

CLIMATE
AND
GLOBAL
CHANGE
EDUCATION
PLAN



National
Oceanic and
Atmospheric
Administration

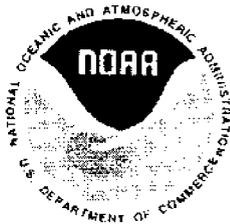


The Earth, for all we know, is a unique planet where a thin blanket of air, a thinner film of water and the thinnest veneer of soil combine to support a web of life of wondrous diversity and continual change. The daily needs of more than five billion people now stress the limits of this naturally regulated system.

The impacts of a changing climate on such a world can be profound. They can be illuminated, in advance, by scientific research and anticipated through broadened public understanding.

NOAA, *Reports to the Nation*
"The Climate System"
Winter 1991, No. 1 (1)

CLIMATE AND GLOBAL CHANGE EDUCATION PLAN



National Oceanic and Atmospheric Administration June 1992

NOAA's mission is to describe and predict changes in the Earth's environment, to manage the nation's coastal resources, and to promote global stewardship of the world's oceans and atmosphere through science and service.

Cover illustration by Peter D. Anderson, Rhode Island Sea Grant Global Change Poster Contest winner, adult category, 1991.

"Caught in the middle of the matrix is our planet Earth. Swirling around the planet are pollutants—one of natural origin, the others caused by human beings. This pollution knows no boundaries; it affects everyone. On top is a simple weather vane. Below is an Upper Atmosphere Research Satellite (UARS), the latest technology to help us understand global environmental change."

—Peter D. Anderson

TABLE OF CONTENTS

1	Preface
2	Background
4	NOAA's Special Capabilities for Climate and Global Change Education
6	Goals
7	Priorities
	Internal
	Intra-agency
	External
	General Public
	Kindergarten through Grade 12
	Postdoctorate
15	Implementation
16	Evaluation
17	Benefits
18	Bibliography
19	Appendix A
20	Appendix B
21	Appendix C

PREFACE

In May 1991, the Office of Global Programs asked the National Oceanic and Atmospheric Administration (NOAA) line offices to send at least one representative to a NOAA-wide workshop to develop a national climate and global change education plan. In addition, several leaders in Sea Grant's climate and global change outreach effort were invited to participate.

Prior to the workshop, representatives were asked to poll others in their offices in order to develop a consensus regarding NOAA's role in climate and global change education and to fill out a questionnaire reflecting those views. Responses were analyzed, compiled, and summarized by the workshop facilitator and included in a pre-conference packet.

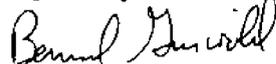
The two-day workshop was held in early June 1991. Participants, under the direction of the workshop facilitator, went through a lengthy process to determine and prioritize those things participants believed should be included in a NOAA national climate and global change education plan. Techniques such as brainstorming, consensus building, and prioritizing were used to clarify goals, set objectives, and develop action plans.

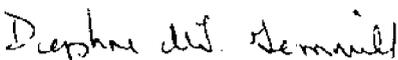
The third day, a writing team composed of representatives from NOAA's National Marine Fisheries Service, National Weather Service, Environmental Research Laboratories, National Sea Grant College Program, and Sea Grant staff from the universities of Hawaii, Louisiana, Mississippi, Rhode Island, and Washington wrote preliminary drafts of separate sections of the plan based on the consensus of the group. These separate sections were then edited and incorporated into an overall first draft and circulated in July to conference participants for review and comment. In October 1991, a second draft was produced incorporating extensive editing refinements and reviewer responses. A third draft was prepared in March and a fourth in June. This document is the final culmination of those efforts.

The project leaders would like to thank Carole Jaworski, Rhode Island Sea Grant Information Office director, for the writing, editing, and design efforts over the past year that served to refine and pull together the disparate elements of this plan into its present unified whole; Lynn Mortensen, workshop facilitator, for helping to make the two-day June 1991 workshop an effective and productive one; and all participants for their time and constructive comments.

Based on committee consensus, the following document represents NOAA's Climate and Global Change Education Plan.

Respectfully submitted, June 17, 1992,


Bernard Griswold, Project Manager
NOAA Climate and Global Change
Education Program, Office of Oceanic
and Atmospheric Research


Daphne Gemmil, Project Officer
NOAA Climate and Global Change
Education Program,
Office of Global Programs

BACKGROUND

Earth has always been a place of change: Over the ages continents have migrated, mountains have been built up and eroded, and variations in world temperature have caused great ice sheets to advance and retreat and sea levels to rise and fall. These changes have occurred slowly over geological time scales of thousands and millions of years, the result of natural forces beyond human control. In the last 100 years, however, humans—one of this planet's newest species—have themselves become powerful agents of environmental change. Collectively, human actions are beginning to have a relatively rapid and profound effect on the planet. (2)

The growing consensus of the world scientific community is that, due to an increase in the amount of "greenhouse" gases pumped into the atmosphere since the Industrial Revolution, the world's temperature may begin to significantly change in the next 50 to 100 years.

There is no doubt that emissions resulting from human activities are substantially increasing the atmospheric concentrations of greenhouse gases, says the 1992 supplemental report of the Intergovernmental Panel on Climate Change (IPCC). "During the last eighteen months there have been a number of important advances in our understanding of greenhouse gases and aerosols. The atmospheric concentrations of the major long-lived greenhouse gases (carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and carbon tetrachloride) continue to increase because of human activities," the report states. (3)

What scientists are not sure of, however, are the full consequences of these human-induced changes to the planet's atmosphere. A recent Brookings Institute study wrestled with this problem and concluded, "While the regional impacts of global warming are uncertain and difficult to predict, many of the anticipated changes are far-reaching and disturbing. Rainfall and monsoon patterns could shift dramatically, upsetting agricultural activities worldwide. . . . Sea level could rise from one to four feet, flooding coasts and allowing salt water to intrude into water supplies. Ocean currents could shift, altering the climate of many areas and disrupting fisheries. . . . Record heatwaves and other weather anomalies could harm susceptible people, crops, and forests." (4)

As the 1992 IPCC report points out, however, the prediction of future climate change is critically dependent on scenarios of future anthropogenic emissions of greenhouse gases and other climate forcing agents, such as aerosols. "These depend not only on factors which can be addressed by the natural sciences but also on factors such as population and economic growth and energy policy where there is much uncertainty and which are the concern of the social sciences." (3)

Even if no climate change does occur, the United Nations has pointed out that responsible action to combat what are perceived climate and global change contributing factors would serve more than one environmental and economic purpose. "Even if the worst scenario does not come about, the world would

benefit in other respects by taking these measures now." (5) In essence, prudence dictates the adoption of "No Regrets" policies—policies for responding to such problems as energy conservation and air pollution that need to be dealt with anyway. Education on these "No Regrets" issues will promote positive behavioral and lifestyle changes that can begin to mitigate the effects of climate and global change problems as well.

To address the scientific uncertainties regarding global change, the U.S. Global Change Research Program (USGCRP) was developed by the interagency Committee on Earth and Environmental Sciences (CEES) of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). The USGCRP was established as a Presidential initiative in the FY 1990 budget and is charged with establishing the "scientific basis for national and international policy-making relating to natural and human-induced changes in the global Earth systems." (6) It serves as the central component of the U.S. Government's approach to global environmental change and its contribution to worldwide efforts. As part of the U.S. Global Change initiative, the National Oceanic and Atmospheric Administration (NOAA) cooperates with other agencies of the U.S. Government through FCCSET's CEES Subcommittee on Global Change Research. Within CEES Working Group on Climate and Global Change is the Task Group on Education, which developed a federal approach to climate and global change education. NOAA was an active participant in the development of that report.

NOAA also participates in FCCSET's Committee on Education and Human Resources (CEHR) that calls for active federal government participation in meeting the national education goals set by the 1989 Education Summit of the Nation's Governors, and spelled out in the FCCSET report, *By the Year 2000: First in the World*. This report sets strategic objectives to guide future federal actions in science and math education and calls for the achievement of scientific literacy in the U.S. population by the year 2000.

To address these needs—climate and global change education and the need for scientific literacy in the U.S. population—a NOAA-wide workshop was convened in June 1991 to develop a NOAA climate and global change education plan that contributes to the goals and objectives of the FCCSET and the CEES Task Group reports.

This document represents the final product of that workshop.

NOAA'S SPECIAL CAPABILITIES FOR CLIMATE AND GLOBAL CHANGE EDUCATION

Since FY 1989, NOAA has expanded its USGCRP efforts and responsibilities in the areas of: (1) documenting Earth system change; (2) understanding Earth system change; (3) modeling, analytical studies, and prediction; and (4) data and information management. The logical extension and culmination of NOAA's research effort is to carry the information gained from this effort one more step: To use this information to educate the American public. The task group report on *Public Information Implementation Measures* from the 1990 Intergovernmental Panel on Climate Change (IPCC), for instance, stressed the importance of an environmentally informed global population as essential to addressing and coping with climate change. (9) What's more, unless human behavior and its consequences for the environment are incorporated into climate and global change research models, the models will be inadequate to explain—or to develop policies for dealing with—global change phenomena. A rational response and sound policy development, however, can only be built upon reliable information. (7) With its solid scientific base, along with its strong outreach potential, NOAA has the perfect combination of strengths to launch a successful climate and global change educational campaign.

As an example, NOAA's Sea Grant and Coastal Zone Management programs have played a significant role in the understanding of the effects of human interactions on the marine and coastal environments. It is a logical next step to extend similar efforts to include a specific focus on those human activities of particular relevance to climate and global change. (8) This undertaking will build on NOAA's expertise in all of Earth's systems: solar, atmospheric, oceanic, terrestrial, and cryospheric. By augmenting its all-encompassing Earth systems research potential with its outreach potential, the agency will be able to integrate, synthesize, and implement some of the nation's highest scientific and educational priorities.

The long-term goal of NOAA's climate and global change research program is to establish a new national information service based on reliable assessments and quantitative predictions of climate change on timescales of seasons to centuries. The scope of this service, however, should not be limited merely to scientists: It should also be made available—in ways that can be understood—to the scientific community, public and private sector decisionmakers at all levels as well as schools and the American public. With research-based information updated as science progresses, citizens can then make informed decisions regarding the conduct of their daily lives as it cumulatively affects conditions for global change. (8)

Because of the special strengths that NOAA brings to the climate and global change education task, these two goals—scientific literacy and an understanding of climate and global change—are both well within its purview. Particular NOAA strengths include:

- A comprehensive, interdisciplinary scientific approach to Earth-systems research and a growing understanding of the interactions between all of

Earth's driving global systems: solar, atmosphere, oceans, terrestrial, and the land/sea coastal interface;

- A broad information base that provides a sound basis for a climate and global change public education campaign;
- A positive and credible public image as a reliable and objective source of information;
- The expertise of a cadre of interdisciplinary scientists that can be tapped as a source for outreach and education;
- The expertise of a cadre of communication, advisory, and education specialists well versed in outreach and education;
- A readiness for launching a national climate and global change educational campaign already in place in every state in the nation, as well as the Caribbean, through the agency's National Weather Service (NWS); Oceanic and Atmospheric Research (OAR) Environmental Research Laboratories (ERL); National Sea Grant College Program; National Environmental Satellite, Data, and Information Service (NESDIS); National Ocean Service (NOS) Sanctuaries and Reserves Division; National Marine Fisheries Service (NMFS); Joint Institutes; and National Undersea Research Centers (NURC).

GOALS

The goals of NOAA's climate and global change education program are:

I. To educate the public on Earth system change in order to encourage responsible action on issues that affect the health of the planet.

II. To foster a scientifically literate population by the year 2000, in keeping with the 1991 goals called for by the Federal Coordinating Council for Science, Engineering, and Technology.

NOAA's climate and global change educational effort will complement its research effort. Specifically, its educational effort will:

- 1. Build:** It will build upon NOAA's strong track record in the climate area.
- 2. Implement:** The climate and global change educational program can be quickly implemented through the agency's existing outreach network.
- 3. Synthesize:** NOAA's climate and global change educational effort can synthesize the results of NOAA's monitoring, research, modeling, and data management efforts into easily understood information products to educate the American public.
- 4. Innovate:** NOAA's climate and global change educational program will integrate in-house scientific and outreach capabilities with those of universities, museums, libraries, and public interest groups to provide a sustained long-term enhancement of the U.S. Climate and Global Change Education Program. By bringing together these established and existing capabilities and using them to develop innovative and effective ways of reaching the public, NOAA can make a major contribution to a national climate and global change educational effort, as well as contribute to the establishment of a scientifically literate public by the year 2000.
- 5. Sustain:** An effective climate and global change educational effort should involve a broad mix of scientists, information and communication specialists, and educators inside and outside of government. To achieve the maximum benefit from such a partnership with the broad educational outreach community, NOAA's climate and global change education program should support major efforts at nongovernment institutions such as universities, museums, aquariums, and libraries. To ensure the highest-quality programming, the climate and global change education program, like its scientific research counterpart, should support an annual grants program that funds competitive, peer-reviewed in-house and extramural proposals.

PRIORITIES

The June 1991 workshop identified four priority audiences for NOAA's climate and global change educational effort: an internal, intra-agency audience and three external audiences—the general public, youth in grades kindergarten through grade 12, and postdoctorate.

INTRA-AGENCY

INTERNAL AUDIENCE

The highest and most-immediate priority was given to internal, intra-agency coordination. Many NOAA line office organizations have educational capabilities. In order for the agency to launch a coordinated, NOAA-wide climate and global change educational effort, all parts of the agency need to be kept informed of each other's activities. That way, a coordinated educational effort can be launched with a minimum duplication of effort and a maximum use of existing strengths and capabilities within the agency.

Recommended Action

HIGHEST PRIORITY

Establishment of a NOAA Intra-agency Climate and Global Change Newsletter

The highest priority is given to the establishment of an intra-agency climate and global change newsletter. Since NOAA's climate and global change education effort will be agency-wide, one of the first tasks should be the identification of a mechanism to keep the entire agency up-to-date and informed of program opportunities and initiatives in a regular, concise fashion. To this end, a NOAA intra-agency newsletter is an essential mechanism.

The newsletter could either be produced within NOAA, or externally through either a contractor or a grant to one of the agency's many university outreach arms.

EXTERNAL AUDIENCE

NOAA's external plan of action should build upon the actions called for by the February 1991 Report of the Committee on Education and Human Resources of FCCSET, *By the Year 2000: First in the World* and planning documents associated with the evolving CEES program in global change education. This plan, to create a scientifically literate population by the year 2000, targets the following audiences: precollege, undergraduate, graduate, and the general public. Within this comprehensive list, workshop participants felt that NOAA's special niche in this broad across-the-board educational plan falls more precisely in two of the above categories: kindergarten through grade 12 and general public. In fact, it is these same two categories that CEES identified a month later, in its July 1991 planning meeting in Rhode Island, as the best targeted audiences for the government to pursue in climate and global change education. One additional audience has also been identified—primarily because of the long time lag involved in the training of a new generation of researchers. NOAA has begun a global change postdoctoral program to ensure that there is a continuing supply of broadly trained climate studies researchers.

GENERAL PUBLIC

The FCCSET report on American education calls for every adult American to be scientifically literate and possess the knowledge and skills necessary to compete in a global economy by the year 2000. One of the high priority CEES public education goals formulated in the Rhode Island July workshop calls for education to equip the public with the knowledge and skills they need about global change so that they become aware of the consequences of actions undertaken in the conduct of their daily lives.

A basic understanding of science is necessary if the public is to understand the scientific and technical issues that affect their lives. Any climate and global change governmental policies or programs that are adopted will need the strong support and endorsement of the public in order to be successful. (9) At present, much of the public is either unaware of the issues, problems, and potential impacts of climate and global change, or confused by the conflicting information they receive from the mass media. The public needs to become better informed of the research on which the political, fiscal, economic, social, and ethical issues raised by global change are based in order to enhance their ability to make or support wise resource decisions.

Although Americans have universal access to education and broad access to information, almost all recent educational reports point out that the state of the American public's scientific literacy is distressing. For instance, in one recent study, half the adults questioned did not know that it took one year for the Earth to orbit the sun. (10) To achieve the objectives of informed public participation and action, individuals must be provided with numerous opportunities to acquire policy-relevant information. This greater public awareness can then translate into increased public commitment and community action.

Recommended Actions

PROJECTS ALREADY UNDERWAY

Train NOAA Outreach Specialists on Climate and Global Change

A number of communication and education specialists already are employed within the various NOAA line organizations and across the country who develop educational materials and programs for the public. By training these specialists concerning the latest scientific information on climate and global change issues, this informational process can be used as a "multiplier" to reach a wide public audience across the United States. A systematic training program and development of complementary educational materials should be instituted in various regions throughout the United States. This effort has already begun with a pilot project to train six Sea Grant Global Change Task Force members who, in turn, will train others throughout the country.

Establishment of a NOAA Industry Advisory Panel

The creation of a NOAA panel that would inform industry on climate and global change issues so that the private sector may undertake the most cost-effective and most-responsible actions was recommended. The Committee on Earth and Environmental Sciences (CEES) has established the Private Enterprise and Government Initiative (PEGI) panel to identify corporate research agendas that will complement the government's research agenda. This panel, on which NOAA is represented, is encouraging corporate research responsibility in the areas of climate and global change.

Creation of Displays/Exhibits

In order to provide a proactive educational program that reaches the public, materials must be developed that are highly visible and accessible. These materials need to go "where the people are," such as to shopping malls and supermarkets. Visual displays and exhibits that highlight climate and global change issues, and NOAA's involvement in these from a research and educational perspective, should be developed. The first steps in the creation of these displays and exhibits has begun with the development of a tabletop display which has been used at national educators conferences and regional science fairs.

OTHER RECOMMENDED PROJECTS

Development of Climate and Global Change Posters, Fact Sheets, and Brochures

Posters, fact sheets, and brochures are very effective communication techniques and should be developed to raise the public's awareness of climate and global change issues.

Information Dissemination through Existing Networks

Once developed, these climate and global change materials can be economically and efficiently disseminated through existing dissemination networks: NESDIS; the more than 30,000 research and public libraries in the country; the National Sea Grant College Program with its ties to media, educators, and environmental organizations in every U.S. coastal state and the Caribbean; the National Marine Educators Association; the National Science Teachers Association, the American Association of Retired People, the League of Women Voters, and other environmental organizations such as the Audubon Society and Sierra Club. Such a network can be used effectively to reach millions of citizens and decision makers.

Development of News Releases/Media Information Packets

Media coverage of climate and global change issues should increase, and those covering the issue must become better informed. Scientifically accurate, interesting, and easily understood climate and global change news releases and information packets that explain the issues and offer possible courses of action should be developed for use by the media.

Programming through Museums, Aquariums, Libraries

Since large numbers of the public visit museums, aquariums, libraries, and interpretive centers, climate and global change educational programming should also be encouraged there.

Reach Local Decision Makers

A large percentage of community leaders are active in service or community organizations, such as Rotary International, Lions, or the League of Women Voters, thereby informally exerting their leadership and influence on numerous local, state, national, and international issues. As part of their normal activities, these organizations conduct informational programs on current issues. By educating these leaders on climate and global change issues, information can be transferred to those who generally hold leadership positions in local communities.

**KINDERGARTEN
THROUGH GRADE 12**

Development of Public Service Announcements (PSAs)

Television and radio reaches into almost all American households. A series of short, 30- to 90-second radio and television public service announcements should be developed to keep the public's awareness of the climate and global change issue current and to encourage responsible action.

Use of Television Spots

Television reaches almost all American households. Periodic spots on existing programs or channels (the Weather Channel, for instance) should be developed for climate and global change education.

Creation of a Global Change/Earth Systems Week

NOAA should spearhead the establishment of a Global Change or Earth Systems Week similar to the Coastweeks celebration that occurs throughout this country during a three-week period each fall. Such a celebration would encourage a variety of statewide programming that would focus public attention on climate and global change issues.

The landmark 1991 FCCSET report, *By the Year 2000: First in the World*, stresses the need to capture children's interest in science at a young age: "The high school graduates of the year 2000 are in the third grade today. For many, it may already be too late. They may have already learned that 'science is not for them. . . .' Their teachers may have never had a college-level course in the subjects they must teach. Many children will never do a science experiment in class, take a field trip to a museum, or use a computer during their entire precollege education. Yet, when they complete their 13 years of basic education, they will enter adult life in the most technically challenging living and work environment the world has ever known." (10)

The report goes on to state that by the time children are in the seventh grade, fully half declare no interest in science. "At the other end of the science pipeline, only six of every 4,000 seventh graders (five men and one woman) will ultimately receive a Ph.D. in science or engineering. The problem of keeping students in the science pipeline is even greater for women, persons with disabilities, and minorities. . . . Today, only 8% of bachelor's degrees in science and engineering are awarded to blacks and Hispanics (20.2% of the total population combined); together these minorities currently earn only 4% of all science and engineering Ph.D.s."

NOAA's primary target in the formal educational process is in the K-12 grade range. Many of the other federal programs currently in the planning stages address the needs of college, graduate, and postdoctoral students.

A similar high-priority audience was identified by participants at the July 1991 CEES workshop, except that this group extended the audience to students in the first two years of college (grades K-14), as well. For this audience, the CEES goal was "to increase awareness and understanding of global change issues by the nation's youth through formal education, thereby creating a more knowledgeable citizenry capable of making positive changes to ensure the survival of our planet." (11)

**PROJECTS ALREADY
UNDERWAY**

Recommended Actions

Development of Climate and Global Change Materials

Climate and global change materials need to be developed and field-tested at all K-12 grade levels. These curricular materials can then be approved formally by state and local boards of education for infusion within existing science curricula.

The first of these efforts is already underway with the creation of NOAA's Climate and Global Change Monograph Series, *Report to the Nation on Our Changing Planet*. The first monograph, "The Climate System," has been disseminated to the general public and to secondary schools and universities throughout the United States. The second in the series, "The Ozone Shield," will appear soon.

Teacher Workshops and Short Courses

Preservice and in-service teacher workshops and short courses are recommended so that climate and global change scientists, science educators, and precollege teachers can work together to "bridge the gap" between the scientists' research and the classroom teacher in a manner that is understood by all. A small amount of programming has begun in this area.

**OTHER
RECOMMENDED
PROJECTS**

Resource Guide

A resource guide for science educators, as well as for specialists in other agencies and institutions, should be produced and published. As part of this guide, lists of publications, articles, and conference proceedings should be provided that deal with climate and global change issues and environmental ethics.

Clearinghouse for Climate and Global Change Information

One of NOAA's greatest strengths is its information base. An important contribution to climate and global change education, therefore, should be for the agency to either serve as, or participate in, a central clearinghouse for climate and global change educational material. Informational products and materials created for both the general public and the K-12 audience should be fed into a central repository and dissemination point.

Computer Networking

The worldwide nature of the climate and global change issue creates distance and time problems. Both of these suggest large sets of environmental data that need to be readily available to researchers. High-speed communications and computers have become indispensable to the scientist. Computer networking could be used to teach students the regional and global nature of interdisciplinary studies. Three possible approaches are recommended:

1. Students in selected schools could participate in a one-year, computer-based, national climate and global change experiment similar to the acid rain experiment developed by the National Geographic Society. This mechanism could also be used by students and teachers to ask questions of NOAA climate and global change scientists.
2. NOAA could provide schools with computer access to regional, national, and global climate monitoring and prediction products.
3. The NOAA/NASA direct readout satellite program could be expanded to reach secondary schools.

Grants for Curriculum Development

Grants should be provided for the development of stand-alone general science courses in climate and global change to be offered to nonscience majors and preservice teachers at universities and community colleges. Curricula should also be developed, through grants and fellowships, for climate and global change issues to be included in preservice science education programs. Climate and global change issues and ethics should also be introduced into existing science, social science, and business programs.

Development of Video and Slide Programs

There is need for development of educational climate and global change slide and/or video programs that can be used by NOAA personnel when speaking to K-12 audiences. Such a program could be disseminated, on call, throughout the NOAA network for use by speakers nationwide. Slide programs could also be loaned to teachers on a short-term basis, as well as be used in speaking to the general public, civic, and industry groups.

Development of Computer Software

There has been a proliferation of computer games in recent years that are enjoyed by both youth and adults. An opportunity exists to work with software and computer game industries (i.e. Microsoft, Nintendo) to develop climate and global change software that are both applicable for classroom and home use. The expertise of NOAA staff could be called upon as consultants when developing these educational materials. Examples that exist today include Simearth, Earthquest, and Climate Learning Tree.

Use of NOAA Facilities

NOAA's national network of federal laboratories, National Weather Service facilities, estuarine reserves and marine sanctuaries, and the university laboratories available through its National Sea Grant College Program, can become centers for student and teacher learning outside the classroom, offering hands-on opportunities and exposure not available in traditional school settings.

Climate and Global Change Newsletter for Teachers

Teachers have little contact with the practicing scientific community and are frequently unable to associate real-life applications to the basic scientific concepts they must teach. Federal agencies can help to better prepare teachers by bringing them closer to the cutting-edge of science and by providing current information and materials so they can better communicate the excitement of science to their students. The American Association for the Advancement of Science estimates that only 33 percent of elementary school teachers, 22 percent of middle school teachers, and from 12 to 31 percent of high school teachers have adequate preparation for teaching science before they begin teaching it. (10) One of NOAA's greatest contributions to climate and global change education, therefore, would be to serve as a bridge, disseminating the knowledge contained in its extensive information base to teachers in an understandable, usable, convenient, and accessible manner.

Since our understanding of climate and global change is changing so rapidly, a newsletter would provide the flexibility and quick response needed to get the latest scientific findings to educators in a timely manner. A newsletter overcomes the major difficulty associated with textbooks in this area: long prepara-

tion times and quickly outdated material. The 1991 FCCSET report, for instance, found that nearly 30 percent of U.S. high schools offer no courses in physics, 17 percent offer none in chemistry, and 70 percent offer none in Earth or space science. "Textbooks for the courses that do exist are sometimes inadequate. In the midst of a scientific information explosion, it can still take several years to bring textbooks up to speed with current knowledge." (10) Through such a newsletter, teachers would gain greater exposure to the latest scientific information, update their knowledge, and become better able to educate students.

The format of the newsletter could consist of short guest features by articulate scientists, as well as regular sections on current climate and global change publications, videos, educational materials, conferences, workshops, and meetings. A newsletter would also alleviate one of the major problems now facing teachers: a simplified method for gaining access to the sources of climate and global change information. And a newsletter would better enable classroom teachers to offer to their students the most up-to-date scientific information and interpretation of the effects of climate and global change on the total Earth system.

Because of its broad information base and its network of outreach professionals positioned throughout the country, NOAA is particularly suited to either undertake such a newsletter or work closely with the National Science Teachers Association to insert appropriate materials into their newsletters.

Summer Fellowships for Science Educators

NOAA should begin a summer climate and global change fellowship program for science educators. Summer fellowships should be provided that enable science educators to work at, or with, NOAA institutions.

Use of Television and Satellite Links

NOAA scientists could be utilized and featured on media presentations to schools via satellite link-up capabilities. NOAA-generated climate and global change information could also be incorporated into existing television science programming, such as the Discovery Channel and the Teaching Channel.

POSTDOCTORATE

Because of the long time lag involved in the training of a new generation of researchers, it was felt that NOAA should also participate in a global change postdoctoral program to ensure that there is a continuing supply of the broadly trained researchers needed for climate studies.

Recommended Action

PROJECTS ALREADY UNDERWAY

Climate Studies Postdoctoral Program

A NOAA climate and global change postdoctoral program has begun in which recently graduated postdoctorates are paired with host scientists in areas of mutual interest. Currently, the program is being managed by the University Corporation for Atmospheric Research (UCAR) on behalf of NOAA and the university community.

The objective of the program is to help create the next generation of climate change researchers. It seeks to attract recent Ph.D.s in atmospheric science, physical oceanography, and other sciences to the field of climate research. The current program offers up to a two-year visiting research appointment.

IMPLEMENTATION

The NOAA Climate and Global Change Education Program should be soundly based in intra-agency cooperation among the line and staff offices. This plan should provide the primary guidance for agency priorities during the formative years. Initial efforts should focus on the recommended projects identified in this plan.

The staff of the Office of Global Programs will administer initial efforts with the assistance of a small advisory committee composed of one representative and an alternate from each line office and the Office of Educational Affairs, plus several Sea Grant education specialists. As funding for climate and global change educational programs increases within NOAA, proposals and projects will become more numerous and complex, and programming potential will become more diverse. A formal NOAA climate and global change education advisory group will be organized. This team will be composed of appropriate staff from all line offices and appropriate staff offices, plus non-NOAA experts in the field. Under the general direction of the Office of Global Programs, the group will oversee the NOAA climate and global change education program by setting priorities; identifying needs; evaluating grant proposals; identifying and developing the most appropriate mechanism to accomplish program goals; and maintaining this plan as a viable and dynamic document.

EVALUATION

The ultimate purpose of this proposed effort is to develop a sustained intra-agency plan for climate and global change education utilizing the special strengths throughout the various components of NOAA. Although environmental education responsibilities are shared by many branches of federal, state, and local governments, the unique configuration of NOAA's various components gives the agency a special niche for long-term climate and global change education.

The hallmark of this educational effort will be an integrated, coordinated synthesis of NOAA's monitoring, research, modelling, data management, and educational projects. This educational effort will complement, and be a vital component of, the interagency USGCRP. The agency will also cooperate with other federal agencies in various educational efforts through the FCCSET Committee on Earth and Environmental Sciences (CEES).

A key component in this educational plan will be the development of evaluation procedures that can be used to determine the success of each concept and activity, as well as to further refine new projects in future years. Each educational project is unique and will need to have individual evaluation plans associated with it. Where appropriate, evaluations should be used to quantify increases in content knowledge, as well as positive changes in attitude by participants. These data will be analyzed using standard statistical methodologies. Results of evaluation will be of major benefit in developing further educational strategies to meet the goals of this plan.

BENEFITS

The expected benefits of this NOAA climate and global change education initiative will be to:

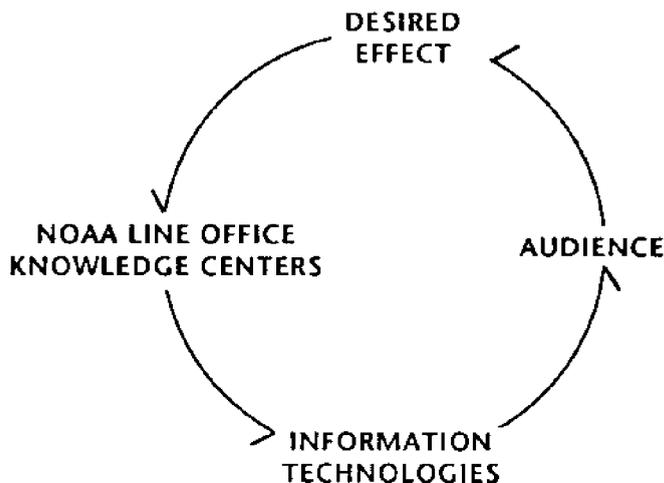
- provide decision makers and the public with the foundation and information needed to support evolving and necessary policy decisions and actions associated with the cause-and-effect changes in the global environment.
- develop a scientifically literate and environmentally conscious public with the knowledge and long-range commitment to support ethically sound decision making.
- contribute to the development of a highly educated cadre of future scientists that will continue future inquiry into these increasingly complex and interdisciplinary issues.

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APPENDIX A

NOAA Climate & Global Change Education Plan



DESIRED EFFECT

- Awareness
- Attitude Change
- Behavior Change
- Scientific Literacy

NOAA KNOWLEDGE CENTERS

- Office of Global Programs (OGP)
- National Weather Service (NWS)
- Oceanic and Atmospheric Research (OAR)
National Sea Grant College Program;
Environmental Research Laboratories
(ERL); National Undersea Research Centers
(NURC); Joint Institutes
- National Marine Fisheries Service (NMFS)
- National Ocean Service (NOS)
Sanctuaries and Reserves Division
- National Environmental Satellite, Data,
and Information Service (NESDIS)
- Education Affairs Division (EAD)

INFORMATION TECHNOLOGIES

- Intra-agency Newsletter
- Posters, Fact Sheets, Brochures
- Information Dissemination Through Existing
Networks
- Newsletter for Teachers
- Establishment of Clearinghouse for Information

- Teacher Workshops & Short Courses
- Grants for Curriculum Development
- Development of K-12 Educational Materials
- Slide Programs
- Public Service Announcements
- Establishment of NOAA Advisory Board
- Displays/Exhibits
- Train NOAA Outreach Specialist
- Reach Local Decision Makers
- Television Spots
- Computer Software
- Programming Through Museums,
Aquariums, Libraries
- Summer Fellowships for Science Educators
- Creation of Global Change/Earth Systems
Week
- News Releases/Media Information Packets
- Computer Networking
- Resource Guide
- Use of Television & Satellite Links

AUDIENCES

- Public
- Educators
- Schools K-12
- Environmental Organizations
- Libraries, Museums, Aquariums, Nature
Centers
- Community Service Clubs

APPENDIX B

Existing NOAA Educational Activities

NOAA LINE/PROGRAM OFFICES	EDUCATIONAL ACTIVITIES
OGP	<ul style="list-style-type: none">• monograph series• exhibits• postdoctoral fellowships
NWS	<ul style="list-style-type: none">• videotapes• brochures• CAC product data on weather & climate• tours• science fairs• summer student program
NESDIS	<ul style="list-style-type: none">• library data access• CD-ROM• satellite data• information• tours
NMFS	<ul style="list-style-type: none">• pamphlets• brochures• curriculum development• tours• talks to schools• science fairs• tutors
OAR/ERL	<ul style="list-style-type: none">• research postdoctorates• student employment program• seminars at universities• science fairs
OAR/SEA GRANT	<ul style="list-style-type: none">• newsletters• magazines• fact sheets• news releases• brochures• PSAs• videos• posters• books• teacher training• curriculum development
NOS/SRD	<ul style="list-style-type: none">• experimental classes, tours, field trips
EAD	<ul style="list-style-type: none">• resource packets for teachers/students• educational resources inventory• speakers bureau

APPENDIX C

NOAA Global Change Education Workshop

PARTICIPANT LIST

Bernard Griswold NOAA National Sea Grant College Program	Lynne Mortensen University of Nebraska
Daphne Gemmill NOAA Office of Global Programs	Ed Myers NOAA ERL
Lynne Carter Hanson University of Rhode Island	Mike Spranger University of Washington Sea Grant
Dale Baker University of Minnesota-Duluth Sea Grant	Sharon Walker Mississippi-Alabama Sea Grant
Ron Becker Louisiana State University Sea Grant	Carol Watts NOAA NESDIS
Rosanne Fortner Ohio State University	Michael Uhart NOAA NWS
Ed Gross NOAA Constituent Affairs	Maureen Witkowski NOAA NOS Sanctuaries and Reserves Division
Aleta Hohn NOAA NMFS	Matt Houston NOAA Office of Global Programs
Arva Jackson NOAA Education Affairs	
Carole Jaworski University of Rhode Island Sea Grant	
Felix Kogan NOAA NESDIS	
Dane Konop NOAA Office of Public Affairs	
Tom Meyer NOAA NMFS	
Bruce Miller University of Hawaii at Manoa Sea Grant	