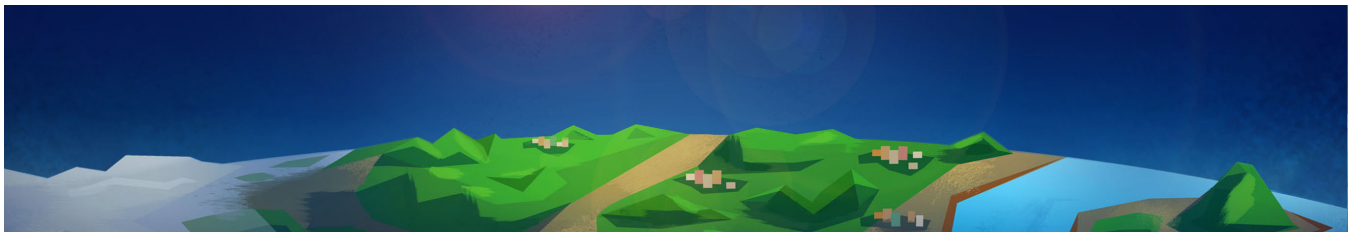
Earth's Changing Climate

Unit Guide



AmplifyScience

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What's in This Unit?

Earth's climate is changing, with average temperatures increasing by about 0.8 since 1880. While the increase may sound small, the result is not. One of the many observable changes is that ice on Earth is vanishing. Students adopt the role of climatologists who help the fictional World Climate Institute research causes of ice loss and climate change with the goal of educating the public about their findings. In order to delve into the mechanism of climate change, students investigate with a computer simulation, data, physical models, and science texts. They refute claims based on common misconceptions—an increase in solar energy or direct heating from human activities cause global warming. Students learn how energy from the sun interacts with Earth's atmosphere and surface. They learn that the amount of energy absorbed at the surface controls global average temperature and that the increase in Earth's temperature correlates with an increase in the amount of carbon dioxide and methane in the atmosphere. So what is causing the temperature increase? Students figure out that whenever more energy enters the atmosphere than exits, the amount of energy absorbed by the surface increases. Then they discover the cause of Earth's energy imbalance—increased carbon dioxide or methane in the atmosphere redirects outgoing energy back to Earth's surface, reducing the flow of energy that exits the Earth system. Through investigations, they learn that human activities, including increased combustion of fossil fuels and greater numbers of livestock kept for the benefit of humans, are responsible for increasing amounts of carbon dioxide and methane in the atmosphere. Along the way, students learn some of the effects of climate change, some possible solutions, and compare our current climate change to other climate changes in Earth's history. The unit concludes with a Science Seminar where students analyze evidence and debate whether large volcanic eruptions cool or warm Earth.

Why?

Climate change represents one of the most critical realities for our planet and the organisms that inhabit it. Earth's Changing Climate provides students with the opportunity to investigate claims about why Earth's temperature is increasing. Though global warming is a well-established phenomenon in the scientific community, one can still hear non-scientists who doubt that Earth is warming, or if it is, that it matters. As such, having the opportunity to figure out what is known and how it is known is an essential topic of study for all citizens of the planet. In this unit, students have the opportunity to investigate and refute common alternative and inaccurate claims as they sort through data for themselves. We chose to lead the unit with an actual observable phenomenon— the melting of Earth's ice. It's much easier for students to initially visualize a concrete indicator, such as melting ice, than to ask them to imagine an increase in invisible gases in the atmosphere. Unlike most curricula that take on this topic, Earth's Changing Climate helps students understand the mechanism of how carbon dioxide and methane lead to higher temperatures, not just the correlation between carbon dioxide, methane, and temperature. Understanding how this occurs results in a deeper understanding of climate change.

How?

In Chapter 1, students are introduced to their role as student climatologists and begin their investigation of what can cause global temperature to increase or decrease. They explore the Earth's Changing Climate Simulation, test effects of changes to the atmosphere, and examine data about the atmosphere. They conclude that increases in carbon dioxide and methane correlate with increases in energy absorbed by the surface and increases in temperature. In Chapter 2, students focus on the flows of energy, both entering and exiting the Earth system. They read about climate change in Earth's history, run tests in the Simulation, and use a simple physical model. They discover that if the amount of carbon dioxide or methane increases in the atmosphere, more energy enters the Earth system than exits, and this is why

increased amounts of these gases cause warming. They discover that these gases redirect outgoing energy back toward Earth's surface, thereby decreasing the amount of energy that leaves the system. In Chapter 3, students figure out that human activities such as combustion, keeping of livestock, and deforestation cause these gases to increase in the atmosphere. They also see evidence that increasing population increases human activities, and that has a direct effect on our planet. Students read an article about different strategies for reducing the amount of carbon dioxide and methane in the atmosphere. In Chapter 4, students investigate and debate what the effect of a large volcanic eruption is on Earth's climate. Students apply what they have learned during the unit as they analyze evidence and make arguments about this question.

While You Present the Lessons

Set up distribution stations for materials and digital devices. The most efficient way to distribute trays of materials, digital devices, or other materials that need to be distributed during an activity is to set up distribution stations from which you or students can obtain materials as needed. If space in your classroom is limited, you may have room for only one station. If you have more space, we recommend setting up two or three distribution stations to relieve student traffic at each station.

Prepare and set out materials on trays. The cafeteria-style trays provided in the starter kit are wonderful management devices for the materials you will use in the unit. For each hands-on investigation activity, set out as many trays of materials as needed for each group of four or each pair. This can be especially efficient if the materials will be needed for more than one lesson, since this allows you to leave the materials set up. Economize space by stacking the trays in a corner of your classroom. Often, trays can be stacked with the materials still on them.

Provide instructions before distributing materials. Don't try to talk to the class when students have materials in front of them. If you do, keep your message very brief. The temptation for students to handle the materials when they are in front of them is overwhelming. You will find that waiting to distribute materials until after everyone knows what they are to do will make a huge difference. Likewise, collecting materials before you have a reflection discussion is recommended. Establish routines. Set up consistent routines for getting students' attention, distributing materials and digital devices, collecting materials, and cleaning up. Students will come to expect these routines, and cleaning up will be more efficient. You can assign cleanup duties to students as needed. If you already have rotating classroom jobs, integrate cleanup into your existing system. Invite adult volunteers to help during the lessons. Having an extra pair of hands (or more) during firsthand science lessons or lessons involving complex use of technology can help a great deal with class and materials management. An extra person to help individual students during lessons focused on reading and writing is also helpful, although not necessary.

Climate Change

Earth's climate is changing. Global average temperature (an average of air temperatures near the surface around the world) has increased dramatically over the last century. This climate change is one of the most critical issues facing people and the other organisms on Earth. The Earth's Changing Climate unit provides students with the opportunity to discover why Earth's temperature is increasing. Climate change is a trend of change in global climate patterns over an extended period of time, typically decades to millions of years. Over the past century, Earth's average temperature has increased by 0.8oC (1.4oF). Although projections about future temperatures vary, we will likely experience another 1.1oC to 6.6oC (2 to 12oF) temperature increase in the next century. These increases may seem insignificant, but small changes in Earth's temperature can have a dramatic effect on global weather patterns, such as droughts, floods, and stronger hurricanes. Earth's oceans are also warming, resulting in rising sea levels, ice cap melt, and changes in both land and ocean ecosystems. These changes generate challenges of

environmental, social, economic, and political significance.

Climate change is not a new phenomenon. In fact, there have been seven major shifts in Earth's climate in the past 650,000 years. During these events, climate changes were induced by small variations in Earth's orbit, volcanic eruptions, and asteroid hits. However the current warming trend is different from those of the past. The consensus among climate scientists is that the current warming trend is almost certainly human-induced and occurring faster than ever experienced in Earth's history.

Lesson Overview

Students begin to talk about forces using their own words. First, they play a game called Rugball, which involves moving a ball across the carpet and describing its movement. Next, they examine a slideshow featuring images of objects starting to move, visualizing the movement of the objects. Students practice using the word because to explain a variety of everyday events, which serves as an introduction to the crosscutting concept of Cause and Effect. They listen to this language again and practice using the visualizing strategy as the teacher reads aloud the first book in the unit, Talking About Forces. This book exposes students to scientific language, including using the vocabulary words force and exert to describe movement. The purpose of this lesson is to connect students' discoveries about movement with scientific language, which, in turn, prepares them for explaining forces when they build their Box Models to test how a pinball machine works.

Students Learn

- An object starts to move when another object exerts a force on it.
- Visualizing is making a picture in your mind and it can be used to notice forces.
- Scientists often talk about how things are connected.

Embedded Supports for Diverse Learners

Student-to-student discussion to introduce and explore content. This introductory lesson in the Metabolism Unit is intended to get students excited about the context of the unit (diagnosing a patient), as well as offer an initial introduction to content: the idea that certain molecules (oxygen and glucose, especially) are needed for cells to function in the human body. As such, the lesson contains multiple opportunities for students to stop and discuss, sharing their initial thinking and making claims about the patient, based mostly on prior knowledge. Students will bring very different experiences and understandings; providing frequent student-discussion opportunities allows students to learn from one another. As students share, listen carefully for student alternate conceptions and either make a plan for handling these later, or step in and intervene on the spot. In addition to the frequent discussion points, the lesson offers several scaffolds for participating in various activities.

Student-to-student discussion to support Simulation experience. Students are provided brief teacher support before working in the Metabolism Simulation (Sim) for the first time in this lesson, but are ultimately encouraged to consult with their peers during this exploratory activity. Research and our own experiences support the idea that students are quick to learn how to use technology such as the Sim and they feel comfortable either trying things out independently or asking their peers for support. Students have success sharing their own technological tricks and discoveries, and may be less engaged when activities involving technology are more "led by the nose"— especially for initial, low-stakes, exploratory activities such as the one in this lesson. This is also an opportunity for students who are not as strong in other subjects at school, but are tech savvy, to have a high-status role as they help their peers.

Potential Challenges in This Lesson

Discussion-focused. Because discussion is central to today's lesson, you might want to consider how you can support participation of students who are not as confident in their ability to communicate orally, or who have difficulties with this type of communication.

Simulation introduction. This lesson introduces students to the Metabolism Sim. The Sim will be used often throughout the unit. If you have students who might find working with this Sim challenging—for example, because it is dependent on clearly seeing the colors that denote various aspects of the Sim, or because your students have trouble processing information in this way—you may want to think ahead about how you can offer these students alternative ways of participating in this aspect of the unit.

Specific Differentiation Strategies for English Learners

Metabolism Glossary. Throughout this unit, you will find resources for supporting English learners in science, including a glossary in the Amplify Library that includes Spanish definitions for native Spanish speakers. If you have English learners in your class whose native language is Spanish, make sure to point out the glossary to them in the Digital Resources.

Promoting inclusion in discussions. To help some English learners and/or other students who have trouble with oral language activities to engage fully in the discussions, have students periodically summarize key ideas from the discussion. Having students summarize key ideas gives English learners a second chance to grasp important ideas they may have missed during the discussion and helps English learners focus on what is most important as the discussion continues. You may also want to allow English learners the choice to share these ideas in either English or their native languages. Other adjustments to consider include providing at least 6–8 seconds of wait time when asking questions, having students discuss ideas with a partner before having them share with the whole class, and asking a range of questions—from those requiring fairly simple responses to those requiring more in-depth explanations.

Activity 1

Exploring and DescribingMovement

1. Review the purpose of the unit. Remind students that they are engineers working to design, or make, a working pinball machine for the class.

2. Hold up the frame of the Class Pinball Machine. To provide context for their upcoming work as engineers, explain to students that this frame will become the Class Pinball Machine by the end of the unit.

3. Refer to the What Engineers Do chart.

4. Review the Investigation Question.

5. Connect today's lesson to prior learning. Elicit student ideas as to classroom objects they made move in the previous lesson.

6. Introduce Rugball and set the purpose. Show students the rugball and explain that today they'll use this ball to play a new game called Rugball. The game will help them think about what it takes to make an object, the ball, start to move.

7. Establish Rugball expectations.

8. Play one round of Rugball. Have students practice how they should move the ball across the circle to one another.

9. Add language expectations to the game. After a few successful passes, have one student hold the ball still as you let the class know that another part of playing Rugball is that students will use their words to describe what they are doing.

10. Resume playing Rugball. If students need prompts to help them describe the movement of the ball, you may ask:

11. Refocus attention on the Investigation Question. After a few more successful rounds of Rugball, remind students that they are trying to figure out what makes an object start to move.

12. Ask the volunteer to describe the movement. After the volunteer makes the ball start moving, ask her to describe with words or actions what she did with her body to make the ball start moving. Specific prompts might include:

13. Refocus attention on the Investigation Question. After a few more successful rounds of Rugball, remind students that they are trying to figure out what makes an object start to move

Possible Responses

What we have learned so far in this unit connects to what I know about evolution. I learned that

evolutionary time measures all the life that has happened on Earth over billions of years. It takes a long time for populations to change into new species. Similarly, it seems like geologic time covers an amazing number of years, and things that first happened on Earth started happening millions and billions of years ago. What we have learned so far in this unit connects to what I know about force and motion. In order to move, an object must experience a force. I know that plates move, and therefore they must experience a force. I learned in the previous lesson that the plates move on top of the soft, solid mantle. When we studied force and motion, we never considered soft, solid surfaces for objects to move across. I wonder what the forces look like between a soft solid and a hard solid.

Activity 2

Investigating Adaptive Traits

1. Review the purpose of the unit. Remind students that they are engineers working to design, or make, a working pinball machine for the class.

2. Hold up the frame of the Class Pinball Machine. To provide context for their upcoming work as engineers, explain to students that this frame will become the Class Pinball Machine by the end of the unit.

3. Refer to the What Engineers Do chart.

4. Review the Investigation Question.

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