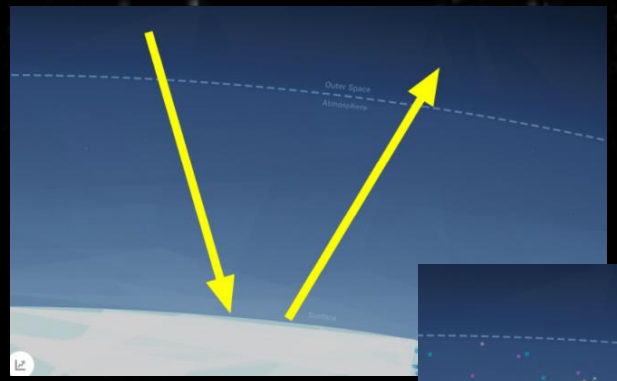
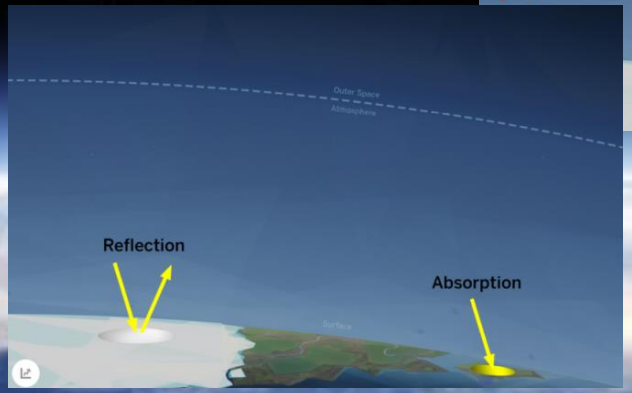
Chapter 2: Energy Entering and Leaving Earth's System

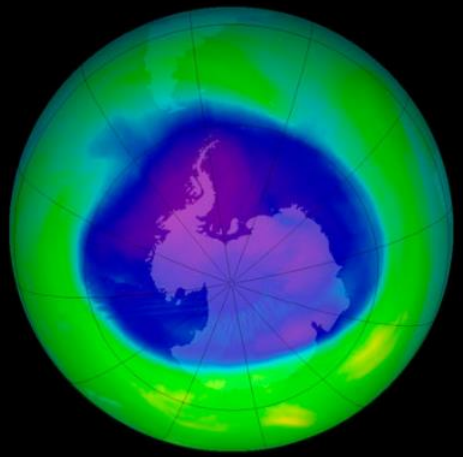
19 Lessons

Earth's Changing Climate

2.5: Reviewing Key Ideas in Climate Change







Chapter 2: Energy Entering and Leaving Earth's System

7 Lessons

1 WARM UP
Warm-Up

ECC: 2.5.1 WARM-UP

Students examine a diagram related to their focal content for the lesson and answer a question. (5 min)

Organize

We are going to organize into groups of 3. Each group will consist of a Green, Blue, and Purple Group member.

GREEN GROUP

BLUE GROUP

PURPLE GROUP

1 WARM UP
Warm-Up

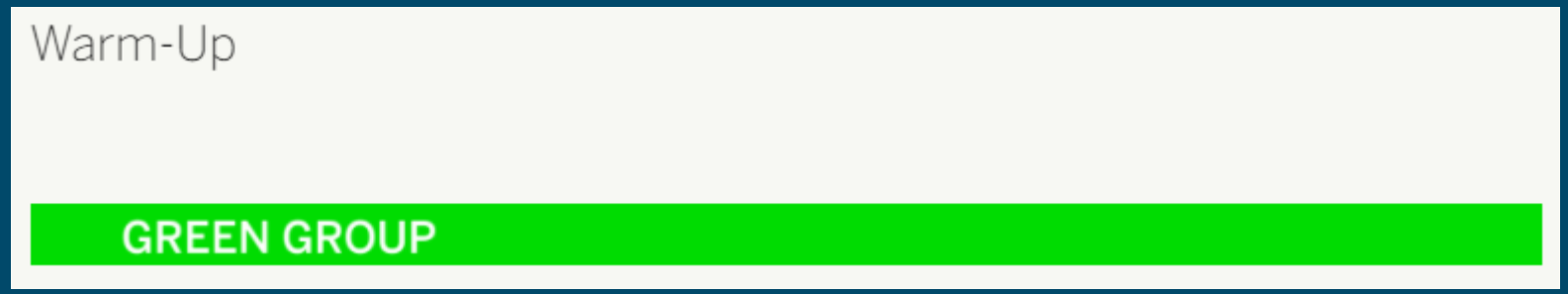
ECC: 2.5.1 WARM-UP

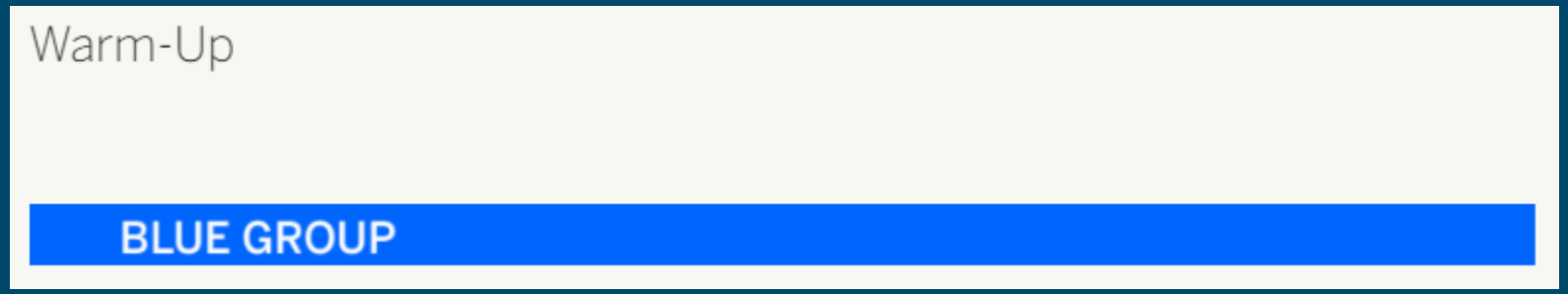
HAND IN

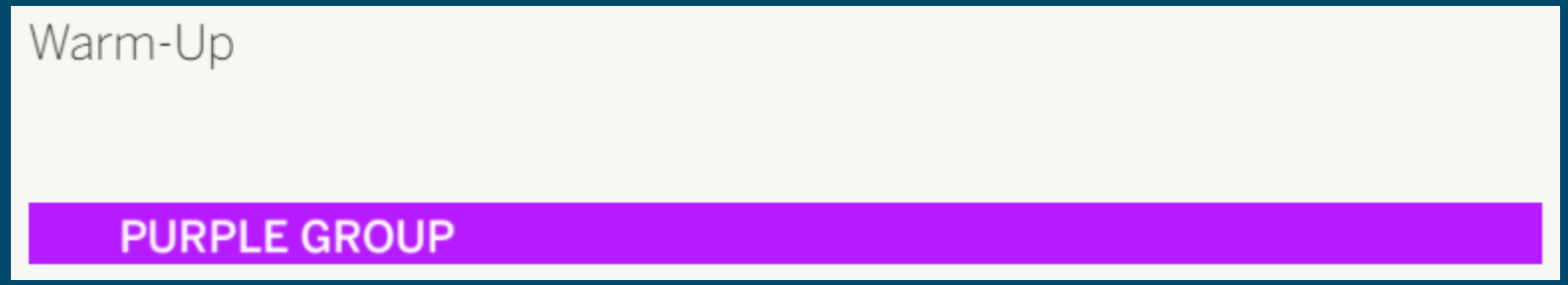
Students examine a diagram related to their focal content for the lesson and answer a question. (5 min)

Warm-Up

Choose the color group you are a part of, and complete the Warm-Up independently.







TEACHER
Preparing for the Sim Activity

ECC: 2.5.2 PREPARING FOR THE SIM ACTIVITY

The teacher introduces the goal for the next set of activities and explains how each group can access their instructions. (3 min)

In the previous lesson you learned how carbon dioxide and methane affect energy entering and exiting the Earth system.

- **If there is an increase in the amount of carbon dioxide or methane, the amount of energy leaving the Earth system decreases, so more energy enters than exits.**

- **If there is an decrease in the amount of carbon dioxide or methane, the amount of energy leaving the Earth system increases, so less energy enters than exits.**

TEACHER
Preparing for the Sim Activity

ECC: 2.5.2 PREPARING FOR THE SIM ACTIVITY

The teacher introduces the goal for the next set of activities and explains how each group can access their instructions. (3 min)

In the previous lesson you learned how carbon dioxide and methane affect energy entering and exiting the Earth system.

- **Today some students will further investigate the Eocene climate change, while others will investigate the Cryogenian. You will focus on different questions, but as a benefit, the class will come together and share results at the end of the lesson.**

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Green Group: Reviewing Climate Change During the Eocene

Part 1: In the Eocene, average temperatures rose to over 25°C. Look back at "Past Climate Changes" and review what changes to the atmosphere caused this climate change, then answer the questions. In the next part of this activity, you will try to model this climate change in the Sim.

1. According to "Past Climate Changes on Earth," what changes to the atmosphere caused temperatures to increase, making the Eocene such a warm time in Earth's history?

2. What changes happened during the Eocene with amount of energy absorbed by Earth's surface? Did absorbed energy **increase**, **decrease**, or **stay the same**? Explain your thinking.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

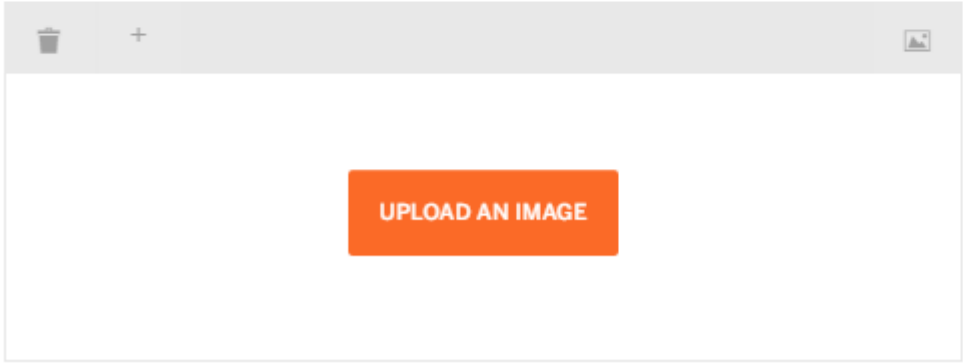
NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Green Group: Reviewing Climate Change During the Eocene

Part 2: Model what happened in the Eocene by making changes to the atmosphere in the Sim. Follow the steps to see if you can make the temperature reach 25°C. Try to make the same kinds of changes that caused the Eocene to be such a warm time.

1. Discuss with your partner what changes you will make to try to model the Eocene.
2. Run the Simulation until the timer reaches 20, then pause to make changes.
3. Observe what happens to temperature and energy absorbed by the surface. Remember to check the graph.
4. If you do not reach 25°C, adjust the settings.
5. Upload a screenshot that shows how your change affected absorbed energy.



2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

HAND IN

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Green Group: Reviewing Climate Change During the Eocene

Part 3: After working with the Sim, you may have learned more or found extra details to add to the answers that you gave earlier. If possible, add more detail to your answers. If you finish early, move to Activity 3.

1. According to "Past Climate Changes on Earth," what changes to the atmosphere caused temperatures to increase, making the Eocene such a warm time in Earth's history?

2. What changes happened during the Eocene with amount of energy absorbed by Earth's surface? Did absorbed energy **increase**, **decrease**, or **stay the same**? Explain your thinking.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Blue Group: Reviewing Climate Change During the Eocene

Part 1: In the Eocene, average temperatures rose to over 25°C. Look back at "Past Climate Changes" and review the description of this climate change, then answer the questions. In the next part of this activity, you will try to model this climate change in the Sim.

1. According to "Past Climate Changes on Earth," what changes to the atmosphere caused temperatures to increase, making the Eocene such a warm time in Earth's history?

2. What happened with the amount of energy entering compared with the amount of energy exiting the Earth system as temperatures increased during the Eocene? Did **more** energy enter than exit, **less** energy enter than exit, or **the same** amount of energy enter as exit?

3. Based on your answer to question 2, explain how energy entering and exiting the Earth system is connected to increased temperature during the Eocene.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Blue Group: Reviewing Climate Change During the Eocene

Part 2: Model what happened in the Eocene by making changes to the atmosphere in the Sim. Follow the steps to see if you can make the temperature reach 25°C. Try to make the same kinds of changes that caused the Eocene to be such a warm time.

1. Discuss with your partner what changes you will make to try to model the Eocene.
2. Run the Simulation until the timer reaches 20, then pause to make changes.
3. Observe what happens to temperature and energy absorbed by the surface. Remember to check the graph.
4. If you do not reach 25°C, adjust the settings.
5. Upload screenshots that show how energy entering and exiting was affected by your change.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

HAND IN

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Blue Group: Reviewing Climate Change During the Eocene

Part 3: After working with the Sim, you may have learned more or found extra details to add to the answers that you gave earlier. If possible, add more detail to your answers. If you finish early, move to Activity 3.

1. According to "Past Climate Changes on Earth," what changes to the atmosphere caused temperatures to increase, making the Eocene such a warm time in Earth's history?

2. What happened with the amount of energy entering compared with the amount of energy exiting the Earth system as temperatures increased during the Eocene? Did **more** energy enter than exit, **less** energy enter than exit, or **the same** amount of energy enter as exit?

3. Based on your answer to question 2, explain how energy entering and exiting the Earth system is connected to increased temperature during the Eocene.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Purple Group: Reviewing Climate Change During the Cryogenian

Part 1: In the Cryogenian, average temperatures fell to about -40°C. Look back at "Past Climate Changes" in the Snowball Earth section, and review the description of this climate change, then answer the questions. In the next part of this activity, you will try to model this climate change in the Sim.

1. According to "Past Climate Changes on Earth," what changes caused temperatures to decrease, making the Cryogenian such a cold time in Earth's history?

2. Describe the connection between reflectivity, energy entering and exiting the Earth system, energy absorbed at the surface, and temperature.

2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

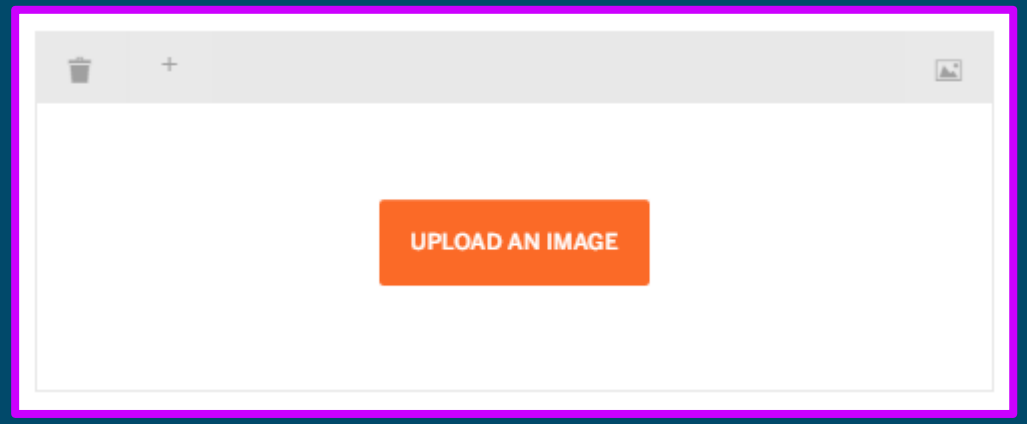
NEXT >

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Purple Group: Reviewing Climate Change During the Cryogenian

Part 2: Model what happened in the Cryogenian by making changes to the atmosphere in the Sim. Try to make the same kinds of changes that caused the Cryogenian to be such a cold time. Note that the Sim is not able to model temperatures quite as cold as those during the Cryogenian.

1. Discuss with your partner what changes you will make to try to model the Cryogenian.
2. Run the Simulation until the timer reaches 20, then pause to make changes.
3. Observe what happens to temperature, energy absorbed at the surface, and energy entering and exiting the Earth system.
4. Upload screenshots that show how your changes affected temperature, energy absorbed, and energy entering and exiting the Earth system.



2 SIM
Simulating Climate Change from the Article

ECC: 2.5.2 SIMULATING CLIMATE CHANGE FROM THE ARTICLE

HAND IN

Students make predictions about, and then test, potential causes of specific climate changes, informed by the article, "Past Climate Changes." (17 min)

Purple Group: Reviewing Climate Change During the Cryogenian

Part 3: After working with the Sim, you may have learned more or found extra details to add to the answers that you gave earlier. If possible, add more detail to your answers. If you finish early, move to Activity 3.

1. According to "Past Climate Changes on Earth," what changes caused temperatures to decrease, making the Cryogenian such a cold time in Earth's history?

2. Describe the connection between reflectivity, energy entering and exiting the Earth system, energy absorbed at the surface, and temperature.

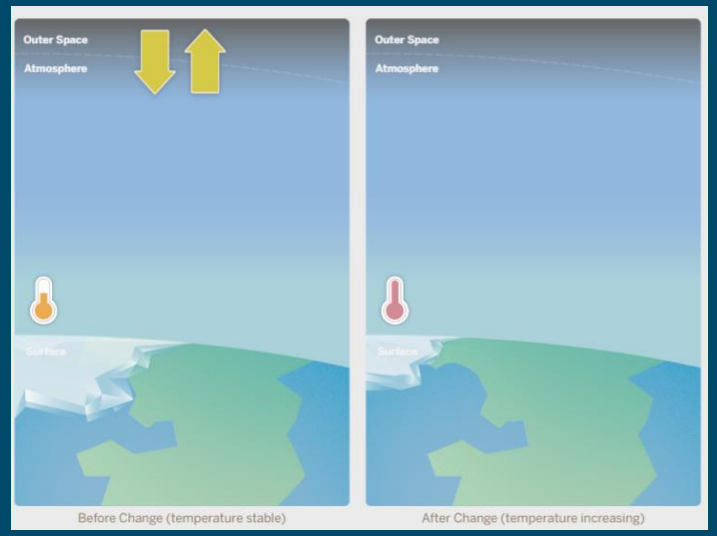
3 MODELING TOOL
Revising or Creating
Modeling Tool Diagrams

ECC: 2.5.3 REVISING OR CREATING MODELING TOOL DIAGRAMS

HAND IN

Students model either a warming climate (Blue and Green groups revise their models from Lesson 2.3) or a cooling climate (Purple group). (10 min)

As scientists gather evidence, they improve their claims, and that means they need to adjust their models so they reflect their current thinking. Sometimes this means small changes that add more detail, but sometimes it can mean big revisions.



- ***The green and blue groups, who focused on the Eocene, will return to the Carbon Dioxide/Methane Modeling Tool activity that you worked on in an earlier lesson. You will improve your models based on what you found today when you worked with the article and Sim.***
- ***Students in the Purple group will create new models showing the causes of the Cryogenian climate change.***

4 TEACHER-LED DISCUSSION
Sharing Results

ECC: 2.5.4 SHARING RESULTS

Students from each group share with the class what they have learned. (10 min)

What changes to the atmosphere caused the Eocene warming? How did energy absorbed by the surface change?
An increase in carbon dioxide and methane in the atmosphere caused more energy to be absorbed at the surface and temperature to increase.

What happened with energy entering and exiting the Earth system during the Eocene warming?
As the warming occurred, more energy entered the system than exited.

What caused the Cryogenian cooling? How did that affect energy in the Earth system?
Sunlight decreased and reflection increased, meaning less energy entered than exited the Earth system.

The amount of reflection is a variable we haven't spent much time investigating. Not all the energy that reaches Earth's surface is absorbed. Some is reflected back toward space, without being absorbed. This energy does not warm the surface. Some surfaces reflect more energy than others. For example, ice reflects more energy than land or water.