



# Lesson 3: Past vs. Present Climate Change

**Phenomenon:** Climate has varied in the past, but today’s climate change rate is much more drastic due to human activity.

**Introduction:** Climate zones are defined by consistent patterns of weather that interact with landscapes and life to support stable ecosystems. In this sense, scientists often describe climate as set and unchanging. Climate as a more general term, however, is known to change constantly over varying time frames. If you look at climate over the course of geologic time it changes dramatically as continents move around and oceans wax and wane. Within geologic time periods, climate changes due to volcanic activity, solar influences, and changes in the earth’s orbit and tilt on its axis. When there are continental land masses at one or both poles, these changes in earth rotation and revolution around the sun lead to the waxing and waning of glaciers. Scientists study climate changes that have taken place over the last few million years as the extent of glaciation has transitioned from maxima to minima in response to these **Milankovitch cycles**. This lesson will focus on these patterns in order to put modern climate change into context and focus.

The misconception that our current rate of climate change is just part of naturally occurring cycles is one of the more difficult to counter because of language and the double-duty the term “climate change” performs. We most often use the term today to refer to the change in natural cycles that human influences have forced. When we talk about “climate change science” we are referring to the efforts by climatologists to understand how we are impacting climate change and to what extent. The more mundane and historical use of the term “climate change” still exists, however, and the tricky juxtaposition between the contexts of the two ways the phrase can be used provides easy opportunity for climate-change deniers to create confusion.

This lesson will engage students with evidence for past climate change in order to help them see the context for our understanding of modern climate change, the same way that scientists use this data to determine the mechanisms and extent of human impacts today.

## Lesson Outline:

Age Level	Grade 5-12 (three options will be developed for 5th, middle, and high school applications. High school accommodations will also be developed for 9th grade bio, AP Bio, and Envi Sci applications)
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Time Needed	One 60 minute period
Vocabulary	<ul style="list-style-type: none"><li>● <b>Paleo:</b> Relating to the geological past</li><li>● <b>Milankovitch cycle:</b> A cyclical movement related to the Earth's orbit around the Sun.</li></ul>
Student Learning Outcomes	<ul style="list-style-type: none"><li>● Student will learn how the earth's climate is changing since millions of years ago to until now.</li><li>● Students will learn what could be the adverse impact of the abrupt climate change.</li><li>● Students will learn why these impacts could not be felt immediately.</li></ul>
Disciplinary Core Ideas	<ul style="list-style-type: none"><li>● HS-ESS1.B2: Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomenon cause a cycle of ice ages and other gradual climate changes.</li><li>● HS-ESS2.A3: The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.</li><li>● HS-ESS2.D3: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.</li><li>● HS-ESS3.D1: Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.</li></ul>
Performance Expectations	<ul style="list-style-type: none"><li>● <a href="#">HS-ESS3-5</a>: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.</li><li>● <a href="#">HS-ESS3-6</a>: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</li></ul>
Educator Prep	<ul style="list-style-type: none"><li>● FLICC: <a href="#">Five characteristics of science denial</a></li><li>● CO2 in the Ice Core Record - <a href="https://cleanet.org/resources/42848.html">https://cleanet.org/resources/42848.html</a></li><li>● Temperature from Ice Core Data - <a href="https://cleanet.org/resources/46205.html">https://cleanet.org/resources/46205.html</a></li><li>● Vostok Ice Core - <a href="https://cleanet.org/resources/42745.html">https://cleanet.org/resources/42745.html</a></li><li>● Ice Core Video - <a href="https://cleanet.org/resources/45159.html">https://cleanet.org/resources/45159.html</a></li><li>● Paleoclimate reconstruction -</li></ul>



	<a href="https://cleanet.org/resources/43394.html">https://cleanet.org/resources/43394.html</a>
Fact	Modern climate change is abrupt and driven by human activity, distinguishing it from past climate change.
Myth	Natural climate change in the past implies current climate change is also natural.
Fallacy	<b>Jumping to conclusions:</b> Just because climate change was caused by natural causes in the past doesn't necessarily mean it's naturally caused now.

## Engage

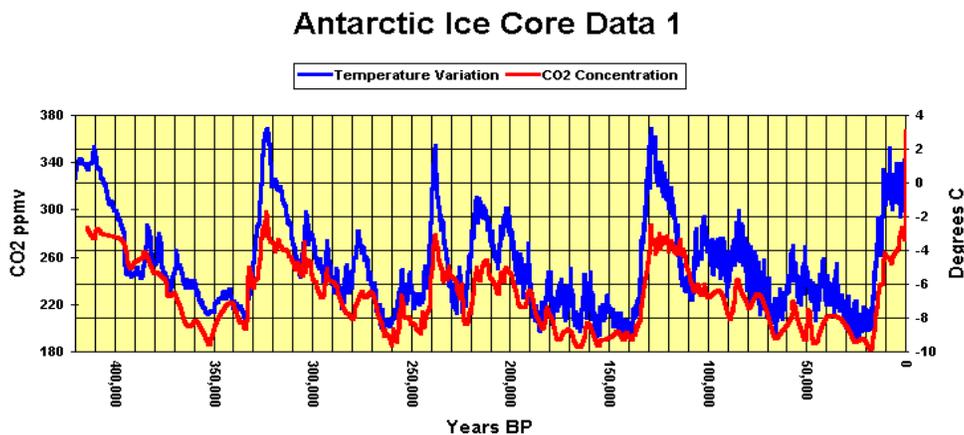
In this lesson, students will learn about climate drivers, and be asked to associate climate variables with observed trends in the paleoclimate record.

## Explore

Divide students into small groups and ask them to use the website listed below to answer the following questions.

<https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/ice-ages-what-are-they-and-what-causes-them/>

Scientists have studied ice cores to measure climate variables in the earth's past. They have measured the rising and falling temperatures in the earth's atmosphere over the few million years. This chart shows the patterns of temperature variation over the past 500,000 years (From the Utah Geological Survey).



As you can see, the climate has seesawed between glacial and interglacial periods for a long time.

**What do you think caused these changes seen in the graph above?**

## Explain

Scientists have determined that this pattern was produced by the interaction of a number of factors, called the Milankovitch Cycles. We will examine how these influence the Earth's Climate.

Go to <https://cimss.ssec.wisc.edu/wxfest/Milankovitch/earthorbit.html>

### Notes:

- The red and gray buttons at the bottom can be turned on and off. Red is on; gray is off. In some cases, multiple buttons can be selected at the same time, such as tilt, precession and eccentricity.
  - The yellow triangle on the graph on the side can be adjusted to move around in time.
1. Toggle the "Vostok Ice Core" button to plot a green line very similar to the graph above. This represents Earth's recent temperature fluctuations. Leave it on during the following investigations. Other aspects are plotted with magenta lines that represent how much a particular parameter varies from today's value.
  2. Click on "Orbit" and "Faster Orbit," as well as "Top View," to see how the system works. Also drag the arrow on the chart up and down.
  3. Select the "Eccentricity" button and go to Top View. Drag the arrow up and down and make note of any changes you see.

**From this investigation, describe what you think eccentricity means.**

**How do you think eccentricity could impact climate?**

4. Unselect the "Eccentricity" button and click on "Precession." Drag the arrow up and down in Top View and Oblique View and make note of any changes you see.

**From this investigation, describe what you think Precession means.**

**How do you think precession could impact climate?**

- Unselect the “Precession” button and click on “Tilt.” Drag the arrow up and down in Top View and Oblique View and make note of any changes you see.

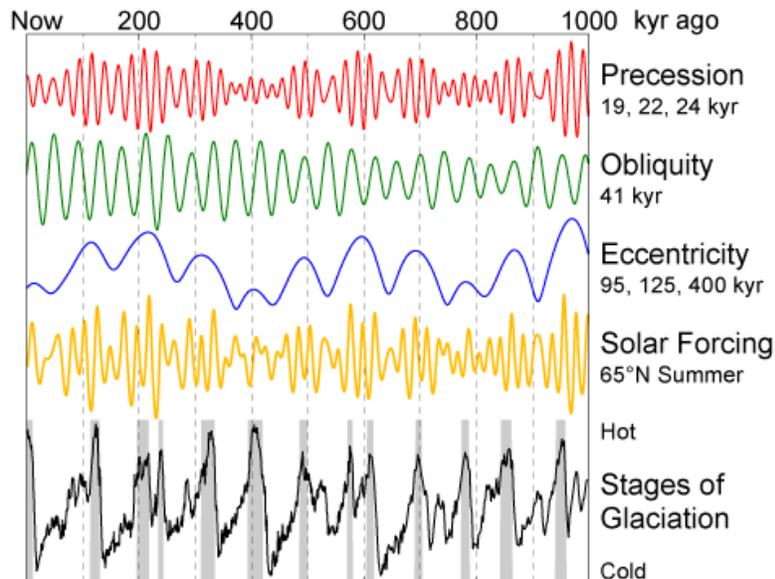
**From this investigation, describe what you think Tilt means.**

**How do you think tilt could impact climate?**

Collectively, these are called the Milankovitch Cycles. Click on Eccentricity, Precession and Tilt at the same time.

**What is different about this graph compared to the others?**

This graph combines all three Milankovitch cycles into the yellow plot and shows how they correspond to the stages of glaciation or ice ages.



**From this investigation, describe how the three cycles combine to explain the stages of glaciation.**

For more clarification about the Milankovitch Cycles, check out the following video:

<https://www.youtube.com/watch?v=TWJyeyV92W4>

Based on the information you gathered from the animations, the video and the graph on the right:

**Do you think there is a connection between the cycles of Ice Ages and the Milankovitch Cycles?**

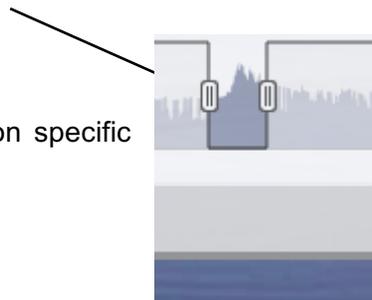
**What evidence would you use to support your answer?**

## Extend

Direct students to the [Climate Trends Learning Tool](#). Have students click the temperature checkbox to view past temperature, and use the scroll bar to zoom to the period around 300,000 to 350,000 years ago. Direct the students to use the slope tool to calculate the rate of warming for the period from 333,000 to 323,000 years ago. Next, have students check Plot > Last 5000 years, then zoom to the most recent few centuries. Using the slope tool, students should calculate the rate of warming for the last 40 years. Students calculate how much faster modern warming is compared to past warming. The purpose of this activity is to discover that modern climate change is much greater than past climate change in the past before industrialization. Conclude by explaining that different factors can cause climate change: sun, volcanoes, changes in the Earth's orbit, but human activity is driving the unique and strong modern warming.

Now, click on the option for Carbon Dioxide.

Drag the sliders on the bottom. Notice how you can focus on specific periods of time.



**How do the slopes of the lines change as you focus in?**

**Describe how the patterns for CO<sub>2</sub> and temperature compare to each other.**

Notice how the temperature line spikes up about 15,000 years ago. This represents the end of the last Ice Age. Notice how a similar spike happened about 135,000 years ago as well.

**Zoom in between at the last spike 15,000 years ago.** Set time period between 20,000-10,000 years ago.

In the TEMP box below, draw a line showing the slope of the zoomed in line.

In the CO<sub>2</sub> box below, draw a line showing the slope of the zoomed in line.



**Zoom in at the last spike 135,000 years ago.** Set time period between 140,000-128,000 years ago.

In the TEMP box above, draw a line showing the slope of the zoomed in line.

In the CO2 box above, draw a line showing the slope of the zoomed in line.

**Finally, zoom in at the very end of the graph, representing TODAY.** Set time period from 10,000-0 years ago.

▪

**CO2  
TODAY**

In the CO2 box on the right, draw a line showing the slope of the zoomed in line.

**Analyze these slopes.**

1. What does these patterns show us?
2. What is creating the new pattern seen in the CO2 graph?
3. How do you think this will impact temperatures?
4. Explain how today's climate change is different from the natural episodes of climate change the Earth has experienced in the past.

**Evaluate – FLICC**



Recap FLICC-- Introduce the students to an example of misinformation arguing that past climate change implies current climate change is natural. Clarify that the chief argument is that because natural factors have caused climate change before, natural factors must be the cause now.

One example you might use is this statement from physicist Richard Lindzen:

“Climate is always changing. We have had ice ages and warmer periods when alligators were found in Spitsbergen. Ice ages have occurred in a hundred thousand year cycle for the last 700 thousand years, and there have been previous periods that appear to have been warmer than the present despite CO<sub>2</sub> levels being lower than they are now. More recently, we have had the medieval warm period and the little ice age.”

**Thinking about this.... What kind of technique has Mr. Lindzen used for this logical fallacy?**

**Note:** This logical fallacy could be referred to as **jumping to conclusions**, also known as non sequitur. It also commits the **single cause fallacy**, arguing that if nature was once the cause, it must always be the cause.

Another example is this video of a statement from Senator Marc Rubio.

<https://www.youtube.com/watch?v=eOIME9zHwa4>

**What FLICC technique of climate denial does Senator Rubio use in his speech?**

After discussing these examples with your students, split the students into groups and assign them the task of resolving the conflict between the unprecedented modern warming and the past climate change argument. Have them present their conclusions to the class.