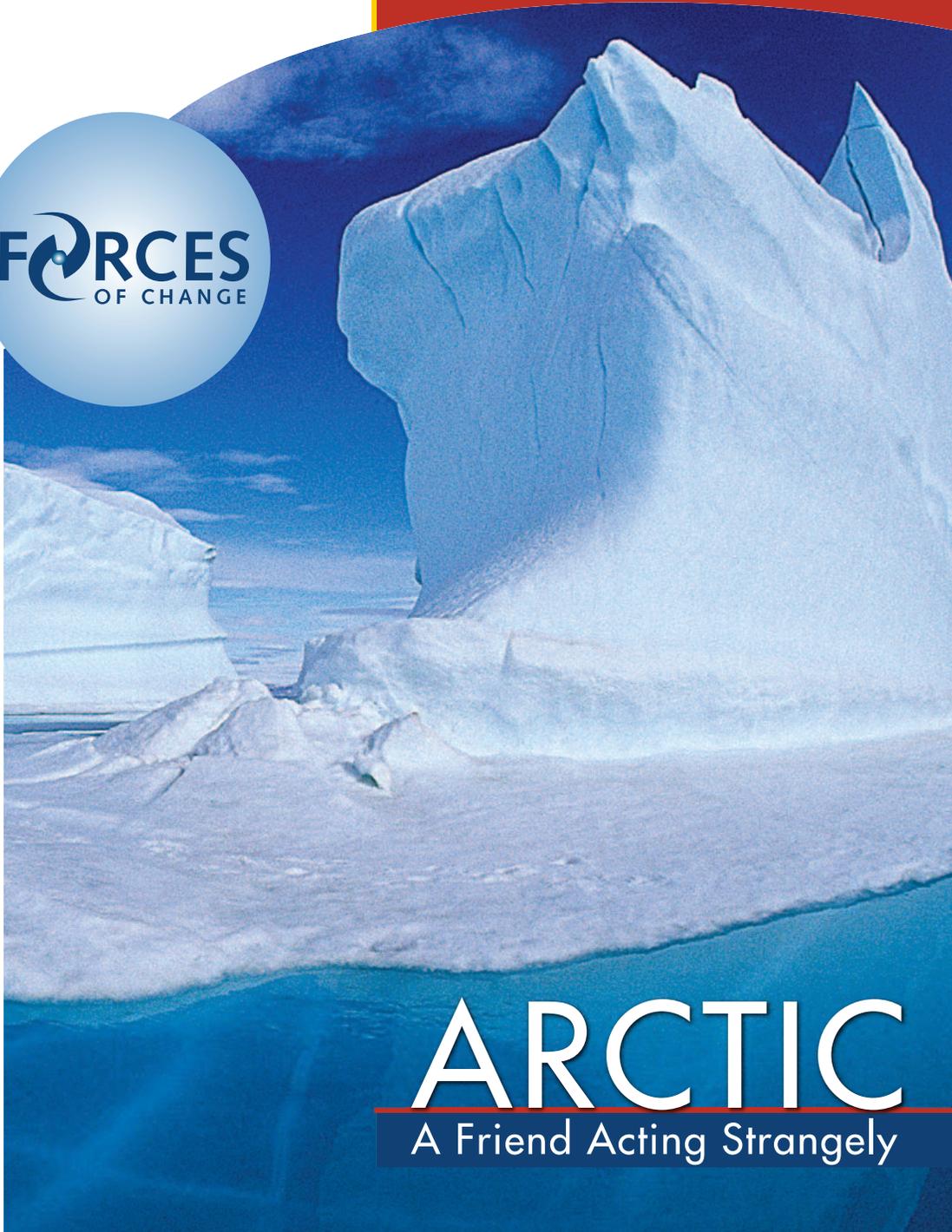


Activity 4
It's a Cool Color



ARCTIC

A Friend Acting Strangely



Smithsonian
National Museum of Natural History

ACTIVITY 4

IT'S A COOL COLOR

THE ALBEDO EFFECT AND CLIMATE

OVERVIEW

Students do a hands-on activity to learn about the albedo effect. Understanding this phenomenon will help them learn how decreases in light-colored snow and ice could cause increases in temperatures.

SUGGESTED GRADE LEVEL

5 – 8

ALIGNMENT WITH NATIONAL STANDARDS

National Science Education Standards

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- Properties and changes of properties in matter
- Structure of the earth system
- Understandings about science and technology
- Science and technology in society
- Science as a human endeavor
- Nature of science

ESTIMATED TIME

One 45-50 minute class period

MATERIALS

- White or light-colored T-shirt (optional)
- Black or dark-colored T shirt (optional)
- White and black construction paper cut into half sheets
- Scissors
- Stapler
- Desk lamp with 150 watt bulb
- Two air temperature thermometers for each group of students
- Kitchen timer
- Cellophane tape
- Global relief map showing polar regions
- Transparency of *Fig. 4.1*
- Transparency of *Fig. 4.3* and *4.4*
- Overhead projector
- Make color copies of *Fig. 4.5* and *4.6*

ACTIVITY 4

OBJECTIVES

Students will be able to:

- 1 > Explain how color affects the temperature of a material.
- 2 > Define the concept of albedo.
- 3 > Formulate a hypothesis, collect data, and draw conclusions.
- 4 > Explain how less snow and ice in the Arctic could warm Arctic and global temperatures.

BACKGROUND

The amount of energy retained by the Earth is strongly dependent on the albedo of its surfaces. Sunlight falling on light colored surfaces strongly reflects back into space. Sunlight falling on dark colored surfaces is strongly absorbed.

That is one reason the Arctic's cold is so extreme—and our planet doesn't over-heat. Ice and snow reflect about 85–90% of sunlight. Open ocean water, for example, reflects just 10%. With less ice cover, the ocean and the land warm, causing more ice to melt, further warming the planet. In recent decades, snow and ice cover has been decreasing in most of the Arctic.

Arctic sea ice—frozen ocean water—is an example. Data collected by satellites show that the area of the Arctic's summer sea ice has shrunk about 15–20% since the late 1970s. Per decade, that loss equals an area the size of Arizona. Aircraft reconnaissance and ship observations extend the record back to the 1950s and also show a steady decrease in sea ice. Radar aboard submarines show the sea ice has also thinned—as much as 40% in some areas in the past few decades.

Why is this important to climate? Sea ice is very sensitive to small changes in the temperature of the air above it and in the water below it. Most scientists believe that shrinking sea ice cover could be one sign of the initial influences of global warming.

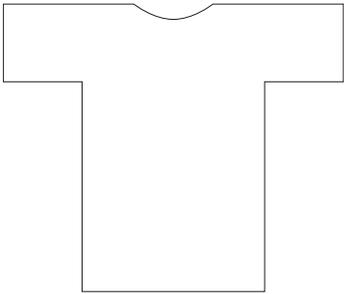
Teacher note: Figs. 4.1, 4.2, 4.3 and 4.4 can be found in the Teacher References at the end of this document.



A polar bear cautiously picks its way across thin ice.

Photo © Chris Linder Photography

ACTIVITY 4



PROCEDURE

STEP 1 > Introduce the activity

- 1 > Show students the black and white T-shirts. Ask them which one they would prefer to wear on a hot, sunny day. Which one would help them stay cooler? Do they know why?
- 2 > Introduce the concept of albedo: how sunlight (light energy) is absorbed or reflected and transformed into heat energy. Dark colors absorb more light energy, hence are warmer. Light colors reflect more light energy, hence are cooler.
- 3 > Tell students that they will observe demonstrations of the albedo effect.

STEP 2 > Albedo demonstration #1

- 1 > Distribute **Activity Sheet F**.
- 2 > Form two pockets from construction paper, one black and one white.
 - Cut each sheet of construction paper in half.
 - Fold each 1/2 sheet of white and black construction paper in half length-wise and staple it on three sides to form two pockets.
 - Place a thermometer inside each pocket. Place both pockets about 12" below a desk light with 150 watt bulb. **Do not turn on the light yet.**
- 3 > During the demonstrations students will use **Activity Sheet F** to:
 - Step 1: Develop a hypothesis as to whether the white pocket or the black pocket will get warmer when exposed to direct light.
 - Begin Step 2: Enter data for "0" minutes for both thermometers.
 - **Turn the light on.** Record the temperature displayed on each thermometer at one-minute intervals for the next 10-minutes.
 - As the demonstration proceeds, students complete Steps 2 and 3 on their activity sheets.

ACTIVITY 4

Teacher note: Figs. 4.5 and 4.6 can be found in the Teacher References at the end of this document.

STEP 3 > Albedo demonstration #2

(This is an alternate or optional demonstration. It could also be performed by small groups of students on their own.)

- 1 > Make comparisons between different parts of the graph.
- 2 > Show class the two photographs of sea ice in the Beaufort Sea, figs. 4.5 and 4.6.
- 3 > Tape a thermometer to the back of each photograph. One thermometer bulb should be under an area of light-colored ice and one under an area of dark-colored water. Place thermometers so that they extend beyond the edges of the photographs.
- 4 > Repeat steps from the Albedo demonstration #1 above.

ASSESSMENT IDEAS

- 1 > Use results of **Activity Sheet F** as an assessment.
- 2 > Ask students to design their own albedo experiment and explain its results to the class.

RESOURCES

http://eo.ucar.edu/educators/ClimateDiscovery/ESS_lesson4_10.19.05.pdf

<http://www.pbs.org/saf/1505/teaching/teach2.pdf>

ACTIVITY 4 > **ARCTIC HEAT WAVE?** > ACTIVITY SHEET F

Student Name _____

STEP 1 > What is your hypothesis? (Predict which thermometer will record the warmer temperature—the one inside the white pocket or the one inside the black pocket.)

STEP 2 > Collect the data. Use this table to record the temperature data.

TIME	Temperature in BLACK pocket	Temperature in WHITE pocket
0 minutes		
1 minute		
2 minutes		
3 minutes		
4 minutes		
5 minutes		
6 minutes		
7 minutes		
8 minutes		
9 minutes		
10 minutes		

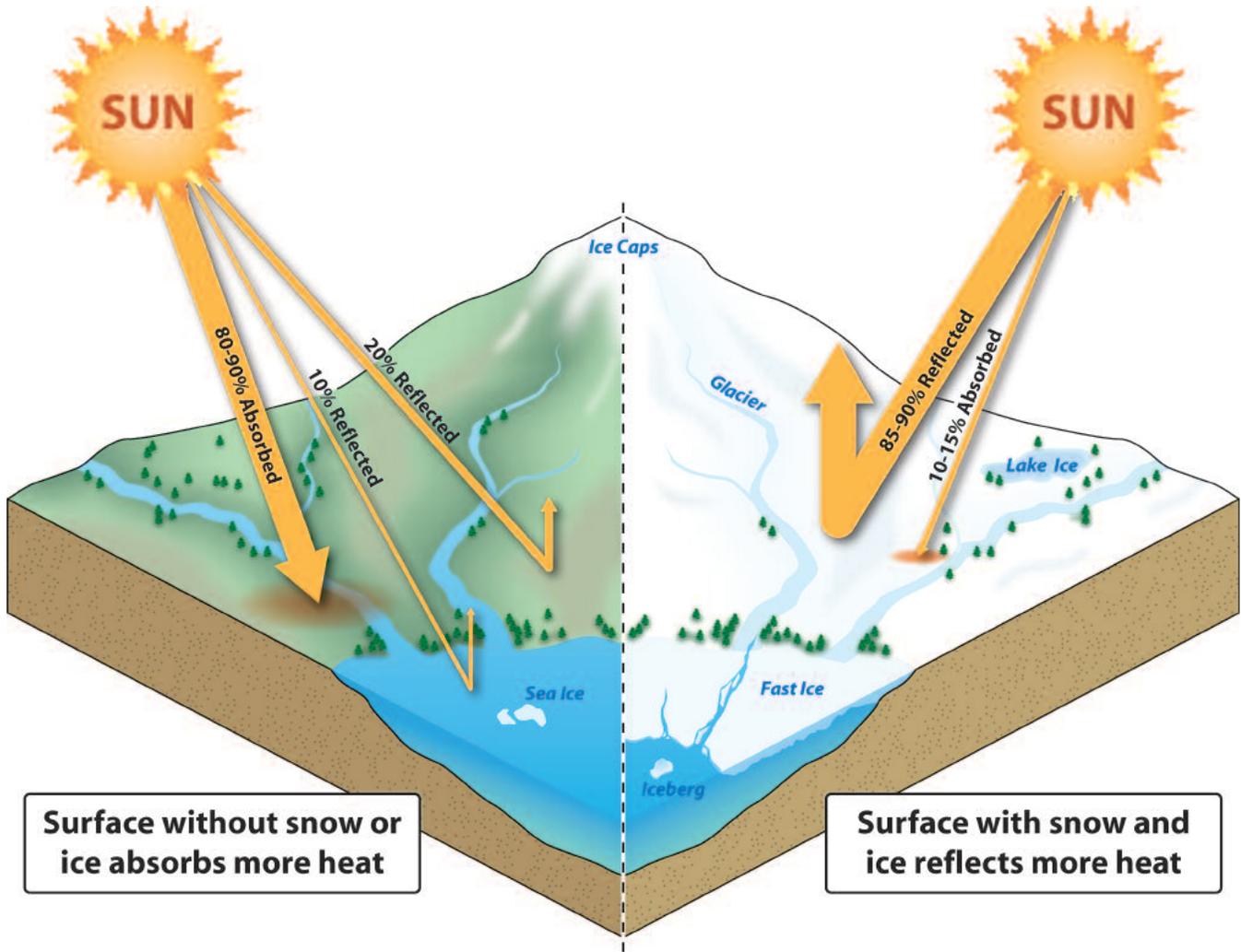
STEP 3 > What did your data tell you about how the color of a material can affect its temperature?

STEP 4 > 1. Define the term “albedo effect.”

2. Research what has happened to snow and ice cover in the Arctic in the past five decades. Based on what you have observed today, might you expect Arctic temperatures in the future to increase or decrease. Why?

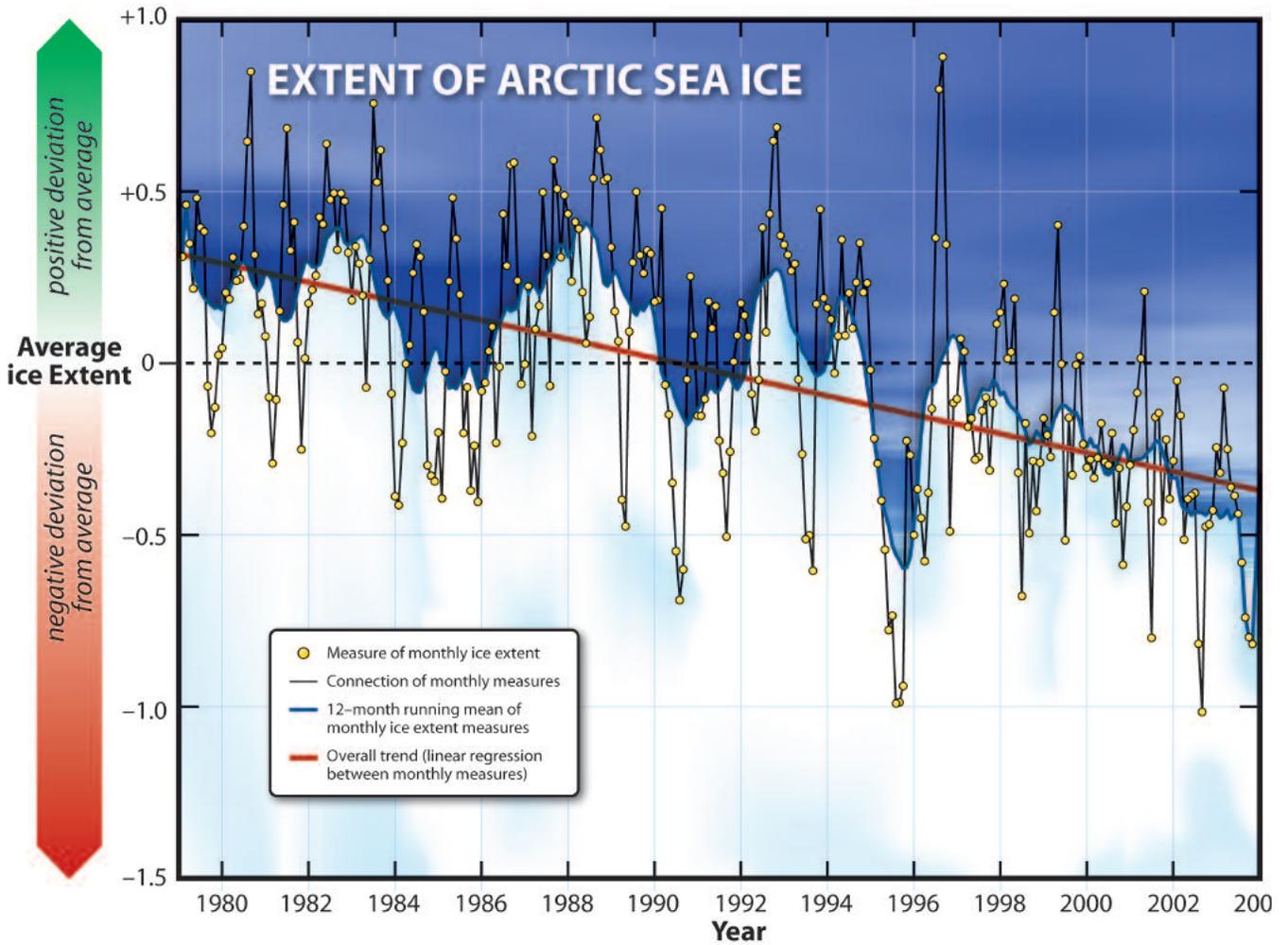
ACTIVITY 4 > TEACHER REFERENCES

Teacher Reference #1: Fig. 4.1 (Albedo Effect)



ACTIVITY 4 > TEACHER REFERENCES

Teacher Reference #2: Fig. 4.2 (Extent of Arctic Sea Ice)

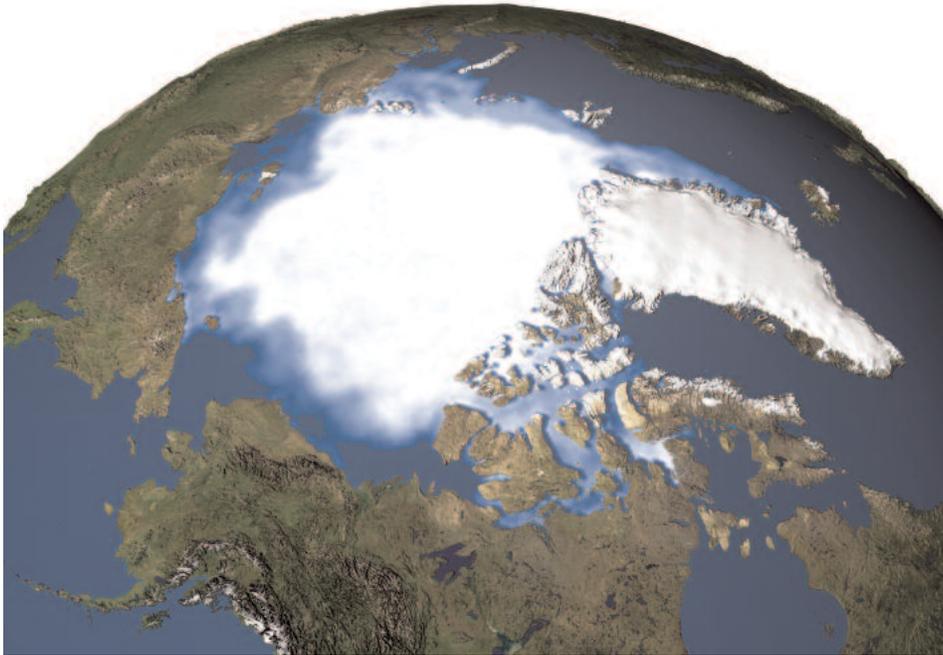


Graph by The M Factory © Smithsonian Institution, based on satellite data collected since 1978 and analyzed by Julienne Stroeve, University of Colorado, CIRES

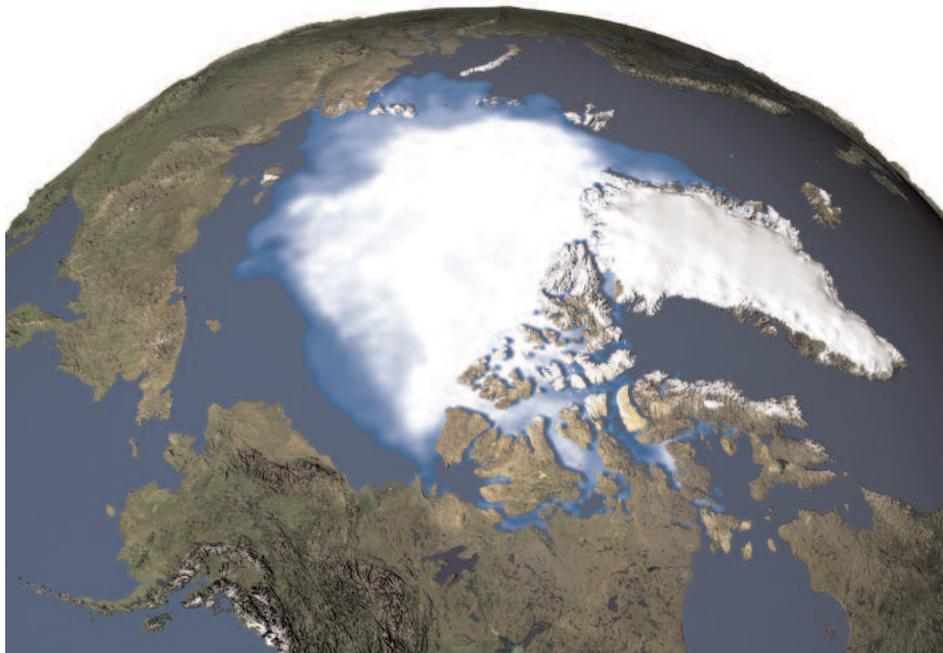
ACTIVITY 4 > **TEACHER REFERENCES**

Teacher note: This is also available as an animation at www.wheredowesendthem.edu

Teacher Reference #3: Fig. 4.3 (Satellite Image of Average Sea Ice Coverage 1979-1981)



Teacher Reference #4: Fig. 4.4 (Satellite Image of Average Sea Ice Coverage 2003-2005)



ACTIVITY 4 > **TEACHER REFERENCES**

Teacher Reference #5: Fig. 4.5 (Beaufort Sea Ice winter)



Photo © RADMM Harley D. Nygren/Department of Commerce

Teacher Reference #6: Fig. 4.5 (Beaufort Sea Ice summer)



Photo © Chris Linder Photography