**Collection:** Masterman, Vicki: Files
**Folder Title:** Stratospheric Ozone IV (6 of 8)
**Box:** 2

objective of the field measurements program is to provide a description of the composition and structure of the atmosphere which can be used as a test of the theoretical models. These field and satellite programs will overcome our greatest shortcoming which is that we are presently data limited. The most important recent development in our knowledge of the chemical composition and structure of the stratosphere has been the analysis validation and release of data obtained by instruments flown on the Nimbus 7 (the Limb Infrared Monitor of the Stratosphere (LIMS), the Stratospheric and Mesospheric Sounder (SAMS), and the Solar Backscatter Ultraviolet/Total Ozone Monitoring System (SBUV/TOMS)), Applications Explorer II (AEM-2) (the Stratospheric Aerosol and Gas Experiment (SAGE), and Solar Mesospheric Explorer (SME) (visible and infrared spectrometers) satellites, and on the Space shuttle (the high resolution ATMOS infrared interferometer). This data is currently undergoing further intensive interpretation.

(2) Laboratory Studies:

Laboratory measurements are carried out to provide the basic input data for the theoretical models. These data consist primarily of chemical kinetics rate constants and photochemical cross-sections. In addition, spectroscopic data of atmospheric constituents are acquired for the interpretation of atmospheric measurements. Development of calibration standards is also a vital aspect of this program.

(3) Theoretical Studies and Data Analysis:

The two principal activities in this area of the program are the development of a hierarchy of models to describe the chemical, radiative, and dynamical processes which control the chemical composition and physical structure of the present atmosphere and to predict possible future changes, and the analysis and interpretation of large satellite data sets and other major field measurement campaigns.

Some specific thrusts in the near term include:

(1) A vigorous effort to understand the processes responsible for the recent decrease in the ozone column above the Antarctic in springtime. This effort is strongly supported by the NSF Polar program, NOAA, and by the CMA. A campaign of ground-based field measurements, in conjunction with satellite observations, was carried out last year. Analysis of the data is currently underway. An aircraft and ground-based field measurement campaign for August 1987 is being planned. NASA is planning to base two aircraft, an ER-2 with an altitude ceiling of 21 kilometers and a DC-8 with an altitude of 13 kilometers, containing approximately 16 state-of-the-art in situ and remote sensing instruments at Punta Arenas, Chile for a six week period starting about the third week of August.

(2) The final design and initial implementation of "A Network for the Detection of Stratospheric Change." This network is being designed to provide the earliest possible detection of changes in the chemical composition and physical structure of the stratosphere, and the means to understand them. Successful implementation of this system will require cooperation and coordination at both the national and international level. Discussions on the implementation of this system are currently in progress. This program has been endorsed by the UNEP scientific panel engaged in negotiation of a protocol to regulate chlorofluorocarbons.

(3) The Upper Atmospheric Research Satellite (UARS), for which the launch date is uncertain due to Challenger manifest changes but is currently scheduled for 1991, will provide the first simultaneous measurements of the atmospheric distributions of oxygen, hydrogen, nitrogen, and chlorine species, coupled with measurements of temperature, dynamical quantities such as winds, and energy inputs and losses. These measurements will allow us to study the coupling between the chemical, radiative, and dynamical processes which control the chemical composition and structure of the stratosphere, and, in particular, the amount and distribution of ozone, in a manner never before possible, the mechanisms responsible for atmospheric variability, and the response of the stratosphere to changes in external factors such as solar activity and natural phenomena such as volcanic eruptions.

(4) Atmospheric concentration measurements and flux measurements of biogenic gases predicted to control atmospheric ozone from representative ecosystems in order to understand past and future trends in the composition of the atmosphere. Particular emphasis is in methane, which also plays an important role as a greenhouse gas.

(5) The continued development of theoretical models which can simulate the coupling between the chemical, radiative, and dynamical processes that control the chemical composition and structure of the atmosphere.

These research activities are ongoing, multiyear efforts aimed at reducing some of the current uncertainties in our scientific understanding of these issues. We expect that progress in most areas will be steady and that many of the key uncertainties should be significantly reduced within a decade. We expects very significant progress on the issue of Antarctic ozone within a few years, but understanding the coupling between the chemical, radiative, and dynamical processes that control the chemical composition and structure of the atmosphere will require the UARS data before much more progress is made. If the "Network for the Detection of Change" is implemented, then significant progress on detecting and understanding the causes of changes in stratospheric composition should be expected within a decade. But a fuller understanding of the factors which control atmospheric ozone will require a new initiative in the Earth sciences because the ozone issue is not simply a problem of understanding the atmosphere, but requires an intimate knowledge of the oceans and land.

In describing the type of research program needed to improve our scientific understanding of environmental issues that affect not only the United States but also the whole world, it is evident that the Earth is a planet characterized by change and has entered an era when the human race has achieved the ability to alter its environment on a global scale. The ozone and greenhouse warming issues are just two of the interrelated environmental issues we face today.

To gain a scientific understanding of how human activities will affect the Earth's environment requires a new approach to Earth sciences. The scientific community believes that we need to obtain a scientific understanding of the entire earth system on a global scale by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to change on all time scales. In particular, the immediate challenge is to develop the capability to predict those changes that will occur in the next decade to century, both naturally and in response to human activity. This will require a nationally and internationally coordinated program of interdisciplinary research to investigate long-term, (10-100 years), coupled physical, chemical, and biological changes in the Earth's environment recognizing that land, atmospheric, oceanic, and biospheric processes are strongly coupled on a variety of temporal and spatial scales. Such a research program is absolutely necessary for informed policy decisions.

The National Academy of Sciences/National Research Council (NAS/NRC) and the International Council of Scientific Unions (ICSU) are currently formulating such a research program. Their programs are known as the Global Change or the International Geosphere Biosphere Program (IGBP). This program would build upon the many excellent ongoing national and international research programs in Earth sciences and would not duplicate or replace them. In parallel, NASA has worked with other agencies to develop an Earth System Science program whose goals and objectives are totally consistent with these proposed programs. NASA is ready to cooperate fully in the detailed scientific planning of such a program in conjunction with the scientific community through the NAS/NRC and ICSU, and implementing the U.S. component of this program with the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the Department of Energy (DOE), and other government agencies. The Earth System Sciences Committee (ESSC), which was established in 1983 by the Advisory Council of NASA, has provided NASA with a clear definition of its specific role in Earth System Sciences. The centerpiece of the NASA contribution is the Earth Observing Satellite (EOS) mission. EOS will provide the global observations required to understand the long-term depletion of ozone by flying remote sensing instruments on the Space Station Polar Platforms.

In summary, given what we know about the ozone and trace gas-chemistry-climate problem we should recognize that we are conducting a global scale experiment on the Earth's atmosphere without a full understanding of the consequences.

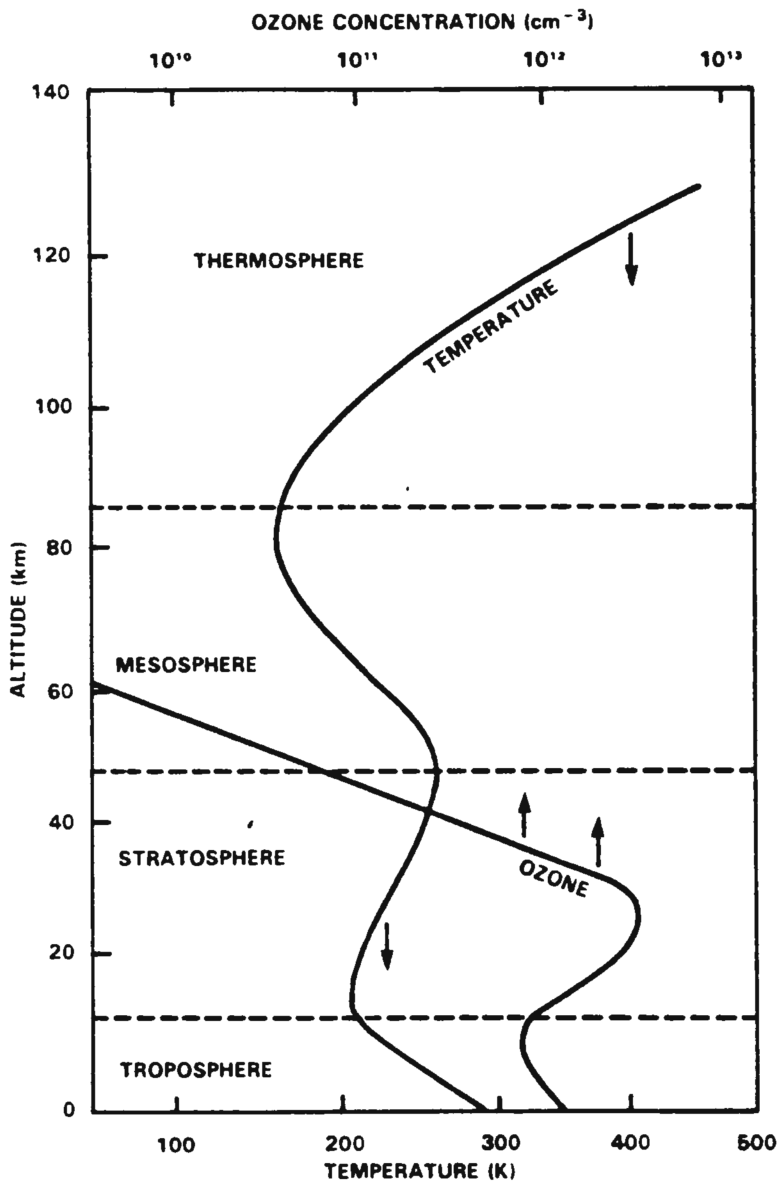
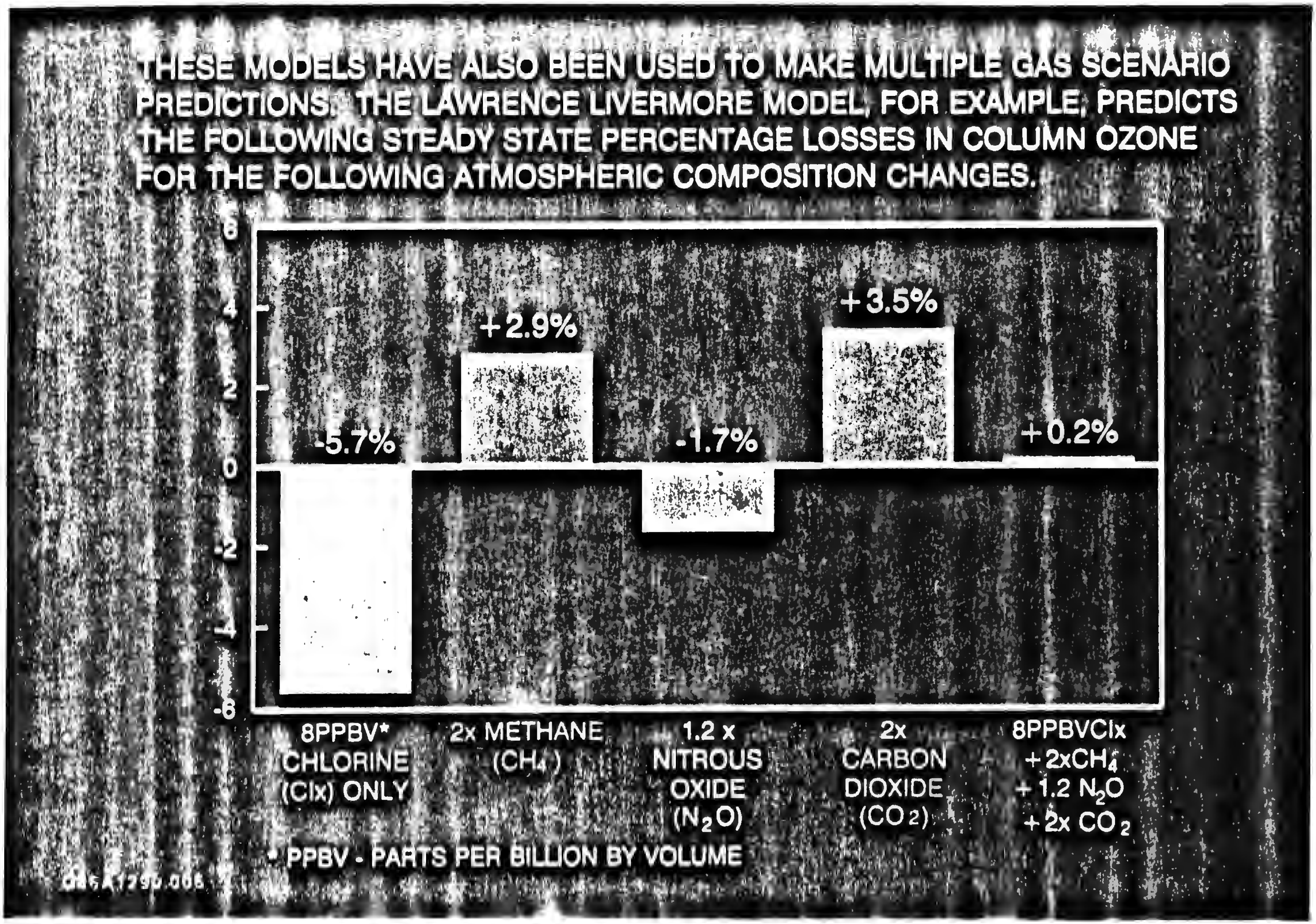



Figure 1. Temperature profile and ozone distribution in the atmosphere.


THESE MODELS HAVE ALSO BEEN USED TO MAKE MULTIPLE GAS SCENARIO PREDICTIONS. THE LAWRENCE LIVERMORE MODEL, FOR EXAMPLE, PREDICTS THE FOLLOWING STEADY STATE PERCENTAGE LOSSES IN COLUMN OZONE FOR THE FOLLOWING ATMOSPHERIC COMPOSITION CHANGES.
6
4
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+3.5%
+0.2%
8PPBV* CHLORINE (Clx) ONLY
2x METHANE ($CH_4$)
1.2 x NITROUS OXIDE ($N_2O$)
2x CARBON DIOXIDE ($CO_2$)
8PPBVClx + $2xCH_4$ + 1.2 $N_2O$ + 2x $CO_2$
* PPBV - PARTS PER BILLION BY VOLUME

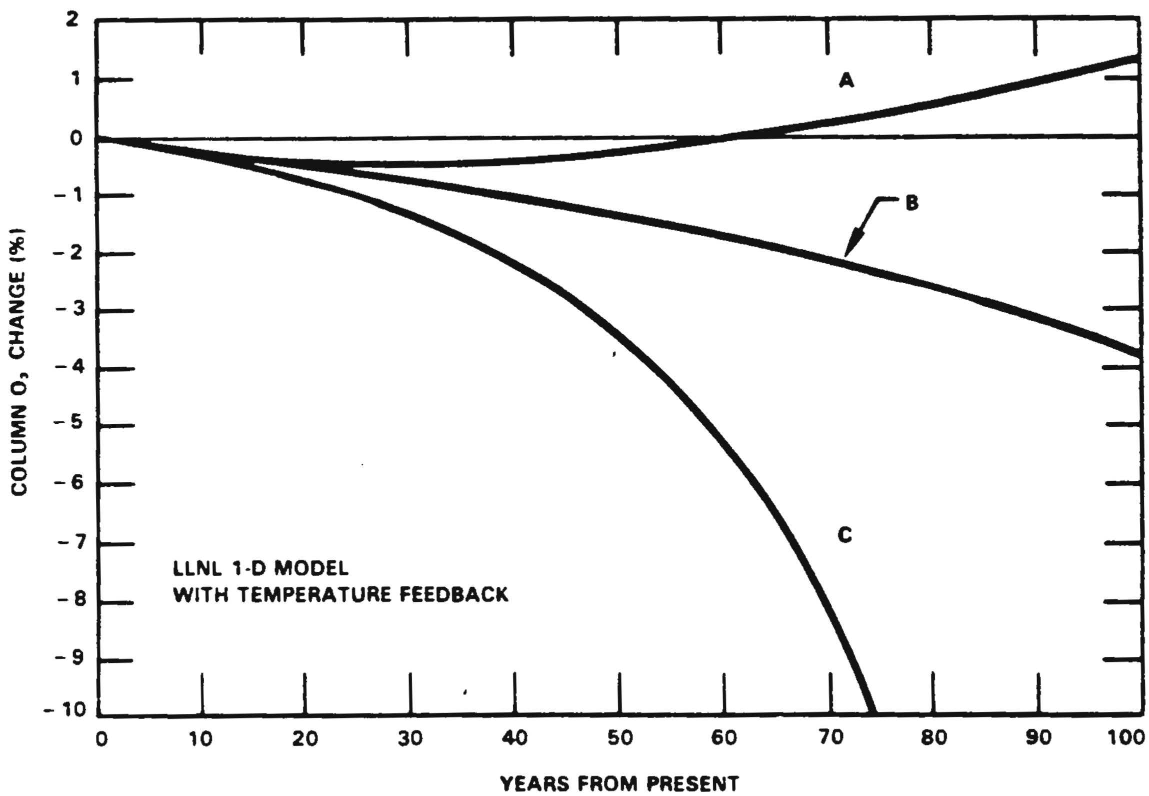


Figure 3. Calculated changes in ozone column with time for time-dependent scenarios: A (CFC flux continues at 1980 level, $CH_4$ increased 1% per yr, $N_2O$ increases 0.25% per yr, and $CO_2$ increases according to the DOE scenario); B (CFC emissions begin at 1980 rates and increase at 1.5% per yr, other trace gases change as with A); C (same as B except CFC emissions increase at 3% per yr).

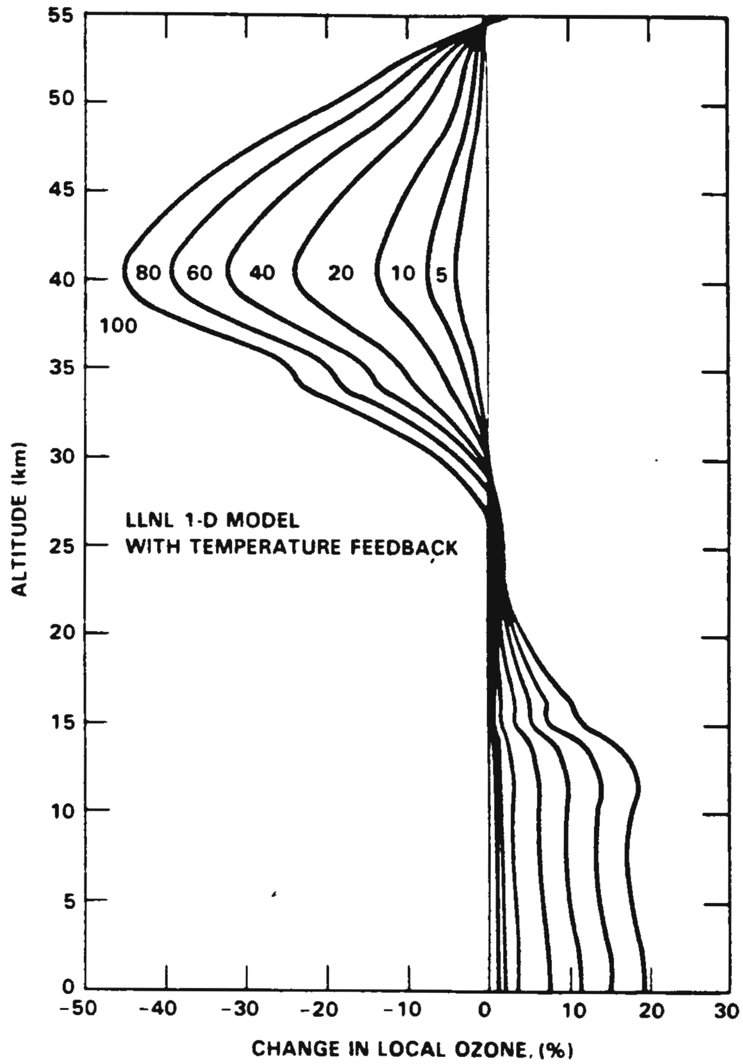


Figure 4. Calculated percentage change in local ozone at selected times (5 to 100 years) for scenario B of Figure 3.

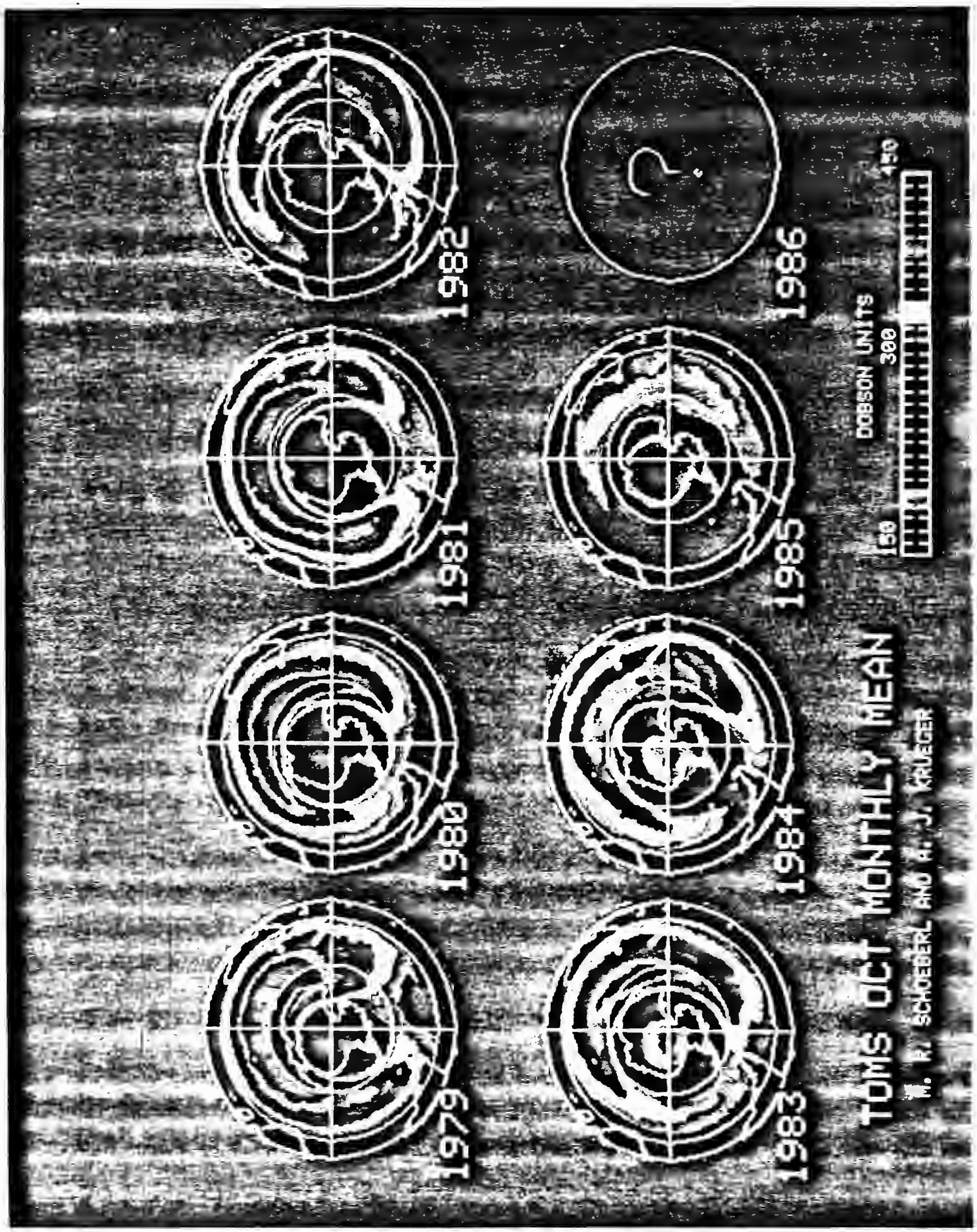
TOMS OCT MONTHLY MEAN
M. R. SCHOEBERL AND A. J. KRUEGER
1979
1980
1981
1982
1983
1984
1985
1986
DOBSON UNITS
150
300
450

Figure 5

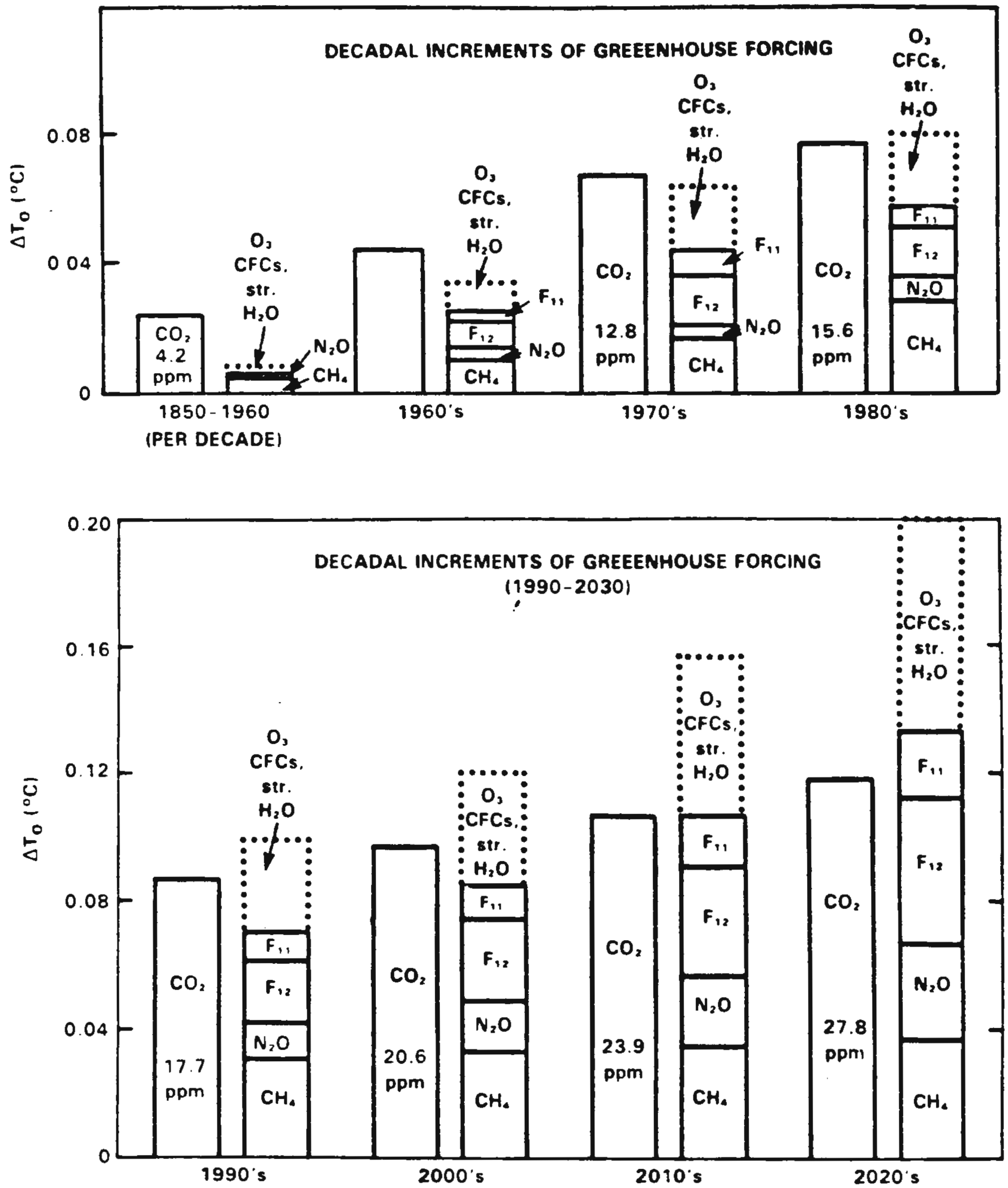


**Figure 6.** Decadal additions to global mean greenhouse forcing of the climate system. $(\Delta T_s)_0$ is the computed temperature change at equilibrium ($t \rightarrow \infty$) for the estimated decadal increases in trace gas abundances, with no climate feedbacks included.

DRAFT 1
3/7/87

**Statement of**
**Richard Elliot Benedick,**
**Deputy Assistant Secretary of State**
**for**
**Health, Environment and Natural Resources**
**to the**
**Subcommittee on Natural Resources,**
**Agriculture Research, and Environment**
**Committee on Science and Technology**
**U.S. House of Representatives**

**March 12, 1987**

The United States, along with other nations of the world, is engaged in an historic effort to undertake cooperative measures to prevent potentially serious adverse effects from depletion of stratospheric ozone. The Vienna Convention for the Protection of the Ozone Layer, signed in March 1985 under the auspices of the United Nations Environment Program (UNEP) and ratified by the United States in August 1986, was an important first step. But additional concrete measures are necessary. We are now engaged in negotiations under UNEP auspices on a protocol to the Convention which would provide for controls on ozone-depleting chemicals.

EPA is the agency with responsibility under the Clean Air Act for domestic regulation of ozone-depleting substances. We are working closely with EPA to keep our domestic and international efforts congruent. We and EPA have consulted closely with other agencies and with representatives of U.S. industry and environmental groups as the domestic and international processes develop.

## Laying the Foundation of Common Understanding of the Issue

Between the adoption of the Convention in Vienna in March 1985 and the resumption of negotiations on control measures in December 1986, the international community participated in a unique cooperative effort to improve common understanding of the nature and impacts of the ozone depletion issue. The United States Government played a leading role in that process.

-- A two-part UNEP workshop, in Rome in May 1986 and in Leesburg, Virginia in September 1986, focused on key economic issues related to the control of ozone-depleting chemicals.

-- In June 1986, the U.S. co-sponsored with UNEP an international conference with over 300 participants on the effects of both ozone depletion and climate change.

-- The Coordinating Committee on the Ozone Layer (CCOL), a UNEP body a comprising scientists from many interested nations, assessed current knowledge of the atmospheric science and effects of ozone depletion, and presented their findings to UNEP for consideration in the development of measures to protect the ozone layer. Scientists and policymakers from EPA and NASA played a leading role.

-- 150 scientists, coordinated by Dr. Robert Watson of NASA, prepared a landmark publication on the state of knowledge about atmospheric ozone, under the auspices of NASA, the World Meteorological Organization (WMO), UNEP, the European Communities, NOAA, FAA and the German Federal Ministry for Research and Technology.

At the same time, U.S. government representatives were working bilaterally with various governments to improve understanding of the nature of the problem and the options for reducing risks.

-- EPA, NASA and NOAA worked with scientists in key nations to increase understanding of the risks if depletion should occur and to advance scientific assessment and monitoring capabilities.

-- We discussed the issue with policymakers in key countries. For example, I traveled, with a team from EPA, to Brussels and Bonn last November for consultations in preparation for the December negotiations.

As this extensive bilateral and multilateral effort moved forward, we saw that consensus was emerging, both in the United States and in the international community, in a number of important areas:

-- The ozone layer is an exceedingly valuable resource for the present and future population of the world.

-- The ozone layer is likely to be adversely affected by the long-lived chlorine molecules which stem from chlorofluorocarbons.

-- If ozone depletion occurs, the increase in harmful ultra-violet radiation reaching the earth could pose significant, even if currently difficult to quantify, risks.

-- While many scientific questions remain to be answered, the risks are sufficiently serious as to warrant control actions.

-- The very nature of the ozone layer requires global cooperation if protective measures are to be effective.

The U.S. Position

The United States Government believes that the potential risks to the stratospheric ozone layer require early and concerted action by the international community. We seek agreement on the following:

o A near-term freeze at current emission levels of CFC 11, 12, 113, and 114, and Halons 1211 and 1301;

o A longer-term scheduled reduction of up to 95% in emissions of these chemicals; linked to

o Periodic reassessment based on a regular review of the science and of economic and technical considerations.

No specific time frames and no specific percentage reductions have been determined for the scheduled reductions as of the present time; studies of environmental and economic implications of various options are under way, however, to provide the basis for a U.S. position on these elements of a protocol.

We believe a protocol should:

-- provide as much certainty as possible for industrial planning in order to minimize the costs of adjustment;

-- provide adequate time for shifting away from ozone-depleting chemicals to avoid social and economic disruption, while at the same time give a strong incentive for the rapid development and employment of safer substitutes and recycling techniques;

-- address all the principal man-made sources of long-lived atmospheric chlorine and bromine;

-- allow flexibility for national implementation by allowing trade-offs among controlled chemicals based on their relative ozone-depleting effects;

-- take into full consideration scientific uncertainties and promote future improvements in understanding by instituting a requirement for periodic reassessment of the goal and timing of limits;

-- create incentives to participate in the protocol by regulating relevant trade between parties and non-parties.

Geneva, December 1986 and Vienna, February 1987

We have come a long way since March 1985 in Vienna, when many nations questioned the need for control measures. In the first round of resumed negotiations last December, representatives from all regions agreed that new measures must be taken in the near term to control emissions of ozone-depleting chemicals. However, the discussions were general, and substantial differences over the scope, stringency and time-phasing of control measures remained.

Among other participants at Geneva in December, Canada and the Nordic countries advocated strong, early action. The European Communities (EC), Japan and the USSR acknowledged the need for controls, but did not yet support the long-term measures, broad coverage, and trade provisions we believe are necessary to make the protocol effective.

Between the December and February rounds, we consulted actively with a number of nations, through discussions with environmental, foreign ministry, and trade officials in Washington and abroad, through our Embassies, official visits, and scientific exchanges. For example, a team from NASA, NOAA and EPA traveled to Moscow. We met in Washington with Canadian representatives. I traveled to Europe again. Deputy U.S. Trade Representative Smith and Assistant Secretaries of State McMinn and Negroponte raised the issue with senior officials in Tokyo. Through the USIA "Worldnet" interactive satellite hookup, Dr. Robert Watson of NASA and I discussed the issue with experts, policymakers and journalists in ten European capitals.

The February round of negotiations in Vienna brought widening agreement on many aspects of a protocol, including a near-term freeze and longer-term reductions. Other elements of progress in Vienna include:

(1) formulation of a useful "Chairman's text" for the critical control Article II;

(2) movement toward agreement on ranking substances according to their ozone-depleting potential;

(3) good progress on restrictions on trade with non-parties;

(4) an "enhanced" commitment to international cooperation on (i) research, (ii) systematic observation, and (iii) international scientific assessments; new.

(5) clear evidence of movement, although not yet unanimous, within the EC;

(6) setting of a date for the Diplomatic Conference (September 14-18 in Montreal).

Trade Measures

We seek a protocol which would protect the stratosphere but avoid giving unfair advantage to industries of countries which do not participate in the protocol. In Vienna, the sub-group on trade accepted with only minor changes U.S.-proposed language which would, *inter alia*, ban bulk imports from non-parties of controlled chemicals and ban or restrict imports from non-parties of products containing these chemicals. Progress on this issue was particularly welcome, since in December many key participants in the negotiations were resistant to discussion of trade measures, largely because they had not yet seriously addressed the issue. Now there is recognition that trade measures such as the U.S. proposed are necessary in order to (a) protect industries in countries party to the protocol from being put at a competitive disadvantage vis-a-vis industries of non-parties; (b) create an incentive for broad participation; and (c) discourage the movement of production facilities to non-parties.

Looking Ahead

All the movement is in the right direction. But the hardest negotiations are still to come. For example, the participants must still negotiate the specific stringency and timing of controls, determine precisely which substances are to be restricted, and specify treatment of developing countries, non-parties and late-signers.

The next round of negotiations is scheduled for April 27-30 in Vienna, with an informal meeting in Oslo April 8-9 to consider the chairman's text. The United States will continue to pursue the objectives I have outlined. We will continue to consult actively with other nations and with interested sectors in the United States.

This is a difficult and complex negotiating process. We have made substantial progress, but we have a long way to go to reach an effective agreement with broad participation. Meanwhile, we must be sure that our actions domestically support and do not undercut that international process, since this is clearly a matter which the U.S. cannot resolve alone. We have entered a new era of truly global environmental management, in which we are all made more conscious of the unity and vulnerability of our planet.

3/7/87 3199T

TO: Holly Fitter
395-6194

FM: Alee Ann Hardershell
647-4463

For clearance

("Chairman's draft")

26 February 1987

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)

Second Session
Vienna, 23-27 February 1987

## ARTICLE II - Control Measures

1. Each party, under jurisdiction of which substances referred to in Annex A are produced, shall ensure that within [one to three] years after the entry into force of this protocol the [annual production and imports] [adjusted annual production] of these substances does [do] not exceed their [its] 1986 level.

2. Each party, under the jurisdiction of which substances referred to in Annex A are not produced at the time of the entry into force of this Protocol, shall ensure that within [one to three] years hereinafter [its annual production and imports] [its adjusted annual production] do [does] not exceed the level of imports in 1986.

3. Each party shall ensure, that within [blank] years after the entry into force of this protocol, levels attained in accordance with paragraphs 1 and 2 will be reduced by [10 to 50] percent, [unless the parties by a two-thirds majority otherwise decide] [if the parties confirm this obligation by a two-thirds majority].

Option A

4. Parties shall decide not later than [blank] years after the entry into force of this protocol by a two-thirds majority on

- new substances to be included in Annex A
- further reduction of 1986 levels.

These decisions shall be reviewed in intervals of [blank] years.

Option B

4. Each party shall ensure that, within [blank] years after the entry into force of this protocol, levels attained in accordance with paragraph 3 will be reduced by [blank] [unless parties by a two-thirds majority otherwise decide] [if parties confirm this obligation by a two-thirds majority].

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR - 9 1987

OFFICE OF
EXTERNAL AFFAIRS

MEMORANDUM

SUBJECT: Draft testimony for Rep. Scheuer's March 12 hearing on CFCs/Ozone Depletion

FROM: Steadman M. Overman
Director
Office of Legislative Analysis

Stead

TO: Ronald Peterson
Legislative Reference Division
Office of Management and Budget
ATTN: Holly Fitter

David Gibbons
Environmental Review Branch
Office of Management and Budget
ATTN: Barbara Gittleman

Attached is draft testimony prepared for Rep. Scheuer's March 12 hearing on stratospheric ozone depletion. This statement consists of material drawn from Craig Potter's 1/28 statement and the Administrator's 3/9 statement. These statements have been cleared by your offices. Please provide your comments and clearance to Christopher Hoff (382-5422) of this office. Thank you.

Attachment

DRAFT

MAR - 9 1987

TESTIMONY OF
J. CRAIG POTTER
ASSISTANT ADMINISTRATOR FOR AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

MARCH 12, 1987

Good morning, Mr. Chairman and members of the Subcommittee. I am pleased to have the opportunity to discuss the current state of our knowledge of the changes in earth's atmosphere, the possible health and environmental implications of these changes and what we at EPA are doing to address these issues both within the United States and in our international negotiations. Our direction from the Administrator has been to place these issues among the Agency's highest priorities, and we are moving forward to understand and respond to these concerns.

Pollution that directly affects land, water, and the air we breathe has been the Environmental Protection Agency's traditional focus. However, the environmental significance of changes now occurring in the composition of the earth's atmosphere as a result of human activities presents a new and demanding challenge, and requires that all nations consider the effect of their actions on the atmosphere.

Obviously, our atmosphere plays a fundamental role in shaping and protecting our planet's environment. Sustaining its viability is of paramount importance to all nations, and true global cooperation is necessary if we are to ensure its protection. For it is possible that a shift in the atmosphere's chemical and physical balance could lead to significant environmental and health concerns, particularly with respect to depletion of the stratospheric ozone layer. Here our concern rests upon a growing body of scientific evidence indicating that continued use of chlorofluorocarbons (CFCs) and other ozone-reactive substances could result in reducing the effectiveness of the atmosphere's outer protective ozone shield. We are certain that if enough chlorine and other halogens are put in the atmosphere, the stratospheric ozone layer will begin to be depleted. Currently, science also tells us that the effect of a diminution in the stratospheric ozone layer would be to allow more damaging ultraviolet-B (UV-B) radiation to penetrate to the earth's surface causing increases in the number of skin cancers, suppression of the immune system, and possible damage to crops and aquatic organisms.

The exact magnitude of these impacts is difficult to quantify and largely depends on the rate of growth of emissions of CFCs and other gases. For example, it is estimated that the number of skin cancers could actually decrease if CFCs were phased out on a global basis and other gases continued to grow. Alternatively, if CFCs and other ozone depleting gases continue to grow at the rates experienced over the past few years, the numbers of skin cancer cases could increase significantly.

Despite our sense that serious environmental risks exist, many scientific questions remain to be answered. These uncertainties are dramatically illustrated by the recent observations concerning the seasonal loss of stratospheric ozone over Antarctica. While we know that substantial losses (as much as 50 percent) have occurred there during the September - November months over the past decade, two important questions remain unanswered.

First, are man-made emissions (CFCs and possibly bromine) responsible for these seasonal losses of ozone?

Second, is this occurrence unique to this region or is it an early indication of what could occur globally?

Recently, the National Ozone Expedition, which is being discussed at these hearings, has begun to address these questions. While extremely useful clues to the cause of this phenomenon were produced, no definitive answer is yet possible.

While the debate over the possible causes of the ozone hole continues, we do not believe we know enough about this phenomenon to know whether it would influence our domestic regulatory action. We will closely monitor developing scientific research on this issue. If evidence suggests that the ozone hole is due to chlorine and possibly bromine, and is not unique to Antarctica then we must, of course, reevaluate our current policies to reflect this added basis for concern.

As we assess these problems, it is important to keep in mind the need to distinguish between the scientific process of risk assessment and risk management. Risk assessment looks specifically and exclusively at the scientific and technical evidence in order to determine the health and environmental risks associated with depletion of the stratospheric ozone layer. Risk assessment will have a particularly important role in evaluating the uncertainties associated with this issue.

Risk management, on the other hand, takes this risk assessment information as its starting point and determines which options are available to address the problem. Any course of action which the United States ultimately chooses must take into consideration the full spectrum of associated economic and social impacts, and must also recognize both the national and international aspects of the issue. Through the risk management process, and pursuant to our mandate under the Clean Air Act, we will make a determination of whether our nation needs to take additional specific actions to control risks related to stratospheric ozone depletion. EPA will make this decision publicly, with ample opportunity for comment by all interested parties.

We feel our risk assessment efforts in this area have led to a greater understanding of the problem of stratospheric ozone depletion and its implications. Decreases in total column ozone would increase the penetration of biologically damaging ultraviolet-B radiation reaching the earth's surface. Exposure to UV-B radiation has been linked by laboratory studies and epidemiology to squamous and basal skin cancers. While uncertainty exists concerning the appropriate action spectrum and measure of exposure, a range of estimates was developed linking possible future ozone depletion with increased incidence of nonmelanoma skin cancers.

The relationship between cutaneous malignant melanoma and UV-B radiation is a complex one. However, recent studies, some of which are financially supported by the Agency, suggest that UV-B radiation plays an important role in causing melanoma. Studies have also demonstrated that UV-B radiation can suppress the immune response system in animals and possibly humans. While UV-B induced immune suppression has been linked to herpes virus infections and leishmaniasis, its possible impact on other diseases has not been studied.

To support our risk assessment efforts, we have a continuing research program to assess the environmental effects of UV-B. About 140 varieties of crop plants have been examined and some two-thirds exhibit some level of sensitivity to increased UV-B radiation. Some of the crops are important human food sources and our work is not completed in this area.

Our aquatic research, mainly with marine environments, has shown marine organisms, especially plankton and larval forms, to be sensitive to increased UV-B; so sensitive that the species composition may be altered by this radiation. The ramifications of these responses on larger fish, which are the top of the food chain, are still being examined.

Modest research and modeling efforts are examining the role of increased UV-B radiation on other air pollutants in the troposphere to determine if they may enhance pollutant formation.

While work still needs to be done to quantify some of our research results, the research evidence clearly shows that increasing levels of UV-B are damaging to humans and many important plant and animal life forms both on land and in the sea.

Given these concerns, we have greatly expanded our efforts to better understand the risks and uncertainties associated with ozone depletion, and have factored our current understanding into our risk management activities.

In January of 1986, we announced our stratospheric ozone protection plan, which sets forth a comprehensive agenda for dealing with both domestic and international aspects of this issue. This plan also formed the basis for settlement of a lawsuit filed by the Natural Resources Defense Council (NRDC) seeking to compel us to make a decision on the need for further domestic regulation.

I would now like to briefly describe the United States' recent international efforts on this issue. As I mentioned earlier, the global aspects of this problem make it paramount that any true solution involve the other CFC-producing and consuming nations. As a result, we have initiated a series of activities aimed at educating and encouraging other governments to support measures to reduce CFC use. Key activities include:

-- U.S. leadership in negotiating and ratifying the Vienna Convention for the Protection of the Ozone Layer, which provides a framework for international cooperation on research, monitoring, and information exchange, and procedures for developing control protocol as needed;

-- U.S. leadership in a two-part workshop organized by the United Nations Environment Programme (UNEP) which focused on key economic issues related to control of CFCs;

-- U.S. co-sponsorship with UNEP of an international conference on the effects of both ozone depletion and climate change.

This series of meetings -- all during the past 12 months -- provided the analytical basis for assessing the nature of the problem and the options for reducing global risks. But our efforts have gone well beyond sponsorship of meetings.

For example --

-- Lee Thomas sent letters to his counterparts in over 100 nations advising them that this issue was a very high priority and requesting their active participation in the UNEP negotiations.

-- We have also sent teams of scientists to key nations as part of our effort to increase understanding of risks if depletion should occur. Scientific teams from NASA, NOAA, EPA, and the State Department were in Europe and Moscow expressly to continue this dialogue during the month of February. And other trips, including one to Japan and Korea, are planned for this Spring.

-- We have, and will continue to participate actively in UNEP negotiations on a protocol to the Ozone Layer Convention.

Domestically, we are also moving forward rapidly. While we hope that we will be able to reach a satisfactory international resolution of this issue in the near-term, we recognize that we face an obligation under the Clean Air Act to assess the need for further domestic regulation here in the U.S.

As part of our regulatory process, we are developing options and analytic support for a proposed decision on further domestic CFC controls. As part of that process we have made extensive efforts to involve all interested parties.

During the past year we held four public meetings to discuss various aspects of this issue and most recently organized a facilitated workshop specifically on domestic regulatory options. We have also initiated joint projects with industry related to both the production and use of benign chemical substitutes for ozone-depleting CFCs, and are planning a CFC Control Technology Fair. We expect to continue to interact with industry and non-governmental organizations over the coming months on key topics including trade and economic-based regulatory approaches.

At the same time, we are preparing our regulatory impact analysis, which will examine such issues as the scope, timing, and stringency of various control options. We are also examining the trade and economic implications of these options. Because CFCs have often replaced more toxic chemicals, we intend to closely examine the health and safety implications of limiting their use. Included among the options being considered are economic-based regulatory approaches (such as fees and permits) and the more traditional emission standards and design and operational requirements.

In summary, I believe that the activities I have just described are important first steps toward expeditiously and aggressively moving forward in our efforts to obtain an international agreement and to assess our domestic regulatory options.

I would be pleased to respond to any questions you may have.

UNMR 1
3/7/87

Statement of
Richard Elliot Benedick,
Deputy Assistant Secretary of State
for
Health, Environment and Natural Resources
to the
Subcommittee on Natural Resources,
Agriculture Research, and Environment
Committee on Science and Technology
U.S. House of Representatives

March 12, 1987

The United States, along with other nations of the world, is engaged in an historic effort to undertake cooperative measures to prevent potentially serious adverse effects from depletion of stratospheric ozone. The Vienna Convention for the Protection of the Ozone Layer, signed in March 1985 under the auspices of the United Nations Environment Program (UNEP) and ratified by the United States in August 1986, was an important first step. But additional concrete measures are necessary. We are now engaged in negotiations under UNEP auspices on a protocol to the Convention which would provide for controls on ozone-depleting chemicals.

EPA is the agency with responsibility under the Clean Air Act for domestic regulation of ozone-depleting substances. We are working closely with EPA to keep our domestic and international efforts congruent. We and EPA have consulted closely with other agencies and with representatives of U.S. industry and environmental groups as the domestic and international processes develop.

Laying the Foundation of Common Understanding of the Issue

Between the adoption of the Convention in Vienna in March 1985 and the resumption of negotiations on control measures in December 1986, the international community participated in a unique cooperative effort to improve common understanding of the nature and impacts of the ozone depletion issue. The United States Government played a leading role in that process.

-- A two-part UNEP workshop, in Rome in May 1986 and in Leesburg, Virginia in September 1986, focused on key economic issues related to the control of ozone-depleting chemicals.

-- In June 1986, the U.S. co-sponsored with UNEP an international conference with over 300 participants on the effects of both ozone depletion and climate change.

-- The Coordinating Committee on the Ozone Layer (CCOL), a UNEP body a comprising scientists from many interested nations, assessed current knowledge of the atmospheric science and effects of ozone depletion, and presented their findings to UNEP for consideration in the development of measures to protect the ozone layer. Scientists and policymakers from EPA and NASA played a leading role.

-- 150 scientists, coordinated by Dr. Robert Watson of NASA, prepared a landmark publication on the state of knowledge about atmospheric ozone, under the auspices of NASA, the World Meteorological Organization (WMO), UNEP, the European Communities, NOAA, FAA and the German Federal Ministry for Research and Technology.

At the same time, U.S. government representatives were working bilaterally with various governments to improve understanding of the nature of the problem and the options for reducing risks.

-- EPA, NASA and NOAA worked with scientists in key nations to increase understanding of the risks if depletion should occur and to advance scientific assessment and monitoring capabilities.

-- We discussed the issue with policymakers in key countries. For example, I traveled, with a team from EPA, to Brussels and Bonn last November for consultations in preparation for the December negotiations.

As this extensive bilateral and multilateral effort moved forward, we saw that consensus was emerging, both in the United States and in the international community, in a number of important areas:

-- The ozone layer is an exceedingly valuable resource for the present and future population of the world.

-- The ozone layer is likely to be adversely affected by the long-lived chlorine molecules which stem from chlorofluorocarbons.

-- If ozone depletion occurs, the increase in harmful ultra-violet radiation reaching the earth could pose significant, even if currently difficult to quantify, risks.

-- While many scientific questions remain to be answered, the risks are sufficiently serious as to warrant control actions.

-- The very nature of the ozone layer requires global cooperation if protective measures are to be effective.

The U.S. Position

The United States Government believes that the potential risks to the stratospheric ozone layer require early and concerted action by the international community. We seek agreement on the following:

o A near-term freeze at current emission levels of CFC 11, 12, 113, and 114, and Halons 1211 and 1301;

o A longer-term scheduled reduction of up to 95% in emissions of these chemicals; linked to

o Periodic reassessment based on a regular review of the science and of economic and technical considerations.

No specific time frames and no specific percentage reductions have been determined for the scheduled reductions as of the present time; studies of environmental and economic implications of various options are under way, however, to provide the basis for a U.S. position on these elements of a protocol.

We believe a protocol should:

-- provide as much certainty as possible for industrial planning in order to minimize the costs of adjustment;

-- provide adequate time for shifting away from ozone-depleting chemicals to avoid social and economic disruption, while at the same time give a strong incentive for the rapid development and employment of safer substitutes and recycling techniques;

-- address all the principal man-made sources of long-lived atmospheric chlorine and bromine;

-- allow flexibility for national implementation by allowing trade-offs among controlled chemicals based on their relative ozone-depleting effects;

-- take into full consideration scientific uncertainties and promote future improvements in understanding by instituting a requirement for periodic reassessment of the goal and timing of limits;

-- create incentives to participate in the protocol by regulating relevant trade between parties and non-parties.

Geneva, December 1986 and Vienna, February 1987

We have come a long way since March 1985 in Vienna, when many nations questioned the need for control measures. In the first round of resumed negotiations last December, representatives from all regions agreed that new measures must be taken in the near term to control emissions of ozone-depleting chemicals. However, the discussions were general, and substantial differences over the scope, stringency and time-phasing of control measures remained.

Among other participants at Geneva in December, Canada and the Nordic countries advocated strong, early action. The European Communities (EC), Japan and the USSR acknowledged the need for controls, but did not yet support the long-term measures, broad coverage, and trade provisions we believe are necessary to make the protocol effective.

Between the December and February rounds, we consulted actively with a number of nations, through discussions with environmental, foreign ministry, and trade officials in Washington and abroad, through our Embassies, official visits, and scientific exchanges. For example, a team from NASA, NOAA and EPA traveled to Moscow. We met in Washington with Canadian representatives. I traveled to Europe again. Deputy U.S. Trade Representative Smith and Assistant Secretaries of State McMinn and Negroponte raised the issue with senior officials in Tokyo. Through the USIA "Worldnet" interactive satellite hookup, Dr. Robert Watson of NASA and I discussed the issue with experts, policymakers and journalists in ten European capitals.

The February round of negotiations in Vienna brought widening agreement on many aspects of a protocol, including a near-term freeze and longer-term reductions. Other elements of progress in Vienna include:

(1) formulation of a useful "Chairman's text" for the critical control Article II;

(2) movement toward agreement on ranking substances according to their ozone-depleting potential;

(3) good progress on restrictions on trade with non-parties;

(4) an "enhanced" commitment to international cooperation on (i) research, (ii) systematic observation, and (iii) international scientific assessments; new

(5) clear evidence of movement, although not yet unanimous, within the EC;

(6) setting of a date for the Diplomatic Conference (September 14-18 in Montreal).

Trade Measures

We seek a protocol which would protect the stratosphere but avoid giving unfair advantage to industries of countries which do not participate in the protocol. In Vienna, the sub-group on trade accepted with only minor changes U.S.-proposed language which would, inter alia, ban bulk imports from non-parties of controlled chemicals and ban or restrict imports from non-parties of products containing these chemicals. Progress on this issue was particularly welcome, since in December many key participants in the negotiations were resistant to discussion of trade measures, largely because they had not yet seriously addressed the issue. Now there is recognition that trade measures such as the U.S. proposed are necessary in order to (a) protect industries in countries party to the protocol from being put at a competitive disadvantage vis-a-vis industries of non-parties; (b) create an incentive for broad participation; and (c) discourage the movement of production facilities to non-parties.

Looking Ahead

All the movement is in the right direction. But the hardest negotiations are still to come. For example, the participants must still negotiate the specific stringency and timing of controls, determine precisely which substances are to be restricted, and specify treatment of developing countries, non-parties and late-signers.

The next round of negotiations is scheduled for April 27-30 in Vienna, with an informal meeting in Oslo April 8-9 to consider the chairman's text. The United States will continue to pursue the objectives I have outlined. We will continue to consult actively with other nations and with interested sectors in the United States.

This is a difficult and complex negotiating process. We have made substantial progress, but we have a long way to go to reach an effective agreement with broad participation. Meanwhile, we must be sure that our actions domestically support and do not undercut that international process, since this is clearly a matter which the U.S. cannot resolve alone. We have entered a new era of truly global environmental management, in which we are all made more conscious of the unity and vulnerability of our planet.

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# ATMOSPHERIC OZONE

A Brief Summary of the State of the Science and NOAA's Efforts to Improve Scientific Understanding of the Chemistry and Dynamics of Atmospheric Ozone.

18 March 1987

## I SUMMARY

### Stratospheric ozone - global

- If the abundances of chlorine- and bromine-containing compounds continue to increase indefinitely in the stratosphere, the present understanding of their chemistry implies that substantial ozone depletion will occur eventually, particularly at high latitudes The current research is focusing on when and how much.

- The existing satellite and some of the ground-based data sets, if taken at face value, show ozone declines, some of which are consistent with the theory of human-caused losses, others that are not. The inconsistencies between parts of the data sets and the likelihood of possible instrumental artifacts have divided the atmospheric science community on the reality of human-caused losses of global ozone. An independent review of the data sets is underway.

Stratospheric ozone - Antarctica

- The loss of a substantial fraction of the stratospheric ozone over Antarctica during austral spring was unexpected and could not be explained with current global models. New hypothese as to the cause include enhanced CFC-instigated chemistry, climate and meteorological change, and solar-cycle nitrogen chemistry.

- NOAA measurements on the 1986 National Ozone Expedition to Antarctica revealed that the abundance of one of the reactive chlorine compounds is highly elevated compared to other regions of the globe. Remaining uncertainties, however, prevent unequivocal identification of CFC's as the cause of the ozone hole. Until the cause is established, the implications of the Antarctic ozone losses for global ozone cannot be addressed.

- The observations of perturbed chlorine chemistry and altered meteorological conditions underscore the importance of the ground-based and airborne expeditions to Antarctica planned by NASA, NSF, NOAA, and CMA during July through October of this year.

Tropospheric ozone

- Limited evidence suggests that human activities may be increasing ozone in the northern hemisphere. NOAA has underway a research effort to establish trends, causes, and climate implications of tropospheric ozone perturbations.

## II DISCUSSION

### Stratospheric ozone - global

It has been 13 years since it was first hypothesized by two University of California scientists that CFC's could migrate from the troposphere to the stratosphere, where they could deplete the ozone layer. During this period, NOAA has focused on gaining an improved scientific understanding of the chemistry and dynamics of the stratosphere in order to address responsibly this question.

For example, shortly after this theory was proposed, NOAA's balloon-borne measurements demonstrated that the CFC's were indeed reaching the stratosphere in the quantities expected by the theory. Furthermore, laboratory studies revealed that some of the ozone-depleting chemistry was different than originally thought; thereby improving the accuracy of the ozone-loss predictions.

The NOAA theoretical work has taken two directions. The first is a better understanding of the natural processes that form and distrubute ozone, which give rise to the natural background against which any human-caused trend will have to be identifed. The second thrust is the development of improved models of the coupling of meteorology and chemistry, the results of which sounded an alert that ozone depletions are likely to be larger at higher latitudes that at the equator.

These experimental and theoretical studies by NOAA, as well as those of others, have substantially increased the confidence in the basic structure of the ozone-depletion hypothesis. Based on the present understanding, most atmospheric scientists, those of NOAA included, believe that, if global CFC emissions continue indefinitely at or greater than present levels, then it is very likely that there will be substantial ozone losses, particularly at higher latitudes. The current research focuses on how much and when. Thus, the present scientific understanding of the global ozone-loss phenomenon implies that, in order to avoid significant future ozone losses, the cholorine and bromine abundances in the stratosphere cannot be allowed to grow indefinitely.

The only significant loss of the CFC's, once they are in the atmosphere, is destruction in the stratosphere. The slow rate of this loss implies that the stratospheric abundance of these compounds would continue to grow for many decades even if their emissions were held constant.

In addition to improving the understanding of how the ozone depletion phenomenon works, NOAA scientists have helped search for the first evidence of human-caused loss of global ozone. Based on the amount of CFC's that have been released into the atmosphere already, current theory predicts that a fraction of a percent ozone loss on the average should have occurred globally.

NOAA is providing some of the accumulating data base that shows how the ozone abundance varies in time and, hence, that can be used to search for human-induced changes. Specifically, the NOAA scientists are operating several ground-based "Dobson" instruments that monitor the total amount of ozone overhead and that estimate how it is distrubuted vertically (via the "Umkehr" method). Balloon-borne ozonesondes are also providing measurements of the vertical structure at selected sites. In addition, NOAA has a Solar Backscatter Ultraviolet (SBUV) instrument on its TIROS satellite that, once the testing is complete, will provide the same information on a global scale. This instrument represents a monitoring continuation of the NASA research version launched several years earlier on the NIMBUS 7 satellite.

NOAA is evaluating this accumulating data to better understand natural variation and to observe the first signs of possible human-caused trends. Theory predicts that ozone losses from CFC's will occur in the upper stratosphere and will be most prominent at the higher latitutes. A NASA scientist believes that satellite data (NIMBUS 7 SBUV) show such losses, even larger than current theory predicts. In addition, some scientists point to what appear to be downward trends in the "Umkehr" data for the upper stratosphere. However many other scientists doubt whether instrument artifacts have been fully accounted for in these upper-altitude data and are concerned whether the several-year data records are of sufficient duration to adequately define a trend. Lastly, others believe that the longer-running "Dobson" data record for the total amount of ozone overhead does not, as a whole, show any clearly human-caused trends. Therefore, the currently unpublished interpretations of the existing data set are somewhat contradictory and very controversial, leading many atmospheric scientists to believe that the question of whether a human-caused global ozone loss is occuring is still perhaps "too close to call" at present.

To resolve this conflict, NOAA has joined NASA and others in an independent assessment of the analyses of this data set, and the group plans a judgement call by the end of this year.

Stratospheric Ozone - Antarctica

In contrast to the search for the beginning of global ozone loss and the debate over its reality, an unanticipated event happened recently that has riveted the attention of the ozone scientists, policy makers, and environmentalists alike, namely, the Antarctic "hole." Here, the amount lost is considerable -- half of the ozone over Antarctica disappears in a very puzzling fashion -- and the agreement between the ground-based, satellite, and balloon-borne ozone data leave no doubt about this. In the Antarctic spring (and only there and only at that season), a substantial fraction of the ozone overhead disappears, and the fractional loss has increased, on the average, over the past several years. The magnitude of the loss and the nature of its occurrence could not be explained by previously existing ozone-loss theory.

NOAA researchers have responded to this puzzle with new theoretical and experimental studies. Shortly after the discovery of the ozone hole was announced by the British Antarctic Survey in 1985, NOAA scientists sought to explain this dramatic phenomenon in terms of two separate theories: natural climate change and man-made chemical perturbation, both theories recognizing certain unique features of the Antarctic region, such as atmospheric circulation patterns, extremely low temperatures, and polar stratospheric clouds. The paucity of chemical data at the time for the Antarctic meant that it was difficult to decide which of these two theories, or the separate solar-cycle theory, was closer to the truth.

In the summer of 1986, NOAA joined with NSF, NASA, and the Chemical Manufacturers Association (CMA) to rectify this data-short situation by organizing, supporting, and participating in the National Ozone Expedition (NOZE). A NOAA scientist served as the team leader, and she and her colleagues made ground-based measurements of a reactive nitrogen and a reactive chlorine compound in the Antarctic stratosphere. They found that these compounds are greatly perturbed in comparision to their abundances elsewhere, the chlorine species being higher and the nitrogen species being lower.

The perturbations are roughly consistent with the theory that the ozone hole is due to CFC's. However, the uncertainties in the abundance of other compounds and in the chemical reactions that link the observed chlorine species to ozone depletion precludes, at present, from treating the observations as proof of the CFC chemical theory. The low nitrogen abundance does make the solar-cycle theory more difficult to accept. The long-term record of meteorological variables continues to support a role of dynamical processes in the ozone hole. Thus, while the role of CFC's seems now somewhat more likely and that of the solar cycle seems less likely, the detailed cause of the ozone hole has not yet been established, and the significance to global ozone cannot be addressed meaningfully.

The fact that the chlorine chemistry in the Antarctic stratosphere is now known to be highly perturbed and the continuing need to define the dynamical processes makes it mandatory to understand their roles in the ozone hole in much more detail. Hence, NOAA plans a greatly expanded effort this year. First, the agency's scientists will take an improved instrument back to NSF's McMurdo Base. Others will provide year-round ozonesonde balloon launches from the South Pole during 1987. In addition, NOAA will join NASA, NSF, CMA, and university investigators in an aircraft expedition to probe the chemistry and dynamics at the stratospheric altitudes where the ozone loss is occurring. NOAA scientists will have five chemical instruments on board NASA's ER-2 and DC-8 aircraft, and one of these investigators will serve as mission scientist.

Tropospheric Ozone

It is now clear that carbon dioxide is not the only greenhouse trace gas in the atmosphere. There are several others that play significant roles in altering the earth's climate. NOAA has a research thrust underway to understand the climate role of these other species, which are primarily tropospheric ozone, CFC's, methane, and nitrous oxide.

This 10-percent of the planet's ozone that resides in the troposphere has long been thought to be the natural result of downward transport from the ozone abundance in the stratosphere. Recently, there have been indications that pollution may now be increasing tropospheric ozone, not just in urban and rural areas, but also on a hemispheric scale.

However, the current data are limited in quantity and are of questionable accuracy. Nevertheless, they demonstrate the need to address directly the issue of perturbations of ozone in the lower atmosphere due to human activities. NOAA is focusing on (a) the chemical processes that form ozone and the dynamical processes that distrubute it, (b) a long-term measurement network, and (c) a theoretical understanding of its greenhouse role. The goal is to define the tropospheric ozone trends, explain why they are occurring, and interpret the possible climatic consequences.