Talking Points

On Ozone Depletion

Meeting of Energy and Environment Working Group
February 20, 1987

- Ralph, a key goal of this discussion is to inform everybody about where things stand on this issue. A second key goal is to discuss how the international negotiations on ozone depletion will affect our writing of domestic regulations.

- You might start out by noting that next week a U.S. team is traveling to Vienna for a second round of negotiations on an international protocol to reduce ozone-depleting chemicals.

- Then, you could call upon Ted Harris to bring the group up to date on the state of negotiations and on the U.S. position.

- You may also want to call on Richard Benedick, the leader of the U.S. delegation, to elaborate.

- You might then turn to the issue of drafting domestic regulations. EPA is under a court order to issue regulations controlling ozone-depleting chemicals by the end of the year.

- You might ask Milton Russell of EPA to fill the group in on where EPA now stands in developing those regulations?

- The Justice Department is also working on some proposals to use market incentives to reduce ozone-depleting chemicals domestically. This initiative was listed in the President's State of the Union message to Congress.

- You might ask Tom Hookano from Hank Habicht's staff at Justice where these proposals stand.

- A key question to ask is to what extent the U.S. international negotiating position will limit the Administration's flexibility in writing regulations domestically?

- Two related, and probably controversial, questions are: By pushing for a phase down in the production of ozone-depleting chemicals internationally, are we almost guaranteeing that we will have to write similarly stringent regulations domestically, even if no international protocol is ever signed?

- And, has the Administration ever decided that the scientific evidence linking CFCs (or chlorofluorocarbons) to ozone

depletion justifies a phase down in CFC production, as opposed merely to a freeze?

- Depending on how the discussion goes, you may be able to determine whether the issue requires that options be presented to the DPC.

THE WHITE HOUSE

WASHINGTON

February 25, 1987

MEMORANDUM FOR JOHN D. NEGROPONTE, STATE
HENRY HABICHT II, JUSTICE
DONALD PEARLMAN, INTERIOR
GEORGE S. DUNLOP, AGRICULTURE
MICHAEL T. KELLY, COMMERCE
RANDY DAVIS, OMB
MILTON RUSSELL, EPA

FROM: RALPH C. BLEDSOE

SUBJECT: Stratospheric Ozone Depletion Review

The Domestic Policy Council Working Group on Energy, Natural Resources and the Environment met on Friday, February 20, 1987 to discuss the United States negotiating position, under the United Nation's Environment Program on the control of chemicals which are thought to deplete stratospheric ozone. The U.S. delegation is meeting in Vienna this week (February 23-27, 1987) to discuss a phase down of emissions of the major ozone depleting chemicals. EPA is under court order to decide by May 1987 whether to engage in rule making on controlling chemicals that may effect the stratospheric ozone layer.

The DPC will be reviewing whether scientific evidence linking CFC's with ozone depletion justifies a phase down, what the economic impact of a phase down would be, and what impact such a phase down would have on our defense capabilities.

In order for the Council to properly address this issue, options and information need to be developed. It would be appreciated if you would serve on this review group in order to outline the following:

- a brief history of the ozone depletion issue;
- the decisions that have been made to date which give guidance to the U.S. delegation to the UNEP ozone layer protocol negotiations;
- the status of the EPA court order to write domestic regulations on ozone depletion;
- the scientific evidence available on ozone depletion;

- the economic impact of a phase down of CFC's in the U.S.;
- policy questions, if any, that should be addressed by the DPC.

I will be in touch with you to schedule our first meeting.

Thank you for your cooperation.

THE WHITE HOUSE

WASHINGTON

Ozone Subgroup Meeting
March 30, 1987

Issue: What positions should the DPC take regarding domestic and international efforts to counter stratospheric ozone depletion?

Background: Strong international and domestic concern exists over stratospheric ozone depletion caused by emissions of CFCs reacting chemically in the upper atmosphere. Ozone is an essential buffer of ultraviolet light; significant depletion could cause skin cancer, retard crop production and damage ecosystems. No significant depletion is now occurring, yet with the continued increase in CFC emissions and the length of time CFCs remain in the atmosphere, depletion is expected to occur absent global reduction efforts.

The United Nations Environment Programme sponsored the Vienna Convention for the Protection of the Ozone Layer in March, 1985. The United States played a leading role in negotiating the Convention. An intensive scientific research and technical analysis effort has been conducted pursuant to the Convention.

The United States, through the State Department and EPA, has continued to play a leading role in the negotiations toward a Protocol on Chlorofluorocarbons to the Vienna Convention. The State Department received authority to negotiate a protocol pursuant to inter-agency approval of the November 28, 1986 Circular 175 requesting such authority. The Circular 175 authorized the United States delegation to negotiate a protocol providing for:

I. A near-term freeze on the combined emissions of the most ozone-depleting substances;

II. A long-term scheduled reduction of emissions of these chemicals down to the point of eliminating emissions from all but limited uses for which no substitutes are commercially available (such reduction could be as much as 95%), subject to III; and

III. Periodic review of the protocol provisions based upon regular assessment of the science. The review could remove or add chemicals, or change the schedule or the emission reduction target.

Status: The next negotiation toward a protocol is scheduled for April 27, 1987. The State Department believes that, in order for the United States to retain control of the negotiations, our

negotiating position must include a specific proposal for future emissions reductions beyond a freeze at 1986 levels. The State Department has requested inter-agency approval of the EPA proposal of a 40-70% reduction over the next 6-10 years. There is widespread perception that the United States currently seeks a 95% reduction in emissions even though this has never been our official position.

As a result of a Natural Resources Defense Council lawsuit against EPA, the Administrator must determine, by May 1, whether domestic emissions reductions are necessary. Unilateral action would disadvantage the United States in world markets and may not result in significant global reductions. It is, therefore, to our advantage to address the ozone issue internationally. Yet an international agreement on emissions reductions would require domestic regulations for implementation.

General DPC Options:

-Let current efforts proceed with State and EPA coordinating interagency concurrence process;

-Determine desired reductions after considering the science, the economic impacts and alternative policies;

-Link or separate domestic and international strategies after considering success of 1978 unilateral ban and interconnecting factors.

THE SECRETARY OF THE INTERIOR

WASHINGTON

June 5, 1987

MEMORANDUM

TO: HEADS OF DEPARTMENTS AND AGENCIES

FROM: SECRETARY OF THE INTERIOR

SUBJECT: CHLOROFLOUROCARBONS (CFCs)/STRATOSPHERIC OZONE

Attached, for your information, is a copy of my June 4, 1987, letter to Senator Tim Wirth which describes in detail my position on CFCs/stratospheric ozone.

I am sharing copies of the letter with Congressional sponsors of CFC/ozone legislation and other interested parties.

Please don't hesitate to call me, or have your staff contact my Executive Assistant Don Pearlman, if you have any questions.

Don Hodel

DONALD PAUL HODEL

Attachment

THE SECRETARY OF THE INTERIOR

WASHINGTON

June 4, 1987

Honorable Timothy E. Wirth
United States Senate
Washington, D.C. 20510

Dear Senator Wirth:

Thank you for inquiring about my position regarding chlorofluorocarbons (CFCs) and stratospheric ozone, and thank you very much for questioning whether statements attributed to me in press reports were true. They were not.

I have not suggested and do not believe that the complex issues concerning effects of stratospheric ozone depletion should be or could be solved by some simplistic approach such as sunglasses, hats and lotions.

In essence, the basic issue is whether the President merely will be presented with a proposal which simply authorizes negotiating "the best possible" international agreement on the subject, or whether he should have the opportunity to establish for our negotiators meaningful guidelines which indicate such things as how many countries must sign, what percentage of global CFC production and/or use must come under the agreement, which chemicals must be included, and the like in order for an agreement to be acceptable to the United States. Certainly, unilateral action by the United States would do little to address the problem and would be to our disadvantage.

This issue currently is before the President's Domestic Policy Council (DPC). Let me elaborate on some of its aspects.

The purpose of DPC consideration is to be sure that, upon the considered advice of his entire Cabinet, the President, rather than just one or two agencies or departments, is afforded the opportunity to pass judgment on the position to be taken by the United States Government during international negotiations concerning possible limitations on global production and use of CFCs and similar chemicals. This is a complex issue of potentially great significance to the American people, their health, their lifestyle, their environment and their economy. It is the DPC's responsibility to subject available scientific information to thoughtful review and to present to the President an array of responsible options concerning the negotiating position of our government.

Contrary to certain press reports, I have not yet decided for myself what options are worthy of consideration by the President, much less what the preferred option should be. Data and analysis on the multi-faceted aspects of the issue still are being developed on an inter-agency staff basis for DPC consideration. Once such information is available, the DPC members, including myself, will be in a position to reflect on a preferred array of options and then discuss our views with the President.

I am quite disturbed by those who carelessly or deliberately provided the misinformation concerning my views which resulted in the erroneous press reports regarding this matter. The potential impact of CFCs and similar chemicals upon stratospheric ozone and the potential consequences of such impacts, and of possible measures to avoid or mitigate such impacts, upon the lives of millions of Americans, not to mention other countries' citizens, are very serious issues which deserve thoughtful evaluation at the highest levels of our government. The manner in which the matter has been characterized by those, who, it appears, are determined to confine the President's options to those only of their crafting, has the unfortunate tendency to trivialize legitimate concerns and to inhibit informed analysis and policy making.

I believe the threshold question to be dealt with is: what is our objective? Are we attempting to deal with a potentially serious health problem, or is the proposed strategy of limiting production and use of CFCs also aimed at other types of potential problems? The essential thrust of the answer so far has been that our primary concern is potential adverse impact on people's health, specifically, skin cancer. Once that threshold question is finally resolved, we must tackle the who, what, when and how questions.

First, if the scientific theories are accurate, then the problem is one that we as a Nation must seek to solve through international cooperation. We must convince a substantial portion of the rest of the world that this is a problem which must be dealt with and solved on a global basis. A negotiating objective of obtaining agreement from "as many nations as possible" could be meaningless if, in our zeal to reach an agreement, we enter a pact which, for example, does not bind those nations which now and prospectively are likely to be significant producers and/or users of CFCs and similar chemicals. My information is that, at the last set of international negotiations in Geneva, which were conducted under the auspices of the United Nations Environment Program (UNEP), less than one-third of the United Nations member countries were represented, and several emerging industrial nations, such as South Korea, Taiwan, the People's Republic of China, India, Singapore, and Pakistan, were not present. The Soviet Union was the only Eastern Bloc nation present. In my view, it would be foolhardy for the United States to limit domestic production and use of CFCs, only to be confronted with global ozone depletion caused by other nations' continuing to enjoy unfettered CFC production and use.

It should be noted that United States leadership on this issue has brought increasing support from other countries, but the President should be given the opportunity to consider to what extent that leadership might cease to be effective if the United States alone, or in concert with only relatively few other producing and consuming countries, entered into a CFC limitation program. The President should be able to consider what constitutes sufficient, assured participation by other nations before any agreement receives our government's approval.

Secondly, we must have a well-thought out proposal which, while designed to protect American interests, will gain acceptance by other countries, with de minimis exceptions, if any. No longer can the United States merely make assertions and arm-twist the world community into agreement and compliance. Our facts, data, and analysis must be credible, so that our arguments will be convincing. We should base our proposals on a realistic understanding of when CFC substitutes will be available in commercial quantities, the cost to our society to adapt to them, and whether they will be safe from a health and environmental standpoint.

If the theories which underlie our concerns about CFCs are accurate, then the burden is on those who would not insist on all chlorine-emitting CFCs,' as distinguished from just a few, being subjected to international limitations. You will note from the enclosed copy of the "Chairman's Text," which emerged from the Geneva negotiations, that only three CFCs were agreed upon, two (indicated by parentheses) were discussed but not agreed upon, and halons (believed to be powerful emitters of ozone-depleting chlorine) were not included at all. I am advised that it is unclear whether Japan will agree to limitations on CFC 113, which is used as an effective cleansing agent for computer chips.

It is important to determine whether and to what extent an international agreement in some way will give "credit" to the United States for its 1978 unilateral ban on "non-essential" aerosol sprays containing CFCs. Since, as mentioned above, substantially all the countries of the world, developed and developing, should be bound by the agreement, the President has to determine whether to accept the suggestions of some that developing countries be excused from the same level of restrictions as are being proposed for the United States.

Certainly, any international agreement should assure that compliance by each signatory is mutual and verifiable. We also need to know whether this Nation, which is committed to the concept of free international trade, will support, as has been suggested by some, trade sanctions against countries which do not adhere to the obligations imposed by an international agreement.

Thirdly, we must have an acceptable mechanism for future decisionmaking. No plan should be put forward which, regardless of good intentions today, in effect-precludes basing the international regulatory actions of the future on serious scientific review. To create today regulatory "targets" which are to obtain five to twelve years from now, based on the modelling of today which admittedly is plagued by uncertainties and which certainly will change after the proposed "freeze" has been in effect for two years, is highly questionable policy. It seems logical to me that there should be adequate time between the proposed "freeze" and the scientific review contemplated by the "Chairman's Text" to enable signatories to ascertain and to evaluate new scientific, technological and medical information before the decision is made to move forward to the next targeted reduction; otherwise, the "scientific review" could be meaningless.

Moreover, any international agreement which provides for future regulatory decisions by vote of signatories should be designed so as not to leave the United States wholly subject to the voting power of other nations whose economic and political objectives may be entirely inconsistent with our own. Before we agree to an international protocol, perhaps it would make sense to have a pretty good idea as to how the domestic regulatory mechanism would allocate among U.S. producers and users of CFCs and similar chemicals the burden of contributing to internationally agreed-upon "freezes" or reductions in their production and use.

The foregoing are but some of the major facets of this complex issue. Neither the Domestic Policy Council nor the President has had an opportunity to address them, notwithstanding the fact that there is divergence of opinion among interested departments and agencies as to the nature and scope of an agreement that will be in the best interests of the people of the United States. Yet, it is reported that those involved in the negotiating process already have scheduled signing of the international agreement at a planned September meeting in Montreal. The President should not be presented with a fait accompli. The Nation and he deserve better.

I believe that, with well-documented information, a scientifically based review process and creative thinking, this issue can be dealt with by the world community in a rational way for the good of all.

Thank you for the opportunity to respond to your interest.

Sincerely,

Don Hodel

DONALD PAUL HODEL

cc: Chairman Bennett Johnston
Ranking Minority Member McClure

Jan 6/4

Cost Benefit Analysis of a Protocol Freeze and a 20% and a further 30% Reduction in CFC Emissions

statistical incidence of premature

A cost benefit analysis has been performed for the projected skin cancer deaths, skin cancer non-fatal cases, and cataracts health effects projected from increased UV(B) occurring at the projected baseline growth of CFC emissions and at the levels of emissions contemplated by a protocol freeze of emissions, a 20 % reduction therof, and a further 30% reduction therof. Such analysis involves economic uncertainties and is not being presented with respect to the benefits derived from reducing the incidence of UV(B) on plants, aquatic life, the human immune system, ground level ozone concentrations, polymer degregation, and global temperature because of the lack of sufficient quantitive experimental information. However the benefits of these non-quanifiabily evaluated benefits are acknowledged to exist and to be additive to the other benefits which were valued and computed.

dollars

A range of assumptions was used in the analysis. The key variations in the assumptions were the ~~valuations of lives saved~~ (2 million and 4 million were used) and the discount rates for the costs and the benefits. 4% and 6% were used for the benefits and the costs were evaluated at the same rate.

benefits of avoidance of premature deaths

Sensitivity analysis was performed with respect to the ~~economic valuation of lives saved~~ and the growth in ~~their~~ value over time. The uncertainty in the underlying data from which the individual health effects were calculated was not separately estimated. The central values for health effects from the EPA Risk Assessment Analysis were used in the cost benefit analysis. In order to bound the benefit assumptions by the uncertainty in the underlying health effects data, climate models, etc., the calculated benefits should be reduced or multiplied by a significant factor which could be as much as _____ % reduction or a _____ fold multiplication.

The conclusions of the analysis, which are shown in table form in Appendix _____, are as follows:

A. The benefits from a "protocol freeze" of the CFC emissions are substantially more ~~beneficial~~ than ~~its~~ costs over all plausible assumptions and ranges of uncertainty.

B The aggregate benefits of a "protocol freeze" plus a 20% reduction in CFC emissions are also in almost all plausible cases substantially in excess of the costs.

C. However the benefits of the 20% ~~step~~ REDUCTION alone are not in all cases in excess of the costs of the 20% ~~step~~ REDUCTION alone.

D. The costs of the further 30% reduction appear in many cases to exceed the benefits from the further 30% reduction.

Hoskano 6/3

STRATOSPHERIC OZONE

Relationship of Protocol to Legislation and Litigation

Legislative Impact

If the international negotiations for a protocol fail, there will be a strong push for a unilateral domestic reduction on Capitol Hill. Key Senators and Congressmen have been making statements to this effect for months; recent press attention will only heighten that resolve. If the protocol called for a freeze plus a 20% reduction, the outcome is less certain. However, Congress would undoubtedly hold additional hearings to determine the need for further domestic reductions. If, on the other hand, the protocol mandated a freeze plus a 50% reduction, it seems likely that any pressure for additional regulation domestically would dissipate. Environmental groups, which were initially backing a 95% target, have agreed that a freeze plus 50% reduction would be a very positive beginning. Therefore, without their pushing additional action, Congressional action, at least in the near term, would be unlikely.

Litigation Impact

If the international negotiations result in a scheduled reduction, that should have little bearing on the pending NRDC suit, which was filed to compel the Administrator of EPA to promulgate regulations governing stratospheric ozone and seeks a schedule for such regulation. Should NRDC or the Court try to impose substantive emissions levels through this suit, we have sound defenses. So long as negotiations are continuing, there would seem to be no impact on current litigation. However, if there is no international agreement, it will be difficult to continue to argue for no domestic regulation, either in the existing schedule suit or in a future challenge. EPA will be hard pressed to urge for more time to study the issue, having had at least eight years (by October 1988) since the ANPRM was published.

Eileen 8/2

SUMMARY OF HEALTH AND ENVIRONMENTAL EFFECTS

Depletion of the ozone layer would result in increased penetration of biologically damaging ultraviolet radiation (UV-B) to the earth's surface. Based on the research completed to date, greater exposure to UV-B radiation has been linked to increases in the number of skin cancers and cataracts, suppression of the human immune response system, damage to crops and aquatic organisms, increased formation of ground-level ozone (smog), and accelerated degradation of certain plastics.

Based on case control, epidemiological, and ecological studies, dose-response relationships were developed and reviewed as part of EPA's risk assessment. This analysis suggests that a protocol freeze of CFC-11, -12, and -113 could result in almost 950,000 fewer deaths in the U.S. for cohorts born before 2075. A 50 percent reduction in the major CFCs would result in almost 1.1 million fewer deaths. This analysis assumes that current trends toward increased exposure to sunlight are halted, that the average age of the population remains constant, and that no major improvements in treatment of skin cancer occur.

Recent studies have also shown a strong dose-response relationship beteen UV-B and the incidence of cataracts. Approximately 12.5 million cases in the U.S. could be averted by a protocol freeze for cohorts born by 2075. A 50% reduction in the major CFCs would result in approximately 16.3 million cases averted. While laboratory studies link UV-B to suppression of the human response system with possible implications for increasing the incidence of herpes simplex and leishmaniasis, research into possible broader implications has not been undertaken.

Limited studies have examined the effects of increased UV-B radiation on plants and aquatic organisms. Five years of field studies of soy beans provide the most extensive data and suggest potentially large losses in yield. Laboratory studies of UV-B effects on aquatic organisms show changes in community composition and reduced breeding season for phytoplankton and loss of larvae for higher order fish. Potential implications for the aquatic food chain have not been studied.

Initial case studies show that increased UV-B radiation will increase background levels of urban groundlevel ozone and will accelerate the breakdown plastics used in outdoor applications.

SUMMARY OF HEALTH AND ENVIRONMENTAL EFFECTS

Depletion of the ozone layer would result in increased penetration of biologically damaging ultraviolet radiation (UV-B) to the earth's surface. Based on the research completed to date, greater exposure to UV-B radiation has been linked to increases in the number of skin cancers and cataracts, suppression of the human immune response system, damage to crops and aquatic organisms, increased formation of ground-level ozone (smog), and accelerated degradation of certain plastics.

Based on epidemiological and ecological studies, dose-response relationships were developed and reviewed as part of EPA's risk assessment. The extent of additional cancer deaths will depend on the degree of CFC control. If today's ozone level is maintained, the projected number of skin cancer deaths for White U.S. citizens born before 2075 would be 2,100,000. If the ozone level is decreased by 26% (no controls on CFCs), there would be a projected increase in the number of skin cancer deaths of 1,200,000 over the base of 2,100,000. For an ozone level decrease of 7.7% (a protocol freeze), there would be an increase in skin cancer deaths of 253,000 over the case in which there was no ozone depletion. For an ozone level decrease of 6.1% (a 20% reduction), there would be an increase in skin cancer deaths of 168,000 over the base. For an ozone level decrease of 3.2% (a 50% reduction), there would be an increase in skin cancer death of 89,000 over the base. This analysis assumes that the average age of the population remains constant, that exposure to sunlight (e.g., sunbathing) does not increase, and that no major improvements in treatment of skin cancer occur.

Recent studies have also shown a strong dose-response relationship between UV-B and the incidence of cataracts. Approximately 12.5 million cases in the U.S. could be averted by a protocol freeze for cohorts born by 2075. A 50% reduction in the major CFCs would result in approximately 15 million cases averted. While laboratory studies link UV-B to suppression of the human response system with possible implications for increasing the incidence of herpes simplex and leishmaniasis, research into possible broader implications has not been undertaken.

Limited studies have examined the effects of increased UV-B radiation on plants and aquatic organisms. Five years of field studies of soy beans provide the most extensive data and suggest potentially large losses in yield. Laboratory studies of UV-B effects on aquatic organisms show changes in community composition and reduced breeding season for phytoplankton and loss of larvae for higher order fish. Potential implications for the aquatic food chain have not been studied.

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1. WITSK (Vicki Masterson)

2. TOR: 04/1452Z

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SPECIAL INSTRUCTIONS/REMARKS:

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PAGE 1 OF 2

F R O M

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TELEPHONE NUMBER FTS 320-5785 or (303) 497-

RAPICOM NUMBER 320-6004

T O

NAME VICKI MASTERMAN (DPC)

TELEPHONE NUMBER (202) 456-6640

RAPICOM NUMBER (202) 395-5221

VERIFY - 320-3775 (MONIKA)

REMARKS:

(BAM, 3June81)

Impact of Chlorofluorocarbons (CFCs) on Atmospheric Ozone:

NOT FOR EXTERNAL CIRCULATION

Issue:

Emissions of chemicals containing chlorine (e.g., CFCs) and bromine (Halons) into the atmosphere may be depleting the stratospheric ozone layer, reducing the screen against harmful ulraviolet radiation and altering the Earth's climate system.

Theory and Model Predictions:

Continued growth of CFC and Halon emissions at 3 percent per year, which is consistent with economic projections, is predicted to yield a globally averaged overhead-column ozone depletion of about 6 percent by the year 2040 and more thereafter. In contrast, a true global freeze of the sum of worldwide emissions of chlorine and bromine containing chemicals at the present rates is predicted to yield a maximum globally averaged column depletion of less than 0.5 percent by the year 2015 and less thereafter. In both cases, this assumes continued growth in the atmospheric abundances of carbon dioxide and methane, which partially offset the chlorine and bromine effect. It is further predicted that the ozone depletion will be 2-3 times larger at high latitudes than the global average and less near the equator.

Furthermore, even with a true global freeze, it is predicted there will be an eventual 25 percent reduction of ozone in the upper stratosphere leading to a local cooling of about 5 degrees centigrade. The consequences of this cooling to climate at the Earth's surface are currently unclear.

The CFCs are greenhouse gases and hence can contribute to a warming of surface temperatures. Current understanding predicts that a true global freeze through 2030 will eventually yield a CFC-induced warming of 0.25-0.8 degrees centigrade, which is comparable to the natural variation observed during the past two centuries.

While these theories indeed simulate much of the present atmosphere fairly well, they are not perfect, which does place factors of two or three uncertainty on their predictive abilities.

Observations:

Ground-based observations show that column ozone generally increased about 3 percent from 1960 to the early 1970's, remained constant throughout the 1970's, and has decreased thereafter by about 4 percent. Recent satellite observations also indicate a decrease in the last several years. In addition, both satellite and ground-based observations have shown that ozone has decreased in the upper stratosphere by about 7 percent during the last decade. Whether the recent decreases in column and upper stratospheric ozone are due to a natural phenomena or in part to CFCs remains an open question.

Observations have demonstrated major (50 percent) column ozone decreases over Antarctica in the spring season since the mid-1970's. Both man-made (CFCs) and natural (solar cycle and climate change) causes have been proposed. None are yet fully confirmed. Therefore global ramifications are currently unknown. However, even if the cause is natural, it would not undermine confidence in global CFC-ozone models.

Implications:

If the goal is to limit predicted global and high-latitude column ozone and the upper stratospheric ozone depletions to less than the decadal natural variability (a few percent), then reductions beyond a true global freeze may be required. It should be noted than even a protocol that reduces emissions as much as 20-50 percent could fall short of a true global freeze since it will not include all chemicals, compliance in developed countries may be less than 100 percent, and substantial growth in CFC usage may occur in developing countries. The long lifetimes of the CFCs and Halons (100 years) imply that if these chemicals cause environmental damage then full recovery would take many decades even with complete termination of emissions. Hence, emission rate reductions done earlier need not be as severe as those done much later.

DRAFT

MEMORANDUM FOR THE DOMESTIC POLICY COUNCIL

FROM: THE ENERGY, NATURAL RESOURCES & ENVIRONMENT WORKING GROUP

SUBJECT: Stratospheric Ozone

On May 20, 1987, the Council met to discuss the international protocol negotiations currently underway to limit emissions of ozone depleting chemicals.

Several questions were raised and the Working Group was asked to provide answers. The questions were:

* What are the legislative and legal impacts of an international ozone protocol?

* What are the most up-to-date scientific data on climatic and health effects of ozone depletion?

* What is the cost/benefit effect of an international treaty restricting ozone depleting chemicals?

The following information has been summarized by the Working Group after discussion of detailed presentations by experts in each area.

Legislative/legal

A pending lawsuit against the EPA seeks to compel the Administrator to promulgate regulations governing stratospheric ozone and to schedule such regulation. The court is not likely to act as long as international negotiations continue. If the international negotiations result in a scheduled reduction, the EPA would have sound defenses to any attempt by the plaintiff or the court to impose substantive emissions levels through the lawsuit. However, if there is no international agreement, it will be difficult to continue to argue for no domestic regulation, either in the existing lawsuit or in future litigation. EPA will be hard pressed to ask for more time to study the issue having initiated study of the issue eight years ago.

To date legislative action has been restrained by strong opponents of domestic legislation (such as Congressman Dingell). If the international negotiations for a protocol fail, there will be a strong push for a unilateral domestic reduction on Capitol Hill. Key Senators and Congressmen have been making statements

to this effect for months; recent press attention will only heighten that resolve. If the protocol called for a freeze or a freeze plus a 20 percent reduction, the legislative outcome is less certain though Congress would undoubtedly hold additional hearings to determine the need for further domestic reductions. If, on the other hand, the protcol mandated a freeze plus a 50 percent reduction, it seems likely that any pressure for additional regulation domestically would dissipate. Environmental groups, which were initially backing a 95 percent target, have agreed that a freeze plus 50 percent reduction would be a very positive beginning. Without a strong push from these groups, additional action, congressional action, at least in the near term, would be unlikely.

Climatic

Both satellite and ground-based observations have shown that ozone has decreased in the upper stratosphere by about seven percent during the last decade. Total column ozone has decreased by about 4 percent since 1980. It is not known whether natural phenomena or CFC and Halon emissions have caused these decreases.

Continued growth of CFC and Halon emissions at three percent per year (as consistent with economic projections) is predicted to yield, by the year 2040, a globally averaged overhead-column ozone depletion of about 6 percent and a stratospheric ozone depletion of about 50 percent. These depletion levels are much larger than natural variability and are, therefore, significant.

In contrast, a true global freeze of the sum of worldwide emissions of chlorine and bromine containing chemicals at the present rates is predicted to yield a maximum globally averaged column depletion of less than 0.5 percent by the year 2015 and a stratospheric depletion of 25 percent in the next 100 years. This stratospheric depletion would be much larger than natural variability and would, therefore, be significant. (Note that a "true global freeze" is not realistically attainable given expected compliance problems and the anticipated concessions to developing countries.) The theories and models upon which these predictions are based have uncertainty factors of two to three.

Health

Depletion of the ozone layer would result in increased penetration of biologically damaging ultraviolet radiation (UV-B) to the earth's surface. Based on the research completed to date, greater exposure to UV-B radiation has been linked to increases in the number of skin cancers and cataracts, suppression of the human immune response system, damage to crops and aquatic organisms, and increased formation of ground-level ozone (smog).

Based on epidemiological and ecological studies, dose-response relationshps were developed and reviewed as part of EPA's risk assessment. The extent of additional cancer deaths will depend on the degree of CFC control. If today's ozone level is maintained, the projected number of skin cancer deaths for White U.S. citizens born before 2075 would be 2,100,000. If the ozone level is decreased by 26 percent, there would be a projected increase in the number of skin cancer deaths of 1,200,000 over the base of 2,100,000. For an ozone level decrease of 7.7 percent (the likely result of a freeze included in the protocol), there would be an increase in skin cancer deaths of 253,000 over the case in which there was no ozone depletion. For an ozone level decrease of 6.1 percent (the likely result of a 20 percent reduction in emissions), there would be an increase in skin cancer deaths of 168,000 over the base. For an ozone level decrease of 3.2 percent (a 50 percent reduction), there would be an increase in skin cancer deaths of 89,000 over the base. This analysis assumes that the average age of the population remains constant, that exposure to sunlight (e.g., sunbathing) does not increase, and that no major improvements in treatment of skin cancer occur.

Recent studies have also shown a strong dose-response relationship between UV-B and the incidence of cataracts. Approximately 12.5 million cases in the U.S. could be averted by a protocol freeze for cohorts born by 2075. A 50 percent reduction in the major CFCs would result in approximately 16.3 million cases averted. While laboratory studies link UV-B to suppression of the human response system with possible implications for incresing the incidence of herpes simplex and leishmaniasis, research into possible broader implications has not been undertaken.

Limited studies have examined the effects of increased UV-B radiation on plants and aquatic organisms. Five years of field studies of soy beans provide the most extensive data and suggest potentially large losses in yield. Laboratory studies of UV-B effects on aquatic organisms show changes in community composition and reduced breeding season for phytoplankton and loss of larvae for higher order fish. Potential implications for the aquatic food chain have not been studied.

Cost/Benefit

A cost benefit analysis has been performed for the projected skin cancer deaths, skin cancer non-fatal cases, and cataracts health effects projected from increased UV-B radiation occuring at the projected baseline growth of CFC emissions and at the levels of emissions contemplated by a protocol freeze of emissions, a 20 percent reduction thereof, and a further 30 percent reduction thereof. Such analysis involves economic uncertainties and is not being presentd with respect to the benefits derived from

reducing the incidence of UV-B on plants, aquatic life, the human immune system, ground level ozone concentrations, polymer degradation, and global temperature because of the lack of sufficient quantitative experimental information. However, the benefits of these non quantifiably evaluated benefits are acknowledged to exist and to be additive to the other benefits which were valued and computed.

A range of assumptions was used in the analysis. The key variations in the assumptions were the valuations of lives saved (two million and four million were used) and the discount rates for the costs and the benefits. Four percent and six percent were used for the benefits and the costs were evaluated at the same rate.

Sensitivity analysis was performed with respect to the economic valuation of lives saved and the growth in their value over time.

The uncertainty in the underlying data from which the individual health effects were calculated was not separately estimated. The central values for health effects from the EPA risk Assessment Analysis were used in the cost benefit analysis. In order to bound the benefit assumptions by the uncertainty in the underlying health effects data, climate models, etc., the calculated benefits should be reduced or multiplied by a significant factor which could be as much as ____ percent reduction of a _____ fold multiplation.

The conclusions of the analysis, which are shown in table form in Appendix _____, are as follows:

--The benefits from a "protcol freeze" of the CFC emissions are substantially more than the costs over all plausible assumptions and ranges of uncertainty.

--The aggregate benefits of a "protocol freeze" plus a 20 percent reduction in CFC emissions are also in almost all plausible cases substantially in excess of the costs.

--However, the benefits of the 20 percent reduction alone are not in all cases in excess of the costs of the 20 percent reduction alone.

--The costs of the further 30 percent reduction appear in many cases to exceed the benefits from the further 30 percent reduction.

QUESTIONS FOR DECISION

DPC guidance is sought on the following six issues involved in the stratospheric ozone negotiations.

1. Should the U.S. continue to participate in international negotiations toward a protocol to control emissions of ozone depleting chemicals?

OK

There is inter-agency agreement that international emissions control action is preferable to unilateral domestic control action for environmental and economic reasons. Unilateral domestic emissions controls are not likely to protect the ozone layer from depletion if other countries continue to emit ozone-depleting substances. In addition, unilateral domestic action would disadvantage U.S. industry in world markets. Moreover, it appears that legislative and judicial pressure may result in unilateral domestic emissions controls in the event negotiations toward an international control protocol fail.

The Working Group recommends that the U.S. continue to participate in international negotiations toward a control protocol.

2. Should the U.S. delegation continue to negotiate pursuant to the Circular 175?

Interior's add'l option

State's objections

The November 28, 1986 Circular 175 (approved by inter-agency review) authorizes the U.S. delegation to negotiate a protocol providing for:

I. A near-term freeze on the combined emissions of the most ozone-depleting substances;

II. A long-term scheduled reduction of emissions of these chemicals down to the point of eliminating emissions from all but limited uses for which no substitutes are commercially available (such reduction could be as much as 95 percent);

III. Periodic review of the protocol provisions based upon regular assessment of the science. The review could remove or add chemicals, or change the schedule or the emission reduction target.

While there has been much discussion about the specific terms of a potential protocol, there is no disagreement with the general framework set out in the Circular 175. The Circular 175, however, allows for various approaches to a control protocol. The remaining issues address the desirability of these various approaches.

The Working Group recommends that the U.S. delegation continue to negotiate pursuant to the Circular 175.

3. What chemicals should the U.S. seek to include in the ~~control protocol~~ freeze?

There is inter-agency agreement that a freeze on emissions at 1986 levels should cover all of the important ozone depleting chemicals including the Halons.

Any further reductions should exclude the Halons for national security reasons.

Note: The Departments of Commerce and Energy question the advisability of requiring further reductions for CFC 113 given its importance to the semi-conductor industry and to the nation's defense.

The Working Group recommends that the delegation seek a freeze on all ozone depleting chemicals including the Halons and CFC 113, and that any further reductions include all important ozone depleting chemicals except the Halons and CFC 113.

4. What emissions control provisions should the delegation seek regarding stringency, timing, future study and implementing mechanisms?

Points of Agreement:

A. ~~All agencies~~ support a freeze, at 1986 levels, on ~~production/consumption~~ of CFCs 11, 12, 113, 114, 115, and Halons 1211 and 1301, to take effect one or two years after the protocol enters into force.

B. ~~All agencies~~ support regularly scheduled assessments of scientific, economic, technological and environmental factors, ~~prior to any emissions reductions, to enable to parties to adjust the reduction schedule and add or subtract chemicals.~~

Remaining Questions:

A. Should the delegation seek an automatic ~~50 percent~~ reduction? ~~(subject to reversal upon 2/3 vote) to take effect four years after entry into force~~?

Yes -- EPA, Commerce, Justice - Lands Division, Energy, State, NASA, OPD

No -- OSTP

Other agencies?

B. Should the delegation seek an additional 30 percent reduction to take effect 8 to 10 years after entry into force and after a majority vote affirming the reduction at a designated future time?

DRAFT

Yes -- EPA, Commerce, Justice - Lands, Energy, State, NASA, OPD

No -- OSTP

Other agencies?

C. Alternatively, should the delegation seek ~~the~~ an additional ~~30 percent~~ reduction to take effect 8 to 10 years after entry into force automatically unless reversed by a 2/3 vote?

- shld it be 30?
- shld it be 6-8 aft

Yes -- EPA, State

No -- Commerce, Justice - Lands, Energy, OMB, OSTP, OPD, USTR

→ How shld this add'l reduce take effect (2 ways.)

Other agencies?

D. ~~Should~~ Should the delegation seek additional ~~scheduled~~ reductions? ~~beyond the cumulative 50 percent reduction achieved through the 20 and 30 percent reductions?~~

- shld it be specified?
- trigger?

Yes -- EPA and State (even if reductions are automatic unless reversed by 2/3 vote)

- shld it be for future consid of whether to proceed?

No -- OSTP

Allow for future consideration -- Commerce, Justice - Lands, Energy, OMB, OPD

what chm's →

The Working Group recommends that the U.S. delegation seek a freeze at 1986 levels; regularly scheduled assessments of scientific, economic, technological and environmental factors for review in future reduction decisions; a 20 percent reduction to take effect four years after entry into force unless reversed by a 2/3 majority vote; an additional 30 percent reduction to take effect 8 to 10 years after entry into force if affirmed by a positive majority vote of the parties; and allowance for further reductions if confirmed by future majority votes of the parties.

reverse 5 & 6 →

5. What should be the U.S. objective regarding the control formula and trade provisions?

There is inter-agency agreement that the U.S. delegation seek to include in the protocol an effective formula to control emissions with accountability, the fewest possible restrictions on the flow of trade and capital among parties, the most favorable formula for U.S. industry, and strong monitoring and reporting provisions.

DRAFT

The Working Group recommends that the U.S. delegation continue to pursue this objective.

Divide 1st question

6. What should be the U.S. objective regarding participation? and voting?

There is inter-agency agreement that there should be the widest possible global participation in the protocol. Limited concessions, such as a grace period for developing countries, may be necessary to gain widespread participation.

There is also inter-agency agreement that the U.S. delegation should seek to include a system of voting which would ~~give due~~ respect the interests of weight to the currently significant producing and consuming countries.

voting system.

The Working Group recommends that the U.S. delegation continue to negotiate for widespread global participation and a voting system which would credit the major producing and consuming countries.

EFFECTS

PROJECTED OZONE DEPLETION WILL INCREASE HEALTH CONSEQUENCES OF UVB

- Even without ozone depletion, projections show UVB is a serious problem
  - 2.977 million skin cancer deaths of Americans born before 2075
  - 165 million skin cancer cases
  - 426.516 million cataracts

2.5% growth

Is this a 3% growth rate?

- Without a protocol, ozone depletion of 26% in 2075 is projected, which would increase UVB related health effects
  - 2 million additional skin cancer deaths
  - 98 million additional skin cancer cases
  - 43 million additional cataracts

- A freeze would decrease ozone depletion to 7.7% and avert UVB damage
  - 1.6 million additional American deaths would be averted from no protocol
  - 79 million additional cases would be averted from no protocol
  - 32 million cataracts would be averted from no controls

2/3 of deaths are result of projected emissions from LDCs

assump's about partic? timing? % compliance?

- A 20% protocol would decrease ozone depletion to 6.1% and avert additional damage
  - 80 thousand additional American deaths would be averted over a freeze
  - 4 million additional skin cancer cases would be averted over a freeze
  - 2 million additional cataracts would be averted over a freeze

- A 50% global protocol would reduce depletion to 3.2% decreasing damage even more
  - 130 thousand additional American deaths would be averted over a 20% protocol
  - 7 million additional skin cancer cases would be averted over a 20% protocol
  - 7 million additional cataracts would be averted over a 20% protocol

- Uncertainties include future ozone depletion, the action spectra and statistical estimates of dose-response coefficients
  - Considering quantifiable uncertainties, there is a 50% chance that the actual damages will be between 50% and 125% of the above estimates
  - There is a 90% chance that the actual damages will be between 20% and 260% the above estimates

- UVB would suppress the immune system
  - Evidence suggests a relationship to infectious disease (cold sores)
  - A relationship has been demonstrated in herpes simplex and the tropical disease, leishmanias

- Most people who get it are old & ~~[illegible]~~ ∼ know how much sooner will die b/c of other causes.
- analysis assumes no behavioral chg

EVIDENCE SUPPORTS THE CONCLUSION THAT DEPLETION WOULD EXACERBATE EXISTING ENVIRONMENTAL PROBLEMS

- Photochemical air pollution in places like Los Angeles would probably worsen
- The lifetime of outdoor plastics and latex paints would be shortened

EVIDENCE SUPPORTS THE CONCLUSION THAT DEPLETION COULD SERIOUSLY INFLUENCE CROPS AND AQUATICS

- Knowledge is limited but experimental data indicate crop production may be reduced and ecosystems disturbed by ozone depletion
- Field experiments have not been done, but laboratory data indicate aquatic organisms are sensitive to higher UVB, especially during critical breeding seasons

HIGHER EMISSIONS OF CFCs AND ITS INDIRECT EFFECTS OF VERTICAL OZONE DISTRIBUTION WILL RAISE GLOBAL TEMPERATURES AND CHANGE CLIMATE

- Reductions in CFCs would lower ultimate global warming directly associated with emissions to 2075 by .84°C for a freeze, .98°C for a 20% reduction, and 1.28°C for a 50% protocol, plus or minus 50%
- Associated with temperature increases would be a yet unpredictable change in weather and climate patterns

CHAIRMAN'S TEXT

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Ad Hoc Working Group of Legal and Technical
Experts for the Preparation of a
Protocol on Chlorofluorocarbons to
the Vienna Convention for the
Protection of the Ozone Layer (Vienna Group)

Third Session
Geneva, 27-30 April 1987

TEXT PREPARED BY A SMALL SUB-WORKING GROUP OF
HEAD OF DELEGATIONS

ARTICLE II: CONTROL MEASURES

1. Each party, under the jurisdiction of which CFC 11, CFC 12, CFC 113, (CFC 114, CFC 115) are produced shall ensure that within (2) years after the entry into force of this Protocol the (combined annual production and imports) (combined adjusted annual production) of these substances do not exceed their 1986 level.

2. Each party, under the jurisdiction of which substances referred to in paragraph 1 are not produced at the time of the entry into force of this Protocol, shall ensure that within (2) years from the entry into force of this Protocol (its combined annual production and imports) (its combined adjusted annual production) do not exceed the levels of imports in 1986.

3. Each party shall ensure, that within (4) years after the entry into force of this Protocol levels of substances referred to in paragraph 1 attained in accordance with paragraphs 1 and 2 will be reduced by 20 per cent.

4. Each party shall ensure that within (6) (a), (8) (b) years after the entry into force of this Protocol, the 1986 levels of substances referred to in paragraphs 1 and 2 will be further reduced (by 30 per cent), (a) (if the majority of the parties so decide, (b) (unless parties by a two-third majority otherwise decide), in the light of assessments referred to in Article III, such decision should be taken not later than (2) (4) years after entry into force.

5. Parties shall decide by (two-third majority) (a majority vote)

- whether substances should be added to or removed from the reduction schedule
- whether further reductions of 1986 levels should be undertaken (with the objective of eventual elimination of these substances).

These decisions shall be based on the assessments referred to in Article III.

Note: A second paragraph reading as follows has to be added to Article III. Beginning 1990, and every four years thereafter, the parties shall review the control measures provided for in Article II. At least one year before each of these reviews, the parties shall convene a panel of scientific experts, with composition and terms of reference determined by the parties, to review advances in scientific understanding ~~of~~ modification of the ozone layer, and the potential health, environmental and climatic effects of such modification.

Effects of CFC Emissions on Ozone Column

Calculations for DPC Working Group

R. Watson/NASA

R. Johnson/OSTP

5 June 1987

OSTP Scenarios

LLNL Parameterized 1-D Model

Key Conclusions

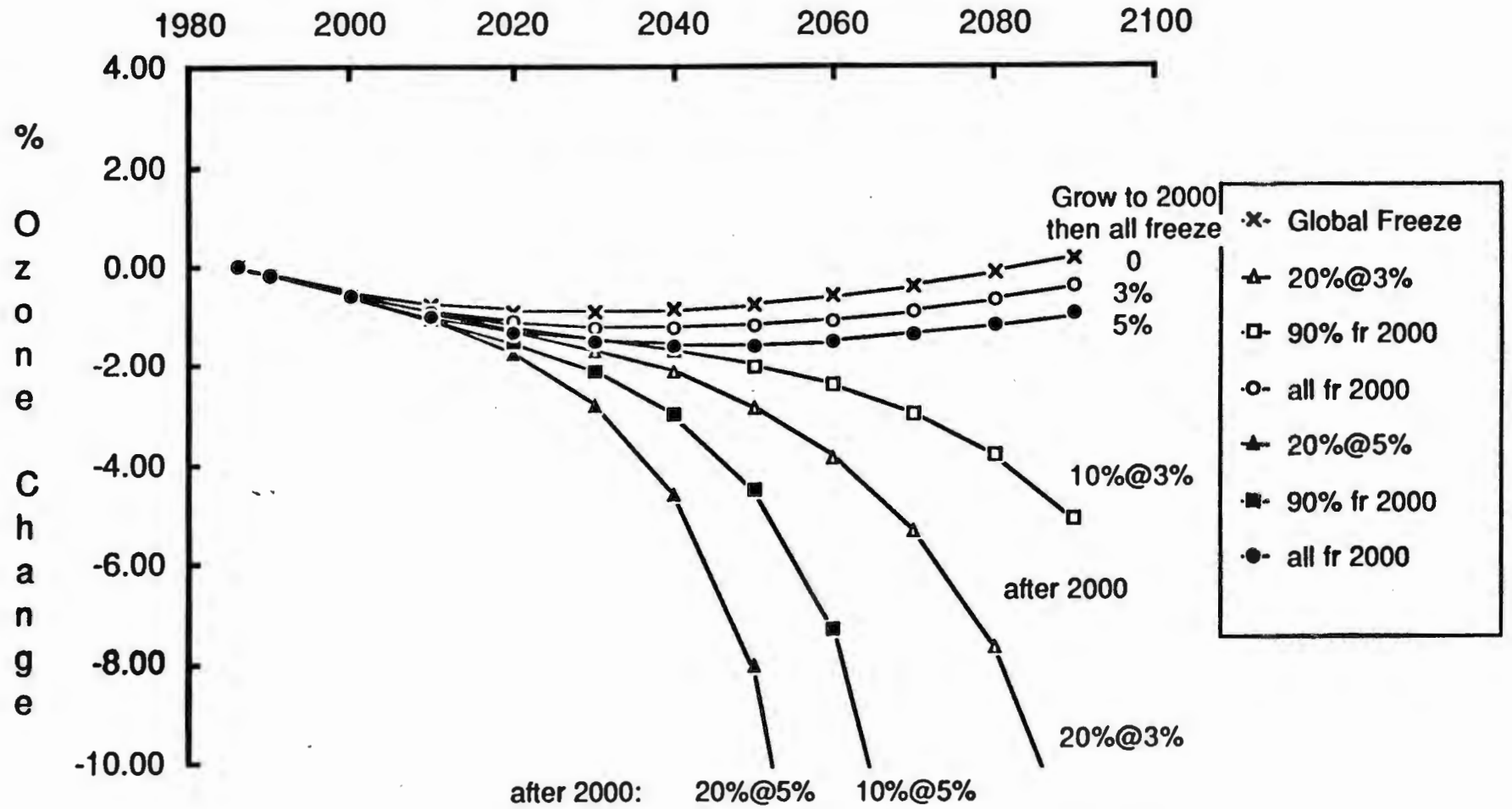
In order to minimize the decrease in the ozone column, it is essential to

1. Minimize the growth rate in non-complying countries: 5% non-compliers growing at 5%/year has the same impact as 20% non-compliers growing at 3%/yr. Even 50% reductions in emissions of complying countries cannot offset the compounding effect of growth in non-compliers.

2. Minimize the fraction of non-compliers at the earliest possible date.

3. Note that a 5 year delay in reductions beyond a freeze among compliers has no significant **direct** impact on ozone. However, if earlier reductions lead to substitutes at an earlier date, and reduce the growth rate in non-compliers, that **indirect** effect would be significant.

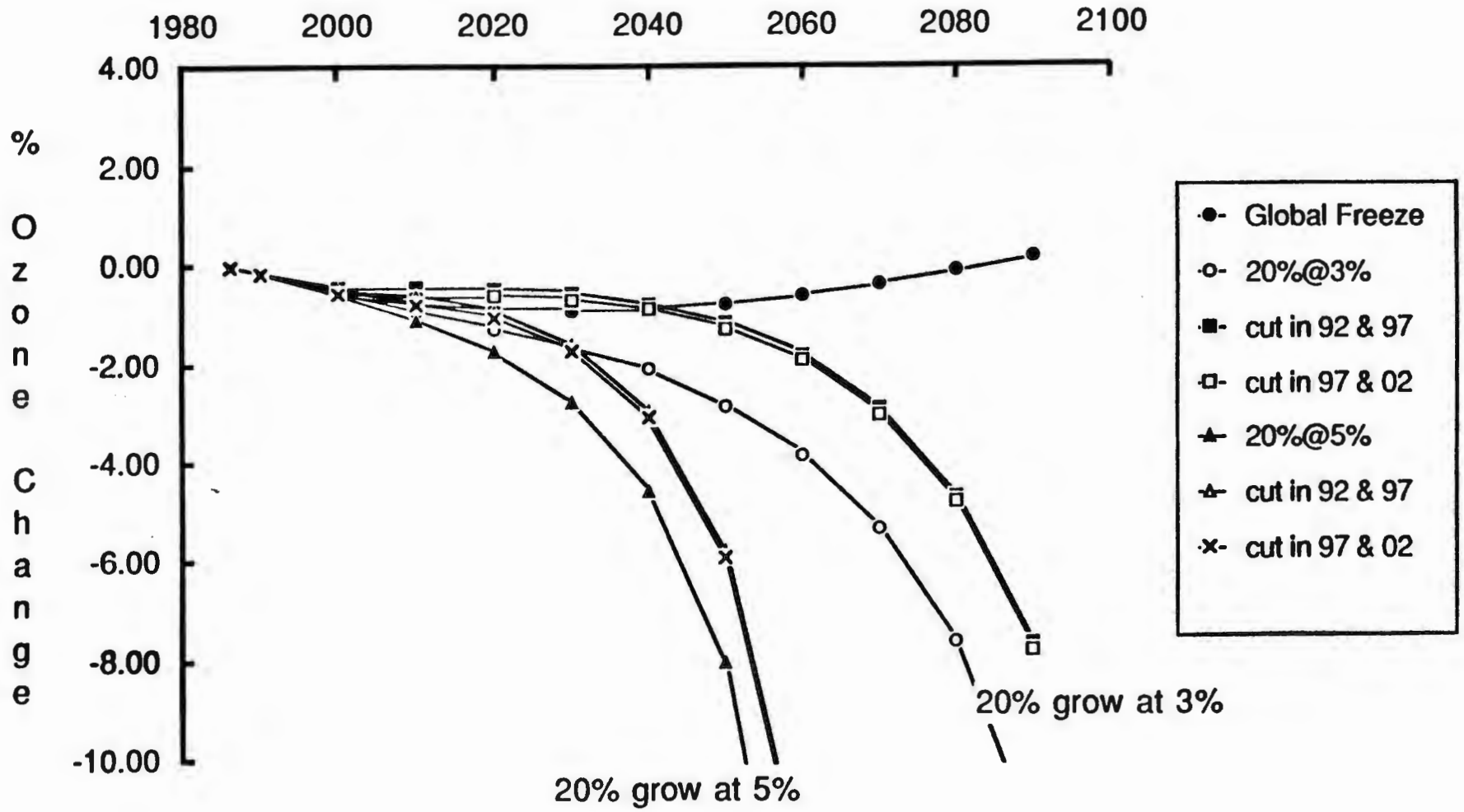
Effects of CFC Reductions



Growing 20% comply in 2000: 0, 1/2, all

JUNE 4

Effects of CFC Reductions



JUNE 2

Effects of CFC Emissions on Ozone Column

Calculations for DPC Working Group

R. Watson/NASA

R. Johnson/OSTP

5 June 1987

OSTP Scenarios

LLNL Parameterized 1-D Model

JUNE 1

PARAMETERIZED CALCULATION OF 1-D TOTAL COLUMN OZONE CHANGE
LLNL PARAMETERIZATION

	SCENARIO							
	1	2	3	4	5	freeze	6	7
1986	.0	.0	.0	.0	.0	.0	.0	.0
1990	-.14	-.14	-.14	-.14	-.14	-.14	-.14	-.14
2000	-.43	-.47	-.42	-.47	-.74	-.50	-.52	-.55
2010	-.52	-.57	-.35	-.45	-1.32	-.75	-.82	-.92
2020	-.51	-.55	-.17	-.26	-1.73	-.88	-1.04	-1.28
2030	-.42	-.46	.08	-.00	-2.01	-.91	-1.22	-1.67
2040	-.27	-.30	.36	.29	-2.18	-.87	-1.38	-2.16
2050	-.06	-.09	.69	.62	-2.27	-.76	-1.57	-2.84
2060	.19	.16	1.04	.99	-2.28	-.60	-1.81	-3.83
2070	.48	.46	1.43	1.38	-2.22	-.38	-2.15	-5.32
2080	.81	.79	1.83	1.79	-2.09	-.12	-2.64	-7.66
2090	1.17	1.15	2.26	2.22	-1.91	.18	-3.35	-11.64

1986 ASSUMED EMISSION LEVELS IN 10**6 kg

CFC-11	CFC-12	CFC-22	CFC-113	CCl4	CH3CCl3	1211	1301
343.4	504.5	117.6	166.5	80.5	564.8	4.5	4.5

SCENARIO DESCRIPTIONS:

CO2 - NAS 50th percentile
CH4 - linear growth @ 0.017 ppm annually (about 1%).
N2O - 0.2% compounded annual growth

1. Emissions of fully halogenated species (including Halons) fixed at 1986 levels to 1992, .8*1986 levels thereafter. CFC-22 and CH3CCl3 fixed at 1986 levels throughout.

2. Emissions of fully halogenated species (including Halons) fixed at 1986 levels to 1995, .8*1986 levels thereafter. CFC-22 and CH3CCl3 fixed at 1986 levels throughout.

3. Emissions of fully halogenated species (including Halons) fixed at 1986 levels to 1992, .8*1986 levels to 1997, .56*1986 levels thereafter. CFC-22 and CH3CCl3 fixed at 1986 levels throughout.

4. Emissions of fully halogenated species (including Halons) fixed at 1986 levels to 1995, .8*1986 levels to 2000, .56*1986 levels thereafter. CFC-22 and CH3CCl3 fixed at 1986 levels throughout.

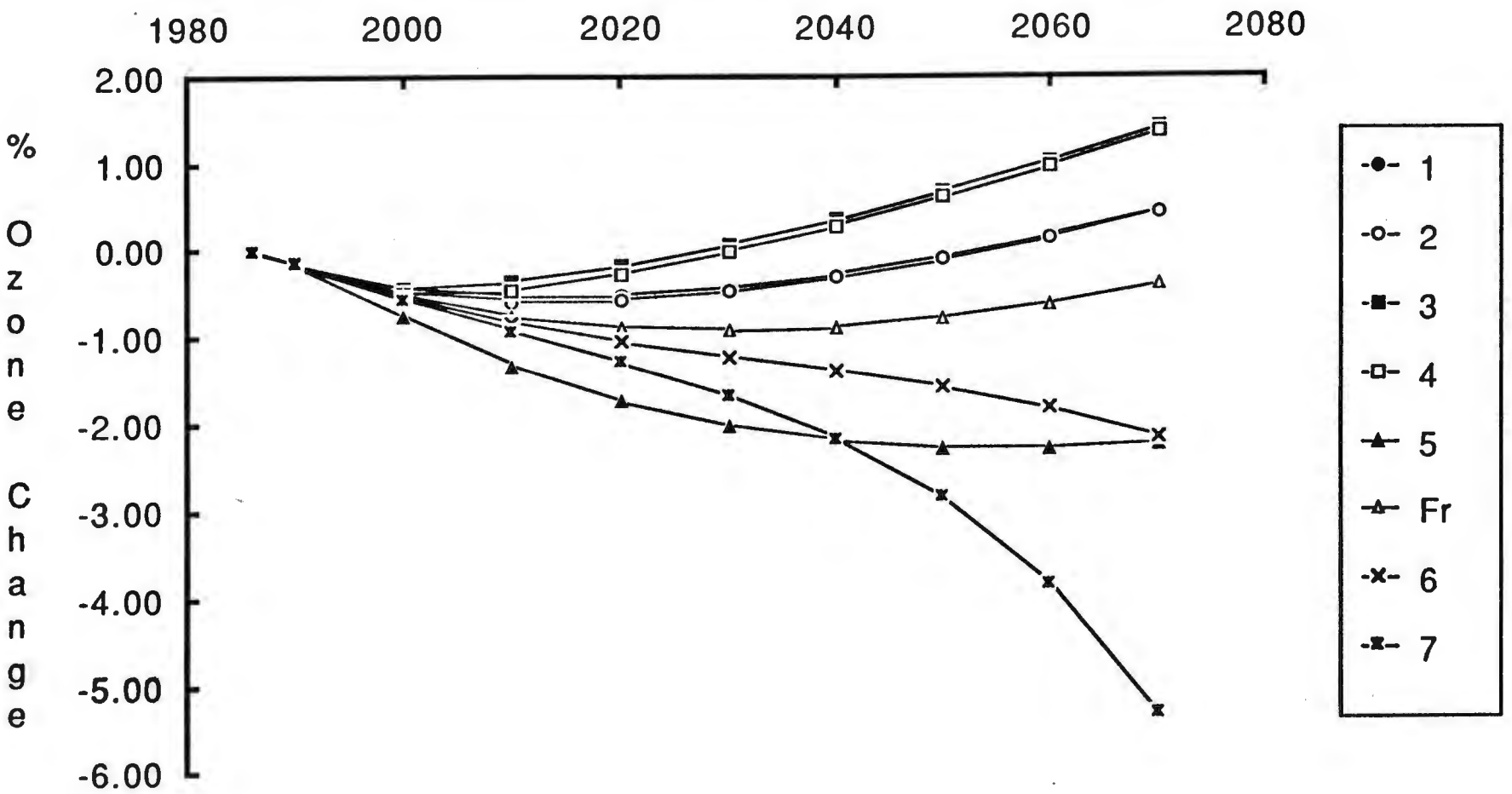
5. Emissions of all halogen-containing species grow at 3% compounded annually until 2000. Emissions frozen at 1996 levels thereafter.

Freeze. Emissions of all halogen-containing species fixed at 1986 levels.

6. Emissions of all halogen-containing species except Halons fixed at 1986 levels throughout. Halon emissions grow at 3% compounded annually.

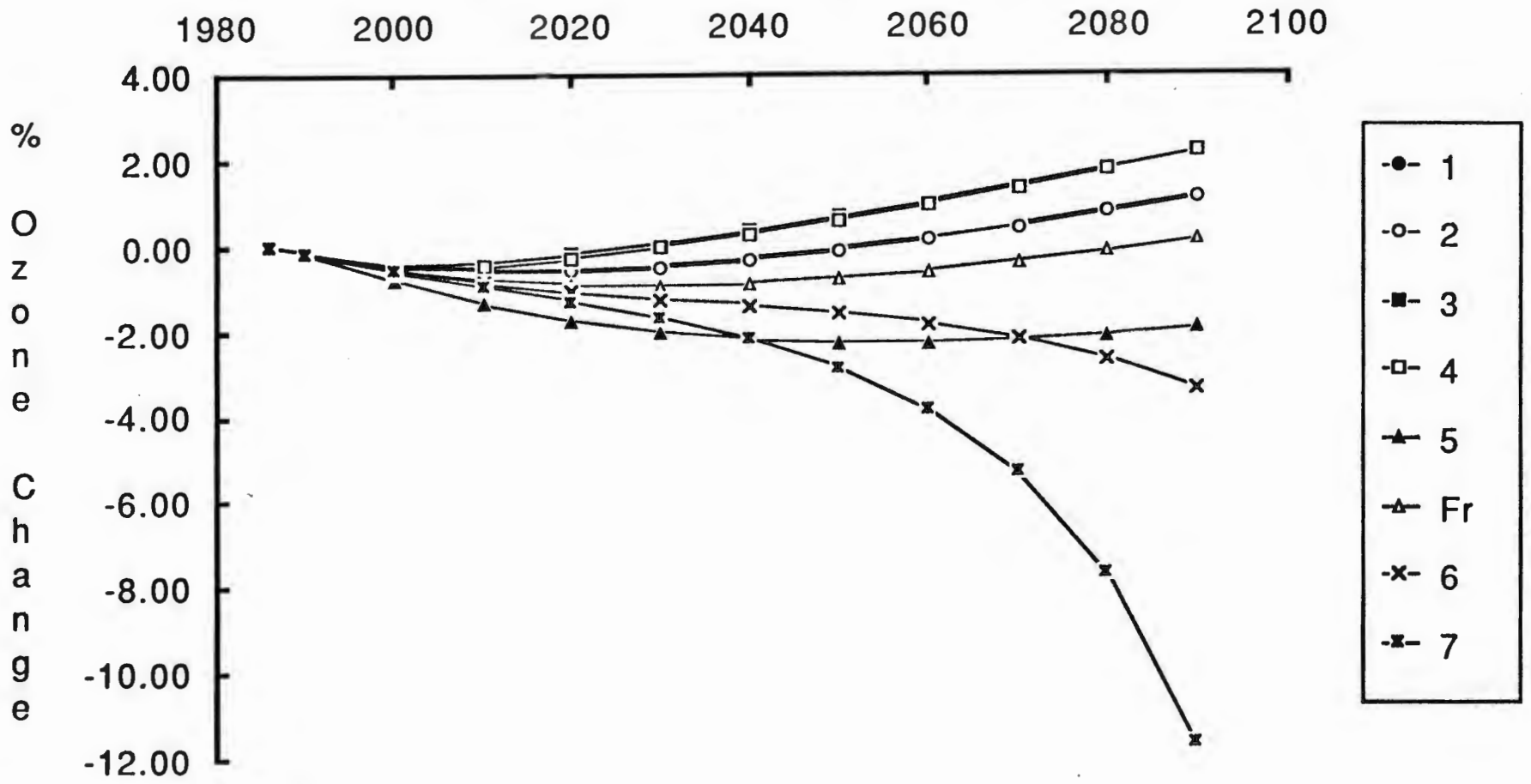
7. 80% of 1986 emissions of all halogen-containing species frozen at 1986 levels throughout. 20% of 1986 emissions allowed to grow at 3% compounded annually.

Column Ozone Change -- %



JUNE 1

Column Ozone Change -- %



JUNE 1

June 2, 1987

PARAMETERIZED CALCULATION OF 1-D TOTAL COLUMN OZONE CHANGE
LLNL PARAMETERIZATION

SCENARIO

	FREEZE			80% / 20%					
	LINEAR CH4 @			20% @ 1.03			20% @ 1.05		
	0.5%	1.0%	1.5%	A	B	C	A	B	C
1986	.0	.0	.0	.0	.0	.0	.0	.0	.0
1990	-.21	-.14	-.06	-.14	-.14	-.14	-.14	-.14	-.14
2000	-.76	-.50	-.25	-.55	-.44	-.54	-.59	-.48	-.57
2010	-1.19	-.75	-.30	-.92	-.44	-.63	-1.09	-.60	-.79
2020	-1.51	-.88	-.24	-1.28	-.46	-.61	-1.74	-.90	-1.06
2030	-1.74	-.91	-.07	-1.67	-.55	-.68	-2.77	-1.58	-1.72
2040	-1.89	-.87	.18	-2.18	-.78	-.88	-4.57	-2.96	-3.10
2050	-1.99	-.76	.60	-2.84	-1.15	-1.26	-8.05	-5.80	-5.94
2060	-2.03	-.60	.87	-3.83	-1.82	-1.92	-16.2	-12.3	-12.5
2070	-2.02	-.38	1.30	-5.32	-2.92	-3.02	-46	-35	-36
2080	-1.97	-.12	1.78	-7.66	-4.70	-4.80	) -50	) -50	) -50
2090	-1.89	.18	2.31	-11.64	-7.70	-7.82	) -50	) -50	) -50

1986 ASSUMED EMISSION LEVELS IN 10**6 kg

CFC-11	CFC-12	CFC-22	CFC-113	CCl4	CH3CCl3	1211	1301
343.4	504.5	117.6	166.5	80.5	564.8	4.5	4.6

SCENARIO DESCRIPTIONS:

CO2 - NAS 60th percentile
CH4 - linear growth @ 0.017 ppm annually (about 1%), except as noted.
N2O - 0.2% compounded annual growth

Freeze

Emissions of all halogen-containing species fixed at 1986 levels.

80%/20%

20% of 1986 emissions assumed to grow at compounded annual rates of 3 or 5 %.

A - 80% of 1986 emissions of all halogen-containing species constant at 1986 levels throughout.

B - 80% of 1986 emissions of all halogen-containing species constant at 1986 levels to 1992, then constant at 0.8*1986 emissions to 1997, then constant at 0.5*1986 emissions.

C - 80% of 1986 emissions of all halogen-containing species constant at 1986 levels to 1997, then constant at 0.8*1986 emissions to 2002, then constant at 0.5*1986 emissions.

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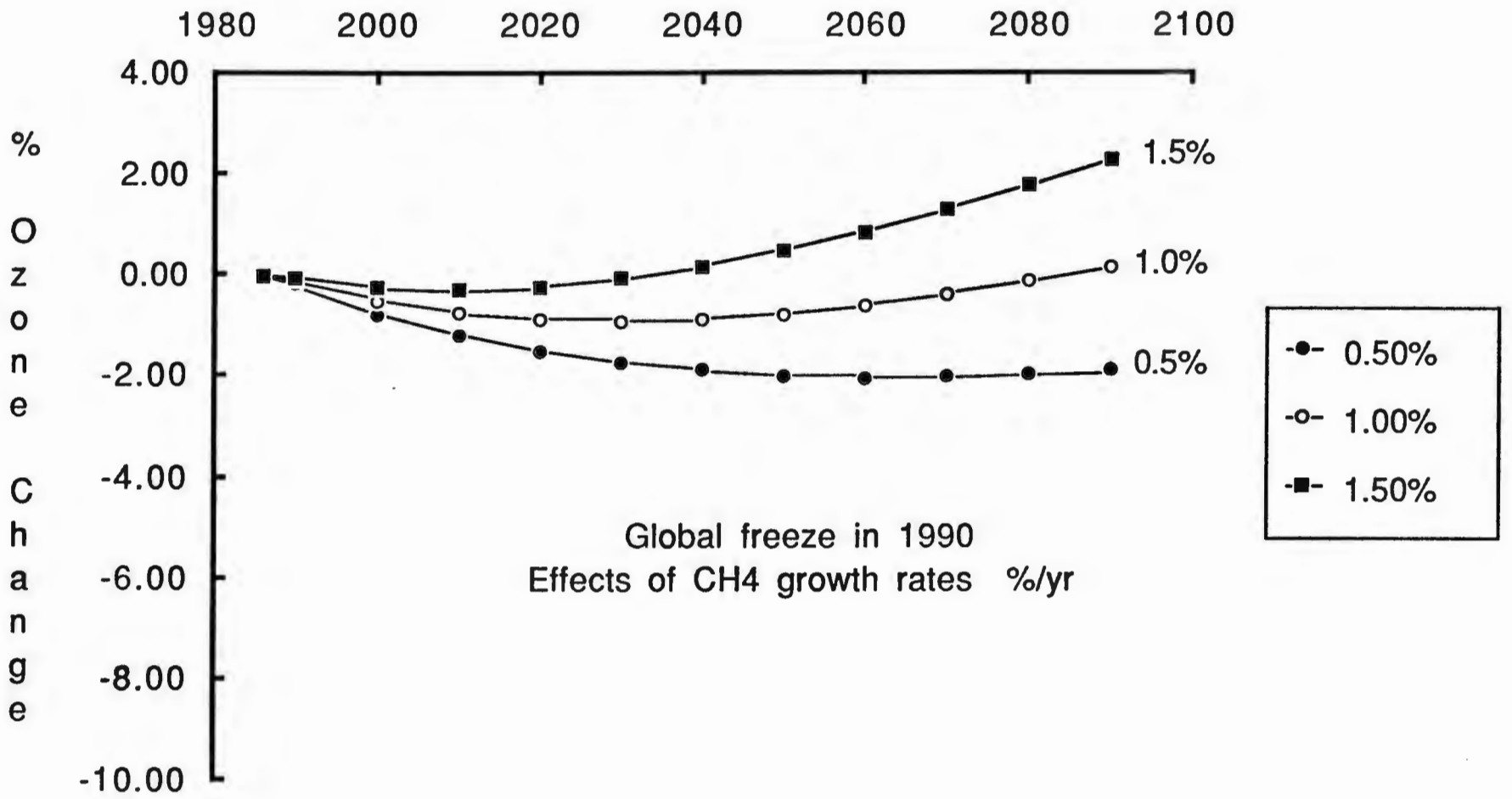
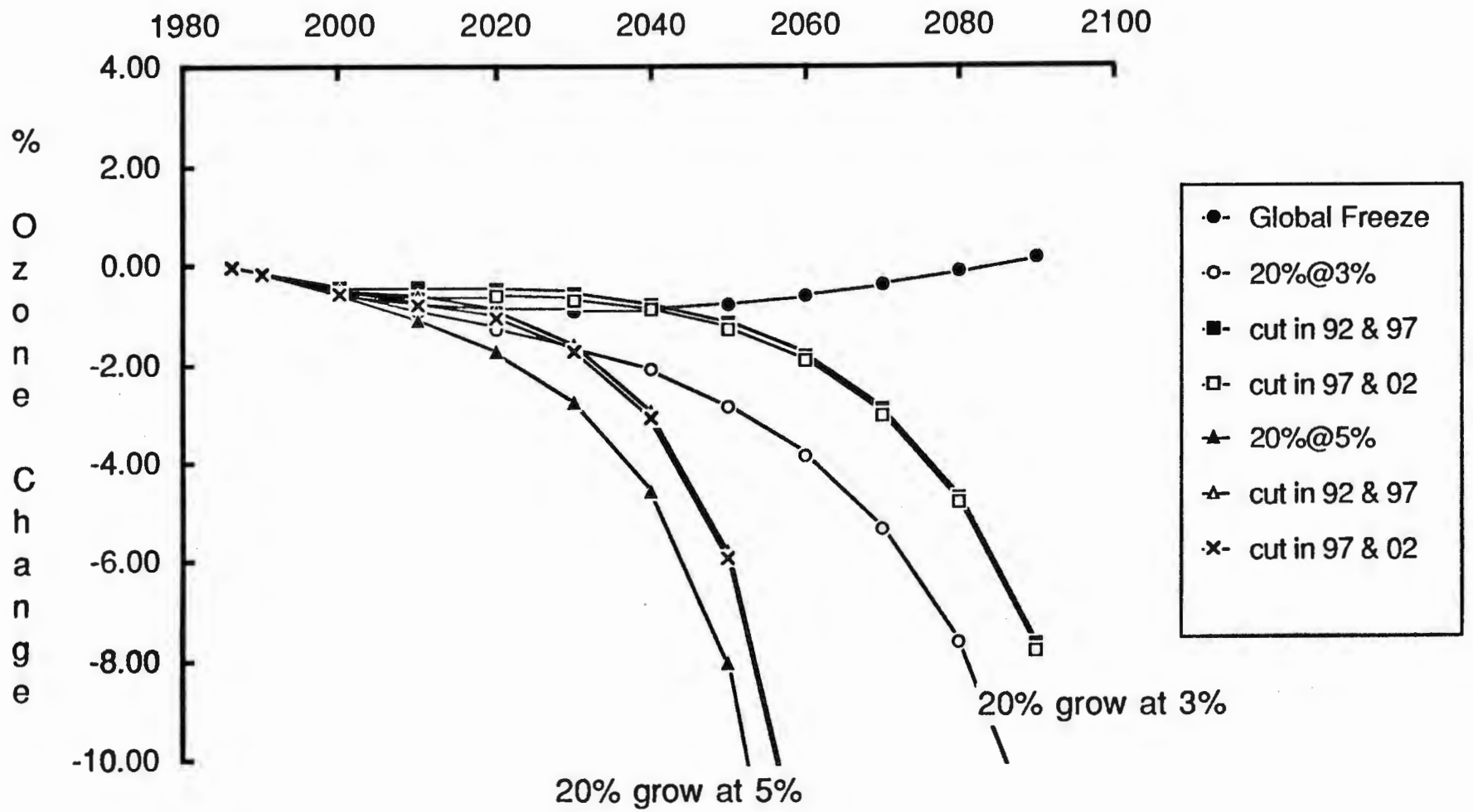

1980
2000
2020
2040
2060
2080
2100
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
% Ozone Change
1.5%
1.0%
0.5%
0.50%
1.00%
1.50%
Global freeze in 1990
Effects of CH4 growth rates %/yr

JUNE 2

Effects of CFC Reductions



JUNE 2

June 4, 1987

PARAMETERIZED CALCULATION OF 1-D TOTAL COLUMN OZONE CHANGE
LLNL PARAMETERIZATION

SCENARIO
20% of 1986 Emissions Grow @

	3% / year			5% / year		
	A	B	C	A	B	C
1986	.0	.0	.0	.0	.0	.0
1990	-.14	-.14	-.14	-.14	-.14	-.14
2000	-.55	-.55	-.55	-.59	-.59	-.59
2010	-.92	-.90	-.89	-1.09	-1.05	-1.01
2020	-1.28	-1.19	-1.10	-1.74	-1.52	-1.31
2030	-1.67	-1.44	-1.21	-2.77	-2.11	-1.48
2040	-2.16	-1.69	-1.23	-4.57	-3.00	-1.57
2050	-2.84	-1.99	-1.18	-8.05	-4.51	-1.57
2060	-3.83	-2.39	-1.07	-16.19	-7.31	-1.50
2070	-5.32	-2.97	-.90	-45.7	-13.36	-1.38
2080	-7.66	-3.82	-.68	(-50	-32.6	-1.19
2090	-11.64	-5.12	-.41	(-50	(-50	-.96

1986 ASSUMED EMISSION LEVELS IN 10**6 kg

CFC-11	CFC-12	CFC-22	CFC-113	CC14	CH3CC13	1211	1301
343.4	504.5	117.6	166.5	80.5	564.8	4.5	4.5

SCENARIO DESCRIPTIONS:

CO2 - NAS 50th percentile
CH4 - linear growth @ 0.017 ppm annually (about 1%).
N2O - 0.2% compounded annual growth

80%/20%

80% of 1986 emissions of all halogen-containing species constant at assumed 1986 emission levels.

20% of 1986 emissions assumed to grow at 3 or 5 % per year compounded until 2000.

A - 20% of 1986 emissions of all halogen-containing species continue to compound at 3 or 5 % annually after 2000.

B - One half of the 20 % fraction of compounding 1986 emissions are frozen after 2000 at their 2000 emission level, the other half continues to compound at 3 or 5 % annually.

C - The 20 % fraction of 1986 emissions allowed to compound until 2000 are frozen at the 2000 emission level.

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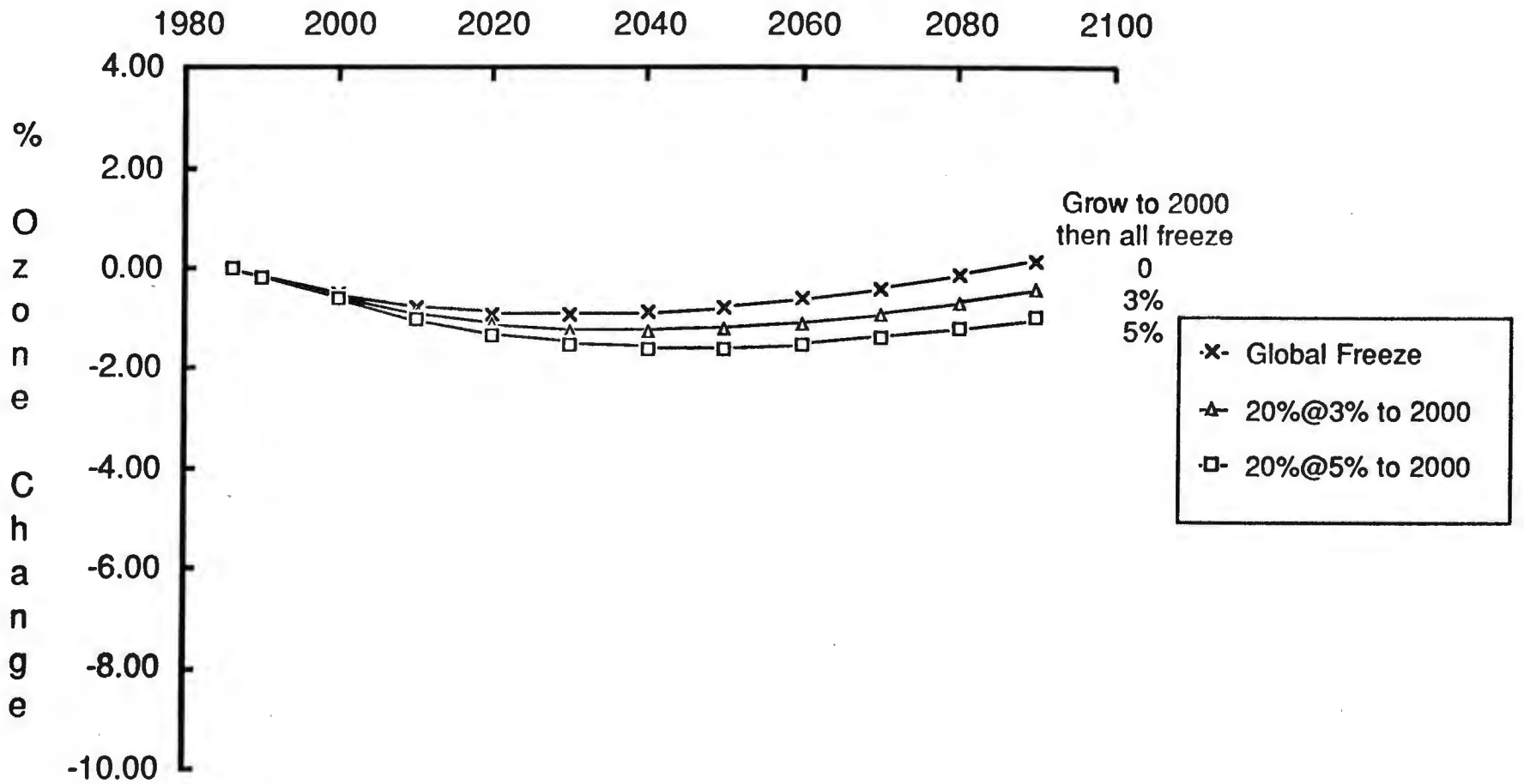
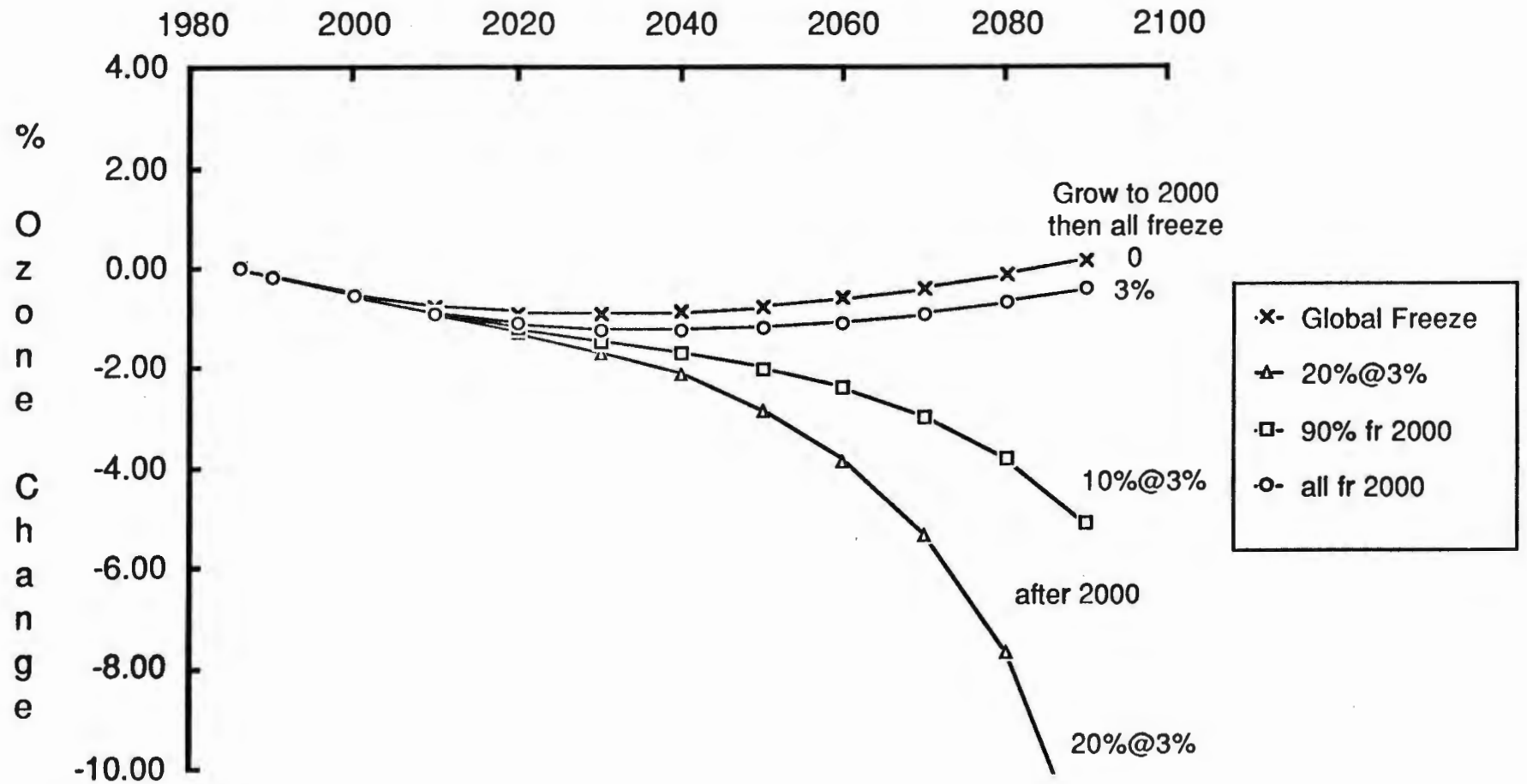
Effects of CFC Reductions



Growing 20% comply in 2000

JUNE 4

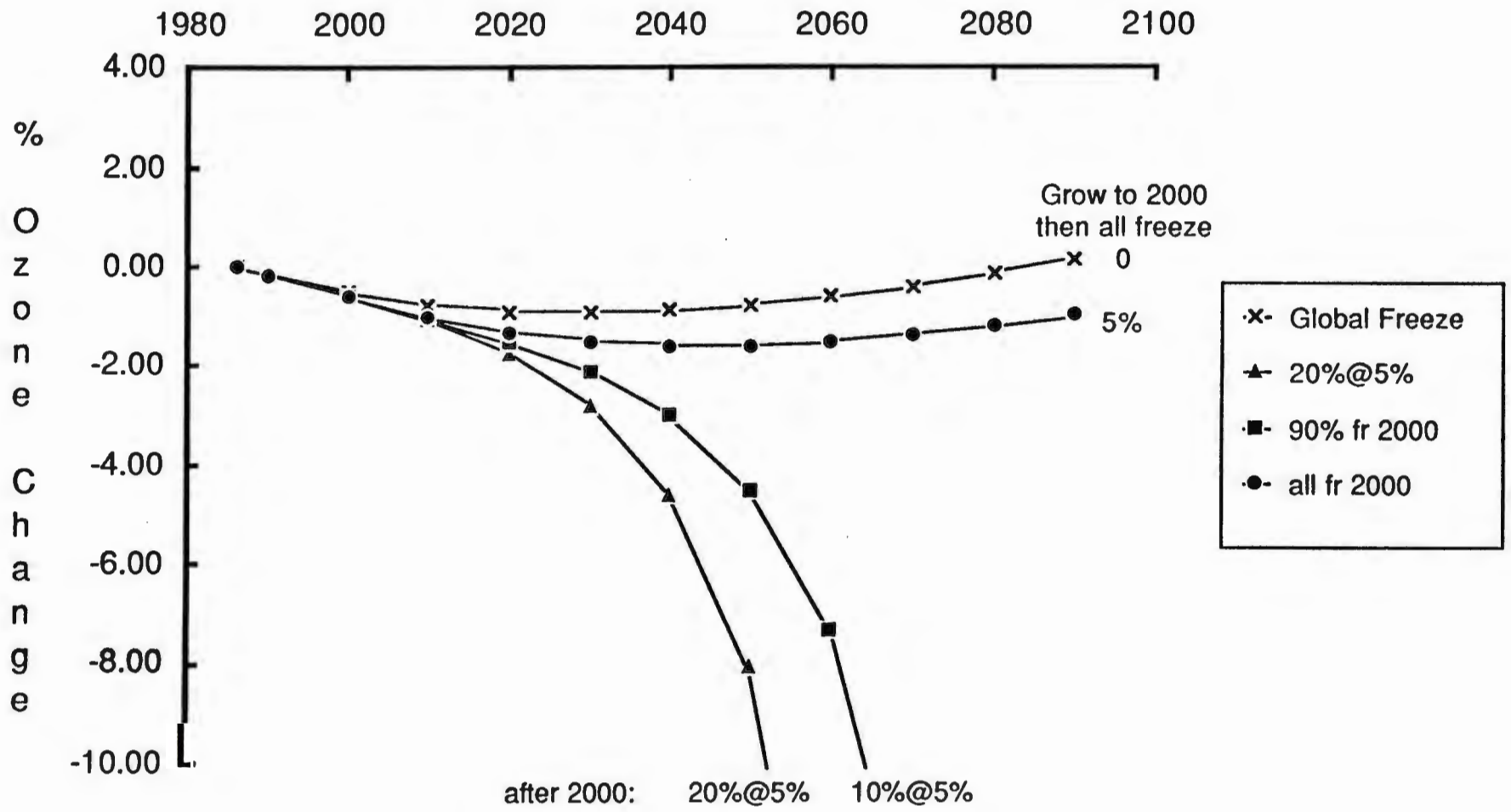
Effects of CFC Reductions



Growing 20% comply in 2000: 0, 1/2, all

JUNE 4

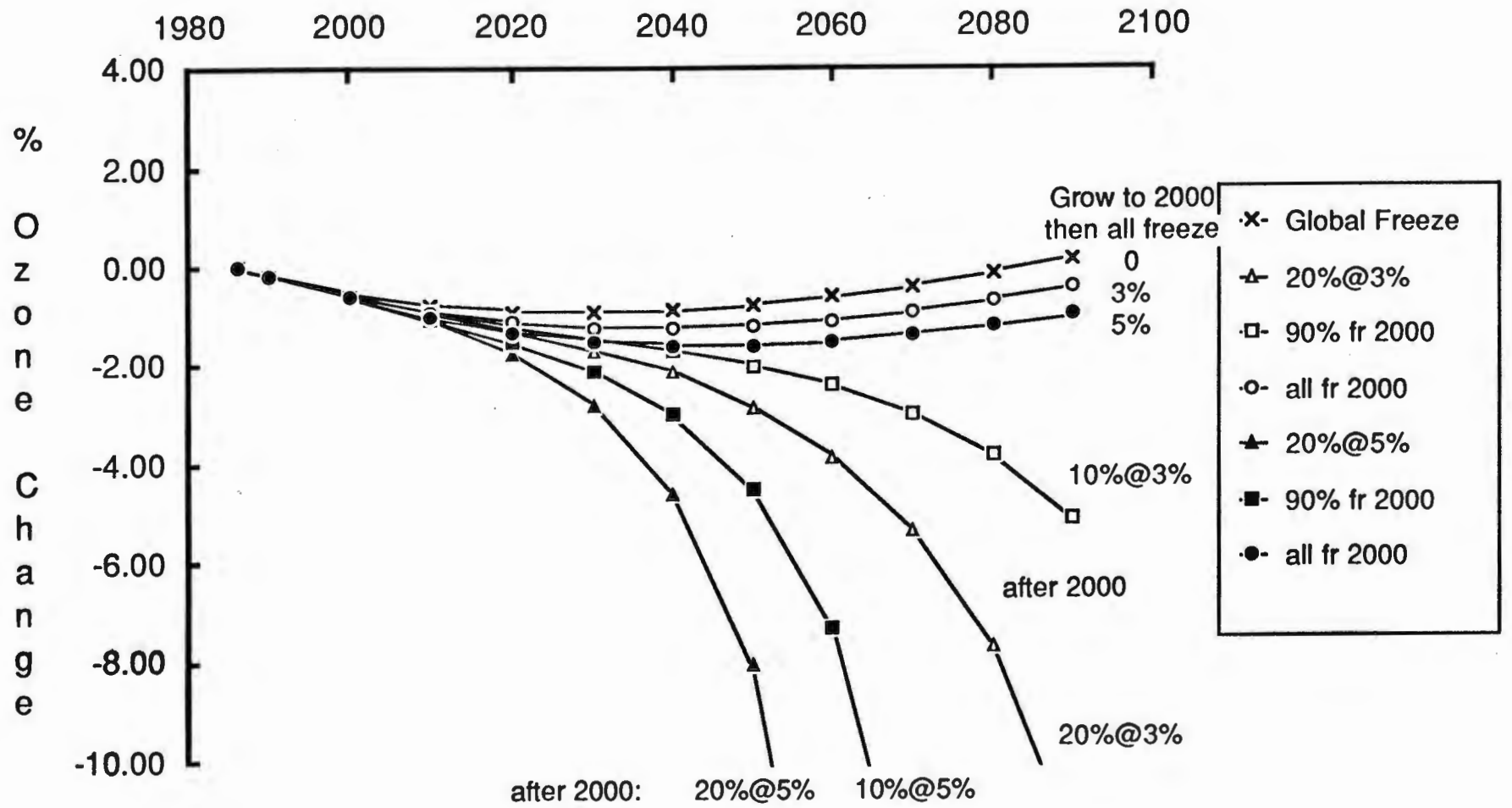
Effects of CFC Reductions



Growing 20% comply in 2000: 0, 1/2, all

JUNE 4

Effects of CFC Reductions



Growing 20% comply in 2000: 0, 1/2, all

JUNE 4