

## Investigation Two: How Much Sea Ice?

### Getting Your Bearings

The Shackleton story is about the ingenuity and resiliency of people facing a dangerous situation in an extreme environment. Sea ice is a big part of that story. Sea ice blocked the way as the *Endurance* tried to sail south from South Georgia Island. Sea ice imprisoned and then crushed the ship. Sea ice became the platform on which the men pitched their tents, housed their dogs, caught their food, cooked their meals, and dragged their sleds and boats. Sea ice was a formidable foe as the men tried to reach land. The sea ice was dangerous because it was so unpredictable. It could be tilted, jagged, pitted, slushy, fragile, or unstable.



Image Courtesy of Antarctic Cooperative Research Centre and Australian Antarctic Division

Sea ice forms when salt water freezes. It is different from icebergs and glaciers. Icebergs and glaciers form from fallen snow or from water that evaporates from the ocean. Icebergs and glaciers have no salt in them. Sea ice, because it is frozen ocean water, is salty.

Sea ice can be found in both the Arctic and the Antarctic. The amount of sea ice changes from season to season and also from year to year. In general, sea ice grows during the winter season, when temperatures decrease and more of the ocean freezes, then shrinks during the summer season, when temperatures rise and most of it melts.

Today, scientists study Antarctic sea ice very carefully. We now know that sea ice covers a huge area of ocean each winter. We also know that the freezing and melting of such a huge amount of ice each year influence local climate and weather. Information about how sea ice changes seasonally and from year to year can be fed into computer models to help us predict future climate conditions. You will learn more about scientists' climate studies later on.

### Goals

1. You will use satellite images to look at the expanse of sea ice around Antarctica in both summer and winter. You will then calculate how much area the sea ice covers.
2. You will learn about the relationship between Earth's seasons, the height of the Sun, and the concentration of energy on Earth's surface.

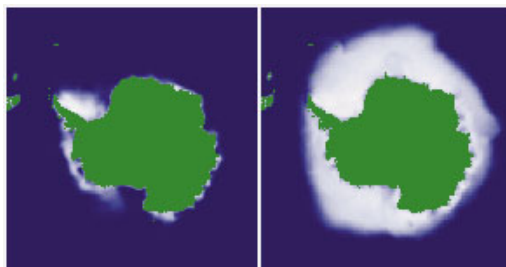
### Exploring and Discovering

#### How Much Sea Ice?

A huge expanse of sea ice forms over the ocean around Antarctica each winter, then melts the next summer. Sea ice influences local and global climate, provides a habitat for organisms, and is a barrier to ships such as the *Endurance*. In this activity, you will use two satellite images to help you measure the amount of sea ice around Antarctica at the end of summer and winter. Scientists call the difference between the winter expanse and the summer expanse the *seasonal change* in sea ice. When scientists describe the size of an area like this, they use square kilometers for their unit of measure. You will do the same in this activity.

#### Materials

- [Image 1: Antarctic Sea Ice, March 1995](#)
- [Image 2: Antarctic Sea Ice, September 1995](#)
- Transparent grid, marked in centimeter squares
- Transparency markers in two colors
- Damp cloth or paper towel
- Calculators



[Image 1](#)  
[March 1995](#)

[Image 2](#)  
[September 1995](#)

### Procedure and Record Sheet

1. Look closely at the two images of the sea ice surrounding Antarctica in March and September, then answer the following questions.

*When is there more sea ice surrounding Antarctica, in March or in September?*

*What season is this in Antarctica?*

2. Using these images, measure the area of sea ice around Antarctica in March and September. You can do this on paper or use the online measuring tool. Record your findings in the data table. Your answers will be in square centimeters.

#### Offline procedure

- Place your transparent grid over Image 1. Mark the edges of the image so you can reposition it if it slips.
- Using one colored marker, trace the outline of the Antarctic continent, including the ice shelves.
- In the other color, trace around the far edge of the sea ice.
- Count the number of squares that are covered by the sea ice. Where the ice takes up only part of a square, combine it with other partially covered squares to make a complete one. You may want to put dots or numbers in the squares as you go along to keep track of the count.
- Use the same steps to calculate how much sea ice is pictured in Image 2.

#### Online procedure

- Click on the link to the image of Antarctica that you'll be working on—Image 1 or Image 2. Be patient, it might take a few seconds to load.
- When the "gridded" image is on your screen, click on a square. It will highlight in red. Count the highlighted squares to fill in the chart "How much sea ice?"
- If you've highlighted a square by mistake, you can double-click on the same square to return it to normal.

#### How much sea ice?

Area of sea ice in <a href="#">March</a> (in centimeter squares)	Area of sea ice in <a href="#">September</a> (in centimeter squares)	Actual area of sea ice in March (in square kilometers)	Actual area of sea ice in September (in square kilometers)	Seasonal change in Antarctic sea ice (in square kilometers)	Seasonal change in sea ice (expressed as a percentage)

3. Use the following scale to find the actual area of sea ice in March and September.

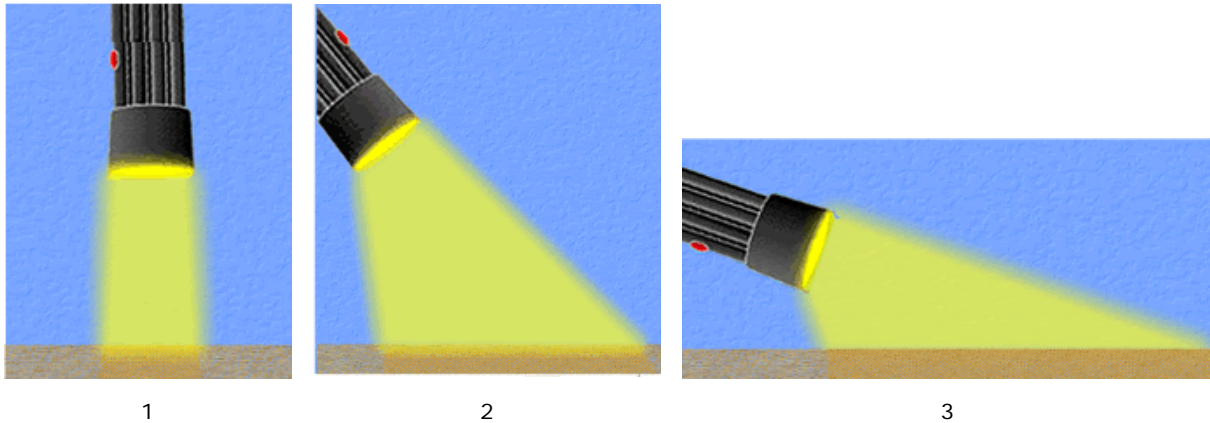
## 1 CENTIMETER SQUARE = 158,000 SQUARE KILOMETERS

Record your answer in the data table above, and show your work here.

- Now calculate the area of seasonal change. Remember, the area of seasonal change is the difference between the amount of ice in winter (September) and the amount of ice in summer (March). To find the answer, just subtract. Record your answer in the data table above, and show your work here.
- Your teacher may also ask you to calculate what percentage of sea ice changed with the seasons in 1995. If so, he or she will give you instructions.

### Looking Closer

#### Check for understanding: Which Angle?



- Choose the diagram that best answers this question:

*At which angle will the paper heat up the most?*

- Explain your answer.

## Tracking the Angle of the Sun in Two Locations

In this activity, you will investigate how the angle of the Sun affects how much heat the Earth absorbs. First you will read a short discussion about solar energy and the angle of the Sun. Then you will compare the maximum angle of the Sun at two latitudes over the course of a full year. These latitudes are 76°S, where the *Endurance* became stuck in the ice, and a city whose latitude is close to your city's latitude. Looking at this data will help you understand how **the seasons are reversed** in the Southern and Northern Hemispheres.

### The Angle of the Sun and Solar Energy

#### Materials

- Graph paper
- Pencils of two different colors

#### Procedure and Record Sheet

1. Look at the data table below. The sun's maximum angle is recorded every two weeks for the location 76° South, where the *Endurance* was trapped in the ice. Graph the angle of the Sun for 76°S on paper or use the online graphing tool. Put the dates on the x-axis and the height of the Sun on the y-axis. Your teacher will suggest a reasonable range for the y-axis.

Maximum Angle of the Sun		
Date (2001)	<i>Endurance</i> beset, 76°S latitude	City:  Latitude:
1/1	37°	
1/15	35°	
1/29	32°	
2/12	30°	
2/26	23°	
3/12	17°	
3/26	12°	
4/9	6°	
4/23	1°	
5/7	-3°	
5/21	-6°	
6/4	-9°	
6/18	-9°	
7/2	-9°	
7/16	-7°	
7/30	-4°	
8/13	0°	
8/27	4°	
9/10	9°	
9/24	15°	

10/8	20°	
10/22	25°	
11/5	30°	
11/19	34°	
12/3	36°	
12/17	38°	
12/31	37°	

\*source Solar Calculator

- Answer the questions in the **Comparing Latitude** table below for the location 76° South. Refer to the **Maximum Angle of the Sun** data table and graph.
- Find the latitude where you live using an atlas or you can find your latitude online.

My latitude is:

Choose a city whose latitude is close to your city's latitude. Your teacher may provide data for your location.

- Record the location, latitude and maximum angle of the Sun for each day in the data table above.
- Graph the angle of the Sun data for a city whose latitude is close to your city's latitude on paper or use the online graphing tool. If you graph on paper, create a color key so you can tell the two locations apart.
- Answer the questions in the **Comparing Latitude** table for a city whose latitude is close to your city's latitude. Refer to the **Maximum Angle of the Sun** data table and graph.

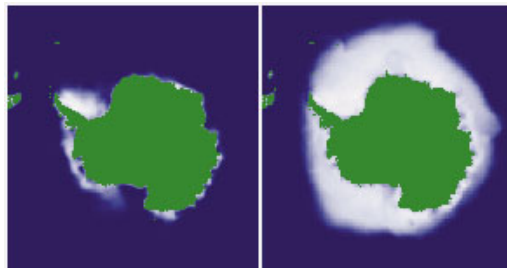
### Comparing Latitudes

Latitude where the Endurance was trapped in the ice  76°S	Latitude where you live or closest to it
1. What date was the Sun highest?	1. What date was the Sun highest?
2. What date was the Sun lowest?	2. What date was the Sun lowest?
3. What months was the Sun's energy most concentrated and intense?  How do you know? What season is this?	3. What months was the Sun's energy most concentrated and intense?  How do you know? What season is this?

<p>4. Are there dates when the Sun doesn't rise at all?</p> <p>How do you know?</p>	<p>4. Are there dates when the Sun doesn't rise at all?</p> <p>How do you know?</p>
<p>5. Is the Sun ever directly overhead (i.e., at 90°)?</p>	<p>5. Is the Sun ever directly overhead (i.e., at 90°)?</p>

7. Use specific evidence from your chart and graph to explain that when it is summer in Antarctica, it is winter in the Northern Hemisphere.

**Check for Understanding: Antarctica Sea Ice, March 1995**



[Image 1](#)  
[March 1995](#)

[Image 2](#)  
[September 1995](#)

In March 1995, there was very little sea ice around Antarctica. By September, sea ice covered a much larger area of ocean. Locate these two months on your graph. Why do you think there was so much sea ice in September and so little in March? Think of several pieces of evidence that support your ideas. You will have a chance to discuss and debate your ideas with others in your class.