GEOGRAPHIC COORDINATES AND PROJECTION

Open the bash terminal and run

```
cd $HOME/SE_data
git pull
```

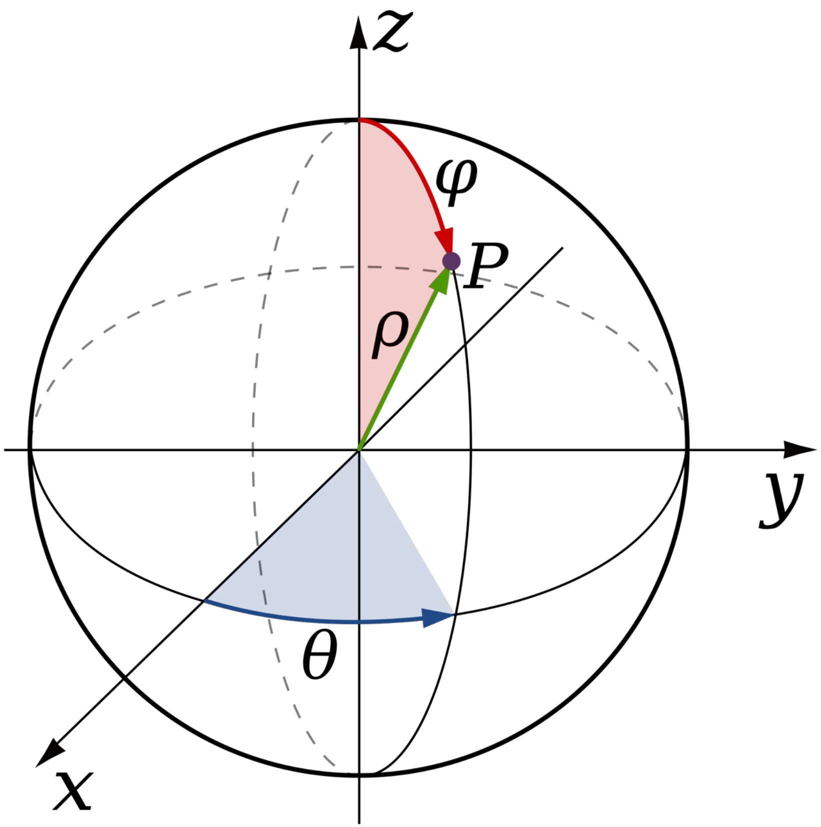
GEOGRAPHIC COORDINATES AND PROJECTION

Coordinate Reference Systems (CRS)

In general CRS can be divided into:
- **geographic coordinate reference systems** (angular coordinates)**.**
- **projected coordinate reference systems** (cartesian or rectangular coordinates)

Geographic Coordinate Reference Systems (angular coordinates)

- 3D spherical representation.
- Measures in **angular degree**
- Earth has an **irregular spheroid** shape.
- we map the earth on a **Geodetic Datum** a reference ellipsoid with a given origin and orientation (2D angular coordinates)



Some Global Datums examples:

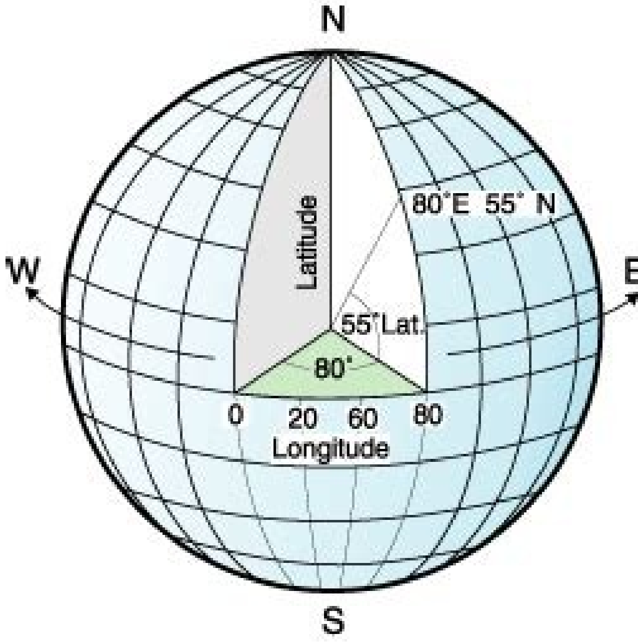
WGS84, World Geodetic System (default for GPS)

NAD83, North American Datum (very similar to WGS 84)

Geographic Coordinate Reference Systems (angular coordinates)

Features of the Geographic Coordinate Reference Systems

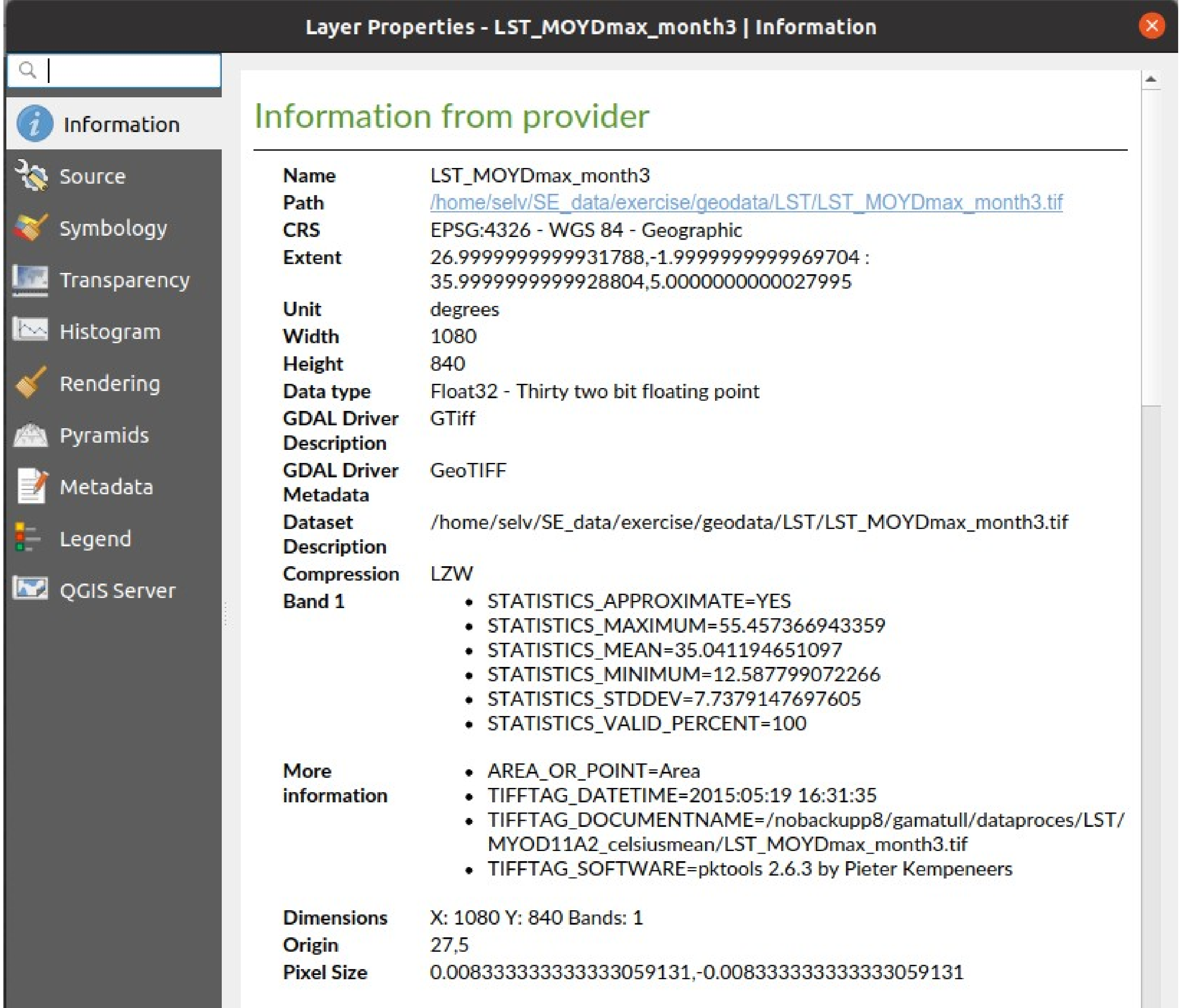
- Longitude
  - WEST-EAST (-180° +180°; total 360°)
  - Longitude (x dimension) is getting smaller going from the Equator to the Poles
  - 1° Longitude = 111.32 km = 69.17 mi at the Equator
  - 1° Longitude / 120 = 0.008333 which is consider ~1km
- Latitude
  - NORD-SOUTH (+90° -90°; total 180°)
  - Latitude (y dimension) is similar going from the Equator to the Poles
  - 1° Latitude = 110.57 km = 68.71 mi at the Equator



Geographic Coordinate Reference Systems for raster or vector files

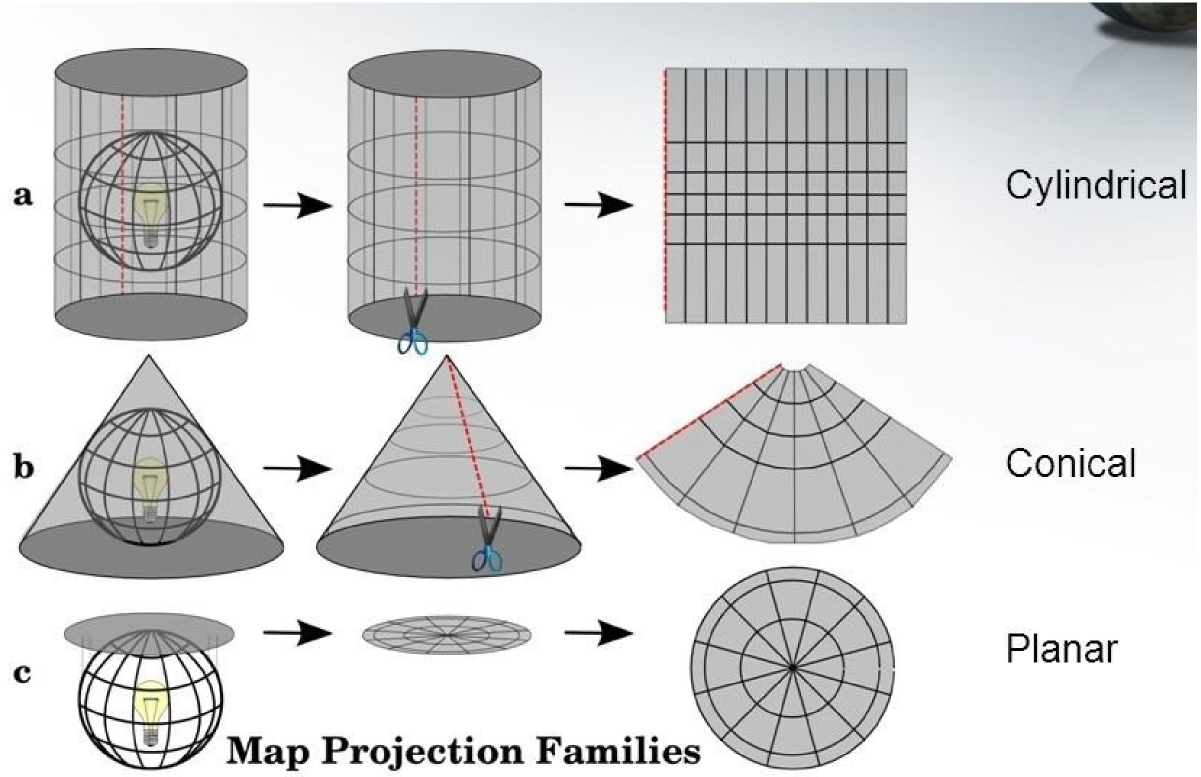
1° Longitude / 120 = 0.008333
111.32 km ÷ 120 = 0.9276 km
which is consider ~1km

1 pixel cover 0.8605 km^2
and is getting smaller and smaller going towards the poles



Projected coordinate reference systems (Cartesian or rectangular coordinate reference systems)

- Map projections are never absolutely accurate representations of the spherical earth. As a result of the map projection process, every map shows distortions of angular conformity, distance and area.

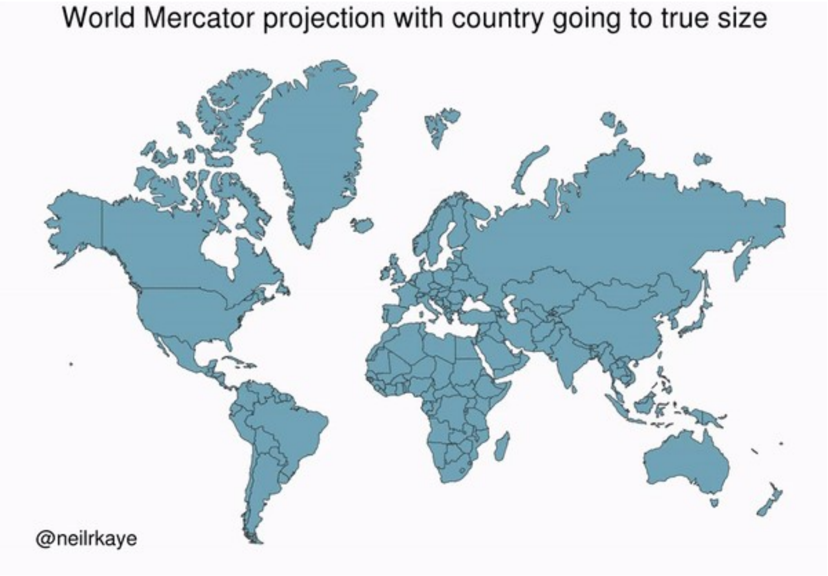


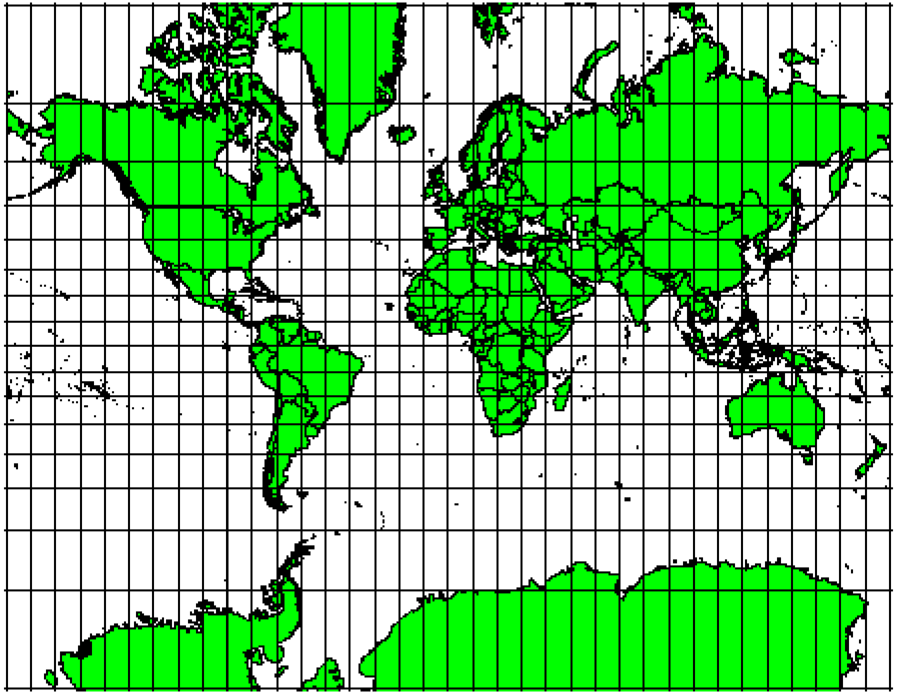
Map projections with angular conformity

They are commonly used for navigational or meteorological tasks.

Mercator projection

Lambert Conformal Conic projection

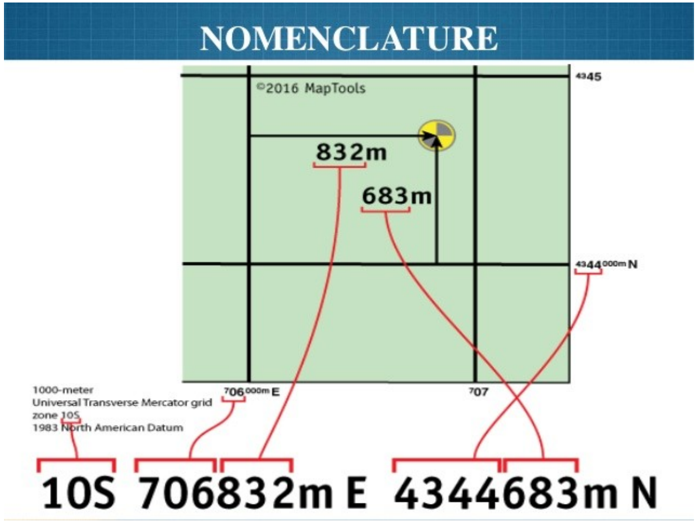


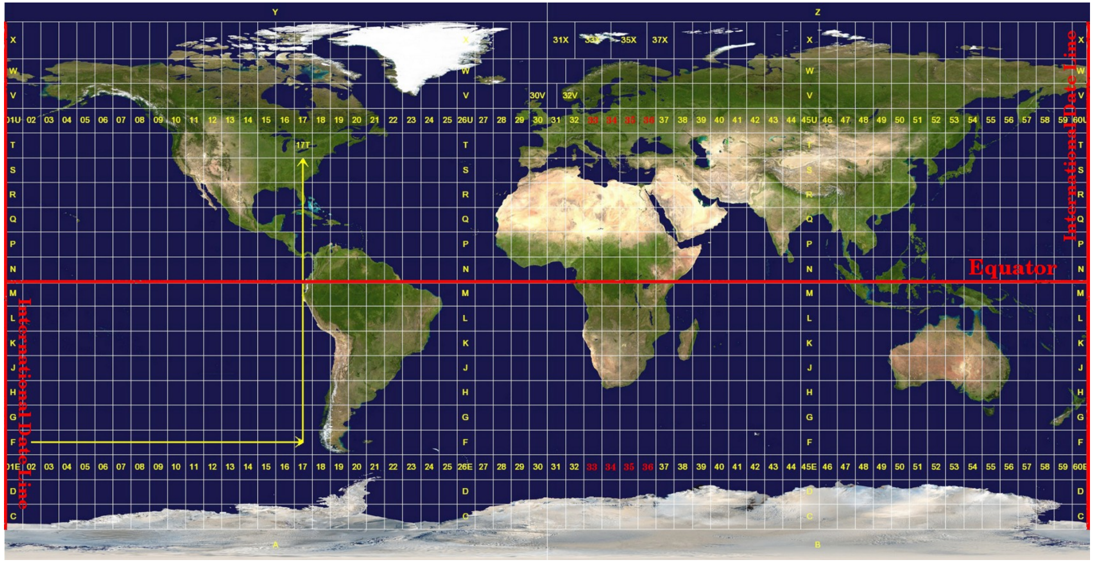


Map projections with angular conformity

Universal Transverse Mercator (UTM)

To avoid too much distortion, the world is divided into 60 equal zones (Fuse) that are all 6 degrees wide.
e.g. UTM 33S, UTM 3N





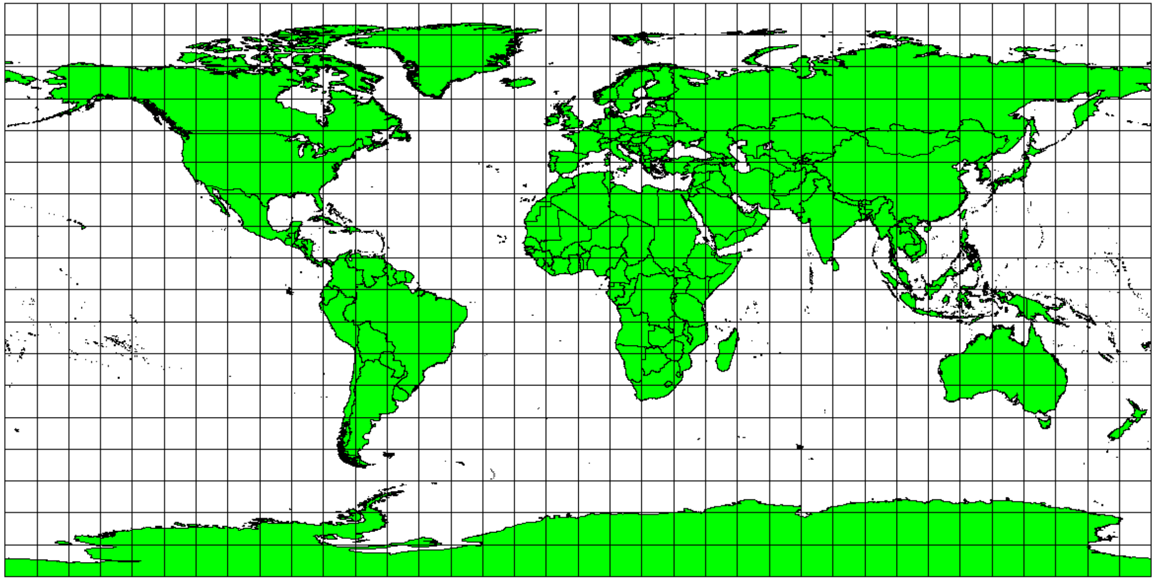
Map projections with equal distance

If your goal in projecting a map is to accurately measure distances

Plate Carree Equidistant Cylindrical

Equirectangular projection

Azimuthal Equidistant projection



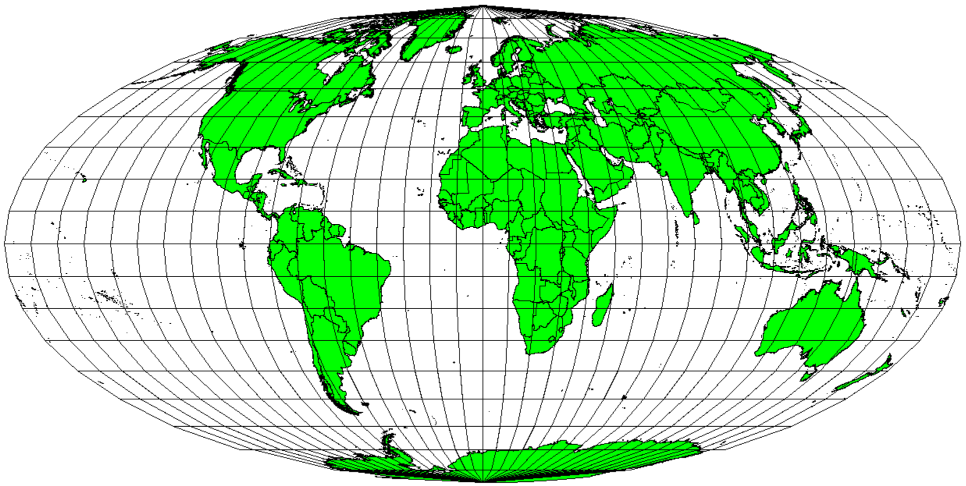
Map projections with equal areas

They are commonly used for navigational or meteorological tasks.

Alber’s equal area,

Lambert’s equal area

Mollweide Equal Area Cylindrical projections



CRS CODES

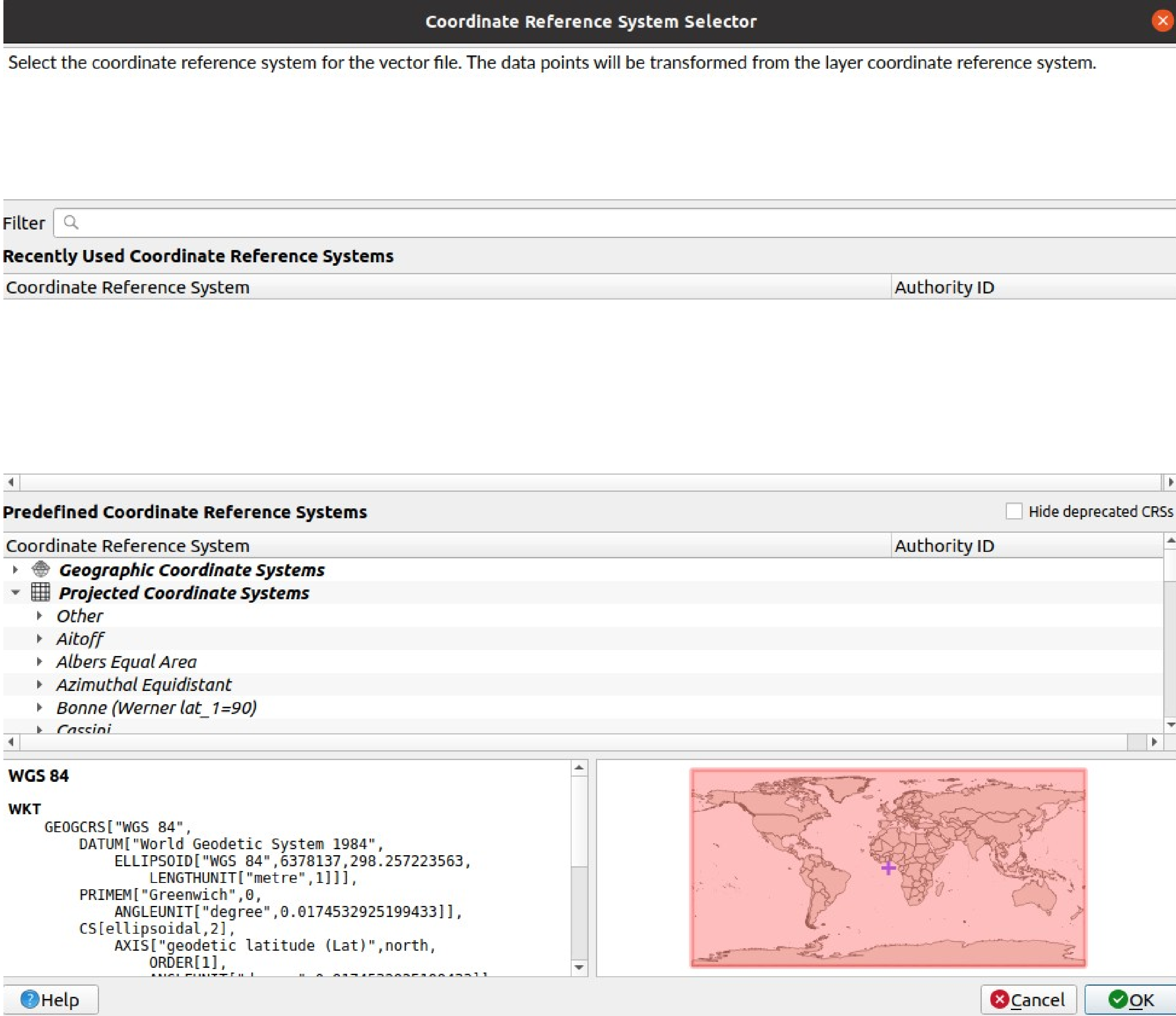
The CRS is defined by EPSG or SR-ORG or ESRI codes.

- EPSG stands for European Petroleum Survey Group and is an organization that maintains a geodetic parameter database with standard codes, the EPSG codes, for coordinate systems, datums, spheroids, units and such alike.
- SR-ORG are user defined projection.
- ESRI are projection defined by the ESRI company.
- The EPSG or SR-ORG or ESRI codes are defined at https://spatialreference.org/

CRS in QGIS

Define/Assign projection: define a projection parameters on the metadata (the geographic features do not change)

Warp/Reproject: change the the projection parameters on the metadata and on the file (the geographic features change)



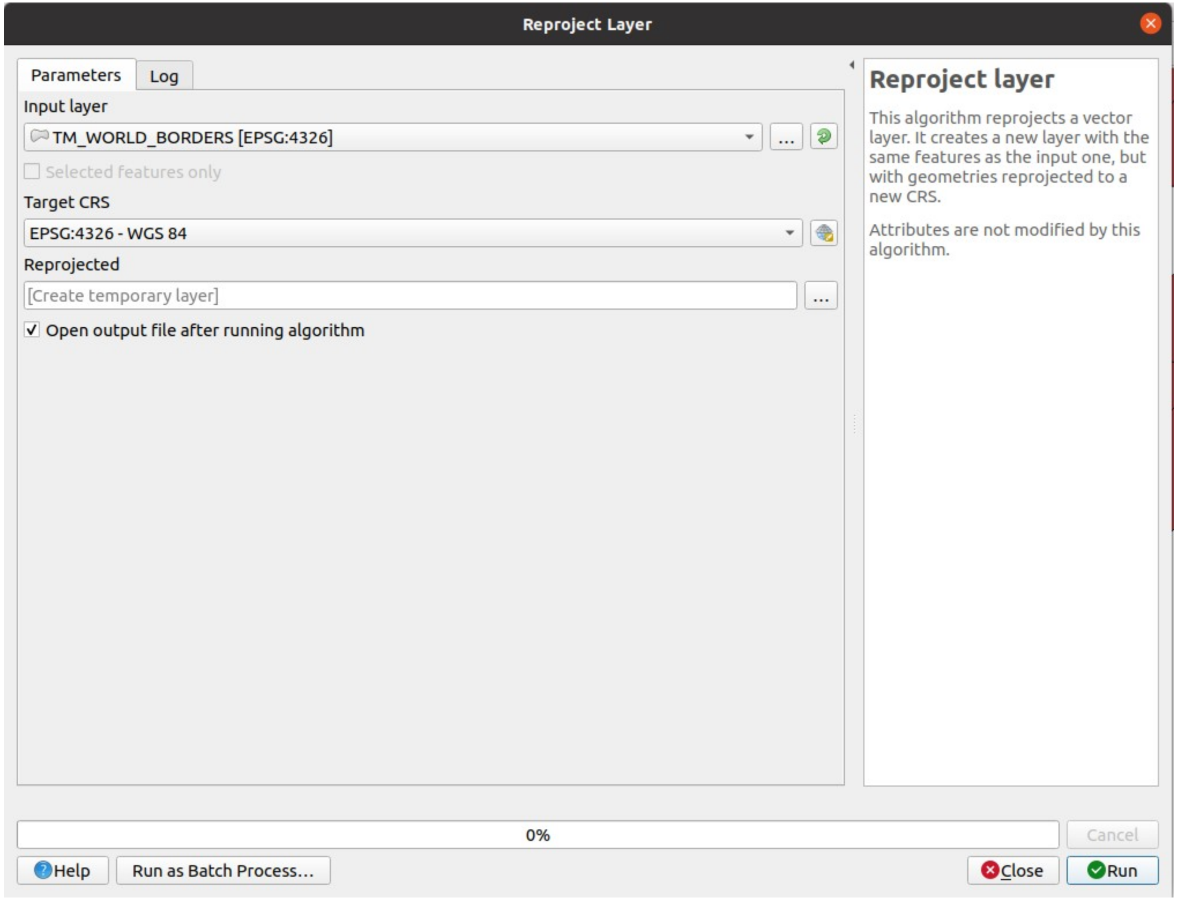
The CRS metadata can be stored in different file format

https://spatialreference.org/ref/epsg/4326/

- Well Known Text as HTML
- Human-Readable OGC WKT
- Proj4 → +proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs
- OGC WKT
- JSON
- GML
- ESRI WKT
- .PRJ File → GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137,298.257223563]],PRIMEM["Greenwich",0],UNIT["Degree",0.017453292519943295]]
- USGS
- MapServer Mapfile | Python
- Mapnik XML | Python
- GeoServer
- PostGIS spatial_ref_sys INSERT statement
- Proj4js format

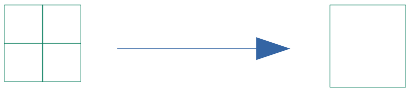
Reproject vector

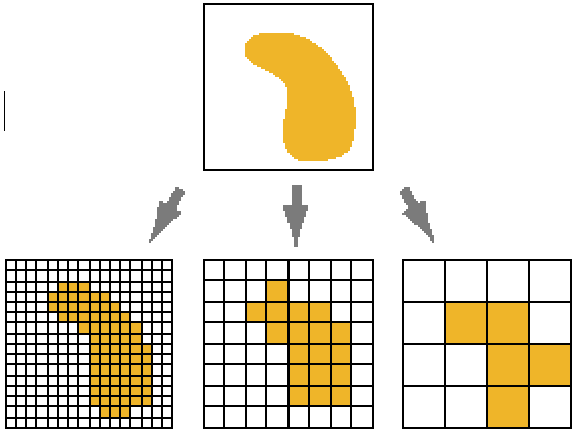
Vector > Data Management Tools > Reproject Layers



Resampling/Aggregate

Resampling/Aggregate/Disaggregate = change pixel resol

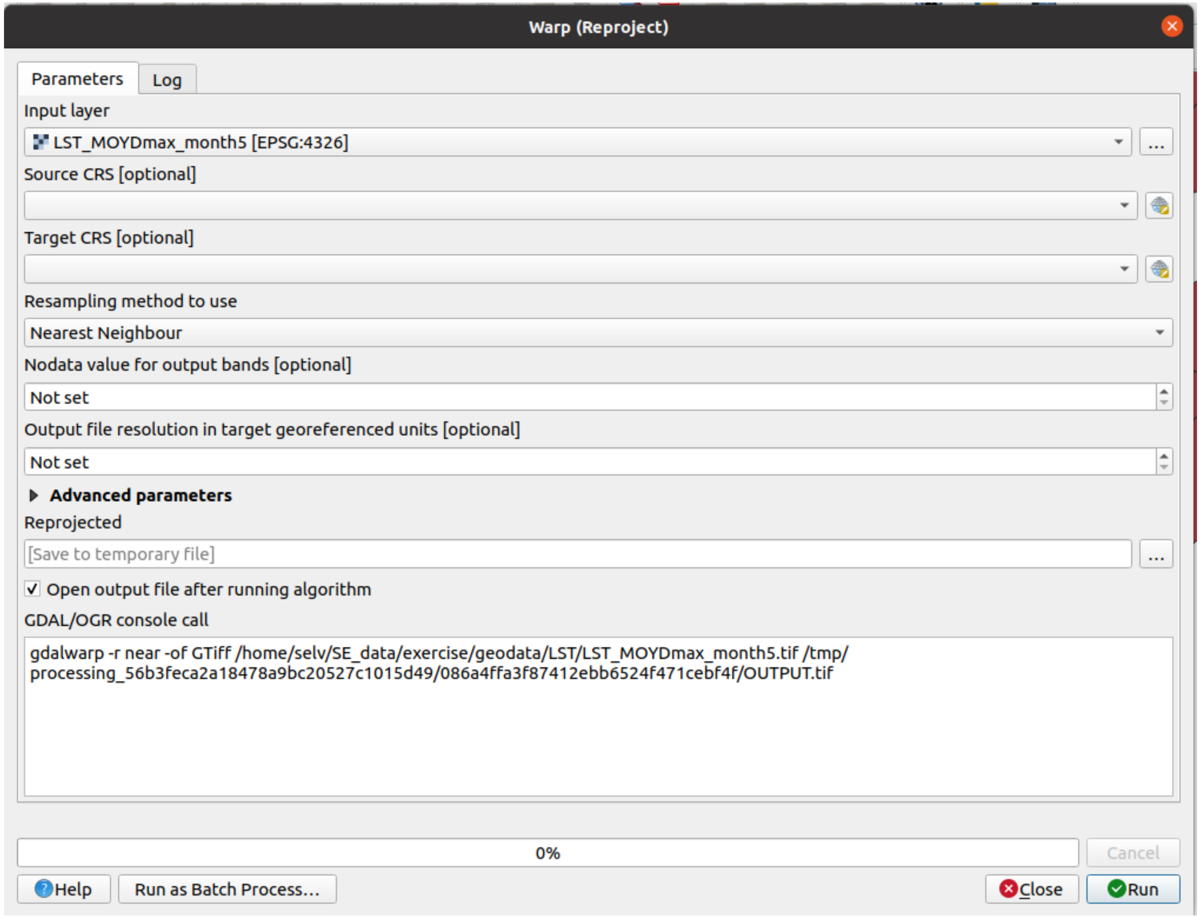




- Continues data
  - Nearest Neighbor
  - Average
  - Median
  - Bilinear Interpolation (weighted average of the 4 surrounding cells)
  - Cubic Convolution Interpolation (weighted average of the 16 surrounding cells)
- Categorical data
  - Nearest Neighbor
  - Count
  - Majority

Reproject Raster

Raster > Projection > Warp (Reproj)



Additional material

https://docs.qgis.org/3.16/en/docs/gentle_gis_introduction/coordinate_reference_systems.html

Exercise

- Navigate in the /home/user/SE_data/exercise/geodata/landsat_ct
- Merge all the tif file in only one large tif
- Reproject the merged tif to match the projection of

  /home/selv/SE_data/exercise/geodata/shp/USA_NAD27.shp
  - Compress the output
  - Select the optima re-sampling method
  - Considering the original resolution is 0.0083333333 degree
    - Define the right target resolution
    - Crop the image in such a way that the tile border is a integer multiply of the defined pixel resolution