Protecting the Ozone Layer: The Evolution and Impact of International Institutions

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Executive Summary

The ozone layer, about 10 to 50 kilometers above the earth's surface, protects life on earth by absorbing most of the damaging ultraviolet (UV) radiation from the sun. It was proposed in 1973 that CFCs, widely used industrial chemicals, could destroy ozone and allow more UV to reach the surface, with serious resultant health and environmental damage. A few countries restricted CFCs domestically, but not until 1985 was any international control --- the Vienna Convention, a weak preliminary treaty -- signed. The Montreal Protocol, with specific control measures, followed in 1987 and was strengthened in 1990.

The Protocol now has 73 parties, pledged to eliminate CFCs and certain other chemicals, and to restrict trade in related goods with non-parties. Industrialized nations who are parties also contribute to a system of technical and financial support to developing country parties including a $160 Million, 3-year Fund. Perhaps most important, parties are pledged to frequent review and adjustment of the treaty based on scientific and technical developments. Global consumption of CFCs has dropped more than 20% since 1986, far ahead of schedule.

Several strong non-institutional factors favored strong action on ozone: the dramatic news of the Ozone hole; convergence to a strongly unified scientific view; eventual industry support for controls; substitutes in many applications; and declining compliance costs. But the institutions established to facilitate international deliberations exercised substantial influence. Aside from the opportunities for persuasion, pressure, and discovery of joint gains that characterize any negotiation process, several institutional characteristics helped advance the process: formal procedures for assessment and revision following early negotiations of weak agreements; expert panels to provide authoritative scientific input and move scientific disagreement away from the main negotiating forum; and trade sanctions against non-Parties. The international process clearly moved some countries to control CFCs who otherwise would not have.

The institutions recently established for implementation of the treaty have not yet shown concrete results, but show two interesting characteristics: a careful attempt to maintain policy control in the Parties despite the formidable presence of the World Bank as an implementing agency; and a competitive contracting-out approach that may get efficient and accountable work from existing international bureaucracies.

Serious implementation challenges remain, particularly in implementing the financial and technical settlements with developing country parties, and in regulating potential new ozone depleters and the less-damaging (but still damaging) "transitional substances". Most sobering of all, recent science suggests that even the seemingly rapid progress may be insufficient to avert serious ozone loss. In retrospect, controls should have been enacted several years earlier; that they were not is partly attributable to international institutions being not sufficiently developed, and partly to an early lack of national leadership.

1. Introduction

Ozone in the stratosphere, the atmospheric layer ranging from about 10 to 50 kilometers above the earth's surface, protects life on earth by absorbing most of the incoming damaging ultraviolet-B (UV-B) radiation from the sun. It was first proposed in 1973 that the Chlorofluorocarbons (CFCs), an exceedingly useful and versatile class of industrial chemicals, could break down in the stratosphere releasing catalysts that destroy ozone, thereby increasing the amount of UV-B reaching the surface and causing large increases in skin cancers as well as other health and environmental damages.

While several countries acted unilaterally to restrict use of CFCs, particularly in aerosol spray cans, no international control action was taken until the mid-1980s. Then, a series of Treaties were signed that included pledges to eliminate CFCs by 2000, and to help developing countries do so through financial and technical assistance. More than 70 countries have joined, and CFC use has declined more than 20% since 1986.

The ozone treaty is widely cited as the most successful international environmental cooperation to date, and the best model for such issues as climate change. Some argue that ozone was an easy issue, though -- that strong scientific evidence, the lack of coherent industry opposition, and the availability of alternatives meant that CFCs would have been eliminated with or without effective international institutions.

This paper examines the evolution of the ozone issue, asking whether and how international negotiations and institutions made a difference to the outcome. It argues that the international institutions -- negotiating bodies, UNEP acting as secretariat, expert scientific bodies, and recently created implementing bodies -- were necessary for controlling of CFCs. The deliberative institutions provided a forum for persuasion, for coordination of proposed control measures, for building representatives' confidence that costly controls undertaken by their countries would be reciprocated, and for putting pressure on the reluctant. Implementing institutions have built capacity to reduce CFCs in private industry, and are on the verge of doing so in developing countries.

Section 2 discusses the CFC industry and the development of scientific concern about CFCs and ozone loss. Sections 3 and 4 trace the history of international action on the ozone layer

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and national ratifications and responses. Section 5 analyzes the determinants of the international agenda and action, and the influence of international institutions on the outcomes. Section 6 offers an overall assessment.

2. **Setting the Agenda:** CFCs and the **Development of Scientific Concern**

Long thought completely safe, CFCs were charged in the early 1970s with damaging the ozone layer and threatening health and environmental risks through increased ultraviolet (UV) light reaching the earth's surface. Since the first statement of scientific concern in 1973, stratospheric ozone science has gone through two broad stages: about ten years of confusion and concern, with newly discovered information frequently revising estimated risks both up and down; then, since 1985, a period of convergence in the basic science, coupled with new observations that give steadily increasing grounds for concern.

The CFCs were invented in 1928 by Dupont and General Motors chemists seeking a non-toxic heat transfer fluid for refrigeration. The simple stable molecules, derivatives of methane and ethane with chlorine and fluorine added, came to be used in a wide variety of applications. Aside from refrigeration and air-conditioning, they were used for blowing foams, as solvents, sterilants, freezing agents, surface treatment agents, and propellants for aerosol spray cans. Major new uses were found for CFCs each decade, and world production doubled roughly every five years through 1970. Halons, related chemicals containing Bromine, are effective, non-toxic, non-corrosive fire extinguishers.

CFC production is concentrated in a few countries. In the 1970s, the United States produced about half the world total, and Dupont about half the US total.' The UK, France, Germany, Italy, and the Netherlands each had one or two major producers, while Japan had five smaller producers and there were a few plants in Spain, Greece, the USSR, and several developing countries.' Aerosol sprays were 50 to 60 per cent of consumption in the US, and worldwide. Most CFCs are used to produce other goods, and user firms are numerous, diverse, and typically much smaller than CFC producers.

For 40 years after their invention, CFCs were thought completely benign. Then, in the early 1970s, concern arose that they could lead to destruction of ozone in the stratosphere, resulting in increased levels of UV radiation at the earth's surface, causing increases in skin cancer, cataracts, immune disorders, and damage to crops and ecosystems. The proposed mechanism, published in 1974, was as follows. Because CFCs are so chemically stable, they persist long enough in the lower atmosphere to diffuse across the boundary to the stratosphere. There, they are broken apart by solar UV radiation and release chlorine atoms, which act as catalysts to convert ozone into molecular oxygen. Although ozone is also

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[1] Dupont CFC revenues were about $600 Million, or 2 % of total revenues.

[2] Maria Geigel, "CEH Product Review: Fluorocarbons", Chemical Economics Handbook, SRI International (1985), cited as Exhibit 7 in Reinhardt (1989).

continually re-created from oxygen by UV radiation, the presence of chlorine speeds up ozone destruction but not ozone creation, thereby reducing the equilibrium level of ozone. With less UV being absorbed by ozone in the stratosphere, more penetrates to the lower atmosphere.' Ozone loss of 1 % causes about 2 % increase in surface UV, which in turn causes somewhat more than 2 % increase in skin cancers.

While evidence supporting several pieces of the CFC-ozone depletion hypothesis was gathered by 1977, continuing discoveries concerning other, related stratospheric reactions caused total estimates of ozone loss to fluctuate markedly until 1985. As an indication of the variation, successive NAS reports gave estimated total ozone loss of 7, 16.5, 5 to 9, and 2 to 4 per cent,' although through this entire period there was always projected a large ozone loss in the upper stratosphere, compensated to a varying degree by ozone creation in the lower stratosphere. The early 1980s also saw serious dispute over whether ground-based measurements already showed global ozone declines, and whether CFC consumption would start growing again. Around 1984 a theory called the "Chlorine Catastrophe" generated intense but short-lived concern, by proposing that large CFC increases could produce extreme ozone loss. [5]

Following this period of fluctuating concern, ozone science since 1985 has proceeded steadily in the direction of increased concern. The first landmark was the May 1985 publication of the "Ozone Hole" paper by members of the British Antarctic Survey. This group had maintained a small research station in Halley Bay, Antarctica for 25 years, and had seen large ozone losses each Austral spring since September 1982. Though they had delayed publication suspecting instrument errors, the 40% loss they saw in September and October 1984, along with corroboration from a second station several hundred miles further north,

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' The basic chemistry of ozone creation and destruction in the stratosphere was explained by Chapman (1930). Modern controversy over ozone loss first concerned nitrogen oxides (NOx) in the exhaust of the supersonic transport (SST). (Crutzen 1970; Johnston 1971; James MacDonald, cited in McElroy 1987.) The SST-ozone controversy may have had two significant impacts on the CFC-ozone controversy: first, it spawned a major environmental impact study that built up the capacity of US stratospheric science; (Grobecker et al, 1974; Glantz, Robinson, and Krenz, 1985.) second, related US discouragement of the Anglo-French Concorde may have generated suspicion among European technical communities that US officials exaggerate environmental risks. (Interviews; Morrissette 1989, p.803; Downing and Kates 1982; Benedick 1991, p.32-33; Rowland interview in Brodeur 1986, p.80.) The risk of chlorine catalysis was first raised by Stolarski and Cicerone (1974). Measurements of CFCs in remote regions, suggesting the absence of tropospheric sinks, were provided by Lovelock, Maggs, and Wade (1973). The landmark paper identifying CFCs as the main source of stratospheric chlorine, independently presenting the mechanism for chlorine catalysis of ozone destruction, was Molina and Rowland (1974). Wofsy, McElroy, and Yung (1975) proposed a similar reaction cycle for bromine.

' National Research Council (1976, 1979, 1982, 1984). The estimates are equilibrium ozone losses in steady-state, giving continued emissions at early 1980s levels.

[5] The catastrophe arose in one-dimensional models, which showed highly non-linear increases in ozone loss above a certain chlorine concentration. Two and three-dimensional models failed to reproduce the result because of horizontal transport, and concern faded. Prather, McElroy, Wofsy (1984); Sand (1985).

moved them to announce their results.' NASA's Nimbus 7 satellite, in polar orbit since 1978, had also recorded the ozone loss, but release of the data had been delayed while it was checked for instrument error.' When released, the satellite data showed a region of severe ozone loss as big as the continental United States originating around 1980. No available theory explained the loss but three were soon advanced, one of which blamed chlorine from CFCs.'

The ozone hole paper was published just as a comprehensive international assessment of ozone science was about to go to press, so the report simply noted the measurements and reported further analysis was underway.' Released in January 1986 and sponsored by seven agencies, [10] the report compared all major ozone models and presented several scenarios for global ozone loss: 9 % with emissions of CFC and other relevant gases constant at 1980 levels; substantially higher losses with increased CFC consumption; and no loss when constant CFC emissions are offset by growth in emissions of carbon dioxide, methane, and other gases."

Also in 1986, analyses of satellite ozone measurements seemed to show global ozone losses as high as 4 per cent." The measurement was highly controversial because the instrument's performance was degrading and it was not certain that analysts had adequately corrected the resultant drift in measurements. In response to this controversy, NASA organized an international team of scientists called the Ozone Trends Panel (OTP) to review all ozone measurements available, both satellite and surface, and determine whether a global change was occurring.

Large NASA-sponsored scientific groups went to Antarctica in September of 1986 and 1987 to look for the cause of the hole. Evidence from ground and balloon observations in the 1986 expedition favored the chlorine hypothesis but was inconclusive." The 1987 expedition, though, flew instruments on high-altitude aircraft into the hole and found striking, near-

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[6] Farman et al (1985).

' Early news reports suggested that NASA's data filters had simply discarded the low observations. NASA officials deny this in correspondence reproduced in Pukelsheim (1990).

[8] Special supplement issue, Geophysical Research Letters 13:November, 1986.

' WMO (1986), p.20.

[10] NASA, NOAA, and FAA in the United States; UNEP and WMO; the EC Commission; and the German Ministry of Science and Technology.

[11] WMO (1986).

[12] Heath (1986).

[13] Geophysical Research Letters (1986), special issue.

definitive confirmation of the CFC-based theory, as well as ozone loss as high as 95 % in the lower stratosphere. [14]

Over the next few months theorists worked out the detailed mechanism for Antarctic ozone destruction. Reactions that occur on the surfaces of the polar stratospheric clouds (PSCs) that form in the extremely cold Antarctic night release highly reactive species of chlorine and Bromine. These accumulate in the area confined by the polar vortex, until the sun rises in the spring. Under sunlight and low temperatures the chlorine and Bromine rapidly destroy ozone. The process stops when the temperature rises and the vortex breaks up. [15] Some contend that the heterogeneous chemistry that forms reactive species on PSC surfaces could occur on other surfaces too, such as the different kinds of PSCs that form in the Arctic winter, or sulfate aerosols that occur naturally in the stratosphere from volcanic eruptions.

On March 15, 1988, the Executive Summary of the Ozone Trends Panel was released. The analysts had exhaustively reviewed the record of ozone observations from ground stations, calibrating them and removing known sources of natural variation. They found significant ozone losses only in the north temperate latitudes: 2 to 3 per cent in summer, and 2 to 6 per cent in winter from 1969 and 1986, two to three times greater than the losses predicted by models. [16] Five separate groups, including one sponsored by CFC manufacturers, re-analyzed the data and confirmed the results"

Following the Antarctic results, there was concern that similar ozone-destruction may be happening in the Arctic. NASA-led studies in 1988 and 1989 found highly perturbed stratospheric chemistry similar to that in the Antarctic, but no ozone hole." Although the Arctic should be less vulnerable than the Antarctic, because it is warmer and because its vortex usually collapses before sunrise, the expeditions found risk of a future Arctic ozone hole, depending on weather conditions from year to year as well as chlorine levels.

Recent observations continue to show increased ozone losses globally, in the Arctic, and the Antarctic. The Antarctic ozone holes of 1990 and 1991 were the most severe so far in both intensity and duration." In December 1990, NASA presented corrected satellite measurements that showed global average ozone loss of 3 per cent over 12 years, 9 per cent in mid-northern winter. These losses are two to three times greater than predicted by

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[14] Anderson, Brune, and Proffitt (1989).

[15] McElroy et al (1986); Molina and Molina (1987); McElroy and Salawitch (1989).

[16] NASA (1988). The full OTP report was not published until January 1991.

[17] WMO (1989), p.ix.

[8] Special issue of Geophysical Research Letters 17, March 1990 supplement.

[9] UNEP (1991c).

homogeneous models." Significant temperate-latitude losses in spring and summer have recently been reported for the first time."

3. International Policies: History of Negotiations and Decisions.

3.1 1977 to 1985: Washington to Vienna

Following the 1974 charge that CFCs could destroy the ozone layer, an intense 3-year debate in the US focused specifically on aerosol sprays, regarded by many as a frivolous and expendable use. The debate was marked by high public and media attention, enactment of several state-level CFC restrictions, two petitions by the Natural Resources Defense Council (NRDC) to the Consumer Product Safety Commission requesting CFC bans, and a hard-fought industry campaign led by Dupont, arguing that the science was too speculative and uncertain to justify regulation. In the course of this debate Dupont officials, in newspaper advertisements and before Congressional Committees, stated that if "reputable evidence" showed CFCs to cause a health hazard through ozone depletion, they would stop producing them." Although the science remained confused through this period, US regulators decided in early 1977 to ban CFC aerosols except for a few "essential" uses.

As this US decision was in train, the first significant international initiative on ozone took place: a UNEP-sponsored Washington meeting in March 1977, with representatives from 33 nations and the EC Commission. The meeting heard a series of research papers and summaries of national research programs, and drafted the "World Plan of Action on the Ozone Layer", a program of recommended international cooperation in research on atmospheric chemistry and modeling, ozone and radiation trends, health and environmental effects, and emission trends of ozone-affecting substances. The Plan was to be implemented by a broad set of institutions -- national governments, UN agencies, and inter-governmental and non-governmental organizations -- with UNEP playing a "coordinating and catalytic" role.[23]

The Washington meeting also recommended creating a "Co-ordinating Committee on the Ozone Layer" (CCOL), composed of experts from agencies and NGOs participating in the Plan of Action. UNEP's Governing Council created the CCOL and adopted the Plan of Action the following May. The CCOL was to coordinate research undertaken by national and international agencies. The Washington meeting, the Plan of Action, and the CCOL were all highly scientific in character." The CCOL met annually from 1977 to 1985, preparing

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NASA (1991), p.3.

[21] UNEP (1991c).

McCarthy (1976).

23 UNEP (1977).

[24] Biswas (1979); UNEP (1977).

reports that summarized recent research for policy-makers and prioritized research needs. The chemical industry, which was sponsoring a few million dollars of ozone research per year, participated actively." Until January 1982, the CCOL was the only formal international body considering the ozone layer.

US CFC production dropped by half following the aerosol ban, world production by about 25%. Three US producers each closed one plant, and one producer left the market. Fearing the risk of restrictions on other applications, producers began research into CFC substitutes; Dupont spent $3 to $4 Million per year through the late 1970s. [26] American regulators had planned to go beyond aerosol controls, and EPA issued a proposal for comprehensive CFC controls in 1980. Two new factors prevented further US restrictions, though. First, in summer 1980 US producer and user industries formed a new lobby group, the Alliance for Responsible CFC Policy, which waged a strong anti-regulatory campaign.' Second, the Reagan administration's new EPA officials were skeptical of the need for CFC controls. Consequently, the pursuit of further CFC controls essentially stopped, as did industry research into substitutes. The early US fight had, though, created three institutional forces that significantly affected later international debate: a politically sophisticated community of atmospheric scientists; expertise and commitment on CFCs within NRDC; and the Alliance.

Three other countries also restricted CFC aerosols in the late 1970s. Sweden and Norway, ¡mporters of CFCs, banned "non-essential" aerosols as had the US, thereby cutting aerosol use 95 - 98%. Canada, a small producer, instead banned CFCs in the three largest applications, hairspray, deodorant, and antiperspirant, cutting use about 80%.

Through the late 1970s, the Nordics pushed repeatedly for authorization of a body to discuss international regulations. They succeeded in April 1981, when UNEP's Governing Council approved a Swedish motion to establish a Working Group to negotiate an international convention on the ozone layer. The Working Group first met in Stockholm in January 1982, with the CCOL designated as its scientific and technical advisory body." The Nordic countries, led by Sweden, introduced a proposal for strong control measures that received

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[25] CCOL reports.

[26] Reinhardt (1989), p.12.

[27] The Alliance had about 400 members, dominated numerically by user industry but principally formed at the instigation of producer industries. The principal goal for its foundation was to prevent regulators from dividing and conquering the industry through a sector-by-sector approach to regulation. Its three founding principles were that any CFC controls should be based on science; should be international, not unilateral; and should apply equitably to all CFC applications. Interviews.

' In 1980 and 1981, the CCOL reports moved from science summaries toward cautious calls for international regulatory action. Once the Working Group was created, CCOL returned more to the character of a purely scientific advisory body -- although their numerical estimates of predicted ozone depletion continued to have strong policy ¡mplications.

little support. With scientific concern declining at the time and CFC consumption reduced by the recession and national aerosol bans, nobody but the Nordics thought strong international controls worth the effort. The US delegation arrived unprepared and unwilling to engage in substantive discussions;[69] the Europeans and Japan were uninterested in any discussions of international controls. The closest the meeting came to controls was a hypothetical discussion of what kind of "triggers" a convention should incorporate -- pre-agreed warning signals that, if observed, would indicate a need for action."

The Working Group met seven times over the following three years, with UNEP providing moral and limited secretarial support. Negotiations moved very slowly, against vehement European opposition. Relations between governments and national producers in Europe and Japan were close, and industry representatives served officially on national delegations through the entire process. The Nordics relaxed their proposal somewhat, to a ban on CFCs 11 and 12 in non-essential aerosols, with unspecified limits on other CFC uses." The US, participating somewhat more actively from April 1983 following EPA's leadership change, proposed a control clause similar to US domestic legislation, while Canada proposed one similar to Canadian legislation. The advocates of controls -- The United States, Canada, the Nordics, Austria, and Switzerland -- finally came together informally in September 1984 to form the "Toronto Group", and endorsed a draft Control article." The Article did not contain a single control measure, but a "multi-options" approach; it listed several possible forms of controls yielding similar overall reductions, of which Parties would choose one. Most of the options involved large aerosol cuts, and each one mirrored existing domestic regulations of one of the measure's sponsors.

Canada presented the Toronto group's package to a Working Group meeting in October, to strenuous objections from EC representatives who argued that no controls were justified." Under pressure, EC representatives eventually responded with a draft protocol that mirrored their own 1980 measures: 30% aerosol reductions from peak 1970s levels, and no expansion of CFC 11 and 12 production facilities. (Neither of these constraints was binding for the EC in 1984.) They argued that only a production capacity cap would guarantee that growth in other uses would not swamp the effect of an aerosol ban. Moreover, they pointed out that allowing trading nations to select different forms of limited control under the "multi-options"

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[69] Meeting Notes.

[70] German Bundestag (1989), pg. 257; Briefing note to Canadian Minister, Dec 22 1981. The state of understanding of the issue at this time was such that several countries had responded to UNEP's data request by saying that they did not use CFCs, so "their ozone layer" was not threatened.

" April 1983 meeting notes.

[72] The sponsors of record of the proposed protocol were Sweden, Norway, Finland, Canada, and the United States. Austria, Denmark, Switzerland and Australia also participated and expressed support "in principle".

" Jan 1984 meeting notes.

approach, could permit unlimited global production expansion. Industry representatives on both sides encouraged this deadlock."

Through this period there was also sharp disagreement over how fast future CFC markets would grow, with industry arguing that markets were largely saturated and others projecting growth as high as 5 or 6 per cent per year. In fact, strong growth and promotion of new application markets, particularly foams and solvents, had reversed the declines that followed the aerosol bans. US and world production surpassed their pre-ban peaks levels in 1984, and several new investments in production capacity were announced between 1982 and 1986.36

In November 1984, as advocates of international CFC controls pressed their case, NRDC sued EPA for failing to regulate CFC production. NRDC delayed the lawsuit a few months due to concern that it might obstruct sensitive negotiations, but proceeded when they decided no international controls were likely to come from the March 1985 Vienna meeting.

None did. Early in the discussions, the Nordics had proposed that controls be a central part of the treaty. When participants settled on a "Convention and Protocol" approach, the Nordics consented to move the bitterly contested control provisions first to an Annex, then to a separate (but simultaneously signed) Protocol. Ultimately, the EC and Toronto Group could not bridge their differences in time for the Ministers' meeting in Vienna, and only the Convention was signed. In it, nations pledged to cooperate in research and monitoring, to share information on CFC production and emissions, to pass control Protocols if and when warranted, and to participate in a non-binding dispute resolution process. Twenty nations plus the EC Commission signed the Vienna Convention. Except for two contentious elements, the dispute resolution process and the voting status and competency of the EC, participants could have agreed to these innocuous measures eight years earlier, for they were all contained in the 1977 World Plan of Action." Even so, a last-minute, ideologically motivated conflict within the State Department over whether the US delegation should sign the Convention was resolved by a decision of the Secretary of State."

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[34] EC Commission (1985). The EC argument invoked the then-current "chlorine catastrophe" to argue that present production levels were innocuous but large increases, which would in principle be possible under the Toronto Group proposal but not under theirs, were potentially catastrophic.

35 Interviews.

[36] Hammitt et al (1986).

[37] As finally agreed, the dispute resolution process permitted parties to opt in to compulsory participation in dispute resolution by either arbitration or the International Court of Justice, though the decisions of these bodies were non-binding.

38 Benedick (1991), p.46; Interviews.

For those advocating CFC controls, the failure of Vienna was mitigated by one small, but ultimately important, victory. In return for the Toronto Group's giving up immediate control measures, a resolution was appended to the Convention empowering UNEP immediately to convene Working Group negotiations for a Protocol, to be signed if possible in 1987. [39] This did not reflect formal designation of UNEP as Secretariat for the Convention; the World Meteorological Organization (WMO) also wanted the job, and there was division among delegations, with (roughly speaking) scientists favoring WMO and diplomats UNEP. The appointment of a Secretariat was deferred to the first Meeting of the Parties. [40]

3.2 1985 to 1987: Vienna to Montreal

Following Vienna, UNEP first organized two informal technical workshops, in Rome in May 1986 and jointly with EPA in Leesburg, Virginia in September. The Leesburg workshop on regulatory strategies represented several firsts: environmental NGOs participated in the international negotiating process for the first time; the USSR presented CFC production data for the first time; and several novel regulatory approaches were presented. The Canadian delegation presented an innovative proposal to re-structure the debate over CFC controls by considering all CFCs comprehensively, deciding on an acceptable global emissions limit, and allocating this limit to countries according to population and GNP in shares to be negotiated." Though the proposal was not adopted, many participants credit it with re-focusing the control debate more broadly and breaking the long-standing deadlock between the EC and the Toronto Group." An EPA report at Leesburg was the first to shift focus from ozone depletion to chlorine concentration, arguing that stabilizing present chlorine levels would require an 85% cut in CFC emissions.

Through 1986, the United States assumed a strong leadership role in the negotiations for the first time. In early fall, Administrator Lee Thomas initiated an EPA position advocating full phaseouts. In November, following a low-level inter-agency review, the official US negotiating position was announced: an immediate freeze in CFC consumption, followed by phased reductions to essentially zero (nominally, 95% reduction), with interim scientific reviews to determine whether the continued cuts were necessary.

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[39] "Resolution on a Protocol Concerning Chlorofluorocarbons", Final Act of the Conference of Plenipotentiaries on the Protection of the Ozone Layer.

[4°] WMO harmed their own case when, while presenting a bid to be Secretariat at the 1984 Governing Council meeting, WMO's Deputy Secretary-General stated that present scientific knowledge did not warrant controls, and the Convention should be largely confined to promoting further research. Several delegations objected strenuously to this breach of policy-neutrality by a scientific advisory body.

" Environment Canada (1986)

[47,] Interviews.

1986 also saw a split in the formerly united front of US and European producers. Previously, both sides held that stratospheric science was too uncertain, and that several years of research were needed to tell whether further CFC controls were justified. The first movement was in March, when a Dupont official announced that substitutes could be available in five years if market conditions warranted the development effort, and that research into substitutes had stopped in the early 1980s. [43] In August the board of the Alliance held an all-day workshop to review the recent science assessment report and CFC growth projections, and decided to endorse international controls on the rate of CFC growth." One week after the Alliance announcement, Dupont went slightly further and endorsed international controls on the level of CFC production."

Dupont also returned to substitute research in late 1986, spending $5 Million in 1986, $10 Million in 1987, and $30 Million in 1988. [46] Four kinds of substitution are possible for present CFC applications: conservation, non-fluorocarbons, and two classes of chemicals related to the CFCs, Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HFCs). Both classes are harder to manufacture than CFCs and cost two to five times as much. HCFCs contain hydrogen, making them more reactive in the lower atmosphere than CFCs and hence only 1 to 6 per cent as ozone-depleting as CFC-11. [47] HFCs contain no chlorine and cause no ozone depletion, but both HCFCs and HFCs are greenhouse gases, contributing to the separate problem of global climate change. [48]

Three rounds of formal negotiations followed the workshops, in December 1986 and February and April 1987. In the opening round, the US proposed phased consumption reductions of CFCs and Halons to near zero; the Europeans proposed a production freeze on CFCs 11 and 12; [49] the Nordics proposed an immediate 25 % reduction in consumption of 11

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[43] Presentation of Donald Strobach at EPA's domestic workshop, preparatory to the Rome workshop. Most interviewees describe this announcement as a clarification of a long-held Dupont view, rather than a change of position.

[44] Richard Barnett press conference, September 16, 1986.

[45] Glas, Joseph P. 1986. "Dupont position statement on the Chlorofluorocarbon-Ozone-Greenhouse Issues", Environmental Conservation 13, 363-4.

[46] Reinhardt, p.12.

[47] WMO (1989), p.xxx.

[48] Dupont's estimate of how present CFC demand will be met in 2000 has changed sharply in the last two years. In 1989 they estimated 307o HCFCs, 9 ⅞ HFCs, 32% non-Fluorocarbon, and 29% conservation. In 1991 this was revised to 24 % HCFCs, 17 % HFCs, 47 % non-Fluorocarbons, and only 12 % conservation. Interviews.

[49] The Europeans first refused to present or discuss any control proposals, as the delegation had received only "the vaguest of mandates". After the delegations caucused, they presented the production freeze, calling it a "non-proposal" for discussion purposes only. They argued that they were unable seriously to negotiate until after a

and 12; and Canada reiterated its Leesburg proposal. Progress was very slow in December and February, with some delegates expressing concern that the process would have to go ahead without European participation.[50]

In March and April, several breakthroughs occurred. At the March Council of Environment Ministers meeting, the EC moved to a position of 20% production cuts. Several observers contend that it was sometime between September 1986 and April 1987 that European industry lost control of their national delegations; by April, the Japanese industry representative no longer sat on the national delegation." In April, UNEP sponsored an international scientific meeting in Wurzburg Germany, where atmospheric modelers from several countries ran their models on common emission scenarios and found they agreed some ozone depletion would occur with any of the control schemes being proposed. At the April negotiations, UNEP Executive Director Mostafa Tolba participated for the first time, and stated in his opening remarks that the Wurzburg results made it "no longer possible to oppose action to regulate CFC release on the grounds of scientific dissent".52 Tolba organized closed-door negotiating sessions with ten key countries, which produced a single draft text called "the Chairman's personal text". Although this text became the basis for subsequent negotiations, several key points were only settled at the last minute in Montreal.

Through early 1987, US supporters of controls campaigned actively to build support for a treaty internationally. US negotiators, EPA officials, and scientists met extensively with foreign officials and scientists, and conducted live video discussions via satellite. Representatives of American environmental NGOs also travelled, encouraging European and Japanese NGOs to become active in the issue." Friends of the Earth UK ran an aggressive campaign through 1987, culminating in a boycott threat against twenty specific CFC-aerosol products.'" The US delegation was pushed domestically by both the NRDC lawsuit and Congress. The lawsuit settlement had called for new interim regulations by May 1987 and

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Council of Environment Ministers' meeting in March, and attempted to block the tabling of a consolidated draft text for future negotiations, and delay the second meeting. Meeting notes.

[50] Briefing note.

[51] Interviews.

[52] UNEP/WG.172/2. "Report of the Ad Hoc Working Group on the work of its Third Session".

53 Benedick (1991), p.28,39.

[54] Cook (1990)

final ones by November, subsequently extended for six months." Bills introduced during 1987 called for unilateral US CFC cuts, accompanied by trade restrictions against countries who do not reciprocate."

Still, strong opponents in the US government felt they had not had their say in developing the negotiating position, and succeeded in establishing a high-level interagency process to reconsider all aspects of the US negotiating position. This bitterly contested process, conducted under the Domestic Policy Council and chaired by OMB, consisted of twice-weekly meetings from 5 PM until after midnight for four months. The meetings reviewed all scientific, technical, economic, and policy aspects of CFC control. Leaks from this process asserted that interior officials were advocating "personal protection", meaning hats, sunglasses, and sunscreen, instead of CFC controls, seriously embarrassing the administration. The dispute was finally resolved in a Cabinet meeting June 18, when the President re-affirmed the original US negotiating position."

International negotiations proceeded to the last minute in Montreal in September, 1987. The final agreement, worked out in post-midnight ministerial discussions, enacted 50% cuts from 1986 levels of production and consumption" of the five principal CFCs (11, 12, 113, 114, and 115) by 1999, with interim controls of a freeze in 1990 and a 20% cut in 1994. Three Halons were frozen at 1986 levels beginning in 1993. Total production and consumption of CFCs and Halons were calculated by weighting each chemical by its ozone-depletion potential (ODP), so countries could choose on which particular chemicals to concentrate their controls. There were a few exceptions to these control measures: those developing countries whose annual consumption is less than 0.3 Kg per capita receive a 10-year grace period, while other nations may exceed production limits by up to 10% for export to meet these countries' "basic domestic needs"; nations producing less than 25,000 metric tons per year may transfer their production quotas to other parties for purposes of industrial rationalization; and the Soviet Union may count one plant under construction in its baseline. The Protocol would enter into force when it received eleven ratifications representing at least two-thirds of 1986 global CFC' consumption.[59]

The Protocol included several restrictions on trade with non-Parties: bulk imports of restricted substances from non-Parties were prohibited in 1990; bulk exports were prohibited

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[55] Doniger (1988).

[56] Shimberg (1991).

[57] Interviews; Benedick (1991), p.58-67.

[58] Defined as production plus imports minus exports.

[59] Montreal Protocol, Final Act, 1987.

from 1993;[60] imports from non-parties of products containing controlled substances were banned (with the possibility of opting out by formal objection) from 1992; and parties agreed to study the feasibility of banning imports of products made with controlled substances, even though not containing them." Some delegations were concerned that these measures would violate GATT, but GATT officials said the discriminatory sanctions would be acceptable if they were clearly related to environmental protection. The Protocol accommodated trade concerns by exempting from the import bans those non-parties who undertake the same controls and data reporting requirements as Parties.

Parties also agreed to provide data on their production and consumption, to share technical information, and to promote technical assistance to help developing countries comply with the Protocol. Regional Economic Integration Organizations (REIOs)[62] are permitted to meet the consumption limits, but not their production limits, jointly rather than country-by-country. An important innovation was a formal commitment to periodic review. Parties were to meet in 1990 and at least every four years thereafter to determine whether the control measures should be changed. Before each review, expert panels would be formed to assess recent scientific, technical, environmental, and economic developments, and report to the parties. The Executive Director of UNEP was empowered to advance the first meeting from 1990 to 1989 if one-third of the parties agreed.

3.3 1987 to 1991: Montreal to London and Beyond

Strong Antarctic evidence against CFCs arrived within weeks of the signing in Montreal, and the first evidence of global decline (the OTP) within six months. Tolba proposed in November 1987 to exercise his power to advance the first meeting of the parties to 1989. Obtaining the required ratifications was the first priority, for without the treaty in force there could be no review process. The Protocol entered into force on schedule on January 1 1989, with 30 parties (including the EC) representing 83% of global consumption.

Though both American and European producers had finally endorsed the Protocol, their position was that the science only justified a freeze, so 50% cuts represented a large safety margin. But Dupont again moved ahead of the other producers in March 1988. In late February, Dupont's CEO had written to three Senators stating that the scientific evidence against CFCs was not yet clear enough to call forth Dupont's old promise to stop making them. Forced to reconsider just two weeks later when the OTP Executive Summary was

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[60] Curiously, bulk exports were only prohibited from developing country Parties. Others could export after 1993, but could not deduct these exports from their calculated domestic consumption -- i.e., you could export to non-parties but only by taking it out of your domestic consumption.

[61] Article 4. This category could include many electronic goods. The stakes are much higher and the detection problems much more severe on this category of goods than on any of the others in Article 4.

[62] A set whose only member at present is the EC.

released, Dupont announced on March 23 that it would stop producing CFCs and Halons by 1999, and endorsed a global phaseout.[63] Other producers, not as exposed as Dupont, awaited the industry-sponsored review of OTP's analysis. In summer 1988, when the completed analysis supported the OTP conclusions, the Alliance, the European industry council (CEFIC), ICI, and the EPA all announced within a few days that they endorsed a phaseout.[64]

It was also summer 1988 that additional chemicals, Methyl Chloroform (MC) and Carbon Tetrachloride (CT) were proposed for controls because of their ozone-depletion risks. CT, highly toxic, had been banned for many years in most industrial countries but was still widely used in developing countries and the Soviet Union. MC is a versatile solvent of very low toxicity and reactivity, widely used for metal degreasing." These proposed controls involved a group of producers not previously experienced with the international ozone process. Only ICI is a major producer of both CFCs and MC. The other major producers are Dow with about half the world market, PPG, and Vulcan. American producers and users formed the Halogenated Solvents Industry Association in September 1988, and have subsequently lobbied both domestically and internationally.

The first step in treaty review was to establish the expert panels. UNEP called a meeting in the Hague in October 1988 to define their mandates: a science panel to report projected ozone losses under various emission scenarios; a technology panel to report the availability of substitutes and the feasibility of larger cuts; an environmental effects panel; and an economic panel. The panels worked through the first half of 1989.

While the panels were working, there were important changes in national positions. In March the EC Council, with the UK now joining the activists, agreed to a full phaseout of all CFCs, "as soon as possible, but not later than 2000".[66] Immediately afterwards, at a London conference called "Saving the Ozone Layer", more than 100 nations endorsed phaseouts and major developing countries first asserted strongly their need for major technical and financial assistance to phase out CFCs.

The first Meeting of the Parties was May 1989 in Helsinki. Here, 80 nations signed a declaration endorsing phaseouts of CFCs by 2000 and Halons as soon as possible, and endorsing somewhat vaguely financial and technical transfers to LDCs.[67] The Helsinki meeting also fixed budgets for the small Secretariats at UNEP Headquarters in Nairobi that

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[6°] Interviews.

Hammitt et al (1986), p. 78.

EC documents.

[67] UNEP (1989).

serve the Protocol and the Vienna Convention (about $1.2 Million per year for both, including meeting expenses). It was not possible to amend the treaty at this meeting because of notice requirements, but the Parties heard interim reports from the panels, and authorized UNEP to convene a working group to hear the final panel reports and negotiate Protocol amendments, which would be finalized at the second meeting of parties, in London, June 1990.

The reports of the science and technology panels were strong and influential. Citing major gaps in the models used to predict ozone loss, the science panel moved one step backward in the causal chain, projecting future time paths of stratospheric chlorine concentrations rather than ozone depletion, for various CFC emission scenarios." The ozone hole first appeared when stratospheric chlorine was about 1.5 - 2.0 ppb, compared to the present 3.3 ppb. If all processes are reversible, the hole should fill when chlorine returns below 2 ppb. The panel studied four scenarios, ranging from a freeze to full phaseouts of CFCs, Halons, CT, and MC by 2000. They found that even with a global phaseout, chlorine will continue increasing to about 4.5 ppb around 2010, and will not return to 2 ppb until 2060.[69]

The technology panel was organized into sectoral sub-panels, each of which consisted mostly of user industry experts financed by their companies. Panelists travelled intensively, visiting plants and laboratories, observing and sharing information on detailed technical solutions to highly specific applications, and spontaneously problem-solving with their hosts. This process thus generated new knowledge and new commercial opportunities in CFC reduction, as well as producing an inventory of existing knowledge. The panel report said CFC cuts of at least 95% were feasible by 2000, and that substitutes presently exist for 90-95% of methyl chloroform uses and "a majority" of carbon tetrachloride uses. Most aspects of their work are uniformly praised; the exception is MC, which many contend was added late and received weak treatment.[70] In contrast to the technology and science panels, the economics and impacts panels presented reports that endorsed tighter controls, but were weakly argued and of little influence.[71]

The working group received the panel reports in September 1989, and began negotiating amendments. In their seven sessions through late 1989 and early 1990, they agreed relatively easily to phase out CFCs and Halons, and focused most on the terms of the proposed financial and technology transfer mechanisms for developing countries. These discussions derailed briefly in April when the US apparently went back on a prior understanding that

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' The chlorine loading approach first appeared in a US EPA report at Leesburg in September 1986; time paths of chlorine concentration first appeared in another EPA report in August 1988.

WMO (1989), p.vii.

[70] Interviews. The Panel was divided on the maximum feasible reduction of halons, with positions ranging from a technology-forcing full phaseout, to no reduction.

" Interviews; Panel reports.

new funding would be required, but a subsequent US "clarification" put them back on track." Both environmental and industry groups participated actively in these negotiations. While only France continued to send industry officials as national negotiators, some nations now included environmental NGOs as "advisers" on their delegation, in order to fund them to attend meetings. [73]

As in 1987, negotiations continued to the last minute. Finally, the Second Meeting of the Parties, in London in June 1990, established the following revised control measures: all fully halogenated CFCs to be phased out in 2000, with interim reductions of 85% in 1997 and 50% in 1995; [74] the original three Halons also to be phased out in 2000, with an interim reduction of 50% in 1995; Carbon Tetrachloride to be eliminated by 2000 with an 85% reduction in 1995; Methyl Chloroform to be eliminated by 2005, with reductions of 30% in 1995 and 70% in 2000; and non-binding resolutions on other Halons, and on HCFCs. [75]

Several other measures fine-tuned the protocol and made it more equitable. Permission to transfer production quotas for industrial rationalization was extended to any parties, not just those below 25 KT per year. Two measures that discriminated against LDCs, weighted voting and the prohibition of non-party exports from developing countries only, were revised; now adjustment of the Protocol requires a two-thirds majority overall, with simple majorities of industrial and developing country parties, and no party may export in bulk to non-parties. Finally, the EC was permitted to report their consumption, import, and export data aggregated.

The most important innovations, though, and the most contentious, were the financial and technology transfer provisions. For financing, a fund was created to pay the incremental costs of developing country parties in meeting their control obligations. A specific list of permitted categories of incremental costs is covered. Industrial country parties contribute to the fund according to the UN scale of assessment, and their contributions must be additional to other funding (although bilateral and regional aid can count as a contribution under certain conditions). The ultimate size of the fund has not been precisely determined, but an interim fund for the three years prior to entry into force was set at $160 - 240 Million. [76]

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[73] Of the outcry that followed the first US announcement, participants report that the one decisive element was a letter from Prime Minister Thatcher to President Bush, implicitly threatening to scuttle the Houston G-7 summit if the US ruined the London meeting.

Interviews.

[74] The 50% reduction applies only to the original five CFCs.

[75] The resolution on HCFCs calls for phaseouts by 2040, "if possible by 2020".

[76] The lower figure is without India and China. Each of them joining increases the fund by $40 Million.

Preambular language, inserted at the insistence of the United States, says that the mechanisms adopted in this case are "without prejudice" for measures that might be undertaken for other issues such as climate change.

In addition to the Fund, there are two important provisions on technology transfer. First, parties pledge to ensure that the technology necessary to meet control obligations is available to developing country parties on "fair and most favorable terms" -- a compromise with the traditional G-77 position of "preferential and non-commercial". Second, a carefully worded passage states that LDC parties' "capacity to fulfill" the control obligations "will depend upon the effective implementation of the financial co-operation ... and transfer of technology". One delegate described the intent of this as "to acknowledge that they are not required to do the impossible, without permitting a unilateral assessment that they haven't been given enough."[77]

The fund is governed by a 14-member Executive Committee of the Parties, 7 from industrial and 7 from developing countries. Each group allocates its seats informally.[78] The Executive Committee has the authority to approve the budget for the fund, develop criteria for project eligibility, and approve proposed expenditures over $500,000. If consensus should fail, the Committee's decisions follow the same voting rule as adjustment of the treaty: two-thirds overall, with simple majorities among both groups. The Committee has a Secretariat resident in Montreal, with a 3-year operating budget of $7.6 M (drawn from the fund), and 9 professional staff. The Committee meets roughly quarterly, and participants from both groups of countries describe its work as businesslike, its working relations good. In June 1991 it was decided that NGOs will be admitted to future Committee meetings except when the committee explicitly decides to exclude them.

The Committee does its actual work -- promoting CFC phaseout in developing countries -- by sub-contracting with "Implementing Agencies", presently the World Bank, UNEP, and UNDP. The functions of each are not precisely defined. At the London meeting, it was suggested that UNDP would perform country feasibility studies, the World Bank would administer investment projects, and UNEP would act as Treasurer for the Fund and perform "clearing-house functions" -- workshops and technical training for developing countries, which have now been assigned to UNEP's Industry and Environment Office in Paris. But in April 1991 the three agencies submitted workplans suggesting that all are bidding to expand their mandates. All three workplans included country studies, training, and pilot or demonstration-scale investment projects. The 1991 budget funded the World Bank at **$5 M,**

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[77] Interview.

[78] The donor countries used a system of regional representation whose effect is to give US a permanent seat (US is an entire region). The other initial members are Canada, FRG, Finland, Netherlands, Japan, USSR, Brazil, Egypt, Ghana, Jordan, Malaysia, Mexico, and Venezuela. Finland is Chair first year, Mexico vice-chair. The Article 5 countries did not establish a formal procedure for allocating their seats, and at the 1991 Meeting of the Parties had much difficulty designating a successor for one country that wished to step down.

UNDP at $1.3, and UNEP at $1.7 (the requests in their proposed 1991 workplans had been $9.5, 5.5, and 2.5 M respectively)." The Bank will manage their own projects within their $1 Billion Global Environmental Facility, but (after some pressure from the Executive Committee) within a separate Ozone Trust Fund under the authority of the Executive Committee. There are also proposals to work with other implementing agencies -- regional development banks, UNIDO, or special national-level agencies created for the purpose." UNIDO, for example, proposed a $250 K project to study CFC disposal and recycling options in three African countries. The implementation process is not fully mature yet, but at this stage seems to have some of the character of contracting-out with competitive bidding.

There are still major implementation issues to be settled. Detailed pre-investment studies were completed for some countries in 1991, with investment to begin in 1992. The interim fund must be replaced by the permanent one in 1994, and the Parties must decide its size and terms of reference. Perhaps most contentious of all, parties must decide what the technology transfer provisions mean in practice.

Other current implementation issues include difficulties with reporting required data, and specification of a non-compliance procedure. On data, the Protocol requires each party to report their total production, imports, and exports of each controlled substance for 1986, 1989, and annually thereafter. Most parties have now reported 1986 data,[81] but only 28 Parties have yet reported for 1989 and many are reporting difficulty with providing the data. Their difficulties are various, but many concern insufficiently fine distinctions in statistical reporting systems. The Harmonized Commodity System does not distinguish ozone-depleting controlled substances from other halogenated hydrocarbons, and the Parties have asked the Customs Cooperation Council to revise the system accordingly. An ad hoc group of experts has been established to consider countries' difficulties in reporting data and technical assistance will be available. Many of the non-reporting countries are small-consuming developing countries for which using UNEP estimates may be a reasonable solution; some, though, are substantial producers such as Italy and Greece."

The non-compliance issue is also not yet resolved. An ad hoc group of legal experts created to develop non-compliance procedures presented its recommendations to the London meeting: create an Implementation Committee to would discuss instances of supposed non-compliance

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• Executive Committee report, June 1991.

[80] This proposal is viewed with skepticism by Executive Committee members, who are concerned about loss of accountability of the Implementing Agencies to the Parties.

[81] 17 parties have either not responded or reported that no data is available

-- UNEP (1991d).

and report to the parties. The ad hoc group was asked to continue working and develop more specific procedures. They are now developing procedures with a consultative, ameliorative flavor, and will report to the parties in 1992.

Parties are also now considering whether to advance the phaseout schedules and broaden coverage further. The second round of Assessment Panels delivered reports at the end of 1991. A Working Group will receive the panel reports and deliberate through 1992, with possible amendments to be decided by the Parties in August. Many participants expect a phaseout advance to about 1995 - 1997 and agreement on eventual phaseout of HCFCs. More chemicals may also be controlled, particularly methyl bromide.

With CFCs and Halons to be phased out, producer industry's regulatory concerns now center on the treatment of substitutes. Patents are pending on several synthesis routes for HCFCs and HFCs, and a few plants are in commercial production, [83] but only about 10 per cent of the investment required to make the transition away from CFCs is yet committed. Some industry officials say they are awaiting clear signals that they will be permitted adequate returns before making major investment decisions. There are two industry positions. American producers advocate pre-announced phaseout dates for HCFCs (possibly in the range 2020 to 2050), with earlier phaseouts for those with longer atmospheric lives and no regulation prior to phaseout. ICI is advocating 'a cap on total ozone depletion from all chemicals, with firms free to allocate their production and consumption within the cap.'

Environmental NGOs are now shifting resources away from stratospheric ozone to focus more on global warming. Their present positions on the two issues are closely linked. Greenpeace advocates only allowing substitutes with zero ozone depletion and zero global warming potentials, of which none is presently known. Other groups distinguish among substitutes, arguing for prohibiting any with more than 2 % the ozone depletion of CFC-11.[85]

4. National Policy Responses: Ratification and Implementation

The Vienna Convention entered into force on September 22, 1988, with 20 ratifications, and there are currently 80. The Montreal Protocol entered into force on January 1 1989, with 30 ratifications, and there are now 74. All major industrial countries ratified Montreal before entry-into-force, as did Egypt, Kenya, Mexico, and Nigeria among the major developing countries. Brazil ratified March 1990, as negotiations were underway for the London amendments. At London, both China and India announced their intention to ratify. India has

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[83] Dupont has commercial-scale plants producing HFC 134a (a CFC-12 replacement), HCFC 123 (a CFC-11 replacement), and Dimethyl Ether, a non-CFC aerosol propellant.

[84] Interviews.

[85] Greenpeace International (1991); Environmental NGOs (1991); Interviews.

since ratified the Convention but not the Protocol, and asserts it cannot ratify the amended Protocol until the amendments enter into force. China is less squeamish, and announced its ratification at the June 1991 meeting of the Parties, as did the Soviet Union. The London amendments narrowly missed the 20 ratifications required for entry into force January 1992 on schedule, but many ratification proceedings are in train. As of March 1992, 19 countries have ratified the amendments; among them are six EC members, Japan, USA, Canada, the Russian Federation, China, and Mexico."

The only national action the Vienna Convention demands is data reporting. But when reports were first required in 1990, the Secretariat (interpreting a long, vague list in the Convention of items to be reported) produced an impossibly intrusive form requesting much data of questionable value. The Vienna Parties agreed in 1991 to reduce data-reporting requirements, probably by folding them into the more specific and focused Montreal reporting format. With this decision, the Vienna Convention will be reduced to an instrument imposing no specific obligations on its Parties.

The Protocol requires national legislation or regulations to implement the control provisions, and most industrial country Parties have established such programs. Indeed, all OECD nations except Australia have already passed programs implementing the 1990 amendments." They are highly disparate in the legal forms of implementation (legislation, regulations, negotiated agreements with industry) and in the policy instruments used (quotas, tradable permits, taxes, direct use regulation). All except Japan over-comply in some way. Some of the over-compliance is minor: for example, the 1990 US Clean Air Act advances interim CFC and Halon phaseout goals by a few years, advances MC phaseout from 2005 to 2002, and includes HCFC controls after 2015[88] (which the Protocol will likely add next year, but does not contain yet). Some of the over-compliance is extreme: Germany's legislation eliminates CFCs by 1993, Halons by 1996, HCFC-22 by 2000, and CT and MC by 1992 (!). Most programs also include immediate provisions for limiting emissions through recovery, recycling, and destruction; the Protocol presently contains only hortatory language on these, no explicit obligations, although one ad hoc working group promotes cooperation and the dissemination of information.

For developing country parties, the first control obligation is a freeze in 2000, but some have still announced control programs. Both Brazil and Mexico have announced that they intend to meet the same control schedules as the industrial countries, renouncing the 10-year grace period that the Protocol offers them. Officials say the motivation is primarily commercial, to keep up with their trading partners. At least two non-parties, Taiwan and South Korea, are implementing controls to avoid trade sanctions. Other developing countries are performing

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UN Treaty Office, 9 March 1992.

$' As of late 1991, Australia's was only delayed by a long legislative queue.

US Public Law 101-549, Section 605.

studies, either with the help of one of the implementing agencies for the fund or through bilateral arrangements, to determine how to accomplish the phaseouts.

National CFC consumption data for 1986 and 1989 is shown in Table 1, for those countries that have reported complete data. As the first control requirement is that industrial countries' CFC consumption in 1989 be no higher than in 1986, the Table shows that most countries are far ahead of requirements.

Table 1

ODP-Weighted CFC Consumption, 1986 and 1989: Tonnes

Country	**1986**	**1989**	% **Change**
Austria	7,760	5,860	-24.5
Canada	19,958	18,843	-5.6
Finland	3,301	1,886	-42.9
German D.R.	15,393	12,471	-19.0
Hungary	5,468	4,848	-11.3
Japan	118,134	109,9971	-6.9
New Zealand	2,088	1,005	-51.9
Norway	1,313	908	-30.9
Switzerland	7.960	4,023	-49.5
USA	305,963	231,083	-24.5
EC	301,679	225,985	-25.1
Jordan	302	257	-14.9
Malaysia	2,190	3,444	**+57.3**
Singapore	4,052	679	-83.2
Thailand	2,300	4,595	+99.8
Venezuela	3,879	3,450	-11.1
All Countries Reporting	801,740	629,334	-21.5

Source: UNEP/OzL.Pro.3/5 and Add.1. EC excludes Eastern Germany.

Industry, particularly user industry, is moving ahead of regulations to reduce CFC use in many sectors. Dupont has now announced that it will stop manufacturing CFCs in 1996 and Halons in 1994.[89] An international group of CFC producers is jointly performing

[19] International Environment Reporter 14, 591.

assessments of environmental impact and toxicity of CFC substitutes.' In Japan, an industry cooperative is working with national regulators to implement a comprehensive system of CFC use limits. One group of high-volume solvent users, mostly electronics and aerospace firms, has established a cooperative to share freely new techniques in conservation, recycling, and substitutes, including a free computer network to exchange technical information." While finding Halon substitutes was recently thought to pose serious difficulties, recent investigation suggests that better management of the existing bank of Halons will allow full production phaseouts within a few years.

5. Analysis

This section reviews with an analytic perspective the institutional history outlined above. Section 5.1 asks what determined the negotiating agenda and the international policy decisions at each stage of the process. Section 5.2 focuses on the crucial output of the process, national action, and asks whether the international processes mattered in determining the outcome observed, or alternatively whether it is plausible to imagine reaching the same point through aggressive leadership by one or a few nations; it concludes that international processes have been of decisive importance.

5.1 Determinants of Agenda and International Decisions.

5.1.1 Prior to Vienna

The early international agenda was limited to forms of cooperation on research and data, the structure of an agreement (Convention/Protocols), the question of whether or not to control CFCs through international measures, and (for only a short time before Vienna and over EC objections) the question of various forms of control.

At the earliest stage, it was largely science and scientists that raised concern about the issue and set the agenda. The Washington meeting and CCOL were both predominantly scientific groups, their agendas focused on research. The Convention/Protocol structure was first proposed by an international legal experts' meeting in November 1981 in Montevideo, whose participants were impressed by the success of the approach in UNEP's Regional Seas program.[92]

Though a few prominent atmospheric scientists remained convinced of the seriousness of ozone depletion throughout the period of apparently declining concern, the Nordics who tried to push a control agenda through this period were thwarted -- prior to 1982, by the lack of

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[90] The two studies are the Alternative Fluorocarbon Environmental Acceptability Study (AFEAS) Report, Volume 2 of WMO (1989); and the Program on Alternative Fluorocarbon Toxicity (PAFT).

[91] Industry Cooperative for Ozone Layer Protection. International Environment Reporter 14, 649; Interviews.

' 31 Dec 1981 briefing note.

an authorized international body to consider controls, and through 1984 by other delegations' perception that they did not understand the current science." Others first advocated only "trigger" controls or none, but by 1984 joined the Nordics in the "Toronto group" proposals. These proposals represented both a softening 'of earlier Nordic demands, and a recognition by other participants (principally the US and Canada) that international controls mirroring their own domestic measures could only benefit them.

The deadlock that resulted at Vienna between the conflicting positions of the EC and the Toronto Group in retrospect seems completely predictable. Each side proposed international measures that required action on others' part but not their own, and indeed in some instances defended their proposals at home by pointing out that it would cost their own industries nothing.' Each side presented valid environmental criticisms of the other's proposals, but presented them in terms that suggested that only these two options were possible and that either one, once enacted, would endure unchanged for decades."

As a result of this deadlock the Vienna Convention contains, with two exceptions, a set of innocuous measures on which all major parties had agreed since 1977. On the one hand, it included no control measures because of the persistent, uncomprehended gap between the two control approaches; on the other hand, the Convention itself did not come about earlier because several delegations continued pushing for their preferred form of controls, thinking it important and possible to include them in the first negotiated agreement.

5.1.2 Vienna to Montreal

Following the Vienna Convention, several factors pushed the agenda forward quickly. The resolution passed at Vienna gave UNEP and its Executive Director more power to force the agenda, which they exploited effectively by calling two broad, informal workshops prior to resuming negotiations. Discovery of the Antarctic ozone hole, although CFCs were but one of three proposed causes, kept public and media attention on the issue. Finally, NGO activity increased, first in the US with the NRDC lawsuit and later in Europe. Science continued to define several key elements of the negotiating agenda: the need to consider all CFCs; trading them off according to ozone-depletion equivalence; and including Halons.

Perhaps most importantly, the US started to provide strong leadership on the issue from early 1986, and many items -- some emerging from the science, some not -- first appeared on the international agenda as elements of the new, aggressive American negotiating position. A near phaseout of all ozone-depleting substances was the American position from November

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93WG Meeting notes, and Advisory Committee meeting Nov 20 1981.

[44] Briefing notes.

95 EC Commission (1985); US State Department Public Information Series, January 21, 1985.

1986;[96] in February 1987 the US submitted an Article proposing control of trade with non-Parties; and in May they proposed weighting substances according to ozone-depletion potentials-'[7]

It was not science, but bargaining, that determined the decisions adopted in Montreal. The 50% cut that was agreed had no particular scientific prominence. Indeed, the distribution of expert opinion at the time seemed strongly divided. If CFCs were not causing the Antarctic hole, then the 1986 WMO report reflected the prevailing science, justifying at most a CFC production freeze. If CFCs were causing the hole, then much more stringent controls than a 50 % cut were justified, possibly of the order of the 85 % cuts EPA had calculated would be required to stabilize atmospheric chlorine concentrations. The 50% cuts adopted were hence either much too strong or much to weak, depending on your view of the then-partial Antarctic evidence. Cutting by half was essentially a bargained outcome between the EC's proposed freeze and the US's 95 % cuts. Where the EC had advocated controlling production and the US controlling consumption, it was agreed to do both.

The trade and LDC issues seem to have garnered broad agreement by the time Montreal approached. So likewise the important provisions for Assessment Panels and periodic review. This measure both enjoyed strong scientific support in a time of rapidly developing science, and allowed both the activist and the reluctant nations to accept a somewhat uncomfortable control protocol in the hope that subsequent review would justify moving to a more favorable one. Periodic reviews of some form had been elements of the original American, EC, Canadian, and Nordic proposals.

The final Protocol has a fairly strong US flavor, as one would expect from the strength of US negotiating leadership from 1986 and the extent to which the US delegation was pushed by Congress and the NRDC lawsuit. Some European participants contend they were bullied into an agreement that unfairly favored US industry, calling the 1987 agreement "The Dupont Protocol", but the argument is weak. Their only specific claim of unfairness in the Protocol concerns the industrial rationalization article, which effectively permits rationalization in North America but not Europe; this item, though, was a Canadian proposal.[98]

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[96] While one can read the vaguely worded Nordic proposals as early as 1982 to advocate full phaseouts, the proponents seemed unwilling to say so clearly without a larger coalition supporting them.

[97] Ozone-depletion potentials first appear in Miller and Mintzer (1986), with reference to "preliminary estimates, Office of Air and Radiation, EPA, Oct 86."

[98] Interviews.

5.1.3 Montreal to London

The three essential elements of the post-Montreal agenda were tightening the control schedule to full phaseouts, broadening the set of chemicals covered, and putting stronger LDC assistance measures in place.

With regard to controls, scientific news and results continued to raise public and political concern, and the provision for periodic review once again gave UNEP the power to advance the negotiations relatively quickly when scientific concern called for it. In contrast to earlier confusion and reversals, the science since 1985, and particularly since 1987, has consistently moved toward greater concern.

Scientists' influence has increased since 1987 with the institutionalization of their roles in the Assessment Panels. These have provided a channel for science to feed directly into the negotiation process, from a forum with the stamp of international objectivity and authoritativeness. All was not sweetness and light in the creation of the panels; many participants describe them as having a US bias, and some report a systematic program of excluding employees of producer industry from the Technology Panel. But even the critics acknowledge that the science and technology reports were of high quality, and that the leaders of the process played fair.

Consequently, particularly given the strong results they had to report, scientists' influence over the negotiations has advanced beyond their prior agenda setting role, to exercising substantial influence over certain aspects of the negotiated decisions. Tolba's earlier statement that it was not possible to oppose controls on the basis of scientific dissent was hyperbolic when he made it in April 1987, but became true in 1989 and 1990. Not all participants in the 1990 negotiations accepted that the science justified full phaseouts, but those who did not were isolated and unable to block global agreement.

Of course, a full CFC phaseout would have been immediately on the post-Montreal agenda in any case, since it had been the prior position of one of the major participants. But when the science panel reported that even full phaseouts would not restore the ozone hole before 2060, and the technology panel reported viable substitutes for essentially all applications would be available in ten years, it became impossible to mount serious opposition to phaseouts. Negotiators agreed on phaseouts relatively easily.

The science panel's graphs of changes in stratospheric chlorine concentration over time, presented to the working group in November 1989, had impact beyond making the case for a CFC phaseout. They also focused attention on all chlorine, thereby requiring consideration of MC, CT, and the HCFCs, and suggested a regulatory approach that discriminates according to atmospheric lifetimes. The scenarios' treatment of HCFCs was limited, though, by

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99 MC and CT had been mentioned on a CCOL report as early as 1980, but first came to wide attention with the World Resources Institute report in November 1986.

difficulty in projecting the extent of substitution. Parties could not agree on treatment of HCFCs, and settled for a non-binding resolution.

Evidence for the panels' influence over decisions is perhaps clearest in the one case where their work was contested. The solvents industry claimed that MC was added late to the technology panel's agenda, and the panel concluded 90% substitutes available by mistakenly assuming MC substitution would be the same as CFC-113 substitution." The industry, a different group from CFC producers and new to the process, was caught unprepared. They commissioned consultant studies and presented their claims to a subsequent meeting of the negotiating group, but report that they were received with suspicion and had little impact.

The environmental argument over MC turned on different interpretations of its short atmospheric life (6.3 years)". After three or four lifetimes, the atmospheric concentration of a gas drops to nearly zero. Consequently, to control the date at which stratospheric chlorine drops below 2 ppb, one need only consider MC emissions within 3 lifetimes of that date, or after 2040 for a 2060 target date. On the other hand, cutting MC now will have the fastest effect on atmospheric concentrations and will shave the most off the peak chlorine concentration that follows a phaseout.

A second-order outcome of the panel's changing from ozone-depletion to chlorine-loading was to open up scenario modeling field to anyone with a powerful desktop computer. [102] Those who played with scenarios quickly discovered that over several decades, full developing country participation would be essential to limiting chlorine levels. This realization drove the discussions of finance and technology transfer, for realizing unanimous participation requires meeting everyone's needs. Representatives of the major developing countries pressed their case very strongly. The details of the financial mechanism and technology transfer Articles were bargained outcomes. The USA, the most cautious participant in the financial discussions, was weakened by its temporary reversal in April.

These Articles were fought out against the broader backdrop of general LDC equity claims and northern attempts to avoid strong re-distributive precedents. With LDC leverage increased by the need for a full global phaseout, and some LDC representatives pressing for very broad claims, the risk of a classic North-South confrontation was real. On the technology transfer language, that both sides now say they gave up too much suggests

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[100] In fact, MC was the preferred substitute for 113 in many applications. At the time, very little research on MC substitutes was available. Interviews.

[101] WMO (1989), p. xxx.

[102] **Ozone-depletion models, particularly multi-dimensional ones, require supercomputers.**

successful negotiation. Many participants attribute the successful negotiation to a high level of shared concern; it surely also helped that estimated costs turned out to be low, declining from billions to hundreds of millions by spring 1990.[103]

5.2 Altering State Behavior: Did Institutions Matter, and How?
5.2.1 Deliberative Institutions: Building Concern and Aiding Contracting

The international ozone-protection system has only since 1990 begun moving from the realm of planning and negotiations, to that of operations. The dominant institutions up to now have been concerned with building collective understanding, structuring deliberations, and developing agreement on joint action, operating in an environment of uncertain expectations about what other nations will do. These institutions, which we might call "institutions of deliberation", have included the following elements: a series of negotiating bodies created under UNEP's authority; UNEP's power as Secretariat to call meetings to advance the negotiations; a series of international scientific and technical bodies; an early decision to follow a Convention/Protocol structure; and the 1985, 1987, and 1990 agreements, each of which influenced the shape of further deliberations.

Because a strong control treaty was negotiated and subsequently tightened, and nations are both ratifying and complying, this phase looks like a striking success. But to what extent are the deliberative institutions responsible for this success? One might argue that the present treaty or an equivalent outcome was determined simply by the eventually decisive science, by the intensity of national interests in protecting the ozone layer, and the eventual acquiescence of industry to a control regime.

The deliberative institutions first served to build and transmit concern about ozone depletion. The very fact of continuing negotiations kept the issue somewhat in public view and imposed on even the most reluctant national governments the requirements to stay abreast of the science, and to present justifications for positions. They also provided the opportunity for activists to persuade their counterparts of the seriousness of the issue. Many delegates describe their increasing concern through 1986 - 1988, and their subsequent attempts to persuade colleagues at home. Since the negotiations were supported by international scientific bodies from the beginning, they also provided for the international transmission of scientific information. As the science converged from 1985, the authoritative international panel reports progressively delimited the range of possible disagreements that could credibly be attributed to different views of the science.

The international negotiations permitted those countries advocating control measures to coordinate the details of their proposed control measures. International deliberations also built participants' confidence that their initiatives would be reciprocated. Even the activists were willing to go further if confident that others would match them, and the negotiations

[103] Third and fourth meetings of Working Group, 9 - 11 May 1990, Geneva, and 20 - 29 June, London.

provided the medium for this confidence to grow. Not even the most activist governments made serious, costly reductions prior to the treaty. The early aerosol bans followed movement away from CFCs by consumers and producers, and turned out to be essentially costless; the substitutes for CFC aerosols were cheaper and about as good." Since the treaty, though, nations have enacted strong controls, many of them going beyond the treaty provisions.

International deliberations also provided the vehicle for moving those governments who were initially uninterested or reluctant. This movement occurred through the combined effects of several factors, none of which could be realized without the negotiating forum: seeking cost-reducing innovations in treaty provisions that allow the reluctant to participate, such as ODP-weighting of controls and the special treatment granted the already-committed Soviet plant in the 1987 treaty; increasing the perceived cost of not joining the treaty, either through simple fear of isolation or through such specific incentives as the trade sanctions against nonsignatories; or building confidence that participation will be sufficiently high that a reluctant nation will not be placed at a competitive disadvantage by joining. The effectiveness of these factors is evident both in the countries whose delegates assert trade sanctions were decisive in their decisions to join, and in the energetic compliance by non-parties Taiwan and South Korea.

Incentives to join and comply with the treaty change as the regime moves toward full phaseout and full participation. With moderate participation, one can imagine a two-regime equilibrium, with a separate international economy of non-parties producing and trading CFCs and related equipment only with each other. But as the number of parties grows, technical progress, economies of scale, commercial standards, and confidence and experience with implementation all act to increase the incentive for remaining nations to join. It is likely that movement away from CFCs is already rapid enough that the stable equilibrium is full participation. Brazil's and Mexico's not taking their 10-year grace period can be viewed in this light, for they would bear no sanctions from going slower. While their decisions could reflect attempts to move to the head of the queue for transfers, they more likely indicate a "critical mass" effect, wherein the commercial advantage is in abandoning CFCs rapidly if enough countries are doing so.

It is clear that the intent of the drafters was for there to be no non-signatories. The early, focused attention they devoted to sanctions against non-parties, as compared with the relatively late and sloppy consideration given compliance measures, indicates a primary concern with getting countries on-board -- and perhaps the expectation that all will comply in good faith once on.

[°4] The picture is slightly more complicated than this suggests. New propellants were cheaper in most applications, and performed as well in many. Estimated 1983 US savings from the aerosol ban were $165 Million. Most substitutes were inflammable, though, and in some applications they performed worse, imposing some cost and risk not counted in these savings.

5.2.2 Implementation Institutions: Building Capacity

Following the 1987 and 1990 agreements, a second kind of international institutions has been created: organizations created under international authority, charged with a specific set of tasks, operating in an environment of more stable expectations about broad-scale national actions. In contrast with the institutions of deliberation, these might be called "institutions of implementation", and have included the Multilateral Fund and Executive Committee, the implementing agencies, various small functional bodies charged with solving particular problems, and some aspects of the technology panels, though these also served a deliberative role.

The primary function of these institutions has been building capacity to reduce CFC use, develop and implement alternatives, and solve related problems. In some cases, this function has been intentional; the fund, executive committee, and implementing agencies have the specific mandate of providing the technical information, planning, and financial support necessary for developing countries to eliminate CFCs. In other cases, the capacity-building has been fortuitous; the technology panels were created to answer questions about how fast various uses could be phased out, but had the additional effect of bringing together key international groups of technical experts able to develop specific new solutions, prompting recognition of new technical solutions and new business opportunities and thereby generating substantial new capacity in industry.

5.2.3 Alternative Hypotheses

To argue that the international institutions did not advance the protection of the ozone layer, one must assert that equivalently strong action to cut CFCs could have come about through national actions alone. Two counter-factual hypotheses can clarify this argument: first, that the United States alone could have passed tough domestic controls accompanied by trade sanctions, and brought about the equivalent of a global regime through a series of bilateral negotiations; second, that a group of large, industrial activist nations could have brought about the equivalent of the treaty through each enacting strong domestic controls, then formalizing them in a collective agreement to sanction others and pull them on-board.

Consider the first scenario, in which the US drags the world. The small costs and huge benefits of CFC controls lend support to this scenario. EPA's 1988 Regulatory Impact Assessment found US benefits so large that a reasonable extrapolation suggests it would be advantageous for America to bear the entire cost of global CFC phaseouts if necessary."

But the US could not accomplish a global phaseout through unilateral action. Other nations must be persuaded to cease production, and it is completely implausible to imagine the US

105 The estimated benefits of the 50% Montreal controls were $6.4 Trillion, mostly from avoided early cancer deaths in the US population born before 2075. Estimated costs were $27 Billion. Simple extrapolations suggest that US benefits from a global phaseout may exceed world costs.

political system generating billion-dollar bribes to subsidize changing industrial processes in the EC, Japan, and the Soviet Union. The strategy of acting unilaterally and sanctioning others unless they follow is only marginally more plausible. It is more flexible, more persuasive, and more conducive to both the discovery of joint gains and the maintenance of good ally relations to proceed through multilateral negotiations than to act alone with a threat-backed exhortation for others to follow. Seen in this light, the strong Congressional bills of 1986 and 1987 can more reasonably be interpreted as nudges to the international process, than as expressions of willingness to act alone.

The most important weakness of this hypothesis, though, is that even the US's commitment to the international process was highly uneven. Despite US leadership in the 1970s and at certain crucial stages of the negotiations, US support for consummation of the agreement was threatened by domestic backlash at all three stages: the last-minute attempt by State officials to reject the 1985 Convention; the counter-attack through the Domestic Policy Council in Spring 1987; and the Chief of Staff's attempt to scuttle the delicate financial agreement in Spring 1990. To imagine that US commitment to a global control regime could be sustained against such powerful domestic opposition without the inertia, interests, and reputations involved in a strong international process, is to imagine much greater domestic consistency and unanimity than ever occurred on US policy-making on this issue.

Now consider the second scenario, a group of activist nations coordinating after the fact to coerce others. The weakness of this scenario is that a successful control regime requires consistency in details, for reasons of trade, technical standards, and imposing consistent obligations on others. Matching the details requires early, detailed coordination among the activists. The failed "multi-option approach" of the Toronto Group in 1984-85 indicates precisely the problem of seeking to accommodate disparate domestic control measures in a post-hoc international agreement. Without coordination from the start, domestic pressure can thwart international collaboration.

A further argument against the significance of the treaty might be based on national over-compliance; if nations over-comply, then the treaty is not a binding constraint and so must not be determining their actions. This argument is unpersuasive for two reasons. First, not everybody over-complies; even moving only the few major nations who comply precisely counts as a significant accomplishment. Second, in a dynamic process of negotiation and re-negotiation, over-compliance does not necessarily indicate action that would have occurred without the treaty. Over-compliance, particularly by an activist nation, can be an attempt to push the treaty further. This is a reasonable explanation for present over-compliance. Most is by nations who sought earlier phaseouts unsuccessfully in 1990, and are now pressing to get them at the 1992 meeting.

This is not to say that international institutions alone were sufficient to bring about the treaty and national CFC controls; strong leadership from activist nations was also necessary. Nations led by taking the initiative to get negotiating bodies authorized, preparing draft proposals, sponsoring research, and pressuring and persuading the reluctant. They also

accepted disproportionate cost burdens; in the 1987 Protocol, the uniform 50% CFC cuts imposed substantially higher costs on the leaders who had already banned aerosols, than on the laggards, for whom aerosol cuts could achieve the 50% at zero or negative cost. But the activists worked through international channels from the outset, and international fora served as an essential vehicle for the expression and realization of their collective intent, although they only achieved effective coordination from late 1986 under US leadership.

In summary, the international deliberative process served three functions that could not have been realized by the initiative of a few activist nations alone: coordinating the details of proposed controls, building confidence that costly actions would be reciprocated, and changing the interests or incentives of reluctant participants so as to make actions feasible or necessary that were not before. Moreover, for the US and indeed for all activists, a continuing international process provides the inertia to smooth over uneven commitment or attention at the national level. Now that major international policy decisions have been made, international implementing institutions are generating new capacity to avoid CFC use in countries and in corporations.

6. Overall Assessment.

This section seeks to summarize lessons from the case. Section 6.1 seeks an overall evaluation of institutional effectiveness, employing a different standard from that implied in the discussion above; granted that the international institutions brought about more environmental protection than would have happened without them, how do the outcomes compare to what apparently is needed? It asks whether the measures undertaken were appropriate, given what was known at the time; what factors obstructed doing better; and in what reasonably achievable ways could international handling of similarly serious environmental issues be improved? Finally, Section 6.2 outlines a few characteristics of the international process that have been particularly important in shaping the present result, and points to some institutional innovations that are likely strongly to shape future progress on the issue.

6.1 The Right Measures, but Too Late?

How is this process to be judged overall? After nearly fifteen years of activity, treaties have been signed and ratified, national policies adopted, CFC use reduced, and commitments taken to eliminate them. The Montreal Protocol is widely praised as a model for future environmental agreements. Relative to prior experience with international environmental cooperation, the praise is richly deserved; in many important respects, the agreement is unprecedented, and it is clear that international action achieved more than could have been realized nationally. But relative to what is likely required to protect the ozone layer, serious reservations are appropriate.

One reservation is simply that a great deal more work remains to be done. Because of CFCs' long atmospheric lifetimes, parties worldwide must maintain their commitments to reducing

emissions, recovering and destroying existing stocks, enforcing production and consumption controls, and controlling potential new ozone-depleting substances, for more than fifty years. Parties must also decide how to treat the less-damaging, but still damaging, transitional substances and remaining implementation questions on financial and technical measures for developing countries.

The more serious reservation is that the Protocol may represent the right measures, enacted too late. Recent scientific results continue to show ozone losses greater than predicted and greater than can be explained by present conventional models; consequently, the ultimate extent of ozone loss remains unknown. The risk remains open that even the seemingly rapid international progress achieved will be insufficient to avert serious global ozone loss. From the perspective of 1991, what was done in 1987 should have been done several years earlier.

But is it fair -- or useful -- to apply this judgment retrospectively to negotiations that took place when less was known than is now? There are two possible perspectives on the negotiations of the early 1980s. First, one could argue that there was no time when strong scientific consensus supported more stringent action than was undertaken. The way science progressed on ozone depletion -- several years of confusion, reversal, and apparently reduced concern, followed by several years of rapidly increasing concern -- may simply represent bad luck that no political process, national or international, can be expected to have out-guessed.

Alternatively, one could argue that the foregoing imposes a mistaken standard of certainty: that international action must (or should) await decisive scientific consensus. There was scientific consensus on some points throughout the early 1980s. Though pre-1985 estimates of total loss fluctuated widely, there was always projected <u>some</u> loss, and large losses at certain altitudes. At the same time, it was known by about 1980 that roughly half of CFC use could be eliminated at essentially no cost. The same balancing of risks and benefits that justified national aerosol phaseouts in four countries by 1980 surely justified equivalently stringent international action by 1983.

If one accepts that CFCs should have been restricted at this lower standard of proof and asks why it did not happen, there are several possible reasons. Factors present in 1987 but not 1985 that favored the agreement included the observation (though cause undetermined) of the Antarctic ozone hole; industry's acknowledgement that substitutes were possible; the 1986 international science assessment; strong negotiating leadership by the US, pushed domestically by Congress and the NRDC lawsuit; more aggressive leadership internationally by Tolba; stronger German pressure within the EC; and more carefully developed, persuasive control provisions on the table.

To argue that some or all of these conditions occurring earlier could have brought about an earlier agreement is highly speculative. Still, sufficiently effective negotiating leadership, by national actors or UNEP, could have realized most of these conditions earlier. Better

leadership could not have advanced the discovery of the hole, and observers differ on whether the 1986 industry announcement was news or not (and what motivated it), but the other factors could all be influenced by negotiating leadership.

It is consequently plausible to argue that more effective leadership within the negotiating process, particularly by national delegations, could have increased the probability of achieving CFC controls in 1985 rather than 1987. The most striking point at which national leadership could have been exercised but was not, was in the disorganized and self-serving "multi-options" proposal of the Toronto group, and in the failure of any member of this group of supposed activists to pull the group together around a single, credible proposal, one that would necessarily impose costs on its proponents as well as on others. Of course, whether such leadership could have broken the 1985 deadlock no one can say.

Of the many lessons that one might draw from the CFC negotiations, one is particularly sobering for future negotiations: perhaps only the United States is in a position to exercise the required leadership, and international action must wait on their willingness to do so. Congress's threat of national action with sanctions clearly increased other nations' interests in negotiating controls. A key question for significant international action on climate change and other issues is whether the other leadership functions largely performed by the US in 1986 and 1987 can only be done by a nation capable of such threats.

6.2 Important Characteristics of the Institutions.

What aspects of the international institutions mattered the most? Any international negotiation will offer some of the benefits of building concern, sharing information, coordination, identifying opportunities for value creation, and persuasion that were realized here. But some particular aspects of the process followed here were important for the successful outcome.

First was skillful use of international expert advisory groups to move the focus of factual dispute out of the main negotiating forum. Such groups were used from the beginning: the CCOL, the Wurzburg meeting, and finally the Assessment Panels. Since 1987 their position has been more formalized and their standing raised, and perhaps the experts participating have grown in political skill; consequently, their influence over the negotiated outcomes increased and the negotiations focused more on strictly political questions.

Second was requirement for periodic review, with input from the expert panels. The Secretariat is empowered procedurally to convene such panels, deliver their results to the Parties, and thereby to force the agenda (in cooperation with some of the Parties) by calling meetings to review developments, with the presumption that negotiations will follow.

Third was regular meetings of the Parties, keeping policy-making power securely in their hands and building communication and relationships. There is a delicate balance between the procedural, agenda-forcing power that is spun off to expert groups and the Secretariat, while keeping full substantive power in the Parties. The Parties in effect have bound themselves to

undertake serious review of scientific and technical events, while retaining their ultimate legitimate authority over the decisions.

Fourth is the frequent use of small, informal working groups for a wide variety of functions: serious bargaining to break deadlocks (Tolba's closed-door sessions at both Montreal and London); assisting Parties with implementation, either by disseminating information or by solving widely shared problems (the expert groups on data-reporting difficulties, and the expert group on destruction technologies); or drafting amendments on matters requiring expert input (the legal experts on non-compliance).

On the success of the existing implementing institutions it is too early to report any real results, but a) early results are promising, and b) two important policy decisions are already clear: first, that policy-making power is to be kept in the Parties by governing the Fund with a small, frequently-meeting Executive Committee whose representation and decision-making rules mirror those of the Parties; and second, that implementation will be through collaboration with several agencies, via a competitive process of contracting-out.

The first, the attempt to maintain control of the Parties over the objectives of the fund, is not yet tested. The test will be in the fully-developed relationship with the World Bank as an implementing agency, with its vastly larger resources and different governance structure. The Bank's Global Environmental Facility is ten times the size of the interim multilateral fund, and protecting stratospheric ozone is but one of its four global environmental goals. If other international environmental funds are created, the Bank may well be an implementing agency to them as well. Under these conditions, the Executive Committee may find its control over the objectives and use of the fund diminished.

The second decision, contracting tasks to implementing agencies competitively, is an important innovation and one that may help the parties retain control. Aside from the potential efficiencies from competition between agencies, this innovation holds the promise of resolving an old contradiction in international governance: doing important new international jobs while keeping sovereign authority in the parties who agree on the jobs, or creating new international institutional capacity without creating new international bureaucracies. The early work looks promising, but it is too early to judge either the effectiveness of implementation on this problem, or the suitability of this structure as a model for other international environmental issues. The next few years will tell.

NOTES

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