Tutorial – Manipulating GEOTIFFs using command line tools (GDAL + Python)

Getting Ready

To follow this tutorial, you have to install basically two software packages: GDAL and Python.

You may download GDAL (Geospatial Data Abstraction Library) for your preferred O.S. at the following link:
http://trac.osgeo.org/gdal/wiki/DownloadingGdalBinaries
Note: In this procedure (Windows 8.1), it was installed in "C:\Program Files (x86)\GDAL"

You may download Python for your preferred O.S. at the following link:
https://www.python.org/downloads/
Note: This procedure uses the release 2.7.9

💡 Hint: If you're using Windows, you may find step-by-step information on how to install GDAL and Python at the following link:

http://cartometric.com/blog/2011/10/17/install-gdal-on-windows/

Also, you have to download and install Numpy, the fundamental package for scientific computing with Python:
http://sourceforge.net/projects/numpy/files/NumPy/1.9.2/
Note: You must choose the Numpy version that matches your Python version. This procedure uses the "numpy-1.9.2-win32-superpack-python2.7.exe"

Finally, download the GeoTIFF samples provided by NOAA-NESDIS at the following ftp link:
ftp://server-ftpdsa.cptec.inpe.br/GDAL_Tutorial_Samples/
username: geonetcast
password: GNC-A

In this procedure, they were saved at: "C:\VLAB\G-13" (avoid using spaces in your folder names for this tutorial)

💡 Hint: The GeoTIFF imagery like the ones used in this tutorial are broadcasted in near real-time through the GEONETCast-Americas system and may be found at "KenCast\Fazzt\incoming\NOAA-NESDIS-GEOTIFFS\IMAGERY" and at "KenCast\Fazzt\incoming\INPE" in your local receive station.

Example 1: Mosaicking the GOES-East Northern Hemisphere Extended and the Southern Hemisphere Sectors

1-) Open the Command Prompt (Windows), Terminal (Linux), etc, and access the GDAL folder.
In this example (Command Prompt): cd "Program Files (x86)"\GDAL

2-) To mosaic the samples, use the following GDAL command structure:
C:\Program Files (x86)\GDAL\gdalwarp -srcnodata 0 C:\VLAB\G-13\GoesEastNH04I30971645.tif
C:\VLAB\G-13\GoesEastSH04I30971708.tif C:\VLAB\G-13\WV.tif

Copy and paste the following line in the command prompt if you want:
gdalwarp -srcnodata 0 C:\VLAB\G-13\GoesEastNH04I30971645.tif C:\VLAB\G-13\GoesEastSH04I30971708.tif C:\VLAB\G-13\WV.tif

Where:
gdalwarp : GDAL image mosaicing, reprojection and warping utility
-srcnodata 0 : Pixel value of the non-image areas (in NOAA's samples it's zero)
C:\VLAB\G-13\ GoesEastNH04I30971645.tif :
Input GeoTIFF 1 (in this example, North Hemisphere Extended - Water Vapor)
C:\VLAB\ G-13\ GoesEastSH04I30971708.tif :
Input GeoTIFF 2 (in this example, Southern Hemisphere - Water Vapor)
C:\VLAB\G-13\WV.tif :
Name of the resulting mosaic (in this example, "WV.tif")

💡 Hint: You may find more information about the gdalwarp utility here: www.gdal.org/gdalwarp.html
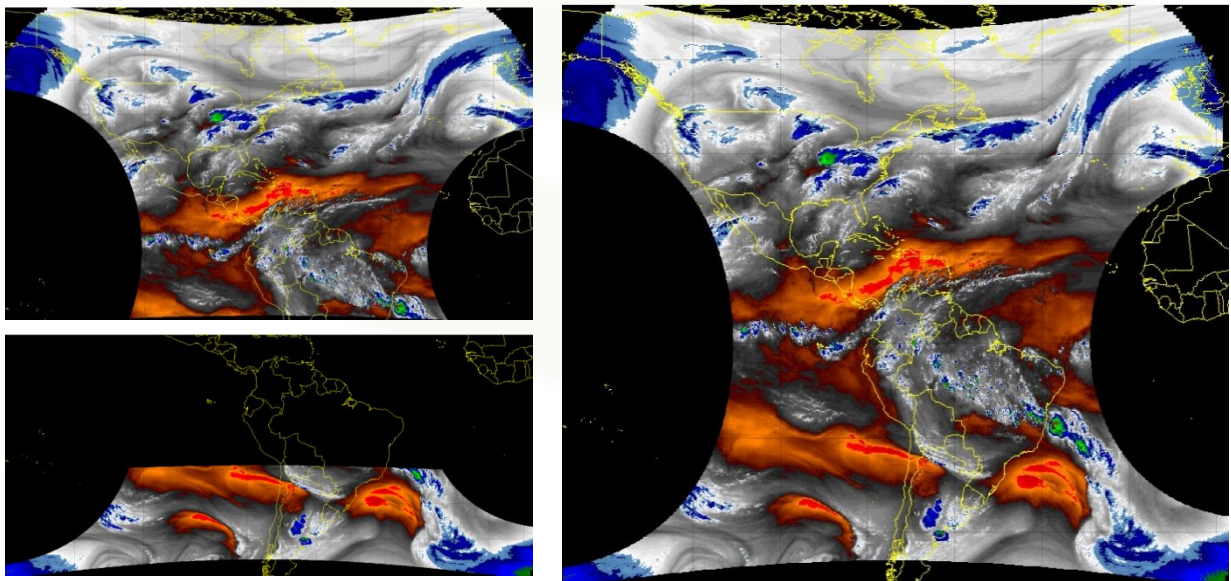

Figure 1: Nothern Hemisphere Extended and Southern Hemisphere (left) and the final mosaic (right)

Example 2: Subsect Central America and the Caribbean from the Northern Hemisphere Extended Sector

1-) To subsect a GeoTIFF, use the following GDAL command structure:
C:\Program Files (x86)\GDAL\gdal_translate -projwin -94 26 -58 6 C:\VLAB\G-13\GoesEastNH01V0971645.tif
C:\VLAB\G-13\VIS_CAC.tif

Copy and paste the following line in the command prompt if you want:
gdal_translate -projwin -94 26 -58 6 C:\VLAB\G-13\GoesEastNH01V0971645.tif C:\VLAB\G-13\VIS_CAC.tif

Where:
gdal_translate : Utility to convert rasters and perform operations like subsetting, resampling, etc
-projwin : Selects a subwindow from the source image
-94 26 -58 6 : Longitude1 Latitude1 Longitude2 Latitude2
C:\VLAB\G-13\GoesEastNH1V0971645.tif :
Input GeoTIFF (in this example, Northern Hemisphere Extended - Visible Channel)
C:\VLAB\G-13\VIS_CAC.tif :
Name of the resulting GeoTIFF (in this example, "VIS_CAC.tif")

💡 Hint: You may find more information about the gdal_translate utility here: www.gdal.org/gdal_translate.html
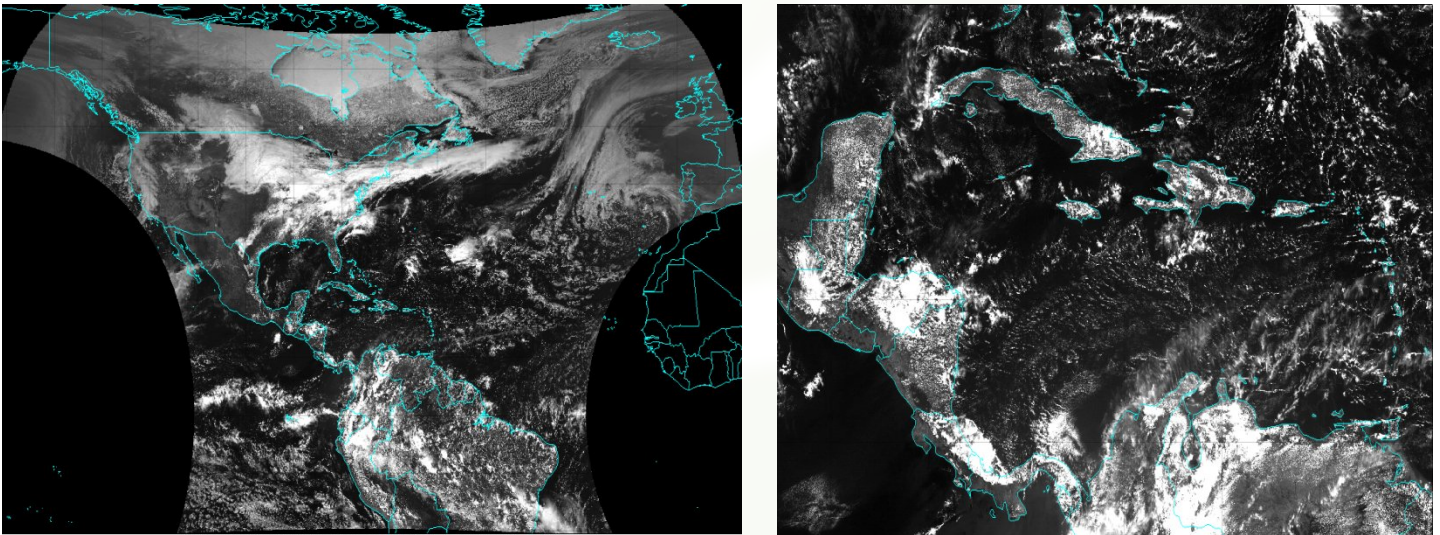

Figure 2: Nothern Hemisphere Extended and (left) and subsected Central America + Caribbean (right)

Example 3: Changing the projection – From Rectangular to Satellite

1-) To change the GeoTIFF projection, use the following GDAL command structure:

C:\Program Files (x86)\GDAL\gdalwarp -s_srs EPSG:4326 –t_srs "+proj=geos +h=35774290 +a= 6378137 +b= 6378137 +lon_0=-75 +units=m +no_defs" C:\VLAB\G-13\GoesEastFDSK04I40971745.tif C:\VLAB\G-13\IR_Satellite.tif

Copy and paste the following line in the command prompt if you want:

gdalwarp -s_srs EPSG:4326 -t_srs "+proj=geos +h=35774290 +a= 6378137 +b= 6378137 +lon_0=-75 +units=m +no_defs" C:\VLAB\G-13\GoesEastFDSK04I40971745.tif C:\VLAB\G-13\IR_Satellite.tif

Where:

gdalwarp : GDAL image mosaicing, reprojection and warping utility

–s_srs EPSG:4326 : Source spatial reference set

–t_srs "+proj=geos +h=35774290 +a=6378137 +b=6378137 +lon_0=-75 +units=m +nodefs" : Target spatial reference set

C:\VLAB\G-13\GoesEastFDSK04I40971745.tif : Input GeoTIFF

C:\VLAB\G-13\IR_Satellite.tif : Name of the resulting GeoTIFF (in this example, "IR_Satellite.tif")

> 💡 Hint: You may find a complete list of coordinate systems at "C:\Program Files (x86)\GDAL\gdal-data\pcs.csv" (for projected coordinate systems) and "C:\Program Files (x86)\GDAL\gdal-data\gcs.csv" (for geographic coordinate systems). You may also find useful information here: spatialreference.org/ref/epsg/
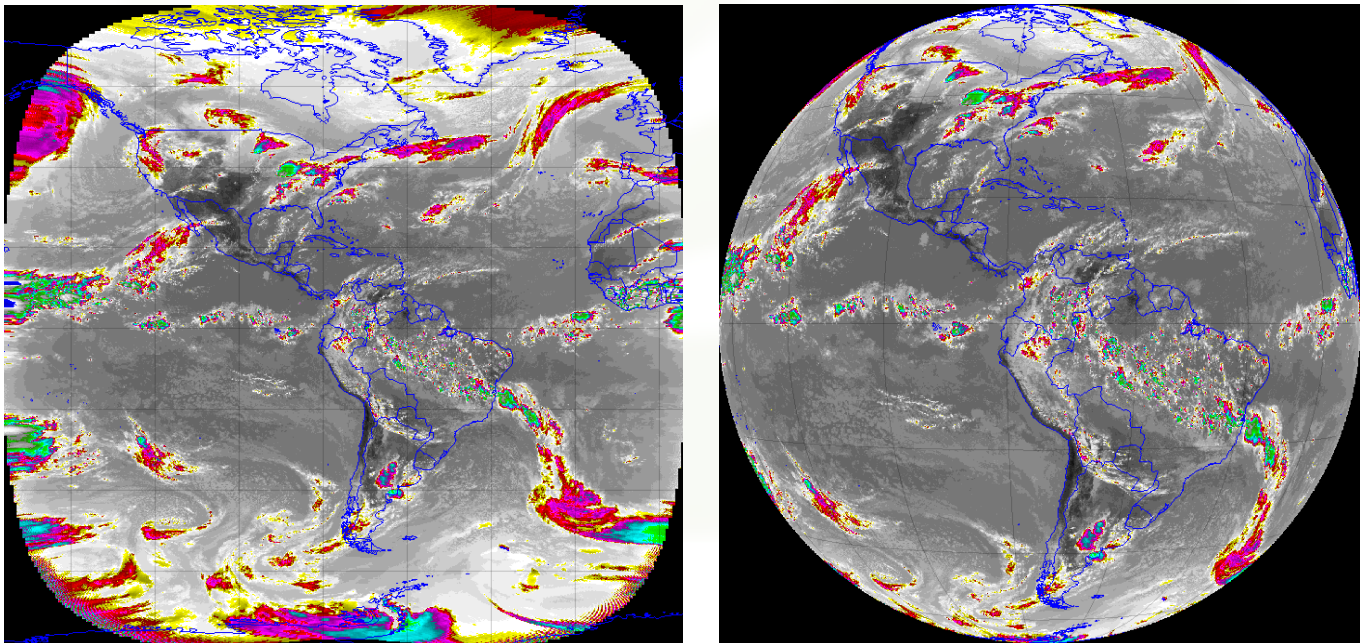

Figure 3: Full Disk in the WGS84 projection (left) and in the satellite projection (right)

Example 4: Applying Mathematical Operations – Converting to Celsius

1-) To apply mathematical operations with a GeoTIFF, use the following GDAL command structure:

C:\Program Files (x86)\GDAL\gdal_calc.py -A C:\VLAB\G-13\GoesEastFDSK04I40971745.tif --outfile=C:\VLAB\G-13\IR_Celsius.tif --calc="(A/10)" --NoDataValue=0 --type=Int16 --overwrite

Copy and paste the following line in the command prompt if you want:

gdal_calc.py -A C:\VLAB\G-13\GoesEastFDSK04I40971745.tif --outfile=C:\VLAB\G-13\IR_Kelvin.tif --calc="(A/10) " --NoDataValue=0 --type=Int16 --overwrite

Where:

gdal_calc.py : Command line raster calculator with numpy syntax

-A C:\VLAB\G-13\GoesEastFDSK04I40971745.tif : Input GeoTIFF file, note you can use any letter from A - Z

--outfile=C:\VLAB\G-13\IR_Kelvin.tif : Output file to generate or fill

--calc="(A/10)" : Calculation in gdalnumeric syntax using +-/* or any numpy array functions (i.e. logical_and())

--NoDataValue=0 : Pixel value of the non-image areas (in NOAA's samples it's zero)

--type=Int16 : output datatype, must be one of ['Int32', 'Int16','Float64', 'UInt16', 'Byte', 'UInt32', 'Float32']

--overwrite : overwrite output file if it already exists

> 💡 Hint 1: You may find more information about the gdalcalc utility here: www.gdal.org/gdal_calc.html
>
> Hint 2: You may find more information about Numpy here: docs.scipy.org/doc/numpy/reference/

Example 5: Changing the Raster Format – From GeoTIFF to ILWIS

1-) To change the GDAL raster format, use the following GDAL command structure:

C:\Program Files (x86)\GDAL\gdal_translate -of ILWIS C:\VLAB\G-13\GoesEastFDSK04I40971745.tif C:\VLAB\G-13\ GoesEastFDSK04I40971745.mpr

Copy and paste the following line in the command prompt if you want:

gdal_translate -of ILWIS C:\VLAB\G-13\GoesEastFDSK04I40971745.tif C:\VLAB\G-13\GoesEastFDSK04I40971745.mpr

Where:

gdal_translate : Utility to convert rasters and perform operations like subsetting, resampling, etc

-of ILWIS : Select the output format. The default is GeoTIFF (GTiff). Use the short format name (see the hint link!).

C:\VLAB\G-13\GoesEastFDSK04I40971745.tif : Input raster

C:\VLAB\G-13\ GoesEastFDSK04I40971745.mpr : Output raster (must have the output extension)

> 💡 Hint: You may find a complete list of GDAL raster formats here: www.gdal.org/formats_list.html

Hands-On Session:

PRACTICE:

1) Mosaic the GOES-East Northern Hemisphere Extended and the Southern Hemisphere Sectors from the following files: C:\VLAB\G-13\GoesEastNH01V0971645.tif and C:\VLAB\G-13\GoesEastSH01V0971708.tif.

   gdalwarp -srcnodata 0 C:\VLAB\G-13\GoesEastNH01V0971645.tif C:\VLAB\G-13\GoesEastSH01V0971708.tif C:\VLAB\G-13\VIS.tif

2) Subsect the resulting image, extracting Bolivia.

   gdal_translate -projwin -71 -9 -57 -24 C:\VLAB\G-13\VIS.tif C:\VLAB\G-13\VIS_BOLIVIA.tif

3) Convert the pixel unit to Albedo (%).

   gdal_calc.py -A C:\VLAB\G-13\VIS_BOLIVIA.tif --outfile=C:\VLAB\G-13\VIS_BOLIVIA_ALBEDO.tif --calc="(A/10)" --NoDataValue=0 --type=Int16 –overwrite

4) Convert from GeoTIFF to ILWIS Raster Map (or the format of your preference).

   gdal_translate -of ILWIS C:\VLAB\G-13\VIS_BOLIVIA_ALBEDO.tif C:\VLAB\G-13\VIS_BOLIVIA_ALBEDO.mpr

Expected Result: