

# C: Projections

## Representing a 3D object onto a 2D surface

Two types of coordinate reference systems (CRS):

Geographic (3D):

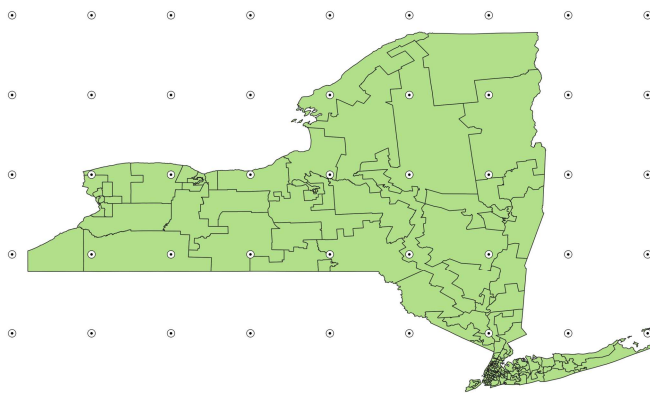
Latitude, longitude, radius

Projected (2D):

X and Y distances on a plane

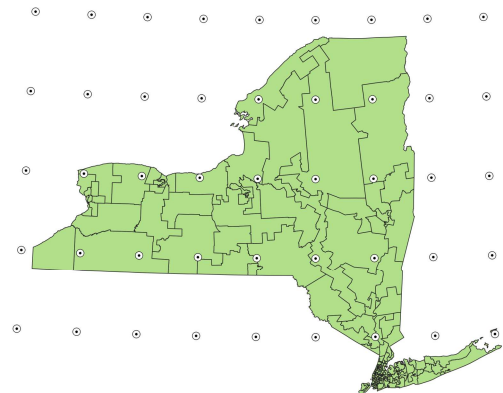
## Why use a projected CRS?

### Geographic CRS



- Grid spacing is uniform
- Coordinates are lat, lon.
- Distances in degrees

### Projected CRS



- Grid matches actual surface
- Coordinates are dist. from ref. pt.
- Distances in meters, feet, miles, km

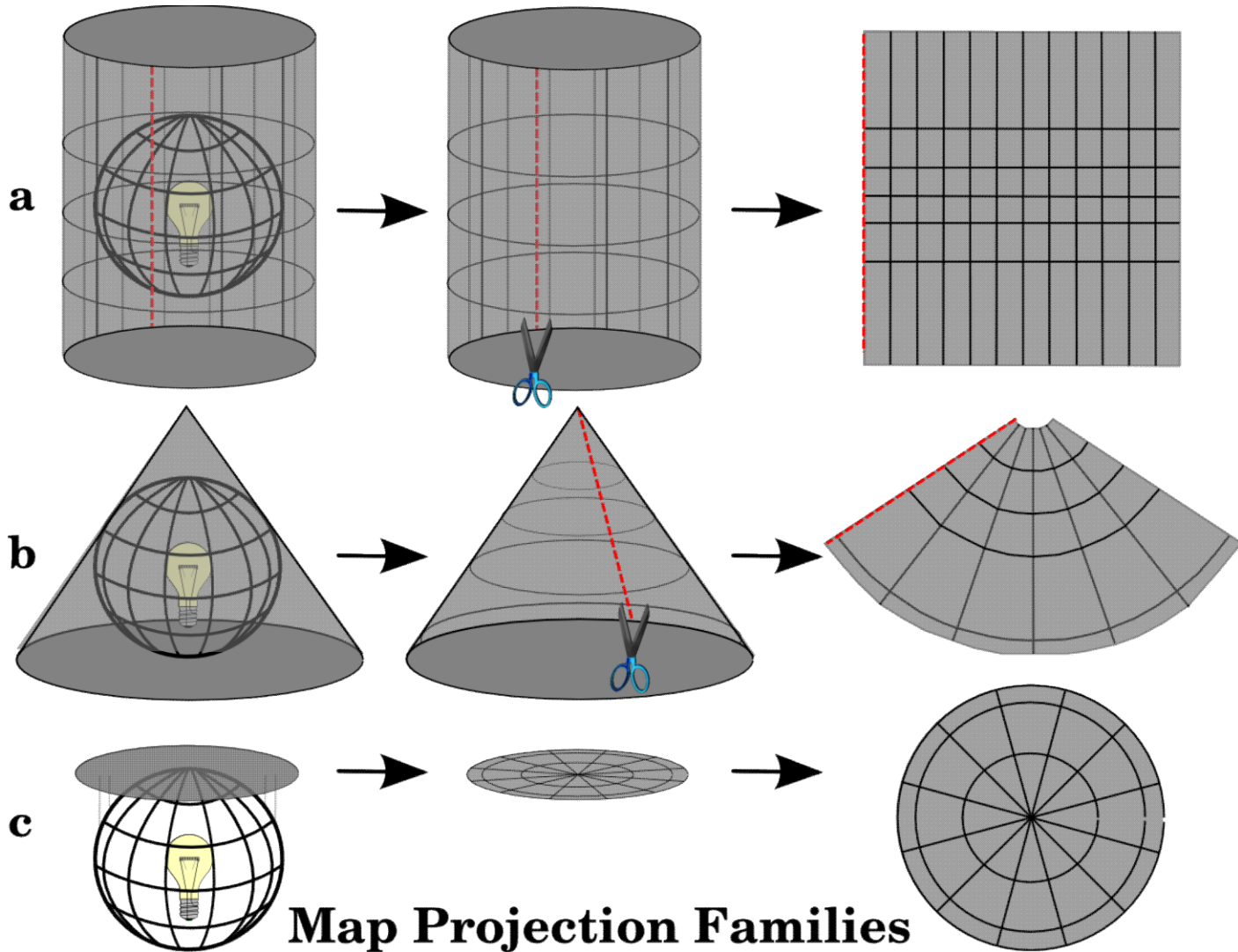
## Many types of projections:

All projections involve tradeoffs in accuracy:

**Navigation vs. distance vs. area**

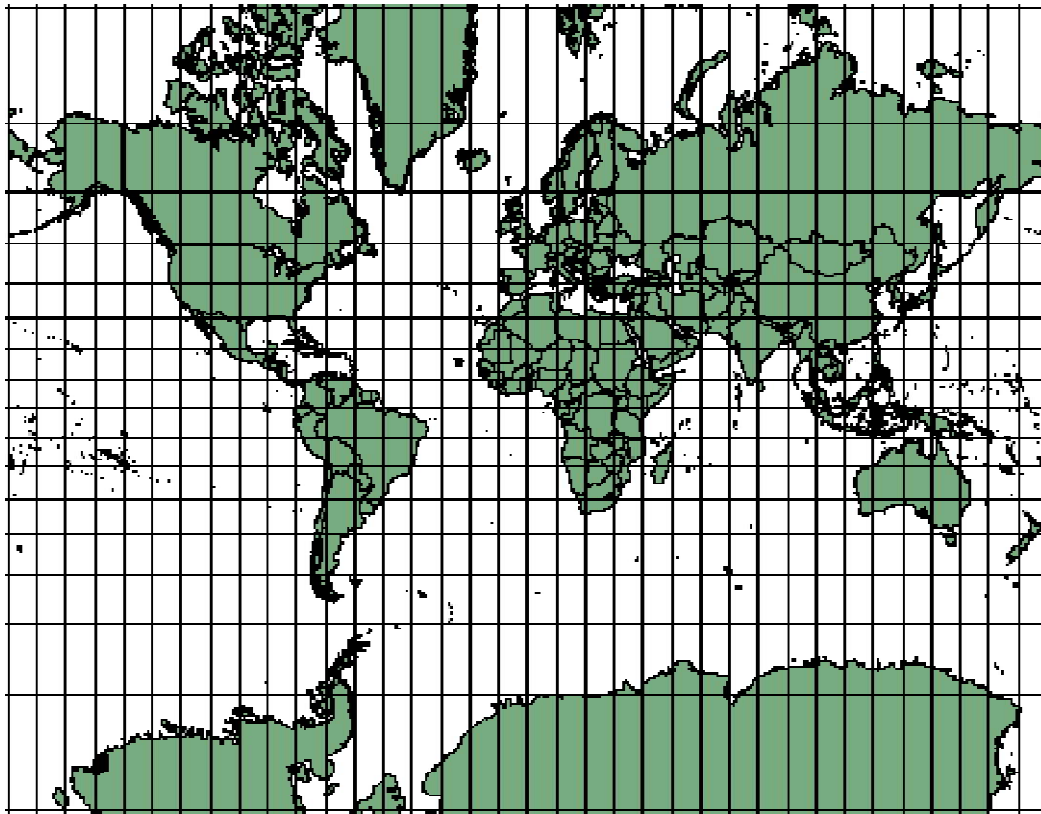
Can't capture all three accurately

Cylindrical, conical, and planar families:



Except as noted figures are from: [https://docs.qgis.org/testing/en/images/projection\\_families.png](https://docs.qgis.org/testing/en/images/projection_families.png)

Classic cylindrical projection: Mercator



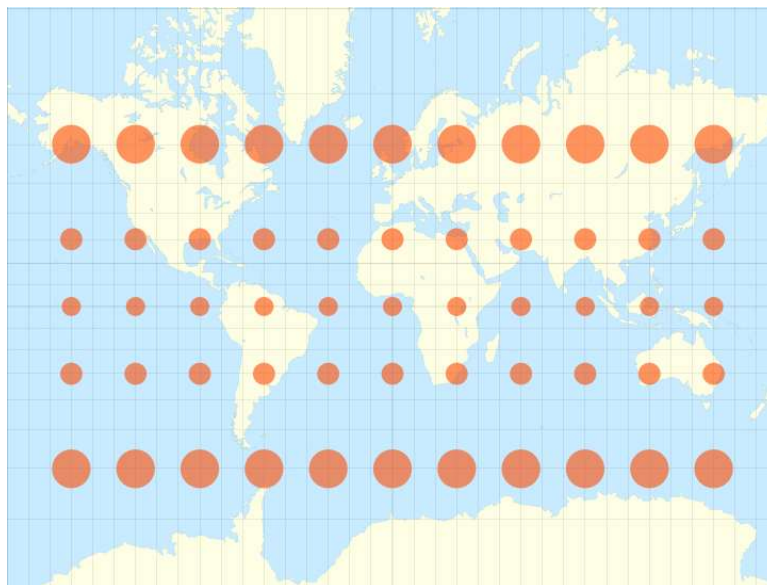
Pro: compass directions are straight and at right angles

Pro: distances accurate near the equator

Con: both N-S and E-W distances distorted toward poles

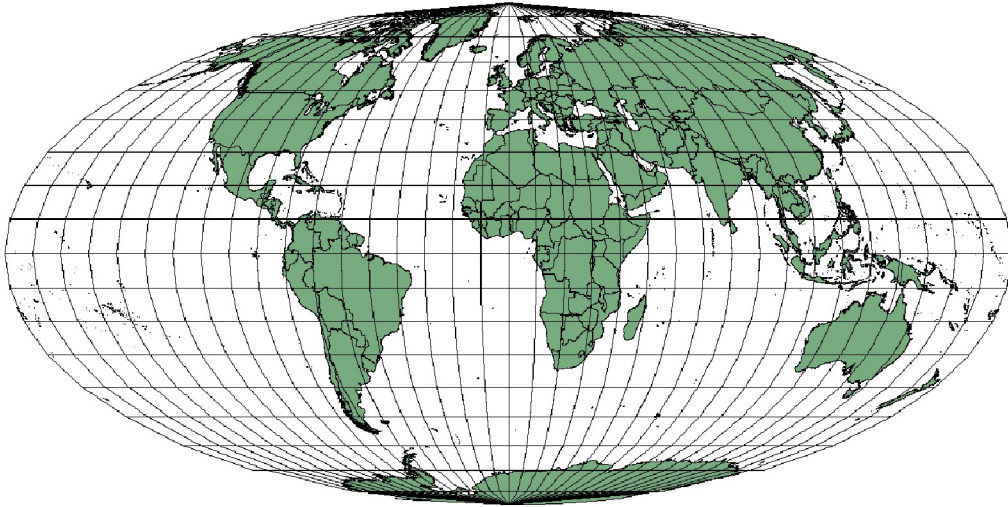
Con: areas badly distorted toward poles

Can see via Tissot indicators: circles with identical radius:



Eric Gaba, Wikimedia

## Mollweide equal area cylindrical projection

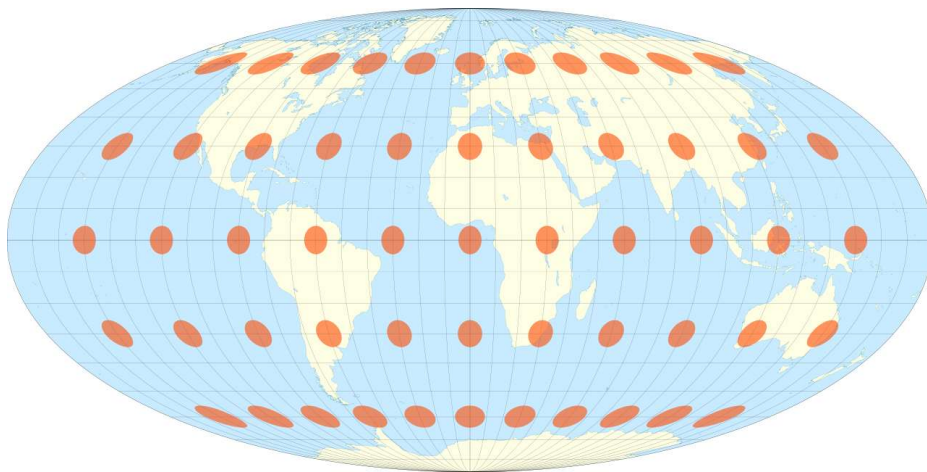


Pro: areas are correct

Con: distances are distorted

Con: compass directions are badly distorted

Tissot:



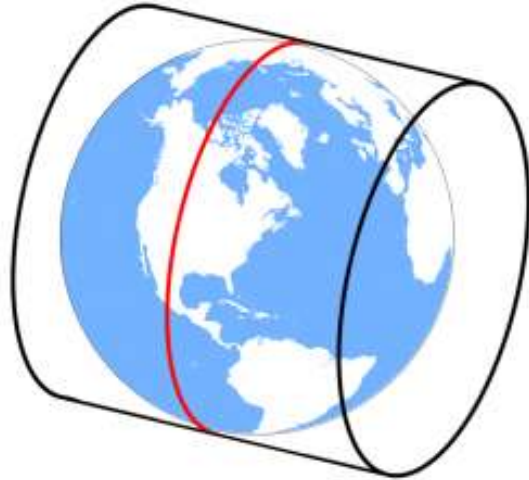
Eric Gaba, Wikimedia

## Universal Transverse Mercator (UTM) system



Two key features:

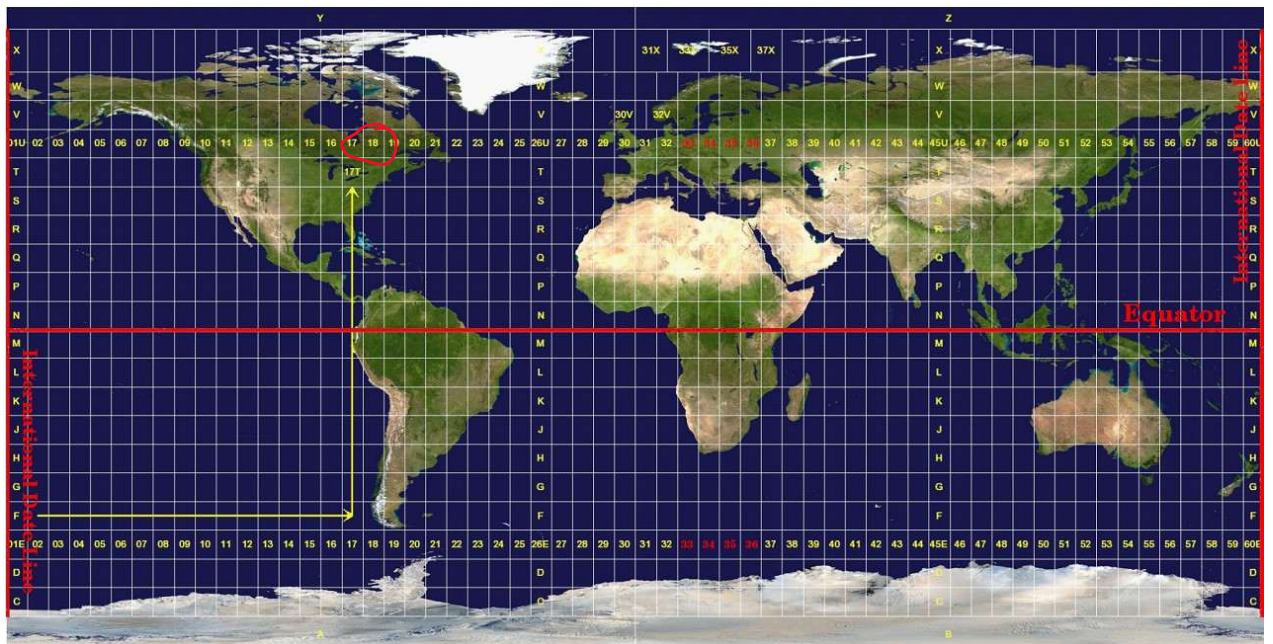
1. Cylindrical projection but with axis rotated 90 degrees:



gisgeography.com

2. Axis rotated horizontally to define 60 six-degree zones

Result:



Characteristics:

- 60 zones, each six degrees wide
- Distances accurate along centerline of zone
- Small distortion within zones

Pretty good compromise:

Widely used for relatively small areas away from poles

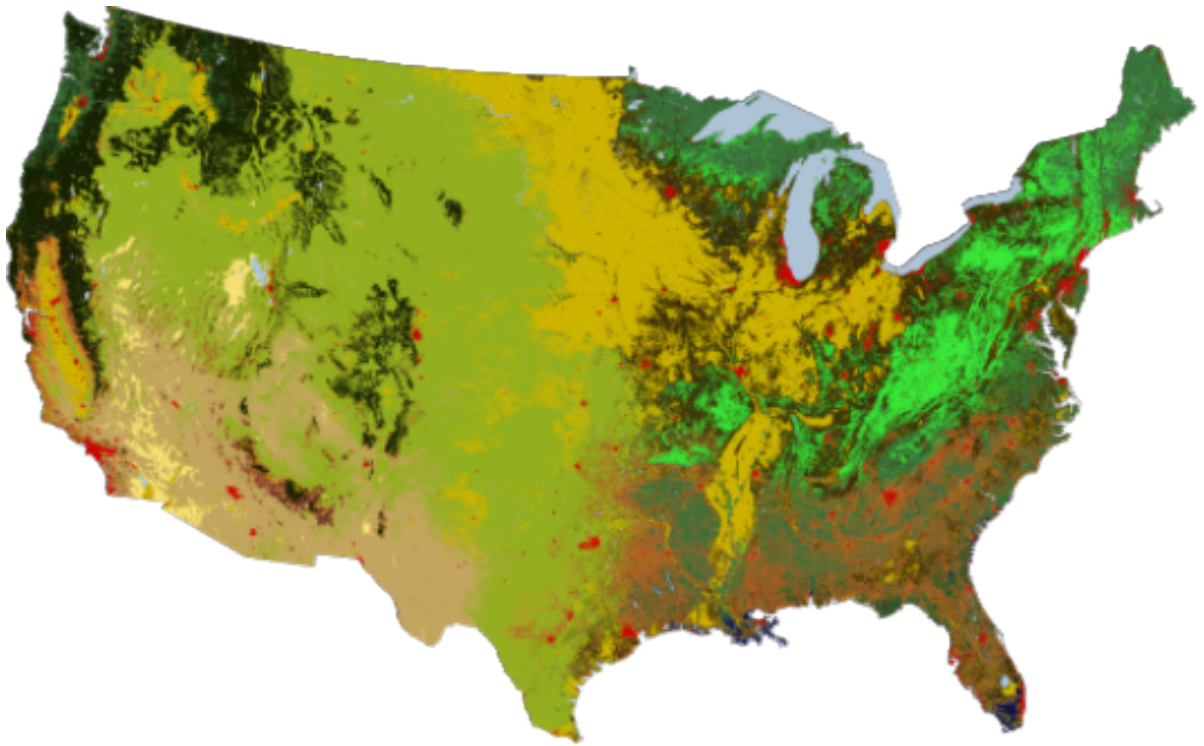
Standard for NYS is UTM 18N

Tissot:



Kurubu, Wikimedia

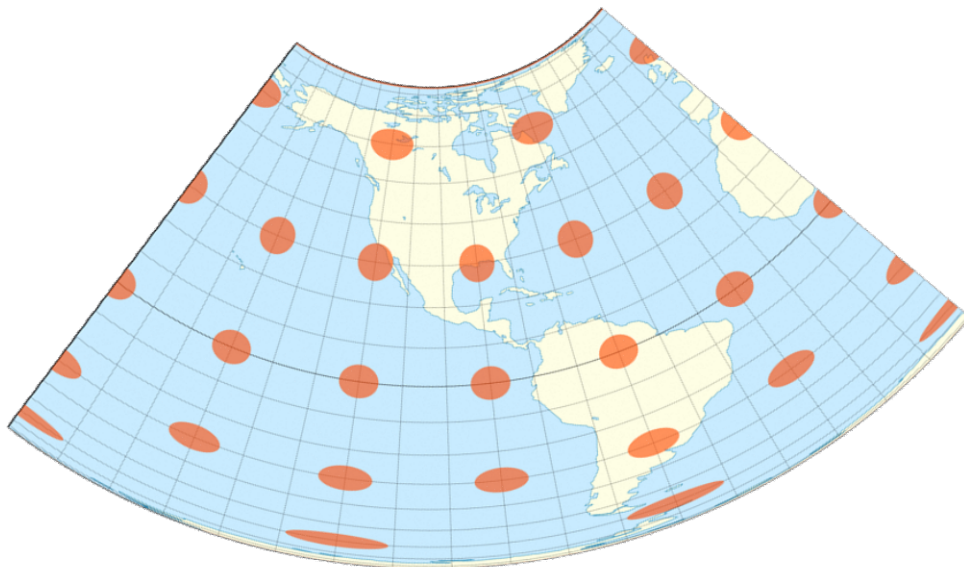
## Albers Equal-Area Conic Projection



<https://medium.com/google-earth/introduction-to-map-projections-with-google-earth-engine-part-1-7840e4ca6264>

Pro: correct areas for large spans and often used for the US

Tissot:



Many more!

- <https://map-projections.net/imglist.php>