{01} The map

Map Interpretation & GPS
Spring 2010
M. Pesses

Tonight

‡ What makes a map
‡ Measuring the Earth

What does a map do?

‡ Shows where things are
‡ Shows spatial (topological) relationships
‡ Shows patterns, differences, etc.

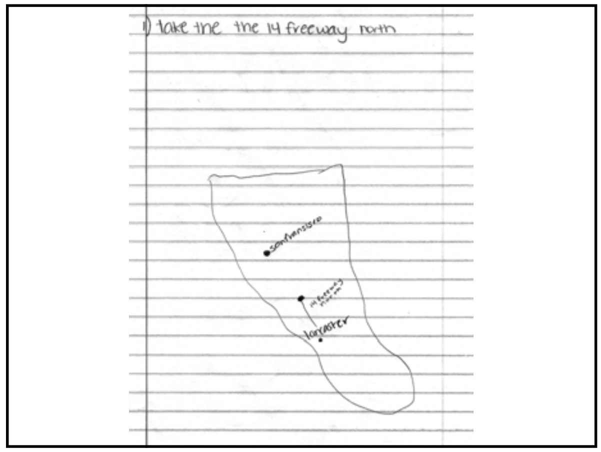
Relative space

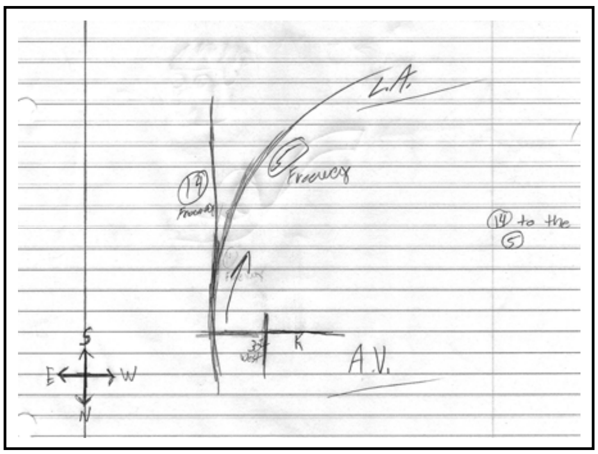
‡ What about things that aren't physical?
‡ Networks, flows, mobilities…
  – *Can we map the migration routes of birds?*
  – *Can we map the Internet?*

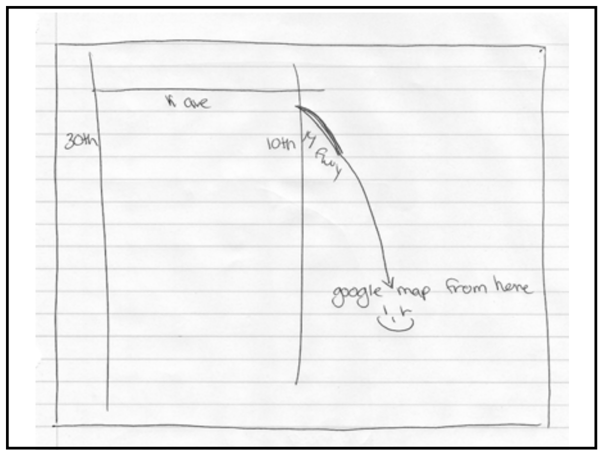
Types of maps

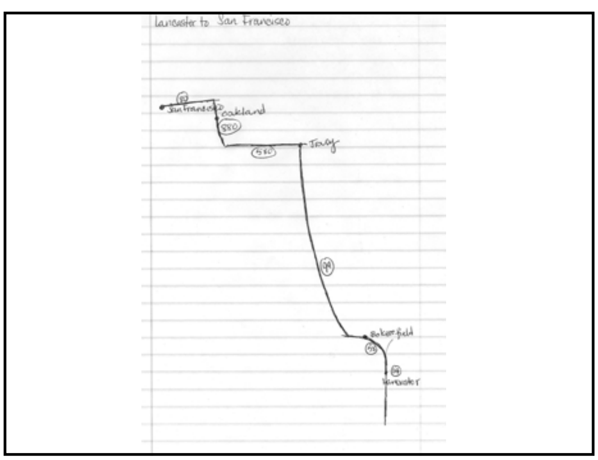
‡ **Mental Maps**
  – How do we see the world?
  – The text focuses on preference of place…
    † Really how we *imagine* the world, regardless of preference
  – What biases do we bring when we draw a map?

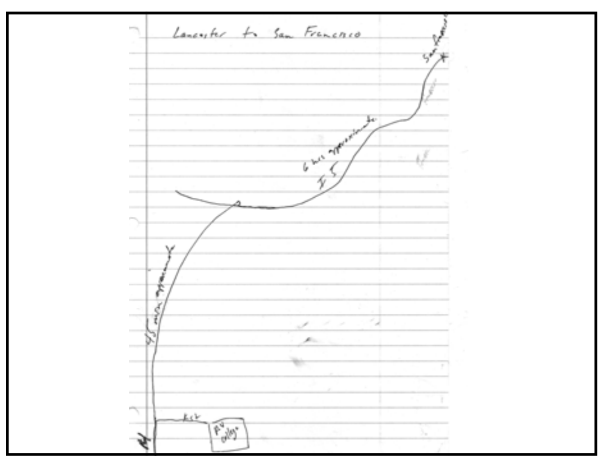

OREGON
CALIFORNIA
POPULATED PLACES
TRANSPORTATION
PHYSICAL FEATURES
NEVADA
UTAH
ARIZONA
MEXICO
MOJAVE DESERT
© Nations Online Project
San Francisco
Los Angeles
San Diego

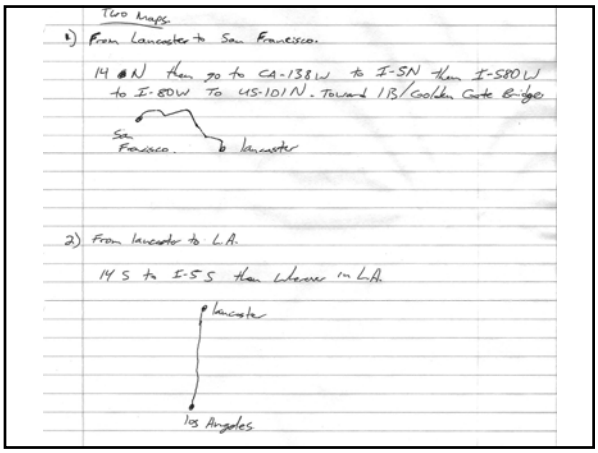

1) take the the 14 freeway north
Lancaster

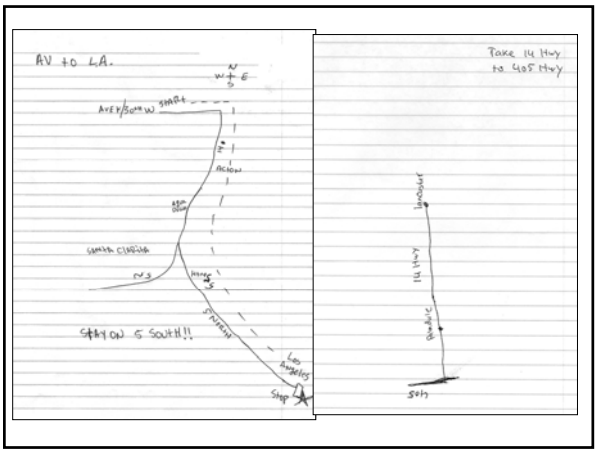

L.A.
5 Freeway
14 Freeway
14 to the 5
K
A.V.
S
E
W
N

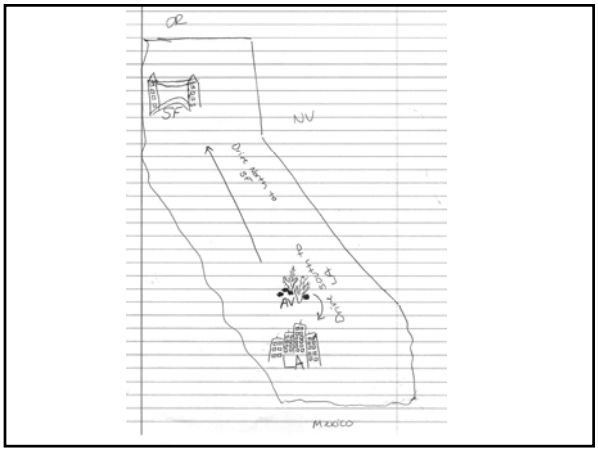

K ave
30th
10th
14 Fwy
google map from here


Lancaster to San Francisco
oakland
580
99
Bakersfield


Lancaster to San Francisco
I-5
14



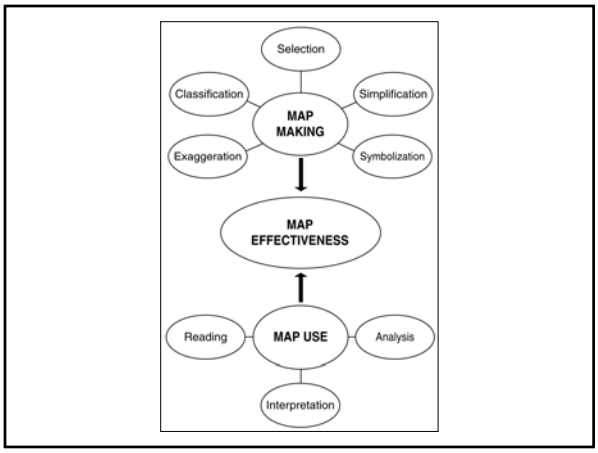




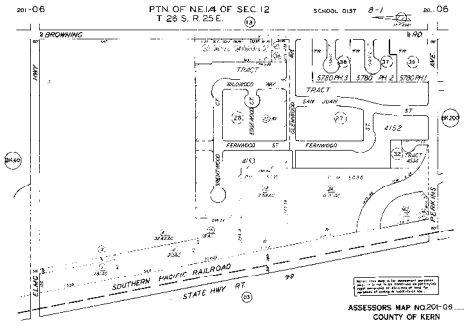
Recorded Maps

‡ Traditional
- Hard copy

‡ Digital
- Geographic Information Systems (GIS)

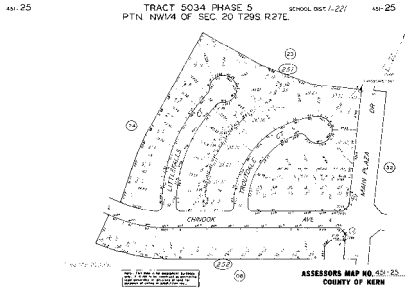


Orientation

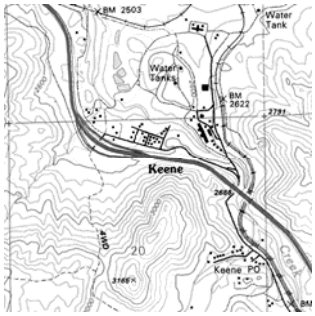


Planimetric

Cadastral

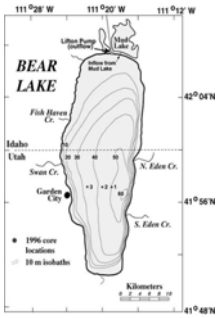


Topographic



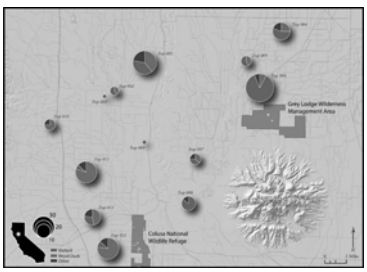
Bathymetric

‡ Shows ***depth*** rather than altitude



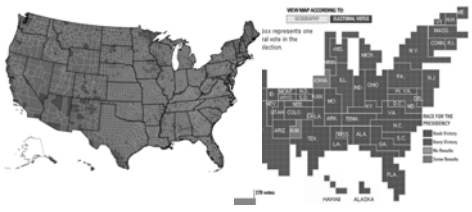
Thematic

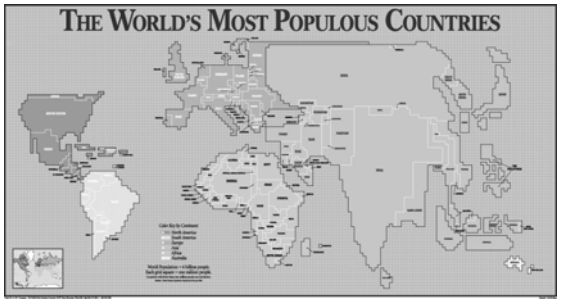
‡ Tells a story

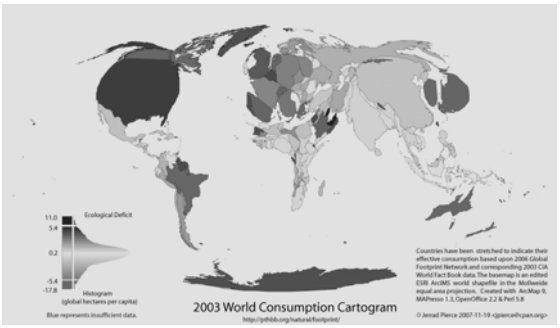


Cartograms

‡ Represents spatial data in new, powerful perspectives

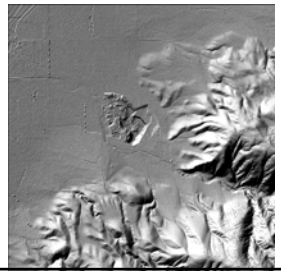






Remote Sensing

‡ Aerials, digital elevation models (DEM), vegetation images

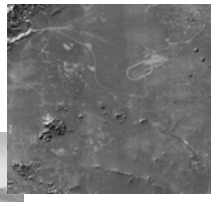


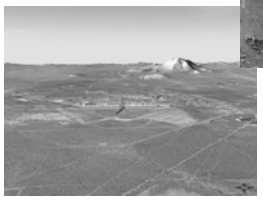
Remote Sensing

‡ With GIS and other software we can easily overlay different types of remote sensing data to begin to make a map

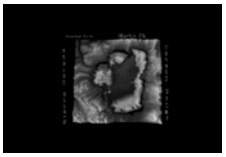
Remote Sensing

‡ These DEMs can also allow for 3D models of the Earth's surface





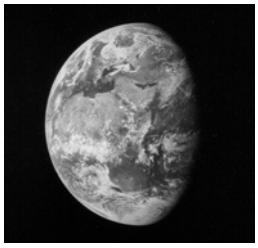
Remote Sensing



Geodesy

Sphericity

- **Geodesy**
  - Science dealing with the measurement of the shape of & locations on the Earth
- *What shape is the Earth?*



Columbus

- In 1492…
- Not the first to think Earth was round
  - Accepted idea around AD 100

Pythagoras

- Greek Mathematician/ Philosopher
  - 580-500 BC
  - Observed Earth was round
  - But how?

Aristotle

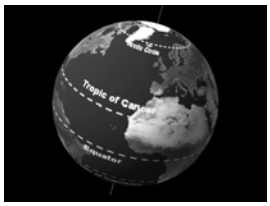
- ~ 400 BC
- 3 observations
  - Ships sailing over the horizon
  - Different stars
  - Lunar eclipse

Eratosthenes

- Librarian at Alexandria, Egypt
  - 247 BC

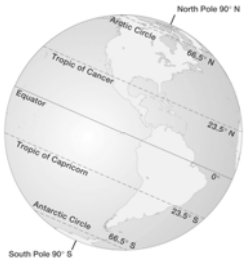
23.5° North

‡ Eratosthenes told that sun was directly overhead a well in Syene, Egypt on June 21st



23.5° North

‡ Summer solstice
- June 21st
- Sun directly overhead the Tropic of Cancer

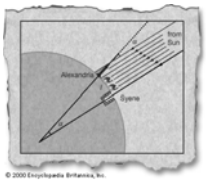


So what?

‡ Eratosthenes new that the sun was not directly overhead in Alexandria on that same day
- Proof that the Earth was round
  - † But he already knew that…

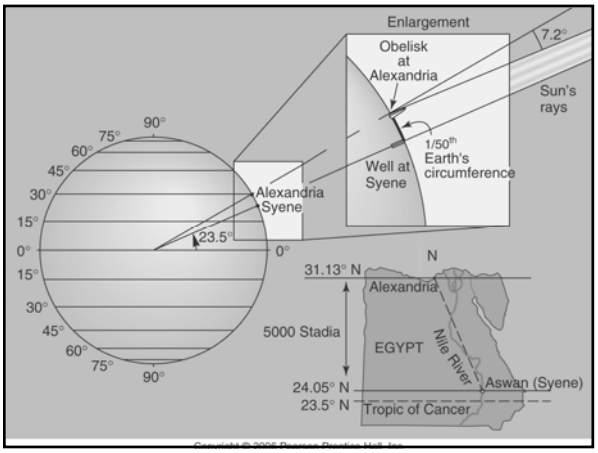
Measuring the Earth

‡ Eratosthenes found that the sun's rays were coming in about 7.2° off of 90°
- Roughly 1/50 of a 360° circle



Measuring the Earth

‡ Measured the distance between the two cities & multiplied by 50
- His circumference, approx. 29,000 miles
- Actually about 25,000 miles



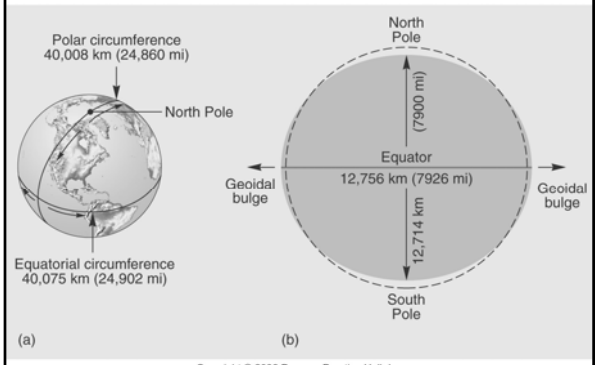
Sphericity

‡ But is the Earth REALLY round?

Newton

‡ If the Earth is spinning on an axis
- Equator moves faster than poles

‡ **Oblate spheroid**
- Centrifugal force at the Equator



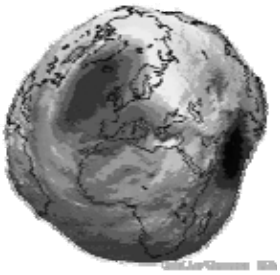
But…

‡ Is it really an oblate spheroid?

Geoid

‡ Literally means "earth shaped"

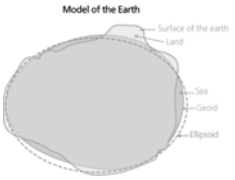
‡ An average sea-level assuming a fluid Earth with Earth's gravitational pull



Geoid

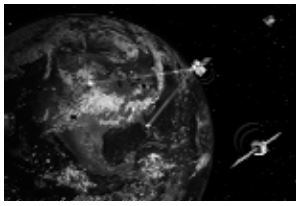
‡ The rock of the Earth is "bumpy"

‡ Sea level is not the same everywhere
- **Mean Sea Level (MSL)** is seeking equilibrium with gravity



GPS

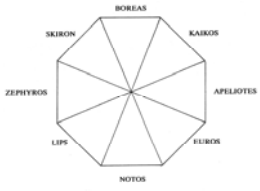
‡ Global Positioning System (GPS)
‡ Up to cm accuracy



Cardinal Direction

‡ North, South, East, West
  – Further refined to 32 directions
  – "Boxing the Compass"

Wind Direction



Wind Direction

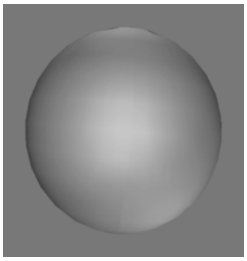
Later expanded by the Italians to 16 directions
  – *Sirocco per levante poco*
    † SE & a little E

The Compass

‡ Points "north"
‡ Crucial to human development

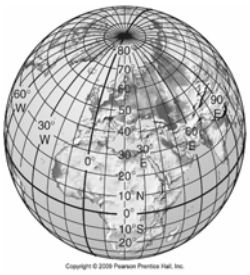
Location

‡ *How does one know where he or she is on a sphere?*



Longitude & Latitude

‡ Lines of longitude and latitude
- An imaginary grid that covers the surface of the Earth



DMS

‡ Reported in Degrees, Minutes, Seconds (DMS) & the direction.
- 360° (degrees) around a sphere
- 60' (minutes) in a degree
- 60'' (seconds) in a minute
- Example: 45° 36' 12'' N

DMS

‡ Developed by Ptolemy, 2nd Century AD
- *But the ability to accurately find one's DMS didn't come for 1700 years!*

Decimal Degrees

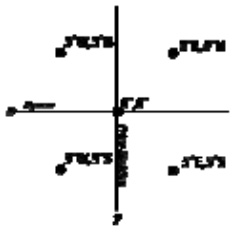
‡ An easier way to report lat/long with computers

‡ DMS = 45° 36' 12'' N

‡ Decimal Degrees (DD) = 45.61015° N

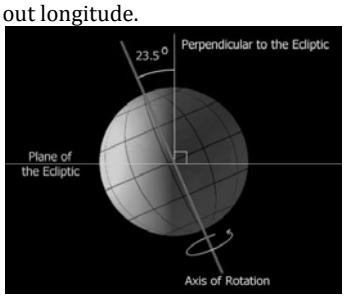
Coordinate System

‡ A grid used to organize a map or globe for the purposes of determining location and/or distance.

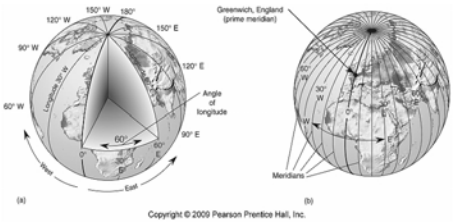


Lines of Longitude

‡ The Earth rotates on its axis; we use this to map out longitude.

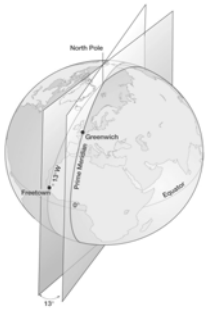


Lines of Longitude



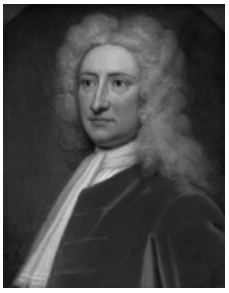
Lines of Longitude

- **Meridians**
- **Great circles**
  - The shortest route between to points on a sphere.



Origin Point

- The **prime meridian** runs through Greenwich, England
- Given the numerical value of "0".



Origin Point

- Measured in degrees, to the ***east*** and the ***west*** from Greenwich.
  - **The direction is crucial!**

Finding Longitude

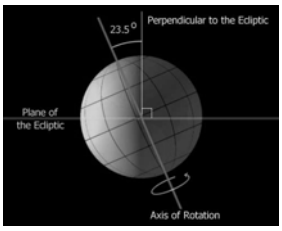
- It's one thing to look up longitude on a globe, but what about finding it on a ship in the ocean?

Finding Longitude

- Determined by measuring the difference between **noon** at the **prime meridian** & **noon** at the meridian in question

Rotation

‡ The sun "moves" through the sky every 24 hours, travels 360° (360/24 = 15° per hour)



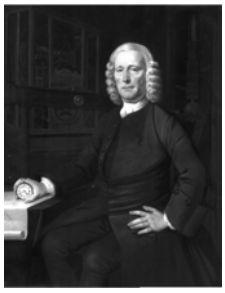
Finding Longitude

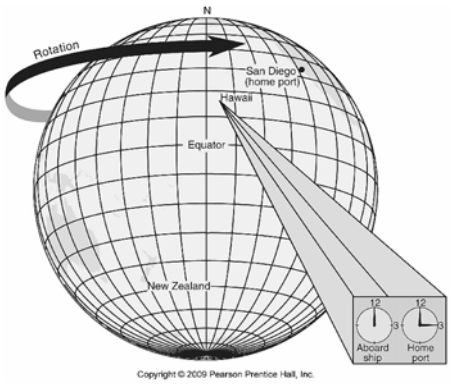
So…

‡ 3pm in Greenwich & noon at your location means you are at 45° West
- 3 hours x 15 degrees = 45 degrees traveled

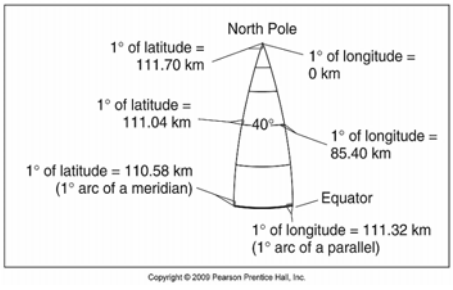
But can you see the problem with this technique?

Harrison's Chronometer





Meridians are not parallel!



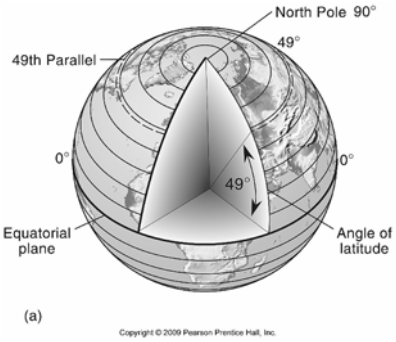
Lines of Latitude

‡ Also called **parallels**

‡ Gives us **North** and **South** coordinates

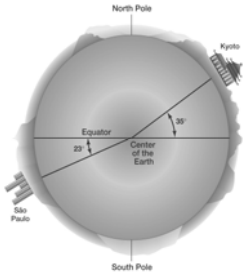
‡ Parallels (with one exception) are ***small circles***

Lines of Latitude

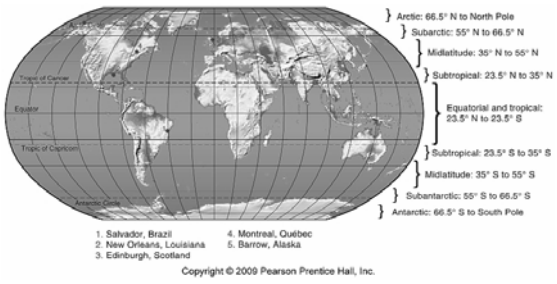


Lines of Latitude

‡ Latitude is the measured angle north or south of the Equator



Latitudinal Zones



Finding Your Latitude

‡ Angle measured between the horizon and solar noon

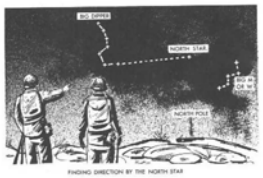
‡ Corrected with celestial charts and the ***analemma***

Finding Your Latitude

‡ We can use other stars too

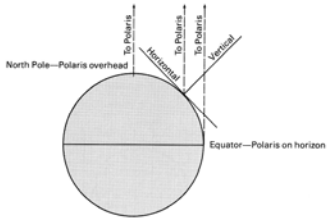
‡ **Polaris**

- The **North Star** – directly over the North Pole
- **Southern Cross** in the Southern Hemisphere



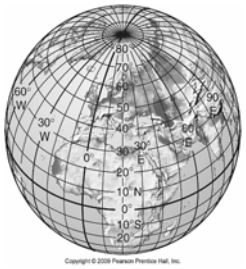
Finding Your Latitude

‡ Measure the angle between Polaris and the horizon to find your latitude



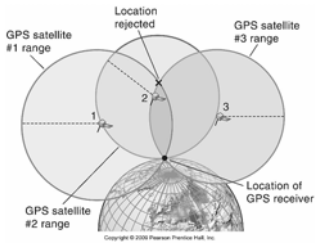
The Graticule

- This system of lat/long is called the **graticule**
- Parallels & meridians cross at right angles (90°)



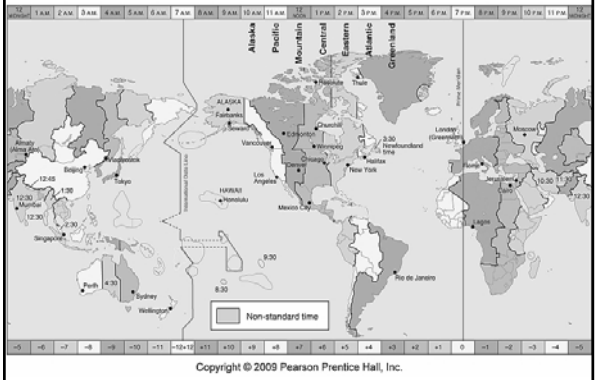
GPS

- **Global Positioning System (G.P.S.)**
- Has made finding your location much easier



Time Zones

- We divide up the globe into 24 time zones
  - 15 degrees wide
- Time "starts" at Greenwich
  - Los Angeles is +8 (8hrs earlier than Greenwich Mean Time)



International Date Line

- Where the day "officially" begins
- Time moves westward as the Earth rotates eastward