Chapter 8

General Raster Images (GR API)

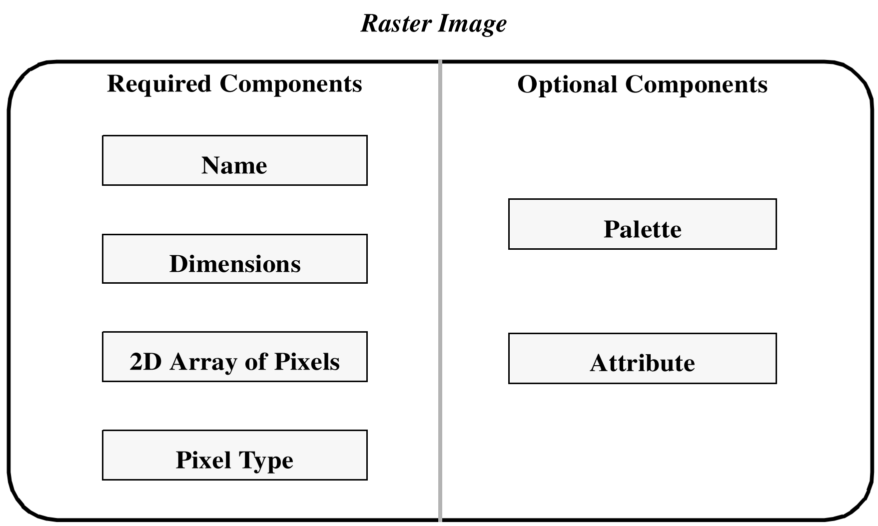
8.1 Chapter Overview

This chapter describes the general raster (GR) data model, the GR interface (also called the GR API), and the interface routines used to manipulate GR data objects. The GR data model is designed to provide a flexible means of manipulating raster images. In addition to the GR interface, HDF provides two interfaces for manipulating raster data. The DFR8 interface works with 8-bit raster images and is described in Chapter 6, *8-Bit Raster Images (DFR8 API)*. The DF24 interface is designed for 24-bit raster images and is described in Chapter 7, *24-bit Raster Images (DF24 API)*.

8.2 The GR Data Model

HDF users familiar with the SD interface will find certain aspects of the GR data model similar to the SD data model. The interfaces are similar in that both interfaces support data storage in multiple files, attributes, compression, and chunking. They are dissimilar in that palettes can be created and attached to an image through GR interface routines and customized dimension information is not supported in the GR interface.

FIGURE 8a **GR Data Set Contents**



The terms ***GR data set***, ***raster image***, and ***image*** are used interchangeably in this chapter.

Refer to Figure 8a on page 265 for a graphical overview of the raster image, or GR data set, structure. Note that GR data sets consist of required and optional components.

8.2.1 Required GR Data Set Components

Every GR data set must contain the following components: ***image array***, ***name***, ***pixel type***, and ***dimensions***. The name, dimensions, and pixel type must be supplied by the user at the time the GR data set is defined.

Image Array

An ***image array*** is a two-dimensional array of pixels. This is the primary data component of the GR model and will be discussed later in this section; it can be compressed, chunked, and/or stored in external files. Refer to Section 8.6.2 on page 281 for a description of raster image compression and Section 8.6.3 on page 281 for a description of external image storage.

A raster image has an index and a reference number associated with it. The ***index*** is a non-negative integer that describes the relative position of the raster image in the file. A valid index ranges from 0 to the total number of images in the file minus 1. The ***reference number*** is a unique positive integer assigned to the raster image by the GR interface when the image is created. Various GR interface routines can be used to obtain an image index or reference number depending on the available information about the raster image. The index can also be determined if the sequence in which the images are created in the file is known.

In the GR interface, a ***raster image identifier*** uniquely identifies a raster image within the file. The identifier is generated by the GR interface access routines when a new GR data set is created or an existing one is selected. The identifier is then used by other GR interface routines to access the raster image until the access to this image is terminated. For an existing raster image, the index of the image can be used to obtain the identifier.

Image Array Name

Each image array has a ***name*** consisting of a string of case-sensitive alphanumeric characters. The name must be provided by the calling program at the time the image is created, and cannot be changed afterward. Image array names do not have to be unique within a file, but if they are not it can be difficult to distinguish among the raster images in the file.

Pixels and Pixel Type

Each element in an image array corresponds to one ***pixel*** and each pixel can consist of a number of color component values or ***pixel components***, e.g., Red-Green-Blue or RGB, Cyan-Magenta-Yellow-Black or CMYK, etc. Pixel components can be represented by different methods (8-bit lookup table or 24-bit direct representation, graphically depicted by Figure 6a on page 231 and Figure 7b on page 250, respectively) and may have different data types.

The data type of pixel components and the number of components in each pixel are collectively known as the ***pixel type***. The GR data model supports all of the HDF-supported data types. A list of these data types appears provided in Table 2E on page 14.

Pixels can be composed of any number of components.

Dimensions

Image array ***dimensions*** specify the shape of the image array. A raster image array has two limited dimensions. The size of each dimension must be specified at the creation of the image and must be greater than 0.

The GR library does not allow the HDF user to add attributes to a dimension or to set dimension scale.

8.2.2 Optional GR Data Set Components

There are two types of optional components available for inclusion in a GR data set: ***palettes*** and ***attributes***. These components are only created when specifically requested by the calling program; the GR interface does not provide predefined palettes or attributes.

Palettes

Palettes are lookup tables attached to images and define a set of color values for each pixel value in the image array. The GR interface provides similar capabilities for storing and manipulating palettes as the DFP interface described in Chapter 9, *Palettes (DFP API)*. However, the DFP interface is restricted to single-file operations while the GR interface allows multifile palette operations.

Eventually, all palette manipulation functionality will reside only within the GR interface. In the meantime, the single-file DFP routines are fully compatible with palettes created with the GR palette routines. The GR palette routines are described in Section 8.10 on page 305.

Attributes

Attributes contain auxiliary information about a file, a raster image, or both. The concept of attributes is described in Chapter 3, *Scientific Data Sets (SD API).*

The GR interface does not support dimension attributes.

8.3 The GR Interface

The GR consists of routines for storing, retrieving, and manipulating the data in GR data sets.

8.3.1 GR Interface Routines

All C routine names in the GR interface have the prefix "GR" and the equivalent FORTRAN-77 routine names are prefaced by "mg". All GR routines are classifiable within one of the following categories:

- ***Access routines*** initialize and terminate access to the GR interface and raster images.
- ***Raster image manipulation routines*** modify the data and metadata contained in a GR data set.
- ***LUT manipulation routines*** modify the palettes, also called color lookup tables or LUTs, contained in a GR data set.
- ***Maintenance routines*** create the data and metadata contained in a GR data set and modify global settings governing the format of the stored data.
- ***Inquiry routines*** return information about data contained in a GR data set.

The GR routines are listed in the following table and described further in subsequent sections of this chapter.

TABLE 8A

GR Library Routines

Purpose	Routine Name7		Description
	C	FORTRAN-77	
Access	GRstart	mgstart	Initializes the GR interface (Section 8.5.1 on page 270)
	GRcreate	mgcreat	Creates a new raster image (Section 8.5.1 on page 270)
	GRselect	mgselct	Selects the raster image (Section 8.5.1 on page 270)
	GRendaccess	mgendac	Terminates access to the raster image (Section 8.5.2 on page 270)
	GRend	mgend	Terminates access to the GR interface (Section 8.5.2 on page 270)
Raster Image Manipulation	GRgetattr	mggnatt/ mggcatt	Reads an attribute of a raster image or a file (Section 8.9.4 on page 300)
	GRidtoref	mgid2rf	Maps a raster image identifier to a reference number (Section 8.8.3 on page 291)
	GRnametoindex	mgn2ndx	Maps the name of a raster image name to an index (Section 8.8.3 on page 291)
	GRreadimage	mgrdimg/ mgrcimg	Reads raster image data (Section 8.7.1 on page 283)
	GRreftoindex	mgr2idx	Maps the reference number of a raster image to its index (Section 8.8.3 on page 291)
	GRsetattr	mgsnatt/ mgscatt	Assigns an attribute to a raster image or a file (Section 8.9.2 on page 296)
	GRwriteimage	mgwrimg/ mgwcimg	Writes raster image data (Section 8.6.2 on page 281)
	GRreqimageil	mgrimil	Sets the interlace mode of the image read for subsequent read operations (Section 8.7.2 on page 284)
LUT Manipulation	GRgetlutid	mggltid	Gets a palette identifier given the palette's index (Section 8.10.1 on page 305)
	GRluttoref	mglt2rf	Maps a palette identifier to a reference number (Section 8.10.2 on page 305)
	GRreadlut	mgrdlut/ mgrclut	Reads palette data from a raster image (Section 8.10.6 on page 307)
	GRwritelut	mgwrlut/ mgwclut	Writes palette data to a raster image (Section 8.10.4 on page 306)
	GRreqlutil	mgrltil	Sets the interlace mode of the next palette for subsequent read operations (Section 8.7.2 on page 284)
Maintenance	GRsetcompress	mgscomp	Specifies whether the raster image will be stored in a file as a compressed raster image (Section 8.6.2 on page 281)
	GRsetexternal-file	mgsxfil	Specifies that the raster image will be written to an external file (Section 8.6.3.1 on page 282)
Inquiry	GRattrinfo	mgatinf	Retrieves information about an attribute (Section 8.9.3 on page 299)
	GRfindattr	mgfndat	Finds the index of a data object's attribute given an attribute name (Section 8.9.3 on page 299)
	GRfileinfo	mgfinfo	Retrieves the number of raster images and the number of global attributes in the file (Section 8.8.1 on page 290)
	GRgetiminfo	mggiinf	Retrieves general information about a raster image (Section 8.8.2 on page 290)
	GRgetlutinfo	mgglinf	Retrieves information about a palette (Section 8.10.3 on page 306)
Chunking	GRsetchunk	mgschnk	Creates chunked raster image (Section 8.11.1 on page 315)
	GRgetchunkinfo	mggichnk	Retrieves information about a chunked raster image (Section 8.11.2 on page 316)
	GRsetchunkcache	mgscchnk	Sets maximum number of chunks to be cached (Section 8.11.3 on page 317)

8.4 Header Files Required by the GR Interface

The header file "hdf.h" must be included in any program that utilizes GR interface routines.

8.5 Programming Model for the GR Interface

As with the SD interface, the GR interface relies on the calling program to initiate and terminate access to files and data sets to support multifile access. The GR programming model for accessing a raster image is as follows:

1. Open an HDF file.
2. Initialize the GR interface.
3. Open an existing raster image or create a new raster image.
4. Perform desired operations on the raster image.
5. Terminate access to the raster image.
6. Terminate access to the GR interface by disposing of the interface identifier.
7. Close the HDF file.

To access a single raster image data set in an HDF file, the calling program must contain the following calls:

C:

```
file_id = Hopen(filename, access_mode, n_dds_block);
gr_id = GRstart(file_id);

ri_id = GRselect(gr_id, ri_index);
OR      ri_id = GRcreate(gr_id, name, n_comps, data_type, interlace_mode,
                dim_sizes);

<Optional operations>
status = GRendaccess(ri_id);
status = GRend(gr_id);
status = Hclose(file_id);
```

FORTRAN:

```
file_id = hopen(filename, access_mode, n_dds_block)
gr_id = mgstart(file_id)

ri_id = mgselct(gr_id, ri_index)
OR      ri_id = mgcreat(gr_id, name, n_comps, data_type, interlace_mode,
                dim_sizes)

<Optional operations>
status = mgendac(ri_id)
status = mgend(gr_id)
status = hclose(file_id)
```

To access several files at the same time, a calling program must obtain a separate interface identifier for each file to be opened. Similarly, to access more than one raster image, a calling program must obtain a separate data set identifier for each data set.

Because every file and raster image is assigned its own identifier, the order in which files and data sets are accessed is very flexible as long as all file and raster image identifiers are individually discarded before the end of the calling program.

8.5.1 Accessing Images and Files: GRstart, GRselect, and GRcreate

In the GR interface, **Hopen** opens the files and **GRstart** initiates the GR interface. Note the contrast to the SD interface, where **SDstart** performs both tasks. For information on the use of **Hopen**, refer to Chapter 2, *HDF Fundamentals.* For information on **SDstart**, refer to Chapter 3, *Scientific Data Sets (SD API).*

GRstart initializes the GR interface and must be called once after **Hopen** and before any other GR routines are called. It takes one argument, `file_id`, the file identifier returned by **Hopen**, and returns the interface identifier `gr_id` or `FAIL` (or `-1`) upon unsuccessful completion. **Hopen** and **GRstart** can be called several times to access more than one file.

GRselect specifies the given image as the current image to be accessed. It takes two arguments, the GR interface identifier `gr_id` and the raster image index `ri_index`, and returns the raster image identifier `ri_id` or `FAIL` (or `-1`) upon unsuccessful completion. The GR interface identifier is returned by **GRstart**. The raster image index specifies the position of the image relative to the beginning of the file; it is zero-based, meaning that the index of the first image in the file is 0. The index of a raster image can be obtained from the image's name using the routine **GRnametoindex** or from the image's reference number using **GRreftoindex**. These routines are discussed in Section 8.8.4 on page 291 and Section 8.8.5 on page 291. The index value must be less than the total number of raster images in the file; that number can be obtained using **GRfileinfo**, described in Section 8.8.1 on page 290.

The parameters for **GRstart** and **GRselect** are further defined in Table 8B on page 271.

GRcreate defines a new raster image using the arguments `gr_id`, `name`, `n_comps`, `data_type`, `interlace_mode`, and `dim_sizes`. Once a data set is created, you cannot change its name, data type, dimension, or number of components. **GRcreate** does not actually write the image to the file; this occurs only when **GRendaccess** is called. Thus, failing to call **GRendaccess** properly will cause a loss of data.

The buffer `name` contains the name of the image; it must not exceed `MAX_GR_NAME` (or `256`). The parameter `n_comps` specifies the number of pixel components in the raster image; it must have a value of at least 1. The parameter `data_type` specifies the data type of the image data; it can be any of the data types supported by the HDF library. The HDF supported data type are defined in the header file "hntdefs.h" and listed in Table 2E on page 14.

The parameter `interlace_mode` specifies the interlacing in which the raster image is to be written; it can be set to either `MFGR_INTERLACE_PIXEL` (or `0`), `MFGR_INTERLACE_LINE` (or `1`), or `MFGR_INTERLACE_COMPONENT` (or `2`). These definitions respectively correspond to pixel interlacing, line interlacing, and component interlacing. The first two interlacing modes are illustrated for the instance of 24-bit pixel representation in Figure 7c on page 251 of Chapter 7, *24-bit Raster Images (DF24 API).* Component interlacing, as the name implies, describes interlacing raster data by color component.

The parameter `dim_sizes` specifies the size of the two dimensions of the image. The dimension sizes must be specified; their values must be at least 1.

GRcreate returns the value of the raster image identifier if successful or `FAIL` (or `-1`) otherwise. The parameters for **GRstart**, **GRselect**, and **GRcreate** are further defined in Table 8B.

8.5.2 Terminating Access to Images and Files: GRendaccess and GRend

GRendaccess disposes of the raster image identifier `ri_id` and terminates access to the data set initiated by the corresponding call to **GRselect** or **GRcreate**. The calling program must make one **GRendaccess** call for every **GRselect** or **GRcreate** call made during its execution. Failing to call **GRendaccess** for each call to **GRselect** or **GRcreate** may result in a loss of data.

GRend disposes of the GR interface identifier `gr_id` and terminates access to the GR interface initiated by the corresponding call to **GRstart**. The calling program must make one **GRend** call for every **GRstart** call made during its execution; failing to call **GRend** for each **GRstart** may result in a loss of data.

GRendaccess and **GRend** return `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of these routines are further defined in Table 8B.

Hclose terminates access to an HDF file and should only be called after **GRend** has been called properly. Refer to Chapter 2, *HDF Fundamentals*, for a description of **Hclose**.

TABLE 8B **GRstart, GRselect, GRcreate, GRendaccess, and GRend, Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRstart [int32] **(mgstart)**	file_id	int32	integer	File identifier
GRselect [int32] **(mgselct)**	gr_id	int32	integer	GR interface identifier
	ri_index	int32	integer	Position of the raster image within the file
GRcreate [int32] **(mgcreat)**	gr_id	int32	integer	GR interface identifier
	name	char *	character*(*)	Name of the image
	n_comps	int32	integer	Number of components in each pixel
	data_type	int32	integer	Data type of the pixel component
	interlace_mode	int32	integer	Interlace mode to be used when writing to the data set
	dim_sizes	int32 [2]	integer (2)	Array defining the size of both dimensions
GRendaccess [intn] **(mgendac)**	ri_id	int32	integer	Raster image identifier
GRend [intn] **(mgend)**	gr_id	int32	integer	GR interface identifier

8.6 Writing Raster Images

A raster image can be written partially or entirely. Partial writing includes writing to a contiguous region of the image and writing to selected locations in the image according to patterns defined by the user. This section describes the routine **GRwriteimage** and how it can write data to part of an image or to an entire image. The section also illustrates the concepts of compressing raster images and the use of external files to store image data.

8.6.1 Writing Raster Images: GRwriteimage

GRwriteimage is used to either completely or partially fill an image array.

Writing data to an image array involves the following steps:

1. Open a file and initialize the GR interface.
2. Select an existing raster image or create a new one.
3. Write data to the image array.
4. Terminate access to the raster image.
5. Terminate access to the GR interface and close the file.

The calling program must contain the following sequence of calls:

C:
```
file_id = Hopen(filename, access_mode, num_dds_block);
gr_id = GRstart(file_id);

ri_id = GRselect(gr_id, ri_index);
OR      ri_id = GRcreate(gr_id, name, n_comps, number_type,
                interlace_mode, dim_sizes);

status = GRwriteimage(ri_id, start, stride, edges, data);
status = GRendaccess(gr_id);
status = GRend(ri_id);
status = Hclose(file_id);
```

FORTRAN:
```
file_id = hopen(filename, access_mode, num_dds_block)
gr_id = mgstart(file_id)

ri_id = mgselct(gr_id, ri_index);
OR      ri_id = mgcreat(gr_id, name, n_comps, number_type, interlace_mode,
                dim_sizes);

status = mgwrimg(ri_id, start, stride, edges, data)
OR      status = mgwrcmg(ri_id, start, stride, edges, data)

status = mgendac(ri_id)
status = mgend(gr_id)
status = hclose(file_id)
```

As with SD arrays, whole raster images, subsamples, and slabs can be written. The data to be written is defined by the values of the parameters `start`, `stride`, and `edges`, which correspond to the coordinate location of the data origin, number of values to be skipped along each dimension during write operation, and number of elements to be written along each dimension.

The array `start` specifies the starting location of the data to be written. Valid values of each element in the array `start` are `0` to the size of the corresponding raster image dimension - 1. The first element of the array `start` specifies an offset from the beginning of the array `data` along the fastest-changing dimension, which is the second dimension in C and the first dimension in FORTRAN-77. The second element of the array `start` specifies an offset from the beginning of the array `data` along the second fastest-changing dimension, which is the first dimension in C and the second dimension in FORTRAN-77. For example, if the first value of the array `start` is 2 and the second value is 3, the starting location of the data to be written is at the fourth row and third column in C, and at the third row and fourth column in FORTRAN-77. Note that the correspondence between elements in the array `start` and the raster image dimensions in the GR interface is different from that in the SD interface. See Section 3.6 on page 55 on **SDreaddata** for an example of this.

The array `stride` specifies the writing pattern along each dimension. For example, if one of the elements of the array `stride` is 1, then every element along the corresponding dimension of the array `data` will be written. If one of the elements of the `stride` array is 2, then every other element along the corresponding dimension of the array `data` will be written, and so on. The correspondence between elements of the array `stride` and the dimensions of the array `data` is the same as described above for the array `start`.

Note that the FORTRAN-77 version of **GRwriteimage** has two routines; **mgwrimg** writes buffered numeric data and **mgwcimg** writes buffered character data.

GRwriteimage returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters for **GRwriteimage** are described in Table 8C.

TABLE 8C

GRwriteimage Parameter List

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRwriteimage [intn] **(mgwrimg/ mgwcimg)**	ri_id	int32	integer	Raster image identifier returned by **GRcreate**
	start	int32 [2]	integer (2)	Array containing the x,y-coordinate location where the write will start for each dimension
	stride	int32 [2]	integer (2)	Array containing the number of data locations the current location is to be moved forward before the next write
	edges	int32 [2]	integer (2)	Array containing the number of data elements that will be written along each dimension
	data	VOIDP	<valid numeric data type>(*)/ character(*)	Buffer for the image data to be written

EXAMPLE 1.

Creating and Writing a Raster Image

This example illustrates the use of the routines **Hopen/hopen**, **GRstart/mgstart**, **GRcreate/ mgcreat**, **GRwriteimage/mgwrimg**, **GRendaccess/mgendac**, **GRend/mgend**, and **Hclose/ hclose** to create an HDF file and store a raster image in it.

In this example, the program creates the HDF file called "General_RImages.hdf" and a raster image in the file. The image created is of size 5x10 and named "Image Array 1", and has data of the int16 data type, 2 components, and interlace mode `MFGR_INTERLACE_PIXEL`. Then the program writes the image data, terminates access to the image and the GR interface, and closes the file.

C:

```
#include "hdf.h"

#define  FILE_NAME     "General_RImages.hdf"
#define  IMAGE_NAME    "Image Array 1"
#define  X_LENGTH      10    /* number of columns in the image */
#define  Y_LENGTH      5     /* number of rows in the image */
#define  N_COMPS       2     /* number of components in the image */

main( )
{
   /************************* Variable declaration **************************/

   intn  status;         /* status for functions returning an intn */
   int32 file_id,        /* HDF file identifier */
         gr_id,          /* GR interface identifier */
         ri_id,          /* raster image identifier */
         start[2],       /* start position to write for each dimension */
         edges[2],       /* number of elements to be written
                           along each dimension */
         dim_sizes[2],   /* dimension sizes of the image array */
         interlace_mode, /* interlace mode of the image */
         data_type,      /* data type of the image data */
         i, j;
   int16 image_buf[Y_LENGTH][X_LENGTH][N_COMPS];

   /********************* End of variable declaration *********************/

   /*
```

```
   * Create and open the file.
   */
   file_id = Hopen (FILE_NAME, DFACC_CREATE, 0);

   /*
   * Initialize the GR interface.
   */
   gr_id = GRstart (file_id);

   /*
   * Set the data type, interlace mode, and dimensions of the image.
   */
   data_type = DFNT_INT16;
   interlace_mode = MFGR_INTERLACE_PIXEL;
   dim_sizes[0] = X_LENGTH;
   dim_sizes[1] = Y_LENGTH;

   /*
   * Create the raster image array.
   */
   ri_id = GRcreate (gr_id, IMAGE_NAME, N_COMPS, data_type,
                     interlace_mode, dim_sizes);

   /*
   * Fill the image data buffer with values.
   */
   for (i = 0; i < Y_LENGTH; i++)
   {
      for (j = 0; j < X_LENGTH; j++)
      {
         image_buf[i][j][0] = (i + j) + 1;     /* first component */
         image_buf[i][j][1] = (i + j) + 1;     /* second component */
      }
    }

   /*
   * Define the size of the data to be written, i.e., start from the origin
   * and go as long as the length of each dimension.
   */
   start[0] = start[1] = 0;
   edges[0] = X_LENGTH;
   edges[1] = Y_LENGTH;

   /*
   * Write the data in the buffer into the image array.
   */
   status = GRwriteimage(ri_id, start, NULL, edges, (VOIDP)image_buf);

   /*
   * Terminate access to the raster image and to the GR interface and,
   * close the HDF file.
   */
   status = GRendaccess (ri_id);
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
         program create_raster_image
      implicit none
C
C     Parameter declaration
```

```
C
      character*19 FILE_NAME
      character*13 IMAGE_NAME
      integer      X_LENGTH
      integer      Y_LENGTH
      integer      N_COMPS
C
      parameter (FILE_NAME  = 'General_RImages.hdf',
     +           IMAGE_NAME = 'Image Array 1',
     +           X_LENGTH   = 10,
     +           Y_LENGTH   = 5,
     +           N_COMPS    = 2)
      integer DFACC_CREATE, DFNT_INT16, MFGR_INTERLACE_PIXEL
      parameter (DFACC_CREATE = 4,
     +           DFNT_INT16   = 22,
     +           MFGR_INTERLACE_PIXEL = 0)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgcreat, mgwrimg, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer status
      integer file_id
      integer gr_id, ri_id, num_type, interlace_mode
      integer start(2), stride(2), edges(2), dimsizes(2)
      integer i, j, k
      integer*2  image_buf(N_COMPS, X_LENGTH, Y_LENGTH)
C
C**** End of variable declaration ************************************
C
C
C     Create and open the file.
C
      file_id = hopen(FILE_NAME, DFACC_CREATE, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Set the number type, interlace mode, and dimensions of the image.
C
      num_type = DFNT_INT16
      interlace_mode = MFGR_INTERLACE_PIXEL
      dimsizes(1) = X_LENGTH
      dimsizes(2) = Y_lENGTH
C
C     Create the raster image array.
C
      ri_id = mgcreat(gr_id, IMAGE_NAME, N_COMPS, num_type,
     +                interlace_mode, dimsizes)
C
C     Fill the image data buffer with values.
C
      do 30 i = 1, Y_LENGTH
         do 20 j = 1, X_LENGTH
            do 10 k = 1, N_COMPS
               image_buf(k,j,i) = (i+j) - 1
10          continue
20       continue
```

```
30    continue

C
C     Define the size of the data to be written, i.e., start from the origin
C     and go as long as the length of each dimension.
C
      start(1) = 0
      start(2) = 0
      edges(1) = X_LENGTH
      edges(2) = Y_LENGTH
      stride(1) = 1
      stride(2) = 1
C
C     Write the data in the buffer into the image array.
C
      status = mgwrimg(ri_id, start, stride, edges, image_buf)

C
C     Terminate access to the raster image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

EXAMPLE 2.

Modifying an Existing Raster Image

This example illustrates the use of the routines **GRselect/mgselct** to obtain an existing raster image and **GRwrite/mgwrimg** to modify image data.

In this example, the program selects the only raster image in the file "General_RImages.hdf" created and written in Example 1, and modifies image data. The program also creates another raster image that is named "Image Array 2" and has 3 components with dimension size of 4x6, data type of DFNT_CHAR8, and interlace mode of MFGR_INTERLACE_PIXEL.

C:

```
#include "hdf.h"

#define  FILE_NAME    "General_RImages.hdf"
#define  X1_LENGTH    5     /* number of columns in the first image
                              being modified */
#define  Y1_LENGTH    2     /* number of rows in the first image
                              being modified */
#define  N1_COMPS     2     /* number of components in the first image */
#define  IMAGE1_NAME  "Image Array 1"
#define  IMAGE2_NAME  "Image Array 2"
#define  X2_LENGTH    6     /* number of columns in the second image */
#define  Y2_LENGTH    4     /* number of rows in the second image */
#define  N2_COMPS     3     /* number of components in the second image */

main( )
{
   /************************* Variable declaration *************************/

   intn  status;         /* status for functions returning an intn */
   int32 file_id,        /* HDF file identifier */
         gr_id,          /* GR interface identifier */
         ri1_id,         /* raster image identifier */
         start1[2],      /* start position to write for each dimension */
```

```
      edges1[2],      /* number of elements to be written along
                        each dimension */
      ri2_id,         /* raster image identifier */
      start2[2],      /* start position to write for each dimension */
      edges2[2],      /* number of elements to be written along
                        each dimension */
      dims_sizes[2],  /* sizes of the two dimensions of the image array */
      data_type,      /* data type of the image data */
      interlace_mode; /* interlace mode of the image */
int16 i, j;           /* indices for the dimensions */
int16 image1_buf[Y1_LENGTH][X1_LENGTH][N1_COMPS]; /* data of first image */
char  image2_buf[Y2_LENGTH][X2_LENGTH][N2_COMPS]; /* data of second image*/

/********************* End of variable declaration *********************/

/*
* Open the HDF file for writing.
*/
file_id = Hopen (FILE_NAME, DFACC_WRITE, 0);

/*
* Initialize the GR interface.
*/
gr_id = GRstart (file_id);

/*
* Select the first raster image in the file.
*/
ri1_id = GRselect (gr_id, 0);

/*
* Fill the first image data buffer with values.
*/
for (i = 0; i < Y1_LENGTH; i++)
{
   for (j = 0; j < X1_LENGTH; j++)
   {
      image1_buf[i][j][0] = 0;  /* first component */
      image1_buf[i][j][1] = 0;  /* second component */
   }
 }

/*
* Define the size of the data to be written, i.e., start from the origin
* and go as long as the length of each dimension.
*/
start1[0] = start1[1] = 0;
edges1[0] = X1_LENGTH;
edges1[1] = Y1_LENGTH;

/*
* Write the data in the buffer into the image array.
*/
status = GRwriteimage (ri1_id, start1, NULL, edges1, (VOIDP)image1_buf);


/*
* Set the interlace mode and dimensions of the second image.
*/
data_type = DFNT_CHAR8;
interlace_mode = MFGR_INTERLACE_PIXEL;
dims_sizes[0] = X2_LENGTH;
dims_sizes[1] = Y2_LENGTH;
```

```
    /*
    * Create the second image in the file.
    */
    ri2_id = GRcreate (gr_id, IMAGE2_NAME, N2_COMPS, data_type,
                                interlace_mode, dims_sizes);

    /*
    * Fill the second image data buffer with values.
    */
    for (i = 0; i < Y2_LENGTH; i++)
    {
       for (j = 0; j < X2_LENGTH; j++)
       {
          image2_buf[i][j][0] = 'A';     /* first component */
          image2_buf[i][j][1] = 'B';     /* second component */
          image2_buf[i][j][2] = 'C';     /* third component */
       }
     }

    /*
    * Define the size of the data to be written, i.e., start from the origin
    * and go as long as the length of each dimension.
    */
    for (i = 0; i < 2; i++) {
       start2[i] = 0;
       edges2[i] = dims_sizes[i];
    }

    /*
    * Write the data in the buffer into the second image array.
    */
    status = GRwriteimage (ri2_id, start2, NULL, edges2, (VOIDP)image2_buf);

    /*
    * Terminate access to the raster images and to the GR interface, and
    * close the HDF file.
    */
    status = GRendaccess (ri1_id);
    status = GRendaccess (ri2_id);
    status = GRend (gr_id);
    status = Hclose (file_id);
}
```

FORTRAN:

```
      program modify_image
      implicit none
C
C     Parameter declaration
C
      character*19 FILE_NAME
      character*13 IMAGE1_NAME
      integer      X1_LENGTH
      integer      Y1_LENGTH
      integer      N1_COMPS
      character*13 IMAGE2_NAME
      integer      X2_LENGTH
      integer      Y2_LENGTH
      integer      N2_COMPS
C
      parameter (FILE_NAME   = 'General_RImages.hdf',
     +           IMAGE1_NAME = 'Image Array 1',
```

```
     +           IMAGE2_NAME = 'Image Array 2',
     +           X1_LENGTH   = 5,
     +           Y1_LENGTH   = 2,
     +           N1_COMPS    = 2,
     +           X2_LENGTH   = 6,
     +           Y2_LENGTH   = 4,
     +           N2_COMPS    = 3)
      integer DFACC_WRITE, DFNT_INT16, DFNT_CHAR8,
     +        MFGR_INTERLACE_PIXEL
      parameter (DFACC_WRITE  = 2,
     +           DFNT_CHAR8   = 4,
     +           DFNT_INT16   = 22,
     +           MFGR_INTERLACE_PIXEL = 0)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgselct, mgcreat, mgwrimg, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer status
      integer file_id
      integer gr_id, ri1_id, ri2_id, data_type, interlace_mode
      integer start1(2), stride1(2), edges1(2)
      integer start2(2), stride2(2), edges2(2), dim_sizes(2)
      integer i, j, k
      integer*2  image1_buf(N1_COMPS, X1_LENGTH, Y1_LENGTH)
      character  image2_buf(N2_COMPS, X2_LENGTH, Y2_LENGTH)
C
C**** End of variable declaration ************************************
C
C
C     Open the HDF file for writing.
C
      file_id = hopen(FILE_NAME, DFACC_WRITE, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Select the first raster image in the file.
C
      ri1_id = mgselct(gr_id, 0)
C
C     Fill the buffer with values.
C
      do 20 i = 1, Y1_LENGTH
         do 10 j = 1, X1_LENGTH
               image1_buf(1,j,i) = 0
               image1_buf(2,j,i) = 0
10       continue
20    continue
C
C     Define the part of the data in the first image that will be overwritten
C     with the new values from image1_buf.
C
      start1(1) = 0
      start1(2) = 0
      edges1(1) = X1_LENGTH
      edges1(2) = Y1_LENGTH
      stride1(1) = 1
```

```
      stride1(2) = 1
C
C     Write the data in the buffer into the image array.
C
      status = mgwrimg(ri1_id, start1, stride1, edges1, image1_buf)

C
C    Set the number type, interlace mode, and dimensions of the second image.
C
      data_type = DFNT_CHAR8
      interlace_mode = MFGR_INTERLACE_PIXEL
      dim_sizes(1) = X2_LENGTH
      dim_sizes(2) = Y2_LENGTH
C
C     Create the second image in the file.
C
      ri2_id = mgcreat(gr_id, IMAGE2_NAME, N2_COMPS, data_type,
     +                interlace_mode, dim_sizes)
C
C     Fill the image data buffer with values.
C
      do 60 i = 1, Y2_LENGTH
         do 50 j = 1, X2_LENGTH
            do 40 k = 1, N2_COMPS
               image2_buf(k,j,i) = char(65 + k - 1)
40          continue
50       continue
60    continue

C
C     Define the size of the data to be written, i.e., start from the origin
C     and go as long as the length of each dimension.
C
      start2(1) = 0
      start2(2) = 0
      edges2(1) =  dim_sizes(1)
      edges2(2) =  dim_sizes(2)
      stride2(1) = 1
      stride2(2) = 1
C
C     Write the data in the buffer into the image array.
C
      status = mgwrimg(ri2_id, start2, stride2, edges2, image2_buf)

C
C     Terminate access to the raster images and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri1_id)
      status = mgendac(ri2_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

8.6.2 Compressing Raster Images: GRsetcompress

*(**Note:** The **GRsetcompress** routine does not work in the current release.)*

Images can be compressed using the routine **GRsetcompress**. **GRsetcompress** compresses the image data at the time it is called and supports all standard HDF compression algorithms. The syntax of the routine **GRsetcompress** is as follows:

C: `status = GRsetcompress(ri_id, comp_type, c_info);`

FORTRAN: `status = mgscompress(ri_id, comp_type, comp_prm)`

The compression method is specified by the parameter `comp_type`. Valid values of the parameter `comp_type` are:

`COMP_CODE_NONE` (or `0`) for no compression

`COMP_CODE_RLE` (or `1`) for RLE run-length encoding

`COMP_CODE_SKPHUFF` (or `3`) for Skipping Huffman compression

`COMP_CODE_DEFLATE` (or `4`) for GZIP compression

The compression parameters are specified by the parameter `c_info` in C and the parameter `comp_prm` in FORTRAN-77. The parameter `c_info` has type `comp_info` and contains algorithm-specific information for the library compression routines. The type `comp_info` is described in the header file "hcomp.h" and in the Reference Manual page for **SDsetcompress**. Compression parameters are only needed when Skipping Huffman or GZIP compression methods are applied.

The skipping size for the Skipping Huffman algorithm is specified in the field `c_info.skphuff.skp_size` in C and in the parameter `comp_prm(1)` in FORTRAN-77.

The deflate level for the GZIP algorithm is specified in the field `c_info.deflate.level` in C and in the parameter `comp_prm(1)` in FORTRAN-77.

GRsetcompress returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The **GRsetcompress** parameters are further described in Table 8D.

TABLE 8D **GRsetcompress Parameter List**

Routine Name [Return Type] **(FORTRAN-77)**	**Parameter**	**Parameter Type**		**Description**
		C	**FORTRAN-77**	
GRsetcompress [intn] **(mgscompress)**	ri_id	int32	integer	Raster image identifier
	comp_type	int32	integer	Compression method
	c_info	comp_info*	N/A	Pointer to compression information structure
	comp_prm	N/A	integer	Compression parameters array

8.6.3 External File Operations Using the GR Interface

An ***external image array*** is one that is stored in a file that is not the file containing the metadata for the image. The HDF file containing the metadata is known as the primary HDF file; the file containing the external image array is known as an ***external file***. The concept of externally stored data is described in Chapter 3, *Scientific Data Sets (SD API)*. The GR interface supports the same external file functionality as the SD interface.

8.6.3.1 Creating a Raster Image in an External File: GRsetexternalfile

Creating an image with the data stored in an external file involves the same general steps as with the SD interface:

1. Create the image array.
2. Specify that an external data file is to be used.
3. Write data to the image array.
4. Terminate access to the image.

To create a data set containing image array stored in an external file, the calling program must make the following calls.

C:
```
ri_id = GRcreate(gr_id, name, n_comps, data_type,
                 interlace_mode, dim_sizes);
status = GRsetexternalfile(ri_id, filename, offset);
status = GRwriteimage(ri_id, start, stride, edges, image_data);
status = GRendaccess(ri_id);
```

FORTRAN:
```
ri_id = mgcreat(gr_id, name, n_comps, data_type,
                interlace_mode, dim_sizes)
status = mgsxfil(ri_id, filename, offset)
status = mgwrimg(ri_id, start, stride, edges, image_data)
status = mgendac(ri_id)
```

GRsetexternalfile marks the image identified by the parameter `ri_id` as one whose data is to be written to an external file. The parameter `filename` is the name of the external file, and the parameter `offset` specifies the number of bytes from the beginning of the external file to the location where the first byte of data will be written.

GRsetexternalfile can only be called once per data set. If a file with the same name as `filename` exists in the current directory, HDF will use it as the external file. If the file does not exist, HDF will create one. Once the name of the external file is specified, it is impossible to change it without breaking the association between the raster image and its data.

Use caution when writing to existing files because the routine **GRwriteimage** begins its write at the specified offset without checking whether existing data is being overwritten. When different data sets have arrays being stored the same external file, the calling program is responsible for avoiding any overlap between them.

GRsetexternalfile returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of **GRsetexternalfile** are further defined in Table 8E.

TABLE 8E **GRsetexternalfile Parameter List**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRsetexternalfile [intn] **(mgsxfil)**	ri_id	int32	integer	Raster image identifier
	filename	char *	character*(*)	Name of the external file
	offset	int32	integer	Offset in bytes from the beginning of the external file to the image data

8.6.3.2 Moving Raster Images to an External File

Images can be moved from the primary HDF file to an external file. To do so requires the following steps:

1. Select the image.
2. Specify the external data file.
3. Terminate access to the image.

The calling program must make the following calls:

C:
```
ri_id = GRselect(gr_id, ri_index);
status = GRsetexternalfile(ri_id, filename, offset);
status = GRendaccess(ri_id);
```

FORTRAN:
```
ri_id = mgselct(gr_id, ri_index);
status = mgsxfil(ri_id, filename, offset)
status = mgendac(ri_id);
```

When **GRsetexternalfile** is used in conjunction with **GRselect**, it will immediately write the existing data to the external file; any data in the external file that occupies the space reserved for the external array will be overwritten as a result of this operation. A data set can only be moved to an external file once.

During the operation, the data is written to the external file as a contiguous stream regardless of how it is stored in the primary file. Because data is moved "as is," any unwritten locations in the data set are preserved in the external file. Subsequent read and write operations performed on the data set will access the external file.

8.7 Reading Raster Images

Image array data can be read as an entire array or as a subsample of the array. Raster image data is read from an external file in the same way that it is read from a primary file; whether the image array is stored in an external file is transparent to the user. This section describes how **GRreadimage** is used to read an entire image and part of an image. The section also describes the routine **GRreqimageil** that sets the interlacing for reading image data.

8.7.1 Reading Data from an Image: GRreadimage

Reading data subsamples from an image array involves the following steps:

1. Select a data set.
2. Read data from the image array.
3. Terminate access to the data set.

To read data from an image array, the calling program must contain the following function calls:

C:
```
ri_id = GRselect(gr_id, ri_index);
status = GRreadimage(ri_id, start, stride, edges, data);
status = GRendaccess(ri_id);
```

FORTRAN:
```
ri_id = mgselct(gr_id, ri_index)

status = mgrdimg(ri_id, start, stride, edges, data)
OR
status = mgrcimg(ri_id, start, stride, edges, data)

status = mgendac(gr_id)
```

GRreadimage can be used to read either an entire image or a subsample of the image. The `ri_id` argument is the raster image identifier returned by **GRselect**. As with **GRwriteimage**, the arguments `start`, `stride`, and `edges` respectively describe the starting location for the read operation, the number of locations the current image array location will be moved forward after each read, and the length of each dimension to be read. Refer to Section 8.6.1 on page 271 for detailed descriptions of the parameters `start`, `stride`, and `edges`. If the image array is smaller than the `data` argument array, the amount of data read will be limited to the maximum size of the image array.

Note that the FORTRAN-77 version of **GRreadimage** has two routines; **mgrdimg** reads numeric image data and **mgrcimg** reads character image data.

GRreadimage returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters for **GRreadimage** are further defined in Table 8F.

8.7.2 Setting the Interlace Mode for an Image Read: GRreqimageil

The **GRreqimageil** routine sets the interlace mode for the next image read. The syntax of this routine is as follows:

C: `status = GRreqimageil(ri_id, interlace_mode);`

FORTRAN: `status = mgrimil(ri_id, interlace_mode)`

GRreqimageil can be called at any time before the read operation and takes two parameters, `ri_id` and `interlace_mode`. The parameter `ri_id` is the raster image identifier returned by the **GRselect** routine and the parameter `interlace_mode` specifies the interlace mode that will be in effect for the image read operation. Refer to Section 8.5.1 on page 270 for a description of the GR interlace modes.

GRreqimagetil may be called more than once; the interlace mode setting specified by the last call to the routine will be used for the next read operation.

GRreqimagetil returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of this routine are further defined in Table 8F.

TABLE 8F **GRreadimage and GRreqimageil Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRreadimage [intn] **(mgrdimg/ mgrcimg)**	ri_id	int32	integer	Raster image identifier
	start	int32[2]	integer (2)	Array containing the starting read coordinates
	stride	int32[2]	integer (2)	Array specifying the interval between the values that will be read along each dimension
	edges	int32[2]	integer (2)	Array containing the number of data elements that will be read along each dimension
	data	VOIDP	<valid numeric data type>(*)/character*(*)	Buffer for the image data to be read
GRreqimageil [intn] **(mgrimil)**	ri_id	int32	integer	Raster image identifier
	interlace_mode	intn	integer	Interlace mode for the next image read operation

EXAMPLE 3.

Reading a Raster Image.

This example illustrates the use of the routine **GRreadimage/mgrdimg** to read an image and its subsets.

In this example, the program reads the image written by Example 1 and modified by Example 2 in the file "General_RImages.hdf". Recall that this image has two components and has 5 rows and 10 columns. The program first reads the entire image, then reads a subset of the image, 3 rows and 2 columns starting at the 2nd row and the 4th column, and finally reads the image skipping all the even rows and all the odd columns. Reading patterns are applied to all components.

C:

```
#include "hdf.h"

#define  FILE_NAME       "General_RImages.hdf"
#define  N_COMPS         2
#define  X_LENGTH        10   /* number of columns of the entire image */
#define  Y_LENGTH        5    /* number of rows of the entire image */
#define  PART_COLS       2    /* number of columns read for partial image */
#define  PART_ROWS       3    /* number of rows read for partial image */
#define  SKIP_COLS       5    /* number of columns read for skipped image */
#define  SKIP_ROWS       3    /* number of rows read for skipped image */
#define  COLS_PART_START 3    /* starting column to read partial image */
#define  ROWS_PART_START 1    /* starting row to read partial image */
#define  COLS_SKIP_START 1    /* starting column to read skipped image */
#define  ROWS_SKIP_START 0    /* starting row to read skipped image */
#define  N_STRIDES       2    /* number of elements to skip on each dim. */

main( )
{
   /************************* Variable declaration **************************/

   intn  status;        /* status for functions returning an intn */
   int32 index;
   int32 file_id, gr_id, ri_id,
         start[2],      /* start position to write for each dimension */
         edges[2],      /* number of elements to bewritten along
                           each dimension */
         stride[2],     /* number of elements to skip on each dimension */
         dim_sizes[2];  /* dimension sizes of the image array */
   int16 entire_image[Y_LENGTH][X_LENGTH][N_COMPS],
         partial_image[PART_ROWS][PART_COLS][N_COMPS],
         skipped_image[SKIP_ROWS][SKIP_COLS][N_COMPS];
   int32 i, j;

   /********************** End of variable declaration **********************/

   /*
   * Open the HDF file for reading.
   */
   file_id = Hopen (FILE_NAME, DFACC_READ, 0);

   /*
   * Initialize the GR interface.
   */
   gr_id = GRstart (file_id);

   /*
   * Select the first raster image in the file.
   */
   ri_id = GRselect (gr_id, 0);
```

```
/*
* Define the size of the data to be read, i.e., start from the origin
* and go as long as the length of each dimension.
*/
start[0] = start[1] = 0;
edges[0] = X_LENGTH;
edges[1] = Y_LENGTH;

/*
* Read the data from the raster image array.
*/
status = GRreadimage (ri_id, start, NULL, edges, (VOIDP)entire_image);

/*
* Display only the first component of the image since the two components
* have the same data in this example.
*/
printf ("First component of the entire image:\n");
for (i = 0; i < Y_LENGTH; i++)
{
   for (j = 0; j < X_LENGTH; j++)
      printf ("%d ", entire_image[i][j][0]);
   printf ("\n");
}

/*
* Define the size of the data to be read.
*/
start[0] = COLS_PART_START;
start[1] = ROWS_PART_START;
edges[0] = PART_COLS;
edges[1] = PART_ROWS;

/*
* Read a subset of the raster image array.
*/
status = GRreadimage (ri_id, start, NULL, edges, (VOIDP)partial_image);

/*
* Display the first component of the read sample.
*/
printf ("\nThree rows & two cols at 2nd row and 4th column");
printf (" of the first component:\n");
for (i = 0; i < PART_ROWS; i++)
{
   for (j = 0; j < PART_COLS; j++)
      printf ("%d ", partial_image[i][j][0]);
   printf ("\n");
}

/*
* Define the size and the pattern to read the data.
*/
start[0] = COLS_SKIP_START;
start[1] = ROWS_SKIP_START;
edges[0] = SKIP_COLS;
edges[1] = SKIP_ROWS;
stride[0] = stride[1] = N_STRIDES;

/*
* Read all the odd rows and even columns of the image.
*/
```

```
   status = GRreadimage (ri_id, start, stride, edges, (VOIDP)skipped_image);

   /*
   * Display the first component of the read sample.
   */
   printf ("\nAll odd rows and even columns of the first component:\n");
   for (i = 0; i < SKIP_ROWS; i++)
   {
      for (j = 0; j < SKIP_COLS; j++)
         printf ("%d ", skipped_image[i][j][0]);
      printf ("\n");
   }

   /*
   * Terminate access to the raster image and to the GR interface, and
   * close the HDF file.
   */
   status = GRendaccess (ri_id);
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
      program read_raster_image
      implicit none
C
C     Parameter declaration
C
      character*19 FILE_NAME
      integer      X_LENGTH
      integer      Y_LENGTH
      integer      N_COMPS
C
      parameter (FILE_NAME  = 'General_RImages.hdf',
     +           X_LENGTH   = 10,
     +           Y_LENGTH   = 5,
     +           N_COMPS    = 2)
      integer PART_COLS, PART_ROWS, SKIP_COLS, SKIP_ROWS
      integer COLS_PART_START, ROWS_PART_START
      integer COLS_SKIP_START, ROWS_SKIP_START
      integer N_STRIDES
      parameter (PART_COLS = 3, PART_ROWS = 2,
     +           SKIP_COLS = 3, SKIP_ROWS = 5,
     +           COLS_PART_START = 1, ROWS_PART_START = 3,
     +           COLS_SKIP_START = 0, ROWS_SKIP_START = 1,
     +           N_STRIDES = 2)
      integer DFACC_READ
      parameter (DFACC_READ = 1)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgselct, mgrdimg, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer status
      integer file_id
      integer gr_id, ri_id
      integer start(2), stride(2), edges(2)
      integer i, j
```

```
      integer*2  entire_image(N_COMPS, X_LENGTH, Y_LENGTH)
      integer*2  partial_image(N_COMPS, PART_ROWS, PART_COLS)
      integer*2  skipped_image(N_COMPS, SKIP_ROWS, SKIP_COLS)
C
C**** End of variable declaration ************************************
C
C
C     Open the HDF file for reading.
C
      file_id = hopen(FILE_NAME, DFACC_READ, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Select the first raster image in the file.
C
      ri_id = mgselct(gr_id, 0)
C
C     Define the size of the data to be read, i.e., start from the origin
C     and go as long as the length of each dimension.
C
      start(1) = 0
      start(2) = 0
      edges(1) = X_LENGTH
      edges(2) = Y_LENGTH
      stride(1) = 1
      stride(2) = 1
C
C     Read the data from the raster image array.
C
      status = mgrdimg(ri_id, start, stride, edges, entire_image)
C
C     Display only the first component of the image since the two components
C     have the same data in this example.
C
      write(*,*) 'First component of the entire image'
      write(*,*)
      do 10 i = 1, X_LENGTH
         write(*,1000) (entire_image(1,i,j), j = 1, Y_LENGTH)
10    continue
      write(*,*)
C
C     Define the size of the data to be read.
C
      start(1) = ROWS_PART_START
      start(2) = COLS_PART_START
      edges(1) = PART_ROWS
      edges(2) = PART_COLS
      stride(1) = 1
      stride(2) = 1
C
C     Read a subset of the raster image array.
C
      status = mgrdimg(ri_id, start, stride, edges, partial_image)
C
C     Display only the first component of the read sample.
C
      write(*,*)
     +  'Two rows and three columns at 4th row and 2nd column',
     +  ' of the first component'
      write(*,*)
      do 20 i = 1, PART_ROWS
```

```
         write(*,1000) (partial_image(1,i,j), j = 1, PART_COLS)
20    continue
      write(*,*)
C
C     Define the size and the pattern to read the data.
C
      start(1) = ROWS_SKIP_START
      start(2) = COLS_SKIP_START
      edges(1) = SKIP_ROWS
      edges(2) = SKIP_COLS
      stride(1) = N_STRIDES
      stride(2) = N_STRIDES
C
C     Read all the odd rows and even columns of the image.
C
      status = mgrdimg(ri_id, start, stride, edges, skipped_image)
C
C     Display only the first component of the read sample.
C
      write(*,*) 'All even rows and odd columns of the first component'
      write(*,*)
      do 30 i = 1, SKIP_ROWS
         write(*,1000) (skipped_image(1,i,j), j = 1, SKIP_COLS)
30    continue
      write(*,*)
C
C     Terminate access to the raster image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
1000  format(1x, 5(I4))
      end
```

8.8 Obtaining Information about Files and Raster Images

The routines covered in this section provide methods for obtaining information about all of the images in a file, for identifying images that meet certain criteria, and for obtaining information about specific raster images.

GRfileinfo retrieves the number of images and file attributes in a file. **GRgetiminfo** provides information about individual images. To retrieve information about all images in a file, a calling program can use **GRfileinfo** to determine the number of images, followed by repeated calls to **GRgetiminfo** to obtain information about each image.

GRnametoindex or **GRreftoindex** can be used to obtain the index of a raster image in a file knowing its name or reference number, respectively. Refer to Section 8.2.1 on page 266 for a description of the raster image index and reference number. **GRidtoref** is used when the reference number of an image is required by another routine and the raster image identifier is available.

These routines are described individually in the following subsections.

8.8.1 Obtaining Information about the Contents of a File: GRfileinfo

GRfileinfo retrieves the number of raster images and the number of file attributes contained in a file. This information is often useful in index validation, sequential searches, or memory allocation. The syntax of **GRfileinfo** is as follows:

```
C:        status = GRfileinfo(gr_id, &n_images, &n_file_attrs);

FORTRAN:  status = mgfinfo(gr_id, n_images, n_file_attrs)
```

The number of images in the file and the total number of file attributes will be stored in the arguments `n_images` and `n_file_attrs`, respectively.

GRfileinfo returns `SUCCEED` (or `0`) if successful or `FAIL` (or `-1`) otherwise. The parameters for **GRfileinfo** are further described in Table 8G on page 290.

8.8.2 Obtaining Information about an Image: GRgetiminfo

It is impossible to allocate the proper amount of memory to buffer the image data when the number of components, dimension sizes, and/or data type of the image are unknown. The routine **GRgetiminfo** retrieves this required information. To access information about an image, the calling program must contain the following:

```
C:        status = GRgetiminfo(ri_id, name, &n_comps, &data_type,
                         &interlace_mode, dim_sizes, &n_attrs);

FORTRAN:  status = mggiinf(ri_id, name, n_comps, data_type,
                         interlace_mode, dim_sizes, n_attrs)
```

GRgetiminfo takes a raster image identifier as input, and returns the name, number of components, data type, interlace mode, dimension size, and number of attributes for the corresponding image in the arguments `name`, `n_comps`, `data_type`, `interlace_mode`, `dim_sizes`, and `n_attrs` respectively. The number of components of an image array element corresponds to the order of a vdata field, therefore this implementation of image components in the GR interface is flexible enough to accommodate any representation of pixel data. The calling program determines this representation; the GR interface recognizes only the raw byte configuration of the data. The attribute count will only reflect the number of attributes assigned to the image array; file attributes are not included.

GRgetiminfo returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of this routine are further defined in Table 8G.

TABLE 8G **GRfileinfo and GRgetiminfo Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRfileinfo [intn] **(mgfinfo)**	gr_id	int32	integer	GR interface identifier
	n_images	int32 *	integer	Number of raster images in the file
	n_file_attrs	int32 *	integer	Number of global attributes in the file

GRgetiminfo [intn] **(mggiinf)**	ri_id	int32	integer	Raster image identifier
	name	char *	character*(*)	Name of the raster image
	n_comps	int32 *	integer	Number of pixel components in the pixel
	data_type	int32 *	integer	Pixel data type
	interlace_mode	int32 *	integer	Interlace mode of the data in the raster image
	dim_sizes	int32 [2]	integer (2)	Array containing the size of each dimension in the raster image
	n_attrs	int32 *	integer	Number of raster image attributes

8.8.3 Obtaining the Reference Number of a Raster Image from Its Identifier: GRidtoref

GRidtoref returns either the reference number of the raster image identified by the parameter `ri_id`, or `FAIL` (or `-1`) upon unsuccessful completion. The syntax of **GRidtoref** is as follows:

C: `ref = GRidtoref(ri_id);`

FORTRAN: `ref = mgid2rf(ri_id)`

This routine is further defined in Table 8H on page 292.

8.8.4 Obtaining the Index of a Raster Image from Its Reference Number: GRreftoindex

GRreftoindex returns either the index of the raster image specified by its reference number, `ref`, or `FAIL` (or `-1`) upon unsuccessful completion. The syntax of **GRreftoindex** is as follows:

C: `ri_index = GRreftoindex(gr_id, ref);`

FORTRAN: `ri_index = mgr2idx(gr_id, ref)`

This routine is further defined in Table 8H.

8.8.5 Obtaining the Index of a Raster Image from Its Name: GRnametoindex

GRnametoindex returns the index of the raster image specified by its name or `FAIL` (or `-1`) upon unsuccessful completion. The syntax of **GRnametoindex** is as follows:

C: `ri_index = GRnametoindex(gr_id, name);`

FORTRAN: `ri_index = mgr2idx(gr_id, name)`

This routine is further defined in Table 8H.

TABLE 8H

GRidtoref, GRreftoindex, and GRnametoindex Parameter Lists

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRidtoref [uint16] **(mgid2rf)**	ri_id	int32	integer	Raster image identifier
GRreftoindex [int32] **(mgr2idx)**	gr_id	int32	integer	GR interface identifier
	ref	uint16	integer	Reference number of the raster image
GRnametoindex [int32] **(mgn2ndx)**	gr_id	int32	integer	GR interface identifier
	name	char *	character *(*)	Name of the raster image

EXAMPLE 4.

Obtaining File and Image Information.

This example illustrates the use of the routines **GRfileinfo/mgfinfo** and **GRgetiminfo/mggiinf** to obtain information such as the number of images and attributes in an HDF file and the characteristics of a raster image in the file.

In this example, the program gets the number of images in the file using the routine **GRfileinfo/mgfinfo**. For each image, the program then obtains and displays its name, number of components, data type, interlace mode, dimension sizes, and number of attributes using the routine **GRgetiminfo/mggiinf**.

C:

```
#include "hdf.h"

#define  FILE_NAME    "General_RImages.hdf"

main( )
{
   /************************* Variable declaration **************************/

   intn  status;            /* status for functions returning an intn */
   int32 file_id, gr_id, ri_id,
         n_rimages,         /* number of raster images in the file */
         n_file_attrs,      /* number of file attributes */
         ri_index,          /* index of a image */
         dim_sizes[2],      /* dimensions of an image */
         n_comps,           /* number of components an image contains */
         interlace_mode,    /* interlace mode of an image */
         data_type,         /* number type of an image */
         n_attrs;           /* number of attributes belong to an image */
   char  name[MAX_GR_NAME], /* name of an image */
        *type_string,       /* mapped text of a number type */
        *interlace_string;  /* mapped text of an interlace mode */

   /********************** End of variable declaration **********************/

   /*
   * Open the file for reading.
   */
   file_id = Hopen (FILE_NAME, DFACC_READ, 0);

   /*
   * Initialize the GR interface.
   */
   gr_id = GRstart (file_id);
```

```
/*
* Determine the contents of the file.
*/
status = GRfileinfo (gr_id, &n_rimages, &n_file_attrs);

/*
* For each image in the file, get and display the image information.
*/
printf ("RI#    Name       Components  Type         Interlace     \
Dimensions   Attributes\n\n");
for (ri_index = 0; ri_index < n_rimages; ri_index++)
{
   ri_id = GRselect (gr_id, ri_index);
   status = GRgetiminfo (ri_id, name, &n_comps, &data_type,
                     &interlace_mode, dim_sizes, &n_attrs);
   /*
   * Map the number type and interlace mode into text strings for output
   * readability.  Note that, in this example, only two possible types
   * are considered because of the simplicity of the example.  For real
   * problems, all possible types should be checked and, if reading the
   * data is desired, the size of the type must be determined based on the
   * machine where the program resides.
   */
   if (data_type == DFNT_CHAR8)
      type_string = "Char8";
   else if (data_type == DFNT_INT16)
      type_string = "Int16";
   else
      type_string = "Unknown";

   switch (interlace_mode)
   {
      case MFGR_INTERLACE_PIXEL:
         interlace_string = "MFGR_INTERLACE_PIXEL";
         break;
      case MFGR_INTERLACE_LINE:
         interlace_string = "MFGR_INTERLACE_LINE";
         break;
      case MFGR_INTERLACE_COMPONENT:
         interlace_string = "MFGR_INTERLACE_COMPONENT";
         break;
      default:
         interlace_string = "Unknown";
         break;
   } /* switch */

   /*
   * Display the image information for the current raster image.
   */
       printf ("%d  %s       %d      %s   %s     %2d,%2d         %d\n",
              ri_index, name, n_comps, type_string, interlace_string,
              dim_sizes[0], dim_sizes[1], n_attrs);

   /*
   * Terminate access to the current raster image.
   */
   status = GRendaccess (ri_id);
}

/*
* Terminate access to the GR interface and close the HDF file.
*/
```

```
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
      program image_info
      implicit none
C
C     Parameter declaration
C
      character*19 FILE_NAME
C
      parameter (FILE_NAME = 'General_RImages.hdf')
      integer DFACC_READ
      parameter (DFACC_READ = 1)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgselct, mgfinfo, mggiinf, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer status
      integer file_id, gr_id, ri_id
      integer n_rimages, n_file_attrs, ri_index
      integer n_comps, interlace_mode, n_attrs, data_type
      integer dim_sizes(2)
      character*10 type_string
      character*24 interlace_string
      character*64 name
C
C**** End of variable declaration ************************************
C
C
C     Open the HDF file for reading.
C
      file_id = hopen(FILE_NAME, DFACC_READ, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Determine the contents of the file.
C
      status = mgfinfo(gr_id, n_rimages, n_file_attrs)
C
C     For each image in the file, get and display image information.
C
      do 100 ri_index = 0, n_rimages-1
         ri_id = mgselct(gr_id, ri_index)
         status = mggiinf(ri_id, name, n_comps, data_type,
     +                    interlace_mode, dim_sizes, n_attrs)
C
C     Map the number type and interlace mode into text strings for
C     output readability.
C
      if(data_type .eq. 4) then
         type_string = 'DFNT_CHAR8'
      else if(data_type .eq. 22) then
         type_string = 'DFNT_INT16'
```

```
      else
         type_string = 'Unknown'
      endif
      if (interlace_mode .eq. 0) then
          interlace_string = 'MFGR_INTERLACE_PIXEL'
      else if(interlace_mode .eq. 1) then
          interlace_string = 'MFGR_INTERLACE_LINE'
      else if(interlace_mode .eq. 2) then
          interlace_string = 'MFGR_INTERLACE_COMPONENT'
      else
         interlace_string = 'Unknown'
      endif
C
C     Display the image information for the current image.
C
      write(*,*) 'Image index: ', ri_index
      write(*,*) 'Image name: ', name
      write(*,*) 'Number of components: ', n_comps
      write(*,*) 'Number type: ', type_string
      write(*,*) 'Interlace mode: ', interlace_string
      write(*,*) 'Dimnesions: ', dim_sizes(1), dim_sizes(2)
      write(*,*) 'Number of image attributes: ', n_attrs
      write(*,*)
C
C     Terminate access to the current raster image.
C
      status = mgendac(ri_id)
100   continue
C
C     Terminate access to the GR interface and close the HDF file.
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

8.9 GR Data Set Attributes

The GR interface provides tools that attach attributes to particular images. This capability is similar to, though more limited than, attribute function capabilities of the SD interface. The concepts of user-defined and predefined attributes are explained in Chapter 3, *Scientific Data Sets (SD API)*. The GR implementation of attributes is similar to the SD implementation. Attributes are not written out to a file until access to the object the attribute is attached to is terminated.

8.9.1 Predefined GR Attributes

The GR API library has only one predefined attribute: `FILL_ATTR`. This attribute defines a fill pixel, which is analogous to a fill value in the SD interface. It represents the default value that is written to each element of an image array not explicitly written to by the calling program, i.e., when only a portion of the entire image array is filled with data. This value must of the same data type as the rest of the initialized image data. The routine used to set the fill value, **GRsetattr**, is explained in the next section.

8.9.2 Setting User-defined Attributes: GRsetattr

GRsetattr creates or modifies an attribute for either a file or a raster image. If the attribute with the specified name does not exist, **GRsetattr** creates a new one. If the named attribute already exists, **GRsetattr** resets all the values that are different from those provided in its argument list. The syntax of **GRsetattr** is as follows:

```
C:          status = GRsetattr(obj_id, attr_name, data_type, n_values,
                               attr_value);

FORTRAN:    status = mgsnatt(obj_id, attr_name, data_type, n_values,
                               attr_value)
OR          status = mgscatt(obj_id, attr_name, data_type, n_values,
                               attr_value)
```

The first argument, `obj_id`, can either be the GR interface identifier or raster image identifier. The argument `attr_name` contains the name of the attribute and can be no more than `MAX_GR_NAME` (or `256`) characters in length. Passing the name of an existing attribute will overwrite the value portion of that attribute.

The arguments `data_type`, `n_values`, and `attr_value` describe the right side of the `label=value` equation. The `attr_value` argument contains one or more values of the same data type. The `data_type` argument describes the data type for all values in the attribute and `n_values` contains the total number of values in the attribute.

Note that the FORTRAN-77 version of **GRsetattr** has two routines; **mgsnatt** writes numeric attribute data and **mgscatt** writes character attribute data.

GRsetattr returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters for **GRsetattr** are further described in Table 8I on page 300.

EXAMPLE 5. **Operations on File and Raster Image Attributes.**

This example illustrates the use of the routines **GRsetattr/mgsnatt/mgscatt** to assign attributes to an HDF file and to an image.

In this example, the program sets two attributes to the existing file "General_RImages.hdf" and two attributes to the image named "Image Array 2". The file is created by the program in Example 1 and the image is created by the program in Example 2. The values of the second attribute of the image are of type `int16` and the values of the other three attributes are of type `char8`.

C:

```
#include "hdf.h"

#define  FILE_NAME          "General_RImages.hdf"
#define  IMAGE_NAME         "Image Array 2"
#define  F_ATT1_NAME        "File Attribute 1"
#define  F_ATT2_NAME        "File Attribute 2"
#define  RI_ATT1_NAME       "Image Attribute 1"
#define  RI_ATT2_NAME       "Image Attribute 2"
#define  F_ATT1_VAL         "Contents of First FILE Attribute"
#define  F_ATT2_VAL         "Contents of Second FILE Attribute"
#define  F_ATT1_N_VALUES    32
#define  F_ATT2_N_VALUES    33
#define  RI_ATT1_VAL        "Contents of IMAGE's First Attribute"
#define  RI_ATT1_N_VALUES   35
#define  RI_ATT2_N_VALUES   6
```

```
main( )
{
   /************************* Variable declaration **************************/

   intn  status;         /* status for functions returning an intn */
   int32 gr_id, ri_id, file_id,
         ri_index;
   int16 ri_attr_2[RI_ATT2_N_VALUES] = {1, 2, 3, 4, 5, 6};

   /********************* End of variable declaration *********************/

   /*
   * Open the HDF file.
   */
   file_id = Hopen (FILE_NAME, DFACC_WRITE, 0);

   /*
   * Initialize the GR interface.
   */
   gr_id = GRstart (file_id);

   /*
   * Set two file attributes to the file with names, data types, numbers of
   * values, and values of the attributes specified.
   */
   status = GRsetattr (gr_id, F_ATT1_NAME, DFNT_CHAR8, F_ATT1_N_VALUES,
                       (VOIDP)F_ATT1_VAL);

   status = GRsetattr (gr_id, F_ATT2_NAME, DFNT_CHAR8, F_ATT2_N_VALUES,
                       (VOIDP)F_ATT2_VAL);

   /*
   * Obtain the index of the image named IMAGE_NAME.
   */
   ri_index = GRnametoindex (gr_id, IMAGE_NAME);

   /*
   * Obtain the identifier of this image.
   */
   ri_id = GRselect (gr_id, ri_index);

   /*
   * Set two attributes to the image with names, data types, numbers of
   * values, and values of the attributes specified.
   */
   status = GRsetattr (ri_id, RI_ATT1_NAME, DFNT_CHAR8, RI_ATT1_N_VALUES,
                       (VOIDP)RI_ATT1_VAL);

   status = GRsetattr (ri_id, RI_ATT2_NAME, DFNT_INT16, RI_ATT2_N_VALUES,
                       (VOIDP)ri_attr_2);

   /*
   * Terminate access to the image and to the GR interface, and close the
   * HDF file.
   */
   status = GRendaccess (ri_id);
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
      program  set_attribute
```

```
      implicit none
C
C     Parameter declaration
C
      character*19 FILE_NAME
      character*13 IMAGE_NAME
      character*16 F_ATT1_NAME
      character*16 F_ATT2_NAME
      character*17 RI_ATT1_NAME
      character*17 RI_ATT2_NAME
      character*32 F_ATT1_VAL
      character*33 F_ATT2_VAL
      integer      F_ATT1_N_VALUES
      integer      F_ATT2_N_VALUES
      character*35 RI_ATT1_VAL
      integer      RI_ATT1_N_VALUES
      integer      RI_ATT2_N_VALUES
C
      parameter (FILE_NAME    = 'General_RImages.hdf',
     +           IMAGE_NAME   = 'Image Array 2',
     +           F_ATT1_NAME  = 'File Attribute 1',
     +           F_ATT2_NAME  = 'File Attribute 2',
     +           RI_ATT1_NAME = 'Image Attribute 1',
     +           RI_ATT2_NAME = 'Image Attribute 2',
     +           F_ATT1_VAL   = 'Contents of First FILE Attribute',
     +           F_ATT2_VAL   = 'Contents of Second FILE Attribute',
     +           F_ATT1_N_VALUES = 32,
     +           F_ATT2_N_VALUES = 33,
     +           RI_ATT1_VAL = 'Contents of IMAGE''s First Attribute',
     +           RI_ATT1_N_VALUES = 35,
     +           RI_ATT2_N_VALUES = 6)
      integer DFACC_WRITE, DFNT_INT16, DFNT_CHAR8
      parameter (DFACC_WRITE  = 2,
     +           DFNT_CHAR8   = 4,
     +           DFNT_INT16   = 22)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgscatt, mgsnatt , mgn2ndx,
     +        mgselct, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer   status
      integer   file_id, gr_id, ri_id, ri_index
      integer*2 ri_attr_2(RI_ATT2_N_VALUES)
      integer   i

      do 10 i = 1, RI_ATT2_N_VALUES
         ri_attr_2(i) = i
10    continue
C
C**** End of variable declaration ************************************
C
C
C     Open the HDF file.
C
      file_id = hopen(FILE_NAME, DFACC_WRITE, 0)
C
C     Initialize the GR interface.
C
```

```
      gr_id = mgstart(file_id)
C
C     Set two file attributes to the file with names, data type, numbers of
C     values, and values of attributes specified.
C
      status = mgscatt(gr_id, F_ATT1_NAME, DFNT_CHAR8,
     +                 F_ATT1_N_VALUES, F_ATT1_VAL)
      status = mgscatt(gr_id, F_ATT2_NAME, DFNT_CHAR8,
     +                 F_ATT2_N_VALUES, F_ATT2_VAL)
C
C     Obtain the index of the image named IMAGE_NAMR.
C
      ri_index = mgn2ndx(gr_id, IMAGE_NAME)
C
C     Obtain the identifier of this image.
C
      ri_id = mgselct(gr_id, ri_index)
C
C     Set two attributes of the image with names, data types, number of
C     values, and values of the attributes specified.
C
      status = mgscatt(ri_id, RI_ATT1_NAME, DFNT_CHAR8,
     +                 RI_ATT1_N_VALUES, RI_ATT1_VAL)
      status = mgsnatt(ri_id, RI_ATT2_NAME, DFNT_INT16,
     +                 RI_ATT2_N_VALUES, ri_attr_2)
C
C     Terminate access to the image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

8.9.3 Querying User-Defined Attributes: GRfindattr and GRattrinfo

Each attribute associated with an object has a unique ***attribute index***, a value ranging from 0 to the total number of attributes attached to the object - 1. Given a GR interface or raster image identifier and an attribute name, **GRfindattr** will return a valid attribute index of the file or raster image attribute if the attribute exists. The attribute index can then be used to retrieve information about the attribute or its values. Given a GR interface or raster image identifier and a valid attribute index, **GRattrinfo** returns the name, data type, and number of values for the file or raster image attribute if the attribute exists.

The syntax for **GRfindattr** and **GRattrinfo** is as follows:

C:
```
attr_index = GRfindattr(obj_id, attr_name);
status = GRattrinfo(obj_id, attr_index, attr_name, &data_type,
                    &n_values);
```

FORTRAN:
```
attr_index = mgfndat(obj_id, attr_name)
status = mgatinf(obj_id, attr_index, attr_name, data_type,
                 n_values)
```

The parameter `obj_id` is either a GR interface identifier or a raster image identifier. The parameter `attr_name` specifies the name of the attribute. The parameter `attr_index` specifies the index of the attribute to be read. The attribute index is a zero-based integer and must be less than the total number of attributes assigned to the specified object. The parameter `data_type` specifies the data type of the attribute. And the parameter `n_values` specifies the number of attribute values.

GRfindattr returns the attribute index if successful and `FAIL` (or `-1`) otherwise. **GRattrinfo** returns `SUCCEED` (or `0`) if successful and `FAIL` (or `-1`) otherwise. The parameters for **GRfindattr** and **GRattrinfo** are further described in Table 8I.

8.9.4 Reading User-defined Attributes: GRgetattr

GRgetattr reads the values of an attribute assigned to the object identified by the parameter `obj_id`. The syntax for **GRgetattr** is as follows:

C:
```
status = GRgetattr(obj_id, attr_index, values);
```

FORTRAN:
```
status = mggnatt(obj_id, attr_index, values)
```

OR
```
status = mggcatt(obj_id, attr_index, values)
```

The parameter `obj_id` is either a GR interface identifier or a raster image identifier. The parameter `attr_index` specifies the index of the attribute to be read. The attribute index is a zero-based integer and must be less than the total number of attributes assigned to the specified object.

It is assumed that the buffer `values`, allocated to hold the attribute values, is large enough to hold the data; if not, the data read will be truncated to the size of the buffer. The size of the buffer should be at least `n_values*sizeof(data_type)` bytes long. If an attribute contains multiple values, **GRgetattr** will return all of them. It is not possible to read a subset of values.

Note that the FORTRAN-77 version of **GRgetattr** has two routines; **mggnatt** reads numeric attribute data and **mggcatt** reads character attribute data.

GRgetattr returns `SUCCEED` (or `0`) if successful and `FAIL` (or `-1`) otherwise. The parameters for **GRgetattr** are further described in Table 8I.

TABLE 8I **GRsetattr, GRfindattr, GRattrinfo, and GRgetattr Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type: C	Parameter Type: FORTRAN-77	Description
GRsetattr [intn] **(mgsnatt/mgscatt)**	obj_id	int32	integer	GR interface or raster image identifier
	attr_name	char *	character*(*)	Name assigned to the attribute
	data_type	int32	integer	Data type of the attribute
	n_values	int32	integer	Number of values in the attribute
	values	VOIDP	<valid numeric data type>(*)/ character*(*)	Buffer with the attribute values
GRfindattr [int32] **(mgfndat)**	obj_id	int32	integer	GR interface or raster image identifier
	attr_name	char *	character*(*)	Name of the attribute
GRattrinfo [intn] **(mgatinf)**	obj_id	int32	integer	GR interface or raster image identifier
	attr_index	int32	integer	Index for the attribute to be read
	attr_name	char *	character*(*)	Name of the attribute
	data_type	int32 *	integer	Data type of the attribute values
	n_values	int32 *	integer	Total number of values in the attribute
GRgetattr **[intn]** **(mggnatt/ mggcatt)**	obj_id	int32	integer	GR interface or raster image identifier
	attr_index	int32	integer	Index for the attribute to be read
	values	VOIDP	<valid numeric data type>(*)/ character*(*)	Buffer for the attribute values

EXAMPLE 6.

Obtaining File and Image Attribute.

This example illustrates the use of the routines **GRattrinfo/mgatinf**, **GRfindattr/mgfndat**, and **GRgetattr/mggnatt/mggcatt** to extract information and values of file and image attributes that were set by the program in Example 5.

In this example, the program gets the information about each file attribute, then extracts its values. The program then selects the second image in the file, finds the attribute named "Image Attribute 2", obtains the data type and the number of values in the attribute, and extracts its stored values.

C:

```
#include "hdf.h"

#define  FILE_NAME       "General_RImages.hdf"
#define  RI_ATTR_NAME    "Image Attribute 2"

main( )
{
   /************************* Variable declaration **************************/

   intn   status;          /* status for functions returning an intn */
   int32  gr_id, ri_id, file_id,
          f_att_index,     /* index of file attributes */
          ri_att_index,    /* index of raster image attributes */
          data_type,       /* image data type */
          n_values,        /* number of values in an attribute */
          value_index,     /* index of values in an attribute */
          n_rimages,       /* number of raster images in the file */
          n_file_attrs;    /* number of file attributes */
   char   attr_name[MAX_GR_NAME];  /* buffer to hold the attribute name     */
   VOIDP  data_buf;                /* buffer to hold the attribute values   */
   int16 *int_ptr;      /* int16 pointer to point to a void data buffer     */
   char8 *char_ptr;     /* char8 pointer to point to a void data buffer     */

   /********************* End of variable declaration *********************/

   /*
   * Open the HDF file.
   */
   file_id = Hopen (FILE_NAME, DFACC_READ, 0);

   /*
   * Initialize the GR interface.
   */
   gr_id = GRstart (file_id);

   /*
   * Determine the number of attributes in the file.
   */
   status = GRfileinfo (gr_id, &n_rimages, &n_file_attrs);

   if (status != FAIL && n_file_attrs > 0)
   {
      for (f_att_index = 0; f_att_index < n_file_attrs; f_att_index++)
      {
         /*
         * Get information about the current file attribute.
         */
         status = GRattrinfo (gr_id, f_att_index, attr_name, &data_type,
                              &n_values);
```

```
      /*
      * Allocate a buffer to hold the file attribute data.  In this example,
      * knowledge about the data type is assumed to be available from
      * the previous example for simplicity.  In reality, the size
      * of the type must be determined based on the machine where the
      * program resides.
      */
      if (data_type == DFNT_CHAR8)
      {
         data_buf = malloc (n_values * sizeof (char8));
         if (data_buf == NULL)
         {
            printf ("Unable to allocate space for attribute data.\n");
            exit (1);
         }
      }
      else
      {
        printf ("Unable to determine data type to allocate data buffer.\n");
         exit (1);
      }

      /*
      * Read and display the attribute values.
      */
      status = GRgetattr (gr_id, f_att_index, (VOIDP)data_buf);
      char_ptr = (char8 *) data_buf;
      printf ("Attribute %s: ", attr_name);
      for (value_index = 0; value_index < n_values; value_index++)
         printf ("%c", char_ptr[value_index]);
      printf ("\n");

      /*
      * Free the space allocated for the data buffer.
      */
      free (data_buf);
   } /* for */
} /* if */

/*
* Select the second image in the file.
*/
ri_id = GRselect (gr_id, 1);

/*
* Find the image attribute named RI_ATTR_NAME.
*/
ri_att_index = GRfindattr (ri_id, RI_ATTR_NAME);

/*
* Get information about the attribute.
*/
status = GRattrinfo (ri_id, ri_att_index, attr_name, &data_type, &n_values);

/*
* Allocate a buffer to hold the file attribute data.  As mentioned above,
* knowledge about the data type is assumed to be available from
* the previous example for simplicity.  In reality, the size of the
* type must be determined based on the machine where the program resides.
*/
if (data_type == DFNT_INT16)
   data_buf = malloc (n_values * sizeof (int16));
```

```
   /*
   * Read and display the attribute values.
   */
   status = GRgetattr (ri_id, ri_att_index, (VOIDP)data_buf);
   printf ("\nAttribute %s: ", RI_ATTR_NAME);
   int_ptr = (int16 *)data_buf;
   for (value_index = 0; value_index < n_values; value_index++)
      printf ("%d ", int_ptr[value_index]);
   printf ("\n");

   /*
   * Free the space allocated for the data buffer.
   */
   free (data_buf);

   /*
   * Terminate access to the raster image and to the GR interface, and
   * close the file.
   */
   status = GRendaccess (ri_id);
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
      program  get_attribute
      implicit none
C
C     Parameter declaration
C
      character*19 FILE_NAME
      character*17 RI_ATTR_NAME
C
      parameter (FILE_NAME    = 'General_RImages.hdf',
     +           RI_ATTR_NAME  = 'Image Attribute 2')
      integer DFACC_READ, DFNT_INT16, DFNT_CHAR8
      parameter (DFACC_READ   = 1,
     +           DFNT_CHAR8   = 4,
     +           DFNT_INT16   = 22)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgfinfo, mgatinf, mggcatt, mggnatt , mgfndat,
     +        mgselct, mgendac, mgend

C
C**** Variable declaration *******************************************
C
      integer      status
      integer      file_id, gr_id, ri_id
      integer      f_att_index, ri_att_index, data_type, n_values
      integer      n_rimages, n_file_attrs
      integer*2    int_buf(10)
      character*17 attr_name
      character*80 char_buf
      integer      i
C
C**** End of variable declaration ************************************
C
C
C     Open the HDF file.
```

```
C
      file_id = hopen(FILE_NAME, DFACC_READ, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Determine the number of attributes in the file.
C
      status = mgfinfo(gr_id, n_rimages, n_file_attrs)
      if ((status .NE. -1) .AND. (n_file_attrs .GT. 0)) then

         do 10 f_att_index = 0, n_file_attrs-1
C
C        Get information about the current file attribute.
C
         status = mgatinf(gr_id, f_att_index, attr_name, data_type,
     +                    n_values)
C
C       Check whether data type is DFNT_CHAR8 in order to use allocated buffer.
C
         if(data_type .NE. DFNT_CHAR8) then
            write(*,*)
     +      'Unable to determine data type to use allocated buffer'
         else
C
C           Read and display the attribute values.
C
            status = mggcatt(gr_id, f_att_index, char_buf)
            write(*,*) 'Attribute ', attr_name, ' : ',
     +                 char_buf(1:n_values)
         endif
10       continue

      endif

C
C     Select the second image in the file.
C
      ri_id = mgselct(gr_id, 1)
C
C     Find the image attribute named RI_ATTR_NAME.
C
      ri_att_index = mgfndat(ri_id, RI_ATTR_NAME)
C
C     Get information about the attribute.
C
      status = mgatinf(ri_id, ri_att_index, attr_name, data_type,
     +                 n_values)
C
C     Read and display attribute values.
C
      status = mggnatt(ri_id, ri_att_index, int_buf)
      write(*,*) 'Attributes :', (int_buf(i), i = 1, n_values)
C
C     Terminate access to the image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

8.10 Reading and Writing Palette Data Using the GR Interface

The GR API library includes routines that read, write, and access information about palette data attached to GR images. Although this functionality is also provided by the HDF Palette API library, it is not a recommended practice to use the Palette API to access and manipulate palette objects created by GR interface routines.

The routines are named **GRgetlutid**, **GRluttoref**, **GRgetlutinfo**, **GRwritelut**, **GRreqlutil**, and **GRreadlut**. Note that the routine names use the term ***LUT*** to refer to palettes; LUT stands for color ***lookup tables***.

8.10.1 Obtaining a Palette ID: GRgetlutid

Given a palette index, the routine **GRgetlutid** is used to get the palette identifier for the specified palette.

The **GRgetlutid** function takes two arguments, `ri_id`, the raster image identifier of the image that has the palette attached to it, and `lut_index`, the index of the palette, and returns the value of the palette identifier corresponding to the specified image. The syntax of **GRgetlutid** is as follows:

C: `pal_id = GRgetlutid(ri_id, lut_index);`

FORTRAN: `pal_id = mggltid(ri_id, lut_index)`

GRgetlutid returns the value of the palette identifier if successful and `FAIL` (or `-1`) otherwise. The **GRgetlutid** parameters are further discussed in Table 8J.

8.10.2 Obtaining the Reference Number of a Specified Palette: GRluttoref

Given a palette identifier, **GRluttoref** can be used to obtain the reference number of the specified palette.

The **GRluttoref** routine takes one argument, `pal_id`, a palette identifier, and returns the reference number of the palette. **GRluttoref** is commonly used to annotate the palette or to include the palette within a vgroup. The syntax of **GRgetlutid** is as follows:

C: `pal_ref = GRluttoref(pal_id);`

FORTRAN: `pal_ref = mglt2rf(pal_id)`

GRluttoref returns the reference number of the palette if successful and `0` otherwise. The **GRluttoref** parameters are further discussed in Table 8J.

TABLE 8J **GRgetlutid, GRgetlutinfo, and GRluttoref Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRgetlutid [int32] **(mggltid)**	ri_id	int32	integer	Raster image identifier
	lut_index	int32	integer	Palette index
GRluttoref [uint16] **(mglt2rf)**	pal_id	int32	integer	Palette identifier

8.10.3 Obtaining Palette Information: GRgetlutinfo

Given a palette identifier, **GRgetlutinfo** retrieves information about the palette and its components.

The **GRgetlutinfo** function takes one input argument, `pal_id`, the identifier of the palette, and several return parameters. The return parameters are `n_comps`, the number of components of the palette; `data_type`, the data type of the palette data; `interlace_mode`, the interlace mode of the stored palette data; and `num_entries`, the number of entries in the palette. The syntax of **GRgetlutinfo** is as follows:

```
C:        status = GRgetlutinfo(pal_id, &n_comps, &data_type,
                            &interlace_mode, &num_entries);

FORTRAN:  status = mgglinf(pal_id, n_comps, data_type, interlace_mode,
                            num_entries)
```

GRgetlutinfo returns `SUCCEED` (or `0`) if successful and `FAIL` (or `-1`) otherwise. The **GRgetlutinfo** parameters are further discussed in Table 8J.

8.10.4 Writing Palette Data: GRwritelut

GRwritelut writes palette data into the palette identified by the parameter `pal_id`. The syntax of **GRwritelut** is as follows:

```
C:        status = GRwritelut(pal_id, n_comps, data_type,
                            interlace_mode, num_entries, pal_data);

FORTRAN:  status = mgwrlut(pal_id, n_comps, data_type, interlace_mode,
                            num_entries, pal_data)

OR        status = mgwclut(pal_id, n_comps, data_type, interlace_mode,
                            num_entries, pal_data)
```

The parameter `n_comps` specifies the number of pixel components in the palette; it must have a value of at least 1. The parameter `data_type` specifies the data type of the palette data. Refer to Table 2E on page 14 for all data types supported by HDF.

The parameter `interlace_mode` specifies the interlacing in which the palette is to be written. The valid values of `interlace_mode` are: `MFGR_INTERLACE_PIXEL` (or `0`), `MFGR_INTERLACE_LINE` (or `1`) and `MFGR_INTERLACE_COMPONENT` (or `2`). Refer to Section 8.5.1 on page 270 for further information.

The parameter `num_entries` specifies the number of entries in the palette. The buffer `pal_data` contains the palette data.

Note that the FORTRAN-77 version of **GRwritelut** has two routines; **mgwrlut** writes buffered numeric palette data and **mgwclut** writes buffered character palette data.

GRwritelut returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of this routine are further defined in Table 8K on page 308.

8.10.5 Setting the Interlace Mode for a Palette: GRreqlutil

GRreqlutil sets the interlace mode for the next palette to be read. The syntax of **GRreqlutil** is as follows:

C: `status = GRreqlutil(pal_id, interlace_mode);`

FORTRAN: `status = mgrltil(pal_id, interlace_mode)`

The parameter `interlace_mode` specifies the interlacing that will be in effect for the next palette read operation. The valid values of `interlace_mode` are: `MFGR_INTERLACE_PIXEL` (or `0`), `MFGR_INTERLACE_LINE` (or `1`) and `MFGR_INTERLACE_COMPONENT` (or `2`). Refer to Section 8.5.1 on page 270 for further information.

GRreqlutil may be called at anytime before the read operation of the specified palette. In addition, it may be called more than once; the interlace mode setting specified by the last call to the routine will be used for the next read operation.

GRreqlutil returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of this routine are further defined in Table 8K on page 308.

8.10.6 Reading Palette Data: GRreadlut

GRreadlut reads data from the palette identified by the parameter `pal_id`. The syntax of **GRreadlut** is as follows:

C: `status = GRreadlut(pal_id, pal_data);`

FORTRAN: `status = mgrdlut(pal_id, pal_data)`

OR `status = mgrclut(pal_id, pal_data)`

The read data will be stored in the buffer `pal_data`, which is assumed to be sufficient to store the read palette data. The sufficient amount of space needed can be determined using the routine **GRgetlutinfo**. The palette data is read according to the interlacing mode set by the last call to **GRreqlutil**.

Note that the FORTRAN-77 version of **GRreadlut** has two routines; **mgrdlut** reads numeric palette data and **mgrclut** reads character palette data.

GRreadlut returns either `SUCCEED` (or `0`) or `FAIL` (or `-1`). The parameters of this routine are further defined in Table 8K.

TABLE 8K

GRgetlutid, GRwritelut, GRreqlutil, and GRreadlut Parameter Lists

<table>
<tr><th rowspan="2">Routine Name
[Return Type]
(FORTRAN-77)</th><th rowspan="2">Parameter</th><th colspan="2">Parameter Type</th><th rowspan="2">Description</th></tr>
<tr><th>C</th><th>FORTRAN-77</th></tr>
<tr><td rowspan="5">GRgetlutinfo
[intn]
(mgglinf)</td><td>pal_id</td><td>int32</td><td>integer</td><td>Palette identifier</td></tr>
<tr><td>n_comps</td><td>int32*</td><td>integer</td><td>Number of components in each palette element</td></tr>
<tr><td>data_type</td><td>int32*</td><td>integer</td><td>Data type of the palette data</td></tr>
<tr><td>interlace_mode</td><td>int32*</td><td>integer</td><td>Interlace mode of the palette data</td></tr>
<tr><td>num_entries</td><td>int32*</td><td>integer</td><td>Buffer for the size of the palette</td></tr>
<tr><td rowspan="6">GRwritelut
[intn]
(mgwrlut/
mgwclut)</td><td>pal_id</td><td>int32</td><td>integer</td><td>Palette identifier</td></tr>
<tr><td>n_comps</td><td>int32</td><td>integer</td><td>Number of components in each palette element</td></tr>
<tr><td>data_type</td><td>int32</td><td>integer</td><td>Type of the palette data</td></tr>
<tr><td>interlace_mode</td><td>int32</td><td>integer</td><td>Interlace mode of the palette data</td></tr>
<tr><td>num_entries</td><td>int32</td><td>integer</td><td>Number of entries in the palette</td></tr>
<tr><td>pal_data</td><td>VOIDP</td><td><valid numeric data type>(*)/
character*(*)</td><td>Buffer for the palette data to be written</td></tr>
<tr><td rowspan="2">GRreqlutil
[intn]
(mgrltil)</td><td>pal_id</td><td>int32</td><td>integer</td><td>Palette identifier</td></tr>
<tr><td>interlace_mode</td><td>intn</td><td>integer</td><td>Interlace mode for the next palette read operation</td></tr>
<tr><td rowspan="2">GRreadlut
[intn]
(mgrdlut/
mgrclut)</td><td>pal_id</td><td>int32</td><td>integer</td><td>Palette identifier</td></tr>
<tr><td>pal_data</td><td>VOIDP</td><td><valid numeric data type>(*)/
character*(*)</td><td>Buffer for the palette data to be read</td></tr>
</table>

EXAMPLE 7.

Writing a Palette.

This example illustrates the use of the routines **GRgetlutid/mggltid** and **GRwritelut/mgwclut** to attach a palette to a raster image and write data to it.

In this example, the program creates an image named "Image with Palette" in the file "Image_with_Palette.hdf". A palette is then attached to the image and data is written to it.

C:

```
#include "hdf.h"

#define  FILE_NAME         "Image_with_Palette.hdf"
#define  NEW_IMAGE_NAME    "Image with Palette"
#define  N_COMPS_IMG       2       /* number of image components */
#define  X_LENGTH          5
#define  Y_LENGTH          5
#define  N_ENTRIES         256     /* number of entries in the palette */
#define  N_COMPS_PAL       3       /* number of palette's components */

main( )
{
   /************************* Variable declaration *************************/

   intn  status,         /* status for functions returning an intn */
         i, j;
   int32 file_id, gr_id, ri_id, pal_id,
         interlace_mode,
         start[2],     /* holds where to start to write for each dimension  */
         edges[2],     /* holds how long to write for each dimension */
         dim_sizes[2];  /* sizes of the two dimensions of the image array   */
```

```
uint8 image_buf[Y_LENGTH][X_LENGTH][N_COMPS_IMG]; /* data of first image */
uint8 palette_buf[N_ENTRIES][N_COMPS_PAL];

/********************* End of variable declaration *********************/

/*
* Open the HDF file.
*/
file_id = Hopen (FILE_NAME, DFACC_CREATE, 0);

/*
* Initialize the GR interface.
*/
gr_id = GRstart (file_id);

/*
* Define the dimensions and interlace mode of the image.
*/
dim_sizes[0] = X_LENGTH;
dim_sizes[1] = Y_LENGTH;
interlace_mode = MFGR_INTERLACE_PIXEL;

/*
* Create the image named NEW_IMAGE_NAME.
*/
ri_id = GRcreate (gr_id, NEW_IMAGE_NAME, N_COMPS_IMG, DFNT_UINT8,
                  interlace_mode, dim_sizes);

/*
* Fill the image data buffer with values.
*/
for (i = 0; i < Y_LENGTH; i++)
{
   for (j = 0; j < X_LENGTH; j++)
   {
      image_buf[i][j][0] = (i + j) + 1;
      image_buf[i][j][1] = (i + j) + 2;
   }
 }

/*
* Define the size of the data to be written, i.e., start from the origin
* and go as long as the length of each dimension.
*/
start[0] = start[1] = 0;
edges[0] = X_LENGTH;
edges[1] = Y_LENGTH;

/*
* Write the data in the buffer into the image array.
*/
status = GRwriteimage (ri_id, start, NULL, edges, (VOIDP)image_buf);

/*
* Initialize the palette to grayscale.
*/
for (i = 0; i < N_ENTRIES; i++) {
   palette_buf[i][0] = i;
   palette_buf[i][1] = i;
   palette_buf[i][2] = i;
}

/*
```

```
   * Define palette interlace mode.
   */
   interlace_mode = MFGR_INTERLACE_PIXEL;

   /*
   * Get the identifier of the palette attached to the image NEW_IMAGE_NAME.
   */
   pal_id = GRgetlutid (ri_id, 0);

   /*
   * Write data to the palette.
   */
   status = GRwritelut (pal_id, N_COMPS_PAL, DFNT_UINT8, interlace_mode,
                      N_ENTRIES, (VOIDP)palette_buf);

   /*
   * Terminate access to the image and to the GR interface, and
   * close the HDF file.
   */
   status = GRendaccess (ri_id);
   status = GRend (gr_id);
   status = Hclose (file_id);
}
```

FORTRAN:

```
      program  write_palette
      implicit none
C
C     Parameter declaration
C
      character*22 FILE_NAME
      character*18 NEW_IMAGE_NAME
      integer      X_LENGTH
      integer      Y_LENGTH
      integer      N_ENTRIES
      integer      N_COMPS_IMG
      integer      N_COMPS_PAL
C
      parameter (FILE_NAME       = 'Image_with_Palette.hdf',
     +           NEW_IMAGE_NAME  = 'Image with Palette',
     +           X_LENGTH        = 5,
     +           Y_LENGTH        = 5,
     +           N_ENTRIES       = 256,
     +           N_COMPS_IMG     = 2,
     +           N_COMPS_PAL     = 3)
      integer DFACC_CREATE, DFNT_CHAR8, DFNT_UINT8, MFGR_INTERLACE_PIXEL
      parameter (DFACC_CREATE = 4,
     +           DFNT_CHAR8   = 4,
     +           DFNT_UINT8   = 21,
     +           MFGR_INTERLACE_PIXEL = 0)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgcreat, mgwcimg, mggltid, mgwclut,
     +        mgendac, mgend
C
C**** Variable declaration *******************************************
C
      integer    file_id, gr_id, ri_id, pal_id
      integer    interlace_mode
      integer    start(2), stride(2), edges(2), dim_sizes(2)
```

```
      integer    status
      integer    i, j
      character  image_buf(N_COMPS_IMG, X_LENGTH, Y_LENGTH)
      character  palette_buf(N_COMPS_PAL, N_ENTRIES)
C
C**** End of variable declaration ************************************
C
C
C     Create and open the file.
C
      file_id = hopen(FILE_NAME, DFACC_CREATE, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Define interlace mode and dimensions of the image.
C
      interlace_mode = MFGR_INTERLACE_PIXEL
      dim_sizes(1) = X_LENGTH
      dim_sizes(2) = Y_lENGTH
C
C     Create the raster image array.
C
      ri_id = mgcreat(gr_id, NEW_IMAGE_NAME, N_COMPS_IMG, DFNT_CHAR8,
     +                interlace_mode, dim_sizes)
C
C     Fill the image data buffer with values.
C
      do 20 i = 1, Y_LENGTH
         do 10 j = 1, X_LENGTH
               image_buf(1,j,i) = char(i + j - 1 )
               image_buf(2,j,i) = char(i + j)
10       continue
20    continue

C
C     Define the size of the data to be written, i.e., start from the origin
C     and go as long as the length of each dimension.
C
      start(1) = 0
      start(2) = 0
      edges(1) = X_LENGTH
      edges(2) = Y_LENGTH
      stride(1) = 1
      stride(2) = 1
C
C     Write the data in the buffer into the image array.
C
      status = mgwcimg(ri_id, start, stride, edges, image_buf)
C
C     Initilaize the palette buffer to grayscale.
C
      do 40 i = 1, N_ENTRIES
          do 30 j = 1, N_COMPS_PAL
             palette_buf(j,i) = char(i)
30        continue
40    continue
C
C     Get the identifier of the palette attached to the image NEW_IMAGE_NAME.
C
      pal_id = mggltid(ri_id, 0)
C
```

```
C     Set palette interlace mode.
C
      interlace_mode = MFGR_INTERLACE_PIXEL
C
C     Write data to the palette.
C
      status = mgwclut(pal_id, N_COMPS_PAL, DFNT_UINT8, interlace_mode,
     +                 N_ENTRIES, palette_buf)
C
C     Terminate access to the raster image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

EXAMPLE 8.

Reading a Palette.

This example illustrates the use of the routines **GRgetlutinfo/mgglinf** and **GRreadlut/mgrclut** to obtain information about a palette and to read palette data.

In this example, the program finds and selects the image named "Image with Palette" in the file "Image_with_Palette.hdf". Then the program obtains information about the palette and reads the palette data.

C:

```
#include "hdf.h"

#define  FILE_NAME      "Image_with_Palette.hdf"
#define  IMAGE_NAME     "Image with Palette"
#define  N_ENTRIES      256     /* number of elements of each color */

main( )
{
   /************************* Variable declaration *************************/

   intn  status,         /* status for functions returning an intn */
         i, j;
   int32 file_id, gr_id, ri_id, pal_id, ri_index;
   int32 data_type, n_comps, n_entries, interlace_mode;
   uint8 palette_data[N_ENTRIES][3];        /* static because of fixed size */

   /************************* Variable declaration *************************/

   /*
   * Open the file.
   */
   file_id = Hopen (FILE_NAME, DFACC_READ, 0);

   /*
   * Initiate the GR interface.
   */
   gr_id = GRstart (file_id);

   /*
   * Get the index of the image IMAGR_NAME.
   */
   ri_index = GRnametoindex (gr_id, IMAGE_NAME);
```

```
    /*
    * Get image identifier.
    */
    ri_id = GRselect (gr_id, ri_index);

    /*
    * Get the identifier of the palette attached to the image.
    */
    pal_id = GRgetlutid (ri_id, ri_index);

    /*
    * Obtain and display information about the palette.
    */
    status = GRgetlutinfo (pal_id, &n_comps, &data_type, &interlace_mode,
                           &n_entries);
    printf ("Palette: %d components; %d entries\n", n_comps, n_entries);

    /*
    * Read the palette data.
    */
    status = GRreadlut (pal_id, (VOIDP)palette_data);

    /*
    * Display the palette data.  Recall that HDF supports only 256 colors.
    * Each color is defined by its 3 components. Therefore,
    * verifying the value of n_entries and n_comps is not necessary and
    * the buffer to hold the palette data can be static.  However,
    * if more values or colors are added to the model, these parameters
    * must be checked to allocate sufficient space when reading a palette.
    */
    printf ("  Palette Data: \n");
    for (i=0; i< n_entries; i++)
    {
       for (j = 0; j < n_comps; j++)
          printf ("%i ", palette_data[i][j]);
       printf ("\n");
    }
    printf ("\n");

    /*
    * Terminate access to the image and to the GR interface, and
    * close the HDF file.
    */
    status = GRendaccess (ri_id);
    status = GRend (gr_id);
    status = Hclose (file_id);
}
```

FORTRAN:

```
      program  read_palette
      implicit none
C
C     Parameter declaration
C
      character*22 FILE_NAME
      character*18 IMAGE_NAME
      integer      N_ENTRIES
      integer      N_COMPS_PAL
C
      parameter (FILE_NAME   = 'Image_with_Palette.hdf',
     +           IMAGE_NAME  = 'Image with Palette',
     +           N_COMPS_PAL = 3,
```

```
     +           N_ENTRIES   = 256)
      integer DFACC_READ, DFNT_CHAR8, DFNT_UINT8, MFGR_INTERLACE_PIXEL
      parameter (DFACC_READ  = 1,
     +           DFNT_CHAR8  = 4,
     +           DFNT_UINT8  = 21,
     +           MFGR_INTERLACE_PIXEL = 0)
C
C     Function declaration
C
      integer hopen, hclose
      integer mgstart, mgn2ndx, mgselct, mggltid, mgglinf,
     +        mgrclut, mgendac, mgend
C
C**** Variable declaration *******************************************
C
      integer    file_id, gr_id, ri_id, ri_index, pal_id, pal_index
      integer    interlace_mode
      integer    data_type, n_comps, n_entries_out
      integer    status
      integer    i, j
      character  palette_data(N_COMPS_PAL, N_ENTRIES)
C
C**** End of variable declaration ************************************
C
C
C     Open the file.
C
      file_id = hopen(FILE_NAME, DFACC_READ, 0)
C
C     Initialize the GR interface.
C
      gr_id = mgstart(file_id)
C
C     Get the index of the image IMAGE_NAME.
C
      ri_index = mgn2ndx(gr_id, IMAGE_NAME)
C
C     Get the image identifier.
C
      ri_id = mgselct(gr_id, 0)
C
C     Get the identifier of the palette attached to the image.
C
      pal_index = 0
      pal_id = mggltid(ri_id, pal_index)
C
C     Obtain information about the palette.
C
      status = mgglinf(pal_id, n_comps, data_type, interlace_mode,
     +                 n_entries_out)
      write(*,*) ' Palette: ', n_comps, ' components;  ',
     +           n_entries_out, ' entries'
C
C     Read the palette.
C
      status = mgrclut(pal_id, palette_data)
C
C     Display the palette data.
C
      write(*,*) "Palette data"
      do 10 i = 1, n_entries_out
         write(*,*) (ichar(palette_data(j,i)), j = 1, n_comps)
10    continue
```

```
C
C     Terminate access to the raster image and to the GR interface,
C     and close the HDF file.
C
      status = mgendac(ri_id)
      status = mgend(gr_id)
      status = hclose(file_id)
      end
```

8.11 Chunked Raster Images

The GR interface also supports chunking in a manner similar to that of the SD interface. There is one restriction on a raster image: it must be created with MFGR_INTERLACE_PIXEL (or 0) in the call to **GRcreate**. We refer the reader to Section 3.11 of Chapter 3, *Scientific Data Sets (SD API)*, and to Chapter 14, *HDF Performance Issues*, for discussions of chunking concepts and performance related topics. The GR interface provides three routines, **GRsetchunk**, **GRsetchunkcache**, and **GRgetchunkinfo**, to create and maintain chunked raster images. The GR interface does not have special write/read routines similar to **SDwritechunk/SDreadchunk**; chunked raster images are written and read by **GRwriteimage** and **GRreadimage**.

8.11.1 Making a Raster Image a Chunked Raster Image: GRsetchunk

GRsetchunk makes the raster image, identified by the parameter `ri_id`, a chunked raster image according to the provided chunking and compression information. The syntax of **GRsetchunk** is as follows:

C: `status = GRsetchunk(ri_id, c_def, flags);`

FORTRAN: `status = mgschnk(ri_id, dim_length, comp_type, comp_prm)`

The parameters `c_def` and `flags` in C or the parameters `comp_type` and `comp_prm` in FORTRAN-77 provide the chunking and compression information and are discussed below.

In C:

The parameter `c_def` is a union of type HDF_CHUNK_DEF, which is defined as follows:

```
typedef union hdf_chunk_def_u
    {
     int32 chunk_lengths[2];  /* chunk lengths along each dim */

     struct
          {
           int32 chunk_lengths[2];
           int32 comp_type;              /* compression type */
           struct comp_info cinfo;
          } comp;

     struct
          {
          /* is not used in GR interface */
          } nbit;
     } HDF_CHUNK_DEF
```

Valid values of the parameter `flags` are HDF_CHUNK for chunked and uncompressed data and (HDF_CHUNK | HDF_COMP) for chunked and compressed data. Data can be compressed using run-length encoding (RLE), Skipping Huffman, or GZIP compression algorithms.

If the parameter flags has a value of HDF_CHUNK, the chunk dimensions must be specified in the field c_def.chunk_lengths[]. If the parameter flags has a value of (HDF_CHUNK | HDF_COMP), the chunk dimensions must be specified in the field c_def.comp.chunk_lengths[] and the compression type in the field c_def.comp.comp_type. Valid values of compression type values are:

COMP_CODE_NONE (or 0) for uncompressed data

COMP_CODE_RLE (or 1) for data compressed using the RLE compression algorithm

COMP_CODE_SKPHUFF (or 3) for data compressed using the Skipping Huffman compression algorithm

COMP_CODE_DEFLATE (or 4) for data compressed using the GZIP compression algorithm

If using Skipping Huffman compression, the skipping size is specified in the field c_def.comp.cinfo.skphuff.skp_size. If using GZIP compression, the deflate level is specified in the field c_def.comp.cinfo.deflate.level. Valid deflate level values are integers from 1 to 9 inclusive. Refer to the discussion of **SDsetcompress** routine in Section 3.5.2 on page 46 for the definition of the structure comp_info.

In FORTRAN-77:

Chunk dimensions are specified in the array dim_length and the compression type in the parameter comp_type. Valid compression types and their values are defined in the "hdf.inc"file and are listed below:

COMP_CODE_NONE (or 0) for uncompressed data

COMP_CODE_RLE (or 1) for data compressed using the RLE compression algorithm

COMP_CODE_SKPHUFF (or 3) for data compressed using the Skipping Huffman compression algorithm

COMP_CODE_DEFLATE (or 4) for data compressed using the GZIP compression algorithm

The parameter comp_prm specifies the compression parameters for the Skipping Huffman and GZIP compression methods. It contains only one element which is set to the skipping size for Skipping Huffman compression or the deflate level for GZIP compression.

GRsetchunk returns SUCCEED (or 0) if successful and FAIL (or -1) otherwise. The **GRsetchunk** parameters are discussed further in Table 8L on page 317.

8.11.2 Obtaining Information about a Chunked Raster Image: GRgetchunkinfo

GRgetchunkinfo is used to determine whether a raster image is chunked and how chunking is defined. The syntax of the **GRgetchunkinfo** routine is as follows:

C: `status = GRgetchunkinfo(ri_id, &c_def, &flag);`

FORTRAN: `status = mggichnk(ri_id, dim_length, flag)`

GRgetchunkinfo retrieves chunking information about the raster image into the parameters c_def and flag in C and into the parameters dim_length and flag in FORTRAN-77. Note that only chunk dimensions are retrieved; compression information is not available.

The value returned in the parameter flag indicates whether the raster image is not chunked, chunked, or chunked and compressed. HDF_NONE (or -1) indicates that the raster image is not chunked. HDF_CHUNK (or 0) indicates that the raster image is chunked and not compressed. (HDF_CHUNK | HDF_COMP) (or 1) indicates that raster image is chunked and compressed with one of the allowed compression methods: RLE, Skipping Huffman, or GZIP.

In C, if the raster image is chunked and not compressed, **GRgetchunkinfo** fills the array `chunk_lengths` in the union `c_def` with the values of the corresponding chunk dimensions. If the raster image is chunked and compressed, **GRgetchunkinfo** fills the array `chunk_lengths` in the structure `comp` of the union `c_def` with the values of the corresponding chunk dimensions. Refer to Section 8.11.1 on page 315 on **GRsetchunk** for specific information on the union `HDF_CHUNK_DEF`. In C, if the chunk length for each dimension is not needed, `NULL` can be passed in as the value of the parameter `c_def`.

In FORTRAN-77, chunk dimensions are retrieved into the array `dim_length`.

GRgetchunkinfo returns `SUCCEED` (or `0`) if successful and `FAIL` (or `-1`) otherwise. The **GRgetchunkinfo** parameters are discussed further in Table 8L.

8.11.3 Setting the Maximum Number of Chunks in the Cache: GRsetchunkcache

GRsetchunkcache sets the maximum number of chunks to be cached for chunked raster image. **GRsetchunkcache** has similar behavior to **SDsetchunkcache**. Refer to Section 3.11.2 on page 106 for specific information. The syntax of **GRsetchunkcache** is as follows:

C: `status = GRsetchunkcache(ri_id, maxcache, flags);`

FORTRAN: `status = mgscchnk(ri_id, maxcache, flags)`

The maximum number of chunks is specified by the parameter `maxcache`. Currently, the only valid value of the parameter `flags` is `0`.

If **GRsetchunkcache** is not called, the maximum number of chunks in the cache is set to the number of chunks along the fastest-changing dimension. Since **GRsetchunkcache** is similar to the routine **SDsetchunkcache**, refer to Section 3.11.2 on page 106 for more detailed discussion of the routine's behavior.

GRsetchunkcache returns the value of the parameter `maxcache` if successful and `FAIL` (or `-1`) otherwise. The **GRsetchunkcache** parameters are discussed further in Table 8L.

TABLE 8L **GRsetchunk, GRgetchunkinfo, and GRsetchunkcache Parameter Lists**

Routine Name [Return Type] (FORTRAN-77)	Parameter	Parameter Type		Description
		C	FORTRAN-77	
GRsetchunk [intn] **(mgschnk)**	ri_id	int32	integer	Raster image identifier
	c_def	HDF_CHUNK_DEF	N/A	Chunk definition
	flags	int32*	N/A	Compression flags
	dim_length	N/A	integer	Chunk dimensions array
	comp_type	N/A	integer	Type of compression
	comp_prm	N/A	integer	Compression parameters array
GRgetchunkinfo [intn] **(mggichnk)**	ri_id	int32	integer	Raster image identifier
	c_def	HDF_CHUNK_DEF	N/A	Chunk definition
	dim_length	N/A	integer	Chunk dimensions array
	flag	int32	integer	Compression flag
GRsetchunkcache [intn] **(mgscchnk)**	ri_id	int32	integer	Raster image identifier
	maxcache	int32	integer	Maximum number of chunks to cache
	flags	int32	integer	Flags determining routine behavior