

“HYDROHASARDS” PostGraduate Study Program

Remote Sensing Lab Exercises

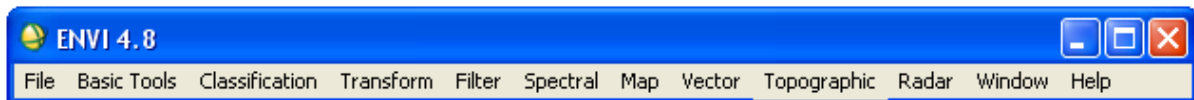
LAB 1: The Basics of ENVI – Image Analysis

Dr. Marios Spiliotopoulos

This lab aims to help you begin to understand the nature and statistical properties of digital remote sensing images. For this purpose ENVI tutorial files are used. By the end of the lab you should have a working knowledge of basic image operations in ENVI and have a basic understanding of digital images.

ENVI Main Menu Bar

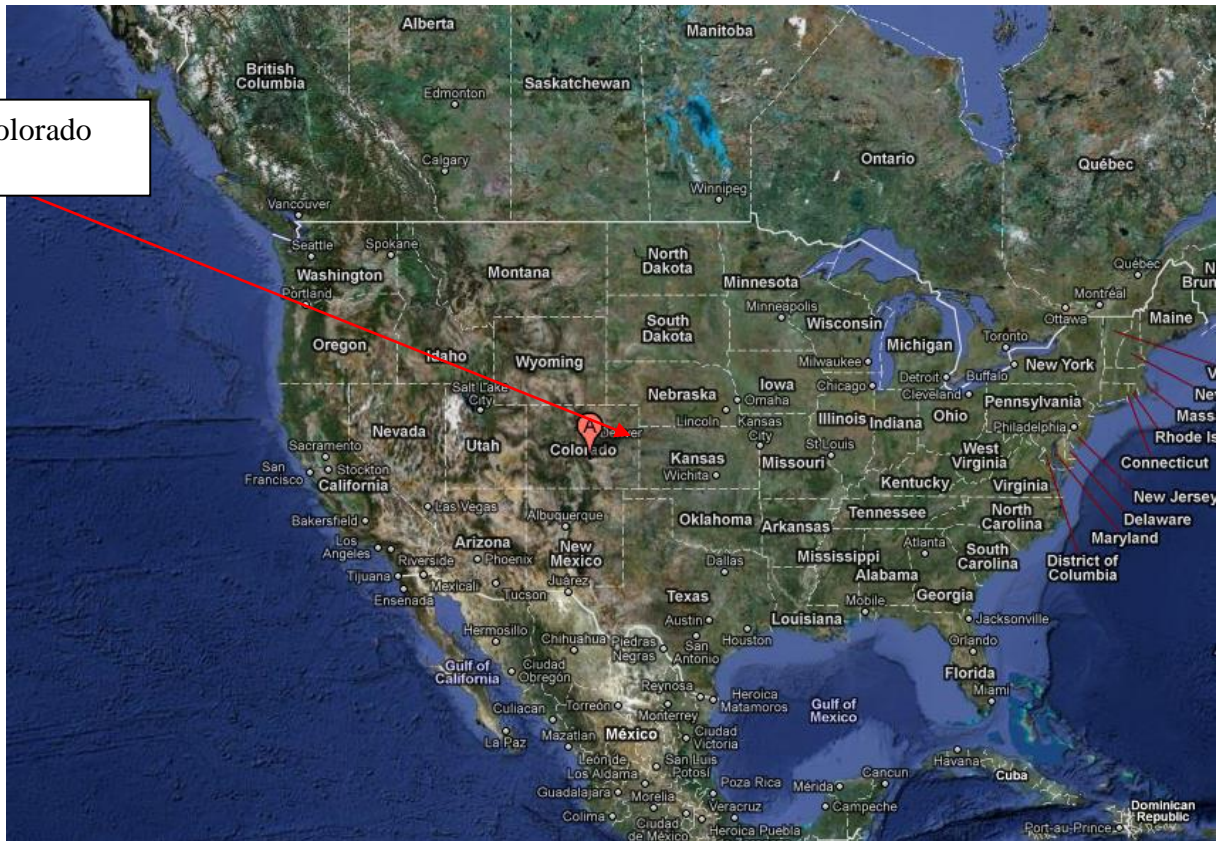
In ENVI, activities are initiated by using the menus in the ENVI main menu bar, which may be oriented horizontally as shown below, or vertically (as set via the option on the **File > Preferences > Miscellaneous** tab).



Opening an image file using ENVI 4.8.

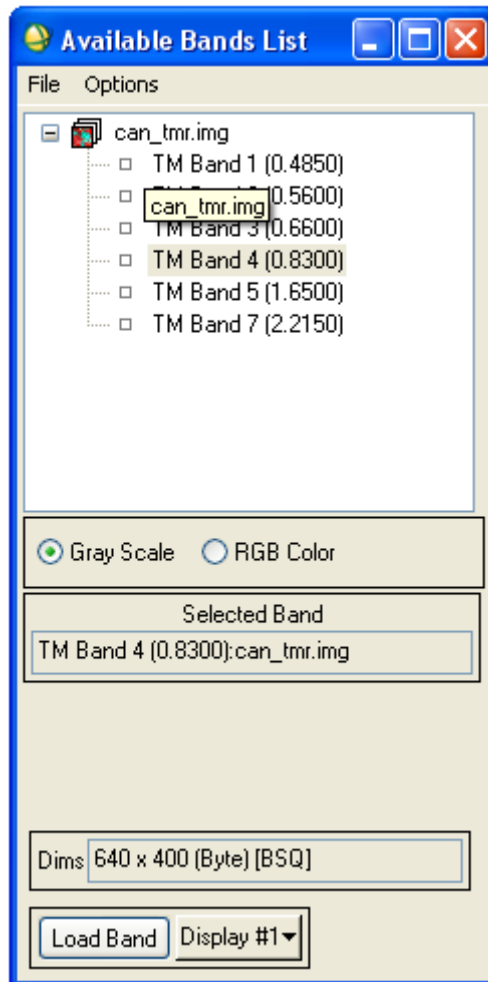
- From the ENVI main menu bar, select **File > Open Image File**.
 - Navigate to the given “can_tm” directory, select the file “can_tmr” from the list, and click **Open**. This is Canon City, Colorado. U.S.A..
-

Canon City, Colorado



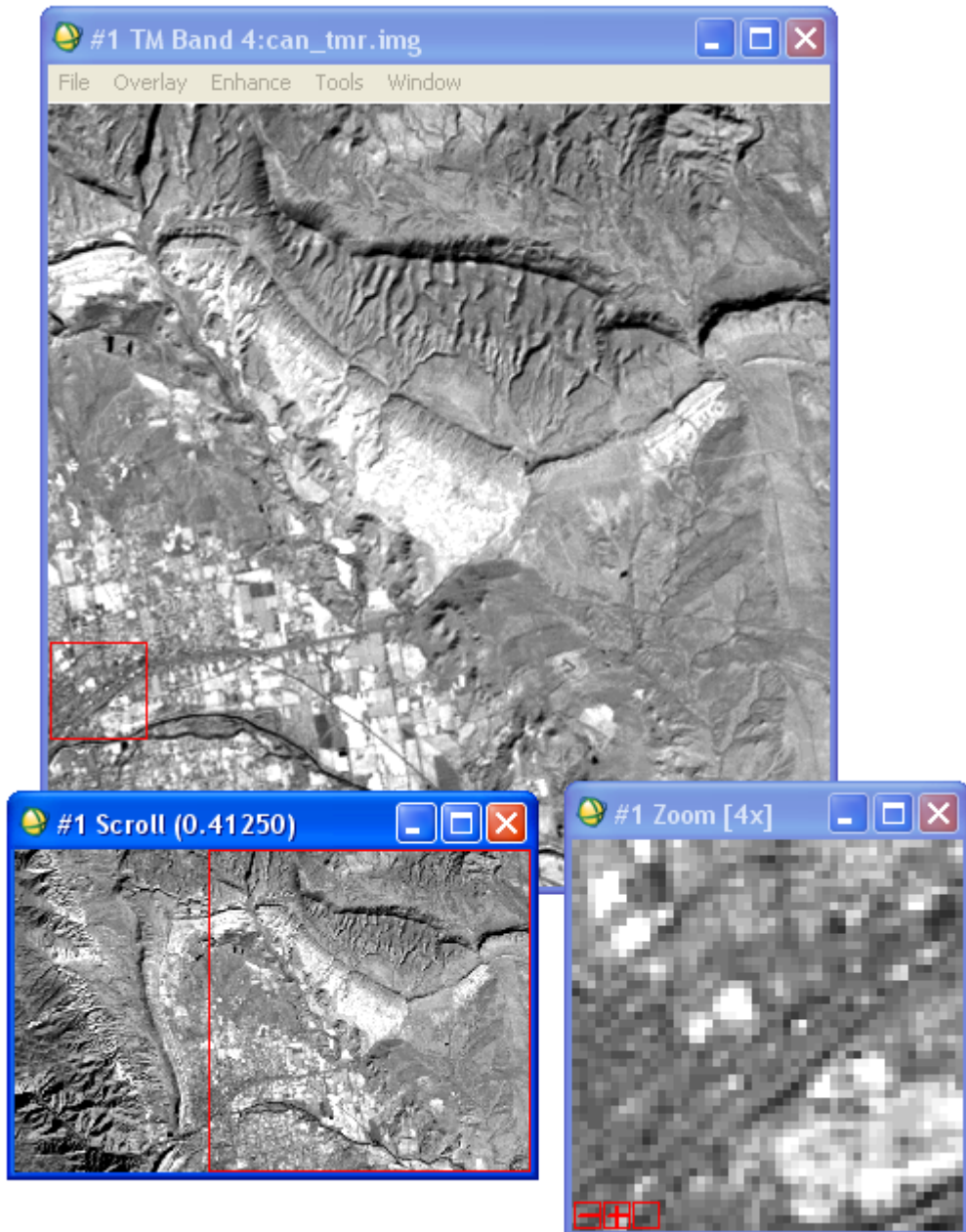
The Available Bands List dialog appears on your screen. This list allows you to select spectral bands for display and processing. You have the choice of loading either a grayscale or an RGB color image.

- Select **TM Band 4**. The band you have chosen is displayed in the field marked Selected Band.
- Click the **Gray Scale** radio button then click **Load Band** to load the image into a new display. Band 4 will be loaded as a gray scale image.



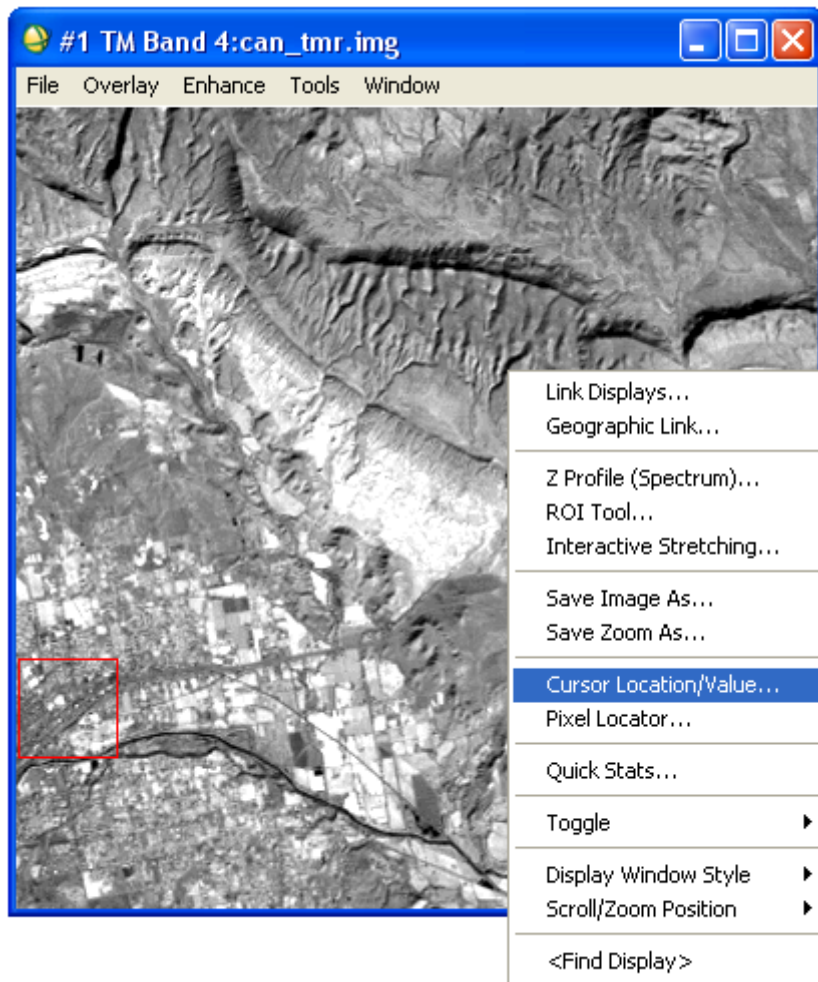
When the image loads, an ENVI image display appears on your screen. The display group consists of an Image window, a Scroll window, and a Zoom window. These three windows are intimately linked; changes to one window are mirrored in the others. You can choose which combinations of windows appear on the screen by right-clicking on any display group window to display the right-click menu and selecting a style from the **Display Window Style** submenu. Use the ENVI main menu bar **File > Preferences > Display Defaults** tab to change the default settings for which windows you wish to display and where you wish to position them. All windows can be resized by grabbing and dragging a window corner with the left mouse button.

1. Resize the Image window to be as large as possible (until the Scroll window disappears).
2. Now, make the Image window smaller than the full extent of the image data (the Scroll window will reappear).
3. Resize the Zoom window and notice how the outlining box changes in the Image window.



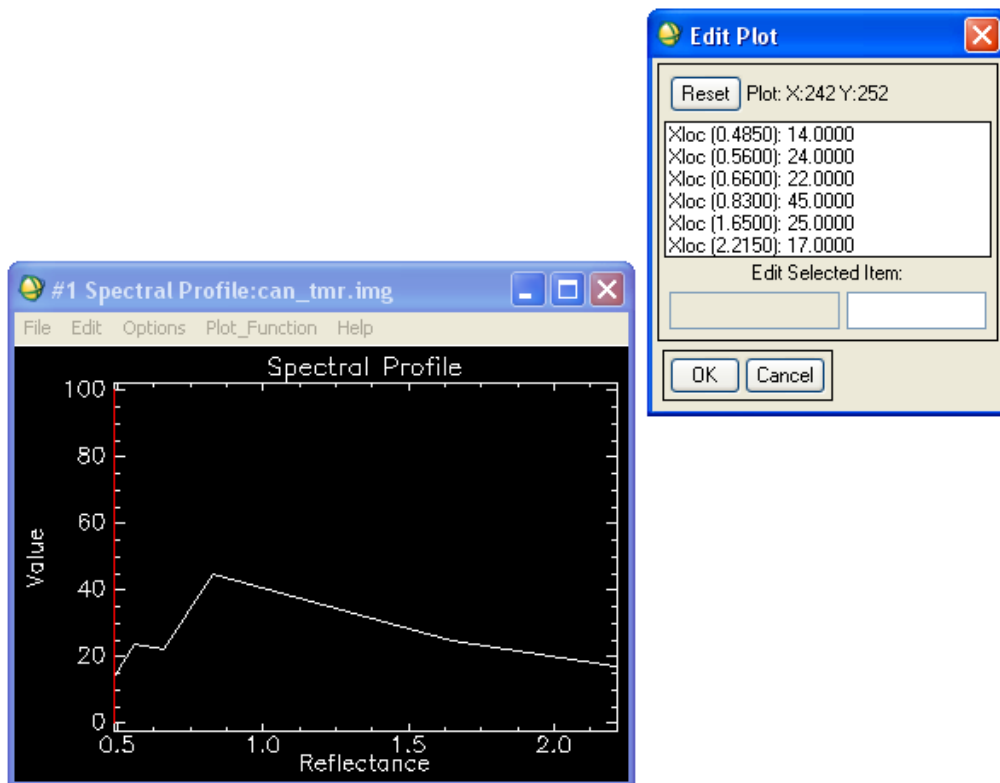
Right-click menus.

Each of the three display windows has a right-click menu for accessing general display settings and some interactive functions. Access this menu by right-clicking in the window.



Applying Z- profile (spectrum)

Place the cursor anywhere in the Image window and click the right mouse button. Click the left mouse button to Z profile (Spectrum). A spectral profile now appears depicting all the values you can get for each channel of the image. When you place the cursor on another pixel in the image window spectral profile changes accordingly. You can modify the appearing plot diagram by clicking **Edit** and then **Plot Parameters**. If you press **Data Values** you can see the data corresponding to each pixel for each channel.

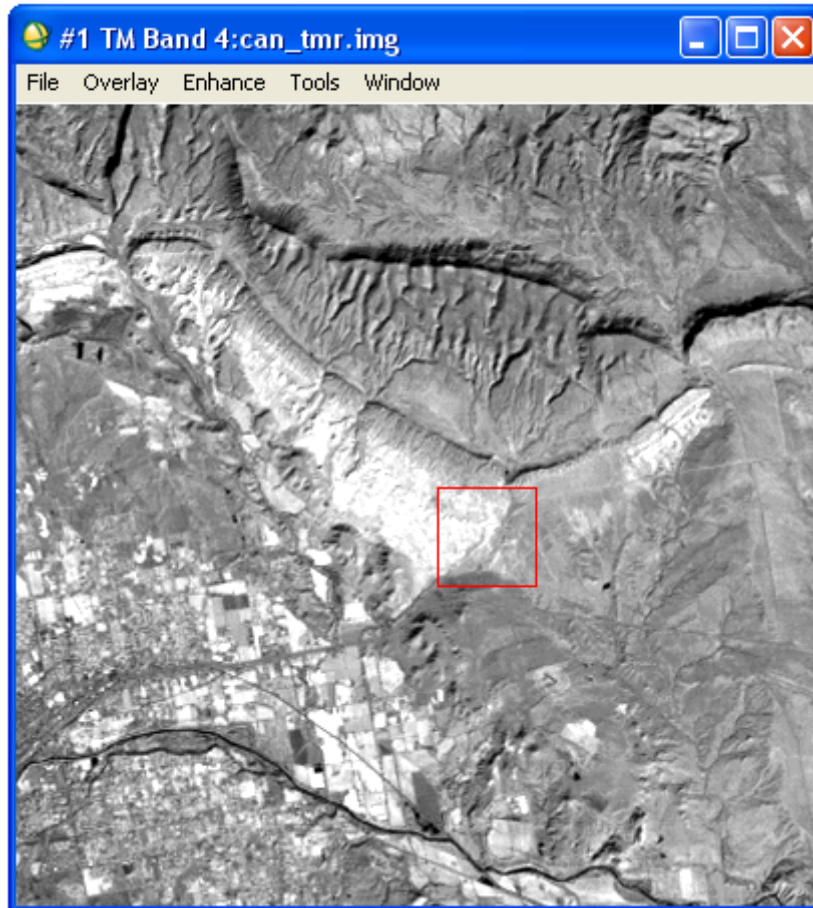


The Image Window

The Image window shows a portion of the image at full resolution. A small box at this image depicts the zoom box appearing separately.

The Display Group Menu Bar

The menu bar in the display group provides access to many ENVI features related to the images in the display group. This menu appears at the top of the Image window by default. If you have chosen to display only the Scroll and Zoom windows or just the Zoom window, the menu bar will appear at the top of the Zoom window.



The Image Window Zoom Box

The Zoom box (the colored box in the Image window) indicates the region that is displayed in the Zoom window.

1. Place the mouse cursor in the Zoom box in the Image window, hold down the left mouse button, and move the mouse. The Zoom window is updated automatically when the mouse button is released.
2. Place the cursor anywhere in the Image window (outside of the Zoom box) and click the left mouse button to move the magnified area instantly. If you click, hold, and drag the left mouse button in this fashion, the Zoom window is updated as you drag.
3. Click once in the Zoom box in the Image window and use the arrow keys on your keyboard to move the box. To move several pixels at a time, hold down the Shift key while using the arrow keys.

Scroll Bars

You can choose to have scroll bars displayed in the Image window. These scroll bars provide a way to move through the Scroll window, allowing you to select which portion of the image appears in the Image window.

1. Right-click in the Image window and select **Toggle > Display Scroll Bars**.
2. To have scroll bars appear in the Image window by default, use the ENVI main menu bar to select the **File > Preferences > Display Defaults** tab. Set the **Image Window Scroll Bars** toggle to **Yes**.

The Zoom Window

The Zoom window shows a portion of the image magnified the number of times indicated by the number shown in parentheses in the Title Bar of the window. The zoom area is indicated by a highlighted box (the Zoom box) in the Image window.

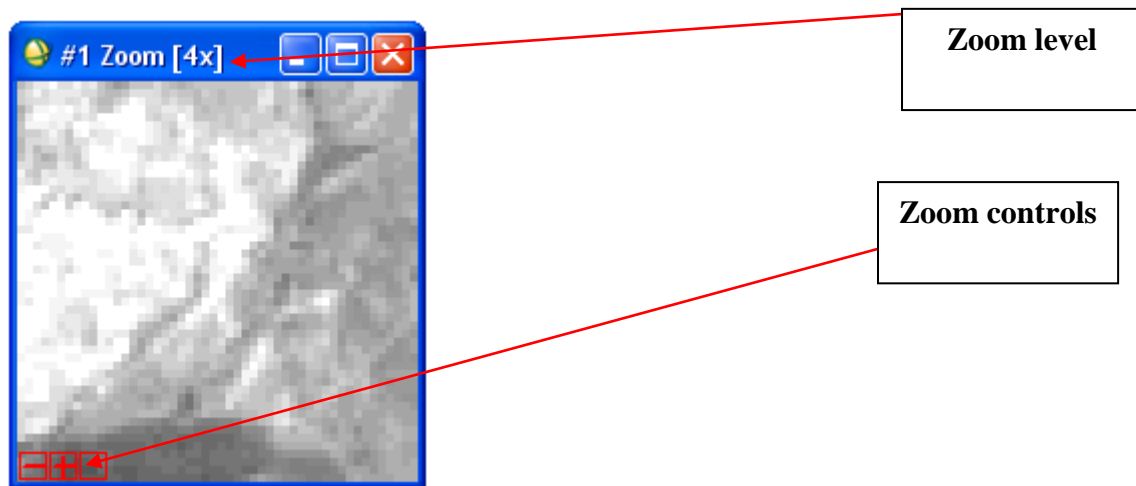
There are three Zoom controls (red by default) in the lower left corner of the Zoom window. These control the zoom factor and the crosshair cursor in both the Zoom and Image windows.

1. Place the mouse cursor in the Zoom window and click the left mouse button to reposition the magnified area (displayed in the Zoom box in the Image window) by centering the zoomed area on the selected pixel.
2. Click and hold the left mouse button in the Zoom window while dragging. This causes the Zoom window to pan within the Image window.
3. Click the left mouse button on the graphic in the lower left corner of the Zoom window to zoom out by a factor of 1.
4. Using a three button mouse, click the middle mouse button on the graphic to zoom out by a factor of 2.
5. Click the right mouse button on the graphic to return the Zoom window to the default zoom factor.
6. Click the left mouse button on the graphic to zoom in by a factor of 1.
7. Click the middle mouse button on the graphic to zoom in by a factor of 2.
8. Click the right mouse button on the graphic to return the Zoom window to the default zoom factor.
9. Click the **right** mouse button on the graphic to toggle the crosshair cursor in the Zoom window on or off.
10. Click the middle mouse button on the graphic to toggle the crosshair cursor in the Image

window on or off.

11. Click the right mouse button on the graphic to toggle the Zoom box in the Image window on or off.

12. The Zoom window can also have optional scroll bars, which provide an alternate method for moving through the Zoom window. Right-click in the Zoom window and select **Toggle > Zoom Scroll Bars**. To have scroll bars appear on the Zoom window by default, use the ENVI mainmenu bar to select the **File > Preferences > Display Defaults** tab. Set the Zoom window **Scroll Bars** toggle to **Yes**.



The Scroll Window

The Scroll window displays the entire image at reduced resolution (subsampling). The subsampling factor is listed in parentheses in the window Title Bar at the top of the image. The highlighted Image box (red by default) indicates the area shown at full resolution in the Image window.

1. Place the mouse cursor inside the Image box, hold down the left mouse button, drag to the desired location, and release to reposition the portion of the image shown in the Image window. The Image window is updated automatically when the mouse button is released.

2. Click anywhere within the Scroll window using the left mouse button to instantly move the selected Image window area. If you click, hold, and drag the left mouse button in this fashion, the Image window will be updated as you drag (the speed depends on your computer resources).

3. Click in the Image box and press the arrow keys on your keyboard. To move the image in larger increments, hold down the **Shift** key while using the arrow keys.



Applying a Contrast Stretch

By default, ENVI displays images with a 2% linear contrast stretch. You can choose to apply a different contrast stretch.

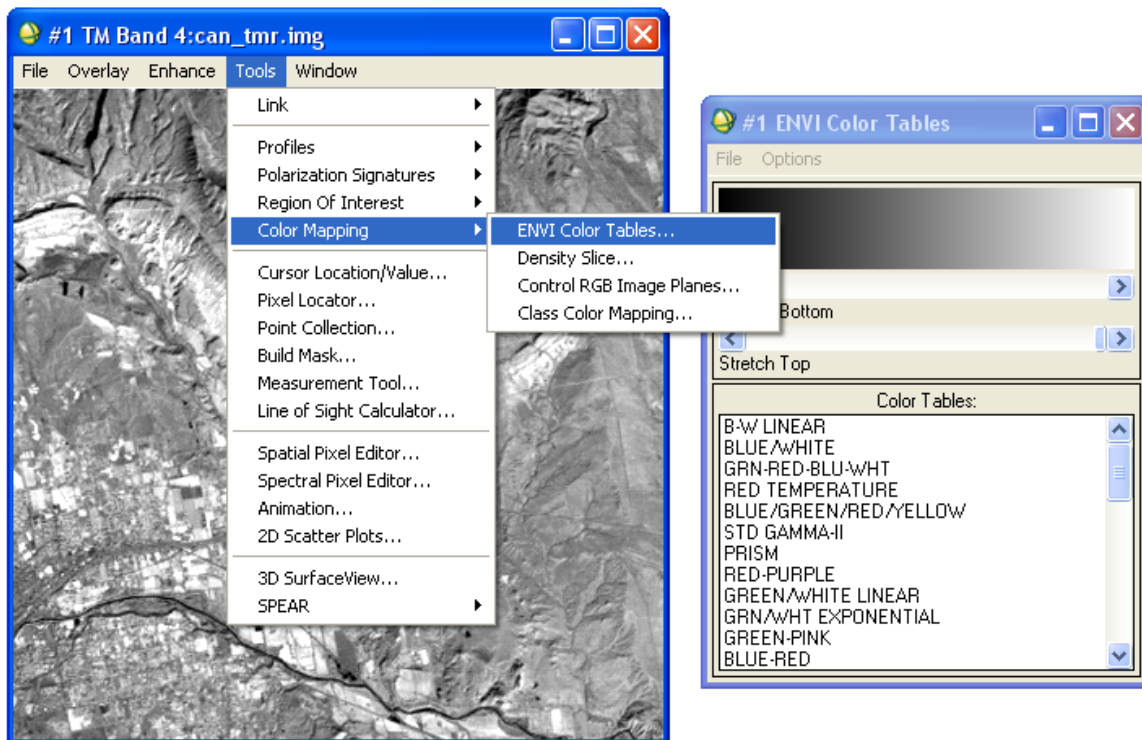
1. From the Display group menu bar, select **Enhance** to display a list of six default stretching options for each of the windows in the display group (Image, Zoom, Scroll).
2. Select an item from the list (for example, **Enhance > [Image] Equalization** to apply a histogram equalization contrast stretch to the Image window). This action also updates the Scroll and Zoom windows in the display group. Try applying several of the different available stretches.
3. Alternatively, you can define your contrast stretch interactively by selecting **Enhance > Interactive Stretching** from the Display group menu bar.

Applying a Color Map

By default, ENVI displays images using a grayscale color table. You can apply a pre-defined color table to an image or select a color table from a list.

1. From the Display group menu bar, select **Tools > Color Mapping > ENVI Color Tables** to display the ENVI Color Tables dialog.
2. Select a color table from the list at the bottom of the dialog to change the color mapping for the three windows in the display group.
3. In the ENVI Color Tables dialog, **Auto Apply** is selected by default (**Options > Auto Apply**), so the color table will automatically be applied. You can toggle this feature on or off using this menu option. If **Auto Apply** is off, you must select **Options > Apply** each time you wish to apply the color table and observe the results.

4. From the ENVI Color Tables menu bar, select **Options > Reset Color Table** to return the display group to the default grayscale color mapping.
5. From the ENVI Color Tables menu bar, select **File > Cancel** to dismiss the dialog.



Animating Your Image

You can animate a multiband image by cycling through the bands of the image sequentially.

1. From the Display group menu bar, select **Tools > Animation** then click the **OK** button on the Animation Input Parameters dialog. Each of the six bands from the TM scene is loaded into an Animation window. Once all the bands are loaded, the images are displayed sequentially creating a movie effect. You can control the animation using the player control buttons (loop backward, loop forward, change direction, and pause) at the bottom of the Animation window, or by adjusting the value shown in the **Speed** spin box to change the speed at which the bands are displayed.
2. From the Animation menu bar, select **File > Cancel** to end the animation.

Using Scatter Plots and Regions of Interest

Scatter plots allow you to quickly compare the values in two spectral bands simultaneously. ENVI scatter plots enable a quick 2-band classification.

1. From the Display group menu bar, select **Tools > 2D Scatter Plots** to display the distribution of pixel values between Band 1 and Band 4 of the image as a scatter plot. The Scatter Plot Band Choice dialog appears.
2. Under **Choose Band X**, select **Band 1**. Under **Choose Band Y**, select **Band 4**. Click **OK** to create the scatter plot.
3. Place the cursor in the Image window (but not inside the Zoom box), then click and drag using the left mouse button to move the cursor around in the window. As you move the cursor, you will notice different pixels are highlighted in the scatter plot, making the pixels appear to “dance.” The dancing pixels in the display are the highlighted 2-band pixel values found in a 10-pixel by 10-pixel region centered on the cursor.
4. Define a region of interest (ROI) in the Scatter Plot window. To do this, click the left mouse button several times in different areas in the Scatter Plot window. Doing this selects points to be the vertices of a polygon. Click the right mouse button when you are done selecting vertices. This closes the polygon. Pixels in the Image and Zoom windows whose values match the values contained in the selected region of the scatter plot are highlighted.
5. To define a second ROI, left-click a few times in the scatter plot to define the vertices of the next ROI class, and right-click to close the new polygon.
6. From the Scatter Plot menu bar, select **Class > New** and repeat the actions described in the step 4.
7. From the Scatter Plot menu bar, select **Class > Items 1:20**, choose the color for your next ROI, and repeat the actions described in step 4.
8. From the Scatter Plot menu bar, select **Options > Export All** to export the regions of interest. The ROI Tool dialog appears. The ROI Tool dialog can also be started from the menu bar in the Image window by selecting **Overlay > Region of Interest**.
9. From the ROI Tool menu bar, select **File > Cancel** to dismiss the dialog. The region definition is saved in memory for the duration of the ENVI session.
10. From the Scatter Plot menu bar, select **File > Cancel** to close the Scatter Plot window.

Loading an RGB Image

ENVI allows you to simultaneously display multiple grayscale and/or RGB color composite images.

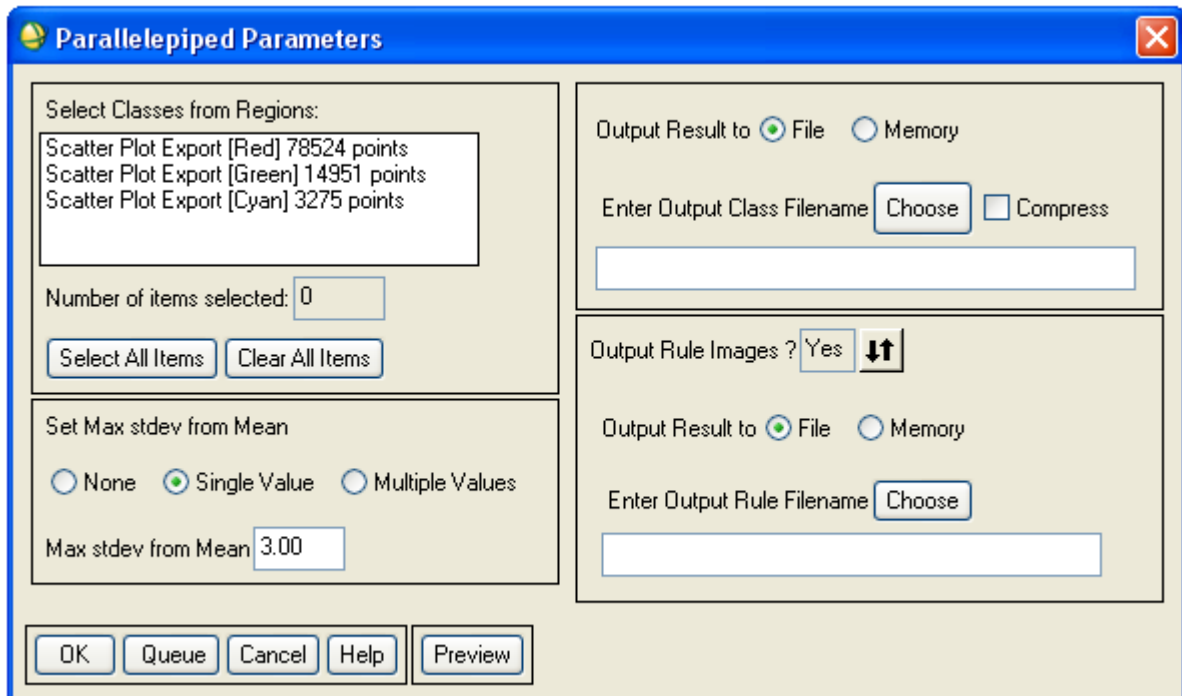
1. Click on the Available Bands List. If you dismissed the Available Bands List during the previous exercises, you can recall it from the ENVI main menu bar by selecting **Window > Available Bands List**.
2. Click on the **RGB Color** radio button in the Available Bands List. Red, Green, and Blue fields appear in the middle of the dialog.
3. Select **Band 7**, **Band 4**, and **Band 1** sequentially from the list of bands at the top of the dialog by left-clicking on the band names. The band names are automatically entered in the Red, Green, and Blue fields.
4. Click the **Display #1** button at the bottom of the Available Bands List and select **New Display**.
5. Click **Load RGB** to load the image into ENVI.

Classifying an Image

ENVI provides two types of unsupervised classification and several types of supervised classification.

The following example demonstrates one of the supervised classification methods.

1. From the ENVI main menu bar, select **Classification > Supervised > Parallelepiped**.
2. In the Classification Input File dialog, select `can_tmr.img`, and click **OK**. The Parallelepiped Parameters dialog appears.
3. Select the regions of interest (ROIs) you created previously by clicking on the region name in the *Select Classes from Regions* list at the left of the dialog.
4. Select **Memory** in the upper right corner of the dialog to output the result to memory.
5. Set the **Output Rule Images** toggle to **No**, then click **OK**. The classification function calculates statistics, and a progress window appears during the classification. A new entry called *Parallel (CAN_TMR.IMG)* is added to the Available Bands List.
6. In the Available Bands List, click **Display #1** and select **New Display**.
7. In the Available Bands List, select the **Gray Scale** radio button, click on **Parallel (CAN_TMR.IMG)**, and select **Load Band**. A new display group containing the classified image is loaded.



Dynamically Overlaying Images

You can link two display groups, allowing direct comparison of the images by displaying one on top of the other.

1. From either of the two Display group menu bars, select **Tools > Link > Link Displays**. The Link Displays dialog appears. Click **OK** to link at the origin.
2. In either of the two Image windows, position the cursor outside the Zoom box and click and hold the left mouse button. A portion of the second image is superimposed over the first image.
3. Change the size of the superimposed area by clicking and dragging the middle mouse button until the superimposed area is the desired size, then click and hold the left mouse button again.
4. Close the two display groups by selecting **File > Cancel** from each of the Display group menu bars.

Overlaying and Working with Vectors

ENVI provides a full suite of vector viewing and analysis tools, including input of ArcView shapefiles, vector editing, and vector querying.

1. Click on **TM Band 4** in the Available Bands List, click the **Gray Scale** radio button, then click **Load Band** to re-display the grayscale image.

2. From the ENVI main menu bar, select **File > Open Vector File** to open a vector file.
3. In the Select Vector Filenames dialog, navigate to the can_tm directory, click can_v1.evf, hold the **Shift** key down and click the last file (can_v4.evf) from the list (all four .evf files should be selected), then click **Open**. The Available Vectors List dialog appears listing the vectors corresponding to the can_tmr.img display.
4. Click on one of the vector layer names and examine the information about the layer at the bottom of the Available Vectors List.
5. Click the **Select All Layers** button near the bottom of the dialog to select all of the listed vectors to plot, then click the **Load Selected** button.
6. When the Load Vector Layer dialog appears, click **Display #1** to load the vectors into the first display. The vector layers are listed in the #1 Vector Parameters dialog.
7. In the Display #1 Vector Parameters dialog, click **Apply** to load the vectors onto the image. From the Vectors Parameters menu bar, select **Options > Vector Information** to start an information dialog about the vectors.
8. To display the currently selected vector layer and list basic information about the vectors, click and drag using the left mouse button in the Image window.
9. Click on another layer name in the Vector Parameters dialog then click and drag in the Image window to track a different layer.
10. From the Vector Parameters menu bar, select **Edit > Edit Layer Properties**. Change vector layer parameters as desired and click **OK**.
11. In the Vector Parameters dialog, click **Apply** to display the changes.
12. You can finish your ENVI session from the ENVI main menu bar **File > Exit** option. Answer **Yes** to the "Terminate this ENVI Session?" prompt. All files are closed automatically.