

NASA Image 2000 Users Guide

Basic Operations

Version 1.1



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Goddard Space Flight Center
Greenbelt, Maryland

Preface

Overview

This document provides detailed instructions for using the basic features of NASA Image2000. The NASA Goddard Space Flight Center's (GSFC) Advanced Architectures and Automation Branch (Code 588) is developing NASA Image2000 for the education programs of the GSFC's Scientific and Educational Endeavors (SEE) and the Center for Image Processing in Education (CIPE). NASA Image2000 is an image processing software package available on multiple platforms, designed to bring high-end scientific image processing capabilities to the standard desktop computer (see Minimum Specifications in Section 1.2 for limitations for Mac and Unix operating systems). Developed to meet the needs of educators, NASA Image2000 supports the display, analysis and processing of satellite imagery.

Audience

This guide is written for users who want to perform basic image processing using NASA Image2000. A companion manual, the Image2000 Users Guide: Advanced Operations describes some of the more advanced features of the system, which allow the user to customize and extend the tool.

Applicability

The information in this document corresponds to NASA Image2000 Version 1.1.

For more information:

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1 Introduction

1.1 What is NASA Image2000?

Why Was NASA Image2000 Developed?

NASA Image2000 is an image processing software package available on multiple platforms, designed to bring high-end scientific image processing capabilities to the standard desktop computer. (See Minimum Specifications in Section 1.2 for limitations for Mac and Unix operating systems.) Developed to meet the needs of educators, NASA Image2000 supports the display, analysis and processing of satellite imagery.

NASA Image2000 Functionality

The functionality built into NASA Image2000 was designed to provide the capability for the display and analysis of geo-coded satellite imagery. Users can perform standard image processing tasks, similar to those available in general graphics packages. In addition, the system provides other less common functions, including (but not limited to) the following:

- Display pixel intensity, pixel location relative to the image, latitude and longitude values and their corresponding projected coordinates (for geo-coded images only)
- Non-destructive image annotation including text, symbols, lines and polygons,
- Processing based on a region of interest (ROI),
- Image math using scalars and other images,
- Compute image statistics,
- Generate a histogram,
- Measurement options including distance, area, perimeter, and angle,
- Apply map projections,
- Create, edit, and animate a stack of images, and
- Create a montage from a stack or from open images.

**Extending
NASA
Image2000**

NASA Image2000 is fully extensible, allowing users to customize the program and add new functionality that is developed in-house or by other Image 2000 users. Through its state-of-the-art design, NASA Image2000 provides a powerful, extensible, platform-independent image processing system. Developed using Java v.2 and Java Advanced Imaging (JAI), it allows users to add plug-in operations or macros to extend the existing capabilities of the system for nearly any image processing task.

The design of NASA Image2000 is based upon a plug-in architecture, and users can therefore extend the functionality of Image 2000 without changing the core infrastructure. Image 2000 provides several ways of adding functionality, and includes examples of each method to assist new users.

In addition to modifying basic functionality in NASA Image2000, it is also possible to modify the look-and-feel by customizing the menus and toolbars. With relatively little effort, therefore, each user community can have its own "version" of Image 2000 that meets its unique needs.

A companion manual, the *NASA Image2000 Users Guide: Advanced Operations*, describes some of the more advanced features of the system, to assist the user in customizing and extending the tool.

1.2 What do I need to Use NASA Image2000?

Overview

NASA Image2000 is a cross-platform tool, written in Java v.2 and Java Advanced Imaging (JAI). The tool is intended to provide advanced scientific image processing capabilities on a standard desktop computer. The following tables describe the minimum system requirements for using NASA Image2000.

NOTE: Future versions of NASA Image2000 are expected to support Macintosh System X.3 and above. Earlier Macintosh operating systems do not provide sufficient support for Java, and therefore will not run NASA Image2000.

Minimum Specifications:

The system requirements for using NASA Image2000 are as follows:

	Required	Recommended
OS	Windows XP, as well as Windows 98, ME, NT and 2000. NASA Image2000 has been run on Solaris and IRIX, but these and others such as Mac OSX and Linux have not been thoroughly tested and are not officially supported in this release.	Windows XP, as well as Windows 98, ME, NT and 2000.
Memory	96 MB RAM	128 MB RAM
Processor	Pentium	Pentium 266 Mhz. (or higher)
Disk Space	2 GB Hard Disk Space (total, for software and storage of images)	2 GB Hard Disk Space (total, for software and storage of images)
Video	800x600	1024x768
Other	CD Rom Drive	CD Rom Drive

Note:

Future versions of NASA Image2000 are expected to support Macintosh System X, which claims to support Java v.2 and JAI. Earlier Macintosh systems do not provide support for the latest versions of Java, and therefore will not run NASA Image2000.

Minimum Specifications for Installation:

There is no installer included at this time for MAC OSX (see note above).

To run the installer you must have 32 MB of free RAM, a minimum of 8-bit color depth (256 colors), and a minimum 640 X 480 screen resolution. Also, the installation software requires 3 X the amount of disk space required by the application it is installing.

Thus you will also need a minimum of 950MB of hard disk space for the "Typical" installation option, although NASA Image2000 once installed will only take up 300MB if a Java VM is installed and 265MB otherwise. If you plan on installing any of the plugins available in the "Custom" installation, their sizes are listed below and you should add those sizes to your minimum space needed to install.

Minimum Space Needed for Plugins

The system requirements for using NASA Image2000 are as follows:

Plugin	Space Used	Install Space
Gaiaxroads	1MB	3MB
SEE_AVHRR	3MB	9MB
CDF	4MB	12MB
HDF	25MB	75MB
FITS	5MB	15MB

1.3 Using this Manual

Organization of this Manual	<p>This manual covers <i>Basic Operations</i> for using NASA Image2000. A companion document, which covers <i>Advanced Operations</i>, describes some of the more advanced features of the system, to assist the user in customizing and extending the tool. The <i>Basic Operations</i> manual is organized as follows:</p> <ul style="list-style-type: none">▪ Section 1 of this document provides introductory material.▪ Section 2 provides basic instructions for getting started with NASA Image2000.▪ Section 3 provides instructions for viewing an image, including opening, saving, printing, zooming, identifying pixel values and locations, and duplicating images.▪ Section 4 provides instructions for enhancing and altering an image in non-destructive ways, including adding annotations, working with Look Up Tables (LUTS), and using overlays.▪ Section 5 provides instructions for defining image properties, such as scale, density calibration, and special pixel values, as well as for changing the data type and canvas color and creating indexed images.▪ Section 6 provides instructions for performing analysis on images, including calculating image and stack statistics.▪ Section 7 provides instructions for enhancing and altering an image in ways that actually change image values, including cropping an image, applying filters, altering brightness and contrast, inverting images, using histogram matching, thresholding, and clamping an image.▪ Section 8 provides instructions for applying mathematical operations to an image and using the math calculator to alter images.▪ Section 9 provides instructions for performing geographic transformations (e.g., flip, rotate, scale operations) on an image.▪ Section 10 provides instructions for working with multiple images, including multi-band images.▪ Section 11 provides instructions for working with stacks, including animating stacks, creating montages, and using projections and overlays with stacks.
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Conventions	<p>This document uses the following terms and notational conventions:</p> <table><tr><td></td><td>Indicates a procedure, directing the user in performing an action.</td></tr><tr><td>Note:</td><td>Indicates a note, providing information that may be helpful to the user.</td></tr><tr><td></td><td>Indicates a Warning, Caution, or very important information that users need to know.</td></tr></table>		Indicates a procedure, directing the user in performing an action.	Note:	Indicates a note, providing information that may be helpful to the user.		Indicates a Warning, Caution, or very important information that users need to know.
	Indicates a procedure, directing the user in performing an action.						
Note:	Indicates a note, providing information that may be helpful to the user.						
	Indicates a Warning, Caution, or very important information that users need to know.						

bold serif type	Indicates menu items, buttons or check boxes that perform some action when selected with the mouse. Can also indicate window and field titles.
<i>Italics</i>	Indicates system messages displayed to the user.
Items in CAPS	Indicates a specific key on the keyboard (e.g., TAB or ENTER).
Items in brackets < >	Describes a value supplied by the user or the database. An example is <requirement ID>, where the user or the system supplies an actual value.
Keystrokes	When menu selections also may be accomplished with a combination of keystrokes, the keystrokes (i.e., accelerator functions) are listed parenthetically with the menu option (e.g., Select All (Ctrl + A)).

2 Getting Started

2.1 Installing NASA Image2000

Before You Begin:

To install NASA Image2000, you must either have a CD-ROM drive, or access to the NASA Image2000 installation through the internet. We recommend installing from CD-ROM if possible, since the installation package is rather large and will take longer to download. Also, please refer to Section 1.2, What do I need to Use NASA Image2000, to verify that your system meets minimum system requirements for using NASA Image2000.



To Install NASA Image2000 from CD-ROM:

1. Insert the NASA Image2000 CD in the CD-ROM drive.
The NASA Image2000 Installation program automatically runs, displaying the NASA Image2000 installation wizard (see Figure 2.1)
2. Click on the **Install NASA Image2000** button.
The Installation Wizard runs.
3. Follow the directions in the wizard to install the system. You will provide the following information:
 - Your name and organization
 - The location in your file directory where you want to install NASA Image2000
 - The type of installation you wish to perform (i.e., typical, custom or compact).In most cases you can accept the defaults provided by the installation program.
4. After you have provided all necessary information, the Installation program will install NASA Image2000 on your system in the specified location. When the installation is complete, you may click the **Finished** button. NASA Image2000 is installed!

Figure 2.1
The NASA
Image2000
Installation
Screen



To Install NASA Image2000 from a network:

1. Download the installation program from the network, and decompress.
2. Double-click on the setup.exe file.
The NASA Image2000 Installation program automatically runs, displaying the NASA Image2000 installation wizard (see Figure 2.1)
3. Proceed as described above.

2.2 Starting and Quitting NASA Image2000

Before You Begin

NASA Image2000 should be properly installed on your computer.



To Start NASA Image2000 in Windows:

1. Click on the **Start** button on your Windows taskbar. 
2. Locate the NASA Image2000 application in your **Start** menu.

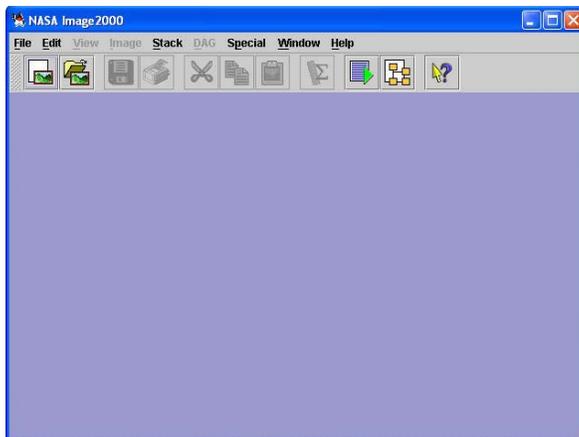
Note: The typical installation has NASA Image2000 located at the following path: Program Files > NASA Image2000 > NASA Image2000

A “splash screen” (see Figure 2.2) will be displayed while the system loads. Then, the NASA Image2000 Main Window will open (see Figure 2.3)

Figure 2.2
The NASA
Image2000
Splash Screen



Figure 2.3
The NASA
Image2000
Main Window

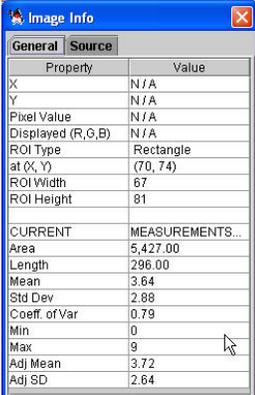
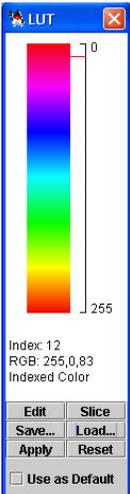




To Quit NASA Image2000:

Pull down the **File** menu and choose **Exit**.

The application will shut down.

<p>Image Info</p>		<p>The Image Info window provides a great deal of important information, including the x and y location for the selected pixel, the real and displayed pixel values, and the results of measurements that have been performed on the image.</p>
<p>Image Layers</p>		<p>The Image Layers window contains information about each separate layer of a given image. This window also allows you to manage image layers, including adding new layers and removing the layers that are no longer needed, as well as flattening the image so that all layers are combined into one.</p>
<p>LUT</p>		<p>The LUT, or Look Up Table window displays the LUT currently assigned to the image. In addition, this window allows you to manage the LUT for the image, including editing the LUT to highlight important image information, or loading other preexisting LUTs.</p> <p>Note: LUTs are only used with single-band images (e.g., greyscale or indexed images).</p>

2.4 NASA Image2000 Toolbars

Overview

The NASA Image2000 interface provides two main toolbars by default. This section describes these toolbars and the features they provide.

Note: These toolbars are customizable by editing the XML definition for the toolbars (see the *NASA Image2000 Advanced Operations Guide*).

Main Window Toolbar

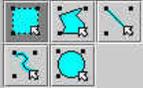
The main NASA Image2000 window contains a selection of commonly used, global tools. This toolbar is always available, although certain tools may be disabled based on the context (e.g., the print tool is unavailable if no image is open to be sent to the printer). The tools that appear on this toolbar (by default) are as follows:

Tool	Function
	New Image: Creates a new, blank image canvas. You can paste in selections from other images, and/or enter annotations.
	Open Image: Provides a Open File window, allowing you to choose an image to open in NASA Image2000.
	Save Image: Saves the image. If the image is new, you can provide a title and location for the image. Previously saved images are simply saved to the original file.
	Print Image: Sends the current image to the printer.
	Cut: Cuts the selected region of interest, leaving a blank background in its place. The “cut” image is placed on the clipboard and may be pasted.
	Copy: Copies the selected region of interest. The copied image is placed on the clipboard and may be pasted.
	Paste: Pastes the contents of the clipboard into the current image. The pasted selection appears as a new layer in the image, and can be manipulated separately.
	Measure: Performs measurements on the image, which can be used in analysis. (See Sections 6.1-6.4.)

	Script: Provides an Open File window, allowing you to select a preexisting script to run. (See the <i>NASA Image2000 Advanced Operations Guide</i> for more on scripting.)
	DAG: Opens the DAG editor, allowing you to customize NASA Image2000. (See the <i>NASA Image2000 Advanced Operations Guide</i> for more on the DAG Editor.)
	Help: Opens context-sensitive help files to assist with using NASA Image2000.

Tools Window

The Tools window may be displayed anytime an image is open in NASA Image2000. This toolbar provides a selection of tools useful for manipulating images. The tools in this window are grouped according to purpose. The tools that appear on this toolbar (by default) are as follows:

Tool	Function
	Arrow: Default Cursor mode. Exits any other cursor or tool.
	Move: Allows the user to “grab” the image and move it. Also moves the “selection” when a region of interest is selected. (The defined ROI is moved, not the image area selected by the ROI.)
	Zoom In: Zooms in, magnifying the image.
	Zoom Out: Zooms out, reducing the magnification of the image.
	Find Pixel: Allows the user to move the cursor using the arrow keys on the keyboard.
	Selection Tools: Allows the user to select a Region of Interest (ROI) to manipulate or analyze. You can select a rectangle, polygon, line, freehand area or circular area.
	Annotations: Allows the user to annotate an image, using text, predefined iconic graphics, rectangles, polygons, freehand drawings, circles and/or lines, and to “grab” existing annotations to move or delete them. See Section 4.1.
	Analysis Tools: Allows the user to plot a profile vertically, horizontally or diagonally. In addition, the Angle tool allows the user to measure angles. See Section 6.6.



	Miscellaneous: Miscellaneous tools, usually provided through plug-ins.
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2.5 NASA Image2000 Menus

Overview

The NASA Image2000 interface provides several main menus by default.

Note: These menus and menu items are customizable by editing the XML definition for the menus (see the *NASA Image2000 Advanced Operations Guide*).

Menu Item	Function
File>	The File menu handles most file management tasks. Items under this menu include creating a New file, Opening a file, Imports and Exports, Saving files, Closing files, Printing, and Exiting the system.
Edit>	Allows you to manage Edits, including the ability to Undo and Redo actions, to Cut, Copy and Paste selections, to Duplicate an image, to Select All of an image, and to change certain Preferences.
View>	Allows you to manage what NASA Image2000 “child” windows are open, including the Image Info window, Tools window, Layers window, and LUT window (see Section 2.3). This menu also allows you to control the magnification of the displayed image (zooming in or out to various percentages). See Section 3.
Image>	Allows you to perform various tasks to enhance and alter images, and to analyze images. These features primarily operate on a single image, or in comparing two images. See Sections 4 and 5.
Stack>	Allows you to work with a stack of images, including the ability to animate a stack, create a montage, use an overlay with a stack, or move images in and out of a stack.
DAG>	Allows you to work with Directed Acyclic Graphs (DAGs). Refer to the <i>Advanced Operations Guide</i> for assistance with creating DAGs.
Special>	Provides access to predefined scripts and plugins.
Windows>	Provides control of windows, including the ability to Cascade windows and Find Lost Windows.
Help	Provides access to NASA Image2000 online help and the NASA Image2000 web site.

3 Viewing an Image

3.1 Opening an Image

Overview

NASA Image2000 supports a wide range of image formats, and allows you to open and work with either a single image or multiple images at a given time. This section will discuss the basic process of opening a single image. For help with working with multiple images, see Section 7.



To Open an image file:

1. Pull down the **File** menu and choose **Open** OR

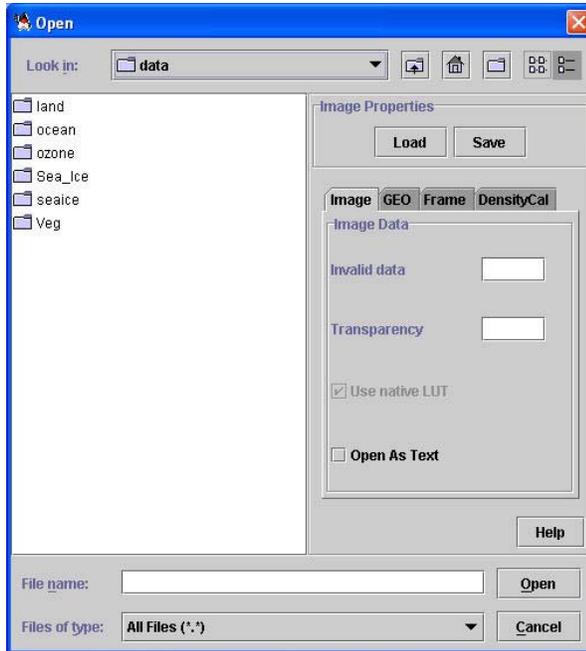
Click on the **Open** icon on the toolbar.



The **Open** window is displayed (see Figure 3.1).

2. Locate and select the file you wish to open.
3. (Optional) Provide the pixel values to be used for **Invalid data** and **Transparency**.
4. (Optional) To provide Geocoding information for geocoded images, click on the **Geo** tab, and provide the geocoding information.
5. Click on the **Open** button to open the image, or on **Cancel** to close the dialog and return to the main window.

Figure 3.1: The Open Window



**Supported
File Types**

NASA Image2000 supports the following file formats through the standard Open File feature.

- BMP format (*.bmp)
- FPX format (*.fpx)
- Generic Image file reader (*.generic)
- GIF format (*.gif)
- JPEG format (*.jpg)
- ERDAS GIS and LAN file reader (*.lan)
- PNG format (*.png)
- PNM format (*.pnm)
- Shapefile file reader (*.shapefile)
- TIFF format (*.tif, *.tiff)
- TOMS ASCII file reader (*.toms)
- WBMP format (*.wbmp)

Note: The user may customize the system to support other formats, using NASA Image2000's advanced configuration features. For information about extending NASA Image2000's capabilities, please refer to the companion document, *NASA Image2000 User Guide: Advanced Operations* .

3.2 Saving an Image

Overview

Once you have made changes to an image, you can choose to save the changes to the original file, to save the changes as a separate file, or to revert to the last saved version of the image.

Note:

Due to limitations in the development environment, NASA Image2000 currently is unable to save multi-image filetypes (including multi-layer images and stacks). As a workaround, NASA Image2000 gives you a choice of either saving the layers/stack images as separate files into a new directory, or saving the image as a single image, (which flattens (collapses) all the layers into a single RGB layer).

In addition, NASA Image2000 may be unable to save your image file in the image's original format. For example, for legal reasons NASA Image2000 is unable to save images in the .GIF format, and also is unable to save images in the TOMS format. NASA Image2000 can, however save these files in one of the supported formats (e.g., .JPEG or .TIF).



To Save changes to the original image file:

Pull down the **File** menu and choose **Save** OR



Click on the **Save** icon on the toolbar.

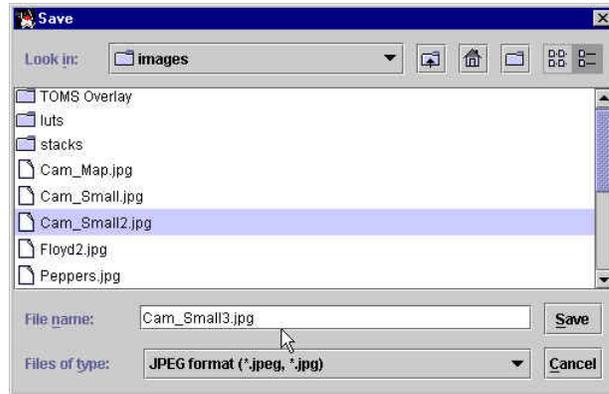
The changes to the image are saved.



To Save changes, creating a new image file:

1. Pull down the **File** menu and choose **Save As...**
The **Save** window is displayed (see Figure 3.2).
2. Change the file name and/or the location where the file should be saved.
3. (Optional) Make any necessary changes to the file type by selecting the appropriate type from the pop-up list.
4. Click on the **Save** button to save the file under a new name, or on **Cancel** to return to your image without saving.

Figure 3.2: The Save Window



To revert to the last saved version of the file:
Pull down the **File** menu and choose **Revert to Saved...**

3.3 Printing an Image

Overview

Images can be printed to your standard printer. NASA Image2000 does not automatically scale the image to fit on a single printed page, however. In order to see how your image will fit, you should first preview the image using Print Preview.

Note: The printing process is a memory-intensive activity. Depending on the amount of memory available to NASA Image2000, the system may have difficulty printing larger images.



To Preview the printed image:

Pull down the **File** menu and choose **Print Preview**

The Print Preview window is displayed (see Figure 3.3).

Figure 3.3: The Print Preview





To Print the image:

Pull down the **File** menu and choose **Print**

OR

Click on the **Print** icon on the toolbar.



The file is sent to the printer.

3.4 Zooming and Panning an Image

Overview

The hand tool, zoom tools, and zoom commands allow you to view different areas of an image at various levels of magnification.

- The zoom in tool and commands allow you to magnify the view of an image. High levels of magnification can allow you to easily see each separate pixel, and to perform analysis at a high level of detail.
- The hand tool allows you to work with an image that is too large, or is magnified to a view that is too large to fit in the window frame. You can use this tool to “pan” the image, moving it so that different parts of the image are visible in the window frame.
- The zoom out tools and commands allow you to reduce the view an image. You can zoom out to achieve high level, “overall” view of an image that may be too large to fit in the window frame.



To Zoom In:

1. Click on the **Zoom In** tool icon. 
The cursor will change to the magnifying glass.
2. Click on the image to increase the magnification OR
Enter the specific scale factor in the text field at the bottom of the tools window
The image magnification will increase. The title bar of the window will indicate the new magnification (e.g., <400%>).
3. (Optional) Continue clicking on the image until you are satisfied with the image magnification. You can click the **UnZoom** button at the bottom of the tools window to return to the standard 100% view.



To Zoom Out:

1. Click on the **Zoom Out** tool icon. 
The cursor will change to a magnifying glass with a “+”..

2. Click on the image to decrease the magnification OR
Enter the specific scale factor in the text field at the bottom of the tools window
.
The image magnification will decrease. The title bar of the window will indicate the new magnification (e.g., <50%>).
3. (Optional) Continue clicking on the image until you are satisfied with the image magnification. You can click the **UnZoom** button at the bottom of the tools window to return to the standard 100% view.

To move (pan) the view of the image:



1. Click on the **Hand** tool icon. 
The cursor will change to the hand.
 2. Click on the image, and, while holding down the mouse button, move the cursor.
The image will move, changing the field of view.
 3. Continue moving (or panning) the image until the view of the image is satisfactory.
- Note:** Double-clicking the hand tool re-centers the image in the image frame.



To magnify or reduce to a specific percentage :

- Pull down the **View** menu and choose **Zoom>**, then select the appropriate percentage view you wish to use (e.g., 50%, 200%).
The magnification will change to the selected magnification.

3.5 Identifying Pixel Location, Values and No-Data Pixels

Overview

It is often useful to identify the exact location and/or value of a given pixel in an image. NASA Image2000 provides the following information about the pixel at the cursor location:

- The exact pixel location in terms of X and Y coordinates.
- The value of the raw data of a given pixel
- The value of the pixel's display (In RGB color)

In addition, when additional image information is available (such as image calibration data or geographical scale) the Image Info window also may provide additional information (such as latitude and longitude or calibrated values).



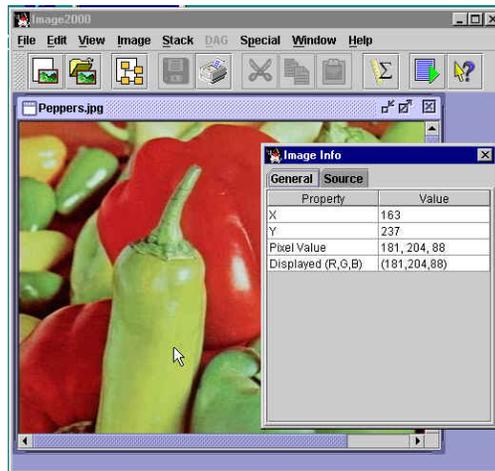
To view the Image Information (including pixel location and values) :

Pull down the **View** menu and choose **Image Info** (Ctrl-I).

The Image Info window is displayed (see Figure 3.4). As you move your cursor over the image, the X and Y coordinates, Pixel Values and RGB Values will change, updating in relation to the pixel where your cursor is located.

Note: The X and Y zero coordinates are located at the top left corner of the image.

Figure 3.4: The Image Information Window



No-Data Pixels A "no-data pixel" is a pixel whose value has been chosen to represent missing or invalid data. For example, in a given image, black pixels (with a value of 0) may be defined as no-data pixels.

The value of the no-data pixel must be explicitly identified. Some images will define the value of no-data pixels in the image's meta-data. Otherwise, the user must explicitly define the pixel value that will be recognized as a no-data pixel. Then, when viewing the Image Information window, pixels with that value may be assumed to represent areas of no data.



To define the value for "No-data pixels" when opening an image:

Enter the pixel value to be identified as a no-data pixel in the **Invalid Data** text field. Then open the image as usual.

The value you provide will be identified as invalid data, and will not be used when performing calculations.



To identify pixels with no-data value:

1. Open the Image Info window: Pull down the **View** menu and select **Image Info**.
The Image Info window is displayed.
2. As you move your cursor over the image, the Image Info window will update, showing the value of the pixels you identify.

3.6 Creating New Images and Duplicating Images

Duplicating an Image

You may at times want to duplicate an image, in order to protect an original image and/or to allow you to work with a subset of an image rather than the image as a whole. This process can have several advantages:

- In some cases only part of the image is appropriate for the analysis you wish to perform. Working with only the relevant portion of the image can help reduce problems with the analysis. Also, large images may be memory-intensive. If you can take a part of that image and work with it separately, you may improve performance of the system. In these cases you could duplicate the image and crop it to work with the relevant region of interest (see Section 4.2).
- You may want to experiment with part of an image, without the risk of making irreversible changes to your main image.

Before you Begin:

Make sure your source image is open, and is the active window.



To duplicate an existing image:

Pull down the **Edit** menu and select **Duplicate**.

A new untitled copy of the source image is displayed.

Creating a New Image from a Subset of an Existing Image

While NASA Image2000 does not provide many of the standard drawing or paint features found in graphics editing packages, you may want to create new images to work with subsets of existing images.



To create a new image from a subset of an image:

1. Pull down the **File** menu and choose **New OR**

Click on the **New** icon on the toolbar. 

The New Image dialog is displayed (see Figure 3.6).

2. Give the image a **File Name** (e.g., *My Image*).
3. Select the desired **Background Color** for the image.
4. Click on the **Ok** button to continue, or on **Cancel** to cancel the operation.

A new, empty image window is displayed.

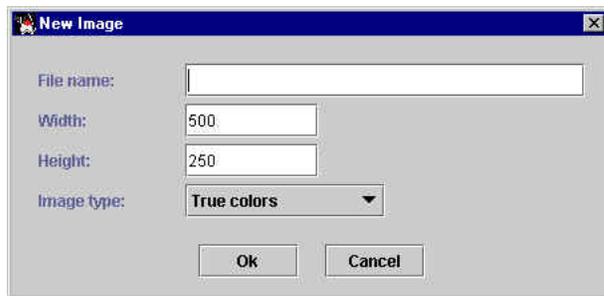
5. Activate the “source” window, and select the part of the image you want to use.

You may use any of the “selection tools” in the Tools window (see Figure 3_7).

6. Pull down the **Edit** menu, and choose **Copy** (Ctrl-C).
7. Activate the new, empty window by clicking on the window.
8. Pull down the **Edit** menu, and choose **Paste**.

The selected, copied area of the image is displayed in the new image window. You may now work with that image.

Figure 3.6: The New Image Dialog



Note: Currently, NASA Image2000 does not copy and paste from external applications. Therefore you can not view an image in another graphics editor, or a browser, for instance, and copy an image from that application to paste into an NASA Image2000 image. You must open the image itself using NASA Image2000 in order to use it with NASA Image2000 images.

4 Changing the Way You See an Image

4.1 Overview

Overview

NASA Image2000 provides many features to allow you to non-destructively highlight certain information or sections in an image, while still working with the original image data for purposes of measurements and analysis. Some of these changes can be saved separately in a non-destructive manner; others, if saved, actually change the image pixel values.

Options

The following features are available:

Feature	Description	How to Save
Annotations	Text and graphic objects such as points and lines. These annotations are added in a separate “layer” in a non-destructive manner, and you can work with them individually, separate from the image itself.	Annotations cannot be saved separate from the image. Saving is done in a “destructive” manner, flattening the image and replacing the image pixel values with those for the annotations. To preserve image data, be sure to delete annotations before you save the image.
Color Look Up Tables	Indexed color or greyscale images can be “recolorized” by applying a new Look Up Table (LUT). The new LUT can be displayed without changing the actual pixel value, allowing you to highlight certain pixel values using color without changing the data for analysis purposes.	<ul style="list-style-type: none"> • LUTs can be saved separately and used with various images. • By default, pixel data is unaffected by a new LUT, and the image file, if saved, maintains its original color information. • If the user explicitly “Applies” the LUT to the image, it actually replaces the old pixel values and color information. If the image file is saved, the new LUT is saved with the image, and the original color information is lost.
Adding a Border to the Image	A border can be added around the image, allowing space for annotations that can be saved with the image without destroying image data.	If you save the image, the border is saved as part of the image.

Adding a Title and Color Key	A title and color key can be added to the image. NASA Image2000 creates a new image with the title and color key added.	You can choose to save the new image with the title and color key, maintaining the original image.
Using Overlays	An overlay image can be added in a separate layer, providing additional reference information (e.g., geographic landmarks, etc.). NASA Image2000 applies overlays in a non-destructive manner, maintaining pixel information for the purposes of measurement and calculation.	Currently, if you choose to save the image with the overlay intact, NASA Image2000 flattens the image (replacing pixels underneath the overlay). To avoid changing pixel data, you may choose to remove the overlay layer before you save.

4.2 Annotating and Drawing on an Image

Overview

NASA Image2000 allows you to annotate images with text and graphic objects such as points and lines. These annotations are added in a separate “layer” in a non-destructive manner, and you can work with them individually, separate from the image itself. It is important to remember, however, that annotations are saved in a “destructive” manner; that is, when the image is saved, the text and graphics objects will become part of the actual image, and replace the image values under them.

You may wish to expand the size of the image canvas, providing white space surrounding the image in which you may place graphics and annotations without changing the image itself (see Section 4.5).



To add annotations and other drawings to an image:

1. Select the annotation tool you want to use from the Tools window.
2. Enter your annotation.



If using the **Text** tool, click in the image, and type in the text you wish to use.



If using the **Icon** tool, select the icon you want to use from the bottom of the toolbar, and then click in the image where you want the icon to be placed.



If using the **Rectangle**, **Circle** or **Line** tool, click in the image at the “starting point” for your object, and, holding down the mouse button, drag the mouse across the image until the object is the desired size and shape.



If using the **Polygon** tool, click in the image at the “starting point” for your polygon, then click again at each “angle point”. Right-click (i.e, click the right hand mouse button) when you want to “close off” the polygon.



If using the **Irregular Shape** tool, click in the image at the starting point, and, holding down the mouse button, drag the mouse in the shape you want to draw. NASA Image2000 will draw a line following the path of the mouse. When you want to “close off” the shape, simply release the mouse button.



To move a single annotation:

1. Click on the **Select Annotation** tool  in the Tools Window.
2. Click on the annotation you want to move, and, holding down the mouse button, drag the annotation to its new location, OR
Double-click on the annotation. This brings up a dialog to allow you to change x,y location, color, font, and symbol.



To delete a single annotation:

1. Click on the **Select Annotation** tool  in the Tools Window.
2. Click on the annotation you want to move.
3. Press the Delete button on your keyboard.

The selected annotation will be deleted.

Note:

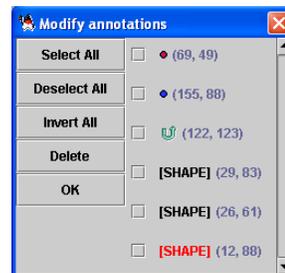
You may only move or delete an annotation *before* the image has been saved. Once you save the image, you the annotation becomes a part of the image itself, and cannot be moved or deleted without affecting the actual image.



To delete multiple annotations at once:

1. Pull down the **Image** menu and select **Graphics>Show Annotations**.
The Modify Annotations window is displayed (see Figure 4.1).
2. Click in the checkboxes beside the annotations to identify the items you wish to delete, or click on the **Select All**, **Deselect All**, or **Invert** buttons to identify the items to be deleted.
3. Click on the **Delete** button to delete the selected annotations.
The annotations are deleted and the Modify Annotations window updates to show only existing annotations.
4. Click on the **OK** button to close the Modify Annotations window.

Figure 4.1 The Modify Annotations window



4.3 Adding/Altering Color Using a Look Up Table (LUT)

Overview

NASA Image2000 uses color look-up tables (LUTs) to define the displayed RGB value of a given pixel. LUTs can be used to apply color to a grayscale image or to redefine the value of a pixel in order to make certain types of image information more obvious (e.g., changes in ozone or weather in a satellite photo).

Before you begin

LUTs can only be applied to indexed color images or grayscale images. To find out whether your image will accept a LUT:

1. Pull down the **View** menu and choose **Image Info** to display the Image Info window.
 2. Look at the **Raw Pixel Value**. If there is only a single value, then the image is either grayscale or indexed. If there are multiple values (usually, but not necessarily three) then the image will not accept a LUT.
-

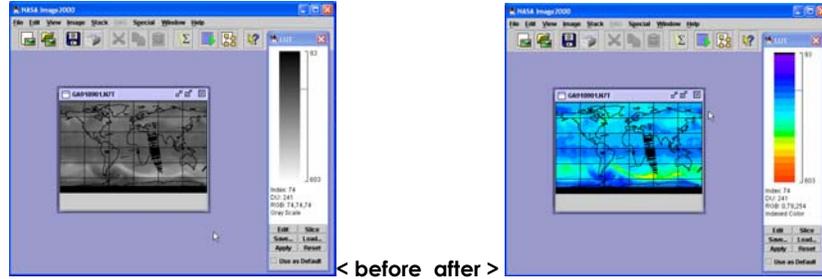


To apply a predefined LUT:

1. Pull down the **View** menu and select **Lookup Table (LUT)...**
The LUT window is displayed (see Figure 4.2 for an example).
2. Click on the **Load** button.
The Open File window is displayed.
3. Select the LUT you wish to apply, and click on the **Open** button.
The new LUT is displayed in the LUT window, showing you the new RGB display values for each raw pixel value. The image is also updated to display the new values.
4. (Optional) Click the **Use as Default** checkbox to automatically apply the selected LUT to subsequent images.
As long as the Use As Default checkbox is checked, and the LUT window remains open, each additional image that is opened will automatically be displayed with the selected LUT.

Figure 4.2: The LUT Window, applied to an Image (before and after)

Note: The image used is a TOMS image; the "after" LUT is TOMS.lut



Saving (or not saving) the color changes

When you load a new LUT, the change in color is to the image display only, and will remain in effect only while the image is open. If you save the image, the change in color is not saved unless you have clicked '**Apply**'. Therefore, if you view the image in the Layer window, you will see the old LUT information reflected. You can choose to either make the new color information permanent (replacing the image's permanent lookup table with the displayed one), or to revert to the old LUT definition.



To make the LUT definition permanent:

While viewing the LUT window, click on the **Apply** button.

The new LUT definition replaces the image's permanent lookup table with the displayed one. When the image is saved, the LUT definition will be saved as well.



To revert to the former LUT definition:

While viewing the LUT window, click on the **Revert** button.

The former LUT is displayed in the LUT window, showing you the RGB display values, which should now match the raw pixel value. The image is also updated to display the raw pixel values.

4.4 Modifying a Look Up Table (LUT)

Overview

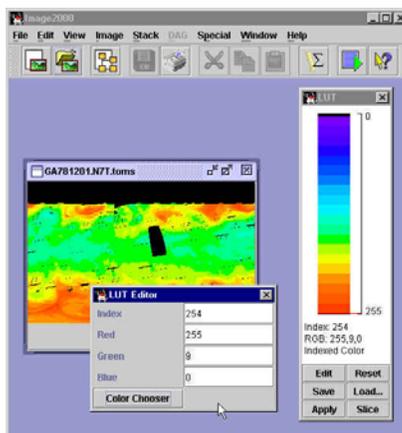
You may at times find it useful to modify a LUT, in order to highlight certain pixel values explicitly. You can modify a LUT in a couple of ways. The most direct, though at times tedious, way is to edit the LUT itself pixel by pixel, defining a new RGB display value for the pixel. Another method for modifying a LUT is density slicing, which allows the user to define a range of pixel values to be highlighted by a single color.



To edit a specific pixel in a LUT:

1. While viewing the LUT, click on the **Edit** button.
The LUT Editor window is displayed (see Figure 4.3).
2. Identify the pixel you wish to edit, either by editing the **Index** text field, or by moving the cursor over the LUT (the Index field will update as you move the cursor).
3. Identify the new RGB display color for the pixel:
Update the text fields to define the new color OR
Click on the **Color Chooser** button, and select the color you want to use.
4. Close the LUT Editor window when you are satisfied with the change.

Figure 4.3: The LUT Editor Window

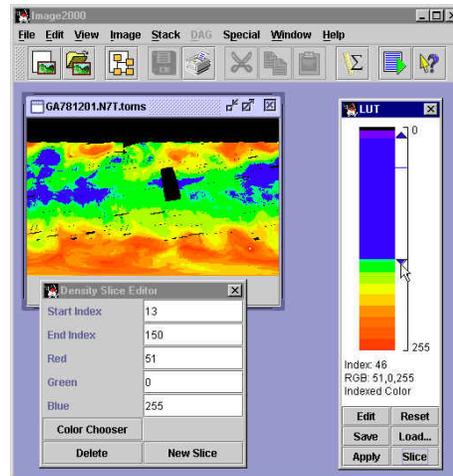


To perform density slicing on a LUT:

1. While viewing the LUT, click on the **Slice** button.
The Density Slice Editor window is displayed.

2. Identify the range of pixels you wish to edit, either by editing the **Start Index** and **End Index** text field, or by moving the range sliders in the LUT window (the Index field and the image itself will update as you move the cursor).
3. Identify the new RGB display color:
 - Update the text fields to define the new color OR
 - Click on the **Color Chooser** button, and select the color you want to use.
4. If you want to define more than one density slice, click on the **New Slice** button, and repeat steps 2, 3 and 4 as needed.
5. To delete a density slice, select the slice in the LUT window and click on the **Delete** button in the Density Slice Editor window.
6. Close the Density Slice Editor window when you are satisfied with the changes.

Figure 4.4: The Density Slice Editor, with LUT changes displayed in the image.



To save the edited LUT definition in a new .lut file:

While viewing the LUT window, click on the **Save** button.

The Save window is displayed, allowing you to provide a name for the LUT and save it for future use.

Note:

LUT's are saved in comma separated value (CSV) format that can be imported into many spreadsheets. Image 2000 can also directly import ASCII LUT's created by NIH Image.

4.5 Adding a Border to an Image

Overview

NASA Image2000 allows you to add a border around the image, providing space to add annotations, etc. without affecting actual image data. The border color is white, and in the current version cannot be changed.



To add a border:

1. Pull down the **Image** menu and select **Graphics>Border Construction...**

The Border Construction Operation window is displayed (see Figure 4.5)

2. Provide the dimensions for the Border you wish the image to have.

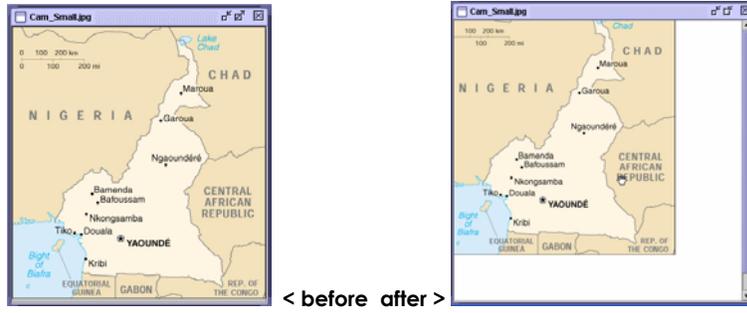
For example, for a border on the right side of the image of 100 pixels, enter <100> into the **Right Pad** text field.

3. Select the desired fill **Type** from the dropdown list.
 4. Click on the **OK** button to accept the changes, or on **Cancel** to close the window without adding the border.
-

Figure 4.5: The Border Construction Window



Figure 4.6:
Example Border



4.6 Adding a Title and Color Key to an Image

Overview

Often a given color is used to correspond to certain types of image information. For example, in a satellite image, certain colors may be associated with various temperatures, or elevations. You can add a title and color key to an image to assist with analysis of such images.



To add a title and color key:

1. Pull down the Graphics menu and choose Add Title and Color Key...
The Create a Color Key window is displayed (see Figure 4.7).
2. Enter the **Legend** text in the text field.
3. (Optional) Change the first “tic” for the color key.
4. (Optional) Change the interval for the tic marks on the color key.
5. (Optional) Click on the **Background** button to change the background color for the color key.
A color picker is displayed. Select the color you want to use, and click on **Ok** to use the color, or **Cancel** to close the color picker and accept the default background color.
6. Click on the **Image** tab to define the title bar.
The Image panel is displayed (see Figure 4.7).
7. (Optional) Change the **Title** text.
8. (Optional) Change the width for the image border, at the **Top**, **Bottom**, **Left** and **Right**, in pixels.
9. (Optional) Click on the **Background** button to change the background color for the color key.
A color picker is displayed. Select the color you want to use, and click on **Ok** to use the color, or **Cancel** to close the color picker and accept the default background color.
10. Click on the **Ok** button to create the Title Bar and Color Key, or **Cancel** to close the dialog without performing the operation.
A new image window is displayed, with a title bar and color key (see Figure 4.8). You may choose to save the new image, and the title bar and color key will be saved with the image.

Figure 4.7
Create a Color Key window:
Color Key and Image panels.

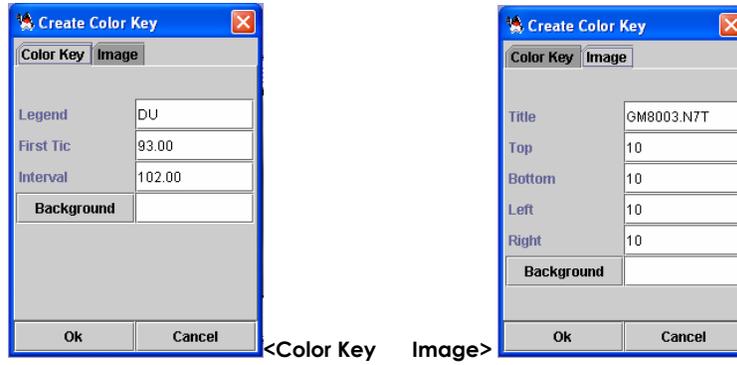
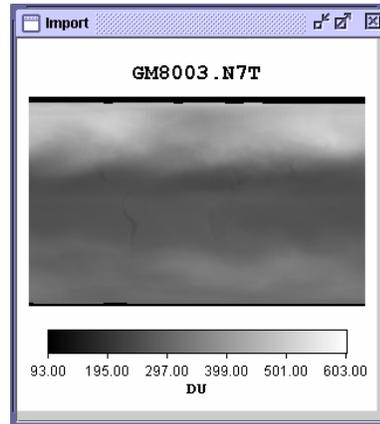


Figure 4.8
Image with Title Bar and Color Key

Note: Sample image is a TOMS image; defaults accepted.



4.7 Using Overlays with a Single Image

Overview

NASA Image2000 allows you to apply an overlay to a single image. Overlays can be useful when viewing satellite images, to give referential information. For example, you might apply an overlay to show geographical borders on an image that displays ozone values, in order to easily identify the location of various differences in ozone values.

Overlays are added in a non-destructive manner, in a separate image layer. Therefore, the overlay must match the base image in size and dimension. In addition, the overlay image must be the same image type as the base image.

Note: If you wish to save your image after an overlay is added, be aware that NASA Image2000 “flattens” the image when saving, replacing the pixels underneath the overlay with the overlay image. To maintain image data, be sure to remove the overlay before saving.



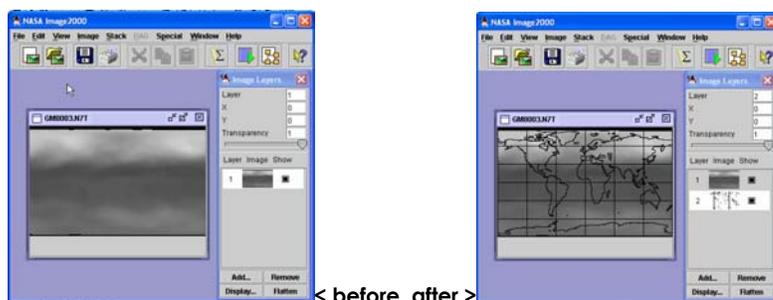
To add an overlay:

1. Pull down the **View** menu and choose **Image Layers**.
The Image Layers window is displayed (see Figure 4.9)
2. Click on the **Add** button in the Image Layers window.
The Open window is displayed.
3. Locate the overlay file you wish to add.
4. Type the **Transparency** pixel value in the text field. (e.g., 255 for white, 0 for black).
5. Click on the **OK** button.

The overlay is added to the image in a separate layer.

Figure 4.9
Image Layers
window with
sample image

Note: Sample
image is a TOMS
image; overlay
file is LatLong.tif





To remove an overlay:

Make sure the overlay layer is selected in the Image Layers window and click on the **Remove** button.

5 Defining Image Properties

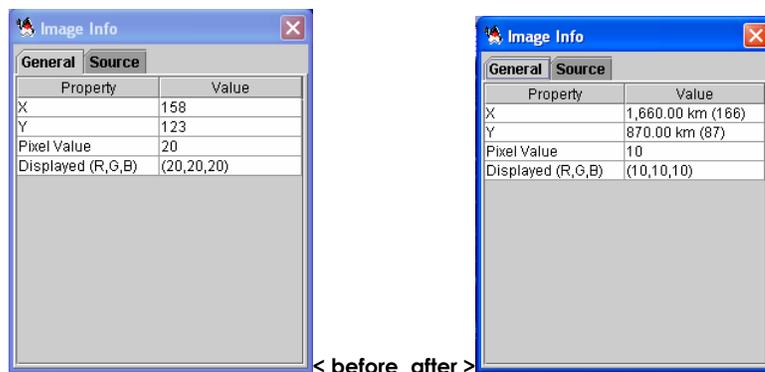
5.1 Setting the Scale

Overview

NASA Image2000 allows you to define the spatial scale of a pixel in your image. For example, you could choose to define that the length and width of pixels are equal to a certain number of kilometers, in order to measure the distance represented in the image.

While some image types include this information by default (e.g., TOMS data or geocoded TIF images), for others you will need to explicitly define the scale in order to perform useful calculations. Figure 5.1 illustrates the difference in the Image Info window before the image scale is defined, compared to after.

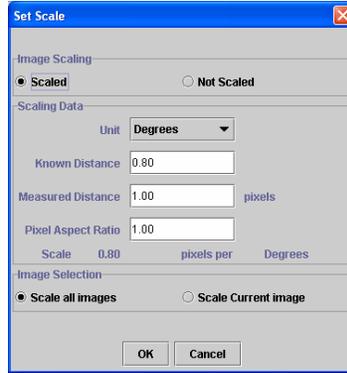
Figure 5.1: The Image Info Window, unscaled and scaled



To Set the Scale:

1. Pull down the **Image** menu and select **Properties> Set Scale...**
The Set Scale window is displayed (see Figure 5.2).
2. If the image is currently not scaled, the **Not Scaled** radio button will be selected. If so, click on the **Scaled** radio button to enable the Image Scaling.
3. Edit the Scaling Data as necessary, to define the **Unit**, **Known Distance**, **Measured Distance** (in pixels) and **Pixel Aspect Ratio**.
For example, you may define that 1 pixel Measured Distance is equal to 10 (Known Distance) Kilometers (the Unit).
4. Click on the appropriate Image Selection radio button to choose to **Scale all images** or to only **Scale current image**.
5. Click on the **OK** button to set the scale.

Figure 5.2: The Set Scale Window



5.2 Defining Density Calibration

Overview

In working with satellite data, you may know the real-world, or geophysical values of a few pixels in the image. NASA Image2000 allows you to define the density calibration for an image in order to mathematically relate the geophysical values with raw pixel values. The density calibration can be saved to a file, which may then be used for similar types of images (e.g., you may define a single density calibration for all images in a single set of data).

In order to define the Density Calibration, you must know the geophysical value of certain pixels in the image (for example, the actual altitude or temperature represented by a given pixel). You will then gather measurements for each of those pixels (for example a Mean value for the pixel).

Note:

An example of using the density calibration on geophysical image data can be found in the Studying Earth's Environment from Space (SEES) modules on Oceanography and Polar Sea Ice Processes (Ex. 1.F). You can access these modules at <http://see.gsfc.nasa.gov/edu/SEES>.



To Define the Density Calibration:

1. Gather the NASA Image2000 measurements for each of your "known" pixels.
To perform a measurement, select the rectangle selection tool  and click on the target pixel, and then click on the Measure icon  on the tool bar. Pull down the **Image** menu and select **Analysis>Measurement Table** to see the results of your measurements.
2. Pull down the **Image** menu and select **Properties> Density Calibration**
The Density Calibration window is displayed (see Figure 5.3), displaying the Mean measurements you collected.
3. Enter the list of known values next to the appropriate measured values in the text boxes at left.
4. Enter the **Unit of Measure** you wish to use in the text box.
5. In order to be able to reuse the calibration file in future NASA Image2000 sessions, click on the **Save** button to save the values. Give the file a name and click **Export** to save.
6. Click on the radio button for the type of mathematical calibration you wish to use. (**Straight Line** is a simple linear calibration.)
7. (Optional) Click on the **Fit Points** button to see the calibration graphically.

8. Click on the **OK** button to accept the Density Calibration and close the window.

The Pixel Value in the Image Info window (**View>Image Info**) will now display the calibrated pixel values.

Figure 5.3: The Density Calibration Window



To apply an existing Density Calibration file:

1. Pull down the **Image** menu and select **Properties>Density Calibration**.
The Density Calibration window is displayed.
2. Click on the **Open** button.
If the image is already calibrated, NASA Image2000 will ask if you want to Overwrite Data. If so, click OK. The Load Calibration Data window is displayed.
3. Locate the relevant density calibration file (it will have a file extension of *.csv), and click **OK**.
The calibration file is loaded.
4. Click on the radio button for the type of calibration you wish to use, and, if necessary, type the **Unit of Measure** in the appropriate text box.
5. Click on the **Fit Points** button to see a graphical representation of the calibration values, or on **OK** to use the calibration data.

Note: You can also identify an existing density calibration file to use when opening an image file. Simply click on the DensityCal tab in the Open File window, and click on the Calibration File radio button to identify the predefined file.

5.3 Changing the Data Type

Overview

There are cases in which you may wish to explicitly change the data type of the image you are viewing. For example, in order to perform certain image mathematic calculations, the image must be in a compatible data type. NASA Image2000 make it simple to change the image data type.

Note: Changing the image type may result in lost or altered image data. You may wish to duplicate the image file before performing this operation (see Section3.6).



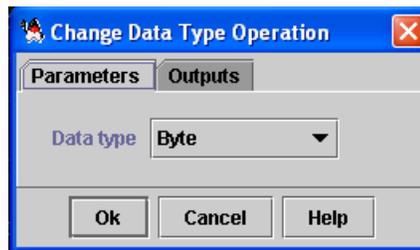
To Change the Data Type:

1. Pull down the **Image** menu and select **Properties>Change Data Type**.

The Change Data Type Operation window is displayed (see Figure 5.4)

2. Select the appropriate data type from the dropdown list.
3. Click **OK** to change the data type.

Figure 5.4: The Change Data Type Operation Window



5.4 Changing the Canvas Color

Overview

NASA Image2000's default canvas color is black. While this background color is rarely obvious, in some cases you may want to change the canvas color. For example, when adding a border to the image, you may want to change the canvas/background color to white, to allow you to add annotations without affecting image data (see Section 4.5).



To Change the Canvas Color:

1. Pull down the **Image** menu and select **Properties>Set Canvas Color**.

The Canvas Color window is displayed (see Figure 5.5)

2. Select the color you want to use from the dropdown list.
 3. Click **OK** to change the canvas color.
-

Figure 5.5: The Change Canvas Color



5.5 Setting Special Pixel Values

Overview

NASA Image2000 allows you to define two types of special pixel values. The first type is the “invalid” pixel value. This special pixel value identifies pixels which should be ignored when performing calculations (see Section 3.5). The second type is the “transparent” pixel value. This special pixel value identifies pixels which should be displayed as transparent (for example, in an overlay).



To Set Special Pixel Values:

1. Pull down the **Image** menu and select **Properties>Set Special Pixel Values**.

The Set Transparent and Invalid Pixel window is displayed (see Figure 5.6)

2. Enter the Invalid and/or the Transparent pixel values in the appropriate text field.

Note: In NASA Image2000, black pixels have a value of “0”, and white pixels have a value of “255”.

3. Click **OK** to set the pixel values.

Figure 5.6: The Set Transparent and Invalid Pixel Window



5.6 Making an Indexed Image

Overview

Indexed formats are mapped to a smaller color palette -- 256-colors or less. In an indexed image, colors are stored in a color look up table (LUT), which allows you to easily highlight specific features of the image.

NASA Image2000 allows you to convert non-indexed image to an indexed format. Since this operation inherently causes a loss of image data, you may wish to duplicate the image before converting a non-indexed image to an indexed format (see Section 3.6).

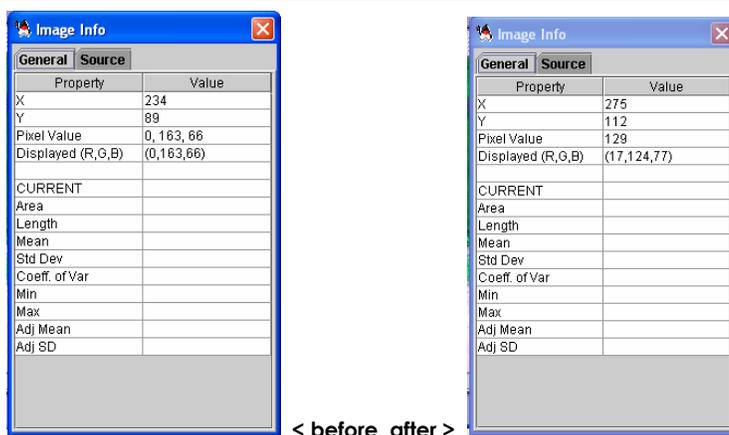


To Make an Indexed Image:

Pull down the **Image** menu and select **Properties>Make Indexed Image**.

The image is converted into an Indexed Image. In the Image Info window (**View>Image Info**), the pixel value now appears with a single value (the index value).

Figure 5.7
Image Info,
before and
after



6 Image Analysis

6.1 Selecting Subregions for Analysis

Overview

Much of the analysis performed using NASA Image2000 is performed on selected regions of interest (ROI) in the image rather than on the image as a whole. NASA Image2000 provides several tools to allow you to select these subregions for analysis in specific ways.



To select a subregion of an image (or ROI):

1. Select the selection tool you want to use from the Tools window.
2. Using the tool, make your selection:



If using the **Rectangle**, **Circle** or **Line** tool, click in the image at the “starting point” for your object, and, holding down the mouse button, drag the mouse across the image until the object is the desired size and shape.

Note: You can use the Rectangle selection tool to select a single pixel. With the tool selected, simply click on the pixel you want to select.



If using the **Polygon** tool, click in the image at the “starting point” for your polygon, then click again at each “angle point”. Right-click (i.e, click the right hand mouse button) when you want to “close off” the polygon.



If using the **Freehand** tool, click in the image at the starting point, and, holding down the mouse button, drag the mouse in the shape you want to draw. NASA Image2000 will draw a line following the path of the mouse. When you want to “close off” the shape, simply release the mouse button.

3. Continue with your analysis of the ROI.

Note:

The ROI shape, location and size are displayed in the Image Info window. The subregion selection remains in effect as long as the “marching ants” are visible, marking out the borders of the selection.



To move a selected subregion of an image (or ROI):

1. Move the cursor over the selected region.

The cursor becomes a “hand” .

2. Click and hold down the mouse button while you drag the selection area to the appropriate area.



To change the selected subregion of an image (or ROI):

1. Move the cursor over the edge of the selected region.

The cursor becomes a double arrow  .

2. Click and hold down the mouse button while you drag the selection area in the direction of arrow to resize the selection.

Note: ROIs selected with the polygon and freehand selection tools are not resizable .

6.2 Measuring Distance and Area and Performing Calculations

Overview

NASA Image2000 allows you to measure several variables (e.g., area, length, pixel mean, standard deviation) for selected regions of interest (ROIs) based on that scale. NASA Image2000 supports the following units for measuring length and area

- Nanometers
- Micrometers
- Millimeters
- Centimeters
- Meters
- Kilometers
- Inches
- Feet
- Miles
- Pixels

NASA Image2000 also supports Arbitrary Units, allowing user-defined units of measurement.

NASA Image2000's Measure command also calculates several other measurements, including the Image Mean and Standard Deviation, as well as the Minor Axis and Major Axis, Angle Measurements, the Coefficient of Variables, and the Min and Max.

Note: You may need to set the scale for the image, so that NASA Image2000 can accurately perform the calculations. See Section 5.1.



To perform measurement and calculations:

1. (Optional) Select a subregion of the image to measure (see Section 6.1).
2. Pull down the **Image** menu item, and select **Analyze>Measure**
The **Image Info** window (**General** tab) is updated with the measurement.

Note: You may choose to perform several measurements for a given image. You can view all the results of your measurements in a Measurement Table. Refer to Section 6.3 for assistance with using the Measurement Table.

Figure 6.1: The Image Info Window, with measurement results



6.3 Viewing Analysis Results in the Measurement Table

Overview

You may often want to take several measurements (such as measuring distance or calculating the image mean and standard deviation) and compare the results. NASA Image2000 allows you to customize a Measurement Table, including the measurements you want to include and excluding those in which you have no interest.

NASA Image2000 “remembers” all the available measurements, even if they are not displayed in the Measurement Table. You may, therefore, choose to display or exclude measurements from the Measurement Table on the fly, without losing data or being required to perform the same measurements multiple times.



To view the Measurement Table:

1. Pull down the **Image** menu, and select **Analyze>Measurement Table**.
The Measurement Table window is displayed (see Figure 6.2).
2. (Optional) To delete a row from the table, select the row and click on the **Delete** button.
3. (Optional) To “reset” the table (deleting all rows from the table, and erasing the measurements from NASA Image2000 memory).
4. (Optional) To change the measurements included in the table view, you can customize the table (see below).
5. To close the Measurement Table, click on the close box in the upper right-hand corner.

Figure 6.2: The Measurement Table Window

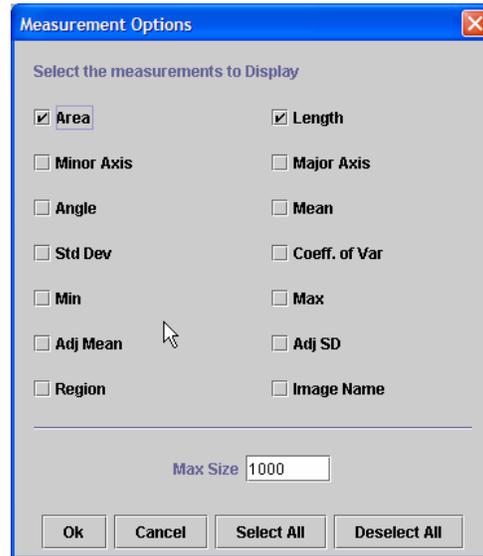
RowID	Area	Length	Angle	Mean	Std Dev	Coeff. of Var
1	1,015,284....	3,715.19 km	N/A	222.12	26.39	0.12
2	3,292,200....	7,260.00 km	N/A	221.09	27.97	0.13
3	20,056.17 ...	2,005.62 km	N/A	225.81	33.63	0.15
4	13,232,700...	14,560.00 k...	N/A	217.07	37.11	0.17



To customize the Measurement Table:

1. Pull down the **Image** menu, and select **Analyze>Measurement Table**.
The Measurement Table window is displayed (see Figure 6.3).
2. Click on the **Options** button.
The Measurement Options window is displayed.
3. Click on the checkboxes to select or unselect the available options, or click on the **Select All** or **Deselect All** buttons.
4. Click on the **OK** button to change the options, or on the **Cancel** button to keep the old configuration.

Figure 6.3: The Measurement Options Window



6.4 Creating a Histogram of an Image

Overview

A histogram provides a graphical representation of the distribution of pixels of different pixel values. A histogram can be generated for either the image as a whole, or for a selected region of interest.



To generate a histogram:

1. (Optional) Use a selection tool to select a subregion of the image for analysis (see Section 6.1).
2. Pull down the **Image** menu, and select **Analyze>Histogram**.
The Generate Histogram Operation window is displayed (see Figure 6_4).
3. Edit the values as needed.
4. Click on the **OK** button to generate the histogram, or on the **Cancel** button to cancel the operation.
The Histogram for <File> window is displayed (see Figure 6_5).
5. (Optional for multi-band images) You may click on the 3-band icon  to view all three bands at once, or on the 1-band icon  to choose a single band to view.
6. (Optional) Click on the Save icon  to save the histogram.
7. Click on the close box in the upper right-hand corner of the window to close the window.

Figure 6.4: The Generate Histogram Operation Window

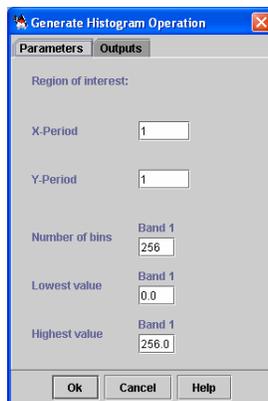
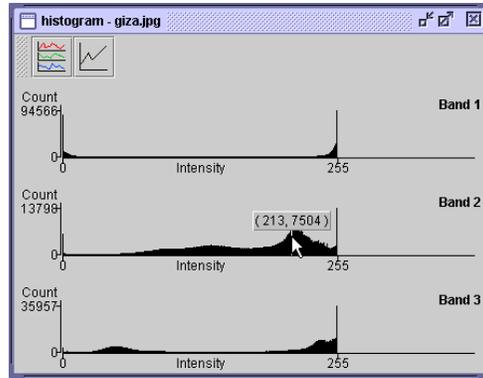


Figure 6.5: The Histogram for <File> Window



6.5 Plotting a Profile of a Single Image

Overview

NASA Image2000 provides several graphical tools to allow you to plot a profile for a single image. Plotting a profile allows you to visualize the distribution of pixel values between two points on an image. This type of plot is useful for illustrating gradients in various phenomena (e.g., ozone values).



To Plot a Profile:

1. Select the profile tool you want to use from the Tools window.
2. Plot your profile:



If using the **Horizontal Profile**, or the **Vertical Profile** tool, move your cursor over the image until you find the x or y axis you want to plot, and then click in the image.

A Horizontal or Vertical Profile window is displayed (see Figure 6.6).



If using the **Horizontal & Vertical Profile** tool, move your cursor over the image until you find point you want to plot, and then click in the image.

Both a Horizontal and a Vertical Profile window are displayed (see Figure 6.7).



If using the **Segment Profile** tool, select the icon you want to use from the bottom of the toolbar, and then click at the “starting point” for your segment, and, holding down the mouse button, drag the mouse across the image until the segment is the desired size and angle.

A Profile Segment window is displayed (see Figure 6.8).

3. (Optional for multi-band images) You may click on the 3-band



icon to view all three bands at once, or on the 1-band icon



to choose a single band to view.

4. (Optional) Click on the Save icon  to save the profile data to a text file.

You may then import the data into a graphics utility or a spreadsheet application.

5. Click on the close box in the upper right-hand corner of the window to close the window.

Note: Once you have plotted a profile, you may choose to leave the Profile window open as you continue plotting profiles. The window will update with the new values for each profile.

Figure 6.6: The Profile Window

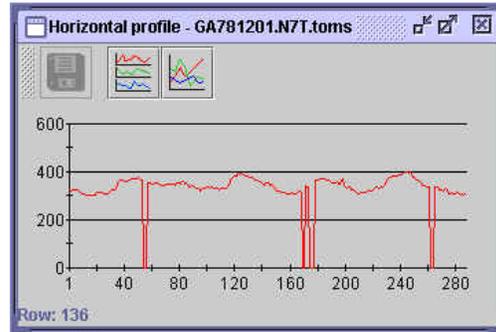


Figure 6.7: The Horizontal and Vertical Profile Windows

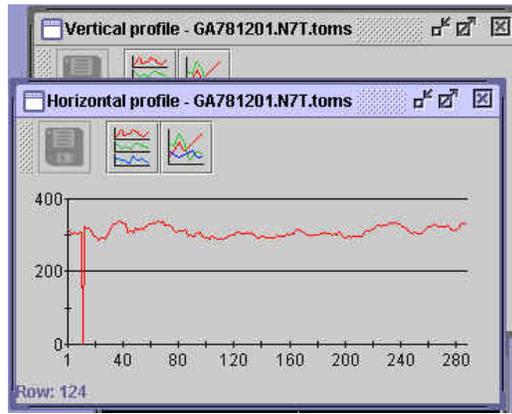
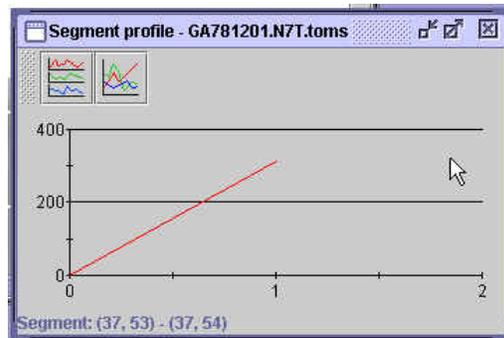


Figure 6.8: The Segment Profile Window



7 Enhancing and Altering an Image

7.1 Cropping an Image

Overview

NASA Image2000 allows you to crop an image either based on a selected region of interest, or based on user-supplied pixel values.

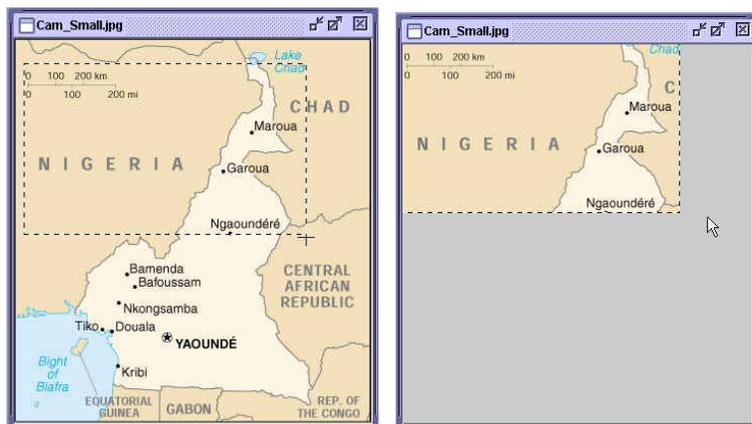


To crop an image based on a region of interest:

1. Use the selection tools (available in the Tools window) to select the area to which you wish to crop the image. (The area inside the selection will be retained, everything outside the selection will be removed.)
2. Pull down the **Image** menu and select **Graphics>Crop Image**.

The image is cropped to the selected area. (See Figure 7.1).

Figure 7.1:
Image Cropped
by Selection
(Before and
After)



To crop an image based specific pixel locations:

1. With no region of interest selected, pull down the **Image** menu and select **Graphics>Crop Image**.
The Crop Image Operation window is displayed (see Figure 7.2).
2. Enter the X and Y initial values (the upper left-hand pixel location for the cropped area).
3. Enter the X and Y final values (the lower right-hand pixel location for the cropped area).

Note: The initial and final pixel location define a rectangular region of interest.

4. Click the **OK** button to continue with the crop operation.
The image is cropped according to your specification (see example in Figure 7.3).

Figure 7.2: Crop Image Operation Window

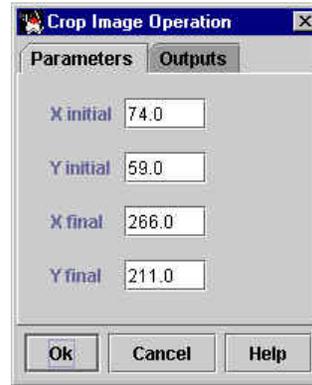
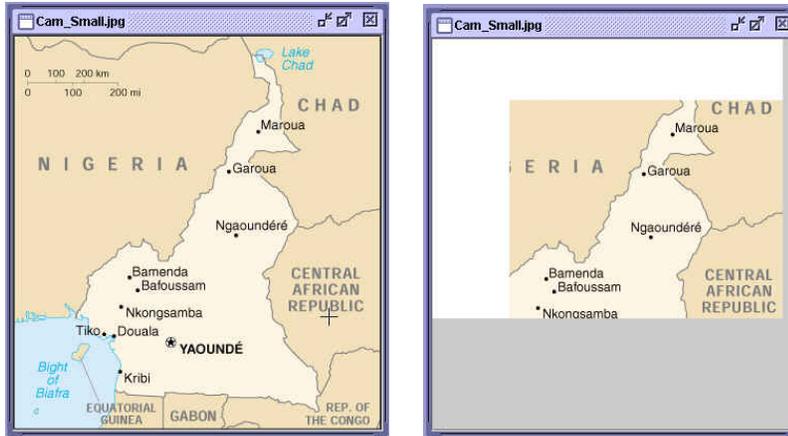


Figure 7.3: Image Cropped by Defined Pixels (Before and After)



7.2 Applying Filters

Overview	NASA Image2000 provides several filters to allow you to improve image quality. The effects of these filters can be quite subtle or dramatic, depending on the image you are working with.
Options	The following filters are available:
Blur	Blurring is used to reduce spurious effects in an image due to poor sampling (e.g. aliasing) or a poor transmission channel (noise). This filter blurs the edges in an image.
Heavy Blur	See above.
Sharpen	Sharpening is used to enhance detail in a blurred image (such as a scanned image). The simple sharpening filter not only enhances edges, but also enhances noise. More sophisticated filtering is required to limit the effect to edges.
Find Edges	Edge Detection is typically used as another sharpening method, or as the first step in creating an outline mask from a image.
Median Filtering...	Median Filtering is used to reduce or eliminate shot or impulse noise (also called speckle).
User Defined...	Users can define their own filter to achieve customized effects.



To apply basic filters (Blur, Heavy Blur, Sharpen, and Find Edges):

1. Pull down the **Image** menu and select **Enhancement>Filters>**.
2. Select the Filter menu item you wish to apply.

The selected filter is applied to the image.



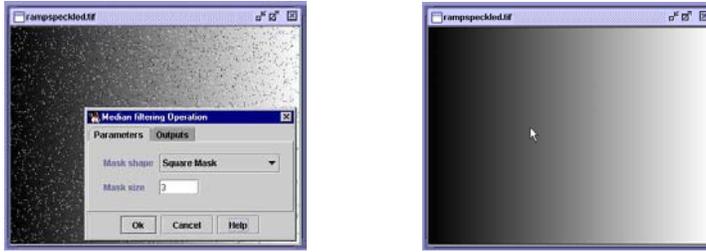
To apply Median Filtering:

1. Pull down the **Image** menu and select **Enhancement>Filters>Median Filtering...**

The Median Filter Operation window is displayed (see Figure 7.4).

2. Select the desired **Mask Shape** from the dropdown list.
3. Enter the **Mask Size** in the text field.
4. Click on the **OK** button to apply the mask, the **Cancel** button to cancel the operation.

Figure 7.4:
Median Filter
window with
original Image,
and Image with
Median Filter
applied.



User Defined Filters

User defined filters use the Convolution operator. The Convolution operator uses two-dimensional matrix (called a kernel) to compute each output pixel by placing the matrix element at (X_origin, Y_origin) over the corresponding pixel in the source image, then summing the products of each matrix element with the source pixel that lies under it.

The values of the kernel elements determine the operation of the filter (see the advanced guide for details). A Box filter is a special case in which all elements of the kernel have the same value. This is the simplest type of blurring (or low-pass) filter. If the Normalize box is checked the sum of all elements in the kernel is the same as the Constant.



To apply a User Defined Filter:

1. Pull down the **Image** menu and select **Enhancement>Filters>User Defined...**
The Convolve window is displayed (see Figure7.5).
2. Enter the desired **Width** and **Height** in the text boxes.
3. Enter the desired **X Origin** and **Y Origin** pixel locations.
4. Provide the **Kernel Data** for the filter.
5. (Optional) Click on the **Load** button to select a preexisting Kernel.
6. (Optional) Click on the **Box Filter** button to use a box filter, and provide a constant.
7. Click on **OK** to apply the filter, or on **Cancel** to cancel the operation.

Figure 7.5: User Defined Filter window



7.3 Altering Brightness and Contrast Manually

Overview

While the look-up table (LUT) is useful for altering the color value of grayscales and indexed images, you may at times want to visually enhance multi-band images, without changing them to indexed color (which can result in a degradation of image quality). The Brightness/Contrast Adjuster provides this ability.

The Brightness/Contrast Adjuster allows you to make simple adjustments to the brightness and contrast of the image as a whole. In addition, you can modify the brightness and contrast values of each RGB band individually.

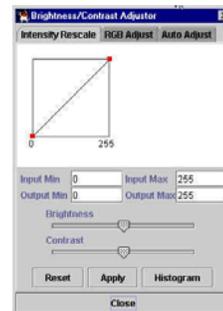


To modify the brightness and contrast values of the image:

1. Pull down the **Image** menu, and choose **Enhancement>Brightness and Contrast**.
The Brightness/Contrast Adjuster window is displayed (see Figure 7.6).
2. Move the “sliders” to adjust the brightness and contrast values.
Move the sliders to the right to increase the value, or to the left to decrease it. The image will update as you adjust the values.
3. (Optional) Click on the **Histogram** button to view the image values as a histogram. (Refer to Section 6.4 for more on histograms.)
4. (Optional) Click on the **Apply** button to apply the new values to the image or on the **Revert** button to return to the original values. Click on the **Close** button to close the window.

You can choose to close the window without permanently applying the new values to the image. If you choose to apply the new values to the image, the intensity scale will update, using the new values as the “norm”.

Figure 7.6: The Brightness/Contrast Adjuster





To modify the brightness and contrast values of specific RGB bands:

1. While viewing the Brightness/Contrast Adjuster, click on **the RGB Adjust** tab.
The RGB Adjuster tab is displayed (see Figure 7.7), providing specific control over the Red, Green and Blue bands.
2. Move the “sliders” to adjust the brightness and contrast values.
Move the sliders to the right to increase the value, or to the left to decrease it. The image will update as you adjust the values.
3. (Optional) Click on the **Apply** button to apply the new values to the image or on the **Revert** button to return to the original values. Click on the **Close** button to close the window.

You can choose to close the window without permanently applying the new values to the image. If you choose to apply the new values to the image, the changes become permanent, and you cannot revert to the original values.

Figure 7.7: The RGB Adjust tab



7.4 Altering Brightness/Contrast through Auto Adjust

Overview

NASA Image2000 provides the ability to alter the Brightness and Contrast of multi-band images using automated adjustments based on mathematical calculations.

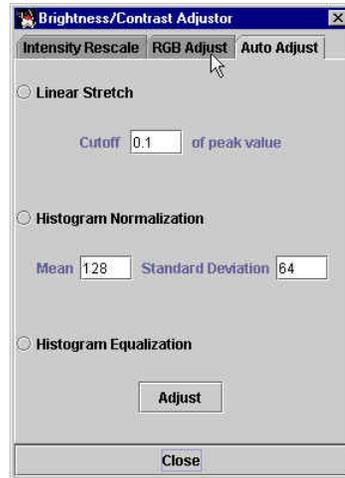
Note: This feature is not available for grayscale or indexed images.



To use the NASA Image2000 automated adjustment features:

1. While viewing the Brightness/Contrast Adjuster, click on the **Auto Adjust** tab.
The Auto Adjuster tab is displayed (see Figure 7.8).
Note: The Auto Adjust features are only available for multi-band images. The tab will not appear for grayscale or indexed images.
2. Select the radio button for the automated adjustment you wish to use:
 - Linear Stretch:
Enter the Cutoff <amount> of peak value in the text field.
 - Histogram Normalization:
Enter the Mean and Standard deviation values in the text field.
 - Histogram Equalization
3. Click on the **Adjust** button to perform the change.
Note: Once you perform the automated adjustments, you cannot revert to the original values. You must close the image (without saving), or use **File->Revert to Saved** to get back to the original image.

Figure 7.8: The Auto Adjust Tab



7.5 Invert an Unsigned Image

Overview

The Invert feature creates a negative of an image. You can use the Invert command to create a positive image from a scanned negative, or to create a negative from a positive image. It is also used to get better contrast in X-ray or MRI images.

When you invert an unsigned image, the brightness value of each pixel is subtracted from the maximum pixel value for its data type. For example, an 8-bit pixel with a value of 255 (white) is changed to 0 (black). A color pixel with a value of 207/62/45 (a bright red on the RGB bands) is changed to 48/193/210 (a light blue). This command is usually used with grayscale images, since the results can be rather odd when the command is applied to a color image. Also, for signed images, invert multiplies every pixel by -1

Note:

Be aware that the Invert feature changes the Image's actual raw pixel values, rather than simply changing the way the image is displayed. If you decide you wish to revert to the original pixel values, you can perform an "Undo" immediately after inverting the image. If you perform other operations, however, you will have to revert to the saved version of the image to retrieve the original pixel values. You may wish to Duplicate the image before performing the operation. (See Section 3.6)



To invert an unsigned image:

Pull down the **Image** menu and select **Enhancement>Invert**

The pixel values are inverted (see Figure 7.9 for an example).

Figure 7.9:
Original Image,
and Image with
Invert
command
applied



Note:

You can also invert an image by applying an inverted color look-up table (LUT). The LUT does not modify the raw pixel value while the actual Invert command does. Applying a LUT, therefore, is a useful way of changing way the image is displayed without actually changing the image itself (in the value of the pixels themselves). Applying a LUT, however, will only work on grayscale or indexed images.

For help with applying a LUT, refer to Section 4.3. To invert a greyscale image using a LUT, use the predefined LUT "I2kGrayInverted", which is provided with the NASA Image2000 installation.

7.6 Using Histogram Matching to Alter an Image

Overview

One enhancement tool, using the histogram, is the Histogram Equalization feature. Histogram Equalization employs a re-assigns the intensity values of pixels in the input image such that the altered image contains a uniform distribution of intensities (*i.e.* a flat histogram). This technique is used in image comparison processes (because it is effective in detail enhancement) and in the correction of non-linear effects introduced by, say, a digitizer or display system.



To use Histogram Equalization to alter an image:

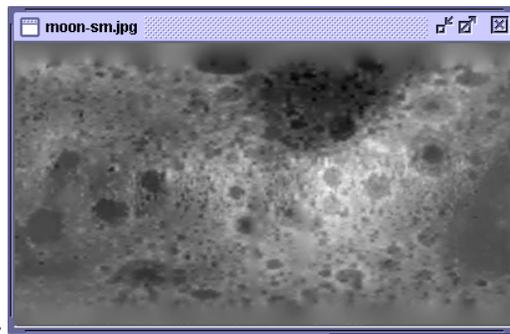
Pull down the **Image** menu and select **Enhancement>Histogram Matching>Histogram Equalization**.

The image is altered, with the histogram equalized. (see Figure 7.10)

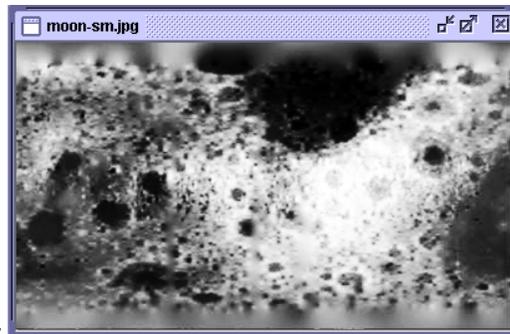
Figure 7.10:
Image, before
and after
Histogram
Equalization

Note: The
image used is
moon-sm.jpg

before >



after >



7.7 Thresholding an Image

Overview

NASA Image2000's Thresholding feature allows you to separate out the regions of the image corresponding to important objects, from the regions of the image that correspond to background. You can perform this segmentation on the basis of the different intensities or colors in the foreground and background regions of an image. In addition, thresholding also allows you to see what areas of an image consist of pixels whose values lie within a specified range, or band of intensities (or colors).

NASA Image2000's Thresholding feature allows you to specify the low and high ends of the pixel value you wish to isolate, and to assign a specific pixel value to any pixels that fall within that range. This feature in many ways results in a display similar to a Density Slice operation. The difference, however, is that the Thresholding operation changes the actual pixel value, as opposed to simply changing the image display. Thresholding, therefore will actually change the results of measurements and calculations, where Density Slicing will not.



To perform the Thresholding operation on an image:

1. Pull down the **Image** menu and select **Enhancement> Thresholding**.
The Threshold operation window is displayed (see Figure 7.11).
2. Enter the Low value in the **Low** text field (this is the lower end of the spectrum you want to isolate).
3. Enter the High value in the **High** text field (this value is the high end of the spectrum you want to isolate).
4. Enter the Value in the **Value** text field (this is the pixel value you want to use to display the thresholded segment of pixels).

For example, if you enter "0" in the Value field, all pixels with a value that falls within your low and high values will be displayed as black. If you enter "255", all the pixels will be displayed as white.

5. Click **OK**.

The image pixels which fall within the defined range are changed to correspond with the defined display value.

Note:

For RGB (non-indexed) images, you can enter these values for each color channel, allowing you to isolate pixels within a given colorspace.

Figure 7.11:
Threshold
Operation
Window
(indexed or
single-band
image)

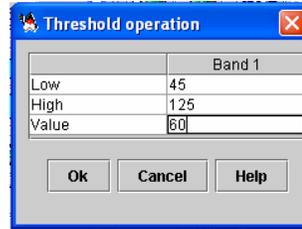
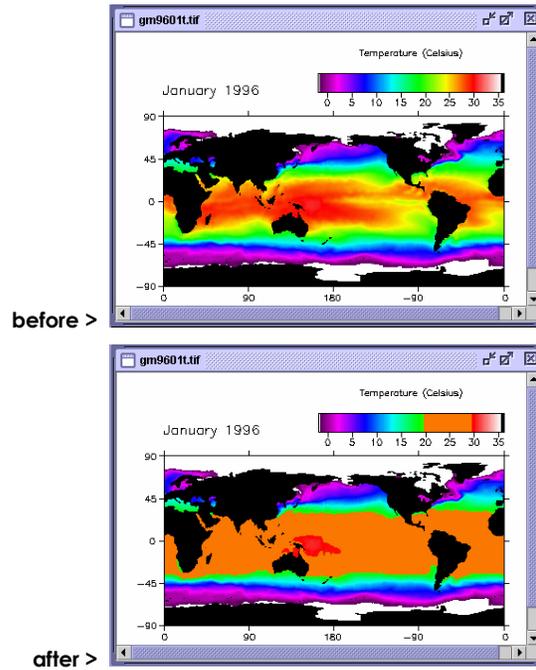


Figure 7.12:
Image, before
and after
Thresholding

Note: The image used is a Sea Surface Temperature image in .tif format, thresholded using the values shown in Figure 7.11.



7.8 Clamping an Image

Overview

NASA Image2000 allows you to “clamp” the values in your image. The Clamp operation sets all the pixels whose value is below a “low” value to that low value and all the pixels whose value is above a “high” value to that high value. The pixels whose value is between the “low” value and the “high” value are left unchanged.

Like Thresholding, this feature allows you to eliminate unimportant image information, isolating or highlighting the pixels you wish to work with.



To perform the Clamp Values operation on an image:

1. (Optional) Use the image selection tools to select the region of interest for which you wish to clamp values.
2. Pull down the **Image** menu and select **Enhancement> Clamp Values**.

The Clamp Values operation window is displayed (see Figure 7.13).

3. Enter the “low” and “high” values you wish to use.
4. Click **OK**.

The image pixel values are clamped to the parameters you set.

Figure 7.13:
Clamp
Operation
Window
(indexed or
single-band
image)

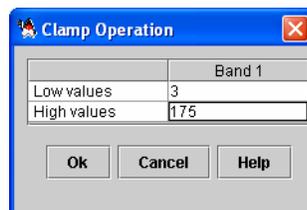
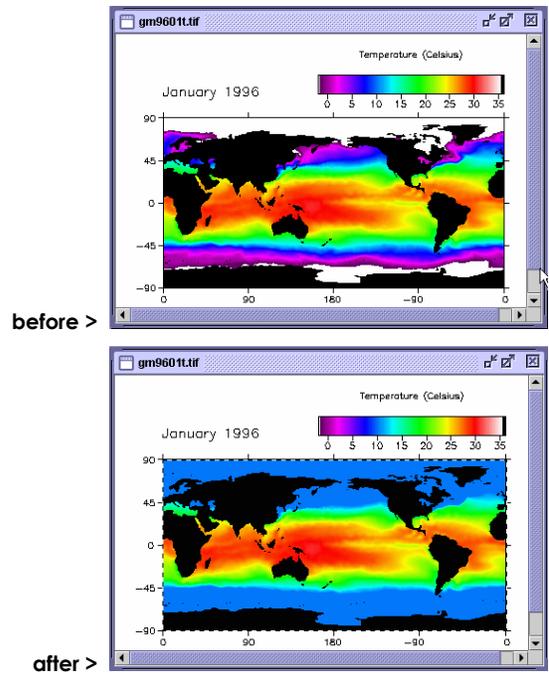


Figure 7.14:
Image, before
and after
Clamping

Note: The image used is a Sea Surface Temperature image in .tif format, with image data selected and clamped using the values shown in Figure 7.13.



8 Applying Math Operations to an Image

8.1 Using Math Operations to Alter Images

Overview	NASA Image2000 provides several math operations, which can be used to manipulate images. These operations modify the image according to user-directed mathematical calculations.
Arithmetic Operators	<p>NASA Image2000 provides the following Arithmetic Operator options for the mathematical manipulation of images.</p> <p>Absolute Value This returns the absolute value of an image. If a pixel value is negative it will return the same number but it will be positive. Positive values remain unchanged.</p> <p>Exponent This applies the exponential method e^x. A pixel value of 1 will return 2.71828.</p> <p>Logarithm(ln) Returns the natural logarithm of each pixel in the image. It is the inverse of the exponential function.</p> <p>Add Constant This adds a user-supplied constant to the pixel value. If the constant is 10, then 10 will be added to all of the pixels in the image ($x + 10$).</p> <p>Subtract Constant This subtracts a user-supplied constant from the pixel value. If the constant is 10, then 10 will be subtracted from all of the pixels in the image ($x - 10$).</p> <p>Subtract from Constant This subtracts a pixel value from a user-supplied constant. If the constant is 10, then the pixel value will be subtracted from 10 for all of the pixels in the image ($10 - x$).</p> <p>Divide by Constant This divides a pixel value by a user-supplied constant. If the constant is 10, then the pixel values will be divided by 10 for all of the pixels in the image ($10 / x$).</p> <p>Divide Into Constant This divides a user-supplied constant by the pixel value. If the constant is 10, then 10 will be divided by all of the pixels in the image ($x / 10$).</p> <p>Multiply Constant This multiplies a user-supplied constant by the pixel value. If the constant is 10, then 10 will be multiplied by all of the pixels in the image ($x * 10$).</p>
Logical Operators	<p>NASA Image2000 provides the following Logical Operator options for the mathematical manipulation of images.</p> <p>Note: These are all binary operations. For the examples, 15 = 00001111 in binary and 225 = 11100001</p> <p>AND to Constant This compares two numbers and if the corresponding bits are the same (both 1 or both 0) then the output bit equals the value of those bits. If the bits are different then the output bit is 0. Example: 00001111 AND 11100001 = 00000001.</p>

OR to Constant This compares two numbers and if either of the corresponding bits equal 1 then the output bit equals 1. If both bits equal 0 then the output bit is 0. Example: 00001111 OR 11100001 = 11101111.

XOR to Constant This compares two numbers and if both of the corresponding bits are the same then the output bit equals 0. If one of the bits equal 0 then the other equals 1 the output bit is 1. Example: 00001111 XOR 11100001 = 11101110.

Relational Operators

NASA Image2000 provides the following Relational Operator options for the mathematical manipulation of images.

Note: These operations all require two images.

Minimum... This compare the two images and for each pixel returns the minimum value (from the two images). Example, x1 = 10, x2 = 45 output = 10.

Maximum... This compare the two images and for each pixel returns the maximum value (from the two images). Example, x1 = 10, x2 = 45 output = 45.



To perform Math Operations:

1. Pull down the **Image** menu and select **Math** > **<Selected Operation Type>** > **<Selected Operation>**.
2. (Optional, depending on operation selected) Provide the constant to be used in the operation. Click **OK** to perform the operation.

8.2 Using the Math Calculator to Alter Images

Overview

The NASA Image2000 Calculator provides an equation to process two images. The user has to fill in the image names, operation, and scale and offset values. The result is an image that is a combination of the two images, calculated based on the values you provide.

The values you need to provide in the calculator are as follows:

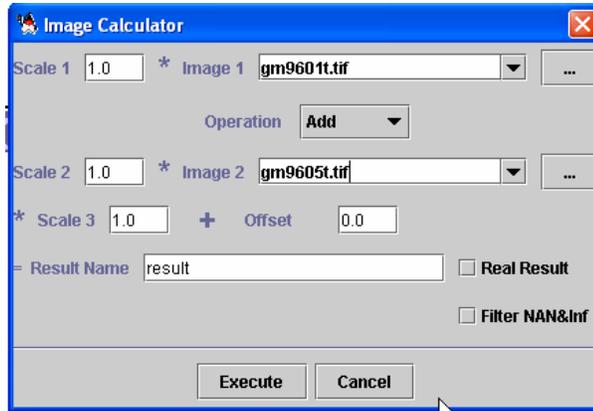
Scale	Scale is simply a number that is multiplied by an input image and/or the result. If the image or result should not be affected by scale then "1.0" should be entered.
Operation	Operation is the action you want to perform with the two images. For example, a user could add two images together.
Offset	Offset is a number that is added to the result. If the result should not be affected by offset then the number should be "0.0"
Real Result	Real Result should be checked if the resulting image should have floating point numbers. If this is not checked, the output image will have integer format.



To use the Math Calculator:

1. Pull down the **Image** menu and select **Math> Calculator...**
The Calculator window is displayed (see Figure 8.1).
2. Select the images you want to use from the **Image 1** and **Image 2** dropdown lists, or click on the "..." button to select an image that is not currently open.
3. (Optional) Provide the **Scale** and **Offset** values as needed.
4. Select the **Operation** you wish to perform from the dropdown list.
5. (Optional) Edit the **Result** field to provide a different title for the result image.
6. (Optional) Check the **Real Result** checkbox if the image should have floating point numbers. If this is not checked, the output image will have integer format.
7. Click on the **Execute** button to perform the operation.

Figure 8.1: The Image Calculator Window



9 Applying Geometric Transformations to an Image

9.1 Applying Map Projections to an Image

Overview

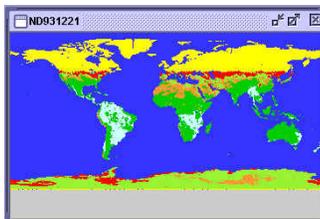
Map projections are used to represent a spherical object (like the Earth) on a flat surface like paper or a computer screen. Unprojected map images are very distorted. For example, the surface area of a pixel on the equator may differ greatly from the surface area of a pixel near the poles. Map projections minimize these distortions. NASA Image2000 provides three map projection operations, which may be used with geocoded images.

Options

The following map projection operations are available:

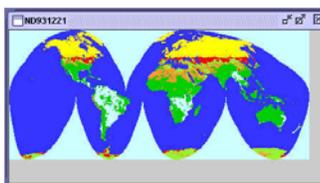
Unprojected (lat/lon)

Used to remove projections, returning the image to the original lat/lon image.



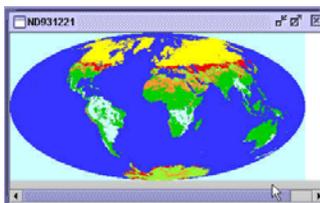
Goode

This projection is used to display global data. The projection is an equal area projection, but the globe is interrupted so that all of the land masses (except Antarctica) are continuous, which helps to preserve the shape of land masses.



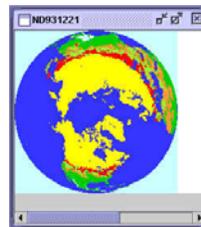
Hammer

This projection is also used to display global data, but the globe is presented as a continuous feature. You have the option to define the center longitude for the projection, which allows you to control the portion of the globe that appears in the center of the image window.



Polar

This projection shows the North or South poles of the Earth as viewed from deep space. The polar regions are often severely distorted by other projections. This projection allows you to choose to view the North or South Pole.

**Before you begin**

Make sure the image you are using is a geocoded image. You may define geocoding information for certain images when opening the image. See Section 3.1.



To apply a map projection:

1. Pull down the **Image** menu, select **Geographic Transformations> Map Projections>**, and choose the desired projection menu item.
2. (Optional) If you selected **Goode**, no further parameters are necessary.
The image is updated, with the Goode projection applied.
3. (Optional) If you selected **Hammer**, enter the Reference Longitude in the text box, and click **OK**.
The image is updated, with the Hammer projection applied.
4. (Optional) If you selected **Polar**, choose the appropriate radio button for either the North or South Pole, and click **OK**.
The image is updated, with the Polar projection applied.



To remove a map projection (displaying the unprojected image):

Pull down the Image menu, select Geographic Transformations> Map Projections, and choose Unprojected (lat/lon).

The image is updated, displaying the unprojected image.

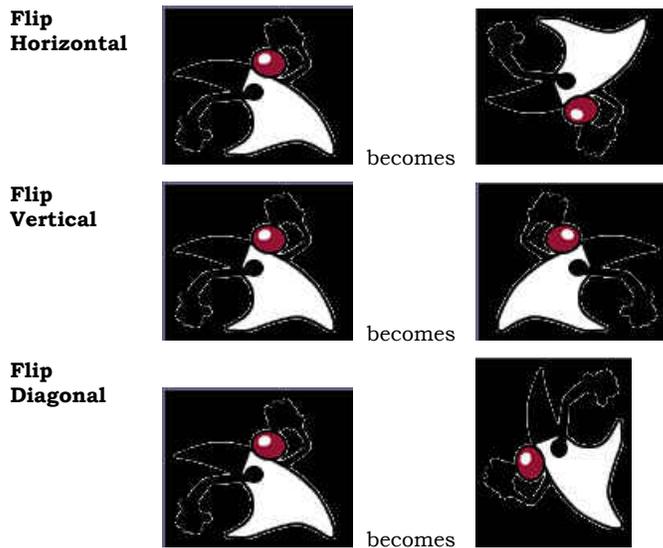
9.2 Flip Image

Overview

NASA Image2000 allows you to “flip” an image horizontally, vertically and/or diagonally.

Flip Image Effects

The effects of the options in the Flip Image operation are as follows:



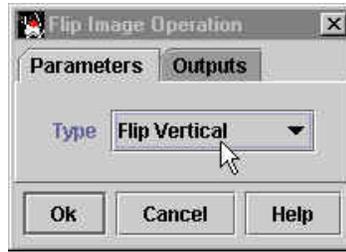
To flip an image:



1. Pull down the **Image** menu and select **Geometric Transformations> Flip Image**.
The Flip Image window is displayed (see Figure 5.1).
2. Select the **Type** of flip from the dropdown list.
3. Click on the **OK** button to flip the image, or on **Cancel** to cancel the operation.

The image is flipped accordingly.

Figure 9.1: The Flip Image Window



9.3 Skew Image

Overview

NASA Image2000 allows you to skew (or shear) an image horizontally or vertically. This feature also allows you to define the method for interpolation. Interpolation provides a way of adjusting the pixel size of an image without producing pixelisation (jaggies). You may select the mathematical formula used to calculate the color of the missing pixels based on the color of surrounding pixels.

Skew Image Effects

The effects of the options in the Skew Image operation, both with a Shear value of 1.0, are as follows:

Skew

Horizontal



becomes



Skew

Vertical



becomes

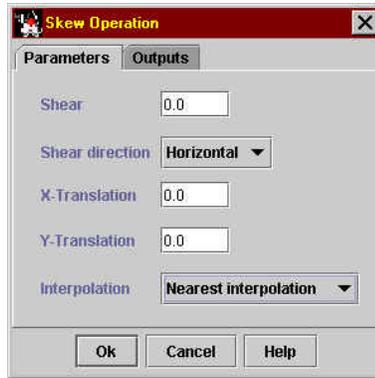


To skew an image:

1. Pull down the **Image** menu and select **Geometric Transformations> Skew**.
The Skew Operation window is displayed (see Figure 5.2).
2. Enter the **Shear** value.
3. Select the **Shear Direction** of flip from the dropdown list.
4. Select the **Interpolation** method from the dropdown list.
5. Click on the **OK** button to skew the image, or on **Cancel** to cancel the operation.

The image is skewed (or sheared) accordingly.

Figure 9.2: The Skew Operation Window



9.4 Translate Image

Overview

NASA Image2000 allows you to translate the image, shifting the origin of the pixels by a user-defined value. The effect of the operation is to shift the image down and to the right. The size of the image frame does not change, so the right and bottom edge of the image is trimmed by the user-defined number of pixels.

Translate Image Effects

The effect of the Translate Image operation, with X-Translation and Y-Translation values of 5 (in other words, with the origin pixel shifted by 5 pixels in each direction) is as follows:

Note: A border is placed around the image to highlight the change in the image.

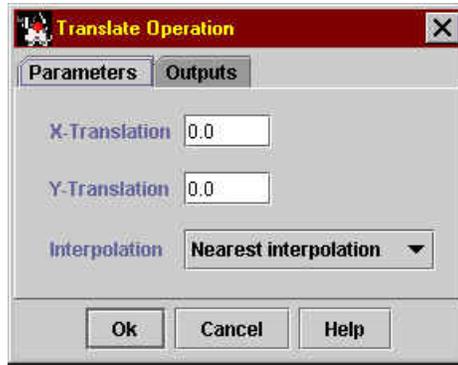


To Translate an image:

1. Pull down the **Image** menu and select **Geometric Transformations> Translate**.
The Translate Operation window is displayed (see Figure 5.3).
2. Enter the **X-Translation** value.
3. Enter the **Y-Translation** value.
4. Select the **Interpolation** method from the dropdown list.
5. Click on the **OK** button to translate the image, or on **Cancel** to cancel the operation.

The image is translated accordingly.

Figure 9.3: The Translate Operation Window



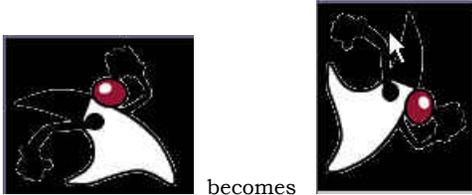
9.5 Rotate Image

Overview

NASA Image2000 allows you to rotate the image, turning it to a user-defined degree. Currently this process is performed based on user-defined pixel values to a specifically defined angle degree. A future version of NASA Image2000 may provide the ability to directly rotate the image.

Translate Image Effects

The effect of the Rotate Image operation, to an angle in degrees value of 90 is as follows:

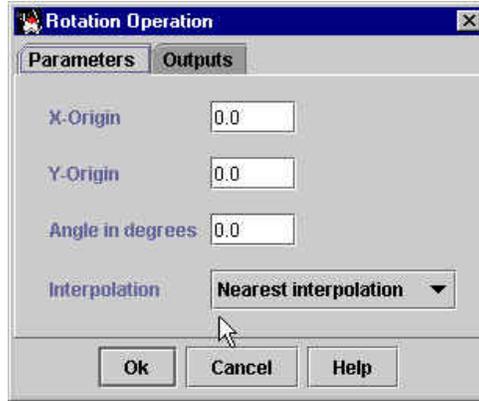


To Rotate an image:

1. Pull down the **Image** menu and select **Geometric Transformations> Rotate**.
The Rotation Operation window is displayed (see Figure 5.4).
2. Enter the **X-Origin** value.
3. Enter the **Y-Origin** value.
4. Enter the **Angle in degrees**.
5. Select the **Interpolation** method from the dropdown list.
6. Click on the **OK** button to rotate the image, or on **Cancel** to cancel the operation.

The image is rotated accordingly.

Figure 9.4: The Rotation Operation Window



9.6 Scale Image

Overview

NASA Image2000 allows you to scale an image, increasing or decreasing its size. You can choose to scale the x and y values proportionately, or separately.

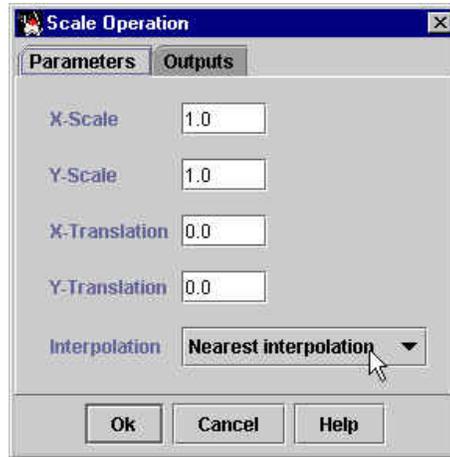
The Scale Image operation has an effect similar to zooming in or out on the image (see Section 3.4); the difference, however, is that the Scale image actually changes the value of the image, while the zoom merely displays the image magnified or shrunk.



To scale an image:

1. Pull down the **Image** menu and select **Geometric Transformations> Scale Image**.
The Scale Image window is displayed (see Figure 5.5).
2. Enter the X-scale factor.
The number entered should be a decimal value of the percentage (e.g., to scale to 50%, enter <.5>; to scale to 120%, enter <1.2>).
3. Enter the Y-scale factor.
The number entered should be a decimal value of the percentage (e.g., to scale to 50%, enter <.5>; to scale to 120%, enter <1.2>).
4. (Optional) Enter the X-Translation value.
5. (Optional) Enter the Y-Translation value.
6. (Optional) Select the **Interpolation** method from the dropdown list.
7. Click on the **OK** button to scale the image, or on **Cancel** to cancel the operation.
The image is scaled accordingly.

Figure 9.5: The Scale Image Window



10 Working with Multiple Images

10.1 Opening Multiple Images at Once

Overview

You may often wish to work with multiple images at a time, either to compare and analyze images or to combine multiple images into a stack, in which the images are opened and arranged in a single window in layers. Usually a stack is comprised of a number of the same type of images (e.g., 12 monthly images of sea surface temperature are opened in a stack), and can be animated. (Refer to Section 11, Working with Stacks). You can, of course, open each image individually, but with some advance preparation you can also open a group of images in one single operation.

In the current version of NASA Image2000, you cannot open multiple images by multi-selecting them in the File:Open dialog. (This limitation is due to a Java bug, which may be corrected in a future version of Java). NASA Image2000 does, however, allow you to select a “folder” or directory to be opened, and the system will in that case open all images contained in the selected directory. You may choose between several options as to how the system will open the images:

- Create a Multi-band image, placing each image in separate layers. This option gives you several options as to how to display the various color bands contained in the source images.
- Open the Images as separate Images. This option allows you to work with each image as a single image in a separate image frame, and therefore provides several options that are not available when working with images in a stack.
- Open the images as a Stack. This option allows you to work effectively with overlays, and to animate images. Some options for analyzing images are not available when working with Stacks, but you can choose to extract the images from the stack into separate windows at a later time if you wish.



To open multiple images at once:

1. Make sure the images you want to open are located in a single “folder” or directory.

Note: Remember that all the images in the directory will be opened. So the directory should contain all the images you want to open, but only the images you want to open.

2. Pull down the **File** menu and choose **Open** OR

Click on the **Open** icon on the toolbar. 

The **Open** window is displayed (see Figure 10.1).

3. Locate and select the directory you wish to open.

4. Click on the **Open** button to open the images, or on **Cancel** to close the dialog and return to the main window.

The Open Directory dialog is displayed (see Figure 10.2).

5. Select the appropriate radio button to open the contents of the directory as a **Multi-Band** image, to simply open **All Images**, or to open the contents a **Stack**.
6. Click on the **OK** button to continue, or the **Cancel** button to cancel the operation.

The images are opened in the manner you chose.

Note: Refer to Section 10.2 for help with working with Multi-Band images.

Figure 10.1: The File:Open Window

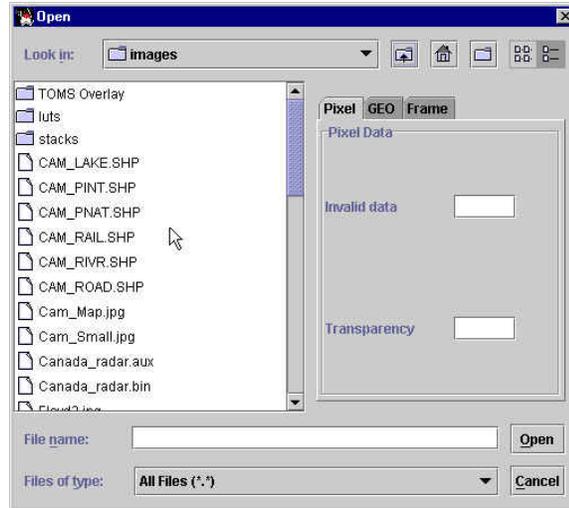


Figure 10.2: The Open Directory Window



10.2 Working with Multi-Band Images

Overview

When you choose to open a directory of images as a Multi-band image, you have the option of opening the images as a single multi-layer image or as separate images. If you choose to open the images as a multi-layer image, you can select which bands are to be loaded or which bands are used to form a color composite. Also, the layers are known to be coregistered so that analysis can be performed on one layer while viewing another by making the layer of interest current.

There are several constraints to working with multi-band images:

- Images in a multi-band image generally originate from a single multi-spectral instrument (such as Landsat or AVHRR) and are geographically coregistered,
- The images in a multi-band directory must all be single banded images
- If any of the images in a multi-band directory are GeoTIFF they must all be GeoTIFF and have the same GeoTIFF encoding.

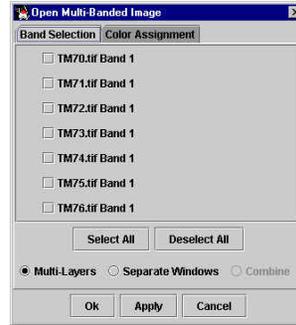
A typical scenario is to load an RGB composite in one layer, placing that layer on top and using visible features as a guide for performing analysis in the lower layers, which may contain thermal or ultraviolet data.



To open a multi-banded image as a multi-layer image or as separate images:

1. Open a directory of images as a Multi-Band Image (see Section 10.1).
The Open Multi-Banded image window is displayed.
2. Select the bands you wish to use in your image by clicking on the check boxes in the **Band Selection** tab (see Figure 10.3).
3. Select the appropriate radio button to determine whether the images will be open as a Multi-Layer image or as Separate Images.
4. Click on the **Apply** button to generate an image based on your selection (you can do this several times) and/or on the OK button to generate the image and close the dialog window.

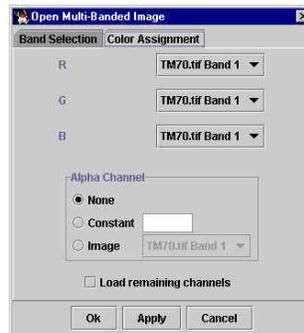
Figure 10.3: The Open Multi-Banded Image Window: Band Selection



To open a multi-banded image as RGB color composite image (with or without an alpha channel):

1. Open a directory of images as a Multi-Band Image (see Section 10.1).
The Open Multi-Banded image window is displayed.
2. Click on the **Color Assignment** tab.
The Color Assignment panel is displayed (see Figure 10.4).
3. Select the files to be assigned to each band (RGB).
4. (Optional) Select the appropriate radio button and provide a constant to be used for the alpha channel, or select an image from the dropdown list.
5. (Optional) Check the checkbox to indicate whether or not to load the remaining channels.
6. Click on the **Apply** button to generate an image based on your selection (you can do this several times) and/or on the OK button to generate the image and close the dialog window.

Figure 10.4: The Open Multi-Banded Image Window: Color Assignment



10.3 Editing Multi-Band Images

Editing a Multi-banded image

You can edit either a multi-layered image, creating a composite image (as described above) or create a multi-layer image out of a composite image.



To edit the multi-banded image, once it has been created:

1. Pull down the **View** menu and select **Image Layers** to view the Layers window.
2. Click on the **Display** button.
The Multiband/Layers operation window is displayed. This window is identical to the Open Multi-Banded Image window.
3. Follow the steps in Section 10.2 to either create a multi-layered image from a composite, or to create a composite from multiple layers.

11 Working with Stacks

11.1 Creating a Stack from Multiple Images

Overview

You may wish to create a stack from a group of images that are currently opened as separate images. NASA Image2000 allows you to both create a stack from open image windows, and to create a set of open image windows from a stack. This section discusses the process for creating a stack.

Note:

Due to limitations in the development environment, NASA Image2000 currently is unable to save multi-image filetypes (including multi-layer images and stacks). As a workaround, NASA Image2000 saves each layer or stack image as a separate image. NASA Image2000 places the group of layer or stack images in a separate directory. The user can therefore, at a later time, choose to open the images as either a multi-band, multi-layer image or as a stack, or can choose to work with the images as separate images (see Section 7.1).



To create a stack from open images:

1. Make sure that the images you want to use for the stack are open.
2. Arrange the image in the order you want them to appear in the stack by selecting each image in reverse order. The image in front will be the first image, the next image back will be the second, and so on.

Note: It may be helpful to “Cascade” the windows while performing this step. Pull down the **Window** menu and select **Cascade**.

3. Pull down the **Stack** menu and select **Windows to Stack>** and either **Include All Layers** or **Current Layer Only**.

The single image windows close, and a new unsaved stack is displayed (see Figure 11.1).

- If you choose to include all layers, each layer contained in the open images will be saved as a separate image in the stack.
- If you choose to include only the current layer, the selected layer in each image frame will be included in the stack as a separate image.
- If the images in question contain only a single layer, the results will be the same with either option.

4. To Save the new stack:

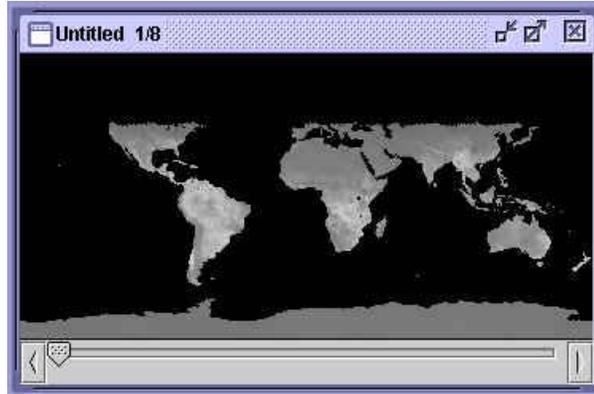
Pull down the **File** menu and choose **Save** OR



Click on the **Save** icon on the toolbar.

The new stack is saved.

Figure 11.1: A
New Stack
Window



11.2 Animating a Stack of Images

Overview

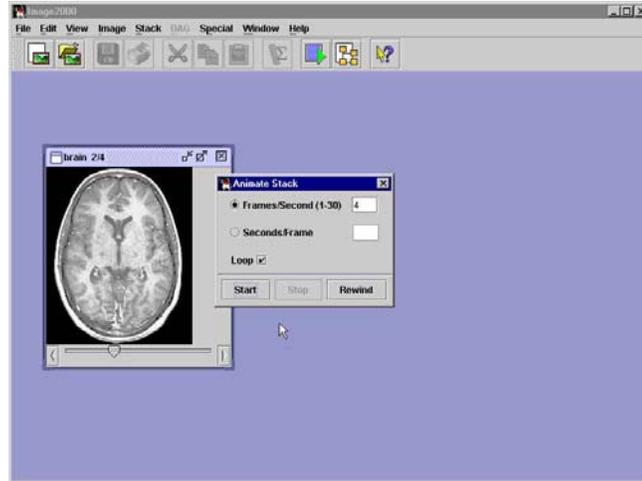
One of the most important applications for a stack of image is animation. Animating a stack can emphasize gradual changes across a series of images (e.g., weather changes, or changes in ozone levels). You can manually imitate the process of animating the stack by simply clicking on the “handle” of the slider (at the bottom of the stack window) and dragging it to the right (to animate “forward”). NASA Image2000 also, however, provides an automated animation feature, which provides several options.



To animate an open stack:

1. Pull down the **Stack** menu and select **Animate...**
The Animate Stack window is displayed (see Figure 11.2).
2. (Optional) For “quick” animation, accept the default radio button selection of **Frames/Second(1-30)**, and edit the text field to define the speed of the animation (in frames per second).
3. (Optional) For a slower animation, more like a slide show, click in the **Seconds/Frame** radio button and define the number of seconds each frame should display.
4. (Optional) Deselect the **Loop** check box to allow the animation to play only a single time, or leave it checked to allow the animation to play indefinitely.
5. Click on the **Start** button to start the animation.
6. (Optional) You can click the **Stop** button at any time to stop the animation. When the animation is stopped, you can click on the **Rewind** button to start the animation over at the beginning.
7. Click in the close box in the upper right-hand corner of the window to close the Animate Stack window.

Figure 11.2: The Animate Stack Window



11.3 Displaying Stack Images using Montage

Overview

You may find it useful to gain a high-level overview of stack images, as opposed to viewing the images one at a time. NASA Image2000 provides the ability to view a montage of images of a stack, which creates a new image with a mosaic view of thumbnail versions of the stack images. You may choose to include all stack images or customize the contents of the montage. You may also choose to save the montage image for later use.



To create a basic montage from an open stack (using the default selections and including all stack image in the montage):

1. Pull down the **Stack** menu and select **Montage...**

The Create Montage window is displayed (see Figure 11.3).

2. Click on the **OK** button to create the montage, or on the **Cancel** button to cancel the operation.

A new untitled image window is displayed, providing a montage of thumbnail versions of the stack images.

3. To Save the new montage image:

Pull down the **File** menu and choose **Save OR**



Click on the **Save** icon on the toolbar.

The Save window is displayed, allowing you to provide a filename and save the image.

Figure 11.3: The Create Montage Window

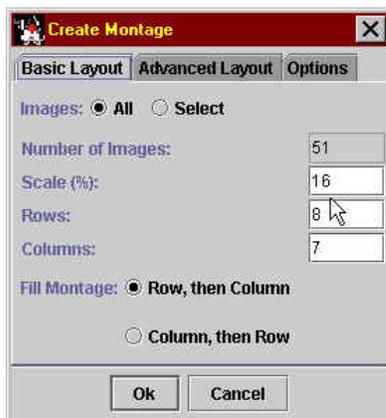
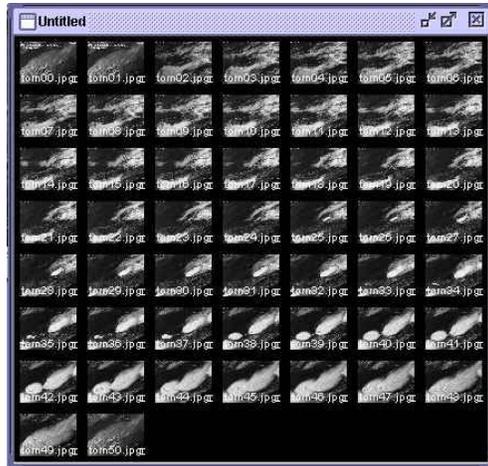


Figure 11.4
Untitled
Montage
Image Window



11.4 Customizing the Stack Montage

Overview

You may choose to include all stack images or customize the contents of the montage. You may also choose to customize certain layout and display features of the montage. This section provides instructions for customizing the stack montage



To create a customized montage from an open stack (changing the layout of the montage or specifying the stack images to include in the stack):

1. Pull down the **Stack** menu and select **Montage...**
 - The Create Montage window is displayed (see Figure 11.5).
2. (Optional) Customize the layout of the montage:
 - a. (Optional) Enter the percentage to which you wish the stack images scaled in the **Scale(%)** text field.
 - b. (Optional) Edit the number of **Rows** and **Columns** to redefine the grid layout for the montage.
 - c. (Optional) Select the appropriate radio button to redefine the order in which the images will be placed (**Row, then Column**, or **Column, then Row**).
3. (Optional) Customize the borders and labels used in the montage:
 - a. Click on the **Options** tab.
 - The Options tab is displayed (see Figure 11.6)
 - b. (Optional) Click to unselect the **Border Images** checkbox remove the borders OR edit the **Size** (in pixels) and **Color** of the border.
 - c. (Optional) Click in the checkboxes to include or exclude labels.
 - d. (Optional) If you are including labels, edit the label's **Font Size** and/or **Color**.
4. (Optional) To manually select the images you wish to include in the montage:
 - a. (If necessary) Click on the **Basic Layout** tab.
 - b. Click on the **Images: Select** radio button.
 - The Image Selection window is displayed (see Figure 11.7)
 - c. Click in the text boxes to select/deselect the images you wish to include in the montage OR click on the buttons to **Select All** or **Deselect All**.
 - d. When your selection is complete, click on **OK** to accept the selection, or **Cancel** to cancel.
5. (Optional) To automatically select the images you wish to include in the montage, based on a numerical increment:

- a. Click on the **Advanced Layout** tab.
The Advanced Layout tab is displayed (see Figure 11.6)
 - b. Edit the **Increment** text field to define which images to include (e.g., every <2> images in the stack).
 - c. Edit the **First Image** and **Last Image** text fields to define the first and last images to include.
6. Click on the **OK** button to create the montage, or on the **Cancel** button to cancel the operation.
A new untitled image window is displayed, providing a montage of thumbnail versions of the stack images.
 7. To Save the new montage image:
Pull down the **File** menu and choose **Save OR**



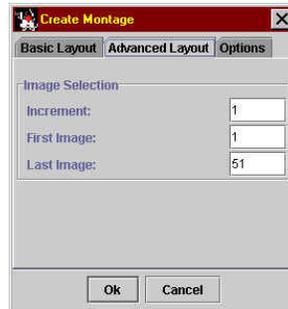
Click on the **Save** icon on the toolbar.

The Save window is displayed, allowing you to provide a filename and save the image.

Figure 11.5: The Options section of the Create Montage Window.



Figure 11.6: The Advanced Layout section of the Create Montage Window



11.5 Altering the Stack (Extracting, Duplicating, Inserting and Deleting)

Overview

NASA Image2000 provides several options for altering a stack. Many enhancement and analysis options are only available in single-image mode. You may therefore wish to extract an image from a stack (removing an image from the stack, but allowing it to be edited as a single image) or duplicate the image (creating a copy of the image which may be edited, but leaving the original image in the stack). In addition, you may wish to change the configuration of a stack by inserting an image into an existing stack, (either to add a new image to the stack or to return an extracted image to its place in the stack) or by deleting an image from the stack.

Extracting Images

When you extract an image from the stack, the image is removed from the stack and displayed as a single image.



To extract an image from an open stack:

1. Bring the image you wish to extract to the top of the stack.
2. Pull down the **Stack** menu and select **Extract**.

The Image window is displayed, along with single-image windows (like the Tool Layer windows).

Duplicating Images

Duplicating a stack image creates a new, untitled copy of the image in view on the stack when the operation is performed. The duplicated image appears in a standard image window, and may be edited and analyzed as needed. The original image remains in its place in the stack.



To duplicate an image in an open stack:

1. Bring the image you wish to duplicate to the top of the stack.
2. Pull down the **Stack** menu and select **Duplicate**.

A new, untitled Image window is displayed, along with single-image windows (like the Tool Layer windows).

Inserting Images

When you insert an image, a copy of the image is inserted into the stack. The image's new location in the stack is determined by the view of the stack when the insert operation is performed: the image is inserted before the top-most image in the stack. The single image window remains open and editable. After the image is inserted into the stack, further edits to the single image are not reflected in the stack image.

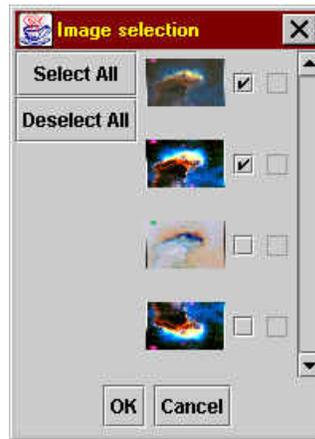


To insert an open image into an open stack:

1. Scroll through the stack to find the location at which you wish to insert the image. (The image will be inserted before the image in view when the operation is performed.)
2. Pull down the **Stack** menu and select **Insert...**
The Image Selection Window is displayed (see Figure 11.7).
3. Click on the check boxes to select the image you want to insert. (Use **Select All** or **Deselect All** buttons as needed.)
4. Click on the **OK** button to insert the image, or on the **Cancel** button to cancel the operation.

The image is inserted into the stack.

Figure 11.7: The Image Selection Window.



Deleting Images

Deleting a stack image removes the image from the stack. If the stack was created from a directory of image files, the corresponding image file is *not* deleted, and the image can therefore be retrieved at a later time.



To delete an image from an open stack:

1. Bring the image you wish to delete to the top of the stack.
2. Pull down the **Stack** menu and select **Delete**.

The image is removed from the stack.

11.6 Using Overlays with a Stack

Overview

NASA Image2000 allows you to apply an overlay to a stack of images. Overlays can be useful when viewing stack animations, to visualize changes in reference to unmoving data. For example, you might apply an overlay to show geographical borders on a stack which displays changes in ozone values, in order to easily identify the location of the changes in ozone values.

Overlays must match the stack images in size and dimension. In addition, the overlay image must be the same image type as the stack images. (An overlay can be thought of as another image in the stack, in that it must match the stack images. In this case, however, the overlay image is superimposed over each image in the stack.)

Adding an Overlay

You can add an overlay to a stack either from a file or an open image. In both cases, however, remember that the file size and type of the overlay must match the stack.



To add an overlay from a file:

1. Pull down the **Stack** menu and select **Overlays>Overlay from File**.
The Open File window is displayed.
 2. Select the overlay file you wish to use, and click on the **Open** button.
The stack is rendered, with the overlay image superimposed over each stack image.
-



To add an overlay from an open image:

1. Pull down the **Stack** menu and select **Overlays>Overlay from Open Images**.
The Image Selection window is displayed (see Figure 11.8).
 2. Click on the **Deselect All** button so that no image is selected.
 3. Click on the check box to select the overlay image you wish to use.
 4. Click on the **OK** button.
The stack is rendered, with the overlay image superimposed over each stack image.
-

Identifying Transparent Pixel Values

Since the overlay is superimposed over the stack images, you may want to identify a “transparent pixel” value. For example, if your overlay has a black background, you may want to specify the color black (pixel value 0) as transparent so that the background does not obscure the stack images. This transparent pixel value is used only for the overlay image, and will not affect the stack images themselves.



To specify a transparent pixel value:

1. Pull down the **Stack** menu and select **Overlays>Choose Overlays Transparent Pixel Value**.

The Transparent Pixel Value dialog is displayed.

2. Enter the pixel value (between 0 and 255) in the text field, and click on the **OK** button.

The stack is rendered, with the specified pixel value in the overlay image appearing transparent.

Removing an Overlay from the Stack

You can choose to either remove an overlay or to extract it. If you remove the overlay, the overlay image is simply removed from the stack. If you extract it, the overlay image is removed from the stack, but displayed in a new image window to allow you to work with it.



To remove an overlay from the stack:

Pull down the **Stack** menu and select **Overlays>Remove Overlays**.

The overlay is removed from the stack.



To extract an overlay from the stack:

Pull down the **Stack** menu and select **Overlays>Extract Overlays**.

The overlay is removed from the stack, and appears in a new image untitled image window.

11.7 Using Projections with a Stack

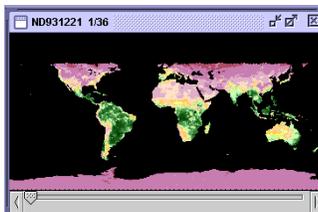
Overview

Map projections are used to represent a spherical object (like the Earth) on a flat surface like paper or a computer screen. Unprojected map images are very distorted. For example, the surface area of a pixel on the equator may differ greatly from the surface area of a pixel near the poles. Map projections minimize these distortions. NASA Image2000 provides four map projection operations for stacks, which may be used with geocoded stacks

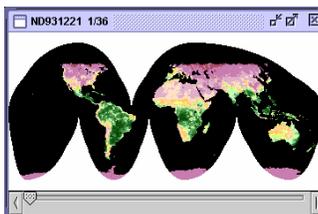
Options

The following map projection operations are available:

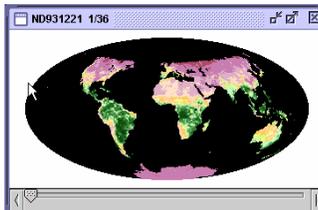
Equirectangular Used to remove projections, returning the stack to the original view.



Goode This projection is used to display global data. The projection is an equal area projection, but the globe is interrupted so that all of the land masses (except Antarctica) are continuous, which helps to preserve the shape of land masses.

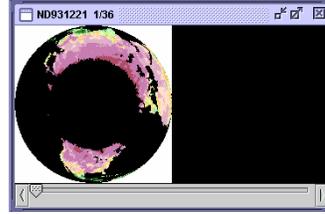


Hammer This projection is also used to display global data, but the globe is presented as a continuous feature. You have the option to define the center longitude for the projection, which allows you to control the portion of the globe that appears in the center of the image window.



Polar

This projection shows the North or South poles of the Earth as viewed from deep space. The polar regions are often severely distorted by other projections. This projection allows you to choose to view the North or South Pole.

**Before you begin**

Make sure the stack you are using is made of geocoded images. You may define geocoding information for certain images when opening the image. See Section 3.1.



To apply a map projection:

1. Pull down the **Stack** menu, select **Project Stack>**, and choose the desired projection menu item.
2. (Optional) If you selected **Goode**, no further parameters are necessary.
The image is updated, with the Goode projection applied.
3. (Optional) If you selected **Hammer**, enter the Reference Longitude in the text box, and click **OK**.
The image is updated, with the Hammer projection applied.
4. (Optional) If you selected **Polar**, choose the appropriate radio button for either the North or South Pole, and click **OK**.
The image is updated, with the Polar projection applied.



To remove a map projection (displaying the unprojected stack):

- Pull down the **Stack** menu, select **Project Stack> Equirectangular**.
The stack is updated, displaying the unprojected image.

11.8 Performing Analysis on a Stack (Profiles, Measurements)

Overview

NASA Image2000 allows you to perform various calculations and measurements on a stack, as well as performing profile operations. In many cases, the stack measurements are performed just as you would on a single image. Before the measurements will work, however, you must first “tell” NASA Image2000 to Record Measurements.



To Record Measurements:

1. Pull down the **Stack** menu, and select **Record Measurements**.
 2. Pull down the **Image** menu item, and select **Analyze>Measure**,
or click on the Measure icon .
 3. To view the recorded measurements, pull down the **Image** menu and select **Analyze>Measurement Table**.
-

Plot Profiles

You can plot profiles on a stack of images just as you would on a single image (see Section 6.5). In addition, NASA Image2000 provides another stack specifically for use with stacks, the Z-Profile. This feature plots a profile based on a selection of a region of interest, graphing the range of pixels represented through the stack.

For example, a series of 40 monthly images of NDVI may be put into a stack. The Z-Profile of NDVI for a region, which represents a time-series of NDVI over 40 months, is plotted in Figure 11.8.

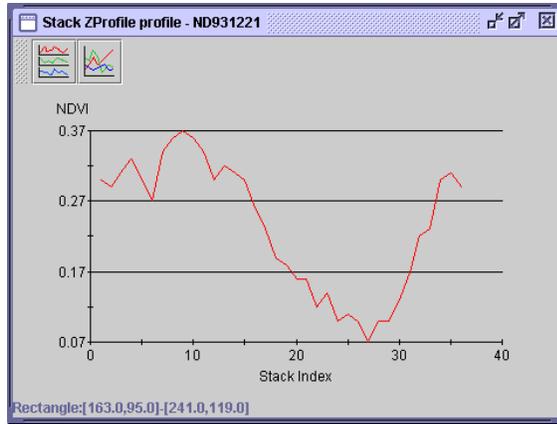


To plot a Z-Profile:

1. Select the region of interest you wish to profile, using one of the selection tools (see Section 6.1).
2. Pull down the **Stack** menu, and select **Z-Profile**.

The Stack Z-Profile window is displayed (see Figure 11.8).

Figure 11.8: The Z-Profile window.

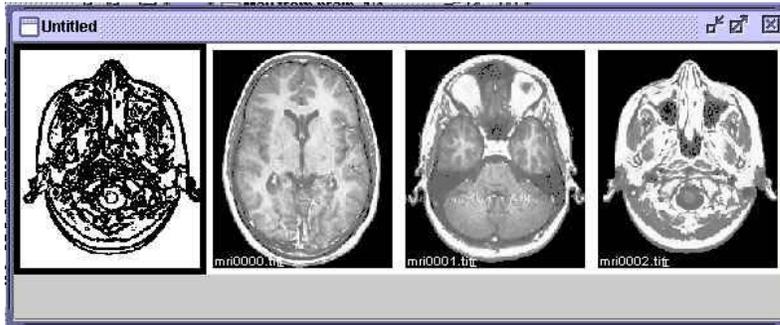


11.9 Calculating Stack Statistics

Overview

NASA Image2000 allows you to create a separate image from a stack, in which each pixel in the image is the result of a calculation of all the corresponding pixels in each stack slice. For example, you can calculate the Mean of the stack, and the resulting image would be one in which each pixel value is calculated as the mean of the corresponding pixel in each of the stack images (see Figure 7.11 and following list).

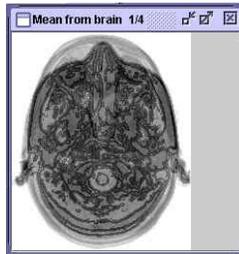
Figure 7.11:
Montage of
Example Stack
Images



Stack Statistic Calculation Effects

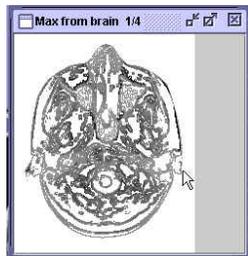
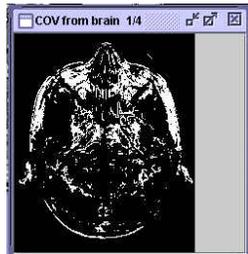
NASA Image2000 allows you to calculate the following stack statistics, which in the case of the above example, achieve the following effects:

Mean



Minimum



Maximum**CoV-
Coefficient
of Variation****Standard
Deviation**

To calculate stack statistics:

Pull down the **Stack** menu and select **Statistics**> **<Selected Statistic>**.

A new Image window is displayed with a composite image calculated by the selected calculation. You can see the changed value for a given pixel by using the **Image Info Window**.

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