

## The Heat Is On: Global Climate Change Revisited

A Classroom Activity for Ocean Gazing Episode #19: Clearing a carbon catastrophe

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**Grade Level:** 8-12

**Lesson Time:** 1.25 – 2h

### Materials Required

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Mauna Loa CO<sub>2</sub> [data](#) & [graphs](#)

### Summary

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Using Mauna Loa and greenhouse gas data, evaluate trends over the past 50 years as well as seasonal variations in sea level.

### Objectives

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- ✓ Recognize the role of greenhouse gases in relation to global warming.
- ✓ Interpret and graph atmospheric carbon dioxide concentrations from the Mauna Loa data record.
- ✓ Predict and assess global climate trends.
- ✓ Compare renewable energy sources.

### Vocabulary

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Global warming, Kyoto protocol, Greenhouse gas, Atmospheric carbon dioxide

### Introduction

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Scientific evidence has revealed that a warming trend occurred in the last century

– on that there is consensus. The [debate](#) is about whether or not this is a natural cycle and how to respond to the evidence. The scientific uncertainty surrounding [climate change](#) makes it particularly difficult for public policy makers, who must decide whether or not to implement costly greenhouse gas reduction policies. The views of our political candidates sometimes vary widely on climate change and the [Kyoto Protocol](#), an international treaty to reduce greenhouse gas emissions. Let's investigate the topic further and examine some data so that you can cast your vote on this issue.

[Global warming](#) refers to an increase over time of the average temperature of the Earth's atmosphere and oceans. The majority of qualified scientists believe that most of the warming observed over the last 50 years is due to the continued emission of greenhouse gases produced by industry and agriculture. Greenhouse gases are so named because they trap heat in the atmosphere by allowing sunlight through but preventing some heat from escaping into space, thus acting like the glass in a greenhouse. The majority of this greenhouse effect is natural, keeping the Earth's average temperature at a pleasant 60°F (15°C), as opposed to the



frigid 0°F (-18°C) we would experience otherwise. However, the atmospheric concentrations of several greenhouse gases have been rising as a result of human activity. Levels of carbon dioxide, which is released primarily by the burning of fossil fuels such as coal, oil and natural gas, have increased by nearly 30% since pre-industrial times. Levels of methane — emitted during the production and transport of coal, natural gas and oil, and released from the decomposition of organic wastes in municipal solid waste landfills and the raising of livestock — have more than doubled, and levels of nitrous oxide — emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels — are increasing, too.

If average global temperatures continue to rise, they would, at some point, be expected to cause changes in precipitation frequency and intensity patterns, changes in soil moisture, and a rise of global sea level. Sea level would rise as a result of warmer air temperatures because ocean waters expand when heated, and many mountain glaciers would melt. Significant [sea level rise](#) would eliminate beaches and plague coastal towns and cities with flooding. Certain islands and low-lying countries such as Bangladesh would be particularly at risk. In addition to the loss of property and historically and culturally significant landmarks that would be caused by flooding, mosquito-borne illnesses and other diseases would increase in incidence. Coastal marine ecosystems would be severely affected by a combination of sea level rise and warmer temperatures. The potential [impacts](#) of global warming are numerous.

It has recently been discovered that the [polar ice caps have been thinning and shrinking](#), and that the [Earth's permafrost is thawing](#). Most scientists believe that the

chances of the ice shrinkage being due to natural cycles are slim. If Arctic ice continues to melt at its present rate, in a few decades it could be nonexistent during summer months. The Arctic would become a huge heat collector, absorbing 80% of the sunlight that reaches it, rather than reflecting it back into space as it does now. Major ocean currents that exchange energy from the tropics to the poles would be altered, as would world weather patterns.

In the past 100 years, Earth's average temperature has increased by 1° Fahrenheit. When deciding what to wear in the morning, this seems trivial; however, consider the fact that during the last Ice Age, the planet was only 9°F cooler than it is now. It doesn't take much to seriously affect climate patterns and ecosystems. If greenhouse gas emissions continue to rise, projections for temperature increases in the next century range from 1.8°F to 6.3°F (assessments by the U.S. National Academy of Sciences and the United Nations' Intergovernmental Panel on Climate Change (IPCC)). During that same period, sea level is projected to rise six inches to as much as three feet. If future climate change occurs at this magnitude, 21st century Earth would experience the fastest warming in the history of civilization and the warmest temperature since the evolution of modern humans. What does this mean for our existence? We cannot possibly know. We are conducting an experiment in real time.

### **Data Activity**

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The longest continuous record of atmospheric carbon dioxide measurements in the world dates back to 1958 and comes from a site in Mauna Loa, Hawaii. This site is considered one of the most favorable locations for measuring undisturbed air because possible local influences of vegetation or human activities on atmospheric CO<sub>2</sub> concentrations are

minimal, and any influences from volcanic vents may be excluded from the records. Because of the favorable site location, continuous monitoring, and careful selection and scrutiny of the data, the Mauna Loa record is considered to be a precise record and a reliable indicator of the regional trend in the concentrations of atmospheric CO<sub>2</sub> in the middle layers of the troposphere.

- ✓ Access the [annual mean Mauna Loa CO<sub>2</sub> data](#), and have students graph year vs. mean (ppm) from 1959 to present.
- ✓ Look for trends in the data. Is atmospheric CO<sub>2</sub> increasing or decreasing? By how much annually?
- ✓ Project what you would expect the data to look like from the present to 2050. What is your predicted value of atmospheric CO<sub>2</sub> by 2050? How much would it the CO<sub>2</sub> level have changed over those 100 years?
- ✓ Optional: graph the [monthly mean Mauna Loa CO<sub>2</sub> data](#). What are the seasonal variations of carbon dioxide?
- ✓ Compare your graphs to [NOAA graphs](#).

Various ideas exist for dealing with the pollution which may be causing climate change. Many of us could take steps in our daily lives to reduce our consumption of energy. There are also good reasons for switching to [renewable energy sources](#). These energy sources are rapidly replaced, unlike fossil fuels, and are generally less polluting. Examples of renewable energy sources are solar power, wind power, hydropower, geothermal energy, and biomass energy.

For more activities and resources, check out the Bridge's [Climate & Atmosphere](#) page, as well as the following sites:

- TOPEX/Poseidon [Analyzing Greenhouse Gases and Global Temperature Data Over Time](#)

- [USGS Global Change](#)
- [The U.S. Global Change Research Program](#)
- [Alliance to Save Energy](#)

## Related Resources

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[Climate](#), [Physical oceanography](#), [Chemical oceanography](#), [Pollution](#), [Sustainability](#)

## References

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“Three Views on Global Warming.” National Public Radio.  
<http://www.npr.org/templates/story/story.php?storyId=1893089&sourceCode=gaw>

Climate Change. US Environmental Protection Agency. <http://www.epa.gov/climatechange/>

Kyoto Protocol. United Nations Framework Convention on Climate Change.  
[http://unfccc.int/kyoto\\_protocol/items/2830.php](http://unfccc.int/kyoto_protocol/items/2830.php)

Climate Change: Basic Information. US Environmental Protection Agency.  
<http://www.epa.gov/climatechange/basicinfo.html>

“Coastal Sensitivity to Sea-level Rise: A Focus on the Mid-Atlantic Region.” US Environmental Protection Agency.  
<http://www.epa.gov/climatechange/effects/coastal/sap4-1.html>

A Student's Guide to Global Climate Change. US Environmental Protection Agency.  
<http://www.epa.gov/climatechange/kids/impacts/>

“Impact of Climate Warming on Polar Ice Sheets Confirmed.” NASA.  
[http://www.nasa.gov/vision/earth/environment/ice\\_sheets.html](http://www.nasa.gov/vision/earth/environment/ice_sheets.html)

“Trends in Atmospheric Carbon Dioxide.” NOAA Earth System Research Laboratory Global Monitoring Division.  
[http://www.esrl.noaa.gov/gmd/ccgg/trends/ml\\_o.html](http://www.esrl.noaa.gov/gmd/ccgg/trends/ml_o.html)

Kids Saving Energy. US Department of Energy.  
<http://www1.eere.energy.gov/kids/>

“Analyzing Greenhouse Gases and Global Temperature Data Over Time.”  
TOPEX/Poseidon, NASA.  
<http://topex-www.jpl.nasa.gov/files/archive/activities/ts1pac1.pdf>

“What Is Climate Change?” USGS Office of Global Change.  
[http://www.usgs.gov/global\\_change/](http://www.usgs.gov/global_change/)

US Global Change Research Program.  
University Corporation for Atmospheric Research (UCAR).  
<http://www.globalchange.gov/>

Alliance to Save Energy.  
<http://ase.org/index.php?q=topics/education>

## **Sources**

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To access an online version of this activity, you can go to the following URL:  
[http://www2.vims.edu/bridge/DATA.cfm?Bridge\\_Location=archive1104.html](http://www2.vims.edu/bridge/DATA.cfm?Bridge_Location=archive1104.html)

The related podcast episode for this activity can be found by going to the podcast section of [www.oceangazing.org](http://www.oceangazing.org)