

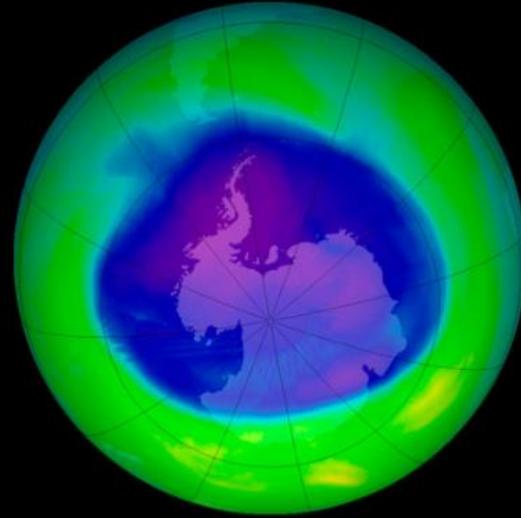
# Chapter 1: Climate and the Atmosphere

19 Lessons

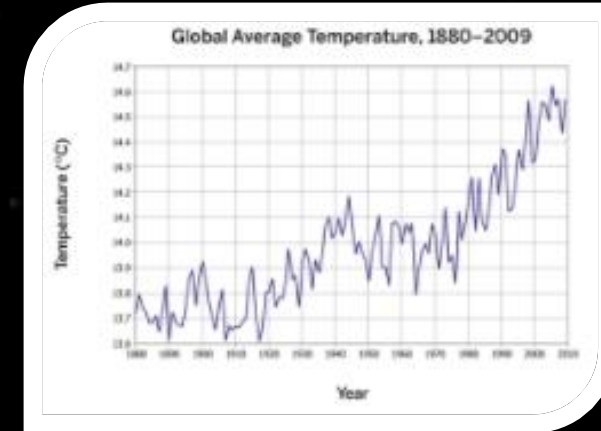
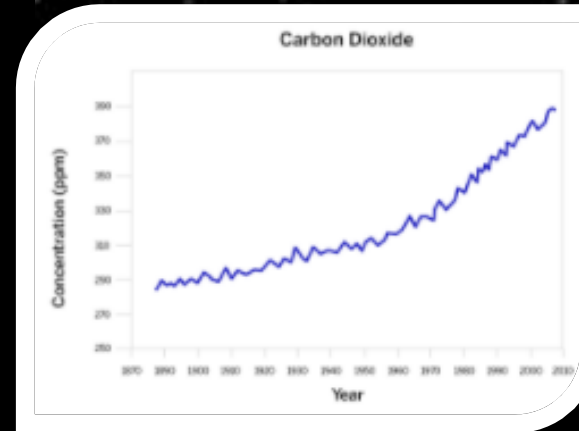
## Earth's Changing Climate



Chapter 1: Climate and the Atmosphere



### 1.5: Evidence About Gases in the Atmosphere





# ECC: 1.5.1 WARM-UP

HAND IN

Students revisit the article that they read for homework. (5 min)

## Warm-Up

You read "A Hole in Earth's Ozone Layer" for homework. Answer the following questions about the article. If you need to, you can review the article.

1. Based on what you read, what is true about gases in the atmosphere?

a All gases in the atmosphere affect energy the same way.

b Different gases in the atmosphere affect energy differently.

c No gases in the atmosphere affect energy at all.

d Ozone is the only gas in the atmosphere.

Check Answer

2. Based on what you read, what is true about the ozone hole?

a The ozone hole causes warmer global average temperature.

b The ozone hole causes cooler global average temperature.

c The ozone hole does not affect global average temperature.

Check Answer



## LW: 1.5.2 ANALYZING GAS AND TEMPERATURE DATA

**The class selects data to analyze, using the Evidence Criterion. Students identify trends in order to make conclusions about gases in the atmosphere. (20 min)**

### Choosing Data

*Global average temperature has increased since about 1880. We want to look at data for methane, carbon dioxide, and sulfur dioxide in the atmosphere in order to consider the claim that an increase in those gases has caused this current warming.*

**Three new claims from the evidence that students gathered yesterday:**

**increasing carbon dioxide  
increasing methane  
decreasing sulfur dioxide**

**The Simulation provided evidence that changes to carbon dioxide, methane, and sulfur dioxide could increase temperature, but we need to find out if these gases have, in fact, changed in the atmosphere over time.**



## LW: 1.5.2 ANALYZING GAS AND TEMPERATURE DATA

HAND IN

**The class selects data to analyze, using the Evidence Criterion. Students identify trends in order to make conclusions about gases in the atmosphere. (20 min)**

### Choosing Data

*Global average temperature has increased since about 1880. We want to look at data for methane, carbon dioxide, and sulfur dioxide in the atmosphere in order to consider the claim that an increase in those gases has caused this current warming.*

Which time period's data would provide the best evidence?

- |   |                        |
|---|------------------------|
| a | data from 1880 to 2014 |
| b | data from 1995 to 2014 |
| c | data from 2013 to 2014 |

Select your answer to each question and press **NEXT** button. There are 7 questions.



## LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

**From:** Irene Lee  
**To:** Student Climatologists  
**Subject:** First Models



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Thank you for your great work so far. By the end of your investigations today, it seems like you'll have some good ideas about what is causing the decrease in ice on Earth's surface. We'd like to create some simple diagrams for our website that can explain possible causes to the public.

Even if you don't have it all figured out yet, please use your *Earth's Changing Climate* Modeling Tool to make a diagram that shows one of your ideas—one that you have evidence to support. Modeling ideas in this way is an important skill that climatologists and other scientists use to clarify our ideas and to communicate those ideas to others.

I look forward to seeing your models!



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

***The Modeling Tool and the Sim are different. In the Modeling Tool, you make diagrams or models of your ideas. Our diagrams need to show ideas supported by evidence. The Modeling Tool doesn't run or respond when you move items, and this tool won't give you feedback about whether your ideas are accurate or not.***

Hand In Instructions Help

Show one idea about what is causing ice to melt and temperature to increase on Earth.

Outer Space  
Atmosphere  
Surface

Before Change After Change

Reset Undo Redo

▼ Energy Entered/Exited  
More Entered Than Exited Equal Less Entered Than Exited

▼ Gases in Atmosphere  
Methane  
Low Medium High  
Nitrogen Dioxide  
Low Medium High  
Carbon Dioxide  
Low Medium High  
Sulfur Dioxide  
Low Medium High

▼ Conditions at Surface  
Global Average Temperature  
Low Medium High





## LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**


*Each student should select only **ONE** idea for their model.*

### Instructions

**Goal**  Show one idea about what is causing ice to melt and temperature to increase on Earth.

**Do** 

- In the atmosphere, show one change that has caused the ice to melt and temperature to increase.
- Show how the amount of absorbed energy has changed.

**Tips** 

- Model an idea that you can support with evidence.
- Temperature is given in both panels; the model shows temperature has increased.
- The amount of ice is given in both panels; the model shows ice has decreased.



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

- **Decreasing ice level:** *medium in the Before Change panel and low in the After Change panel*
- **Increasing temperature:** *medium in the Before Change panel and high in the After Change panel*

Hand In Instructions Help

Reset Undo Redo

Show one idea about what is causing ice to melt and temperature to increase on Earth.

Outer Space  
Atmosphere  
Surface

Before Change After Change

Energy Entered/Exited  
More Entered Than Exited Equal Less Entered Than Exited

Gases in Atmosphere  
Methane  
Low Medium High  
Nitrogen Dioxide  
Low Medium High  
Carbon Dioxide  
Low Medium High  
Sulfur Dioxide  
Low Medium High

Conditions at Surface  
Global Average Temperature  
Low Medium High





# LW: 1.5.3 INTRODUCING THE MODELING TOOL

Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)

**Decreased nitrogen dioxide: Place a medium amount of nitrogen dioxide in the Before Change panel and a low amount of nitrogen dioxide in the After Change panel. Acknowledge that you could have also used high in the Before Change panel and medium or low in the After Change panel.**

Hand In Instructions Help

Reset Undo Redo

Show one idea about what is causing ice to melt and temperature to increase on Earth.

Outer Space  
Atmosphere  
Surface

Before Change After Change

Energy Entered/Exited  
More Entered Than Exited Equal Less Entered Than Exited

Gases in Atmosphere  
Methane  
Low Medium High  
Nitrogen Dioxide  
Low Medium High  
Carbon Dioxide  
Low Medium High  
Sulfur Dioxide  
Low Medium High

Conditions at Surface  
Global Average Temperature  
Low Medium High



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

**Increased nitrogen dioxide:** Place a medium amount of nitrogen in the Before Change panel and a high amount of nitrogen dioxide in the After Change panel. Acknowledge that you could have also used low in the Before Change panel and medium or high in the After Change panel.

Hand In Instructions Help

Reset Undo Redo

Show one idea about what is causing ice to melt and temperature to increase on Earth.

Outer Space  
Atmosphere  
Surface

Before Change After Change

Energy Entered/Exited  
More Entered Than Exited Equal Less Entered Than Exited

Gases in Atmosphere  
Methane  
Low Medium High  
Nitrogen Dioxide  
Low Medium High  
Carbon Dioxide  
Low Medium High  
Sulfur Dioxide  
Low Medium High

Conditions at Surface  
Global Average Temperature  
Low Medium High



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

***No change in nitrogen dioxide: Show students that they can show this by putting the same amount of nitrogen dioxide in both panels.***

The screenshot displays the Modeling Tool interface. At the top, there are navigation buttons: 'Hand In' (blue), 'Instructions', and 'Help'. Below these is the instruction: 'Show one idea about what is causing ice to melt and temperature to increase on Earth.' The main area contains two side-by-side panels: 'Before Change' and 'After Change'. Each panel shows a cross-section of the Earth with layers labeled 'Outer Space', 'Atmosphere', and 'Surface'. The 'Surface' layer shows ice melting. The 'After Change' panel has a red thermometer icon on the surface, indicating a temperature increase. On the right side, there is a control panel with several sections:

- Energy Entered/Exited:** Three icons representing 'More Entered Than Exited', 'Equal', and 'Less Entered Than Exited'.
- Gases in Atmosphere:** Four sections, each with three icons representing 'Low', 'Medium', and 'High' levels:
  - Methane
  - Nitrogen Dioxide
  - Carbon Dioxide
  - Sulfur Dioxide
- Conditions at Surface:** One section with three icons representing 'Global Average Temperature'.



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

- **Decreased energy absorbed by the surface.**
- **Increased energy absorbed by the surface.**
- **No change in energy absorbed by the surface.**

Hand In Instructions Help

Reset Undo Redo

Show one idea about what is causing ice to melt and temperature to increase on Earth.

Outer Space  
Atmosphere  
Surface

Before Change After Change

Carbon Dioxide  
Low Medium High

Sulfur Dioxide  
Low Medium High

Conditions at Surface  
Global Average Temperature  
Low Medium High

Energy Absorbed  
Low Medium High



# LW: 1.5.3 INTRODUCING THE MODELING TOOL

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

- *Decreased energy absorbed by the surface.*
- *Increased energy absorbed by the surface.*
- *No change in energy absorbed by the surface.*

**We have been thinking a lot about how energy absorbed by the surface might affect ice and temperature, so be sure to include absorbed energy in your model.**

The screenshot shows the Modeling Tool interface. At the top, there are buttons for 'Hand In', 'Instructions', and 'Help'. Below these are 'Reset', 'Undo', and 'Redo' buttons. The main area displays a prompt: 'Show one idea about what is causing ice to melt and temperature to increase on Earth.' Below the prompt are two maps of Earth labeled 'Before Change' and 'After Change'. The 'After Change' map shows a significant reduction in ice coverage. On the right side, there is a control panel with various sliders and buttons. The 'Energy Absorbed' section is highlighted with a red box, showing three options: 'Low', 'Medium', and 'High'. The 'Energy Absorbed' section is currently set to 'High'.



## LW: 1.5.3 INTRODUCING THE MODELING TOOL

NEXT >

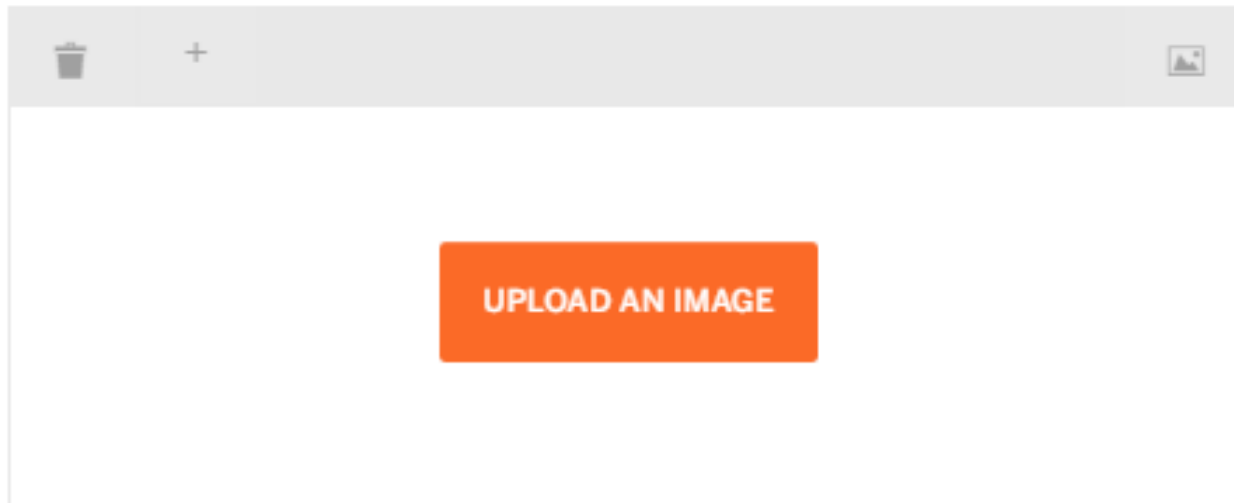
**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

### Making a Model to Show Your Ideas

*Why is ice on Earth's surface decreasing (melting) and temperature increasing?*

Use the Modeling Tool: **Ice and Temperature** to show one idea about what is causing this to happen. Model an idea that you can support with evidence. If you have time, you can press NEXT and complete a second model.

Press HAND IN in the Modeling Tool in order to see a screenshot of your completed model below.



Explain what your model shows.

A large, empty rectangular text box with a thin grey border, intended for the student to write an explanation of their model.



## LW: 1.5.3 INTRODUCING THE MODELING TOOL

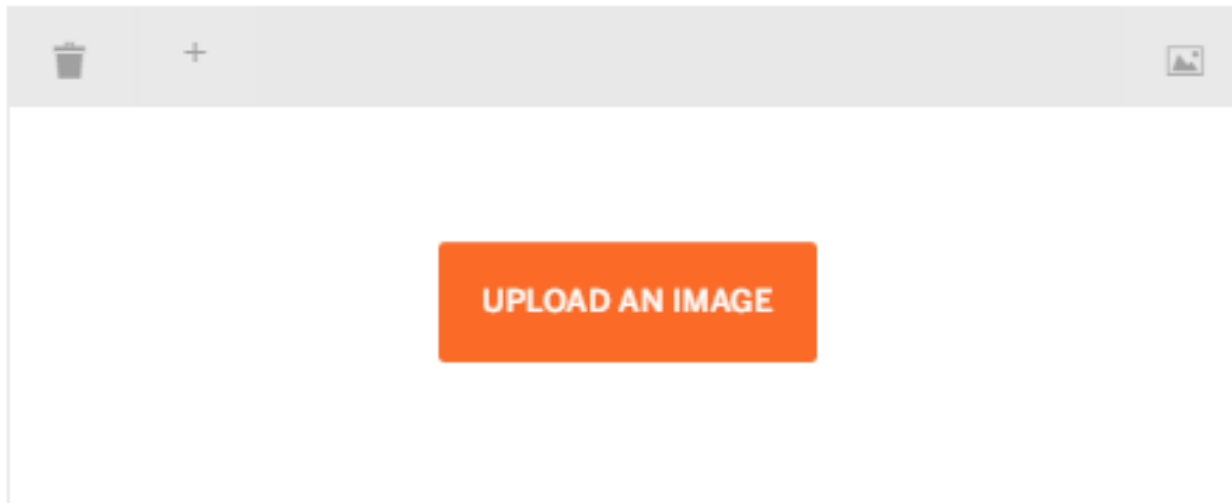
HAND IN

**Students are introduced to the Modeling Tool and create a model of one possible claim about the cause of the current climate change. (20 min)**

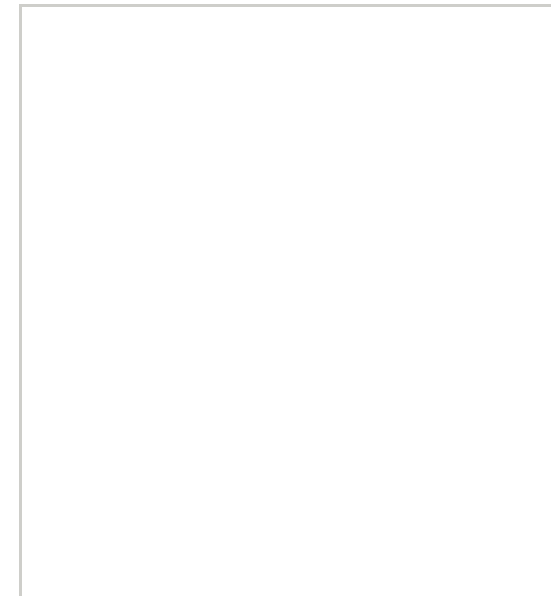
### Ice and Temperature Model 2

If you have time, use the Modeling Tool: [Ice and Temperature 2](#), and create a second model that shows a different idea about what might be causing ice to melt and temperature to increase.

Press HAND IN in the Modeling Tool in order to see a screenshot of your completed model below.



Explain what your model shows.

A large, empty rectangular text box with a thin grey border, intended for the student to write an explanation of their model.



**Students are challenged to make a change to the atmosphere in the Sim in order to make the temperature as cold as possible.**

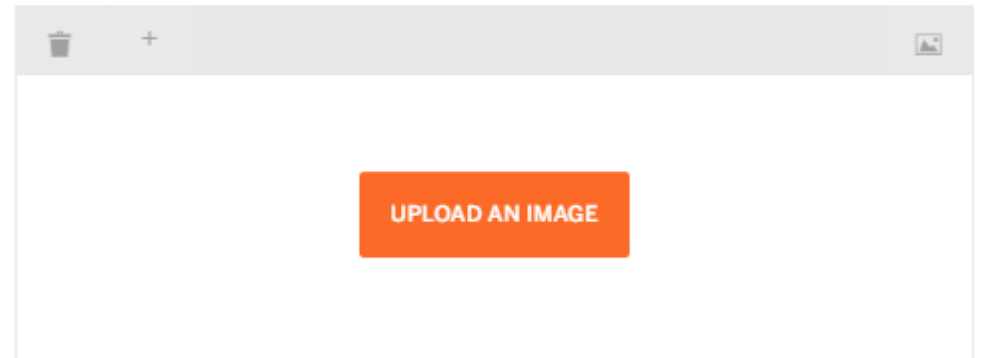
## Sim Mission: Make Earth as Cold as Possible

- *Using what you learned about gases in the atmosphere and temperature, complete the following mission in the Earth's Changing Climate Simulation.*
- *Without changing the sun and reflectivity, change the atmosphere so Earth's temperature becomes as cold as you can make it.*

1. How did you make Earth as cold as possible?

2. When you succeeded in your mission, describe what happened with energy absorbed by the surface.

Upload a screenshot showing the results of your mission.



The screenshot shows a web interface for uploading a screenshot. At the top, there is a header bar with a trash icon, a plus sign, and a small image icon. Below the header is a large white area for the screenshot. At the bottom center of this area is an orange button with the text "UPLOAD AN IMAGE".





# LW: 1.5.5 SELF-ASSESSMENT

HAND IN

**Students assess their current understanding of the Unit Question, What causes climate change?**

## Check Your Understanding

- This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond.*

Scientists investigate in order to explain their observations. You have been investigating why the climate has been changing. Are you getting closer to understanding what causes climate change?

1. I understand how the atmosphere is related to the ice melting.

2. I understand what can affect energy entering and exiting the Earth system, and how this affects climate.

3. I understand what can happen when energy hits gases.

4. I understand what causes the amount of gases in the atmosphere to change.

5. What about climate change are you still wondering?

Explain your answer choice.