

# Climate Change in the Golden State



Earth has experienced natural climate changes since the planet formed billions of years ago. Many of these climate changes have been slow, occurring over centuries or millennia. Subtle differences in Earth’s orbit around the Sun, or shifting landmasses (for example, moving tectonic plates or the uplift of mountain ranges) cause these slow climatic changes. Rapid changes in climate, those that happen over decades or even a few years, are triggered by sudden events, such as volcanic eruptions, collisions with meteors, or drastic shifts in ocean currents.

## Constantly Changing Climate

Climate change is a shift in the “average weather” that a given region experiences. This is measured by changes in the features we associate with weather, such as temperature,

wind patterns, precipitation, and storms. Global climate change means change in the climate of Earth as a whole. Global climate change can occur naturally; an

ice age is an example of naturally occurring climate change. Earth’s natural climate has always been, and still is, constantly changing. The climate change we are seeing today, however, differs from previous climate change in both its rate and its magnitude.



Snow melting in Sierra Nevada Mountains, California

## Greenhouse Effect

To understand climate change, you have to know that Earth’s climate is regulated by the greenhouse effect, without which life as we know it would be impossible. The greenhouse effect occurs when greenhouse gases are released on the planet, where they build up in Earth’s atmosphere. This forms a layer in the upper atmosphere that allows heat and light in; then some of the heat/light energy is absorbed near and

at Earth's surface. The rest escapes out into space. Without the effect of these naturally occurring gases, the average temperature on Earth would be  $-0.4^{\circ}\text{F}$  ( $-18^{\circ}\text{C}$ ), instead of the current average  $59^{\circ}\text{F}$  ( $15^{\circ}\text{C}$ ). Life as we know it would be impossible.

The last 10,000 years has been a warm and stable period, and the last millennium, over which current societies have developed, has been one of the most stable climates observed. Yet, during the 20<sup>th</sup> century, we have observed a rapid change in the climate and atmospheric concentration of greenhouse gases attributable to human activities. These recent changes in greenhouse gases far exceed the extremes of the ice ages, and the global mean temperature is warming at a rate that cannot be explained by natural causes alone. The natural archives of Earth's climate, such as fossils, ocean sediments, and ice cores, record global temperature fluctuations that have resulted in ice ages and warm periods. During the last ice age, Earth was approximately  $10^{\circ}\text{F}$  ( $5.6^{\circ}\text{C}$ ) cooler than it is now. Sheets of ice a mile thick covered the poles and the northern United States. Now we are in a warm period. The global temperature has risen almost  $2^{\circ}\text{F}$  ( $1.1^{\circ}\text{C}$ ) in the last century. And the rate of warming is increasing.

### Observing Climate

### Change in California

Changes in California's own climate are in line with the warming trends in many other places. Our winter and spring temperatures have risen steadily in the last 50 years. This rise has caused the snowpack in the Sierra Nevada Mountains to melt earlier every spring. Even the wildflowers bloom two weeks earlier. Scientists predict that if the warming trend continues, the state's temperatures will rise as much as  $10.5^{\circ}\text{F}$  ( $5.8^{\circ}\text{C}$ ) by 2100. This increase will put a great deal of extra stress on both the people and natural systems of California.

In January 2007, the National Oceanic and Atmospheric Administration (NOAA) announced that 2006 was the warmest year on record in the United States. In 2006, NASA confirmed that 2005 was the warmest year recorded in human history. As the climate changes and periods of higher temperatures increase, there can be detrimental effects for people who suffer from heat-related illnesses. For example, elderly people, young children, and people who are already sick are at the greatest risk for heat-related dehydration, heatstrokes, heart attacks, or strokes.

Most of the rain and snow that falls in California falls in the northern part of the state. The

greatest demand for water, however, comes from drier Southern California, home to two-thirds of the state's population. A system of reservoirs, aqueducts, and pipelines move massive amounts of water to the crowded cities of the Los Angeles Basin. This water comes from melting snow in the Sierra Nevada Mountains each spring.

If the climate continues to warm, more precipitation will fall as rain, and less will fall as snow. The snow that does fall will melt sooner. The snowpack could decrease by 70–90% by the year 2100. This loss of snow would cause huge problems for the people who manage the state's water resources. If not enough water is stored in the winter, people may not have enough drinking water or water for agriculture. Without enough water to flow through dams, power operators might not be able to generate as much electricity. Without lots of snow, winter tourism (including skiing) would decline, causing hard times for snow-related businesses.

### Effects of Climate Change in California

Climate change will also affect California's agricultural regions, which are considered to be some of the world's most productive and diverse growing regions.



California Water Project

California produces 50% of the nation's fruits, vegetables, and nuts. If climate change continues, the state could experience severe drought. Many fruit and nut trees would not produce good crops if they were exposed to extreme heat. In order to develop healthy buds, these trees need "chill hours" with temperatures below 45° F (7.2° C). Loss of these cold conditions and the greater number of hot

days could mean a great loss for California farmers.

Warming temperatures would also increase the number of pests and the frequency of plant diseases that affect California crops. Pest breeding seasons would become longer, and pests that like warmer weather will spread to new areas. For example, a certain type of leafhopper, the glassy-winged sharpshooter, spreads Pierce's disease when they eat grape leaves.

Pierce's disease is a bacterial disease that destroys grapevines. These leafhoppers love hot, dry weather, so they would prosper with rising temperatures, leaving vineyard owners in northern California to deal with an increase of this damaging disease.

Rising temperatures, hot winds, and drought conditions could cause a 55% increase in destructive wildfires. Low-intensity fires actually help regenerate certain ecosystems. They clear woody debris and underbrush, release nutrients into the soil, crack open heat-dependent seed coats, and allow light to penetrate through thick foliage. However, current trends are to not allow low-intensity fires to burn, so fuel sources like underbrush build up. Earth's warming trend could spark intense firestorms from this underbrush, destroying property and wildlife habitat. These fires could also cause the disappearance of plant and animal species in ecosystems already affected by human activity. Wildfires also have severe consequences for human health because they can cause air pollution to spike to unhealthy levels across a broad area.

Climate change already affects California's native trees and plants. Warmer weather in the north is causing cold-loving Douglas firs to die off. Drought-





Forest fire

resistant madrone and oak are taking the place of these firs. Nonnative grasses are replacing burned-out forests with dry weeds that can spark dangerous fires. In the Sierra Nevada, the fragile plants that make up the alpine tundra are receding to higher and higher elevations. Scientists predict these plants will decline 60–80% by the end of this century.

Future effects would include an increase in extreme heat days, additional rise in sea level, significant loss of snowpack, and increases in forest fires and energy use. The magnitude of these effects depends on the temperature increase. Perhaps the greatest effect

of climate change in the future will be felt along the coasts of California. Known for its beaches and recreation, the state attracts people from all over the world. During the last 100 years, sea levels along the California coast have risen seven inches. As Earth continues to warm, sea levels could rise as much as 35 inches by the year 2100. In this case, inland areas will flood with sea water, breaching levees and degrading freshwater supplies for drinking. Animal and plant habitats would also change, causing many species to move out of the area or disappear entirely. Severe storms, pushed inland by high winds, can erode beaches and

cause billions of dollars of damage to property, water supplies, utilities, and businesses.

The natural systems of California have seen many climate changes. For example, the La Brea Tar Pits formed many thousands of years ago, trapping plant matter and animals that were part of the ancient Los Angeles ecosystem that existed during the last ice age, more than 10,000 years ago. The 3.5 million fossils collected in the Tar Pits give a glimpse of life before California's ancient native plants and animals had to either adapt to a different climate, or become extinct. The giant sequoia

and the now-endangered California condor both survived this period. The question is: will we survive the changes of the future? The better we understand the causes and effects of climate change, the better we can predict how Earth will be affected. This understanding is key to our planetary and personal survival as the global climate continues to change.

### **Making Choices**

The challenge of ensuring clean air and a healthy climate can be met. Choices made by businesses, communities, and individuals can lead to meaningful reductions in air pollutants and greenhouse gas emissions. Home energy improvements, tree planting programs, alternative transportation, beverage container recycling, and increased use of public transit are just some of the choices that can be acted upon at the individual, business, and community levels. In many cases, one action will reduce both air pollutants and greenhouse gas emissions. Many actions will save money in the short- and long-term. Actions taken now and continued over the long-term can make a significant difference in ensuring clean air and a healthy climate for California.



Storm surge