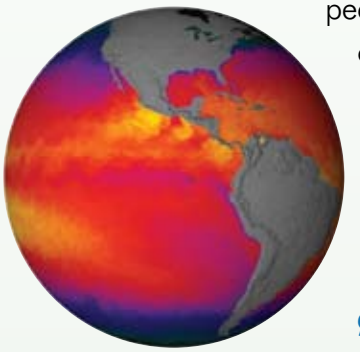
Frequently Asked Questions
ABOUT GLOBAL WARMING AND CLIMATE CHANGE:
Back to Basics

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The Earth's climate is changing. In most places, average temperatures are rising. Scientists have observed a warming trend beginning around the late 1800s. The most rapid warming has occurred in recent decades. Most of this recent warming is very likely the result of human activities.



Many human activities release "greenhouse gases" into the atmosphere. The levels of these gases are increasing at a faster rate than at any time in hundreds of thousands of years.

We know that greenhouse gases trap heat. If human activities continue to release greenhouse gases at or above the current rate, we will continue to increase average temperatures around the globe. Increases in global temperatures will most likely change our planet's climate in ways that will have significant long-term effects on people and the environment.

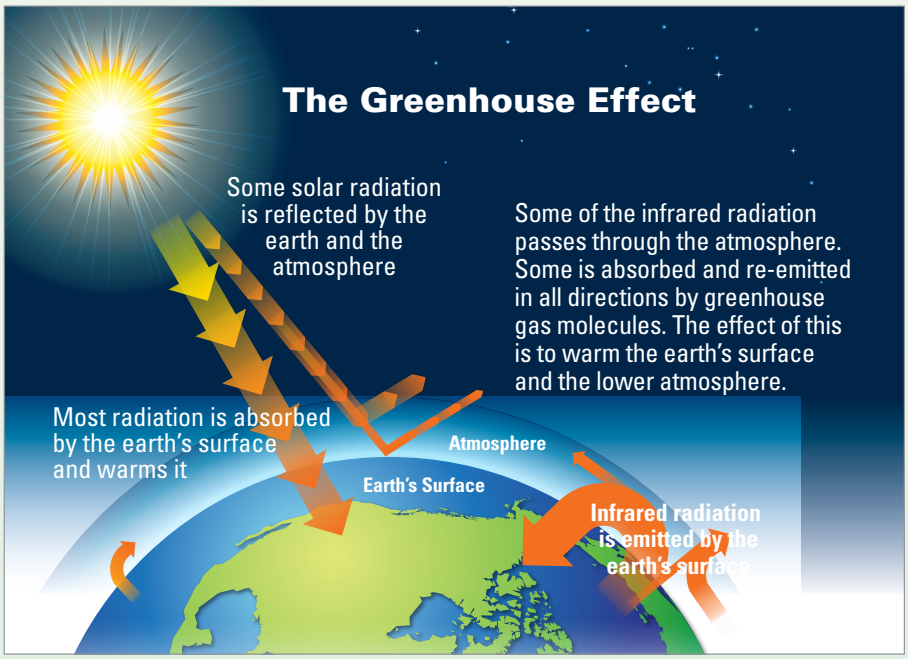
This fact sheet addresses the most frequently asked questions about the science of global warming and climate change. The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (2007) serves as the key reference for this brochure. The IPCC was formed jointly in 1988 by the United Nations Environment Programme and the United Nations World Meteorological Organization. The IPCC brings together the world's top scientists, economists and other experts, synthesizes peer-reviewed scientific literature on climate change studies, and produces authoritative assessments of the current state of knowledge of climate change.

The Greenhouse Effect

Q. What is the greenhouse effect?

A. The Earth's greenhouse effect is a natural occurrence that helps regulate the temperature of our planet. When the Sun heats the Earth, some of this heat escapes back to space. The rest of the heat, also known as infrared radiation, is trapped in the atmosphere by clouds and greenhouse gases, such as water vapor and carbon dioxide. If all of these greenhouse gases were to suddenly disappear, our planet would be 60°F colder and would not support life as we know it.

Human activities have enhanced the natural greenhouse effect by adding greenhouse gases



to the atmosphere, very likely causing the Earth's average temperature to rise. These additional greenhouse gases come from burning fossil fuels such as coal, natural gas, and oil to power our cars, factories, power plants, homes, offices, and schools. Cutting down trees, generating waste and farming also produce greenhouse gases.

Q. What are the most important greenhouse gases? Where are they coming from and how have they changed?

A. Many greenhouse gases, like water vapor and carbon dioxide (CO_2), occur naturally. Fuel burning and other human activities are adding large amounts of carbon dioxide and other gases to the natural mix at a faster rate than at any other time on record. Other important greenhouse gases produced by human activity include methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

Since 1750, atmospheric concentrations of CO_2, CH_4 and N_2O have increased by over 36 percent, 148 percent and 18 percent, respectively. Scientists have concluded that this is due primarily to human activity.

Climate Change, Global Warming, and Global Change Defined

Q. How are the terms climate change, global warming, and global change different?

A. The term climate change is often used as if it means the same thing as the term global warming. According to the National Academy of Sciences; however, "the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are [other] changes in addition to rising temperatures."

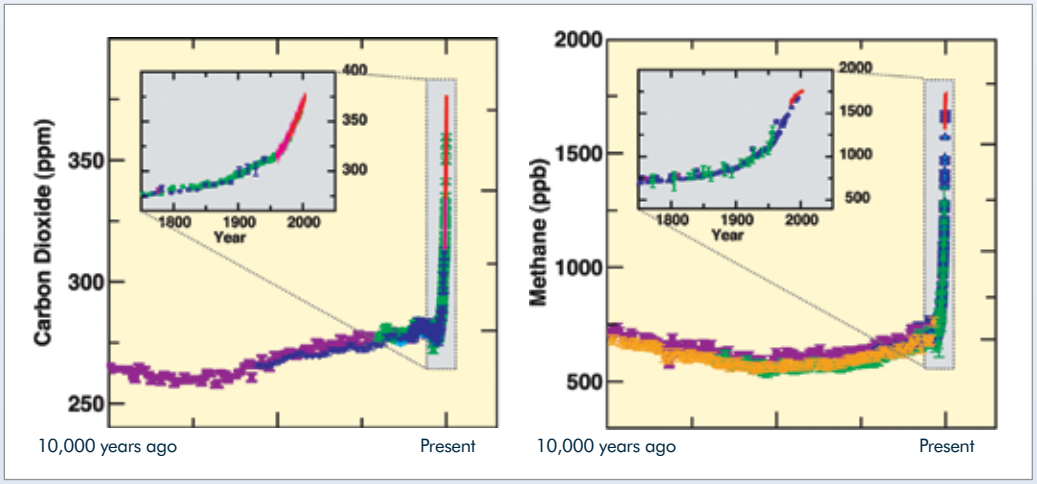
Climate change refers to any distinct change in measures of climate lasting for a long period of time. In other words, "climate change" means major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from:

- natural factors, such as changes in the Sun's energy or slow changes in the Earth's orbit around the Sun;
- natural processes within the climate system (e.g., changes in ocean circulation);
- human activities that change the atmosphere's make-up (e.g, burning fossil fuels) and the land surface (e.g., cutting down forests, planting trees, building developments in cities and suburbs, etc.).

Global warming is an average increase in temperatures near the Earth's surface and in the lowest layer of the atmosphere. Increases in temperatures in our Earth's atmosphere can contribute to changes in global climate patterns. Global warming can be considered part of climate change along with changes in precipitation, sea level, etc.

Global change is a broad term that refers to changes in the global environment, including climate change, ozone depletion, and land use change.

Carbon Dioxide and Methane Concentrations Over the Last 10,000 Years

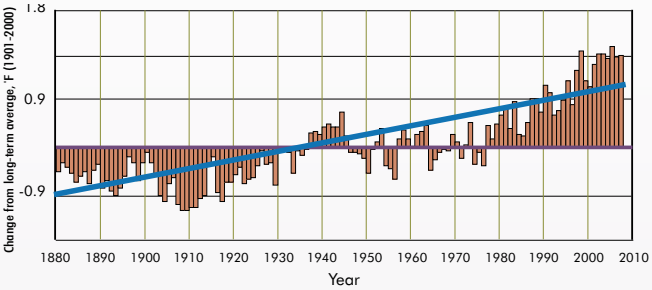


Atmospheric concentrations of carbon dioxide (in parts per million) and methane (in parts per billion) over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). Source: IPCC, 2007

Present and Future Climate Change

Q. Is our planet warming?

Annual Global Temperature Over Oceans and Land



Annual global surface temperature departure (also known as anomalies) from 1901-2000 average for the period 1880-2007. Source: NOAA, 2007

A. Yes. The global temperature record shows an average warming of about 1.3°F over the past century (see graph). According to the National Oceanic and Atmospheric Administration (NOAA), seven of the eight warmest years on record have occurred since 2001. Within the past 30 years, the rate of warming across the globe has been approximately three times greater than the rate over the last 100 years. Past climate information suggests the warmth of the last half century is unusual in at least the previous 1,300 years in the Northern Hemisphere.

The IPCC concluded that warming of the Earth's climate system is now "unequivocal" (i.e., "definite"). The IPCC bases this conclusion on observations of increases in average air and ocean temperatures, melting of snow and ice, and average sea level across the globe.

Late Summer Arctic Sea Ice Changes

Ice is melting. *Arctic sea ice, an indicator of climate change, set a record low in September 2007. Sea ice extent was 38 percent below the 1979-2007 average. Source: NASA, 2007*

Q. Are human activities responsible for the warming?

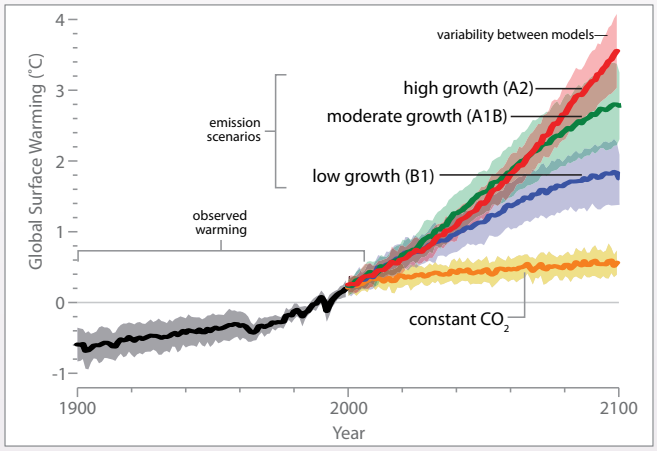
A. IPCC scientists believe that there is a greater than 90 percent chance that most of the warming we have experienced since the 1950s is due to the increase in greenhouse gas emissions from human activities.

Q. How do scientists project future climate change?

A. The Earth's climate is very complex and involves the influences of air, land, and oceans on one another. Scientists use computer models to study these interactions. The models project future climate changes based on expected changes to the atmosphere. Though the models are not exact, they are able to simulate many aspects of the climate. Scientists reason that if the models can mimic currently observed features of the climate, then they are also most likely able to project future changes.

Q. How much will the Earth warm if emissions of greenhouse gases continue to rise?

Warming Projections to 2100



Temperature projections to the year 2100, based on a range of emission scenarios and global climate models. Scenarios that assume the highest growth in greenhouse gas emissions provide the estimates in the top end of the temperature range. The orange line ("constant CO_2") projects global temperatures with greenhouse gas concentrations stabilized at year 2000 levels. Source: NASA (adapted from IPCC, 2007)

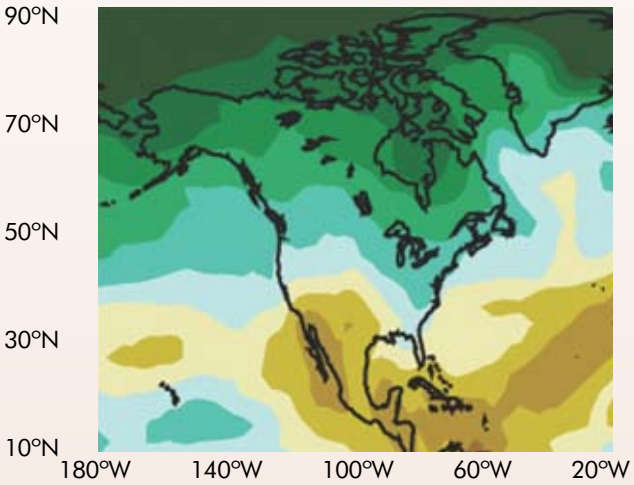
A. If humans continue to emit greenhouse gases at or above the current pace, we will probably see an average global temperature increase of 3 to 7°F by 2100, and greater warming after that. Temperatures in some parts of the globe (e.g., over land and in the polar regions) are expected to rise even more.

Even if we were to drastically reduce greenhouse gas emissions, returning them to year 2000 levels and holding them constant, the Earth would still warm about 1°F over the next 100 years. This is due to the long life time of many greenhouse gases and the slow cycling of heat from the ocean to the atmosphere.

Q. How will a warming climate affect precipitation?

A. Rising temperatures will intensify the Earth's water cycle. Increased evaporation will make more water available in the air for storms, but contribute to drying over some land areas. As a result, storm-affected areas are likely to experience increases in precipitation and increased risk of flooding. But areas located far away from storm tracks are likely to experience less precipitation and increased risk of drought. In the U.S., warming is expected to cause a northward shift in storm tracks, resulting in decreases in precipitation in areas such as the Southwest U.S. but increases in many areas to the north and east. However, these changes will vary by season and depend on weather fluctuations.

Precipitation Projection for North America 2100

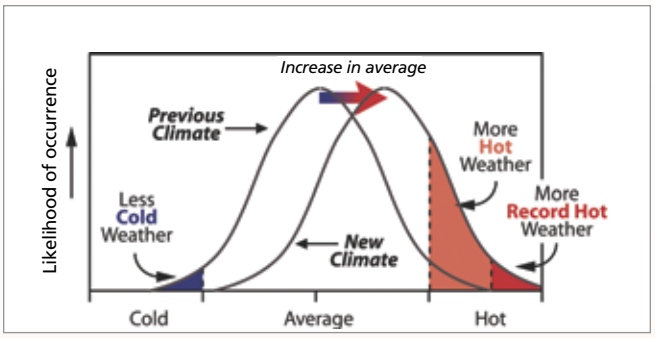


Precipitation changes averaged over 21 climate models between 1980 to 1999 and 2080 to 2099. As storm tracks shift north, precipitation tends to increase in the middle and northern latitudes but decrease in the southern latitudes in North America. Yellow shades indicate decreases in precipitation and green shades indicate increases in precipitation. Darker shades indicate larger increases or decreases. Source: IPCC, 2007

Q. Will a warming climate make temperatures more extreme?

A. Most scientists think that a warming climate will alter the frequency and severity of extreme temperature events. In general, they expect increases in heat waves and decreases in cold spells. These effects will vary from place to place.

Increase in Likelihood of Extremes in a Warmer Climate



Global warming increases the likelihood it will be hot or very hot and decreases, but does not eliminate, the likelihood it will be cold or very cold. Source: IPCC, 2007

Q. How will a warming climate affect hurricanes?

A. Because warm sea surface temperatures energize hurricanes, a warming climate is likely to make hurricanes more intense. Hurricanes in the future will probably have stronger peak winds and increased rainfall. The relationship between sea surface temperatures and the frequency of hurricanes is less clear. There is currently no scientific consensus on how a warming climate is likely to affect the frequency of hurricanes, but research continues.

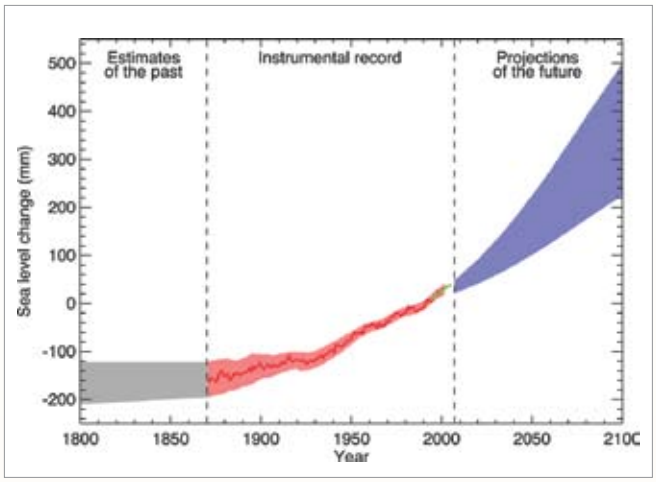
Q. How will a warming climate and climate change affect the polar ice sheets, sea levels, and sea ice?

A. Polar ice sheets (such as those on Greenland and Antarctica) are some of the largest surface features on our planet. Any changes to them, however small, could have far-reaching effects. Polar ice sheets potentially will accumulate more snow and ice because of an increase in precipitation. However, overall melting due to global warming is expected to reduce the size and extent of the polar ice sheets. Melting of polar ice and land-based glaciers is expected to contribute to sea level rise. The IPCC projects a six inch to two foot rise in sea level during the 21st century.

Sea level rise may be greater if there are sudden increases in ice sheet melt. Such increases have already been observed but their effects have not yet been incorporated into current projections of sea level rise.

The stability of the West Antarctic Ice Sheet is of particular concern. A sudden collapse of the ice sheet could raise sea levels 16 to 20 feet. The IPCC is unable to estimate the likelihood or timing of such a collapse, however, due to incomplete understanding of all the processes affecting this ice sheet.

Sea Level Changes and Projections



Past and projected global average sea level. The gray shaded area shows the estimates of sea level change from 1800 to 1870 when measurements were not available. The red line is a reconstruction of sea level change measured by tide gauges with the surrounding shaded area depicting the uncertainty. The green line shows sea level change as measured by satellite. The purple shaded area represents the range of model projections for a medium growth emissions scenario (IPCC SRES A1B). For reference 100mm is about 4 inches. Source: IPCC, 2007

In addition to the ice sheets, sea ice is also melting. Though the melting of floating sea ice that covers part of the Arctic Ocean does not effect sea level, sea ice is important for wildlife and for keeping the region cool by reflecting sunlight back to space. If the Arctic loses the reflective surface of ice and then the dark Arctic Ocean absorbs more heat, the northern regions may warm even more rapidly.

Q. How serious is a warming of a few degrees?

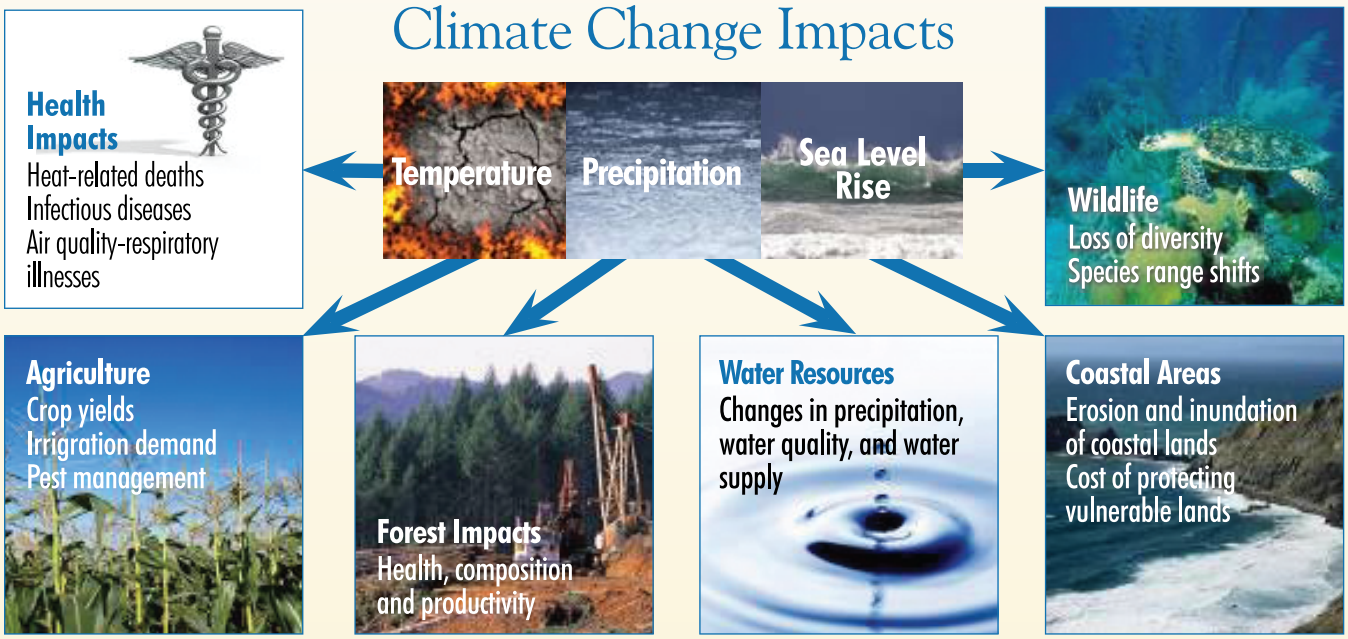
A. The IPCC estimates it has warmed 1.2 to 1.4°F over the past century and projects a further 3 to 7°F over the 21st century. The increases may appear minor compared to short-term weather changes from night to day and winter to summer. In global climate terms, however, warming at this rate would be much larger and faster than any of the climate changes over at least the past 10,000 years.

Q. Will a warming climate have more positive or negative effects?

A. A warming climate will have both positive and negative impacts. Local impacts are the most difficult to predict, making it a challenge to know exactly who or what will be harmed or benefit.

Generally, the risk of negative impacts from climate change increases the faster it warms. More rapid climate change makes adapting to change more difficult and costly. This is especially true for vulnerable groups (such as the poor, the very young and older adults) and fragile ecosystems which may struggle to adapt to even small changes. The IPCC suggests that temperature increases above the range of 3.5 to 5.5°F over the next 100 years would dramatically increase the negative impacts of climate change. So a major aim of climate action is to reduce the risk and likelihood of large, rapid warming.

Climate Change Impacts



Q. How might global warming and climate change affect my health and well-being?

A. Because global temperatures, precipitation, sea levels and the frequency of some extreme weather are expected to increase, climate change could affect you in many ways. Our health, agriculture, forests, water resources, energy, coasts, wildlife and recreational opportunities would all react to climate changes.

Scientific results suggest that climate changes may affect you in the following ways:

Health: Longer, more intense and frequent heat waves may cause more heat-related death and illness. There is virtual certainty of declining air quality in cities since greater heat can also worsen air pollution such as ozone, or smog. Insect-bourne illnesses are also likely to increase as many insect ranges expand. Climate change health effects are especially serious for the very young, very old, or for those with heart and respiratory problems. Conversely, warmer winter temperatures may reduce the negative health impacts from cold weather.

Agriculture and Forestry: The supply and cost of food may change as farmers and the food industry adapt to new climate patterns. A small amount of warming coupled with increasing CO_2 may benefit certain crops, plants and forests, although the impacts of vegetation depend also on the availability of water and nutrients. For warming of more than a few degrees, the effects are expected to become increasingly negative, especially for vegetation near the warm end of its suitable range.

Water Resources: In a warming climate, extreme events like floods and droughts are likely to become more frequent. More frequent floods and droughts will affect water quality and availability. For example, increases in drought in some areas may increase the frequency of water shortages and lead to more restrictions on water usage. An overall increase in precipitation may increase water availability in some regions, but also create greater flood potential.

Coasts: If you live along the coast, your home may be impacted by sea level rise and an increase in storm intensity. Rising seas may contribute to enhanced coastal erosion, coastal flooding, loss of coastal wetlands, and increased risk of property loss from storm surges.

Energy: Warmer temperatures may result in higher energy bills for air conditioning in summer, and lower bills for heating in winter. Energy usage is also connected to water needs. Energy is needed for irrigation, which will most likely increase due to climate change. Also, energy is generated by hydropower in some regions, which will also be impacted by changing precipitation patterns.

Wildlife: Warmer temperatures and precipitation changes will likely affect the habitats and migratory patterns of many types of wildlife. The range and distribution of many species will change, and some species that cannot move or adapt may face extinction.

Recreational opportunities: Some outdoor activities may benefit from longer periods of warm weather. However, many other outdoor activities could be compromised by increased beach erosion, increased heat waves, decreased snowfall, retreating glaciers, reduced biodiversity and changing wildlife habitats.

Resources

A great place to start is EPA's Climate Change Web site at: **www.epa.gov/climatechange**
The site contains detailed information about greenhouse gas emissions, science, effects of climate change and what you can do.

Here are some other Web sites you may find useful:

Intergovernmental Panel on Climate Change
http://www.ipcc.ch

NASA's Global Warming Web site
http://earthobservatory.nasa.gov/Library/GlobalWarmingUpdate

NASA's Climate Change—Eyes on the Earth Web site
http://climate.jpl.nasa.gov

NOAA's National Climatic Data Center
http://www.noaa.gov/climate.html

United States
Environmental Protection
Agency

www.epa.gov/climatechange

Office of Air and Radiation (6207J)
EPA-430-R08-016
www.epa.gov
April 2009

Recycled/Recyclable
Printed on paper that contains
at least 50% post consumer fiber.