

# 9

## Education, Training, and Outreach

Federal agencies' climate change education, training, and outreach efforts seek to ensure that individuals and communities understand the essential principles of Earth's climate system and the impacts of climate change, and are able to evaluate and make informed and responsible decisions with regard to actions that may affect the climate. Increasing our resilience to these impacts depends not only upon our ability to understand climate science and the implications of climate change, but also upon our ability to integrate and use that knowledge effectively. Changes in our economy and infrastructure as well as changes in individual attitudes, societal norms, and government policies will be required to alter the impact of climate change on human lives. Individuals, communities, and countries will be called on to implement

effective management strategies for critical institutional and natural resources to ensure the stability of both human and natural systems as temperatures rise.

As nations and the international community seek solutions to global climate change over the coming decades, a more comprehensive, interdisciplinary approach to fostering public climate literacy—one that includes economic and social considerations—will play a vital role in knowledgeable planning, decision making, and governance. Increased efforts to integrate social sciences into federal agencies' educational and outreach programs would help to ensure informed decision making and effective systems-level responses to climate change. This integration offers a significant challenge to the nation's diverse educational systems. It is imperative that these responses to climate change



are supported by sustained and robust educational initiatives to develop a climate-literate citizenry and skilled workforce.

## UPDATES SINCE THE 2006 U.S. CLIMATE ACTION REPORT

Climate change education, training, and outreach efforts have expanded significantly since the last *U.S. Climate Action Report* was released in 2006. Since then, federal programs to support formal educational initiatives on climate change have expanded considerably. These programs involve K–12 and undergraduate curricula and postgraduate professional development programs, as well as informal education programs conducted in museums, parks, nature centers, zoos, and aquariums across the country.

### Federal Programmatic Coordination

Increased coordination across the federal agencies is critical to increasing public climate literacy in the United States. A Climate Change Education Interagency Working Group was formed in 2008 to coordinate an integrated national approach to climate change education. This coordination mechanism is an outgrowth of discussions within the U.S. Global Change Research Program (USGCRP) Communications Interagency Working Group (CIWG) and the federal science agencies currently conducting climate research, and climate change education and outreach. This Interagency Working Group consists of senior staff members of the USGCRP member agencies that have climate and climate change education programs. Their primary responsibilities are to:

- serve as a forum in the USGCRP for the development of a national climate and climate change education strategy that is inclusive of all USGCRP members,
- coordinate climate education activities and priorities across the USGCRP members, and
- make recommendations to agency management on all aspects of federal agencies' climate and climate change educational activities.

It is critical that climate scientists and climate science agencies play a more active role in the dissemination of their findings. The public and students at all levels—in both formal and informal learning settings—must have access to climate data in ways that foster climate literacy and informed decision making. The federal agencies are working with social scientists to determine the most effective ways to communicate with students and the public about how Earth's climate is changing. In an effort to extend their education and outreach programs and maximize their impact, federal agencies are addressing the following questions: How can local high-impact activities be scaled up and serve as national models? What are effective climate change

literacy professional development opportunities for policy decision makers at all levels? How do we assess changes in individuals' understanding of Earth's climate system and the decisions they make about their actions? How can nationally representative assessments of public knowledge and understanding of climate change help identify common knowledge gaps, misunderstandings, sources of confusion, and key concepts the American public needs to understand about climate change?

Table 9-1 at the end of this chapter presents an extensive listing of federal agencies' online, climate-relevant education resources.

## OVERVIEW OF NATIONAL EFFORTS TO ENGAGE THE UNITED STATES ON CLIMATE CHANGE

During the period of this *U.S. Climate Action Report* (2006–2010), nongovernmental organizations (NGOs) and the federal government conducted major communications campaigns to raise awareness and educate the nation and the world about global warming. On May 24, 2006, the popular film *An Inconvenient Truth* was released, featuring former U.S. Vice President Al Gore's efforts to educate citizens about global warming. Many colleges and high schools use the film to complement their science curricula.

Roughly one year later, Vice President Gore and other celebrities conducted "Live Earth"—a 24-hour music concert spanning seven continents and delivering a worldwide call to action to address climate change. During the performances, viewers were invited to support a seven-point pledge to adopt solutions to address climate change. Subsequently, "Live Earth" launched a multi-year campaign to encourage individuals, corporations, and governments to take action.

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment on Climate Change was published in a series of reports in 2007. The first report issued by Working Group 1, titled *The Physical Science Basis*, was published on February 2, 2007. Later in 2007, the second and third IPCC reports were released and then completed by a summary *Synthesis Report* released on November 17, 2007. Collectively, the IPCC's fourth climate assessment updated, clarified, and strengthened societal understanding of the causes and effects of climate change. The reports also bolstered climate science lessons used in classrooms and in public outreach efforts. Later in 2007, former Vice President Gore and the IPCC shared the 2007 Nobel Peace Prize.

Perhaps not coincidentally, news media coverage of climate change began to change in 2007, with the number of articles on the subject increasing substantially (Figure 9-1).<sup>1</sup> Recent studies on the role of mass

<sup>1</sup> See <http://www.eci.ox.ac.uk/research/climate/mediacoverage.php>.



media in communicating climate science, mitigation, and adaptation have been mixed or more positive (Boykoff and Boykoff 2007).

In March 2008, a group of 11 organizations led by the National Oceanic and Atmospheric Administration (NOAA) produced a publication titled *Climate Literacy: The Essential Principles of Climate Science*. One year later, the USGCRP issued a revised and expanded second version of this publication, with endorsement by its 13 federal agency members and an expanded list of partners that includes 24 institutions and organizations (available online at <http://www.globalchange.gov/>).

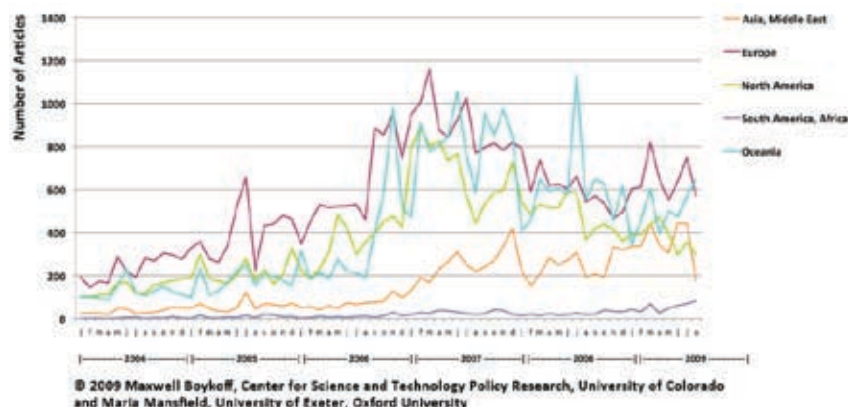
Numerous reports and studies by various social scientists documented increasing public awareness and concern regarding climate change and the need for individuals and governments to take action to address the problem. The 2008 U.S. presidential election debates and campaign speeches placed an unprecedented emphasis on the importance of addressing climate change. The U.S. Congress began new climate change education-focused programs at three federal agencies—the National Aeronautics and Space Administration (NASA), the U.S. National Science Foundation (NSF), and NOAA—while other agencies launched major education and outreach programs to help promote public climate literacy.

Efforts by state and local governments, universities, schools, and NGOs are essential complements to federal programs that educate industry and the public regarding climate change. State environment and energy agencies continue to provide teacher training, often in cooperation with universities and local utility companies. Local school systems are adopting climate change curricula and activities at the middle and high school levels. Universities are joining forces with NGOs to educate staff and students about the importance of energy efficiency and are instituting new, sustainable practices on campuses across the country. From wildlife conservation groups (e.g., National Wildlife Federation, National Council for Science and the Environment, National Environmental Education Foundation, and Council of Environmental Deans and Directors), to science-based organizations (e.g., American Meteorological Society, University Corporation for Atmospheric Research, and Federation of Earth Science Information Partners), to education organizations (e.g., American Association for the Advancement of Science Project 2061, Association of Science-Technology Centers, and National Science Teachers Association), a variety of NGOs conduct programs and surveys, produce brochures and kits, and write media articles to alert the public to the science underlying, impacts of, and possible solutions to climate change.

Industry also plays a role in education, training, and outreach. Several corporations have contributed to the

**Figure 9-1 2004–2009 World Newspaper Coverage of Climate Change or Global Warming**

In 2007, news media coverage of climate change increased substantially. Recent studies on the role of mass media in communicating climate science, mitigation, and adaptation have been mixed or more positive.



National Park Service’s efforts to communicate energy efficiency messages.

Because of these efforts, segments of the American public are better informed about climate change and better equipped to act on that information. The USGCRP 2009 *Global Climate Change Impacts in the United States* report states that “future climate change and its impacts depend on choices made today” (Karl et al. 2009). As such, the nation has a considerable way to go in comprehending and realizing the implications of climate change. The *Climate Literacy* publication captures this concept well in its Guiding Principle B:

*Reducing human vulnerability to the impacts of climate change depends not only upon our ability to understand climate science, but also upon our ability to integrate that knowledge into human society. Decisions that involve Earth’s climate must be made with an understanding of the complex inter-connections among the physical and biological components of the Earth system as well as the consequences of such decisions on social, economic, and cultural systems.*

## FEDERAL AGENCY EDUCATION, TRAINING, AND OUTREACH PROGRAM OVERVIEWS

A number of federal agencies provide state and local governments, industry, NGOs, and the public with information about national and global climate change research and risk assessment studies, U.S. mitigation activities, and policy development. They work both independently and in partnership with other agencies, NGOs, and industry toward the common goal of increasing awareness about the potential environmental and societal challenges posed by climate change.

### U.S. Global Change Research Program

USGCRP is responsible for communicating with a variety of stakeholders nationally and globally on

issues related to climate variability and climate change science and coordinating the federal agencies' climate change education programs. The CIWG leads efforts to coordinate interagency education and communications activities.

## **U.S. Department of Commerce**

### *National Oceanic and Atmospheric Administration*

NOAA is committed to the development of a society that is environmentally responsible and utilizes effective, science-based problem-solving skills. Improvements in societal stewardship of natural resources extend directly from effective formal and informal education systems. NOAA's climate education programs support the development of strong and comprehensive education materials about climate and oceanic and atmospheric sciences. NOAA is committed to supporting and facilitating system-wide change of the formal education system to build educators' capacity to produce climate-literate citizens. Such change requires engagement and participation across the spectrum of the education community—including policy-makers, academic institutions, professional associations, teachers, and students.

Informal education plays a critical role in developing climate-literate citizens. To help equip informal education institutions with modern instructional resources and interdisciplinary methods for teaching Earth system science, NOAA pioneered Science On a Sphere® (SOS). The animated global data sets projected onto this 6-foot-diameter sphere, with live or pre-recorded interpretive narration, show members of the lay public cause-and-effect relationships at work in the global climate system. SOS® is now operating in more than 40 informal education venues across the United States and internationally, and more locations are being planned.

NOAA is engaged in the improvement of both formal and informal education systems because these venues are important to the development of literate citizens and to the long-term maintenance of their skills, knowledge, and attitudes. Partnerships and collaboration are integral to sustaining and scaling up NOAA's ability to promote public climate literacy.

## **U.S. Department of Energy**

The U.S. Department of Energy's (DOE's) Atmospheric Radiation Measurement (ARM) Climate Research Facility Education and Outreach Program is involved in climate change educational outreach in the communities and regions hosting ARM data-gathering field sites. The program also provides educational resources to a global audience through its Web site.<sup>2</sup> The goal of the program is to develop basic science awareness and increase critical thinking skills focusing on environmental science and climate change for K–12 students. In addition, the program supports relationship build-

ing among teachers, students, scientists, and the community. Lesson plans, puzzles, and related materials are made available at the Web site. The site also includes the "Ask a Scientist" interface that provides the opportunity for anyone to pose questions to ARM scientists. Questions and answers are posted on the Web site.

Additionally, DOE's Office of Energy Efficiency and Renewable Energy (EERE) funds partners to develop curricula and implement standardized, high-quality training programs. These projects are aimed at creating a pipeline beginning at the K–12 level and extending through the postgraduate level to ensure the ongoing development of a workforce to invent and scale up clean energy and energy efficiency technologies and processes over the long term. Education and workforce training are critical parts of EERE's mission, which is to create an energy-literate generation of skilled workers, leaders, and innovators who will produce affordable, abundant, and clean energy, thus accelerating the transition to a low-carbon economy and ensuring U.S. global competitiveness.

## **U.S. Department of the Interior**

### *National Park Service*

As the steward of the world's foremost system of national parks, the fundamental mission of the National Park Service (NPS), as articulated in the 1916 NPS Organic Act is: "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for future generations." Nearly 100 years later, this still holds true, as the NPS manages 392 natural and cultural sites, including 58 National Parks, 18 National Recreation Areas, and 20 National Preserves and Reserves. Together, these units cover over 84 million acres (more than 3.5 percent of the nation's total area) across 49 states. Park units are found in diverse locations, from remote areas to urban settings, and in all of the country's climatic zones. Recognizing its role as the model for national park systems around the world, NPS has increased its support of education on climate change and environmental stewardship through several innovative programs.

### *U.S. Geological Survey*

As the nation's largest water, earth, and biological science and civilian mapping agency, the U.S. Geological Survey (USGS) collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The agency's diversity of scientific expertise enables it to carry out large-scale, multidisciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers. USGS climate change science efforts include the development and implementation of the framework for a comprehensive,

<sup>2</sup> See <http://education.arm.gov>.

national climate effects research and monitoring network; continuation of the rigorous scientific research that provides the data, new knowledge, inputs to modeling, and other outcomes that are required to understand, assess, adapt to, and mitigate climate change; and efforts to build partnerships and to translate scientific findings into real-life applications and decision-support tools.

### **U.S. Department of Transportation**

The U.S. Department of Transportation (DOT) developed many programs to address the questions raised by the public, government employees, state and local agencies, and other transportation stakeholders about climate change. For example, the Federal Transit Administration (FTA) has several programs that provide information about the benefits of public transit and how to reduce the environmental impacts of transportation. FTA's Environmental Management Systems Training, in particular, offers training for public transit agencies to assess and reduce the environmental impact of their operations, including their carbon footprint. The Federal Highway Administration (FHWA) targets metropolitan planning organizations (MPOs) and local transportation agencies to provide information on their climate science and mitigation strategies. In 2008, the FHWA hosted three peer exchanges, which allowed senior staff of MPOs and state departments of transportation to come together and share information about integrating adaptation and mitigation strategies into the transportation planning process. These efforts are in addition to a DOT-wide effort to educate federal and state employees about a variety of transportation and climate change issues, which includes the Transportation and Climate Change Clearinghouse Web site. The site serves as a one-stop source of information about transportation and climate change topics, and is intended for use by the transportation community and general public. DOT is committed to engaging federal employees and all invested parties on the topic of climate change, especially as it relates to transportation.

### **National Aeronautics and Space Administration**

NASA supports extensive education, training, and public awareness on climate change that take advantage of NASA's unique observational, research, and modeling assets. NASA outreach includes a Science Education Program, which sponsors educational activities at all levels of formal and informal education and creates inspiring new educational products based on NASA observations and technologies. NASA also produces informational materials and participates in public events in order to engage directly with young people and citizen scientists on a broad range of scientific topics, including climate change.

### **U.S. National Science Foundation**

Consistent with its mission to support research and education across a broad range of science and engineering disciplines, NSF funds research and education in numerous areas related to global climate change, from training of undergraduate and graduate students in climate change research, to education and cognition research on how to better communicate the complex science of climate to lay audiences, to efforts to improve public understanding of climate change, to research on climate-related decision making. NSF's Directorates for Geosciences; Biological Sciences; Social, Behavioral, and Economic Sciences; Education and Human Resources; Mathematics and Physical Sciences; Computer and Information Science and Engineering; and the Office of Polar Programs participate in the USGCRP and provide access to climate-related results from principal investigators.

NSF is the principal federal agency charged with promoting science, technology, engineering, and mathematics (STEM) education. To this end, NSF supports the development of a diverse and well-prepared scientific and technical workforce, and a scientifically literate citizenry. NSF investments in climate change education occur through a variety of core programs aimed at strengthening STEM education. Among the projects currently being supported through these investments are the Communicating Climate Change (C3) project, to build the capacity of science centers and Long-Term Ecological Research centers to engage the public in climate change science; Seasons of Change, an effort to identify "dominant climate forcings, feedbacks, and component linkages driving change in the Arctic system seasonality"; Creating a Learning Community for Solutions to Climate Change, an effort to engage scientists and other experts in creating curricular resources to teach about climate change; and a National Academies Roundtable on Climate Change Education, to develop a national strategy for climate change education.

### **Smithsonian Institution**

The Smithsonian is addressing the global challenge of climate change with special exhibitions and ongoing research. Smithsonian collections related to the evidence about, impact of, and response to climate change provide a unique and accessible resource for public education. Smithsonian scientists and curators regularly engage the museums' millions of U.S. and foreign visitors on climate change issues, from the perspectives of science, history, and art. The Smithsonian has also brought its outreach online to reach an even wider audience. In September 2009, a Smithsonian online climate change conference drew more than 3,700 participants in 82 countries and U.S. territories and in all 50 states. The three-day conference approached the subject from myriad Smithsonian



disciplines, from wildlife management to paleontology to art history. Ten Smithsonian units took part, along with NSF, the GLOBE (Global Learning and Observations to Benefit the Environment) program, the Corporation for National and Community Service, and others. Such events support the Smithsonian's core mission to promote the "increase and diffusion of knowledge."

### **U.S. Agency for International Development**

As the foreign assistance arm of the U.S. government, the U.S. Agency for International Development (USAID) plays a leadership role in delivering climate change-related international assistance to over 40 developing and transition countries. With headquarters in Washington, D.C., USAID has field offices in many regions of the world—namely, sub-Saharan Africa, Asia, the Middle East, Latin America and the Caribbean, and Europe and Eurasia. USAID works in close partnership with private voluntary organizations, indigenous groups, universities, American businesses, international organizations, other governments, trade and professional associations, faith-based organizations, and other U.S. government agencies.

USAID's Global Climate Change Program incorporates climate change considerations into development projects, supporting on-the-ground programs to achieve climate change results and strengthen economic growth. Climate change education, training, and outreach are a cornerstone of USAID's activities, providing the foundation for sustainable actions. Capacity building for improved decision making through applied science and access to information is increasingly important. Building on clean energy, sustainable landscapes, and adaptation strategies, USAID will continue to integrate education, outreach, and training into its development mission to contribute to reducing the threat of climate change around the world.

### **U.S. Department of Agriculture**

#### ***Agricultural Research Service***

As the U.S. Department of Agriculture's (USDA's) chief intramural scientific research body, the Agricultural Research Service (ARS) is responsible for research on the impacts of agricultural practices on climate change, and the impacts of climate change on agriculture. Although ARS has no formal educational mechanism to disseminate research information to the general public, it employs a number of less formal means to communicate and make use of research advances.

All USDA scientific research publications are submitted with an Interpretive Summary that is used for timely news releases. In addition, through collaboration with university scientists, climate change research information is provided to state and county cooperative extension agencies for release to identified pro-

ducers. Also, all USDA field locations publish informative brochures and technical reports that describe their work and the impact of the research findings on stakeholders' interests.

#### ***National Institute of Food and Agriculture***

The National Institute of Food and Agriculture (NIFA), formerly the USDA Cooperative State Research, Education, and Extension Service, is the primary USDA agency that supports extramural research, extension, and education by providing \$1.2 billion annually in competitive and state-designated formula funds. NIFA also supports a number of research, education, and extension funding programs on climate change.

#### ***U.S. Forest Service***

All U.S. Forest Service (USFS) national efforts in climate change education, training, and public awareness are based on the scientific expertise and findings of the agency's more than 500 scientists. The USFS Research and Development program conducts a wide variety of climate change research, investigating how climate change is and may be affecting terrestrial and freshwater natural resources and ecosystems. These results are made available to professional resource managers and the public through a variety of Web sites and publications. USFS also provides climate change education resources to educators and students through a variety of programs. One of these is *The Natural Inquirer*, a science education journal based on published Forest Service science, targeted for U.S. and international middle school students. A Climate Change Edition of *The Natural Inquirer*, focused on contemporary research findings regarding climate change and wildfires and the impact of a changing climate on wildlife and stream temperatures, will be published in 2010. In addition, EUGENE (Ecological Understanding as a Guideline for Evaluation of Nonformal Education)—a broadly applicable, user-friendly Web-based environmental education evaluation instrument that assesses student knowledge on limits, regulation, and adaptation related to climate change—will assist educators in the evaluation and improvement of their climate change programs and will increase accountability in climate change education.

#### ***U.S. Environmental Protection Agency***

Climate change information, education, and outreach at the U.S. Environmental Protection Agency (EPA) have traditionally been coordinated through the Climate Change Division (CCD) in the Office of Air and Radiation. Besides managing EPA's Climate Change Web site, CCD has produced educational and informational materials that reach a wide range of audiences. In addition, CCD provides outreach programs that educate decision makers and the public about opportunities to reduce greenhouse gas

emissions and to adapt to the impacts of climate change that humans and nature are already facing.

EPA's Environmental Education Division's grant program distributes over \$3 million a year to formal and informal education programs across the country that educate learners of all ages about the reasons for and ways to solve environmental problems. For the last several years a good percentage of those funds went specifically to climate change education programs.

EPA's National Center for Environmental Research in the Office of Research and Development manages

fellowship and other programs at the undergraduate, graduate, and postdoctoral levels, all of which have climate change educational components. In particular, the Science To Achieve Results (STAR) fellowship program has attracted and supported approximately 1,400 of America's new generation of environmental scientists, engineers, and policymakers since 1995.

EPA's Office of Children's Health Protection and Aging Initiatives provides information and outreach to populations particularly vulnerable to the effects of climate change.

Table 9-1 Federal Climate Change Programs Grouped by Primary Audience

Program Name	Description	Audiences	Learning Setting	Web Site
<b>K–12 Students</b>				
<b>National Aeronautics and Space Administration (NASA)</b>				
Global Learning and Observations to Benefit the Environment	GLOBE is a worldwide hands-on, primary and secondary school-based science and education program. GLOBE observations and measurements include atmosphere and climate, hydrology, land cover and phenology, and soils. GLOBE students, teachers, and scientists collaborate on inquiry-based investigations of the environment and the Earth system, working in close partnership with NASA and NSF Earth System Science Projects, on research topics related to the carbon cycle, watersheds, seasons, and biomes and extreme environments. Understanding Earth as an interconnected system is at the core of the GLOBE program. <i>Partner: National Science Foundation (NSF)</i>	K–12 Students, K–12 Teachers	Formal/Informal	<a href="http://www.globe.gov/">http://www.globe.gov/</a>
Signals of Spring	In Signals of Spring, middle and high school students investigate migration patterns of land and marine animals. Animal location data relayed from small satellite transmitters are overlaid onto maps of topography, vegetation, sea surface temperature, and other NASA Earth data, prompting students to pose, research, and analyze questions about the many factors affecting the migration and health of different species. Students use online journals, which are then read and commented on by Earth scientists and wildlife biologists. The program provides teacher training, which can be conducted on site or by live, interactive Webcasts.	K–12 Students, K–12 Teachers	Formal	<a href="http://www.signalsofspring.net/">http://www.signalsofspring.net/</a>
3D-View (Virtual Interactive Environmental Worlds)	Project 3D-VIEW is a comprehensive curriculum engaging students in Earth system science with immersive three-dimensional (3D) views. The program combines NASA mission data with 3D technologies in grades 5 and 6 as students “explore” five units: lithosphere (land), hydrosphere (water), biosphere (life), atmosphere (air), and Earth systems. A project goal is for students to understand Earth system science topics and science-based decision making, preparing them for high school and beyond. Using simple Web interfaces and a custom viewer, students explore 3D stereo views to learn traditional science content. Project 3D-VIEW provides teacher training and is aimed at increasing student achievement in middle school science by using 3D technology to help students to truly understand abstract concepts.	K–12 Students, K–12 Teachers	Formal	<a href="http://www.3dview.org/">http://www.3dview.org/</a>
Students’ Cloud Observations On-Line	S’COOL is a component of NASA’s CERES (Clouds and the Earth’s Radiant Energy System) instrument. CERES instrument measures the amount of energy reflected and emitted by the Earth system and focuses on understanding how clouds affect these energy transfers. Participating students make basic weather observations and record the types and features of clouds in the sky at the time the satellite passes over their location. The data are then submitted to NASA (by Web, e-mail, fax, or mail) for entry into an online database. Students can access their results as well as those from other participating schools using the S’COOL Web site (which is available in seven languages). Satellite observations for matching times are also posted so that students can compare their observations to those of the satellite, and scientists can evaluate CERES’ performance. Participants receive instructional materials and information necessary for reporting results.	K–12 Students, K–12 Teachers	Formal/Informal	<a href="http://science-edu.larc.nasa.gov/SCOOOL/index.php">http://science-edu.larc.nasa.gov/SCOOOL/index.php</a>
Earth Climate Course: What Determines a Planet’s Climate?	The Earth Climate Course is a set of student activities and teacher’s guides designed to connect NASA Earth science research with the teaching and learning of core science and mathematics concepts and skills, while addressing national education standards. The four modules cover: (1) Temperature Variations and Habitability, (2) Modeling Hot and Cold Planets, (3) Using Mathematical Models to Investigate Planetary Habitability, and (4) How Do Atmospheres Affect Planetary Atmospheres. Scientific inquiry and the tools used to do research play a major role in the lessons. Presented with a science problem, students seek answers and consensus by experimenting with physical and computer models, collecting and analyzing their own measurements, and conducting comparisons with real-world data from satellites and ground-based observations.	K–12 Students, K–12 Teachers, Undergraduate Students	Formal	<a href="http://icp.giss.nasa.gov/education/modules/eccm/">http://icp.giss.nasa.gov/education/modules/eccm/</a>



Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>K–12 Students (Continued)</b>				
<b>U.S. Environmental Protection Agency (EPA)</b>				
EPA Climate Change Kids Site	This popular environmental education Web site provides a wealth of resources for students and educators. Graphically engaging and interactive, it includes information about science, what we can do to make a difference, resources for educators and administrators, games (e.g., multiple-choice tests, hangman, word searches, crosswords), and more. One feature is a greenhouse gas calculator for classrooms, which instructs students about steps they can take to reduce their carbon “footprint”—measured in pounds of carbon dioxide annually—and what those reductions can mean for the environment. This site will be undergoing a revision to update it and improve its accessibility in 2010.	K–12 Students	Formal (K–12)	<a href="http://www.epa.gov/climatechange/kids">http://www.epa.gov/climatechange/kids</a>
Climate Change Emission Calculator Kit (Climate CHECK)	High school students can investigate the link between everyday actions at their high school, greenhouse gas emissions, and climate change. Using Climate CHECK, students can learn about climate change, estimate their school’s greenhouse gas emissions, and conceptualize ways to mitigate their school’s climate impact. Students gain detailed understandings of climate change drivers, impacts, and science; produce an emission inventory and action plan; and can submit the results of their emission inventory to their school district.	K–12 Students	Formal (K–12)	<a href="http://www.epa.gov/climatechange/wycc">http://www.epa.gov/climatechange/wycc</a>
Global Warming Wheel Card Classroom Activity Kit	A hand-held wheel card and other resources in this kit created by EPA help middle school students estimate their classroom’s and their household’s greenhouse gas emissions. The activities in the kit encourage critical thinking skills and new ideas about ways to reduce the students’ personal, family, school, and community contributions to climate change.	K–12 Students	Formal (K–12)	<a href="http://www.epa.gov/climatechange/emissions/wheel_card.htm">http://www.epa.gov/climatechange/emissions/wheel_card.htm</a>
Climate for Action Campaign	Children suffer disproportionately from the health effects of some environmental hazards, and climate change could increase some of those hazards. EPA’s Climate for Action Campaign educates young people about climate change and its effects on children’s health, and encourages them to take actions to reduce greenhouse gas emissions. These “climate ambassadors” will in turn educate others and mobilize their communities to “create a new climate for action.”	K–12 Students/ Public	Formal/Informal	<a href="http://www.epa.gov/climateforaction/">http://www.epa.gov/climateforaction/</a>
<b>U.S. National Science Foundation</b>				
Discovery Research K–12	The program seeks to enable significant advances in pre-K–12 student and teacher learning of the science, technology, engineering, and mathematics (STEM) disciplines through development, study, and implementation of resources, models, and technologies for use by students, teachers, and policymakers.	K–12 Students	Formal (K–12)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500047">http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500047</a>
<b>K–12 Teachers</b>				
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
American Meteorological Society Education Program	This AMS program promotes the teaching of atmospheric, oceanographic, and hydrologic sciences through pre-college teacher training and instructional resource material development. It also promotes instructional innovation at the introductory college course level. All programs promote activity directed toward greater human resource diversity in the sciences AMS represents. To date, over 100,000 teachers have received training and instructional resources, which have benefited millions of students. <a href="#">Partners: NSF, NASA</a>	K–12 Teachers, Introductory College Teachers	Formal (K–12)	<a href="http://www.ametsoc.org/amstedu/">http://www.ametsoc.org/amstedu/</a>
Climate Literacy (“Climate Smart”) through National Marine Sanctuaries	NOAA’s National Marine Sanctuaries works with partnering organizations to offer bilingual (Spanish and English) education to audiences in California on environmental threats, including climate change.	K–12 Teachers, K–12 Students, Public	Formal (K–12)	<a href="http://sanctuaries.noaa.gov/education/merito/welcome.html">http://sanctuaries.noaa.gov/education/merito/welcome.html</a>
Climate Program Office CommEd: Climate Literacy	This program takes an audience-focused approach to promoting climate science literacy among the public. It communicates the challenges, processes, and results of NOAA-supported climate science through stories and data visualizations on the Web and in popular media, and provides information to a range of audiences to enhance society’s ability to plan for and respond to climate variability and change. <a href="#">Partner: U.S. Global Change Research Program</a>	K–12 Teachers	Formal (K–12)	<a href="http://climate.noaa.gov/education/">http://climate.noaa.gov/education/</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>K–12 Teachers (Continued)</b>				
Multicultural Education for Resource Issues Threatening Oceans	As part of the Climate Smart Sanctuaries initiative, NOAA's National Marine Sanctuaries are developing a climate literacy program called MERITO, which is based on the Climate Literacy Essential Principles.	K-12 Teachers, K-12 Students, Public	Formal/Informal	<a href="http://sanctuaries.noaa.gov/education">http://sanctuaries.noaa.gov/education</a>
NSTA Learning Center	The National Science Teachers Association (NSTA) collaborates with NOAA, NASA, and NSF on the NSTA Learning Center to provide a variety of climate-focused online learning experiences to fit the learning style and content needs of 3 million science teachers. Accessible 24 hours a day, The Learning Center is NSTA's e-professional development portal for teachers of science. <a href="#">Partners: NSF, NASA</a>	K–12 Teachers	Formal/Informal	<a href="http://learningcenter.nsta.org/">http://learningcenter.nsta.org/</a>
<b>National Aeronautics and Space Administration (NASA)</b>				
MY NASA DATA	MY NASA DATA works to make NASA Earth science data accessible to the K–12 and citizen scientist communities. The principal activity of the project is to create “micro sets” from large scientific data sets, and to wrap these with tools, lesson plans, and supporting documentation for teachers’ classroom use. Climate change-related lesson plans are available for middle and high school.	K–12 Teachers, K–12 Students, Citizen Scientists	Formal/Informal	<a href="http://mynasadata.larc.nasa.gov/ClimChg_lessons.html">http://mynasadata.larc.nasa.gov/ClimChg_lessons.html</a>
Global Climate Change Education	The GCCE project extends the results of NASA's Earth Science Program to the education community by sponsoring unique and stimulating opportunities for global climate and Earth system science education. GCCE is designed to improve the quality of the nation’s STEM (science, technology, engineering, and mathematics) education and enhance students’ and teachers’ literacy about global climate and Earth system change from elementary grades to lifelong learners. <a href="#">Partners: Related programs at NSF and NOAA</a>	K–12 Teachers, Undergraduate Students, Formal (K–12 and Undergraduate)	Formal/Informal	<a href="http://www.nasa.gov/offices/education/programs/descriptions/Global_Climate_Change_Education_Project.html">http://www.nasa.gov/offices/education/programs/descriptions/Global_Climate_Change_Education_Project.html</a>
Earth System Science Education Alliance	ESSEA is an NSF-supported program implemented by the Institute for Global Environmental Strategies to improve the quality of geoscience instruction for pre-service and in-service K–12 teachers. The program is based on a series of online courses for teachers that are offered by more than 40 participating universities. The inquiry-based and place-based course modules provide teachers with the content knowledge and tools they need to incorporate Earth system science into their curricula. ESSEA modules are also available online as teacher resources. ESSEA was initially developed through NASA support, and many of the course modules use NASA data and content. Some examples of ESSEA course modules include black carbon, Brazilian deforestation, coral reefs, Hurricane Katrina, stratospheric ozone, and sea ice. Additional funding from NASA and NOAA is being used to expand the course modules, including climate change-related resources. <a href="#">Partners: NSF, NOAA</a>	K–12 Teachers, Pre-service Teachers	Formal	<a href="http://esseacourses.strategies.org/">http://esseacourses.strategies.org/</a>
<b>U.S. Department of Agriculture (USDA)/U.S. Forest Service (USFS)</b>				
Forest Service Climate Change Educator Resources	USFS has several interrelated programs to help forests, grasslands, and humans mitigate and adapt to the effects of global climate change. This Web site contains a variety of resources for researchers, managers, educators, and the public on climate change issues and science, and provides links to free climate change education resources.	K–12 Teachers/K–12 Students/Public	Formal/Informal	<a href="http://www.fs.fed.us/climatechange/">http://www.fs.fed.us/climatechange/</a>
Green Schools	In partnership with the American Forest Foundation–Project Learning Tree, USFS selected five schools in Washington, D.C., to pilot the GreenSchools Initiative. The program provides training and funding for diverse and underserved pre-K–12 public schools. Students and teachers investigate environmental issues at their schools and engage with their community in ongoing service-learning projects that create green and healthy learning environments. <a href="#">Partner: American Forest Foundation – Project Learning Tree</a>	Pre-K–12 Teachers/ Pre-K–12 Students/Public	Formal/Informal	<a href="http://www.plt.org/cms/pages/21_23_242.html">http://www.plt.org/cms/pages/21_23_242.html</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>K–12 Teachers (Continued)</b>				
Washington, D.C., Green Summer Jobs Program	USFS is joining Anacostia Urban Tree House partners to train the on-the-ground supervisors of the Washington, D.C., Mayor’s Green Summer Job Corps program, which introduces young District residents to green-collar career paths. The program uses a combination of substantive work projects and traditional educational sessions to increase job readiness, connect youths to the environment within their communities, and improve the District’s environment overall. Broadly, this program complements the District’s efforts in combating climate change, restoring its waterways, and increasing its green infrastructure by engaging youths and preparing them to be part of a future skilled labor force. <i>Partner: DC Mayor’s Green Summer Job Corps program</i>	K–12 Teachers/K–12 Students/Public	Formal/Informal	<a href="http://green.dc.gov/green/cwp/view,a,1233,q,461478.asp">http://green.dc.gov/green/cwp/view,a,1233,q,461478.asp</a>
<b>U.S. National Science Foundation</b>				
Innovative Technology Experiences for Students and Teachers	ITEST addresses the growing U.S. demand for professionals and information technology workers and seeks solutions to help ensure the breadth and depth of the STEM workforce. ITEST supports research studies to address questions about how to find solutions.	K-12 Students, K-12 Teachers	Formal (K-12)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5467">http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5467</a>
<b>Graduate Students</b>				
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
Climate and Society Master’s Program	This program enables understanding of climate science, decision processes, and social needs to deliver management strategies that incorporate climate. The International Research Institute has developed the core courses of the program for Climate and Society in collaboration with renowned Columbia University faculty in climate, engineering, policy, public health, economics, political science, statistics, psychology, sociology, and anthropology.	Graduate Students	Formal (Grad)	<a href="http://www.columbia.edu/cu/climatesociety/">http://www.columbia.edu/cu/climatesociety/</a>
<b>U.S. Environmental Protection Agency</b>				
Science To Achieve Results (STAR) Fellowship Program	The STAR fellowship program exists to help the U.S. meet its current and projected human resource needs in the environmental science, engineering, and policy fields by encouraging promising students to obtain advanced degrees and pursue careers in these areas. The program has provided a steady stream of well-trained environmental specialists to meet such challenges as climate change, and has also supported environmental research in engineering and in the physical, biological, health, and social sciences. A new topic area in the program focuses exclusively on global change.	Graduate Students	Formal (Grad)	<a href="http://www.epa.gov/ncer/fellow/">http://www.epa.gov/ncer/fellow/</a>
<b>U.S. National Science Foundation (NSF)</b>				
Integrative Graduate Education and Research Traineeship Program	This program has been developed to meet the challenges of educating U.S. Ph.D. scientists and engineers who will pursue careers in research and education, with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become, in their own careers, leaders and creative agents for change.	Graduate Students, Professionals	Formal (Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
<b>Undergraduate and Graduate Students</b>				
<b>U.S. Department of Agriculture (USDA)/Cooperative State Research, Education, and Extension Service (CSREES) and National Institute of Food and Agriculture (NIFA)</b>				
Higher Education Challenge Grants	The CSREES/NIFA grant program addresses national priorities in the development of higher education programs and curricula.	Undergraduate and Graduate Students	Formal (Undergrad/ Grad)	<a href="http://www.csrees.usda.gov/">http://www.csrees.usda.gov/</a>
1890 Capacity-Building Grants Program	The CSREES/NIFA grant program addresses capacity building in teaching, research, and extension in national priorities. The program supports the development of courses, curricula, and faculty development in these priorities.	Undergraduate and Graduate Minority Students, Faculty, Scientists, and Extension Agents	Formal (Undergrad/ Grad) and Informal Education	<a href="http://www.csrees.usda.gov">http://www.csrees.usda.gov</a>



Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Undergraduate and Graduate Students (Continued)</b>				
<b>U.S. National Science Foundation (NSF)</b>				
Significant Opportunities in Atmospheric Research in Science	The SOARS undergraduate-to-graduate bridge program is designed to broaden participation in the atmospheric and related sciences. The program is equal parts research internship, learning community, and mentoring. <i>Partner:</i> <a href="#">University Corporation for Atmospheric Research</a>	Undergraduate Students	Formal (Undergrad)	<a href="http://www.soars.ucar.edu/">http://www.soars.ucar.edu/</a>
Ecosystem Studies Program	This program investigates whole-system ecological processes and relationships across a diversity of spatial and temporal (including paleo) scales to advance understanding of: (1) material and energy fluxes and transformations within and among ecosystems; (2) the relationships between structure, including complexity, and functioning of ecosystems; (3) ecosystem dynamics and trajectories of ecosystem development through time; and (4) linkages among ecosystems at different spatial and temporal scales.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Population and Community Ecology Program	This program supports fundamental studies in the broadly defined areas of population and community ecology. Topics include the population dynamics of individual species, demography, and fundamental ecological interactions affecting populations, communities, and their environments. Themes include, but are not limited to: population regulation; food-web structure and trophic dynamics; competition, predation, mutualism, and parasitism; mechanisms of coexistence and the maintenance of species diversity; community assembly; paleoecology; landscape ecology; conservation and restoration biology; behavioral ecology; and macroecology. The program particularly encourages studies that can be applied to a wide range of habitats and taxa across multiple spatial and temporal scales.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Emerging Topics in Biogeochemical Cycles	ETBC proposals should be interdisciplinary and address biogeochemical processes and dynamics within and/or across one or more of the following systems: terrestrial, aquatic, and atmospheric. The program encourages proposals that focus on nonlinear dynamics and/or on interactions and thresholds in climate, ecological, and/or hydrological systems. The goals of this effort are to increase understanding of how biological systems respond to changing physical and chemical conditions and influence the physical and chemical characteristics of soils and sediments, air, or water.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/pubs/2009/nsf09030/nsf09030.jsp">http://www.nsf.gov/pubs/2009/nsf09030/nsf09030.jsp</a>
Multi-Scale Modeling	The MSM program seeks to support projects that focus on the development and/or integration of environmental models that link local, regional, and global scales. Proposals are encouraged that have the potential to dramatically improve understanding of how small- and large-scale processes lead to non-linearities and activation thresholds, as well as to improve predictive capabilities. Projects could address, but are not limited to, such topics as the carbon cycle, climate, population dynamics, food webs, biodiversity, biogeochemical cycles, and hydrological processes.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/pubs/2009/nsf09032/nsf09032.jsp">http://www.nsf.gov/pubs/2009/nsf09032/nsf09032.jsp</a>
Emerging Frontiers in Research and Innovation	The EFRI Office is launching a new funding opportunity for interdisciplinary teams of researchers to embark on rapidly advancing frontiers of fundamental engineering research. For this solicitation, the EFRI Office will consider proposals that aim to investigate emerging frontiers in (1) Renewable Energy Storage and (2) Science in Energy and Environmental Design: Engineering Sustainable Buildings. This solicitation will be coordinated with other NSF Directorates, as well as with the U.S. Department of Energy (DOE), and EPA. <i>Partners:</i> DOE, EPA	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Energy for Sustainability	This program supports fundamental research and education in energy production, conversion, and storage, and is focused on environmentally friendly and renewable energy sources.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Environmental Engineering	The goal of this program is to encourage transformative research that applies scientific principles to minimize solid, liquid, and gaseous discharges into land, inland and coastal waters, and air that result from human activity, and to evaluate the adverse impacts of these discharges on human health and environmental quality.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Undergraduate and Graduate Students (Continued)</b>				
Environmental Implications of Emerging Technologies	This program seeks fundamental and basic research to establish and understand outcomes as a result of the implementation of new technologies, such as nanotechnology and biotechnology. The program also supports research on the development and refinement of sensors and sensor network technologies that can be used to measure a wide variety of physical, chemical, and biological properties of interest in characterizing, monitoring, and understanding environmental impacts.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Environmental Sustainability	This program supports engineering research with the goal of promoting sustainable, engineered systems that support human well-being and that are also compatible with sustaining natural (environmental) systems that provide ecological services vital for human survival. The long-term viability of natural capital is critical for many areas of human endeavor. This program typically considers long time horizons and may incorporate contributions from the social sciences and ethics.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Decision, Risk and Management Sciences	This program supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decision making; and management science and organizational design.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Climate and Large-Scale Dynamics	The goals of this program are to: (1) advance knowledge about the processes that force and regulate the atmosphere's synoptic and planetary circulation, weather, and climate; and (2) sustain the pool of human resources required for excellence in synoptic and global atmospheric dynamics and climate research.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Climate Process and Modeling Teams	This concept aims to speed development of global coupled climate models and reduce uncertainties in climate models by bringing together theoreticians, field observationalists, process modelers, and the large modeling centers to concentrate on the scientific problems facing climate models today.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Paleo Perspectives on Climate Change	The goal of research funded under the interdisciplinary P2C2 solicitation is to utilize key geological, chemical, and biological records of climate system variability to provide insights into the mechanisms and rate of change that characterized Earth's past climate variability, the sensitivity of Earth's climate system to changes in forcing, and the response of key components of the Earth system to these changes.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Paleoclimate	NSF supports research on the natural evolution of Earth's climate, with the goal of providing a baseline for present variability and future trends through improved understanding of the physical, chemical, and biological processes that influence climate over the long term.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Global Ocean Ecosystems Dynamics Program: Pan-Regional Synthesis	As the culmination of a series of solicitations for U.S. GLOBEC, this solicitation seeks a broader understanding of climate impacts on marine ecosystems that builds upon findings from the three regional U.S. GLOBEC studies: the Northwest Atlantic, the Northeast Pacific, and the Southern Ocean.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Collaboration in Mathematical Geosciences	CMG aims to enable collaborative research at the intersection of mathematical sciences and geosciences, and to encourage cross-disciplinary education. Projects should fall within one of three broad themes: (1) conducting mathematical and statistical modeling of complex geosystems, (2) understanding and quantifying uncertainty in geosystems, or (3) analyzing large/complex geoscience data sets.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Undergraduate and Graduate Students (Continued)</b>				
Environment, Society, and the Economy	The Intergovernmental Group on Earth Observations and the Directorate for Social, Behavioral, and Economic Sciences will consider proposals that describe new research efforts relating to the integrated study of environment, society, and economics. Interdisciplinary teams of researchers are strongly encouraged. Projects are expected to involve researchers in the geosciences and social and behavioral sciences, but may also include other disciplines.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/pubs/2009/nsf09031/nsf09031.jsp">http://www.nsf.gov/pubs/2009/nsf09031/nsf09031.jsp</a>
CHE-DMR-DMS Solar Energy Initiative	The SOLAR initiative supports interdisciplinary efforts by groups of researchers from the NSF Divisions of Chemistry (CHE), Materials Research (DMR), and Mathematical Sciences (DMS) to address the scientific challenges of highly efficient harvesting, conversion, and storage of solar energy.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_id">http://www.nsf.gov/funding/pgm_summ.jsp?pims_id</a>
Antarctic Earth Sciences Program	Beneath its thick ice sheets, Antarctica is a dynamic and diverse continent with mountains, volcanoes, deserts, meteorites, dinosaur fossils, and some of Earth's most ancient crust. The Antarctic Earth Sciences Program supports research to interpret this rich history and the processes that shape Antarctica today.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Antarctic Glaciology Program	This program is concerned with the study of the history and dynamics of all naturally occurring forms of snow and ice, including floating ice shelves, glaciers, and continental and marine ice sheets. Program emphases include paleoenvironments from ice cores, ice dynamics, numerical modeling, glacial geology, and remote sensing of ice sheets.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Antarctic Ocean and Atmospheric Sciences	Antarctic oceanic and tropospheric studies focus on the structure and processes of the ocean-atmosphere environment and their relationships with the global ocean, the atmosphere, and the marine biosphere. As part of the global heat engine, the Antarctic has a major role in the world's transfer of energy. Its ocean-atmosphere system is known to be both an indicator and a component of climate change.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Antarctic Organisms and Ecosystems	The goal of this program is to improve understanding of Antarctic organisms and their interactions within the biosphere and geosphere. The program supports projects directed at all levels of biological organization, from molecular, cellular, and organismal, to communities and ecosystems, up to regional and global scales. Investigators are encouraged to develop and apply theory and innovative technologies to understand how organisms adapt to and live in high-latitude environments and how populations and ecosystems may respond to global change.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Arctic Natural Sciences Program	Areas of special program interest include marine and terrestrial ecosystems, Arctic atmospheric and oceanic dynamics and climatology, Arctic geological and glaciological processes, and their connectivity to lower latitudes.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Arctic Observing Network	Compared with much of the rest of the planet, the Arctic is a data-sparse region where large, rapid, and system-wide environmental change is occurring. The Arctic Observing Network aims to enhance the environmental observing infrastructure required for the scientific investigation of Arctic environmental change and its global connections.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Arctic System Science Program	The Arctic system behaves in ways that we do not understand fully, and has demonstrated the capacity for rapid and unpredictable change with global ramifications. Because the Arctic is pivotal to the dynamics of our planet, it is critical that we understand this complex and interactive system.	Undergraduate Students, Graduate Students, Professionals	Formal (Undergrad/ Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences	The goal of this activity is to enhance undergraduate education and training at the intersection of the biological and mathematical sciences and to better prepare undergraduate biology or mathematics students to pursue graduate study and careers in fields that integrate the mathematical and biological sciences.	Undergraduate Students, Professionals	Formal (Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>



Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Informal Educators, Public</b>				
<b>U.S. National Science Foundation (NSF)</b>				
Informal Science Education	ISE invests in projects that promote lifelong learning of STEM in a wide variety of informal settings. Funding is provided for projects that advance understanding of informal STEM learning, develop and implement innovative strategies and resources for informal STEM education, and build the national professional capacity for research, development, and practice in the field.	Informal Educators, Public	Informal	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
<b>National Aeronautics and Space Administration (NASA)</b>				
Earth to Sky: Climate Change Professional Development for Informal Educators	Earth to Sky is an ongoing and expanding partnership between NASA, the National Park Service (NPS), and the U.S. Fish and Wildlife Service (USFWS), providing professional development for informal educators to access and use relevant NASA science, data, and educational products in their work. <i>Partners: NPS, USFWS</i>	Informal Educators	Training	<a href="http://www.earthtosky.org/">http://www.earthtosky.org/</a>
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
Environmental Literacy Grants Program	The NOAA Office of Education supports applications for projects designed to build capacity within NOAA's Science On a Sphere (SOS) <sup>®</sup> Users Collaborative Network (Network) to enhance the educational use of spherical display systems as public exhibits, environmental literacy projects in support of K–12 education, and Free-Choice Learning projects that will create new, or capitalize on existing, networks of institutions, agencies, and/or organizations to provide common messages about key concepts in Earth system science.	Formal/Informal Educators	Formal/Informal	<a href="http://www.oesd.noaa.gov/funding_opps.html">http://www.oesd.noaa.gov/funding_opps.html</a>
Ocean Education Grants for AZA-Accredited Aquariums	The NOAA Office of Education issued a request for applications to support education projects in aquariums accredited by the Association of Zoos and Aquariums that are designed to engage the public in activities that increase ocean and/or climate literacy and the adoption of a stewardship ethic.	Informal Educators	Informal	<a href="http://www.oesd.noaa.gov/funding_opps.html">http://www.oesd.noaa.gov/funding_opps.html</a>
Science On a Sphere	SOS <sup>®</sup> is a spherical display system approximately 6 feet in diameter that shows “movies” of animated Earth system dynamics. NOAA supports the use of SOS <sup>®</sup> in public exhibits as part of a focused effort to increase environmental literacy. The institutions that currently have NOAA's SOS <sup>®</sup> , as well as other partners who are creating content and educational programming for these systems, have formed a collaborative network. <i>Partners: NASA, DOE</i>	Informal Educators	Informal	<a href="http://www.sos.noaa.gov/">http://www.sos.noaa.gov/</a> ; <a href="http://www.oesd.noaa.gov/network/">http://www.oesd.noaa.gov/network/</a>
International Action on Global Warming	IGLO is a project of the Association of Science-Technology Centers, an international organization of science centers and museums dedicated to furthering the public understanding of science. IGLO is designed to raise worldwide public awareness about global warming and the particular ways that the polar regions profoundly influence Earth's climate, environments, ecosystems, and human society. IGLO's activities present the best of current research to an international audience and explain how global warming affects their daily lives. <i>Partners: NSF, NASA</i>	Informal Educators	Informal	<a href="http://astc.org/iglo/">http://astc.org/iglo/</a>
<b>Formal/Informal Educators</b>				
<b>U.S. Global Change Research Program (USGCRP)</b>				
<i>Climate Literacy: The Essential Principles of Climate Sciences—A Guide for Individuals and Communities</i>	This guide presents important information for individuals and communities to understand Earth's climate, the impacts of climate change, and approaches for adapting to and mitigating change. Principles in the guide can serve as discussion starters or launching points for scientific inquiry. The guide can also serve educators who teach climate science as part of their science curricula, and is available to help individuals of all ages understand how climate influences them—and how they influence climate. The guide was compiled by an interagency group led by NOAA.	Formal/Informal Educators	Formal/Informal	<a href="http://globalchange.gov/resources/educators/climate-literacy">http://globalchange.gov/resources/educators/climate-literacy</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Formal/Informal Educators (Continued)</b>				
Climate Change, Wildlife and Wildlands Toolkit for Formal and Informal Educators	This new toolkit is an updated and expanded version of the award-winning, popular Climate Change, Wildlife and Wildlands Toolkit for Teachers and Interpreters, first published in 2001. It profiles climate stewards in all 11 eco-regions. For example, students can participate in programs that grow native plants for wetland and dune restoration projects, or help protect terrapins endangered by sea level rise, or train citizen scientists to monitor bird migrations and spring “budbursts.” The new kit is designed for classroom teachers and informal educators in parks, refuges, forest lands, nature centers, zoos, aquariums, science centers, etc., who work with the middle school grade level. EPA, in partnership with six other federal agencies (NPS, USFWS, NOAA, NASA, USDA/USFS, Bureau of Land Management), developed the kit to aid educators in teaching how climate change is affecting our nation’s wildlife and public lands, and how everyone can become climate stewards.	Formal/Informal Educators	Formal/Informal	<a href="http://globalchange.gov/resources/educators/toolkit/">http://globalchange.gov/resources/educators/toolkit/</a>
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
Office of Education: Environmental Literacy Grants	This program supports applications for projects designed to build capacity within NOAA’s Science On a Sphere (SOS) <sup>®</sup> Users Collaborative Network to enhance the educational use of spherical display systems as public exhibits, environmental literacy projects in support of K–12 education, and Free-Choice Learning projects that create new, or capitalize on existing, networks of institutions, agencies, and/or organizations to provide common messages about key concepts in Earth system science.	Formal/Informal Educators	Formal/Informal	<a href="http://www.oesd.noaa.gov/funding_oppo.html">http://www.oesd.noaa.gov/funding_oppo.html</a>
NOAA’s International Polar Year Program	Throughout the 2007–2009 period of the International Polar Year (IPY), NOAA and several other federal agencies were involved in numerous educational programs and activities to help educators and students understand the polar regions, as well as continuing stewardship of Earth. NOAA’s Climate Program Office and Office of Education coordinated the NOAA-wide IPY education and outreach activities and other agencies’ activities that focused primarily on teacher professional development, as well as developing materials for use in classrooms, science centers, and museums. Additionally, “The Arctic: A Friend Acting Strangely” exhibition was developed by the Smithsonian Institution’s National Museum of Natural History with a grant from NOAA’s Arctic Research Office. The exhibition puts a human face on warming in the Arctic by exploring how changes have been observed and documented by scientists and polar residents alike. <i>Partners: Smithsonian Institution, NASA, NSF, USGS</i>	Formal/Informal Educators	Formal/Informal	<a href="http://ipy.noaa.gov/">http://ipy.noaa.gov/</a> and <a href="http://forces.si.edu/arctic/">http://forces.si.edu/arctic/</a>
<b>U.S. Environmental Protection Agency (EPA)</b>				
Environmental Education Grant Program	This program distributes over \$3 million annually to formal and informal education organizations across the nation to provide environmental education programs to learners of all ages. Many of these grants have been awarded to climate change education programs over the last several years, including public school districts, privately run nature centers, public and private colleges and universities, and community organizations.	Formal/Informal Educators	Formal/Informal	<a href="http://www.epa.gov/enviroed/">http://www.epa.gov/enviroed/</a>
<b>General Audiences (Undergraduate Students, Graduate Students, K–12 Students, K–12 Teachers, Informal Educators, Professionals, Public)</b>				
<b>U.S. Department of Agriculture (USDA)/Cooperative State Research, Education, and Extension Service (CSREES) and National Institute of Food and Agriculture (NIFA)</b>				
Higher Education Challenge Grants	This grant program addresses national priorities in the development of higher education programs and curricula.	Undergraduate and Graduate Students	Formal (Undergrad/ Grad)	<a href="http://www.csrees.usda.gov/">http://www.csrees.usda.gov/</a>
<b>U.S. National Science Foundation (NSF)</b>				
National STEM Education Distributed Learning	NSDL aims to establish a national network of learning environments and resources for science, technology, engineering, and mathematics (STEM) education at all levels.	Undergraduate Students, Graduate Students, K–12 Students, K–12 Teachers, Professionals, Public	Formal/Informal	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>General Audiences (Undergraduate Students, Graduate Students, K–12 Students, K–12 Teachers, Informal Educators, Professionals, Public) (Continued)</b>				
Dynamics of Coupled Natural and Human Systems	CNH promotes quantitative, interdisciplinary analyses of relevant human and natural system processes and complex interactions among human and natural systems at diverse scales.	Undergraduate Students, Graduate Students, K–12 Teachers	Formal (K–12, Undergrad, Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Geoscience Education	GeoEd aims to improve the quality of geoscience education at all educational levels; increase the number and competency of Earth and space science teachers at K–12 levels; demonstrate the relevance of the geosciences by identifying and promoting traditional and nontraditional career opportunities in the field; increase the number of students enrolling in geoscience courses and degree programs at all educational levels; increase the number of students drawn from groups underrepresented in STEM fields in geoscience courses and degree programs; and increase the public’s understanding of geoscience-related issues.	Undergraduate Students, Graduate Students, K–12 Teachers, Professionals	Formal (K–12, Undergrad, Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Centers for Ocean Science Education Excellence	With 12 Centers and a Central Coordinating Office located throughout the United States, each COSEE Center is a consortium of one or more ocean science research institutions, informal science education organizations, and formal education entities. COSEE is funded primarily by NSF, with support from NOAA. In addition to the work at the Centers, the program engages in network-level activities, such as scientist-educator partnerships, ocean literacy, and promoting ocean careers. <i>Partner: NOAA</i>	Graduate Students, K–12 Teachers and Students, Informal Educators, Professionals	Formal (K–12, Undergrad, Grad), Informal	<a href="http://www.cosee.net">http://www.cosee.net</a>
Arctic Research and Education Program	Arctic research spans the major STEM fields and is often multi- or interdisciplinary. Research in the Arctic has clear applications for education and outreach at many levels. The region itself is an interesting hook for teaching about life, physical, and social sciences, and concepts such as ocean and atmosphere circulation, climate, Earth system science, animal migrations, and life in extreme environments.	Undergraduate Students, Graduate Students, K–12 Teachers, Professionals	Formal (K–12 Undergrad, Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
Organization of Projects on Environmental Research in the Arctic	This program seeks proposals for activities to foster and sustain collaboration among projects funded by NSF that contribute to the U.S. Arctic environmental change research effort.	Undergraduate Students, Graduate Students, K–12 Teachers, Professionals	Formal (K–12 Undergrad, Grad)	<a href="http://www.nsf.gov/funding/pgm_summ.jsp?pims_">http://www.nsf.gov/funding/pgm_summ.jsp?pims_</a>
<b>Public</b>				
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
National Snow and Ice Data Center	The Center manages about 60 NOAA data sets, and publishes several new data sets each year, with an emphasis on <i>in situ</i> data, digitizing old and sometimes forgotten but valuable analog data, and data sets from operational communities, such as the U.S. Navy. The Center also helps develop educational pages, created Google Earth™ files that enable the public to overlay data-based images on a virtual globe, and houses many photographic prints of glaciers, taken from both the air and the ground. <i>Partners: NSF, NASA</i>	Public	Informal	<a href="http://nsidc.org/data/virtual_globes/">http://nsidc.org/data/virtual_globes/</a>
Sea Grant	NOAA’s Sea Grant is a nationwide network of 32 university-based programs that work with coastal communities. The National Sea Grant College Program engages this network of the nation’s top universities in conducting scientific research, education, training, and extension projects designed to foster science-based decisions about the use and conservation of natural resources and to increase coastal resiliency. The Sea Grant network is engaged in a multifaceted and diverse series of programs to address climate change in coastal and Great Lakes regions.	Public	Formal/Informal	<a href="http://www.seagrants.noaa.gov/">http://www.seagrants.noaa.gov/</a>



Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Public (Continued)</b>				
<b>U.S. Environmental Protection Agency (EPA)</b>				
Climate Change and Health Effects on Older Adults	This Web page is the top site the public sees on Google when searching for information about older adults and climate change. A fact sheet entitled "It's Too Darn Hot: Planning for Excessive Heat Events" was developed and has been widely disseminated throughout aging and public health networks. Now in its second printing, this fact sheet was translated into 15 languages. "Beat the Heat" posters highlighting key messages about steps to take during extreme heat are available in English and Spanish and have been shared in senior centers around the country.	Public	Informal	<a href="http://www.epa.gov/aging/resources/climatechange/index.htm">http://www.epa.gov/aging/resources/climatechange/index.htm</a> ; <a href="http://www.epa.gov/aging/resources/factsheets/itdhpfefe/index.htm">http://www.epa.gov/aging/resources/factsheets/itdhpfefe/index.htm</a>
Climate Change	Managed by EPA's Climate Change Division, this Web site is rated number one for "climate change" hits in the Google search engine. It offers comprehensive information accessible to U.S. and international visitors—communities, individuals, businesses, states and localities, and governments. The site features information about climate change science, greenhouse gas emissions and inventories, health and environmental effects, U.S. climate policy, mitigation and adaptation opportunities, educational resources, and EPA's varied activities on the issue. In response to public inquiries, a "Frequent Questions" database was added in 2009; other updates and improvements are planned for 2010. Many informational fact sheets and tools can be downloaded for printing.	Public	Formal/Informal	<a href="http://www.epa.gov/climatechange">http://www.epa.gov/climatechange</a>
Individual Emissions Calculator	This calculator is one of the most popular features of the Climate Change Web site. Individuals can use it to get a "ballpark" estimate of personal or family greenhouse gas emissions, and also explore the impact of taking various actions to reduce emissions. Newspapers and other media outlets frequently feature this useful tool to help consumers learn about their own habits' effects on energy consumption and climate change.	Public	Formal/Informal	<a href="http://www.epa.gov/climatechange/emissions/ind_calculator.html">http://www.epa.gov/climatechange/emissions/ind_calculator.html</a>
Climate "Back to Basics" Informational Materials	Among the resources available on the climate change site and in print form is a series of What You Can Do fact sheets and Web pages that provide over 25 easy steps readers can take to not only reduce greenhouse gas emissions, but also increase energy efficiency and save resources. A related science education resource for adults and students is the brochure "Frequently Asked Questions About Global Warming and Climate Change: Back to Basics." The brochure addresses key questions about this issue by restating in easy-to-understand language the most current climate science from widely accepted, peer-reviewed scientific literature.	Public	Formal/Informal	<a href="http://www.epa.gov/climatechange/wycd">http://www.epa.gov/climatechange/wycd</a> ; <a href="http://www.epa.gov/climatechange/downloads/Climate_Basics.pdf">www.epa.gov/climatechange/downloads/Climate_Basics.pdf</a>
Climate Friendly Parks	EPA worked closely with the National Park Service to establish this program to provide national parks with management tools and resources to address greenhouse gas emissions and climate change effects in the parks. In some cases, local communities, nonprofit organizations, and others have taken on projects and programs to enhance this joint partnership over the last few years. This program provides awareness-raising and educational activities through staff and community workshops, instruction in the use of greenhouse gas inventory tools, and pledges for park visitors to reduce their carbon footprint. <i>Partner: National Park Service</i>	Public/ Professionals	Informal	<a href="http://www.nps.gov/climatefriendlyparks">http://www.nps.gov/climatefriendlyparks</a>
<i>Climate Change Indicators in the United States</i>	This path-breaking report presents 24 indicators, each describing trends in some way related to the state, causes, and effects of climate change. The indicators focus primarily on the United States, but in some cases present global trends to provide context or a basis for comparison. Indicators are divided into five chapters: Greenhouse Gases, Weather and Climate, Oceans, Snow and Ice, and Human Society and Ecosystems. Data sources come from EPA, other government agencies, academia, and nongovernmental organizations.	Public/ Professionals	Formal/Informal	Under development

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Public (Continued)</b>				
Climate Ready Estuaries	This program works with EPA's National Estuary Program and other coastal managers to assess climate change vulnerabilities, develop and implement adaptation strategies, engage and educate stakeholders, and share the lessons learned with other coastal managers. The program's Web site offers information on climate change impacts on estuaries in various U.S. regions, access to tools and resources to monitor changes, and information to help managers develop adaptation plans for estuaries and coastal communities. By fostering information sharing among estuary managers and communities around America's coasts, this program promotes adaptation to a changing climate.	Public/ Professionals	Training	<a href="http://www.epa.gov/cre">www.epa.gov/cre</a>
<b>U.S. Department of Agriculture (USDA)/U.S. Forest Service (USFS)</b>				
Forest Service Research Web Site	This site provides online access to USFS climate change research.	Public	Formal/Informal	<a href="http://www.fs.fed.us/research/climate/usfs-cc-research.shtml">http://www.fs.fed.us/research/climate/usfs-cc-research.shtml</a>
Climate Change in the Southern Region	This Web site provides information on upcoming climate change seminars, climate-related reading materials, regional and agency climate initiatives, and tips for reducing one's carbon footprint. Additionally, leaders from various resource areas participate in region-wide climate change seminars, discussing such topics as region-specific information, adaptation, carbon, and planning.	Public	Formal/Informal	<a href="http://fsweb.r8.fs.fed.us/climate/index.php">http://fsweb.r8.fs.fed.us/climate/index.php</a>
Treesearch	This online search engine provides access to almost 30,000 USFS publications, including over 4,500 climate change-related publications for the general public and land managers.	Public	Formal/Informal	<a href="http://www.treesearch.fs.fed.us">http://www.treesearch.fs.fed.us</a>
i-Tree	i-Tree is a state-of-the-art, peer-reviewed software suite that provides urban forestry analysis and benefits assessment tools. The i-Tree tools help professionals in communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide, including those that mitigate the effects of climate change.	Public/ Professionals	Formal/Informal	<a href="http://www.itreetools.org/">http://www.itreetools.org/</a>
Task Force on Traditional Forest Knowledge	This USFS Research and Development and International Union of Forest Research Organizations task force provides information on traditional forest knowledge and practices related to climate change.	Public/ Professionals	Formal/Informal	<a href="http://www.iufro.org/science/task-forces/traditional-forest-knowledge/">http://www.iufro.org/science/task-forces/traditional-forest-knowledge/</a>
<i>National Report on Sustainable Forests—2010</i>	This draft report provides access to a public review draft in preparation for its 2010 release. It is designed for the general public and managers.	Public/ Professionals	Formal/Informal	<a href="http://www.fs.fed.us/research/sustain/">http://www.fs.fed.us/research/sustain/</a>
<b>U.S. Department of Energy (DOE)</b>				
Atmospheric Radiation Measurement Climate Research Facility	The ARM program provides online materials to develop basic science awareness related to climate change and supports community outreach in ARM program site regions.	Public	Formal/Informal	<a href="http://education.arm.gov">http://education.arm.gov</a>
<b>U.S. Department of Transportation (DOT)</b>				
Hydrogen Working Group	In 2009, the Hydrogen Working Group distributed \$900,000 to five projects with a focus on outreach.	Public, Government	Informal	<a href="http://hydrogen.dot.gov/">http://hydrogen.dot.gov/</a>
University Transportation Centers	This program awards grants to universities across the United States to advance the state of the art in transportation research and develop the next generation of transportation professionals.	Public	University	<a href="http://utc.dot.gov/">http://utc.dot.gov/</a>
Transportation and Climate Change Clearinghouse	This Web site aims to serve as a one-stop source of information for the transportation community on transportation and climate change issues. Intended for use by all levels of government, private industry, and nonprofit organizations, the site provides a forum to share information, learn about new research, and understand practices and approaches being used to address the linkages between transportation and climate change. The Clearinghouse is funded jointly through the National Cooperative Highway Research Program and DOT's Center for Climate Change and Environmental Forecasting.	Public	Online	<a href="http://www.climate.dot.gov">http://www.climate.dot.gov</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Public (Continued)</b>				
<b>National Aeronautics and Space Administration (NASA)</b>				
Global Climate Change: NASA's Eyes on the Earth	This Web resource for educators, citizen scientists, and the public includes the planet's vital signs, feature stories, visualizations, and links to NASA missions involved in investigating climate change.	Public, K–12 Students, K–12 Teachers, Informal Educators	Informal	<a href="http://climate.nasa.gov/">http://climate.nasa.gov/</a>
Earth Observatory	The award-winning Earth Observatory's Web site's mission is to share with the public the images, stories, and discoveries about climate and the environment that emerge from NASA and Earth science research, including satellite missions, in-the-field research, and climate models.	Public, K–12 Students, K–12 Teachers, Informal Educators	Informal	<a href="http://earthobservatory.nasa.gov/">http://earthobservatory.nasa.gov/</a>
<b>Professionals</b>				
<b>U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)</b>				
Coastal Training Program	This program provides up-to-date scientific information and skill-building opportunities to individuals who are responsible for making decisions that affect coastal resources. Through this program, National Estuarine Research Reserves can ensure that coastal decision makers have the knowledge and tools they need to address critical resource management issues of concern to local communities.	Professionals	Training	<a href="http://www8.nos.noaa.gov/publicnerrs/training.aspx">http://www8.nos.noaa.gov/publicnerrs/training.aspx</a>
Coastal Resource Managers Training and Capacity Building	NOAA's Coastal Services Center works with other federal agencies to impart information, services, and technology to the nation's coastal resource managers. This community includes state coastal zone management and natural resource management offices, research reserves, sanctuaries, and Sea Grant offices. Each of these organizations has the difficult task of helping coastal communities balance the often competing demands for coastal resources.	Professionals	Training	<a href="http://oceanservice.noaa.gov/topics/coasts/training/">http://oceanservice.noaa.gov/topics/coasts/training/</a>
Responding to Climate Change: A Workshop for Coral Reef Managers	Resources from a global series of workshops are distributed to coral reef managers to support their learning of how to predict where coral bleaching will occur, measure coral reef resilience, and assess the socioeconomic impacts of climate damage. The aim is to help managers develop response strategies for coping with climate change. NOAA, the Great Barrier Reef Marine Park Authority, and The Nature Conservancy host the workshops. These partners joined with the International Union for the Conservation of Nature on <i>A Reef Manager's Guide to Coral Bleaching</i> , the book that inspired these workshops. <a href="#">Partners: Great Barrier Reef Marine Park Authority, The Nature Conservancy</a>	Professionals	Training	<a href="http://coralreefwatch.noaa.gov/satellite/education/workshop/index.html">http://coralreefwatch.noaa.gov/satellite/education/workshop/index.html</a>
Training Program in Climate Services	NOAA's National Weather Service initiated a training program in climate services in 2001 to increase the knowledge base of its field staff. It included about 25 hours of online distance learning material, a 5-day virtual course on Climate Variability and Change, and a 3-day residence course on Operational Climate Services. Due to the continuing interest in global and regional climate variability and change as well as their local impacts on socioeconomic development, this training program is expanding.	Professionals, Graduate Students, Educators	Training	<a href="http://www.nws.noaa.gov/om/csd/pds/DistanceLearning.shtml">http://www.nws.noaa.gov/om/csd/pds/DistanceLearning.shtml</a>
<b>U.S. Department of Agriculture (USDA)/U.S. Forest Service (USFS)</b>				
Climate Change Resource Center: Information and Tools for Land Managers	The Center is a joint project of USFS's Pacific Northwest Research Station and Rocky Mountain Research Station. This Web-based resource summarizes climate change research for resource managers, provides implications for management based on the scientific findings, and contains video presentations from scientists describing their findings.	Professionals	Formal/Informal	<a href="http://www.fs.fed.us/ccrc/">http://www.fs.fed.us/ccrc/</a>
Western Wildland Environmental Threat Assessment Center	The Center's mission is to generate and integrate knowledge and information to provide credible prediction, early detection, and quantitative assessment of environmental threats in the western United States. The Center provides regional online access to the general public and land managers.	Professionals	Formal/Informal	<a href="http://www.fs.fed.us/wwetac/threats/climate_change.html">http://www.fs.fed.us/wwetac/threats/climate_change.html</a>
Eastern Forest Environmental Threat Assessment Center	The Center is an interdisciplinary resource that develops new technology and tools to anticipate and respond to emerging eastern forest threats, including climate change. Center researchers work with other scientists nationally as well as with a variety of federal, state, and local government agencies, universities, and nongovernmental partners to address these threats. The Center provides regional online access to the general public and land managers.	Professionals	Formal/Informal	<a href="http://www.forestthreats.org/climate-change">http://www.forestthreats.org/climate-change</a>

Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

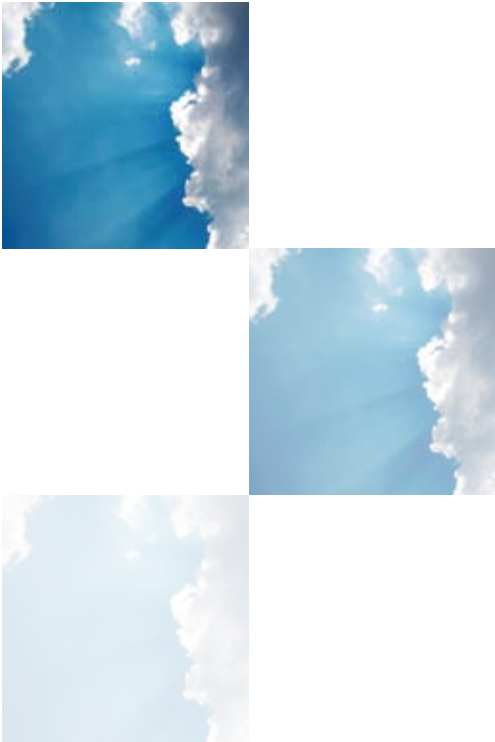
Program Name	Description	Audiences	Learning Setting	Web Site
<b>Professionals (Continued)</b>				
<b>U.S. Department of the Interior (DOI)/National Park Service (NPS)</b>				
Climate Leadership In Parks (CLIP) Tool	This Microsoft Excel-based calculator is designed for parks to assess their greenhouse gas emissions. It focuses on operational activities—electricity use, transportation, waste and wastewater treatment, and other greenhouse gas-emitting activities—inside parks. While this tool has a method for calculating forest carbon flux, it is not the most up-to-date tool, nor is it specific enough to adequately represent park forest carbon storage/emissions. For parks that want to include forest carbon in their reporting, NPS recommends that they use the latest forest models to calculate the flux, and then enter the numbers into the CLIP tool.	Professionals	Training	<a href="http://www.nps.gov/climatefriendlyparks/index.html">http://www.nps.gov/climatefriendlyparks/index.html</a>
<b>U.S. Department of the Interior (DOI)</b>				
Regional Climate Change Response Centers	The eight DOI regional centers—serving Alaska, the Northeast, the Southeast, the Southwest, the Midwest, the West, the Northwest, and the Pacific regions—synthesize existing climate change impact data and management strategies, help resource managers put them into action on the ground, and engage the public through education initiatives.	Professionals	Training	<a href="http://www.doi.gov/news/09_News_Releases/091409.html">http://www.doi.gov/news/09_News_Releases/091409.html</a>
<b>U.S. Department of Transportation (DOT)</b>				
Climate Change Forums	DOT's Center for Climate Change and Environmental Forecasting offers this ongoing series to raise awareness of the many and varied perspectives of American industry, government, and nonprofit organizations.	Professionals (government employees)	Classroom/Briefing Style	
<b>U.S. Department of Transportation/Federal Aviation Administration (FAA)</b>				
Partnership for Air Transportation Noise and Emissions Reduction	PARTNER is a leading aviation cooperative research organization and an FAA/NASA/Transport Canada-sponsored Center of Excellence. It fosters break-through technological, operational, policy, and workforce advances for the betterment of mobility, economy, national security, and the environment. The organization comprises 9 universities and 51 advisory board members. PARTNER has funded outreach and educational activities, and the research of more than 200 master's and Ph.D. students, many in climate research.	Professionals (aviation stakeholders, including airlines, airports, manufacturers, the public, and government organizations)	Formal/Informal	<a href="http://www.partner.aero">http://www.partner.aero</a>
<b>U.S. Department of Transportation/Federal Highway Administration (FHWA)</b>				
Peer Exchanges on Transportation and Climate Change Mitigation and Adaptation Issues	Conducted in 2008, these workshops allowed senior staff from a variety of metropolitan planning organizations (MPOs) and state departments of transportation (DOTs) from across the country to come together to share information, experiences, and challenges regarding how both climate change mitigation and adaptation issues can be integrated into the transportation planning process. FHWA (with support from the American Association of State Highway Transportation Officials (AASHTO) conducted a peer exchange on adaptation of transportation infrastructure to climate change impacts in December 2008. <a href="#">Partner: AASHTO</a>	Professionals (state DOTs, local transportation agencies, MPOs)	Formal/Informal	<a href="http://www.fhwa.dot.gov/hep/climate/resources.htm">http://www.fhwa.dot.gov/hep/climate/resources.htm</a> or <a href="http://www.fhwa.dot.gov/planning/statewide/pwsacci.htm">http://www.fhwa.dot.gov/planning/statewide/pwsacci.htm</a>
Highways & Climate Change	DOT's Office of Planning, Environment and Realty's Web site provides information on FHWA research, publications, and resources related to climate change science, policies, and actions. Visitors will also find some current state and local practices in adapting to climate change and reducing greenhouse gas emissions, and the <i>Transportation and Climate Change Newsletter</i> .	Professionals (state DOTs, local transportation agencies, MPOs, public)	Formal/Informal	<a href="http://www.fhwa.dot.gov/hep/climate/index.htm">http://www.fhwa.dot.gov/hep/climate/index.htm</a> ; <a href="http://www.fhwa.dot.gov/hep/climatechange/newsletter/index.htm">http://www.fhwa.dot.gov/hep/climatechange/newsletter/index.htm</a>



Table 9-1 (Continued) **Federal Climate Change Programs Grouped by Primary Audience**

Program Name	Description	Audiences	Learning Setting	Web Site
<b>Professionals (Continued)</b>				
<b>U.S. Department of Transportation/Federal Transit Administration (FTA)</b>				
Education and Outreach Conferences	FTA organizes, sponsors, and participates in numerous conferences as part of its outreach efforts, including conferences and sessions geared toward education on environmental and climate change issues. In 2009, FTA sponsored and participated in climate change panels at the annual Transportation Research Board conference, the Rail-Volution conference, the American Public Transportation Association sustainability workshop, and the New Partners for Smart Growth conference.	Professionals (transit agencies, state and local governments, academics)	Conferences	<a href="http://www.fta.dot.gov/news/news_events_415.html">http://www.fta.dot.gov/news/news_events_415.html</a>
Transit and Environmental Sustainability	This Web site provides the public and transit agencies with information on the environmental benefits of transit (including reducing greenhouse gas emissions), FTA activities to support sustainability, and information on what transit agencies are doing across the country to reduce the environmental impacts of transportation.	Professionals (transit agencies, state and local governments, public)	Web Site	<a href="http://www.fta.dot.gov/planning/planning_environment_8510.html">http://www.fta.dot.gov/planning/planning_environment_8510.html</a>
National Transit Institute	Established under the Intermodal Surface Transportation Efficiency Act of 1991, the NTI provides training, education, and clearinghouse services in support of U.S. public transportation and quality of life. NTI courses on transportation planning, environmental review, transit-oriented development, and transportation and land use are particularly relevant to climate change issues.	Professionals (transit agency staff, public transportation, transit industry private companies)	Classroom and Online Courses	<a href="http://www.ntionline.com/">http://www.ntionline.com/</a>
Environmental Management Systems Training and Assistance	FTA sponsors training for public transit agencies to continually assess and reduce the environmental impact of their operations. Training and technical assistance include workshops, on-site technical support visits, electronic software, and consultation. During the 18-month training period, each agency develops an environmental management system suited to its needs.	Professionals (transit agencies)	Workshops, On-Site Technical Support Visits, Electronic Software, Consultation	<a href="http://www.fta.dot.gov/planning/environment/planning_environment_227.html">http://www.fta.dot.gov/planning/environment/planning_environment_227.html</a>

# Appendices



# Appendix A: Emission Trends



**TABLE 10 EMISSION TRENDS**  
**CO<sub>2</sub>**  
**(Part 1 of 2)**

Inventory 2007  
Submission 2009 v.1.1  
UNITED STATES OF AMERICA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)		1991		1992		1993		1994		1995		1996		1997		1998		1999		
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	
<b>1. Energy</b>	4,870,953.27	4,836,985.34	4,936,119.34	5,063,791.85	5,149,752.90	5,201,233.13	5,375,999.90	5,464,356.29	5,497,051.13	5,577,645.24											
A. Fuel Combustion (Sectoral Approach)	4,836,644.15	4,803,782.01	4,903,586.99	5,029,995.51	5,115,919.64	5,167,081.83	5,344,184.55	5,432,694.24	5,467,404.39	5,547,011.49											
1. Energy Industries	1,820,634.08	1,818,266.55	1,829,956.81	1,912,854.25	1,938,171.63	1,954,374.11	2,028,073.81	2,097,640.10	2,185,937.48	2,196,703.57											
2. Manufacturing Industries and Construction	834,203.71	820,587.80	859,330.47	845,258.56	854,409.80	862,557.10	896,469.91	900,700.99	853,819.95	828,918.19											
3. Transport	1,436,605.15	1,396,509.98	1,446,753.58	1,492,574.68	1,536,849.54	1,567,436.09	1,603,248.65	1,627,139.89	1,650,444.90	1,720,181.80											
4. Other Sectors	552,559.71	566,412.85	571,144.07	585,555.67	577,249.83	578,843.59	619,202.36	596,848.13	549,032.05	569,344.17											
5. Other	193,141.50	201,944.84	196,404.07	195,752.36	209,238.84	203,670.93	197,189.84	210,365.15	228,168.01	231,865.76											
B. Fugitive Emissions from Fuels	34,109.12	33,203.32	32,530.35	33,796.33	33,833.26	34,151.30	31,664.05	29,646.74	29,646.74	30,633.76											
1. Solid Fuels	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO											
2. Oil and Natural Gas	34,109.12	33,203.32	32,530.35	33,796.33	33,833.26	34,151.30	31,664.05	29,646.74	29,646.74	30,633.76											
<b>2. Industrial Processes</b>	197,622.92	185,599.17	188,123.22	185,342.00	191,408.79	198,584.35	198,200.97	201,177.86	197,639.68	194,664.61											
A. Mineral Products	54,079.29	52,453.88	53,152.90	54,951.90	57,411.73	61,127.15	62,617.93	63,099.61	65,031.29	66,054.32											
B. Chemical Industry	23,566.36	23,369.71	24,588.15	24,770.76	25,900.88	25,335.69	25,304.46	27,055.43	25,609.06	25,609.06											
C. Metal Production	119,977.27	109,775.58	110,382.17	105,619.33	108,096.18	112,121.50	110,278.58	111,602.36	105,552.95	103,001.23											
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE											
E. Production of Halocarbons and SF <sub>6</sub>																					
F. Consumption of Halocarbons and SF <sub>6</sub>																					
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO											
<b>3. Solvent and Other Product Use</b>	NA,NO	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE											
<b>4. Agriculture</b>																					
A. Enteric Fermentation																					
B. Manure Management																					
C. Rice Cultivation																					
D. Agricultural Soils																					
E. Prescribed Burning of Savannas																					
F. Field Burning of Agricultural Residues																					
G. Other																					
<b>5. Land Use, Land-Use Change and Forestry<sup>(b)</sup></b>	-833,312.75	-851,158.63	-837,851.17	-779,963.93	-904,804.98	-842,885.19	-761,102.39	-836,046.07	-732,305.85	-686,851.10											
A. Forest Land	-529,273.49	-571,489.63	-564,608.35	-524,816.68	-563,902.11	-568,151.87	-543,329.69	-566,674.83	-500,461.50	-435,441.31											
B. Cropland	-20,175.45	-22,118.72	-33,574.35	-35,057.79	-36,745.27	-12,947.30	-21,148.24	-19,889.29	-16,014.07	-5,877.31											
C. Grassland	-69,001.74	-49,703.91	-29,828.28	-13,972.28	-96,315.76	-58,906.42	-113.60	-45,106.17	-12,728.90	-47,943.69											
D. Wetlands	1,033.48	962.28	919.55	980.58	937.87	1,017.94	872.25	1,037.48	1,084.22	1,154.91											
E. Settlements	-60,648.74	-62,825.20	-65,001.67	-67,178.13	-69,354.39	-71,531.05	-73,707.52	-75,883.98	-78,060.44	-80,236.90											
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE											
G. Other	-155,246.82	-145,983.44	-145,758.07	-139,919.64	-139,425.12	-132,366.49	-123,675.60	-129,329.28	-126,125.16	-130,261.42											
<b>6. Waste</b>	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE											
A. Solid Waste Disposal on Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE											
B. Waste-water Handling	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE											
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA											
<b>7. Other (as specified in Summary L<sub>1</sub>)</b>																					
<b>Total CO<sub>2</sub> emissions including net CO<sub>2</sub> from LULUCF</b>	4,235,263.44	4,171,425.88	4,286,391.39	4,469,169.91	4,436,356.71	4,556,932.29	4,813,098.48	4,829,490.08	4,962,384.96	5,085,458.75											
<b>Total CO<sub>2</sub> emissions excluding net CO<sub>2</sub> from LULUCF</b>	5,068,576.19	5,022,584.51	5,124,242.56	5,249,133.85	5,341,161.69	5,399,817.48	5,574,200.87	5,665,536.15	5,694,690.81	5,772,309.85											
<b>Memo Items:</b>																					
<b>International Bankers</b>	114,329.60	123,567.53	115,588.68	104,003.73	106,489.22	101,620.41	108,308.43	111,092.04	120,332.95	102,459.82											
Aviation	46,377.60	49,489.37	52,132.13	51,205.39	56,297.74	51,195.57	57,693.42	56,587.38	61,848.03	55,561.92											
Marine	67,952.00	74,078.16	63,456.54	52,798.34	50,191.48	50,424.84	50,615.00	54,504.66	58,484.91	46,897.90											
<b>CO<sub>2</sub> Emissions from Biomass</b>	219,340.79	220,082.20	230,513.03	223,686.48	232,174.48	236,774.53	241,236.81	235,458.98	218,102.50	221,354.19											

Note: All footnotes for this table are given at the end of the table on sheet 5.

**TABLE 10 EMISSION TRENDS**  
**CO<sub>2</sub>**  
**(Part 2 of 2)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000		2001		2002		2003		2004		2005		2006		2007		Change from base to latest reported year	
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)		%
<b>1. Energy</b>	<b>5,753,192.29</b>	<b>5,676,392.94</b>	<b>5,725,316.43</b>	<b>5,785,075.45</b>	<b>5,865,681.40</b>	<b>5,910,830.29</b>	<b>5,830,206.44</b>	<b>5,919,451.52</b>										<b>21.53</b>
A. Fuel Combustion (Sectoral Approach)	5,723,473.25	5,647,271.04	5,695,363.30	5,756,310.03	5,837,253.92	5,881,080.19	5,800,139.21	5,890,484.85										<b>21.78</b>
I. Energy Industries	2,300,662.09	2,263,809.72	2,273,168.45	2,302,469.44	2,333,871.91	2,400,534.15	2,347,137.23	2,417,976.57										<b>32.81</b>
2. Manufacturing Industries and Construction	844,553.58	839,115.92	842,053.96	844,277.95	844,607.28	828,008.27	844,505.28	845,415.82										<b>1.34</b>
3. Transport	1,772,568.94	1,748,893.27	1,786,899.10	1,782,181.60	1,830,672.19	1,855,548.29	1,838,382.71	1,864,111.44										<b>29.76</b>
4. Other Sectors	597,284.45	582,938.69	581,272.90	595,244.74	595,566.44	579,799.62	554,976.35	579,799.62										<b>0.49</b>
5. Other	208,404.20	212,513.44	211,968.88	212,513.44	232,536.11	212,513.44	232,536.11	208,004.68										<b>7.70</b>
B. Fugitive Emissions from Fuels	29,719.04	29,121.90	29,953.13	28,765.42	28,427.48	29,750.10	29,827.23	28,966.67										<b>-15.08</b>
I. Solid Fuels	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE										<b>0.00</b>
2. Oil and Natural Gas	29,719.04	29,121.90	29,953.13	28,765.42	28,427.48	29,750.10	29,827.23	28,966.67										<b>-15.08</b>
<b>2. Industrial Processes</b>	<b>193,216.55</b>	<b>174,662.49</b>	<b>173,359.36</b>	<b>168,930.68</b>	<b>173,691.29</b>	<b>171,074.83</b>	<b>175,897.22</b>	<b>174,938.59</b>										<b>-11.48</b>
A. Mineral Products	64,314.74	63,868.84	65,321.71	65,056.15	70,248.55	71,285.60	73,859.38	69,442.20										<b>28.41</b>
B. Chemical Industry	24,210.16	20,080.99	21,391.06	19,886.44	19,886.44	20,334.61	19,832.55	21,526.11										<b>-8.66</b>
C. Metal Production	104,491.64	90,712.66	86,646.59	83,988.09	82,426.22	79,454.62	82,205.28	83,970.28										<b>-30.01</b>
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE										<b>0.00</b>
E. Production of Halocarbons and SF <sub>6</sub>																		
F. Consumption of Halocarbons and SF <sub>6</sub>																		
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO										<b>0.00</b>
<b>3. Solvent and Other Product Use</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>	<b>NA,NE</b>										<b>0.00</b>
<b>4. Agriculture</b>																		
A. Enteric Fermentation																		
B. Manure Management																		
C. Rice Cultivation																		
D. Agricultural Soils																		
E. Prescribed Burning of Savannas																		
F. Field Burning of Agricultural Residues																		
G. Other																		
<b>5. Land Use, Land-Use Change and Forestry<sup>(b)</sup></b>	<b>-708,737.38</b>	<b>-736,975.85</b>	<b>-1,019,122.24</b>	<b>-1,256,125.55</b>	<b>-1,285,822.59</b>	<b>-1,113,812.87</b>	<b>-1,041,773.03</b>	<b>-1,053,548.12</b>										<b>26.43</b>
A. Forest Land	-399,675.24	-489,904.29	-754,103.55	-1,028,558.70	-1,044,794.02	-871,739.16	-791,694.96	-809,631.52										<b>52.97</b>
B. Cropland	-20,272.80	-845.54	1,873.13	-3,472.07	-4,619.69	-4,465.72	-5,247.42	-5,698.80										<b>-17.75</b>
C. Grassland	-83,352.93	-57,734.31	-71,396.80	-31,199.75	-31,240.83	-31,290.80	-31,326.57	-31,362.65										<b>-54.55</b>
D. Wetlands	1,227.28	1,140.27	1,000.95	983.07	1,194.82	1,078.91	878.94	1,010.50										<b>-2.22</b>
E. Settlements	-82,413.36	-84,589.83	-86,766.29	-88,942.75	-91,119.21	-93,295.68	-95,472.14	-97,648.60										<b>61.01</b>
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE										<b>0.00</b>
G. Other	-124,250.32	-105,042.16	-109,729.67	-104,935.34	-115,243.66	-114,100.42	-118,910.87	-110,217.05										<b>-29.01</b>
<b>6. Waste</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>	<b>IE,NA,NE</b>										<b>0.00</b>
A. Solid Waste Disposal on Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE										<b>0.00</b>
B. Waste-water Handling																		
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE										<b>0.00</b>
D. Other	NA	NA	NA	NA	NA	NA	NA	NA										<b>0.00</b>
<b>7. Other (as specified in Summary L4)</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>										<b>0.00</b>
<b>Total CO<sub>2</sub> emissions including net CO<sub>2</sub> from LULUCF</b>	<b>5,237,671.46</b>	<b>5,114,079.58</b>	<b>4,697,880.58</b>	<b>4,697,880.58</b>	<b>4,753,550.10</b>	<b>4,964,330.63</b>	<b>4,964,330.63</b>	<b>5,040,841.99</b>										<b>19.02</b>
<b>Total CO<sub>2</sub> emissions excluding net CO<sub>2</sub> from LULUCF</b>	<b>5,946,408.84</b>	<b>5,851,055.43</b>	<b>5,898,675.79</b>	<b>5,954,006.13</b>	<b>6,039,272.69</b>	<b>6,081,905.12</b>	<b>6,006,103.66</b>	<b>6,094,390.11</b>										<b>20.24</b>
<b>Memo Items:</b>																		
<b>International Bankers</b>	<b>98,965.90</b>	<b>97,046.95</b>	<b>104,628.27</b>	<b>100,392.03</b>	<b>114,869.20</b>	<b>111,487.07</b>	<b>110,519.62</b>	<b>108,755.77</b>										<b>-4.88</b>
Aviation	57,693.74	58,180.80	63,215.60	55,615.00	60,784.92	56,423.97	54,563.91	52,739.81										<b>13.72</b>
Marine	41,272.16	38,866.16	41,412.67	44,777.03	54,084.29	55,063.10	55,955.71	56,015.96										<b>-17.57</b>
<b>Multilateral Operations</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>										<b>0.00</b>
<b>CO<sub>2</sub> Emissions from Biomass</b>	<b>227,276.44</b>	<b>203,163.58</b>	<b>204,350.53</b>	<b>209,537.43</b>	<b>224,825.39</b>	<b>231,481.40</b>	<b>240,385.63</b>	<b>247,829.09</b>										<b>12.99</b>

Note: All footnotes for this table are given at the end of the table on sheet 5.



TABLE 10 EMISSION TRENDS  
CH<sub>4</sub>  
(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)										1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	
<b>1. Energy</b>	12,651.30	12,582.00	12,088.81	12,076.10	11,969.96	12,064.61	11,871.58	11,677.96	11,257.74		
A. Fuel Combustion (Sectoral Approach)	577.52	578.38	590.88	553.71	546.77	551.23	510.59	475.04	470.87		
1. Energy Industries	26.99	26.69	26.83	28.61	27.45	28.54	29.57	31.54	31.57		
2. Manufacturing Industries and Construction	82.52	81.01	83.52	87.00	88.63	90.19	91.98	86.30	86.04		
3. Transport	213.73	207.45	204.47	200.47	194.20	185.55	176.68	167.56	157.24		
4. Other Sectors	250.56	259.58	269.33	233.85	233.00	243.63	208.93	186.18	192.57		
5. Other	3.86	3.71	3.74	3.77	3.48	3.33	3.43	3.46	3.46		
B. Fugitive Emissions from Fuels	12,073.98	12,003.42	11,897.93	11,522.39	11,423.20	11,513.38	11,360.99	11,202.92	10,786.87		
1. Solid Fuels	4,290.85	4,155.70	4,077.32	3,631.23	3,585.27	3,583.39	3,521.73	3,508.75	3,329.88		
2. Oil and Natural Gas	7,783.13	7,847.72	7,820.61	7,891.16	7,837.92	7,929.99	7,839.26	7,694.17	7,457.00		
<b>2. Industrial Processes</b>	88.46	85.23	89.35	97.71	100.30	101.31	104.49	104.76	103.41		
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA		
B. Chemical Industry	46.24	44.19	45.30	51.81	53.02	55.37	58.40	59.96	60.38		
C. Metal Production	46.24	41.04	44.05	45.90	47.28	45.93	46.09	44.80	43.04		
D. Other Production											
E. Production of Halocarbons and SF <sub>6</sub>											
F. Consumption of Halocarbons and SF <sub>6</sub>											
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO		
<b>3. Solvent and Other Product Use</b>	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO		
<b>4. Agriculture</b>	8,161.33	8,230.38	8,419.81	8,713.50	8,873.04	8,643.63	8,751.29	8,715.01	8,715.01		
A. Enteric Fermentation	6,342.30	6,357.38	6,557.05	6,687.95	6,837.01	6,723.17	6,894.89	6,528.64	6,498.54		
B. Manure Management	1,446.92	1,509.02	1,451.75	1,491.07	1,641.54	1,577.75	1,655.91	1,806.70	1,784.94		
C. Rice Cultivation	339.21	333.19	374.79	391.13	362.90	331.75	356.24	376.26	394.87		
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE		
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA		
F. Field Burning of Agricultural Residues	32.89	30.80	36.22	38.82	31.59	35.92	36.60	37.69	36.66		
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA		
<b>5. Land Use, Land-Use Change and Forestry</b>	218.36	190.15	284.79	175.92	525.89	82.85	162.34	217.74	772.75		
A. Forest Land	218.36	190.15	284.79	175.92	525.89	82.85	162.34	217.74	772.75		
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE		
C. Grassland	NE	NE	NE	NE	NE	NE	NE	NE	NE		
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE		
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE		
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE		
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO		
<b>6. Waste</b>	8,240.20	8,328.94	8,406.04	8,379.05	8,098.92	7,937.43	7,619.79	7,306.02	7,243.56		
A. Solid Waste Disposal on Land	7,105.30	7,173.42	7,227.68	7,221.48	6,870.91	6,711.18	6,373.85	6,056.73	5,984.13		
B. Wastewater Handling	1,119.66	1,138.10	1,158.76	1,176.65	1,183.28	1,186.66	1,202.14	1,201.60	1,206.02		
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE		
D. Other	15.24	17.42	19.60	25.04	34.73	39.59	43.80	47.68	53.42		
<b>7. Other (as specified in Summary L4)</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA		
<b>Total CH<sub>4</sub> emissions including CH<sub>4</sub> from LULUCF</b>	<b>29,359.85</b>	<b>29,416.72</b>	<b>29,688.80</b>	<b>29,792.25</b>	<b>29,325.06</b>	<b>29,604.79</b>	<b>28,401.83</b>	<b>28,057.76</b>	<b>28,092.48</b>		
<b>Total CH<sub>4</sub> emissions excluding CH<sub>4</sub> from LULUCF</b>	<b>29,141.49</b>	<b>29,226.57</b>	<b>29,404.01</b>	<b>29,266.36</b>	<b>29,032.21</b>	<b>28,771.94</b>	<b>28,239.49</b>	<b>27,840.02</b>	<b>27,319.73</b>		
<b>Monitors:</b>											
International Bankers	8.04	8.71	7.73	6.55	6.43	6.61	6.95	7.48	6.19		
Aviation	1.51	1.60	1.63	1.73	1.58	1.75	1.71	1.86	1.68		
Marine	6.53	7.11	6.10	4.82	4.86	4.86	5.24	5.63	4.51		
<b>Multiateral Operations</b>	NE	NE	NE	NE	NE	NE	NE	NE	NE		
<b>CO<sub>2</sub> Emissions from Biomass</b>											

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10. EMISSION TRENDS  
CH<sub>4</sub>  
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000		2001		2002		2003		2004		2005		2006		2007		Change from base to latest reported year	
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
<b>1. Energy</b>	11,380.90	11,252.09	11,001.27	10,872.90	10,468.41	9,831.58	9,795.39	9,795.51	10,468.41	9,831.58	9,795.39	9,795.51	10,468.41	9,831.58	9,795.39	9,795.51	22.57	
A. Fuel Combustion (Sectoral Approach)	478.23	452.15	435.90	437.43	436.83	439.33	415.01	423.81	436.83	439.33	415.01	423.81	436.83	439.33	415.01	423.81	-26.62	
1. Energy Industries	32.58	32.31	32.49	33.61	34.02	35.49	33.70	34.79	34.02	35.49	33.70	34.79	34.02	35.49	33.70	34.79	28.88	
2. Manufacturing Industries and Construction	87.42	83.20	81.02	80.74	84.12	84.89	84.12	84.89	84.12	84.89	84.12	84.89	84.12	84.89	84.12	84.89	2.44	
3. Transport	150.25	144.54	127.74	117.45	111.72	105.24	98.95	92.67	111.72	105.24	98.95	92.67	111.72	105.24	98.95	92.67	-56.64	
4. Other Sectors	204.56	187.92	190.83	201.35	201.69	210.15	191.14	207.77	201.69	210.15	191.14	207.77	201.69	210.15	191.14	207.77	-17.08	
5. Other	3.42	4.18	3.81	4.28	4.50	4.33	4.28	4.05	4.50	4.33	4.28	4.05	4.50	4.33	4.28	4.05	9.08	
B. Fugitive Emissions from Fuels	10,902.67	10,799.94	10,565.37	10,435.47	10,031.58	9,392.24	9,380.39	9,371.69	10,031.58	9,392.24	9,380.39	9,371.69	10,031.58	9,392.24	9,380.39	9,371.69	-22.38	
1. Solid Fuels	3,231.16	3,195.35	2,998.34	2,990.45	3,046.74	2,984.45	3,043.19	3,016.85	3,046.74	2,984.45	3,043.19	3,016.85	3,046.74	2,984.45	3,043.19	3,016.85	-29.69	
2. Oil and Natural Gas	7,671.50	7,604.60	7,567.03	7,445.02	6,984.84	6,407.79	6,337.20	6,354.85	6,984.84	6,407.79	6,337.20	6,354.85	6,984.84	6,407.79	6,337.20	6,354.85	-18.35	
<b>2. Industrial Processes</b>	103.73	93.84	93.61	92.34	98.45	86.16	83.25	82.46	98.45	86.16	83.25	82.46	98.45	86.16	83.25	82.46	-6.78	
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
B. Chemical Industry	59.34	54.86	56.39	54.78	59.44	51.70	48.21	48.83	59.44	51.70	48.21	48.83	59.44	51.70	48.21	48.83	15.66	
C. Metal Production	44.39	38.98	37.22	37.56	39.01	34.46	35.03	33.63	39.01	34.46	35.03	33.63	39.01	34.46	35.03	33.63	-27.27	
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
E. Production of Halocarbons and SF <sub>6</sub>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
F. Consumption of Halocarbons and SF <sub>6</sub>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>3. Solvent and Other Product Use</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>4. Agriculture</b>	8,596.63	8,634.38	8,665.36	8,692.89	8,663.34	8,832.54	8,894.49	9,047.06	8,663.34	8,832.54	8,894.49	9,047.06	8,663.34	8,832.54	8,894.49	9,047.06	10.85	
A. Enteric Fermentation	6,398.46	6,362.80	6,381.62	6,410.32	6,368.96	6,474.14	6,579.88	6,617.96	6,368.96	6,474.14	6,579.88	6,617.96	6,368.96	6,474.14	6,579.88	6,617.96	4.35	
B. Manure Management	1,803.59	1,870.96	1,924.78	1,916.11	1,892.31	1,991.37	1,993.34	2,093.30	1,892.31	1,991.37	1,993.34	2,093.30	1,892.31	1,991.37	1,993.34	2,093.30	44.67	
C. Rice Cultivation	356.84	363.78	325.20	328.37	328.37	325.20	328.37	328.37	328.37	325.20	328.37	328.37	328.37	325.20	328.37	328.37	-13.53	
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
F. Field Burning of Agricultural Residues	37.73	36.84	33.77	38.09	41.84	40.93	39.30	42.47	41.84	40.93	39.30	42.47	41.84	40.93	39.30	42.47	29.14	
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>5. Land Use, Land-Use Change and Forestry</b>	982.60	573.34	863.00	553.19	313.62	676.21	1,488.53	1,381.15	313.62	676.21	1,488.53	1,381.15	313.62	676.21	1,488.53	1,381.15	532.51	
A. Forest Land	982.60	573.34	863.00	553.19	313.62	676.21	1,488.53	1,381.15	313.62	676.21	1,488.53	1,381.15	313.62	676.21	1,488.53	1,381.15	532.51	
B. Cropland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
C. Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
D. Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
E. Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
F. Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>6. Waste</b>	7,083.96	6,926.00	7,038.35	7,346.49	7,252.75	7,321.56	7,451.46	7,566.06	7,038.35	7,321.56	7,451.46	7,566.06	7,038.35	7,321.56	7,451.46	7,566.06	-8.18	
A. Solid Waste Disposal on Land	5,824.65	5,688.59	5,802.62	6,109.60	6,009.43	6,088.08	6,211.43	6,327.42	6,009.43	6,088.08	6,211.43	6,327.42	6,009.43	6,088.08	6,211.43	6,327.42	-10.95	
B. Waste-water Handling	1,199.62	1,177.35	1,174.98	1,167.65	1,169.04	1,158.91	1,164.62	1,159.85	1,169.04	1,158.91	1,164.62	1,159.85	1,169.04	1,158.91	1,164.62	1,159.85	3.59	
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
D. Other	59.69	60.06	60.75	69.24	74.28	74.57	75.41	78.78	74.28	74.57	75.41	78.78	74.28	74.57	75.41	78.78	416.90	
<b>7. Other (as specified in Summary I.4)</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>Total CH<sub>4</sub> emissions including CH<sub>4</sub> from LULUCF</b>	28,147.82	27,479.65	27,661.59	27,557.81	26,796.56	26,748.04	27,713.12	27,872.24	26,796.56	26,748.04	27,713.12	27,872.24	26,796.56	26,748.04	27,713.12	27,872.24	-5.07	
<b>Total CH<sub>4</sub> emissions excluding CH<sub>4</sub> from LULUCF</b>	27,165.21	26,906.31	26,798.59	27,004.62	26,482.94	26,071.83	26,224.59	26,491.09	26,482.94	26,071.83	26,224.59	26,491.09	26,482.94	26,071.83	26,224.59	26,491.09	-9.09	
<b>Memo Items:</b>																		
<b>International Bankers</b>	5.70	5.49	5.87	5.99	7.03	6.99	7.00	6.96	7.03	6.99	7.00	6.96	7.03	6.99	7.00	6.96	-13.47	
Aviation	1.74	1.76	1.89	1.68	1.83	1.70	1.63	1.58	1.74	1.76	1.89	1.63	1.74	1.76	1.89	1.63	4.42	
Marine	3.96	3.73	3.98	4.31	5.21	5.29	5.38	5.38	3.96	3.73	3.98	4.31	5.21	5.29	5.38	5.38	-17.62	
<b>Multilateral Operations</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>CO<sub>2</sub> Emissions from Biomass</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	

Note: All footnotes for this table are given at the end of the table on sheet 5.

**TABLE 10 EMISSION TRENDS**  
**N<sub>2</sub>O**  
**(Part 1 of 2)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
<b>1. Energy</b>	183.77	189.97	200.39	207.87	213.77	217.62	221.87	224.47	223.63	220.09
A. Fuel Combustion (Sectoral Approach)	183.77	189.97	200.39	207.87	213.77	217.62	221.87	224.47	223.63	220.09
1. Energy Industries	27.56	27.22	27.67	28.83	29.01	29.08	30.57	31.28	31.91	31.92
2. Manufacturing Industries and Construction	13.47	13.25	13.68	13.64	14.18	14.40	14.69	14.96	14.15	14.15
3. Transport	136.38	143.01	152.66	159.41	164.83	168.49	170.76	172.95	172.67	169.02
4. Other Sectors	4.69	4.83	4.93	4.59	4.43	4.40	4.64	4.11	3.69	3.84
5. Other	1.67	1.65	1.45	1.41	1.32	1.24	1.20	1.18	1.20	1.16
B. Fugitive Emissions from Fuels	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
1. Solid Fuels	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
2. Oil and Natural Gas	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
<b>2. Industrial Processes</b>	113.84	112.65	108.58	112.57	119.72	127.76	130.20	110.34	95.18	90.83
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	113.84	112.65	108.58	112.57	119.72	127.76	130.20	110.34	95.18	90.83
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF <sub>6</sub>										
F. Consumption of Halocarbons and SF <sub>6</sub>										
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
<b>3. Solvent and Other Product Use</b>	14.21	13.81	13.02	14.80	14.80	14.80	14.80	15.74	15.74	15.74
<b>4. Agriculture</b>	686.34	704.66	671.32	724.08	698.35	695.55	750.35	709.30	749.63	676.89
A. Enteric Fermentation	38.92	40.69	39.71	41.15	41.28	41.62	40.90	42.35	43.20	43.53
B. Manure Management	646.22	662.80	630.27	681.83	655.59	652.70	708.08	665.50	704.95	631.91
C. Rice Cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural Soils	1.20	1.17	1.33	1.10	1.47	1.23	1.37	1.45	1.48	1.44
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	4.89	4.77	5.73	5.66	8.34	6.43	10.14	5.59	5.39	9.43
<b>5. Land Use, Land-Use Change and Forestry</b>	1.65	1.45	2.19	1.50	3.94	2.46	6.39	1.97	2.44	6.59
A. Forest Land	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE
B. Cropland	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
C. Grassland	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02
D. Wetlands	3.22	3.31	3.53	4.14	4.39	3.96	3.74	3.61	2.93	2.83
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
G. Other	13.04	13.48	14.05	14.62	15.32	15.62	16.25	16.59	17.19	18.09
<b>6. Waste</b>	11.90	12.18	12.58	12.74	13.01	13.02	13.28	13.30	13.62	14.08
A. Solid Waste Disposal on Land	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Waste-water Handling	1.14	1.31	1.47	1.88	2.31	2.60	2.97	3.28	3.58	4.01
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<b>7. Other (as specified in Summary L.4)</b>	1,016.08	1,039.25	1,013.10	1,079.60	1,070.29	1,077.78	1,143.61	1,082.03	1,106.77	1,031.06
Total N <sub>2</sub> O emissions including N <sub>2</sub> O from LULUCF	1,011.20	1,034.57	1,007.37	1,073.94	1,061.95	1,071.35	1,133.46	1,076.44	1,101.38	1,021.64
Total N <sub>2</sub> O emissions excluding N <sub>2</sub> O from LULUCF	3.40	3.64	3.42	3.13	3.21	3.05	3.25	3.29	3.56	3.07
<b>Memo Items:</b>										
International Bankers Aviation	1.74	1.84	1.87	1.84	1.99	1.82	2.01	1.96	2.13	1.93
Multilateral Operations	1.66	1.81	1.55	1.29	1.22	1.23	1.23	1.33	1.43	1.14
CO <sub>2</sub> Emissions from Biomass	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Note: All footnotes for this table are given at the end of the table on sheet 5.

**TABLE 10 EMISSION TRENDS**  
**N<sub>2</sub>O**  
**(Part 2 of 2)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000		2001		2002		2003		2004		2005		2006		2007		Change from base to latest reported year		
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%	
<b>1. Energy</b>	218.53	208.43	194.98	184.95	177.09	167.32	156.37	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	-20.68	
A. Fuel Combustion (Sectoral Approach)	218.53	208.43	194.98	184.95	177.09	167.32	156.37	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	145.76	-20.68	
1. Energy Industries	33.50	33.72	33.49	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	33.72	24.77	
2. Manufacturing Industries and Construction	14.41	14.14	13.85	13.93	14.61	14.58	15.07	14.71	14.71	14.71	14.71	14.71	14.71	14.71	14.71	14.71	14.71	9.27	
3. Transport	165.51	156.62	143.40	132.15	123.34	112.88	102.68	91.58	91.58	91.58	91.58	91.58	91.58	91.58	91.58	91.58	91.58	-32.85	
4. Other Sectors	4.07	3.86	3.81	4.07	4.08	4.13	3.72	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	-15.81	
5. Other	1.14	1.26	1.19	1.31	1.23	1.23	1.15	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	-32.06	
B. Fugitive Emissions from Fuels	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0.00	
I. Solid Fuels	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0.00	
2. Oil and Natural Gas	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0.00	
<b>2. Industrial Processes</b>	90.78	73.85	81.74	78.85	77.02	79.21	77.96	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	-21.68	
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
B. Chemical Industry	90.78	73.85	81.74	78.85	77.02	79.21	77.96	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	89.16	-21.68	
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
E. Production of Halocarbons and SF <sub>6</sub>																			
F. Consumption of Halocarbons and SF <sub>6</sub>																			
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	
<b>3. Solvent and Other Product Use</b>	15.74	15.74	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	14.15	-0.38	
<b>4. Agriculture</b>	706.18	758.59	717.00	700.43	728.15	726.91	721.01	719.60	719.60	719.60	719.60	719.60	719.60	719.60	719.60	719.60	719.60	4.85	
A. Enteric Fermentation	45.13	46.19	45.91	44.74	45.33	45.85	46.99	47.40	47.40	47.40	47.40	47.40	47.40	47.40	47.40	47.40	47.40	21.80	
B. Manure Management																			
C. Rice Cultivation																			
D. Agricultural Soils	659.56	710.91	669.69	654.26	681.16	679.42	672.40	670.65	670.65	670.65	670.65	670.65	670.65	670.65	670.65	670.65	670.65	3.78	
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
F. Field Burning of Agricultural Residues	1.49	1.50	1.39	1.44	1.66	1.63	1.62	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	29.50	
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>5. Land Use, Land-Use Change and Forestry</b>	11.75	9.67	11.79	9.81	8.31	10.55	16.21	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71	221.43	
A. Forest Land	7.83	5.05	7.24	5.03	3.16	5.65	11.24	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	535.55	
B. Cropland	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	IE,NE	0.00	
C. Grassland	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	0.00	
D. Wetlands	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-2.37	
E. Settlements	3.90	4.60	4.54	4.76	5.13	4.88	4.96	5.19	5.19	5.19	5.19	5.19	5.19	5.19	5.19	5.19	5.19	61.29	
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00	
G. Other	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	
<b>6. Waste</b>	18.85	19.28	19.09	19.87	20.55	20.93	21.14	21.61	21.61	21.61	21.61	21.61	21.61	21.61	21.61	21.61	21.61	65.72	
A. Solid Waste Disposal on Land																			
B. Waste-water Handling	14.37	14.78	14.53	14.68	14.98	15.33	15.49	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	15.70	31.98	
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	0.00	
D. Other	4.48	4.50	4.56	5.19	5.57	5.59	5.66	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	5.91	416.90	
<b>7. Other (as specified in Summary L4)</b>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00	
<b>Total N<sub>2</sub>O emissions including N<sub>2</sub>O from LULUCF</b>	1,061.83	1,085.56	1,038.75	1,008.07	1,025.28	1,019.07	1,006.85	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	1,005.99	-0.99	
<b>Total N<sub>2</sub>O emissions excluding N<sub>2</sub>O from LULUCF</b>	1,050.08	1,075.89	1,026.96	998.26	1,016.97	1,008.51	990.64	990.29	990.29	990.29	990.29	990.29	990.29	990.29	990.29	990.29	990.29	-2.07	
<b>Memo Items:</b>																			
<b>International Bankers</b>	3.00	2.97	3.18	3.02	3.42	3.29	3.24	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	-6.33	
Aviation	2.00	2.02	2.17	1.93	2.00	2.17	1.95	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	1.82	4.42	
Marine	1.01	0.95	1.01	1.09	1.32	1.34	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	-17.62	
<b>Multilateral Operations</b>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00	
<b>CO<sub>2</sub> Emissions from Biomass</b>																			

Note: All footnotes for this table are given at the end of the table on sheet 5.



TABLE 10 EMISSION TRENDS  
HFCs, PFCs and SF<sub>6</sub>  
(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year ( 1990 )										1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)		
<b>Emissions of HFCs<sup>(b)</sup> - (Gg CO<sub>2</sub> equivalent)</b>	36,924.10	33,546.69	38,282.65	38,755.86	44,050.24	61,803.33	71,168.28	81,040.87	96,890.42	94,853.65		
HFC-23	3.13	2.81	3.12	2.83	2.72	2.84	2.69	2.69	2.61	2.64		
HFC-32	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-41	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.		
HFC-43-10mee	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-125	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	0.01	0.04	0.29	0.58	0.91	1.21	1.53		
HFC-134	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-134a	I.E.N.A.N.O.	I.E.N.A.N.O.	0.83	3.57	8.58	19.54	26.20	32.88	36.05	40.00		
HFC-134b	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-152a	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-143	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	0.02	0.05	0.13	0.25	0.40	0.58	0.80		
HFC-143a	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-227ea	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	0.01	0.03	0.04	0.04	0.05	0.06	0.08		
HFC-236bf	I.E.N.A.N.O.	I.E.N.A.N.O.	I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
HFC-245ca	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	656.99	658.63	1,590.70	2,780.98	3,452.19	4,076.77	4,203.48		
Unspecified mix of listed HFCs <sup>(b)</sup> - (Gg CO <sub>2</sub> equivalent)	331.04	640.05	648.53	16,807.74	15,167.42	15,587.02	16,600.19	15,222.69	14,029.04	13,961.47		
<b>Emissions of PFCs<sup>(b)</sup> - (Gg CO<sub>2</sub> equivalent)</b>	20,759.93	17,774.74	16,539.87	16,807.74	15,167.42	15,587.02	16,600.19	15,222.69	14,029.04	13,961.47		
C <sub>2</sub> F <sub>6</sub>	2.55	2.16	1.99	1.96	1.75	1.75	1.86	1.68	1.47	1.46		
C <sub>3</sub> F <sub>8</sub>	0.45	0.46	0.39	0.41	0.41	0.45	0.49	0.47	0.49	0.49		
C <sub>4</sub> F <sub>10</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
C <sub>6</sub> F <sub>14</sub>	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
C <sub>8</sub> F <sub>18</sub>	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
C <sub>10</sub> F <sub>22</sub>	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
C <sub>12</sub> F <sub>26</sub>	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
C <sub>14</sub> F <sub>30</sub>	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.	C.I.E.N.A.N.O.		
Unspecified mix of listed PFCs <sup>(b)</sup> - (Gg CO <sub>2</sub> equivalent)	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.	NA, N.E.N.O.		
<b>Emissions of SF<sub>6</sub><sup>(b)</sup> - (Gg CO<sub>2</sub> equivalent)</b>	32,787.70	31,399.66	31,892.00	31,043.81	29,535.10	28,880.98	27,314.39	25,553.93	22,585.93	22,891.96		
SF <sub>6</sub>	1.37	1.31	1.32	1.30	1.24	1.17	1.14	1.07	0.94	0.96		

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS  
HFCs, PFCs and SF<sub>6</sub>  
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
<b>Emissions of HFCs<sup>(9)</sup> - (Gg CO<sub>2</sub> equivalent)</b>									
HFC-23	100,098.22	96,905.86	104,307.81	101,361.21	112,376.34	116,073.33	119,072.79	125,531.42	239.97
	2.47	1.70	1.82	1.07	1.49	1.37	1.21	1.48	-52.78
HFC-32	0.04	0.09	0.17	0.27	0.40	0.56	0.91	1.33	100.00
HFC-41	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
HFC-43-10misc	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
HFC-12.5	1.87	2.15	2.44	2.80	3.22	3.67	4.39	5.25	100.00
HFC-134	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
HFC-134a	44.01	46.89	49.33	51.27	53.28	54.23	54.36	52.78	100.00
HFC-152a	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
HFC-143	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
HFC-143a	1.09	1.41	1.78	2.19	2.65	3.20	3.78	4.40	100.00
HFC-227ea	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
HFC-236fa	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.14	100.00
HFC-245ea	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	C,IE,NA,NO	0.00
Unspecified mix of listed HFCs <sup>(9)</sup> - (Gg CO <sub>2</sub> equivalent)	4,045.51	3,965.97	4,517.98	5,178.10	5,559.65	5,917.87	6,194.60	6,482.85	1,858.34
<b>Emissions of PFCs<sup>(9)</sup> - (Gg CO<sub>2</sub> equivalent)</b>									
CF <sub>4</sub>	13,479.45	6,979.60	8,711.06	7,077.89	6,125.08	6,194.63	6,030.44	7,479.87	-63.97
C <sub>2</sub> F <sub>6</sub>	1.48	0.67	0.88	0.67	0.55	0.56	0.51	0.69	-73.03
C <sub>3</sub> F <sub>8</sub>	0.41	0.27	0.31	0.28	0.27	0.26	0.28	0.32	-30.10
C <sub>4</sub> F <sub>10</sub>	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	1,417.03
C <sub>6</sub> F <sub>14</sub>	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	0.00
C <sub>8</sub> F <sub>18</sub>	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,IE,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	0.00
Unspecified mix of listed PFCs <sup>(9)</sup> - (Gg CO <sub>2</sub> equivalent)	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
<b>Emissions of SF<sub>6</sub><sup>(9)</sup> - (Gg CO<sub>2</sub> equivalent)</b>									
SF <sub>6</sub>	19,199.54	18,761.05	18,122.79	18,207.16	17,756.95	17,893.06	17,026.87	16,458.76	-49.80
	0.80	0.78	0.76	0.76	0.74	0.75	0.71	0.69	-49.80

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS  
SUMMARY  
(Part 1 of 2)

	Base year (1990)									
	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)
<b>GREENHOUSE GAS EMISSIONS</b>										
CO <sub>2</sub> emissions including net CO <sub>2</sub> from LULUCF	4,235,263.44	4,171,423.88	4,286,391.39	4,469,169.91	4,436,356.71	4,556,932.29	4,813,098.48	4,829,490.08	4,962,384.96	5,085,458.75
CO <sub>2</sub> emissions excluding net CO <sub>2</sub> from LULUCF	5,068,576.19	5,022,584.51	5,124,242.56	5,249,133.85	5,341,161.69	5,399,817.48	5,574,200.87	5,665,536.15	5,694,690.81	5,772,309.85
CH <sub>4</sub> emissions including CH <sub>4</sub> from LULUCF	61,655,569.93	61,751,111	62,346,481	610,298.60	625,637.28	615,826.21	621,700.54	596,438.37	589,213.01	589,942.12
CH <sub>4</sub> emissions excluding CH <sub>4</sub> from LULUCF	61,197,133	61,757,888	61,784,233	606,604.31	614,593.49	609,676.45	604,210.74	593,029.25	584,640.47	573,714.28
N <sub>2</sub> O emissions including N <sub>2</sub> O from LULUCF	314,985.77	322,197.59	314,660.21	334,677.36	331,790.72	334,113.02	354,518.38	335,429.09	343,099.44	319,630.09
N <sub>2</sub> O emissions excluding N <sub>2</sub> O from LULUCF	313,470.98	320,717.41	312,383.69	332,922.92	329,204.20	332,119.16	351,373.55	333,695.17	341,428.62	316,707.45
HFCs	36,924.10	33,540.69	38,282.65	38,755.86	44,050.24	61,803.33	71,168.28	81,040.87	96,880.42	94,853.65
PFCS	20,759.93	17,774.74	16,539.87	16,507.74	15,167.42	15,587.02	16,600.19	15,222.69	14,029.04	13,961.47
SF <sub>6</sub>	32,787.70	31,399.66	31,592.00	31,043.81	29,535.10	28,080.98	27,314.39	25,551.89	22,535.93	22,891.96
<b>Total (including LULUCF)</b>	<b>5,257,277.87</b>	<b>5,194,089.67</b>	<b>5,310,330.93</b>	<b>5,500,453.29</b>	<b>5,482,537.48</b>	<b>5,612,342.86</b>	<b>5,904,400.25</b>	<b>5,883,172.99</b>	<b>6,028,142.80</b>	<b>6,126,738.05</b>
<b>Total (excluding LULUCF)</b>	<b>6,084,490.17</b>	<b>6,039,774.89</b>	<b>6,140,425.01</b>	<b>6,274,968.47</b>	<b>6,373,712.14</b>	<b>6,447,084.43</b>	<b>6,644,868.01</b>	<b>6,714,076.03</b>	<b>6,754,205.30</b>	<b>6,794,438.66</b>

	Base year (1990)									
	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)
<b>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</b>										
1. Energy	5,193,603.06	5,160,098.15	5,260,504.40	5,379,469.73	5,469,619.64	5,520,063.22	5,698,135.18	5,783,247.60	5,811,613.44	5,882,285.73
2. Industrial Processes	325,243.41	305,025.99	310,075.03	308,517.81	319,325.85	345,768.84	355,773.21	359,993.67	362,791.93	356,700.76
3. Solvent and Other Product Use	4,404.02	4,281.69	4,037.02	4,587.52	4,587.52	4,587.52	4,587.52	4,587.52	4,879.50	4,879.50
4. Agriculture	384,152.80	391,282.02	384,925.21	401,290.41	399,470.61	401,954.09	414,647.53	401,397.92	416,163.86	392,850.32
5. Land Use, Land-Use Change and Forestry <sup>(6)</sup>	-827,212.31	-845,685.22	-830,094.08	-774,515.18	-891,174.66	-834,741.57	-740,467.76	-830,903.04	-726,062.50	-667,700.62
6. Waste	177,087.09	179,087.04	180,883.36	181,103.00	180,708.52	174,710.76	171,724.56	165,157.34	158,576.57	157,722.35
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<b>Total (including LULUCF)<sup>(6)</sup></b>	<b>5,257,277.87</b>	<b>5,194,089.67</b>	<b>5,310,330.93</b>	<b>5,500,453.29</b>	<b>5,482,537.48</b>	<b>5,612,342.86</b>	<b>5,904,400.25</b>	<b>5,883,172.99</b>	<b>6,028,142.80</b>	<b>6,126,738.05</b>

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(3) Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO<sub>2</sub> equivalent emissions.

(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (due to missing confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO<sub>2</sub> equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

(5) Includes net CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from LULUCF.

**TABLE 10 EMISSION TRENDS  
SUMMARY  
(Part 2 of 2)**

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year (%)
	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	
CO <sub>2</sub> emissions including net CO <sub>2</sub> from LULUCF	5,237,671.46	5,114,079.58	4,879,553.55	4,697,880.58	4,753,550.10	4,968,092.25	4,964,330.63	5,040,841.99	19.02
CO <sub>2</sub> emissions excluding net CO <sub>2</sub> from LULUCF	5,946,408.84	5,851,055.43	5,898,675.79	5,954,006.13	6,039,372.69	6,081,905.12	6,006,103.66	6,094,390.11	20.24
CH <sub>4</sub> emissions including CH <sub>4</sub> from LULUCF	591,104.15	577,072.62	580,893.47	578,713.95	562,727.77	561,708.94	581,975.56	585,317.05	-5.07
CH <sub>4</sub> emissions excluding CH <sub>4</sub> from LULUCF	570,469.46	565,032.48	562,770.39	567,097.01	556,141.75	547,508.47	550,716.44	556,312.80	-9.09
N <sub>2</sub> O emissions including N <sub>2</sub> O from LULUCF	329,168.37	336,524.87	322,013.18	312,501.78	317,835.74	315,910.27	312,124.05	311,857.84	-0.99
N <sub>2</sub> O emissions excluding N <sub>2</sub> O from LULUCF	325,524.81	333,525.98	318,357.20	309,459.55	315,259.52	312,638.86	307,099.01	306,988.74	-2.07
HFCs	100,098.22	96,905.86	104,307.81	101,361.21	112,376.34	116,073.33	119,072.79	125,531.42	239.97
PFCS	13,479.45	6,979.60	8,711.06	7,077.89	6,125.08	6,194.63	6,030.44	7,479.87	-63.97
SF <sub>6</sub>	19,199.54	18,761.05	18,122.79	18,207.16	17,756.95	17,893.06	17,026.87	16,458.76	-49.80
<b>Total (including LULUCF)</b>	<b>6,290,721.21</b>	<b>6,150,323.57</b>	<b>5,913,601.85</b>	<b>5,715,742.55</b>	<b>5,770,371.99</b>	<b>5,985,872.47</b>	<b>6,000,560.33</b>	<b>6,087,486.93</b>	<b>15.79</b>
<b>Total (excluding LULUCF)</b>	<b>6,975,180.33</b>	<b>6,872,260.40</b>	<b>6,910,945.04</b>	<b>6,957,208.94</b>	<b>7,047,032.33</b>	<b>7,082,213.46</b>	<b>7,006,049.20</b>	<b>7,107,161.69</b>	<b>16.81</b>

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year (%)
	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	CO <sub>2</sub> equivalent (Gg)	
1. Energy	6,059,934.22	5,977,299.97	6,016,786.57	6,070,742.36	6,140,416.84	6,169,162.03	6,084,385.29	6,170,343.23	18.81
2. Industrial Processes	356,315.05	322,171.53	331,806.83	321,960.17	335,893.15	337,598.92	343,943.73	353,779.52	8.77
3. Solvent and Other Product Use	4,879.50	4,879.50	4,387.15	4,387.15	4,387.15	4,387.15	4,387.15	4,387.15	-0.38
4. Agriculture	399,444.64	416,485.79	404,242.71	399,683.72	407,657.36	410,825.55	410,297.98	413,064.72	7.53
5. Land Use, Land-Use Change and Forestry <sup>(1)</sup>	-684,459.12	-721,936.83	-997,343.18	-1,241,466.39	-1,276,660.34	-1,096,340.99	-1,005,488.87	-1,019,674.76	23.27
6. Waste	154,606.92	151,423.60	153,721.78	160,435.54	158,677.84	160,239.81	163,035.05	165,587.07	-6.49
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.00
<b>Total (including LULUCF)<sup>(2)</sup></b>	<b>6,290,721.21</b>	<b>6,150,323.57</b>	<b>5,913,601.85</b>	<b>5,715,742.55</b>	<b>5,770,371.99</b>	<b>5,985,872.47</b>	<b>6,000,560.33</b>	<b>6,087,486.93</b>	<b>15.79</b>

<sup>(1)</sup> The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

<sup>(2)</sup> Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

<sup>(3)</sup> Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO<sub>2</sub> equivalent emissions.

<sup>(4)</sup> In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO<sub>2</sub> equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

<sup>(5)</sup> Includes net CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from LULUCF.



SUMMARY 2 SUMMARY REPORT FOR CO<sub>2</sub> EQUIVALENT EMISSIONS

Inventory 2007

(Sheet 1 of 1)

Submission 2009 v1.1

UNITED STATES OF AMERICA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO <sub>2</sub> <sup>(1)</sup>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs <sup>(2)</sup>	PFCs <sup>(2)</sup>	SF <sub>6</sub> <sup>(2)</sup>	Total
	CO <sub>2</sub> equivalent (Gg)						
<b>Total (Net Emissions)<sup>(1)</sup></b>	<b>5,040,841.99</b>	<b>585,317.05</b>	<b>311,857.84</b>	<b>125,531.42</b>	<b>7,479.87</b>	<b>16,458.76</b>	<b>6,087,486.93</b>
<b>1. Energy</b>	<b>5,919,451.52</b>	<b>205,705.62</b>	<b>45,186.09</b>				<b>6,170,343.23</b>
A. Fuel Combustion (Sectoral Approach)	5,890,484.85	8,900.08	45,186.09				5,944,571.01
1. Energy Industries	2,417,976.57	730.57	10,657.92				2,429,365.07
2. Manufacturing Industries and Construction	845,415.82	1,775.24	4,561.61				851,752.68
3. Transport	1,864,111.44	1,946.01	28,389.41				1,894,446.85
4. Other Sectors	554,976.35	4,363.22	1,224.81				560,564.37
5. Other	208,004.68	85.03	352.34				208,442.05
B. Fugitive Emissions from Fuels	28,966.67	196,805.54	IE,NA,NE				225,772.22
1. Solid Fuels	IE,NE,NO	63,353.76	IE,NE				63,353.76
2. Oil and Natural Gas	28,966.67	133,451.79	IE,NA,NE				162,418.46
<b>2. Industrial Processes</b>	<b>174,938.59</b>	<b>1,731.76</b>	<b>27,639.12</b>	<b>125,531.42</b>	<b>7,479.87</b>	<b>16,458.76</b>	<b>353,779.52</b>
A. Mineral Products	69,442.20	NA	NA				69,442.20
B. Chemical Industry	21,526.11	1,025.51	27,639.12	NA	NA	NA	50,190.74
C. Metal Production	83,970.28	706.25	NA	NA	3,836.03	2,973.25	91,485.81
D. Other Production	NE						NE
E. Production of Halocarbons and SF <sub>6</sub>				16,999.76	NA,NE	NA,NE	16,999.76
F. Consumption of Halocarbons and SF <sub>6</sub> <sup>(2)</sup>				108,531.66	3,643.84	13,485.51	125,661.00
G. Other	NA,NO	NA,NO	NA,NO	NA	NA	NA	NA,NO
<b>3. Solvent and Other Product Use</b>	<b>NA,NE</b>		<b>4,387.15</b>				<b>4,387.15</b>
<b>4. Agriculture</b>		<b>189,988.21</b>	<b>223,076.51</b>				<b>413,064.72</b>
A. Enteric Fermentation		138,977.19					138,977.19
B. Manure Management		43,959.32	14,693.81				58,653.14
C. Rice Cultivation		6,159.75					6,159.75
D. Agricultural Soils <sup>(3)</sup>		NA,NE	207,900.52				207,900.52
E. Prescribed Burning of Savannas		NA	NA				NA
F. Field Burning of Agricultural Residues		891.95	482.18				1,374.13
G. Other		NA	NA				NA
<b>5. Land Use, Land-Use Change and Forestry<sup>(1)</sup></b>	<b>-1,053,548.12</b>	<b>29,004.25</b>	<b>4,869.11</b>				<b>-1,019,674.76</b>
A. Forest Land	-809,631.52	29,004.25	3,255.32				-777,371.95
B. Cropland	-5,698.80	NE	IE,NE				-5,698.80
C. Grassland	-31,362.65	NE	IE				-31,362.65
D. Wetlands	1,010.50	NE	5.09				1,015.59
E. Settlements	-97,648.60	NE	1,608.69				-96,039.91
F. Other Land	NE	NE	NE				NE
G. Other	-110,217.05	NA,NO	IE,NA,NO				-110,217.05
<b>6. Waste</b>	<b>IE,NA,NE</b>	<b>158,887.20</b>	<b>6,699.87</b>				<b>165,587.07</b>
A. Solid Waste Disposal on Land	NA,NE	132,875.92					132,875.92
B. Waste-water Handling		24,356.87	4,868.21				29,225.08
C. Waste Incineration	IE	NE	IE				IE,NE
D. Other	NA	1,654.41	1,831.66				3,486.07
<b>7. Other (as specified in Summary I.A)</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>	<b>NA</b>
<b>Memo Items:<sup>(4)</sup></b>							
<b>International Bunkers</b>	108,755.77	146.09	986.08				109,887.94
Aviation	52,739.81	33.16	562.70				53,335.67
Marine	56,015.96	112.93	423.39				56,552.27
<b>Multilateral Operations</b>	<b>NE</b>	<b>NE</b>	<b>NE</b>				<b>NE</b>
<b>CO<sub>2</sub> Emissions from Biomass</b>	<b>247,829.09</b>						<b>247,829.09</b>
Total CO <sub>2</sub> Equivalent Emissions without Land Use, Land-Use Change and Forestry							7,107,161.69
Total CO <sub>2</sub> Equivalent Emissions with Land Use, Land-Use Change and Forestry							6,087,486.93

(1) For CO<sub>2</sub> from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO<sub>2</sub> from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary I.A.

# B

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