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# HDF5 Augmentation Tool for JPSS Product Files

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# Contents

1. Introduction .....	5
1.1. When to Run h5augjpss .....	6
1.2. When Not to Run h5augjpss .....	6
2. Building, Installing, and Running h5augjpss .....	7
2.1. Building and Testing the Program .....	7
2.2. Command Syntax .....	8
2.3. Command Line Options .....	9
2.4. Input File Directories .....	11
2.5. File Diagram and Command Line Actions .....	12
3. Examples of h5augjpss Usage .....	13
3.1. Modifying a File with h5augjpss .....	14
3.1.1. Using the <code>-o1</code> Option .....	15
3.1.2. Using the <code>-o2</code> Option .....	17
3.1.3. Using the <code>-o3</code> Option .....	22
3.1.4. Using the <code>-o4</code> Option .....	24
3.2. Using All of the <code>-o</code> Options .....	26
3.3. Using the Restore Options .....	27
3.3.1. Using the <code>-r1</code> Option .....	27
3.3.2. Using the <code>-r4</code> Option .....	28
4. Making Changes to JPSS Data Files after Using h5augjpss .....	31
4.1. Visualizing Data with IDV and Panoply .....	31
4.2. Producing a More Accurate Visualization .....	34

## 1. Introduction

JPSS data products are distributed in the HDF5 file format. However, many applications that will use this data are “netCDF-based.” That is, many popular data analysis and visualization applications used by the climate and weather forecasting and research communities assume their data conforms to the netCDF data model. In addition, many programmers prefer to implement applications using a netCDF application programming interface (API).

Although the new version of the netCDF library, netCDF-4, uses HDF5 as its storage layer, applications built with the netCDF library cannot read every HDF5 file. Applications that use the netCDF-4 API can only read files that conform to the netCDF-4 data model. Since JPSS product files do not conform to the netCDF-4 data model, the netCDF-4 library cannot access them. This means, in turn, that applications that use the netCDF-4 library also cannot access JPSS product files.

To complicate matters, many data analysis and visualization tools need more than just a netCDF-4 accessible file. These tools rely on metadata such as dimension variables, geolocation information, and miscellaneous attributes to interpret and display the data. Since this metadata is not present in JPSS data product files, additional modifications may be needed before data can be meaningfully analyzed and visualized. Fortunately, much of the needed metadata is available in JPSS XML product files and in JPSS geolocation files.

To change JPSS data files so that they are accessible to netCDF-based tools, we have developed an augmentation tool. The name of the executable is h5augjpss. The options that are available with the tool will enable users to change the JPSS files only as much as they need. The tool and the various options will be described in the rest of this document.

### For More Information

It is not necessary to know HDF5 or netCDF in order to follow this material, but a basic understanding of netCDF and HDF5 would be helpful. For a primer on the two formats, see the netCDF Tutorial at <http://www.unidata.ucar.edu/software/netcdf/docs/netcdf-tutorial.html>, and see the HDF5 Tutorial at <http://www.hdfgroup.org/HDF5/Tutor>.

The files used in the examples of this document can be found at <http://www.hdfgroup.uiuc.edu/ftp/pub/outgoing/JPSS>.

### Comments

Send questions or comments to the HDF Group Help Desk via [help@hdfgroup.org](mailto:help@hdfgroup.org).

## 1.1. When to Run h5augjpss

The following table assumes the user application is built to read non-aggregated and non-packaged JPSS product files.

If the user application is built to read:	Then the user should run h5augjpss with this option:
netCDF-4 files	-o1
netCDF classic (netCDF-3) files	-o1 and -o4
Files with dimension scales or other attributes and the data file does not have these attributes	-o2
Files with geolocation datasets (datasets labeled Height, Latitude, and Longitude (or links labeled Height, Latitude, and Longitude to datasets)) and the data file does not have these datasets	-o3

IDV and Panoply use netCDF-Java. If the version of netCDF-Java is 4.2 or later, then the JPSS data files do not need to be changed with h5augjpss. If the version of netCDF-Java is earlier than 4.2, then the data files need to be changed with h5augjpss using the -o1 option. If visualization is required, then the -o3 option should also be used.

## 1.2. When Not to Run h5augjpss

If an application requires an attribute that is not found in the XML schema file or the geolocation file, then h5augjpss will not be able to change the JPSS data file enough. If the commonly required changes that h5augjpss can make will not help, then you might want to consider using the HDFView or h5edit tools to change the data file. See the “Making Changes to JPSS Data Files after Using h5augjpss” chapter on page 31 for more information.

## 2. Building, Installing, and Running h5augjpss

The following are some notes about how to build, install, and run h5augjpss.

A copy of the h5augjpss source files can be downloaded from <http://www.hdfgroup.org/ftp/HDF5/projects/jpss/h5augjpss/>.

h5augjpss is a standalone tool that is run from the command line. The currently available version of the program can be built to work on 32- and 64-bit Linux systems.

The installation process is a file copy operation: copy the file to the directory where you want to keep the program.

In this version of the program, there is no file with configuration settings. To adjust the program's behavior, add one or more of the options to the command line statement when the program is executed. The available options are described in the "Command Syntax" section beginning on page 8.

To run the program, run it from the directory where it is kept, or put in the path the directory where the program is stored.

### 2.1. Building and Testing the Program

Here are some notes that will help you build and test the h5augjpss program.

Before you can build the program, confirm that **HDF5 Release 1.8.x** software is installed and that the **libxml2-devel** package has been installed.

The Makefile in the src directory will use **h5cc** from the installed HDF5 software. If more than one copy of HDF5 is installed, the Makefile will use the first h5cc found according to the PATH. If h5cc is not in the PATH or if h5cc from a different HDF5 version is desired, the Makefile can be edited to specify the full path to h5cc.

The Makefile expects to find header files for **libxml2** in `/usr/include/libxml2` and to link to `/usr/lib/libxml2.a`. If these are installed in another location, edit the paths in the Makefile.

When the paths are correct:

1. Run make in the src directory.
2. Check for the h5augjpss binary in the top level directory.

To **test** the program, go to the test directory, and check the `NCDUMP` and `H5DUMP` variables at the top of the script. If the variables do not work as specified, change them to point to the installed `ncdump` and `HDF5 h5dump` binaries. To run the test, enter the following at the command line:

```
sh test_h5ajpss.sh
```

Please use only the netCDF-4 version of the `ncdump` utility.

## 2.2. Command Syntax

The general command line syntax for the h5augjpss program is the following:

```
h5augjpss [[-option]|[-rrestore_option]] [xmlSchemaFile] h5file
```

where

**h5augjpss** is the name of the executable,

**-option** specifies one of the ways the data file might be changed,

**-rrestore\_option** specifies one of the ways to undo the changes made by a **-o** option,

**xmlSchemaFile** is the name of the XML schema file associated with the data file, and

**h5file** is the name of the JPSS data file that will be changed.

These command line elements are explained in more detail in the sub-sections below.

For help, use the following command line syntax:

```
h5augjpss [-h|--help]
```

### **h5augjpss**

If the program is run without specifying any options, all the options, -o1 to -o4, will be used.

#### **-option**

The **-o** command line option is used to specify a type of change made to a data file by h5augjpss. *option* is a number. The currently valid numbers are 1, 2, 3, and 4 and would appear on the command line as **-o1**, **-o2**, **-o3**, or **-o4**. Any or all of the **-o** command line options can be used when the program is run. The order of the **-o** command line options is not important. In other words, the **-o** options do not need to be in ascending order. If **-o** is not included on the command line, then the program will run as if **-o1**, **-o2**, **-o3**, and **-o4** had been specified. See the “Command Line Options” section on page 9 for a description of the actions taken by the different options.

**-rrestore\_option**

The `-r` command line options can be used to undo the actions of some of the `-o` command line options. *restore\_option* is a number. The currently valid numbers are 1 and 4 and would appear on the command line as `-r1` or `-r4`. The program can be run without one of the `-r` options being specified. The `-r` option might be used once or twice and can occur in any order in the command line. See the “Command Line Options” section on page 9 for a description of the actions taken for the different options.

**xmlSchemaFile**

Each type of data file is associated with a JPSS product profile XML schema file. The XML schema file defines the elements in the data file. The XML schema file should be added to the command line when option 2, `-o2`, is used or when no options are specified. See the “Command Line Options” section below for more information.

**h5file**

`h5file` is the JPSS data file and must be specified each time the program runs. All JPSS data files are HDF5 files. See the “File Diagram and Command Line Actions” section on page 12 for a simplified view of a JPSS data file.

**2.3. Command Line Options**

When you run the `h5augjps` program from the command line, you can use any of several options to tell the program what to change in a data file. The various command line options are described in the table below.

Option	Comments
<code>-h</code> or <code>-help</code>	Use one of these options to display the available help text.
<code>-o1</code>	<p>Use this option to remove the link to the <code>Data_Products</code> group. Removing the link hides the group and allows <code>netCDF-4</code>-based tools and applications to open the data file. The <code>Data_Products</code> group may contain an HDF5 reference datatype or an integer attribute with multiple dimensions that will block <code>netCDF-4</code>-based tools and applications from opening the file. Running this option should be sufficient to allow a basic <code>netCDF-4</code> based tool such as <code>ncdump</code> to display the contents of the data file. This option is not a prerequisite for executing the other options, but it is necessary in order to see with <code>ncdump</code> the effects of the other command line options.</p> <p>If the data file does not have a <code>Data_Products</code> group, <code>h5augjps</code> returns a message saying the group was not found.</p> <p>If <code>ncdump</code> is used to display data in a file with a visible <code>Data_Products</code> group, the following error message will be returned: “NetCDF: Bad type ID.”</p> <p>When the program uses this option, it saves information about the link to the <code>Data_Products</code> group so that at a later time the link might be restored. The changes made with <code>-o1</code> can be</p>

Option	Comments
	<p>reversed by using the <code>-r1</code> option.</p> <p>For more information, see the “Using the <code>-o1</code> Option” section on page 15.</p>
-o2	<p>Use this option to add dimension scales and other attributes to each of the datasets that contain raw data. If this option is used, an XML schema file must also be specified on the command line.</p> <p>This option adds dimension scales and other attributes from the specified XML schema file. The specified XML schema file’s <code>&lt;CollectionShortName&gt;</code> value must match the name of the data file’s <code>All_Data</code> group that contains the file’s raw data datasets. The dimension scales and several other attributes specified by <code>&lt;datum&gt;</code> in the XML schema file will be attached to the appropriate datasets after running this option.</p> <p>This option adds:</p> <ul style="list-style-type: none"> <li>• Dimension scales for <code>&lt;Field&gt;/&lt;Dimension&gt;</code> tags in the XML schema file as long as the file has a dataset with a name that matches the <code>&lt;Field&gt;</code> name and does not already have a dimension scale attached.</li> <li>• An attribute to the dataset matching the <code>&lt;Field&gt;</code> name for each <code>&lt;Field&gt;/&lt;Datum&gt;</code> in the XML schema file.</li> </ul> <p>This version of h5augjpss also checks that the size of the datatype for each field is the same for the dataset that it matches. If they are not the same or if no dataset matching the field (by name) is found, a warning is issued. These mismatches commonly occur together where the datatype of the “Radiance” field is unsigned short while that of the “Radiance” field is float, and at the same time, the <code>RadianceFactors</code> dataset is missing.</p> <p>Please note that there is no option provided to reverse the changes made with this option.</p> <p>For more information, see the “Using the <code>-o2</code> Option” section on page 17.</p>
-o3	<p>Use this option to add the Height, Latitude, and Longitude geolocation datasets from the file specified by the <code>N_GEO_Ref</code> attribute in the data file.</p> <p>This option copies the geolocation datasets from the file specified in the data file’s <code>N_GEO_Ref</code> attribute. The <code>N_GEO_Ref</code> attribute is attached to the root group. In order for this option to work, the data file and the file with the geolocation datasets must be in the same directory. The data file will have datasets named “Height”, “Latitude,” and “Longitude” after running this option. If the data file already has Height, Latitude, and Longitude datasets, then the program will not copy these datasets to the data file.</p> <p>The Height, Latitude, and Longitude datasets will always be copied to the group that is holding the raw data datasets. If the program runs the <code>-o4</code> option before the <code>-o3</code> option, the group structure will first be restored; the Height, Latitude, and Longitude datasets will be added to the <code>&lt;CollectionShortName&gt;</code> group; and then the raw data and geolocation datasets will be linked directly to the root group.</p> <p>Please note that there is no option provided to reverse the changes made with this option.</p>

Option	Comments
	For more information, see the “Using the <code>-o3</code> Option” section on page 22.
-o4	<p>Use this option to move the datasets that hold raw data to the root group. This change is accomplished by making links from the root group to the raw data datasets and by removing the link from the root group to the All_Data group. This flattening of the file’s structure allows some netCDF-based tools and applications that do not support HDF5 groups to potentially access the file.</p> <p>The <code>-r4</code> option can be used to restore the links to their original configuration.</p> <p>For more information, see the “Using the <code>-o4</code> Option” section on page 24.</p>
-r1	<p>Use this option to reverse the change made by the <code>-o1</code> option. In other words, this option restores the link to the Data_Products group from the root group.</p> <p>For more information, see the “Using the <code>-r1</code> Option” section on page 27.</p>
-r4	<p>Use this option to reverse the change made by the <code>-o4</code> option. In other words, this option restores the link to the All_Data group from the root group and removes the links to the datasets from the root group.</p> <p>For more information, see the “Using the <code>-r4</code> Option” section on page 28.</p>

Note that the `-o` options described above can be run in any order and any combination and that the `-r` options described above can be run in any order.

If h5augjpss is run with no options specified, then the program will run with all four `-o` options.

See the “File Diagram and Command Line Actions” section on page 12 for more information.

## 2.4. Input File Directories

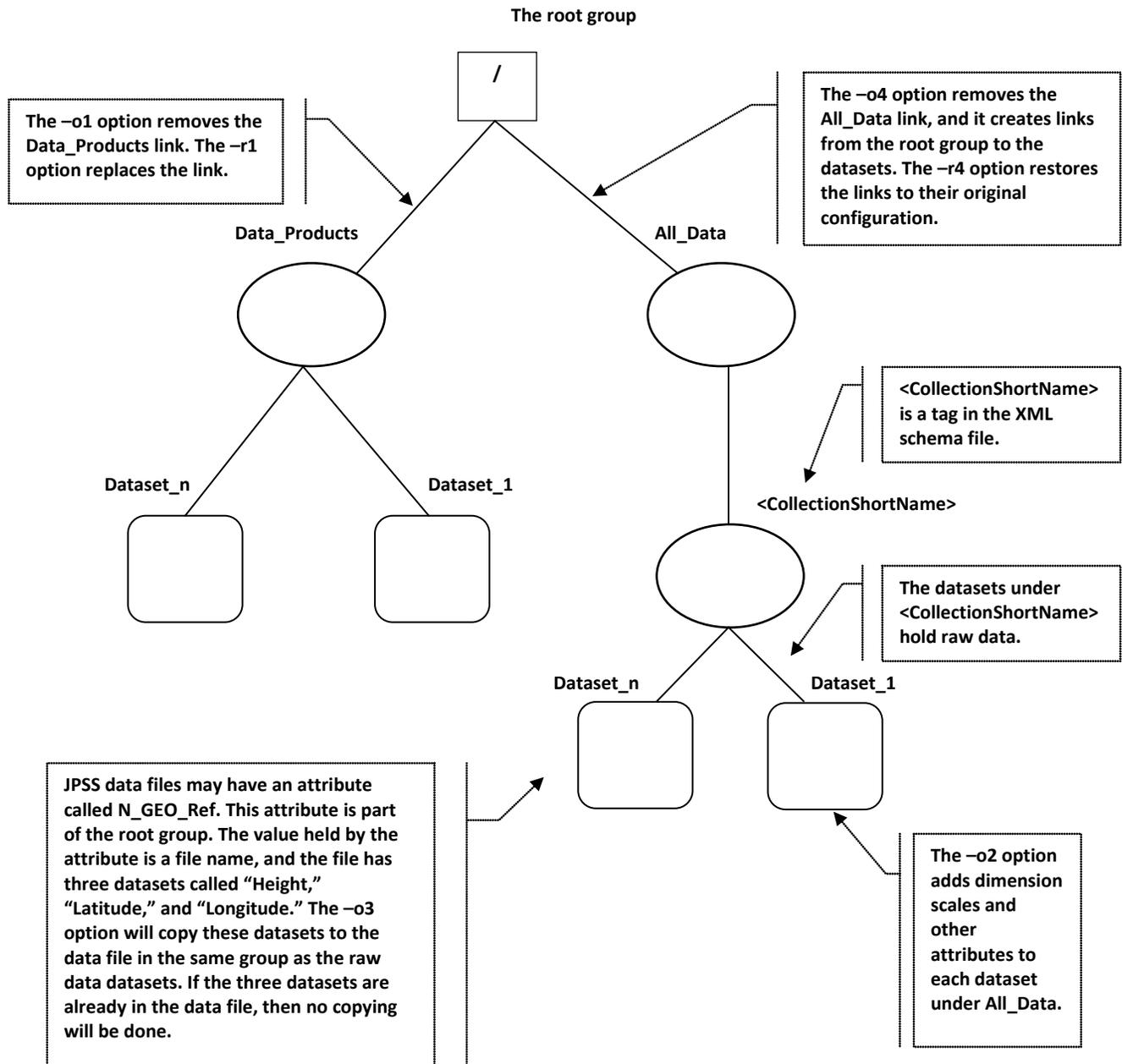
Absolute or relative paths (relative to the current working directory) may be specified for the XML schema file and the data file. An environment variable H5AUGJPSS\_DATADIR may also be set with a path to the directory where the files are located. If H5AUGJPSS\_DATADIR is defined, the paths may be omitted. If the environment variable is set and a path is also specified, the specified path will be used.

If a path is specified for the data file only, the path will be used for the data file, and h5augjpss will search for the XML schema file first in the directory specified by the environment variable if set, then in the directory specified for the data file, and finally in the current working directory.

The file specified in the data file for the geolocation datasets must be in the same directory as the data file.

## 2.5. File Diagram and Command Line Actions

The picture below shows the groups, links, and datasets in a simplified JPSS data file and where the h5augjps tool might change the file. This picture is another view of what the various command line options might do. See the “Command Line Options” section on page 9 for more information.



### 3. Examples of h5augjpss Usage

The examples in this chapter demonstrate different ways that data files might be changed by h5augjpss. The examples show the effect of the four augmentation options and the two restore options currently available with the program. The augmentation options and the restore options will be used one at a time. See the “Command Line Options” section on page 9 for more information.

The example files used in this chapter can be found at <http://www.hdfgroup.uiuc.edu/ftp/pub/outgoing/JPSS>.

The names of the three files used in these examples are the following:

- **SVI05\_aqu\_d20110314\_t0827436\_e0828535\_b47134\_c20110314115650161557\_grav\_dev.h5**
- **D34862-03\_NPOESS-CDFCB-X-Vol-III\_D\_VIIRS-I5-SDR-PP.xml**
- **GIMGO\_aqu\_d20110314\_t0827436\_e0828535\_b47134\_c20110314115547657273\_grav\_dev.h5**

The bold text in the file names above are abbreviations of the file names. These abbreviations will be used in the rest of this document when referring to these three files. The abbreviated names are the following:

- SVI05.h5
- D\_VIIRS-I5-SDR-PP.xml
- GIMGO.h5.

### 3.1. Modifying a File with h5augjps

This set of examples shows what happens when the h5augjps augmentation options are applied to a data file. In these examples, the options will be applied one at a time.

To see if a file needs one or more of the augmentation options, run the ncdump tool with the following command line:

```
ncdump -h SVI05.h5
```

If the tool returns the following message, then the data file will need to be changed:

```
ncdump: SVI05.h5: NetCDF: Bad type ID
```

This message means the file cannot be opened by ncdump. The “Bad type ID” is caused by the H5T\_REFERENCE datatype which is not recognized by netCDF-4.

The HDF5 h5ls tool shows the datasets (variables in netCDF-4) and groups in the original file. Use the following command line to look at the data file with h5ls:

```
h5ls -r SVI05.h5
```

h5ls will return the following:

```
/
/All_Data          Group
/All_Data/VIIRS-I5-SDR_All Group
/All_Data/VIIRS-I5-SDR_All/BrightnessTemperature Dataset {1536, 6400}
/All_Data/VIIRS-I5-SDR_All/BrightnessTemperatureFactors Dataset {2}
/All_Data/VIIRS-I5-SDR_All/ModeGran Dataset {1}
/All_Data/VIIRS-I5-SDR_All/ModeScan Dataset {48}
/All_Data/VIIRS-I5-SDR_All/NumberOfBadChecksums Dataset {48}
/All_Data/VIIRS-I5-SDR_All/NumberOfDiscardedPkts Dataset {48}
/All_Data/VIIRS-I5-SDR_All/NumberOfMissingPkts Dataset {48}
/All_Data/VIIRS-I5-SDR_All/NumberOfScans Dataset {1}
/All_Data/VIIRS-I5-SDR_All/PadByte1 Dataset {3}
/All_Data/VIIRS-I5-SDR_All/QF1_VIIRSIBANDSDR Dataset {1536, 6400}
/All_Data/VIIRS-I5-SDR_All/QF2_SCAN_SDR Dataset {48}
/All_Data/VIIRS-I5-SDR_All/QF3_SCAN_RDR Dataset {48}
/All_Data/VIIRS-I5-SDR_All/QF4_SCAN_SDR Dataset {1536}
/All_Data/VIIRS-I5-SDR_All/QF5_GRAN_BADDETECTOR Dataset {16}
/All_Data/VIIRS-I5-SDR_All/Radiance Dataset {1536, 6400}
/All_Data/VIIRS-I5-SDR_All/RadianceFactors Dataset {2}
/Data_Products    Group
/Data_Products/VIIRS-I5-SDR Group
/Data_Products/VIIRS-I5-SDR/VIIRS-I5-SDR_Aggr Dataset {16/Inf}
/Data_Products/VIIRS-I5-SDR/VIIRS-I5-SDR_Gran_0 Dataset {16/Inf}
```

### 3.1.1. Using the `-o1` Option

Using h5augjps with the `-o1` option hides the Data\_Products group with the unrecognized H5T\_REFERENCE datatype. This allows ncdump to display the file. This modification is necessary for any netCDF-4-based tool or application. For more information on the `-o1` option, see page 9.

Use the following command line to run h5augjps with the `-o1` option:

```
H5augjps -o1 SVI05.h5
```

where

`h5augjps` is the name of the executable,

`-o1` specifies the way the data file will be changed,

`SVI05.h5` is the name of the JPSS data file that will be changed.

#### Command Output (stderr):

The following status message will be returned by h5augjps:

```
Data file is SVI05.h5.
Disconnect Data_Products group.
```

#### Check the Resulting File

To check the result of the operation on the file, run ncdump from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

The output from ncdump will be the following:

```
netcdf SVI05 {
// global attributes:
    string :N_GEO_Ref =
"GIMGO_aqu_d20110314_t0827436_e0828535_b47134_c20110314115547657273_grav_dev.h5" ;
    string :Distributor = "grav" ;
    string :Mission_Name = "NPP_Proxy" ;
    string :N_Dataset_Source = "NOAA" ;
    string :N_HDF_Creation_Date = "20110314" ;
    string :N_HDF_Creation_Time = "115650.000000Z" ;
    string :Platform_Short_Name = "NPP" ;
    :HDF5_internal_address_of_Data_Products = 19664264UL ;
    :HDF5_internal_name_of_Data_Products = "/Data_Products" ;

group: All_Data {
    group: VIIRS-I5-SDR_All {
```

```
dimensions:
  phony_dim_0 = 1536 ;
  phony_dim_1 = 6400 ;
  phony_dim_2 = 2 ;
  phony_dim_3 = 1 ;
  phony_dim_4 = 48 ;
  phony_dim_5 = 3 ;
  phony_dim_6 = 16 ;
variables:
  ushort BrightnessTemperature(phony_dim_0, phony_dim_1) ;
  float BrightnessTemperatureFactors(phony_dim_2) ;
  ubyte ModeGran(phony_dim_3) ;
  ubyte ModeScan(phony_dim_4) ;
  int NumberOfBadChecksums(phony_dim_4) ;
  int NumberOfDiscardedPkts(phony_dim_4) ;
  int NumberOfMissingPkts(phony_dim_4) ;
  int NumberOfScans(phony_dim_3) ;
  ubyte PadByte1(phony_dim_5) ;
  ubyte QF1_VIIRSIBANDSDR(phony_dim_0, phony_dim_1) ;
  ubyte QF2_SCAN_SDR(phony_dim_4) ;
  ubyte QF3_SCAN_RDR(phony_dim_4) ;
  ubyte QF4_SCAN_SDR(phony_dim_0) ;
  ubyte QF5_GRAN_BADDETECTOR(phony_dim_6) ;
  ushort Radiance(phony_dim_0, phony_dim_1) ;
  float RadianceFactors(phony_dim_2) ;
} // group VIIRS-I5-SDR_All
} // group All_Data
}
```

The attributes beginning with HDF5\_internal are added by the tool to save information needed to restore the hidden groups.

Since there are no dimension scales, ncdump creates phony\_dims to display the dimensions.

### 3.1.2. Using the `-o2` Option

If you run `h5augjpss` with the `-o1` option and see phony dimension scales, then you will want to run the tool with the `-o2` option. The `-o2` option will get the dimension scales from the XML schema file specified on the command line and replace the `phony_dims`. For more information on the `-o2` option, see page 10.

Use the following command line to run `h5augjpss` with the `-o2` option:

```
h5augjpss -o2 D_VIIRS-I5-SDR-PP.xml SVI05.h5
```

where

`h5augjpss` is the name of the executable,

`-o2` specifies the way the data file will be changed,

`D_VIIRS-I5-SDR-PP.xml` is the name of the XML schema file associated with the data file, and

`SVI05.h5` is the name of the JPSS data file that will be changed.

A substantial number of attributes will be added from the data in the XML schema file. Failures to match between the XML schema file and the data file will be reported as WARNINGS on `stderr`. If this option is used after the `-o4` option has been used on the data file, then the links to the `All_Data` group and any sub-groups will be restored and then removed.

#### Command Output (`stderr`):

The following will be returned by `h5augjpss`:

```
XML file is D_VIIRS-I5-SDR-PP.xml.  
Data file is SVI05.h5.  
Restored link to /All_Data group.  
Parse xml file D34862-03_NPOESS-CDFCB-X-Vol-III_D_VIIRS-I5-SDR-PP.xml.  
Process fields.  
Add links in '/' to datasets in /All_Data/VIIRS-I5-SDR_All, then remove  
access to /All_Data group.
```

#### Check the Resulting File

To check the result of the operation on the file, run `ncdump` from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

The following is the first part of the output from `ncdump`:

```

netcdf SVI05 {
dimensions:
    AlongTrack = 1536 ;
    CrossTrack = 6400 ;
    Detector = 32 ;
    Factors = 2 ;
    Granule = 1 ;
    Granule_3 = 3 ;
    Scan = 48 ;
variables:
    int AlongTrack(AlongTrack) ;
    ushort BrightnessTemperature(AlongTrack, CrossTrack) ;
        BrightnessTemperature:Description = "Calibrated Top of Atmosphere (TOA) Brightness Temperature for each
VIIRS pixel" ;
        BrightnessTemperature:DatumOffset = 0 ;
        BrightnessTemperature:Scaled = 1 ;
        BrightnessTemperature:ScaleFactorName = "BrightnessTemperatureFactors" ;
        BrightnessTemperature:MeasurementUnits = "kelvin" ;
        BrightnessTemperature:FillValue_NA_UINT16_FILL = -1US ;
        BrightnessTemperature:FillValue_MISS_UINT16_FILL = -2US ;
        BrightnessTemperature:FillValue_ONBOARD_PT_UINT16_FILL = -3US ;
        BrightnessTemperature:FillValue_ONGROUND_PT_UINT16_FILL = -4US ;
        BrightnessTemperature:FillValue_ERR_UINT16_FILL = -5US ;
        BrightnessTemperature:FillValue_VDNE_UINT16_FILL = -7US ;
        BrightnessTemperature:FillValue_SOUB_UINT16_FILL = -8US ;
        string BrightnessTemperature:DIMENSION_LABELS = "AlongTrack", "CrossTrack" ;
    float BrightnessTemperatureFactors(Factors) ;
        string BrightnessTemperatureFactors:DIMENSION_LABELS = "Factors" ;
        BrightnessTemperatureFactors:Description = "Scale = first array element; Offset = second array element" ;
        BrightnessTemperatureFactors:DatumOffset = 0 ;
        BrightnessTemperatureFactors:Scaled = 0 ;
        BrightnessTemperatureFactors:MeasurementUnits = "scale = unitless; offset = kelvin" ;
    int CrossTrack(CrossTrack) ;
    int Detector(Detector) ;
    int Factors(Factors) ;
    int Granule(Granule) ;
    int Granule_3(Granule_3) ;
    float Height(AlongTrack, CrossTrack) ;
    float Latitude(AlongTrack, CrossTrack) ;
    float Longitude(AlongTrack, CrossTrack) ;
    ubyte ModeGran(Granule) ;
        string ModeGran:DIMENSION_LABELS = "Granule" ;
        ModeGran:Description = "The VIIRS operational mode, reported at the granule level" ;
        ModeGran:DatumOffset = 0 ;
        ModeGran:Scaled = 0 ;
        ModeGran:MeasurementUnits = "unitless" ;
        ModeGran:FillValue_MISS_UINT8_FILL = 254UB ;
        ModeGran:FillValue_ERR_UINT8_FILL = 251UB ;

```

```

ModeGran:FillValue_VDNE_UINT8_FILL = 249UB ;
ModeGran:LegendEntry_Night = 0. ;
ModeGran:LegendEntry_Day = 1. ;
ModeGran:LegendEntry_Mixed = 2. ;
ubyte ModeScan(Scan) ;
string ModeScan:DIMENSION_LABELS = "Scan" ;
ModeScan:Description = "The VIIRS operational mode, reported at the scan level" ;
ModeScan:DatumOffset = 0 ;
ModeScan:Scaled = 0 ;
ModeScan:MeasurementUnits = "unitless" ;
ModeScan:FillValue_MISS_UINT8_FILL = 254UB ;
ModeScan:FillValue_ERR_UINT8_FILL = 251UB ;
ModeScan:FillValue_VDNE_UINT8_FILL = 249UB ;
ModeScan:LegendEntry_Night = 0. ;
ModeScan:LegendEntry_Day = 1. ;

```

### Compare the XML File with the ncdump Output

Two fields from the D\_VIIRS-I5-SDR-PP.xml file are shown below. The values for BrightnessTemperature and BrightnessTemperatureFactors shown below can be found in the ncdump output shown above. Compare, for example, the values tagged as FillValue below with the BrightnessTemperature fill values listed above.

```

<Field>
  <Name>BrightnessTemperature</Name>
  <Dimension>
    <Name>AlongTrack</Name>
    <GranuleBoundary>1</GranuleBoundary>
    <Dynamic>0</Dynamic>
    <MinIndex>1536</MinIndex>
    <MaxIndex>1536</MaxIndex>
  </Dimension>
  <Dimension>
    <Name>CrossTrack</Name>
    <GranuleBoundary>0</GranuleBoundary>
    <Dynamic>0</Dynamic>
    <MinIndex>6400</MinIndex>
    <MaxIndex>6400</MaxIndex>
  </Dimension>
  <DataSize>
    <Count>2</Count>
    <Type>byte(s)</Type>
  </DataSize>
  <Datum>

```

```

pixel</Description>
  <Description>Calibrated Top of Atmosphere (TOA) Brightness Temperature for each VIIRS
  <DatumOffset>0</DatumOffset>
  <Scaled>1</Scaled>
  <ScaleFactorName>BrightnessTemperatureFactors</ScaleFactorName>
  <MeasurementUnits>kelvin</MeasurementUnits>
  <DataType>unsigned 16-bit integer</DataType>
  <FillValue>
    <Name>NA_UINT16_FILL</Name>
    <Value>65535</Value>
  </FillValue>
  <FillValue>
    <Name>MISS_UINT16_FILL</Name>
    <Value>65534</Value>
  </FillValue>
  <FillValue>
    <Name>ONBOARD_PT_UINT16_FILL</Name>
    <Value>65533</Value>
  </FillValue>
  <FillValue>
    <Name>ONGROUND_PT_UINT16_FILL</Name>
    <Value>65532</Value>
  </FillValue>
  <FillValue>
    <Name>ERR_UINT16_FILL</Name>
    <Value>65531</Value>
  </FillValue>
  <FillValue>
    <Name>VDNE_UINT16_FILL</Name>
    <Value>65529</Value>
  </FillValue>
  <FillValue>
    <Name>SOUB_UINT16_FILL</Name>
    <Value>65528</Value>
  </FillValue>
</Datum>
</Field>

<Field>
  <Name>BrightnessTemperatureFactors</Name>
  <Dimension>
    <Name>Factors</Name>
    <GranuleBoundary>1</GranuleBoundary>
    <Dynamic>0</Dynamic>
    <MinIndex>2</MinIndex>
    <MaxIndex>2</MaxIndex>
  </Dimension>

```

```
</Dimension>
<DataSize>
  <Count>4</Count>
  <Type>byte(s)</Type>
</DataSize>
<Datum>
  <Description>Scale = first array element; Offset = second array element</Description>
  <DatumOffset>0</DatumOffset>
  <Scaled>0</Scaled>
  <MeasurementUnits>scale = unitless; offset = kelvin</MeasurementUnits>
  <DataType>32-bit floating point</DataType>
</Datum>
</Field>
```

### 3.1.3. Using the `-o3` Option

Running the h5augjpss program with the `-o3` option will add geolocation data to the data file. For more information on the `-o3` option, see page 10.

Use the following command line to run h5augjpss with the `-o3` option:

```
h5augjpss -o3 SVI05.h5
```

where

`h5augjpss` is the name of the executable,

`-o3` specifies the way the data file will be changed, and

`SVI05.h5` is the name of the JPSS data file that will be changed.

If this option is used after the `-o4` option has been used on the data file, then the links to the All\_Data group and any sub-groups will be restored and then removed.

#### Command Output (stderr):

The following will be returned by h5augjpss:

```
Data file is SVI05.h5.  
Restored link to /All_Data group.  
Add geolocation datasets.  
Add links in '/' to datasets in /All_Data/VIIRS-I5-SDR_All, then remove  
access to /All_Data group.
```

#### Check the Resulting File

To check the result of the operation on the file, run `ncdump` from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

The variables Height, Latitude, and Longitude are now present in the file. Note they have the same dimensions as several of the original variables. The output from `ncdump` will be the following:

```
netcdf SVI05 {  
dimensions:  
    phony_dim_0 = 1536 ;  
    phony_dim_1 = 6400 ;  
    phony_dim_2 = 2 ;  
    phony_dim_3 = 1 ;  
    phony_dim_4 = 48 ;  
    phony_dim_5 = 3 ;  
    phony_dim_6 = 16 ;
```

```
variables:
    ushort BrightnessTemperature(phony_dim_0, phony_dim_1) ;
    float BrightnessTemperatureFactors(phony_dim_2) ;
    float Height(phony_dim_0, phony_dim_1) ;
    float Latitude(phony_dim_0, phony_dim_1) ;
    float Longitude(phony_dim_0, phony_dim_1) ;
    ubyte ModeGran(phony_dim_3) ;
    ubyte ModeScan(phony_dim_4) ;
    int NumberOfBadChecksums(phony_dim_4) ;
    int NumberOfDiscardedPkts(phony_dim_4) ;
    int NumberOfMissingPkts(phony_dim_4) ;
    int NumberOfScans(phony_dim_3) ;
    ubyte PadByte1(phony_dim_5) ;
    ubyte QF1_VIIRSIBANDSDR(phony_dim_0, phony_dim_1) ;
    ubyte QF2_SCAN_SDR(phony_dim_4) ;
    ubyte QF3_SCAN_RDR(phony_dim_4) ;
    ubyte QF4_SCAN_SDR(phony_dim_0) ;
    ubyte QF5_GRAN_BADDETECTOR(phony_dim_6) ;
    ushort Radiance(phony_dim_0, phony_dim_1) ;
    float RadianceFactors(phony_dim_2) ;

// global attributes:
    string :N_GEO_Ref = "GIMGO.h5" ;
    string :Distributor = "grav" ;
    string :Mission_Name = "NPP_Proxy" ;
    string :N_Dataset_Source = "NOAA" ;
    string :N_HDF_Creation_Date = "20110314" ;
    string :N_HDF_Creation_Time = "115650.000000Z" ;
    string :Platform_Short_Name = "NPP" ;
    :HDF5_internal_address_of_/Data_Products = 19664264UL ;
    :HDF5_internal_name_of_/Data_Products = "/Data_Products" ;
    :HDF5_internal_address_of_/All_Data = 800UL ;
    :HDF5_internal_name_of_/All_Data = "/All_Data" ;
}
```

To replace the phony\_dim values, see the “Using the –o2 Option” section on page 17 for more information.

### 3.1.4. Using the `-o4` Option

The `-o4` options can be used with `h5augjpss` to flatten the group structure in the data file to one level. This is done by removing the link to the `All_Data` group and by adding links from the root group to the raw data datasets located under the `All_Data` group. For more information on the `-o4` option, see page 11.

Use the following command line to run `h5augjpss` with the `-o4` option:

```
h5augjpss -o4 SVI05.h5
```

where

`h5augjpss` is the name of the executable,

`-o4` specifies the way the data file will be changed, and

`SVI05.h5` is the name of the JPSS data file that will be changed.

#### Command Output (stderr):

The following will be returned by `h5augjpss`:

```
Data file is SVI05.h5.  
Add links in '/' to datasets in /All_Data/VIIRS-I5-SDR_All, then remove access to /All_Data  
group.
```

#### Check the Resulting File

To check the result of the operation on the file, run `ncdump` from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

The variables (datasets in HDF5 terminology) will appear in the top level of the file which is now without any group structure. Since there are no dimension scales, `ncdump` creates `phony_dims` to display the dimensions. See the “Using the `-o2` Option” section for more information on dimension scales.

The output from `ncdump` will be the following:

```
netcdf SVI05 {  
  dimensions:  
    phony_dim_0 = 1536 ;  
    phony_dim_1 = 6400 ;  
    phony_dim_2 = 2 ;  
    phony_dim_3 = 1 ;  
    phony_dim_4 = 48 ;  
    phony_dim_5 = 3 ;  
    phony_dim_6 = 16 ;  
  variables:
```

```
ushort BrightnessTemperature(phony_dim_0, phony_dim_1) ;
float BrightnessTemperatureFactors(phony_dim_2) ;
ubyte ModeGran(phony_dim_3) ;
ubyte ModeScan(phony_dim_4) ;
int NumberOfBadChecksums(phony_dim_4) ;
int NumberOfDiscardedPkts(phony_dim_4) ;
int NumberOfMissingPkts(phony_dim_4) ;
int NumberOfScans(phony_dim_3) ;
ubyte PadByte1(phony_dim_5) ;
ubyte QF1_VIIRSIBANDSDR(phony_dim_0, phony_dim_1) ;
ubyte QF2_SCAN_SDR(phony_dim_4) ;
ubyte QF3_SCAN_RDR(phony_dim_4) ;
ubyte QF4_SCAN_SDR(phony_dim_0) ;
ubyte QF5_GRAN_BADDETECTOR(phony_dim_6) ;
ushort Radiance(phony_dim_0, phony_dim_1) ;
float RadianceFactors(phony_dim_2) ;

// global attributes:
    string :N_GEO_Ref = "GIMGO.h5" ;
    string :Distributor = "grav" ;
    string :Mission_Name = "NPP_Proxy" ;
    string :N_Dataset_Source = "NOAA" ;
    string :N_HDF_Creation_Date = "20110314" ;
    string :N_HDF_Creation_Time = "115650.000000Z" ;
    string :Platform_Short_Name = "NPP" ;
    :HDF5_internal_address_of_/Data_Products = 19664264UL ;
    :HDF5_internal_name_of_/Data_Products = "/Data_Products" ;
    :HDF5_internal_address_of_/All_Data = 800UL ;
    :HDF5_internal_name_of_/All_Data = "/All_Data" ;
}
```

### 3.2. Using All of the `-o` Options

The previous section described what would happen to a data file if each of the `-o` options was used with `h5augjpss`. All of the `-o` options can be specified on one command line, and all of the operations described in the previous section will be executed on the data file. See the “Modifying a File with `h5augjpss`” section on page 14 and the “Command Line Options” section on page 9 for more information.

Use the following command line to run `h5augjpss` with the `-o1` option:

```
h5augjpss D_VIIRS-I5-SDR-PP.xml SVI05.h5
```

or use the following equivalent command line:

```
h5augjpss -o1 -o2 -o3 -o4 D_VIIRS-I5-SDR-PP.xml SVI05.h5
```

where

`h5augjpss` is the name of the executable,

`-o1 -o2 -o3 -o4` specifies the way the data file will be changed,

`D_VIIRS-I5-SDR-PP.xml` is the name of the XML schema file associated with the data file, and

`SVI05.h5` is the name of the JPSS data file that will be changed.

### 3.3. Using the Restore Options

The two restore options are `-r1` and `-r4`. See the “Command Line Options” section on page 9 for more information. These options reverse the actions of the `-o1` and `-o4` options. The program with the restore options can be run at any time. The information that the program needs to restore group and link configurations is kept in the file.

#### 3.3.1. Using the `-r1` Option

This option restores the `Data_Products` group and the `H5T_REFERENCE` datatype that blocks opening the file. The group can be hidden again to undo the restore. Any datasets or attributes that might have been added by `h5augjps` with the `-o2` and `-o3` options will remain in the file. For more information on the `-r1` option, see page 11.

Use the following command line to restore the `Data_Products` group to the file called `SVI05.h5`:

```
h5augjps -r1 SVI05.h5
```

where

`h5augjps` is the name of the executable,

`-r1` specifies the restore option, and

`SVI05.h5` is the name of the JPSS data file that will be changed.

#### Command Output (stderr):

The following status message will be returned by `h5augjps`:

```
Data file is SVI05.h5.  
Restored link to /Data_Products group.
```

#### Check the Resulting File

To check the result of the operation on the file, run `ncdump` from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

If the restore operation was successful, `ncdump` will return the following message:

```
ncdump: SVI05.h5: NetCDF: Bad type ID
```

### 3.3.2. Using the `-r4` Option

This option restores the All\_Data group structure. Any datasets or attributes that might have been added by h5augjpss with the `-o2` and `-o3` options will remain in the file. For more information on the `-r4` option, see page 11.

Use the following command line to restore the All\_Data group to the file called SVI05.h5:

```
h5augjpss -r4 SVI05.h5
```

where

h5augjpss is the name of the executable,

`-r4` specifies the restore option, and

SVI05.h5 is the name of the JPSS data file that will be changed.

#### Command Output (stderr):

The following status message will be returned by h5augjpss:

```
Data file is SVI05.h5.  
Restored link to /All_Data group.
```

#### Check the Resulting File

To check the result of the operation on the file, run `ncdump` from the command line. Use the following command line:

```
ncdump -h SVI05.h5
```

If the restore operation was successful, `ncdump` will return the following set of messages:

```

netcdf SVI05 {

// global attributes:
    string :N_GEO_Ref = "GIMGO_aqu_d20110314_t0827436_e0828535_b47134_c20110314115547657273_grav_dev.h5" ;
    string :Distributor = "grav" ;
    string :Mission_Name = "NPP_Proxy" ;
    string :N_Dataset_Source = "NOAA" ;
    string :N_HDF_Creation_Date = "20110314" ;
    string :N_HDF_Creation_Time = "115650.000000Z" ;
    string :Platform_Short_Name = "NPP" ;
    :HDF5_internal_address_of_/Data_Products = 19664264UL ;
    :HDF5_internal_name_of_/Data_Products = "/Data_Products" ;
    :HDF5_internal_address_of_/All_Data = 800UL ;
    :HDF5_internal_name_of_/All_Data = "/All_Data" ;

group: All_Data {

    group: VIIRS-I5-SDR_All {
        dimensions:
            AlongTrack = 1536 ;
            CrossTrack = 6400 ;
            Detector = 32 ;
            Factors = 2 ;
            Granule = 1 ;
            Granule_3 = 3 ;
            Scan = 48 ;
        variables:
            int AlongTrack(AlongTrack) ;
            ushort BrightnessTemperature(AlongTrack, CrossTrack) ;
            BrightnessTemperature:Description = "Calibrated Top of Atmosphere (TOA) Brightness Temperature for each
VIIRS pixel" ;
            BrightnessTemperature:DatumOffset = 0 ;
            BrightnessTemperature:Scaled = 1 ;
            BrightnessTemperature:ScaleFactorName = "BrightnessTemperatureFactors" ;
            BrightnessTemperature:MeasurementUnits = "kelvin" ;
            BrightnessTemperature:FillValue_NA_UINT16_FILL = -1US ;
            BrightnessTemperature:FillValue_MISS_UINT16_FILL = -2US ;
            BrightnessTemperature:FillValue_ONBOARD_PT_UINT16_FILL = -3US ;
            BrightnessTemperature:FillValue_ONGROUND_PT_UINT16_FILL = -4US ;
            BrightnessTemperature:FillValue_ERR_UINT16_FILL = -5US ;
            BrightnessTemperature:FillValue_VDNE_UINT16_FILL = -7US ;
            BrightnessTemperature:FillValue_SOUB_UINT16_FILL = -8US ;
            string BrightnessTemperature:DIMENSION_LABELS = "AlongTrack", "CrossTrack" ;
            float BrightnessTemperatureFactors(Factors) ;
            string BrightnessTemperatureFactors:DIMENSION_LABELS = "Factors" ;
            BrightnessTemperatureFactors:Description = "Scale = first array element; Offset = second array element" ;
            BrightnessTemperatureFactors:DatumOffset = 0 ;
            BrightnessTemperatureFactors:Scaled = 0 ;

```

```

        BrightnessTemperatureFactors:MeasurementUnits = "scale = unitless; offset = kelvin" ;
int CrossTrack(CrossTrack) ;
int Detector(Detector) ;
int Factors(Factors) ;
int Granule(Granule) ;
int Granule_3(Granule_3) ;
float Height(AlongTrack, CrossTrack) ;
float Latitude(AlongTrack, CrossTrack) ;
float Longitude(AlongTrack, CrossTrack) ;
ubyte ModeGran(Granule) ;
    string ModeGran:DIMENSION_LABELS = "Granule" ;

...

float RadianceFactors(Factors) ;
    string RadianceFactors:DIMENSION_LABELS = "Factors" ;
    RadianceFactors:Description = "Scale = first array element; Offset = second array element" ;
    RadianceFactors:DatumOffset = 0 ;
    RadianceFactors:Scaled = 0 ;
    RadianceFactors:MeasurementUnits = "scale = unitless; offset = W/(m^2 ũm sr)" ;
    int Scan(Scan) ;
} // group VIIRS-I5-SDR_All
} // group All_Data
}

```

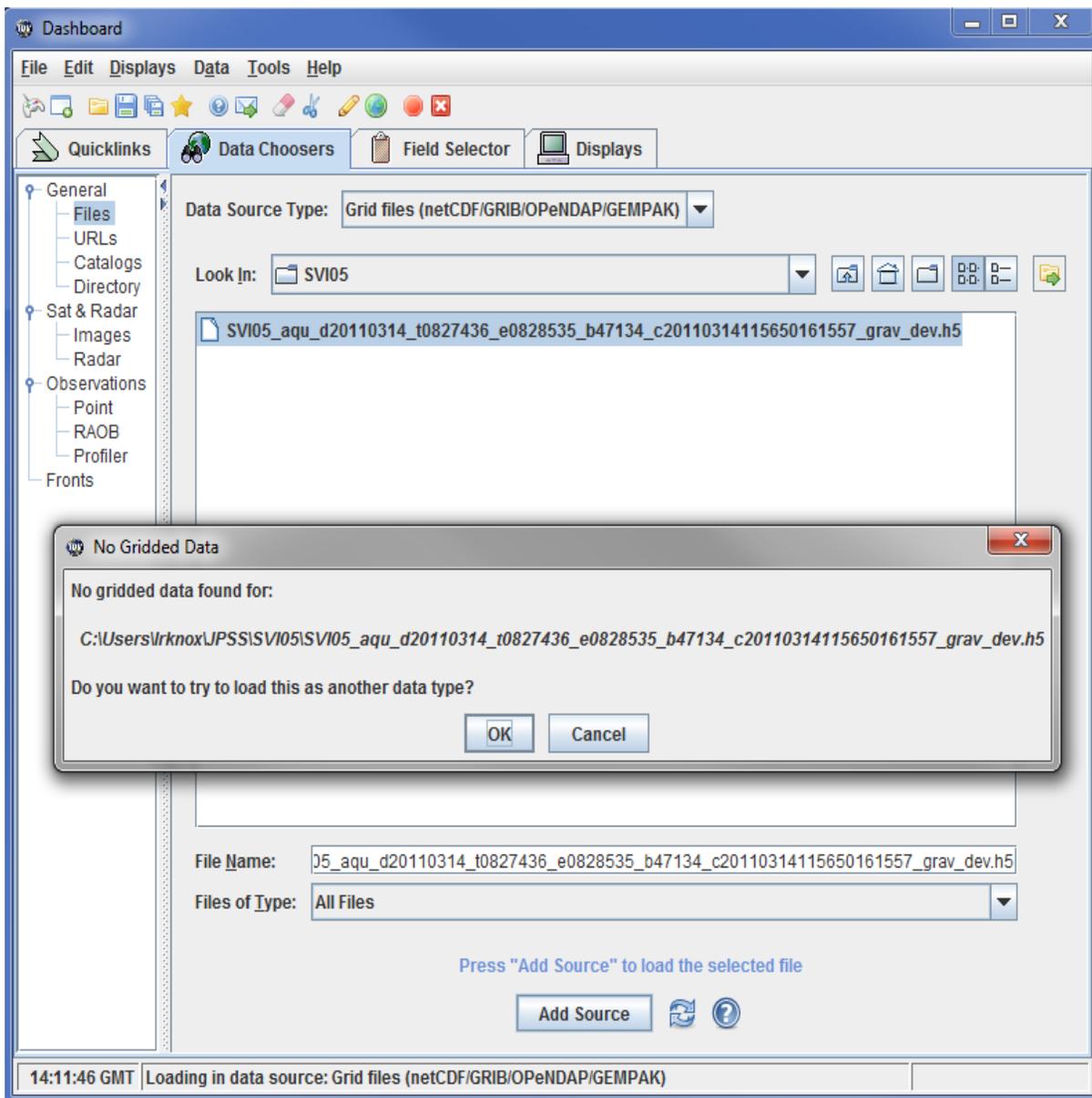
## 4. Making Changes to JPSS Data Files after Using h5augjpss

The “Building, Installing, and Running h5augjpss” chapter beginning on page 7 describes how h5augjpss can be used to make JPSS files readable by netCDF-based applications such as IDV and Panoply. Certain kinds of data files may need attributes that h5augjpss does not yet handle. The purpose of this chapter is to describe these additional attributes and how they can be added to JPSS data files. These additional attributes are Units, Coordinates, add\_offset, scale\_factor, valid\_min, and valid\_max. Units and Coordinates are dimension scale attributes and are required by applications such as IDV and Panoply to properly display data. The valid\_min and valid\_max attributes can be used to exclude the fill values for a dataset and will be specific to the dataset. The add\_offset and scale\_factor attributes can be used to more accurately display data. These additional attributes can be added with either the HDFView or h5edit tools.

### 4.1. Visualizing Data with IDV and Panoply

The example file mentioned earlier in this document can be dumped by the ncdump utility and should be accessible to many NetCDF-4 based tools. Certain datasets in the modified file can be “visualized” by IDV or Panoply. An example is the “Radiance” dataset. However, datasets with dimension scales need further modification before they can be visualized: the Units and Coordinates attributes need to be added. With the Units and Coordinates attributes, a dataset can be at least roughly displayed.

The screenshot below shows the error message that IDV displays when IDV tries to open a data file that does not have the Units and Coordinates attributes.



The Units and Coordinates attributes shown in the table below should be the same for all common 2D datasets of atmospheric and earth's surface readings.

Variable	Required Attribute	Type	Value
Latitude	Units	String	degrees_north
Longitude	Units	String	degrees_east
Radiance	Coordinates	String	Latitude Longitude
	add_offset	Float	-0.08
	scale_factor	Float	2.8339462E-4
	valid_min	Ushort	0
	valid_max	Ushort	65527

**Table 1: Attributes on the “Latitude”, “Longitude”, and “Radiance” variable required by IDV**

The valid\_min and valid\_max attributes exclude the fill values used for the dataset and will be specific to the dataset.

The add\_offset and scale\_factor attributes are generally found in the Data product file in the *DatasetFactors* dataset the matches the *Dataset* dataset. For example, the *RadianceFactors* dataset matches the *Radiance* dataset. In some cases it appears that datasets have already been converted and the matching *DatasetFactors* dataset removed.

HDFView can be used to add Units, Coordinates, add\_offset, scale\_factor, valid\_min, and valid\_max. Use the values shown in the table above.

h5edit is a command line tool that can also be used to edit attributes. The following are two examples of how the command might be used to add the scale\_factor and units attributes:

```
h5edit -c "CREATE /Radiance scale_factor {H5T_IEEE_F32LE SIMPLE(1) DATA{2.8339462E-4}};"
file.h5
h5edit -c "CREATE /Longitude units {H5T_STRING { STRSIZE 12 } DATA {'degrees_east'}};"
file.h5
```

The commands to add all of the attributes in the table above are found in the idv\_attributes file. Here is a sample idv\_attributes file:

```
CREATE /Latitude/units {H5T_STRING { STRSIZE 13 } SCALAR DATA {"degrees_north"}};
CREATE /Longitude/units {H5T_STRING { STRSIZE 12 } SCALAR DATA {"degrees_east"}};
CREATE /Radiance/coordinates {H5T_STRING { STRSIZE 19 } SCALAR DATA {"Latitude
Longitude"}};
CREATE /Radiance/add_offset {H5T_NATIVE_FLOAT SIMPLE(1) DATA{-0.08}};
CREATE /Radiance/scale_factor {H5T_NATIVE_FLOAT SIMPLE(1) DATA{2.8339462E-4}};
CREATE /Radiance/valid_min {H5T_NATIVE_USHORT DATASPACE SIMPLE(1) DATA {0}};
CREATE /Radiance/valid_max {H5T_NATIVE_USHORT DATASPACE SIMPLE(1) DATA {65527}};
```

These commands can be executed from the command line with the following:

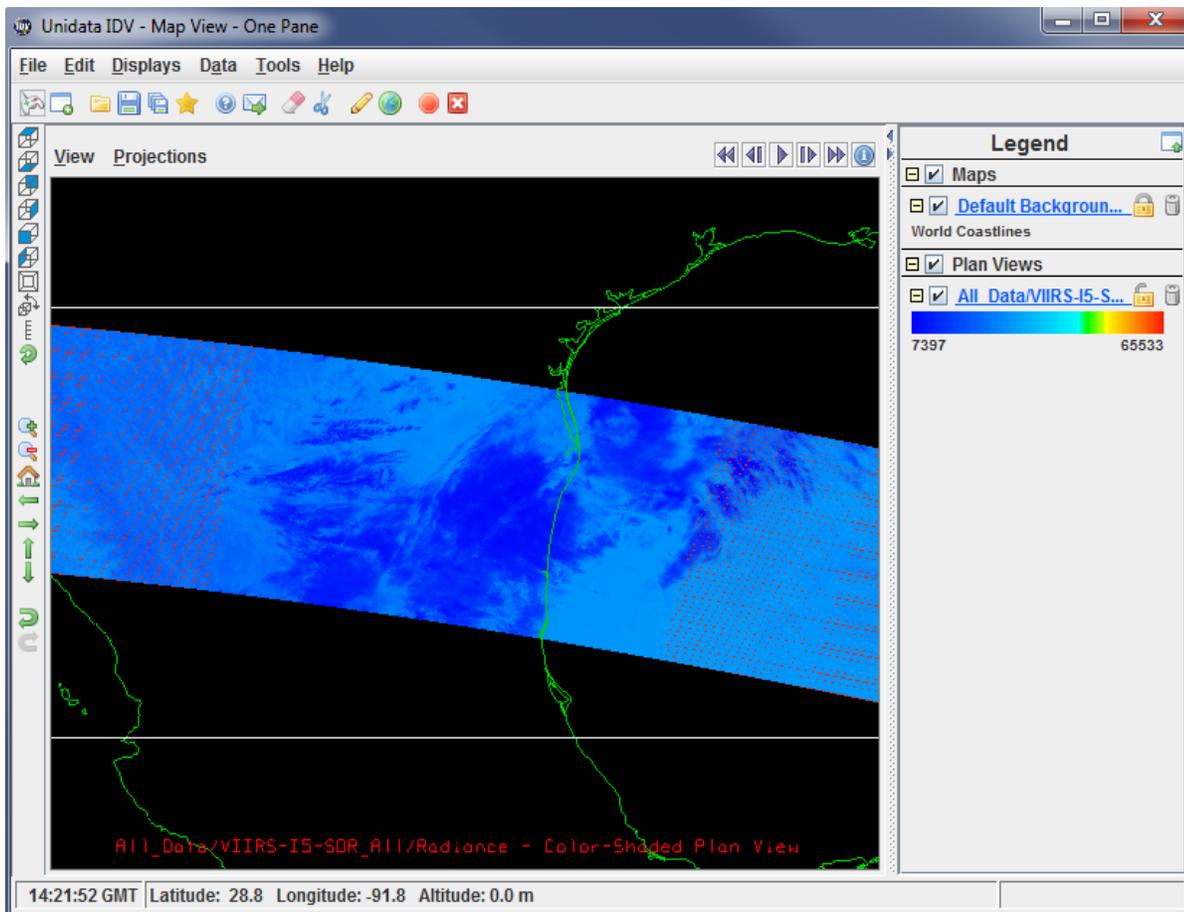
```
h5edit -command-file idv_attributes
```

This example idv\_attributes file can be found at

[http://www.hdfgroup.uiuc.edu/ftp/pub/outgoing/JPSS/h5augjpss\\_example/idv\\_attributes](http://www.hdfgroup.uiuc.edu/ftp/pub/outgoing/JPSS/h5augjpss_example/idv_attributes).

## 4.2. Producing a More Accurate Visualization

IDV version 3.0 and later and Panoply version 3.0 and later are no longer blocked by the presence of objects with reference types or by the HDF5 group structure due to changes in the underlying NetCDF Java version. These versions will also make assumptions about dimensions scales if possible. The file in the example shown below was changed from the original only by the addition of the geolocation datasets, “Height”, “Longitude”, and “Latitude” from the file specified by the attribute /N\_GEO\_Ref. This was done using the command “h5augjpss -o3 SVM15\_aqu\_...\_grav\_dev\_o3.h5” which copies the three geolocation datasets into the data file.



This visualization (above) is sufficient to establish the approximate geographic location of the file’s data and perhaps give some clue as to whether the data is interesting, but the dimensions are unnamed and the data values and the scale are not correct since the data may not be converted from the unsigned short type used for storage to the floating point type that represents the actual data. The fully augmented file with dimension scales and IDV specific attributes is shown below. In other words, to get the most accurate visualization, run h5augjpss with all options and then run h5edit with the idv\_attributes file as described above.

