Data Puzzles

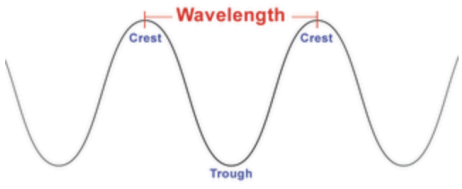
Name: Date:

On a Budget

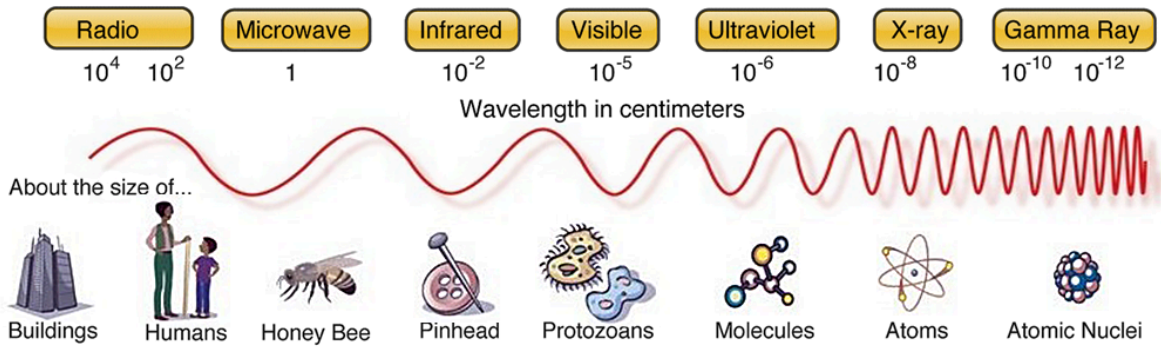
Puzzle Plot

What does it mean when someone says that they are “on a budget?” Usually, it means they want to maintain a certain amount of money in their wallet or bank account, which in turn means they have to balance how much money they spend versus how much money they save. Just like you and I might have a financial budget, Earth has an energy budget. The Earth’s energy budget describes the balance between the energy that is reaching the Earth from the Sun and the energy that is emitted by the Earth, which flows back out into space. In the simplest sense, if this energy budget stays balanced, Earth’s temperature stays constant.

Most of the energy on Earth comes from the Sun. The energy released from the Sun travels in waves, some of these waves are short and others are long. The properties of energy (the way the energy behaves) are determined by its wavelength (see image to the right). For example, we can see things around us because of shortwave energy called visible light and we can feel the heat from a campfire because of longwave energy called infrared energy (heat).



Wavelength is defined as the distance between one peak or crest of a wave of energy and the next peak or crest. NASA's satellites can study different wavelengths of energy from space. *Image from NASA.*

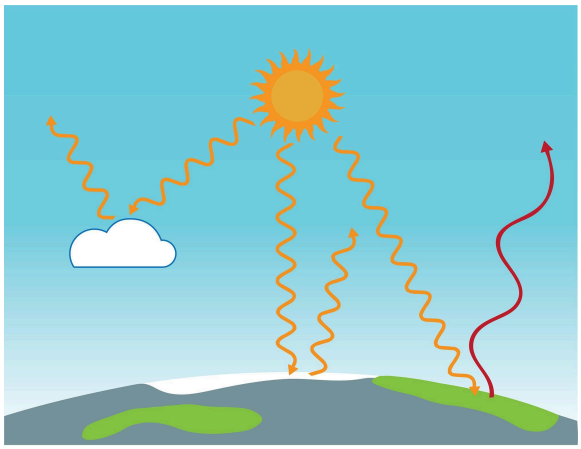


This diagram shows the types of wavelengths going from longest (left) to shortest (right). *Image from NASA.*

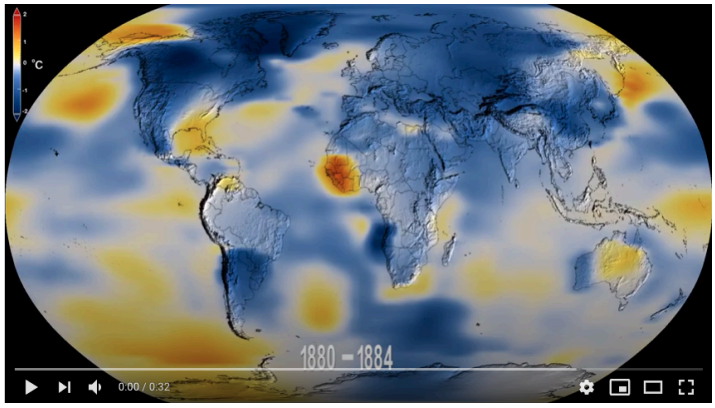
Data Puzzles

Name: Date:

The Sun largely emits shortwave energy which is either reflected or absorbed by the Earth's surface. Shortwave energy absorbed by the Earth's surface causes the surface to heat up. The Earth releases (emits) this heat back into the atmosphere as longwave energy (heat). If the amount of incoming shortwave energy from the Sun (yellow) is equal to the amount of outgoing energy emitted by the Earth (red), Earth's temperature should stay constant. *Image from CIRES.*



Rising global temperatures over the past century indicate that Earth's energy budget is out of balance. This energy imbalance is not equal across Earth's surface as scientists have observed that the Arctic is heating up at a rate faster than the global average, a phenomenon known as Arctic amplification *(see figure below)*. Scientists studying Arctic amplification are investigating the following question, "*Why might the Arctic be warming faster than other places on Earth?*" Scientists predict that increasing longwave energy emitted by the Arctic is contributing to the dramatic rise in Arctic temperatures.



Watch this video to see how temperatures around the world have changed from 1880-2021.

- **Blue** = temperatures cooler than 1951-1980 average
- **Red** = temperatures warmer than 1951-1980 average

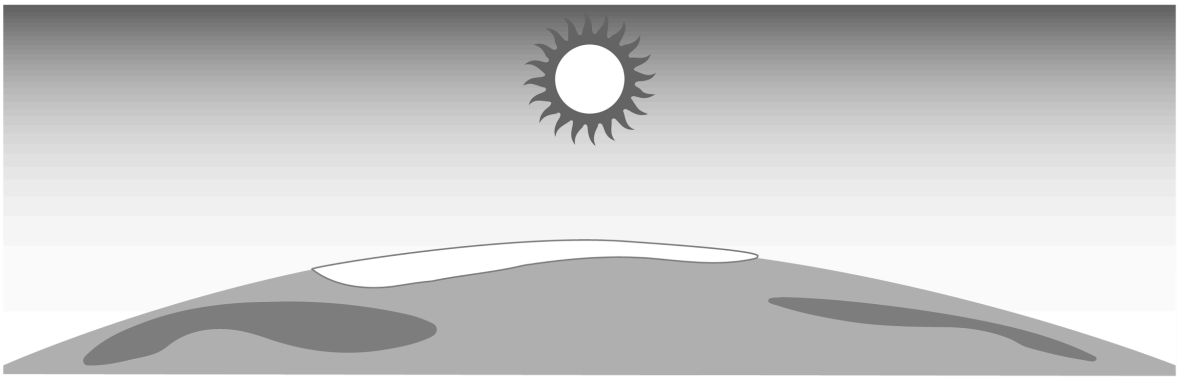
Since 2000, satellites as part of NASA's Clouds and Earth's Radiant Energy System (CERES) project have been measuring the amount of incoming shortwave and outgoing longwave energy to and from Earth. These data allow scientists to study Earth's energy budget and how it varies around the world.

Data Puzzles

Name: Date:

Identifying Important Science Ideas

1. Draw and describe Earth's energy budget when it is perfectly balanced (temperatures not changing) by annotating (add text, arrows, drawings) the image below.



2-3 sentence description of the Earth's energy budget when it is perfectly balanced (temperatures not changing).

2. **Investigative Question**: What question are scientists investigating?

3. **Make a prediction:** I predict that the Arctic is warming faster than other places on Earth because…*(circle one of the predictions below)*
   a. The Arctic is receiving more incoming shortwave energy (sunlight) than it has in the past.
   b. The Arctic is emitting more longwave energy (heat) than it has in the past.

I think this because…

Name: Date:

Supporting Ongoing Changes in Thinking

Instructions: Refer to Figures 1 and 2 below for the following questions.

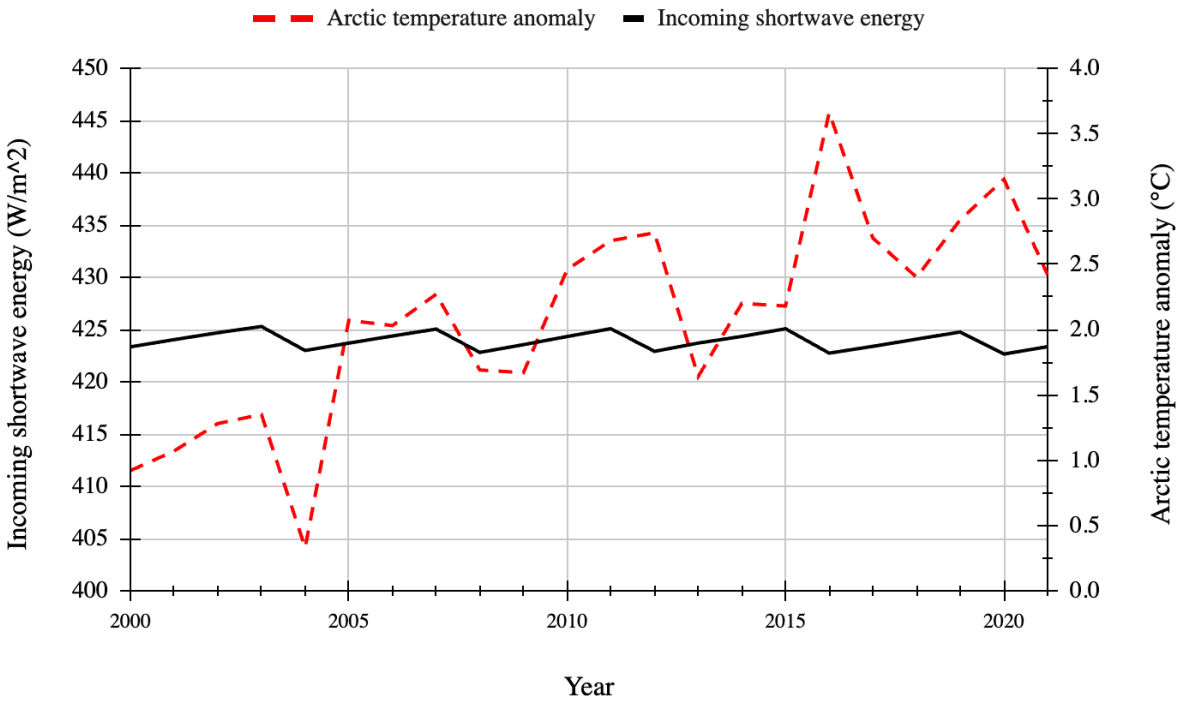


Figure 1. *Graph showing changes in incoming shortwave energy (energy from the Sun) and Arctic temperatures from 2000-2021.*

4. Find and describe the data from 2000.

Incoming shortwave energy =

Arctic temperature anomaly =

5. Find and describe the data from 2021.

Incoming shortwave energy =

Arctic temperature anomaly =

6. What patterns do you observe in the data (see figure 1)?

-
-

Name: Date:

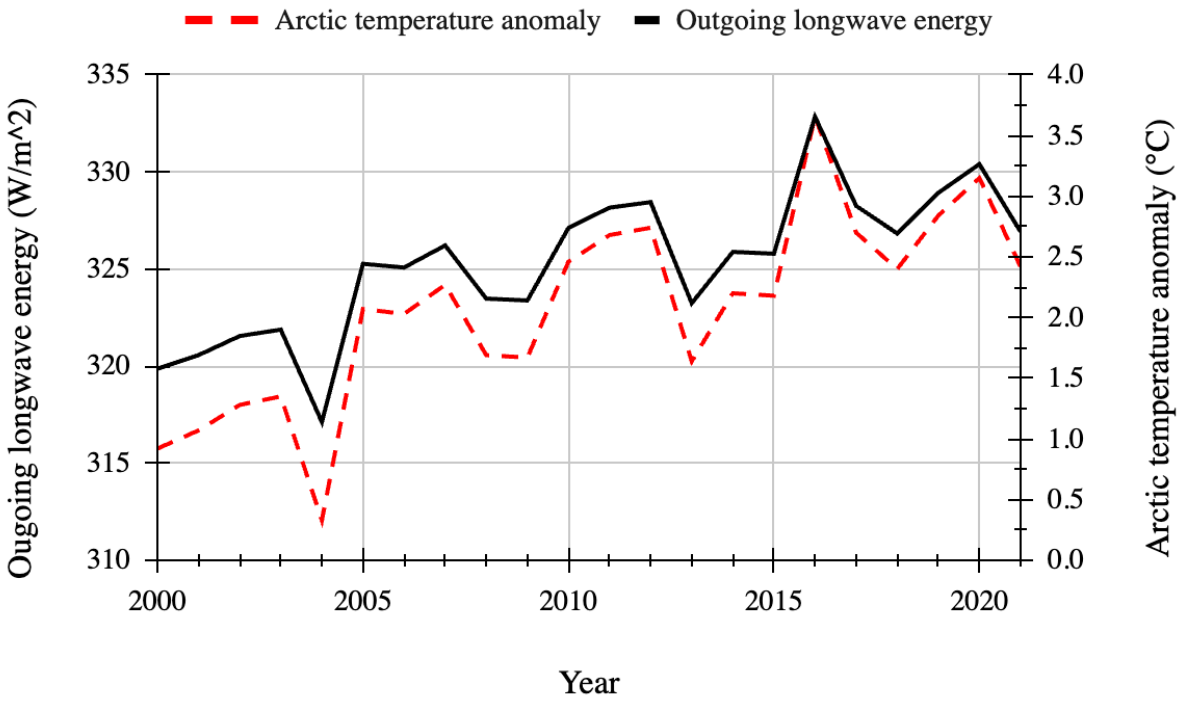


Figure 2. *Graph showing changes in outgoing longwave energy (heat from the Arctic) and Arctic temperatures from 2000-2021.*

7. Find and describe the data from 2000.

    Outgoing longwave energy =

    Arctic temperature anomaly =

8. Find and describe the data from 2021.

    Outgoing longwave energy =

    Arctic temperature anomaly =

9. What patterns do you observe in the data (see figure 2)?

-
-

Name: Date:

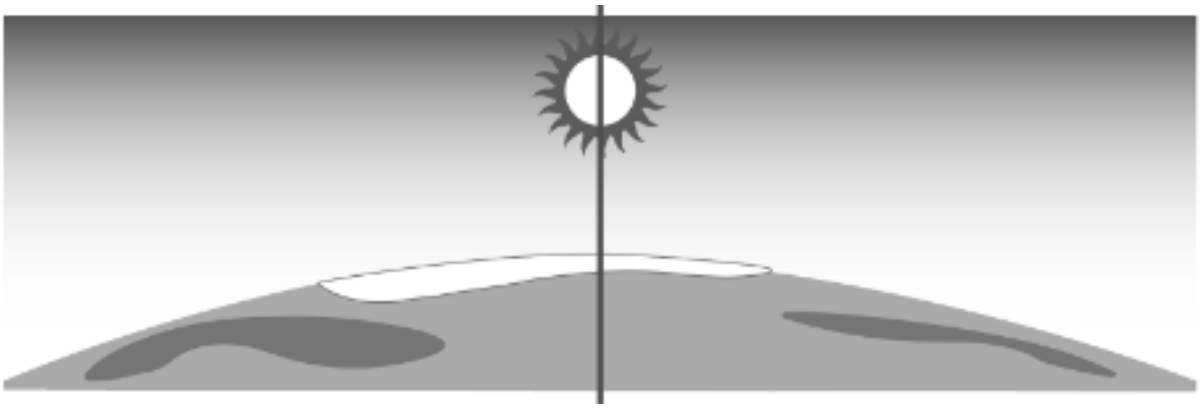
10. Based on the patterns you identified in Figure 2, create a rule to describe the relationship between outgoing longwave energy and temperature. *Example: As x increases, y decreases.*

11. **Revisit your prediction:** Did the data support your prediction for the investigative question? Explain.

Name: Date:

Constructing Evidence-Based Explanations

12. Create a model (annotated sketch) to explain the investigative question, “Why might the Arctic be warming faster than other places on Earth?”

Year 2000	Year 2021
	

13. **Digging deeper:** Scientists think that melting sea ice is leading to an increase in the amount of longwave energy (heat) emitted from the Arctic. How might declining Arctic sea ice lead to more longwave energy (heat) being emitted?

Name: Date: