

A Quick Note on Coordinate Systems and Map Projections



Coordinate Systems

- A **Coordinate System** is a way of associating mapped objects with their real location on the Earth
- Any coordinate system needs to reference a **datum** point from which all mapped measurements can be tied back to the Earth
- They also need a **geoid/ellipsoid** to help tie the geometry of a flat map to a curved Earth
- A coordinate system is not necessarily **projected**
- **Projections** are coordinate systems that mathematically “unbend” curvilinear distances into flat distances

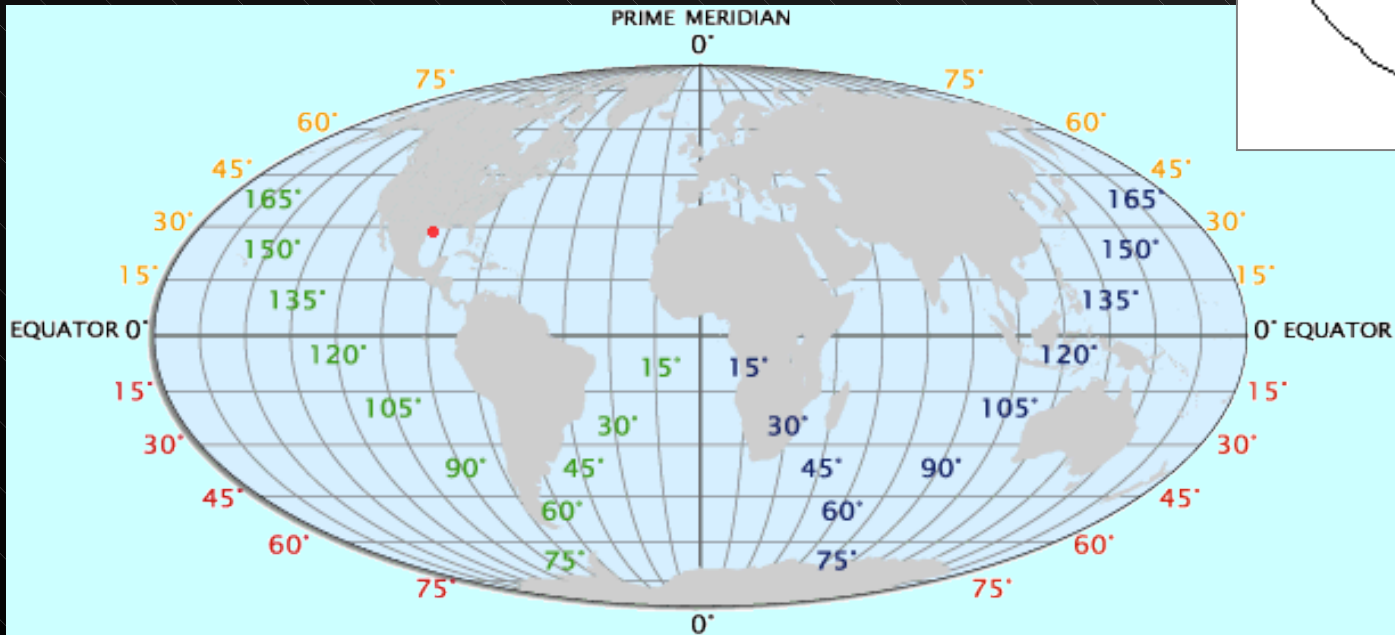
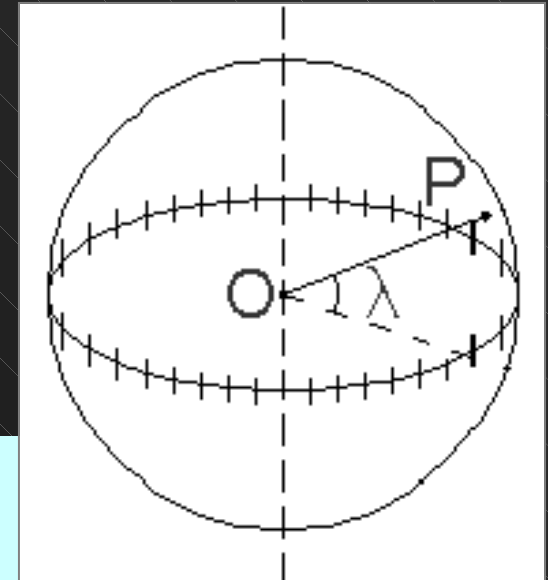
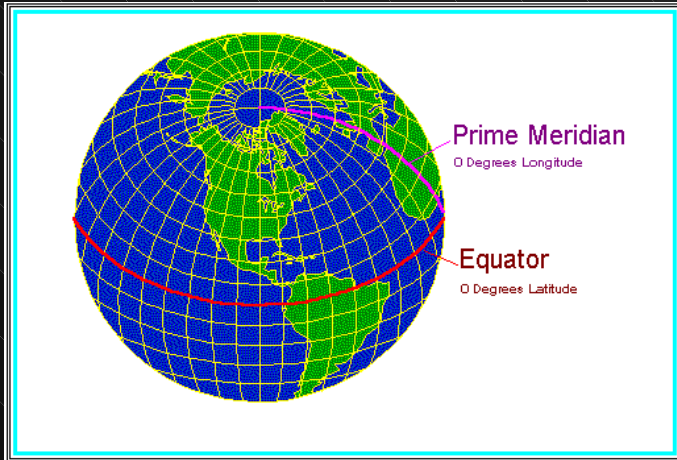
Coordinate Systems

- Coordinate systems are standardized methods for assigning codes to real locations so that locations can be found using the codes alone
- In a coordinate system, these codes are coordinate pairs where the x-direction value is the easting and the y-direction value is the northing. Most systems make both values positive
- A paper map is based on relative locations (i.e., relative to the edge of the paper).
- A GIS needs to relate the relative coordinates of a map with a standard earth coordinate system.

Geographic Coordinate System

- A geographic coordinate system: works worldwide
- Latitude/Longitude (Lat/Lon)
- All distances in this type of projection are measured as fractions of the Earth's diameter
(degrees/minutes/seconds, or decimal degrees)

Latitude/Longitude



Latitude Longitude

```
.....  
0.215 9.297  
0.166 9.319  
0.050 9.340  
0.055 9.324  
0.006 9.324  
-0.022 9.308  
-0.105 9.286  
-0.243 9.281  
-0.530 9.270  
-0.640 9.276  
.....
```

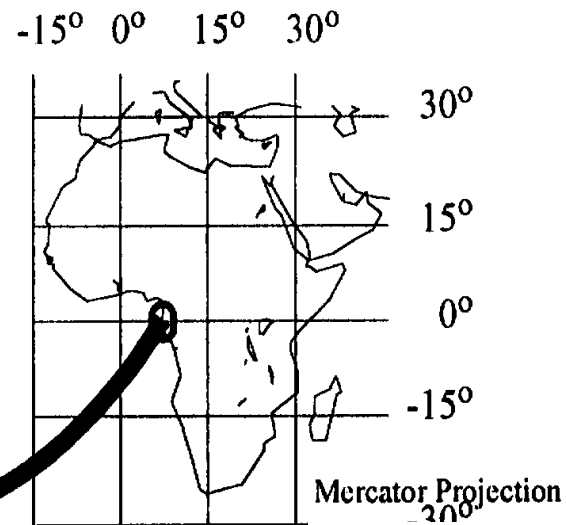


Figure 2.10 Part of the World Data Bank I listing of the coordinates of the coastline of Africa. Format is geographic coordinates in decimal degrees.

Projected Coordinate Systems

- “Unbend” a curvilinear world to fit it on a flat map.
- Several different ways of doing this: Cylindrical, Conic, Planar, etc.

Map Projection Types

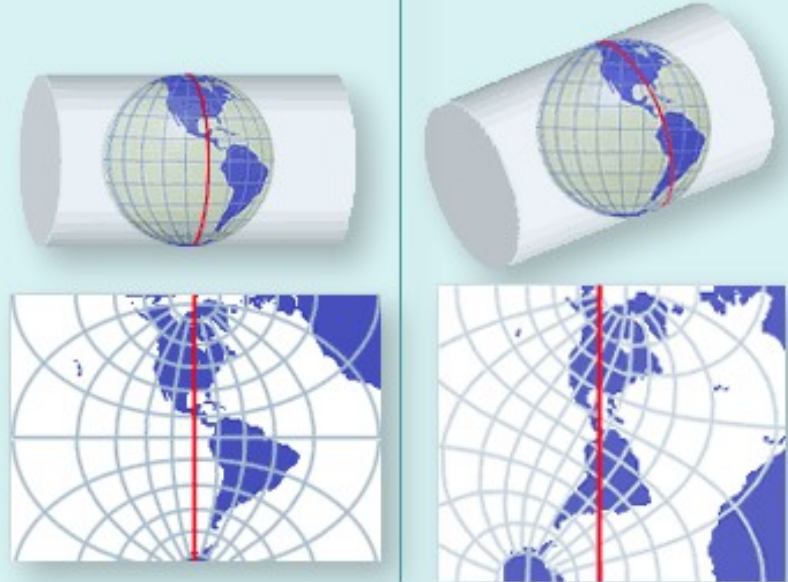
Tangent at a selected line

Secant along two lines



Transverse Mercator

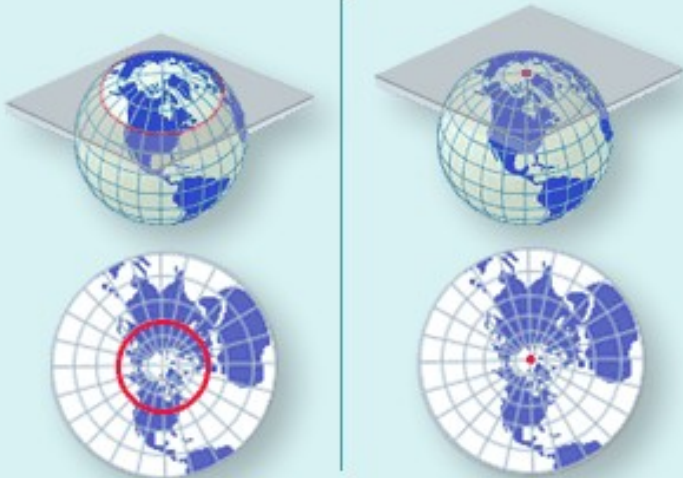
Oblique Mercator



Planar Projection

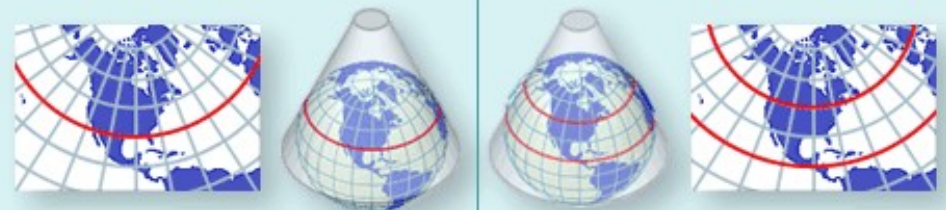
Secant

Tangent



Tangent at a single parallel

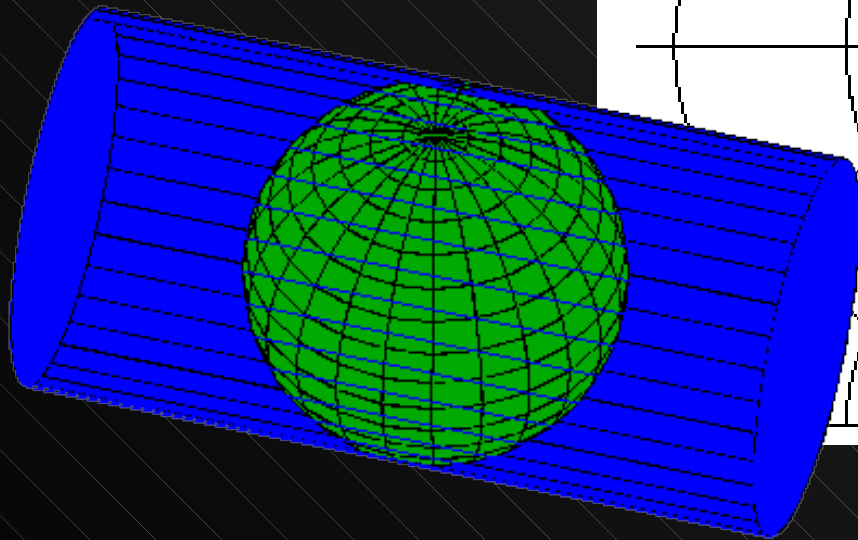
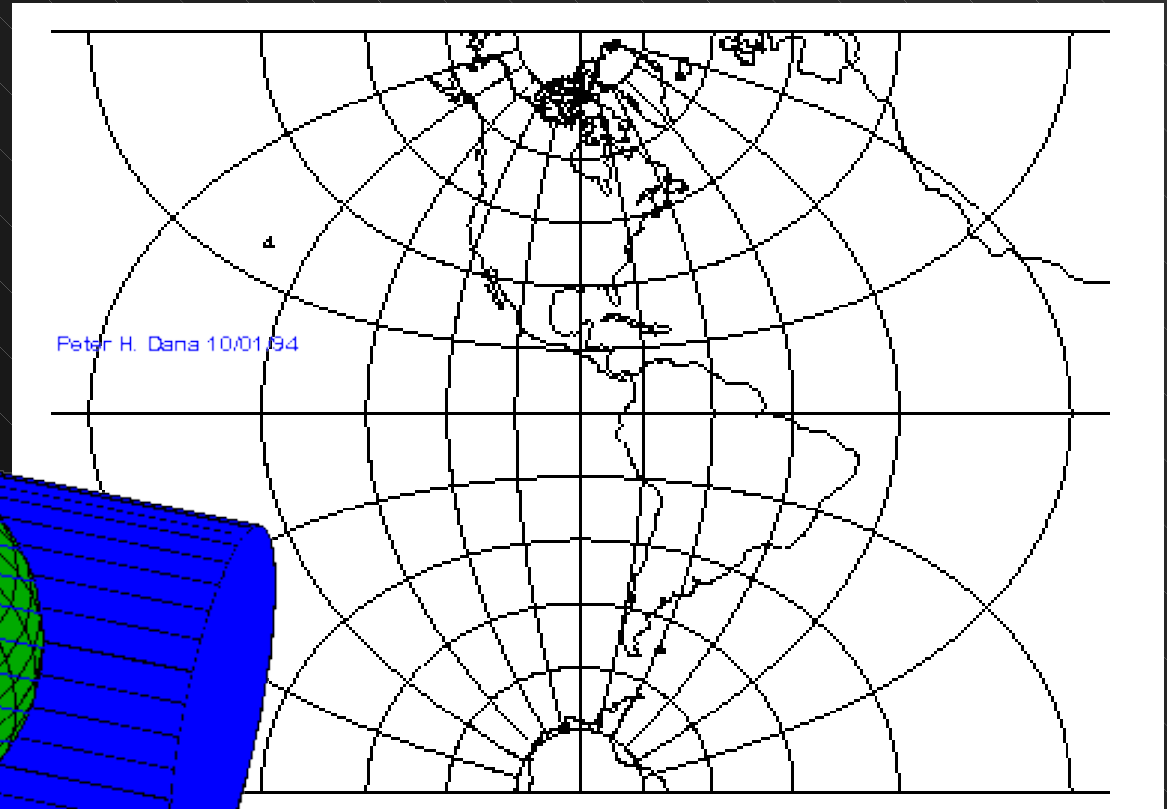
Secant at two parallels



Projected Coordinate Systems

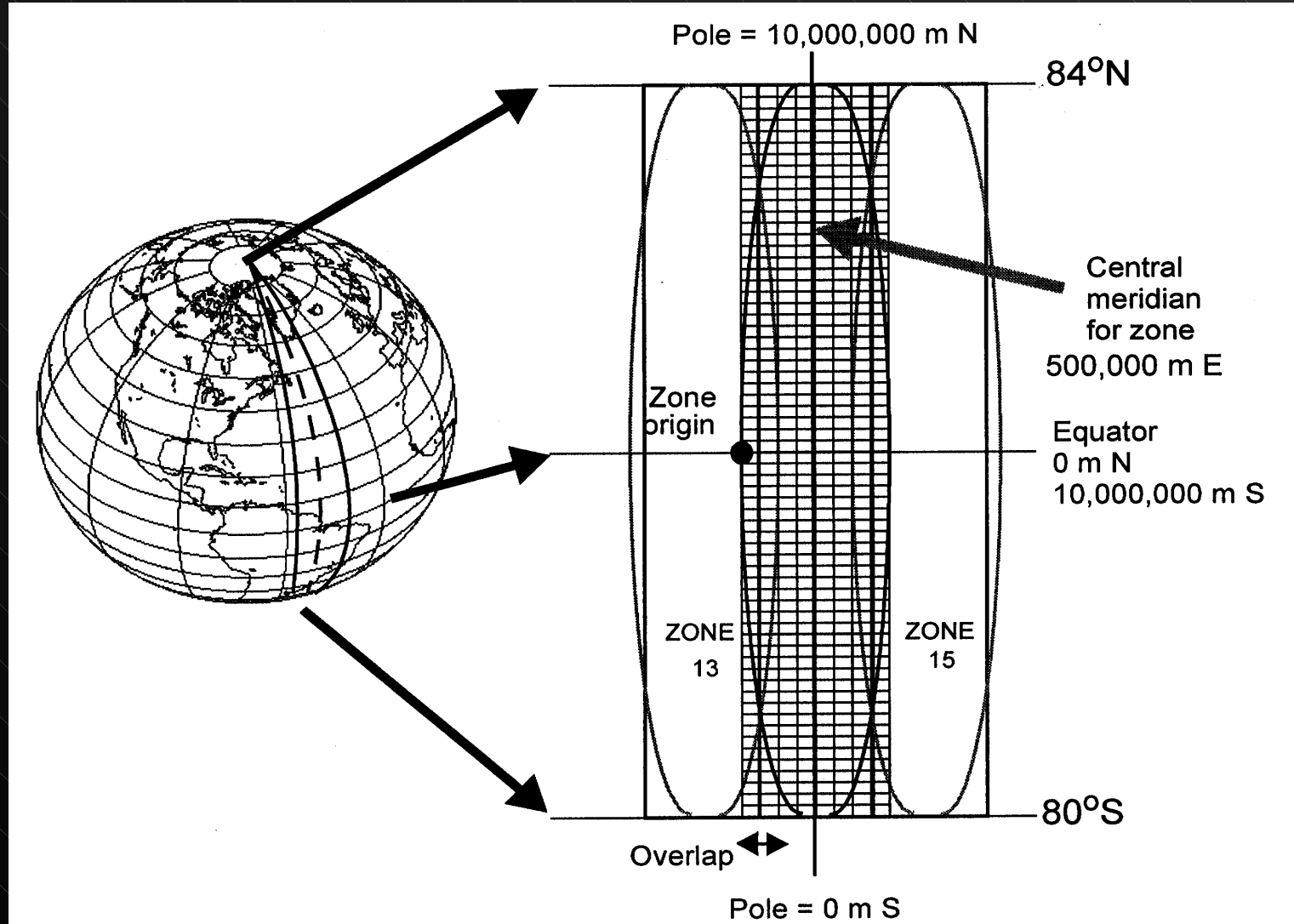
- “Unbend” a curvilinear world to fit it on a flat map.
- Several different ways of doing this: Cylindrical, Conic, etc.
- Universal Transverse Mercator (UTM) projection is most common
- Is a **projected** coordinate system: broken up into a series of **zones** across the world
- It’s units are **meters**, but you must stay within only the correct zone, or your data will become distorted

UTM Projection



**Transverse Cylindrical
Projection Surface**

Coordinate Systems: UTM



GIS and Map Scale

- A **Map Scale** is based on the representative fraction, the ratio of a distance on the map to the same distance on the ground.
- A GIS can be considered **scaleless** because maps can be enlarged and reduced and plotted at many scales other than that of the original data.
- This is true even for raster data formats, which, while they do have specific cell resolutions, can still be viewed at any scale.