


Lecture 2
Theory of the Tropics



Earth & Solar Geometry, Celestial Mechanics

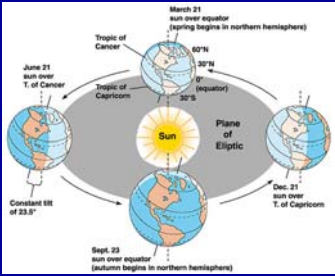
The geometrical relationship between the earth and sun is responsible for the earth's climates.

The two principal movements of the earth are rotation and revolution.

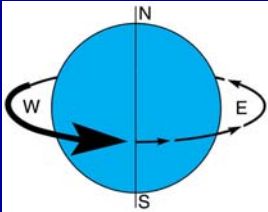
Celestial Mechanics

Revolution is the movement of the earth in an elliptical orbit around the sun whose average distance is 93 million miles away. The time to travel 1 orbit = 1 year. During this time there are 365.25 rotations of the earth.

Theory of the Tropics



Rotation is the movement of the earth around an imaginary axis (north and south pole).



The rotation is complete in 24 hours producing night and day in non-polar regions.

The angle of rotation is toward the East.

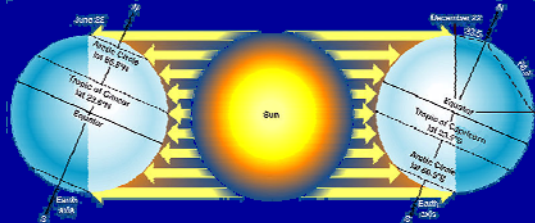
Thus the sun, moon, and stars rise in the East and set in the West.

The rotation also effects wind direction (e.g. easterly trade winds) and ocean currents.

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Tilt of the Earth (Inclination of the Earth's Axis)

The axis of the earth's rotation is inclined 66.5° from the plain of the ecliptic or 23.5° from an imaginary line vertical to it.



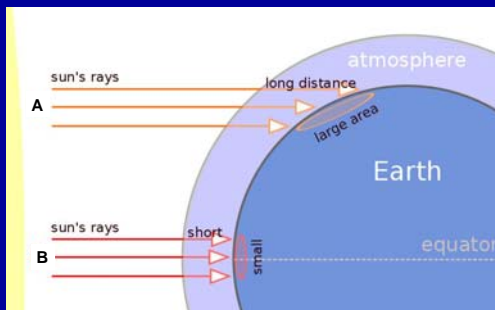
The angle of inclination of the earth's axis is *constant*; this is known as the *parallelism* of the axis.

Distribution of Solar Energy

A number of factors affect the distribution of solar energy over the earth and are responsible for night and day and the change in seasons.

- Degree of inclination of the earth's axis
- Parallelism of that axis
- The earth's spherical shape
- Rotation of the earth on its axis
- Variation in altitude of the land surface

Oblique solar rays (A) deliver less energy at the earth's surface than vertical rays (B), because their energy is spread over a larger surface (top), and because they pass through a thicker layer of reflecting and absorbing atmosphere.



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Seasons & Daylength

Without the inclination of the earth there would be no seasons.
Daylength would be exactly 12 hr light and 12 hr dark except at the poles (90° N&S) when the sun would always be at the horizon.

At Lafayette Indiana the sun would be always 40° from the zenith (directly overhead) at noon.

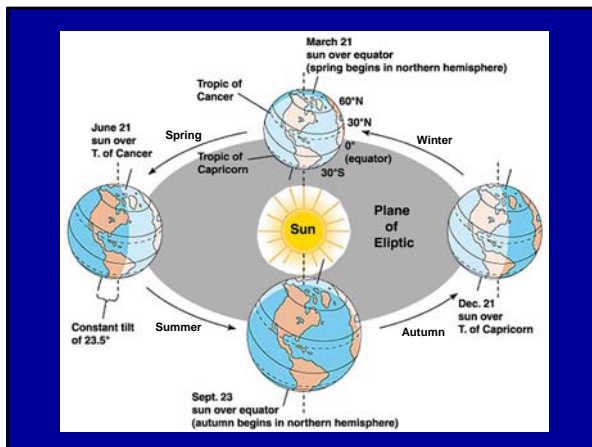
Seasonal time (solstice and equinox) is based on the geometry of the earth in relation to the sun during its yearly revolution

Solstice

The date the sun stands still on its N-S migration. Because of the *inclination* of the earth's axis the sun at its zenith is directly overhead at 23.5° N on June 21 (the summer solstice) and directly overhead at 23.5° S on Dec. 21 (Winter solstice).

Equinox

Refers to date of equal night and day period. This is the date when the sun at noon is directly overhead at the equator (March 21 = vernal equinox in the N hemisphere and Sept. 23 = autumnal equinox in the N hemisphere)



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Daylength			
	Latitude	Shortest day	Longest day
Tropics	0	12:07	12:07
	10	11:32	12:42
	20	10:56	13:20
Temperate	30	10:14	14:04
	40	9:20	15:00
	50	8:05	16:21
	60	5:54	18:49
Polar	70	0:00	24:00
	80	0:00	24:00
	90	0:00	24:00

Length of Day in Various Northern Latitudes*										
Month	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Jan.	12:07	11:35	11:02	10:24	9:37	8:30	6:38	0:00	0:00	0:00
Feb.	12:07	11:49	11:21	11:10	10:42	10:07	9:11	7:20	0:00	0:00
Mar.	12:07	12:04	12:00	11:57	11:53	11:48	11:41	11:28	10:52	0:00
Apr.	12:07	12:21	12:36	12:53	13:14	13:44	14:31	16:06	24:00	24:00
May	12:07	12:34	13:04	13:38	14:22	15:22	17:04	22:13	24:00	24:00
June	12:07	12:42	13:20	14:04	15:00	16:21	18:49	24:00	24:00	24:00
July	12:07	12:40	13:16	13:56	14:49	15:38	17:31	24:00	24:00	24:00
Aug.	12:07	12:28	12:50	13:16	13:48	14:33	15:46	18:26	24:00	24:00
Sept.	12:07	12:12	12:17	12:23	12:31	12:42	13:00	13:34	15:16	24:00
Oct.	12:07	11:55	11:42	11:28	11:10	10:47	10:11	9:03	5:10	0:00
Nov.	12:07	11:40	11:12	10:40	10:01	9:06	7:37	3:06	0:00	0:00
Dec.	12:07	11:32	10:56	10:14	9:20	8:05	5:54	0:00	0:00	0:00

* In hours and minutes on the 15th of each month

The Tropics

The tropic (=turning) is a place where the sun is directly overhead during its N-S migration at the time of the turning. This is 23.5° N and 23.5° S. The names of the tropics (place or band around the earth) are:

Tropic of Cancer (23.5° N)
Tropic of Capricorn (23.5° S)

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