COORDINATE SYSTEMS

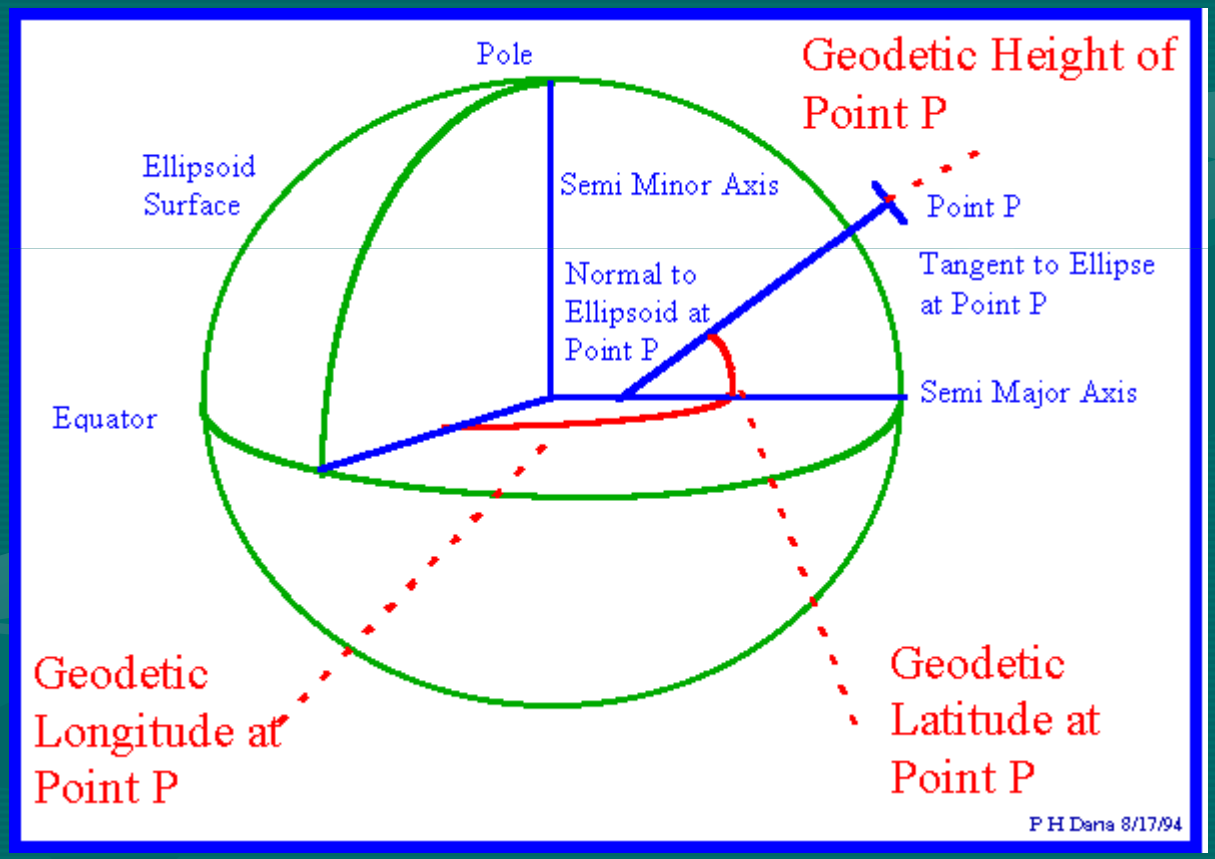
- An overview of coordinate systems for georeferencing provides a brief description of local and global systems for use in precise positioning, navigation, and geographic information systems for the location of points in space.
- There are many different coordinate systems, based on a variety of geodetic datums, units, projections, and reference systems in use today.

Coordinate System

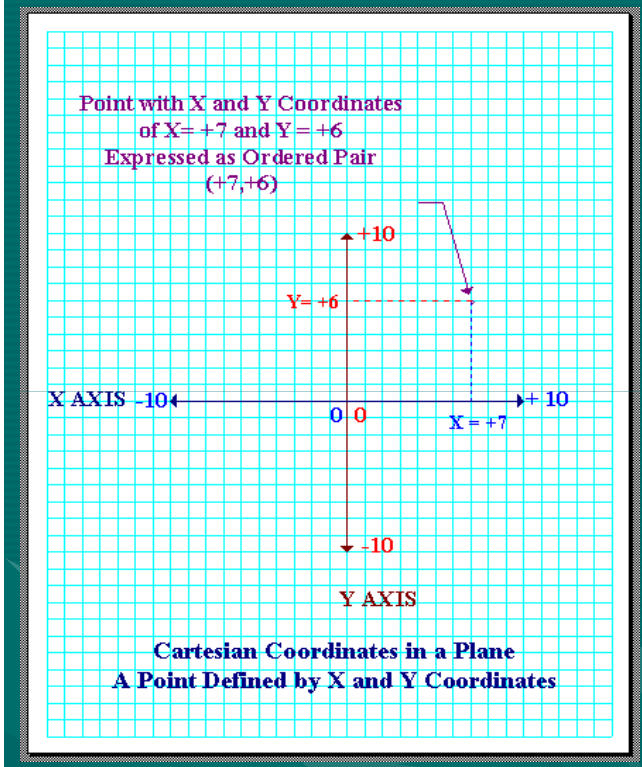
- There are many different coordinate systems, based on a variety of **geodetic datums**, **projections**, and units in use
- Geographic coordinate systems (no projection): Spheroid (or Ellipsoid)-based systems, local systems.
- Projected coordinate systems: world, continental, polar, US National Grids, UTM, state plane.

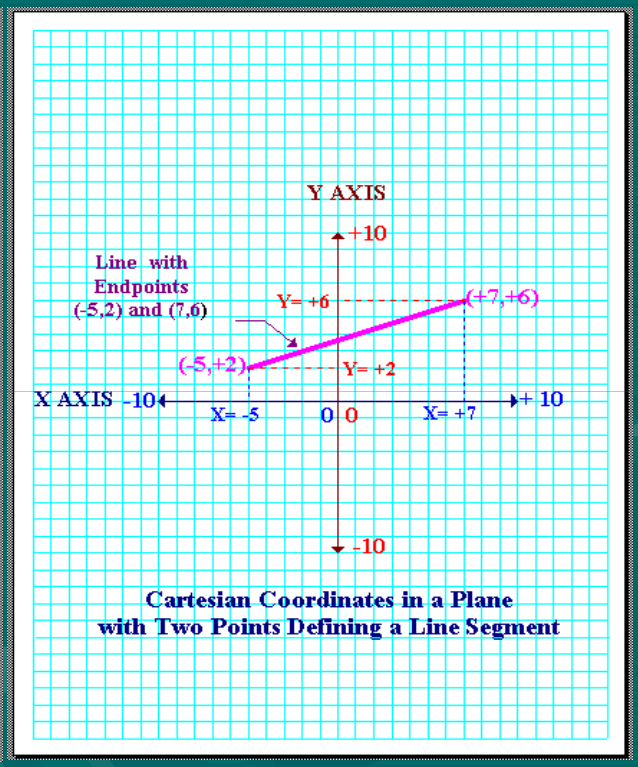
open ArcGIS for a demo

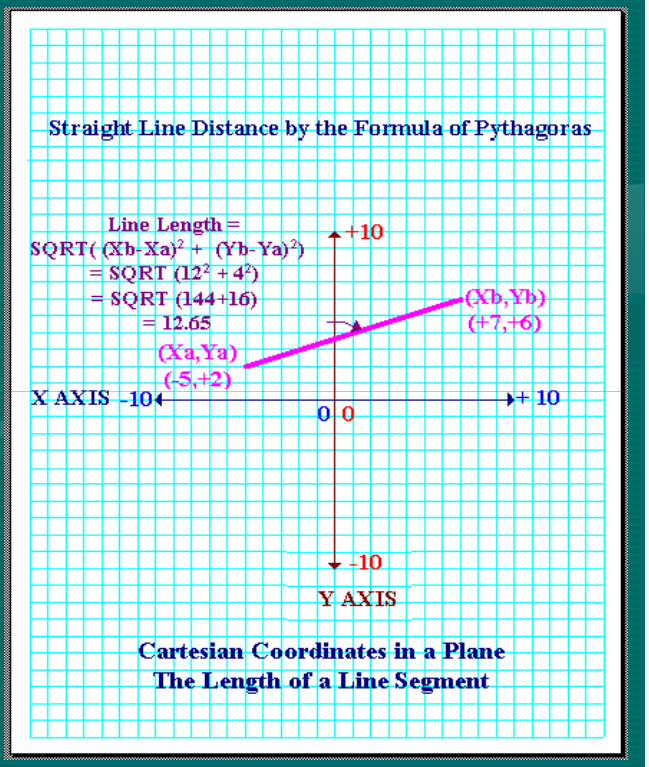
Geographic Latitude/Longitude Coordinate System



- Plane Coordinate Systems
  - Two-dimensional coordinate systems are defined with respect to a single plane.



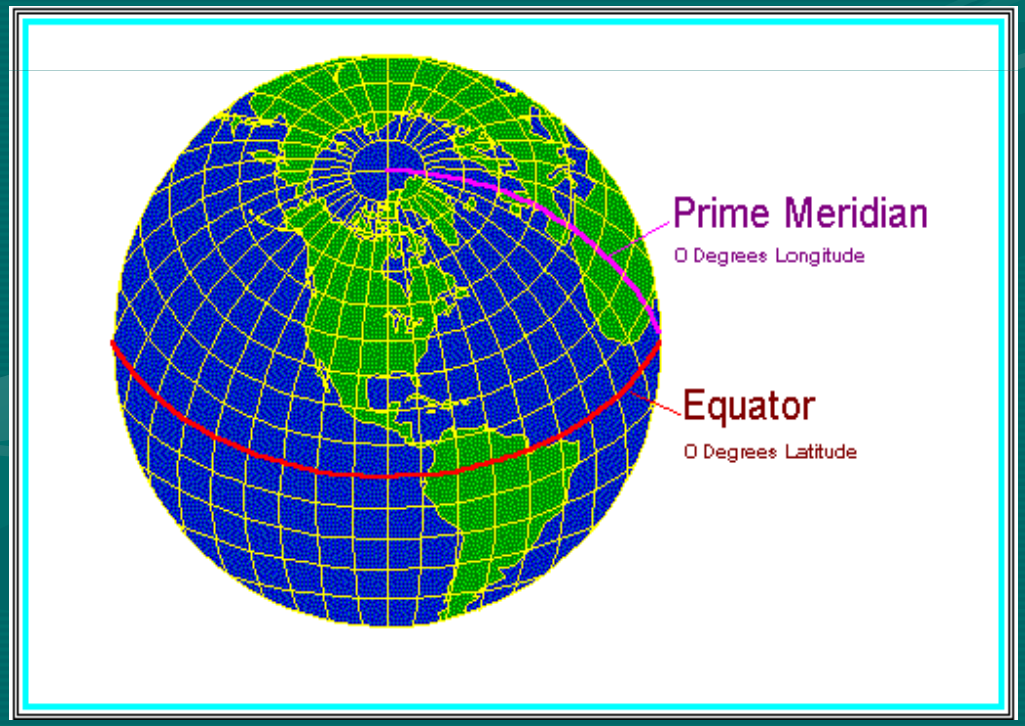




Coordinate Systems

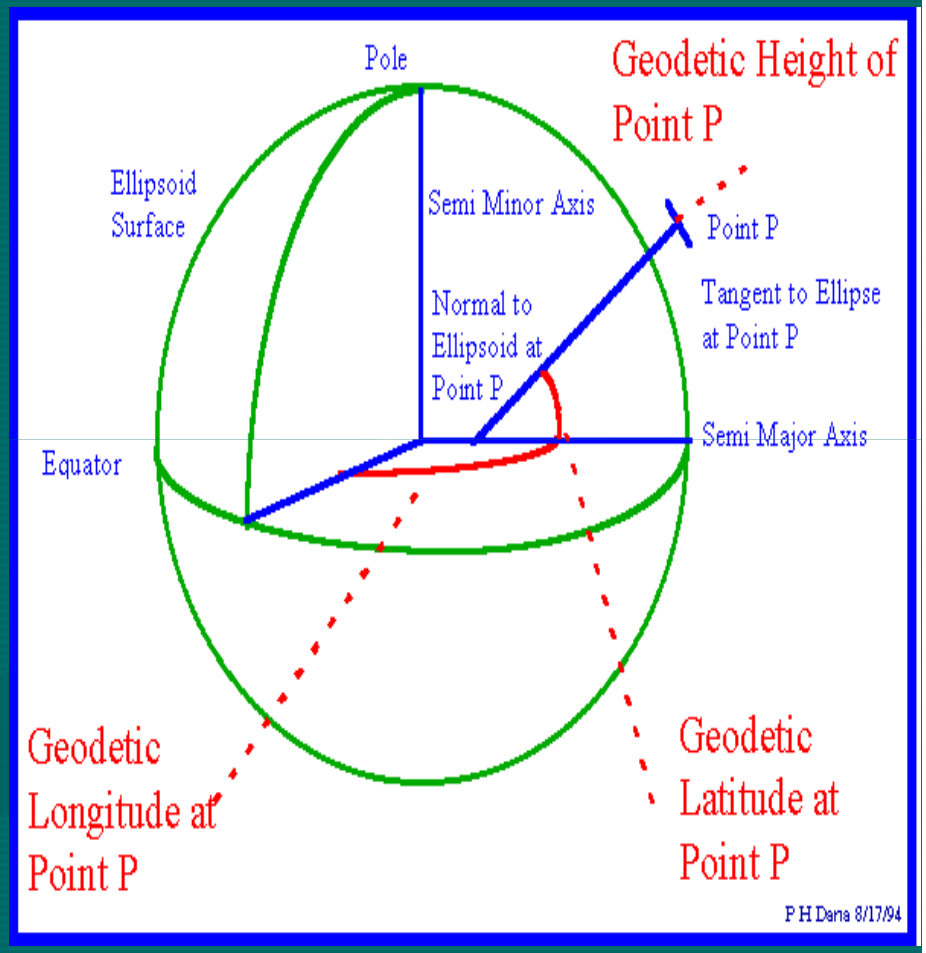
Global Systems

- **Latitude, Longitude, Height**
  - The most commonly used coordinate system today is the latitude, longitude, and height system.
  - The Prime Meridian and the Equator are the reference planes used to define latitude and longitude.
  - Equator and Prime Meridian

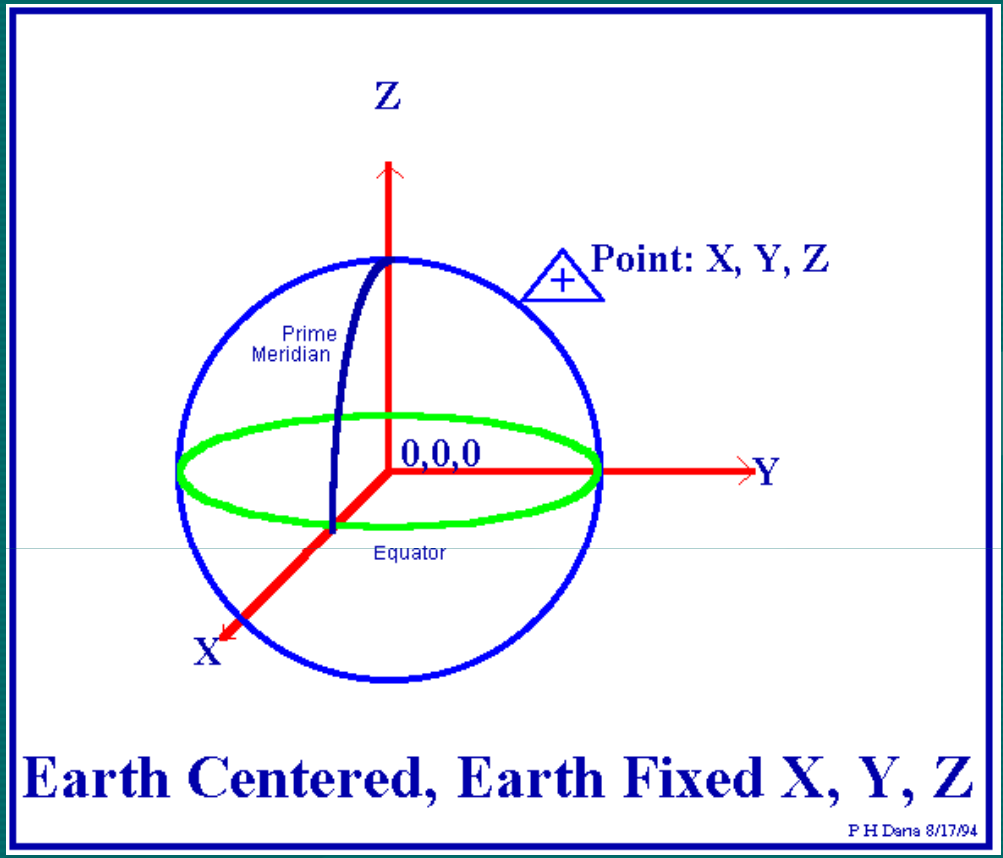


Geodetic Latitude, Longitude, and Height

- The geodetic latitude (there are many other defined latitudes) of a point is the angle from the equatorial plane to the vertical direction of a line normal to the reference ellipsoid.
- The geodetic longitude of a point is the angle between a reference plane and a plane passing through the point, both planes being perpendicular to the equatorial plane.
- The geodetic height at a point is the distance from the reference ellipsoid to the point in a direction normal to the ellipsoid.

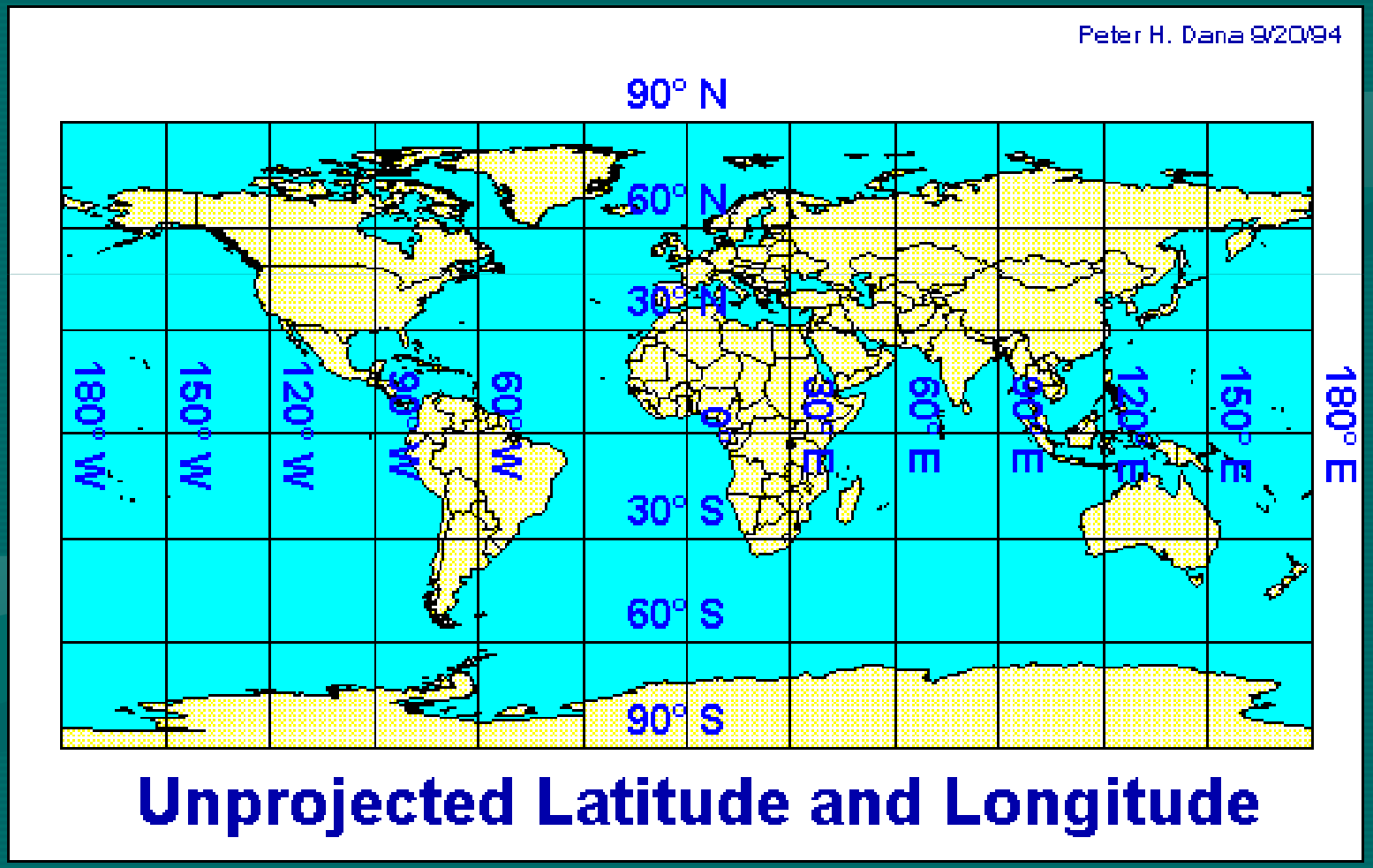


- ECEF X, Y, Z
  - Earth Centered, Earth Fixed Cartesian coordinates are also used to define three dimensional positions.
  - Earth centered, earth-fixed, X, Y, and Z, Cartesian coordinates (XYZ) define three dimensional positions with respect to the center of mass of the reference ellipsoid.

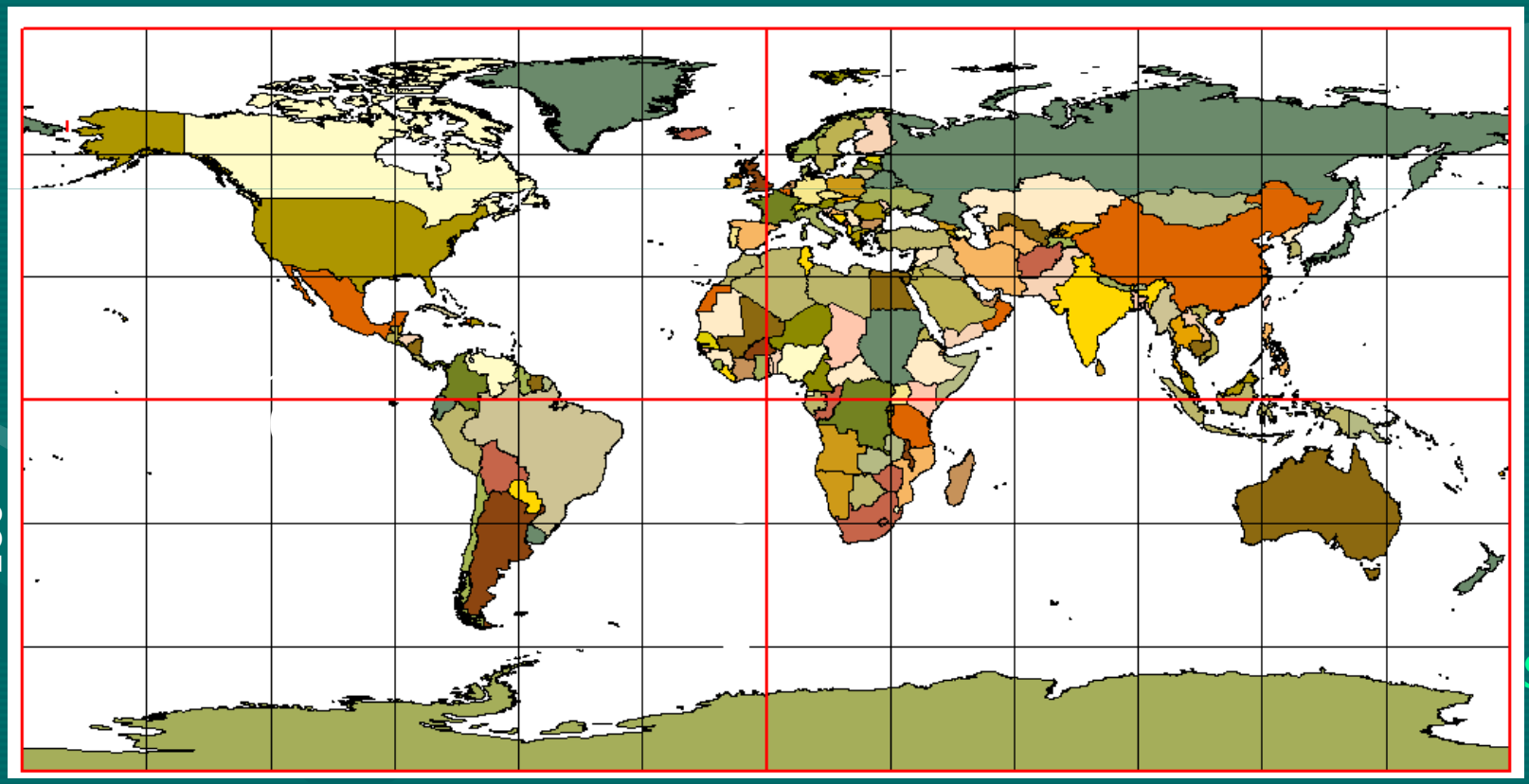


Geographic Latitude/Longitude on a flat surface (WGS 84 datum)

Scale, distance, area, and shape are all distorted with the distortion increasing toward the poles.



Geographic Latitude/Longitude in GIS system



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Universal Transverse Mercator (UTM) Coordinate System

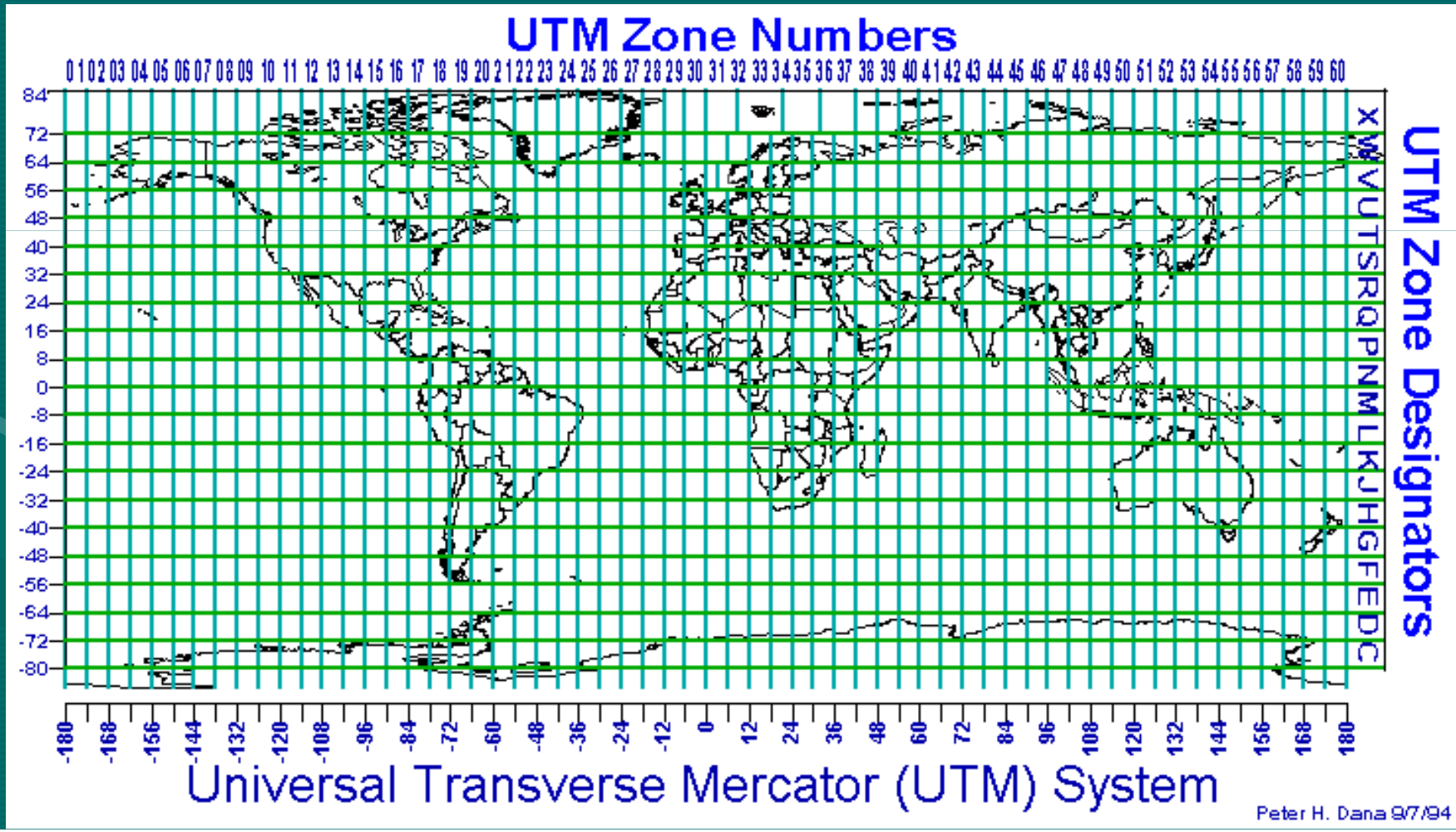
- UTM system is transverse-secant cylindrical projection, dividing the surface of the Earth into 6 degree zones with a central meridian in the center of the zone. each one of zones is a different Transverse Mercator projection that is slightly rotated to use a different meridian. UTM zone numbers designate 6 degree longitudinal strips extending from 80 degrees South latitude to 84 degrees North latitude. UTM is a **conformal** projection, so small features appear with the correct shape and scale is the same in all directions. (all distances, directions, shapes, and areas are reasonably accurate). Scale factor is 0.9996 at the central meridian and at most 1.0004 at the edges of the zones.

- UTM coordinates are in meters, making it easy to make accurate calculations of short distances between points (error is less than 0.04%)

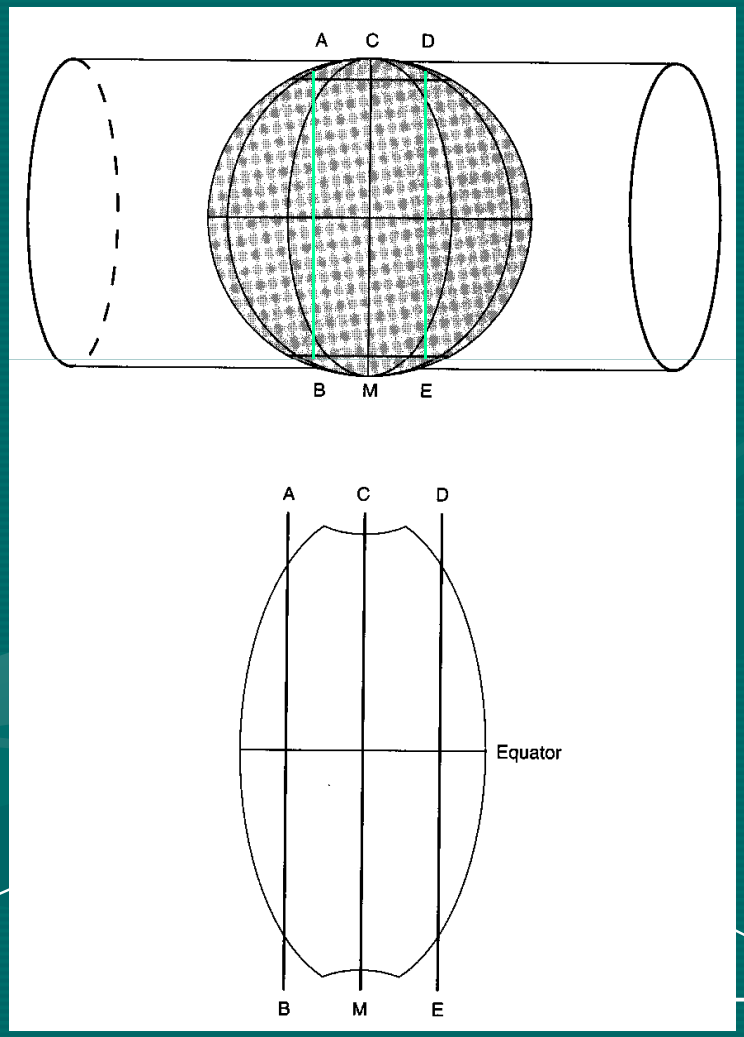
- Used in USGS topographic map, and digital elevation models (DEMs)

- Although the distortions of the UTM system are small, they are too great for some accurate surveying. zone boundaries are also a problem in many applications, because they follow arbitrary lines of longitude rather than boundaries between jurisdictions.

UTM Zone Numbers



Transverse-secant Cylindrical (Mercator) Projection



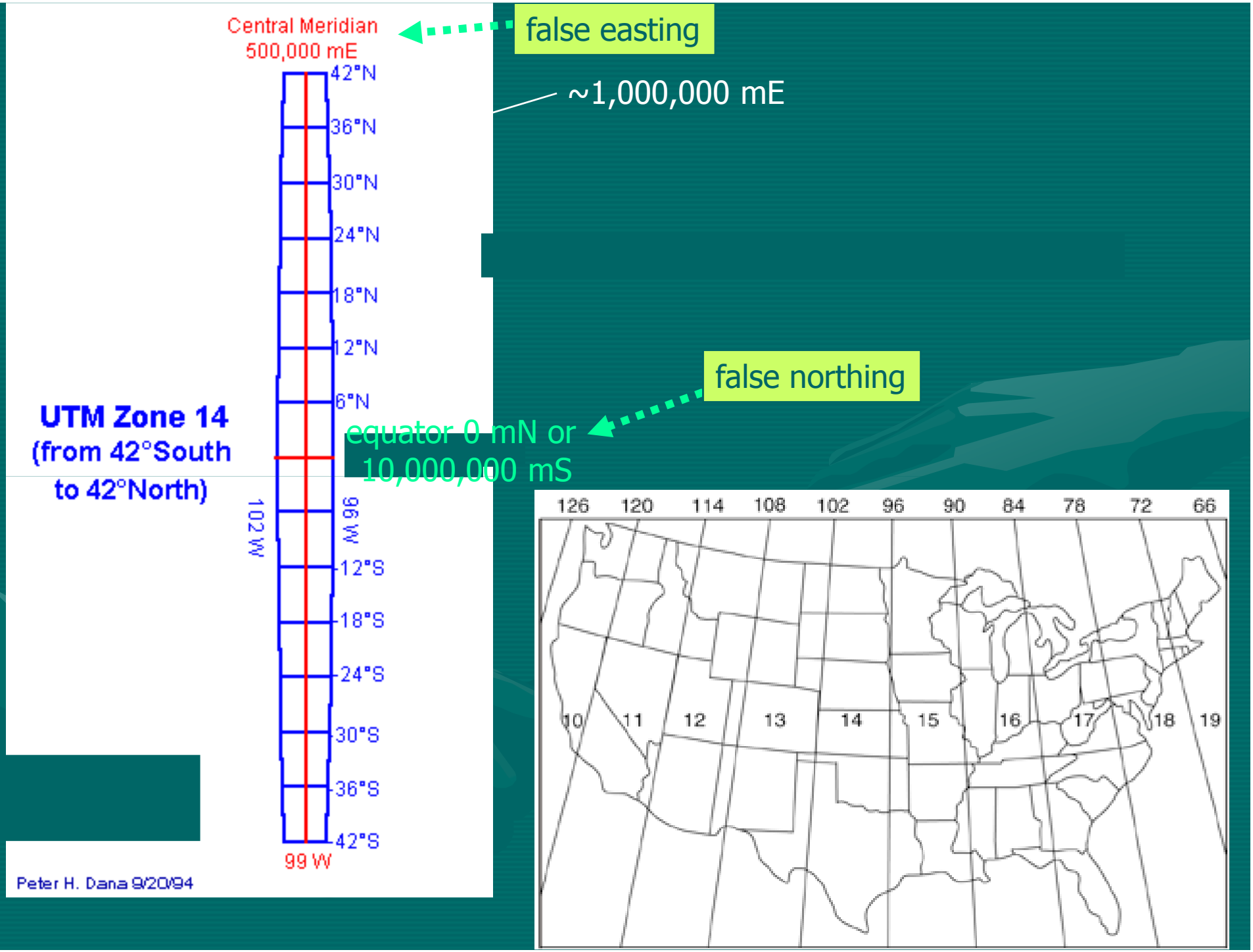
Most New Mexico in Zone 13

CM: central meridian
AB: standard meridian
DE: standard meridian

-108

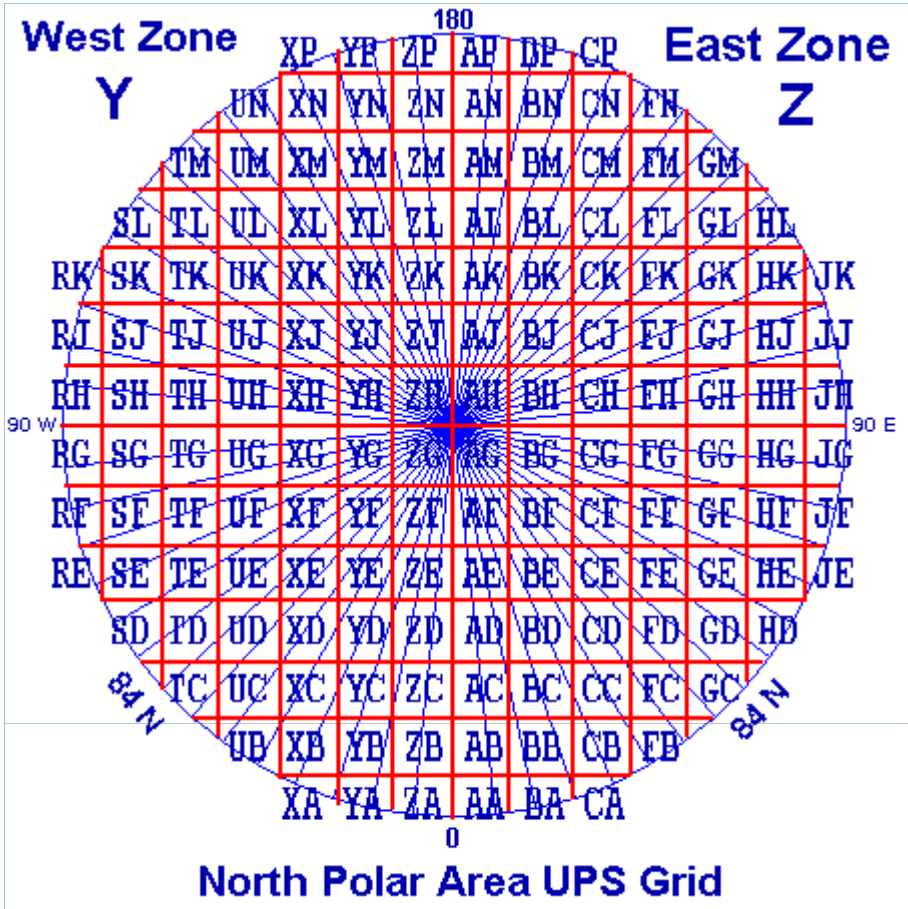
-102

-105

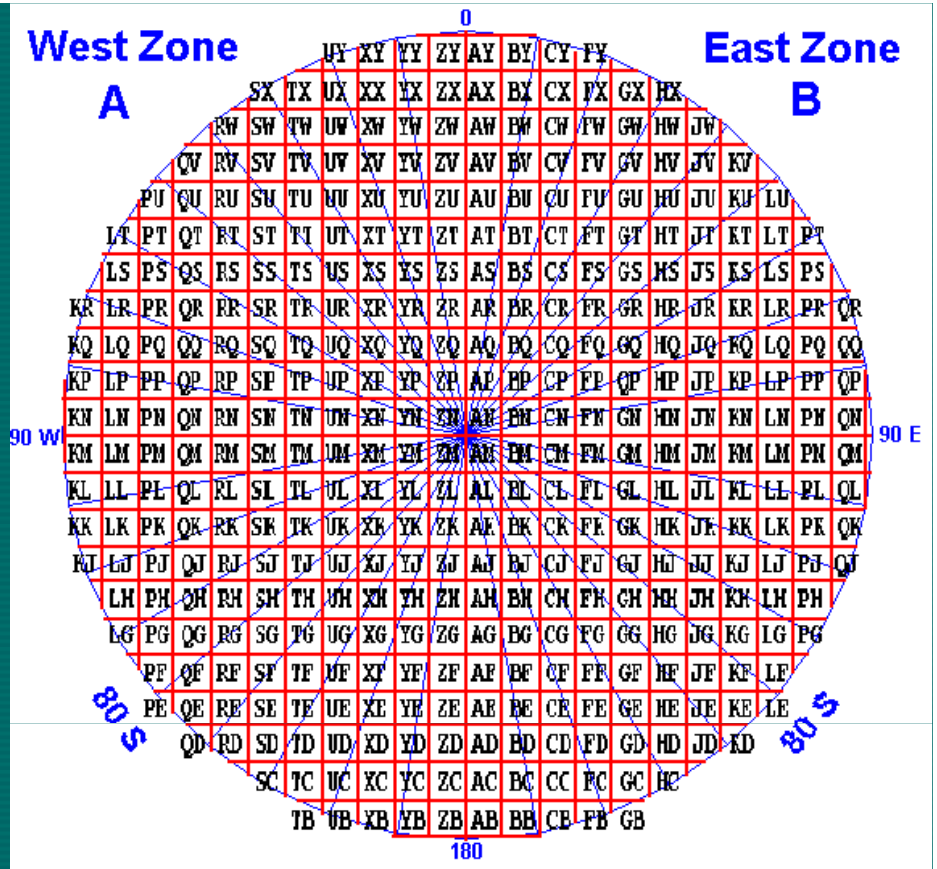

Central Meridian
500,000 mE
42°N
36°N
30°N
24°N
18°N
12°N
6°N
102 W
96 W
12°S
18°S
24°S
30°S
36°S
42°S
99 W
UTM Zone 14
(from 42°South
to 42°North)
Peter H. Dana 9/20/94
false easting
~1,000,000 mE
false northing
equator 0 mN or
10,000,000 mS
126
120
114
108
102
96
90
84
78
72
66
10
11
12
13
14
15
16
17
18
19

Universal Polar Stereographic (UPS) Coordinate System

- The UPS is defined above 84 degrees north latitude and south of 80 degrees south latitude.
- The eastings and northings are computed using a polar aspect stereographic projection.
- Zones are computed using a different character set for south and north Polar regions.



North Polar Area UPS Grid



South Polar Area UPS Grid

WGS-84 Latitude, Longitude
85:40:30.0 N 85:40:30.0 E

Universal Polar Stereographic
ZGG7902863771

North Polar Area UPS Example

WGS-84 Latitude, Longitude
85:40:30.0 S 85:40:300.0 W

Universal Polar Stereographic
ATN2097136228

South Polar Area UPS Example