

exercise 6

further examination of differences between spring Arctic and spring Antarctic ozone distributions

To demonstrate how ozone is distributed and varies in the spring for either the North or South Pole we will compare March and October monthly images from 1979 and 1992. We will use histograms and profiles to look at distribution patterns and will generate ratio images to enhance regions of change between March and October of each year.

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

importing and coloring TOMS images

1—Insert the disk *OPT_004A* from the TOMS set.

2—Select 'File/IMPORT TOMS ASCII' and enter "1" for the number of images to import. Input "95" and "601" for the minimum and maximum values for scaling. Click OK.

3—Go to Desktop | HD | SEE Image | Data | Ozone | ozex6 | GM7903.N7T
Desktop | OPT_004A | Y79 | GM7903.N7T and click Open.

4—Select 'Options/Color Tables/TOMS'.

5—Repeat 2–4, going to Desktop | HD | SEE Image | Data | Ozone | ozex6 | GM7910.N7T
Desktop | OPT_004A | Y79 | GM7910.N7T

6—Insert Disk *OPT_004B*.

7—Repeat 2–4, going to Desktop | HD | SEE Image | Data | Ozone | ozex6 | GM9203.N7T; Desktop | HD | SEE Image | Data | Ozone | ozex6 | GM9210.N7T
Desktop | OPT_004B | Y92 | GM9203.N7T; Desktop | OPT_004B | Y92 | GM9210.N7T

B

generating histograms of global ozone data

1—Select the March 1979 image (GM7903.N7T).

2—Select 'Analyze/Show Histogram'

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*.

To explore seasonal distributions in total column ozone we can apply a valuable mathematical analysis tool called the histogram. A histogram is a plot of the frequency of occurrence of a value against the value. For TOMS images, it provides the number of pixels in a image with a given Dobson Unit (DU) value.

Do A and B now.

This draws a histogram of the ozone values. The X axis contains the ozone values and the Y axis contains the number of pixels for a particular ozone value. To read the histogram information, move the cursor into the histogram window and view the results in the Info window. **Level** shows the ozone value and **Count** lists how many pixels there are for that Level. This histogram can be printed by selecting 'File/Print Histogram'.

investigating the March and October histograms

1. Sketch the histogram for March 1979 (or attach the printed histogram) below labeling the lowest and highest values and the values for any significant peaks. Supply the requested information in the table below. Ignore the spike at 95 on the histograms. This represents the no-data or black areas on the image.

Image	Most Frequent Ozone Value	Lowest Ozone Value	Highest Ozone Value	Range for ~75% of Pixels
March 1979 "GM7903.N7T"				
October 1979 "GM7910.N7T"				
March 1992 "GM9203.N7T"				
October 1992 "GM9210.N7T"				

Important Notes:

Only one histogram window is available at a time so if you generate a histogram for a second image or region, the first histogram will be replaced by the second. If you wish to retain the first as an image file, be sure to save it before

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generating another histogram. Directions for this can be found in the SEE Image Tutorial.

You may save the histogram as an image file but you will not be able to access the Count and Level values from that image file. Be sure to record any data you need from the histogram before saving it as an image or look in the SEE Image Tutorial for directions on exporting histogram information to other applications.

2. Repeat Procedure B and complete Question 1 for October 1979 (GM7910.N7T), March 1992 (GM9203.N7T), and October 1992 (GM9210.N7T).

(Sketch or attach histograms here)

- 3a. Look at the sketches and data you recorded for the March and October 1979 histograms. What are the major similarities and differences between the two histograms?

- 3b. Would you expect the histograms to be the same or different? Explain.

3c. Does there appear to be a general spring pattern to the ozone value distributions? Explain.

3d. Compare the March and October 1992 histograms. Is the pattern of distribution for 1992 similar to 1979? Explain.

3e. Compare the two October histograms. What is the major difference between these two? What might account for this difference?

Close the Histogram window when finished.

We can plot pixel values for any line segment on the image we select using the profile tool. This can be useful for looking at latitudinal differences in ozone values on a TOMS image. 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.

C

drawing n-s ozone profiles

1—Select the March 1979 image (GM7903.N7T).

2—Select the profile tool (a rectangle with a crooked line inside) in the Tools window.

3—In the GM7903.N7T window move the cursor to the location X=170 and Y=0. Click and hold as you drag a vertical line to the bottom of the image so that in the Info window DX=0 and DY=180. When the mouse button is released, the profile will be plotted in the Plot window.

This profile plot graphs the ozone values which lie directly under the line. The X axis represents pixels along the profile line (0 corresponds to the top of the image since that is where the profile line originated) and the Y axis represents ozone values. This plot can be printed if desired by selecting ‘File/Print Plot’.

Do C now.

4. Sketch the resulting plot or attach a print of the plot here. Label the axes.

Important Note:

Like the histogram, there is only one Plot window. When you generate a second plot it will replace the first. If you want to compare plots you should sketch or save data from the first or save the first one as a file or print the plot you generate before proceeding with additional plots. Directions for saving the plot can be found at the end of this exercise.

5. Repeat Procedure C to generate plots for the following images.GM7910.N7T; GM9203.N7T; GM9210.N7T.

(Sketch plots here)

comparing the March and October profiles

6a. Why is there a steep rise at the beginning and end of each plot? Should it be considered when interpreting the plot? Explain.

6b. Compare the two March slice plots. Are they similar in shape. Is this expected? Explain.

6c. Explain why the maximum values fall where they do on both March plots.

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D*producing a ratio of two images to visualize seasonal change*

1—Select 'Analyze/Options'. Be sure that Digits Right of Decimal Point is "2". Click OK.

2—Select 'Process/Image Math' to activate the Image Calculator.

3—Select the March image (GM7903.N7T) from the upper most drop-down menu. Select the October image (GM7910.N7T) from the second drop-down menu (underneath the first one).

4—Select the symbol for division from the operation drop-down menu. Enter "1" in the box next to the times sign (X) since we do not want to multiply the result by a constant. Enter "0" in the box next to the plus sign (+) since we don't want to add a constant to the resulting image. Type "March/October 1979" in the box next to the equal sign (=). This will be the name of the output image. Select the Real Result check box since the resulting image pixel values will be outside the 1–254 range. Click OK to perform the division.

5—Select 'Options/Color Tables/Special Ratio' to view this image with a color table that will enhance differences.

E*applying a latitude/longitude overlay*

1—Select 'File/Open'.

2—Go to HD | SEE Image | Overlays | LATLONG.TIF. Click Open

3—Activate the LATLONG.TIF image by clicking in its image window then select 'Edit/Select All' followed by 'Edit/Copy Selection'.

4—Select the March/October 1979 image and then select 'Edit/Paste'. The overlay image will completely cover the base image at this point. Next select 'Windows/Show Paste'.

5—In the Paste Control window, click and hold the Transfer Mode pop-up menu ('Copy' is the default setting) and select 'Replace'.

6—Select 'Windows/Hide Paste Control' to close the Paste Control window.

7—Close the LATLONG.TIF image.

7a. Are the plots for the two Octobers the same? Explain.

7b. What is evident on the October 1992 plot that is not present in October 1979?

Close the Plot window when finished.

Another image processing technique used to visualize the difference between two images involves determining the ratio of the images. Since each pixel represents a value, we can compute a ratio of each corresponding pixel to produce another image. The result is an image where numbers greater than one indicate areas where the numerator image had a higher value and numbers less than one indicate areas where the denominator image had a higher value. The further the resulting value is from one, the greater the difference between the two images.

We will ratio the March and October 1979 images.

Do D now.

To determine the approximate latitude ranges for certain values we can apply an overlay that has latitude and longitude lines.

Do E now.

investigating a ratio image

Move the cursor over the pixels in the ratio image March/October 1979 and note the values in the Info window. Each value is the ratio for that pixel.

8a. What color range represents values greater than 1?

8b. What color range represents values less than 1?

8c. What latitude range (north or south polar, north or south midlatitude, tropical) shows values higher than 1?

Why would you expect this?

8d. What latitude range shows the least difference in ozone values from March to October? Explain why.

Keep the ratio image open.

comparing ozone values in March 1992 to October 1992

Would you expect the same ratio values if you compared March and October data from 1992? Explain why or why not.

To test your hypothesis do the comparison of the March and October 1992 images.

Repeat Procedures D and E using March 1992 (GM9203.N7T) and October 1992 (GM9210.N7T).

9. Do you see the same latitudinal trend in the 1992 ratio image as in the 1979 ratio image? Explain.

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saving or exporting a plot

1—To save a plot, select the Plot window and then select 'Edit/Copy Plot'.

2—Select 'File/New' to create an image window in which we can paste the profile plot. Enter the following settings.

click on the Image Window button

Width: 250 Height: 125

Title: March 1979 Plot

3—Click OK to create the window then select 'Edit/Paste' to paste the plot in the image window.

4—To save the profile data for further analysis in a spreadsheet or other software, select 'File/Export' while the Plot window is active. In the Export window, type a name for the saved file, click the Plot Values button and then click the Save button. The plot values will be saved in a text file. Each value corresponds with pixels along the profile line.

The first line in the text file corresponds to the northernmost pixel, the second line corresponds to the second pixel and so on. This text file can be imported into most spreadsheet software programs.

10a. Where are the most significant changes in the ratio values from 1979 to 1992?

10b. What is responsible for these changes?

11. Suggest another ratio that might provide useful information using the images in this exercise and try it out. Explain what you expected, did, and what the results were in the space below.

Close all images when finished.