

STATE OF THE CLIMATE IN 2010



HIGHLIGHTS



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MAJOR EVENTS 2010

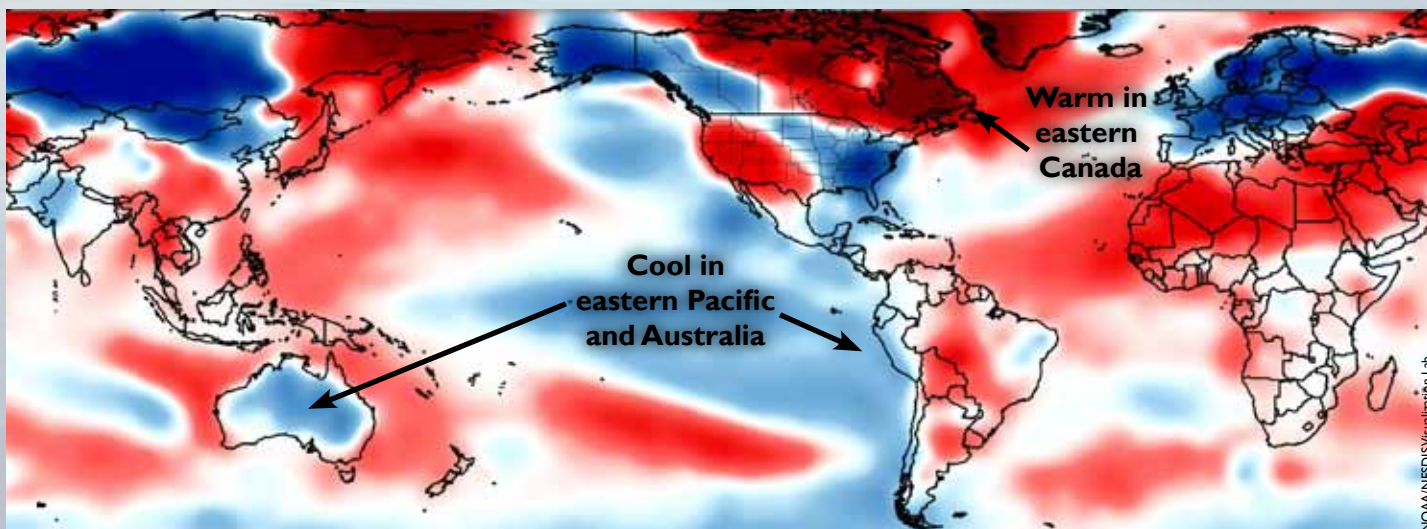
Flooding in Australia. Snowstorms in the eastern United States. The coldest winter in modern British history. During 2010, two of the world's major climate patterns—the El Niño-Southern Oscillation and the Arctic Oscillation—drove many of the year's most memorable weather events.

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weather. In the background of many unique events, long-term trends are visible in the data; despite snow and cold in some locations, tens of thousands of observations around the world combine to reveal a 2010 average global surface temperature among the two warmest years on record.

Searing heat in Russia. Floods in Pakistan. On the other hand, some events of 2010 had no apparent connection to large-scale climate patterns or trends, but were examples of unusual, extreme

This document gives a brief view of climate data collected around the world in 2010, used by scientists to understand the planet's climate patterns and trends.



December 2010: Surface air temperatures show a cool eastern Pacific and Australia influenced by La Niña. Cold air in the eastern United States and an unusually warm eastern Canada/Western Greenland are both influenced by the negative Arctic Oscillation.

El Niño to La Niña

The transition from a warm El Niño climate pattern at the beginning of the year to a strong version of its cool sister pattern, La Niña, by July contributed to some unusual weather around the globe in 2010.

Quiet year for tropical cyclones, except in the North Atlantic

The La Niña pattern brought cooler temperatures to the tropical eastern Pacific Ocean in the second half of 2010. Since cyclones get energy from ocean heat, that cooler water helped give the Eastern Pacific hurricane basin an extremely quiet season. Meanwhile, during an unusually active Atlantic season, no hurricanes made landfall in the United States while eastern Canada experienced one of its most active tropical cyclone seasons on record.

Learn more at: <http://www.elnino.noaa.gov>.

Global land and ocean surface temperatures among warmest ever recorded

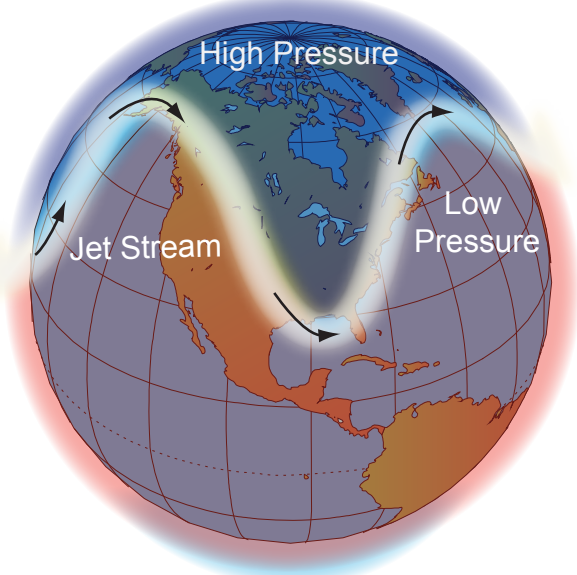
Warm land and ocean surface temperatures worldwide in 2010 were at least partly related to the El Niño climate pattern that prevailed in the first half of the year. The warm water temperatures and related air patterns, combined with a decades-long warming trend, were influential in making 2010's global temperatures among the two warmest years on record.

Floods in Australia

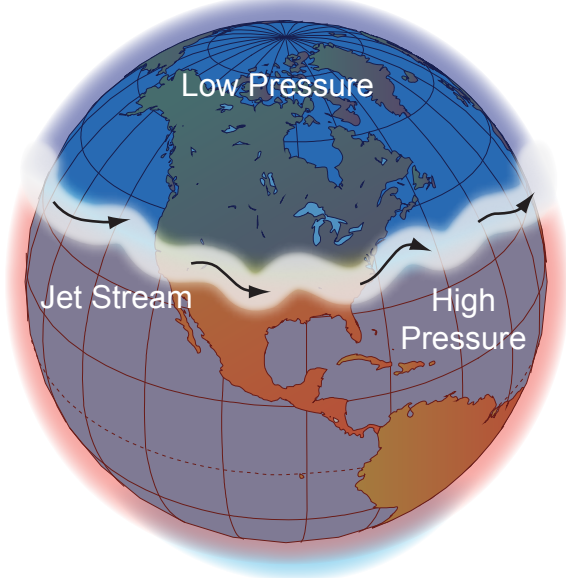
Australians were deluged with rain during late 2010. Influenced by the La Niña climate pattern, Australia experienced its wettest spring (in the Southern Hemisphere, September–November) since record keeping began 111 years ago. In December, precipitation in the state of Queensland was more than double the average amount.

Arctic Oscillation

Negative Phase



Positive Phase



The negative phase Arctic Oscillation, as shown above, is similar to events in February 2010 over North America.



Flooding in Australia in December 2010 was influenced by the La Niña climate pattern.

MAJOR EVENTS 2010

Arctic Oscillation

The Arctic Oscillation, an atmospheric climate pattern that affects large parts of the Northern Hemisphere, most often keeps colder air confined in northern latitudes. When it switches to its negative phase, as it did in 2010, this frigid air can flow out of the Arctic and contribute to unusually cold weather farther south.

Severe winter storms in the eastern United States

Unusually heavy snow blanketed the East Coast at the beginning and end of 2010. Several cities, from Cincinnati to New York City, had their snowiest months on record during February, as the Arctic Oscillation reached its most negative value.

Cold winter in Europe

The strong negative Arctic Oscillation contributed to Britain's coldest winter (December 2009–February 2010) since the winter of 1978/79. Britain also experienced its coldest December on record in 2010 as much of Europe was affected once again by the arctic weather.

Mild winter in Canada

As the Arctic Oscillation remained negative throughout most of the year, Canada recorded its warmest year since records began in 1948. Oscillations in the jet stream allowed warm air to flow far north in parts of Canada.

Southern Annular Mode

Ice growth in the Antarctic

Average sea ice volume in the Antarctic grew to an all-time record maximum in 2010. This accumulation of ice was related to a climate phenomenon known as the Southern Hemisphere Annular Mode.

Other Major Events

Heat wave in Russia

From late June through mid-August, Russia suffered from a searing heat wave. After 62 days of above-average heat, Russian officials attributed nearly 14,000 deaths to the unusual temperatures. This heat wave was caused by a persistent blocking pattern, which climate scientists do not currently see as part of any repeating or trending climate pattern.

Flooding in Pakistan

Floods at the end of July and early August 2010 displaced more than 20 million Pakistanis and inundated a fifth of the country following heavy monsoon rains. Scientists analyzing climate indicators from 2010 believe that this disaster was in part related to the same blocking pattern that contributed to the heat wave in Russia.



Greenhouse Gases

More than 800 weather balloons are launched around the world every day to collect upper atmospheric data.

CLIMATE INDICATORS 2010

Dozens of climate indicators, measured by tens of thousands of instruments around the world, track the major components of Earth's climate system, including the atmosphere, land, ice, and oceans. Climate indicators from the upper atmosphere to the ocean floor are monitored around the world for the purpose of better understanding the global climate, from year to year and over longer time periods. These data inform the *State of the Climate in 2010* report.

STRATOSPHERIC TEMPERATURE, air in the upper layers of the atmosphere, continued to be colder than average. This is expected, given increased greenhouse gases and decreased ozone levels.

Levels of **GREENHOUSE GASES** in the atmosphere continued to rise. Carbon dioxide levels increased at a faster rate in 2010 than in 2009 and also faster than the average rate over the past 30 years. Greenhouse gases trap heat in Earth's lower atmosphere.

SNOW COVER during February was high over the Northern Hemisphere, but by May warm surface temperatures reduced it to the lowest area ever recorded by satellites. The decrease in snow cover from December to May was the largest in more than 40 years. The amount of snow and timing of melt affects the water cycle and water supply.

AIR TEMPERATURE above land was the second warmest on record. The Arctic continued to warm at about twice the rate of lower latitudes. Locally and regionally, changes in temperature can influence the distribution of expected weather, alter precipitation patterns, and affect trends in many other climate indicators.

The world's mountain **GLACIERS** lost mass for the 20th consecutive year. Greenland glaciers lost more mass in 2010 than any other year on record. Water from melting glaciers and ice sheets around the world contributes to acceleration of the water cycle and sea-level rise.

ANTARCTIC SEA ICE grew to record levels during the South Pole's winter, affected by an air circulation pattern that locked in the cold. Sea ice responds to colder temperatures by growing more. In turn, more sea ice leads to less sunlight absorption in the water and thus less warming.

Surface instruments collect data such as temperature, precipitation, and wind speed.



ARCTIC SEA ICE shrank to its third smallest area on record. The area was so small in September that for the first time in modern history, both the Northwest Passage and the Northern Sea Route were open for navigation. Sea ice responds to warmer temperatures by shrinking more. In turn, less sea ice leads to more sunlight absorption in the water and thus more warming.

SEA LEVEL continued to rise across the world's oceans on average. Water expands as it warms and thus ocean heating is responsible for much of the sea-level rise; melting glaciers and ice sheets are responsible for the rest.

SEA SURFACE TEMPERATURE in the eastern tropical Pacific Ocean cooled almost 2 degrees Fahrenheit from 2009 to 2010, reflecting the transition from an El Niño to La Niña climate pattern. Even so, the average sea surface temperature for 2010 of all the oceans around the world was the third warmest on record. These warmer temperatures contribute to more evaporation from the ocean into the atmosphere and to changes in sea level.

OCEAN SALINITY - The world's oceans were saltier than average in areas where evaporation is high and fresher than average where precipitation is high, suggesting that the water cycle is intensifying. Heavier downpours and snows can be expected with a faster water cycle.

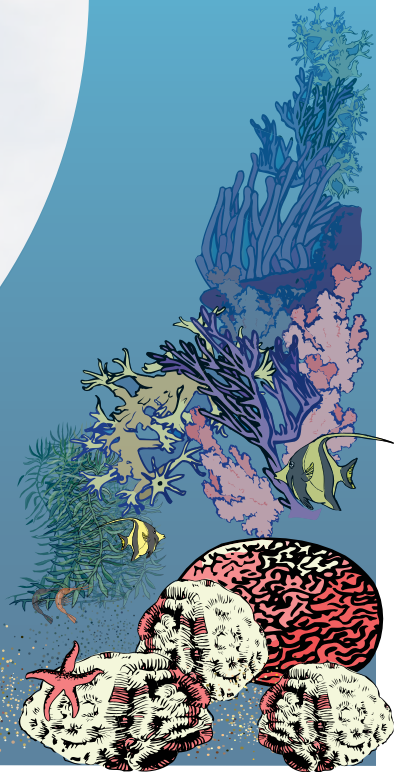
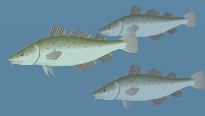
OCEAN HEAT CONTENT in 2010 was similar to 2009 and was among the highest values in the record. Oceans store a large portion of the heat that is trapped by increasing greenhouse gases. Changes in heat content contribute to changes in sea level.



Moored buoys transmit air, wind, water, and wave data.

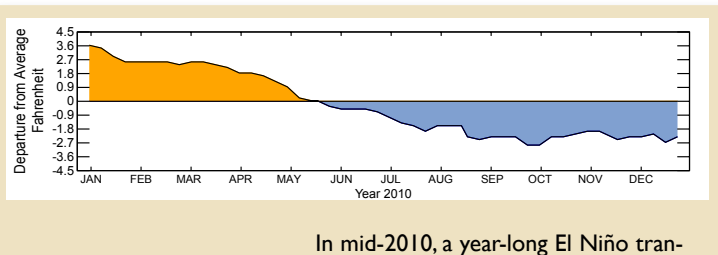


3000 Argo float sensors measure salinity and temperature from the ocean surface down to a depth of approximately one mile.



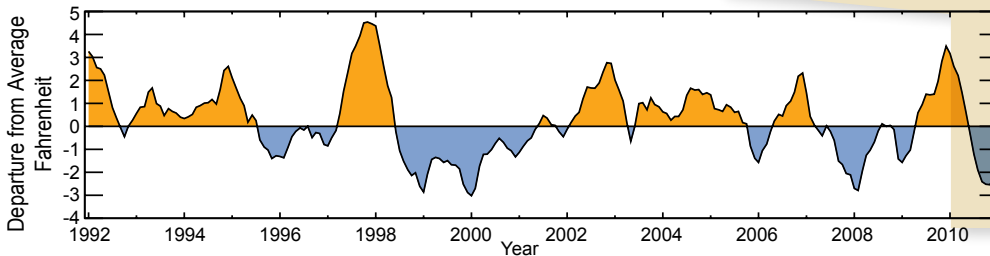
CLIMATE PATTERNS AND LONG-TERM TRENDS

Climate Patterns



In mid-2010, a year-long El Niño transitioned into the La Niña part of its pattern, as shown by the Pacific Ocean temperature variations from average.

El Niño/La Niña

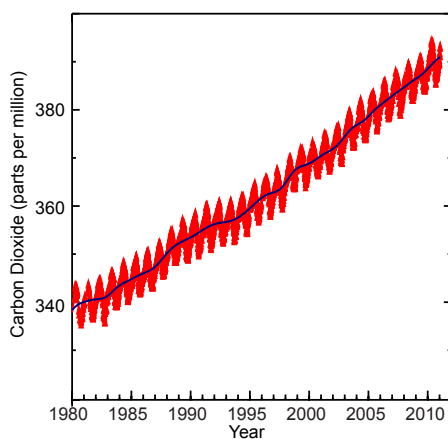


Throughout the complex ocean and air circulation patterns of Earth's climate system, large-scale climate patterns shift back and forth repeatedly. The Arctic Oscillation and El Niño/La Niña are examples of such patterns. Some patterns last for weeks at a time, while some can persist for years.

Long-Term Trends

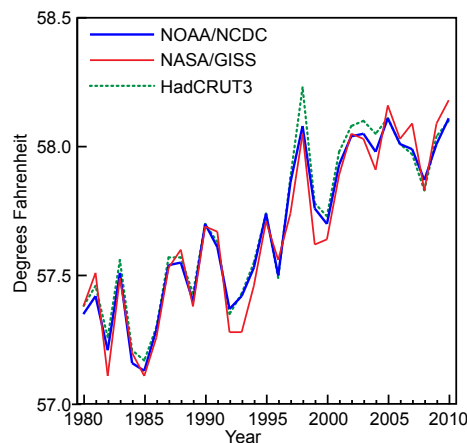
Even as the Earth is influenced by large-scale climate patterns, climate indicators continue to capture the underlying march of long-term trends, such as the steady increase in greenhouse gas concentrations and loss of Greenland's ice sheet.

Greenhouse Gases



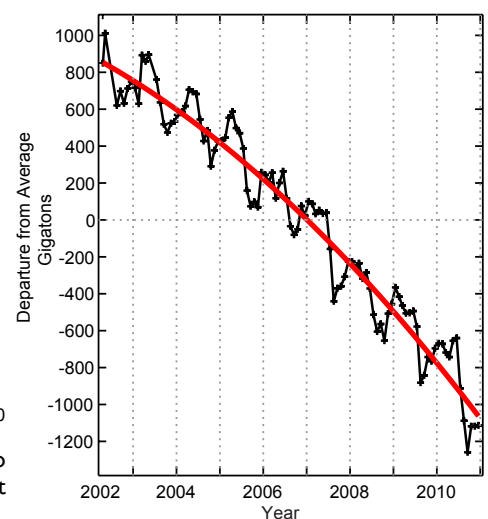
Air samples collected weekly at NOAA's Mauna Loa observatory continue to show a rise in the concentration of carbon dioxide and methane.

Global Surface Temperature



Global surface temperatures continue to rise, as 2010 was one of the two warmest years on record.

Greenland Ice Mass



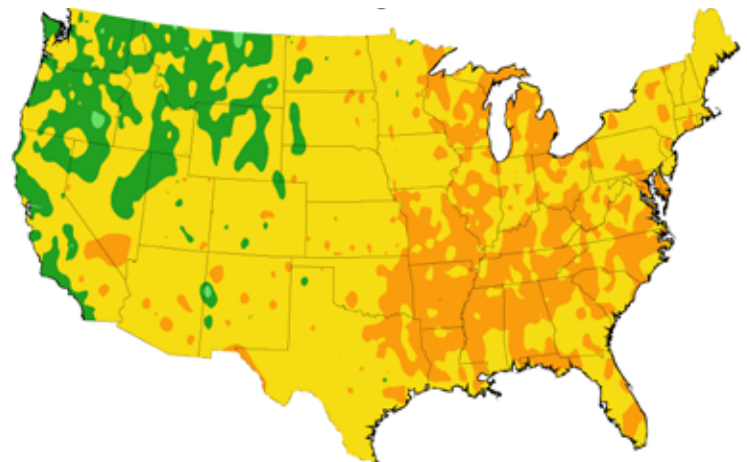
Greenland's ice sheet continues to lose mass, and in fact lost more mass in 2010 than at any time in the past ten years.

CLIMATE DATA AND THE U.S. ECONOMY



Companies throughout the United States routinely reap the benefits of using climate data for planning and risk management. NOAA estimates that dependable climate data helps American companies save billions of dollars each year. For instance, NOAA's El Niño/La Niña forecasts are estimated to save nearly \$100 million per year for United States agriculture in the Southeast alone by predicting areas that may be drier or wetter than usual.

Summer 2010 Overnight Lows



Degrees Fahrenheit Departure from Average
 -18.0 -14.4 -10.8 -7.2 -3.6 0.0 3.6 7.2 10.8 14.4 18.0

The map above shows how “overnight lows” in the United States compared to normal during summer 2010. Twelve states in the East experienced their warmest summer on record; this warmth was driven by overnight lows, as opposed to hotter daytime highs.

Periods with unusually warm summer nights can affect:

Energy Demand

Above-average summer heat occurred on the East Coast, where energy demand is greater than it would be in less densely populated areas.

Public Health

Those who work outdoors or live without air conditioning have less recovery time from heat stress.

Agriculture

Many plants thrive when cooler nighttime temperatures allow some recovery from heat stress. When nights are hotter, some crop yields can drop.



Sector	Use of Climate Data
Agriculture	<ul style="list-style-type: none"> Choose seed types and planting and harvesting schedules. Plan for irrigation needs and forecast crop yields. Match garden and landscape design to long term expected conditions.
Energy	<ul style="list-style-type: none"> Forecast fuel needs and electricity demand based on expected conditions. Analyze how temperature conditions affect demand. Assess the best sites for solar and wind energy.
Water	<ul style="list-style-type: none"> Manage reservoirs in drought or flood conditions. Balance competing water demands such as industry, agriculture, recreation, and wildlife. Understand spring snowmelt in the West and the impact on water supply.
Insurance	<ul style="list-style-type: none"> Help businesses and individuals manage financial risks by designing insurance products based on raw and modeled climatic data such as temperature, wind, and sea surface temperatures.
Infrastructure	<ul style="list-style-type: none"> Plan airports, roads, bridges, levees, and other infrastructure to withstand extreme weather conditions. Design building performance for expected heating and cooling needs.
Health	<ul style="list-style-type: none"> Prepare public health response measures such as cooling centers, vaccination programs, and epidemic action plans.

Cover Notes:

Front: Photo—Vancouver B.C. had little snow when it hosted the 2010 Winter Olympics (AP Photo/Ricardo Mazalan).

Figure:Temperature anomalies in North America during winter 2010 (State of the Climate Report in 2010 Fig. 7.5)

Back: Record-breaking snow fell on the Capitol in Washington, DC. February 2010. ©iStockphoto.com/DaveNewman

ABOUT STATE OF THE CLIMATE IN 2010

Purpose

State of the Climate in 2010 is the latest installment of an annual collection of climate observations from around the globe, edited at NOAA's National Climatic Data Center (NCDC) and published each year in the *Bulletin of the American Meteorological Society* (BAMS). Its purpose is to document dozens of observed climate indicators which, when viewed together, provide a picture of the world's climate system and our capacity to observe it.

Information in this Report

Climate indicators tracked in *State of the Climate in 2010* include temperature of the lower and upper atmosphere, precipitation, sea ice, greenhouse gases, humidity, cloud cover and type, glaciers, temperature and saltiness of the ocean, snow cover, and more. The report also documents extraordinary weather and climate events that took place during the year, and discusses climate patterns or trends to which they may relate.

Authors

Climate scientists in academic and scientific institutions around the world contribute articles about their own regions or areas of specialty. The articles are edited at NOAA's National Climatic Data Center in Asheville, NC. The *Bulletin of the American Meteorological Society* provides scientific peer reviewers for each chapter. More than 350 scientists from 45 countries contributed to *State of the Climate in 2010*. Their names and institutions are listed in the full report.

Find this Report Online

State of the Climate in 2010 and *State of the Climate* reports from past years are available online from NOAA's National Climatic Data Center: <http://www.ncdc.noaa.gov/bams-state-of-the-climate>. The site also provides access to raw data from the report for key climate indicators.

The series of annual *State of the Climate* reports incorporate information from NOAA's monthly National and Global Climate Summaries. These monthly reports are available at: <http://www.ncdc.noaa.gov/sotc>.



<http://www.ncdc.noaa.gov/bams-state-of-the-climate/>

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