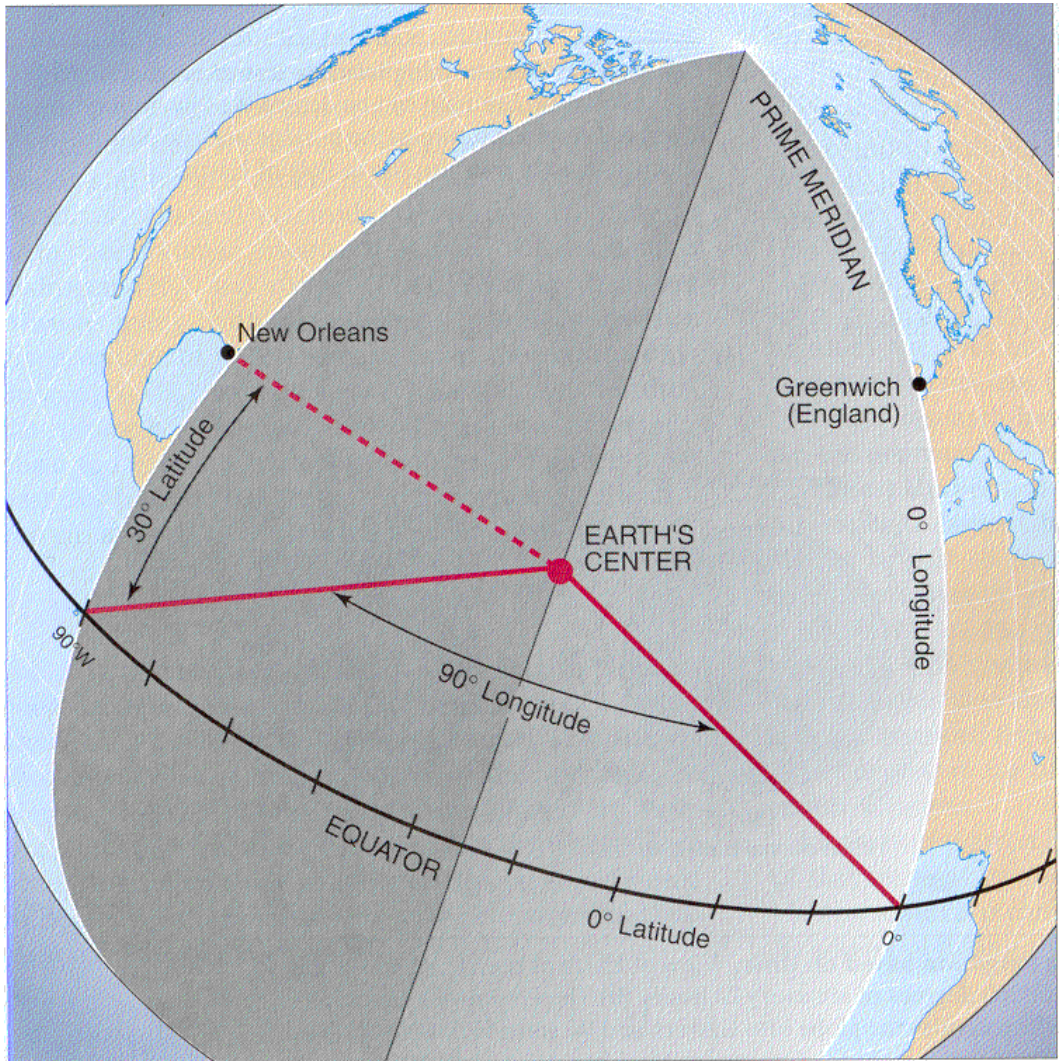
Getting Your Coordinates

AdOc 4060/5060
Spring 2013



Some Important Imaginary Lines on the Earth

Earth's Axis: A line through the North and South poles about which the Earth rotates once every 24 hours. (right-hand rule)

Parallels of Latitude: Parallel circles centered on the Earth's axis; -90 to 90 degrees.

Equator: The largest parallel of latitude, located midway between the poles and defined to have a latitude of zero degrees.

Tropic of Cancer: The northernmost latitude on Earth where the Sun can ever be directly overhead (***Summer Solstice***) located at a 23.5 degrees North. (= tilt angle)

Tropic of Capricorn: The southernmost latitude on Earth where the Sun can ever be directly overhead (***Winter Solstice***) located at a 23.5 degrees South.

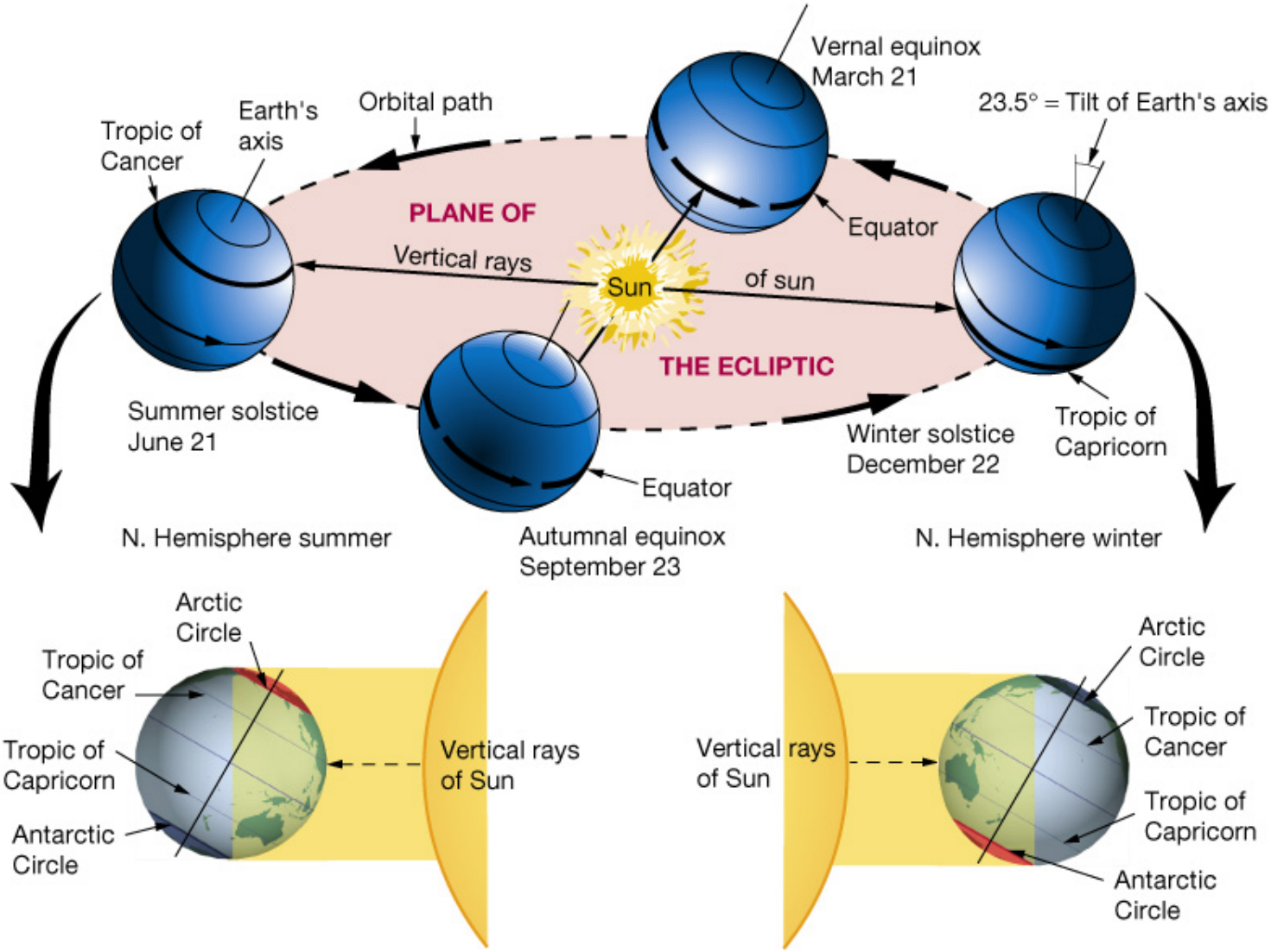
Arctic Circle: The smallest northern latitude for which it is possible to have one or more days with no sunrise or no sunset, at 66.5 degrees North.

Antarctic Circle: The smallest southern latitude for which it is possible to have one or more days with no sunrise or no sunset, at 66.5 degrees South.

Meridians of Longitude: The set of all great circles that pass through both the North and South poles. They are *not* parallel, but cross at the poles.

Prime Meridian: The meridian through Greenwich, England defined to have a longitude of zero. Note that there is no "natural" choice. Defines GMT.

Correcting Latitude for Sun's Declination

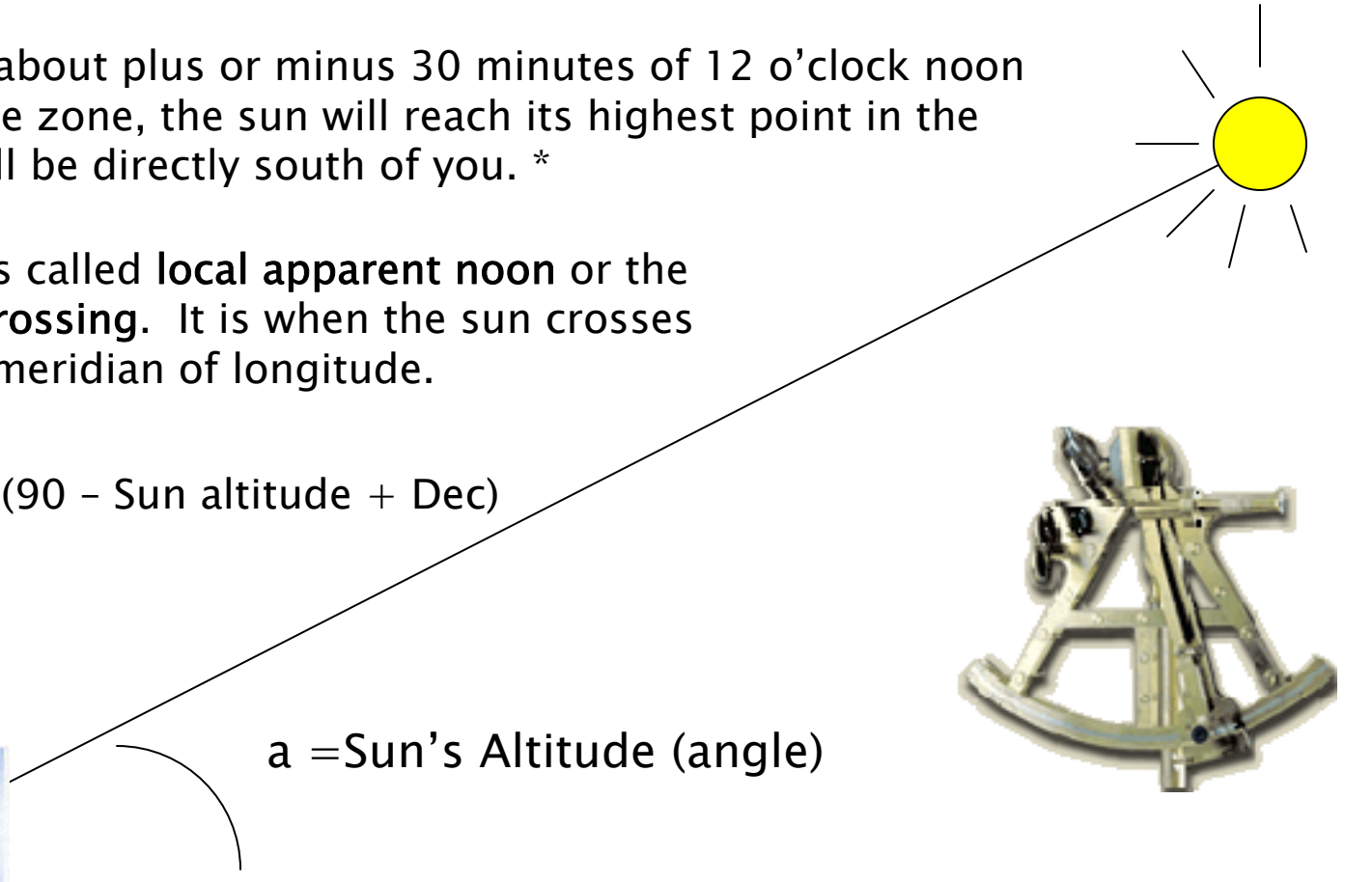


Using a Sextant to Find Latitude

Sometime about plus or minus 30 minutes of 12 o'clock noon in your time zone, the sun will reach its highest point in the sky and will be directly south of you. *

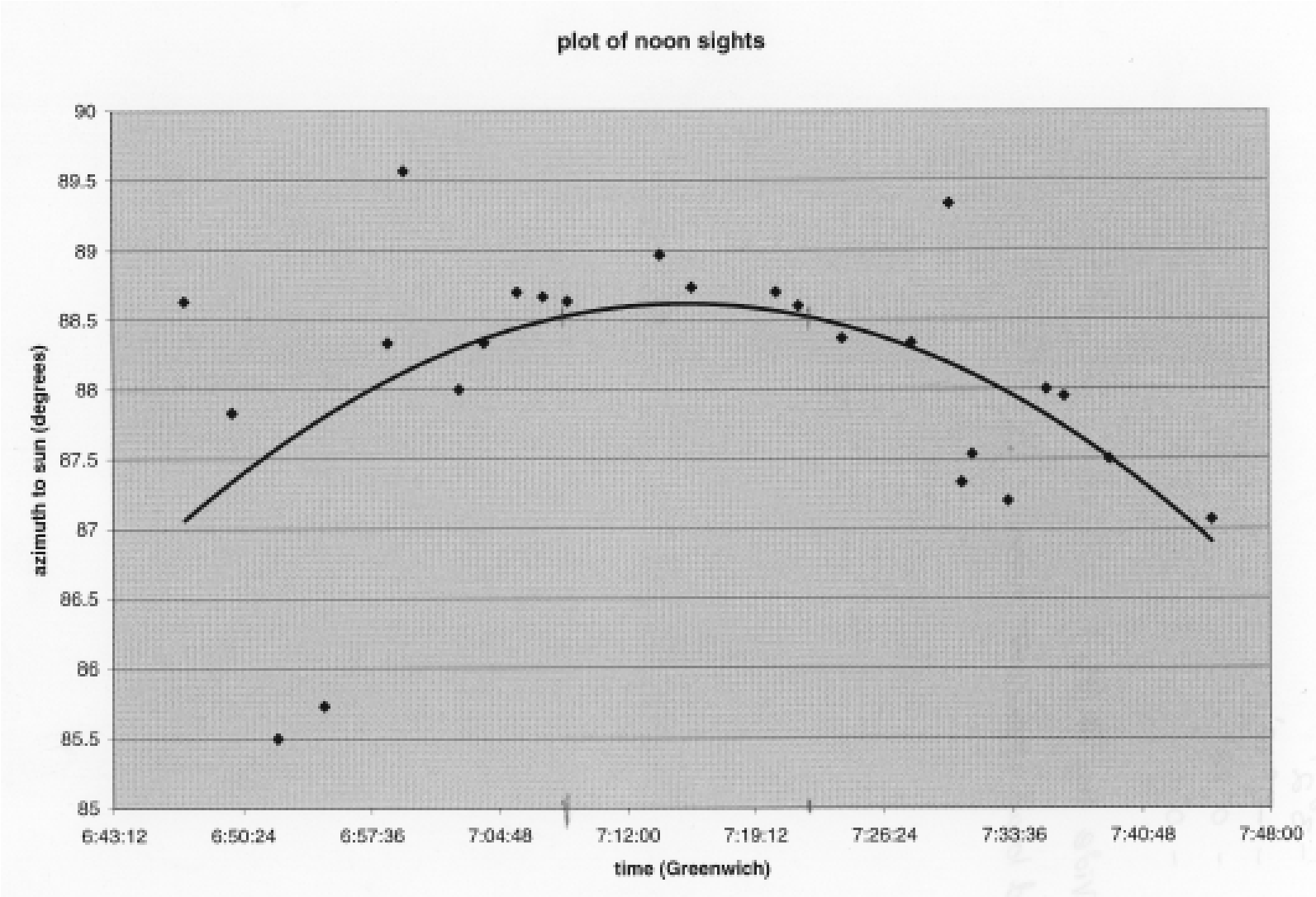
This time is called **local apparent noon** or the **meridian crossing**. It is when the sun crosses your local meridian of longitude.

Latitude = (90 – Sun altitude + Dec)



** Assuming that you are in the northern hemisphere.*

Noon Sight Plot (of yore)



Using Time to Find Longitude

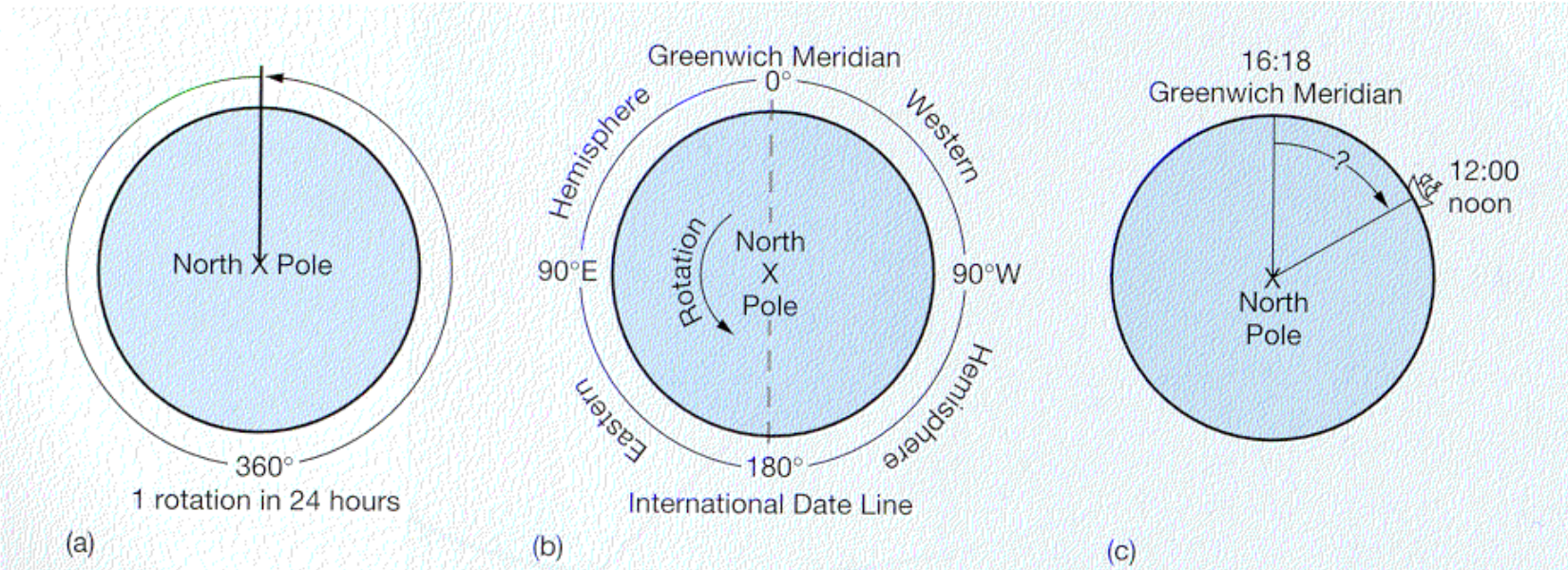


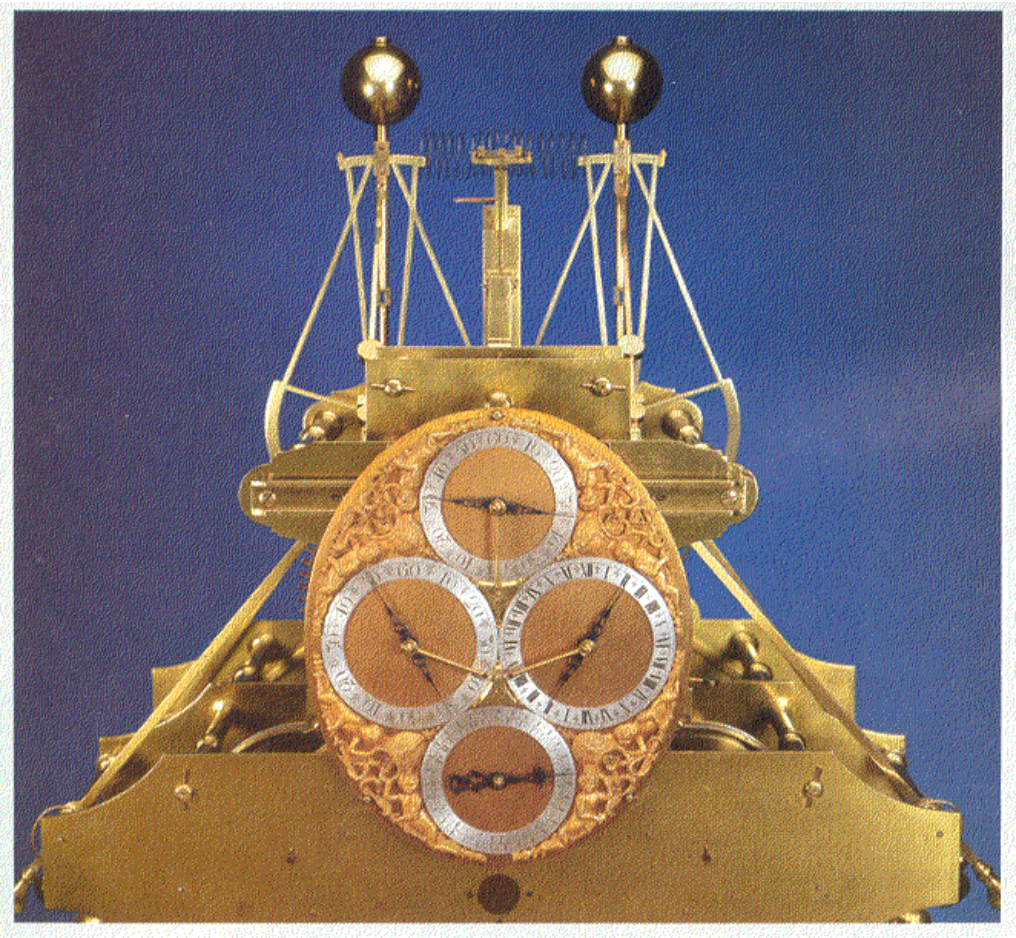
Figure A3–4 Determining longitude based on time. View of Earth as seen from above the North Pole. **(a)** Earth rotates 360 degrees of arc every 24 hours. **(b)** The Greenwich Meridian is set as 0 degree longitude, which divides the globe into Eastern and Western Hemispheres. The International Date Line is 180 degrees from the Greenwich Meridian. **(c)** An example of how a ship at sea can determine its longitude using time.

360 degrees in 24 hours = 15 degrees/hour

Longitude = 15 x (Greenwich Noon – Local Apparent Noon)

(Both times measured in GMT.)

John Harrison's Chronometer

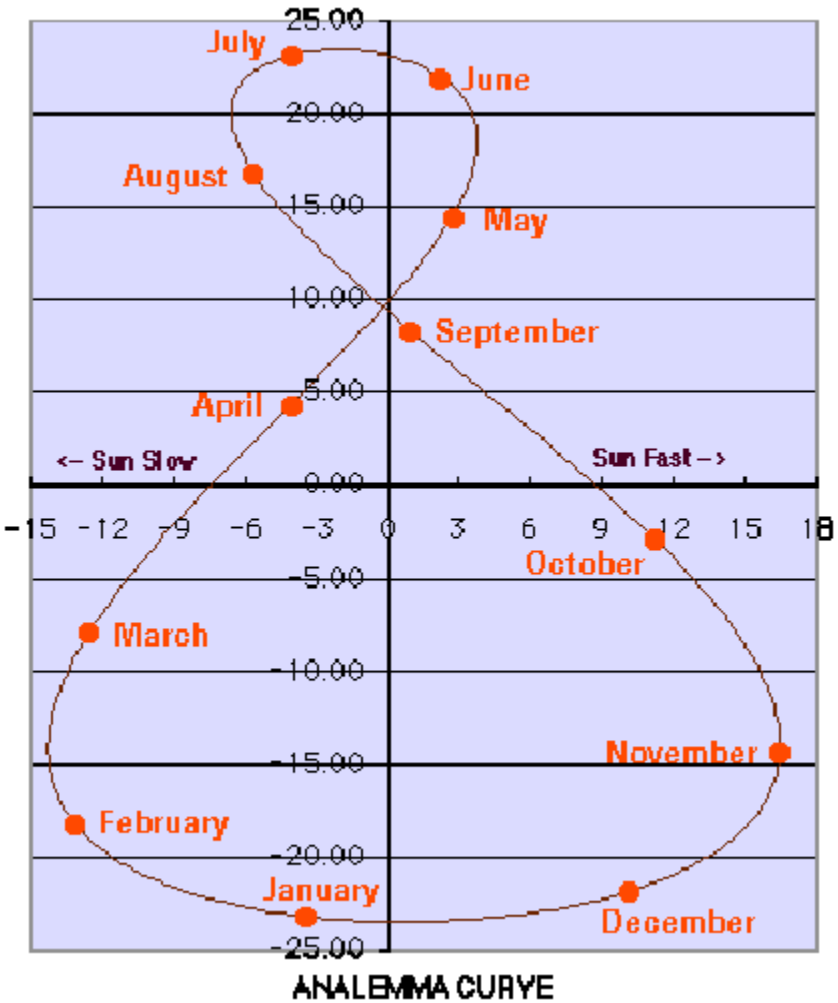


Harrison's first chronometer had a helical balance spring that remained horizontal and very accurate, even on a moving ship.

He won a monetary prize of 20,000 British pounds for solving the problem of finding longitude at sea.

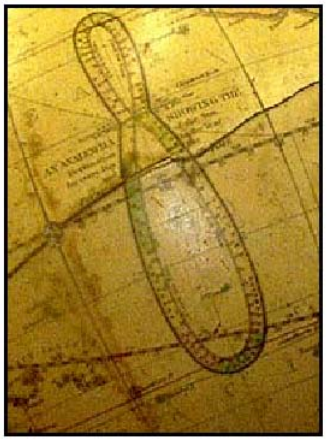
Learn more about Harrison's accomplishment on the NOVA site:
http://www.pbs.org/wgbh/nova/longitude/

Correcting Longitude for the Analemma: The Equation of Time

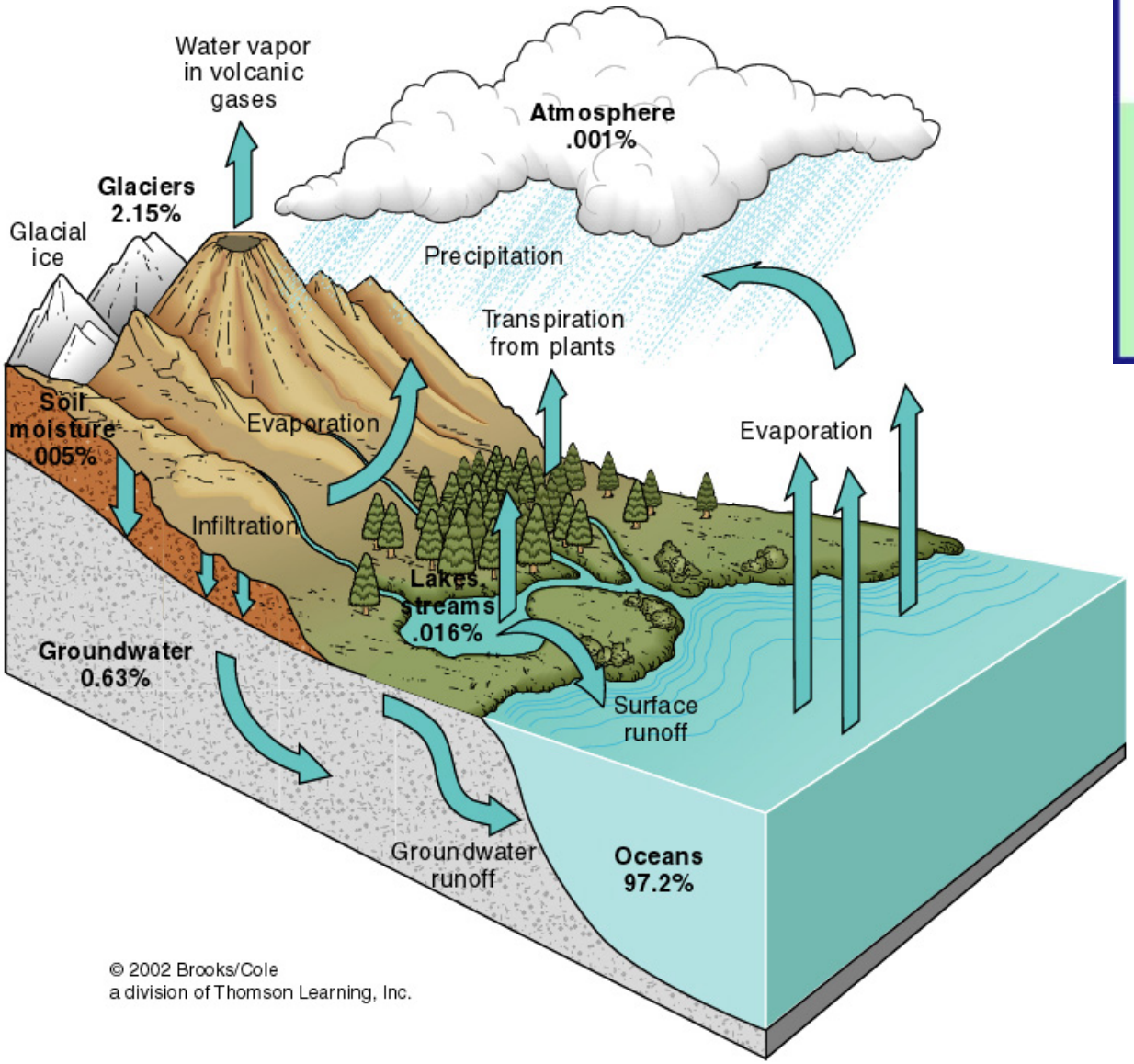


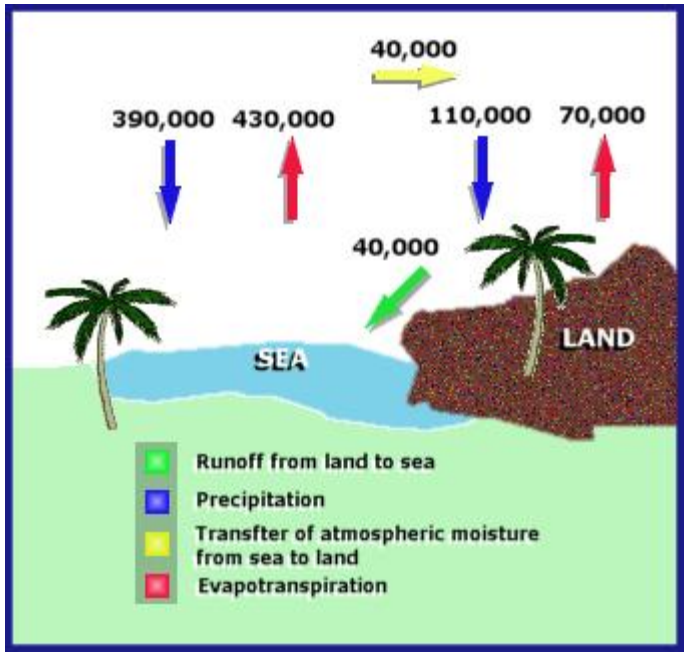
Since Earth's orbit around the Sun is elliptical vs. circular, we must make a small correction to longitude.

For more details, visit:
http://www.analemma.com



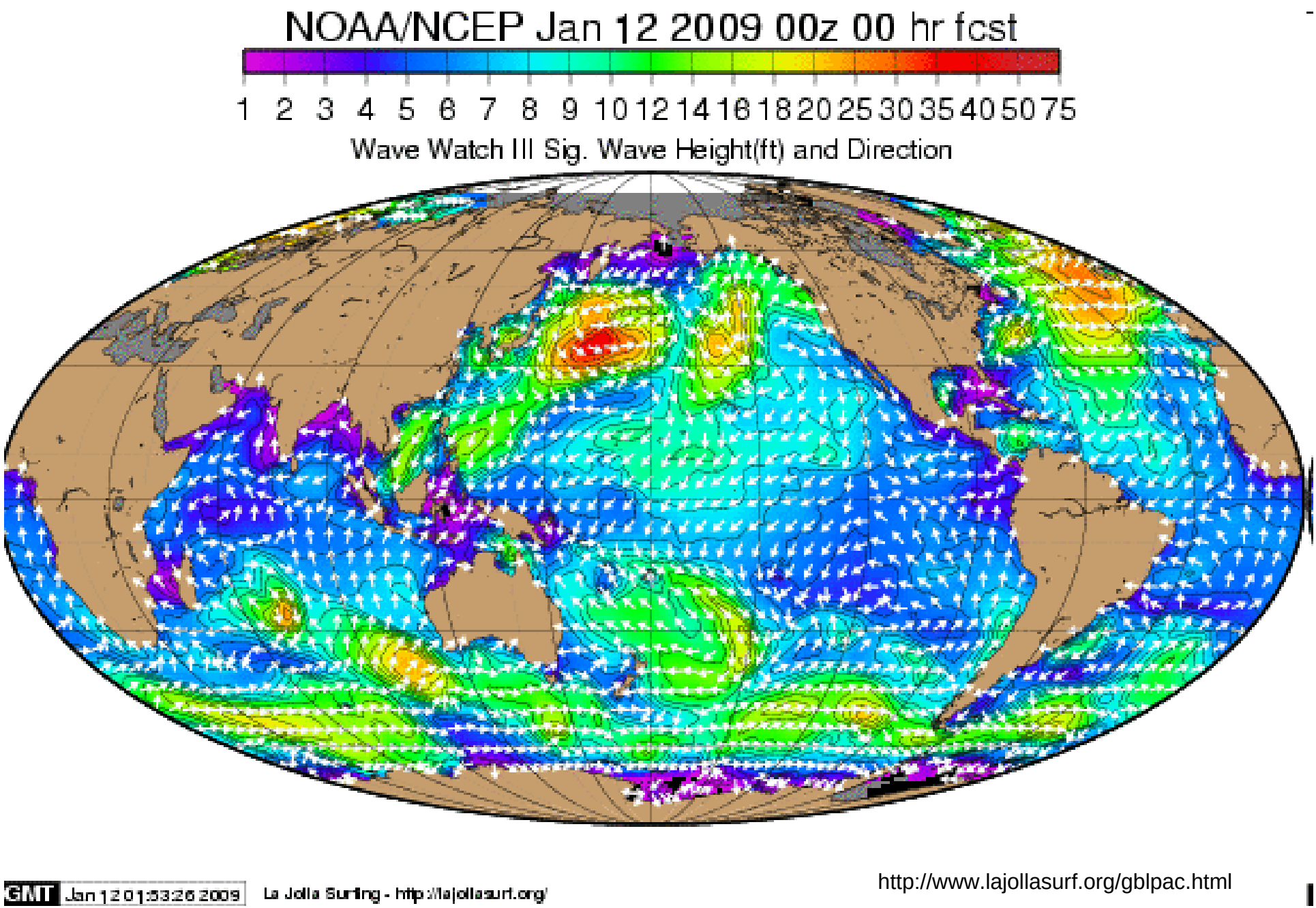
I. Scale of the oceans
A. Water at Earth's surface



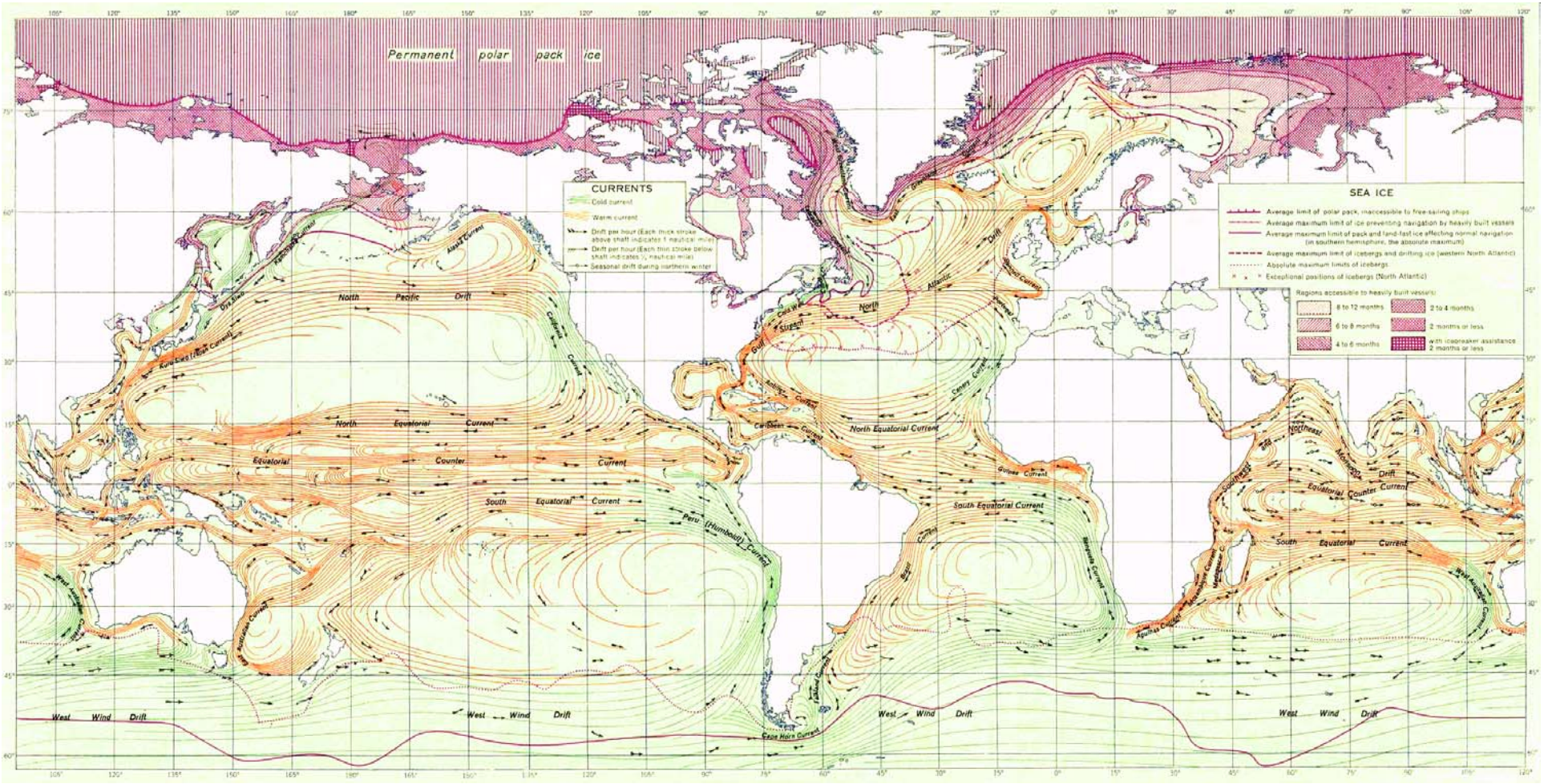


In km3 /y (Fig after Gleick)

- water constantly cycles through different 'reservoirs' cover 71% of Earth's surface
- average depth: 3.8 km *(aspect ratio like a sheet of paper)*
- average temperature: 3.9°C
- average salinity: 34.5 g/kg (3.45%)

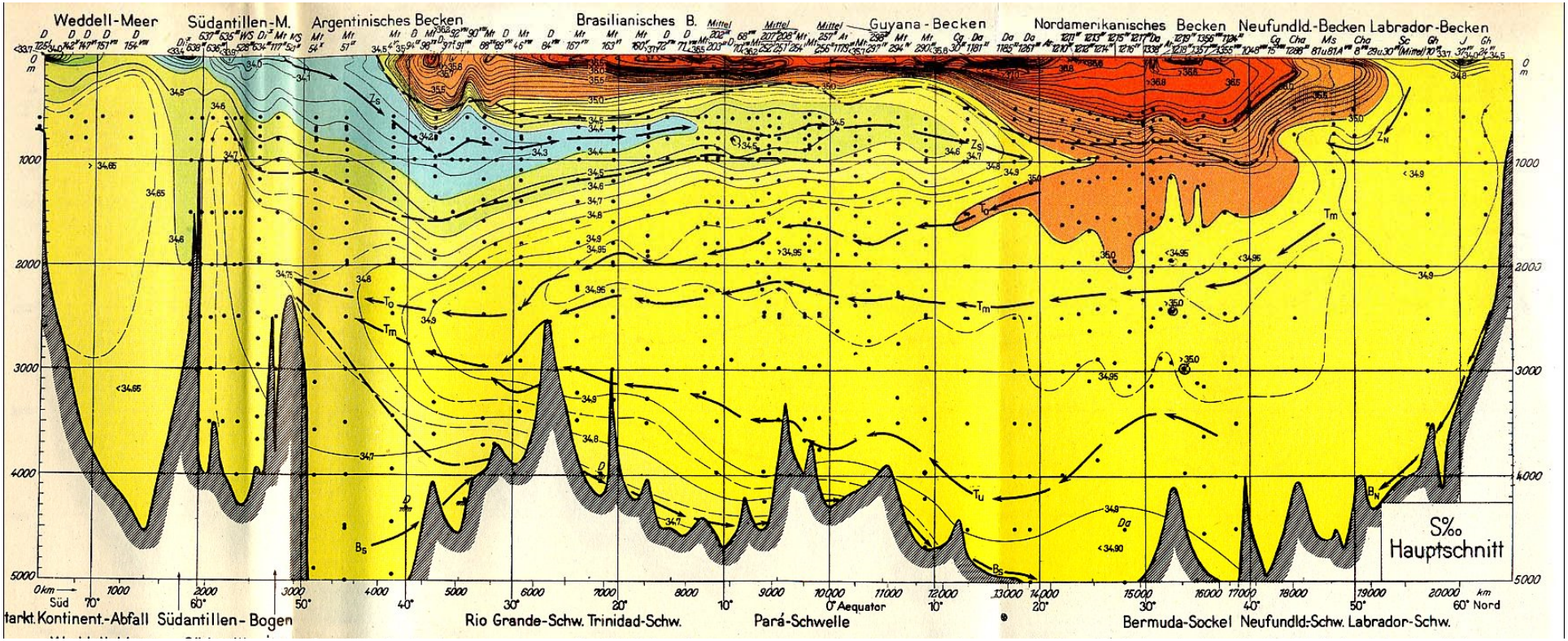


http://www.lajollasurf.org/gblpac.html



http://en.wikipedia.org/wiki/File:Ocean_currents_1943_(borderless)3.png

By depths …


Weddell-Meer
Südantillen-M.
Argentinisches Becken
Brasilianisches B.
Guyana-Becken
Nordamerikanisches Becken
Neufundld.-Becken
Labrador-Becken
S‰
Hauptschnitt
Kontinent.-Abfall
Südantillen-Bogen
Rio Grande-Schw.
Trinidad-Schw.
Pará-Schwelle
Bermuda-Sockel
Neufundld-Schw.
Labrador-Schw.
0° Aequator
60° Nord

Operationally …

- seawater very conductive to electricity (shorts) and very corrosive (rust)
- organisms may colonize (biofouling)
- dangerous to deploy instruments (rolling, pitching)
- difficult to perform shipboard experiments and analyses

• Inaccessible: very deep (av. 3.8 km): instruments on long wires (time, drift, breakage, tangles)

• Pressure increases by 1 atm for every 10 m (compare to outer space): submersibles: small, thick, spherical crew chambers; most seafloor exploration done remotely

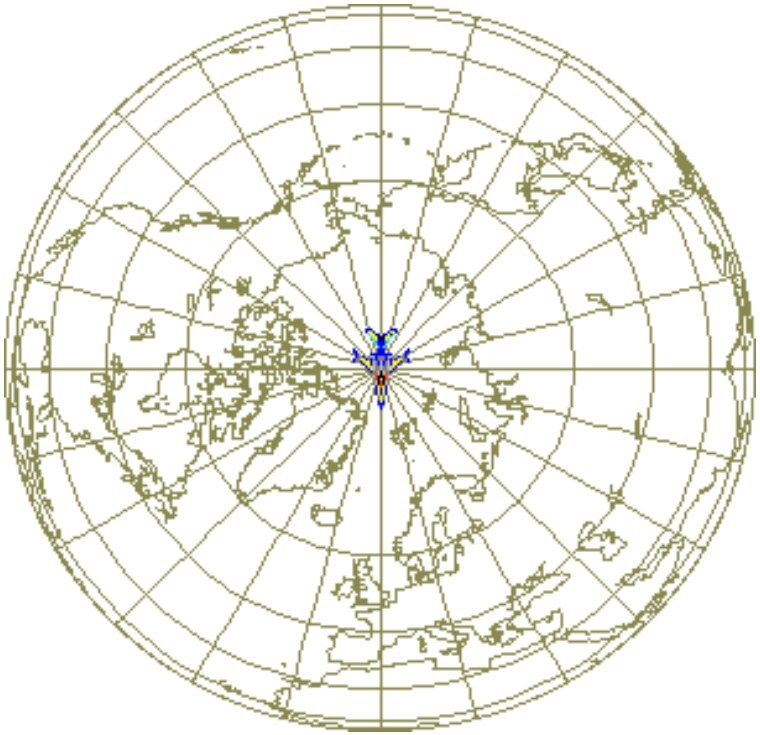
Coriolis effect

• the rotation of Earth causes moving objects or fluid parcels to be deflected from their initial course

• curve to right in Northern Hemisphere
• curve to left in Southern Hemisphere

• effect increases with latitude
• = 0 at equator

• the movement is termed *apparent*, because it depends on the rotating frame of reference



Coriolis Effect Movies

Merry-go-round
http://www.youtube.com/watch?v=mcPs_OdQOYU

Coriolis effect

• affects moving objects and fluids with little frictional contact with the Earth, especially air and ocean currents

• the Coriolis "force" associated with a moving fluid is perpendicular to that fluid's horizontal motion (*90° to the right in NH*) with a magnitude of:

$$2\Omega\sin\phi * V$$

Ω = Earth's angular velocity
ϕ = latitude
V = fluid's horizontal velocity
$2\Omega\sin\phi$ is also known as the Coriolis parameter, f

• the "force" therefore increases with latitude and the fluid's velocity