SOLAR RADIATION, HEAT BALANCE

The earth receives almost all of its energy from the sun. The earth in turn radiates back to space the energy received from the sun. As a result, the earth neither warms up nor does it get cooled over a period of time. Thus, the amount of heat received by different parts of the earth is not the same. This variation causes pressure differences in the atmosphere.

Radiation

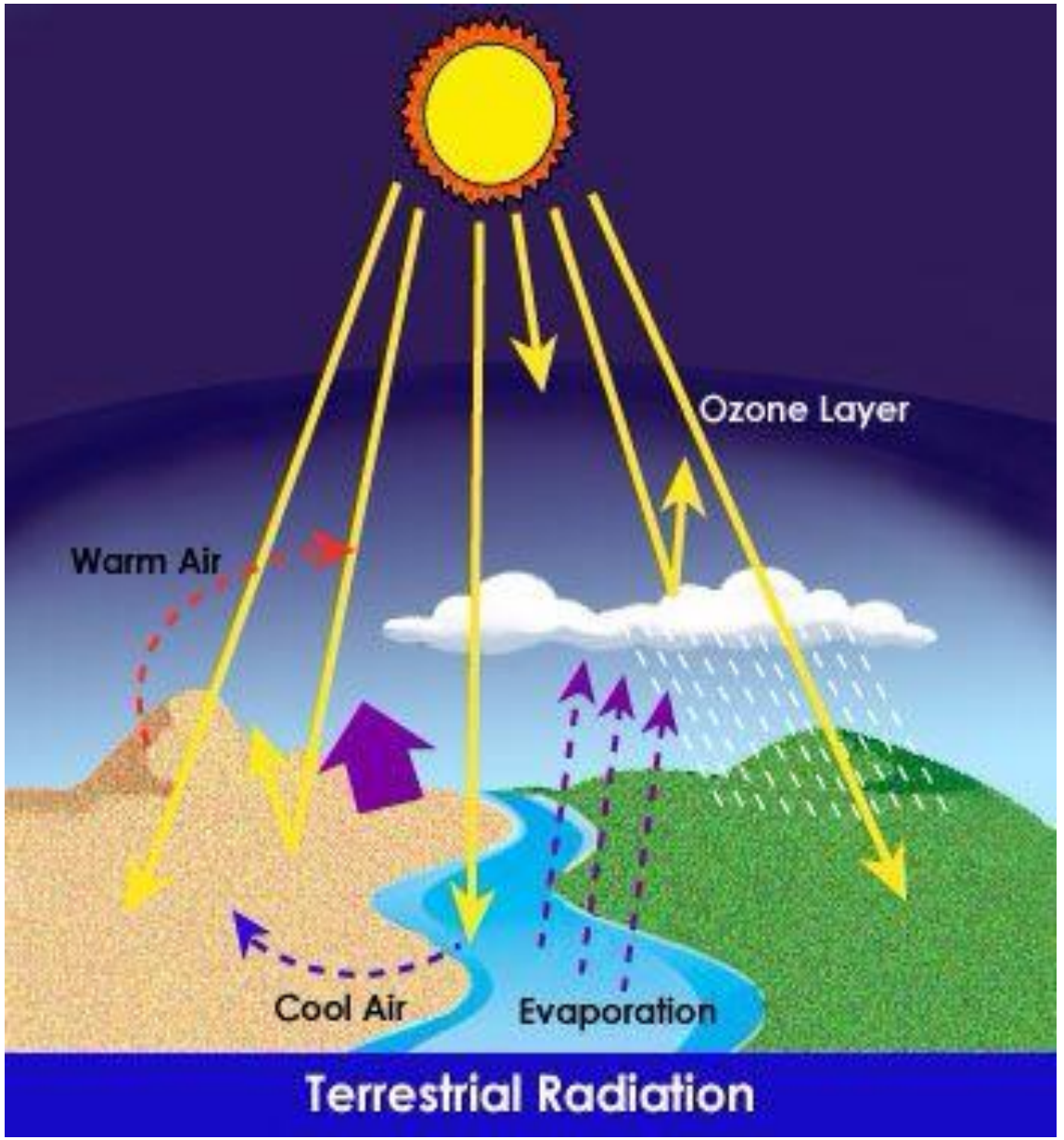
earth's surface receives most of its energy in short wavelengths. The energy received by the earth is known as incoming solar radiation which in short is termed as insolation.
As the earth is a geoid resembling a sphere, the sun's rays fall obliquely at the top of the atmosphere and the earth intercepts a very small portion of the sun's energy.
The solar output received at the top of the atmosphere varies slightly in a year due to the variations in the distance between the earth and the sun.

. During its revolution around the sun, the earth is farthest from the sun (152 million km) on 4th July. This position of the earth is called aphelion.
On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion.
However, the effect of this variation in the solar output is masked by other factors like the distribution of land and sea and the atmospheric circulation.
The factors that cause these variations in insolation are : (i) the rotation of earth on its axis; (ii) the angle of inclination of the sun's rays; (iii) the length of the day; (iv) the transparency of the atmosphere; (v) the configuration of land in terms of its aspect.

Terrestrial Radiation

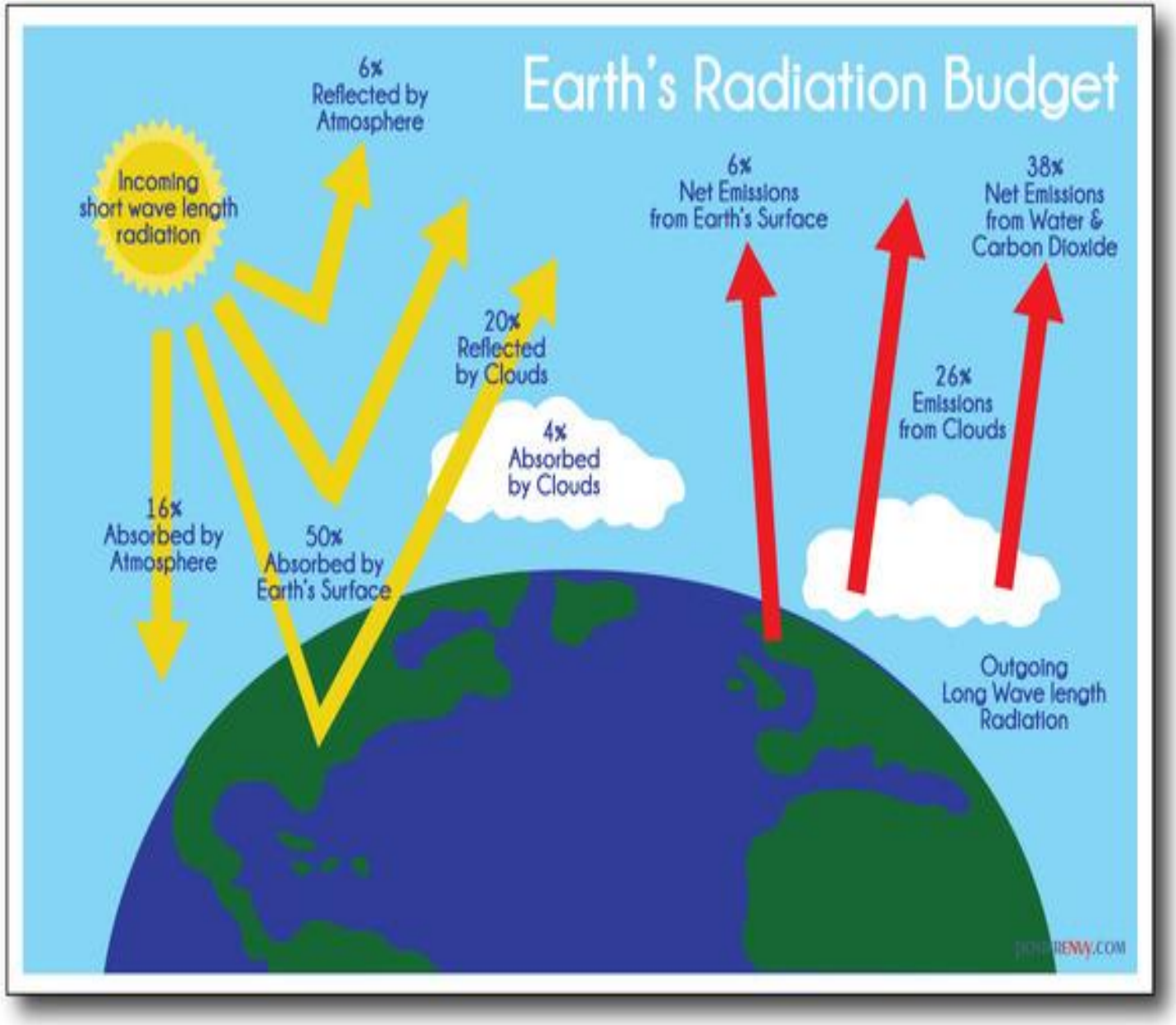
The insolation received by the earth is in short waves forms and heats up its surface. The earth after being heated itself becomes a radiating body and it radiates energy to the atmosphere in long wave form. This energy heats up the atmosphere from below. This process is known as terrestrial radiation.

The long wave radiation is absorbed by the atmospheric gases particularly by carbon dioxide and the other green house gases. Thus, the atmosphere is indirectly heated by the earth's radiation. The atmosphere in turn radiates and transmits heat to the space. Finally the amount of heat received from the sun is returned to space, thereby maintaining constant temperature at the earth's surface and in the atmosphere



Heat Budget of the Planet Earth

Consider that the insolation received at the top of the atmosphere is 100 per cent. While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Only the remaining part reaches the earth surface. Roughly 35 units are reflected back to space even before reaching the earth's surface. Of these, 27 units are reflected back 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 (6 units absorbed directly by the atmosphere, 9 units through convection and turbulence and 19 units through latent heat of condensation). 48 units absorbed by the atmosphere (14 units from insolation +34 units from



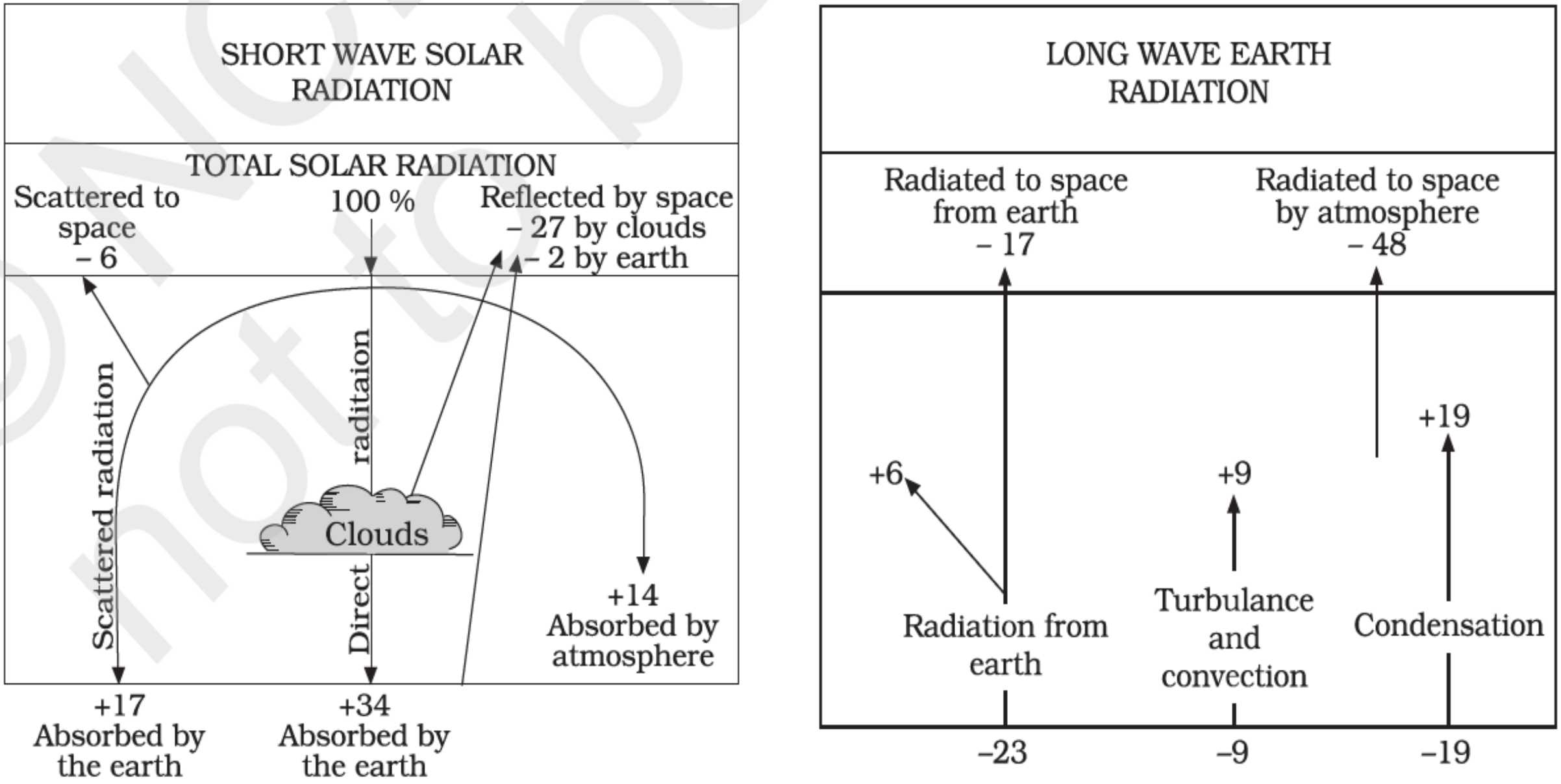


Figure 9.2 : Heat budget of the earth

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. This is termed the heat budget or heat balance of the earth. This explains, why the earth neither warms up nor cools down despite the huge transfer of heat that takes place.

Variation in the Net Heat Budget at the Earth's Surface As explained earlier, there are variations in the amount of radiation received at the earth's surface. Some part of the earth has surplus radiation balance while the other part has deficit. Figure 9.3 depicts the latitudinal variation in the net radiation balance of the earth — the atmosphere system. The figure shows that there is a surplus of net radiation balance between 40 degrees north and south and the regions near the poles have a deficit. The surplus heat energy from the tropics is redistributed pole wards and as a result the tropics do not get progressively heated up due to the accumulation of excess heat or the high latitudes get permanently frozen due to excess deficit.

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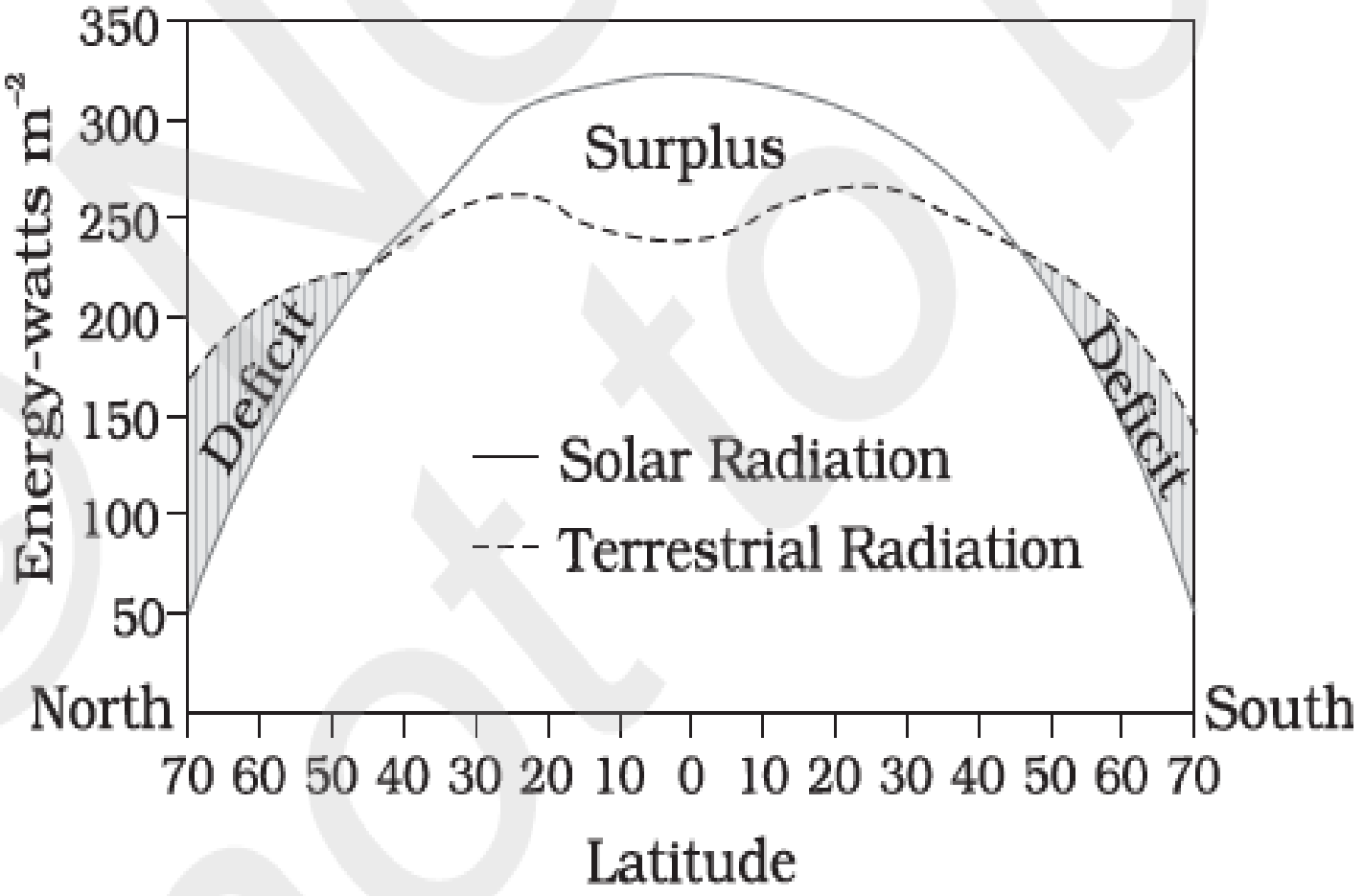

Figure : Latitudinal variation in net radiation balance

TEMPREATURE

The interaction of insolation with the atmosphere and the earth's surface creates heat which is measured in terms of temperature. While heat represents the molecular movement of particles comprising a substance, the temperature is the measurement in degrees of how hot (or cold) a thing (or a place) is

Factors Controlling Temperature Distribution

The temperature of air at any place is influenced by (i) the latitude of the place; (ii) the altitude of the place; (iii) distance from the sea, the airmass circulation; (iv) the presence of warm and cold ocean currents; (v) local aspects

The latitude : The temperature of a place depends on the insolation received. It has been explained earlier that the insolation varies according to the latitude hence the temperature also varies accordingly.

The altitude : The atmosphere is indirectly heated by terrestrial radiation from below. Therefore, the places near the sea-level record higher temperature than the places situated at higher elevations. In other words, the temperature generally decreases with increasing height. The rate of decrease of temperature with height is termed as the normal lapse rate. It is 6.5°C per 1,000 m.

Distribution of Temperature

The global distribution of temperature can well be understood by studying the temperature distribution in January and July. The temperature distribution is generally shown on the map with the help of isotherms. The *Isotherms* are lines joining places having equal temperature. Figure (a) and (b) show the distribution of surface air temperature in the month of January and July.

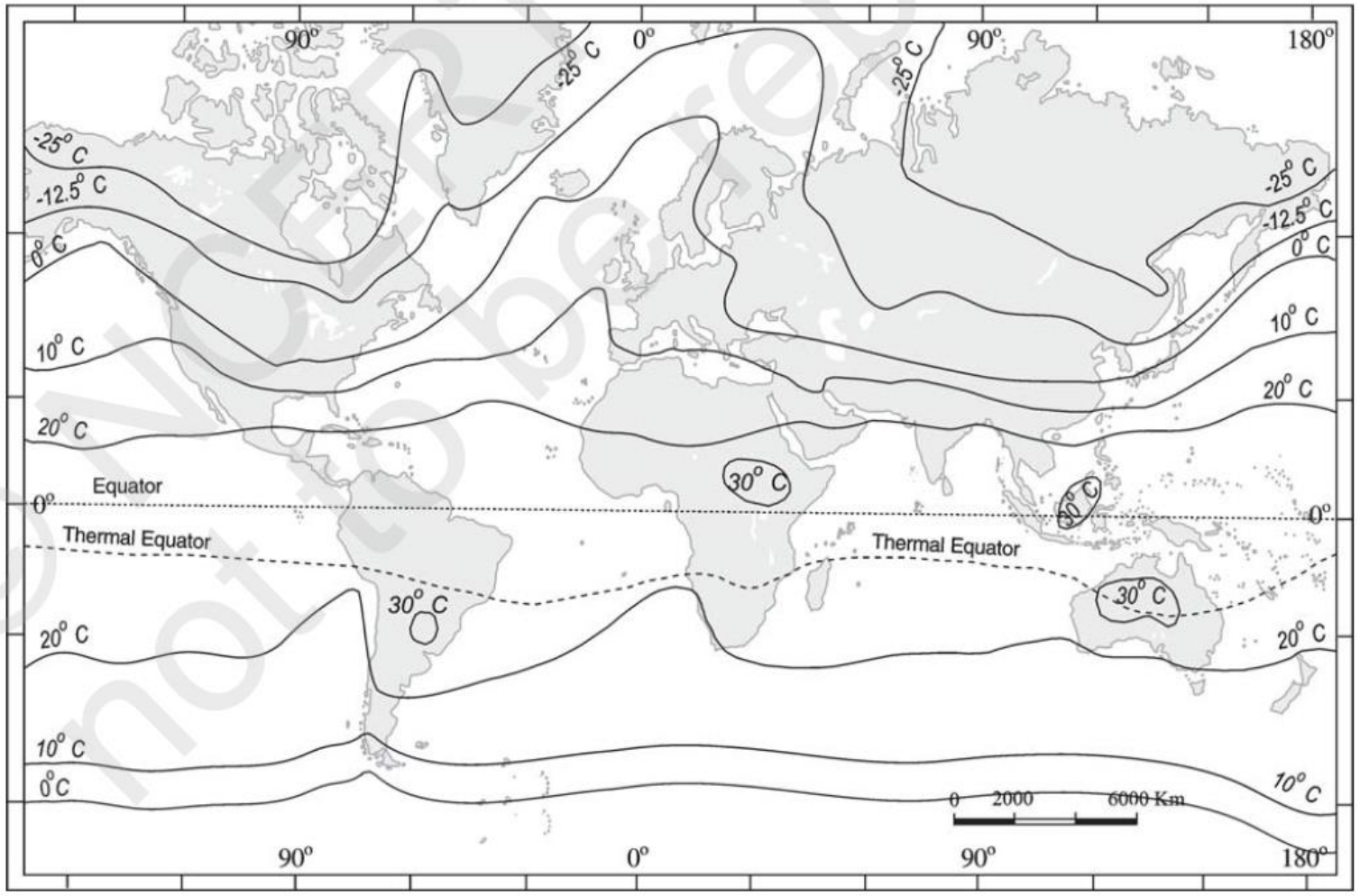

Figure 9.4 (a) : The distribution of surface air temperature in the month of January

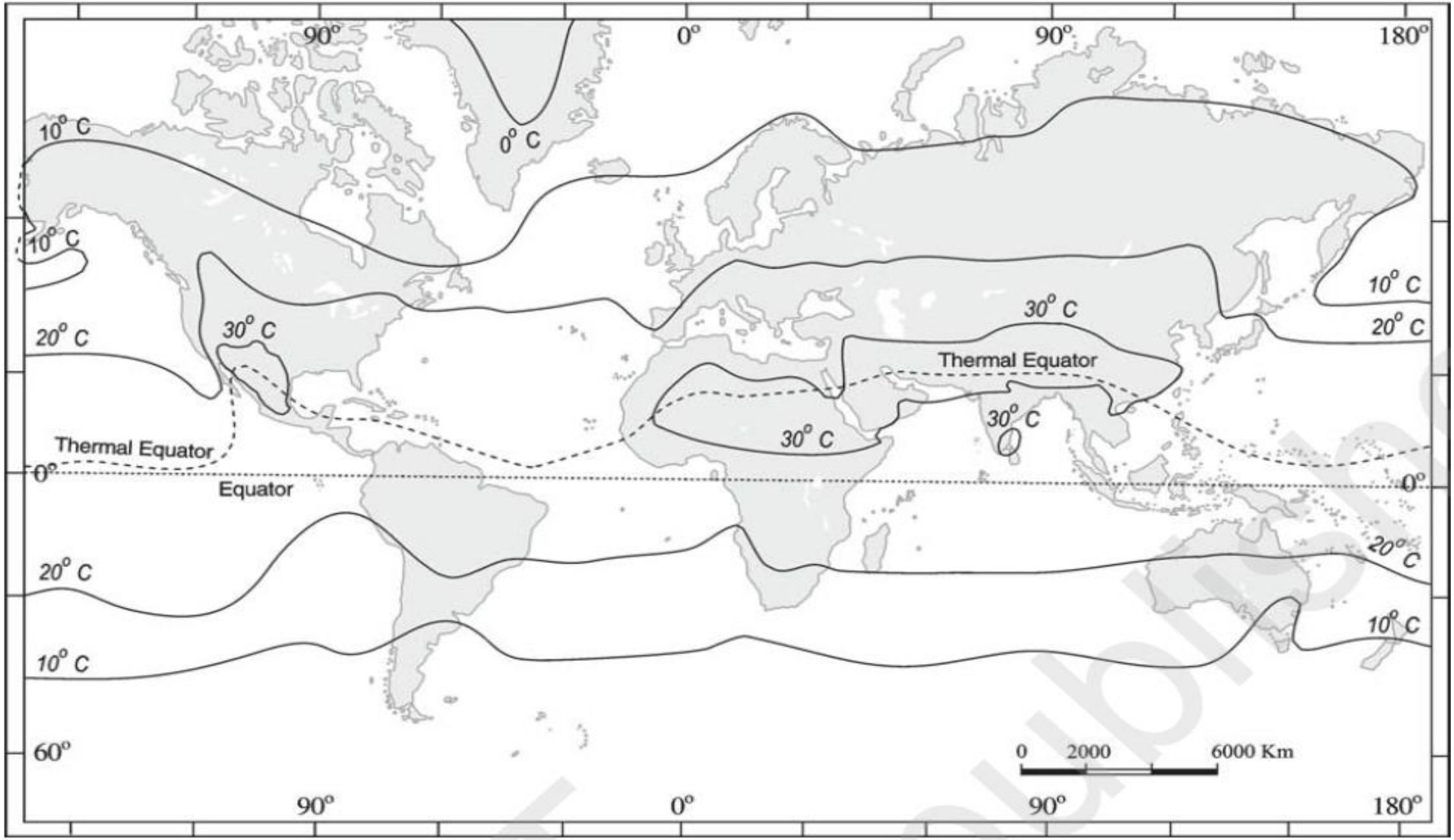

Figure 9.4 (b) : The distribution of surface air temperature in the month of July

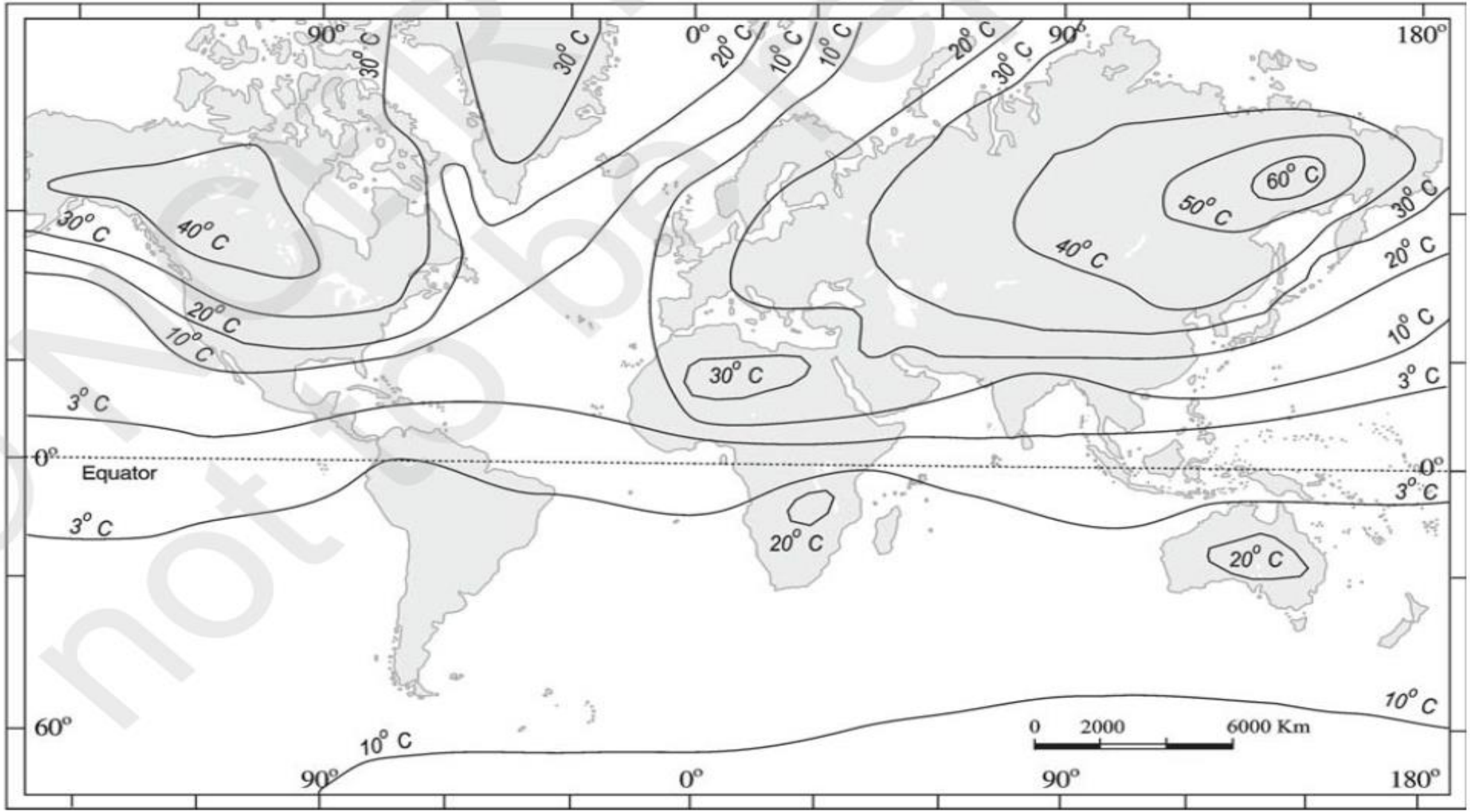

Figure 9.5 : The range of temperature between January and July