



Earth's Changing Climate

SUBJECT: climate change, fossil fuel emissions, climate change, weather

GRADE LEVEL: 9-12

CLASS TIME: 50-60 minutes

OVERVIEW

In this lesson students will watch the video *Is it too Late to Avoid Serious Impacts of Climate Change?*, where Dr. James McCarthy talks about the serious implications of increased CO₂ levels and climate change.

Students then participate in the activity, *Observing Climate Changes in your Hometown*, where students will use data from the Goddard Institute of Space Studies and the National Weather Service to see how climate change is affecting their community.

Supplemental readings are provided to help broaden knowledge on the concept of climate change.

OBJECTIVES

Students will:

- Provide a basic overview of climate change science
- Review physical, chemical, and biological aspects of climate change
- Understand complex ways that changes in the climate impact biological processes



STANDARDS

National Science Education Standards (NSES):

Earth and Space Science Standards, Grades 9-12

- Geochemical Cycles

Science and Technology Standards, Grades 9-12

- Communicate and defend a scientific argument
- Understandings about science and technology

About the Lecturer

James McCarthy is the Alexander Agassiz Professor of Biological Oceanography

Lesson Video

Is it Too Late to Avoid Serious Impacts of Climate Change? Harvard Thinks Green.

Video Length

11:22 minutes

Climate Change

Summary

Within the last four decades evidence that Earth's climate is changing at an unusual rate has drawn the attention of scientists who endeavor to understand how the physical, chemical, and biological aspects of climate are linked. Our species, *Homo sapiens*, has altered many fundamental aspects of the climate system, most notably the composition of Earth's atmosphere. Over the last several million years, climate fluctuations were driven by basic properties of Earth - Sun orbital geometry, and over shorter periods, by lags in the response of atmospheric and ocean circulation, solar variability, volcanic activity and by the functioning of the biosphere. Changes in the atmospheric concentration of greenhouse gases resulting from human activities now have the potential to swamp these natural changes. The fundamental physical and chemical aspects of these processes are known, but important details, especially the moderating and enhancing properties of biological processes, are still only poorly quantified.

Greenhouse gases are now at higher concentration in the atmosphere than at any time in the last million or more years. Should we be concerned? This enhanced "insulation" in the lower atmosphere will continue to warm the surface of Earth, evaporate more water, and energize the atmosphere. How much difference will this make in Earth's climate, and how much of this change might we be prepared to live with?

Activity: Observing Climate Changes in Your Hometown

Use data from the Goddard Institute for Space Studies (<http://data.giss.nasa.gov/csci/stations/>) and the National Weather Service (<http://www.nws.noaa.gov/climate/>), to help students observe how climate change is affecting their community. Pick several other cities and see if the temperature effects are similar to your town. Discuss similarities and differences, and how climate change might affect different regions of the world in distinct ways.

Discussion Questions

1. How are CO₂ emissions in China related to those in the United States?
2. What are the drivers of climate change, and how can a 2° C change in global temperature cause serious distribution to climate systems?
3. How is climate change in the Arctic regions connected to your daily life? What are examples of small changes that add up to significant differences in CO₂ emissions?

Key Vocabulary Words

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|-----------------------------|-------------------------------------|
| 1. Anthropogenic | 5. Drivers |
| 2. Greenhouse Gas Emissions | 6. Emission Scenarios |
| 3. Climate Change Modeling | 7. Global Atmospheric Concentration |
| 4. Continental Ice | 8. IPCC |

Comprehension Exercise

Indigenous communities in the Arctic have given us much of the information available about how climate change has impacted the Arctic through their observations of changing sea ice coverage, snow levels, tree line, and weather patterns. Has a changing climate impacted your hometown? Ask students to find an older adult that has lived in the area since s/he was a child. Students should ask the adults the following questions, and rate each answer on a scale of 1 to 10:

1. What was the weather usually like for you on your first day of school each year? Is it the same now?
2. Are snow and storm patterns similar to how they were when you were a child?
3. Are there bird, plant, or animal species that are more/less present in our town than they were in the past?

Add additional questions that apply to your specific region. When students return with answers, have students combine answer totals and plot each answer on a graph to determine the average answer for each question. See if these totals match up with the GISS and NWS data.

Background Reading

1. IPCC. "Summary for Policy-Makers." *Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. ed. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor, and H.L. Miller. Cambridge, UK and New York, NY: Cambridge University Press, 2007.
2. Gillis, Justin. (2011) *Carbon Emissions Show Biggest Jump Ever Recorded*. New York Times

All videos and materials associated with this lesson can be found free-of-charge on the Center for Health and the Global Environment's website at:
chge.med.harvard.edu/education