

Climate Change

Student Objectives

The student:

- will explain how human activity, especially the burning of fossil fuels, is increasing the amount of carbon dioxide in the atmosphere
- will explain how high levels of carbon dioxide in the atmosphere would lead to a super greenhouse world
- will describe a super greenhouse world and an anoxic ocean
- can explain the difference between climate and weather

Materials:

- *Crude: The Incredible Journey of Oil* internet download (see Internet Sites below)
- Science Journal

Key Words:

anoxic
carbon dioxide
climate
feedback loop
super greenhouse
threshold
tipping point
weather

Time:

1 class for video & discussion
1 - 2 classes for skits (or videos)
Optional 1 - 2 classes for teams to prepare skits/videos

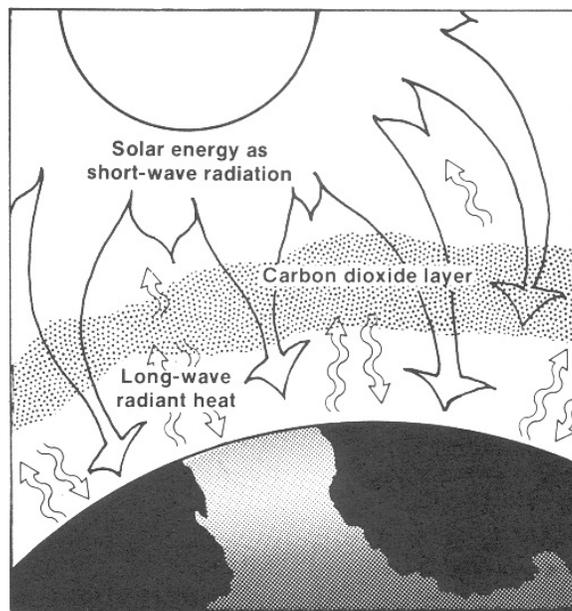
Background Information

Climate, as defined by the U.S. Global Change Research Program, is the long-term average of conditions in the atmosphere, ocean, ice sheets and sea ice as described by statistics such as means and extremes. **Climate Change** refers to changes in the Earth's global climate over long periods of time—from decades to millions of years. These changes can be caused by forces inside the Earth (for example volcanos), forces from outside of the Earth (meteors, or differences in the intensity of sunlight), forces on the Earth (biology of living organisms), or the interaction of two or more of these. The Ice Ages are a well known example of climate change, although the forces that caused the Ice Ages are still not fully understood. More recent changes, especially those changes thought to be caused by human activity, have been dubbed **global warming**.

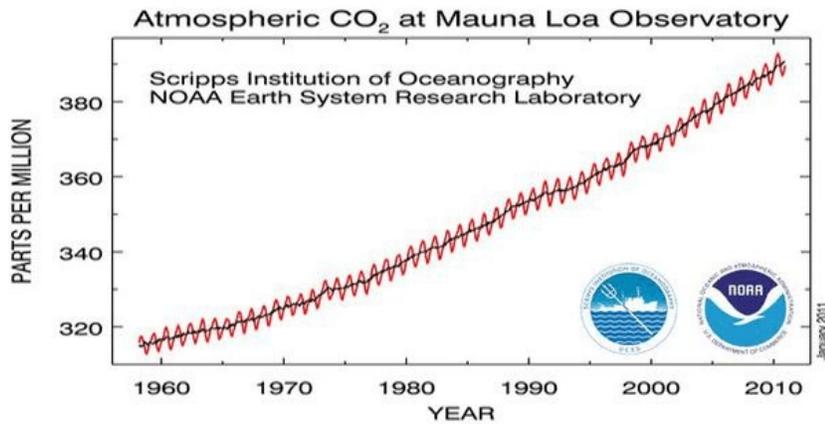
In order to understand the climate change that we are currently experiencing, we need to understand how “sunshine” works and how it plays its part in creating the greenhouse effect. The Sun, a medium-sized yellow star, gives off energy. The energy that is emitted from the Sun is called the electromagnetic spectrum, which is made up of varying wavelengths of energy.

Longest (Rainbow) *Shortest*
Radio – Radar & Microwave – Infrared – Visible light – UV – X-Rays – Gamma rays

The Sun's shortwave radiation, including visible light is unstopped by molecules in the Earth's atmosphere. However, re-radiated longwave heat rays are reabsorbed and re-radiated by molecules of gases, mostly water vapor and carbon dioxide. These gases radiate heat energy so that half of it returns to Earth where it is absorbed before being re-radiated back into the atmosphere. This results in the build-up of heat energy. This is similar to what happens when your car's interior heats up on a sunny day. The Sun's shortwave energy passes through the window glass. However, the re-radiated longwave, heat-producing (infrared) energy is trapped by that same window glass and the metal structure of the vehicle, turning your car into a solar thermal collector.



Global temperatures today are averaging .74° C (1.33° F) higher than 150 years ago. Most scientists agree that the cause is the increase in atmospheric CO₂ and the greenhouse effect that this gas causes. Measurements of atmospheric CO₂ taken in locations that are far away from fossil fuel and other atmospheric polluting sources have shown that carbon dioxide in the atmosphere is steadily increasing. Below is the graph of CO₂ concentration collected by the National Oceanic and Atmospheric Administration (NOAA) at the observatory on the top of Mauna Loa on the big island of Hawaii. The jagged line is the monthly averages showing the seasonal variations, and the smoother line is the yearly average. In both lines, a clear trend is obvious.



Vehicle exhausts, coal burning power plants, factories and other human activity vent about 23 billion tons of carbon dioxide into the atmosphere each year. In fact there is over 30% more CO₂ in the atmosphere now than there was in 1750 before the Industrial Revolution. Three quarters of the CO₂ that is released into the atmosphere comes from fossil fuels; the rest comes from factors such as cutting down and burning trees.

As the Earth's average temperature rises, ice at the caps will melt, and sea level will rise (from the increased water from the poles as well as the expansion of the warmer water). Weather patterns will change, probably affecting where and when food crops can be grown. Other effects are not as easily predicted; however most scientists agree that there will be extremes in the weather leading to larger storms, flooding, and droughts.

Although it seems clear that the burning of fossil fuels is altering the Earth's climate, so far governments and policy makers are unable to agree on what to do. The Intergovernmental Panel on Climate Change (IPCC), an international group founded by the United Nations and made up of hundreds of scientists, put out a report in 2014 that stated unequivocally that humans are behind the warming of the Earth's average temperature. Rajendra Pachauri, the chairman of the IPCC stated, "...no one on this planet is going to be untouched by climate change."

Procedure

1. Ask the students to explain the difference between climate and weather. (Make sure that students understand that weather is the current state and that climate is a long term average. Even though winter is usually cold, a warm weather day can occur during the winter months.)
2. Tell the students that they will be learning about climate change today. Show part 3 of the video. If you use the direct link, the video is already broken into three parts, if you are using the mirror sites (YouTube), start the video at the 59 minute, 4 second point.
3. Allow 5 - 10 minutes for the students to complete the Science Journal.
4. Lead a class discussion about the video. Some topics to discuss might include:
 - Climate change is an "issue" (and a theory), and therefore causes a lot of discussion and debate.
 - Scientists have analyzed data and concluded that we are living in a world with increasing levels of carbon dioxide in the atmosphere (this is a fact).
 - Scientists are analyzing data that shows that the major cause of the increased carbon dioxide in the atmosphere we see today is the burning of fossil fuels

(versus volcanos in Mesozoic times).

- Scientists are compiling and analyzing data in rock and ice samples from Earth's distant past to find times when the carbon dioxide level in the atmosphere was high. They are using what they know about the climate on Earth at those times to figure out what could happen to Earth's plants, animals, climate (and us) as carbon dioxide continues to increase in our atmosphere.
- Scientists are using computers and large programs to model the Earth's climate. With these modeling programs they can then run simulations to see what effects different variables (such as increased CO₂ or particulate matter from a volcano) could have on the climate.
- Scientists see the possibility of a problem *in the future*, and are warning us now so that we can take action. It is up to all of us to be responsible stewards of our Earth.
- There are many things each of us, *at any age*, can do to help.

Note: It is very important to make sure that the students do not see this issue as all “doom & gloom”, but rather as a call to action for all of us. Try to end the discussion with the positives.

5. Tell the students that they are going to be working on skits (or short videos if your school has the available equipment) about some aspect of climate change (causes, ways to stop it, or ways to live in our changing world). Tell the students that they will be performing their skits and they will be rated by the rest of the class on these criteria:
 - content knowledge (Did the group present accurate information?)
 - creativity & originality (Did the skit present the facts in an interesting and original way?)
 - interest level (Was the skit interesting to watch?)
6. Divide the students into groups (4 or 5 students per group) and monitor them as they work on their ideas. Help as needed.
7. Give the class time to prepare their skits. If it is difficult for students to work together outside of school hours, you may wish to give them one or two more classes to work on the skits.

Procedure (presentation day)

1. Hand out copies of the rating sheet.
2. Have the students rate the other skits on a scale of 1 - 10 (with 10 being the highest) for each of the three criteria.
3. After the skits, announce which group has the highest score. Lead a classroom discussion of what that group did to make an effective and interesting skit.

Key Words & Definitions

- **anoxic** – lacking oxygen
- **carbon dioxide (CO₂)** – a colorless, odorless, incombustible gas composed of one carbon and two oxygen atoms
- **climate** – the long-term prevalent weather conditions in the atmosphere, ocean, ice sheets and sea ice.

- **feedback loop** – the path by which some of the output of a circuit, system, or device is return to the input
- **super greenhouse** – a term used to refer to the climate present in the later Jurassic and Cretaceous periods
- **threshold** – the magnitude or intensity that must be exceeded for a certain reaction, phenomenon, result or condition to occur
- **tipping point** – the point at which a series of small changes or incidents becomes significant enough to cause a larger, more important change
- **weather** – the current state of the atmosphere with respect to wind, temperature, cloudiness, moisture, pressure, etc.

Related Research

1. Greg Johnson, one of the scientists who was part of the Intergovernmental Panel on Climate Change (IPCC), realized that it can be difficult to communicate scientific facts and numbers in a way that all people can understand. He worked with his artist daughter to create haiku paired with watercolor illustrations to distill the 27 page “summary” of the IPCC’s 2013 climate change report into a form that is easily understood. View his haiku <https://www.sightline.org/2013/12/16/the-entire-ipcc-report-in-19-illustrated-haiku/> then using art, poetry or both, distill the facts from the third part of *Crude: The Incredible Journey of Oil* into something easier for younger students to understand.
2. Create a song about recycling or other “green living” technique.
3. Make posters of recycling and green living ideas, “10 Easy Things to Save the Earth”, and post them around the school.

Related Reading

- ***365 Ways to Live Green for Kids: Saving the Environment at Home, School, or at Play*** by Sheri Amsel (Adams Media, 2009)
Activities for recycling, reusing and learning about green technologies.
- ***Climate Change*** by John Woodward (DK Eyewitness Books, 2008)
An in-depth look at the phenomenon of global warming—what’s causing it, what it might lead to, and what we can do to fight back.
- ***The Everything Kids’ Environment Book*** by Sheri Amsel (Adams Media, 2007)
This fun guide shows students how to reduce waste, recycle materials, protect plant and animals, and more. Filled with 30 eco-friendly activities and puzzles.
- ***The New 50 Simple Things Kids Can Do to Save the Earth*** by EarthWorks Group (Andrews McMeel Publishing, 2009)
Easy to do and kid-friendly projects.
- ***Under the Weather: Stories About Climate Change*** edited by Tony Bradman (Frances Lincoln Children’s Books, 2012)
A collection of stories portraying the issues surrounding climate change in personal terms. These stories from various authors offer warnings and inspiration in equal measure.

Internet Sites

Video for this lesson

<http://www.abc.net.au/science/crude/>

Crude: The Incredible Journey of Oil, ABC Television (Australia), Science Series.

<https://www.youtube.com/watch?v=IC40mZHu2ZQ>

Mirror site - same video as above.

The Problem:

<http://learning.blogs.nytimes.com/2014/04/02/teaching-about-climate-change-with-the-new-york-times/>

New York Times, Learning Network. Resources for instructors teaching about climate change.

<http://climatekids.nasa.gov/>

NASA's interactive student website on weather and environmental issues.

http://www.ted.com/talks/gavin_schmidt_the_emergent_patterns_of_climate_change

Ted Talk with Gavin Schmidt discussing the hows and whys of climate change modeling.

<http://ed.ted.com/lessons/climate-change-earth-s-giant-game-of-tetris-joss-fong>

Ted Ed lesson, includes video, discussion questions and lesson ideas.

<https://www.teachingchannel.org/video/climate-change-lesson>

Video of a classroom experiment on climate change. The students design, build, and test models of the greenhouse effect. The teacher discusses what and how was done.

Solutions:

<https://www.youtube.com/watch?v=O14WoeMW6F8>

Saving the Planet, One Lunchroom at a Time

<http://betterlesson.com/community/document/2930958/bill-nye-the-science-guy-pollution-solutions-full-episode-mp4>

Bill Nye the Science Guy - Pollution Solutions

<https://www.youtube.com/watch?v=W0bEOfA0j4c>

Curious Kids: Eco Footprint. Curious Kids is produced in Naples, Florida.

<https://www.youtube.com/watch?v=oROsbaxWH0M>

Change the World in 5 Minutes - Everyday at School

Climate Change

Rate the other groups on a 1 - 10 scale (with 10 being the highest) for each of the three categories. Total each groups score across.

Group Name/Title	Content Knowledge	Creativity & Originality	Interesting ?	Total Score

Rate your own group's performance below. List the contributions that each team member made and then rate their performance on a 1 - 10 scale (with 10 being the highest).

Group Name _____

Team Member Name	Role / Contributions	Score

What do you think was the best part of your group's performance?

What do you think your group could have improved?

Climate Change

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Practice of Science	# 1	SC.6.N.1			X		X							
Characteristics of Science Knowledge	# 2	SC.6.N.2		X	X									
Earth Structures	# 6	SC.6.E.6	X											
Earth Systems & Patterns	# 7	SC.6.E.7						X						
Grade 7														
Practice of Science	# 1	SC.7.N.1			X			X	X					
Characteristics of Science Knowledge	# 2	SC.7.N.2	X											
Earth Structures	# 6	SC.7.E.6		X		X		X						
Energy Transfer & Transformations	# 11	SC.7.P.11		X	X									
Grade 8														
Practice of Science	# 1	SC.8.N.1					X	X						
Science & Society	# 4	SC.8.N.4	X	X										
Matter & Energy Transformations	# 18	SC.8.L.18			X									
Social Studies Standards	Sixth Grade: SS.6.G.3.2 Seventh Grade: SS.7.E.1.5, SS.7.C.2.13 Eighth Grade: SS.8.G.5.1, SS.8.G.5.2													
Language Arts Standards	Sixth Grade: LAFS.6.SL.1., LAFS.6.SL.1.2, LAFS.6.SL.2.4, LAFS.6.SL.2.5 Seventh Grade: LAFS.7.SL.1.1, LAFS.7.SL.2.4, LAFS.7.SL.2.5 Eighth Grade: LAFS.8.SL.1.1, LAFS.8.SL.2.4, LAFS.8.SL.2.5													

Sixth Grade Benchmarks

Science—Big Idea 1: The Practice of Science

- SC.6.N.1.3 - Explain the difference between an experiment and other types of scientific

- investigation, and explain the relative benefits and limitations of each.
- SC.6.N.1.5 - Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.

Science—Big Idea 2: The Characteristics of Scientific Knowledge

- SC.6.N.2.2 - Explain that scientific knowledge is durable because it is open to change as new evidence or interpretations are encountered.
- SC.6.N.2.3 - Recognize that scientists who make contributions to scientific knowledge come from all kinds of backgrounds and possess varied talents, interests, and goals.

Science—Big Idea 6: Earth Structures

- SC.6.E.6.1 - Describe and give examples of ways in which the Earth’s surface is built up and torn down by physical and chemical weathering, erosion, and deposition.

Science—Earth Systems and Patterns

- SC.6.E.7.6 - Differentiate between weather and climate.

Social Studies – Geography

- SS.6.G.3.2 - Analyze the impact of human populations on the ancient world’s ecosystems.

Language Arts—Standards for Speaking and Listening

- LAFS.6.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly.
- LAFS.6.SL.1.2 - Interpret information presented in diverse media and formats and explain how it contributes to a topic, text, or issue under study.
- LAFS.6.SL.2.4 - Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
- LAFS.6.SL.2.5 - Include multimedia components and visual displays in presentation to clarify information.

Seventh Grade Benchmarks

Science—Big Idea 1: The Practice of Science

- SC.7.N.1.3 - Distinguish between an experiment and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.
- SC.7.N.1.6 - Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.
- SC.7.N.1.7 - Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.

Science—Big Idea 2: The Characteristics of Scientific Knowledge

- SC.7.N.2.1 - Identify an instance from the history of science in which scientific knowledge has changed when new evidence or new interpretations are encountered.

Science—Big Idea 6: Earth Structures

- SC.7.E.6.2 - Identify the patterns within the rock cycle and relate them to surface events and sub-surface events.
- SC.7.E.6.4 - Explain and give examples of how physical evidence supports scientific theories that Earth has evolved over geologic time due to natural processes.
- SC.7.6.6 - Identify the impact that humans have had on Earth, such as deforestation,

urbanization, desertification, erosion, air and water quality, changing the flow of water.

Science–Big Idea 11: Energy Transfer and Transformations

- SC.7.11.2 - Investigate and describe the transformation of energy from one form to another.
- SC.7.11.3 - Cite evidence to explain that energy cannot be created nor destroyed, only changed from one form to another.

Social Studies – Civics & Government

- SS.7.C.2.13 - Examine multiple perspectives on public and current issues.

Social Studies – Economics

- SS.7.E.1.5 - Assess how profits, incentives, and competition motivate individuals, households, and businesses in a free market economy.

Language Arts – Standards for Speaking and Listening

- LAFS.7.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 7 topics, texts, and issues, building on others; ideas and expressing their own clearly.
- LAFS.7.SL.1.2 - Analyze the main ideas and supporting details presented in diverse media and formats and explain how the ideas clarify a topic, text, or issue under study.
- LAFS.7.SL.2.4 - Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- LAFS.7.SL.2.5 - Include multimedia components and visual displays in presentation to clarify claims and findings and emphasize salient points.

Eighth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.8.N.1.5 - Analyze the methods used to develop a scientific explanation as seen in different fields of science.
- SC.8.N.1.6 - Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.

Science–Big Idea 4: Science and Society

- SC.8.N.4.1 - Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels.
- SC.8.N.4.2 - Explain how political, social, and economic concerns can affect science, and vice versa.

Science–Big Idea 18: Matter and Energy Transformations

- SC.8.L.18.3 - Construct a scientific model of the carbon cycle to show how matter and energy are continuously transferred within and between organisms and their physical environment.

Social Studies – American History

- SS.8.A.1.3 - Analyze current events relevant to American History topics through a variety of electronic and print media resources.

Social Studies – Economics

- SS.8.E.1.1 - Examine motivating economic factors that influenced the development of the United States economy over time including scarcity, supply and demand, opportunity

costs, incentives, profits, and entrepreneurial aspects.

Social Studies – Geography

- SS.8.G.5.1 - Describe human dependence on the physical environment and natural resources to satisfy basic needs in local environments in the United States.
- SS.8.G.5.2 - Describe the impact of human modifications on the physical environment and ecosystems of the United States throughout history.

Language Arts – Standards for Speaking and Listening

- LAFS.8.SL.1.1 - Engage effectively in a range of collaborative discussions with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- LAFS.8.SL.2.4 - Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- LAFS.8.SL.2.5 - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

National Next Generation Science Standards - Sixth to Eighth Grade Standards

Science – Earth's Place in the Universe

- MS-ESS1-4 - Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion year old history.

Science – Earth and Human Activity

- MS-ESS3-1 - Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy and groundwater resources are the result of past and current geoscience processes.
- MS-ESS3-4 - Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- MS-ESS3-5 - Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Note: Related Common Core Language Arts Standards are listed in the Florida section above.

4. What do scientists believe stopped the runaway greenhouse effect of the global anoxic events of the past?

5. Why is the current loss of ice at the poles worrying to climate scientists?

6. According to the video, will we run out of crude before we ruin our climate?

7. What can we do to decrease the amount of carbon dioxide that is getting put in the atmosphere from the burning of fossil fuels.....
(list at least three actions for each group below)

.....as an individual?

....in my family?

.....at our school?

....as a nation?