Chapter 3- Models of Earth

I. Modeling the Planet

A. Maps can be constructed using different angles of view projections. A projection is a 2-D representation of a 3-D world. The following are examples of map projections:

Polar : accurate at the poles

1. Gnomonic Maps or planar projections. This kind of projection is made as if a sheet of paper has been laid on a point on the Earth's surface, often one of the poles. Although it accurately shows the shortest distance between two points, it distorts landmass shapes away from the center point.

Accurate at the equator

2. Mercator Maps are maps which stretch out the land near the poles so that both latitude and longitude lines are parallel. By making the lines straight, land around the poles is distorted.

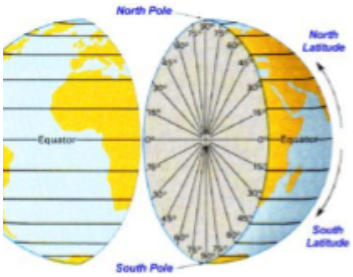
Accurate mid latitudes

3. Polyconic Maps are maps which show either the Northern or Southern Hemisphere projected on a cone shape then laid flat.

4. The best general map projection is the globe. It is closest representation of the Earth.

B. Since the surface of the earth is so large man has invented a system to locate points on the earth's surface. The System is known as latitude and longitude.

1. Latitude is a set of lines which run parallel to the equator both north and south of it. These lines are often called parallels.

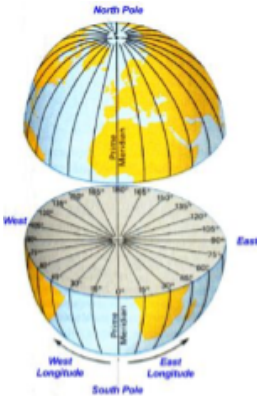


a. Zero degrees latitude is the equator.

b. 90 degree latitude is either the North or South pole

c. Latitude lines measure north & south but the lines run east to west.

2. Longitude is a set of lines which run through the poles.



a. Zero degrees longitude is the prime meridian.

b. 180 degrees longitude is the international date line.

c. Longitude lines run north & south but they measure east and west.

d. Longitude lines are sometimes also called meridians or half circles.

Latitude= 0 degrees to 90N or 90S
Longitude = 0 degrees to 180 E or W

3. Points can be located by identifying the intersections of longitude and latitude lines. To do this a set of rules should be followed. They are:

   a. When locating a point or naming a point latitude is reported north or south of the equator first.

   b. When locating a point or naming a point longitude is reported second east or west of the prime meridian.

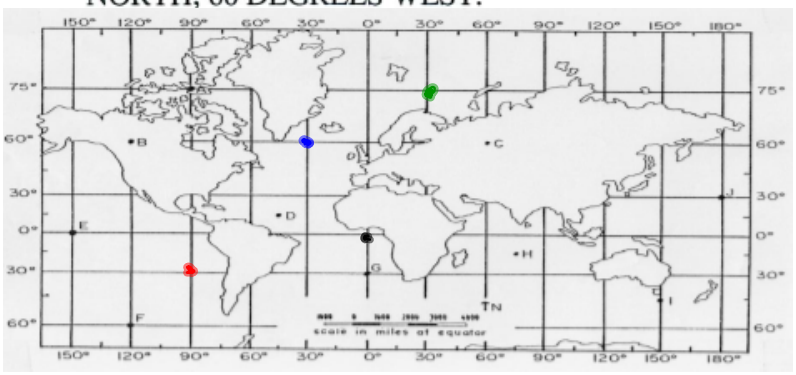
EXAMPLE: THE POINT BELOW MARKED WITH THE X IS 45 DEGREES NORTH, 60 DEGREES WEST.

Black: 0 ° , 0 °

Green: 75° N, 30° E

Red: 30° S, 90° W

Blue: 60° N, 30° W



C. Maps use coded symbols, colors, and numbers to help you read the map.

1. Legend or Key--a legend is the key to the map. It shows the coded symbols and colors used on the map. It also contains important background information on the map such as year printed, area covered, publishers, etc.

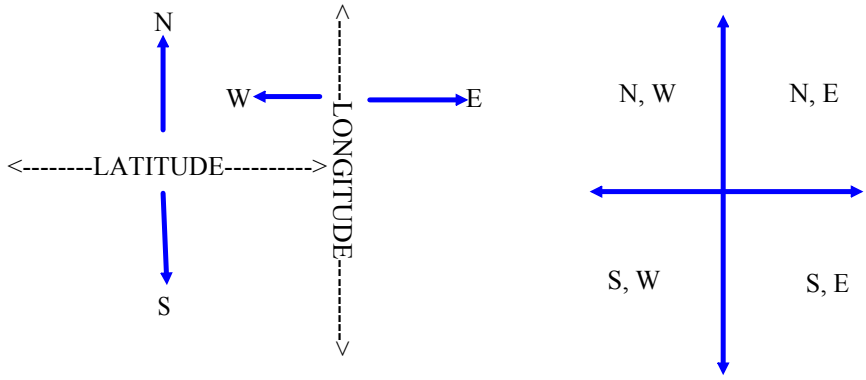
2. Scale--The scale tells you the size of the map compared to the actual size of the land.

   a. Scaling a map allows you to represent a large area on a small piece of paper.

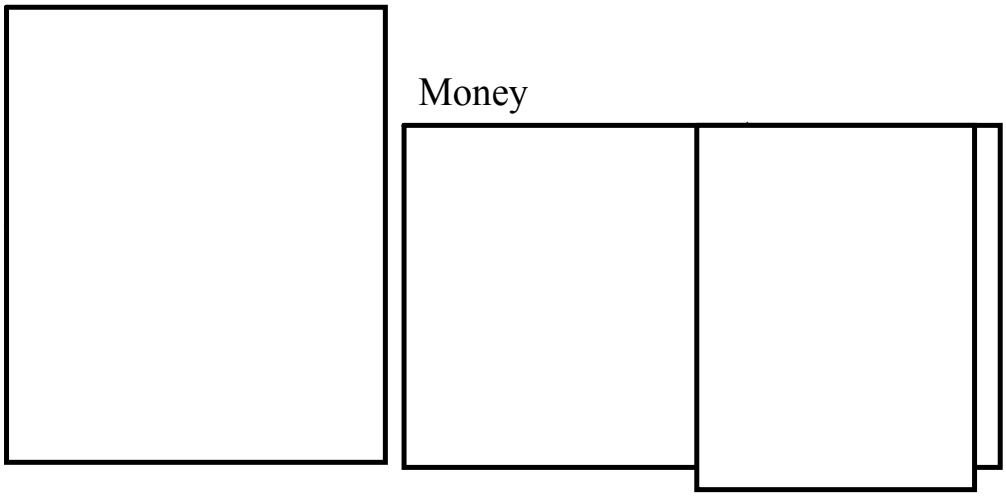
   b. Some scales are written 1 inch = so many miles.

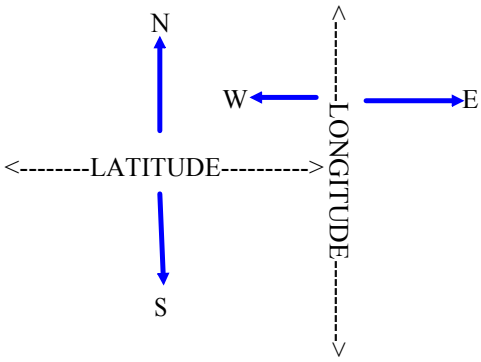
   c. Some scales are written in a ratio of the size of the map to the size of the land. The unit is interchangeable.

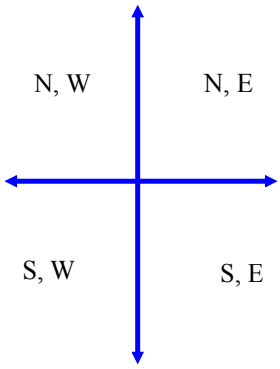
      i. 1 : 600,000 this means that 1 inch on the map equals 600,000 inches on the Earth or 1 meter equals 600,000 meters on the Earth.

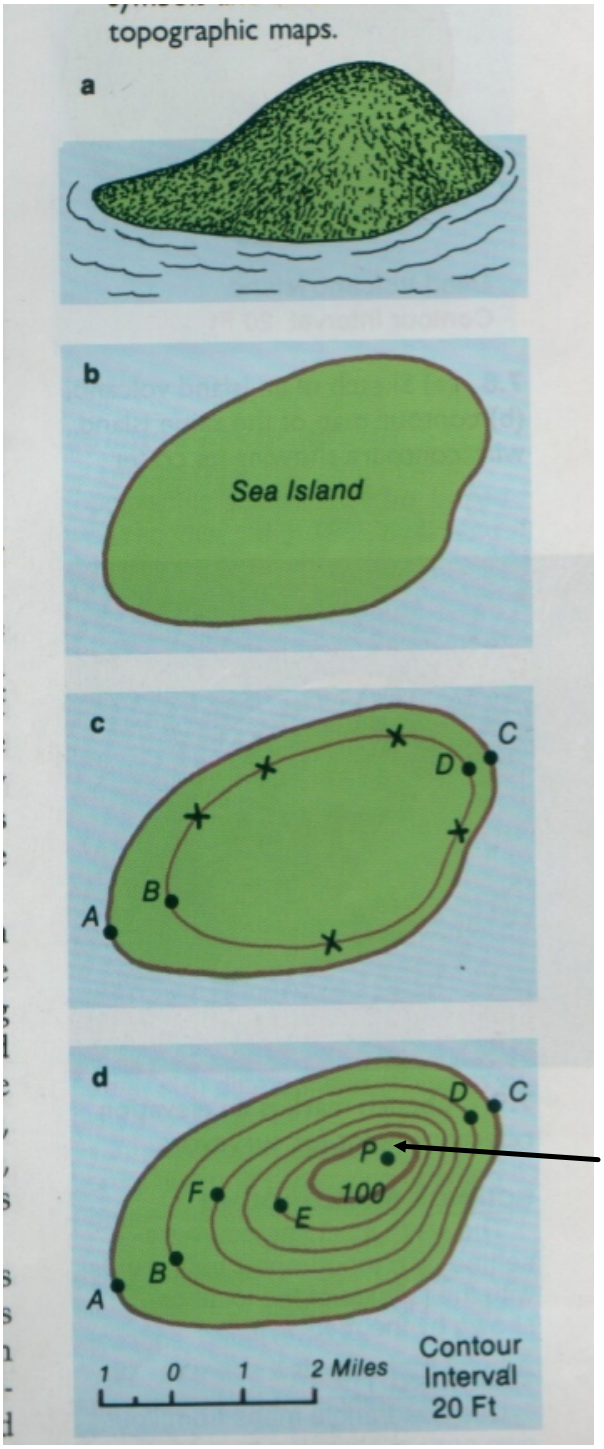

N
W
E
S
<--------LATITUDE---------->
<----LONGITUDE---->
N, W
N, E
S, W
S, E

Large Scale
1:1
1:10
1:100
1:24,000
1:50,000
1:500,000
1:4,560,000
1:7,000,000
1:41,849,600
Small Scale









All topographic map elevations begin at sealevel = 0 ft.

Index Contour: **every 5th contour line that is darker and usually labelled with the elevation**

F= 40 ft

E= 80 ft

P=101 - 119 ft

II. Topographic Maps are maps which show changes in elevation.

A. Some topographic maps show changes in elevation by changes in color.

B. Most topographic maps show changes in elevation by using contour lines.

1. Contour lines are lines which connect areas of equal elevation. Brown lines

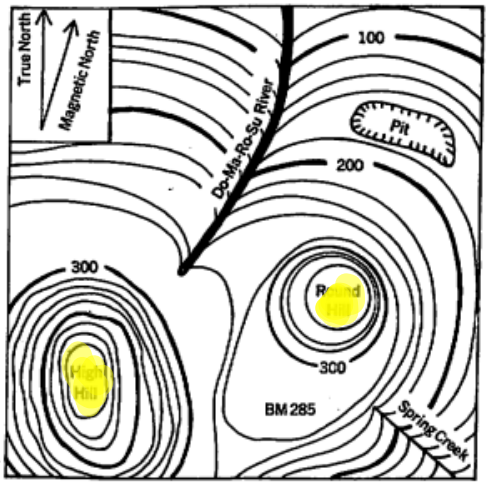
2. **Contour Interval** is the set change in elevation between each line.

3. The closer contour lines are together, the steeper the slope of the land.

4. The farther apart the contour lines are, the more gentle or gradual the slope of the land.

C. Contour lines can also show downward elevation in the case of a depression. In order to show that elevation is going down instead of up, small comb-like lines called "hachures" are placed on each contour line that is going down instead of up. The elevation of the first contour line with hachures is the same as the contour line just before it.

Contour lines form "V"s that point upstream when they cross a river.



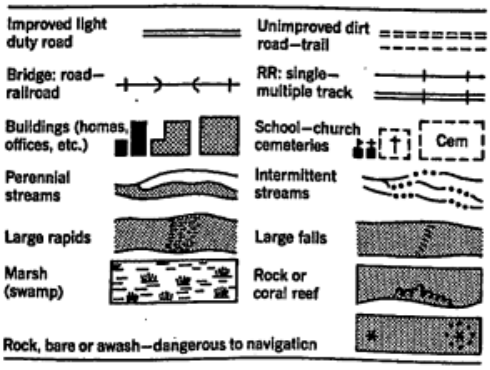


Fig. 10-17. Symbols on topographic maps.

A. Contour interval?
B. Max elevation of Round Hill / High Hill?
C. Direction river is flowing?
D. Number of hills?
E. Elevation of pit?

D. US Geological Survey Topographic maps are generally at a scale of 1:24,000. This works out to a latitude an longitude coverage of 7.5" on a side. The next size up of topographic maps are those with a scale of 1:50,000. It takes four 7.5" maps to make up one 15" map.

Chapter 4: Earth's Structure and Motion

I. Earth's Formation

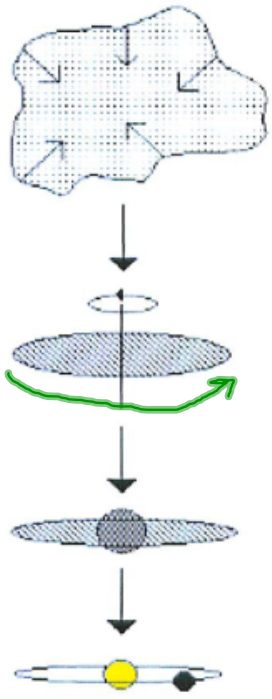
A. Origin of the Solar System

1. The most widely accepted model of the formation of our solar system is called the nebular hypothesis. It suggests that 4.6 billion years ago a great cloud of gas and dust was rotating slowly in space. The cloud was at least 10 billion kilometers in diameter. Shrank to about 5 Billion km

2. As time passed, the cloud shrank under the pull of its own gravity. As it shrank, its rate of rotation increased. Most of the material in the rotating cloud gathered around its center.

3. The compression of this material made its interior so hot that a powerful reaction called hydrogen fusion occurred. At this time, the star we now know as the Sun was born.

Nebular Hypothesis



self–gravity contracts a gas cloud

conservation of angular momentum pulls cloud into a disk

disk begins to rotate

central mass forms (proto–Sun)

centrifugal force balances gravitational forces and a ring forms

ring forms into a planet

90 % of the material in the disk became the Sun

4. About 10 percent of the material in the cloud formed into a giant plate like disk surrounding the sun and extending far into space. Frictional, electromagnetic, and gravitational forces within the disk caused most of the material to condense, forming solid particles of ice and rock. These particles eventually combined into larger bodies called planetesimals.

B. Earth's Size and Shape

1. The planetesimals continued to compress and spin, sometimes colliding with each other and other objects in space. Eventually, these planetesimals developed into planets and moons. Of these objects, the third closest to the sun became Earth.

2. The spinning motion of the young Earth caused it to form into a sphere that bulges at the center. Such a shape is called an oblate spheroid. Earth is not a perfect sphere. difference of 70 miles

3. One way scientists show that Earth is not a perfect sphere is by measuring the weight of an object at several different places on Earth's surface. The weight of an object, in newtons, is the force with which gravity pulls that object towards Earth's center.

4. The closer an object is to Earth's center the heavier it would weigh. The farther away an object is from Earth's center, the lighter it would weigh. If you eliminate this elevation difference, and if the Earth were a perfect sphere, objects would weight the same over all points. Objects weigh slightly more at the poles than at the equator. The poles are closer to Earth's center than the equator due to bulging at the equator. Polar locations are slightly closer to Earth's center than equtorial locations.

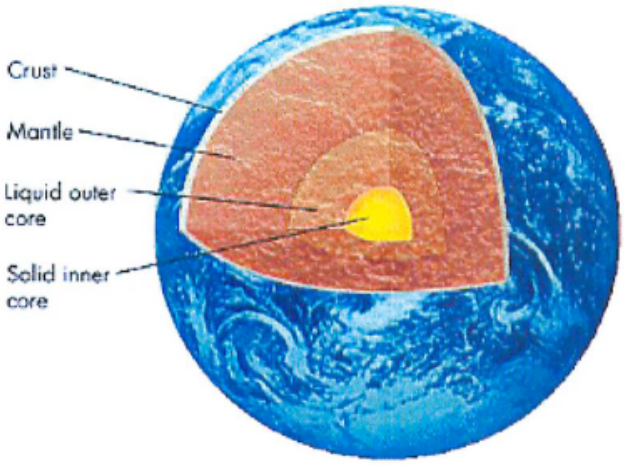
5. The total surface area of Earth is about 510 million square kilometers equal to about 55 continental United States of Americas. Of this area about 149 million square kilometers lie above sea level as continents and islands. Oceans cover the remaining 361 million square kilometers. About 71% of Earth is covered by water and 29 percent of Earth's surface is dry land.

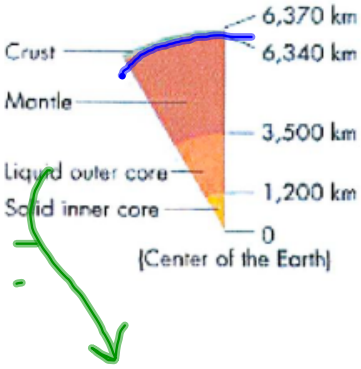
C. Earth's Interior

1. We believe that the surface of Earth looked much like our present moon and was most likely composed of the same material from its surface to its center.

2. The early solar system must have been a very chaotic place. Objects frequently collided with Earth causing impact craters and heating up the surface enough for heavy metals such as iron and nickel to melt.

3. The high density of these materials caused them to sink towards Earth core and settle there while the lighter density materials were forced to surface as Earth's interior separated into layers.





Iron/Nickel

Inner core - composed of solid iron and nickel
Outer core - composed of liquid iron and nickel
Mantle - composed mostly of compounds rich in iron, silicon, and magnesium.
although **solid** behaves as a liquid in some ways (Silly Putty)
Asthenosphere - Thin upper mantle layer that lithosphere floats on.
Crust - thin rigid layer of lighter rock that includes Earth's surface.

Crust / Upper Mantle

$10{,}000^0$ F Earth's Interior
$6{,}000^0$ F Surface of the Sun

D. Earth's Heat

1. Events that gave rise to the formation of Earth generated heat. Some of the heat that caused Earth's layers to form came from meteorite impacts, and some arose as the weight of overlying materials caused compression in Earth's interior. Heat was also generated by the decay of radioactive isotopes.

2. Earth has been slowly losing heat. The amount of heat loss varies from place to place, and from the following reasons:

   a. Some rocks lose heat more quickly than others.

   b. The thickness of crustal rocks varies from place to place. 6 - 60 miles thick

   c. The percentage of radioactive materials on rocks varies.

3. Caves are naturally cooler year round due to the fact that they are not influenced by solar energy. Below 70 meters however, ground temperatures begin to increase. While the rate of temperature increase varies from place to place, the average rate of temperature increase in the outer crust is about 1° C for every 40 meters in depth. This increase is believed to become more gradual below 100 meters depth.

E. Earth's Magnetic Field

because of the solid core spinning inside the liquid core

1. A compass needle points North due to fact that it lines up with the magnetic force lines that make up Earth's magnetic field. The north pole is similar to the positive end of a bar magnet and the needle is attracted to it. The south pole is like negative end of a bar magnet and it repels the needle.

2. To visualize Earth's magnetic field, imagine a bar magnet lying inside Earth with each end pointing towards a pole. Now imagine the ends of the magnet are tilted 11° away from the poles. This explains why the geographic north pole and the magnetic north pole are not in exactly the same place.

3. Scientists are unsure about the origin of Earth's magnetic field but many support the hypothesis that the field is generated by the motion of the liquid outer core. This motion of molten metals creates an electric current. This electric current creates a magnetic field that combines with an already existing but weak magnetic field. Together, these fields combine to create the Earth's stronger magnetic field.

Source of the Earth's Magnetosphere- protects Earth from the harmful radiation from the Sun.

Rotation and Revolution

II. Earth's Rotation

A. Evidence for rotation

1. A remarkable piece of evidence for Earth's rotation was built by french physicist Jean Foucault. The Foucault pendulum was first demonstrated in 1851. The Foucault pendulum is nothing more than a very long pendulum suspended from a well-oiled ball-and-socket joint overhead, so it is free to swing in any direction.

a. Foucault set up such a pendulum in the Pantheon in Paris, and set it swinging north to south. As hours passed, however, the direction in which the pendulum was swinging moved around in a clockwise direction. After a while, the pendulum was swinging northeast-southwest; after a while longer, it was swinging east-west, then southeast-northwest, then north-south again.

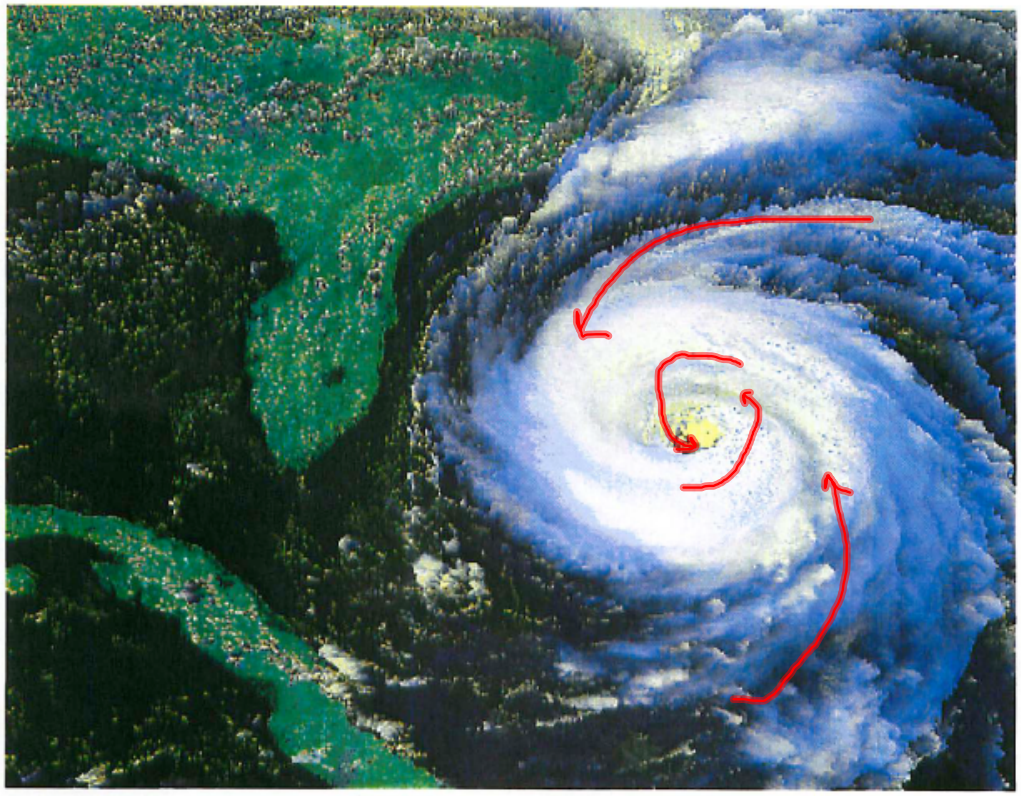
b. What causes this change in the pendulum's direction of swing? The rotation of the Earth, of course.

2. The Earth is rotating around an axis (called its **rotational axis**). Some objects rotate about a horizontal axis, like a rolling log. Some objects, such as a skater, rotate about a vertical axis. The Earth's axis is tipped over about 23.5° from vertical.

3. Earth's rotational axis always points in the same direction, so that the North Pole points towards the star Polaris. Think of the Earth as a spinning top, tipped over to one side.

4. The Earth rotates around once in 24 hours - that's a rate of 1000 miles per hour!. The time it takes for the Earth to rotate completely around once is what we call a day. It's Earth's rotation that gives us night and day. This rotational rate varies from the poles (0 miles per hour, to about 45° latitude (about 700 miles per hour), to the equator (about 1000 miles per hour)

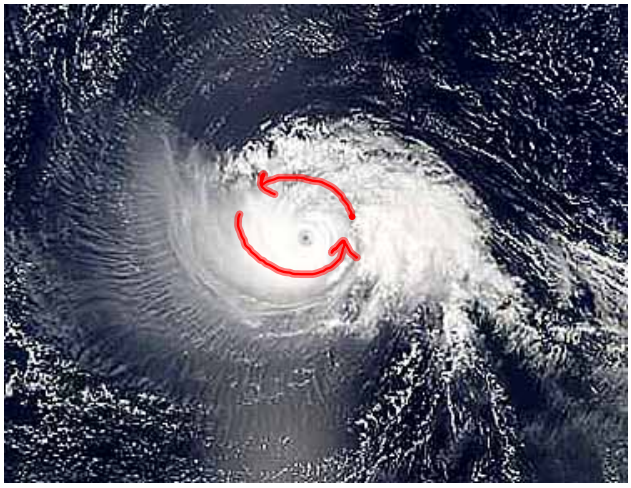
5. Coriolis Effect: Demonstration of the Earth's rotation about its axis. The Coriolis effect was first described in 1835 by a French scientist by the name of Gustave Coriolis. The net result of the Coriolis Effect: In the Northern Hemisphere, winds rushing inward to a low pressure area will swerve to the right, and set up a COUNTERCLOCKWISE hurricane. Below, for instance, is Hurricane Fran, spinning counterclockwise, about to slam into Florida in September 1996.



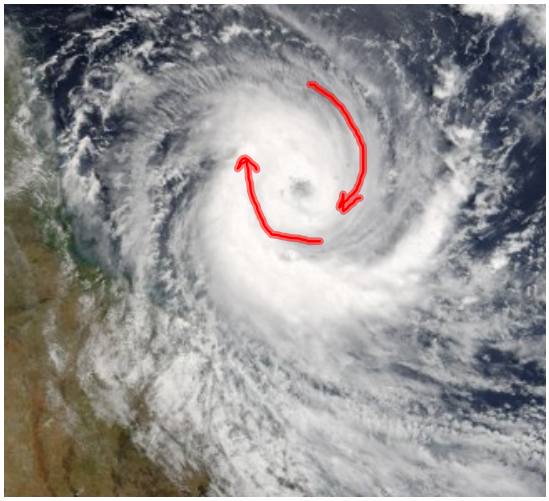
In the Southern Hemisphere, projectiles swerve to the left, and air rushing inward to a low pressure area will set up a CLOCKWISE hurricane.

There is a common misconception that the Coriolis Effect causes water to spiral down the drain counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. (In fact, this was the premise of an episode of the Simpsons during which Bart places a long-distance phone call to Australia to ask whether toilets flush clockwise down under.) In truth, the Coriolis Effect inside something as small as a sink, toilet, or bathtub is negligibly tiny. The direction in which water swirls down the drain is actually determined by any residual eddying motions of water. The Coriolis effect is too minuscule to affect the situation.

Whether one says the Earth is rotating or the pendulum is rotating depends on one's point of view. The important fact (independent of where you're standing) is that the Earth and the pendulum's swing are rotating relative to each other. If the Earth did not rotate on its axis, the direction of swing of a Foucault pendulum would remain fixed relative to the surface of the Earth.



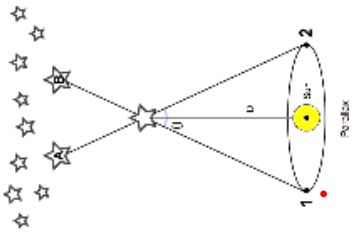
Northern Hemisphere Hurricane



Southern Hemisphere Hurricane

http://www.wiley.com/college/strahler/0471480533/animations/ch07_animations/animation2.html

Earth moving in its path around the Sun.



Observe over a 6 month period

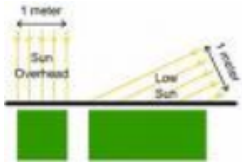
III. Earth's Revolution

A. Stellar Parallax: Demonstration of the Earth's revolution around the Sun. Stellar parallax was first detected in the year 1837, by the German astronomer Friedrich Bessel. In general terms, **parallax** can be defined as the shift in the observed position of an object, resulting from a change in the observer's location.

1. To demonstrate parallax, close your right eye and hold up your thumb at arm's length. Looking through your left eye, note the position of your thumb relative to some more distant object, such as a light switch or picture hanging on the wall. Now, keeping your thumb in the same place, close your left eye and open your right eye. Your thumb will appear to shift position relative to the more distant background object. The closer you hold your thumb to your eyes, the larger the shift in your thumb's apparent position will be.

2. This shift in the position of nearby stars, called **stellar parallax** was searched for by astronomers from ancient times onward. However, prior to the invention of the telescope, stellar parallax was not observed.

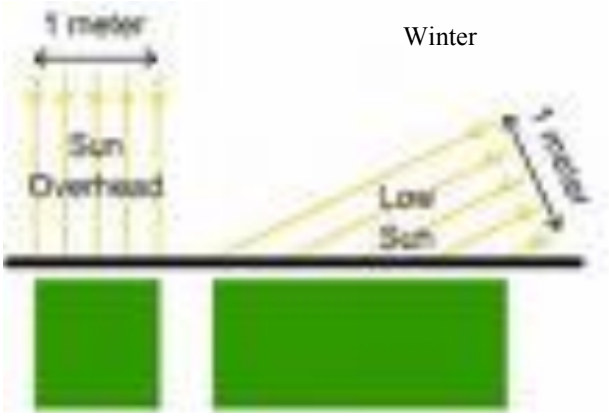
B. The Earth's axis always remains pointing in the same direction as it revolves around the sun. As a result, the solar angle varies at a given place throughout the year. The variation in sun angle is the prime cause of our seasons. The orientation of the Earth with respect to the Sun also determines the length of day. Together, the sun angle and day length determine the total amount of solar radiation incident at the Earth.



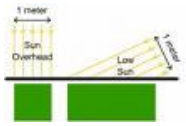
18 hr daylight
6 hr night

On June 22 the Northern hemisphere is tipped toward the sun. At noon, the ***subsolar point***, or place where the sun lies directly overhead at noon, is located at 23 1/2^0 north latitude. This date is known as the ***summer solstice***, the longest day of the year for places located north of Tropic of Cancer. The 231/2° parallel was so named because it is during the astrological sign Cancer when the Sun's rays strike at their highest angle of the year north of this line. The North pole tips into the Sun and tangent rays strike at the Arctic and Antarctic Circles. (A tangent ray is one that meets a curve or surface in a single point). This creates a 24 hour period of daylight ("polar day") for places located poleward of 66 1/2° north. We find the South Pole tipped away from the Sun, sending places poleward of 66 1/2° south into 24 hours of darkness ("polar night").

Summer



Winter



2. On Sept 23rd, the Earth has moved around the Sun such that the poles are neither pointing toward or away from the sun. On this day, the Sun is directly overhead 0 degrees, the equator, at noon. Tangent rays strike at the N is the ***autumnal equinox*** and all places experience 12 hours of day light and 12 hours of darkness.

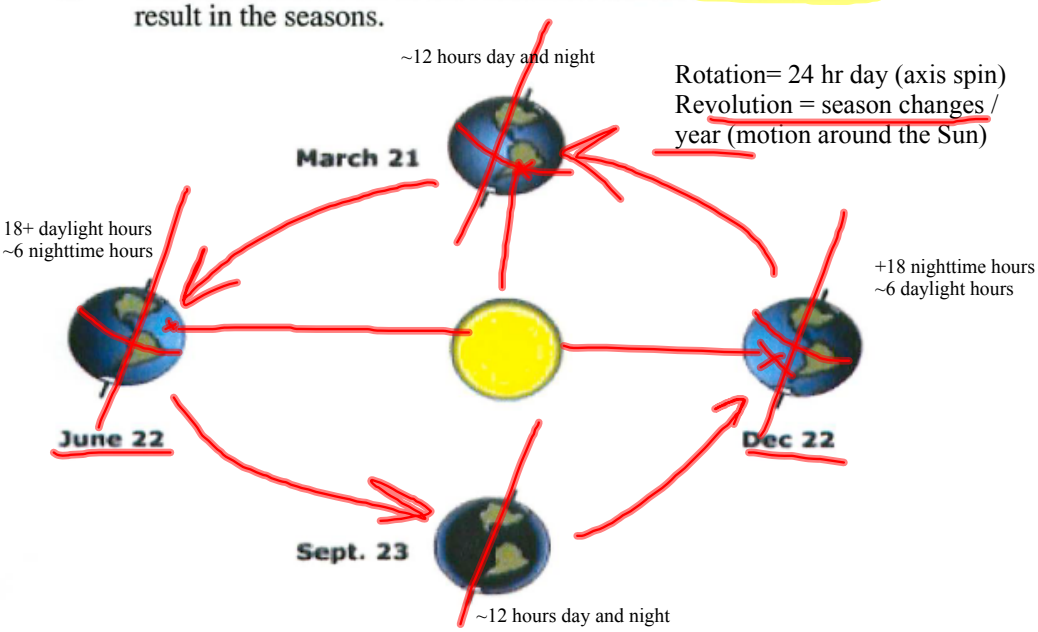
equator

3. The ***winter solstice*** occurs on December 22nd when the Earth has oriented itself so the North Pole is facing away from, and the South Pole into the Sun. Again, tangent rays strike at the Arctic and Antarctic circles. Places poleward of 66 1/2° north are in the grips of the cold, polar night. Places poleward of 66 1/2° south experience the 24 hour polar day. The Sun lies directly over 23 1/2° south. Occurring during the astrological sign of Capricorn, 23 1/2° south latitude is called the Tropic of Capricorn.

18 hrs darkness
6 hrs daylight

4. Continuing to March 21st (i.e. *Spring Equinox*) the Earth has positioned itself similar to that which occurs in September, only on the other side of the Sun. Once again tangent rays strike at the North and South poles, and the perpendicular rays of the Sun strike the Equator at noon . All places have equal day length (12 hour day;12 hours of night) as the circle of illumination cuts all latitudes in half.

C. The combined effect of the Earth's tilt and its orbital motion result in the seasons.



Chapter 3 - Models of Earth

I. Modeling the Planet

A. Maps can be constructed using different angles of view. A projection is a 2-dimensional representation of 3-D world. The following are examples of map projections:

1. Gnomonic or Planar projection-

Attachments

HotHotHot.wma