Map Projections II

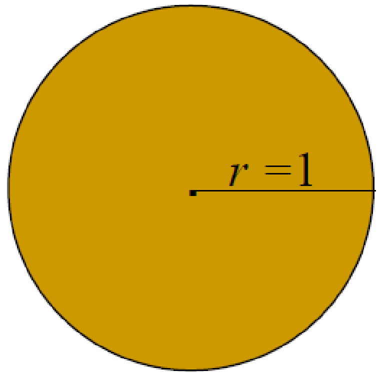
GEOG380 Fall 2018

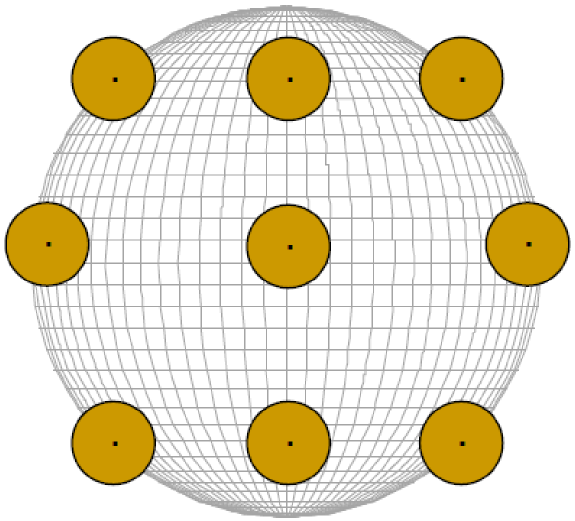
The round earth vs. a flat map/screen

- Map Projections I
  - The process of map projections
  - Geographic coordinates
  - Projected coordinates
  - Map projection characteristics
  - Distortion
  - Scale
- Map Projections II
  - More about projections
  - Selecting an appropriate map projection

Tissot's indicatrix

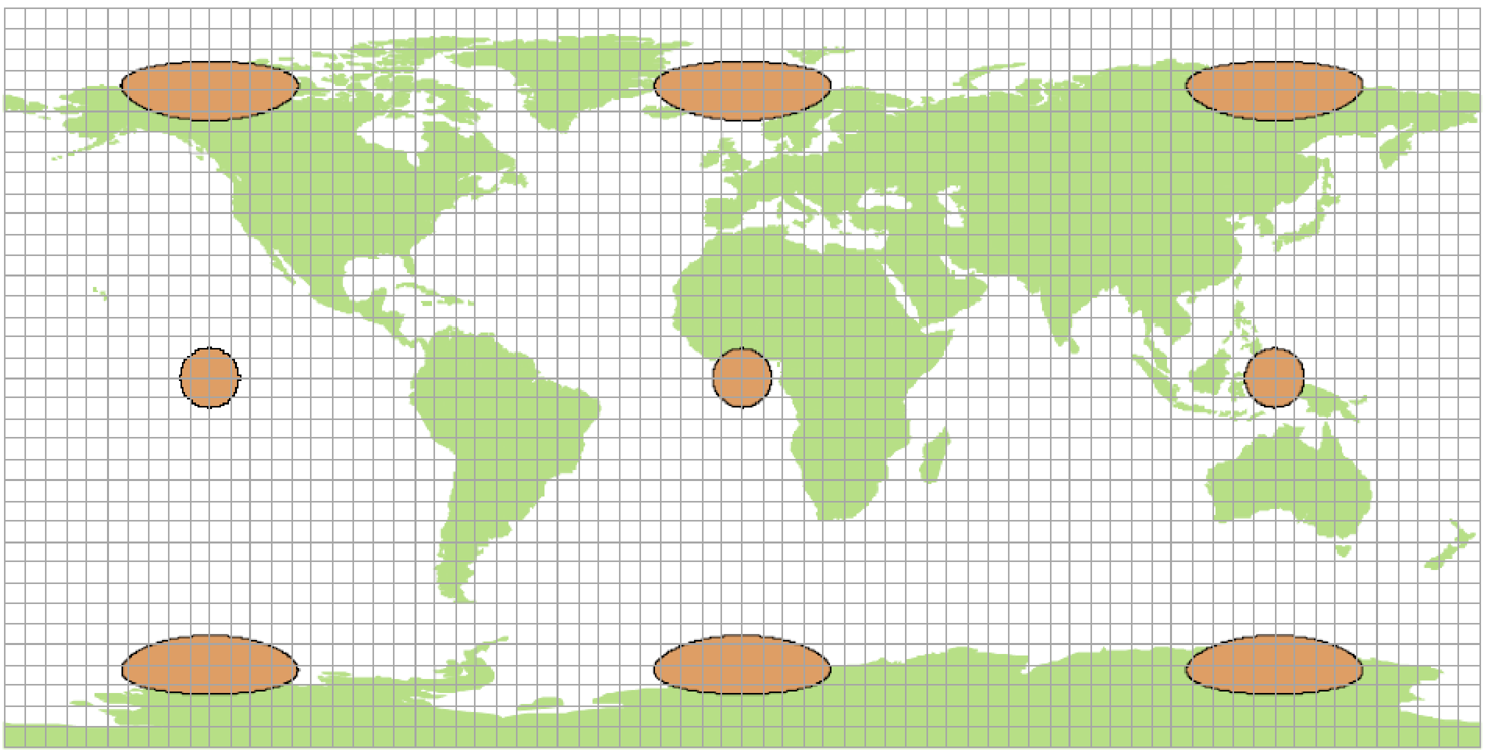
- A way to visually explore and understand distortion of different projections
- A symbol representing a really small point *on the* reference globe with unit radius





Tissot's indicatrix (cont.)

- Each indicatrix gets projected onto the developable surface (projecting land masses and graticules from the reference globe) together with the geographic features



Tissot's indicatrix

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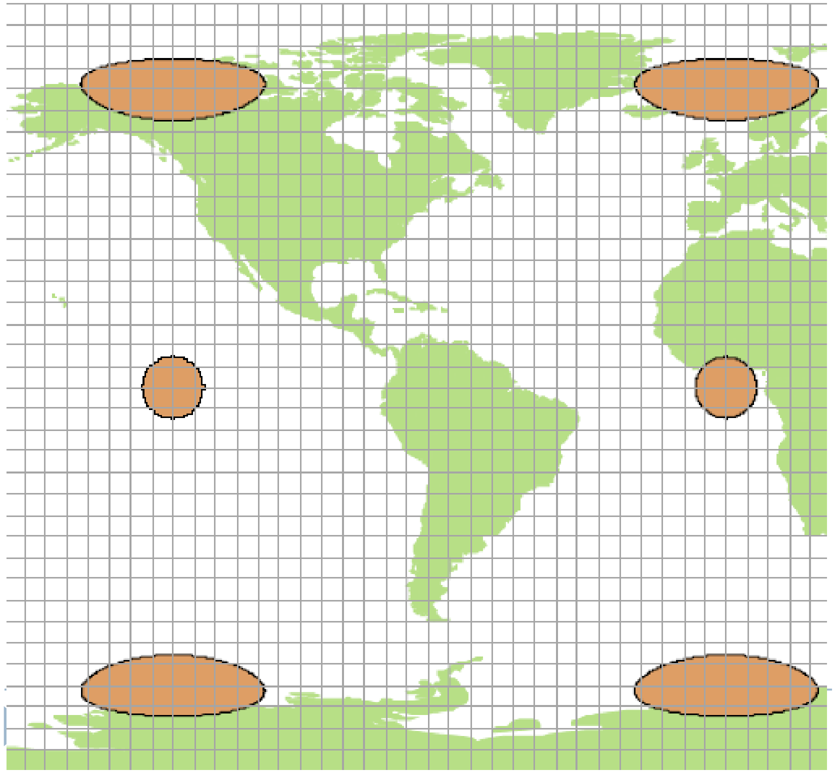
- A *symbol representing a really small point on the* reference globe with unit radius



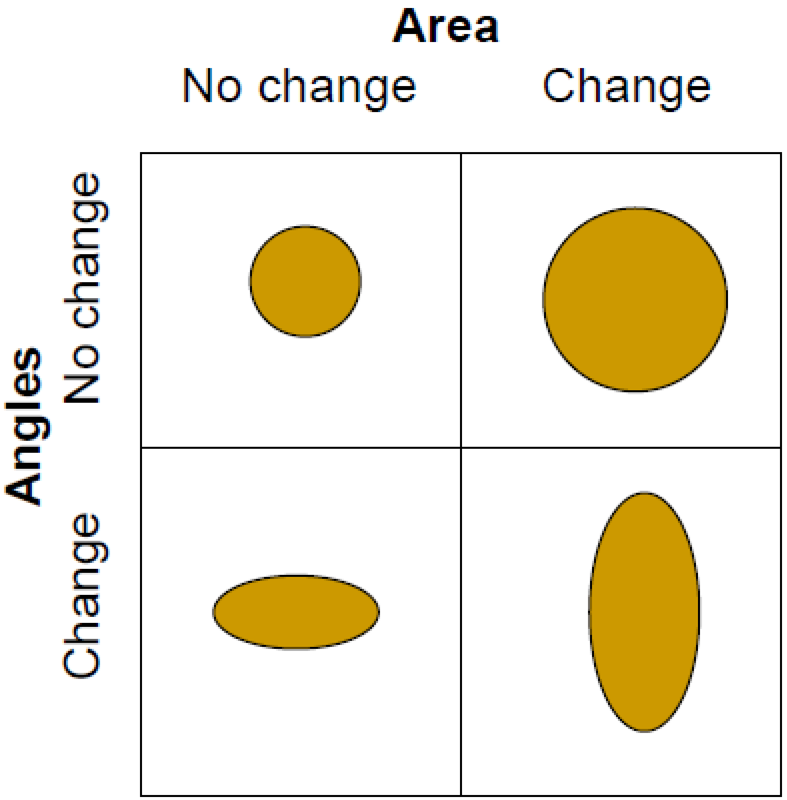
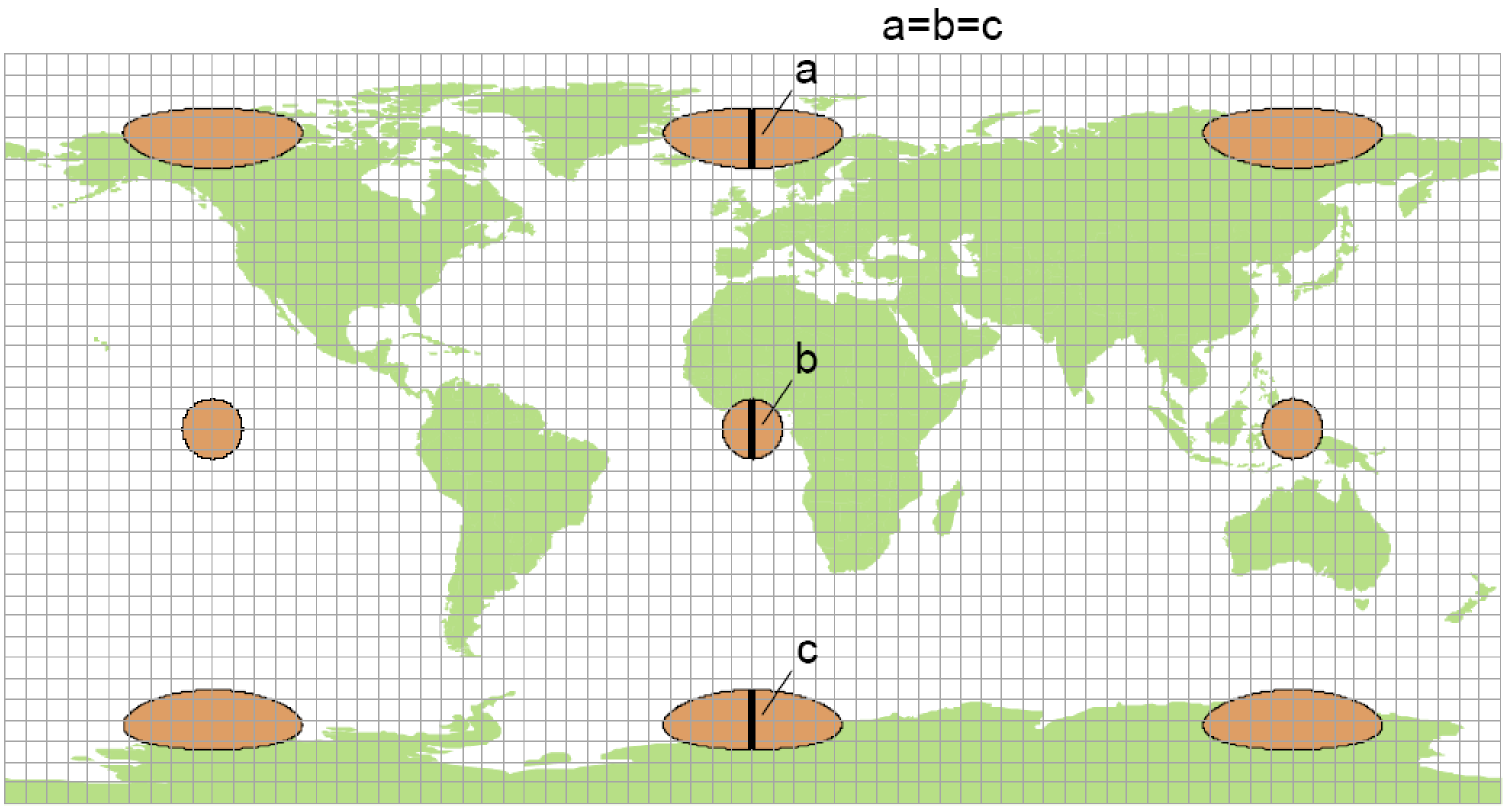


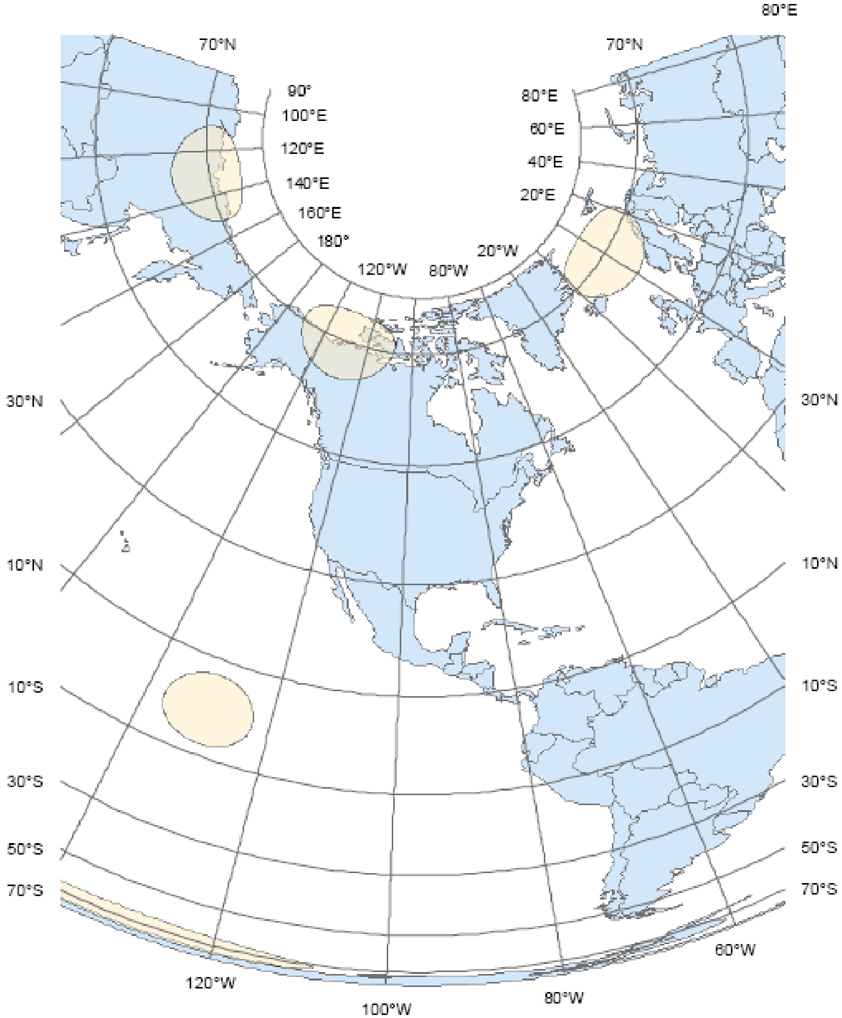
Plate carrée (flat square)

- Equidistant – preserves distance
- Cylindrical developable surface



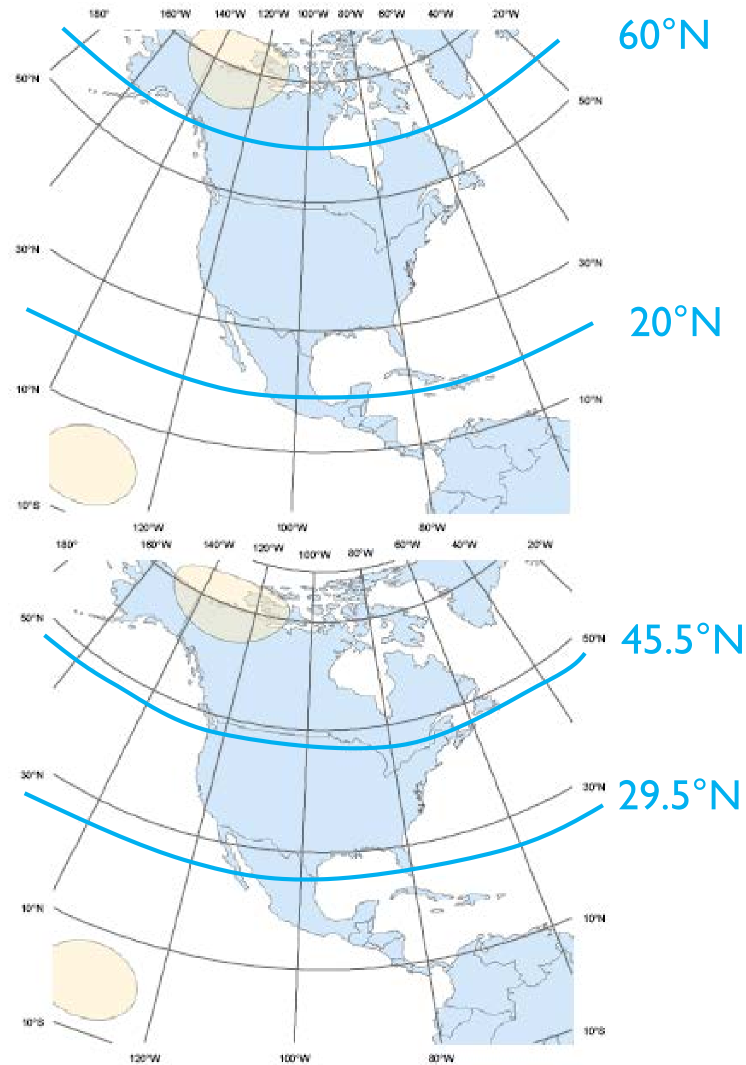
Albers Equal Area Conic

- Equivalent – Equal area
- Conic developable surface
- Works very well for areas in mid-latitudes



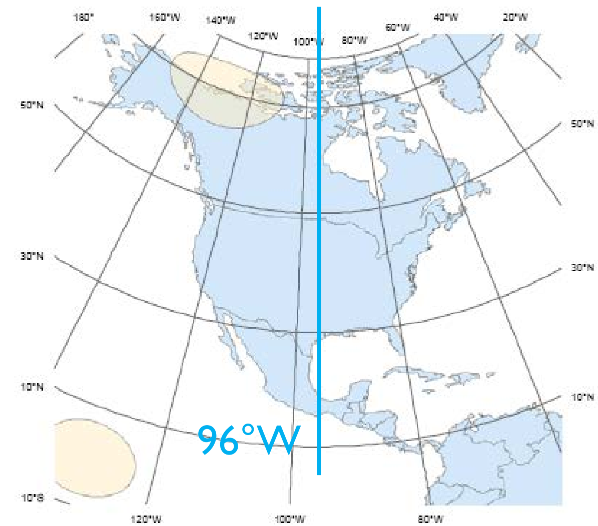
Adjusting projection center

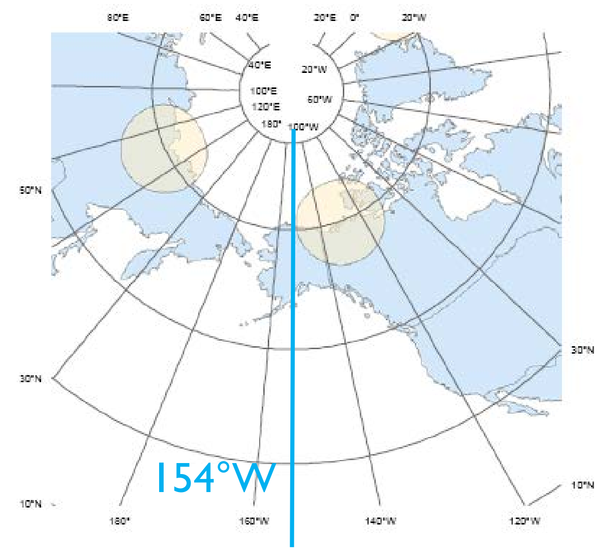
- Latitude adjustment
- Ex. Albers equal area conic
  - North America
    - Standard parallels: 20 and 60 degrees N
  - Contiguous US
    - Standard parallels 29.5 and 45.5 N
- *Why adjust the projection center?*



Adjusting projection center (cont.)

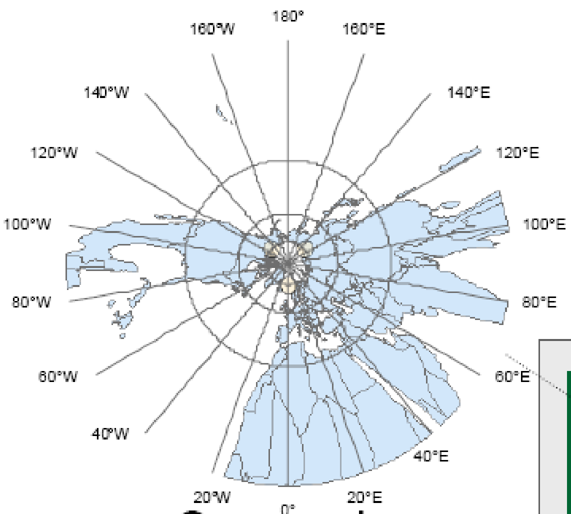
- Longitude adjustment
- Ex. Albers equal area conic
  - Contiguous US
    - Central meridian 96° W
    - Standard parallels: 29.5°N and 45.5° N
  - Alaska
    - Central meridian 154° W
    - Standard parallels 55°N and 65° N



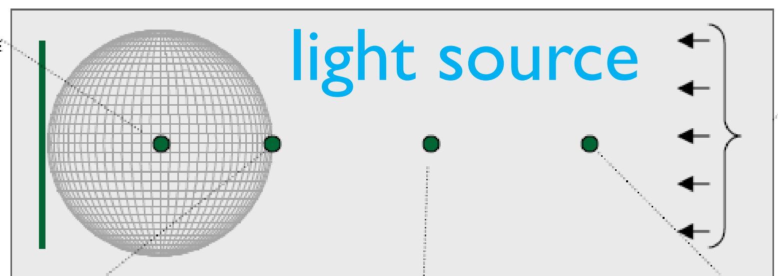


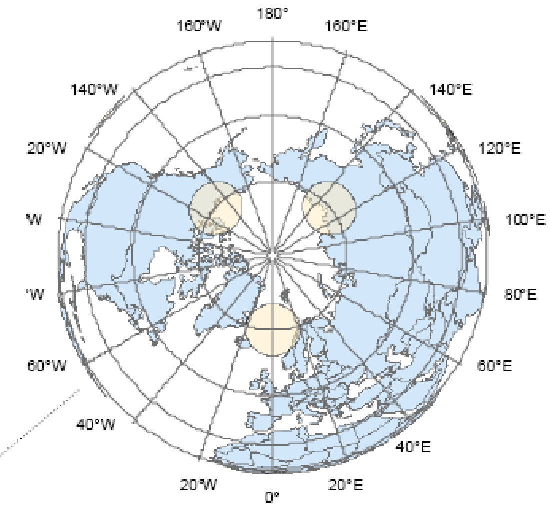
Azimuthal projections (keeps direction)

- All have circular distortion pattern suitable for similarly-shaped areas
  - Antarctica
  - North America

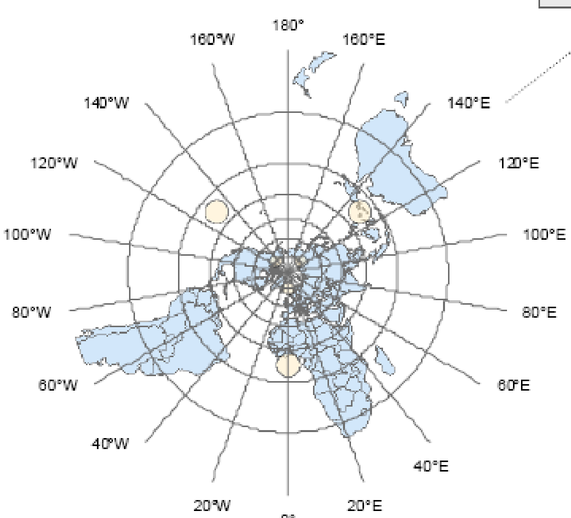


Gnomonic

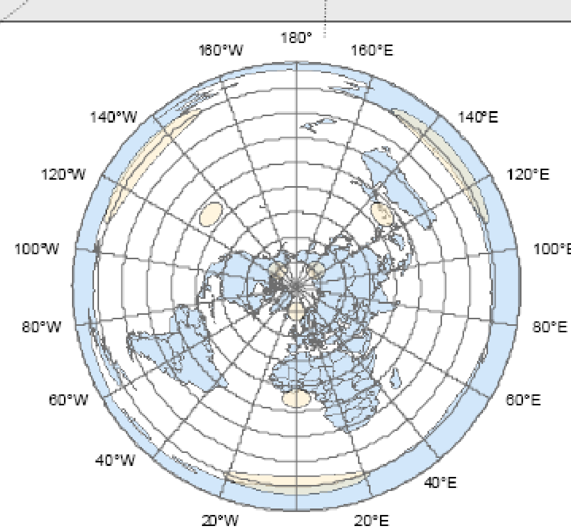




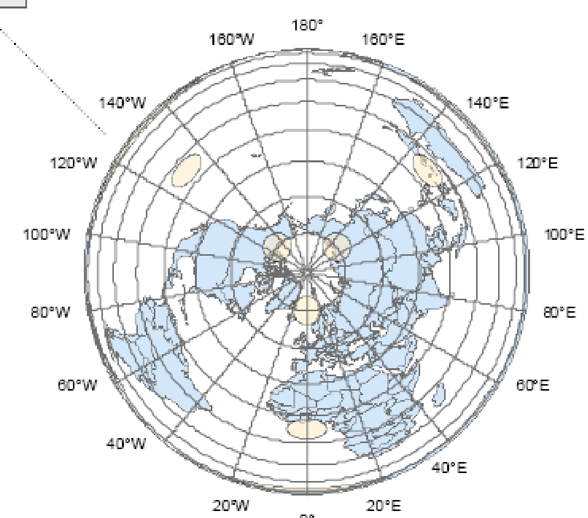
Orthographic



Stereographic



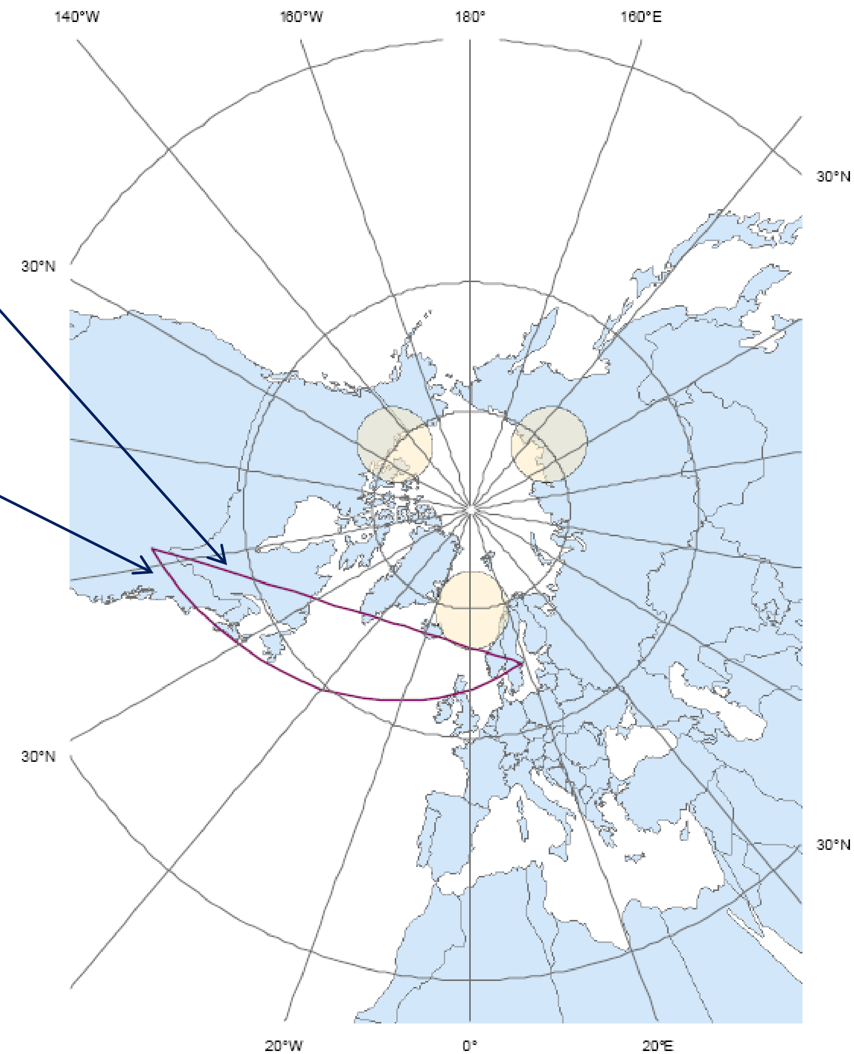
Equidistant

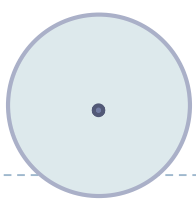


Equivalent

Azimuthal - Gnomonic

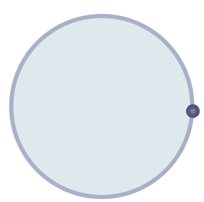
- Any great circle arcs become a straight line
  - Preserves direction
  - cf. loxodrome
- Useful for navigation
- Extreme distortions away from the center
  - Only part of the globe is projected
  - Circles are not preserved

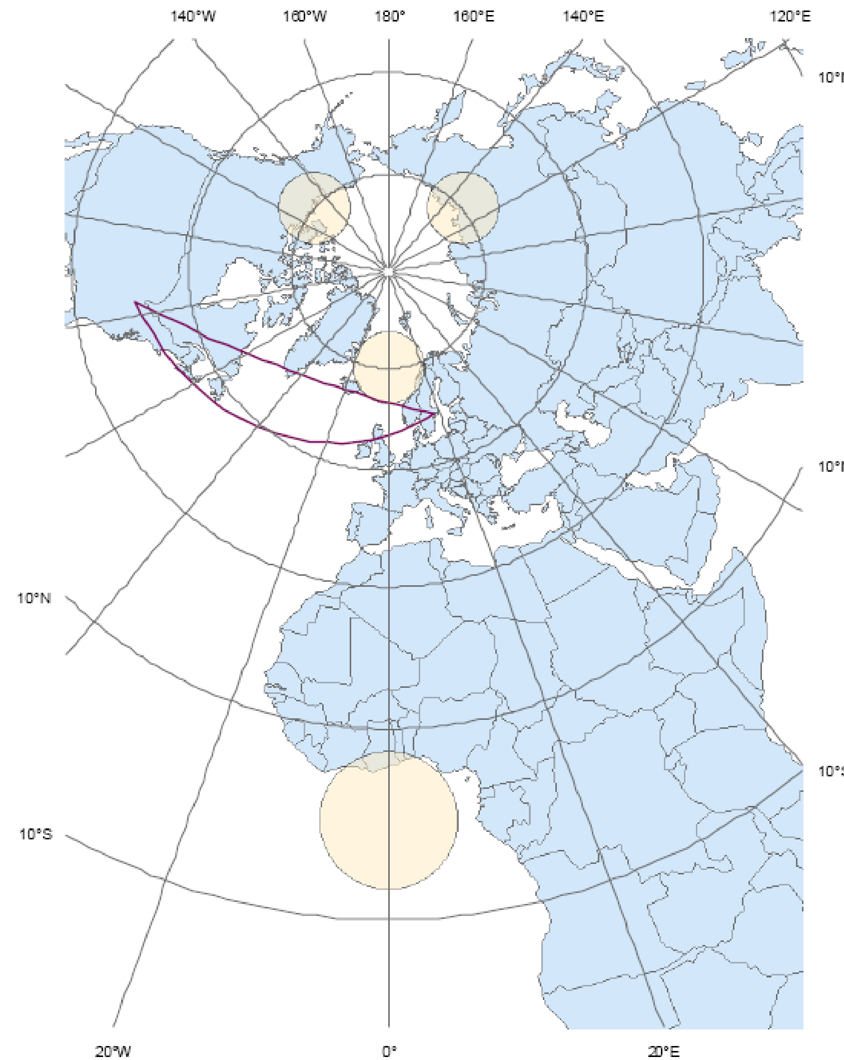




Azimuthal - Stereographic

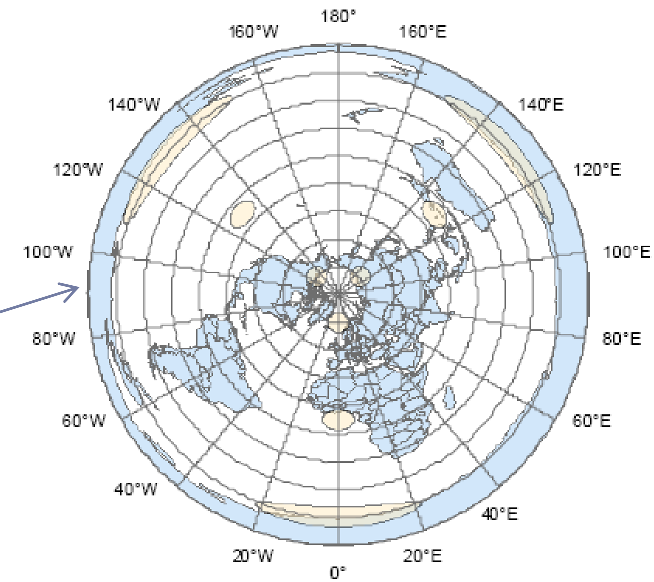
- Conformal – preserves angles
  - Circles and circular arcs are preserved

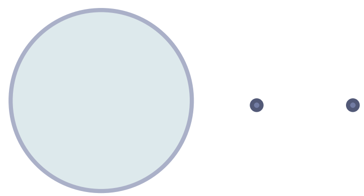




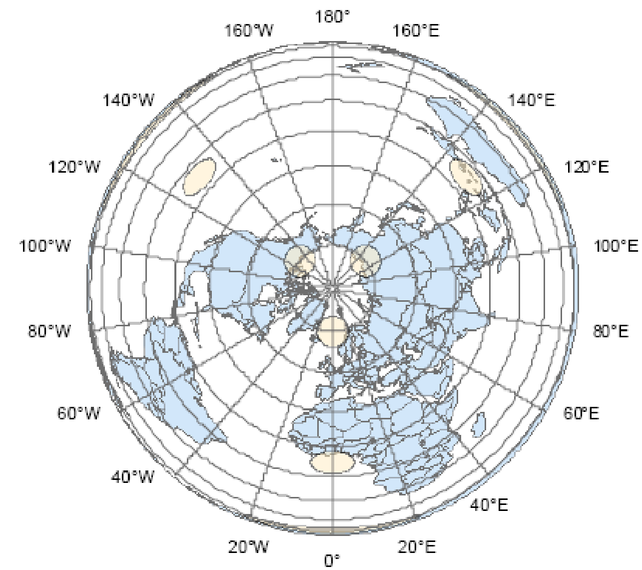
Azimuthal – Equidistant, Equivalent

- Equidistant
  - Scale constant along radiating straight lines
  - Preserves distance
  - Antipode becomes a bounding circle



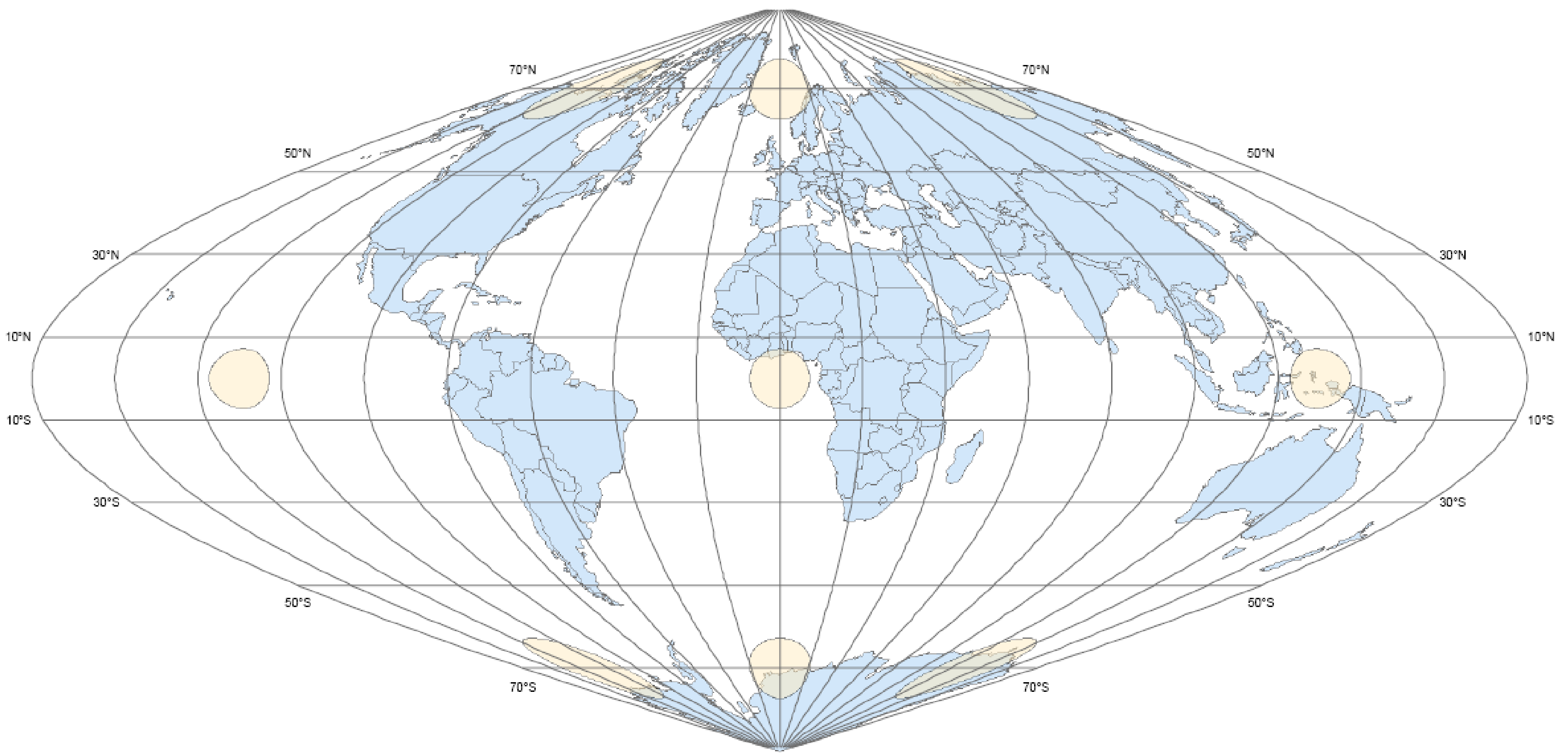


- Equivalent
  - Compression towards the antipode
  - Preserves areas

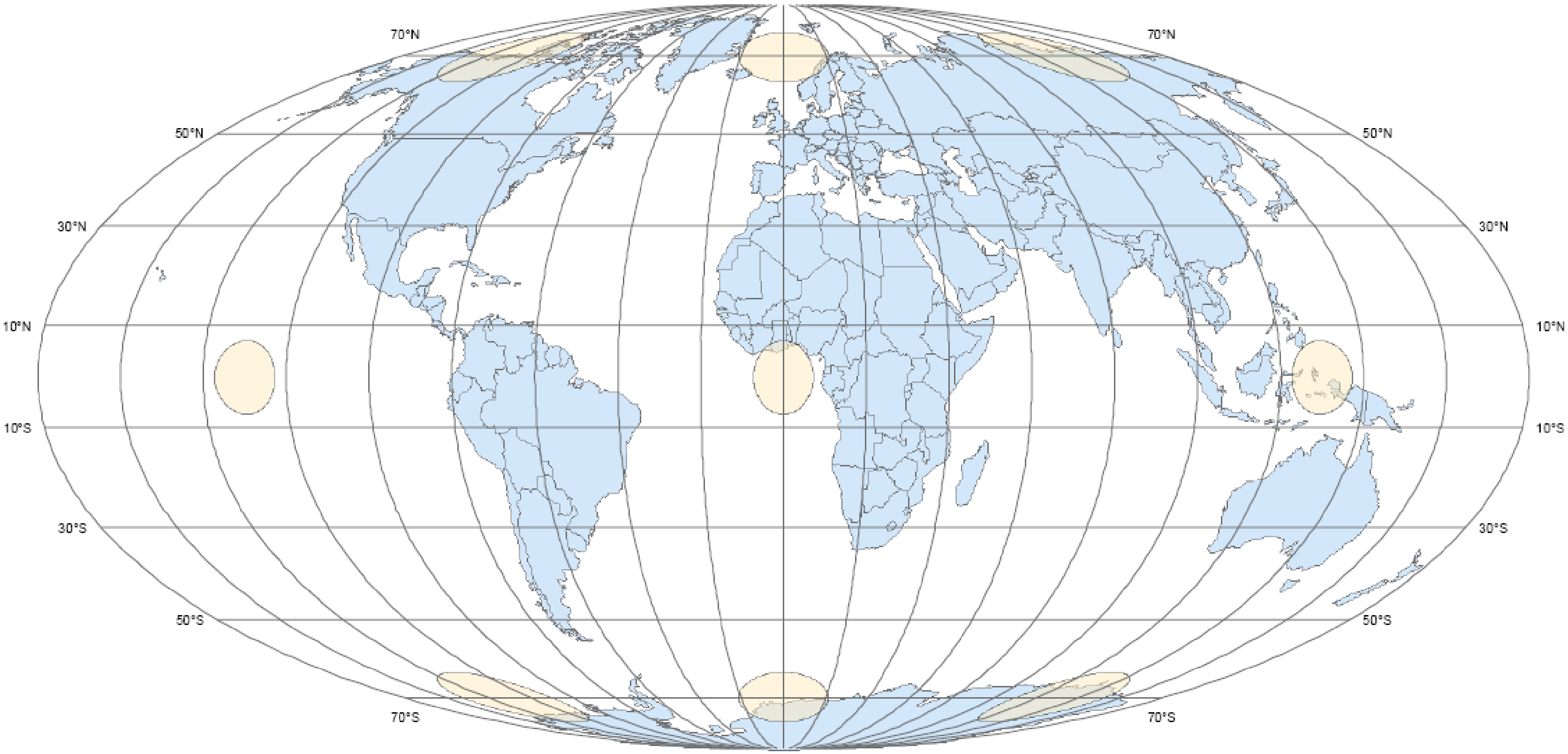


- (See the parallels)

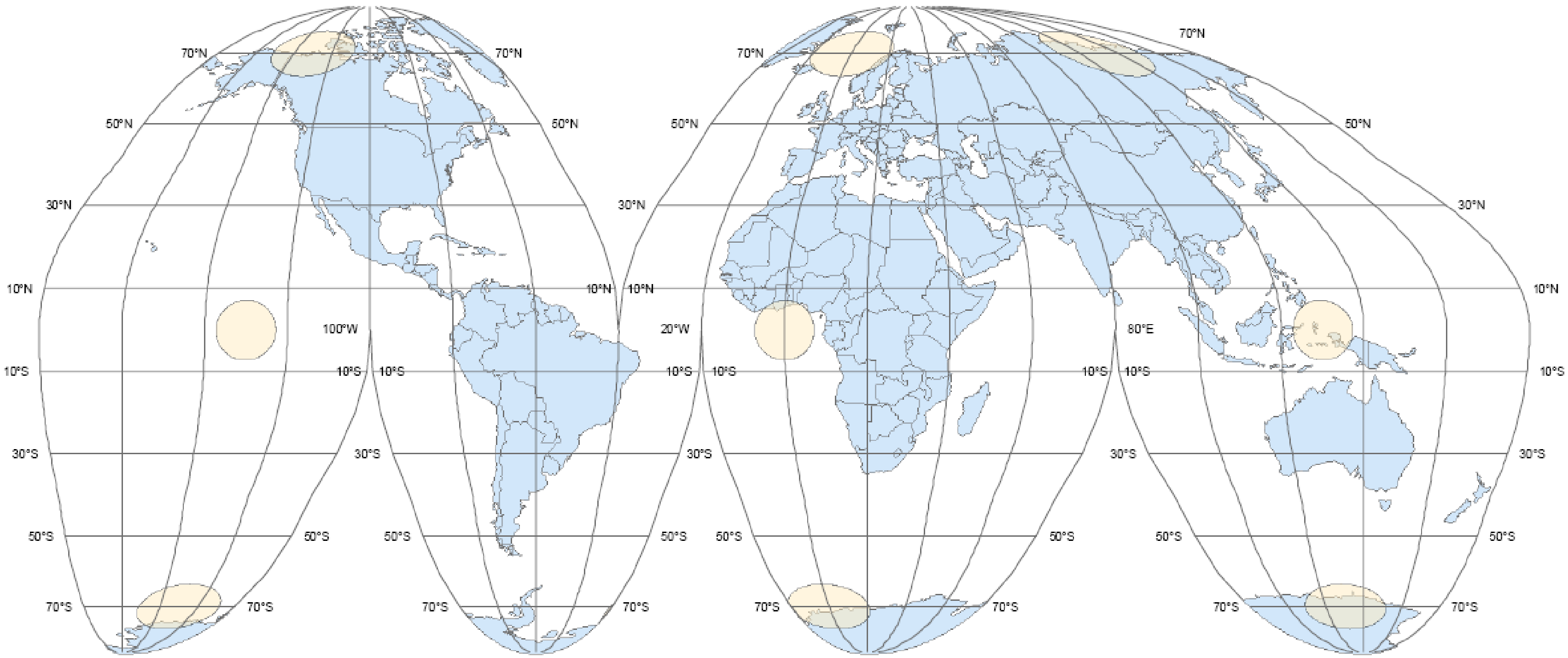
Equal area Projections - Sinusoidal



Equal area Projections - Mollweide

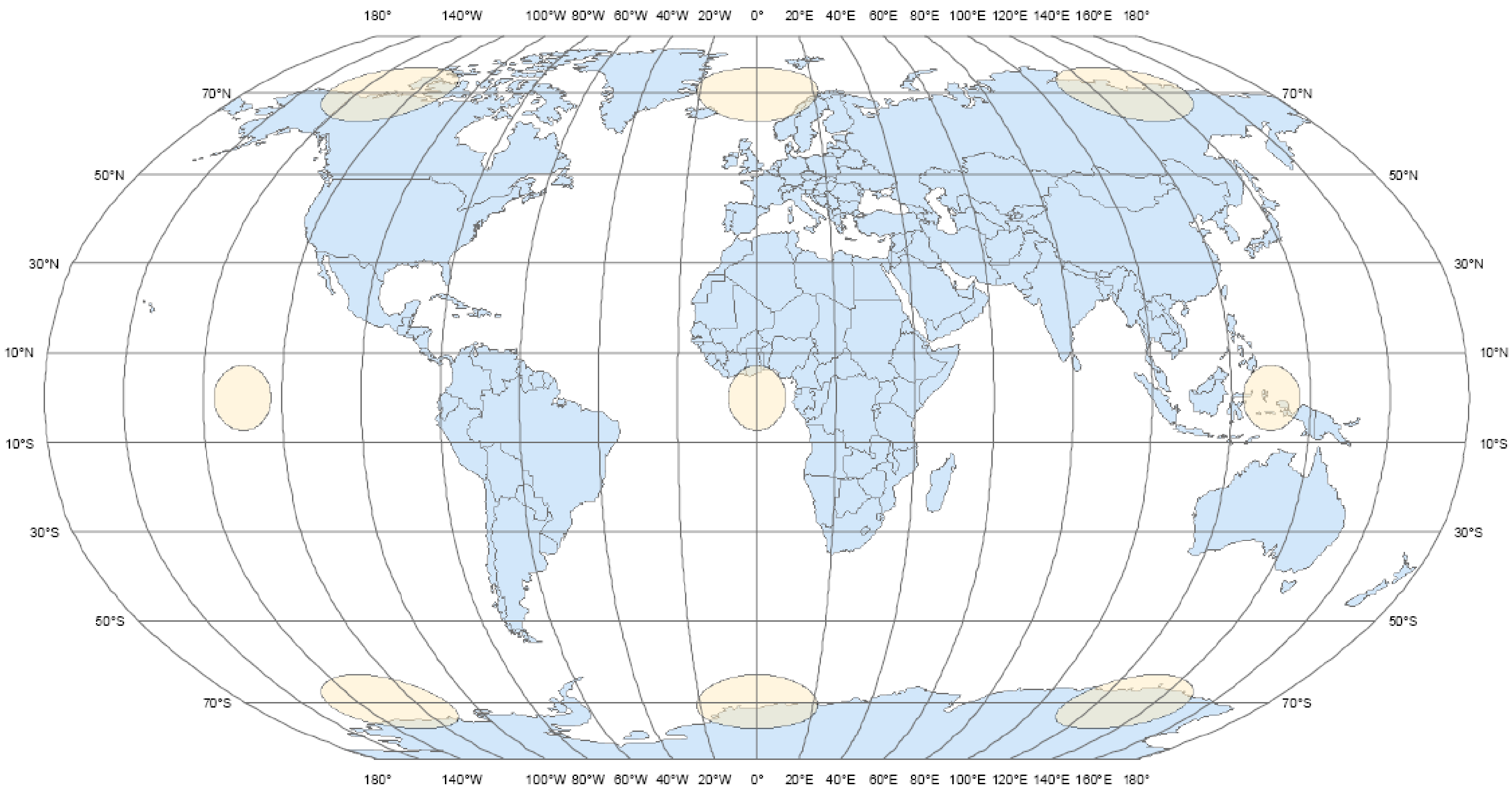


Equal area Projections - Goode's homolosine



Robinson

- Compromise – minimize distortion (shape+area+ angle…)



Choices, choices, choices…

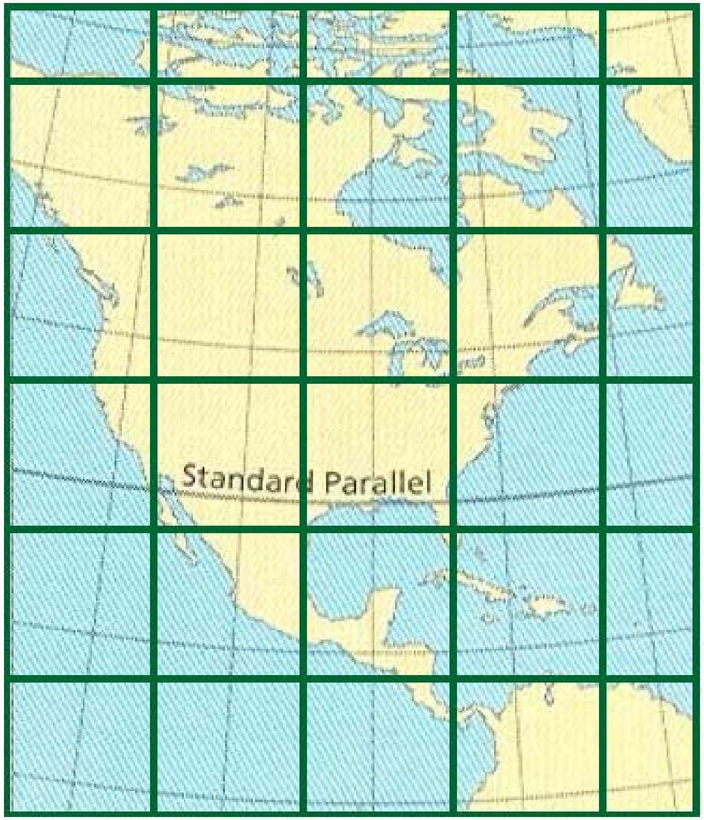
- Snyder's projection selection guidelines
  - World (Table 9.1, p.155), hemisphere (Table 9.2, p.156) continent, ocean, or smaller areas (Table 9.3, p.158)

TABLE 9.1 Snyder's map projection guideline showing projections for mapping the world

Region Mapped	*Property*	*Characteristic*	*Named Projection*
World	Conformal	Constant scale along Equator	Mercator
		Constant scale along a meridian	Transverse Mercator
		Constant scale along an oblique great circle	Oblique Mercator
		No constant scale anywhere on the map	Lagrange
			August
			Eisenlohr
	Equivalent	Noninterrupted	Mollweide
			Eckert IV & VI
			McBryde or McBryde–Thomas
			Boggs Eumorphic
			Sinusoidal
			Other miscellaneous pseudocylindricals
			Hammer (a modified azimuthal)
		Interrupted	Any of the above except Hammer
			Goode's Homolosine
		Oblique aspect	Briesemeister
			Oblique Mollweide
	Equidistant	Centered on a pole	Polar azimuthal equidistant
		Centered on a city	Oblique azimuthal equidistant
	Straight rhumb lines		Mercator
	Compromise distortion		Miller cylindrical
			Robinson pseudocylindrical

Geographic vs. projected coordinates

- Because of projection a geographic coordinate grid will typically not be square-shaped (3D sphere)
- This is *inconvenient* in a flat map context and also in a GIS where digitizers and remote sensing data use square grids
- It also introduces errors in calculation of distance and area



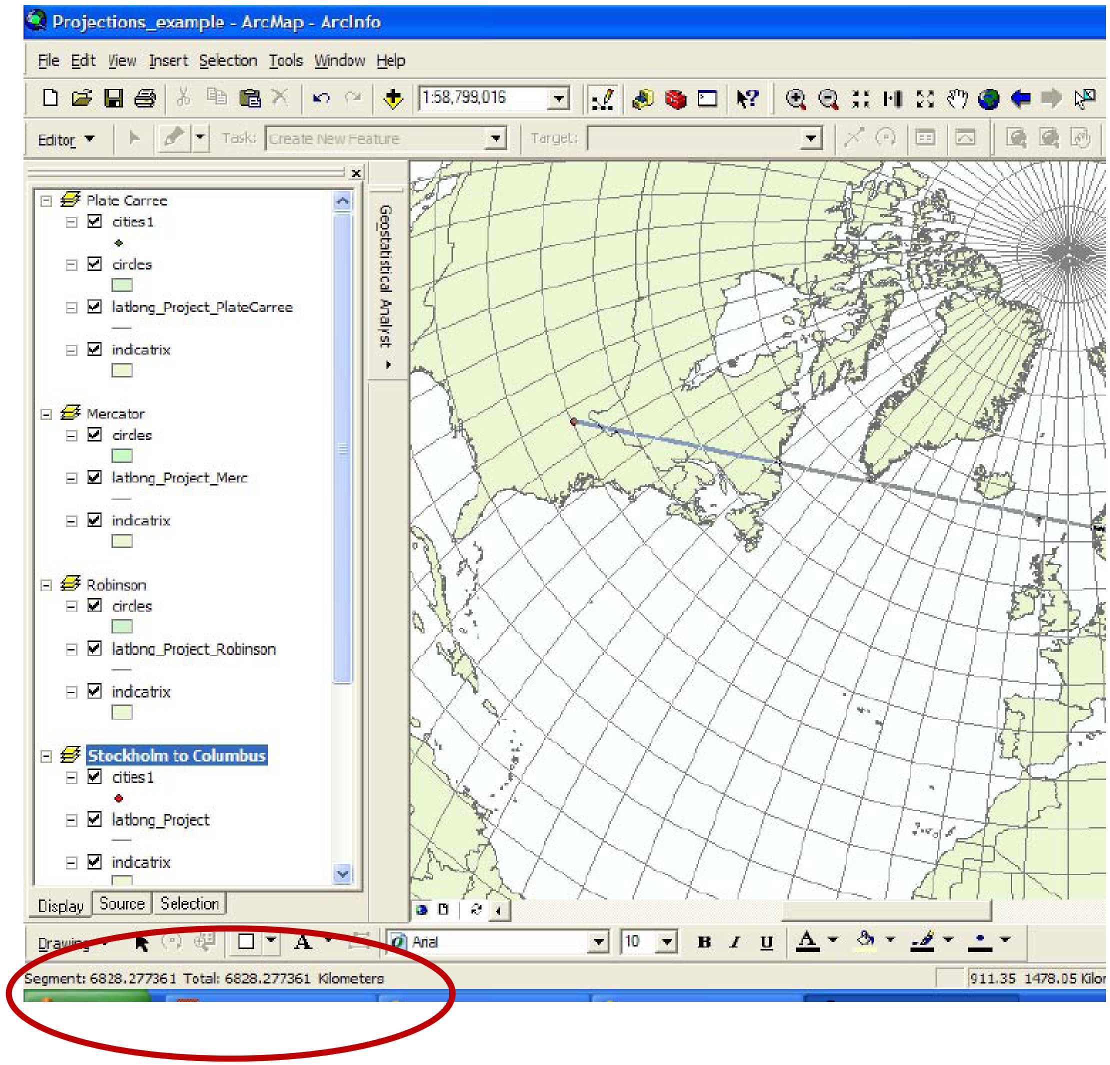
geographic coordinate grid

projected coordinate grid

Source: Goode's World Atlas

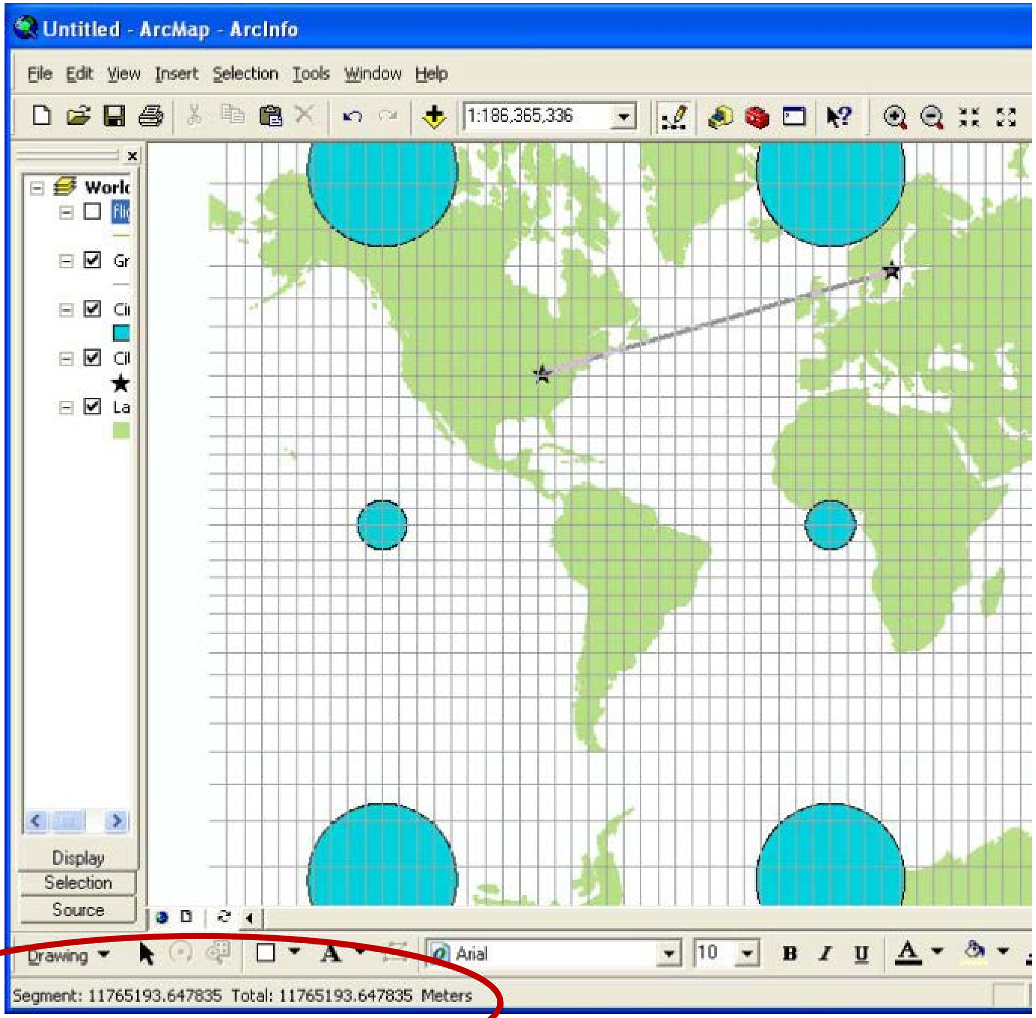
Measurement error example

- Using a geographic grid, distance between two points is calculated along great circles from a central point
  - Ex) 6,828km



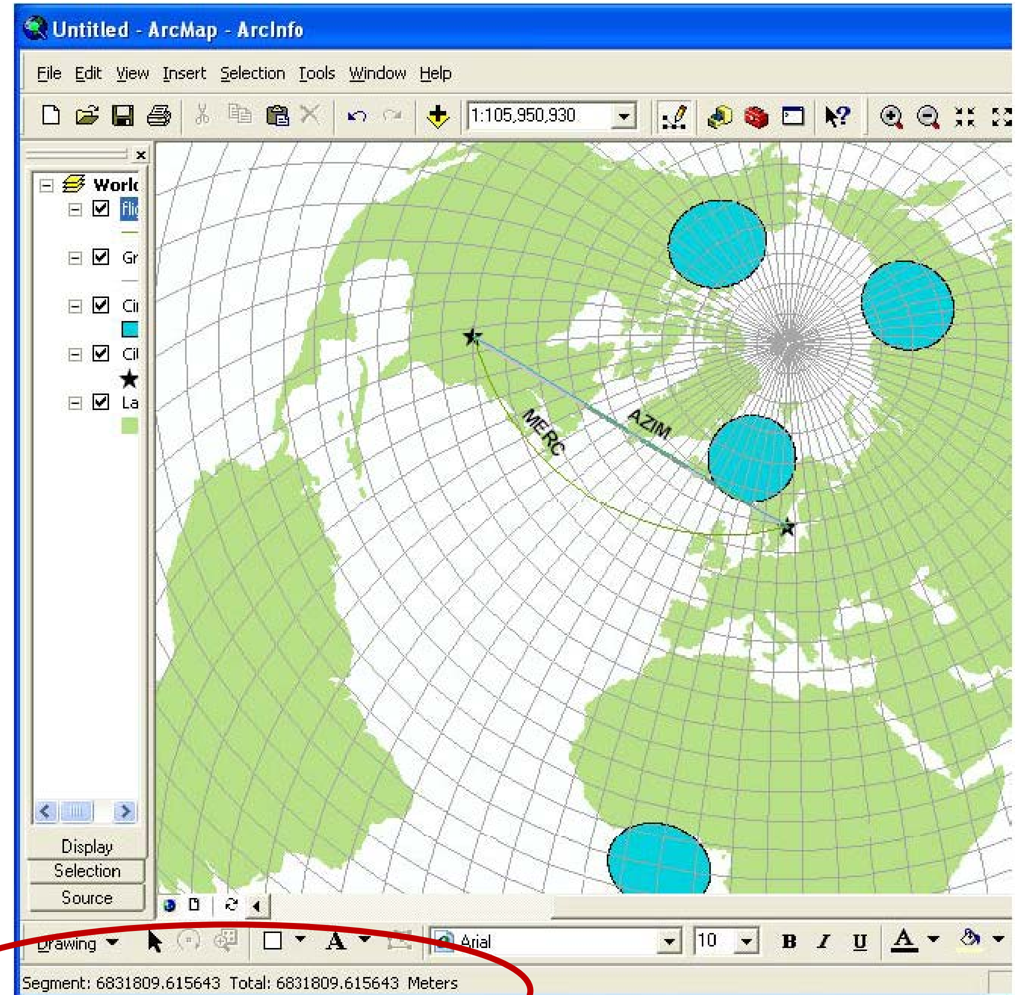
Mercator distance

- Projected data as measured on a map will be distorted
- What really is 6,828km is measured to be about 11,700 km!



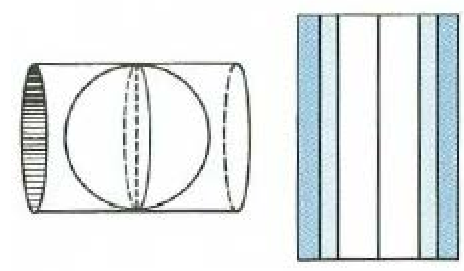
Azimuthal distance (keeps direction)

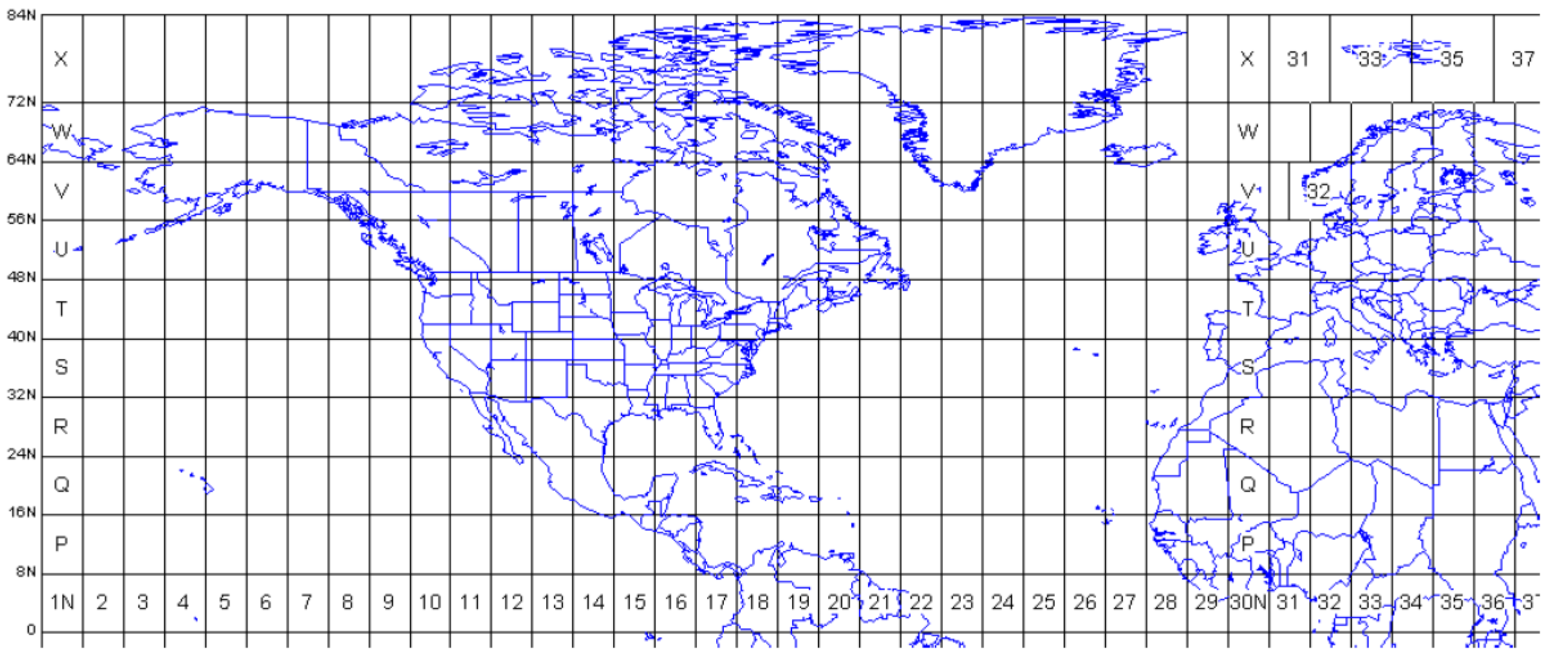
- Equidistant azimuthal projection centered on two different points can be used to measure the correct distance
- What is a straight line in Mercator projection is a curved line (loxodrome) in Azimuthal projection
- What really is 6,828km is measured to be about 6,832 km!



Some common map coordinate systems

- Universal Transverse Mercator (UTM) grid
  - Specified for 60 x 20 zones (ex. 11N)
  - Measured in meter
  - Distortions within 1 meter

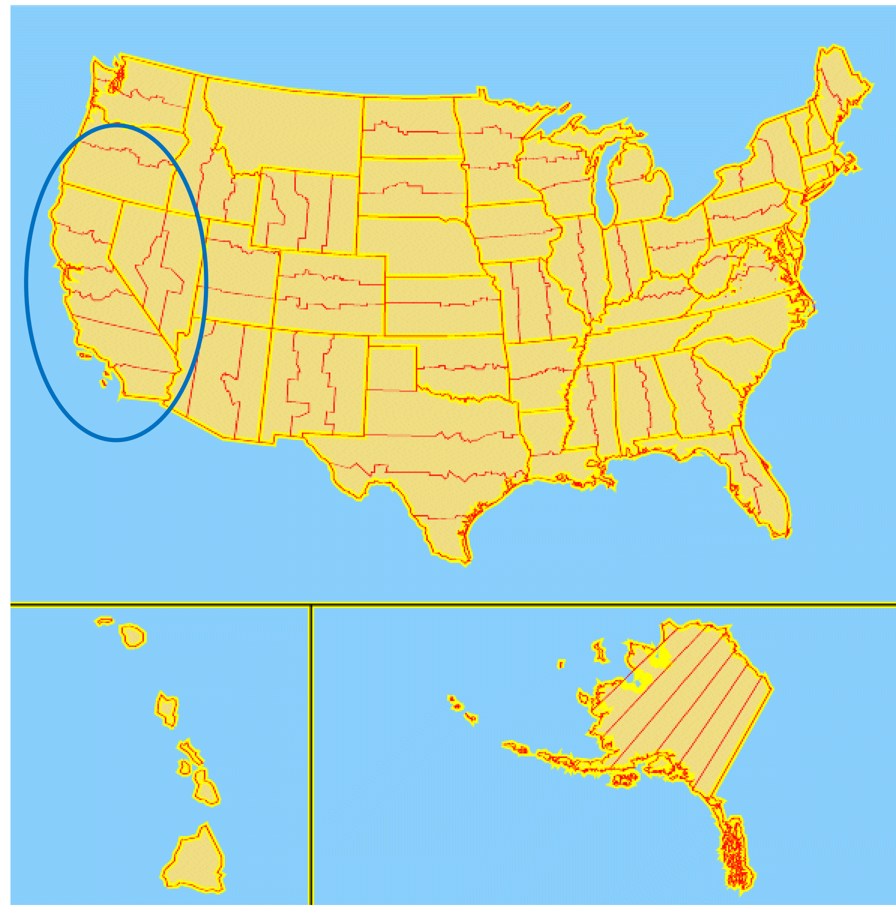


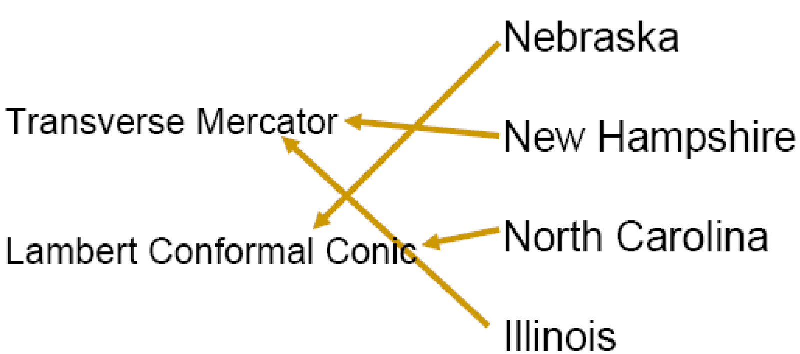


Some common map coordinate systems (cont.)

- State plane coordinate systems (SPC)
  - Each state uses optimal projection
  - Measured in feet
  - Distortions less than 1 foot
  - False Easting, Northing

California State has 6 SPCs





Source: http://www.warnercnr.colostate.edu/class_info/nr502/lg3/datums_coordinates/spcs.html

To do…

- Reading
  - Ch. 11
- Test 1: lecture notes #01~07
  - Sep. 25 (at the beginning of class, about 30 minutes)
    - Study guide & sample questions on the BeachBoard