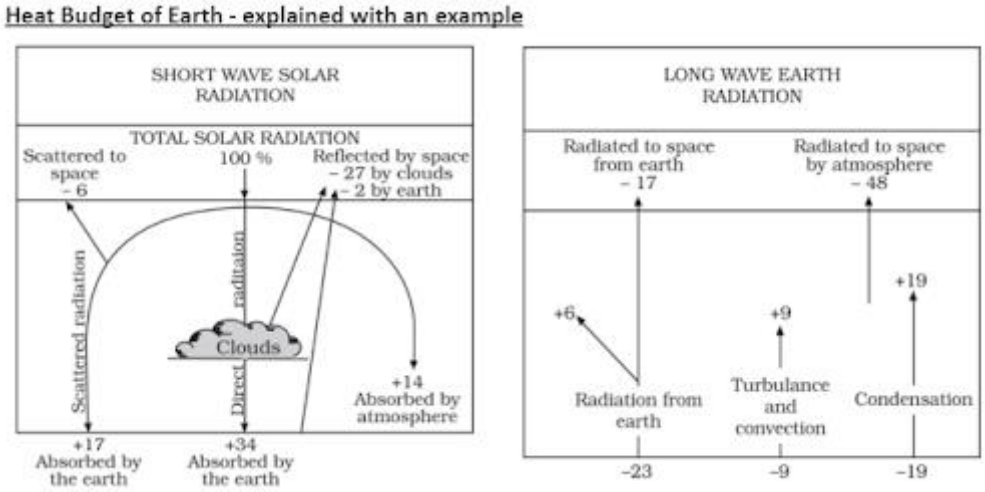
Heat Budget of the Earth

Heat is a form of energy that is received by the earth from the sun. The concept of Heat Budget deals with the amount of heat energy received from the sun and its utilization in the atmosphere and the surface of the earth. This explains why the earth neither warms up nor cools down despite the huge transfer of heat that takes place.

What is Heat Budget of Earth?

- A heat budget is a perfect balance between incoming heat (insolation) absorbed by the earth and outgoing heat (terrestrial radiation) escaping it in the form of radiation.
- If the incoming heat and the outgoing heat are not balanced, then Earth would be getting either too warmer or cooler. Since these are perfectly balanced the earth is neither too warm nor too cold.
- The equilibrium that exists between the insolation (short waves) and the terrestrial radiation (long waves) is called the **heat budget of the earth**.



- If the total insolation received at the top of the atmosphere is considered to be 100%, a certain amount of energy is reflected, scattered and absorbed while passing through Earth's atmosphere and only the remaining amount of radiation reaches the earth's surface.
- Approximately 35 units are reflected to space even before reaching the earth's surface.
    - Of these, 27 units are reflected from the top of the clouds and 2 units from the snow and ice-covered areas of the earth. The reflected amount of radiation is called the **albedo of the earth**.
- The remaining **65 units** are absorbed, 14 units within the atmosphere and 51 units by the earth's surface. The earth radiates back 51 units in the form of **terrestrial radiation**.
    - Of these, 17 units are radiated to space directly and the remaining 34 units are absorbed by the atmosphere
- The 48 units absorbed by the atmosphere (14 units from insolation + 34 units from terrestrial radiation) are also radiated back into space.
- Thus, the total radiation returning from the earth and the atmosphere respectively is 17+48=65 units which balance the total of **65 units received from the sun**.

Heat Budget Components

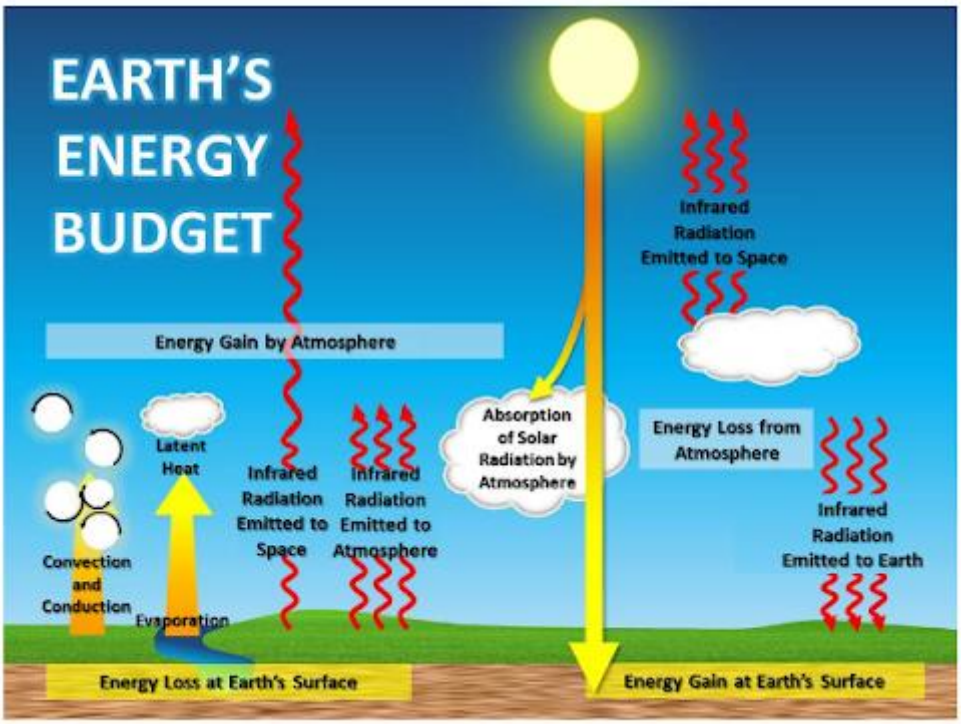


Image source: Center for Environmental Studies

- **Insolation –** Insolation refers to the incoming shortwave solar radiation to the earth's surface. The processes involved with insolation in maintaining heat balance include:
    - **Reflection** – Reflection occurs when incoming solar waves bounce back from a surface that it strikes in the atmosphere, on land, or water, and are not transformed into heat.
    - **Absorption** – Absorption of radiation involves the conversion of electromagnetic radiation into heat energy.
    - **Scattering** – Scattering of solar waves takes place when the radiation strikes small objects in Earth's atmosphere, such as air molecules or water droplets or aerosols which disperse the solar waves in all directions.
- **Terrestrial Radiation –** Terrestrial Radiation refers to longwave radiation that is emitted by the Earth′s surface or by the atmosphere. The processes involved with Terrestrial Radiation in maintaining heat balance include
    - **Latent heat transfer –** It is the amount of heat transferred during the point where one substance is ready to change its state.
    - Example: From solid to liquid or from liquid to gas,
    - **Sensible heat transfer –** It is the energy that is transferred as heat to an object, without any change in the state
    - **Emission by vapour and clouds –** Huge amounts of terrestrial radiation are also released by the water vapour and clouds.

Heat Balance of Earth

- The incoming solar radiation at the surface of the Earth varies from place to place, i.e. some parts of the earth receive surplus radiation while some parts receive deficient radiation.
- There is a surplus of net radiation balance between 40°N and 40°S and the regions near the poles are in deficit.
- The surplus heat energy from the tropics gets redistributed towards the poles.
    - This balance is extremely crucial as this ensures that the tropics don't get extremely heated up because of the accumulation of excess heat and the areas in high altitudes do not get permanently frozen because of deficit radiation

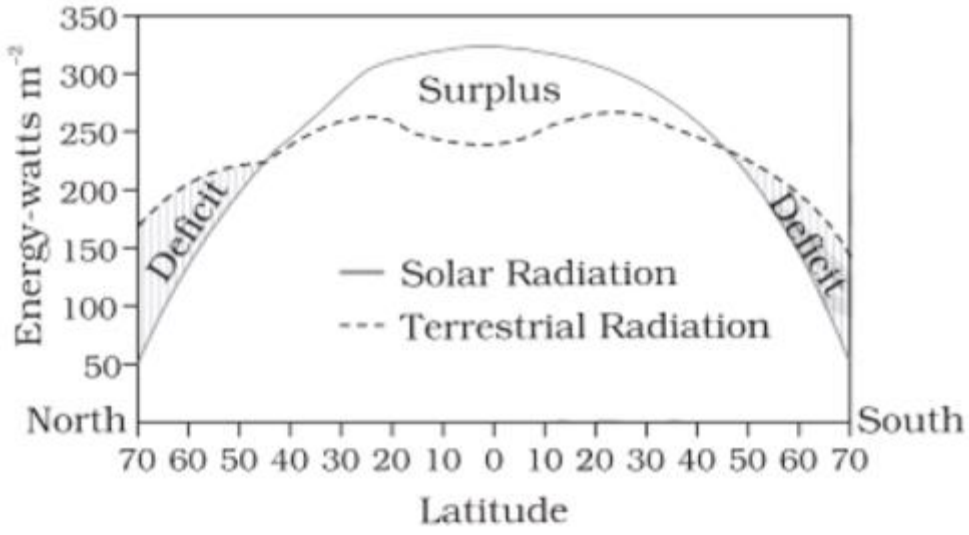


Image Source: NCERT

- The factors that cause these variations in insolation are :
    - The rotation of the earth on its axis
    - The angle of inclination of the sun's rays
    - The length of the day
    - The transparency of the atmosphere
    - The configuration of land in terms of its aspect.