NATIONAL CENTER FOR POLICY ANALYSIS

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Disclaimer: This primer is based on a review of available scientific research. The NCPA received no money and no input from any private company or government agency.

A Global Warming Primer

The purpose of this primer is to explore some of the main scientific, economic and political issues surrounding the topic of global warming.

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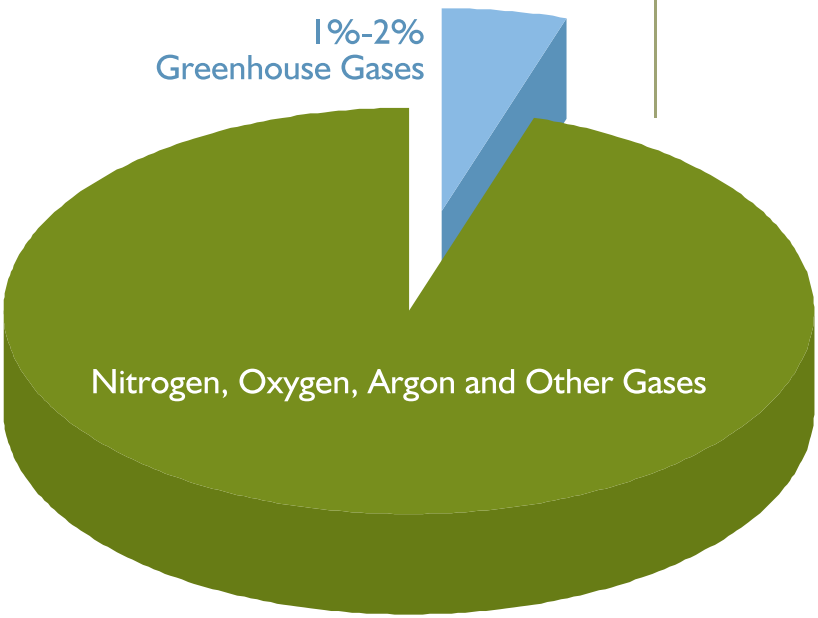
Part I: A Brief History of Global Warming

Greenhouse gases are a small part of the Earth's atmosphere. However, they are critical to making the planet habitable—keeping the Earth from being a freezing rock in space like Mars.

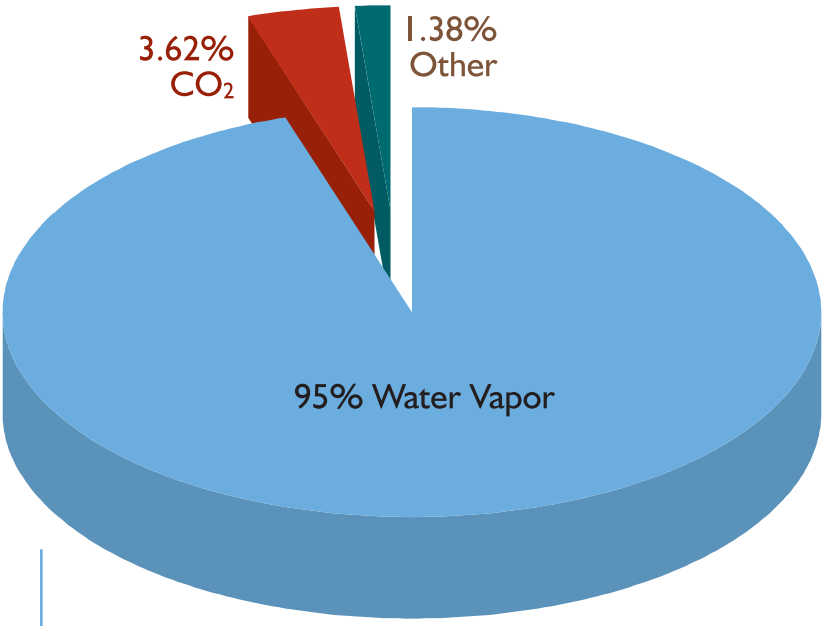
Human activities, primarily the burning of fossil fuels for energy and deforestation, have contributed to an increase in greenhouse gases and many scientists believe this has caused the present warming trend.

Greenhouse gases make up no more than 2 percent of the Earth's atmosphere.



How Much of the Atmosphere Is Greenhouse Gases?

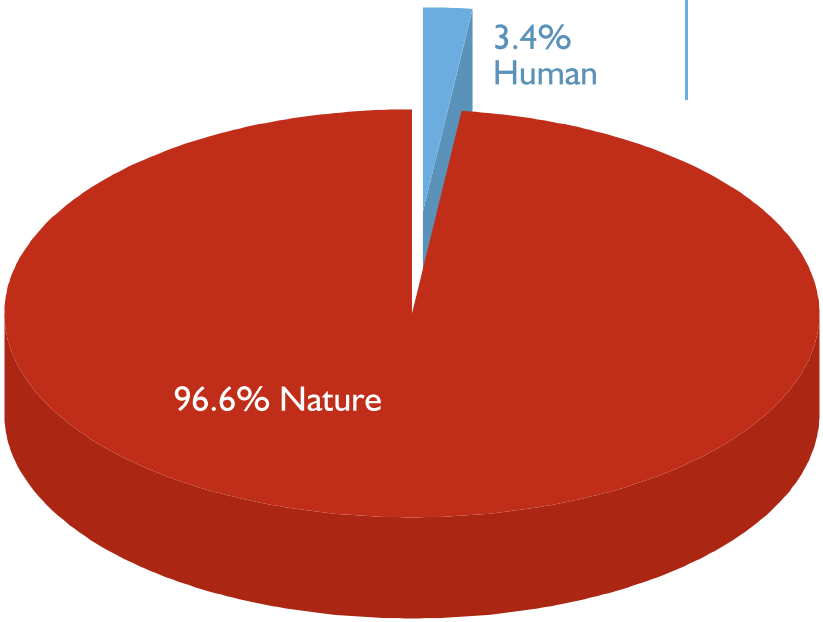
What Are the Greenhouse Gases in the Atmosphere?



CO_2 is a naturally occurring greenhouse gas. Humans and other animals emit CO_2 into the atmosphere when they exhale, and plants absorb it.

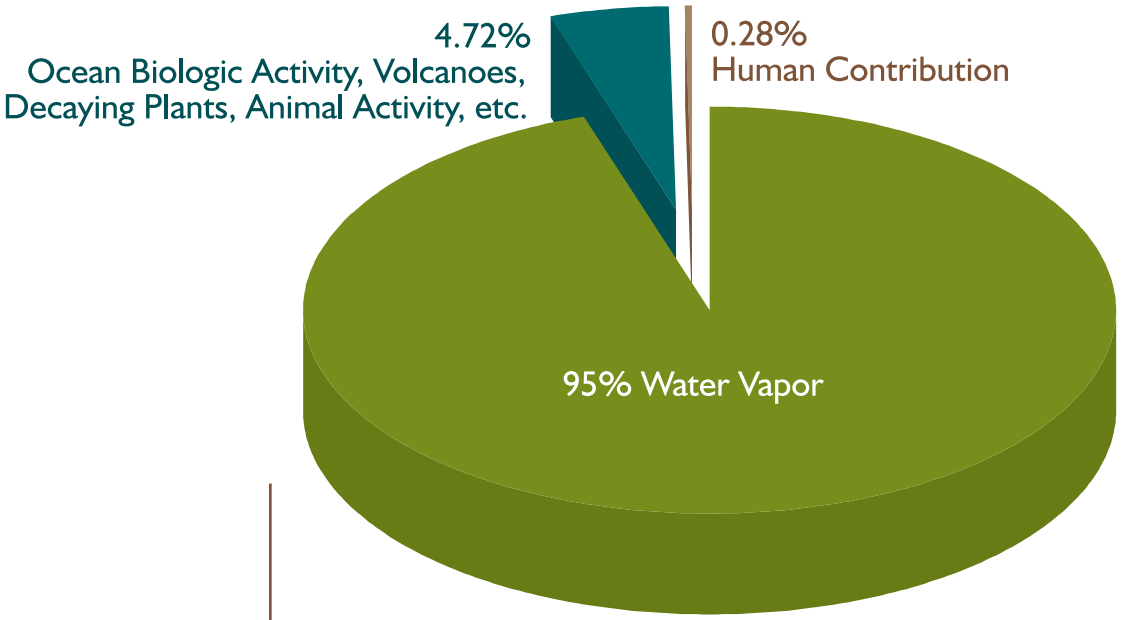
CO_2 and other trace gases are only 5 percent of the greenhouse gases in the atmosphere. Water vapor makes up the other 95 percent.

Humans contribute approximately 3.4 percent of annual CO_2 emissions. However, small increases in annual CO_2 emissions, whether from humans or any other source, can lead to a large CO_2 accumulation over time because CO_2 molecules can remain in the atmosphere for more than a century.



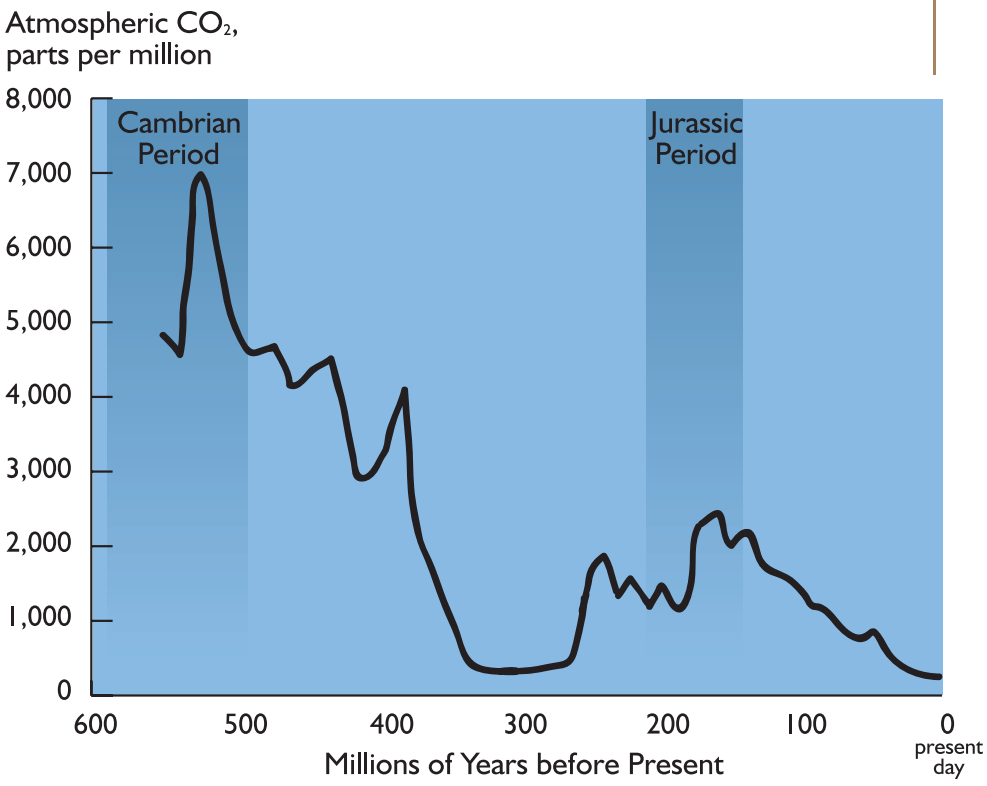
Where Do CO_2 Emissions Come From?

What Is the Human Share of the Greenhouse Effect?



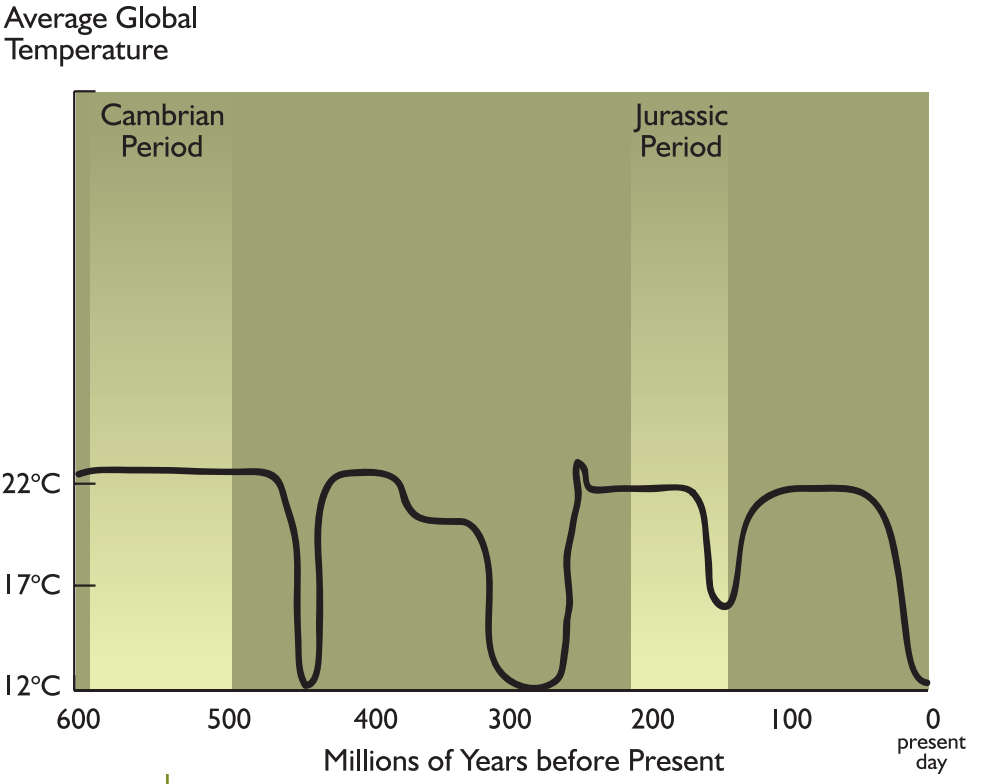
Humanity is responsible for about one-quarter of 1 percent of the greenhouse effect.

There was an explosion of life forms 550 million years ago (Cambrian Period), when CO_2 levels were 18 times higher than today. During the Jurassic Period, when the dinosaurs roamed the Earth, CO_2 levels were as much as nine times higher than today.



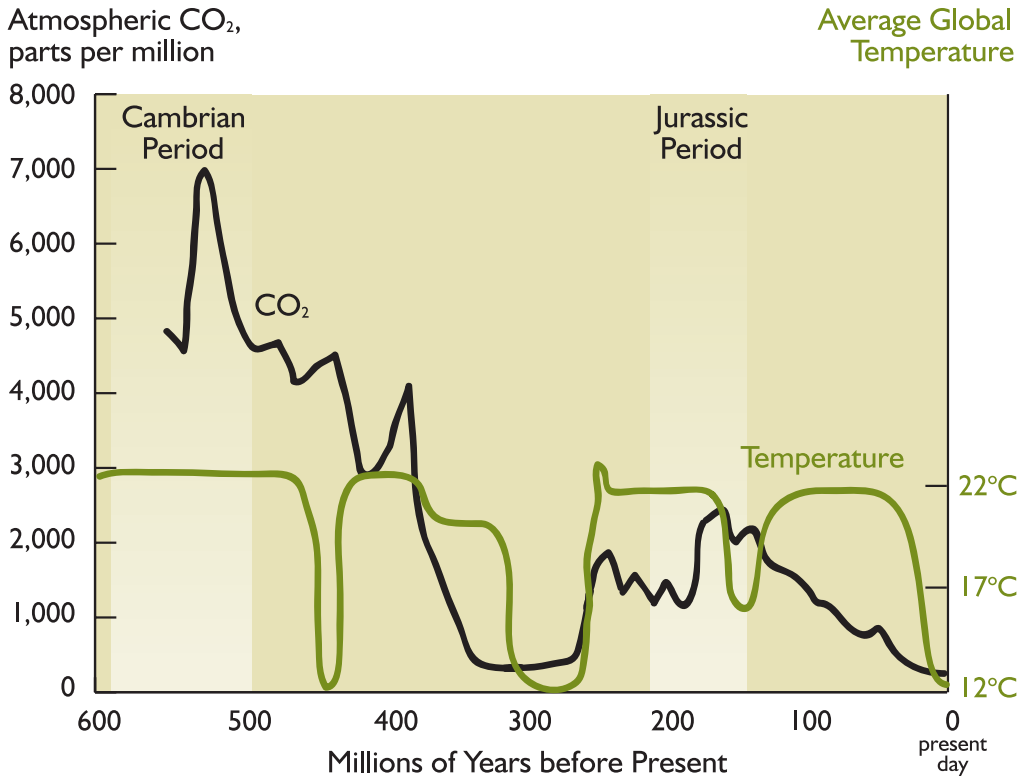
How Have CO_2 Levels Changed over the Past 600 Million Years?

How Has the Earth's Temperature Changed over the Past 600 Million Years?



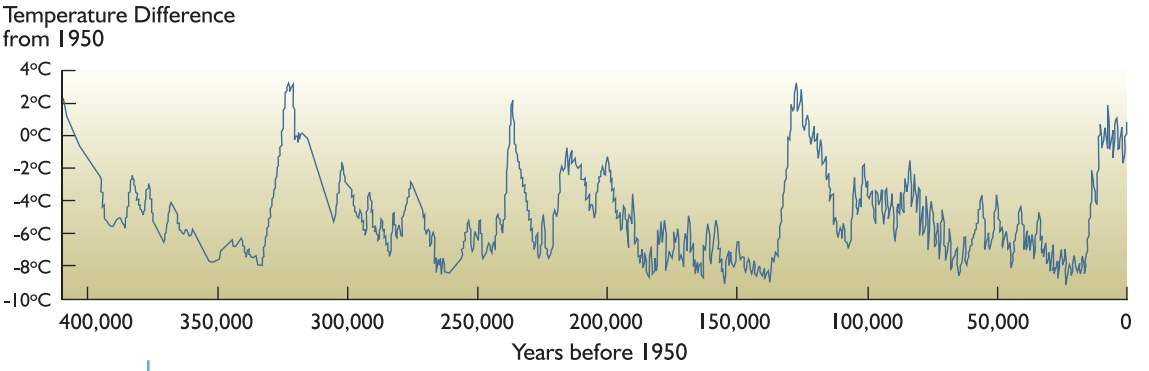
During the time dinosaurs roamed the Earth, the average temperature was about 18°F (10°C) warmer than it is today.

Over long periods of time, there is no close relationship between CO_2 levels and temperature.



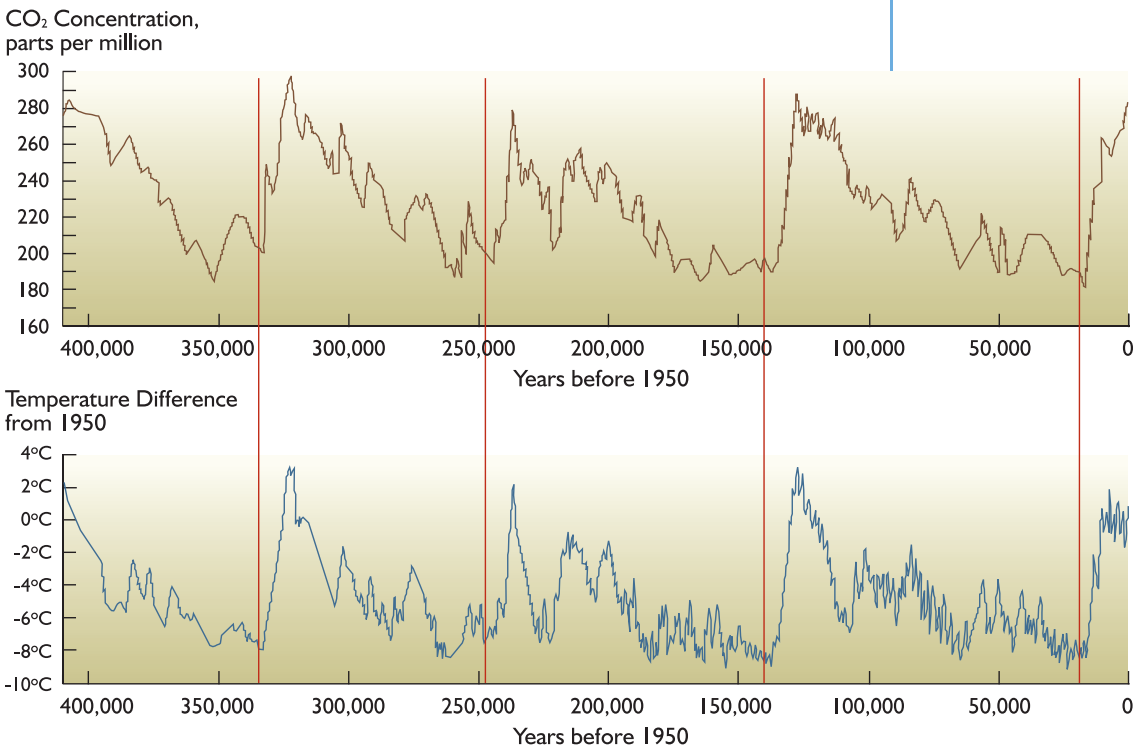
Is There a Relationship Between CO_2 and Global Temperature over the Earth's History?

How Has the Earth's Temperature Changed over the Past 400,000 Years?



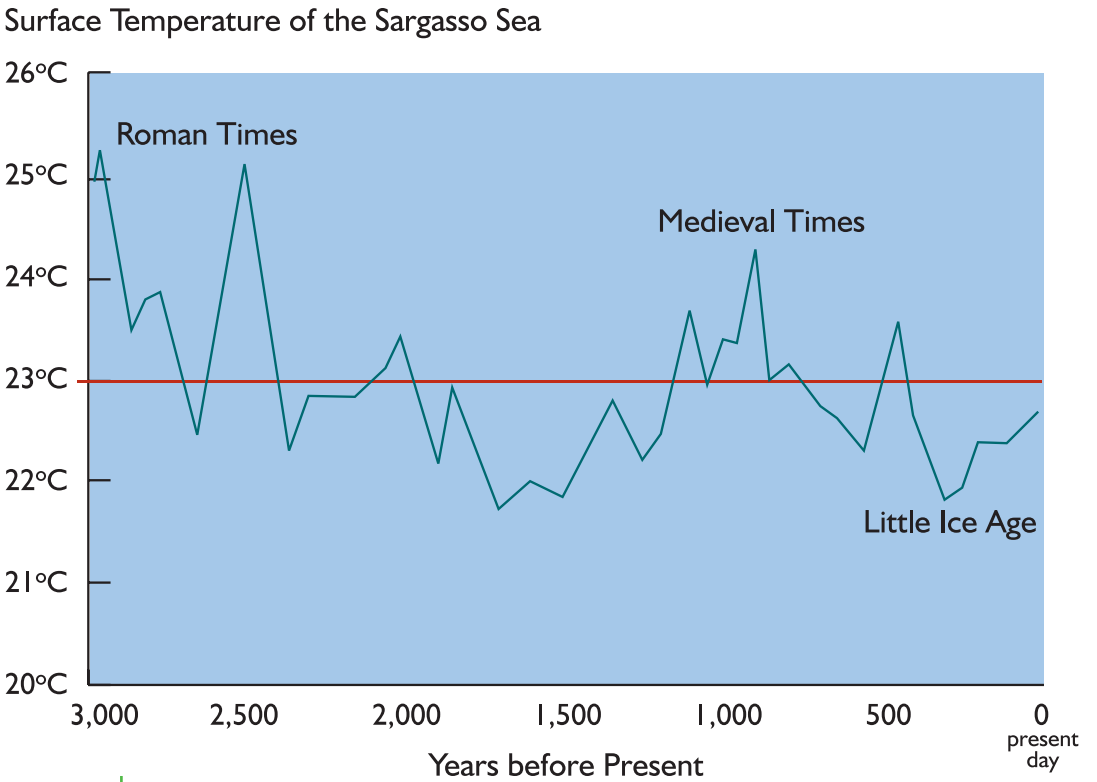
Over the past 400,000 years, there has been a series of ice ages lasting 100,000 years, on the average, interrupted by warm periods lasting about 10,000 years. During ice ages, the temperature drops by as much as 21°F, sea levels fall dramatically, glaciers expand and most living things are forced to migrate toward the equator. During periods of relative warmth, sea levels rise and glaciers retreat. We are currently at the tail end of a warm period.

For the past 400,000 years, temperature and CO_2 levels have varied together. However, the Earth's temperature has consistently risen and fallen hundreds of years prior to increases and declines in CO_2 levels.



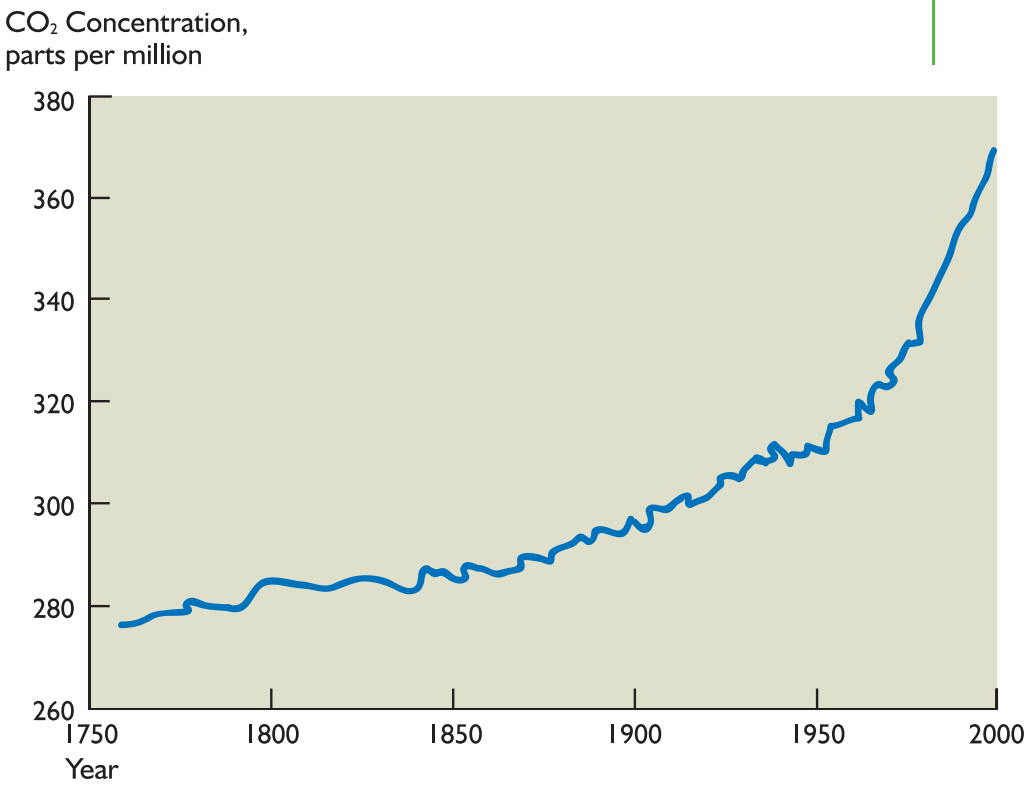
What Is the Relationship between Temperature and CO_2 over the Past 400,000 Years?

How Have Temperatures Changed over the Past 3,000 Years?



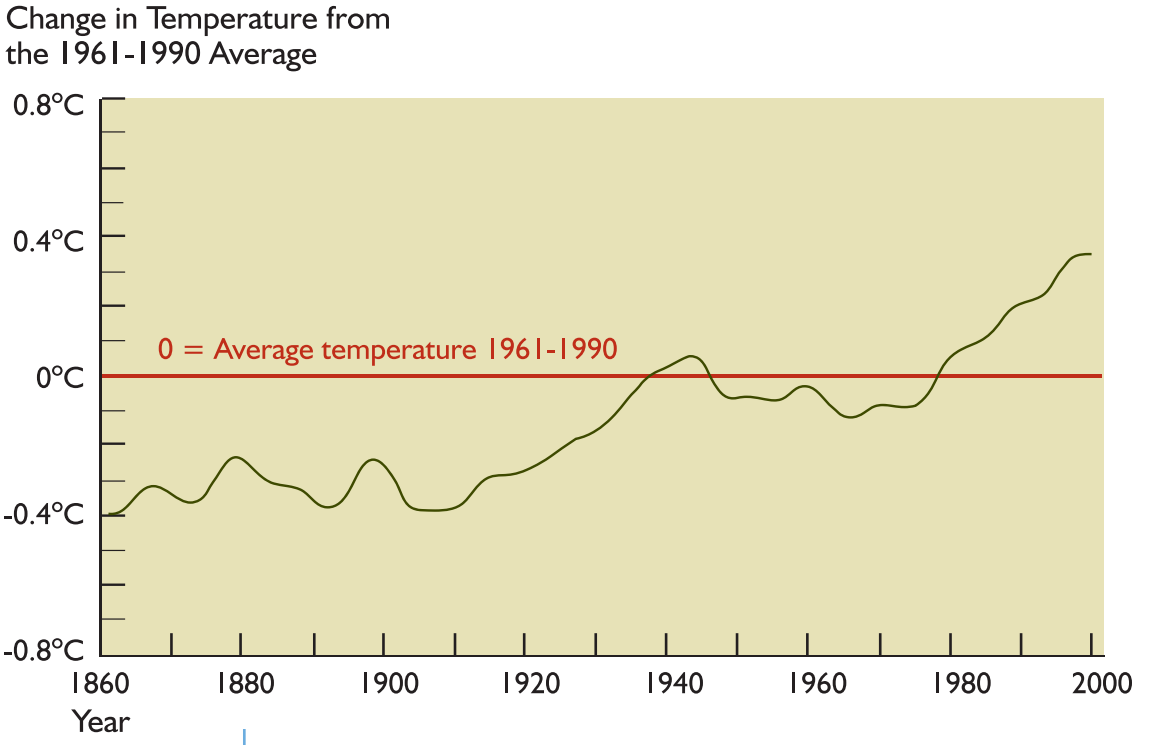
During Roman and medieval times, the Earth was as warm as or warmer than it is today. A "little ice age" began in the 1300s and ended in the mid-1800s.

CO_2 levels have been fairly constant for the last 10,000 years. Largely due to human activities, including the burning of fossil fuels and deforestation, CO_2 levels have risen approximately 35 percent since the beginning of the industrial revolution, with more than 80 percent of that rise occurring since 1950.



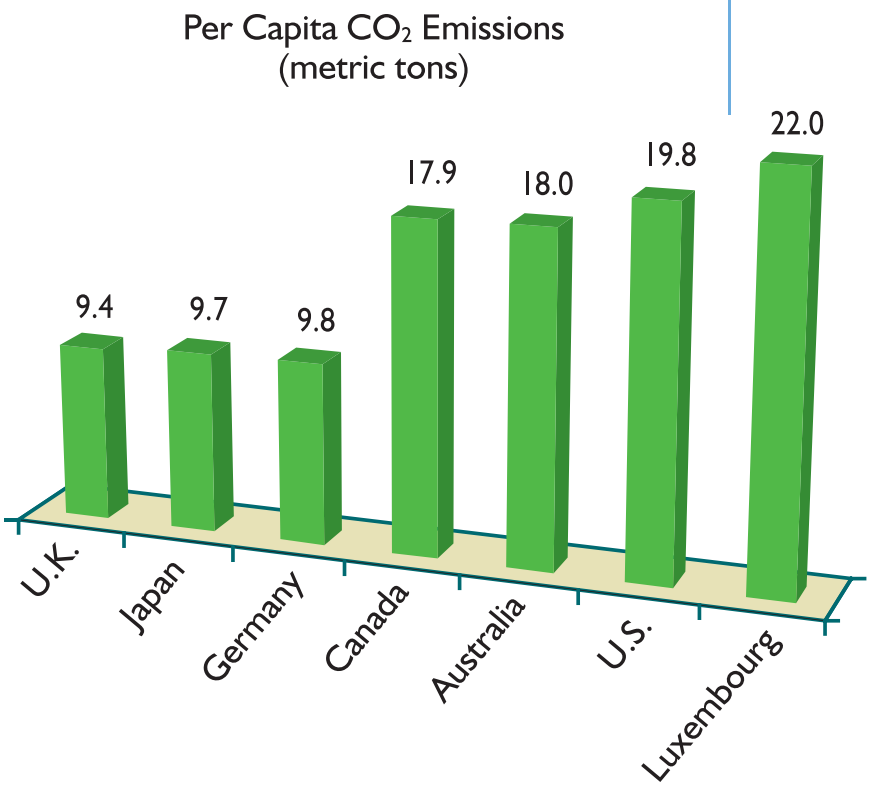
How Much Have CO_2 Levels Changed in Recent Times?

How Much of the Present Warming Was Caused by Increasing Levels of CO_2?



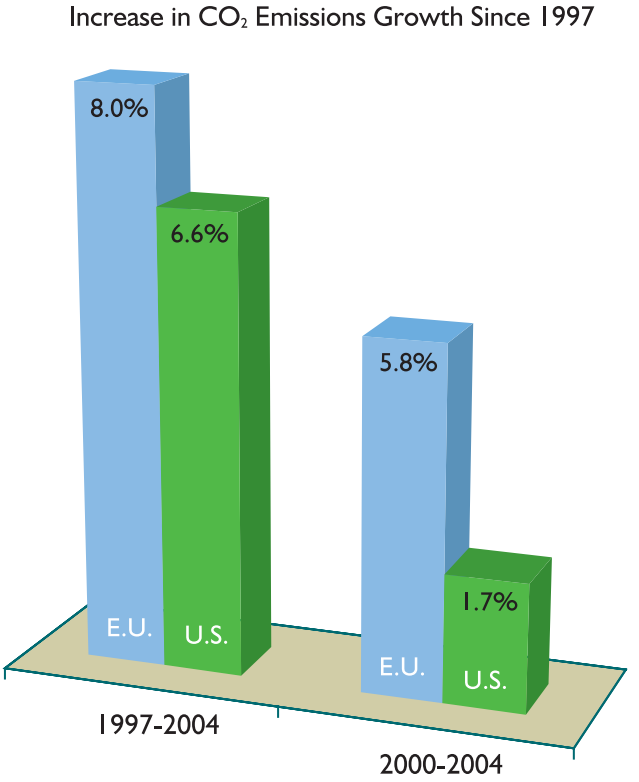
The Earth's average temperature has risen a little less than one degree Celsius over the past century. Although almost half of this warming occurred before 1940, greenhouse gas emissions began to rise substantially only after the 1950s.

The United States emits more CO_2 per person than almost any other developed country.



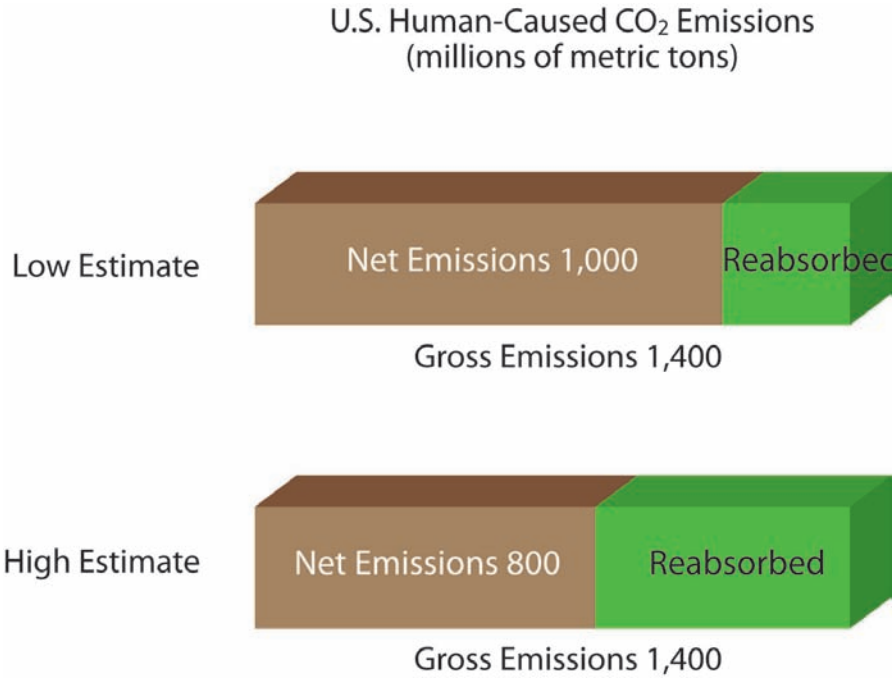
How Do America's CO_2 Emissions Compare to Other Developed Countries?

How Have CO_2 Emissions Changed in Recent Years?



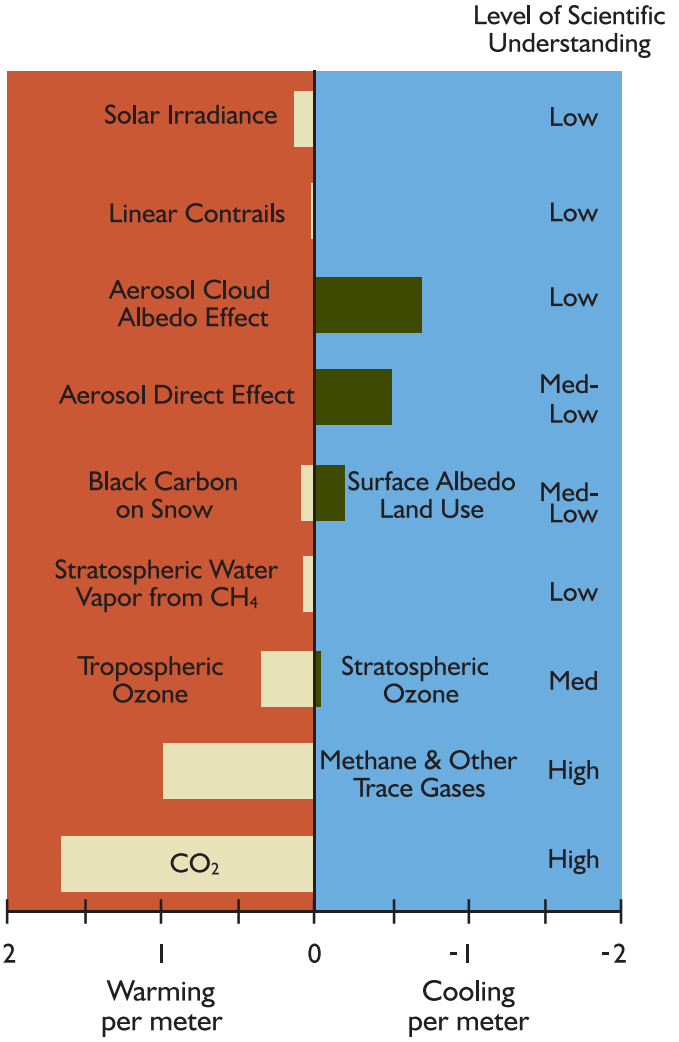
The United States has slowed the growth of its emissions far more than the European Union—despite larger population growth and higher economic growth.

Most reports focus on gross CO_2 emissions. However, as much as 40 percent of U.S. human CO_2 emissions are reabsorbed, primarily by vegetation.



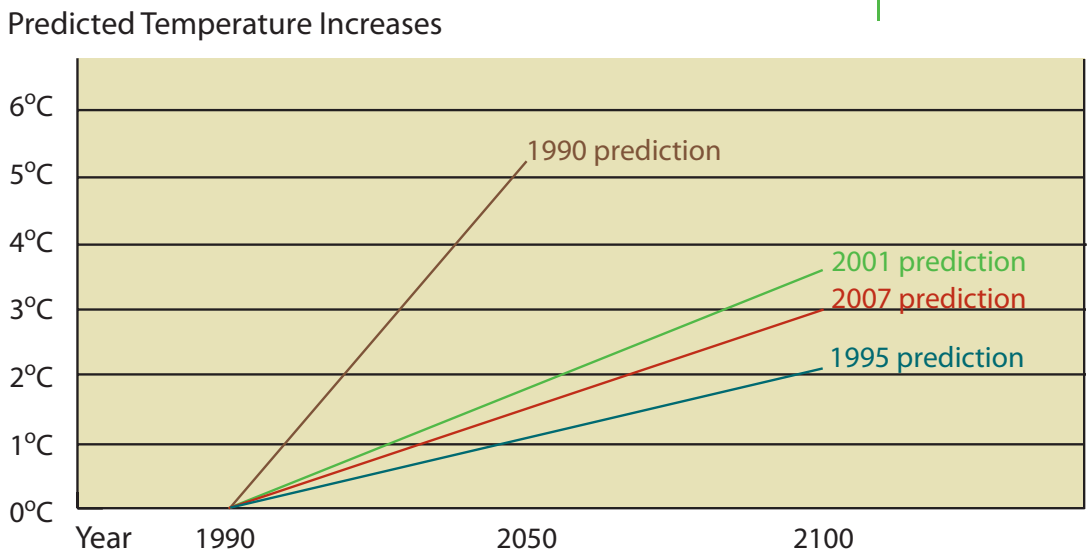
How Much CO_2 Does the United States Really Emit?

How Much Do We Know about the Causes of Global Temperature Change?



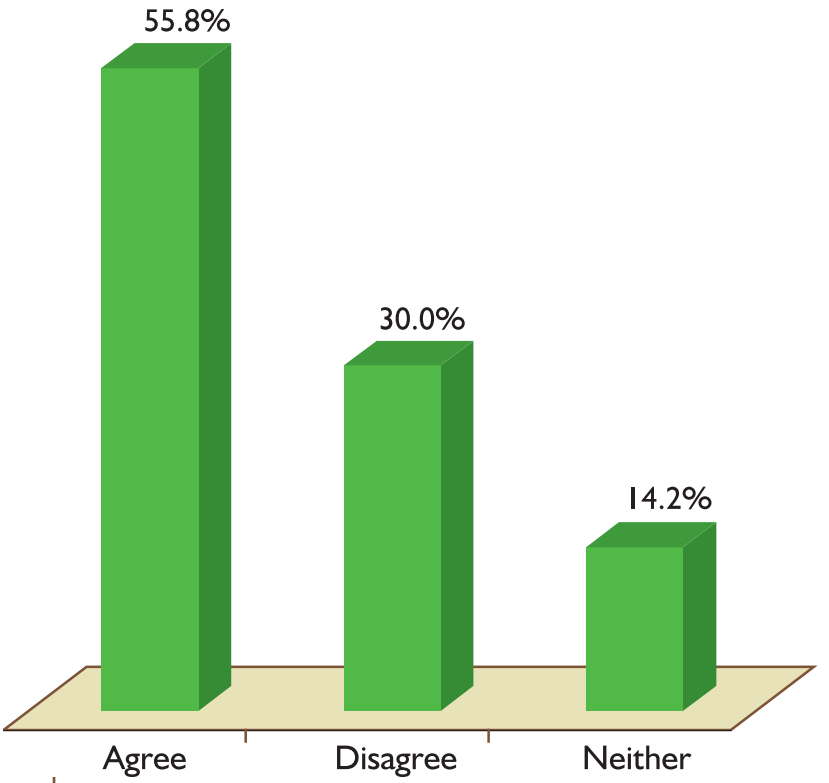
We know very little about 75 percent of the factors that scientists believe influence global temperature.

There are many climate change models used to predict global warming. This graph shows how the mid-range estimates of those models have changed over time.



How Good Are Climate Models at Predicting Global Warming?

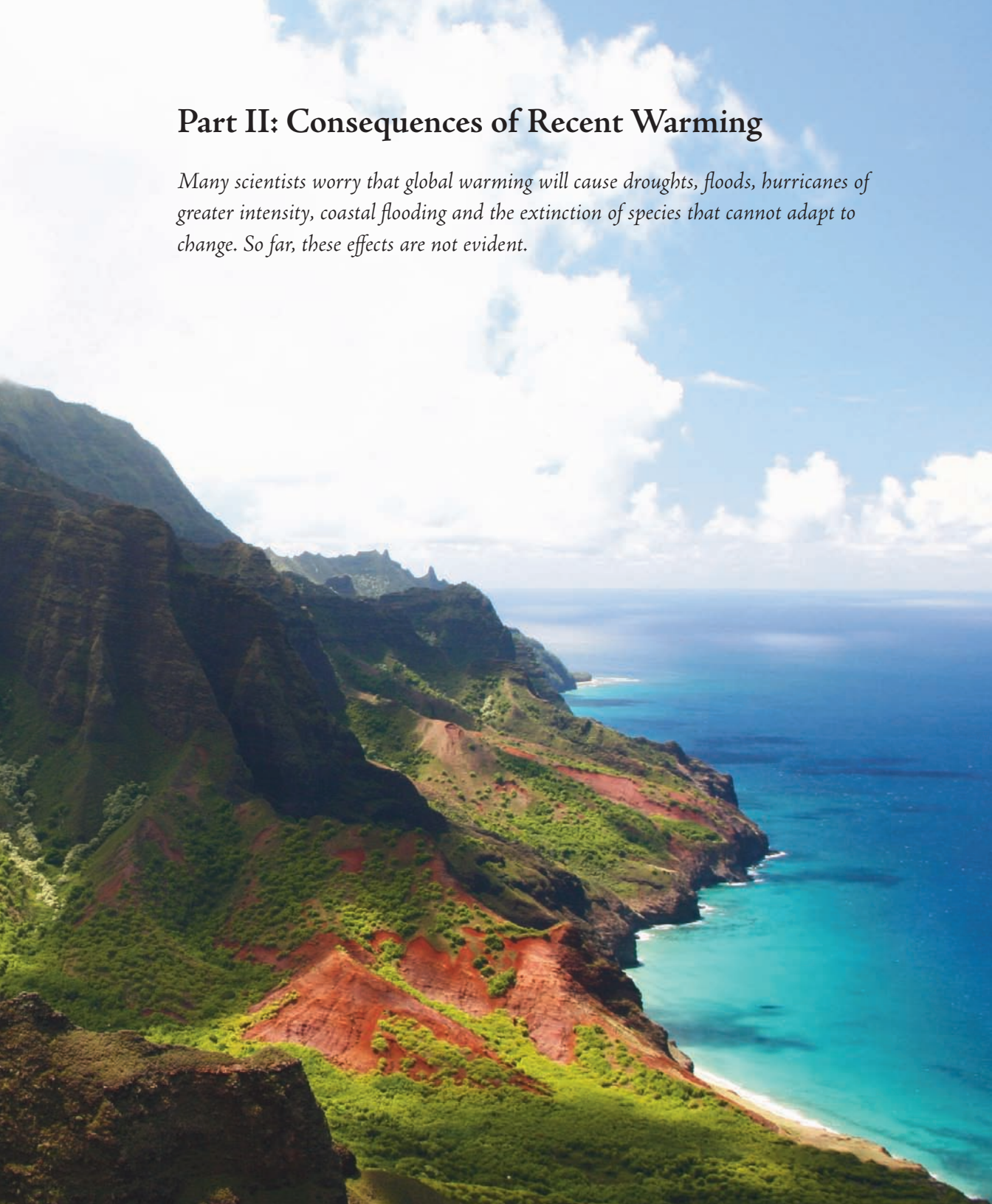
Do Scientists Agree That Humans Are Causing the Present Warming?



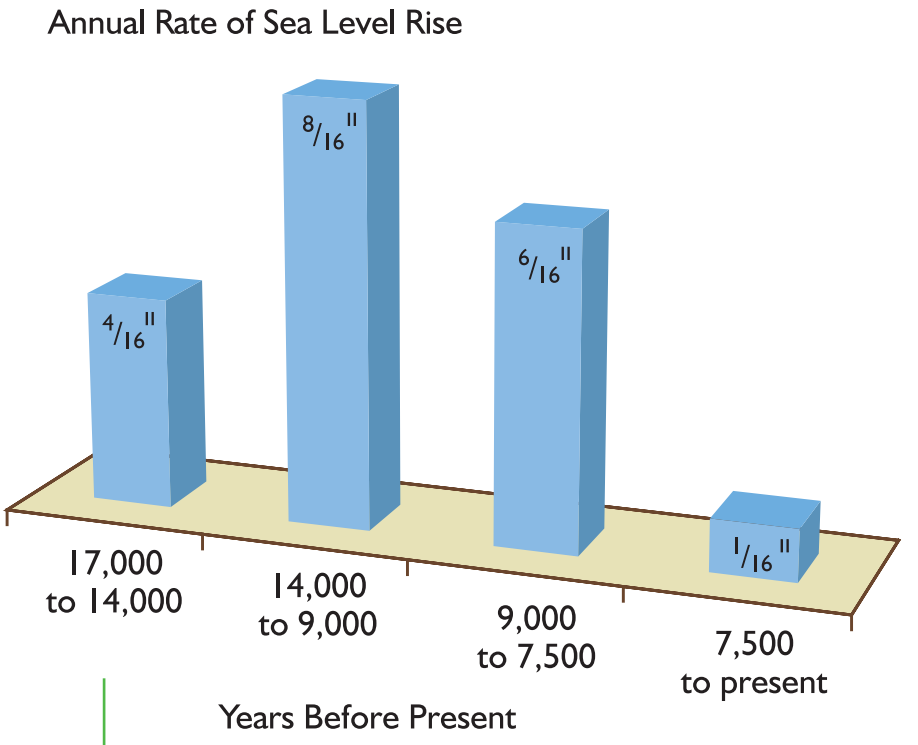
Approximately 56 percent of climate scientists worldwide believe humans are the cause of global warming.

Part II: Consequences of Recent Warming

Many scientists worry that global warming will cause droughts, floods, hurricanes of greater intensity, coastal flooding and the extinction of species that cannot adapt to change. So far, these effects are not evident.

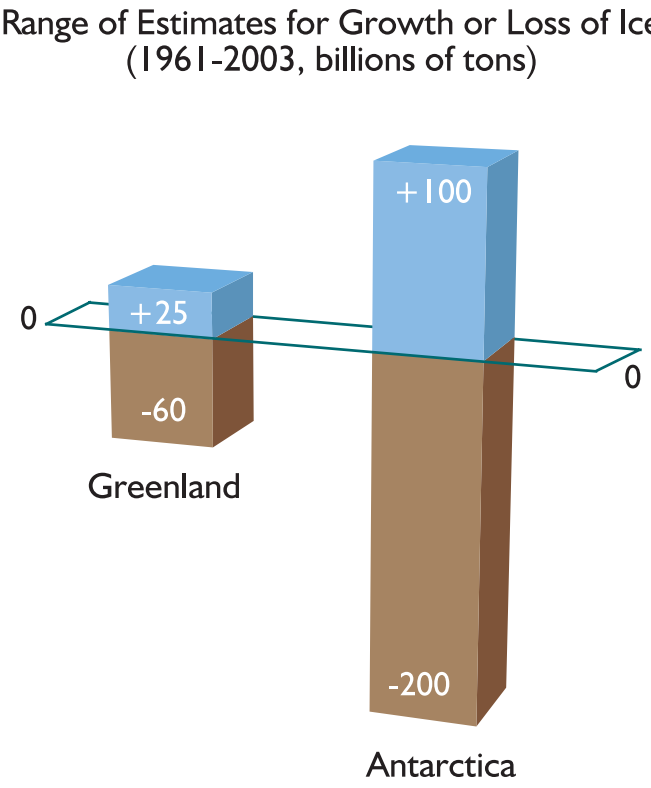


Is Global Warming Causing Rising Sea Levels?



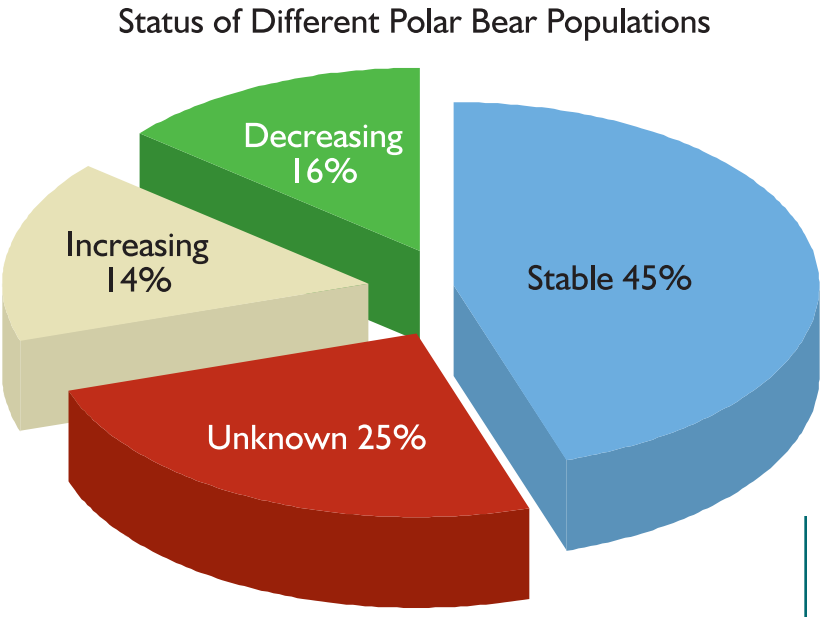
Sea levels have risen since the Earth began to come out of the last ice age. However, the rate of sea level rise since 1961, less than two-sixteenths of an inch annually, is far lower than the historic average.

While ice has melted at the edges and thinned in other locations on Greenland and Antarctica, much of their interiors have thickened due in part to increased annual snowpack. Estimates of the net effect range from ice gains to ice losses. At most, ice loss in the two regions since 1993 has contributed 0.8 mm to annual sea level rise per year—a rate that would total 3 inches by 2100.



Are the Ice Sheets Melting?

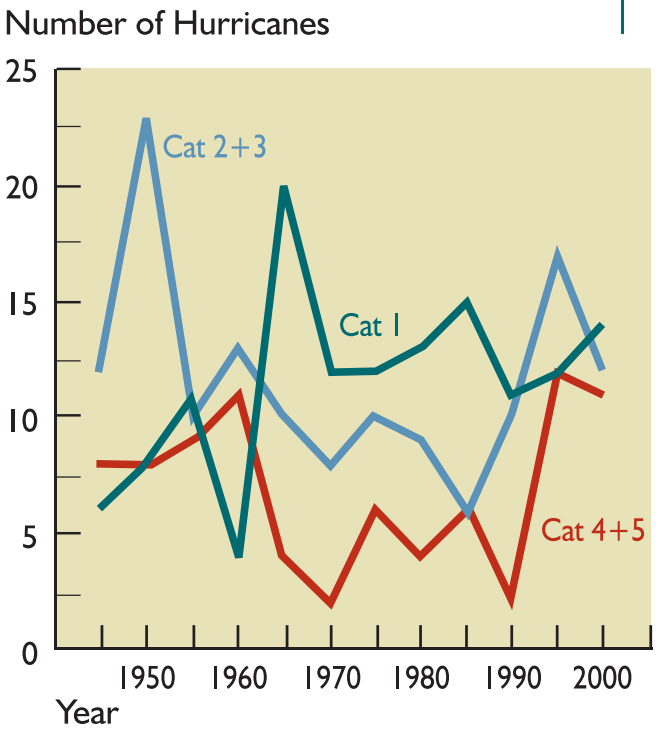
Is Global Warming Killing Polar Bears?



Polar bear numbers increased dramatically from around 5,000 in the 1950s to as many as 25,000 today, higher than at any time in the 20th century.

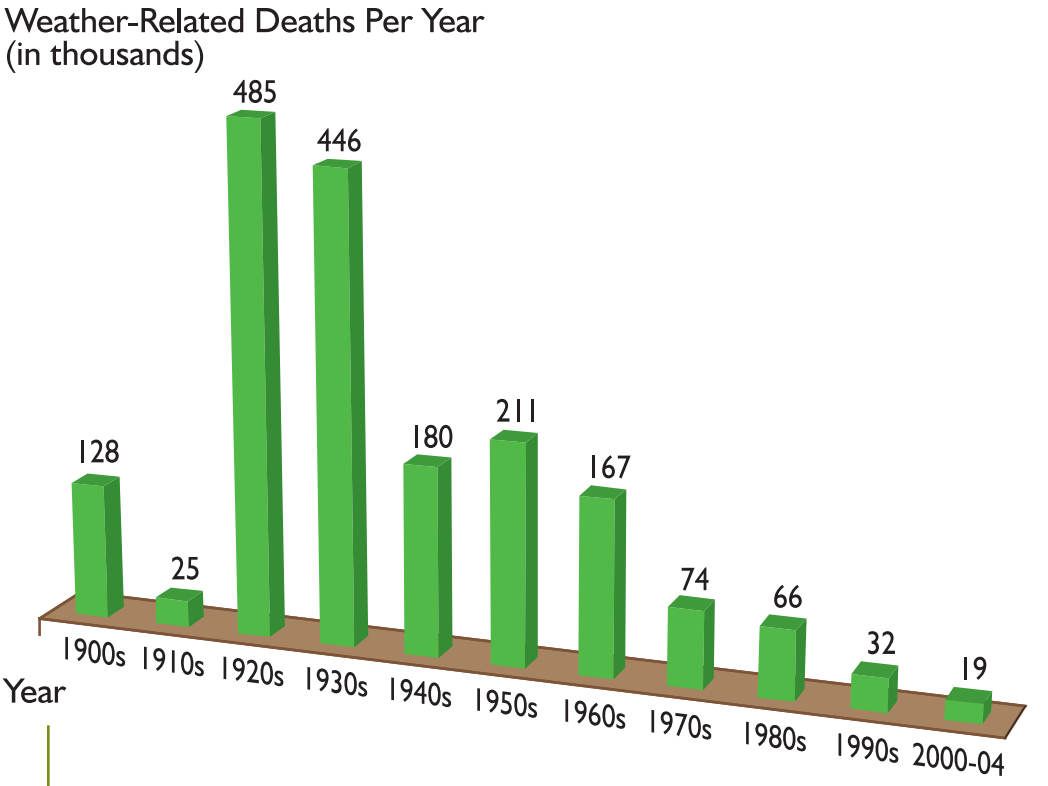
Of the distinct polar bear populations worldwide, only two populations are decreasing. The majority of the populations are stable or increasing.

Neither the number nor the strength of hurricanes has increased outside the natural range of variability (category 1 is the lowest wind velocity and category 5 is the highest).



Is Global Warming Causing More Frequent or More Severe Hurricanes?

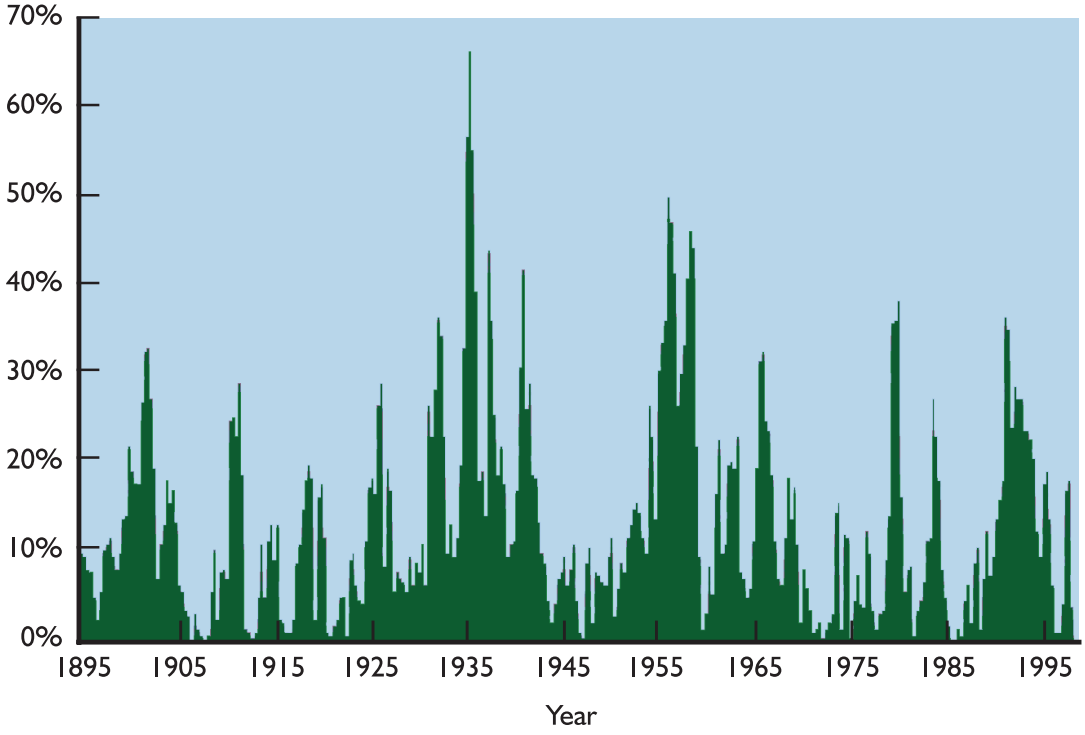
Is Global Warming Causing More Weather-Related Deaths?



Worldwide weather-related deaths have declined dramatically over the past eight decades.

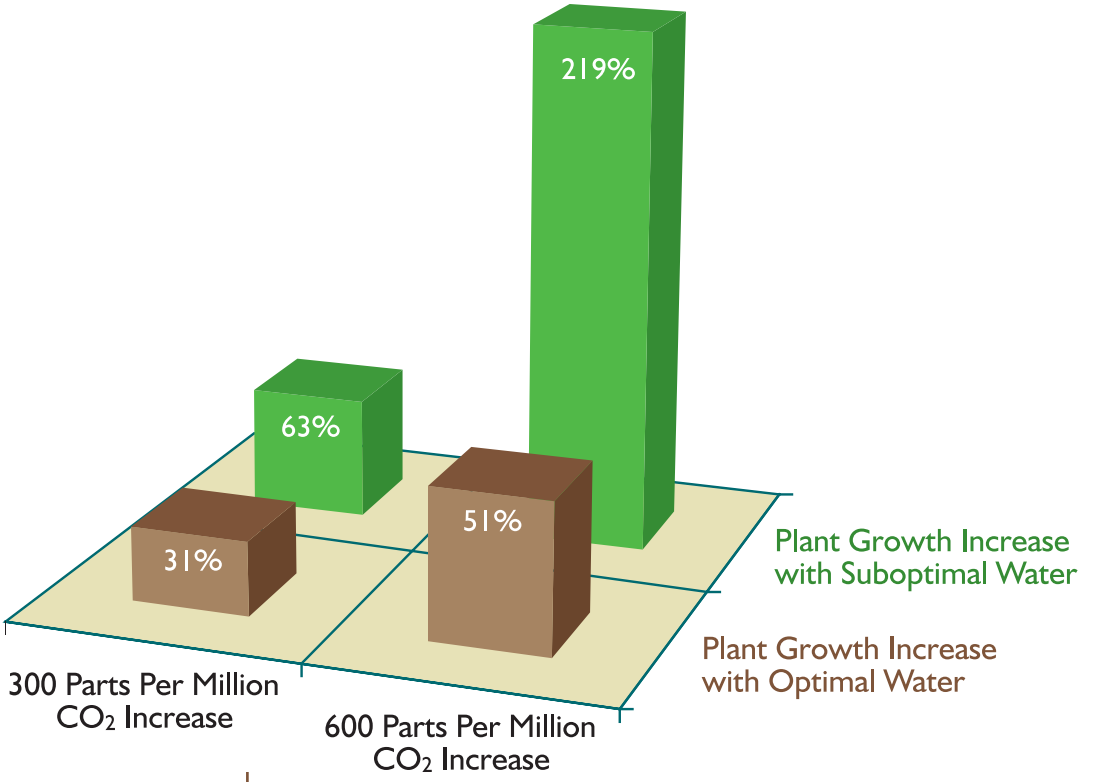
Natural variability has produced more frequent and longer droughts in the past than we experience today.

U.S. Land Area Affected by Drought

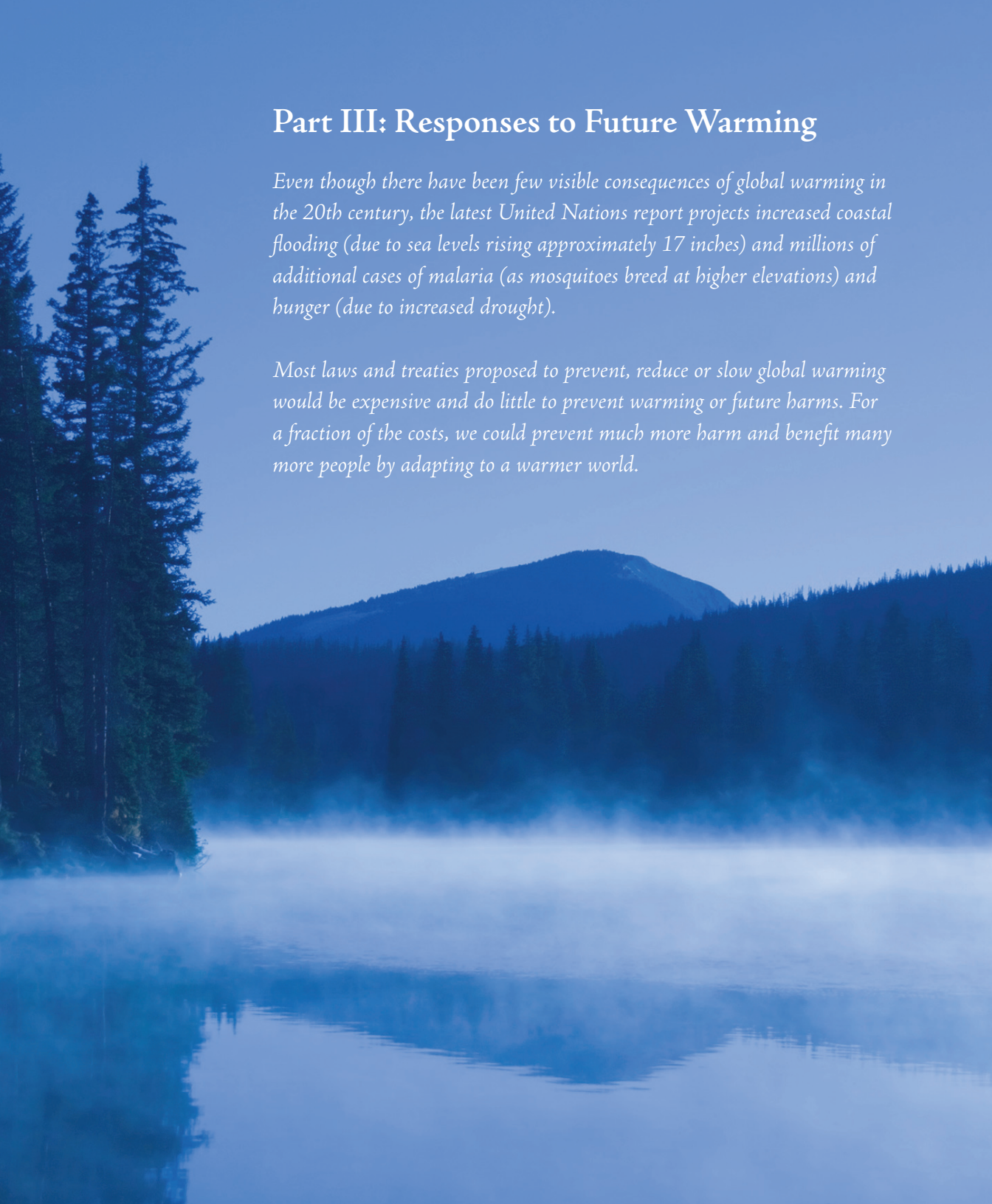


Is Global Warming Causing More Frequent or More Severe Droughts?

Are There Any Benefits from Increased CO_2?



CO_2 is like plant food and most plants evolved at times when CO_2 levels were much higher than today. Laboratory results show that plants grow bigger and faster with increased levels of CO_2.

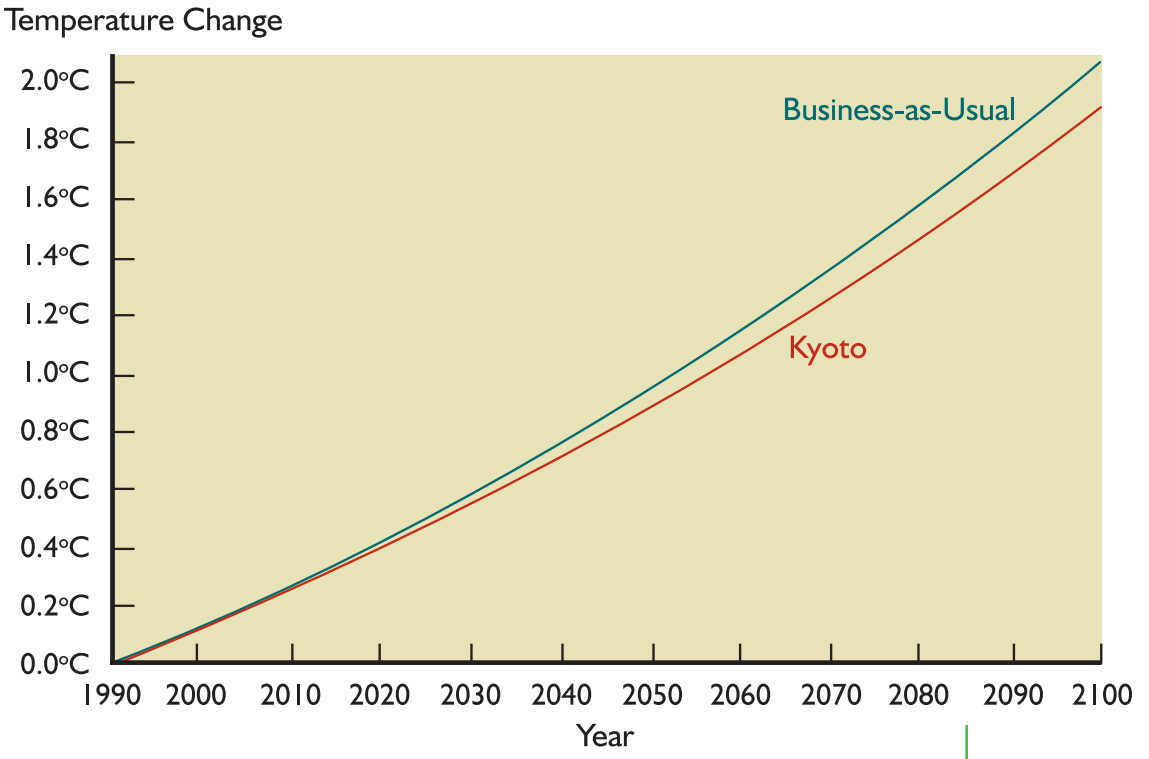


Part III: Responses to Future Warming

Even though there have been few visible consequences of global warming in the 20th century, the latest United Nations report projects increased coastal flooding (due to sea levels rising approximately 17 inches) and millions of additional cases of malaria (as mosquitoes breed at higher elevations) and hunger (due to increased drought).

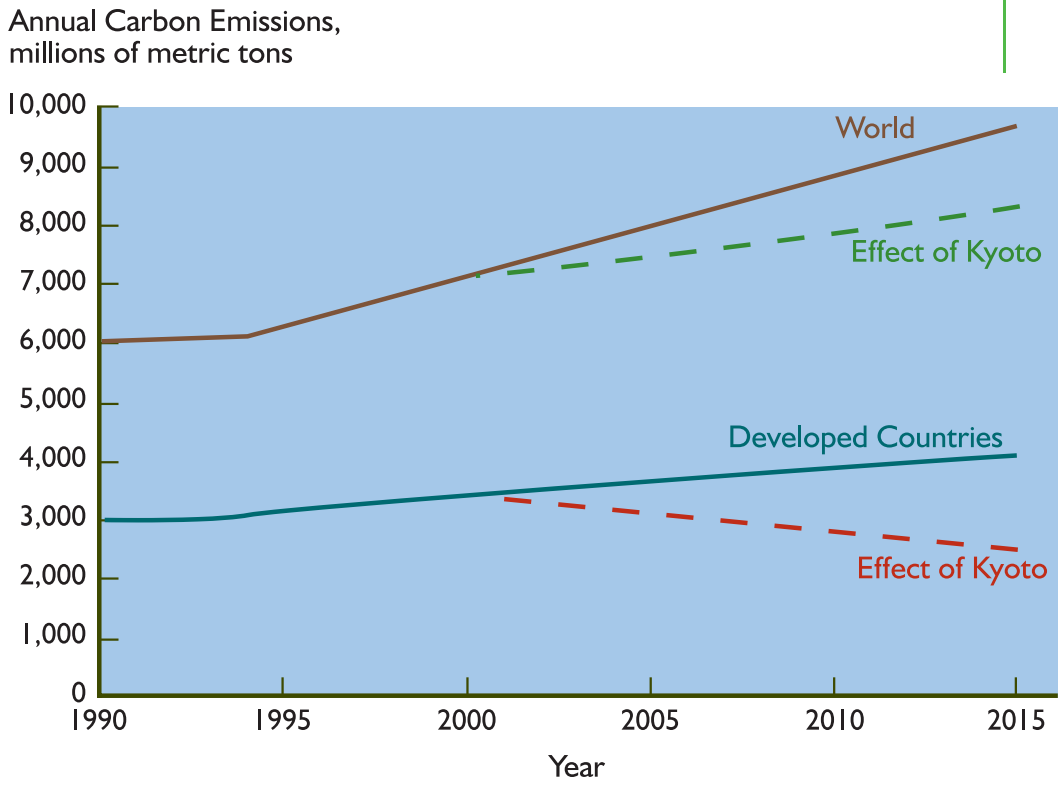
Most laws and treaties proposed to prevent, reduce or slow global warming would be expensive and do little to prevent warming or future harms. For a fraction of the costs, we could prevent much more harm and benefit many more people by adapting to a warmer world.

Can the Kyoto Protocol Stop Global Warming?



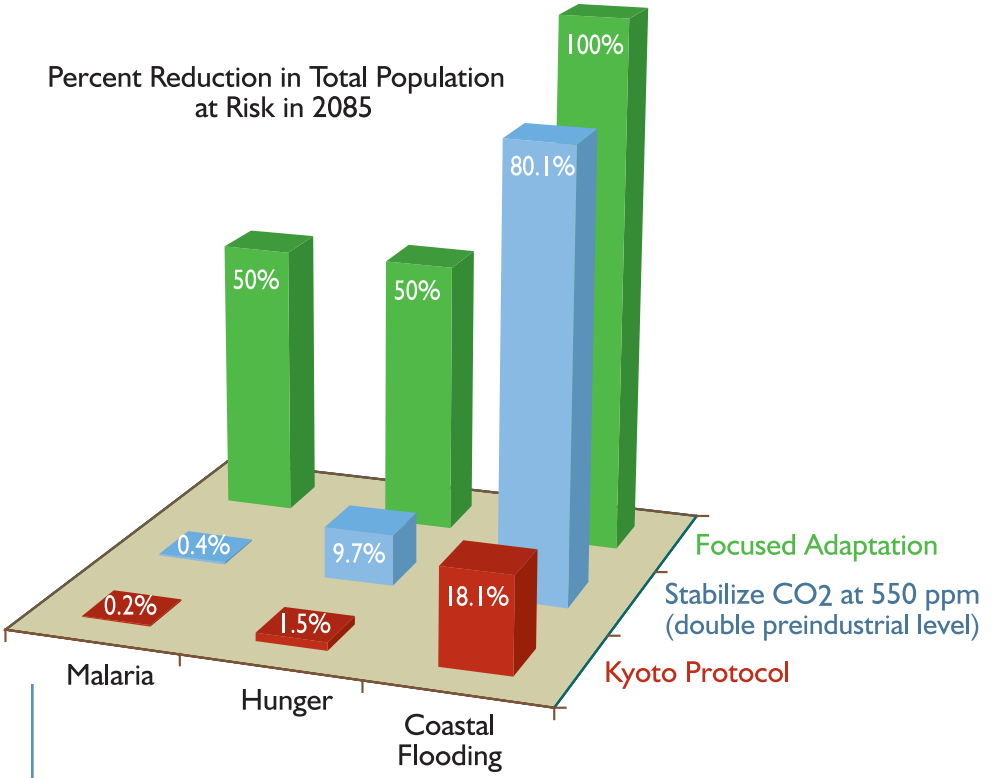
The Kyoto Protocol is an international treaty designed to reduce greenhouse gas emissions from industrial countries an average of 5 percent below their 1990 levels by 2012. Even if all of the countries complied, the Earth would only be marginally cooler by 2100.

Greenhouse gas concentrations will continue to increase despite CO_2 cuts in developed countries. The reason: Fast-growing countries that do not have to reduce emissions under the Kyoto Protocol—such as China, India, South Korea, Brazil and Indonesia—will account for as much as 85 percent of the projected increase in the next two decades.



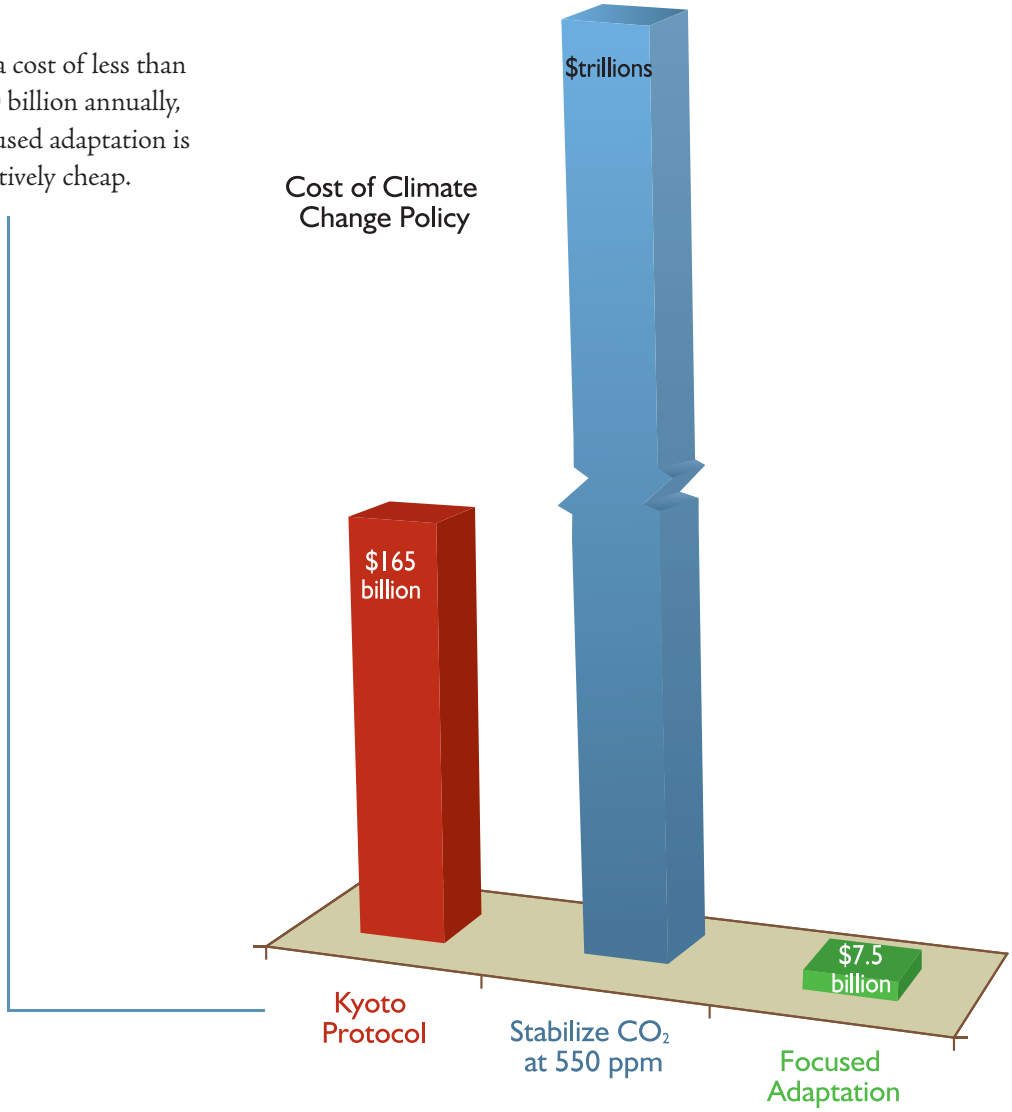
Can Developed Countries Alone Prevent Global Warming?

Will Cutting CO_2 Emissions Reduce the Harms to Which Warming Contributes?



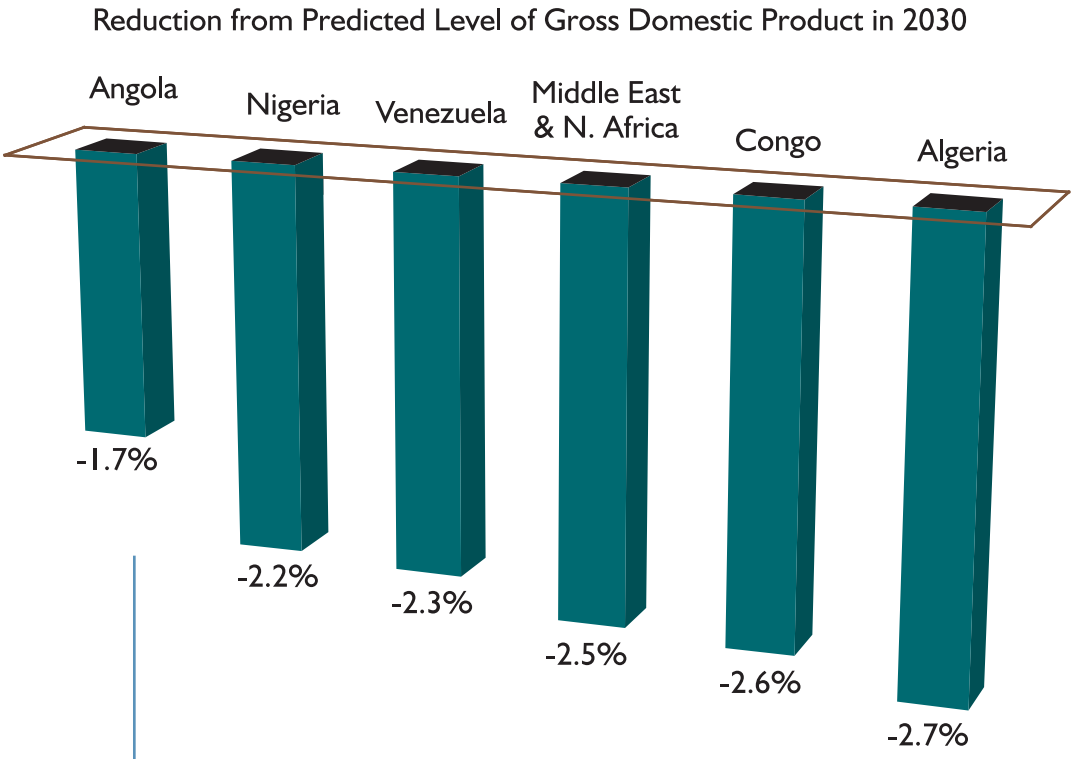
Focused adaptation means taking steps now to adapt to warmer conditions—such as using pesticides to kill malaria-bearing mosquitoes, improving farming practices and ending subsidies to coastal development. These measures could virtually eliminate the threat of coastal flooding and cut in half the number of people projected to be at risk from malaria and hunger.

At a cost of less than $10 billion annually, focused adaptation is relatively cheap.



Would Adapting to Climate Change Be Better Than Trying to Prevent It?

How Would the Kyoto Protocol Affect Poor Countries?



Less-developed countries (which are not required to reduce CO_2 emissions) would suffer significant harm from the Kyoto Protocol due to loss of world trade and other economic impacts.

The Copenhagen Consensus, a panel of eight world-renowned economists (including three Nobel laureates), met in 2004 to discuss and prioritize proposals that address ten of the world's greatest challenges and advance global welfare (see ranking below). The challenges, identified by the United Nations, included: civil conflicts; climate change; communicable diseases; education; financial stability; governance; hunger and malnutrition; migration; trade reform; and water and sanitation.

Very Good	**1**	**Diseases**	**Control of HIV/AIDS**
	2	**Malnutrition**	**Providing micronutrients**
	3	**Subsidies and Trade Barriers**	**Trade liberalization**
	4	**Diseases**	**Control of malaria**
Good	**5**	**Malnutrition**	**Development of new agricultural technologies**
	6	**Water and Sanitation**	**Small-scale water technology for livelihoods**
	7	**Water and Sanitation**	**Community-managed water supply and sanitation**
	8	**Water and Sanitation**	**Research on water productivity in food production**
	9	**Government**	**Lowering the cost of starting a new business**
Fair	**10**	**Migration**	**Lowering barriers to migration for skilled workers**
	11	**Malnutrition**	**Improving infant and child nutrition**
	12	**Malnutrition**	**Reducing the prevalence of low birth weight**
	13	**Diseases**	**Scaled-up basic health services**
Bad	**14**	**Migration**	**Guest worker programs for the unskilled**
	15	**Climate**	**Optimal carbon tax**
	16	**Climate**	**The Kyoto Protocol**
	17	**Climate**	**Value-at-risk carbon tax**

How Do Scholars Rank the World's Ills and Opportunities to Contain Them?

Source List

Graph/chart complete sources, by page number.

Pg. 5 "Atmosphere: Components and Characteristics of the Earth's Atmosphere," *Columbia Electronic Encyclopedia*, 2007, published on Factmonster.com. Available at http://www.factmonster.com/ce6/sci/A0856758.html. Access verified July 2, 2007.

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Pg. 15 Charles D. Keeling and Timothy P. Whorf, "Atmospheric CO_2 Records from Sites in the SIO Air Sampling Network" in "Trends Online: A Compendium of Data on Global Change," Carbon Dioxide Information Analysis Center, U.S. Department of Energy, 2005; available at http://cdiac.ornl.gov/trends/trends.htm. David M. Etheridge et al., "Historical CO_2 Records from the Law Dome DE08, DE08-2, and DSS Ice Cores," in "Trends Online: A Compendium of Data on Global Change," Carbon Dioxide Information Analysis Center, U.S. Department of Energy, 1998. And Albrecht Neftel et al., "Historical CO_2 Records from the Siple Station Ice Core," in "Trends Online: A Compendium of Data on Global Change," Carbon Dioxide Information Analysis Center, U.S. Department of Energy, 1994.

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