RESPONSE STRATEGIES WORKING GROUP
of the
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

FIRST MEETING

WASHINGTON, D.C. January 30 - February 1, 1989

INF/1
1/16/89

GENERAL INFORMATION

The United States Government will host the First Meeting of the Response Strategies Working Group (RSWG) of the Intergovernmental Panel on Climate Change (IPPC) in Washington from January 30, 1989 to February 1, 1989.

At its first session, November 9-11, 1988, the IPCC established working groups to carry out three main tasks.

(i) Assessment of available scientific information on climate change;

(ii) Assessment of environmental and socio-economic impacts of climate change;

(iii) Formulation of response strategies.

The First Meeting of the Working Group III (RSWG) will develop a work plan for its activities.

Headquarters

The headquarters of the Meeting and the offices of the Secretariat will be located in the International Conference Suite on the first floor of the Department of State. Access to the Conference Suite is through the Diplomatic Entrance at 2201 C Street, N.W.

Opening Session

The opening Session will convene at 09:30 a.m. on Monday, January 30, in the Loy Henderson Conference Room. Sessions will be limited to officially designated delegates and observers.

Registration

Registration of participants will begin at 8:30 a.m. on Monday, January 30 at the Conference Information Center. Arrangements will be made to admit participants into the building for registration.

Each Delegate will be issued a conference pass which must be shown for entrance into the State Department and which must be worn at all times while in the building.

Documentation

The Documents Officer, Ms. Helen Longino, will be located in Room 1207 and will be responsible for the processing and distribution of all documents of the meeting.

At the time of registration each delegation will complete a Request for Documents Form which will indicate the daily document requirements of the delegation (i.e., number of copies needed). Document distribution will be at the Conference Information Center.

Information, Mail and Messages

Receptionists will be on duty at the Conference Information Center during the period of the meeting to provide information regarding conference arrangements and activities, and to assist in the distribution of documents, mail and messages. Participants are urged to check at the desk at least twice daily.

Local Transportation

Taxi service may be obtained by telephone. The larger taxi companies are listed in the yellow pages of the telephone directory under "taxicabs". Most are radio dispatched. The driver should be requested to call at the Diplomatic Entrance of the State Department, 2201 C Street, N.W., for pickups.

Hotels

Two hotels convenient to the conference site are:

Guest Quarters, 801 New Hampshire Avenue, and
2500 Pensylvania Avenue
Telephone: 800 424-2900
202 785-2000
Telex: 892346

River Inn, 924 25th Street, N.W.
Telephone: 800 424-2741
202 337-7600
Telex: 440546, answer Back Code: OWCH-VI

Hotel reservations and payment are to be made directly by participants.

#236

* * *

MEMORANDUM

COUNCIL OF ECONOMIC ADVISERS

November 1, 1989

TO: MICHAEL

FROM: DICK

SUBJECT: Global Warming

I am busily filling out our "economic costs" task force, and I have encountered a small problem. Bruce Gardner is the logical USDA person, and he is eager to participate. But, since he was not the USDA person at the 10/20 meeting with Bromley (and, I infer, has a sensible newcomer's reluctance walk near others' toes), he would like us to ask Yeutter to name a representative - ideally in such a way the he, Bruce, is the logical choice. What follows is an attempt at a letter (to be faxed) that will do this. Please revise as necessary, keeping in mind the non-zero probability that we may need to try this same trick in one or two other cases as well.

- -

Dear Clayton:

The CEA has been asked by Dr. Allan Bromley, Chairman of the DPC Working Group on Global Change, to chair a Task Force on the economic costs of global climate change. He has described our task as follows:

> As you know, rational models of the economic cost of either action or inaction are conspicuously missing from the public and international debate on this subject. Economic consequences must be understood before sound policy can be developed and economically and socially acceptable actions taken. We simply cannot proceed without that understanding.
>
> I would ask that your Task Force on Economics include broad interagency representation and identify, review and inventory similar work being done elsewhere -- at universities, think-tanks, and by your counterparts in other industrialized nations. I would ask you to produce at least a preliminary report in three months.

I feel that it is very important that the Department of Agriculture have a voice in these deliberations, and I would thus ask you to designate a policy-level representative to the Task Force. As our task will have a large analytical component, it

would be useful to all concerned if your representative were conversant with economic analysis and modeling techniques and could draw on staff support in these areas as necessary.

Please have your office notify Francine Obermiller (395-5036) of your choice as soon as possible so that a meeting schedule can be be set up quickly. Thank you for your help.

Sincerely,

THE WHITE HOUSE

WASHINGTON

Global climate

September 28, 1989

MEMORANDUM FOR MICHAEL DELAND
BOB GRADY
JOHN SCHMITZ
DICK SCHMALENSEE ✓
JUANITA DUGGAN
BARRY MCBEE

FROM: KENNETH P. YALE KY

SUBJECT: Attached Papers on Response Strategies Working Group

To follow up our meeting yesterday morning, I thought you might find the attached materials on the Response Strategy Working Group's Geneva Workshop useful. Additional materials may be obtained through Fred Bernthal's office at the Department of State.

ENVIRONMENTAL STATEMENT OF G-7 SUMMIT

33) There is growing awareness throughout the world of the necessity to preserve better the global ecological balance. This includes serious threats to the atmosphere, which could lead to future climate changes. We note with great concern the growing pollution of air, lakes, rivers, oceans and seas; acid rain, dangerous substances; and the rapid desertification and deforestation. Such environmental degradation endangers species and undermines the well-being of individuals and societies.

Decisive action is urgently needed to understand and protect the earth's ecological balance. We will work together to achieve the common goals of preserving a healthy and balanced global environment in order to meet shared economic and social objectives and to carry out obligations to future generations.

34) We urge all countries to give further impetus to scientific research on environmental issues, to develop necessary technologies and to make clear evaluations of the economic costs and benefits of environmental policies.

The persisting uncertainty on some of these issues should not unduly delay our action. In this connection, we ask all countries to combine their efforts in order to improve observation and monitoring on a global scale.

35) We believe that international cooperation also needs to be enhanced in the field of technology and technology transfer in order to reduce pollution or provide alternative solutions.

36) We believe that industry has a crucial role in preventing pollution at source, in waste minimization, in energy conservation, and in the design and marketing of cost-effective clean technologies. The agricultural sector must also contribute to tackling problems such as water pollution, soil erosion and desertification.

37) Environmental protection is integral to issues such as trade, development, energy, transport, agriculture and economic planning. Therefore, environmental considerations must be taken into account in economic decision-making. In fact good economic policies and good environmental policies are mutually reinforcing.

In order to achieve sustainable development, we shall ensure the compatibility of economic growth and development with the protection of the environment. Environmental protection and related investment should contribute to economic growth. In this respect, intensified efforts for technological breakthrough are important to reconcile economic growth and environmental policies.

Clear assessments of the costs, benefits and resource implications of environmental protection should help governments to take the necessary decisions on the mix of price signals (e.g., taxes or expenditures) and regulatory actions, reflecting where possible the full value of natural resources.

We encourage the World Bank and regional development banks to integrate environmental considerations into their activities. International organizations such as the OECD and the United Nations and its affiliated organizations, will be asked to develop further techniques of analysis which would help governments assess appropriate economic measures to promote the quality of the environment. We ask the OECD, within the context of its work

on integrating environment and economic decision-making, to examine how selected environmental indicators could be developed. We expect the 1992 UN Conference on Environment and Development to give additional momentum to the protection of the global environment.

38) To help developing countries deal with past damage and to encourage them to take environmentally desirable action, economic incentives may include the use of aid mechanisms and specific transfer of technology. In special cases, ODA debt forgiveness and debt for nature swaps can play a useful role in environmental protection.

We also emphasize the necessity to take into account the interests and needs of developing countries in sustaining the growth of their economies and the financial and technological requirements to meet environmental challenges.

39) The depletion of the stratospheric ozone layer is alarming and calls for prompt action. We welcome the HELSINKI conclusions related, among other issues, to the complete abandonment of the production and consumption of chlorofluorocarbons covered by the MONTREAL protocol as soon as possible and not later than the end of the century. Specific attention must also be given to those ozone-depleting substances not covered by the Montreal protocol. We shall promote the development and use of suitable substitute substances and technologies. More emphasis should be placed on projects that provide alternatives to chloro-fluorocarbons.

40) We strongly advocate common efforts to limit emissions of carbon dioxide and other greenhouse gases, which threaten to induce climate change, endangering the environment and ultimately the economy. We strongly support the work undertaken by the Intergovernmental Panel on Climate Change, on this issue.

We need to strengthen the worldwide network of observatories to: greenhouse gases and support the World Meteorological Organization initiative to establish a global climatological reference network to detect climate changes.

41) We agree that increasing energy efficiency could make a substantial contribution to these goals. We urge international organizations concerned to encourage measures, including economic measures, to improve energy conservation and, more broadly, efficiency in the use of energy of all kinds and to promote relevant techniques and technologies.

We are committed to maintaining the highest safety standards for nuclear power plants and to strengthening international cooperation in safe operation of power plants and waste management, and we recognize that nuclear power also plays an important role in limiting output of greenhouse gases.

42) Deforestation also damages the atmosphere and must be reversed. We call for the adoption of sustainable forest management practices, with a view to preserving the scale of world forests. The relevant international organizations will be asked to complete reports on the state of the world's forests by 1990.

43) Preserving the tropical forests is an urgent need for the world as a whole. While recognizing the sovereign rights of developing countries to make use of their natural resources, we encourage, through a sustainable use of tropical forests, the protection of all the species therein and the traditional rights to land and other resources of local communities. We welcome the German initiative in this field as a basis for progress.

To this end, we give strong support to rapid implementation of the Tropical Forest Action Plan which was adopted in 1986 in the framework of the Food and Agricultural Organization. We appeal to both consumer and producer countries, which are united in the International Tropical Timber Organization, to join their efforts to ensure better conservation of the forests. We express our readiness to assist the efforts of nations with tropical forests through financial and technical cooperation, and in international organizations.

44) Temperate forests, lakes and rivers must be protected against the effects of acid pollutants such as sulphur dioxide and nitrogen oxides. It is necessary to pursue actively the bilateral and multilateral efforts to this end.

45) The increasing complexity of the issues related to the protection of the atmosphere calls for innovative solutions. New instruments may be contemplated. We believe that the conclusion of a framework or umbrella convention on climate change to set out general principles or guidelines is urgently required to mobilize and rationalize the efforts made by the international community. We welcome the work under way by the United Nations Environment Program, in cooperation with the World Meteorological Organization, drawing on the work of the Intergovernmental Panel on Climate Change and the results of other international meetings. Specific protocols containing concrete commitments could be fitted into the framework as scientific evidence requires and permits.

46) We condemn indiscriminate use of oceans as dumping grounds for polluting waste. There is a particular problem with the deterioration of coastal waters. To ensure the sustainable management of the marine environment, we recognize the importance of international cooperation in preserving it and conserving the living resources of the sea. We call for relevant bodies of the United Nations to prepare a report on the state of the world's oceans.

We express our concern that national, regional and global capabilities to contain and alleviate the consequences of maritime oil spills be improved. We urge all countries to make better use of the latest monitoring and clean-up technologies. We ask all countries to adhere to and implement fully the international conventions for the prevention of oil pollution of the oceans. We also ask the International Maritime Organization to put forward proposals for further preventive action.

47) We are committed to ensuring full implementation of existing rules for the environment. In this respect, we note with interest the initiative of the Italian government to host in 1990 a forum on international law for the environment with scholars, scientific experts and officials, to consider the need for a digest of existing rules and to give in-depth consideration to the legal aspects of environment at the international level.

48) We advocate that existing environment institutions be strengthened within the United Nations system. In particular, the United Nations Environment Program urgently requires strengthening and increased financial support. Some of us have agreed that the establishment within the United Nations of a new institution may also be worth considering

49) We have taken note of the report of the sixth conference on bioethics held in Brussels which examined the elaboration of a universal code of environmental ethics based upon the concept of the "human stewardship of nature".

50) It is a matter of international concern that Bangladesh, one of the poorest and most densely populated countries in the world, is periodically devasted by catastrophic floods.

We stress the urgent need for effective, coordinated action by the international community, in support of the Government of Bangladesh, in order to find solutions to this major problem which are technically, financially, economically and environmentally sound. In that spirit, and taking account of help already given, we take note of the different studies concerning flood alleviation, initiated by France, Japan, the US and the United Nations Development Program, which have been reviewed by experts from all our countries. We welcome the World Bank's agreement, following those studies, to coordinate the efforts of the international community so that a sound basis for achieving a real improvement in alleviating the effects of flood can be estalbished. We also welcome the agreement of the World Bank to chair, by the end of the year, a meeting to be held in the United Kingdom by invitation of the Bangladesh Government, of the countries willing to take an active part in such a program.

51) We give political support to projects such as the joint project to set up an observatory of the Saharan areas, which answers the need to monitor the development of that rapidly deteriorating, fragile, arid region, in order to protect it more effectively.

FOR RSWG OCT. WORKSHOP
DRAFT CONCLUSION DOCUMENT

Environmental considerations, including uncertainties and impacts of global climate change, must be taken into account in economic decision making. Countries need to work together to achieve common goals of preserving a healthy and balanced global environment in order to meet shared economic and social objectives and to meet obligations to future generations.

Institutions and agreements to support common efforts to limit emissions of carbon dioxide and other greenhouse gases threatening to induce climate change need to be analyzed in conjunction with the results of the IPCC 1990 report,

Although numerous uncertainties remain with regard to the likelihood and potential extent of anthropogenically induced climate change and its impacts, a consensus has emerged on certain principles of how to implement any needed action.

Countries should give further impetus to scientific research on environmental issues, to develop necessary technologies and to make clear evaluations of the economic costs and benefits of environmental policies. The persisting uncertainty on some of these issues should not unduly delay action.

Countries need to combine their efforts in order to improve observation and monitoring on a global scale. Worldwide cooperation in monitoring and research to identify the mechanisms and impacts of climate change is imperative, and will lay the groundwork for any needed follow-up response measures.

International cooperation to improve the knowledge base regarding the science and prediction of climate change will require technology transfer. This will strengthen indigenous capacity and infrastructure in LDCs, and will heighten the awareness of decision makers and the public to the issues. International cooperation also needs to be enhanced in the field of technology and technology transfer in order to reduce pollution or provide alternative solutions.

To be effective, governmental actions to address climate change must be based on general intergovernmental concensus, encompassing countries of all stages of economic development and the entire spectrum of political-economic systems. If predictions of global climate change are accurate, a cooperative global effort is necessary to limit global climate change rates.

Early agreement on concerted action and mechanisms to develop concensus on appropriate responses is required, as few countries are likely to unilaterally initiate extensive action. In view of the uncertainties, priority should be given to those measures warranted on grounds other than climate change, promising measurable benefits independent of their effect on climate.

Although the potential problem is global, remedies must be tailored to the local context. The approach should be one that considers pilot projects rather than crash programs. This will allow experimentation with approaches and techniques suited to different local circumstances.

Existing institutional mechanisms should be used rather than seeking to develop new ones. The goal of sound resource management applies to institutions as well as to natural resources. Existing institutions represent an investment of physical, technical, financial, and administrative resources, time and experience. These can and should be tapped to meet newly urgent concerns, thereby enhancing development assistance activities. Existing structures, mechanisms, and policies should be scrutinized to determine how they can strengthened, including identifying and correcting inadvertent adverse effects with regard to climate change.

The market system has proven itself an efficient agent of technology development and transfer, and offers the best prospects for timely development of technologies to mitigate and adapt to climate change. Government-sponsored actions should emphasize the removal of impediments to the rational play of market forces, and activities strengthening the working of the market should have priority. These actions include:

- o International standardization -- to facilitate data collection, informed choice of technologies, and technology transfer, and to reduce trade barriers;
- o Information dissemination -- to enable decision makers to make informed choices;
- o Facilitation of international trade and investment.

The steps taken in each of the five topic areas of the workshop should further these broad principles and be mutually reinforcing.

1. Public education and information must provide an accurate foundation for discussions on global climate change. By fostering the concept of the global public good, public education can create the political will to implement voluntary energy conservation and pollution prevention, and accept and support appropriate government policies, including regulatory interventions where warranted. Public education and information can shape market forces, catalyzing demand for new technologies, thus spurring technology development and transfer and acceptance of government policies. NGOs have had notable success in heightening and sustaining public consciousness; private industry can similarly stimulate consumer awareness and demand.

2. Market economic incentives should make the deployment of new technologies economically attractive and encourage

technology transfer and investment from abroad. Cost effectiveness, calculated to include environmental impacts, must be the guiding principle in technology transfer to avoid constraining growth and economic development.

3. The concept of sustainable development requires that environmental and developmental policies be closely linked. Foreign development assistance should be structured to help train and equip local communities adapt and implement suitable technologies and maintain necessary infrastructure in a manner that fosters longterm self-reliance.

   Collaborative efforts offer substantial potential savings for all countries. In this regard, regional consortia could provide opportunities for collaborative R&D to strengthen indigenous S&T capacity, improve the use of trained S&T personnel, and accelerate technology development and transfer. Such organizations could join public and private sector institutions in networks for research, information, technology development and extension. Regional consortia could be attractive candidates for partnership with private firms in industrialized countries, a link forged through investments and joint ventures.

4. In the international arena, risk insurance, credit guarantees and other devices controlled by industrialized countries can help create a favorable environment for technology transfer and technology development in LDCs. The recipient countries would have a corresponding responsibility to ensure adequate return on investment to the originators of the technology.

5. Governmental entities, including the multilateral development banks, can draw on the resources and expertise of the private sector and nongovernmental organizations to speed the deployment of new technologies. NGOs and PVOs have compiled an impressive record in heightening public consciousness, mobilizing voluntary action, and developing and transferring environmentally benign technologies. Private industry is skilled in stimulating consumer awareness and demand, and promoting technology transfer, adaptation and extension.

6. By establishing a process for ongoing review and assessment, a framework convention could stimulate individual countries and international organizations to carry out national and regional programs more expeditiously and effectively than they would otherwise.

DRAFT

Policy Guidelines for RSWG October Workshop on Implementation Measures

The primary objective of the RSWG workshop on implementation measures schaduled for October 2-6 in Geneva will be to produce a report covering the five topics on which participants have been invited to submit papers. The U.S. has submitted papers on all five topics after completing a lengthy interagency process. Although these papers will be important inputs to the final report of the workshop, the report will of necessity reflect a number of viewpoints different from our own. Therefore, it is important that all members of the U.S. delegation follow common policy guidelines as they participate in the workshop discussions and drafting sessions in which the report is prepared.

The U.S. delegation should be motivated fundamentally by the clear desire of the President to lead the efforts of the international community to protect and enhance the quality of the global environment. The guidance and conclusions document should emphasize positive objectives that can contribute ultimately to the "decisive action... to understand and protect the earth's ecological balance" called for by the President and other leaders of the Paris Economic Summit.

The following are basic policy guidelines to which all members of the delegation shall adhere:

Legal and Institutional Measures

(1) Framework Convention

-- The provisions suggested in the U.S. paper (attached) should all be included.

-- The workshop report is to recommend a general framework convention that includes immediate obligations for research, monitoring and data exchange, and for periodic assessments of science, impacts, technology and economics, but does not include obligations to take any specific response strategy.

-- The framework convention should follow the general organization and scope of the 1985 Vienna Convention. The Convention should take note of the elements of the Vienna Convention and its protocols for controls on ozone depleting substances.

-- A task for the IPCC (RSWG) and, subsequently, of the Convention Parties is to compile and maintain an inventory of existing legal and institutional mechanisms for

reference in implementing future research, assessment and response strategy obligations. These mechanisms are to be used in tandem with new mechanisms established by the Convention and any subsequent amendments and protocols.

-- While measures for providing future amendment of the convention and for appending protocols, the initial Convention should not include specific response strategies. The convention should include establishment of a working group to evaluate response strategies based on them.

-- The Convention should include establishment of a working group to evaluate mechanisms to provide financial and related assistance for consideration of the Parties of the Convention (after the Convention enters into force). The Convention shall not include any mechanisms to provide financial assistance in meeting obligations of the Convention. Such mechanisms will be provided, as appropriate, in subsequent protocols.

-- The Convention should provide for cooperation in the development, assistance and transfer of technology and management practices to limit and adapt to climate change. In this area, the Convention should call for early establishment of a working group to provide recommendations for consideration by the Parties to the Convention.

-- The Convention should provide a mechanism to inventory current emissions of greenhouse gases and to forecast future emissions. The Convention should call for early establishment of a working group (or subgroup) for this purpose.

-- Any general objectives set forth in the convention should be stated in terms of minimizing adverse environmental, social and economic impacts of future climate change. Limitation of emissions levels or atmospheric concentrations of greenhouse gases is not an objective per se, but is recognized as a means of accomplishing the objectives. Specific emission reduction targets or timetables must be avoided in the Convention. Additionally, an objective -- to stabilize or protect the climate at current conditions, per se - is neither feasible nor acceptable.

-- The institutional structure and procedures are provided for in the framework convention should have the effect of formalizing the existing three-track IPCC process: Scientific monitoring and research; socioeconomic and natural resources impacts research and assessments; response strategy identification, evaluation and (future) negotiations.

-- There should be no specific provision of:

- Emissions limitation responses such as taxes on CO_2 or other greenhouse gas emissions, taxes placed on specific fuel sources, or subsidies provided for use of specific energy supply or demand technologies
- Financial mechanisms such as an international climate fund to assist developing countries to meet convention or subsequent protocol obligations
- A binding process to settle disputes among parties.

These matters may be referred to working groups of the convention for further evaluation.

(2) Other Legal Measures

-- The report should refer to, [call for coordination with], and encourage fuller use of, existing agreements, laws and regulations. It should not propose a new "Law of the Atmosphere" or other over-arching legal scheme similar to the Law of the Sea.

-- The report may wish to address means of improving the effectiveness and status of WMO, UNEP, and other international organizations. It should not propose the creation of new international institutions beyond the Conference of the Parties or subgroups established under the framework convention itself.

-- The U.S. delegation should consider the appropriate roles of UNEP, WMO, IPCC, UN regional economic organizations, or other UN organizations in support of Convention Parties in their implementing of the Convention, once it enters into force and for transitional activities between opening for signature and entering into force.

Technology Assistance, Development and Transfer

-- The conclusions in the report of the meeting should call for increased cooperation in development and transfer of technologies and management practices to limit and adapt to climate change. Establishment of a working group on technology assistance, development and transfer can be proposed as an essential subsidiary activity to support the activities of the Parties to the Convention.

-- Intellectual property rights and other rights of firms and individuals owning technology must be protected.

-- Maximum use of existing institutions and mechanisms, governmental and nongovernmental, for technology transfer should be encouraged.

-- Recipient countries should provide favorable political, legal and economic conditions for technology transfer. Some national case studies to determine existing barriers, needs, and opportunities for conditions to facilitate technology transfer need to be conducted.

-- The capabilities of some technologies and management practices to limit and adapt to climate change that may also assist a nation in meeting other national and international goals, and the consideration of such collateral benefits, should be noted.

-- The need for coordinated activities in areas of education, training and information transfer, especially associated with the use of modernized technologies and practices in developing and less industrialized countries should be noted in the technology related conclusions of the report.

Financial Measures

-- The report should describe existing bilateral and multilateral financial assistance mechanisms,and call for coordination with them,and encourage their fuller use.

-- A working group should be established to examine financial mechanisms to provide assistance to LDCs to limit or adapt to climate change. Among the options that might be considered are creation of global climate funds or imposition of mandatory fees or taxes to finance support for developing countries. The report should not recommend creation of such mechanisms at this time.

-- The report should stress the need to identify specific, projects in individual countries before funding commitments are made. Considerations for such projects should include country needs, barriers and opportunities, etc.

-- Within existing assistance programs and development plans, priority should be given to measures which are desirable on both economic and environmental grounds.

-- Consideration of financial mechanisms must recognize both global climate change issues and overall national goals and needs of recipient countries.

Economic Measures

-- The report should stress the importance of market mechanisms, including a price structure, in reference to top-down command and control regulations in reducing greenhouse gas emissions. Use of market mechanisms needs to consider the special circumstances of each Party in choosing specific implementation steps. The report should note the advantages of giving individual sources maximum flexibility to find the most economically efficient approach to reducing emissions.

-- A working group should be established under the convention to address economic implementation measures such as taxes, fees, performance standards or other methods for reflecting environmental costs and benefits in economic decision making.

The economics section of report conclusions should emphasize the need for, and the role of, information and educational processes to increase effectiveness of economic measures.

Education and Information Measures:

-- The complementarity of education of the public and market incentives or regulations should be stressed. Effective assistance and transfer of technology and management practices also depend on supporting education, training and information processes.

-- The report should stress the need to present the science of climate change and its impacts on natural resources and socioeconomic conditions in a balanced and objective way which reflects all of the areas of agreement and the uncertainties.

-- An important element of education and information measures is their supporting and complementary role to other implementation measures. The implementation of technology, economic or financial assistance measures in many countries will require training and education.

THE WHITE HOUSE

Office of the Press Secretary
(Spokane, Washington)

For Immediate Release September 18, 1989

FACT SHEET

ADMINISTRATION ENVIRONMENTAL INITIATIVES

CLEANING UP THE NATION'S AIR

Clean Air Act. On June 12, the President announced proposals to reduce emissions which cause acid rain, urban ozone and toxic air pollution. The proposals, the first major overall of the Clean Air Act to be proposed by an Administration in over a decade, calls for a 10 billion ton reduction in SO2 emissions by the year 2000, a 2 million ton reduction in NOx, and a 40 percent reduction in emission of volatile organic compounds which cause urban smog, and a reduction of 75 to 90 percent in air toxic emissions. These reductions will also help to curb an increase in global warming resulting from fossil fuel combustion. The proposal also calls for use of alternative fuels in one million vehicles by 1997. Alternative fuels, while reducing ozone precursors, will also reduce the toxic aromatics which come from conventional gasoline. The President submitted a comprehensive clean air bill to the Congress on July 21 embodying the proposals announced on June 12.

Clean Coal Technologies. The President proposed $710 million in FY 1990 for the Clean Coal Technology Program to encourage development of new technologies to reduce SO2 and NOx, while still allowing coal to play a role in our energy future.

Fuel Efficiency. The Administration approved action to increase Corporate Average Fuel Efficiency (CAFE) standards for automobiles to 27.5 miles per gallon. This action will reduce oil imports and reduce the contribution of automobile emissions to global warming.

AIRBORNE TOXICS

Asbestos Ban. On July 7, EPA announced an almost total phaseout of all uses of asbestos by 1997. The ban will prohibit importation, manufacture and processing of asbestos, a carcinogen linked to lung cancer and mesothelioma (lung and chest cancer). EPA estimates asbestos is responsible for 3000 to 12,000 cancer deaths each year. The action comes after over a decade of proposed rulemaking and data analysis on effects of asbestos and its uses.

- more -

Air Toxics Emissions Standards for Benzene. On August 31st, the EPA Administrator announced standards to reduce public health risks from benzene emissions. This air toxics standard has been in litigation for years and this action represents an important step toward reducing emissions of a major air toxic pollutant.

HAZARDOUS WASTE CLEAN-UP

Medical Waste. EPA implemented a medical waste tracking program on March 10 to track medical wastes to ensure proper disposal and prevent ocean pollution. The pilot program applies to ten states. EPA will report to Congress after two years on whether nationwide application is needed. Violators can be charged up to $25,000 for civil penalties and up to $50,000 for criminal penalties. The program constitutes a first step in the President's pledge to clean up medical wastes which have washed up on beaches.

Superfund Clean-Up. The President's budget proposed $315 million to pursue an aggressive clean-up schedule of toxic waste sites; and the Administration has opposed Congressional efforts to cut the Superfund budget to $150 million.

Superfund Management Review. The President proposed in February a major strengthening of the Superfund program to beef up enforcement. On June 14, under the President's direction, Administrator Reilly concluded a Management Review of the Superfund Program outlining initiatives for a more effective program, including immediate control of acute threats; better enforcement to induce private-party clean-ups; and expanded research into better technologies for clean-up. Over five hundred people will be added to EPA's enforcement staff to ensure that sites are cleaned up.

Department of Energy Nuclear Weapons Facilities. The President has endorsed a major increase of almost a billion dollars in the Federal government's effort to clean up the environmental effects of federal nuclear weapons plants. Under the President's direction, Secretary Watkins announced a five-year environmental and safety clean-up for federal nuclear weapons facilities. The Administration is aggressively investigating any possible violations of applicable environmental laws that may have occurred at federal facilities.

National Energy Strategy. The President announced the development of a National Energy Strategy and the Department of Energy has conducted five public hearings across the nation to elicit public testimony. The Strategy will have as one component a plan to reconcile the need for a secure, abundant energy supply with environmental protection.

Ocean Pollution. The President proposed in his 1990 budget and has sent to Congress legislation which will toughen penalties for those who dump waste illigally in our oceans. The legislation calls for criminal felony sanctions against illegal dumpers. The Administration signed a consent agreement with New York providing for phase-out of ocean dumping of sewage, sludge and industrial wastes by 1991.

INTERNATIONAL ENVIRONMENT

Global Climate Change. The President proposed an increase in global environmental research for FY 1990 of 43 percent or $191.5 million. In addition to Clean Air Act initiatives and the Clean Coal Technology Program, the United States will host the plenary meeting next Frebruary of the Intergovernmental Panel on Climate Change (IPCC). The United States chairs the Response Strategies Working Group which Secretary Baker addressed last January where he stressed the importance of a coordinated effort to address climate change. The United States has begun discussions on a framework for a global convention to reduce emissions of gases which may cause global warming.

Chlorofluorocarbons. On March 3, the President called for a world wide phase-out of chlorofluorocarbons by year 2000, if safe substitutes are available. Chlorofluorocarbons are responsible for depletion of the ozone layer.

Hazardous Waste Exports. On March 10, the President called for a ban on the export of hazardous waste unless the receiving country agrees to its proper disposal through a bilateral agreement. A small amount of hazardous waste generated in this country is exported, some to developing countries whose lack of good disposal practices could pose environmental problems.

Poland and Hungary. On July 9 and 10, the President announced technical assistance to both Poland and Hungary to control air pollution and improve water quality.

Driftnet Fishing Agreements. The Administration successfully persuaded Japan, Taiwan and Korea to enter into driftnet fishing agreements to monitor driftnet practices and enforce laws prohibiting the take of U.S. origin salmon. The agreements will allow the U.S. to quantify the incidental take of seabirds, seals, whales and other marine mammals. Each year several hundred billion dollars worth of illegal U.S. origin salmon is traded on the international market. The agreements will protect the U.S. fishing industry from such losses in the future, while protecting the Marine environment at the same time.

Peace Corps Initiative. On September 18, the President announced a joint Peace Corps/EPA initiative to begin in 1990 the training of Peace Corps volunteers as part of their standard preparation for duty, to deal with a full range of environmental challenges: water pollution prevention, waste disposal, reforestation, pesticide management.

ENDANGERED SPECIES AND HABITAT PROTECTION

Ban on African Elephant Ivory. On June 5, the Administration announced a ban on importation of African elephant ivory into the United States. Under the ban, importation of African elephant ivory from any country is illegal and includes both commercial and non-commercial shipments. Seized goods could subject a traveller to $5000 fines. As a result, the value of ivory on the world market has plummeted, reducing the incentive for illegal poaching of elephants.

Desert Tortoise. The Department of the Interior issued an emergency listing of the Desert Tortoise as an endangered species under the Endangered Species Act in Southern California, Utah, Nevada.

Panthers. The Department of the Interior has acquired additional habitat for endangered panthers in Florida.

Habitat Protection. The EPA has denied a permit for construction of the controversial Two Forks Dam in Colorado because construction would have destroyed thousands of acres of valuable wildlife habitat.

Fishery Development. The President reversed a proposal to cap the outlay of funds collected under the Wallop-Breaux Trust Fund used for fisheries protection and development.

Offshore Oil Drilling. In his February address to the Joint Session of the Congress, the President proposed to postpone lease sales of offshore oil and gas development in environmentally sensitive areas off the coasts of California and Florida. The President set up a task force to examine environmental concerns associated with these sales, and pledged to pursue development only in areas where drilling can be accomplished in an environmentally sound manner. The Administration published proposed rules to prohibit oil and gas leasing in the environmentally sensitive Cordell Bank National Marine Sanctuary off the coast of California.

RESOURCE RESTORATION AND PROTECTION

Wetlands. The President has called for a national goal of "no net loss" of wetlands. Consistent with that pledge, an interagency task force has been convened and is meeting to develop recommendations to meet that goal. The President has proposed special legislative authority to allow interest from monies collected under the Pittman-Robinson Act to be used for wetland purchases under the North American Waterfowl Management Act.

Expanding Parks and Refuges. The President proposed in his FY 1990 budget new spending of $206 million to expand America's national parks, forests, and wildlife refuges. This was the first proposed expansion in several years.

Reforestation. The President has long believed that the concept of stewardship of our natural resources is the basis of a sound approach to the environment. As part of this belief, the President has long been an advocate of reforestation. His personal commitment to planting trees is indicative of his support for the ongoing efforts of federal, state, and local programs, as well as reforestation projects undertaken by private and voluntary organizations.

# # #

IMMEDIATE

UNCLASSIFIED

WHITE HOUSE SITUATION ROOM

PAGE 01 OF 02

PRT YALE
SIT CROMPTON

PREC IMMEDIATE CLAS UNCLASSIFIED DTG 120056Z MAY 89

FM THE WHITE HOUSE//SITUATION ROOM//

TO RUEHGV/USMISSION GENEVA

UNCLAS
QQQQ
PLEASE DELIVER THE FOLLOWING MESSAGE TO U.S MISSION GENEVA FOR IMMEDIATE ATTENTION OF ASSISTANT SECRETARY OF STATE BERNTHAL, HEAD OF U.S. DELEGATION TO THE STEERING GROUP OF THE RESPONSE STRATEGIES WORKING GROUP. FROM CHIEF OF STAFF, JOHN SUNUNU.

1. THE PRESIDENT APPRECIATES YOUR EFFORTS AND IS ENCOURAGED BY THE REPORTS OF PROGRESS THUS FAR. WE CONSIDER THE REPORTED EMERGING AGREEMENT ON AN ADVANCED PREPARATORY PROGRAM TO ADDRESS GLOBAL CLIMATE RESPONSE ISSUES COMPREHENSIVELY TO BE EXTREMELY POSITIVE. TO FURTHER THIS PROCESS. PLEASE MAKE EVERY EFFORT TO OBTAIN AGREEMENT ON A GLOBAL WARMING WORKSHOP THIS FALL, HOSTED BY THE UNITED STATES. THIS WORKSHOP SHOULD BE DESIGNED TO IDENTIFY THE SCIENTIFIC, LEGAL, TECHNICAL AND ECONOMIC ISSUES

PAGE 02 RUEADWW0102 UNCLAS

CRITICAL TO FURTHER PROGRESS ON BEGINNING NEGOTIATIONS ON AN INTERNATIONAL CONVENTION ON GLOBAL CLIMATE CHANGE.

2. WE WOULD ENCOURAGE STRONGEST EFFORTS BY U.S. DELEGATION TO ATTAIN APPROVAL OF THIS PREPARATORY PROGRAM. THE SCOPE AND IMPORTANCE OF THIS ISSUE ARE SO GREAT THAT IT IS ESSENTIAL FOR THE U.S. TO EXERCISE LEADERSHIP ROLE. WE SHOULD SEEK TO DEVELOP FULL INTERNATIONAL CONSENSUS ON NECESSARY STEPS TO PREPARE FOR A FORMAL TREATY NEGOTIATING PROCESS. HOWEVER, BECAUSE THE SIZE OF THE POTENTIAL PROBLEM IS SO LARGE, IMPROPER OR ILL-ADVISED

ACTIONS COULD HAVE ENORMOUS UNINTENDED ENVIRONMENTAL ECONOMIC AND SOCIAL CONSEQUENCES. AT THE SAME TIME WE SHOULD ENSURE THAT THE INTERESTS OF DEVELOPING COUNTRIES ARE TAKEN INTO ACCOUNT IN CONSIDERING RESPONSES TO CLIMATE CHANGE

3. SERIOUS AND SUSTAINED SCIENTIFIC TECHNICAL ECONOMIC AND LEGAL ANALYSIS WILL BE CRITICAL TO SUCCESSFUL COMPLETION OF ANY GLOBAL CLIMATE CONVENTION NEGOTIATIONS. IN ADDITION TO PROMPT

DEVELOPMENT OF THESE ANALYSES. THE WORKSHOP, UNDER THE AUSPICES OF THE RSWG, SHOULD BE STRUCTURED TO HELP IDENTIFY THE ELEMENTS THAT SHOULD BE INCLUDED IN A FRAMEWORK CONVENTION ON GLOBAL CLIMATE, AS WELL AS IDENTIFYING KEY DOMESTIC AND ECONOMIC POLICIES OF ALL COUNTRIES THAT MUST BE INCLUDED IN ANY COMPREHENSIVE PROCESS.

#0102

Global Climate

Global Climate

DRAFT Dick fyi

Policy Guidelines for RSWG October Workshop on Implementation Measures

The primary objective of the RSWG workshop on implementation measures schaduled for October 2-6 in Geneva will be to produce a report covering the five topics on which participants have been invited to submit papers. The U.S. has submitted papers on all five topics after completing a lengthy interagency process. Although these papers will be important inputs to the final report of the workshop, the report will of necessity reflect a number of viewpoints different from our own. Therefore, it is important that all members of the U.S. delegation follow common policy guidelines as they participate in the workshop discussions and drafting sessions in which the report is prepared.

Plenary Next January — DC, Pres. input / summary

Interim Report Fall '90

The U.S. delegation should be motivated fundamentally by the clear desire of the President to lead the efforts of the international community to protect and enhance the quality of the global environment. The guidance and conclusions document should emphasize positive objectives that can contribute ultimately to the "decisive action... to understand and protect the earth's ecological balance" called for by the President and other leaders of the Paris Economic Summit.

translated W. ⊛?

The following are basic policy guidelines to which all members of the delegation shall adhere:

Legal and Institutional Measures

(1) Framework Convention

-- The provisions suggested in the U.S. paper (attached) should all be included.

-- The workshop report is to recommend a general framework convention that includes immediate obligations for research, monitoring and data exchange, and for periodic assessments of science, impacts, technology and economics, but does not include obligations to take any specific response strategy.

premature

-- The framework convention should follow the general organization and scope of the 1985 Vienna Convention. The Convention should take note of the elements of the Vienna Convention and its protocols for controls on ozone depleting substances.

-- A task for the IPCC (RSWG) and, subsequently, of the Convention Parties is to compile and maintain an inventory of existing legal and institutional mechanisms for

reference in implementing future research, assessment and response strategy obligations. These mechanisms are to be used in tandem with new mechanisms established by the Convention and any subsequent amendments and protocols.

-- While measures for providing future amendment of the convention and for appending protocols, the initial Convention should not include specific response strategies. The convention should include establishment of a working group to evaluate response strategies based on them.

-- The Convention should include establishment of a working group to evaluate mechanisms to provide financial and related assistance for consideration of the Parties of the Convention (after the Convention enters into force). The Convention shall not include any mechanisms to provide financial assistance in meeting obligations of the Convention. Such mechanisms will be provided, as appropriate, in subsequent protocols.

-- The Convention should provide for cooperation in the development, assistance and transfer of technology and management practices to limit and adapt to climate change. In this area, the Convention should call for early establishment of a working group to provide recommendations for consideration by the Parties to the Convention.

-- The Convention should provide a mechanism to inventory current emissions of greenhouse gases and to forecast future emissions. The Convention should call for early establishment of a working group (or subgroup) for this purpose.

-- Any general objectives set forth in the convention should be stated in terms of minimizing adverse environmental, social and economic impacts of future climate change. Limitation of emissions levels or atmospheric concentrations of greenhouse gases is not an objective per se, but is recognized as a means of accomplishing the objectives. Specific emission reduction targets or timetables must be avoided in the Convention. Additionally, an objective -- to stabilize or protect the climate at current conditions, per se - is neither feasible nor acceptable.

-- The institutional structure and procedures are provided for in the framework convention should have the effect of formalizing the existing three-track IPCC process: Scientific monitoring and research; socioeconomic and natural resources impacts research and assessments; response strategy identification, evaluation and (future) negotiations.

-- There should be no specific provision of:

- Emissions limitation responses such as taxes on CO_2 or other greenhouse gas emissions, taxes placed on specific fuel sources, or subsidies provided for use of specific energy supply or demand technologies
- Financial mechanisms such as an international climate fund to assist developing countries to meet convention or subsequent protocol obligations
- A binding process to settle disputes among parties.

These matters may be referred to working groups of the convention for further evaluation.

(2) Other Legal Measures

-- The report should refer to, [call for coordination with], and encourage fuller use of, existing agreements, laws and regulations. It should not propose a new "Law of the Atmosphere" or other over-arching legal scheme similar to the Law of the Sea.

-- The report may wish to address means of improving the effectiveness and status of WMO, UNEP, and other international organizations. It should not propose the creation of new international institutions beyond the Conference of the Parties or subgroups established under the framework convention itself.

-- The U.S. delegation should consider the appropriate roles of UNEP, WMO, IPCC, UN regional economic organizations, or other UN organizations in support of Convention Parties in their implementing of the Convention, once it enters into force and for transitional activities between opening for signature and entering into force.

Technology Assistance, Development and Transfer

-- The conclusions in the report of the meeting should call for increased cooperation in development and transfer of technologies and management practices to limit and adapt to climate change. Establishment of a working group on technology assistance, development and transfer can be proposed as an essential subsidiary activity to support the activities of the Parties to the Convention.

-- Intellectual property rights and other rights of firms and individuals owning technology must be protected.

Defense?

-- Maximum use of existing institutions and mechanisms, governmental and nongovernmental, for technology transfer should be encouraged.

-- Recipient countries should provide favorable political, legal and economic conditions for technology transfer. Some national case studies to determine existing barriers, needs, and opportunities for conditions to facilitate technology transfer need to be conducted.

-- The capabilities of some technologies and management practices to limit and adapt to climate change that may also assist a nation in meeting other national and international goals, and the consideration of such collateral benefits, should be noted.

-- The need for coordinated activities in areas of education, training and information transfer, especially associated with the use of modernized technologies and practices in developing and less industrialized countries should be noted in the technology related conclusions of the report.

Financial Measures

-- The report should describe existing bilateral and multilateral financial assistance mechanisms, and call for coordination with them, and encourage their fuller use.

-- A working group should be established to examine financial mechanisms to provide assistance to LDCs to limit or adapt to climate change. Among the options that might be considered are creation of global climate funds or imposition of mandatory fees or taxes to finance support for developing countries. The report should not recommend creation of such mechanisms at this time.

-- The report should stress the need to identify specific projects in individual countries before funding commitments are made. Considerations for such projects should include country needs, barriers and opportunities, etc.

-- Within existing assistance programs and development plans, priority should be given to measures which are desirable on both economic and environmental grounds.

-- Consideration of financial mechanisms must recognize both global climate change issues and overall national goals and needs of recipient countries.

Economic Measures

-- The report should stress the importance of market mechanisms, including a price structure, in reference to top-down command and control regulations in reducing greenhouse gas emissions. Use of market mechanisms needs to consider the special circumstances of each Party in choosing specific implementation steps. The report should note the advantages of giving individual sources maximum flexibility to find the most economically efficient approach to reducing emissions.

-- A working group should be established under the convention to address economic implementation measures such as taxes, fees, performance standards or other methods for reflecting environmental costs and benefits in economic decision making.

The economics section of report conclusions should emphasize the need for, and the role of, information and educational processes to increase effectiveness of economic measures.

Education and Information Measures:

-- The complementarity of education of the public and market incentives or regulations should be stressed. Effective assistance and transfer of technology and management practices also depend on supporting education, training and information processes.

-- The report should stress the need to present the science of climate change and its impacts on natural resources and socioeconomic conditions in a balanced and objective way which reflects all of the areas of agreement and the uncertainties.

-- An important element of education and information measures is their supporting and complementary role to other implementation measures. The implementation of technology, economic or financial assistance measures in many countries will require training and education.

Economics Measures in a Global Climate Change Policy - 7/21/89

Draft - Not for general circulation
Refer comments to Ken Richards, CEA, OEOB, Rm 330,
Office Phone 395-5104, Fax 456-2461
This paper does not necessarily represent the views of CEA

1. Summary: The market oriented framework is the most appropriate way to view policies that attempt to alter producer and consumer choices through 1) changing prices, 2) providing information and 3) regulatory action. Information can enhance the efficient use of "consumer technologies", but it must work in conjunction with the price structure. Regulatory action is appropriate when there is a significant likelihood of market failure, particularly in the case of socially counterproductive behavior by oligopolies, very high risk investments, and basic research. In all cases regulation and market intervention should stress the end results, not the means, e.g. the total pollutant output rather than the particular technology for pollution control.

2. In the relatively near future nations will have to decide how to best confront the problems associated with potential global climate change. One key challenge to those officials and decision makers charged with developing national policy is to understand the purpose and relative merits, weaknesses, and effectiveness of the various policy options available. In this discussion we will examine the role that economic policy measures can play in the development of a larger climate change policy.

3. Although this discussion will concentrate on the microeconomic aspects of policy development, there are two aspects of macroeconomics that we could additionally consider. First, we could consider the use macroeconomic measures, such as manipulation of interest rates and inflation, to achieve desired changes in consumption patterns. However, this is an indirect way of addressing the problem and could have far reaching and unanticipated effects on the economy. Second, it is often suggested that development of climate change policy should explicitly entail consideration of effects on economic growth and GNP. However, it is likely that efficiency at the microeconomic level will minimize negative effects on social welfare, and hence on GNP to the extent that GNP represents social welfare. Therefore, efficiency will be an important policy evaluation criteria.

4. Section I will consider general principles of economic policy, particularly the role of information and incentives. Section II will consider the criteria that should be used to evaluate the relative merits of policy options. Section III will then examine the options that an individual nation faces as it develops economic policy related to global climate change. While this section is written from the perspective of an industrialized market economy,

many of the lessons could be applied to both developing and decentralized economies. Section IV will conclude with a discussion of how the lessons of the first three sections can be generalized to development of international agreements and policy.

I. The Role of Information and Incentives in Economic Policy Measures

5. Most environmental problems arise when decision makers, whether they are consumers, farmers, government officials or any other individual who makes decisions about how to use resources, face one or both of two situations - inadequate information or improper incentives.

6. Information: There are three types of information problems.

> 1) The information does not exist - for example, we simply do not know or are very uncertain about the magnitude of environmental impacts, we do not have adequate technology to accomplish certain goals, we can not predict the social impacts of certain actions;
>
> 2) The information is not disseminated - either the public is not aware that its decisions have an impact on the environment, or they do not know that there are alternatives to their current actions;
>
> 3) The decision makers do not know how to use the information - that is, they do not possess the technical skills needed to implement desired changes.

7. The first of the information problems - that the information does not exist - suggests that governments have a role in uncovering new information, whether it relates to the science and prediction of climate change, the development of new technologies, or the measurement of likely impacts of shifts in precipitation patterns.

8. While the first type of information problem relates to the existence of adequate information, the second and third deal with its dissemination. The specific policy measures related to information dispersal will be discussed in the two companion papers on Public Education and Technical Assistance that will be submitted to the Response Strategies Working Group.

9. Incentives: Information alone is insufficient, however, to assure that the public interest and welfare will be protected. Many environmental problems arise when decision makers have incentives that differ from those of the larger society. For example, the prices we pay for electricity may not reflect environmental costs, so we use more than we should. Or, farmers may be wasteful with their water supply if they gain no personal

benefit from conservation because they are not allowed to sell their surplus water rights. While it may be beneficial to the global community to undertake reforestation projects, no individual has a reason to bear that burden alone.

10. The important lesson here is that both information and incentives are important in the development of policy, neither one alone is sufficient. Where either is lacking, the government has a responsibility to step in and correct the situation.

II. Developing Policy Options

11. The process of policy development can be separated into two related parts. The first part asks <u>if</u> we should undertake a given policy, such as decreasing emissions of greenhouse gases, and to what extent. Answering this question may involve cost-benefit studies, impact assessments and least cost analysis to examine the potential for social welfare improvement. It is also true that political benefits and costs may weigh in to override the results of economic analysis.

12. The second part of the policy development is to determine <u>how</u> best to proceed with the implementation of a given policy. Which of the policy response options are the most promising? If the decision to take policy action is based on socio-economic analysis, then the determination of the best means to proceed may be inherent in that study. However, if political considerations are an important factor in the decision to take action (again, such as decreasing greenhouse gas emissions), then it is the role of the policy analyst to determine the most socially beneficial policy options, given the political constraints.

13. In the next section we will examine some of the specific economic policy options available to an individual nation. But first, we will examine how a policy maker could judge the relative merits of those options by proposing several evaluation criteria. In cases where the impact of the option is very simple or there is ample information available, this evaluation may be quite detailed and quantitative. In other cases, where there is limited information or the impacts are complex, these criteria may be used as a preliminary screening process for eliminating clearly undesirable options and identifying areas where further research is required.

14. The proper execution of this evaluation will ultimately require a great deal of economic analysis in order to quantify the effects of each response option. This analysis will be useful in addressing questions of effectiveness, efficiency, equity, and national security. Other criteria such as information needs, acceptability to the public, ease of administration and legal and institutional requirements will require mostly qualitative evaluation. In all cases, it will be necessary to recognize that

tradeoffs must be made between the various criteria, and that the weighing process is inevitably difficult.

15. The following evaluation criteria are suggested under the three broad categories of "effectiveness", "social, environmental and economic consequences" and "implementation":

Effectiveness

The option should have reasonable certainty of bringing about the desired change.

Social, environmental and economic consequences

Because implementation of new policies will inevitably require tradeoffs between societal goals, it is important to evaluate policies for their negative impacts as well as for their positive effects. The following criteria are useful in examining these criteria.

Efficiency

Cost-effectiveness suggests that for a given level of action (e.g., a set amount of emissions reduction), the implementation mechanism(s) that imposes the least cost or burden on society are generally preferred. Costs include social, environmental and economic consequences. Failure to choose the most cost effective alternatives may cause unnecessary rises in prices and unemployment and reductions in standard of living. However, the level of action taken through a given implementation mechanism must be carefully chosen so as to assure that benefits exceed the social costs (but again, political considerations may prevent this). An implication of this is that scarce resources should be allocated to their most socially valuable use.

Equity

Policies should reflect equity, both in procedure and in outcome. Procedural equity requires that affected parties be given standing in the decision process. Outcome equity must consider redistribution of costs along geographic, intergenerational and income class categories. Two common concepts are horizontal and vertical equity. Horizontal equity requires that people in similar situations should be treated similarly. Vertical equity suggests that people in disadvantaged situations should be treated preferentially.

National Security

Policies that relate to global climate change may have significant national security implications, particularly if the policies effect modes of production. Any option should be evaluated for its potential impact on the security of individual nations, and how that will effect

their willingness to participate in cooperative efforts.

Implementation

Many policies that seem effective and efficient in theory are simply not feasible because of noneconomic factors. The following criteria can be used to evaluate a response option or implementation mechanism for its potential for successful implementation.

Acceptability to the public

In order to receive general public support a policy should be understandable to the general public. This implies that both the need for the policy and the manner in which it achieves its goals should be readily apparent.

Institutional and legal impediments

There may be significant legal and institutional impediments associated with particular response options. As such, many options will require changes in the legal and institutional environment.

Ease of administration

As policies become more complicated, the cost of administration generally goes up, even as the effectiveness of that administration decreases. Policies should be easily understood and realistic with respect to implementation and monitoring requirements.

Information needs

Effective policies can not require unrealistic or excessive amounts of information. They must also take into account the high level of uncertainty involved in global climate change and how this affects the decision process.

III. Economic Measures in a National Climate Change Policy

16. Consider an individual nation that has decided, perhaps unilaterally or in agreement with other nations, to implement a national policy on climate change that includes emissions reduction. The decision to take action has been settled - whether because of compelling benefit-cost figures or due to political imperative does not matter. Policy makers and analysts must now ask <u>how</u> to best implement the policy. While the following discussion is developed around the example of emissions reductions the observations can be generalized to other areas of climate change policy.

17. A nation generally has a choice between two general policy approaches - direct control of production/consumption decisions, or other more flexible programs.

18. There are many types of direct control. Substances may be totally banned from use or permitted only under very narrowly prescribed circumstances (e.g. CFC production and consumption). Production processes may have limits on the amount of emissions that are allowed (e.g. restrictions on the level of SOx per MBtu in electricity generation), or restrictions on the type of materials or energy that are used as input (e.g. requirements for use of specific fuel types in the generation of electricity). Consumption controls can be used to ration or disproportionately increase the cost of certain types of activities that the government wishes to limit (e.g. efficiency standards for automobiles and appliances). Choices of technology can either be prescribed directly through technology standards (e.g. scrubbers for smokestacks) or indirectly through licensing requirements.

19. Each of these measures has the common feature of regulatory intervention in the decision making process, prescribing and limiting the activities themselves rather than their negative effects on society. In terms of the evaluation criteria, they tend to score very well with respect to effectiveness, implementation and equity. They are weaker on the efficiency criteria. This is inherent in their inflexibility; producers and consumers can not shape their choices to reflect new technologies, local circumstances, personal preferences or shifts in costs. For example, if CO2 reductions are primarily regulated through energy efficiency standards, there is little incentive to develop and adopt CO2 capturing technologies.

20. The challenge, then, is to develop economic policies that provide flexibility, so that the decision maker can pursue more efficient outcomes, while at the same time retaining the positive aspects of effectiveness, equity and feasibility of implementation. The emphasis needs to be placed on holding the decision maker responsible for the <u>outcome</u> of his actions, not the <u>means</u> by which the end is achieved. For this we will look to more market-oriented approaches.

21. As mentioned in the discussion of incentives, problems arise when individual decision makers face different incentives than the larger community - i.e. individual costs vary from social costs. The purpose of market-oriented economic policy measures is 1) to force decision makers to consider and respond to social costs (such as environmental impacts) as if they were personal costs, and 2) to provide those individuals the flexibility to decide how best to respond to the costs. There are several mechanisms to do this.

22. <u>Taxes and Fees</u> - Excise taxes, pollution fees, and environmental charges (which will be taken as virtually synonymous) are perhaps the simplest way to inject social cost considerations into private production and consumption decisions.

23. When the purpose of the fee is to send a price signal regarding the social cost of the emissions, the tax level per unit of pollution is set equal to some measure of the social cost of that pollution. Alternatively, the primary purpose of the tax may be to raise revenue. The two goals are not inconsistent, but the emphasis of one or the other may effect the shape of the particular environmental charge chosen. For example, if the primary purpose of the tax is to decrease pollution, it is often politically more palatable to link the revenues from these charges to dedicated uses, such as subsidizing environmental cleanup. If the tax is more of a revenue raising devise, the proceeds are less likely to be encumbered. Experience has indicated that in general the tax systems are more durable if they are designed to increase at small, steady, predictable increments over time, so as to avoid undue economic and social disruption.

24. The tax/fee approach has several advantages as well as limitations. In general it is more efficient to raise revenues by taxing activities that society wants to discourage, such as CO2 or methane emissions, rather than those which are viewed positively, such as labor or investment. Further, it assures that producers of pollutants will decrease their emissions as long as the cost of doing so is less than the level of the emission charge.

25. The problem with this tax is that if it is intended to send a price signal to greenhouse gas emitters, it requires government to determine the social cost of pollution emissions (or the benefit of avoiding those emissions), a task that is currently impossible in the case of CO2. Also, a simple tax has no explicit limit on the level of emissions, only on the economic cost of each unit of emissions reductions. If the tax is set too low it may be ineffective at reducing emissions levels.

26. An additional problem is one that is common to any pollution control system, that of monitoring. How does a government assess a tax on nonpoint sources of emissions such as methane from rice patties, or nitrogen compounds from fertilizer use? The problem is somewhat better for point source pollution, but there are many countries where even these would require more record keeping than is feasible.

27. There has been some practical application of environmental charges. For example, Sweden has a gasoline tax that increases with the lead and sulfur concentration of the gasoline. The United States has a system of taxes on petroleum and chemical feedstocks, the revenues of which are used to finance hazardous waste cleanup under Superfund. The Netherlands has had a system of wastewater effluent charges in place since 1969 which appears to have made significant difference in the levels of BOD and heavy metals.

28. <u>Marketable Permits</u> - Marketable permits can be used to put a cap on total emissions, while still maintaining the flexibility

that allows decision makers to respond to their particular situations. Under this system policy makers are not required to assess the social cost of each unit of emissions, but rather to determine the overall level of greenhouse gases emissions that is acceptable. (It could be argued, however, that this is the same as implicitly determining the social value of avoiding the emissions.) The government then issues a limited number of emissions permits each year (or other arbitrary time period), that entitles the holder to a certain amount of greenhouse gas emissions for each permit owned. The permits may be bought and sold just like any other private resource. They represent a tradeable commodity - the right to emit a set amount of pollutant. If the markets for emissions rights function well, the permits will eventually find their way to the highest value use. This is a economically efficient outcome.

29. The government has various options regarding the initial distribution of the permits. They may be distributed on the basis of some prior claim, such as grandfathering emitters to some proportion of their former level. Alternatively, the permits may be dispersed through an auction which distributes the permits to the highest bidders. The former approach, distributing permits on the basis of historical use levels, may present the potential for large windfall profits to those who can decrease their emissions at relatively low costs. This is not unlike rewarding those who have historically been the most careless polluters. On the other hand, the latter approach may appear to be an unfair seizure of assumed rights to pollute - forcing emitters to pay for what they have previously enjoyed free of charge.

30. In contrast to the tax system, the drawback of this approach is that it is difficult to predict beforehand what the ultimate market price will be. This could lead to inordinately high costs of pollution abatement, higher than the value of the social benefits. It also makes it very difficult for businesses to plan production costs. However, the same is generally true of emissions standards that can be varied over time. Also, in marketable permit programs where extra regulations make trading difficult, or where the future of the program is uncertain, or where there are very few participants in the program, the effectiveness of the system is likely to be severely limited.

31. One example of a successful marketable permit program is the case of lead trading in the United States from 1982 to 1987. This program allowed gasoline refiners greater flexibility during a period when the amount of lead in gasoline was being significantly reduced. There was a great deal of trading activity - approximately 15% of the total lead rights used were banked.

32. The U.S. Environmental Protection Agency has implemented the CFC phasedown requirements of the Montreal protocol by allocating production and consumption limits to producing and importing firms based on their 1986 levels and then allowing the firms to use or

transfer these rights among themselves.

33. Subsidies - Subsidies can be used to encourage actions that the government sees as beneficial. Subsidies have commonly been used to encourage purchase of energy efficient equipment and installation of alternative energy equipment. They are designed to make the preferred alternatives more cost competitive with the status quo. There are two problems with this approach. Subsidies can be prohibitively expensive, potentially draining large sums from the government coffers. More importantly, subsidies inadequately deal with the real problem. For example, a tax on energy consumption or on the carbon content of fossil fuels encourages decision makers to switch to alternative fuels and to decrease the use of fuel in general. A subsidy on renewable energy, on the other hand, encourages switching to alternative fuels, but encourages a general increase in energy consumption. The net effect may be either a rise or fall in CO2 emissions.

34. As mentioned above, the national climate change policy should be aimed at the end product of an activity not at the means of reaching that end. So, in the case of subsidies, where possible the government should aim not at specific technologies, but at the effect or outcome of using those technologies. It should subsidize the removal of carbon from the atmosphere, not the use of energy efficient equipment. It should tax the release or production of CFCs, not subsidize the purchase of alternative refrigeration equipment.

35. In the development of a national policy, there is a reverse side to the use of subsidies to encourage socially beneficial activities. That is the removal of subsidies that are counter to the welfare of the community. Many countries provide tax incentives for oil production, energy use, or other activities that have socially harmful externalities. These subsidies send exactly the wrong price signal to consumers and producers.

36. Offsets - An offset system allows polluters to balance their emissions by proving that they have removed equal amounts of the substance elsewhere. A good example of this is the electric company that pays to have land areas planted in trees that will sequester CO2 at a rate equal to the projected emissions of the generation plant. Similarly, companies could scrub CO2 out of their flue gases. Such a program would assure that for all new sources of CO2, an equal amount of CO2 is sequestered.

37. Deposit/Refund - This system can be thought of as a hybrid of either the tax and subsidy mechanism, or the marketable permits and offsets systems. It addresses some of the problems inherent in the tax scheme - that of determining the social costs of pollution and the potential for little or no pollution reduction - but still avoids the danger of the permit system, i.e. the unpredictability of the final cost of pollution abatement.

38. The program is based on several premises. First, the individual consumers and producers should be forced to cover the social cost of their choices - the polluter pays principle. Second, taxes and subsidies should be aimed directly at the problem, in this case greenhouse gases that will be emitted to the atmosphere. Third, amounts of CO2, methane, and CFCs can be expressed in terms of their relative contribution to global warming. We will posit a hypothetical unit of gas called a greenhouse gas equivalent (GHGE) which is the amount of each gas that causes a set amount of warming. Fourth, withdrawing or sequestering GHGs from the environment has the same social value as avoiding the emission in the first place.

39. The components of the program are as follows.

i. Producers of carbon based fuel must pay a carbon tax proportional to the carbon content of the fuel, regardless of the energy content of the fuel. This could be paid at the wellhead or mine and will involve a relatively few number of producers. (If there is concern that the price signal would be completely damped before reaching the consumer, the tax could be placed on the end use product.) Taxes would be applied to the harvest of wood products for fuel or shortlived consumer products. Importers of fossil fuels will be charged a similar fee. Producers of CFCs and methane would be charged the same fee on the basis of GHGEs.

ii. Payments will be provided to those who can show that they have effectively decreased atmospheric carbon through:

    a. Planting of trees for sequestering carbon;

    b. Removing fossil fuels from the energy production process (such as use of petroleum products for feed stock rather than energy);

    c. Scrubbing carbon from flue gases;

    d. Captured, CFCs, methane, or other GHGs that have been taxed.

    e. Other verifiable means.

iii. The charge for the production of a GHGE is set equal to the fee paid for sequestering or capturing a GHGE, which in turn is set equal to the government's least cost method for removing a GHGE from the atmosphere (probably reforestation of government owned land).

40. This system has several important features.

i. The energy and chemical producers will likely pass some portion of the cost of the GHG tax on to the consumers who will respond to this new higher price by decreasing consumption, increasing efficiency, and substituting alternatives.

ii. It minimizes the cost of collecting taxes by assessing GHG production at the earliest possible point. This is much simpler than assessing every electricity producer, gasoline station, heating oil distributor and appliance manufacturer, etc. The monitoring costs will be minimized.

iii. The programs requires a new mechanism for making payment (essentially subsidies) to those with claims for GHG sequestering. Perhaps existing forestry and industrial monitoring systems can be adapted to this purpose.

iv. It encourages private entrepreneurs to seek least cost methods to sequester GHGs. At the same time it encourages development of alternative energy and energy efficiency technologies, substitutes for CFCs and natural gas production systems that reduce fugitive methane.

v. By setting the GHGE tax equal to the government's cost of sequestering a GHGE, it avoids the problem of having to define the social costs of GHG emissions. It also allows the government to control the level of total net emissions. If the gap between GHG emissions and private GHG sequestering is larger than the government wishes, it can use a portion of the taxes to undertake public programs of GHG removal.

41. In terms of the evaluation criteria, this program would likely be effective and efficient as well as relatively easy to administer (when compared to current control technologies). There are, however, some potential drawbacks to such a system. First, it would be necessary to account for the energy content of exports and imports. This would likely require a relatively complex system akin to the current EEC value added tax (VAT) system of accounts.

42. Second, it is not clear that a program such as this would be highly acceptable to the public. It would entail dramatic changes in energy prices. Also, the subsidies or payments are aimed at relatively untraditional activities (tree planting and flue gas scrubbing) rather than to more traditional endeavors such as energy efficiency investments. For such a program to be implemented, it would have to be presented carefully, in terms which the general population can understand and accept.

43. Perhaps most importantly, as mentioned earlier, there are serious equity considerations involved in any program of this magnitude. First, there is the question of allocation of pollution

rights. If the GHG production rights are distributed as permits on the basis of who had already been producing GHGs, the recipients would stand to gain an enormous windfall. On the other hand, the imposition of a new tax or fee could be viewed as an unfair removal of previously established rights. However, this differs little from the imposition of new emissions standards - both cases involve unexpected new costs.

44. Another equity concern arises with respect to low income individuals. If these people tend to spend relatively more of their disposable income on energy needs, then they could be disproportionately effected by the carbon component of the new tax. The only simple solution to this is to use some portion of the revenues of the GHG tax to redistribute wealth to the poor through any number of government assistance programs.

IV. International Applications

45. Many of the observations and lessons regarding the development of national policy within the boundaries of a sovereign country apply equally to the development of international agreements. In this section we will first consider the role and importance of international cooperation and then turn to the role that market mechanisms could play in promoting that cooperation.

46. One of the roles of a national government is to enforce compliance with rules that are established for the general good of the citizens. Even individuals who agree that the rules are beneficial and needed might not observe them if they felt that enforcement was inadequate and that others were not cooperating.

47. Similarly, a nation may feel that reducing greenhouse gases is an urgent priority, but be unwilling to take unilateral action for one or both of two reasons. First, because limiting emissions could put the country at a trade disadvantage. The opportunity to emit GHGs is a resource, similar to energy, labor and capital resources - it is an environmental resource. And like the other resources it is used in the production of goods and services, some of which are traded internationally. If the country decides to give up some of its energy or capital resources, the remaining capital and energy would become more expensive and the country would find itself at a disadvantage in the world trade market. The same is true of GHG emissions; a decision to limit the use of this resource would require substitution from other resources, and would have a negative impact on trade. At the same time it is important to note that there may be limits to the size of the GHG sink. The ability of the biogeosphere to absorb carbon dioxide and related GHGs may be a limited resource.

48. Second, it likely that anything less than a cooperative global effort to reduce GHGs will be ineffective. The dynamics of the

distribution of GHG emissions is such that in the next few decades any real reductions in GHGs will require that all types of nations reduce their emissions, developing and industrial countries alike.

49. Therefore, if a sufficient number of countries have decided that there exists sufficient evidence regarding the benefits of reducing greenhouse gases, it is likely that they will attempt to act in consort, coordinating their efforts and sharing the burden.

50. The Montreal Protocol serves as an example of such a cooperative action. The threat to the ozone layer was sufficiently clear that several countries jointly committed to reductions in the production and consumption of CFCs and other potential ozone depleting substances. This was accomplished through negotiations to determine the required reductions that each country would accept. Individual country circumstances were considered. Developing countries were allowed a longer grace period before reductions were required. Countries with plants already under construction were also given special consideration. At the end of all of this, the outcome was that each country had an allowable production and consumption level which to be met.

51. A similar arrangement may be made with respect to emissions of greenhouse gases. And it is in this respect that observations from the discussion of domestic policy development become valuable. First, in development of domestic policy we observed that it is preferable to allow individual decision makers the freedom to find the most efficient means to achieve the stated goals, given the regulatory or market constraints. Similarly, an international agreement should allow individual countries to choose how best to pursue stated goals.

52. Accordingly, a protocol on GHG reductions should not prescribe that coal burning be reduced, that alternative energy sources be adopted or that energy efficiency standards be observed. Rather, each country should be allocated a set amount of the fixed resource, in this case the emission of GHGs. This may be assigned on the basis of some notion of fairness - per capita, historical contribution to the problem, potential for benefiting from cooperation - or according to political might, bargaining power or strategic position. Regardless of the process, the outcome is that each country would have a target level or quota of emissions and the freedom to choose the most appropriate path to reach that level.

53. Second, an important element of increasing the efficiency of environmental protection methods was to provide for markets in tradeable emissions permits. This assured that the "right to pollute" would go to the highest value user. In the same way, the signatories to an emissions protocol should have the opportunity to trade portions of their permissible levels if they do not use all of their quotas. For example, if one country is easily staying

within the limits of its allocation of GHG emissions, it may choose to sell some its allocation to a country that is finding the quota to be a serious constraint on production and consumption. Implicitly, the property rights to this resource initially rest with the governments of the individual nations. They may choose to sell off some of those rights to governments or firms from other countries, or they may distribute those rights with in the country and allow the private sector to trade intra- and inter-nationally.

54. Such a provision is likely to benefit the developing countries. In the case of the Montreal Protocol the LDCs were allowed targets that were above their actual consumption levels. A similar arrangement in a GHG protocol that has provisions for trading emissions allowances, would place the LDCs in a position to bargain for the technology and economic resources needed to adapt to the changing climate and energy resource restrictions. They will have the means and incentives to develop more energy efficient technologies. Countries will need to recognize this as they negotiate individual country allocations. Such an arrangement would certainly raise the stakes of the protocol negotiations, but it would ultimately lead to a more efficient, equitable outcome.

THE WHITE HOUSE

WASHINGTON

June 13, 1989

MEMORANDUM FOR THE SECRETARY OF STATE
THE SECRETARY OF THE INTERIOR
THE SECRETARY OF AGRICULTURE
THE SECRETARY OF ENERGY
THE DIRECTOR OF MANAGEMENT AND BUDGET
THE CHIEF OF STAFF
THE ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY
THE CHAIRMAN, COUNCIL OF ECONOMIC ADVISORS
THE ASSISTANT TO THE PRESIDENT FOR NATIONAL SECURITY
THE COUNSEL TO THE PRESIDENT
THE ASSISTANT TO THE PRESIDENT FOR DOMESTIC AND ECONOMIC POLICY

FROM: DAVID BATES,
ASSISTANT TO THE PRESIDENT AND SECRETARY TO THE CABINET

SUBJECT: Options paper for the International Conference on the Environment

Attached is a paper discussing various options for an international conference on the environment that the President could announce this year.

This paper will be discussed at a meeting on Thursday, June 15, 1989 at 2:00 p.m. in the Roosevelt Room. The Chief of Staff will chair the meeting.

Thank you for keeping this paper closely held.

June 13, 1989

ISSUE:

A decision is needed on the structure, agenda, and timing of an international conference on global environmental issues to fulfill the President's campaign pledge.

BACKGROUND:

The President's campaign pledge:

> "The problem is international in scope; unilateral action on the part of the United States alone will not solve it...
>
> "In my first year in office, I will convene a global conference on the environment at the White House. It will include the Soviets, the Chinese, the developing world as well as the developed. All nations will be welcome -- and indeed, all nations will be needed...
>
> "The agenda will be clear. We will talk about global warming. We will talk about acid rain. We will talk about saving our oceans, and preventing the loss of tropical forests. And we will act."

In the year ahead, as many as 15 international meetings will be held to address international environmental issues, particularly global warming. A partial sampling of other international meetings on environmental issues includes:

9/89:	Tokyo Summit on global Environment
11/89:	Hague Ministerial on Global Environment
4/90:	London Meeting of CFC Protocol Parties
11/90:	World Meteorological Organization Second World Climate Conference

Moreover, under the auspices of the United Nations Environmental Programme (UNEP), the Intergovernmental Panel on Climate Change (IPCC) was created to provide an international forum for discussion of global warming issues. The U.S. was an aggressive partner in shaping the IPCC and succeeded in winning the chair of a crucial working group, the Response Strategies Working Group (RSWG) that will consider mitigating strategies for global warming. The U.S. convened and chaired the first meeting of RSWG in January, 1989.

At the most recent meeting of the RSWG Steering Group, May, 1989, the U.S. delegation issued an invitation to the participating countries to attend a "workshop" in the U.S. in the fall of 1989 to discuss a framework convention on climate change. The workshop will be a lower-level working meeting that would probably not be appropriate for Presidential participation. Moreover, many in the environmental community believe that the President is planning a conference in addition to the workshop to fulfill the campaign pledge.

The emphasis of most meetings is the science of global climate change, "legal mechanisms" for encouraging or requiring responses, or environmental effects and response strategies of potential warming.

The challenge is to convene a conference to explore substantive new information, to promote U.S. policy goals and to avoid "reinventing the wheel."

OPTIONS:

Four options have been identified:

OPTION 1: GLOBAL OPTION

A. GLOBAL CONFERENCE ON THE ENVIRONMENTAL AND ECONOMIC IMPACTS OF CLIMATE CHANGE: THE COST OF RESPONSE; THE COST OF INACTION

The United States would hold the first international conference on the economic and social costs and benefits of global climate change. The conference would address the costs of both mitigation and adaptation measures. This option would allow the President to develop internationally the theme that it is possible to have both economic growth and environmental protection.

All nations would be invited to the conference. The President would host the conference and would address the opening or plenary session.

PRO

- Fulfills the President's campaign pledge in a unique way that does not merely echo other international discussions.

- Focuses much needed attention on the significant social and economic impacts of the global warming issue (including the effect on

U.S. competitiveness). Even though there are large uncertainties in the range of economic costs and social impacts, an early international forum on the topic would greatly contribute to more responsible debate on the issue.

- Builds upon the current U.S. role as Chair of the IPCC Working Group on Response Strategies, since the responsibility for developing response strategies must include a consideration of economic and social costs.

CON

- Because of the large scientific uncertainties, it is extremely difficult to estimate the costs that may result from global warming or the cost of response strategies.

- A conference focused on social and economic issues may be perceived as self-serving of U.S. economic interests, and may not advance the President's intent to assert a leadership role for the U.S. in global environmental issues.

- A conference emphasizing economics may be perceived as a delaying tactic to divert attention from the scientific assessments and to delay response actions.

B. PLENARY SESSION OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Under this option, the U.S. would simply utilize the structure of the IPCC already in place to host a conference on climate change. The U.S. would propose, at the June, 1989, IPCC Bureau meeting, to host the scheduled plenary session for January, 1990 in the United States. It should be noted that the U.S. is committed to hosting a RSWG workshop on a framework convention in the fall of 1989; the State Department believes the IPCC will not agree to do both the workshop and the plenary in the United States. It would be possible to allow the workshop to take place elsewhere and commit to the IPCC plenary for January. The President would address the opening session. Attendance would be at least the 35 IPCC member nations.

PRO

- avoids duplicating a forum and process already in existence to which the U.S. is committed.

- reaffirms the U.S. commitment to orderly development of global climate policy.

- fulfills campaign pledge.

- reaffirms U.S. leadership role in IPCC.

CON

- utilizing a conference that would take place with or without the U.S. could be seen as an insincere attempt to gloss over campaign pledge.

- The IPCC is not controlled by the U.S.; it is a U.N. forum subject to East-West and North-South tensions.

- IPCC may not agree to allow U.S. to host the meeting.

- The conference would be difficult to announce within the intended time-frame because our invitation must be negotiated and agreed to in the IPCC Bureau meeting.

- This option would require making a choice between the workshop on the framework convention which we have already announced our intention to host and the IPCC plenary. The State Department believes there is some flexibility to move the workshop to another country, despite our initial invitation.

OPTION 2: REGIONAL OPTION

NORTH AMERICAN CONFERENCE

Under this option, the U.S. would invite Canada and Mexico to join in a discussion of international environmental issues that are of immediate mutual concern to North America. It would be possible to include issues in addition to global warming, such as air pollution, protection of international water bodies, pollution prevention and waste minimization,

debt exchange for environmental protection and ozone layer depletion.

PROS

- This conference would provide an opportunity to develop North American unity/goals/agenda for environmental efforts, with the U.S. as a catalyst.

- Relations with Mexico and Canada are particularly important and environmental relations have been for the most part positive.

- Does not conflict with the many other international conferences due to limited scope.

- Logistically possible to implement this year.

CONS

- Does not fulfill President's campaign pledge to host a global conference that would "...include the Soviets, the Chinese, the developing world..."

- Canada is likely to pursue commitments on acid rain issues before they are sorted out domestically.

- Mexico is likely to pursue financial assistance for environmental programs in excess of U.S. fiscal ability to assist.

- Both Canada and Mexico's separate agenda may place the United States in a negative posture at its own conference.

- Environmental groups have stated in response to this option that it is not sufficiently broad in scope.

OPTION 3: PROBLEM-SPECIFIC OPTION

CONFERENCE ON CLIMATE CHANGE AND REFORESTATION/DEFORESTATION/AGRICULTURE

Forests and agriculture represent a major "sink" for CO2 emissions which otherwise would reach the upper atmosphere and contribute to the greenhouse effect.

Reforestation appears to be a very promising strategy for reducing emissions at a comparatively low cost with other control technologies. There are other benefits as well: timber and biomass energy production, improved water quality, reduced soil erosion and wildlife habitat creation. The conference would be a much-needed forum for the discussion of plant resiliency so that areas are better able to adapt and respond to climate change. The conference could follow a U.S. announcement of "no net loss of forests" as a policy goal similar to the "no net loss of wetlands" policy goal. The Response Strategies Working Group, chaired by the United States under the IPCC, plans to address the forestry issue in three technical working-level workshops. Hosting a ministerial-level conference on this issue would elevate the importance and potential of forestry/agriculture in mitigating global warming.

PROS

- Forestation /agriculture has received little a formal attention in the climate change debate. Such a conference could significantly alter the terms of debate and would reflect very favorably on the United States.

- The forestation theme could provide positive, action-oriented outcomes and would be controllable by the United States.

- Forestation does not cause fear of undue economic costs for emission controls.

- The issue provides a link for programs between private and public sectors.

CONS

- Developing countries, particularly Brazil, may view the issue as a means of preventing development. Developing countries would need to be carefully consulted.

- Current U.S. forest policies may not be consistent with the "no net loss" goal or with concern about climate change.

DISCUSSION:

There is some support for Option 2 (North American Conference) on its merits, yet it falls short of the campaign pledge to host a global conference.

Although Option 1 (Economics of Climate Change) is sound from a public policy viewpoint and would yield the most needed information heretofore ignored, it is possible it would be criticized by environmentalists for focusing only on climate change's effect on the economy. This option is consistent with the President's over-arching theme: economic growth and sound ecology can coexist.

Option 1A (Plenary Session of the IPCC) is an otherwise good option, except for the complication of the workshop on a framework convention which we previously committed to host. According to the State Department, the communique resulting from the May, 1989 RSWG meeting does not specify the U.S. as the host for the workshop, although there is an informal agreement that the U.S. would do so. It is possible to move the workshop to Geneva in favor of hosting the IPCC plenary. This option avoids any duplication of other efforts and would be simple to implement. Choosing this option would require a decision not to host the workshop on the framework convention.

Option 3 (Forestation and Climate Change) is very attractive because it places the U.S. in a favorable position of strength, would address a potential solution to global warming, as opposed to merely warning about its effects, and does not require nations to commit to expensive control technologies. However, it could cause concern in the U.S. timber industry and create friction with several developing country governments. The Department of Agriculture strongly supports this option and believes U.S. research and policy is consistent with this approach. The President has also stated that he wants to implement an aggressive tree-planting program to mitigate global-warming.

DECISION:

Option 1 A_____ B_____

Option 2 _____

Option 3 _____

Copy to Bob Hahn

THE WHITE HOUSE

WASHINGTON

June 21, 1989

MEMORANDUM FOR THE SECRETARY OF STATE
THE SECRETARY OF THE INTERIOR
THE SECRETARY OF AGRICULTURE
THE SECRETARY OF ENERGY
THE DIRECTOR OF MANAGEMENT AND BUDGET
THE CHIEF OF STAFF
THE ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY
THE CHAIRMAN, COUNCIL OF ECONOMIC ADVISORS
THE ASSISTANT TO THE PRESIDENT FOR NATIONAL SECURITY
THE COUNSEL TO THE PRESIDENT
THE ASSISTANT TO THE PRESIDENT FOR DOMESTIC AND ECONOMIC POLICY

FROM: DAVID Q. BATES
ASSISTANT TO THE PRESIDENT AND SECRETARY TO THE CABINET

SUBJECT: Meeting on the International Conference on the Environment

Attached are two papers prepared by EPA and the Department of State at the Chief of Staff's request at the June 15, 1989 meeting on the International Conference on the Environment. The first paper (Attachment 1), prepared by EPA, discusses the general status of scientific consensus and budgetary issues on global climate change. The second paper (Attachment 2), prepared by the Department of State, discusses the status of scientific consensus and inquiry in the Intergovernmental Panel on Climate Change.

These papers, as well as the original options paper on a possible international conference, will be discussed at a meeting on Friday, June 23, 1989, at 4:15 p.m. in the Roosevelt Room. The Chief of Staff will chair the meeting.

[redacted]

SUMMARY OF CURRENT KNOWLEDGE ABOUT GLOBAL CLIMATE CHANGE

INTRODUCTION

Past research has provided an understanding of many important aspects of the greenhouse effect, the warming of the atmosphere through the absorption of radiation by gases such as carbon dioxide. This paper summarizes current knowledge and uncertainties ranging from unequivocal increases in the abundance of these gases in the atmosphere to the uncertain ability to predict consequences for specific regions.

HUMAN INDUCED CHANGES IN THE ATMOSPHERE

- Given current trends in emissions, an equivalent doubling of carbon dioxide and other gases compared to pre-industrial levels, is virtually certain and may occur as early as the 2030's.

  Emissions of carbon dioxide are increasing largely due to fossil fuel combustion and to a much lesser extent because of deforestation. Future atmospheric concentrations of CO2 will depend strongly on economic, technical and policy developments and on the net uptake by vegetation and the oceans, the effects of which is somewhat uncertain.

- The existence and increases of other greenhouse gases are well known.

  Methane, chlorofluorocarbons (CFC's), ozone (low level) and nitrous oxide are also increasing in the atmosphere. The increases are documented by current monitoring stations, but the reasons for some of the increases are only partially clear. For example, the specific emissions of methane from rice fields, gas pipelines, cattle, coal mines, and wetlands can only be estimated at this time. While future concentrations are difficult to predict, it is clear that they will add to the greenhouse effect produced by CO2.

- Confidence is high in the understanding of the basic radiation physics of trace gases.

  By virtue of evidence from palioclimatic records and probes to other planets, there is solid agreement that

the addition of greenhouse gases will increase the thermal forcing of the climate system and that global temperatures will increase.

- Predicting the response of the entire climate system is much more difficult because the role of clouds and the oceans is less certain.

  Based on complex simulation models, the National Academy of Sciences has estimated that it is likely the average global temperature increase could range from 1.5 to 4.5 degrees Celsius. The academy has also indicated that temperature increases near the poles would be higher (very probably), that precipitation would increase globally (very probably), that mid-continental dryness would increase (likely in the long term) and that increases in sea level are probable. Some scientists caution that we do not yet have enough knowledge about many processes and others indicate that the earth's system could produce surprises e.g., changes in ocean currents that could radically alter the climate response.

- Current models do not have the ability to predict the climate of a particular region or year. Other relevant variables, such as rainfall and winds are difficult to estimate.

- There is a wide spectrum of opinion (and no consensus) on whether a greenhouse "signal" has already been seen.

  The surface air and sea temperature records indicate that there has been an increase of between 0.5 and 0.7 degree Celsius over the last century. The pattern of the increase, that was interrupted by a cooling between the 1940's and the 1960's, suggests that natural variations play an important role. In addition, the reliability of the records has been questioned. Thus for several reasons there are differences of opinion among scientists as to whether warming has actually begun.

THE EFFECTS OF CLIMATE CHANGE

- The environmental effects of a relatively rapid warming over the next century are difficult to predict. It is likely that many natural systems (forests/wetlands) would not be able to adapt, while impacts on other systems (agriculture) could be managed, but would be expensive even in the U.S.

  Sensitivity studies of many systems including water resources, forests, wetlands, agriculture, cities, electricity demand and human health suggest that climate change would significantly alter the lives of many Americans. Changes in the landscape of North America,

due to similar temperature increases since the last ice age, confirm these findings. The impacts of these changes will vary between regions, with the timing of change, and with changes in the frequency of extreme events. The impacts of these changes on developing countries could be even more significant, since they are unlikely to have sufficient resources to adapt.

DRAFT

FEDERAL RESEARCH EXPENDITURES IN GLOBAL CHANGE

A Federal Global Change Research Program has been developed by the Committee on Earth Sciences (CES) of the Federal Coordinating Council on Science, Engineering and Technology (FCCESET), in the President's Office of Science and Technology Policy (OSTP). EPA was a founding member in March, 1987. The first government-wide budget crosscut was undertaken for FY-1988 in close collaboration with OMB. This exercise was undertaken to determine the feasibility of such an exercise, and to establish agreed upon budget categories. Seven research foci were developed based on the work of the Committee on Global Change (CGC) of the National Academy of Sciences.

CES, at the request of OMB, established two major categories of research: focussed and supporting. Focussed research was research conceived, funded, and undertaken to address the problem of global change. Supporting research was work that was or would be undertaken in any case, but would provide essential support to the global change effort. Table 1 indicates the FY-89 and FY 90 budget breakdowns, for the focused budget. The supporting budget was not published, but the ratio of supporting to focussed was about 10 to 1.

A similar exercise is being undertaken for FY-91. Whereas for FY-89 and 90, OMB simply accepted the figures submitted by the agencies, it has indicated that it intends to use the recently drafted Global Change Federal Research Plan to prioritize research and allocate investments. As a result, several problems have arisen.

1. CES maintains that only the causes and some effects of global change are to be considered. EPA staff in ORD and OPPE holds that mitigation and response research must be included, as scenarios of change will be dependent on evolving technologies and social decisions, and that response strategies are critical research issues. Although a separate Committee under OSTP may be established to address mitigation and response concerns, this issue is currently unresolved. Inasmuch as OMB has indicated that the Research Plan represents ALL federal investment in global change, this issue is of critical importance to EPA.

2. Whereas EPA's work in this area is broadly supported by the Agency, and it's budgets are reasonably accurate representations of planned activities, this may not be the case for other agencies and departments as they pre-submit their budgets for FY-91. They are using their budget number presubmissions as a political tool to garner support in OMB and elsewhere, to use in influencing their own organizations. Numbers from certain agencies, therefore, may be quite speculative.

3. DOI has only just begun to formulate its program in this area, and USDA has just begun to reevaluate its program. We are not aware of any specific global change research in DOI; rather, from their submissions to date, it appears that they will simply pick and choose work they would be doing anyway and call it global change research. Similar exercises are going on in other agencies as well.

7

FY 1990 U. S. Global Change Research Program Budget

- **Biogeochemical Dynamics:** These programs concentrate on the study of the biogeochemical constituents (e.g., oxygen, carbon, nitrogen, etc.) within the earth system and their influence on the life-sustaining envelope of the earth, including global warming. The FY 1990 budget proposes $44.9 million for this element, a 51 percent increase over the FY 1989 level.

- **Ecological Systems and Dynamics:** These programs focus on how ecological systems both impact and respond to a wide range of global changes. The FY 1990 budget proposes $39.5 million for this element, a 41 percent increase over the FY 1989 level.

- **Climate and Hydrological System:** This research examines the physical processes that govern the climate and hydrologic system, including the atmosphere, hydrosphere, cryosphere, land surfaces, and biosphere. These efforts are clearly central to the description, understanding, and prediction of global change. The FY 1990 budget proposes $59.3 million for this element, a 56 percent increase over the FY 1989 level.

- **Human Interactions:** These programs study the interface between natural processes and human activities. Roughly two-thirds are policy studies and not earth science research. However, these studies benefit greatly from close association with the research activities. The FY 1990 budget proposes $22.0 million for this element.

- **Earth System History:** This element is crucial to documenting past natural changes. Climate information from the past will be very important in distinguishing the relative roles of natural phenomena and human activity in global change. The FY 1990 budget proposes $7.0 million for this element, roughly doubling the FY 1989 level.

- **Solid Earth Processes:** Interactions between the earth's surface and the atmosphere, hydrosphere, cryosphere, and biosphere are the key elements of this program. The FY 1990 budget proposes $10.5 million for this element, an 18 percent increase over the FY 1989 level.

- **Solar Influences:** These programs are designed to study the impact of solar variability on the atmosphere and climate. The FY 1990 budget proposes $7.3 million for this element, a 78 percent increase over the FY 1989 level.

Table 1
1989-1990 U. S. Global Change Research Program Budget
(Dollars in Millions)

Focused Program	Total Budget		Biogeochemical Dynamics		Ecological Systems and Dynamics		Climate and Hydrologic System		Human Interactions		Earth System History		Solid Earth Processes		Solar Influences	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Agency Totals	133.9	190.5	29.8	44.9	28.1	39.5	38.0	59.3	22.0	22.0	3.0	7.0	8.9	10.5	4.1	7.3
NSF	39.2	53.5	13.5	18.3	1.9	1.9	13.2	17.0	0.0	0.0	2.0	4.7	6.2	6.5	2.4	5.1
DOE	20.2	27.2	6.0	5.5	4.2	6.7	7.0	10.2	2.0	3.6	0.0	0.0	0.0	0.0	1.0	1.2
DOI/USGS	5.3	10.3	0.0	0.0	0.0	0.3	2.3	5.0	1.5	2.0	1.0	2.3	0.5	0.7	0.0	0.0
NASA	14.5	21.5	3.0	4.4	4.3	6.4	4.3	6.4	0.0	0.0	0.0	0.0	2.2	3.3	0.7	1.0
DOC/NOAA	9.0	20.0	0.0	3.0	0.0	0.0	9.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EPA	27.4	35.3	0.8	3.5	7.4	13.2	0.7	2.2	18.5	16.4	0.0	0.0	0.0	0.0	0.0	0.0
USDA	18.3	22.7	6.5	10.2	10.3	11.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOURCE:

Our Changing Planet:
A U. S. Strategy for Global Change Research

A Report by the Committee on Earth Sciences

To Accompany the

A Perspective on the Science of Global Climate Change

Introduction

Past and present research provide an incomplete understanding of the greenhouse effect, i.e. the warming of the Earth's atmosphere through absorption of longwave radiation by certain gases like carbon dioxide. Some aspects of the issue are clear; others are poorly understood.

Basic Mechanism and Emissions Trends

The basic mechanism of greenhouse warming has been well understood since the end of the 19th century. Trace quantities of greenhouse gases -- water vapor, CO2, methane, N_2O, chloroflourocarbons (CFCs) and others -- absorb infrared radiation from the earth's surface in the troposphere and warm the earth. If this greenhouse effect did not take place, the earth's surface would be approximately 60 degrees Fahrenheit cooler and life as we know it could not exist.

The increasing accumulation of greenhouse gases in the atmosphere resulting from fossil fuel combustion and other human activities has also been well documented. Measurements at the Muana Loa Observatory in Hawaii and analysis of ice cores have shown that atmospheric CO2 concentrations have increased by approximately 25 percent from 280 ppm before the industrial revolution to 350 ppm today. Concentrations of other greenhouse gases have also been increasing. At current rates of increase it is expected that overall concentrations of greenhouse gases will reach the equivalent of a doubling of CO2 from preindustrial levels before 2050.

Predictions of Future Greenhouse Warming: General Circulation Models

Scientists have developed complex computer models to estimate the consequences of such a doubling by simulating the interactions of the complex global climate system. Based on these simulations, many scientists believe that an eventual average global warming in the range of one to five degrees Celsius is a reasonable estimate of those consequences. Discrepancies among the results of different models and disagreements among scientists indicate, however, that we have not identified or correctly characterized all of the key processes involved. This is particularly true of several of

the so called "feedback" processes such as the occurrence of clouds and their ability to reflect incoming solar radiation (see testimony by Dr. Daniel Albritton at TAB B for a fuller discussion of this issue.)

A key question is whether the behavior of the global climate system is consistent with the prediction of our existing models. The answer to this question is unclear. During the last hundred years there appears to have been an increase in the average global temperatures of between 0.3 and 0.7 degrees Celsius. The magnitude, timing and distribution of this change does not fully comport with what would have been predicted by our current models. Thus, while our recent climate experience can be considered consistent with the greenhouse hypothesis, we do not yet have a clear signal that such warming is occurring.

It is clear, however, that if we do experience greenhouse warming at even the lower end of the range predicted by current models, we will experience climate changes which are more rapid and far reaching than any in recent history.

The impacts of climate changes, even at the lower end of the estimated range, would almost certainly be considerable and could result in major social and economic dislocation. For example, a rise in the sea level caused by thermal expansion of the oceans and melting mountain glaciers and polar ice sheets would have significant effects. While the degree of sea level rise from global warming is uncertain, coastal communities would have to invest in massive shore protection projects to ensure their continued viability. In addition, it is possible that between 30 to 70 percent of U.S. coastal wetlands would be lost using moderate impact assumptions.

Climate System Responses and Potential Impacts

Most, but not all, climate scientists currently believe that the eventual response of the climate system to greenhouse forcing is likely to be, on the average, a global warming. While it is clear that current science can accurately calculate the thermal forcing of the atmosphere due to increases in greenhouse gases, it is also clear that estimating the subsequent response of the climate system to that forcing is a much more difficult task. Several of the key processes which govern that response are quite complex, such as the occurrence of clouds, which reflect radiation. On the other hand water vapor itself is a greenhouse gas.

An example of a critical feedback is the melting of ice and snow during warmer periods, which exposes darker surfaces that absorb more radiation and add to the warming. It is the net effect of the interactions among all these processes, including positive and negative feedbacks, that determines the new equilibrium climate state that the planet will reach after an increase in radiative forcing by the greenhouse gases.

At this point it is not possible to say with certainty what specific impacts are likely to occur. Scientists believe that warming is likely to be more pronounced at higher latitudes than at lower latitudes. This suggests that higher evaporation rates will increase demand for scarce water resources in areas that are now particularly important to agriculture. Thus, global warming could result in major shifts in agricultural production patterns.

Current models do not predict with certainty the climate of a particular region or of a given year. Other relevant climate variables, such as rainfall, are also beyond the capacity of existing models. However, many scientists believe that the models do suggest that, because of the greenhouse effect, regional changes in climate patterns, like the drought in the mid-west, would become more likely in coming decades.

The working group to reduce science uncertainties of the Intergovernmental Panel on Climate Change has prepared a work program focused on how each key climate forcing element has changed relative to the past, how they operate today, and how they may change in the future. This work program will assess the current understanding of the geophysical and biological processes that determine the radiative balance of the atmosphere. Both man-made and natural emissions sources will be considered.

The science working group is to produce by mid-1990 a peer-reviewed study by the best scientists available worldwide and an executive summary directed to policy officials and suitable for release to the private sector and general public. The study will consider the full range of climate change phenomena: climate forcing aspects, past climate record, processes involved in climate change, climate model formulation, tests of climate models, simulation of past climate changes, predictions of future climate, and physical and biological responses to climate change. It will focus particularly on identifying gaps in our knowledge and a better quantification of uncertainties. Drafting is underway in a series of sub-groups keyed to specific chapters of the study.

John Houghton of the U.K. chairs the science working group; Brazil, Denmark,the FRG, Japan, Italy, Senegal,

Scientific Assessment of Climatic Change
Status Report: 19 June 1989

Daniel I. Albritton (NOAA) and Robert T. Watson (NASA)
U. S. Representatives on the IPCC Science Working Group

Introduction

The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) are sponsoring the Intergovernmental Panel on Climate Change (IPCC) to obtain an international, state-of-the-knowledge review of climate change. There are three companion IPCC assessments: (1) science, (2) socio-economic impacts, and (3) policy options. The IPCC has assigned lead responsibilities for the preparation of the assessments reports as follows: (1) Science - United Kingdom; (2) Socio-Economic Impacts - USSR; and (3) Policy Options - USA.

The counties represented on the Science Working Group are United Kingdom (chair), Brazil, Denmark, Federal Republic of Germany, Italy, Japan, Senegal, Switzerland, Tanzania, United States of America, and Union Soviet Socialists Republics.

This summary gives the current status of the progress of the Science Working Group on the *Scientific Assessment of Climatic Change*.

Scope

The main features of the *Scientific Assessment of Climatic Change* are the following:

- It will be a peer-reviewed scientific document done by the best scientists available and submitted to the IPCC. It will be accompanied by a summary directed to government officials and suitable for IPCC release to the private sector and the general public.

- Its scope will be the full climate change phenomenon, namely: climate forcing agents, past climate record, processes involved in climate change, climate model formulation, tests of climate models, simulation of past climate changes, predictions of future climate, and physical and biological responses to climate change.

- A special emphasis throughout will be an identification of gaps in the knowledge and a better quantification of uncertainties.

Timetable

The timetable established by the IPCC for the completion of the three assessments is brisk. The major events and milestones for the *Scientific Assessment of Climatic Change* are the following:

9 - 11 November 1988	First meeting of the IPCC to establish the goals, scopes, and schedule of the assessments. (Geneva, Switzerland)
24 - 26 January 1989	First plenary meeting of the Science Working Group (WG 1) to establish the features of the *Scientific Assessment of Climatic Change* and the interactions with the other Working Groups. (Oxford, United Kingdom)
6 - 7 February 1989	IPCC Bureau meeting to review the plans of the three Working Groups. (Geneva, Switzerland)
7- 8 March 1989	Lead authors of the *Scientific Assessment of Climate Change* meet to establish the contents of the Assessment, the participants, and the schedule of working meetings. (Princeton, USA)
April 1989 - Feb 1990	Subgroup meetings to draft the individual chapters of the *Assessment*.
June 1989	Plenary meeting of the IPCC to review progress and interactions of the Working Groups. (Nairobi, Kenya)
5 - 9 March 1990	Meeting of the lead authors of the Science Working Group to review the draft of the Assessment. (United Kingdom)
March 1990	The draft *Assessment* is sent out for formal peer review.
May 1990	Comments received from Peer Reviewers.
July 1990	Meeting of lead authors and members of the Science Working Group to consider the comments and suggestions of the peer review. (United Kingdom)
July 1990	The *Scientific Assessment of Climatic Change* is sent to the IPCC.
12 - 16 November 1990	Second World Climate Conference, at which the reports of the IPCC will be presented. (Geneva, Switzerland)

Contents

The *Scientific Assessment of Climatic Change* is to have ten sections. Lead authors are coordinating the work within each section. Other scientists have been selected as participants. Subgroup meetings have been held or planned in many cases. The lead authors, major topics, and activities of each section are summarized below.

SECTION 1. Greenhouse Gases and Other Forcing Agents

Lead Authors: Watson (USA), Siegenthaler (Switzerland), Oeschger (Switzerland), and Rodhe (Sweden).

Areas of Emphasis: Biospheric feedbacks of carbon dioxide and methane, anthropogenic aerosols as cloud condensation nuclei, and ecosystem flux measurements.

Liaison with Working Group 3: Emission scenarios and joint meeting (Bilthoven, 7 8 April 1989).

SECTION 2. Relative Importance of Climate Forcing Agencies

Lead Authors: Morcrette (France) and Ramanathan (USA).

Areas of Emphasis: Revised calculations of relative "greenhouse" role of gases (including potential substitutes for the fully halogenated chlorofluorocarbons).

SECTION 3. Processes and Modelling

Lead Authors: Cubasch (FRG) and Cess (USA).

Areas of Emphasis: Review of critical processes and details of models used for climate predictions.

Activities: Meeting of subgroup lead authors (New York, 15 May 1989). Next working meeting scheduled for October, 1989 (FRG).

SECTION 4. How Large are Potential Effects?

Lead Authors: Mitchell (UK), Tokioka (Japan), Manabe (USA), and Meleshko USSR).

Areas of Emphasis: Paleo-analog versus General Circulation Models as approaches to scaling effects, effects of critical feedbacks on uncertainties in prediction, and possible changes in extremes of climate.

Activities: Contributors meeting held (Amherst, 13 May 1989) and contributors workshop planned (Brisbane, December, 1989).

SECTION 5. Validation of Climate Models

Lead Authors: Gates (USA), Rowntree (UK), and Zeng (PRC).

Areas of Emphasis: Simulation of extremes, simulation of feedbacks, and response to anomalies.

SECTION 6. Transient Climate Change

Lead Authors: Schlesinger (USA) and Bryan (USA).

Areas of Emphasis: Use of simple transient models to investigate policy-related scenarios, examination of coupled atmosphere-ocean models regarding differences from equilibrium results, and effects of ocean circulation changers.

Activities: Contributors meeting (Amherst, 13 May 1989) and contributors workshop planned (Brisbane, December, 1989).

SECTION 7. Climate Observations

Lead Authors: Folland (USA), Karl (USA), Trenberth (USA), and Vinnikov (USSR).

Areas of Emphasis: Changes in frequencies of extremes, corrections in the temperature record, and cryosphere observations.

Activities: Lead authors meeting (Washington, March, 1989), contributors meeting (Amherst, 13 May 1989), and contributors workshop planned (29 November - 1 December 1989, United Kingdom).

SECTION 8. Comparison of Observations and Simulations

Lead Authors: Wigley (UK) and Barnett USA).

Areas of Emphasis: Natural variability, "greenhouse" signal detection, and climate sensitivity.

SECTION 9. Sea Level Rise

Lead Authors: Warrick (UK) and Oerlemans (Netherlands).

Areas of Emphasis: Estimation of contributions to sea level change and estimation of uncertainties.

Activities: Lead authors meeting (Utrecht, March 1989) and contributors workshop planned (Reading, September 1989).

SECTION 10. Effects on Ecosystems

Lead Authors: Mellilo (USA), Salati (Brazil), Sinha (India), and Woodward (UK).

Liaison with Working Group 2: Interaction at meetings (Birmingham, 21 April 1989 and Bracknell, 16 May 1989) and plans for scientific basis for impacts to be used in Working Group 2's report.

Relation to Policy

While the *Scientific Assessment of Climatic Change* will be a scientific document, its value to decisionmakers will be considerable. The reasons for this are severalfold:

o *It will be a strong single concise statement from the scientific community.*

In the *Assessment*, major representatives of the scientific community will speak at one time and one place regarding the knowns and unknowns of climate change, including global warming . Dissenting viewpoints and their biases will be stated clearly. The *Assessment* can, therefore, be a common reference point for decisionmakers, in contrast to sporadic and separate statements reflecting the opinions of individuals.

o *It will be an international scientific assessment.*

All nations would have a common basis of scientific input for their decision making, as opposed to only several national statements.

o *The scientific scope will be comprehensive.*

With the Assessment, decisionmakers will have available a single, homogeneous summary of the current scientific understanding of the whole climate change phenomenon, ranging from the causes of change to the physical and biological responses to that change. This is likely to be be more useful than separate reviews of components of the phenomenon done at different times and perhaps for different purposes.

o *Both natural and human-induced climate change will be considered.*

In contrast to considering only the potential perturbation of climate by human activities, the *Assessment* will place that predicted change in the context of the observed and predicted changes that are a natural part of the climate system. The

comparison of the two will afford immediate and straightforward insight into the significance of any predicted human-induced perturbations.

- *The focus on identifying gaps in the knowledge and quantifying uncertainties will aid risk analysis.*

The difference between (a) "The predicted range of possibilities is from X to Z" and (b) "The prediction is Y" is, with regard to decision making, a highly relevant difference, since the first statement explicitly reflects the existence of uncertainties in the prediction.

CORE MEMBERSHIP OF WORKING GROUPS

	WORKING GROUP I *	WORKING GROUP II *	WORKING GROUP III *
CHAIR	UK (Dr. Houghton)	USSR (Prof. Izrael)	USA
V/CHAIR	BRAZIL SENEGAL	AUSTRALIA JAPAN	CANADA CHINA MALTA NETHERLANDS ZIMBABWE
MEMBERS	CHINA FRG ITALY JAPAN DENMARK SWITZERLAND TANZANIA USA USSR KENYA	ALGERIA CANADA FINLAND INDIA ISRAEL MEXICO NEW ZEALAND NIGERIA[1] INDONESIA	AUSTRALIA BRAZIL GDR INDIA JAPAN SWEDEN UK USSR NORWAY FRANCE SAUDI ARABIA
EX OFFICIO	CHAIRMAN JSC[2] REP IGBP[3]	SAC[4]	

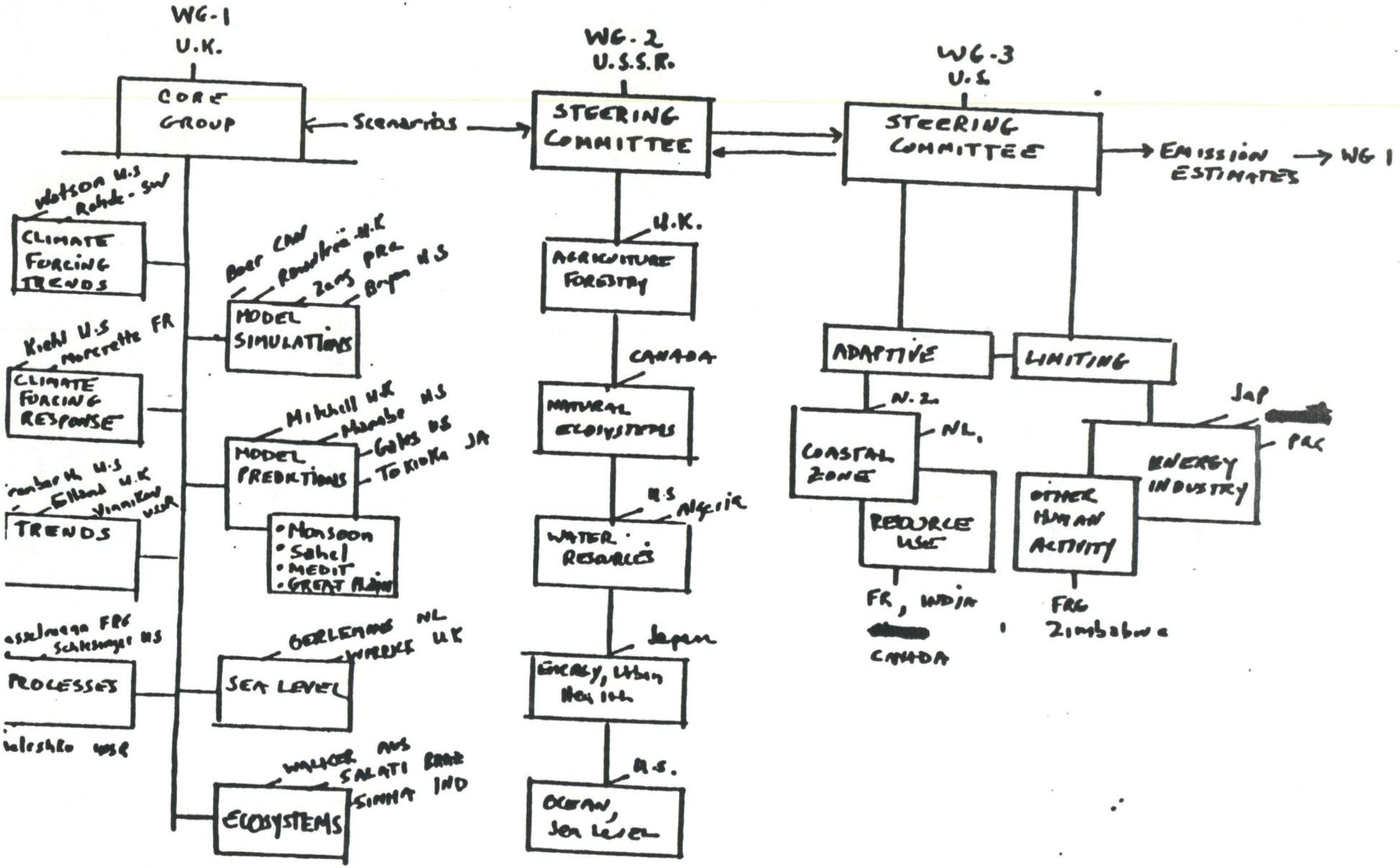
1) NIGERIA or another country from Africa

2) JSC - WMO/ICSU Joint Scientific Committee for the World Climate Research Programme

3) IGBP - ICSU International Geosphere-Biosphere Programme

4) SAC - Scientific Advisory Committee for the UNEP World Climate Impact Studies Programme

* The tasks assigned to Working Groups I, II and III are, respectively, assessment of available scientific information on climate change, assessment of environmental and socio-economic impacts of climate change and formulation of response strategies.



TESTIMONY OF
DR. DANIEL L. ALBRITTON
DIRECTOR, AERONOMY LABORATORY
ENVIRONMENTAL RESEARCH LABORATORIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON ENERGY AND POWER
COMMITTEE ON ENERGY AND COMMERCE
U.S. HOUSE OF REPRESENTATIVES

FEBRUARY 21, 1989

Mr. Chairman and Members of the Subcommittee:

My name is Dan Albritton. I am Director of NOAA's Aeronomy Laboratory in Boulder, Colorado, which studies the chemistry and dynamics of the Earth's atmosphere. I appreciate this opportunity to appear before your Subcommittee to discuss global warming.

As you requested, I will focus this summary on three topics: (1) the uncertainties in our scientific understanding of global warming, (2) the current efforts of the international scientific community to assess that state of knowledge, and (3) the highest-priority research that is needed in order to reduce those uncertainties.

I. SCIENTIFIC UNCERTAINTIES

Past and present research have provided an understanding of several aspects of the greenhouse effect, the warming of the Earth's atmosphere through the absorption of longwave radiation by certain gases like carbon dioxide. Some things are known with high certainty; others remain very poorly understood. This testimony will summarize this spectrum of knowledge and uncertainty, ranging from unequivocal increases in the atmospheric abundance of carbon dioxide (a "known") to the inability to predict the climatic consequences for a specific region and year (an "unknown"). The focus in this summary is on the most policy-relevant aspects, namely, those points relating to the following questions:

- What can cause climate change, particularly human activities that may influence change?

- What are the predicted changes associated with human influences, and how do they compare with natural variability?

- Have we seen any human-induced changes yet?

- What is the degree of confidence in current predictions?

The following summary is my personal interpretation of the current spectrum of viewpoints in the scientific community regarding the state of the science of the greenhouse effect.

A. Human-Influenced Climate Forcings

- Given current trends in emissions, a doubling of carbon dioxide in the next century, compared to pre-industrial levels, is virtually certain.

  The atmospheric abundance of carbon dioxide is increasing, in large part due to the combustion of fossil fuels by humans. All scientists are convinced of this. The future rate of increase will depend strongly on (1) technical developments, economic factors, and policy decisions which cannot be predicted in advance, and (2) the net uptake of carbon dioxide by vegetation and the oceans, the effect of which is still somewhat uncertain. Nevertheless, essentially all scientists agree that a doubling of carbon dioxide abundances will occur within the next century.

- The existence of other greenhouse gases is well known.

  Methane, chlorofluorocarbons (CFC's), ozone in the lower atmosphere, and nitrous oxide are also greenhouse gases. Their abundances are also increasing in the atmosphere. The reasons for these increases are only partially clear. The CFC's are industrially produced; however, the sources of the other gases are not as clear because the biological mechanisms for their emission characteristics are particularly ill-defined at present. While the future atmospheric abundances of these gases cannot be reliably predicted yet, it is clear that they will add to the greenhouse effect produced by carbon dioxide.

- Confidence is high in the understanding of the basic radiation physics of trace gases.

  The above mentioned gases act to reduce the loss of outgoing thermal radiation to space, thereby increasing the radiation back toward the surface of the planet. Thus, scientists are in solid agreement that the greenhouse gases increase the "thermal forcing" of the climate system.

B. Climate System Responses

- Most (but not all) climate scientists currently believe that the eventual response of the climate system to greenhouse forcing is likely to be, on the average, a global warming. While it is clear that current science can accurately calculate the thermal forcing of the atmosphere due to increases in the greenhouse gases, it is also clear that estimating the subsequent response of the climate system to that forcing is a much more difficult task. Several of the key processes which govern that response are quite complex, for example, the occurrence of clouds and their ability to reflect radiation. Many of these processes are so-called "feedbacks." An example is ice and snow which melt during warmer periods, exposing darker surfaces that absorb more radiation and add to the warming; hence, the warming is amplified. Other processes could involve negative feedbacks which would dampen the warming. It is the net effect of the interactions among all these processes, including positive and negative feedbacks, that determines the new equilibrium climate state that the planet will reach after an increase in radiative forcing by the greenhouse gases.

  Scientists have simulated this complex system with computer models and have used these models to estimate the consequences of a doubling of carbon dioxide. Based on those simulations, many scientists believe that an eventual global average warming in the range of 1-5 degrees Celsius is a reasonable estimate. Based on disagreements among models and different approaches to simulating nature, some scientists, however, caution that we have not identified and/or characterized all of the key processes; hence, the above uncertainty range may be optimistically large. If, however, a warming in the range of 1-5 degrees Celsius were to occur, it would be comparable to, or substantially larger than, the known temperature changes that have happened naturally in the past.

- There is a wide spectrum of opinion (and no consensus) on whether a greenhouse "signal" has already been seen.

  Current models predict that, due to the greenhouse gases already in the atmosphere, the global average surface warming should be in the range of 0.5 to 1 degree Celsius. Has that warming been seen in the temperature record? The answer is not clear. While the surface temperature record shows that there has been an increase of that magnitude over the past several decades, the pattern of that increase - one relatively rapid increase in the 1920's and another in the 1980's - does not match that predicted from models of the greenhouse effect, namely, a gradual increase in temperature. This suggests that our models may be incomplete, or that there are other, presumably natural, processes at work

that can influence temperature changes of a fraction of a degree Celsius. As a consequence, scientists are searching for a "signal" whose magnitude is likely to be comparable to the natural variations of the climate system, which is a challenging task indeed! Furthermore, the reliability of some of the temperature records, both global and regional, have been questioned, adding another complication. On a regional scale, for example, a recent analysis of about 100 years of temperature and precipitation records for about 6000 U.S. weather stations shows no statistically significant evidence of an overall increase in annual temperature or change in annual precipitation for the contiguous United States between 1895 and 1987 (Geophysical Research Letters, Vol. 16, No. 1, pages 49-52, January, 1989). Thus, for several reasons, the current differences of opinion among scientists as to whether the greenhouse warming has actually begun are substantial.

- Current models do not have the ability to predict the climate of a particular region or the climate of a given year. Other socially relevant climate variables, such as rainfall, are also difficult to estimate with climate models.

Those who construct climate models clearly state that models are not yet sufficiently realistic representations of the global system to yield reliable estimates of climate features on regional scales. Similarly, they cannot estimate the climate of a particular year. This means that the models cannot say whether the U.S. midwestern drought of 1988 was due to the greenhouse effect, nor can they predict the climate features of the next few years. However, many scientists do believe that the models can (and do) suggest that, because of the greenhouse effect, regional changes in climatic patterns, like the U.S. midwestern drought, would become more likely in coming decades.

II. STATE-OF-KNOWLEDGE ASSESSMENT

I would now like to summarize an assessment process that will undoubtedly be of great use to national and international efforts to evaluate and respond to potential changes in global climate. Namely, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) are sponsoring the Intergovernmental Panel on Climate Change (IPCC) to obtain an international, state-of-knowledge review of climate change.

A. Timetable and Content

The main features of this Scientific Assessment of Climatic Change are as follows:

- There are three companion WMO/UNEP assessments taking place: (1) science, (2) socio-economic impacts, and (3) policy options.

- They will be prepared internationally, with the following leaders: science - U.K.; socio-economic impacts - U.S.S.R; and policy options - U.S.A.

- The highlights of the process and schedule that the U.S. is following in their participation on the Science Working Group are the following:

  - The Committee on Earth Sciences (CES) charged Messrs. Albritton (NOAA) and Watson (NASA) to draft a plan for a scientific assessment which would provide the basis for U.S. involvement. (June, 1988)

  - Draft plan described to:
    -- CES (July, 1988)
    -- Ad Hoc Group of U.S. Scientific Experts (July, 1988)
    -- Domestic Policy Council Working Group (September, 1988)
    -- National Academy of Sciences (October, 1988)

  - Watson and Albritton, representing CES, met informally in London with the U.K. Chairman to discuss plans for the Science Assessment. (December, 1988)

  - The U.S. position and plans were completed. Albritton and Watson were named as (i) representatives of the interagency steering committee for IPCC and as (ii) the U.S. delegates on the IPCC Science Working Group. (January, 1989)

  - The Science Working Group met in Oxford, U.K. and established the plans for the Scientific Assessment. A summary report is available. (January, 1989)

- The main features of the Scientific Assessment of Climatic Change are the following:

  - It will be a peer-reviewed scientific document done by the best scientists available and submitted to the IPCC. It will be accompanied by a summary directed to government officials and suitable for IPCC release, to the private sector, and the public.

  - Its scope will be the full climate change phenomenon, namely: climate forcing agents, past climate record, processes involved in climate change, climate model formulation, tests of climate models, predictions of past and future climate, and physical and biological

responses to climate change.

- A special emphasis throughout will be an identification of gaps and knowledge and a better quantification of uncertainties.

o The timetable is brisk: lead authors will meet in early March, 1989; a draft will be available for review in December, 1989; lead authors and Science Working Group will examine the revised draft in April, 1990; and the Assessment will be provided to the IPCC in September, 1990 and to the Second World Climate Conference and the United Nations General Assembly in late 1990.

B. Relation to Policy

Of what value will this Assessment be to decision-makers? The answer is "considerable," but it may be useful to elaborate here on the fundamental reasons why this is true:

o It will be a strong single concise statement from the scientific community.

In the Assessment, major representatives of the scientific community will speak at one time regarding the knowns and unknowns of climate change, including global warming. Dissenting viewpoints and their biases will be clearly stated. This can be a common reference point for decision-makers, in contrast to sporadic and separate statements reflecting the opinions of individuals.

o It will be an international scientific statement.

All nations would have a common basis of scientific input for their decision-making, as opposed to several national statements.

o The scientific scope will be comprehensive.

With the Assessment, decision-makers will have available a single, homogeneous summary of the current scientific understanding of the whole climate change phenomenon, ranging from the causes of change to the physical and biological responses to that change. This is likely to be more useful than separate reviews of components of the phenomenon done at different times and perhaps for different purposes.

o Both natural and human-induced climate change will be considered.

In contrast to considering only the potential perturbation of climate by human activities, the Assessment will place that predicted change in the context of the observed and

predicted changes that are a natural part of the climate system. The comparison of the two will afford an immediate and straightforward insight into the significance of any predicted human-induced perturbations.

- The focus on identifying gaps and knowledge quantifying uncertainties will aid risk analysis.

The difference between (a) "The predicted range of possibilities is from X to Z." and (b) "The prediction is Y." is, with regard to decision-making, a highly relevant difference, since the first explicitly reflects the existence of uncertainties in the prediction.

III. RESEARCH NEEDS

While the Assessment will usefully summarize the current state of understanding, it is clear that key issues related to global warming need further elucidation. Therefore, it will prove to be crucially important over the coming years to continue to improve, test, and assess our understanding of the phenomenon, as embodied in numerical, climate-system models.

These models are, of course, only as good as the accuracy and completeness with which their components represent the relevant processes of the "real" world. Some of the shortcomings of our understanding of these processes are clear now, and hence, define some of the priority tasks that need research emphasis. Other required tasks are associated with establishing a better observational system that could not only provide additional input to the models, but also could serve as a means of detecting whether greenhouse warming is taking place. Resolving these shortcomings will require collaborative research among several disciplines, including atmospheric and biological sciences.

Some of the highest-priority needs are the following:

- Better characterization of the cloud feedback mechanisms, such as observations and theories that can relate the radiative effects of cloud-scale processes to planetary-scale processes.

- Identification of other significant feedback processes, such as biogenic emissions/cloud-formation interactions.

- Better experimental and theoretical understanding of the biological, chemical, and physical processes that control the emissions and uptake of the radiatively important trace gases other than carbon dioxide.

- Defining the trends of likely additional greenhouse molecules, such as lower-atmospheric ozone and stratospheric water vapor.

- Characterizing the trends and spatial variations of climate-sensitive properties, such as temperature and ozone, in the middle-to-upper stratosphere.

- Better global coverage of the observations of key response variables, such as surface temperature and albedo globally at oceanic locations and a better monitoring record of sea level.

- Establishing more accurate decadal trends in the radiative forcings, such as cloud cover, in order to develop and test improved models of key feedback systems.

- Improving the understanding (that is, the observations, process studies, and modeling) of major subcomponents of the climate system, such as the coupled ocean-atmosphere of the equatorial South Pacific, since these submodels are part of the basis of eventual global coupled models.

- Better characterization of the processes that determine the thermal inertia of the oceans, such as large-scale vertical motions.

- Improving the quality of, and learning to interpret better, the long-term record of past climate change in order to develop and test our century-scale models, as a means of validating models within the range of experience before using them under new conditions.

EPILOGUE

Global climate has often changed substantially and severely in the past. There is every reason to believe that such natural change will continue in the future. There is now the likely prospect that human activities will add to climate change in the future. There are two implications for us to consider. They both have separate, different, and equally important associated policy questions.

(1) Natural Variation: How do we accommodate it?

(2) Human-Induced Variation: Do we need to mend our ways?

Policymakers will be addressing both questions. Scientists must assist with both answers. Improved answers require a better understanding of the fundamental processes of the ocean/atmosphere climate system, which is a challenging task.

Nevertheless, the fundamental understanding of natural processes that relate to the well-being of mankind are almost always cost-effective. For example, comparison of the cost of a Salk/Sabin vaccine for polio to the economic and human costs of an iron lung teaches us what can be achieved when the cause of a thing is truly understood. Regarding our environment and what it means to us all, it is the price of ignorance that we cannot afford.

Mr. Chairman, this concludes my prepared remarks. I would be pleased to answer any questions that you or the members of the Subcommittee may have.

TAB C

GREENHOUSE POLICY AND CLIMATE UNCERTAINTY

Robert M. White
President
National Academy of Engineering

National Academy of Sciences
Annual Meeting
April 24, 1989
Washington, D.C.

Greenhouse Policy and Climate Uncertainty

1.0 INTRODUCTION

The global climate warming issue has now become an international scientific and political happening. It is difficult today to pick up a newspaper, or view television without encountering a story or an interview on the subject of global climate warming now familiarly embraced in the vernacular under the rubric of the "Greenhouse" effect.

No ideological or political boundary separates the calls to action. From General Secretary Gorbachev of the USSR to Prime Minister Margaret Thatcher of the U.K., from Prime Ministers Mulroney of Canada and Brundtland of Norway, calls for international action resound.

Last month representatives of twenty-three nations including many heads of state, gathered in the Hague at the urging of President Mitterand of France and other European

leaders and recommended that the United Nations be given supranational authority to regulate global activities regarded as the causes of the greenhouse problem.

Not to be outdone, in the bidding for international leadership on the issue, the United States through the pronouncements and actions of President Bush and Secretary of State Baker, is urging action on many international environmental fronts. The Congress is no less active. A half dozen new pieces of climate legislation are being considered.

Nor have the Academies of Sciences and Engineering been silent. Quite the contrary, we have been vocal and forward on the issue. For over a decade these Academies have conducted studies on global climate change, assessments that have buttressed the legitimacy of the concerns expressed by our political representatives. Most recently, as a result of legislation in the last Congress, the Academies have embarked on new studies of climate and

the underlying energy issues. In a move to place its views before the new Bush Administration, the Academies have issued a "white paper" on global change with broad policy recommendations.

The scientific community has identified an issue that lends itself to support by leaders everywhere---the mission of saving the habitability of the planet. It is a mission that now ranks in importance and political panache with saving the planet from nuclear destruction. And like the mission to save the planet from nuclear destruction, it raises politically divisive concerns as between the technologically advanced and developing nations.

How robust is the scientific basis for this grand outpouring of world concern? What are the policy directions that make sense in the light of the certainties and uncertainties in our knowledge? What are the policy problems that need resolution given the likely social and economic costs of action or the consequences of inaction?

My colleagues Bert Bolin and Steve Schneider have ably described the state of our knowledge of the forcing functions---those activities that cause the changes in the composition of the atmosphere---and the atmosphere's response to these changes---the ways in which the climate of the earth is projected to be altered as a result of such compositional changes.

As scientists and engineers we often eschew responsibility for policy decisions because they are laden with judgments balancing known facts, uncertain interpretation and social and economic costs more properly made in the political arena. Unfortunately we cannot totally escape that responsibility because those political judgments are shaped by the way we present our conclusions to those who have to formulate policy. We have it in our power to trigger political action unwarranted by data or scientific findings. Conversely, we can so allay real concerns that inaction results when action is desirable.

Whether we in the scientific community like it or not, we have awakened the political beast and those communities of scholars who revel in the challenge of public policy formulation and debate. The ability of the scientific community to influence actions recedes as groups are increasingly locked into policy positions.

The fact is that we grapple with an issue that is noisy in many dimensions. The climate record is noisy, as are the results of mathematical computations. Knowledge of likely impacts is speculative and the policy debate is informed with contradictory data and interpretations. Can we isolate the signals from the noise in all significant dimensions? That is our task. That is our obligation.

2.0 THE KNOWLEDGE BASE

Any soundly based policy actions must emerge from our knowledge of causes and effects and the uncertainties in that knowledge weighed against the risks, consequences and costs of action. We know much about the former and little

about the latter. Our knowledge of the likely causes is well documented. Our knowledge of the climate system response to these causes is extensive but frought with uncertainty. Our knowledge of the social and economic consequences is weak and speculative.

The concentrations of greenhouse gases have been accurately measured for over a quarter of a century in many parts of the world and they reveal inexorable increases. The CO_2 record of observations taken at the NOAA Mauna Loa Observatory in Hawaii is arguably the most important geophysical record in this century. We know much about causes of changing atmosphere composition---the burning of fossil fuels, the industrial production of CFC's and the agricultural production of nitrous oxides. We know less about others, the sources of the increases in methane for example.

We can assess the climate system response in two ways. We can simulate the system with mathematical models and

examine the range of responses to the known and projected forcing functions. We can also examine the actual climatic record. Mathematical models developed by many groups in the U.S. and abroad yield the basic projections on which our concerns are principally based. As Steve Schneider has described, they yield projections of global average surface temperature increases ranging from 2^{o}-5^{o}C since the turn of the century with greater increases in polar regions for a doubling of greenhouse gas concentrations sometime after the middle of the next century. The models do not portray regional and local effects well.

The models are approximations to the real world and their simulation of natural physical processes is well known to generate considerable uncertainties in the results, especially as they reproduce critical feedback processes.

Our confidence in the mathematical models is based on their ability to reproduce the seasonal variations of

climate, the general reasonableness of the manner in which climatic factors are portrayed, and the consistency of results. Some question whether our confidence in the output of these models is well placed given the uncertainties. Yet there is a preponderance of views among those who have worked the problem, that a large measure of confidence is warranted but that the uncertainties are troubling and need much attention.

What about the system response as deduced from the observational record? Does the observational system response support the theoretical response calculations and does the response evidence any systematic changes in climate.

It is well documented that climate is observed to fluctuate on all time and space scales. Drought and wet climates have been the perennial scourge of mankind. For the past century in which humanity's introduction of greenhouse gases into the atmosphere has increased greatly,

the instrumental record is equivocal. It is a noisy record affected by the sampling of the global atmosphere through a network of observations established for other reasons---principally weather forecasting. It is affected by the accuracy and representativeness of the observations. It is also affected by external factors such as urban growth which produces real, but climatically artificial local and regional temperature readings. Such data reveal that global average surface temperatures have had a roller coaster history. During the period 1900 to 1940 temperatures increased, cooled during the period 1940 to 1965 and have increased again from 1965 to 1988.

Over land areas of the United States where we have the richest and probably most reliable data, there has been no detectable increase in temperature since the turn of the century. This could be a sampling problem. The U.S. may be unrepresentative of the global average temperature. For the globe, the data pool presents sampling difficulties

also. Over many parts of the less developed world, the tropics, and the oceans, data are of poor quality, sparse and may be unrepresentative. The best analyses of such data reveal a net increase of about 0.5°C over the past century. This net temperature change is consistent with the lower end of the projections from the mathematical models but could also be a natural phenomenon. Recent findings of the effects of urban growth suggest that this increase may be an overestimate.

But, there are puzzling features of the observed global climate record. For example, temperature increases, largely attributable to the records from tropical and ocean areas, are not consistent with model projections that the largest temperature increases should occur in polar regions.

Is it too early to extract the signal from the noise of the record? Many would argue, yes. Others would argue that a century during which the CO_2 content of the

atmosphere has increased some 25% should have revealed a clear signal by now. Those who argue that the global temperatures of the past five years, the warmest in the instrumental record, signal the onset of the greenhouse climate could have come to an analogous conclusion during the drought of the thirties. However, they would have encountered the systematic cooling during the mid-century years, which incidentally gave rise at that time to predictions by some of a new ice age. In my view, the jury is out.

We are confronted with an inverted pyramid of knowledge: A huge and growing mass of proposals for policy action is balanced upon a handful of real facts. Data on likely causes are robust, though future emission projections vary widely. Projections based upon mathematical approximations of atmospheric and oceanic conditions are credible but uncertain. Evidence from the climatic data is equivocal.

Policy actions must reflect the risk of serious social and economic consequences of climatic change. They could be severe but are in the realm of informed speculation. Most of our information is analogue or scenario based. We know a great deal about the effect of weather and climate on agriculture, water resources, forestry and other economic functions from extensive study of the effects of droughts or heat waves or severe winters. We know the devastating ramifications for economic and social conditions---witness the effects of the droughts of the Sahel in Africa in recent years, and the drought of last summer on the midwest of the U.S. Such analogue information is sound and extrapolable. It is the scenario based information that is speculative. By scenario I refer to the "what if" studies. These studies are useful if they are considered for what they do---provide a range of possibilities. But frequently they are interpreted as forecasts. It is here that the apocalyptic nature of

outcomes emerges and penetrates the political consciousness through news stories about imminent global catastrophe.

If our model projections are correct we can say some interesting things. For example, we can expect an increase in sea level and recent observations seem consistent with this projection. If sea level rises we can be reasonably certain that coastal areas will be affected with saline intrusions and increased coastal erosion. On the other hand we cannot say much about local and regional effects of temperature and precipitation changes and their specific local effects on agriculture, water resource, and ecological and economic systems. There would be effects on agriculture but we're not quite sure what they would be and whether they might be acceptable or even beneficial. Increased carbon dioxide content of the atmosphere favors increased photosynthesis and crop growth. There would be effects on storm tracks, probably moving them toward the poles, a result of the reduced pole to equator temperature

gradients. Precipitation belts would likely migrate to more polar latitudes with consequences for agriculture and water resources in the U.S. southwest. There would be effects on natural ecosystems and their resiliency would depend upon the rate of change of climatic temperatures and precipitation. But it is impossible to be specific beyond such generalization.

3.0 POLICY PRINCIPLES

And so we find ourselves in a classic dilemma of policy formulation. Possibly severe but unknown levels of risk of undesirable consequences of climatic change in the face of great uncertainty about causes, costs and consequences. The dilemma is compounded because the consequences will be visited on future generations and unevenly through the redistribution of global climatic resources. Policy principles in such a situation would suggest;

o Investment in improving the information base to reduce uncertainties so that policy actions could be based on improved understanding.

o Adoption of policies that address causes and predicted consequences in such a way that future options are not foreclosed if projections turn out to be incorrect, and which may be desirable for other environmental and economic reasons. Insurance policies if you wish.

The policy framework would have to recognize the inherent international nature of the issue; its potential divisiveness as between developed and developing nations; the considerable social and economic costs attendant on significant actions; and the absence of institutions on the international scene in a position to formulate and implement necessary policies. Let us examine the policy issues and see what conclusions they lead to.

Improving the information base to reduce uncertainties in our data, in our projections and in the understanding of

consequences would seem to be a sine qua non. These actions are not costly, do not preclude future policy options and can sharpen policy decisions. This means investment in improved understanding of physical processes so that they can be modelled more accurately, intensified examination of climate data bases, improved assessments of projected emission rates of greenhouse gases, and improved space and ground based monitoring systems. Programs to achieve some of these objectives have been formulated in President Bush's proposed "Global Change Initiative" and it is expected that strong support will be forthcoming from the Congress. The World Climate Research Program of the World Meteorological Organization and the International Geosphere-Biosphere Program of the International Council of Scientific Unions are underway and receiving widespread international support. The first international intergovernmental forum has been established to examine the full range of climate problems including the possibilities

for national and international responses under the aegis of the World Meteorological Organization and the United Nations Environmental Program.

The really controversial policy issues surround the possibilities for intervention in the climate change process. Can we arrest or slow the processes that increase the concentrations of greenhouse gases? The answer is yes. But we have no grasp on the social and economic ramifications of intervention. We have a reasonable grip on the sources and amounts of emissions. We have a reasonable grasp on the reductions in emissions that would be necessary to constrain the global temperature increase.

The possible courses of policy action are in a sense obvious, and they relate largely to the production, distribution and end use of energy. If fossil fuels use is the principal culprit in the CO_2 buildup, policies should be directed to the use of the least polluting fossil fuels; the reduction in use of all fossil fuels; and development

and use of non-fossil energy sources. In practical terms we must shift from coal to oil to natural gas; undertake major efforts to increase energy efficiency; develop and deploy passively safe and publicly acceptable nuclear power as well as other non-fossil energy sources.

Energy policy actions have great leverage because they also address a broad set of environmental issues. Most environmental problems are interrelated through their physics, chemistry and biology and have common causes. Thus certain policies will have multiple environmental leverage. For example, the problems of acid rain, global warming and local air pollution are largely energy based environmental problems, generated by the use of fossil fuels.

Energy policies that move the national energy system toward energy efficiency also serve many other national objectives: the lessening of dependence on foreign sources of oil, thus achieving a greater measure of energy

independence; reduction of the energy component of the trade deficit; and increasing industrial competitiveness to the extent that energy efficiency can lower costs of production.

It is in the implementation of policies that the issues are joined. It is here that we finally address the economic and social consequences and the hard questions of who pays, who is affected, at what costs and with what societal disruptions. In the case of the greenhouse problem, we are forced to address the fundamental activities of society that relate to economic growth, the production of food and the sources of energy. We are talking about changing the global energy and agricultural systems to say nothing of the implications for global population growth.

Recently the EPA issued a most useful report in response to a Congressional request on options for "stabilizing" the greenhouse gas concentrations in the

atmosphere. A sampling of some of their proposals indicates the pervasiveness of the measures that need to be considered. The social and economic costs were not assessed. Raise average gasoline mileage of new cars to 50 mpg---a doubling of present fleet mileage. Impose fuel emission fees to reflect full social costs of abut $30/ton of coal and $3.00 barrel of oil. Launch major reforestation programs. Phase out CFCs.

Ultimately if the climate warming is to be prevented other forms of intervention in the world energy structure will be required. The logical direction for policy is to encourage the development and use of non-fossil energy sources. Science, engineering and technology offer the promise of alternative energy sources---nuclear and other alternative forms of energy. Today the problems of public acceptability of nuclear power are severe. Concerns about nuclear power plant safety and the disposal of radioactive wastes dominate any concerns about the greenhouse problem.

But research on passively safe reactors has been underway for years and it appears that commercially useful passively safe reactors are on the horizon.

The world must face up to the fact that within the bounds of current technological knowledge there may be no way out of the greenhouse problem without some recourse to the nuclear option. Other forms of non-fossil energy have become more promising as the years have passed. There is new promise in photovoltaics with efficiency increases up to 30% in recent experiments. And biomass as source of energy can be further emphasized. Policy options aimed at other causes of increasing greenhouse gas concentrations such as the release of CFCs and deforestation present their own politically divisive features. The tropical deforestation issue confronts us with the conflict between economic development and environmental protection in a direct way. Mankind has traditionally used the environment for economic growth and mankind's track record is poor. We

in the United States have polluted our rivers, destroyed our wildlife and replaced our forests with farms. We continue to overuse the last of our natural rain forests in the northwest for economic gain.

Now, recognizing the global consequences of the destruction of forests we call upon other nations emerging from economic penury to arrest their development to protect the global environment. Is it any wonder that countries like Brazil or India or China perceive our proposals as hypocritical? Nobody has yet advanced a workable proposal but many have been suggested. The swap of foreign debt for the preservation of tropical forests is an interesting proposal, but who will pay?

The issue of economic development and environmental protection arose only last month in London at a conference called by Prime Minister Margaret Thatcher to phase out the production of CFCs. China, India and other nations refused to submerge their need for CFCs and associated economic

development to the global interest in environmental protection. If we are to be serious about international action, a global bargain will be necessary. But what kind of global bargain makes sense?

The divisive nature of the issue is also evident in the suggestion that we shift from fossil fuels such as coal to other kinds of fossil fuels such as oil and gas. But what of countries like China whose energy future is dependent on their large supplies of coal? The recent U.N. report, Our Common Future, (1987) on economic development and the environment carried the message on the necessary global bargain clearly. Global environmental protection will only be resolved in the context of the economic development of less prosperous nations.

If we cannot arrest the processes of climate change then we will need to adapt to them. And adaptation policies also need to be those that will foreclose least on future options. It seems wise that we introduce into our

long range planning for our coastal areas the possibility of a sea level rise of the order of a half meter over the next fifty years. Water resource planning must take into account the possibility that the climatic regimes of the future will be different and water resource infrastructures and management techniques will have to incorporate a flexibility not inherent in present planning. Planning for agricultural adjustment will need to take advantage of genetic engineering of plants and animals so that they can be more tolerant of environmental extremes.

Perhaps, however, the policy approaches to the climate warming issue which we seem to be taking are inappropriate to the problem. We are dealing with intergenerational matters where the consequences of action taken by one generation are visited on another. Nor do we have guidelines for developing policies in the face of uncertainties of the scope involved in the climate problem. We address a problem in which knowledge and information are

being continually refreshed by new findings and interpretations, and our assessment of risk and uncertainties are continually changing.

Robert Lind of Cornell has suggested that we should not think in terms of choosing a static "best policy", but think in terms of strategies and sets of options. We should think in terms of a continuous policy process where we periodically reassess our responses in light of new findings and information. In such a policy approach the design of research and information gathering projections must become an integral part of the policy process.

This view suggests that what we might do is establish continuing mechanisms and processes that periodically, say every three or five years that would be charged with performing an evaluation of the state of our knowledge about the science and the implications of various policy options. Through this process, recommendations for changes in policies and in areas of scientific investigation would

emerge. In this way by a series of incremental policy steps, policy would be kept in lockstep with knowledge.

In the end scientists and engineers must accept the responsibility for having triggered a worldwide movement which may result in policies of a pervasive nature affecting all humanity. Each of us is responsible for representing the extent of our knowledge and accompanying uncertainties so that there is a balance between optimism and catastrophism. Each of us can make headlines any day by projecting or intimating that mankind faces a global catastrophe.

We have sufficient experience to know that controversy makes headlines and those not as familiar with the scientific uncertainties take us at our word. Our pronouncements will be excerpted to suit the needs of an exciting story. We need to make sure that the uncertainties in our knowledge are well understood and that there are risks in action as well as in inaction. We need

to be true to ourselves and our work as well as to the humanity we serve.

Let us not confuse selected observations with representative samples. Let us not confuse scenarios with predictions. Let us not confuse short term fluctuations with long term implications. Above all let us not confuse our friends and colleagues who must make the political decisions that will ensure the habitability of this planet.

Thank you.

4/19/89-3NAS

T
A
B

D

U.S. INTERNATIONAL POSTURE ON CLIMATE CHANGE

A Discussion Paper

Prepared for

the Advisory Committee

to the Department of State

Bureau of Oceans and

International Environmental and Scientific Affairs

October 31, 1988

U.S. International Posture on Climate Change Issues

At the request of Frederick M. Bernthal, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, a working group of the OES Advisory Committee met to examine elements of the U.S. international posture on greenhouse/climate issues. Members of the working group were Robert M. White (Chairman), Jessica Mathews, Christian Herter, Jr., Gordon J. MacDonald, William Nierenberg, and Herman Pollack. Our views are presented below:

STATE OF SCIENTIFIC KNOWLEDGE

Policies and programs to be advanced by the United States in international forums should be based on the current state of scientific knowledge. Numerous scientific assessments have been carried out both domestically and internationally. It is our view that the U.S. accept as a basis for policy determination now, the "basic scientific understanding" as outlined in the 1985 Villach International Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases (Text appended.) This assessment was prepared under the sponsorship of the World Meteorological Organization (WMO), the United Nations Environment Program (UNEP), and the International Council of Scientific Unions (ICSU). The summary of that report's

scientific assessment is attached. This assessment is a reasonable appraisal of the present state of scientific knowledge. Other scientific appraisals prepared by the NAS/NAE/National Research Council and by the Scientific Committee on Problems of the Environment yield similar conclusions but differ in details. U.S. policy determination should of course be reviewed as new assessments are made.

MONITORING, RESEARCH AND ASSESSMENT

The United States should exercise leadership in stimulating the organization of international programs to advance research, monitoring and assessment activities on problems of climate change. A useful first step would be to urge that an inventory of work related to climate change in all countries be prepared to identify the scope of the present international effort and lay the basis for future programmatic efforts. Within the United States we understand that such an inventory is being prepared by the Committee on Earth Sciences of the Federal Coordinating Council on Science Engineering and Technology (FCCSET).

While monitoring, research, and assessment of many different kinds will be needed, we have identified a number of areas which we believe should have priority in international efforts to improve our understanding of the greenhouse/climate problem.

a) Signal/Noise Issue

It is crucial that international agreement be reached on the extent to which the observations of global surface temperature increases during the past century and increases in sea level are the result of natural fluctuations or due to the effects of increasing concentrations of greenhouse gases. Analyses of global temperature data by Hansen, earlier by Wigley, and still earlier by Mitchel, indicate that global temperature increases are consistent with the hypothesis that increasing concentrations of greenhouse gases are causing an anomalous increase in global temperature. Because of the central importance of such a conclusion to further policy and program formulation, and because of the uncertain representativeness of some observational data, we urge a review of the data and analyses of the temperature records of the past century under international auspices. Such an assessment should be undertaken at a qualified center or centers such as the National Center for Atmospheric Research. We recommend that the U.S. offer to have the National Center for Atmospheric Research in Boulder, Colorado undertake such a study under the auspices of an international steering committee, possibly in cooperation with other qualified centers. These analyses should also examine sources of corroborating data such as data on subsurface temperatures

in permafrost. It is important that outstanding independent statisticians be involved in this effort.

b) Monitoring

We strongly recommend that the U.S. urge the establishment in appropriate countries of monitoring systems and other means that would provide more accurate and representative data on emissions, and concentrations of greenhouse and related gases (carbon monoxide, oxygen, etc.) and other geospheric and biospheric parameters over long periods of time. Such monitoring systems would provide the essential data, on the basis of which, changes in planetary environmental conditions could be confirmed. Space and other technologies now place such capabilities within reach, although emissions in some cases will need to be calculated from surrogate data such as data on fossil fuel use and agricultural production. The many proposals for such monitoring systems include the planned 1990 FAO Forest Assessment Program and the space monitoring systems proposed in NASA's Earth Systems Science program. Support for these and other monitoring efforts will be important.

c) Mathematical Modeling

Mathematical models of the atmosphere represent the only way the effects of greenhouse gases on climate can be simulated. It is therefore important that such models

simulate atmospheric, oceanic and other changes with great fidelity. Further research is required to achieve this goal. Present mathematical models are deficient in accounting for exchange processes between the atmosphere, on one side and boundary surfaces of the solid earth, the oceans, and the biosphere on the other. They are also deficient in simulating hydrologic processes. They do not at present predict finer scale regional changes with great accuracy. Nor do they provide data on the statistical properties of weather in an altered climate regime. Since many economic losses are associated with extreme events, the development of appropriate models is an important task. For these reasons we recommend that a program of research addressing mathematical model deficiencies be undertaken now and be strongly supported.

d) Assessments of Climate Effects

It is important to support continued studies of the potential effects of climate changes on societal activities such as agriculture, water resources, coastal habitability, etc. The United States should encourage such climate assessments in all countries, by regional groups, and by international organizations. It is important that these climatic effects address the social and economic consequences so that the costs of remedial actions can be judged against the costs of adaptation or inaction. In

this connection it will be important to consult with appropriate industrial groups such as utilities, energy and chemical companies as well as independent research groups in universities and other institutions. We noted the complexity of the interactions of the effects of the recent drought in the United States and suggest that integrated regional studies analyzing the complexity of the effects on all functions in a region may be helpful. The U.S. should encourage such analyses by competent bodies throughout the world such as the OECD, and other international organizations.

POLICY ISSUES

Considering the present state of scientific knowledge we suggest that the U.S. government adopt the following policy posture.

a) Although there are other factors that must be considered, we agreed that the climate change issue is primarily a global energy policy issue. In light of the present state of scientific knowledge, we recommend that the U.S. government advocate a prudent set of energy options that: (1) favor lower CO_2 emissions, (2) would be desirable for other environmental and economic reasons; and (3) would not foreclose future options that might be desirable in the light of improved understanding. The U.S.

government should take the strong position that increased international attention be directed toward improved energy efficiency and that research, development, and application of high energy efficiency technologies be pursued. This is a direct and immediate way to reduce fossil fuel consumption, thus reducing the emissions of carbon dioxide and some other greenhouse gases such as nitrous oxide and methane. Such a course would also have beneficial effects on other environmental problems such as acid deposition. It should advocate the use wherever economically feasible of fossil fuels that yield the least carbon dioxide per thermal unit. Where economically advantageous, natural gas will be the fuel of choice. The U.S. should further recognize that ultimately non-fossil energy sources, including nuclear, solar, and biological will need to comprise a larger fraction of world energy production and consumption. We urge that increased research on alternative energy systems be strongly supported. Most of us believe that the nuclear energy option needs to be revisited and steps taken to investigate inherently safe and publicly acceptable nuclear power systems. We also note the progress made in solar photovoltaic energy efficiency, and urge support for the further development of this option.

We believe it important to recognize that small reductions on the order of 10-20% in the atmospheric CO_2

emission rates will not have large effects on predicted global temperature increases because of the long residence time of carbon dioxide in the atmosphere. However, it was recognized that any slowing of the rate of increase of temperature would be beneficial, to the extent that further time will be available for adoption of various options.

We discussed proposals for quantitative reductions in the CO_2 emissions to the atmosphere, such as those proposed at the recent Toronto Conference where a 20% reduction in CO_2 loading by the year 2000 was advocated. We agree that it is premature to set quantitative goals for CO_2 reduction at the present time because of present scientific uncertainties and a lack of understanding of the full economic and social consequences and how such a goal would be achieved. However, we urge that the U.S. advocate that each country explore how each can reduce its CO2 emissions. Discussions on feasible goals and methods of obtaining them would be useful.

The U.S. government should recommend that governments and international organizations assess the implications of various energy options. It is likely that global energy policy deliberations will be divisive between advanced and developing countries. The U.S. position on international energy policy issues will need to take the political consequences of its positions fully into account.

c) Trace Gases

Other greenhouse gases contribute significantly to the climatic warming. Reductions in Chloro-fluorocarbons (CFCs) have been successfully addressed by international treaty in the Montreal Protocols. Because CFCs also represent a greenhouse gas, we agree that the U.S. should seek a complete phase out of CFCs on a reasonable time scale.

d) International Action

The United States might exercise leadership in urging international action through a presidential statement or appearance at the United Nations. The issue should also be raised in all pertinent international forums, such as the Economic Summits, NATO Foreign Ministers meetings, OECD Ministerial conferences, etc. to familiarize the world's political and economic leadership with the problem and through them raise the world's consciousness about the climate issue. We note that presidential candidates of both parties have declared that they will call an international meeting to address the climate issue.

INTERNATIONAL ARRANGEMENTS

a) International action on climate change requires international organizations capable of effectively addressing the multiple aspects of the problem. The

climate change issue is very broad and complex, extending beyond the purview of any existing intergovernmental organization. The WMO working with ICSU should remain the central U.N. technical agency on climate change matters working closely with other technical agencies, including UNEP, FAO, and UNESCO in their fields of specialization. However, the WMO and other technical agencies are not appropriate forums to address broad policy responses. At the present time the United Nations' Environmental Program is the only existing agency with sufficient scope to address the policy aspects of the climate problem. Some of us felt that UNEP could not adequately discharge these functions. Others felt strongly that UNEP has a successful track record in arriving at international agreements on environmental problems and could serve as the focal U.N. agency for policy matters. We also discussed the possibility of the establishment of a new U.N. council on climate change, analogous to the Outer Space Committee of the United Nations which could have the breadth of purview necessary to deal with climate policy issues. Careful study should be given to the many possible organizational arrangements.

b) We examined the desirability of U.S. government participation in the preparation of a convention on climate. We came to the conclusion that it is premature to

consider a climate convention. The economic, political, and social consequences are not well enough known and the uncertainties of current scientific knowledge are too great. Some of us felt that the U.S. should be willing to seek international exploration of principles that might serve as guides for national activities and at a later date, when sufficient knowledge of consequences are available, be the basis of a future convention. Others felt that a "framework" convention might be explored which would by international agreement establish a set of principles which could serve as a basis for a more specific convention.

STATE DEPARTMENT ACTIONS

There are some actions wholly within the authority of the Department of State that should be undertaken:

1. AID programs should encourage energy efficiency and conservation, emphasizing economic benefits while achieving some small steps toward CO_2 reduction.
2. The Department should stimulate a broad international educational and consultative process at both technical and political levels to acquaint leaders in all countries with the nature of the climate issues.
3. The Department should establish a process for further education of members of the Foreign Service through programs at the Foreign Service Institute, newsletters

and ambassadorial briefings on the nature of the climate issue and current USG national and international efforts.

4. Finally, the Department should undertake a review of existing treaties and international agreements that bear some analogy to the greenhouse issue. Although climate change is very different from other treaty issues and will undoubtedly require new approaches, we believe it would be helpful if previous precedents were well understood for their applicability to the climate issue.

OES-11/3/88

FROM
CONFERENCE STATEMENT

INTERNATIONAL ASSESSMENT OF THE ROLE OF CARBON DIOXIDE AND OF OTHER GREENHOUSE GASES IN CLIMATE VARIATIONS AND ASSOCIATED IMPACTS

Sponsored by UNEP/WMO/ICSU

VILLACH, AUSTRIA, 9-15 October 1985

These conclusions are based on the following consensus of current basic scientific understanding:

- The amounts of some trace gases in the troposphere, notably carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), ozone (O_3) and chloro-fluorocarbons (CFC) are increasing. These gases are essentially transparent to incoming short-wave solar radiation but they absorb and emit longwave radiation and are thus able to influence the Earth's climate.

- The role of greenhouse gases other than CO_2 in changing the climate is already about as important as that of CO_2. If present trends continue, the combined concentrations of atmospheric CO_2 and other greenhouse gases would be radiatively equivalent to a doubling of CO_2 from pre-industrial levels possibly as early as the 2030s.

- The most advanced experiments with general circulation models of the climatic system show increases of the global mean equilibrium surface temperature for a doubling of the atmospheric CO_2 concentration, or equivalent, of between 1.5 and 4.5°C. Because of the complexity of the climatic system and the imperfections of the models, particularly with respect to ocean-atmosphere interactions and clouds, values outside this range cannot be excluded. The realization of such changes will be slowed by the inertia of the oceans; the delay in reaching the mean equilibrium temperatures corresponding to doubled greenhouse gas concentrations is expected to be a matter of decades.

- While other factors such as aerosol concentrations, changes in solar energy input, and changes in vegetation may also influence climate, the greenhouse gases are likely to be the most important cause of climate change over the next century.

- Regional scale changes in climate have not yet been modelled with confidence. However, regional differences from the global averages show that warming may be greater in high latitudes during late autumn

and winter than in the tropics; annual mean runoff may increase in high latitudes; and summer dryness may become more frequent over the continents at middle latitude in the Northern Hemisphere. In tropical regions, temperature increases are expected to be smaller than the average global rise, but the effects on ecosystems and humans could have far reaching consequences. Potential evapotranspiration probably will increase throughout the tropics whereas in moist tropical regions convective rainfall could increase.

- It is estimated on the basis of observed changes since the beginning of this century, that global warming of 1.5°C to 4.5°C would lead to a sea-level rise of 20-140 centimeters. A sea level rise in the upper portion of this range would have major direct effects on coastal areas and estuaries. A significant melting of the West Antarctic ice sheet leading to a much larger rise in sea level, although possible at some future date, is not expected during the next century.

- Based on analyses of observational data, the estimated increase in global mean temperature during the last one hundred years of between 0.3 and 0.7°C is consistent with the projected temperature increase attributable to the observed increase in CO_2 and other greenhouse gases, although it cannot be ascribed in a scientifically rigorous manner to these factors alone.

- Based on evidence of effects of past climatic changes, there is little doubt that a future change in climate of the order of magnitude obtained from climate models for a doubling of the atmospheric CO_2 concentration could have profound effects on global ecosystems, agriculture, water resources and sea ice.