Contents

CHAPTER 1. CLIMATOLOGY

WEIGHTAGE & TIPS (CLIMATOLOGY)

Please refer to the weightage of this topic (Chapter 1: Climatology of Book 5: Building Services & Environment) from GATE 2011 to GATE 2023 tabulated below:

GATE YEAR	WEIGHTAGE (Marks)
2023	4
2022	8
2021	5
2020	7
2019	5
2018	6
2017	0
2016	3
2015	5
2014	2
2013	0
2012	7
2011	4
Average	**4 Marks**

Students are advised to remember the following points, before you start studying this Chapter:

- The basics of this subject are covered under Section 3: Environmental Planning and Design of Part A (Common Part). Thermal quantities and Solar Architecture are covered under Section B1.3: Building Services and Sustainability (Architecture Part). However clear subdivision of topics into Common and Architecture Part is difficult in this subject.
- In recent past this chapter had a high weightage in GATE (like 8 marks in GATE 2022 and 7 marks in GATE 2020). This shows how important this subject can be for good GATE score.
- The important areas of this chapter for numerical questions are calculations related to conductive heat gain and U-value calculations, Solar Architecture and Ventilation.
- The topic of Solar Architecture, though small, can be important from both theory and numerical questions point of view.
- Theory parts like Passive design techniques; Climate and climate responsive design; various measuring instruments; etc., are also important for the exam.

Scan the QR Code to Watch the Video:
Introduction to Chapter 1 - Climatology

1.1 CLIMATE & DESIGN

1.1.1 Climatic Factors

Three important factors which affect climate of a place are;

(i) Solar Radiation and Temperature

(ii) Humidity conditions

(iii) Prevailing winds

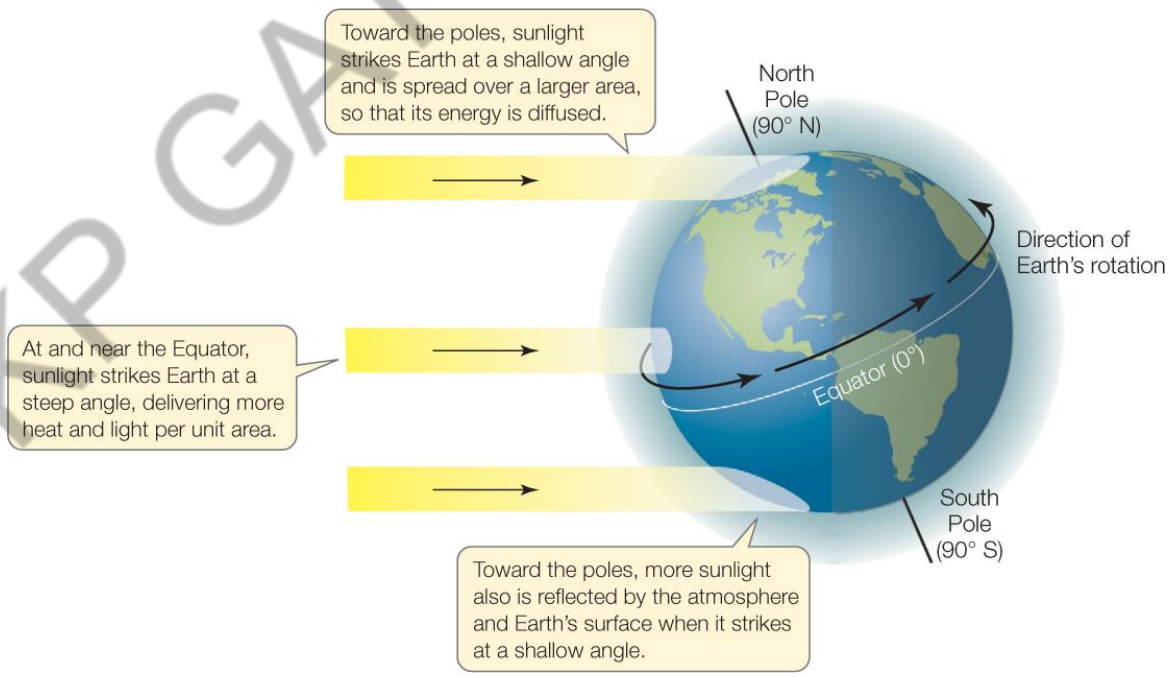
Other factors which affect climate of a place are; topography, distance from the sea, ocean currents, sky condition etc. However, these additional factors indirectly affect climate by influencing the three important factors listed above.

Further details regarding how the three important factors listed above influence climate, are discussed below;

(i) Solar Radiation and Temperature: Solar radiation and Temperature of a place are mainly influenced by the latitude and altitude of the place. Solar radiation is also dependent on sky condition.

Based on Latitude: The angle of incoming solar radiation influences seasonal temperatures of locations at different latitudes. When the sun's rays strike Earth's surface near the equator, the incoming solar radiation is more direct (nearly perpendicular or closer to a 90˚ angle). Therefore, the solar radiation is concentrated over a smaller surface area, causing warmer temperatures.

At higher latitudes, the angle of solar radiation is smaller, causing energy to be spread over a larger area of the surface and cooler temperatures. Because the angle of radiation varies depending on the latitude, surface temperatures on average are warmer at lower latitudes and cooler at higher latitudes (even though higher latitudes have more hours of daylight during the summer months).



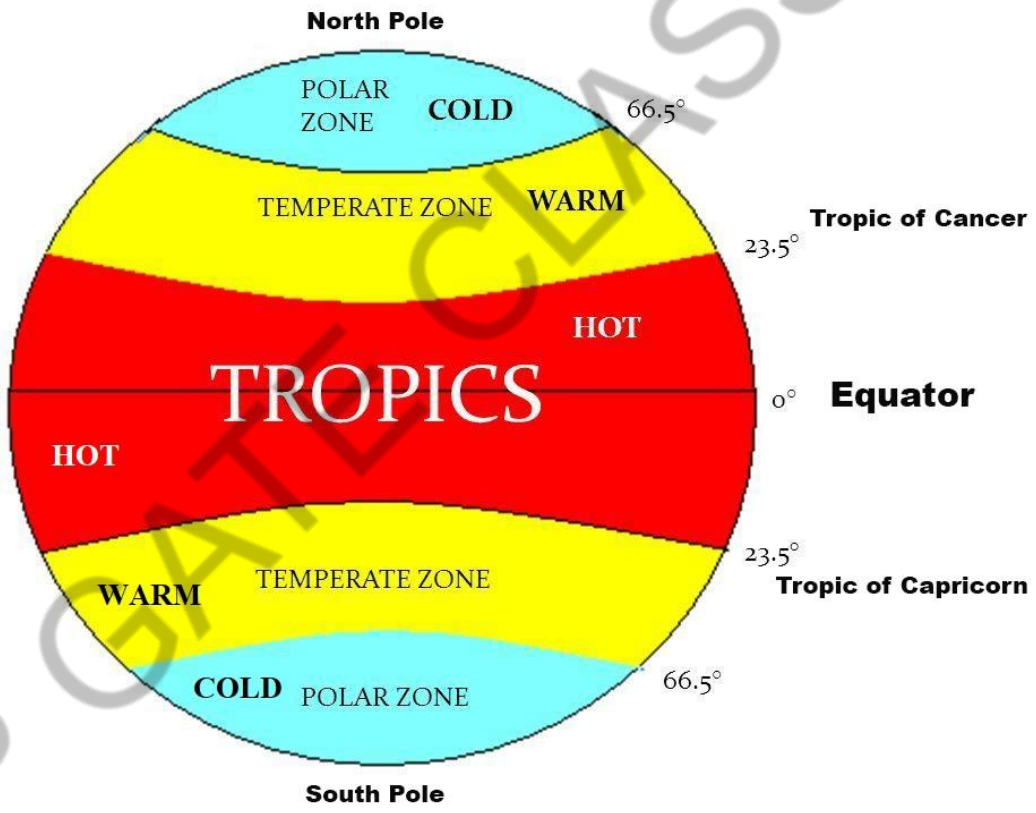
Based on this concept that the average temperatures reduce moving away from the equator and average temperatures are higher closer to the equator (which is 0-degree latitude); earth is divided into three zones;

(a) Tropical Zone (on either side of the equator, bound between tropic of cancer and tropic of Capricorn) – Hottest zone

(b) Temperate Zone (on either side of tropical zone, bounded by arctic circle and Antarctic circle) – Moderate temperature zone

(c) Polar zone (Arctic polar region and Antarctic polar region includes latitudes greater than Arctic circle in the North and Antarctic circle in the South)

The above discussed zones and corresponding boundary lines of these zones are shown in the image given below. The boundary lines are, namely; Tropic of Cancer (23°26′11.8″ North Latitude); Tropic of Capricorn (23°26′11.8″ South Latitude); Arctic Circle (66°33′48.2″ North Latitude) and Antarctic Circle (66°33′48.2″ South Latitude).



NOTE: Solar constant is the rate at which energy reaches the earth's surface from the sun, on an average. It is usually taken to be 1,388 watts per square metre.

Based on Altitude: Temperatures decrease with height (in the troposphere of earth's atmosphere). The air is less dense and cannot hold heat as easily. The temperature usually decreases by 1°C for every 100 metres in altitude.

The graph below shows the variation of temperature with rise in altitude, across the layers of atmosphere. The decrease in temperature with rise in altitude (marked with an ellipse in the graph)

can be observed in the troposphere (within which all the geographical locations of earth's topography exist).

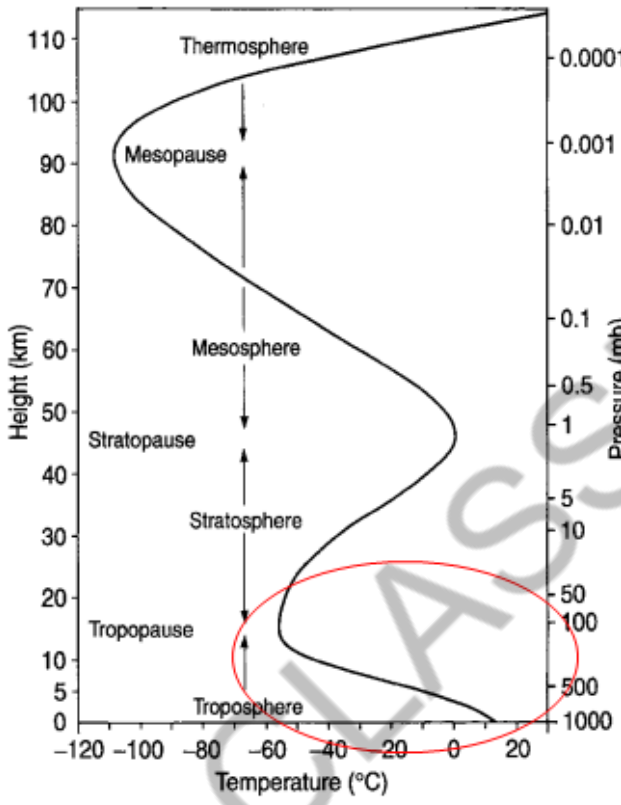


Fig. 1.3. Zonal mean vertical profile of temperature during June at 45°N.

(ii) Humidity Conditions: Humidity refers to the presence of **water vapor** in the air, and affects how warm the air feels to us.

In general, warm temperatures feel even warmer as the humidity increases because, as it increases, the speed at which water evaporates at any given temperature decreases. When we are warm, our bodies depend on the evaporation of water from the surface of our skin for cooling; therefore, high humidity slows down our body's natural cooling mechanism.

Measurements of humidity are recognized in several different ways. Humidity is generally quantified in terms of **relative humidity**, given as a percentage and referring to the amount of moisture in the air relative to the air's capacity to hold moisture. Other terms related to measure of humidity are discussed under the topic of 'Psychrometric Properties' in this Chapter.

It is important to note that humidity is higher in coastal regions, resulting in humid climates.

(iii) Prevailing Winds: Winds are basically convection currents in the atmosphere, tending to even out the differential heating of various zones. The pattern of movements is modified by the earth's rotation.

At the maximum heating zone (which is somewhere between the tropics of Cancer and Capricorn) air is heated by the hot surface, it expands, its pressure decreases and air becomes lighter. Lighter air rises vertically and flows off at a high level towards colder regions. Part of this air, having cooled down at the high level, descends to the surface in the subtropic regions, from where the cooler, heavier air is drawn in towards the Equator from both north and south.

The area where the air rises, where these northerly and southerly winds meet, where the 'tropical front' is formed, is referred to as the **"inter-tropical convergence zone" (ITCZ).** This area experiences either completely calm conditions or only very light breezes of irregular directions and is referred to by the sailors as 'doldrums'.

Global wind patterns are defined by trade-winds and the Coriolis force. The figure below shows global pattern of thermal air movements – which is further discussed below.