FOIA Number: 2012-0769-F

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Clouds Hearing - Briefing Memo to Democratic Members

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MEMORANDUM
October 1, 1991

TO: DEMOCRATIC MEMBERS, SENATE COMMERCE COMMITTEE
FROM: MIKE NELSON AND ANTHONY SOCCI
RE: OCTOBER 1 HEARING ON GLOBAL WARMING

At 9:30 a.m. on Monday, October 7, 1991, the Senate Commerce Committee will hold a Full Committee hearing on the role of clouds in global climate change. Scientists agree that clouds could play a critical role in amplifying the effects of greenhouse warming. At the hearing, researchers will discuss their efforts to determine the extent of that role and the many scientific uncertainties that surround the issue. In addition, the witnesses will discuss whether Federal research programs are properly structured to provide the answers policymakers need to assess the threat of global climate change.

Rather than follow the usual hearing format, witnesses and Committee members will all join in a roundtable discussion. This will ensure a free and open discussion of the scientific issues.

BACKGROUND ON GLOBAL WARMING

There is a growing consensus that human activities are enhancing the earth's "greenhouse effect," inevitably leading to an increase in the earth's average temperature. Researchers have been studying the greenhouse effect for more than a hundred years, and there is general agreement on the main point of the theory--that small concentrations of so-called "greenhouse gases" in the air, most notably carbon dioxide (CO_2) and water vapor, absorb infra-red radiation from the sun, trapping heat in the earth's atmosphere that would otherwise radiate back into space. The natural greenhouse effect keeps the earth almost 35^{o} Celsius (63^{o} Fahrenheit) warmer than it would otherwise be.

Man-caused emissions have raised the worldwide concentrations of several greenhouse gases. Each year, deforestation and the burning of fossil fuels pump over 30 billion metric tons of carbon dioxide into the atmosphere. As a result, the concentration of carbon dioxide has increased about 25% since the start of the Industrial Revolution. Increased emissions of other greenhouse gases, including methane (CH_4), chlorofluorocarbons (CFCs), nitrous oxide, and ozone are expected to cause at least as much global warming as carbon dioxide. The United States, with less than 5 percent of the world's population, is responsible for about 25 percent of global emissions of greenhouse gases.

If present trends continue, the concentration of carbon dioxide in the atmosphere will double by the year 2030. Atmospheric scientists have constructed computer models to study the effects of increased concentrations of carbon dioxide and other greenhouse gases. Most models predict a warming of between 1.5^{o} and 4.5^{o} C (3^{o}-8^{o} F) for a doubling of CO_2 concen-

tration, although how quickly this warming would occur is still debated. A global increase of even two degrees Celsius would lead to significant changes in regional climate and have huge economic and societal impacts. Eliminating the threat of global warming would necessitate major changes in energy use and agricultural practices in the United States and worldwide.

Various agencies within the Commerce Committee's jurisdiction, have responsibility for research on global warming. The National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA) are responsible for most of the Federal government's effort to understand and assess global warming and other aspects of global change. For Fiscal Year 1992, the Administration is requesting more than $1 billion for the multi-agency United States Global Change Research Program.

IMPROVING PROJECTIONS OF GLOBAL CLIMATE CHANGE

One of the goals of the United States Global Change Research Program is to develop more reliable computer models of the global climate, which could provide policymakers with projections of the timing and extent of global warming. These "Global Circulation Models" (GCMs) are very complicated, taking into account dozens of different paramaters and physical processes, but they cannot possibly mimic all the complexity of the earth's climate system. Even though they use some of the world's most powerful supercomputers, researchers have to make approximations and assumptions as they develop the models. In addition, there are many areas where scientists still lack a full understanding of the basic physics of the climate system.

Still, despite the shortcomings of the models, there is general agreement among the various GCMs that have been developed that increased greenhouse gas concentrations in the atmosphere will lead to an increase in the average global temperature of between 1.5 and 4.5 degrees Celsius by the middle of the next century. The models are less consistent when it comes to predicting local or regional changes in temperature and rainfall. These inconsistencies are due primarily to 1) the lack of sufficient computing power, 2) uncertainty in how the oceans will absorb heat and greenhouse gases as global warming progresses, and 3) the role of clouds in the climate system.

THE ROLE OF CLOUDS IN CLIMATE CHANGE

Clouds play a key role in the earth's heat budget. Clouds can cool the earth by reflecting solar radiation or warm the earth's surface by trapping heat near the earth's surface. Researchers surmise that a very small increase in the earth's cloud cover could lead to substantial decreases in global temperatures. A mere four-percent increase in low-altitude

clouds, which tend to cool the lower atmosphere, could offset the rise of 2-3 degrees Celsius in global temperature predicted by GCMs. On the other hand, if high-altitude clouds, like cirrus clouds, which tend to trap heat, become more common as temperatures increase, the effects of greenhouse warming would be amplified. There is still considerable debate in the scientific community over which effect will predominate, but recent NASA satellite data seems to indicate that global warming would not change the distribution and density of clouds enough to prevent a significant rise in average global temperature, although clouds would certainly play a role in controlling local and regional climate.

Most computer models assume that an increase in greenhouse gases will lead to an increased evaporation and a rise in the atmospheric concentration of water vapor, an important greenhouse gas. This would amplify global warming. There is good evidence for this kind of amplification effect. Without it the earth would be much cooler than it is today. However, there is a small group of researchers (most notably Dr. Richard Lindzen from M.I.T.) who contend that this effect becomes less important as temperatures rise. According to Lindzen, greenhouse warming would lead to more evaporation and more clouds, but it would also generate more storms and rainfall. The end result would be less water vapor in the atmosphere and negligible warming.

United States researchers have made the role of clouds in global climate change the number one research priority for the U.S. Global Change Research Project and have initiated a number of national and international research programs focused on the problem. NASA's Earth Radiation Budget Experiment (ERBE) uses data from a NASA satellite and NOAA weather satellites to study the type and distribution of clouds. NOAA and NSF are funding the Tropical Ocean-Global Atmosphere (TOGA) program which uses aircraft and ships to study clouds, particularly in the tropical Pacific. Numerous other projects, including NOAA's Global Precipitation Climatology Project, the Global Energy and Water Cycle Experiment (GEWEX), and the International Satellite Cloud Climatology Project (ISCCP), are all contributing important data on the physics of clouds. NSF'S Role of Clouds Program funds numerous university researchers working on the problem. In addition, NSF's Greenland Ice Sheet Program will produce new data on past climate change as recorded in ice cores.

A number of planned NASA satellite missions will also contribute to our understanding of clouds and the hydrologic cycle. NASA recently initiated the Tropical Rainfall Measurement Mission (TRMM) which will provide data on the intensity and distribution of rainfall over areas like the Amazon Basin. NASA's proposed Earth Observing System (EOS), which will cost at least $11 billion over the next ten years, will provide huge amounts of data on clouds as well. In addition, in this year's VA-HUD-Independent Agencies Appropriations bill, the Congress

provided $15 million for Climsat, a small satellite to provide additional data on atmospheric processes.

KEY ISSUES

Just how much will clouds amplify or ameliorate global warming? We an answer to this question in order to know how much global temperatures will rise over the next 50-100 years and how much effort and money the United States and other countries should devote to slowing and preparing for global warming.

What are the uncertainties in our understanding of the role of clouds? And how large are they? At present, there are many unanswered scientific questions regarding how and why clouds form and where they are distributed. Further research is needed at all scales, from global to microscopic, to answer these questions.

Are Federal research programs properly structured to provide the data needed to better understand the role of clouds in the climate system? Are the sensors planned to fly on NASA and NOAA satellite going to provide the type and volume of data needed? Is enough attention being paid to ground-based and aircraft experiments to investigate the basic physics and chemistry of clouds?

WITNESSES

Witnesses expected to testify include Dr. V. Ramanathan from the University of California at San Diego; ~~Dr. Stephen Schneider~~ and Dr. Kevin Trenberth from the National Center for Atmospheric Research, Boulder, Colorado; Dr. Richard Lindzen from M.I.T.; Dr. Robert Charleson from the University of Washington; Dr. Robert Cess from the State University of New York at Stonybrook; Dr. William Rossow and Dr. Albert Arking, NASA scientists; Dr. Alan Betts from RDI, Middlebury, Vermont; as well as representatives from NASA and the National Oceanic and Atmospheric Administration.