Climate Change Home

Our planet's climate affects--and is affected by--the sky, land, ice, sea, life, and people found on it. To understand the entire story of climate change--what we know, what we still have to learn, and what humankind can do to prepare for the future--we must study all of the natural and human systems that contribute to and interact with Earth's climate system.

"Climate change is the most important puzzle humankind has attempted to solve"

Discussions with the Experts

Credits

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Climate Change Introduction

To explain the difference between weather and climate, scientists often say, "climate is what you expect, weather is what you get."" Climate is the weather of a particular region, averaged over a long period of time. Climate is a fundamental factor in ecosystem health--while most species can survive a sudden change in the weather, such as a heat wave, flood or cold snap--they often cannot survive a long-term change in climate. Global climate is the average of all regional trends, and researchers have concluded that Earth's climate, as a whole, is warming.

Researchers know that human activities including fossil fuel use, agriculture and land use have been the dominant causes of increased concentrations of greenhouse gases in the atmosphere over the past 250 years. In addition, aerosols and land surface changes are also altering the Earth's climate, making it extremely likely[1] that human activities have had a net warming effect since 1750[2]. These human-caused changes to the climate system, and their consequences, provide much of the impetus for the National Science Foundation's (NSF) climate change research.

Researchers funded by NSF have discovered signs of a changing climate in nearly every corner of the globe, from the icy expanses of Earth's polar regions to its equatorial ecosystems. Our planet's climate affects--and is affected by--the sky, land, ice, sea, life and the people found on it. To piece together the entire puzzle of climate change--what we know, what we still have to learn and what humankind can do to prepare for the future--we must study all of the physical, natural and human systems that contribute to and interact with Earth's climate system.

As researchers piece together the climate puzzle, they are revolutionizing the way we understand the Earth system as a whole. Researchers have realized that they must reach across disciplinary boundaries to study questions that extend beyond any one field of science or engineering. In fact, because of the complexity of Earth's climate, this research involves contributions from nearly every field of science, math and engineering.

In no area is NSF's contribution more important--or more influential--than in interdisciplinary research. NSF responds to the needs of research communities by supporting teams that include experts from multiple disciplines. NSF is unique among other government agencies with a science mission because NSF funds research, infrastructure and education across *all* disciplines of science and engineering.

Putting the Pieces Together
The evidence we have for a changing planet goes well beyond any one field of science or engineering.

Ecologists have noted marked changes in the habitats of the species they study--changes in the places where they find a particular species, changes in the dates plants first sprout and bloom, changes in plant growth rates and even signs of evolutionary adaptation brought on by a warming climate. In some cases, species extinctions appear linked to climate change.

Ocean scientists have recorded higher temperatures and higher ocean acidity, which alter the characteristics of the most fundamental organisms of the ocean food chain. Coral reefs--some of which have thrived for centuries--have died off suddenly as a result of ocean temperatures that exceed the corals' ability to survive.

Polar scientists have watched vast tracts of Arctic sea ice melt away, leaving behind more open water than anyone can remember seeing during any previous Northern Hemisphere summer. Glaciologists have witnessed ice shelves--once thought too large to be influenced by anything short of cataclysmic environmental change--break up into a churning sea of icebergs in a matter of days.

Social scientists have recorded the bewilderment of indigenous people. Their cultural knowledge, which stretches back in time through numerous generations, holds no record of the kinds of environmental conditions they are encountering today.

Paleoclimatologists have discovered--through tree ring data, ice cores and other corroborating records--that the concentration of carbon dioxide, and the Earth's average temperature, are nearing levels that haven't been reached for hundreds of thousands of years.

Innovative scientists and engineers have responded to the call for alternative energy sources that reduce the amount of carbon dioxide we put into the atmosphere. Computer scientists are creating new tools for geoscientists, decision-makers and the public to understand Earth's changing climate. Social scientists are studying human decisions and behaviors that influence the environment. By studying such issues as the energy grid, land use, urban planning, building materials and economic factors that are linked to anthropogenic climate change, researchers are beginning to tackle some of the more nuanced, but essential, questions regarding the human impact on, and response to, the Earth's changing climate.

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1. According to the Treatment of Uncertainties in the Working Group I Assessment of the Intergovernmental Panel on Climate Change, 'extremely likely' corresponds to a likelihood of >95% probability. Solomon, S., et al. Technical Summary, in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2007 Cambridge University Press. Box TS.1

2. Solomon, S., et al. Technical Summary, in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2007. Cambridge University Press. pp. 81

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Sky: Background

The sea, land, ice, life and people of Earth are all connected by the 'sky'--Earth's atmosphere, neighboring geospace, and the Sun. Climate and weather are the result of atmospheric conditions, which are in a constant state of flux. Variables including air density, temperature, moisture content, wind currents, chemical composition and aerosol content, just to name a few, determine weather and climate. Because of the complexity of the interactions of atmospheric variables, forecasting the future is no easy task. It's no coincidence that many of the world's leading researchers in climate and atmospheric science are experts in chaos theory.

NSF funds atmospheric research at all levels--from single investigator projects to major centers devoted to research and education. NSF-funded research covers all areas of atmospheric science, from the troposphere (lower atmosphere) to the stratosphere (upper atmosphere).

One of NSF's major investments in sky research is the National Center for Atmospheric Research (NCAR) located in Boulder, Colo. Using various tools and techniques, including climate models, radar, weather-balloon observations and satellite data, NCAR climate researchers are working to understand the impacts of global and regional climate variability and change.

Computational modeling is one of the most essential tools used by climate scientists. Researchers develop climate models to simulate the interactions of the varying factors that influence Earth's atmosphere. Models are essential tools for climate scientists, because it is not possible to recreate the atmosphere and its interactions with Earth's systems in a laboratory. As researchers learn more about the effects and interactions of the different components of the climate system, they can increase the complexity of climate models.

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Sky: Major Programs

NSF funds multiple major efforts in atmospheric science, including a number of cross-disciplinary programs drawing on the expertise of researchers outside of atmospheric science.

National Center for Atmospheric Research (NCAR)
NSF's premier "sky" research facility is the National Center for Atmospheric Research (NCAR), located in Boulder, Colo. The NCAR Web site hosts a wealth of information on global climate change, including materials suitable for teachers and students. NCAR hosts several major programs devoted to climate change research including, the satellite-based observational COSMIC (Constellation Observing System for Meteorology Ionosphere and Climate).
http://www.ncar.ucar.edu/

National Solar Observatory (NSO)
The Sun is the predominant source of heat and energy in the climate system, and therefore, is an important factor in modeling Earth's past, present and future climate. The mission of the National Solar Observatory (NSO) is to advance knowledge of the Sun, both as an astronomical object and as the dominant external influence on Earth, by providing forefront observational opportunities to the research community.
http://www.nso.edu/

Center for Multiscale Modeling of Atmospheric Processes
Colorado State University's Center for Multiscale Mapping of Atmospheric Processes (CMMAP), a recently established NSF Science and Technology Center, focuses on atmospheric phenomena that are as familiar to us as they are elusive to climate modelers--clouds.
http://cmmap.colostate.edu/

Information about "sky" research funding opportunities can be found at:
http://www.nsf.gov/div/index.jsp?div=ATM
http://www.nsf.gov/dir/index.jsp?org=CISE
http://www.nsf.gov/dir/index.jsp?org=OCI
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut

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Sky: Research Highlights

- Enhancing Studies of Aerosol-Cloud Interactions
- Intensification of Pacific Storm Track Linked to Asian Pollution
- New Computer Model Helps Coastlines Prepare for Storm Surges
- Will There be an Increase in Severe Thunderstorms Due to Climate Change?
- New NSF-Sponsored Research Aircraft Studies Atmospheric Particle Formation
- Improving Climate Model Predictions through a Surprising Link to Snow Cover Simulation
- Following the Asian-Pacific Pollution Plume
- Human Activities Are Boosting Ocean Temperatures in Areas Where Hurricanes Form, New Study Finds
- Expect a Warmer, Wetter World this Century, Computer Models Agree
- The Effects of Climate Change on Ozone Distribution
- Fossil Fuel Burning Interrupts Natural Carbon Cycle
- Future Heat Waves: More Severe, More Frequent, Longer Lasting
- Urban Trace-gas Emissions Study (UTES): Interactions Among Canopy Processes, Anthropogenic Emissions and Social Institutions in the Salt Lake Valley, Utah
- Individual-particle Investigations of East Asian Aerosols from the Aerosol Characterization Experiment (ACE)-Asia
- Climate Change Affecting Earth's Outermost Atmosphere
- Identifying Clouds Using Statistical Tools
- Why is this Cloud Raining on Me?
- Project Atmospheric Brown Clouds (ABC) Advances U.S. Leadership in Climate Research and Education
- In Search of the North American Monsoon

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Sea: Background

The ocean covers roughly 71 percent of Earth's surface and hosts some of its most productive ecosystems. Sea currents and surface temperature drive weather patterns and create the climate patterns we know today. Evaporation from its surface accounts for most of the precipitation that falls on Earth. The ocean's ability to absorb and store energy allows it to serve as a buffer against extreme climatic swings.

NSF-supported researchers have long sought accurate models of the properties and circulation of the world's oceans because of the important role they play in our planet's climate. Researchers know that the sea is as essential to a global climate model, such as the NSF-supported Community Climate System Model (CCSM), as the atmosphere itself.

The warming or cooling of the ocean's surface can have far-flung effects on the atmosphere. The ocean surface and the air above it exchange heat and moisture, a process driven by the temperature difference between the water and the air. This exchange helps drive atmospheric circulation. For example, the "El Niño" phenomenon is associated with the extent of warm water extending across the tropical Pacific, which helps to steer local storms and upper-level winds, thereby shaping climate across much of the globe. Researchers use CCSM and other global climate models to predict El Niño events, which can have profound impacts on human activities.

NSF-sponsored investigators have deployed instrumentation to characterize the gas fluxes between the ocean and atmosphere, with the aim of improving sea-air exchange simulations in global climate models. The shipboard instrument enables the measurement of climatically relevant gas molecules, including aerosol precursors.

Earth's changing climate will significantly affect the ocean's living things. Environmental variables such as temperature and acid content directly affect an organism's physiological processes and ultimate survival. These climate-driven effects are expected to result in alterations of ecosystem structure and function over time.

NSF-supported researchers are attempting to gain an understanding of how ocean ecosystems will respond to climate and subsequent environmental changes. This research includes observational programs to sample ocean regions most critically impacted by climate variability, focusing on factors such as ocean acidification.

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Sea: Major Programs

NSF sponsors several major efforts and projects that address, in whole or in part, global climate change and the sea. These programs include:

Ocean Observatories Initiative (OOI)
The Ocean Observatories Initiative (OOI) has the potential to revolutionize ocean science by providing the means to collect sustained, detailed, time series data sets. OOI was created in response to community demand for long-term and adaptive measurements in the world's oceans.
http://www.orionprogram.org/OOI/default.html

Integrated Ocean Drilling Project (IODP)
NSF's premier ocean core drilling project, the Integrated Ocean Drilling Project (IODP), is operated jointly with Japan's Ministry of Education, Culture, Sports, Science and Technology. IODP is an international marine research program that explores Earth's history and structure, as recorded in seafloor sediments and rocks.
http://www.iodp.org/

GLOBEC Program - GLOBal Ocean ECosystems Dynamics
The U.S. Global Ocean Ecosystems Dynamics program is a multidisciplinary research program designed by oceanographers, fishery scientists and marine ecologists to examine how climate change affects marine ecosystems and fisheries. US GLOBEC is led by the NSF with cooperation from NOAA; it is part of the international program of the International Biosphere-Geosphere Programme.
http://www.globec.org

Academic Research Fleet and University-National Oceanographic Laboratory System
The Academic Research Fleet consists of 23 vessels in the University-National Oceanographic Laboratory System. These vessels vary in size, endurance and capabilities, and enable scientists supported by NSF and other federal agencies to conduct marine research in coastal and open waters.
http://www.unols.org/

Information about "sea" research funding opportunities can be found at:
http://www.nsf.gov/div/index.jsp?div=OCE
http://www.nsf.gov/dir/index.jsp?org=OPP
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut

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- Reversing Course: Changes in Ocean Currents during Global Warming
- Air-Sea Exchange Measurements by Eddy Correlation
- Evolution of the Eastern Tropical Pacific Through Plio-Pleistocene Glaciation
- First Arctic Ocean Drilling Reveals Subtropical Past
- Tracing Sea Level and Environmental Change on Tahiti's Coral Reefs
- 'Frozen' Natural Gas Discovered at Unexpectedly Shallow Depths Below Seafloor
- New Climate Mode of Variability, the North Pacific Gyre Oscillation, Links Ocean Climate and Ecosystem Change
- Ocean Acidification and Polar Ecosystems
- Marine Radiocarbon Evidence for the Mechanism of Deglacial Atmospheric CO_2 Rise
- Tracking the Ocean's Motion, Temperature and More
- Interactions Between the Wind and Oceanic Eddies Stimulate Higher Biological Productivity in Subtropical Ocean Surface Waters
- How Much Excess Fresh Water Was Added to the North Atlantic in Recent Decades?
- Science and Technology Center for Coastal Margin Observation and Prediction
- Coral Reef Bleaching: A Novel Strategy for Survival
- Saltier Tropical Oceans and Fresher Ocean Waters Near the Poles Further Signs of Global Climate Change's Impacts

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Ice: Background

Ice has a significant impact on global climate, influencing the amount of solar radiation reflected back into space; the exchange of heat between the polar oceans and the atmosphere; the amount of freshwater entering the sea; and, indirectly, the strength of the global ocean's overturning circulation. Snow and ice cover about 10 percent of the land surface of Earth, including virtually all of the landmasses of Greenland and Antarctica, and seasonal sea ice spans much of the Arctic and Antarctic Circles during winter in each hemisphere.

Snow and ice factor into Earth's climate in a number of important ways. The amount of land-based ice determines global sea level--the geological record shows that higher sea levels occurred during "greenhouse Earth" periods in the past. The reflectivity, or albedo, of snow and ice introduces climate sensitivity, particularly in Earth's polar regions; as ice disappears, less solar energy is reflected away and more is absorbed, heating the surface, which causes the remaining ice to become more susceptible to melting. Ice also plays an important role in the circulation and currents of the world's ocean, because the formation and melting of sea ice affects the temperature and salinity of the surrounding seawater, which are important factors driving global ocean circulation.

Snow and ice at high elevations at temperate, and even tropical latitudes, affects local ecosystems and regulates local climate. In many parts of the world, human drinking water supplies depend on reliable and predictable patterns of glacial accumulation and thaw, which are threatened by alterations in global temperature and weather patterns. High-altitude glaciers around the world face uncertain futures. They also serve as powerful visual illustrations of a changing climate, as historical photographs reveal the dramatic extent to which many of them have receded. In some cases, they've already disappeared.

Ice is disappearing around Earth's poles as well. In 2007, satellite images confirmed what was plain enough to the researchers and indigenous people on the ground: Arctic sea ice cover shrank to a record new low.

Because of the importance of ice to Earth's climate, and because of its sensitivity to climate feedbacks, constant monitoring and observation is critical--both on the ground and from satellites above. Through decades of support of basic research, NSF has advanced our understanding of the physical, chemical and biological processes that make interpreting observational data possible. NSF's contribution to 'ice' research, particularly in the polar regions, has led to substantial advances in what we know about Earth's changing ice and snow, and how those changes may lead to further changes.

International Polar Year

The International Polar Year (IPY) 2007-2008, a world-wide scientific effort in which participating government agencies sponsor heightened activities in their polar research programs, aims to increase the public's knowledge of and benefit from research conducted at Earth's northern and southernmost extremities.

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Ice: Major Programs

NSF plays a central leadership role in coordinating U.S. government research efforts in the areas surrounding both poles. These efforts include some of the most important climate change research currently being conducted. In addition, NSF-funded researchers study snow and ice at more temperate latitudes around the world. Major efforts include the following:

International Polar Year (IPY)
The International Polar Year (IPY) 2007-2008, a world-wide scientific effort in which participating government agencies sponsor heightened activities in their polar research programs, aims to increase the public's knowledge of and benefit from research conducted at Earth's northern and southernmost extremities.
http://www.ipy.gov/

ANDRILL
ANDRILL (ANtarctic geological DRILLing) is a multinational collaboration comprised of more than 200 scientists, students and educators from five nations (Germany, Italy, New Zealand, the United Kingdom and the United States), to drill "back in time" through the Antarctic sediment record to recover a history that will inform our understanding of how glacial and interglacial changes took place in the Antarctic.
http://www.andrill.org

International Trans Antarctic Scientific Expedition (ITASE)
The International Trans Antarctic Scientific Expedition (ITASE) collects and interprets a continental-wide array of environmental parameters assembled through the coordinated efforts of scientists from 20 nations.
http://www2.umaine.edu/itase/

Polar Earth Observatory Network (POLENET)
NSF-supported researchers are part of the international Polar Earth Observatory Network (POLENET) project, a consortium involving researchers from 28 nations who are engaging in fieldwork to improve the collection of geophysical data across the Earth's poles.
http://www.polenet.org

Arctic Observing Network (AON)
The Arctic Observing Network (AON) is a new NSF-supported program that will encompass a system of atmospheric, land- and ocean-based observational capabilities, from ocean buoys to satellites.
http://www.arcus.org/search/aon.html

WAIS Divide Ice Coring Project
WAIS Divide is a United States deep ice coring project in West Antarctica. The WAIS Divide ice core will provide Antarctic records of environmental change with the highest time resolution for the last ~100,000 years and will be the first Southern Hemisphere climate record of comparable time resolution and duration to some of the most important Greenland ice core records.
http://www.waisdivide.unh.edu/

Center for Remote Sensing of Ice Sheets (CReSIS)
The Center for Remote Sensing of Ice Sheets (CReSIS), a Science and Technology Center (STC) established by NSF in 2005, develops new technologies and computer models to measure and predict the response of sea-level change to the mass balance of ice sheets in Greenland and Antarctica.
https://www.cresis.ku.edu/

Information about "ice" research funding opportunities can be found at:
http://www.nsf.gov/dir/index.jsp?org=OPP
http://www.nsf.gov/dir/index.jsp?org=GEO
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut

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- Understanding the Structure of Sea Ice
- Center for Remote Sensing of Ice Sheets
- ITASE (International Trans Antarctic Scientific Expedition)
- Winter Research Capability at Toolik Field Station, Alaska
- Improving Climate Model Predictions Through a Surprising Link to Snow Cover Simulation
- Loss of Arctic Sea Ice Observed in 2007
- What is Happening to the Antarctic Sea Ice Cover?
- Sea Level Rise from Polar Ice Sheets: Societal Relevance and Broader Impacts
- Connections: Sea-level Rise, Climate-change and the Dynamics of Glaciers
- Ancient Glaciers in Antarctica Key to Understanding Climate Change
- A Warming Climate Can Support Glacial Ice
- Calibrating Past Climate Change in the High Arctic: Svalbard, Norway Research Experiences for Undergraduates
- Novel Ice Core Drill Reveals Pacific Northwest's Climate Past
- Studying Past Changes in Arctic Fossils
- Abrupt Ice Retreat Could Produce Ice-Free Arctic Summers by 2040
- Antarctic Temperature Changes, 1958-2002
- Arctic Cetaceans: Indicators of Climate Change

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Land: Background

Earth's land masses support critical ecosystems, host Earth's freshwater environments, and sustain almost all human agricultural activities. Land separates freshwater from the sea, stores nutrients essential for terrestrial and aquatic life, and holds a paleological record of Earth's climatic past.

As the Earth warms, the conditions favorable to many plant and animal species are expected to shift toward higher latitudes and higher elevations. These altered species distributions will likely cause significant disruptions to established ecosystems as habitats adjust to new species assemblages.

Land use is inextricably linked to the carbon cycle. Changing land-use patterns, such as clearing forest to create agricultural plots, changes the dynamics of the carbon cycle. Livestock such as cattle contribute a net surplus of carbon to the atmosphere in the form of methane, a powerful greenhouse gas.

NSF-supported researchers study all aspects of the land-climate connection. Through observational networks, researchers gather vital data about critical ecosystems, the hydrological cycle, the timing of seasonal events such as wildflower blooms, and other critical indicators of land-based ecosystem health.

NSF also supports geologists who use cave formations, the fossils of ancient plant and animal species, and other "proxy" climate records to open a window into Earth's history, and learn how the land responded to past climate change events.

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Land: Major Programs

NSF-supported researchers study all aspects of the land-climate connection. Some of these efforts include:

Center for Sustainability of Semi-Arid Hydrology and Riparian Areas (SAHRA)
The Center for Sustainability of Semi-Arid Hydrology and Riparian Areas, an NSF Science and Technology Center (STC), furnishes new knowledge to elected officials, water managers and policy experts to augment their ability to improve the sustainability of water resources in the U.S. and around the world.
http://www.sahra.arizona.edu/

Global Lake Ecological Observatory Network (GLEON)
The Global Lake Ecological Observatory Network (GLEON), an international ecological collaboration, is advancing our understanding of lakes' roles in the global carbon balance. Researchers from the U.S. are collaborating with international scientists to form a network of sensors deployed on lakes to gather data on metabolism and nutrient cycling.
http://gleon.org/

Critical Zone Observatories (CZO)
The CZO network represents the first set of systems-based observatories dedicated to land surface processes, which include the water cycle, the break-down of rocks and formation of soil, the geochemical and physical erosion of that soil, the evolution of rivers and valleys and patterns of vegetation.

Information about "land" research opportunities can be found at:
http://www.nsf.gov/dir/index.jsp?org=GEO
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut
http://www.nsf.gov/dir/index.jsp?org=BIO

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Life: Background

If climate had no significant impact on Earth's ecosystems and living things, then climate change would be a mere curiosity of planetary science. Instead, we know that ecosystems depend on predictable annual weather patterns for survival. Changing weather patterns affect where plants can grow and where animals can thrive. Even small changes in climate can tip the delicate balance of competition and cooperation among the residents of an ecosystem. The potential for climate change to disrupt life on Earth makes studying it essential.

Earth's ecosystems are not only affected by climate, they also play a major role in influencing global climate. Living things regulate the composition of the atmosphere. Plants use carbon dioxide (CO_2) to grow and produce oxygen; when plants die, microorganisms break them down into the organic matter of soil, CO_2, methane gas, and other byproducts. Changes in land use or average temperature can disrupt an ecosystem's cycling and storage of carbon, creating the potential for large amounts of CO_2 or methane to be released into the atmosphere. Earth's forests, marine environments, wetlands, tundra, and other habitats together store vast amounts of carbon. Land cover and the choices humans make about determining where plants will grow can have a profound impact on both regional and global climate. Understanding the biological processes involved in the carbon cycle is essential to predicting future climate, and efforts are currently underway to incorporate living systems into global climate models.

NSF supports biologists as they seek a greater understanding of what a warmer global climate means to life on Earth. NSF supports 63 percent of the fundamental environmental biology research at U.S. academic institutions, fostering advances in the biological sciences through research grants and providing the infrastructure to enable those advances.

The urgency of this research comes sharply into focus when we realize that our own species is highly dependent on Earth's ecosystems. Living organisms do much more for us than provide food, clothing and shelter. Plants are not only responsible for the very oxygen we breathe; they help to regulate the temperature and moisture of the places we call home. Plant roots prevent topsoil from eroding away or burying our houses. Forests of swaying trees and acres of wetlands literally calm storms by dissipating wind and wave energy. Microorganisms decompose our garbage and help us digest our food. Without the ecosystems of the world, big and small, our existence would be impossible.

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Life: Major Programs

Long-Term Ecological Research (LTER) Program
For more than 25 years, NSF has steadfastly supported the Long-Term Ecological Research (LTER) Network, a collaborative effort currently involving more than 1,800 scientists and students studying ecological processes at sites strategically located around the United States, Puerto Rico, Tahiti and Antarctica. The 26 LTER sites are windows to global change.
http://www.lternet.edu/

National Ecological Observing Network
The National Ecological Observatory Network (NEON), a regional-to-continental scale network, will help us understand the impacts of climate change, land-use change and invasive species on ecology. NEON will gather data on ecological responses of the biosphere to changes in land use and climate, and on feedbacks with the atmosphere, water cycle and other natural and human systems.
http://www.neoninc.org/

Bering Ecosystem Study (BEST)
In partnership with the North Pacific Research Board, NSF launched the Bering Ecosystem Study (BEST) to improve our understanding of the effects of climate variability on the Bering Sea marine ecosystems, including the social implications of climate change and the role of human activities in the system. BEST will examine such factors as diminishing sea ice, decreasing ocean salinity and shifting plankton availability on the Bering Sea ecosystem.
http://www.arcus.org/bering/index.html

National Center for Ecological Analysis and Synthesis (NCEAS)
The National Center for Ecological Analysis and Synthesis (NCEAS) focuses on developing and testing important ecological ideas and theories using existing data. Working in teams, NCEAS researchers focus on analyzing ecological information with cutting-edge approaches, accessing and using data, promoting the use of sound science in policy and management decisions, investigating sociological issues that pertain to the science of ecology and educating with sound ecological principles.
http://www.nceas.ucsb.edu/

Information about "life" research funding opportunities can be found at:
http://www.nsf.gov/dir/index.jsp?org=BIO
http://www.nsf.gov/dir/index.jsp?org=OPP
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut

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Life: Research Highlights

- Global Warming Linked to Amphibian Extinction
- Predicting the Next Mammals at Risk
- Genetic Consequences of Climate Change
- Climate Change: A Driver of Evolution
- Is There a Relationship Between Global Climate Change and Flowering?
- First-ever Global Map of the Influence of Total Anthropogenic Activities on the Marine Ecosystem
- Coral Reef Bleaching: A Novel Strategy for Survival
- Germ Bath Helps Amphibians Fight off Fungus
- Long Term Ecological Research Program to Examine Effects of Sea-level Rise on South Florida
- Sea-Level Rise Threatens Mangrove Forests
- Positive Feedbacks: New Plant Growth in Tundra Cause Further Warming
- Poison Ivy to Become More Toxic and Abundant Due to Rising CO_2 Levels
- Tropical Forests Affected by Climate Change
- Long-term Study Leads to Elegant Understanding: Nitrogen Cycling
- Nitrogen: The Fertilizer of Climate Change Modeling
- What Happens When Permafrost Melts?
- Effects of Global Warming on Trees and the Insects that Eat Them
- Cyberinfrastructure and Biodiversity
- How Climate Change is Choking Marine Ecosystems
- EcoPod: An Electronic Field Guide for Informed Amateurs and Professionals
- Nature vs. Nurture: How Does Genetic Structure Affect Plant Response to Environmental Cues?

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Climate Change — Text-only | **Flash Special Report**
People: Background

The last piece of the climate puzzle is perhaps the most complicated and dynamic of all--people. The overwhelming majority of climate researchers have reached the understanding--based on decades of evidence, modeling and debate--that it is extremely likely that human activities are responsible for rising temperatures on Earth. Human behavior will continue to be a major factor in climate change, and understanding the feedbacks between human behavior and climate variability is critical. Humans can adopt social and commercial practices and implement government policies and laws that significantly affect greenhouse gas emissions. Humans can also increase our energy efficiency as well as invent alternative fuel sources for our energy-intensive activities. And, human ingenuity may even provide geoengineering technologies capable of reversing some of the effects of anthropogenic climate change.

NSF supports research in all non-health-related human sciences. Some academic fields, such as sociology, rely almost exclusively on NSF for government research funding within the U.S. Overall, NSF provides approximately 61 percent of federal support for basic research in the social sciences at U.S. academic institutions. NSF's tradition in the social, behavioral and economic sciences has emerged as a key strength for climate change research. Human systems must not only be factored into climate projections, but an understanding of human science provides the entire research community with the opportunity to learn how to effectively communicate research findings to society. At NSF, we see the transformative research of the future emerging at the boundaries between the traditional scientific and engineering disciplines, and climate change is no exception. Some of the most compelling and paradigm-changing research results have come from multidisciplinary teams that include the human science aspect.

In addition to supporting the social, behavioral and economic sciences, NSF also addresses the human aspect of climate change through education. NSF research grants to academic institutions not only provide funds for research equipment, overhead costs and infrastructure, they also enable principal investigators (PIs) to offer financial support to graduate students and postdoctoral researchers training to become the next generation of scientists and engineers dedicated to studying climate change and addressing its impacts. NSF PIs frequently share their time and resources through educational outreach activities involving undergraduate and K-12 students and members of the community at large. These outreach activities, along with NSF-supported formal and informal education programs, including classroom materials, television programs and Web sites, serve to engage and educate students and members of the public about scientific and technological issues including

climate change.

Engineering and the physical sciences hold the potential to provide breakthrough technologies in energy, transportation, construction and other human endeavors that impact the climate. Progress in these "hard" sciences influences human-factors research as we strive to understand the emergence, dissemination and adoption of new knowledge and advanced technologies. These tools have the potential to help us adapt to climate change, as well as reduce, and perhaps one day, reverse anthropomorphic greenhouse gas accumulation in the atmosphere.

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People: Major Programs

Decision Making Under Uncertainty (DMUU) Centers
Given that the uncertainties in the projections of future temperature, precipitation patterns, species adaptation and many other variables cannot be fully resolved, and given that government officials, business owners and the public at large will have to make decisions based on uncertain science, NSF funds three Decision Making Under Uncertainty (DMUU) Centers and two interdisciplinary research teams to tackle these issues.

Dynamics of Coupled Human and Natural Systems
The interactions between humans and ecosystems, and in particular the dynamics of these interactions, are expected to change as the effects of global climate change are increasingly seen in local ecosystems. To gain a greater understanding of these issues, NSF created a formal, multidisciplinary program to support teams of researchers focused on the social, natural and physical science behind the coupling of human and natural systems.
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13681&org=NSF&sel_org=NSF&from=fund

Arctic Social Sciences Program
To capture native knowledge and to involve native people in the study of their own environment, NSF-funded researchers have enlisted the input of native people in environmental observation, while at the same time helping the people document and preserve their cultural heritage for future generations. The knowledge and observations passed on to indigenous people from their ancestors provide researchers an invaluable source of information about climate change.
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13425&org=NSF&sel_org=NSF&from=fund

Information about "people" research funding opportunities can be found at:
http://www.nsf.gov/dir/index.jsp?org=SBE
http://www.nsf.gov/dir/index.jsp?org=EHR
http://www.nsf.gov/dir/index.jsp?org=OPP
http://www.nsf.gov/dir/index.jsp?org=ENG
http://www.nsf.gov/dir/index.jsp?org=MPS
http://www.nsf.gov/dir/index.jsp?org=CISE
http://www.nsf.gov/dir/index.jsp?org=OCI
http://www.nsf.gov/funding/pgm_list.jsp?type=xcut

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