exercise 5

comparing spring Antarctic (14 Octobers) ozone values and spring Arctic (15 Marches) ozone values

There has been a significant amount of discussion of the variations in the size and extent of the Antarctic "ozone hole". By viewing a sequence of TOMS monthly averages for the spring Antarctic phenomena from October 1979 to October 1992, we will be able to observe how the size and shape of the ozone hole over the South Pole has varied. Then we will observe the Spring Arctic fluctuations in ozone for the monthly average data from March 1979 to March 1993 and compare it to Antarctic Spring ozone distributions.

BEFORE YOU BEGIN THIS EXERCISE
make sure you have read through the Introduction to Module 1: Stratospheric Ozone Computer Lab Exercises document and have completed Sections 1–4 of the tutorial, *Using SEE Image With TOMS Ozone Data*.

Do A if necessary, B, C, and D now.

NOTE

Throughout these exercises, the navigational paths shown in italics are for use only by those who are using the TOMS Ozone CD set as their data source.

A

this procedure is only for users of the TOMS data CDs

transfering files from CD to a folder

1—Click anywhere on the Desktop.

2—Go to Desktop | HD | SEE Image | Data | Ozone and click Open. Create a new folder called "ozex5" and Open. Create two more new folders called "14Octobers" and "15Marches" within the ozex5 folder.

3—Insert disk OPT_004A from the TOMS set.

4—Go to Desktop | OPT_004A | Y79.

5—Open the Y79 folder. Find the file GM7903.N7T (monthly average for March 1979) and drag it into the 15Marches folder. Drag the GM7910.N7T file into the 14Octobers folder. Repeat this procedure for Y80 through Y87.

6—Replace OPT_004A with OPT_004B. Drag the March and October gridded monthly files for Y88 to Y92 (Y93 for March) into the appropriate folders. When you are finished you will have the following files in the folders.

15Marches	***14Octobers***
GM7903.N7T	GM7910.N7T
GM8003.N7T	GM8010.N7T
GM8103.N7T	GM8110.N7T
GM8203.N7T	GM8210.N7T
GM8303.N7T	GM8310.N7T
GM8403.N7T	GM8410.N7T
GM8503.N7T	GM8510.N7T
GM8603.N7T	GM8610.N7T
GM8703.N7T	GM8710.N7T
GM8803.N7T	GM8810.N7T
GM8903.N7T	GM8910.N7T
GM9003.N7T	GM9010.N7T
GM9103.N7T	GM9110.N7T
GM9203.N7T	GM9210.N7T
GM9303.N7T	

B

importing, stacking, and coloring the monthly average images

1—Click on the Tools window to activate SEE Image

2—Select 'File/IMPORT TOMS ASCII' and check the check-box "Import all images in the folder." Enter "95" and "601" for the minimum and maximum values for scaling. Click OK.

3—Go to Desktop | HD | SEE Image | Data | Ozone | ozex5 | 14Octobers | GM7910.N7T and click Open. All of the images in the folder will be imported.

4—Select 'Stacks/Windows to Stack'.

5—Click on the stack of images .

6—Select 'Option/ColorTables/TOMS'.

C

overlaying the continents on each image

1—Select 'File/Open' and go to Desktop | HD | SEE Image | Overlays | LATLONG.TIF and click Open.

2—Select 'Edit/Select All'.

3—Select 'Edit/Copy Selection'.

4—Click on the stack of images (GM7910.N7T–GM7910.N7T) to make it active.

5—Select 'Special/MultiPasteReplace'.

6—Close the LATLONG.TIF image window.

D

making a montage of the 14 images

1—Select 'Stacks/Make Montage'.

2—Enter 4 for columns, 4 for rows, 1 for increment and leave the rest at the default settings. Click OK.

investigating Antarctic springs from a montage

October is a spring month for the southern hemisphere where seasons are reversed compared to the northern hemisphere. Observe the ozone distribution patterns in the southern hemisphere. Use the cursor to move over various pixels on the images to view ozone Values displayed in the Info window. Remember that black has a value of 95 and represents the no-data value—it should not be considered a minimum value.

1a. What is the highest ozone value recorded on any image?

1b. Where are the highest values concentrated on any of the images?

1c. What is the lowest ozone value displayed on any image?

1d. Where are the lowest values concentrated on any of the images?

1e. Explain why you might expect to see this ozone distribution pattern.

2a. Is there an obvious pattern or trend in the maximum and minimum values you observe while examining the montage of images? Explain.

2b. What does this imply about southern polar spring ozone values during the period from 1979 to 1992?

2c. What factors may be responsible for the changes with time? Explain.

We can often see the patterns in data for a particular region more clearly by generating a projection that places the location we are interested in at the center of an image. In the next procedures we will generate and explore a South Polar map projection (placing the South Pole at the center) using the ozone data for Antarctic spring.

Do E and F now.

E

generating a South Pole map projection

1—Close the montage and activate the stack of 14Octobers (GM7910.N7T–GM7910.N7T).

2—Select 'Special/ProjectPole'.

3—Enter "2" to select a South Pole projection and click OK.

4—Enter "South Pole 14 Octobers" for the name of the projected image (which will really be a stack).

F

making a montage of the 14 projected images

1—Select 'Stacks/Make Montage'.

2—Enter 4 for columns, 4 for rows, 1 for increment and leave the rest at the default settings. Click OK.

investigating Antarctic spring ozone values from a montage of south polar map projected images

3a. Would you say that there is a latitudinal distribution of ozone values? Explain.

3b. What are the basic shapes of the most prominent features on a majority of the images?

3c. What is the approximate range of ozone values associated with each feature?

3d. Based on your answers above, what are these features?

3e. Which year shows the lowest values of ozone along with largest circular feature size? Recall that you have sequential images for 1979 to 1992 displayed.

3f. What is the cause of these features? Explain.

We can use another tool of *SEE Image,* Plot Profile, to investigate the symmetry of features on the individual images in this montage. In ozone studies the word "profile" refers to a plot of ozone as a function of altitude. For that reason we will call the selections we make "slices" to avoid confusion.

G

plotting values for a slice across an Antarctic spring ozone feature

1—In the Tools window click on the Profile Plot tool (rectangle with a crooked line in it).

2—Position the cursor at the point where you want to begin a line.

3—Hold down the mouse and draw the line over the region you want to slice. When you release the mouse the plot will appear.

Do G now.

investigating ozone feature symmetry

Select the 1987 (#9) image on the montage and generate a horizontal slice across the prominent circular feature.

4a. What is the source of the downward spikes on the profile? Should you consider them when interpreting the plot? Explain.

4b. Is the feature reasonably symmetrical based on the horizontal slice? Explain.

4c. Generate slice plots for the same feature with lines at varying angles. Try to keep each line passing through the same central point (approximate position of the South Pole). What can you say in general about the longitudinal symmetry of this feature based on this image?

4d. Try the same technique for the same feature for several different years. Can you make a general statement about the symmetry of this feature?

H

Do H now.

stacking and animating the images

1—Select 'File/ Save'. Go to Desktop | HD | SEE Image | Images | Ozone. Select TIFF format and save as "South Polar October Montage." Click Save. Close the montage image window.

2—Click on the stack South Pole 14 Octobers to activate.

3—Select 'Stacks/Animate'.

When an animation is running, use the number keys 1–9 to change the speed of the animation. Lower numbers animate the images at slower speeds. While the animation is running you will see the stack title but not the titles of the individual images. You can stop the animation by clicking anywhere on the desktop.

To view the stack, image by image, press the period (.) key to look at the next image and the comma (,) key to view the previous image. You will see the stack and image titles in this mode.

investigating the South Pole projections through animation

View it through several cycles. Stop the animation and use the period and comma keys to move sequentially through the stacked images. Repeat these operations as necessary to answer the following questions. The title will be too long to display on the projected image stack so if you need know what year you are observing you should go to the top (1979) or bottom (1992) of the stack and count from there (or save the stack with a very short title).

Describe what happens to the following characteristics of the central circular feature in October from 1979 to 1992.

5a. Size

5b. Shape

5c. Position with respect to Antarctica

6. Do you see the same pattern of change with the banana shaped feature? Explain.

Close both stacks of October images when you are finished.

investigating ozone during Arctic spring

A logical question is, "Can we see the same features or patterns in the northern polar regions during Arctic spring (March)?"

7. Do you think the features and patterns will be the same? Explain.

To uncover the answer to this question we need to repeat some of the same procedures using data from March while concentrating on the northern hemisphere

8. Repeat Procedures B–D using the 15 images for March 1979–1993.

9a. What color represents the highest values of ozone in the northern hemisphere during Arctic spring?

What range of values is associated with this color?

9b. What year appears to have sustained the highest values over the largest area?

What year shows the lowest values for ozone in the north polar region?

9c. Is there an obvious pattern or trend in the ozone values you observe in the northern hemisphere while examining the montage of images for Arctic spring? Explain.

To see if features similar to the ones we saw in Antarctica during October exist during Arctic spring (March) we can generate a north polar map projection.

Activate the stack of March images. Repeat Procedures E and F but enter "1" to generate a North Polar projection and name the stack of images "North Pole 15 Marches."

10a. Is a there a latitudinal distribution of ozone apparent from the images in the montage? Explain.

10b. Are there prominent ozone distribution features comparable to the ones in the Antarctic? Explain based on size and shape.

For comparison you can open "South Pole 14 Octobers." You will have to move the montages to compare them. If you have a small screen you can reduce the size of the montages by selecting 'Edit/Scale and Rotate' and entering 0.5 for the horizontal scale. Be sure that the Create New Window box is checked.

10c. How would you characterize the symmetry of the March ozone distribution? You can generate slices through the North Pole as you did in Procedure G for a number of the images to support your response. Be sure the line extends an equal distance in both directions from the pole. Because you will cross many no-data points, the slices will be noisier than before. Look at the general trend from one side of the resulting plot to the other to assess symmetry.

Close all montage windows.

Animate the North Pole 15 Marches stack and watch it through several cycles.

11a. Is there a clear pattern to the ozone distribution that is more obvious from the animation? Explain.

11b. Why do you think there is a difference in the ozone distribution in the northern and southern polar regions during their respective springs?

Close all images and stacks when finished.