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Folder Title:
Global Warming / Greenhouse 2/5/90 [OA 8312] [2]

Stack:	Row:	Section:	Shelf:	Position:
G	26	19	6	3

all think it's inappropriate - don't reflect group's concerns.

want to follow Watkins / Reilly

re-write regs. session

White House Sci / Econ. Conf. ✓ C. Cawley

Watkins Reilly Bromley Zoellick will meet

envir. cold exec - no.

77 nations there

M

POSSIBLE
ANY-POTENTIAL CLIMATE CHANGE

Bromley: Emph. U.S. major investment — understanding the prob.
our leadership — # $ spent research. Monitoring systems.
— our support of IPCC

Watkins: reiterate statements to date
— reiterate Baker (stress continuity)
incl. Noordwijk
'91 budget — adding it all up:
$ R&D research alone
tech. dev.

1st prior: → [what we do, we do well.] serious.
get it right
credible balanced analysis.

BOSKIN: up front — vital input to improve the science aggressively
abridged, objective, empirical.

* do that which we ought to do anyway.

WATKINS: — more voluntary than Browner — ocean as a sink

* NO regrets strategy

No context in actions ill-taken with the # we're investing
w/ the Commits we're making

not be tied to a policy that leads us away from R&D. To deal with hunger. Prosp.

Ac. Tolba — mentor / I'm confident that the IPCC will continue to have Sweden's leadership.

Eg. 2 only 3 dim. models

No 1-dim model where ghg is being analyzed.

2 + 3 dim models mitigate:

— CO_2 abs. vs H_2O

— heat sink effect H_2O

— reflective effect of clouds

— rather than commit to:

low-prob, high cost event

— take prudent actions w/ benefits in their own right.

— wise policies expose benefits exceed costs, but don't concede on disaster scenarios

(the sci./tech./econ/analysis

do in envirs. of uncertainty, do that which you know has positive effects (the no regrets policy.)

We can go as far as Watcher on policy, but don't frame it w/ assump. of warming.

- get list of countries to attend conference April 18, 19th here [G 7, China Brazil Australia, EC, OECD, Nigeria India USSR Mexico]

to Agenda? Sebard, Boston, Bromley:

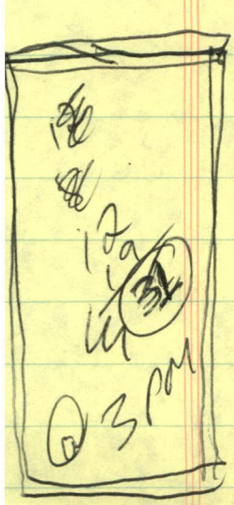
Tom Super - econ. & envir. aren't distinct

& false distinction

On global c -- say the envir issue, too much put an end to envir. cold war wasted effort & lost time.

State: Strong statement, reaffirming Rostiz

Don't seek to trading emissions permits



IPCC – We need to address:

- Reaffirm leadership on int'l env. issues
  - commitment to lead efforts
    - past:
      - World Bank (we want only bank to invest in sound projects)
      - AID; Peace Corps
      - "Env. President"? Jackson after C.A.A.
    - Future:
      - Malta Proposal
    - Pending:
      - Clean Air legis.
        - → call Grady

SQ

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Steve Olson
WH Science Office
(Bromley's) X.

final rpt = 1st Assessment rpt.
not final

follow up for ft. fr.

0

Energy and Climate Panel
on Climate Control
Georgetown University

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only for venue for "fr. cow. on climate"

1st neg. session toward

Who — UNGA? least pref.

like Montreal → UNEP & WMO = vehicle

exp. mandate of IPCC from study ⇒ forum

JAN 16 1990

MEMORANDUM

TO: **Dr. D. Allan Bromley**
Assistant to the President

FROM: Admiral James D. Watkins
Secretary of Energy

William K. Reilly
Administrator, Environmental Protection Agency

SUBJECT: Presidential Speech to the IPCC

The meeting of the Intergovernmental Panel on Climate Change during the first week of February offers the President an important opportunity to reaffirm his leadership on international environmental issues. Attached is the outline of a speech that he might give (Tab A).

We believe that it is a positive statement of: (1) his concern for the environment in general and about global warming in particular, (2) his commitment to lead international efforts in these areas, (3) the significant U.S. efforts to fulfill this commitment and (4) U.S. support for the IPCC as the proper forum for addressing the climate change issue. We also believe that the statement is fully consistent with existing Administration policy.

Also attached is an issue paper outlining options for carrying forward and expanding in the IPCC the cost and economic impact analysis of measures to limit greenhouse gas emissions (TAB B). Although not linked to the speech, the issue needs to be carefully considered. Such work must be continued in the IPCC or the international debate will continue to be based more on bold rhetoric than solid information.

We have shared this outline with the State Department and believe it is, in essence, supported by them. We would like to explore these ideas with you and our colleagues in the rest of the Administration. To this end, we would appreciate your circulating these documents in preparation for a discussion which you might lead. We would welcome your advice on how to move the inter-agency review process forward expeditiously given that the date of the speech is fast approaching.

Attachments

cc: Frederick M. Bernthal, Assistant Secretary,
Oceans & International Environmental & Scientific Affairs Bureau,
Department of State

Proposal for Presidential Speech before the Intergovernmental Panel on Climate Control (IPCC)

1. General statement of commitment to and concern for the global environment and economic development.

   -- Reiterate determination that the President will take active role in addressing concern about global climate change.

   -- Reiterate Secretary Baker's approach (spelled out in January 1989).

   -- Reiterate Noordwijk commitment to greenhouse gas stabilization as soon as possible, consistent with the requirement for global economic growth that can enhance the quality of life for people everywhere.

   -- Stress strong U.S. commitment to environment; e.g., domestic programs, leadership in forging international agreements on environment, assistance to and cooperative efforts with developing countries and current or former centrally planned economies.

2. U.S. Supports the IPCC Process

   -- Stress need for international cooperation.

   -- Congratulations to IPCC sponsors, the United Nations Environment Program (UNEP), the World Meteorological Organization (WMO) and to Dr. Bolin of Sweden, IPCC Chairman.

   -- Establishment of the IPCC has filled the need for an orderly, intergovernmental process to assess scientific understanding, evaluate potential impacts and develop appropriate response options.

   -- Welcome IPCC reports due in August.

   -- U.S. is committed to playing a leadership role through our chairmanship of the Response Strategies Working Group (RWSG) and supporting IPCC as best forum for global climate change policy development.

   -- Support for UK proposal at UN to continue IPCC.

3. Past and Ongoing U.S. Contributions and Views on Key Issues of Convention and Emissions-Limiting Agreements

-- Science

- o U.S. budget is the largest in the world and is rising, nearly $500 million in FY 1990 and to increase to almost $1 billion in FY 1991.

- o Importance of all countries, no matter what their level of development or economic system, contributing to understanding of the science. This cooperation needs to take several forms:

  - cooperation in assessment of state of the science; and

  - cooperation in monitoring and analysis of climate change.

- o Periodic international reassessment of the science at fixed intervals to aid in our decision making.

-- Technology Development

- o U.S. has active technology development programs to improve the efficiency of both supply and demand side technologies, and reduce greenhouse gas emissions.

  - More efficient fossil fuel generation technologies.

  - Renewable and energy efficiency technology initiative.

  - Conservation technology: end-use efficiency.

  - Nuclear: new generation with enhanced safety features under development.

- o Any framework convention should provide for regular assessments of the state of technology development to determine the availability and cost of technologies.

-- U.S. is sensitive to the need for technology transfer to other countries.

  - o Clean coal, renewable, conservation, end-use services for technology transfer, and nuclear.
  - o A.I.D. appropriation bill.
  - o EPA/Peace Corps agreement.
  - o Change in World Bank policy.
  - o EPA's IETTAB and DOE's CORECT program to examine technology transfer.
  - o Policy aid package.

-- Economics

  - o Follow-up on Administration commitment to develop real data on costs of various response strategies and assess new response measures.
  - o Challenge others to do the same.
  - o Offer technical support to those who need it.

-- Policy

  - o President should encourage consideration of truly innovative responses including:
    - comprehensive approach: all major greenhouse gases are included; and
    - trading of emission permits.
  - o President should define general criteria for future agreements to limit greenhouse gas emissions:
    - market mechanisms such as "integrated resource" planning and consistency with economic growth in all countries; and

- need to work with industry to ensure that response actions do not adversely affect economic growth around the world.

-- U.S. Clean Air Act Legislation

o Encourages emissions trading.

o Use of efficiency energy supplies; e.g., new clean coal technology and conservation technologies.

-- National Energy Strategy

o Comprehensive blueprint for addressing future energy needs with consideration to climate change and other environmental issues.

o As first step, take those steps which contribute tO other goals, but also reduce greenhouse gas emissions; e.g., clean coal technology, DOE conservation programs.

-- Energy efficiency programs: lighting, appliance efficiency standards, model building codes, industrial process improvement, encouraging utilities to provide the service of electricity demand reduction, transportation research and development, etc.

-- Alternative energy sources are being developed.

o Renewables: hydro, solar, biomass, geothermal.

o Nuclear: new reactor design.

-- Reforestation: Trees for U.S.

-- Phase-out of CFCs by 2000 providing safe substitutes are available.

o U.S. contribution to: development of safe substitutes, assessments of needs by other countries.

4. Reiterate Malta Offer to Host Convention Negotiations when IPCC is Ready

-- Express commitment to finding global solutions.

-- Demonstrate U.S. willingness to facilitate the process.

-- To further the debate, U.S. will host international environmental meeting composed of senior science, economics and environmental officials from all nations.

TAB B

Issue: How to carry forward and expand in the IPCC the cost and economic impact analysis of measures to limit greenhouse gas emissions?

Discussion: The IPCC's Response Strategies Working Group (RSWG) must conclude its work in the next couple of months for its report to be written on schedule. Consequently much of the cost and economic analysis that is beginning to emerge will not be included in the report. Without an ongoing analytical effort, the international discussion of emission targets and timetables will be dominated by the countries who are prepared to make substantial political commitments without much information on how they will fulfill those commitments.

To move the debate over commitments to limit greenhouse gas emissions away from bold rhetoric to a realistic assessment of what is possible over different timeframes, the IPCC's work on cost and economic impact analysis must be continued and expanded. Furthermore, because targets and timetables, especially for CO_2 are likely to be a major focus of attention at the fourth IPCC plenary next August and at the Second World Climate Conference (SWCC) next October-November, a means must be found for an ongoing effort over the next 5-7 months.

There are three major options for proceeding. The first is to request individual countries such as the U.S., Japan and the FRG to conduct studies and continue to provide results to the IPCC even after the conclusion of the RSWG's report. A second is to instruct the RSWG's Energy and Industry Subgroup (EIS) led by Japan to continue its analyses beyond the Spring and prepare a supplemental report. The third is for the U.S. to offer to lead, under the auspices of the RSWG and perhaps in collaboration with EIS, a special effort and produce a supplemental report in time for the fourth IPCC plenary. The latter option might entail a significant commitment of resources but may be most likely to result in substantive output. The latter option also offers the possibility of bringing a number of developing countries more fully into the process, because of a cooperative project already underway in ten developing countries.

Position: The U.S. should promote an ongoing effort to analyze the costs and economic impacts of a variety of targets and timetables for limiting greenhouse gas emissions. This should include the production of a supplemental report for consideration by the fourth IPCC plenary. The U.S. should favor a leadership role for EIS but be prepared to offer to lead the effort if discussions at the February IPCC meeting suggest it would be necessary to ensure meaningful output.

United States Department of State

Washington, D.C. 20520

POLICY PLANNING STAFF

FACSIMILE COVER SHEET

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Date Sent: 1/23/90

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TO:	NAME	AGENCY	PHONE #	FAX #
	Carolyn Cawley	WH	456-7750	456-6218

FROM: Chris Dawson **PHONE #:** 647-3638

SUBJECT: President's Speech Before IPCC

COMMENTS:

United States Department of State
Policy Planning Staff

Carolyn,

EPA has included all the comments I gave them. I know Secretary Baker believes it is particularly important to reiterate explicitly the points he made in his January, 1989, speech (I've attached a copy for your use).

I look forward to working with you on this.

Chris Dawson

647-3638

P.3

BRITISH INFORMATION SERVICES

POLICY STATEMENT **FRIDAY 10 NOVEMBER, 1989**
57/89

THE GLOBAL ENVIRONMENT

The Prime Minister, The Rt. Hon. Margaret Thatcher, FRS, MP, addressed the 44th Session of the United Nations General Assembly on 8 November, 1989. The full text is attached.

The main points of the Prime Minister's address are as follows:

* Britain is to establish a Centre for Climate Change Prediction. The Centre's objective will be to produce the best possible predictions of future climate change as a basis for developing policies to control the greenhouse effect, building on the established base of modelling and scientific expertise in the United Kingdom.

* The most pressing task facing the international community is the negotiation of a framework Convention on climate change - a "good conduct guide" for all nations. Such a convention would be modelled in the Vienna Convention of 1985 and the Montreal Protocol of 1987 and should be ready in time for the World Conference on Environment and Development in 1992.

* A further global convention on the conservation of animal and plant life is urgently needed. Between 3 and 50 species are being lost each day and the international community must act together to conserve this precious heritage.

* The British Government is to commit a further £100 million ($160 million) in bilateral aid to tropical forestry activity over the next three years. The funds will be used to support projects aimed at reducing deforestation, promoting afforestation and better management of existing tropical forests.

MJH:lh
A1/3/6; B5; EEC; F3/13; G3/1/6/7; G7/1/2/3/4/5;
P1/3/9/10/11/13/18; PSp2; PSp9.

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THE GLOBAL ENVIRONMENT

Mr President, it gives me great pleasure to return to the podium of this assembly. When I last spoke here four years ago, on the 40th anniversary of the United Nations, the message that I and others like me gave was one of encouragement to the organisation to play the great role allotted to it. Of all the challenges faced by the world community in those four years, one has grown clearer than any other in both urgency and importance; I refer to the threat to our global environment. I shall take the opportunity of addressing the General Assembly to speak on that subject alone.

INTRODUCTION

During his historic voyage through the South Seas on the Beagle, Charles Darwin landed one November morning in 1835 on the shore of Western Tahiti. After breakfast he climbed a nearby hill to find a vantage point to survey the surrounding Pacific. The sight seemed to him like "a framed engraving", with blue sky, blue lagoon, and white breakers crashing against the encircling coral reef. As he looked out from that hillside, he began to form his theory of the evolution of coral. One hundred and fifty four years after Darwin's visit to Tahiti we have added little to what he discovered then.

What if Charles Darwin had been able, not just to climb a foothill, but to soar through the heavens in one of the orbiting space shuttles? What would he have learned as he surveyed our planet from that altitude? From a moon's eye view of that strange and beautiful anomaly in our solar system that is the earth? Of course, we have learned much detail about our environment as we have looked back at it from space, but nothing has made a more profound impact on us than these two facts.

First, as the British scientist Fred Hoyle wrote long before space travel was a reality, he said: "Once a photograph of the Earth taken from the outside is available ...a new idea as powerful as any other in history will be let loose". That powerful idea is the recognition of our shared inheritance on this planet. We know more clearly than ever before that we carry common burdens, face common problems, and must respond with common action.

Second, as we travel through space, as we pass one dead planet after another, we look back on our Earth, a speck of life in an infinite void. It is life itself, incomparably precious, that distinguishes us from the other planets. It is life itself - human life, the innumerable species of our planet - that we wantonly destroy. It is life itself that we must battle to preserve.

For over 40 years, that has been the main task of this United Nations. To bring peace where there was war; comfort where there was misery; life where there was death. The struggle has not always been successful. There have been years of failure. But recent events have brought the promise of a new dawn, of new hope. Relations between the Western nations and the Soviet Union and her allies, long frozen in suspicion and hostility, have begun to thaw. In Europe, this year,

freedom has been on the march. In Southern Africa, Namibia and Angola, the United Nations has succeeded in holding out better prospects for an end to war and for the beginning of prosperity. And in South East Asia, too, we can dare to hope for the restoration of peace after decades of fighting.

While the conventional, political dangers - the threat of global annihilation, the fact of regional war - appear to be receding, we have all recently become aware of another insidious danger. It is as menacing in its way as those more accustomed perils with which international diplomacy has concerned itself for centuries. It is the prospect of irretrievable damage to the atmosphere, to the oceans, to earth itself.

Of course major changes in the earth's climate and the environment have taken place in earlier centuries when the world's population was a fraction of its present size. The causes are to be found in nature itself: changes in the earth's orbit, changes in the amount of radiation given off by the sun, the consequential effects on the plankton in the ocean, and in volcanic processes. All these we can observe and some we may be able to predict. But we do not have the power to prevent or control them.

What we are now doing to the world, by degrading the land surfaces, by polluting the waters and by adding greenhouse gases to the air at an unprecedented rate - all this is new in the experience of the earth. It is mankind and his activities which are changing the environment of our planet in damaging and dangerous ways. We can find examples in the past. Indeed we may well conclude that it was the silting up of the river Euphrates which drove man out of the Garden of Eden. We also have the example of the tragedy of Easter Island, where people arrived by boat to find a primeval forest. In time the population increased to over 9,000 souls and the demand placed upon the environment resulted in its eventual destruction as people cut down the trees. This in turn led to warfare over the scarce remaining resources and the population crashed to a few hundred people without even enough wood to make boats to escape.

The difference now is in the scale of the damage we are doing. We are seeing a vast increase in the amount of carbon dioxide reaching the atmosphere. The annual increase is three billion tonnes and half the carbon emitted since the industrial revolution still remains in the atmosphere. At the same time as this is happening, we are seeing the destruction on a vast scale of tropical forests which are uniquely able to remove carbon dioxide from the air. Every year an area of forest equal to the whole surface of the United Kingdom is destroyed. At present rates of clearance we shall, by the year 2000, have removed 65 per cent of forest in the humid tropical zones. The consequences of this become clearer when one remembers that tropical forests fix more than ten times as much carbon as do forests in the temperate zones.

We now know, too, that great damage is being done to the ozone layer by the production of halogens and chlorofluoro-carbons. But at

least we have recognised that reducing and eventually stopping the emission of CFCs is one positive thing we can do about the menacing accumulation of greenhouse gases.

It is of course true that none of us would be here but for the greenhouse effect. It gives us the moist atmosphere which sustains life on earth. We need the greenhouse effect - but only in the right proportions. More than anything, our environment is threatened by the sheer numbers of people and the plants and animals which go with them. When I was born the world's population was some 2 billion people. My grandson will grow up in a world of more than 6 billion people. Put in its bluntest form: the main threat to our environment is more and more people, and their activities: the land they cultivate ever more intensively; the forests they cut down and burn; the mountain sides they lay bare; the fossil fuels they burn; the rivers and seas they pollute. The result is that the change in future is likely to be more fundamental and more widespread than anything we have known hitherto. Change to the sea around us, change to the atmosphere above, leading in turn to change in the world's climate, which could alter the way we live in the most fundamental way of all.

That prospect is a new factor in human affairs. It is comparable in its implications to the discovery of how to split the atom. Indeed, its results could be even more far-reaching.

THE LATEST SCIENTIFIC EVIDENCE.

We are constantly learning more about these changes affecting our environment, and scientists from the Polar Institute in Cambridge and the British Antarctic Survey have been at the leading edge of research in both the Arctic and the Antarctic, warning us of the greater dangers that lie ahead. Let me quote from a letter that I received only two weeks ago, from a British scientist* on board a ship in the Antarctic Ocean. He wrote: "In the polar regions today, we are seeing what may be early signs of man-induced climatic change. Data coming in from Halley Bay and from instruments aboard the ship on which I am sailing show that we are entering a spring ozone depletion which is as deep as, if not deeper, than the depletion in the worst year to date. It completely reverses the recovery observed in 1988. The lowest recording aboard this ship is only 150 Dobson units for ozone total content during September, compared with 300 for the same season in a normal year". That of course is a very severe depletion. He also reports on a significant thinning of the sea ice. He writes that, in the Antarctic, "our data confirm that the first-year ice, which forms the bulk of sea ice cover, is remarkably thin and so is probably unable to sustain significant atmospheric warming without melting. Sea ice", he continues, "separates the ocean from the atmosphere over an area of more then 30 million square kilometres. It reflects most of the solar radiation falling on it,

* Dr. Peter Wadhams.

helping to cool the earth's surface. If this area were reduced, the warming of earth would be accelerated due to the extra absorption of radiation by the ocean. The lesson of these Polar processes", he goes on, "is that an environmental or climatic change produced by man may take on a self-sustaining or 'runaway' quality ... and may be irreversible". That is from the scientists who are doing work on the ship that is at present considering these matters.

These are sobering indications of what may happen and they led my correspondent to put forward the interesting idea of a World Polar Watch, amongst other initiatives which will observe the world's climate system and allow us to understand how it works.

We also have new scientific evidence from an entirely different area, the Tropical Forests. Through their capacity to evaporate vast volumes of water vapour, and of gases and particles which assist the formation of clouds, the forests serve to keep their regions cool and moist by weaving a sunshade of white reflecting clouds and by bringing the rain that sustains them. A recent study by our British Meteorological Office on The Amazon Rainforest shows that large-scale deforestation may reduce rainfall and thus affect the climate directly. Past experience shows us that without trees there is no rain, and without rain there are no trees.

The Scope for International Action.

Mr President, the evidence is there. The damage is being done. What do we, the international community, do about it? In some areas, the action required is primarily for individual nations or groups of nations to take. I am thinking of action to deal with the pollution of rivers - and many of us now see the fish back in rivers from which they had disappeared. I am thinking of action to improve agriculture methods - good husbandry which ploughs back nourishment to the soil rather than the cut-and-burn which has damaged and degraded so much land in some parts of the world. I am thinking of the use of nuclear power which - despite the attitude of so-called greens - is the most environmentally safe form of energy.

But the problem of global climate change is one that affects us all and action will only be effective if it is taken at the international level. It is no good squabbling over who is responsible or who should pay. Whole areas of our planet could be subject to drought and starvation if the pattern of rains and monsoons were to change as a result of the destruction of forests and the accumulation of greenhouse gases. We have to look forward not backward. We shall only succeed in dealing with the problems through a vast international, co-operative effort.

Before we act, we need the best possible scientific assessment, otherwise we risk making matters worse. We must use science to cast a light ahead, so that we can move step by step in the right direction. The United Kingdom has agreed to take on the task of co-ordinating such an assessment within the inter-government panel on climate change, an assessment which will be available to everyone by the time

of the second world climate conference next year. But that will take us only so far. The report will not be able to tell us where the hurricanes will be striking, who will be flooded, or how often and severe the droughts will be. Yet we will need to know these things if we are to adapt to future climate change. That means we must expand our capacity to model and predict climate change. We can test our skills and methods by seeing whether they would have successfully predicted past climate change for which historical records exist.

Britain has some of the leading experts in this field and I am pleased to be able to tell you that the United Kingdom will be establishing a new centre for the prediction of climate change, which will lead the effort to improve our prophetic capacity. It will also provide the advanced computing facilities that scientists need. And it will be open to experts from all over the world, especially from the developing countries, who can come to the United Kingdom and contribute to this vital work.

But as well as the science, we need to get the economics right. That means first we must have continued economic growth in order to generate the wealth required to pay for the protection of the environment. But it must be growth which does not plunder the planet today and leave our children to deal with the consequences tomorrow.

Second, we must resist the simplistic tendency to blame modern multinational industry for the damage which is being done to the environment. Far from being the villains, it is on them that we rely to do the research and find the solutions. It is industry which will develop safe alternative chemicals for refrigerators and air-conditioning. It is industry which will devise bio-degradable plastics. It is industry which will find the means to treat pollutants and make nuclear waste safe - and many companies, as you know, already have massive research programmes. The multinationals have to take the long view. There will be no profit or satisfaction for anyone if pollution continues to destroy our planet. As people's consciousness of environmental needs rises, they are turning increasingly to ozone-friendly and other environmentally safe products. The market itself acts as a corrective: the new products sell and those which caused environmental damage are disappearing from our shelves. By making these new products widely available, industry will make it possible for developing countries to avoid many of the mistakes which we older industrialised countries have made. We should always remember that free markets are a means to an end. They would defeat their object if by their output they did more damage to the quality of life through pollution than the well-being they achieve by the production of goods and services.

On the basis then of sound science and sound economics, we need to build a strong framework for international action. It is not new institutions that we need. Rather we need to strengthen and improve those which already exist; in particular, the World Meteorological Organisation and The United Nations Environment Programme. The United

Kingdom has recently more than doubled its contribution to UNEP. We urge others, who have not done so and who can afford it, to do the same, and the central organs of the United Nations, like this General Assembly, must also be seized of a problem which reaches into virtually all aspects of their work and will do so still more in the future.

The most pressing task which faces us at the international level is to negotiate a framework convention on climate change - a sort of good conduct guide for all nations. Fortunately we have a model in the action already taken to protect the ozone layer. The Vienna Convention in 1985 and the Montreal Protocol in 1987 established landmarks in international law. They aimed to prevent rather than just cure a global environmental problem. I believe we should aim to have a convention on global climate change ready by the time the World Conference on Environment and Development meets in 1992. That will be among the most important conferences the United Nations has ever held. I hope that we shall accept a responsibility to meet this timetable. The 1992 conference is indeed already being discussed among many countries in many places. I draw particular attention to the very valuable discussion that members of the Commonwealth had under the Prime Minister of Malaysia's chairmanship at our recent Commonwealth Heads of Government meeting in Kuala Lumpur.

But a framework is not enough. It will need to be filled out with specific undertakings, or protocols in diplomatic language, on the different aspects of climate change. These protocols must be binding and there must be effective regimes to supervise and monitor their application. Otherwise those nations which accept and abide by environmental agreements, thus adding to their industrial costs, will lose out competitively to those who do not. The negotiation of some of these protocols will undoubtedly be difficult, and no issue will be more contentious than the need to control emissions of carbon dioxide, the major contributor - apart from water vapour - to the greenhouse effect.

We can't just do nothing. But the measures we take must be based on sound scientific analysis of the effect of the different gases and the ways in which these can be reduced. In the past there has been a tendency to solve one problem at the expense of making others worse. The United Kingdom therefore, proposes that we prolong the role of the inter-governmental panel on climate change after it submits its report next year, so that it can provide an authoritative scientific base for the negotiation of this and other protocols. We can then agree to targets to reduce the greenhouse gases, and how much individual countries should contribute to their achievement. We think it important that this should be done in a way which enables all our economies to continue to grow and develop. We agreed yesterday at the Dutch Ministerial Conference on Climate Change that the Inter-Governmental Panel would examine the basis on which carbon dioxide and other greenhouse gases would be stabilized. The challenge for our negotiators on matters like this is as great as for any disarmament treaty. The intergovernmental panel's work must remain on target, and we must not allow ourselves to be diverted into fruitless and divisive arguments. Time is too short for that.

Before leaving the area where international action is needed, I would make a plea for a further global convention, one to conserve the infinite variety of species - of plant and animal life - which inhabit our planet. The tropical forests contain a half of the species in the world, so their disappearance is doubly damaging. It is astonishing but true that our civilisation, whose imagination has reached the boundaries of the universe, does not know, to within a factor of ten, how many species the earth supports. What we do know is that we are losing them at a reckless rate - between three and fifty each day on some estimates - species which could perhaps be helping us to advance the frontiers of medical science. We should act together to conserve this precious heritage.

Britain's Contribution

Every nation will need to make its contribution to the world effort. So I want to tell you how Britain intends to contribute, either by improving our own national performance in protecting the environment, or through the help that we give to others. And I shall tell you under four headings.

First, we shall be introducing over the coming months a comprehensive system of pollution control to deal with all kinds of industrial pollution whether to air, water or land. We are encouraging British industry to develop new technologies to clean up the environment and minimise the amount of waste it produces, and we aim to recycle fifty per cent of our household waste by the end of the century.

Secondly, we shall be drawing up over the coming year our own environmental agenda for the decade ahead. That will cover energy, transport, agriculture, industry - everything which affects the environment. With regard to energy, we already have a 2 billion pounds sterling programme of improvements to reduce acid rain emissions from our power stations. We shall be looking more closely at the role of non-fossil fuel sources, including nuclear, in generating energy, and our latest legislation requires companies which supply electricity positively to promote energy efficiency. On transport, we shall look for ways to strengthen controls over vehicle emissions and to develop the lean-burn engine which offers a far better long term solution than the three-way catalyst, in terms of carbon dioxide and the greenhouse effect. We have already reduced the tax on lead-free petrol to encourage its use. That is an example of using market-based incentives to promote good environmental practice. We shall see whether there are other areas where this same principle can be applied. With regard to agriculture, we recognise that farmers not only produce food - which they do with great efficiency - they need to conserve the beauty of the priceless heritage of our countryside. So we are therefore encouraging them to reduce the intensity of their methods and to conserve wild-life habitats. We are planting new woods and forests - indeed there has been a fifty per cent increase in tree planting in Britain in the last ten years. We also aim to reduce chemical inputs to the soil and

are bringing forward measures to deal with the complex problem of nitrates in water. All that is part of our own ten-year programme coming up to the end of this century.

Third, we are increasing our investment in research into global environmental problems. I have already mentioned the climate change centre that we are establishing. In addition we are supporting our own scientists, and in particular the British Antarctic survey's crucial contribution to the world ocean circulation experiment, as well as the voyages of our aptly-named research ship, the 'Charles Darwin'. We have also provided more money for the climate and environment satellite monitoring programmes in the European Space Agency.

Fourth, we help poorer countries cope with their environmental problems through our aid programme. We shall give special help to manage and preserve the tropical forests. We are already assisting in twenty countries and have recently signed agreements with India and Brazil.

As a new pledge, I can announce today that we aim to commit a further 100 million pounds sterling bilaterally to tropical forestry activities over the next three years, mostly within the framework of the tropical forestry action plan. That is all of what we are doing in Britain under these four headings - all of those things.

Conclusion

Mr President, the environmental challenge which confronts the whole world demands an equivalent response from the whole world. Every country will be affected and no-one can opt out. We should work through this great organisation and its agencies to secure world-wide agreements on ways to cope with the effects of climate change, the thinning of the ozone layer, and the loss of precious species.

We need a realistic programme of action and an equally realistic timetable. Each country has to contribute, and those countries who are industrialised must contribute more to help those who are not. The work ahead will be long and exacting. We should embark on it hopeful of success, not fearful of failure.

I began with Charles Darwin and his work on the theory of evolution and the origin of species. Darwin's voyages were among the high-points of scientific discovery, they were undertaken at a time when men and women felt growing confidence that we could not only understand the natural world but that we could master it, too. Today, we have learned rather more humility and respect for the balance of nature. But another of the beliefs of Darwin's era should help to see us through - the belief in reason and the scientific method.

Reason is humanity's special gift. It allows us to understand the structure of the nucleus. It enables us to explore the heavens.

It helps us to conquer disease. Now we must use our reason to find a way in which we can live with nature, and not dominate nature.

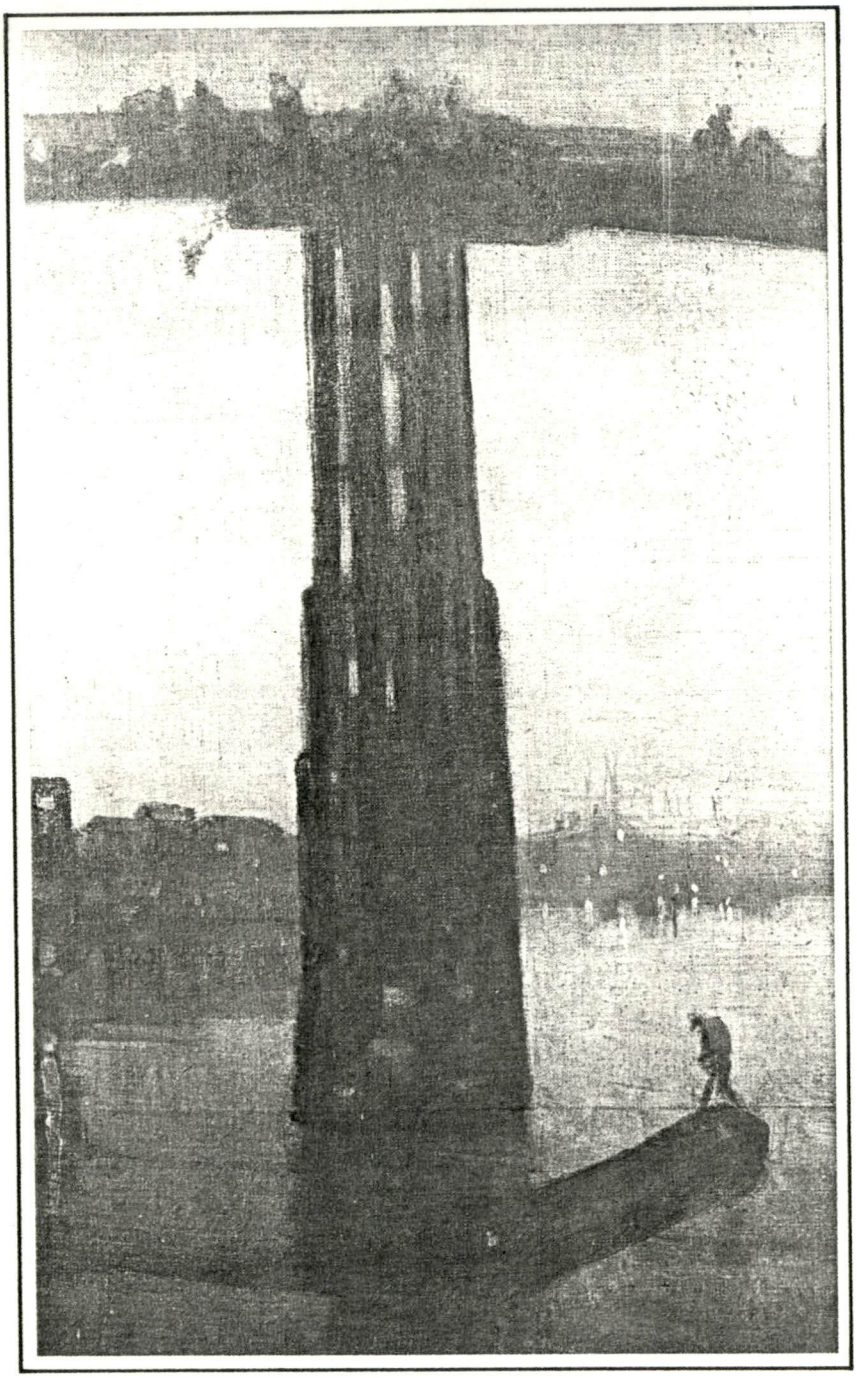
At the end of a book* which has helped many young people to shape their own sense of stewardship for our planet, its American author quotes one of our greatest English poems, Milton's "Paradise Lost". When Adam in that poem asks about the movements of the heavens, Raphael the Archangel refuses to answer.

> "Let us speak", he says,
> "The Maker's high magnificence, who built
> So spacious, and his line stretcht out so far,
> That man may know he dwells not in his own;
> An edifice too large for him to fill,
> Lodg'd in a small partition, and the rest
> Ordain'd for uses to his Lord best known".

We need our reason to teach us today that we are not, that we must not try to be, Lords of all we survey. We are not the Lords, we are the Lord's creatures, the trustees of this planet, charged today with preserving life itself; preserving life with all its mystery and all its wonder. May we all be equal to that task.

*"The End of Nature"; Bill McKibben. (Random House, 1989.)

E N D



THE NORTON ANTHOLOGY OF ENGLISH LITERATURE

Fifth Edition

The Second Coming[1]

Turning and turning in the widening gyre
The falcon cannot hear the falconer;
Things fall apart; the center cannot hold;
Mere anarchy is loosed upon the world,
The blood-dimmed tide is loosed, and everywhere
The ceremony of innocence is drowned;
The best lack all conviction, while the worst
Are full of passionate intensity.[2]

Surely some revelation is at hand;
Surely the Second Coming is at hand.
The Second Coming! Hardly are those words out
When a vast image out of *Spiritus Mundi*[3]
Troubles my sight: somewhere in sands of the desert
A shape with lion body and the head of a man,
A gaze blank and pitiless as the sun,
Is moving its slow thighs, while all about it
Reel shadows of the indignant desert birds.
The darkness drops again; but now I know
That twenty centuries of stony sleep
Were vexed to nightmare by a rocking cradle,[4]
And what rough beast, its hour come round at last,
Slouches towards Bethlehem to be born?

January 1919 1920, 1921

A Prayer for My Daughter[1]

Once more the storm is howling, and half hid
Under this cradle-hood and coverlid
My child sleeps on. There is no obstacle
But Gregory's wood[2] and one bare hill

1. This poem expresses Yeats's sense of the dissolution of the civilization of his time, the end of one cycle of history and the approach of another. He called each cycle of history a "gyre" (line 1)—literally a circular or spiral turn (Yeats pronounced it with a hard *g*). The birth of Christ brought to an end the cycle that had lasted from what Yeats called the "Babylonian mathematical starlight" (2000 B.C.) to the dissolution of Greco-Roman culture. "What if the irrational return?" Yeats asked in his prose work *A Vision*. "What if the circle begin again?" He speculates that "we may be about to accept the most implacable authority the world has known."
2. Lines 4–8 refer to the Russian Revolution of 1917. "The ceremony of innocence" suggests Yeats's view of ritual as the basis of civilized living. Cf. the last stanza of *A Prayer for My Daughter*.
3. The Spirit or Soul of the Universe, with which all individual souls are connected through the "Great Memory," which Yeats held to be a universal subconscious in which the human race preserves its past memories. It is thus a source of symbolic images for the poet.
4. I.e., the cradle of the infant Christ.
1. Yeats's daughter, christened Anne Butler, was born on Feb. 26, 1919, in the refitted Norman tower of Thoor Ballylee (Ballylee Castle) in Galway, where Yeats lived: it is not far from Coole Park.
2. Originally part of the Gregory estate, which had once also included Thoor Ballylee.

(1)

(Lange/Cawley)
January 31, 1989
7:00 A.M.
[IPCC.DOC]

PRESIDENTIAL ADDRESS: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
GEORGETOWN UNIVERSITY
MONDAY, FEBRUARY 5, 1990
10:15 A.M.

who else ?!

Thank you, Dr. Bolin. Professor Obasi. Dr. Tolba. Delegates of the World Meteorological Congress, and the United Nations Environment Program. Let me congratulate all of you...

Reifsnyder

[[Brief reflection, post-war: even as prospect of world war appears to diminish, importance of world stewardship grows.]]

Over the last forty years, we've unleashed the most technologically advanced creations of man. We've gained new, better, albeit, still incomplete understanding of the most ecologically fragile creations of nature. But whether created by man or nature -- what is critical to endurance, is **balance**.

Balance will certainly be crucial to the efforts of this Panel. For you are called upon to strike an unprecedented international bargain: a balance between global environmental policy, and global economic policy, where **both** sides benefit -- and **neither** is compromised.

This will be possible only if we understand that economic growth and environmental integrity are **not** contradictory priorities. One reinforces and complements the other.

A sound environment is the basis for the continuity and quality of human life and enterprise. And strong economies allow nations to fulfill the obligations of environmental stewardship. Where there is economic strength, environmental stewardship is considered a necessity. But where there is poverty, it is too often a luxury.

For that reason, I believe that within this decade, we must usher in a new era of global cooperation: for environmental protection **and** economic growth. For intelligent management of industrial **and** natural resources. Above all, for **sustainable** development -- around the world.

The United States believes the I.P.C.C. is the best forum to develop policy on global climate change. We're committed to international cooperation on this issue. And we consider it vital that the community of nations is drawn together -- in an ordered, rational way -- to assess the potential for climate change.

The state of the science; the social and economic impacts; and the right response strategies: all are crucial components to a global resolution. **But in this, we must attend to what we know. And what we do, must be done responsibly and well.**

The stakes here are very high.

There is no question that human activities are changing the atmosphere in unexpected and unprecedented ways. Over the past three centuries, the level of carbon dioxide in the atmosphere has gone up by 25 percent. Atmospheric methane has doubled.

What we **don't** yet understand are the extent and consequences

of the alterations we've brought about -- and how they're linked to a significant, imminent climate change. **The state of our thinking, like the state of nature, calls for balance.**

Last fall, many -- among them, world leaders -- were citing a significant thinning of sea ice at the poles, as evidence that global warming had arrived. But recent observations show that the polar ice sheets are not melting, they're **growing** in size.

I'm not prepared -- academically, or otherwise -- to draw conclusions. But I have noticed something about the scientists drawing the conclusions.

Those who see climate change as a clear and present danger represent one distinct minority. Those who discount it completely, represent another minority. But many scientists -- if not most -- are **not** ready to claim that the extent of global climate change can now be reliably detected -- or predicted. That may be to their credit.

Observing the fervor of the French Revolution, the English poet William Blake wrote, "The best lack all conviction, while the worst are filled with passionate intensity." Here, too, we are called upon for action based on observation -- not media-driven emotion, or the politics of apocalypse.

What science now knows with confidence, policy-makers can't use. And what policy-makers are interested in, science doesn't yet know.

The questions that remain -- over the reflective effects of cloud cover, the cooling effects and CO2 absorption of oceans, and other sinks and feedback mechanisms we don't yet understand -- suggest that we should attend to what is known about climate change -- and work to know more.

Current computer models are marvels of mathematics. Still, they cannot yet be said to represent reality -- and cannot be expected to predict the future. Above all, responsible policy cannot rest on the shifting sands of hypothesis and a chaos of conjecture.

Given this level of uncertainty, some suggest we should act now, on the chance that significant climate change becomes certain. Others point to the opposite edge of that sword: any meaningful preemptive policies would bring only the certainty of prohibitive expense; conflict with Third World development; and declining standards of living, worldwide.

We're confident that the world will neither be caught surprised by a greenhouse effect it didn't expect, nor impoverished in anticipation of a cataclysmic warming that never arrived.

There is a middle way that may be sought -- **a balance that must be struck -- that reconciles policy to emerging scientific knowledge, and environmental protection to economic development.**

The United States remains committed to its leadership role on environmental issues: in our domestic programs, in our work to forge international agreements, in our assistance to

developing and East Bloc nations, and through our chairmanship of the Response Strategies Working Group in the I.P.C.C.

Overall, we're already doing more than any other country -- in terms of financial and human resources, **by more than a factor of ten** -- to understand and address global warming, among other major environmental concerns. Funds devoted to environment-related research in our proposed 1991 budget now total over $70 billion.

Funding for the U.S. Global Change Research Program will increase by nearly 60 percent in fiscal 1991, to over $1 billion. It allows NASA to proceed with its "Mission to Planet Earth" -- and funds the launch of the first U.S. Earth Observing System, to advance the state of knowledge about the planet we share.

Along the way, we will seek the involvement of all nations, no matter what their level of development or economic system, to monitor and analyze climate change, and reassess the science. We place the highest priority on better understanding the earth and its interrelated systems -- and developing high-performance computing systems up to the task.

We seek immediate action, and have already taken a number of steps, that bring major benefits in their own right; make sense on their own merits; and will **also** help reduce emissions of carbon dioxide and other gases now building up in the atmosphere, stimulating concern about potential climate change.

Last year I announced our support for a worldwide ban on clorofluorocarbon production, to the extent safe substitutes are

available. We recently placed a fee on CFC production that is expected to reduce American CFC emissions even below the levels of international protocols.

We have compelling reasons to stabilize -- and reduce where possible -- both overall emissions and energy consumption. Ultimately, but eventually, fossil fuel will be all too finite.

So we're actively pursuing technology development programs to improve the effectiveness of both supply- **and** demand-side technologies for energy of all kinds -- through more efficient fuel generation technologies, renewable sources and end-use efficiency, and enhanced nuclear generation safety. And we're committed to regular assessments of the state of technology development.

To achieve domestic reductions in airborne emissions, we've introduced new Clean Air Act legislation -- emphasizing clean coal technology, conservation measures, the trading of emissions permits, and other devices to encourage industry to find creative, market-driven solutions.

Leg. Aff.

We're in the midst of a comprehensive review and revision of our National Energy Strategy, to consider our future energy needs in light of environmental, efficiency, and conservation issues -- and to develop alternative energy sources in hydro, solar, biomass, and geothermal designs.

Forests, particularly in tropical regions, are being lost at a rate of 40 million acres a year -- an area larger than East Germany. The burning of this biomass and its after-effects

account for as much as a quarter of the carbon dioxide that human beings are adding to the atmosphere. For that reason -- and for the sake of the irreplaceable species being lost day by day -- we are working through diplomatic channels, and through innovative measures like debt-for-nature swaps, to do more than simply reduce deforestation. **We hope to reverse it.**

Here at home -- aware that new growth forests absorb significantly more CO2 than old grove timber -- we've launched a major reforestation initiative, to plant a **billion** trees a year on private land across America.

The economics of our domestic strategies are now being scrutinized in Congress. Let me also assure you, given our role in the R.S.W.G., that the economics of international responses to potential climate change will get equally intensive study.

We intend to develop real data on the costs of various response strategies, assess new measures, and challenge other nations to follow suit. We will offer technical support to those who need it.

In creating policy to manage CO2 and other emissions now believed to be implicated in climate change, we want to encourage truly innovative responses -- including the trading of emissions permits if appropriate -- as well as a comprehensive approach where **all** major emissions implicated in climate change are included.

Wherever possible, we believe that market mechanisms should be applied -- and that policy must be consistent with economic

growth and free market principles in **all** countries. **This is where the quest for balance will be most crucial.**

It will be important to work with, not against, industry if we hope to promote environmental protection and economic growth around the world. That will mean moving beyond the tradition of command, control, and compliance -- toward a new kind of environmental cooperation. Many industries, in fact, are already providing crucial research and solutions. And a few are already ahead of us.

One power-plant management firm, just across the river in Virginia, donated $2 million in 1988 for tree planting in Guatemala -- to compensate for a coal-fired plant it was building in Connecticut. The company expects to couple tree-planting programs with all seven new power plants now on its drawing boards.

Where the developing nations are concerned, some suggest we'll have to abandon the laissez-faire, free-market principles that allowed the industrial world to prosper. Well, we're headed in the opposite direction. We intend to apply the principles of the free market in the **service** of the environment -- **especially** in the developing nations. Sustainable economic development demands that we **enlist** the desires of the developing world, rather than try to limit them.

To be effective, the I.P.C.C. must truly represent the interests of the **world** community of nations. The share of total emissions contributed by developing countries is expected to rise

dramatically in the future -- becoming more than 50 percent by 2025. We understand that China plans to double its use of coal by the end of the century, and India plans a tripling.

But there may be good news here. To the extent we can accelerate the **advancement** of these and other developing nations, it will take **less** energy for them to produce wealth: In modern industrial countries, energy use per unit of Gross National Product has **declined** -- steadily, and dramatically.

So we need to work <u>with</u> the developing nations: Applying the power of the marketplace. Allowing for the trading of emissions permits where appropriate. Considering technology transfer for clean coal and renewable technologies, conservation, and end-use services. And encouraging industry to assist developing nations in making quantum leaps in technologies. Leaps that will allow LDC's (NIDC) to grow more quickly and easily -- and may help them avoid making the environmental mistakes we older nations have made.

As I said earlier, I believe we should make use of what we know. We know of the power of free markets to find creative solutions. To make resources and talent more rapidly available. **We understand the efficiency of an economic incentive. We should apply it now, in defense of the environment we share.**

We rely on the greenhouse effect, as long as it remains in balance. Without it, the surface of the earth would resemble that of the moon.

So just as we rely on the corrective action of the biosphere, we must learn to rely on the corrective actions of free markets to give incentives and integrity to our climate change strategies.

To keep this process moving, and advance the debate, we will host an international environment meeting on April 18 and 19 here in Washington. I look forward to first assessment report in June, and IPCC reports in August, etc. Reifsnyder

Wish the three working groups the best of luck. Confident your work will be done carefully and well. Sure the I.P.C.C. will continue to prosper under ____, and benefit from Dr. Tolba's leadership.... Reifsnyder

# # #

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 18 1990

OFFICE OF
THE ADMINISTRATOR

MEMORANDUM

SUBJECT: IPCC Speech Material

FROM: Daniel C. Esty DCE
Special Assistant to the Administrator

TO: Robert E. Grady
Associate Director
Natural Resources, Energy and Science

Attached is a copy of the proposed Presidential speech outline, as revised through consultations with the Energy Department. Also attached are several sets of "raw material" to help flesh out the outline.

The draft speech outline has been sent to Dr. Bromley as a joint product of Secretary Watkins and Administrator Reilly. The State Department (Zoellick) has also reviewed the draft.

Let me know if you would like anything else.

Attachments

Raw Input for Presidential Speech

U.S. Supports the IPCC Process

1. Congratulations to its sponsors, UNEP and WMO, and to Dr. Bolin (Sweden) its chairman.

- In May, 1987 the Tenth World Meteorological Congress asked the Executive Council of the World Meteorological Organization (WMO), in cooperation with the U.N. Environment Programme (UNEP) "to arrange appropriate mechanisms to undertake further developments of scientific and other aspects of greenhouse gases."

- In June 1987, the WMO Executive Council (which consists o representatives of WMO member countries) and the UNEP Governing Council (which is made up of representatives of essentially the same countries) responded by asking the Secretary-General of WMO, Professor Obasi, and the Executive Director of UNEP, Dr. Tolba to cooperate in the establishment of an intergovernmental mechanism to carry out the intentions of the Tenth Congress.

- The IPCC was established after subsequent discussions.

- The first session of the IPCC was held in Geneva, Switzerland, on November 9-11, 1988. It was attended by representatives of 30 countries and 18 international organizations.

- Dr. Bert Bolin of Sweden, a senior science advisor to the government of Sweden, was elected Chairman. Dr. Bolin is generally recognized as an outstanding chairman -- even handed, adroit, with an excellent, understated sense of humor.

2. U.S. saw a need for an orderly, intergovernmental process to assess scientific understanding, evaluate potential impacts and develop appropriate response strategies.

- The issue of global climate change began to emerge as an important public policy issue during early and mid nineteen eighties as the earth experienced some of the hottest years in the last century (5 of the 10 hottest years in the last 100 have occurred in the 1980s) and as evidence of a significant build-up in the atmosphere of certain "greenhouse gases" became more widely known.

NO

- During the early and mid 1980s, discussion of the issue took place largely in the context of a number of loosely resulted, albeit important conferences.

- As the implication of the issue became clearer, the U.S. and a number of the countries began to perceive the need to address the issue through an on-going, international process that spann the broad range of relevant issues and expertise.

- This led to the proposals by the Tenth World Meteorological Congress, the WMO Executive Council, and the UNEP Governing Council.

3. IPCC has filled that role.

- Participation in the IPCC has increased continuously and now includes over 50 nations, hundreds of scientists and policy makers, and many non-governmental and international organizations.

- The work of the IPCC is carried out through three major working groups:

The Working Group on Science, chaired by the United Kingdom, is reviewing and assessing the existing scientific information on, and understanding of, global climate change.

The Working Group on Impacts, chaired by the USSR, is assessing the potential environmental and socio-economic impacts of global climate change.

The Response Strategies Working Group, chaired by the U.S., is identifying and assessing possible strategies for responding to global climate change -- both by limiting greenhouse gas emissions and adapting to climate change.

4. Welcome the IPCC reports due in August.

- The three working groups will complete their reports to the IPCC late this Spring. The overall IPCC report will be prepared during the Summer and considered by the full IPCC at a meeting in Stockholm at the end of August. It will then be forwarded to UNEP and WMO and considered by the U.N. General Assembly next Fall and at the Second World Climate Conference (SWCC) during the last week of October and first week of November.

5. U.S. is committed to playing a leadership role and supporting the IPCC as the best forum for global climate change policy development.

- The IPCC is the best forum for global climate change policy development because: (a) it is focused exclusively on the issue; (b) its program of work addresses the broad range of relevant issues, not just e.g. emission reduction; (c) it has successfully involved the broad range of necessary expertise; (d) it is not overly politicized; and (e) it is truly international, with over 50 countries currently involved and more becoming involved. Essentially, it has proved a productive and increasingly popular forum for international analysis and discussion of the issue.

- The President is committed to playing a leadership role in the international community's efforts to address global climate change. The U.S. is playing a major leadership role in the IPCC and has provided substantial financial and analytic support for all major IPCC activities.

6. Support the UK proposal at the UN to continue the IPCC

- In her speech on November 9, 1989, to the UN General Assembly, Prime Minister Thatcher proposed the continuation of the IPCC after it submits its interim report next Fall so that it can provide an authoritative scientific basis for the negotiation of protocols to a framework convention. We should strongly support this proposal and broaden its rationale to include the need for a sound analytical basis, broadly construed to include analysis of the administrative and technical feasibility, costs and economic consequences of future protocols. There will be a need for years to come to (a) continually improve and periodically assess our scientific understanding of global climate change and its impacts, and (b) develop and evaluate response measures.

NO NO NO

Much softer commitment

RAW MATERIAL FOR A PRESIDENTIAL SPEECH TO THE IPCC

Section 5:

1. The Clean Air Act

I have submitted to Congress extensive revisions to the Clean Air Act which should result not only in cleaning the nation's air, but in reducing greenhouse gas emissions as well. Powerful incentives exist in our acid rain program for conserving energy. These will reduce carbon dioxide emissions from electric utilities by about 75 million tons. The alternative transportation fuels program in the bill also offers the potential for reductions in emissions, up to 60 million tons, depending on what fuels make it to the market.

2. Energy Conservation Program.

Since taking office, my Administration has proposed or promulgated energy efficiency standards for refrigerators, dishwashers, washing machines, and dryers. Together, these will reduce emissions by around 15 million tons. In addition, I have submitted a request to Congress to increase the size of DOE's Conservation Program by $150 million.

3. Alternative Energy Sources

to be provided by DOE

4. Reforestation

The U.S. is firmly committed to positive action in response to threats imposed by global climate change. One immediate and tangible action which I have called for is a major reforestation program within the U.S. I am calling upon all Americans to join in a twenty-year program to plant and maintain twenty billion trees. We expect to provide up to $175 million per year to support programs ranging from urban tree planting, to sharing the cost of large tree plantations, to enhancing the quality and ultimately the biological yield of existing timber stands.

Complimenting these public investments, I have called for a private, non-profit foundation called the "America the Beautiful Foundation", which would capitalize a fund of potentially billions of private dollars, the yield of which will be used to support tree planting and maintanance throughout the United States. The objectives of these tree planting programs will be to absorb from 5 to 10 percent of U.S. carbon dioxide emissions, as well as enhance water quality and wildlife habitat.

5. Chloroflourocarbons (CFCs)

These currently account for 25% of the current U.S. contribution to global warming. In addition to possibly affecting the climate system, these substances also are responsible for the depletion of the ozone layer. I fully support the international efforts to fully phaseout production of these substances by the year 2000. In addition, the US is aggressively working with developing countries to assist them in making the transition to

substitute chemicals. For example, we are working with the refrigeration industry to facilitate CFC substitution in China and we are sending technical missions to Brazil, Egypt and Mexico.

6. State Initiatives

The States deserve significant credit for their contributions to reducing greenhouse gas emissions. Their efforts include programs to increase energy efficiency in homes, offices, and industries, to expand the use of alternative fuels in the transportation sector, and to plant trees. Several states have even mandated general greenhouse gas emissions reduction efforts. For example, the Governor of New Jersey recently signed an executive order requiring state agencies to implement measures designed to reduce energy and CFC use and to maximize the number of trees in New Jersey. The Oregon legislature has mandated that the state reduce emissions of greenhouse gases by 20% by 2005.

Almost every state has implemented energy efficiency programs. An example of a program that has successfully reduced energy consumption in industry is the Energy Advisory Service to Industry in New York. In 1988, CO_2 reductions attributable to this program were approximately 682,000 tons, while consumers saved more than $60 million in energy costs. In California, the South Coast Air Quality Management District is implementing stringent air quality standards that will eventually require substantial use of alternative fuels. (However, this plan calls for the use of methanol fuel, which, if derived from natural gas, is only slightly less carbon intensive than coal, and, if derived from coal, is 50-

75% more carbon intensive than coal.)

In addition to individual programs, a number of states are now undertaking "Least-Cost Utility Planning" which requires utilities to undertake the least cost alternative to providing power, which is also often the option with the lowest greenhouse gas emissions, i.e., energy efficiency. A few states, such as Wisconsin, New York and Oregon, are taking this a step further by applying an environmental weighting factor in competitive bidding procedures for private power supply options. This tends to encourage natural gas and non-fossil sources of energy.

States are also undertaking their own tree planting programs geared toward reducing carbon dioxide. The States of North Dakota and Missouri, for example, have established tree planting programs. The former has set a target of 100 million trees by 2000.

THE WHITE HOUSE

Office of the Press Secretary

REMARKS BY CHIEF OF STAFF
GOVERNOR JOHN SUNUNU
TO THE AMERICAN STOCK EXCHANGE

October 30, 1989

Mayflower Hotel
Washington, DC

GOVERNOR SUNUNU: I appreciate you giving the right priority to all that. You're absolutely right. The last is what I consider my most significant involvement and achievement.

It is a pleasure to be here with you today. Obviously, it is a gathering that not only is representative of what is important and strong about America's economy, but what is important and strong about the world economy. Those of you who are here from outside of town and outside of the country, let me add my welcome to that which I'm already positive you have heard from previous speakers.

It is my understanding that Brent Scowcroft was here ahead of me. I'll have to remind him one of my jobs is cleaning up after him. (Laughter.) But it's my understanding that Brent was here a little earlier and talked to you about some of the wonderful, amazing things that are taking place around the world today. And as trite as the statement of these are, these times are the most interesting and critical times in a long, long time. As trite as that statement may be, I really do think it applicable in the sense of both what is happening and the potential for what can continue to happen and impact the world around us.

I'm sure Brent spent a little time talking to you about what was happening in the context of a victory for Western values. And it really is, although we are very careful at times not to give it that emphasis. Any careful reading of what is taking place in the Soviet Union and Eastern Europe -- even in China, although it was aborted a little bit -- and around the world is a celebration of victory in two respects. First of all, the American -- the Western commitment to democracy is being rejoiced around the world in political change and reform that is being pressed from within, being pressed from the bottom up in many cases, and accompanied -- surprisingly enough and constructively enough -- by a pressure that -- it joins what's coming from the bottom up by a movement aggressively in that direction in virtually all those countries from the top down as well.

It has created a sense of inevitability in many cases for the kind of political change that has been the hope and dream of free countries around the world that see extended to those countries that have lived in less free environments.

In the same respect, accompanying this we see changes on the economic side -- changes that again it is not inappropriate to say is a celebration of the Western commitment to the free market approach, the Western commitment to a capitalist society. It is surprising to me that even those of us in this country who are -- have had an opportunity to discuss or own economic system seem reluctant at times to suggest that it is a capitalist society. And yet that is a fact and we ought not to be uncomfortable with that world.

And what we are seeing in these countries around the world is a yearning to make themselves a structure in which the

economy and the benefits of free markets are accrued to their citizens. And in order to do that, they understand that one thing that has to be done is to establish an internal economic structure that is attractive to investment, attractive to capital. And I find it amazing that we can go to Poland and hear the President of Poland and the leader of the communist party in Poland asking the President of the United States how that economic system can create incentives for capital investment so that they can improve their situation and job opportunities.

And it's amazing then when you move down to Hungary and hear the leaders of the communist party in Hungary talk about the changes they're going to make, and again emphasize their understanding that what they need is a society that is attractive to capital investment so that a strong economy can be created.

And the context of that discussion just before the President of the United States was to go to Karl Marx University and give a talk on the issues of democracy and free markets. It's just unbelievable, and yet that is what is happening. And I only point that out that as we in this country have opportunities for establishing policies that are incentives for the investment of capital, we ought to just keep in our mind the amazing context that the rest of the world at times seems to understand this better than those of us who have had these benefits all along.

There are other issues taking place not only -- developing not only in this country, but around the world, that will impact what is clearly understood now to be an economy that is so globally interwound that major changes in one country, whether it is overregulation or appropriate regulation or deregulation, can have impacts on what takes place in other countries around the world.

A situation that is real, a situation that is of interest, a situation that is of concern and a situation that is populist enough to capture headlines is the situation involved in terms of the environment. And I am fortunate today as I came to talk to you to have join me in the visit here, alhough not scheduled to speak today, Bill Reilly, who is the Administrator at EPA, and Dr. Allan Bromley, who is the President's Advisor on Science and Technology -- both of who are involved in the development of environmental policy and very much involved in the development of economic and domestic policy for this administration.

And I point that out because what I would like to touch on for a little bit this afternoon are some of those issues involved in terms of the environment, and the approach that I'm sure will have all the details filled in by Bill Reilly when he makes his presentation tomorrow that I would like to talk about -- the approach that has been taken by this administration to bring together some of these very same basic principles that are clearly the strengths of this nation and the strengths that are being aspired to by countries around the world.

This President, President Bush, has laid out a series of initiatives -- an agenda on the environment that is as much an agenda involving the economy as a commitment to making sure that we fulfill our responsibility as stewards of the environment. And it is important that we understand that national and international environmental policy is in part a component of national and international economic policy. They go hand in hand. An effective focus on these issues provides policies that are complementary, rather than contradictory. An effective focus -- a focus that deals with our responsibilities across the board is a focus that yields -- to no one in our -- the strength of our commitment to the environment. It yields to no one in terms of our understanding that a strong economy is critical, so that we can fulfill the obligations of that stewardship.

And so what the President has put forward in terms of its environmental initiatives, the Clean Air Act, a bill that was presented by the President to Congress to break the logjam that

existed for nearly a decade in terms of dealing with our needs of establishing policies that were broad enough to deal with the environment and protect the air quality of this country and constructive and realistic enough to allow that and, in fact, require that to be done without gutting the strength of the economic system that supports -- (inaudible.)

That plan was sent up by the President. It was a plan that was balanced; it was a plan that reflected an understanding of the role of a free market itself in creating domestic and internal incentives to do what is right. It was a plan that balanced out the requirements and the commitments and, in fact, the impositions that are necessary for us as citizens and for us as members of public institutions, such as local government, state government and the federal government to deal with these issues. It was a plan that understood that the global playing field not only domestically, but internationally, requires us to do this in a way that does not put our domestic industries at a disadvantage. And yet, it was a plan that was realistic enough in terms of what had to be accomplished for the environment that was recognized as being a significant step forward in that direction.

I urge you to understand that the balance that was developed within that program is one that must be maintained and kept as we work this through Congress. I understand that everybody impacted one way or the other is tempted to suggest the dials ought to be readjusted to get back individually or corporately a little bit more preference. And I hope that that part of the system does not so disrupt the balance fills into the program that again this country will lose an opportunity to get an act of clean air legislation that is both protective and will work in -- (inaudible) -- with our economic strength.

The President, in addition to that, has proposed a phase out of the chloroflouro carbons that have a negative impact on the quality of not only our own environment, our own air quality, but in terms of the international aspect in terms of the long-range capacity of the world environment -- (inaudible.) And we made that commitment to phasing these out in a practical way, in a responsive way by the year 2000. It was done with an understanding that merely stating the phase-out without recognizing that the partnership with the private sector sector would be required in order to develop the alternatives, but impose on us the obligation to have a time frame that was doable. And it was done with that in mind and in a balance way that again, this administration leads -- and it's across the board in all the departments of this administration -- we believe that that approach is one that meets both the environmental and the economic responsibility.

So the administration has taken action again in dealing with fuel economy. It's taken action again in addressing our responsibilities towards the global environment in terms of global climate research. The President's budget that he sent up in February included significant increases for this research, both -- (inaudible) -- what impact specific pollutants have, or the capacity of our environment to maintain not only air quality detecting, but the integrity of the thermal balance that is so critical.

We are spending as a government with a budget proposed by the President almost one half a billion dollars -- $500 million across all government entities. And the reserach that is necessary to help us to find a policy that makes sense and addresses not only our needs within our own borders, but makes us a constructive partner for policies around the world.

Now, let me address that because it has become an issue that is easy for folks to get -- (inaudible) -- with. It has become an issue that appears to be a bit -- (inaudible) -- and yet, the fact of the matter is, an issue that must be examined not only in a popular sense, not only in an emotional response to the concern that caring citizens around the world have for the environment, but must be dealt with in such a way where the policies which will shift the

focus of resources probably in a global level, unprecedented in history. It must be done in such a way in which that shift of resources truly has the promise of having a beneficial impact.

For those of you that may not know the general history of that issue, let me point out that, in the last couple of years, as a result of examination of some data and as a result of some of the computer modeling, the analysis that is being done, there is a discussion of a coupling between the emissions of some of the industrial products that we have, some of the inevitable industrial products that we have, as having an impact on the environment's tendency to be warmed as a result of the non-linear relationships between entity in and entity out, depending on the composition of the environment.

Carbon-dioxide is one of the components of concern. Carbon-dioxide is an inevitable product and it is virtually an unscrubable product of the combustion of any of the fossil fuels, whether it is natural gas or coal or oil or wood. The fact is that there have been in recent years, over the last handful-and-a-half of decades, a buildup of the levels of carbon-dioxide in our atmosphere. And there is some concern that there is a coupling between that buildup and the change in the average temperature, the mean temperature of the world's atmosphere over a period of time.

There has been significant work done in this direction. There is significant work yet to be done. May I point out tangentially that the level of concern which focused worldwide attention were concerns in which people determined with the initial models that about a four or five -- (inaudible) -- degree rise in temperature might be expected if we -- over a period of years -- 30 to 50 years double the concentration of CO2 in the atmosphere.

There have been in recent months some refinements of those models which fortunately, in terms of policy and certainly these are not yet in themselves definitive models -- models which suggest this rise may be less, but still in that same general direction. It's been reported in a number of journals in recent months that work done at both the British Meteorlogical Office and work done at the National Center for Atmospheric Research in Boulder have indicated a rise of between one and two degrees is a more realistic assessment.

The point is, is that neither the older pessimistic numbers nor the current optimistic numbers should be taken as the final word. And what we ought to do is commit ourselves to the kind of investment, both in terms of dollars and national resources, that the President has laid out as part of his agenda and determine as quickly as we can and as accurately as we can both the quantitative impact and cause of the kinds of problem we are concerned with and the benefits of any remedial action that may result from international policy to -- (inaudible) -- this change.

Those are the kinds of obligations we have to ourselves as members of the nation and to ourselves as a nation as members of an international community. And I guess one concern that I have as I look at those who are involved in policy development on the Hill is a sometimes irresponsible commitment to -- (inaudible) -- because it seems to fit the more populist image or that newer data that seems to reflect that a more prudent approach might be more constructive. And I ask that those who of you that care about this issue, that those of you who understand the coupling of this issue to economic well-being so that we can meet our responsibilities to those parts of the world that do not enjoy the quality of life that we do -- and I am talking very specifically about our economic capacity to deal with the parts of the world that have hunger problems, parts of the world that have problems in terms of their development and their industrialization -- that we understand that we have a responsibility to do this right, not only to ourselves, but to the billions that fall into the categories of the have-nots around the world.

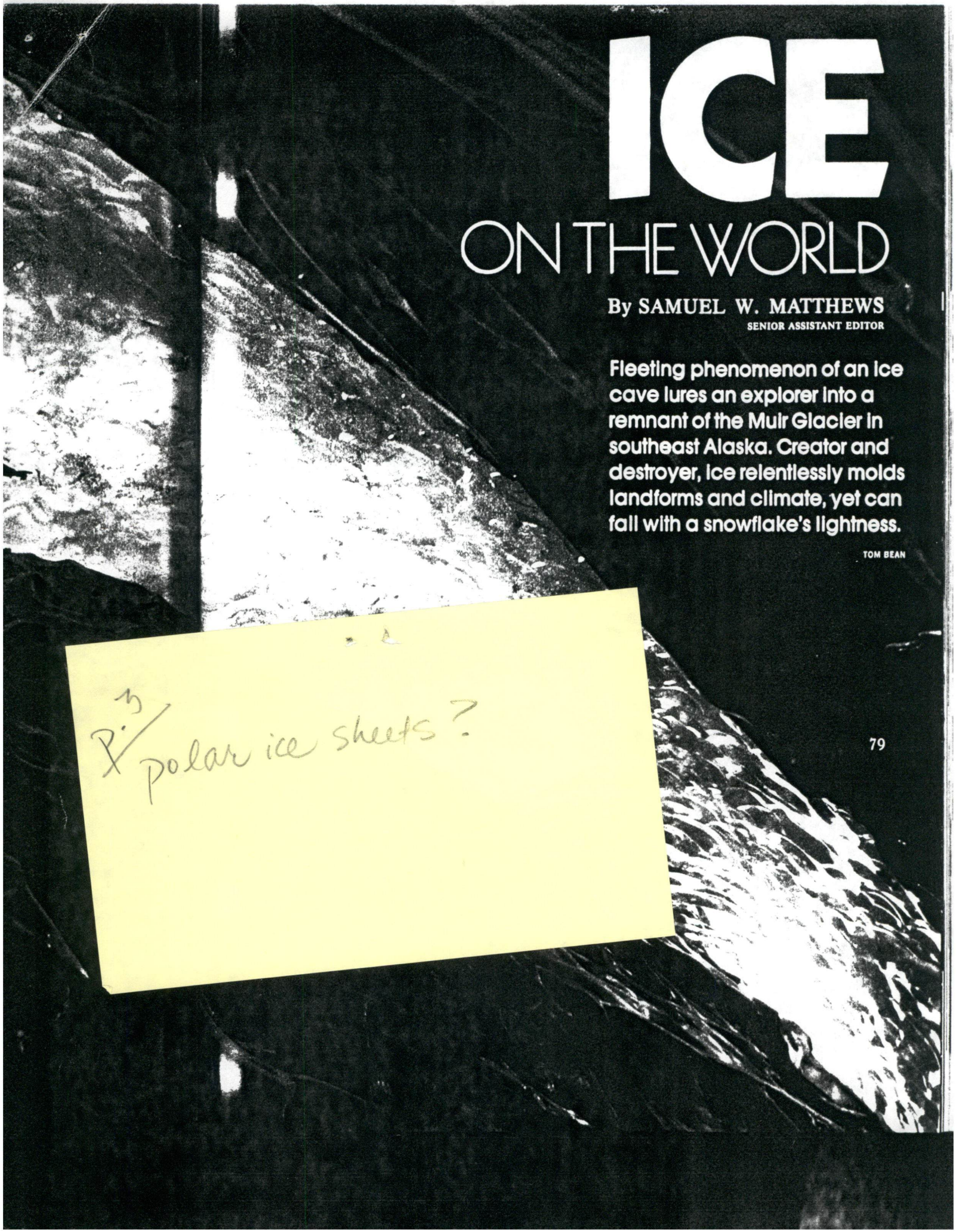
Bill Reilly and Al Bromley will be going to the

Netherlands in about a week to discuss with the international community how we can responsibly -- and the emphasis is on that word "responsibly" -- address the current status of understanding of the problem, the current commitment to developing a better understanding of the issue, and a utilization of that better understanding for the development of international policies that constructively deal with our obligations across the board.

And it is important to understand that as they do so they are going again in the context of an administration that has made a commitment to deal with this issue. An administration that has laid out an agenda, working with the United Nations intergovernmental panel on -- (inaudible) -- to develop by 1990, by November 1990, a report in which the status of what is understood both as the state of the art or science and the capacity of economic and industrial response to deal with the environmental needs can be put into a worldwide context.

In that respect, Administrator Reilly -- the President has made a commitment to host here a meeting, probably in very early 1990, with the working group that is developing those policies. And it is expected that as part of that program, there will be initiated -- discussions will continue that have already been initiated, mainly the discussions on a framework convention on this issue of global warming.

Now, I spent a little bit of time in my presentation today on this issue because I find it is one that is certainly -- (end of tape.)



ICE ON THE WORLD

By SAMUEL W. MATTHEWS
SENIOR ASSISTANT EDITOR

Fleeting phenomenon of an ice cave lures an explorer into a remnant of the Muir Glacier in southeast Alaska. Creator and destroyer, ice relentlessly molds landforms and climate, yet can fall with a snowflake's lightness.

TOM BEAN

P. 3
polar ice sheets?

ICE ON THE WORLD

IT BEGINS, if it can be said to have any one beginning, in the great storm of early December. The jet stream dips sharply south, and a huge tongue of polar air slides under warm and humid low-pressure air all across the North American heartland. Dense, blowing snow all but obliterates pro football games that Sunday in Minneapolis, Green Bay, Buffalo, and Boston. The snow falls, and blows into great drifts, for five days.

That winter brings a series of such storms, more than anyone in the North can remember. In January the snowpack on fields outside Buffalo lies 17 feet deep. The white blanket extends south to Mississippi. Orange groves in Florida die as far south as Okeechobee. There is ice on the Tenn-Tom Waterway and the aqueducts of the Central Arizona Project.

By July it should have been only a memory—but it is not. Snow still lies in sheltered, shadowy places outside Butte and Duluth and Bangor. It is colder across the northern tier than at any time in weather records.

And when the first snow comes again, in late August in the high country, it falls on snow from the winter before that has not melted. It piles up faster even than in that bad December. More of it comes, and keeps coming, again for months.

The TV weathermen talk about it constantly, but it is the glaciologists who recognize the signal. The Ice Age, which has really not left the planet for two million years, is reasserting itself. The warm time, which has lasted less than 12,000 years, is over. The next great return of ice has begun.

WAS THERE EVER REALLY an age of ice, long ago and far away?

Yes and no. Yes, an Ice Age (the most recent, that is) did exist in the time of man on earth—Cro-Magnon man and his ilk. Some 18,000 years ago it buried more than three-tenths of the world's land surface under thick ice and mantling snow. And no, the Ice Age, geologists say firmly, is still with us. We are living in only a slightly warmer spell of it.

Ice scoured and heaped the hills around New York City, fed the river courses that meet at St. Louis, shaped the lochs and golf links of Scotland, gouged the Great Lake basins and Norwegian fjords, and even now, by continued melting, is slowly raising the level of all the oceans. Someday—soon, say some climatologists, who think in millennia—ice could creep south again over North America to bulldoze away Chicago and shove its wreckage to St. Louis.

Ice still covers one-tenth of all earth's land. An entire ocean, the Arctic, is covered with it, like a solid scum on a bowl of cold pea soup. Huge domes of ice lie atop Antarctica and Greenland. Glacial rivers of ice in Canada and Alaska and on mountains even on the Equator help regulate earth's weather.

The Alaskan glaciers have recently been puzzling and bemusing scientists with unexpected, even startling, activity. While some are retreating, others are surging forward. Last spring the giant Hubbard Glacier blocked the mouth of a long tidal fjord and turned it into a fast-rising freshwater lake (pages 107-119).

Ice not only crowns polar reaches and towering mountains with white glory, it also gleams as diadems from roof edges and

An oasis of fresh water *on sea ice quenches a Greenlander's thirst. Salt water freezes at 28.7°F. As sea floes thicken, gravity pulls brine from the surface. The relatively fresher layer on top can be sipped in summer or chipped and melted in winter.*

BRYAN AND CHERRY ALEXANDER

Freshwater islands, *icebergs fall from oceanfront glaciers and sail on keels that form the bulk of their mass* ***(below).*** *North Atlantic icebergs, such as the one that sank* Titanic, *break away from Greenland and Canada.*

Dye sprayed on the face of Antarctica's Ross Ice Shelf ***(facing page)*** *locates a current meter emplaced for a study of ice and sea interaction. The shelf may have calved the largest berg ever recorded—some 200 by 60 miles.*

MITSUAKI IWAGO (ABOVE); STAN JACOBS, LAMONT-DOHERTY GEOLOGICAL OBSERVATORY (RIGHT)

sheathes forests and gardens in shimmering crystal, brings streams and waterfalls to frozen stillness.

It menaces your daily life. It can kill you on a street or highway, ground your plane or sink the ship you take to Europe, cause a tree or hailstones the size of baseballs to fall on your head. It can break your water pipes or car's engine block, flood your farm, freeze your crops, cut off your electricity.

As seen from the moon or space, the earth is blue, brown, and white. Much of the white is ice, whether solid, rime, snow, or frozen cloud.

A REMARKABLE STUFF indeed. Not only does ice produce heat while freezing and absorb it in melting; it floats, because (unlike almost every other substance) it is lighter as a solid than as a liquid.

If it were not for this phenomenon, ice cubes dropped in a glass of water would go straight to the bottom. Icebergs would not float. Lakes, rivers, and seas would freeze from the bottom up. The world would be in deep, cold trouble.

Ice is one of nature's most beautiful and elegant substances. It can form in the atmosphere as snow—lacy, delicate crystals, like fairy place mats, each flake unlike any other.

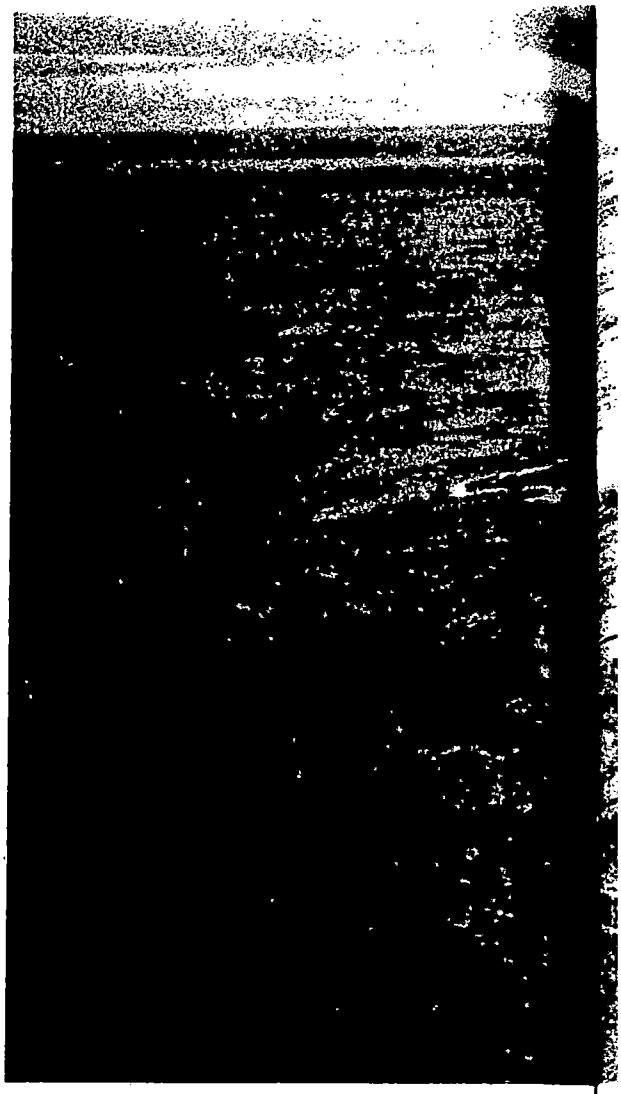
Thoreau called snowflakes chariot wheels fallen from a battle in the sky. To Job, Elihu said, "By the breath of God ice is given, and the broad waters are frozen fast."

On quiet ponds and lakes, as winter air drops water temperature to zero degrees C (32°F), a thin skim of ice glazes the surface. The heat given up by crystallization is lost to the air; the water beneath is both slightly warmer and denser. If the lake is absolutely still, the skim will rapidly thicken, forming a transparent pane on the surface. The pond creaks, even sometimes groans soulfully, as it freezes. In daylight it appears as black as the water beneath.

This black ice, skaters know, is the best of all—strong, absolutely smooth, lightning fast. If not yet too thick, it will undulate beneath you, yet safely hold your weight as you glide across it. If wind or current ripples the ice, or if snow falls upon it while freezing, a white, softer ice forms, full of air, rougher to the skates, opaque to the eye. It cannot be shaved down to black ice; unless it melts completely before the next freeze, that year's skating will be second-rate.

Sea ice is unlike freshwater ice. Because of its dissolved minerals (3.5 percent on average), salt water does not begin freezing until its temperature drops to minus 2°C (28.7°F). Then a thin slurry or scum of freshwater ice crystals appears. Between the crystals, as they grow and interconnect, tiny pockets of brine are trapped and enclosed.

Sea ice thus separates fresh and salt water to some extent. Newly frozen, it may be only



Fighting ice with ice, *an Exxon oil rig in Alaska's Beaufort Sea pumps out water that freezes into bulwarks against crushing ice floes. Standing on a steel mat anchored 60 feet down, the movable station reduces the cost of Arctic oil exploration.*

one-tenth as salty as the water beneath. As the ice grows older and thicker, it becomes fresher; the heavier brine migrates downward, pulled by gravity.

Eskimos know and make use of this phenomenon; they melt the surface ice and its covering snow for drinking and cooking. The Inuit, or Eskimos, have dozens of words for different kinds of ice.

SNOW THAT FALLS on land either melts away entirely the next summer or becomes thicker year by year, compresses by sheer weight, and gradually turns to ice.

"Whenever and wherever one year's snowfall doesn't melt before the next year's snow, a glacier is born," University of Wisconsin climatologist Reid Bryson reminds his students. "If it goes on long enough and widely enough, you have an ice sheet."

Such an ice sheet covered much of North America's northern half in the time geologists call the Pleistocene (map, facing page). The glacial age began more than 2.5 million years ago, when man's early forebears, the australopithecines, prowled Africa's plains. It was at its most recent peak only 18,000 years ago, when Cro-Magnon artists were painting cave walls in southern France.

In that human span of time the ice sheets and glaciers came and went, waxed and waned; the oceans rose and fell; extensive areas of the globe were alternately dry land and below sea level. The forcing mechanisms for these vast changes are now believed to be slow variations in earth's orbit around the sun, its tilt in space, and stately back-and-forth nodding of its spin axis.

These so-called Milankovitch cycles, named for the Yugoslav astronomer who calculated them in the 1920s, control the amount of sunlight received by the two hemispheres in winter and summer.

Much of this theory is supported by deep-sea sediments. Shells of long-dead sea creatures can reveal the temperature of the waters, both surface and deep, in which they grew and died. Core samples brought up by oceanographic research ships can reveal as well just how much ice existed on the earth in different geologic ages.

"Seabed cores are our library of the far past," marine geologist William Ruddiman of Columbia University's Lamont-Doherty Geological Observatory said to me recently. "They tell us the earth's past climate, the movements of its crustal plates, where the ice sheets lay, and why in large part life today is as it is."

At different times in the past one million years, there must have been about three times as much ice on the earth as now exists in Antarctica and Greenland. The greatest amount, the geologic record shows, lay on North America, in the Laurentide and

GENE MOORE (ABOVE); GERD PFEIFER

s, hailstones grow
as they pass through
ooled water droplets.
aindrops are called sleet,
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does.

Cordilleran ice sheets. Ice stretched from the high Arctic islands south across what is now Hudson Bay and the Great Lakes, down the midwestern plains as far as today's Ohio and Missouri River Valleys, and in the west across the Yukon and western British Columbia to Puget Sound.

In Europe an ice sheet covered the entire Scandinavian Peninsula, the North and Baltic Seas, much of the British Isles, and extended from the Low Countries across northern Germany and Poland into Russia. There was ice in Siberia and, beyond the dry Bering Strait, glaciers spilled out from the mountains of southern Alaska (although other parts of that far northern peninsula remained strangely ice free).

The Pleistocene ice advanced and withdrew, again and again. In the past million years there have been nine full glacial periods, separated by much shorter interglacials, or warm spells. Each glacial period has lasted about 100,000 years; each interglacial, as little as 10,000.

The most recent advance of the ice is called the Wisconsin glaciation in North America, the Würm in the Alps. At its height 18,000 years ago, it withdrew unevenly, probably in two distinct stages of melting, about 13,000 and 10,000 years ago, glaciologists now think.

That marks the start of the Holocene, or wholly modern, era. The world was warmer at 6000 B.C., in the so-called Climatic Optimum or Thermal Maximum, than at any time since the previous interglacial some 125,000 years ago.

There have been bitter returns to cold, wet times for mankind since then—from the second to the first millennium B.C., and again beginning after A.D. 1200 in high latitudes of the Northern Hemisphere, continuing until the mid-1800s. In the latter Little Ice Age, glaciers grew again in the Alps and southeastern Alaska. Viking colonies were frozen out in Greenland.

Then the world's climate turned warm again—warmer than in any period since the Climatic Optimum. From about 1880 until present, temperatures have ranged well above the average for the entire Holocene interglacial period. Yet, in our self-centered view, we regard our own time in history as "normal." It is anything but that.

HOW THICK were the northern ice sheets at the height of the Wisconsin? In New England the ice had to be at least 4,000 feet deep to have covered the White and Green Mountains. Over Hudson Bay and the ancient Canadian Shield it must have been more than two miles thick to have bent down and depressed bedrock as much as 1,000 feet. The land surface from the Great Lakes north is still rebounding from release of that great weight, as is all Scandinavia.

When the meltback began and the release came, it took relatively little time—a few thousand years. The land was unlocked, changed dramatically by both the coming and the going of the ice.

The ice sheet left ground-up debris, called till or drift, smeared wherever it had been. It left ridges, or moraines, of heaped-up debris along the farthest lines of advance; Long Island and Cape Cod are two such moraines. It left myriad lake basins, as in Wisconsin and Minnesota; ice-block potholes, called kettles; long sinuous ridges of stream-deposited gravel, called eskers; and curious ice-molded hills, called drumlins.

And it left water—sheets of water running from atop and below the ice, rivers gushing from tunnels in the ice front, huge glacial lakes such as Agassiz in Minnesota, Manitoba, and the Dakotas, and Bonneville in Utah and Nevada.

These lakes occasionally broke out from behind ice dams in monstrous floods. One swept across northern Idaho and southeastern Washington and created the channeled, tortuous scablands. Another came sweeping down the Mississippi Valley to decimate life in the Gulf of Mexico about 11,600 years ago. Year after year, century after century, the flow of meltwater must have been prodigious.

As the ice melted from North America, from northern Europe, from the icebergs that spilled from Antarctica and Greenland, the seas steadily rose. Measurements on the continental shelves, on drowned seamounts, on coral islands, all put the rise at close to 110 meters—360 feet. Intruding seas dramatically reshaped coastlines, broke up floating ice shelves, flooded into Hudson Bay and the Baltic Sea, and left the face of the globe much as we see it today.

TO GO BACK, to actually see what the ice atop North America must have been like, one can fly across Greenland en route to Iceland or Europe. Better yet, one can go to Antarctica.

Almost 90 percent of all the ice on earth lies atop the Antarctic Continent: seven million cubic miles of it (30 million cubic kilometers). It rises more than two miles; at the South Pole it is 9,200 feet thick; at the Soviet Union's Vostok Station, more than 12,000.

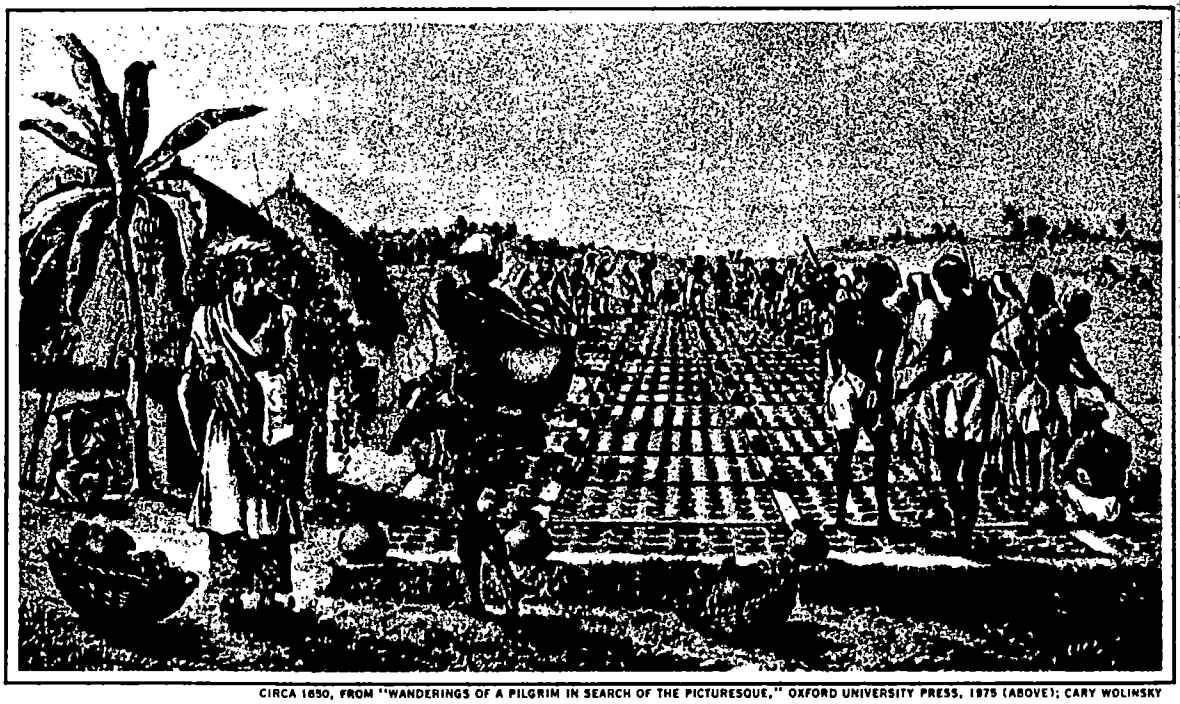
Antarctica is literally a desert; most of it gets less than two inches of snow a year. But that snow scarcely ever melts—it just blows from place to place and grows deeper.

From the lofty dome of ice deep in the interior, behind a wall of mountains that divides the white continent diagonally, ice slowly flows outward and down to the sea on all sides. It escapes through passages in the mountains to the ice-submerged archipelago called West Antarctica, and to the great ice shelves of the Ross and Weddell Seas.

To reach the South Pole, on the high inland plateau of ice, one flies from the main U. S. Antarctic base at McMurdo Sound, at the edge of the Ross Ice Shelf, up the massive, fractured Beardmore Glacier. On the dark, gaunt mountainsides, striations and narrow bands of glacial debris, called lateral moraines, show where ice higher than today's has scoured and scraped across in the dim past. More dramatically still, here and there run bands of lighter sandstones, and amid them jet black streaks of coal.

Antarctica was not always shrouded in ice. Long before the Pleistocene, the continent was warm and held lush vegetation, even forests. Only such organic matter, later covered by warm seas and thick marine sediment, could have produced the coal seams that run through the Transantarctic Mountains, some of the most extensive on earth.

Other startling evidence of ancient landscapes and seaways near the South Pole has recently been found high on these peaks. Tree stems, roots, pollen, and tiny fossils of open-water marine life have been identified



CIRCA 1850, FROM "WANDERINGS OF A PILGRIM IN SEARCH OF THE PICTURESQUE," OXFORD UNIVERSITY PRESS, 1975 (ABOVE); CARY WOLINSKY

*"**We are making ice by evaporation** almost every night." In the winter of 1828 in Allahabad, "the oven of India," Englishwoman Fanny Parks described how water ladled into bowls set into the ground froze as a result of cooling evaporation even when air temperatures hovered above freezing. Preserved in pits covered by thatched-roofed huts, the 120 tons produced that year lasted into August. Today pond ice hauled from storage caves comes to market in Kashi, China **(right)**.*

by Ohio State geologists Peter-Noel Webb, David M. Harwood, and John H. Mercer as being two to four million years old, from the Pliocene epoch. Yet up to now it has been thought that ice lay deep on Antarctica as long as 15, even 30, million years ago.

The shrub wood (following page) grew on the banks and shores of alpine streams and lakes during several interglacial periods, the researchers suggest. In those relatively warm times, great open seaways may have reached deep into the Antarctic interior, and the great central ice mass may have retreated to much smaller ice caps and high alpine glaciers (diagrams, page 97).

When, as in the Northern Hemisphere, the central ice sheet began growing again, it must have scraped up the tiny fossils from the floor of an inland sea and carried them high into the Transantarctic Mountains.

Or did the mountain range, the mightiest in Antarctica, also lurch and rise upward thousands of feet? If it once was lower, less ice would have been needed to override it.

The polar vegetation found on the flanks of the Beardmore Glacier late in 1985, say Webb and his colleagues, must have grown along the edges of the ice as it advanced and retreated, melted and returned, in a time much warmer than today.

Thus the microfossils from the sea and the ancient wood fragments require a major and radical rethinking of Antarctica's long glacial history. Its ice cover must have been unstable, subject to massive advances and retreats much like those of the northern half of the globe.

IS THE ICE on Antarctica today shrinking, growing, or in balance? On this subject scientists are deeply divided. Most admit they simply do not know, and say it will take years, if not decades, of further research to find out.

The outpouring of ice from the high interior down to the coast, feeding the great floating ice shelves, seemingly keeps Antarctica's ice cover in balance. "But that balance may

be illusory," says glaciologist George H. Denton of the University of Maine.

Denton and his colleague Terence J. Hughes are authors of a monumental study, *The Last Great Ice Sheets*. In it they discuss what might happen if the West Antarctic ice sheet, resting largely below sea level, were to "collapse," or melt away entirely.

"The edges of that ice sheet have clearly retreated," Denton says. "We see it in the Ross and Weddell Sea embayments and on coastal mountains poking up through the ice, like so many dipsticks in reverse."

Ian Whillans of Ohio State, studying great ice streams that drain the broad West Antarctic ice sheet, agrees: He sees thinning of ice on both sides of the Transantarctic Mountains. Denton, conversely, thinks the main East Antarctic ice cap is growing thicker. He cites increased snowfall brought on by a still warming climate. The paradox: warmer times, more snow and ice.

Oddly enough, in that much warmer time before the truly polar Pleistocene Ice Age began, the East Antarctic ice sheet must have been far thicker than today's, Denton says. As it grew, pushing perhaps through Peter Webb's inland seas, the ice left marks on the very tops of the Transantarctic Mountains, above 14,000 feet today.

If indeed the central ice sheet is again thickening, that growth may be matched by outflow of glaciers, by calving of icebergs from the ice shelves (recent Norwegian studies show more bergs being produced than previously assumed), and perhaps by melting underneath the ice shelves.

Hughes and others have calculated that a total collapse of West Antarctic ice, with the ice shelves gone, would cause a rise in sea level worldwide of four to six meters—14 to 20 feet—in as little as two to five centuries. But if the ice shelves hold, says Denton, the specter of collapse of Antarctic ice and a catastrophic rise of sea level seems unlikely.

Though worried by continuing increase of carbon dioxide in the atmosphere, leading to even warmer climate ahead, most scientists put the possible rise in sea level, largely from expansion of warm seawater and the melting of Northern Hemisphere glaciers, at only one to two feet by the year 2100.

After that, as polar ice grows thicker from more snowfall, sea level may fall again.

DRILLING DEEP into Antarctica's ice is a way for climatologists to read the far past. Such work in Antarctica was undertaken by the United States in 1967-68 at Byrd Station, where a core drill went down 2,164 meters (7,101 feet) before it hit liquid water near bedrock, then froze fast.

In 1970 Soviet scientists began drilling at Vostok Station, high on the inland ice cap in East Antarctica. In 1981-82 French scientists reached more than 900 meters beneath a point named Dome C, near the center of the huge ice cap. And since 1980 the Vostok ice drillers have bored through more than

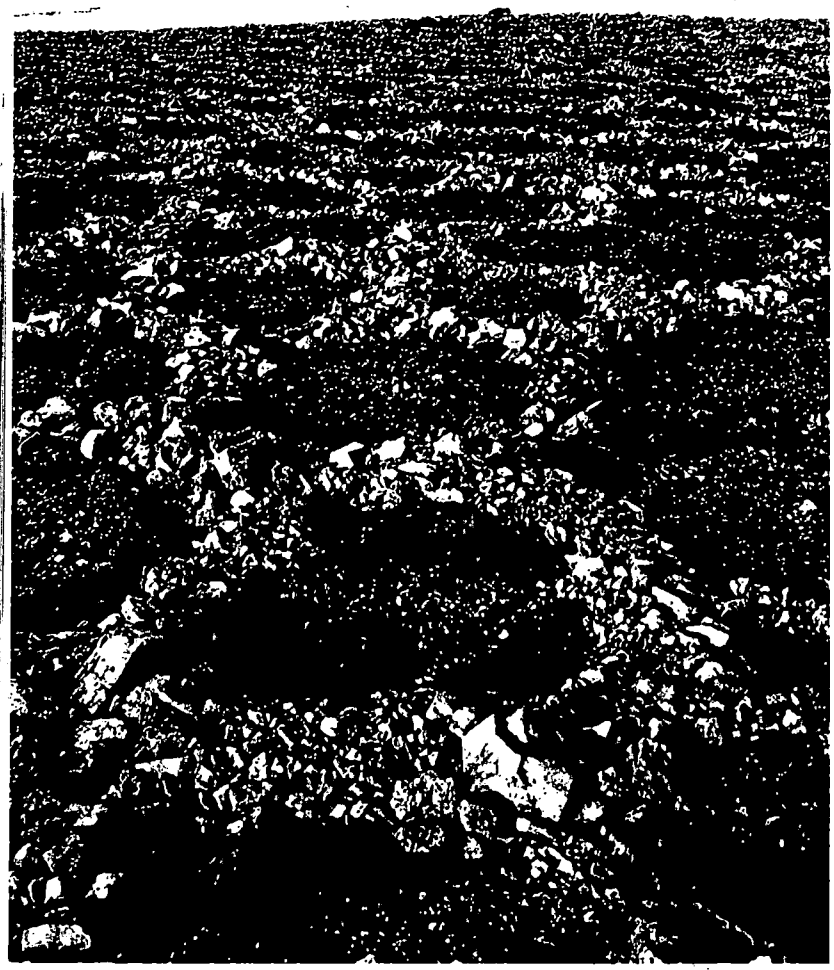
JAMES A. SUGAR, BLACK STAR

2,080 meters of the 3,700 meters (12,140 feet) of the ice under the station.

"The Vostok core is the first to cover, completely and unambiguously, the entire last 150,000 years of earth's ice-age cycle," French glaciologist Claude Lorius reported in 1985, after working with Soviet scientists on the ice core. "It clearly goes back through earth's previous interglacial warm period, called the Eem or Sangamon, and well into the ice age before that.

"That previous interglacial was similar but markedly warmer than our present warm spell, the Holocene," he told me in Washington, D. C., a few months after returning from Antarctica in 1985. "The beginning of the previous warming was as sharp and extensive as was the opening of the Holocene, between about 10,000 and 8,000 years ago."

The Vostok core, somewhat surprisingly

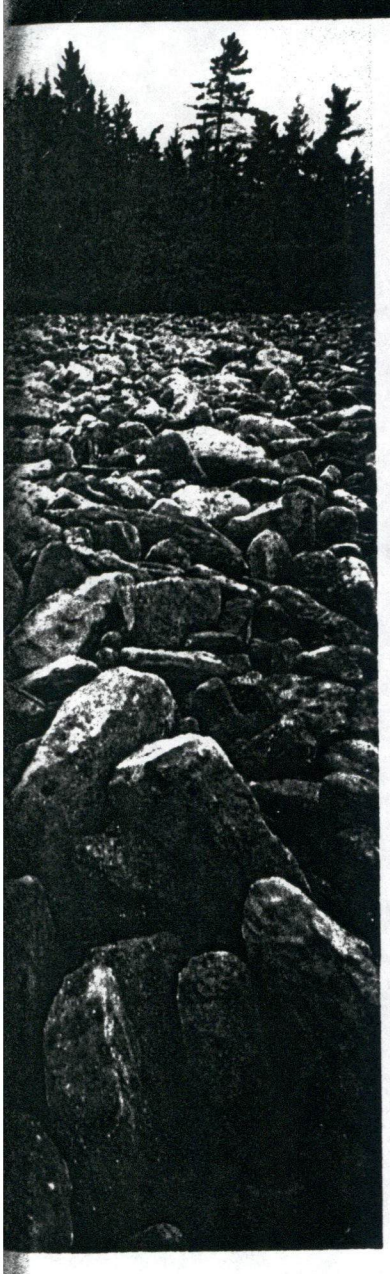


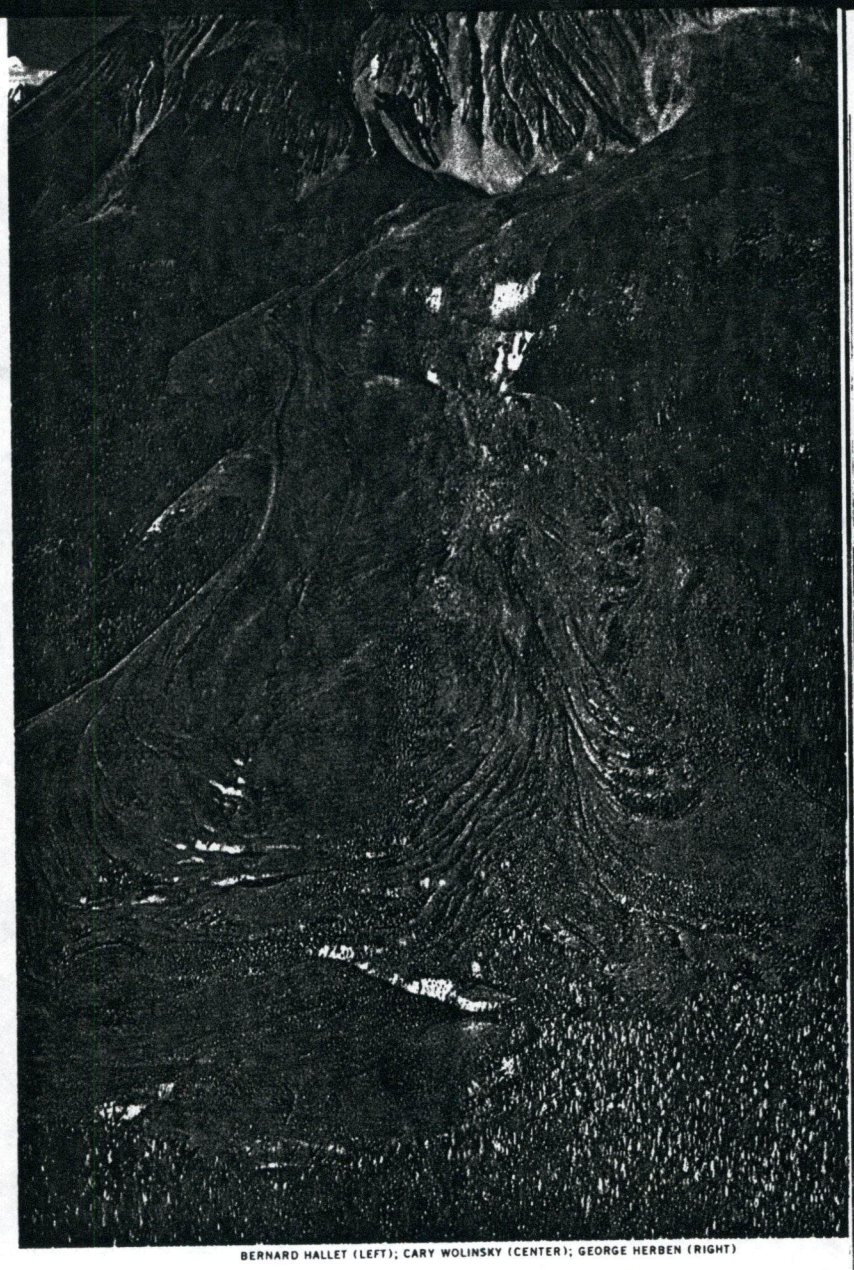
Ice's handiwork *can be as annoying as a pothole or as magical as circles of stones found in Spitsbergen* ***(above)*** *and periglacial regions worldwide. As wet silty ground freezes and thaws, the soil slowly circulates by convection. Rocks lifted to the surface by repeated freezing drift to the border of the soil current. Eastern Pennsylvania resembled present-day Greenland when these red sandstone boulders* ***(center)*** *were fractured by frost and rounded by meltwater 10,000 years ago. In Alaska's Wrangell Mountains frost-shattered rock interlaced with ice creeps downhill one to two inches a year as a rock glacier* ***(far right)****.*

to Professor Lorius, does not hold evidence of more volcanic activity on earth during the past glacial age and previous interglacial than in modern times. But the volcanic dust seen there, as in cores taken from the Greenland ice cap, has given a precise and dramatic record of many great volcanic events of the distant past.

IN 1980-81 Danish, Swiss, and American scientists penetrated more than a mile deep at a point named Dye 3 in southern Greenland. From winter-summer variations in the preserved frozen core, the drillers can read year-by-year weather for the past 11,000 years.

The massive eruptions of the volcanoes





BERNARD HALLET (LEFT); CARY WOLINSKY (CENTER); GEORGE HERBEN (RIGHT)

Laki in Iceland in 1783 and Tambora in the East Indies in 1815 are clearly identifiable near the top of the Dye 3 core. The latter produced the notorious "Year Without a Summer" in New England in 1816, when crops froze and snow fell in July and August.

Sequences of heavy summer melting from A.D. 950 to roughly 1200 confirm the world's warmth during the time that Vikings settled and thrived in Greenland, before the cold of the Little Ice Age froze them out. (From about 1200 until the mid-1800s, world climate was colder than at any time since the last deglaciation.)

Even deeper in the core, volcanic acids show that an eruption must have darkened skies over Rome the year Julius Caesar was killed in 44 B.C. A blast in 1390 B.C. may have been one of several that spelled the end of the volcanic isle of Thera in the Aegean.

On back through time, the Dye 3 core gives absolute dates to unwritten events:

- 4401 B.C. Explosion of Mount Mazama in Oregon created Crater Lake.
- 7911 to 7090 B.C. Seven different great eruptions occurred somewhere on earth.
- From 25,000 down to 10,000 years ago, high amounts of wind-blown continental dust marked the last glacial maximum in the Northern Hemisphere, before the start of global warming in the Holocene.

Analyses of a previous deep ice core taken at Camp Century in Greenland provide ominous evidence that the last interglacial may

have ended suddenly and dramatically. A brief, sharp cooling was followed by temperatures only slightly lower than today's. But both ice and seabed cores show it took only 5,000 to 10,000 years for ice sheets to build up on the earth—some 25 million cubic kilometers of ice, with a corresponding 60-meter (200-foot) drop in world sea level.

Could it happen again? And that fast, in the stately turning of the geologic calendar?

EAST OF GREENLAND, which is no longer green, lies Iceland, an island of volcanic fire and ash more than of ice. But it does hold one of the largest ice caps outside Antarctica and Greenland, named Vatnajökull. Lying underneath Vatnajökull is an active volcano, Grímsvötn. And beneath the smaller Mýrdalsjökull, not far to the southwest, is another, Katla.

TOM BEAN

***Wiggling** through tiny air pockets in an Alaska glacier, an inch-long ice worm—Mesemchytraeus solofiugus, once thought to be mythical—feeds on algae and pollen.*

I have twice been to Iceland to see these glaciers, and to drive across vast outwash plains of black sand and ground-up lava between the ice-locked mountains and the cold sea. With an Icelandic glacier expert, Helgi Björnsson, I talked of what happens when a volcano exists under a huge sheet of ice.

"There is what we call a *jökulhlaup*—a glacier burst—and it is nothing to be in the way of," he said. "At least 13 have occurred from the Grímsvötn region of Vatna since 1955. Katla produced a catastrophic one in 1918; more water than the Amazon carries burst forth and flowed to the sea for only a few days.

"These floods shape much of Iceland's south coast. They keep stretches of it all but cut off from the rest of the country because of the washout of roads on the coastal plain.

"Vatna bursts about every two years, with a bad one every five years. In between, geothermal heat beneath the ice builds up a big pool or reservoir of meltwater, as much as a thousand feet deep. A ridge of rock holds it in, until suddenly it breaks open a channel under the ice, sometimes 30 miles long."

Helgi told me of an ambitious plan to end the Grímsvötn floods. After a future burst, when the glacier pool has drained to its lowest, a tunnel "the size of my office" might be drilled through the mountain ridge, he said, to carry off gathering meltwater and prevent another outburst.

FROM TALK of a volcano meltwater tunnel in Iceland, I traveled to a highway tunnel being bored through a mountain beneath the largest glacier left in Norway, Jostedalsbreen.

Much of west-central Norway is cut off from the populated south by deep fjords and the glacier-capped mountains above. Boats and roundabout roads provide the only way to reach towns and farms isolated by ice. But a dream of decades was nearing reality at the head of a lovely fjord and farm community named Fjærland.

"We'll be driving our cars 4,000 feet beneath the surface of Jostedalsbreen when the

tunnel is completed," said an old friend, glaciologist Olav Orheim of the Norsk Polarinstitutt. A veteran of research journeys to both the Arctic and Antarctic, Olav for years has helped his family operate a summer hotel at Fjærland. Its name, the Mundal, is not only that of the oldest farm in the valley, but also—as anglicized—that of former Vice President of the United States Walter Mondale, whose family came from there.

Olav and I and GEOGRAPHIC photographer Otis Imboden flew by floatplane over the heights of Jostedalsbreen, under clouds only a few hundred feet above the glacier surface. Down the tumbled, crevassed spillways of ice we twisted and turned, following ancient scour marks and moraine lines on the mountainsides. Finally we landed on the ink-dark water at Fjærland.

"This fjord drops to more than 3,000 feet deep at its mouth," Olav said, "and once it held solid ice up to 3,000 feet above us."

A LIVING DIORAMA of the Ice Age in the United States lies in the glaciers of Alaska's southeastern Panhandle and the Chugach, Wrangell, and St. Elias ranges between Anchorage on the west and Yakutat to the east.

Amid mountain scenery as spectacular as any on earth, the glaciers spill down from gaunt peaks, flow together, and fan out in

DOUG ALLEN, OXFORD SCIENTIFIC FILMS, LTD.

***A crimson tide** of summer blooming algae tints a glacier in the South Orkney Islands. Common throughout the world, these one-celled plants form a vital first link in polar food chains. Discovery of brown algae on the underside of Arctic ice floes renews concern about the effects of oil spills on the environment.*

LONNIE G. THOMPSON

***Frozen archive** of weather reports, the 50-meter face of the Quelccaya Ice Cap in Peru's Andes displays annual layers of snow separated by dry-season dust. A 165-meter-long ice core, taken at the ice cap's summit, holds 1,500 years of climatic data. Ice cores from Greenland and Antarctica trace conditions as far back as 150,000 years. But Quelccaya offers a rare record of equatorial weather patterns, such as El Niño, which can wreak global havoc.*

multistriped ice fields along the Gulf of Alaska. Each black stripe of glacial debris is a side moraine from a different ice river. Count the stripes, and you know the number of glaciers feeding the final broad ice stream.

Occasionally a glacier will "surge"—a technical term to glaciologists, translated in popular jargon to "galloping." The ice suddenly begins flowing far faster than normal, grinding and pushing downhill at speeds of tens, even hundreds of feet a day.

I went to Alaska in 1982 because a well-known glacier immediately adjacent to the Hubbard, the Variegated, was in early stages of a surge. Glaciologists from the Universities of Washington and Alaska, Caltech, and the Swiss Federal Institute of Technology were camped on the glacier with ice drills, theodolites, and other gear to record the ice river's gallop forward. It had begun only a few weeks before.

"Our thinking is that a glacier that surges has changed its internal plumbing system," explained Barclay Kamb of Caltech, a friendly, articulate ice scientist. "Meltwater at the base, blocked in its normal escape passages, builds up pressure until the friction between ice and rock is nearly overcome, allowing the ice to slide downhill much faster [diagrams, pages 114-15]."

Day by day I could sense it moving—hear it and all but see it. Along the edges of the Variegated, creaking and groaning and booming of tortured ice gave loud proof that the frozen river on which the scientists were camped was indeed lurching downhill.

"We can measure not only the surface motion—between three and twenty feet a day right now—but also what is more interesting to us: pulses of water pressure traveling underneath. In a series of drill holes through the glacier, we are recording pressure waves moving as fast as 1,000 feet an hour."

The surface of the ice was also rising and falling slowly, like the back of a massive caterpillar, measured by precise instruments mounted on high promontories and cliff ledges above the glacier. Water flowed through deep crevasses in the glacier and gushed in a milky freshet from its snout.

When British explorer George Vancouver sailed this coast in 1794, ice entirely blocked the mouths of several of today's deep,

winding fjords—among them, Glacier Bay southeast of Yakutat. He saw that an inlet existed there, but he could not sail in to prove it. Today ships as large as ocean liners call regularly in Glacier Bay—call with their great horns to try to bring down ice cliffs in thunderous collapse.

Muir Glacier, from the point where famed naturalist John Muir saw it in 1879, has retreated an additional 30 miles, nearly doubling the extent of the ice-freed bay.

ANOTHER ICE RIVER in Alaska is in the process of doing the same thing: Columbia Glacier, just west of the oil-pipeline port of Valdez. Its towering ice cliffs front on deep water in Prince William Sound. There it has stood, calving icebergs and smaller chunks called growlers and bergy bits and brash ice, for hundreds of years.

It has, that is, until a few years ago. Then, for reasons best known to the gods of ice and sea change, the cliffs began spawning more icebergs and inching back off the glacier's doorsill, its terminal moraine.

NATIONAL GEOGRAPHIC photographer Joe Scherschel and I visited Valdez in 1982 to see the Columbia as its retreat was accelerating. With a grizzled, friendly glaciologist named Austin Post, we flew over the Columbia and down along its face in an old Cessna. From the plane's open door we peered straight down and full face at a great embayment in the ice front. It towered 200 to 300 feet above the water. Loose brash ice and bergy bits clustered at its face, but remarkably few large icebergs.

Four years later the scene at the Columbia was far different (following pages). The glacier's face had moved back more than a mile and a half. In front of it, trapped between the glacier and its former submarine sill, lay a jam-packed apron of icebergs, floes, and bits—loose ice that kept any ship, no matter how large, from approaching.

"The Columbia went back fast the first couple of years," Austin told me. "Now it's thinned down somewhat and may be pausing before it begins breaking back again. But since the terminus lies in deep water [measured in September at nearly 1,000 feet], we think it will continue to retreat rapidly.

"Exactly the opposite is happening to the Hubbard. While the Columbia draws back, the Hubbard may be undergoing a major advance, heading back down its bay toward where it stood hundreds of years ago.

"Why? Tidewater glaciers such as these seem to follow long-term cycles of advance and retreat. They do not behave alike or in phase. Their changes relate to dynamics of ice movement, different shapes of their valleys and snow-accumulation areas, and conditions at and under their faces."

Extraordinarily heavy snows of the past three winters in southeastern Alaska, from 1983 to 1986, may be forcing the Hubbard's advance, says Dr. Maynard M. Miller of the University of Idaho. For 40 years he has studied and recorded glacier activity centered in the Juneau Ice Field.

But other glaciologists disagree. Many of them see little connection between local weather or short-term climate changes and the behavior of these great ice streams that end in the sea.

THUS GLACIOLOGISTS watch and measure and ponder: Under the inexorable Milankovitch cycles of earth's solar orbit, will the great continental ice sheets again begin growing? A hundred, a thousand years hence, will the ice have returned?

Certainly the planet's climate will change in coming millennia, say the scientists of a study called CLIMAP—an acronym for Climate: Long-range Investigation, Mapping, and Prediction. The Northern Hemisphere, overall but particularly in high latitudes, appears already to be cooling, after a century and a half of abnormal warmth.

On the other side of the equation is man himself. Will we, by our profligate burning of hydrocarbon fuels, intensify the greenhouse effect of excessive carbon dioxide in the atmosphere and delay the natural planetary cycle? Will the present interglacial thus become even warmer, and the oceans continue to rise, as the ice sheets of Antarctica and Greenland pull back and turn to water? Or will the ice caps grow and spread under increasing snowfall, and the seas begin to fall again?

Stay tuned for the weather broadcasts of the next millennium. □

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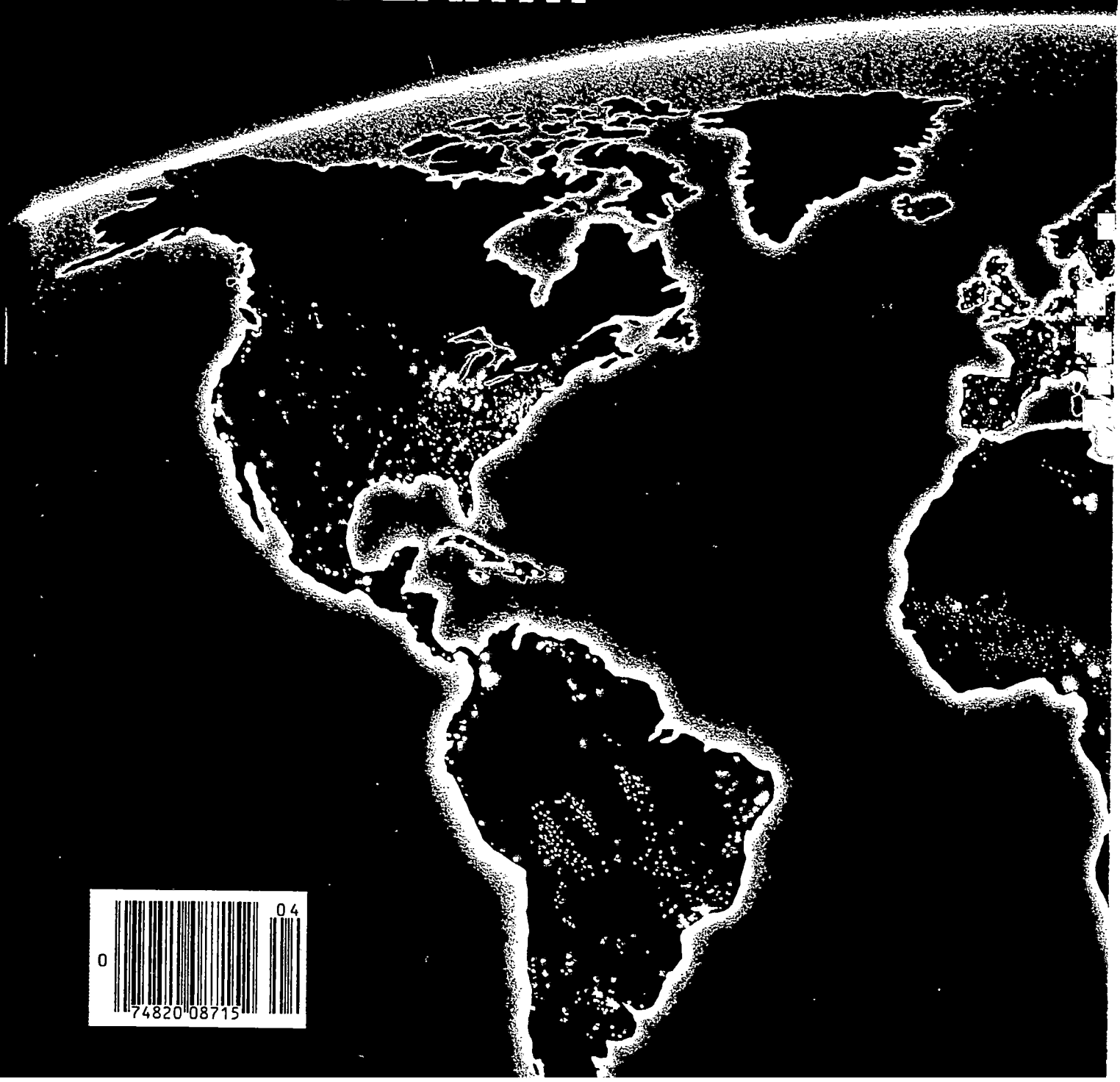
MANAGING PLANET EARTH



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SCIENTIFIC AMERICAN September 1989 Volume 261 Number 3

Managing Planet Earth

Introducing a single-topic issue that explores the prospects for sustainable human development on a planet with finite resources and a fragile environment

by William C. Clark

Every form of life continually faces the challenge of reconciling its innate capacity for growth with the opportunities and constraints that arise through its interactions with the natural environment. The remarkable success of our own species in meeting that challenge is reflected in the striking image that graces the cover of this single-topic issue of *Scientific American*. That initial success, however, is only the beginning of the story.

As we seek to imagine different ways in which that story might unfold, analogies can be helpful. The global pattern of light created by today's civilizations is not unlike the pattern of exuberant growth that develops soon after bacteria are introduced to a nutrient-rich petri dish. In the limited world of the petri dish, such growth is not sustainable. Sooner or later, as the bacterial populations deplete available resources and submerge in their own wastes, their initial blossoming is replaced by stagnation or collapse.

The analogy breaks down in the fact that bacterial populations have no control over, and therefore no responsibility for, their ultimate collision with a finite environment. In contrast, the same wellsprings of human inventiveness and energy that are so transforming the earth have also given us an unprecedented understanding of how the planet works, how our present activities threaten its workings and how we can intervene to improve the prospects for its sustainable development. Our ability to look back on ourselves from outer space symbolizes the unique perspective we have on our environment and on where we are headed as a species. With this knowledge comes a responsibility not borne by the bacteria: the responsibility to manage the human use of planet earth.

At the individual level, people have begun to respond to increased awareness of global environmental change by altering their values, beliefs and actions. Changes in individual behavior are surely necessary but are not enough. It is as a global species that we are transforming the planet. It is only as a global species—pooling our knowledge, coordinating our actions and sharing what the planet has to offer—that we have any prospect for managing the planet's transformation along pathways of sustainable development. Self-conscious, intelligent management of the earth is one of the great challenges facing humanity as it approaches the 21st century.

Although efforts to manage the interactions between people and their environments are as old as human civilization, the management problem has been transformed today by unprecedented increases in the rate, scale and complexity of those interactions. What were once local incidents of pollution now involve several nations—witness the concern for acid deposition in Europe and in North America. What were once acute episodes of relatively reversible damage now affect multiple generations—witness the debates over chemical- and radioactive-waste disposal. What were once straightforward confrontations between ecological preservation and economic growth now involve multiple linkages—witness the feedbacks among energy consumption, agriculture and climatic change that are thought to enter into the greenhouse effect.

We have entered an era characterized by syndromes of global change that stem from the interdependence between human development and the environment. As we attempt to move

MANAGING PLANET EARTH will require answers to two questions: What kind of planet do we want? What kind of planet can we get? To resolve these questions human beings must understand how their activities affect the global environment and must choose strategies for developing the planet. One local aspect of a possible global strategy is symbolized here by a Nepalese woman planting a tree as part of a reforestation project.

WILLIAM C. CLARK is a senior research associate at Harvard University's Kennedy School of Government. He received a B.S. in 1971 from Yale University and a Ph.D. in 1979 from the University of British Columbia. Clark led studies on sustainable development of the biosphere at the International Institute for Applied Systems Analysis in Austria. He is a member of the U.S. National Academy of Sciences Committee on Global Change and edits *Environment* magazine. His interests at the Kennedy School focus on the policy issues that arise from the competing international concerns of development, environment and security. In 1983 Clark received the MacArthur prize.

striking a global bargain

from merely causing these syndromes to managing them consciously, two central questions must be addressed: What kind of planet do we want? What kind of planet can we get?

What kind of planet we want is ultimately a question of values. How much species diversity should be maintained in the world? Should the size or the growth rate of the human population be curtailed to protect the global environment? How much climatic change is acceptable? How much poverty? Should the deep ocean be considered an option for hazardous-waste disposal?

Science can illuminate these issues but cannot resolve them. The choice of answers is ours to make and our grandchildren's to live with. Because different people live in different circumstances and have different values, individual choices can be expected to vary enormously. As pointed out by Gro Harlem Brundtland in the closing essay to this issue, poor people and rich people are especially likely to place different values on economic growth and environmental conservation. Recently, however, the longstanding debate over growth versus environment has matured considerably. A broad consensus has begun to emerge that interactions between people and their environments should be managed with the goal of sustainable development.

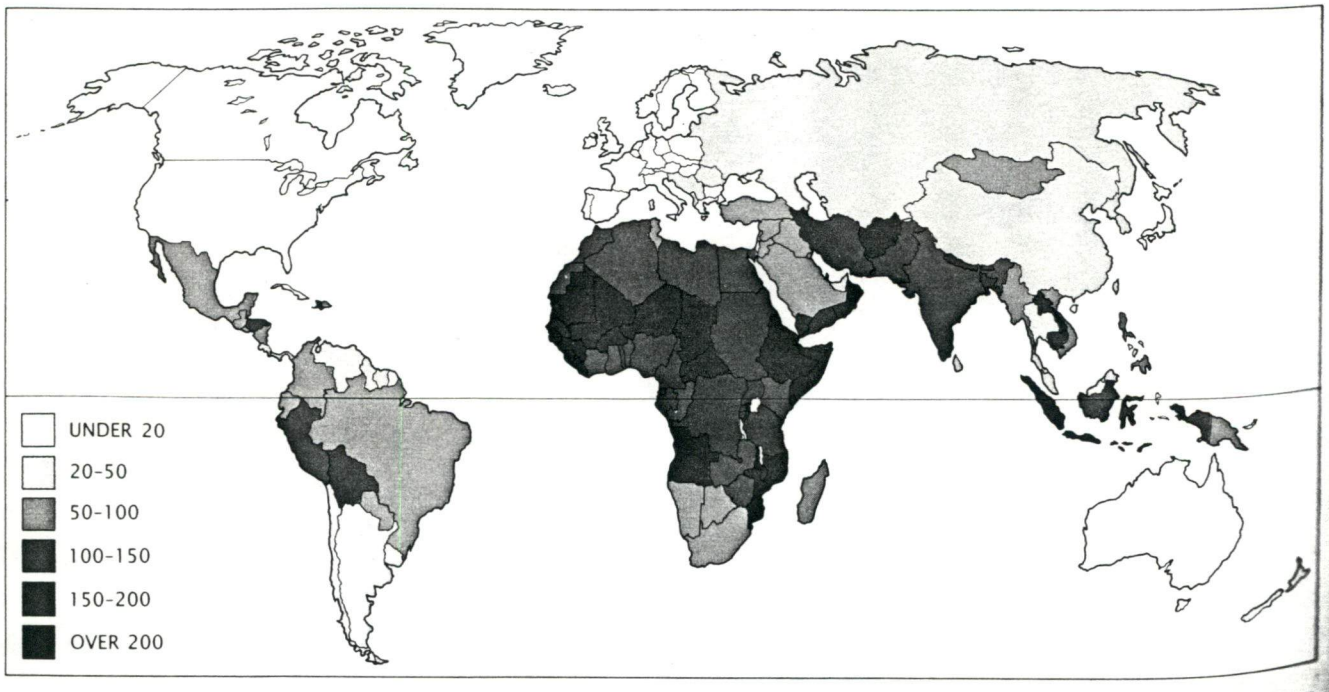
The World Commission on Environment and Development (WCED), chaired by Prime Minister Brundtland, characterizes sustainable development as paths of social, economic and political progress that meet "the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development thus reflects a choice of values for managing planet earth in which equity matters—equity among peoples around the world today, equity between parents and their grandchildren.

Managing the planet toward sustainable development is an undertaking made no less daunting by its urgency. The basic human dimensions of the task are explored by Nathan Keyfitz in "The Growing Human Population" on page 118 and by Jim MacNeill in "Strategies for Sustainable Economic Development" on page 154. The broad picture, although familiar, bears recounting. The planet today is inhabited by somewhat more than five billion people who each year appropriate 40 percent of the organic material fixed by photosynthesis on land, consume the equivalent of two tons of coal per person and produce an average of 150 kilograms of steel for each man, woman and child on the earth. The distribution of these people, their well-being and their impact on the environment vary significantly among countries [*see illustrations below and on next three pages*].

At one extreme, the richest 15 percent of the world's population consumes more than one third of the planet's fertilizer and more than half of its energy. At the other extreme, perhaps one quarter of the world's population goes hungry during at least some seasons of the year. More than a third live in countries where the mortality for young children is greater than one in 10. The vast majority exist on per capita incomes below the official poverty level in the U.S.

As we look to the future, it is encouraging that the growth rate of the human population is declining virtually everywhere. Even if the trends responsible for the decline continue, however, the next century will probably see a doubling of the number of people trying to extract a living from planet earth. Nearly all of the increase will take place in today's poorer countries. According to the WCED, a fivefold to tenfold increase in world economic activity during the next 50 years will be required to meet the basic needs and aspirations of the future population. The implications of this desperately needed economic growth for the already stressed planetary environment are at least problematic and are potentially catastrophic.

Efforts to manage the sustainable development of the earth must therefore have three specific objectives.



CHILD MORTALITY is one measure of a population's well-being. The map shows deaths per 1,000 live births for children younger than five years. More than one third of the world's people live in countries where the mortality is greater than one in 10. The data, estimated for 1985 to 1990, are from the U.N.'s Department of International Economic and Social Affairs.

One is to disseminate the knowledge and the means necessary to control human population growth. The second is to facilitate sufficiently vigorous economic growth and equitable distribution of its benefits to meet the basic needs of the human population in this and subsequent generations. The third is to structure the growth in ways that keep its enormous potential for environmental transformation within safe limits—limits that are yet to be determined.

If the goals of sustainable development describe the type of planet people want, the second question still remains: What kind of planet can we actually get? When we address this question, the focus shifts from what we value to what we know.

In the end the strategies for sustainable development must translate into local action if they are to have any impact at all. As I have noted, however, many of today's most intractable challenges to sustainability involve time scales of decades or centuries and global spatial scales. Any significant improvements in our ability to manage planet earth will require that we learn how to relate local development action to a global environmental perspective.

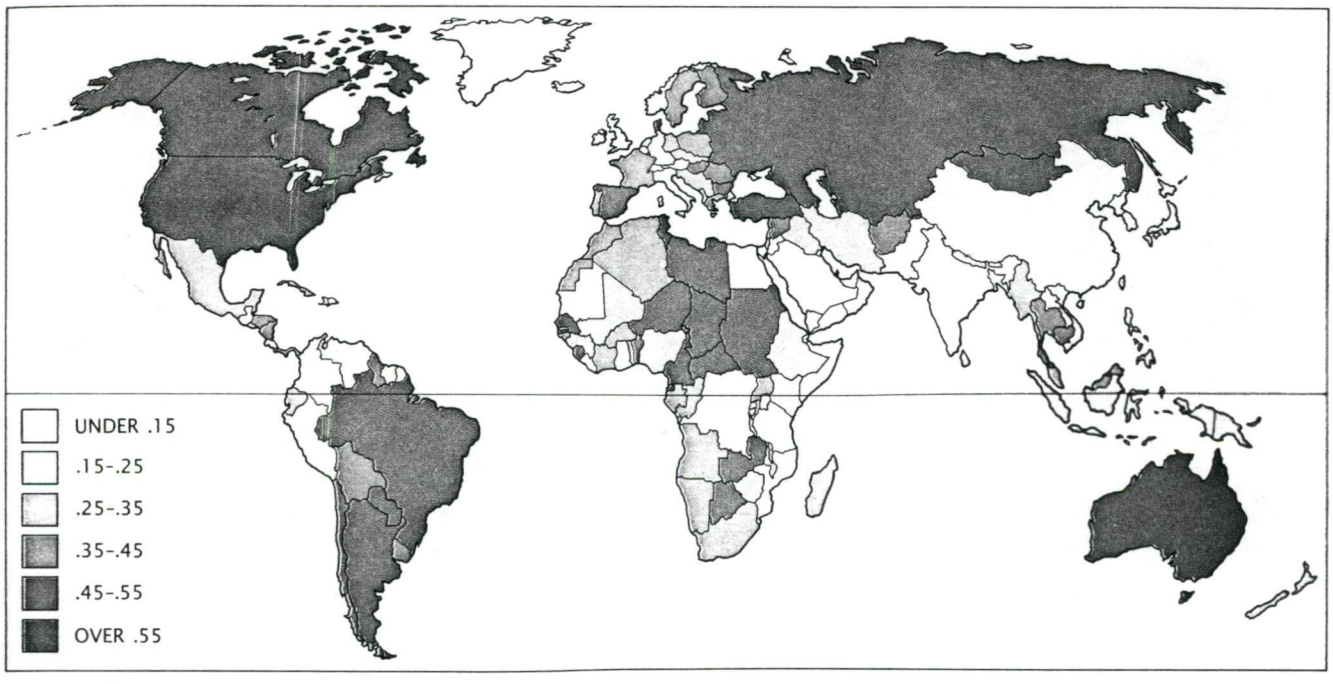
Fortunately, understanding of global environmental change has been revolutionized in recent years. The revolution has its roots in the 1920's, with the Russian mineralogist Vladimir I. Vernadsky's seminal writings on the biosphere. It received important impetus from the International Geophysical Year of 1957 and is now being carried forward through a lively array of research and monitoring efforts around the world, capped by an ambitious new International Geosphere Biosphere Program. Although the "global change" revolution is far from complete, its broad outlines can be summarized in the illustration on page 52.

The view of environmental change outlined in the illustration shows a planet dominated through decades and centuries by the interactions of climate and chemical flows of major elements, interactions that are woven together by the global hydrological cycle and are significantly influenced by the presence of life.

The climate system incorporates atmospheric and oceanic processes that govern the global distribution of wind, rainfall and temperature. Processes central to human transformation and management of planet earth include changes in concentrations of greenhouse gases and their impact on temperature; the effect of ocean circulation on the timing and distribution of climatic changes; and the role of vegetation in regulating the flux of water between land and atmosphere [see "The Changing Climate," by Stephen H. Schneider, page 70].

A second important component of the planet's environment is the global circulation and processing of major chemical elements such as carbon, oxygen, nitrogen, phosphorus and sulfur. These elements are the principal components of life. In chemical forms such as carbon dioxide, methane and nitrous oxide, they also exert a major influence on climate. Even in the absence of human influences, the earth's climate and chemistry have undergone abrupt and tightly linked changes such as those reflected in the ice-core records shown on page 75. When added to these natural fluctuations, human activities have created disturbances in global chemical flows that manifest themselves as smog, acid precipitation, stratospheric ozone depletion and other problems [see "The Changing Atmosphere," by Thomas E. Graedel and Paul J. Crutzen, page 58].

The third component of the illustration, the hydrological cycle, includes the processes of evaporation and precipitation, runoff and circulation. Water is a key agent of topographic change and an overall regulator of global chemistry and climate. As described by J. W. Maurits la Rivière in "Threats to the World's Water" on page 80, human impacts on the hydrological cycle that require attention include pollution of groundwater, surface waters and oceans, redistribution of water flows on the earth's surface



CROPLAND PER CAPITA is an index of the flexibility societies have to adjust their land-use practices. Shown here is cropland in hectares per capita for the mid-1980's. Countries with less than about .2 hectare per capita are especially limited in their options for managing the environment. Data are from the United Nations Food and Agriculture Organization (FAO).

and potential sea-level changes induced by global warming.

Life, the final component in the illustration on page 52, has found the environment of planet earth to be replete with possibilities, resulting in the evolution of an astounding—but rapidly decreasing—degree of biological diversity [see "Threats to Biodiversity," by Edward O. Wilson, page 108]. It has not been widely appreciated until recently that life is also a key player in conditioning and regulating the global environment, through its influence on the chemical and hydrological cycles. Finally, one form of life—the human species—has grown over the past several centuries from a position of negligible influence at the planetary scale to one of great significance as an agent of global change.

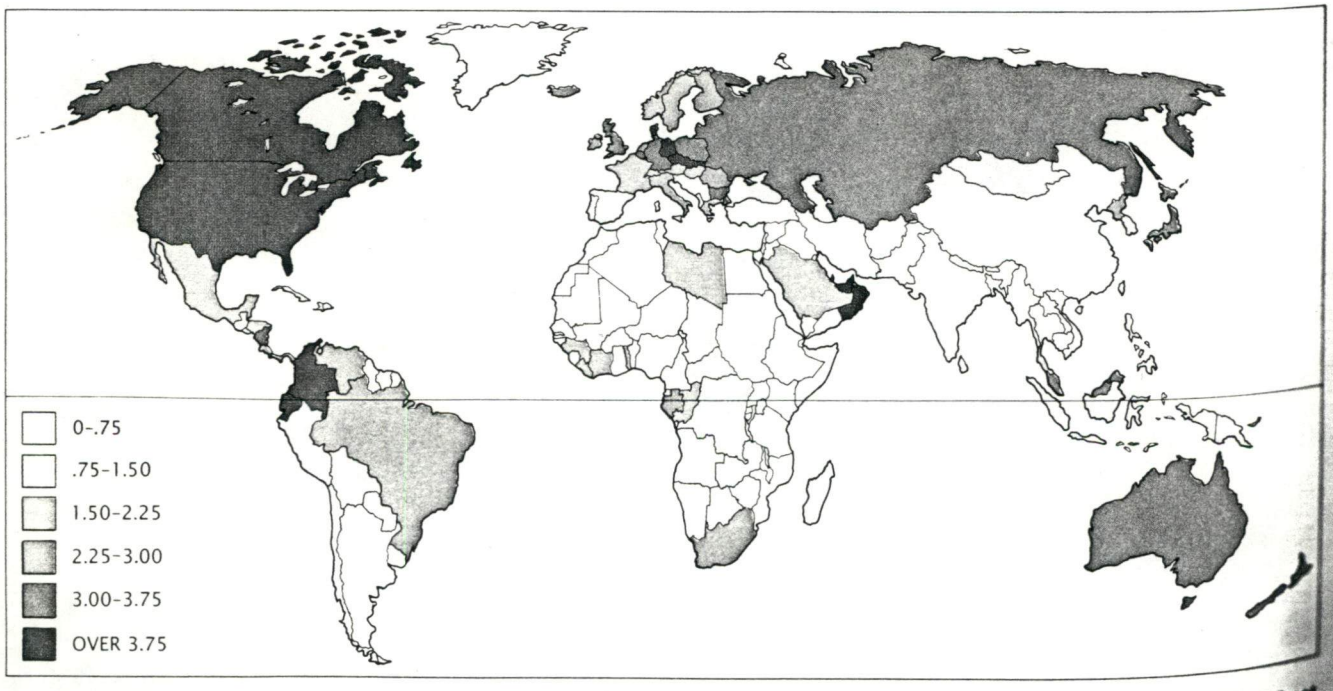
Although our knowledge of the earth system is quickly expanding, we do not yet know enough about it to say with any certainty how much change the system as a whole can tolerate or what its capacity may be for sustaining human development. We do, however, know a good deal about interactions between individual components of the global environment and specific human activities. This admittedly incomplete knowledge provides some useful perspectives on questions of planetary management.

Since the beginning of the 18th century, the human population has increased by a factor of eight; average life expectancy has at least doubled. During the same period human economic activity has become increasingly global, with demands for goods and services in one part of the planet being met with supplies from half a world away. The volume of goods exchanged in international trade has increased by a factor of 800 or more and now represents more than a third of the world's total economic product.

The three components of this growth and globalization of human activity that have had greatest impact on the environment are agriculture, energy and manufacturing, each of which is discussed at length in subsequent articles. Agriculture has been the dominant agent of global land transformation; since the middle of the last century, nine million square kilometers of the earth's surface have been converted into permanent croplands [see "Strategies for Agriculture," by Pierre R. Crosson and Norman J. Rosenberg, page 128]. Energy use has risen by a factor of 80 over the same period, with profound consequences for the planet's chemical flows of carbon, sulfur and nitrogen [see "Strategies for Energy Use," by John H. Gibbons, Peter D. Blair and Holly L. Gwin, page 136]. Finally, the world's industrial production has increased more than 100-fold in 100 years, supported by long-term growth rates of more than 3 percent a year in the utilization of such basic metals as lead, copper and iron [see "Strategies for Manufacturing," by Robert A. Frosch and Nicholas E. Gallopoulos, page 144].

The transformation of the planetary environment induced by this explosion of human activity is particularly evident in changes to the physical landscape. Since the beginning of the 18th century, the planet has lost six million square kilometers of forest—an area larger than Europe. Land degradation has increased to a significant but uncertain degree [*see illustration on opposite page*]. Sediment loads have risen threefold in major river systems and eightfold in smaller basins that support intense human activity; the resulting flow of carbon to the sea is between one and two billion tons a year. During the same period the amount of water humans withdraw from the hydrological cycle has increased from perhaps 100 to 3,600 cubic kilometers per year—a volume equivalent to that of Lake Huron.

Many substantial changes in the planet's other chemical flows have taken place. In the past 300 years agricultural and industrial development has doubled the amount of methane in the atmosphere and increased the concentration of carbon dioxide by 25 percent. The global flows of major elements such as sulfur and nitrogen that result from human activity are comparable to or



CARBON DIOXIDE EMISSIONS are one impact of human activities on the environment. Shown are carbon dioxide releases from energy use, industrial activities and deforestation expressed as tons of carbon per person per year. Highest are East Germany and the U.S. Lowest are Burundi and Bhutan. Data were compiled by the author's student Susan Subak.

greater than the natural flows of these elements. Among the trace metals, many of which are toxic to life, Jerome O. Nriagu of the Canadian National Water Research Institute and Jozef M. Pacyna of the Norwegian Institute for Air Pollution Research have shown that human emissions of lead, cadmium and zinc exceed the flux from natural sources by factors of 18, five and three, respectively. For several other metals, including arsenic, mercury, nickel and vanadium, the human contribution is now as much as two times that from natural sources. Finally, of the more than 70,000 chemicals synthesized by humans, a number—such as the chlorofluorocarbons and DDT—have been shown to affect the global environment significantly, even at very low concentrations.

Assessment of the prospects for sustainable development of the earth shows that the change in the rates at which human activities are transforming the planet may be as important as the absolute magnitudes involved. B. L. Turner, Robert W. Kates and I have analyzed historical transformation rates for several components of the global environmental system. For each component, we first characterized the recency of change—the date by which half of the total human transformation from prehistoric times to the present had taken place. Next, we assessed the acceleration of change by comparing the present rate of transformation with that of a generation ago. The dominant impression from this analysis is the relative recency of most global environmental change. None of the components we reviewed had reached 50 percent of its total transformation before the 19th century. Most passed the 50 percent level only in the second half of the 20th century.

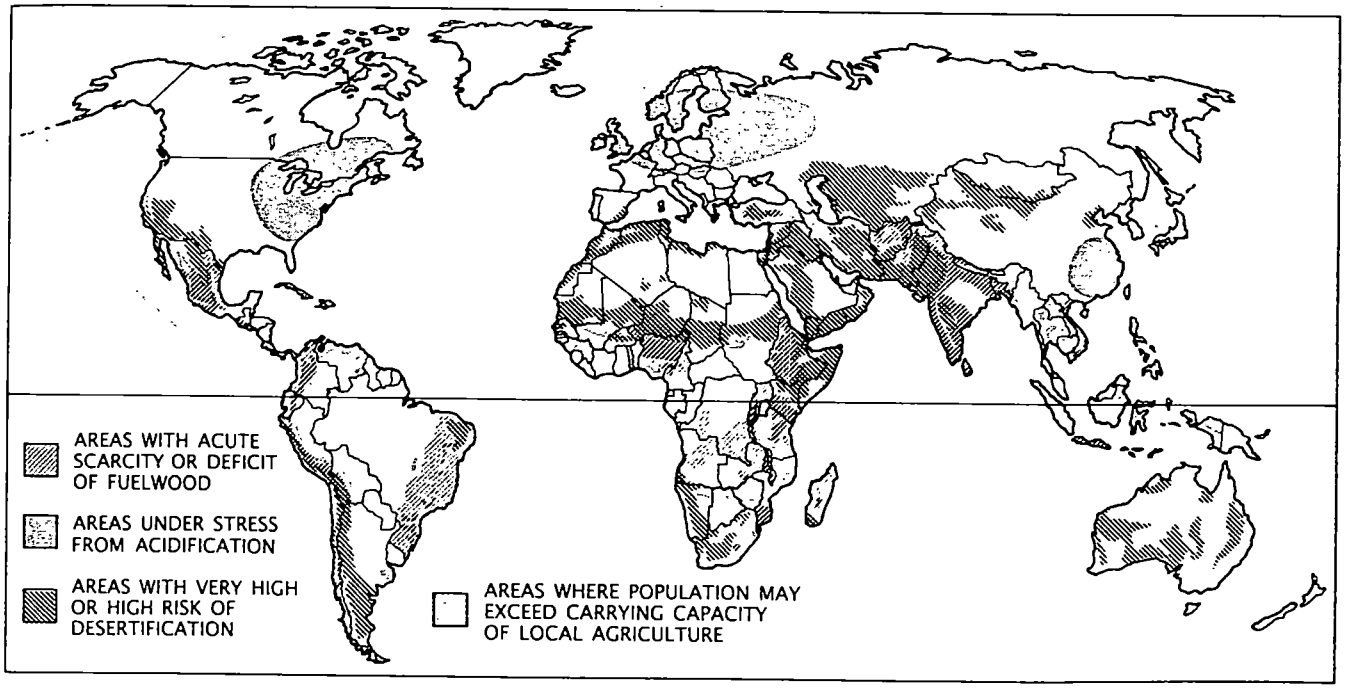
Beyond this general conclusion, four broad patterns of transformation emerge. The first pattern, characterized by relatively long-established and still accelerating change, includes deforestation and soil erosion. The second, established relatively recently and still accelerating, includes the destruction of floral diversity, withdrawal of water from the hydrological cycle, sediment flows and human mobilization of carbon, nitrogen and phosphorus. There is little reason to believe that human society has yet learned to manage on a global scale any of these accelerating transformations of the environment.

More encouraging are two decelerating trends. Human-induced extinctions of terrestrial vertebrates reached half of their present total by the late 19th century and are apparently occurring more slowly today than they were a generation ago. The remaining group of transformations we examined—releases of sulfur, lead, radioactive fallout, a representative organic solvent and extinction of marine mammals—also represents primarily phenomena of the 20th century that are now decelerating.

The crude measure of long-term deceleration presented here gives no assurance that the declining transformation rates reflect increasing competence in planetary management. (Specific transformation rates could, for example, decline simply because there are no more species to exterminate or because we turn to cheaper fuels that happen to emit different pollutants.) Nevertheless, for most of the cases I have cited, at least some fraction of the deceleration can be attributed to deliberate large-scale, long-term efforts at environmental management.

The global patterns sketched so far provide a necessary but insufficient perspective from which to reflect on the prospects for improving the management of planet earth. Also needed is an appreciation of the regional faces of change. To analyze regional situations in any detail is beyond the scope of this essay; still, it will be helpful to recall the extraordinary range of local circumstances that will have to be dealt with if the human transformation of the planet is to be steered along paths of sustainable development.

Any classification of regional perspectives on sustainable development



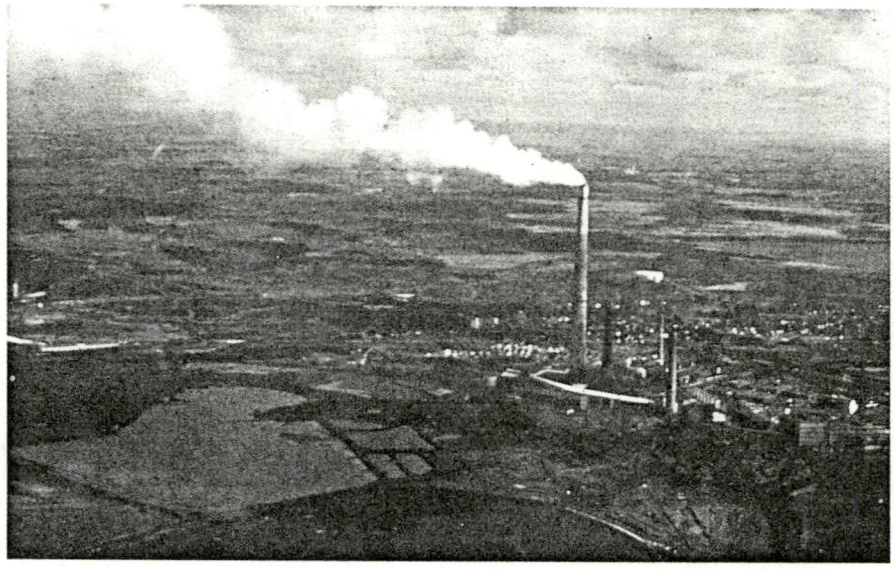
LAND DEGRADATION results from a variety of human activities. Shown are regions threatened by desertification, overharvesting of firewood, acid rain and stress induced by efforts to feed more people than the land is actually able to support. The data are from the U.N.'s Food and Agriculture Organization and the Scientific Committee on Problems of the Environment.

Oliver S. Owen

The HEAT Is On

The Greenhouse Effect and the Earth's Future

Weather experts are seeking the causes and effects of global warming — the "greenhouse effect." Now is the time to examine how this worldwide warm-up may affect our lives.



Greenhouse gases emitted from millions of industrial smokestacks as well as other sources have a warming influence on the world's climate.

Consider the following events for a moment:

- In 1987, an enormous chunk of ice — twice the size of Rhode Island — broke away from the Antarctic ice field and splashed into the sea.
- Shortly after being spawned off the west coast of Africa in August 1988, Hurricane Gilbert attained wind speeds of more than 200 miles per hour. At its peak, it was the most violent hurricane ever experienced in the Western Hemisphere.
- During the summer of 1988, all-time heat records for many cities throughout the United States were shattered. On August 1, for example, Furnace Creek, California, lived up to its name with an oven-like temperature reading of 116° F.

At first glance, it would appear that the above events have little in common. Nevertheless, according to some scientists these seemingly unrelated episodes may all be the direct result of a global climatic phenomenon called the greenhouse effect. The importance of this phenomenon to human society can hardly be overstated. Indeed, according to one prominent climatologist, the greenhouse effect, if uncontrolled, could wipe out civilization within 500 years.

It is ironic that we ourselves are responsible for the climatic dilemma with which we are now threatened. "Humanity is conducting an enormous, unintended, globally pervasive experiment whose ultimate consequences could be second only to a nuclear war," was the message issued by an international conference of scientists and policy makers that convened in Toronto in 1988. The "test tube" that humanity is using in this global experiment is the atmosphere. Into this "test tube" we are spewing a variety of greenhouse gases, such as carbon dioxide, methane, nitrous oxide, and ozone, all of which have a warming influence on the world's climate. These gases are emitted from millions of industrial smokestacks, motor vehicles, waste dumps, and other sources.

Today the world's industrialized nations, such as the United States, England, West Germany, and Japan, are enjoying a quality of life unsurpassed in human history. Regrettably, however, that lifestyle is being bought at enormous environmental costs. And one of these costs is global warming caused by the greenhouse effect. The less-developed nations of South America, Africa, and Asia are also contributing to the greenhouse problem, but on a much smaller scale.

Our inadvertent tampering with the global climate must be controlled. As one scientist at the Toronto meeting stressed: "This conference is screaming out to the nations of the world to put the brakes on the emissions of greenhouse gases."

The Greenhouse Effect

What is the greenhouse effect? Let's give a familiar example. You know what happens if you park your car in the parking lot on a hot summer day and forget to open the windows. When you get back inside your car, it is hot as an oven. This rapid warm-up is due to a greenhouse effect: The sun's radiant energy easily passes through the car's windows, and some of this energy is then converted into heat or infrared radiation. Since this radiation cannot readily escape back through the windows, it is trapped inside, and the car warms up.

Molecules of greenhouse gases, such as CO_2, behave very much like the glass in car windows or in

a greenhouse. In a sense, the greenhouse gases form a "glass window" over the earth. They trap heat that otherwise would escape from the earth's surface into outer space.

Carbon dioxide is continuously removed from the atmosphere by green plants during photosynthesis. On the other hand, carbon dioxide is gradually released back into the air when plants and animals respire, when organic matter decays, when forests, grasslands, or any organic material is burned, and when water evaporates. For thousands of years these processes were in balance, the amount of carbon dioxide removed from the atmosphere equaling the amount entering it. Since 1860, however, atmospheric levels of CO_2 have risen substantially. By itself, fossil-fuel consumption is responsible for the annual release of 5 billion metric tons of carbon into the air — roughly one ton for each person on earth! The rate of carbon release from such combustion has increased 53-fold since 1860. The clearing and burning of tropical rain forests to make room for cattle ranches and farms releases an additional 1.6 billion tons into the air annually.

Scientists have used several different techniques to determine the atmospheric CO_2 levels of past centuries. For example, they have analyzed air bubbles trapped in glacial ice and have examined wood from century-old trees. Since 1958, CO_2 levels have been continuously monitored with sensitive instruments atop Mauna Loa, a 13,677-foot volcanic mountain on the island of Hawaii. Another current monitoring site is located at the South Pole station of the U.S. Antarctic Program. Both sites are far removed from industrial areas where CO_2 levels would be abnormally high. The CO_2 levels recorded at Mauna Loa and the South Pole are virtually identical.

On the basis of such techniques, climatologists have determined that levels of atmospheric CO_2 rose from 275 parts per millimeter (ppm) in 1860 to 346 ppm in 1986 — an increase of 26%. At current rates of increase, the CO_2 concentration will reach 550 ppm by the year 2050 and will hike up the global "thermostat" about 4° C (7° F).

The Greenhouse Controversy

It may appear that the greenhouse explanation of the global warming trend of the 1980s is universally accepted by the scientific community. This is not true. In fact, a number of highly respected climatologists are not convinced.

Stephen Schneider, a climatologist with the National Center for Atmospheric Research at Boulder, Colorado, states that the current warm-up during the 1980s "doesn't prove the greenhouse effect." Schneider's views are similar to those of Chester Ropelewski, a weather expert with the Climate Analysis Center in Maryland. According to Ropelewski, "It's still not clear whether this is the CO_2 signal. The hard evidence isn't there." Kenneth E.F. Watt, professor of environmental science at the University of California–Davis, has ridiculed concern about the greenhouse effect as the "laugh of the century."

Despite such skepticism, however, several highly respected climatologists are certain that the current warm-up of our planet is indeed a bona fide greenhouse signal. For example, in late 1988 James E. Hansen of NASA's Goddard Institute of Space Studies testified before the Senate Energy and Natural Resources Committee that "we can state with 99% confidence that a cause-and-effect relationship exists between the greenhouse effect and the observed warming."

"Greenhouse" Benefits

The effects of the greenhouse phenomenon will not all be bad. Let's consider some of its possible benefits:

- **The cost of heating homes,** stores, and factories would be somewhat less. According to F. Kenneth Hare, a meteorologist at the University of Toronto, if the CO_2 level rises to 550 ppm by 2050, Canadian fuel costs for heating purposes could be slashed by 15%.
- **The sub-Arctic grasslands,** now populated largely by lemmings and caribou, may warm up sufficiently to attract not only

Senator Gore In Antarctica

Senator Albert Gore, Jr., has long been interested in the earth's environment. He chaired the first congressional hearings on the greenhouse effect and has introduced legislation to combat climate change and ozone depletion.

In 1988, Gore visited Antarctica to gather information about global warming and other environmental problems and found that the Antarctic ice contains clear evidence of how the earth's atmosphere is changing.

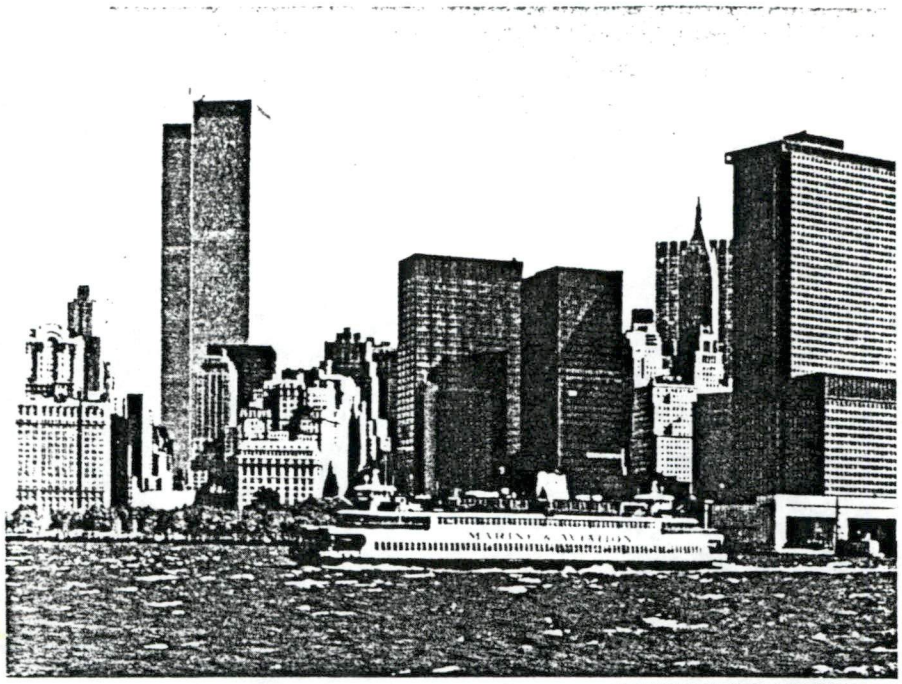
"Ice cores contain highly accurate information about the makeup of the Earth's atmosphere year by year for tens of thousands of years," Gore reported. "From such cores, we know, for example, that there were dramatically lower levels of carbon dioxide in the atmosphere at the peak of the last Ice Age, 20,000 years ago. . . . By contrast, the ice and snow laid down in the 1980s show levels of carbon dioxide, methane, CFCs, nitrous oxide, and other gases responsible for the greenhouse effect higher than they have been in at least 160,000 years (as far back as the ice cores measure). . . .

"Something else is different about the ice layers from the 1980s — they *look* different to the naked eye because of the thick, alternating layers of 'hoar' ice, apparently caused by partial melting and recrystallization into larger granules. The scientists are as yet cautiously withholding judgment on whether this is the clear signal of Antarctic warming that many have anticipated."

Source: "Postcard Antarctica: Unbearable Whiteness" by Albert Gore, in the December 26, 1988, issue of *The New Republic*.

human settlement, but agricultural and industrial development as well. Certainly an average warm-up of 7° F or more would probably be most welcome to the few people who are now living in the frigid realms of northern Canada, Scandinavia, and the Soviet Union. Some greenhouse researchers have even suggested that millions of Americans will emigrate to Canada because they will find living and working opportunities so attractive. As a result, Canada's population, as well as its political and economic clout, could grow enormously, eventually even surpassing that of the United States.

- **The added carbon dioxide** in the atmosphere could bring increased rainfall as well as a longer growing season; hence, agricultural production should improve in places such as Canada, Europe, and northeast Africa. For example, the 110-day growing season in Canada's wheat belt could increase to 160 days. As Robert Stewart, climate expert from Agriculture Canada, has said, "The greenhouse effect is not doom and gloom [for Canada] in any sense!"



NEW YORK CONVENTION & VISITORS BUREAU

If the level of the earth's seas rises due to melting of the polar ice caps, waterfront cities such as New York would experience major flooding and destruction.

Harmful Effects

Unfortunately, most of the effects of global warming would be highly detrimental. These negative effects include:

- **Melting of glaciers and rising seas.** An increase in global average temperature of only 4° C (7° F) would result in a thermal expansion of the warmed-up sea water, a melting of glaciers such as the Antarctic ice cap, and, therefore, a rise in ocean levels. Indeed, such melting has already begun, as evidenced by the slab of ice that broke off from the Antarctic ice field in 1987 and splashed into the Ross Sea. So huge was this chunk — 25 by 99 miles in area — that its loss actually reshaped Antarctica's shoreline. In fact, the Bay of Whales is now gone forever, except in mapmakers' memories!

Guy Guthrie, manager of the National Science Foundation's Polar Information Program, notes, "The size of the iceberg in human terms is staggering. If you could somehow transport it to California and melt it, it would supply all the water needs of Los Angeles for the next 675 years!"

A 3.3 foot (1 meter) rise in ocean levels by 2035 would cause the seas to move 100 feet (30 meters) further inland along our nation's shores, thus reshaping the coastline. Along the Atlantic and Gulf shores, major portions of Florida and Louisiana would be flooded. Billions of dollars of property, including homes, factories, chemical storage tanks, railroads, and highways would be inundated. It is estimated that the city of Charleston, South Carolina, alone would sustain $650 million in flood damage. Boston, New York City, Baltimore, Norfolk, Miami, Mobile, New Orleans, and Houston would likely experience similar destruction. Millions of people would be forced to relocate; human stress, anxiety, and discomfort would be severe. The salty water of the rising seas would gradually "invade" brackish water estuaries such as the Chesapeake Bay, with the result being a massive contamination of breeding and nursery habitats used by valuable food fish such as red snapper, bluefish, striped bass, and flounder. Moreover, salt water would seep into water-holding layers of porous rock (aquifers) and pollute the drinking water on which millions of people depend.

- **Hotter summers.** Several of the leading weather experts in the United States are confident that the searing heat experienced in 1988 was indeed the result of the greenhouse phenomenon. Heat records were broken and re-broken in towns throughout the Middle West, as well as in New England, the Middle Atlantic states, and the far West. In Ohio, the Environmental Protection Agency issued an ozone warning because the hot air acted like a lid over Cleveland, Columbus, and other cities and caused a serious buildup of the health-threatening gas. Health authorities throughout the United States advised the aged and those with heart or respiratory problems to remain indoors and reduce their physical activity during extreme heat waves. Despite these warnings, however, a number of heat-related deaths occurred.
- **More frequent and severe droughts.** Suppose that the U.S. Weather Service announced tomorrow that the nation would receive 40% less precipitation than normal during the next 100 years. The report would send shock waves through the country. Such a drastic decline in moisture would cause an environmental-agricultural-economic disaster of enormous dimensions. But such cli-

matic trauma is precisely what is predicted by Walter Orr Roberts, former director of the National Center for Atmospheric Research in Boulder, Colorado, when the greenhouse effect really takes hold. In other words, droughts would be considered "normal" and could be expected year after year.

• **An increase in the frequency and severity of dust storms.** The most-destructive soil storms in U.S. history raged during the Dust Bowl era of the 1930s. Coffee-colored dust clouds more than a mile thick billowed darkly across central U.S. prairies. On May 11, 1934, one of these "black blizzards" airlifted 300 million tons of fertile soil — an amount equal to the tonnage scooped out of Central America to form the Panama Canal. The soil loss in this single storm was equivalent to the removal of 3,000 one-hundred-acre farms.

Soil erosion is still a critical problem today. In March 1989, the U.S. Soil Conservation Service reported wind-erosion rates of at least 15 tons per acre per year on 4.7 million acres of cropland — an area the size of New Jersey. This is triple the rate that soil scientists consider "tolerable."

And what of the future? Unfortunately, because of the greenhouse effect, soil scientists predict that the dust storms of the future will be even worse. Greenhouse expert Walter Orr Roberts writes, "The Dust Bowl of the 1930s was the greatest climatic disaster in the nation's history. But it will seem like child's play compared to the Dust Bowls of the 2040s."

• **More frequent and severe hurricanes.** The energy that powers a hurricane is derived from ocean waters that have warmed up to at least 80° F (27° C). Is it possible that 1988's Hurricane Gilbert was spawned by an ocean warm-up caused by the greenhouse effect? Several leading climatologists are of that opinion. One of them is Carl Wunsch of MIT. Wunsch believes that Hurricane Gilbert may have been only the first of an increasing number of very intense hurricanes that will be triggered by global warming. Wunsch has stated that "the climatic conditions associated with Gilbert were consistent with what you would expect to see happen under the greenhouse effect. My gut feeling is that that is what we are seeing." Several other researchers at MIT predict that an ocean warming of only 5° F would fuel super-hurricanes that could be 50% more destructive than those of the past.

• **A growth in the number and severity of forest fires.** The U.S. Forest Service called the summer of 1988 the worst fire season in 30 years. That summer's drought transformed much of the nation's timber into kindling wood, vulnerable to being set ablaze by lightning strikes. By midsummer, scores of forest fires were raging in Alaska, Idaho, California, Oregon, Utah, Wyoming, and Wisconsin. More than 3.65 million acres — an area larger than Connecticut — was reduced to char and smoking em-

USDA

The greenhouse effect would make forest fires, such as the ones that devastated millions of acres of U.S. forests in 1988, more common in the future.

"The rate of wildlife extinction will be much greater during the sudden temperature rise of the next century than it was in the much more gradual thousand-year warm-ups of the past."

bers. At Yellowstone National Park alone, flames seared more than a million acres, forcing the evacuation of thousands of tourists who had come to watch the eruptions of Old Faithful. Fire Chief Fred Roach, who had battled such blazes for more than 20 years, told reporters he "had never seen anything as awesome as this."

The outbreak of fires in 1988 may or may not have been an authentic greenhouse signal. However, scientists predict that, as forests become hotter and drier when the greenhouse effect does arrive, the forest wildfire picture in the United States will be much like that of 1988, but on a regular basis, year after year.

• **Wildlife extinction.** Many major temperature shifts have occurred during the 3-billion-year history of life on this planet. During the last thermal rise, thousands of years ago, a number of warm-climate species expanded their ranges northward as far as Canada. Osage oranges, for example, grew near Toronto; wild pigs flourished in Pennsylvania. Of course, many plants and animals were not able to adjust to the thermal shift and became extinct. The crucial point is that these extinctions were caused by a warm-up of 5° C over

Larry Ephron

The Next Ice Age

Not everyone agrees that the greenhouse will lead to worldwide warming. In fact, some experts think that a new ice age may be imminent. Author Larry Ephron is one such contrarian.

Most people assume that the greenhouse effect will warm the earth's climate dramatically in coming years. There does seem to have been a slight increase in the earth's average temperature during the past 100 years, and the four hottest years of the century were all in the 1980s. But winters have also been getting longer and colder during this same period of time. Never in recorded history have Northern Hemisphere winters been so cold or has snow fallen so late in the season in so many areas. What is going on?

The greenhouse effect is occurring primarily in the tropics and lower latitudes, where there is a lot more of the sun's heat for the greenhouse gases to magnify. Since the polar regions are cold and even dark much of the year, the greenhouse effect is minimal there. So the greenhouse effect is resulting in the tropics becoming hotter, while the poles stay about the same.

Any meteorologist can tell you the consequences: The hot tropical air rises faster, and cold polar air rushes in to replace it. The result is higher winds, including more and bigger hurricanes and tornadoes. These greenhouse winds often carry much moisture with them, evaporated from the overheated tropical oceans. Carried in clouds to the higher latitudes, this moisture falls as increasing rain during the spring and fall and as increasing snow during the winter. Thus, winters get longer and colder, and there are more devastating floods in the spring.

Major ice ages recur on a vast 100,000-year cycle — about 90,000 years cold, only about 10,000 years warm (with up to a couple of thousand years variation). Evidence of the past 25 of these cycles has been discovered in sea-floor and polar-ice cores.

We are about 10,800 years into a warm period, one of the so-called interglacial periods. Everything we call human civilization — pottery, agriculture, writing, cities — has been created in that brief span of time since the last major ice age ended and the earth warmed up again.

What could cause such an awesome recurring cycle of ice ages? Up until recently, many scientists have believed that the major ice ages are caused by very small changes in the earth's orbit and rotation, affecting the amount of sunlight falling on various parts of the globe. Some of these orbital movements do seem to cause relatively minor fluctuations in the earth's ice cover. But many scientists now feel that these variations are too small to be the cause of major ice ages.

a span of thousands of years. Today, however, greenhouse scientists predict an equivalent temperature rise in only 61 years.

If the global temperature does indeed rise 5° C by 2050, the climate will shift poleward about 200 miles per century. Could wildlife keep pace? Many of their natural migration paths or escape routes would, of course, be blocked. For example, it would be extremely difficult for a deer to thread its way through the urban sprawl of a major city.

If the greenhouse prophets are correct, the rate of wildlife extinction will be much greater during the sudden temperature rise of the next century than it was in the much more gradual thousand-year warm-ups of the past.

International Law of the Atmosphere

What can be done to mitigate the greenhouse effect? In 1989, the Environmental Protection Agency advocated a number of policy options that, in aggregate, could reduce the rate of global warming by 60%, to about 1° C per century. Among the recommended options are the following:

1. Reduce CO_2 emissions from cars by switching from gasoline to cleaner-burning fuels such as methane, making more-extensive use of mass transit, mandating that all new cars have a minimum fuel efficiency of 50 miles per gallon, and eventually converting to electric-powered vehicles.

2. Impose a CO_2-user tax on all fossil fuels.

3. Promote energy conservation by recycling paper, glass, and metals and using garbage and crop residues as sources of fuel.

4. Greatly expand the development of solar energy so that the use of fossil fuels can be reduced.

5. Develop large "energy plantations" of fast-growing trees. Burning this wood would not result in any net increase in atmospheric CO_2, since the CO_2 released would only equal the amount taken in by the trees when they were alive.

6. Halt the destruction of forests in the tropics.

These measures should be pursued vigorously as soon as possible, both in the United States and around the world. Since CO_2 and other greenhouse gases have long air-lives and disperse readily

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Fifty years ago, Sir George Simpson, former head of Great Britain's Royal Meteorological Society, suggested that some source of increased energy would be needed to move the huge amounts of moisture that build up ice-age glaciers. More recently, John Hamaker, a mechanical engineer who has been studying the climate from a multidisciplinary perspective for the past 15 years, has theorized that the energy to build up the ice-age glaciers comes from a greenhouse effect.

Science has long known that a great deal of erosion by wind and water takes place during the 10,000 years of each warm interglacial period. One of the major consequences of this erosion is that the minerals in the soil get eroded away or are leached deep into the subsoil where they are no longer available to the trees and other plants. As the minerals vital to plant growth get eroded away, the earth's temperate-region forests get progressively weaker and eventually begin to die back. They succumb more readily to insects, disease, drought, and forest fires.

As the forests die back, they not only consume less carbon dioxide, but they also release the huge amounts of carbon stored in them back into the atmosphere, where it recombines with oxygen to form large quantities of carbon dioxide. Since carbon dioxide traps more heat from the sun, the increase creates a naturally occurring greenhouse effect, with severe climatic consequences.

This greenhouse effect continues for tens of thousands of years, transferring more and more moisture to the growing polar glaciers and creating an ice age. Paradoxically, the tropics are known to be hotter during an ice age and, initially, summers in temperate regions get hotter and hotter for a while.

Why does an ice age ever come to an end? That's the last piece of this incredible puzzle. As the glaciers slowly advance over tens of thousands of years, they grind up the rocks in their path into a fine dust. This dust is carried by streams and blown by wind over the earth. This rock dust — composed of vital minerals — remineralizes the earth's soil and nourishes the forests again. As the forests thrive and spread, they consume the excess carbon dioxide in the atmosphere. The greenhouse engine eventually subsides, and another temperate interglacial period is ushered in.

This time around, we're accelerating the natural processes of climatic change by adding our own man-made greenhouse effect: cutting down the world's remaining forests at an ever-increasing pace, burning fossil remains of long-buried forests that have turned to coal, oil, and natural gas, and so forth.

In 1979, Genevieve Woillard, a pollen specialist in France, concluded from detailed studies of the remains of ancient trees that the shift from a warm interglacial climate to the beginning of the last ice age (when it became too cold for fruit and nut trees to grow) took less than 20 years. Observing that European forests now seem to be dying in a similarly precipitous way, she wrote that we may now be in a similar period of climatic change and could be only a few years from the beginning of the next ice age.

About the Author

Larry Ephron is director of People for a Future, author of *The End: The Imminent Ice Age & How We Can Stop It*, and producer of the hour-long video *Stopping the Coming Ice Age*. His address is 2140 Shattuck Avenue, Berkeley, California 94704.

"The effective control of the greenhouse problem demands a concerted international effort."

through the air from one nation to another, the effective control of the greenhouse problem demands a concerted international effort. To this end, the United Nations has sponsored a series of conferences involving over 40 countries. The first was held in Washington, D.C., in early 1989. It is hoped that these conferences will lead eventually to an International Law of the Atmosphere, with provisions for the significant reduction of greenhouse-gas emissions throughout the world.

Unfortunately, there are serious obstacles to the implementation of such a law. One problem is that a number of underdeveloped nations, such as China and India, have just launched an industrialization process that they hope will lead to a better quality of life. However, such development is dependent on energy derived from fossil fuels, the consumption of which releases large amounts of CO_2. Currently, the per capita emission of CO_2 by heavily industrialized nations such as the United States and Japan is 20 to 50 times greater than that by underdeveloped nations such as China and India. Certainly it only seems right that the poor nations have the same opportunity to develop economically as did first-world nations. Suppose, however, that China would like to increase per capita gross national product to just 15% that of the United States. To accomplish this, the nation would have to burn so much fossil fuel that the increase in CO_2 emissions would equal the total CO_2 released from all the coal currently consumed by the United States.

The world's soaring population is another major barrier to the international control of CO_2 emissions. The number of people on earth is projected to double in the next half century. It is apparent, therefore, that without creative control strategies emissions of CO_2 will increase dramatically even if the global quality of life is merely maintained at its present level.

Despite these formidable problems, a growing number of the world's weather experts, environmentalists, and lawmakers are convinced that humanity must come to grips with the greenhouse effect. At a recent congressional hearing, Senator Max Baucus of Montana sounded a note of urgency: "The Environmental Protection Agency's policy options report makes a compelling argument for action *now*. The question confronting us is, will we heed this warning?" We should indeed — and without further delay. After all, "the heat is on."

Clouds and Global Warming

Scientists are paying more attention to the "wild card" in the climate system — clouds — to determine their relationship to global warming. Different cloud formations can either prevent or accelerate global warming, so a crucial question is how warmer surface temperatures on the earth will affect clouds.

Marine stratocumulus clouds, which form low-lying cloud banks over the oceans off the west coasts of North America, South America, and Africa, prevent sunlight from reaching the earth and therefore keep the planet cooler. Thus, a warmer climate resulting in more marine stratocumulus clouds will help prevent global warming, says Howard Hanson, a research associate with the Cooperative Institute for Research in Environmental Sciences at the University of Colorado at Boulder.

But if a warmer climate results in more cirrus clouds — high, thin ice clouds — the problem could be compounded because cirrus clouds do not block sunlight and tend to trap heat near the earth.

Noctilucent clouds, the striking silvery blue clouds seen on summer evenings only at high latitudes, have been viewed as a natural phenomenon for the past century. However, Gary Thomas, a professor at CU-Boulder, now believes they are actually a signal of atmospheric changes brought on by the Industrial Revolution — specifically, increasing levels of methane gas in the upper atmosphere.

Source: University of Colorado at Boulder, Office of Public Relations, 354 Willard Administrative Center, Campus Box 9, Boulder, Colorado 80309-0009.

About the Author

Oliver S. Owen is professor of biology at the University of Wisconsin–Eau Claire, Eau Claire, Wisconsin 54702. He is the editor of *Natural Resource Conservation: An Ecological Approach*, the fifth edition of which will be published by Macmillan Press this fall.

(Lange/Cawley)
January 31, 1989
9:45 A.M.
[IPCC.DOC]

PRESIDENTIAL ADDRESS: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
GEORGETOWN UNIVERSITY
MONDAY, FEBRUARY 5, 1990
10:15 A.M.

Thank you, Dr. Bert Bolin. Professor Obasi. Dr. Tolba. Delegates of the World Meteorological Congress, and the United Nations Environment Program. Let me thank and congratulate all of you, for taking on an issue of such great importance.

In recent years we've seen emerge the most technologically advanced creations of man. We've also gained new -- better -- though still incomplete understanding of the most ecologically fragile creations of nature. But whether created by man **or** by nature -- what is critical to endurance \\ survival? is **balance**.

Balance will certainly be crucial to the efforts of this Panel. For you are called upon to strike an unprecedented international bargain: a balance between global environmental policy, and global economic policy, where **both** sides benefit -- and **neither** is compromised.

This will be possible only if we understand that economic growth and environmental integrity are **not** contradictory priorities. One reinforces and complements the other.

A sound environment is the basis for the continuity and quality of human life and enterprise. And strong economies allow nations to fulfill the obligations of environmental stewardship. Where there is economic strength, such stewardship is considered

a necessity. But where there is poverty, it is too often a luxury.

For that reason, I believe that within this decade, we must usher in a new era of global cooperation: for environmental protection **and** economic growth. For intelligent management of industrial **and** natural resources. Above all, for **sustainable** development -- around the world.

The United States believes the I.P.C.C. is the best forum to develop policy on global climate change. We're committed to international cooperation on this issue. And we consider it vital that the community of nations is drawn together -- in an ordered, rational way -- to assess the potential for climate change.

The state of the science; the social and economic impacts; and the right response strategies: all are crucial components to a global resolution. **But in this, we must attend to what we know. And what we do, must be done responsibly and well.**

The stakes here are very high.

There is no question that human activities are changing the atmosphere in unexpected and unprecedented ways. Over the past three centuries, the level of carbon dioxide in the atmosphere has gone up by 25 percent. Atmospheric methane has doubled.

What we **don't** yet understand are the extent and consequences of the alterations we've brought about -- and how they're linked to a significant, imminent climate change. **The state of our thinking, like the state of nature, calls for balance.**

Last fall, many -- among them, world leaders -- were citing a significant thinning of sea ice at the poles, as evidence that global warming had arrived. But recent observations show that the polar ice sheets are not melting, they're **growing** in size.

I'm not prepared -- academically, or otherwise -- to draw conclusions. But I have noticed something about the scientists drawing the conclusions.

Those who see climate change as a clear and present danger represent one distinct minority. Those who discount it completely, represent another minority. But many scientists -- if not most -- are **not** ready to claim that the extent of global climate change can now be reliably detected -- or predicted. That may be to their credit.

Observing the fervor of the French Revolution, the English poet William Blake wrote, "The best lack all conviction, while the worst are filled with passionate intensity." Here, too, we are called upon for action based on observation -- not media-driven emotion, or the politics of apocalypse.

What science now knows with confidence, policy-makers can't use. And what policy-makers are interested in, science doesn't yet know.

The questions that remain -- over the reflective effects of cloud cover, the cooling effects and CO2 absorption of oceans, and other sinks and feedback mechanisms we don't yet understand. -- suggest that we should attend to what is <u>known</u> about climate change -- and work to know <u>more</u>.

Current computer models are marvels of mathematics. Still, they cannot yet be said to represent reality -- and cannot be expected to predict the future. Above all, responsible policy cannot rest on the shifting sands of hypothesis and a chaos of conjecture.

Given this level of uncertainty, some suggest we should act now, on the chance that significant climate change becomes certain. Others point to the opposite edge of that sword: any meaningful, preemptive policies would bring only the certainty of prohibitive expense; conflict with Third World development; and declining standards of living, worldwide.

We're confident that the world will neither be caught surprised by a greenhouse effect it didn't expect, nor impoverished in anticipation of a cataclysmic warming that never arrived.

There is a middle way that must be sought -- **a balance that must be struck -- that reconciles policy to emerging scientific knowledge, and environmental protection to economic development.**

The United States remains committed to its leadership role on environmental issues: in our domestic programs, in our work to forge international agreements, in our assistance to developing and East Bloc nations, and through our chairmanship of the Response Strategies Working Group in the I.P.C.C.

Overall, we're already doing more than any other country -- in terms of financial and human resources, **by more than a factor of ten** -- to understand and address global warming, among other

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NY Academy

major environmental concerns. Funds devoted to environment-related research in our proposed 1991 budget now total over $70 billion.

Funding for the U.S. Global Change Research Program will increase by nearly 60 percent in fiscal 1991, to over $1 billion. It allows NASA to proceed with its "Mission to Planet Earth" -- and funds the launch of the first U.S. Earth Observing System, to advance the state of knowledge about the planet we share.

Along the way, we will seek the involvement of all nations, no matter what their level of development or economic system, to monitor and analyze climate change, and reassess the science. We place the highest priority on better understanding the earth and its interrelated systems -- and developing high-performance computing systems up to the task.

We seek immediate action, and have already taken a number of steps that bring major benefits in their own right; that make sense on their own merits; and that will **also** help reduce emissions of carbon dioxide and other gases now building up in the atmosphere, stimulating concern about potential climate change. **Let me outline them very briefly:**

We called last year for a **worldwide ban on chloro-flourocarbon production**, to the extent safe substitutes are available. We're working to stabilize, and reduce where possible, both overall **emissions** and **energy consumption**. We're actively pursuing **technology development** to improve the

effectiveness of both supply- **and** demand-side technologies for energy of **all** kinds.

We've introduced new **Clean Air Act** legislation -- emphasizing clean coal technology, conservation measures, the trading of emissions permits, and other devices to encourage industry to find creative, market-driven solutions.

Legis Affairs

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Watkins/Reilly memo to Bromley

We're working through diplomatic channels, and through innovative measures like debt-for-nature swaps, to do more than simply reduce global deforestation. **We hope to reverse it.**

Treasury

And here at home -- aware that new growth forests absorb significantly more CO2 than old grove timber -- we've launched a major reforestation initiative, to plant a **billion** trees a year on private land across America. [+30B in communities]

ISG FY'91 Budget p. 122

The **economics** of our domestic strategies are now being scrutinized in Congress. Rest assured, given our role in the R.S.W.G., that the economics of international responses to potential climate change will get equally intensive study.

We intend to develop real data on the costs of various response strategies, assess new measures, and challenge other nations to follow suit. We will also offer technical support to those who need it.

In creating **policy** to manage CO2 and other emissions now believed to be implicated in climate change, we want to encourage truly innovative responses -- including the trading of emissions permits if appropriate -- as well as a comprehensive approach where **all** major emissions implicated in climate change are included.

Wherever possible, we believe that market mechanisms should be applied -- and that policy must be consistent with economic growth and free market principles in **all** countries. **This is where the quest for balance will be most crucial.**

If we hope to promote environmental protection **and** economic growth around the world, it will be important to work with, not against, industry. That will mean moving beyond the tradition of command, control, and compliance -- toward a new kind of environmental cooperation. Many industries, in fact, are already providing crucial research and solutions. And a few are already ahead of us.

One power-plant management firm, just across the river in Virginia, donated $2 million in 1988 for tree planting in Guatemala -- to compensate for a coal-fired plant it was building in Connecticut. The company expects to couple tree-planting programs with all seven new power plants now on its drawing boards.

Fortune Magazine 1/12/90 p. 55

Where developing nations are concerned, some suggest we'll have to abandon the laissez-faire, free-market principles that allowed the industrial world to prosper. Well, we're headed in

the opposite direction. We intend to apply the principles of the free market in the **service** of the environment -- **especially** in the developing nations. Sustainable economic development demands that we **enlist** the desires of the developing world, rather than try to limit them.

The share of total emissions contributed by developing countries is expected to rise dramatically in the future. We understand that China plans to double its use of coal by the end of the century, and India plans a tripling.

Bernthal's speech to NPC; Sept 1989 State Dept PAO # 1216

To the extent we can accelerate the **advancement** of these and other developing nations, it will take **less** energy for them to produce wealth: Because in modern industrial countries, energy use per unit of Gross National Product has **declined** over time -- steadily, and dramatically.

Policy Options for Stabilizing Global Climate; EPA IPT to Congress; 9/89 p. I-7.

So we need to work <u>with</u> the developing nations: Applying the power of the marketplace. Considering technology transfer for conservation, clean coal and renewable technologies. And encouraging industry to assist developing nations in making quantum leaps in technologies. That will allow LDC's to grow more quickly and easily -- and may help them avoid making the environmental mistakes we older nations have made.

As I said earlier, I believe we should make use of what we know. We know of the power of free markets to find creative solutions. To make resources and talent more rapidly available. **We understand the efficiency of an economic incentive. We should apply it now, in defense of the environment we share.**

You all understand that we benefit from the greenhouse effect -- **as long as it remains in balance**. Without it, the surface of the earth would resemble that of the moon.

As you begin your Third Plenary Session, I hope the idea of balance takes root and prospers here. Without it, the intellectual climate may be more than a little harsh.

And just as we rely on the corrective action of the biosphere, I hope we will learn to rely on the corrective actions of free markets -- to give incentives and integrity to our strategies for climate change.

I wish the three working groups the best of luck. I'm confident that your work will be done carefully, and well -- and that the I.P.C.C. will continue in its vital role.

Thank you, and God bless you. And good luck!

# # #

DRAFT #3

(Lange/Cawley)
January 31, 1989
2:45 P.M.
[IPCC.DOC]

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MONDAY, FEBRUARY 5, 1990
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Rafsnyder 647-4069

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But unfortunately, somewhere along the way, we picked up a bias, that has harmed both man and nature: a mistaken belief that there is a divergence of interests -- a logical division -- between the natural world and we who inhabit it.

Nothing could be further from the truth -- or more central to the work of this Panel. For you are called upon to strike an unprecedented international bargain: a convergence between global environmental policy, and global economic policy, where **both** sides benefit -- and **neither** is compromised.

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Fortune magazine 1/12/90 p.55

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Let me wish the three working groups the very best of luck. I'm confident that your work will be done carefully, and well -- and that the I.P.C.C. will continue in its vital role.

Thank you -- and God bless you.

# # #

Draft #4

(Lange/Cawley)
January 31, 1989
7:00 P.M.
[IPCC.DOC]

PRESIDENTIAL ADDRESS: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
GEORGETOWN UNIVERSITY
MONDAY, FEBRUARY 5, 1990
10:15 A.M.

Reifsnyder
647-4069

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Watkins/Reilly memo to Bromley

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Foreign Policy spring '89, p3 climate, chaos by D. Wirth

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What we **don't** yet understand is the extent of the alterations we've brought about -- and how they're linked to a significant, imminent climate change.

Thatcher speech to the UN Oct, 1989

Last fall, many clear thinkers -- among them, world leaders -- were citing a significant thinning of sea ice at the poles as evidence that global warming had arrived. Recent observations show that the polar ice sheets are not melting, they're **growing** in size.

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Those questions, among others, suggest that we should attend to what is known about climate change -- and work to know more.

Current computer models are marvels of mathematics. Still, they cannot yet be said to represent reality -- and cannot be expected to predict the future. Above all, responsible policy cannot rest on the shifting sands of hypothesis and a chaos of conjecture.

In the search for answers, the United States continues to lead the world. We're seeking hard data and new ways to improve the science. Because what science now knows with confidence, policy-makers can't use. And what policy-makers need to make decisions, science doesn't yet know.

In spite of the uncertainty, some suggest we should act now, on the chance that significant climate change becomes certain. Others point to the opposite edge of that sword: any meaningful preemptive policies would bring only the certainty of prohibitive expense; conflict with Third World development; and declining standards of living, worldwide.

I believe we can do better. There is a middle way, that matches policy to emerging scientific knowledge -- and reconciles environmental protection to economic development.

With every word, with every decision made here, we're also making a committment that is profoundly personal. I think all of us understand, deep inside, how the actions we take now speak to the future.

Last week, in my State of the Union address, I spoke of stewardship. I believe it's something we owe our children and grandchildren -- because the earth we stand upon is only borrowed, never owned.

Chris Dawson State Dept Policy 647-3638

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Steve Olson X5860

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Robert Mathias OVE

I just proposed a budget to our Congress for fiscal 1991 that devotes a total of over [$70] billion to environment-related work. Funding for the U.S. Global Change Research Program will increase by nearly 60 percent, to over $1 billion.

1sg Budget FY'91 p. 129

That will allow NASA to move forward with its "Mission to Planet Earth" -- and will fund the launch of the first U.S. Earth Observing System, to advance the state of knowledge about the planet we share.

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Chris Dawson

usually don't single out "greenhouse" gases

We want to stabilize -- and reduce wherever we can -- both our energy consumption **and** our total emissions. So we're pursuing new **technology development**. Working on a revised **Clean Air Act** with incentives for industry to find creative, market-driven solutions. Working out a comprehensive review and revision of our **National Energy Strategy**. And launching a major **reforestation initiative** to plant a **billion** trees a year on private land across America.

We're also working through diplomatic channels, and through innovative measures like debt-for-nature swaps, to do more than simply reduce global deforestation. **We hope to reverse it.**

The **economics** of our response strategies to climate change are getting intensive study. We intend to develop real data on the costs of various response strategies, assess new measures, and challenge other nations to follow suit. We will offer technical support to those who need it.

And as we work to create **policy** to manage CO2 and other emissions, we want to encourage the most innovative responses. Wherever possible, we believe that market mechanisms should be applied -- and that policy must be consistent with economic growth and free market principles in **all** countries. **This is where ending the environmental cold war will be most crucial.**

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To the extent we can accelerate the **advancement** of these and other developing nations, it will take **less** energy for them to produce wealth: in modern industrial countries, energy use per unit of Gross National Product has **declined** over time -- steadily, and dramatically.

So we need to work <u>with</u> the developing nations: Applying the power of the marketplace, considering technology transfer, and encouraging industry to assist developing nations in making quantum leaps in technologies. That will allow developing nations to grow more quickly and easily -- and may help them avoid making the environmental mistakes we older nations have made.

As I said earlier, I believe we should make use of what we know. We know that free markets find creative solutions. We understand the efficiency of economic incentive. **Our challenge now is to apply that knowledge, in defense of the environment we share.**

Just as we are coming to understand the natural mechanisms and symmetry of the planet that supports us, I hope we will **also** learn to rely on the corrective action and natural wisdom of free markets: they can bring integrity to our strategies for climate change.

Let me wish the three working groups the very best of luck. I'm confident that your work will be done carefully and well -- and that the I.P.C.C. will continue in its vital role.

Thank you -- and God bless you.

# # #

Draft #5
Staffed Copy

(Lange/Cawley)
February 1, 1989
10:45 A.M.
[IPCC.DOC]

PRESIDENTIAL ADDRESS: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
GEORGETOWN UNIVERSITY
MONDAY, FEBRUARY 5, 1990
10:15 A.M.

Thank you, Dr. Bolin [Bo-leen]. Professor Obasi. Dr. Tolba. Delegates of the World Meteorological Congress, and the United Nations Environment Program. Let me thank and congratulate **all** of you, for taking on an issue of such great importance. The decisions this organization makes will have a profound effect on the world's environmental and economic policy.

In the post-war era, we've produced the most technologically advanced creations of man. We've also gained new understanding -- though still incomplete -- of the most ecologically fragile creations of nature.

But unfortunately, somewhere along the way, we picked up a bias, that has harmed both man and nature: a mistaken belief that there is a divergence of interests -- a logical division -- between the natural world and we who inhabit it.

Nothing could be further from the truth -- or more central to the work of this Panel. You are called upon to strike an unprecedented international bargain: a convergence between global environmental policy, and global economic policy, where **both** sides benefit -- and **neither** is compromised.

You are called upon to end the environmental cold war.

This will be possible only if we understand that economic growth and environmental integrity are **not** contradictory priorities. One reinforces and complements the other.

A sound environment is the basis for the continuity and quality of human life and enterprise. And strong economies allow nations to fulfill the obligations of environmental stewardship. Where there is economic strength, such stewardship is considered a necessity. But where there is poverty, it is too often a luxury.

For that reason, I believe we must usher in a new era of global cooperation: for environmental protection **and** economic growth. For intelligent management of industrial **and** natural resources. Above all, for **sustainable** development -- around the world.

The United States believes the I.P.C.C. is the best forum to develop policy on global climate change. We're committed to international cooperation on this issue. And we consider it vital, that the community of nations is drawn together -- in an ordered, rational way -- to assess the potential for climate change.

The state of the science; the social and economic impacts; and the right response strategies: all are crucial components to a global resolution. **The stakes here are very high.**

There is no question that human activities are changing the atmosphere in unexpected and unprecedented ways. Since the mid-

1800s, the level of carbon dioxide in the atmosphere has gone up by 25 percent.

What we **don't** yet understand is the extent of the alterations we've brought about -- and how they're linked to a significant, imminent climate change.

Last fall, many clear thinkers -- among them, world leaders -- were citing a significant thinning of sea ice at the poles as evidence that global warming had arrived. Recent observations show that the polar ice sheets are not melting, they're **growing** in size.

I'm not prepared -- academically, or otherwise -- to draw conclusions. But I have noticed something about the scientists drawing the conclusions.

Those who see climate change as a clear and present danger represent one distinct minority. Those who discount it completely, represent another minority. But many scientists -- if not most -- are **not** ready to claim that the extent of global climate change can now be reliably detected -- or predicted. That may be to their credit.

When he was observing the fervor of the French Revolution, the English poet ~~William Blake~~ William Yeats wrote, "The best lack all conviction, while the worst are filled with passionate intensity." Here, too, we are called upon for action based on observation -- not media-driven emotion, or the politics of apocalypse. **The decisions being made are too important to be compromised intellectually -- or polarized politically.**

Questions remain: about the reflective effects of cloud cover, the cooling effects and CO2 absorption of oceans, and other sinks and feedback mechanisms we don't yet understand. Those questions, among others, suggest that we should attend to what is known about climate change -- and work to know more.

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In the search for answers, the United States continues to lead the world. We're seeking hard data and new ways to improve the science. Because what science now knows with confidence, policy-makers can't use. And what policy-makers need to make decisions, science doesn't yet know.

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I just proposed a budget to our Congress for fiscal 1991 that devotes a total of over ~~[$70] billion~~ 2B in new spending to environment-related work. Funding for the U.S. Global Change Research Program will increase by nearly 60 percent, to over $1 billion.

Rob Fairweather OMB x6827

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# # #

Add

- Malta ⇒ framework
- White House mtg.

The Greenhouse Blues

Keep Cool About Global Warming

Dixy Lee Ray

The year 1988 ended on a high note of hysteria, one that was to continue well into 1989. The issue, fueled by an unusually hot, dry summer, was global warming. NASA's James Hansen testified at a Senate hearing that the high temperatures presaged the onset of the long-debated "greenhouse effect" and global warming due to buildup of carbon dioxide in the atmosphere. Forgotten were the harsh winters of 1978 (when barges carrying coal and heating oil froze in river ice and more than 200 people lost their lives in the cold weather) and 1982.

Memory is a capricious thing. Perhaps the early winter months of 1989 will remind prophets of global warming that nature can be fickle. Only days after *Time* magazine featured as its "Man" of the Year for 1988 a doomed Planet Earth, perishing from human mismanagement and greenhouse overheat, Alaska experienced the worst cold in its history. Twenty locations in our most northerly state recorded their lowest-ever temperatures, mainly in the range of -50 to -65 degrees Fahrenheit. The cold did not begin to move south until the first week in February, when it seeped down from Alaska on both sides of the Rocky Mountains, bringing near-record lows to the Pacific Northwest and throughout the Midwest, south to Texas, and eventually to the mid-Atlantic and New England states. Proponents of the "greenhouse-effect-is-here-global-warming-has-begun" theory were very quiet during these weeks.

Seeing Infrared

To be fair, even if there is a potential for increased temperatures due to enhancement of the greenhouse effect, no one would expect it to occur all at once or without intervening cold spells. So let us examine the situation more closely.

Earth, with its blanket of atmosphere, constitutes a "greenhouse." This fact has never been at issue. Indeed, were it not for the greenhouse function of air, the Earth's surface would be like the moon's, bitterly cold (-270 degrees Farenheit) at night and unbearably hot (+212 degrees) during the day. Although the amount of solar energy reaching the moon is similar to that reaching the Earth, the Earth's atmosphere permits incoming solar radiation to penetrate. When that warms the surface, infrared heat is radiated back. The "greenhouse gases"—carbon dioxide, water vapor, methane, hydrocarbons—all absorb longwave (infrared) radiation. This process moderates the surface temperature. Let us therefore rejoice and be glad that the Earth does indeed function as a greenhouse!

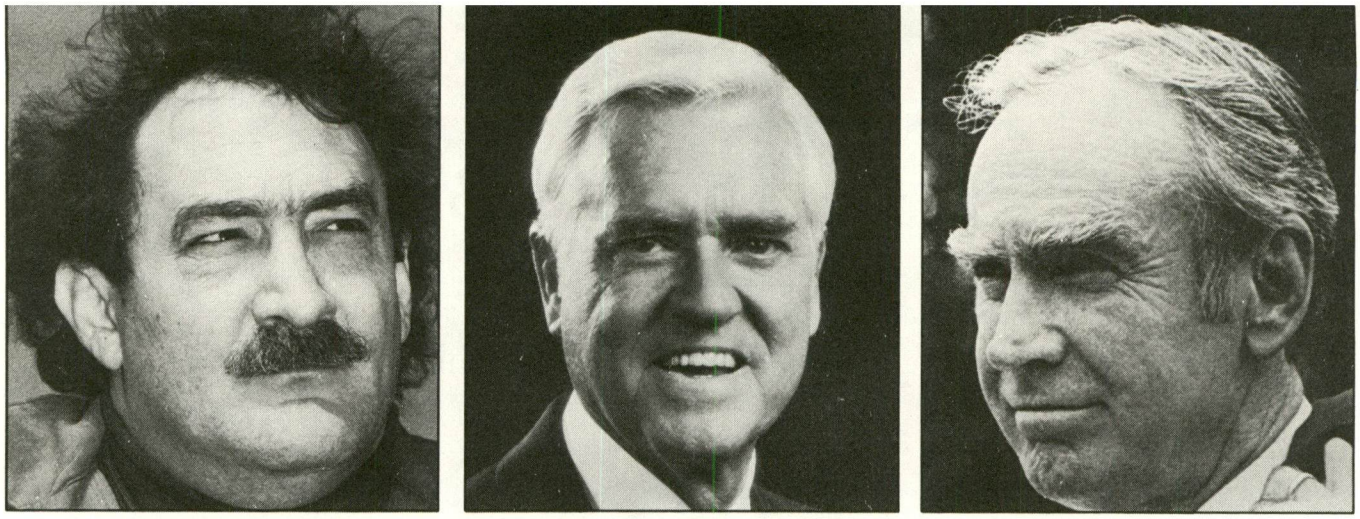
In addition, the greenhouse gases are all produced by nature as well as by human activity. For example, carbon dioxide comes from the respiration of all living things, and from forest fires, decaying vegetation, and volcanoes, as well as from humans burning fossil fuel. The total amount divides about 50/50 between what nature produces and what people can be blamed for. Hydrocarbons come from growing plants, especially evergreens such as the pines and firs that cause the "blue haze" of the Great Smoky Mountains and other areas where coniferous forests abound. Hydrocarbons also come from various industrial activities and incomplete combustion in automobiles. Both hydrocarbons and methane enter the atmosphere from the "burping" of cows and other ruminants. The contribution of hydrocarbons to our air is also about evenly divided between nature and human activities. Methane comes from swamps, termites, coal mines, and rice paddies. Approximately 90 percent of methane comes from nature and only about 10 percent from human activity.

Contrary Computer Models

These gases have always been present in the atmosphere, but in total they have been increasing during the last century. Carbon dioxide, the most carefully measured, has increased 25 percent since the Industrial Revolution. The current rate of increase in carbon dioxide plus the other greenhouse gases is about 1 percent a year. Assuming this rate continues, the amount of greenhouse gases will double in this century.

According to the leading computer models of climate

Dixy Lee Ray *was formerly Democratic governor of Washington state and chairman of the Atomic Energy Commission, a precursor to the Nuclear Regulatory Commission. This article is excerpted from a forthcoming book on the excesses of environmentalism.*



Although Mitch Snyder admits his numbers are meaningless, Ernest Hollings and Jim Wright cited them this year as fact.

less than 50 percent (less than 1-to-1), and six of these were less than 30 percent. The one study that found a ratio higher than 50 percent adds less fuel for the homeless advocates' fire than one might imagine. Over a six-month period during 1985-86, sociologist Peter Rossi of the University of Massachusetts' Social and Demographic Research Institute conducted a stratified random sample of street homeless on Census blocks in Chicago (a separate count had been conducted of the city's shelters). City authorities assisted Rossi in dividing blocks into those with a high probability of encountering a homeless person, and those with a low probability. Interviewers then searched all possible sites where the homeless might be found. During autumn months, the street-to-shelter ratio was 59 percent; during the colder winter months, the figure declined to 27 percent. Rossi, a pioneer in social research methods, estimated the total number of Chicago's homeless to be between only 3,700 and 6,000.

One local study that generously allowed for the possibility of not detecting the concealed homeless still counted many fewer homeless than the Community for Creative Non-Violence maintains. According to a full count of street and shelter people conducted by the University of the District of Columbia's Center for Applied Research and Public Policy, the maximum number of homeless in Washington, D.C., in July 1985 was 7,142. The author, Frederic Robinson, obtained this figure by weighting the actual street count upward by 2.5; without this inflation, the figure would have been 4,347. In either case, the total is well below the 1980 Hombs-Snyder Washington estimate of 15,000.

Why Numbers Matter

Advocates for the homeless have made an art form of deflecting questions about their inflated and often absurd estimates, either by denying the validity of lower estimates, questioning the competence or the sensitivity of researchers who obtain them, or denying altogether the importance of accurate measurement. As a result, the perception of millions of neglected homeless roaming the streets has gathered wide currency, abetted by a news media that has given advocates a nearly free ride, regularly indulging their grand gestures such as hunger strikes without subjecting their assertions to reasonable scrutiny. This situation is harmful not only to housing policymaking, but to all policymaking.

An inaccurate count of the homeless, high or low, diverts attention from the condition of the people who need help. To devise effective treatment programs for the mentally ill homeless, who account for about one-third of the homeless population, it is essential to know just how many of these tragic individuals there are. The problems of homeless alcoholics are far different from those of homeless mothers with young children, and "advocates" who disparage research about their numbers are doing a serious injustice to the people they ostensibly are trying to aid.

For better or worse, Mitch Snyder's aggressive contempt for facts has set the tenor for the homeless movement. His meteoric rise in stature has been an inspiration for heightened political involvement among an irrational social type for whom strident moral appeals, often tinged with religious symbolism, can and must substitute for good research. Such people reject more than "good data." They reject the very rational-positivist basis of science—that problem definition precedes solution; that facts precede values; and that means and ends are intimately linked. In this sense, Snyder's remark about Americans having "Western little minds" is more than a little self-revealing.

Snyder sounded the opening salvo of a national speaking tour in mid-April, announcing to a church group in Harrisonburg, Virginia, "they [Congress] know we're facing the worst domestic crisis the country has ever faced. And all that stands between that happening and not is money....Affordable housing disappears, because if the federal government doesn't build affordable housing, nobody does." Of course, one might respond that unsubsidized private enterprise has been responsible for most of the more than 12 million housing completions this decade, that the nonprofit sector has initiated successful, low-cost housing rehabilitation programs nationwide, that there were homeless people before HUD's budget cuts, and that a strong economy is still the best defense against a housing depression. Snyder would view making such points as foot-dragging, an excuse for continuing neglect, as the number of homeless climbs to four million, five million, and God-knows-what beyond. Ironically, this manipulation of issues and statistics into a giddy, evasive, and yes, McCarthyist game will do little for the people who most need help: the homeless. ☎

scientists, the rise in carbon dioxide concentration since the middle of the 19th century should have caused measurable warming of 1 to 5 degrees centigrade (2 to 9 degrees Fahrenheit). But it hasn't! The temperature has oscillated and the overall rise is in the range of 0.3 to 0.7 degrees centigrade. (Nobody knows what has happened in the Southern Hemisphere, which is 90 percent ocean, because oceanic temperature measurements are so scarce.)

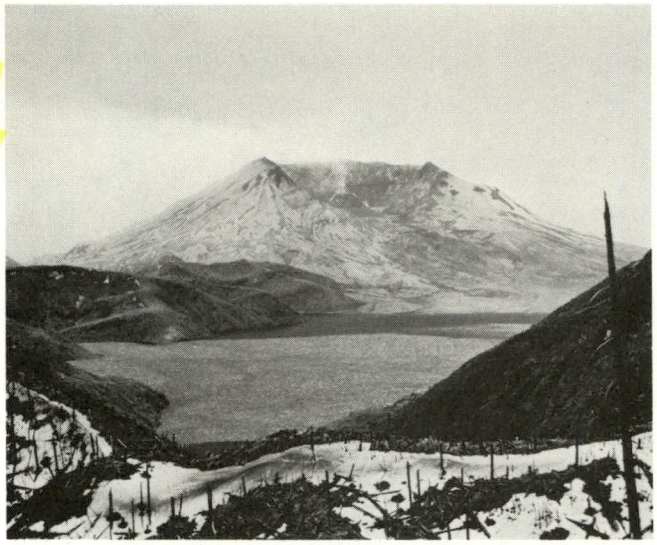
Recall that the public furor started June 1988, when NASA scientist James Hansen testified in the U.S. Senate that the greenhouse effect was here and changing the climate. He said he was 99 percent sure of it and that "1988 would be the warmest year on record...unless there is some remarkable, improbable cooling in the remainder of the year." Well, there was. (Ask them in Alaska!) While Hansen was testifying, the eastern tropical Pacific Ocean cooled drastically. The temperature dropped 7 degrees quite suddenly and is now at near-record lows. No one knows why. The phenomenon is called La Niña, to contrast it with the warmer El Niño current. Such cooling has occurred 19 times in the last 102 years. But Hansen didn't consider La Niña because his computer model didn't take sea temperatures into account even though sea water covers 73 percent of Earth's surface. When a NASA scientist talks "global" it's hard to imagine that he would ignore 73 percent of the globe's surface—but he did.

Another possible explanation for the absence of the warming predicted by the computer models: both carbon dioxide and water vapor have several absorption bands besides the infrared. While longwave (infrared) radiation may be kept *in*, some shorter waves of the incoming solar radiation may be kept *out* (by the combined effect of carbon dioxide and water) so that less heat becomes available to be trapped in the first place. Nature has many feedback and self-regulating mechanisms of which this is only one.

Eddy's Sun Spots

There also may be cosmic forces at work that influence Earth temperatures more than does the greenhouse effect. John Eddy of the National Center for Atmospheric Research has found an interesting correlation between decades of low sunspot activity and cold periods such as the "Little Ice Age" of the 17th century, when there was a virtual absence of sunspot activity between 1645 and 1715. (During the winter of 1683-84, recorded in the novel *Lorna Doone*, the trees of Somerset could be heard bursting in the cold.) Conversely, Eddy found that decades of high sunspot activity coincided with warm temperatures on Earth. If Eddy's theory holds up, the high solar activity of the mid-20th century accounts for the period's unusual warmth, and Earth may soon enter a slow return to colder temperatures. (Ice ages recur about every 10,000 to 12,000 years, and it is now 11,000 years since the last one.)

While most environmentalists blame deforestation and the burning of fossil fuel for the carbon dioxide increase, they generally fail to take into account the role of volcanoes in affecting the composition of the atmosphere. We are currently near the peak of a 500-to-600-year cycle of volcanic activity, which may have something to do with the carbon dioxide increase. The quantity of air-polluting materials produced by man during his entire existence on Earth does not begin to equal the quantities of toxic gases and particulates spewed forth into the atmosphere from just three volcanic eruptions: Krakatau in Indonesia in 1883, Mount Katmai in Alaska in 1912, and Hekla in Iceland in 1947. Mount St. Helens pumped out 910,000 metric tons of carbon dioxide during six months in 1982, not including the eruption.



Washington State Tourism Division

Volcanoes such as Mount St. Helens are responsible for some of the increase in carbon dioxide.

Switch to Nuclear

Despite the uncertainty about whether we are now experiencing global warming, it is prudent to reduce the production of greenhouse gases through human activity. Because no one really knows what the ultimate consequences of the increases in carbon dioxide and other greenhouse gases might be, we should reduce man's contribution wherever possible. While there is no need to take draconian measures that would damage our standard of living, there are several things we can do.

For starters, we can phase out the use of fossil fuel for generating electricity and turn to technology with no known adverse impact on the atmosphere—nuclear power. We can shift to an essentially all-electric economy. We can turn, once again, to electric buses and trains and eventually to electric automobiles. For air travel we could

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Reforestation is far more effective in carbon dioxide reduction than preservation of existing forests.

replace fossil fuels with hydrogen. New ceramics materials and ceramics-metal compounds can overcome the former problem of embrittlement resulting from the absorption of hydrogen into metal. Recent advances in storage technology promise to ease the necessity for large, heavy, high-pressure, low-temperature hydrogen storage tanks.

Sapling Hopes

We can also take advantage of photosynthesis to absorb carbon dioxide and produce oxygen. Those who urge preservation of old growth, or "climax," forests on the basis of their contribution to the oxygen-carbon dioxide balance in the atmosphere overlook the fact that old trees metabolize far less rapidly than young ones (like humans and most living things). Indeed, old trees contribute little to removing carbon dioxide or producing oxygen, whereas a forest of young trees will remove carbon dioxide from the air at a rate of five or six tons per acre. Reforestation, therefore, is far more effective in carbon dioxide reduction than is preservation of existing forests. We should also vastly increase the use of plants in urban areas, where air pollution is usually worse than in rural regions.

In considering possible carbon dioxide mitigating actions, it is important to keep in mind that these steps are feasible for an advanced, highly technical industrialized society with plenty of electricity. Around the world, however, fossil fuel burning will inevitably continue for many years. In China, for example, 936 million metric tons of coal were burned in 1987-88. Who is going to tell them to stop or to change? What alternatives do they have? No matter what we do in the United States, or even throughout the Western world, the carbon dioxide from man-made sources is bound to rise. Should global warming occur, it is estimated that no nation, acting alone, could affect it by more than 10 percent. We should nevertheless do what we can to reduce our own carbon dioxide contribution—proper stewardship of the Earth demands nothing less.

To do so, we need not be panicked into precipitous and costly "corrective" actions that only reduce our standard of living. We can phase out fossil fuels—replacing them with nuclear power and other fuels such as hydrogen—in a deliberate, responsible way. We can also plant lots of trees.

Apocalypse No

A final note on the supposedly dire consequences of a global temperature rise of 1.5 to 4.5 degrees centigrade over the next 50 years: Such a climate change, should it occur, is not nearly so drastic a change for humans as a move by an Alaskan to Palm Springs. Elevated temperatures would have greater impact on agriculture and vegetation in general. But with plants, temperature is hardly the only determinant of growth. Perhaps as important are the duration and quality of light (latitude is significant here), soil moisture, and the amounts, timing, and duration of rainfall, and the possibilities for irrigation. A warmer Earth—and the changes in rainfall that might accompany it—would make some areas of farmland more fertile or less fertile than today. But that hardly constitutes global environmental doom.

Nor do the predictions of melting ice caps and possible inundation of low-lying areas. Most weather specialists predict that a global temperature rise of 1.5 to 4.5 degrees centigrade—enough to dislodge Antarctic ice submerged under the surface—would cause the sea level to rise by one and a half to four and a half feet. Should this happen, a number of cities would be vulnerable to flooding of the sort that Venice and Holland have coped with for centuries. Some beachfronts would be gradually moved back a few miles, and some people would have to move. The inconvenience of all this should not be minimized, but it is hardly apocalypse.

Is a global warming on the way? Maybe sometime, but it is not here now. Why do so many people believe in the dire forecasts? Perhaps the historian Hans Morgenthau was right when he wrote in 1946, "The intellectual and moral history of mankind is the story of insecurity, of the anticipation of impending doom, of metaphysical anxieties." John Maddox, editor of the British journal *Nature*, says, "But these days there also seems to be an underlying cataclysmic sense among people. Scientists don't seem to be immune to this."

High solar activity, not the greenhouse effect, may account for the unusual warmth of the mid-20th century.

Well, they ought to be. What the greenhouse debate needs most is a dose of healthy skepticism. ☎