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Use GDAL/OGR for raster/vector operations - osgeo

Recorded lecture-1 from 2024
Recorded lecture-2 from 2024

Additional Recorded lecture: 1:28:45 - 2:19:43

Setting working directory for the OSGeoLive

GDAL is a translator library for raster and vector geospatial data formats that is released under an X/MIT style Open Source License by the Open Source Geospatial Foundation. As a library, it presents a single raster abstract data model and single vector abstract data model to the calling application for all supported formats. It also comes with a variety of useful command line utilities for data translation and processing (source https://gdal.org/).

Open the bash terminal, migrate in the directory, and open the jupter-notebook.ipynb

```
cd /media/sf_LVM_shared/my_SE_data/exercise
jupyter-lab gdal_osgeo.ipynb
```

We are going to use the jupyter-notebook as an editor for running gdal commands. The beauty of using gdal in the bash environment is that we can combine it with other bash utilities such awk, sed, and other.

Start to use GDAL commands

Explor the files

Change directory and list all the files with the extension .tif

```
[2]: !ls /media/sf_LVM_shared/my_SE_data/exercise/geodata/*/*.tif
```

```
/media/sf_LVM_shared/my_SE_data/exercise/geodata/cloud/SA_intra.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/cloud/SA_meanannual.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/dem/GMTED2010.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/dem/SA_all_dep_1km.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/dem/SA_are_1km_msk.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/dem/SA_elevation_mn_GMTED2010_mn_msk.ti
/media/sf_LVM_shared/my_SE_data/exercise/geodata/dem/SA_elevation_mn_GMTED2010_mn.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/875_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/876_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/877_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/878_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/879_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/880_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/881_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/882_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/883_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/884_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/885_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/886_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/887_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/888_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/889_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/890_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/891_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/892_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/893_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/894_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/895_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/896_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/897_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/898_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/899_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/900_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/901_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/902_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/903_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/904_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/905_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/906_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/907_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/908_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/909_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/910_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/911_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/912_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/913_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/914_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/915_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/916_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/917_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/918_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/919_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/920_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/921_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/922_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/923_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/924_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/925_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/926_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/927_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/928_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/929_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/930_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/931_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/932_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/933_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/934_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/935_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/936_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/937_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/938_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/939_crop.tif
```

```
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/940_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/941_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/942_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/glad_ard/943_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/071W_41N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/071W_42N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/072W_40N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/072W_41N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/072W_42N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/073W_40N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/073W_41N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/landsat_ct/073W_42N_med_B1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month10.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month11.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month12.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month1.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month2.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month3.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month4.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month5.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month6.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month7.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month8.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/LST/LST_MOYDmax_month9.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/mask/msk_1km.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/SDM/eBirdSampling_filtered_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/SDM/eBirdSampling_filtered.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/temperature/ug_bio_3.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/ETmean08-11_01_msk.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/ETmean08-11_crop.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/ETmean08-11.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/ETstdev08-11.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/GPPmean08-11.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/GPPstdev08-11.tif
/media/sf_LVM_shared/my_SE_data/exercise/geodata/vegetation/SA_tree_mn_percentage_GFC201
```

Retrive the characteristic of the one tif file

[8]:
```
!gdalinfo geodata/cloud/SA_intra.tif
```

```
Driver: GTiff/GeoTIFF
Files: geodata/cloud/SA_intra.tif
Size is 5880, 8400
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (-83.000000000000000,14.000000000000000)
Pixel Size = (0.008333333333333,-0.008333333333333)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=DEFLATE
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  ( -83.0000000,  14.0000000) ( 83d 0' 0.00"W, 14d 0' 0.00"N)
Lower Left  ( -83.0000000, -56.0000000) ( 83d 0' 0.00"W, 56d 0' 0.00"S)
Upper Right ( -34.0000000,  14.0000000) ( 34d 0' 0.00"W, 14d 0' 0.00"N)
Lower Right ( -34.0000000, -56.0000000) ( 34d 0' 0.00"W, 56d 0' 0.00"S)
Center      ( -58.5000000, -21.0000000) ( 58d30' 0.00"W, 21d 0' 0.00"S)
Band 1 Block=5880x1 Type=UInt16, ColorInterp=Gray
  NoData Value=65535
```

[9]:
```
! gdalinfo /home/user/jupyter/notebook_gallery/Rasterio/data/RGB.byte.tif
```

```
Driver: GTiff/GeoTIFF
Files: /home/user/jupyter/notebook_gallery/Rasterio/data/RGB.byte.tif
Size is 791, 718
Coordinate System is:
PROJCRS["UTM Zone 18, Northern Hemisphere",
    BASEGEOGCRS["Unknown datum based upon the WGS 84 ellipsoid",
        DATUM["Not_specified_based_on_WGS_84_spheroid",
            ELLIPSOID["WGS 84",6378137,298.257223563,
                LENGTHUNIT["metre",1],
                ID["EPSG",7030]]],
        PRIMEM["Greenwich",0,
            ANGLEUNIT["degree",0.0174532925199433,
                ID["EPSG",9122]]]],
    CONVERSION["Transverse Mercator",
        METHOD["Transverse Mercator",
            ID["EPSG",9807]],
        PARAMETER["Latitude of natural origin",0,
            ANGLEUNIT["degree",0.0174532925199433],
            ID["EPSG",8801]],
        PARAMETER["Longitude of natural origin",-75,
            ANGLEUNIT["degree",0.0174532925199433],
            ID["EPSG",8802]],
        PARAMETER["Scale factor at natural origin",0.9996,
            SCALEUNIT["unity",1],
            ID["EPSG",8805]],
        PARAMETER["False easting",500000,
            LENGTHUNIT["metre",1],
            ID["EPSG",8806]],
        PARAMETER["False northing",0,
            LENGTHUNIT["metre",1],
            ID["EPSG",8807]]],
    CS[Cartesian,2],
        AXIS["easting",east,
            ORDER[1],
            LENGTHUNIT["metre",1,
                ID["EPSG",9001]]],
        AXIS["northing",north,
            ORDER[2],
            LENGTHUNIT["metre",1,
                ID["EPSG",9001]]]]
Data axis to CRS axis mapping: 1,2
Origin = (101985.000000000000000,2826915.000000000000000)
Pixel Size = (300.037926675094809,-300.041782729804993)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  INTERLEAVE=PIXEL
Corner Coordinates:
Upper Left  (  101985.000, 2826915.000) ( 78d57'31.14"W, 25d30'21.91"N)
Lower Left  (  101985.000, 2611485.000) ( 78d53'53.28"W, 23d33'53.97"N)
Upper Right (  339315.000, 2826915.000) ( 76d35'57.98"W, 25d33' 3.15"N)
Lower Right (  339315.000, 2611485.000) ( 76d34'29.73"W, 23d36'21.41"N)
Center      (  220650.000, 2719200.000) ( 77d45'28.46"W, 24d33'41.70"N)
Band 1 Block=791x3 Type=Byte, ColorInterp=Red
  Min=0.000 Max=255.000
  Minimum=0.000, Maximum=255.000, Mean=29.948, StdDev=52.341
  NoData Value=0
  Metadata:
    STATISTICS_MAXIMUM=255
    STATISTICS_MEAN=29.947726688477
    STATISTICS_MINIMUM=0
    STATISTICS_STDDEV=52.340921626611
Band 2 Block=791x3 Type=Byte, ColorInterp=Green
  Min=0.000 Max=255.000
  Minimum=0.000, Maximum=255.000, Mean=44.516, StdDev=56.934
  NoData Value=0
  Metadata:
    STATISTICS_MAXIMUM=255
    STATISTICS_MEAN=44.516147889382
    STATISTICS_MINIMUM=0
    STATISTICS_STDDEV=56.934318291876
Band 3 Block=791x3 Type=Byte, ColorInterp=Blue
```

```
Min=0.000 Max=255.000
Minimum=0.000, Maximum=255.000, Mean=48.113, StdDev=60.113
NoData Value=0
Metadata:
  STATISTICS_MAXIMUM=255
  STATISTICS_MEAN=48.113056354743
  STATISTICS_MINIMUM=0
  STATISTICS_STDDEV=60.112778509941
```

Visualize the image

[11]:
```
!  /usr/bin/openev/bin/openev geodata/vegetation/*.tif
```

```
Default software rendering mode (use -h if accelerated video card installed).
Loading tools from /usr/bin/openev/tools/Tool_Export.py
Loading tools from /usr/bin/openev/tools/Tool_ShapesGrid.py
Loading tools from /usr/bin/openev/tools/Tool_DriverList.py
```

Reply to the following questions:
What is the pixel size?
How do you get min and max pixel values?

Understanding data type

Numerical System Decimal vs Binary. Recorded lecture: 1:28:45 - 1:48:00

	Ranges of GDAL data types		base^bit	Precision
GDAL data type	Minimum	Maximum		
Byte	0	255	2^8	
UInt16	0	65,535	2^16	
Int16, CInt16	-32,768	32,767	2^16	
UInt32	0	4,294,967,295	2^32	
Int32, CInt32	-2,147,483,648	2,147,483,647	2^32	
UInt64	-9.22E18	+9.22E18	2^64	
Int64	0	+1.84E19		
Float32, CFloat32	-3.4E38	3.4E38	2^38	Integer -1677
Float64, CFloat64	-1.79E308	1.79E308	2^308	

Understanding NoData Value Recorded lecture: 1:47:55 - 2:06:00

[12]:
```
!gdalinfo -mm geodata/vegetation/ETmean08-11.tif
```

```
Driver: GTiff/GeoTIFF
Files: geodata/vegetation/ETmean08-11.tif
Size is 720, 600
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (29.000000000000000,4.000000004000000)
Pixel Size = (0.008333333340000,-0.008333333340000)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (  29.0000000,   4.0000000) ( 29d 0' 0.00"E,  4d 0' 0.00"N)
Lower Left  (  29.0000000,  -1.0000000) ( 29d 0' 0.00"E,  1d 0' 0.00"S)
Upper Right (  35.0000000,   4.0000000) ( 35d 0' 0.00"E,  4d 0' 0.00"N)
Lower Right (  35.0000000,  -1.0000000) ( 35d 0' 0.00"E,  1d 0' 0.00"S)
Center      (  32.0000000,   1.5000000) ( 32d 0' 0.00"E,  1d30' 0.00"N)
Band 1 Block=720x2 Type=Float32, ColorInterp=Gray
    Computed Min/Max=0.547,7.492
  NoData Value=-3.39999995214436425e+38
```

[13]:
```
!gdal_edit.py -a_nodata -9999 geodata/vegetation/ETmean08-11.tif
```

[14]:
```
!gdalinfo -mm geodata/vegetation/ETmean08-11.tif
```

```
Driver: GTiff/GeoTIFF
Files: geodata/vegetation/ETmean08-11.tif
Size is 720, 600
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (29.000000000000000,4.000000004000000)
Pixel Size = (0.008333333340000,-0.008333333340000)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (  29.0000000,   4.0000000) ( 29d 0' 0.00"E,  4d 0' 0.00"N)
Lower Left  (  29.0000000,  -1.0000000) ( 29d 0' 0.00"E,  1d 0' 0.00"S)
Upper Right (  35.0000000,   4.0000000) ( 35d 0' 0.00"E,  4d 0' 0.00"N)
Lower Right (  35.0000000,  -1.0000000) ( 35d 0' 0.00"E,  1d 0' 0.00"S)
Center      (  32.0000000,   1.5000000) ( 32d 0' 0.00"E,  1d30' 0.00"N)
Band 1 Block=720x2 Type=Float32, ColorInterp=Gray
    Computed Min/Max=-339999995214436424907732413799364296704.000,7.492
  NoData Value=-9999
```

[15]:
```
!gdal_edit.py -a_nodata -339999995214436424907732413799364296704.000
geodata/vegetation/ETmean08-11.tif
```

[16]:
```
!gdalinfo -mm geodata/vegetation/ETmean08-11.tif
```

```
Driver: GTiff/GeoTIFF
Files: geodata/vegetation/ETmean08-11.tif
Size is 720, 600
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (29.000000000000000,4.000000004000000)
Pixel Size = (0.008333333340000,-0.008333333340000)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (  29.0000000,   4.0000000) ( 29d 0' 0.00"E,  4d 0' 0.00"N)
Lower Left  (  29.0000000,  -1.0000000) ( 29d 0' 0.00"E,  1d 0' 0.00"S)
Upper Right (  35.0000000,   4.0000000) ( 35d 0' 0.00"E,  4d 0' 0.00"N)
Lower Right (  35.0000000,  -1.0000000) ( 35d 0' 0.00"E,  1d 0' 0.00"S)
Center      (  32.0000000,   1.5000000) ( 32d 0' 0.00"E,  1d30' 0.00"N)
Band 1 Block=720x2 Type=Float32, ColorInterp=Gray
    Computed Min/Max=0.547,7.492
  NoData Value=-3.39999995214436425e+38
```

Recorded lecture: 2:06:00 - 2:19:43 + Recorded lecture: 42:18 - 1:46:40

Calculate minimum and maximum values for all the images

[1]:
```
%%bash
for file in geodata/vegetation/*.tif ; do
gdalinfo  -mm  $file  | grep Computed
done
```

```
    Computed Min/Max=-10.000,5.000
    Computed Min/Max=0.638,6.957
    Computed Min/Max=0.547,7.492
    Computed Min/Max=0.209,3.332
    Computed Min/Max=0.000,9.738
    Computed Min/Max=0.000,4.220
    Computed Min/Max=0.000,10000.000
```

Create a Coefficient of variation

GPPmean08-11.tif temporal mean of Gross Primary Productivity
GPPstdev08-11.tif temporal standard deviation of Gross Primary Productivity

[18]:
```
%%bash
gdal_calc.py --type=Float32 --overwrite  -A geodata/vegetation/GPPstdev08-11.tif -B
geodata/vegetation/GPPmean08-11.tif \
--co=COMPRESS=DEFLATE --co=ZLEVEL=9   --calc="( A.astype(float) / ( B.astype(float) +
0.000000001 ) )" --outfile=geodata/vegetation/GPPcv08-11.tif
```

```
0.. 0.. 0.. 1.. 1.. 1.. 2.. 2.. 2.. 3.. 3.. 3.. 4.. 4.. 4.. 5.. 5.. 5.. 6.. 6.. 6.. 7..
7.. 7.. 8.. 8.. 8.. 9.. 9.. 9.. 10.. 10.. 10.. 11.. 11.. 11.. 12.. 12.. 12.. 13.. 13..
13.. 14.. 14.. 14.. 15.. 15.. 15.. 16.. 16.. 16.. 17.. 17.. 17.. 18.. 18.. 18.. 19..
19.. 19.. 20.. 20.. 20.. 21.. 21.. 21.. 22.. 22.. 22.. 23.. 23.. 23.. 24.. 24.. 24..
25.. 25.. 25.. 26.. 26.. 26.. 27.. 27.. 27.. 28.. 28.. 28.. 29.. 29.. 29.. 30.. 30..
30.. 31.. 31.. 31.. 32.. 32.. 32.. 33.. 33.. 33.. 34.. 34.. 34.. 35.. 35.. 35.. 36..
36.. 36.. 37.. 37.. 37.. 38.. 38.. 38.. 39.. 39.. 39.. 40.. 40.. 40.. 41.. 41.. 41..
42.. 42.. 42.. 43.. 43.. 43.. 44.. 44.. 44.. 45.. 45.. 45.. 46.. 46.. 46.. 47.. 47..
47.. 48.. 48.. 48.. 49.. 49.. 49.. 50.. 50.. 50.. 51.. 51.. 51.. 52.. 52.. 52.. 53..
53.. 53.. 54.. 54.. 54.. 55.. 55.. 55.. 56.. 56.. 56.. 57.. 57.. 57.. 58.. 58.. 58..
59.. 59.. 59.. 60.. 60.. 60.. 61.. 61.. 61.. 62.. 62.. 62.. 63.. 63.. 63.. 64.. 64..
64.. 65.. 65.. 65.. 66.. 66.. 66.. 67.. 67.. 67.. 68.. 68.. 68.. 69.. 69.. 69.. 70..
70.. 70.. 71.. 71.. 71.. 72.. 72.. 72.. 73.. 73.. 73.. 74.. 74.. 74.. 75.. 75.. 75..
76.. 76.. 76.. 77.. 77.. 77.. 78.. 78.. 78.. 79.. 79.. 79.. 80.. 80.. 80.. 81.. 81..
81.. 82.. 82.. 82.. 83.. 83.. 83.. 84.. 84.. 84.. 85.. 85.. 85.. 86.. 86.. 86.. 87..
87.. 87.. 88.. 88.. 88.. 89.. 89.. 89.. 90.. 90.. 90.. 91.. 91.. 91.. 92.. 92.. 92..
93.. 93.. 93.. 94.. 94.. 94.. 95.. 95.. 95.. 96.. 96.. 96.. 97.. 97.. 97.. 98.. 98..
98.. 99.. 99.. 99.. 100 - Done
```

[19]:
```
! gdalinfo -mm geodata/vegetation/GPPcv08-11.tif
```

```
Driver: GTiff/GeoTIFF
Files: geodata/vegetation/GPPcv08-11.tif
Size is 720, 600
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (29.000000000000000,4.000000004000000)
Pixel Size = (0.008333333340000,-0.008333333340000)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  COMPRESSION=DEFLATE
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  (  29.0000000,   4.0000000) ( 29d 0' 0.00"E,  4d 0' 0.00"N)
Lower Left  (  29.0000000,  -1.0000000) ( 29d 0' 0.00"E,  1d 0' 0.00"S)
Upper Right (  35.0000000,   4.0000000) ( 35d 0' 0.00"E,  4d 0' 0.00"N)
Lower Right (  35.0000000,  -1.0000000) ( 35d 0' 0.00"E,  1d 0' 0.00"S)
Center      (  32.0000000,   1.5000000) ( 32d 0' 0.00"E,  1d30' 0.00"N)
Band 1 Block=720x2 Type=Float32, ColorInterp=Gray
    Computed Min/Max=0.000,1.476
  NoData Value=3.402823466000000016e+38
```

Change pixel resolution

Looping trough the images

[20]:
```
%%bash
for file in geodata/LST/LST_MOYDmax_month?.tif geodata/LST/LST_MOYDmax_month??.tif; do
  filename=$(basename $file .tif )
  gdalwarp -overwrite -te 29 -1 35.0000000048 4.000000004 -tr 0.008333333340000
0.008333333340000 -co COMPRESS=DEFLATE -co ZLEVEL=9 $file
geodata/LST/${filename}_crop.tif
done
```

```
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month1.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month1.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month1.tif to destination
geodata/LST/LST_MOYDmax_month1_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month2.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month2.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month2.tif to destination
geodata/LST/LST_MOYDmax_month2_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month3.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month3.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month3.tif to destination
geodata/LST/LST_MOYDmax_month3_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month4.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month4.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month4.tif to destination
geodata/LST/LST_MOYDmax_month4_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month5.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month5.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month5.tif to destination
geodata/LST/LST_MOYDmax_month5_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month6.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month6.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month6.tif to destination
geodata/LST/LST_MOYDmax_month6_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month7.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month7.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month7.tif to destination
geodata/LST/LST_MOYDmax_month7_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month8.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month8.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month8.tif to destination
geodata/LST/LST_MOYDmax_month8_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month9.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month9.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month9.tif to destination
geodata/LST/LST_MOYDmax_month9_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month10.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month10.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month10.tif to destination
geodata/LST/LST_MOYDmax_month10_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month11.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month11.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month11.tif to destination
geodata/LST/LST_MOYDmax_month11_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
Creating output file that is 720P x 600L.
Processing geodata/LST/LST_MOYDmax_month12.tif [1/1] : 0Using internal nodata values
(e.g. -9999) for image geodata/LST/LST_MOYDmax_month12.tif.
Copying nodata values from source geodata/LST/LST_MOYDmax_month12.tif to destination
geodata/LST/LST_MOYDmax_month12_crop.tif.
...10...20...30...40...50...60...70...80...90...100 - done.
```

Get value at one pixel/line image-location

Looping trough the images

[21]:
```
%%bash
for file in geodata/LST/LST_MOYDmax_month?.tif geodata/LST/LST_MOYDmax_month??.tif; do
   gdallocationinfo  $file  1079 0
done
```

```
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 50.8218383789062
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 52.4714660644531
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 50.2210998535156
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 45.1343078613281
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 43.8952941894531
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 45.8667602539062
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 47.9639892578125
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 49.0910339355469
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 49.9898986816406
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 47.5579528808594
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 45.6031494140625
Report:
  Location: (1079P,0L)
  Band 1:
    Value: 47.5201110839844
```

Get value at lat/long image-location

Looping trough the images

[22]:
```
%%bash
for file in geodata/LST/LST_MOYDmax_month?.tif geodata/LST/LST_MOYDmax_month??.tif; do
   gdallocationinfo -valonly -geoloc $file  33.3 2
done
```

```
37.4764404296875
40.2584228515625
38.2513122558594
33.0213928222656
30.0732116699219
29.0838928222656
28.9105224609375
29.6008605957031
31.0305480957031
30.5758056640625
30.636962890625
33.5576171875
```

Get value at multiple lat/long image-location

[23]:
```
%%bash
# Create the lat long file
echo 32.5 2.5 > geodata/LST/x_y.txt
echo 31.1 2.1 >> geodata/LST/x_y.txt
# looping trough the images
for file in geodata/LST/LST_MOYDmax_month?.tif geodata/LST/LST_MOYDmax_month??.tif; do
   gdallocationinfo -valonly -geoloc $file < geodata/LST/x_y.txt
   echo ""
done
```

```
37.4022827148438
35.0345764160156

40.3694458007812
37.824951171875

38.5549926757812
36.6663208007812

32.7738952636719
32.6803283691406

29.0351257324219
30.0338134765625

29.025634765625
29.3355102539062

29.0183715820312
29.4237365722656

29.1660461425781
29.3502197265625

29.6674194335938
29.7001647949219

28.8177490234375
29.066650390625

29.2975463867188
29.015869140625

32.8586730957031
31.3289184570312
```

From Image to text and from txt to image

[24]:
```
%%bash
# from tif to 3 col txt XYZ
gdal_translate -of  XYZ   geodata/vegetation/ETmean08-11.tif
geodata/vegetation/ETmean08-11_crop.txt
# masking
awk '{if ($3>2 && $3<4) {print $1,$2,50 } else {print}}' geodata/vegetation/ETmean08-
11_crop.txt > geodata/vegetation/ETmean08-11_crop_trh.txt
# back to tif
gdal_translate -co COMPRESS=DEFLATE -co ZLEVEL=9  -ot Byte
geodata/vegetation/ETmean08-11_crop_trh.txt geodata/vegetation/ETmean08-
11_crop_trh.tif
```

```
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
```

The use of VRT to stack images and tiling

[25]:
```
%%bash
# stck the tif
gdalbuildvrt -overwrite -separate geodata/vegetation/stack.vrt
geodata/vegetation/ETmean08-11.tif geodata/vegetation/ETstdev08-11.tif
gdalinfo geodata/vegetation/stack.vrt
```

```
0...10...20...30...40...50...60...70...80...90...100 - done.
Driver: VRT/Virtual Raster
Files: geodata/vegetation/stack.vrt
       geodata/vegetation/ETmean08-11.tif
       geodata/vegetation/ETstdev08-11.tif
Size is 720, 600
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (29.000000000000000,4.000000004000000)
Pixel Size = (0.008333333340000,-0.008333333340000)
Corner Coordinates:
Upper Left  (  29.0000000,   4.0000000) ( 29d 0' 0.00"E,  4d 0' 0.00"N)
Lower Left  (  29.0000000,  -1.0000000) ( 29d 0' 0.00"E,  1d 0' 0.00"S)
Upper Right (  35.0000000,   4.0000000) ( 35d 0' 0.00"E,  4d 0' 0.00"N)
Lower Right (  35.0000000,  -1.0000000) ( 35d 0' 0.00"E,  1d 0' 0.00"S)
Center      (  32.0000000,   1.5000000) ( 32d 0' 0.00"E,  1d30' 0.00"N)
Band 1 Block=128x128 Type=Float32, ColorInterp=Undefined
  NoData Value=-3.39999995214436387e+38
Band 2 Block=128x128 Type=Float32, ColorInterp=Undefined
  NoData Value=-3.39999995214436387e+38
```

[26]:
```
%%bash
# split in tiles
gdal_translate -srcwin 0     0 360 300 geodata/vegetation/stack.vrt
geodata/vegetation/stack_UL.tif
gdal_translate -srcwin 0   300 360 300 geodata/vegetation/stack.vrt
geodata/vegetation/stack_UR.tif
gdal_translate -srcwin 360   0 360 300 geodata/vegetation/stack.vrt
geodata/vegetation/stack_LL.tif
gdal_translate -srcwin 360 300 360 300 geodata/vegetation/stack.vrt
geodata/vegetation/stack_LR.tif

# recompose the image
gdalbuildvrt -overwrite geodata/vegetation/ETmosaic.vrt
geodata/vegetation/stack_UL.tif geodata/vegetation/stack_UR.tif
geodata/vegetation/stack_LL.tif geodata/vegetation/stack_LR.tif
gdal_translate -co COMPRESS=DEFLATE -co ZLEVEL=9 geodata/vegetation/ETmosaic.vrt
geodata/vegetation/ETmosaic.tif
```

```
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
0...10...20...30...40...50...60...70...80...90...100 - done.
Input file size is 720, 600
0...10...20...30...40...50...60...70...80...90...100 - done.
```

Create shp border tiles

[27]:
```
%%bash
rm -f geodata/vegetation/tiles.*
gdaltindex  geodata/vegetation/tiles.shp  geodata/vegetation/stack_??.tif
```

```
Creating new index file...
```

Surface distance/buffer

[28]:
```
%%bash
# Continues distance surface
gdal_proximity.py -co COMPRESS=DEFLATE -co ZLEVEL=9 -values 0 -distunits PIXEL -ot
UInt32 geodata/vegetation/ETmean08-11_crop_trh.tif geodata/vegetation/ETmean08-
11_crop_proximity.tif
```

```
0...10...20...30...40...50...60...70...80...90...100 - done.
```

[29]:
```
%%bash
# Fix buffer surface
gdal_proximity.py -fixed-buf-val 4 -maxdist 4 -nodata 10 -co COMPRESS=DEFLATE -co
ZLEVEL=9 -values 0 -distunits PIXEL -ot Byte geodata/vegetation/ETmean08-
11_crop_trh.tif geodata/vegetation/ETmean08-11_crop_buffer.tif
```

```
0...10...20...30...40...50...60...70...80...90...100 - done.
```

Topography variables

[30]:
```
%%bash
# calculate  slope
gdaldem slope -s 111120 -co COMPRESS=DEFLATE -co ZLEVEL=9 geodata/dem/GMTED2010.tif
geodata/dem/slope.tif

# calculate  apect
gdaldem aspect -zero_for_flat -co COMPRESS=DEFLATE -co ZLEVEL=9
geodata/dem/GMTED2010.tif geodata/dem/aspect.tif

# calculate  Terrain Ruggedness Index TRI
gdaldem TRI -co COMPRESS=DEFLATE -co ZLEVEL=9 geodata/dem/GMTED2010.tif
geodata/dem/tri.tif

# calculate  Topographic Position Index TPI
gdaldem TPI -co COMPRESS=DEFLATE -co ZLEVEL=9 geodata/dem/GMTED2010.tif
geodata/dem/tpi.tif

# calculate  Roughness
gdaldem roughness -co COMPRESS=DEFLATE -co ZLEVEL=9 geodata/dem/GMTED2010.tif
geodata/dem/roughness.tif
```

```
0...10...20...30...40...50...60...70...80...90...100 - done.
0...10...20...30...40...50...60...70...80...90...100 - done.
0...10...20...30...40...50...60...70...80...90...100 - done.
0...10...20...30...40...50...60...70...80...90...100 - done.
0...10...20...30...40...50...60...70...80...90...100 - done.
```

Start to use OGR Commands

Select a polygon and create a new shape file

[31]:
```
%%bash
ogrinfo -al -geom=NO   geodata/shp/TM_WORLD_BORDERS.shp  | head -80
```

```
INFO: Open of `geodata/shp/TM_WORLD_BORDERS.shp'
      using driver `ESRI Shapefile' successful.

Layer name: TM_WORLD_BORDERS
Metadata:
  DBF_DATE_LAST_UPDATE=2021-02-09
Geometry: Polygon
Feature Count: 246
Extent: (-180.000000, -90.000000) - (180.000000, 83.623596)
Layer SRS WKT:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["latitude",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["longitude",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
FIPS: String (2.0)
ISO2: String (2.0)
ISO3: String (3.0)
UN: Integer (3.0)
NAME: String (50.0)
AREA: Integer (7.0)
POP2005: Integer64 (10.0)
REGION: Integer (3.0)
SUBREGION: Integer (3.0)
LON: Real (8.3)
LAT: Real (7.3)
OGRFeature(TM_WORLD_BORDERS):0
  FIPS (String) = AC
  ISO2 (String) = AG
  ISO3 (String) = ATG
  UN (Integer) = 28
  NAME (String) = Antigua and Barbuda
  AREA (Integer) = 44
  POP2005 (Integer64) = 83039
  REGION (Integer) = 19
  SUBREGION (Integer) = 29
  LON (Real) = -61.783
  LAT (Real) = 17.078

OGRFeature(TM_WORLD_BORDERS):1
  FIPS (String) = AG
  ISO2 (String) = DZ
  ISO3 (String) = DZA
  UN (Integer) = 12
  NAME (String) = Algeria
  AREA (Integer) = 238174
  POP2005 (Integer64) = 32854159
  REGION (Integer) = 2
  SUBREGION (Integer) = 15
  LON (Real) = 2.632
  LAT (Real) = 28.163

OGRFeature(TM_WORLD_BORDERS):2
  FIPS (String) = AJ
  ISO2 (String) = AZ
  ISO3 (String) = AZE
  UN (Integer) = 31
  NAME (String) = Azerbaijan
  AREA (Integer) = 8260
  POP2005 (Integer64) = 8352021
  REGION (Integer) = 142
  SUBREGION (Integer) = 145
```

```
  LON (Real) = 47.395
  LAT (Real) = 40.430

OGRFeature(TM_WORLD_BORDERS):3
  FIPS (String) = AL
  ISO2 (String) = AL
  ISO3 (String) = ALB
  UN (Integer) = 8
```

[32]:
```
%%bash
# base on an attribute
rm -f shp/TM_UGANDA_BORDERS-0.3.*
ogr2ogr  -overwrite  -f "ESRI Shapefile"  -where "NAME = 'Uganda'"
geodata/shp/TM_UGANDA_BORDERS-0.3.shp geodata/shp/TM_WORLD_BORDERS.shp
/usr/bin/openev/bin/openev geodata/shp/TM_UGANDA_BORDERS-0.3.shp
```

```
Default software rendering mode (use -h if accelerated video card installed).
Loading tools from /usr/bin/openev/tools/Tool_Export.py
Loading tools from /usr/bin/openev/tools/Tool_ShapesGrid.py
Loading tools from /usr/bin/openev/tools/Tool_DriverList.py
```

[33]:
```
%%bash
# base on dimension of the polygons
rm -f geodata/shp/TM_LARGE_BORDERS.*
ogr2ogr  -overwrite  -f "ESRI Shapefile" -sql "SELECT * FROM TM_WORLD_BORDERS WHERE
OGR_GEOM_AREA > 100 " geodata/shp/TM_LARGE_BORDERS.shp
geodata/shp/TM_WORLD_BORDERS.shp
/usr/bin/openev/bin/openev geodata/shp/TM_LARGE_BORDERS.shp
```

```
Default software rendering mode (use -h if accelerated video card installed).
Loading tools from /usr/bin/openev/tools/Tool_Export.py
Loading tools from /usr/bin/openev/tools/Tool_ShapesGrid.py
Loading tools from /usr/bin/openev/tools/Tool_DriverList.py
```

Remove all the output

[35]:
```
%%bash
rm -f geodata/shp/polygons.sqlite geodata/shp/point-buf_stat.csv
geodata/shp/point_stat.csv geodata/vegetation/GPPcv08-11.tif LST/*_crop.tif
geodata/vegetation/ETmean08-11_crop_trh.tif geodata/vegetation/ETmean08-
11_crop_trh.txt vegetation/ETmean08-11_crop.txt geodata/vegetation/ETmosaic.vrt
geodata/vegetation/ETmosaic.tif  geodata/vegetation/stack_??.tif
geodata/vegetation/stack.vrt geodata/vegetation/tiles.* geodata/vegetation/ETmean08-
11_crop_proximity.tif geodata/vegetation/ETmean08-11_crop_buffer.tif
geodata/dem/slope.tif geodata/dem/aspect.tif  geodata/dem/tri.tif geodata/dem/tpi.tif
geodata/dem/roughness.tif geodata/vegetation/ETmean08-11_01_trh?.tif
geodata/LST/LST_MOYDmax_month1-msk.tif geodata/LST/LST_MOYDmax_monthStdev.tif
geodata/LST/LST_MOYDmax_monthMean.tif geodata/LST/LST_MOYDmax_month_mean_stdev.tif
geodata/LST/LST_MOYDmax_month.vrt geodata/LST/LST_MOYDmax_monthMean_aggreate10mean.tif
geodata/LST/LST_MOYDmax_monthMean_circular11mean.tif
geodata/temperature/reclass_ug_bio_3.tif geodata/temperature/reclass_ug_bio_3.txt
geodata/shp/polygons_stat.csv geodata/shp/polygons_stat.*
geodata/shp/TM_LARGE_BORDERS.shp.* geodata/shp/TM_UGANDA_BORDERS-0.3.*
geodata/vegetation/ETmean08-11_crop.txt
```