

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 | psiex4 | maximums. Click the "Open All" box then click OK.

3 — Select 'Stacks/Windows to Stack' to put all 18 images 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.

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

5 — 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 4**observing northern hemisphere interannual variability**

If you haven't already done so while working through other exercises during this same lab session, *do A now*.

qualitative tools for exploring the interannual variability of arctic sea ice distribution

Use the results from Exercise 2 to help you answer this question.

1. In the Northern Hemisphere, which month of the year typically shows the maximum sea ice extent? _____

Do B now.

C**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.

D**use the stack another way**

1 — Select 'Analyze/Reset.'

2 — Use the Rectangle Selection Tool



and draw a box around a specific area of interest.

3 — Step through the images one at a time gaging the amount of ice showing up in the box. It's fairly easy to see which images have lots of ice in the region and which ones don't. Then jot down the year.

Choose and perform either C or D.

Using either your animation or montage, visually inspect the general interannual variability in the Northern Hemisphere sea ice distribution and answer the following questions.

Which years had the largest ice extent in the

2a. Barents Sea _____

2b. Bering Sea _____

2c. Sea of Okhotsk _____

2d. Labrador Sea _____

2e. Greenland-Norwegian Seas _____

Which years had the smallest ice extent in the

3a. Barents Sea _____

3b. Bering Sea _____

3c. Sea of Okhotsk _____

3d. Labrador Sea _____

3e. Greenland-Norwegian Seas _____

4. From these qualitative observations, do you observe or can you conclude anything in regard to any long-term trend in the extent of sea ice in the Northern Hemisphere?

Close all stacks, animations, and montages without saving them.

quantitative tools for exploring the interannual variability of arctic sea ice distribution

In this activity you'll quantitatively explore two questions regarding the interannual variation in the areal extent of the Northern Hemisphere sea ice cover. First, what is the interannual variability in the maximum extent of sea ice? Second, what is the interannual variability in the extent of the Northern Hemisphere permanent sea ice cover; i.e., variability in the minimum areal extent?

First, you'll recreate and calibrate your stack of maximums. Then you'll use the Density Slice tool to find the sea ice areal extent for each sea ice maximum (March) image in your stack for all 18 years and make plots to use in analysis.

Repeat Step B then do E, F, and G..

E

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.

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.

Measured Distance: Pixels

Known Distance:

Pixel Aspect Ratio:

Units:

Scale: pixels per

G

density slice your stack

1 — Double click the Density Slice Tool



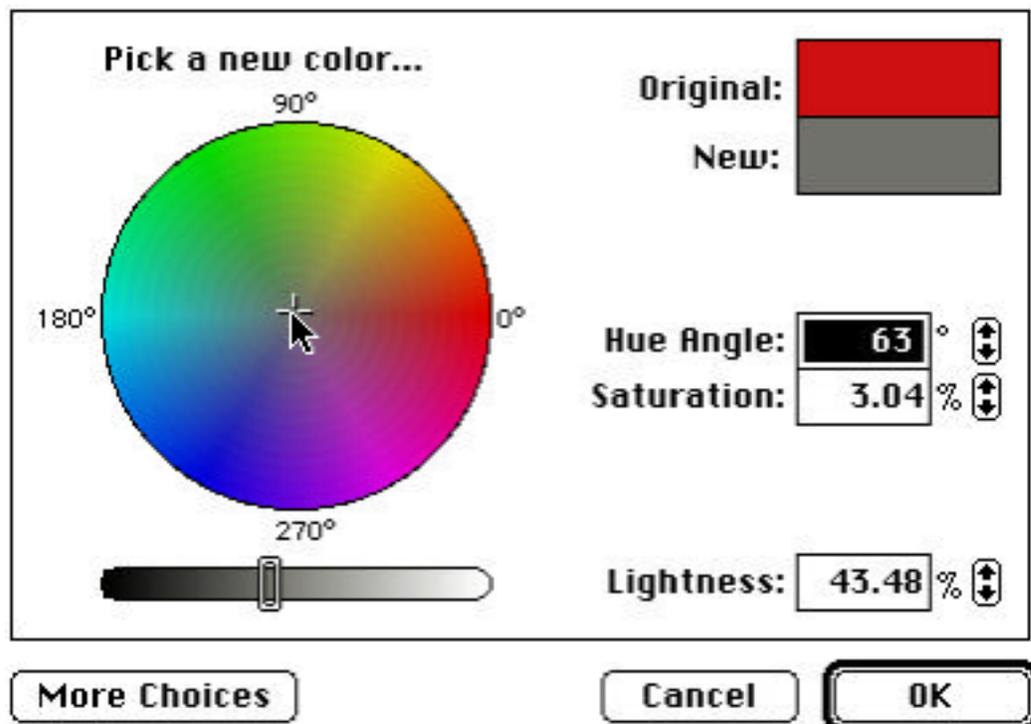
in the Tools Window, which will put a solid block of color (default is red) on the LUT window.

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.



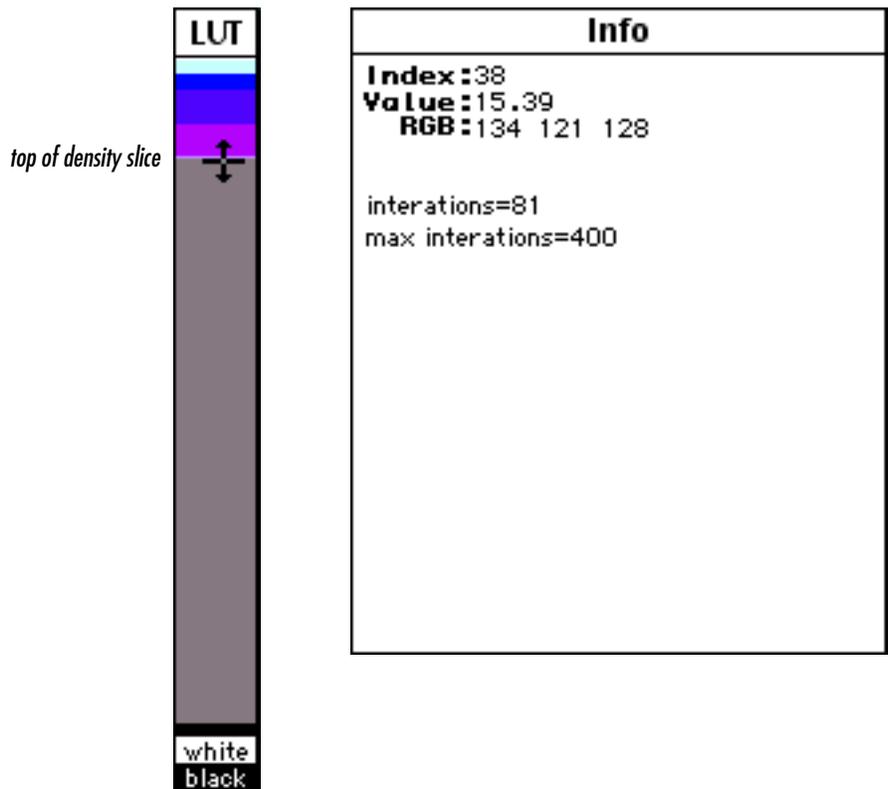
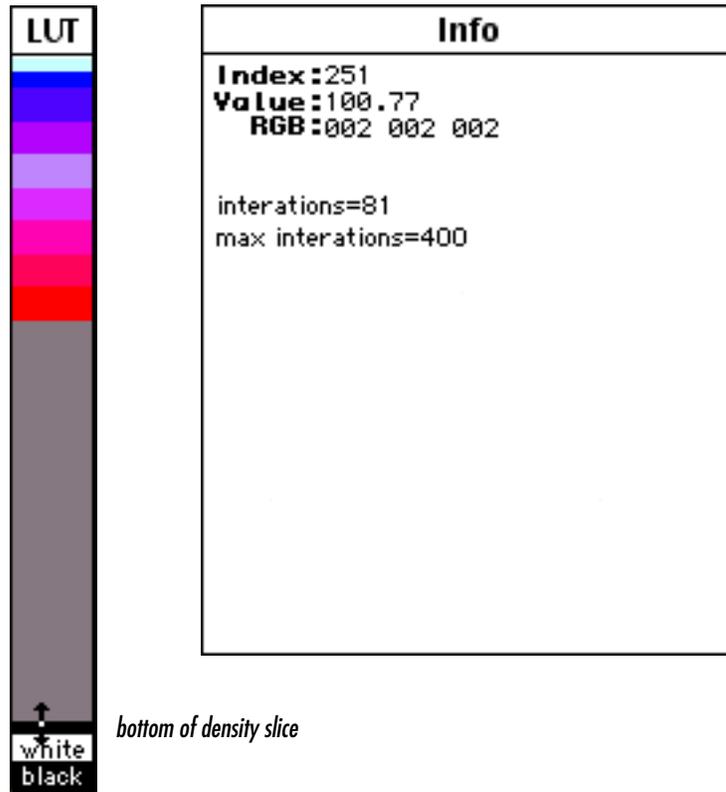
G

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



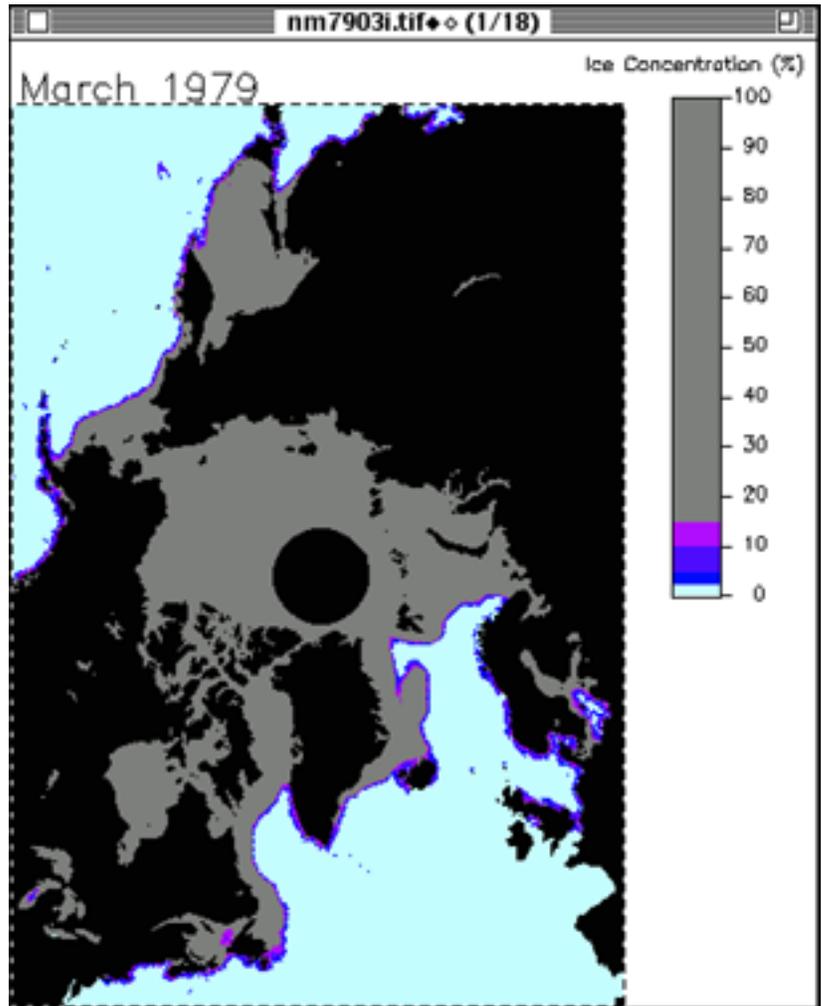
and select just the image window, as shown.

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

10—Select 'Analyze/Show Results.'

11—Beginning with the earliest March 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 18 years, as shown in the following example.

Results			
	Area	Mean	S.D.
1.	16093125.00	84.63	21.27
2.	15736875.00	84.71	22.01
3.	15085000.00	85.82	20.85
4.	15725000.00	85.28	21.73
5.	15587500.00	84.70	21.38
6.	15196875.00	84.75	21.18
7.	15656875.00	83.49	22.39
8.	15685625.00	83.45	21.58
9.	15343750.00	85.13	21.31
10.	16549375.00	85.55	22.62
11.	15915000.00	84.46	23.15
12.	16306875.00	84.30	21.69
13.	15858750.00	85.93	22.22
14.	15873125.00	86.33	22.58
15.	16309375.00	86.20	21.53
16.	16085000.00	86.17	22.02
17.	15668750.00	86.50	22.10
18.	15543750.00	84.61	22.11



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.

5. Record the data from your Results window onto the table on the next page. Add the appropriate missing data amount 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 Maximums

YEAR Month: _____	AREA (square kilometers)	MEAN SIC (in percent)	STANDARD DEVIATION (%)
1979	-----		
1980	-----		
1981	-----		
1982	-----		
1983	-----		
1984	-----		
1985	-----		
1986	-----		
1987	-----		
1988	-----		
1989	-----		
1990	-----		
1991	-----		
1992	-----		
1993	-----		
1994	-----		
1995	-----		
1996	-----		

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

Add up the adjusted area amounts for each year and divide by 18 to find the average SIC maximum. This average is called the Climatological Mean for the period you're studying. Compare this average to the maximum ice extent for each year.

6a. What is the Climatological Mean for maximum SIC?

6b. Do any years stand out as being greater or less than the Climatological Mean? List them here.

7a-c. Now create plots of the **maximum sea ice extent**, the **mean**, and the **standard deviation** as functions of time. On the plot of maximum sea ice extent, plot the climatological average you computed. Do this either by hand or use a software package, such as Excel. Be certain to label all of your axes and give each plot a title.

8a. Which years had the largest maximum sea ice areal extent?

8b. Which years had the smallest maximum sea ice areal extent?

8c. What is the percent difference between them? _____

9. Do a best fit line to your maximum sea ice extent time series. Again, you can do this either by hand, or use a software package, such as Excel. Is there any long-term trend evident? Explain.

10. What additional information regarding interannual changes in the character of the maximum ice cover of the Arctic can you deduce from the mean percent SIC and the standard deviation time series?

Now we'll perform the same procedures on the 18-years' minimums. Checking your results from Exercise 2,

11. in the Northern Hemisphere, which month of the year typically shows the minimum sea ice extent? _____

Do B, E, and F using the data from

Desktop | HD | SEE Image | Data | Sea_Ice | piex4 | minimums

Do G, steps 1–7 only then skip to H.

H

density slicing continued on part of your stack

1— Use the Rectangle Selection Tool



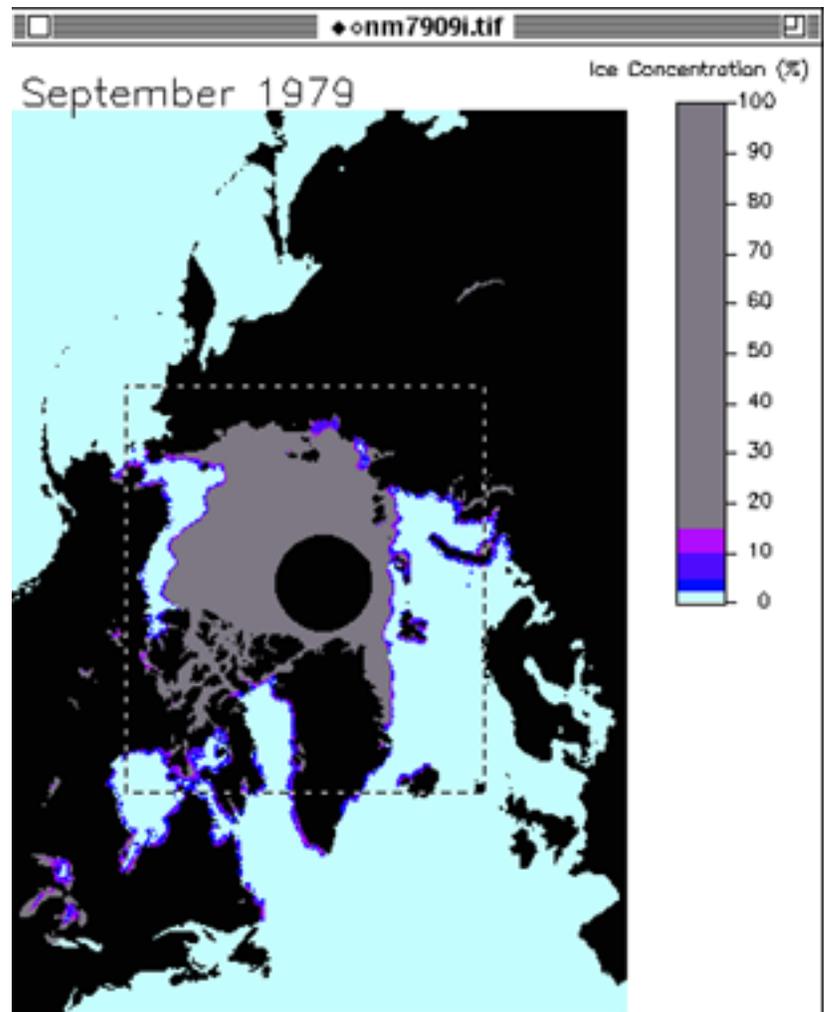
to select just the northernmost reaches of the image from within the display window. See figure at right.

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

3— Select 'Analyze/Show Results.'

4— 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 18 years, as shown in the following example.

	Area	Mean	S.D.
1.	5813125.00	75.46	23.01
2.	6436875.00	72.54	22.03
3.	5846875.00	72.28	22.29
4.	6041250.00	70.09	21.02
5.	6123750.00	73.27	23.06
6.	5793125.00	67.70	23.85
7.	5545000.00	72.82	23.37
8.	6139375.00	73.44	21.09
9.	6936875.00	77.92	23.54
10.	6953125.00	73.74	21.72
11.	6500525.00	71.35	20.67
12.	5723750.00	75.71	22.56
13.	6040000.00	71.27	20.97
14.	7008750.00	73.99	20.00
15.	5985000.00	72.71	22.63
16.	6665625.00	73.60	21.17
17.	5639375.00	74.87	22.26
18.	7326875.00	73.67	22.46



The reason we don't want to compute the areal extent based on the entire image is because of something called "land contamination," when the satellite data for the ocean are being contaminated by having some radiation from the land mixed in with that from the ocean. For that reason, the halo of colors around the land boundaries should be ignored, as the sea ice calculations are not reliable adjacent to land. Obviously, there is no sea ice in the Great Lakes in September.

12. Record the data from the Results Window onto the table on the next page, adding the missing data region amounts.

Northern Hemisphere Areal Sea Ice Extent Minimums

YEAR Month: _____	AREA (square kilometers)	MEAN SIC (in percent)	STANDARD DEVIATION (%)
1979	-----		
1980	-----		
1981	-----		
1982	-----		
1983	-----		
1984	-----		
1985	-----		
1986	-----		
1987	-----		
1988	-----		
1989	-----		
1990	-----		
1991	-----		
1992	-----		
1993	-----		
1994	-----		
1995	-----		
1996	-----		

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

Add up the adjusted area amounts for each year and divide by 18 to find the average SIC minimum: the Climatological Mean for the period you're studying. Compare this average to the minimum ice extent for each year.

13a. What is the Climatological Mean for minimum SIC?

13b. Do any years stand out as being greater or less than the Climatological Mean? List them here.

14a-c. Now create plots of the **minimum sea ice extent**, the **mean**, and the **standard deviation** as functions of time. On the plot of minimum sea ice extent, plot the climatological average you computed. Do this either by hand or use a software package, such as Excel. Be sure to label all of your axes and give each plot a title.

15a. Which year was the permanent ice cover the largest?

15b. Which year was the permanent ice cover the smallest?

15c. What is the percent difference between the two years? _____

16. Do a best fit line to your minimum sea ice extent time series. Again, you can do this either by hand, or use a software package, such as Excel. Is there any long-term trend evident? Explain.

17. What additional information regarding interannual changes in the character of the permanent ice cover of the Arctic can you deduce from the mean percent SIC and the standard deviation time series?

Compare the results of your maximum and minimum sea ice areal extent time series with this figure.

