CONTROLLING FACTORS OF INSOLATION

Semester – III
CC5: Climatology
Unit I: Elements of the Atmosphere

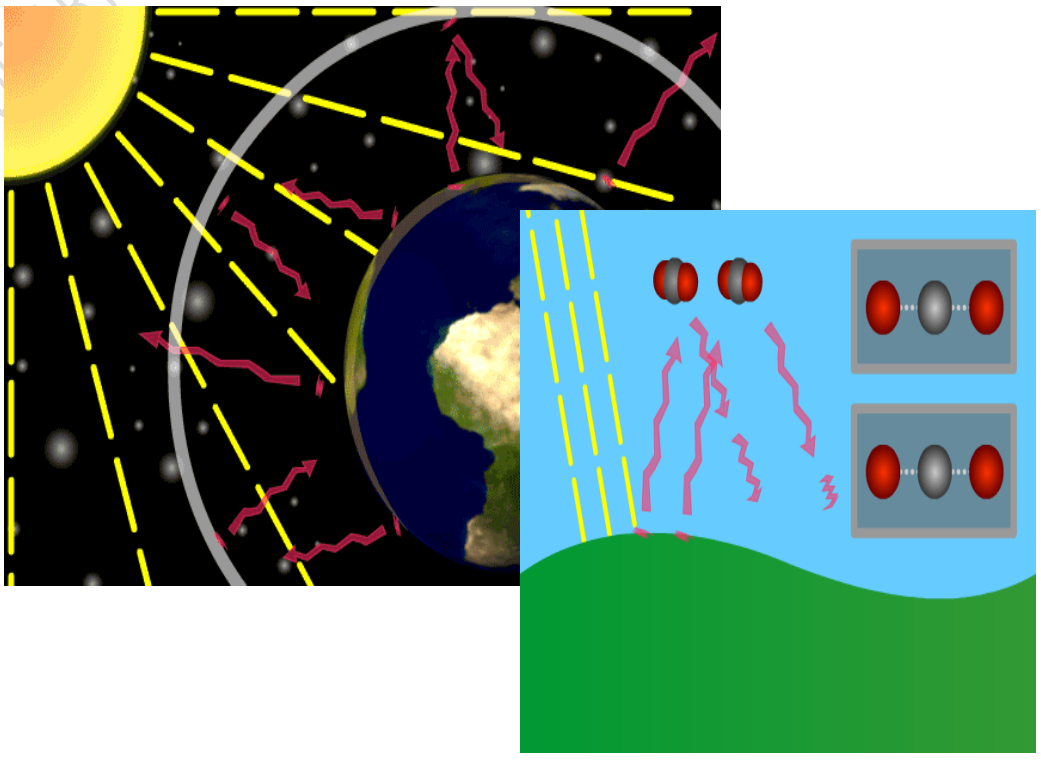
Study Material Prepared by
Mukul Maity
Department of Geography
Kharagpur College

What is Insolation?

The radiant energy received from the sun, transmitted in a form analogous to shortwave (1/250 - 1/6700 mm in length), and travelling at the rate of 186000 miles a second is called solar radiation or Insolation. It is measured by the amount of solar energy received per square centimetre per minute.

INSOLATION

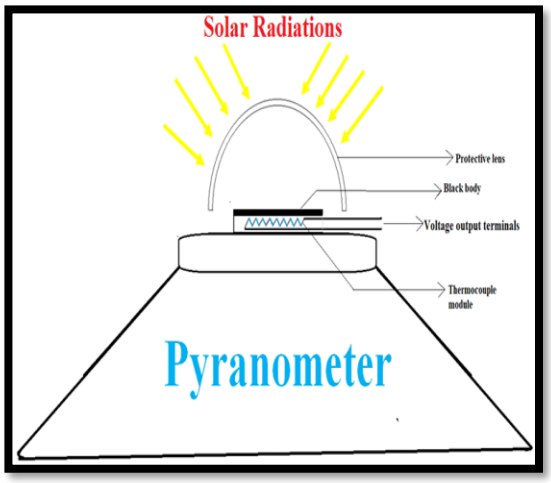
Incoming Solar Radiation

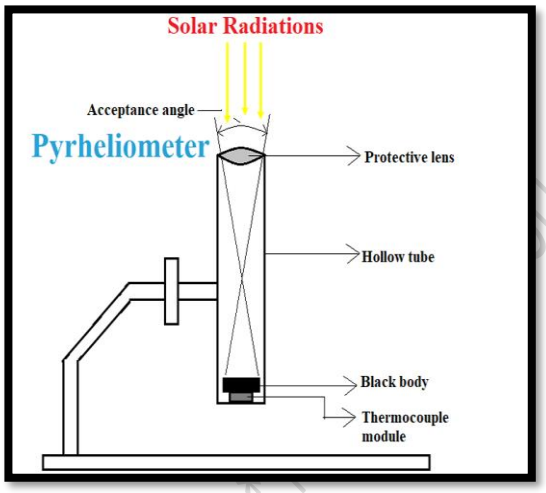


Instruments:

Insolation can be measure through different instrument:

1. Pyranometer
2. Pyrheliometer

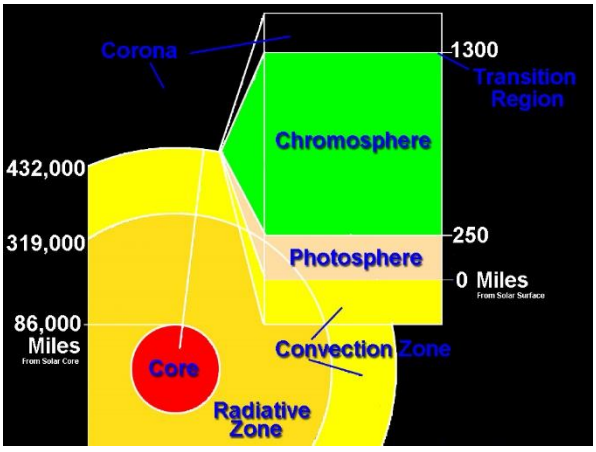




The Fact of Sun:

The sun is supposed to have been formed of four major zones namely core, Photosphere, Chromospheres and Corona.

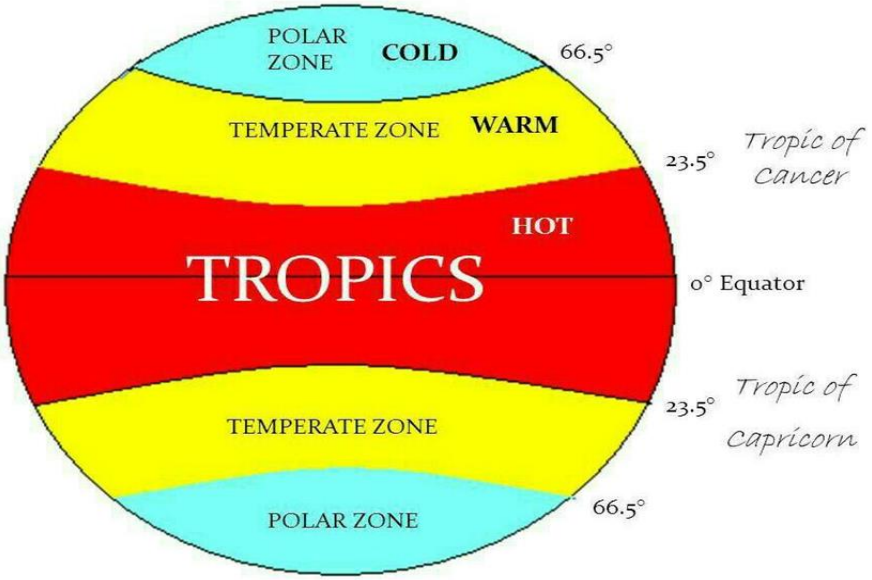
- The bright outer surface of the sun is called Photosphere because of the dominance of photons.
- The photosphere consists of 90 percent hydrogen and 10 percent helium.
- Within photosphere there are cool and dark spots, known as sunspots and hotspots which are collectively known as **Faculae.**
- The surface temperature of the sun is 6000 K.



The electromagnetic radiation emitted from the outer surface of the sun consists of four spectra of radiation waves:

- **a.** The first spectrum of the electromagnetic waves includes gamma rays, hard X-rays, soft X-rays and ultra violet rays are called short waves.
- **b.** The second spectrum of the electromagnetic radiation waves is also called as the spectrum of visible light.
- **c.** Third spectrum of the electromagnetic radiation waves is called as infrared spectrum which consists of infrared waves of the wavelengths ranging from 0.7 micron to 300 microns.
- **d.** Fourth spectrum of the electromagnetic radiation waves consists of long waves including microwaves, radar waves and radio waves.

Zonation (Depends on temperature variation):



Depends on Temperature

Three zones of the Globe

1. Low latitude or tropical zone
2. Middle latitude or temperate zone
3. Polar zone

Factors Affecting Insolation:

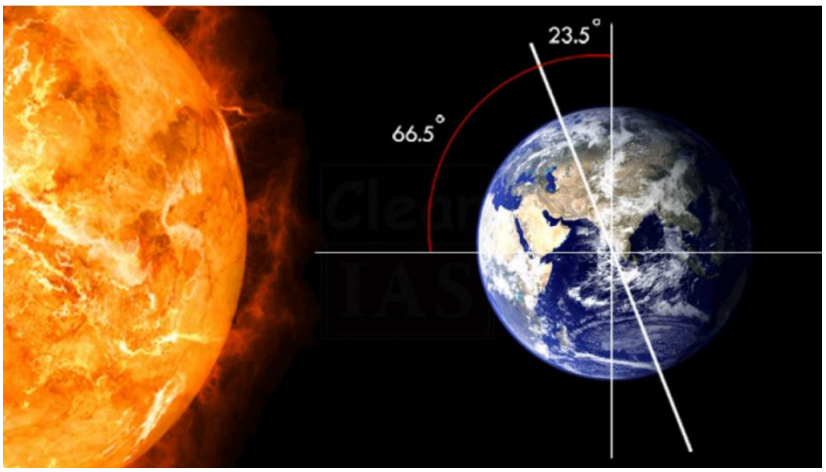
Long term factors	Short term factors	Local Factors
❑ Rotation of the earth on its axis ❑ Angle of the sun's ray ❑ Ocean Currents ❑ Altitude of Land ❑ Prevailing winds ❑ Distance between the earth and the sun ❑ Sunspots ❑ Effects of the atmosphere	❑ Length of day ❑ Seasonal Changes	❑ Aspect ❑ Urbanisation ❑ Amount of cloud cover

Long term factors:

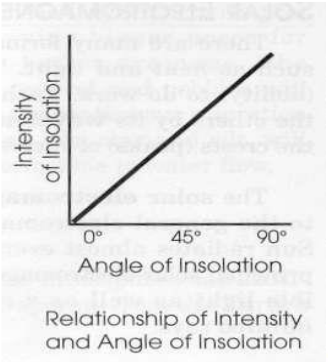
1. Rotation of the earth on its axis:

The earth rotates on its own axis which makes an angle of 66.5 with the plane of its orbit around the sun.

The rotation of the earth on this inclined axis has a greater influence on the amount of insolation received at different latitudes.



2. The angle of incidence of the sun's rays:



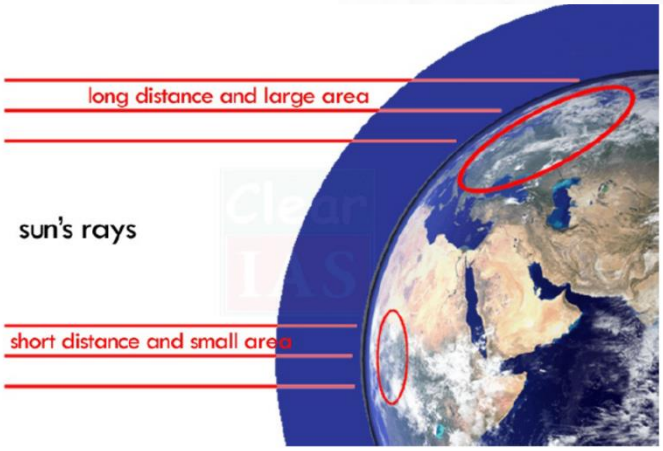
Relationship of Intensity and Angle of Insolation

Since the earth is a geoid resembling a sphere, the sun's rays strike the surface at different angles at different places. This depends on the latitude of the place. The higher the latitude, the less is the angle they make with the surface of the earth.

The area covered by the vertical rays are always less than the slant rays. If more area is covered, the energy gets distributed and the net energy received per unit area decreases.

Moreover, the sun's rays with small angle traverse more of the atmosphere than rays striking at a large angle.

Longer the path of the sun's rays, greater is the amount of reflection and absorption of heat by the atmosphere. As a result, the intensity of insolation is less.



3. Transparency of the atmosphere:

The transparency of the atmosphere depends upon the cloud cover and its thickness, dust particles, water vapour, etc. They reflect, absorb or transmit insolation.

Thick cloud hinders the solar radiation to reach the earth's surface. Similarly, water vapour absorbs solar radiation resulting in less amount of insolation reaching the surface.

4. Prevailing Winds:

Sometimes prevailing winds increase or decrease the temperature of the region from which it passes. Example:

a) Sirocco is a warm wind blowing from Sahara Desert and raises the temperature there.

b) Chinook is warm wind moving down from Rockies mountain of North America and increases the temperature of the area it passes.

C) Loo is warm wind blowing in the areas of Punjab and Haryana and increases its temperature.

Distance from Sea: Places which are near to sea have moderate temperature because of the sea breeze (movement of wind from sea to land). Lands get heated during day as a result of which area of low pressure is created over it which results in moving of wind from sea.

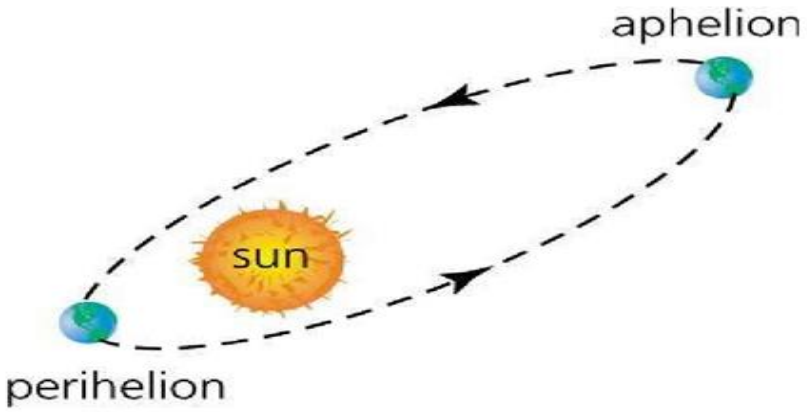
Therefore, places like Mumbai, Bengaluru have moderate temperature as compared to Delhi and Punjab.

5. Distance between the earth and the sun:

It is generally believed that the distance of Earth from Sun affects the insolation; but the fact is it has very less impact on the insolation.

The perihelion of any orbit of a celestial body about the Sun is the point where the body comes nearest to the Sun. It is the opposite of aphelion, which is the point in the orbit where the celestial body is farthest from the Sun

Earth is about 147.1 million kilometres from the Sun at perihelion around January 3, in contrast to about 152.1 million kilometres at aphelion around July 4. If it affects the temperature must be highest at perihelion but it happens in January.

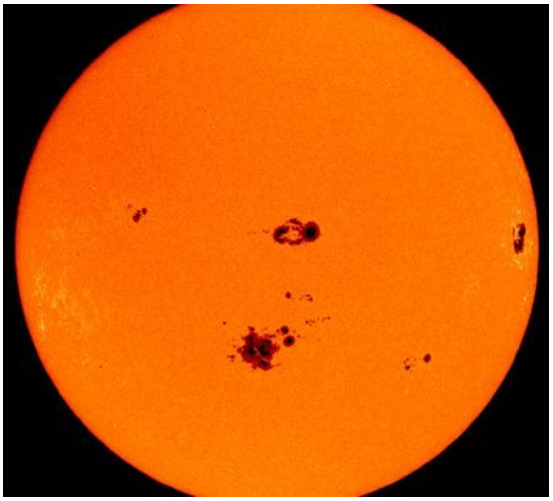


Sunspots:

Sunspots defined as dark areas within photosphere of the sun and surrounded by chromospheres, are created in the solar surface.

These dark areas are cool areas because they are characterized by 15000 c less temperature then the chromospheres which surrounded them.

It is believed that the energy radiated from the sun increases when the number of sunspots increases and consequently the amount of insolation received at the earth's surface also increases.



Short term factors:

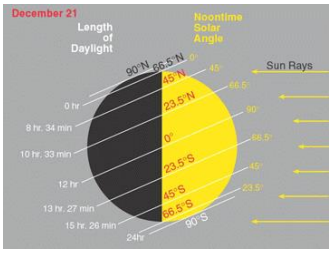
1. Duration of the day

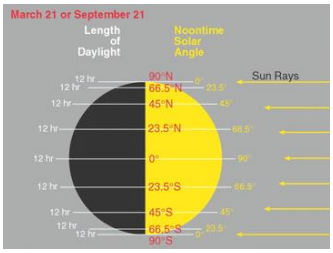
Duration of the day varies from place to place and season to season. It decides the amount of insolation received on the earth's surface.

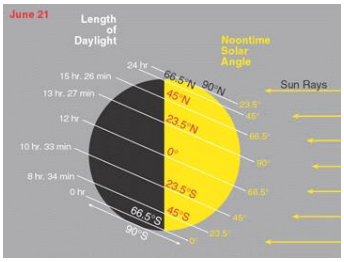
The longer the duration of the day, the greater is the amount of insolation received. Conversely shorter the duration of the day leads to receipt of less insolation.

Latitudes	0	10	20	30	40	50	60	70	80	90
Insolation in percent	100	99	95	88	79	68	57	47	43	42

Latitude	March 21	June 21
0	12 hrs	12h 00m
10	12 hrs	12h 35m
20	12 hrs	13h 12m
30	12 hrs	13h 56m
40	12 hrs	14h 52m
50	12 hrs	16h 18m
60	12 hrs	18h 27m
70	12 hrs	2 months
80	12 hrs	4 months
90	12 hrs	6 months
Latitude	March 21	June 21

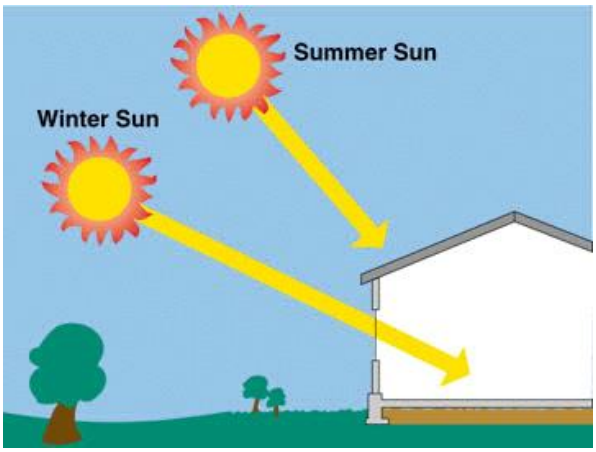






2. Seasonal Changes

The angle of **insolation changes** throughout the year because Earth's tilt stays the same as Earth orbits the Sun. At this time, the tilt of the Earth causes the Southern Hemisphere to receive direct (90°) **solar radiation** while the Northern Hemisphere receives less direct **solar radiation**.



Important Questions:

1. **What is Insolation?**
2. **Briefly discuss about the different types of controlling factors of Insolation.**
3. **What is sun spot?**
4. **How insolation influenced by incidence of angle?**

Study Material Prepared by

Mukul Maity

Department of Geography

Kharagpur College