

My NASA Data

Changing Sea Ice Extent Story Map

Lesson Plan

Purpose: Students will explore changes in **sea ice extent** as it relates to other spheres within the Earth System. Students will develop an iterative concept map that they will use to document their understanding of the Earth System as it relates to changes in sea ice. During the Evaluate stage, they will consider how an increase in our air temperatures may impact other parts of the system that have been explored in this story map.

Grade Level: 7 – 12	Lesson Objectives: <ul style="list-style-type: none">• Students will analyze maps and time series data to understand changes.• Students will construct data-based explanations and conclusions.• Students will compare multiple variables of the Earth System as they analyze global changes in the Cryosphere.• Students will consider the impact of environmental changes on wildlife..	Sphere(s): <ul style="list-style-type: none">• Cryosphere• Atmosphere• Biosphere• Hydrosphere
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Phenomena NASA Connection:

Sea ice plays a fundamental role in polar ecosystems and global climate. The ice itself is habitat for animals such as seals, foxes, polar bears, and whales. The white surface reflects far more sunlight back to space than ocean water does. As more ice melts and exposes more dark water, the water absorbs more sunlight and, in turn, melts more ice. Over several years, this ice-albedo feedback can influence global climate. Additionally, sea ice melt can influence air temperatures and the salinity of the ocean, which can impact weather and ocean circulation patterns. NASA measures sea ice from space using both active and passive sensors operating at a variety of wavelengths. Active sensors, like radars and lasers, send a signal out and receive it back, whereas passive sensors passively receive radiation coming to the instrument from elsewhere. These sensors will help NASA measure sea ice changes and how they influence the other spheres of the earth system.

Essential Questions:

1. How do seasons influence changes in sea ice extent?
2. How does sea ice melt influence the Arctic ecosystem?
3. What affect does changing air temperatures have on observed trends in sea ice extent?
4. How does sea ice melt change ocean circulation patterns?
5. What is albedo and how does it affect the cryosphere?



NGSS Performance Expectations:

- **5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- **MS-ESS2-6** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation the determine regional climates.
- **HS-ESS2-1** Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth Systems.
- **HS-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Science and Engineering Practices:

Developing and Using Models

Develop and use a model to describe phenomena.

Analyzing and Interpreting Data

Analyze data using tools, technologies, and/or models.

Asking Questions and Defining Problems

Ask questions to identify and clarify evidence of an argument.

Disciplinary Core Ideas:

ESS2.A Earth Materials and Systems

Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

ESS2.D Weather and Climate

Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

ESS3.D Global Climate Change

Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

Crosscutting Concepts:

Stability and Change

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Systems and System Models

Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy, matter, and information flows within systems.

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

NCTM Math Standards: n/a



Cross-curricular Connections: National Geography Standards

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

STEM Career Connection:

- **Glaciologist** – A Glaciologist is one who studies and analyzes the movement and physical properties of glaciers and ice. Glaciologists research characteristics of the Cryosphere that include formation, movement and effects of other parts of the Earth System.
- **LIDAR Remote Sensing Technologist** – LIDAR Remote Sensing Technologists use remote sensing strategies to analyze data to solve problems in areas around the globe. They use LIDAR (Light Detection and Ranging) as a method of examining the surface of the earth.
- **Mathematical Modeler** – Mathematical Modelers use mathematics to create models that demonstrate complex processes or solve problems. Many mathematical modelers use their skills to create and animate 3D representations of their processes with the assistance of software technology.

Multimedia Resources

- Changes in Sea Ice Extent Story Map, <https://nasa.maps.arcgis.com/apps/MapSeries/index.html?appid=2adb302f548945d08f9aed5e41352255>
- EO Kids, Ice on Earth: By Land and By Sea, https://mynasadata.larc.nasa.gov/sites/default/files/2018-08/EOKids_Ice508.pdf
- My NASA Data, <https://mynasadata.larc.nasa.gov/>
- Global Ice Viewer, <https://climate.nasa.gov/interactives/global-ice-viewer/#/>

Materials/Resources Needed

Per Student:

- “Changes in Sea Ice Extent Story Map Datasheet”

Per Group:

- Laptop
- Internet Access

Key Vocabulary

- Albedo
- Air Temperature
- Ecosystem
- Minimum Sea Ice Extent
- Sea Ice Extent
- Salinity

Background Information

Sea ice is frozen seawater that floats on the ocean surface in both the Arctic and the Antarctic. This floating ice has a profound influence on the polar environment, influencing ocean circulation, weather, and regional climate. Sea ice is constantly changing with periods of growth and melting throughout the year. The amount of sea ice in the Arctic increases during winter months, usually starting in September, and decreases during the summer months, usually starting in March.



Prerequisite Student Knowledge

- Familiarity with finding coordinates on a map
- Familiarity with line plots
- Basic understanding of seasonal changes
- Familiarity with trends in data



Student Name:

Date:

Period:

Sea Ice and the Earth System Story Map

Link to Story Map:

<https://nasa.maps.arcgis.com/apps/MapSeries/index.html?appid=2adb302f548945d08f9aed5e41352255>

Part A: Engage

A.1 What patterns do you see?

A.2 Why do you think this is happening?

A.3 What do you think causes these patterns?

A.4 What does this animation make you wonder?

A.5 What is the difference in minimum sea ice extent between 1979 and 2018? (Click on the ice to see the extent value.)



A.6 Why do you think these changes in sea ice extent are happening?

A.7 As a class, you will work to create your own concept map for the topic **Changes in Sea Ice Extent**. *NOTE: you will continue to develop this concept map and edit it as you learn more about this phenomenon.*

Instructions:

1. Brainstorm main ideas and terms related to Changes in Sea Ice Extent. Think of ways in which Changes in Sea Ice Extent relate to other spheres of the earth system (atmosphere, biosphere, geosphere, hydrosphere).
2. Organize these ideas. Create groupings based on how similar they are to one another or their relation to the main topic.
3. Map out the ideas by putting them into boxes and rearranging them around the main topic.
4. Connect the ideas through phrases that describe their relationship. See the chart below for sample connecting phrases.

Sample Phrases
Affects
Controls
Decreases
Forms
Includes
Increases
Is Connected To
May Lead To
Relies On



Part B: Explore

B.1 Which month in 2018 had the greatest sea ice extent?

B.2 Which month had the least?

B.3 How does sea ice extent change over the course of a year?

B.4 How has Arctic sea ice minimum extent changed between 1979 and 2018?

B.5 After seeing this data, what questions do you have that you would like to investigate?

B.6 What year had the least amount of arctic sea ice minimum coverage?

B.7 What other variables within the Earth System do you think have affected sea ice extent over time?



B.8 What colors do you see on the map?

B.9 What do these colors mean?

B.10 How does surface air temperature change between March and September?

B.11 What patterns do you notice between the extent of sea ice and surface air temperature?

B.12 How have global temperatures changed over time?

B.13 How have certain locations been affected more than others? Explain.

B.14 What are some different ways in which Arctic animals interact with sea ice?



B.15 Do you think some of these animals rely on sea ice more than others? Explain your reasoning.

B.16 Is Arctic sea ice generally growing or melting during the summer months when polar bears are active?

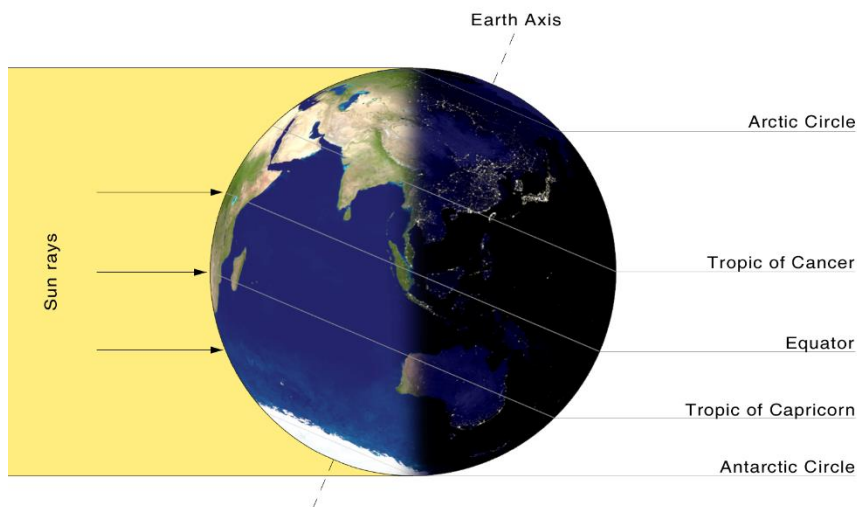
B.17 How does sea ice melt affect polar bear migration? Explain your reasoning.

Part C: Explain

C.1 Where does most of the Earth's energy come from?

C.2 What types of materials are affected by Earth's Energy Budget?

C.3 How does Earth's energy stay in balance?



C.4 In the diagram above, is the northern hemisphere or the southern hemisphere experiencing summer?



C.5 During which month does the Arctic receive the most direct energy from the Sun?

C.6 Does the South Pole experience these same day and night cycles? Explain.

C.7 In the animation, what is happening to the solar radiation as the ice continues to melt?

C.8 What does it mean when we say sea ice has a high albedo?

C.9 What is the ice-albedo feedback?

C.10 In what seasons do you expect a change in albedo in the Arctic to have the greatest impact in the amount of sunlight absorbed and reflected at the surface?



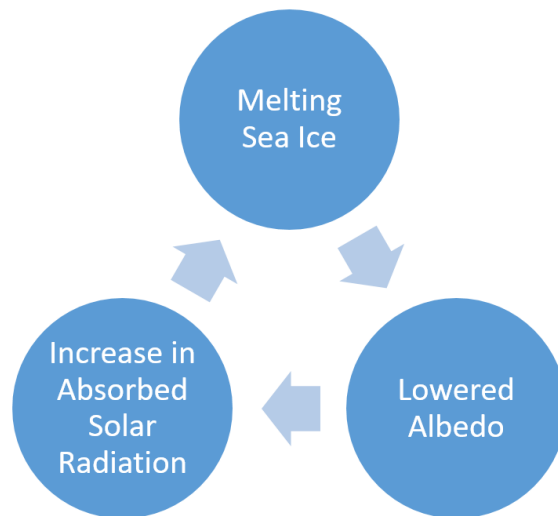
C.11 Write a paragraph explaining how the flow of energy into the Arctic impacts sea ice extent. Refer to the concepts covered earlier in this section.

C.12 What are the processes that contribute to sea ice melt?

C.13 All of these groups collected these data independently, yet obtained similar results. What does this tell us about the reliability of the data?

C.14 What is the overall trend in this data?

C.15 Why is the Arctic more sensitive to warming than other regions on Earth?



C.16 Describe the diagram above. What is the relationship between melting sea ice, lowered albedo, and increasing solar radiation?

C.17 What role does sea ice play in polar bears' lives?

C.18 Think of another animal that may be affected by changes in sea ice. How would this animal be affected?

C.19 How do changes in sea ice extent benefit some animals?



C.20 Can you think of another animal that may benefit from changes in sea ice extent? How would this animal benefit from the changes?



Part D: Elaborate

D.1 As a class, watch the animation and discuss ways in which you think sea ice could influence changes in ocean density that drive the conveyor belt system.

D.2 Based on the animation of global temperature anomalies, do you think polar ocean waters have been increasing or decreasing in density during the past several years? Explain.

D.3 What patterns do you notice about sea salinity across location?

D.4 Describe the relationship between the amount of sea ice and amount of salinity in the Arctic?

D.5 Write a paragraph describing the importance of sea ice in the ocean conveyor belt system. Explain how sea ice influences temperature and salinity. Include how temperature and salinity drive changes in ocean circulation.



Part E: Evaluate

E.1 Why is an one-degree increase in average global temperature significant to climate?

E.2 Based on the trend in this graph, do you think temperatures will increase, decrease, or stay the same? Why?

E.3 Use the graphic organizer to provide an example of how changing air temperatures will impact the other spheres of the Earth System (atmosphere, biosphere, cryosphere, geosphere, hydrosphere). Provide lines of evidence to support each of your examples.

When you are finished, discuss your results as a class.



Earth System Graphic Organizer

A green rectangular box with rounded corners and a green border. In the bottom-left corner, there is a circular icon containing a green leaf.

A light blue rectangular box with rounded corners and a blue border. In the bottom-left corner, there is a circular icon containing a blue water drop.

A dark blue rectangular box with rounded corners and a dark blue border. In the bottom-left corner, there is a circular icon containing a white cloud.

A purple rectangular box with rounded corners and a purple border. In the bottom-left corner, there is a circular icon containing a white snowflake.

A red rectangular box with rounded corners and a red border. In the bottom-left corner, there is a circular icon containing a white volcano.