

## Title: How does the Earth's Climate Change?

### Introduction:

**Climate** is the average weather conditions in a place over many years. For example, the climate in Alaska is snowy and cold compared to the climate in Florida which is sunny and warm. How would you describe the climate of where you live? There is also a **global climate** - the average climate around the world.

You may have heard the phrase **climate change**. Scientists and people around the world discuss climate change because the global climate is getting warmer. That means that over many years, the Earth's average temperature has increased.

When the Earth's temperature rises, there are many consequences. Some of those consequences are droughts, extreme weather, melting glaciers, rising sea levels, and warmer oceans. These changes will affect people, animals, and ecosystems in many ways.



Droughts



Extreme Weather



Rising sea levels



Melting glaciers

### Your goal:

Examine why our climate is changing. You must figure out what is happening to make the earth warmer.

### Important Definitions:

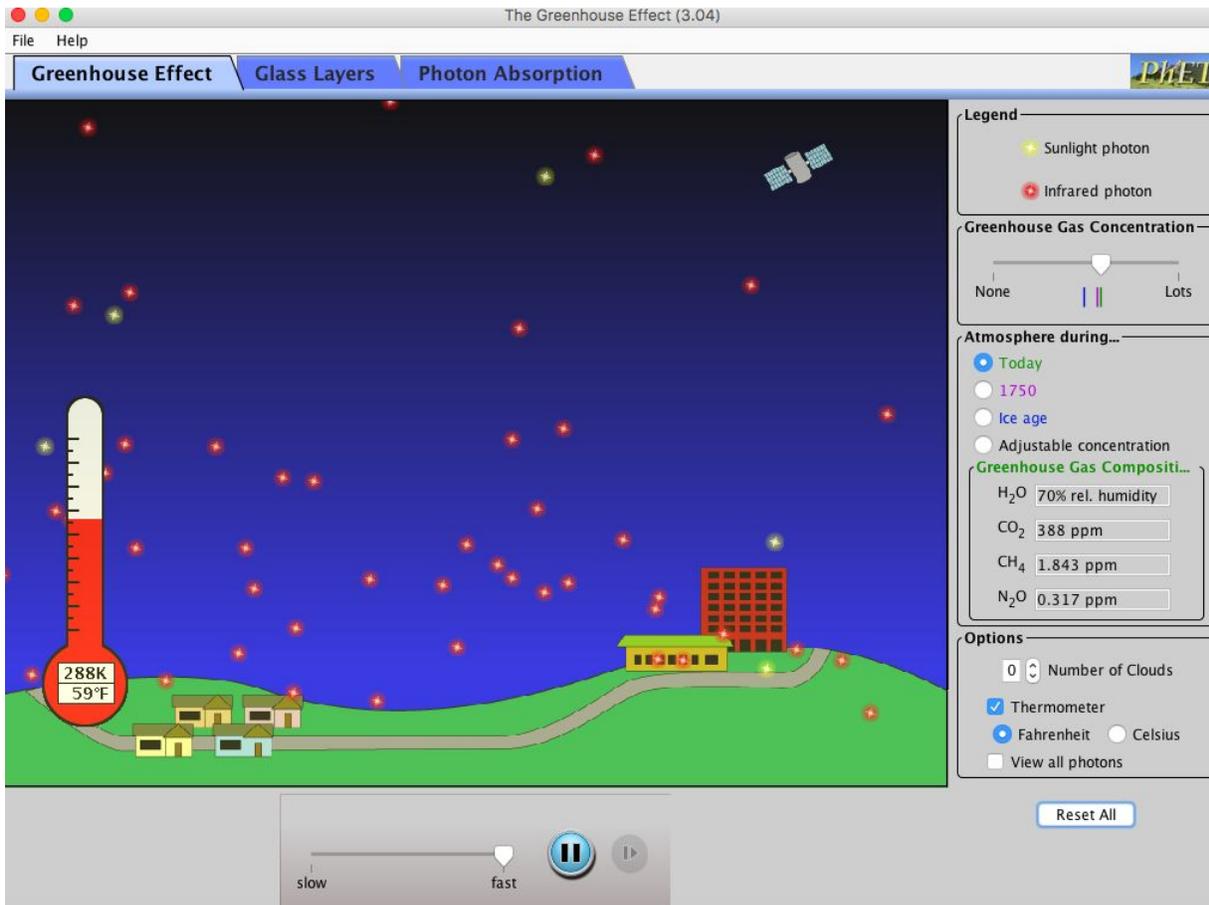
- **Greenhouse Gases:** Gases in the air that trap heat.
- **Greenhouse Gases Examples:**
  - Carbon Dioxide (CO<sub>2</sub>) - formed by burning fuels and breathing
  - Water Vapor (H<sub>2</sub>O) - formed when water evaporates
- **The Greenhouse Effect:** The warming of the Earth's surface and the air above it caused by gases in the air (greenhouse gases) that trap heat.

### Important Questions:

- What factors increase the earth's temperature?
- How has the amount of greenhouse gases on earth changed over time?
- How has this change affect the earth's temperature over time?
- How do greenhouse gases increase temperature?
- What happens to the Earth's oceans as the earth's temperature increases?

## Exploration Phase:

1. Click this link: <https://phet.colorado.edu/en/simulation/legacy/greenhouse>
2. Make sure you are on "Greenhouse Effect" Tab. Your screen should look like this...



3. Examine the Legend
  - Yellow dots - Sunlight photons (from the sun)
  - Red dots - Infrared photons (heat radiation)

*Where do the sunlight photons appear to come from?*

*Where do the infrared photons appear to come from?*

4. Try moving the greenhouse gas concentration dial.

*Where do you put the dial to have less infrared photons on the screen?*

*Where do you put the dial to have more infrared photons on the screen?*

5. Try adding clouds.

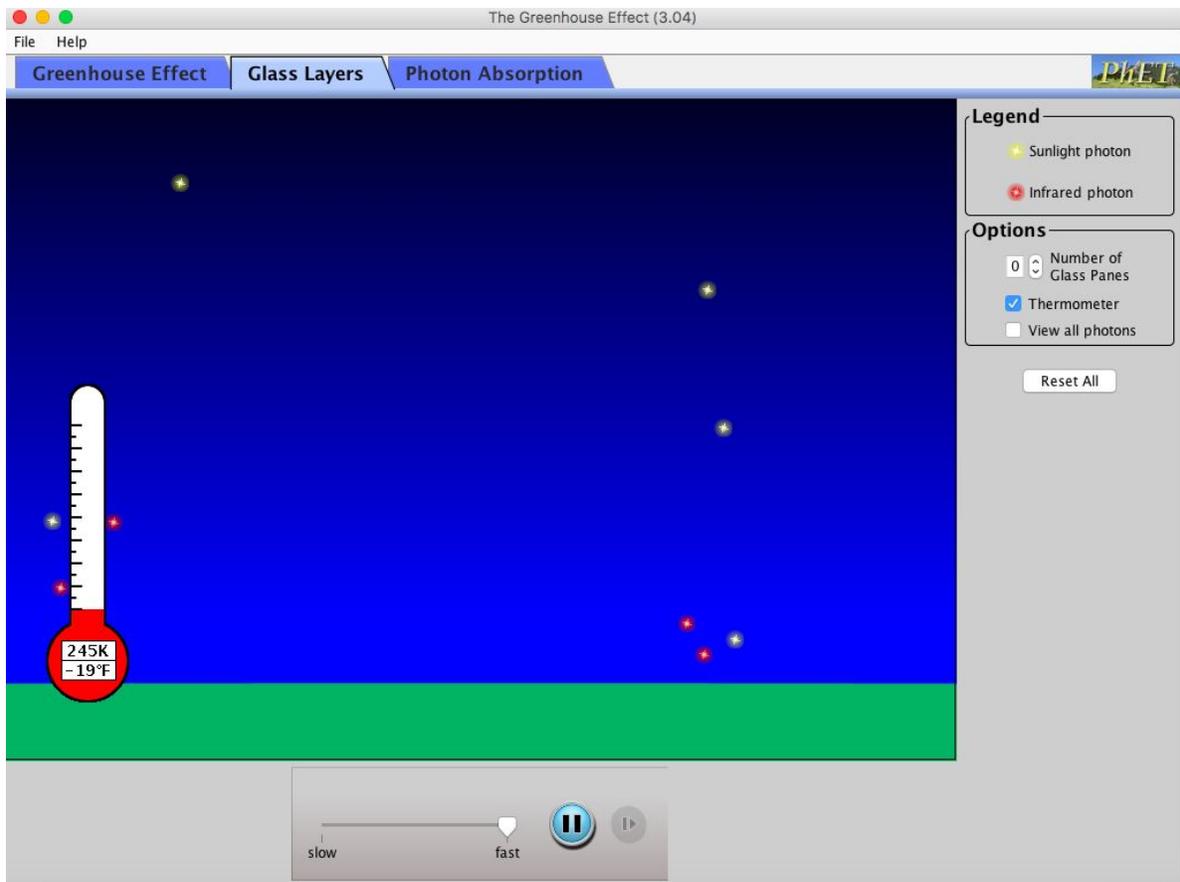
*What happens to the temperature as you increase the amount of clouds on the screen?*

6. Click the Rest All button in the bottom right corner.

### Explanation Phase - Part 1:

- **Aim:** Explain how a greenhouse increases temperature.

1. Click the “Glass Layer” tab. Your screen should look like this...



2. Before you begin, keep your eye on the infrared photons.

*Where do the infrared photons appear to go?*

- Increase the number of glass panes to complete the table. Record the temperature once it has stabilized.

Number of Glass Panes	Temperature (°F)	Ranking (0 as the coldest, 4 as the hottest)
0		
1		
2		
3		

- Make a claim about the relationship between the number of glass panes and the temperature. Use words such as increase and decrease.

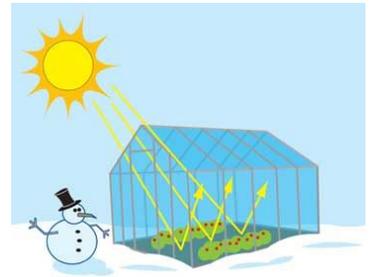
**Claim:** As the number of glass panes \_\_\_\_\_, the temperature \_\_\_\_\_.

- Put number of glass panes at 3. Keep your eyes on the infrared photons.

*Where do the infrared photons appear to go? Do they all go up into the atmosphere?*

- A greenhouse is a house made of glass used to keep plants warm - even in the winter.

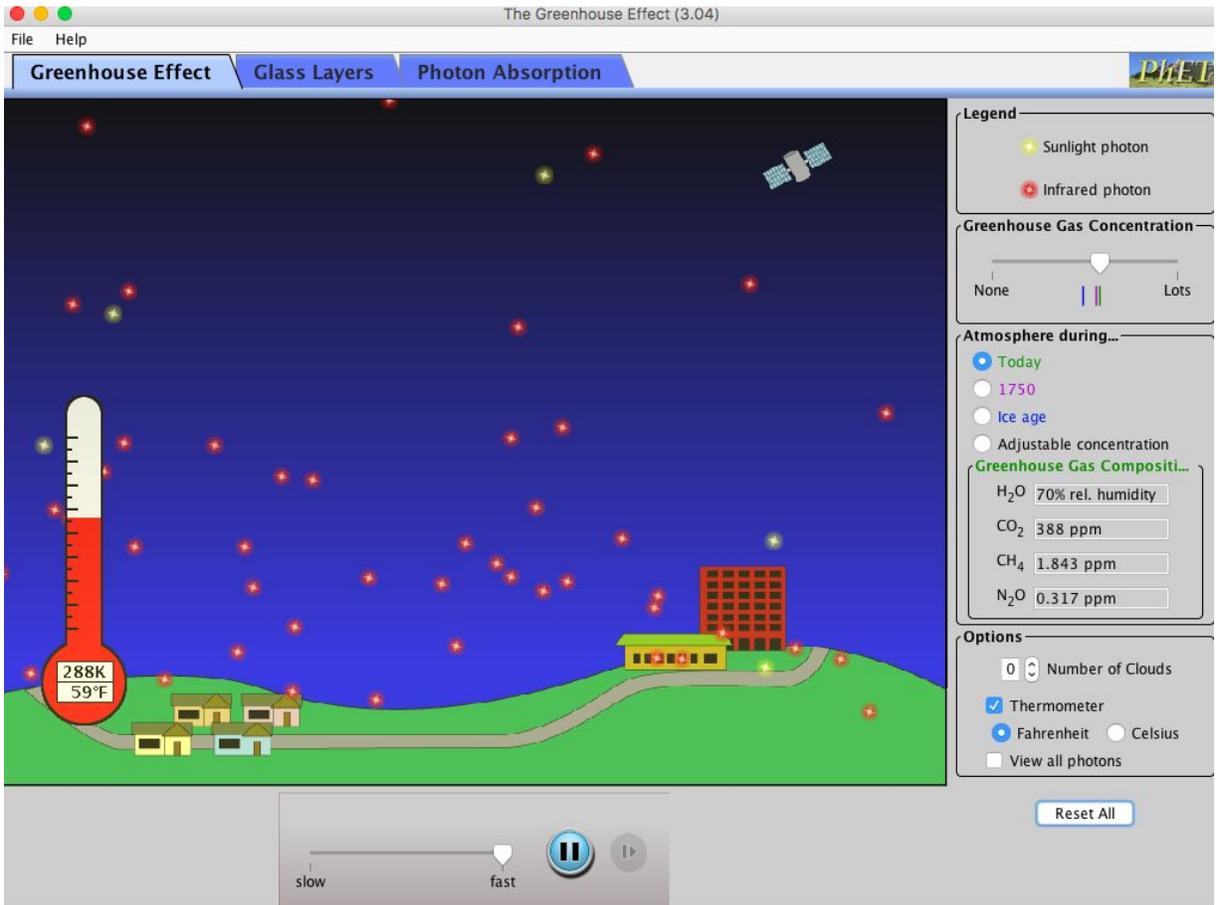
*Based on this simulation, how does the greenhouse keep plants warm? Use "infrared photons" in your explanation*



### Explanation Phase - Part 2:

- Aim:** Determine the relationship between the amount of greenhouse gases in the atmosphere and the temperature of the Earth.

- Click the "Greenhouse Effect" tab. Your screen should look like this...



2. Click the buttons for Atmosphere Today, 1750, and Ice Age to complete the table. When describing the location of the landscape, explain what you see on the screen (Do you see buildings? infrastructure? specific weather?)

Atmosphere during...	Description of Landscape	Carbon Dioxide (ppm)	Water Vapor (ppm)	Temperature Range (F °)
Ice Age				
1750				
Today				

3. Make a claim about the relationship between Carbon Dioxide and Temperature of Earth. Use the words increase or decrease.

**Claim:** As the amount of Carbon Dioxide in the atmosphere \_\_\_\_\_ the temperature on Earth \_\_\_\_\_.

4. Make a claim about the relationship between Water Vapor and Temperature of Earth. Use the words increase or decrease.

**Claim:** As the amount of Water Vapor in the atmosphere \_\_\_\_\_ the temperature on Earth \_\_\_\_\_.

5. Turn the Greenhouse Gas Concentration dial to None.

- *Use your claim to predict your answer to the following question. What will happen to the temperature if the Greenhouse Gas Concentration dial is turned to None?*
  
- *Use the simulation. What is the temperature when the Greenhouse Gas Concentration dial is turned to None?*
  
- *Describe what happens to the infrared photons...*

As the greenhouse gas concentration decreases, the infrared photons ...

- *Was your prediction correct? Why or why not?*

6. Turn the Greenhouse Gas Concentration dial to Lots.

- *Use your claim to predict your answer to the following question. What will happen to the temperature if the Greenhouse Gas Concentration dial is turned to Lots?*
  
- *Use the simulation. What is the temperature when the Greenhouse Gas Concentration dial is turned to Lots?*
  
- *Describe what happens to the infrared photons...*

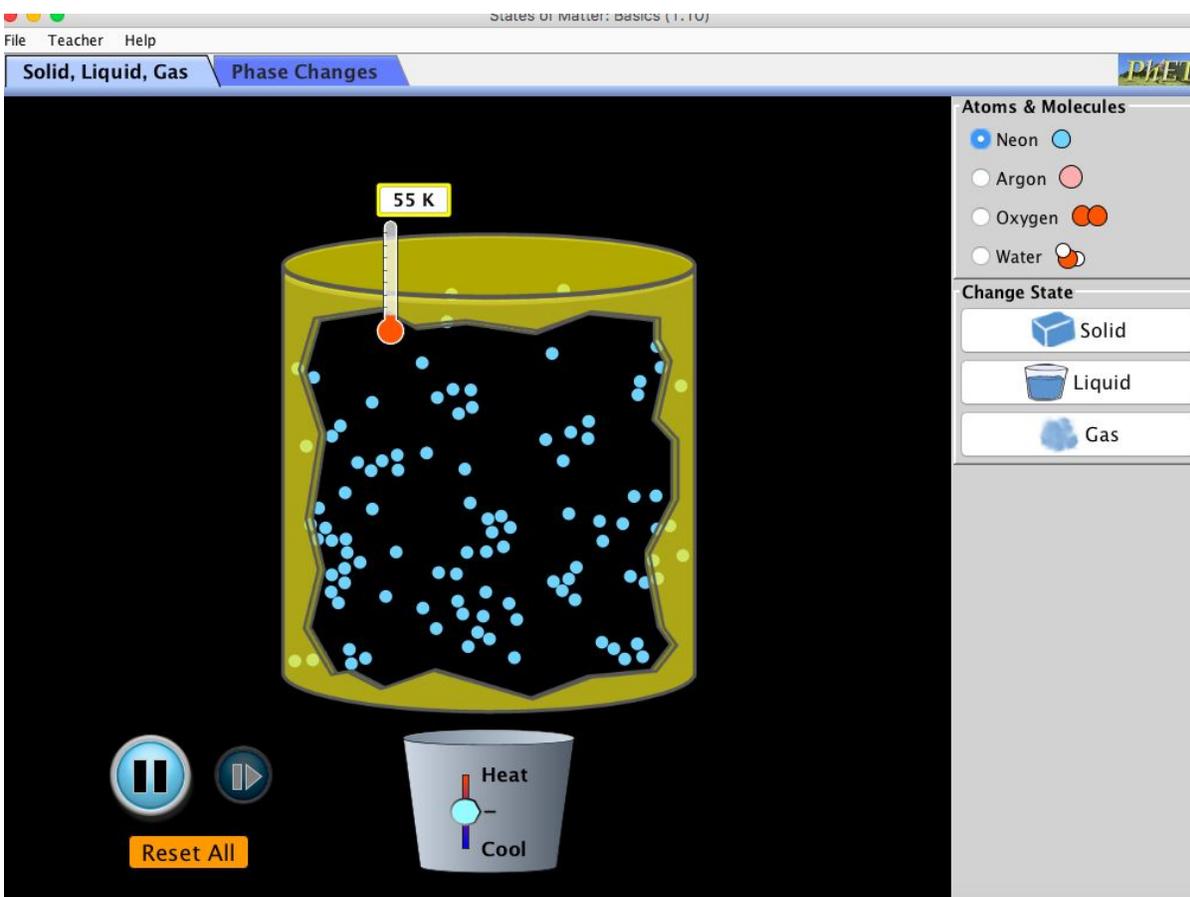
As the greenhouse gas concentration increases, the infrared photons...

- *Was your prediction correct? Why or why not?*

- Based on what you know about Carbon Dioxide (look at the definitions section) and the Description of the Landscapes, how did the amount of Carbon Dioxide in the atmosphere increase over time?
- Carbon Dioxide and Water vapor are greenhouse gases. How do greenhouse gases act like the glass in greenhouses?

### Application Phase:

- Aim:** Explain how increasing Earth's temperature can cause extreme weather.
- Click this link: <https://phet.colorado.edu/en/simulation/legacy/states-of-matter-basics>
  - Make sure you are on the "Solid, Liquid, Gas" Tab. Your screen should look like this...



- On the top right of the screen you will see a "Atoms & Molecules" legend. Click "Water".
- Below the "Atoms & Molecules" legend you will see a "Change State" legends. Click "Liquid"

5. How would you describe the liquid molecules?

6. At the bottom of the screen, you can control the temperature. Increase the heat on the simulation.  
*What happens to the liquid molecules as you increase the heat?*

*If the molecules were not contained, where would the molecules go?*

7. Based on what you know about greenhouse gases increasing Earth's temperature, what happens to the temperature of Earth's oceans over time?

8. Use words like increase or decrease to complete the claim.

**Claim:** As the oceans (liquid) temperatures \_\_\_\_\_, the amount of water vapor in the atmosphere \_\_\_\_\_.

9. Make a prediction...

*With the increased amount of water vapor in the atmosphere, if it were to snow, would it be a heavy snowfall or a light snowfall? Why do you think that?*

*With the increased amount of water vapor in the atmosphere, if it were to rain, would it be a heavy rainfall or a light rainfall? Why do you think that?*