

1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 01 (Class XI, Semester - 1)
Module Name/Title	World Climate – Part 1
Module Id	keyg_11201
Pre-requisites	General understanding of world climate and classification of climate
Objectives	This lesson will make you understand- <ul style="list-style-type: none">• Explain the world climate,• Describe the classification of climate• Explain the Koeppen’s classification of climate.
Keywords	V. Koeppen, Climate, Koeppen’s scheme

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Table of Content:

1. Introduction
2. Koeppen's Sceme on classification of Climate
3. Conclusion

Climate is a mean of daily weather conditions as expressed by temperature, precipitation, pressure, winds and humidity taken over a long time. Temperature is regarded as basic factor of climate as other elements are directly or indirectly related to it. On the basis of temperature, the world has been divided into Torrid, Frigid and Temperate Zones. Rainfall patterns are similarly fundamental in establishing climatic regimes. As such wet, humid, sub-humid, semiarid and arid are common climatic description.

Variation in the amount, intensity, and seasonal distribution of the elements controlling weather and climate give rise to a great variety of climatic regions on the earth. A *climatic region* is defined as an area on the earth's surface, where an approximately homogeneous set of climatic conditions is produced by the combined effect of climatic controls. Different sets of climatic conditions are called *climatic types*

A classification system consists of arbitrary rules, which help, in separating, or segregating various features and phenomena into easily remembered groups. Hence, the objective or purpose of grouping is the key in designating a classification and also in the choice of criteria.

The ancient Greeks broadly divided the earth into winterless tropical region, the summer less polar regions and intermediate region having both winter and summer. This classification is too simple to be of much use, giving only a very generalised picture of temperature taking no account of precipitation.

The world climate can be studied by organizing information and data on climate and synthesizing them in smaller units for easy understanding, description and analysis. Three broad approaches have been adopted for classifying climate. They are

- a) Empirical: Empirical classification is based on observed data, particularly on temperature and precipitation.
- b) Genetic: Genetic classification attempts to organize climates according to their causes.
- c) Applied: Applied classification is for specific purpose.

Koepfen's Scheme of Classification of Climate

The most widely used classification of climate is the empirical climate classification scheme developed by V. Koepfen. The system is based on the concept that native vegetation is the best expression of climate. Koepfen identified a close relationship between the distribution of vegetation and climate. Thus, climate zone boundaries have been selected with vegetation distribution in mind. It combines average annual and monthly temperatures and precipitation, and the seasonality of precipitation.

He selected certain values of temperature and precipitation and related them to the distribution of vegetation and used these values for classifying the climates. It is an empirical classification based on mean annual and mean monthly temperature and precipitation data. He introduced the use of capital and small letters to designate climatic groups and types. Although developed in 1918 and modified over a period of time, Koepfen's scheme is still popular and in use.

Koepfen recognized five major climatic groups, four of them are based on temperature and one on precipitation. Table below lists the climatic groups and their characteristics according to Koepfen. The capital letters: A, C, D and E delineate humid climates and B dry climates.

Climatic Groups According to Koepfen

<i>Group</i>	<i>Characteristics</i>
A - Tropical	Average temperature of the coldest month is 18 °C or higher
B - Dry Climates	Potential evaporation exceeds precipitation
C - Warm Temperate	The average temperature of the coldest month of the (Mid-latitude) climates years is higher than minus 3 °C but below 18 °C
D - Cold Snow Forest Climates	The average temperature of the coldest month is minus 3 °C or below
E - Cold Climates	Average temperature for all months is below 10 °C
H - High Land	Cold due to elevation

The climatic groups are subdivided into types, designated by small letters, based on seasonality of precipitation and temperature characteristics. The seasons of dryness are indicated by the small letters: f, m, w and s, where f corresponds to no dry season, m - monsoon climate, w- winter dry season and s - summer dry season. The distribution of climatic groups and types is shown on the map

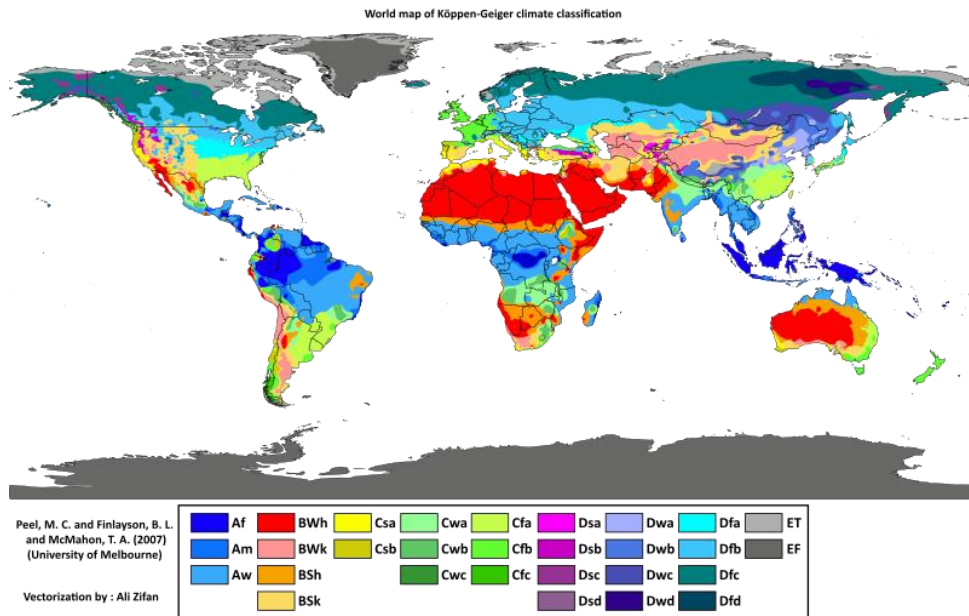


Fig. No. 01 Köppen Classification

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The small letters a, b, c and d refer to the degree of severity of temperature. The B- Dry Climates are subdivided using the capital letters S for steppe or semi-arid and W for deserts. The climatic types are listed in Table.

Group	Type	Letter Code	Characteristics
A-Tropical Humid Climate	Tropical wet	Af	No dry season
	Tropical monsoon	Am	Monsoonal, short dry season
	Tropical wet and dry	Aw	Winter dry season
B-Dry Climate	Subtropical steppe	BSh	Low-latitude semi arid or dry
	Subtropical desert	BWh	Low-latitude arid or dry
	Mid-latitude steppe	BSk	Mid-latitude semi arid or dry
	Mid-latitude desert	BWk	Mid-latitude arid or dry
C-Warm temperate (Mid-latitude) Climates	Humid subtropical	Cfa	No dry season, warm summer
	Mediterranean	Cs	Dry hot summer
	Marine west coast	Cfb	No dry season, warm and cool summer
D-Cold Snow-forest Climates	Humid continental	Df	No dry season, severe winter
	Subarctic	Dw	Winter dry and very severe
E-Cold Climates	Tundra	ET	No true summer
	Polar ice cap	EF	Perennial ice
H-Highland	Highland	H	Highland with snow cover

Group A: Tropical Humid Climates

Tropical humid climates exist between Tropic of Cancer and Tropic of Capricorn. The sun being overhead throughout the year and the presence of Inter Tropical Convergence Zone(ITCZ) make the climate hot and humid. Annual range of temperature is very low and annual rainfall is high. The tropical group is divided into three types, namely

- (i) Af- Tropical wet climate;
- ii) Am - Tropical monsoon climate;
- iii) Aw- Tropical wet and dry climate.

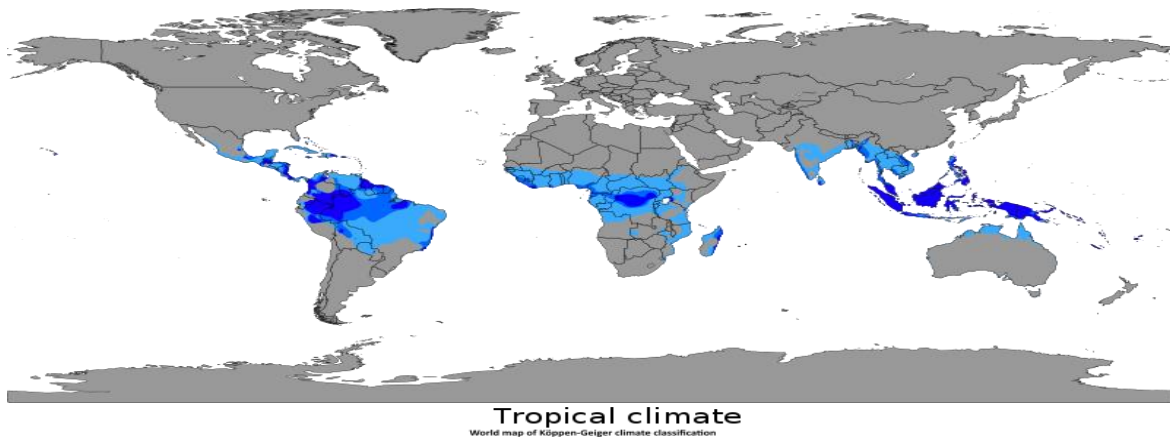


Fig. No. 02 Tropical humid climates

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Tropical Wet Climate (Af)

Tropical wet climate is found near the equator. The major areas are the Amazon Basin in South America, western equatorial Africa and the islands of East Indies. Significant amount of rainfall occurs in every month of the year as thunder showers in the afternoon. The temperature is uniformly high and the annual range of temperature is negligible. The maximum temperature on any day is around 30°C while the minimum temperature is around 20°C. Tropical evergreen forests with dense canopy cover and large biodiversity are found in this climate

Tropical dense evergreen forests with dense canopy cover and large biodiversity are found in this climate. It has a succession of vegetation right from the tallest trees to the creepers, grasses, ferns, mosses and fungi. The vegetation is so dense that it prevents the penetration of the sunlight, thus hampering the undergrowth. In winter season too, the trees do not shed their leaves altogether and so the forest appears to be evergreen. They are also known as Tropical rainforests or the selvas.



Fig. No. 03 Rainforests

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Tropical Monsoon Climate (Am)

Tropical monsoon climate (Am) is found over the Indian sub-continent, North Eastern part of South America and Northern Australia. Heavy rainfall occurs mostly in summer. Winter is dry. The detailed climatic account of this climatic type is given in the book on India: Physical Environment.

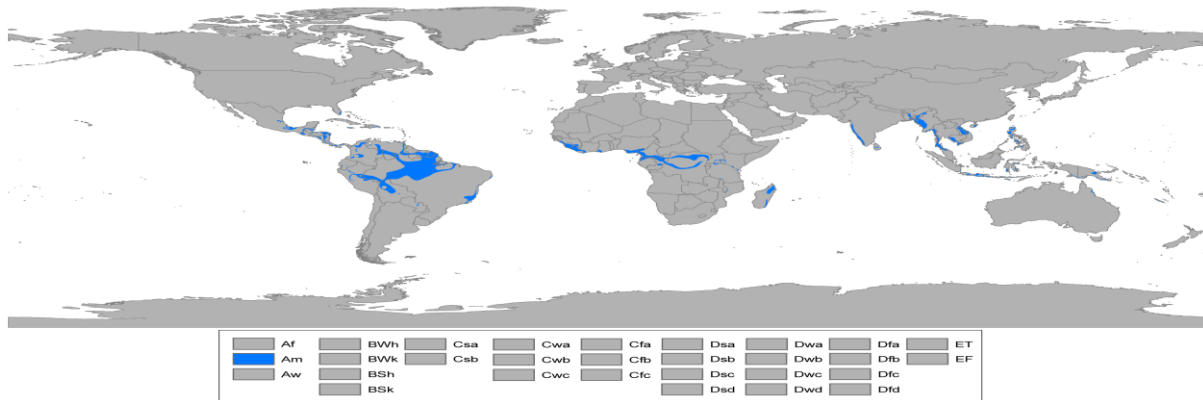


Fig. No. 04 Tropical monsoon climate

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Tropical Wet and Dry Climate (Aw)

Tropical wet and dry climate occurs north and south of Af type climate regions. It borders with dry climate on the western part of the continent and Cf or Cw on the eastern part. Extensive Aw climate is found to the north and south of the Amazon forest in Brazil and adjoining parts of Bolivia and Paraguay in South America, Sudan and south of Central Africa. The annual rainfall in this climate is considerably less than that in Af and Am climate types and is variable also. The wet season is shorter and the dry season is longer with the drought being more severe. Temperature is high throughout the year and diurnal ranges of temperature are the greatest in the dry season. Deciduous forest and tree-shredded grasslands occur in this climate.

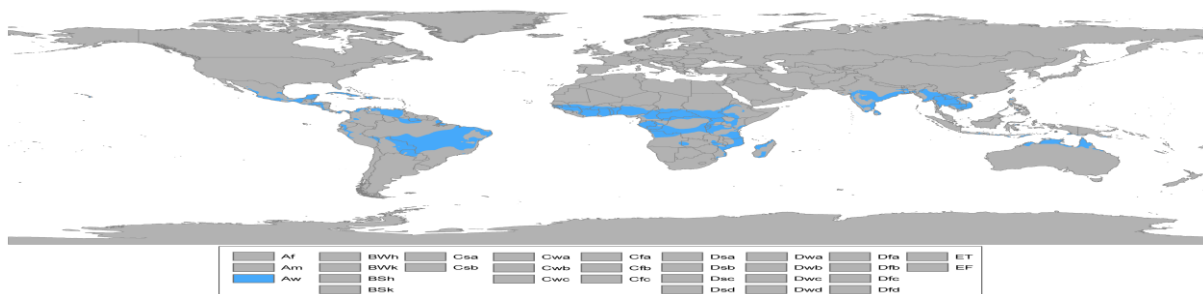
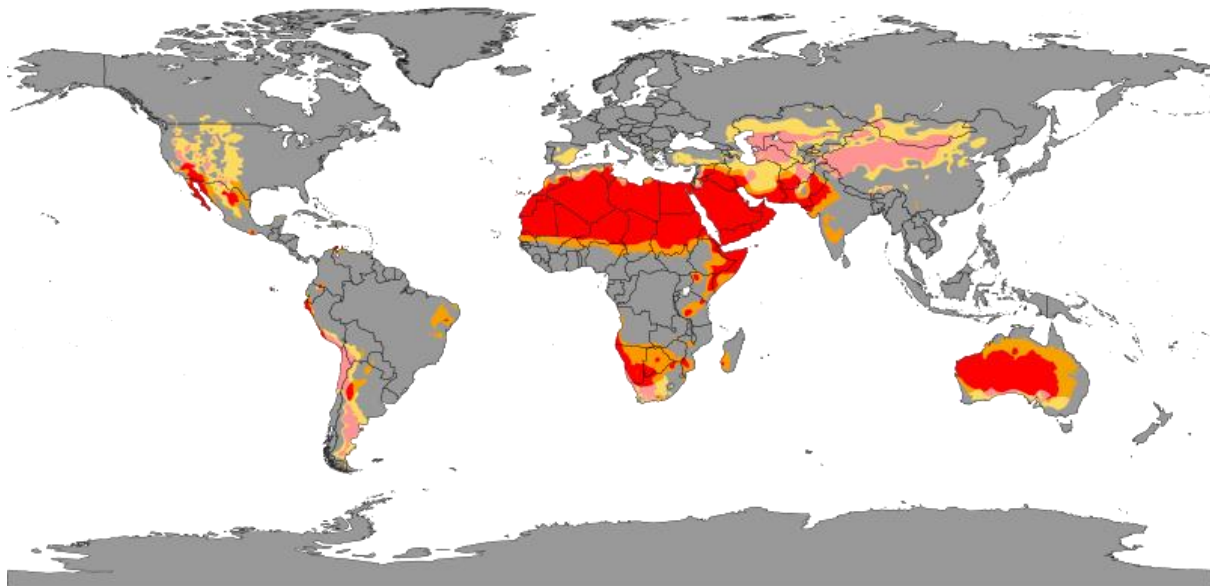


Fig. No. 04 Tropical Wet and Dry Climate

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Dry Climates: B



Dry climate

World map of Köppen-Geiger climate classification

Fig. No. 05 Dry climate

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Dry climates are characterised by very low rainfall that is not adequate for the growth of plants. These climates cover a very large area of the planet extending over large latitudes from 15° - 60° north and south of the equator. At low latitudes, from 15° - 30°, they occur in the area of subtropical high where subsidence and inversion of temperature do not produce rainfall. On the western margin of the continents, adjoining the cold current, particularly over the west coast of South America, they extend more equatorwards and occur on the coast land. In middle latitudes, from 35° - 60° north and south of equator, they are confined to the interior of continents where maritime-humid winds do not reach and to areas often surrounded by mountains.

Dry climates are divided into steppe or semi-arid climate (BS) and desert climate (BWh). They are further subdivided as subtropical steppe (BSh) and subtropical desert (BWh) at latitudes from 15° - 35° and mid-latitude steppe (BSk) and mid-latitude desert (BWk) at latitudes between 35° - 60°.

Subtropical Steppe (BSh) and Subtropical Desert (BWh) Climates

Subtropical steppe (BSh) and subtropical desert (BWh) have common precipitation and temperature characteristics. Located in the transition zone between humid and dry climates, subtropical steppe receives slightly more rainfall than the desert, adequate enough for the growth of sparse grasslands. The rainfall in both the climates is highly variable. The

variability in the rainfall affects the life in the steppe much more than in the desert, more often causing famine. Rain occurs in short intense thundershowers in deserts and is ineffective in building soil moisture. Fog is common in coastal deserts bordering cold currents. Maximum temperature in the summer is very high. The highest shade temperature of 58° C was recorded at Al Aziziyah, Libya on 13 September 1922. The annual and diurnal ranges of temperature are also high.

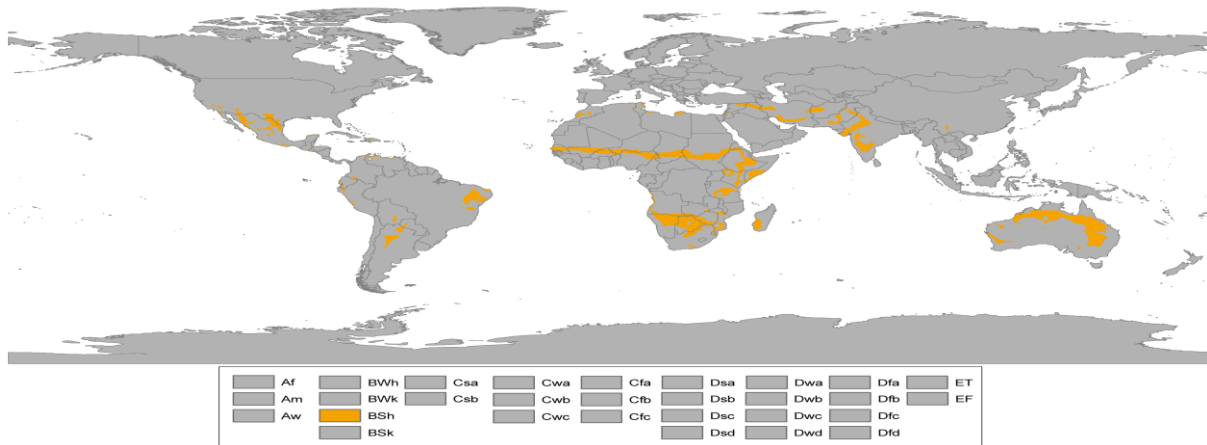


Fig. No. 06 Subtropical steppe

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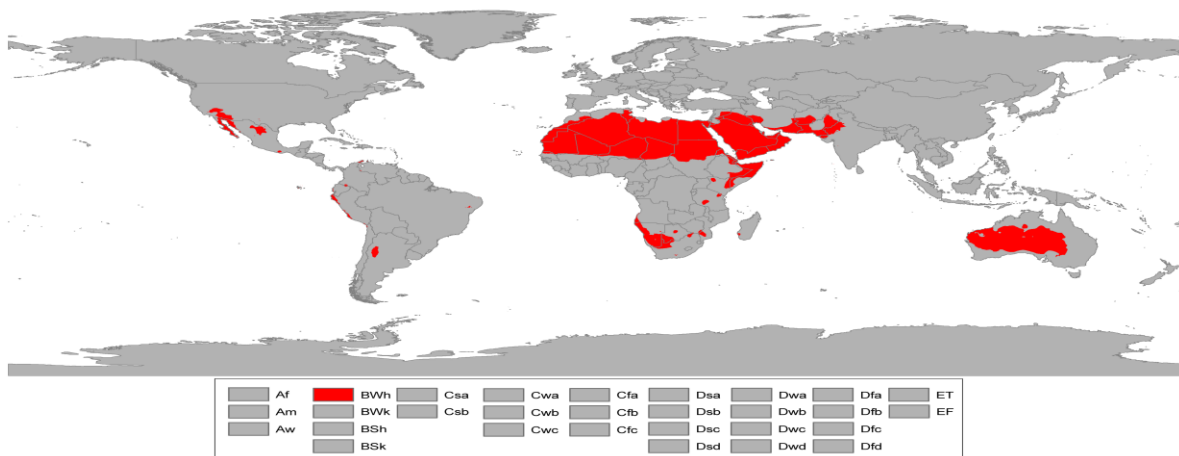


Fig. No. 07 Subtropical Desert

Warm Temperate (Mid-Latitude) Climates-C

Warm temperate (mid-latitude) climates extend from 30° - 50° of latitude mainly on the eastern and western margins of continents. These climates generally have warm summers with mild winters. They are grouped into four types: (i) Humid subtropical, i.e. dry in winter and hot in summer (Cwa); (ii) Mediterranean (Cs); (iii) Humid subtropical, i.e. no dry season and mild winter (Cfa); (iv) Marine west coast climate (Cfb).

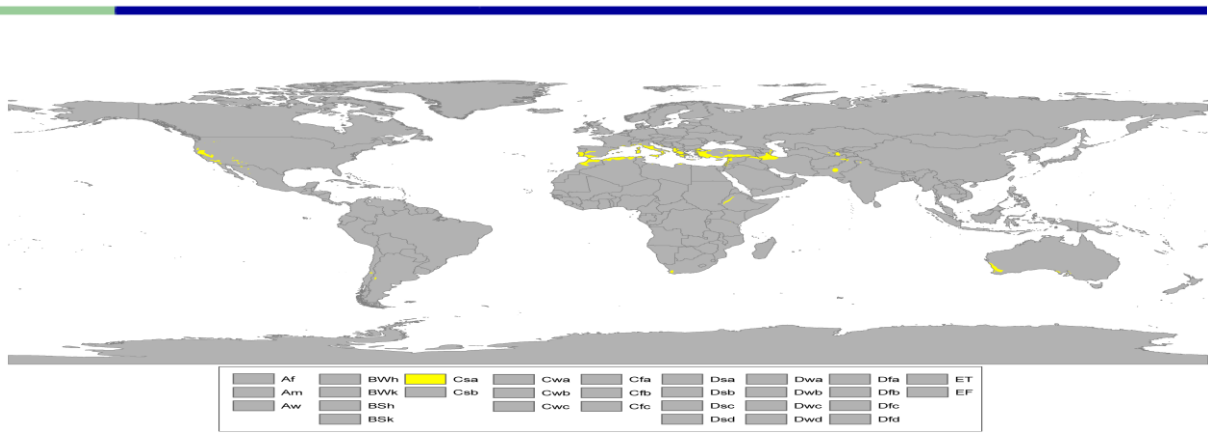


Fig. No. 10 Mediterranean climate

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Humid Subtropical (Cfa) Climate

Humid subtropical climate lies on the eastern parts of the continent in subtropical latitudes. In this region the air masses are generally unstable and cause rainfall throughout the year. They occur in eastern United States of America, southern and eastern China, southern Japan, northeastern Argentina, coastal south Africa and eastern coast of Australia. The annual averages of precipitation vary from 75-150 cm. Thunderstorms in summer and frontal precipitation in winter are common. Mean monthly temperature in summer is around 27°C, and in winter it varies from 5°-12° C. The daily range of temperature is small.

Marine West Coast Climate (Cfb)

Marine west coast climate is located poleward from the Mediterranean climate on the west coast of the continents. The main areas are: Northwestern Europe, west coast of North America, north of California, southern Chile, southeastern Australia and New Zealand. Due to marine influence, the temperature is moderate and in winter, it is warmer than for its latitude. The mean temperature in summer months ranges from 15°-20°C and in winter 4°-10°C. The annual and daily ranges of temperature are small. Precipitation occurs throughout the year. Precipitation varies greatly from 50-250cm.

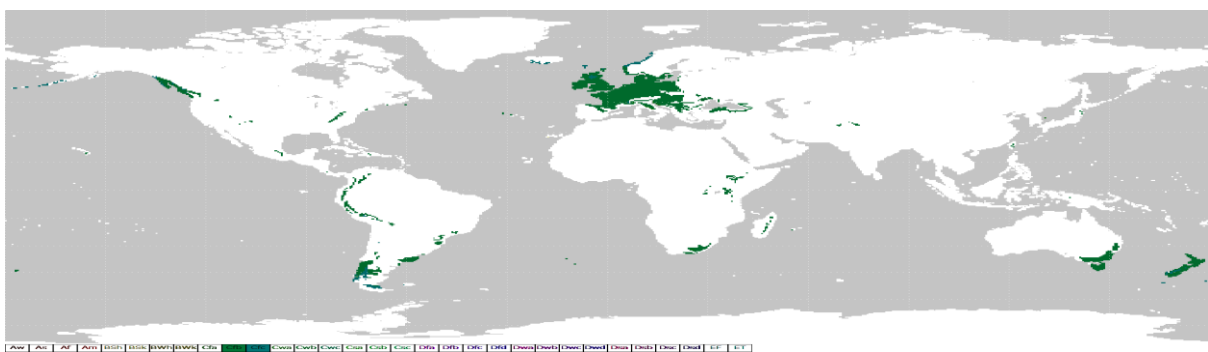


Fig. No. 11 Marine West Coast Climate

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Cold Snow Forest Climates (D)

Cold snow forest climates occur in the large continental area in the northern hemisphere between 40°-70° north latitudes in Europe, Asia and North America. Cold snow forest climates are divided into two types: (i) Df- cold climate with humid winter; (ii) Dw- cold climate with dry winter. The severity of winter is more pronounced in higher latitudes.



Fig. No. 12 Cold Snow Forest Climates

<https://pxhere.com/en/photo/1200757>

Cold Climate with Humid Winters (Df)

Cold climate with humid winter occurs poleward of marine west coast climate and mid latitude steppe. The winters are cold and snowy. The frost free season is short. The annual ranges of temperature are large. The weather changes are abrupt and short. Poleward, the winters are more severe.



Fig. No. 13 Köppen climate types of Russia

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Cold Climate with Dry Winters (Dw)

Cold climate with dry winter occurs mainly over Northeastern Asia. The development of pronounced winter anti cyclone and its weakening in summer sets in monsoon like reversal of wind in this region. Poleward summer temperatures are lower and winter temperatures are extremely low with many locations experiencing below freezing point temperatures for up to seven months in a year. Precipitation occurs in summer. The annual precipitation is low from 12-15 cm.

Polar Climates (E)

Polar climates exist poleward beyond 70° latitude. Polar climates consist of two types: (i) Tundra (ET); (ii) Ice Cap (E

Tundra Climate (ET)

The tundra climate (ET) is so called after the types of vegetation, like low growing mosses, lichens and flowering plants. This is the region of permafrost where the sub soil is permanently frozen. The short growing season and water logging support only low growing plants. During summer, the tundra regions have very long duration of day light.

Ice Cap Climate (EF)

The ice cap climate (EF) occurs over interior Greenland and Antarctica. Even in summer, the temperature is below freezing point. This area receives very little precipitation. The snow and ice get accumulated and the mounting pressure causes the deformation of the ice sheets and they break. They move as icebergs that float in the Arctic and Antarctic waters. Plateau Station , Antarctica ,79°S, portray this climate.

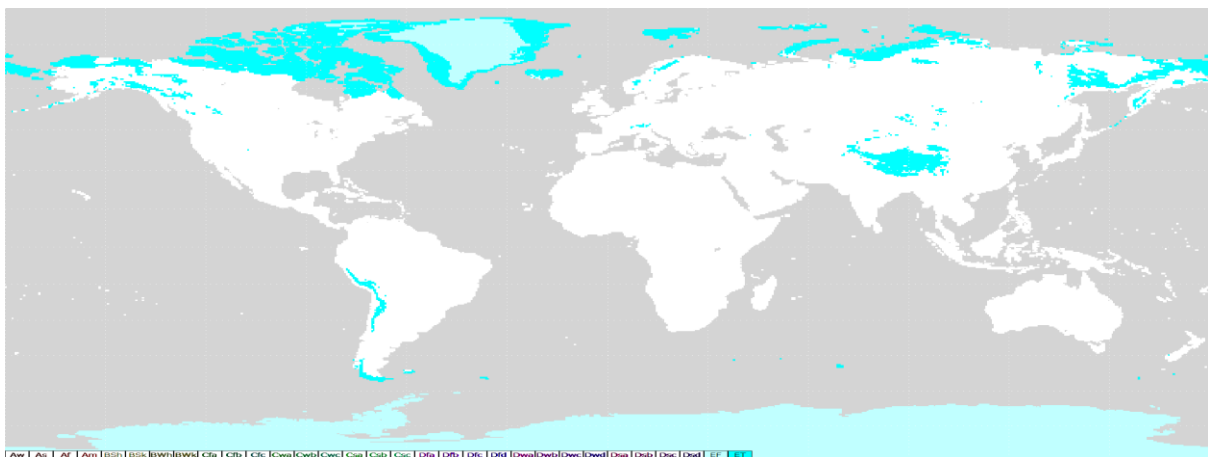


Fig. No. 14 Polar climates

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Highland Climates (H)

Highland climates are governed by topography. In high mountains, large changes in mean temperature occur over short distances. Precipitation types and intensity also vary spatially across high lands. There is vertical zonation of layering of climatic types with elevation in the mountain environment.



Fig. No. 15 Highland Climates (H)

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Ecological significance

The Köppen climate classification is based on the empirical relationship between climate and vegetation. This classification provides an efficient way to describe climatic conditions defined by temperature and precipitation and their seasonality with a single metric. Because climatic conditions identified by the Köppen classification are ecologically relevant, it has been widely used to map geographic distribution of long term climate and associated ecosystem conditions.

Over the recent years, there has been an increasing interest in using the classification to identify changes in climate and potential changes in vegetation over time. The most important ecological significance of the Köppen climate classification is that it helps to predict the dominant vegetation type based on the climatic data and vice versa.