# What is Climate Change?

*Alaska FFA Association and USDA Northwest Climate Hub*

*Levels 6-12*

*Alaska's Muir glacier in August 1941 and August 2004.Credit: USGS*

## DESCRIPTION

Students will learn what causes climate change, how climate change is already affecting Alaska, and how it might affect Alaska in the future. Students will then conduct an experiment to test the greenhouse gas effect.

## OBJECTIVES

1. Students will be able to identify the cause of climate change.
2. Students will be able to identify five potential effects of climate change in Alaska.
3. Students will be able to define greenhouse gasses and explain how they contribute to climate change.

## MATERIALS NEEDED

1. Computer and projector
2. Tall plastic soda bottle
3. Glass jar that can fit inside the plastic bottle (2)
4. Thermometer (2)
5. Scissors

## POWERPOINT PRESENTATION

Open with a PowerPoint presentation that will give a definition of climate change, what causes climate change, and how climate change is affecting Alaska.

**Slide 1: Opening Slide**

**Slide 2: What is climate change?**

Climate change is a change in the average conditions like temperature and precipitation in a region over a long period (more than 30 years). For example, 20,000 years ago, much of what is now Alaska was covered in glaciers and had much colder temperatures. Now, Alaska has fewer glaciers and is warmer.

**Slide 3: What causes climate change?**

Many factors contribute to Earth's climate. However, scientists agree that Earth has been getting warmer in the past 100 years largely due to human activities.

- Concentrations of key greenhouse gasses, like carbon dioxide, methane, and nitrous oxide, have all increased since the Industrial Revolution due to human activities. Greenhouse gas concentrations are now higher in the Earth's atmosphere than any time in the last 800,000 years. Greenhouse gas emissions have increased the greenhouse effect and caused the Earth's surface temperature to rise.
- Burning fossil fuels changes the climate more than any other human activity.
- Graph shows the increase in atmospheric carbon dioxide (a greenhouse gas) over the last 800,000 years.

**Slide 4: The Greenhouse Gas Effect**

- Watch NASA's "What is the Greenhouse Effect" Video.
- Greenhouses are used to grow plants in places where the temperature or season makes growth difficult. In the day, sunlight shines into the greenhouse and warms the plants and air inside. At night, the greenhouse retains the warm air that day brought when the glass walls of the greenhouse trapped the sun's heat.
- The greenhouse effect on Earth works a lot like a greenhouse. Greenhouse gasses in the atmosphere, like carbon dioxide, methane, and nitrous oxide, trap heat like the glass roof of a greenhouse.
- The sun shining through our gaseous atmosphere warms the surface of Earth. At night, Earth's surface cools, releasing heat back into the air. Some of that heat is trapped by the greenhouse gasses in the atmosphere. Greenhouse gasses aren't all bad–they're what keeps the earth habitable for us and other animals. But when there are too many greenhouse gasses, like now, the Earth can heat up too quickly.

- Human activities — such as burning fuel to power factories, cars, and buses — are changing the natural greenhouse. These changes cause the atmosphere to trap more heat than it used to, leading to a warmer Earth.
- Carbon dioxide from human activity is increasing more than 250 times faster than it did from natural sources after the last Ice Age.

**Slide 5: How much is Alaska's climate changing?**

Climate change is always happening and has always happened since Earth's formation. So why is it a big deal now?
The Earth is warming faster than ever before!

- And some parts of the Earth, like Alaska, are warming faster than others. On average, global air temperatures near Earth's surface have gone up about 2 ºF in the past 100 years. Alaska's surface temperature has gone up 2.5-6 ºF.
- The past five years have been the warmest five years in centuries.
- Winter and spring in Alaska have been particularly warm, with a 6 ºF increase in average winter temperatures across Alaska, with some areas experiencing more warming than others.
- Alaska is experiencing the fastest loss of glacier ice on Earth.
- When the whole Earth's temperature changes by one or two degrees, that change can have big impacts on the health of Earth's plants and animals. If the temperature of Earth changes too quickly, many plants and animals will not be able to adapt and may become extinct.

Why does Alaska experience faster climate change?

- Arctic amplification, or sea ice loss, causes Alaska's climate to warm faster than other areas of the United States. As sea ice declines from warming surface temperatures, it becomes thinner, and more vulnerable to further decline. When sea ice disappears, the darker ocean can absorb more energy from the sun causing more heating and further sea ice loss.

**Slide 6: The Effects of Climate Change in Alaska**

- Global temperature rise
- Warming oceans and rising sea levels
- Shrinking ice sheets and glaciers
- Sea ice melting at a faster rate, or not developing at normal times
- Changes in growing season
- Extreme precipitation events and flooding
- Decreased snow cover
- Ocean acidification

**Slide 7: Rising Temperatures**

Temperatures in and around Alaska have been rising since the 1970s, with temperatures now 2.5-6ºF warmer than during the early and mid-20th century. Recent years have all been exceptionally warm. In fact, 2014–16 and 2018 were warmer than any year prior to 2014.

- There are fewer very cold days.
- Record high temperatures outnumber record low temperatures.
- Fall and winter are warmer than average.
- The greatest warming is happening in the west and north, traditionally the coldest regions of Alaska.

**Slide 8: Precipitation Changes**

Alaska's precipitation is increasing throughout the state. However, precipitation varies greatly over short distances and is very strongly influenced by the way air flows across Alaska's mountain ranges.
Some of the effects of increased precipitation are:

- More runoff on the North Slope
- Increased freezing rain events
- More precipitation falling as rain, rather than snow
- Drought in the rainforests of southeast Alaska, followed by excessive rain, floods, and landslides
- Shorter snow season
- Shrinking snow fields in the Brooks Range
- Coastal and riverine flooding

**Slide 9: Sea Ice & Water Temperature Changes**

Sea ice plays a distinct role in the climate, environment, and economies of Alaska. The presence of sea ice maintains regional temperatures and moisture, determines whether marine animals eat and live, and shapes the kinds of activities that people can or cannot do, from subsistence and travel to resource extraction to national security. Nothing in the Alaska environment is changing faster than sea ice. The loss of sea ice also causes arctic amplification, which increases the rate of climate change in Alaska.

- Sea ice is forming later in the fall.
- There are larger open-water areas.
- Sea ice concentration is rapidly declining.

**Slide 10: Warming temperature in the waters in and surrounding Alaska have also caused:**

- Algal blooms off the coast of Alaska, which threaten marine animals and their food supply.
- Warming surface waters in the Bering Sea.
- Ocean acidification - the process of ocean water becoming more acidic as it absorbs carbon dioxide from the atmosphere, which threatens crustaceans.
- Rising sea levels, which cause coastal erosion.

- Warming stream and river water temperatures, which stress fish populations. pH and water temperature are also associated. Warmer water is correlated with more acidic water, which is problematic for fish and other aquatic life.

In June and July of 2019, thousands of salmon died as they migrated to their spawning grounds in western Alaska on the Yukon River. Although the cause is not confirmed, scientists suspect warm water temperatures above the range that causes stress to adult salmon. Warm water causes several problems: it contains less life-sustaining dissolved oxygen than cool water, greatly accelerates metabolism, resulting in faster burning of stored energy in the migrating fish, and promotes the growth of parasites and fungus that can weaken fish.

**Slide 11: Thawing Permafrost and Glacial Retreat**

As temperatures increase, permafrost is thawing in Alaska. Measurements of permafrost temperatures at depths of 30–65 feet show warming at nearly all monitoring sites in northern and interior Alaska. The warming is especially strong on the North Slope, where sites along the Dalton Highway have warmed by 2–5°F from the 1980s to 2018.

Another measure of permafrost change is the depth of how much permafrost thaws during the summer season, also known as active layer depth. Measurements show that the depth of the active layer is increasing in many places in Alaska.

- Near-surface permafrost is estimated to cover 38 percent of Interior Alaska, which is expected to shrink by 10–18 percent by the end of the century due to higher temperatures
- Permafrost thaw contributes to greenhouse gas emissions and negatively impacts land stability and infrastructure, including transportation infrastructure that is critical to local agriculture transport and supply chains.
- Like the ocean, permafrost stores a lot of carbon. As permafrost thaws, that carbon releases into the atmosphere and intensifies warming.

Loss of Glacial Ice:

- More than 90% of Alaska's glaciers are retreating.
- Between 2002 and 2017, Alaska glaciers thinned by several feet per year. Overall mass loss during this period was nearly 60 billion tons of ice per year. Alaska's glaciers contain enough ice to raise sea level by about 1.5 inches if all their ice were to melt.

**Slide 12: Alaskan Plants and Climate Change**

- Compared to other regions of the state, the tundra of the North Slope shows the most greening, or more plant growth, in the past five years relative to the longer-term average.
- Over the past five years, all regions of the state have had more total warmth than the long-term normal, with the largest changes in southwest Alaska.
- The growing season in many regions of Alaska is getting longer.

- Invasive plants are moving into areas where they previously have not been recorded as temperatures increase.

**Slide 13: Seasonal Variations**

- Wildfires are intensifying and becoming more frequent throughout Alaska. The wildfire season is beginning earlier and ending later.
- Because the wildfire season is longer and more intense, there are more smoky days, affecting human and wildlife health and plant growth.
- River break-up is happening earlier, affecting aquatic life and human transportation.
- Snow is falling later and melting earlier.
- Sea ice is building up later in the year and breaking up earlier in the year.

**Slide 14: Why does this matter for Alaskans?**

Alaska has experienced many extreme climate-related events, including the longest growing season ever recorded in Bethel, Alaska, the five warmest winters in Utqiagvik, and record low sea ice extent in the Bering Sea between 2018 and 2019. Climate change has many implications for Alaskans and could change many Alaskans way of life.

- Subsistence hunting could require a shift to different animals, as animals that favor cold weather and cold water must migrate to survive.
- Alaska's fishing industry could face dire circumstances if ocean acidification and warming waterways continue to increase, and salmon and other fish face major die-offs.
- Wildfires could threaten communities and wildlife and pose a risk to already thawing permafrost.
- Thawing permafrost could cause severe damage to community infrastructure, health, and roadways.
- Melting sea ice could impact travel and subsistence hunting and increase greenhouse gas emissions.
- Increased growing season could open agricultural possibilities in Alaska, but also poses a risk for increased invasive plants and a "greening" of Alaska's tundra.

## ACTIVITY

**A Greenhouse Gas Effect Activity**

To learn about how greenhouse gasses warm our atmosphere, students will use the materials provided to test temperatures in two climatic scenarios.

1. Use the scissors to cut off the bottom of the plastic bottle. Remove the label but leave the lid on.
2. Stand one of the thermometers inside a glass jar. Place the prepared bottle over the glass jar and leave it for an hour in a sunny spot. Check the temperature in an hour.
3. Stand the other thermometer in a glass jar uncovered. Leave it in a sunny spot for an hour. Check its temperature and compare with the other jar's temperature.

**Conclusion:**

The temperature reading from the thermometer covered by the plastic bottle will be considerably warmer than the temperature reading from the uncovered thermometer. That's because the solar energy passing through the bottle has turned into heat that cannot escape. The Earth's atmosphere functions in a very similar way to the bottle! It allows the sun's energy to pass through but does not allow all the heat released from that energy to return to space. As greenhouse gasses increase, the ability of the atmosphere to retain heat increases too.