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global changes in

the environment:

Our common future

EMERGING ISSUES FORUM 1990
North Carolina State University

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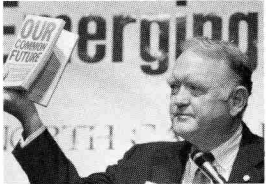
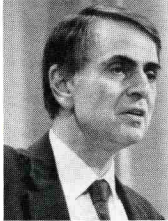
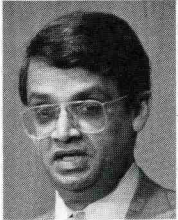




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Global Changes In The Environment: Our Common Future

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Forum chairman Jim Hunt convened the conference

Looking at the list of speakers and participants at the 1990 Emerging Issue Forum, no one could fail to be impressed. Their expertise ranged from the local to the global – even the cosmic.

But what we all share with them is a commitment to exploring what we must do to protect our world from environmental collapse. We are, in a sense, all explorers – asking questions and seeking answers for a world environment we are only beginning to understand.

Our exploration has a great urgency today because it will take decades of intensive efforts to correct only some of the detrimental results of human activity on Earth. Global warming is one of the most serious problems our natural world has ever faced. It is devastating to rich and poor nations alike. Along with such problems as acid rain and toxic wastes, it represents the tragic result of human error over nearly two centuries of industrialization.

I recently re-read a notebook about Roanoke Island, written in 1588 by an Englishman, Thomas Herriot. What struck me most was Herriot's description of the varied and abundant plant and animal life and other natural resources in that corner of North Carolina four centuries ago. His descriptions and the drawings by his partner, John White, provide our earliest glimpses of North Carolina before Europeans arrived in large numbers. They recorded how Native Americans lived in their environment without destroying it. Just as important, they help us understand the bounty that once existed here and the immense toll on our state in the years since then.

On shores where Indians once fished for scallops, oysters, crabs, and flounder, we now can reap a bounty of garbage and medical wastes. Many shellfish beds are closed to fishermen because of pollution. In rivers that flowed pure, factory and farm wastes now threaten our health. And many of the forests where deer, bears, and other animals roamed free no longer exist.

Growth and industrialization are often the cause of this environmental destruction. To be honest, they have brought with them a standard of living envied by the rest of the world. We need to make no apologies for that. But we must admit that we paid too little attention to the scars that growth left behind in North Carolina and elsewhere.

Now attention is turning to conservation and preservation of our natural resources. North Carolina State University's new Natural Resources Research Center is one of the many signs of that. And we must do more. We must build a public consensus to support the immense undertaking necessary to reverse environmental damage. There are several steps we can take.

First, we need scientists to help us understand the issues and to shape the policies we need.

We can take comfort that in many public opinion polls Americans have said they are ready to pay more and to scale back some comforts to help improve environmental quality. That certainly is a positive sign, but there is a big difference between answering a pollster's question and actually paying a real price.

This is not to say that Americans are spoiled and won't make sacrifices. They simply need convincing that global warming is a real problem, not simply a theory, and that the burdens we ask of them will be burdens shared by others. We need convincing evidence, and we need to communicate it effectively.

There is a healthy skepticism among Americans that insists their leaders come to them with thoroughly examined problems and solutions. I hope that the discussions at the 1990 Emerging Issues Forum brought us closer to a solid consensus that we must take action.

Second, all of us must take upon ourselves the leadership of a movement to bring the public closer to solutions.

I mean that we must examine our nation's problems and the proper role of government. We should exert leadership to ensure that we no longer postpone the tough decisions about the environment.

I am pleased that President Bush has acknowledged the problem of global warming with his proposal to plant a billion new trees in this decade, including trees in urban areas. An acre of growing trees can absorb up to nine tons of carbon dioxide a year. But planting trees will be little more than a symbolic gesture unless we combine it with other, more comprehensive – and costly – efforts.

Simply to hold carbon dioxide output steady could cost as much as 1 to 2 percent of our national income, by some estimates. To gain public acceptance for a new burden of that magnitude will take a much more vigorous leadership effort by scientists, government, industry, and the media. The problem of global warming is too important to leave to business as usual. You need to be involved.


Third, we must recognize and make the most of the many opportunities around the world to mend our planet. Solutions to our global environmental problems will require international cooperation on an unprecedented scale. Right now, we face a tremendous opportunity for repairing the extensive environmental damage in Eastern Europe, the result of a single-minded policy of building heavy industries there. I was especially delighted to learn that five east-bloc nations have invited teams from our U.S. Environmental Protection Agency to help them with pollution problems.

The rise of democracies in Eastern Europe presents another opportunity as we reduce the burden of military spending in NATO and Warsaw Pact countries. These countries account for close to a trillion dollars a year in military spending. I believe the necessity for that spending has eroded significantly.

The peace dividend, in other words, is not simply a budgetary abstraction. It is very real and about to become a worldwide phenomenon, which can free up tens of billions of dollars in current annual spending for a greatly increased worldwide environmental effort.

Finally, let us remember that global warming is fundamentally a human problem – a problem of basic attitudes, lifestyles, and interests.

Global warming will demand more research, more commitment, more creativity, and more international cooperation than we have ever needed in our history.

I recall what one of our astronauts said after returning from the moon. Asked what struck him most about his historic journey, he replied, "I could hold up my thumb and blot out the whole Earth." That underscores what all of us increasingly understand – the Earth is a small, fragile place that today needs protection from the ravages of our own doing. I hope that each of us will carry forward from the 1990 Emerging Issues Forum a commitment to be at least a small part of a growing movement to provide that protection. 

Bill Clinton

“Our Common Future” demands long-term, global thinking on environment, speakers say

The threat of global warming requires a fundamental rethinking of our place on this planet, speakers stated and repeated at the Emerging Issues Forum in February.

“What is required of us is nothing less than a spiritual transformation in the way we see ourselves in relation to the natural world,” said Madeleine M. Kunin, governor of Vermont. “. . . We are not the center of the universe.”

One after another, scientists, politicians, business leaders, and public policy analysts picked up that theme and applied it in a number of ways. We must, they said:

- Learn to think in global and intergenerational terms.
- Recognize the complexity of environmental problems and the solutions they require.
- Approach environmental protection with the seriousness applied to traditional national security issues.

Approximately 1,500 people attended the fifth annual Forum Feb. 8-9 at North Carolina State University. The conference, titled **Global Changes in the Environment: Our Common Future**, combined the usual public policy forum with a full-day scientific symposium and the dedication of Jordan Hall, home of NCSU's new Natural Resources Research Center.

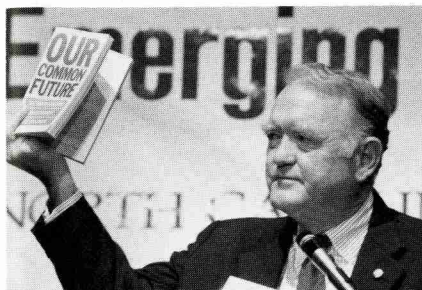
As they spoke of the grave challenges ahead, these leaders from different fields called for an alliance of politicians, scientists, economists, and theologians to find solutions for protecting the environment without relegating the undeveloped world to poverty and despair. Kunin predicted that the public is more ready to grasp those solutions than politicians have been willing to admit.

“I think once again that the depth and breadth of environmental concern in this country and throughout the world is being dramatically underestimated,” she said. “I believe that the public is way ahead of policy makers and growing increasingly impatient.”

Forum chairman James B. Hunt Jr., former governor of North Carolina, summed up the overriding message when he opened the public policy session. “Global warming is fundamentally a human problem,” he said, “a problem of basic attitudes, lifestyles, and interests.”

The first attitude challenged was the belief that humans have little impact on the total ecosystem. Exponential population growth and industrialization have skewed whatever balance once existed, we were told.

Said Carl Sagan, astronomer, director of the Laboratory of Planetary Studies at Cornell University, and keynote speaker: “Our technology and our numbers have reached a state where inadvertently we can pose a danger to the global environment, especially through the atmosphere.”



■ William S. Lee III delivered the concluding luncheon address.

Said Gilbert Grosvenor, president and chairman of the board of the National Geographic Society: "The forces of man are now of such immense power, they can threaten the very forces of nature, the very physical forces that make up the Earth itself."

Said U.S. Sen. Albert Gore Jr.: "There's an assumption now on the part of the skeptics who minimize and deny the existence of a global environmental crisis. They assume the Earth is so vast and nature is so powerful, human beings can't possibly overwhelm it. Just ain't so."

Recognizing these realities may change not only the way we see nature, but the way we see ourselves. "To some of you hearing scientific discussions of global warming for the first time, it may sound like science fiction," said V. Ramanathan, professor of geophysical sciences at the University of Chicago. "The only difference from conventional science fiction is that the villains are not aliens from another planet but we, the so-called intelligent life on this planet."

With our ability to destroy our environment, the speakers said, comes the responsibility to save it.

"Some scientists say that within the lifetimes of people in this room we may witness the loss of more than half of all the living species on Earth," Gore said. "My religious faith teaches me we are given dominion over this Earth, and if we witness with our own two eyes as a result of our own collective actions while we are alive on this planet the destruction of more than half of all the living creatures God put on this Earth, then we must accept the responsibility for preventing that outcome. We must not allow that to occur."

Intoning the parable of the faithful servant, Gore said, "Our home is being ransacked. We are accountable for protecting it against the destruction that is occurring."

Protection, however, will be difficult. Once environmental action meant collecting trash from the roadsides. Then it required cleaning up rivers and waste dumps that posed immediate, local hazards. Gradually, we saw that toxics and organic substances dumped upstream could endanger estuarine systems on the coast, that acid rain from midwestern states could damage trees, lakes, and human edifices in New England and the Southern Appalachian mountains, that the extinction of a single species could send shock waves reverberating throughout an ecosystem, that careless acts today could haunt generations to come.

The response to the environmental crisis must be global, transgenerational, and holistic, we were told.

"National boundaries have no bearing on these global environmental issues," Sagan said. "No one nation can solve this problem by itself. It has to be all the nations working together."

From William C. Clark, senior research associate and lecturer in Harvard University's Science, Technology, and Public Policy Program, came an equally somber thought. These are "our choices to make," he said, "our grandchildren's choices to live with."

No one answer will solve all the world's environmental problems, and no speaker claimed to have all the answers. But common ground emerged. They spoke of sustainable development, of clean, renewable energy sources, of revamping political and economic systems that now encourage inefficient, destructive uses of natural resources.

Gro Harlem Brundtland, former prime minister of Norway and chairman of the United Nations' World Commission on Environment and Development, called poverty "the most serious and fundamental problem we face, both for the environment and for human destiny." In a speech delivered by W.H. Lindner, executive director of the Center for Our Common Future, she showed the link between environmental degradation and deepening poverty. "Protection of the environment does not inhibit economic activities," she said. "Rather, it is at the root of economic activities."

Her remarks emphasized the need for equity in resource allocation and universal responsibility for action. "Our trends in overconsumption and inefficiency cannot continue," she said. "Just as the poor countries must develop, so must the industrial countries develop. Automobiles must now have much greater pollution controls and much greater fuel efficiency. Industry cannot continue to fill the air and the water with chemicals that cause acid rain, deplete the ozone layer, or endanger coastal areas with chemical wastes. Government regulations must prevent this, and government incentives must promote changes. All segments of the world must be engaged in the effort."

Grosvenor noted that it is difficult to fathom the depths of the environmental problem and to see the global connections. "So what do you do?" he asked. "How do you introduce a long-term, permanent environmental ethic among nations and peoples?" The answer, he said, lies in education, which he described as a relatively inexpensive solution that can be accomplished in a single generation.

He predicted that the major summits of the 21st century will focus on the environment: air and ocean pollution, global hunger, deforestation, desertification, population balance, and conservation. "But if our people don't understand geography," he said, "how can our leaders form a consensus and sell us on the short-term sacrifices for global change? . . . Without global knowledge, no one can understand that an ozone hole over Antarctica affects people in Raleigh or that the destruction of tropical rain forests in Brazil affects the climate of Winston-Salem."

“Our home is being ransacked. We are accountable for protecting it against the destruction that is occurring.”
—Albert Gore Jr.

While there may be many pieces to the solution and the answers may change as we learn more about the interrelationships of natural systems, speakers said, our approach must be cohesive. Calling the environmental crisis a “syndrome of planetary transformation,” Clark compared it with the treatment of human illness. We cannot rest with treating individual symptoms, he said. We must attack the underlying disease.


“It is managing the syndromes rather than picking off an acid rain problem today and a lead pollution problem tomorrow and a little bit of a drought stress problem the third day, each in a different university department, each in a different federal agency—that is the challenge we face,” he said.

The belief that human action is causing global climate change was not unanimous among the Forum’s speakers. Wallace S. Broecker, Newberry professor of geology at Columbia University, pointed to evidence indicating a basic instability in the Earth’s climate. The sun’s electromagnetic field and ocean currents, which lie outside human control, may have caused past climate changes, he said.

Even so, Broecker said, human beings are engaged in “an enormous experiment in climate modification” and called for a massive scientific undertaking to increase our knowledge of the environment and our relation to it.

Sagan answered skeptics with words of caution. In dozens of planetary explorations, he said, we have found life on no other planet — “not a mouse, not a footprint, not a microbe, not even an organic molecule.” This should tell us that there is “something rare and precious about this planet,” he said, and past extinctions make clear that not only is life rare, but it is tenuous.

For that reason, he said, we must take the threat seriously rather than requiring certainty of scientific predictions. He noted that the United States has invested \$10 trillion in the military buildup since World War II. “How certain was it the Russians would invade?” he asked. “The thinking was, ‘If the threat is great enough, you prepare for the worst scenario.’ Why doesn’t that thinking apply to global warming?”

Furthermore, he said, policies being advocated to counter global warming all make sense on other grounds as well—helping to clean up acid rain, end our dependence on foreign oil, or improve the human condition in the Third World. But adoption of policies today will never be enough, the speakers said. Just as eternal vigilance is the price of freedom, so is it the price of a habitable planet. Environmental protection, Kunin said, “is never a done job.” 



Global warming threatens life on Earth, Sagan says

Greenhouse warming is a serious threat to life on this planet, Carl Sagan said in the keynote address of the 1990 Emerging Issues Forum, and it warrants the same consideration given to traditional national security issues.

He chided the doubters who point to the uncertainty of the predictions about global warming and its effects, noting that the United States has spent \$10 trillion on defense since 1945.

“How certain was it that the Russians were going to invade?” he asked. “Was it 100 percent certain? Guess not, since they never invaded. What if it was only, let’s say, 10 percent certain? What would advocates of big military buildup have said? They would have said, ‘We must be prudent. It’s not enough to count on only the most likely circumstance. If the worse happens – and it’s really extremely dangerous for us – we have to prepare for that. . . .’ It’s classic military thinking. You prepare for the worst case.

“And so now I ask my friends who are comfortable with that argument . . . why doesn’t that same argument apply to global warming? You don’t think it’s 100 percent likely? Fine. . . . If there is only a small probability of its happening, since the consequences are so serious, don’t you have to make some serious investment to prevent it or mitigate it? I think there’s a double standard at work, and I don’t think we should permit it.”

In a speech that earned him a standing ovation, Sagan explained why he takes global warming seriously and what he thinks should be done to mitigate it. But first, the astronomer, author, and television personality looked to space and time to explain why planet Earth should be protected from the ravages of human activity.

Dozens of planetary explorations have found no sign of life anywhere else in the universe, “not a mouse, not a footprint, not a microbe, not even an organic molecule,” he said. “There is something extraordinary about the planet that we are privileged to live on and, in this peculiarly self-congratulatory way, about us ourselves. Life is rare.”

Rare and tenuous. The geologic record of mass extinctions demonstrates “there is no guaranteed tenure for any species,” he said. With no guarantee, it follows that, if life is to continue, the conditions that enable its existence must be preserved and protected.

Instead, he said, they are being threatened by what has become known as the greenhouse effect, a condition by which certain gases trap heat in the atmosphere. Some scientists predict the increases in greenhouse gases could raise average global temperatures 4 degrees C or more in the next half century.

There’s no question a greenhouse effect exists, Sagan said. Without it, Earth’s temperature would be 20 degrees C below zero, incapable of supporting life. But a runaway greenhouse could be equally disastrous, and that is what the planet faces. Scientific records can demonstrate increases in the levels of greenhouse gases, such as carbon dioxide, and in global temperatures, he said. “The slow increase with time is becoming abundantly clear,” he said. “One indication of

“How certain was it the Russians would invade? . . . The thinking was, ‘If the threat is great enough, you prepare for the worst scenario.’ Why doesn’t that thinking apply to global warming?”— Carl Sagan

that is that the five hottest years of the 20th century were in the decade of the 1980s. That is also the decade that had the highest abundance of all of those greenhouse gases."

Furthermore, he said, records from the Antarctic ice core, show a virtual one-to-one correlation between past temperature increases and increases in atmospheric carbon dioxide.

No one understands all of the evidence and the implications for feedbacks that could worsen or ameliorate warming conditions, he said, but given the possible range of predictions, the degree of scientific consensus is amazing. And frightening.

"Several degrees is a very major temperature increase, and some of these predictions prognosticate that the American Midwest will be converted into something approaching scrub desert by the second half of the 21st century, and likewise the Soviet Ukraine and so on. But the American Midwest is the breadbasket of the world. If the grain and cereal foodstuffs from those places are unavailable, we are in serious trouble."

Further trouble could result if the oceans rise as a result of the polar ice caps melting. Populous low-lying areas could be flooded, he said, creating "environmental refugees."

These threats make the prospect of global warming so serious that it demands response, he said. "Unlike the military buildup, which made no sense whatever except if you were confident that there was a real danger of Soviet troops pouring across the Elbe," he said, every precaution that should be taken with regard to global warming makes sense on completely separate grounds.


He outlined five proposals:

— **Immediately halt production of chlorofluorocarbons, a manmade greenhouse gas also blamed for drastic reductions in the Earth's protective ozone shield.** This would benefit the environment both in terms of the greenhouse effect and in halting destruction of the ozone layer, he said, and the first steps have already been taken. "We're not as immobile and resistant to these arguments as you might otherwise expect."

— **Increase energy efficiency.** The United States contributes more carbon dioxide—a byproduct of burning fossil fuels—into the atmosphere than any other nation on Earth, he said, and one-third of it comes from automobiles. "Why do we permit automobiles that get 15 to 25 miles a gallon when the technology exists for automobiles that get 60 to 100 miles a gallon?" Similar arguments could be made about other fossil fuel use, he said. Increasing energy efficiency would have further advantage of decreasing U.S. dependence on foreign oil supplies.

— **Seek alternative energy sources that do not produce carbon dioxide.** The mix of tidal, geothermal, wind, and especially solar looks promising, he said, and again would decrease dependence on foreign oil. Solar energy research lost 10 years to funding cutbacks during the Reagan administration that have yet to


■ In his keynote address, Carl Sagan emphasizes a point.



be restored, he said. "Despite that, the progress in solar energy technology has been steady and impressive, and if you were to levy an environmental tax on the burning of fossil fuels to pay for the additional burden on society from the increase of the greenhouse effect, even today, solar energy would be economically competitive with fossil fuels. And if we were to spend some significant amount of research money on solar energy, the price per kilowatt hour would certainly go down."


— **Plant trees.** Trees, like other plants, remove carbon dioxide from the atmosphere for use in photosynthesis. "Plant forests. That seems to be good advice to mitigate greenhouse warming. Instead, the human species is destroying forests, and we're doing it at the rate of an acre every second. . . . We're doing something immensely stupid." Halting forest decline would not only help remove atmosphere carbon, he said, but could also preserve species diversity.

— **Deal with the world population crisis.** This may be the most important way to mitigate greenhouse warming, Sagan said, and it has equally profound ramifications for world political and economic stability. Even minimal standards of life require activities such as cooking and heating that with current technologies release carbon dioxide into the atmosphere. "If we continue exponential population growth, it will overwhelm any of the other measures that I've been talking about no matter how seriously they are approached," he said.

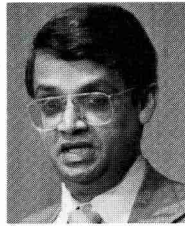


The way to respond to population growth is by improving standards of living. "It's not that the billion poorest people on the planet are too dumb to understand that they shouldn't have more children. That's not the issue. The issue is that they are so poor that more children is a kind of social security to provide for their old age." Around the globe, in every kind of political and cultural system, he said, a rise in per capita income results in lower birth rates. The issues of global warming and environmental protection transcend national boundaries, Sagan said. "Solving these problems requires a transnational and a transgenerational perspective," he said. "To my mind, that's a very grown-up kind of perspective — deprovincializing, dechauvinising — an awareness of one species on one exquisite, fragile planet."

For those who still doubt, Sagan points again to space and specifically to the planet Venus, which is nearly identical to Earth in size, mass, and density. Atmospheric pressure 90 times that of Earth's and a surface temperature of 900 degrees F make it inhospitable to life. The temperature is caused not by proximity to the sun, he said, but by the tremendous amounts of carbon dioxide in the atmosphere — a runaway greenhouse effect.

"The lesson is not only that a greenhouse effect can exist but that a large greenhouse effect can be exceptionally dangerous," Sagan said. "So for anyone who views our exquisite planet and hears the warning of scientists and says, 'All this greenhouse stuff is just some theory,' I ask him to reflect on the fate of the planet Venus, our nearest planetary neighbor." 

Scientists ask when, not whether, we'll feel the heat



Global warming is not theory so much as certainty, a distinguished panel of scientists told the Emerging Issues Forum. The questions, they said, lie in how hot, how soon, and how many concurrent, amplifying phenomena are to be expected.

"The question is at what concentration levels will these pollutants, or these greenhouse gases, trigger a major, unprecedented climate change," said V. Ramanathan, professor of geophysical sciences at the University of Chicago. "Are we reaching the stage in the near future, or can we keep going on recklessly for another several decades before we reach such a stage? To me, that is the uncertainty."

Others described drought conditions, accelerated respiration rates in plants, rising ocean temperatures, and sea level changes that could magnify the effects of the initial atmospheric warming or otherwise wreak havoc around the world. As

"Global warming is fundamentally a human problem—a problem of basic attitudes, lifestyles, and interests. It will demand more research, more commitment, more creativity, and more international cooperation than we have ever needed in our history."—James B. Hunt Jr.

they spoke, the term "positive feedback" took on troubling connotations. Tracing likely patterns of drought, NASA climate modeler David Rind said, "Were this condition to actually occur, I think it's not overly dramatic to say this would be the end of civilization as we know it. Severe drought of this intensity over that magnitude of the [developed] world or even the Third World, that would be unsustainable." Wallace S. Broecker, Newberry professor of geology at Columbia University, pointedly refrained from attributing observed planetary warming to human activities. Nonetheless, he said, modern society is engaged in an enormous experiment in

climate modification as the burning of fossil fuels pumps carbon dioxide into the atmosphere.

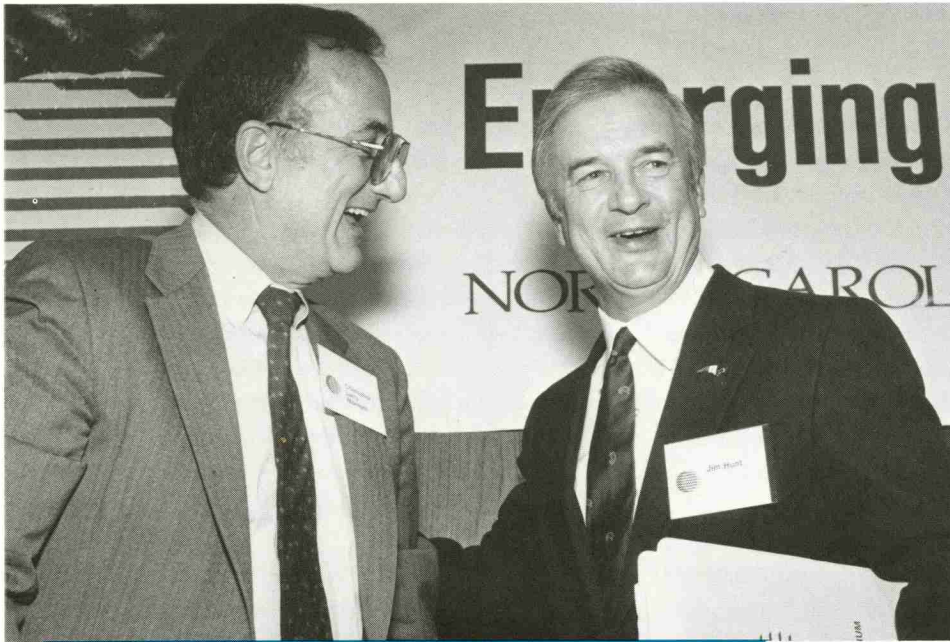
At the heart of this scientific discussion lie predictions that the buildup of greenhouse gases in the atmosphere will increase average global temperatures between 2.5 and 5.5 degrees C (roughly twice that in Fahrenheit) by the middle of the next century. The most frequently quoted figure is 4 degrees C. The predictions are based on computer models of the Earth's climate.

The "greenhouse effect" derives its name from the way these gases—primarily water vapor and carbon dioxide, but in smaller quantities methane, chlorofluorocarbons, nitrous oxide, and others—trap heat in the atmosphere. It resembles the way a horticultural greenhouse functions.

Although some of these gases, such as chlorofluorocarbons, occur only as a result of human activity, others in their natural abundance help make the planet habitable. Without them, the Earth would be too cold to support life.

Over the last century, however, these gases have been increasing. The level of carbon dioxide, a byproduct of burning fossil fuels and the chief culprit usually cited in global warming discussions, has increased 25 percent. Nitrous oxide is up 19 percent; methane, 100 percent. These measurements coincide with the rise of industrialization and its heavy reliance on fossil fuels for production and transportation. They also coincide with an observable increase in temperature. The average global temperature has risen six-tenths of a degree C during the same time period.

Though causal relationships cannot be established with certainty, these observations correspond with other findings. Analysis of ice core samples taken from Antarctica, for example, show a clear correlation between carbon dioxide levels and past warming trends.



■ Chancellor Larry Monteith and Forum Chairman Jim Hunt

Scientists also are concerned because of the time lag involved in any corrective actions. Forty percent of all CFCs released today will still be in the atmosphere 100 years from now, Ramanathan said. It will take another 100 years to cut that in half again. "So we are talking about a problem not only global in nature but living long after us," he said. ". . . With each passing decade, the problem gets larger and more complex."

In fact, some models say the Earth is committed to a 2 degree C warming based on carbon dioxide already released into the atmosphere. Additional CO₂ buildup is anticipated as developing nations increase their fuel consumption. The

"The forces of man are now of such immense power, they can threaten the very forces of nature, the very physical forces that make up the Earth itself."—Gilbert M. Grosvenor

destruction of forests—which is occurring rapidly in the tropics—creates a double-whammy, releasing stored carbon into the atmosphere and eliminating "consumers" of carbon dioxide. If these activities continue at their present rate, according to the models, we can expect a 4 degree C warming.

"To put that in perspective, 4 degrees is about the order of magnitude we feel the ice ages were colder than today," Rind said.

The scientists acknowledged the uncertainties involved in climate modeling, but noted that trends to date are consistent with the models' predictions. As the models have become more sophisticated, too, Ramanathan said, they have moved closer to agreement with one another, converging on the upper ranges of predicted change.

And even if the models are wrong, Rind said, they could be wrong in either direction. "Maybe the models are overestimating the warming," he said. "Maybe it'll happen slower. Maybe the oceans will absorb more heat from the atmosphere. But, on the other hand, both of these things could work in the reverse. The models could be too insensitive. The oceans could take up heat less rapidly, and the whole thing could come more rapidly."

The potential for positive feedbacks complicates the issue and could increase regional variabilities. Ramanathan said temperatures at the poles could increase one and a half to three times the average warming as the ice cap—which previously reflected heat—melts to reveal more heat-absorbing ocean. Warming the oceans also increases evaporation, he noted. Because water vapor is a greenhouse gas, that in turn could cause more warming. As yet another issue, he said, warming the oceans may increase the range in which tropical storms develop.

The major "wild card" is cloud cover, he said. Currently, clouds have an overall cooling effect because they reflect heat back into space, but they also have the ability to block radiant heat from escaping the atmosphere, he said. The difference, he explained, may be felt between the shade of a cloud on a hot day and the way nighttime clouds prevent overnight cooling. It's uncertain which effect may

dominate in a warmer climate, he said. *George M. Woodwell, a biologist and director of the Woods Hole Research Center, introduced another possibility for positive feedback: plants.*

"Biotic systems, living systems, particularly those on land, play a much larger role in determining the composition of the atmosphere with respect to the heat-trapping gases than most of the climatologist, meteorologists, oceanographers, and others who've dealt with this problem have recognized," he said. By increasing the respiration rate of plants, he said, climate warming could lead to even further warming.

For evidence, he pointed to recorded levels of atmospheric carbon dioxide that show yearly oscillations. Carbon dioxide peaks in late winter and reaches its minimum in late summer. The cause, he said, is the metabolism of plants—primarily forests—in the Northern Hemisphere. Plants store carbon through photosynthesis during the growing season and release it during winter through respiration, which he described as "the process of breaking down carbon compounds and turning them into carbon dioxide, heat, and water." Plant respiration can account for a 1 or 2 percent change in atmospheric carbon dioxide levels in just a few weeks, he said.

The potential is far greater. It's estimated that plants and soil hold up to 2 trillion tons of carbon. The atmosphere, by contrast, contains only about 750 billion tons in its stable state. The oceans and fossil fuel deposits hold still more, and there are constant exchanges among all of these systems. But the exchanges are now out of kilter. The atmosphere has been collecting an excess of 3 billion tons every year—about half the annual release of carbon through burning of fossil fuels—and it's this excess, along with its heat-trapping ability, that causes concern about global warming. Were it not for the metabolism of forests, Woodwell said, even larger amounts of carbon would be collecting in the atmosphere.

"Any factor that affects one of these flows has the potential for affecting the composition of the atmosphere significantly in a short time," he said. Global warming is one such factor.

With warming, he said, several things will happen. The warmer oceans will be able to take in less carbon, and with sufficient warming, they'll actually release pools of stored carbon back into the atmosphere, which will be one positive feedback.

Rapid warming of terrestrial ecosystems also is likely to increase the respiration rate of plants, especially if the models are correct in predicting the greatest warming in the winter months, he said. On the other hand, he said, warming will have little effect on photosynthesis. "The net result will be a further release of carbon into the atmosphere," he said. Even more greenhouse gases—either carbon dioxide or methane—will be produced by faster rates of decay in the warmer climate, he said. More greenhouse gases, more warming: positive feedback. Hotter and hotter, drier and drier.

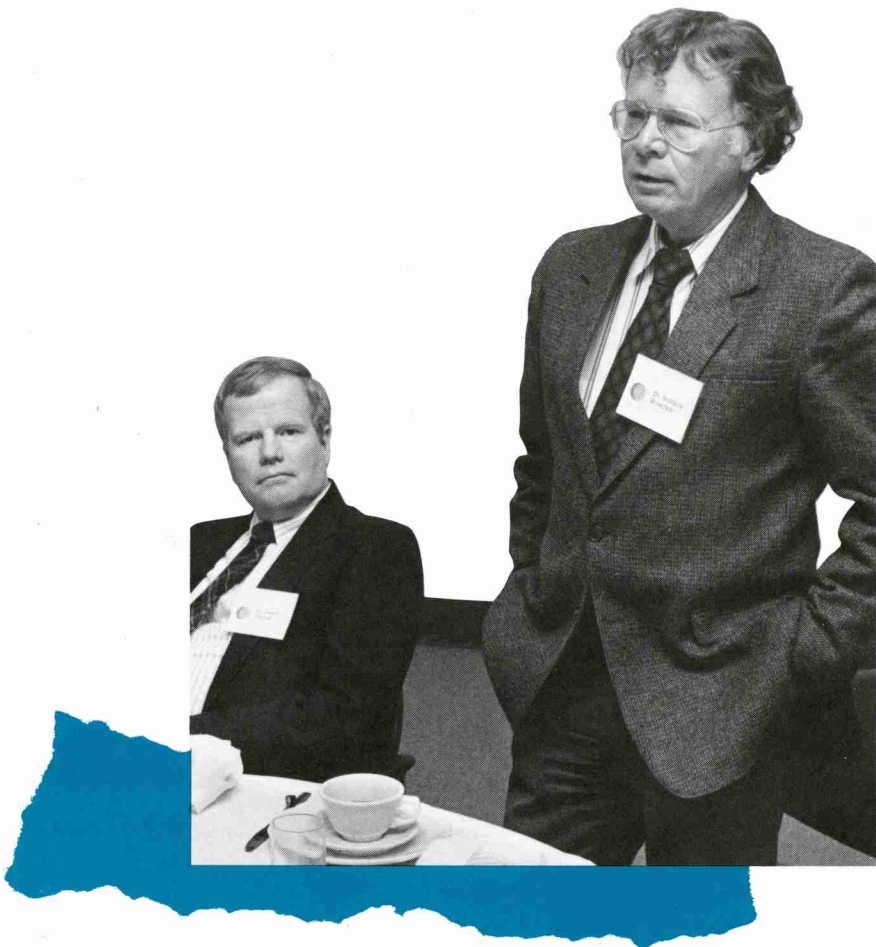
***"Were a 4 degree C global warming to actually occur, I think it's not overly dramatic to say this would be the end of civilization as we know it."* — David Rind**

The most extreme, potentially damaging aspect of global warming lies in widespread drought, said Rind, a climate modeler with NASA's Goddard Institute for Space Studies. "From removing excess heat in electrical power plants to agriculture to drinking, almost everything we do is associated with how much water we have available," he said.

But a warm atmosphere can hold more moisture and will draw it both from land and water, he said. Increasing evaporation, however, will not result in increased precipitation. Instead, the models predict an overall 15 percent decrease in precipitation.



■ David Rind from NASA Goddard addressed round two of the scientific symposium.



■ Wallace Broecker responded to a question from the floor.

“I think the Earth is sort of an ornery beast. When provoked, our climate system does some odd things.”—Wallace C. Broecker

Rising temperatures, he said, will cause a geometric increase in drought conditions. A 2 degree C increase in temperature could spread severe drought—of an intensity currently experienced over only 1 percent of the Earth’s surface—over 8 to 9 percent of the globe. By the time the average temperature has increased 4 degrees C, he said, extreme drought will cover 40 percent of the land.

The changes will not be uniform. Rind used a video and a series of color transparencies to show anticipated changes in temperature and hydrologic regimes. These showed drought following rising temperature patterns, appearing first in inland areas and the lower latitudes, but gradually spreading. Areas already warm will suffer first because the air there can hold proportionately more moisture, he

said. By the 2050s, in the scenario based on a 4 degree C warming, he said, extreme drought could extend across most of the United States.

By contrast, some high latitudes may show an increase in precipitation, he said. “When you warm the climate and the low latitudes can hold a lot more moisture, that moisture is not sufficient to saturate low latitudes and produce rain, but when that moisture is advected to the high latitudes, which are cooler and therefore can hold less moisture and are easier to saturate, then it does rain quite a lot,” he said.

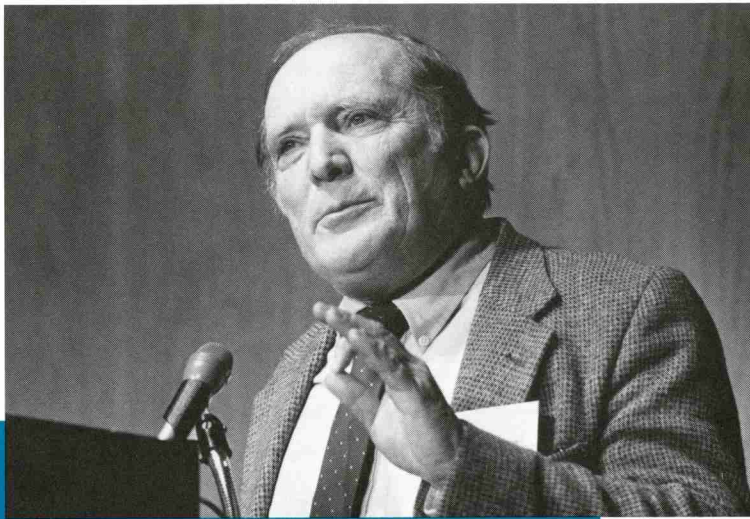
With this warming, however, plants will demand more moisture, and the increased precipitation “is nowhere near the magnitude necessary” to keep up with demand, he said. As a result massive diebacks of up to 50 percent of the biomass could be expected in areas such as northeastern United States.

Extreme drought becomes the average condition, he said. “If that degree of warmth happens,” Rind said, “I can’t see how we can possibly sustain a civilized society with this depression in water availability.”

Two other speakers looked at the oceans from a different perspective. *William E. Carter*, chief of the advanced technology section of the Geodetic Research and Development Laboratory of the National Geodetic Society, dealt with sea level changes that may result from global warming, and Broecker, of Columbia University, argued that natural phenomena rather than human activity could account for CO₂ accumulations.

Sea level changes are difficult to measure, Carter said, but readings from several sources point to an average 1.6 millimeter annual rise in sea level. This is after adjustment for glacial rebound—alterations in the Earth’s crust following

■ George Woodwell, Director of the Woods Hole Research Center, spoke to the final round of the scientific symposium.



“From the perspective of a biologist, it appears urgent to recognize that the era of fossil fuels has passed.”—George M. Woodwell

the end of the last ice age. The temperature increase in the oceans and melting of alpine glaciers can account for changes so far, Carter said. But alpine glaciers account for only 1 percent of the Earth's ice mass, so any future changes affecting the poles, with 90 percent of the ice mass, or Greenland, with 9 percent, could have a significant influence on sea level.

With the observed changes, he said, the impact is most likely to be localized. Greater than average relative rises in sea level are occurring along the Southeastern United States because of the dual phenomena of glacial rebound and higher water, he said. Here land that had bulged out as a result of the weight of glaciers to the north is sinking in relative terms just as the water level rises.

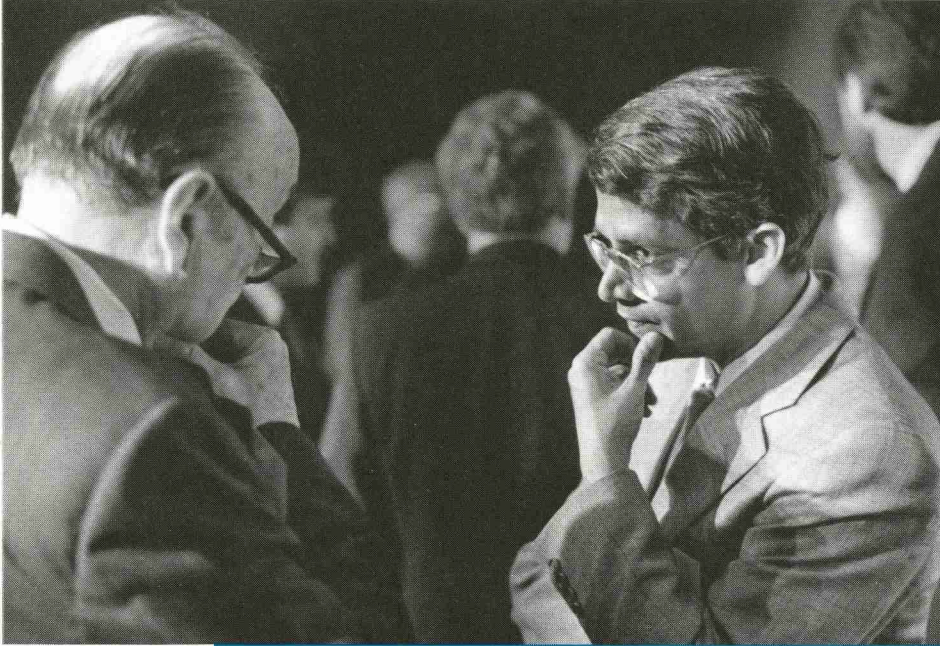
Broecker began with a set of assumptions that differed from most of the other speakers. Where they characterized the biosphere-atmosphere as a naturally stable system, Broecker said the past 9,000 years have been an abnormally calm period.

“I may not be able to say where the Earth is going to go, but I can say with full conviction that the Earth is anything but a self-stabilizing system,” he said. “I think the Earth is sort of an ornery beast. When provoked, our climate system does some odd things.”

Furthermore, he said, recorded temperature changes cannot be used to prove global warming theories. The planet began pulling out of the last of a series of cold phases called the Little Ice Age

“Water availability turns out to be . . . the most extreme, potentially damaging aspect of this question of climate change.”—David Rind

around 1850, he said, and warming may merely reflect that. “Now, it's possible . . . that we would've been going into another of these phases of the Little Ice Age, and what's happened is that the warming has more than compensated for what might have been a natural cooling,” he said. “On the other hand, maybe the Earth is coming out of the Little Ice Age, and that's all natural.”



■ V. Ramanathan reflected on forum proceedings.

Radiocarbon content of the atmosphere suggests that the relatively small climate changes in the Little Ice Age may have been related to changes in the electromagnetic field of the sun, Broecker said, but he was more interested in the greater transitions from full glaciation to full interglaciation.

The differences in the two periods are dramatic, he said: During glaciation, sea level dropped 125 meters, atmospheric dust rose by a factor of 10, and the average temperature fell by 5 degrees C. During interglaciation, carbon dioxide content of the atmosphere was 40 percent higher and methane, 100 percent higher.

“So we are talking about a problem not only global in nature but living long after us . . . With each passing decade, the problem gets larger and more complex.”—V. Ramanathan

But most astounding, Broecker said, are not the big transformations between the two periods, but the rapidity with which they took place. “These were

crashing halts of glacial periods,” he said. He explained it with a theory involving ocean salinity, deep sea circulation, and the influence of the oceans on the atmosphere.

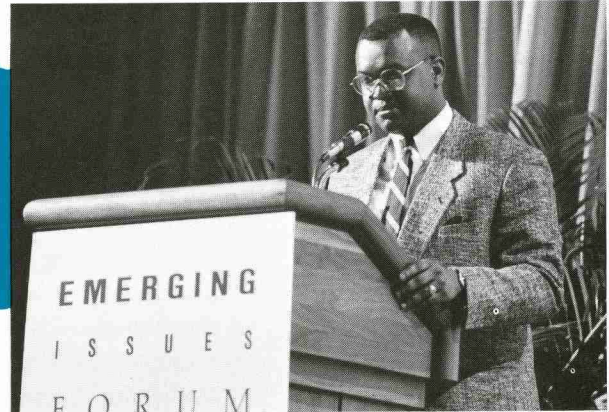
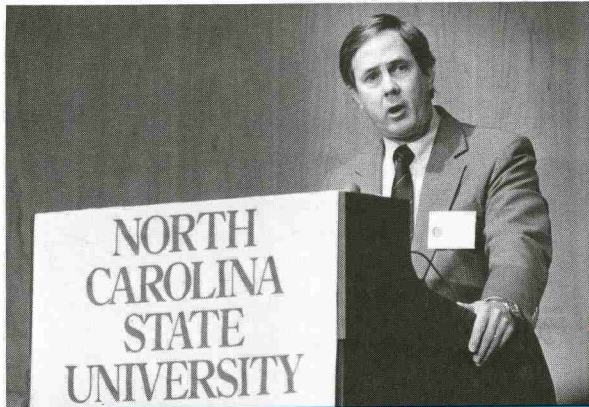
“As I see it, what happened in these periods of large change is that the Earth’s system underwent a monsoonlike reorganization,” he said. “One century it was operating one way, then its salt budget got out of balance to the extent where it was no longer efficient to operate in that way, and the system went into chaos, reformed, and operated another way. And when this happens it’s not only the ocean that changes. Because the ocean has such a great influence on the atmosphere, the atmosphere changes, the cloudiness changes, the CO₂ changes, the methane changes, the winds change, so the whole system can, you might say, jump from one state to another.”

Also worth noting, he said, was that during the ice age, the climate was much less stable than now. Dust levels and temperature ricocheted constantly. “To me it says the system during that time wasn’t functioning locked into a given mode,” he said. “It was bouncing back and forth between a couple of modes.”

Still, Broecker and others offered some advice for the more immediate problem. Planting trees—though a worthwhile project for other reasons as well—is no panacea, they said.

“National boundaries have no bearing on these global environmental issues.”—Carl Sagan

■ Jerry L. Whitten, Dean of the College of Physical and Mathematical Sciences




■ Brian Nixon, NCSU Student Body President

Both Rind and Woodwell advocated reducing carbon dioxide emissions. "From the perspective of a biologist," Woodwell said, "it appears urgent to recognize that the era of fossil fuels has passed, that we absolutely have to abandon them as rapidly as possible and seek alternative sources of energy to drive the industrial societies and to support the development of the less developed world."

The political actions that should be taken have not changed in the past 20 years, he said, nor are they likely to change in the next 10. "One can only hope," he said, "for an early spring greening of one Bush."

Broecker was less than optimistic about reducing total CO₂ emissions, particularly in light of Third World population growth. Less developed countries must increase their energy use to raise standards of living, he said. "The root of all of our problems is really in that we're going to overpopulate the planet," he said.

Instead, Broecker called for increased funding for scientific research and education worldwide. Noting the breadth of environmental problems facing every country, he said the number of environmental scientists needs to be increased 10 times in the next 30 years. "We need a cadre of wise people to counsel society on what are the cost-effective ways to deal with all these problems, and we have to know, to do that, as much as we can about the Earth's system," he said. 

"One of the great challenges facing North Carolina is the need to pioneer a path between preservation and progress. —James G. Martin

Urgency unites the messages of governors and U.S. senator



Optimism and caution mingled in equal measures when public officials discussed environmental concerns at the 1990 Emerging Issues Forum.

Optimism because of growing public sentiment in favor of protecting the environment, because arms control treaties have shown we can and will respond to perceived danger, because political changes in Eastern Europe demonstrate that miracles do happen.

Caution because so much must be done to reverse the current course of environmental degradation.

Three office holders who addressed the Forum brought different perspectives but a common sense of urgency:

Madeleine M. Kunin, governor of Vermont and chairman of the National Governors' Association Committee on Energy and Environment. She not only has strengthened environmental measures in her own state, but has guided opposing interests in the Governors' Association to a broad consensus on acid rain and supported regional action to reduce toxic components in packaging.

Steve Cowper, governor of Alaska and a leader on energy issues for the National Governors' Association. In 1989, Cowper found himself battling corporate, federal, and natural forces when the worst oil spill in U.S. history gushed out of the Exxon Valdez into Prince William Sound. He also is working at national and international levels to protect the seas from overharvest.

"There's an assumption now on the part of the skeptics who minimize and deny the existence of a global environmental crisis. They assume the Earth is so vast and nature is so powerful, human beings can't possibly overwhelm it. Just ain't so."—Albert Gore Jr.

Albert Gore Jr., U.S. senator from Tennessee and chairman of the Senate's Environmental and Energy Study Conference. He chaired the first congressional hearings on the greenhouse effect and wrote the World Environmental Policy Act of 1989.

Kunin called for strong leadership on environmental issues at the national and international level. "We've gone through a long period where at the federal level domestic issues have not received attention, where environmental issues have been ignored, and governors have had little choice but to devise our own solutions," she said.

She discussed steps Vermont had undertaken on a number of environmental issues, from reducing litter and eliminating billboards to preserving open spaces and removing toxics from the waste streams.

"Recently I issued an executive order to develop a Vermont strategy to address global warming, knowing full well that our small population could not change global trends, but also recognizing that the motto of thinking globally and acting locally is ours to realize," she said. "The executive order will require the development of a comprehensive energy plan which is designed to reduce greenhouse gases by 15 percent by the year 2000 and reduce per capita energy consumption by 20 percent over that same period, and for the first time we are requiring that energy choices, whether we choose oil or hydro or nuclear or whatever, will not be based on the economic cost, the dollars-and-cents costs alone, but that we will also measure to the best of our ability the environmental cost. In addition, we will require recycling, soil separation, and the reduction of the solid waste stream."

But it is time, she said, that these issues move from the state to the national and international agenda. "We governors can't do global warming by ourselves," she said.

Characterizing much-publicized battles within the Bush Administration as a "showdown between environmentalists and good-old-boy energy network," she said the title of environmental president has yet to be earned. It is time, she

said, to move "beyond doubt, beyond delay" to face the new moral and ethical challenges of the environmental crisis.

She called for a new personal value system in which we see ourselves as part of the natural world rather than apart from it. Citizens, who are far ahead of public officials on environmental awareness, must apply the pressure that will bring about change in consumer goods as well as government policies, she said. And a coalition of scientists, policy-makers, economists, and theologians must address the economic difficulties that will result.

Rescuing the environment will require a strong, well-articulated national and international strategy and a strengthened United Nations capable of enforcing global rules, she said. It will require long-term thinking, constant re-evaluation, and recognition that special interests must give way to the general interest of continued life on Earth. "Perhaps we are entering a time," she said, "when a democracy will be judged not only by the freedom of expression it permits, not only by the economic prosperity it can foster, but also by the environmental protection it offers its citizens."

Cowper recalled the frustration of trying to protect his state's coastline and fish hatcheries in the wake of the Valdez accident. About 15 hours after the ship hit the reef, he said, a "pancake" of oil four miles wide and eight miles long floated on top of the water. Working to contain it were two small boats with booms and another with a skimmer, but the skimmer wasn't working.

Rage and anger welled up, he said, and the powerful identification with the land, long pacified by the economic boon oil had brought to the state, "was no longer dormant in me or any other Alaskan."

As the state continues to assess the damage, he said, the nation is doing little to prevent other disasters. "The United States, the largest consumer of petroleum



■ Sen. Al Gore made a point to Gilbert Grosvenor, President of National Geographic Society.

in the world, has never taken seriously the risk of a major oil spill," he said. Although three-quarters of its oil is shipped by ocean-going tankers, it does not own a dredge-skimmer ship capable of handling a spill of the magnitude of the Valdez'.

He described the need for such ships in congressional testimony, he said, "and what I got was a glazed stare."

Cowper also spoke of the "tragedy of the commons." Outside the 200-mile territorial limits, he said, the ocean's bounty is threatened by the greed of a relative few. He described Alaskans' efforts to

"What is required of us is nothing less than a spiritual transformation in the way we see ourselves in relation to the natural world."—Madeleine M. Kunin

achieve an international ban on high-seas drift nets and discussions with the Soviets encouraging a bilateral agreement protecting migratory fish in the Bering Sea. In the end, he said, it may take trade sanctions and boycotts against such major abusers as Japan, Korea, and Taiwan to halt practices that abuse the world's natural resources.

"Oil in the waters of Prince William Sound is an outrage, especially to Alaskans," he said. "But reducing the risk



■ Vermont's Governor Madeleine Kunin addressed the public policy forum.

of oil spills is only part of what we have to do. As events like the Exxon Valdez create a sea-change in the political chemistry in this country and elsewhere, we have to be ready to offer environmental policy that is thoughtful and carefully drawn, and which takes into account the reality that economic considerations drive political decisions.

"In the end, environmental protection is a global responsibility. Progress will be slow, and it will be dominated by pragmatic decisions, made by governments which are increasingly democratic, acting on behalf of their constituents. The real work will be done through political organizing, rigorous analysis,

"Perhaps we are entering a time when a democracy will be judged not only by the freedom of expression it permits, not only by the economic prosperity it can foster, but also by the environmental protection it offers its citizens."—Madeleine M. Kunin

tedious negotiations, and by remembering what often happens to the best laid plans of mice and men."

Gore, in turn, pointed to the hidden tragedy of the Valdez. If oil from the Exxon Valdez hadn't leaked in the sound, he said, it would have leaked into the atmosphere in the form of carbon dioxide, one of the leading greenhouse gases. And as poorly as the United States is preparing

for the possibility of future oil spills, he said, its lack of response to the greenhouse effect is equally pitiful.

"Our human species has suddenly entered into a brand new relationship to the ecological system of this Earth," he said. "The change has been sudden. The implications are profound. Industrial civilization as it is currently constituted is on a collision course with the ecological system supporting life as we know it."

He traced the mirrored patterns of environmental problems: population growth, accumulation of greenhouse gases, destruction of the ozone layer, soil erosion, species extinction, loss of forests. He called for new lines on an imaginary graph charting those patterns. "We need leadership that goes straight up toward higher goals and higher values with courage and determination to face this problem," he said. "And then we need a change in the line measuring personal commitment on the part of each one of us."

A world birth rate that adds "one China every 10 years" must be brought down, he said. To do that, he said, "You have to concentrate first on saving the lives of children and empowering and educating women in areas of the world where they are now powerless and deprived of the information they need to control their lives." When child mortality drops, he said, demographics the world over show a corresponding drop in the birth rates as parents choose to have smaller families.

At the same time, he said, science and technology—which are equally responsible for many of the world's environmental problems—must be put to work on correcting them. "We need a Strategic Environmental Initiative to develop new technologies and widely disseminate them to soften this conflict now existing between economic growth and environmental protection," he said.

Responding to a question, Gore said President Bush should move now to convene a global environmental convention to reach an international commitment to reduce carbon dioxide emissions, stop deforestation, begin reforestation, immediately ban chlorofluorocarbons, and find a new approach to population control and development.

He called for a "global Marshall Plan" to enable economic development in the Third World. Such a plan, he said, must end policies that encourage short-sighted environmental degradation. "Governments have done more to create problems than individuals have," he said.


Furthermore, he said, the United States also must take steps at home to improve credibility on environmental issues. "The fastest species loss on the planet is in Hawaii," he said.



■ Sen. Al Gore and Gov. Steve Cooper discussed mutual concerns in a question and answer session.

"As events like the Exxon Valdez create a sea-change in the political chemistry in this country, we have to be ready to offer environmental policy which takes into account the reality that economic considerations drive political decisions."—Steve Cowper

For all of us, Gore said, the environmental crisis demands a new way of thinking. "At least since Aristotle, we have suffered the illusion that we are separate from the Earth, entitled to exploit it at will," he said. "And at least since the explosion of the hydrogen bomb, we have questioned the idea of the future."

But the idea of the future has re-emerged, he said, and it put an end to the arms race. "We used our God-given ability to see ahead and make changes now to create a different and a brighter future," he said. "We must now do the same thing where the impact of civilization on the world's environment is concerned." 

"How do you introduce a long-term, permanent environmental ethic among nations and peoples? . . . My answer is fairly simple. It's relatively inexpensive, and it can be accomplished in one generation. The answer is education."—Gilbert M. Grosvenor

Sustainable development called solution to problems of environment, poverty



The world environmental crisis is inextricably bound up in the problem of poverty, Gro Harlem Brundtland said in a message to the Emerging Issues Forum. "To solve both

our environmental and development problems," she said, "we have to have a new era of development that holds the environment and the poor in equal high esteem and that reconciles their needs with economic growth."

It's the philosophy behind the movement for sustainable development, and no one has been a more forceful or more compassionate advocate than *Brundtland*, the former prime minister of Norway and chairman of the United Nations' World Commission on Environment and Development. The 1987 report issued by the commission, *Our Common Future*, has become the centerpiece of wide-ranging discussions about world economic development.

The commission defined sustainable development as "meeting the needs and aspirations of people today without undermining the ability of future generations to meet their own needs and aspirations," Brundtland said in a speech

"To solve both our environmental and development problems, we have to have a new era of development that holds the environment and the poor in equal high esteem and that reconciles their needs with economic growth."—Gro Harlem Brundtland

delivered by *W.H. Lindner*, executive director of the Center for Our Common Future. "It means protecting the environment from pollution, and natural resources from overexploitation, while recognizing that the needs of people today must be met so they will have the opportunity not to degrade or overuse their environmental capital." The growing consensus that the planet should be

managed with a goal of sustainable development represents a maturing of the the debate over growth versus preservation, said *William C. Clark*, senior research associate and lecturer in the Science, Technology, and Public Policy Program at Harvard University.

People define it differently, he said, but more important than a universal definition is why the phrase and its broad concepts have caught on. "My own [idea]," he said, "is that this notion of sustainable development as a worthy goal for planetary management is reflecting a broadly based choice of values for managing the planet in which we choose equity to matter, we choose to focus on fairness. Equity, fairness among peoples of the world today, rich countries and poor. Equity, fairness between parents and their grandchildren."

Some of the basic facts giving rise to the discussion are:

- World population has more than doubled in the past 45 years, growing from 2 billion people in 1945 to 5 billion today.
- Projections estimate world population will reach 6.1 billion by the year 2000 and 8.2 billion by 2025 and 10 billion in 2050.
- Currently, almost 4 billion people, three-fourths of the world's population, live in poor, developing countries.
- Ninety percent of future population growth is expected to occur in these Third World countries.
- In 1985, more than 730 million people did not get enough food to lead fully productive lives. Half of those did not consume enough to prevent stunted growth and other severe health problems.
- In Africa, Asia, and South America, infant mortality rates range from 64 to 114 deaths per 1,000 live births.



■ Gov. James G. Martin enjoyed a word of advice from Bill Lee, Duke Power CEO.

□ In 1984, per capita income in the poorest countries was \$190 compared with \$11,430 in industrial-market economies.

□ One-quarter of the world's population consumes 75 percent of the world's energy

□ The richest 5 percent consume more than one-third of all fertilizer and one-half of all energy.

□ A child born in the United States consumes as many natural resources as 15 children born in developing countries.

□ Agricultural production is declining at about 1 percent a year in Africa.

□ Soil erosion is a major problem worldwide, including the United States, where erosion exceeds soil formation on about one-third of all farmland.

□ Productive land lost to desertification and other forms of soil degradation outpaces land put into agricultural use.

Under the pressure of an expanding human population, much of the world's natural resources are being overexploited and degraded. "The poor, when forced to

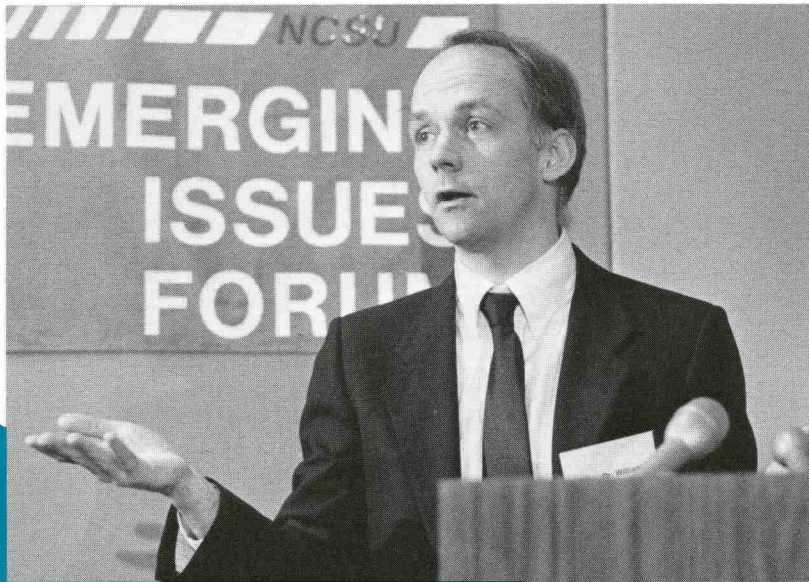
search for food and shelter, will do whatever necessary to satisfy their immediate needs," Brundtland said. Yet by depleting their resources, she said, the poor doom themselves to ever-deepening poverty.

Poverty, in turn, reinforces high birth rates. "Poverty and the insecurity that comes with it cause high birth rates and population growth," she said. "Insecure parents seek the security of additional hands to work the fields, to labor for food, to support them in old age. Women deprived of education don't understand

"With the knowledge we have today, we dare not abandon any of the means of generating electricity, nor should we put all our eggs in just a few baskets." —William S. Lee III

importance of spacing births. Families that see their young children die have even more as protection against losses."

Three-fourths of the world's people cannot be expected to continue living in poverty, Forum speakers said, but their



■ William Clark from Harvard's John F. Kennedy School offered his opinions at a forum press conference.

efforts to develop promise to place further strains on an already overtaxed environment. The prospect of additional carbon releases, increased deforestation, and spreading deserts gives the developed world practical as well as altruistic interest in Third World development.

"It is the idea not only that a healthy environment is critical to economic growth, but that economic growth is critical to success in maintaining the environment," Brundtland said.

"It is managing the syndromes rather than picking off an acid rain problem today and a lead pollution problem tomorrow and a little bit of a drought stress problem the third day, each in a different university department, each in a different federal agency—that is the challenge we face."—William C. Clark

Answers will not be easy. Referring to the Brundtland commission report, Clark said a five- to 10-fold increase in world economic production will be necessary to meet the basic needs of the growing population. That will require increased energy just as we're saying we need to improve the outlook on global warming

by reducing emission of carbon dioxide, a by-product of many forms of energy production.

Reducing carbon emissions under these circumstances, Clark said, will require "a technological and institutional revolution that literally will make the kinds of transformation we did during the Second World War in this country and Europe look small by comparison."

William S. Lee III, president and chief executive officer of Duke Power Company, dismissed any thought of miraculous discoveries to cure problems within the next half century. Because it takes 40 to 50 years to move a technological breakthrough to full deployment, he said, the technologies that will be available to meet the dual challenge of economic development and environmental preservation have already been discovered—"but not necessarily deployed."

Systematically, he analyzed the productivity required to meet acceptable living standards for 9 billion people and estimated that, even with an optimistic 50 percent increase in energy efficiency, it will require three times current world production of electricity.

"With the knowledge we have today, we dare not abandon any of the means of generating electricity, nor should we put all our eggs in just a few baskets," he said. "We should continue with a diverse mix, further developing each of the technologies in our quest for optimum solutions." After reviewing the prospects for different sources of electricity, he concluded, "In my view, we cannot hope to significantly increase the standard of living of the world's growing population without a substantial contribution from nuclear fission."

Proven methods for the safe disposal of nuclear waste exist, he said, but putting them into practice “will call for tough political choices and visionary leadership.” He spoke optimistically about the safe operation of nuclear power plants, noting that all owners of operating nuclear plants have joined together in a world organization to share expertise in training and safety. “Radioactivity knows no political boundaries nor should nuclear safety,” he said.

Carl Sagan, director of the Laboratory for Planetary Studies at Cornell University, disagreed with Lee and others who promote nuclear fission even as a short-term answer. He said no nuclear plants existing today meet his standards for acceptability: that they be safe and cost-effective to operate, that their waste can be safely stored for thousands of years, and that they not produce weapons-grade material.

Instead of nuclear, Sagan encouraged the development of alternative, non-polluting energy sources. Solar looks especially promising, he said, in spite of 10 years of research lost to federal budget cuts.

“Despite that, the progress in solar energy technology has been steady and impressive, and if you were to levy an environmental tax on the burning of fossil fuels to pay for the additional burden on society from the increase of the greenhouse effect, even today, solar energy would be economically competitive with fossil fuels,” he said. “And if we were to spend some significant amount of research money on solar energy, the price per kilowatt hour would certainly go down.”

The effort to foster economic growth in Third World since the 1950s has failed,

Brundtland said. “Today, developing countries’ average incomes are lower than in the 1960s, and indicators of social well-being have significantly declined,” she said. “Decrepit shanty towns are everywhere, teeming with dirty water, disease, and death. Roads, institutions, and production systems of nations are in decay. Human suffering and stalled development are readily visible, and environmental degradation on a massive scale is undermining the future economic development as well.”

Old, piecemeal policies should be replaced with an approach “founded on the interconnectedness of many factors, including equitable distribution of benefits, environmental protection, incentives

“There is something extraordinary about the planet that we are privileged to live on and, in this peculiarly self-congratulatory way, about us ourselves. Life is rare.”—Carl Sagan



■ Jim Hunt and Carl Sagan engaged in a quiet exchange of ideas before Sagan delivered the keynote address.



■ Larry W. Tombaugh, Dean of the College of Forest Resources

to produce, education, equitable trade patterns, democracy, sound financial systems, culture, and not least of all, hope for our children," she said.

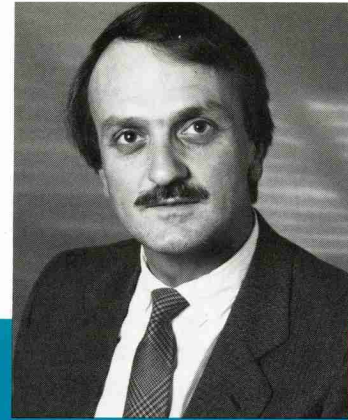
Among the components might be:
□ Restructuring Third World debt. "Developing countries now pay over \$35 billion more each year to industrial countries due to their indebtedness than they receive from those countries in development assistance," she said. "This is a perversion of all international goals. . . . It may seem like a financial problem

*"Some scientists say that within the lifetimes of people in this room we may witness the loss of more than half of all the living species on Earth. . . . We must not allow that to occur."
—Albert Gore Jr.*

instead of an environmental one, but it is not. It may seem like a problem for the poor countries alone, but it is not. It is a problem for all countries. The global economic system will not withstand the shock of the collapse of Third World countries."

□ A world climate convention that will include strategies for reversing current trends.

□ Better terms for transferring technology to the Third World.




■ Warren H. Lindner, Executive Director, Center For Our Common Future.

□ Additional financial resources to allow developing nations to invest in their environmental resources. A possible source of funds, she said, could be levies placed on carbon dioxide emissions or fossil fuel use.

□ Stronger international organizations. She proposed establishing within the United Nations a new authority with effective and binding decision-making procedures.

Political changes in Eastern Europe and the Soviet Union present new opportunities to help those nations improve efficiency of production and benefit from environmental technology, Brundtland said. It is time, she said, to forge active partnerships with those nations and with the poorest countries of Africa, Latin America, and Asia.

"The variable and interconnected elements of a process of sustainable development are suddenly available, and we must seize the occasion, for Europe, for the Third World, for all of us," she said. "We must treat it as an occasion for human progress, shared and coordinated among all parts of the world because it is only the progress that we make in common that will last." 

Jordan Hall symbolizes NCSU's commitment to the future



■ Former Lt. Gov. Robert B. Jordan visits with friends at Jordan Hall Dedication.

"In keeping with the long-established progressive tradition of this university, we dedicate this facility and commit ourselves anew to principles of freedom, individual rights, free enterprise, and environmental protection."

— Robert B. Jordan III

Jerry L. Whitten Dean of the College of Physical and Mathematical Sciences

Jordan Hall, which we dedicated as part of the 1990 Emerging Issues Forum, is a focal point of our campus for research dealing with our planet and its natural resources—the land, the atmosphere, oceans, and fresh water. It houses the Department of Marine, Earth and Atmospheric Sciences in the College of Physical and Mathematical Sciences as well as research laboratories of the College of Forest Resources. The research carried out by scientists and students in these laboratories will help shape our understanding of our environment and the management of our natural resources.

Our world seemed to changed abruptly in recent years. We suddenly realized that we had the potential to alter the Earth and its atmosphere in potentially long-lasting ways. Perhaps we noticed this first with radioactivity, nuclear waste, and pesticides. We now know of other, more subtle forms of pollution, ranging from nutrients to toxic substances and the release of greenhouse gases. We also know that we cannot live with reckless abandon, that our quality of life is at stake, and that we require a new form of public awareness and scientific literacy.


Deep study is needed to understand the science. From the research conducted in Jordan Hall and the Natural Resources Research Center housed in it, we will gain the understanding we need of atmospheric and terrestrial processes. Industries will benefit from the knowledge we generate. The public will benefit from a higher quality of life and economic vitality. Through research and education, we will leave our legacy to the future.

Larry W. Tombaugh, Dean of the College of Forest Resources

The history of mankind on this planet can be read largely as a continuing struggle over natural resources—land, minerals, water, fish, open range, and many others. Such conflicts will inevitably continue into the future, but two things have changed to complicate matters further. First, we have more and more people pressing against a limited land base. Second, natural resource and environmental issues have become much more complicated and interrelated.

Over the centuries, we have evolved a system of property rights that we had hoped would reduce conflict and bring some order to the use of resources. But now that resource issues include air pollution, climate change, hazardous and toxic waste disposal, and the need for biological diversity, among others, we have outstripped our institutional ability to deal with the issues.

We must take a new look at the scientific, economic, and social dimensions of the use of our resource base. Indeed, we must substantively address such fundamental matters as our ethical and moral responsibilities to the land itself and to the implications of our use of this land to future generations. These issues demand the very best of our intellectual resources.

Jordan Hall and the Natural Resources Research Center should rapidly become a focal point for harnessing the creativity, not just of North Carolina State University, but of all the institutions in this state to grapple with and to provide answers to natural resource and environmental issues. It should provide the intellectual glue that links industry, government, and universities, and enables them to strike that essential balance between economic necessities and environmental imperatives. 

Chancellor Larry K. Monteith looks to the future




North Carolina State University was the right place for a conference titled “Global Changes in the Environment” because the environment is at the heart of our institutional purpose. In forestry, agriculture, and in marine, earth, and atmospheric sciences, we focus on our primary natural resources; and we have long responded to global environmental problems through our teaching, research, and public service missions.

Specifically, we have focused on TropSoils research for conservation and agriculture in the tropics. Our Camcore research project aims to preserve tropical tree species. We have worked with endangered species through a joint project with Duke University to save Madagascar’s lemurs, and we have engaged in oceanographic studies such as the Amazon River Delta project. Furthermore, we have addressed such issues as waste minimization, acid rain, ozone pollution, and stream degradation.

Jordan Hall, which we dedicated as a part of the Emerging Issues Forum, represents a physical symbol of this university’s intention to position itself anew to address the most compelling issues of our times: issues about the quality and stability of our environment and about the availability of natural resources to support our society.

The fifth annual Emerging Issues Forum, with its global environmental theme, was another such symbol. By bringing scientific experts from many fields together with public policy makers, it gave us an opportunity to calibrate our thinking. It reminded us that we all use our natural resources and that all of us together share a responsibility to be good stewards of these resources.

North Carolina now faces a unique opportunity to emerge as a leader in establishing a rational means of dealing with the almost daily crises in these areas. The impact of this effort will apply not only to North Carolina, but to the region, to the nation, and to the world. North Carolina State University will respond, as it always has, with practicality, foresight, and courage. 

Larry K. Monteith

Fifth Annual Emerging Issues Forum

GLOBAL CHANGES IN THE ENVIRONMENT: OUR COMMON FUTURE

AGENDA

SCIENTIFIC SYMPOSIUM

Thursday morning, February 8, 1990

8:30 a.m.

Morning Session I

Franklin D. Hart, Presiding
Vice Chancellor for Research
North Carolina State University

Larry W. Tombaugh
Dean, College of Forest Resources
North Carolina State University

Jerry L. Whitten
Dean, College of Physical and
Mathematical Sciences
North Carolina State University

V. Ramanathan
Professor
Geophysical Sciences
University of Chicago

Wallace S. Broecker
Newberry Professor of Geology
Columbia University

10:30 a.m.

Morning Session II

Jerry L. Whitten, Presiding

David Rind
Climate Modeler
NASA Goddard Institute for
Space Studies

William E. Carter
Chief, Advanced Technology Section
Geodetic Research and Development Lab
National Geodetic Survey

Thursday afternoon, February 8, 1990

12:00 noon

Luncheon Session

Larry K. Monteith, Presiding
Chancellor, North Carolina State
University

James B. Hunt, Jr.
Chairman
Emerging Issues Forum

Gro Harlem Brundtland
Former Prime Minister of Norway
Chairman, World Commission on
Environment and Development

1:30 p.m.

Afternoon Session

Larry W. Tombaugh, Presiding

George M. Woodwell
Director
The Woods Hole Research Center

William C. Clark
Senior Research Associate and Lecturer
Science, Technology, and Public Policy
Program
Harvard University

3:00 p.m.

Forum Recess

3:30 p.m.

Dedication of NCSU Natural Resources
Building
Jordan Hall

PUBLIC POLICY FORUM

Thursday evening, February 8, 1990

7:30 p.m.

Evening Session

James B. Hunt, Jr., Presiding

Roy H. Park
Chairman and CEO
Park Communications, Inc.
Ithaca, New York

Carl Sagan
Director
Laboratory for Planetary Studies
Cornell University

Friday morning, February 9, 1990

8:30 a.m.

Morning Session I

Larry K. Monteith
Presiding

Madeleine M. Kunin
Governor of Vermont

Steve Cowper
Governor of Alaska

Albert Gore, Jr.
U.S. Senator, Tennessee

11:00 a.m.

Morning Session II

James B. Hunt, Jr., Presiding

Jay D. Hair
President
National Wildlife Federation

Gilbert M. Grosvenor
President and Chairman of the Board
National Geographic Society

MEET THE PRESS

Charles B. Crawford
Cable News Network

Warren Brown
The Washington Post

Friday afternoon, February 9, 1990

12:30 p.m.

Luncheon Session

Larry K. Monteith
Presiding

James G. Martin
Governor of North Carolina

John F. Ahearne
Executive Director
Sigma Xi, The Scientific Research
Society

William S. Lee III
President and Chief Executive Officer
Duke Power Company
President, World Association of
Nuclear Operators

2:00 p.m.
Conference Adjournment

North Carolina State University

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