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THE WHITE HOUSE
WASHINGTON

Global Change Working Group

March 30, 1990

AGENDA

1. Scientific briefing on global change
 - o Dr. Daniel Albritton (DOC/NOAA)
 - o Dr. Warren Washington (National Center for Atmospheric Research)
2. Update:
White House Conference on Science and Economics Research Related to Global Change
3. Timing of Framework Climate Convention Negotiations

COLLECTION OF VIEWGRAPHS

For Presentation to the
Domestic Council on Global Warming

30 March 1990
Washington, D.C.

By Warren M. Washington
National Center for Atmospheric Research
Boulder, Colorado

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What are climate models?

What do climate models tell us about the greenhouse effect?

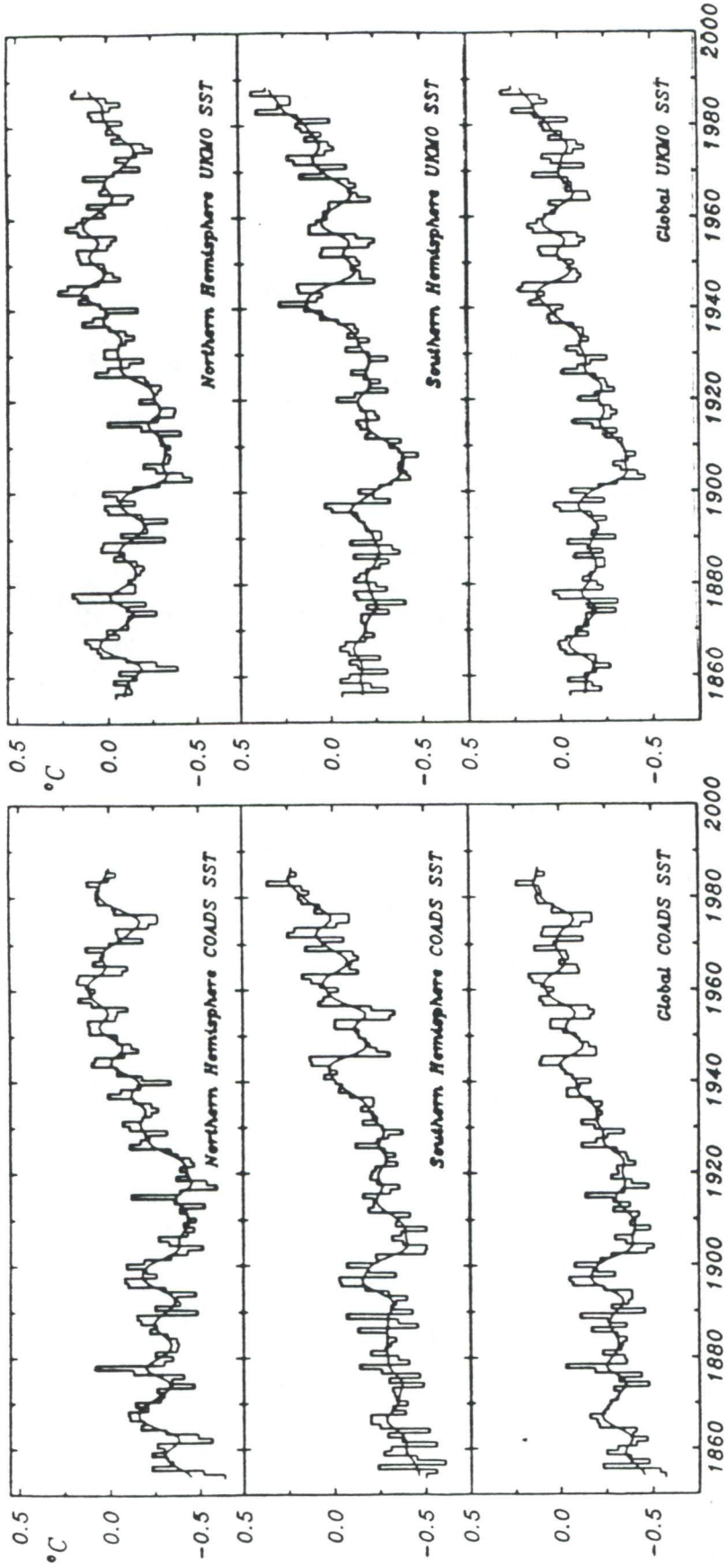
What new information are climate models telling us about regional changes?

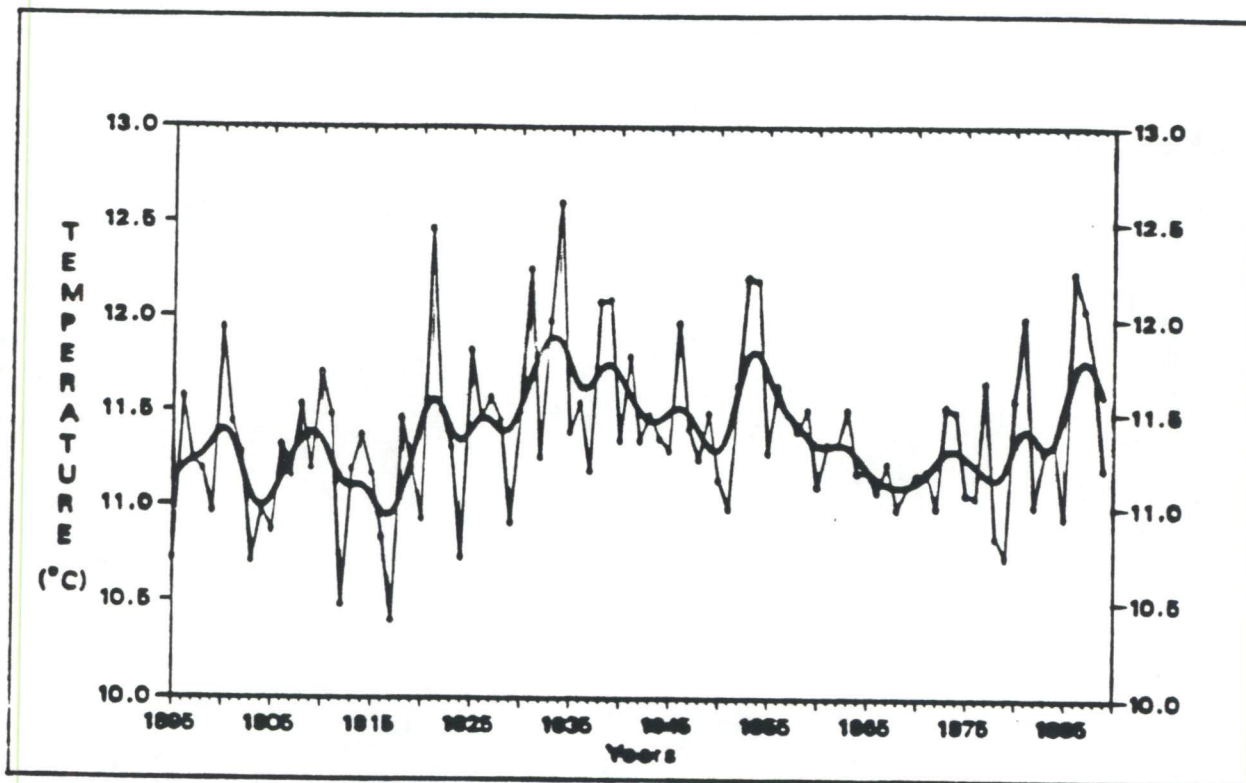
How will the U.S. Global Change Research Program reduce uncertainties?

**GLOBAL WARMING AND
RECENT CLIMATE CHANGE
Observations and Modeling**

1. Climate observations.
2. Climate modeling.
3. Comparisons of model results
with observations.

Observed Hemispheric and Global Sea Surface Temperatures





U.S. Averaged Surface Temperatures
[from T. Karl, 1988 (NOAA)]

GREENHOUSE-GAS-INDUCED CLIMATE CHANGE

- Observations show an increase in "global" temperature of $\sim 0.5^{\circ}\text{C}$, of which $\sim 0.1^{\circ}\text{C}$ is due to urban warming (maybe more!).
- Climate models indicate that $\pm 0.2^{\circ}\text{C}$ in global T can readily occur over 100 years without external causes of climate change.
- Such fluctuations are seen in the observed climate record, (e.g., the warmest period in the U.S. is still the 1930s).
- Thus, it is not possible to attribute the observed global T change to the observed greenhouse gas increase.

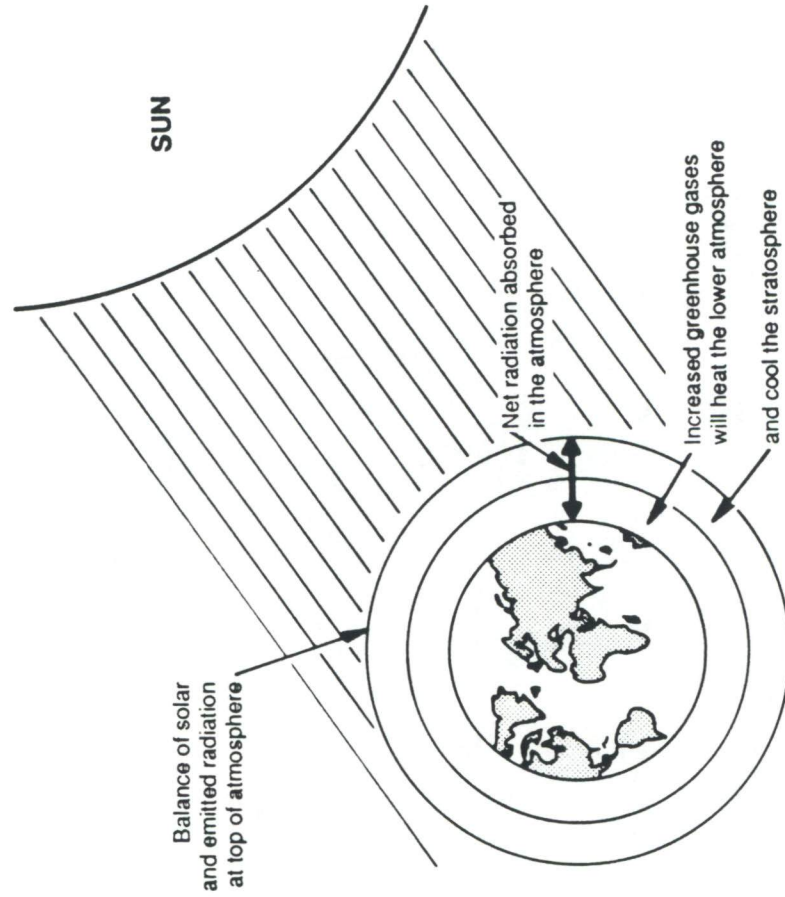
WHAT IS THE INFLUENCE OF CLIMATE PROCESSES?

Earth energy balance:

- Determined by difference between absorbed and emitted radiation.
- Water vapor, CO₂, and other trace gases absorb radiation and heat atmosphere.
- Clouds and aerosols can both heat and cool atmosphere.

Clouds and water vapor are the largest contributors to climate energy balance:

- 1% change in global mean cloud cover \approx 4% change in CO₂.
- Low-level clouds tend to cool.
- High-level clouds tend to heat.



WHAT IS A CLIMATE MODEL?

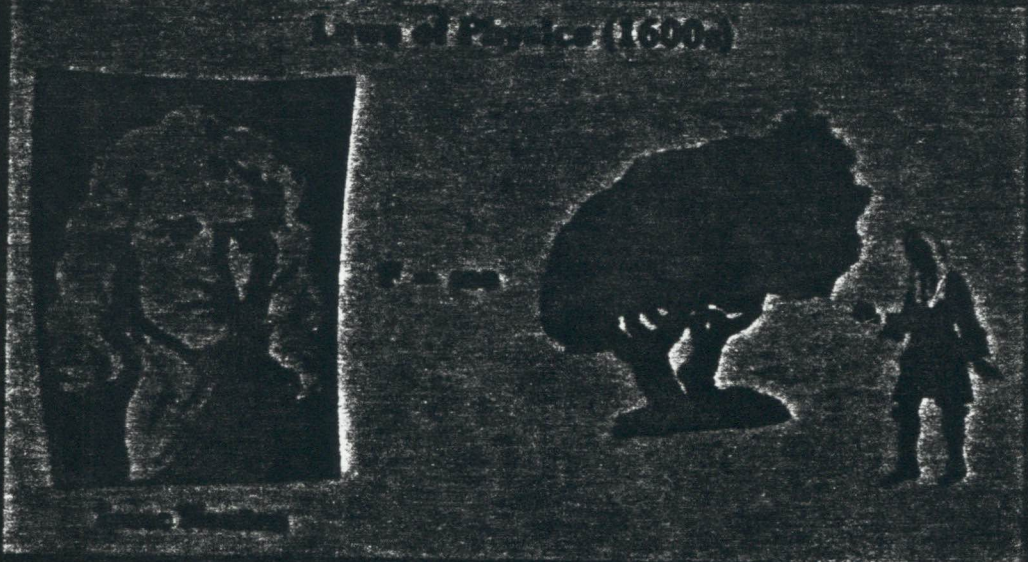
A COMPUTER PROGRAM which numerically solves the MATHEMATICAL EQUATIONS that represent the LAWS OF PHYSICS.

Components include the ATMOSPHERE, OCEAN, LAND, CRYOSPHERE and BIOSPHERE and all the dynamics, physical processes and interactions between them.

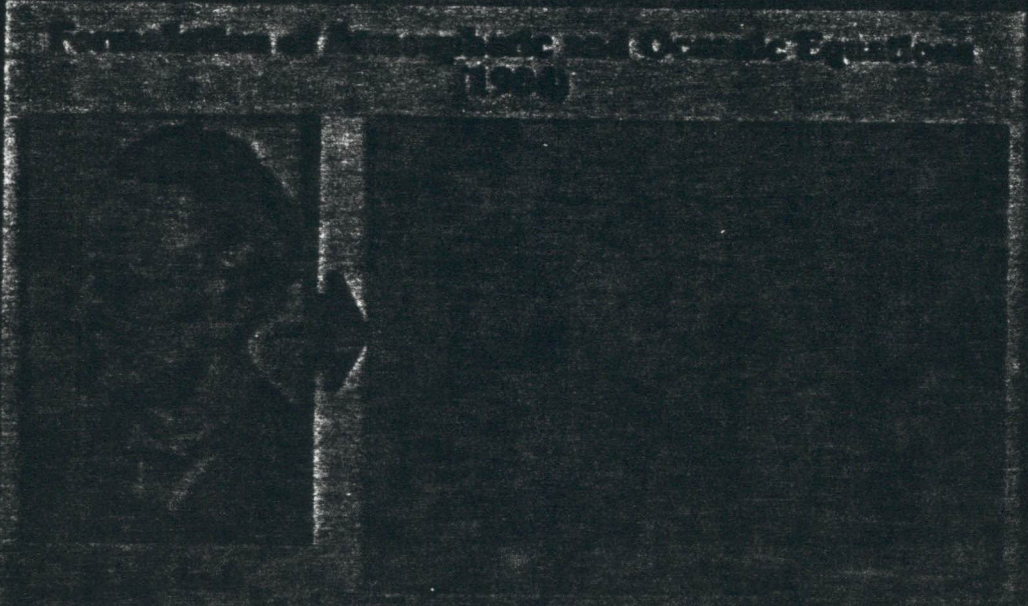
The most comprehensive climate models include GENERAL CIRCULATION MODELS (GCMs) as atmospheric and oceanic components.

An atmospheric GCM follows the evolution of all the weather systems, clouds, and rain, and the interactions with the land and ocean.

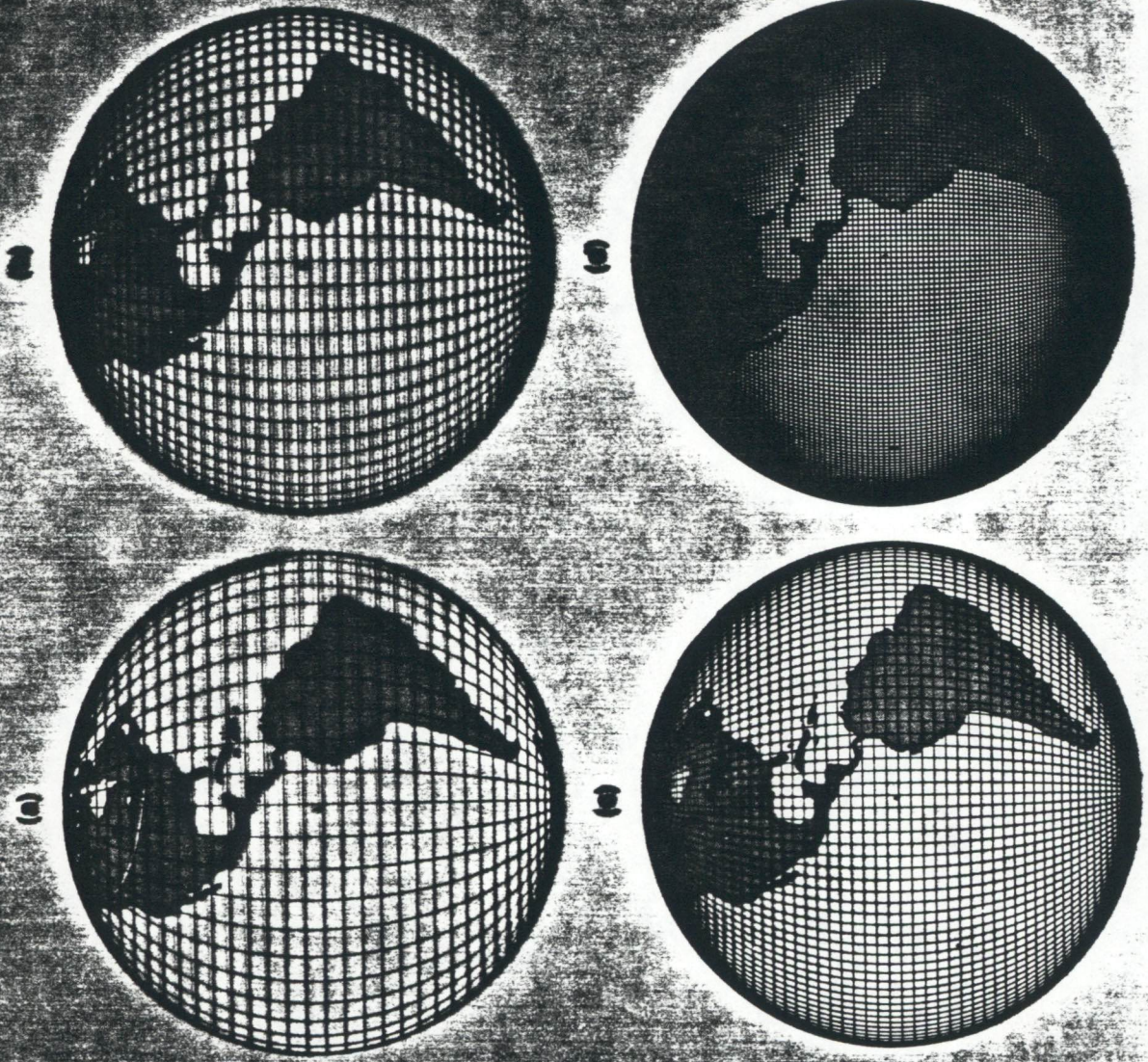
U.S. POSTAGE (600)



U.S. POSTAGE (600)



Model Resolutions



Present Climate Model Grids



Grids: 1990-2000



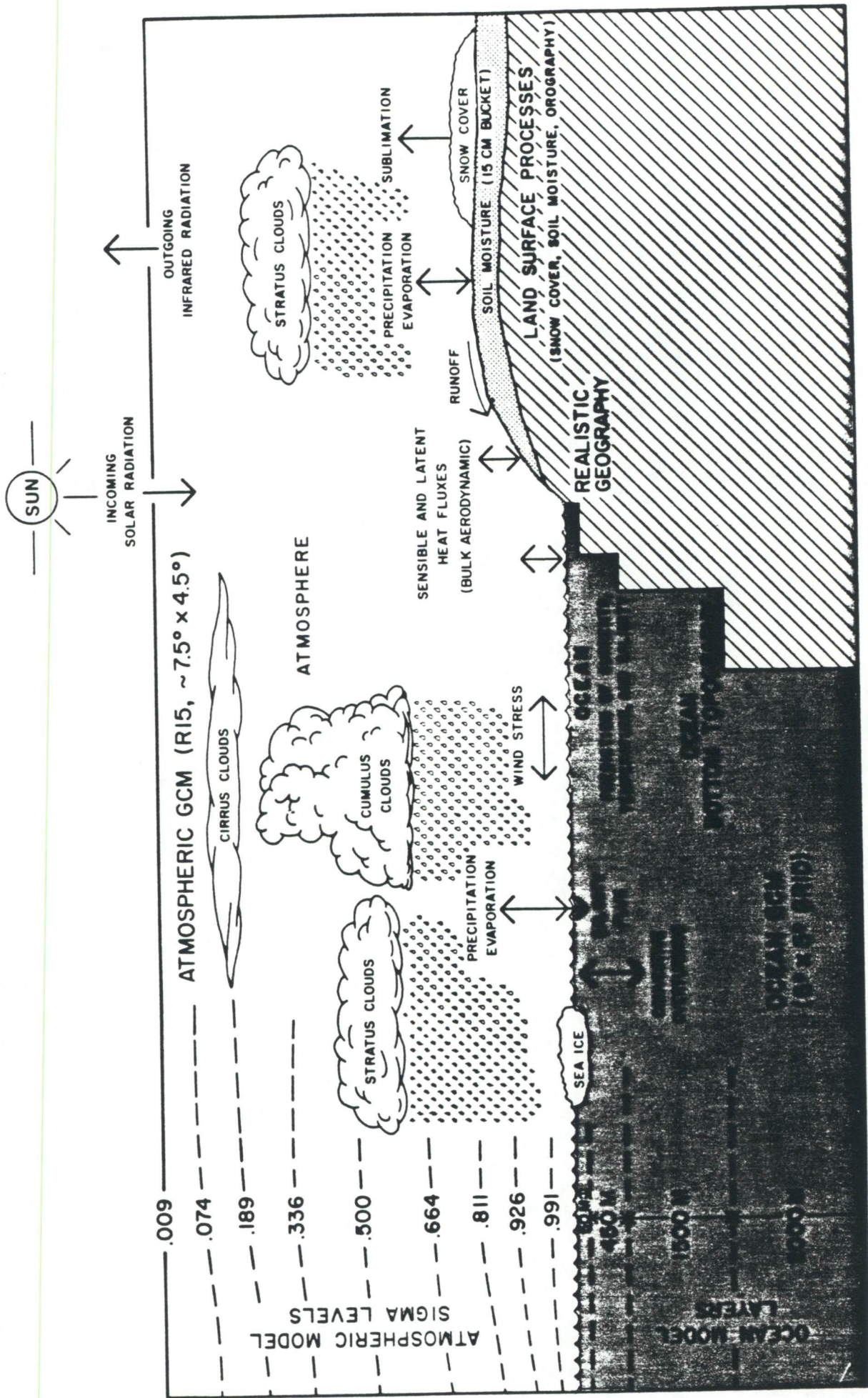
Grids: 2000-2010



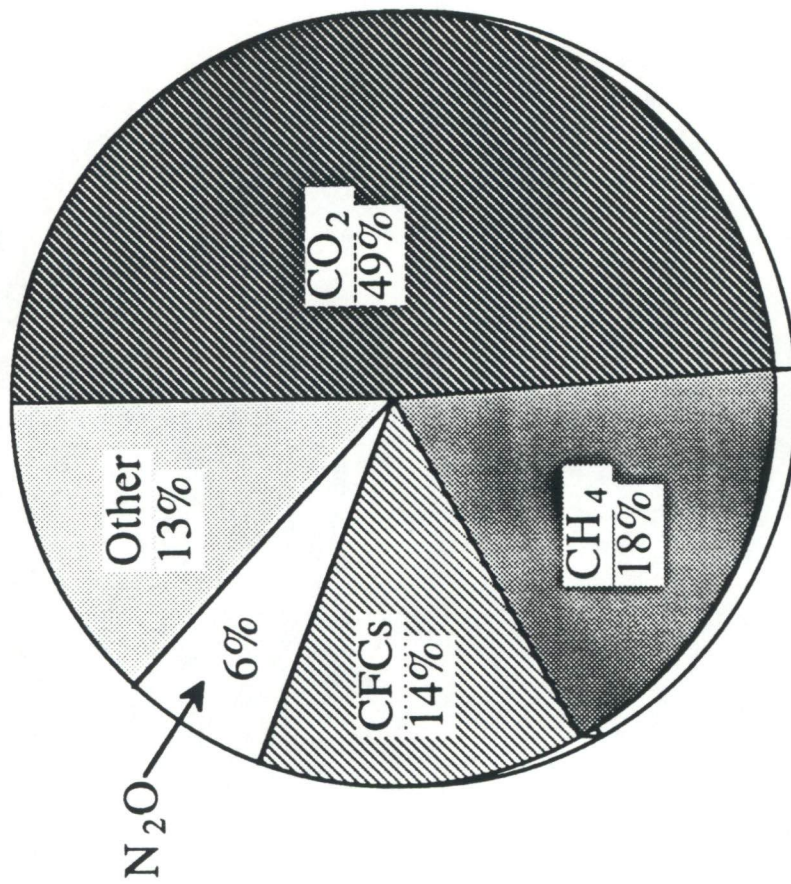
Grids: Beyond 2010



CLIMATE MODEL PROCESSES



GREENHOUSE GASES THAT CONTRIBUTE TO GLOBAL WARMING



CO₂: Carbon Dioxide
CH₄: Methane
CFCs: Chlorofluorocarbons
N₂O: Nitrous Oxide

Source: EPA

NEW CLIMATE MODEL EXPERIMENTS WITH DYNAMICAL OCEANS

Main Results:

- Land areas warm faster than oceans.
- More warming at high latitudes—especially Northern Hemisphere.
- Including ocean currents (dynamics) causes minimum warming near Antarctica and North Atlantic Ocean.
- Time lag in warming caused by ocean sequestering heat.

CLIMATE SYSTEMS RESPONSE TO INCREASED GREENHOUSE GASES

Temperature:

- Lower atmosphere warming—**high certainty**
- Stratosphere cooling—**high certainty**
- Surface air temperature increase—**moderate certainty**
- Surface wintertime high latitude air temperature increase—**moderate certainty**
- Surface tropical air temperature increase—**moderate certainty**

Precipitation:

- Globally increases (as does evaporation)—**high certainty**
- High latitude increase (especially wintertime)—**moderate certainty**
- Less in subtropical land areas—**low certainty**

Soil Moisture:

- Increase in high latitude in winter—**moderate certainty**
- Decrease in North American mid latitude—**low certainty**

-
- Asian summer monsoon intensifies—**moderate certainty**
 - Day-to-day variability stays the same—**low certainty**
 - Deforestation has small global effect on climate but large local effects—**moderate certainty**

Prevent Parasitic Diseases After Cardinal 50, Inc.



All territories are in Eastern Hemisphere

Parasitic diseases are a major cause of death and disability in many parts of the world. The most common parasitic diseases are malaria, schistosomiasis, and hookworm. These diseases are caused by parasites that live in the blood, the intestines, and the skin. They are spread by insects, snails, and other animals. The World Health Organization (WHO) estimates that over 1 billion people are infected with parasitic diseases. In many developing countries, parasitic diseases are a leading cause of death and disability. They can cause anemia, malnutrition, and other health problems. In some cases, they can be fatal. The WHO is working to prevent parasitic diseases by improving sanitation, providing medical treatment, and educating the public. The Cardinal 50, Inc. is a leading manufacturer of parasitic disease prevention products. Their products are effective and easy to use. They are available in many countries around the world. The Cardinal 50, Inc. is committed to helping people prevent parasitic diseases and live healthier lives.

Global Change Research Program

Objectives

Establish an integrated, comprehensive, and sustained program to document the Earth system on a global scale

Conduct a program of focused and exploratory studies to improve understanding of the physical, chemical, biological, and social processes that influence Earth system changes and trends on global and regional scales

Develop integrated, conceptual, and predictive Earth system models on global and regional scales

GLOBAL CHANGE RESEARCH BASIC QUESTIONS

Major Uncertainties:

- What is the role of clouds in the Earth's radiation and heat budgets?
- How do the oceans interact with the atmosphere in the storage, transport, and uptake of heat?
- How will changes in climate affect temperature, precipitation, and soil moisture patterns, and the general distribution of water and ice on the land surface?
- How can the reliability of global- and regional-scale climate predictions be improved?

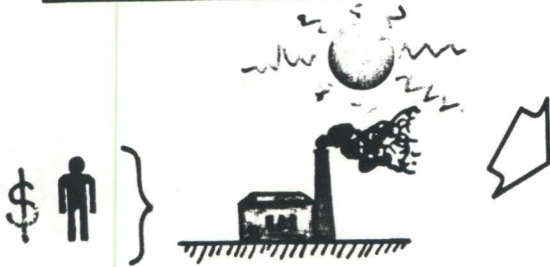
TRACE GASES & CLIMATE: KNOWN & UNKNOWN

- WARREN WASHINGTON - NAT'L CENTER FOR ATMOSPHERIC RESEARCH
- DAN ALBRITTON - NOAA AERONOMY LAB

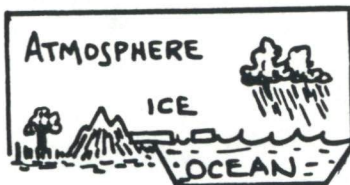
DPC WORKING GROUP ON GLOBAL CHANGE, WASHINGTON, 30 MAR 90

• CONTEXT OF OUR SUMMARY...

• CLIMATE CHANGE FORCINGS



• PHYSICAL PROCESSES



• PHYSICAL RESPONSES



• BIOLOGICAL PROCESSES



• IMPACTS

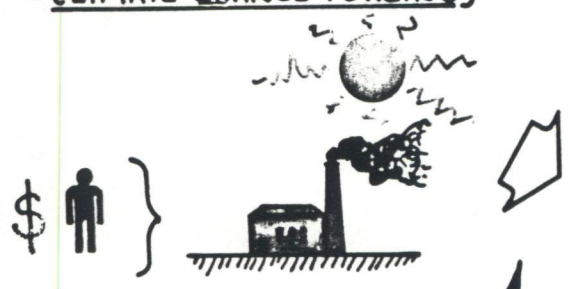
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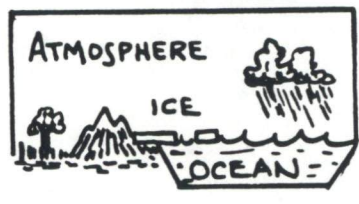
DPC WORKING GROUP ON GLOBAL CHANGE, WASHINGTON, 30 MAR 90

• CONTEXT OF OUR SUMMARY...

• CLIMATE CHANGE FORCINGS



• PHYSICAL PROCESSES



Ⓐ HOW WELL DO WE UNDERSTAND OUR TRACE-GAS FORCING? (ALBRITTON)

Ⓑ HOW WELL DO WE UNDERSTAND HOW THE PLANET WILL RESPOND? (WASHINGTON)

• PHYSICAL RESPONSES



• BIOLOGICAL PROCESSES

• IMPACTS

A hand-drawn diagram of impacts. It shows a person icon next to a dollar sign (\$).

A TRACE GASES & MANKIND: THE SCIENCE STATUS

(FROM THE STANDPOINT OF POLICY RELEVANCE)

THIS SUMMARY...

● SCIENCE BACKGROUND:

THE GREENHOUSE "EFFECT"
VIS-A-VIS
THE GREENHOUSE "PROBLEM"

} WHAT'S THE DIFFERENCE
(& WHY IS IT IMPORTANT TO US)

● TRACE GASES & CLIMATE:

RADIATIVE FORCING

(HOW MUCH & SINCE WHEN?)

EMISSIONS VIS-A-VIS ABUNDANCE

(A LITTLE VOCABULARY)

IMPORTANT TRACE GAS PROPERTIES:

(ALL GASES ARE NOT CREATED EQUAL)

3 MAJOR FEATURES

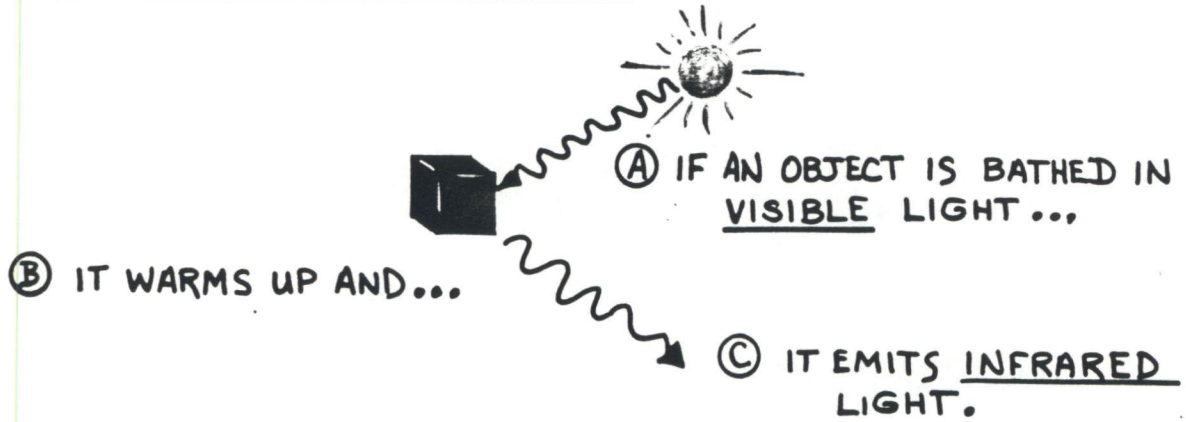
(ONES THAT MOST RELATE TO CURRENT POLICY DISCUSSIONS)

● RESEARCH & BETTER ANSWERS

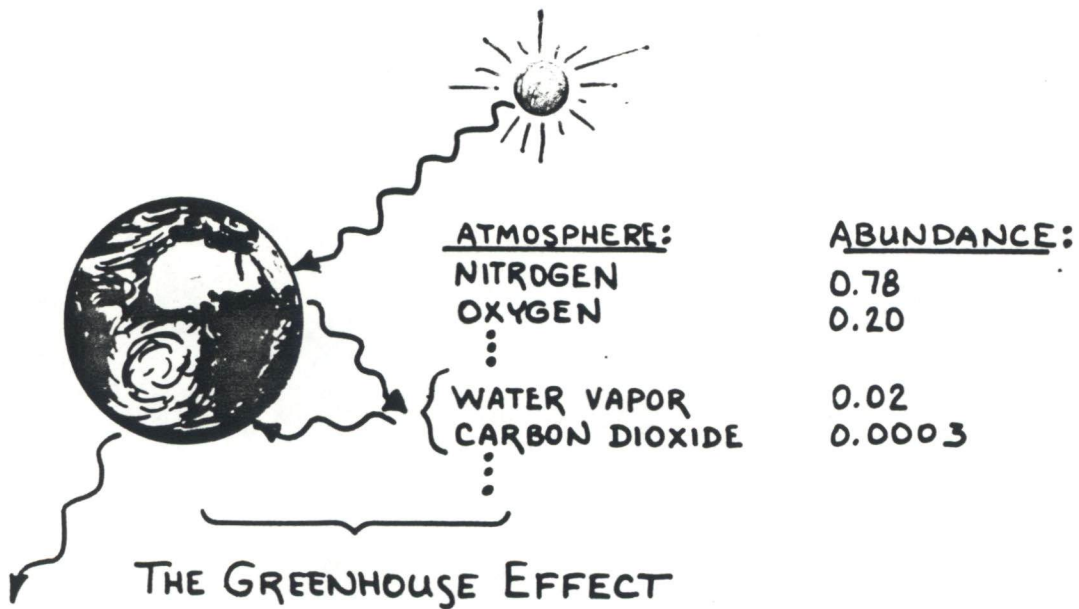
(IN THE • VERY NEAR TERM
• LONGER TERM)

THE GREENHOUSE EFFECT: WHAT IS IT?

● IN TERMS OF BASIC PHYSICS:




● IN TERMS OF OUR PLANET EARTH:



● A FEW POINTS TO NOTE...

- THE GREENHOUSE EFFECT IS A NATURAL PART OF THE PLANETARY SYSTEM.
- WATER VAPOR (H_2O) AND CARBON DIOXIDE (CO_2) HAVE BEEN PART OF THE ATMOSPHERE FOR MILLIONS OF YEARS.
- THEIR PRESENCE HAS PRODUCED AN AVERAGE SURFACE TEMPERATURE (\bar{T}_s) OF $\sim 15^\circ C$ ($\sim 60^\circ F$)
- WITHOUT THEM, \bar{T}_s WOULD BE $-15^\circ C$ ($5^\circ F$)

BOTTOM LINE IMPLICATION  THE GREENHOUSE EFFECT IS REAL. WE UNDERSTAND ITS BASIC PRINCIPLES.

So... WHAT IS THE PROBLEM?

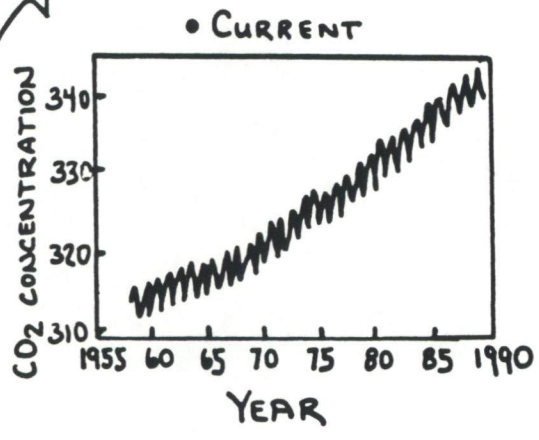
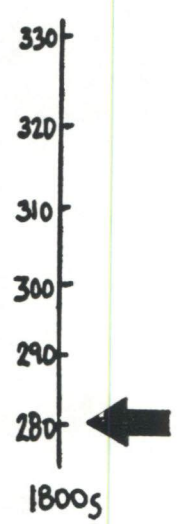
→ JUST RECENTLY (GEOLOGICALLY SPEAKING), WE HAVE BEGUN TO ALTER THE GREENHOUSE EFFECT.

THE GREENHOUSE "PROBLEM"

• THE FAMILIAR PART



• HISTORY

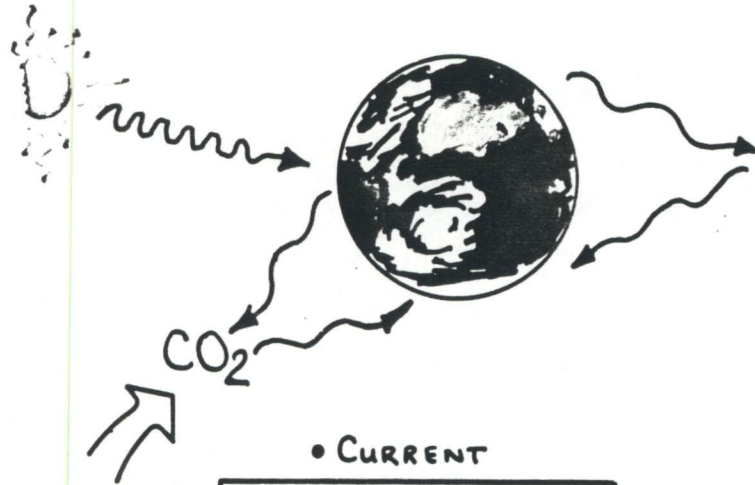


• 25% INCREASE OVER PRE-INDUSTRIAL LEVELS.

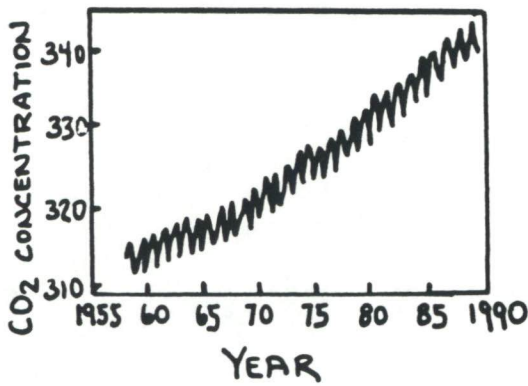
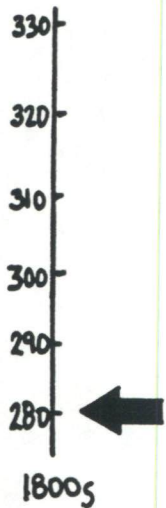
THE GREENHOUSE "PROBLEM"

• THE FAMILIAR PART

• THE "RECENT" PART

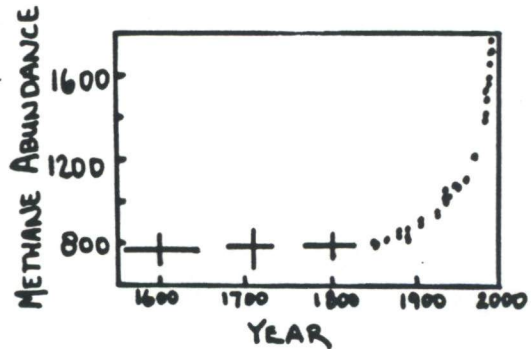


• HISTORY



• 25% INCREASE OVER PRE-INDUSTRIAL LEVELS.

• METHANE HAS DOUBLED OVER THE INDUSTRIAL ERA.



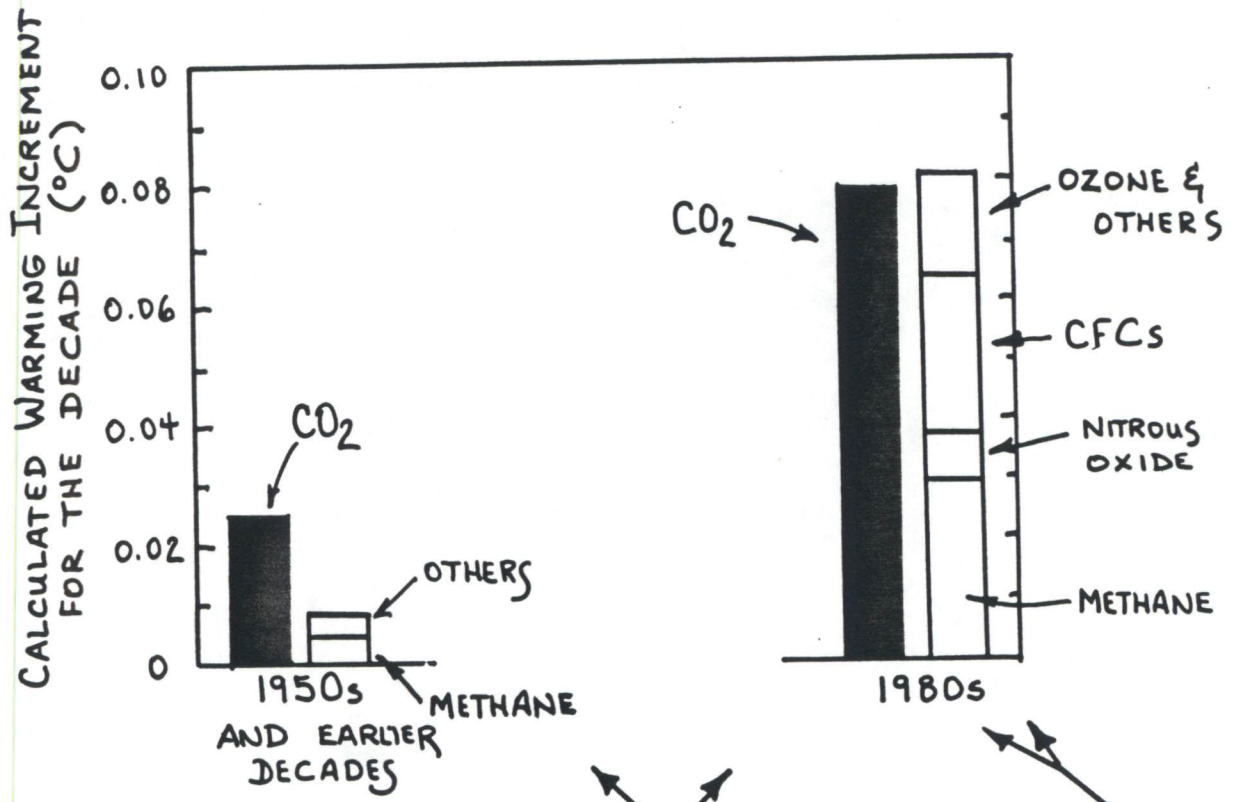
BOTTOM-LINE IMPLICATION



WITHOUT A DOUBT, SEVERAL GREENHOUSE GASES ARE INCREASING IN THE ATMOSPHERE (& MANY RAPIDLY).

RADIATIVE FORCINGS

● IMPLICATIONS OF TRACE-GAS INCREASES: (CURRENT THEORY)



● FOURFOLD INCREASE IN FORCING OVER JUST FOUR DECADES.

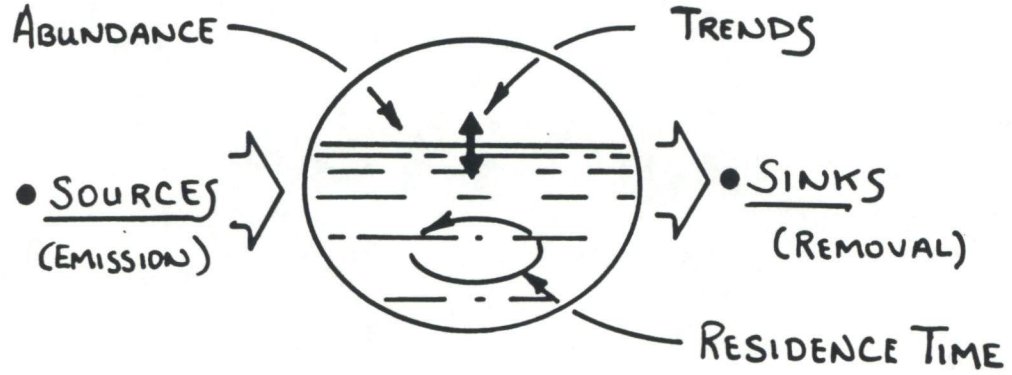
● NON-CO₂ GASES NOW HAVE COMPARABLE FORCING.

IMPLICATIONS

FROM A SCIENTIFIC PERSPECTIVE, GLOBAL-WARMING POLICY FORMULATION SHOULD CONSIDER ALL OF THE GREENHOUSE GASES (NOT JUST CO₂).

EMISSIONS VIS-À-VIS ABUNDANCE

● THE ATMOSPHERE: (VESSEL ANALOGY)



○ RELATIONS: (FOR A GIVEN SPECIES)

- ▷ IF SOURCES EXCEED SINKS → UPWARD TRENDS (E.G., MOST GASES!)
- ▷ IF SINKS ARE WEAK → LONG RESIDENCE TIME (E.G., CFC-12 130 YEARS)
- ▷ HUMANS INFLUENCE MAINLY THE SOURCES, NOT SINKS.

HENCE, WHILE A POLICY GOAL MIGHT BE

- SLOWING AN UPWARD TREND OR
- STABILIZING THE ABUNDANCE ...

IMPLICATION THE MECHANISMS WHEREBY POLICY IS IMPLEMENTED INVOLVE EMISSIONS (AND SOMEWHAT, SINKS).

THE POLICY-RELEVANT TRACE GAS PROPERTIES

POSED
POLICY
QUESTIONS

- WHAT ARE THE RELATIVE GREENHOUSE FORCINGS OF THE VARIOUS TRACE GASES?
- CAN SCIENCE DEVISE AN "EQUIVALENCY" AMONG THEM?
- CAN A UNIVERSAL EMISSIONS ABATEMENT APPROACH BE IMPLEMENTED?

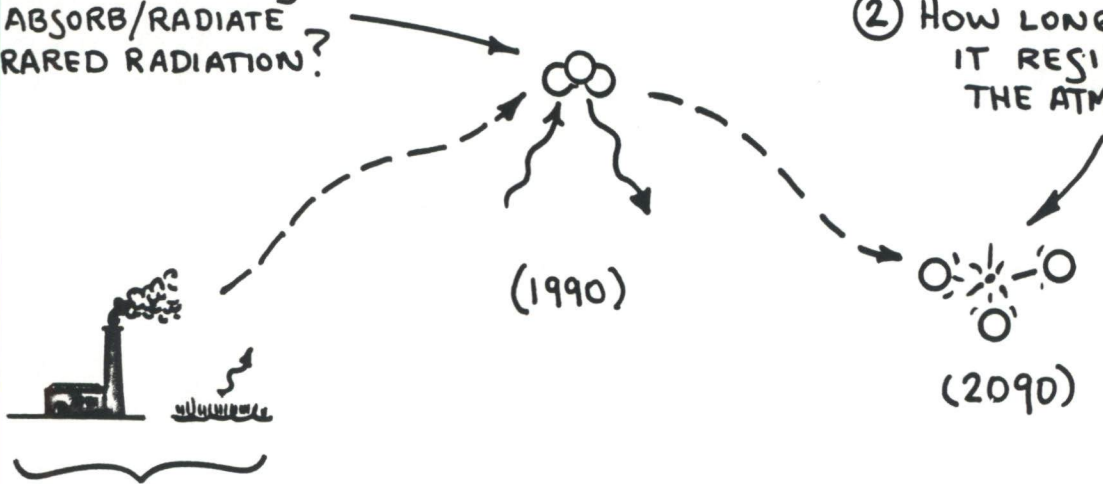
● THE SCIENCE: A STATUS REPORT:

THERE ARE 3 MAJOR TRACE GAS PROPERTIES THAT RELATE TO THESE QUESTIONS.

○ FOR EACH SPECIES (E.G., CO₂, METHANE, OR CFC):

① HOW WELL DOES IT ABSORB/RADIATE INFRARED RADIATION?

② HOW LONG DOES IT RESIDE IN THE ATMOSPHERE?



③ HOW WELL IS THE SOURCE UNDERSTOOD?

(THE DETAILS...)

① MOLECULAR RADIATIVE PROPERTIES

PER MOLECULE, THEY VARY CONSIDERABLY...

EXAMPLES: 1 CH₄ (METHANE) \approx 25 CO₂ | VERY WELL KNOWN!
1 CFCl₃ (CFC-II) \approx 10000 CO₂

BUT AN EMITTED CH₄ MOLECULE IS AVAILABLE FOR A FAR LESS TIME TO IMPOSE ITS FORCING...

② ATMOSPHERIC RESIDENCE TIME

THE LIFETIMES OF THE GASES ALSO VARY CONSIDERABLY...

EXAMPLES: CO₂ \sim 100 YEARS | FAIR-TO-GOOD ESTIMATES
METHANE \sim 10 | UNCERTAINTIES LIE IN QUANTIFYING THE SINKS.
NITROUS OXIDE \sim 150

① + ② GLOBAL WARMING POTENTIAL

THE "GWP" FOLDS BOTH PROPERTIES TOGETHER...

	<u>SPECIES</u>	<u>LONG-TERM GWP</u>	
EXAMPLES:	CO ₂	1 (REFERENCE)	TRANSIENT (NEAR-TERM) AND EQUILIBRIUM (LONG-TERM) GWPs DIFFER & HENCE, THE TIME MUST BE SPECIFIED.
	METHANE	25	

IMPLICATION



GWPs CAN SERVE AS A PER-MOLECULE EQUIVALENCY FOR SCALING EMISSIONS ON A COMMON BASIS (WITH SCIENTIFIC UNCERTAINTIES THAT IMPROVE OVER TIME, OF COURSE).

③ EMISSION SOURCE CHARACTERIZATION

THE RADIATIVELY IMPORTANT TRACE GASES HAVE A WIDE VARIETY OF TYPES OF SOURCES (AND SINKS)...


EXAMPLES:	<u>SOURCE/SINK</u>	<u>IDENTIFIED</u>	<u>QUANTIFIED</u>
▶ CFCs	• AEROSOLS, REFRIGERANTS, ... • STRATOSPHERIC BREAKUP	WELL	WELL
▶ CO ₂	• COMBUSTION • VEGETATION, OCEAN	WELL FAIR	WELL NOT AS GOOD
▶ METHANE	• CATTLE, TERMITES, RICE, INDUSTRIAL, ... • CHEMICAL REACTIONS	FAIR WELL	POOR NOT GOOD

ILLUSTRATIVE CASES:

(ASSUME AN AGREED-UPON EQUIVALENCY SCALE.)

▶ NATION X PROPOSES TO REDUCE ITS FORCING BY:

- | | <u>SCIENTIFICALLY DEFENSIBLE?</u> |
|--|-----------------------------------|
| • xxx CO ₂ -EQUIVALENTS OF CFC BY REDUCTION IN REFRIGERATION. | STRAIGHTFORWARD |
| • yyy CO ₂ -EQUIVALENTS OF METHANE BY CHANGING CATTLE FEED. | <u>MUCH, MUCH HARDER!</u> |

IMPLICATION  DEVELOPING A DEFENSIBLE UNDERSTANDING OF SOURCE (AND SINK) CHARACTERISTICS TO PERMIT AN EFFECTIVE IMPLEMENTATION OF EQUIVALENCY SCALE IS A CHALLENGE TO CURRENT (AND FUTURE) SCIENCE.

RESEARCH PLANS FOR BETTER ANSWERS

● FOR THE VERY NEAR TERM:

○ EXAMPLE: STATE-OF-SCIENCE "STOCK-TAKING"

INTERGOVERNMENTAL PANEL
ON CLIMATE CHANGE
(WMO-UNEP sponsored)



3 REVIEWS:

- SCIENCE ←
- SOCIO-ECONOMICS
- POLICY OPTIONS

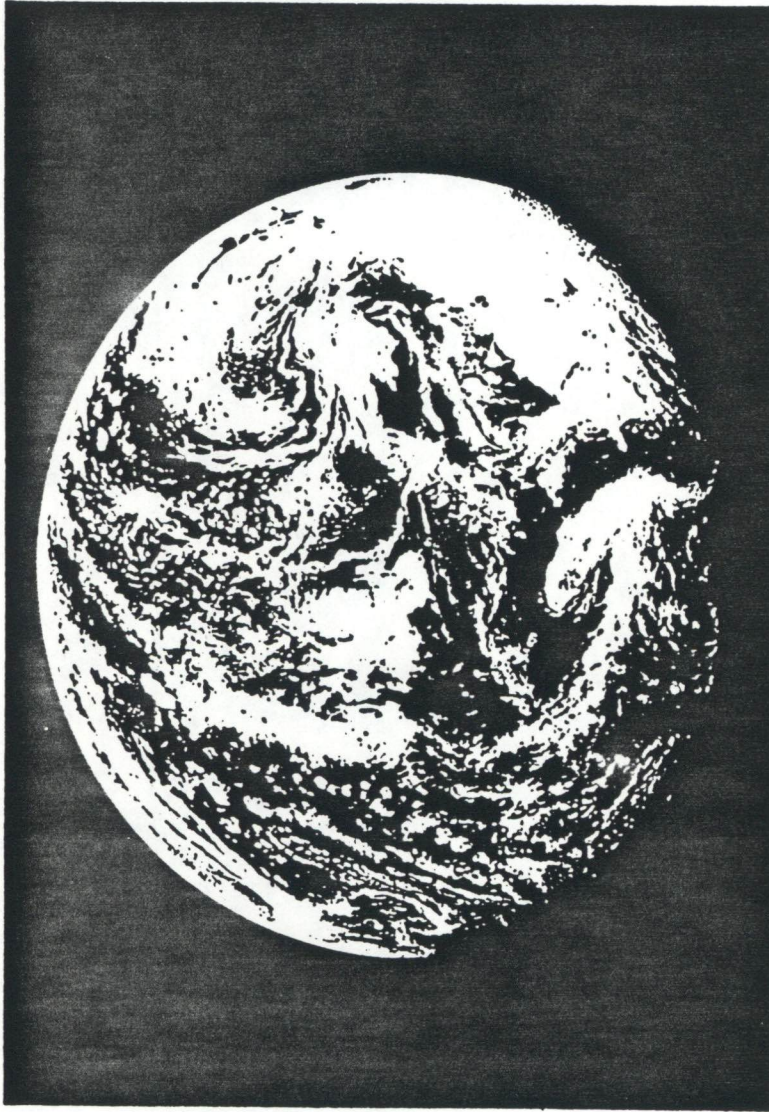
○ TIMETABLE

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		⋮	
<input type="checkbox"/>	MAR	1990	PEER REVIEW
<input type="checkbox"/>	JUNE		COMPLETED
<input type="checkbox"/>	FALL		PUBLICATION
<input type="checkbox"/>	LATE	1990	2ND WORLD CLIMATE CONF.

PAYOFFS  THERE ARE SEVERAL...

- THE SCOPE IS COMPREHENSIVE (I.E., END-TO-END { FORCING
⋮
RESPONSE })
- IT WILL BE SCIENCE-COMMUNITY STATEMENT (NOT INDIVIDUALS AT HEARINGS, PRESS,)
- IT WILL INTERNATIONAL (NOT COUNTRY A VIS-A-VIS COUNTRY B)
- IT WILL INCLUDE BOTH NATURAL & HUMAN-INFLUENCES (SINCE CREDIBILITY REQUIRES BOTH!)

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



A Report by the Committee on Earth Sciences

To Accompany the
U. S. President's Fiscal Year 1990 Budget

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Brian Dunbar
Headquarters, Washington, D.C.
(Phone: 202/453-1547)

For Release:
EMBARGOED UNTIL
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March 29, 1990

Jim Sahli
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

Phil Gentry
University of Alabama-Huntsville
(Phone: 205/895-6414)

RELEASE: 90-45

SCIENTISTS ADVANCE MONITORING OF GLOBAL ATMOSPHERIC TEMPERATURES

An improved technique for potentially measuring global atmospheric temperature changes and possible global warming has been developed by scientists at NASA's Marshall Space Flight Center, Huntsville, Ala., and the University of Alabama in Huntsville (UAH).

Dr. Roy Spencer, a Marshall scientist in the Earth Science and Applications Division, and Dr. John Christy, a research scientist at UAH's Johnson Research Center, evaluated temperature data gathered by the National Oceanic and Atmospheric Administration (NOAA) satellites since 1979 to monitor monthly temperature variations over the globe to a mean accuracy of 0.01 degree Centigrade, setting a standard against which future temperature trends will be measured. While future global temperature variations were not specifically addressed, the decade from 1979-1988 showed no net warming or cooling trend.

The NOAA data had been used previously for localized weather forecasting, which involved only small portions of the data. By developing a 10-year data record with global coverage, Spencer and Christy have improved upon the surface thermometer network currently used to monitor global temperature.

Thermometers are largely restricted to populated areas, leaving the atmosphere over oceans essentially unmeasured. Earlier data used to support claims of global warming during the past 100 years have come from temperatures measured with these thermometers at the Earth's surface.

- more -

While monthly temperature variations measured by the satellites showed poor agreement with the surface thermometer data, annual averages agreed much better. Nothing could be said, however, about the validity of any long term warming trend observed by thermometers before 1979, due to the relatively short satellite data record.

The satellite data Christy and Spencer used came from microwave radiometers, developed by NASA, that each day measure the average temperature of the lowest 6 miles of the atmosphere over most of the Earth. By providing a precise record of monthly temperature changes over the Earth, this data will be extremely valuable in improving the understanding and prediction of climate changes.

The most dramatic events recorded by the satellites were the 1983 and 1987 El Ninos, when unusually warm water in the tropical Pacific Ocean affected weather conditions worldwide. Similar effects are believed to have contributed to the 1988 drought over the United States.

The two El Nino events caused global temperatures to rise more in a few months than might be forecast from several decades of "enhanced greenhouse warming," the researchers noted. Dramatic global coolings, such as that following the 1983 El Nino, were part of the unexpectedly large annual and seasonal global temperature changes observed during the 1980s.

Spencer's and Christy's research will be published Friday in Science magazine.

- end -

A26 FRIDAY, MARCH 30, 1990

THE WASHINGTON POST

Satellites Find No Evidence of Global Warming

Associated Press

Ten years of temperature measurements by weather satellites have failed to find any evidence of global warming from the greenhouse effect, scientists said in a report published today, but they added it will take at least another decade of measurements to draw a firm conclusion.

The data, collected from 1979 through 1988 by the TIROS-N weather satellites, proved that the atmosphere's temperature can be measured accurately by instruments probing from space, two scientists say in a paper in the journal Science.

"We found that the Earth's atmosphere goes through fairly large

year-to-year changes in temperature and over that 10-year period we saw no long-term warming or cooling trend," said Roy W. Spencer of the Marshall Space Flight Center in Huntsville, Ala.

Spencer's co-investigator, John R. Christy of the University of Alabama, Huntsville, said there were temperature swings "that can be quite dramatic" during the decade, but, on a global basis, the thermal changes tended to even out.

"The northern hemisphere goes up slightly during those 10 years and the southern hemisphere goes down slightly," said Christy. "The net effect for the globe is basically zero."

Conventional temperature measurements have found the 1980s to

have been the warmest decade on record but also do not show a strong warming trend within the decade.

Detecting a climate trend from space, the scientists said, will take at least another decade of satellite measurements.

"There is no guarantee that if you take a 10-year segment out of a long time, that you'll get the overall trend," said Christy. "The data cannot be used to say we've got an enhanced greenhouse effect."

Christy said the findings "are enough to tantalize us... but this is just a start" and satellite measurements are continuing.

"By the turn of the century, we should see a trend," said the scientist.

SALE 49.99

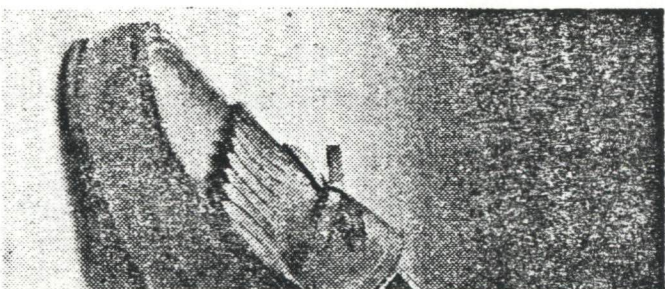
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7th meeting of the Global Change Working Group
Friday, March 30, 1990
2:00 - 4:00 PM
Roosevelt Room

ATTENDEES

OSTP D. Allan Bromley (Chairman)
DOE James Watkins
NASA Richard Truly
CEA Michael Boskin
DOS Richard McCormack
DOC John Knauss
DOI Frank Bracken
EPA Hank Habicht
WHO Andrew Card
WHO David Demarest
WHC C. Boydon Gray
OPD Roger Porter
OCA Stephen Danzansky
WHC John Schmitz
NSF Erich Bloch
OMB Robert Grady
CEQ David Struhs
WHO Steve Hart
DPC Kenneth P. Yale
DOT Philip Brady
DOS Fred Bernthal
DOJ Richard Stewart
USDA Charles Hess
DOS Richard Smith
NSC Eric Melby
OCA Barry McBee
DOJ Bill Myers
OSTP Nancy Maynard

PRESENTERS

NCAR Warren M. Washington
NOAA Daniel Albritton

DOOR

DOOR

Hess

Stewart

Porter

Gray

Habicht

McCormack

Bracken

Truly

Watkins

Bromley

Boskin

Knauss

Card

Bloch

Danzansky

Demarest

Grady

Struhs

The Roosevelt Room

DOOR

Brumley

THE WHITE HOUSE
WASHINGTON

DRAFT

Global Change Working Group

March 30, 1990

AGENDA

1. Scientific briefing on global change (background materials attached)
 - o Dr. Daniel Albritton (DOC/NOAA)
 - o Dr. Warren Washington (National Center for Atmospheric Research)

2. Update:

White House Conference on Science and Economics Research Related to Global Change (call on Corell + Keel)

3. Timing of Framework Climate Convention Negotiations

(call on Fred B.)

 - 2 Issues:
 - Timing of Negotiations
 - Who sit in negotiating position for us (what level)?

4. Other Business
 - Next Friday → (1) Full briefing on WH Conference 2-4 pm
 - (2) Economics briefing (arranged by Boskin's office)

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NCAR Warren M. Washington
NOAA Daniel Albritton

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Bromley

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Knauss

Card

Bloch

Danzansky

Demarest

Grady

Struhs

The Roosevelt Room

DOOR

Daniel L. Albritton

Personal: Birthplace - Selma, Alabama. 8 June 1936.
Married (1 August 1959), three children.
Residence - Boulder, Colorado.

Education: Georgia Institute of Technology, B.S. Degree, Electrical Engineering, 1959.
Georgia Institute of Technology, M.S. Degree, Physics, 1963.
Georgia Institute of Technology, Ph.D. Degree, Physics, 1967.

Employment

Aeronomy Laboratory, Boulder, Colorado; Environmental Research Laboratories; National Oceanic and Atmospheric Administration, 1967 - present:

Research Physicist (1967 - 1981). Personal research: laboratory investigations of ion-molecule reactions of planetary ionospheres and theoretical studies of the structure of diatomic molecules of atmospheric interest. (100 peer-reviewed journal papers in primarily the *Journal of Chemical Physics* and the *Journal of Molecular Spectroscopy*, serving on the Editorial Board of the latter).

Atmospheric Sampling Program Leader (1981 - 1984). Program research: field investigations of atmospheric trace-gas photochemistry. The approaches included aircraft- and balloon-borne and ground-based field campaigns addressing stratospheric ozone chemistry, stratospheric/tropospheric exchange, tropospheric formation of acids and oxidants, and biogenic emissions. (Coauthor on 25 peer-reviewed journal papers in primarily the *Journal of Geophysical Research* and the *Journal of Atmospheric Chemistry*, serving on the Editorial Board of the latter).

Director, Aeronomy Laboratory (1984 - present). Laboratory research: understanding the chemistry and dynamics of the atmosphere. Several key environmental phenomena are being addressed: stratospheric ozone depletion (including the recently discovered Antarctic ozone "hole"), acid deposition, tropospheric ozone formation, tropical ocean/atmosphere interactions, and the "greenhouse" effect. The Laboratory is staffed with approximately 100 scientists, engineers, and support personnel.

Professional Affiliations and Honor Societies

American Physical Society
American Geophysical Union
Phi Kappa Phi (Scholastic)
Tau Beta Pi (Engineering)
Eta Kappa Nu (Electrical Engineering)
Sigma Pi Sigma (Physics)

Scientific Committee and Panel Memberships

Recent: Member, Steering Committee, NASA Global Tropospheric Experiment, 1984 - 1987.
Cochairman (with R. Prinn, MIT), Global Distributions and Trends Working Group, U.S. Global Tropospheric Chemistry Program Planning Workshop, Boulder, Colorado, April, 1985.

WARREN M. WASHINGTON—Biographical Sketch

Warren M. Washington is an atmospheric scientist involved in climate modeling at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. He has served on the President's National Advisory Committee on Oceans and Atmosphere, on numerous committees of the American Meteorological Society, the American Geophysical Union, the American Association for the Advancement of Science, and the National Academy of Sciences, and as visiting professor of meteorology and oceanography at the University of Michigan. He is a Senior Scientist and Director of NCAR's Climate and Global Dynamics Division.

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FAX TRANSMISSION

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DOCUMENT

TODAY'S DATE 3/29/90 TIME 8:44am NO. OF PAGES 1

TO: Dr. Nancy Maynard
 LOCATION: Washington, DC
 FAX NUMBER: 202-395-3719
 TELEPHONE NUMBER:
 COMMENTS:

FROM: Warren M. Washington
 LOCATION: Boulder, Colorado
 FAX NUMBER: 303-497-1837
 TELEPHONE NUMBER:

UPDATE OF
DELEGATION LISTS

Current as of: March 29, 1990; 2:00 p.m.

Today's additions: U.K. full list
Brazil partial delegation
Zaire name

Note: Delegation lists are tentative

NAME OF COUNTRY: BRAZIL

DELEGATION:

Name

Title

Jose Lutzenberger

Environment Secretary

Jose Goldemberg

Science Secretary

NAME OF COUNTRY: EUROPEAN COMMUNITY (TENTATIVE)

DELEGATION:

<u>Name</u>	<u>Title</u>
Laurens Jan Brinkhorst	Director-General for Environment, Nuclear Safety and Civil Protection
Jurgen Henningsen	Director for Environmental Quality and Natural Resources
Michael Emerson	Director for Economic Evaluation of Community Policies, Directorate- General for Economic and Financial Affairs
Philippe Bourdeau	Director for Environment and Non-Nuclear Energy Sources, Directorate- General for Science, Research and Development
Stanley Johnson	Director for Energy Policy, Directorate- General for Energy
David Wright	Central Advisory Group, Secretariat-General of the Commission

NAME OF COUNTRY: FEDERAL REPUBLIC OF GERMANY

DELEGATION:

Name

Title

Professor Dr. Klaus Toepfer

Federal Minister for the
Environment, Nature Protection
and Nuclear Safety

Dr. Gerhardt Ziller

Deputy Minister for Research
and Technology

Dr. Peter Krause

Director, Office of
Environmental Research;
Ministry of Research
and Technology

Dr. Hartmut Grosse

Scientist, Max Planck
Society, Hamburg

Dr. Glatzel

Head, Environment Referat;
Chancellor's Office

Baldur Wagner

Director, Soc. & Env.
Issues; Chancellor's Office
(Boskin Counterpart)

NAME OF COUNTRY: INDIA

DELEGATION:

Name

Title

Ms. Maneka Gandhi

Min. of State for
Environment and Forests

Vasant Gowarikar

Secretary of Dept. of
Science and Technology

Mahesh Prasad

Secretary of Min. of Env.
& Forests

Dr. A.P. Mitra

Director General of
Council for Science &
Ind. Research

NAME OF COUNTRY: INDONESIA

DELEGATION:

Name

Title

Prof. Dr. Ing. B.J. Habibie

State Minister for
Research and Technology;
Chairman of the Agency
for the Assessment and
Application of
Technology; Science
Advisor to the President

Prof. Dr. S.B. Joedono

Assistant (Industry,
Mines & Energy) to the
State Minister for
Economic, Finance,
Industry and Development
Supervision; Expert Staff
for Economic Affairs to
the State Minister for
Research and Technology

Dr. M. Alwi Dahlan

Assistant for Population
to the State Minister for
Population and Life
Environment

Prof. Dr. Samaun Samadikun

Chairman, Indonesian
Institute of Sciences

Prof. Dr. IR Gunawan Satari

Secretary to the State
Minister for Research and
Technology

Prof. Dr. Rustam Didong

Deputy for Economic
Affairs, National
Development Planning
Board

Prof. Dr. IR Harsono Wiryosumarto

Deputy Chairman for
Technology Development;
Agency for the Assessment
and Application of
Technology

Drs. Poedji Koentarlo

Director General for
Foreign Economic
Relations; Department of
Foreign Affairs

Page 2

NAME OF COUNTRY: INDONESIA

DELEGATION:

Name

Title

Prof. Dr. John A. Katili

Senior Advisor to the
Minister of Mines and
Energy; Senior Advisor to
the State Minister for
Research and Technology

Ambassador Abdulrachman Ramly

Indonesian Ambassador to
the United States of
America

NAME OF COUNTRY: MEXICO

DELEGATION:

Name

Title

Patricio Chirinos

Secretary of Urban
Development and Ecology

NAME OF COUNTRY: NETHERLANDS

DELEGATION:

Name

Title

Hans Alders

Minister for Housing,
Physical Planning and
Environment

Dr. B.C.J. Zoeteman

Deputy Director-General
for Environment

Dr. Pier Vellinga

Coordinator for National
Climate Programs

N.D. Van Egmond

Director for Chemistry
and Physics, State
Institute for Public
Health and Env.
Hygiene

I.G. Roos

Directorate-General for
European Cooperation,
Ministry of Foreign
Affairs

Dr. H.M. Fijnaut

Director of the Royal
Dutch Meteorological
Institute

Dr. A.P.M. Baede

Head of the Department
for Dynamical Meteorology

C.W.M. Dessens

Director-General for
Energy

or

D.F.W.T. Pietermaat

Environmental Coordinator
in the Directorate-
General for Energy,
Ministry of Economic
Affairs

Prof. J.B. Opschoor

Professor in Ecology,
Free University,
Amsterdam

NAME OF COUNTRY: NORWAY

DELEGATION:

Name

Title

Kristin Hille Valla

Minister of Environment

Einar Steens Naes

Minister of Education and
Science

Oddmund Graham

Under Secretary
Equivalent; Ministry of
Environment

Per Bakken

Senior Researcher,
Ministry of Environment

Tore Olsen

Director General,
Ministry of Education and
Science

Kare Bryn

Director General,
Ministry of Foreign
Affairs

Professor Ivar Isacsen

University of Oslo

Ambassador Kjell Vibe

Norwegian Ambassador to
U.S.

Leif Westegaard

Science Officer,
Norwegian Embassy in
Washington

NAME OF COUNTRY: OECD

DELEGATION:

Name

Title

William L. Long

Director of the
Environmental Directorate

John Ferriter

Deputy Ex. Director,
Int'l Energy Agency

NAME OF COUNTRY: UNITED KINGDOM

DELEGATION:

Name

Title

David Trippier RD, JP, MP

Min. for the Environment
and Countryside

Sir John Fairclough

Chief Scientific Adviser,
the Cabinet Office

Sir Crispin C.C. Tickell, GCMG, KCVO

United Kingdom Permanent
Representative to the
United Nations

Dr. John T. Houghton CBE

Director-General,
Meteorological Office

J.G. Odling-Smee

Deputy Chief Economic
Adviser; HM Treasury

Dr. David J. Fisk

Chief Scientist,
Department of Environment

Dr. W. David Evans

Chief Scientist,
Department of Energy

Dr. Eileen Buttle

Secretary, Natural
Environment Research
Council

NAME OF COUNTRY: ZAIRE

DELEGATION:

Name

Title

Lobo Kanza

Secretary of State
(Deputy Minister);
Department of
Environment and
Conservation of Nature

COLLECTION OF VIEWGRAPHS

For Presentation to the
Domestic Council on Global Warming

30 March 1990
Washington, D.C.

By Warren M. Washington
National Center for Atmospheric Research
Boulder, Colorado

COLLECTION OF VIEWGRAPHS

For Presentation to the
Domestic Council on Global Warming

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Boulder, Colorado

What are climate models?

What do climate models tell us about the greenhouse effect?

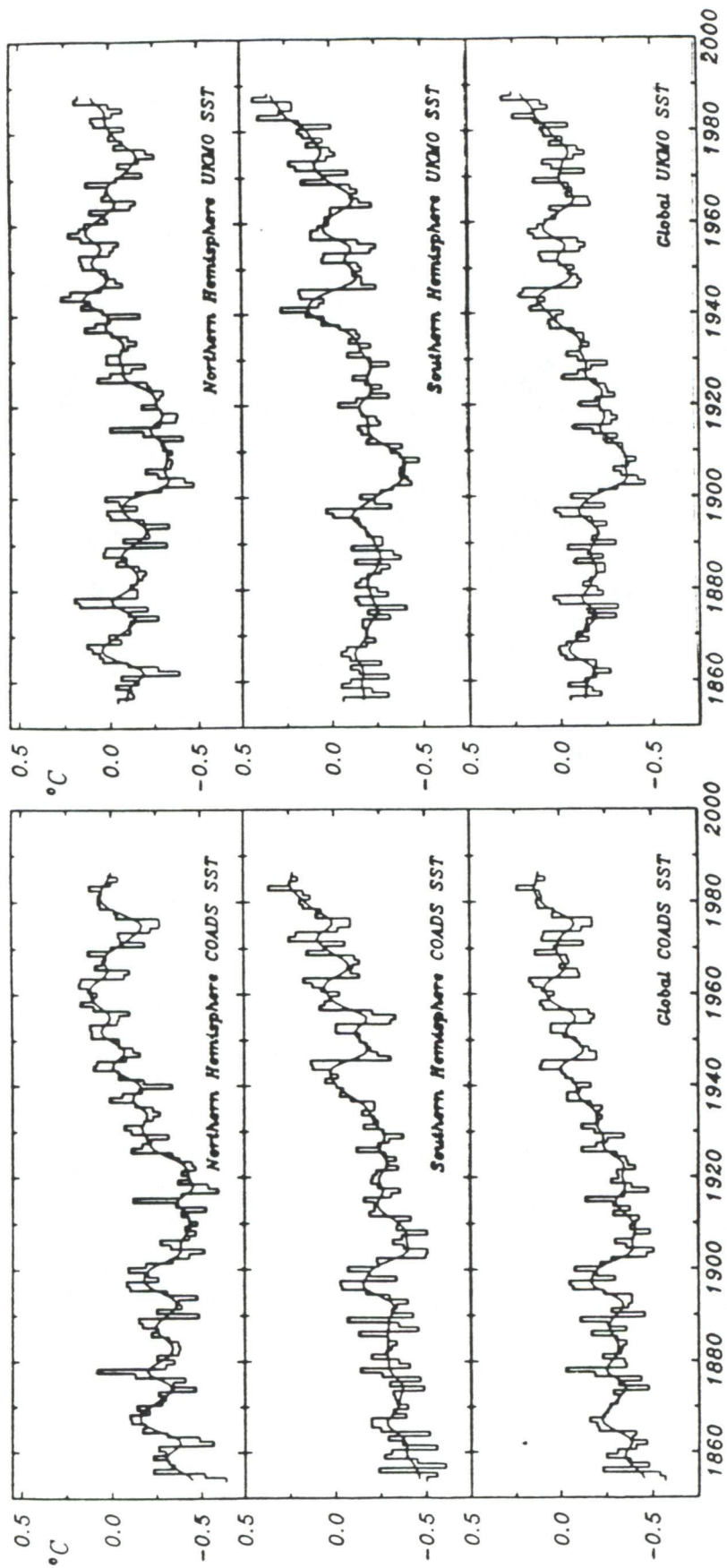
What new information are climate models telling us about regional changes?

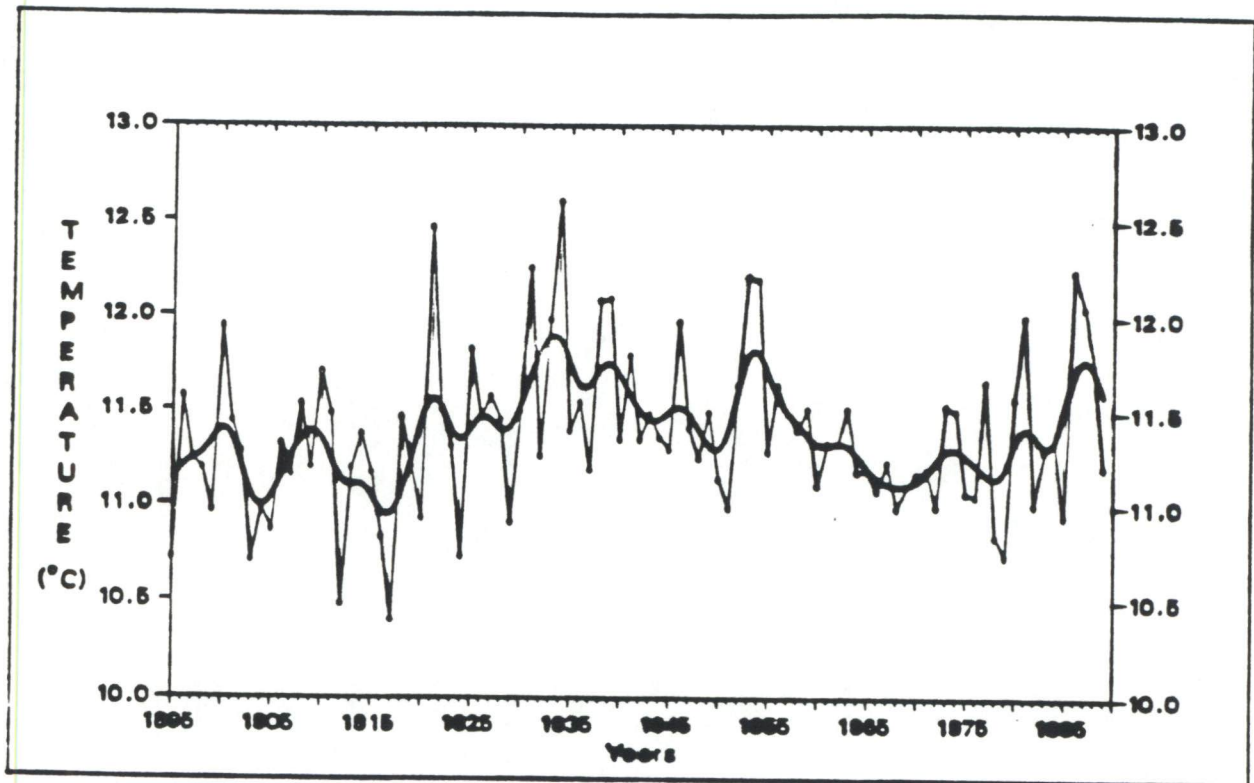
How will the U.S. Global Change Research Program reduce uncertainties?

**GLOBAL WARMING AND
RECENT CLIMATE CHANGE
Observations and Modeling**

1. Climate observations.
2. Climate modeling.
3. Comparisons of model results
with observations.

Observed Hemispheric and Global Sea Surface Temperatures





U.S. Averaged Surface Temperatures
[from T. Karl, 1988 (NOAA)]

GREENHOUSE-GAS-INDUCED CLIMATE CHANGE

- Observations show an increase in "global" temperature of $\sim 0.5^{\circ}\text{C}$, of which $\sim 0.1^{\circ}\text{C}$ is due to urban warming (maybe more!).
- Climate models indicate that $\pm 0.2^{\circ}\text{C}$ in global T can readily occur over 100 years without external causes of climate change.
- Such fluctuations are seen in the observed climate record, (e.g., the warmest period in the U.S. is still the 1930s).
- Thus, it is not possible to attribute the observed global T change to the observed greenhouse gas increase.

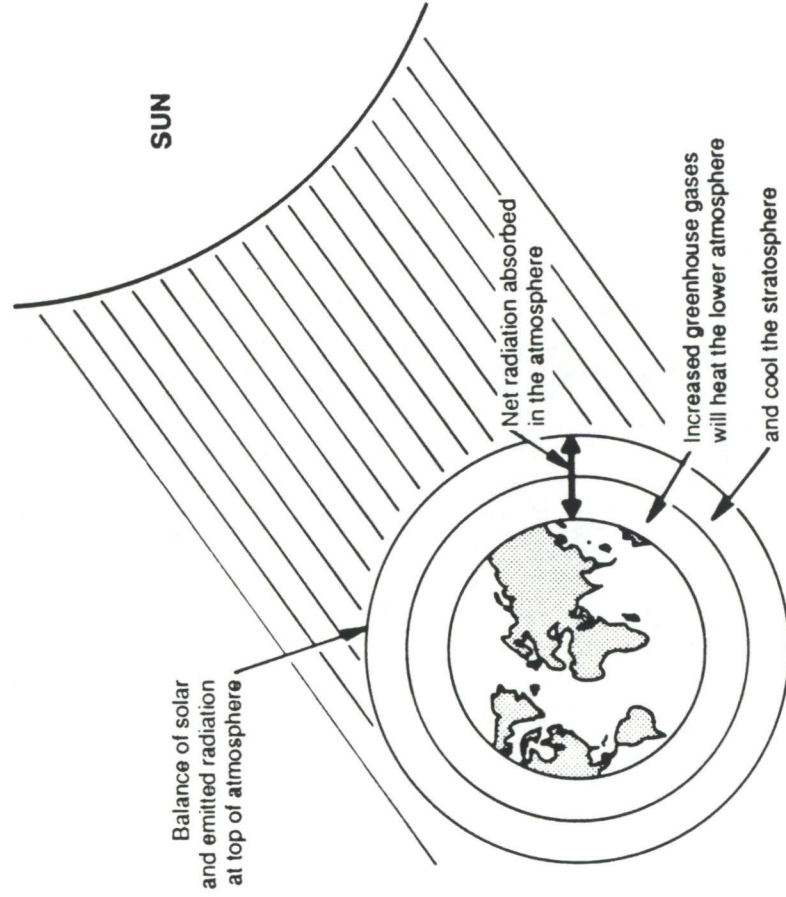
WHAT IS THE INFLUENCE OF CLIMATE PROCESSES?

Earth energy balance:

- Determined by difference between absorbed and emitted radiation.
- Water vapor, CO₂, and other trace gases absorb radiation and heat atmosphere.
- Clouds and aerosols can both heat and cool atmosphere.

Clouds and water vapor are the largest contributors to climate energy balance:

- 1% change in global mean cloud cover \approx 4% change in CO₂.
- Low-level clouds tend to cool.
- High-level clouds tend to heat.



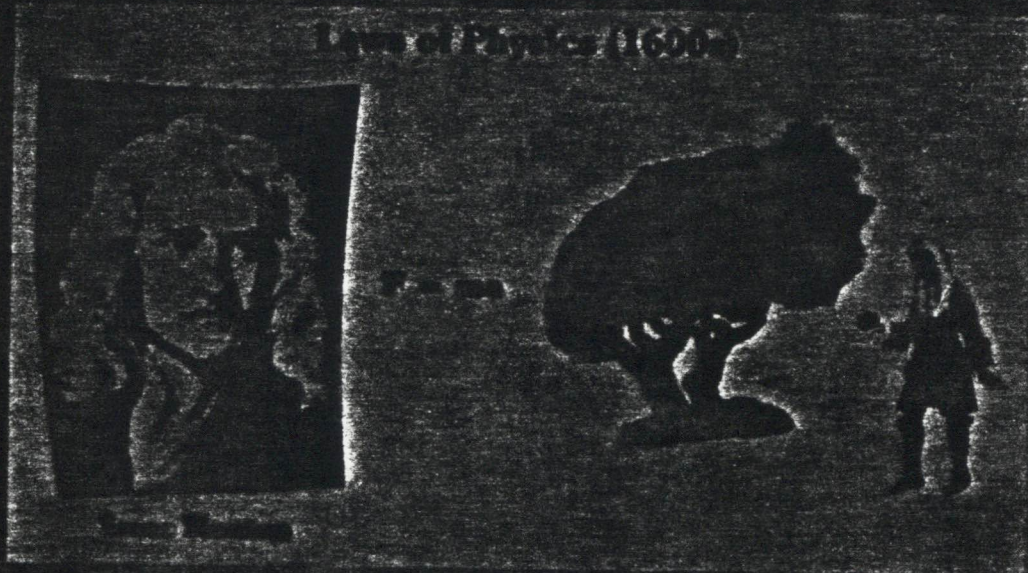
WHAT IS A CLIMATE MODEL?

A COMPUTER PROGRAM which numerically solves the MATHEMATICAL EQUATIONS that represent the LAWS OF PHYSICS.

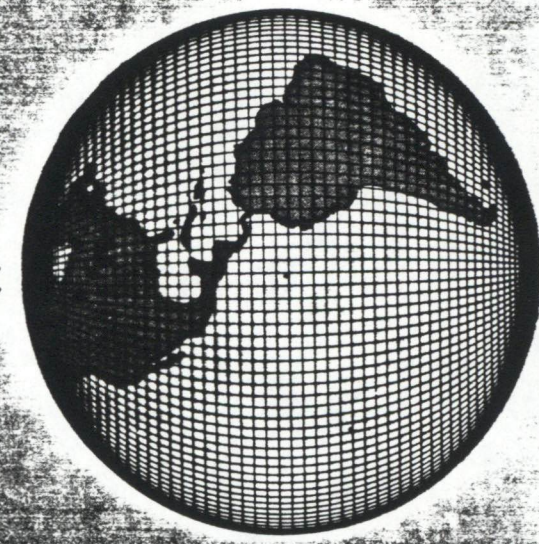
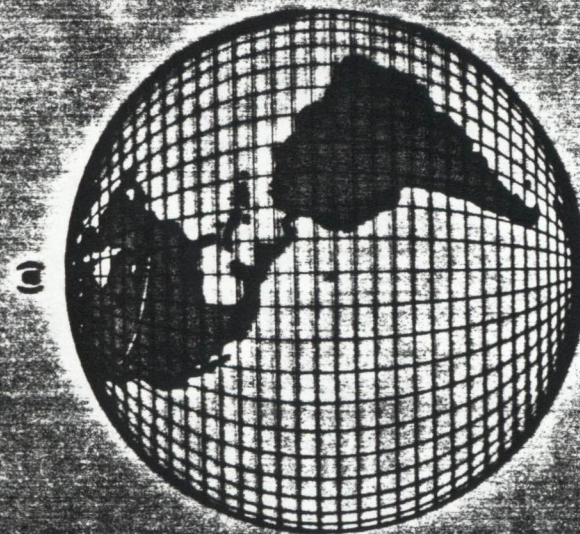
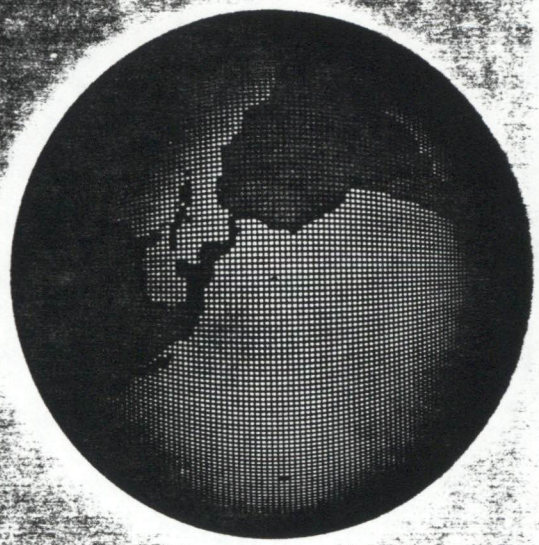
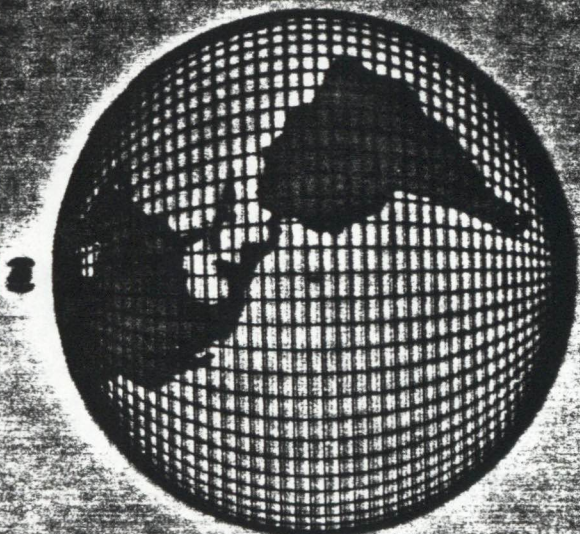
Components include the ATMOSPHERE, OCEAN, LAND, CRYOSPHERE and BIOSPHERE and all the dynamics, physical processes and interactions between them.

The most comprehensive climate models include GENERAL CIRCULATION MODELS (GCMs) as atmospheric and oceanic components.

An atmospheric GCM follows the evolution of all the weather systems, clouds, and rain, and the interactions with the land and ocean.



Model Resolutions



(a)

(b)

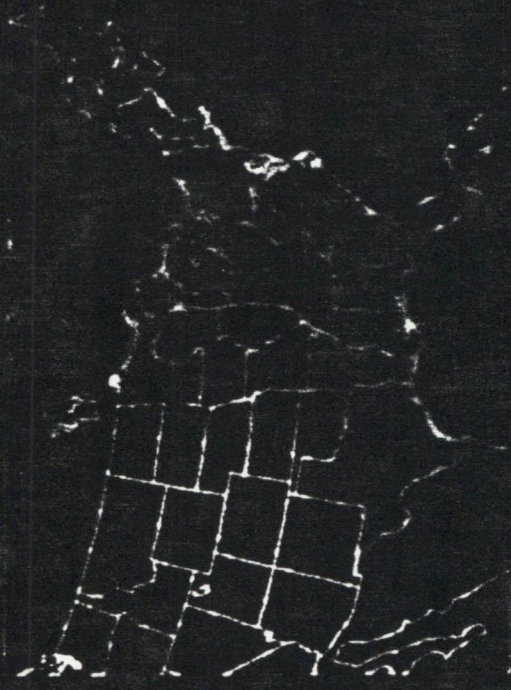
(c)

(d)

Present Climate Model Grids



Grids: 1990-2000



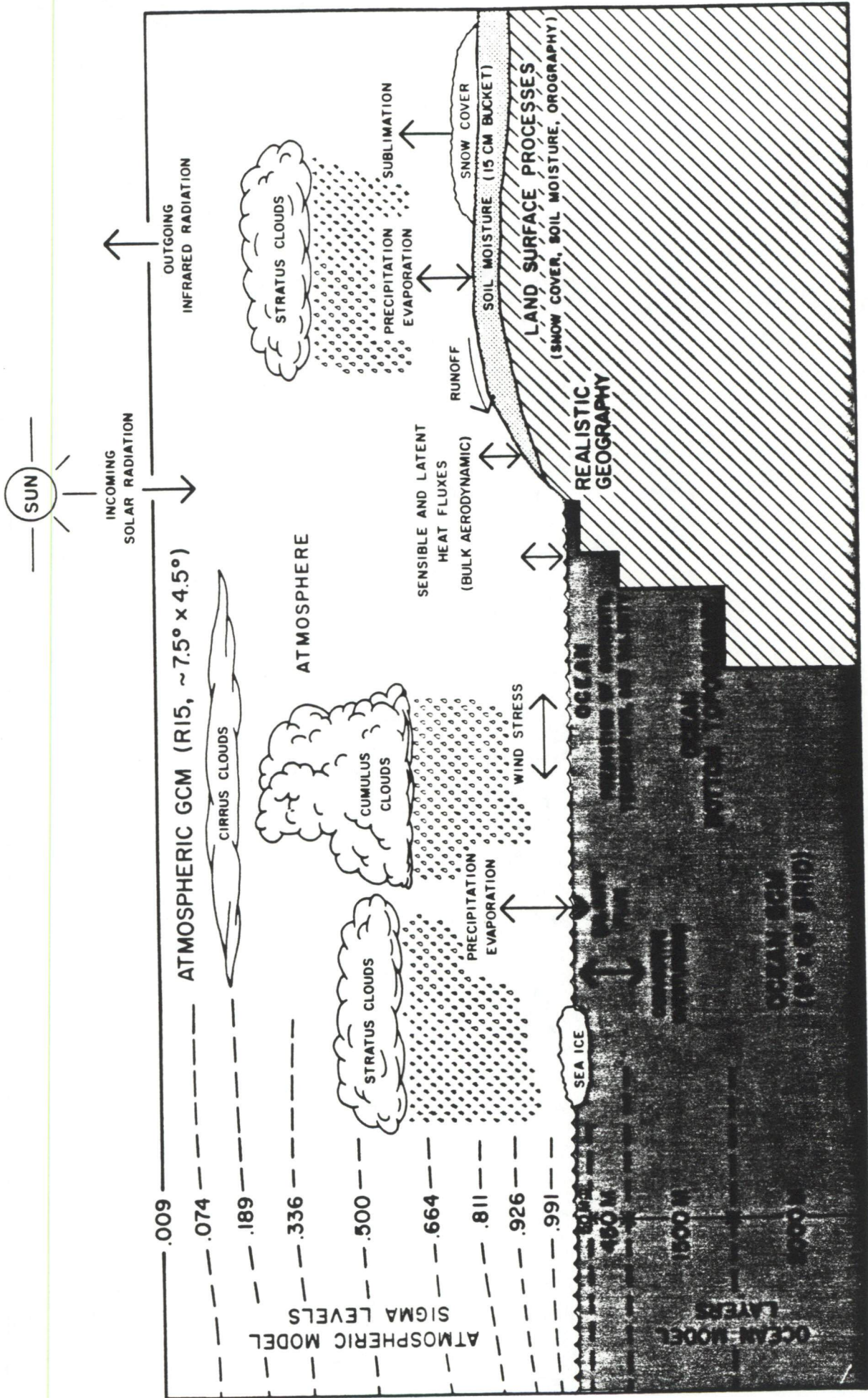
Grids: 2000-2010



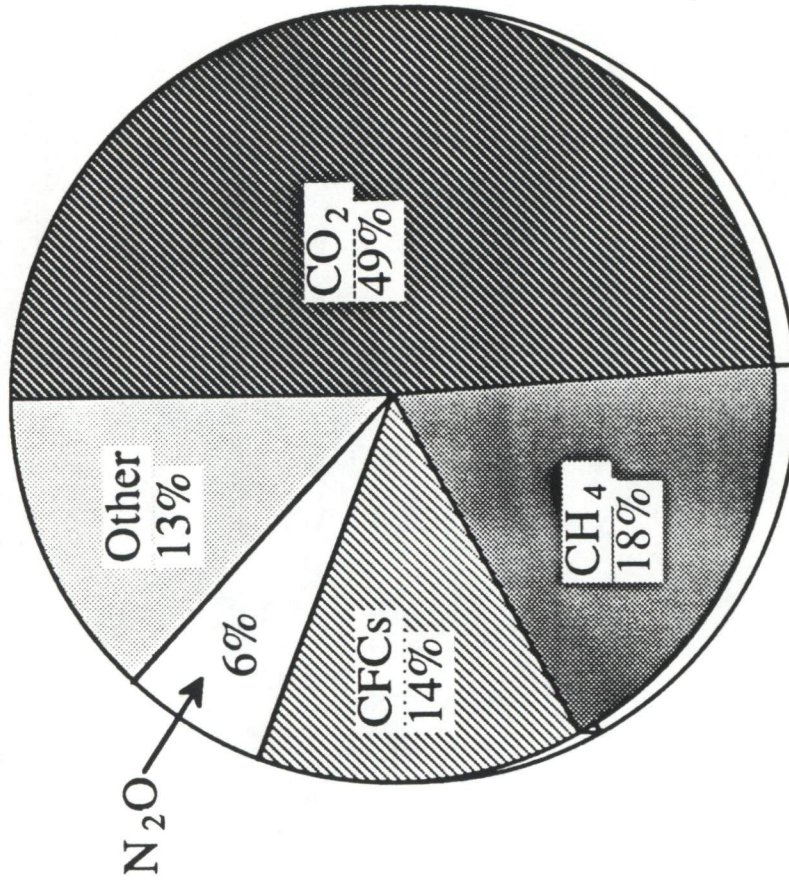
Grids: Beyond 2010



CLIMATE MODEL PROCESSES



**GREENHOUSE GASES THAT
CONTRIBUTE TO GLOBAL WARMING**



CO₂: Carbon Dioxide
CH₄: Methane
CFCs: Chlorofluorocarbons
N₂O: Nitrous Oxide

Source: EPA

NEW CLIMATE MODEL EXPERIMENTS WITH DYNAMICAL OCEANS

Main Results:

- Land areas warm faster than oceans.
- More warming at high latitudes—especially Northern Hemisphere.
- Including ocean currents (dynamics) causes minimum warming near Antarctica and North Atlantic Ocean.
- Time lag in warming caused by ocean sequestering heat.

CLIMATE SYSTEMS RESPONSE TO INCREASED GREENHOUSE GASES

Temperature:

- Lower atmosphere warming—**high certainty**
- Stratosphere cooling—**high certainty**
- Surface air temperature increase—**moderate certainty**
- Surface wintertime high latitude air temperature increase—**moderate certainty**
- Surface tropical air temperature increase—**moderate certainty**

Precipitation:

- Globally increases (as does evaporation)—**high certainty**
- High latitude increase (especially wintertime)—**moderate certainty**
- Less in subtropical land areas—**low certainty**

Soil Moisture:

- Increase in high latitude in winter—**moderate certainty**
 - Decrease in North American mid latitude—**low certainty**
-

- Asian summer monsoon intensifies—**moderate certainty**
- Day-to-day variability stays the same—**low certainty**
- Deforestation has small global effect on climate but large local effects—**moderate certainty**

Global Change Research Program

Objectives

Establish an integrated, comprehensive, and sustained program to document the Earth system on a global scale

Conduct a program of focused and exploratory studies to improve understanding of the physical, chemical, biological, and social processes that influence Earth system changes and trends on global and regional scales

Develop integrated, conceptual, and predictive Earth system models on global and regional scales

GLOBAL CHANGE RESEARCH BASIC QUESTIONS

Major Uncertainties:


- What is the role of clouds in the Earth's radiation and heat budgets?
- How do the oceans interact with the atmosphere in the storage, transport, and uptake of heat?
- How will changes in climate affect temperature, precipitation, and soil moisture patterns, and the general distribution of water and ice on the land surface?
- How can the reliability of global- and regional-scale climate predictions be improved?

NATURAL HISTORY

This issue contains an article by
Warren Washington on the greenhouse
effect (pp. 66-72).



3/90



The Gulf Stream, shown in red and orange on this satellite image, transports enormous quantities of heat northward from the tropics.

Brown, Evans, and Carle; University of Miami, Rosenstiel School of Marine and Atmospheric Science

Where's the Heat?

Greenhouse gases in the atmosphere are expected to raise temperatures, but shifts in ocean circulation may obscure the evidence of global warming

by Warren M. Washington

In 1896, the Swedish chemist Svante Arrhenius resolved a longstanding mystery. Scientists had been unable to explain how the earth's atmosphere could maintain the planet's relatively warm temperature, when oxygen and nitrogen, which constitute 99 percent of the atmosphere, do not absorb heat from the infrared radiation emitted from the earth back into space. Arrhenius discovered that carbon dioxide, which makes up only a tiny fraction of the atmosphere, could trap enough of the escaping heat to warm the planet's surface. Furthermore, he realized that the burning of coal, oil, and natural gas was raising the concentration of CO₂, and he predicted that a doubling of the gas could warm the planet by more than 10° F, a prediction that is considered reasonable by scientists today.

Now well known as the greenhouse effect, this warming phenomenon was given little attention until Charles David Keeling and Roger Revelle, of the Scripps Institution of Oceanography, in La Jolla, California, began to study the carbon cycle and carefully record the atmosphere's carbon dioxide in 1958. On the slopes of Mauna Loa in Hawaii, far from sources of industrial pollution, Keeling was able to measure the subtle, seasonal ups and downs in the concentration of the gas as plants in the Northern Hemisphere varied their consumption and release of CO₂. In addition to this annual cycle, he documented a steady rise in CO₂ due to human activities—from 315 parts per million thirty years ago to 350 today. Using these data, as well as evidence from tree rings and ice cores, climatologists estimate that

the level of CO₂ before the dawn of the Industrial Revolution was about 280 parts per million. Humans have already increased CO₂ by 25 percent and are expected to have doubled the preindustrial levels of CO₂ by the year 2075.

In the 1970s scientists began to realize that increases in other "greenhouse" gases, such as methane, chlorofluorocarbons, nitrous oxide, and ozone in the lower atmosphere, could rival the warming effects expected from CO₂. The rapid destruction of forests, which normally remove CO₂ from the atmosphere, could also hasten global warming. Given these conditions, the effects resulting from a doubling of CO₂ could occur much sooner, perhaps by 2030.

So where is the evidence of global warming? Shouldn't our atmosphere's increased ability to trap heat—the signs of the greenhouse effect—be noticeable by now? The 1980s saw the four warmest years recorded in the last 110. The first seven months of 1988 were hot enough to break all records and caused some to declare that the greenhouse effect was now being felt. Unfortunately, the problem of distinguishing a long-term warming trend caused by increasing CO₂ from the natural variation in the earth's climate is a formidable one. Serious droughts and heat spells have occurred from time to time in the past. How can one be sure that the weather in the 1980s reflected warming due to human alteration of the atmosphere, especially when 1989 was relatively cool? Nevertheless, some researchers estimate that a warming of 1° F has already occurred during the last century.

Global temperature averages, calculated by climatologists at the University of East Anglia, show that the planet has warmed by about one degree Fahrenheit since 1860. Some scientists believe this slight warming trend is caused by the concurrent buildup of carbon dioxide. But against a background of large year-to-year temperature variations, the evidence of a warming trend is not clear; a direct correlation between rising levels of CO₂ and global warming remains controversial.

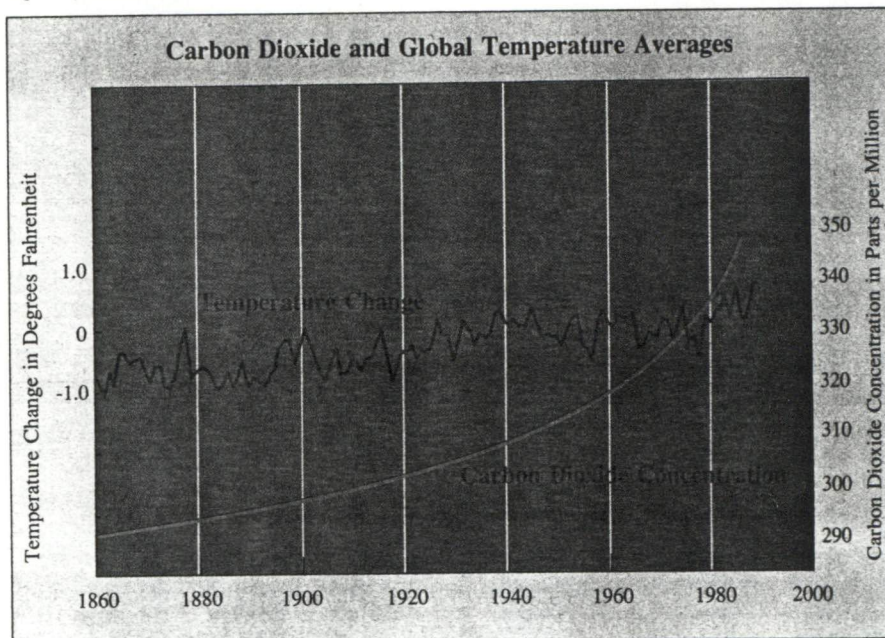
Diagrams by Joe LeMonnier

But because of the difficulty of comparing past and present measurements, this finding is far from being universally accepted.

Because the warming may be hard to detect with certainty until well into the next century, climatologists have turned to computer models to make rough predictions of how much warming will occur, and where and when it should become noticeable. A major shortcoming of the computer models, however, has been that they have focused almost entirely on the atmosphere's response to the rising levels of CO₂, neglecting the oceans. Although slower to react to change than our gaseous atmosphere, the oceans are nonetheless active components of the globe's climatic system and can influence long-term temperature variations. The oceans' most important effect, in this case, is their ability to absorb, release, and redistribute heat. Thus, the response of the oceans to increased greenhouse gases (difficult to read on a short time scale) is a critical unknown in most climate models.

The reason for this is that the forces at work in oceans aren't nearly so well observed and understood as are those of the atmosphere. Furthermore, modeling oceans and their complex interactions with the atmosphere in mathematical terms that can be easily processed by computer has been a daunting task. Therefore, most computer simulations of the earth's climate have complex atmospheric components, joined to a very simple model of the ocean.

Three types of coupled atmosphere-ocean models have been used to study greenhouse warming. All have similarly sophisticated atmospheric components, but their ocean components are quite different. In 1975, Syukuro Manabe and Richard Wetherald, of the National Oceanic and Atmospheric Administrations's Geophysical Fluid Dynamics Laboratory, were the first to create a three-dimensional climate model to study the greenhouse effect. The ocean component in their model was essentially a "swamp"—a stagnant, wet surface that absorbed and released heat and moisture. The swamp model calculated the oceans' surface temperatures by balancing such factors as so-



lar radiation, infrared radiation to and from the earth, evaporation, and heat transfer between sea and air. Other important ocean processes, such as currents and salinity, seasonal changes, and stored heat, were not factored in at all.

The late 1970s saw the development of models that treated the upper ocean as though its layers were mixed together. These models assumed an ocean that was a slab 150 feet deep with constant temperature from top to bottom. This approach allowed for heat storage in the summer and release to the atmosphere in the fall and winter. Although they did not include ocean currents, these models were a major advance because they reproduced an important seasonal feature of the upper ocean.

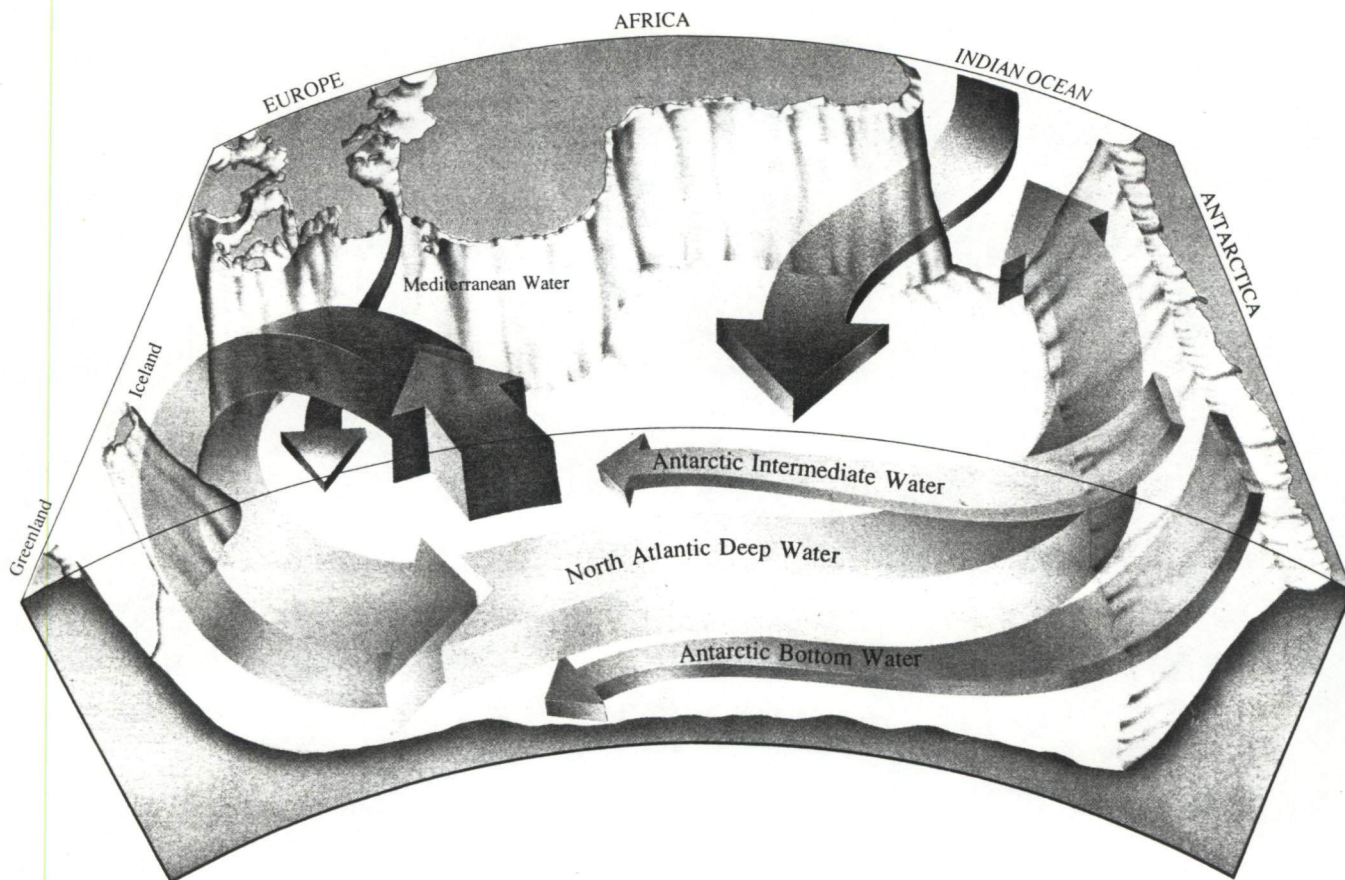
The basic physics of ocean circulation, first explained by Count Rumford in 1800, is only now being incorporated into coupled atmosphere-ocean climate models. (The count, born Benjamin Thompson in Woburn, Massachusetts, spent most of his later life in Europe, where the Elector of Bavaria honored him with the title count for his many scientific contributions.) In his research on how ocean circulation is driven, Count Rumford wrote: But if the water of the ocean, which, on being deprived of a great part of its Heat by

cold winds [evaporation], descends to the bottom of the sea, cannot be warmed where it descends, as its specific gravity [density] is greater than that of water at the same depth in warmer latitudes, it will immediately begin to spread on the bottom of the sea, and to flow towards the equator, and this must necessarily produce a current at the surface in an opposite direction.

Measurements of surface and deep ocean currents confirm this simple picture of ocean circulation, where cold, highly saline water sinks and warm, fresher water floats on the surface. In a complex way, local atmospheric conditions help determine the temperature and salinity of an ocean's surface waters. Thus, the rapidly changing atmosphere works to influence the formation of deep ocean currents that may take tens to hundreds of years to circulate.

Any model omitting ocean currents, and the associated north-to-south heat transport, will produce a grossly inaccurate picture of global climate. The tropical oceans will be too warm and the polar regions too cold, because, as pointed out by Count Rumford, warmer water near the surface transports heat poleward and colder, denser water sinks and travels toward the equator. In 1984, James Hansen (NASA Goddard Institute of Space Studies, New York) fixed this shortcoming of

A cross section of the earth shows major features of Atlantic Ocean circulation. At the poles, cold water (blue) sinks and travels toward the equator. North of the equator, warm surface currents (red) move northward, where their heat is transferred to Europe by prevailing winds. Computer simulations of the greenhouse effect, however, indicate that atmospheric warming may weaken ocean circulation in the North Atlantic, cooling northern Europe.



the model. Even though his model did not explicitly calculate ocean currents, it took into account the heat they transfer from the tropics to the poles. This type of model has limited usefulness in climate-change experiments, however, because the amount of heat transferred remains the same; in reality the heat transfer would vary as the ocean currents adjust to altered atmospheric conditions.

To overcome this remaining limitation, climatologists have only recently attempted to run atmospheric models simultaneously with dynamic models of the ocean. Physics and mathematics translate the simple heat-transfer process described by Count Rumford into useful computer climate models that can predict how changing atmospheric conditions at the ocean's surface will affect its circulation. These models can simulate temperature- and salinity-driven deep ocean currents, as well as allow for upper-layer, wind-driven surface currents (such as those created by the westerlies in the midlatitudes and the

trade winds in the tropics). Most importantly, heat is stored in the tropics and subtropics and later released to the atmosphere as currents move poleward.

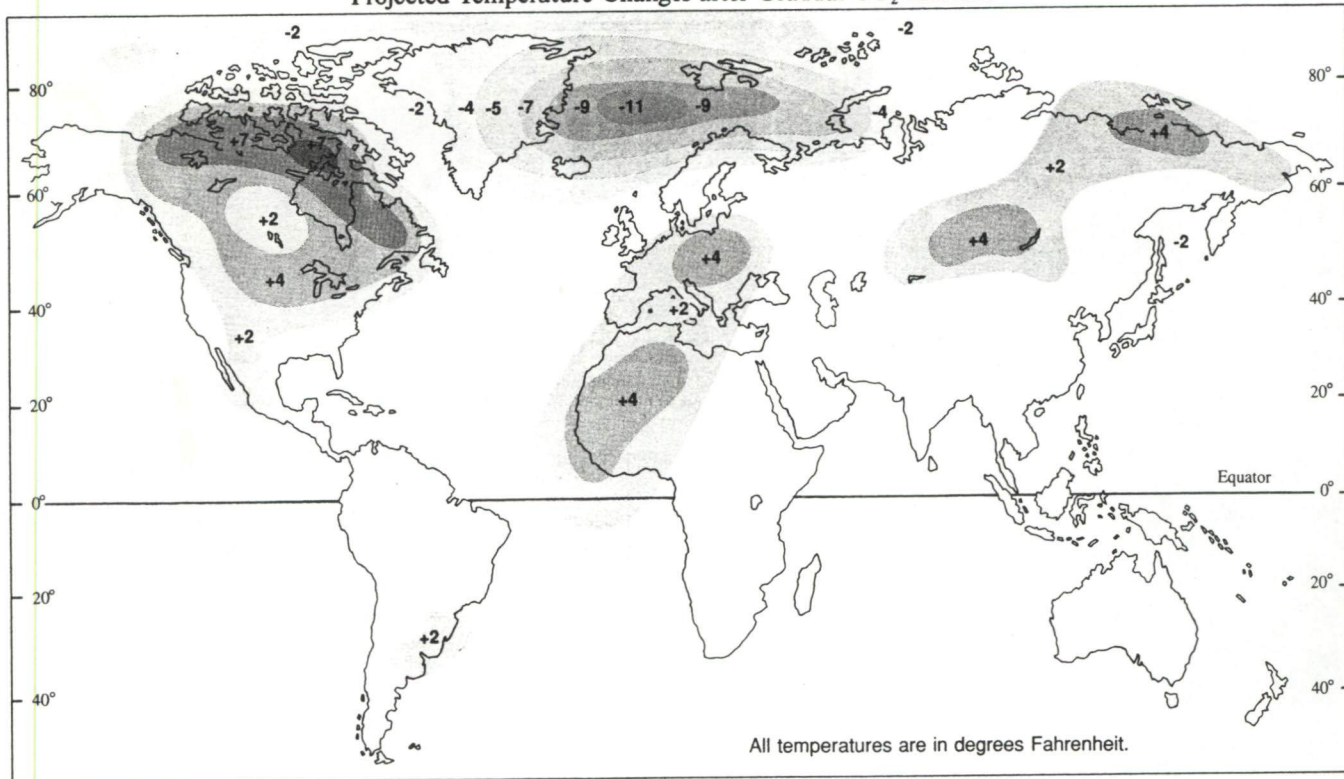
What can such a model tell us about how the greenhouse effect might modify today's ocean currents and how the new patterns will affect temperatures on land? At the National Center for Atmospheric Research in Boulder, Colorado, we have developed a climate model in which the atmosphere and ocean components run simultaneously, so that we can observe the effects of the complex feedback between the two systems. We performed two experiments, one with the present amount of CO₂ and the other starting with the current level and increasing it by about one percent each year for the thirty years of the computer simulation. (This one percent is twice the actual rate at which CO₂ is currently increasing, but it is meant to account for increases in the other greenhouse gases mentioned earlier.) As the computer simulations play out each sea-

son's weather, the model with increasing CO₂ shows the lower atmosphere and the surface of the ocean gradually warming by a global average of about 1° F. But the warming is not equally distributed; some regions, mainly the continental interiors, become as much as 7° F warmer.

Toward the end of the computer runs, however, a seemingly paradoxical cooling appears in northern Europe, where temperatures drop by as much as 11° F during the winter months, as compared to a simulation in which the CO₂ levels were kept constant at today's levels. This result, not seen in computer simulations that use simple and mixed-layer ocean models, was unexpected. That this cooling appears only in the model that incorporates the effects of the ocean currents is reason to suspect that it is due to a significant change in the ocean circulation caused by the increasing CO₂. But figuring out exactly which elements of our climate simulation were responsible would require examining how ocean currents affect the

A computer simulation of future climate suggests which regions may warm and which may cool. The temperature differences are winter averages for the last five years of the thirty-year simulation. Developed at the National Center for Atmospheric Research, the climate model used to calculate these results takes into account the effects of oceans and atmosphere on global temperatures. While the warming of continental interiors is evident in other simulations, the cooling of northern Europe appears only in the model that calculates ocean currents.

Projected Temperature Changes after Gradual CO₂ Increase



temperatures on land in northern Europe, and then how these currents might have been altered by the generally warming climate.

In the North Atlantic, warm surface currents move northward toward the British Isles, transporting heat from the tropics to the high latitudes, where westerly winds transfer the heat across northern Europe. These currents flow north to replace water sinking to form what oceanographers call the North Atlantic Deep Water. (In accordance with Count Rumford's theory, as the salty water cools in the northernmost Atlantic, it descends, spreads across the ocean bottom, and travels toward the equator.)

As the earth's climate warms, more water will evaporate into the atmosphere, and more moisture will travel to the higher latitudes; the result will be increased precipitation over certain regions. Increased rainfall during the summer and fall will form a layer of fresher, less dense water on the surface of the North Atlantic, where more saline waters now sink. And the

strength of the westerlies, which help drive the warm waters across the Atlantic, will fade. These changes have the effect of weakening the ocean circulation in this part of the world, so that the warm waters are not drawn as far north. With less heat transported toward the Arctic from the midlatitudes, the climate of northern Europe cools despite a general warming of the planet.

The results of our model cannot yet be used to predict the details of regional climates in 2020. Even the best such models still oversimplify ocean circulation, precipitation, moisture exchange near the atmosphere-ocean-land interface, and the role of clouds. Nor can we yet realistically factor in changes in soil moisture and vegetation. Such simulations can nonetheless suggest large-scale phenomena. Significant changes in ocean circulation are possible as the climate warms in response to rising levels of CO₂ and other trace gases, and these changes may produce unexpected effects, such as the cooling of northern Europe. The results of our model

suggest one plausible reason why we cannot unequivocally detect the greenhouse signal. As the oceans shuffle global climates into new patterns, the warming produced by the greenhouse effect may be even harder to detect, and some areas may actually cool.

Some have suggested that if the earth had no oceans at all, we would have been able to measure the greenhouse warming with certainty by now. Oceans not only have the ability to alter climate patterns, they can also slow down the warming effects by absorbing a great deal of heat. (Anyone who has boiled water may have noticed that it takes a large amount of heat to raise the temperature of water only a few degrees.) Because the Southern Hemisphere contains substantially more ocean than the Northern Hemisphere, it probably will not warm as rapidly. This may seem like good news, but eventually the heat stored in the oceans will affect our climate, perhaps not in years, but—on the time scale of ocean circulation—decades and centuries from now. □

The Global Climate System: Knowns and Unknowns

by Dr. Daniel L. Albritton
NOAA Aeronomy Laboratory

The Basic Question

What will the Earth's climate system do in the 21st century? The answer is actually easy to give: *It will vary.* However, the glibness of this reply (which is also the answer given by a turn-of-the-century financier when asked similarly about the future Stock Market) hides the crucial importance of that answer. Namely, ours is a planet of change. That fact lies at the heart of the emerging dialogue between science and public policy regarding key global environmental issues.

However, before exploring the point, it is best first to subdivide the opening question, to label its two parts, and to show explicitly the science/policy interface for each:

- (a) Natural variations: *Can we predict the naturally varying climate of the next century (particularly the extreme swings)?*

(The payoff: Learning to better live with what we cannot avoid.)

- (b) Human-induced change: *Can we predict how human activities could alter the average climate?*

(The payoff: Learning that we may have to mend our ways.)

Although seldom posed in two parts, it clear that decision makers should be keen on science providing answers to both questions, for the following reasons.

Natural Variation. Memories of record-breaking heat waves or unusually frigid winters demonstrate that climate variability occurs even on human time scales. The historical and geological records amply document longer-term variations of substantial magnitudes: the Little Ice Age of the 15th and 16th centuries, the onset of the current aridity in southwestern U.S. somewhat earlier, and the great ice sheets of more-distant times. No charges of human causes have been leveled at these changes; they reflect the wanderings of an inherently variable global system. Yet, these natural changes have impacted our species greatly: extensive migrations, economic losses, and personal hardships. The recent human misery wrought by the Sahelian drought in Africa is beyond quantification. The hot, dry summer of 1989 in the midwestern U.S. shows the vulnerability of even a modern industrial society. Clearly, to be able to predict such natural variations and hence to be able to prepare better for them, would be a boon to life on this planet. This is particularly true as population growth increasingly stresses our institutions and societies.

Human-Induced Change. Recently, however, an additional factor has entered this varying scene. Over the past 100 years, humans have demonstrated that they have achieved the dubious capability of being able to alter the atmosphere on global scales. The atmospheric abundance of carbon dioxide (CO₂) has increased substantially since pre-industrial times. Chlorofluorocarbons (CFCs), once nonexistent, are now present throughout the atmosphere. Indeed, they are a semipermanent feature, because of their century-long residence times. The consequences of these perturbations are very clear in some cases, but not fully so in others. While the CFCs have valuable industrial uses, their use has also given us a new long-term, continental-sized global feature: the Antarctic ozone "hole". Increasing CO₂ abundances have raised the prospects of an enhanced "greenhouse" effect (see *EPA Journal*, Vol. 15, Jan/Feb 1989, pp. 4 - 7). Namely, CO₂ absorbs and reflects back toward the surface part of the outgoing thermal radiation of the planet, thereby potentially warming the lower atmosphere and the Earth's surface. Just as decision makers asked science what are the consequences of increasing CFCs on the ozone layer, they are now rightly asking the same question regarding increasing CO₂ and climate change. This article addresses the quality of science's current answer.

The Challenge to Science

Scope. Science knows the scope of the problem that it faces. As sketched in the figure, a variety of natural and human-induced "forcings" nudge the global system into responding with physical changes. In turn, these changes impact the planet's biological systems, including humans. Science aims to understand the processes that link the forcings, responses, and impacts. That understanding comes from long-term observations, field campaigns, laboratory studies, and theory.

"Modelsmithing". A "model" of the global system is built (that is, mathematical expressions that describe the linkages and that reside in large computers). The model is used to explore "what-if" scenarios, for example, what if CO₂ were to double? The scientific goal is for the model to be a representative replica of the planet (that is, has adequate formulations of the major pertinent processes). If that is indeed true, then it can identify natural climate changes about which we would want to be forewarned (and hence forearmed). In addition, it could identify changes that we ourselves are about to cause (and hence hopefully avoid). But how good are we at model building?

A Complexity: Feedbacks. The system is not as "linear" as the sketch in the figure may lead one to believe. Parts of the global system are remarkably intertwined. There are "feedbacks" that either amplify or attenuate the effect of a forcing, such as CO₂ increases. These feedbacks must be represented adequately if the model's simulation of a response to a forcing is to be usefully accurate. Within the physical system, for example, the sketch illustrates how clouds can introduce both types of feedbacks. On the one hand, a more cloud-shrouded (hence brighter)

planet reflects more of the incoming solar energy back to space, thereby tending to produce a cooler planet. On the other hand, a cloudier planet traps more outgoing surface radiation, thereby tending to produce a warmer planet. This example demonstrates a case where the net effect is a near-cancellation of two difficult-to-characterize effects, thereby posing quite a challenge in modeling. Another circular coupling involves the biological emissions of methane, which, like CO₂, is a greenhouse gas. Changing surface temperatures can alter the amount of methane emitted from high-latitude tundra, for example. These emissions can then in turn change the radiative forcing that may have originally caused the temperature change.

Another Complexity: A Time Lag. In addition, the simple sketch cannot show the predicted time dimension of greenhouse-forced climate change. While the reflected radiation arising from trace gases will increase in step with their growth rates, the response of the planet will not. One key factor is the time lag introduced by the huge thermal inertia of the world's oceans. It takes some decades for such a large volume of water to warm, the lag depending largely on the slow overturning of the warm surface waters with the colder deep-ocean water. Thus, a prediction of the response of the planet to increasing greenhouse gases necessarily includes a prediction of the arrival time of the response, which adds a challenging dimension. A key implication of the time lag and the long atmospheric residence times of the greenhouse gases is that is hard to "quit the game". Namely, we are committed into the future to whatever responses are in store from the long-lived greenhouse gases that we have placed (and are placing) in the atmosphere.

And There is Both Good News and Bad News Regarding Impacts. As the sketch also indicates, physical changes can cause biological responses that can be both beneficial or detrimental to mankind. Increased carbon dioxide does stimulate plant growth. Furthermore, a warming of marginally productive high-latitude regions can enhance their habitation and other use. But the impacts of past natural variations of rainfall and temperature have demonstrated what the human costs of a greenhouse-enhanced warming could be. Therefore, with both gains and losses potentially in store, policy decisions become more acutely sensitive to details of the predictions, which current science is hard pressed to provide accurately.

Where Things Stand: The Knowns and Unknowns

Despite the scope and complexity noted, past and present research have provided an understanding of several, but not all, aspects of the greenhouse effect. Some things are known with high certainty; others remain very poorly understood. The following status report proceeds through that spectrum from "knowns" to "unknowns". The focus is on the most policy-relevant aspects, namely, those points relating to the following questions: *What can cause climate change, particularly specific human activities? What is the nature of the predicted changes, and how do*

they compare with natural ones? Have we seen any human-induced changes yet? What is the degree of confidence in current predictions of future changes?

A greenhouse effect is essential to life. If the three major radiation-trapping trace gases -- water vapor, CO₂, and ozone -- were not present in the atmosphere, our solar-powered planet would be ice covered. Thus, a greenhouse effect is a major feature of the atmosphere (fortunately) and is one whose general properties are understood. Models yield very reasonable simulations of the average temperature of the Earth, the pattern of the seasons, the latitudinal changes in temperatures, and the vertical temperature structure of the atmosphere. Why then is the greenhouse effect labeled as an environmental issue? The answer is simple: we have begun to enhance it.

A doubling of carbon dioxide in the next century is virtually certain. The atmospheric abundance of CO₂ is increasing, clearly due largely to the combustion of fossil fuels by humans. All scientists are convinced of this. The future rate of increase will depend strongly on (i) technical developments, economic factors, and policy decisions, which cannot be predicted entirely in advance, and (ii) the net uptake of carbon dioxide by vegetation and the oceans, which are rather uncertain. Nevertheless, essentially all scientists agree that a doubling of carbon dioxide abundances will occur within the next century.

The existence of other greenhouse gases is well known. Methane, CFCs, ozone in the lower atmosphere, and nitrous oxide are also greenhouse gases. Their abundances are also increasing in the atmosphere. The reasons for the increases are only partially clear, which is a situation highly relevant to formulating possible control strategies. The CFC's are industrially produced. However, the sources of the other gases are not as clear, since the biological mechanisms for their emissions are particularly ill-defined at present. Hence, the future atmospheric abundances of gases like methane cannot be predicted reliably yet.

Confidence is high in the understanding of the basic radiation physics of trace gases. All of the above-mentioned gases act to reduce the loss of outgoing thermal radiation to space. The relative efficiencies for molecules of each chemical species are calculatable. However, their residence times in the atmosphere (hence the time over which they contribute) are more poorly known.

Most (but not all) climate scientists currently believe that the eventual response of the climate system to increased greenhouse forcing is likely to be, on the average, a global warming. While it is clear that current science can accurately calculate the thermal forcing of the atmosphere due to increases in the greenhouse gases, it is also clear that predicting the subsequent response of the climate system to that forcing is a much more difficult task. Based on current model simulations, many scientists believe that an eventual global average warming in the range of 1 - 5 degrees Celcius is likely. However, some scientists have cautioned that we may not have identified and/or characterized a sufficient number of the key atmospheric,

terrestrial, and oceanic processes that determine the responses. If indeed a warming in the range of 1 - 5 degrees Celsius were to occur, it would be comparable to or substantially larger than the known temperature changes that have happened naturally in the past.

There is a wide spectrum of opinion (and no consensus) on whether a greenhouse "signal" has already been seen. Current models predict that, due to the greenhouse gases that are already in the atmosphere, the global average surface warming should be in the range 0.5 to 1 degree Celsius. Has that warming been seen in the temperature record? The answer is not clear, but most scientists currently think not. While the surface temperature record shows that there has been an increase of that magnitude over the past several decades, the pattern of that increase (one relatively rapid increase in the 1920's and another in the 1980's) does not match that predicted for the greenhouse effect, namely, a gradual increase in temperature. Therefore, there must be other, presumably natural, processes at work that can influence temperature changes of a fraction of a degree Celsius. As a consequence, scientists are having to search for a "signal" whose magnitude is likely to be comparable to the natural variations of the climate system, which is a challenging task indeed! Furthermore, the reliability of some of the temperature record has been questioned recently, adding another complication.

Current models do not have the ability to predict with confidence the climate of a particular region or the climate of a given year. Those who construct climate models clearly state that they are not yet sufficiently realistic representations of the global system to yield reliable predictions of climate features on regional scales. Similarly, they cannot predict the climate of a particular year. This means that the models cannot say whether the U. S. midwestern drought of 1988 was due to the greenhouse effect, nor can they predict the climate features of the next few years. However, many scientists do believe that the models can predict that, because of the enhanced greenhouse effect, episodes like that of 1988 will become more likely in coming decades.

The Path to Better Answers

The above summary is a personal interpretation of the current spectrum of viewpoints of the scientific community regarding the state of the science of the enhanced greenhouse effect. What are the prospects for improved answers? In the near term? In the longer term?

State-of-knowledge review. First, a worldwide statement of the knowns, unknowns, and implications is due out soon. Namely, the Intergovernmental Panel on Climate Change (IPCC) of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) are sponsoring an international state-of-knowledge review of climate change. There are three companion WMO/UNEP assessments taking place: science, socio-economic

impacts, and policy options. The main features of the first of these, the "Scientific Assessment of Climatic Change", are the following. It will be a peer-reviewed scientific assessment of the whole climate-change phenomenon done by the best scientists available worldwide. It will be accompanied by a summary directed to government officials, the private sector, and the public. The timetable is brisk, having been started in early 1989 and with plans to finish in the summer of 1990.

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

- o It will be a single consensus statement from the scientific community. In the Assessment, the scientific community will speak with one voice regarding the knowns and unknowns of global warming. This can be a common reference point for decision makers, in contrast to sporadic and separate statements reflecting the opinions of individuals.
- o It will be an international scientific statement. All nations will have a common basis of scientific input for their decision making, as opposed to several national statements.
- o The scientific scope will be comprehensive. With the Assessment, decision makers will have available a single homogeneous summary of the current scientific understanding of the whole climate-change phenomenon, ranging from the causes of change to the impacts of that change to that change. This will be far more useful than separate reviews of components of the phenomenon done at different times and perhaps for different purposes.
- o Both natural and human-induced climate change will be considered. In contrast to considering only the potential influence of climate by human activities, the Assessment will place that predicted change in the context of the observed and predicted changes that are a natural part of the climate system. The comparison of the two will afford an immediate and straightforward insight into the significance of the predicted human influences.

Earth system science. While the Assessment will usefully summarize the current state of understanding, it is clear that key problems related to global warming will need further elucidation. Some of the shortcomings of our understanding are clear now and hence define some of the priority tasks that need research emphasis:

- o Building a better observational system that could not only provide additional input to the models, but also could signal the arrival of a greenhouse warming.

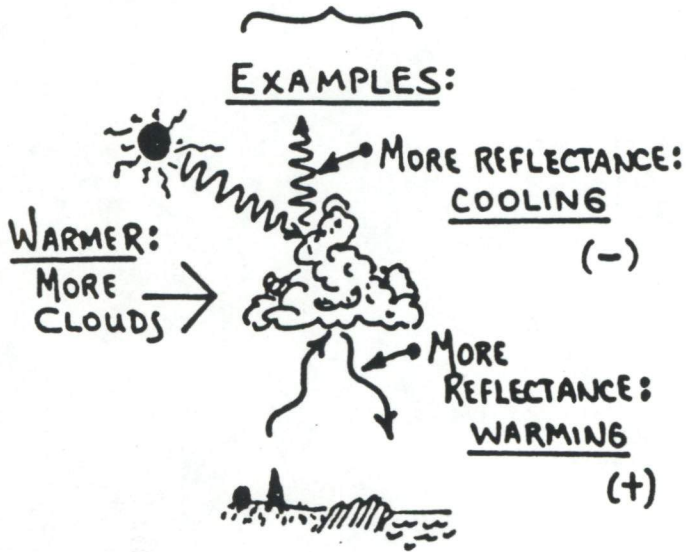
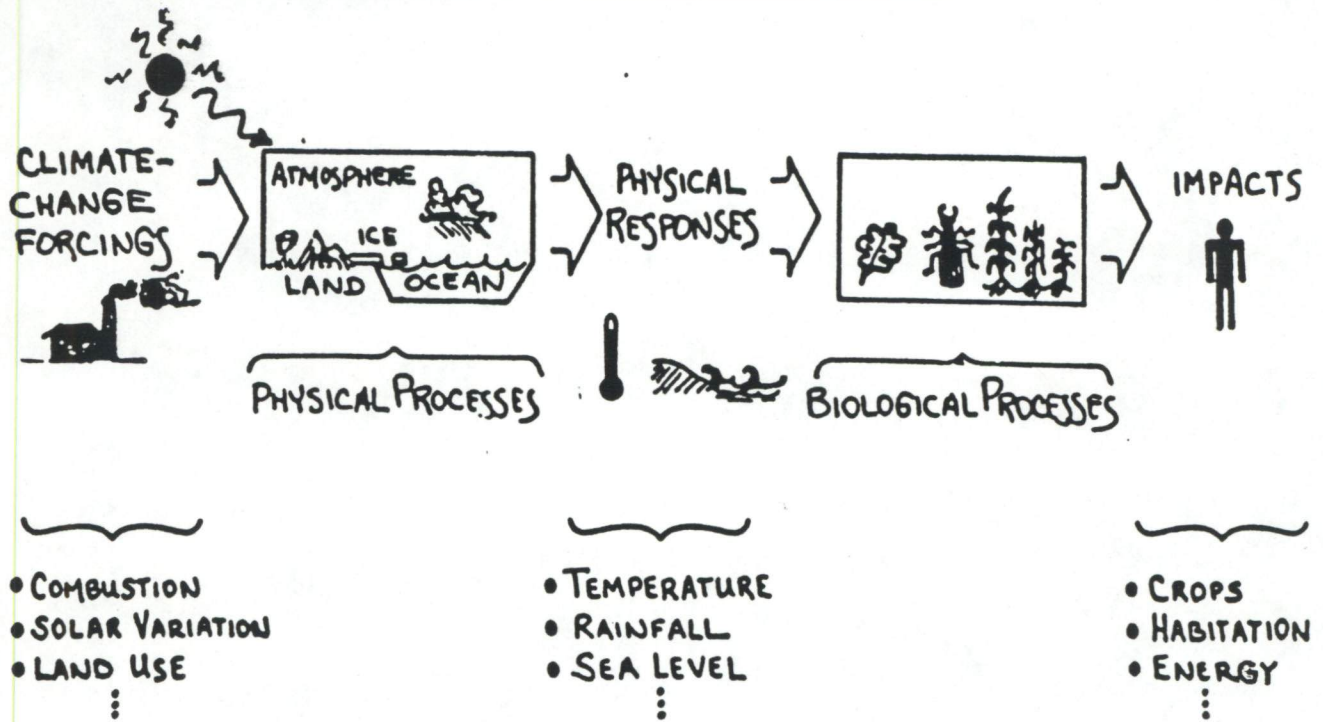
- o Improving the characterization of the cloud feedback mechanisms, such as observations and theories of cloud processes and radiation.
- o Developing a predictive capability for the growth of the biologically related greenhouse gases, rather than having only the "extrapolative" capability of the present.
- o Characterizing the processes that determine the thermal inertia of the oceans, such as large-scale vertical motions.
- o Improving the quality of, and learning to interpret better, the long-term record of past climate change, which can further develop and test our century-scale models, since we clearly cannot wait for the future centuries of data in order to do so.

Within the United States, these questions are being addressed by the comprehensive Global Change Research Program, which is being designed by the Committee on Earth Sciences, a effectively functioning consortium of Federal earth-sciences Agencies. Expanded research efforts have also by mounted by other countries, for example, the United Kingdom and Australia.

The Underlying Rationale

Improved answers require a better understanding of the basic workings of the ocean/atmosphere climate system, which is a challenging task. Such answers do not come cheap, nor do they all come fast. Nevertheless, the fundamental understanding of natural processes that relate to the well-being of mankind are almost always cost effective. For example, the comparison of the cost of a single Salk/Sabin vaccine for polio to the economic and human costs of a life in an iron lung teaches us what can be achieved when the cause of a thing is truly understood. Regarding our common environment and what it means to us all, it is the price of ignorance that we cannot afford.

● THE CLIMATE SYSTEM & HOMO SAPIENS:



- EXAMPLES:
- MORE CO₂: STIMULATED PLANT GROWTH (BENEFIT)
 - LESS SOIL MOISTURE: RETARDED PLANT GROWTH (HARM)

THE WHITE HOUSE
WASHINGTON

CABINET AFFAIRS STAFFING MEMORANDUM

Date: Feb. 15, 1990 Number: _____ Due By: _____

Subject: Domestic Policy Council Meeting Tuesday, February 20, 1990 from 4:00 to 5:30 PM in the Roosevelt Room (for principals only).

	Action	FYI		Action	FYI
ALL CABINET MEMBERS	<input type="checkbox"/>	<input type="checkbox"/>	CEA	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vice President	<input checked="" type="checkbox"/>	<input type="checkbox"/>	CEQ	<input checked="" type="checkbox"/>	<input type="checkbox"/>
State	<input checked="" type="checkbox"/>	<input type="checkbox"/>	OSTP	<input type="checkbox"/>	<input type="checkbox"/>
Treasury	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
Defense	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
Justice	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
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HHS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Cicconi (For WH Staffing)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
HUD	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
Transportation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
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USTR	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Executive Secretary for:		
Chief of Staff	<input type="checkbox"/>	<input type="checkbox"/>	DPC	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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National Science Foundation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>
SBA	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>

REMARKS: The Domestic Policy Council will meet on Tuesday, Feb. 20, 1990 from 4:00 to 5:30 PM in the Roosevelt Room to discuss the attached paper on the Administration's Literacy Strategy. In addition, a brief update will be given on the math/science initiative (summary paper attached). Please note that the attached papers on the Administration's Literacy Strategy and the Administration's Activities for Math and Science Education are sensitive in nature and should be treated as close hold documents. Please refrain from copying.

RETURN TO: Please inform Honor willson (456-2800) by COB, Friday, Feb. 16 as to whether or not you plan to attend this meeting.

David Q. Bates
Cabinet Secretary
456-2174
(1st Floor, West Wing)

Associate Director
Office of Cabinet Affairs
456-2800
(Room 235, OEOB)

THE WHITE HOUSE
WASHINGTON

February 15, 1990

MEMORANDUM FOR THE DOMESTIC POLICY COUNCIL

FROM: KENNETH P. YALE *KY*
Executive Secretary

SUBJECT: Meeting of the Domestic Policy Council, Tuesday,
February 20, 1990, 4:00 P.M. in the Roosevelt Room

The Domestic Policy Council will hold a meeting, for principals only, on Tuesday, February 20, 1990 from 4:00 to 5:30 P.M. in the Roosevelt Room. This meeting was originally scheduled for February 1, but was postponed.

The topic for discussion will be the Administration's Literacy Strategy. Education Secretary Cavazos will give the presentation. The Department of Energy will give a brief update on the Administration's math/science initiative.

Attached for your review prior to the meeting are: 1) an agenda; 2) a revised options paper on the Administration's literacy strategy; and 3) a summary paper entitled The Bush Administration's Commitment to Science and Mathematics Education. Note that the options section (beginning on page 9) of the literacy strategy paper has been changed from the version distributed to you on January 30 and should be reviewed before the February 20 meeting.

Please note also that the papers are sensitive in nature and should be treated as close hold documents. Please refrain from making additional copies.

Please inform Honor Willson (456-2800) by C.O.B. Friday, February 16, as to whether or not you plan to attend this meeting.

Attachments

THE WHITE HOUSE
WASHINGTON

DOMESTIC POLICY COUNCIL

Tuesday, February 20, 1990

4:00 P.M.

The Roosevelt Room

AGENDA

1. The Administration's Literacy Strategy
2. Math/Science Initiative Update

DRAFT

CLOSE HOLD

February 15, 1990

THE BUSH ADMINISTRATION'S COMMITMENT TO SCIENCE AND MATHEMATICS EDUCATION

NATIONAL EDUCATION GOAL IN SCIENCE AND MATHEMATICS EDUCATION

In this State of the Union Address, President Bush announced six national education goals, including one related to science and mathematics education: "By the year 2000, U.S. students will be first in the world in science and mathematics achievement."

The six goals represent the first phase in realizing commitments made at the President's Education Summit with Governors. They will be extended and adopted by the Nation's governors at the National Governors' Association Winter Meeting on February 25-27, 1990.

Reaching the ambitious goals of being first in science and mathematics education will require the concerted effort of all sectors of society, including the education community, the private sector, the mathematics and scientific communities, all levels of Government, as well as each individual citizen.

The Administration will work with appropriate agencies and organizations to ensure that appropriate and constructive measurements are developed to track progress. The President has requested a 50% increase in the Department of Education's statistics budget.

THE DEPARTMENT OF ENERGY INITIATIVE

The Department of Energy (DOE) has launched an agency-wide initiative to expand the use of its unique scientific facilities and personnel to help make American students the best in the world in mathematics and science. The Secretary of Energy's prototype utilizes partnerships and expert outreach to improve student and teacher knowledge, and provides a model that other Federal agencies with scientific laboratories, equipment, and expertise can replicate.

Specifically, the Secretary has directed the National Laboratories and other DOE scientific facilities programs to:

- o Clarify their mission to identify education as a fundamental part of their activities.

- o Open their doors to provide access to hands-on science experiences to students and teachers in surrounding communities.
- o Broaden their educational programs or initiate additional ones to encompass the elementary and middle grades, to reach "average" students, and to increase participation by minority and female students.
- o Collaborate with businesses, school districts, universities, museums, public libraries, community groups, and other partners to develop or expand education programs.
- o Encourage scientists, engineers, technicians, and other experts to go into their communities and work with students and teachers.

The goals for this initiative parallel those of the Education Summit and focus on the year 2000. The major goals are as follows:

- o Each year 10% of the Nation's mathematics and science teachers will be provided with high-quality teacher enrichment programs in hands-on science in Federal and private sector facilities;
- o In numbers equaling at least 10% of the teaching force, scientists, engineers, and mathematicians will serve as volunteer expert teaching partners, bringing cutting-edge science into the classroom; and
- o In 10% of the Nation's school districts, science alliances will be established, over the next 24 months, that include partners from the Federal government and the education and business communities.

Attaining these goals will require the involvement of all Federal agencies with mathematical and scientific facilities and expertise. Toward this end, the Department of Energy is compiling a list of existing Federal mathematics and science education programs and gathering information about the capacity of these programs to serve more teachers and students. In addition, Secretary Watkins has contacted chief executive officers of 10,000 corporations and is compiling similar information on private sector programs.

EXAMPLES OF OTHER COMMITMENTS IN THE FY91 BUDGET

The Bush Administration's commitment to strengthening science and mathematics education in elementary, secondary, and post-secondary education already extends across many Cabinet Departments and agencies.

The President's request for the FY1991 budget proposes over \$1 billion in direct spending on science, mathematics, and engineering education by Energy, Education, the National Science Foundation, the National Aeronautical and Space Administration, and the National Institutes of Health, an overall increase of more than 27 percent above 1990.

Investing in Science, Mathematics, and Engineering Education
(in millions of dollars)

Department or Agency	Budget Authority			
	1990 Enacted	1991 Proposed	Dollar Change	Percent Change
NSF	\$ 357	\$ 463	+106	+39
Dept. of Ed.	180	292	+112	+62
NASA	42	51	+8	+21
Energy	17	25	+8	+47
NIH	287	292	+5	+2
	<u>\$ 883</u>	<u>\$1,123</u>	<u>+239</u>	<u>+27</u>

- o The President has proposed the **National Science Scholars** program in the "Educational Excellence Act of 1989," originally sent to Congress last year. The program would provide scholarships of up to \$10,000 each year for four years to talented high school seniors interested in pursuing a degree in science, mathematics or engineering at the institution of their choice.
- o **The Department of Education - \$292 million (up 62%).** The President has requested a 70 percent increase in the **Dwight D. Eisenhower Mathematics and Science Education programs**, from \$136 to \$230 million, for elementary and secondary programs that provide grants to states to enhance the abilities of math and science teachers.

Department programs such as the **National Research and Development Centers for Science and Mathematics**, **Science Improvement Programs** for minorities, and others develop and implement improved programs for teaching science and mathematics.

Often overlooked is that an estimated \$1.5 billion of the \$4.0 billion Chapter 1 budget goes to improve mathematics education for the disadvantaged.

- o **Department of Energy - \$25 million (up 47%).** The Department supports a variety of internships, research opportunities, and semester programs in state-of-the-art laboratories for secondary and post-secondary students.
- o **National Science Foundation math and science education programs - \$463 million (up 28%).** NSF will provide increased support of programs designed to improve education and human resources for science and engineering. NSF will expand the focus of precollege math and science programs on teacher preparation and enhancement, instructional materials development, educational technologies, the young scholars program, informal science education, and a new initiative (a systemic statewide math and science education activity).

In addition, funds will support an increased number of the NSF sponsored **Career Access Centers** that serve to enhance the participation of minorities in mathematics, science, and engineering education at both the precollege and undergraduate levels.

At the undergraduate level, the NSF supports research experiences for undergraduate students. NSF has initiated a program to support a major revision of courses and curricula in all fields of science, engineering and mathematics. NSF also provides support for laboratory improvements at all types of institutions and continues efforts to double the number of NSF graduate fellowships in science and engineering.

- o **National Aeronautics and Space Administration - \$51 million (up 21%).** NASA's activities include presentations and workshops around the country, grants for undergraduate and graduate student research, and special efforts to ensure minority participation in science and engineering education.

In particular, "**Scientific Literacy for the 21st Century**" informs and involves students, teachers, universities, and the general public in space education. Teacher internships, scholarships, space science competitions, private sector partnerships, and pilot teacher programs with education colleges are included.

NASA's new space grant college and fellowship program will expand the network of postsecondary institutions and industrial partnerships involved in space education, research, and training.

- o National Institutes of Health - \$292 million (up 2%). NIH will support 12,000 graduate trainees in research laboratories throughout the nation in FY91.

OTHER PROGRAMS

Other programs exist in the Departments of Agriculture, Commerce, and Interior, Defense, as well as the Environmental Protection Agency and others.

For instance, the Department of Defense sponsors a number of precollege programs, the largest of which provides high school students with research-related work experiences in DOD laboratories through a DOD cooperative education program. Universities receive DOD research and development grants to support some 8,000 graduate assistants and about 660 fellows.

Recognizing the need to attract more minorities into the field, the Army, Navy, and Air Force have expanded a long tradition of support for research activities, scholarships, and assistantships at Historically Black Colleges and Universities as well as other minority institutions.

The Smithsonian Institution and the National Academy of Sciences have established the National Science Resources Center to improve the teaching of science and mathematics in the nation's schools. The NSRC is developing and disseminating resources materials for science and mathematics teachers, maintaining a curriculum database, and offering teachers, school administrators, and scientists a program of outreach and leadership development activities.

FEDERAL COORDINATION

The Domestic Policy Council Working Group on Education Policy is working to provide coordination across agencies.

The President's Science Advisor chairs the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) which, through its committees, provides the policy-making bodies of the Administration with accurate, timely, objective information on Federal science and technology.

The FCCSET Committee on Education and Human Resources will focus on mathematics, science, engineering, and technology education and the development of a scientific and technological workforce.

The President recently announced the President's Council of Advisors on Science and Technology (PCAST). PCAST and its ad hoc panels of private sector executives, researchers, and academics provide science and technology advice for the President.

All data coming tomorrow.

MATHEMATICS/SCIENCE/ENGINEERING PROGRAMS:
RESPONSES TO AGENCY SURVEY

<u>Agency</u>	<u>Number of Programs</u>	<u>Facilities Usable As Education Sites</u>
AGRICULTURE	7	122; list submitted
COMMERCE	19	50+ labs; list submitted
DEFENSE	(not provided)	(not provided) <i>will be provided</i>
EDUCATION	4 *	N.A.
ENERGY	32	35+ labs/facilities; list submitted
EPA	8	18+
HHS	27	20+
HUD	0	N.A. (telephone response)
INTERIOR	32	Several mentioned in text
JUSTICE	3	2
LABOR	7	0
NASA	20	9; list submitted
NSF	16**	23+
VETERANS	(see memorandum submitted)	

* ED's Intra-Agency Task Force on Math and Science Education will provide program list in near future.

** In addition, NSF has teacher enhancement programs supporting 13,000 teachers, located at 260 institutions.

All responding agencies reporting having programs targeted at the full education range, i.e., K-12, college, graduate, post-graduate, and teacher training. In addition, many had community or public outreach programs.

2/6/90

CLOSE HOLD

February 15, 1990

*DE estimates
~27 million
illiterate.*

MEMORANDUM FOR THE DOMESTIC POLICY COUNCIL

FROM: LAURO F. CAVAZOS, CHAIRMAN
WORKING GROUP ON EDUCATION

SUBJECT: Strategy for Adult Literacy Policy: Background,
Issues and Options for the Bush Administration

SUMMARY:

This paper responds to the charge from the Domestic Policy Council to the Working Group on Education Policy to develop a national strategy to increase the literacy rate. The paper provides a framework for a literacy strategy. Two steps are focused on the short term: (1) emphasizing current Presidential involvement, especially the "good news" in the FY91 budget for literacy programs; and (2) selecting a legislative strategy to address congressional proposals.

In addition, the DPC may wish to consider five other options in the short term, including: (1) directing the cabinet to develop plans, (2) establishing a private sector workplace initiative, (3) expanding research and practice assistance, (4) creating a national commission, and (5) increasing support for teacher training. Other long-term policy recommendations could be considered by a task force on literacy of the DPC.

INTRODUCTION:

The level of adult functional illiteracy in the U.S. poses serious economic, social and educational issues. In recognition of the problem, efforts have spread nationally to improve the basic skills of adults. Options to address the literacy problem must consider these efforts and their limitations. Generally, there is a need to develop a strategy to fulfill the President's goals, to increase the emphasis on workforce literacy, to enhance coordination of existing programs, and to improve the state of knowledge about effective programs. Steps are already underway to assess the extent of the literacy problem, to define literacy, to encourage school reform, to identify the extent of existing federal programs and to extend their reach.

ISSUES:

Available evidence makes clear that the nation faces a serious educational problem with an economic impact. Increasing demands in the workplace and decreasing educational success in schools have added to literacy problems that also result from immigration and learning disabilities. The issues that should frame a literacy strategy are listed below.

(1) Identifying the Problem

Analysts disagree over the extent and even the definition of literacy. Estimates of the number of functionally illiterate adults in the United States range roughly between 20 and 30 million people, or 13 - 20 percent of the adult population.

(2) Problems of the Schools

Many schools seem unable to impart the basic skills, including basic reading, writing and complex information processing, that allow children to become successful adults in the modern economy. Illiteracy and related social problems grow each year as children leave school functionally illiterate. Improving elementary and secondary education is essential to addressing the literacy issue.

Adult illiteracy endangers school reform itself. Research has documented that education levels tend to be linked inter-generationally. Children of parents with low skills are at far greater risk of failing to achieve in school, compounding the educational and economic cost in the future.

(3) The Increasing Demand for Skills in the Workplace

School reform comes too late, however, to improve the basic skills and productivity of those who are already adults. Two-thirds of those who will make up the U.S. labor force in the year 2000 are already working.

In an historical context, literacy problems in America are not new. One scholar estimated in 1933 that 20 percent of Americans could not read newspapers.

One crucial difference today is that the necessary literacy level is rising, especially in the workplace. The relative proportion of low-skill jobs is declining as new employment opportunities increasingly demand higher skills.

(4) Shortcomings of Existing Efforts to Improve Adult Literacy

A number of vital programs now exist to train and to educate adults generally and to improve literacy specifically. Sponsors of literacy programs represent almost every element of society. Businesses, foundations, libraries, the media, thousands of volunteers, schools, colleges, community-based organizations, and local, state and federal agencies support or provide adult literacy services. The United Nations has declared 1990 to be "International Literacy Year." Despite their considerable merits, existing efforts suffer from shortcomings, particularly the lack of: (a) leadership and direction, (b) awareness of the reach of existing activities, (c) coordination and (d) knowledge about effective practices.

(4a) Steps to Provide National Leadership and Direction

The President is taking steps to provide national leadership and direction by establishing a national goal for literacy. Now, a strategy for achieving it is necessary, including ascertaining the role of the private and voluntary sectors, and the importance of basic skills literacy as opposed to functional literacy or workplace literacy.

(4b) The Reach of Existing Activities

The current literacy effort does not reach most of the estimated number of functionally illiterate adults. The degree to which it falls short is unclear, however, as there is no plain picture of the full scope of federal or private sector efforts.

(4c) Poor Coordination of Existing Programs

Adult literacy services are fragmented among local, state and federal governmental levels, as well as among industry and voluntary sectors. A decentralized service delivery system has significant benefits. However, structures for coordinating service delivery do not appear to be effective.

(4d) Lack of Knowledge about Effective Practices

Efforts suffer from a lack of basic research and knowledge about effective practices. Few professional schools focus on adult literacy. The field requires better measurements of achievement. Information dissemination is difficult, particularly given the delivery system, and voluntary and part-time teaching force.

Most adult teachers were trained as elementary or secondary school teachers and are unfamiliar with methods to teach adults or link curricula and the workplace. The nature of the teaching force increases the need for training.

There is some evidence to suggest that few adult learners persist long enough to make significant gains and that gains often fade considerably soon after departure. There are indications, though, that inter-generational and job-related basic skills programs are effective.

(5) Legislation

Congress is attempting to pass a literacy bill this year. The Simon bill (S. 1310) has been approved 99-0 by the Senate. The Sawyer bill (H.R. 3123) may be marked-up in committee in March. Congressman Goodling, ranking Republican on the House Education and Labor Committee, co-sponsors the Sawyer bill.

Provisions in the bills vary somewhat, though the measures are similar in intent. Titles in one or both bills would create: a Presidential task force, a Cabinet council, an assistant secretary of an Office of Literacy in the Department of Education, an independent national clearinghouse, grants to state clearinghouses, library and workforce demonstration programs, scholarships, requirements for Private Industry Councils, set asides for JTPA, and new Families for Literacy grants, among other provisions (Appendix C). In the first year, the bills would increase total authorizations by \$230m (Simon) or \$460m (Sawyer).

EXISTING EFFORTS TO ADDRESS THE ADULT LITERACY PROBLEM:

Before suggesting a literacy strategy, a review of the range of existing efforts to address the literacy problem may be useful.

Volunteer and Private

About 200,000 volunteers from Laubach Literacy Action, Literacy Volunteers of America, and hundreds of civic, service and church groups provide individual and small-group tutoring. Mrs. Bush has played a major role in inspiring their participation. Businesses and foundations have funded literacy efforts, including the Gannett and MacArthur Foundations. ABC and PBS operate PLUS, a TV campaign to increase literacy awareness.

Some businesses have literacy programs for their employees. One study shows that 36 percent of the Fortune 500 provides remedial basic skills courses. For example, Ford and the United Auto Workers have mounted a joint workplace literacy effort.

Voluntary and private efforts are admirable and essential to fostering literacy. Their efforts would be helped by more information about exemplary methods, more professionalism and coordination, as well as increased participation. Most businesses probably do not provide workplace literacy training. Coordination and technical assistance organizations exist to a limited extent. The Coalition for Literacy loosely organizes some of the national groups, provides some advice and maintains a toll-free hotline to refer callers to local services. There is a national quarterly literacy newsletter for businesses.

State and Local

At least 40 states have mounted literacy initiatives. State and local spending for adult basic and secondary education increased by 127 percent between FY83 and FY88, to \$375 million. It was more than three times greater than federal funding available under the Adult Education Act in FY88.

The best state and local efforts include a cooperative system of referral and recruitment or a coalition of providers. Often, however, services are fragmented. States and localities lack a vehicle to share information about successful practices, though the National Governors' Association has announced its intention to form an information clearinghouse for states.

At the local level, assorted literacy programs have emerged. As an example, in Columbus, Ohio, at least 14 community organizations provide services, ranging from the Cambodian Mutual Assistance Association, to programs for prisoners, mental health clients, and city employees, as well as efforts through libraries and schools, and federal programs. A coalition has begun to help coordinate services and collect data. It estimates that the effort reaches about 10% of the adult population in need.

Federal

Numerous federal programs directly or indirectly promote adult literacy (Appendix A) for the diverse population needing services. There is little clear information to determine what portion of spending goes to basic skills or to what extent the programs are successful. cursory studies of programs have found between 5 and 14 federal agencies operating 10 to 79 programs, spending \$127m to \$348m in FY85 on adult literacy services. There is little coordination among the federal programs.

The Adult Education Act authorizes the only program that provides as its main purpose adult basic skills education to the general public. The largest expenditure (\$157.8 million in FY90, up from \$98m in FY86) was devoted to state grants that served about 3 million people over the past year. Of the population served, about 60 percent are members of a minority group, about 40 percent enroll for English as a Second Language (ESL), and about 20 percent are age 45 or over.

Several programs provide basic skills training for individuals in situations of interest to the federal government, including basic skills training for military recruits and federal prisoners. Programs also provide grants for adult basic education for Native Americans, the homeless and immigrants.

The Even Start program (\$24.2m) combines parent education, including literacy, with education for children aged 1-7. Head Start has funded similar programs on a demonstration basis.

Workplace Literacy Grants (\$19.7m) fund demonstration programs for job-related adult basic skills education. Moreover, a range of major vocational education and job training programs have a basic skills component, though its extent is often indeterminate. The Vocational Education Act, the Job Training Partnership Act (JTPA), the Job Opportunities and Basic Skills Training Program (JOBS) of the Family Support Act, and the Food Stamp Act support or require adult education related to employment.

ADMINISTRATION EFFORTS UNDERWAY:

Steps already undertaken address many of the issues related to the adult literacy problem and provide key elements of the Administration's strategy.

(1) Identifying the Problem

- o The Hawkins-Stafford Elementary and Secondary School Improvement Amendments of 1988 mandated the **National Survey of Adult Literacy**. By 1993, the study could help provide a more precise definition and survey of the problem. The National Center for Education Statistics has contracted with the Educational Testing Service to develop criteria for defining literacy, to generate assessment methods and to conduct a national survey of adult literacy.

(2) Reforming the Schools

- o The President has taken action to encourage school reform and stem the flow of unprepared young adults into the potential employee pool. In March, he submitted to Congress the **Educational Excellence Act of 1989**. The Act would fund grants for merit and magnet schools and provide for alternative teacher and principal certification, among other provisions.
- o On September 27th, the President convened the **Education Summit** with Governors which opened a new era for debate and progress toward school reform. One of the six working groups at the Summit specifically considered adult workforce literacy and competitiveness. In addition, the working groups on the learning environment and post-secondary education included issues related to life-long learning, early childhood education, and remedial education. Of the goals stated as examples in the joint statement concluding the summit, one goal specifically considers the functional literacy of adults.
- o Secretary Cavazos conducted a series of five **Regional Strategy Meetings on Choice in Education** during October and November to promote school choice.
- o Secretary Watkins is developing a plan to use federal facilities to provide training for math and science teachers resulting from the **Math/Science Education Action Conference**.

(3) Skills in the Workplace

- o Secretary Dole has announced a **seven-point "Agenda for Action"** to improve workplace skills.

(4a) Steps to Provide Leadership and Direction

- o The **Working Group on Education Policy** was formed on June 1, 1989, and charged with developing a national literacy strategy.
- o A **national goal for adult literacy** will give the nation a target for its efforts.

(4b) The Reach of Existing Efforts

- o The congressionally-mandated **Joint Study of Adult Education**, conducted by Labor, HHS and Education, will inventory federal adult education resources by the end of April, 1990.

- o The FY91 President's request for Education asks to increase the federal commitment to Adult Education state programs by 27% and increase funding for Even Start by 98%. Education will fund fully the Literacy training for Homeless adults program (up 35%). In total, the FY91 request asks for a 33% increase for adult literacy over FY90 appropriations.
- o The FY91 President's request for ACTION doubles funding for the ACTION Literacy Corps (for budget items see Appendix B).

(4c) Coordinating Existing Programs

- o On September 15, 1989, Health and Human Services, Labor and Education agreed to develop jointly a **Management by Objective** initiative on literacy for each agency at the request of the Office of Management and Budget.
- o The same departments also agreed to **coordinate technical assistance activities related to the JOBS** program through an interagency agreement signed on November 8, 1989.

(4d) Knowledge about Effective Practices

- o Education will fund a **small national research center** on adult literacy in FY91. The Department of Labor has agreed in principle to join in funding the center.
- o The FY91 President's request includes a **National Clearinghouse on Adult Education** to improve the dissemination of information about effective practices.

(5) Legislation

- o The Administration **opposed the Simon bill**, noting that it would be unjustifiably duplicative and expensive as well as an intrusion on executive prerogative.

STEPS TO HIGHLIGHT ADMINISTRATION EFFORTS:

Administration efforts underway address each of the issues related to the literacy problem. Additional steps are necessary to give impetus to the existing strategy, particularly drawing attention to the priority of literacy for the President and contending with legislation. These steps, some of which are underway already, are presented here for the consideration and approval of the DPC.

STEP 1 -- Draw attention to the priority of literacy in the Administration's education strategy and make clear efforts underway. Draw public and congressional attention toward ongoing Administration efforts, including the literacy goal, increases for literacy-related activities in the FY91 budget, the place of literacy in the Points of Light Foundation, and any other items adopted by the President from the DPC's recommendations. The Administration also needs to call on:

(1) business and labor communities to establish plans to address the literacy needs of the workforce;

(2) the media and volunteer sectors to continue to use their resources to address the literacy problem; and

(3) the Cabinet to determine how their programs and services can help achieve the literacy goal.

The DPC will create a Task Force on Literacy of the Working Group on Education Policy to consider proposals for the federal government, business and labor. It will review findings of the Joint Study of Adult Education and seek input from bodies such as the President's Educational Advisory Committee, Points of Light Foundation, Mrs. Dole's Commission on Achieving Necessary Skills and the Commission on the Skills of the American Workforce.

STEP 2 -- The White House and the Departments of Education and Labor will develop and implement immediately a closely coordinated legislative strategy to determine provisions of the Sawyer bill that can be supported and areas where compromise and modification are necessary (see Appendix D).

The Simon bill (S. 1310) was approved 99-0 by the Senate. Representative Goodling has expressed willingness to work with the Administration to produce a House bill the President can support. He shares Administration concerns on a number of key provisions and recognizes efforts in the FY91 budget including the national clearinghouse and increases in Even Start, Adult Education and Head Start. Should an acceptable bill pass the House, the Administration will continue to work to enact responsible legislation in conference. The House committee is not expected to report out the literacy bill until sometime in March. By that time, short-term strategies could be underway.

SHORT-TERM OPTIONS TO EXPAND THE ADMINISTRATION'S EFFORTS:

In the short-term, options are available to direct Cabinet involvement, promote workplace basic skills, expand research and technical assistance, establish a commission, and promote teacher training. The options are distinct, but not mutually exclusive.

OPTION 1 -- Issue a Presidential memorandum directing Cabinet members to develop specific plans detailing how their programs and services can promote literacy. The memorandum (draft attached as Appendix E) would direct each Cabinet official: (1) to develop plans to assure federal employees are literate, skilled workers; (2) to review federal programs that provide literacy and other basic skills services to citizens, working toward compatibility of goals and outcomes; (3) to set as a high priority the replication of family literacy programs aimed at overcoming inter-generational literacy problems. Plans would be submitted to the President through the DPC.

Pros:

- o Builds upon MBO on literacy and the Joint Study of Adult Education.
- o The first comprehensive effort to direct basic skills programs toward compatibility and a common goal.
- o Employee literacy programs would demonstrate federal commitment to workforce literacy.

Cons:

- o Plans could be viewed as paper exercise if not implemented.
- o Unclear if every department could contribute to replicating such models.

_____ Approve _____ Disapprove

OPTION 2 -- Establish a Workplace Literacy Assistance Collaborative to help small and medium sized businesses, business associations and labor organizations. This business-led program would help businesses conduct workplace literacy audits, assess individual worker literacy needs, and implement new or upgraded literacy and basic skills programs. The Collaborative would include a governing board with representatives of the business and labor communities, service providers, SBA and the Departments of Commerce, Education and Labor. Funding would extend for three to four years at \$10 million per year beginning in FY92. The Collaborative would be independent but maintain an affiliation with any federally-funded national research center. Planning and start up could begin in 1990 and 1991.

Pros:

- o Recognizes and mobilizes business and labor as essential partners in addressing the literacy problem.

- o Strengthens links of business and labor to existing education, job training and business assistance programs.
- o Focuses assistance on firms and unions with few resources for workplace literacy programs that provide the majority of entry-level jobs filled by the least educated workers.

Cons:

- o Cost as much as \$10 million per year in new appropriations.
- o Could be viewed as shifting to business a major part of the burden for addressing the literacy problem.

_____ Approve _____ Disapprove

OPTION 3 -- Establish a National Literacy Center for Research and Practice funded jointly by the Departments of Education, Labor, Health and Human Services, Defense and Commerce. The Center would be funded by the five departments from existing resources at \$10 million a year in total. Education and Labor have planned to fund a small research center on adult literacy. Other agencies would support this effort to expand its capabilities and broaden the scope of its research. The Center would provide technical assistance in teaching and volunteer training, compile and disseminate information about best practices, and serve as a focal point for coordinating federal research efforts. (NOTE: Education is budgeting \$5 million for an adult education clearinghouse that could be joined with this effort.)

Pros:

- o Provides an opportunity for federal departments to collaborate on the development of a coherent literacy research agenda.
- o Fosters cost-effective sharing of information among federal agencies, business, labor and volunteer organizations.

Cons:

- o Establishes another literacy-focused organization.

_____ Approve _____ Disapprove

OPTION 4 -- Create a President's National Literacy Advisory Commission. Members would be broadly representative of Governors, Mayors, business, labor, education, and volunteer programs that provide adult education and literacy services. The Commission would recommend a strategy to achieve the national literacy goal. In addition, the Commission would serve as a forum for discussion of the literacy needs of the nation, share information between public, private, and non-profit provider groups, and encourage national cooperation.

Pros:

- o Creates focal point to organize providers and encourage private sector involvement.
- o Offers an opportunity to develop a strategy in response to the literacy goal.
- o Preempts call for Congressional/Presidential task force as included in the Sawyer bill.

Cons:

- o Could confuse the process with Governors and interfere with the President's Education Policy Advisory Committee.
- o Historically, federal advisory commissions have not been productive. The National Advisory Council on Adult Education was eliminated one year ago for that reason.
- o Might produce unrealistic recommendations for major new expenditures.

_____ Approve _____ Disapprove

OPTION 5 -- Increase support for training teachers who teach adults. Funds could be provided through the Adult Education Act (AEA) for inservice training, professional development and upgrading qualifications for adult education teachers, including volunteers. Approaches available include, (1) expanding the existing set-aside in the AEA for teacher training, and (2) creating a new grant program in the AEA (with new funding of approximately \$20 million).

Pros:

- o Addresses issue of teacher preparation and qualifications - a critical need of the delivery system.
- o Enhances effectiveness of teaching especially by giving volunteers professional guidance and direction.

Cons:

- o Volunteer sector organizations might view it as devaluing volunteer teachers and tutors.
- o Could create new demands from adult education teachers that could be more costly.
- o Would either create a new program or divert funds from existing activities.

_____ Approve _____ Disapprove

TOPICS FOR CONSIDERATION IN THE LONGER TERM:

It would be premature to adopt policies involving more far-reaching changes in federal programs before Cabinet officials respond to any directive and the Joint Study of Adult Education. In light of those events, the Working Group on Education Policy, and its Task Force on Literacy if created, will investigate policy ideas and report again to the DPC with recommendations.

Among the policy ideas that the group will consider:

- o any directives received from the President and the DPC;
- o targeting funds under the Adult Education Act more directly on undereducated adults, using criteria focused on the most economically and educationally disadvantaged (in coordination with efforts of the Low-Income Opportunity Board);
- o increasing accountability of adult education programs;
- o providing for continuing assessment of adult literacy nationally and state by state;
- o exploring ways to promote literacy for people with disabilities and immigrants;
- o promoting math and science literacy;
- o improving coordination of federal programs at the state and local levels;
- o improving the learner recruitment and referral system, including outreach activities;
- o increasing literacy and basic skills training for federal prison inmates.

APPENDIX A

Estimates of the combined federal effort to promote adult literacy vary considerably. An overview is presented in the table below.

Many of the programs listed in the overview table were suggested by the 1986 Literacy Management Information Project Report (LMIPR). Other federal programs relevant to literacy were added to the list by the members of the Working Group on Education Policy.

The LMIPR report distinguished three types of programs. Primary programs explicitly included literacy as a priority objective in authorizing legislation. In secondary programs, literacy was approved in authorizing legislation to support the primary objective of the program. Indirect programs have no explicit legislative mandate for literacy activities, but they could result from a policy decision. The programs presented below are categorized according to the original LMIPR study.

Note that the LMIPR study was extremely controversial due to the treatment of secondary and indirect programs, especially what portion of expenditures if any should be considered as part of the federal literacy effort.

PLEASE BE AWARE THAT SECONDARY AND INDIRECT AMOUNTS ARE TOTAL PROGRAM DOLLARS AND SHOULD NOT BE CONSIDERED AS SPENDING ON LITERACY SPECIFICALLY.

AGRICULTURE:

Indirect:

Food Stamp Prog: Employment & Training	126.1
Cooperative Extension Service	(1)

DEFENSE:

Secondary:

Basic Skills - Army	5.1
Skill Enhancement - Navy	2.5

EDUCATION:

Primary:

Adult Education - State Grants OVAE	136.3
Indian Education - Adult Ed. OESE	4.0
Library Literacy Prog. LSCA IV OERI	4.7
Workplace Literacy Partnerships	11.9
English Literacy Grants	4.9
Adult Education for the Homeless	7.1
National Programs	2.0
Even Start	14.8
Student Literacy Corps OPE	4.9
Family English Literacy OBEMLA	4.7

Secondary:

Bilingual Education OBEMLA	192.7
Chapter 1	4,555.0
Public Library Srv. LSCA St.I OERI	81.0
Library Training and Demonstr. OERI	.7
Special Services for Disadvant. OPE	219.3
Vocational Ed.- Basic Grants OVAE	825.6
Vocational Ed.-Cons.& Homemaker OVAE	33.1
Vocational Ed.-CBOs OVAE	8.9
Bilingual Vocational Training OVAE	3.8
Post-Sec.Ed. for Handicapped OSERS	5.8
Centers for Independent Living OSERS	26.0
Nat. Inst. of Handicapped Res. OSERS	53.5
Secondary Ed. for Handic.Youth OSERS	7.3
Library Srv. Indians & Hawaiian Nat.	1.6
LSCA IV OERI	
Comprehens.Srv. for Indep.Liv. OSERS	12.7

PLEASE BE AWARE
THAT SECONDARY
AND INDIRECT
AMOUNTS ARE
TOTAL PROGRAM
DOLLARS AND
SHOULD NOT BE
CONSIDERED AS
SPENDING ON
LITERACY
SPECIFICALLY.

NOTE: 1. Agriculture estimates less than \$1m goes to literacy under this program. Total expenditure is \$361.6m.

FY89
(in \$ millions)

Indirect (Education):		PLEASE BE AWARE
Handicapped Innovation and Dev.OSERS	17.0	THAT SECONDARY
National Vocational Education Res.	7.1	AND INDIRECT
Fund for Innovation in Education	6.8	AMOUNTS ARE
FIPSE	11.9	TOTAL PROGRAM
College Work Study	610.1	DOLLARS AND
Interlibrary Cooperation	19.1	SHOULD NOT BE
National Diffusion Network	11.1	CONSIDERED AS
Vocational Ed.-Indian & Hawaiian	13.0	SPENDING ON
Rehab.Services - Service Projects	48.3	LITERACY
		SPECIFICALLY.

HHS:

Secondary:		
Admin. on Dev. Disabil. - Basic Grt.	59.8	
Work Incentive Program	91.4	
Refugee and Entrant Asst.-State Prog	367.5	
Refuge Asst.-Volunteer Agency Prog.	15.8	
Job Opps.& Basic Skills Tr.	-	(2)
Independent Living	45.0	

Indirect:

Native American Progs - Fin.Asst.Grt	30.0
Social Services Block Grant	2,700.0
Special Programs for Aging - III	276.6
Clinical Res. - Neuro/Com. Disorders	134.4
Biological Basic Res.- Neuro/Com.	255.2
Special Programs for the Aging - IV	318.6
Community Services Block Grant	381.0
Head Start	1,235.0
State Legalization Impact Grants	900.0

HUD:

Secondary:	
Community Dev. BG-Entitlement Gr.CPD	1,972.0
Community Dev. BG-Small Cities CPD	845.0

INTERIOR:

Secondary:	
BIA Adult Education BIA	3.1
Solo Parent Program	.1

NOTE: 2. The JOBS program was not yet operating in FY89

Indirect (Interior):
Adult Vocational Training

20.1	PLEASE BE AWARE THAT SECONDARY AND INDIRECT AMOUNTS ARE TOTAL PROGRAM DOLLARS AND SHOULD NOT BE CONSIDERED AS SPENDING ON LITERACY SPECIFICALLY.
1.9	
.8	
2.1	
5.4	
.0	(3)
2.4	

JUSTICE:

Primary:
Training NIC
Policy & Program, Dev., Res., Eval. NIC
Technical Assistance NIC

Secondary:
Adult Basic Education FBP
Cuban & Haitian Resettlement CRS
Law Related Education program

LABOR:

Secondary:
Job Corps JTPA IV-A ETA
Emp. & Train. Asst-Dislocated Wkrs ETA
(JTPA III)
Training Srv. for Disadv. JTPA IIA ETA
Job Training for the Homeless

Indirect:
Research, Eval. Pilot & Dem. Prog:
Workplace literacy, JTPA IV

VETERANS:

Secondary:
Veterans Ed. Assistance (GI Bill) VB
Post-Vietnam Vets Ed. Asst.

Indirect:
Vocational Rehab. for Disabled Vets.
Dependents Educational Assistance
Voc. Train. for Vets. Receiving Pensions

ACTION:

Primary:
Literacy Corps

Secondary:
Retired Senior Volunteer Program
Volunteers in Service to America
Mini-Grant Program
Volunteer Demonstration Program

NOTE: 3. \$42,000 in FY89.

APPENDIX B

MAJOR PROGRAM SUMMARIES
(dollars in millions)

Department of Education

Adult Education:

	1989 <u>Actual</u>	1990 <u>Enacted</u>	1991 <u>G-R-H Base</u>	1991 <u>Proposed</u>
BA.....	162	193	201	239
O.....	122	137	186	190

- o This is the largest Federal program focused directly on adult literacy.
- o Most funds are distributed to States in formula grants for local programs providing basic education services to adults who lack a high school diploma. At least 80 percent of the funds must be used for adults who have basic educational skills below the eighth grade level; the remaining funds may be used for programs to help adults obtain a high school equivalency certificate.
- o For 1991, the Budget provides \$239 million, an increase of \$46 million, 24 percent above 1990, as part of the Administration's strategy to combat illiteracy.
- o \$5 million of the increase will be used to launch a National Clearinghouse on Adult Education. The Clearinghouse will provide leadership and direct support for research and development, identification and dissemination of effective practices, and technical assistance to States and localities and the private and volunteer sectors to improve adult literacy and basic education skills.
- o \$20 million of the total will be available for Workplace literacy programs.
- o For Literacy training for Homeless adults, the total includes \$10 million, the full authorization under the McKinney Act, for literacy services in homeless shelters.
- o For English Literacy grants, the total includes \$1 million, a reduction of \$4.8 million below the 1990 level for this small, redundant activity. Funds requested will be used for carefully designed demonstrations designed to learn how better to provide literacy services to adults who have limited proficiency in English.
- o ACTION Literacy Corps funding was doubled from \$3 to \$6 million in the President's request for ACTION.

Comparison of Literacy BillsS. 1310 (Simon)H.R. 3123 (Sawyer)Administration PositionDefinition

Defines literacy as the skills necessary to function at the 8th-grade level.

Defines literacy and basic skills as the level of attainment needed to meet individual goals.

Support a functional definition because it reflects current research on literacy.

Joint Task Force

No provision.

Creates 6-month task force to evaluate literacy programs and set national goals.

Oppose. Impinges on Executive prerogative and would achieve little.

Cabinet Council

Creates inter-agency council to coordinate Federal efforts and develop model systems.

Creates council to set policies and administer programs.

Oppose as infringement on Executive prerogative. Cabinet councils should not administer programs.

Office on Literacy

Authorizes Assistant Secretary for OVAE to coordinate ED literacy programs.

Creates Assistant Secretary for Adult Literacy position to coordinate all literacy programs.

Support S. 1310 formulation.

National Center

Authorizes \$10 million national center for research, technical assistance, policy analysis, etc.

Authorizes \$30 million national center for research, technical assistance, policy analysis. Governed by Board of Directors.

Funding for a national clearinghouse is included in the FY 91 budget. Clearinghouse might be expanded to include additional functions, but should be administered by ED. Planned OERI research center might also be consolidated.

State Resource Centers

Authorizes discretionary grants to States for centers to facilitate cooperation and development of innovative programs. Authorization = \$15 million.

Authorizes Cabinet Council to make formula grants for network of State or regional centers that would facilitate coordination, improvement, and experimentation. Authorization = \$32.5 million.

Support authorization for regional centers to assist local service providers with evaluations and accountability for results.

State Coordination

Makes minor changes in structure and functions of (optional) State advisory councils currently authorized by AEA Section 332.

Requires States to create State advisory boards. Requires Governor to submit 4-year plan and annual report to the Cabinet Council.

Oppose H.R. 3123 provisions because they duplicate the planning, reporting, and coordination requirements under the existing Adult Education Act.

Amendments to Current Adult Education Programs

No provision.

Requires States to maintain their 1989 split between ESL programs and other programs.

Oppose. Requirement is arbitrary and would not be sensitive to changing State needs.

No provision.

Revises Federal-to-State formula to allocate 50% of new funds on the basis of LEP counts

Oppose. Would penalize States that have major need for services but low numbers of LEP adults.

Increases, after a funding threshold is met, demonstration projects and teacher training set-aside from 10% to 15%; 7.5% of this amount would be for teacher training.

Creates a matching grants program for staff training and investment in learning technologies. Authorizes \$10 million Literacy Leader Training program.

Support: (1) an increase in the set-aside from 10% to 15%, with training made the highest priority for expenditures under the set-aside, or (2) creation of a small discretionary program for teacher training.

S. 1310 (Simon)

H.R. 3123 (Sawyer)

Administration Position

Raises cap on funding of GED programs from 20% to 25% of State grant.

Repeals cap on GED funding.

Oppose increase or removal of the cap. Program should continue to focus on the most needy.

No provision.

Requires that 10 percent of State Grant go to community-based organization and volunteer agencies.

Oppose set-aside for CBOs. However, statute could be amended to give CBOs and other nonprofits an equal opportunity to compete for funding within the State.

No provision.

Repeals the maintenance of effort requirement.

Make the MOE requirement consistent with the requirement in Chapter 1.

Families for Literacy

Authorizes a new program to provide intergenerational literacy services to parents and their children age 3 and under.

No provision.

Oppose this authority, which would duplicate Even Start.

Challenge Grants for Training and Technology

No provision.

Authorizes grants to States, made by the Cabinet Council, for staff training and development of learning technologies. States would match the grants with funds from other programs.

Oppose. Authorities would be duplicative of current activities.

Literacy Leader Training Fund

No provision.

Authorizes grants for education and research, to individuals pursuing careers in adult education.

Oppose.

APPENDIX D

Department of Education's Position on Rep. Sawyer's Literacy bill, H.R. 3123

- Definition: Support functional definition of illiteracy.
- Joint Task Force on Coordination: Oppose.
- Cabinet Council on Literacy: Oppose.
- Office on Literacy in ED: Oppose.
- National Center: Oppose an independent center. Support the establishment of a center administered by the Department of Education. Would agree to an advisory board with representatives from the community. Might also recommend that other agencies (DOL/HHS/DOD) jointly administer and support the center. Currently ED plans to fund a small research center through existing budgets, and ED has included \$5 million in its FY'91 budget request for a clearinghouse on adult education, both of which could be merged into a national center.
- State Resource Centers: Support instead regional resource centers to provide technical assistance and service to all literacy providers, coordinated with national research center and clearinghouse. Fund at reduced level.
- State Coordination: Rather than new state councils, recommend the creation of the Human Investment Council, included in JTPA and Vocational Education bills. Also oppose proposed formula directing 50% of new money to ESL programs.
- Teacher Training: Support Simon provision increasing setaside in current law from 10% to 15% for inservice training of teachers of adults. Other option is to agree to new funds (\$20 million?) for a new state grant program for in service teacher training.
- Split of Funds Between Basic Education and English-as-a-Second Language (ESL) programs: Oppose split/setasides. Support flexibility at state level to determine needs.
- Setasides for Community Based Organizations: Oppose.
- Repeal of the Cap on Funds for High School Equivalency Programs: Oppose. Support current language focusing on lower skill levels.
- Workforce Literacy Amendments to JTPA: DOL wants to deal with these issues in the JTPA legislation. If something is needed to satisfy Sawyer, possible amendment to establish the Workplace Literacy Assistance Collaborative at \$10 million subject to Cabinet Council approval.

- New Programs (Matching Grants for Training and Technology; Literacy Leader Training; Literacy Challenge Grants): Oppose.
- Authorizations: Oppose increases in bill. ED budget request \$239 million for Adult Education, an increase of 24%. ED budget request doubled funds for Even Start from \$24 million to \$48 million. \$500 million increase in Head Start and Chapter 1.

APPENDIX E

DRAFT

MEMORANDUM TO: THE HEADS OF EXECUTIVE DEPARTMENTS

ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY
ADMINISTRATOR OF THE NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION
DIRECTOR OF THE OFFICE OF NATIONAL DRUG CONTROL
POLICY
DIRECTOR OF THE OFFICE OF PERSONNEL MANAGEMENT
DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY
POLICY
UNITED STATES TRADE REPRESENTATIVE

SUBJECT: Accomplishing National Literacy Goal

In my State of the Union Address, I established a national goal that "by the year 2000, every adult American will be literate and possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship." I request that you personally commit your agency to three tasks necessary to make this goal a reality.

First, I am charging each of you to determine how your various programs and services will contribute to accomplishment of this national goals. You are to:

- o Review the programs under your direction, look at the literacy needs of people served against the requirements of the goal, and prepare a ten-year plan for implementing an Agency strategy.
- o Identify, in this plan, any administrative, regulatory, and statutory changes that are needed to achieve the goal; establish a process to assess the literacy proficiency of clients against the goal, and assure the provision of services necessary to accomplish the goal.
- o Include support in your Fiscal Year 1992 budgets for those research and technical assistance activities that are essential to carry out your plan.

Second, I believe that the Federal Government should serve as a model employer and demonstrate exemplary workplace literacy and basic skills training practices for its workforce. Therefore, I direct each of you to prepare a specific plan by the end of 1990 on how to improve the literacy and basic skills of your own staffs. The Office of Personnel Management will work with your Agency to establish measurable objectives and timetables, share appropriate curricula, develop a tracking and reporting system, and monitor progress toward accomplishing the objectives.

Third, I am directing the Domestic Policy Council to set up a task force to conduct a review of key Federal programs that provide services to families with literacy and basic skills needs. The purpose of the review is to recommend the removal of barriers to Federal, State, and local coordination of literacy services, specifically to study:

- o Developing uniform literacy-related program definitions;
- o Formulating complementary and consistent goals and performance criteria and outcome measures; and
- o Revising statutes, regulations, and reporting requirements to strengthen coordination.

At a minimum, the task force should include in the review: Even Start, Head Start, Chapter One and Chapter Two of the Elementary and Secondary Education Act, Adult Education Act, Carl D. Perkins Vocational Education Act, Dropout Prevention in Hawkins-Stafford Amendments, Job Training Partnership Act, and Job Opportunities and Basic Skills Program.

It is important that we keep in mind that these strategies are designed to help each individual receiving services under our programs acquire the literacy and basic skills necessary to succeed in the labor market and to exercise their citizenship responsibilities. I look forward to reviewing with you our progress in accomplishing this vitally important national literacy goal.

THE WHITE HOUSE

WASHINGTON

February 20, 1990

DPC Meeting

AGENDA

1. Literacy
2. Math/Science Education

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

February 20, 1990

MEMORANDUM FOR D. ALLAN BROMLEY AND THOMAS RATCHFORD

FROM: Mary Harley Kruter *MHK*

SUBJECT: DPC Meeting on February 20

The purpose of the paper on **science and mathematics education** is to provide the President specific information on his administration's efforts on the national math/science education goal **for possible use at the NGA meetings scheduled to begin later this week.** The paper does serve its purpose; however, it is my opinion that the concept of interagency coordination (FCCSET Committee on Education and Human Resources) should be better highlighted (see page 6). In addition to restating the increases in the budgets of the various agencies, the paper could more powerfully show commitment by emphasizing the **coordination** of resources and activities **to form a more coherent federal strategy** in striving **to achieve the national goal** to be the best in the world in mathematics and science by 2000.

The purpose of the literacy paper is to have DPC approval for a short term strategy to put the Administration in the lead on the adult literacy issue. It is a response to proposed legislation in Congress which may, if passed, give Congress the leadership on the issue which has been a long-term interest of both the President and Mrs. Bush. If asked to choose one of the five options for a short-term strategy, I recommend Option 3 (page 11) because it fosters interagency coordination among those agencies with the greatest stake in the issue and because it has the federal government doing what it can best do in the education arena---conduct research and collect and disseminate information. On page 13 of the literacy paper there is a list of topics to consider for a long term strategy; please note that one of them is to promote math and science literacy.