Map Projections

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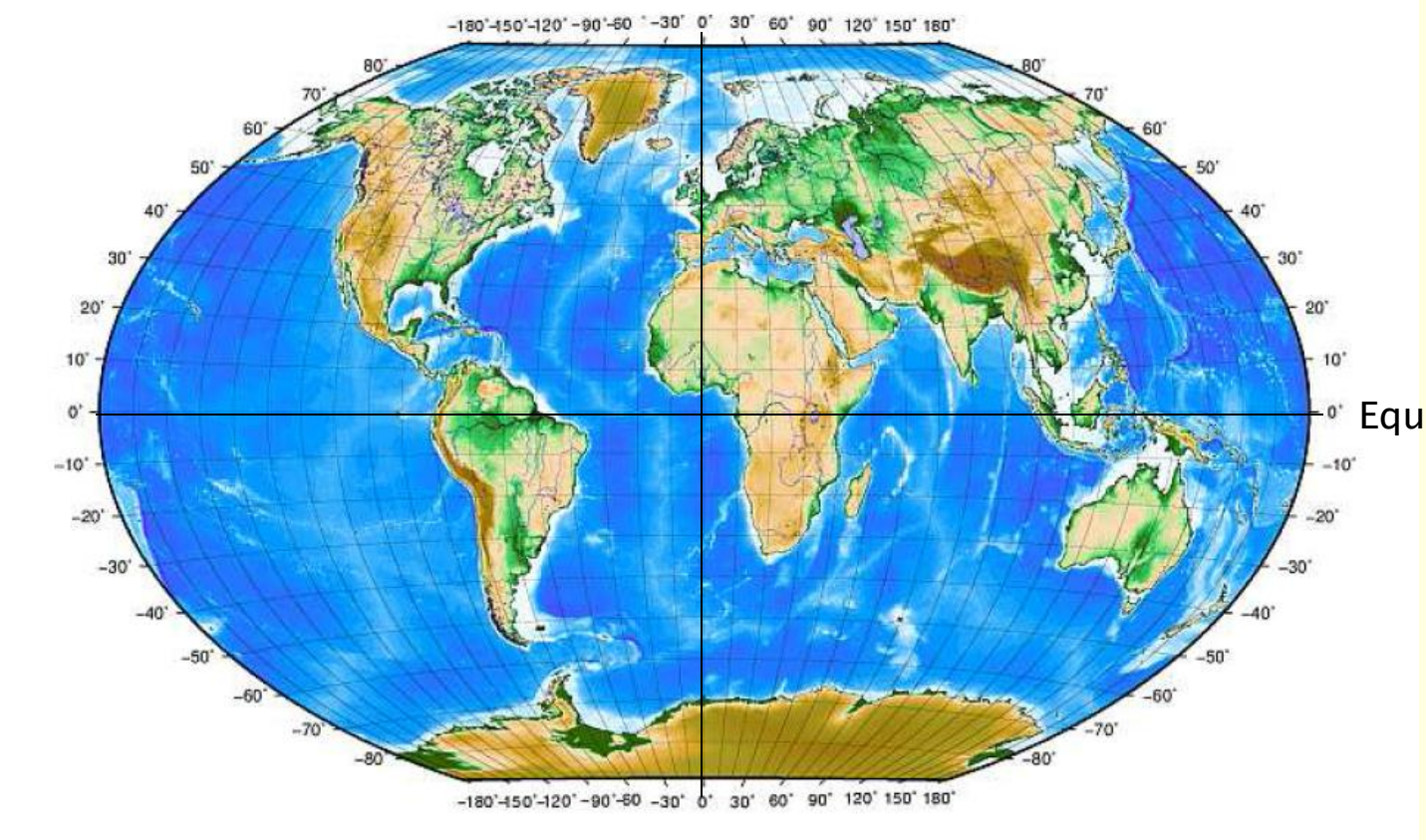
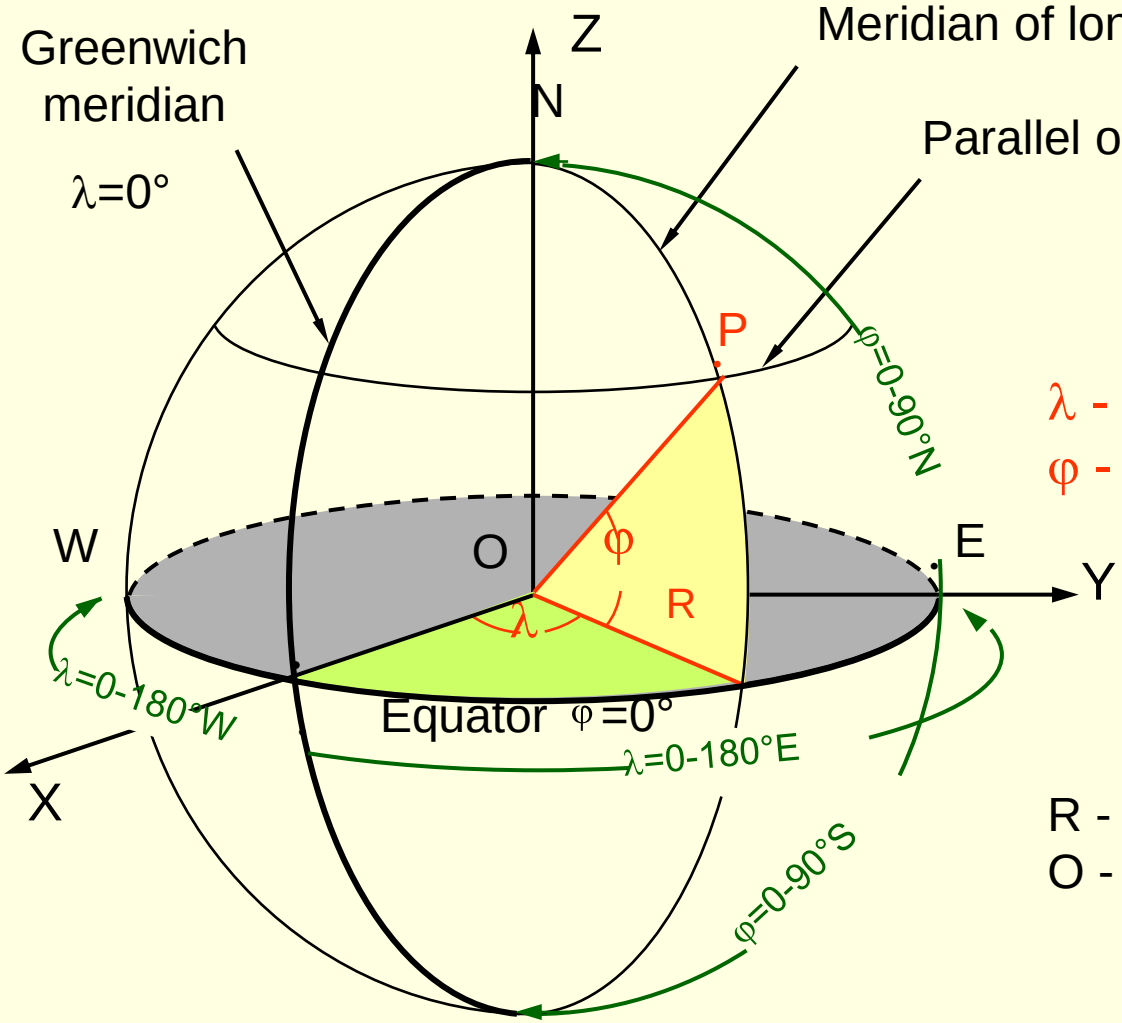
Geographic Coordinates (ϕ, λ, z)



Location of any point is represented in form of Latitude & longitude which is denoted by degrees N or S, degrees E or W

Latitude and Longitude on a Sphere



λ - Geographic longitude
φ - Geographic latitude

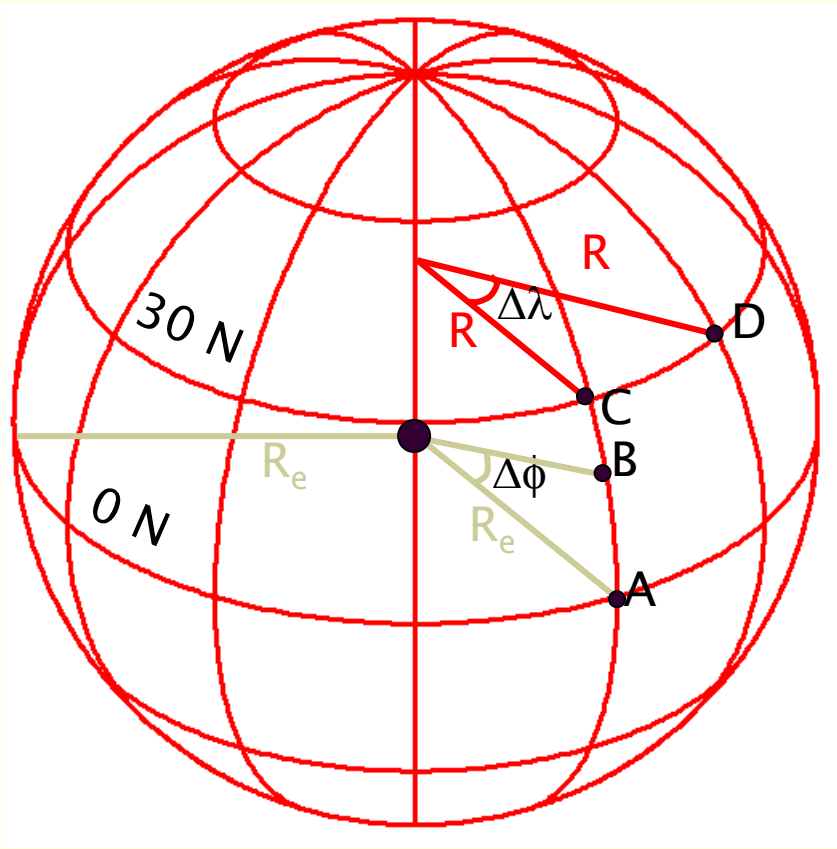
R - Mean earth radius
O - Geocenter

Length on Meridians and Parallels

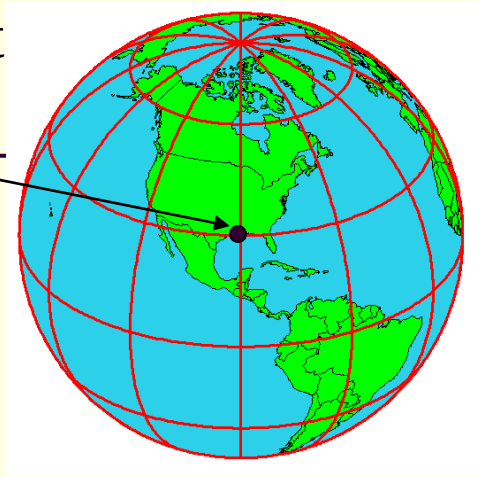
(Lat, Long) = (ϕ, λ)

Length on a Meridian:
AB = $R_e \Delta\phi$
(same for all latitudes)

Length on a Parallel:
CD = $R \Delta\lambda = R_e \Delta\lambda \cos\phi$
(varies with latitude)



Example: What is the length of a 1º increment on a meridian and on a parallel at 30N, 90W? Radius of the earth = 6370 km.



Solution:

• A 1º angle has first to be converted to radians

π radians = 180 º, so 1º = $\pi/180$ = 3.1416/180 = 0.0175 radians

• For the meridian, $\Delta L = R_e \Delta\phi = 6370 * 0.0175 =$ <u>111 km</u>

• For the parallel, $\Delta L = R_e \Delta\lambda \text{ Cos } \phi$

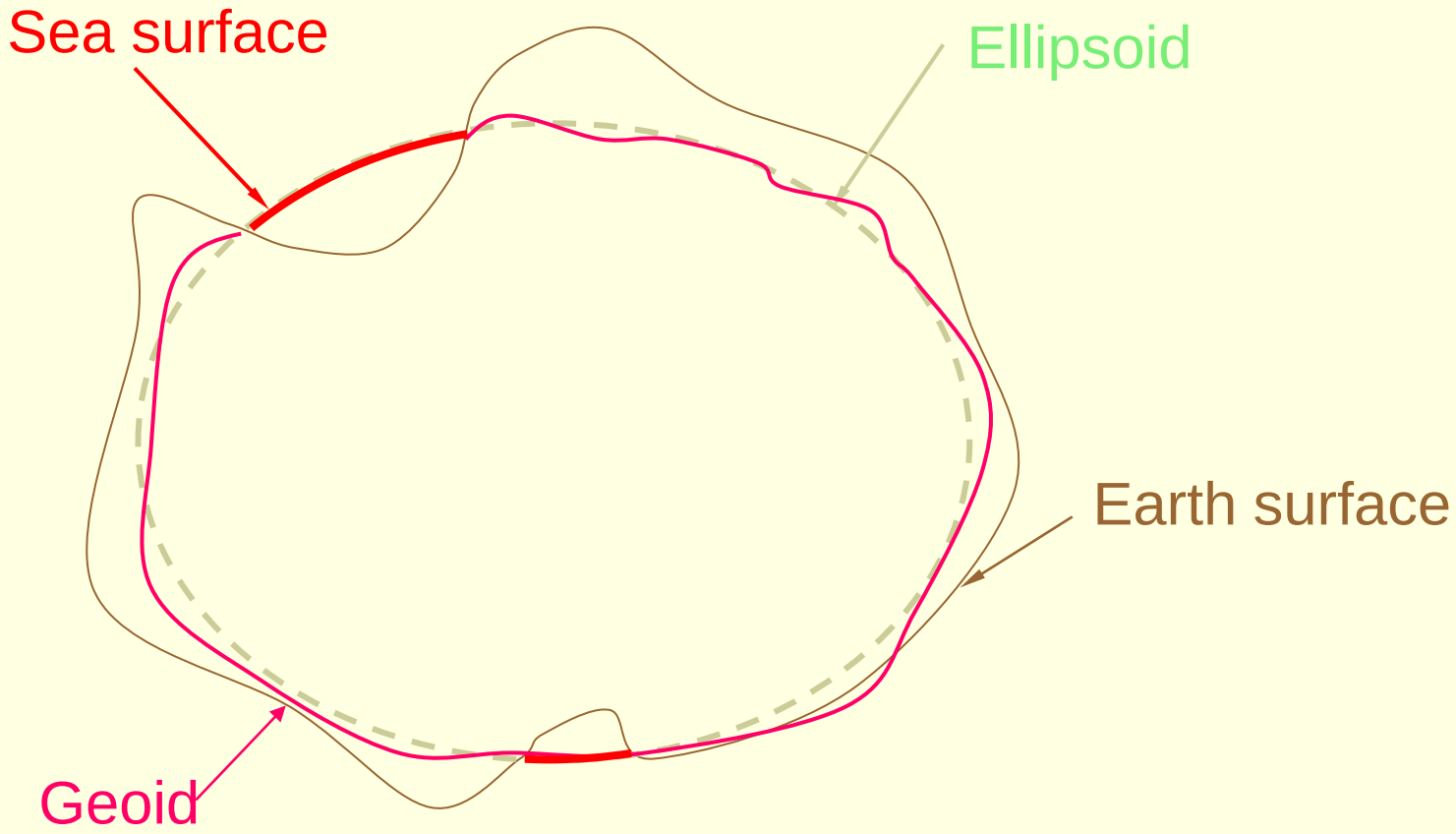
$= 6370 * 0.0175 * \text{Cos } 30$

$=$ <u>96.5 km</u>

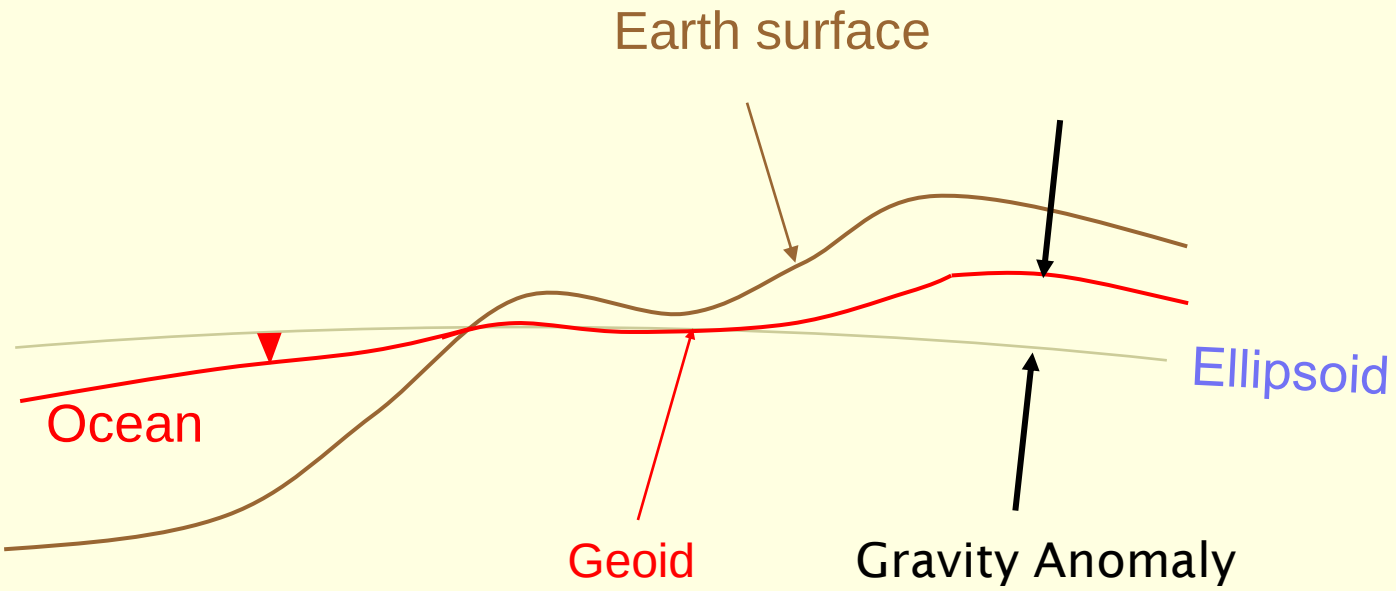
• Parallels converge as poles are approached

Representations of the Earth

MSL - surface of constant gravitational potential called Geoid

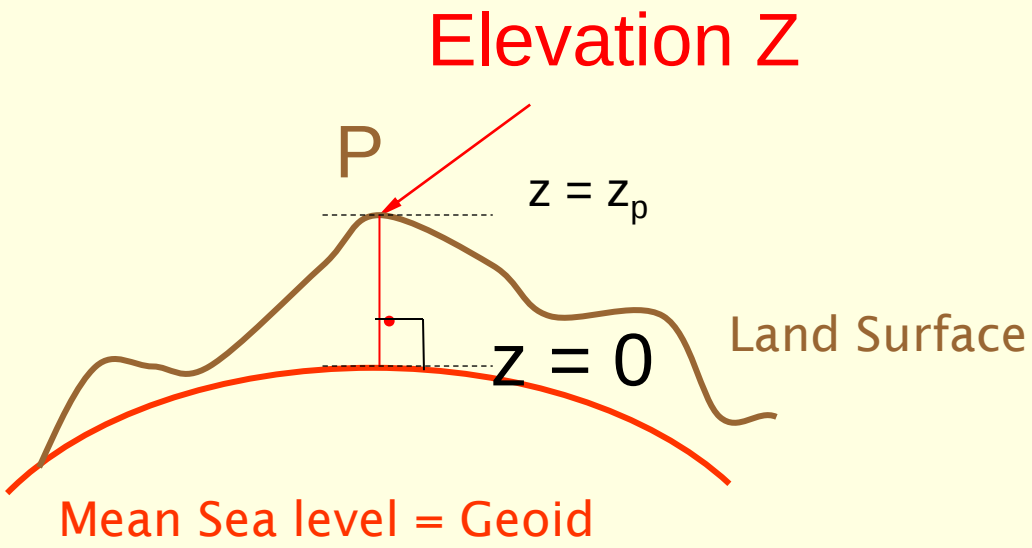


Geoid and Ellipsoid



Gravity anomaly - elevation difference between a standard shape of the earth (ellipsoid) & a surface of constant gravitational potential (geoid)

Definition of Elevation



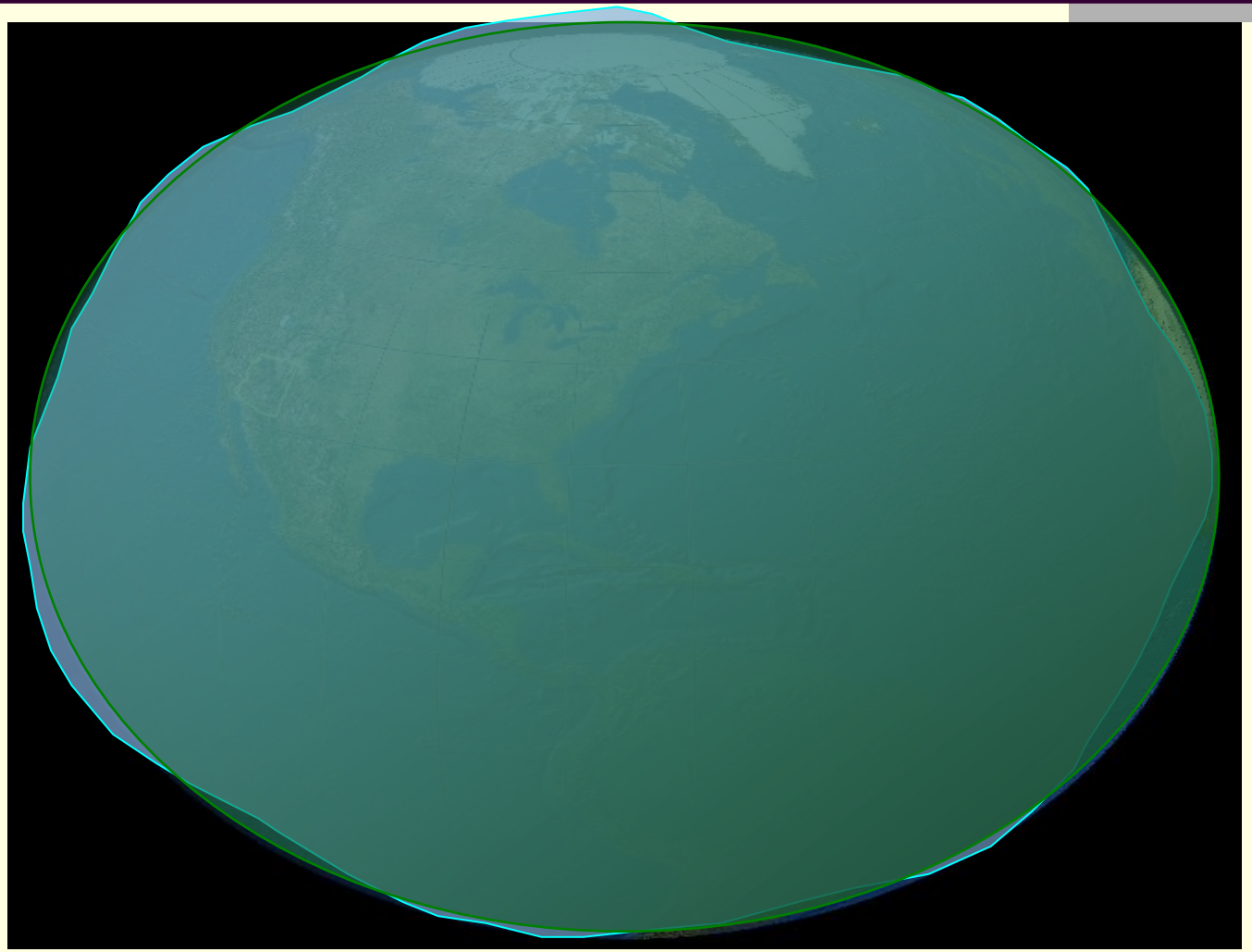
Elevation is measured from the Geoid

Geographic Coordinates (ϕ, λ, z)

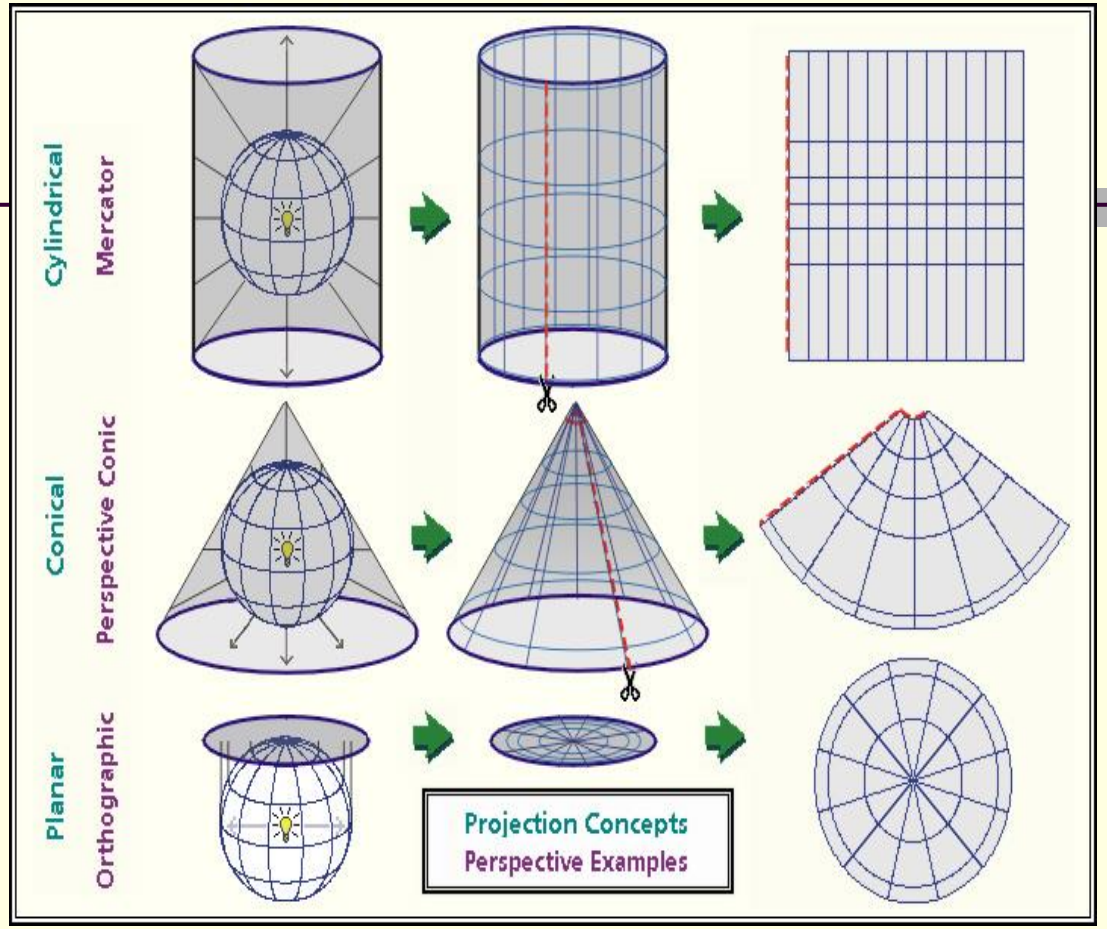
- Latitude (ϕ) and Longitude (λ) defined using an ellipsoid, an ellipse rotated about an axis
- Elevation (z) defined using geoid, a surface of constant gravitational potential
- The observations made on the geoid are transferred to a hypothetical regular geometric reference surface (ellipsoid) for the mathematical computations of geodetic data reduction, also called 'Geodetic Datum' or 'Map datum'. The accuracy of such computations and mapping is directly affected by the suitability of the datum used

“Figure” of the Earth

Best-fit ellipsoid
(GRS-80, WGS-84)

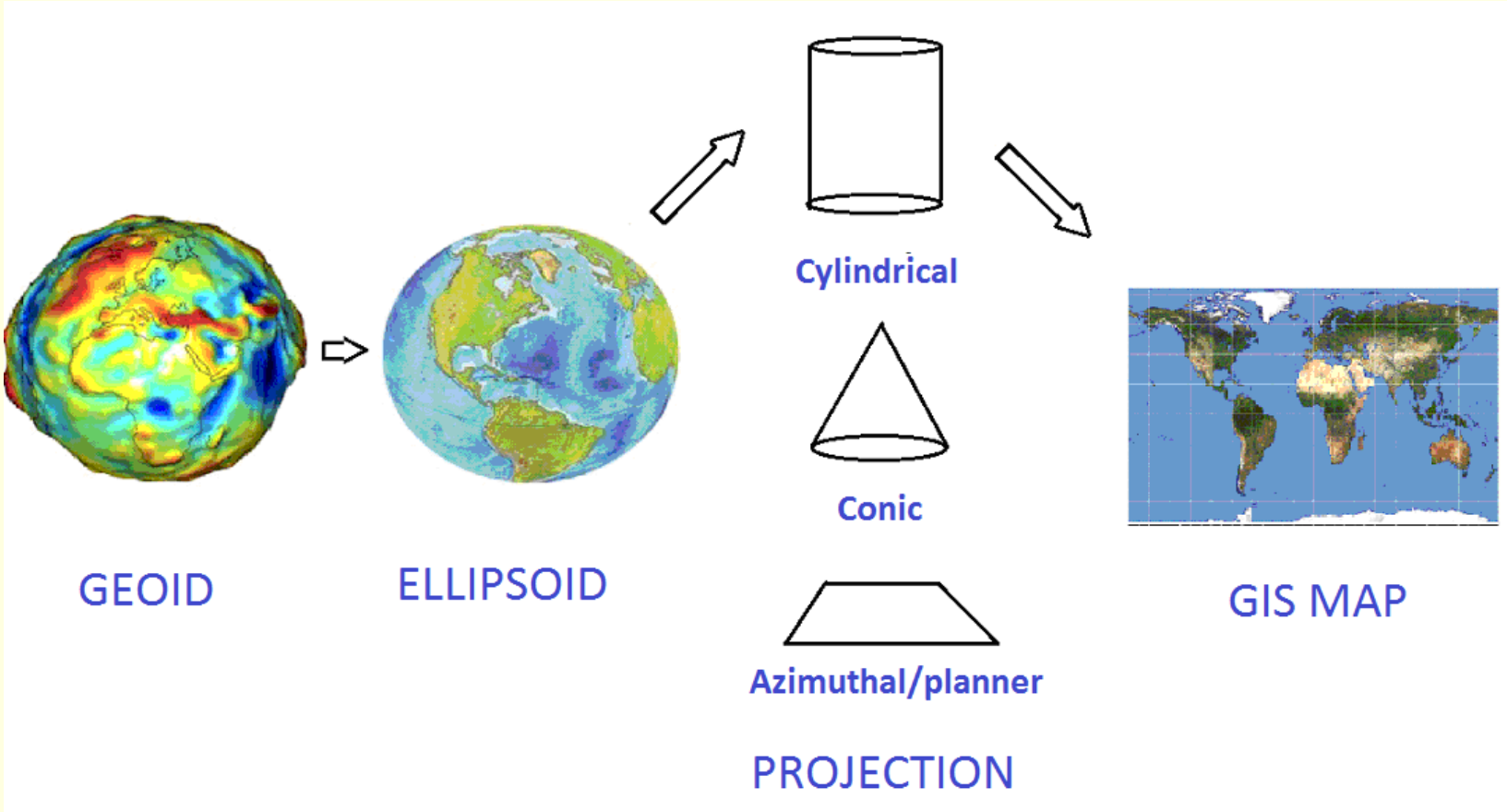


Map projection



- Map projection transforms a position on the Earth's surface identified by lat/long into a position in Cartesian coordinates (x, y)
- Impossible to have same scale everywhere, or for the pixel size to be perfectly constant & projections preserve certain properties.

Map projection



Projections

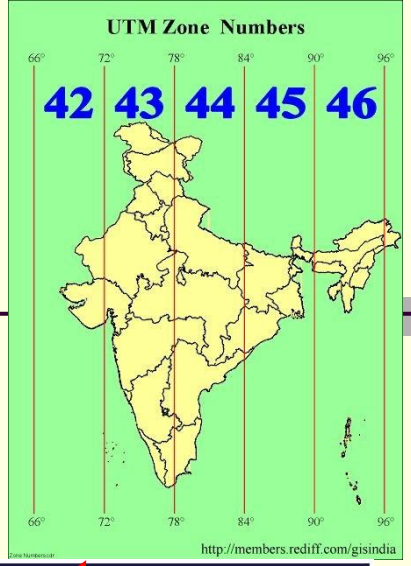
- All map projections distort features
- **Conformal/Orthomorphic** – preserves local shape- retains the property of maintaining correct angular correspondence. They are commonly used for navigational or meteorological tasks. Example- UTM, LCC
- **Equal-area** – Areas measured on the map are in the same proportion to areas on the Earth's surface. Used where calculations of area like masuring landuse/landcover.
- **Equidistant** – preserves distance between certain points. These projections are used for radio and seismic mapping, and for navigation.
- **True-direction** (azimuthal) – gives true direction along great circle

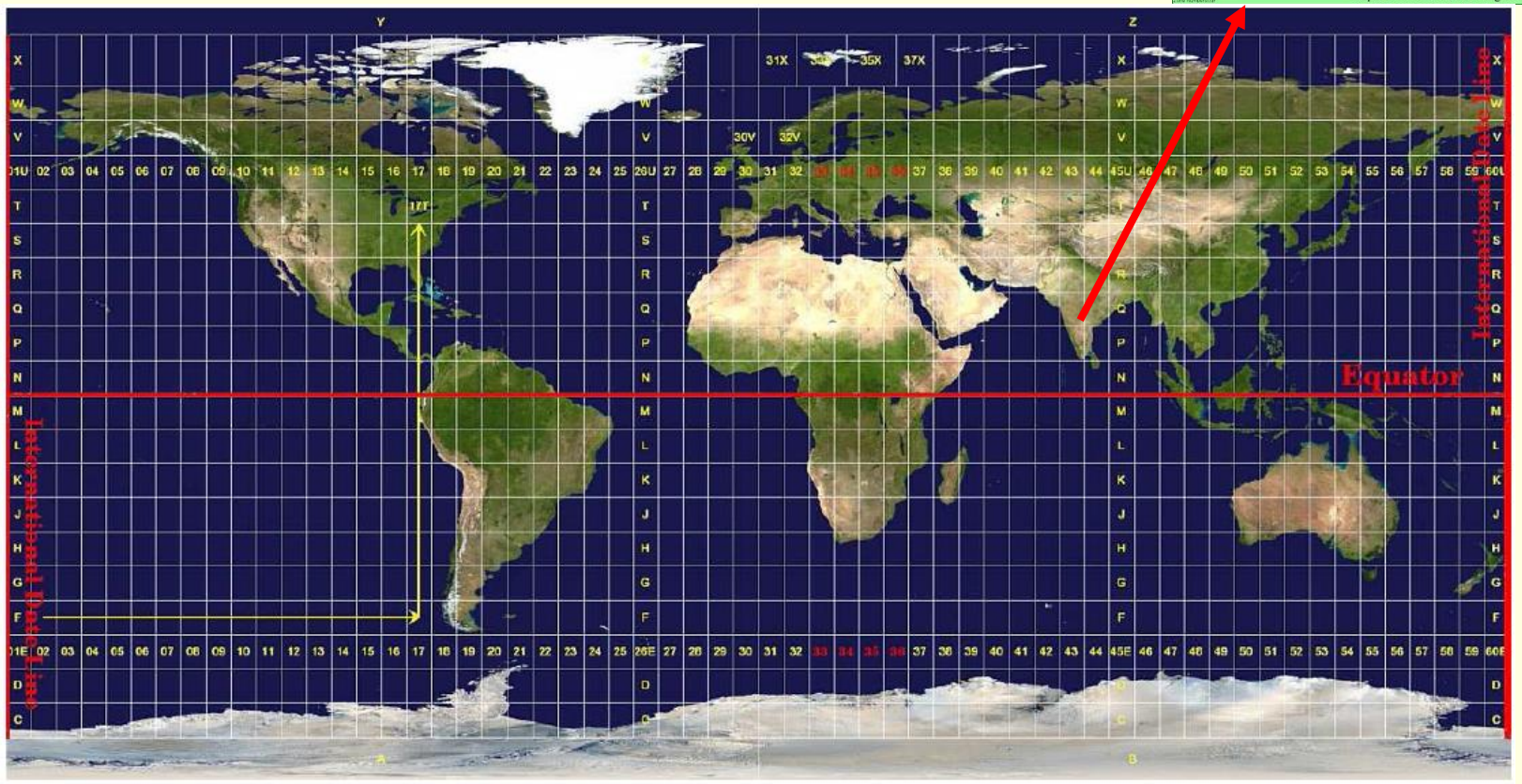
Please Note

- *It is usually impossible to preserve all characteristics at the same time in a map projection. A Map Projection is a compromise that distorts all the properties of area, distance and angular conformity, within some acceptable limit*

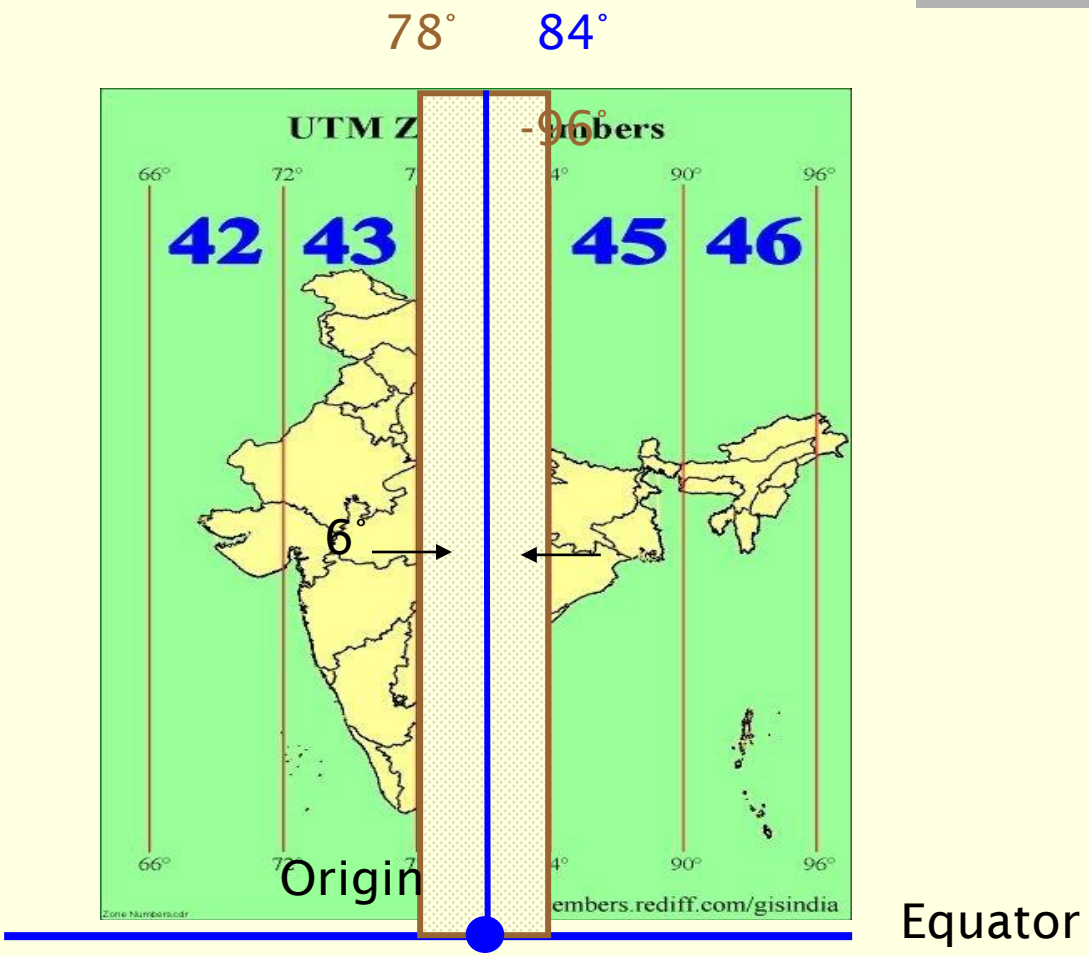
- *you need to use a map projection that provides the best characteristics for your analyses. For example, if you need to measure distances on your map, you should try to use a map projection for your data that provides high accuracy for distances.*

Universal Transverse Mercator (UTM)





UTM Zone 44


78˚
84˚
-96˚
UTM Z
mbers
66°
72°
90°
96°
42
43
45
46
6˚
Origin
embers.rediff.com/gisindia
Equator

Summary Concepts (Cont.)

- To prepare a map, the earth is first reduced to a globe and then projected onto a flat surface
- Three basic types of map projections: conic, cylindrical and azimuthal
- A particular projection is defined by
  1. a datum,
  2. a projection type
  3. a set of projection parameters

Please Note

- ***There are hundreds of different projections available worldwide each trying to portray a certain portion of the earth's surface as faithfully as possible on a flat piece of paper. In reality, the choice of which projection to use, will often be made for you. Most countries have commonly used projections and when data is exchanged people will follow the national trend.***

- ***The National Spatial Framework for India uses Datum WGS84 with a LCC projection and is a recommended NNRMS standard. Each state has its own set of reference parameters given in the standard.***