



## MOSAiC Motivation

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### Setting the Stage

Since the 1893 Fram expedition, there have been more than 100 Arctic expeditions. Because of these expeditions, coupled with tremendous improvements in technology, our understanding of the Arctic has increased dramatically. Today, we use submarines and icebreakers to navigate the Arctic and satellites to estimate temperatures and the amount of sea ice. Despite these technological advances, year-round meteorological data has been impossible to come by because nobody lives in the central Arctic, and as a result, our understanding of the Arctic climate system is incomplete. In this lesson, students discover what is known and unknown about the Arctic, and what is [motivating](#) hundreds of scientists from around the world to spend a year frozen in ice as part of the [MOSAiC](#) expedition.



Photo Credit: Stefan Hendricks/AWI

### Lesson Overview

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- *Part 1 – (10 minutes) MOSAIC Expedition*  
Students will complete a warm up to assess how motivated they might be to visit the Arctic before being introduced to the MOSAIC expedition.
- *Part 2 – (45 minutes) Sea Ice Extent Changes Over Time*  
Observe changes in Arctic sea ice extent in this graphing exercise and create a whole class public record of factors that impact the growth and melt of sea ice.
- *Part 3 – (20 minutes) Climate Models*  
Compare modelled and observed sea ice extent data. Students will ultimately determine that the differences between the modelled and observed sea ice extent datasets can be attributed to a lack of understanding of the processes impacting the growth and melt of sea ice (refer to the whole class public record created in Part 2). MOSAIC scientists are motivated to understand these Arctic processes to better inform climate models.
- *Part 4 – (15 minutes) Exit Ticket/Update Summary Table*  
Students reflect on their learning by completing an exit ticket and updating the whole class summary table.



Instructional Overview	
<b>Grade Level</b>	Middle/High School
<b>Instructional Time</b>	90 minutes
<b>Standards Alignment</b>	<p><b>NGSS <a href="#">Scientific Knowledge is Open to Revision in Light of New Evidence</a>:</b></p> <ul style="list-style-type: none"> <li>Scientific explanations are subject to revision and improvement in light of new evidence</li> </ul> <p><b>NGSS Disciplinary Core Ideas:</b></p> <ul style="list-style-type: none"> <li>ESS2.A Earth's Materials and Systems</li> </ul> <p><b>NGSS Science and Engineering Practices:</b></p> <ul style="list-style-type: none"> <li>Analyzing and Interpreting Data</li> </ul> <p><b>NGSS Crosscutting Concepts:</b></p> <ul style="list-style-type: none"> <li>Patterns</li> <li>Cause &amp; Effect</li> </ul>
<b>Unit Driving Question</b>	<ul style="list-style-type: none"> <li>How have scientific questions, methods, technologies, and our knowledge of the Arctic changed over time?</li> </ul>
<b>Driving Question(s) For This Lesson</b>	<ul style="list-style-type: none"> <li>What is the motivation for the MOSAiC expedition?</li> </ul>
<b>Learning Goals</b>	<ul style="list-style-type: none"> <li>Identify factors contributing to changes in sea ice extent (growth and melt)</li> <li>Describe and compare sea ice extent observations to model projections</li> </ul>
<b>Materials</b>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <a href="#">MOSAiC Motivation PPT</a></li> <li><input type="checkbox"/> <a href="#">MOSAiC Motivation student worksheet</a> (1 per student)</li> <li><input type="checkbox"/> <a href="#">Exit Ticket Rubric</a></li> <li><input type="checkbox"/> <a href="#">Answer Key</a></li> <li><input type="checkbox"/> <a href="#">Arctic Sea Ice Minimum data visualization</a></li> <li><input type="checkbox"/> <a href="#">MOSAiC video</a></li> <li><input type="checkbox"/> <a href="#">MOSAiC Expedition Overview video</a></li> <li><input type="checkbox"/> Rulers</li> <li><input type="checkbox"/> Butcher paper or white board space to create a "sea ice public record" (see Part 2)</li> <li><input type="checkbox"/> Summary Table - <i>if using entire unit</i> (large butcher paper or <a href="#">digital copy</a>, 1 per class)</li> </ul> <p>Optional Resources:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> <a href="#">MOSAiC Climate Model Video</a></li> <li><input type="checkbox"/> Podcast - <a href="#">Why do we need more observations in the Arctic?</a></li> <li><input type="checkbox"/> <a href="#">Average September Sea Ice Extent Data (1979-2019)</a></li> </ul>
<b>Material Preparation</b>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Cue and test web links</li> <li><input type="checkbox"/> Print student worksheets/datasets</li> <li><input type="checkbox"/> Review speaker notes from the <a href="#">MOSAiC Motivation PPT</a></li> </ul>



	<ul style="list-style-type: none"> <li><input type="checkbox"/> Watch this <a href="#">MOSAiC video</a> for additional background information related to the MOSAiC expedition</li> <li><input type="checkbox"/> Set up butcher paper for the sea ice public record (see Part 2)</li> <li><input type="checkbox"/> Display summary table - <i>if using entire unit</i></li> </ul>
<b>Vocabulary</b>	<p><b>Sea Ice Extent:</b> area (km<sup>2</sup>) covered by at least some ice</p> <p><b>Climate Model:</b> Tool used to understand and predict climate behavior on different timescales.</p>

### Part 1 - MOSAiC Expedition (10 minutes)

Driving Question(s): What is the motivation for the MOSAiC expedition?

Refer to Part 1 slides included in the [MOSAiC Motivation PPT](#). See PPT presenter notes for additional information.

1. Students complete warm up prompt: “Would you want to participate in an Arctic expedition? Why or why not?”
2. Introduce students to the MOSAiC expedition (See PPT presenter notes for additional information).
  - a. Watch this [MOSAiC video](#) to provide students with additional background information about MOSAiC expedition.
  - b. Watch this [“MOSAiC Expedition Overview” video](#) to learn more about the MOSAiC ice camp.

### Part 2 - Sea Ice Changes Over Time (45 minutes)

Driving Question(s): What is the motivation for the MOSAiC expedition?

Refer to Part 2 slides included in the [MOSAiC Motivation PPT](#). See PPT presenter notes for additional information.

1. Read the background information from the student worksheet aloud as a class before students beginning graphing exercise.
  - a. Refer to the NASA image of sea ice to describe the term “ice extent” - area covered by ice.
2. Students graph Average September Sea Ice Extent from 2000-2019.
  - a. Students answer Part 2 questions #2-4 with a partner.
3. After students have completed their graphs and questions, watch this [Arctic sea ice minimum data visualization](#) to help students better understand what is represented by their graphs.



4. Create a public record (T-chart) of student ideas addressing factors that contribute to the growth and melt of sea ice.
  - a. You will refer back to this “sea ice public record” in Part 3.

Teacher Tip:

- See [Answer Key](#) for complete list factors that influence the growth and melt of sea ice.

Part 3 - Climate Models (20 minutes)

Driving Question(s): What is the motivation for the MOSAIC expedition?

Refer to Part 1 slides included in the [MOSAIC Motivation PPT](#). See PPT presenter notes for additional information.

1. Read background information from the student worksheet aloud
  - a. Emphasize that climate scientists must consider all factors that contribute to sea ice growth and melt (**refer to the growth/melt of sea ice public record**) when creating sea ice models.
2. Describe the “Arctic sea ice: observed vs. modelled” figure to students (see PPT presenter notes for figure description)
3. Students refer to the “Arctic sea ice: observed vs. modelled” figure and the “sea ice public record” to answer Part 3 questions.
4. Summarize Part 3 by **saying**, “*Rising global temperatures are contributing to a decline in sea ice extent. Predicting future changes to sea ice is challenging because there are so many factors (**refer to public record**) that influence the growth and melting of sea ice.*”

Optional Extension: Best for high school students

- Watch this [MOSAIC climate model video](#).



#### Part 4 - Exit Ticket/Update Summary Table (15 minutes)

Driving Question(s): What is the motivation for the MOSAiC expedition?

Refer to Part 4 slides included in the [MOSAiC Motivation PPT](#). See PPT presenter notes for additional information

1. Exit Ticket - Students create an annotated sketch to answer the driving question, “What could climate scientists do to improve the accuracy of their sea ice extent models?”.
  - a. Project and describe the [Exit Ticket Rubric](#) to the class before they begin the assessment as this is what you will use to grade their exit tickets.
2. Update Summary Table (**if using entire unit**) - Gather student ideas to update the MOSAiC Motivation box in the summary table (see [Answer Key](#)).

#### Teacher Tip:

- Encourage students to think about their responses to the Exit Ticket when considering what should be included in the summary table’s “MOSAiC Motivation” box.

Optional Extension: [Why do we need more observations in the Arctic?](#) - Podcast (3:30 minutes)

- [Listen](#) to MOSAiC scientists describe the motivation for the MOSAiC expedition and why it is important to collect more observational data from the Arctic.