

Sphere 5E Lesson Plan #1  
Cryosphere and Glacier Retreats

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**Title:** Cryosphere and Glacier Retreats

**Grade level:** 7<sup>th</sup> grade

**Time:** The activity will take about 2 class periods (45 min each).

**Materials:** A computer, student worksheet, ruler, pencils and a calculator.

**Summary:**

The students will learn about the Earth's cryosphere which contains the frozen parts of the planet such as snow, ice on land, ice caps, glaciers, permafrost and sea ice. They will learn that the changes in the cryosphere provide valuable information about the past, present and future of the planet. The students will learn how NASA uses satellites to analyze and collect the cryosphere data.

**Engage:**

Students will view the video about Earth's cryosphere and ICESat-2 satellite:

<https://icesat-2.gsfc.nasa.gov/files/real-world-icesat-2-and-earths-cryosphere>

Students demonstrate they learned about the Earth's cryosphere and how NASA collects the cryosphere data by writing down their new understanding and questions from the video then answering these questions:

- 1) What do you know about the Earth's cryosphere?
- 2) How does NASA collect the Earth's cryosphere data?
- 3) Why do we need to collect and analyze the cryosphere data?

This will assist them in the next stage of the lesson because the video will help the students understand about Earth's cryosphere and the ICESat-2 satellite mission before they read about the NASA Landsat missions.

**Explore:**

Students demonstrate they learned about the Landsat missions and how the Jakobshavn Glacier has retreated over the years by reading the overview about the Landsat missions ([https://www.nasa.gov/mission\\_pages/landsat/overview/index.html](https://www.nasa.gov/mission_pages/landsat/overview/index.html)) and calculating the retreat distance between 1953 to 2001 and 2001 to 2006 by using the image taken by the Landsat-7 satellite (<https://svs.gsfc.nasa.gov/3395>). They will calculate the rate of retreat per year (see student worksheet for the detailed steps). They will answer these questions:

- 1) What's the average rate of glacier retreat per year from 1953 to 2001? Write your answer in kilometers per year.

- 2) What's the average rate of glacier retreat per year from 2001 to 2006? Write your answer in kilometers per year.

This will assist them in the next stage of the lesson because the students will be able to explain if the retreat is slowing down or moving faster based on their investigations and mathematical calculations.

**Explain:**

Students demonstrate they learned that the Jakobshavn Glacier (<https://svs.gsfc.nasa.gov/3395>) has retreated faster by comparing and explaining their results after calculating the average rate of retreat per year between 1953 to 2001 and 2001 to 2006. They will answer the following question:

- Determine if the glacier retreat is accelerating (faster) or decelerating (slower). Explain your reasoning!

This will assist them in the next stage of the lesson because the students will be able to extend their knowledge by calculating the retreat distance of Gangotri Glacier and applying the knowledge by looking at a different location.

**Elaborate:**

Students will elaborate by applying the new knowledge by calculating the retreat distance of Gangotri Glacier, situated in the Uttarkashi District of Garhwal Himalaya from 1956 to 2001. <https://nsidc.org/cryosphere/glaciers/questions/climate.html>

Students demonstrate they learned that the Gangotri Glacier has retreated also by calculating the retreat rate from 1956 to 2001 and comparing the retreat rate with Jakobshavn Glacier during the same time frame to determine which area is warming up faster.

The students will also elaborate by making the connection to the importance of monitoring and analyzing the cryosphere data using the satellites as glacier stability has changed over time and how human activities factor into the rise of global temperatures. They will also share their ideas on how to prevent the Earth's global warming, then compare their answers to the suggestions listed on the NASA climate kids website (<https://climatekids.nasa.gov/how-to-help/>) to see if there are additional things that they can do to help.

The students also demonstrate they learned the causes and the impacts of melting glaciers, such as rising sea level, by answering the questions below. They will list different things that they can do to reduce the Earth's global warming.

- 1) What do you think causes the glacier retreats?
- 2) What are the impacts of melting glaciers?
- 3) What do you think causes the Earth's global warming? Do human activities affect the rise in temperature? Explain using examples.
- 4) What can you do to help reduce the Earth's global warming?

- 5) Read the information in this NASA climate kids website and list new ideas on how you can help reduce Earth's global warming that you have not listed above.  
<https://climatekids.nasa.gov/how-to-help/>

**Evaluate:**

Formative assessment: We will have discussions after the students complete the questions in each stage of the lesson plan. I teach in a virtual classroom called Blackboard Collaborate. They will work collaboratively in groups in the breakout rooms and I will move from one breakout room to another to monitor their progress. I will pull them back into the main room to have the class discussion. Students will answer questions through polling, chat or microphone during formative assessments. Their answers will help determine if the students are moving in the right direction before moving on to the next stage of the lesson plan.

Summative assessment: The assessment rubric is used to evaluate each student's understanding of the phenomena and to hold each student accountable that they are completing the worksheet.

**Content:** To measure the students' understanding of the purpose of collecting and analyzing cryosphere data using the satellites.

**Application:** To measure the students' understanding of the reasons and impacts of melting glaciers and what they can do to help reduce the global warming.

**Accuracy:** To measure if they calculate the retreat distances and rate accurately for both glaciers.

**Completion:** To make sure that students are completing all components of the worksheet.

**Time:** To help students stay on task and complete their assignments on time.

**STANDARDS:****NGSS:**MS-ESS3-5. Students who demonstrate understanding can:

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.

Science and Engineering Practices:

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

### Disciplinary Core Ideas:

#### ESS3.D: Global Climate Change

Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

### Cross Cutting Concepts:

#### Stability and Change

Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

### **Common Core:**

#### **7<sup>th</sup> Grade Math Standards:**

- Analyze proportional relationships and use them to solve real-world and mathematical problems. (CCSS: 7.RP)
- Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. (CCSS: 7.RP.1)
- Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. (CCSS: 7.G.1)

#### **7<sup>th</sup> Grade ELA Standard 1: Oral Expression and Listening, Standard 2: Reading for All Purposes & Standard 3: Writing and Composition.**

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others’ ideas and expressing their own clearly. (CCSS: SL.7.1)
- Engage in a wide range of nonfiction and real-life reading experiences to solve problems, judge the quality of ideas, or complete daily tasks.

### Cryosphere and Glacier Retreats Worksheet

1) View the video below and write down your new understanding and questions from the video.

Earth's cryosphere and ICESat-2 satellite (5 min and 23 sec):

<https://icesat-2.gsfc.nasa.gov/files/real-world-icesat-2-and-earths-cryosphere>

Observations I have about the video	Questions I have about the video

2) What do you know about the Earth's cryosphere?

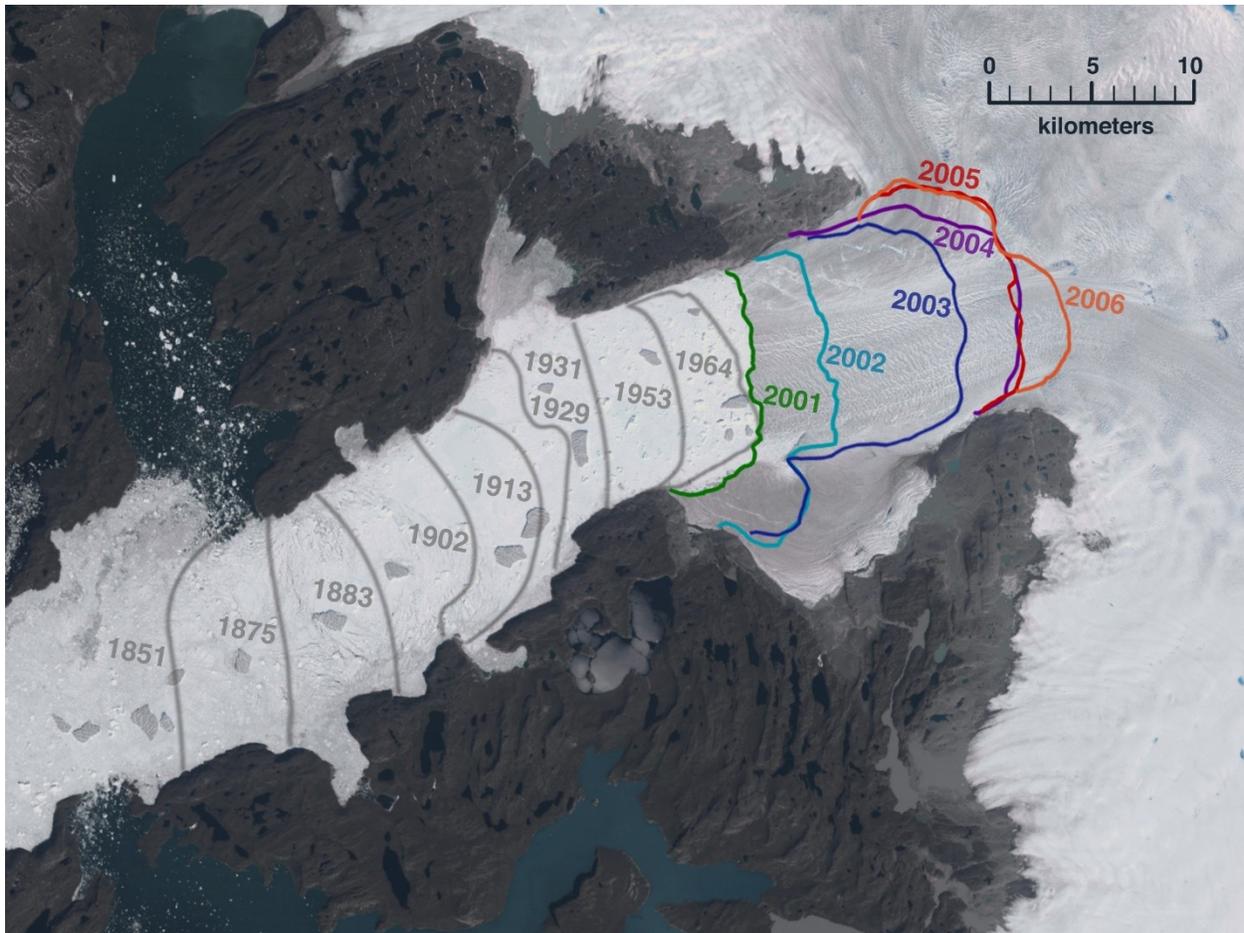
3) How does NASA collect the Earth's cryosphere data?

4) Why do we need to collect and analyze the cryosphere data?

**Collaboration/Discussion time: Share your response with the class.**

5) Explore this website and read the short overview including the video of the Landsat mission:

[https://www.nasa.gov/mission\\_pages/landsat/overview/index.html](https://www.nasa.gov/mission_pages/landsat/overview/index.html)



### **Jacobshavn Glacier**

Explore this website and view the image of the Jacobshavn Glacier then follow the steps listed below to determine the length and the speed of the glacier retreat.

<https://svs.gsfc.nasa.gov/3395>

Step 1: Record the scale given on the image in kilometers. Record your answer below.

Step 2: Using a metric ruler, measure the length of the scale given on the image in millimeters. Record your answer below.

Step 3: To find the scale factor in kilometers per millimeter, divide your answer to step 1 by your answer in step 2.

$$\text{Scale factor} = \frac{\text{Scale given} \in \text{kilometers}}{\text{Length} \in \text{millimeters}}$$

Step 4: Using a metric ruler, measure the length of the glacier retreat on the image from the center and record your answers below in millimeters.

- A) From 1953 to 2001.
- B) From 2001 to 2006.

Step 5: Find the actual length of the glacier retreat by multiplying your answer from Step 3 by your answer in Step 4. Record your answers below.

- A) From 1953 to 2001.
- B) From 2001 to 2006.

**Note: You can also set up a proportional relationship as shown below and use the cross-product method to find the actual distance of the glacier retreat in kilometers. Let  $d$  = the actual distance of the glacier retreat in kilometers.**

$$\frac{\text{scale given} \in \text{kilometers}}{\text{scale length} \in \text{millimeters}} = \frac{\text{glacier retreat distance} \in \text{kilometers}}{\text{glacier retreat distance} \in \text{millimeters}}$$

$$\text{Answer} \in \text{step 1} \frac{\in}{\text{Answer} \in} \text{step 2} \in = \frac{d}{\text{Answer} \in} \text{Step 4} \in$$

- 1) What's the average rate of glacier retreat per year from 1953 to 2001? Write your answer in kilometers per year.
- 2) What's the average rate of glacier retreat per year from 2001 to 2006? Write your answer in kilometers per year.
- 3) Determine if the glacier retreat is accelerating (faster) or decelerating (slower). Explain your reasoning!

**Collaboration/Discussion time: Share your response with the class.**



### **Gangotri Glacier.**

Click on this link to view the image of Gangotri Glacier, situated in the Uttarkashi District of Garhwal Himalaya: <https://nsidc.org/cryosphere/glaciers/questions/climate.html>

Find the distance and rate of the Gangotri Glacier retreat from 1956 to 2001 using the same steps that you used previously for Jakobshavn Glacier. Show your complete math work in the space below!

Compare the rate of retreat between the Jakobshavn Glacier and Gangotri Glacier around the same time period (1950's to 2001). Explain which area is retreating faster.

**Collaboration/Discussion time: Share your response with the class.**

- 1) What do you think causes the glacier retreats?
  
- 2) What are the impacts of melting glaciers?
  
- 3) What do you think causes the Earth's global warming? Do human activities affect the rise in temperature? Explain using examples.
  
- 4) What can you do to help reduce the Earth's global warming?

**Collaboration/Discussion time: Share your response with the class.**

- 5) Read the information in this NASA climate kids website and list new ideas on how you can help reduce Earth's global warming that you have not listed above.  
<https://climatekids.nasa.gov/how-to-help/>

**Rubric:**

	Exemplary 4	Meets the Standard 3	Approaching 2	Does Not Meet 1
<b>Content</b>	Shows a full understanding of the benefits of collecting and analyzing the cryosphere data.	Shows a good understanding of the benefits of collecting and analyzing the cryosphere data.	Shows a basic understanding of the benefits of collecting and analyzing the cryosphere data.	Does not seem to understand the benefits of collecting and analyzing the cryosphere data.
<b>Application</b>	Able to list reasons, impacts and at least 5 applications that they can do to reduce global warming.	Able to list reasons, impacts and 3-4 applications that they can do to reduce global warming.	Able to list only a few reasons, impacts and 1-2 applications that they can do to reduce global warming.	Not able to list reasons, impacts and applications that they can do to reduce global warming.
<b>Accuracy</b>	Set up the rate/proportion, calculate the length and speed of glacier retreats accurately.	Set up the rate/proportion, calculate the length and speed of glacier retreats with minimal errors.	Set up the rate/proportion, calculate the length and speed of glacier retreats with some errors.	Set up the rate/proportion, calculate the length and speed of glacier retreats with too many errors.
<b>Completion</b>	All work assigned is complete.	Most work assigned is complete.	Some work assigned is complete.	Minimal work assigned is complete.
<b>Timeliness</b>	Assignments turned in on time.	Assignments turned in 1 day late.	Assignments turned in 2 days late.	Assignments turned in 3 or more days late.

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