

Climate Change Educator's Guide

Teaching in the Exhibiton: Answers to Guiding Questions

Use the Guiding Questions in the Teaching in the Exhibition section as a springboard for discussion, which may go in many directions. The answers below summarize key concepts of the exhibition. For more information, visit the exhibition website at amnh.org/climatechange.

1. Introduction

Why is atmospheric CO₂ on the rise?

Levels of atmospheric carbon dioxide (CO₂) are climbing mostly because humans are burning fossil fuels in ever-increasing amounts — an activity that releases carbon dioxide. The increase began when coal replaced wood as a common fuel, and was spurred by the invention of the steam engine. CO₂ emissions have accelerated even more over the last 150 years with the commercial production of electricity from coal.

How are different kinds of machines powered?

Machines are powered by different kinds of fuel, including oil (which includes gasoline and diesel fuels), ethanol, and electricity. Our world runs on electrical power, and much of that power comes from coal.

How have different kinds of carbon-based technologies affected human societies?

Carbon-based technologies have vastly improved our lives. Labor once performed by humans is now carried out by machines. Harnessing electricity provided safe, bright light — and energy. Steam engines powered trains and boats, and oil-based power cars and planes move us comfortably around the world. Electronic devices, including personal computers and mobile phones, have transformed the way we work and communicate.

2. Climate Change Today

How do greenhouse gases affect Earth's atmosphere?

The atmosphere is a transparent, protective blanket that admits enough of the Sun's energy to warm our planet. Greenhouse gases in the atmosphere — carbon dioxide (CO₂), water vapor, methane, and nitrous oxide — retain some of this heat. Without this greenhouse effect, Earth's surface would be frozen and probably lifeless.

What human activities are causing the atmosphere to warm?

Human activity, particularly the burning of fossil fuels, creates greenhouse gases. Burning coal to generate electricity is the most significant source of this CO₂; deforestation also plays a part. Humans are withdrawing carbon — in the form of coal and oil — from the long-term rock reservoir in which it sat for tens of millions of years, and pumping vast amounts of it into the surface reservoirs — the atmosphere, ocean, and biosphere. The increasing CO₂ content of the atmosphere is causing it to absorb and hold more heat emitted by Earth's surface.

3. Making a Difference

What can you do to conserve energy and reduce CO₂ in the atmosphere?

There are many ways to reduce you and your family's energy use. Switch to compact fluorescent light bulbs, install energy-efficient appliances, and turn off appliances and electronics when not in use. Take shorter showers. Drive less; instead, ride your bike or take public transportation, and carpool when you can. In the winter, dress more warmly instead of turning up the thermostat; keep blinds and curtains closed at night and open during the day. In the summer, raise the thermostat to 78, and turn on a ceiling fan instead of the AC.

How could you and others work together to broaden the effect of your actions?

You could conduct school- or community-wide campaigns — using leaflets, posters, or announcements in school assemblies — that promote the activities listed above. Work with local organizations to promote public transportation, tree-planting, energy-efficient construction, and large-scale recycling programs. Get involved in Earth Day and other renewable-energy or conservation-oriented activities.

4. Changing Atmosphere

What's the difference between weather and climate?

Weather describes the conditions today, tomorrow, or in the days to come. Climate is the average weather over years or longer.

What are some ways in which climate change affects weather?

Warming may change wind and weather patterns, generally bringing more rain to ocean areas and less to land.

What's the evidence that Earth's atmosphere is changing?

Cores drilled through ice caps contain samples of the different gases that made up the air when the ice solidified. These atmospheric "time capsules" show that there is more CO₂ in the atmosphere than at any time over the past 800,000 years — and probably much longer.

What are some of the consequences of a warming atmosphere take?

Intense storms have and are expected to become more common, heat waves are likely to become more frequent and intense, and we can expect more droughts and floods.

5. Changing Ice

How will melting ice affect the world around us?

Sea levels will rise. Low-lying land will experience erosion and become submerged, and coastal areas will experience more flooding during storm surges, with devastating consequences for the hundreds of millions of people who live near the ocean.

What role do seasonal changes in snow and ice cover play in Earth's climate?

The bright white of ice and snow reflects the Sun's radiant energy back into space. Much of this takes place at the high latitudes, where ice and snow cover builds up during the winter and shrinks during the summer. More of that cover disappears when summers are long and warm. The more ice and snow that survive the summer, the cooler Earth stays.

Why is the Arctic so sensitive to climate change?

The North Pole is significantly warmer than the South Pole because it's in the middle of an ocean. Long, warm summers decrease snow and ice cover and expose the dark water, which absorbs far more solar energy. As a result, the Arctic is heating up twice as fast as the rest of the Northern Hemisphere. On the other hand, Antarctica is less affected by climate change because it's much colder; its climate is insulated from the rest of the world by circumpolar ocean currents. Also, most Antarctic ice sits on land rather than water, so it's less vulnerable to warming ocean temperatures.

6. Changing Ocean

How do scientists study ocean temperature and chemistry?

Many ships measure water temperature and chemistry as they travel across the oceans. Scientists also rely on satellites to measure sea surface height (which corresponds to temperature), and outfit buoys, floats, and ocean gliders to measure temperature, pH, salinity, or CO₂ content.

Why is the ocean so important to Earth's climate?

The ocean plays a key role in the climate system because it holds far more CO₂ than the atmosphere or biosphere. Ocean waters absorb CO₂ directly from the atmosphere, and some ocean organisms take up CO₂ as they grow. Will climate change affect the ocean's ability to remove CO₂ from the atmosphere and thus intensify greenhouse warming? We do not know.

How might changing conditions affect marine ecosystems?

About 30 percent of the CO₂ released by humans over the past 200 years has been absorbed by ocean waters. This has changed the chemistry of the water, making it less basic: the sea is "acidifying." Ocean acidification could make it harder for shell-forming organisms, from corals to tiny plankton, to grow their shells. Eventually, shell-forming organisms could disappear.

7. Changing Land

Why will both droughts and floods become more common?

When warm air passes over land, moisture evaporates from the soil, drying it out. At the same time, warming will likely change weather patterns, bringing much less precipitation to certain parts of the world. On the other hand, when water evaporates from Earth's surface, particularly the ocean, it adds a significant amount of energy as well as water vapor to the atmosphere. The result is storms that are less frequent but unusually strong.

What are some of the ways that climate change is affecting organisms?

Some species are shifting their geographic ranges to higher elevations. Changes in temperature and rainfall patterns are enabling others to spread more widely. Some are blooming, migrating, or breeding earlier. While some organisms can adjust to climate change, others cannot. Tropical species, which typically can survive only within a narrow temperature range, are especially at risk.

8. A New Energy Future

Why is clean electricity key to solving climate change?

Plants that produce electricity are responsible for more than 30 percent of global CO₂ emissions each year, by far the largest source of those emissions. In addition, CO₂ emissions from electricity production are growing much faster than emissions from other sources.

What do you think governments like ours should do?

Answers will vary. They may include:

- Directly tax carbon emissions
- Develop a cap-and-trade system (which gives companies an economic incentive to reduce emissions)
- Invest in alternative energy technologies
- Raise fuel-efficiency standards for trucks and cars
- Build public transportation systems
- Give tax breaks to homeowners who use less energy
- Support research on renewable energy
- Give scholarships in environmental science
- Give prizes for innovation in green buildings and sustainable development
- Protect forests, plant trees, and work to prevent deforestation worldwide
- Work with governments around the world to protect shared resources like the oceans and the atmosphere