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Sphinx¹

User's Manual

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Laboratoire d'Optique Atmosphérique

Université des Sciences et Technologies de Lille

¹ Satellite Process Handling Images uNder XWindow (SPHINX): Trademark no 88 3500200 registered with "l'Agence pour la Protection des Programmes."

THE SPHINX IMAGE PROCESSING & ANALYSIS SYSTEM

Sphinx is the result of years of research and development in satellite image processing at the Laboratoire d'Optique Atmosphérique (LOA) of the Université de Lille, France. This satellite image processing package was designed and developed in response to the daily research needs of scientists conducting applied global climate investigations using satellite data and remote sensing techniques.

LOA scientists apply space-based observations and numerical modeling techniques to study the earth's radiation budget and atmospheric processes. They are specialists in observing and modeling interactions of solar and telluric radiation with the earth system under clear and cloudy conditions.

Constructing atmospheric models has required a synergy of knowledge from several disciplines, namely climatology, meteorology, and remote sensing. To test climatological models, LOA scientists employ space-based observations and ground-truth data. The steady, global coverage of satellite observations constitutes an ideal tool for verifying climatological models as well as for conducting process studies and investigating new phenomena.

Owing to the reliance on satellite observations, extensive research and development at LOA has been devoted to building Sphinx, a state-of-the-art image processing system that runs across a spectrum of high performance computer platforms operating under UNIX and the X Window System.

Today, Sphinx serves as LOA's day-to-day image processing tool. It has benefited from critical feedback from users in the scientific community. The Sphinx image processing system provides:

- simple and friendly usage,
- fast interactive performance,
- capabilities to combine images, vector graphics, and text for generating quality reports,
- rapid display of high-resolution (1024 x 1024) multispectral images,
- interactive generation of new algorithms for converting satellite signals.
- easy interfacing with externally generated software.

For flexibility, the menu driven Sphinx package is built using a number of reentrant modules. Hence, the user can return at anytime to the main menu to begin a new process using the results of ongoing calculations.

The software package includes:

- An interactive interpreter for both algebraic equations and images. This allows the user to manipulate and combine individual data channels interactively. Standard FORTRAN notation is used for formula entry and for trigonometric and transcendental functions.
- An on-line 2 and 3 dimensional graphics editor. This provides complete flexibility for modifying vector graphics and integrating vector graphics and images.
- Multiple output possibilities (e.g., color, gray scale, black and white) for both inkjet and laser printers.
- Satellite signal simulation in the solar spectrum.
- An English/French on-line help manual.

Sphinx was selected by the French space agency, Centre National d'Etudes Spatiales (CNES), for analyzing the results from the POLDER satellite program. The Sphinx package is now in use at many laboratories in France, including:

- Centre National d'Etudes Spatiales

- Centre des Faibles Radioactivités
- Centre de Recherche en Physique de l'Environnement
- Ecole Normale Supérieure
- Institut National de la Recherche Agronomique
- Laboratoire d'Etudes et de Recherches en Télédétection Spatiale
- Laboratoire de Glaciologie et de Géophysique de l'Environnement
- Laboratoire de Météorologie Dynamique
- Laboratoire d'Océanologie Dynamique et de Climatologie
- Laboratoire de Physique et Chimie Marine
- NASA - Goddard Space Flight Center

1.0 SPHINX ENVIRONMENT

1.1 Image Files

Sphinx processes various image formats using the DIRECT ACCESS READ and FREE FORMAT READ functions. The dialog boxes associated with these functions are used to specify the image format, such as header size, record length and pixel value coding (e.g., bit, integer or real).

The SIMPLE FILE READ function reads basic image formats composed of a line and column array with byte encoded pixels.

Sphinx reads and writes both TIFF and GIF formats. Sphinx can read and write compressed image formats (suffix .Z). When they are read, the files are automatically decompressed before being displayed. When they are saved, they are compressed as they are written to a file.

1.2 Image Planes

Sphinx displays 8 bit 1024 x 1024 images. However, it can also process larger images, displaying them either partially or as complete images reduced through sampling to 1024 x 1024.

Sphinx operates using two image plane groups. The first group of visible planes is displayed on the screen, while the second group of hidden planes is stored to disk. The EDIT menu allows you to exchange the contents of the visible and hidden planes.

Each group is composed of three 8 bit 1024 x 1024 planes denoted as R, G, and B (Red, Green, Blue). The DISPLAY menu allows you to display one of the three planes or to display a composite image of all three planes ("true color" mode).

Each plane is divided into 4 quadrants represented as A, B, C, and D (from top to bottom and left to right) for the visible planes, and E, F, G, and H for the hidden planes. The various Sphinx functions can work on an entire plane or on the quadrants selected by the user.

1.3 Color

Sphinx operates in two color modes. In the PLANE mode, a single (R, G or B) plane is displayed on the screen. In true color mode, Sphinx displays the composite image of the three planes. Sphinx approximates the true color by using 3/3/2 bit coding. In true color mode, however, the results are output in 24-bit true color. The user can obtain a good idea of the true color output by using the special 24 to 8 bit transform function under the Print Menu.

Each plane possesses its own color map. The color maps are read and written to files which may be modified using the COLOR functions.

1.4 The Sphinx Screen

The IMAGE window takes up the largest part of the screen, displaying a 1024 x 1024 plane that is divided into the four A, B, C and D quadrants.

The COLOR MAP window is located to the right of the IMAGE window and shows the color scale in use. Two commands in the DISPLAY menu, SHOW COLOR MAP and HIDE COLOR MAP, displays and hides this window.

The VALUES window, a long thin strip located beneath the IMAGE window, displays the pixel values in an image.

The small COORDINATE window, located in the lower right of the screen, displays the pixel coordinates beneath the mouse location.

The RGB window, located in the lower right of the screen, registers the plane being displayed as R, G or B, or R/G/B when in true color mode.

The small INFORMATION window, also located in the lower right of the screen, displays the operation mode as it awaits a command, such as selecting an image area.

You can hide the windows of the Sphinx environment by using the ICONIFY Sphinx function. This redisplay the original screen prior to launching Sphinx. To return to the Sphinx environment, simply click on the small icon.

1.5 Using The Mouse

The right mouse button is used to display the pop-up main menu and to select image areas. The left mouse button is used within the menus and dialog boxes. The middle mouse button, when it is present, is not utilized by Sphinx.

1.6 Sphinx Main Menu

The Sphinx main menu is not displayed continuously so that the IMAGE window is not obstructed. To make it appear, press on the right mouse button without letting go.

The Sphinx menu contains listings that either access the submenus (indicated by arrows) or activate the corresponding functions.

To access a submenu, place the mouse on the right part of the desired listing (over the arrow). This makes the corresponding submenu appear from which you can select a function. When you have selected the desired function, release the mouse button.

The main menu can be called up from the function dialog boxes by clicking with the right button on the Sphinx MENU window located on the lower right of the screen. This allows you to execute another function, and after this function is executed, Sphinx returns to the initial box. For instance, if you are in a dialog box and you want to measure a pixel value, you click on the Sphinx MENU window and select the PIXEL VALUES function. This mechanism allows you to queue up to nine function requests.

1.7 The Function Dialog Boxes

Most Sphinx functions begin by displaying a dialog box that allows you to specify various parameters (e.g., file names and sizes, image planes, quadrants, etc.).

If you need help using a function dialog, click the left button on the "?" icon located to the right of the title bar.

To move the dialog box, place the mouse arrow on the title bar and hold down the left mouse button. Then move the mouse to the desired screen position.

You can also move the dialog box by clicking the left mouse button on the "X" icon located to the left of the title bar. This will automatically move the dialog box to the right side of the screen. Clicking again on this icon will return the dialog box to its initial position.

All dialog boxes include an EXIT button. To exit a function, click on this button using the left mouse button.

Certain dialogs include an EXECUTE or RUN button. In these boxes you can input various options before executing the function by clicking the button. As mentioned above, from all the dialog boxes you can call up the main menu by clicking on the Sphinx MENU window with the right button.

1.8 On-Line Help

You can access the on-line help by using either the HELP submenu or the "?" icon in each dialog box. From the HELP submenu, you can select the

desired topic. Using the "?" icon in each dialog box, you directly access the description of that function.

The help boxes contain a NEXT button to advance to the subsequent instruction page, a PREVIOUS button to return to the previous page, and an EXIT button to quit the on-line help. You must click these buttons using the left mouse button.

NOTE: when a help dialog box is displayed, the other dialog boxes as well as the Sphinx main menu are not active. You must leave the on-line help (by clicking the EXIT button in the box) in order to redisplay the other Sphinx functions.

2.0 MAIN FUNCTIONS

From the main menu you can directly access the PIXEL VALUES, ZOOM, REFRESH and ICONIFY Sphinx functions. The other functions are accessed through the submenus.

PIXEL VALUES determines the value of a pixel.

ZOOM enlarges specific image areas on the screen.

REFRESH redraws the screen and clears the overlay plane.

The FILE submenu reads and writes image and color table files as well as contour and annotation files. It also allows you to save a work session that can be continued at a later time.

The DISPLAY submenu controls the choice of the plane displayed (R, G, B or a combination of the three planes in true color mode). It also controls the display of the COLOR MAP window.

The COLOR submenu accesses the color manipulation functions.

The EDIT submenu accesses the basic image manipulation functions and the annotation functions.

The PROCESS submenu contains the mathematical processing functions, the external functions, and the animation functions.

The PLOT submenu accesses functions to graph, contour, and grid.

The PRINT submenu accesses the printing functions to print on PostScript or LaserJet printers.

The SIGNAL MODELS submenu accesses the satellite signal simulation functions.

The GEOMETRY MODELS accesses the geometric manipulation functions, such as warping, satellite geometry and orbit simulation.

The HELP submenu accesses the on-line help by topic.

The TEST submenu accesses various Sphinx functions.

2.1 File Menu

The FILE submenu reads and writes files containing images, color maps, annotations, and contours. It also allows you to save a work session that can be continued later.

The SIMPLE FILE READ function reads basic image formats (i.e. a line and column array of any size and with byte encoded pixels).

The DIRECT ACCESS READ function samples rows and columns and can therefore read images larger than 1024 x 1024.

The FREE FORMAT READ function can read image pixel values that are either integer (from 1 to 32 bit) or real. Since this menu calls up the DIRECT ACCESS READ menu, it can also sample images.

To select the file name for reading or writing, use the DIRECTORY CONTENTS menu. This menu lists the files and directories contained in the current directory. NOTE: only 99 files in the directory are displayed.

To change directories, click on the name with the left mouse button. One click on the "../" symbol at the top of the entry list allows you to climb to the directory above.

To select a file in the current directory, click on its name.

You can also directly enter the directory and file names by typing them into the Path Name and File Name boxes. In the Path Name box type "../" or \$HOME, which returns you to the root or home directory.

2.2 Display Menu

The DISPLAY submenu controls which image planes are displayed (R, G, B or a combination of the three in true color mode. It also controls the display of the COLOR MAP window (i.e., functions SHOW COLOR SCALE and HIDE COLOR SCALE).

The FLIP FLOP BANKS function displays two of the three planes alternatively. This enables you to compare images contained in the three planes.

2.3 Color Menu

The COLOR submenu accesses the color manipulation functions.

SAVE COLOR SCALE attaches the color map to the image plane. As long as this function is not called up, changes in the color map remain temporary, and upon leaving the COLOR menu the previous color map is restored.

TRUE COLOR changes Sphinx into the true color mode (this has the same effect as the TRUE COLOR function in the DISPLAY menu).

STRETCH THE 8 BIT COLOR SCALE modifies the color map (e.g., contrast control, min./max. scaling, brightness, etc.)

FILL LEVELS WITH COLOR creates false color images by modifying the color map by pixel value intervals.

AUTO INTENSITY BALANCE and RGB MANUAL INTENSITY BALANCE controls the pixel values of the planes in true color mode either automatically or manually.

BUILD COLOR SCALE creates a color map and displays the histogram of the image plane.

2.4 Edit Menu

The EDIT submenu contains the following fundamental image manipulation and text annotation functions.

MOVE EXCHANGE ROTATE: various functions that move, exchange, and rotate image areas.

IMAGE RESIZE: enlarges or reduces images.

DRAW IMAGE ANNOTATION: inserts text and simple graphics (e.g., lines, boxes, symbols) in the image.

DRAW COLOR LEGEND: creates a color legend.

GRID DRAWING: draws grid lines.

PAGE SETTING: constructs a mosaic of smaller images of any size stored on disk.

PIXEL MASKING: masks selected areas of the image.

AREA FILLING: fills an image area with a selected pixel value color.

MERGE TEXT AND IMAGE: merges together the image plane with the overlaid text or graphics.

2.5 Process Menu

The PROCESS submenu accesses the mathematical processing functions, the external functions, and the animation functions.

IMAGE ALGEBRA: performs basic algebraic functions on an image.

AREA STANDARD DEVIATION: calculates the standard deviation of an image area.

CONVOLUTION PRODUCT: calculates the convolution product and filtering of an image area.

FOURIER TRANSFORM: computes Fourier transform filtering of an image area.

STRUCTURE FUNCTION: calculates the structure function of an image area.

CLUSTER ANALYSIS: analyzes the cellular structure of an image or selected area.

PRINCIPAL COMPONENTS ANALYSIS: analyzes the principal components of an image.

PIXEL CLASSIFICATION: classifies pixels using cluster dynamics.

EXTERNAL PROCESSES: performs external user-developed programs.

MOSAIC ANIMATION: animates images.

2.6 Plot Menu

The PLOT submenu accesses the following functions to graph, contour, and grid images.

REDRAW SAVED GRAPH: redraws the previously saved graphics.

CLEAR SAVED GRAPH: erases the previously saved graphics.

HISTOGRAM: plots histograms.

RADIAL: plots radials.

CONTOURING: plots contours.

BIDIMENTIONAL PLOT: plots two dimensional scatter plots using two image planes.

3D COLOR GRAPHIC: constructs a scatter plot around three axes representing the red, green and blue coordinates of a pixel.

CHANGE SAVED GRAPH NAME: changes the file name of a saved graphics.

IMPORT GRAPH FROM FILE: imports an existing graphics file (x, y).

2.7 Print Menu

The PRINT submenu contains the print commands for PostScript or LaserJet printers. The images and graphics can be printed in either color or levels of gray. Sphinx can send print jobs to the print spooler or store the print images in a file.

2.8 Signal Models Menu

The SIGNAL MODELS submenu accesses the satellite signal processing functions.

2.9 Geometry Models Menu

The GEOMETRY MODELS submenu accesses the geometric image manipulation functions for warping, computing satellite geometry and simulating satellite orbits.

2.10 Tests Menu

The TEST submenu accesses the various test functions (image overlay, etc.).

3.0 SPHINX FUNCTIONS

3.1 The File Menu

Read An Image From Disk

This function reads 8-bit images (scaling them to 512 x 512 or 1024 x 1024) that do not incorporate record headers. Images that do not meet this specification should be read using the FREE FORMAT READ or DIRECT ACCESS READ functions.

Choose the file name by filling the PATH NAME and FILE NAME or by selecting in the DIRECTORY CONTENTS menu and then clicking once on READ FILE.

Sphinx analyzes the file and determines the image size (Sphinx determines if the file size is the square of a number that would compose the number of rows and columns of an image). If Sphinx cannot determine the image size, or if the calculated image size is incorrect (for instance 512 x 512 for a 1024 x 256 image), you can modify it by explicitly filling in the "Nb lines" and "Nb columns" boxes. (To help determine the file size, the user can create an external file (".sphinx_fmt") that is stored in the home directory and that contains several lines with common format dimensions ("Nb lines", "Nb columns", "header size")). For instance, create the file:

```
vi .sphinx_fmt
288 384 0
512 411 112
etc.
```

The VISIBLE and MASKED option boxes allow you to place the file read into either the visible (A, B, C, D) or masked (E, F, G, H) quadrants.

The A, B, C, D or E, F, G, H options (according to the VISIBLE or MASKED options selected) indicate the quadrant into which the image is loaded.

The RED, GREEN and BLUE option buttons allow you to chose the plane into which the image is loaded.

The RGBCM option simultaneously loads the three R, G, B image planes and the color map if the corresponding files are present (suffixes R, G, B and CM).

The EXPAND option enlarges the image to 1024 x 1024 by duplicating points.

The UP/DOWN, LEFT/RIGHT options inverts and reverses the image placement.

Clicking a second time on READ FILE initiates the loading of the image into the plane and quadrant specified. WARNING: the image does not appear immediately on the screen if it is read into a plane other than the one currently displayed or into a masked quadrant. To display it, depending on the situation, you must change the displayed plane (DISPLAY menu) or transfer the image to a visible quadrant (EDIT menu).

WARNING: a displayed image will not appear correctly on the screen if the color map is not appropriately adapted to the image. If, for instance, you read an image containing pixel values equal to either 0 or 1 and you display the image with a color map adapted for continuous shades of gray, the image will display as a uniformly black image since there is no scaling between the 0 or 1 values. To display the image correctly, you must first modify the color map using the HISTOGRAM STRETCH function.

Image files produced by Fortran programs:

The files produced by Fortran programs contain at the beginning and the end of each record a 4-byte word that indicates the length. A file

containing a $n \times n$ image and written in one single record will have a size equal to $((4 + n) \times (n + 4))$ bytes.

The Sphinx READ FILE function takes this procedure into account before reading an image file. Sphinx determines the size of the file (i.e., size_file) and reads the values in the first 4 bytes (i.e., size_header). If the size_header is equal to size_file - 8, Sphinx assumes that the file contains an image whose size is given by size_header and that begins at the forth byte of the file.

To facilitate the exchange of images between machines that do not employ the same bit order representations within words (high end bits first or last), Sphinx analyzes the 4 bytes written according to the two possible orders. One can then read, for instance, on a RS 6000 a file produced on a DecStation.

WARNING: images produced by Fortran programs but written in several segments must be read by FREE FORMAT READ to enable Sphinx to ignore the written byte length.

Write Image To Disk

Choose the file name by filling in the PATH NAME and FILE NAME boxes or by selecting it in the DIRECTORY CONTENTS.

The A, B, C, D options indicate which image quadrant is written. The 1024 option allows you to write the complete image.

If you choose the 1024 option, the REDUCE option allows you to decrease the written image size to 512 x 512.

The RED, GREEN and BLUE options tell Sphinx which plane contains the image for writing.

The COMPRESS option box allows you to write in compressed format.

The "Nb lines" and "Nb columns" boxes give you the option to write format sizes other than 512 x 512 or 1024 x 1024.

Click on WRITE FILE to begin writing. WARNING: if the file already exists, the writing cannot taking place. The dialog box, however, provides an OVERWRITE FILE option, which can be activated by clicking once upon YES and then upon WRITE FILE.

Restore Color Map

This function reads a color map file and updates the color maps associated with the three R, G, or B image planes.

The color map files contain 4608 bytes or 3 color maps of 1536 bytes (one for the BLUE plane, one for the GREEN plane, and one for the RED plane). Each color map consists of 3 series of 512 bytes with the first containing 256 levels of red (each one encoded in 2 bytes), the second containing 256 levels of green, and the third containing 256 levels of blue.

The Sphinx utility directory contains the source code of the two utilities: print_cm.c and build_cm.c. Print_cm produces an ASCII image of a color map file, and build_cm constructs a color map file from an ASCII image.

The ASCII files created by print_cm and read by build_cm are composed of lines having the format: p iii rrr ggg bbb, where

plane (R, G, or B)
table index (from 0 to 255)
levels of red (from 0 to 255)
levels of green (from 0 to 255)
levels of blue (from 0 to 255)

Save Color Map

This function writes a color map file from the color maps associated with the three R, G, B planes.

Annotations Restore

This function loads the table files used by the image annotation functions. The table files allow you to use 50 different text and 50 symbol graphics.

Annotations Save

This function writes to disk the table files used by the image annotation functions.

Contour Restore

This function reads contour files (see CONTOUR SAVE function). A contour file's contents are overlaid on an image. The contours themselves are simply superimposed upon the image without masking it. They can be erased without erasing the image by using the REFRESH function. To incorporate the contours into the image, use the MERGE TEXT & IMAGE function in the EDIT menu.

Contour Save

This function writes contour files from the contents of a selected image plane. The plane can contain text added using DRAW IMAGE ANNOTATIONS, masks created using PIXEL MASKING, contours created using CONTOURING, grids produced using GRID DRAWING and contours read using CONTOUR RESTORE.

The saved contour files can be superimposed upon the image (see CONTOUR RESTORE FUNCTION above).

To create a contour using a binary image, such as a contour map, you must first read a binary image. Next create a mask corresponding to the points of the contour map (PIXEL function from the EDIT menu), and then save the mask using CONTOUR SAVE.

To create a contour file from contours calculated by Sphinx on an image, use the PLOT menu's CONTOURING function and then save the contours using CONTOUR SAVE.

Restore Session

This function restores a previously saved work session (cf. function SAVE SESSION).

Save Session

This function saves a work session. The session can be restored later by using the RESTORE SESSION function.

The name of the save file is fixed, having the root name "Save_cont...".

Direct Access Read

This function allows you to select and read a 512 x 512 or 1024 x 1024 area in an image file of any size.

Once the file is selected, click on READ FILE. Sphinx begins by reading the first two integers of the file to determine the image size. If this information is missing, two boxes appear on the screen for entering the number of lines and columns of the image.

The SHOW GLOBAL IMAGE option displays an entire 512 x 512 image area in the A quadrant.

Before clicking on READ FILE, you must first select the image size, the image plane and quadrant for display, the starting line, the line step, the starting column, and the column step.

SELECT can be used to define the starting point. Sphinx takes into consideration the image size and the selected line and column step samplings. By moving the mouse over the A quadrant, a window displaying the size of the corresponding image area appears. A click on the right button fills the parameter boxes with the values corresponding to the selected area.

Free Format Read

This function reads image files having various formats, and it allows you to sample the lines and columns and scale the image to 8 bits. As an example, one can use this function to read a file containing several channels.

The first step decodes the file. The dialog box allows you to specify the data unit size (bit or byte) and the following file structure:

- the image structure: pixel length, number of lines and columns, data type (integer or real)
- header offset, record length
- record structure: header record and trailer record

The SWAP LOW AND HIGH option allows you to swap high end and low end bits.

The HIGH BYTE option allows you to read only the high end bits.

The LOW BYTE option allows you to read only the low end bits.

The SCALE TO 8 BITS option allows you to scale the pixel values over 8 bits. For this case, if the "MIN" and "MAX" boxes are empty, an initial reading will find the exact minimum and maximum values as well as the values representing 1% and 99% of the pixels. The exact values are displayed in the "MIN" and "MAX" box. You can modify these entries directly or by clicking on the 1% and 99% values displayed below.

A second reading decodes the image file and recalculates the pixel values between the minimum and maximum values specified.

For instance, to read a file containing a 16-bit 1250 x 1250 image having a 4-byte header in which each line is written in one 2500 byte record, you must enter the specifications for a 4-byte header and a pixel length of 2 with 1250 "Nb lines" and 1250 "Nb columns".

This first step creates a /tmp/sphinx_crt0 file in standard image format that can be read by the DIRECT ACCESS READ function whose menu is called up automatically. You can of course select image parts and sample the image by skipping lines and columns (see information on the DIRECT ACCESS READ function).

TIFF Format Read

Reads an image in TIFF format with its color map. This format, for instance, allows you to read images created on an Apple scanner.

TIFF Format Write

Writes an image in TIFF format.

GIF Format Read

Reads an image in GIF format with its color map.

GIF Format Write

Writes an image in GIF format.

3.2 The Display Menu

Show True Color

Displays on the screen an image obtained by combining the color values contained in the three R, G, B planes. On machines limited to 8 color planes

(256 different colors), Sphinx approximates the true color by using a 3/3/2 coding.

Show Blue Bank

Displays on the screen the image contained in the B plane. The image is displayed using the color map associated with the B plane.

Show Green Bank

Displays on the screen the image contained in the G plane. The image is displayed using the color map associated with the G plane.

Show Red Bank

Displays on the screen the image contained in the R plane. The image is displayed using the color map associated with the R plane.

Show Color Scale

A scale showing the color associated with each pixel value is displayed in the COLOR SCALE window (to the right of the IMAGE window) WARNING: when Sphinx is in true color mode, the scale displayed has no significance.

Hide Color Scale

The scale showing the color associated with each pixel value is erased.

Flip-Flop Banks

This function allows you to display two image planes alternatively. To activate the function, click on the desired change. After a brief delay, a message in the lower right indicates the action to take. Keep the right button pressed down and change the flip speed by moving the mouse up or down on the screen, with the higher being faster and the lower slower.

3.3 The Color Menu

Save Color Scale

SAVE COLOR SCALE attaches the color map to the image plane.

True Color

(See Display Menu above).

8 Bit Gray Scale, Color Scale

When a plane is displayed, Sphinx changes into false color mode. An image pixel value is an index of the red, green, and blue intensities that make up the color displayed for that point. There is a maximum of 250 possible colors (six pixel values are saved for X 11, although the output results are displayed in 256 colors). For gray scales, the three RGB planes have the same value. For color, an artificial scale is created.

Other Color Scales

This function allows you to select a color map from a pre-defined selection.

Build Color Scale

This function modifies the color scale using a histogram and line graphs of the three R, G, B color components. The histogram of the image plane is displayed in black at the bottom of the graph, and the 3 components of the color scale are displayed in red, green and blue. The X axis denotes the pixel values (0-255) and the Y axis denotes the color intensity.

The right mouse button draws straight line segments, while the left button draws curves. When the graph is drawn (in black), it can be applied to a section of the color table by clicking "R", "G" or "B". The result is immediately displayed. The "Gray" box applies the same values to the three RGB components. The "C" box exits the function.

Note: also see in the Sphinx utilities the `build_cm` utility which constructs a color map using pre-defined values.

Stretch The 8 Bit Color Scale

Sphinx provides the possibility of:

- modifying high values
- modifying low values
- rotating the scale
- inverting the scale upside-down
- modifying the scale by equalizing a number of pixels by class
- modifying the scale by performing a histogram stretch

To modify the high or low values, place the cursor on the maximum (or minimum) and then click the right mouse button. The new scale is immediately displayed. By continuing to press the right button and moving it up or down on the screen, you can visualize a sliding scale. All the points located beyond boundaries appear in black or white according to the option selected.

You can adjust the color intensity of the scale using the BRIGHTNESS TUNE function. The intensity is multiplied by a coefficient dependent upon the cursor position on the screen: lighter toward the top and darker toward the bottom.

EQUALIZE STRETCH queries you to select an area. Sphinx creates a histogram of the selected area and constructs groups of pixel classes for which each class consists of the same number of pixels. The color map reflects the groups of point classes. After this transformation within the selected section, each level corresponds to the same number of points. A look at the COLOR MAP window illustrates the transformation.

HISTOGRAM STRETCH queries you to select an area. Sphinx examines the pixel values to determine the dynamic range of the area (minimum and maximum pixel values of the area: `vmin` and `vmax`). The color map is adjusted so that values from 0 to `vmin-1` are assigned to 0, values from `vmin` to `vmax` are assigned values between 0 and 255, and values from `vmax+1` to 255 are assigned to 255. The result improves the contrast of the area selected but at the expense of the rest of the image. A look at the COLOR MAP window illustrates this transformation.

SAVE COLOR SCALE attaches the color table to the image plane.

Fill Levels With Color

This function creates an artificial color scale.

Begin by selecting a fill color. Then place the mouse in the COLOR MAP window. By keeping the right button pressed, Sphinx fills in the corresponding pixels with the selected color.

If you make a mistake, the PREVIOUS SCALE button reverts to the previous table.

To help identify the pixel classes, you can determine a pixel value by placing the cursor on the image and pushing the right button.

The best results are achieved by starting with a scale in shades of gray and then coloring the value ranges.

SAVE COLOR SCALE attaches the color table to the image plane.

RGB Auto Intensity Balance

In the case of images displayed in true color, the only way to modify the contrast is to change the pixel values of the image. This function

automatically balances the three RGB planes by performing histograms on a 384 x 384 area selected by the user. The result is displayed in the same area. If the transformation is judged satisfactory, then it can be applied to the entire image or to a given quadrant.

NEW AREA allows you to select a new area.

GRAPH: displays the histograms before and after the transformations. Three parameters allow you to modify the results:

Brightness: from 0 to 100

% lower: is the percentage of minimum value pixels representing the zero function value.

% upper: is the percentage of maximum value pixels representing the highest function value.

RGB Manual Intensity Balance

For images displayed in true color, the only way to modify the contrast is to change the pixel values of the image. Using a 384 x 384 area selected by the user, this function manually allows you to:

- select an area.
- plot the histograms for the three RGB planes.
- modify the histograms. For each color place the cursor on the corresponding histogram (the values are displayed at the bottom of the scale) and then click to change the minimum or maximum frequencies. The compressed or stretched color scale is displayed in the selected area.
- add or subtract a constant. As above, by positioning the cursor on the histogram of the corresponding color, the value of this constant is displayed at the bottom of the scale. The value is between -39 and 300.

The result is displayed in the window, and if it is satisfactory, the same transformation can be applied to the entire image or to a given quadrant.

3.4 The Edit Menu

Move/Exchange/Rotate

This dialog box offers several functions. To execute one of these functions, first select the quadrant and the source plane in the FROM box. Next select the quadrant and the destination plane from the TO box. Then select the desired function and click on EXECUTE.

The 512 and 1024 options allow you to work on one of the 4 visible (A, B, C, or D) or masked (E, F, G, or H) quadrants or on the entire screen.

The functions CUT AND PASTE PIXELS, CLEAR and COPY PIXEL AREA work on an area that is selected after you click on EXECUTE. The other functions work on the entire quadrant chosen.

The function COPY COLOR MAP copies a color map from one plane to another. For this function, choosing a quadrant is not necessary.

The function EXPAND enlarges an area by a factor of two. This enlargement affects the upper left part of the area selected. The function IMAGE RESIZE of the EDIT menu can be used if you desire more flexibility when choosing the enlargement factor and the area to enlarge.

The function COMPRESS reduces the image by a factor of two.

WARNING: don't forget to select the FROM plane, otherwise the functions do not work.

Image Resize

This function modifies the size of an image by a variable factor x and y when using the image's upper left corner as the origin.

Select the source quadrant and the destination quadrant, as well as the source plane and the destination plane, using the FROM and TO boxes and the button options.

Choose the origin point and the scale factors using the X and Y orig, and X and Y factor boxes, respectively.

Pick the interpolation method, either the nearest pixel or the bicubic spline, which gives the best results but demands more computations.

Click on RUN.

Draw Image Annotation

This function writes text or draws lines and symbols on the image. These text and line annotations can be modified, masked, or rewritten at any time. They can also be saved to a file (see the ANNOTATION SAVE function under the FILE submenu).

The function MERGE ANNOTATIONS AND IMAGE allows you to inlay the annotations in the image. In the case of an image displayed in false color, all the pixels above 249 are reduced to 249, and a special scale is used in the interval from 250 to 255 in order to define the overlay graphics colors. If this scale is lost, the function INSERT GRAPHIC SCALE in the submenu TEST recreates it without altering the image.

See the function DRAW COLOR LEGEND from the EDIT menu and the functions CONTOURING and DRAW GRID from the PLOT menu.

Draw Color Legend

This function constructs a color legend.

The DRAW RAINBOW function draws a rectangle containing the color map.

To select a color, enter its RGB value or click on SELECT COLOR FROM IMAGE.

SELECT COLOR FROM IMAGE allows you to choose a color in the image. After clicking on this button, place the mouse on the image area and press the right mouse button. While the button is pressed, the color of the pixel is displayed at the mouse position. When the desired color is obtained, release the right button.

DRAW ICON draws a symbol (e.g., box, diamond, circle, triangle) of the selected color. After clicking on this button, select the point where the symbol should be displayed by clicking on the right mouse button.

CLEAR LAST INSERT undoes the last insert.

CLEAR AREA erases an area selected with the mouse.

The options KEEP X and KEEP Y force the horizontal or vertical alignment of the symbols placed by DRAW ICON.

NOTE: Also see the function DRAW IMAGE ANNOTATION from the EDIT menu.

Grid Drawing

This function draws grids. You can choose the quadrant, the line thickness, the origin and the size of the selected area, and the grid step in X and Y.

The result can then be saved in a file using the SAVE CONTOUR function from the FILES menu.

Page Setting

This function menu sets up a 1024 x 1024 mosaic plane of smaller images of any size stored on disk. The menu is composed of the 4 following areas:

File format definitions

This top area is used to define various file format dimensions (see FREE FORMAT READ under section 3.1). For example, to read a 16 bit file of size 288 x 384 that has a 32 bit header and values between 1000 and 3500, you must enter:

Pixel length :	2	
Nb lines:	288	
Nb columns:	384	
Header offset:	4	
Scale to 8:	1%: 1000	99%: 3500

Grid drawing

This area is used to define the mosaic grid in which the images are placed. For example, 288 x 384 images can be arranged in 100 x 150 cells that use an origin point of 100, 100 (x, y) for the resulting image. The images are separated by 10 pixels. For these specifications, enter:

y orig:	100
x orig:	100
thickness:	10
height:	100
width:	150
(Show grid)	

Selection

This area is used to define the link between the image size on disk and the mosaic grid size. You may select either a part of the image or a line and column sampling of the image. For example, you can display the center of 288 x 384 images by entering:

line:	44
line step:	2
column:	42
column step:	2

Read the file

This area decodes a file and places the result in a grid cell by using the mouse. For example, enter Read and then select the placement with the right mouse button. After placing the first image, you can select another file in the Directory Contents and then repeat the Read command.

Pixel Masking

This function creates a mask by filtering pixels using one or several parameters and then attaches it to the image. To use this function, you first create a mask and then connect it to the image.

To create a mask, select the quadrant and the plane desired from the CREATE box. Next select the filter conditions for the R, G, and B planes. For each plane you specify an interval of pixel values to which the filtering conditions are applied. The conditions for the three planes can be combined using AND and OR options. The INVERS option inverses the mask. Once you've made your selections, click on CREATE.

The masked areas are displayed on a screen in magenta. The mask can be modified by clicking on ERASER to erase the masked areas.

To merge the mask to the image, select the destination area and plane in the MERGE box, and select the value that will be given to the masking pixels. This value is stated as a constant (value choice); however, if you are in true color mode, you may state this value as a color. Once the selection is made, click on merge.

The mask created can be used by the IMAGE ALGEBRA function (under section 3.5) to select specific pixels to modify.

Area Filling

This function selects a contour or an area using the mouse and then merges it to the image with a desired pixel value.

Select the target quadrant and plane (TO box) and then select the type of background plane: IMAGE or VALUE. If you select IMAGE, the TO area will be initialized using the FROM area, which must be selected in the FROM box. If you select VALUE, the TO area will be initialized using the constant indicated in the box located to the right of the "Background : value" option button.

Select one of the three plot types (e.g., rectangular area, closed area, free contour) and then press RUN. You can then select the area.

Select the fill value (in the box to the right of the "Merge with value" option) and then RUN.

Merge Text and Image

This function merges the graphics overlay plane with the image plane. The overlay plane contains the collection of annotations created using DRAW IMAGE ANNOTATIONS, masks created using PIXEL MASKING, the contours created using CONTOURING, the grids created using GRID DRAWING and the contours read by CONTOUR RESTORE.

For images displayed in false color, all the pixel values above 249 are assigned the value 249, and then a specialized scale is used for the interval 250 to 255 in order to define the overlay graphics colors. If this color scale is lost, the function INSERT GRAPHIC SCALE under the "Test" submenu will recreate it without altering the image.

3.5 The Process Menu

Image Algebra

This function computes equations written in symbolic notation. The operators are standard mathematical functions. (The calculation is done in real 32 bits).

The possible operands are

- images:

 - A, B, C, D denote the visible 512 x 512 quadrants.

 - E, F, G, H denote the masked 512 x 512 quadrants.

 - V denotes the visible planes 1024 x 1024.

 - M denotes the masked planes 1024 x 1024.

 - R, G, B denote the color planes.

 - T denotes the ensemble of the 3 planes.

- the variables X and Y designate the row number and column number of the image.

- the notation [c,r] allows you to shift the rows and columns.

 - Example: $AB = \text{abs} (AG - AR[1,0])$ (AR is shifted by one to the left (-1 would be to the right))

 - Example: $VR = \sin (X) \times 128 + 128$ (X ranges from 0 to 1023)

WARNING: if the results are not within the values of 0 to 255, then the image will not be correctly displayed.

SAVE EQUATION adds the current equation to the Sphinx equation database named (\$home).SP_ALGEBRA.

FILE RESULT: creates a binary 32-bit file named SP_ALGEBn that contains the image in real values with FORTRAN headers.

FILTER MASK: executes the operation on the pixels that are not masked (see Pixel Masking for creating a mask).

Area Standard Deviation

This function plots the contour of an area and then calculates the area, the minimum and maximum values, the average value, and the standard deviation.

To select an area, click on RUN.

PLOT allows you to plot a histogram (see the Graphics editor).

This function works on the three RGB planes. It also takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values in physical units.

Convolution Product

This function calculates an image R whose pixel values are the product of pixel values in a coefficient matrix C by the pixel values in the original image matrix I.

$$R(i,j) = \sum_{k=1}^{k=n} \sum_{l=1}^{l=m} I(i - \frac{n}{2} + k, j - \frac{m}{2} + l) \cdot C(k,l)$$

The coefficient matrix C can be created using the keyboard (option owner), read from a file, or selected from Sphinx's predefined operators: smoothing, Sobel operator, edge detection (vertical, horizontal, or diagonal).

You can specify the matrix size, the threshold above which results are no longer kept, and the desired plane and quadrant.

To start the computation, click on CONVOLUTION.

WARNING: don't forget to specify the FROM plane, otherwise the function will not work.

This menu also allows you to filter an image using a vector of V elements contained either in a file or entered by hand:

$$4 = I(i,j) \times V(i \text{ module } n) \text{ or}$$

$$5 = I(i,j) \times V(j \text{ module } n)$$

To use the filter, select the file containing the V vector, and then click on FROM FILE. For a vector line, enter 1 in the box "Nb columns"; and for a vector column, enter 1 in the box "Nb lines". Then click on the button FILTERING. Using, for instance, a vector line [1.00 0.00] will create a filtered image that only contains every other line. Similarly, a vector column will create a filtered image that only contains every other column.

Fourier Transform

The bidimensional Fourier transform of an image represents the spectral components of an image. If an image's spectral frequency varies rapidly, the transform image will have a large brightness amplitude.

An artificial image is constructed using calculated frequencies. The center pixel of a transform image will be the average amplitude. From this pixel, the value of each pixel is calculated as the logarithm of (1 + the amplitude). Its distance (p,q) with respect to the center provides the corresponding frequency (p/n, q/n). The dialog box for the Fourier transform function is divided into the following three areas.

The top part of the dialog box calculates a transform. Select the quadrant that will receive the result (RESULT TO). Next, select the area size of the source (areas X and Y). Click on RUN and designate the source image area by clicking the right button. The calculation is then executed and the result is displayed in the selected quadrant.

VALUE displays the frequency values. After clicking on VALUE, select the points in the destination quadrant and click the right button.

STRETCH expands the amplitude scale, improving the contrast.

INV recalculates the inverse transform without filtering.

UNDO restores the original image residing in the three planes.

SAVE allows you to save the results into a database.

The center part of the dialog box calculates an inverse transform after a frequency or amplitude filtering. For a frequency filtering, select the "zone" option, and then click on SELECT and define the filter areas. The right button mouse draws line segments and the left button closes the contour. Click next on APPLY. (If the "complement" box is not activated, the saved frequencies are the masked frequencies. The others are assigned to 0).

The option "zone & graph" applies a linear or exponential function starting from the center of the masked area and diminishing toward the borders in order to avoid a radical reset to 0. After clicking on the APPLY function, if "zone & graph" is selected, the user must define a radial crossing the masked area. A perpendicular to this radial will separate the area into two parts. The dampening coefficients will be maximum over the crest and will lessen toward the borders parallel to the drawn radial. A plot of dampening lines is produced along with a box allowing you to apply either the linear function or the exponential function (in this case, you can modify the alpha coefficient, and by clicking on "apply" the new graph is plotted).

Three options are possible.

EXIT: stops the filtering.

APPLY: performs the filtering with the dampening coefficients selected to suppress the desired frequencies.

TEST: creates an artificial image in the 0-255 range to which the dampening coefficients are applied.

To calculate an inverse transform after an amplitude filtering, select the amplitude filtering (i.e., "color" option) and click on Select and define the level to filter. The right mouse button allows you to color the levels on the color bar which appears to the right of the image. Next click on APPLY.

The lower part of the Fourier transform dialog box performs the following operations on the transforms saved in the data base.

- The "Show" option displays an image file.
- The "Inver" option displays the inverse transform of an image file.
- The "Save" option writes the results to a file.

To perform an operation, the user must:

- select the A button and choose the transform from the selection
- select the B button and choose another transform from the selection
- select one of the following operations:
 - add: transform addition
 - sub: transform subtraction
 - conv: transform convolution
 - unconv: transform deconvolution

- correl: transform correlation
- click the "Run" button.

Structure Function

This function calculates the structure function $FS(d)$ in the order of either lines (n) or columns (m) for any rectangular area, and then graphs the values as a function of distance d.

$$FS(d) = \sqrt{\sum_{i=0}^{i=n} \sum_{j=0}^{j=m} \frac{(V_{i,j}) - V(i+d,j)}{m \cdot n}}$$

The user specifies the minimum and maximum boundaries. The value of FS for the minimum d values is displayed. In the case where the boundaries are different, the function graphs a function $FS(d)$.

Cluster Analysis

This function employs a threshold technique to define and analyze the cellular structure of an image.

To use this function, choose the input and output planes and quadrants, determine the threshold (box) value below which pixels are considered background (this can easily be done using the Fill levels with color), and select the weighting to be used: 1 or PV. With the 1 weighting, all the pixels will have the same weight and the barycenter will be geometric; with the PV weighting, the pixels whose digital values are high will have a heavier weight and the barycenter will be physical.

After clicking on RUN, Sphinx queries the user to select the analysis area and then displays the results:

a.) on the image plane:

- an artificial image showing the cells;
- the number of background pixels for the points below the threshold;
- the number of cells and its surface area.

b.) on the graphic plane:

- the gravity centers of all the cells superimposed on the original image.

If the "Result File" option is selected, the file clsize.rs is created with:

- the coordinates of the processed area;
- the surface and perimeter for each cell;
- the average value of the cellular digital pixel values;
- the position of the gravity center (line and column numbers);
- an estimate of the fractal dimension and the size distribution of the cells.

PLOT displays a series of plots:

- the surface area of the cells as a function of their perimeter in number of pixels; (in a log-log graph, a linear fit obtains the fractal dimension of the distribution);
- distribution of the cell area covered by a specific class, normalized by the size of the class and the surface area of the studied region, as a function of the average value of the diameter associated with the class (the units obtained are in pixels - 1);
- the size distribution of cells as a function of diameter classes. It is obtained by counting the number of cells by diameter class and then

dividing by the class size and by the total surface area of the region (the units are in pixel -3).

Principal Components Analysis

This function analyzes an image composed of three spectral ranges in the RGB planes. A vector transformation constructs an artificial image in which the new spectral components are fully decorrelated.

The displayed results are:

- the correlation matrix constructed using the covariance matrix. It expresses the percent of correlation between the different channels.
- the eigenvalues and the eigenvectors of the covariance matrix (for instance, a strong drop in the eigenvalue size will increase in strong correlation with the base spectral components, with the final result being more statistically significant.) The first eigenvector will produce the strongest component and is placed in the blue plane. The second vector will produce a weaker component and is placed in the green plane. The third corresponds to the residual noise of weak amplitude and is placed in the red plane.
- a linear Taylor series expansion of the final numerical values into a 0-255 range and the different coefficients are displayed.

These results can be saved to a SPHINX_PCAn file and applied to the images, where (n) is augmented with each usage.

Pixels Classification

This classification method by cluster dynamics regroupes pixels into classes of the same spectral components. In 1024 mode (the entire image) the classification is completed using the three RGB planes. In 512 mode, the classification is applied to selected quadrants in the RGB planes in which various wavelengths of the same image have already been placed.

To execute the function, select the mode (1024 or 512), the classification area(s), where you want to display the results and the number of desired classes.

Next choose the class definition method:

- automatic, using a histogram of values
- by pixel, choosing the class values by clicking on a pixel with the left mouse button (the right button displays the color sampled)
- by area, choosing the classes by using the maximum histogram value of an area defined in the image using the right mouse button
- manually, defining the RGB levels desired

You can display the results in true color mode or in the blue plane. RUN executes the calculation. UNDO restores the initial image.

P.VALUES displays the pixel values. It is identical to the PIXEL VALUES function in the main menu and is placed in the CLASSIFICATION in order to display pixel values without having to revert to the main menu. When the calculation is finished, a 24 bit composite image is displayed.

CLASS/COLOR allows you to modify the colors of the classes. After clicking on this button, Sphinx displays a color table, and then for each class it displays the number (in the upper left of the screen) and color (to the right of the color table). You can then select a new color any where in the image with the right button and change the class with the left button). WARNING: when you enter into this sequence, you should redefine the colors for all the classes. To exit quickly from the process, simply click the left button on the color showing the different classes.

External Processes

This function allows Sphinx to execute independent programs. These programs employ a library delivered with Sphinx to accept images transferred by Sphinx and to retransfer images to Sphinx that have been processed externally. The chapter "Development of External Programs" contains the necessary information for writing and integrating external programs.

To execute a program, select the program, the image(s) to be employed by the program, and the plane(s) and quadrant(s) to display the image(s) computed by the external program. Then click on EXECUTE. For programs that require additional parameters, a dialog box can be used to transfer the parameters to the program.

The program is executed in parallel. You can continue to use Sphinx while the program is being executed. The results are displayed by Sphinx as soon as the program is finished executing.

The PENDING JOB STATUS button displays the program status (Waiting, Running, Ended).

WARNING: To communicate with the external programs, Sphinx uses (tmp)/sphinx_data* and (tmp)/sphinx_sema* files. These files are normally deleted when quitting Sphinx. If the Sphinx application quits unexpectedly, some of these files may not be deleted.

Mosaic Animation

This function animates images of size 128 x 128, 256 x 256 or 512 x 512.

To use this function, you need to arrange within a 1024 x 1024 image an ensemble of sixty four 128 x 128 sub-images, sixteen 256 x 256 sub-images, or four 512 x 512 sub-images.

After loading images into one of the three RGB planes, select the plane containing the images and click on RUN or RUN FAST (for HP stations with the Turbo SRX card). Sphinx moves successively through the sub-images to produce an animated movie effect.

DIRECTORY CONTENTS directly loads images and color tables.

3.6 The Plot Menu

Graphics Editor

The graphics editor is called from various Sphinx functions by clicking on PLOT.

You can intervene on a graphic presentation to:

- change the window size (MOVE AND RESIZE)
- select the line style (e.g., straight line, arrowhead, etc.), the symbol type represented by points, one of 5 colors, and line thickness
- define the axes, such as linear or logarithmic, minimum and maximum, and the gradation marks
- write the title and label axes
- define a line step in the case of a scatter plot
- zoom part of the graph by selecting an area with the mouse in the graph window

After making modifications, display the results by clicking REDRAW. At any time you can return to the default values by clicking on DEFAULTS.

You can enhance a graphic overlay by using a combination of lines, boxes, symbols (30 maximum), and text (30 maximum). For each graphic addition, you can redefine the color and graphic type. To insert a graphic element, you need to click on DRAW and then position the cursor on the image position

desired. If you make an error or incorrect placing, you can delete the graphic by clicking on CLEAR and then replacing the cursor over the incorrect graphic text, line, box, or symbol.

PRINT executes the printing of a graphic image.

MERGE WITH IMAGE merges the graphic with the image.(*)

MOVE AND RESIZE moves a graphic window and allows you to modify its size anywhere on the image using the mouse.

SAVE writes the graphics to a file, and the graphic can be inserted later by using the REDRAW SAVED GRAPH function.

OVERLAP displays all the graphics one by one.

NEXT PLOT allows you to advance to the next graph.

FITS accesses a window that performs a smoothing or polynomial approximation for a displayed graph. The derived function can be either added to the original graph or used to replace it.

To zoom one part of a graph, you must first define the upper-left corner of the zoom area with the right button and then move the mouse to the desired lower-right corner before letting go of the button directly on the graph window.

(*) If Sphinx is in true color mode, then the three RGB planes are affected by the displayed graphics. In plane mode (R, G or B), all the pixel values greater than 249 are scaled down to 249, and then a special scale is used within the 250 to 255 range in order to define the annotation and graphics colors. If this scale is lost, the INSERT GRAPHIC SCALE function in the TESTS menu can recreate it without modifying the image.

Histogram

This function calculates a histogram of an image area. The menu allows you to choose in which plane to perform the computation (boxes R, G, and B).

To select the processing area(s), fill in the boxes "x start", "x end", "y start" and "y end" or, more simply, select the area(s) using the mouse. The mouse directions are displayed in a small window in the lower right of the screen.

The histogram function takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values.

To display the histogram graphics, click on PLOT (see Graphics editor)

CLEAR BITMAP erases the area graphics on the screen.

CLEAR LAST undoes the last execution.

Cumulative Histogram

This function calculates cumulative histograms. Using the menu, you choose the plane in which to perform the computations (boxes R, G, and B).

To select the processing area(s), fill in the boxes "x start", "x end", "y start" and "y end" or, more simply, select the area(s) using the mouse. The mouse directions are displayed in a small window in the lower right of the screen.

The function also takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values when working with physical values.

To display the histogram graphics, click on PLOT (see Graphics editor)

CLEAR BITMAP erases the area graphics on the screen.

CLEAR LAST undoes the last execution.

Radial f(x)

This function calculates radial functions of x. Using the menu, you choose the plane in which to perform the computations (boxes R, G, and B).

To select the processing segment(s), fill in the boxes "x start", "x end", "y start" and "y end" or, more simply, select the segment(s) using the mouse. The mouse directions are displayed in a small window in the lower right of the screen.

The function also takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values when working with physical values.

To display the graphics, click on PLOT (see Graphics editor)

CLEAR BITMAP erases the area graphics on the screen.

CLEAR LAST undoes the last execution.

Radial f(d)

This function calculates radial functions as a function of the distance to the origin of a segment. Use the menu to choose the plane in which to perform the computations (boxes R, G, and B).

To select the processing segment(s), fill in the boxes "x start", "x end", "y start" and "y end" or, more simply, select the segment(s) using the mouse. The mouse directions are displayed in a small window in the lower right of the screen.

The function also takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values when working with physical values.

To display the graphics, click on PLOT (see Graphics editor)

CLEAR BITMAP erases the area graphics on the screen.

CLEAR LAST undoes the last execution.

Free Radial

The FREE RADIAL function calculates a function for a hand-drawn curve as a function of distance to the origin of the curve. Use the menu to choose the plane in which to perform the computations (boxes R, G, and B).

The function also takes into account the values that have been entered into the PHYSICAL VALUES menu in the PIXEL VALUES function to determine pixel values when working with physical values.

The right mouse button allows you to draw the curve.

To display the graphics, click on PLOT (see Graphics editor).

CLEAR BITMAP erases the area graphics on the screen.

Redraw Saved Graph

REDRAW SAVED GRAPH allows you to redraw, modify, or overlay graphs saved using the SAVE function in the graphics editor. After selecting a title in the "Graphic Saved Titles" window, the corresponding graphic is superimposed over the previous graphics. The graphic determines the frame size, with the minimum and maximum adjusting to each new choice. At any time the user can:

- erase the graphics window (CLEAR GRAPH).
- create an ASCII file containing the values of the graphics (EXTRACT DATA). The file created is named SPHGRAXYn.
- print the results (PRINT).

- call up the graphics editor in order to modify the graphics presentation (REDRAW WITH CHANGE). In this case the graphics are displayed one by one in the order they were selected.

Clear Saved Graph

This function deletes an already saved graph from a file by simply clicking on the graphics file title in the menu.

Contouring

The CONTOURING function plots isocontours of various values and in the five colors and then merges them into the image plane. You must select the quadrant for plotting and the contour values; an eraser tool (ERASER) allows you to erase any errors or aberrations.

The resulting graphics can be saved in a file by using the SAVE CONTOUR function in the FILES menu.

Bidimensional Plot

The BIDIMENTIONAL PLOT function generates bidimensional histograms. You must select the x and y plane to display as well as the area to process. Two plotting options are available:

- a 2D graphic presented as a scatter plot
- a 3D graphic displaying the frequencies on the Z axis

3D Color Graphic

This functions uses the image plane to display a user-defined area by placing on three RGB axes the values of pixels in color.

The user can modify the view angle by 30 degree intervals. You can also project the points in white or with their original image color.

Change Saved Graph Name

This function changes the file name of the saved graphics file, which is implicitly named SPHINX_GRAPHX in the default start-up directory.

By clicking on the "Record" button the function verifies the file's status and warns the user if it already exists.

Import Graph From File

This function allows you to plot graphics using existing data in an ASCII file. Two options are offered:

- "Lines ": for line graphs
- "Scatter": for scatter plots

The "Lines skipped" box allows you to skip a defined number of lines at the beginning of a file (implicitly zero). "Nb Columns" defines the number of graphics (implicitly 1, and x being the data number). The data are expected to be arranged in the format: x y1 y2 ... yn. "Nb Lines" is either calculated by the program or given by the user.

3.7 The Print Menu

Print Color Image

This function sends an image file to print by a PaintJet or PostScript printer. The file is either written to the disk file SPHINX_PJETn (n is incremented with each usage) or sent to the print spooler.

The user selects:

- the image quadrant or the area to print
- the printing (or suppression) of the color bar
- the number of copies

- the output: PostScript or PaintJet

Print a Gray Level Image

This function prints an 8 bit image in 16 shades of gray on a laser printer.

It calculates a standard scale, stretched between 0 and 255 in increments of 16. In the first menu the user can reduce or expand the scale in order to adjust the contrast for printing.

Several options are available:

- high value scaling
- lower value scaling
- histogram stretch by area
- permanently saving the gray scale

High (low) values scaling is done by placing the cursor on the new maximum (minimum). Then by clicking on the right button and moving the mouse, the new scale is displayed. Keeping the button pressed, you can stretch the scale. All the pixel values outside the limit appear as either black or white.

Histogram stretch automatically calculates the scale in a rectangular area defined by the user.

When the scale is adjusted correctly, PRINT brings up the print menu.

The result is always written to the file SPHINX_GJETn (where n is incremented with each execution). The user selects:

- the quadrant or the area using the mouse
- the printing (or suppression) of the gray scale bar
- the number of copies
- the output: PostScript or PaintJet

Scale 24 Bits to 8 (classif)

This function transforms a 24 bit image into an 8 bit image. The algorithm regroups pixel classes into a three dimensional space. The RGB components of the classes become the color table and the number of the class replaces the original pixel values. The result is arranged and displayed in the blue plane.

Scale 8 Bits to 24 (3/3/2)

This function transforms an 8 bit image into a 24 bit image using a 3/3/2 coding algorithm. For the R and G components, it keeps 3 bits, and for the B component it only keeps 2.

Scale 8 Bits to 24

This function generates a 24 bit RGB image using an 8 bit image and its COLORMAP. The original image pixels are replaced by their corresponding color in the COLORMAP.

3.8 Pixel Values

A pixel's position and value is displayed by placing the cursor over the pixel and clicking the right mouse button. The values of the current plane are automatically displayed. The "All channels" option provides the values of the 3 planes.

RECORD memorizes the positions and values of pixel values designated in the file SPHINX_VALn, (where n is incremented at each execution).

PHYSICAL VALUES opens a dialog that allows you to select the coefficients of a binomial equation $ax + b$ that is applied to the pixel values. These values are taken into account by the graphing functions.

NEW COORDINATES opens a dialog that allows you to change the coordinates x and y (implicitly between 0 and 1023).

MAGNIFY enlarges a small area around the cursor by a factor of 4 at each selection in order to more accurately select the pixels.

3.9 Zoom

The ZOOM function enlarges the image center around the cursor position. The zoomed image is placed in the A or B quadrant and can itself be zoomed again.

The effects of ZOOM are lost as soon as you leave the function. If you want to retain a zoomed image, you must use the IMAGE RESIZE function in the EDIT menu or the EXPAND function in the MOVE EXCHANGE ROTATE menu. If you want to save an image created with the ZOOM function, then before leaving the function you must call up the main Sphinx menu (clicking with the left button in the Sphinx MENU area) and copy the zoomed image using the MOVE EXCHANGE ROTATE function.

MAGNIFY zooms a small image area outlined by the cursor. The glass window is activated by using the right mouse button. The left button increases the zoom factor.

ROAM multiplies a 1024 x 1024 image by a factor of 2 or 4. The screen size displays the geometry of origin and the cursor position on the screen determines the zoomed area displayed.

RESET returns to the original zoom factor.

3.10 Refresh

This function refreshes the screen and redisplay the image. All the graphic elements (text, lines, contours, symbols, etc.) that have been superimposed on the image are erased, except for those that have been merged with the image (e.g., MERGE WITH IMAGE function).

3.11 Iconify Sphinx

ICONIFY Sphinx redisplay the screen as it was before launching the Sphinx program. To return to Sphinx, click on the Sphinx icon.

3.12 The Signal Models Menu

Satellite Signal Simulation

This function calculates the satellite signal sensitivity from 0.25 to 4.0 microns in a cloud-free atmosphere. It takes into account the principal atmospheric effects, namely molecular and aerosol diffusion and gas absorption by water vapor, carbon dioxide, oxygen, and ozone. The effects of a heterogeneous surface can be approximated.

The following data are required:

- the geometric viewing conditions
- an atmospheric model and its gas components
- aerosol model with types and concentrations
- spectral conditions
- surface reflectance properties, including type and spectral variation

It is possible to take into account a heterogeneous surface characterized by a circular target for which you can specify the radiation, the reflectance, and the reflectance of the surrounding environment.

At each step you can either define your own conditions or choose a model from the listing of standard models (taking as spectral conditions, for instance, the spectral bands of a given satellite).

Limitations:

Viewing geometry: the solar and satellite zenith angles must be less than 60 and 50 degrees, respectively.

Atmospheric model: no limitations.

Aerosol model: the horizontal visibility introduced must be greater than 5 km.

Spectral conditions: the gas transmission and phase functions are correct between 0.25 and 4.0 microns, but the treatment of the interaction between absorption and scattering is inaccurate for large absorption values. If a calculation of the signal within the absorption band is needed, this interaction must be reconsidered.

Surface reflectance (spectral variation): Four base reflectances are supplied for a predefined spectral range. The predefined spectral domain is different depending on the case, and reflectance is considered zero outside the imposed limits. The user must verify these limits.

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- Conventions:**

north latitude > 0 ; south latitude < 0