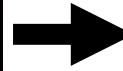Geography 12: Maps and Spatial Reasoning
Lecture 3:
Map Projection Basics

Professor Keith Clarke

Recall: The scale transformation
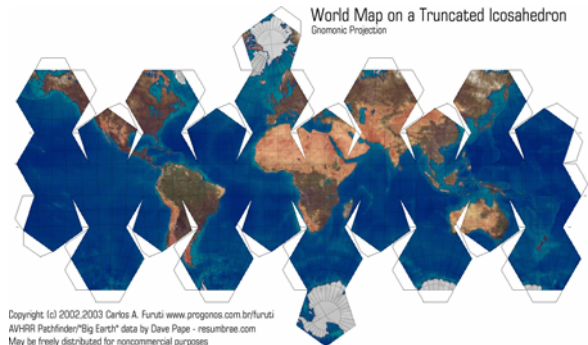

1:400M

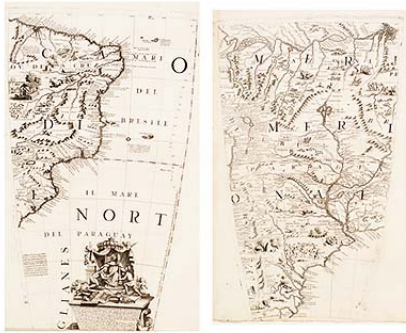The real world   A representation of the world

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A cartographic problem

A possible solution?

World Map on a Truncated Icosahedron
Gnomonic Projection

Copyright (c) 2002,2003 Carlos A. Furuti www.progonos.com.br/furuti
AVHRR Pathfinder "Big Earth" data by Dave Pape - resumbrae.com
May be freely distributed for noncommercial purposes

That's how "gores" are made!

But…..

- Not all of the world is on one section
- Lots of cuts/breaks are necessary
- The earth is still distorted
- It is very cumbersome to use globes for measuring
- All large cartographic scale maps would only curve a little bit
- Cartography would be goring

The solution

- Wikipedia says…

  A **map projection** is any method used in cartography to represent the two-dimensional curved surface of the earth or other body on a plane. The term "projection" here refers to any function defined on the earth's surface and with values on the plane, and not necessarily a geometric projection.
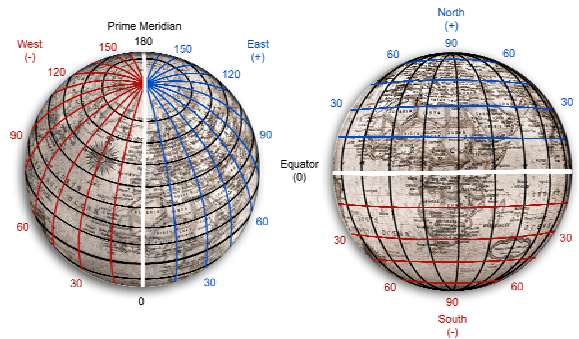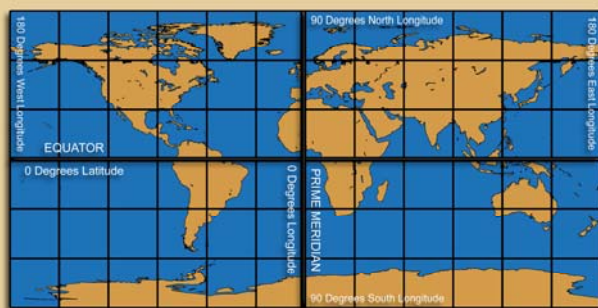
A projection!

The graticule

- **graticule:** The latitude and longitude grid drawn on a map or globe. The angle at which the graticule meets is the best first indicator of what projection has been used for the map.

The graticule shows increments of latitude and longitude

Geographic Coordinates

Some stuff about geographic coordinates

- Latitude goes from -90 to +90 (180 degrees)
- Longitude goes from -180 to +180 (360 degrees)
- Degrees can be divided like time, into 60 minutes and each minute into 60 "second minutes" or seconds
- State as: 119°15'27"
- Often also given as decimal degrees 119.2575°
- Remember to distinguish N-S vs. E-W
- Graticule increments vary, common are 10° and 15°

3

Length of a degree of latitude

| Latitude	Length of a degree (m)
0-1	110 567
39-40	111 023
89-90	111 699
Approximate average	111 111

Length of a degree of longitude

- Length of a degree of longitude at the equator: 110 567 m
- Length of a degree of longitude at the pole: Small, approaching 0 m
- If the Goleta quad is seven-and-a-half minutes of latitude and seven-and-a-half minutes of longitude why isn't it square?

The longitude problem

- Latitude has as a point of origin (the equator) and ends at the poles: distinct locations
- It can be measured directly by observing the sun or the stars
- Can also measure the tropics of cancer and capricorn
- Not so for longitude
- Hard to measure

At first, each country had its own prime meridian
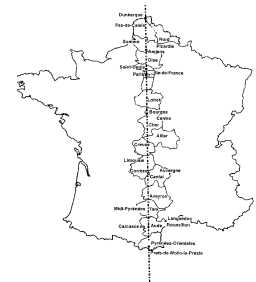
The International Meridian Conference (1884: Washington DC)

"That it is the opinion of this Congress that it is desirable to adopt a single prime meridian for all nations, in place of the multiplicity of initial meridians which now exist."

"That the Conference proposes to the Governments here represented the adoption of the meridian passing through the center of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude."

"That from this meridian longitude shall be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus."

The Prime Meridian (1884)

Now, on to projections

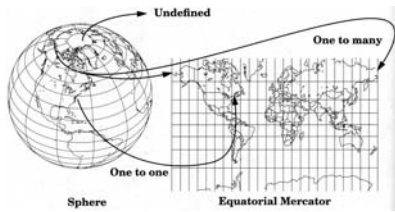Round   Flat

Thinking about projections

Cylindrical   Azimuthal   Conical

Thinking about projections

- Mathematical (and digital)
- Input is long/lat pair (λ, ϕ)
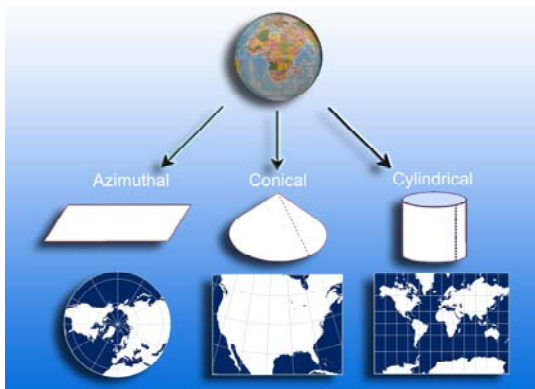- Output is (x, y) coordinates on paper

Again, mathematically

$$x' = Rs \, (\lambda - \lambda_0)$$

$$y' = Rs \log \left(\tan \left[\frac{\pi}{4} + \frac{\phi}{2} \right] \right)$$

We already know R and s

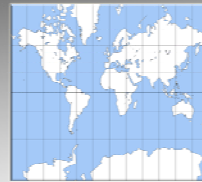## Map projections: Form

Map projections: Aspect

Secant vs. Tangent

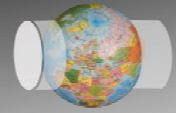## Secant Cylindrical Projections

During the projection transformation

- We have to distort the 3D earth
- We reduce scale (generalize)
- We make break lines (interruptions)
- We distort scale
- We distort area
- We distort directions

No flat map can be both equivalent and conformal

Map Projections : Summary so far (1)

- The second important cartographic transformation is the projection
- Globes are round, maps are flat
- There are 180 degrees of latitude and 360 of longitude
- It is easy to measure latitude, harder for longitude
- The prime meridian was standardized in 1884 at Greenwich
- Map projections can be created mechanically or mathematically

Map Projections : Summary so far (2)

- We can project onto a plane, a cylinder or a cone
- We can orient the projection as equatorial, oblique or transverse
- We can make the projection tangent or secant
- No flat map can be both equivalent and conformal