as a cautionary tale. The evidence now indicates that the threats to human health and environmental quality from ozone loss were greatly exaggerated, thus the benefits of the Montreal Protocol are far less than originally claimed. In addition, the costs have been unnecessarily high. Moreover, the difficulties and inequities in globally implementing and enforcing the Montreal Protocol should raise serious doubts that the more ambitious Kyoto Protocol could work as intended.

There is one major difference between the two treaties. The Montreal Protocol largely dealt with a specific class of chemicals, while the Kyoto Protocol targets the ubiquitous by-product of all fossil fuel use. Thus, the mistakes of the Montreal Protocol, if repeated in the Kyoto Protocol, would be far more costly.

THE MONTREAL PROTOCOL - HISTORY

The Birth of an Environmental "Crisis"

Concerns about human-induced ozone loss date back to the beginning of the modern environmental movement, and were among the first global environmental issues addressed. Throughout the early and mid 1970s, aircraft exhaust, nuclear testing, and nitrogenous fertilizers were said to be sources of compounds that deplete the ozone layer, which shields the earth from excessive ultraviolet-B radiation (UVB). The most successful of the early ozone depletion campaigns concerned the Supersonic Transport (SST). Exhaust from a large fleet of these high-flying aircraft, it was argued, could conceivably cause severe depletion, with dire consequences, particularly an

[3] Richard Benedick, *Ozone Diplomacy* (Cambridge, Mass.: Harvard University Press, 1991), p. 7.

increase in UVB-induced skin cancers.[4] These highly publicized concerns played a key role in ending U.S. funding for the SST.[5]

The SST and other early ozone depletion hypotheses, though largely forgotten today, established a new pattern for the manner in which environmental issues are advanced. Money played a bigger role in the science than ever before, with federal and international agencies and individual scientists going to unprecedented lengths to attract funding in the burgeoning field of environmentally-related scientific research. Some scientists crossed the line from science to advocacy, injecting themselves into policy debates and allowing non-scientific concerns to influence their views.[6] For the first time, environmental activists wielded considerable influence on an international issue.[7] The role of the mass media in shaping public and political opinion took on greater significance. Simplistic and sensationalistic claims in newspapers and television became as important, if not more so, than the scholarly debate within the scientific community.[8] All the elements of agenda science were in place, waiting for a bigger issue to come along.

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CFCs and Ozone Depletion

The road to the Montreal Protocol began with a paper published in the June 28, 1974 edition of the journal Nature.[9] In it, two scientists, F. S. Rowland and Mario J. Molina, first hypothesized that CFCs, a widely used class of compounds, may reach the stratosphere, break down, and initiate the catalytic destruction of ozone molecules. Ozone molecules are collectively referred to as the ozone layer, and the depletion of this layer could conceivably result in an increase in ground-level UVB. The Rowland-Molina hypothesis, though unsupported by measured data at the time, survived early attacks on its plausibility.[10] Within a year, a consensus emerged that the hypothesis warranted further study.

The bureaucracy that was created to research the SST's environmental impacts on the stratosphere latched on to this more promising avenue of study. For NASA, the study of the stratospheric ozone layer and the possible

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[4] Harold S. Johnston, "Reduction of Stratospheric Ozone by Nitrogen Oxide Catalysts From Supersonic Transport Exhaust," *Science*, August 6, 1971, pp. 517-522.
[5] Lydia Dotto and Harold Schiff, *The Ozone War* (New York: Doubleday and Company, 1978), pp. 61-64.
[6] S. Fred Singer, "My Adventures In The Ozone Layer," *National Review*, June 30, 1989, pp. 34-38.
[7] Elizabeth Cook, "Global Environmental Advocacy: Citizen Activism In Protecting the Ozone Layer," *Ambio*, October 1990, pp. 334-337.
[8] Dotto and Schiff, at 262-298.
[9] Mario J. Molina and F.S. Rowland, "Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom-catalysed Destruction of Ozone," *Nature*, June 28, 1974, pp. 810-812.
[10] Dotto and Schiff, at 10-25.

effects of CFCs on it was one of the agency's first major forays outside of space exploration. At the Environmental Protection Agency (EPA), the issue became a long-term regulatory priority. Internationally, the United Nations Environment Programme (UNEP), and the World Meteorological Organization (WMO), began to study the ozone layer.

One of the first of what would become a series of large scale studies of the impacts of CFCs on the stratosphere was conducted by the National Academy of Sciences. Released in 1976, it generally concluded that the Rowland-Molina hypothesis was valid, but hedged somewhat as to the need to take immediate action before more facts were known.[11]

The initial target for restrictions was aerosol spray cans, for which CFCs were used as propellants.

The initial target for restrictions was aerosol spray cans, for which CFCs were used as propellants. The evidence that CFCs could, at least theoretically, affect the ozone layer, combined with media hype about skin cancer and other human health and environmental concerns, led to the first federal restrictions on CFC use. The change was also facilitated by some manufacturers, who saw a competitive advantage in non-CFC alternatives.[12] In 1978, the use of CFCs in spray cans, which accounted for nearly half of CFC consumption at the time, was banned by Congress.[13] Despite America's "leadership" on the issue, few other nations followed suit.

The regulations did not effect any other uses for CFCs, particularly as refrigerants in many types of air-conditioning and refrigeration systems. CFCs were cheap, efficient, and safe refrigerants, and equipment using them comprised a large and growing market. The decline in CFC use due to the aerosol spray can ban was significant but temporary. It was going to take more to create the political climate necessary to impose more painful sacrifices in the name of protecting the ozone layer.

In the early 1980s, the issue languished, with estimates of ozone loss fluctuating with each new study.

In the early 1980s, the issue languished, with estimates of ozone loss fluctuating with each new study. Overall, earlier speculation of massive ozone thinning was tempered by more refined and modest assessments of the problem.[14] It was unclear when and indeed if anthropogenic (human induced) ozone loss would unambiguously exceed natural variability in the ozone layer. The issue had ceased to capture the media's attention. Ozone depletion found itself relegated to the status of a potential environmental concern, but not a crisis warranting costly action. Efforts by environmental pressure groups to go beyond the spray can ban were making little headway. Nonetheless, the research continued.

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[11] Dotto and Schiff, at 262-298.
[12] Dotto and Schiff, at 165-168.
[13] 43 *Federal Register* 11,300 (1978).
[14] National Academy of Sciences, *Causes and Effects of Stratospheric Ozone Reduction: An Update* (Washington, D.C.: National Academy Press , 1983).

Internationally, more than 20 nations, including the United States, signed the 1985 Vienna Convention for Protection of the Ozone Layer. The signatories did not agree to binding requirements of any kind, but merely acknowledged ozone depletion as a potential threat and promised to "take appropriate measures" to protect the ozone layer.[15] More importantly, the parties to the Vienna Convention pledged continued research and empowered UNEP to conduct future meetings and initiate more concrete measures if justified based on its determination of the state of the science.[16]

The Antarctic Ozone Hole

In 1985, Nature published the most important single piece of ozone layer research since the Rowland and Molina paper, and introduced a new issue, the so-called Antarctic ozone hole.[17] Rather than a slight global decline in ozone levels, arguably within the range of natural variability, a team of British scientists now announced a sharp (reaching 50 percent or more) and probably unprecedented drop in ozone levels between September and November over Antarctica. Subsequent reanalysis of American satellite measurements indicated that the annual phenomenon had been occurring since 1979.[18] The term "ozone hole" is misleading, as total ozone never disappears completely and returns to normal levels for the rest of the year.[19] In addition, the unique conditions in Antarctica limit the phenomenon to that region.[20] Nonetheless, the Antarctic ozone hole, and the massive amounts of publicity that surrounded it, served to create the perception of a global ozone crisis.

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After the discovery of the Antarctic ozone hole, the policy debate took on a more alarmist tone, and was dominated by a series of gloomy announcements implying a seriousness to ozone depletion claims and an urgent need to take action. For example, a 1987 EPA report speculated that ozone depletion could cause 150 million additional skin cancers and 3 million additional deaths among those born before 2075.[21] In the aftermath of the Antarctic ozone hole scare, such claims, though not new, were taken more seriously by the media and Congress. The phenomenon also seemed to add credibility to the environmental organizations that had long professed ozone

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[15] Vienna Convention for the Protection of the Ozone Layer, March 1985.
[16] Benedick, at 45-46.
[17] J.C. Farman et al., "Large Losses of Total Ozone in Antarctica Reveal Seasonal ClOx/NOx Interaction," *Nature*, May 16, 1985, pp. 207-210.
[18] R.S. Stolarski et al., "Nimbus 7 Satellite Measurements of the Springtime Antarctic Ozone Decrease," *Nature*, August 28, 1986, pp. 808-811.
[19] Sallie Baliunas, *The Ozone Crisis* (Washington, D.C.: George C. Marshall Institute, 1994), pp. 9-11.
[20] Baliunas, at 9-10.
[21] 52 *Federal Register* 47,494 (1987).

depletion to be a dire threat. Beyond merely shaping public opinion, these groups, as NGOs (nongovernmental organizations), acquired an expanded official role in both scientific and policy matters.[22]

The Montreal Protocol

Spurred on by these renewed and highly publicized concerns over the ozone layer, international negotiators reconvened in 1987.

Spurred on by these renewed and highly publicized concerns over the ozone layer, international negotiators reconvened in 1987. Building on the Vienna Convention, which was now deemed too weak, negotiators created the first binding international restrictions on CFCs and other putative ozone-depleting compounds. The preamble to the Protocol called for the eventual elimination of ozone-depleting compounds, but the agreement itself merely required a freeze at 1986 production and consumption (production plus imports minus exports) levels by 1989, a 20 percent reduction in 1993 to be followed by another 30 percent reduction in 1998, applicable to signatories that are developed nations.[23] The treaty also placed a freeze on halons, which were used as fire fighting agents. (See Figure 1.) Parties were periodically required to assess these timetables in light of ongoing research and adjust them if they considered it necessary, or amend the treaty to encompass other compounds.[24] Trade in CFCs and products containing CFCs between parties and non-parties was to be controlled, providing a strong incentive for nations to join.[25] Whether these trade restrictions are compatible with the General Agreement on Tariffs and Trade (GATT) is unclear.[26] The Protocol also required the creation of procedures for punishing incidences of non-compliance.[27]

Developing nations (defined by per capita use of CFCs) argued that such restrictions would unduly burden their fragile economic prospects and deprive their citizens of the benefits of products using CFCs, and that the developed nations were the overwhelming source of the CFCs in the atmosphere.[28] In response, developing nations were granted a ten-year extension of time to comply with the Protocol's provisions.[29] Parties to the agreement from developed nations also pledged to provide technical assistance to signatories from developing countries.[30]

CFC producers generally supported the phaseout, as it gave them the mechanism to make the transition away from the mature market in CFCs to

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[22] James M. Sheehan, *Global Greens: Inside The International Environmental Establishment*, (Washington, D.C.: Capital Research Center, 1998), pp. 33-37.
[23] Montreal Protocol, Preamble and Article 2.
[24] Montreal Protocol, Articles 2, 6, 11.
[25] Montreal Protocol, Article 4.
[26] Duncan Brack, *International Trade and the Montreal Protocol* (London: Earthscan Publications Ltd., 1996), pp. 65-85.
[27] Montreal Protocol, Article 9.
[28] Benedick, at 148-149.
[29] Montreal Protocol, Article 5.
[30] Montreal Protocol, Article 10.

FIGURE 1

THE MONTREAL PROTOCOL AND ITS TWO MAJOR REVISIONS

1987 Montreal Protocol

CFCs - Freeze by 1989, 20% reduction by 1993, 50% reduction by 1998
Halons - Freeze by 1992

1990 London Amendments

CFCs - elimination by 2000
Halons - elimination by 2000
HCFCs - non-binding resolution to eliminate by 2040
Carbon tetrachloride - elimination by 2000
Methyl Chloroform - elimination by 2005

1992 Copenhagen Amendments

CFCs - elimination by 1996
Halons - elimination by 1994
HCFCs - elimination by 2030
Carbon Tetrachloride - elimination by 1996
Methyl Chloroform - elimination by 1996
Methyl bromide - Freeze by 1995

new and potentially more profitable substitutes. American producers were particularly satisfied to have an international agreement, rather than unilateral restrictions as had occurred with the spray can ban.[31] Once producers agreed to move away from CFC production, CFC users had little choice but to accept an eventual phaseout.

Twenty-four nations signed the Protocol, including the U.S. Still, many developing nations held out, including China and India. The Senate ratified the treaty in 1989, the year the Protocol took effect.

The push to tighten the initial targets and time-tables came almost immedi-ately.

Post-Montreal Developments

The push to tighten the initial targets and timetables came almost immediately. In 1988, the next major scientific study, the Ozone Trends Panel Report, was released, representing the latest research findings of NASA, NOAA, UNEP, WMO and other agencies. In many respects, it represented

[31] Daniel McInnis, "Ozone Layers and Oligopoly Profits," in, *Environmental Politics: Public Costs, Private Rewards*, M. Greve and F. Smith, eds. (New York: Praeger, 1992), pp. 144-148.

the culmination of several disturbing developments in ozone depletion-related science and the manner in which it was used to influence policy. While prior research often included a simplistic and overstated executive summary as well as a detailed study, the 1988 Ozone Trends Panel Report was initially released only in executive summary form, distributed during a March 1988 press conference. The full report was not made available, which, unlike the executive summary, contained enough information for independent scientists to assess. In effect, the process of scientific debate and peer review was sidestepped while the executive summary was aggressively marketed to the media. Its conclusion that the ozone layer had been in decline since 1969 due to CFCs was widely reported as an undisputed fact. Key weaknesses in the evidence, such as the uncertainties regarding natural ozone variability and the fact that the feared long-term increase in UVB attributed to ozone loss had not been measured, were downplayed or ignored.

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Several pages of the executive summary were devoted to a listing of the 100 scientists involved in the study, implying that the document represented the overwhelming consensus of expert opinion. However, the executive summary was written by a handful of individuals, with NASA's Robert Watson, the Ozone Trends Panel's chairman, exercising considerable editorial control. Aware that conflicting views on the science would forestall action, Watson realized that "there was a drastic need for an international consensus so there could be no excuse about what the science did or didn't say."[32] Indeed, one of the hallmarks of the scientific assessments under Watson's leadership is unambiguous executive summaries (often released during press conferences) asserting near unanimity among the participating scientists that ozone depletion is a proven threat. Watson has now assumed the identical role in the global warming debate, as chairman of the Intergovernmental Panel on Climate Change (IPCC).

In truth, the majority of scientists were only involved in the underlying research, and not in its packaging in the executive summary. Nonetheless, the executive summary of the Ozone Trends Panel Report was treated by policymakers as the official scientific consensus. The process also served to ostracize scientific critics who were not direct participants in this bureaucracy. In at least one case, a government scientist was fired for questioning the so-called consensus, particularly the lack of measured evidence of a UVB increase.[33]

By this time, NASA, NOAA, EPA, UNEP, WMO and other agencies had come to rely on ozone depletion as a substantial source of funding, and it showed in their work. Although much of the underlying research was well done, the manner in which it was summarized for non-scientific audiences

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[32] Deborah MacKenzie, "How To Use Science And Influence People," *New Scientist*, April 29, 1989, pp. 69-70.

[33] Ronald Bailey, "Political Science," *Reason*, December 1993, pp. 61-63.

was geared more toward justifying a pre-determined policy agenda and securing continued funding than in stating the facts. The institutional self-interest of the ozone bureaucracy had overtaken traditional scientific method.[34]

The parties met again in 1990 in London. The London Amendments accelerated the restrictions on CFCs and halons to a total ban by 2000. The parties also amended the treaty to include other types of CFCs, methyl chloroform, carbon tetrachloride, and hydrochlorofluorocarbons (HCFCs). (See Figure 1.) In response to complaints from developing nations, the parties added a multilateral fund, providing a financial mechanism to assist developing nations in moving away from CFC production and use.[35] The fund was initially set at $160 million, which was later raised to $240 million. The U.S. agreed to supply 25 percent of these and future contributions to the multilateral fund. Several more developing nations, including China and India, signed the treaty. In addition to ratifying the London Amendments, the U.S. enacted the 1990 Amendments to the Clean Air Act, Title VI of which obligates the nation to the CFC phaseout.[36]

Although much of the underlying research was well done, the manner in which it was summarized for non-scientific audiences was geared more toward justifying a pre-determined policy agenda and securing continued funding than in stating the facts.

Like clockwork, the newly revised agreement once again came under attack as insufficient in light of new findings that purported to show that "ozone depletion has reached a crisis," and that "a more urgent global ban against these chemicals is essential."[37] In 1991, a UNEP and WMO study (or more precisely, its executive summary) claimed that ozone depletion was occurring faster than previously predicted, and again assumed a resultant UVB increase and speculated that skin cancers and cataracts would become more prevalent.[38] As with previous announcements, this led to another round of pessimistic coverage and calls for a faster phaseout.[39] EPA Administrator William Reilly claimed that ozone depletion may cause "200,000 deaths from skin cancer in the United States over the next 50 years."[40]

In February 1992, NASA held an "emergency" press conference, claiming that an Antarctic-like ozone hole was likely to open over the Arctic region and extend into North America.[41] This announcement caused the most alarmist reaction to date. Time magazine asserted that "life may never be the

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[34] Christopher Douglass, "Environmental Crossing Guards: International Environmental Treaties and U.S. Foreign Policy," *Working Paper* 168 (St. Louis: Center for the Study of American Business, May 1998).
[35] Montreal Protocol, London Revisions, Article 10.
[36] 42 U.S.C. Title VI.
[37] Malcolm W. Browne, "Worst Ozone Hole Stirs Health Fear," *New York Times*, October 10, 1991.
[38] United Nations Environment Programme and World Meteorological Organization, "Executive Summary- Scientific Assessment of Stratospheric Ozone," 1991.
[39] Michael Weisskopf, "Ozone Study Predicts Increase in Cataract, Skin Cancer Risks: Ultraviolet Radiation Found to Affect Immune System," *Washington Post*, November 16, 1991; Keith Schneider, "Ozone Depletion Harming Sea Life," *New York Times*, November 16, 1991.
[40] Sharon Begley, "A Red Alert Over The Ozone," *Newsweek*, April 22, 1991.
[41] NASA Press Release, "Scientists Say Arctic 'Ozone Hole' Increasingly Likely," February 3, 1992.

In February 1992, NASA held an "emergency" press conference, claiming that an Antarctic-like ozone hole was likely to open over the Arctic region and extend into North America.

same," and then-Senator Al Gore, the Montreal Protocol's most strident political champion, urged his colleagues to respond to this "immediate, acute emergency threat," with a faster CFC phaseout.[42] Senator Gore proceeded to take the politicization of ozone science to a new level, claiming that "we can expect an ozone hole above Kennebunkport," the location of president George Bush's Maine residence, and accused the president of ignoring ozone thinning until it threatened him personally.[43] The media picked up on Gore's assertions, repeating them as scientific fact.[44] The Senate voted 96 to 0 to speed up the phaseout to the end of 1995, and a beleaguered President Bush, who had been sharply criticized for doing too little on the issue, agreed to the acceleration. This all occurred within days of NASA's press conference, prior to the publication of any scientific evidence in support of the agency's claims. NASA's subsequent admission that the predicted Arctic ozone hole never occurred received little press attention and had no effect on policy.[45]

Later in 1992, the parties to the Montreal Protocol met in Copenhagen and agreed to a phaseout of CFCs by the end of 1995 and an eventual phaseout of HCFCs to 2030. They also added methyl bromide, the widely used crop fumigant, to the list of restricted compounds. Within the span of a decade, a non-binding convention had been converted into total ban on many important chemicals.

OZONE DEPLETION AND THE CFC PHASEOUT: WHAT WE KNOW TODAY

It is now more than 24 years after the CFC-ozone depletion hypothesis was first advanced, more than 10 years after the Montreal Protocol was signed, and more than 2 years after production of new CFCs has been banned in the developed world. It is also, according to the evidence, nearly 30 years that the planet and its inhabitants have been subjected to the effects of a reduced ozone layer and nearly 20 years since the Antarctic ozone hole began making its annual appearance. Continued research provides us with far more information today than was known when the relevant policy decisions were made. The passage of time also allows for an assessment of the many predictions of imminent human health and environmental damage that so dominated the policy debate. Beyond the science, we also know more about the extent of international compliance with the Montreal Protocol, and of the costs of instituting a rapid phaseout of these compounds.

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[42] Michael Lemonick, "The Ozone Vanishes," *Time*, February 17, 1992, pp. 60-68; Congressional Record, February 6, 1992, pp. S-1128 - 1138.
[43] *Congressional Record*, February 6, 1992 at S-1129.
[44] See "The Ozone Hole Over Mr. Bush's Head," *New York Times*, February 5, 1992.
[45] NASA Press Release, "NASA Spacecraft Finds Large Arctic Ozone Depletion Averted," April 30, 1992.

The Benefits of the Montreal Protocol – Disaster Averted?

The Montreal Protocol was a response to a putative environmental crisis. However, the evidence now indicates that the concerns about ozone loss and its consequences had been greatly exaggerated. In truth, the problem addressed by the Montreal Protocol was a minor one.

Today, a majority of scientists do believe that anthropogenic ozone loss is a real phenomenon. They argue that CFCs released at ground level do eventually reach the stratosphere, where they are broken down by sunlight and engage in the destruction of ozone molecules, at least to some extent. Nonetheless, some scientists point out that the global changes in the ozone layer are not distinguishable from normal ozone fluctuations, and thus argue that there is no clear evidence of a worldwide anthropogenic footprint.[46] The Antarctic ozone hole is a well-documented localized seasonal thinning of the ozone layer, probably exacerbated by anthropogenic emissions of CFCs.

The evidence, however, still does not support any of the claims of ozone depletion-induced human health and environmental damage on which the Montreal Protocol was justified.

The evidence, however, still does not support any of the claims of ozone depletion-induced human health and environmental damage on which the Montreal Protocol was justified. Quite the contrary, the published research is devoid of any evidence of serious effects attributed to ozone loss. Virtually all the lurid claims of human health and environmental harm remain without any support whatsoever. (See Figure 2.) Proponents of the Montreal Protocol are left only to speculate about future disasters they claim have been averted by the CFC phaseout.[47]

It should be noted that depletion of the ozone layer, in and of itself, is not the primary concern. It is the ozone layer's role in filtering out most of the sun's UVB radiation that is the main concern. However, most measurements do not show the feared long-term increase in ground-level UVB corresponding to a loss of ozone.[48] Proponents of the Montreal Protocol have attempted to sidestep this central weakness in the scientific case by selectively publicizing calculations of hypothetical UVB increases or emphasizing the minority of UVB measurements that indicate a short-term rise.[49]

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[46] Baliunas, at 4-9; S.F. Singer, "Ozone Depletion Theory," *Science*, August 27, 1993, pp. 1101-1102.

[47] Michael Prather et al., "The Ozone Layer: The Road Not Taken," *Nature*, June 13, 1996, pp. 551-554; Harry Slaper et al., "Estimates of Ozone Depletion and Skin Cancer Incidence To Examine the Vienna Convention Achievements," *Nature*, November 21, 1996, pp. 256-258.

[48] Joseph Scotto et al, "Biologically Effective Ultraviolet Radiation: Surface Measurements in the United States, 1974 to 1985," *Science*, February 12, 1988, pp. 762-764 ; David Correll et al., "Spectral Ultraviolet-B Radiation Fluxes at the Earth's Surface: Long Term Variations at 39N, 77W," *Journal of Geophysical Research*, May 20, 1992, pp. 7,579 – 7,591; Richard McKenzie et al., "Chapter 9: Surface Ultraviolet Radiation," in *Scientific Assessment of Ozone Depletion: 1994* (Geneva, Switzerland: World Meteorological Organization, 1995).

[49] J. Herman et al., "UV-B Increases (1979-1992) From Decreases in Total Ozone," *Geophysical Research Letters*, August 1, 1996, pp. 2117-2120; J.B. Kerr and C.T. McElroy, "Evidence For Large Upward Trends Of Ultraviolet Radiation Linked To Ozone Depletion," *Science*, November 12, 1993, pp. 1032-1034.

FIGURE 2

THE OZONE "CRISIS": HYPE VERSUS REALITY

HYPE	REALITY
"In Patagonia, hunters now report finding blind rabbits; fishermen catch blind salmon." Al Gore, *Earth In The Balance* (1992).	There is no empirical support for the anecdotal claims of blind animals caused by ozone loss. Even the environmental organization Greenpeace, one of the original sources of these claims, later conceded that there was no truth to them.
"Decreasing crop yields could lead to starvation in many parts of the world." *New York Times*, April 17, 1988.	There is no evidence of any actual decline in the yield of any crop attributable to ozone depletion. In fact, during the period in which the global ozone layer has supposedly been thinning, world food production has increased substantially. *World Resources 1994-95* (New York: Oxford University Press, 1994), Chapter 6.
"If these tiny, free-floating seaplants called phytoplankton are fried by the harmful radiation, the entire food web of Antarctic could collapse." *Washington Post*, November 6, 1989.	There is no published evidence of any adverse impact on the Antarctic food web caused by ozone loss, and studies have shown the effects on phytoplankton to be negligible. A. McMinn et al., "Minimal Effects of UVB Radiation on Antarctic Diatoms Over the Last 20 Years," Nature, August 18, 1994, pp. 547-549; Osmund Holm-Hansen et al., "Ultraviolet Radiation in Antarctica: Inhibition of Primary Production," *Photochemistry and Photobiology*, October 1993, pp. 567-570.
"Higher doses of ultraviolet radiation expected to leak through a badly frayed ozone layer by the turn of the century could cause 1.6 million cases of cataracts, and 300,000 new skin cancers a year worldwide, a panel of scientists reported yesterday." *Washington Post*, November 16, 1991.	As the turn of the century nears, there is no published evidence of an actual increase in cataracts or skin cancers caused by ozone depletion.
"On certain days, Punta Arenas receives extremely high doses of UV radiation. When it's not filtered by the ozone layer, that radiation damages living tissue, causing skin cancer and cataracts." ABC News "Primetime," July 1, 1993.	In the only attempt to quantify the damage caused by the Antarctic ozone hole in Punta Arenas (the largest South American city in the vicinity of the Antarctic ozone hole), a team of researchers concluded that there has been no such damage, and that the increase in UVB is too small to have an appreciable effect. Oliver Schein et al., "Ocular and Dermatologic Health Effects of Ultraviolet Radiation Exposure From the Ozone Hole in Southern Chile," *American Journal of Public Health*, April 1995, pp. 546-50.
"The world now knows that danger is shining through the sky." *Time*, February 17, 1992.	Actual long-term measurements of the amount of the sun's ultraviolet-B radiation (UVB) reaching ground level over populated regions show no significant change beyond natural variability. John Frederick et al., "Trends And Interannual Variations In Erythemal Sunlight, 1978-1993," Photochemistry and Photobiology, September 1995 pp. 476-484; Richard McKenzie et al., "Chaper 9: Surface Ultraviolet Radiation,' in *Scientific Assessment of Ozone Depletion: 1994* (Geneva, Switzerland: World Meteorological Organization, 1995).

The 1993 publication of UVB measurements over Toronto provides a good example of the biases in the reporting. Two researchers, upon measuring a few anomalously high UVB readings after several years of no change, published their findings, claiming an increasing trend.[50] Their results were reported as "filling a hole in the ozone argument."[51] However, their claimed trend came under scientific criticism.[52] Subsequently, the researchers conceded that UVB had returned to normal levels and that they had merely measured a "perturbation, rather than a trend."[53] Nonetheless, their 1993 paper is still misleadingly publicized as evidence of a UVB increase.

The published research is devoid of any evidence of serious effects attributed to ozone loss.

Thus far, there remains no consensus that there has been a measured long-term UVB increase attributable to the claimed long-term decline in ozone. Many scientists believe that any long-term effect of anthropogenic ozone loss on ground-level UVB, whether or not it is actually occurring, is too small to be distinguishable from the background noise caused by cloud variability, tropospheric pollution, and other factors.[54] Either way, the UVB data unambiguously shows ozone depletion to be, at most, a modest concern.

Proponents of the Montreal Protocol have also failed to place the expected UVB increase in the context of latitude changes. It is well established that ground-level UVB increases by 5000 percent from the poles to the equator, or approximately 1 percent for each 6 miles.[55] Thus, the expected increase from even the worst case scenario of steady state global ozone loss, approximately 10 percent, is little different than a move of 60 miles closer to the equator.[56] This fact, though never disputed by the ozone bureaucracy, is rarely mentioned, for obvious reasons. Comparing the worst case effect of ozone loss to the effect of equatorward displacement does something to the ozone issue that the alarmist rhetoric and executive summaries have scrupulously avoided – it puts it in perspective, and further demonstrates that it is not a crisis.

Not surprisingly, the litany of predicted human health and environmental damage attributable to increased UVB has not occurred either. Ozone depletion, the public was repeatedly told, would lead to UVB-induced

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[50] Kerr and McElroy.
[51] See Tim Appenzeller, "Filling a Hole In the Ozone Argument," *Science*, November 12, 1993, pp. 990-991; William K. Stevens, "Rise in Ultraviolet Rays Seen in North America," *New York Times*, November 16, 1993.
[52] Patrick J. Michaels et al., "Ozone Depletion: Is There a Trend?" *Science*, May 27, 1994, pp. 1341-1342.
[53] Scientific Assessment of Ozone Depletion:1994, at 9.11.
[54] John Frederick et al., "Trends And Interannual Variations In Erythemal Sunlight, 1978-1993," *Photochemistry and Photobiology*, September 1995, pp. 476-484; Elizabeth C. Weatherhead et al., "Analysis of Long-Term Behavior of Ultraviolet Radiation Measured by Robertson-Berger Meters at 14 Sites in the United States," *Journal of Geophysical Research*, April 20, 1997, pp. 8737-54; Sean Ryan, "Ozone Layer Hole Does Not Cause Skin Cancer," *Sunday Times*, June 20, 1993.
[55] T. Mo and A.E.S. Green, "A Climatology of Solar Erythema Dose," *Photochemistry and Photobiology*, Vol. 20, 1974, pp. 483-496; Hugh W. Ellsaesser, "A Rational View On Stratospheric Ozone," *Technology: Journal of The Franklin Institute*, Vol. 332A, 1995, pp. 67-76.
[56] Fred Singer, "(N)03 Problem," *The National Interest*, Summer 1994, pp. 73-76.

increases in "skin cancer, eye disease, immune system disorders, and damage to various marine and terrestrial ecosystems." [57] The media frequently reported that these effects were already occurring.

Despite claims to the contrary, there is still no established link between ozone-depletion and skin cancer. The incidence and mortality rates for skin cancers are increasing, but National Cancer Institute data indicate that this trend predates the ozone issue, and is believed to be due to lifestyle changes rather than depletion of the ozone layer.[58] Indeed, recent evidence indicates that the rates of increase in incidence and mortality of malignant melanoma, the deadliest form of skin cancer, have begun to decelerate.[59] If ozone depletion was having the feared effect, these rates should be accelerating. Further, research has demonstrated that malignant melanoma is largely induced by wavelengths of radiation unaffected by the ozone layer, and not UVB.[60]

Ozone depletion, the public was repeatedly told, would lead to UVB-induced increases in "skin cancer, eye disease, immune system disorders, and damage to various marine and terrestrial ecosystems."

The many other claims of harm, such as decimation of phytoplankton populations and declining crop yields, remain equally devoid of empirical support.[61] Nonetheless, as with skin cancer, the predicted link between ozone loss and these adverse consequences is still reported as fact.

The 1985 announcement of the Antarctic ozone hole generated some of the most disturbing speculation about skin cancers, blindness, and large scale environmental destruction, the repetition of which has become an annual media ritual when the hole makes its September appearance. Yet, the only published study that has attempted to document these adverse effects found no evidence of harm, and concluded that the actual increase in UVB is likely too small to cause any measurable impacts.[62] Nor is this surprising, given the evidence. Despite its scary sounding name, the Antarctic ozone hole is nothing more than a temporary localized thinning that occurs in the early spring, when ground-level UVB is very low to begin with. In retrospect, the Antarctic ozone hole has proven to be a very real, but grossly exaggerated phenomenon.

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[57] Environmental Protection Agency, "Stratospheric Ozone Depletion: A Focus on EPA's Research," March 1995.

[58] National Cancer Institute, *Annual Cancer Statistics Review, Including Cancer Trends, 1950-1985* (Washington, D.C.: U.S. Departmnent of Health and Human Services, 1987); Joseph Scotto et al., "Indications of Future Decreasing Trends in Skin-Melanoma Mortality Among Whites in the United States," *International Journal of Cancer*, Vol. 49, 1991, pp. 490-497.

[59] Phyllis Wingo et al., "Cancer Incidence and Mortality, 1973-1995," *Cancer*, March 15, 1998, pp. 1197- 1207.

[60] Richard Setlow et al., "Wavelengths Effective in Induction of Malignant Melanoma," *Proceedings of the National Academy of Science*, July 1993, pp. 6,666-6,670.

[61] A. McMinn et al., "Minimal Effects of UVB Radiation on Antarctic Diatoms Over the Last 20 Years," *Nature*, August 18, 1994, pp. 547-549; Osmund Holm-Hansen et al., "Ultraviolet Radiation in Antarctica: Inhibition of Primary Production," *Phtotochemistry and Photobiology*, October 1993, pp. 567-570.

[62] Oliver Schein, et al., "Ocular and Dermatologic Health Effects of Ultraviolet Radiation Exposure From the Ozone Hole in Southern Chile," *American Journal of Public Health*, April 1995, pp. 546-550.

Some revisionists are claiming that disaster has been averted by the Montreal Protocol, and that these dire predictions are not coming true because of the international restrictions on CFCs.[63] This claim conflicts with numerous statements over the past decade that harm is already occurring, and that additional damage is inevitable no matter what CFC restrictions are imposed.[64] For example, in 1991, Robert Watson predicted that even if all ozone-depleting chemicals were immediately banned, the damage would continue for several more decades, due to the long atmospheric lifetimes of the already-released CFCs.[65] Nor has any evidence been advanced explaining how the unrestricted and large scale use of CFCs for the past several decades could have no tangible effects, but that a few additional years of use would have suddenly had a substantial impact. In sum, there is no real evidence that the Montreal Protocol helped avoid an imminent catastrophe. The predictions of catastrophe were simply overblown in the first place.

Despite claims to the contrary, there is still no established link between ozone-depletion and skin cancer.

The Montreal Protocol is often cited as a positive example of the precautionary principle – governments acting in the face of scientific uncertainty in order to avoid potentially disastrous harm that would have been unavoidable if policy makers insisted on waiting for more definitive evidence.[66] In truth, the Montreal Protocol demonstrates the flaws of the precautionary principle, which has only led to actions being taken against what has proved to be a non-crisis. More than 10 years after the original agreement was signed, there is still no evidence that anything has been prevented, at the very least demonstrating that there was no need to act so quickly. Perhaps the only urgency to the phaseout of CFCs, and the real impetus behind the first large-scale application of the precautionary principle in an environmental context, was the realization among its proponents that the hysteria they created would eventually fade in light of the growing evidence of no actual danger, and that their ambitious agenda would quickly become more difficult to implement.

In retrospect, the Antarctic ozone hole has proven to be a very real, but grossly exaggerated phenomenon.

It should be noted that, with regard to the lack of a long-term UVB increase and the total absence UVB-related harm, the critics of the so-called consensus have proven to be right. While the "official" ozone science establishment overstated the ozone threat, a few vocal skeptics, though often derided as being on the scientific fringe, were correct in dismissing the alarmist predictions of ozone depletion-induced dangers.[67]

The supposed benefits of the CFC phaseout are derived from the human health and environmental damage presumably avoided as a result of stemming the depletion of the ozone layer and its resultant UVB increase. These

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[63] Joby Warrick, "Disaster Averted, Experts Say," *Washington Post*,, November 21, 1996; Prather et al.; Slaper et al.
[64] See Gore, at 85-87.
[65] Keith Schneider, "Ozone Depletion Harming Sea Life," *New York Times*, November 16, 1991.
[66] Benedick, at 3; Prather et al.; Slaper et al.; Warrick.
[67] Singer, note 54; Baliunas; Ellsaesser.

benefits have been entirely speculative, as there still is no empirical evidence of adverse effects or of a UVB increase substantial enough to cause them. EPA's Regulatory Impact Analysis assumed that, had CFC use continued unabated, there would have been a massive depletion of the ozone layer and a large increase in UVB radiation. Based on these assumptions, the agency then calculated a catastrophic rise in skin cancers, cataracts, and environmental damage. Further assuming that this nightmare scenario would have prevailed throughout most of the next century, the agency estimated benefits (from the Montreal Protocol and the 1990 Clean Air Act) of a staggering 7 to 32 trillion dollars in the U.S.[68] Other studies making similar assumptions have drawn similar conclusions.[69] Far from being reasonable extrapolations of measured evidence to date, these studies sharply contradict what is now known, and hinge on assumptions that have been empirically disproven. The actual benefits are almost certainly far lower and could very well be negligible.

In truth, the Montreal Protocol demonstrates the flaws of the precautionary principle, which has only led to actions being taken against what has proved to be a non-crisis.

Compliance With the Montreal Protocol

Overall, the Montreal Protocol has been successful in sharply reducing the global production and use of CFCs and other ozone-depleting substances. However, there have been increases in production among developing nations and numerous instances of non-compliance throughout the world.

Globally, annual production and use of these compounds has declined by 80 percent from 1986, the year before the Protocol, to 1995.[70] The drop in production and use has been confirmed by atmospheric measurements, which indicate that the concentrations of most types of CFCs are peaking, and a few are already beginning to fall.[71] Thus far, the Montreal Protocol is accomplishing its goal of limiting the compounds it targets.

This decline is due to large reductions in developed nations, which accounted for nearly 90 percent of CFC use.[72] CFC production in the U.S., by far the largest producer of CFCs, declined 89 percent from 1986 to 1995, and by 94 percent in the European Community.[73] This decline is most likely a permanent one, as CFCs have been replaced in nearly all new equipment, and

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[68] Environmental Protection Agency, *Regulatory Impact Analysis: Compliance with Section 604 of the Clean Air Act for the Phaseout of Ozone Depleting Chemicals*, (ICF Incorporated, 1992 and 1993 Addendum) (EPA Regulatory Impact Analysis).
[69] *Global Benefits and Costs of the Montreal Protocol on Substances That Deplete the Ozone Layer*, (Environment Canada, 1997).
[70] Sebastian Oberthur, *Production and Consumption of Ozone Depleting Substances 1986-1995* (Berlin: Ecologic Centre for International and Environmental Research, 1997) p. 63.
[71] Stephen A. Montzka et al., "Decline in the Tropospheric Abundance Of Halogen From Halocarbons: Implications for Stratospheric Ozone Depletion," *Science*, May 31, 1996, pp. 1318-1322; J.W. Elkins et al., "Decrease in the Growth Rates of Atmospheric Chlorofluorocarbons 11 and 12," *Nature*, August 26, 1993, pp. 780-783.
[72] Benedick, at 149-150.
[73] Oberthur, at 30.

the existing base of CFC-requiring equipment will continue to dwindle over time. Sharp declines in the developed world have more than offset the increases in developing nations. (See Figure 3.)

Nonetheless, production and use in developing nations has increased since 1986, by approximately 250 percent.[74] Production in China and India has risen 304 and 889 percent, respectively.[75] Consumption of CFCs has also increased, but by a smaller amount, indicating that many of these nations have replaced CFC imports with higher domestic production to satisfy growing domestic demand.

It is unclear whether these increasing trends in the developing world will soon reverse. Indeed, production capacity has recently been expanded in several of these nations.[76] Increased CFC production and use can be corroborated with economic development.[77]

The actual benefits are almost certainly far lower and could very well be negligible.

There is also evidence of non-compliance with the Montreal Protocol. CFC production and use in several eastern European countries, including Russia (which is treated as a developed nation under the Montreal Protocol, though it is petitioning for extra time to comply), has not declined enough to put them in compliance.[78] Developing nations, though still allowed to produce CFCs for their own use, have also engaged in illegal trade with developed nations. There is substantial evidence of a large black market in illicit CFCs, particularly from Russia, China, and India, that make their way into Western Europe and the U.S., where they supply the still strong demand for CFCs in existing equipment.[79] In the U.S., black market CFCs have become the most lucrative illegal import other than narcotics.[80] Though substantial, this black market is as of yet too small to offset the major reductions in legal use in the developed world.

Enforcement has been lax outside the U.S. Despite mechanisms for trade sanctions and other penalties, the enforcement provisions under the Montreal Protocol have thus far been toothless. No punitive action has been taken against any nation not in compliance, due in part to a lack of an effective international enforcement mechanism. Moreover, other than the U.S., few nations have strongly enforced the Montreal Protocol domestically, largely due to an unwillingness to accept the higher costs of restricted CFC

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[74] Oberthur, at 35.
[75] Oberthur, at 30.
[76] Oberthur, at 36.
[77] Oberthur, at 38.
[78] Brack, at 112-113; Oberthur at 62.
[79] Brack, at 105-113; 1997; Jim Vallette, *Deadly Complacency: US CFC Production, The Black Market, and Ozone Depletion*, (Washington, D.C.: Ozone Action, 1995).
[80] David Spurgeon, "Ozone Treaty Must Tackle CFC Smuggling,'" *Nature*, September 18, 1997, p. 219.

FIGURE 3

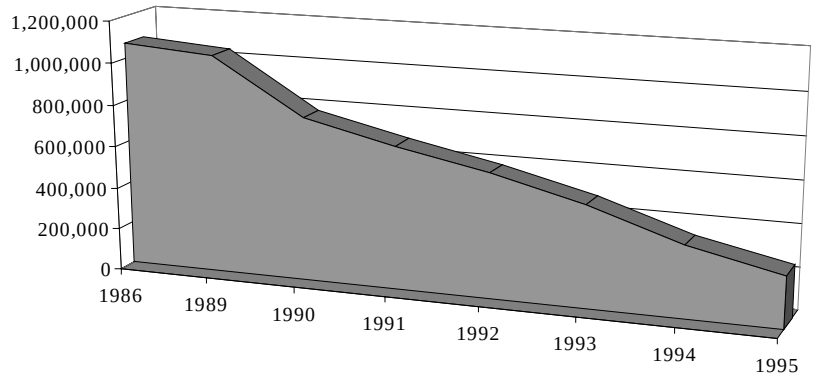
PRODUCTION OF CFCS 1986-1995 (IN ODP TONS)

Source: Ecologic Centre for International Environment Research, Berlin

INDUSTRIALIZED COUNTRIES

DEVELOPING COUNTRIES

GLOBAL TOTAL



availability. America has zealously policed its borders against incoming CFCs, and has enforced the law against smugglers and sellers, including several criminal convictions and prison sentences for violators.[81] In contrast to American efforts, most western European nations, many of which have been vocal proponents of the Protocol, have done little to stop the flow of illegal CFCs into their countries.[82] The majority of enforcement actions against illegal trade in CFCs have been undertaken by the U.S. government against those attempting to satisfy U.S. demand. This, in part, explains the price differential between the U.S. and other developed nations. The cost of CFCs today is considerably higher in the U.S. than nearly every other nation, included those that, at least on paper, are committed to the same phaseout.[83] Ironically, the federal government has often cited the Montreal Protocol and America's purported need to live up to its international obligations as a justification for ever tougher domestic control measures that have, in reality, contributed to this disproportionate effect.

There is substantial evidence of a large black market in illicit CFCs, particularly from Russia, China, and India, that make their way into Western Europe and the U.S., where they supply the still strong demand for CFCs in existing equipment.

The "success" of the Montreal Protocol is largely due to compliance by a small number of large CFC producers. Most CFC production prior to the phaseout could be attributed to a few American and western European chemical giants, for which compliance has been very good.[84] Two producers, DuPont and Allied Signal, alone accounted for 75 percent of U.S. production. Ensuring compliance from a handful of large sources has been relatively easy. In fact, there has been little incentive for these companies to risk penalties and adverse publicity by violating the Protocol, as CFC production and sales were only a small part of their overall operations, and most are now doing equally well (or better) selling CFC substitutes. The willingness of fewer than ten big chemical companies to drastically curtail CFC production in accordance with the Montreal Protocol, has, thus far, compensated for the spotty compliance by others and enforcement problems around the globe.

The Costs

Worldwide, the economic impact of the Montreal Protocol has been substantial. The higher costs associated both with replacing CFCs in their many applications, and the maintenance of the existing base of equipment

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[81] Brack, at 106-108; Department of Justice Press Release, "Nationwide Enforcement Initiative Snares Smugglers Of Banned Refrigerant That Destroys Ozone Layer," January 9, 1997;Department of the Treasury U.S. Customs Service Press Release, "Miami's 'Operation Cool Breeze' Team To Receive Prestigious Stratospheric Ozone Protection Award," October 22, 1996.

[82] Brack at 110-112.

[83] The retail price for CFC-12 has reached the $40 - $50 per pound range in the U.S., but is still well below $10 per pound throughout most of western Europe. Only part of this difference is due to the taxes levied on CFCs in the U.S., which were $5.35 per pound in 1995 and $5.80 in 1996.

[84] Alternative Fluorocarbons Environmental Acceptability Study Program Office, "Production, Sales And Atmospheric Release Of Fluorocarbons Through 1995."

using CFCs makes this one of the most expensive environmental measures to date.

Yet, during the policy debate, these costs were overshadowed by the many claims of dire harm attributed to ozone thinning. For example, the EPA calculated that the costs of the CFC phaseout are nearly a thousand times less than the benefits from avoiding ozone depletion.[85] But now, as it is becoming clear that ozone depletion posed far less serious and imminent a threat than policymakers had assumed, the costs are looking more substantial.

Worldwide, the economic impact of the Montreal Protocol has been substantial.

At this point, the transition away from CFC production and use is approximately 50 percent complete. The initial costs of switching to CFC substitutes in new equipment have already been incurred, at least in the developed world. On the other hand, there still are billions of dollars worth of existing CFC-using systems not yet converted or retired.

Estimates vary greatly, depending on the assumptions made, but all serious efforts concede costs in the tens of billions and perhaps into the low hundreds of billions of dollars. For example, Environment Canada, the Canadian government's environmental agency, puts the global costs of phasing out all ozone-depleting compounds from 1987-2060 at $235 billion dollars.[86] EPA's Regulatory Impact Assessment estimates costs in the U.S. under various scenarios in the $40 to $60 billion dollar range.[87] DuPont has estimated costs in the developed world of at approximately $40 billion dollars.[88] This author, in a 1994 study, placed the U.S. cost of the CFC phaseout in the $45 to $100 billion dollar range.[89]

A significant portion of these costs is associated with the acceleration of the CFC phaseout, which imposed additional burdens on the owners of the approximately $132 billion dollars of existing CFC-using equipment.[90] A more orderly retreat from CFC use would have allowed this equipment to live out its useful life relatively unaffected, to be replaced in due course by non-CFC systems. As it is, millions of CFC-using air-conditioning and refrigeration equipment owners, including more than 100 million American car

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[85] Environmental Protection Agency, Regulatory Impact Analysis.
[86] Environment Canada, at 42.
[87] Environmental Protection Agency, Regulatory Impact Analysis, Tables 8 and 9 (President's Scenarios).
[88] F.A. Vogelsberg, DuPont Fluoroproducts, "An Industry Perspective: Lessons Learned And The Cost of CFC Phaseout," presented at the International Conference on Ozone Protection Technologies, October 1996.
[89] Ben Lieberman, *The High Cost of Cool: The Economic Impact of the CFC Phaseout in the United States* (Washington, D.C.: Competitive Enterprise Institute, June 1994).
[90] United Nations Environment Programme, Report of the Technology and Assessment Panel, December 1991, p. E-6.

owners, have faced substantially increased costs to keep these systems in use over the past few years.[91] Vehicles manufactured since the 1994 model year no longer use CFCs in their air-conditioners, but the additional repair costs to pre-1994 cars could exceed $20 billion in the U.S.[92]

Proponents of the phaseout continue to downplay the economic impact. For example, EPA, despite its official estimates, has engaged in a public relations campaign to understate costs. In one brochure, the agency even told car owners that the CFC phaseout may actually save them money.[93] In addition, none of the agencies involved in the phaseout has attempted to quantify the adverse health effects as refrigeration and air-conditioning becomes more expensive and thus unavailable to some, particularly in developing nations.

Several factors not yet accounted for in existing estimates could substantially raise the final tally. The above estimates assume no unpleasant surprises regarding the future availability of the major substitutes for CFCs, which have become as economically important as CFCs once were. As these compounds were introduced over the past several years, they enjoyed an initial "honeymoon" period, during which they were praised by regulators, environmental activists, and manufacturers alike as examples of industry's ability, when faced with specific deadlines, to develop innovative and cost-effective alternatives to environmentally dangerous CFCs.[94] Many of these compounds were rushed into service because the accelerated phaseout, with insufficient time to fully evaluate them.

Now, the honeymoon appears to be ending, and many of these ozone-friendly alternatives are being targeted due to other perceived problems. Several CFC substitutes have been branded greenhouse gases, including HFC-134a, the most widely used alternative refrigerant in the U.S.[95] Preliminary research has indicated that the breakdown products of several substitutes can accumulate in wetlands.[96] Some reports suggest that certain alternatives pose a serious health threat to exposed individuals.[97]

A significant portion of these costs is associated with the acceleration of the CFC phaseout, which imposed additional burdens on the owners of the approximately $132 billion dollars of existing CFC-using equipment.

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[91] Aaron Lucchetti and Gabriella Stern, "Freon's Price Gives Motorists The Chills," Wall Street Journal, July 11, 1996; Julie Edelson Halpert, "Car Owners Feel The Heat As The Price Of Freon Climbs," *New York Times*, July 29, 1996.

[92] Lieberman at 7 – 9.

[93] Environmental Protection Agency, "Help Protect The Ozone Layer: Recycle The Refrigerant In Your Car's Air Conditioner," April 1992.

[94] French, at 156-162.

[95] International Institute of Refrigeration, "Fluorocarbons and Global Warming," July 1997.

[96] T.K. Tromp et al., "Potential Accumulation of a CFC-Replacement Product in Seasonal Wetlands," *Nature*, July 27, 1995, pp. 327-330.

[97] Perrine Hoet et al., "Epidemic of Liver Disease Caused by Hydrochlorofluorocarbons Used as Ozone-Sparing Substitutes of Chlorofluorocarbons, *The Lancet*, Vol. 350 (1997), pp. 556-559; Alain Astier, Francois Paraire, "Fatal Intoxication with 1,1-Dichloro-1-Fluoroethane," *The New England Journal of Medicine*, September 25, 1997, p. 940.

While none of the adverse effects of CFC substitutes have been proven, scientists and policymakers are already beginning to call for additional restrictions on their use. For example, HFC-134a and other CFC substitutes are among the greenhouse gases listed under the Kyoto Protocol.[98] The EPA has already banned HFC-134a for use in self-chilling beverage cans, because of its "potential to contribute to global warming."[99] Research continues on the other environmental and human health concerns associated with these compounds. While the ultimate fate of the CFC substitutes cannot be known at this time, any secondary phaseouts of compounds pressed into service because of the CFC phaseout could greatly increase the costs associated with the Montreal Protocol.

Several CFC substitutes have been branded greenhouse gases, including HFC-134a, the most widely used alternative refrigerant in the U.S.

HCFCs, a class of refrigerants chemically similar to CFCs, are currently under a much slower phaseout schedule because their effect on the ozone layer is believed to be far less serious. They have also come into expanded use as alternatives for CFCs in several applications. However, efforts are currently underway to accelerate the HCFC phaseout under the Montreal Protocol, which could add tens of billions to the ultimate cost.

Beyond the question of how much the Montreal Protocol is costing is that of who is paying for it. The distribution of costs yields several important lessons.

Despite claims that the Montreal Protocol has led to globally shared burdens, at present the costs are being disproportionately shouldered by Americans.[100] Perhaps half of the global costs have been incurred in the U.S. Americans owned the most CFC-using equipment, and for this reason were also the most adversely impacted when the phaseout deadlines were advanced. In addition to the Montreal Protocol's requirements, American producers and consumers must also comply with other U.S. environmental laws, which make the CFC phaseout considerably more difficult than in any other country. The 1990 Clean Air Act, for example, imposed onerous refrigerant recovery and recycling rules that add further costs to equipment repairs.[101] As with other examples of American "leadership" on this issue, few other nations have followed the U.S. lead in instituting an expensive refrigerant recovery and recycling program. Since 1990, the federal government has taxed CFCs to further drive up their prices and discourage stockpiling for future needs.[102]

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[98] Kyoto Protocol, Annex A.

[99] 63 *Federal Register* 5,491 (February 3, 1998).

[100] In addition to the costs of the CFC phaseout itself, American taxpayers are also the largest contributors to the costs of supporting the massive scientific and regulatory bureaucracy that has grown around this issue. For the past decade, approximately $1 billion U.S. tax dollars have been spent annually, including America's 25 percent contribution to the multilateral fund.

[101] 42 U.S.C. §§ 608, 609.

[102] David Gushee, *Congressional Research Service Issue Brief: Stratospheric Ozone Depletion: Regulatory Issues*, August 24, 1994, pp.10-11.

Many U.S. laws unrelated to CFCs and ozone depletion have also made the Montreal Protocol more of a challenge. For example, the strict and constantly changing energy efficiency standards for air-conditioners and refrigerators continue to create additional problems for manufacturers as they move away from CFCs.[103] Other laws have also limited the CFC substitute options available in America. For example, various regulatory and legal barriers have discouraged the use of hydrocarbons as refrigerants in the U.S., even though they have been used with considerable success in Germany.[104]

America is also paying a higher price for its strict enforcement of the Montreal Protocol. This nation's nearly solitary effort to aggressively fight the illegal trade in CFCs has, as with illegal narcotics, helped raise the market price for these compounds well above that prevailing in the rest of the world.

Despite claims that the Montreal Protocol has led to globally shared burdens, at present the costs are being disproportionately shouldered by Americans.

Much of the cost burden is on consumers rather than industry. Automobile producers, for example, have incurred costs in moving away from CFCs, but most of the burden has fallen on car owners.[105] In many instances, industry is gaining from the phaseout of CFCs. Most CFC substitutes are more profitable for their producers than CFCs. Some manufacturers have experienced increased sales of certain types of equipment, due in part to faster retirements of existing CFC systems, which have become more expensive to maintain.[106] Indeed, most chemical companies and equipment manufacturers support the Montreal Protocol. Some analysts have mistaken industry's support as proof that the CFC phaseout is a win-win policy, neglecting to fully recognize the adverse impact on consumers.[107]

The transition away from CFCs is just beginning in the developing world, due to the ten year delay granted all Article 5 nations under the Protocol. Some in poor nations are profiting by engaging in the production of CFCs for illegal export to developed nations. But, overall, the Montreal Protocol could pose serious problems for the Third World.

In many respects, CFCs were ideal for impoverished nations. They were cheap, as was the equipment using them. CFC systems were also remarkably durable and easy to maintain. Refrigeration was beginning to make substantial inroads among developing nations. The benefits of refrigeration, from improved diets and food safety to the increasing availability of refrigera-

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[103] Tekla S. Perry, "'Green' Refrigerators," *IEEE Spectrum*, August 1994, pp. 27-28.
[104] Perry at 25-26.
[105] Vogelsberg at 12; Lieberman at 7-9.
[106] Air Conditioning and Refrigeration Institute Press Release, "World Demand For Chillers Sets New Record, Huge U.S. Market Looms For Replacement Units," April 3, 1996.
[107] Elizabeth Cook ed., *Ozone Depletion in the United States: Elements Of Success* (Washington, D.C.: World Resources Institute, 1996).

tion-dependent medical care, were being enjoyed by growing numbers of people.[108] Likewise, the spread of air-conditioning has substantially reduced heat-related deaths.[109] The full benefits of refrigeration and air-conditioning are not yet enjoyed by most of the world's population, as these technologies have only begun to become more prevalent in developing nations. The switch to more expensive CFC substitutes and the more complicated systems that use them is likely to slow this progress, possibly at a cost in public health. Though not insubstantial at several hundred million dollars, the multilateral fund could be overwhelmed by any serious difficulties with the implementation of the CFC phaseout in the developing world.

The benefits of refrigeration, from improved diets and food safety to the increasing availability of refrigeration-dependent medical care, were being enjoyed by growing numbers of people.

LESSONS FOR GLOBAL WARMING

In several respects, global warming policy is today where ozone depletion policy was several years ago. The non-binding 1992 Framework Convention on Climate Change was quickly denounced as too weak and ineffective, as was the 1985 Vienna Convention. It led to the Kyoto Protocol, with the first binding targets for greenhouse emissions. As with the 1987 Montreal Protocol, these initial targets have come under immediate attack as being inadequate.[110] The now-familiar progression from a "soft" agreement to a hard one, and then to a harder one, is well underway.[111] The Kyoto Protocol also includes provisions that facilitate subsequent tightening based on the ongoing research.[112] And, once again, developing nations have initially been exempted, and most can be expected to hold out for valuable concessions before agreeing to binding limits, as essentially occurred with the Montreal Protocol's multilateral fund.

As with the policy, the development of the underlying science has also followed the ozone depletion model. A summary of the massive 1995 Intergovernmental Panel on Climate Change (IPCC) Report was distributed to the media before the full study was made available. The summary's statement that "[t]he balance of the evidence suggests that there is a

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[108] See International Institute Of Refrigeration, "The Role of Refrigeration In Worldwide Nutrition," November 1996; *World Resources 1994-1995* (New York: World Resources Institute, 1994), p. 78; Christopher Howson, "The Decline in Gastric Cancer: Epidemiology of an Unplanned Triumph," *Epidemiologic Reviews*, Vol. 8, 1986, pp. 1-27; John Lloyd, "The Cold Chain," *World Health*, December 1989, pp. 26-27.

[109] See Dimitrios Seretakis et al., "Changing Seasonality of Mortality From Coronary Heart Disease," *Journal of the American Medical Association*, September 24, 1997, pp. 1012-14; J.C. Semenza et al., "Heat-Related Deaths During The July 1995 Heat Wave in Chicago," *New England Journal of Medicine*, July 11, 996, pp. 84-90.

[110] Joby Warrick, "Reassessing Kyoto Agreement, Scientists See Little Environmental Advantage," *Washington Post*, February 13, 1998.

[111] Douglass, at 9-10.

[112] Kyoto Protocol, Article 9.

discernable human influence on global climate," was widely but erroneously reported as a conclusion of the scientific majority.[113] Even some of the people who played a key role in ozone science have now switched to global warming. Robert Watson, chairman of the Ozone Trends Panel, and chief engineer of its many executive summaries, has assumed the same role at the IPCC. And the media, which so heavily publicized the dubious claims of ozone depletion-related skin cancer epidemics, destruction of the ocean food chain, declining crop yields and the like, are now publicizing equally questionable global warming-related claims of increased storm activity, northerly spread of tropical diseases, and rising sea levels. Key weaknesses in the evidence, specifically the lack of actual temperature increases that can plausibly be attributed to anthropogenic greenhouse emissions, have been dismissed or ignored, as was the actual UVB data in the ozone debate.

In several respects, global warming policy is today where ozone depletion policy was several years ago.

In light of what is now known about ozone depletion and the Montreal Protocol, several useful lessons can be drawn that may be relevant to global warming and the Kyoto Protocol, but they are not the lessons the proponents have drawn. Indeed, there are several myths regarding the Montreal Protocol that need to be dispelled:

Myth 1: The Montreal Protocol was a successful application of the precautionary principle. Rather than proactively averting a dire environmental threat, the Montreal Protocol has proven to be a costly overreaction to a largely non-existent problem. The need to implement immediate measures was greatly overstated. In truth, there would have been little risk in delaying any CFC restrictions for several additional years while more scientific evidence was obtained, and then fashioning a better informed response at a later date. The risks of not acting quickly enough were never balanced against the risks of acting too quickly, the latter of which turned out to be greater as the policy has proven to be based on an exaggerated assessment of the threat. The same is also true of global warming, where substantial uncertainties still exist, and no compelling reason has been advanced for the costly immediate actions advocated.[114]

Myth 2: The Montreal Protocol has shown that global environmental concerns can be quickly dealt with at minimal cost. The Montreal Protocol has proven to be expensive. The costs have already reached the tens of billions and may well exceed $100 billion, not including the public health impacts as refrigeration and air-conditioning becomes more costly and less available throughout the world. Much of this burden could have been avoided if the phaseout had been slower, providing adequate grandfathering

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[113] Roger Bate, "The Political Economy of Climate Science," in *The Costs of Kyoto* (Washington, D.C.: Competitive Enterprise Institute, 1997), pp. 104-106.

[114] Roy Spencer, "The State of Climate Science," in *The Costs of Kyoto* (Washington, D.C. : Competitive Enterprise Institute, 1997), pp. 93-98; T. Wigley et al., "Economic and Environmental Choices in the Stabilization of Atmospheric C02," *Nature*, January 18, 1996, pp. 240-243.

for the large existing base of CFC-using equipment, and sufficient time for the development of alternatives. The economic impact will be far more severe for any developed or developing nation that attempts to curtail fossil fuel use, especially if forced to do so over a relatively short time span.[115]

There are several myths regarding the Montreal Protocol that need to be dispelled.

Myth 3: The Montreal Protocol process was driven by sound and objective science. The science, and particularly the manner in which it was summarized and communicated to policymakers and the public, was manipulated by a self-interested bureaucracy and environmental advocacy groups to advance a pre-determined agenda. The total lack of empirical support for the many alarming claims of ozone depletion-induced damage confirms that the forecasted consequences of ozone loss were grossly exaggerated. Several criticisms raised by scientific "outsiders" but ignored by the official research establishment, have proven to be well founded. The same questionable practices are occurring in the dissemination of global warming related science. As a result, the scientific consensus, particularly as relates to the degree of scientific certainty about global warming and the possibility of adverse consequences, has not been accurately presented.[116]

Myth 4: The Montreal Protocol proves that global cooperation and compliance can be achieved. If not for the high levels of compliance in the developed world, particularly the U.S., and among the few large corporations that produced most of the world's CFCs, there would not have been substantial declines in CFC production and use. Overall, global compliance has been inconsistent, especially among the large developing nations, and there is no viable enforcement mechanism to deter treaty violators. These flaws may totally undermine attempts to reduce greenhouse emissions, which have many more sources and will require far greater economic sacrifices and global cooperation. While CFC production in China, India, and Russia combined was approximately one third that in the U.S. when the Montreal Protocol was signed, these three nations already account for greater greenhouse emissions.[117] The lack of truly global compliance with the Montreal Protocol does not bode well for the prospects of significantly reducing greenhouse emissions under the Kyoto Protocol, a far more ambitious task, and one that will require high levels of cooperation from nations whose compliance with the Montreal Protocol has not been strong.

Myth 5: The Montreal Protocol is fair. The costs are disproportionately being shouldered by Americans, especially consumers. Developing nations, to the extent they choose to comply, are being asked to jeopardize

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[115] T. Wigley et al.; Rob Coppock, "Implementing the Kyoto Protocol," *Issues in Science and Technology*, Spring 1998, pp. 66-74; WEFA, Inc., "Global Warming: The High Cost of The Kyoto Protocol," 1998.

[116] Spencer; David Murray, "Print Media and Climate Change Coverage," in *The Costs of Kyoto* (Washington, D.C.: Competitive Enterprise Institute, 1997), pp. 109-125.

[117] Oberthur at 30; *World Resources, 1996-1997*, Table 14.1.

their economic prospects and public health. These same inequities could be repeated on a much larger scale if the Kyoto Protocol is implemented.

CONCLUSION

The path taken by the global warming debate has closely followed that of ozone depletion, and the Montreal Protocol has indeed proven to be a blueprint for the Kyoto Protocol. However, in contrast to the proponents of the Montreal Protocol who see it as a success, the evidence now reveals that the treaty has numerous and costly flaws. The science informing the policy exaggerated the threat, while the implementation costs have been unnecessarily high. Worldwide compliance has been inconsistent. All of these problems are likely to be magnified under the Kyoto Protocol.

Overall, global compliance has been inconsistent, especially among the large developing nations, and there is no viable enforcement mechanism to deter treaty violators.

ABOUT THE AUTHOR

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