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Mr. file of other materials + all testimony from Boucher hearing

M E M O R A N D U M

DATE: 10/11/91

TO: Katie

FROM: Frank

SUBJECT: Subcommittee on Science Hearing 10/10/91

Panel 1: Dr. Robert McCormick Adams
Secretary, Smithsonian Institution

Summary: Dr. Adams: Not enough data for Gobal warming theory
At least 5-10 years more research
No immediate actions necessary
Co2 control is anti-free market

Dr. Adams challenged the Global Warming theory by insisting that there was not enough data available to support it. He did not disagree however with the observation that "the Greenhouse effect has indeed an effect". But there is, as he sees it, no proof that the temperature increase is related. He said that more money was needed for research.

After being questioned by Chairman Boucher, Dr. Adams emphasized that at least 5 - 10 years of research had to be done, before one could be assured that measures had to be taken (to reduce Co2 emissions).

When asked about Co2 reduction programms in Europe, Dr. Adams explained that Western Europe could not be seen as an example for the U.S. as the economies there were more controlled. Co2 control programms would collide with the spirit of freedom in the US and the free market economy. In addition to this, forced investments would weaken the economy.

The market economy argument was challenged by Rep. Thornton. He said that if the US had waited for the market to regulate itself we would still use crude oil as the sole, cheapest energy form.

Panel 2: Dr. Vicke Sutton
Assistant Director, Office of Science and Technology Policy

Dr. Robert Corell
Assistant Director, Geosciences Directorate
National Science Foundation

Dr. W. Franklin Harris
Executive Officer, Biological, Behavioral, and Social Sciences Directorate. National Science Foundation

see ms sutton's testimony

discussion:

rep. Boucher to NSF: 3.4 million out of 140 million budget goes to global climate change research: "why so little?"

harris: research mainly done by universities. also 3.4. million was highest budget increase within NSF

concerning international cooperation:

Sutton: provided through International Funding Agencies for Global Change Research (IGFA). meetings every 6 months for 3-4 days since summer 1990. 20 nations cooperate, including all G7 members.
US: largest global change research program in the world/inter-agency panel to avoid duplication of efforts.

volcano effect: will fewer people believe in GW theory because of possible cooling?
Harris: yes, but as an isolated incident it will have no effect on scientific community.

It was, all in all a very boring 2nd panel.

SUBCOMMITTEE ON SCIENCE

Hearings on
Priorities in Global Climate
Change Research

October 10, 1991 - 9:30 a.m. 2318 RHOB

WITNESS LIST

PANEL 1

Dr. Robert McCormick Adams
Secretary
Smithsonian Institution
Washington, DC

PANEL 2

Dr. Vickie Sutton
Assistant Director for
Federal Coordinating Council
for Science, Engineering, and Technology
Office of Science and Technology Policy
Washington, DC

Dr. Robert Corell
Assistant Director
Geosciences Directorate
National Science Foundation
Washington, DC

accompanied by:

Dr. W. Franklin Harris
Executive Officer
Biological, Behavioral, and Social
Sciences Directorate
National Science Foundation
Washington, DCFederal Coordinating Council

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

TESTIMONY OF

DR. VICKIE SUTTON

ASSISTANT DIRECTOR

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

EXECUTIVE OFFICE OF THE PRESIDENT

SUBCOMMITTEE ON SCIENCE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

OCTOBER 10, 1991

Thank you, Mr. Chairman. My name is Vickie Sutton. I am the Assistant Director of OSTP with primary responsibility for the activities of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET).

I appreciate the opportunity to appear before you today to discuss activities and functions of FCCSET, particularly as they relate to the Committee on Earth and Environmental Sciences (CEES). I will briefly outline this morning the overall FCCSET process, and then address CEES in the context of its roles and objectives.

BACKGROUND AND SCOPE OF FCCSET

The FCCSET considers problems and developments in the fields of science, engineering, technology, and related activities affecting more than one federal agency. It formulates options, recommends policies, and makes decisions to assist agencies to: (1) provide more effective integration, coordination, and planning for federal scientific, engineering, and technological programs; (2) identify research needs, including areas requiring additional emphasis; (3) achieve more effective utilization of the scientific, engineering, and technological resources and facilities of federal agencies; and (4) further international cooperation in science, engineering and technology.

The forum provided by FCCSET is a coming together of agencies to provide synergism, to minimize duplication of efforts, and to coordinate their respective program components in a more cost-effective manner on an ongoing basis. Over the past several years, FCCSET committees have devoted a substantial effort to the cross-cutting review of programs and budgets in selected areas, in close liaison with the Office of Management and Budget (OMB). However, its activities are not limited to these alone. FCCSET plays a major role in the non-budgetary aspects of science, engineering, and technology activities. Examples include the Ad Hoc Working Group on Risk Assessment, the Subcommittee on Megascience, and the Committee on Interagency Radiation Research and Policy Coordination. These groups, and others, survey programs, generate valuable recommendations, and produce reports and reference materials useful in coordinating federal activities in their respective disciplines.

The FCCSET meetings in this Administration have had excellent participation from the departments and agencies, with Cabinet secretaries and heads of independent agencies constituting the majority of those in attendance. The success of FCCSET is a tribute to the work of these agencies which have voluntarily supported this forum for coordinating U.S. science and technology programs and activities.

FCCSET STRUCTURE

I am particularly pleased to be able to discuss FCCSET with you today, because I believe FCCSET is beginning to function as it was originally intended to function. In recent years, Dr. Bromley has worked to reorganize and revitalize FCCSET and to elevate this forum by greatly increasing the participation of Cabinet secretaries in its activities. We continue to foresee a substantially enhanced role for FCCSET in the Executive Branch.

FCCSET's revitalization is reflected in the recent success that several FCCSET committees have had in coordinating cross-cutting areas of science and technology. For example, the Committee on Earth and Environmental Sciences (CEES) has taken all of the formerly disparate research being done by 11 federal agencies on the global environment and has organized it into the U.S. Global Change Research Program -- a coherent, government-wide approach to furthering the scientific understanding of global change. I believe we are all familiar with the success of CEES. This success has been a model for FCCSET to apply to many other important areas of science and technology.

FCCSET has formed seven committees to oversee broad areas of science and technology; each committee is chaired by a high-level official of a federal agency or department. Several subcommittees and working groups are active within each of these committees to examine, coordinate, and integrate federal activities in selected areas of science and technology. The seven committees are:

(1) Committee on Earth and Environmental Sciences (CEES), chaired by Dallas Peck, Director of the U.S. Geological Survey, Department of the Interior;

(2) Committee on Education and Human Resources (CEHR), chaired by James Watkins, Secretary of the Department of Energy;

(3) Committee on Food, Agriculture and Forest Research (CFAFR), chaired by the Assistant Secretary for Science and Education Administration, Department of Agriculture;

(4) Committee on International Science, Engineering and Technology (CISET), chaired by Reginald Bartholomew, Under Secretary for Security Assistance, Science and Technology of the Department of State;

(5) Committee on Life Sciences and Health (CLSH), chaired by James Mason, Assistant Secretary of the Department of Health and Human Services;

(6) Committee on Physical, Mathematical, and Engineering Sciences (PMES), chaired by Walter Massey, Director of the National Science Foundation; and

(7) Committee on Industry and Technology (CIT), chaired by Robert White, Under Secretary for Technology of the Department of Commerce.

As has been demonstrated in the case of CEES, these FCCSET committees can have a very substantial effect on the coordination of federal program content as well as on federal R&D budgets. Working through OSTP and OMB, FCCSET committees can review the components of cross-cutting programs, making it possible to consider the program as a whole, that is, as a coherent national activity rather than a collection of agency programs. In unprecedented fashion and in close collaboration, OSTP and OMB have developed the crosscut approach. Through this mechanism, the member agencies work together at all levels to review the distribution of federal funds and to ensure that the Administration's proposals to Congress represent the most efficient and effective allocation of those funds.

For FY 1993, five crosscuts have been initiated by OSTP and OMB and approved by FCCSET. Three of them are ongoing (Global Change Research, High Performance Computing and Communications, and Mathematics and Science Education), while two are new (Biotechnology and Advanced Materials) and are being prepared for consideration as components of the President's FY 1993 Budget.

When FCCSET committees identify policy issues that transcend internal science and technology matters and have substantial economic, political, international or other components, these issues are referred to the parent FCCSET council or to one of the other White House councils for resolution. In those very few cases where it may be found necessary, the issue will be taken to the President for his determination.

CEES

Let me then turn to the Committee on Earth and Environmental Sciences (CEES), one of the seven FCCSET committees. I would emphasize at the outset that each committee has its own structure and methods of operation; thus, significant differences among FCCSET committees do exist. All of the committees share, however, the common goal of helping to construct the best possible overall scientific or technological program for each dollar that the Congress is able to make available for the particular federal activity in question.

CEES is the oldest of the FCCSET committees and, in many ways, provided some of the momentum for revival of the FCCSET process itself. The purpose of CEES is to advise and assist FCCSET to increase the overall effectiveness and productivity of federal R&D efforts affecting two or more federal agencies directed toward an understanding of the Earth as a global system. As such, CEES addresses significant issues that cut across agency boundaries. In particular, CEES:

(a) reviews federal R&D programs in earth and environmental sciences, including both domestic and international programs;

(b) facilitates planning, coordination, and communication among federal agencies engaged in earth and environmental sciences R&D;

(c) identifies and recommends to FCCSET earth and environmental sciences R&D priorities;

(d) proposes and updates long-range plans for the overall federal R&D effort in earth and environmental sciences; and

(e) provides reviews, analyses, advice, and recommendations to the Chairman of FCCSET on federal policies and programs concerned with earth and environmental sciences R&D, particularly in assessing scientific data on humankind's impact on the global environment.

In carrying out these functions, CEES has developed a number of subcommittees and working groups to focus on specific issues. These include the Working Group on Global Change, which has helped to define an overarching and long-term goal for the U.S. Global Change Research Program. This goal is to establish the scientific basis for national and international policymaking relating to natural and human-induced changes in the global Earth system.

The following departments and agencies are represented on CEES and are essential participants in the U.S. Global Change Research Program:

Department of State
Department of Defense
Department of the Interior

Department of Agriculture
Department of Commerce
Department of Energy
Department of Transportation
Department of Health and Human Services
Department of Housing and Urban Development
Office of Management and Budget
Office of Science and Technology Policy
National Aeronautics and Space Administration
Environmental Protection Agency
National Science Foundation
Council on Environmental Quality
Nuclear Regulatory Commission
Smithsonian Institution
Tennessee Valley Authority

Other federal agencies participate in CEES activities, as appropriate.

These departments and agencies have worked through CEES to define carefully their respective roles in the Program. Generally, these roles fall into one of three categories:

(1) Agencies whose budget initiatives are focused on a particular aspect of global change research. These agencies include USDA, DOC, DOI, DOE, EPA, NASA, and NSF.

(2) Agencies who make contributions to the overall Program. These agencies provide support to many of the science elements, and their contributions are linked and coordinated at the project level. These projects provide important support to the objectives of the Program and are an integral part of the CEES effort. The DOD programs in oceanographic and atmospheric measurement are an example of this type of participation.

(3) Agencies and offices of the Executive Branch that contribute policy and coordination counsel and guidance to the Program. These agencies and offices are vital contributors to the architecture of the Program and are key vehicles for coordinating and linking the Program with overall national and international policy on global change. These include DOS, DOT, Council on Environmental Quality, OMB, OSTP, and the White House Office of Policy Development.

In addition to the interactions implied by these roles, the individual agencies and OMB operate along the lines of agreed terms of reference that guide the budget process for global change research.

CEES has also developed a multi-level priority-setting framework that is being used to focus and integrate program development and budget proposals through FY 1997. This framework contains three levels of priorities to be met in developing the U.S. Global Change Research Program. In the interest of time, I would refer the Subcommittee to the series of Our Changing Planet documents, which discuss the planning and

priority framework for the Program in greater detail. I would stress here, however, that the strategic, integrating, and scientific priorities are designed to ensure that the Program makes rapid progress toward resolving the most significant scientific uncertainties.

ASSESSMENT

CEES has been very effective in its task of pulling together a coherent national program for global change research, both in terms of financial investment and scientific focus. An unprecedented partnership has evolved not only among the agencies of the U.S. Government with global and regional environmental science responsibilities, but also with the scientific community, particularly with the U.S. National Academy of Sciences, and with international organizations, including the International Council of Scientific Unions.

CEES' work has been premised on the idea that a successful program demands an effective partnership between agency scientists and the academic research community -- a true partnership that takes advantage of the unique talents and special capabilities of each group at all levels in the planning, development, implementation, and evaluation of the Program. The CEES agencies are equally committed to maintaining the special partnership that has developed between CEES and the non-federal research community. CEES agencies have also pursued effective partnerships with private sector interests and representatives of the environmental community concerned with global change research issues.

OSTP and FCCSET, in particular, as the parent body for CEES, are committed to facilitating these interactions, as appropriate. A case in point is the establishment last year of the President's Council of Advisors on Science and Technology (PCAST), a group of 12 distinguished scientists and engineers, designed to provide greater input from the private sector. The activities of FCCSET and PCAST are coordinated informally through Dr. Bromley, who chairs both Councils, so that each benefits from the other's activities. For example, much of the work of PCAST is carried out through panels with extensive private sector representation which in many cases parallel the committee and subcommittee structure of FCCSET. This allows the concerns and activities of the private sector to be taken into account in the deliberations of FCCSET committees, including CEES, and it allows PCAST to be aware of relevant governmental plans and activities.

These internal and external partnerships are essential to ensuring that the activities of the Global Change Research Program are focused in critical areas to reduce uncertainty in both the scientific and economic assessment of global change.

I should note that the work of CEES is further enhanced by the FCCSET process because matters internal to science and technology are usually resolved within FCCSET by many of the same departments and agencies

that have helped design the Global Change Research Program and are most familiar with its requirements.

I am confident that FCCSET will continue to be an effective instrument in the shaping of federal science and technology programs and activities. The interdisciplinary planning and coordination provided by FCCSET will allow for more effective use of the scientific and technological resources of federal agencies. FCCSET will also continue to help develop and review, in close cooperation with OMB, annual and long-range federal budget plans in selected cross-cutting areas of science and technology.

Dr. Bromley has recently referred to CEES and the U.S. Global Change Research Program as legacies of this Administration. Dr. Bromley and the FCCSET staff are committed to maintaining a process that takes advantage of the expertise available in CEES and the other FCCSET committees and that provides, in return, an efficient mechanism for facilitating the implementation of truly national science and technology programs.

Thank you once again for the opportunity to report to the Subcommittee today. I look forward to working with all of you to ensure the continued success of our federal R&D efforts.

House Subcommittee on Science
Tuesday, October 8, 1991 9:30am HR2318
Hearing on Priorities in Global Climate Change Research

Notes on the hearing: Mari Margil

PANEL 1: Dr. Jerry D. Mahlman, Dr. Richard Lindzen, Dr. Ralph Cicerone

(conclusion of opening statements...)

Dr. Mahlman: Climate model efforts need to be improved. US global change research program is doing fairly well. Need long-term study and monitoring of these models.

Dr. Lindzen: **The conceptual possibility of global warming exists. The claim of excessive warming is without substantial evidence. Model problems, not reality, lead to and create the catastrophic global warming ideas that we have.

Gases do not necessarily increase temperature. Other reasons for increased temperature.

Water vapor and layer clouds are most important part of greenhouse effect. Models cannot predict layer clouds if do not have water vapor.

In absence of "positive feedbacks," doubling of carbon dioxide??? Positive feedbacks..collateral changes that will increase effect of carbon dioxide alone. Current feedback is water vapor. When temperature increases so is water vapor increasing. If no water vapor feedback, no model will show temperature increasing (perhaps up to 2 degrees C).

Water vapor most important in upper trophosphere. 12km up water vapor molecule is 1,000 times more important than one at ground level. Main greenhouse gas is water vapor molecule in upper trophosphere. We do not know the size, shape, nor make-up of this molecule. We know nothing about this. So no model can possibly explain global warming. No basis exixts to say a 1.5-5 degree C temperature increase is going to occur. Water vapor must be deeply studied. Cloud physics is essential.

Important to study past climate data. We must reconstruct past climate change to have something to compare to our current climate.

Dr. Cicerone: Chemicals related to greenhouse effect:

Methane over the past 160,000 years has been 0.3-0.4 parts per million. Amount lowest during glacial periods and highest during warmer periods. Amount is now double what it once was. Perhaps the atmosphere has been losing the ability to cleanse itself of methane.

Synthetic chemicals--CFCs, etc. CFC 11 and CFC 12 continue to be put in our atmosphere. Many questions still about OH in atmosphere. We do not know why nitrous oxide is increasing in the atmosphere.

Ozone in trophosphere. Water vapor in stratosphere should be increasing because of increased methane, but we do not know.

Negative forcing...sulfate particles block sunlight in Northern Hemisphere in polluted areas. Been going on for 30-50 years. Has sulfur pollution inadvertendly suppressed greenhouse gases? Negative climate forcing. Could 1970-1975 northern hemisphere cooling be due to sulfur dioxide?

We can slow climate change by decreasing carbon dioxide in the atmosphere, more research...

Chairman Boucher: Our purpose today: is there adequate US global change research?

Dr. Mahlman: Lack of intellect keeps us from moving ahead. Time is also a factor...process, modeling, observational science needs time for progress to be made. There is an international unwillingness to deal with this situation. Why? 1.cost 2.need international cooperation 3.big time commitment (50 years+) 4.countries do not want to face the reality of the situation.

Sufficient computer resources exist today, good funding for them. At the moment it is okay, but in 10-15 years we'll need 1,000 times present capability. Even if we had such capability today, we would not get the answers we need.

Data collection--not enough resources today. Prudent and focussed increases are necessary. We are underfunding monitoring, not computers.

Development of theory to model systems. Lack of human talent, need more graduate and post-graduate programs. Education needs to attract more people.

Dr. Lindzen: Universities today are getting more smaller grants for more specific projects. Scientists must make proposals all the time for funding. Funding structure doesn't lend itself to long-term efforts. Structural changes could save money.

Monitoring is not good. Example: monitor water vapor from above the trophosphere, not below as we currently do. Different methods should be used. Non-human piloted/flown planes to monitor water vapor. This would cost $1-2 billion dollars a year. This would be better than satellites.

Data analysis needs much more assistance.

Dr. Cicerone: "Process understanding," the question of why something is happening, is lacking in scientific study. Satellites are not the answer, aircraft is necessary. Need more money for these, the smaller items. Breakthroughs will come from medium-sized field programs, labs, aircrafts, ships. Too much federalization. "Big project" mentality not working.

Chairman Boucher: Current climate change models today...much unreliability? Should we trust them?

Dr. Lindzen: For purposes of global change, models are not useful policy tools.

Chairman Boucher: Research program today: how soon until reliable models and information will allow us to make informed policy choices?

Dr. Mahlman: 10 years. Once models get stronger, your questions will get tougher.

Dr. Lindzen: Decade.

Dr. Cicerone: 5-10 years. Need more general consensus and sharing internationally.

Mr. Gilchrest (Maryland): If we solve pollution problems such as acid rain and air pollution, will this possibly cure the greenhouse effect?

Dr. Mahlman: There is an indirect and weak connection. Combustion processes of nitric oxides is a connection, but generally there is no connection.

Dr. Cicerone: There is a strong connection between pollution and the greenhouse effect. Combustion is important with acid rain, fuels also contribute.

Dr. Lindzen: It has been suggested that increased sulfates cool the earth surface. Coal cumbustion produces sulfates. Pollution and environmental problems get confused with each other. Cleaner air and water probably will improve the earth's environment.

Mr. Gilchrest: It has been theorized that the sea level will rise up to 4 feet. Land sinking too. Why would sea level rise at all? Is there a connection to global warming?

Dr. Mahlman: Assuming world temperature increases, heat gets stored in the oceans, warming the water and expanding the ocean. We don't really know what is going to happen in this regard.

Dr. Lindzen: Sea level rising has nothing to do with global warming. Example, the building of La Guardia airport in New York, sank land and water level rose 1.5 feet. Techtonics and development often causes rise in sea level. Over last century, sea level rose, but very small amount. Greenhouse effect has had little effect.

Dr. Cicerone: Rise in sea level is usually due to glacial ice. Probably how sea level will rise in the future. But we really have no idea.

Mr. Dipetski (Oregon): With models, what is going on nationally and internationally?

Dr. Cicerone: Few people studying this, but all are talking the same language in regard to the models.

Mr. Dipetski: What to do about data and information collected, analyzing it, to share it, etc. What do we do with the huge amount of data?

Dr. Cicerone: Not much of a problem. Most new reports/findings go through journals, an essential first step. This takes time. NRC (National Research Council) reviews are also a good step. This also takes time, however. Info flow the above 2 ways.

Dr. Lindzen: Data is overwhelming, trouble accessing it. Much data lost/archived.

Mr. Dipetski: Are policy makers looking for specific answers and is this causing the problem with data?

Dr. Lindzen: With the space program, the public supports the preliminary excitement of the project. Yet, the process afterwards of collecting and analyzing data is not really understood or recognized or supported by the public. Public pressure is less that it should be on accessibility being necessary. However, this is improving.

Dr. Mahlman: Political biases do exist. Stakes high...global warming difficult quantatative problem. Need to make it more socially acceptable to analyze data and not just collect it.

Mr. Dipetski: Lawmakers cannot wait for models to improve and become more reliable. We need to make policies now. Do you scientists understand politicians' problems with this?

Dr. Mahlman: Sometimes a serious gap exists between scientists and Congress. Scientist's perspective: every decision you (Congress) makes is uncertain, this situation is not really any different than other policy questions.

Dr. Lindzen: There is no information right now that will allow the Congress to make advantageous judgments/policies.

Dr Cicerone: Specialization is necessary for these studies, we need to counterbalance this by realizing how it affects others. Encouraging signs to make Congress's job easier with more information.

Chairman Boucher: Are priorities of global change programs following old patterns, and are new priorities not being carried out?

Dr. Mahlman: No.

Dr. Lindzen: Yes.

Chairman Boucher: Is NSF pursuing new priorities as it should or just relabeling old programs?

Dr. Lindzen: NSF is pretty good at avoiding relabeling.

Dr. Cicerone: Others are relabeling old programs, but NSF is generally not.

Mr. Ritter (Pennsylvania): Dr. Mahlman, what steps should we take? Are models such that we are ready to make policy?

Dr. Mahlman: We must remember that uncertainty is a double-edged sword. Could go right or wrong. Models are uncertain.

Mr. Lindzen: Too many things we cannot access.

Dr. Cicerone: Yes, we can rely on models to a certain extent, but we must be careful. For example, energy conservation we know will be good no matter what.

Mr. Ritter: Urban Heat Island Effect?

Dr. Lindzen: Impact not great.

PANEL 2: Dr. Richard G. Richels, Dr. William D. Nordhaus, Dr. Harold K. Jacobson

(opening remarks...)

Dr. Richels: projecting future energy needs is difficult

Dr. Nordhaus: need more funding/$$

Dr. Jacobson: Social and behavioral research is essential. Human perceptions on global change will affect their behaviors. Need more funding.

Chairman Boucher: What about "industrial metabolism?"

Dr. Jacobson: Interaction of population dynamics with energy and source use.

Chairman Boucher: 1. Are focuses right in terms of social science research? 2. Is there enough money and is it properly allocated? 3. Are there enough people working on this, a large community of interest?

Dr. Richels: 1. Need to better balance the costs and benefits of what we do to the earth and her atmosphere.
2. Need more money, especially in benefits area.
3. Yes, enough people in the field.

Dr. Nordhaus: 1. Focussing through NSF leads to good fundamental research.
2. Need more money.
3. Community exists, it is small, but good.

Dr. Jacobson: 1. Focus is difficult to address.
2. Funding is terribly inadequate.
3. In developed countries enough people, but not enough in underdeveloped countries.

Mr. Gilchrest: Wouldn't we benefit from research about fuel efficiency and less gases in the atmosphere? Shouldn't we move ahead in these areas anyway, even if the greenhouse effect is not happening?

Dr. Richels: Yes.

Dr. Nordhaus: More research and development on energy technologies with fossil fuels are necessary.

Mr. Ritter: How can we possibly know if we are going in the right direction with the uncertain information we have right now about global warming and such? Isn't this "dicey?!"

Dr. Jacobson: Yes.

SUBCOMMITTEE ON SCIENCE

Hearings on
Priorities in Global Climate
Change Research

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WITNESS LIST

PANEL 1

Dr. Jerry D. Mahlman
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Geophysical Fluid Dynamics Laboratory
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Dr. Richard Lindzen
Alfred P. Sloan Professor of Meteorology
Massachusetts Institute of Technology
Cambridge, Massachusetts

Dr. Ralph Cicerone
Professor of Geosciences
and of Chemistry
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PANEL 2

Dr. Richard G. Richels
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Palo Alto, California

Dr. William D. Nordhaus
A. Whitney Griswold Professor of Economics
Yale University
New Haven, Connecticut

Dr. Harold K. Jacobson
Jesse S. Reeves Professor of Political Science
and
Director, Center for Political Studies
Institute for Social Research
University of Michigan
Ann Arbor, Michigan

OPENING STATEMENT
HON. DON RITTER (R-PA)
HEARING ON PRIORITIES IN
GLOBAL CLIMATE CHANGE RESEARCH

OCTOBER 8, 1991

THANK YOU, MR. CHAIRMAN. I WISH TO COMMEND YOU FOR HOLDING THESE IMPORTANT HEARINGS, AND I THANK BOTH YOU AND MR. PACKARD FOR ALLOWING ME TO JOIN YOU TODAY AND DELIVER SOME OPENING REMARKS AS WELL.

GLOBAL CLIMATE CHANGE IS PERHAPS THE PREMIER, BIG-STAKES ENVIRONMENTAL ISSUE OF THE 1990S. WITH SOME DOOMSDAY SCENARIOS, THE COST OF MEASURES TO CURB THOSE PREDICTIONS OF CATASTROPHE COULD AMOUNT TO INESTIMABLE BILLIONS OF DOLLARS, AND POTENTIALLY STIFLE WORLD ECONOMIC GROWTH. IF SUCH LIFE-ALTERING SCENARIOS ARE BASED ON SOLID SCIENCE, THEN IT IS OUR RESPONSIBILITY TO FIND CURES TO FIT THE DISEASE, NOW MATTER HOW DRASTIC.

BUT IF THE DOOMSDAY SCENARIOS ARE NOT BASED ON SOLID SCIENCE, IT IS OUR RESPONSIBILITY NOT ONLY TO SAY SO, BUT TO DEPOLITICIZE THE ISSUE, AND TO GIVE SOME PAUSE TO THE POPULAR VISION JUGGERNAUT OF GLOBAL WARMING. THEREFORE, OUR FOREMOST QUESTIONS IN THIS SUBCOMMITTEE AND IN THE FULL COMMITTEE, MUST BE, HOW SOLID IS THE SCIENCE BEHIND THE SCENARIOS? WHAT IS THE STATE OF THE CLIMATOLOGICAL AND METEROLOGICAL SCIENCE NECESSARY TO EXPLAIN OBSERVED PHENOMENA? WHAT DOES IT TELL US RIGOROUSLY, AND WHAT CAN WE PREDICT FROM IT? HOW DOES IT MATCH WITH REAL WORLD OBSERVATIONS OVER THE LAST 100 YEARS?

WITH SO MUCH AT STAKE, IT IS ABSOLUTELY ESSENTIAL THAT AMERICA AND AMERICANS FOCUS FIRST ON SCIENTIFIC VALIDITY, RELIABILITY, AND PREDICTABILITY. NOTHING LESS IS ACCEPTABLE. IT IS HARD TO BELIEVE THAT LESS THAN FIFTEEN YEARS AGO, SOME RESPECTED SCIENTISTS THOUGHT WE WERE HEADING INTO A PERIOD OF GLOBAL COOLING. INDEED, ONE OF TODAY'S MOST AVID PROPONENTS OF ANTHROPOGENIC, OR HUMAN-ENHANCED GLOBAL WARMING, DR. STEPHEN SCHNEIDER, WAS SUPPORTIVE OF SUCH A COOLING THEORY IN HIS BOOK ON GLOBAL CLIMATE CHANGE.

NOW THAT'S QUITE A SWITCH!

SOME SAY WE ALREADY HAVE A SCIENTIFIC "CONSENSUS" THAT ENHANCED GLOBAL WARMING IS OCCURRING; THAT FUTURE WARMING WILL BE SEVERE, AND THAT WE MUST TAKE STRONG ACTIONS TO SHARPLY CURB THE GREENHOUSE GASES GENERATED BY MAN, WHICH, I SHOULD ADD, TODAY AMOUNT TO 2% OF TOTAL GREENHOUSE GASES. HOWEVER, THE DATA TELL US THAT ALL THREE ASSERTIONS ARE FLAWED.

CONSULTING THE SCIENTIFIC LITERATURE AND THE SCIENTIFIC COMMUNITY SHOWS THERE IS NO SCIENTIFIC CONSENSUS! YES, ALTHOUGH IT'S HARD TO FIND IN THE PUBLIC MEDIA, A RESPECTED CROSS-SECTION OF CLIMATE SCIENTISTS FROM AMERICA'S PREMIER ACADEMIC INSTITUTIONS HAS VOICED EXTREMELY WELL-DOCUMENTED SKEPTICISM ABOUT GLOBAL WARMING...NOT SO MUCH THAT IT IS OR IS NOT TAKING PLACE (ALTHOUGH THAT CERTAINLY COMES UP), BUT IF IT IS, THEY SERIOUSLY QUESTION MAGNITUDES, IMPACTS, AND HUMAN BLAME DEFINED BY COMPUTER MODELS WHICH ARE EXTREMELY UNABLE TO REFLECT THE WHOLE PICTURE.

FOR EXAMPLE, A RECENT SURVEY OF REVIEWERS OF THE REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) FOUND CONSIDERABLE DISAGREEMENT – NOT THE WIDELY-TOUTED "CONSENSUS" OVER GLOBAL WARMING. THE REVIEW PANEL WAS SPLIT ABOUT THE RATE AND MAGNITUDE OF GLOBAL CLIMATE CHANGE, THE VALIDITY OF KEY ASSUMPTIONS, AND THE VERY MODE OF PRESENTATION OF THE REVIEW DOCUMENT. ALSO, THE REVIEW TEAM DIFFERED STRONGLY FROM THE CONTRIBUTORS.

BASICALLY, IF YOU DIG DEEP ENOUGH INTO THE IPCC REPORT, YOU FIND OUT THAT WE DO NOT KNOW WHETHER GLOBAL WARMING DUE TO AN ACCUMULATION OF GREENHOUSE GASES IS OCCURRING WITH ANY REAL DETRIMENT TO OUR LIVES. THE SUPPOSEDLY "CONSENSUS" IPCC REPORT SAYS, ALBEIT BURIED DEEP ON PAGE 254, "IT IS NOT POSSIBLE TO ATTRIBUTE ALL, OR EVEN A LARGE PART, OF THE OBSERVED GLOBAL-MEAN WARMING [OF 0.5 DEGREES C SINCE 1890] TO THE ENHANCED GREENHOUSE EFFECT ON THE BASIS OF OBSERVATIONAL DATA CURRENTLY AVAILABLE." IN OTHER WORDS, IT'S ALL COMPUTER MODELS...AND VERY LITTLE REALITY.

EVEN THE NATIONAL ACADEMY OF SCIENCES REPORT "POLICY IMPLICATIONS OF GREENHOUSE WARMING," A SUMMARY OF THE REPORTS OF FIVE INDIVIDUAL PANELS (ONE ON SCIENCE, THE REST ON IMPACTS), STATES, "NEITHER THE AVAILABLE CLIMATE RECORD NOR THE LIMITED CAPABILITIES OF THE CLIMATE MODELS PERMIT A RELIABLE FORECAST OF THE IMPLICATIONS OF CONTINUED ACCUMULATIONS OF GREENHOUSE GASES IN THE ATMOSPHERE." IN OTHER WORDS, WE DON'T KNOW MUCH!

I SHOULD POINT OUT THAT, WITH ONE EXCEPTION, THE INDIVIDUAL NAS PANEL REPORTS HAVE NOT BEEN RELEASED. THE ONE RELEASED MOST RECENTLY WAS NOT THE REPORT ON THE SCIENCE, WHICH MOST CERTAINLY SHOULD HAVE GONE FIRST, BUT A REPORT ON ADAPTATION TO THE POSSIBILITY OF GLOBAL WARMING. IT WOULD BEHOOVE THE ACADEMY TO PUT THE SCIENCE FIRST, BEFORE THE POLICY IMPLICATIONS...WHICH HAVE A TENDENCY TO REPLACE, TO OVERWHELM THE SCIENCE IN A POLITICALLY CHARGED CLIMATE. IN OTHER WORDS, AND THIS MAY COME AS A SHOCK TO SOME, THE RECORD TO DATE SEEMS NOT TO SHOW ANYWHERE NEAR A DANGEROUS "GLOBAL WARMING" AS RESULTING FROM MAN-GENERATED GREENHOUSE GAS ACCUMULATIONS.

THOSE WHO WANT TO TAKE SIGNIFICANT ACTIONS ON GLOBAL WARMING HAVE, IN EFFECT, DOWNPLAYED OR VIRTUALLY PUT ASIDE THE DIRECT EVIDENCE OF HISTORIC CLIMATE RECORDS. THEY RELY ON COMPUTER MODELS OF THE FUTURE THAT DO NOT YET PORTRAY METEROLOGICAL REALITY OF THE PRESENT OR THE PAST! I SUBMIT THAT SUCH A SCHEME IS IN NO WAY A BASIS FOR INTELLIGENT POLICY.

DESPITE VERY SUBSTANTIAL SCIENTIFIC UNCERTAINTIES, THE NAS REPORT CALLED FOR CERTAIN LIMITED, BUT NOT NECESSARILY UNREASONABLE ACTIONS TO REDUCE GREENHOUSE GAS EMISSIONS – RECOMMENDATIONS CONFORMING LARGELY WITH A DESIRE TO BE MORE ENERGY EFFICIENT. BUT IT MAY BE THAT REPORT ITSELF WAS LESS THAN OBJECTIVE FROM THE OUTSET. THE SYNTHESIS PANEL RESPONSIBLE FOR PREPARING THE SUMMARY DOCUMENT – THE FIRST AND ONLY DOCUMENT RELEASED FOR A PERIOD OF MANY MONTHS – THE ONLY DOCUMENT AVAILABLE, AND THEREFORE THE ONLY ONE TO GET MAJOR PRESS PLAY – CONTAINED SEVERAL STRONG GLOBAL WARMING ADVOCATES, ON THE RECORD IN FAVOR OF MAJOR SOCIETAL ACTION TO CURB THE PHENOMENON.

I SHOULD POINT OUT THAT ON THE ENTIRE SYNTHESIS PANEL, THERE WAS NOT ONE SCIENTIST INCLUDED WHO HAD ADVOCATED SKEPTICISM ABOUT THE VALIDITY OF THE POPULAR VISION OF GLOBAL WARMING. NO ONE WAS INCLUDED FROM THE HIGHLY REGARDED GROUP OF SCIENTISTS WHO DON'T GO ALONG WITH THE DOOMSDAY SCENARIOS.

THE SUBCOMMITTEE SHOULD ALSO KNOW THAT THE GENESIS OF THE NAS REPORT WAS SENATE APPROPRIATIONS BILL LANGUAGE INSERTED BY SENATOR TIM WIRTH, A WELL-KNOWN ADVOCATE OF THE POPULAR VISION OF WARMING. THAT LANGUAGE CONTAINED A HOST OF REQUIREMENTS FOR THE ACADEMY STUDY, GOING WELL BEYOND THE STILL-DISPUTED SCIENCE, AND WELL INTO THE POLICY REALM. FOUR OF THE FIVE PANELS DEALT WITH "WHAT IF" QUESTIONS; ONLY ONE WITH THE SCIENCE. SO THE POPULAR VISION JUGGERNAUT CERTAINLY HAS ITS POLITICAL BACKERS.

THE NAS REPORT ALSO OVERLOOKED CRITICAL RESEARCH, SUCH AS THE WORK OF CLIMATOLOGISTS SCHLESINGER AND JIANG AT THE UNIVERSITY OF ILLINOIS, SHOWING THERE WOULD BE LITTLE RISK IN DELAYING PROGRAMS TO REDUCE CARBON DIOXIDE EMISSIONS, UNTIL MORE IS KNOWN ABOUT SCIENTIFIC UNCERTAINTIES.

IN 1989, DR. RALPH CICERONE, WHO IS A WITNESS HERE TODAY, CLAIMED THAT THE "HIGH MORAL GROUND" BELONGS TO "COUNTRIES THAT PROVIDE LEADERSHIP IN STABILIZING CLIMATE." I WOULD AGREE – IF CLIMATE WAS BEING DESTABILIZED. BUT, MY COLLEAGUES, BEFORE THE CLIMATE SCIENCE JUSTIFIES ACTION, IF WE TAKE MAJOR STEPS TO REDUCE GREENHOUSE GAS EMISSIONS – STEPS THAT ARE NOT JUSTIFIED FOR SIGNIFICANT OTHER REASONS – THEN WE YIELD THE HIGH MORAL GROUND.

WHEN WE YIELD RIGOR, WHEN WE YIELD COMMON SENSE, WHEN WE FOCUS OUR EFFORTS ON THE WRONG TARGET, WE YIELD OUR VERY ABILITY TO BETTER OUR GLOBAL ENVIRONMENT. PLUS, WE CAN END UP DOING GREAT AND UNJUSTIFIED DAMAGE. THAT IS WHY THESE SUBCOMMITTEE HEARINGS ARE SO CRUCIAL. TOO MANY OTHER BODIES IN THIS CONGRESS HAVE PUT THE POLICY CART BEFORE THE SCIENCE HORSE. THE "SCIENCE" SUBCOMMITTEE CAN GIVE SCIENCE ITS RIGHTFUL PLACE – LITERALLY, ITS RIGHTFUL HEARING.

AS DR. PHILIP ABELSON, A HIGHLY-RESPECTED EDITOR OF THE FOREMOST AMERICAN SCIENTIFIC JOURNAL SCIENCE, PUTS IT, IN A MARCH 31, 1990 LEAD EDITORIAL, "THERE HAS BEEN MORE HYPE THAN SOLID FACT" ABOUT GLOBAL WARMING. THE GROWING ACCUMULATIONS OF MAN-INDUCED GREENHOUSE GASES CANNOT BE IGNORED, BUT MUCH MORE RESEARCH – AND MUCH LESS BANDWAGONING – OVER THE NEXT DECADE, IS NECESSARY TO YIELD A SOUND SCIENTIFIC FOUNDATION BEFORE ANY SIGNIFICANT ACTION IS TAKEN.

MR. CHAIRMAN, CONCERN ABOUT THE IMPACT OF HUMAN ACTIVITIES ON CLIMATE IS NOT NEW. THOMAS JEFFERSON ONCE PREDICTED THAT CONTINUED DEFORESTATION WOULD BRING SEA BREEZES TO THE BLUE RIDGE MOUNTAINS, AND PROPOSED THAT SCIENTIFIC STUDY BE DEVOTED TO THE ISSUE. HE PROPOSED A MEETING OF KEY PARTIES EVERY THIRTY YEARS. NOW, I'M NOT PROPOSING WE WAIT THAT LONG, BUT GIVEN THE TREMENDOUS AMOUNT OF SCIENTIFIC UNDERSTANDING COMING TO THE FOREFRONT EACH AND EVERY DAY, AND GIVEN THE TIME FRAME OF CLIMATE CHANGE, I THINK JEFFERSON WOULD BE HORRIFIED BY THE RUSH TO JUDGMENT AND PRECIPITOUS ACTION OVER GLOBAL WARMING.

HOPEFULLY, OUR WITNESSES WILL SHED LIGHT ON THE DIRECTIONS IN WHICH WE OUGHT TO MOVE TO REDUCE THE SCIENTIFIC UNCERTAINTIES. THAT SHOULD BE OUR MISSION: TO RIGOROUSLY EVALUATE THE SCIENCE, EVALUATE THE

UNCERTAINTIES, AND GIVE APPROPRIATE ASSISTANCE TO OUR SCIENTIFIC COMMUNITY TO REDUCE THOSE UNCERTAINTIES. I WELCOME OUR DISTINGUISHED WITNESSES, AND I LOOK FORWARD TO A PRODUCTIVE DISCUSSION.

TESTIMONY OF

J.D. MAHLMAN, DIRECTOR
GEOPHYSICAL FLUID DYNAMICS LABORATORY
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMITTEE ON SCIENCE

HEARING ON
PRIORITIES IN GLOBAL CLIMATE CHANGE RESEARCH

U.S. HOUSE OF REPRESENTATIVES

OCTOBER 8, 1991

Mr. Chairman and Members of the Subcommittee:

My name is Jerry Mahlman. I am the Director of the Geophysical Fluid Dynamics Laboratory (GFDL) of the National Oceanic and Atmospheric Administration (NOAA), in Princeton, New Jersey. I will offer perspectives on model estimates of climate change and their current level of uncertainties. For over thirty years our Laboratory has been a pioneer in mathematical modeling of the earth's climate.

For many decades scientists have known that the buildup of carbon dioxide (CO2) in the atmosphere has potential to warm earth's climate through enhancing the so-called "greenhouse" effect. Over the past 10 years, awareness has grown that other increasing greenhouse gases can contribute as much to climate warming as the increased CO2. These include methane, nitrous oxide, and human-produced chlorofluorocarbons. The atmospheric

concentrations of all these gases are currently increasing at a rate sufficient to have substantial climatic consequences over the next century.

Today I will emphasize only the estimated climatic effects of increasing greenhouse gases. Because I speak as a physical scientist, I will not offer value judgements about the effects that I discuss.

At the onset it is very important to recognize that a major international effort to assess climate warming was completed in 1990. This is "Climate Change: The IPCC Assessment" (1990), prepared by the Intergovernmental Panel on Climate Change. The report preparation involved nearly two years and 170 scientists from 25 countries, followed by a comparable number of scientific reviewers. This document is generally regarded to be the most authoritative and widely accepted statement on climate change that has ever been made by the scientific community. I strongly recommend the IPCC Report to your use as a foundation for your own evaluations. I also recommend its use as a point of departure for assessing the validity of opinions that disagree with it.

Occasionally, my opinions will differ somewhat from those in the 1990 IPCC Assessment due to consideration of further research and newer thinking. Overwhelmingly, however, my statements are in accord with those in the IPCC Assessment. This includes my support for their statement of the highest priorities for climate change research.

The information that I will present is derived from a variety of three-dimensional mathematical models of the climate system. Climate models have grown steadily in scope, complexity, and computational resolution over the past two decades. Accompanying this growth is an improvement in the ability of the models to simulate the current climate. Accordingly, modeling atmospheric responses to changing conditions (e.g., seasonal and daily cycles, ice age conditions) has become progressively more reliable. Unfortunately, substantial uncertainties remain due to deficiencies in scientific understanding and insufficient computer power. However, significant progress is expected on both fronts over the next ten years. The significant remaining deficiencies in understanding of such areas as ocean circulation, cloud processes, land surface processes, and chemical interaction will diminish. The estimates I present will attempt to take account of these deficiencies.

Some of the possible climate responses in the middle of the next century to increased greenhouse gases are rather well understood, while others remain controversial. I will give my estimates of scientific confidence levels based upon simple "betting odds". To give some guideline, by "virtually certain" I mean that there is no plausible alternative interpretation. "Very probable" means I estimate about a 90 percent (9 out of 10) chance, and "probable" implies about a 67 percent (2 out of 3) chance. "Uncertain" in this context means an effect that is conceptually plausible, but for which there is a lack of appropriate evidence.

I list below, in decreasing order of my current scientific confidence, some important aspects of greenhouse warming phenomena. This list has many aspects that are similar to those in National Research Council, 1987, and in IPCC, 1990.

* Human-Caused Increasing Greenhouse Gases (virtually certain)
  There is essentially no remaining doubt that the increasing concentrations of greenhouse gases measured over the last 30 years are due to accelerated human activities. Clearly, identified are the burning of fossil fuels and the use of human-produced chlorofluorocarbons.

* Radiative Effect of Increased Greenhouse Gases (virtually certain)
  Greenhouse gases have known ability to absorb and reradiate infrared radiation at wavelengths characteristic of earth temperatures. Independent of other factors, this property acts to produce a net increased heating effect on the earth system. The uncertainties arise later from an incomplete knowledge as to how the complex climatic processes would respond to such additional heating.

* Large Stratospheric Cooling (virtually certain)
  A reduction in upper stratospheric ozone by chlorine compounds will lead to reduced absorption of solar radiation and thus, less heating. Increased stratospheric concentrations of CO2 will increase infrared radiative heat loss from the stratosphere. This decreased heating and

increased cooling will lead to a marked lowering of upper stratospheric temmperatures, perhaps by 15x-35xFarenheit. Also, polar ozone losses over the past decade have already produced significant cooling in the high latitude, lower stratosphere.

* Long Time Scales in the Problem (virtually certain)
It is universally recognized that it takes a long time (decades to centuries) to produce the buildup of greenhouse gases and the associated climatic response. Much less appreciated is that a "return to normal" due to any mitigative action will require additional centuries.

* Global-Mean Surface Warming (very probable)
For the middle of the next century (assuming current trends continue), global-mean surface warming is estimated to be in the range of 2-8xFarenheit. The most significant uncertainty arises from the effects of clouds. The actual rate of warming over the next century will be influenced by the growth rate of greenhouse gases, natural fluctuations in the climate system, and the detailed response of the slowly changing parts of the climate system, i.e., oceans and glacial ice. My own opinion, based on historical temperature records and recent cloud-radiation studies, is that the observed global warming is more likely to be in the lower half of this range.

* Global-Mean Precipitation Increase (very probable)
  As the climate warms, the rate of evaporation should increase, leading to an increase in global-mean precipitation. Despite this increase in global-mean precipitation, some local regions would experience decreases in precipitation.

* Reduction of Northern Sea Ice (very probable)
  As the climate warms, models calculate a total sea ice reduction in response to warming in high latitudes of the Northern Hemisphere. However, recent GFDL model results with a fully interactive ocean indicate substantial initial resistance to climate change at high Southern Hemisphere latitudes (Stouffer et al., 1989). Thus, little change in sea-ice cover may occur there over the next century.

* Northern Polar Winter Surface Warming (very probable)
  As the sea-ice boundary is shifted northward, the models predict a significantly enhanced winter surface warming in northern polar regions. The greater fraction of open water and thinner sea ice produces this warming. Observation of this effect may be obscured temporarily by the larger natural variability and slower responses in these regions relative to lower latitudes.

* Rise in Global Mean Sea Level (very probable)
  A further rise of 4-12 inches in mean sea level by the middle of the next century is generally estimated due to thermal

expansion of sea water in the warmer future climate. Far less certain are the contributions due to melting and calving of land ice. Predictions of actual rise rates for mean sea level remain difficult.

* Higher-Latitude Precipitation Increase (probable)
  As the climate warms, the increase poleward penetration of warm, moist air would likely increase the annual-average precipitation and river runoff in higher latitudes.

* Summer Mid-Continental Dryness/Warming (probable)
  Several model studies have indicated a marked decrease of the soil moisture over some mid-latitude interior continental regions during summer. In the models, this drying is mainly caused by an earlier termination of snow melt and rainy periods, and thus, an earlier onset of the normal spring-to-summer reduction of soil moisture.

* Regional Vegetation Changes (uncertain)
  Changes in temperature and precipitation of the kinds indicated above would likely lead to long-term changes in the surface vegetative cover. The exact nature of such changes and how they might feed back to the climate remain uncertain.

* Tropical Storm Increases (uncertain)
  A number of scientists suggest and some models indicate that a warmer, wetter atmosphere could lead to an increased number and intensity of tropical storms, such as hurricanes.

However, tropical storm formation is governed by other factors such as regional wind structure. At the present time, this effect has not been satisfactorily addressed due to the coarse resolution and simplified physics in current climate models.

* Regional and Temporal Details of Next 25 Years (uncertain)
The results given above describe calculated changes averaged over decades in the middle of the next century. At present, the tropospheric greenhouse warming signal is still estimated to be modest relative to the decadal-scale natural fluctuations in the climate system. Such natural climatic fluctuations should continue to occur on the scale of years to decades that arise out of episodic events such as volcanos or from interactions between the atmosphere and the oceans. The midwestern drought in the 1930's and the high water levels of the Great Lakes in the 1980's are examples of such climatic fluctuations. On these shorter time scales, it is almost inevitable that natural fluctuations will artificially reduce or enhance any greenhouse warming signals. Until these fluctuations are understood or predictable, it will remain difficult to diagnose the specific signals of permanent climate change as they evolve over the next quarter century.

Even though the remaining uncertainties are daunting, we must not forget that important advances have already been achieved in the observation, understanding, and modeling of the climate system. The current models are capable of simulating many aspects of

climate and its changes. These advances have initiated the current public awareness of climate change and its potential implications for the future of the world. This awareness has, in turn, escalated the need for reliable climate predictions, and for accurate assessments of the causes of the actual changes occurring.

Although progress has been made, very important deficiencies remain in the capability of the scientific community to address these needs. Much more effort than is currently planned should be expended world-wide toward providing a calibrated climate/chemical monitoring system and a commitment to continue measurements over many decades. Focussed research into climate processes must be accelerated so that theories can be formulated and re-evaluated in the light of newer data. To reduce climate modeling uncertainty, climate modeling efforts must receive resources that are in balance with the broader scientific programs.

I am pleased that the U.S. Global Change Research Program is making important progress toward addressing the above research needs. Given the formidable challenge, even more work will be needed in the years ahead. For example, a viable world climate/ chemical monitoring system is needed so that our research and predictions can be evaluated in the light of the actual climate changes.

Through careful, long-term climate monitoring and careful research on observation, modeling, and analysis, uncertainties will decrease and the confidence for predicting details of the climate

system and its changes will increase. However, it is reasonable to expect that scientific surprises will hit us that may decrease or increase the estimated effects outlined here. The Antarctic Ozone hole provides a superb example of such a surprise. Finally, a very confident prediction is that the societal need for accurate and detailed climate change predictions and their effects will increase as fast or faster than the scientific community can provide them. The effort to meet these societal challenges will require the combined forces of the world leadership and its scientific community in a sustained effort spanning decades.

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OPENING STATEMENT
BY THE
HONORABLE RICK BOUCHER, (D-VA), CHAIRMAN
SUBCOMMITTEE ON SCIENCE
ON
HEARING ON PRIORITIES IN
GLOBAL CLIMATE CHANGE RESEARCH

October 8, 1991

This morning and again on Thursday morning, the Subcommittee on Science will explore research needs for assessing the effects of greenhouse gas emissions on climate. The Subcommittee will also attempt to compare identified research needs to the priorities established in the U.S. Global Change Research Program.

In general, the term "greenhouse warming" refers to changes in global climate due to an increase in greenhouse gas concentration in the atmosphere arising from human activities. There is no dispute that anthropogenic emissions of greenhouse gases are significant. For example, the concentration of carbon dioxide has increased about 25 percent from the beginning of the Industrial Revolution until present time, and is now increasing at about one-half percent per year.

However, to date, scientists have been unable to identify a signal in the climate record due to the effects of human activities. An increase of about one-half degree centigrade in average global temperature has occurred over the past 100 years. Whether this change is due to natural climate variability or to greenhouse warming or to a combination of effects cannot yet be proven.

Much of the current attention to global warming has been triggered by the results of numerical climate models, called general circulation models. These models have predicted a possible range of global average temperature rise which, at the upper end of the estimate, could result in significant environmental effects. But the general circulation models are known to have pronounced limitations due to inaccuracies in the modeling of the physics of important phenomena, such as the effects of clouds and ocean circulation. Moreover, the models cannot provide sufficient spacial resolution to determine, for example, temperature extremes and rainfall changes in different regions of the United States.

Greenhouse warming has engendered concern throughout the world despite the large uncertainties about whether it has begun, whether it will manifest itself in the coming decade or so, and whether the severity of the phenomena, if it occurs, would warrant heroic preventative measures. The concern is driven by the perception that a non-negligible chance exists that greenhouse warming could have a catastrophic effect on the world's ecology, economy, and social fabric. The argument goes that by the time conclusive scientific evidence is accumulated, it could be too late to mitigate harmful effects.

The other side of the argument, of course, is that the effects of greenhouse warming may not be severe or may prove to be minor compared to natural climate variability. In that case, moving forward now with vigorous measures to reduce significantly greenhouse gas emissions would not only be costly and highly disruptive to the economy, but also unnecessary.

From a public policy perspective, decision makers provided

with incomplete information are left with the problem of choosing among options where the consequences of a wrong choice could be disastrous. Partly in response to this dilemma, the U.S. Global Change Research Program was established as a Presidential initiative in fiscal year 1990. The Program's goal is to establish the scientific basis for policymaking relating to natural and human-induced changes in the global earth system. We look forward in these hearings to assessing whether that Program has the promise to meet this broad objective, relative to greenhouse warming. A successful outcome would imply the generation of the right kinds of information within a short enough time-frame to influence public policy choices.

Our first panel of scientists this morning has been invited to review the major sources of uncertainty in the scientific evidence for global warming and in the models used to forecast climate change. We also have asked them to highlight the most critical research issues that ought to be addressed in order to improve the scientific basis for assessing global warming.

A second panel of economic and social scientists will review the dependability of economic models available to assess different options for mitigation and for adaptation to greenhouse warming projections. In addition, we have asked for a review of research issues associated with human responses and adaptations to changing climate and environment.

I want to welcome all of our distinguished witnesses this morning and look forward to your testimony.