

 **Laurea / B.A.  
in Global Governance**

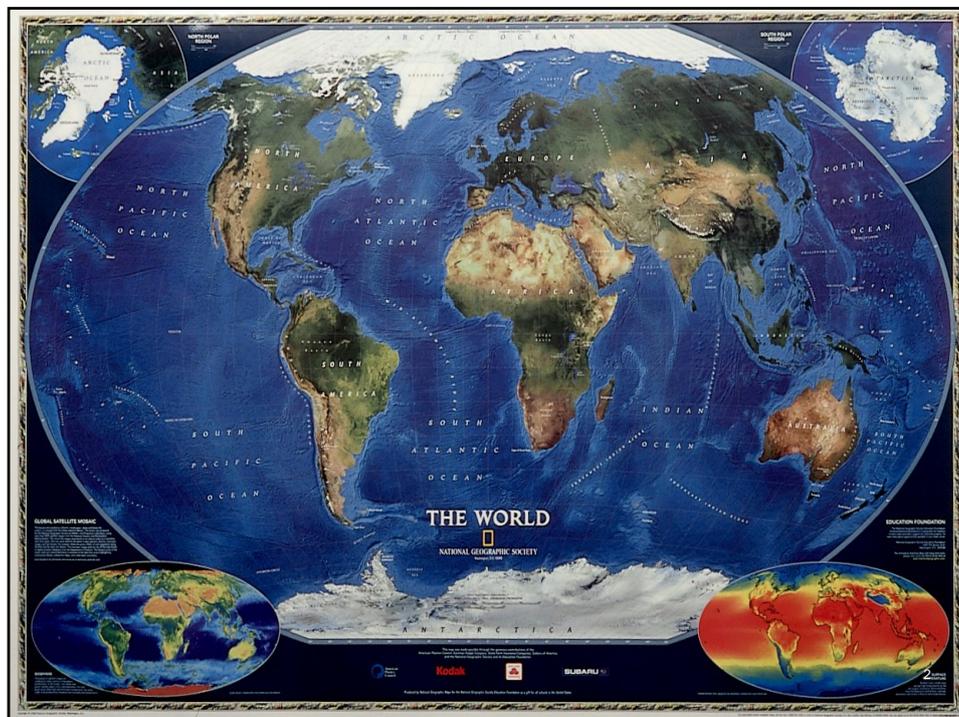
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**Plants and environments  
Köppen Climate  
Classification System**

2021/2022

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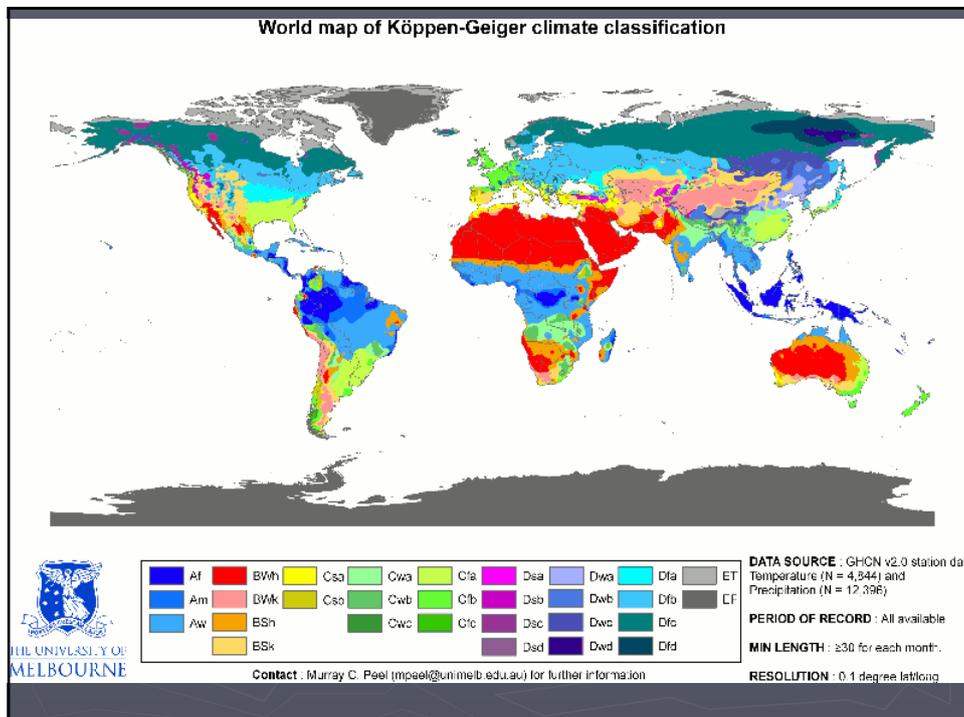
# Köppen Climate Classification System

- ▶ The **Köppen Climate Classification System** is the most widespread system used to classify the climates of places on our planet.
- ▶ The system was developed by German climatologist and amateur botanist **Wladimir Köppen** (1846-1940) who divided the world's climates into several major categories based upon general temperature profile related to latitude.

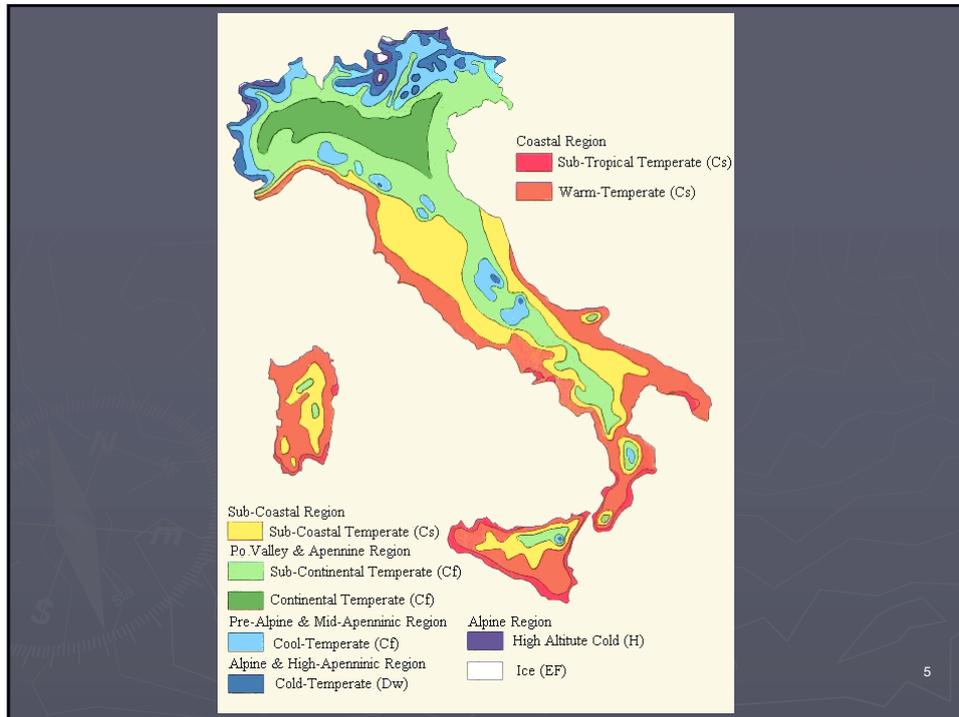


September 25, 1846  
June 22, 1940 3

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## Major Köppen Climate Categories

- ▶ **A - Tropical Moist Climates**
- ▶ **B - Dry climates**
- ▶ **C - Moist Mid-latitude Climates with mild winters**
- ▶ **D - Moist Mid-Latitude Climates with Cold Winters**
- ▶ **E - Polar climates**
- ▶ **F - Highland Climates**

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## Secondary Köppen Climate Categories

- ▶ At the secondary level, the major climate groups are further subdivided according to the **seasonal distribution of precipitation**, the degree of aridity, or the presence/absence of permanent ice.
- ▶ Lowercase letters **f**, **w**, and **s** are used to distinguish precipitation patterns and are only applicable to **A**, **C**, and **D** climates.
- ▶ Af- Tropical Wet
- ▶ Aw- Tropical Wet and Dry
- ▶ Am – Tropical Monsoon

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**f = (felt, without dry season)**  
**s = (summer trocken: dry season in summer)**  
**w = (winter trocken: dry season in winter)**

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- ▶ Uppercase **W** and **S** identify desert (arid) or steppe (semiarid) climate subtypes for the **Dry Climates (B)** major category. Thus:
  - ▶ BW – Dry Arid (Desert)
  - ▶ BS – Dry Semiarid (Steppe)
- ▶ **W**üste = desert
- ▶ **S**teppe = steppe

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## Polar Climates

- ▶ For the **Polar Climates (E)**, the secondary letters **F** and **T** distinguish whether the site is covered by permanent ice fields and glaciers or free of snow and ice during the summer season. Thus:
  - ▶ ET – Polar Tundra
  - ▶ EF – Polar Ice Cap

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## Tropical Moist Climates - A Climate Type

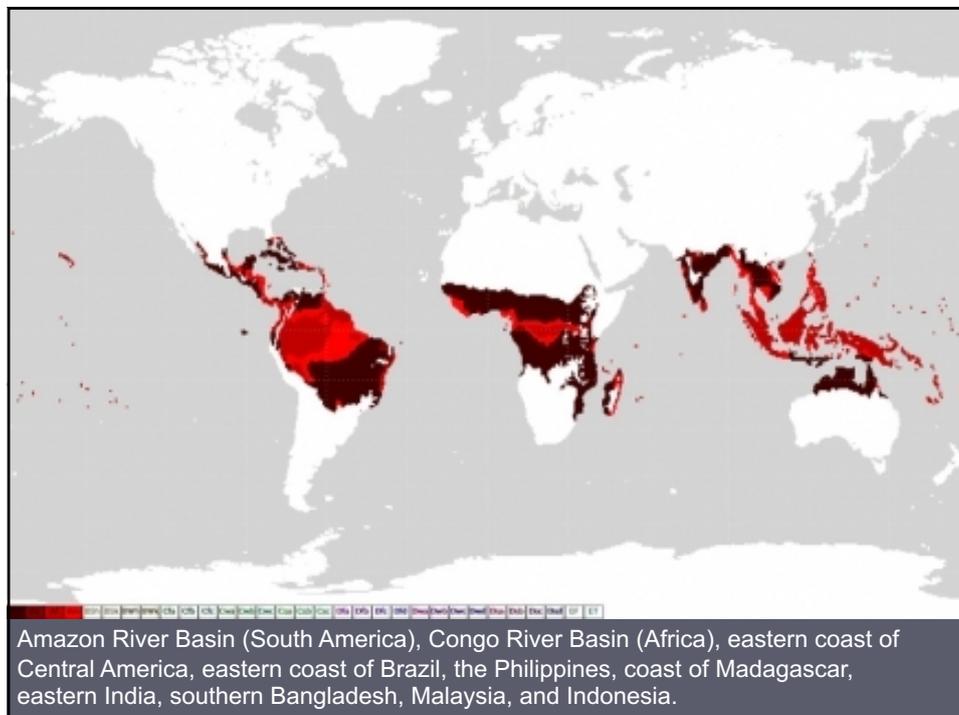
These are very warm climates found in the tropics that experience high quantities of precipitation.

The primary distinguishing characteristic of these climates is all months have average temperatures above 18° C

**No dry season.** The driest month has at least 60 mm of rain. Rainfall is generally evenly distributed throughout the year.

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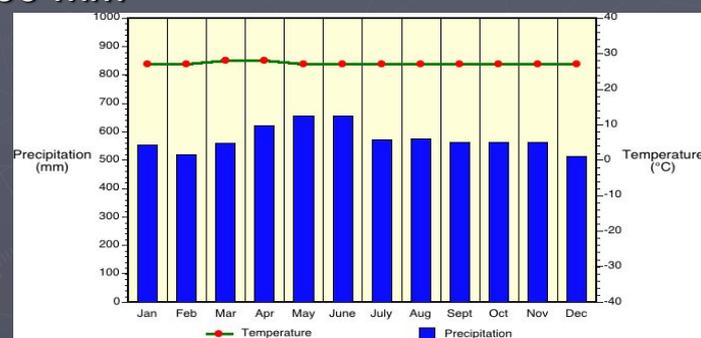
## Location:

- ▶ Amazon River Basin (South America), Congo River Basin (Africa), eastern coast of Central America, eastern coast of Brazil, the Philippines, coast of Madagascar, eastern India, southern Bangladesh, Malaysia, and Indonesia.

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- ▶ **tropical moist climates** extend northward and southward from the equator to about 15 to 25° of latitude. In these climates, all months have average temperatures greater than 18° Celsius.
- ▶ Annual precipitation is often greater than 1500 mm



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## Af – Tropical Wet

- ▶ **Af** or **tropical wet** is a tropical climate where precipitation occurs all year long. Monthly temperature variations in this climate are usually less than 3° C. Because of intense surface heating and high humidity, cumulus and cumulonimbus clouds (thunderstorms) **form early in the afternoons** almost every day. Daily highs T are about 32° C. Radiative cooling during the evening is limited because of cloud cover and high humidity. Night-time daily temperatures average about 22° C. <sup>15</sup>

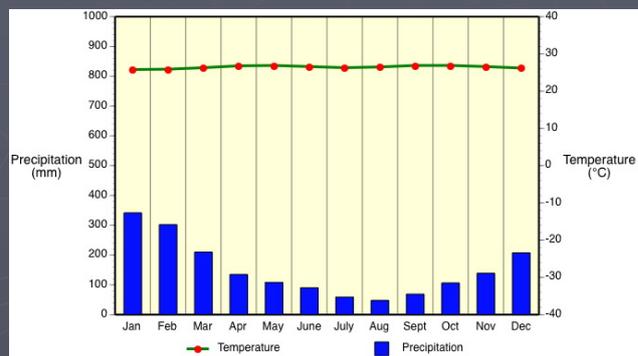
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## Aw – Tropical Wet and Dry

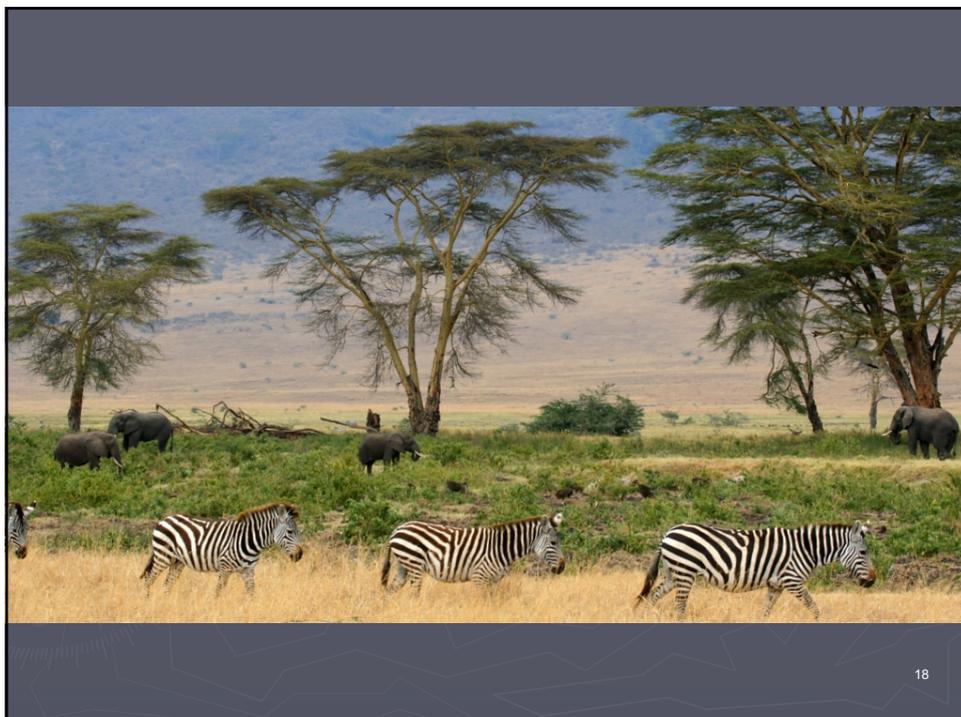
- ▶ The **tropical wet and dry** or **savanna (Aw)** has an extended dry season during winter. Precipitation during the wet season is usually less than 1000 millimeters, and only during the summer season.
- ▶ Average monthly temperatures for all months is greater than 18° C. More than two months have less than 60 mm) of precipitation. There is a distinct dry season during low-sun period (winter) and a distinct wet season during the high-sun period (summer). These climates are generally pole-ward of Af climate areas. <sup>16</sup>

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- ▶ Northern and eastern India, central Myanmar, the Indo-Chinese Peninsula, northern Australia, region around the Congo River basin, south-central Africa, western Central America, parts of Venezuela, and parts of Brazil, southern tip of Florida, and the Caribbean Islands.



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## Am – Tropical Monsoon

- ▶ **Am** is a **tropical monsoon** climate. Annual rainfall is equal to or greater than Af, but most of the precipitation falls in the hottest months.
- ▶ It has a very pronounced wet season. During the dry season very little rainfall occurs. Average monthly temperatures for all months is greater than 18° C. It has one or more months with less than 60 mm of precipitation.

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- ▶ **Climate of this category is transitional between Af and Aw.**
- ▶ **Heaviest rainfall records in world occur in this climate type (Cherrapunji, India – 12,000 mm).**

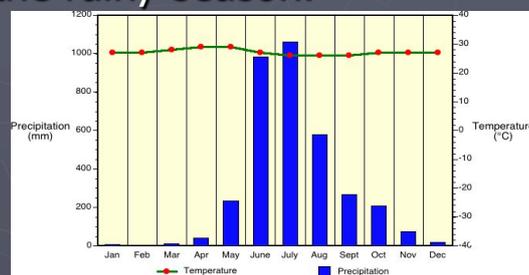


Coastal areas of southwestern India, Sri Lanka, Bangladesh, Myanmar, southwestern Africa, Guyana, Surinam, French Guiana, and parts of northeast and southeast Brazil

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- ▶ Yearly total precipitations range from between 1500 to 4000 mm.
- ▶ Dry season is associated with low-sun (winter) period.
- ▶ Annual temperature range of monthly averages is about 2 to 6° C,
- ▶ Highest monthly temperature often occurs just prior to the start of the rainy season.



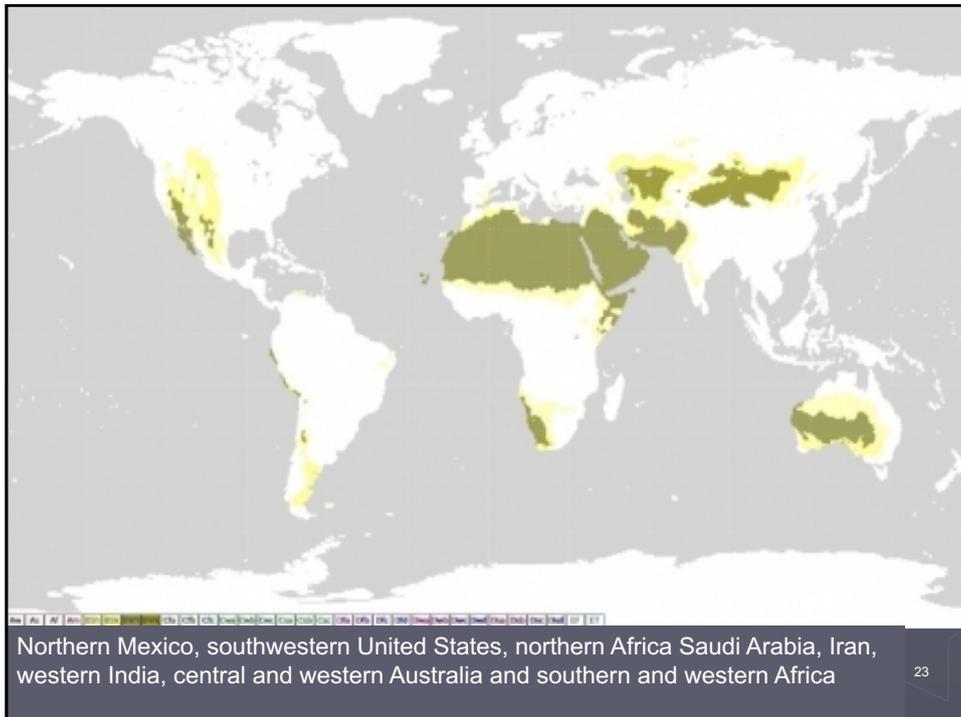
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## Dry Climates - B Climate Type

- ▶ The most obvious feature of this category of the **Dry Climates - B Climate Type**, is that potential evapotranspiration exceeds precipitation
- ▶ These Köppen climate types extend from 20 to 35° North and South of the equator and in large continental regions of the mid-latitudes often surrounded by mountains.

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## Index of aridity

- ▶  $R = 2T + 14$  (rainfall in summer or aridity in winter)
- ▶  $R = T + 7$  (without aridity)
- ▶  $R = 2T$  (rainfall in winter or aridity in summer)
- ▶  $R =$  Rainfall expressed in cm
- ▶  $T =$  yearly average temperature

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## BW - Dry Arid (Desert)

- ▶ **BW** is a true **desert** climate. It covers 12% of the Earth's land surface and is dominated by xerophytic vegetation.
- ▶ The additional letters **h** and **k** are used generally to distinguish whether the dry arid climate is found in the **subtropics** or in the **mid-latitudes**, respectively.
- ▶ Climate is very arid and air has low relative humidity.
- ▶ Rainfall is very irregular and unreliable.
- ▶ Annual rainfall totals less than 250 mm.

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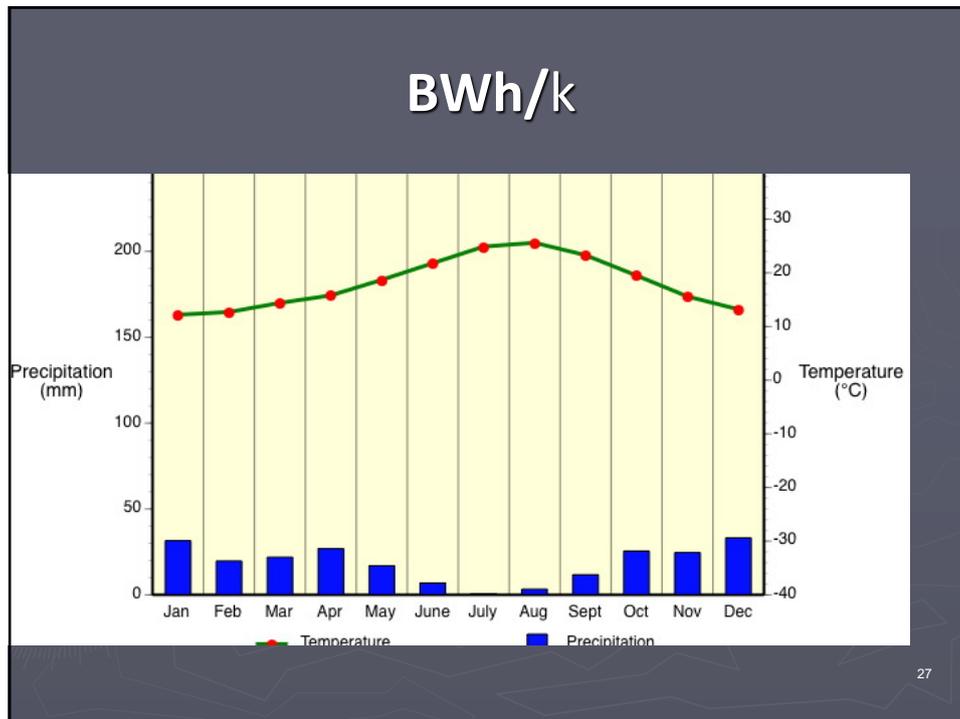
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## Dry Arid Low Latitudes

- ▶ **BWh** is a **dry arid** climate found in low latitude deserts. The most distinguishing aspect of this climate is **that precipitation is less than 50% of potential evapotranspiration**.
- ▶ Annual average temperature is over 18° C  
Daily minimum temperatures infrequently go below 0° C during the winter season.
- ▶ **Locations:** Northern Mexico, south western United States, northern Africa Saudi Arabia, Iran, western India

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## BS Semiarid (Steppe)

- ▶ This is a grassland climate that covers 14% of the Earth's land surface. It receives more precipitation than the **BW** either from short incursions of the Intertropical Convergence Zone or from occasional mid-latitude cyclones. Once again, the additional letters **h** and **k** are used generally to distinguish whether the dry semiarid climate is found in the subtropics or in the mid-latitudes, respectively.

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### ► **BSh – Semiarid Low Latitudes**

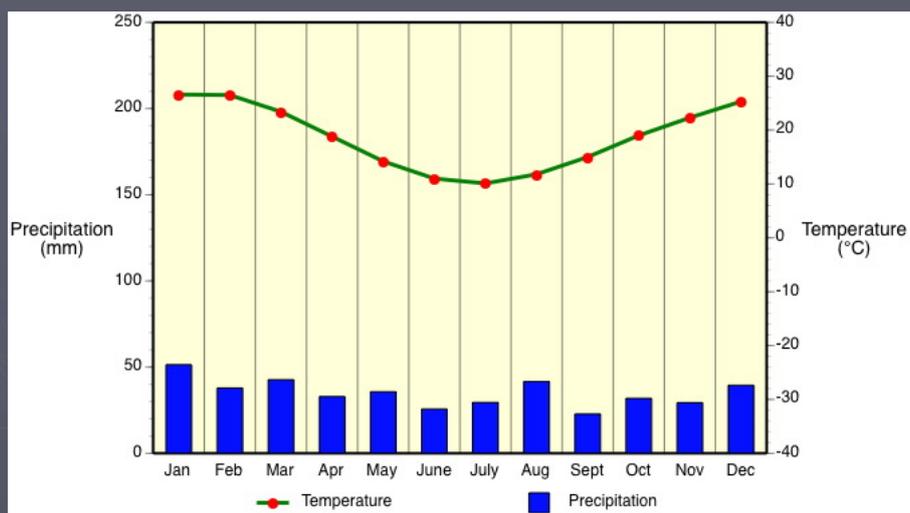
► **Locations:** About 13 to 15° North latitude in Africa, about 20° South latitude southern Africa, border areas around Australian desert, parts of southern South America, parts of India, and areas marginal to BWh climates of northwestern Africa, Saudi Arabia, and western India.

### ► **BSk - Semiarid Mid-Latitudes**

► Western plains of the United States, south-central Canada, and borders **BWk** climate areas from the Caspian Sea eastward to China and Mongolia.

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## **C Climate Type -Moist Mid-latitude Climates with Mild Winters**

- ▶ this climate type generally has warm and humid summers with mild winters. Its extent is from 30° to 50° of latitude mainly on the eastern and western borders of most continents. During the winter, the main weather feature is the mid-latitude cyclone. Convective thunderstorms provide precipitation in the summer months.

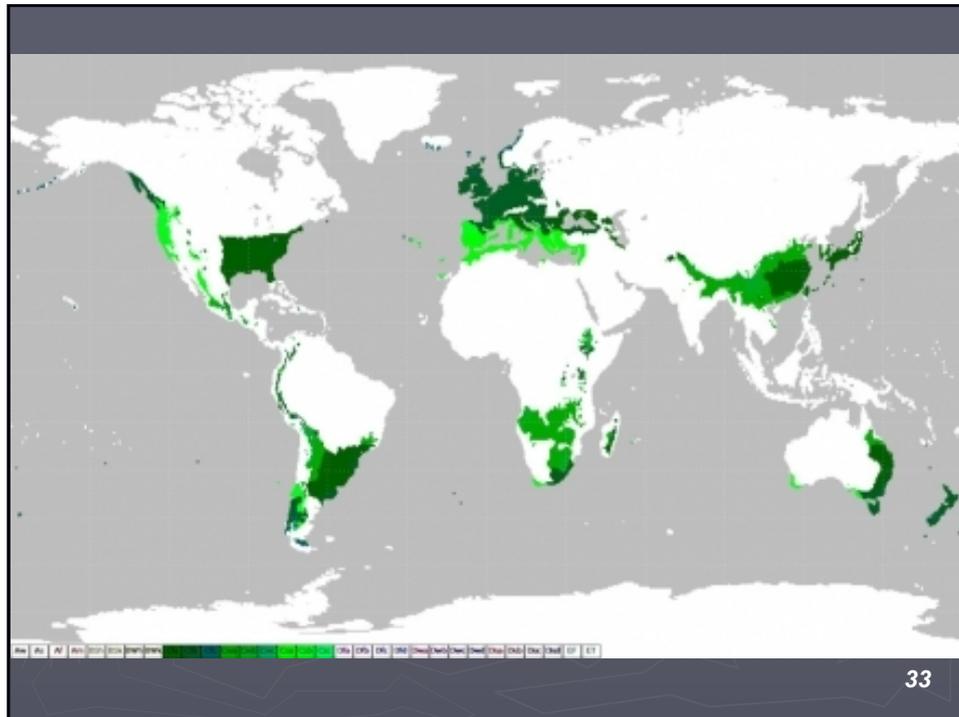
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- ▶ Three new letter:
- ▶ **a** summer very hot
- ▶ **b** summer hot
- ▶ **c** cool summer

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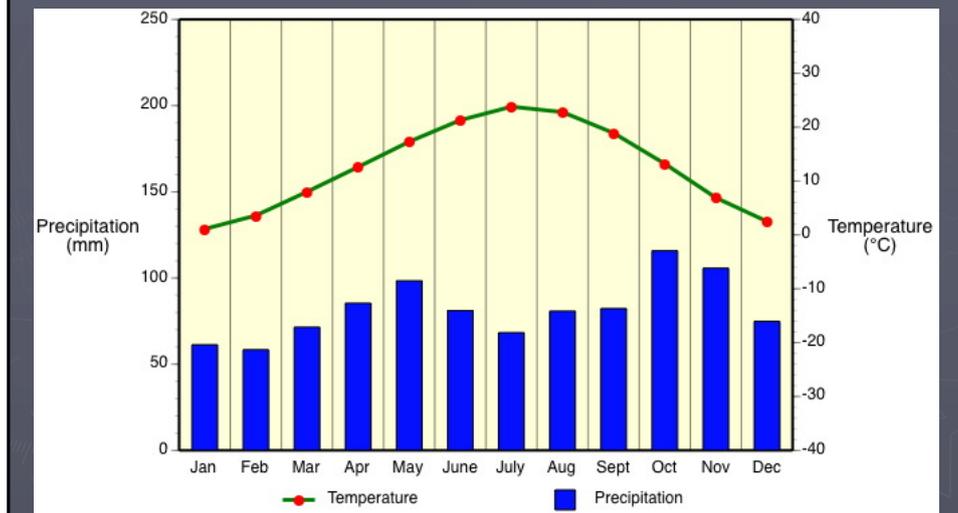
## Cfa – Humid Subtropical

- ▶ The **humid subtropical** climate (**Cfa**) has hot muggy summers and frequent thunderstorms. Winters are mild and precipitation during this season comes from mid-latitude cyclones. This climate type is quite common on the east coasts of continents. A good example of a region of the world with a Cfa climate is the south-eastern USA. Average temperature of the warmest month is above 22° C. Average temperature of the coldest month is below 18° C but above -3° C.
- ▶ Rainfall is equally spread out through the year.

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- South-eastern United States, northern Argentina, Uruguay, southern Brazil, southern Japan, and southern China.



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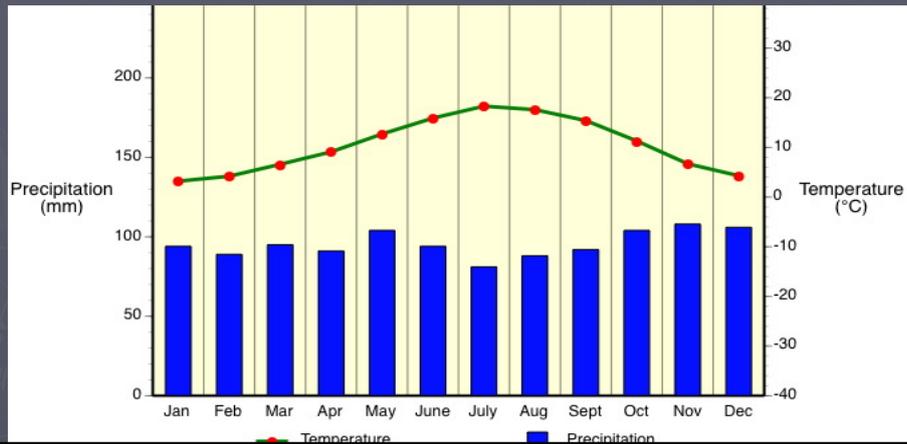
## Cfb/Cfc – Marine

- Cfb/Cfc marine climates are often found on the western coasts of continents. They have a humid climate with short dry summers. Heavy precipitation occurs during the mild winters because of the continuous presence of mid-latitude cyclones.

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- ▶ Coastal Oregon, Washington, west coast of Canada and southern west coast of Alaska, central and northwest Europe, southern Chile, southern coast of South Africa, southeast Australia and New Zealand.



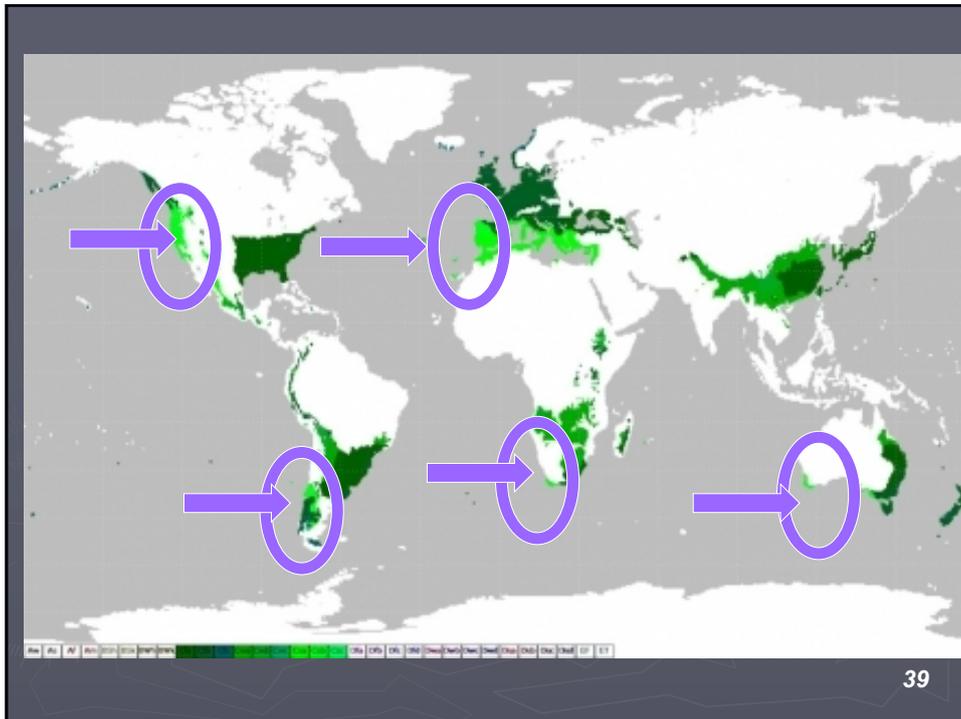
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## Csa/Csb – Mediterranean

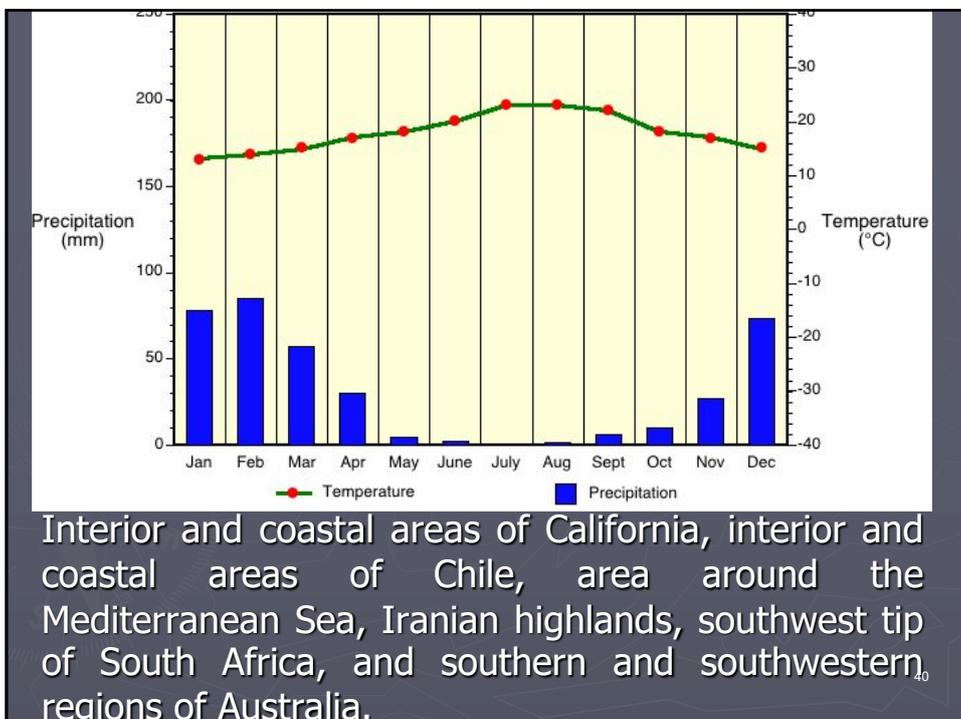
- ▶ Mediterranean climates (Csa/Csb) receive rain primarily during winter season from the mid-latitude cyclone.
- ▶ Extreme summer aridity is caused by the sinking air of the subtropical highs and may exist for up to 5 months.

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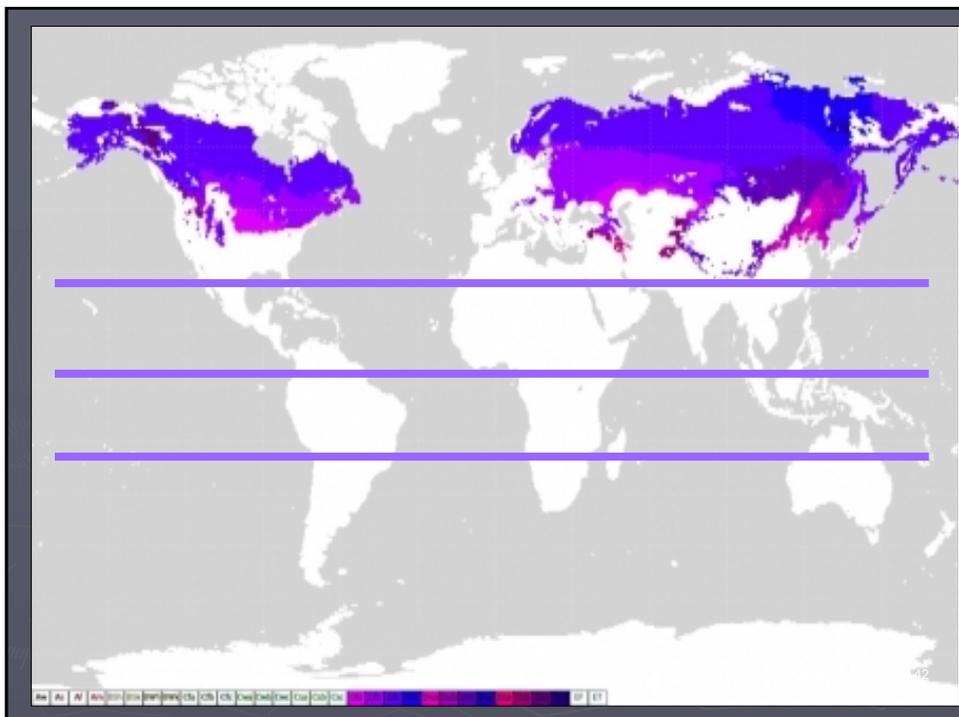
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## Moist Continental Mid-latitude Climates - D Climate Type

- ▶ moist continental mid-latitude climates have warm to cool summers and cold winters.
- ▶ The location of this Köppen climate type is pole ward of the C climates. The average temperature of the warmest month is higher than  $10^{\circ}\text{C}$ , while the coldest month is less than  $-3^{\circ}\text{C}$ .
- ▶ Winters are severe with snowstorms, strong winds, and bitter cold from Continental Polar or Arctic air masses. This Köppen climate type has three second-level categories:
  - ▶ Dw - dry winters;
  - ▶ Ds - dry summers;
  - ▶ Df - wet all year.

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## Dfa/Dwa

- ▶ Dfa: Humid Continental Hot Summer, Wet All Year
- ▶ Average temperature of the coldest month is  $-3^{\circ}\text{C}$  ( $27^{\circ}\text{F}$ ) or lower. Average temperature of the warmest month is greater than  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ). Precipitation is equally spread across the year.

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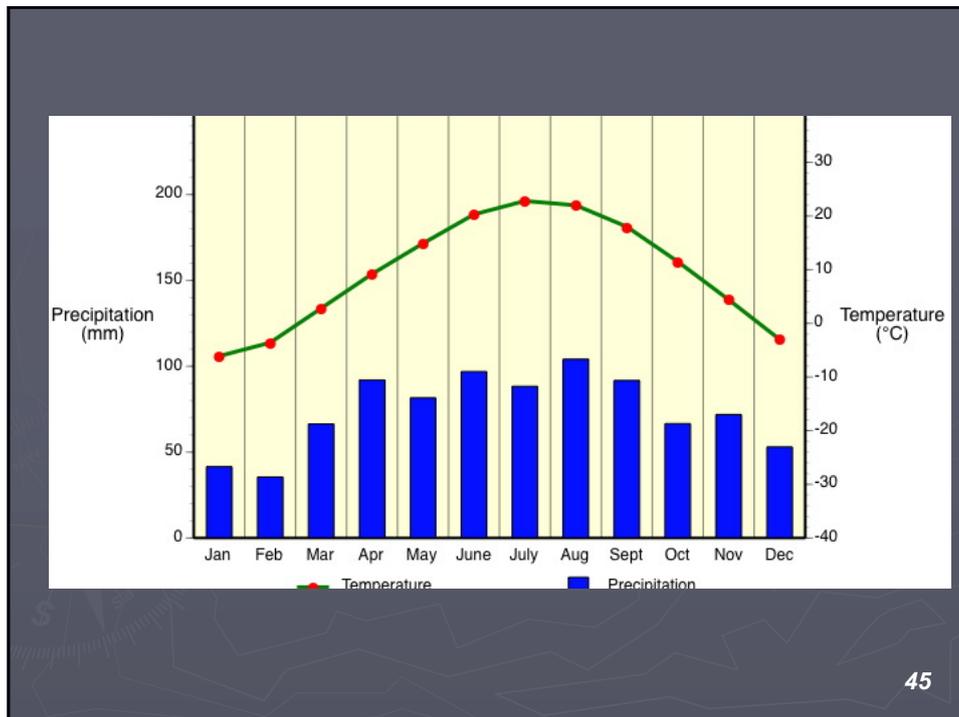
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## Dwa: Humid Continental Hot Summer, Dry Winter

- ▶ Average temperature of the coldest month is  $-3^{\circ}\text{C}$  or lower. Average temperature of the warmest month is greater than  $10^{\circ}\text{C}$ . Wettest summer month has about 10 times more precipitation when compared to the driest winter month.

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## Dfb/Dwb

- ▶ Dfb: Humid Continental Mild Summer, Wet All Year
- ▶ Average temperature of the coldest month is  $-3^{\circ}\text{C}$  or lower. Average temperature of the warmest month is greater than  $10^{\circ}\text{C}$ . No month has an average temperature over  $22^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ). Precipitation is equally distributed across the year.

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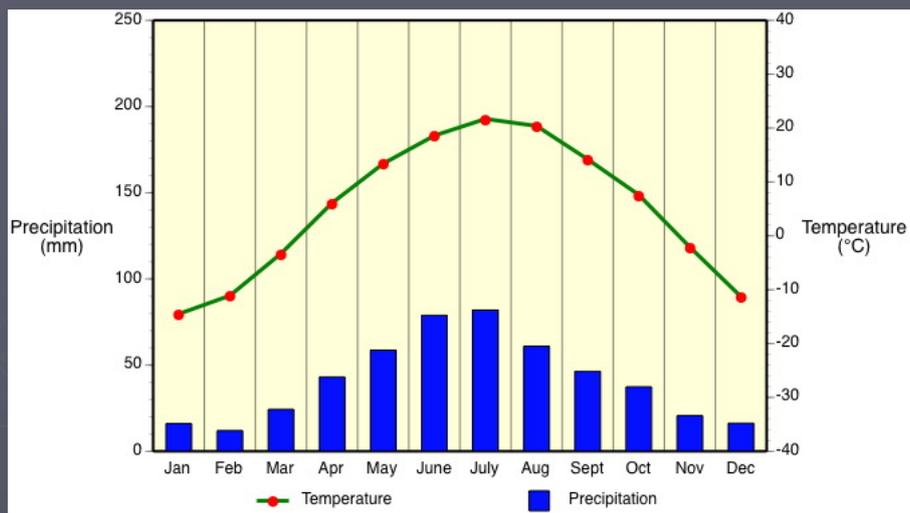
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## Dwb: Humid Continental Mild Summer, Dry Winter

- ▶ Average temperature of the coldest month is  $-3^{\circ}\text{C}$  or lower. Average temperature of the warmest month is greater than  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ). No month has an average temperature over  $22^{\circ}\text{C}$  ( $72^{\circ}\text{F}$ ). Wettest summer month has about 10 times more precipitation when compared to the driest winter month.

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## Dfc/Dwc/Dfd/Dwd

- ▶ **Dfc: Subarctic With Cool Summer, Wet All Year**
- ▶ **Dfd: Subarctic With Cold Winter, Wet All Year**
- ▶ **Dwc: Subarctic With Cool Summer, Dry Winter**
- ▶ **Dwd: Subarctic With Cold Winter, Dry Winter**

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## Subarctic With Cool Summer, Dry Winter

- ▶ Dwc: Subarctic With Cool Summer, Dry Winter
- ▶ Average temperature of the coldest month is  $-3^{\circ}$  C or lower. Average temperature of the warmest month is greater than  $10^{\circ}$  C. One to three months with an average temperature over  $10^{\circ}$  C.
- ▶ Wettest summer month has about 10 times more precipitation when compared to the driest winter month.

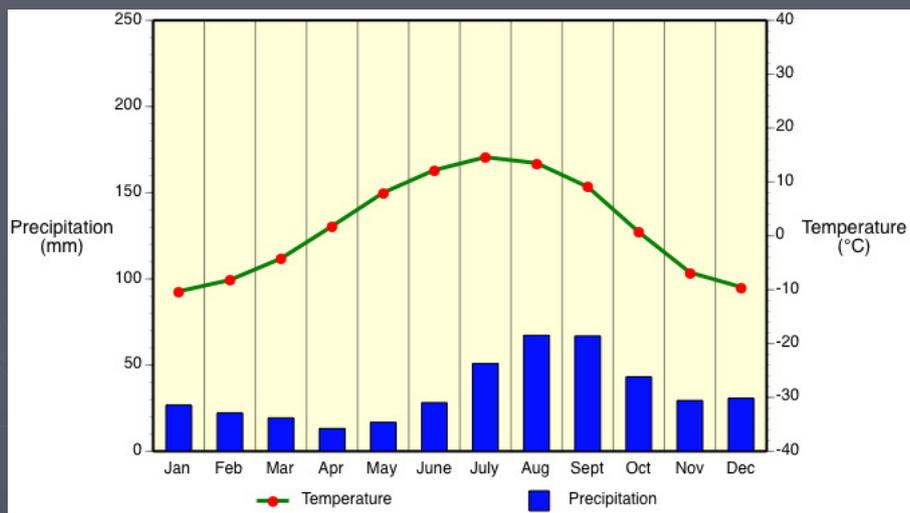
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- ▶ Dwd: Subarctic With Cold Winter, Dry Winter
- ▶ Average temperature of the coldest month is  $-38^{\circ}\text{C}$  or lower. Average temperature of the warmest month is greater than  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ). Wettest summer month has about 10 times more precipitation when compared to the driest winter month.

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## Polar Climates - E Climate Type

- ▶ **polar climates** have year-round cold temperatures with the warmest month less than 10° Celsius. Polar climates are found on the northern coastal areas of North America, Europe, Asia, and on the landmasses of Greenland and Antarctica.

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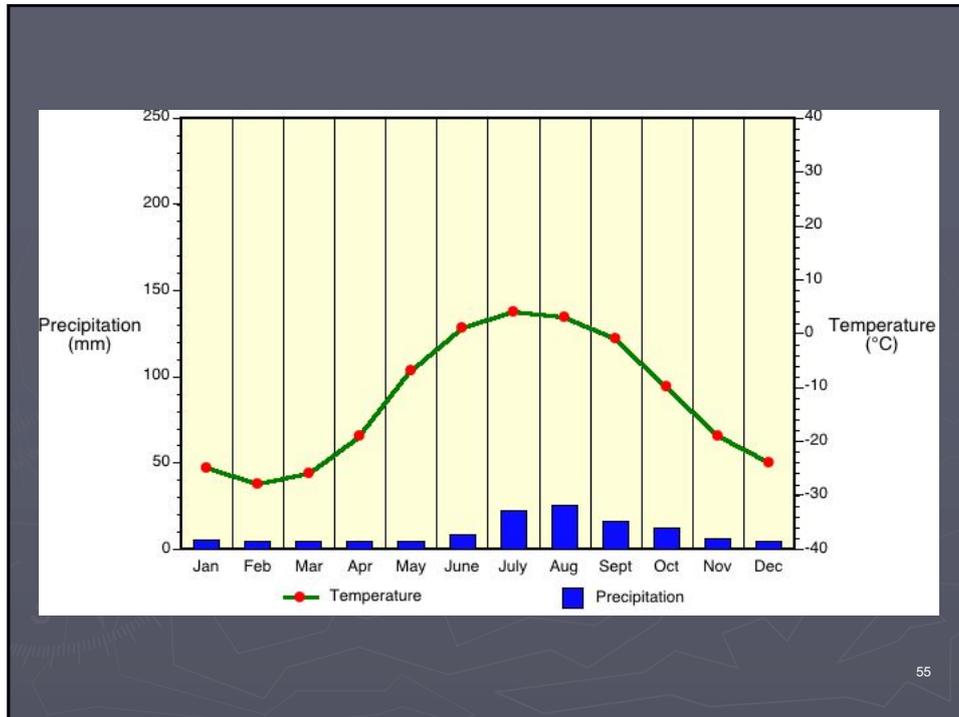
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## ET - Polar Tundra

- ▶ Average temperature of warmest month for this climate is below 10° C (50° F) but is above 0° C (32° F). Precipitation generally is greater than potential evaporation.
- ▶ **Locations:** Regions in North America, Greenland, and Eurasia that border the Arctic Ocean, Antarctic Peninsula, and many polar islands.

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## EF - Polar Ice Cap

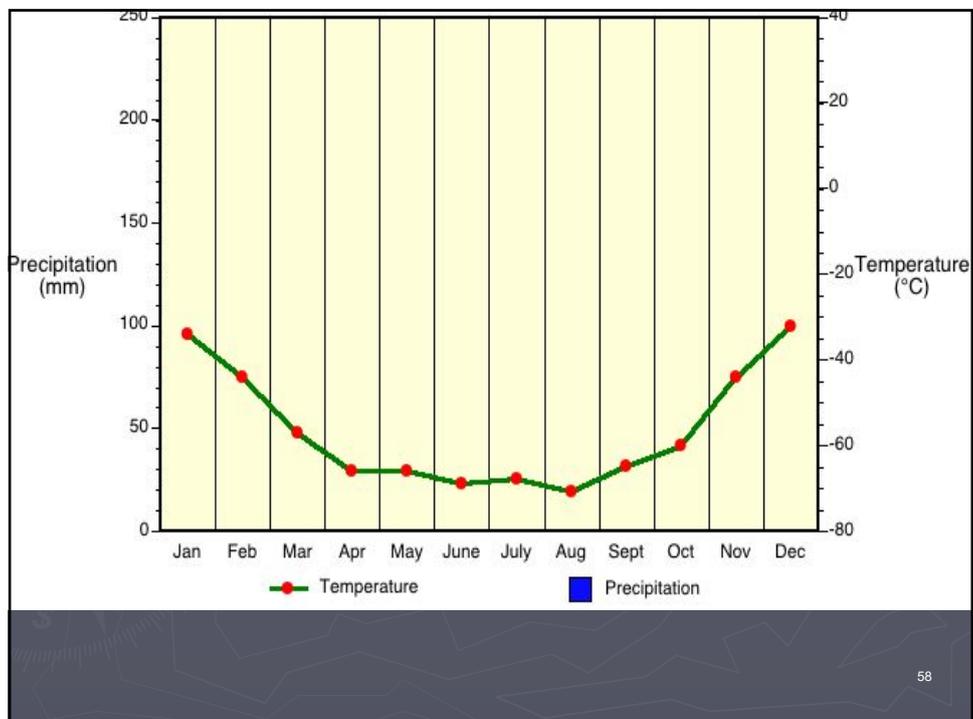
- ▶ Average temperature of warmest month for the EF climate is  $0^{\circ}$  C or less. Precipitation generally is greater than potential evaporation.
- ▶ **Locations:** Interior Greenland, most of Antarctica, and most Arctic Islands.

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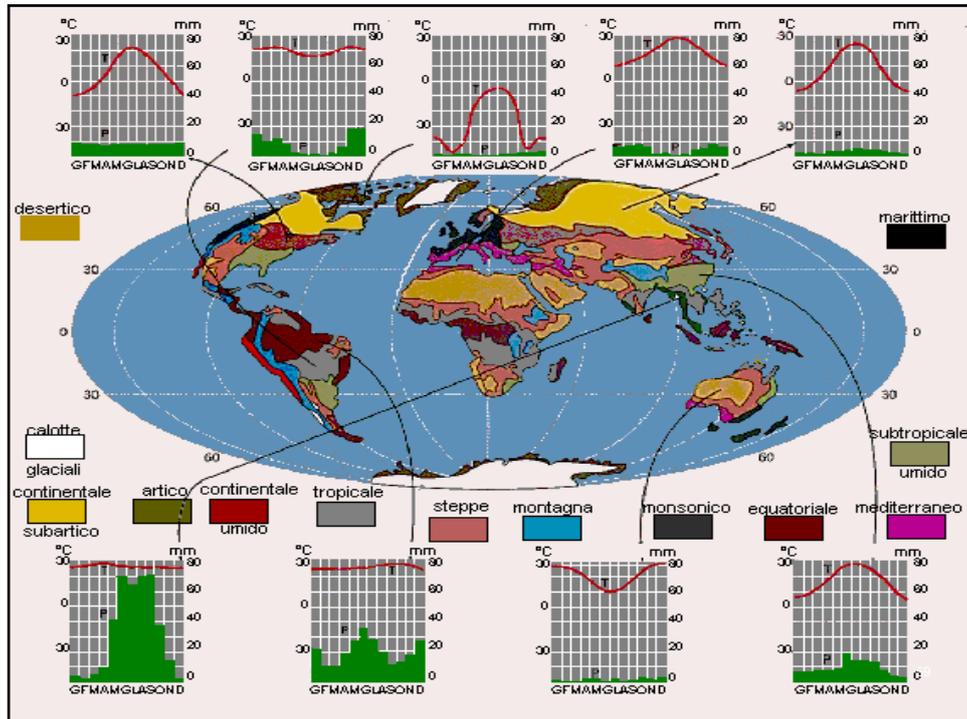
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<https://www.britannica.com/science/Koppen-climate-classification>

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