



Warming Up to Global Warming

Middle School Grades

Lesson Summary

Students will take a pre-test to show what they already know about climate change and discuss the basic principles of global warming. They will then go to different media sources to find current events dealing with the topic of climate change in order to frame a discussion and debate with their peers.

Prior Knowledge & Skills

- Media Observation
- Critical Thinking
- Group Discussion

AAAS Science Benchmarks

The Physical Setting

Processes that Shape the Earth

Human Society

Global Interdependence

Habits of Mind

Communication Skills

NSES Science Standards

Science in Personal and Social Perspectives

Populations, Resources, and Environments

Natural Hazards

Teaching Time: 45 – 60 minutes

Additional time outside the classroom searching and reviewing news coverage on global warming

Materials

- Access to newspapers, radio, TV, magazines, possibly also the internet
- *Confronting Climate Change in the Gulf Coast Region* (attached)

Advanced Planning

Preparation Time: ~10 minutes

1. Review the instructions
2. Gather the necessary supplies.

Recommended Reading: (attached)

- *Confronting Climate Change in the Gulf Coast Region*

Introduction:

Climate Change in the Classroom

Global climate change is a challenging topic to teach and to learn. As climate change science rapidly advances, it is essential for educators to have up-to-date, relevant teaching materials that present the basic concepts in ways that stimulate student interest. At the same time, it is important to recognize that students as well as teachers often have misconceptions about global warming that can negatively impact the construction of new knowledge. By understanding these misconceptions, teachers are in a better position to devise strategies for successfully addressing them in the classroom. Although challenging to teach, the complexity of global climate change offers an opportunity to engage students in higher order thinking skills and in an interdisciplinary and multidisciplinary analysis of the issues. In this section we present basic information on the state of the science, background on common misconceptions, and possible assessment strategies for the activities in this guide.

Climate Science Primer

Today's observed and projected changes in the global climate are different from those of any other time in the Earth's history because they are now attributable to human activity. Earth's climate does vary naturally, of course; it has changed in the past and will continue to change in the future. We know about past climate history from scientific analysis of tree rings, coral, ice cores and rocks. All of these sources show that our climate has cycled through ice ages and warm periods during the last 100 million years. In the past, natural variations in the Earth system have driven these climate changes. Some of these natural mechanisms are well understood—like the role of the sun and of volcanoes—while others are less well understood—such as the role that plants and animals play, and the links between the atmosphere and the ocean.

One thing we know for sure is that seemingly small changes in global average temperatures can make a huge difference for life on Earth. The last ice age, for example, was at its peak about 18,000 years ago. During this time sea level was much lower (since much of the Earth's water was locked up as ice), the atmosphere was drier and windier, and the global average temperature was just 7°F colder than today.

An important discovery about past climate is that certain heat-trapping gases (like carbon dioxide and methane) also cycle with climate. When the Earth is warm, there are more heat-trapping gases in the atmosphere than when Earth is cool. These gases act like a 'blanket' and trap outgoing heat to keep our atmosphere (and us) warm. Without them, humans could not inhabit Earth. Human activities, however, are rapidly increasing the atmospheric concentration of these gases, as well as adding new heat-trapping gases that are not found in nature. Over the last two hundred years, burning of fossil fuels and land-use changes (such as deforestation) have altered the atmosphere enough to produce a warming trend in global climate that is distinct from natural variation. Global average

temperature has increased by 1°F over the last century and is projected to rise by 2.5–10.4°F over the next century, comparable to the change seen between ice ages. [Note: For more information on the science of global warming, see the misconceptions text.]

A Note on Nomenclature

In this Guide (and in much of the material currently available on this subject) you will find a variety of terms used fairly loosely and sometimes interchangeably to describe the phenomenon of ‘global warming’. It is not our intention to be scientifically rigorous in our use of terms, nor is it our intention to be confusing – but we do point out that the meaning of a particular term is sometimes contextual. The following definitions are outlined for clarification:

Climate change is often used to describe any kind of change in climate that may be natural or human-induced. In the context of this guide, it is often used to describe the ‘human-induced’ climate change in place of the term ‘global warming’.

Global warming refers only to the human-induced climate change that is predicted to have an overall warming effect on Earth’s average temperature.

Understanding Student Misconceptions

Educational research on student awareness and understanding of global atmospheric issues has revealed some common misconceptions that should be addressed in any lesson or unit on climate change. Three predominant misconceptions among students are:

- Depletion of the stratospheric ozone layer (“ozone hole”) is a direct cause of global warming.
- All types of pollution cause global warming (aerosols, acid rain).
- Weather and climate are the same (global warming is about weather).

Confusion between the stratospheric “ozone hole” and global warming

Confusion between the ozone hole and global warming, and the various pollutants that are involved in either phenomenon, has been widely reported in age groups ranging from fifth-graders to university students and among the general public. The ozone hole, more accurately described as ‘ozone depletion,’ is the thinning of a layer of protective gas high in Earth’s stratosphere about 20 miles above Earth’s surface. The depletion occurs seasonally and mainly above the North and South poles and is due to human use of ozone-depleting chemicals such as chlorofluorocarbons (CFCs). In contrast, global warming occurs worldwide in the lower eight miles of the atmosphere and is due to increasing concentrations of greenhouse gases, some of which are (coincidentally) human-produced CFCs.

To help clarify the differences between the two phenomena, educators suggest a distinct separation in time between units on ozone depletion and global warming, and the use of different teaching materials. (See Additional Teacher Resources below.)

Additional Teacher Resources:

- For a brief overview of how the ozone hole and global warming are different but also connected phenomena, see <http://www.ucsusa.org/environment/gw.faq.html#8>
- For more information about ozone depletion, see <http://www.cs.ruu.nl/wais/html/na-dir/ozone-depletion/.html>
- For more information on ozone depletion and human health effects, see <http://sedac.ciesin.org/ozone/>
- To learn more about the discovery of the ozone hole, see <http://www.atm.ch.cam.ac.uk/tour/index.html>

Confusion about air pollution and global warming

Many students believe that what they generally understand to be pollution and toxic chemicals are major contributors to climate change. In fact, most pollutants from industrial processes—such as carbon *monoxide*, organic carbons, sulfate, soot, and some oxides of nitrogen—are not greenhouse gases.

The major contributor to global warming is carbon dioxide—a colorless, odorless, naturally occurring gas. In addition to natural sources, carbon dioxide is also released during the burning of coal, oil, and gas to produce energy for electricity, heat, and transportation. Unlike the air pollutants that create visible smog, carbon dioxide forms an unseen heat-trapping layer within the atmosphere, which increases Earth’s surface temperature.

Although air pollution does not cause global warming, these two phenomena are connected. Industrial pollutants can, for example, affect the lifetimes of other greenhouse gases in the atmosphere, and therefore play an indirect role in climate change. Further, higher temperatures are likely to make air pollution worse. [Please refer to Chapter 4 of *Confronting Climate Change in the Gulf Coast Region* for more information on this connection.]

Additional Teacher Resources:

- For a brief summary clarifying human activities that contribute to climate change, see <http://www.gcric.org/ipcc/qa/04.html>
- The US Environmental Protection Agency has a clearinghouse of information about air pollution and air quality, see <http://www.epa.gov/ebtpages/air.html>
- For a description of the major pollutants emitted from motor vehicles, see <http://www.ucsusa.org/vehicles/cars.html>

Confusion between weather and climate

Classroom discussions of global climate change should include a clarification of the difference between weather and climate. Weather is the day-to-day variations in atmospheric conditions, while climate is the average background within which weather occurs. The type and intensity of weather patterns that result depend, to a certain degree, on this background. The release of fossil fuels into the atmosphere forces a gradual change in climate over longer time periods. Since the climate system is finely balanced, small changes in the background state can have potentially large influences on weather in a particular location. Confusion arises because all our direct experience is with weather, so it is difficult for people to accept that such a large problem as global warming could result from such “small” predicted changes in temperature. The Gulf Coast region climate impacts report can help students make the connection between a rise in global average temperature and potential impacts on climate and weather in a specific location.

Additional Teacher Resources:

For basic explanations of the difference between weather and climate, see

<http://www.explorit.org/science/weather.html>

<http://www.ngdc.noaa.gov/paleo/globalwarming/paleo.html>

http://weathereye.kgan.com/cadet/climate/climate_vs.html

<http://www.epa.gov/globalwarming/kids/climateweather.html>

Understanding Related Public Misconceptions

Additional misconceptions about global warming are prevalent in the general population and may influence student learning. These misconceptions can stem from a person’s physical senses and learned understanding of her environment. Or, they may be generated and perpetuated by media depiction and policy treatment of the global warming debate. The media often, for example, presents both sides of this issue without qualifying or quantifying either, leading to the belief that there are large and relatively equal groups of researchers on both sides (Gilmore, 2000). Some common public misconceptions to be aware of:

- The atmosphere is so vast that humans cannot affect it.
- The timeline for the consequences of global warming is a long way in the future (hundreds of years).
- The temperature changes are so small and so gradual that plants and animals can adapt.
- There are no solutions to global warming.
- Global warming can be addressed gradually.

Misconception: *The atmosphere is so vast that humans cannot affect it.*

Reality: *Human activities are rapidly increasing the atmospheric concentration of greenhouse gases as well as adding new heat-trapping gases that are not found in nature.*

While many greenhouse gases (e.g. carbon dioxide, methane, and nitrous oxide) are produced naturally, human activities such as the burning of fossil fuels and land-use changes (such as deforestation) add significantly to atmospheric concentrations of these gases. The present atmospheric concentration of carbon dioxide is unprecedented in the last 420,000 years and likely the last 20 million years, and the rate of increase is faster than at any time during the last 20,000 years (IPCC, 2001). About three-quarters of the CO₂ added to the atmosphere by humans comes from the burning of fossil fuels. Just over half of the current methane emissions are from human activities (e.g. fossil fuels, cattle, rice agriculture, and landfills), and about one-third of nitrous oxide emissions are human-caused (e.g. agriculture, cattle feed lots, and chemical industry).

For more information, see the report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC), Summary for Policymakers, at:
<http://www.ipcc.ch/pub/spm22-01.pdf>

Misconception: *The timeline for the consequences of global warming is a long way in the future (hundreds of years).*

Reality: *The consequences of global warming are already evident.*

The consequences of global warming have already been observed and are quantifiable today—so much so that the most authoritative scientific body on this issue has stated that “an increasing body of observations gives a collective picture of a warming world and other changes in the climate system” (IPCC, 2001). Global average surface temperatures have increased by 1° Fahrenheit this century. Snow cover and sea-ice thickness have decreased. Mountain glaciers in all parts of the world have retreated. Global average sea level has risen and ocean water temperature has increased. These changes have led to physical and ecological changes such as thawing permafrost, a lengthening growing season, and shifts in the geographical range of some species of animals and plants. These observations are consistent with a warming world.

For more information see the reports of IPCC Working Groups I and II, Summary for Policymakers, at: <http://www.ipcc.ch/pub/spm22-01.pdf> and <http://www.ipcc.ch/pub/wg2SPMfinal.pdf>

For specific examples of the early warning signs of climate change see:
<http://www.climatehotmap.org>

Misconception: *The temperature changes are so small and so gradual that plants and animals can adapt.*

Reality: *The projected rate of climate change is more rapid than any that has occurred in the last 10,000 years and may overwhelm the ability of plants and animals to adapt.*

Global average temperatures are projected to rise by 2.5–10.4°F over the next century. Even a small increase in global temperature can change the climate dramatically. At the peak of the last Ice Age (18,000 years ago), for example, the temperature was only 7°F colder than it is today, yet large glaciers covered much of the world. Most past climate changes have occurred slowly, allowing plants and animals to adapt to the new conditions or to move elsewhere. The very fast environmental changes projected to occur with global warming threaten the survival of some species.

Those species that exist and/or reproduce within a very narrow set of conditions (e.g. salt level for aquatic species, narrow temperature range, or certain requirements for water availability) may need to shift their ranges to keep up with a changing climate. However, a number of factors can limit a species' ability to move, including: lack of suitable habitat to move to; barriers between the current and potentially available new habitat, such as wide roads, dense development, bulkheads and seawalls; competition for space, nutrients, light, etc. from other moving or already established species in the new habitat; increased or unprecedented predation from other moving or already established species; and changes in or loss of beneficial relationships that help some species to survive, thrive, or have a competitive advantage. Moreover, because many species are already under stress from pollution and human alteration of the land, they are less resilient to further change.

For more information:

- *Global Warming and Terrestrial Biodiversity Decline*, World Wildlife Fund report –<http://www.panda.org/resources/publications/climate/speedkills/index.cfm>
- “Why can’t ecosystems just adapt?” <http://www.ieagreen.org.uk/11.htm>

Misconception: *There are no solutions to global warming.*

Reality: *Solutions exist and are being implemented worldwide.*

The most important action to take to slow global warming is to reduce emissions of heat-trapping gases. This can be done at the individual, business, and government levels. Individuals can drive less, drive more-efficient and less-polluting cars, and use less electricity in general. Currently many industries are looking to replace fossil fuel dependence with new technologies like fuel cells, whose only emission is water vapor. This clean technology is already being used to power vehicles in many countries worldwide. Governments can increase energy efficiency standards, encourage the use of renewable energy sources, and protect forests.

For more information:

- UCS Common Sense on Climate Change –
<http://www.ucsusa.org/environment/solutions.html>
- EPA Global Warming Action –
<http://www.epa.gov/globalwarming/actions/index.html>
- Climate Change Solutions –
<http://www.climatechangesolutions.com/english/individuals/default.htm>

Misconception: *Global warming can be addressed gradually.*

Reality: *Steps to curb global warming are needed now.*

Scientists predict that even if human emissions of greenhouse gases stopped immediately, the climate would not stabilize for many decades because the gases already released into the atmosphere will stay there for years or even centuries. If we reduce emissions of heat-trapping gases significantly, the warming may be less or it may occur at a slower rate than predicted, but global temperatures cannot quickly return to today's averages. The longer we wait to implement solutions, the more the Earth warms, and the greater the chances for some irreversible climate changes.

Activity 1: Warming Up to Global Warming –
What Is It and Why Should I Care?

Objectives

- To raise awareness of global warming as one of the biggest scientific and political challenges of our times.
- To build an understanding of the controversies surrounding the topic of climate change.
- To develop a healthy critical perspective in students as they read and hear about climate change.

National Science Education Standards

Specific Skills

- Media observation (following newspaper and other media coverage)
- Critical thinking
- Group discussion (listening, formulating arguments, debating, finding consensus)

Materials

Access to newspapers, radio, TV, magazines, possibly also the web
Confronting Climate Change in the Gulf Coast Region report, pages 4-5

Time

1 class session

Additional time outside the classroom searching and reviewing news coverage on global warming

Background Information

This activity is recommended for students who are relatively unfamiliar with the issue, or simply as an introduction to the issue to pique students' interest, and for teachers, to gauge their knowledge and understanding to get a baseline for assessing students' learning. It can be used in combination with any of the other activities in this set. For teachers unfamiliar with the topic, we recommend several resources to prepare and to become familiar with the basic scientific and political issues and controversies involved. You may also want to review some scientific, governmental, and climate contrarian web sites—see Appendix and Additional Resources below—and to follow the news for a while (and/or review recent news coverage at the informational climate change sites listed in the Appendix). This will provide you with sufficient background on where the science stands at present, who the “skeptics” are, who the environmental advocacy groups are, which interests they represent, and what is being done in industry and in national and international politics about global warming.

Key teacher resources

Objective, succinct, easily accessible and readable background information include the following:

- 1) Office of Science and Technology. 1998. *Climate change: State of knowledge*. Washington, DC. (Available at <http://www.usgcrp.gov/usgcrp/nacc/default.htm>)
- 2) UCAR/JOSS and NOAA/Office of Global Programs. 1997. *Report to our nation: Our changing climate*. Washington, DC.
- 3) IPCC. 2001. *Climate change 2001: The scientific basis. Summary for policymakers* (A Report of Working Group I of the Intergovernmental Panel on Climate Change). WMO, UNEP. (Available at <http://www.ipcc.ch/pub/spm22-01.pdf>)
- 4) IPCC. 2001. *Climate change 2001: Impacts, adaptation, and vulnerability. Summary for policymakers* (A Report of Working Group II of the Intergovernmental Panel on Climate Change) WMO, UNEP. (Available at <http://www.ipcc.ch/pub/wg2SPMfinal.pdf>)
- 5) United Nations Environment Program. *Vital Climate Graphics*. (Available at <http://www.grida.no/climate/vital/>)
- 6) The New York Times and the Washington Post both have climate change websites where they gather their coverage of the issues. These are easy-to-find examples of media coverage of science and climate issues.

Activity Guide

Ask students to observe current, and to research past, news coverage (say over the past year) on global warming. Ask them to make lists of the topics covered (new scientific discoveries, national and international political developments, discussion of climate change impacts, etc.), the people interviewed, the general positions they hold, and so on. Students should bring those to the class session as background.

Pick one recent news item, and explore it together in the same fashion in class. Ask students to summarize what the global warming news is about—what’s the issue? What’s at stake? Did the issue make waves in the news, and if so, why? What’s the tone of the news coverage—gloom and doom, speculative, sincerely concerned, a wake-up call, a call to action? How has the news coverage changed over time? How is the climate issue presented— with a focus on what’s known or on what’s uncertain? What are the scientific uncertainties, and why do they tend to be so prominent in the news coverage? Why are these uncertainties so hard to resolve? How do new discoveries revise our knowledge base? Who are the different interest groups involved in the debate and what is at stake for them?

Ask students to formulate what they think about the issue, whether they care about the debate, or about climate change. Why or why not? Help them identify what is at stake for them personally. Also help them identify why different interests have such opposing views. Conclude the class with a discussion (and resolution) of how best to approach information about climate change (careful, critical, etc.).

Teaching Strategies

Prior to starting this activity, we recommend asking students to complete the Questionnaire on Climate Change (see Appendix), which will help identify any preconceptions or misconceptions regarding the topic. Students can then refer back to their answers to the questionnaire after completing this activity to assess if their knowledge and/or attitudes have changed (see *Climate Change in the Classroom*, page 5, for more information).

The news analysis can be modified for group work by asking students to bring one news item of interest to class. In class have students give a 30-second summary of their item, and list the topics covered on the board by category (new scientific discoveries, political developments, economic impacts, impacts on ecosystems, possible mitigation strategies, etc.). Assign students to groups according to their interest in a particular topic. Ask students to work as a group to summarize the issues in their category—the controversies, interest groups, remaining questions, ongoing studies, etc. Ask each group to present their analysis to the rest of the class.

Students should come away with an understanding of the current scientific consensus on climate change. Depending on the news items students collect, it may be necessary to provide additional reading so that students can critically analyze the media coverage as it relates to scientific understanding. The box on pages 4-5 of the Gulf report could serve as an in-class reading to provide an overview of the current scientific consensus and the process by which it was developed.

Additional Resources

- Many climate contrarians have elaborate web sites. Examples include:
 - 1) Center for the Study of Carbon Dioxide and Global Change at <http://www.co2science.org/>
 - 2) The Science & Environmental Policy Project at <http://www.sepp.org/>
 - 3) The Greening Earth Society at <http://www.CO2andClimate.org/>

- Several web sites aim at sorting out the controversial issues debated in the media. See for example:
 - 1) Environmental Protection Agency at <http://www.epa.gov/globalwarming/index.html>
 - 2) UNEP/WMO at <http://www.gcrio.org/ipcc/qa/cover.html>
 - 3) PBS: “What’s up with the weather?” at <http://www.pbs.org/wgbh/warming/>
 - 4) Union of Concerned Scientists at <http://www.ucsusa.org>

8. What can you yourself do about global warming?

9. Do you think action should be taken now to slow the pace and magnitude of global warming? Explain your position.