1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 01 (Class XI, Semester - 1)
Module Name/Title	Temperature – Part 2
Module Id	kegy_20902
Pre-requisites	Basic understanding of the composition and structure of the atmosphere and solar radiation
Objectives	After reading this lesson, learners will be able to know about: • Explain the factors affecting distribution of temperature • Explain the various factors affecting the horizontal distribution of temperature; • Explain with the help of map, the main characteristics of temperature distribution in the world in the month of January and July; λ • Explain the conditions in which inversion of temperature occurs.
Keywords	Isotherms, Lapse rate, Inversion of temperature

2. Development Team

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Introduction

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. All places possess some heat although some have more heat than others. The temperature of a place is a measure of the amount of heat a place possesses, and it gives us an idea of the degree of 'hotness' or 'coldness' of the place. Temperature may be expressed in various units, but degrees centigrade (˚C) and degrees Fahrenheit (˚F) are the most commonly used units.

Temperature indicates the relative degree of heat of a substance. Heat is the energy which make things or objects hot, while temperature measures the intensity of heat. Although quite distinct from each other, yet heat and temperature are closely related because gain or loss of heat is necessary to raise or lower the temperature. The celsius scale, named after the swedish astronomer. Anders Celsius, is accepted internationally by Scientists for reporting air temperature. The historical temperature records of several English-speaking countries include values on the Fahrenheit scale, Fahrenheit temperatures may be converted to their celsius equivalents by the formula 5 C (F 32) 9 ₀ ⁱⁱ . Moreover, difference in temperature determines the direction of flow of heat. This we can understand by studying temperature distribution.

Source:- MODULE - 4 Insolation and Temperature 174 Notes The domain of Air on the Earth NIOS

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. Latitude is the angular distance (measured in degrees) to the north and south of the equator. Generally speaking, temperature decreases as one moves towards higher latitudes. This happens due to two main reasons. Away from the equator, the angle of incidence of sun rays is less than 90°, thus solar radiation is spread over a larger area .Therefore, less intense heating takes place, causing temperature to become lower. Secondly, the smaller the angle of incidence of sun rays, the greater the distance through the atmosphere the rays have to pass. More heat is thus absorbed by the atmosphere or reflected back into outer space, which results in less heat reaching the earth's surface.

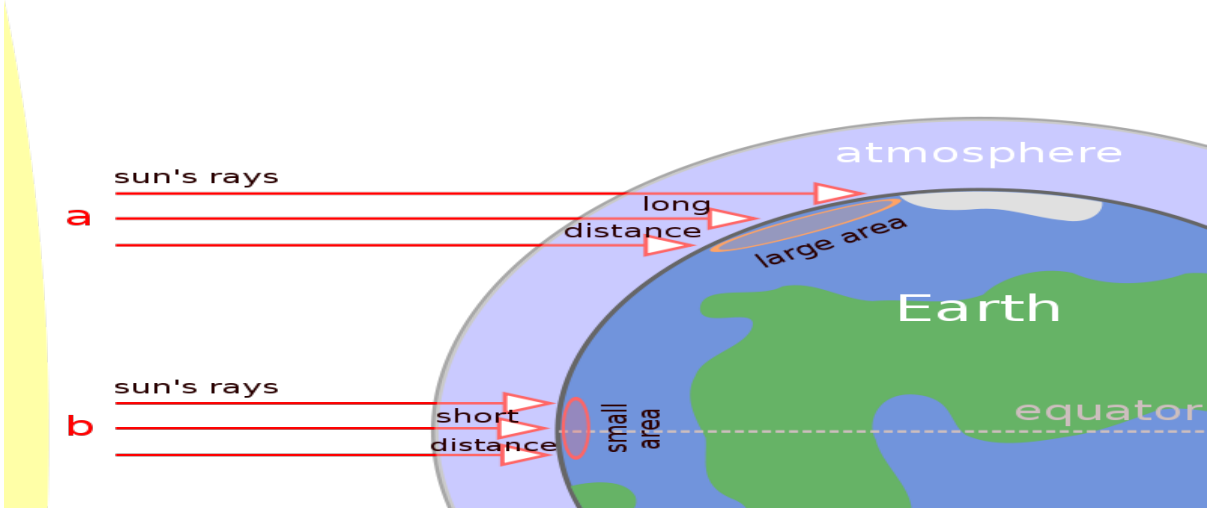

Fig.No 01 Effect of the Earth's shape and atmosphere on incoming solar radiation

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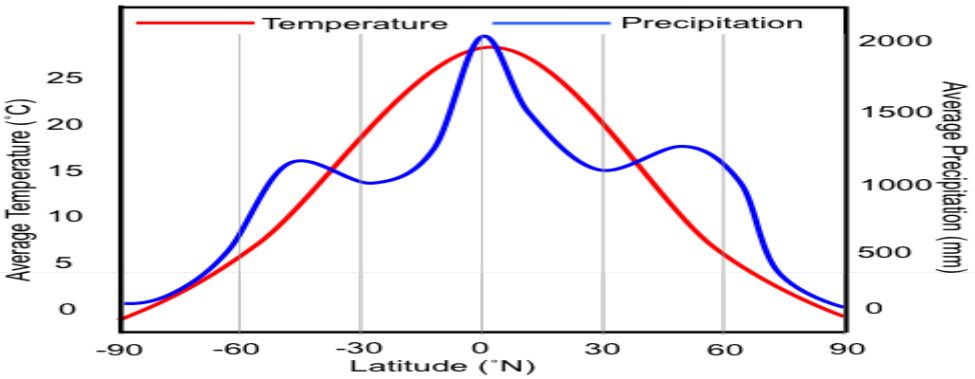

Fig.No 02 Relationship between latitude vs.temperature andnprecipitation

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Higher the angle of incidence, higher is the temperature. Lower angle of incidence leads to

the lowering of temperature. It is because of this that higher temperatures are found in tropical regions and they generally decrease at a considerable rate towards the poles. Temperature is below freezing point near the poles almost throughout the year.

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. The air at high altitudes is less dense. The concentration of greenhouse gases, dust and water vapour (which are good at absorbing heat) is lower than at sea level. Thin air is unable to absorb heat as effectively as the dense air at sea level because there are fewer molecules to trap heat. Thus places at higher altitudes have a lower temperature.

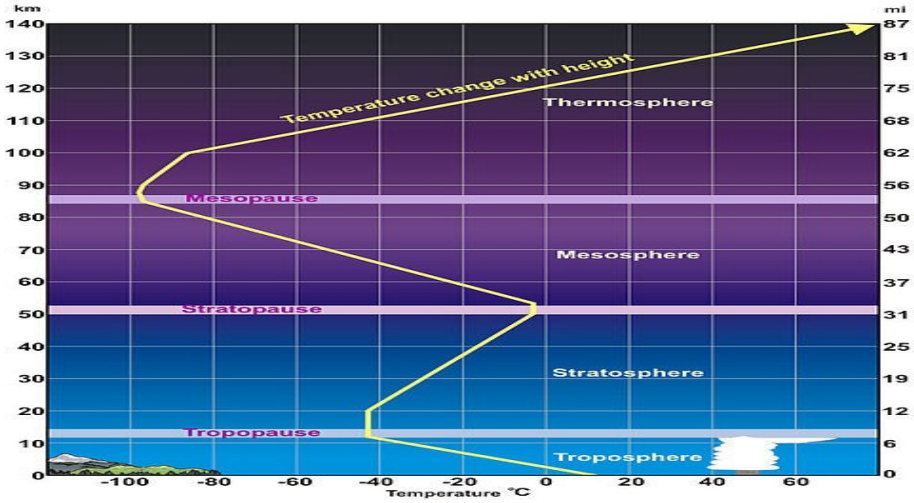

Fig.No 03 Altitude

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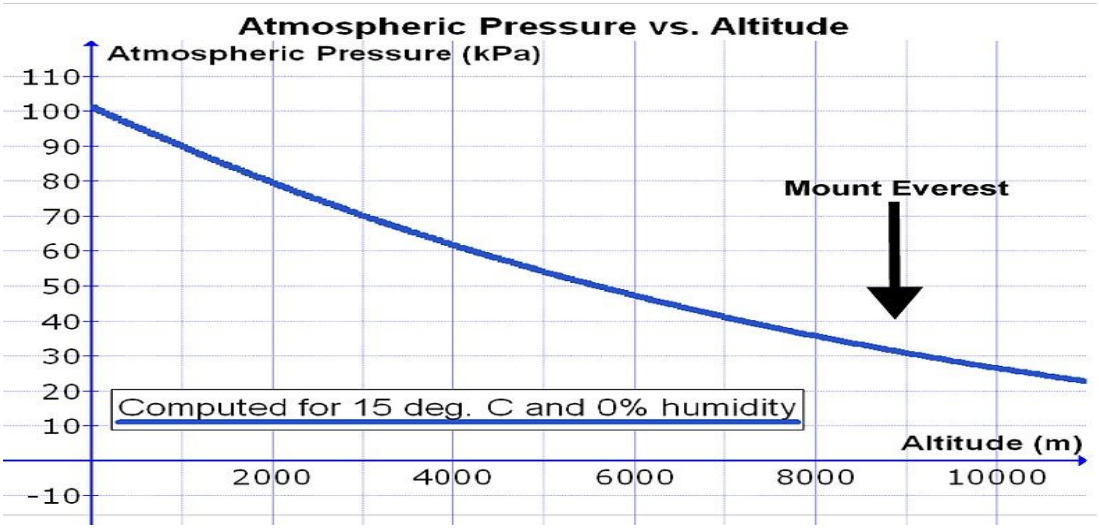

Fig.No.04 Altitude and Air Pressure

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Distance from the sea:

Another factor that influences the temperature is the location of a place with respect to the sea. Compared to land, the sea gets heated slowly and loses heat slowly. Land heats up and cools down quickly. Therefore, the variation in temperature over the sea is less compared to land. The places situated near the sea come under the moderating influence of the sea and land breezes which moderate the temperature. The, places having an inland location have higher temperatures during the day and in summer. Similarly, these places have lower temperatures at night and in winter than places closer to the sea, even if the latitude is the same.

Air-mass and Ocean currents:

Like the land and sea breezes, the passage of air masses also affects the temperature. The places, which come under the influence of warm air-masses experience higher temperature and the places that come under the influence of cold airmasses experience low temperature. . For example, the southwest monsoon is the prevailing wind in India in summer. A wind blowing from a colder area to a warmer area will lower the temperature of that area and vice versa.

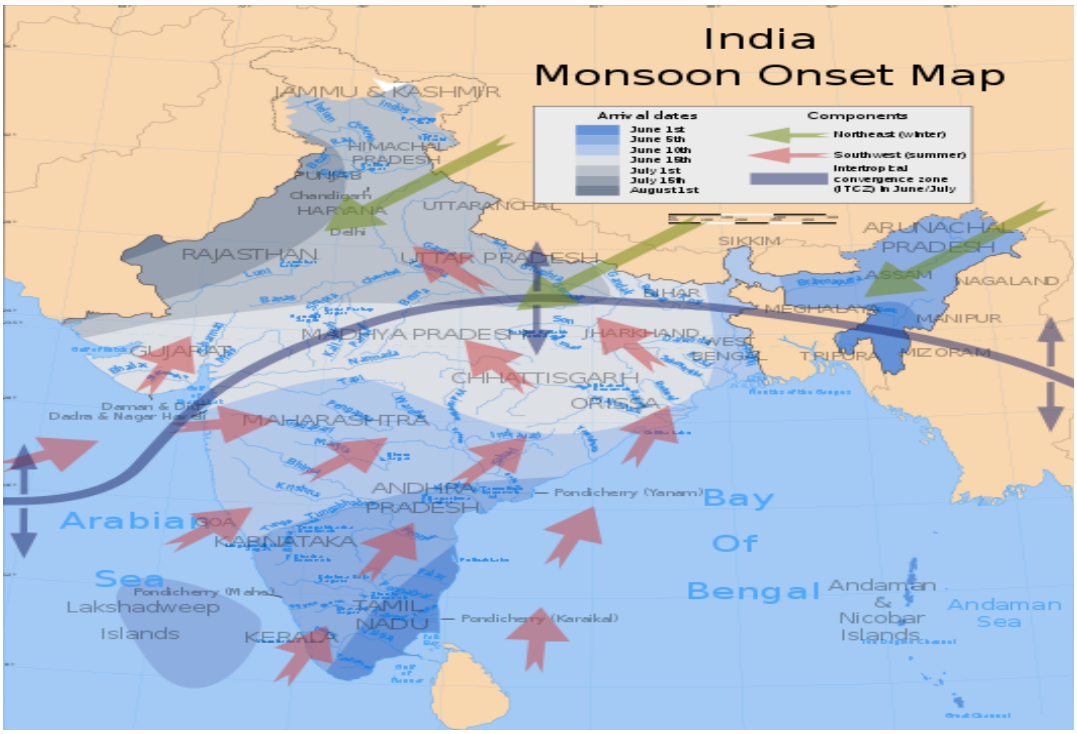

Fig. No 05 India southwest summer monsoon onset

https://commons.wikimedia.org/wiki/File:India_southwest_summer_monsoon_onset_map_en.svg

Similarly, the places located on the coast where the warm ocean currents flow record higher temperature than the places located on the coast where the cold currents flow. For example, the warm North Atlantic Drift causes parts of coastal Europe to be warmer in January as compared to other places on the same latitude. On the other hand, New York is very cold because of the cold Labrador current. The effect of the ocean current is more pronounced if the wind blows from the ocean to the land.

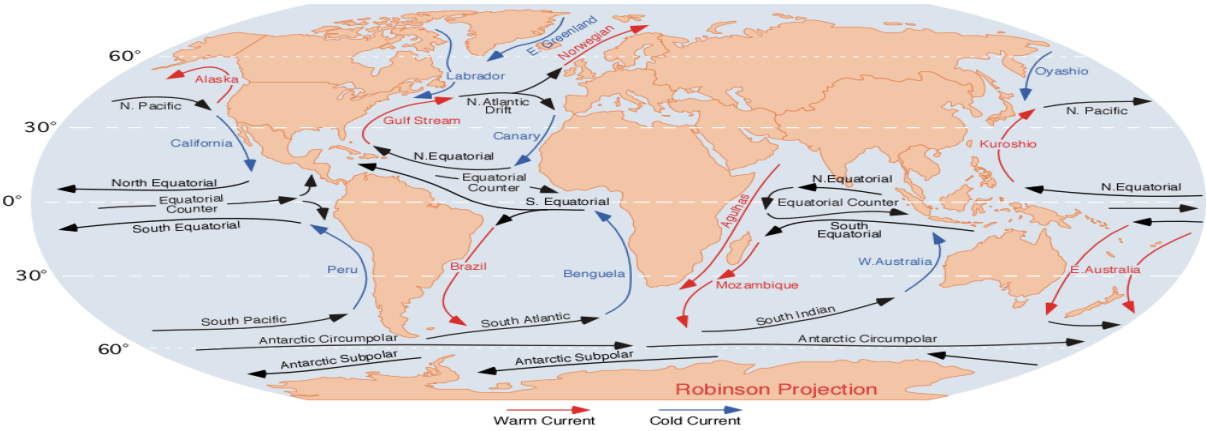

Fig.No 06 Ocean current

https://en.wikipedia.org/wiki/Ocean_current#/media/File:Corrientes-oceanicas.png

LOCAL ASPECTS

Vegetation Cover: Soil devoid of vegetation cover receives heat more rapidly than the soil under vegetation cover. Because vegetation cover absorbs much of sun's heat and then prevents quick radiation from the earth whereas the former radiates it more rapidly. Hence the temperature variations in dense forested areas are lower than those in desert areas. For example annual range of temperature in equatorial regions is about 5°C while in hot deserts, it is as high as 38°C.

Nature of the Soil: Colour, texture and structure of soils modify temperature to a great degree. Black, yellow and clayey soils absorb more heat than sandy soils. Likewise heat radiates more rapidly from sandy soils than from black, yellow and clayey soils. Hence temperature contrasts are relatively less in black soil areas than those of sandy soils. (viii) Slope and Aspect : Angle of the. slope and its direction control the receipt of insolation. The angle of incidence of sun's rays is greater along a gentler slope and smaller along a steeper slope. The ray in both the cases carry an equal amount of solar energy. Greater concentration of solar energy per unit area along gentler slope raises the temperature while its lesser concentration along steeper slopes lowers the temperature. For such reasons, the southern slopes of the Himalaya are warmer than the northern ones. At the same time the slopes, in terms of aspect, exposed to the sun receive more insolation and are warmer than those which are away from the direct rays of the sun. The northern slopes of the Himalaya for example,

not facing the sun are exposed to cold northernly winds are obviously colder. On the other hand the southern slopes of the Himalaya are sun-facing and are also shelter from the northernly cold winds are warmer. Hence we observesettlements and cultivation largely on the southern slopes of the Himalaya while the northern slopes are more under forest area.

Relief:- Mountains act as barriers against the movement of winds. The Himalayan ranges prevent cold winds of Central Asia from entering India, during winter. Because of this Kolkata is not as cold as Guangzhou (Canton) in winter though both are situated almost on the same latitude.

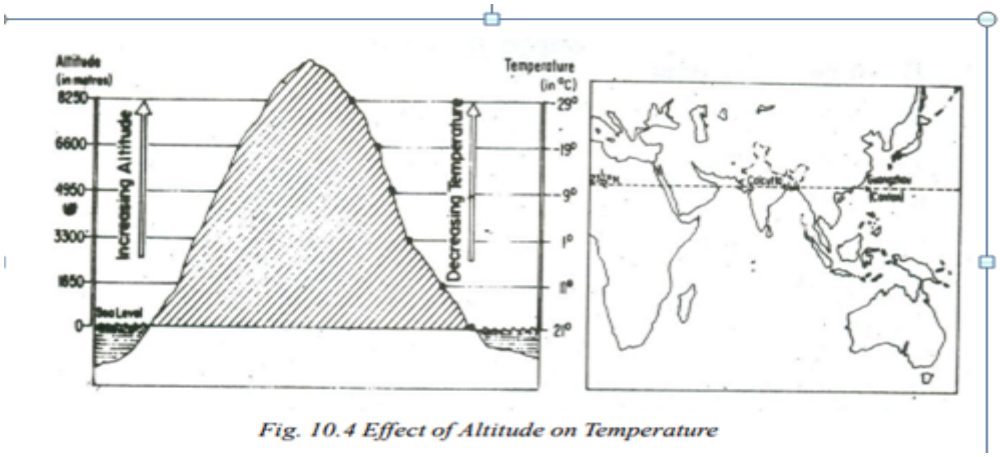

Fig. 10.4 Effect of Altitude on Temperature

Land and Sea Contrast: Land and sea contrast affects temperature to a great extent. Land gets heated more rapidly and to a greater degree than water during sunshine. It also cools down more rapidly than water during night. Hence, temperature is relatively higher on land during day time and it is higher in water during night. In the same way there are seasonal contrasts in temperature. During summer the air above land has higher temperature than the oceans. But the air above oceans gets higher temperature than landmasses in winter. Not withstanding the great contrast between land and water surfaces, there are differences in the rate of heating of different land surfaces. A snow covered land as in polar areas warms very slowly because of the large amount of reflection of solar energy. A vegetation covered land does not get excessively heated because a great amount of insolation is used in evaporating water from the plants.

Winds: Winds also affect temperature because they transport heat from one region to the other, about which you have already studied under advection.

Source;- MODULE - 4 Insolation and Temperature 174 Notes The domain of Air on the Earth NIOS

Distribution of Temperature

Horizontal 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. In general the effect of the latitude on temperature is well pronounced on the map, as the isotherms are generally parallel to the latitude. The deviation from this general trend is more pronounced in January than in July, especially in the northern hemisphere. In the northern hemisphere the land surface area is much larger than in the southern hemisphere. Hence, the effects of land mass and the ocean currents are well pronounced. In January the isotherms deviate to the north over the ocean and to the south over the continent. This can be seen on the North Atlantic Ocean. The presence of warm ocean currents, Gulf Stream and North Atlantic drift, make the Northern Atlantic Ocean warmer and the isotherms bend towards the north. Over the land the temperature decreases sharply and the isotherms bend towards south in Europe. It is much pronounced in the Siberian plain. The mean January temperature along 60° E longitude is minus 20° C both at 80° N and 50° N latitudes. The mean monthly temperature for January is over 27° C, in equatorial oceans over 24° C in the tropics and 2° C - 0° C in the middle latitudes and –18° C to –48° C in the Eurasian continental interior.

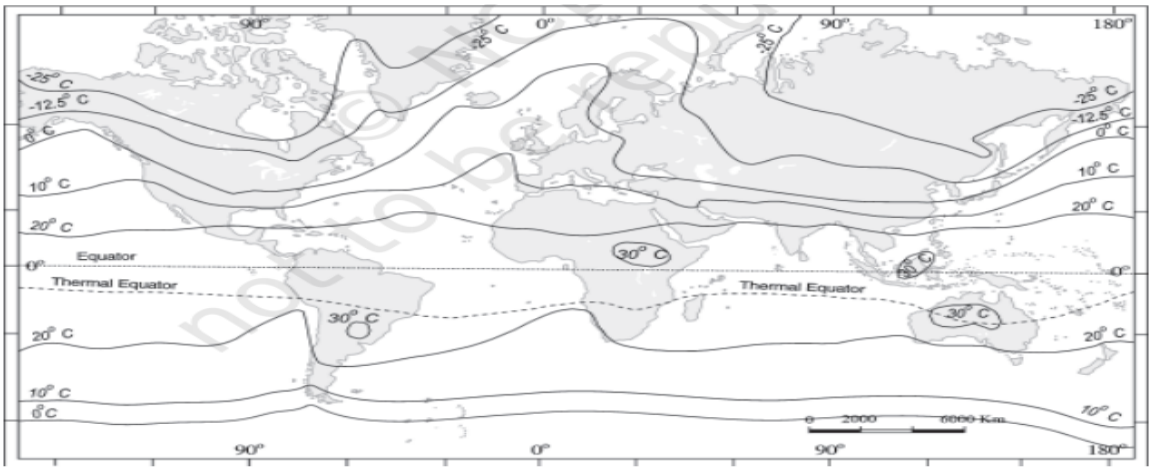

Figure 9.4 (a) : The distribution of surface air temperature in the month of January

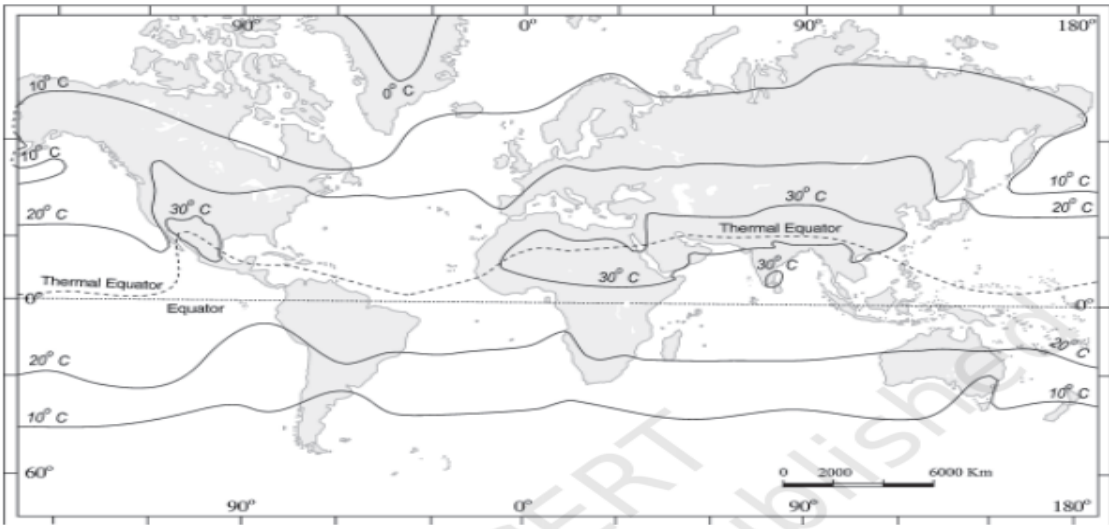

Figure 9.4 (b) : The distribution of surface air temperature in the month of July

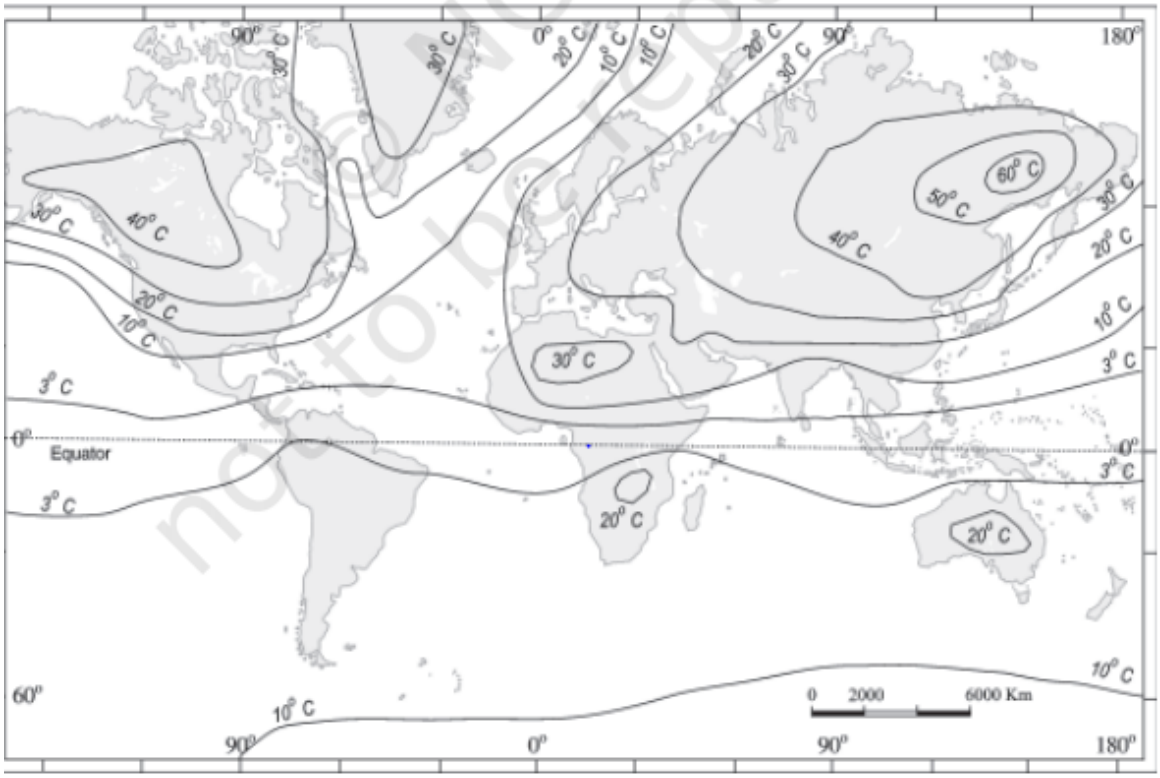

Figure 9.5 : The range of temperature between January and July

The effect of the ocean is well pronounced in the southern hemisphere. Here the isotherms are more or less parallel to the latitudes and the variation in temperature is more gradual than in the northern hemisphere. The isotherm of 20° C, 10° C, and 0° C runs parallel to 35° S, 45° S and 60° S latitudes respectively. In July the isotherms generally run parallel to the latitude. The equatorial oceans record warmer temperature, more than 27°C. Over the land more than 30°C is noticed in the subtropical continental region of Asia, along the 30° N latitude. Along the 40° N runs the isotherm of 10° C and along the 40° S the temperature is 10° C. Figure 9.5 shows the range of temperature between January and July. The highest range of temperature is more than 60° C over the north-eastern part of Eurasian continent. This is due to continentality. The least range of temperature, 3°C, is found between 20° S and 15° N.

A comparison between the January and July isotherm maps reveals the following important characteristics.

The latitudinal shifting of highest temperature as a result of migration of the vertical rays of the sun. The occurance of highest values in the low latitudes and the lowest value in the high latitudes is due to the decreasing insolation from equator to the poles. In northern hemisphere the isotherms on leaving the land usually bend rather sharply towards poles in winter and towards the equator in the summer. This behaviour of the isotherms is due to the differential

heating and cooling of landmasses. The continents are hotter in the summer and colder in the winter than the oceans.

Vertical Distribution of Temperature

The permanent snow on high mountains, even in the t ropics, indicate the decrease of temperature with altitude. Observations reveal that there is a fairly regular decrease in temperature with an increase in altitude. The average rate of temperature decrease upward in the troposphere is about 60C per km, extending to the tropopause. This vertical gradient of temperature is commonly referred to as the standard atmosphere or normal lapse rate, but is varies with height, season, latitude and other factors. Indeed the actual lapse rate of temperature does not always show a decrease with altitude.

Source;- MODULE - 4 Insolation and Temperature 174 Notes The domain of Air on the Earth NIOS

INVERSION OF TEMPERATURE Normally, temperature decreases with increase in elevation. It is called normal lapse rate. At times, the situations is reversed and the normal lapse rate is inverted. It is called Inversion of temperature. Inversion is usually of short duration but quite common nonetheless. A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is cooler than the air above. Over polar areas, temperature inversion is normal throughout the year. Surface inversion promotes stability in the lower layers of the atmosphere. Smoke and dust particles get collected beneath the inversion layer and spread horizontally to fill the lower strata of the atmosphere. Dense fogs in mornings are common occurrences especially during winter season. This inversion commonly lasts for few hours until the sun comes up and beings to warm the earth. The inversion takes place in hills and mountains due to air drainage. Cold air at the hills and mountains, produced during night, flows under the influence of gravity. Being heavy and dense, the cold air acts almost like water and moves down the slope to pile up deeply in pockets and valley bottoms with warm air above. This is called air drainage. It protects plants from frost damages.

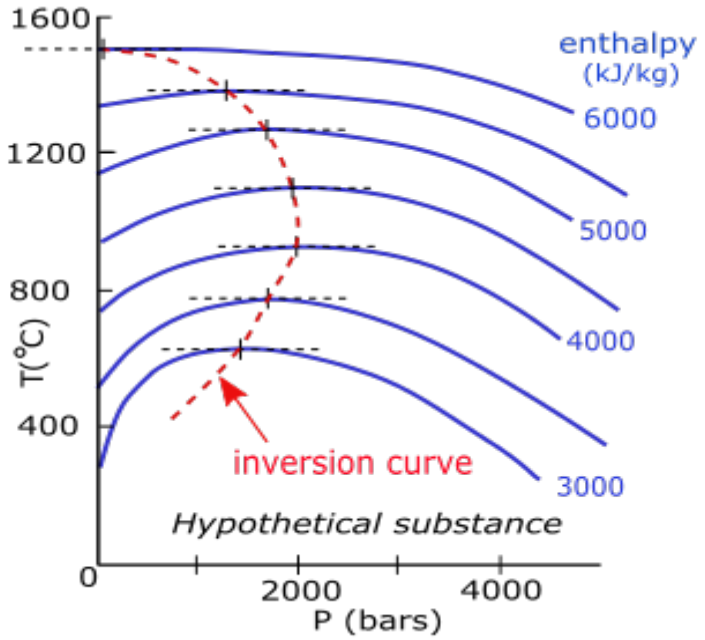

Fig.No. 07 Inversion of Temperature

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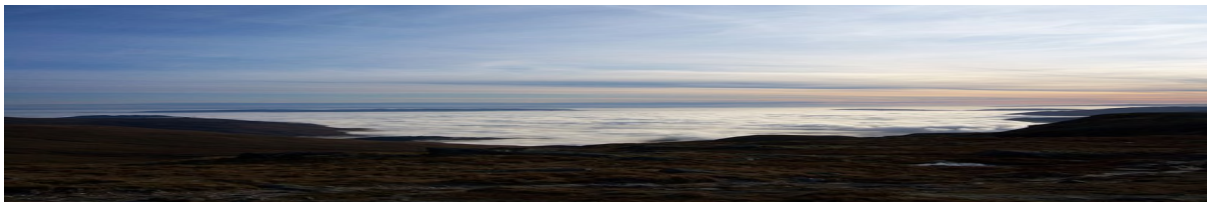

Fig.No 08 Temperature Inversion

https://commons.wikimedia.org/wiki/File:Temperature_Inversion_-_Flickr_-_Graham_Grinner_Lewis_(1).jpg

Plank's law states that hotter a body, the more energy it will radiate and shorter the wavelength of that radiation. Specific heat is the energy needed to raise the temperature of one gram of substance by one Celsius.