
Climate Classification and Distribution & Climographs

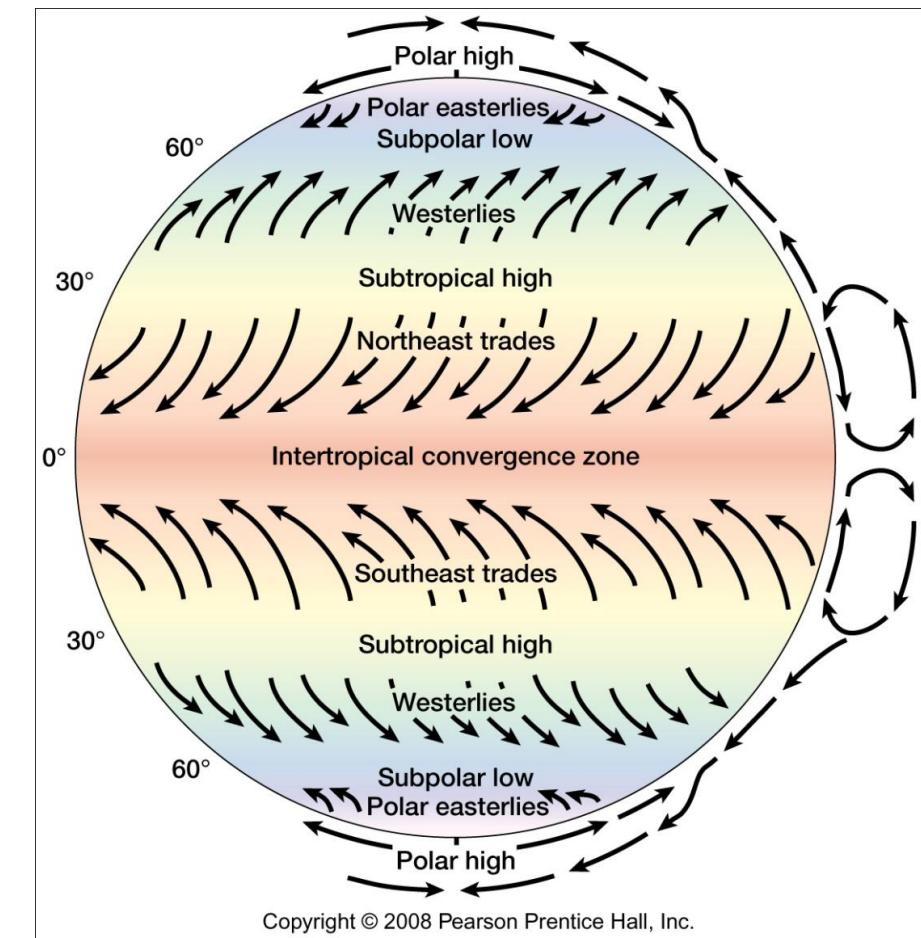
July 12th, 2021

Drivers of Climate

1. Latitude

ITCZ: Occurs at the location on earth receiving the most direct radiation

ITCZ “shifts” to N. Hemisphere in our summer, and the S. Hemisphere in our winter (Dallas, Texas)



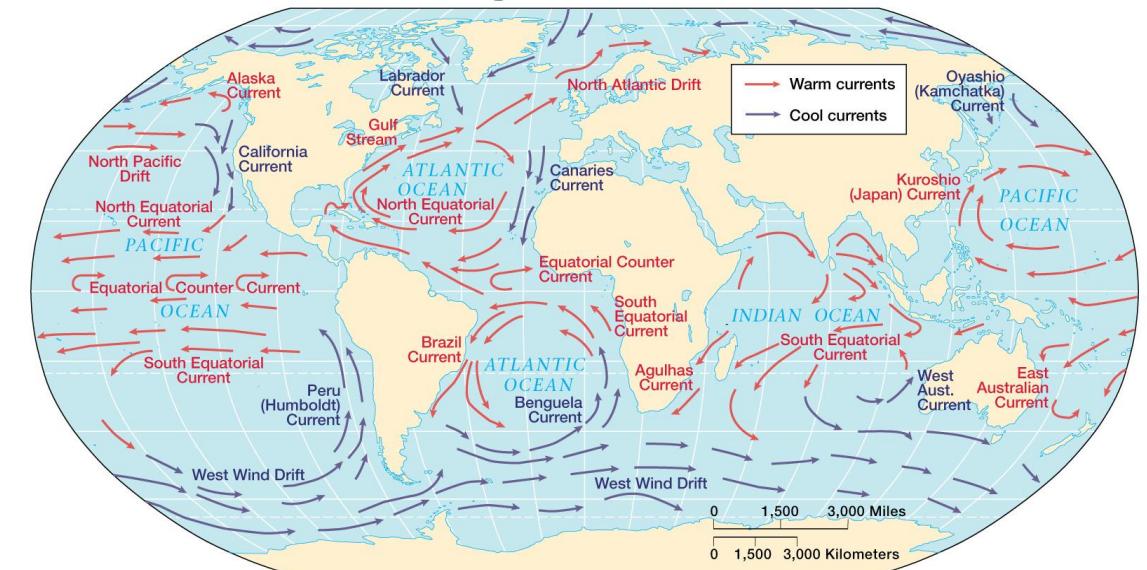
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Drivers of Climate

2. Ocean Gyres and Global Wind Patterns

East coasts have different climates from west coasts

Recall: the **west** coasts of continents tend to have cold currents offshore; whereas **east** coasts have warm currents (hence people swim at the Jersey shore, but not on the beaches of the Pacific Northwest).



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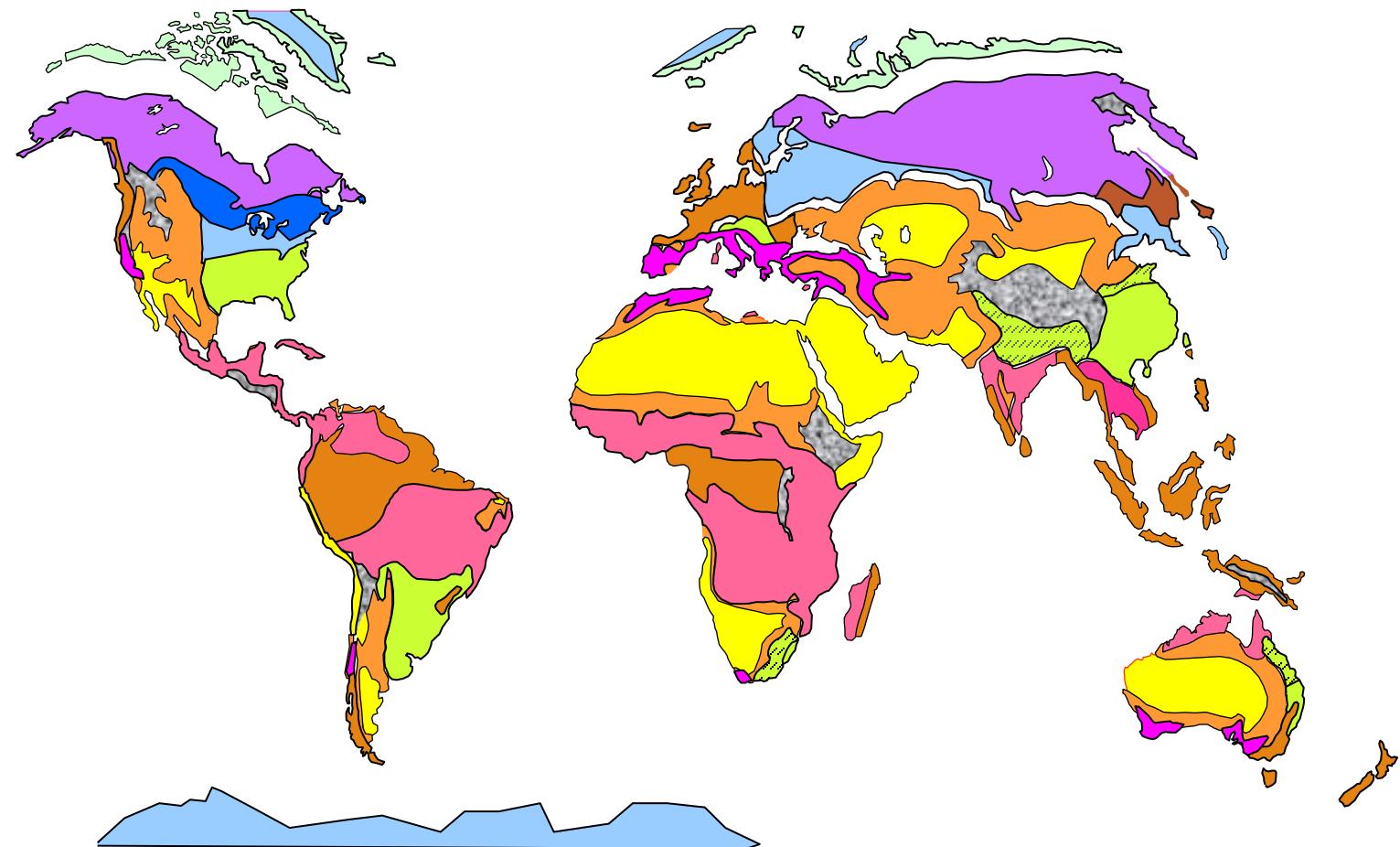
Drivers of Climate

3. Continentality: Proximity to the ocean moderates the seasonal variation in temperature

Climate Classification

The Purpose of
Classifying Climates

- To understand distribution of climates
- To compare climates of different places

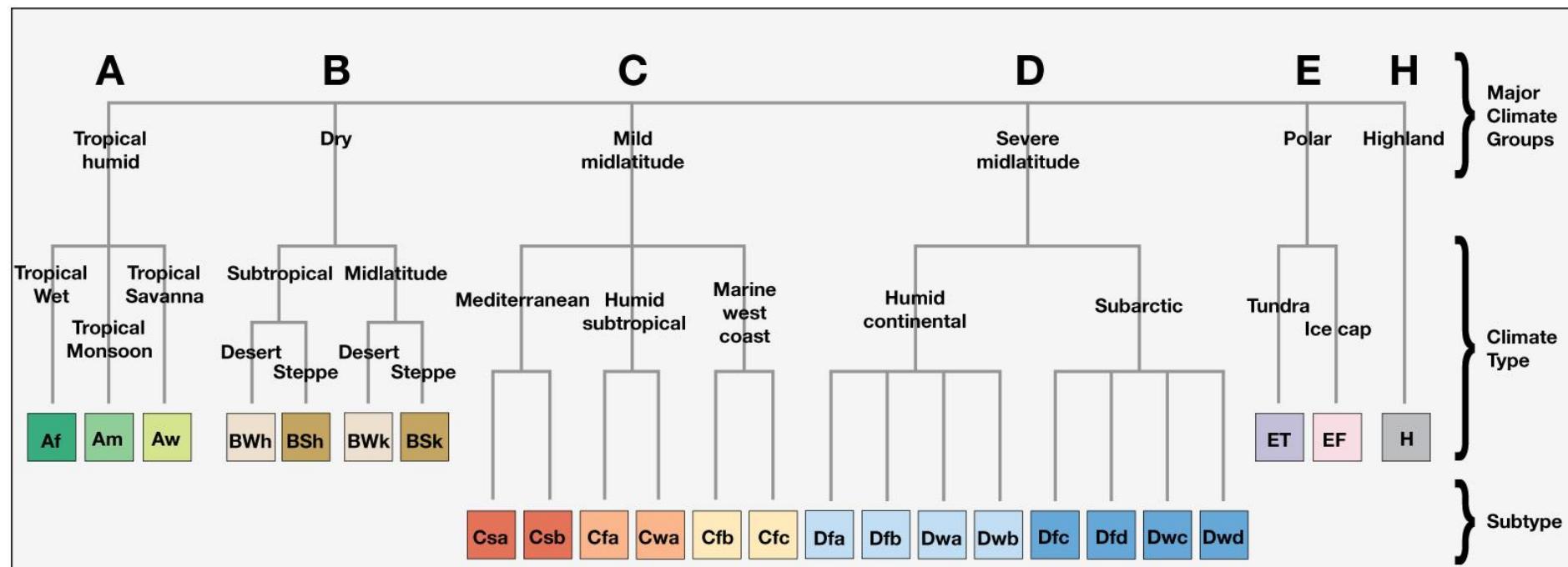


The Köppen Classification System

- Wladimir Köppen (1846-1940) climatologist and botanist.
- First classification 1918, last 1936.
- Empirical System
- Has a numerical basis
 - Temperature data
 - Precipitation data
- Teaching tool:
 - Simple to comprehend and to use
 - Shows an orderly pattern over the world
 - Gives some indication of climate origin (genesis)
- Koppen defined four of his five climate groups by **temperature characteristics**, the fifth (the B group) **based on moisture**.
- Each group was subdivided into climate types according to various **temperature and precipitation** relationships
- His system has been the springboard for most climate classification in use today.

Modified Köppen System

- Five major climate groups
 - Groups A, B, C, D, and E
 - 14 individual climate types
 - Special category of highland (H) climate



Köppen Letter Code System

- The first letter designates the major climate group; also called:

• A =	Tropical
• B =	Dry
• C =	Mesothermal
• D =	Microthermal
• E =	Polar
• H =	Highland

- The second letter describes precipitation patterns
- The third letter (if any) describes temperature patterns.
- E.g. Csa =
 - C = mild midlatitude climate
 - S = summer dry season
 - a = hot summers
- More letters you have, the more complicated but more precise it gets.

TABLE 8-2 Generalized Description of the Letter Codes of the Modified Köppen Climate Classification System

First Letters: Major climate group

A	Tropical Humid	low latitude; warm and wet
B	Dry	evaporation exceeds precipitation
C	Mild Midlatitude	mild winters, warm or hot summers
D	Severe Midlatitude	severe, cold winters
E	Polar	very high latitude, cold climates
H	Highland	high mountains; elevation is dominant control

Second Letters:

A, C, and D Climate Precipitation

f	wet all year
m	monsoonal precipitation pattern (very wet summer)
w	winter dry season
s	summer dry season

B Climate Precipitation

W	desert
S	steppe

E Climate Temperature

T	tundra
F	ice cap

Third Letters:

C and D Climates Temperature

a	hot summers
b	warm summers
c	cool summers
d	very cold winters

B Climate Temperature

h	hot desert or steppe
k	cold desert or steppe

- Letter Combinations

Some explanations (see more details on next two slides)

Tropical Wet Climate
A – High temperatures
every month
f – Year-round rainfall

Mediterranean Climate
C – Mild temperatures
s – Dry summer
a – hot summer

TABLE 8-1 Climate Types of the Modified Köppen Classification System

Major Group	Climate Type	Letter Code	General Characteristics
A–Tropical Humid Climates	Tropical Wet	Af	Rain throughout year
	Tropical Savanna	Aw	Winter (low-Sun) dry season
	Tropical Monsoon	Am	Short dry season; heavy rains in other months
B–Dry Climates	Subtropical Desert	BWh	Low-latitude (hot) desert
	Subtropical Steppe	BSh	Low-latitude (hot) semiarid
	Midlatitude Desert	BWk	Midlatitude (cold) desert
	Midlatitude Steppe	BSk	Midlatitude (cold) semiarid
C–Mild Midlatitude Climates	Mediterranean	Csa	Dry, hot summer
	Humid Subtropical	Csb	Dry, warm summer
	Marine West Coast	Cfa	No dry season; hot summer
		Cwa	Dry winter; hot summer
	Humid Continental	Cfb	No dry season; warm summer
		Cfc	No dry season; cool summer
D–Severe Midlatitude Climates	Severe winter; no dry season; hot summer	Dfa	Severe winter; no dry season; hot summer
		Dfb	Severe winter; no dry season; warm summer
		Dwa	Severe winter; dry winter; hot summer
		Dwb	Severe winter; dry winter; warm summer
		Dfc	Severe winter; no dry season; cool summer
		Dfd	Very cold winter; no dry season
	Subarctic	Dwc	Dry winter; cool summer
		Dwd	Dry winter, very cold winter
		ET	Polar tundra with no true summer
		EF	Polar ice cap
H–Highland Climates		H	High elevation climates

TABLE V-1 Code Letters of the Modified Köppen Classification System

<i>Letters</i>			
<i>1st</i>	<i>2nd</i>	<i>3rd</i>	<i>Description</i>
A			Low-latitude humid climates
	f		No dry season [German: <i>feucht</i> ("moist")]
	m		Monsoon; short dry season compensated by heavy rains in other months
	w		Winter dry season (low-Sun season)
B			Dry climates
	W		Desert (German: <i>wüste</i> ["desert"])
	S		Steppe (semiarid)
C	h		Low-latitude (subtropical) dry climate (German: <i>heiss</i> ["hot"])
	k		Midlatitude dry climate (German: <i>kalt</i> ["cold"])
	s		Summer dry season
<i>Definitions</i>			
Average temperature of each month above 18°C (64°F)			
Average rainfall of each month at least 6 cm (2.4 in.)			
1 to 3 months with average rainfall less than 6 cm (2.4 in.)			
3 to 6 months with average rainfall less than 6 cm (2.4 in.)			
Evaporation exceeds precipitation			
Average annual precipitation generally less than 38 cm (15 in.) in low latitudes; 25 cm (10 in.) in midlatitudes			
Average annual precipitation generally between 38 cm (15 in.) and 76 cm (30 in.) in low latitudes; between about 25 cm (10 in.) and 64 cm (25 in.) in midlatitudes; without pronounced seasonal concentration			
Average annual temperature more than 18°C (64°F)			
Average annual temperature less than 18°C (64°F)			
Average temperature of coldest month between 18°C (64°F) and -3°C (27°F); average temperature of warmest month above 10°C (50°F)			
Wettest winter month has at least 3× precipitation of driest summer month			

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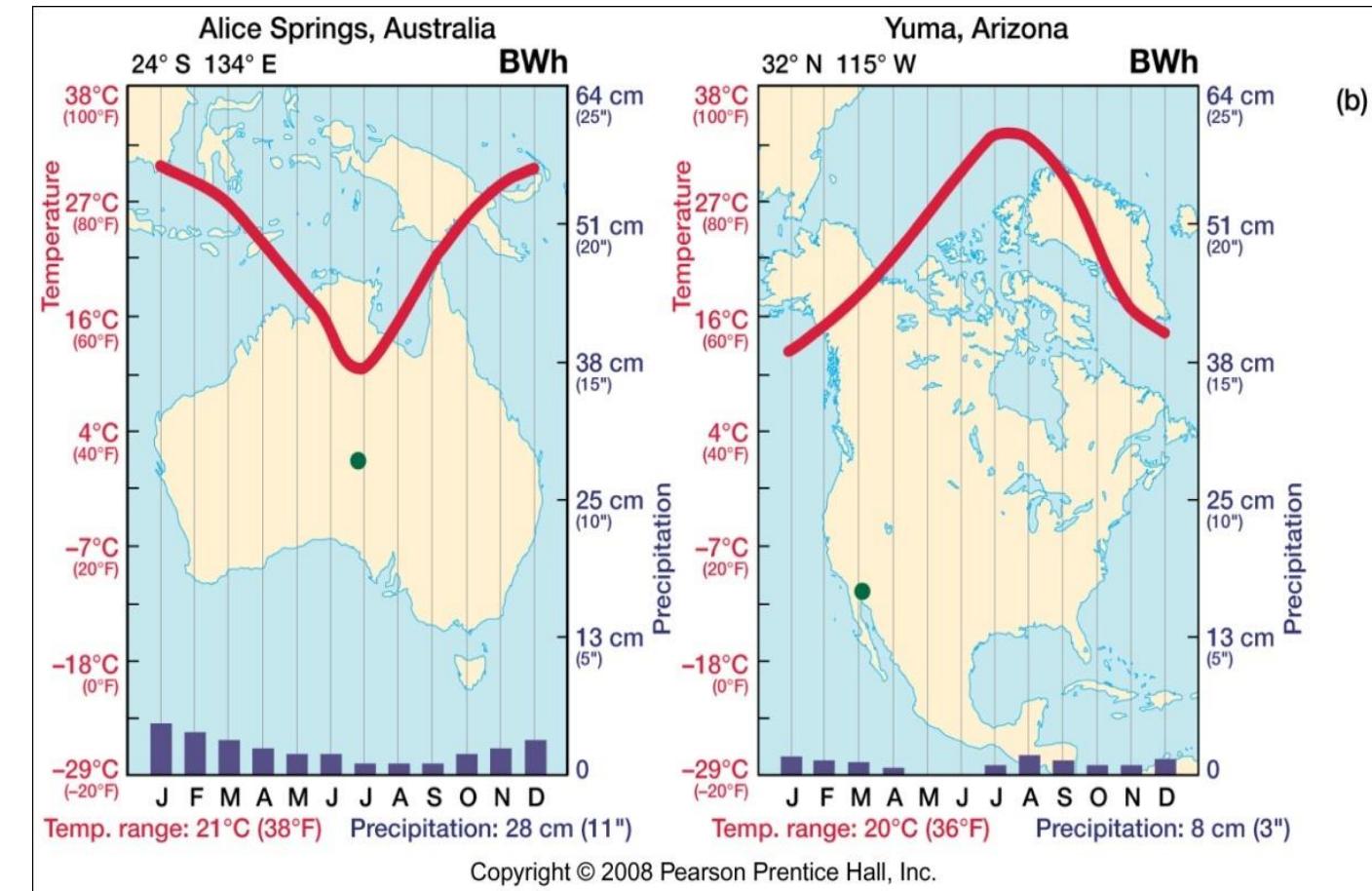
TABLE V-1 (continued)

Letters

<i>1st</i>	<i>2nd</i>	<i>3rd</i>	<i>Description</i>	<i>Definitions</i>
	w		Winter dry season	Wettest summer month has at least 10× precipitation of driest winter month
	f		No dry season (German: <i>feucht</i> ["moist"])	Does not fit either s or w above
	a		Hot summers	Average temperature of warmest month more than 22°C (72°F)
	b		Warm summers	Average temperature of warmest month below 22°C (72°F); at least 4 months with average temperature above 10°C (50°F)
	c		Cool summers	Average temperature of warmest month below 22°C (72°F); less than 4 months with average temperature above 10°C (50°F); coldest month above -38°C (-36°F)
D			Humid midlatitude climates with severe winters (2nd and 3rd letters same as in C climates)	Warmest month above 10°C (50°F); coldest month below -3°C (27°F)
	d		Very cold winters	Average temperature of coldest month less than -38°C (-36°F)
E			Polar climates; no true summer	No month with average temperature more than 10°C (50°F)
T			Tundra climates	At least one month with average temperature more than 0°C (32°F) but less than 10°C (50°F)
F			Ice cap climates ("frost")	No month with average temperature more than 0°C (32°F)
H			Highland Climates	Significant climatic changes within short horizontal distances due to altitudinal variations

Climographs

Simple graphical representation of monthly temperature and precipitation for a specific weather station



World Distribution of Major Climates

Three Questions

- Where are the various climate types located?
- What are the characteristics of each climate?
- What are the main Dominant Controls of these climates?

Climatic Regions of the World

A TROPICAL HUMID CLIMATES

- Af Tropical wet
- Am Tropical monsoon
- Aw Tropical savanna

B DRY CLIMATES

- BWh Subtropical desert
- BWk Midlatitude desert
- BSh Subtropical steppe
- BSk Midlatitude steppe

C MILD MIDLATITUDE CLIMATES

- Cfa Humid subtropical
- Cwa
- Cfb Marine west coast
- Cfc
- Csa Mediterranean
- Csb

D SEVERE MIDLATITUDE CLIMATES

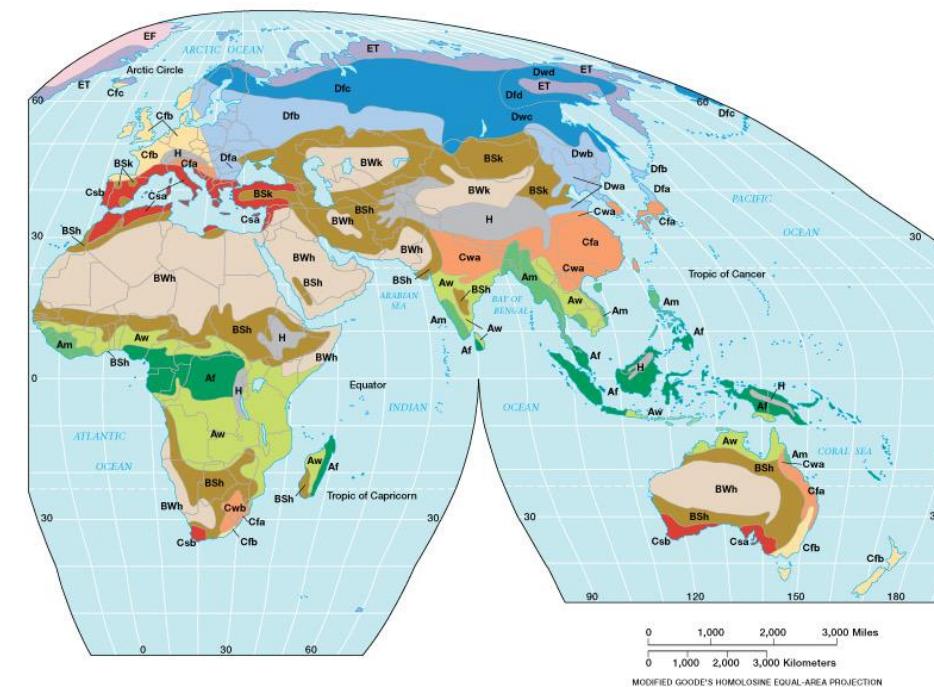
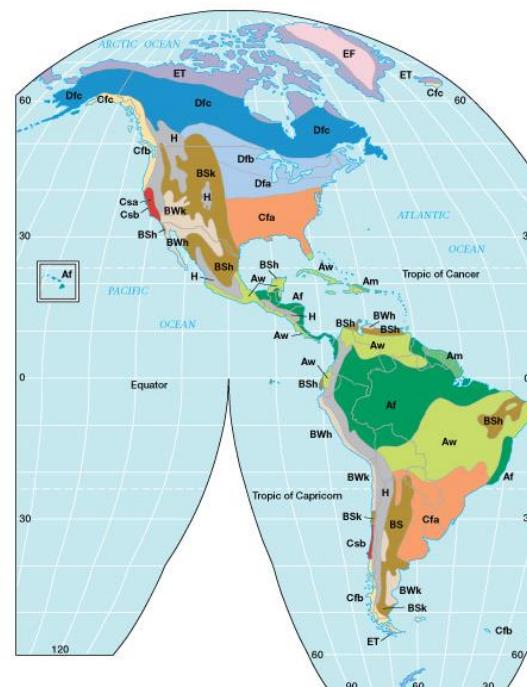
- Dfa
- Dwa
- Dfb
- Dwb
- Dfc
- Dwc
- Dfd
- Dwd
- Subarctic

E POLAR CLIMATES

- ET Tundra
- EF Ice cap

H HIGHLAND

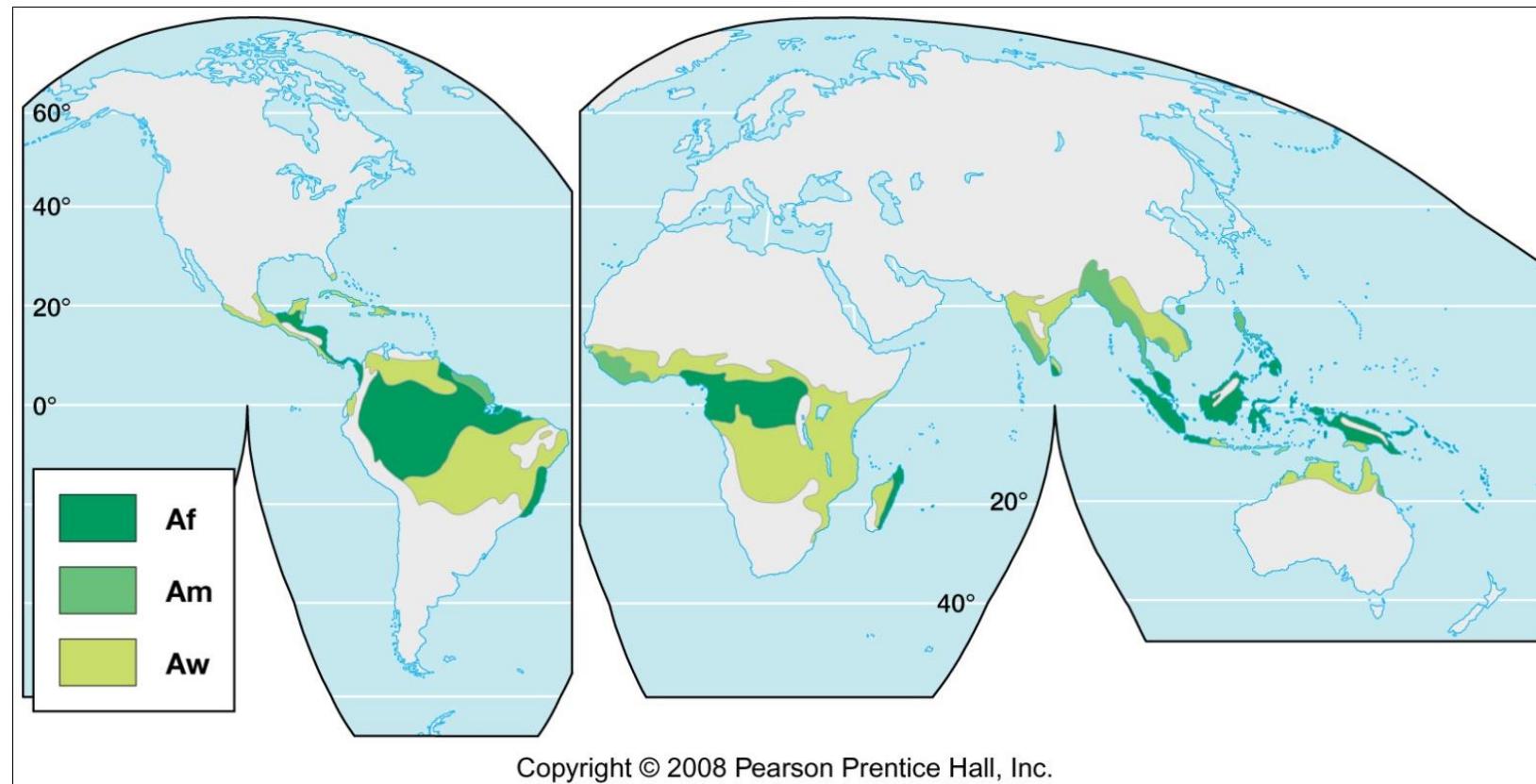
- H Cold climates due to elevation



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Tropical Humid Climates (Group A)

Distribution of A Climates: within 0–25° of equator



Distinctive Features of A Climates

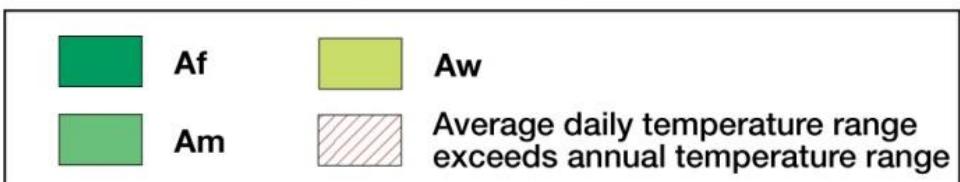
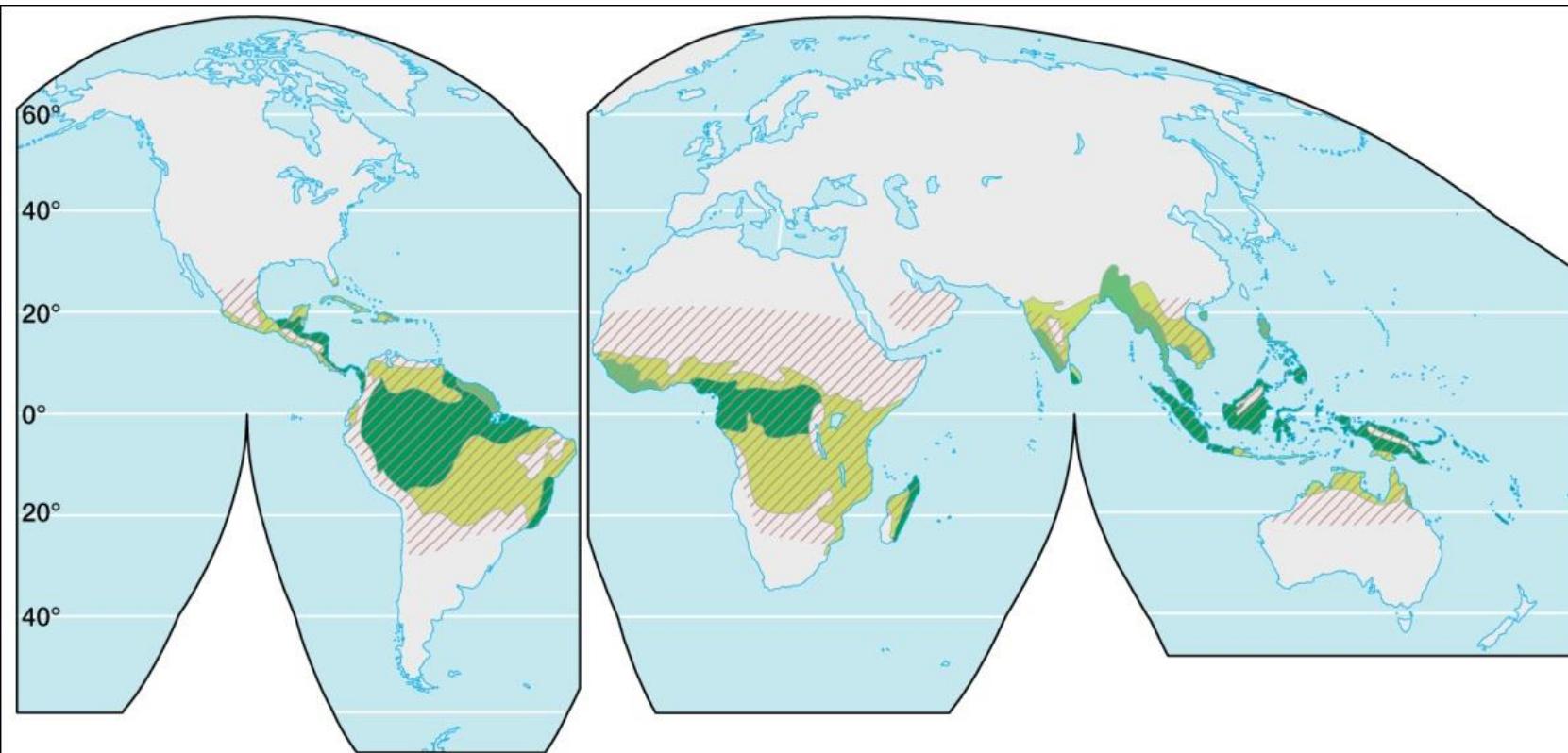
Average daily temperature greater than annual temperature range

Sun of overhead throughout the year

ITCZ causes heating

Two peaks of precipitation during the year as the ITCZ migrates North and South of the equator

- No true winter
- High temperatures prevail every month
 - A climates are distinguished by the monthly pattern of rainfall
 - f = year-around rainfall
 - m = year-round rainfall, but with a brief drier period
 - w = wet summer and dry winter



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1. Tropical Wet Climate (Af)

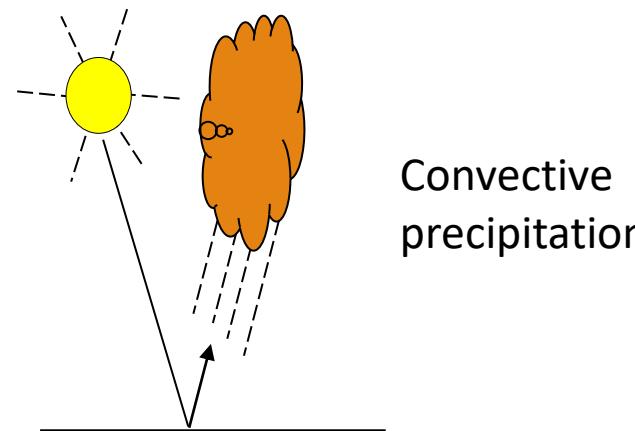
Main locations

- Within 5–10° of equator
- Amazon basin
- Northern Congo basin
- Islands of East Indies

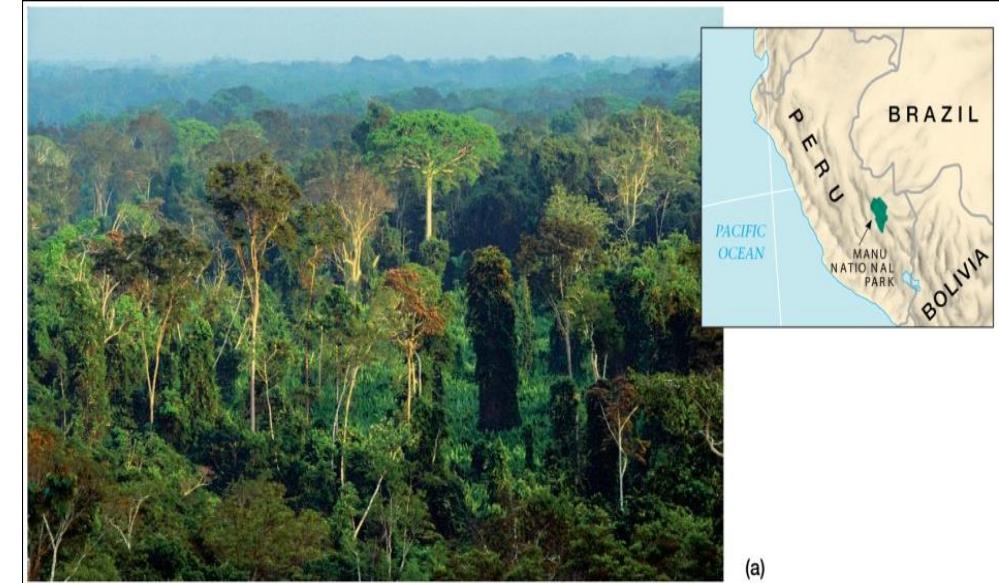
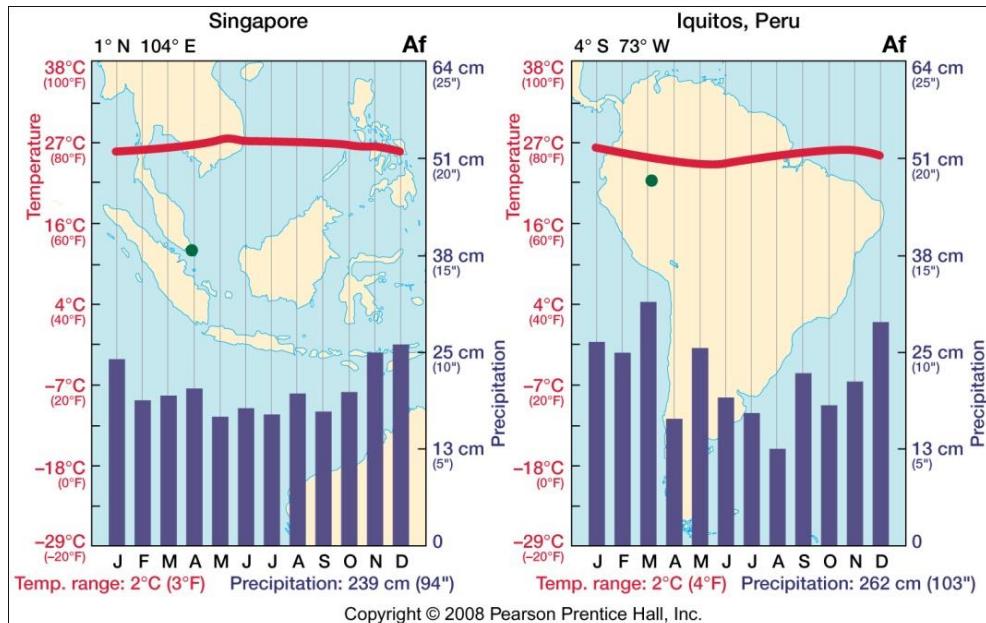
Characteristics

- Monotonous (“seasonless”)
- High humidity
- Afternoon convective thundershowers
- High annual rainfall, evenly distributed during year

- Dominant Controls: ITCZ influence entire year



- Climographs



2. Tropical Wet and Dry Climates or Tropical Savanna (AW)

Main locations

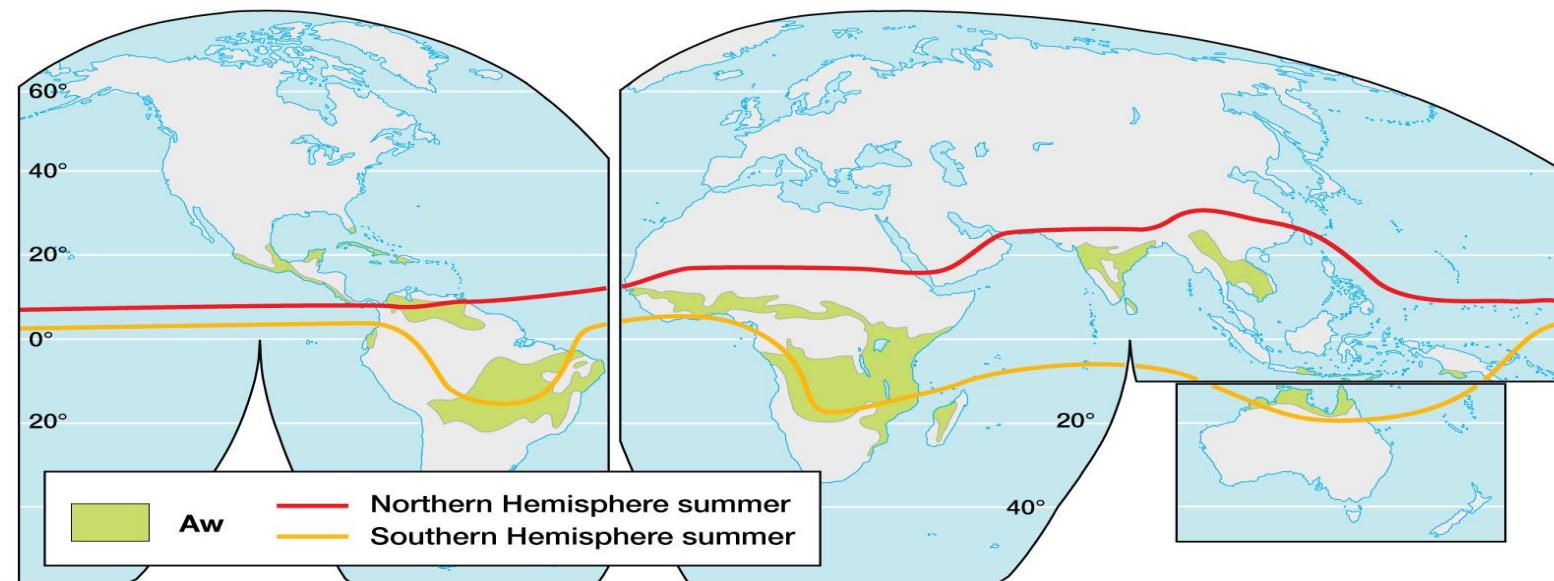
- 5–25° of latitude
- Most extensive of A climates
- Adjacent to Af climates
- Most widespread in Africa, South America
- South Asia and northern Southeast Asia
- Northern Australia

Characteristics:

- Clear-cut seasonal alternation of wet and dry periods
- Lower precipitation than other A climates

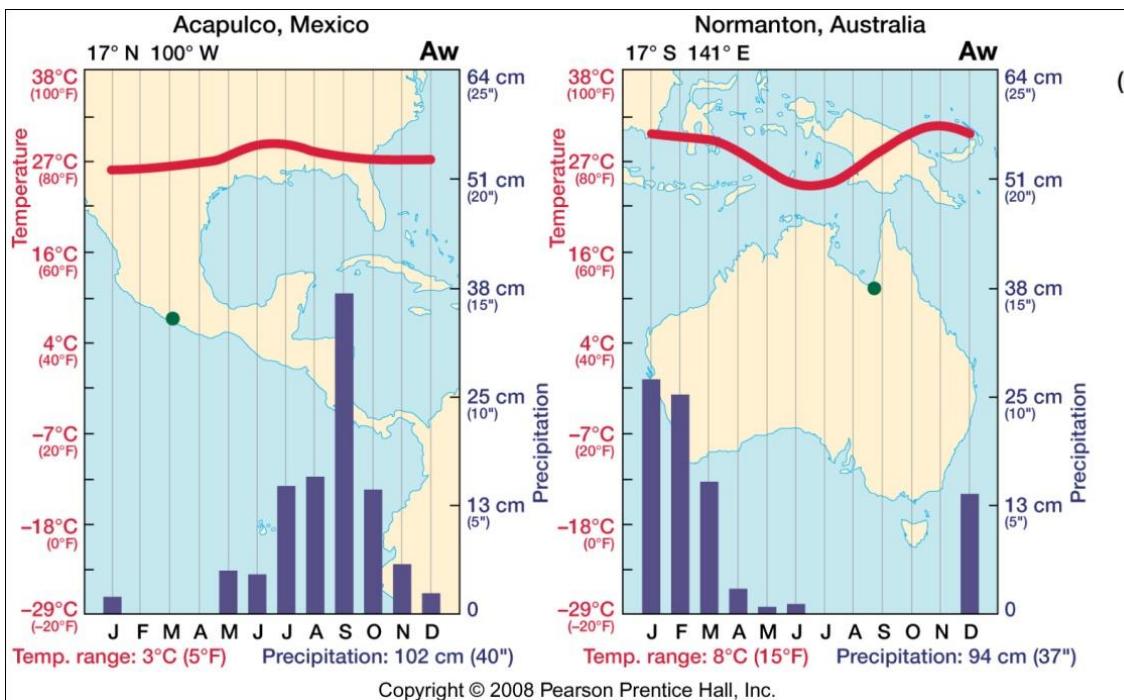
Dominant Controls

- ITCZ dominates during summer
- cT or cP air mass dominates during cooler periods
- When the ITCZ moves towards the Southern Hemisphere, you have dry season in the Northern Hemisphere and vice versa.



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• Climographs



(b)



3. Tropical Monsoon (AM)

Main locations

- Coastal regions
- Most prominent area is west-facing coasts of India, southeastern Asia
- Smaller areas scattered in tropical latitudes

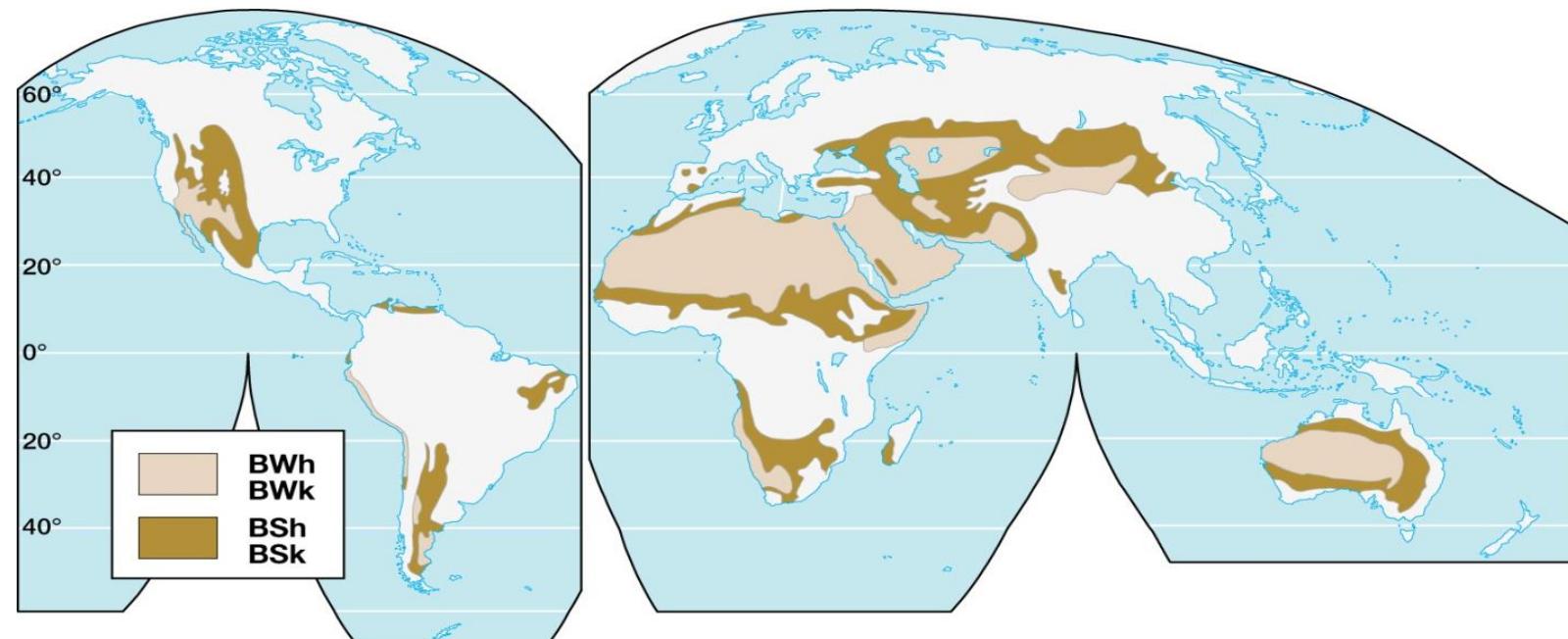
Characteristics:

- Very high rainfall totals in summer
- Brief (1-4 months), drier period in winter

Dry Climates (Group B)

Distribution of B Climates

- Subtropical Dry Climates within 20–35° of latitude
- Midlatitude Dry Climates within 35–55° of latitude



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Distinctive Features of B climates

- Cover 30% of the total land area of the world
 - More area than any other climate group
- Dry conditions prevail all year
 - Potential evapotranspiration is greater than precipitation
- Two main sub-types based on precipitation
 - **BW** is extremely arid (desert)
 - **BS** is steppe (semi-arid)
- The two sub-types are further subdivided based on temperature
 - h is for the hot subtropical desert (BWh, BSh)
 - k is for the cold midlatitude desert (BWk, BSk)

1. Subtropical Desert (BWh)

Main locations

- Centered at latitudes 25–30°
- Western sides of continents, including coasts
 - Extend into continental interiors
- Northern Hemisphere
 - Sonora-Colorado: North America
 - Sahara: Africa
 - Arabian: Southwestern Eurasia
- Southern Hemisphere
 - Peru: Atacama desert – the driest of the dry lands
 - Kalahari-Namib

Subtropical Desert (BWh)

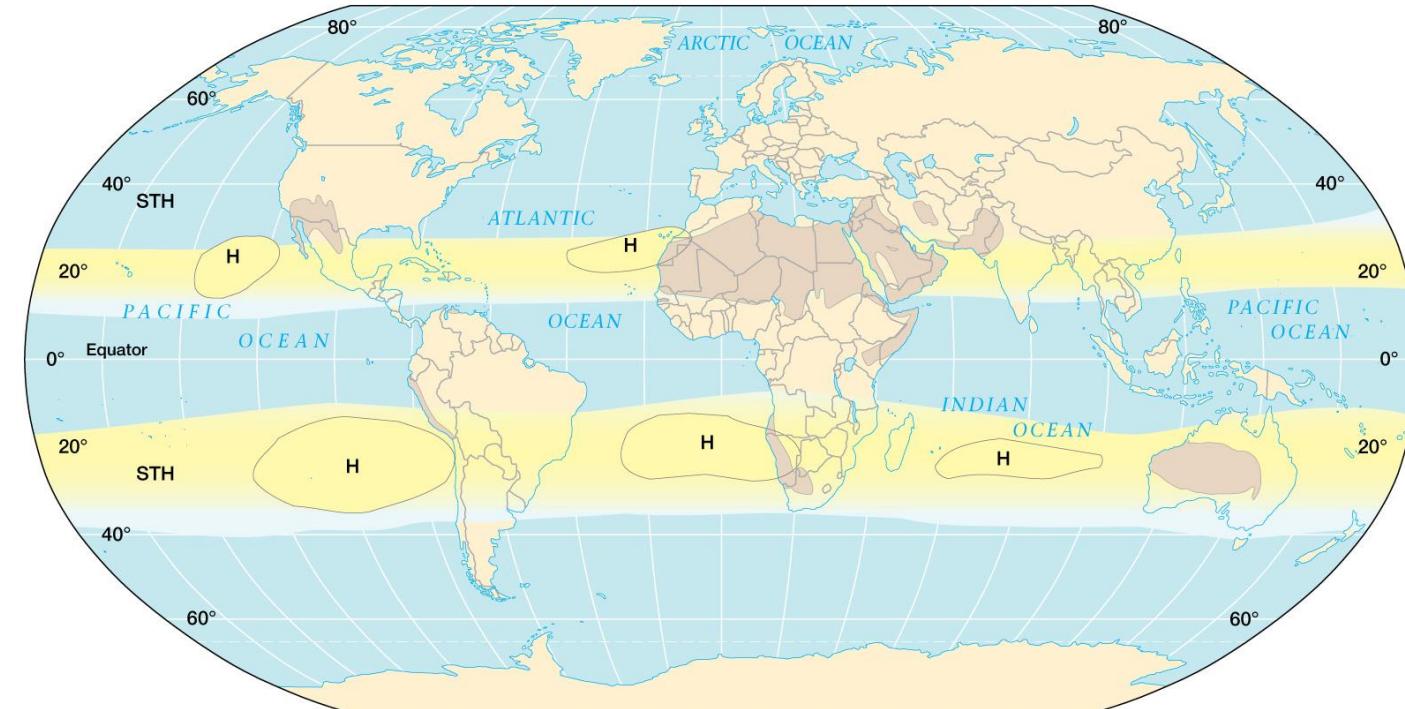
Characteristics

- Precipitation: extremely arid
 - Scarce (most nearly rainless regions on Earth)
 - Unreliable (extremely long periods without rain)
 - Intense (brief, but heavy convective downpours)
- Very hot summers
- Enormous daily temperature range
- Coastal equatorward extensions: advection fog off-shore

Dominant Controls

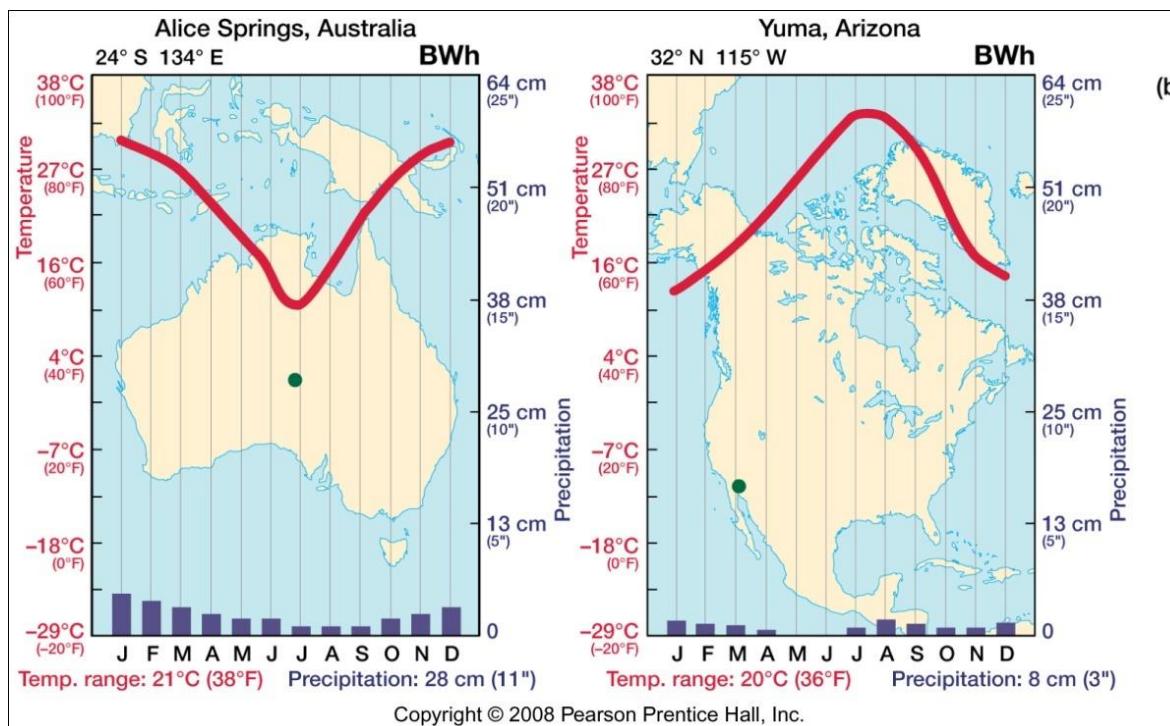
Subsidence from subtropical highs (STHs)

Hadley cells sinking back to the surface – dry all year

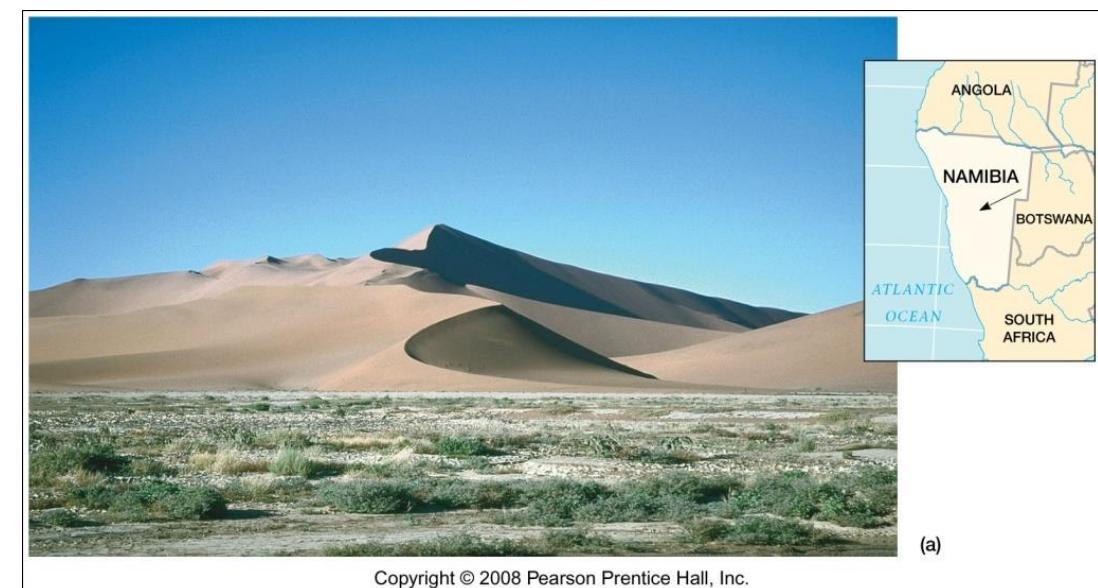


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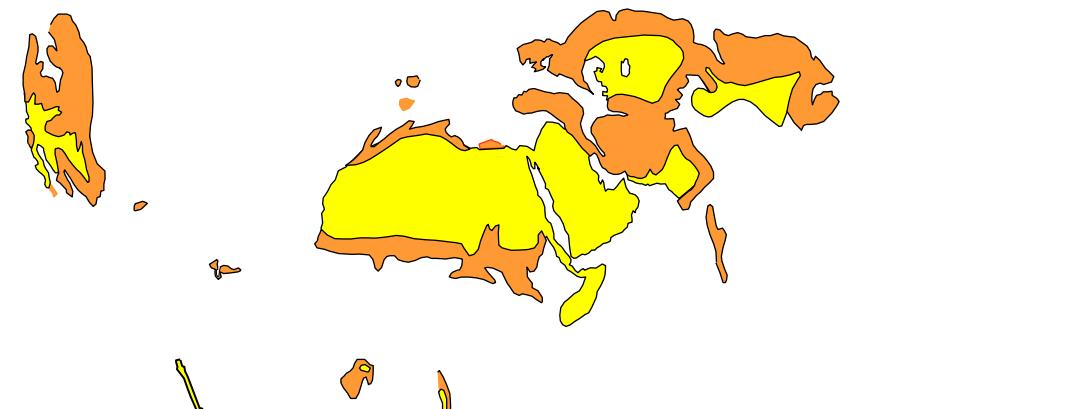
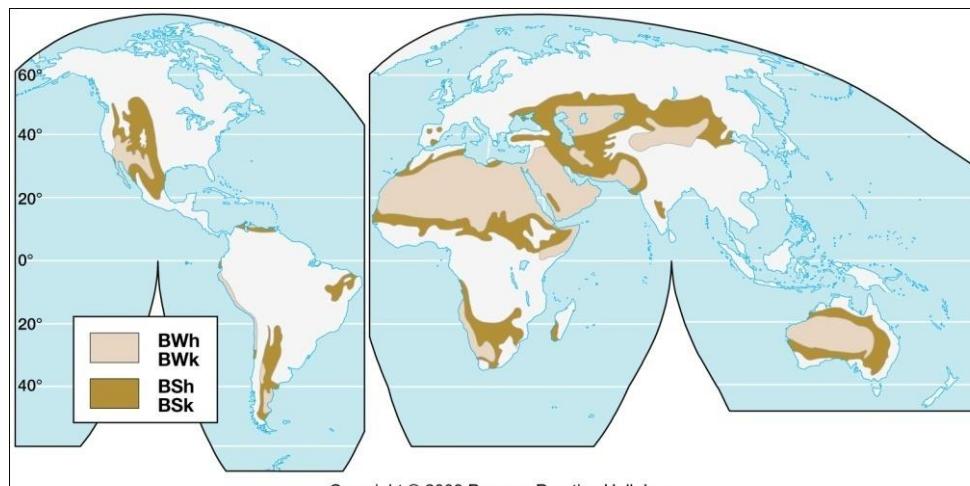
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2. Midlatitude Desert (BWk)

Main locations

- Central Asia
- Western interior of United States
- Patagonia



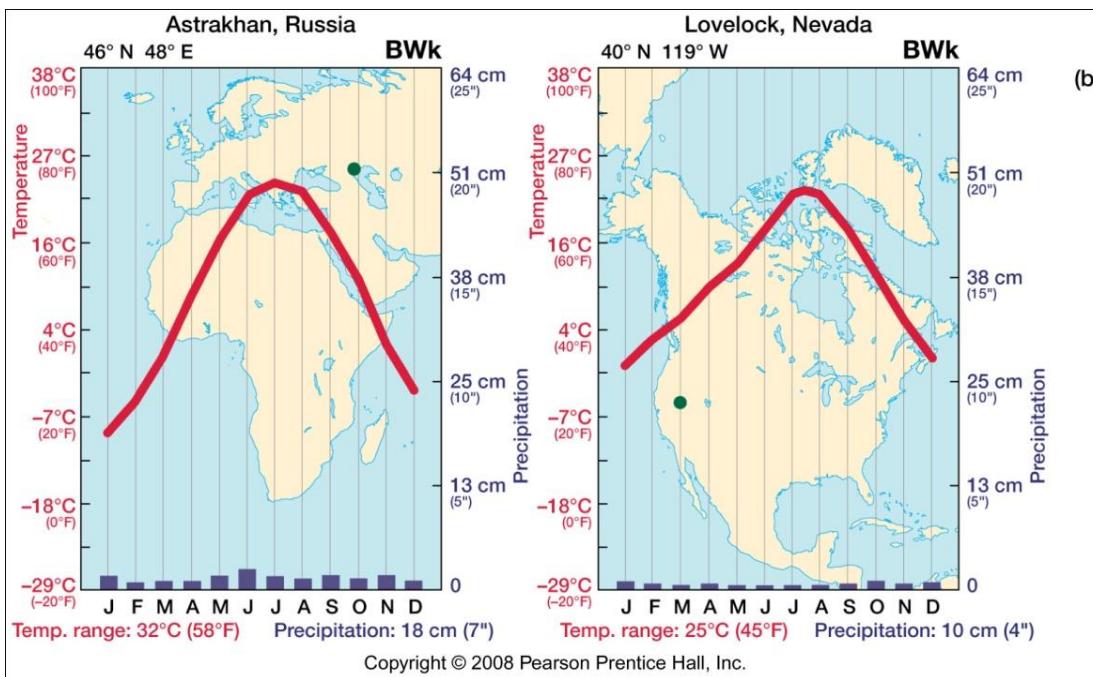
Characteristics

- Precipitation meager
 - Erratic, mostly showery
 - Some winter snow
- Temperatures
 - Hot summers, cold winters
 - Very large annual temperature range
 - Large daily temperature range

Dominant Controls

- Rain shadow effects
- Distance from sources of moisture

• Climographs



(b)



3. Subtropical Steppe (BSh)

Main locations

- Fringing BWh (subtropical deserts) except on west coasts

Characteristics

- Similar to BWh but more moderate
- Precipitation: **semiarid**

Dominant Controls

- Similar to BWh

4. Midlatitude Steppe (BSk)

Main locations

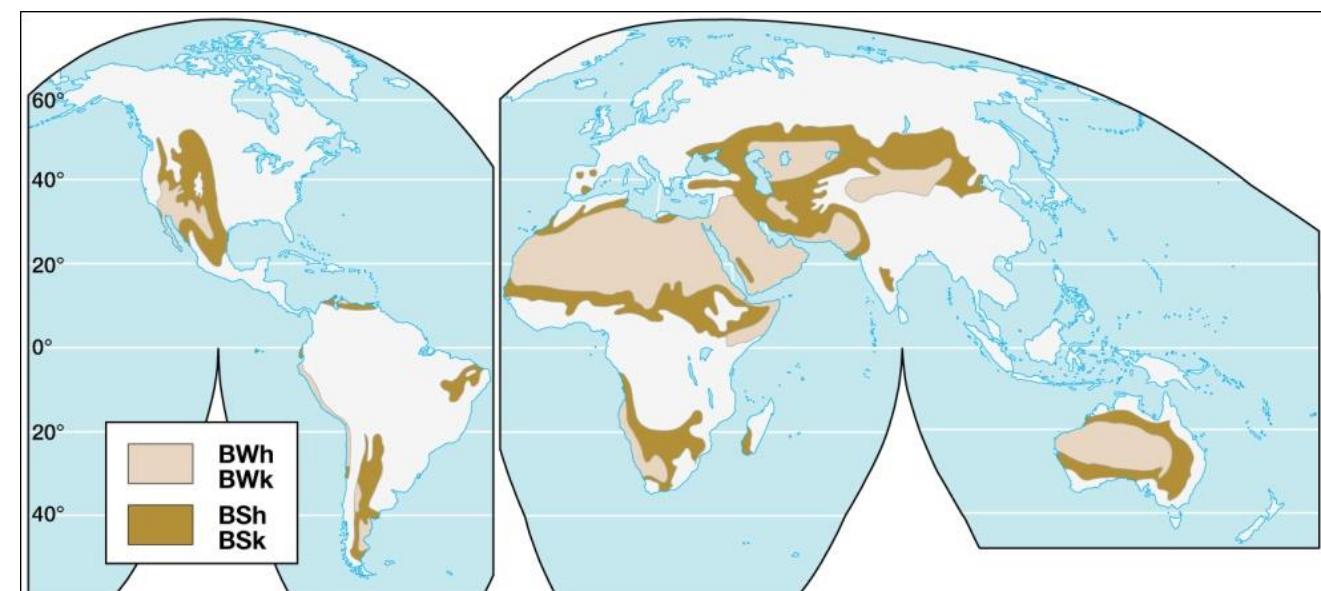
- Fringing BWk

Characteristics

- Similar to BWk (more moderate)
- Precipitation: semiarid

Dominant Controls

- Similar to BWk



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- Climographs

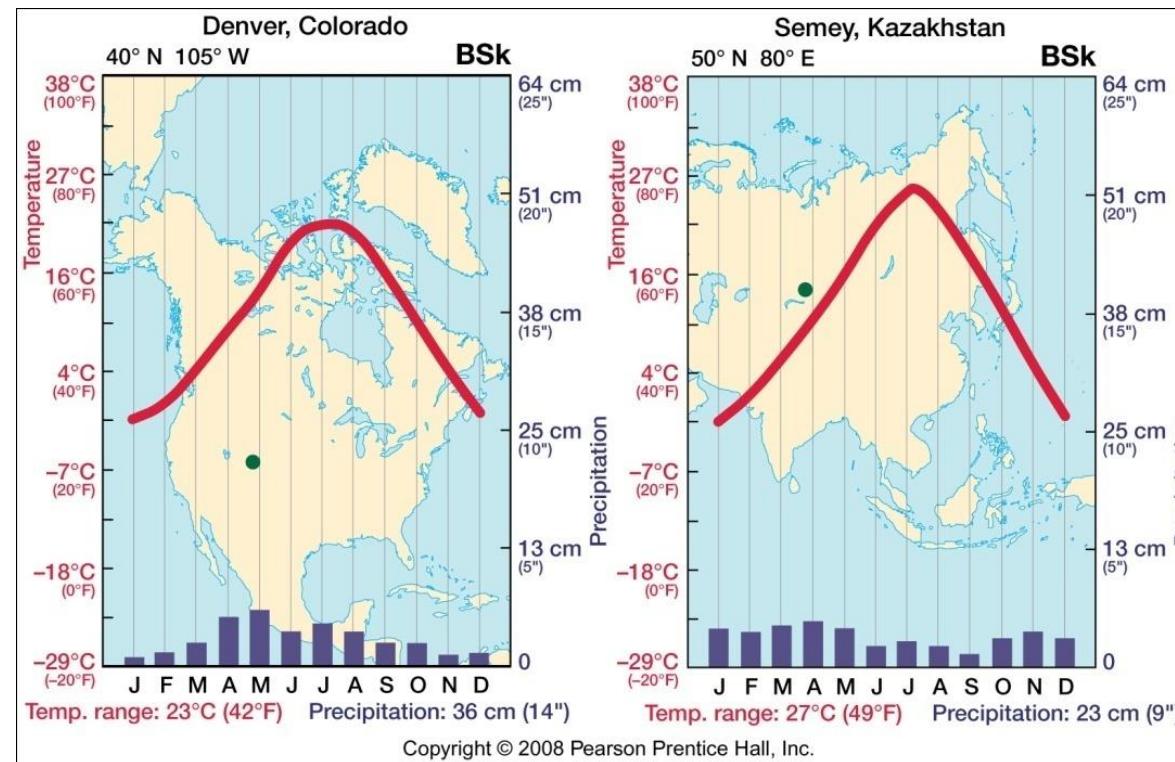
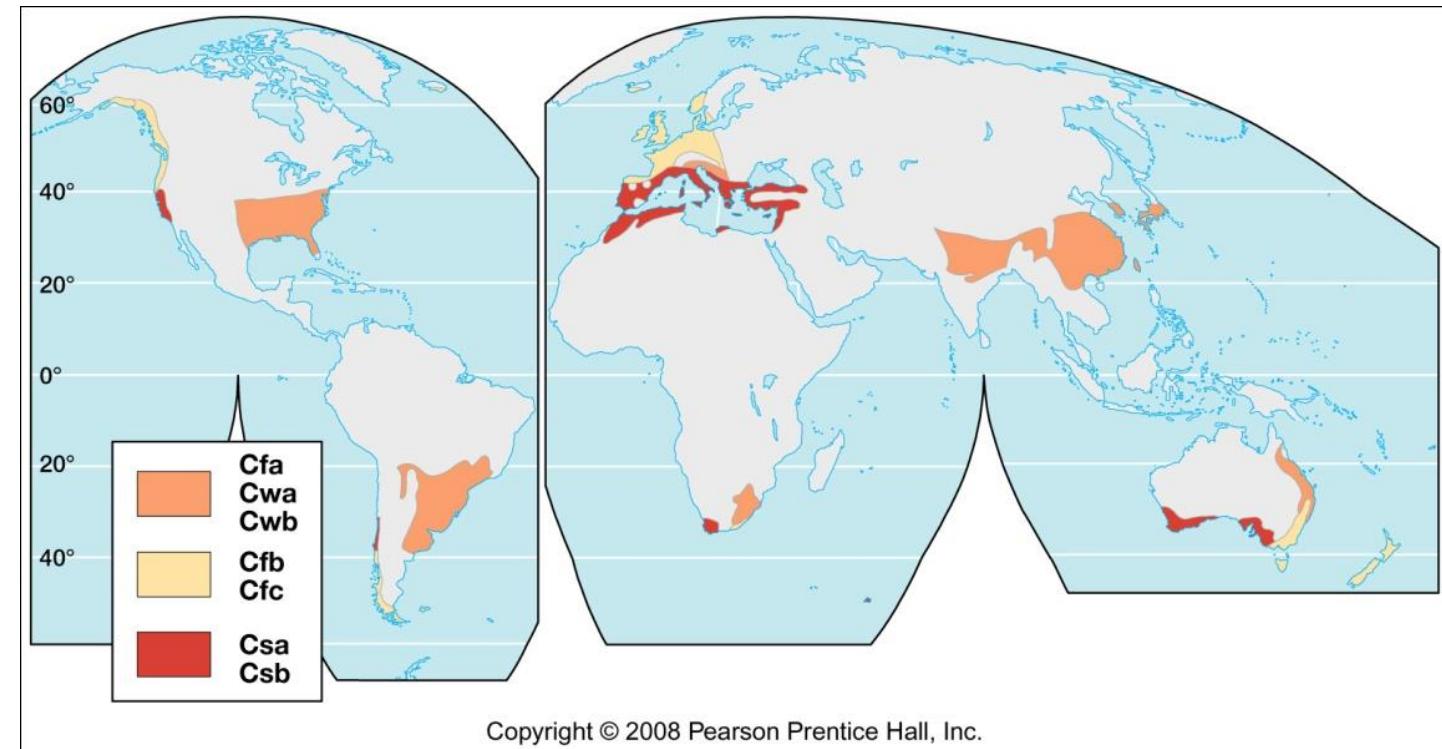


Photo: U.S. Great Plains, South Dakota

Mesothermal: Mild Midlatitude Climates (Group C)

Distribution of C Climates

- Equatorward margin of the middle latitudes
- Within 25-40° of latitude with some poleward extensions



Distinctive Features of C climates

- Temperatures
 - Long summers, usually hot
 - Short winters, relatively mild
- Precipitation
 - No year-round moisture deficiency
 - Some climates have seasonal shortages
- Three subtypes
 - Mediterranean (Csa, Csb)
 - **Humid subtropical (Cfa)**
 - Marine west coast (Cfb, Cfc)

1. Mediterranean Climates (Csa, Csb)

Main locations

- Western side of continents
 - 30–40° of latitude
- Mediterranean coast
- California
- Central Chile
- Southern tip of Africa (Cape Town)
- Australia (Perth & Adelaide)

Characteristics

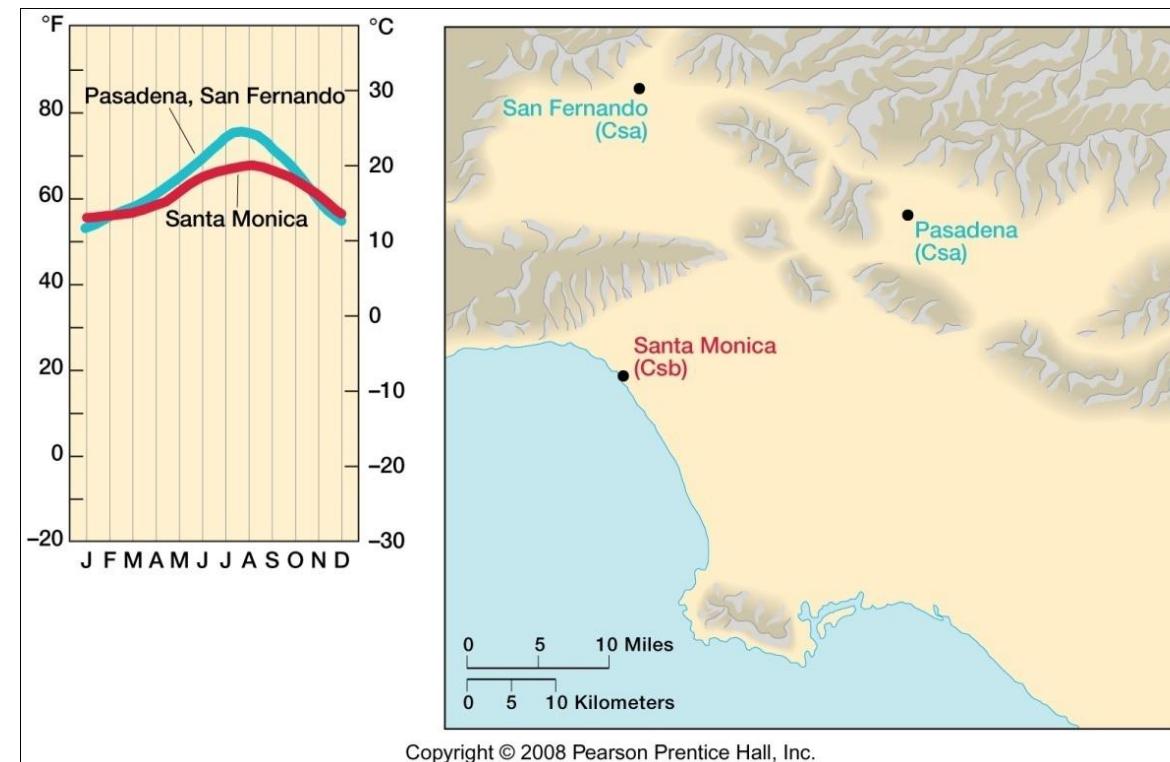
- Mild, wet winters, dry summers
- There are usually large anti-cyclones off the coast over the oceans. In summertime these serve as “blocking highs” preventing storm systems from getting to the coast
- In wintertime, the high-pressure system move southward, allowing low pressure to arrive on the coast, causing precipitation
- Two sub-types based on summer temperatures
 - a – hot summer (interior location)
 - b – cool/mild summer (coastal location)

Precipitation

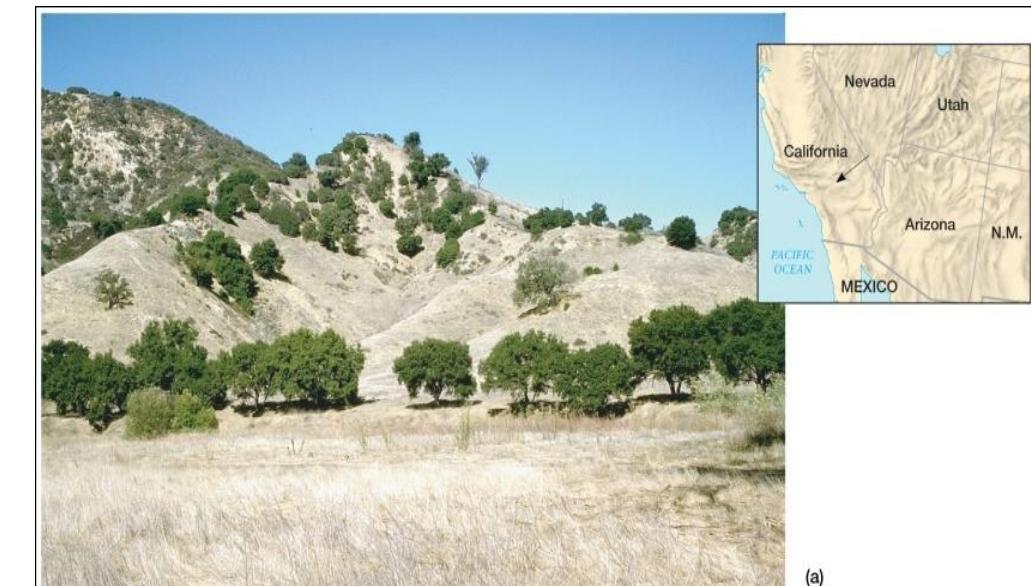
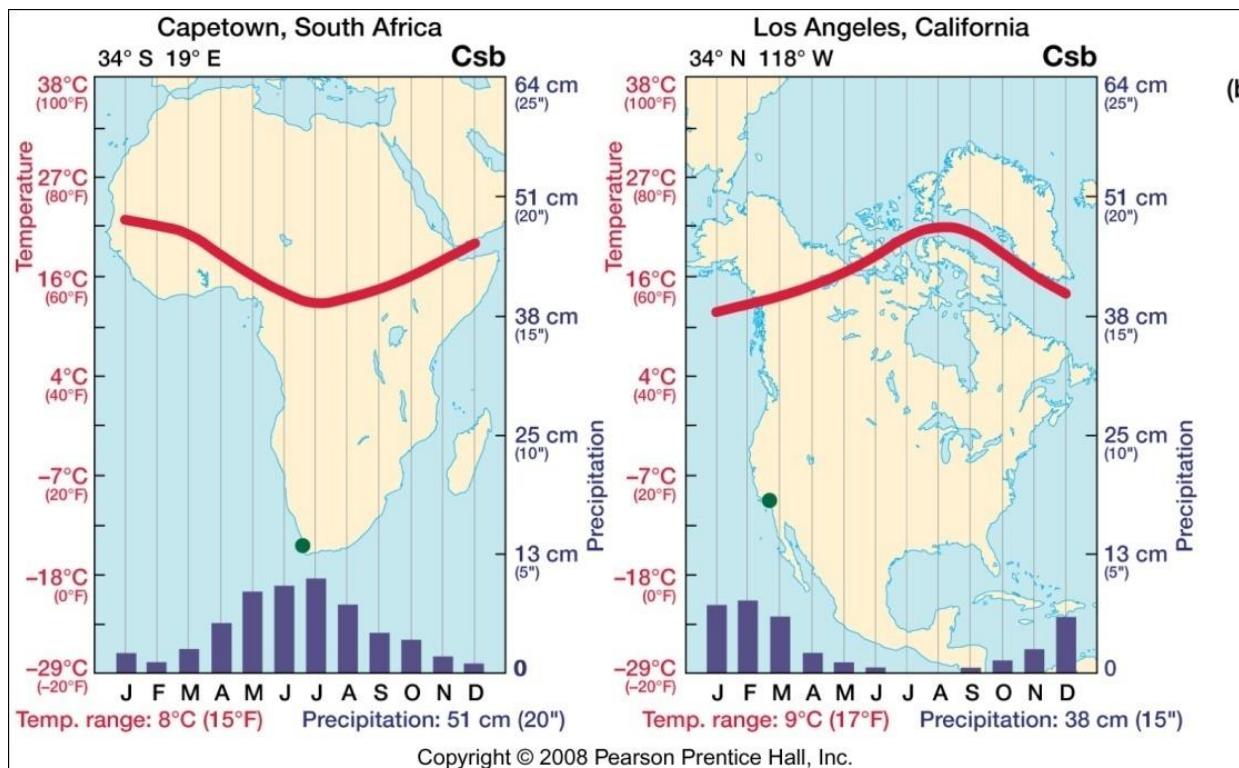
- Moderate annually
- Winter maximum (midlatitude cyclonic storms)

Dominant Controls

- STH subsidence in summer (forces cyclonic storms poleward)
- Westerly winds and cyclonic storms shift equatorward in winter



• Climographs



2. Humid Subtropical (Cfa, Cwa)

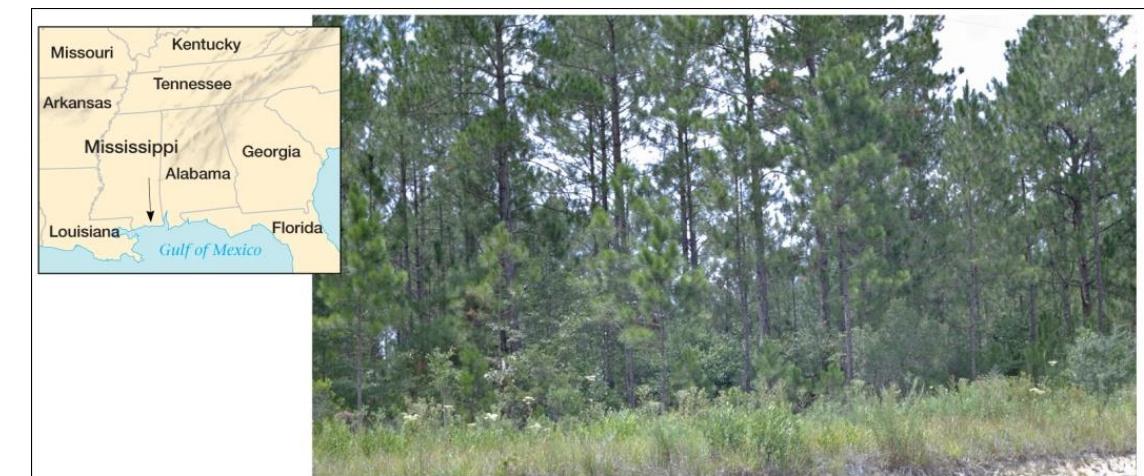
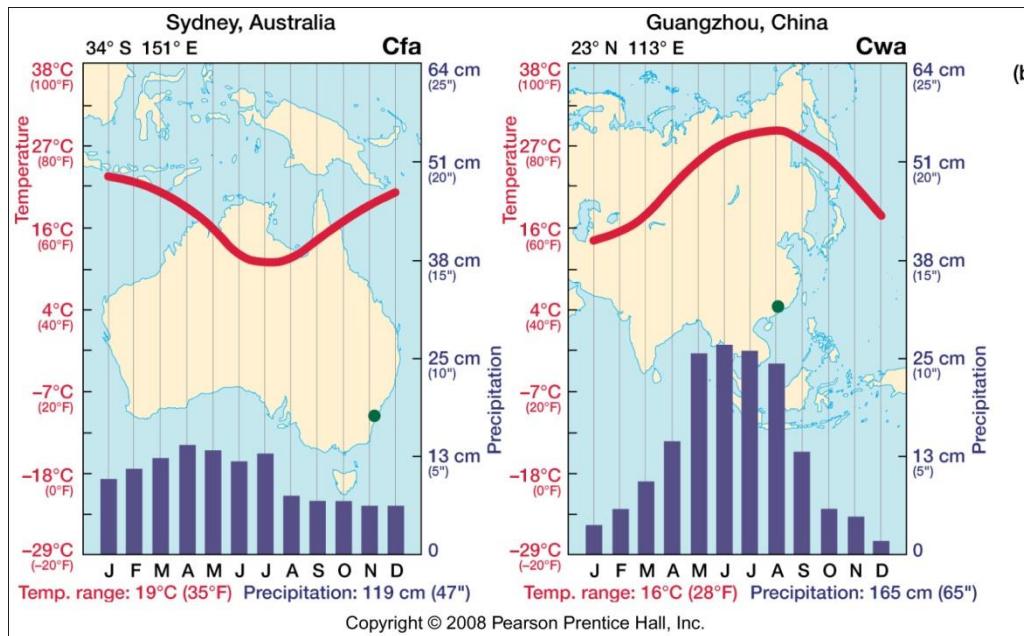
Main locations

- Eastern sides of continents
 - 25–30° of latitude
- Southeastern United States
- Eastern China
- Southern Brazil and Uruguay
- Small areas in Africa and Australia
- **Dallas, Texas (Cfa)**

Characteristics

- Temperatures
 - Summers, warm to hot
 - Winters, mild to cold
- Precipitation
 - Abundant, mostly as rain
 - Summer maximum
 - There is no maritime influence in terms of those “blocking highs” keeping low pressure systems at bay.

- Climographs



3. Marine West Coast

Main locations

- Western sides of continents, mainly
 - 40–65°
- Western and central Europe
 - Largest area
- North America
 - Oregon to Alaska
- New Zealand and eastern Australia

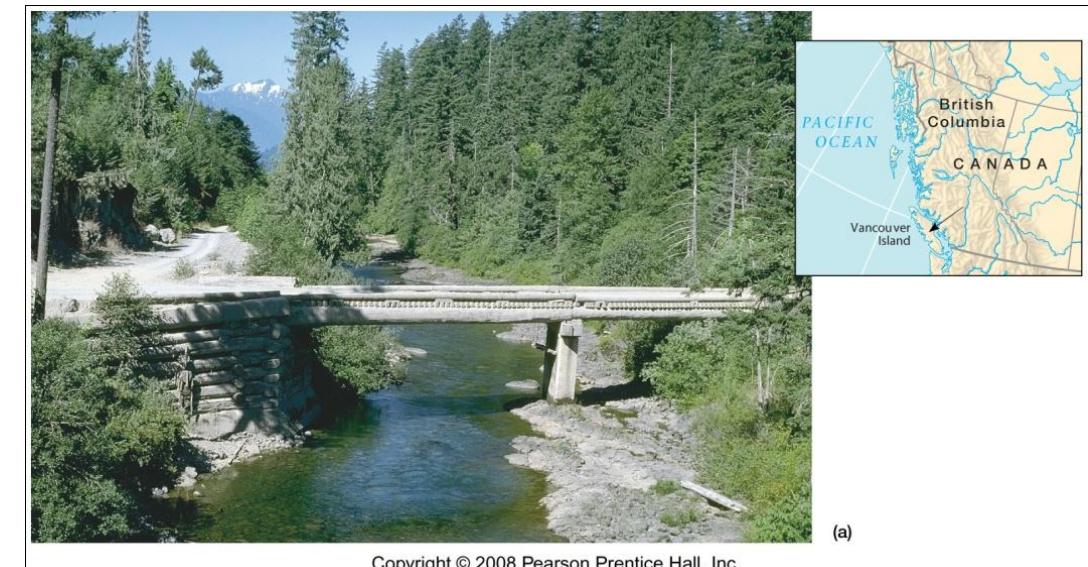
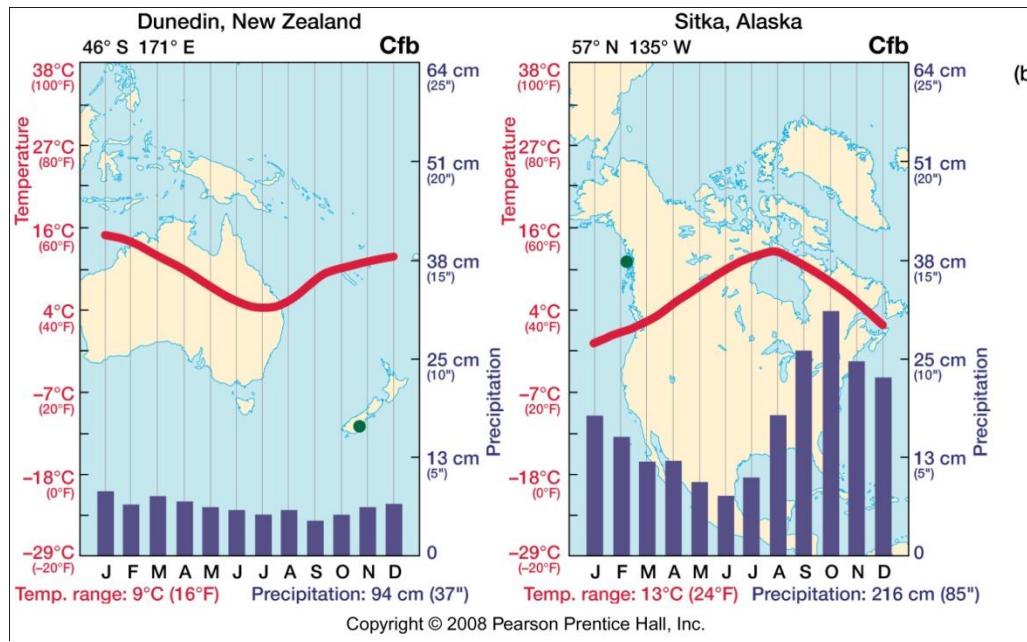
Characteristics

- Temperature
 - Very mild winters for latitude
- Precipitation
 - **Moderate to abundant, mostly in winter: these areas are usually too high up, especially Oregon, Washington, Vancouver, for the blocking highs to prevent storm systems from getting to shore.**
 - Many rainy days: wet all year almost – Washington always rainy?
 - Much cloudiness

Dominant Controls

- Westerly flow and oceanic influence year-round

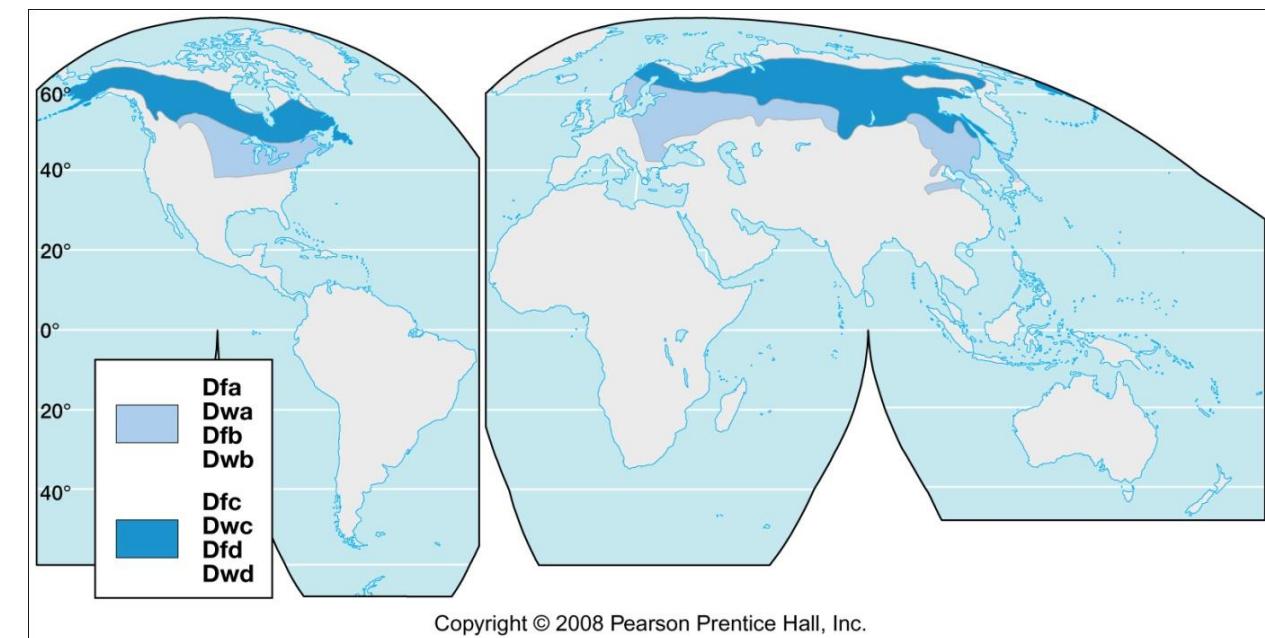
- Climographs



Microthermal: Severe Midlatitude Climates (Group D)

Distribution of D Climates

- Only in Northern Hemisphere
- Within 35–70° of latitude



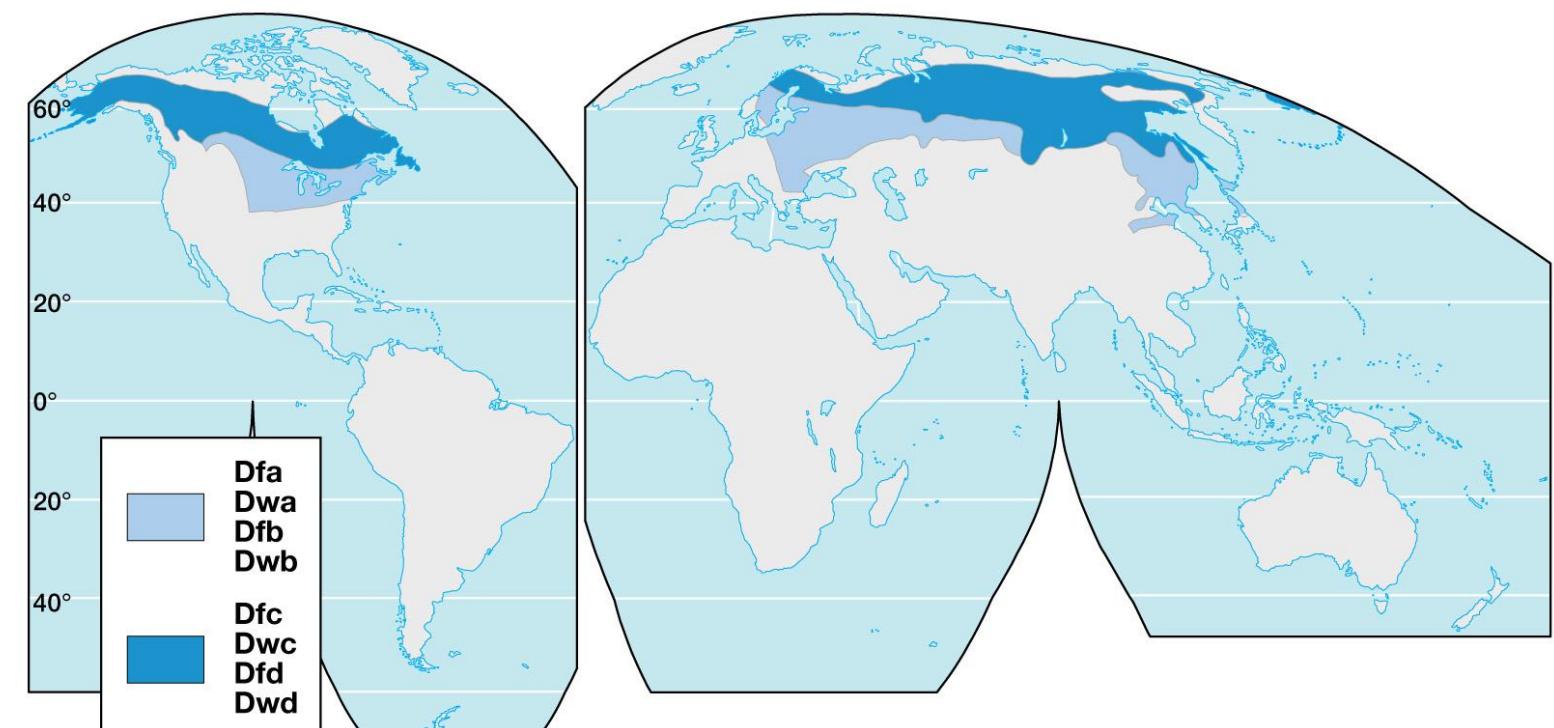
Distinctive Features of D climates

- Temperatures
 - Large annual temperature range
 - Continentiality
 - Cold winter, relatively short summer, e.g. Syracuse, NY
- Precipitation
 - Summer maxima
 - Abundant to meager amounts
 - Diminishes toward inland and poleward
- Two Main Subtypes
 - Humid Continental
 - Subarctic

Humid Continental (Dfa, Dfb, Dwa, Dwb)

Location

- N. Hemisphere only
- 35–55° of latitude
(Syracuse, NY)
- Eastern sides of continents



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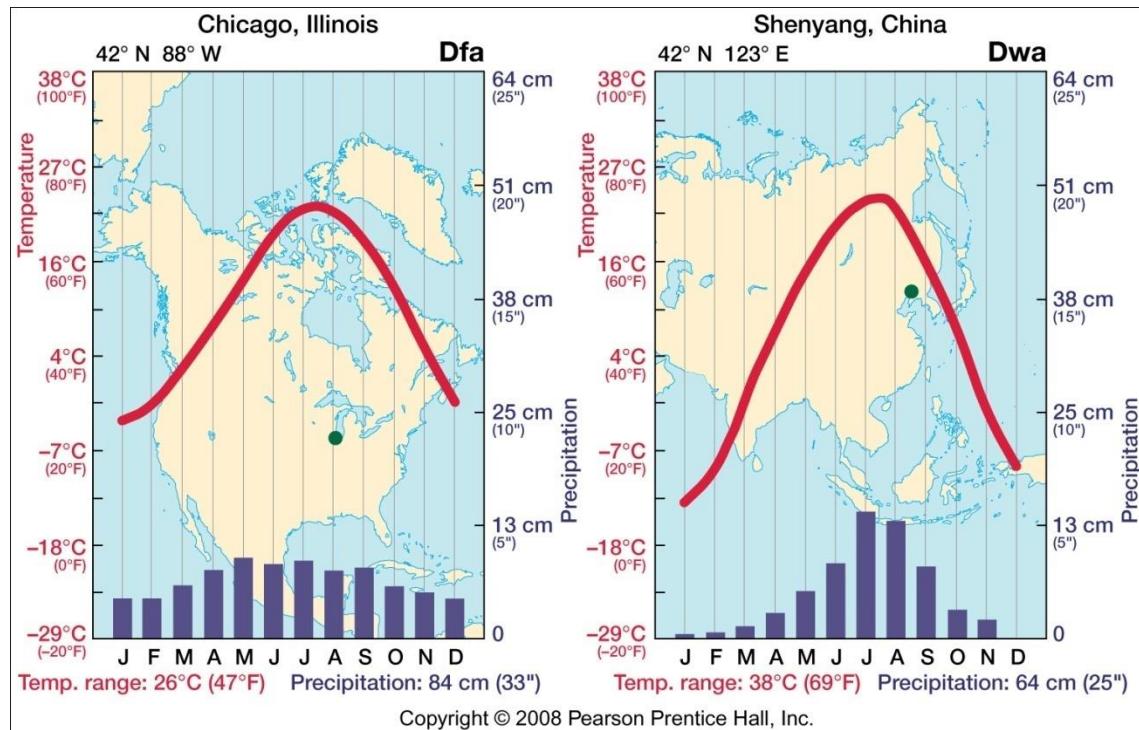
Characteristics

- Temperature
 - Warm/hot summers
 - Large annual temperature range
- Precipitation
 - Moderate to abundant
 - Summer maxima

Dominant Controls

- Westerly winds and storms
 - Midlatitude cyclones in winter in North America
 - Monsoons in Asia

• Climographs



(b)



Sub Arctic (Dfc, Dfd, Dwc, Dwd)

Location

- Northern Hemisphere only
- Latitudes 50–70°
- Across North American and Eurasia

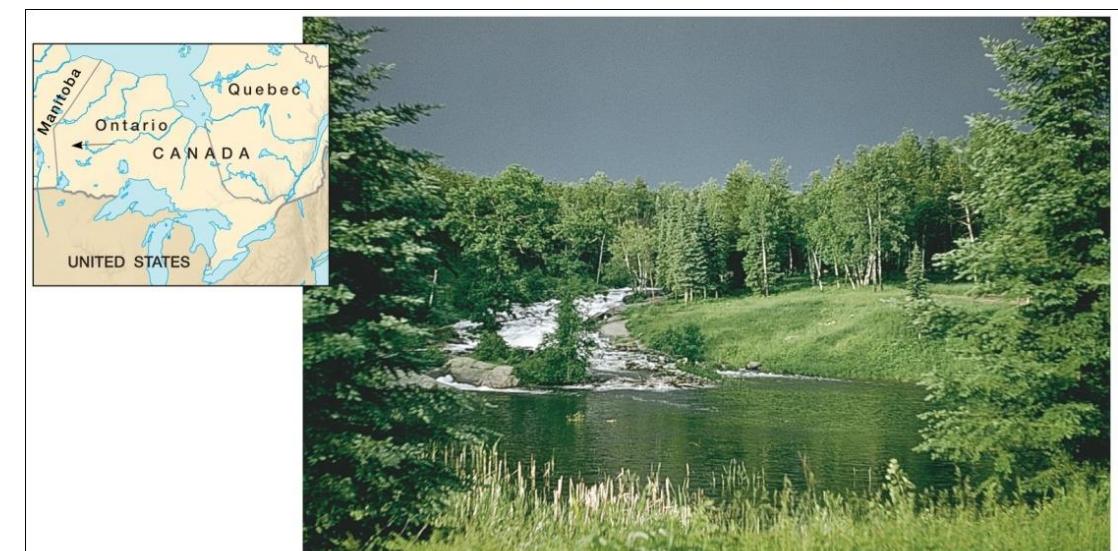
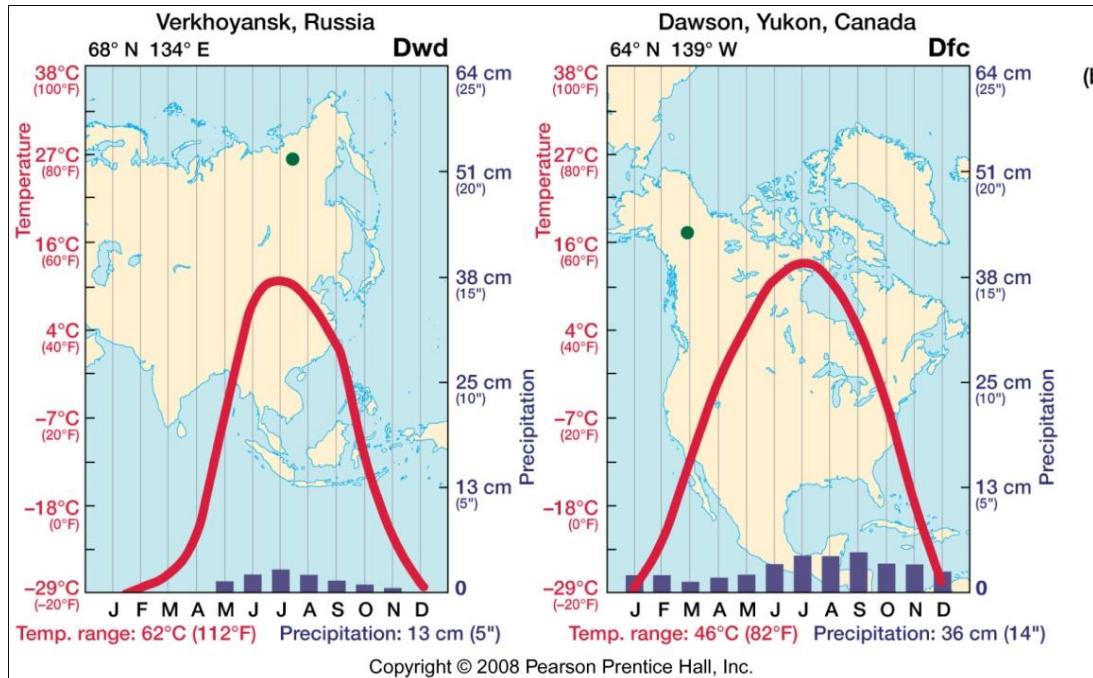
Characteristics

- Temperature
 - Long, dark, very cold winters
 - Brief, mild summers
 - Enormous annual temperature range
- Precipitation
 - Meager
 - Summer maxima
 - Light snow in winter, little melting

Dominant Controls

- Pronounced Continentality
- Alternating...
 - Westerlies and cyclonic storms
 - Prominent anticyclones

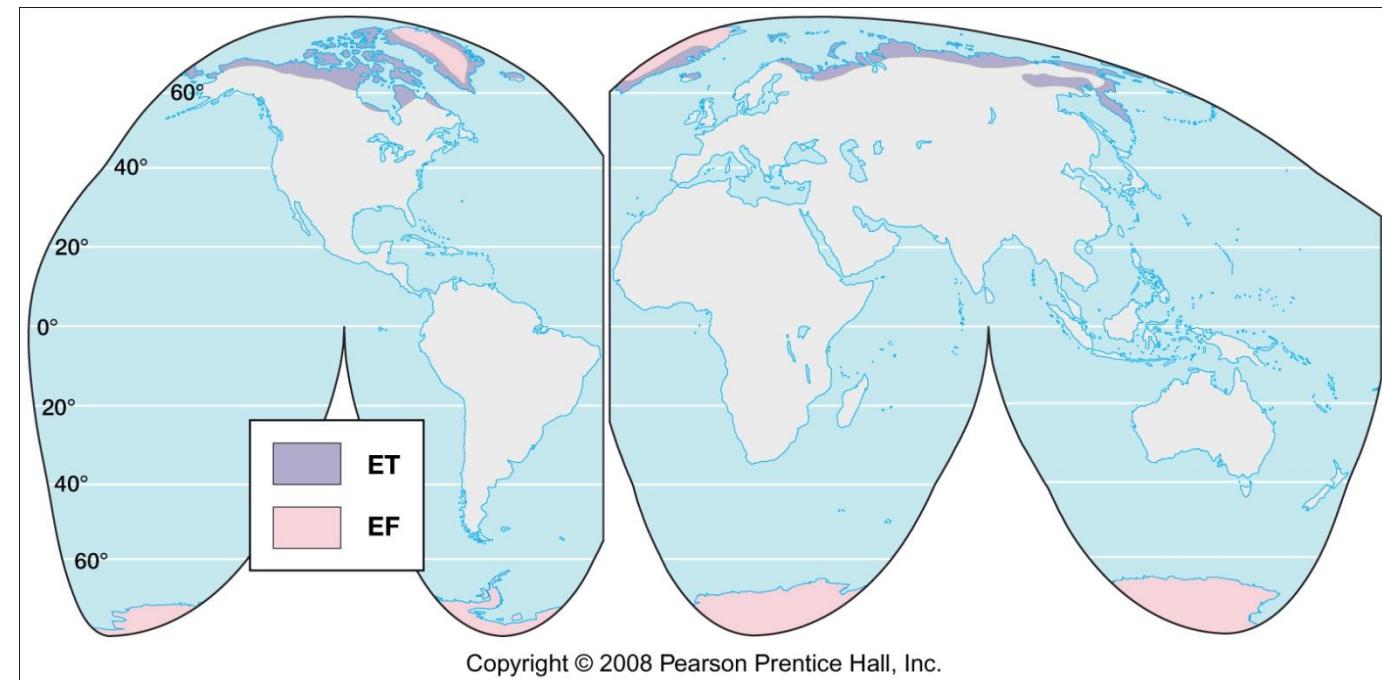
• Climographs



Polar Climates (Group E)

Distribution of E Climates

- Poleward of 70° of latitude



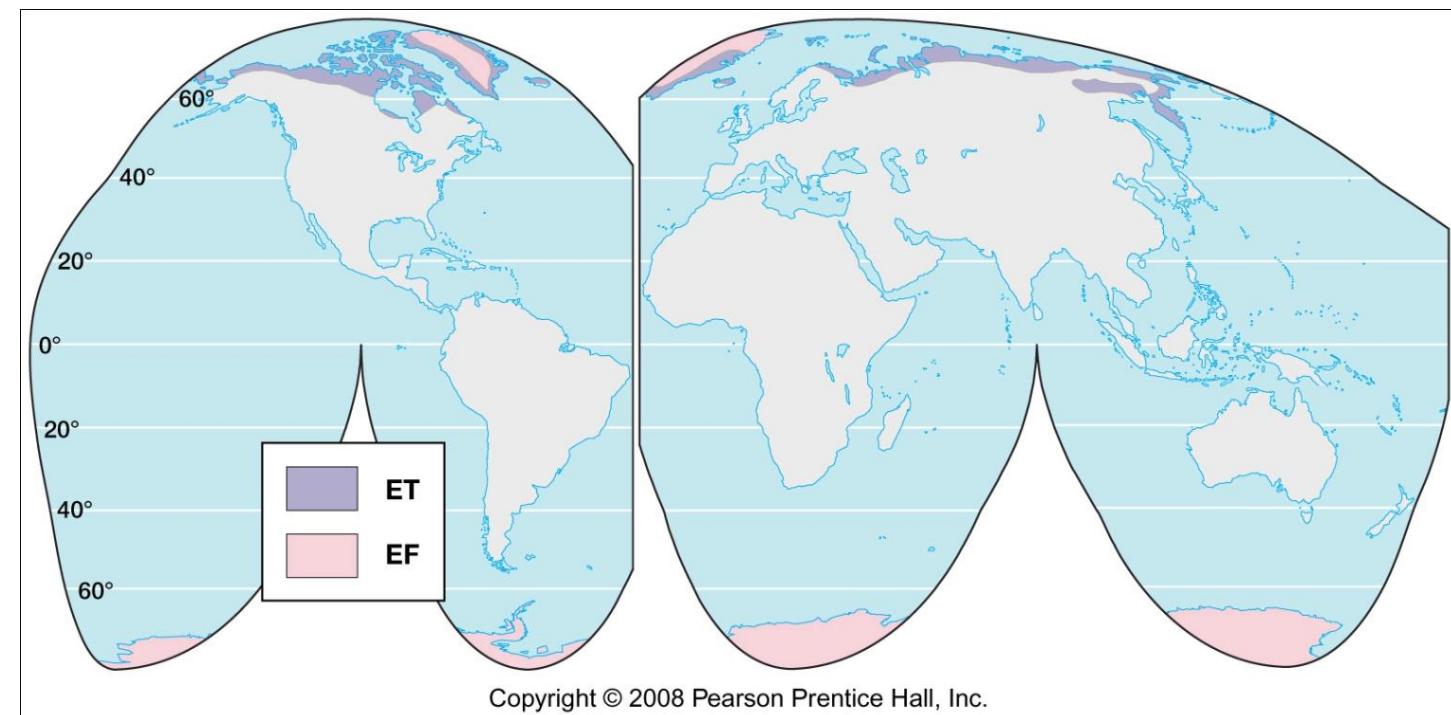
Distinctive Characteristics

- Temperatures
 - Coldest summers
 - Lowest annual average
 - Large annual temperature range
 - Small daily temperature range
- Extraordinarily dry
 - Low precipitation, mostly snow
 - Evaporation is almost zero - nil
- Two subtypes
 - Tundra
 - Ice Cap

Tundra (ET)

Main Locations

- Fringes of Arctic Ocean
- Small coastal areas in Antarctica



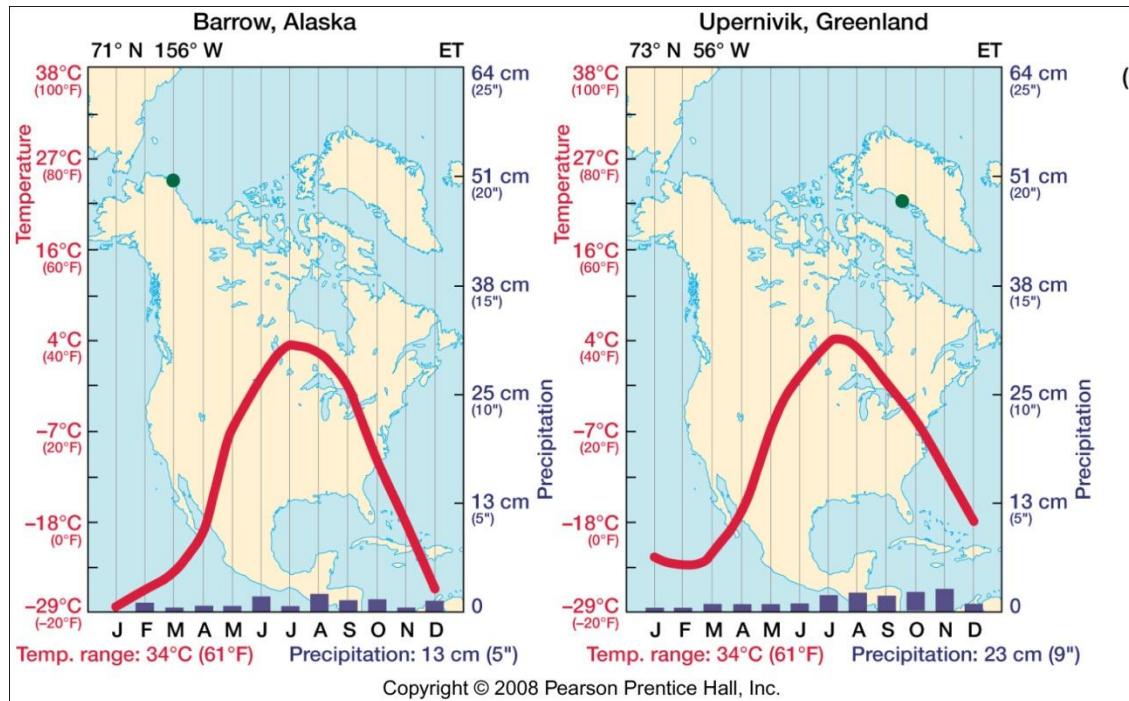
Characteristics

- Temperature
 - Long, cold dark winters
 - Brief, cool summers
- Precipitation
 - Very sparse
 - Mostly snow

Dominant Controls

- Latitude
- Distance from sources of heat and moisture
- Extreme seasonal contrasts in sunlight/darkness
- Polar anticyclones (A and cP air masses)

• Climographs



(b)



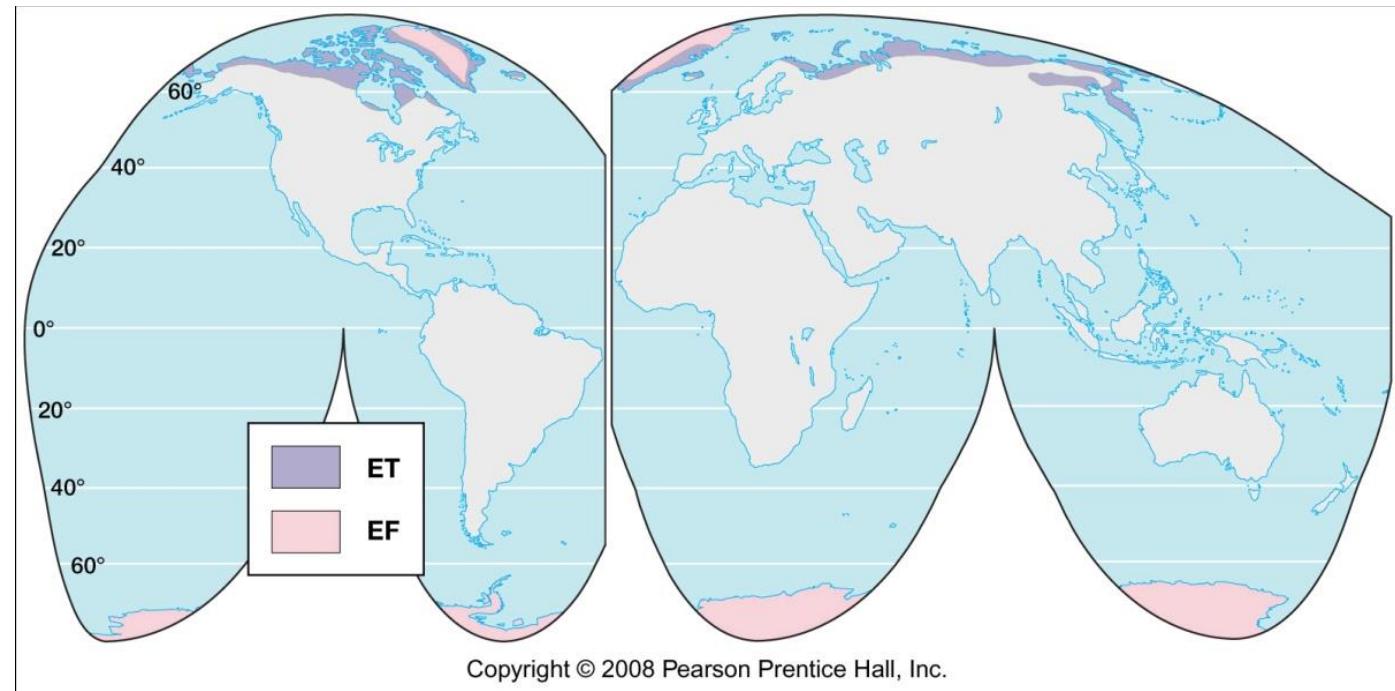
Ice Cape (EF)

Location

- Antarctica
- Greenland

Characteristics

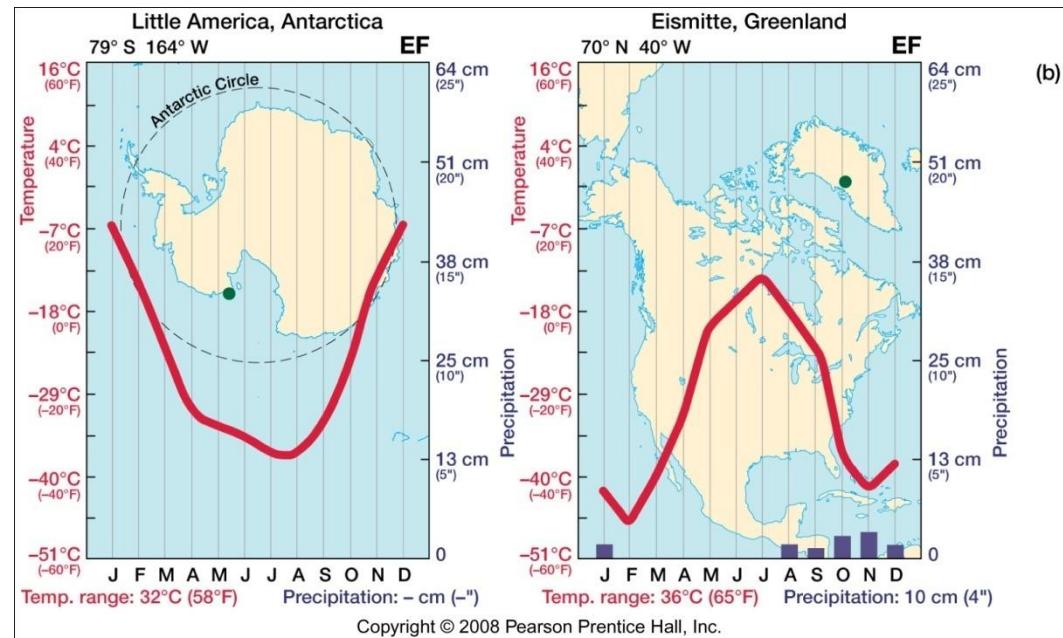
- Temperature
 - Long, cold, dark winters
 - Cold, windy summers
- Precipitation
 - Very sparse, all snow



Dominant Controls

- Latitude
- Distances from sources of heat and moisture
- Extreme seasonal contrasts in sunlight/darkness
- Polar anticyclones (A and cP air masses)

• Climographs



(b)



Highland Climate (Group H)

Locations

- High uplands (mountains and plateaus)
- Not defined in the same sense as the others
- Climatic conditions in mountainous areas have almost infinite variations from place to place, many of the differences extend over very limited horizontal distances.
- These are outside of the Koppen system.



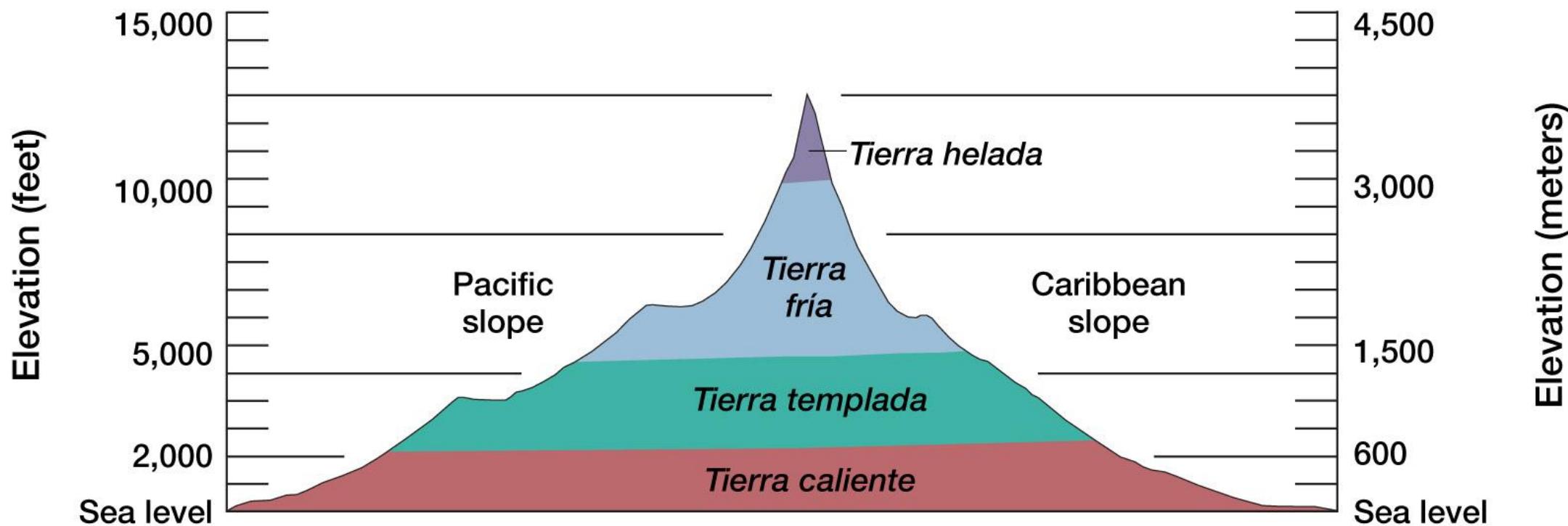
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Characteristics

- Complex local variation in small areas
- Vertical climate zonation

Dominant Controls

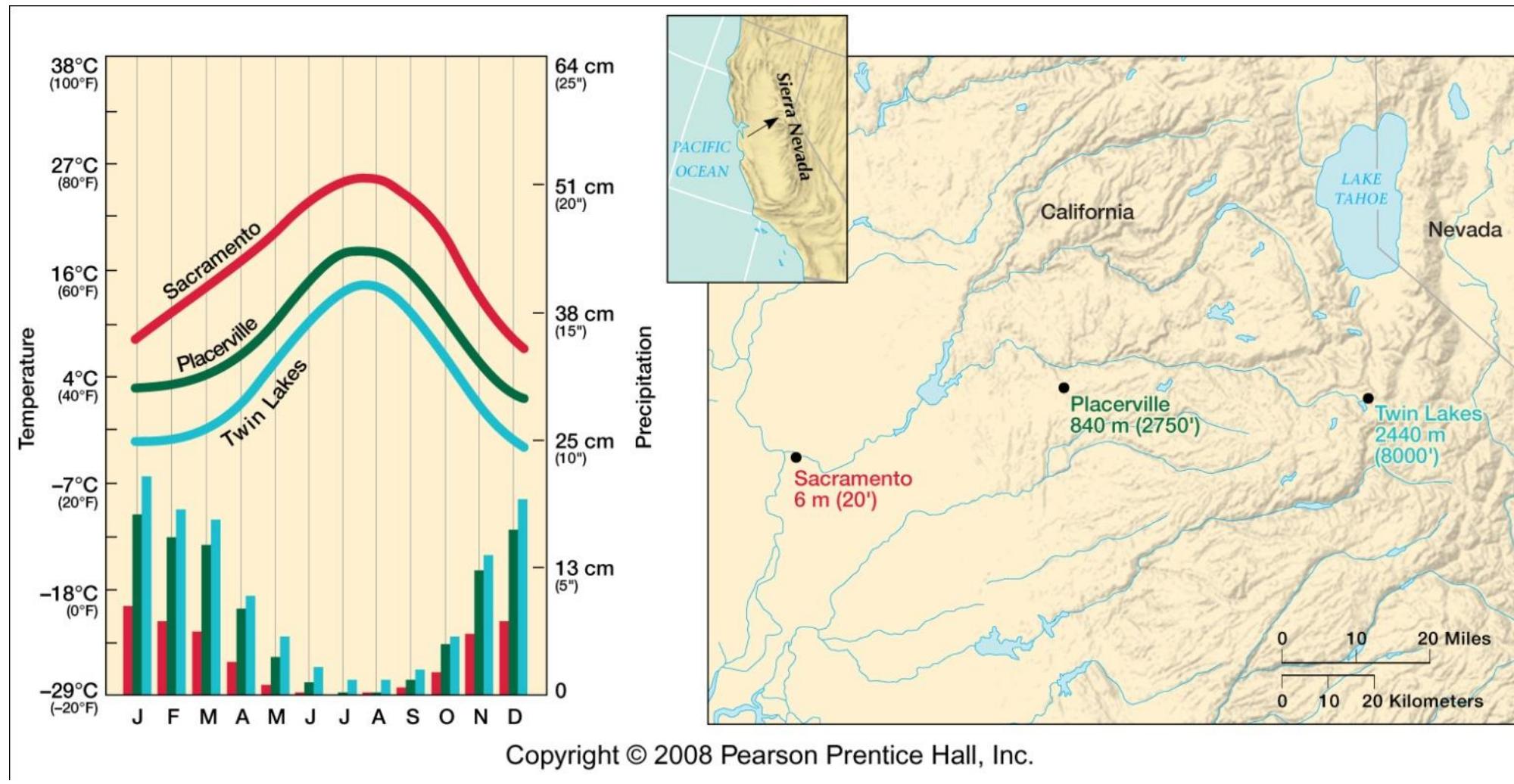
- Altitude and not Latitude
- Slope aspect and slope angle



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Vertical climate zonation is particularly noticeable in tropical mountainous areas. This diagram idealizes the situation at about 15 degrees latitude in Guatemala and southern Mexico. *Tierra caliente* (hot land) is a zone of high temperatures, dense vegetation, and tropical agriculture. *Tierra templada* (temperate land) is an intermediate zone of slopes and plateaus and temperatures most persons would find comfortable. *Tierra fria* (cold land) is characterised by warm days and cold nights, and its agriculture is limited to hardy crops. *Tierra helada* (frozen land) is a zone of cold weather throughout the year.

- Climographs



Project Extra Credit

Upload a document in elearning that we will give information regarding your chosen geographic feature and a paragraph (not more than 200-250 words) that explains what you are planning to include in your story map.

5 points towards Project

Due Date: 07/14/2021