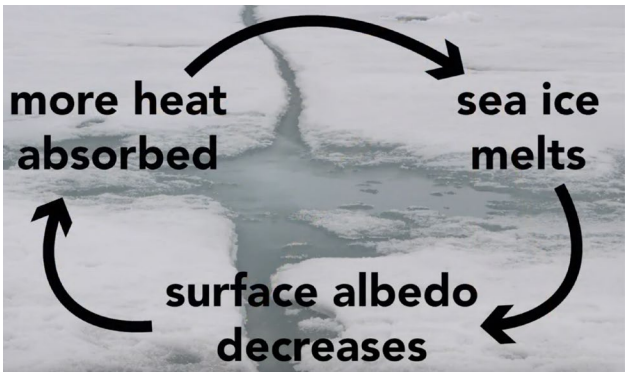
Ice-Albedo Feedback

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, and 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) Arctic 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) Update Earth's energy budget model worksheet*
  Students update their "Earth's energy budget model worksheet" to include concepts related to albedo and sea ice loss.
- *Part 4 – (10 minutes) Summary Table*
  Students reflect on their learning and how it helps them understand the unit driving question.

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

Instructional Overview	
Grade Level	Middle/High School
Instructional Time	60 minutes
Standards Alignment	**NGSS Disciplinary Core Ideas:** ● **ESS2.A: Earth Materials and Systems** **NGSS Science and Engineering Practices:** ● Using Mathematics and Computational Thinking **NGSS Crosscutting Concepts:** ● Cause and Effect ● Scale, Proportion, and Quantity
Unit Driving Question	● Why might the Arctic be warming twice as fast as the rest of the world?
Driving Question(s) For This Lesson	● What is a feedback loop? ● How does a decline in 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) ❑ Answer Key ❑ Arctic Feedbacks video ❑ Ice-albedo - Global View video ❑ Summary Table ❑ Initial Ideas public record
Material Preparation	❑ Cue and test web links ❑ Print student handouts ❑ Review presenter notes from the Ice-Albedo Feedback PPT ❑ Review Answer Key ❑ Display summary table and initial ideas public record.
Vocabulary	Feedback Loop: a cycle within a system that increases (positive) or decreases (negative) the effects on that system.

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Part 1 - “Arctic Feedbacks” Video (15 minutes)

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).
- Stress that negative feedbacks do not necessarily cause negative effects

1. Watch the “Arctic Feedbacks” video.
    a. Students record factors that increase or decrease warming in the Arctic on their student worksheet
    b. Review student-generated lists as a whole class

Part 2 - Calculating Albedo (35 minutes)

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

1. Read through background information included in the student worksheet as a whole class. Refer to the Ice-Albedo Feedback PPT to discuss the difference 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 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 and answer questions (done individually or in pairs).

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

Part 3 - Update Earth's energy budget model worksheet (10 minutes)

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

1. Teacher guides students through updating their "Earth's energy budget model worksheet" to include information about the ice-albedo feedback.The teacher should update the class model under a document camera (see Answer Key for example). Students may want to use colored pencils to copy the whole class model onto their worksheet.

Part 4 - Summary Table (10 minutes)

Refer to Part 4 slides included in the Ice-Albedo Feedback PPT. See PPT presenter notes for additional information.

1. Students work in groups to reflect on their learning and how it relates back to the unit driving question, "Why might the Arctic be warming twice as fast as the rest of the world?"

2. Facilitate a discussion in which students come to a consensus about what they learned and how it helps them understand the unit driving question. Ideas/concepts agreed upon by the class should be included in the summary table (see Answer Key).
    - Students record new summary table entries onto their own summary tables.

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