Insolation and Heat Balance

The Sun is the source of light and heat on the Earth. The heat and energy radiated by the Sun in all directions is known as **solar radiation**.

Types of Radiation and Heat Balance

The radiation of the Sun is made of three parts—white light (which we see), infrared radiation and ultraviolet radiation. The Sun also emits atomic particles known as **Solar Winds**.

Insolation

The amount of solar energy received by the Sun is known as **insolation**. The Sun's energy reaches the Earth as short waves. Of the total solar energy, 51% reaches the Earth.

Terrestrial Radiation

The Earth does not absorb all the heat of the Sun which strikes its surface. A part of the Sun's heat is radiated back in the atmosphere in the form of long waves. The heat radiated by the Earth in the form of long waves is known as **terrestrial radiation**.

Heat Balance

The state of equilibrium which exists on the Earth between incoming solar radiation and outgoing terrestrial radiation is known as **heat balance**.

Heat Budget

As stated above, the Earth does not absorb all the heat that is radiated by the Sun. The balance maintained between the incoming solar radiation absorbed by the Earth and the heat which escapes from the Earth into space is known as the **heat budget**. Following is an example of the heat budget of the Earth:

- Of 100 units of heat which is radiated by the Sun, 35 units of heat are reflected into space by the layers of the atmosphere.
- 14 units are absorbed by the ozone layer.
- The remaining 51 units are received by the Earth.
- Of 51 units, 34 units are absorbed by the Earth and sent back in the atmosphere.
- The remaining 17 units are radiated directly into the space by the Earth.

Therefore, we see that a balance is maintained between the incoming and outgoing solar radiation from the Earth.

How is the Balance Achieved?

- The rotation of the Earth on its axis impacts the distribution of heat in various parts of the Earth. As the Earth rotates on its axis, the Sun heats different parts of the Earth at different time (the part facing the Sun experiences day and vice versa).
- When heat and energy are radiated by the Earth, it warms the layers of the atmosphere above it directly. This is called conduction. When one layer of the Earth absorbs radiation, it transfers the heat to the lower level by the process of conduction.
- The transfer of heat from one medium to another or from one part of the liquid or gas to another part in the form of the movement of particles is known as convection. Sea breeze is caused by the convectional currents in the atmosphere.
- Land is a bad conductor and a good radiator of heat. Therefore, it heats quickly during the day and cools rapidly at night. During the night, because the land cools rapidly, land breeze blows from the land to the oceans.

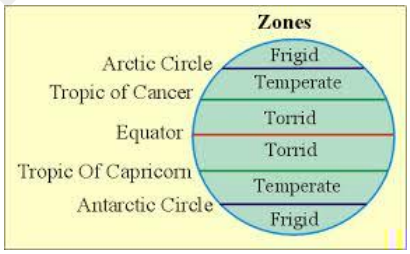
- On the contrary, water takes a longer time to get heated and loses heat slowly during the night. The sea, which is cooler during the day time, gives rise to the sea breeze which blows from the sea to the land.

The atmosphere acts as a blanket of the Earth. During the day, the atmosphere acts like a greenhouse and keeps the surface of the Earth warm by preventing the terrestrial radiation from escaping into space. During the day, the atmosphere absorbs 14% of insolation and regulates the temperature of the Earth. Thus, it prevents the Earth from becoming too hot during the day and too cold at night.

Heat Zones

On the basis of insolation received by the surface of the Earth, the world is divided into three main heat zones. They are

Torrid Zone: This zone lies between to 23 1/2° North and South to the Equator. The Sun shines exactly overhead at the places near the Equator and in tropics. Direct vertical rays of the Sun fall over these places. Therefore, the equatorial and tropical regions receive maximum insolation.



Heat zones of the Earth

Temperate Zone: This zone lies between 23 1/2° and 66 1/2° North and South of the Equator. The regions in the temperate zone experience the slanting rays of the Sun. Because of the spherical shape of the Earth, the amount of insolation received by these regions is less.

Frigid Zone: This zone is located between 661/2° and 90° North and South of the Equator. This zone experiences extremely slanting rays of the Sun over a large distance. Hence, the amount of insolation received is very less even during summers.

Temperature

All the parts of the Earth do not receive equal sunlight. Thus, temperature varies from region to region. Factors affecting the distribution of temperature are

Differential Heating and Cooling of Land and Water

- As discussed above, land absorbs and releases heat quickly, while oceans and seas retain heat for a longer period of time. Oceans in the Equatorial Regions remain hot and give rise to warm currents.
- On the contrary, oceans in the Polar Regions are cold. When warm currents move towards the cooler region, they transport heat to the polar latitudes.
- Similarly, cold currents moving from the Polar Regions to the Equatorial Regions bring down the temperature of the coastal areas located in the Equatorial Regions.
- For example, the warm North Atlantic Drift raises the temperature of Northwestern Europe. As a result, the port of Bergen in Norway does not freeze even during winters.

Latitude

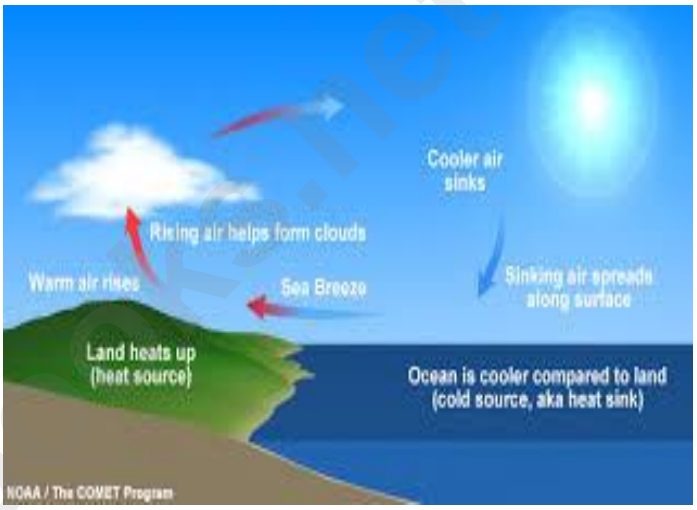
- Because the Earth is spherical, the rays of the Sun strike the Earth at varying angles of incidence.
- The areas lying in the Equatorial Regions receive direct or vertical rays of the Sun, so the temperatures are high.
- As we move away from the Sun to the Polar Regions, the temperature decreases. The Polar Regions get slanting rays of the Sun; therefore, the temperature is extremely low. This is the reason that the Poles of the Earth are covered with snow.

Altitude

- Altitude means height. The air is dense near the surface of the Earth as it contains dust particles and water vapour. These particles absorb heat, and thus, the surroundings are warmer.
- However, at high altitude, the air becomes less dense and generally does not have dust particles, and therefore, less heat is absorbed.
- Hence, in summer, people from the plains (where the temperature is 35ºC) visit hill stations (where the temperature is about 13–14ºC).

Distance from the Sea

- The temperature of a place also depends on its distance from the sea. Land has the property of absorbing and releasing heat quickly, while the sea takes relatively longer time to absorb and release heat.
- Therefore, the land gets heated during the day time and becomes cooler in the night. On the contrary, the oceans are cooler during the day time and are warmer in the night.
- Thus, the coastal areas (Mumbai) experience cooler winds even in the afternoon, while the plains (Allahabad) experience extremely hot winds during afternoons.



Sea and Land Breezes

Direction of Mountain Ranges

- The direction of mountain ranges influences the temperature of a place. In the Northern Hemisphere, the Himalayan Mountains stretch from west to east. Thus, they act as a barrier to the cold winds blowing from the poles.
- Therefore, the Gangetic Plain has relatively moderate temperature and does not freeze. However, in North America, the mountain ranges stretch in the North–South direction. Therefore, they allow the cold polar winds to blow up to 30º N latitude, lowering the temperature of the region and resulting in snow formation. Therefore, New Orleans located at about 29ºN has snowfall in winter.

Soil and Vegetation Cover

- The plant and forest cover helps in reducing the temperature of the place.
- Various kinds of soil support various vegetation and plants. As the plant cover affects the amount of rainfall in a particular region, it also defines the climate of the regions.
- A forest cover absorbs more sunlight than the bare ground or snow fields. Most of the absorbed sunlight is used by plants and trees in photosynthesis. Thus, the forest cover reduces the temperature of a place.

Cloud Cover and Humidity

- Heavy cloud cover prevents the incoming solar radiation and keeps a check on the outgoing radiation. Thus, in the hot wet regions, where the cloud cover is dense, the average temperature usually does not go beyond 30°C.
- There is no cloud cover in the desert regions. So, there is high insolation during the day time and rapid loss of heat because of terrestrial radiation at night. As a result, deserts are hot during the day time and cold during the night.

Measurement of Temperature

- Temperature is measured by a thermometer. Centigrade and Fahrenheit are the two scales which are used for measuring temperature.
- While the Centigrade scale has 100 divisions, the Fahrenheit scale has 180 divisions.
- The formula to convert one scale to the other is °F = (°C × 9/5) + 32.

Range of Temperature

- Diurnal Range of Temperature is the difference between the maximum and minimum temperatures during a day.
- Mean Monthly Temperature is the average of mean temperatures of all the days in the month.
- Mean Annual Range of Temperature is the difference between the mean temperature of the hottest month and the mean temperature of the coldest month.

World's Distribution of Temperature

On maps, the distribution of temperature is shown by **isotherms** which join all the places with the same mean temperature.

Equatorial Regions receive direct rays of the Sun and thus experience high temperatures. The temperature declines as one goes towards the temperate regions which receive slanting rays of the Sun. Polar Regions are very cold and are mostly frozen as they receive extremely slanting rays of the Sun.