Where Heat Goes

Trace how evidence reveals changes in Earth's energy flow

ESS.5.c "Construct explanations from evidence of how the flow of energy through Earth's systems has changed over time."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline evidence from two different time periods and circle phrases that describe energy moving or being stored. Number at least one chain of three linked cause-and-effect steps to show how the flow changed.

From Ice Sheets to Warmer Seas

1. About 20,000 years ago, thick ice sheets covered much of northern North America. Earth's orbit and tilt gave the far north less summer sunlight than it would receive later, so winter snow was more likely to survive. Bright snow and ice reflected much of the sunlight striking them, sending that energy back toward space. As summer sunlight increased over thousands of years, some ice melted and exposed darker land and ocean. Those surfaces absorbed more sunlight than ice had. More absorbed energy warmed the surface, helping further ice retreat. Landforms left by moving ice record that retreat.

2. Air trapped in ancient Antarctic ice provides another clue. Ice from the last glacial period contains about 180 parts per million of carbon dioxide, compared with about 280 parts per million before widespread fossil fuel use. Carbon dioxide absorbs infrared energy emitted by Earth's surface and sends some energy back downward. As carbon dioxide rose during deglaciation, less outgoing energy escaped directly to space, adding to warming already started by changing sunlight and retreating ice. Shells preserved in ocean sediment also help scientists reconstruct warming water, evidence that the oceans took up some of the added heat.

3. The energy story changed again with industrialization. Burning coal, oil, and natural gas has raised atmospheric carbon dioxide above 420 parts per million in the 2020s, a much faster rise than the long glacial-to-preindustrial change. Modern thermometers show rising global surface temperatures, while ocean measurements show that the sea has stored most of the recent excess heat. Satellites also detect an energy imbalance: over recent decades, Earth has absorbed more solar energy than it has emitted to space as heat. These observations show extra energy building up in Earth's systems, driven chiefly by human-produced greenhouse gases.

2 ANSWER WITH EVIDENCE

Use the passage

1. How did increased summer sunlight change the flow of solar energy as the ice sheets retreated? Use evidence from the passage.

2. How do the ice-core measurements help explain a change in outgoing energy between the last glacial period and preindustrial times?

3. What evidence shows that the main driver of today's energy change differs from the initial driver of ice retreat?

4. Use the satellite and ocean evidence together to explain where excess energy has gone in recent decades.

3 YOUR TURN

Your own words

A large volcanic eruption puts sunlight-reflecting particles high in the atmosphere. Over the next year, instruments record less sunlight reaching the surface and a small drop in average global surface temperature. In four sentences, explain the change in energy flow, use both measurements as evidence, and predict what may happen after the particles clear.

ANSWER KEY

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HIGH SCHOOL · ESS.5.c

PART 1 · READ AND MARK

Underline evidence from two different time periods and circle phrases that describe energy moving or being stored. Number at least one chain of three linked cause-and-effect steps to show how the flow changed. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How did increased summer sunlight change the flow of solar energy as the ice sheets retreated? Use evidence from the passage.	**Increased summer sunlight melted ice and exposed darker surfaces. Those surfaces absorbed more sunlight than the bright ice had reflected, adding energy to the surface and helping more ice melt.**
2	How do the ice-core measurements help explain a change in outgoing energy between the last glacial period and preindustrial times?	**Ice cores show carbon dioxide rose from about 180 to 280 parts per million. More carbon dioxide absorbed more infrared energy and sent some back downward, so less outgoing energy escaped directly to space.**
3	What evidence shows that the main driver of today's energy change differs from the initial driver of ice retreat?	**Ice retreat began as changes in Earth's orbit and tilt increased northern summer sunlight. Today's change is driven chiefly by fossil fuel burning, which has raised carbon dioxide above 420 parts per million.**
4	Use the satellite and ocean evidence together to explain where excess energy has gone in recent decades.	**Satellites detect that Earth has absorbed more solar energy than it has emitted as heat. Ocean measurements show that the sea has stored most of the recent excess heat.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The particles reflect some incoming sunlight toward space before it reaches the surface. Instruments measuring less sunlight at the surface provide evidence that the surface receives less solar energy. The small drop in average global temperature is consistent with reduced surface heating. After the particles clear, more sunlight may reach and warm the surface if other conditions stay similar.

Accept explanations that connect evidence to a change in energy absorbed, reflected, emitted, or stored. For the volcanic scenario, accept a cautious temperature prediction that recognizes other conditions can affect the outcome.