
Collection: Masterman, Vicki: Files
Folder Title: Stratospheric Ozone I (3 of 8)
Box: 1

UNEP OZONE LAYER PROTOCOL NEGOTIATIONS
INTER-AGENCY TRADE ISSUES GROUP
SUMMARY OF DISCUSSIONS AND RECOMMENDATIONS
ON DRAFT TRADE ARTICLE

The Inter-Agency Trade Issues Group strongly supported the progress made at the last UNEP negotiating session on the issue of trade between Parties and non-parties. It felt that the draft article developed at the last session (based largely on a U.S. proposal) provided a very good focus for further discussions at the upcoming session. It recommended that the U.S. actively support the draft article, but seek to strengthen and improve it, as noted below:

1. <u>"Non-Party Compliers" exemption</u>: The Trade Issues Group felt that the bracketed language in paragraphs 1-5, which allows a non-party otherwise in compliance to be exempted from the import restrictions, should be deleted. The Group's view was that it added unnecessary complexity to the Trade Article and might create a disincentive to membership in the Protocol.

Among the reasons that had initially been used in support of this provision were: (a) it would ensure that the Article was consistent with the GATT (which allows trade restrictions for environmental protection, providing such restrictions were non-discriminatory); (b) the U.S. needed it in order for the protocol to be implemented wholly under the authority of the Clean Air Act; (c) it would encourage compliance by so-called "pariah" states (e.g., Taiwan, South Africa) which would not be able to join the protocol because they were barred from the UN.

On these points, the group felt that: (a) it could be argued that membership in the protocol would be the only way to ensure that a country was shouldering its responsibility to protect the ozone layer, and hence the exemption was not required to ensure consistency with GATT; (b) the language in the Clean Air Act was sufficiently broad so as to cover restrictions on non-party imports, without the exemption; (c) any <u>state</u> (e.g., South Africa) could legally become a Party to the protocol, and any entity which was not a state (e.g., Taiwan) would not be subject to the import restrictions in the protocol, but could be covered by bilateral restrictions (see 4-15-87 USTR memo, attached).

2. <u>Non-Party Export Restriction</u>: The Group considered whether paragraphs 1 - 3 of the draft Trade Article should be broadened to include non-Party exports, a question that had been raised by the delegation of France at the last negotiating session. The Group concluded that paragraphs 1 - 3 should <u>not</u> also cover exports.

The group felt that banning or restricting non-Party imports already provided sufficient incentive for non-parties to join the protocol. Furthermore, since the adjusted production formula provides that only exports to Parties could be subtracted from a Party's annual emissions calculation, any exports to non-Parties would be counted in the exporting Party's annual limit (and presumably the protocol is designed so that the sum of the national limits is at or below a level that adequately protects the ozone layer). Finally, restricting exports might, by cutting off supply, induce non-parties to begin producing CFCs on their own.

3. Imports of Products Containing CFCs: The Trade Issues Group recommended that paragraph 2 of the draft Trade Article be strengthened by having an annex developed now, containing a list of the primary products in this category. The Group felt that this paragraph should be amended so that Parties would ban products containing the controlled substances, including but not limited to those on this list. The protocol should then provide for Parties to periodically review and amend the annex. The Group recommended that the delegation table a draft annex at the upcoming session, which would include a list of products (suggested list is attached) and the following definition of products containing:

> An article of trade which contains any of the substances controlled by this protocol as an active or passive element in its operation [, function, or design] or which contains any of the controlled substances in its structure or matrix over [ ] by volume or [ ] parts per million by weight.

4. Products made with CFCs: While acknowledging that it still appears to be impractical to develop workable restrictions on imports for this product category, the Group felt that it would be useful to strengthen the wording of this paragraph by:

(a) changing "study the feasibility" to "determine the feasibility";

(b) giving the parties a deadline for making this determination (i.e., "Within [ ] years after entry into force of this protocol, the Parties shall..."); and

(c) adding a sentence at the end of the paragraph obliging the Parties to ban or restrict any products which they have determined to be feasibly banned or restricted, and to develop a list of such products in an annex.

5. Timing of import restrictions: The Group recommended that the U.S. delegation propose the following timing for paragraphs 1 - 3 of the trade article:

Bulk - same time as the freeze (U.S. position is for 1 year after entry into force);

Products containing - later than for bulk, but reserve position until the timing of the control article becomes clearer;

Products made with - allow 1 -3 years for Parties to determine the feasibility of restricting non-party imports of products in this category.

6. Technology export restrictions: The Group reaffirmed its previously held view that paragraph 4 would be difficult to enforce, given the nature of the technology, and that consequently the delegation should be instructed to trade this paragraph for something of higher priority. If this was not possible and the article remained, the group felt that the delegation should support retaining the verb "discourage" (one of the three bracketed choices in the text) and should support having this article apply only to non-parties.

However, the Group felt that paragraph 5 should be strongly supported, and should be generally applicable (i.e., not just restricted to non-parties).

7. Exemption from paragraghs 4 and 5: At the previous UNEP session an exemption to paragraghs 4 and 5 was proposed, to allow for the export of "good" technologies (i.e., those which do not contribute to a depletion of the ozone layer). The Group agreed with the rationale for this exemption (paragraph 6 of the trade article), but suggested that the language be tightened up. The Group therefore recommended that the delegation propose the following language for paragraph 6:

> "The provisions of paragraphs 4 and 5 shall not apply to products, equipment, plants, or technologies which improve containment, recovery, recycling, or destruction of the controlled substances, or otherwise contribute to the reduction of emissions of these substances."

8. Definition of bulk: At the previous session, the delegation had been authorized to propose a definition on bulk trade, for the purposes of the trade article and the adjusted production formula (which the U.S. has proposed only count bulk exports and imports). As the delegation had not had the opportunity to propose a definition at that session, the Group felt that the delegation to the upcoming session should do so. The definition is as follows:

> "bulk exports or imports means any export or import of a commodity containing [10 lbs.] or more of non-recycled substance(s) controlled by this protocol.

9. Non-compliance by Parties: The Group considered the question of whether non-complying parties should be treated as non-parties for the purposes of this article. If they are not, then the possibility exists of a nation joining the protocol for the sole purpose of avoiding the import restrictions, but with no intention of fulfilling its obligation under the control article. If they are, then the protocol would contain an element of "enforcement" which has heretofore been lacking.

The major problem which the Group identified of having the trade restrictions apply to non-compliers as well as non-Parties was how a non-complying Party would be identified. Some possibilities (which are not mutually exclusive) include: (a) by the secretariat (for the simple case where a party's own submitted data show it to be out of compliance); (b) by a majority vote of the parties; (c) by having one or more parties submit an allegation of noncompliance to an arbitration panel, which would issue a finding.

The Group recommended that the delegation discuss this issue at the upcoming session. However, it felt that the issue had ramifications that went beyond the trade article, and that having general provisions on non-compliance in the protocol made more sense.

Drafted by:

Jim Losey
EPA/OIA (382-4894)
4/21/87

"PRODUCTS CONTAINING"
PROPOSED LIST

1) refrigeration equipment

   auto air conditioners, building air conditioners, refrigerators, freezers, dehumidifiers

2) rigid foam

   insulation, packaging, food service

3) flexible foam

   seating and padding cushions

4) fire fighting systems and products

   portable fire extinguishers, fire systems, recharge tanks

5) small containers

   recharge and consumer products

→ What shld be the US posit?
└ not undercut posit. later.

EPA's

Becky

2 pgs - what we agree on & what issues must be resolved

OZONE LAYER PROTOCOL
PROPOSED U.S. NEGOTIATING POSITION

I. General Objectives

& which og prefer?

The general objectives for the USG in these negotiations continue to be as delineated in the Circular 175 of November 28, 1986:

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

B. 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 C; and

C. 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.

II. Objectives for this Session:

A. Keep the negotiations focused on elaborating a protocol based on the U.S. freeze-reduction approach (now included in the Chairman's text), and resist efforts to resurrect other options (e.g., Canadian, Soviet). ? → Avg of 84, 85 & 86 } for baseline)

B. Maintain previous U.S. negotiating position as long as possible, including goal of virtual phaseout ~~unless~~ subject to ~~new~~ scientific evidence ~~emerges~~. substits?

C. Focus attention on defining a meaningful initial reduction step beyond a freeze, and try to narrow stringency and timing ranges in the Chair's text.

objec ① → D. ~~Continue to press for~~ Insist on as broad a coverage of chemicals as possible (based on initial U.S. list of priority chemicals), with CFC 113 specifically included.

E. Compromise (based on section III below) if this is judged essential to achieve protocol which meets basic U.S. objectives (i.e., protecting the environment, stimulating a transition away from CFC reliance, and avoiding major economic dislocations and shocks).

F. Maintain and strengthen earlier U.S. positions on trade and scientific assessment, which have received strong support. Strive for progress on the LDC issue, emphasizing an approach that will encourage LDCs to join but does not undercut our long-range environmental objectives. objec ②

G. Work toward final agreement on all basic elements of the protocol, including stringency, timing, scope, trade aspects, treatment of developing countries, and scientific assessment.

DPC, Room 200, EOEB
456-6640

Vicki Masterman

Attached is a DOE-staff proposal on a proposed next negotiation position for the ozone depletion protocol. It is as stated, but leaving out the two subclauses of the first two bullets.

I added these subclauses to suggest one mechanism for the US (and the EC) to receive partial credit for their past demonstrable actions on controlling aerosol emissions. At each step some credit is obtained, yet all parties are required to take a significant action, so that the argument that major CFC-use countries are getting a free (or cheap) ride is weakened.

Note in particular the last point; this is a Departmental position.

Ted Williams

cc: Dave Gibbons

- Freeze the ozone depletion potential of emissions from CFC-11, -12, -13, and halons 1301 and 1211, at 1986 levels in the first full calendar year after the protocol enters into force;

    - any country that has 1986 levels within 70% of their historic high of aerosol use additionally will reduce aerosol use by 25%.

- Schedule a 20% reduction of ozone depletion potential of emissions from 1986 levels in the sixth year after the protocol comes into force;

    - change to a 30% reduction; also add--for countries that have demonstrated that by 1986 a majority of aerosol propellants were not the CFC species now being a candidate for control--the level of national reduction is set at 20% of 1986 levels, plus a reduction of ozone depletion potential of emissions equal to the 1986 aerosol usage.

- Schedule a scientific and technological review to be completed 5 years after the protocol is <u>opened for signature</u> and, based on this review determine:

    (1) if the 20% reduction level (or the 30% minus the aerosol credit level) is sufficient or more control stringency is needed.

    (2) if a next round of emission reductions, to go into force 8 to 10 years after the first reduction, should be negotiated.

- Emissions in terms of ozone depletion potential to be calculated are:

    Production + Imports - (Exports + Distruction + Long-Term Encapsulation)

    Where Long-Term is 50 years or more,

    and other articles of the protocol will determine how the calculation of each term is to be demonstrated.

Interior
4/13

A Proposal For A Revised CFC Negotiation Posture For the U.S.

Background. In 1976 the U.S. unilaterally initiated a ban on the use of CFC as propellants in aerosol containers. This action was based on preliminary scientific information that CFCs could have an adverse environmental effect. To date only the Nordic countries and Canada have followed suit. (West Germany, we are told, is planning such a ban.) Our actions have had the following effect between 1976 and 1985 according to industry data:

- U.S. use of CFCs as aerosols declined 92% (from 412 to 32 million pounds).
- Total U.S. use of CFCs declined by 13% (from 750 to 650 million pounds) mainly because non-aerosol use increased by 83% (from 338 to 618 million pounds).
- In the Rest-Of-The-World (ROW), use of CFC aerosols declined by 31% (from 632 to 438 million pounds).
- Total ROW use of CFCs increased by 9% (from 1150 to 1250 million pounds) because of a 57% increase in non-aerosol use (from 518 to 812 million pounds).
- Aerosols often use CFC-11 and 12 which are environmentally the worst actors.
- Currently 25% of world CFC use is for aerosols. In ROW the corresponding figure is 35%.
- The rate of growth for non-aerosol CFC usage was 6.93% for the U.S., 5.12% for ROW, and 5.87% for the entire world.

* The following information excludes consumption in the eastern bloc nations.

Happens that a freeze would result in a more-or-less stable overall ozone situation. (See Exhibit C.) However, a freeze at current levels of CFC consumption would have the largest negative economic impact on the U.S. and others who have already eliminated aerosol use. The ROW would be able to preserve more beneficial uses while eliminating aerosols. In fact, we estimate that the ROW could absorb reductions up to 25 or 30% phased in over 5-10 years by merely shifting out of aerosol usage of CFCs.

Environmentalists will not be satisfied with a freeze because while total ozone would remain constant, the ozone profile would be redistributed with more ozone near the ground and less in the stratosphere. They believe an 85% reduction is the minimally acceptable position.

Finally, CFCs add to potential global warming.

Proposal. To ensure a level playing field, the U.S. should seek as a first step, a worldwide reduction equivalent to a 95% reduction, from 1976 levels, on aerosol CFC usage. This would allow the immediate establishment of a new "baseline" quota for each nation based on, say, its 1985 consumption level minus 95% of CFC aerosol use in 1976. This would:

- Effectively reduce worldwide CFC usage by about 22% "immediately". Most of this would be in CFC 11 and 12, the most environmentally damaging.
- Establish a baseline which would not economically penalize the U.S. and other countries which have banned CFC for aerosols for their early, unilateral action--an action which all EEC nations have benefited from environmentally but were unwilling to undertake.
- It would allow each nation to reduce uses in the most economically-efficient fashion.

To cushion any adverse social and economic impacts in the short run, each developed nation could be given a small (x%) growth allowance until 1997, i.e., for ten years.

It is assumed that x = 2%, i.e., the baseline quota is allowed to increase by 2% each year.

Tables 2 and 3 provide approximate future CFC consumption figures under this scheme. This scheme would:

- Provide greater reductions in CFCs than the currently proposed freeze until 1997. Cumulative consumption would be less with this proposal than under a freeze until past 2005--if this scheme were extended till at least that time.
- Compared with a freeze-plus-20% reduction, the proposed reduction scheme is environmentally better for the first few years and worse after that. See Table 3 for a sample calculation with a hypothetical schedule which assumes that: (a) the freeze would be at 1985 levels and become effective in 1988, and (b) the additional 20% reduction becomes effective in 1990. That table shows that using this schedule, "crossover" would occur around 1993. Obviously one can vary the crossover point by varying either the rate of

allowed growth applied to an adjusted base or the schedule.

- Drastically reduce growth rates for nonaerosol uses from a 95% increase over 10 years to 22% for the U.S., and a possible 65% to 22% for the ROW. These are based on assuming that nonaerosol uses would grow at the same level as the 1976-85 average.
- It would buy time to gain additional information on the phenomenon and to work on environmentally, and otherwise, safe substitutes. It is not expected that ozone-depletion over the short run should be drastically affected by this approach. See Exhibit C provided by EPA/NASA during the briefings. An examination of this figure shows that under this proposal there would be virtually no change in stratospheric ozone in the early years. In fact, the ozone-depletion curve under this proposal would be above line A until 2006--at which point it will intersect that line.

Finally, it is recommended that domestic agencies reallocate budgets and priorities to make this issue, both prevention and mitigation, a top priority. For example:

- NIH/NCI research on skin cancers.
- NIH research on UV effects on the immune system and other, non-cancer health effects.
- DOI, USDA research to address possible effects of UV radiation on aquatic and plant species.

The ban on aerosols is a first step. If the science continues to suggest the potential for serious life-threatening consequences, we would urge significant reduction from the 1985 adjusted base.

<u>Further Discussion</u>

Those countries which have not accepted the aerosol ban will probably be unhappy with this proposal. They would argue that there are several CFC uses especially in the U.S. which are just as frivolous (e.g., auto air conditioners and fast-food packaging), and that the U.S. per capita and per GNP consumption remains higher than in the rest of the world. To counter these arguments we should note that:

- The U.S. took the first step in eliminating non-essential aerosol use.

- U.S. needs are greater than Europe's because the U.S. has, a larger proportion of population living in warmer, more humid climates, and that the distances between cities makes air-conditioned automobiles more beneficial. It may make sense to readjust quotas partly on the basis population-weighted climatic conditions.

- The "non-aerosol-ban" nations have had a free-ride since 1978. It seems appropriate for the "non-aerosol-ban" nations to shoulder their fair share of the future burden. In fact, even this would not compensate the aerosol-ban nations for the cost of past reductions, and research that enabled the phase out of CFC aerosol usage.

- By establishing a historical 1985 base, the U.S. would probably have to reduce actual consumption since its initial baseline would be lower than current consumption. Moreover, it will involve a substantial slow down in non-aerosol CFC growth in the U.S.

Under the above scheme, developing nations could be given a higher allowable growth rate than developed nations. For the 10-year period (i.e., until 1997) such a differential growth rate is not expected to increase overall CFC consumption drastically because of the present relatively low level of consumption in the developing world. Finally, any reduction in CFCs will help reduce concerns regarding fossil fuel combustion's effect on global warming (via CO2 emissions).

Caveats. The numbers presented here are to be used with caution.

- They assume consumption = emissions.

- They also assume all CFCs have an equal ozone-depletion potential.

- They ignore consumption/emissions in the eastern-bloc nations (EBN).

- The numbers were generated by using the pie charts on Exhibit A and B.

Table 1: Total CFC Use (Excluding EBNs), 1976-85, in Millions of Pounds

	U.S.		ROW		Total	
	1976	1985	1976	1985	1976	1985
Non-Aerosol	338	618	518	812	856	1430
Aerosol	412	21	632	438	1044	459
Subtotal	750	639	1150	1250	1900	1889

Table 2: Total CFC Use (Excluding EBNs) Under Proposal, in Millions of Pounds

	U.S.			ROW			Total		
	1985 Actual	1985 Base	1995	1985 Actual	1985 Base	1995	1985 Actual	1985 Base	1995
Non-Aerosol	618	618		812	812		1430	1430	
Aerosol	32	21		438	32		470	53	
Subtotal	650	639	779	1250	844	1029	1900	1483	1808

Table 3: Comparison of Non-EBN Consumption Under Various Reduction Schemes, 1988-1997, in Millions of Pounds

Year	Freeze1	@ 2% Increase2	Freeze-plus-20% reduction3	A4	B5
1988	1900	1573	1900	-327	-327
1989	1900	1605	1900	-295	-622
1990	1900	1637	1520	+117	-505
1991	1900	1670	1520	+150	-355
1992	1900	1703	1520	+183	-172
1993	1900	1738	1520	+219	+ 47
1994	1900	1772	1520	+252	+299
1995	1900	1807	1520	+287	+586
1996	1900	1844	1520	+324	+910
1997	1900	1881	1520	+361	+1271
Total	19,000	17,230	15,960		

---

1 This assumes that the "immediate" freeze will be at 1985 levels and go into effect in 1988.

2 This column is for the proposal using a 2% in annual adjustment to the base line. This assumes that first year of compliance with proposal will be 1988.

3 This assumes that 20% reduction will go into effect in 1990.

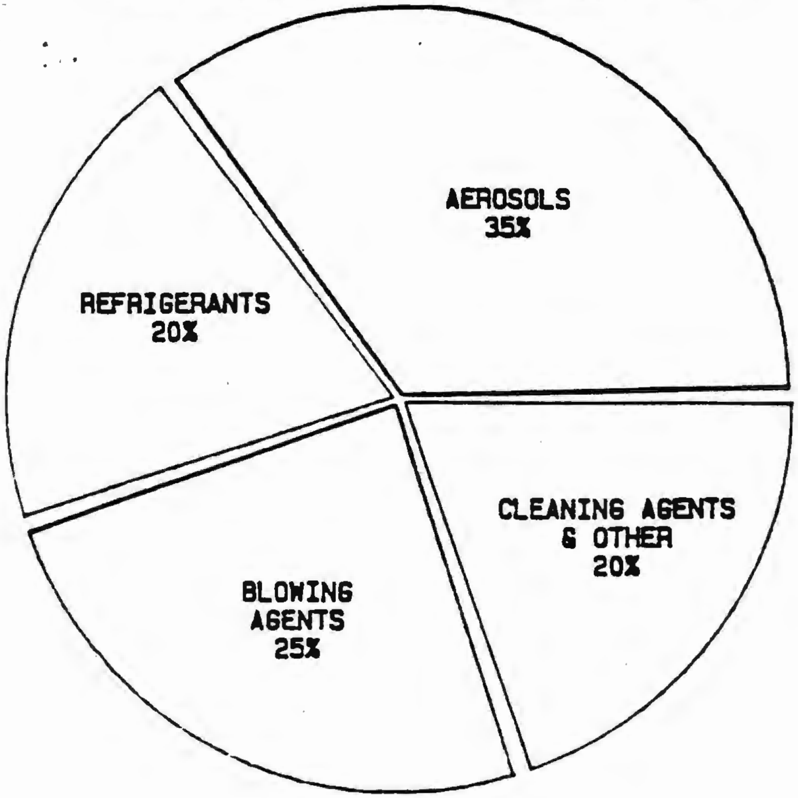
4 A = Difference between the previous two columns.

5 B = Cumulative difference between proposal and "freeze-plus-20% reduction". Negative sign indicates that proposal (at 2% increase) produces fewer cumulative emissions. This column shows that "crossover" occurs in 1992/3.

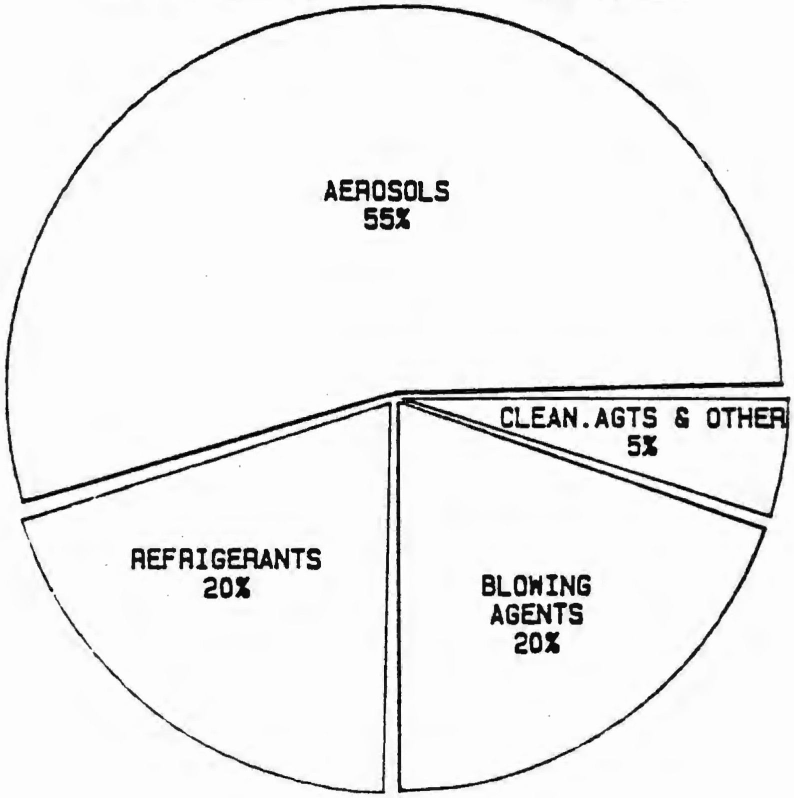
EXHIBIT A

FC-11/12/113/114/115 VOLUME BY INDUSTRY

1985 WORLDWIDE (EX. U.S.): 1250 MM LBS



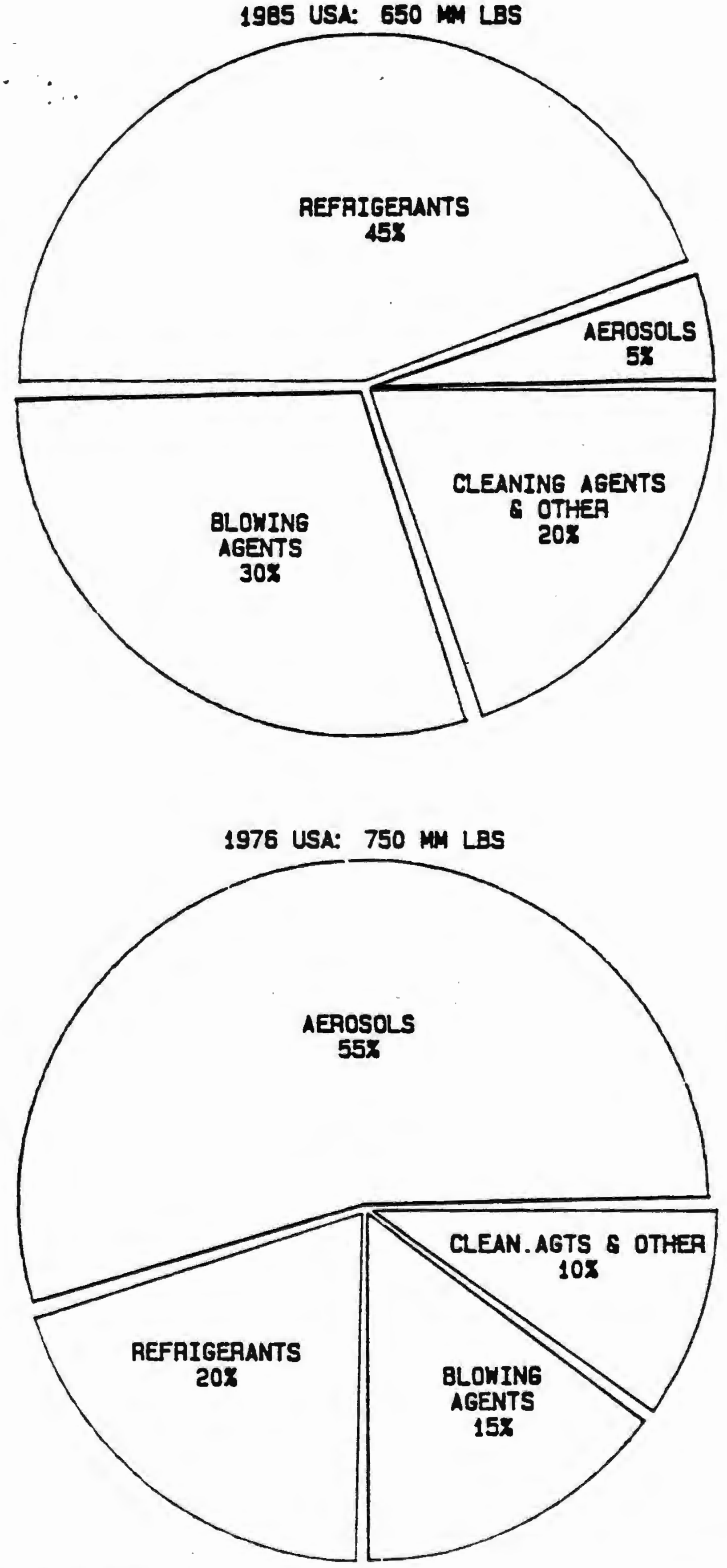
1976 WORLDWIDE (EX. U.S.): 1150 MM LBS



11-18-86

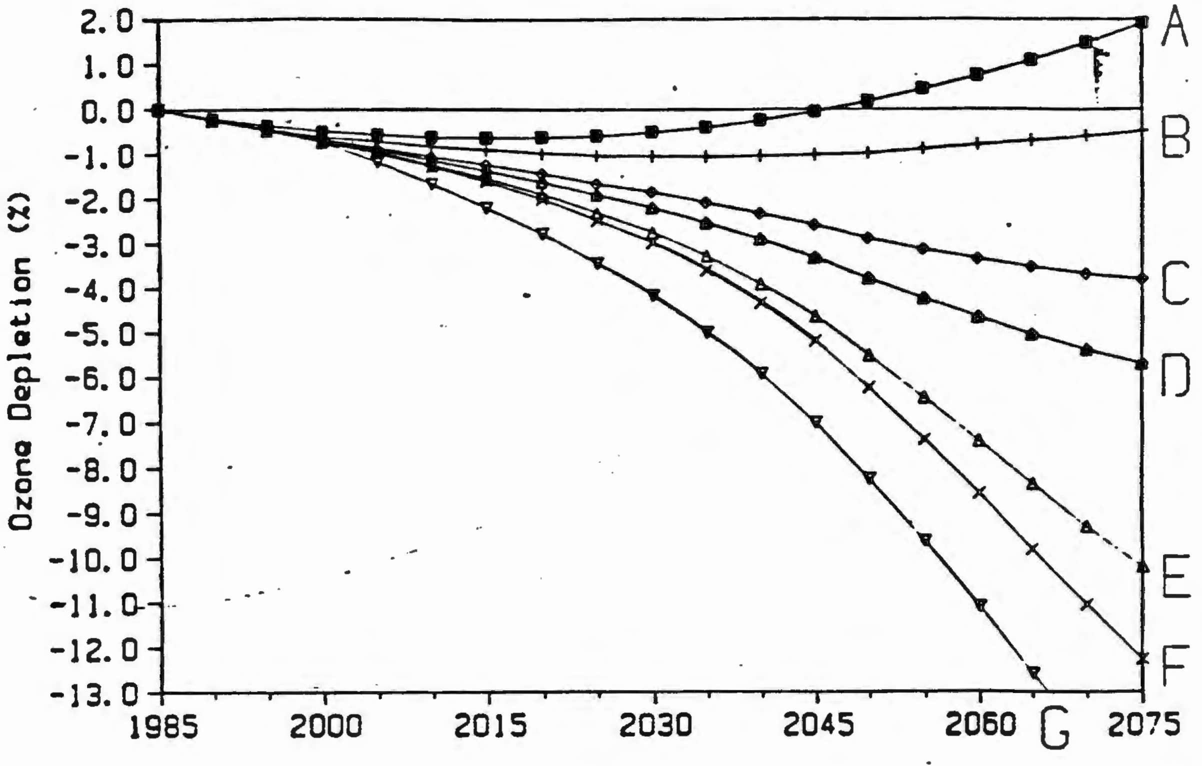
EXHIBIT B

FC-11/12/113/114/115 VOLUME BY INDUSTRY



RK85UC 11-18-86

C



A = Freeze of all CL-containing compounds at 1986 levels.
- 100% compliance globally
- CH_4 @ 1%/YR
- N_2O @ 0.25%/YR
- CO_2 @ 0.8%/YR (per Wuebbles et al., 1984)

This is Similar to WMO (1986), and looks ≈ Same.

B = Freeze all CL-containing compounds at 1986 levels
- 100% Compliance
- CH_4 @ 0.017 ppm/YR
- N_2O @ 0.20%/YR
- CO_2 @ 0.7%/YR (per NAS 50th percentile)

C = Same as B, except CH_3CCl_3, Halon 1211 and Halon 1301 allowed to grow @ 2.5%/YR from 1985 to 2050 (constant thereafter)

D = Same as C, except CFC-113 allowed to grow @ 2.8%/YR from 1985 to 2050 (constant thereafter)

E = Same as D, except developing nations allowed to grow to current global average use per capita

F = Same as E, except 80% compliance globally. (Note: baseline rate for CFC-11 and CFC-12 is 2.5%/YR 1985 to 2050, constant thereafter).

G = No controls on 2.5% [illegible] growth 1985 to 2050; constant [illegible]

BACKGROUND PAPER

PROTECTION OF STRATOSPHERIC OZONE

&

CONTROL OF GLOBAL CHLOROFLUOROCARBON EMISSIONS

The Science

Most of the ozone in the earth's atmosphere resides in the stratosphere which extends from about 8k at the poles and 17k at the equator to about 50k above the earth's surface. Ozone is the only gas in the atmosphere which prevents harmful ultraviolet radiation from reaching the surface of the Earth; thus, changes in the amount of stratospheric ozone would modify the amount of ultraviolet radiation which reaches the Earth's surface. During the 1970's the discovery was made that certain chlorine compounds might degrade stratospheric ozone. In 1979 the NAS concluded that "...continued release of halocarbons [e.g chlorofluorocarbons, or CFC's such as Freon] into the atmosphere will result in a decrease in stratospheric ozone."

NAS conclusion

Chlorofluorocarbons are the primary trace gases responsible for the modification of the ozone layer and there is now compelling observational evidence that the composition of the atmosphere is changing rapidly on a global scale. Concentrations of the CFC's and other trace gases are increasing rapidly,some by more than 5% per year. Since the lifetime of these gases in the atmosphere is measured in time periods from years to many decades most believe that action is necessary now (see Watson testimony for additional details on the science).

The only known source of CFC's is industrial production. The variety of their uses includes aerosol propellants, refrigerants, foam blowing agents and solvents. As the use of refrigeration, computers, etc. rises so does CFC use; thus, industrial growth is a key factor in determining future atmospheric concentrations.

source & use

Because of the long lifetime of these gases in the atmosphere, any change brought about by their increasing concentrations will be difficult to rectify. Return to acceptable ozone levels will take several tens to hundreds of years after the emission of the gases into the atmosphere ceases.

Policy Concerns

Realization of the dramatic atmospheric consequences of continued emissions and the potential for severe environmental and health impacts has led to action both domestically and internationally. The U.S. has played a leadership role since the 1970's when use of CFC's as aerosol propellants was banned. Currently, the EPA is under court order to determine, by May, 1) that there is not enough evidence to demand further regulation of CFC's at this time or, 2) to begin rulemaking procedures and issue final regulations in November. EPA is seeking an extension of these dates, but any extension will be of limited duration. Internationally, a treaty for protection of the ozone layer was negotiated in 1985. The treaty calls for the development of protocols to insure the protection of the ozone layer and the U.S. has been a leader in negotiating these protocols (see Benedick testimony). The long lifetime of CFC's in the atmosphere means that they are transported around the world; thus multilateral action is required to protect against further damage.

NRDC cd

Current Activities

Negotiation of protocols began in December 1986. The U.S. position for these discussions (see Circular 175) was designed to address three concerns: 1) effective protection of the ozone layer; 2) availability of cost-effective substitutes for controlled chemicals; and 3) equitable treatment for U.S. industry. A science component was included so that scheduling could be modified in response to any "surprises".

It was not until the second round of negotiations, February 23-27, that a consensus began to emerge. During that session specific trade provisions and the broad economic implications of alternative approaches were discussed. At the end of the meeting a paper was presented by the Conference Chairman which is likely to provide the start point for the next negotiating session in April (see Chairman's Paper). The paper generally follows the philosophy and process of the U.S. position. The UN is organizing a two-day scientific workshop to be held in early April to evaluate a range of control scenarios set forth in the Chairman's Paper. An informal consultation in Oslo with participation by the U.S. and others will follow, leading to the April negotiating session. This meeting is supposed to be the final round of deliberations and is scheduled to be followed by a diplomatic conference in September to approve the protocols. Many, however, believe the schedule will slip.

Chairman's text

Open Issues

EPA is conducting an economic impact analysis and work has begun to identify and analyze the import/export implications of the international protocol and the domestic rule. Little of this type of analysis has been done outside of EPA raising the question of who should be involved and what analysis is required. Consideration should also be given to the question of adding more specificity to the Circular 175 if available analysis so indicates. Environmental groups contend that we already have sufficient information and stringent controls are needed now. Industry, while agreeing with the need for a freeze, is not united beyond that point. Some producers of CFC's and many users are concerned with the timing of proposed actions. Timing is also important to EPA. If we are to avoid unilateral action on the part of the U.S. that might disadvantage domestic industry and/or consumers then the interplay between the domestic and international processes must be properly syncronized. Additionally, there is some interest in Congress. Hearings have been held recently and several Bills introduced.

envir

indus

United States Department of State

Bureau of Oceans and International
Environmental and Scientific Affairs

Washington, D.C. 20520

April 20, 1987

MEMORANDUM

To : Agriculture - Dr. Orville Bentley
Commerce - Mr. Michael T. Kelly
NOAA/NWS - Dr. Richard Hallgren
Council of Economic Advisers - Mr. T.G. Moore
Council of Environmental Quality - Mr. Allen Hill
Defense - Mr. David Tarbell
Domestic Policy Council - Mr. Ralph Bledsoe
Energy - Dr. Joel A. Snow
EPA - Dr. Richard Morgenstern
Interior - Mr. Martin Smith
Justice - Dr. F. Henry Halbricht, II
NASA - Mr. Shelby Tilford
Office of Policy Development - Mr. Jan Mares
OMB - Mr. David Gibbons
Treasury - Mr. Don Craft
NSF - Dr. Eugene Bierly
AID - Dr. Nyle Brady
HUD - Dr Truman Goins
NCPO - Mr. Alan Hecht
USTR - Ms. Lisa Gothereich

From: OES/E - Richard Elliot Benedick

Subject: Interagency Meeting on WMO Tenth Congress and UNEP Governing Council Considerations of International Coordination for Greenhouse Gas Evaluation.

I would like to meet with you this Friday, April 24 in Room 7835 Main State (OES Conference Room) at 1 p.m. to discuss the issue of international coordination of Greenhouse gas impact evaluation.

Prior to the WMO Tenth Congress, May 4-29 and the UNEP Governing Council Meeting June 9-19, we need policy level decisions regarding the most effective international action to address the impact of Greenhouse gases upon the atmosphere and future world climate trends. We believe it essential that the international community adopt a focused and concerted effort to address this issue, so that resources and research can be most effectively and expenditiously utilized.

All agencies who wish to participate in this decision review will be welcome. I look forward to seeing you Friday afternoon.

Drafted:OES/SAT:DARose:dmd
4/20/87:ext 72434:W4298T

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

MAR 23 1987

OFFICE OF
EXTERNAL AFFAIRS

MEMORANDUM

SUBJECT: EPA responses to Rep. Bates' follow-up questions from the March 9 Waxman stratospheric ozone hearing

FROM: Steadman M. Overman
Director
Office of Legislative Analysis

Chris Hoff
382-5422

TO:

Name	Agency	Telephone	Transmission
Barbara Moore	(NOAA/DOC)	443-8845	FACS. 377-5270
Michael Kelley	(DOC)	377-0614	FACS. 377-5270
Richard Bradley	(DOE)	586-4759	FACS. 586-2707
Ted Harris	(DOE)	586-5659	FACS. 586-2707
Bob Watson	(NASA)	453-1681	FACS. 472-7634
Pep Fuller	(USTR)	395-7203	FACS. 395-3911
Marty Smith	(DOI)	343-1632	FACS. 289-4714
Coleman Nee	(CEQ)	395-5750	OMB HAND CARRY
Jan Mares	(OPD)	456-2752	OMB HAND CARRY
Stephen DeCario	(CEA)	395-6982	OMB HAND CARRY

The Office of Management and Budget has requested that we solicit your comments on the attached responses.

Please provide any comments to Barbara Gittleman (395-6827) at OMB no later than C.O.B. WEDNESDAY, 25 March 1987.

Attachment

Seidel 382-2787

cc: Barbara Gittleman
OMB/FACS. 395-3130
Tele. 395-6827

5 pp to follow

Question 1:

The Clean Air Act, Section 157(b) gives you the authority to propose regulations to control substances that are known to harm the ozone layer. Professors Rowland and Molina predicted in 1974 that chloroflourocarbons or CFCs would deplete the ozone layer. In the ensuing 13 years, the scientific consensus has only grown stronger that CFCs do indeed pose a threat to the ozone layer. Why then have you not exercised your authority under the Clean Air Act to propose regulations to regulate CFCs? Why did you have to be forced to do so by a suit by the Natural Resoures Defense Council?

Response: INSERT Ⓐ

~~Scientific understanding concerning chlorofluorocarbons (CFCs) and their role in depleting ozone has evolved considerably since the theory was first proposed in 1974. For example, while the theory that chlorine depletes ozone has been further supported by research, we now know that other gases whose atmospheric concentrations are also increasing (e.g., methane and carbon dioxide), actually have the opposite effect on total column ozone.~~

~~In the early 1980s global use of CFCs appeared to be decreasing. However, we now believe that this downturn reflected reductions in CFC use in aerosols worldwide, and the generally depressed economic conditions which reduced demand for new autos, refrigerators and other consumer goods produced with CFCs. With a return to economic growth in the mid-1980s and a flattening out of CFC use in aerosols, total CFC use has increased at roughly 5% annually on a global basis during the past few years.~~

~~Before this recent increase in CFC use, and based on an analysis of changes in all trace gases, the 1982 update on stratospheric ozone depletion by the National Academy of Sciences suggested that the risks were substantially less than previously thought. Accordingly,~~ EPA did not take any further regulatory action in the early 80's (e.g., follow-up on its 1980 Advance Notice) on CFCs.

Beginning in 1984, because of concern about growing global use of CFCs, we expanded our efforts. We developed a stratospheric protection plan aimed at providing a sound analytical basis for future decisions. It is important to note that this plan also committed EPA to participating in international negotiations related to global actions to limit CFCs. This plan then became the basis for settlement of a lawsuit brought by NRDC. The plan is published in the Federal Register (51 FR 1257).

More recent analysis and improvements in scientific evidence have been incorporated in EPA's risk assessment, "An Assessment of the Risks from Gases that Modify the Stratosphere." This

RA

one factor considered in

document will be ~~a basis for~~ our upcoming decisions concerning the need for further regulation under Section 157(b). A copy of the latest draft of the Executive Summary is enclosed.

Question 2:

The court settlement of the suit by the Natural Resources Defense Council directs you to decide by May whether or not regulating the substances that harm the ozone layer is necessary. On what will you base your decision? Will it be based on the prognosis for the protocol negotiations in Vienna? If, so, please explain why domestic action should hinge on international action. If you decide that regulations are necessary, what shape will they take? How stringent will they be in relation to the protocol that is being negotiated?

Response:

considered will include: ← INSERT (B)

As discussed above, EPA has been moving forward in its internal evaluation of whether further regulation of ozone-depleting chemicals is warranted, and if so, what action should be taken. In making a decision, ~~we will consid~~er the ~~following~~ factors: the effect of U.S. actions on reducing risks to health and welfare from ozone modification; the feasibility and costs of possible reduction in ozone-depleting chemicals; and the effect of unilateral U.S. action on obtaining an effective global response to stratospheric ozone protection. Since internationally-agreed controls will ultimately be required to effectively address the risk of ozone depletion, we must take care that our domestic actions support and do not undermine the prospects for successful completion of an international protocol.

We are also currently evaluating the timing, scope and stringency of regulatory actions. We are analyzing a wide range of options for each of these design parameters and will be examining the costs and feasibility of achieving emission reductions. We would be happy to give you a draft of this analysis when it becomes available for public review. copy

draft?

Finally, we are examining both traditional command and control type regulations and alternatives based on market-based approaches. In the latter category, we are analyzing marketable permit systems and regulatory fees. If regulations are warranted, these approaches might be more appropriate to the unique nature of this issue (e.g., the large number of firms, the ability to move away from the targetted chemicals over time) and could achieve a specified regulatory goal at lower costs. We would also pass you this analysis when it is ready for public review.

Alt's to fed reg?

Question 3:

You testified yesterday that you believe we should pursue an international agreement on a freeze on production of ozone-depleting chemicals, followed by a phase-out of 96% of the production of these chemicals. While Ambassador Benedick seemed to think that a protocol could be negotiated by September of this year, his optimism could be upset by the reluctance of some CFC-producing nations to support tough measures to protect the ozone layer. Given this uncertainty, and the fact that the United States produces 30% of the world's supply of CFCs, what is your view on unilateral action by the United States to protect the ozone layer? Wouldn't action on our part reinforce our efforts to get other CFC-producing nations to address this issue? What will your strategy be if the protocol negotiations reach a stalemate? Should we wait indefinitely for these negotiations to reach a conclusion.

no, it's naive to think so. we always kick ourselves b-4 others do.

Response:

We share Ambassador Benedick's belief that it might be possible to conclude negotiations by the September Diplomatic Conference and intend to take whatever steps are possible in support of that goal. At the same time, we realize that further delay in reaching a final accord is possible. We recognize our responsiblity under Section 157(b) of the Clean Air Act and are moving forward to assess domestic regulatory options.

what auth?

If no international agreement is reached prior to our deadline for proposal, a key issue we must assess is whether unilateral action would support or hinder efforts to achieve an effective global response to reducing risks from ozone depletion. The argument has been made that the U. S. acting alone would discourage other nations from seriously negotiating since our actions would, at least for a time, reduce the risks. At the same time, U.S. industry could be disadvantaged relative to its competition aboard. Also, domestic regulation (without trade restrictions) might tend to displace CFC emissions to other countries, thereby undermining the effectiveness of domestic regulation.

will unilat ↓ help?

✓ yes ✓

Arguments can also be made in support of unilateral action. Although the U.S. share of production is only 30% of the global total and U.S. action alone would not prevent depletion, it would delay and reduce the magnitude of such harm.

-at the expense of our competitiveness at a time of unprec'd trade deficits.

The effectiveness of environmental protection could possibly be increased while also reducing any adverse impacts on U.S. industry if trade restrictions were placed on products containing CFCs imported from countries which have not adopted similar domestic programs to reduce CFC emissions. Such restrictions could also serve as a strong inducement for other nations to negotiate and join an effective protocol. In addition, U.S.

trade restric's alt.

industry would have the opportunity to develop new emission control and recycling technologies and chemical substitutes for the domestic market and then might have a competitive advantage over their foreign competition. Finally, although only a few nations followed the U.S. lead in severely restricting CFCs used in aerosols, many have made substantial reductions. For example, the European Economic Community has reduced CFCs used in aerosols by 30-40 percent (with Denmark acting last year to ban all nonessential uses). New Zealand has reduced aerosol CFC use by 60%, Japan by 40-50%, and other nations including Egypt and India by large amounts. While these reductions generally fall short of those made by the U.S., it can be argued that our actions have encouraged those of others.

Ex. of failure of unilat action = aerosol (but can be viewed both ways)

While we are closely examining the considerations discussed above, we do not intend to wait indefinitely to achieve a protocol. Instead, we intend to continue our efforts to expedite the successful completion of these negotiations and failing that will examine our options to achieve an effective response to this environmental issue.

Question 4:

As support for focusing on international efforts, you and others at the hearing cited the 1978 United States ban on CFCs as propellants for aerosol spray. As I understand it, only the use of CFCs in domestic production of aerosol sprays was prohibited in the 1978 ban. Recent proposals for unilateral action however, are more comprehensive and include trade provisions. Examples are S. 570 and S. 571 in this Congress and H.R. 5737 in the 99th Congress. Clearly there are differences between Congress' approach in 1978 and our approach in 1987. What are your views on these bills? Won't their trade provisions mitigate the economic harm to the U.S.? Wouldn't unilateral action of this sort provide incentives for other CFC-producing nations to join the protocol to the Vienna Convention?

Response:

The 1978 EPA regulation (43 FR 11301) limited the use of CFCs as propellants in nonessential aerosols. It also prohibited the import of similar aerosols from other countries into the U.S. In this respect, that regulation is similar to the bills introduced by the Senate. We have initiated a more detailed analysis of trade-related issues. In these studies we will obtain more detailed information on the quantity and identity of goods either produced with CFCs or still containing CFCs by other countries. We will be evaluating the identity and quantity of CFCs involved with these products, the value of the products and the costs of the CFCs involved, the ability to detect CFCs in those products where it no longer contains the chemical when it is shipped, and the likelihood of shifts in the location of manufacturing if CFCs are restrictecd in the U.S. but not elsewhere. We will be examining these factors in light of U.S. industries' competitiveness at home and abroad and the degree to which incentives would be provided for other nations to join with the U.S. in taking action.

The analyses described above should provide a better basis for evaluating whether the proposed trade restrictions in the Senate bills would in fact be likely to accomplish their goals of encouraging other nations to restrict CFC use. We would be happy to give these studies to you as they become available.

Insert Ⓐ ~~The role of CFCs in ozone depletion~~

ridiculous sentence

Over the past 15 years, Ozone depletion in the stratosphere has been fraught with uncertainty. At the time Section 157 was legislated ~~at~~ it was generally thought that ozone depletion would occur relatively rapidly. This view underwent a change in the late 70's and 80's. The reasons for this change were that new scientific data coupled with a decline in the use of CFC's in the early 80's indicated that the risks of ozone depletion were substantially smaller than previously thought. In fact, the NAS's 1982 update on stratospheric ozone depletion confirmed that view.

by whom?

?

However, since that time the pendulum has once again swung in the direction of increasing concern. CFC's use worldwide is up because of ~~increased~~ the improved worldwide economic picture, ~~world~~ ~~and~~ Also scientific data also indicates greater cause for concern.

We note that while we have cause for concern we are not confident of the [illegible] ultimate impact, because there are several scientific uncertainties.

of what?

[A paragraph on uncertainties should be included at this point].

EPA's response has more-or-less mirrored the ebb and flow of the stratospheric ozone debate. Thus,

i.e. not have an agency view & behind the curve rather than in front.

~~The environmental~~

Ⓑ The availability of substitutes and the~~ir~~ environmental ~~and~~, health and safety impacts of using them rather than CFCs; The scientific uncertainties; the costs ~~of~~ and/or benefits of opting to accumulate more data/analysis given uncertainties; competitiveness of U.S. industry;

what specifically about it? who will EPA consult?

Question 3

This should note that absent any international action, U.S. share will fall because use of air conditioning and refrigeration in developing nations is expected to pick up. This reduction in U.S. share means that the global impact of controlling only U.S. share will be much less than one would expect using only the 30% figure. (In fact, even the protocol would allow for the possibility of increased use of CFCs in developing nations -- thus the effect of only controlling usage in developed nations would be diluted).

Some quantitative analysis of the global impact on stratospheric ozone ~~dep~~ depletion in the event only the U.S. acted would be quite useful.

Questions 3/4

These should note that U.S. sanctions/actions against those nations not adopting CFC restrictions would use up the goodwill some of these nations may have for the U.S. and could, therefore, undermine attainment of other foreign policy goals and objectives.

3/5/87

STATEMENT OF

Dr. Robert T. Watson

Earth Science and Applications Division

Office of Space Science and Applications

National Aeronautics and Space Administration

before the

Subcommittee on Health and the Environment

Committee on the Energy and Commerce

U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss three separate issues in my testimony, (a) the current state of scientific knowledge concerning the physical and chemical processes which control the abundance and distribution of atmospheric ozone and its susceptibility to change due to human activities or to natural phenomena, (b) appropriate national and international responses, and (c) a description of the NASA Upper Atmospheric Research Program. I have prepared a written statement for the record, which, with your permission I will summarize.

A. Scientific Knowledge

This statement is based primarily on material contained in a comprehensive assessment document titled "Atmospheric Ozone 1985: Assessment of our Understanding of the Processes Controlling its Present Distribution and Change"-World Meteorological Organization Global Ozone Research and Monitoring Project Report #16 that was coordinated by the National Aeronautics and Space Administration (NASA) and cosponsored by NASA and two other U.S. agencies, the Federal Aviation Administration (FAA) and the National Oceanic and Atmospheric Administration (NOAA); three international agencies, the World Meteorological Organization (WMO), the United Nations Environment Program (UNEP), and the Commission of the European Communities (CEC); and the Bundesministerium fur Forschung und Technologie (BMFT) of the Federal Republic of Germany. Approximately 150 scientists from 11 countries contributed towards this 1500-page assessment report. This comprehensive assessment has been summarized by NASA into a 130-page report titled "Present State of Knowledge of the Upper Atmosphere: Processes that control ozone and other climatically important trace gases," NASA Reference Publication 1162. This NASA report was submitted to the Congress and to the Environmental Protection Agency (EPA) in

January of this year as part of NASA's obligations under the Clean Air Act Amendments of 1977.

For several decades scientists have sought to understand the complex interplay among the chemical, radiative, and dynamical processes that govern the structure of the Earth's atmosphere. During the last decade or so there has been particular interest in studying the processes which control atmospheric ozone since it has been predicted that human activities might cause harmful effects to the environment by modifying the total column amount and vertical distribution of atmospheric ozone. Most of the ozone in the Earth's atmosphere resides in a region of the atmosphere known as the stratosphere. The stratosphere extends from about 8 km at the poles, and 17 km at the equator, to about 50 km above the Earth's surface. Ozone is the only gas in the atmosphere that prevents harmful solar ultraviolet radiation from reaching the surface of the Earth. The total amount of ozone in the atmosphere would, if compressed to the pressure at the Earth's surface, be a layer about one eighth of an inch thick. Figure 1 schematically illustrates the vertical distribution of ozone and temperature. Unlike some other more localized environmental issues, e.g. acid deposition, ozone layer modification is a global phenomenon which affects the well-being of every country in the world. Changes in the total column amount of atmospheric ozone would modify the amount of biologically harmful ultraviolet radiation penetrating to the Earth's surface with potential adverse effects on human health (skin cancer and suppression of the immune response system) and on aquatic and terrestrial ecosystems. Changes in the vertical distribution of atmospheric ozone, along with changes in the atmospheric concentrations of other infrared active (greenhouse) gases, could contribute to a change in climate on a regional and global scale by modifying the atmospheric temperature structure which could lead to changes in atmospheric circulation and precipitation patterns. The so-called greenhouse gases are gases which can absorb infrared radiation emitted by the Earth's surface, thus reducing the amount of energy emitted to space, resulting in a warming of the Earth's lower atmosphere and surface.

The ozone issue and the greenhouse warming issue are strongly coupled because ozone itself is a greenhouse gas, and because the same gases which are predicted to modify ozone are also predicted to produce a climate warming. These gases include carbon monoxide (CO), carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and several chlorofluorocarbons (CFC's), including chlorofluorocarbons 11 (CFCl1) and 12 (CF2Cl2). CH4, N2O, and the CFC's, respectively, are precursors to the hydrogen, nitrogen, and chlorine oxides which can catalyze the destruction of ozone in the stratosphere by a series of chemical reactions. Concentrations of these gases in the parts per billion range control the abundance of ozone whose concentration is in the parts per million range, e.g. one molecule of a chlorofluorocarbon destroys thousands of molecules of ozone. CO and CO2 can affect ozone indirectly. CO controls the concentration of the hydroxyl radical in the troposphere which itself controls the atmospheric concentrations of some of the gases which can affect stratospheric chemistry. CO2 plays a key role in controlling the temperature structure of the stratosphere which itself is important in controlling the rates at which the hydrogen, nitrogen, and chlorine oxides destroy ozone.

There is now compelling observational evidence that the chemical composition of the atmosphere is changing at a rapid rate on a global scale. The atmospheric concentrations of CO2, CH4, N2O, and CFC's 11 and 12 are currently increasing at rates ranging from 0.2 to 5.0% per year. The concentrations of other gases, including CFC 113 and Halons 1211 and 1301, important in the ozone and global warming issues are also increasing, some at an even faster rate. These changes in atmospheric composition reflect in part the metabolism of the biosphere and in part a broad range of human activities, including agricultural and combustion practices. It should be noted that the only known source of the CFC's is industrial production. They are used for a variety of uses, including aerosol propellants, refrigerants, foam blowing agents, and solvents. At present one of our greatest difficulties in accurately predicting future changes in ozone or global warming is our inability to predict the future evolution of the atmospheric concentrations of these gases. We need to understand the role of the biosphere in regulating the emissions of gases such as CH4, CO2, N2O, and methyl chloride (CH3Cl) to the atmosphere, and we need to know the most probable future industrial release rates of gases such as the CFC's, N2O, CO, and CO2 which depend upon economic, social, and political factors.

One important aspect of the ozone and global warming issues is that the atmospheric lifetimes of gases such as N2O, CFCl3, and CF2Cl2 are known to be very long. Consequently, if there is a change in atmospheric ozone or climate caused by increasing atmospheric concentrations of these gases the full recovery of the system will take several tens to hundreds of years after the emission of these gases into the atmosphere is terminated.

Numerical models are used as a tool to predict to what extent human activities will modify atmospheric ozone and climate. The types of models most commonly used to predict ozone modification are known as one- and two-dimensional photochemical models. One-dimensional models predict changes in the column content and vertical distribution of ozone, but cannot predict variations in ozone modification with latitude, longitude, or season. Major progress has been made over the past few years to develop two-dimensional models which can predict the variation of ozone change as a function of season and latitude. Three-dimensional models which include longitudinal variations are being developed to study the coupling between the chemical, radiative, and dynamical processes which control the distribution of ozone, but these models are not yet ready to perform perturbation calculations.

Because it is now well recognized that the chemical effects of these gases on atmospheric ozone are strongly coupled and should not be considered in isolation, the most realistic calculations of ozone change take into account the impact of simultaneous changes in the atmospheric concentrations of CO2, CH4, N2O, the CFC's, and possibly other gases such as CO, oxides of nitrogen (NOx), and bromine containing substances. The effects of these trace gases on ozone are not simply additive. Increased atmospheric concentrations of CFC's and N2O are predicted to decrease the column content of ozone, whereas, increased atmospheric concentrations of CO2 and CH4 are predicted to increase the column content of ozone. Therefore, it can be seen that the effects of increasing concentrations of CFC's and N2O are to some degree offset by increasing concentrations of CO2 and CH4 as shown in figure 2. This is contrasted to the global warming issue where increased atmospheric concentrations of the same trace gases are all predicted to increase the temperature of the atmosphere in an approximately cumulative manner.

One-dimensional model calculations have been performed to predict how ozone would change with time assuming that the atmospheric concentrations of CO2, CH4, and N2O continue to increase at their current rates of 0.5, 1.0, and 0.2% per year, respectively, for the next 100 years, in conjunction with three different assumptions for the annual growth rates in the emission of CFC's 11 and 12 to the atmosphere, i.e. 0.0, 1.5, and 3.0%. For CFC emission increases of up to 1.5% per year the ozone column changes were calculated to be less than 3% over the next 70 years. With a CFC growth rate of 3.0% per year, the predicted ozone depletion is 10% after 70 years and rapidly increasing (see figure 3). The results of these calculations demonstrate the strong chemical coupling that exists between these gases, and the time scale on which ozone changes are predicted to occur. In essence, when the growth rates of the CFC's are less than the growth rates of CH4 and CO2 only small column ozone changes are predicted because the CFC effects on ozone are temporarily masked. However, when the growth rates of the CFC's exceed those of CH4 and CO2, these gases can no longer buffer the impact of the CFC's and large ozone depletions are predicted.

It should be noted that even when the predicted column ozone changes are small, and hence little change is expected in the amount of ultraviolet radiation reaching the Earth's surface; major changes in the vertical distribution of ozone are still predicted with potential consequences for climate. Figure 4 shows that ozone is predicted to decrease in the middle to upper stratosphere due primarily to the increasing concentrations of CFC's, and to increase in the troposphere due primarily to the increasing concentrations of CH4.

Two-dimensional models predict a significant variation in the ozone column decrease with latitude with the greatest depletions occurring at high latitudes. Depending upon the exact trace gas scenario used to predict ozone change, the pole to equator ratio of ozone depletion can range from a factor of 2 to 10. Seasonal effects are predicted but are somewhat less pronounced than the latitudinal effects. In general, two-dimensional models predict somewhat greater amounts of ozone depletion for the same trace gas scenarios than do one dimensional models. For example, a two-dimensional model calculation using the no growth scenario for CFCs discussed above (scenario A) would predict a global average ozone depletion of about two percent during the next 50-70 years with a depletion of 1.5% at the equator, 2% at 30 degrees North, and up to 4% at 60 degrees North.

One important question that has been debated during the last couple of years is whether the magnitude of the predicted ozone change is a linear or nonlinear function of atmospheric chlorine concentration. The issue is still somewhat unresolved although it now appears from most one- and two-dimensional model calculations that ozone change is a linear function of atmospheric chlorine (for atmospheric concentrations of chlorine of 25 parts per billion or less), and that sudden catastrophic global ozone depletions are unlikely with only small changes in the atmospheric concentrations of chlorine. However, this statement assumes that the models accurately represent the real world, yet prudence tells us that we should remember that these models are not perfect and that they cannot explain the observed large changes which are currently occurring in ozone over the Antarctic during springtime. Antarctic ozone is discussed later.

A crucial question is to assess the extent of changes in global ozone that have already taken place, and to compare the changes to what has been predicted by theory. The search for global ozone trends involves looking for small secular changes amidst large natural variations that occur on many time scales. Observations of the total column content and the vertical distribution of ozone have been made for several decades using networks of different measurement techniques. Unfortunately, each of these observational techniques have certain limitations which tends to restrict our confidence in the results. These limitations arise from factors such as the lack of continuity of reliable calibration and the uneven geographic distribution of stations. Statistical analyses of the data are required to identify small trends, amongst high natural variability, using data from relatively few stations.

In general, analyses for the trends in the total global column content of ozone using data from the ground based Dobson spectrophotometer network show no statistically significant trend since 1970, in agreement with model predictions for the same period when the changes in all of the trace gases are taken into account. It should be noted that the values of total global column ozone in the last three years have exhibited significant variability. Abnormally low values of total column ozone were observed in 1983 following the eruption of El-Chichon and the largest El-Nino event of this century. However, the values of total column ozone recovered in 1984, only to decrease significantly in 1985.

Trend estimates have also been made for the altitude profile of ozone from the network of stations using the Umkehr technique. Deriving an accurate trend for changes in the vertical distribution of ozone is more difficult than for the total column because there are fewer stations and the Umkehr measurements are very sensitive to the presence of aerosols in the atmosphere. Recent volcanic eruptions such as El-Chichon have deposited large quantities of aerosols into the stratosphere and thus the Umkehr data must be corrected. After correcting the derived ozone amounts for the aerosol interference, an estimate of the ozone trend in the middle and upper stratosphere (30 to 40km) gives a 2 to 3% decrease for the period 1970 to 1980. The magnitude of the change is broadly consistent with the predictions of photochemical models which predict that chlorine will have its maximum effect at this altitude.

A recent preliminary analysis of Nimbus 7 satellite Solar Backscatter Ultraviolet (SBUV) data has indicated that there has been a statistically significant change in both the total column content (a decrease) and the vertical distribution (a decrease in the middle and upper stratosphere) of atmospheric ozone between 1978 and 1984. Further analysis of the data indicates that most of the change has occurred since 1981. It is crucial to evaluate whether the data has been interpreted correctly, and if so, whether the decrease is due to natural causes such as a decrease in solar radiation, the 1982 eruption of El-Chichon, or the 1982 El-Nino event, or whether it is due to human activities such as the use of chlorofluorocarbons. At this time any of these explanations are plausible.

Important new observational evidence on ozone changes has recently been obtained. Data from a single Dobson instrument at Halley Bay (76 S, 27 W) has indicated a considerable decrease (greater than 40%) in the total column content of ozone above the Antarctic during the spring period (late August to early November) since 1957 with most of the decrease occurring since the mid

1970's. Satellite measurements using both the Nimbus 7 Total Ozone Monitoring System (TOMS) and the SBUV instruments have verified this trend over the Antarctic since 1979 and have demonstrated the spatial and temporal variations in this feature. It can be seen from the satellite data that the ozone decreases are not just confined to an area above Antarctica but extend from the South Pole to about 45 degrees South. Figure 5 shows the decrease in the monthly mean concentrations of the column amount of ozone over the Antarctic in October observed from 1979 to 1986. It should be noted that the amount of ozone in 1986 during October was higher than that observed in 1985. This may simply be the result of known interannual variability in atmospheric ozone or the start of a recovery in Antarctic ozone. During September the concentrations of ozone in 1986 were comparable to those in 1985. Ozone changes of a comparable magnitude are not observed over the Arctic. It is not yet evident whether the behavior of ozone above the Antarctic is an early warning of future changes in global ozone or whether it will always be confined to the Antarctic because of the special geophysical conditions that exist there. A special issue of Geophysical Research Letters in November 1986 contained about 40 papers discussing observations of ozone and other related parameters over Antarctica, and possible theoretical explanations of this phenomena. Both chemical and dynamical explanations have been advanced to explain the observation. While it has been suggested that these Antarctic ozone decreases are caused by increasing concentrations of chlorine in the stratosphere, no credible mechanism has been demonstrated. It is clear that the models using present chemical schemes are unable to simulate this effect. Until the processes responsible for the decrease in springtime Antarctic ozone are understood, it will not be possible to state with any certainty whether it is a precursor of a global trend. A major ground-based field measurement campaign took place at McMurdo between August and November of last year to study the ozone layer above the Antarctic. This campaign was cosponsored and coordinated by NASA, the National Science Foundation, the National Oceanic and Atmospheric Administration, and the Chemical Manufacturers Association. The campaign was exceedingly successful and the data from all four groups of experimentalists is now in the final stages of being analyzed. An extensive set of measurements of the chemical composition will result which will provide an important test of the different theoretical explanations of the Antarctic ozone hole. The measurements will include hydrochloric acid, chlorine nitrate, chlorine monoxide radical, chlorine dioxide, nitric acid, nitrogen dioxide, nitric oxide, nitrous oxide, hydrofluoric acid, ozone and other chemical species. It is clear from the results presented before this subcommittee by Solomon that the chemical composition of the lower stratosphere over Antarctica is significantly perturbed relative to that expected from theoretical considerations using standard homogeneous chemistry. The abundances of odd nitrogen species are low, while the abundances of odd chlorine species are high. However, it is in my opinion, premature to conclude that the cause of the loss of ozone over Antarctica is due to chlorofluorocarons. A comprehensive ground, aircraft and satellite program of measurements is planned for 1987 which should provide more definitive conclusions about the cause of the Antarctic ozone hole. This work is being complemented by additional laboratory research and theoretical modeling.

NASA has initiated a thorough scientific review of all satellite and ground-based total column and vertical distribution ozone data. This review, which will be completed by late summer of this year, includes a critical analysis of, (1) the calibration procedures used for ground and satellite instrumentation, (2) the information content of the measurements, (3) the statistical procedures used to analyze the data, (4) the consistency of satellite and ground-based data, and (5) the extent and cause for the depletion of ozone over Antarctica in springtime.

There are now observations of increases in the atmospheric concentrations of the gases predicted to affect ozone, and there are observations indicating that the total column content of ozone has changed significantly on a regional and possibly global scale. In addition, there are indications that the vertical distribution of ozone may also have changed. The question still remains concerning the reliability of the models used to predict ozone change. Given that we cannot directly test the accuracy of a prediction of the future state of the atmosphere, including the distribution of atmospheric ozone, we must test the models by trying to simulate the present atmosphere, including the distribution of atmospheric ozone, or by trying to simulate the evolution of the atmosphere, in particular ozone, over the past few years. This is done by comparing model predictions with atmospheric observations.

We should note that nearly all the key chemical constituents that are predicted to be present in the atmosphere, and that are important in ozone photochemistry, have now been observed. In general, the models predict the distribution of the chemical constituents quite well. However, the measurements are not adequate for critically testing the reliability of the photochemical models. Close examination of the intercomparison of measurements and model simulations of the present atmosphere reveal several disturbing disagreements. One of the major disagreements appears to be that modeled ozone concentrations are typically 30 to 50% lower than measured ozone concentrations in the upper stratosphere where it should be easiest to predict the concentration of ozone, and where chlorine is predicted to have its maximum effect. These types of disagreements limit our confidence in the predictive capability of these models. In the end, however, our predictive capability will be tested by measuring the changes taking place in the atmosphere. This will require careful measurements of critical species to be carried out over long time periods, i.e. decades. NASA, NOAA, and CMA recently cosponsored a workshop to design a "Network for the Detection of Stratospheric Change." This network would be designed primarily to provide the earliest possible detection of changes in the chemical and physical structure of the stratosphere, and the means to understand them. Implementation of such a network is a high priority.

As stated earlier, the observed increases in the atmospheric concentrations of the CFC's, CH4, CO2, and N2O also have direct implications for the Earth's radiative balance through the so-called greenhouse effect. These gases absorb infrared radiation in a part of the spectrum which is otherwise transparent. Presently, and in the near future, changes in the concentrations of trace gases other than CO2 are thought to be contributing to the greenhouse warming of the Earth's surface and lower atmosphere by an amount that is about equal to that due to changes in the concentration of CO2 (figure 6). The cumulative effect of the increase in all trace gases for the period 1850 to 1980 is a predicted equilibrium warming (this neglects the heat capacity of the oceans) in the range 0.7 to 2.0 K, about half of which should have occurred to date. Model calculations indicate that the greenhouse warming predicted to occur during the next 50 years should be about twice that which has occurred during the previous 130 years. Thus, problems of ozone change and climate change

comments to
Bob Hinswelend

should be considered together. It is also apparent that what has been previously thought of as the CO2-climate problem should more properly be thought of as the trace gas-chemistry-climate problem.

B. National and International Responses

In my opinion, protection of the ozone layer is one of the most important global environmental issues of our time. The issue of what, if any, National and International regulatory responses are needed for chemicals which threaten to modify the abundance and distribution of atmospheric ozone is, of course, timely. The United States has already signed and ratified the Vienna Convention for the Protection of the Ozone Layer, and is now actively participating in the current international negotiations on a protocol to limit/regulate chlorofluorocarbons. While in the long term we must confront the problem of ozone modification presented by all the trace gases whose atmospheric concentrations are increasing, i.e., the chlorinated alkanes, chlorofluorocarbons, Halons, methane, nitrous oxide, and carbon dioxide, it is appropriate in the short term to focus on the chlorofluorocarbons and the Halons. Based on our current understanding, it is clear that an uncontrolled expansion of the production and subsequent emission of chlorofluorocarbons into the Earth's atmosphere would lead to significant reductions in the total column concentration of ozone during the next several decades which could lead to adverse consequences for human health and aquatic and terrestrial ecosystems. In addition there would be a substantial redistribution of the vertical distribution of ozone which could modify the climate system. Consequently, even in the face of scientific uncertainties, prudence would dictate that it is urgent for us to devise at the International level a short term, as well as a long term, strategy to limit the emission of these chemicals into the atmosphere.

[illegible]

The cause of the recently observed Antarctic ozone hole is not yet understood. Until the mechanism of the ozone depletion is established, we will not be able to predict its global consequences. If the hole is shown to be caused by CFC's, in a mechanism that would destroy ozone on a global scale, then the need for CFC regulation would be significantly enhanced. For the present, however, I consider the Antarctic hole to be an indication that the ozone layer is indeed fragile, and subject to significant modification.

The real issues concern the scope of the chemicals covered, and the exact stringency of the short term and long term measures. Atmospheric ozone responds to the total atmospheric burden of chlorine and does not care from which particular partially or fully halogenated alkane the stratospheric chlorine originated, i.e., from fully halogenated chlorofluorocarbons with long atmospheric lifetimes such as CFC-11, CFC-12, CFC-113, or CFC-114, or from partially halogenated alkanes with short atmospheric lifetimes such as CH3CHl3, or CFC-22. In addition, it is recognized that emissions of brominated chemicals into the atmosphere, such as the Halons, would also lead to modification of the ozone layer. Consequently when formulating the scope of the regulations, policy makers should aim for broad coverage, taking into account four parameters, (a) the current levels of production of the chemicals, (b) their ozone depleting potential, (c) their atmospheric lifetimes, and (d) the potential for growth in their production. The broader the scope of regulations, the lower the stringency required to provide equal protection for the ozone layer.

It is essential that the United States continue to actively promote International cooperation. Unilateral action on the part of the United States would fall far short, in the long term, of the measures required to protect the ozone layer. National actions can never be as meaningful as an international agreement on a global issue such as this. Attention should currently focus on CFCs 11, 12 and 113 due to their high emission rates, high fraction reaching the stratosphere, and their high efficiency to destroy ozone. Consequently, if the initial goal is to insure that even in the absence of further regulatory measures that the long term depletion in total ozone is limited to a few percent globally and less than 5% at any latitude then an International protocol with maximum possible participation should be negotiated regulating the production of at least CFC's 11, 12, and 113 at today's level, with agreement to further reductions in production (perhaps 25%) within the next several years. Other chemicals which require consideration include Halons 1301 and 1211 which currently have low emission rates, but have the potential for rapid growth and have a very high efficiency to destroy ozone.

Obtaining an International agreement on a long-term phase out strategy is going to be more difficult because factors far beyond science are involved, such as the incentives and time required to stimulate the development and testing of substitutes. The one area in which all nations agree is that a long term strategy must incorporate an enhanced commitment to scientific research and assessment, with particular attention to the development and implementation of a Network for the Detection of Stratospheric Change. The key issue is whether it is necessary to agree now on a schedule for the complete phase out of all fully halogenated chlorofluorocarbons which can only be reversed by new scientific developments, or whether it would be sufficient to agree on a timetable for a partial reduction in the production of chlorofluorocarbons and a reassessment of the adequacy of the control measures based on scientific, technical, economic and other considerations.

C. NASA's Upper Atmospheric Research Program

It is clear that significant progress has been made in our understanding of the physical and chemical processes that control the distribution of ozone. However, we must recognize that significant uncertainties in our knowledge remain, and that these can only be resolved by a vigorous program of research. It is essential that the U.S. government and industry continue their strong commitment to studying the upper atmosphere, and that the scientific agencies continue their close collaboration at both the national and international level.

Several years ago, at the direction of Congress, NASA implemented a program of research, technology development, and monitoring of the Earth's upper atmosphere, with particular emphasis on the stratosphere where 90% of the Earth's ozone layer resides. In compliance with the Clean Air Act Amendments of 1977, Public Law 95-95, NASA biennially prepares an assessment report on the state of knowledge of the Earth's upper atmosphere, and on the content and progress of the NASA Upper Atmosphere Research Program (UARP). Since 1978 NASA has provided Congress with five assessment reports on the potential threat to atmospheric ozone from human activities. These assessments reflect the work of hundreds of atmospheric scientists and were produced after extensive discussion and analysis. The conclusions of the latest assessment report, titled "Present State of Knowledge of the Upper Atmosphere: An Assessment Report: Processes that control ozone and other climatically important trace gases," was transmitted to Congress in January 1986. The second part of the report which was also transmitted to Congress in January was titled "NASA Upper Atmosphere Research Program: Research Summaries 1984-1985." The next in these series of reports will be prepared later this year, and delivered to Congress in January 1988.

The long-term objectives of the NASA Upper Atmosphere Research Program are to perform research to:

(a) understand the chemical, dynamical, and radiative processes that control the physical structure and chemical composition of the Earth's upper atmosphere, and

(b) accurately assess possible perturbations of the upper atmosphere caused by human activities. Specifically, of greatest urgency at present is an assessment of the combined effects of continued increases in the atmospheric concentrations of carbon monoxide (CO), carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), oxides of nitrogen (NOx), and halogen containing gases such as chlorofluorocarbons 11 and 12 (CFCl3 and CF2Cl2) and methylchloroform (CH3CCl3) on atmospheric ozone and the climate system.

Our knowledge of the key physical and chemical processes controlling the chemical composition and structure of the upper atmosphere has advanced significantly during the last few years. However, we must recognize that significant uncertainties in our knowledge still remain and can only be resolved by a vigorous program of research. NASA is committed to continuing its leadership role in studying the upper atmosphere and working closely with the university and non-university scientific community; other U.S. government agencies, in particular the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Federal Aviation Administration (FAA); industry, i.e. the Chemical Manufacturers Association (CMA); and other national and international scientific agencies, e.g. the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), to resolve these outstanding uncertainties in an expeditious manner.

NASA's program is broad and comprehensive and its research activities generally fall into three general categories:

(1) Field Measurements and Technology Development:

This activity consists of studying the geographic distributions and strengths of trace gases released at the Earth's surface, measuring the solar irradiance incident on the Earth's atmosphere, determining the chemical composition and physical structure of the atmosphere using a balanced set of in-situ and remote sensing techniques, and the development of instrumentation. A wide range of instruments are currently being utilized on a variety of platforms including aircraft, balloons, rockets, space shuttle, and satellites. Ground based observations are also performed. The principal 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.

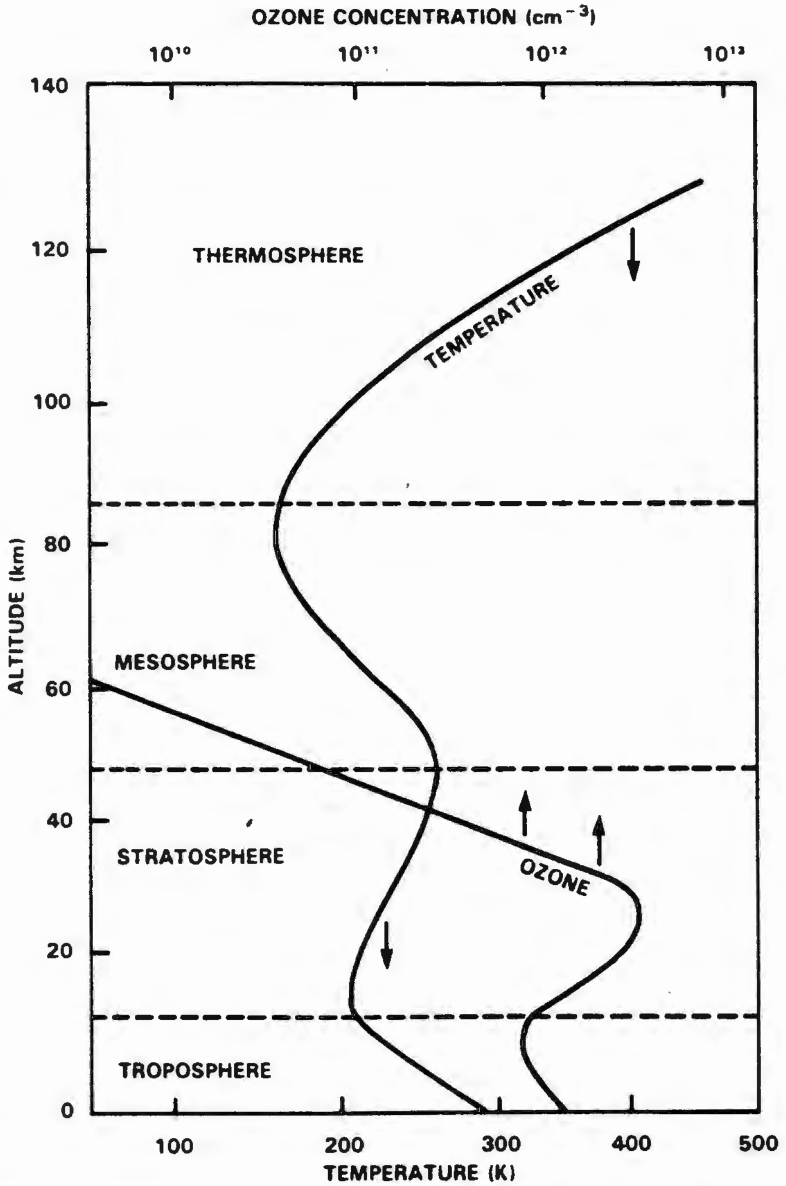
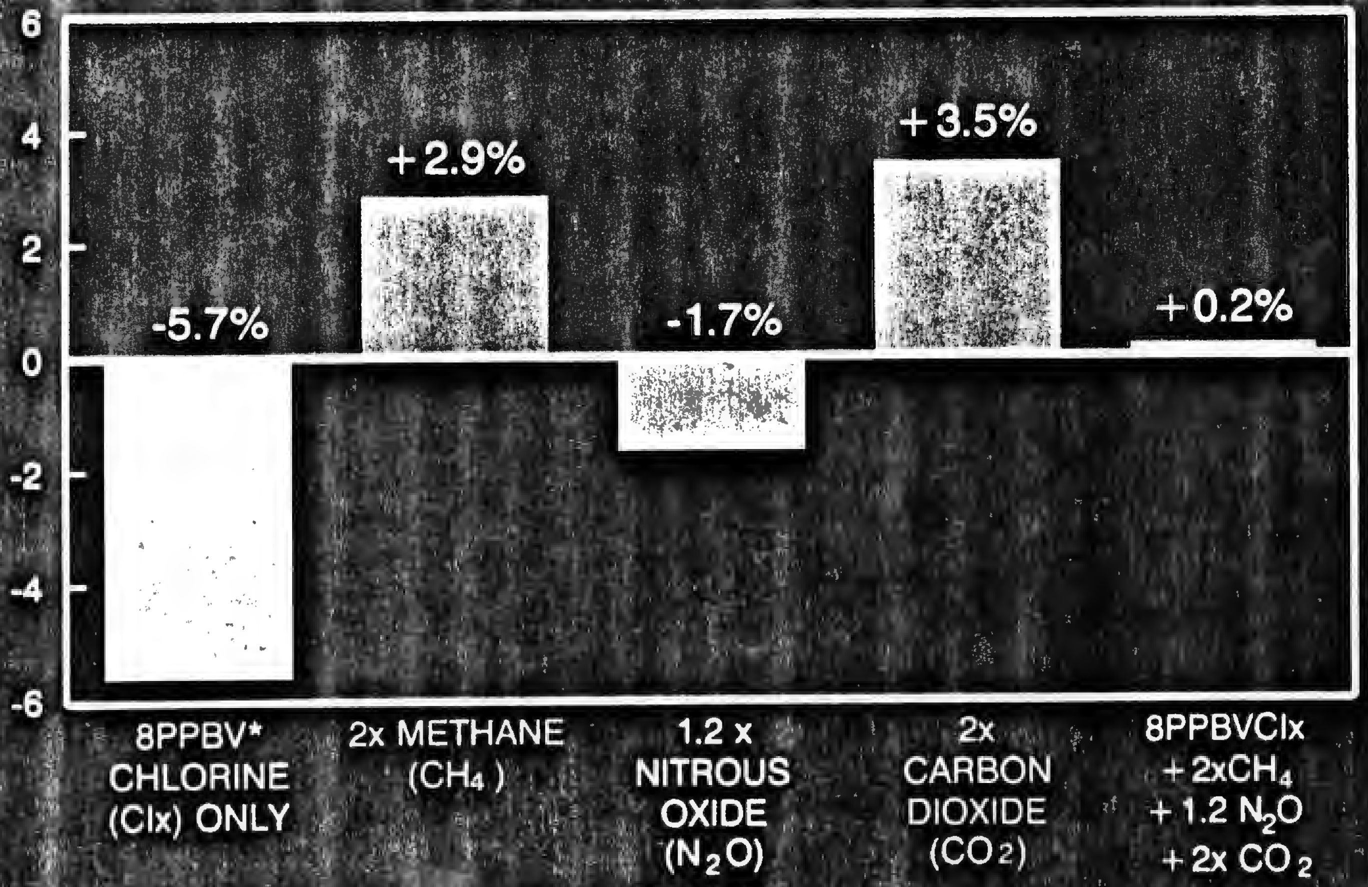


Figure 1. Temperature profile and ozone distribution in the atmosphere.

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.



* PPBV - PARTS PER BILLION BY VOLUME

G86A1290.005

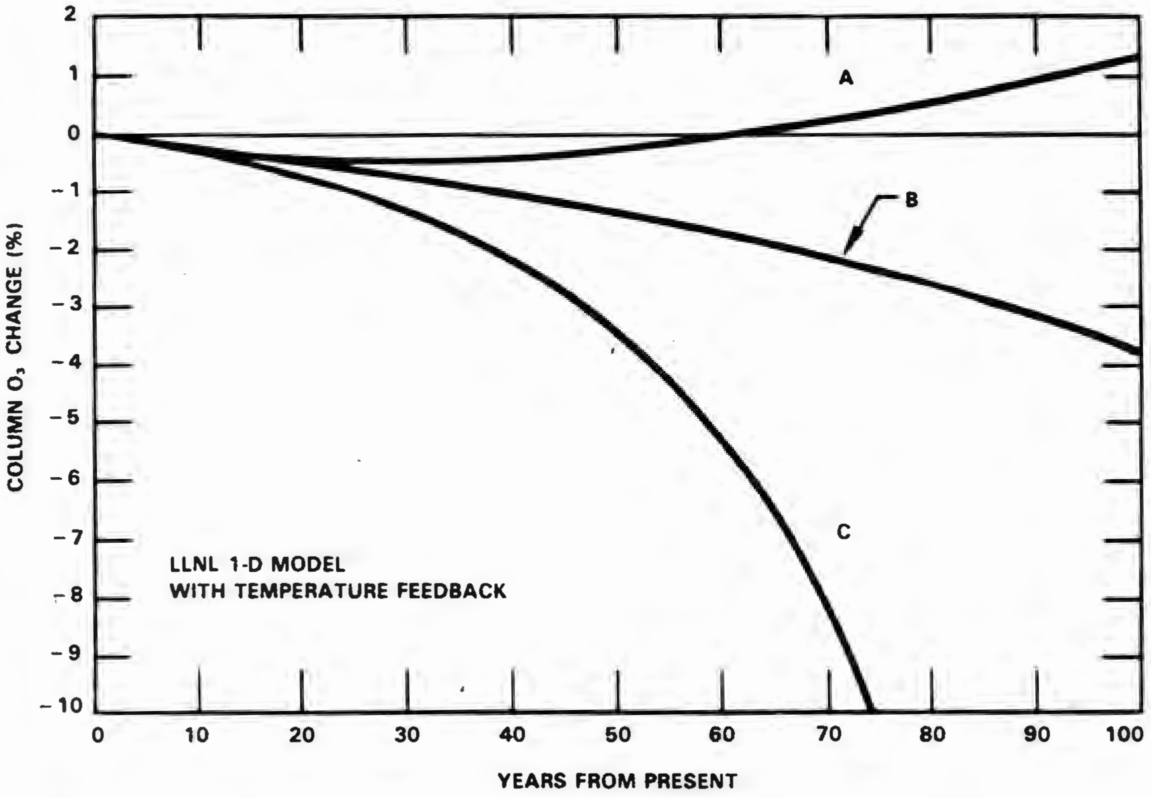


Figure 3. Calculated changes in ozone column with time for time-dependent scenarios: A (CFC flux continues at 1980 level, CH_4 increased 1% per yr, N_2O increases 0.25% per yr, and CO_2 increases according to the DOE scenario); B (CFC emissions begin at 1980 rates and increase at 1.5% per yr, other trace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

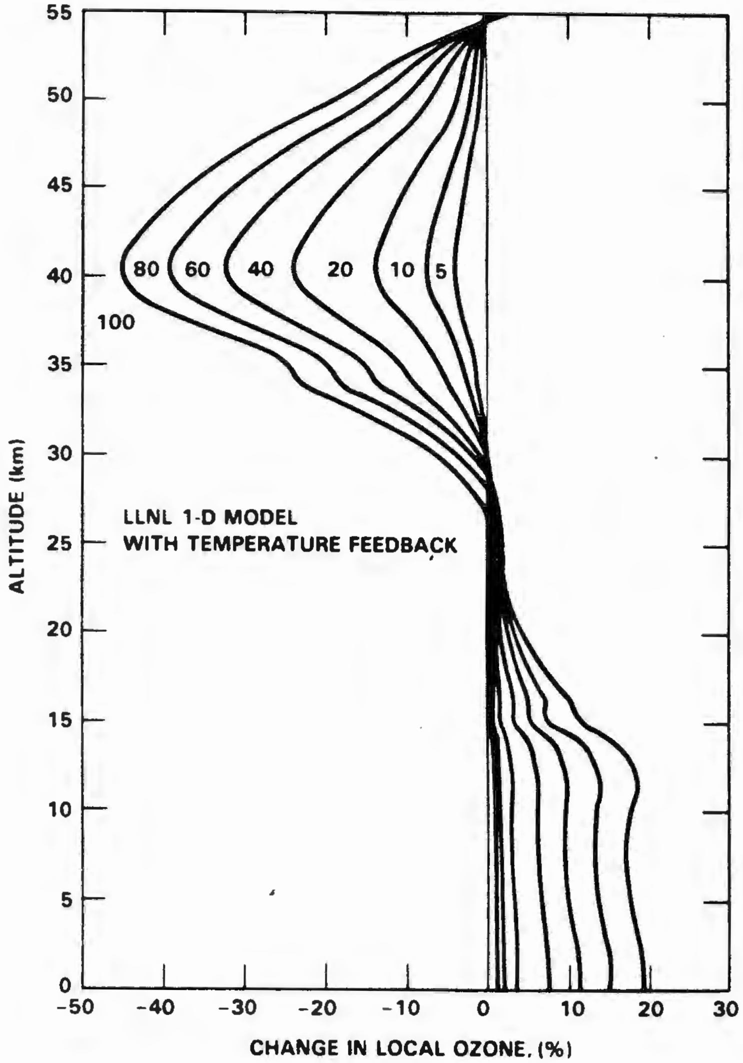
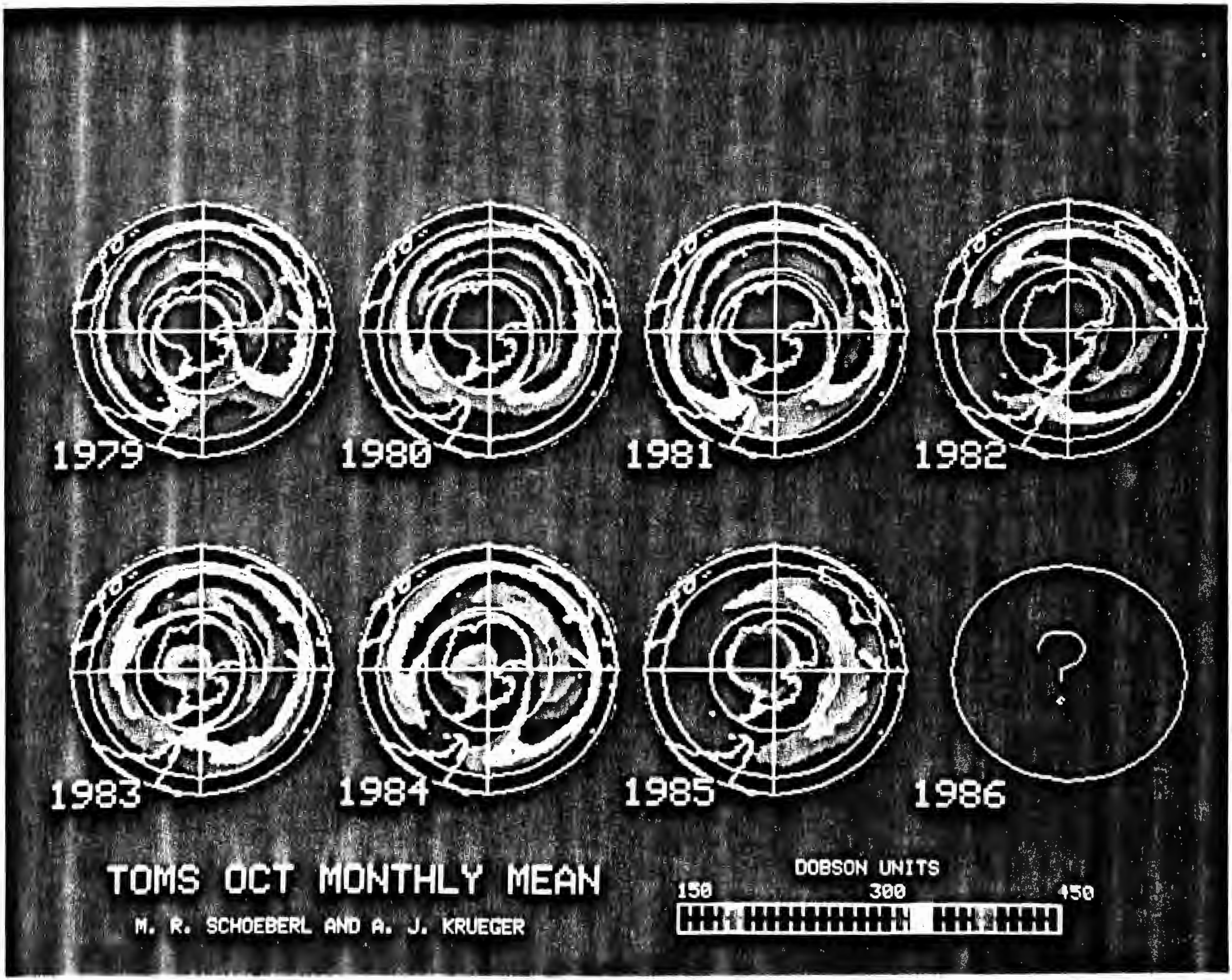


Figure 4. Calculated percentage change in local ozone at selected times (5 to 100 years) for scenario B of Figure 3.

Figure 5


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

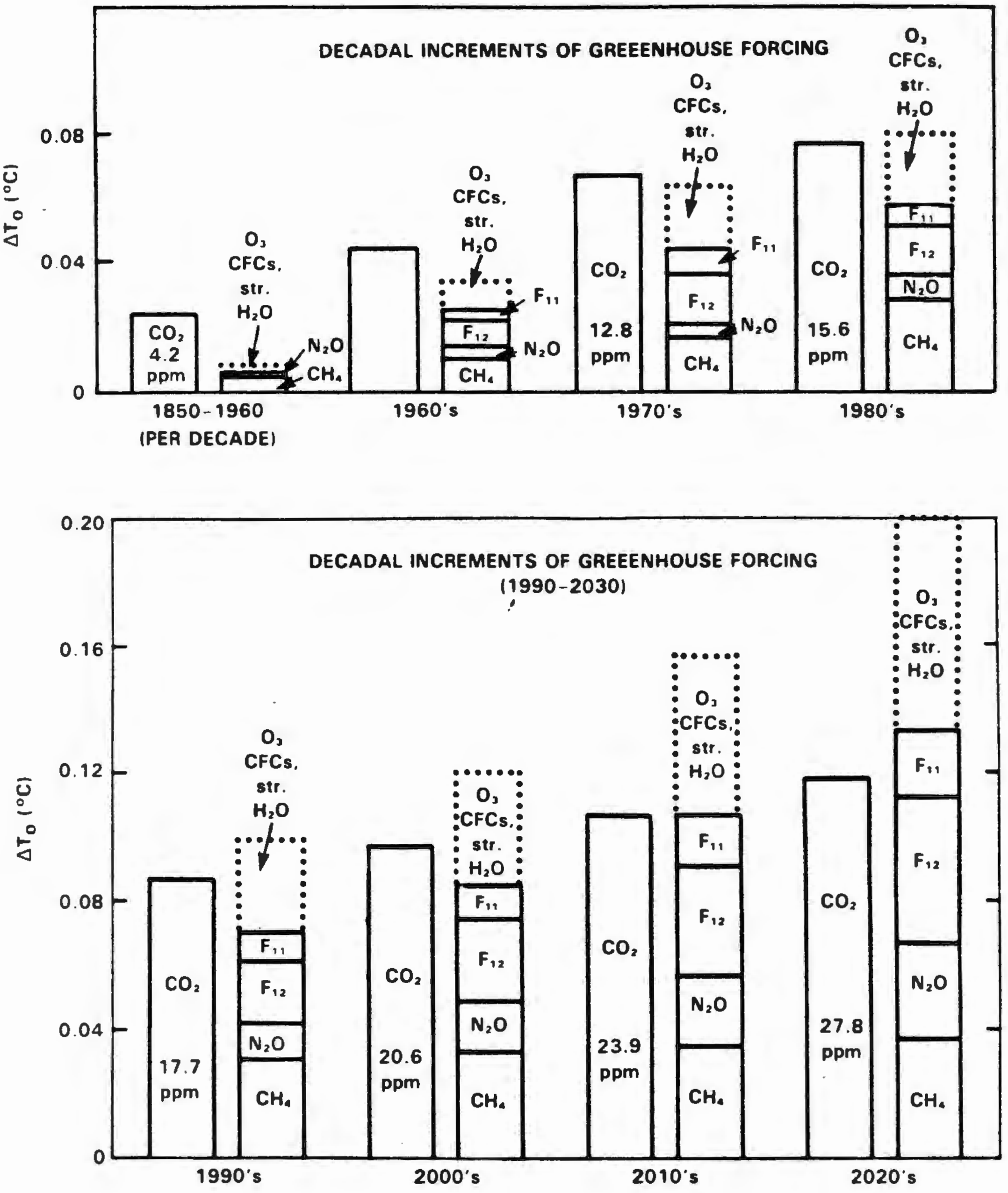


Figure 6. Decadal additions to global mean greenhouse forcing of the climate system. $(\Delta T_s)_0$ is the computed temperature change at equilibrium ($t \to \infty$) for the estimated decadal increases in trace gas abundances, with no climate feedbacks included.