KEY

ATHENAS
Apparel and Textiles Higher Education
Nurturing Advancement of Sustainability

# Climate Change and the Textile & Apparel Industry Module

## Climate Change and the Textile and Apparel Industry

### POGIL Activity 1: The Earth's Greenhouse
### (Why does Earth's atmosphere trap heat?)

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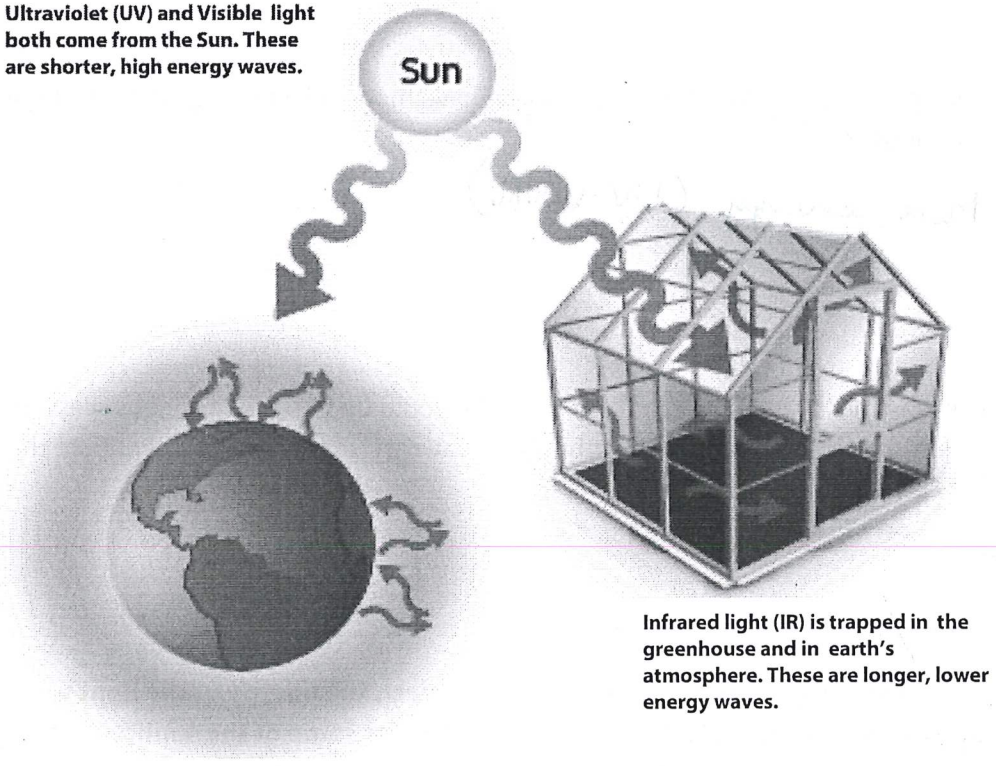
## Model 1: Energy of Electromagnetic Radiation (Light) and the Greenhouse



**Critical Thinking Questions**

1. Use Model 1 to determine the two types of light (also called electromagnetic radiation, EMR) that are radiated from the sun and penetrate the greenhouse glass.

UV (ultraviolet) + visible light penetrate the greenhouse.

2. What type of light is trapped in the greenhouse?

Infrared light (IR) is trapped in the greenhouse.

3. Is the light that penetrates the greenhouse of longer or shorter wavelength than the light that is in the greenhouse?

Shorter wavelength (UV-visible)

4. Does the light that penetrates the greenhouse have more or less energy than the light that is in the greenhouse?

More energy (UV-visible)

5. Theorize why the lower energy infrared (IR) light would be trapped inside the glass of the greenhouse, unable to get out, while the short wavelengths of light can penetrate the glass to get in?

**Information: When high-energy sunlight hits an object, the energy of the light warms that object. For instance sunlight heats up a black road. After some of the sunlight's energy is used to warm the object like the road, leftover energy is emitted to the surroundings as heat, that is, *infrared light*. You can feel this infrared light (heat) if you stand on the road on a sunny day.**

6. As the UV and visible light from the sun continues to shine on the greenhouse, how does the temperature of the greenhouse and all of its contents change?

It heats up.

7. How does the earth's atmosphere (shown in light blue in Model 1) work similarly to the greenhouse? Individually, answer this question and write a few sentences justifying your response. When everyone in your group has finished this question, compare your answers and write the group's response in the box below your individual answer.

Earth atmosphere transmits sunlight (like glass/a greenhouse) but traps heat (like a greenhouse).

## Model 2: The Earth's Greenhouse

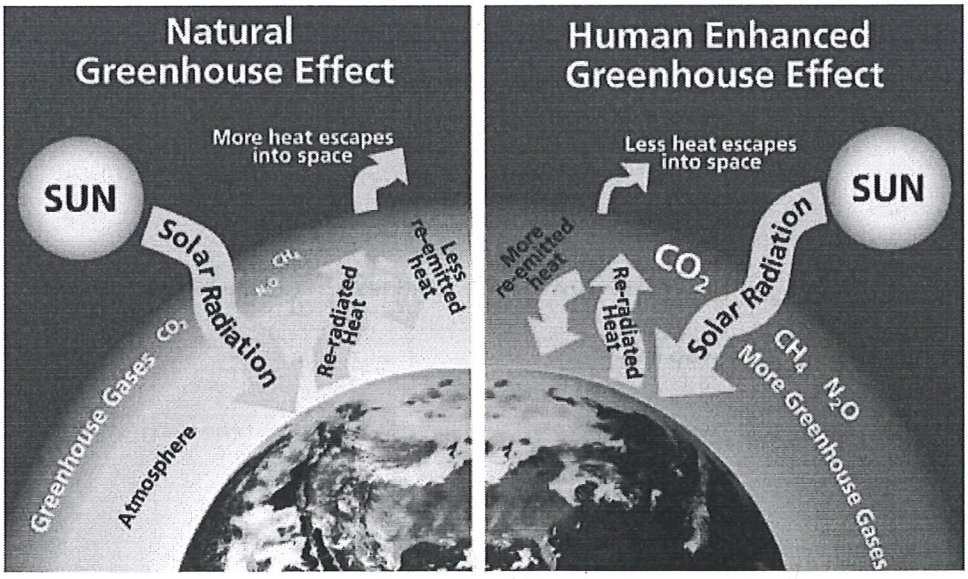



Image Source: http://www.nps.gov/grba/naturescience/what-is-climate-change.htm

## Critical Thinking Questions

8. What are the chemical formulas for the three greenhouse gases shown in the image titled "Natural Greenhouse Effect"? (Write their names too if you know them.) These gases occur naturally in earth's atmosphere.

   $CO_2$ - carbon dioxide
   $CH_4$ - methane
   $N_2O$ - nitrous oxide

9. How does the amount of these three gases change in the image "Human Enhanced Greenhouse Effect"?

   All of them increase.

10. The arrow indicating the amount of solar radiation, that is UV and visible light from the sun, is the same in both images. Similarly the amount of heat re-radiated from the earth is the same in both images. How do the two arrows showing infrared radiation (heat) change from the first to the second image?

    The arrow is larger in the first indicating that more heat escapes with lower concentrations of greenhouse gases

11. The three substances – all gases that have increased from the first to the second image (see CTQ 9) hold the heat into the atmosphere by capturing heat (IR) and radiating it back towards the earth rather than allowing the heat to escape to space.
    a. How is this similar to the greenhouse retaining heat (IR) because of the glass?

    b. Why does the second image say "human enhanced"?

       Humans increase the amount of certain greenhouse gases in the atmosphere.

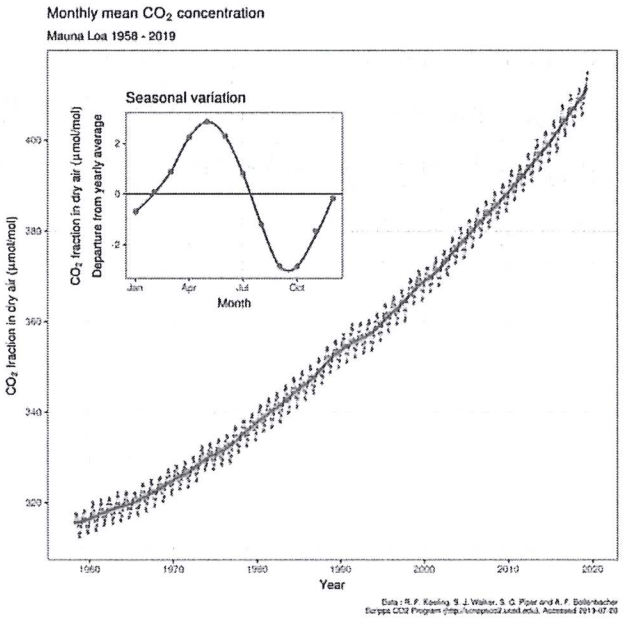
    c. From your own knowledge and experience, can you list the sources of these "human enhanced" gases?

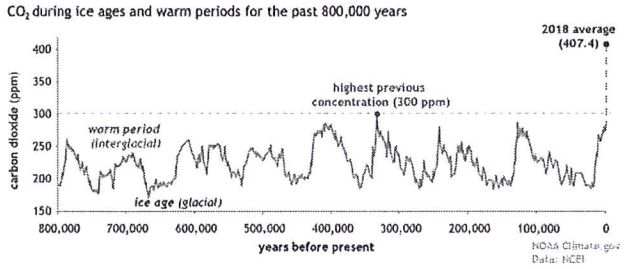
       Burning of fossil fuels (primarily)

12. Describe the earth's greenhouse effect. Individually, answer this question in a few sentences. When everyone in your group has finished this question, compare your answers and write the group's response in the box below your individual answer.

Incoming UV-visible light can pass through the atmosphere and gets absorbed by Earth. The Earth emits this energy as IR light. The IR light gets absorbed by greenhouse gases in the atmosphere and stored as heat.

**Information: The graphs below show present day (top) and historic (bottom) $CO_2$ concentrations.**




13. How does the present $CO_2$ concentration compare to historic $CO_2$ concentrations over the past 800,000 years? Provide *quantitative* values (i.e. numbers, not only descriptors).

The previous maximum value was 300 ppm, with a typical range of 175 - 275 ppm. Present values are 400 ppm.

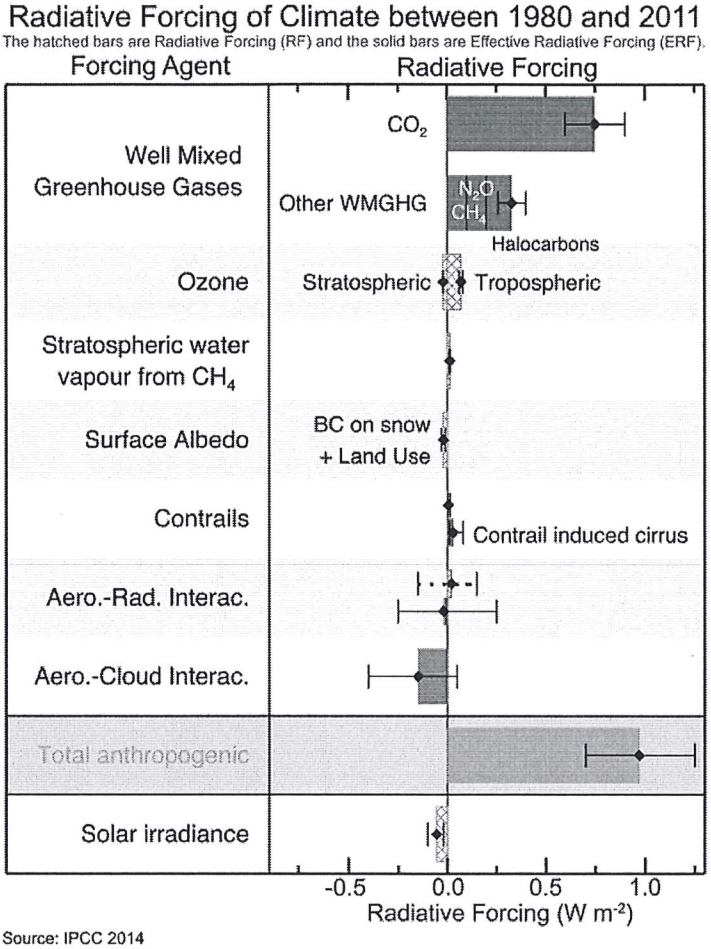
14. What effect do you expect this to have on Earth's greenhouse effect and thus Earth's temperature?

Increase greenhouse effect + temperature.

15. Based on what you know about the sources and sinks (reservoirs) of $CO_2$, explain the seasonal variation shown in the upper plot.

Plant uptake $CO_2$ during the growth season. This $CO_2$ is released when leaves fall and decay in winter.

**Information: The graph below shows the major contributors to climate change. *Radiative forcing* describes how heavily something affects the climate. Positive radiative forcing equates to warming and negative radiative forcing equates to cooling.**




Source: IPCC 2014

16. Which forcing agent had the largest impact on the energy balance, and was thus the largest contributor to global warming, over recent decades?

$CO_2$

17. How did solar radiation change over the period and what impact did it have on global warming?

It has decreased slightly. This ~~forced~~ had a cooling effect on Earth's temperature