

A**set up see image**

1 — Start *SEE Image* by double clicking on its icon



SEE Image 2.56/ppc

2 — Select 'Options/Preferences'.

3 — Make sure the 'Undo & Clipboard Buffer Size' is set to >500 k and that "Invert Y-Coordinates" is NOT selected. Click OK. (If these preferences were already set and you didn't have to change anything, no message box will appear. Skip to step 8.)

4 — Click OK again to close the message box you'll see.

5 — Select 'File/Record Preferences'.

6 — Select 'File/Quit' to exit *SEE Image*.

7 — Restart *SEE Image*.

8 — Select 'Special/Load Macros'. Go to Desktop | HD | SEE Image | Macros | SEE_macros. Click Open.

B**make a stack of color images**

1 — Select 'File/Import'.

2 — Go to Desktop | HD | SEE Image | Data | Sea_Ice | psiex2 | 1984 | nm8409i.tif. Click the "Open" box then click OK. Repeat for files nm8410i.tif, nm8411i.tif, and nm8412i.tif.

3 — Go to Desktop | HD | SEE Image | Data | Sea_Ice | psiex2 | 1985. Click the "Open All" box then click OK.

4 — Select 'Stacks/Windows to Stack' to put all 16 months (one whole year plus the previous fall) in a stack. Use the . key (also the > key) to move forward through the stack and the , key (also the < key) to move backward through the stack.

5 — Select 'Options/Color Tables/SEAICE'. Note that the color LUT will be applied to all images in the stack.

6 — Choose 'Options/Preferences' and select "Display Slice Titles Only." This will display the files names across the top of the stack when you move through the stack images with the [.>] and [,<] keys.

exercise 2**observing northern hemisphere sea ice distribution and seasonal variability**

This exercise has four sections. In the first three you'll use some of the tools from *SEE Image* to explore the seasonal variation of SIC in a *qualitative*, or descriptive manner, where you'll

- Create a stack of images and apply color to them and calibrate them
- Learn to create a movie, called an Animation, from the stack
- Create a Montage of the stack to observe seasonal changes.

The last section of this exercise will hone your *quantitative* skills in analyzing the data, where you'll

- Create and plot a time series of SIC using *SEE Image* to collect the time series data

Do A, B, and C now.

C**calibrate the top image of the stack with a saved calibration file**

1 — Select 'Analyze/Reset.'

2 — Select 'Analyze/Calibrate.'

3 — Click the Straight Line button and type "percent" (or "%") in the box titled Units of Measure.

4 — Click the Open button in the dialog box and find the calibration standards file you saved and named "Ice_Standards" in Exercise 1. Click Open, click OK. Close the plot window that appears.

NOTE: if you don't have the calibration standards file because you skipped Exercise 1, Step E, stop this exercise and go back and do it now.

Calibrating the top image in the stack will cause all images in the stack to be calibrated with the same calibration standards. An open diamond is displayed to the left of the file name in the title bar of the stack when the images have been calibrated.

investigating seasonal variations in sea ice concentration from an animation

A technique commonly used by scientists to visualize data collected over time is called animation. Each image in a stack is displayed automatically, and in sequence, to give the impression of a movie.

Do D now.

1a. In what month is the sea ice areal extent a maximum?

1b. In what month is the sea ice areal extent a minimum?

2. In general terms, describe how the sea ice extent grows from September 1984 to March 1985. Consider

- is it a steady growth rate, or does it start growing quickly then more slowly later; or slower at first then more quickly later
- where does it start growing
- where are the largest initial changes?

D**animate your stack**

1 — Select 'Stacks/Animate' to animate this stack. Use the number keys from 1 (slowest) to 9 (fastest) to control the speed. To stop the animation, click anywhere on the image.

3. In general terms, describe how the sea ice extent melts and recedes from March 1985 to September 1985. Consider
- is it a steady melt rate or does it start melting quickly then more slowly later; or slower at first then more quickly later
 - where does it start melting
 - where are the largest initial changes?

HINT—look at locations of polynyas.

E

make a montage of your stack

1 — Select 'Stacks/Make Montage.' Enter "4" for columns, "4" for rows, "1" for increment, and leave the rest at the default. You'll see cameos of all 16 months' images on one screen.

2 — Now experiment. Try entering 4 columns, 2 rows (or 2 columns, 4 rows) and 2 for the increment. This will display a montage of every other month, and each cameo will be larger.

investigating seasonal variations in sea ice concentration from a montage

Do E now.

4. Describe the sea ice distribution in the Barents and Norwegian Seas in late winter (February–March) and use your North Pole Reference Map (especially the ocean currents you sketched in Exercise 1) to explain it.

5. Compare the sea ice distribution along the east and west coast of Greenland in late winter (north and south and onshore and offshore extents), and use your North Pole Reference Map (especially noticing the ocean currents you sketched) to explain it.

6a. Looking at the total annual cycle, where does the ice edge change the most from the summer minimum sea ice extent to the late winter maximum sea ice extent?

6b. Where does it change the least?

6c. What is your best explanation for this?

7. Describe the marginal ice zone (MIZ) during freeze-up (winter). Consider

- is it wide
- is it narrow
- does the ice concentration vary rapidly or slowly across the MIZ?

Close this stack.

create a time series of the sea ice extent

The impact of sea ice on the environment would be of little consequence if sea ice were rare. But, the reality is that sea ice extends over a substantial area, mostly in polar regions, of course. At any given time, sea ice covers approximately 25 million square kilometers of Earth's oceans, making it as extensive as the area of the North American continent, which covers about 24.4 million square kilometers. We'll begin studying this by measuring the extent of sea ice for each month in a 16-month sequence of images.

Repeat **Steps B and C** for the years 1995 and 1996 (instead of 1984 and 1985). Position the stack with the earliest September image on top.

F

set your measurements

1 — Select 'Analyze/Set Scale.'

NOTE: For this to work correctly, you must set up the dialog box exactly in the order instructed, even though it jumps around the dialog box a bit.

2 — Set Known Distance to "25."

3 — Go down to Units and click and drag the menu bar to select "Kilometers."

4 — Go back up and set Measured Distance to "1."

5 — Make sure that the Pixel Aspect Ratio is set to 1 and the Scale reads 0.040. Click OK.

Do F now.

Measured Distance: Pixels

Known Distance:

Pixel Aspect Ratio:

Units: ▼

Scale: pixels per

G

density slice your stack

1 — Double click the Density Slice Tool



in the Tools Window, which will put a solid block of color (default is red) on the LUT window.

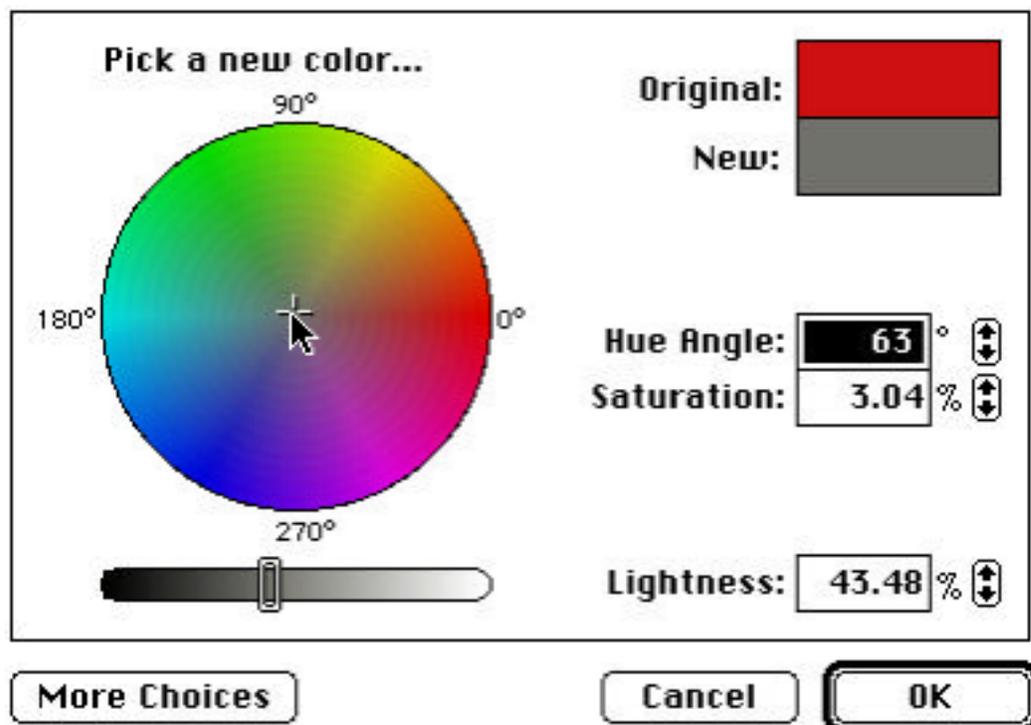
2 — Select the Eyedropper



from the Tools Window. Move your cursor to the middle of the solid block of red on the LUT. Notice that the cursor arrow turns into an Eyedropper when it is positioned in this density slice block on the LUT.

3 — Double click with the Eyedropper on the red color block in the LUT window to bring up a color wheel and click once in the middle of the wheel. The window will now display gray as the “New” color. Click OK. The Density Slice color block in the LUT window will turn gray.

Do G now.



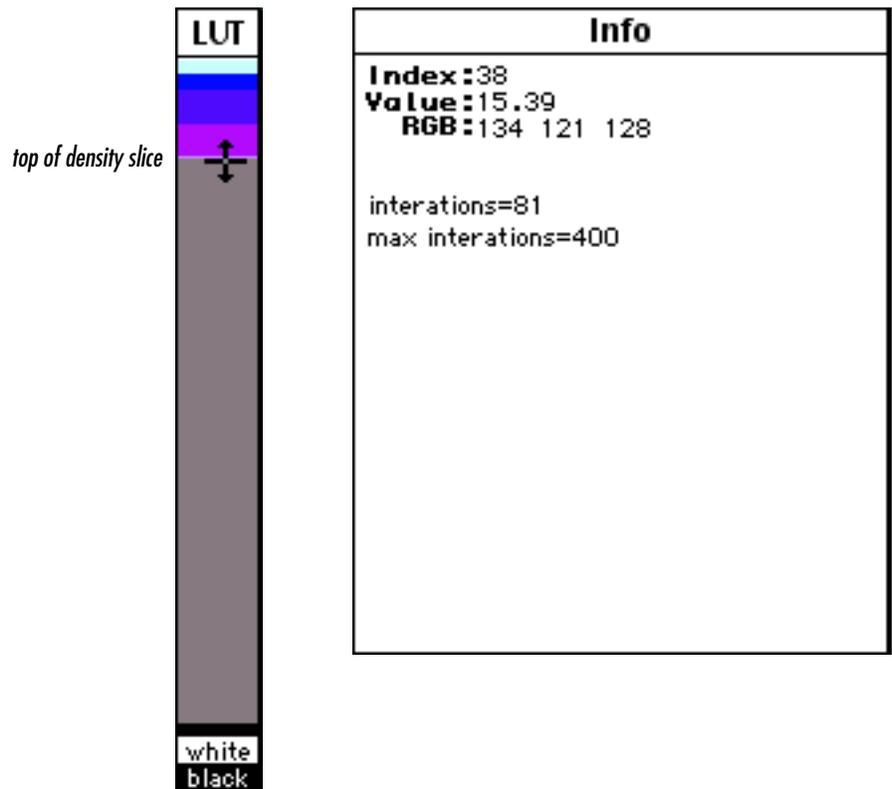
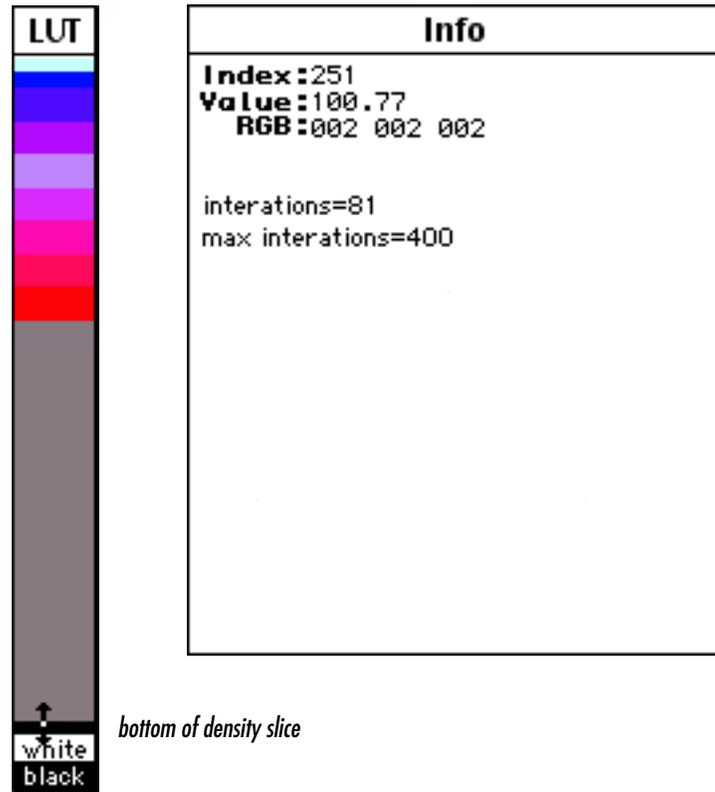
G

density slice your stack, continued

4 — Click once on the Density Slice Tool to reactivate it.

5 — On the bottom of the gray Density Slice color block, click, hold, and drag the mouse down until the Value in the info window shows approximately 100% (get as close as possible without making the big black dot on the image go away). Release the mouse button.

6 — Repeat step 5, this time dragging the top of the Density Slice to a value of 15%.



G

density slice your stack, continued

7 — Select 'Analyze/Options' and make sure that Area, Mean, and Standard Deviation are selected. Click OK.

8 — Use the Rectangle Selection Tool



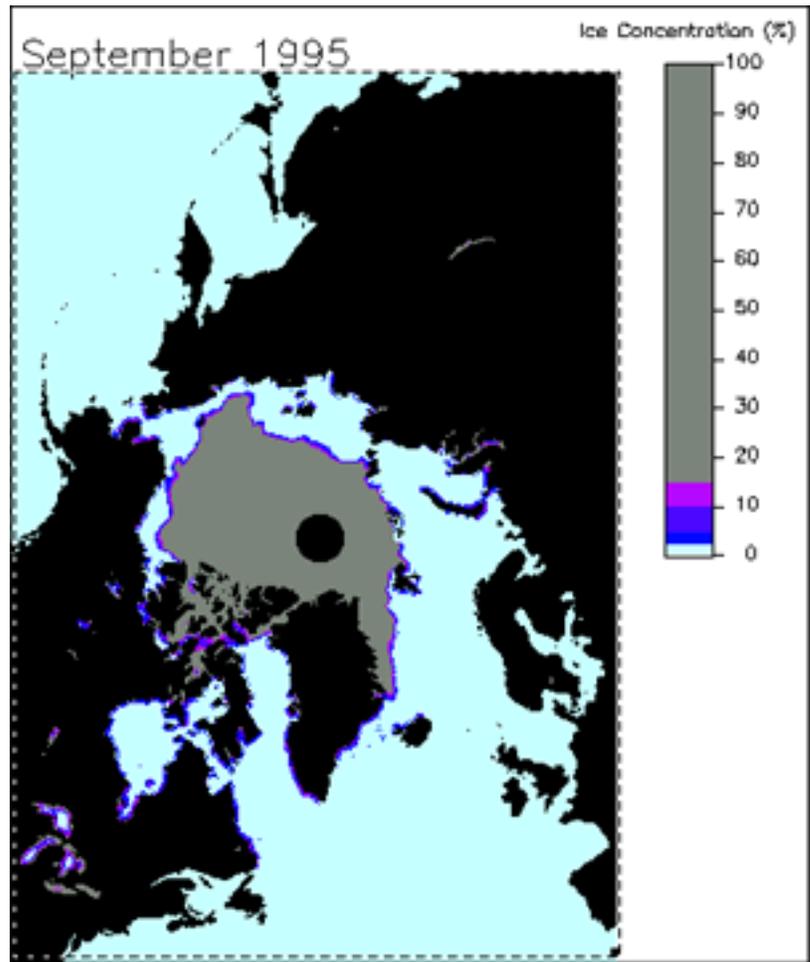
and select just the image window, as shown.

9 — Select 'Analyze/Reset' to clear any previous measurements.

10 — Select 'Analyze/Show Results.'

11 — Beginning with the earliest September image, apply 'Analyze/Measure.' You'll see the area, mean, and standard deviation data appear in the Results window. Use the [.>] key to activate the next image and apply 'Analyze/Measure' to it. Continue through the entire stack in this manner until you gather the information for all 16 months, as shown in the following example.

	Area	Mean	S. D.
1.	5930000.00	72.73	23.94
2.	8685000.00	67.12	27.08
3.	10886875.00	81.15	24.86
4.	12993125.00	84.76	22.07
5.	14468750.00	84.33	23.27
6.	15652500.00	84.27	22.62
7.	15599375.00	84.29	22.41
8.	14494375.00	85.43	23.35
9.	13070625.00	85.93	21.30
10.	11976875.00	81.21	21.48
11.	10210000.00	71.19	25.04
12.	7998750.00	69.73	24.60
13.	7611875.00	72.13	23.61
14.	9093750.00	80.84	21.53
15.	10405000.00	82.41	24.00
16.	13163125.00	83.21	23.89



about areas of missing data

Notice the “black hole” at the North Pole position on your stack of images. That’s an area of missing data. Because of its location, we’re safe to assume that it too is always ice covered. Therefore, when you record measurements of areal sea ice extent, you’ll need to add the area of the region of missing data. Make note of the following amounts for future studies.

Data Collection Period	Area of Missing Data
1979–1987	1,124,375 sq. km.
1988–1996	292,500 sq. km.

8. Record the data from your Results window onto the table on the next page. Since we’re working with years 1995–1996 here, add **292,500** to each amount in the Area column and write that down as well (we left enough room for both values).

Northern Hemisphere Areal Sea Ice Extent

MONTH Years: _____ – _____	AREA (square kilometers)	MEAN SIC (in percent)	STANDARD DEVIATION (%)
September	-----		
October	-----		
November	-----		
December	-----		
January	-----		
February	-----		
March	-----		
April	-----		
May	-----		
June	-----		
July	-----		
August	-----		
September	-----		
October	-----		
November	-----		
December	-----		

Add missing data area to column 2 as appropriate — 1,124,375 for years 1979–1987; 292,500 for years 1988–1996

exploring polar sea ice processes using satellite data — computer lab exercises

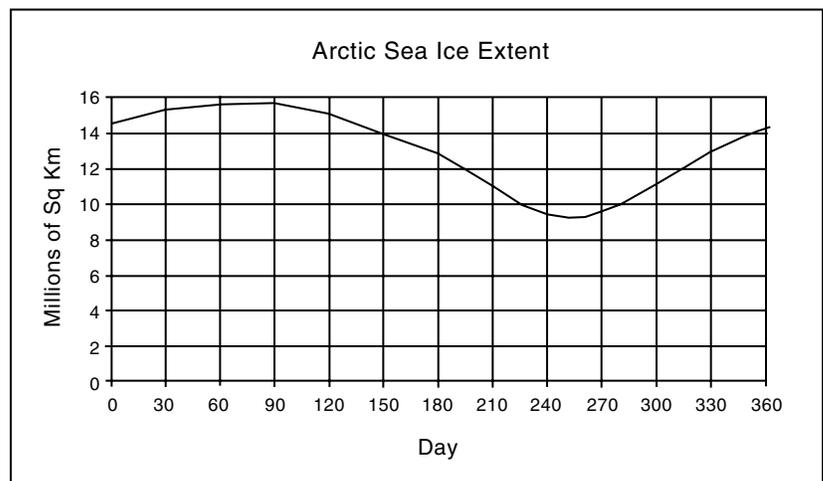
9a. Plot a time series of the sea ice area (as a function of time) for the Arctic region. Plot the month on the X axis and the area on the Y axis.

9b. What is the **minimum** areal extent in square kilometers?

9c. What is the **maximum** areal extent in square kilometers?

9d. What is the percent difference?

10a. Compare your results to the figure below depicting the 1978–1987 average seasonal cycle determined from SMMR data.



Average seasonal cycle for the Arctic (from Gloersen et al., 1992)

10b. Compare your results here to your answers to questions **1a** through **3**.

11a-b. For advance exploration, plot the Mean Percent SIC as well as the Standard Deviation, each as a function of time.

11c. What additional information regarding the seasonal changes in the character of the Arctic sea ice cover can you deduce from these plots?