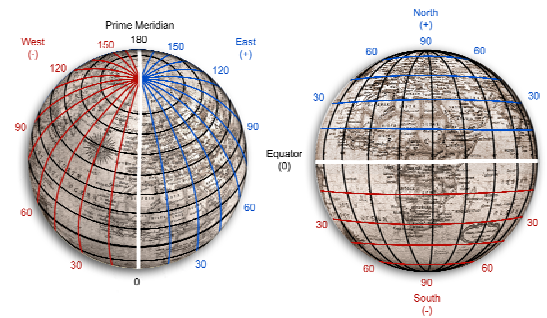


Geography 12: Maps and Spatial Reasoning
Lecture 4:
Some Useful Map Projections







Professor Keith Clarke



The **graticule** shows increments of latitude and longitude



No flat map can be both equivalent and conformal

CONFORMAL Preserves Shape	EQUIVALENT Preserves Area	COMPROMISE Preserves Neither
 Mercator	 Albers Equal Area	 Robinson
 Lambert Conformal Conic	 Sinusoidal	 Miller

Burn Onto Your Brain Cells

- **No flat map can be both equivalent and conformal**
- **We always distort scale, direction or shape**
- **We ignore projections at our peril!**

We've already covered...

- Form (planar, cylindrical, conic)
- Aspect (equatorial, oblique, transverse)
- Property preservation (shape, area, direction)
- Analog vs. mathematical
- Tangent vs. secant

The central meridian

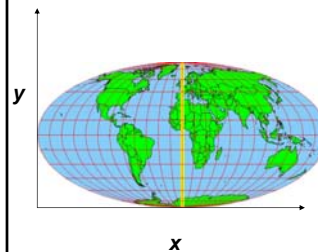
- In the mathematical derivation, x can map onto any meridian, by default we get 0°
- $x' = f(\lambda - \lambda_0)$
- We can change the center of the map
- Can even change the direction of the axis

Changing the central meridian



Mollweide: An equal area pseudocylindrical projection

x and y are not independent

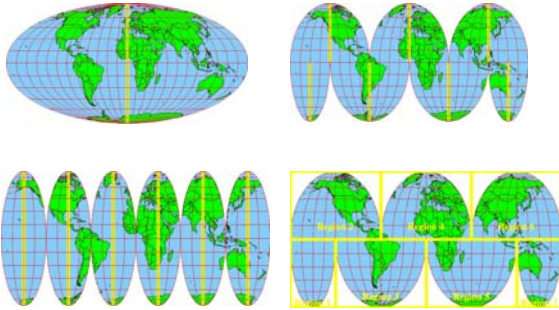


$$x = \frac{2\sqrt{2}}{\pi} \lambda \cos\left(\frac{\theta}{2}\right)$$

$$y = \sqrt{2} \sin\left(\frac{\theta}{2}\right)$$

$$\theta + \sin(\theta) = \pi \sin(\phi)$$

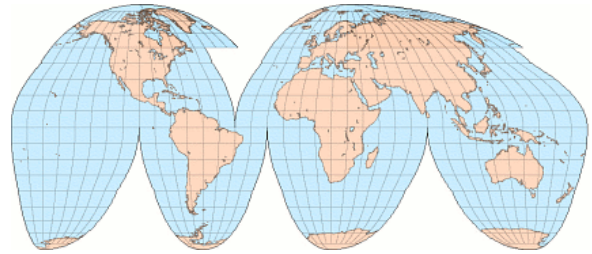
We can also choose the interruptions



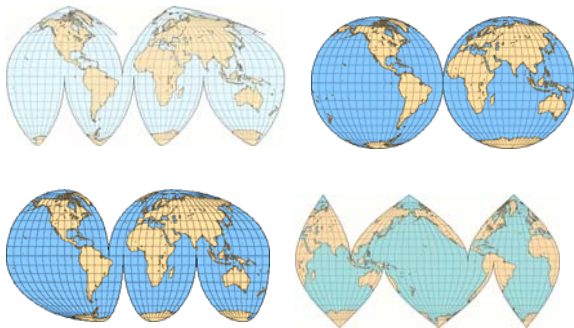
Interrupted Mollweide

And mix projections together

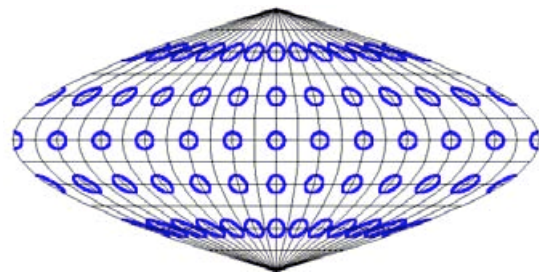
Goode's Homolosine=Mollweide (lobes) plus sinusoidal near the equator (J.P. Goode, 1923)



Many possible interruptions

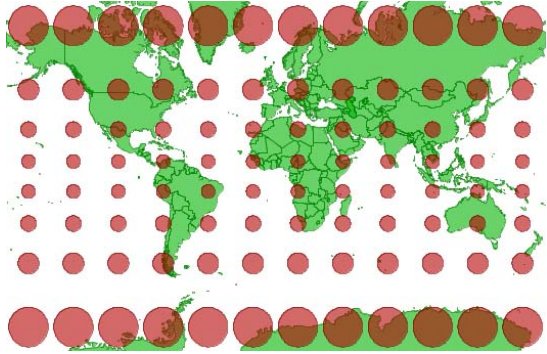


Projection distortion: Tissot's Indicatrix

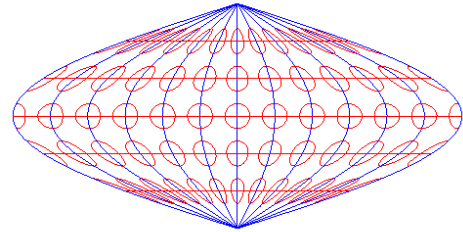


Werner projection

Mercator plus Tissot



Sinusoidal plus Tissot

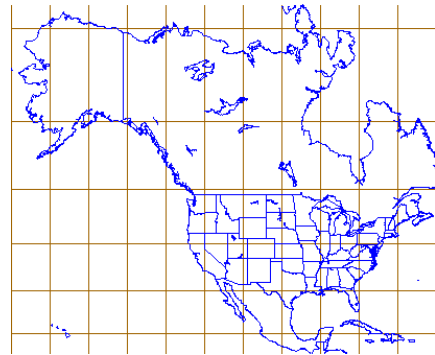


Projections for the USA



Lambert conformal conic

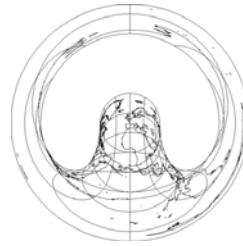
USA on Mercator



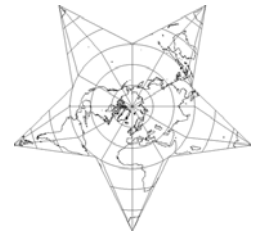
GS-50 Snyder



Fun projections

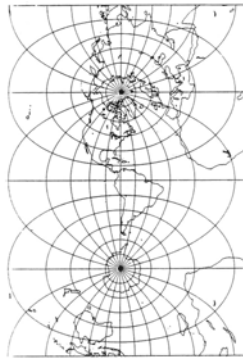


Hammer retroazimuthal

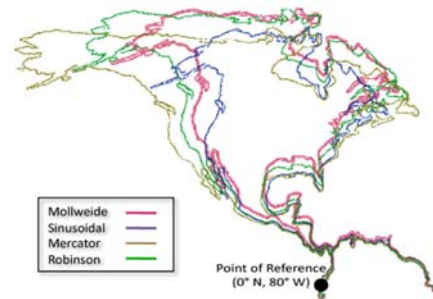


Berghaus star

Customizing error



Projection does matter!



Projection websites

- Geographers Craft: http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html
- Wikipedia: http://en.wikipedia.org/wiki/Map_projection
- Gallery of Map Projections: <http://www.csiss.org/map-projections/index.html>
- Carlos Furuti: <http://www.progonos.com/furuti/MapProj/Normal/TOC/cartTOC.html>
- Hunter College: <http://www.geography.hunter.cuny.edu/mp/>
- Information on projections for GIS <http://spatialreference.org/>

Final notes

- Many features of projections can be varied
- Since no flat map can be both conformal and equivalent, all have distortion (max)
- We can customize where and how much error is in a projection
- We can know and display the error
- The smaller the extent the map covers, the less overall distortion
- Always include information about the projection