Answer Key

MOSAiC Motivation

Background:

The MOSAiC expedition commenced on September, 20 2019, when the German icebreaker Polarstern set sail from Tromso, Norway to spend a year drifting across the Arctic Ocean, frozen in sea ice. Hundreds of scientists from 19 countries will take part in this historic endeavor...but why? In today's lesson, you'll discover what is known and unknown about the Arctic, and ultimately the motivation behind the MOSAiC expedition.

Part 1: MOSAiC Motivation

Warm up: Would you want to participate in an Arctic expedition? Why or why not?

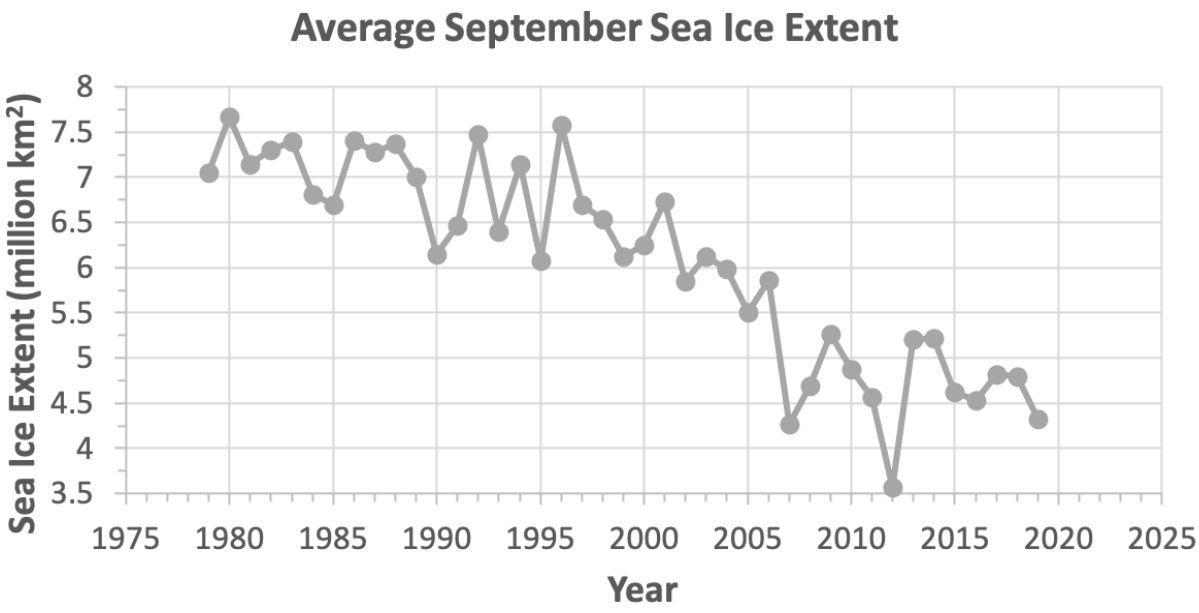
Answers will vary.

Part 2: Sea Ice Extent Changes Over Time

Background: Arctic sea ice reaches its minimum extent (smallest size) at the end of summer every September. Scientists compare each September's sea ice extent to data from years past to identify patterns.

1. Use the "Average September Sea Ice Extent" data table to complete the graph below and observe how sea ice extent has changed over the years.

   See graph below.



The materials were developed by CIRES Education and Outreach at CU Boulder

Answer Key

2. Describe any patterns you observe in the September sea ice extent graph?
   The overall trend is a decrease in Average September sea ice extent with sea ice having decreased from 7.2 million km^2 in 1979 to 3.8 million km^2 in 2019.

3. How can you explain the patterns you observed in the September sea ice extent graph?
   The decrease in September sea ice extent from 1979-2019 might be due to increasing global temperatures.

4. What factors could be contributing to changes *(growth or melt)* in sea ice extent? List as many as you can.
   Answers will vary. See table below for a complete list of factors that influence the growth and melt of sea ice.

   Sea Ice Public Record:

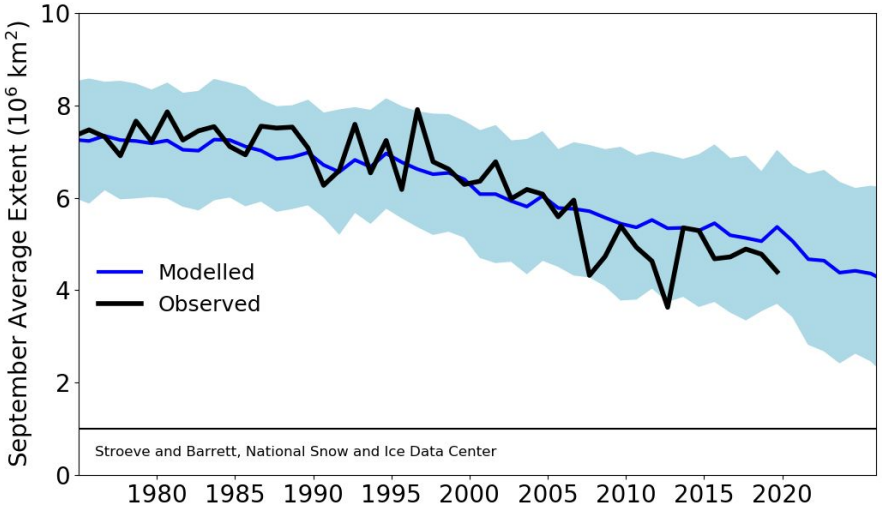
Growth of Sea Ice	**Melting of Sea Ice**
Air temperatures ● Decreased air temperatures lead to increased ice cover Ocean temperatures ● Decreased ocean temperatures lead to increased ice cover The amount of snowfall and snow cover ● More highly reflective snow cover on sea ice means that it takes longer to expose the darker sea ice Fewer melt ponds ● Melt ponds darken the sea ice surface and allow more shortwave radiation (energy from the sun) to be absorbed.	Air temperatures ● Increased air temperatures lead to increased ice melt. Ocean temperatures ● Increased ocean temperatures lead to increased ice melt The amount of snowfall and snow cover ● Less highly reflective snow cover on sea ice means that it takes less time to expose the darker sea ice More melt ponds ● Melt ponds darken the sea ice surface and allow more shortwave radiation (energy from the sun) to be absorbed. More leads (cracks) in the ice

Answer Key

Fewer leads (cracks) in the ice • Leads/cracks in the ice expose dark water which absorbs more shortwave radiation (energy from the sun), warming surface water and melting ice. Wind • Wind can cause ice to spread out Storms and waves • Storms and waves can break up ice, exposing more open, dark water. This dark water absorbs more shortwave radiation (energy from the sun).	• Leads/cracks in the ice expose dark water which absorbs more shortwave radiation (energy from the sun), warming surface water and melting ice. Wind • Wind can cause sea ice to converge (shrink) Storms and waves • Storms and waves can break up ice, exposing more open, dark water. This dark water absorbs more shortwave radiation (energy from the sun).

Part 3: Climate Models

Climate models are computer simulations used to predict how Earth's climate will change in the future. To create a model, scientists must understand all of the factors that will influence the outcome. For example, to build a model to predict sea ice change, scientists must understand how winds and currents influence sea ice motion and account for air and ocean temperatures, among other forces that contribute to the growth and melt of sea ice. The figure below compares the observed September sea ice extent (black) to models predicting September sea ice extent (blue).



Answer Key

1. How do the observed and modelled September sea ice extents compare to one another? Are they similar? Different?
   Answers will vary.
   Similarities: Overall decrease in average September sea ice extent.
   Differences: Models underestimate observed decline in sea ice.

2. Why do you think observed and modelled September sea ice extent datasets are different? (Hint: consider the whole class growth/melt of sea ice public record).
   Answers will vary. Differences are based on uncertainty of factors (processes) that impact the growth and melt of sea ice **(see sea ice public record above)**.

Part 4 - Exit Ticket/Update Summary Table

Exit Ticket:
What could climate scientists do to improve the accuracy of their sea ice extent models?
Answers will vary. Climate scientists could conduct fieldwork in the Arctic; gathering data as it relates to all the factors included in the "sea ice public record" to understand the Arctic climate processes and better inform climate models.

Summary Table:

Expedition	**Motivation**	**Navigation/ Technologies**	**Investigation**
Fram (1893-1896)			
MOSAiC (2019-present)	Gather data to better understand the Arctic climate system and improve climate models		