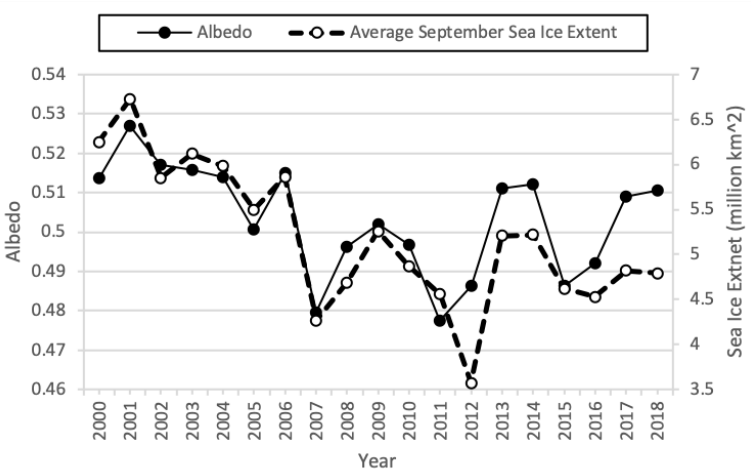
Model Testing

Setting the Stage

Scientific models are constructed to explain phenomena. These models are revised as more is learned, and must be tested to see how closely they resemble the phenomenon. In this lesson, students will test their models by matching their ideas against real-world data about the phenomenon, arctic amplification.



Lesson Overview

- *Part 1 – (10 minutes) Model Testing*
  Revisit the concept of scientific models and how/why it's important to test models.
- *Part 2 – (20 minutes) Albedo and Sea Ice Line Graph*
  Students construct a line graph comparing albedo and sea ice extent in the Arctic from 2000-2018.
- *Part 3 – (20 minutes) Albedo and Temperature Scatter Plot*
  Students construct a scatter plot to study the relationship between albedo and temperature in the Arctic from 2000-2018.
- *Part 4 – (20 minutes) Wrap-up Questions*
  Students work in pairs to answer questions requiring them to reflect upon and provide evidence for their learning as it relates to the unit driving question: why might the Arctic be warming twice as fast as the rest of the world?

Instructional Overview

The materials were developed by CIRES Education and Outreach at CU Boulder with support from AGS 1554659 and OPP 1839104

Grade Level	Middle/High School
Instructional Time	70 minutes
Standards Alignment	**NGSS Disciplinary Core Ideas:** • **ESS2.A: Earth Materials and Systems** • **ESS2.D: Weather and Climate** **NGSS Science and Engineering Practices:** • Analyzing and Interpreting Data • Constructing Explanations **NGSS Crosscutting Concepts:** • Patterns
Unit Driving Question	• Why might the Arctic be warming twice as fast as the rest of the world?
Driving Question(s) For This Lesson	• Can we use real-world data to confirm or refute our model/understanding of the unit driving question?
Learning Goals	• Identify and explain patterns in data
Materials	❑ Model Testing PPT ❑ Model Testing Student Worksheet (1 per student) ❑ Answer Key ❑ Sea Ice Visualization ❑ Arctic Sea Ice Reaches 2019 Minimum Extent video ❑ Option 1 Dataset (1 per student - graphing by hand) ❑ Option 2 Dataset (graphing on the computer) ❑ Summary Table ❑ Initial Ideas public record Optional: ❑ "Tools of Science: Modeling" video ❑ "Creating a scatter plot and drawing a line of best fit" video
Material Preparation	❑ Cue and test web links ❑ Print student worksheets and datasets ❑ Review speaker notes in the Model Testing PPT ❑ Review Answer Key ❑ Display summary table and initial ideas public record.
Vocabulary	• No new vocabulary

Part 1 - Model Testing (10 minutes)

Refer to Part 1 slides included in the Model Testing PPT. See PPT presenter notes for additional information.

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1. Revisit the concept of a scientific model and how/why it's important to test models.

Optional: "Tools of Science: Modeling" video (6:11 minutes)
- Watch and discuss this video about modeling in science.

2. Describe and show examples of line graphs and scatter plots. In Parts 2 and 3 students will be constructing both line graphs and scatter plots using real-world data about the phenomenon (sea ice extent, temperature and albedo).
    a. Play the Arctic sea ice extent visualization and show the line graph (on the same webpage) to demonstrate line graphs are a tool to show changes over time.

Part 2 Albedo and Sea Ice Line Graph- (20 minutes)

Refer to Part 2 slides included in the Model Testing PPT. See PPT presenter notes for additional information.

1. Students will plot Arctic albedo data onto a line graph to compare albedo and sea ice extent in the Arctic from 2000-2018.
    a. Students will either plot data by hand (Option 1) or on the computer (Option 2)

2. Students identify and explain patterns they observe from their line graph.

Part 3 - Albedo and Temperature Scatter Plot (20 minutes)

Refer to Part 3 slides included in the Model Testing PPT. See PPT presenter notes for additional information.

1. Students will plot Arctic albedo and Arctic temperature anomaly data onto a scatter plot and add a line of best fit to identify and explain the relationship between the two variables .
    a. If students are unfamiliar with scatter plots, consider constructing this scatter plot as a whole class or providing students with a completed scatter (see Answer Key)

2. Students identify and explain patterns they observe from their scatter plot.

Teacher Tip:
- Discuss other mechanisms potentially contributing to the Arctic's amplified warming as a way to explain variability in the relationship between albedo and temperature.
    - An increase in the amount of warm air from lower latitudes reaching the Arctic
    - Warm ocean water flowing into the Arctic

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Optional: "Creating a scatter plot and drawing a line of best fit" video (3:42 minutes)

- Watch and discuss this video to instruct/model for students how to construct a scatter plot.

Part 4 - Wrap up Questions (20 minutes)

Refer to Part 4 slides included in the Model Testing PPT. See PPT presenter notes for additional information.

1. Watch the "Arctic Sea Ice Reaches 2019 Minimum Extent" video to reinforce the ice-albedo feedback concept in the context of what the Arctic is warming twice as fast as the rest of the world.

2. Students work in pairs to answer wrap-up questions. Students should reference lessons/activities they've completed as evidence when describing new concepts.
    a. The questions have been designed to help students connect the dots and explain why the Arctic is warming twice as fast as the rest of the world.

3. Discuss wrap-up questions as a class.
    a. Refer to the "Initial Ideas" public record. See if the class comes to a consensus on ideas/concepts that explain the unit driving question. Feel free to add or remove (cross off) ideas/concepts to the list.

4. Preview next day - Final Model Construction

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