

Originally Processed With FOIA(s):
2005-0336-F

FOIA Number:
2005-0336-F

FOIA MARKER

**This is not a textual record. This is used as an
administrative marker by the George Bush Presidential
Library Staff.**

Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: Global Climate Change Files

OA/ID Number: 62049
Folder ID Number: 62049-005

Folder Title:
Environment: Global Change [1 of 3] [1991]

Stack:

Row:

Section:

Shelf:

Position:

0

0

0

0

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9125269

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: YOSIE, Terry F.: AMERICAN PETROLEUM INSTITUTE

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/23/91

SUBJECT: HE IS FORWARDING A COPY OF A PAPER ENTITLED "CLIMATE
CHANGE AND ENERGY EFFICIENCY".

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
ENVIRONMENT
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 12/30/91 DEPT RECEIVED:
FILE: P-ENVIRONMENT-GLOBAL CHANGE
CENTRAL FILES:

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005
202-682-8090



Terry F. Yosie
Vice President

5269 J
RECEIVED

91 DEC 30 P 2: 21

OSTP
MAIL ROOM

December 23, 1991

Dr. Allan Bromley
Assistant to the President for
Science & Technology
The White House
360 OEOB
Washington, DC 20500

Allan
Dear Dr. Bromley:

The continuing scientific and policy debate over potential global climate change has highlighted the potential role that private industry can play through transferring information and techniques for more efficient use of energy.

Through a joint effort between the United Nations Environmental Programme and the International Petroleum Industry Environmental Conservation Association (of which the American Petroleum Institute is a principal member), a primer has been prepared, entitled Climate Change and Energy Efficiency, on how to achieve improved energy efficiency with a particular focus on small to medium sized firms in developing countries. This document provides a number of examples on how managers in these firms can practice energy auditing and thereby achieve the environmental gains such efficiency can yield.

This document is part of a continuing series of efforts by the petroleum industry to provide information to better inform scientists and policymakers in the development of climate change response strategies.

Sincerely,

**CLIMATE
CHANGE
AND
ENERGY
EFFICIENCY
IN
INDUSTRY**



"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9125253

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: LEE, T.J.: NASA, MARSHALL SPACE FLIGHT CENTER

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/23/91

SUBJECT: HE IS FORWARDING THE LATEST RESULTS OF SATELLITE
TEMPERATURE DATA COMPILED BY DR. ROY SPENCER, A
SCIENTIST IN THE REMOTE SENSING BRANCH OF THE
MARSHALL SPACE FLIGHT CENTER AND DR. JOHN CHRISTY OF
THE UNIVERSITY OF ALABAMA.

DIRECTORATE

ASSIGNED:

STAFF

ASSIGNED:

ACTION
REQUIRED:

STAFF
ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE:
DATE COMPLETED:

STAFF DUE DATE
DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
ENVIRONMENT

WHITE HOUSE TRACKING #:

CONTACT PERSON:
PHONE:

EXT:

REMARKS:

OSTP RECEIVED: 12/30/91 DEPT RECEIVED:
FILE: P-ENVIRONMENT-GLOBAL CHANGE

CENTRAL FILES:

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
AC(205)544-2121

RECEIVED

NASA

5253 J

91 DEC 30 P2:23

OSTP
MAIL ROOM
DEC 23 1991

Reply to Attn of: DA01

The Honorable Dr. Allan D. Bromley
Assistant to the President
for Science and Technology
Old Executive Office Building
17th St. & Pennsylvania Ave., N.W.
Washington, DC 20506

Dear Dr. Bromley:

As part of NASA's effort to keep your office fully informed of the Agency's science activities, I am forwarding to you the latest results of satellite temperature data compiled by Dr. Roy Spencer, a scientist in the Remote Sensing Branch of the Marshall Space Flight Center's Space Science Laboratory, and Dr. John Christy at the University of Alabama in Huntsville.

This information represents the third in a series of reports to Sen. Albert Gore following testimony by Dr. Spencer on global satellite temperature data studies before the Committee on Commerce, Science, and Transportation on October 11, 1990. Sen. Gore requested that we keep his office regularly informed of updates in his research.

The figures contained in this report show globally averaged, as well as latitude-band averaged, temperature trends in the lower troposphere and lower stratosphere from 1979 through October 1991. Of particular interest are the effects of the Mt. Pinatubo volcanic eruption of June 1991. Dramatic warming in the lower stratosphere has occurred since July of this year in response to the large amount of sulfuric acid aerosols produced by the volcano (Figures 1 and 2). The rate and magnitude of this warming is greater than that of the El Chichon eruption of 1982. This is consistent with other satellite and ground-based measurements which have suggested that the Pinatubo cloud might be at least twice as large as the El Chichon cloud, making Pinatubo the largest eruption of this century.

A significant consequence of this volcanic aerosol cloud is its possible effect on global temperatures. After El Chichon erupted in early 1982, global tropospheric temperatures in the tropics and mid-latitudes remained cool through 1986 (Figures 3 and 4), except during the record-setting 1983 "El Nino" warm event. While it cannot be conclusively proved that a cool period was directly due to El Chichon, it must be pointed out that a tropical cooling trend is now in progress (Figures 3 and 4) where the Pinatubo aerosol cloud has been concentrated. Note that a cool event in 1989 was related to a strong "La Nina", where strengthened upwelling of cool tropical ocean water caused temperatures to fall. Thus, since we are now supposedly entering a weak El Nino warm event, the current cooling trend cannot be attributed to La Nina.

As the cloud from Pinatubo spreads over most of the Earth this winter we might well see a continued cooling trend which could persist for several years. If this occurs, (potential) global warming due to an enhanced greenhouse effect would also be delayed.

We appreciate the opportunity to provide you with the results of the collaborative efforts by Dr. Spencer and Dr. Christy.

Sincerely,


T. J. Lee
Director

Enclosure

LOWER-STRATOSPHERE TEMP

CHAN= 4 SAMP RATE = 6 FILT WIDTH = 51

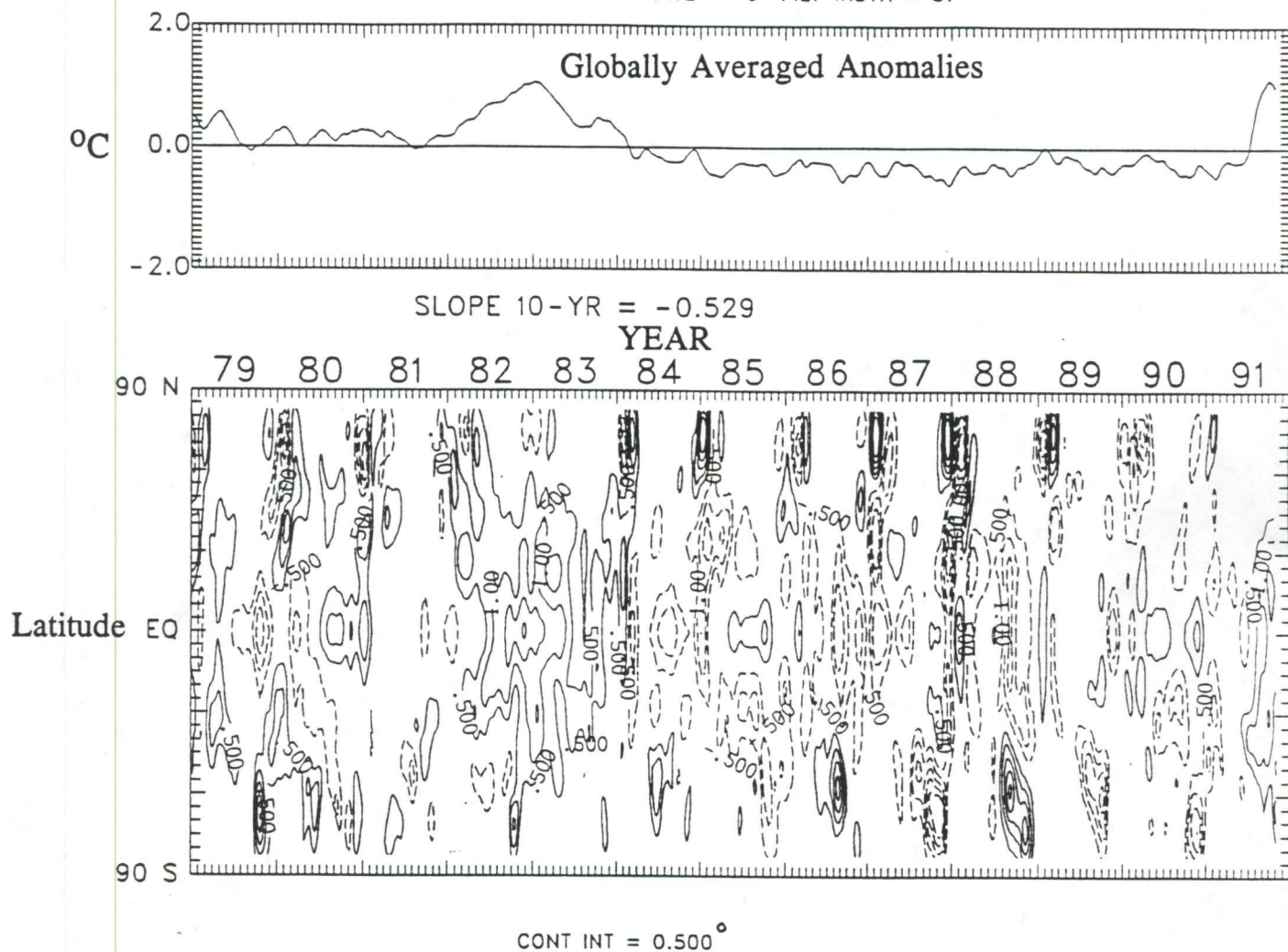


Figure 1

LOWER-STRATOSPHERE TEMP

CHAN= 4 SAMP RATE = 6 FILT WIDTH = 51

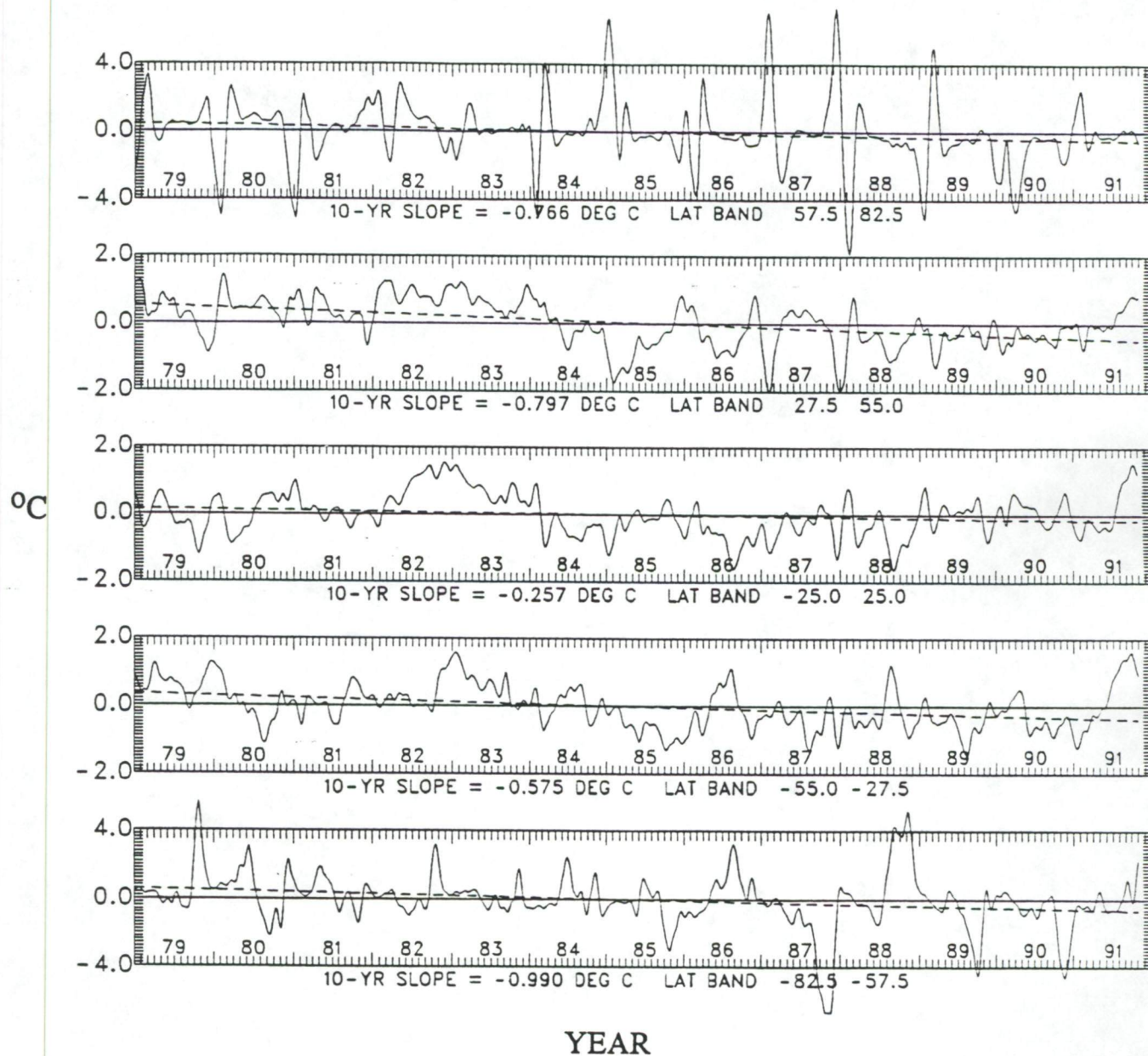
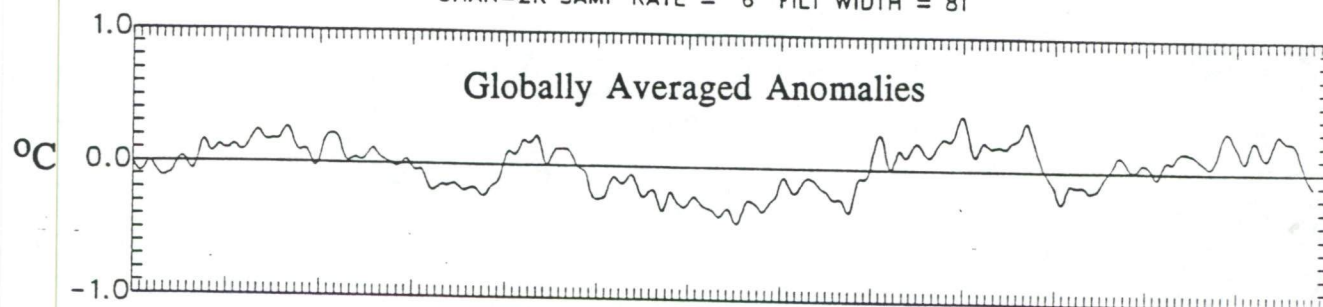


Figure 2

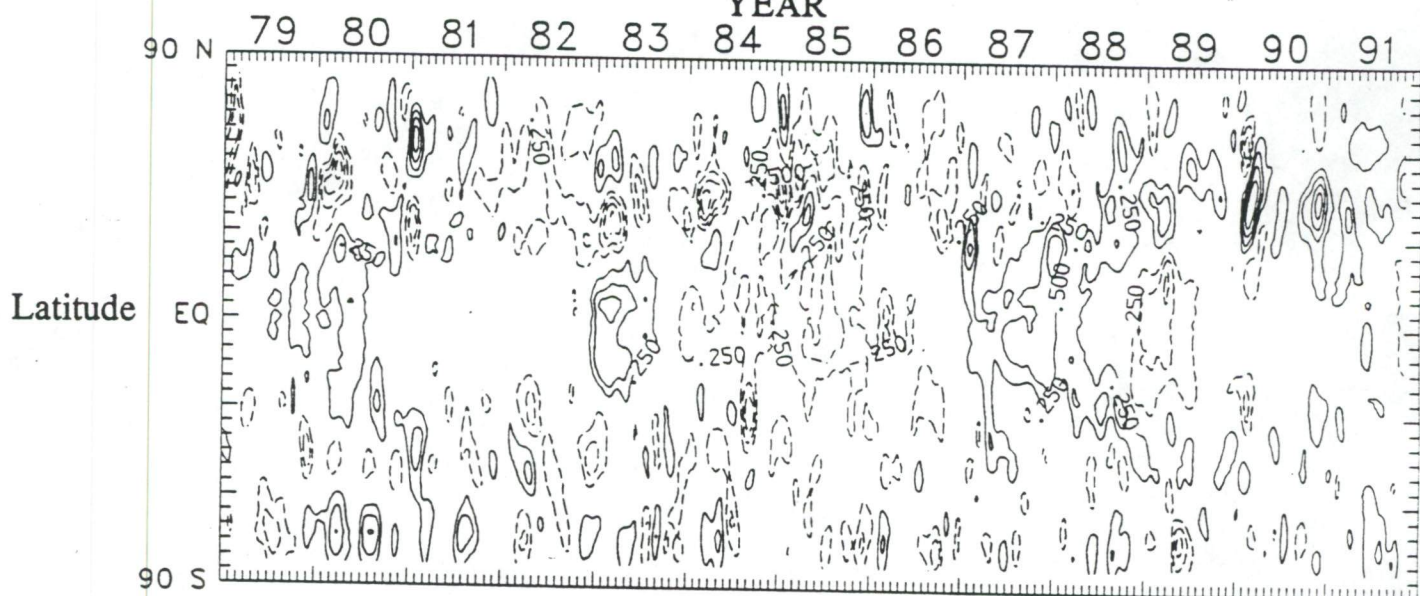
LOWER-TROPOSPHERE TEMP

CHAN=2R SAMP RATE = 6 FILT WIDTH = 81



SLOPE 10-YR = 0.077

YEAR



CONT INT = 0.250°

Figure 3

LOWER-TROPOSPHERE TEMP
CHAN=2R SAMP RATE = 6 FILT WIDTH = 81

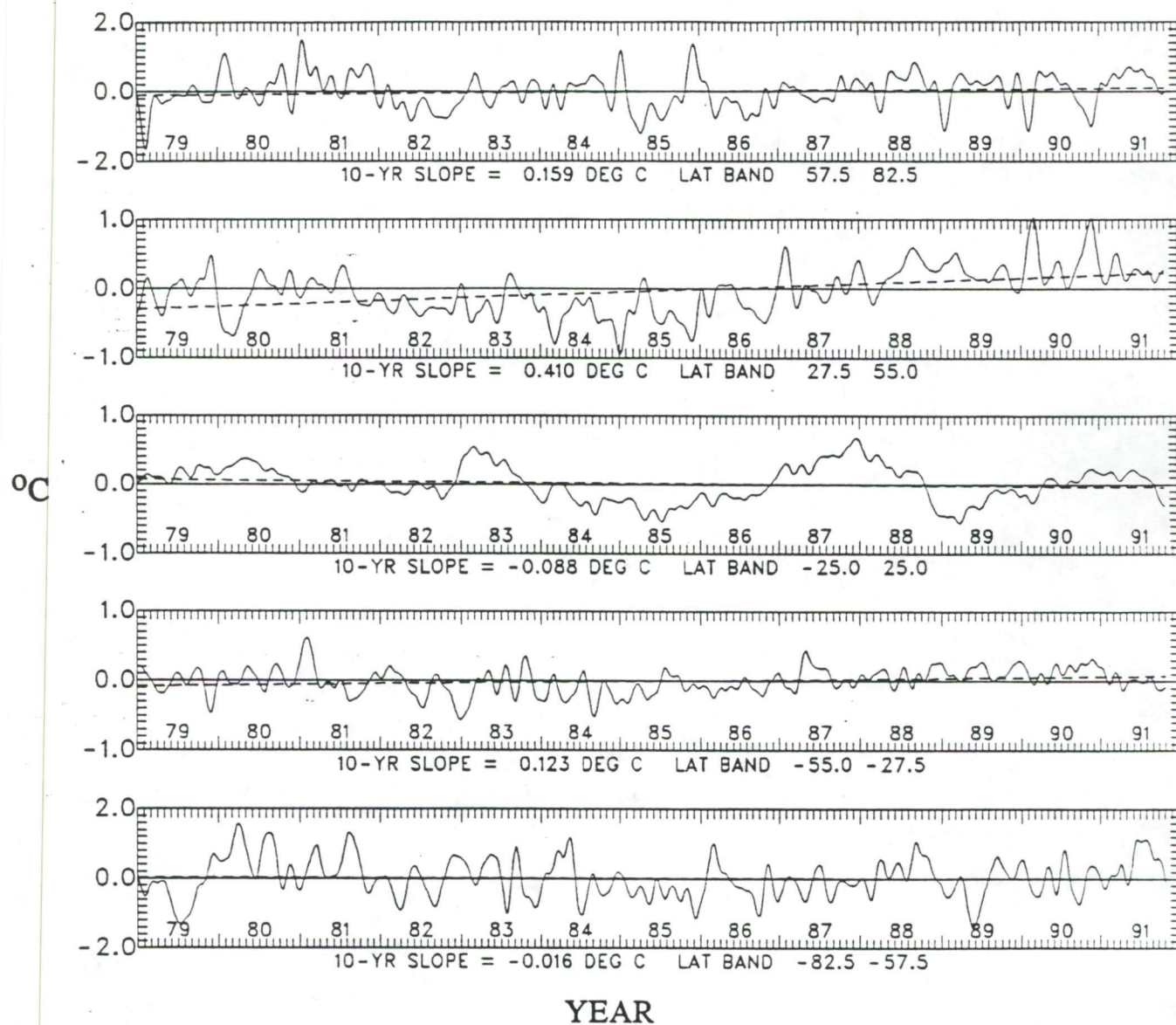


Figure 4

"Document Control"

TYPE: INFORMATION
ORIGINATOR: 02

DOCUMENT NUMBER: 9125112
DIRECTORATE STATUS

FROM: SUNLY, Madeline: THE MIT PRESS

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/06/91

SUBJECT: SHE IS PROVIDING DR. BROMLEY WITH A COPY OF "GLOBAL
BIOMASS BURNING" AS A RESULT OF HIS SPEECH ON "AN
APPROACH TO GLOBAL CLIMACTIC CHANGE: A UNITED STATES
PERSPECTIVE".

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 12/17/91

COPIES TO: D. Allan Bromley
ENVIRONMENT

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

CLOSED

OSTP RECEIVED: 12/13/91 DEPT RECEIVED:
FILE: P-ENVIRONMENT-GLOBAL CHANGE

CENTRAL FILES:

*I do want to
keep it - please
write an extra
pleasant note. I have
been a program full editor
for years prior to
Washington
DAB*

The MIT Press

55 Hayward Street
Cambridge
Massachusetts 02142

Massachusetts
Institute
of Technology

Telex
92.1473 MIT CAM
FAX Number
617.258.6779

6 December 1991

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
Old Executive Office Building
17th Street & Pennsylvania Avenue, NW
Washington, D.C. 20506

Dear Dr. Bromley:

One of our authors, Dr. Joel S. Levine of NASA, heard you speak on "An Approach to Global Climactic Change: A United States Perspective" at the CHEMRAWN VII World Conference The Chemistry of the Atmosphere: Its Impact on Global Change in Baltimore, Maryland on December 3, 1991. He tells us you gave a very enlightening and stimulating talk, and that you mentioned biomass burning and deforestation as a possible cause of global change.

The state of the information known about global biomass burning and its environmental impact is assessed in a new book entitled Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications, edited by Dr. Levine, published this month by the MIT Press. The book is based on an international conference organized by Dr. Levine and the American Geophysical Union (AGU). More than 200 scientists, government officials, and environmental policy planners from over 20 countries attended the conference in Williamsburg, Virginia in March, 1990.

Four important conclusions of the conference detailed in the book are that: 1) biomass burning (the burning of forests, grasslands, and agricultural stubble after the harvest) is much more widespread than previously believed (outliend in volume introduction); 2) biomass burning is a very significant source of atmospheric gases and may be responsible for as much as 40% of the global annual production of carbon dioxide, 32% of the world's production of carbon monoxide, and as much as 38% of the photochemical production of ozone in the troposphere (see

RECEIVED

91 DEC 13 P 3:07

OSIP
MAIL ROOM

Office of the Director

~~XXXXXXXXXX~~

617/253-4113

5112 I

page 13, Table 1.6); 3) the bulk of biomass burning is human-initiated and is increasing with time (pages 321-325); and 4) the majority of the human-initiated biomass burning may be significantly decreased over the next decade (pages 445-456).

Global Biomass Burning is the first and only definitive and comprehensive statement on biomass burning as a driver of global change. The advance comments and reviews indicate that it will become a very important and influential book. Its publication just six months before the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil is most timely.

In the hope that you and your staff will find this information useful, please accept the enclosed copy of Global Biomass Burning with the good wishes of the MIT Press and the volume editor, Joel S. Levine.

Sincerely,



Madeline Sunley,
Acquisitions

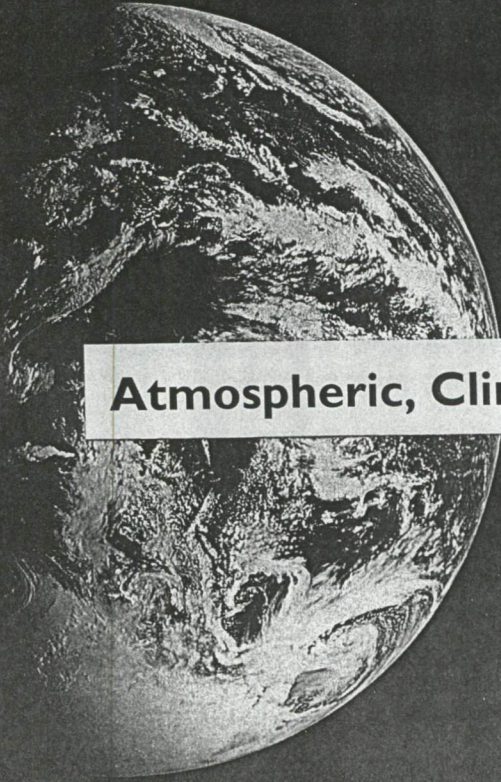
Enc.



GLOBAL

BIOMASS

BURNING



Atmospheric, Climatic, and Biospheric Implications

edited by

Joel S. Levine

THE WHITE HOUSE
WASHINGTON

December 17, 1991

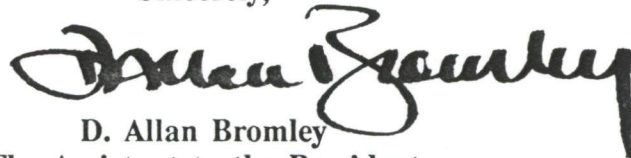
Dear Ms. Sunley:

Thank you for your recent letter and your comments on my CHEMRAWN speech in Baltimore.

I do appreciate your thinking of me and sending me Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications. As you know, the scientific uncertainties associated with global change make this an especially difficult issue for policy-makers. Therefore, a publication such as this which provides indepth information on one of the main factors in the global change question is most welcome. I intend to read it carefully and then share it with interested staff here.

My best wishes,

Sincerely,

A handwritten signature in dark ink, appearing to read "D. Allan Bromley", written in a cursive style.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Ms. Madeline Sunley
Acquisitions
The MIT Press
55 Hayward Street
Cambridge, MA 02142

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9125053
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS C

FROM: LAWSON, Richard L.: NATIONAL COAL ASSOCIATION

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/03/91

SUBJECT: RE: THE DRAFT EMISSIONS SCENARIO. HE REQUESTS DR.
BROMLEY AND OSTP TO REVIEW THE SCENARIO AND THE COAL
ASSOCIATIONS COMMENTS.

DIRECTORATE STAFF
ASSIGNED: ENVIRONMENT ASSIGNED: Nancy Maynard
Jim Waddell

ACTION STAFF
REQUIRED: AS NECESSARY ACTION: As Necessary

SENDER'S DUE DATE:
OSTP DUE DATE: 12/20/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT: 01/28/92

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS: Info Shared w/ IPCC Working Group - No further Action Needed,
Incominf in Admininstration files; Enviro X-REF: Make file For
Enviro Groups

OSTP RECEIVED: 12/06/91 DEPT RECEIVED: 12/06/91
FILE: P-ENVIRONMENT-GLOBAL CHANGE

CENTRAL FILES:



NATIONAL
COAL
ASSOCIATION



RECEIVED

RICHARD L. LAWSON
President
(202) 463-2647

91 DEC 6 A10:30

December 3, 1991

OSTP
MAIL ROOM

Dr. D. Allan Bromley
Assistant to the President for
Science and Technology
Old Executive Office Building
Washington, D.C. 20506

Dear Dr. Bromley:

I know that you are very much aware of the ongoing international negotiations which are leading to a framework convention on climate change. The National Coal Association strongly supports the Administration's "No Regrets" position which recognizes that the scientific evidence underlying the current popular projections of temperature increases is indeed, far from certain. Given these uncertainties, the only prudent actions for any nation to take are those which are economically beneficial in their own right.

An international group charged with providing background and technical information to the international negotiating teams, the Intergovernmental Panel on Climate Change, has recently issued a draft report, "Emissions Scenarios for the IPCC -- An Update", which could, if adopted in its current form, enhance the arguments of those in the international community that are supporting hasty and economically untested strategies to reduce emissions of greenhouse gases.

The draft report projects that global CO₂ emissions will be 25.0 percent higher in 2000 than the original IPCC estimates upon which current international projections of climate change are based. In 2025, CO₂ emissions are projected to be 30.5 percent higher than the original estimates which were accepted barely a year ago.

Should these new and higher emission estimates be accepted, there will be corresponding change in the estimates of the speed and magnitude of temperature increases. This would in turn increase international pressure for the United States to move away from the reasonable "no regrets" strategy of today.

This draft report, prepared in part by a US EPA contractor, is faulty from the start and should not be used as the basis for climate change forecasts (or as input to climate models which are themselves questionable) without a thorough and informed review by experts in the United States as well as abroad. National Coal Association,

along with the Edison Electric Institutes and the Climate Council, have reviewed the draft report as best we could without the benefit of an underlying analysis (not available to report reviewers), and a copy of our comments, along with a copy of the original draft report, is enclosed.

In addition to the very tenuous exercise of projecting energy emissions over a period of 110 years, we found that there are substantive problems with the assumptions upon which these forecasts are apparently based. For example, economic growth rates (particularly in developing countries the source of the greater proportion of future greenhouse gas emissions) are unrealistically high; there is no indication that prices of energy are considered; there seems to be little recognition that the conservation policies of developed nations especially, will affect energy consumption in the future.

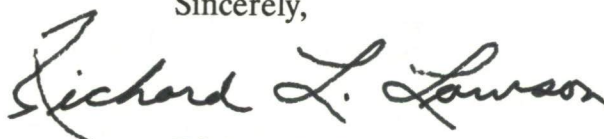
Most importantly the report seems to ignore the technological improvements and the improvements in efficiencies that will, without doubt, occur over the next 110 years. Technological improvements, efficiency and conservation are the underpinnings of the Administration's National Energy Strategy. The energy policies adopted in the United States, the technologies advanced as a result of the NES which will in turn be available throughout the world, are apparently ignored by this draft report.

We are very concerned that the data and analysis which will underlay projections of climate change, upon which response policies will undoubtedly be based, are so poorly prepared and will be adopted with little or no expert review or revisions.

I would like to urge you to instruct your staff to give review of the draft emissions scenario and our comments a high priority. It is essential that the United States representatives to the IPCC insist that all documentation underlying the report and estimates be available for thorough review and that the report, and emissions forecasts that it will include, be based on sound economic and technical projections and not, as is currently the case, upon poorly documented work.

There will be additional opportunities over the next few weeks to make our concerns known and it is especially important that the U.S. attend the IPCC meeting on January 13 - 15 prepared to disagree with the report and vote against its adoption until the substantive defects of the report are addressed.

Sincerely,

A handwritten signature in dark ink, reading "Richard L. Lawson". The signature is fluid and cursive, with the first name "Richard" being the most prominent part.

Richard L. Lawson

Emissions Scenarios for the IPCC an update

by

Robert J. Swart
William J. Pepper

Jane Leggett
L.G. Meira Filho
M.X. Wang
Jae Edmonds
John Wasson
[I.K. Abrol, Wu Zhongxin]

1. Introduction and Background

In 1989, the Response Strategies Working Group (RSWG) of the Intergovernmental Panel on Climate Change (IPCC) requested a US-Netherlands expert group to prepare a set of four scenarios for the global emissions of CO₂, CH₄, N₂O, halocarbons and the ozone precursors NO_x and CO (IPCC, 1991a). These scenarios were used by the Science Working Group for its assessment of future climate change (Houghton et al., 1990). New information has become available since the development of the original scenarios. In March 1991 the IPCC requested an update of these scenarios as part of the supplement to its first scientific assessment. In response to this request, Working Group I established an expert group to develop these scenarios (Swart et al., 1991). This chapter describes an updated reference scenario based on current programs, provides insights on uncertainties associated with the scenario through sensitivity analysis, and compares the updated reference scenario with previous studies. More detailed documentation is available in a companion document (Pepper et al., forthcoming).

The new information incorporated into this update reflects ongoing scientific research, policy agreements to reduce these emissions, and a revised understanding of future activities leading to emissions of greenhouse gases. This information includes:

- an improved understanding of current sources and sinks of greenhouse gases
- new data on rates of deforestation and forest biomass
- revised global and regional population forecasts
- recent national energy forecasts
- amendments to the Montreal Protocol and developments in participation and compliance with the Protocol

The reference scenario presented here also includes preliminary estimates of present and future emissions of volatile organic compounds and sulfur oxides.

The update of the emission scenarios differs from the original scenarios in several ways. First, while the scenarios of the first assessment had a normative character in that they had prescribed end points in terms of a doubling of the equivalent carbon dioxide concentrations, no

Draft-do not cite or quote

such restriction was placed upon the update of the scenarios. Second, only one full scenario has been developed for the update. This will be called the "1991 IPCC Reference Scenario" or "IRS91" and will be compared to the "1990 Business-As-Usual (BAU90) Scenario" from the first assessment.

The reader should be cautioned. A long term assessment of greenhouse gas emissions is necessary in order to assess the lagged impact of climate change. The 1991 IPCC Reference Scenario is part of this long term assessment. Its value is in identifying the implications of the factors most critical in determining future emission levels. It should not be considered a prediction of human activities or emissions. It represents an internally consistent view of one of the many ways in which the future could evolve, given a reasonable set of assumptions. These are based on numerous expert analyses, including scenarios of future national energy use, most of which have been subject to extensive review. Nevertheless many uncertainties exist over what will happen in the future, especially in the period beyond two to three decades from now. These uncertainties are of the following two types (Working Group I, 1991):

- 1) a scientific uncertainty attached to lack of knowledge concerning the physical parameters, emission factors, etc.
- 2) a more qualitative uncertainty associated with the evolution of future patterns of human activity in response to both climate and non-climate influences, such as technological advances and government policies.

We have addressed some of these uncertainties with sensitivity analyses of key parameters in order to provide insight into the range of uncertainty surrounding this reference scenario. We have not included the effects that climate change may have on agricultural production, energy demand, and terrestrial ecosystems.

2. General Assumptions

The assumptions for the 1991 IPCC Reference Scenario are based on a number of sources, primarily the approved forecasts of major international organizations. The assumptions are moderate and within the range of plausible alternatives, although these data generally reflect higher population and economic growth than assumed in the earlier assessment. The update also includes additional policies which reduce some emissions of the greenhouse gases. Future population growth is based on recent analyses by the World Bank (Bulatao, 1989). As shown in Figure 1, the updated population assumptions are close to 10% higher than the assumptions in the original assessment: global population increases from 4.84 billion in 1985 to 11.33 billion in 2100 with most of the growth in the developing countries. The UN also provides a forecast of future population (UN, 1990) through 2025. Global population in their median estimate reaches 8.51 billion in 2025, 1% higher than the World Bank estimate of 8.42 billion.

Future economic growth assumptions are based on the analyses prepared by the Energy and Industry Sub-Group (EIS) of the RSWG (IPCC, 1991b) and are summarized in Table 1. Economic growth assumptions are generally higher than those used in the first assessment especially in the USSR, Eastern Europe, and China. Income per capita rises most rapidly in the developing world but continues to remain well below levels in the developed economies. It should be noted that the results provided in this paper are highly sensitive to these assumptions.

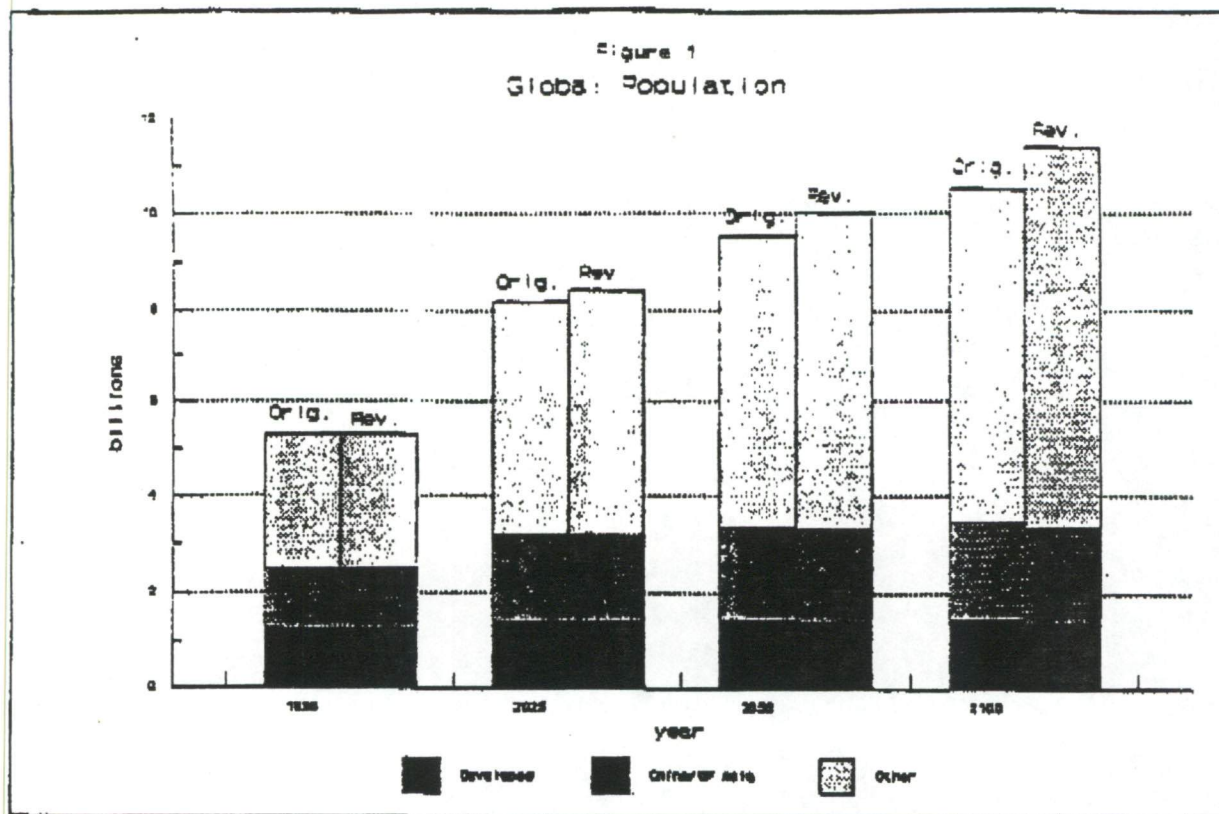


Table 1
Economic Growth Projections
(% GDP growth per year)

	1990 BAU Scenario*				1991 Reference Scenario**			
	1985- 2000	2000- 2025	2025- 2050	2050- 2100	1985- 2000	2000- 2025	2025- 2050	2050- 2100
US	2.5	2.0	1.5	1.1	2.6	1.9	1.5	1.1
W.Europe/Canada	2.5	2.0	1.5	1.1	2.6	2.1	1.5	1.1
OECD Pacific	3.0	2.0	1.5	1.1	3.9	2.7	1.5	1.1
USSR/E.Europe	3.6	3.1	2.3	2.0	3.3	3.1	2.3	2.0
China & CP Asia	4.5	4.0	3.5	3.1	5.2	5.4	3.5	3.2
Middle East	3.7	3.7	2.9	2.5	5.4	4.6	3.3	2.6
Africa	3.7	3.3	2.8	2.4	2.8	4.7	3.8	3.1
Latin America	3.7	3.2	2.7	2.3	3.5	3.3	2.7	2.4
S/SE Asia	4.6	3.8	3.3	2.9	4.5	4.6	3.8	3.1

* Average of high and low economic growth assumptions (IPCC, 1990).

** Based on EIS (IPCC, 1991b) through 2025. Adapted from original scenarios after 2025.

It is highly uncertain whether some of the ambitious growth figures can be realized and maintained in all regions, notably in the presently volatile circumstances in the nations of the USSR, Eastern Europe, and some of the developing areas. (The significance of these events are discussed later in this chapter.) Possible negative impacts of environmental degradation or, for that matter, environmental policies on economic growth have not been taken into account. On the other hand, an unexpected even more positive development of economic productivity than assumed can not be ruled out.

Several national and international policy proposals or agreements have a bearing on greenhouse gas emissions. The 1991 IPCC Reference Scenario incorporates only those emission controls internationally agreed upon and national policies enacted into law. For example, this comprises the London Amendments to the Montreal Protocol, the revised US Clean Air Act and the provisions of the NO_x protocol of the Convention on Long Range Transboundary Air Pollution. It does not include the CO₂-emissions targets that have been proposed by a large number of OECD countries or broad policy proposals to cut back on deforestation. We have included an evaluation of the potential impact of proposed CO₂ emission targets as part of a sensitivity analysis.

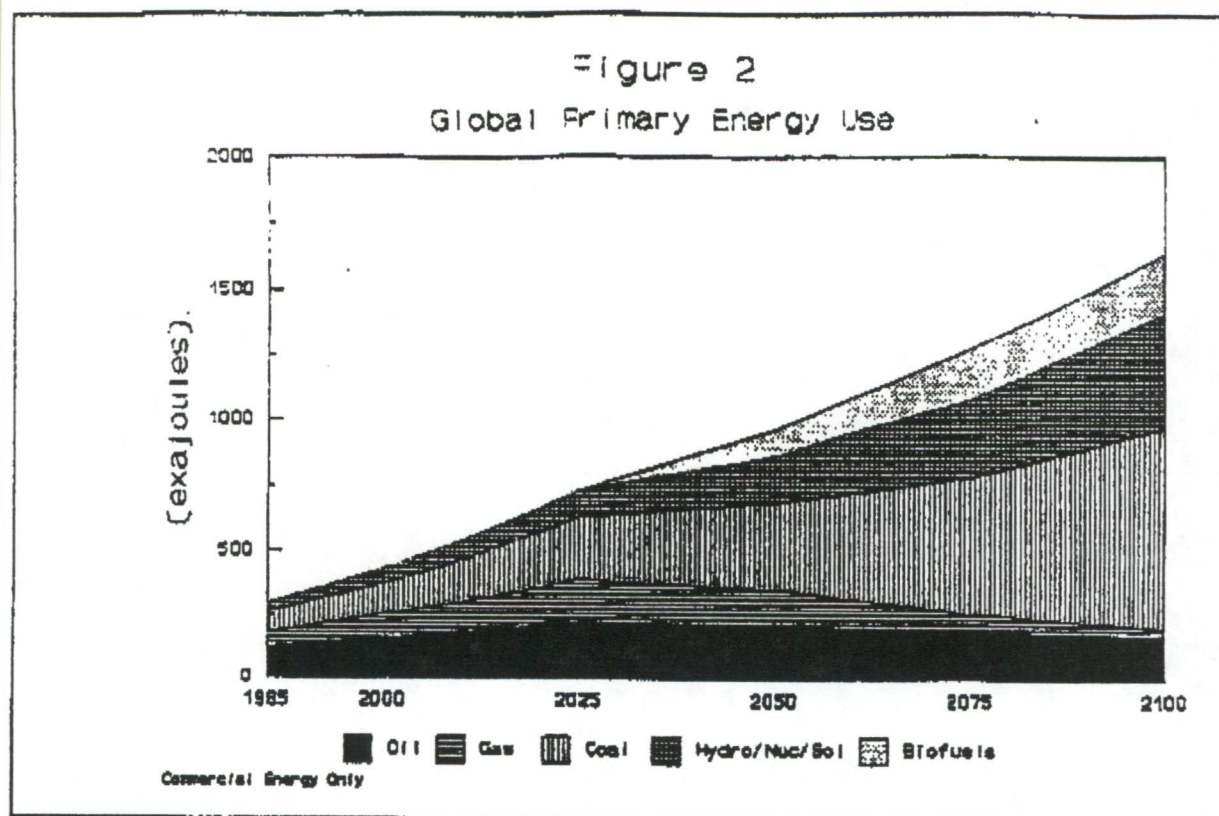
3. Energy

The reference case for consumption and supply of energy and the associated emissions of carbon dioxide are based on the Reference Scenario of the EIS (IPCC, 1991b). The EIS scenario estimates future energy use and emissions through 2025 by sector and by fuel type for a large number of countries, as derived from both national submissions and independent country case studies. For regional estimates and an extrapolation beyond 2025, the U.S. EPA's Atmospheric Stabilization Framework (ASF) has been used as a tool to achieve consistency. In this way global energy supplies have been matched with the national demand and supply estimates. Emission factors from the OECD have been applied to estimate associated emissions.

This scenario represents a global energy system which continues to be dependent on fossil fuels, notably coal, and which shows only moderate gains in energy efficiency and technological development of non-fossil energy sources. This scenario assumes no policies to reduce emissions of CO₂ or other greenhouse gases. It also assumes slow structural change in the economies of the USSR and Eastern Europe.

Global energy use rises quickly through 2025 in response to rapid increases in population and income (see Figure 2). After 2025, this growth is more moderate due to the stabilization of population levels in many regions and reductions in the rate of growth in income. Commercial primary energy use which is 349 exajoules (EJ) in 1990, grows to 737 EJ by 2025 and to 1641 EJ by 2100.¹ Primary fossil energy use represents over 85% of primary energy use through 2025. After 2025, the fossil share of primary energy declines to 60% by 2100 despite increases in fossil energy production and use of 80%. Energy sources such as nuclear, hydro, solar, and commercial biofuels play a much more important role after 2025.

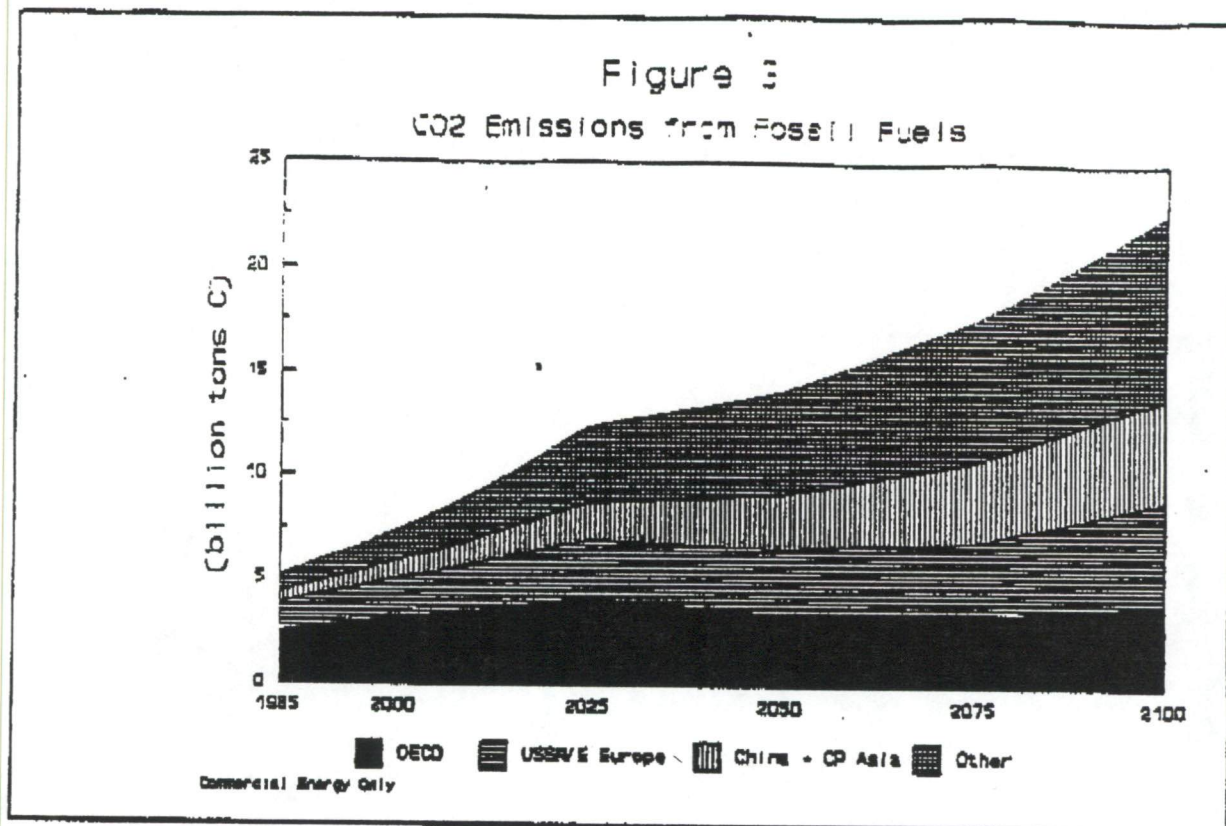
¹ Primary energy use in the 1990 BAU scenario was 473 to 657 EJ in 2025 and 728 to 1682 EJ in 2100, the range reflecting alternate economic growth projections.



CO₂ emissions from energy use increase in proportion to the increases in primary energy use. CO₂ emissions increase from 5.9 billion tons of carbon (Bt C) in 1990 to 12.4 Bt C in 2025 and 22.6 Bt C in 2100.² Compared to the original BAU scenario, this represents somewhat faster growth before 2025 but more moderate growth afterwards. Through 2025, these differences reflect the more rapid population and economic growth assumptions in the updated scenario compared to the 1990 BAU scenario combined with less optimistic assumptions concerning improvements in energy efficiency and are based on the EIS reference scenario. After 2025, the updated scenario relies more heavily on non-fossil energy sources thereby reducing the rate of growth in CO₂ emissions.

While global CO₂ emissions from energy use grow fairly constantly from 5.9 Bt C in 1990 to over 20 Bt C by 2100 (see Figure 3), the regional patterns differ considerably. CO₂ emissions from the developed economies grow at an average annual rate of 1.5% through 2025. After 2025, lower economic growth combined with stabilized population levels and increasing use of non-fossil energy sources yield reductions in this growth to an annual average of 0.3% with some developed economies experiencing some decline in emissions from 2025 levels. Emissions from developing economies, which are less than 25% of emissions from developed economies on a per-capita basis, continue to rise due to increases in population and economic growth.

² Average CO₂ emissions in the 1990 BAU scenario was 11.5 Bt C in 2025 and 22.4 Bt C in 2100.



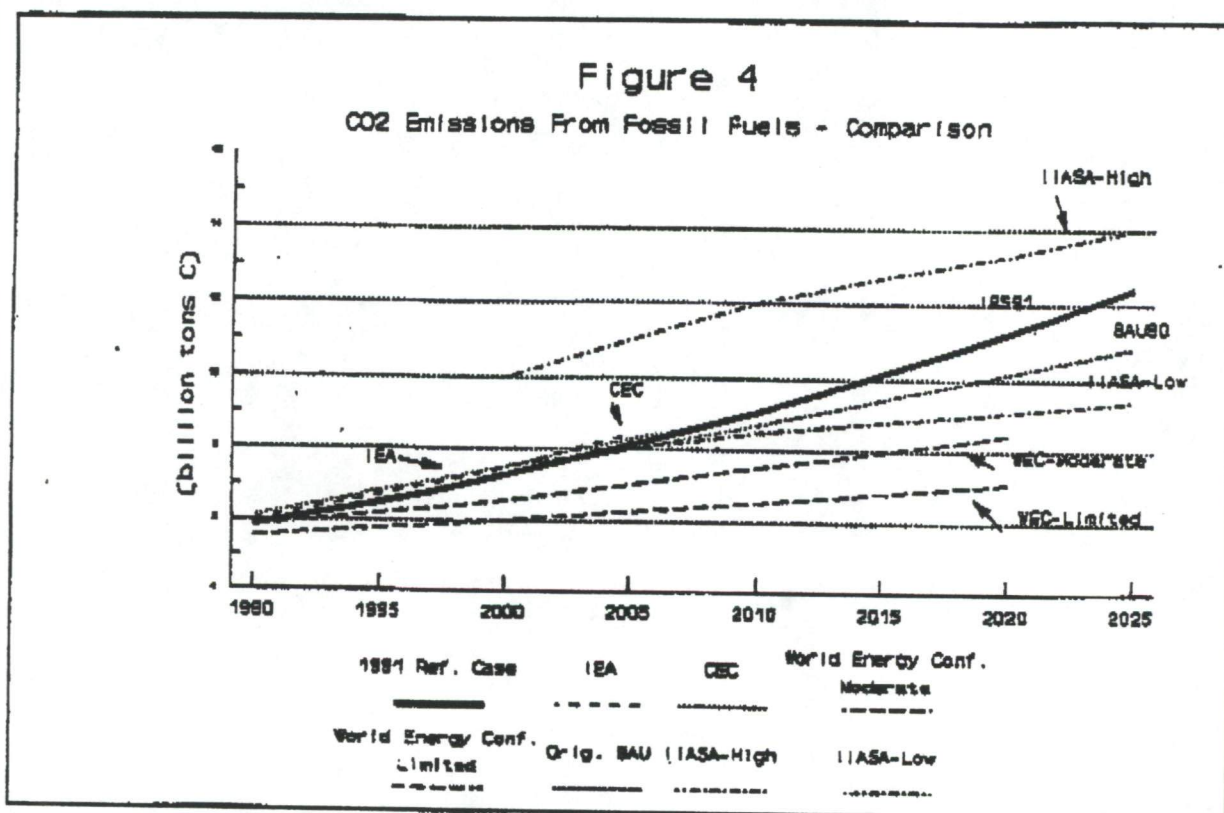
The stabilization goal for fossil carbon dioxide emissions for the year 2000 proposed by the majority of OECD countries has also been analyzed. If these proposals are implemented and if emissions are kept at targets specified by the countries and the rest of the world does not adopt similar measures, global emissions in 2025 of fossil carbon would be 0.6 Bt C lower than in the 1991 IPCC Reference Scenario. This reduction represents a reduction of 15 per cent in emissions of CO₂ from the OECD from the reference scenario but only a 5 per cent reduction in global emissions. These results reflect the importance of the economies of developing countries and of the economies of the USSR and Eastern Europe over the long term.

One area requiring close inspection is the USSR and Eastern Europe. The EIS scenario assumes that very slow progress is made toward restructuring these economies and that economic growth rates of over 3 per cent annually could be maintained. If we assumed that the economies did not grow over the next ten years and then started to grow at similar rates then energy use and emissions of CO₂ could be expected to be much lower. Annual primary energy use could be more than 20 EJ less in the period 2000 to 2025 and annual CO₂ emissions could be more than 0.3 Bt C less in this period.

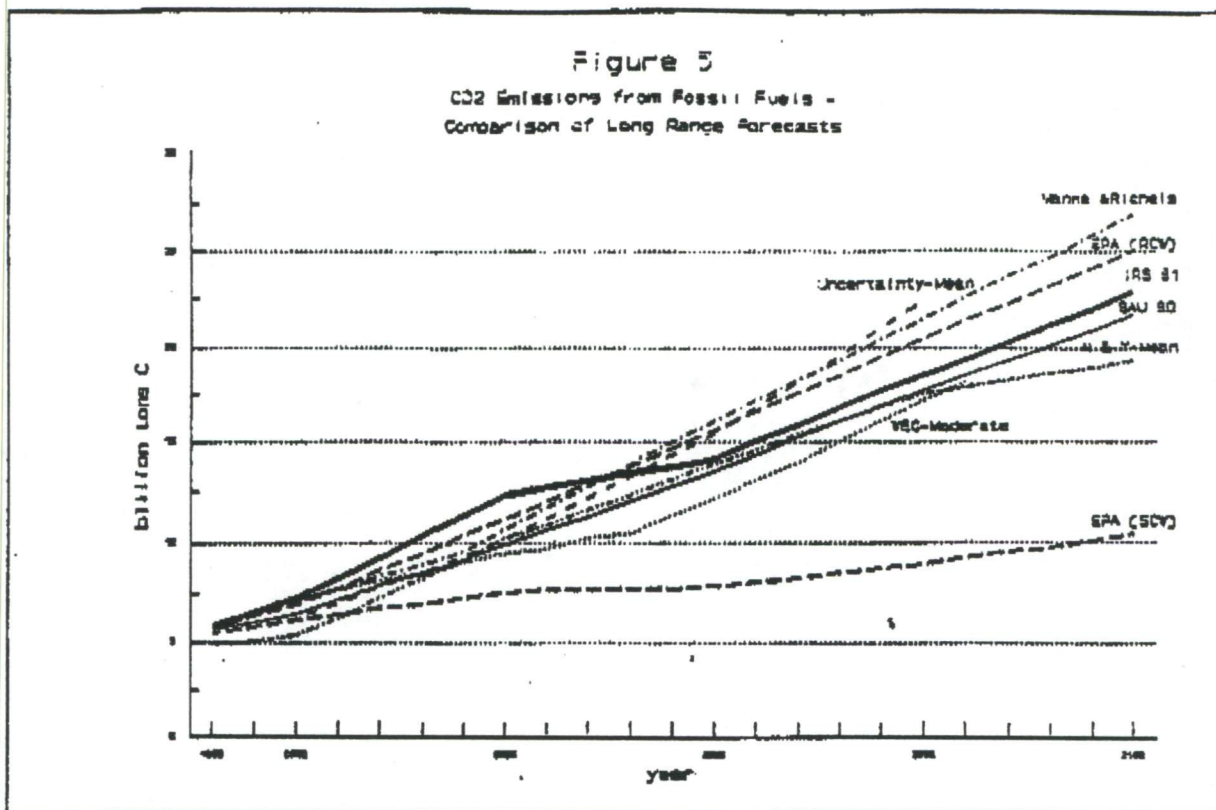
The scenario of future energy use and emissions of greenhouse gases resulting from this energy use represents only one of many possible futures. To help assess the degree of uncertainty associated with the reference scenario, we have assembled and reviewed 24 reference scenarios from 12 analyses of fossil fuel carbon emissions (Edmonds et al., 1991).

Two studies, Edmonds et al. (1986) and Nordhaus and Yohe (1983) examined the issue of uncertainty explicitly and both found a relatively wide variation in potential future emissions in the absence of policies to limit this growth. The 1991 IPCC Reference Scenario fell within the bounds of both of these studies and was very close to the median values from Nordhaus and Yohe in the 2050 to 2100 time period and within the 25th and 75th percentiles in the Edmonds analysis. The results from these studies also show that emission trajectories are extremely sensitive to a number of key parameters including population growth, improvements in energy efficiency and structural change in the economy, economic growth, and the future cost of fossil energy and alternative non-fossil energy.

Figure 4 compares CO₂ emissions from 1991 IPCC Reference Scenario to emissions adapted from scenarios of future energy use developed by the International Energy Agency (IEA, 1991), the Commission of the European Communities (CEC, 1989), the World Energy Conference (WEC, 1989), IASA (Hafele, 1981), and the 1990 BAU scenario for the period up to 2025. Emissions in the IEA and CEC scenarios are 5% higher than the emissions from the IRS91 through 2010. Emissions in the WEC moderate scenario are 25% less. Emissions from the 1991 Reference Scenario fall within the high and low estimates from IASA. Figure 5 compares these emissions to 7 other scenarios including the 1990 BAU scenario, two scenarios developed by the EPA (1990), the mean scenario from Edmonds uncertainty analysis, the median scenario from Nordhaus and Yohe, a scenario from Manne and Richaels (1990), and the WEC scenario. Emissions are at the high end of the range through 2025 but fall towards the middle of the range by 2100. The results of the 1991 Reference Scenario are also well within the range of



Draft-do not cite or quote



the scenarios developed within the framework of the Energy Modeling Forum, an authoritative international panel of energy analysts that will publish its results in mid-1992 (Weyant, 1991: personal communication).

The relatively high growth through 2025 in the IRS91 is due primarily to optimistic assumptions about economic growth in the near term assumed in EIS, compared to assumptions in the other studies. Assumptions concerning efficiency improvements are more optimistic in IRS91 than in the other studies after 2025. Also, the IRS91 assumes that the international fossil energy production and distribution capacity, necessary to satisfy the national energy demands, can be developed and effectively maintained under the assumed energy price conditions. *This would require sustained growth effort that is, however, not beyond historical precedence.*

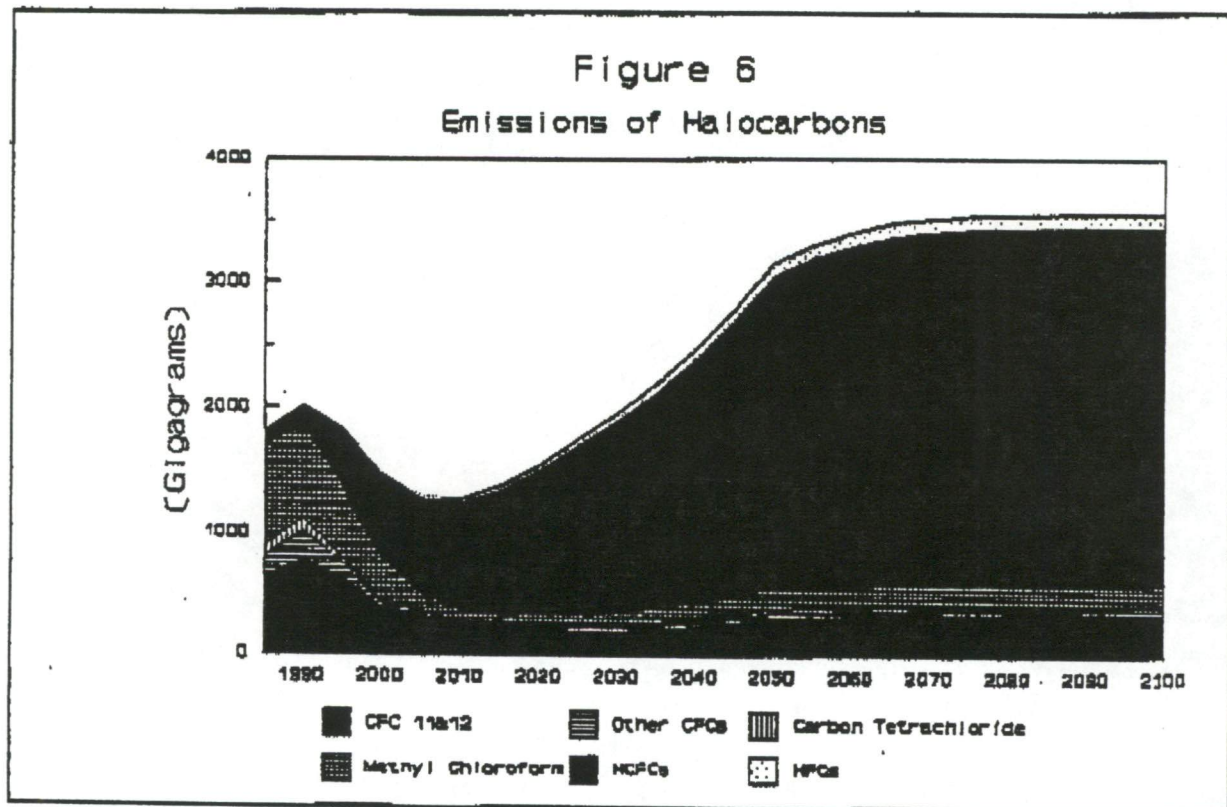
4. Halocarbons

An important event since the development of the scenarios for the first assessment is the agreement to amend the Montreal Protocol in London in 1990. Most key nations have either now signed the agreement or have pronounced the intention to do so. In our reference scenario, 70% of the developing world is assumed to comply with the London Amendments which is based on the GNP of countries that have signed and/or ratified as of 7/23/91 (China is assumed to comply while India is not). Although the London Amendments contain a recommendation only to use halocarbon substitutes in a transition period, there are no binding regulations for eventually phasing down the production of these compounds. Therefore in the IRS91 we assume that the production of substitutes would mimic the growth rate for the underlying controlled

compounds that they replace under the phase-out, adjusted for markets lost due to non-chemical substitution and increased use of recycling and other emission control programs. Accordingly, 1991 IPCC Reference Scenario assumes that the production of the substitutes grows by 2.5 per cent annually and that HCFCs and HFCs replace 30 per cent of the phased-out CFCs.

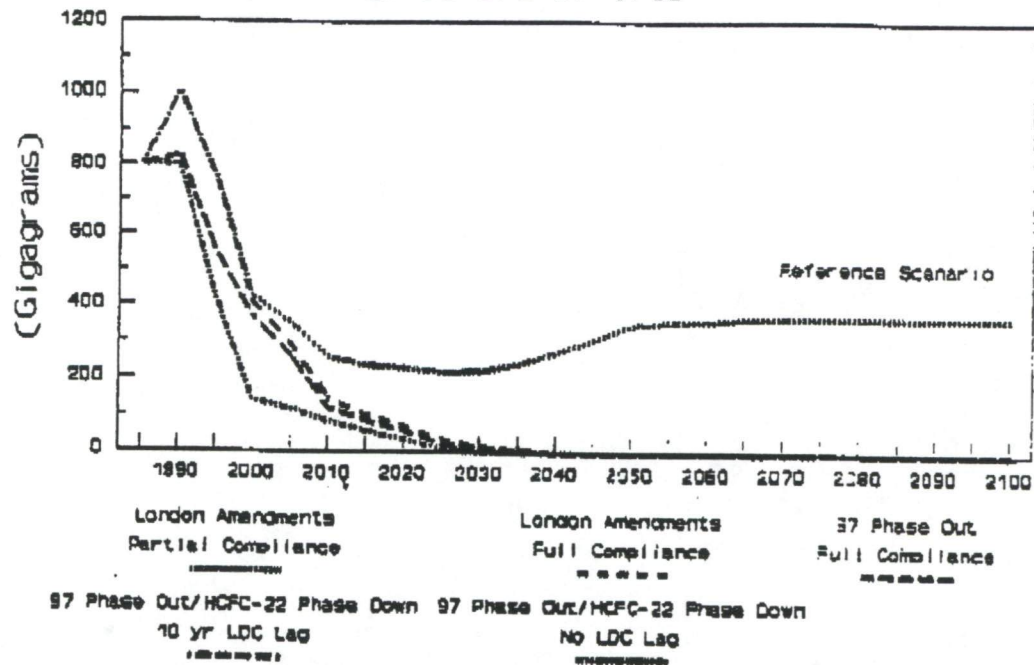
For the calculations, EPA's Integrated Assessment Model for CFCs was used and the results for the emissions of the main halocarbons are depicted in Figure 6. Emissions of CFCs, carbon tetrachloride, and methyl chloroform decline rapidly through 2010 reflecting the phase out by countries complying to the provisions of the London Amendment. After 2010, these emissions stabilize and then start to increase reflecting growth from those countries that are not complying with the provisions of the London Amendments. Emissions of HCFCs and HFCs grow rapidly throughout the whole time horizon reflecting their role as a substitute for the CFCs and the existence of no firm controls on their future emissions.

The implementation of the London Amendments of the Montreal Protocol is still surrounded by some uncertainties and we performed a sensitivity analysis of the impact of different assumptions on future emissions. These uncertainties are important for both the depletion of the stratospheric ozone layer and global climate change. When this report was written, some key countries such as India had not signed. As shown in Figures 6 and 7, emissions of CFCs continue in the reference scenario (London Amendments - Partial Compliance). If full compliance with the London Amendments is assumed then emissions are nearly eliminated by 2025 (London Amendments - Full Compliance). Recent data showing more severe ozone



Draft-do not cite or quote

Figure 7
Emissions of CFCs



depletion (Stratospheric Ozone Assessment, 1992) could lead to a more rapid phase out of CFCs and of Halons, carbon tetrachloride, and methyl chloroform and Figures 7 and 8 show the impact of these possible actions on emissions of these gases (97 Phase Out - Full Compliance). Further controls on the use of HCFCs is also possible based on these same concerns. Figures 7 and 8 show the impacts of these controls on halocarbon emissions with two different assumptions about the implementation in developing countries (97 Phase Out with HCFC-22 Phase Down and 10 yr LDC Lag and 97 Phase Out with HCFC-22 Phase Down and No LDC Lag).

5. Agriculture and Forestry

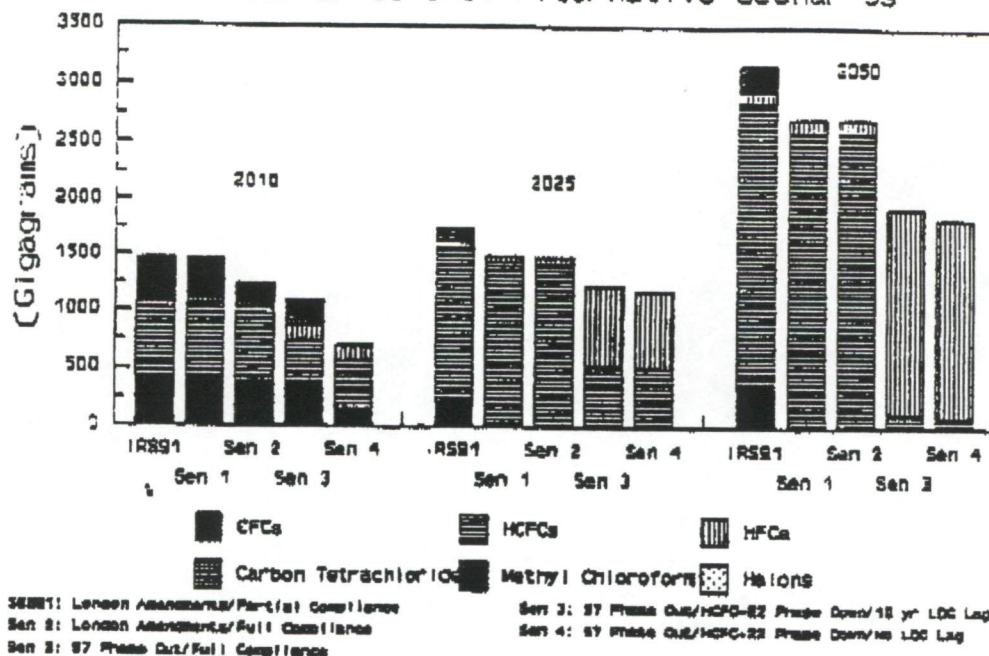
Agriculture: The scenario of emissions from agriculture has been revised to reflect updated population and economic growth assumptions along with revisions in the emission factors and global emission budgets. The scenario of future land use for rice production, fertilizer use, domestic animal stocks has been produced by the ASF and adapted from scenarios produced by the Basic Linked System (BLS). The BLS was originally developed by the International Institute for Applied System Analysis (IIASA) and maintained by the Center for Agriculture and Rural Development (CARD) (EPA, 1990).

The distribution of the global emissions of non-CO₂ greenhouse gases among different sources in the base year has been taken from the assessment of the global budgets reported in Chapter __, this document. Since this distribution is still poorly understood for most gases, the assessment of future emissions from these base year estimates is shrouded by uncertainty. Nevertheless, they represent the best estimates we can provide at this moment.

Draft-do not cite or quote

Figure 8

Halocarbon Emissions: Alternative Scenarios



Emissions of CH_4 from rice cultivation are highly uncertain. Average emission coefficients of 38 g/meter²/year have been selected based on the CH_4 emission budget of 60 teragrams (Tg). These emissions rise gradually from 60 Tg in 1990 to 88 Tg by 2050, then decline to 84 Tg by 2100. The growth in emissions is slower than growth in rice production, which more than doubles. This trend reflects continued advances in crop yields averaging 0.5% annually over the period.

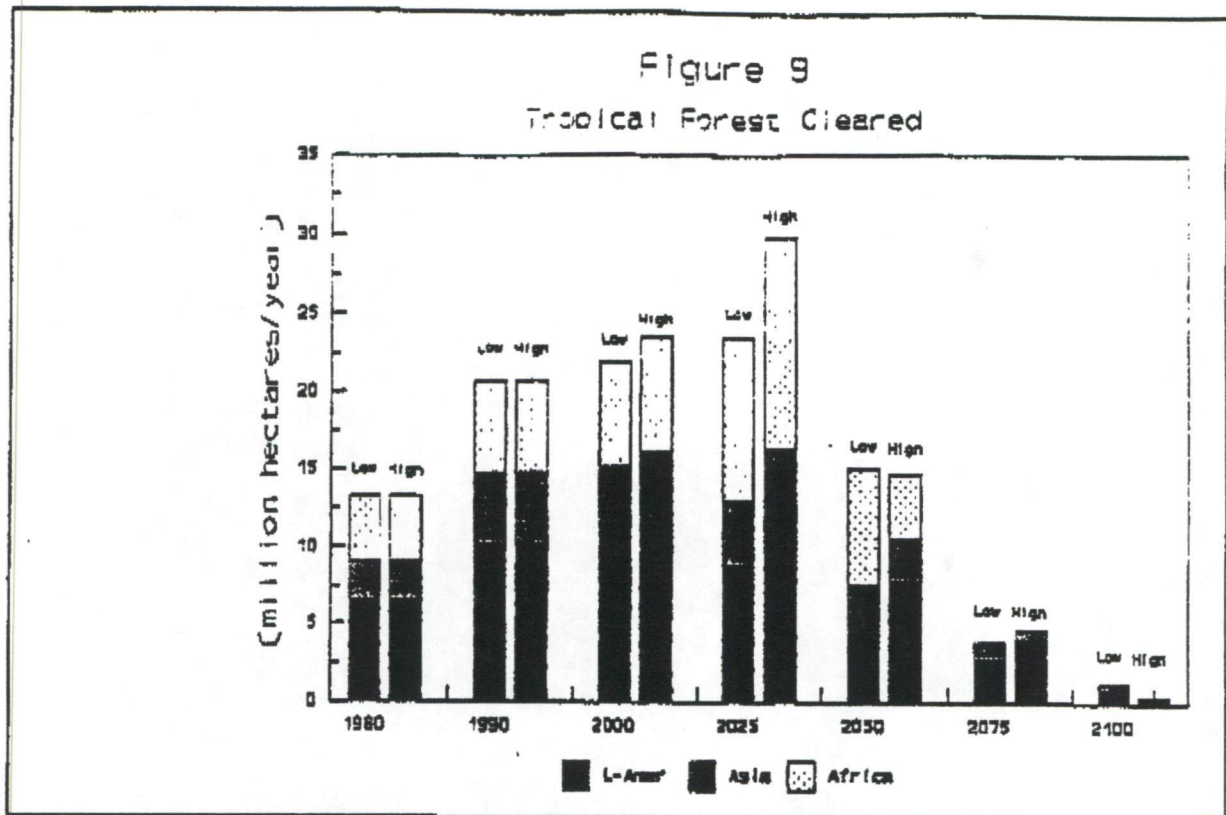
CH_4 emissions from enteric fermentation rise from 84 Tg in 1990 to close to 200 Tg by 2100. This increase reflects a rapid increase in consumption of meat and dairy products and assumes constant emissions per unit of production. Emissions of CH_4 from animal wastes have been added and track meat and dairy production. Emissions from animal wastes increase from 26 Tg CH_4 in 1990 to 62 Tg CH_4 by 2100. It is uncertain whether this growth in production of meat and dairy productions can actually be maintained, taking into account possible land and feed constraints, which are not explicitly dealt with in these scenarios. Autonomous developments that affect the emissions from enteric fermentation or animal waste per unit of production, such as those resulting from changed feeding patterns, are not taken into account either.

Emissions of N_2O from fertilized soils increase in proportion to fertilizer use, which more than doubles during the period. Emissions in 1990 of 2.0 Tg N have been selected as the starting budget, falling within a range of uncertainty of 0.3 to 3.0 Tg N. The impact of changing fertilization practices and the dependency of N_2O emissions on local circumstances has not been taken into account.

Forests: In the first IPCC assessment, the emissions of CO₂ from deforestation in the 1980s were assumed to be in the range of 0.6 to 2.5 Bt C per year (Houghton, 1990; IPCC, 1991a). For this scenario, a value for the base year was chosen at the low end of the possible range (0.7 Bt C/year), consistent with the evaluations performed with the ASF and the Dutch IMAGE model. New information with respect to carbon stored within the forest aboveground vegetation and rates of forest clearing are available from FAO, from scientists in tropical countries, and from other investigators. To account for these new data, two scenarios (high and low) were developed which reflect a range of current and future emissions from tropical deforestation. These scenarios, developed using the deforestation component of the ASF, were then combined into one average scenario. A sensitivity analysis was then performed in order to explore a wider range of possible futures as well as to identify the importance of several key assumptions. Our reference case has CO₂ emissions from tropical deforestation increasing from 1.8 Bt C in 1990 to 2.2 Bt C in 2025 then declining to 1.4 Bt C in 2050. By 2100, net emissions from deforestation are eliminated with possible net carbon uptake possible from established plantations.

The basis for the deforestation assumptions is preliminary data from FAO on the 1990 Tropical Forest Assessment Project (FAO, 1991) and the 1988 update of the 1980 Tropical Forest Assessment Project (FAO, 1988). These sources estimate that on average 17.0 million hectares of tropical closed and open forest are cleared annually. While questions have been raised concerning the reliability of these data, they are the most recent and best currently available for the world. From these data we have developed two scenarios of forest clearing which have global rates of clearing increasing from 13.2 million hectares in 1980 to 20.8 million hectares in 1990. After 1990, clearing in the low scenario increases to 23.6 million hectares in 2025 and then declines. In the high scenario, forest clearing increases to 29.9 million hectares in 2025 before declining. In both of these scenarios, available forest resources within each country provide upper bounds on future clearing. In the low scenario, 84% of all tropical forests (1.74 billion hectares), is cleared by 2100. In the high scenario, this fraction increases to 88%. By 2025, countries representing 43% of forest clearing in 1980 have (or have nearly) exhausted their forest resources in the low scenario. By 2050, this fraction increases to 52%. For the 1991 IPCC Reference Scenario, it is assumed that all forest, not legally protected, including areas which have been classified as non-productive, can be subject to deforestation.

Other factors which differ between the high and low scenarios include carbon stored in the aboveground biomass, the fate of fallow forest, and future rates of plantation establishment. The low scenario utilizes estimates of carbon stored in the biomass from OECD (1991) which have been adapted from Brown and Lugo (1984), Brown et al. (1989), and Brown (1991). The high scenario adjusts these estimates to reflect uncertainties in the measuring techniques and results from other measurements utilizing alternative approaches (Houghton, 1991). The high scenario also includes another proposed net source of carbon due to permanent clearing of fallow forests. The high scenario assumes that up to 10 million hectares of fallow forest are currently being converted to permanent agriculture annually (Houghton, 1991) and that this clearing continues into the future until almost all fallow forest is converted. In the low scenario, the establishment of plantations, which FAO (1988) estimates as 1.3 million hectares annually between 1980 and 1985, is assumed to continue with 133 million hectares added between 1990 and 2100. The high scenario assumes that no new plantations are added after 1990. Figure 9 illustrates the rates of total forest cleared by region in the two scenarios.

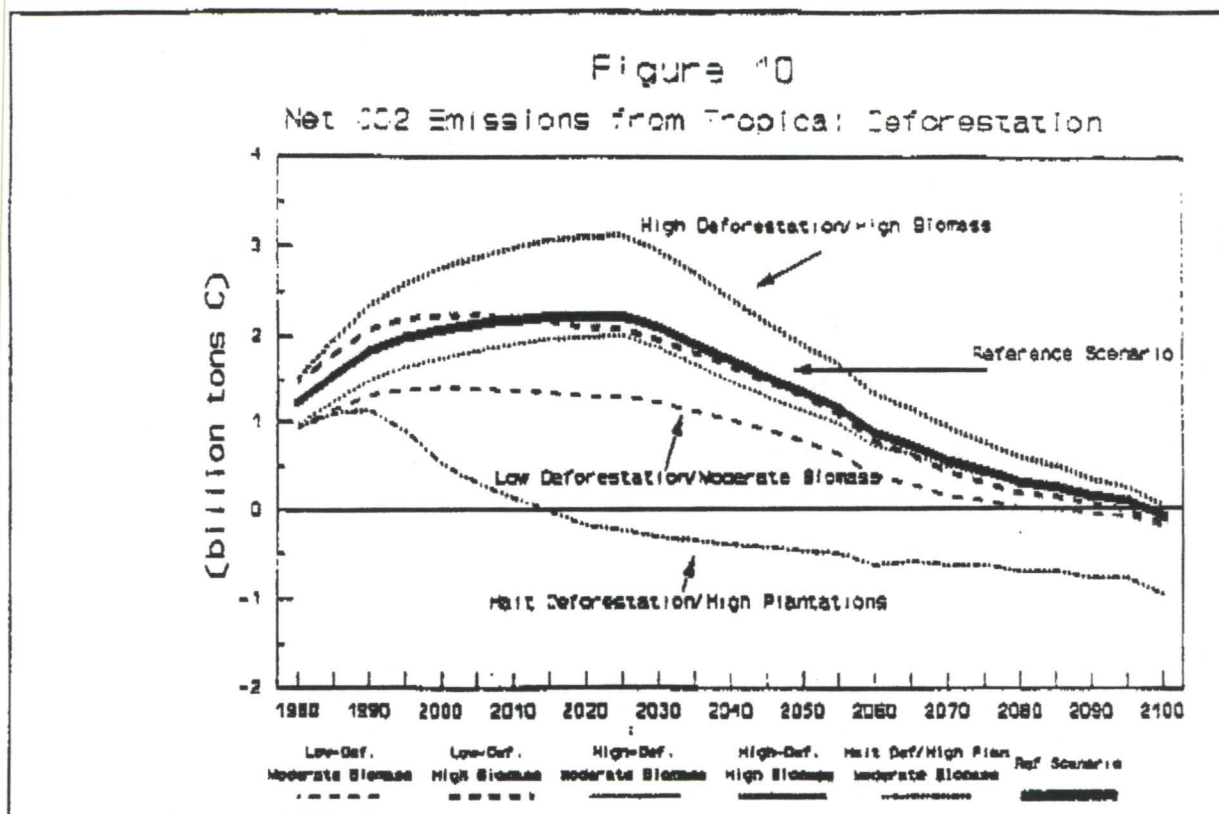


CO₂ emissions from these scenarios range from 1.3 Bt C to 2.3 Bt C in 1990. In the low scenario, emissions increase to 1.4 Bt C by 2000, decline slightly to 1.3 Bt C in 2025 and then start to decline more rapidly. Net emissions are slightly negative by 2100 due to carbon sequestration by plantations. In the high scenario, emissions increase to 3.1 Bt C by 2025, decline to 1.9 Bt C in 2050 and 0.04 Bt C by 2100. For the purposes of the reference case, we have averaged these two scenarios to create the reference scenario.

It should be noted that these two scenarios do not span the complete range of possibilities for both current and future emissions. There is a strong need for improvement of the base data. Moreover, current trends in deforested area, combined with changes in policies, could very well lead to emissions lower than in the low scenario.

Figure 10 illustrates the CO₂ emissions from the high and low scenarios, the reference scenario, and three sensitivities. One sensitivity, *High-Def./Moderate Biomass* illustrates the impact of the higher clearing rates and fallow forest clearing assumptions on CO₂ emissions. The sensitivity, *Low-Def./High Biomass*, illustrates the importance of assumptions concerning carbon stored within the biomass. The *Halt Deforestation- High Plantations* sensitivity illustrates the potential for reducing emissions by quickly stopping forest clearing and actively establishing plantations. In this sensitivity, forest clearing is reduced starting in 1991 and eliminated by 2025. Up to 293 million hectares of plantations are established by 2100.

Resolution of Land Assumptions: While these scenarios and sensitivities provide a likely range of emissions they do not address all of the uncertainty. A key concern with these scenarios



is consistency of the assumptions about land use among the different sectors. Because the models and methodologies used for the different sectors are not fully integrated with respect to land use, this consistency is not automatically guaranteed. With population doubling by 2100, improved nutrition in the developing economies, and the agricultural land base possibly under degradation stress, the demand for additional land conversion to produce crops especially in the developing countries would be significant, even if sustained productivity increases were gained. Above, we already noted the anticipated demand for land for livestock and feed production, while the energy scenario assumes over 200 EJ of energy from commercial biofuels by 2100, of which 70 per cent is in developing countries.

A review of current land uses, forest clearing, and plantation assumptions suggest that the these assumptions are not inconsistent. FAO (1986) reported that in 1984, 1.5 billion hectares were used for arable land and permanent crops and 3.1 billion hectares were used for permanent pasture leaving 4.1 billion hectares of forest and woodlands. The scenario assumes that on average 1.8 billion hectares of tropical forests will be cleared by 2100 while 0.1 billion hectares of forest plantations will be established, roughly allowing for a doubling of the arable land base. Table 2 summarizes these statistics for Latin America, Africa, and the Far East along with the reference case assumptions for these regions. Clearing of forest land in these tropical regions matches well the increase in population and demand for food. The largest concern would be in Asia where population densities are the highest and cleared forest land might not have the same productivities as existing cropland nor may the production be as sustainable. Any reduction in deforestation would reduce the potential land base and would have to be matched by increased productivity on existing land. Other anthropogenic influences on the terrestrial carbon cycle, such

Table 2
Land-Use Assumptions
(10⁶ hectares)

	<u>Africa</u>	<u>Asia *</u>	<u>Latin America</u>
FAO			
1984 Arable Land & Perm Crops	154	272	177
1984 Perm Pasture	630	35	551
Remaining Tropical Forest (1990)	656	384	870
Forest Cleared ** (1990-2100)	653	335	797
Plantation Area Estab. *** (1990-2100)	27	47	59
Max Energy Plantation Area ****	88	101	118

* Far East as Defined by FAO

** Average of Low and High Scenarios

*** Low scenario (additional plantation area is 0 in high scenario)

**** Energy Plantation Area in Addition to Other Plantation Area

as erosion, desertification, logging in temperate and boreal zones and carbon sequestration in managed forests, have not been taken into account in this study because of the absence of quantitative information.

6. Other Sectors and Gases

The 1991 Reference Scenario includes emissions of additional gases and emissions from additional sectors. Specifically, emissions of N₂O, CH₄, CO, and NO_x from energy combustion and production were developed using the ASF and assumptions about emission controls consistent with the US Clean Air Act and the Protocols under the Convention on Long-Range Transboundary Air Pollution. Our estimate of emissions of CO from fossil fuel fall below the low end of the range of some estimates. These emissions reflect the latest data on energy consumption and emission coefficients, but the discrepancies should be investigated further. Emissions of N₂O from production of nitric and adipic acid have been included and reflect scenario assumptions on nitrogen fertilizer production and economic growth (respectively). Emissions of CO₂ from cement production and CH₄ from landfills reflect regional population and economic growth assumptions as well as expectations of resource limitations and saturation. Emissions of N₂O, CH₄, CO, and NO_x from biomass burning are based on emission coefficients from Crutzen and Andreae (1990) and future rates of deforestation, clearing of fallow lands for shifting agriculture, non-commercial biofuel use, and other burning activities. Emissions of volatile organic compounds (VOCs) are highly uncertain, especially for developing countries. They are based on a detailed country level emissions inventory developed by EPA (1991). They are compared to other sources and extended into the future based on activities such as

Draft-do not cite or quote

Table 3
Global Emissions*

	<u>1990</u>	<u>2000</u>	<u>2025</u>	<u>2050</u>	<u>2100</u>
CO₂ Emissions (Bt C)					
Energy	5.86	7.32	12.42	14.11	22.58
Deforestation	1.83	2.00	2.21	1.35	-0.08
Cement	0.15	0.20	0.43	0.55	0.73
Total	7.84	9.60	15.06	16.01	23.23
CH₄ Emissions (Tg)					
Energy Production and Use	90.7	118.3	222.7	248.0	393.8
Enteric Fermentation	83.6	99.1	138.1	173.2	198.5
Rice	60.0	66.0	78.3	87.5	83.6
Animal Wastes	26.1	31.0	43.2	54.1	62.0
Landfills	40.2	47.8	71.6	115.2	226.1
Biomass Burning	30.9	33.1	38.9	37.6	32.3
Wetlands	115.0	115.0	115.0	115.0	115.0
Termites	20.0	20.0	20.0	20.0	20.0
Oceans/Freshwater	15.0	15.0	15.0	15.0	15.0
Methane Hydrates	5.0	5.0	5.0	5.0	5.0
Domestic Sewage	25.0	29.3	39.7	47.4	53.4
Total	511.6	579.5	787.6	918.1	1204.8
N₂O Emissions (Tg N)					
Energy	0.4	0.5	0.8	0.9	1.2
Fertilized Soils	2.0	2.7	3.8	4.2	4.5
Land Clearing	0.8	0.8	0.9	0.8	0.5
Nitric Acid	0.2	0.3	0.4	0.5	0.5
Adipic Acid	0.5	0.7	1.4	1.8	2.4
Biomass Burning	0.6	0.7	0.8	0.8	0.7
Oceans/Freshwater	2.2	2.2	2.2	2.2	2.2
Tropical Soils	4.7	4.7	4.7	4.7	4.7
Temperate Soils	1.4	1.4	1.4	1.4	1.4
Total	12.8	14.0	16.5	17.3	18.1
CO Emissions (Tg C)					
Energy	130.2	149.8	228.2	314.8	638.2
Biomass Burning	331.5	354.4	416.9	402.6	345.7
Plants	43.0	43.0	43.0	43.0	43.0
Oceans	17.0	17.0	17.0	17.0	17.0
Wildfires	13.0	13.0	13.0	13.0	13.0
Total	534.8	577.2	718.1	790.4	1056.9

Table 3 (continued)
Global Emissions

	1990	2000	2025	2050	2100
NO _x Emissions (Tg N)					
Energy	26.2	30.2	48.8	62.5	102.9
Biomass Burning	3.8	4.2	5.1	5.0	4.4
Natural Lands	12.0	12.0	12.0	12.0	12.0
Lightning	9.0	9.0	9.0	9.0	9.0
Total	51.0	55.3	74.9	88.5	128.3
Halocarbons					
CFC-11	353	174	93	131	143
CFC-12	428	210	98	169	183
CFC-113	202	32	21	40	40
CCl ₄	119	34	19	35	35
MCF	738	353	97	184	184
HCFC-22	148	302	619	1148	1298
HCFC-123		146	360	656	770
HCFC-141b		180	349	631	705
HCFC-124		7	30	57	69
VOC Emissions by Gas (Tg)					
Paraffins	55.5	61.3	85.3	106.1	161.6
Olefins	42.0	43.9	50.6	56.7	75.0
Aromatics (bt _x)**	15.5	16.5	20.8	25.3	38.8
Other	7.6	8.5	12.0	15.1	24.7
Total	120.6	130.2	168.7	203.2	300.2
VOC Emissions by Sector (Tg)					
Energy Prod & Use	26.7	31.1	47.8	62.5	109.0
Biomass Burning	52.8	53.6	55.5	53.9	51.4
Industry	23.0	25.4	37.6	47.1	68.5
Other	18.1	20.1	27.8	39.8	71.3
Total	120.6	130.2	168.7	203.2	300.2
Sulfur Emissions (Tg S)					
Energy Prod & Use	67.0	74.7	126.6	163.5	292.0
Biomass Burning	2.7	2.8	3.3	3.2	2.8
Other Industrial	8.0	9.8	16.3	19.0	22.1
Natural	22.4	22.4	22.4	22.4	22.4
Total	100.1	109.7	168.6	208.1	339.3

Tg - Teragrams or 10¹² grams, Bt - Billion metric tons or 10¹⁵ grams
 ** Benzene, toluene, and xylene

transportation energy use, deforestation and biomass burning, and industrial activity. Emissions of SO_x from energy use are based on a study performed by Spiro et al. (1991) where emissions reflect average sulfur content of the different fossil fuels and adjusted for emission control programs. Emissions of all trace gases by gas and sector are summarized in Table 3.

7. Conclusions

The 1991 Reference Scenario is a function of a number of assumptions about the future and is only one of many possible outcomes. The updated scenario incorporates a limited set of important new information which influences our assessment of future greenhouse gas emission trends. This exercise also considers a range of reasonable forecasts as reported by other efforts and explores the sensitivities of our reference scenario to certain assumptions. A more thorough exploration of the sensitivities could reveal more about the confidence policy-makers should have in such emission scenarios as well as the influence that the decisions they make may have on determining which of the scenarios that future emission paths will most resemble.

The updated scenario in many ways portrays a future very similar to that portrayed in the original BAU scenario. Emissions of greenhouse gases tend to grow with population and income, reflecting increases in uses of fossil energy, industrial activity, production of agricultural products, and other areas where human production and consumption result in emissions. Differences in the scenarios reflect changes in estimates of current emission budgets, policies to reduce or control emissions, and changes in assumptions about growth in factors that lead to emissions. Table 4 summarizes the global emissions of the main trace gases derived from the scenarios developed in this report for the different sectors. These emissions are reported in units of equivalent carbon dioxide, calculated by applying Global Warming Potentials for direct radiative absorption with an integration time of 100 years, as recommended elsewhere in this report. The GWPs applied here do not include the indirect effects of CH_4 , CO , and NO_x emissions on tropospheric ozone and warming from tropospheric ozone, nor the indirect effects of halocarbon emissions on stratospheric ozone depletion and potential cooling effects on the stratosphere and troposphere.

Emissions of CO_2 are higher in the 1991 Reference Scenario than in the 1990 BAU scenario, especially in the first decades covered by the scenario. This result depends on countries achieving their economic growth ambitions, population growing as projected by the World Bank, and energy efficiency improvements penetrating moderately. The IRS91 is within the range of plausible futures as assessed by the European Community, the International Energy Agency, and the World Energy Council. In the updated assessment, current and future biotic carbon emission estimates are higher until well into the next century due to FAO raising its estimates of current rates of deforestation and to analyses suggesting higher forest biomass contents than used in the 1990 BAU scenario. Emissions of other gases from tropical deforestation and biomass burning follow a different pattern due to explicit modeling of shifting agriculture, higher current rates of forest clearing, and slower expansion of area cleared. Total emissions of CH_4 did not change significantly from the first assessment. But, due to new insights in the CH_4 budget, estimated emissions from some sources have been decreased (rice, biomass burning) and other increased (landfills, energy). Total emissions of N_2O are expected to be similar to the first assessment, but cultivated soils and industrial emissions have surpassed fuel combustion as the most important sources. Emissions of CO differ in the revised scenario in a number of ways. Emissions from energy are lower in the earlier years due to revised emission estimates from mobile sources but these emissions grow at a faster rate throughout the time period resulting in similar emissions by

Table 4
Emissions of Greenhouse Gases
IRS91 vs BAU90

(billion tons of CO₂ equivalent)*

	<u>1990</u>	<u>2000</u>	<u>2025</u>	<u>2050</u>	<u>2100</u>			
<u>IRS91</u>								
CO2	→ 28.7	35.2	55.2	58.7	85.2	1.9	1.0	0.6
N2O	5.4	5.9	6.9	7.3	7.6			
CH4	5.6	6.4	8.7	10.1	13.3			
CFCs	5.3	2.3	1.1	1.9	2.0			
HCFC&HFCs	0.2	0.6	1.4	2.6	2.9			
Total	45.3	50.4	73.3	80.5	110.9	1.4	0.8	0.6
CO2	63%	70%	75%	73%	77%			
N2O	12%	12%	9%	9%	7%			
CH4	12%	13%	12%	13%	12%			
CFCs	12%	5%	2%	2%	2%			
HCFC&HFCs	1%	1%	2%	3%	3%			
Total	100%	100%	100%	100%	100%			
<u>BAU90</u>								
CO2	→ 24.0	28.1	42.3	55.7	82.1	1.6	1.1	0.9
N2O	5.7	6.0	6.9	7.3	7.4			
CH4	6.2	6.8	8.4	9.9	11.7			
CFCs	5.3	4.4	3.6	3.8	3.8			
HCFC&HFCs	0.3	0.8	2.1	4.3	4.7			
Total	41.5	46.0	63.3	80.9	109.7	1.2	0.9	0.7
CO2	58%	61%	67%	69%	75%			
N2O	14%	13%	11%	9%	7%			
CH4	15%	15%	13%	12%	11%			
CFCs	13%	10%	6%	5%	3%			
HCFC&HFCs	1%	2%	3%	5%	4%			
Total	100%	100%	100%	100%	100%			

* Excludes indirect effects of NO_x, CO, VOCs, CH₄, and CFCs.

2100. Emissions from biomass burning are higher in the early years but show less growth through 2050 due to changes in the deforestation assumptions. The revised scenario includes much lower emissions of CFCs, as induced by the London Amendments to the Montreal Protocol and a wider participation in this Protocol than foreseen in the previous assessment. Emissions of CFCs, CCl₄, and methyl chloroform decline rapidly due to the phase out in most countries but then start to increase as production from non-participating countries increase. Emissions of HCFCs are similar to emissions of HCFC-22 in the 1990 BAU scenario. We have included in the revised scenario emissions of VOCs and SO_x. Emissions of VOCs grow manyfold in the future, reflecting in part increases in transportation energy use and industrial activity. Future emissions of SO_x reflect the rapid increases in the use of coal throughout the world with limited emission control strategies outside of the developed economies.

The 1991 IPCC Reference Scenario reflects a number of assumptions concerning factors which are inherently uncertain and represents only one way in which the future will evolve. There are many ways in which the future emissions of greenhouse gases could be higher or lower. For example, continued low energy prices combined with continued public opposition to expansion of nuclear power, and declining research investments in renewable energy and energy efficiency could lead to greater use of fossil fuels. Agriculture practices may lead to greater pressure on forest land than assumed here. Consideration of these factors would yield emissions that are higher than in this scenario.

More optimistic analysts will point to the growing awareness around the world that, even at today's relatively low energy prices, investments in energy efficiency are often replacing investments in energy supply. Technological advances in industry could lead to major reductions in the energy intensity of production. Similarly, technological advances in energy supply could provide economically competitive alternatives to continued use of fossil fuels. Political developments in the USSR and Eastern Europe could lead to rapid and significant improvements in the efficiency of energy use and the overall energy intensity of their economies. Concerns over biodiversity and environmental degradation could lead to a global forest agreement which significantly reduces forest clearing. Consideration of these factors would yield future emissions which would be lower. *In general, our evaluation of other scenarios of future emissions and the sensitivity analyses presented in this paper suggest that the revised scenario falls within a broad range of possible futures.* While the uncertainties are large, greenhouse gas emissions could be expected to rise substantially in the coming century in the absence of new policy actions, rapid market penetration of technological advances, or other unforeseen developments.

References

- Brown, S., A.E. Lugo. 1984. Biomass of tropical forests: A new estimate based on forest volumes. *Science* 223:1290-1293.
- Brown, S. and A.J.R. Gillespie, and A.E. Lugo. 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. *Forest Science* 35:881-902.
- Brown, S. 1991. Personal Communication.
- Bulatao, R.A., E. Bos, and My T. Vu. 1989. *Asia Region Population Projections: 1980-80 Edition; Latin America and the Caribbean (LAC) Region Population Projections: 1980-80 Edition; Africa Region Population Projections: 1980-80 Edition; Europe, Middle East, and Africa (EMN) Region Population Projections: 1980-80 Edition*. Population and Human Resources Department, World Bank, Washington, D.C.
- Commission of the European Communities (CEC). 1989. *Energy in Europe: Major Themes in Energy*. Brussels.
- Crutzen, P.J., M.O. Andreae. 1990. Biomass Burning in the Tropics: Impact on Atmospheric Chemistry and Biogeochemical Cycles. *Science* 250: 1669-1678.
- Edmonds, J.A., J.M. Reilly, R.H. Gardner, and A. Brenkert. 1986. *Uncertainty in Future Global Energy Use and Fossil Fuel CO₂ Emissions 1975 to 2075*. TR036, DOE3/Nbb-0081 Dist. Category UC-11, National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia.
- Edmonds, James A, L Mintzer, W. Pepper, K. Major, V. Schater. 1991. *The IPCC Reference Case in Relationship to Other Studies' Reference Cases*. Washington, D.C.
- EPA (Environmental Protection Agency). 1991. *Policy Options for Stabilizing Global Climate: Report to Congress - Technical Appendices*. United States Environmental Protection Agency, Washington, D.C.
- EPA (Environmental Protection Agency). 1991. *Global Inventory of Volatile Organic Compound Emissions From Anthropogenic Sources*. EPA, Air and Energy Engineering Research Laboratory. Research Triangle Park, North Carolina.
- FAO (Food and Agriculture Organization of the United Nations). 1986. *1985 FAO Production Yearbook, Vol. 39*. FAO, Rome.
- FAO (Food and Agriculture Organization of the United Nations). 1988. *An Interim Report on the State of the Forest Resources in the Developing Countries*. FAO, Rome.
- FAO (Food and Agriculture Organization of the United Nations). 1991. *Forest Resources Assessment 1990 Project*. Forestry N. 7. FAO, Rome.

Houghton, J.T., G.J. Jenkins and J.J. Ephraums (ed.). 1990. *Climate Change: The IPCC Scientific Assessment*. Cambridge University Press, Cambridge, Massachusetts.

Houghton, R. A. 1991. *Tropical Deforestation and Atmospheric Carbon Dioxide*. Submitted to Climate Change.

IEA (International Energy Agency). 1991. *International Energy Agency: Energy and Oil Outlook to 2005*. Paris.

Hafele, W. 1981. *Energy in a Finite World*. Ballinger Publishing Company, Cambridge, MA.

IPCC (International Panel on Climate Change). 1991a. *Climate Change: The IPCC Response Strategies*. Island Press, Washington, D.C.

IPCC (International Panel on Climate Change). 1991b. *Energy and Industry Subgroup Report*. EPA (Environmental Protection Agency), Washington, D.C.

IPCC (International Panel on Climate Change). 1990. *Emissions Scenarios prepared by the Response Strategies Working Group of the Intergovernmental Panel on Climate Change*. Report of the Expert Group on Emissions Scenarios.

Manne, A.S. and R.G. Richels. 1990. *Global CO₂ Emissions Reductions—the Impacts of Rising Energy Costs*. Electric Power Research Institute, Palo Alto, CA.

Nordhaus, W.D. and G.W. Yohe. 1983. *Future Carbon Dioxide Emissions from Fossil Fuels*. *Changing Climate*. pp.87-153. National Academy Press, Washington D.C.

OECD (Organization for Economic Cooperation and Development). 1991. *Estimation of Greenhouse Gas Emissions and Sinks*. Final Report from the OECD Experts Meeting, Paris, 18-21 February, 1991.

Pepper, W.J., R.J. Swart, Forthcoming. *Emission Scenarios for the IPCC - Assumptions, Methodology, and Results*

Spiro, P.A., D.J. Jacob, J.A. Logan. 1991. *Global Inventory of Sulfur Emissions with 1°x1° Resolution*. submitted to *Journal of Geophysical Research*. August 1991.

Swart, R.J., W.J. Pepper, C. Ebert, J. Wasson. 1991. *Emissions Scenarios for the Intergovernmental Panel on Climate Change an Update: Background Paper and Workplan*. Washington, D.C.

United Nations. 1990. *Population Prospects 1990*. United Nations, New York.

Working Group I. 1991. Summary of WG I task force meeting (Shepperton, UK, 8-11, July 1991) regarding emission scenarios and the WG III discussion of scenarios.

World Energy Conference, 14th Congress (WEC). 1989. *Global Energy Perspectives 2000-2020*. Conservation and Studies Committee. Montreal.

PRELIMINARY COMMENTS ON
"EMISSIONS SCENARIOS FOR THE IPCC -- AN UPDATE"
FROM
THE CLIMATE COUNCIL,
EDISON ELECTRIC INSTITUTE, and
NATIONAL COAL ASSOCIATION

November 22, 1991

TABLE OF CONTENTS

	Page
INTRODUCTION	1
THE PROCESS FOR REVIEW OF IRS91 IS FUNDAMENTALLY FLAWED. FOR THAT REASON ALONE, ANY USE OF IRS91 IN PREDICTIONS OF CLIMATE CHANGE IS NOT JUSTIFIED.	2
THE CUMULATIVE EFFECTS OF WHOLLY INADEQUATE WARNINGS ABOUT THE INHERENT UNCERTAINTIES OF LONG-TERM SCENARIOS AND THE MISLEADING CHARACTERIZATION OF ASSUMPTIONS AS BEING "MODER- ATE" STRAIN THE CREDIBILITY OF IRS91.	4
Inconsistencies	6
Misleading Characterization: "Moderate" Assumptions	7
High-end Forecast of Energy-Related CO ₂ Emissions	7
High-end Forecast of Total Global CO ₂ Emissions	9
High Assumptions of Economic and Energy Growth	12
Unreasonably High Projections of USSR Energy Use	13
Other Misleading Characterizations and Statements	14
SUBSTANTIVE PROBLEMS WITH ASSUMPTIONS AND ANALYSIS	18
The Unreliability of the EIS Reference Scenario as a Foundation for the IRS91	18
Inadequate Recognition of Energy (Especially Oil) Prices	19
Lack of Justification for Higher Economic Growth Rates	19
Lack of Justification for Timid Assumptions about Reductions in Energy Intensity	21
The Curious Pattern of Changes in the Rates of Growth of Greenhouse Gas Emissions from the Energy Sector	22
CONCLUSION	24

PRELIMINARY COMMENTS ON
"EMISSIONS SCENARIOS FOR THE IPCC -- AN UPDATE"
FROM
THE CLIMATE COUNCIL,
EDISON ELECTRIC INSTITUTE, and
NATIONAL COAL ASSOCIATION

November 22, 1991

INTRODUCTION

The following comments on the first draft of "Emissions Scenarios for the IPCC -- An Update" ("IRS91"), dated October 25, 1991, are respectfully submitted for consideration of IPCC Working Group I by The Climate Council, an association of U.S. energy companies and railroads, the Edison Electric Institute, the association of U.S. investor-owned electric utilities, and the National Coal Association, the association of U.S. coal producers.

When The Climate Council made arrangements with Working Group I to be one of the reviewers of IRS91, it was invited by the Secretariat to act as a "conduit" for the comments of such other industry organizations as it chose to involve. These comments reflect the collaboration of the three named organizations and of the energy economists who are associated with them, including Dr. Helmut A. Merklein, an independent energy economist, immediate past Administrator of the U.S. Energy Information Administration, and former Assistant Secretary of the U.S. Department of Energy for International Affairs and Energy Emergencies.

It must be emphasized at the beginning, and borne in mind throughout, that, because of the inability of reviewers to obtain crucially important information from IPCC Working Group I, these are only preliminary comments. The parties expressly reserve

their rights to comment further, at a later date, on all aspects of the draft IRS91 discussed herein, as well as on additional topics. Absence of comment on any matter contained in or pertinent to the draft IRS91 should not be interpreted as agreement with, or acquiescence to, such matter.

I.

THE PROCESS FOR REVIEW OF IRS91 IS FUNDAMENTALLY FLAWED. FOR THAT REASON ALONE, ANY USE OF IRS91 IN PREDICTIONS OF CLIMATE CHANGE IS NOT JUSTIFIED.

The choice by IPCC Working Group I of greenhouse gas emissions scenarios will influence greatly its predictions of potential climate change. This is especially true of emissions attributed to the energy sector. According to the IPCC's First Assessment Report ("FAR"), "the energy sector accounts for an estimated 46% (with an uncertainty range of 38-54%) of the enhanced radiative forcing resulting from human activities" during the period 1980-90. FAR, Working Group III Policymakers Summary ("WG-III Pol. Sum."), p. 1 (August 1990). In that circumstance, it is vitally important that future IPCC predictions of potential climate change, if they are to be credible, be based on reliable greenhouse gas emissions scenarios (including, specifically, those that are energy-related).

A respectable peer review process of greenhouse gas emissions scenarios is imperative. This is particularly true in the case of energy-related emissions, when, as here, there does not appear to be adequate representation of professional energy economists or of experts from the energy sector among the lead authors of the draft IRS91.

With all due respect to the good intentions of Working Group I, we firmly believe that the entire review process for IRS91 is fatally flawed. This process, as developed, actually prevents both considered review and the opportunity for the authors of IRS91 to take constructive advantage of reviewers' comments. Because of the importance of this fundamental procedural defect, we emphasize the following points.

1. The draft IRS91, dated October 25, 1991, was first made available to The Climate Council on the evening of October 29. The fax transmission sheet indicates other reviewers received the draft on or about that date. On October 31, the Secretariat of IPCC Working Group I was notified, orally and in writing, of the urgent need for reviewers to receive the document referred to in

the first paragraph of the draft IRS91 as "more detailed documentation . . . available in a companion document (Pepper et al., forthcoming)." See Attachments 1 and 2. That document, by W. J. Pepper and R. J. Swart, is Emission Scenarios for the IPCC -- Assumptions, Methodology, and Results ("underlying study").

2. The underlying study is essential to the review of IRS91. The draft IRS91 apparently is merely a summary of the principal conclusions of the underlying study. IRS91 contains little detail concerning assumptions and virtually no explanation as to why one assumption was chosen over others. Explication of methodology is scant. The purpose of a "peer review" is to do more than comment on whether a summary, such as IRS91, fairly characterizes an underlying study; that is an editorial function. A reviewer must have the opportunity to consider the underlying study itself and, if prompted by a reading of the study, to challenge its data and related assumptions, its methodology, its analysis, and its conclusions. Neither the editorial function nor the review function can be accomplished without possession of the Pepper-Swart underlying study; yet that is precisely the position in which all reviewers of IRS91 find themselves as of November 22, 1991, the date Working Group I requires reviewers' comments to be submitted.

3. Because the unavailability of the Pepper-Swart underlying study would make adequate review of IRS91 impossible, The Climate Council, on November 7, again requested that study and asked for an extension of the comment period to a date that would allow for its review. See Attachment 3. Not having received either the underlying study or a response to the extension request, a further request for extension of the comment period was made on November 18. See Attachment 4. On November 19, the extension request was denied. See Attachment 5.

4. According to the November 19 letter from the Working Group I Secretariat, there is no assurance that the Pepper-Swart underlying study "will be available until the second review stage beginning early-to-mid December." It is not clear whether the study will be available to reviewers prior to the time the Working Group I Secretariat sends to governments and other reviewers another draft of IRS91 "around 9 December."

5. As a consequence of this situation: (i) any revisions to the first draft of IRS91 made in light of reviewers' comments submitted by the November 22 deadline will be without benefit of any review of, or comments upon, the Pepper-Swart underlying study; and (ii) there does not appear to be any chance that reviewers will have reasonable opportunity to make comments on the second draft of IRS91 in light of considered review of the

underlying study; nor does the schedule allow the authors to consider and incorporate reviewers' comments in light of the December 9 deadline for transmittal of the further revised draft that will be the subject of the Working Group I plenary session in China January 13-15, 1992.

We appreciate that Working Group I, under the rules of IPCC-V, must receive the final draft of IRS91 four weeks before the January plenary session. But, that is no excuse whatsoever for providing Working Group I with an integral element of any proposed "update" of climate predictions that has not undergone thorough peer review. Because of the failure to provide reviewers with the Pepper-Swart underlying study, the first round of "peer reviews" is no review at all; and the time schedule indicated by the Working Group I Secretariat assures that the follow-up "review" cannot measure up to standards that policymakers and the public have a right to expect from the IPCC.

The process in place effectively prevents informed peer review. For that reason alone, if there is to be any credibility to the proposed IPCC "update," it should not be based on IRS91 or any modification thereof that has not undergone thorough peer review.

II.

THE CUMULATIVE EFFECTS OF WHOLLY INADEQUATE WARNINGS ABOUT THE INHERENT UNCERTAINTIES OF LONG-TERM SCENARIOS AND THE MISLEADING CHARACTERIZATION OF ASSUMPTIONS AS BEING "MODERATE" STRAIN THE CREDIBILITY OF IRS91.

At the August 6-7, 1991 meeting of the Energy and Industry Subgroup ("EIS") of IPCC Working Group III, a representative of Working Group I made a presentation of the general approach to be taken by IRS91. Numerous delegations, including representatives of two of the three organizations submitting these comments, raised the serious issue of the unreliability of greenhouse gas emissions scenarios based on long-term energy scenarios.

It was pointed out, however, that a long-term -- that is, a 110-year -- emissions scenario was "necessary" in order to enable prediction of potential climate changes through the 21st century. As IRS91 states, "a long term assessment of greenhouse gas emissions is necessary in order to assess the lagged impact of climate change." IRS91, p. 2. In order to minimize the controversy that ensued, those who objected to the use of long-term energy-

related emissions scenarios offered what was thought at the time to be a sensible compromise. The proposed solution included, among other things, a full, adequate, and fairly placed description of the numerous reasons why one should not assume that energy and energy-related emissions scenarios, covering more than 10 or 20 years, will be realized in actuality. Our concerns and a proposed solution to the problem were set forth in an August 19 letter from The Climate Council to Working Group I Chairman Houghton. See Attachment 6.

One example of the deficiencies of the disclosures, or caveats, in IRS91 should suffice, given the importance of other issues in these preliminary comments. It is stated that "many uncertainties exist over what will happen in the future, especially in the period beyond two to three decades from now. These uncertainties are of the following two types: 2) a more qualitative uncertainty associated with the evolution of future patterns of human activity in response to both climate and non-climate influences, such as technological advances and government policies." IRS 91, p. 2.

Among other things:

- The caveat wholly fails to describe the real-world experiences, known to those who deal with energy issues, that prompted the apt statement by one nation's delegate to the EIS plenary that "it is impossible to make reliable energy forecasts of more than 10 to 15 years, and anything beyond that is pie in the sky." There is no reason for a reader to view a "scenario" realistically unless there are appropriate statements of how frequently and how materially guesses about the future of energy have been wrong and of the great likelihood that they will continue to be wrong. It makes no difference that IRS91 calls its emissions projection a "scenario" and that it points out that "it should not be considered a prediction of human activities or emissions." That is nothing other than playing with words, because the emissions figures resulting from the "scenario" are what will drive the climate models. Even if the fine distinction between a "scenario" and a "prediction" or "forecast" is noticed initially, it ultimately will long be forgotten, while the resulting prediction of climate change indelibly is part of the public's mindset.

- The bare mention of "technological advances and government policies" is inadequate. Why not tell the reader to imagine he or she was presented with an energy emissions "scenario" in 1880 and to think about how off-base the "scenario" would be in light of technology

developments in the ensuing 110 years (e.g., automobiles, aircraft, computers, nuclear power, etc.)? Instead of merely referring to "government policies," why not describe at least the types of regulatory, tax, educational, and hortatory policies that already are constraining greenhouse gas emissions and mention the unrelenting pressures on governments to expand such policies?

- There is no mention, until the inadequate, cryptic references on page 7, of the important impacts of changes in energy prices and of structural changes in economies upon energy consumption and related emissions.

- Most importantly, the material surrounding the discussion of uncertainty is designed to obscure the significance of the "caveat" and to offset its cautionary function. Immediately before, the authors contend -- incorrectly, we submit -- that the scenario "represents an internally consistent view of one the many ways in which the future could evolve, given a reasonable set of assumptions. These are based on numerous expert analyses, including scenarios of future national energy use, most of which have been subject to extensive peer review." Immediately after, the authors assert, "We have addressed some of these uncertainties with sensitivity analyses of key parameters in order to provide insight into the range of uncertainty surrounding this reference scenario."

But IRS91 presents more than a case of glaringly insufficient warning of the inherent frailties of 110-year greenhouse gas emissions scenarios. Preliminary review of the draft IRS91 indicates the following major areas where the draft mischaracterizes the study and its underlying assumptions.

Inconsistencies

The IRS91 states that it is an "internally consistent view" of the future. IRS91, p. 2. We challenge that statement for two reasons.

First. As will be elaborated later, one of the significant defects of the Energy and Industry Subgroup's Reference Scenario -- the major building block of IRS91 through the year 2025 -- is that major reporting countries did not use the same assumptions concerning world oil prices in preparing their energy forecasts. For example, the Federal Republic of Germany used world oil prices for the years 2000 and 2010 that were only about 50% and 75%, respectively, of the prices assumed for those years by Japan. Compare "Economic Growth, Energy Demand and CO₂ Emissions

in FRG (1990), p. 7 with "Outline of Interim Japanese Country Study (1990), p. 1. Canada assumed that world oil prices would remain constant at \$25 per barrel after 2005, although, for the year 2030, Japan and the United States assumed prices that were more than 75% higher. Compare Report of EIS Meeting, pp. 1 and 4 (Sept. 1989) with the abovementioned Outline, p. 1. These are material inconsistencies that cast significant doubt on the credibility of the resulting integrated scenario.

Second. There is inconsistency in the starting dates of the individual country studies upon which the EIS Reference Scenario was based. Attachment A of "Integrated Analysis of Country Case Studies" shows starting dates that vary from country to country. For example, the Federal Republic of Germany's data begin in 1987, France's and Japan's begin in 1986, and Finland's starts in 1988. There is no evidence that the EIS's integration process included any attempt to adjust for what appears to have been the use of different historical bases. The resulting base level of emissions calculated by an integration process that does not incorporate, or at least properly adjust for, all known historical information is likely to be incorrect. Use of an incorrect base figure automatically flaws any projections based thereon.

Misleading Characterization: "Moderate" Assumptions

From the beginning, the draft IRS91 seeks to create the aura that it is moderate. On page 2, under the caption "General Assumptions," the authors assert that "the assumptions are moderate" That statement is reinforced by the prior assurance that it is based on "a reasonable set of assumptions. These are based on numerous expert analyses, including scenarios of future national energy use, most of which have been subject to extensive review." IRS 91, p. 2.

If the underlying assumptions were "moderate," one would expect the resulting scenarios to be "moderate" as well. However, there is nothing "moderate" about some of the important segments of the greenhouse gas emissions scenario portrayed by IRS91. This, in turn, creates serious doubt about the appropriateness of the initial assertion that the assumptions are "moderate." Without benefit of the Pepper-Swart underlying study, we cite the following examples.

High-end Forecast of Energy-Related CO₂ Emissions

Although the IRS91 goes out all the way to the end of the next century, a critical component is the projection of energy

related CO₂ emissions during the first 35 years, to 2025. The importance of this part of the scenario is that: (i) the earlier period is the base to which future annual emissions growth rates are applied, so that the higher the base, the higher the emissions during the remaining three quarters of a century; and (ii) because of the lagged potential response of the climate system to greenhouse emissions, higher emissions in the earlier part of the scenario have the effect, under current General Circulation Models relied upon by the IPCC, of speeding up and locking in relatively higher temperature changes during the 110-year period covered by the climate change prediction.

When the energy-related CO₂ emissions at 2025 in Table 3 of IRS91 are compared with the estimate of Scenario A of the FAR (the BAU Scenario), one sees an enormous increase -- 12.42 BtC versus 9.9 BtC. Compare IRS91, p. 16 with WG-III Pol.Sum., p. xxxii. That is an increase of over 25% to the IPCC's basic scenario, made just over a year ago.

As a consequence of such a major change in view concerning energy-related CO₂ emissions, the IRS91 version of such emissions from fossil fuels is substantially higher than four of the five scenarios (including the BAU scenario)^{1/} that extend to 2020 and are compared in Figure 4 on IRS91, p. 7. Since the draft IRS91 portrays such comparisons in graphic, rather than tabular form, it is not possible to calculate precise comparisons. However, estimates from the graph indicate that, at 2020, the IRS91

^{1/} The IRS91 scenario is not made more respectable by showing in Figure 4 that one of the five comparative scenarios resulted in higher energy-related CO₂ emissions. That one was the IIASA "high" scenario. See B. Keepin and B. Wynne, "Technical Analysis of IIASA Energy Scenarios," Nature, p.691 (Dec. 1984), the introductory summary for which states: "Despite the appearance of analytical rigour, IIASA's widely acclaimed global energy projections are highly unstable and based on informal guesswork. This results from inadequate peer review and quality control, raising questions about political bias in scientific analysis."

Moreover, the principal author of the IIASA study, in a subsequent study, only relies on the IIASA low scenario and other similar scenarios, thereby implicitly disavowing the IIASA high scenario. See W. Hafele, et al., "Future Uses of Fossil Fuels: A Global View of Related Emissions and Depositions," Advances in Organic Chemistry 1985, Organic Geochemistry, Vol. 10, at pp. 2-3 (1986).

emissions are higher than those depicted in other studies by the following approximate percentages:

<u>Comparison Scenario</u>	<u>IRS91 Approximate Increase</u>
IPCC-BAU	13%
IIASA - Low	20%
WEC - Moderate	34%
WEC - Limited	63%

The absence of moderation in the IRS91 scenario of CO₂ emissions, as of 2020, becomes all the more clear by the time the scenario reaches 2025. As noted earlier, the IRS91 envisions CO₂ emissions from the energy sector that, by then, are more than 25% higher than those estimated by the IPCC's BAU scenario. The IRS91 CO₂ emissions from fossil fuels at 2025 appear from Figure 4 to be approximately 30% higher than projected by IIASA's low case.

Based on these comparisons, there is nothing at all "moderate" about IRS91's portrayal of CO₂ emissions from fossil energy. If the scenario is not "moderate," it follows that the underlying assumptions are not "moderate" either. If that is the case, IRS91's characterization of the assumptions is misleading.

Moreover, given the IRS91's 25% increase in projected energy-related CO₂ emissions over those estimated by the IPCC's BAU scenario in 2025, noted above, it is misleading merely to say that "compared to the original BAU scenario, this represents somewhat faster growth before 2025" IRS91, p.5 (emphasis added).

High-End Forecast of Total Global CO₂ Emissions

Comparison of the IRS91 estimate of total CO₂ emissions with other analyses strongly reinforces the concern that the resulting scenario is not moderate. The underlying assumptions reflect a pessimistic view of the future and thus create a strong bias toward a high projection of emissions.

The First Assessment of IPCC Working Group III ("FAR-WG-III") developed multiple scenarios of total, global greenhouse gas emissions. Two extreme cases were the "2030 High Emissions (Average) Scenario" -- characterized as "Carbon-intensive, represents a pessimistic view of future non-fossil developments" -- and the "2060 Low Emissions (Average) Scenario" -- characterized as "Gas-intensive," where "increased use of natural gas is

encouraged in order to meet a number of environmental goals, including reducing CO₂ emissions." FAR-WG-III, p. 23.

The IRS91 shows total, global CO₂ emissions that are higher than the emissions levels for each year under the pessimistic assumptions of the 2030 High Emissions (Average) Scenario. Compare FAR-WG-III, p. 26 with IRS91, p. 16. In 2025, for example, global CO₂ emissions under the IRS91 are 31% higher than those under the 2030 High Emissions Scenario.

Comparison to the 2060 Low Emissions (Average) Scenario results in even greater exaggerated differences. Total, global CO₂ emissions are significantly higher in all years, with the ultimate level of 23.23 billion tons being more than double the 10.3 billion tons estimated in the 2060 Low Emissions Scenario. Compare FAR-WG-III, p. 27 with IRS91, p. 16.

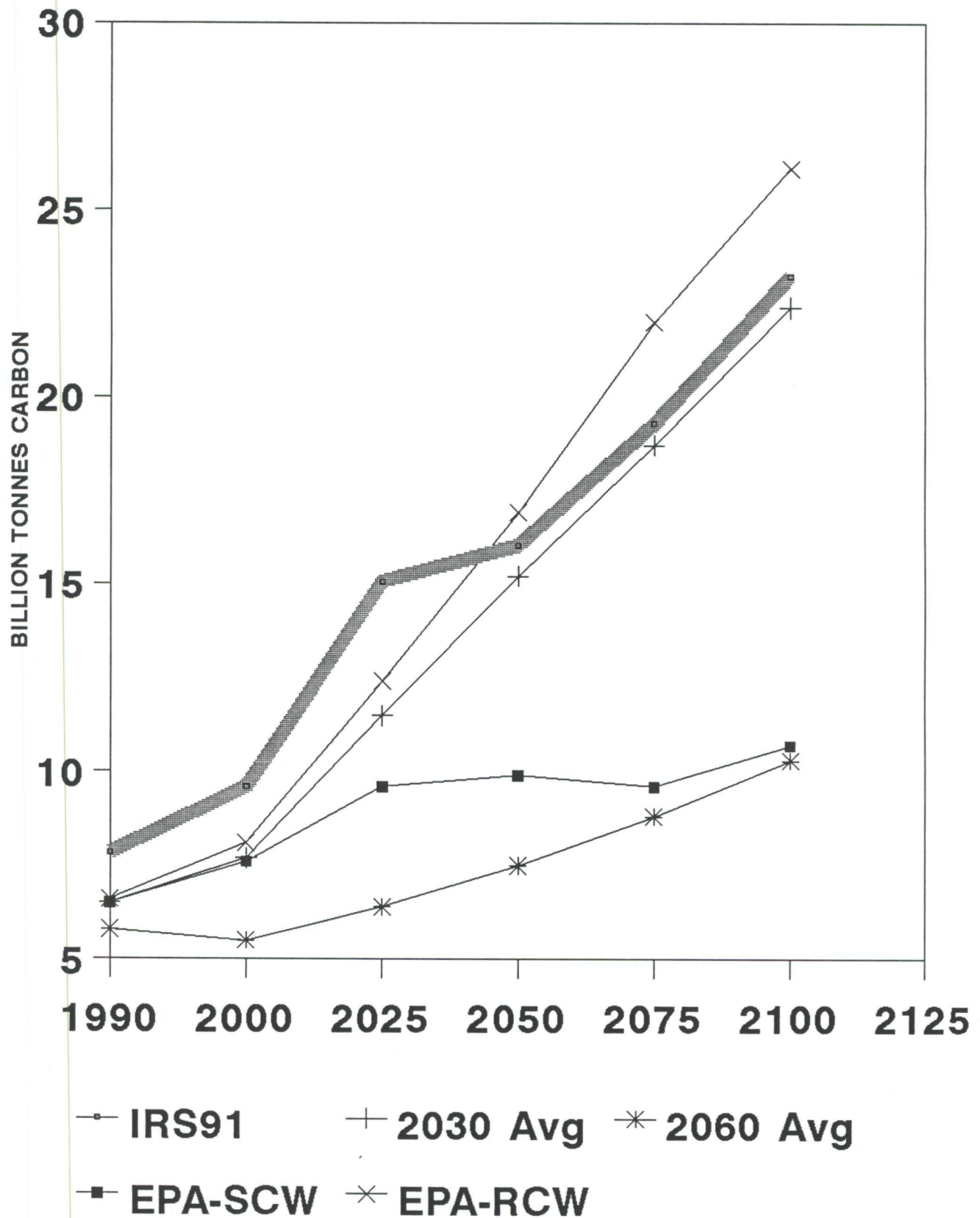
The U.S. Environmental Protection Agency's Policy Options for Stabilizing Global Climate (December 1990) ("EPA, Policy Options") provides two reference scenarios that bound its analysis. One, called "Rapidly Changing World" and labelled "RCW," is described as assuming that "rapid economic growth and structural change occur and that little attention is given to the global environment" -- a rather pessimistic view. EPA, Policy Options, p. VI-10. The total, global CO₂ emissions projected by IRS91 for 2025 are an amazing 21% higher than the projection for that year by EPA's pessimistic RCW scenario, and they are only about 11% lower than the RCW forecast for 2100. Compare EPA, Policy Options, p. VI-42 with IRS91, p. 16.

Alternatively, the U.S. EPA's scenario called "Slowly Changing World" and labelled "SCW" is characterized as assuming that "the recent experience of modest economic growth will continue indefinitely, with no concerted policy response to the risk of climate change." EPA, Policy Options, p. VI-10. Total, global CO₂ emissions under IRS91 are significantly higher than those under the SCW scenario for all years and are more than double the SCW levels by 2100.

These four comparison scenarios, done within the last year or two, fall into two clusters that are depicted in Figure 1 (on the next page). The two clusters can serve to bound a range of future outcomes, with the pessimistic IPCC 2030 High Emissions scenario and the rapid-growth EPA-RCW scenario forming the upper bound, and the gas-intensive IPCC 2060 scenario and the modest growth EPA-SCW scenario forming the lower bound.

Given our belief, stated earlier, that "moderate" assumptions should produce essentially "moderate" scenarios, the IRS91 scenario should fall well between the upper- and lower-bound

FIGURE 1
WORLD CO2 EMISSIONS -- ALL SOURCES



clusters if it were based on "moderate" assumptions. However, that is not the case. As easily can be seen from Figure 1, the IRS91 scenario falls directly within the range of the upper bound cluster, which has total, global CO₂ emissions in 2100 that are more than double the range of the lower cluster.

Once again, the assertion by IRS91 that its assumptions are "moderate" just is not borne out by the results.

High Assumptions of Economic and Energy Growth

For five of the nine country groupings listed, the IRS91 estimates of rate of GDP growth are higher than those of the IPCC BAU scenario for the period 1985-2000. During the important period 2000-2025, the IRS91 is higher in seven of the nine cases, with one remaining unchanged. In some cases, the increase is "only" one-tenth of a percentage point per year, but, in others, the increase is as much as 1.4 percentage points per year (e.g., China and Centrally Planned Asia, and Africa, during 2000-2025). IRS91, p. 3, Table 1.

It must be remembered that "only" one-tenth of a percentage point in assumed rate of economic growth will have very substantial consequences in the ultimate calculation of GDP. There is a compounding effect, which, over long periods, will produce materially higher GDP estimates. (Assuming a 2.1% annual growth rate for the 110-year study horizon, GDP in 2100 will be 11% higher than if the growth rate were reduced by only 0.1%, to 2.0% per year). Wisely, IRS91 acknowledges that "the results provided in this paper are highly sensitive to these assumptions." IRS91, p. 2. Economic growth, of course, is one of the major factors in determining energy consumption.

There is no information in IRS91 that would justify including the assumptions concerning economic growth among the assumptions the draft describes as "moderate." There is no explanation as to why the materially higher growth rates chosen by IRS91 are preferable to the growth-rate assumptions in the IPCC's BAU. Indeed, the blanket characterization of "moderate" assumptions on page 2 of the draft are inconsistent with the statement that "it is highly uncertain whether some of the ambitious growth figures can be realized and maintained in all regions, notably in the presently volatile circumstances in the nations of the USSR, Eastern Europe, and some of the developing areas." IRS91, p. 4.

Unreasonably High Projections of USSR Energy Use

The IRS91 states that "one area requiring close inspection is the USSR and Eastern Europe." IRS91, p. 6. And well it should, since the USSR is projected to make a significant contribution to global CO₂ emissions in the coming decades. See Energy and Industry Subgroup Report, p. 33. The level of USSR energy use assumed by IRS91 will be an important factor, along with assumptions concerning fuel mix and the like, in estimating total world CO₂ emissions. Preliminary investigation indicates that USSR energy use incorporated into the IRS91 exceeds the estimates provided by five other studies.

The problem begins with the EIS Reference Scenario. Its "Integrated Analysis of Country Case Studies" (September 1990) shows that 61.06 exajoules (EJ) of primary energy were used in the USSR in 1990. Use is expected to rise to 117.2 EJ by 2025. See Attachment A to Case Study report.

A paper, "USSR and East Europe: Future Energy Development and CO₂ Reduction Problem," presented in June 1990 by Igor Bashmakov, one of the authors of the EIS country case study, appears to contradict the EIS case study. That paper presents two useful comparisons. The first, labeled "Reference Scenario," is based on continuation of past trends without additional policy efforts and assumes 2% annual economic growth for the period 1990 to 2020. (Bashmakov, p. 7) It estimates primary energy use in 2020 at 95 EJ (id., p. 8), which is 12% below the interpolated value of 108.2 EJ for 2020 from the IRS91.

Importantly, however, Bashmakov believes that the chance of realization of that scenario is very small because of the inability to increase the standard of living. He believes that a much more likely outcome is the "Market Efficiency Potential Scenario" (MEPS). Under MEPS, there are policies that include raising energy prices to market levels and some shift of production towards less energy-intensive industries. Id., p. 10. Economic growth is expected to be 1% annually for 1990-95, 2.5% for 1996-2000, and 3 percent for 2001-20; thus, primary energy use in 2020 is expected to be 86.8 EJ. Id., p. 11. This is 20% below the interpolated IRS91 level.

A 1989 paper by Alexei Makarov and Bashmakov, entitled "The Soviet Union: A Strategy of Energy Development with Minimum Emission of Greenhouse Gases," presents a "Structural Change" (SC) case that anticipates some policy reforms that are the least aggressive of those considered in the study. Economic growth for the SC case is 3 to 3.5% through 2005, but drops to 2.5 to 3% during 2006 to 2020. Makarov, p. 5. Resulting primary energy

use is estimated at 95.5 EJ in 2020, id., p. 28, which, as under Bashmakov's less likely, higher scenario, is 12% below the interpolated IRS91 value of 108.2 EJ.

Another study is the Economic Commission for Europe's (ECE) 1991 report, entitled "Energy Reforms in Central and Eastern Europe -- The First Year." The ECE, at page 58 of its report, estimates total energy consumption by the USSR in 2010 will be 1901 million tonnes oil equivalent (MTOE), which corresponds to 81.2 EJ. That is 12% lower than the IRS91 estimate of 92.27 EJ for the same year.

Finally, the U.S. Energy Information Administration (EIA) has prepared a 20-year forecast for energy use in the USSR. It anticipates energy use of 65.3 quads, or 68.9 EJ, by 2010. EIA, International Energy Outlook 1991, p. 31. That is 25% below the IRS91 value for the same year.

To summarize: Five alternate studies of energy use in the USSR all show primary energy use at the end of their respective forecast periods that is 12 to 25% lower than the IRS91 level for the comparable year. For 2025, the IRS91 value of 117.2 EJ is 14 to 47% higher than the extrapolated value in 2025 for all comparison studies. (Note that the extrapolation has been done using the implicit growth rate for the last 10 forecast years of each study.) These results are shown graphically in Figure 2 (on next page).

It is apparent that the IRS91 estimates for the USSR hardly can be regarded as "moderate." Indeed, they are at or beyond the high end of reasonableness. Because of the contribution of the USSR to global emissions, this may explain, at least in part, why the entire emissions scenario of IRS91 is driven to the upper bound of reasonableness.

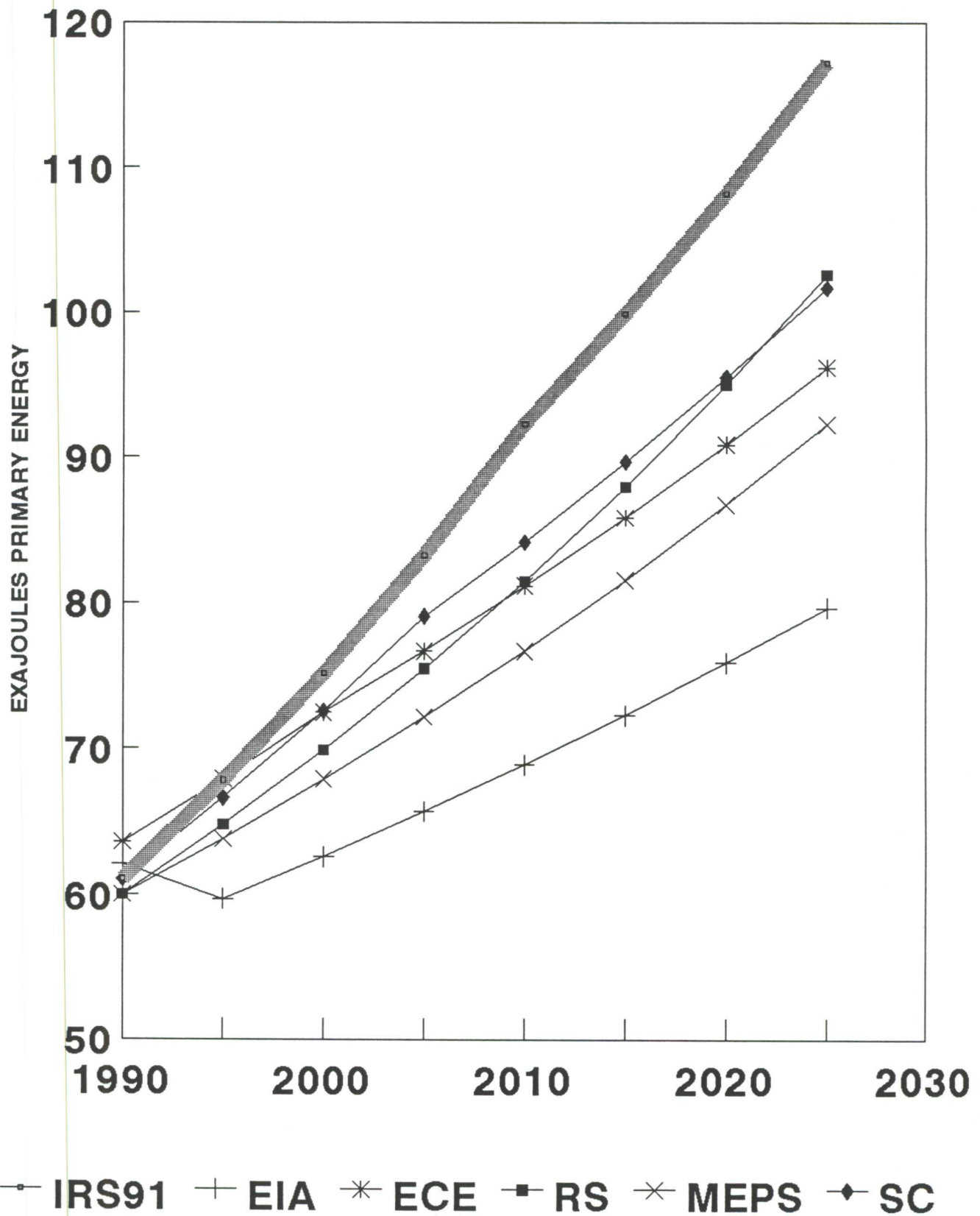
The point of the examples cited over the last several pages is quite plain: there is nothing "moderate" about the IRS91 assumptions concerning economic growth or the resulting assumptions about energy-related CO₂ emissions. To so state is to mislead the reader. And, that serious problem of mischaracterization is separate from the issue of the substantive defects in the draft IRS91, which are discussed in Part III of these comments.

Other Misleading Characterizations and Statements

The draft is replete with language well chosen to create the impression that IRS91 is a carefully prepared and balanced

FIGURE 2

USSR PRIMARY ENERGY



study and that its assumptions and analyses are based on the extensively reviewed studies of persons sufficiently expert so that the reader should be content with the results. To illustrate this promotion of credibility and to demonstrate why that raises serious concerns, we offer the following examples.

- The draft refers to "new information . . . [that] reflects . . . revised understanding of future activities leading to emissions of greenhouse gases" and to "recent national energy forecasts." IRS91, p. 1. What "recent national energy forecasts?" The basic building block of IRS91 is the EIS Reference Scenario of 1990, the same year as the BAU scenario. Were the more recent forecasts used to adjust the EIS Reference Scenario? What "recent national energy forecasts" go out to the year 2100? Who prepared them? What, exactly, is the "revised understanding" of future activities that produce greenhouse gas emissions from the energy sector?

- IRS91 refers to "scenarios of future national energy use, most of which have been subject to extensive review." IRS91, p. 2. Exactly what was this extensive review of the key EIS Reference Scenario and of any studies that project energy use for 110 years? Who performed the review? As far as we know, the current review of IRS91 is the first alleged peer review of the EIS Reference Scenario or of any longer-term scenario (other than, possibly, the IPCC's BAU scenario, which IRS91 overtakes).

- The draft asserts that the "EIS scenario estimates future energy use and emissions through 2025 . . . for a large number of countries, as derived from both national submissions and independent country case studies." IRS91, p. 4. There were only 12 country studies prepared by countries and only nine prepared independently, all of the latter having been prepared for the U.S. EPA. IPCC, Response Strategies Working Group, Energy and Industry Subgroup Report, p. 27 (prepared 1990; published 1991). Of the 21 country studies, only six were from developing countries; none were from Africa; only four were from Asia; and only three were from Latin America.

- IRS91 asserts that it "provides insights on uncertainties associated with the scenario through sensitivity analysis," IRS91, p. 1, and contends, "We have addressed some of these uncertainties with sensitivity analyses of key parameters in order to provide insight into the range of uncertainty surrounding this reference scenario." IRS91, p. 2. Insofar as one can determine from the draft, there are only two sensitivity analyses pertinent to emissions from the energy sector: one for the USSR and Eastern Europe, which uses only one variable; and one for OECD countries, using an assumption of stabilization of CO₂

emissions by 2000 for an undisclosed portion of those countries. There is no information concerning the results of sensitivity analyses, if any, that take into account -- either for the world, for regions, or for individual countries -- varying assumptions concerning economic growth (except for one varying assumption for the USSR and Eastern Europe), world oil prices, energy efficiency improvements, or changes in fuel mix.

- The text of IRS91 tries to create the impression that its emissions projections are in the mid-range of the projections by others. That impression is demonstrably inaccurate. See "High-End Forecast of Energy-Related CO₂ Emissions" and "High-End Forecast of Total Global CO₂ Emissions," pages 7-12, above. Moreover, when the IRS91 asserts that its scenario is "very close to the median values from Nordhaus and Yohe in the 2050 to 2100 time period," IRS91, p. 7, it conveniently ignores the fact that it is approximately 25% higher at the year 2025 (IRS91, p. 8, Figure 5). Under current GCMs, the 2025 emission levels have significant climate impact in out-years because of the previously mentioned lag in climate response. The assertion at page 7 that the IRS91 scenario falls "within the 25th and 75th percentiles in the Edmonds analysis," which stops a quarter century before the IRS91, is meaningless.

Conclusion: Part II

The draft IRS91 makes an inadequate attempt to set forth caveats that point out, only in general terms, the uncertainties in long-term energy and energy-related emissions scenarios. In implicit recognition that such uncertainties warrant a relatively cautious approach to constructing scenarios, the authors artfully attempt to create the impression that IRS91 is based on "moderate" assumptions.

In wholesale disregard of moderation, IRS91 portrays a future that is consistently at the high end of alternative scenarios -- those characterized by rapid growth and intensive use of energy. Often, the energy-related emissions scenarios of IRS91 are dramatically higher than the future indicated by lower-growth, less energy-intensive alternatives. IRS91 seems to know no middle ground.

As a result the readers of IRS91, and policymakers who will base decisions on that report, will be misled. The cumulative effects of wholly inadequate warnings about the inherent uncertainties of long-term scenarios and the aggressive, immoderate selection of portraits of the future strain the credibility of IRS91.

III.

SUBSTANTIVE PROBLEMS WITH ASSUMPTIONS AND ANALYSIS

The Unreliability of the EIS Reference Scenario as a Foundation for the IRS91

Many of the problems with IRS91 discussed in these preliminary comments apply to the EIS Reference Scenario, which covers the period through 2025, as well as to the 75-year extrapolation to the end of the next century. For example, absence of thorough peer review appears to have been just as much a problem for the EIS Reference Scenario as it is to the whole of IRS91. The previously noted inconsistencies in the choices by various countries of world oil price assumptions is a specific problem of the EIS Reference Scenario. There is no indication that the EIS Reference Scenario was the subject of any sensitivity analyses. The problem of exaggerated economic and energy growth rates appears to be more pronounced with respect to the EIS Reference Scenario than it is for the out-years of the IRS91. The problem of unrealistically low expectations concerning future energy efficiency is just as much a problem for the EIS Reference Scenario as it is for the whole of the IRS91.

Given the procedural and substantive problems of the EIS Reference Scenario, the fact that it was part of the IPCC's FAR is no justification for using it as the foundation for the IRS91. Working Group I cannot point with pride to an "update" of greenhouse gas emissions scenarios based on "new" information and analysis and, at the same time, walk away from new and valid criticism of the content of the the EIS Reference Scenario and of the process by which it was constructed.

To be sure, it is unfortunate that the industrial and energy communities were not more involved in the IPCC at the time the EIS Reference Scenario was developed. Had they been more involved, some of the problems embedded in the proposed IRS91 scenario might have been averted a year ago. But, such failure does not justify immunizing the fundamental building block of IRS91 from challenges warranted by facts or sound economic analysis.

That said, we now turn to the major categories of substantive problems that appear from a preliminary review of IRS91, without benefit of the Pepper-Swart underlying study.

Inadequate Recognition of Energy (Especially Oil) Prices

A major flaw of the IRS91 is its cavalier treatment of the important role energy prices, especially oil prices, play in determining CO₂ emissions levels over time. Energy prices have direct and material bearing on the amount of energy that will be consumed and on energy intensity itself. There is little, if any, reason to doubt that crude-oil prices will be a major determinant of energy prices in the years covered by the IRS91 scenario, as they have been over much of the past century.

Notwithstanding the critical importance of crude-oil prices, the EIS Reference Scenario, the major building block of the IRS91, was itself constructed on a variety of inconsistent views as to what world oil prices would be during its time horizon. See discussion at pages 6-7, above. There was no discussion in the EIS Reference Scenario or in the draft IRS91 as to what these discrepancies imply, or whether or how they were resolved.

Similarly, one would think that the authors of IRS91 would have made energy prices, and, specifically, crude-oil prices, an explicit variable when they extended the EIS Reference Scenario out to the end of the next century. Since the Pepper-Swart underlying study has not been made available as of this date, we have no way to know what assumptions, if any, the IRS91 used concerning world crude-oil prices. Nor do we know what sensitivity analyses were performed to test the impact of differing crude-oil prices. The draft IRS91 is silent on these points.

The failure to deal forthrightly with the issue of oil prices may explain, at least in part, the rather high assumptions of annual economic growth and the rather low assumptions about energy-efficiency gains used by IRS91.

Lack of Justification for Higher Economic Growth Rates

The IRS91 offers no justification whatsoever for raising the economic growth projections that were used in last year's IPCC BAU scenario in 12 of the 18 instances where it projects percentage GDP growth by groups of countries during the period ending 2025. See IRS91, p. 3, Table 1.

Earlier, we pointed out that the economic growth assumptions of IRS91 hardly can be called "moderate." See page 12, above. Why does IRS91 use some projections of economic growth, which even the authors characterize as being "ambitious" and "highly uncertain" in terms of their ultimate realization? See IRS91, p. 4.

What has occurred within the past year to 18 months that warrants the surge of optimism in IRS91's economic growth assumptions? This certainly is not the current situation in the economies of the OECD countries. The debate among economists seems to be whether countries, such as the United States, really are out of the recession that has plagued them for the past 24 months, or whether they face a so-called "double-dip" recession. While the set-backs of a year or two are not necessarily harbingers of long-term stagnation, neither do they create something "new" for an "updated" scenario that warrants increasing the annual GDP growth rates for the entire OECD through the next century.

It is true that economic growth during the 1960s and '70s had been generally favorable, but there is reason to doubt that those growth rates are sustainable in the long run. For example, the IRS91 assumes a 1985-2000 growth rate of 3.5% for Latin America and 3.2% for the first quarter century thereafter. Although the GDP growth rates for Latin America were 5.4% in 1961-70 and 5.9% in 1971-80, the growth rate during 1981-90 had dwindled to 0.9% and, on a per-capita basis, to a negative, at -1.2%. In the short run, the Latin American growth rates look even more ominous, for they declined at an annual rate of 0.4% in the period 1988-90, with a concurrent per-capita decline rate of 2.2%. Inter-American Development Bank, Economic and Social Progress in Latin America, 1991, p. 273.

Not surprisingly, the International Monetary Fund (IMF) is very pessimistic about GDP growth in Eastern Europe and the USSR. For 1989, the growth rate was 1.9%. The IMF projection for the near future is grim: for 1990, based in part on historical information, the GDP growth rate is negative (-3.6%), for 1991 it is -10.6%, and for 1992 it is -3.9%. IMF, World Economic Outlook, 1991, p. 85. For the period 1985-92, which is nearly half of the IRS91 projection period of 1985-2000, the region of the USSR and Eastern Europe will have a cumulative compound growth rate, according to the IMF, of -1.0%. Ibid. Therefore, to achieve the IRS91 compound growth rate of 3.3% envisioned, the region would have to grow at the incredible rate of 7.2% over the period 1992-2000.

One is struck, also, by the enormous increases, over the IPCC's BAU scenario, in the projections of economic growth for China and Centrally Planned Asia. The IRS91 increases the annual rate of growth for that region from 4.5% per year to 5.2% per year between 1985 and 2000, and from 4.0% per year to 5.4% per year between 2000 and 2025. The World Bank's World Development Report - 1990, p. 8 observes that China's growth fell to 3.9% in 1990, less than half the average for the decade. That very significant slowdown in the GDP growth of China (which dominates the figures for the region) may be a temporary aberration; but, if it

represents a more permanent shift, then the growth in emissions attributed by IRS91 to China could be vastly overstated. Given the size of current emissions, that would reflect a significant deficiency of the IRS91. Hence, the obvious question: what do the authors of IRS91 know that warrants such great confidence? Moreover, what did the authors assume about the possibility that, during the next 35 years, China may move to a market economy?

When one studies the IRS91 Table 3, it is apparent that the authors believe that there will be rapid economic growth throughout the world (except in the United States) for the first 35 years of the scenario, with a pronounced decline in expectations for the remaining 75 years. By the last half of the next century, average annual growth rates appear to drop by one-third to one-half of what they were earlier. What prompts the sudden caution?

Insofar as energy-related emissions are concerned, it would have been helpful if IRS91 had provided explicit information concerning changes in per capita income. Similarly, it would help if sensitivity analyses had been run to determine the impact on energy-related emissions of declines or increases in per capita income, particularly in developing countries. How much gain in per capita income is necessary in a low-income family before it begins to divert income to energy-intensive goods, such as automobiles, rather than using added income, if any, for food, shelter, health care, education, and other basic necessities that are not as energy-intensive?

Lack of Justification for Timid Assumptions about Reductions in Energy Intensity

The EIS Reference Scenario assumed that the global average decrease in energy intensity, during the period 1985-2025, was only 0.8% per year. Energy and Industry Subgroup Report, p.59. This estimate is lower than the lowest of the four energy efficiency scenarios underlying the IPCC's BAU scenario, which range from 0.9% to 2.3%. FAR - Working Group III, p. 24.

The IRS91 offers no explanation for such pessimism. No more reason is given for that outlook on the future than the IRS91 gives for its mind-boggling assumption that, by 2100, between 84 and 88% of all tropical forests will be cleared. Perhaps the Pepper-Swart underlying study can explain.

The Curious Pattern of Changes in the Rates of Growth of Greenhouse Gas Emissions from the Energy Sector

The increases in CO₂ emissions from the energy sector, as set forth in IRS91, p. 3, Table 3, are truly phenomenal during the period through 2025. There is a 24.9% increase from 1990 to 2000, and a 69.7% increase in the first quarter of the next century. From 1990 to 2025, the increase is a whopping 111.9%. Similarly big gains -- some higher, some lower -- are assumed for the other energy-related greenhouse gases.

But then, miraculously, there is a precipitous decline in the growth rates for energy-related CO₂ and other greenhouse gas emissions. The average annual growth rate for CO₂, which was 2.14% per year from 2000 to 2025, unexpectedly drops to a mere 0.52% per year during the period 2025 to 2050. This phenomenon, along with similarly steep drops in the rate of growth of other energy-related greenhouse gases, is depicted in Figure 3 (on next page).

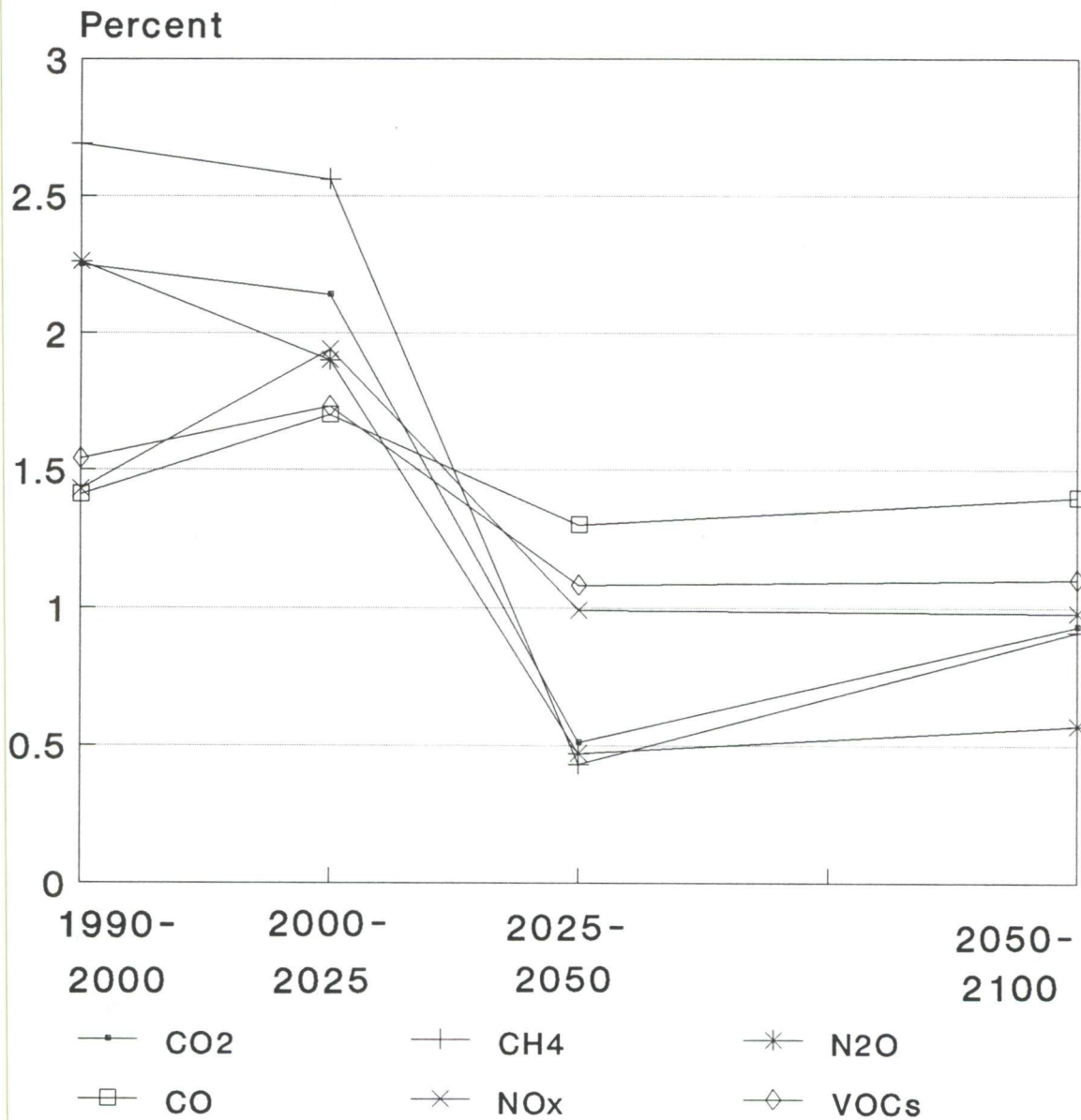
The sudden and severe decline in these growth rates is inexplicable. We anxiously await the Pepper-Swart underlying study to learn, if it provides the analysis, why there is such a dramatic change in the pattern of energy-related greenhouse gas emissions.

We have speculated as to why. Could it be that the world is running out of fossil fuels? No, at least according to IRS91's Figure 2, which seems to show global primary energy use from oil at about the same level in 2050 as it was in 2025, and an increase in coal use that appears roughly to offset the assumed decline in gas during that period.

Could it be that non-greenhouse-gas emitting energy sources suddenly materialize? Perhaps. But, if that is the case, then what accounts for the fact that, from 2050 to the end of the century, the growth rates for CO₂ and most of the other greenhouse gases start to rise again? One would think that the replacement of fossil fuels, if it were to occur during the second quarter of the next century, would cause the growth rates for energy-related CO₂ emissions to continue on a downward path, or, at least, to stay level. But, that is not what is shown by Figure 3.

Until we have an opportunity to examine and to scrutinize the Pepper-Swart underlying study, we shall refrain from expressing a judgment on these curious matters. Suffice it to say that grave concerns are raised about the bases for the assumptions that result in the energy future portrayed by IRS91.

FIGURE 3
AVERAGE ANNUAL GROWTH RATES
IN GREENHOUSE GAS EMISSIONS



CONCLUSION

The process for peer review of IRS91 is fundamentally flawed because it effectively prevents informed review. For this reason alone, any use of IRS91 in predicting future climate will not be justified until the underlying Pepper-Swart study is made available for meaningful peer review and comment, and the lead authors take constructive advantage of reviewers' comments.

The cumulative effects of wholly inadequate warnings about the inherent uncertainties of long-term scenarios and the misleading characterization of assumptions as being "moderate" strain the credibility of IRS91.

Substantive problems with the assumptions and analysis of IRS91 abound. Many of these problems stem from the defects embedded in the EIS Reference Scenario, the foundation for IRS91. Key flaws in IRS91 that must be redressed include:

- Inadequate recognition of the important role that energy prices, especially oil prices, play in determining CO₂ emission levels over time.
- Lack of justification for high economic growth rates.
- Lack of justification for timid assumptions about reductions in energy intensity.
- Sudden and unexpected changes in the rates of growth of greenhouse gas emissions from the energy sector.

Because the IRS91 will play such a critical role in any IPCC Working Group I "update" of climate change predictions, any such "update" must await cure of the procedural and substantive defects of IRS91 described in these comments.

APPENDIX 1

Geneva, Switzerland

31 October 1991

BY HAND DELIVERY - GENEVA

Mr. Bruce Callander
Executive Secretariat
IPCC Working Group I

Dear Bruce:

Thank you for arranging the faxing to me of the 22-page draft paper entitled "Emissions Scenarios for the IPCC - an update," dated October 25, 1991. I received it the evening of October 29, but, like you, will not be able to focus on it until my return to my office from the IPCC and Working Group III meetings occurring in Geneva this week. My colleagues and I shall do our best to submit comments by November 22, as your transmittal letter requests.

The introductory paragraph of the draft states: "More detailed documentation is available in a companion document (Pepper et al., forthcoming)." Presumably, that document is the one identified in the list of references, attached to the draft, as "Pepper, W. J., R. J. Swart, ... Forthcoming, Emission Scenarios for the IPCC - Assumptions, Metho[d]ology, and Results."

We will be severely hampered in our ability to review the draft and to comment on it until we have received, and had adequate time to review, the underlying document prepared by Messrs. Pepper and Swart. It presumably exists already, since the draft you have furnished, which sets forth specific projections of future global greenhouse gas emissions, was based on

Mr. Bruce Callander
31 October 1991

Page 2

the assumptions and methodologies described in the underlying document, but which are not disclosed in the draft report.

For this reason we respectfully request that IPCC Working Group I immediately furnish us a complete copy of the Pepper/Swart underlying document. The document should be faxed to me at my office in Washington, D.C. --
(202) 457-6315.

Thank you for your cooperation.

Sincerely yours,



Donald H. Pearlman
for The Climate Council

APPENDIX 2



WORLD METEOROLOGICAL
ORGANIZATION



UNITED NATIONS
ENVIRONMENT PROGRAMME

'91 NOV -7 A10:59

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

SCIENTIFIC ASSESSMENT OF CLIMATE CHANGE

Chairman: Dr J T Houghton

Don Pearlman.
The Climate Council,
Suite 700,
2550 M Street, N.W.,
Washington DC 20037

Our ref: M/IPCC/12/9/3/3

Your ref:

7 November 1991

Dear Don,

IPCC EMISSIONS SCENARIOS - BACKGROUND DOCUMENT

In response to your letter hand-delivered to me at IPCC-VI in Geneva, I have contacted Bill Pepper and Rob Swart. The document has been written and is being checked before release. I have asked that this process be expedited so that the document is available as soon as possible.

Yours sincerely,

Bruce A. Callander,
IPCC WG1 secretariat.

APPENDIX 3

THE CLIMATE COUNCIL

SUITE 700

2550 M STREET, N.W.

WASHINGTON, D.C. 20037

(202) 457-6501

November 7, 1991

VIA FAX AS INDICATED

Mr. Bruce Callander
Secretariat
IPCC Working Group I
Meteorological Office, Hadley Climate Centre
London Road, Bracknell, RG12 2SY, United Kingdom
Fax: 011-44-344-856912

Subject: IPCC Working Group I -- Emissions Scenarios

Dear Bruce:

Thank you for your fax, received today, which advised that the Pepper-Swart document, "Emissions Scenarios for the IPCC -- Assumptions, Methodology, and Results," has been written and that you have requested that your review process be expedited so that the document can be made available as soon as possible. Your fax came less than an hour after I had a telephone conversation with Jane Leggett concerning that matter.

When I returned to my office this Monday from the IPCC meetings in Geneva and discovered that the Pepper-Swart document had not been received, I called Mr. Pepper. He informed me that he could not release it on his authority, as he (or ICF) was in the process of preparing the document as a contractor to the U.S. EPA. I immediately telephoned Jane Leggett, but she did not return my call. I telephoned her again this morning.

Ms. Leggett informed me as follows: (i) the Pepper-Swart document is being reviewed by her and by the "lead authors" (presumably of the chapter entitled "Emissions Scenarios for the IPCC -- an Update"); (ii) Ms. Leggett has a priority workload that will not permit her to review the document until, perhaps, this weekend, with the result that she likely will not complete her review until about next Tuesday, November 12; and (iii) the Pepper-Swart document will not be released to reviewers, such as me, until she and the lead authors are satisfied with it.

Mr. Bruce Callander
November 7, 1991

Page 2

Review by Ms. Leggett and the lead authors is quite understandable. Those in Working Group I who are responsible for preparing the updated emissions scenarios have both the right and the responsibility to be comfortable with the product upon which the important work of Working Group I will be based. Similarly, I have empathy for the burdens upon Ms. Leggett's professional time schedule. This communication to you should not be interpreted as criticism of her.

At the same time, it is not possible for reviewers of the chapter on updated emissions scenarios to do an adequate review until we have possession of, and sufficient time to analyze, the Pepper-Swart document which underlies the chapter. That document should have been delivered concurrently with delivery of the chapter draft. Frankly, I am somewhat surprised that review of the Pepper-Swart document by Working Group I's management had not been completed prior to the release of the chapter on updated emissions scenarios, which presumably is a summary of the Pepper-Swart document.

Your memorandum that transmitted the chapter on updated emissions scenarios states that reviewer's comments should be sent to Ms. Leggett and to you "by 22 November at the very latest." If the underlying Pepper-Swart document is not received until next week, some time on or after November 12, we would have ten days or less to consider it, engage in such further research as might be appropriate, and prepare written comments. That amount of time is wholly inadequate in view of the complex issues involved.

I genuinely appreciate your efforts to obtain the expedited management review referred to in your fax. However, the circumstances described above necessitate **my formally requesting that the date for comments on the chapter concerning updated emissions scenarios be extended to a date that is 24 days after receipt by reviewers of the underlying Pepper-Swart document.** The draft of the chapter was received by fax on October 29, which was 24 days prior to the scheduled date of November 22 for submission of our comments.

I recognize that reviewers will have a second opportunity for review, since a revised draft of the chapter is scheduled for distribution "during December." However, if there is any chance that reviewer's comments seriously will be taken into consideration by the lead authors, it occurs to me that the first revised draft of the chapter should reflect those comments, so that preparation of the second revised draft, to be submitted to the

Mr. Bruce Callander
November 5, 1991

Page 3

Working Group I meeting in Guangzhou, in January, will involve consideration primarily of editorial matters, rather than the fundamental, substantive issues that, I suspect, may be brought out during the first effort of reviewers.

Those in charge of Working Group I have established an ambitious schedule for completion of its updated science report. The emissions scenarios will constitute a principal assumption of the modelling effort intended to "update" the predictions of future climate. For that reason, the credibility of the end product will be hampered seriously if the effort is characterized by a rush to judgment on the emissions scenarios. We merely seek an opportunity to have the review process be a meaningful one.

Thank you for your consideration of our request.

Sincerely yours,



Donald H. Pearlman

cc: Ms. Jane Leggett
U.S. Environmental Protection Administration (PM-221)
Climate Change Division/OPPE
401 M Street, S.W.
Washington, D.C. 20460
Fax: (202) 252-0512

APPENDIX 4

THE CLIMATE COUNCIL

SUITE 700

2550 M STREET, N.W.

WASHINGTON, D.C. 20037

(202) 457-6501

November 18, 1991

VIA FAX AS INDICATED

Mr. Bruce Callander
Secretariat
IPCC Working Group I
Meteorological Office, Hadley Climate Centre
London Road, Bracknell, RG12 2SY, United Kingdom
Fax: 011-44-344-856912

Subject: IPCC Working Group I -- Emissions Scenarios

Dear Bruce:

More than two and a half weeks have passed since I delivered to you in Geneva my October 31 letter, which emphasized the urgent need for reviewers of the draft of "Emissions Scenarios for the IPCC -- An Update" ("IRS91") to receive promptly the underlying Pepper-Swart document, "Emissions Scenarios for the IPCC -- Assumptions, Methodology, and Results." More than ten days have passed since my November 7 letter was faxed to you and to Jane Leggett, which, by reason of our not having that underlying document, formally requested an extension of time within which to submit comments on the IRS91. To date, I have received neither the underlying document nor a response to the request for extension of the comment period.

My colleagues and I have been engaged in preliminary review of IRS91 and of certain materials pertinent thereto, including publications listed in the table of references at the end of the draft and others that we believe contain reliable data and analyses. Our preliminary review has intensified our conviction that credible review of, and comments upon, IRS91 cannot be completed unless and until we possess, and have adequate time to review and to consider, the underlying Pepper-Swart document.

In addition to that document, we also request that you provide us with two of the documents listed in the draft IRS91, neither of which has been published or distributed publicly:

Mr. Bruce Callander
November 18, 1991

Page 2

Edmonds, Mintzer, Pepper, Major and Schater, The IPCC Reference Case in Relationship to Other Studies' Reference Cases (1991); and the 1991 personal communication from Weyant cited at page 8 of the draft IRS91.

If the reason for delay in receiving the underlying Pepper-Swart document is that Ms. Leggett and other lead authors still are reviewing it (notwithstanding October 29 release of the draft IRS91, which presumably is a summary of that underlying document), we applaud the implicit desire of you and they to be confident of the information and conclusions contained therein.

At the same time, if the review process is taken seriously by those of you in the "management" of the IPCC and Working Group I -- that is, if the review process is to be credible -- one would think that you would not even want reviewers of IRS91 to submit comments before they had a reasonable opportunity to read and to reflect upon the underlying document.

If you are going to reject our request (made more than ten days ago) to delay the due date for comments, with the consequence that comments will be required by November 22, we may be able to submit something. However, that would mean our comments would have to be submitted with our having had a mere four days to review the Pepper-Swart underlying document, assuming it arrived today. That, of course, is wholly unsatisfactory. In that circumstance, our comments necessarily will be abridged, will not provide you and the lead authors with either the quantity or quality of information and considered judgment to which you are entitled, and, to say the least, will not be the last word on the subject from us.

There is no justification for putting us in the position where, to meet the November 22 deadline, we have to do our work on the basis of unacceptably incomplete information from Working Group I, only to have to re-do our work once we finally obtain the Pepper-Swart underlying document. Among other things, that approach results in sheer waste of human and financial resources.

In view of the foregoing, we hereby renew our request of November 7 for an extension of the comment period on IRS91 to a date which is 24 days after reviewers' receipt of the underlying Pepper-Swart document, modified now by the additional requirement that we also have received the abovementioned study by Edmonds, Mintzer, et al. and the personal communication from Weyant.

When we were in Geneva, I gave Professor Bolin a copy of my October 31 letter to you. I assume he has a continuing interest

Mr. Bruce Callander
November 18, 1991

Page 3

in the review process concerning all aspects of the "update" report of Working Group I; hence, I am faxing to him copies of my November 7 letter and of this one.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "Don", with a horizontal line underneath.

Donald H. Pearlman

cc: IPCC Chairman Bolin
Fax: 46-8-157-185

Ms. Jane Leggett
U.S. Environmental Protection Administration (PM-221)
Climate Change Division/OPPE
Fax: (202) 260-0512

APPENDIX 5



WORLD METEOROLOGICAL
ORGANIZATION



UNITED NATIONS
ENVIRONMENT PROGRAMME

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

SCIENTIFIC ASSESSMENT OF CLIMATE CHANGE

Chairman: Dr J T Houghton

Don Pearlman,
The Climate Council,
Suite 700,
2550 M Street, N.W.,
Washington DC 20037

Our ref: M/IPCC/12/9/3/3

Your ref:

19 November 1991

Dear Don,

IPCC EMISSIONS SCENARIOS - BACKGROUND DOCUMENT

Thank you for your fax of 18 Nov. My only surprise was that it took two-and-a-half weeks for you to get on my tail.

IPCC Rules of Procedure, agreed at IPCC-V, require that working documents are in the hands of national representatives at least four weeks before WG meetings. Consequently the background documents for Guangzhou must, at the absolute latest, be in reviewers' hands by 16 December, implying their dispatch from the WGI secretariat by around 9 December. These are fixed points in the schedule. If we are to allow time for lead authors to incorporate comments from the first review, you can see that we do not have the flexibility to offer a postponement of the review date.

I talked with Jane Legget today. I and the lead authors would like the background document to be available for circulation as soon as possible, but in view of the resources available (the provision of a background document was not originally a component of the task allocated to the lead authors) and also because of additional explanations which the lead authors are being asked for by parts of the US administration, I cannot reassure you or myself that the background document will be available until the second review stage beginning early-to-mid December.

I therefore suggest to you the following options:

(a) Submit those comments which you have collated by 22 Nov with a clear statement of those aspects on which you reserve your position.

(b) Submit no comments until the second review stage, when we are confident that the background document will be available.

Yours sincerely,

Bruce Callander

Bruce A. Callander,
IPCC WG1 secretariat.

cc. Jane Leggett, US EPA.

APPENDIX 6

THE CLIMATE COUNCIL

SUITE 700

2550 M STREET, N.W.

WASHINGTON, D.C. 20037

(202) 457-6501

August 19, 1991

VIA FAX: 44-344-856909

Sir John Houghton
Chairman
Working Group I
Intergovernmental Panel on Climate Change
Meteorological Office, Hadley Centre
London Road, Bracknell
Berkshire, RG 12 SY
United Kingdom

Dear Sir John:

The purposes of this letter are (i) to call to your attention serious concerns expressed at the fourth plenary session of IPCC Working Group III regarding scenarios of future energy use and related greenhouse gas emissions and (ii) to urge your favorable consideration of an approach to those issues that should facilitate in a credible manner the important efforts of Working Group I.

You undoubtedly will review the report of the Working Group III meeting and receive observations concerning emissions scenarios issues from IPCC Chairman Bolin, from Working Group III Chairman Reinstein, from Energy and Industry Subgroup (EIS) Co-Chairman Yokobori, and from your representative, Dr. Bruce Callandar, all of whom were present during all or portions of the lengthy discussions of these issues. The comments herein are those of The Climate Council, which initially raised the emissions scenarios issue at the EIS meeting and which will continue its active participation in the IPCC.

I.

ROLE OF ENERGY EMISSIONS SCENARIOS IN CLIMATE PREDICTIONS

The choice by Working Group I of greenhouse gas emissions scenarios will greatly influence its climate change predictions based on current climate models. It is said that "the energy sector accounts for an estimated 46% (with an uncertainty range of 38-54%) of the enhanced radiative forcing resulting from human

activities" during the period 1980-90. IPCC First Assessment Report, Working Group III Policymakers Summary, p. 1 (August 1990). Hence, the chosen scenario of future energy use and related emissions will play a central role in what Working Group I predicts about future climate change.

According to the "Schedule for the Preparation of a Supplement to the IPCC First Scientific Assessment Report" (revised version July 1991), an "update" of existing emissions scenarios, "which will enable a range of climate change predictions to be carried out," currently is in process and is scheduled to be completed by November 30, 1991. Our understanding is that, at its July 8-11, 1991 meeting in Shepperton, the Working Group I task force on emissions scenarios decided that the "energy sector component [of emissions scenarios] will be based on the 1990 EIS scenario to 2025," which "will be extended to 2100 using econometric models" and other assumptions, such as those provided by the World Bank concerning population. See Summary of Conclusions of Working Group I task force, attached as Appendix F to Draft Report of IPCC Working Group III, August 5-8, 1991.

II.

CONCERNS EXPRESSED ABOUT LONG-TERM ENERGY SCENARIOS

At the August 6-7, 1991 meeting of the EIS, there was lengthy discussion of the substantial risks associated with developing and using long-term scenarios of energy use and related emissions. A highly abridged summary of the discussion is set forth in the EIS Co-Chairman's report forming part of the report of the fourth plenary session of Working Group III.

The discussion grew out of the widespread realization that, in order not to jeopardize the credibility of the IPCC, great care must be taken in both the development and the presentation of energy and energy-related emissions scenarios. There were numerous expressions of concern by national delegations, as well as by representatives of the International Energy Agency and of the International Atomic Energy Agency, about using energy scenarios covering periods of more than 10 to 20 years. It was clear that the concerns increase greatly as the time period of the scenario is extended. As one delegate from an OECD nation succinctly stated, "it is impossible to make reliable energy forecasts of more than 10 to 15 years, and anything beyond that is pie in the sky."

Several speakers pointed out that even short-term energy forecasts often have been way off the mark. Examples were given of errors by factors of three or more.

No disagreement was expressed with the idea stated by several delegations that energy forecasts for as much as 50 to 100 years, to coincide with the Working Group I climate predictions to the year 2100, were inherently unreliable.

Numerous, imponderable factors will determine whether there may be any relationship at all between an energy scenario and future reality. A prime factor is whether new technology will be invented, will receive sufficient capital for deployment, and will be accepted by the public. As Jessica Mathews, Vice President of the World Resources Institute, observed in her newspaper column this past week, "Technology forecasts reliably produce comic results." The Washington Post, p. A21 (August 15, 1991).

Other important factors that cause skepticism about longer-range energy scenarios include population growth, economic growth and changes in the sectoral makeup of each nation's economy, changes in consumer preferences and choices about lifestyle, and market price responses to those factors and to government policies.

The ability to foresee these changes decreases over time and rapidly moves from what, at best, are informed guesses in the very near term to fanciful speculation in the longer term.

To make matters even more complicated, questions arose as to how it is possible to develop credible scenarios of future global greenhouse gas emissions when so much more work must be done to have confidence in current emissions inventories. It was noted that, subject to availability of funding, the draft IPCC guidelines for a methodology to determine national emissions inventories is scheduled for mid-1992, with final guideline methodology not scheduled until June 30, 1993.

In these circumstances, some delegations at the EIS meeting urged that Working Group III advise Working Group I that it should not use energy and energy-related emissions scenarios of more than 20 years' duration. It was recognized, however, that Working Group I appears to be determined to publish updated climate change predictions to the year 2100. In a good-faith effort to avoid prolonged and contentious debate within Working Group III and between Working Groups I and III, it also was recognized that it might be desirable, if possible, to devise an approach to accommodate Working Group I's determination, the concerns stated above, and IPCC credibility.

An important theme emerged as a possible way to assure that policymakers, the media, and the public would not be misled as a

consequence of Working Group I's using long-term energy and energy-related emissions scenarios. This was that there should be full and adequate disclosure by Working Group I of the facts that:

- (i) the Working Group I predictions of climate change are based to material degree on only a hypothetical scenario of energy and energy-related emissions, which scenario is neither a prediction, nor a projection, nor a forecast; and
- (ii) for the various reasons described above, no assumption should be made that the scenario will be realized in actuality.

As stated in the report of the EIS Co-Chairman to Working Group III, the "Subgroup recommended its co-chairs to forward, through the Working Group 3 Chair, a clearly worded caution to the Chairs of WG I and of the IPCC, pointing out the reservations expressed, the uncertainty inherent in such scenarios, and asking that IPCC reports carefully note that such scenarios should not be used as predictions."

This approach is entirely in keeping with the wise comments of IPCC Chairman Bolin, as stated in the draft report of the Working Group III plenary session: "In updating them [emissions scenarios], all assumptions should be clearly spelled out and all resulting changes explained clearly. Careful attention should be paid to the difference between the inherent uncertainties due to inadequate knowledge of the behaviour of the climate system on the one hand and the sensitivity of emissions scenarios to alternative assumptions about future emissions on the other."

III.

ISSUES TO BE RESOLVED

In our view, full and adequate disclosure by Working Group I requires dealing appropriately with the following matters:

- 1) Explanation of the dependency of the climate change predictions on the energy and energy-related emissions scenario.
- 2) Meaningful distinction between scenarios, on the one hand, and predictions, projections, and forecasts, on the other.

Sir John Houghton
August 19, 1991

Page 5

3) Description of the numerous reasons why, in light of experience, one should not assume energy and energy-related emissions scenarios, especially those covering more than 10 or 20 years, will be realized in actuality.

4) Explanation of the methodology and assumptions of the IPCC 1991 Reference Scenario, the differences between that scenario and Scenario "A" used in the First Assessment Report, and the reasons for, and consequences of, changing the scenarios. (As you know, the EIS Reference Scenario depicts carbon dioxide emissions from the energy sector in the year 2025 at a level that is more than 25 percent higher than the level in Scenario "A").

5) Location and format of the foregoing material in the Working Group I "update" report, including any policy-makers or executive summary.

We have great concern about both the substance and manner of presentation of information on emissions scenarios in Working Group I's First Assessment Report. For example, the all-important Policymakers Summary introduces the reader to the complex issues covered by Working Group I with bold-face assertions such as "We are certain of the following. . .," "We calculate with confidence that. . .," "Based on current model results, we predict. . .," and "Our judgment is that. . .;" but, it is not until page 19 (of 26) that there is any mention of the "uncertainties in the above climate predictions [that] arise from our imperfect knowledge of future rates of human-made emissions" The two-sentence elaboration, referring without explanation to "various complex economic and sociological factors," is not adequate in our view.

It is our hope that similar problems can be avoided in the forthcoming "update."

IV.

PROPOSAL

In order to assure that the Working Group I "update" reasonably reflects your new scientific assessments in light of the need for full and adequate disclosure of the matters described above, and to resolve potential differences of opinion in an amicable, professional, and efficient manner, we request the opportunity, along with such other energy experts from governments and NGOs as might be interested, to develop with you and/or the authors of the "update" an agreed presentation of necessary information, as outlined in Part III of this letter.

Sir John Houghton
August 19, 1991

Page 6

We note that a drafting session of "greenhouse gases lead authors" is scheduled for October 16-18 in Les Diablerets, Switzerland. It occurred to us that such session might be a convenient time to attempt to resolve these issues. The objective would be to develop, if possible, an agreed approach prior to the sixth plenary session of the IPCC on October 29-31, but, in any event, prior to the January 13-15 session of Working Group I. Refinement of final language might have to await ultimate decisions by Working Group I on how it wanted to present the substance of its "update."

We recognize fully that you will have a better idea than we do about what would make the most sense from the perspective of Working Group I's work schedule. Hence, we are prepared to be quite flexible, subject only to two principal qualifications: (i) our commitments to participate in sessions of the INC, of IPCC Working Group III, and of the EIS; and (ii) our desire to reach final, constructive agreements on these matters so they may be reflected in the Working Group I "update" report, thereby avoiding a contentious issue when that report is submitted for approval by the IPCC at its seventh plenary session, which we understand is scheduled for February 13-15, 1992.

If you, or Dr. Callandar, if you prefer, would like to discuss these matters, please call me at (202) 457-6512, my direct line, or you can fax me at (202) 457-6315.

We appreciate your consideration.

Sincerely yours,


Donald H. Pearlman

cc: IPCC Chairman, Bert Bolin
IPCC Working Group III Chairman,
Robert Reinstein
IPCC Energy and Industry Subgroup Co-Chairmen,
Keiichi Yokobori
Shao-Xiong Xie