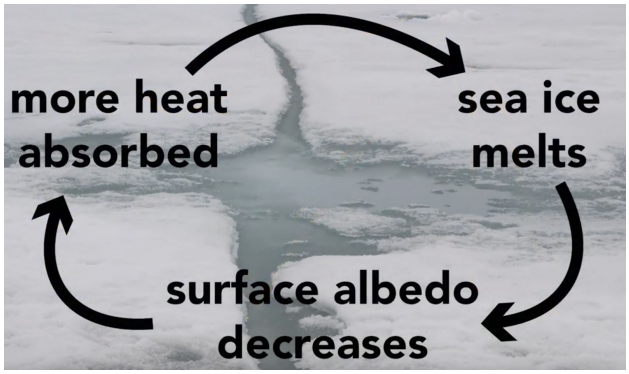
Ice-Albedo Feedback

Setting the Stage

The ice-albedo feedback is an example of a positive feedback loop. A feedback loop is a cycle within a system that increases (positive) or decreases (negative) the effects on that system. In the Arctic, melting sea ice exposes more dark ocean (lower albedo), which in turn absorbs more heat and causes more ice to melt...the cycle continues. In this lesson, students will use maps to calculate and compare changes in albedo.



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Lesson Overview

- *Part 1 – (15 minutes) Albedo Feedbacks Video*
  In this video, scientists explain positive and negative feedbacks in the Arctic.
- *Part 2 – (35 minutes) Calculating Albedo*
  Students will calculate the albedo for Maps A and B.
- *Part 3 – (10 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	
Grade Level	Middle/High School
Instructional Time	60 minutes
Standards Alignment	**NGSS Scientific Knowledge is based on Empirical Evidence:** ● Science knowledge is based upon logical and conceptual connections between evidence and explanations. **NGSS Disciplinary Core Ideas:** ● ESS2.D: Weather and Climate **NGSS Science and Engineering Practices:** ● Using Math and Computational Thinking ● Developing and Using Models **NGSS Crosscutting Concepts:** ● Cause and Effect ● Energy and Matter ● Systems and System Models ● Stability and Change
Unit Driving Question	● How have scientific questions, methods, technologies, and our knowledge of the Artcie changed over time?
Driving Question(s) For This Lesson	● What is a feedback loop? ● Why does a decline in Arctic sea ice lead to further melting of sea ice?
Learning Goals	● Describe the ice-albedo feedback loop
Materials	❏ Ice-Albedo Feedback PPT ❏ Middle School Student Worksheet (1 per student) ❏ High School Student Worksheet (1 per student) ❏ Exit Ticket Rubric ❏ Answer Key ❏ Arctic Feedbacks video ❏ Ice-albedo - Global View video ❏ Summary Table- *if using entire unit* (large butcher paper or digital copy, 1 per class)
Material Preparation	❏ Print student handouts ❏ Cue and test web links ❏ Review presenter notes from the Ice-Albedo Feedback PPT ❏ Display summary table - *if using entire unit*
Vocabulary	Feedback Loop: a cycle within a system that increases (positive) or decreases (negative) the effects on that system.

Part 1 - "Arctic Feedbacks" Video (15 minutes)
Driving Question: What is a feedback loop?

Refer to Part 1 slides included in the Ice-Albedo Feedback PPT. See PPT presenter notes for additional information.

1. Introduce the term "feedback loop" in the context of the ice-albedo feedback (see PPT).

Teacher Tip:

- Use the following example to reinforce the concept of a feedback loop. The climate system is warming. In this case, a positive feedback occurs when factors further increase that warming (melting sea ice), while a negative feedback occurs when factors reduce the warming (increased cloud cover).

2. Watch the "Arctic Feedbacks" video.
    a. Students record factors that increase or decrease warming in the Arctic on their student worksheet (see Answer Key)
    b. Review student-generated lists as a whole class

Part 2 - Calculating Albedo - Map A (35 minutes)
Driving Question: Why does a decline in Arctic sea ice lead to further melting of sea ice?

Refer to Part 2 slides included in the Ice-Albedo Feedback PPT. See PPT presenter notes for additional information.

1. Read through background information found on the student worksheet. Refer to the "Ice-Albedo Feedback" PPT to discuss the different sea ice albedos.

2. Calculate the albedo of Map A as a **whole class** following the steps below:
    a. Let students know that each box represents 1 km^2, and that the total map area is 100 km^2. The land cover shown in white represents sea ice and the land cover shown in gray represents ocean.
    b. Instruct students to estimate how many total boxes are covered by ice and to record this number in Column A.
    c. Instruct students to estimate how many total boxes are covered by the ocean and to record this number in Column A.
    d. Complete the Map A Table together as a whole class (see Answer Key).

3. Students follow the same procedure above to estimate the albedo for Map B (done individually or in pairs).

4. Show this 20 second, Ice Albedo - Global View video to reinforce the ice-albedo feedback concept.

Part 3 - Exit Ticket/Update Summary Table (10 minutes)

Driving Question: Why does a decline in Arctic sea ice lead to further melting of sea ice?

Refer to Part 3 slides included in the Ice-Albedo Feedback PPT. See PPT presenter notes for additional information.

1. Exit Ticket - Students create an explanation and annotated sketch to answer the driving question, “How does a decline in Arctic sea ice lead to further melting of sea ice?”.
    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 Investigation box in the summary table (see Answer Key).
    a. Students record new summary table entries onto their own summary tables.