

Lab 1 part 1 - Using HDFLook to create true color images with MODIS.

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 Microsoft Windows (under Cygwin), Linux, Apple OS X, and Sun Solaris operating systems.

(1) Cygwin Installation

In this exercise, HDFLook will be installed to run under Microsoft Windows. 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 on Windows.

Note: To install HDFLook on a Linux, OS X, or Solaris computer, start at step (2) below.

To install Cygwin on a Windows computer, 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.

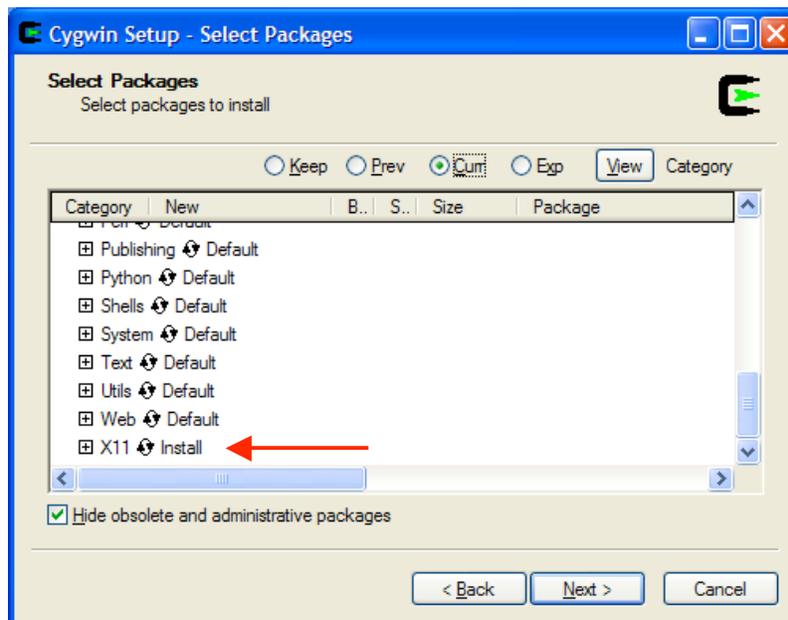


Figure 1: Cygwin Setup – Select Packages

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.

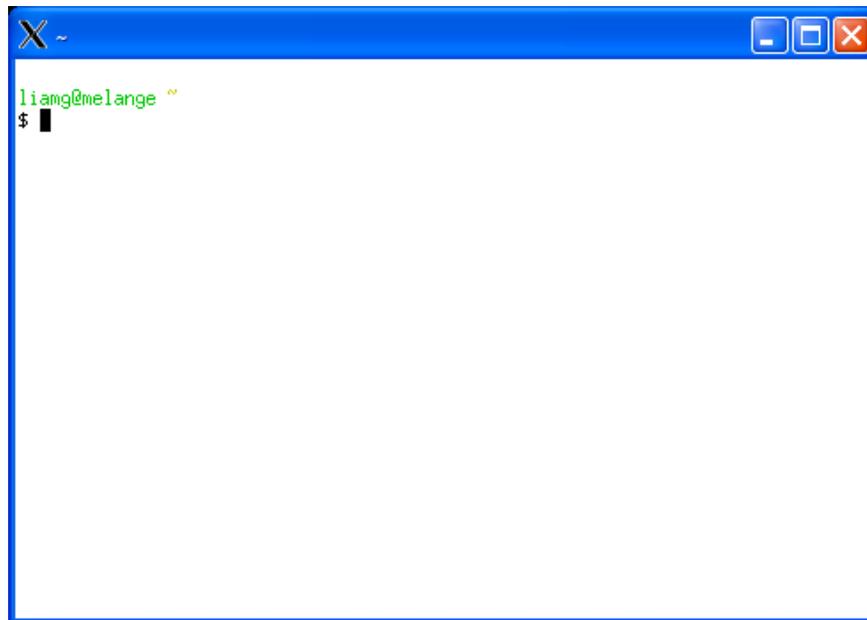


Figure 2: Cygwin xterm window

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. Next, you will need to navigate to the directory where the MODIS files are stored for this exercise. The location will vary, so please check with your instructor. For example, if the files are stored in

```
C:\MODIS\TrueColor
```

then you will need to enter the following command:

```
$ cd /cygdrive/c/MODIS/TrueColor
```

Note that the `$` sign is simply the command prompt: you do not need to type the `$` sign. Also note that case is important (i.e., `TrueColor`, not `truecolor`).

For this exercise, you will run HDFLook in batch mode, where 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, you can list the built-in help by typing

```
$ HDFLook -help
```

HDFLook can also run in an interactive mode which allows you to visualize and analyze MODIS, AIRS, and other HDF-formatted data files. To start HDFLook in interactive mode, just type `HDFLook` at the prompt.

(4) Creating a True Color MODIS Image

Now you will edit a HDFLook script that creates a MODIS true color image. On Windows platforms, WordPad is a good choice for editing the script. On the Windows desktop, select Start | Programs | Accessories | WordPad. Enter the HDFLook commands shown below in the WordPad editor, and save it to a text file named `script01.txt` in the data directory for this exercise, e.g. `C:\MODIS\TrueColor`

```
verbose
clear_data
set_input_hdf_file MOD021KM.A2007302.1445.005.2007302233251.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
```

Notes:

1. Every line must end with a carriage return, so make sure you press the 'Enter' key at the end of each line, including the last line.
2. Lines starting with # are comments, and are ignored by HDFLook.
3. Lines ending with \ are continued on the next line.
4. 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 Terra MODIS daytime granule from 2007 day 302 at 14:45 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. To execute this command script in HDFLook, type

```
$ HDFLook script01.txt
```

An image in JPEG format named `image01.jpg` should be created. To view the image, double click on its icon (in Windows File Explorer), or else open it in the web browser. The image should look like the one shown in Figure 3. Note that the syntax for HDFLook script commands can be displayed by typing

```
$ HDFLook -help
```

A small text file will also be created named `image01.jpg.met` which provides information on the output `.jpg` file including the latitude and longitude boundaries of the file.

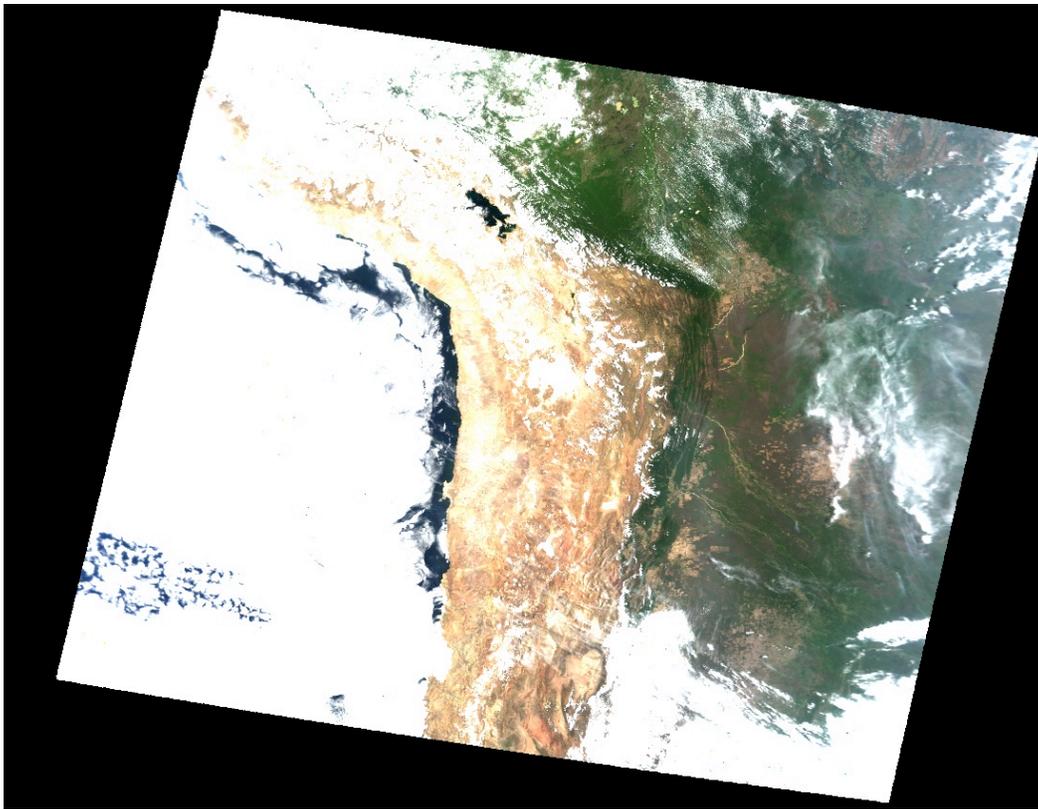


Figure 3: HDFLook True Color image

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 at a higher spatial resolution (say 250 meters) with a better color enhancement. HDFLook offers a number of customization options as described below.

To select a latitude/longitude region 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. Edit the script file as shown below to create a Lambert Azimuthal Equal Area projection at 1000 meter resolution covering the region 22S,65W to 12S,75W:

```
set_projection_to_geometry ProjectionTo=Lambert \  
  PixelSizeXTo=1000 PixelSizeYTo=1000 \  
  LatitudeMaxTo=-12.0 LongitudeMinTo=-75.0 \  
  LatitudeMinTo=-22.0 LongitudeMaxTo=-65.0
```

Note that because you have specified the corner coordinates and pixel size of the reprojected image, HDFLook will calculate the width and height (in pixels). The color enhancement method can also be specified directly. In this case, you will use an automated scene-based image enhancement (autocorrelation mode). Edit the last command in the script as shown below:

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

You may wish to save this new version of the script as `script02.txt`. Rerun HDFLook with the new version of the script. 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 a little blurred or out of focus along the northwestern edge. 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 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 HKM input data to create a reprojected 1000 meter resolution image. Try editing your script as shown below:

```
set_input_hdf_file MOD02HKM.A2007302.1445.005.2007302233251.hdf
```

and change the output file name to `image03.jpg`. After you run 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. Edit the script file to use the QKM MODIS data, and select the following region:

```
set_input_hdf_file MOD02QKM.A2007302.1445.005.2007302233251.hdf
set_projection_to_geometry ProjectionTo=Lambert \
  PixelSizeXTo=250 PixelSizeYTo=250 \
  LatitudeMaxTo=-14.0 LongitudeMinTo=-70.0 \
  LatitudeMinTo=-18.0 LongitudeMaxTo=-66.0
```

Finally, you can specify the color enhancement method more precisely, so that the same enhancement is used for all images. Edit the last line command in the script as shown below:

```
create_modis_jpeg_image Filename=image04.jpg RGBMode=Log \
  minR=5.6 maxR=9.5 minG=5.6 maxG=9.5 minB=5.6 maxB=9.5
```

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 can also create images with coastline, political boundary, and text overlays. For example:

```
verbose
clear_data
set_input_hdf_file MOD021KM.A2007302.1445.005.2007302233251.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="Terra MODIS True Color Image 29 October 2007 14:45 UTC"
add_maps Coastlines=Yes CoastlineColor=Green \
  Boundaries=Yes BoundaryColor=Black
add_grids color=White \
  LatitudeMin=-35 latitudeMax=-10 LatitudeStep=5 \
  LongitudeMin=-85 LongitudeMax=-50 LongitudeStep=5
create_modis_jpeg_image Filename=image05.jpg \
  width=1100 height=850 RGBMode=Log \
  minR=5.6 maxR=9.5 minG=5.6 maxG=9.5 minB=5.6 maxB=9.5
```

The method used to create image05.jpg is useful for automated processing of many MODIS granules, because it will create the same kind of image for very granule.

(5) Summary

In this lab exercise, you have learned how to install HDFLook on a Windows computer, and create MODIS true color images at a variety of resolutions. You have seen how the resolution of the reprojected output image can be specified independently of the resolution of the MODIS input data. You have used different image enhancement techniques, including a method which creates a similar image for any MODIS input file (`RGBMode=Log`). Finally, you have learned how to create an image with overlays including coastlines and political boundaries.

There are many other features to explore in HDFLook. In this exercise, you have used the “script mode” of HDFLook. One advantage of this method is that you can create automated processing scripts to handle multiple input files. However HDFLook also offers an interactive graphical user interface mode, which can be started by typing

```
$ HDFLook
```

In this mode there are many options for exploring MODIS input files including MOD02 (Level 1B radiance/reflectance), MOD35/06/07/04/05 (Level 2 atmosphere products), MOD09 (Level 2 land surface reflectance), and MOD28 (sea surface temperature). You can also load other sensor datasets including AIRS. If you want to learn about HDFLook, go the HDFLook website and download the manual for the software.