

Summary of Key Points

Greenhouse Gases



U.S. Greenhouse Gas Emissions. In the United States, greenhouse gas emissions caused by human activities increased by 5 percent from 1990 to 2012. However, since 2005, total U.S. greenhouse gas emissions have decreased by 10 percent. Carbon dioxide accounts for most of the nation's emissions and most of the increase since 1990. Electricity generation is the largest source of greenhouse gas emissions in the United States, followed by transportation. Emissions per person have decreased slightly in the last few years.



Global Greenhouse Gas Emissions. Worldwide, net emissions of greenhouse gases from human activities increased by 35 percent from 1990 to 2010. Emissions of carbon dioxide, which account for about three-fourths of total emissions, increased by 42 percent over this period. As with the United States, the majority of the world's emissions result from electricity generation, transportation, and other forms of energy production and use.



Atmospheric Concentrations of Greenhouse Gases. Concentrations of carbon dioxide and other greenhouse gases in the atmosphere have increased since the beginning of the industrial era. Almost all of this increase is attributable to human activities. Historical measurements show that current levels of many greenhouse gases are higher than any levels recorded for hundreds of thousands of years, even after accounting for natural fluctuations.



Climate Forcing. Climate forcing refers to a change in the Earth's energy balance, leading to either a warming or cooling effect. An increase in the atmospheric concentrations of greenhouse gases produces a positive climate forcing, or warming effect. From 1990 to 2013, the total warming effect from greenhouse gases added by humans to the Earth's atmosphere increased by 34 percent. The warming effect associated with carbon dioxide alone increased by 27 percent.

Weather & Climate



U.S. and Global Temperature. Average temperatures have risen across the contiguous 48 states since 1901, with an increased rate of warming over the past 30 years. Seven of the top 10 warmest years on record have occurred since 1998. Average global temperatures show a similar trend, and the top 10 warmest years on record worldwide have all occurred since 1998. Within the United States, temperatures in parts of the North, the West, and Alaska have increased the most.



High and Low Temperatures. Many extreme temperature conditions are becoming more common. Since the 1970s, unusually hot summer temperatures have become more common in the United States, and heat waves have become more frequent—although the most severe heat waves in U.S. history remain those that occurred during the “Dust Bowl” in the 1930s. Record-setting daily high temperatures have become more common than record lows. The decade from 2000 to 2009 had twice as many record highs as record lows.



U.S. and Global Precipitation. Total annual precipitation has increased in the United States and over land areas worldwide. Since 1901, precipitation has increased at an average rate of 0.5 percent per decade in the contiguous 48 states and 0.2 percent per decade over land areas worldwide. However, shifting weather patterns have caused certain areas, such as Hawaii and parts of the Southwest, to experience less precipitation than usual.



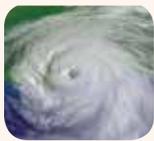
Heavy Precipitation. In recent years, a higher percentage of precipitation in the United States has come in the form of intense single-day events. Nationwide, nine of the top 10 years for extreme one-day precipitation events have occurred since 1990. The occurrence of abnormally high annual precipitation totals (as defined by the National Oceanic and Atmospheric Administration) has also increased.



Drought. Average drought conditions across the nation have varied since records began in 1895. The 1930s and 1950s saw the most widespread droughts, while the last 50 years have generally been wetter than average. However, specific trends vary by region. A more detailed index developed recently shows that between 2000 and 2013, roughly 20 to 70 percent of the United States experienced drought at any given time, but this index has not been in use for long enough to compare with historical drought patterns.



A Closer Look: Temperature and Drought in the Southwest. The southwestern United States is particularly sensitive to changes in temperature and thus vulnerable to drought, as even a small decrease in water availability in this already arid region can threaten natural systems and society.



Tropical Cyclone Activity. Tropical storm activity in the Atlantic Ocean, the Caribbean, and the Gulf of Mexico has increased during the past 20 years. Increased storm intensity is closely related to variations in sea surface temperature in the tropical Atlantic. However, changes in observation methods over time make it difficult to know for sure whether a long-term increase in storm activity has occurred. Records collected since the late 1800s suggest that the actual number of hurricanes per year has not increased.



Ocean Heat. Three separate analyses show that the amount of heat stored in the ocean has increased substantially since the 1950s. Ocean heat content not only determines sea surface temperature, but also affects sea level and currents.



Sea Surface Temperature. Ocean surface temperatures increased around the world over the 20th century. Even with some year-to-year variation, the overall increase is clear, and sea surface temperatures have been higher during the past three decades than at any other time since reliable observations began in the late 1800s.



Sea Level. When averaged over all the world's oceans, sea level has increased at a rate of roughly six-tenths of an inch per decade since 1880. The rate of increase has accelerated in recent years to more than an inch per decade. Changes in sea level relative to the land vary by region. Along the U.S. coastline, sea level has risen the most along the Mid-Atlantic coast and parts of the Gulf coast, where some stations registered increases of more than 8 inches between 1960 and 2013. Sea level has decreased relative to the land in parts of Alaska and the Northwest.



A Closer Look: Land Loss Along the Atlantic Coast. As sea level rises, dry land and wetland can turn into open water. Along many parts of the Atlantic coast, this problem is made worse by low elevations and land that is already sinking. Between 1996 and 2011, the coastline from Florida to New York lost more land than it gained.



Ocean Acidity. The ocean has become more acidic over the past few centuries because of increased levels of atmospheric carbon dioxide, which dissolves in the water. Higher acidity affects the balance of minerals in the water, which can make it more difficult for certain marine animals to build their skeletons and shells.





Arctic Sea Ice. Part of the Arctic Ocean is covered by ice year-round. The area covered by ice is typically smallest in September, after the summer melting season. The minimum extent of Arctic sea ice has decreased over time, and in September 2012 it was the smallest on record. Arctic ice has also become thinner, which makes it more vulnerable to additional melting.



Glaciers. Glaciers in the United States and around the world have generally shrunk since the 1960s, and the rate at which glaciers are melting has accelerated over the last decade. The loss of ice from glaciers has contributed to the observed rise in sea level.



Lake Ice. Most lakes in the northern United States are freezing later and thawing earlier compared with the 1800s and early 1900s. Freeze dates have shifted later at a rate of roughly half a day to one day per decade, while thaw dates for most of the lakes studied have shifted earlier at a rate of half a day to two days per decade.



Community Connection: Ice Breakup in Two Alaskan Rivers. Regions in the far north are warming more quickly than other parts of the world. Two long-running contests on the Tanana and Yukon rivers in Alaska—where people guess the date when the river ice will break up in the spring—provide a century's worth of evidence revealing that the ice on these rivers is generally breaking up earlier in the spring than it used to.



Snowfall. Total snowfall—the amount of snow that falls in a particular location—has decreased in most parts of the country since widespread records began in 1930. One reason for this decline is that more than three-fourths of the locations studied have seen more winter precipitation fall in the form of rain instead of snow.



Snow Cover. Snow cover refers to the area of land that is covered by snow at any given time. Between 1972 and 2013, the average portion of North America covered by snow decreased at a rate of about 3,500 square miles per year, based on weekly measurements taken throughout the year. However, there has been much year-to-year variability.



Snowpack. The depth or thickness of snow on the ground (snowpack) in early spring decreased at about three-fourths of measurement sites in the western United States between 1955 and 2013. However, other locations saw an increase in spring snowpack. The average change across all sites for this time period amounts to about a 14 percent decline.



Heating and Cooling Degree Days. Heating and cooling degree days measure the difference between outdoor temperatures and the temperatures that people find comfortable indoors. As the U.S. climate has warmed in recent years, heating degree days have decreased and cooling degree days have increased overall, suggesting that Americans need to use less energy for heating and more energy for air conditioning. This pattern stands out the most in the North and West, while much of the Southeast has experienced the opposite results.



Heat-Related Deaths. Over the past three decades, nearly 8,000 Americans were reported to have died as a direct result of heat-related illnesses such as heat stroke. The annual death rate is higher when accounting for other deaths in which heat was reported as a contributing factor. Considerable year-to-year variability in the data and certain limitations of this indicator make it difficult to determine whether the United States has experienced long-term trends in the number of deaths classified as “heat-related.”



Lyme Disease. Lyme disease is a bacterial illness spread by ticks that bite humans. Tick habitat and populations are influenced by many factors, including climate. Nationwide, the rate of reported cases of Lyme disease has approximately doubled since 1991. Lyme disease is most common in the Northeast and the upper Midwest, where some states now report 50 to 90 more cases of Lyme disease per 100,000 people than they did in 1991.



Length of Growing Season. The average length of the growing season in the contiguous 48 states has increased by nearly two weeks since the beginning of the 20th century. A particularly large and steady increase has occurred over the last 30 years. The observed changes reflect earlier spring warming as well as later arrival of fall frosts. The length of the growing season has increased more rapidly in the West than in the East.



Ragweed Pollen Season. Warmer temperatures and later fall frosts allow ragweed plants to produce pollen later into the year, potentially prolonging the allergy season for millions of people. The length of ragweed pollen season has increased at 10 out of 11 locations studied in the central United States and Canada since 1995. The change becomes more pronounced from south to north.



Wildfires. Since 1983, the United States has had an average of 72,000 recorded wildfires per year. Of the 10 years with the largest acreage burned, nine have occurred since 2000, with many of the largest increases occurring in western states. The proportion of burned land suffering severe damage each year has ranged from 5 to 22 percent.



Streamflow. Changes in temperature, precipitation, snowpack, and glaciers can affect the rate of streamflow and the timing of peak flow. Over the last 73 years, minimum, maximum, and average flows have changed in many parts of the country—some higher, some lower. Nearly half of the rivers and streams measured show peak winter-spring runoff happening at least five days earlier than it did in the mid-20th century.



Great Lakes Water Levels and Temperatures. Water levels in most of the Great Lakes have declined in the last few decades. Water levels in lakes are influenced by water temperature, which affects evaporation rates and ice formation. Since 1995, average surface water temperatures have increased by a few degrees for Lakes Superior, Michigan, Huron, and Ontario. Less of a temperature change has been observed in Lake Erie.



Bird Wintering Ranges. Some birds shift their range or alter their migration habits to adapt to changes in temperature or other environmental conditions. Long-term studies have found that bird species in North America have shifted their wintering grounds northward by an average of more than 40 miles since 1966, with several species shifting by hundreds of miles. On average, bird species have also moved their wintering grounds farther from the coast, consistent with inland winter temperatures becoming less severe.



Leaf and Bloom Dates. Leaf growth and flower blooms are examples of natural events whose timing can be influenced by climate change. Observations of lilacs and honeysuckles in the contiguous 48 states suggest that first leaf dates and bloom dates show a great deal of year-to-year variability. Leaf and bloom events are generally happening earlier throughout the North and West but later in much of the South.



Community Connection: Cherry Blossom Bloom Dates in Washington, D.C. “Peak” bloom dates of the iconic cherry trees in Washington, D.C., recorded since the 1920s, indicate that cherry trees are blooming slightly earlier than in the past. Bloom dates are key to planning the Cherry Blossom Festival, one of the region’s most popular spring attractions.

