

Laboratory Exercise: Creating True Color MODIS Images with HDFLook

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The purpose of this exercise is to learn how to create true color MODIS images using HDFLook. HDFLook is an application for visualizing and analyzing data from MODIS, AIRS, and other EOS sensors. It also reads any file stored in the HDF4 format. HDFLook was developed at the Laboratoire d'Optique Atmosphérique, Université des Sciences et Technologies de Lille, France, by Louis Gonzalez and Christine Deroo. HDFLook is available for Linux (Intel), Apple OS X, Microsoft Windows (Cygwin), Sun Solaris, IBM AIX, and SGI IRIX operating systems.

(1) Cygwin Installation

In this exercise, HDFLook will be installed to run under Microsoft Windows XP. Before you install HDFLook, you must first install Cygwin. Cygwin provides a Linux-like environment for Windows, and it is required in order to run HDFLook.

To install Cygwin, go to <http://www.cygwin.com/> and download setup.exe. Double click setup.exe to install Cygwin. Note that you may wish to use a local mirror site for faster installation. When you get to the screen named “Cygwin Setup – Select Packages”, scroll down until you see the Category “X11”, then click on “Default” next to it: it should change to “Install” as shown in Figure 1. Click on Next to continue the installation.

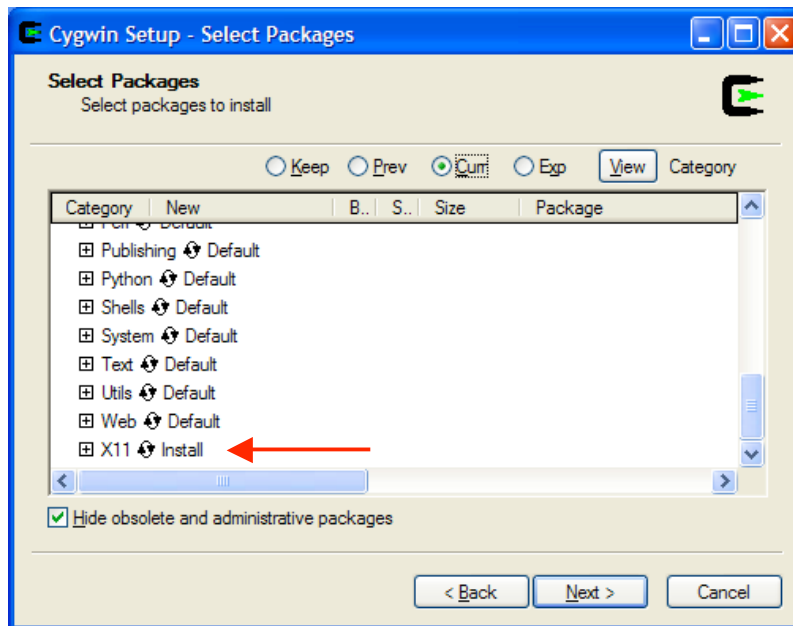


Figure 1: Cygwin Setup – Select Packages

When Cygwin installation is complete, a Cygwin icon should appear on the desktop. Double click this icon to start Cygwin, and a Cygwin bash shell should open. At the command prompt, type “startx” and then return. An xterm window should appear as shown in Figure 2.

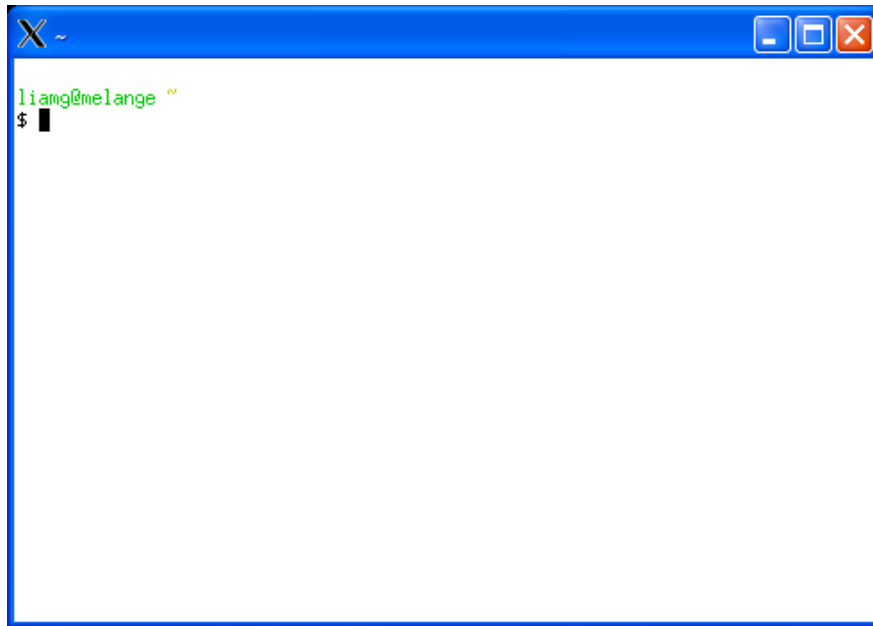


Figure 2: Cygwin xterm window

To discover the location of your Cygwin home directory, type `pwd` at the xterm prompt, e.g.

```
$ pwd
/cygdrive/d
```

In this case, the home directory is `/cygdrive/d`, which corresponds to `D:\` in the Windows file system.

(2) HDFLook Installation

To install HDFLook, go to <http://www-loa.univ-lille1.fr/Hdflook/> and follow the “Download now” link at lower left to the HDFLook FTP site. For Windows platforms, download the following files to your Cygwin home directory:

```
CYGWIN_INTEL_HDFLook.tar.gz
MAPS.tar.gz
```

To install HDFLook, type the following commands at the xterm prompt:

```
$ mkdir HDFLook
$ cd HDFLook
$ gzip -dc ../CYGWIN_INTEL_HDFLook.tar.gz | tar xvf -
$ gzip -dc ../MAPS.tar.gz | tar xvf -
```

To add HDFLook to your UNIX path, enter the following commands at the xterm prompt, or store them in your `$HOME/.profile` login file:

```
$ export PATH=$PATH:$HOME/HDFLook/CYGWIN_INTEL
$ export HDFLOOKMAPS=$HOME/HDFLook/MAPS
$ export HDFLOOKTMP=.
```

(3) Running HDFLook

If you have not already done so, start Cygwin by double clicking the Cygwin icon on the Windows desktop, then type “startx” in the bash shell to open an xterm window.

HDFLook can run in two modes. In interactive mode, HDFLook can open, visualize, and analyze MODIS, AIRS, and other HDF-formatted data files. To start HDFLook in interactive mode, type the following at the xterm prompt:

```
$ HDFLook
```

However, for this exercise you will run HDFLook in command mode, here HDFLook reads commands from a text file created by the user, e.g.

```
$ HDFLook script.txt
```

When HDFLook is run in this mode, it processes an input file according to the commands contained in the named file (`script.txt` in this case). For more information, list the built-in help by typing

```
$ HDFLook -help
```

(4) Creating a True Color MODIS Image

The following is a basic HDFLook command script named `script.txt` for creating a MODIS true color image:

```
# Create basic MODIS true color image
verbose
clear_data
set_input_hdf_file MYD021KM.A2006073.1240.005.2006075012425.hdf
set_projection_to_geometry ProjectionTo=Orthographic
set_image_rgb_composite Visible
set_misc_options BilinearPixel=Yes
create_modis_jpeg_image Filename=image01.jpg width=1100 \
  height=850 RGBMode=AutoCorrelation
```

(Note that lines starting with a # are comments, and lines ending with \ are continued on the next line. The command syntax is not case sensitive.)

First, verbose mode is activated (`verbose`) and all data and settings in memory are cleared (`clear_data`). Then the input filename is set to use an Aqua MODIS daytime granule over South Africa from 2006 day 73 at 12:40 UTC (`set_input_hdf_file`). The output map projection is set to Orthographic (`set_projection_to_geometry`), and by default the projection limits are set to the lat/lon limits of the granule. The type of RGB composite is then selected (`set_image_rgb_composite`) to use the MODIS true color bands 1, 4, 3 (red, green, blue). Then bilinear interpolation is selected for resampling the output pixels (`set_misc_options`). Finally, the true color image is created in JPEG format (`create_modis_jpeg_image`) with a size of 1100 x 850 pixels and enhanced using an autocorrelation technique. To execute this command script:

```
$ HDFLook script.txt
```

An image in JPEG format named `image01.jpg` should be created. To view the image, double click on its icon, or else open it in the web browser. The image should look like the one shown in Figure 3.

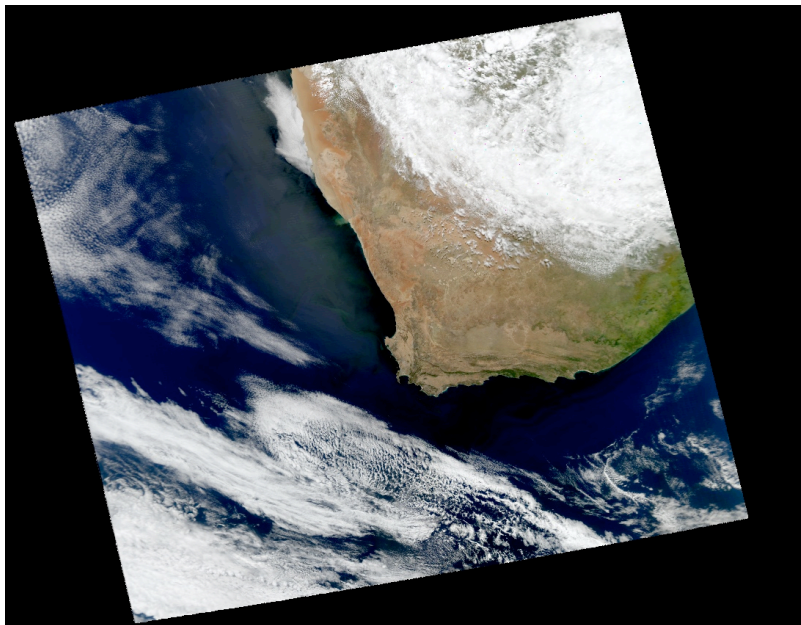


Figure 3: HDFLook True Color image

(Note that the syntax for all HDFLook script commands is contained in the help text which is printed when you execute `$ HDFLook -help`).

4.1 Customizing MODIS True Color images in HDFLook

Now you can begin to customize the image created by HDFLook. For example, you might want to create an image which covers a certain region, or at a higher spatial resolution (say 250 meters). HDFLook offers a number of customization options as described below.

To select a certain region in latitude/longitude for the reprojected image, you can set the coordinates of the upper left and lower right of the image. You can also set the desired size of the reprojected image pixels. For example, to create a Lambert Azimuthal Equal Area projection at 1000 meter resolution covering the region 25S,14E to 35S,30E, you would configure the projection like this:

```
set_projection_to_geometry ProjectionTo=Orthographic \  
  PixelSizeXTo=1000 PixelSizeYTo=1000 \  
  LatitudeMaxTo=-25.0 LongitudeMinTo=14.0 \  
  LatitudeMinTo=-35.0 LongitudeMaxTo=30.0
```

Now that you have specified a reprojected pixel size of 1000 meters, you will need to let HDFLook calculate the width and height of the reprojected image. You will need to edit the last line of the script to read

```
create_modis_jpeg_image Filename=image02.jpg \  
  RGBMode=AutoCorrelation
```

Edit the script file using WordPad for Windows (Click Start, Programs, Accessories, WordPad) to use the new projection and size information shown above. Save the edited script, and rerun HDFLook. Note that when HDFLook runs, it echoes your commands to the display as it executes. It is helpful to scan this output to make sure HDFLook interpreted your script correctly. For example, if you misspelled one of the HDFLook options, the program will ignore it and use the default value instead.

When you examine the new reprojected file (image02.jpg), you will notice that the image appears blurred or out of focus along the southeast coast of South Africa. This is because the MODIS instrument is looking to the side of the orbit ground track, and the region of the Earth's surface sensed in the MODIS field of view increases as a function of the scan angle. At the edge of the MODIS swath, the region sensed is about 2 x 5 km in size. When you reproject to 1000 meter resolution using these pixels, the result will be somewhat blurred. To get around this problem, and to allow higher resolution reproject images, HDFLook allows you to use the MODIS 1KM, HKM, or QKM data as input. When 1KM or HKM input is used, HDFLook combines the red, green, and blue bands (bands 1, 4, 3) from the given input file. When QKM input is used, HDFLook locates the corresponding HKM file in the same directory and applies the sharpening technique described in your lecture material to create sharpened bands 1, 4, and 3. Remember that you can choose the output reprojected resolution independently of the input data resolution. For example, you can use QKM input data to create a reprojected 1000 meter resolution image. Try editing your script as shown below:

```
set_input_hdf_file MYD02QKM.A2006073.1240.005.2006075012425.hdf
```

and change the output file name to image03.jpg. When you rerun HDFLook, you should notice that the new true color image is somewhat sharper than before.

Now you can try creating a 250 meter resolution reprojected image. For the best output image quality, it is recommended that you select regions close to center of the MODIS swath. Try selecting the following region:

```
set_input_hdf_file MYD02QKM.A2006073.1240.005.2006075012425.hdf
set_projection_to_geometry ProjectionTo=Orthographic \
  PixelSizeXTo=250 PixelSizeYTo=250 \
  LatitudeMaxTo=-28.0 LongitudeMinTo=15.5 \
  LatitudeMinTo=-35.0 LongitudeMaxTo=23.0
```

And set the output filename to `image04.jpg`. Rerun HDFLook to create the reprojected image (it will take a little while). Examine the reprojected image file in your viewer. This image represents the highest quality true color image that can be created from MODIS Level 1B data. You can apply the same techniques to other scenes to create similar images. You may also wish to try some other options in HDFLook, including coastline, political boundary, and text overlays, e.g.,

```
verbose
clear_data
set_input_hdf_file MYD021KM.A2006073.1240.005.2006075012425.hdf
set_projection_to_geometry ProjectionTo=Orthographic
set_image_rgb_composite Visible
set_misc_options BilinearPixel=Yes
add_text x=10 y=10 ForegroundColor=White \
  Text="Aqua MODIS True Color Image 2006 day 073 12:40 UTC"
add_maps Coastlines=Yes CoastlineColor=Green \
  Boundaries=Yes BoundaryColor=Black
add_grids color=White \
  LatitudeMin=-90 LatitudeMax=90 LatitudeStep=5 \
  LongitudeMin=-180 LongitudeMax=180 LongitudeStep=5
create_modis_jpeg_image Filename=image05.jpg \
  width=1100 height=850 RGBMode=AutoCorrelation
```

Finally, you may wish to try creating an image from a Terra MODIS granule over the islands of Bahamas, where shallow water depths make for spectacular natural colors. The MODIS 1KM file name is

```
MOD021KM.A2003021.1600.004.2003022113345.hdf
```

Use the techniques you have learned to create

- (a) a large scale overview image of this granule, and
- (b) a 250 meter resolution image centered on South Florida and the Bahamas.