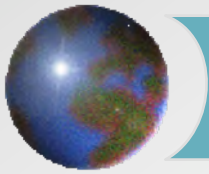


# *Climate Classification*

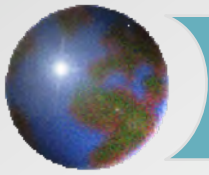
**GEOG/ENST 2331 – Lecture 19**

**Ahrens: Chapter 17**



## *Defining climate*

- ✦ The statistical properties of the atmosphere over the long-term constitute the climate of a particular area
  
- ✦ Certain areas have similar annual and multi-annual ranges in weather properties
  - ✦ Temperature
  - ✦ Precipitation
  - ✦ Air Mass Types
  - ✦ Energy Budget
  - ✦ Seasonal Water Budget

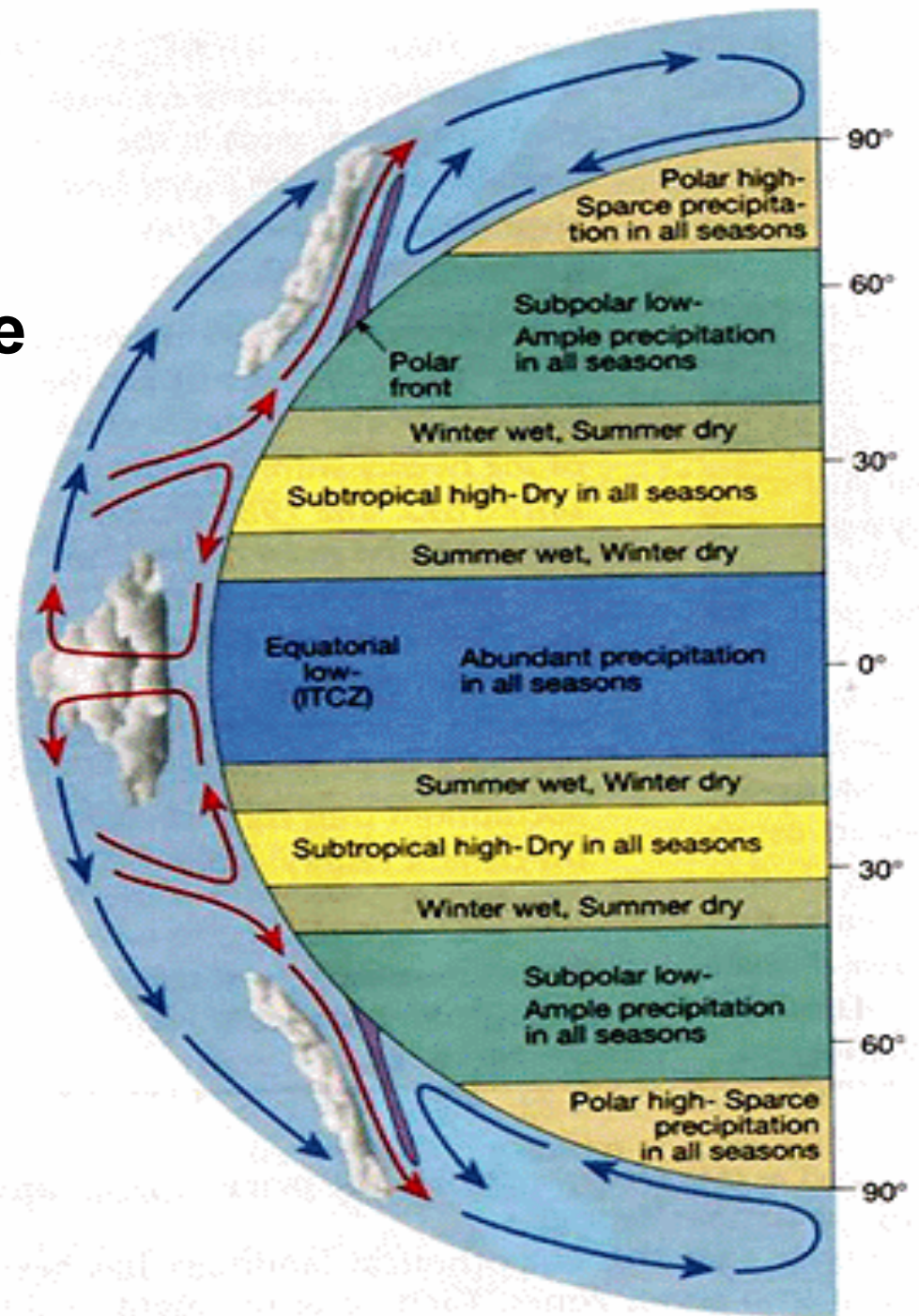


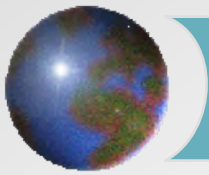
# *Climate classification*

- ✦ Variables are not independent
  - ▣ Similar regions can be grouped together
  - ▣ Generalizations can be useful
  
- ✦ Ancient Greeks
  - ▣ Tropical, temperate and polar
  - ▣ Classification based on latitude



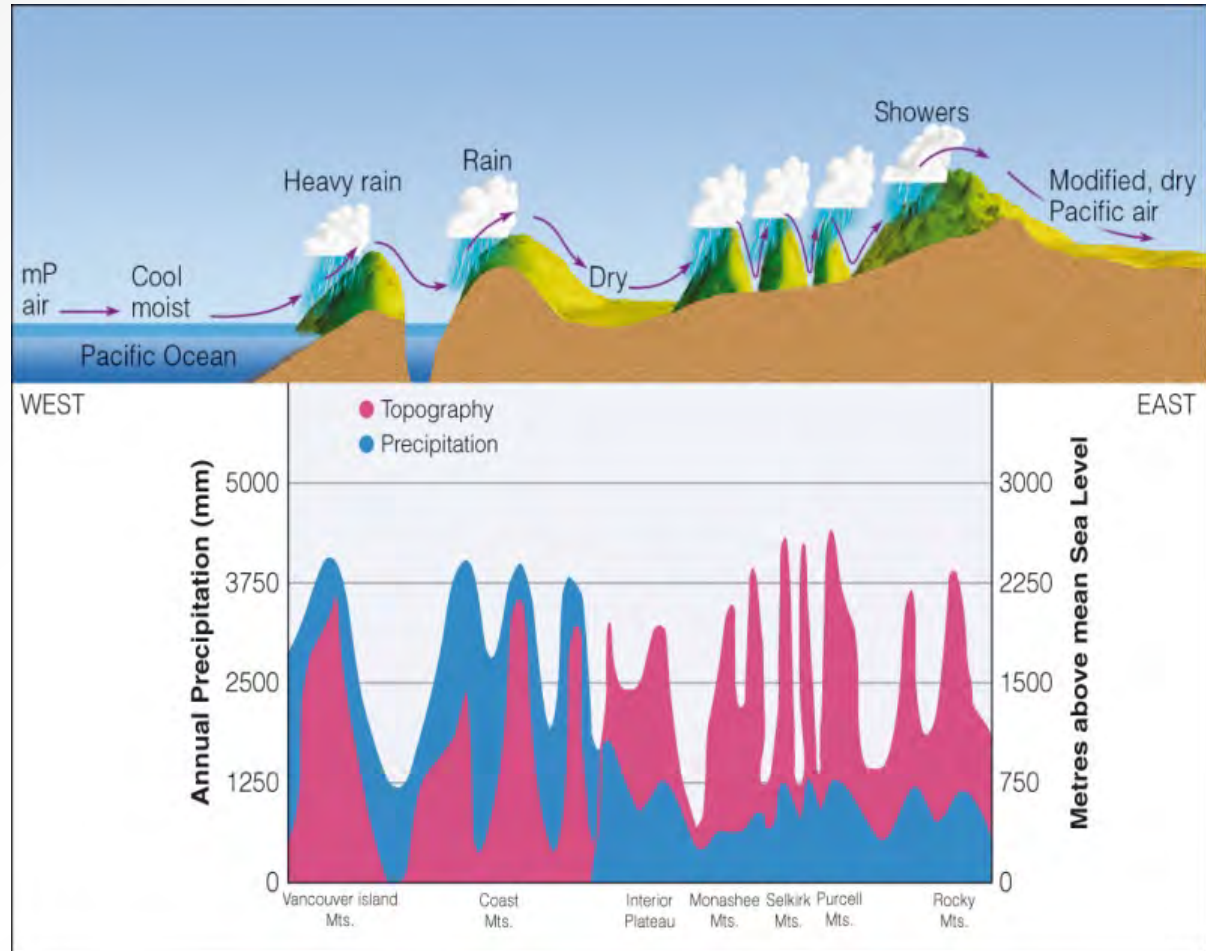
# Global precipitation pattern predicted by the general circulation





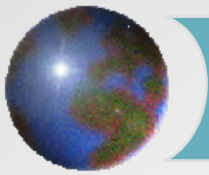
# *Mountains*

- ☉ Temperature decreases with altitude
- ☉ Rain shadows form downwind



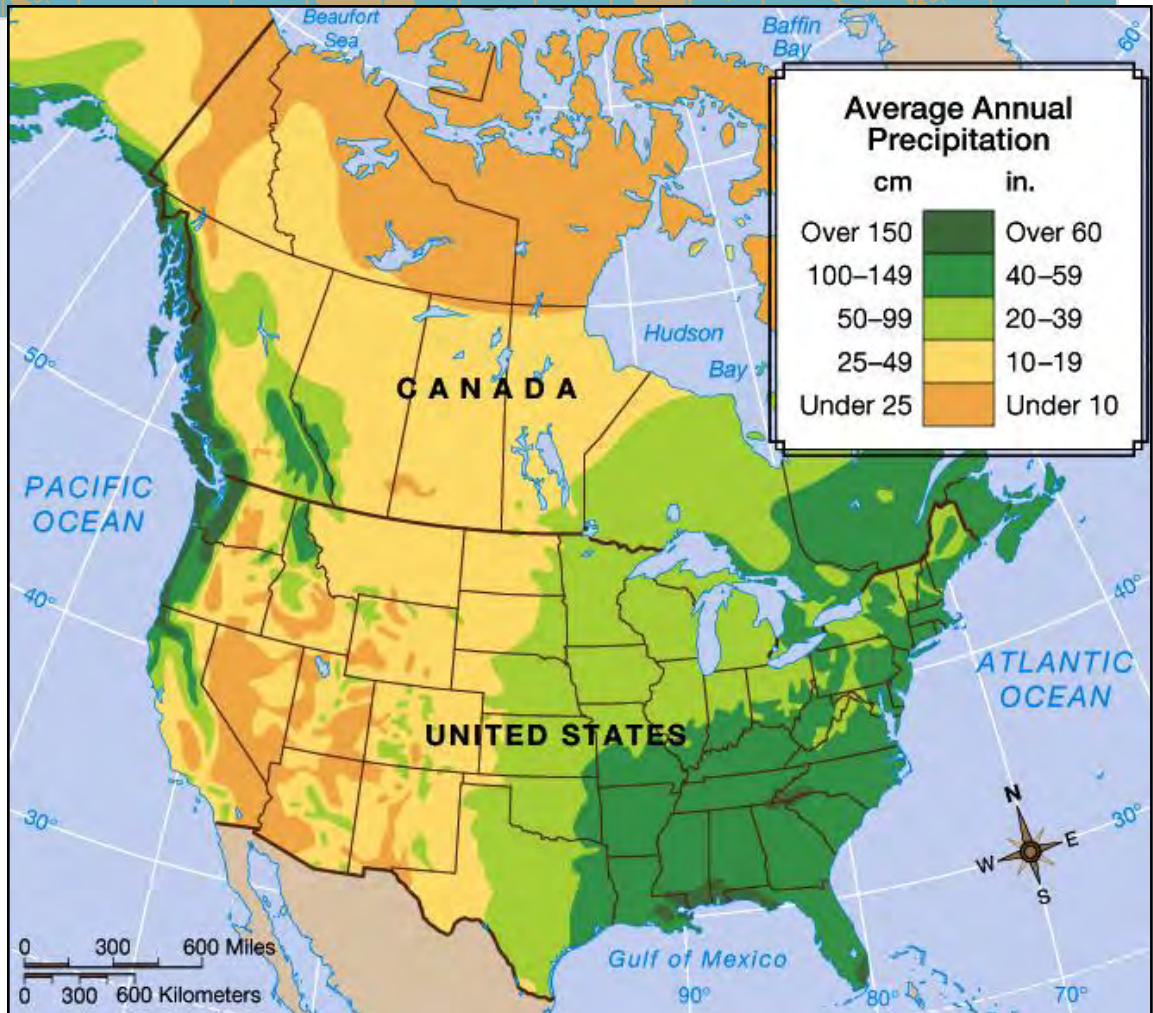
Ahrens: Fig. 16.6



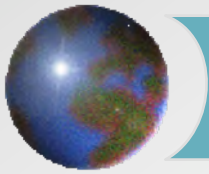


# Oceans

- ⊕ Moderate temperature
- ⊕ Provide moisture



A&B: Figure 7-10



# *Climate classification*

## ✦ Ancient Greeks

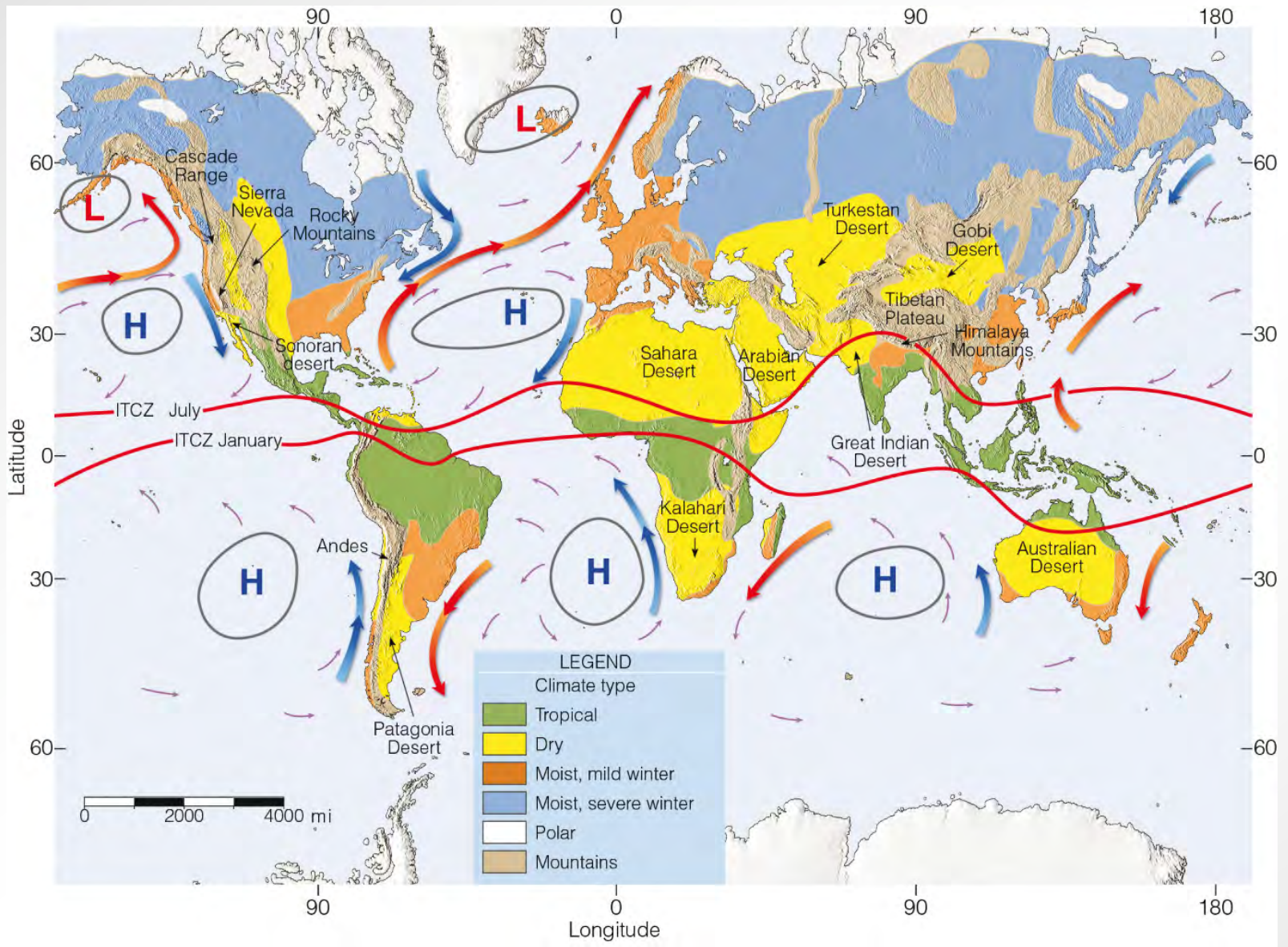
- ▣ Latitude (temperature)

## ✦ The Köppen System (1918)

- ▣ Vegetation used as an indicator because of sparseness of direct observations

## ✦ Thornthwaite's System

- ▣ P/E index (1930)
- ▣ Potential evapotranspiration (1948)



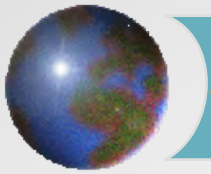
# The Köppen System

Ahrens: Fig. 16.7 See text p. 480



**Table 15-1 Climate Types According to Koeppen**

| Type                     | Subtype              | Letter Code                                      | Characteristics   |
|--------------------------|----------------------|--|---|
| A—Tropical               | Tropical wet         | Af   | No dry season   |
|                          | Tropical monsoonal   | Am   | Short dry season  |
|                          | Tropical wet and dry | Aw   | Winter dry season                                       |
| B—Dry                    | Subtropical desert   | BWh  | Low-latitude dry  |
|                          | Subtropical steppe   | BSh  | Low-latitude semi-dry                                   |
|                          | Mid-latitude desert  | BWk  | Mid-latitude dry  |
|                          | Mid-latitude steppe  | BSk  | Mid-latitude semi-dry                                   |
| C—Mild<br>Mid-latitude   | Mediterranean        | Csa  | Dry, hot summer   |
|                          |                      | Csb  | Dry, warm summer  |
|                          | Humid subtropical    | Cfa  | Hot summer, no dry season                               |
|                          |                      | Cwa  | Hot summer, brief winter dry season                     |
|                          | Marine west coast    | Cfb  | Mild throughout year, no dry season, warm summer        |
| Cfc                      |                      | Mild throughout year, no dry season, cool summer |   |
| D—Severe<br>Mid-latitude | Humid continental    | Dfa  | Severe winter, no dry season, hot summer                |
|                          |                      | Dfb  | Severe winter, no dry season, warm summer               |
|                          |                      | Dwa  | Severe winter, winter dry season, hot summer            |
|                          |                      | Dwb  | Severe winter, winter dry season, warm summer           |
|                          | Subarctic            | Dfc  | Severe winter, no dry season, cool summer               |
|                          |                      | Dfd  | Extremely severe winter, no dry season, cool summer     |
|                          |                      | Dwc  | Severe winter, winter dry season, cool summer           |
|                          |                      | Dwd  | Extremely severe winter, winter dry season, cool summer |
|                          |                      |  |   |
| E—Polar                  | Tundra               | ET   | No true summer  |
|                          | Polar ice cap        | EF   | Perennial ice   |
| H—Highland               | Highland             | H  | Highland  |



## *Additional codes for A, C and D*

✦ *f* – full year precipitation

✦ *s* – driest in summer

✦ *w* – driest in winter

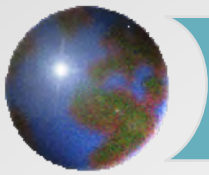
✦ *m* – monsoon

✦ *a* – hottest summers

✦ *b*

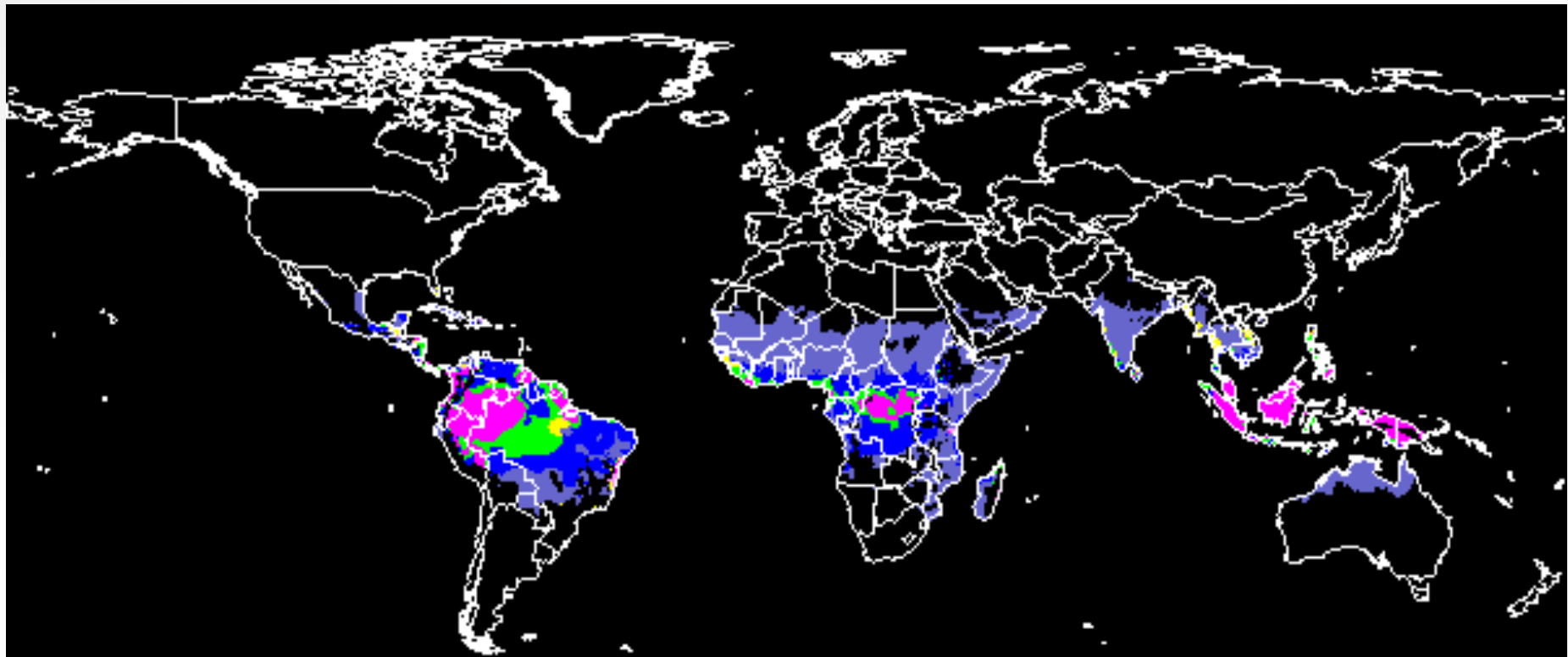
✦ *c*

✦ *d* – coldest summers



## *A - Tropical Climates*

- ⊠ Between the Tropics of Cancer and Capricorn
- ⊠ Exhibit warm temperatures and minimal seasonal temperature



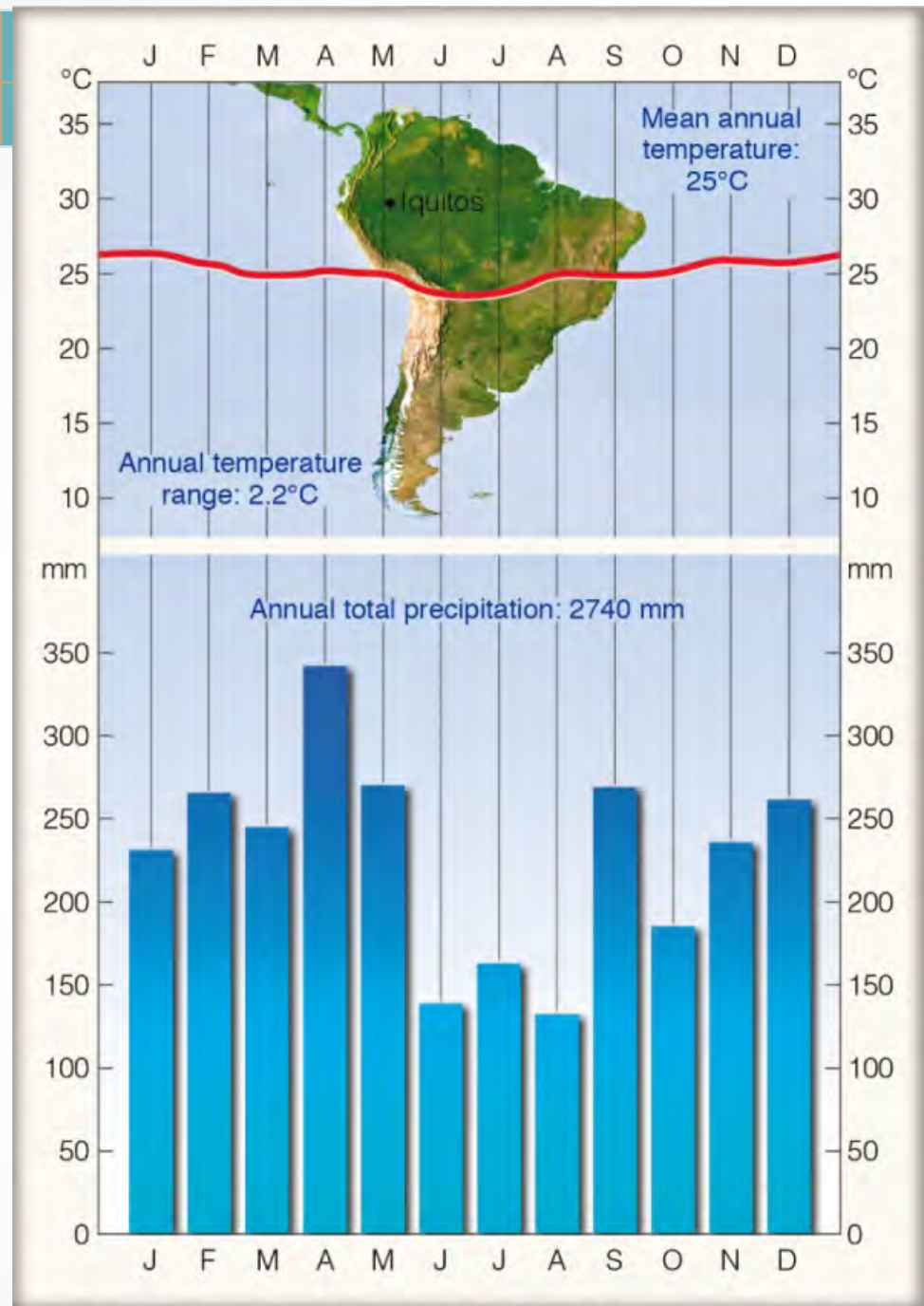
**Koeppen's Climate Classification: Class A: Tropical**

by FAO - SDRN - Agrometeorology Group - 1997

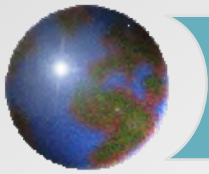


# *Af – Tropical wet climate*

- ✦ ***Climograph*** for Iquitos, Peru
- ✦ 4°S, 73°W
- ✦ 130 m above MSL
- ✦ ITCZ is always close
- ✦ Windward side of Andes

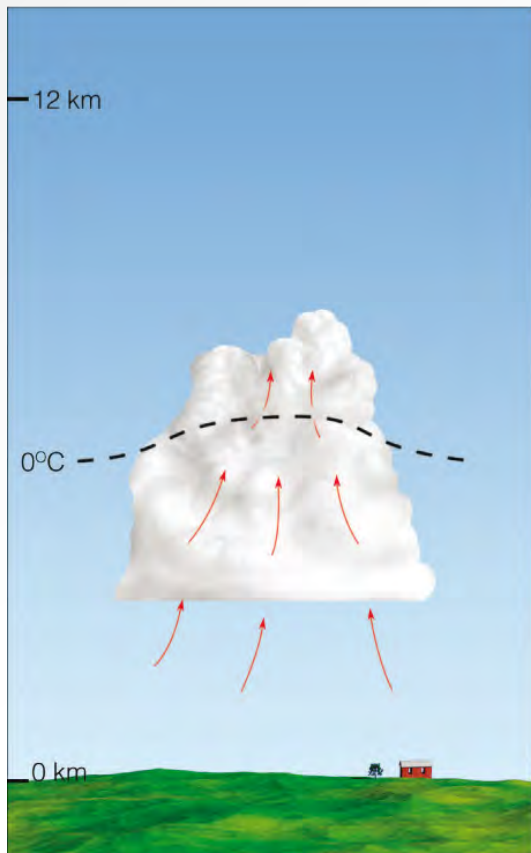




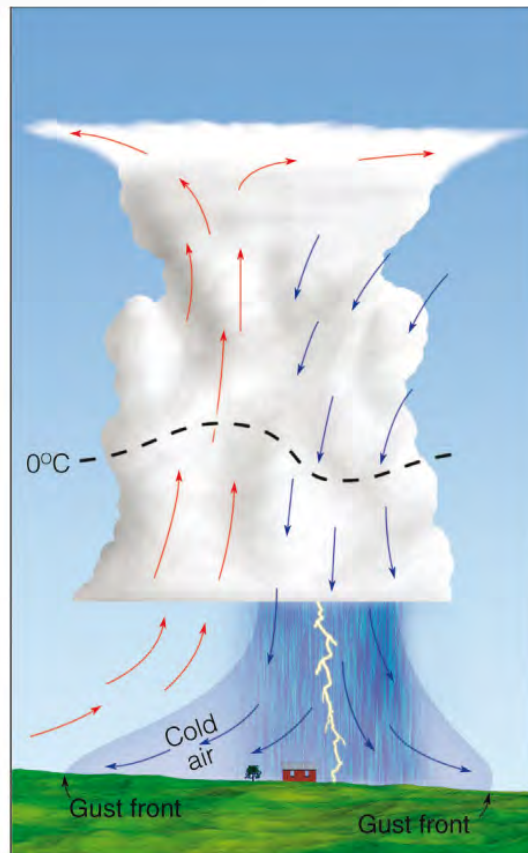


# *Tropical wet climates (Af)*

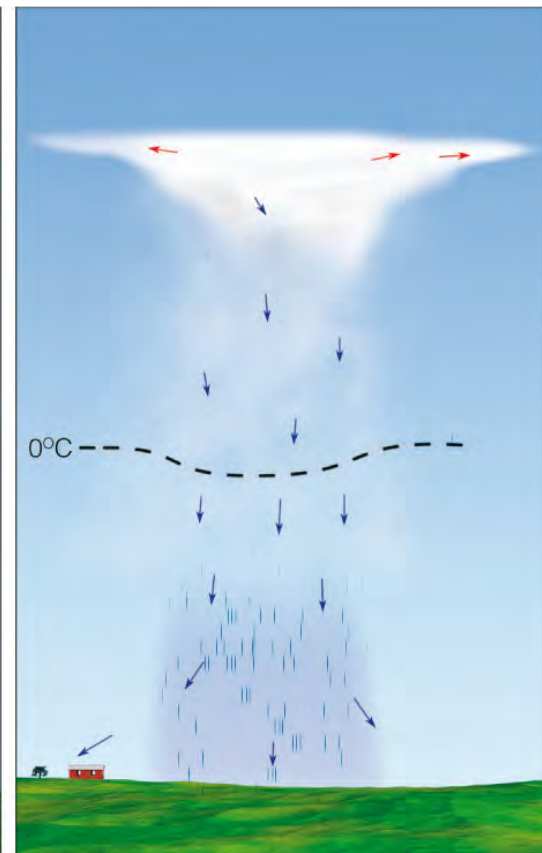
Brief but often heavy afternoon thundershowers



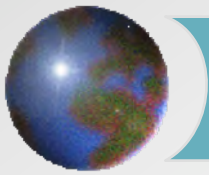
(a) Cumulus



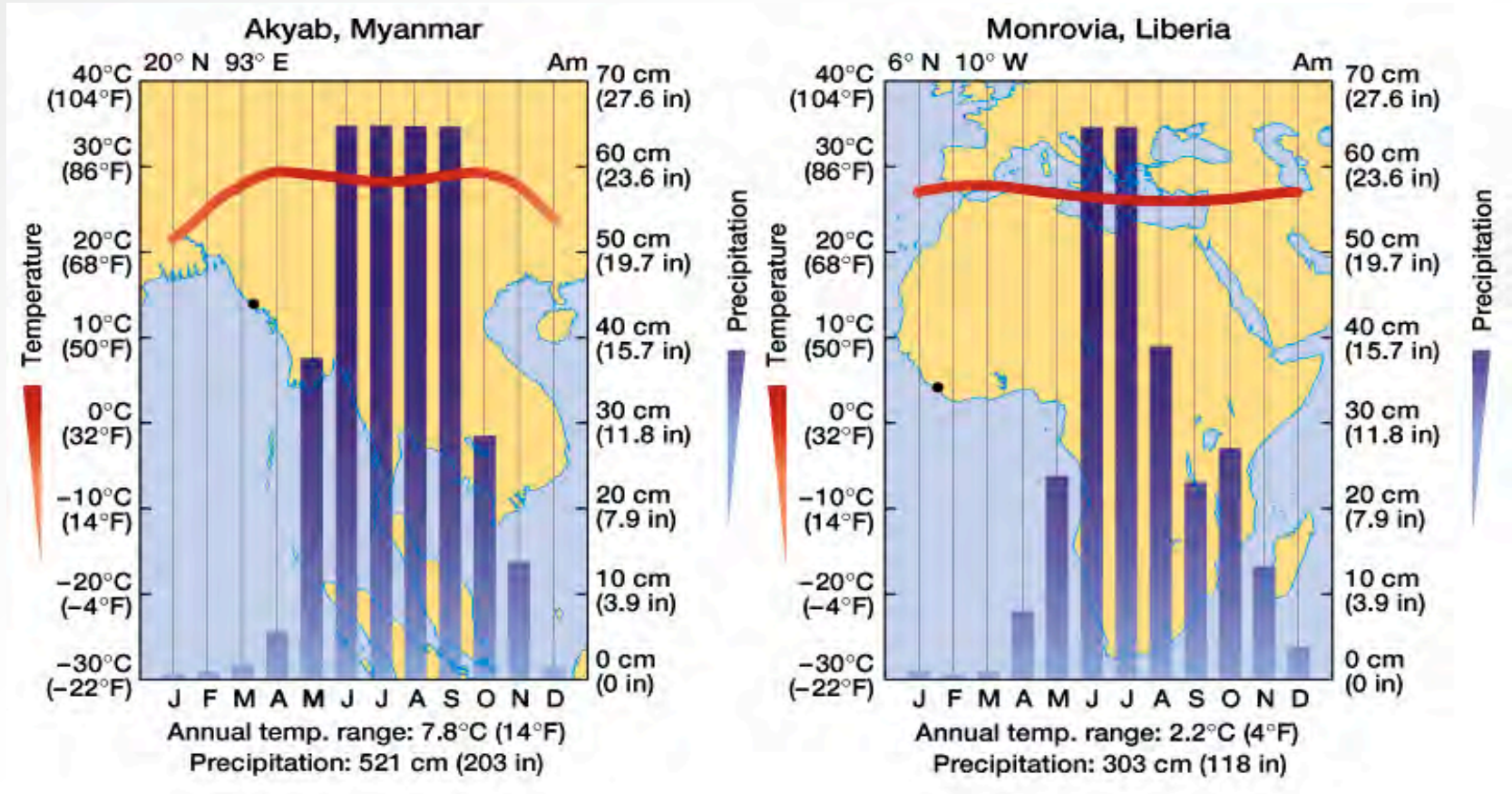
(b) Mature



(c) Dissipating

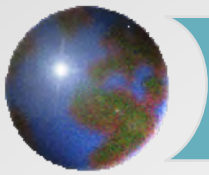


# *Am* climographs – Monsoonal



Occur near tropical coastal areas receiving onshore winds through much of the year

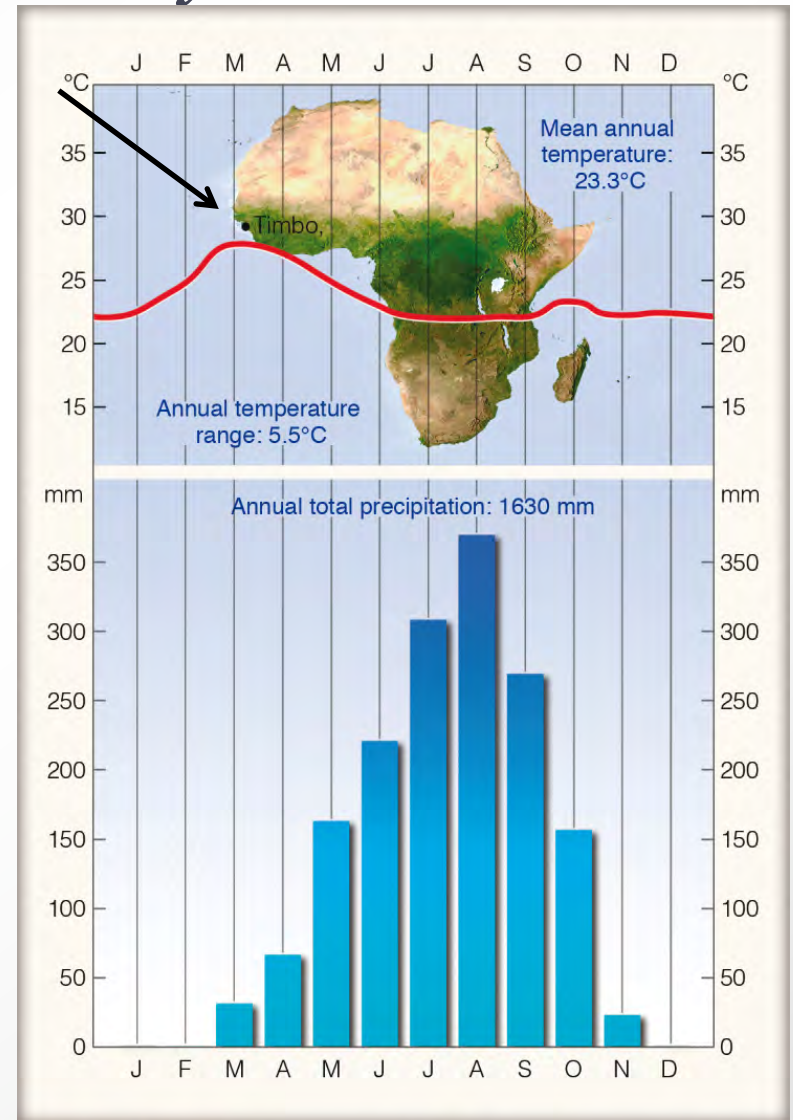
Pronounced seasonal variations of precipitation

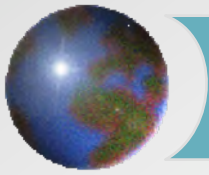


# *Aw – Tropical wet-and-dry climate*

- ☉ Timbo, Guinea
- ☉ 10°N, 12°W
- ☉ ITCZ in summer
- ☉ Subtropical high in winter
  - ☐ Higher *T* from sunny skies

☉ Ahrens: Fig. 16.14

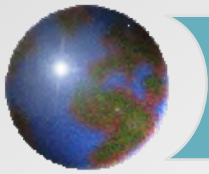




## *Aw climates*

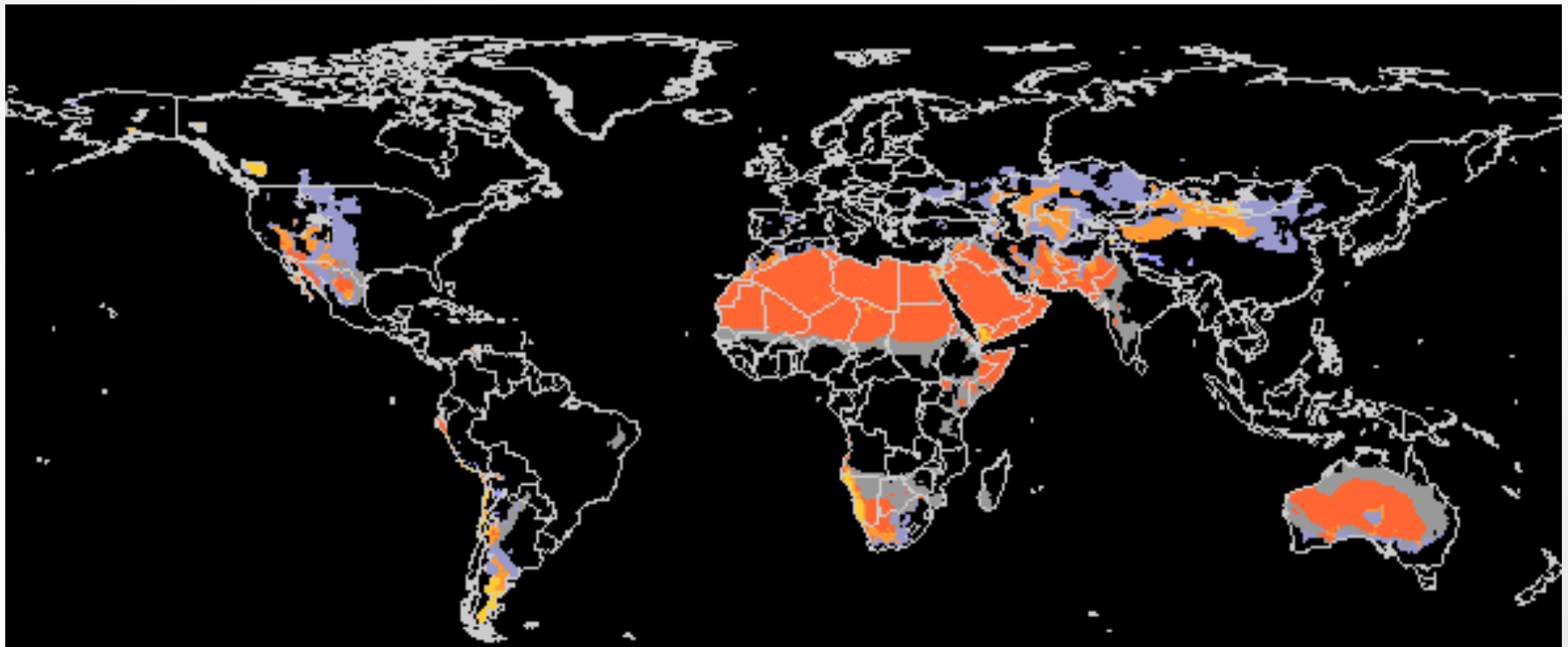
- ✦ Rainfall may be unreliable
  - ✦ E.g. Sahel region
- ✦ Savanna vegetation regimes dominate due to a lack of precipitation and frequent fires in the dry months
- ✦ Diurnal temperature variations are pronounced in dry season when ranges may be as high as 15 C°
  - ✦ Few clouds
  - ✦ Closer to arid than tropical



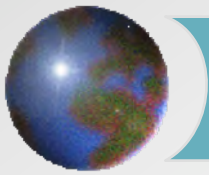


## *B* – *Dry Climates*

- Potential evapotranspiration exceeds precipitation
- Regions sub-classified as either semi-desert (steppe) or desert

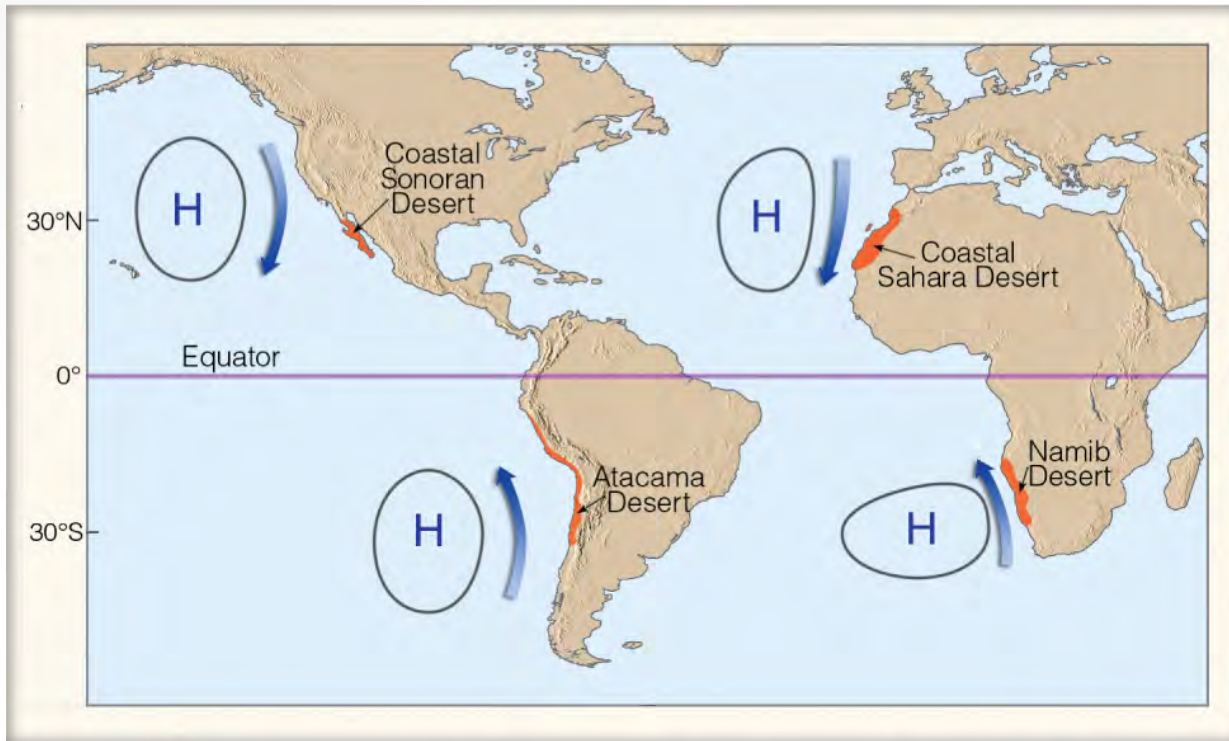


**Koeppen's Climate Classification: Class B: Dry**  
by FAO - SDRN - Agrometeorology Group - 1997



# *Dry climates (B)*

- ✦ Subtropical highs
- ✦ Rain shadows and continentality
- ✦ Cold air
  - ✦ Can bring dry climates even to coastal areas





# *BWh – Arid hot climates*

☉ Phoenix, Arizona

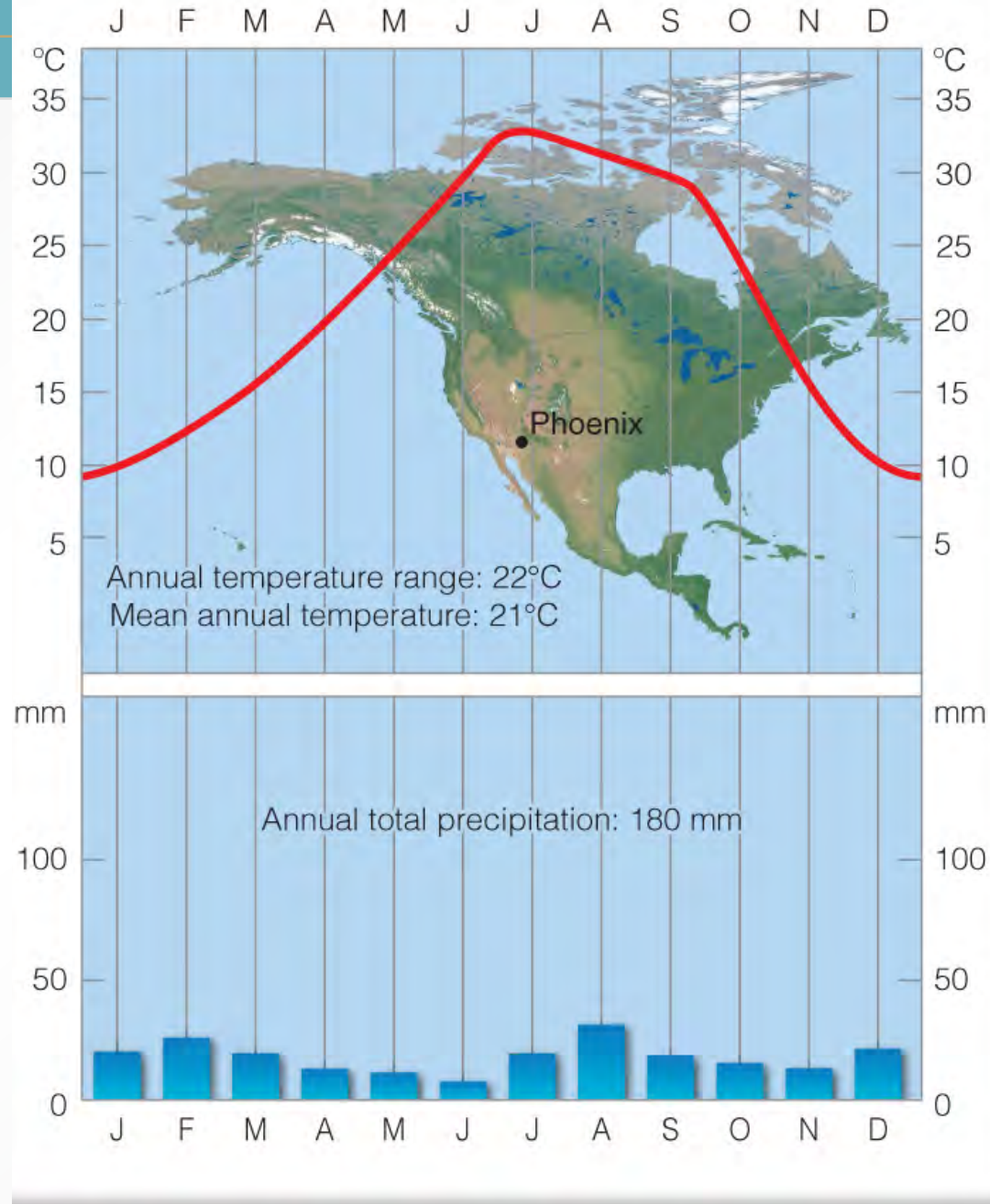
☉ 33°N, 102°W

☉ Subtropical highs

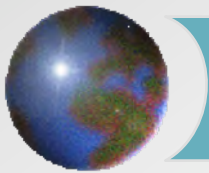
☒ Band from 10°-30°

☉ Hot days, cold nights

Ahrens: Fig. 16.17

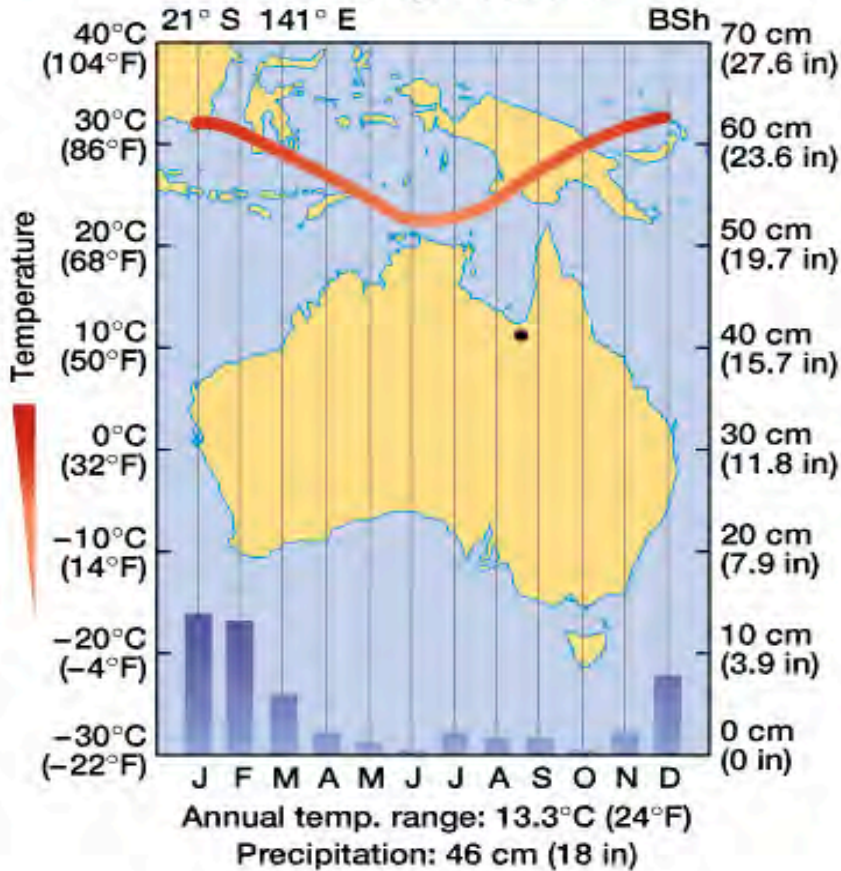




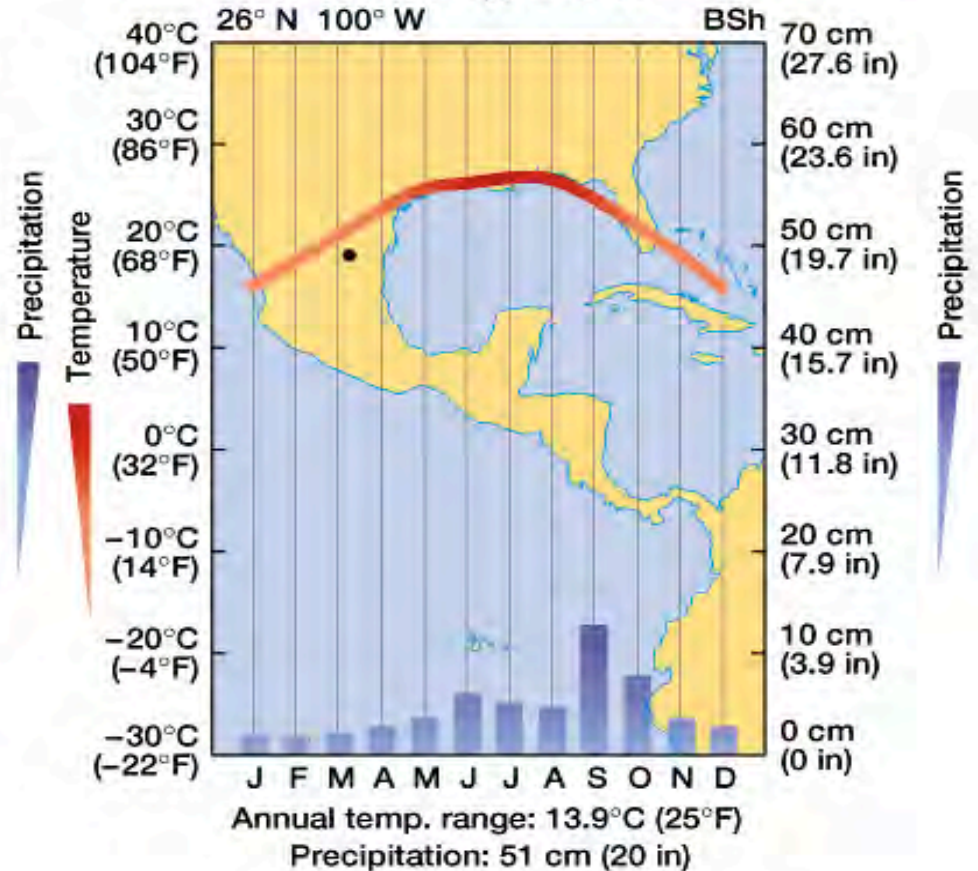


# *BSh – Semi-arid hot climates*

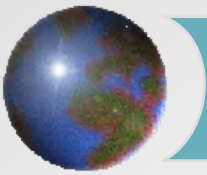
Cloncurry, Australia



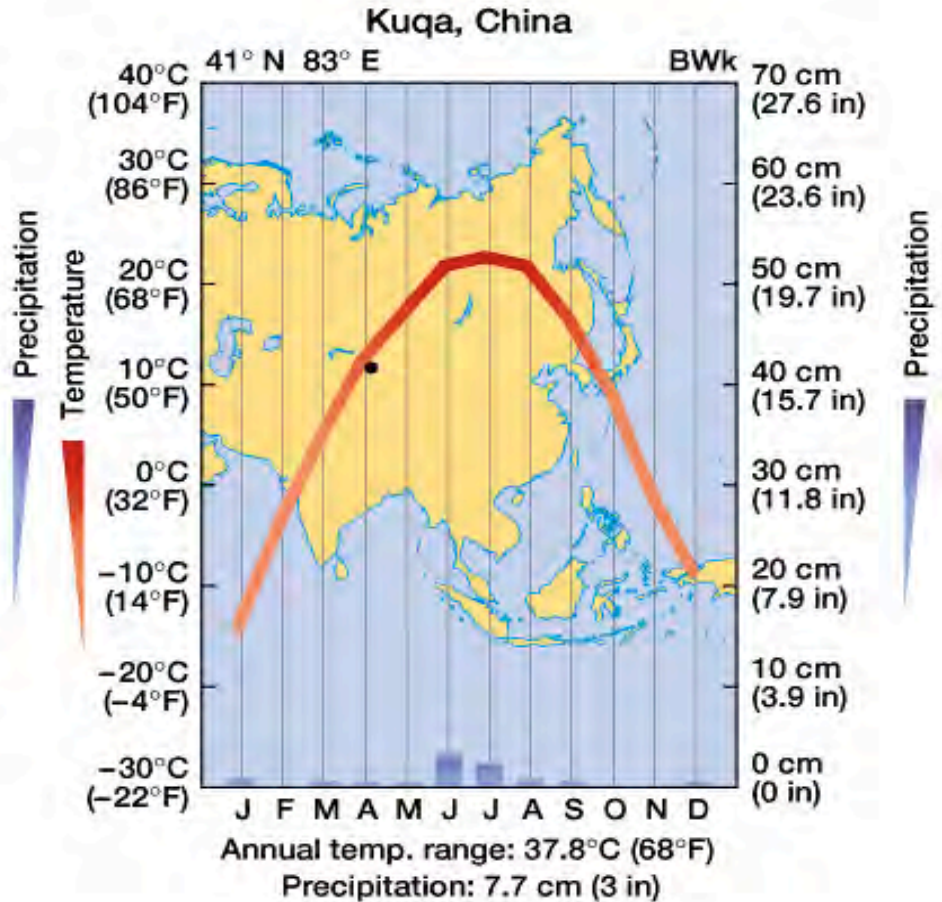
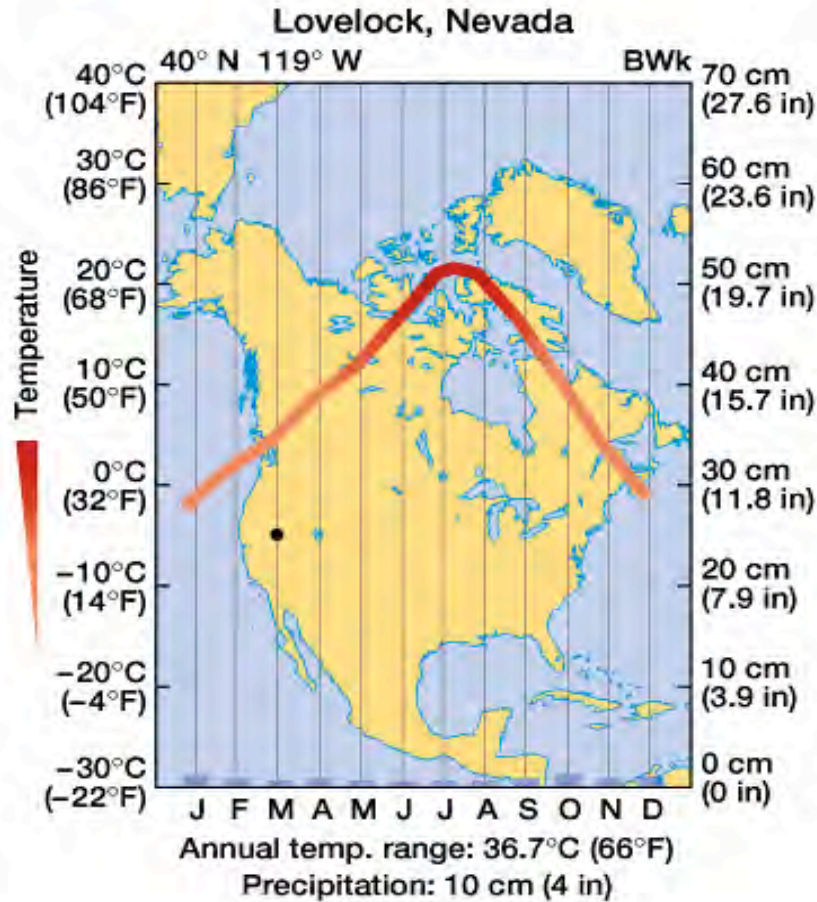
Monterrey, Mexico







# *BWk – Arid cool climates*



Extreme continentality and/or rain shadows

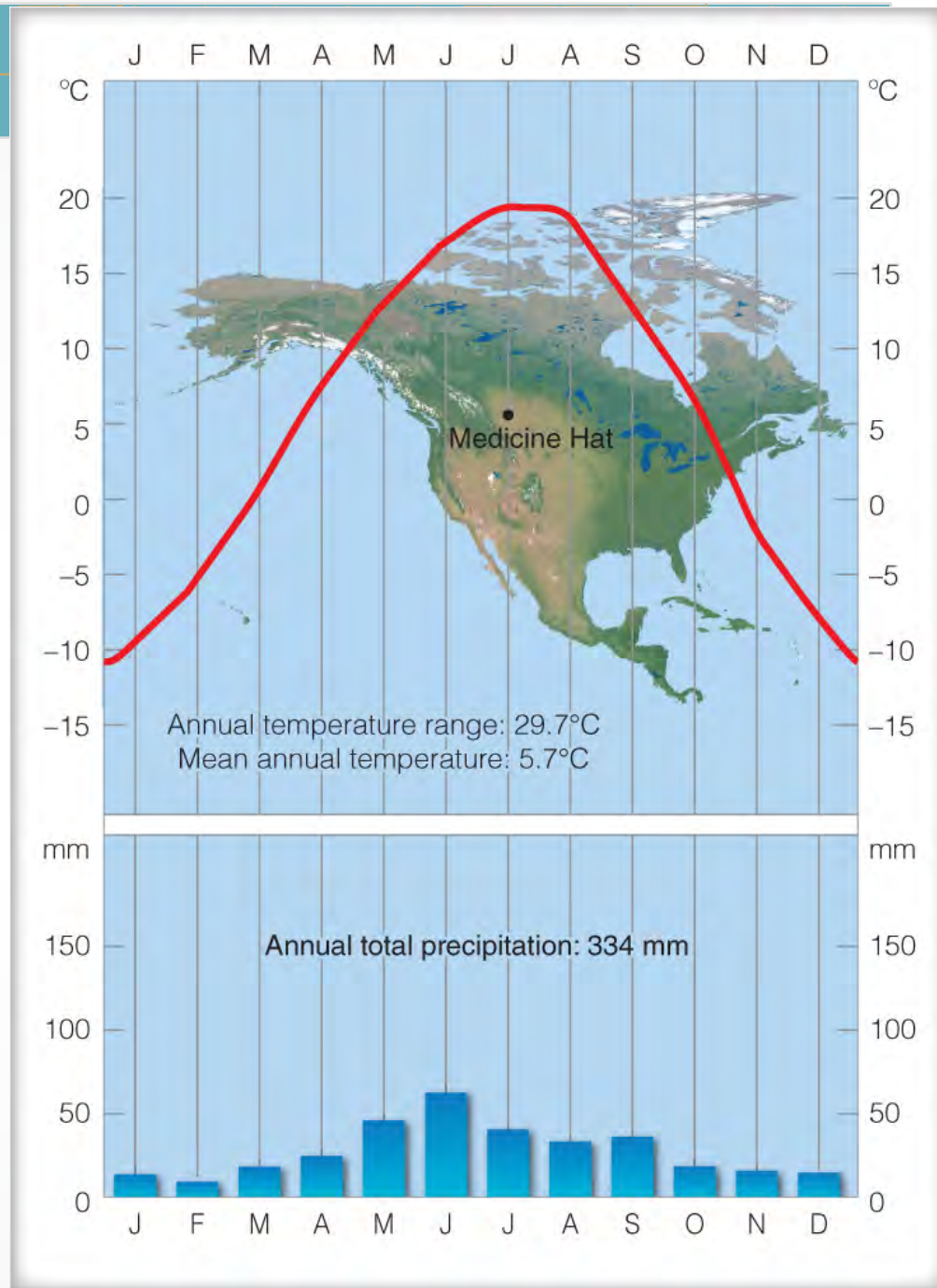
Very cold winter nights

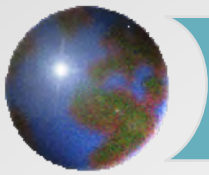


# *BSk – Semi-arid cool climates*

- ✚ Medicine Hat, Alberta
- ✚ 50°N, 140°W
- ✚ Higher annual average precipitation

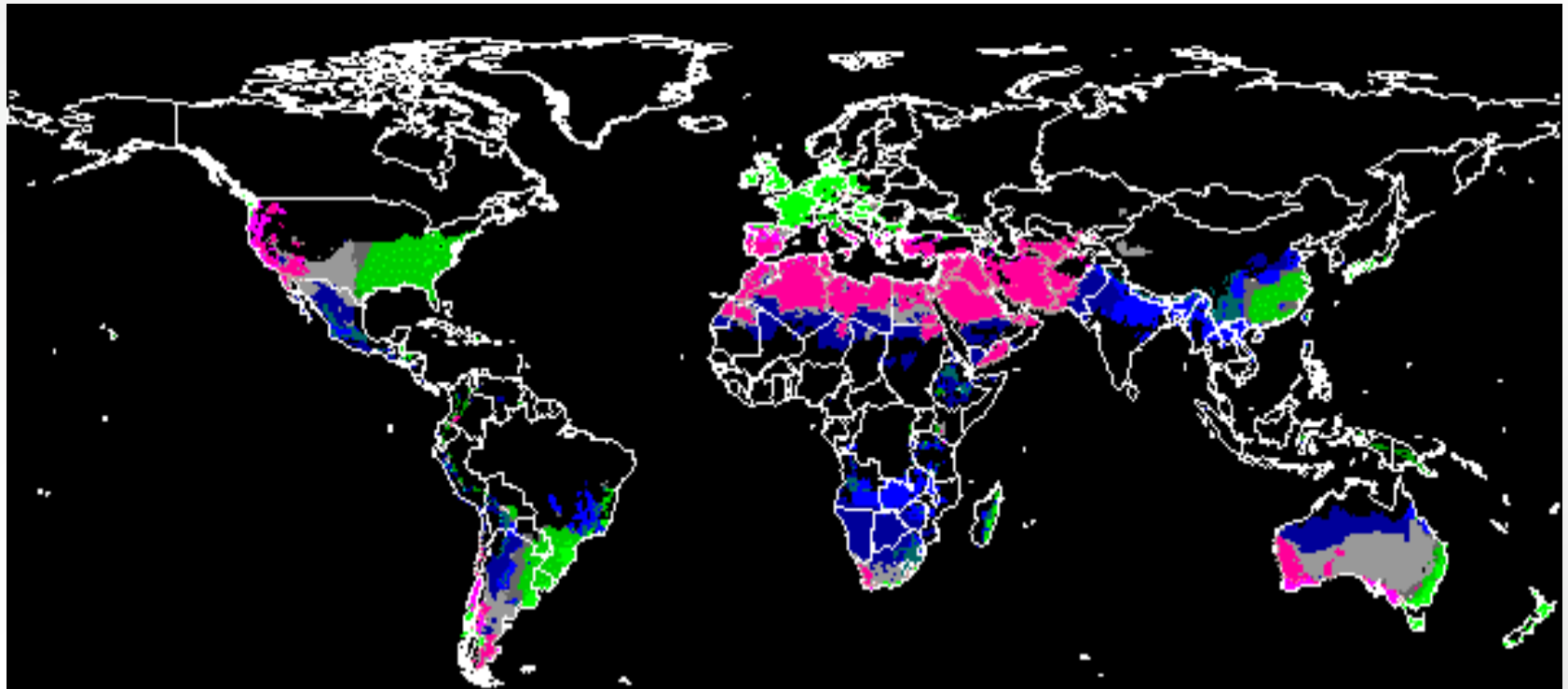
Ahrens: Fig. 16.20





## *C – Temperate Climates*

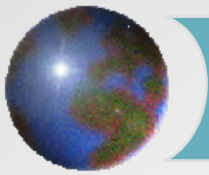
- Exist between 30° and 60°
- Not cold enough for persistent snow in winter
- Precipitation regimes vary considerably



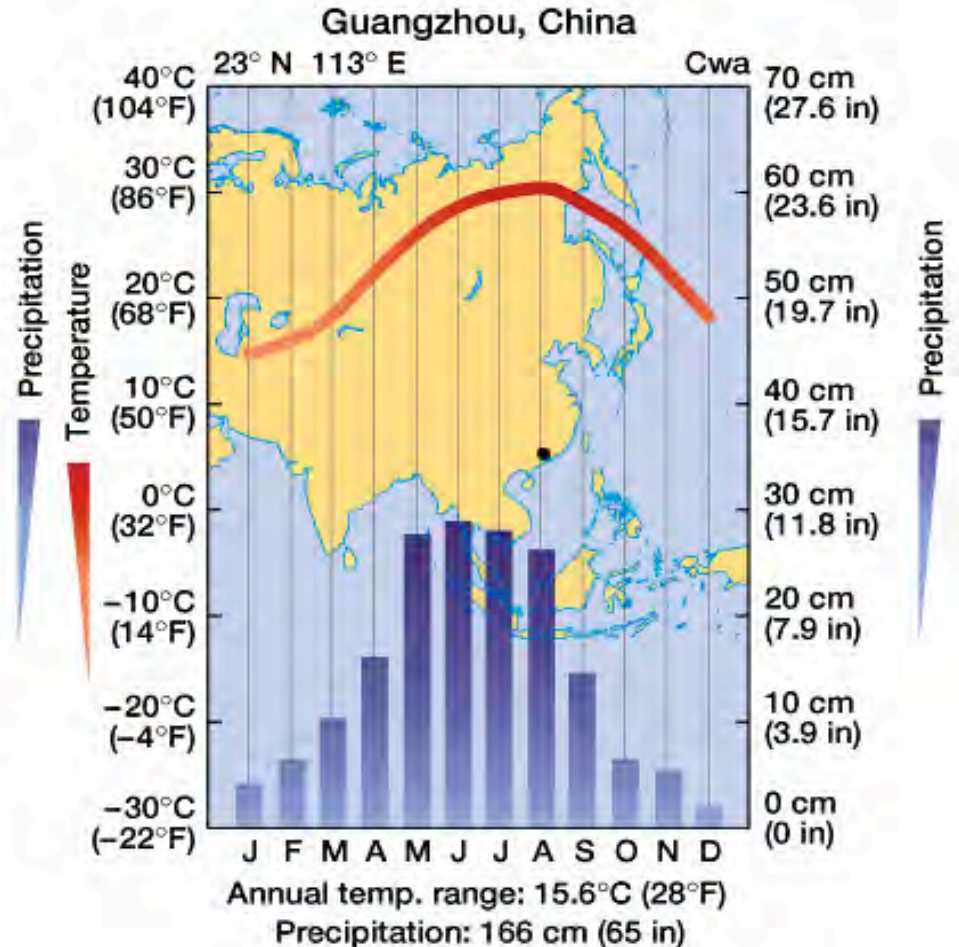
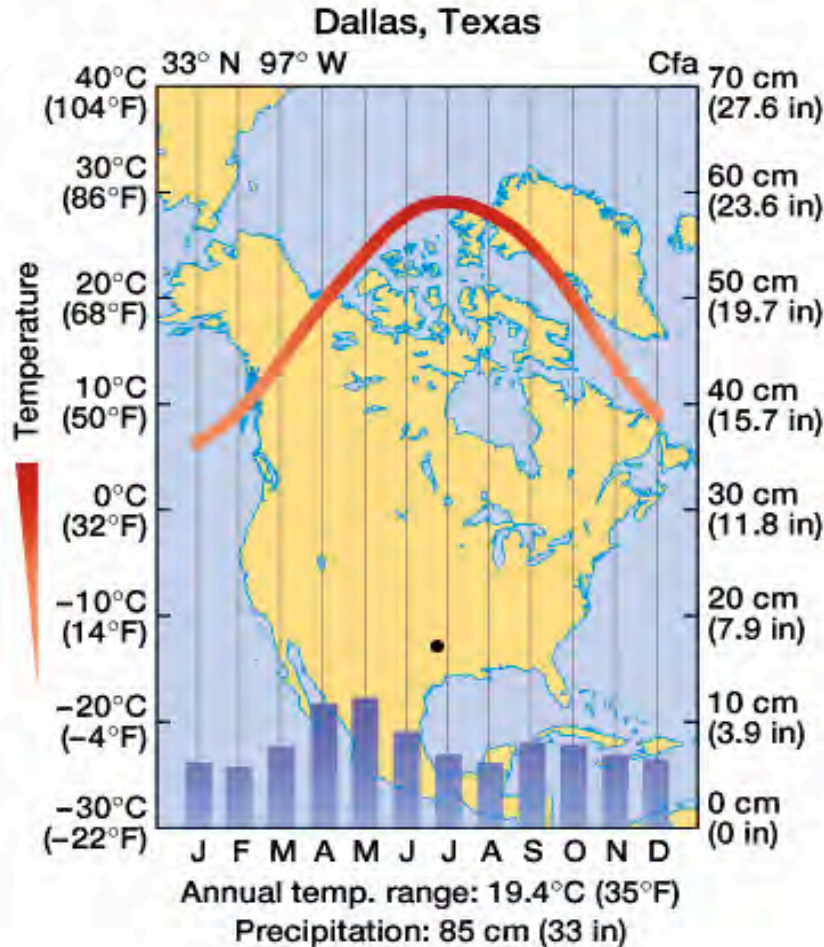
**Koeppen's Climate Classification: Class C: Temperate**

by FAO - SDRN - Agrometeorology Group - 1997



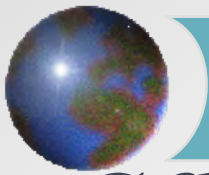


# *Cfa, Cwa – Humid subtropical climates*



Heat and moisture from on-shore advection due to off-shore subtropical highs





# *Cfb, Cfc - Marine west coast climates*

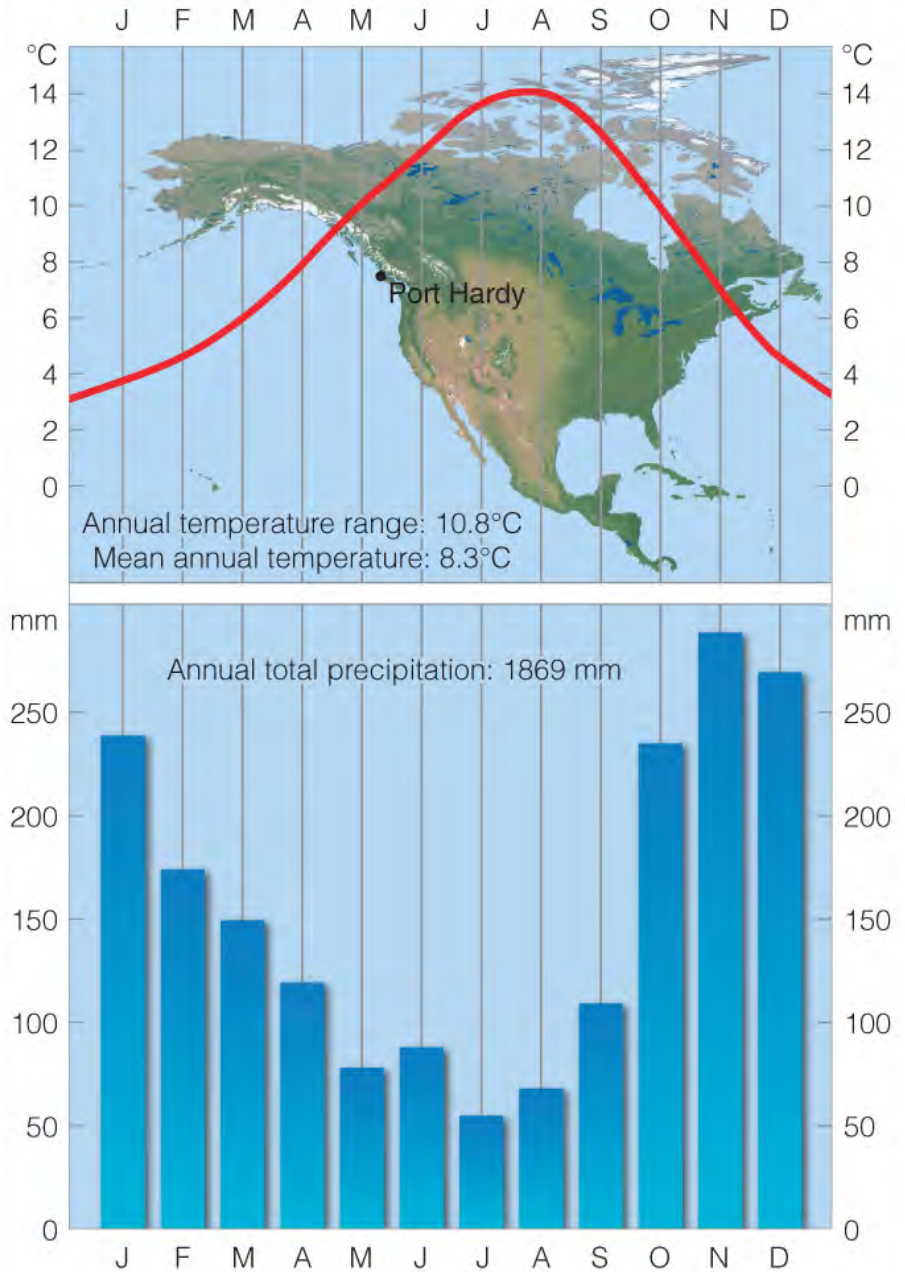
✚ Port Hardy, BC (Cfb)

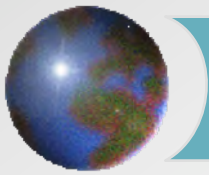
✚ 50°N, 127°W

✚ Sea breeze

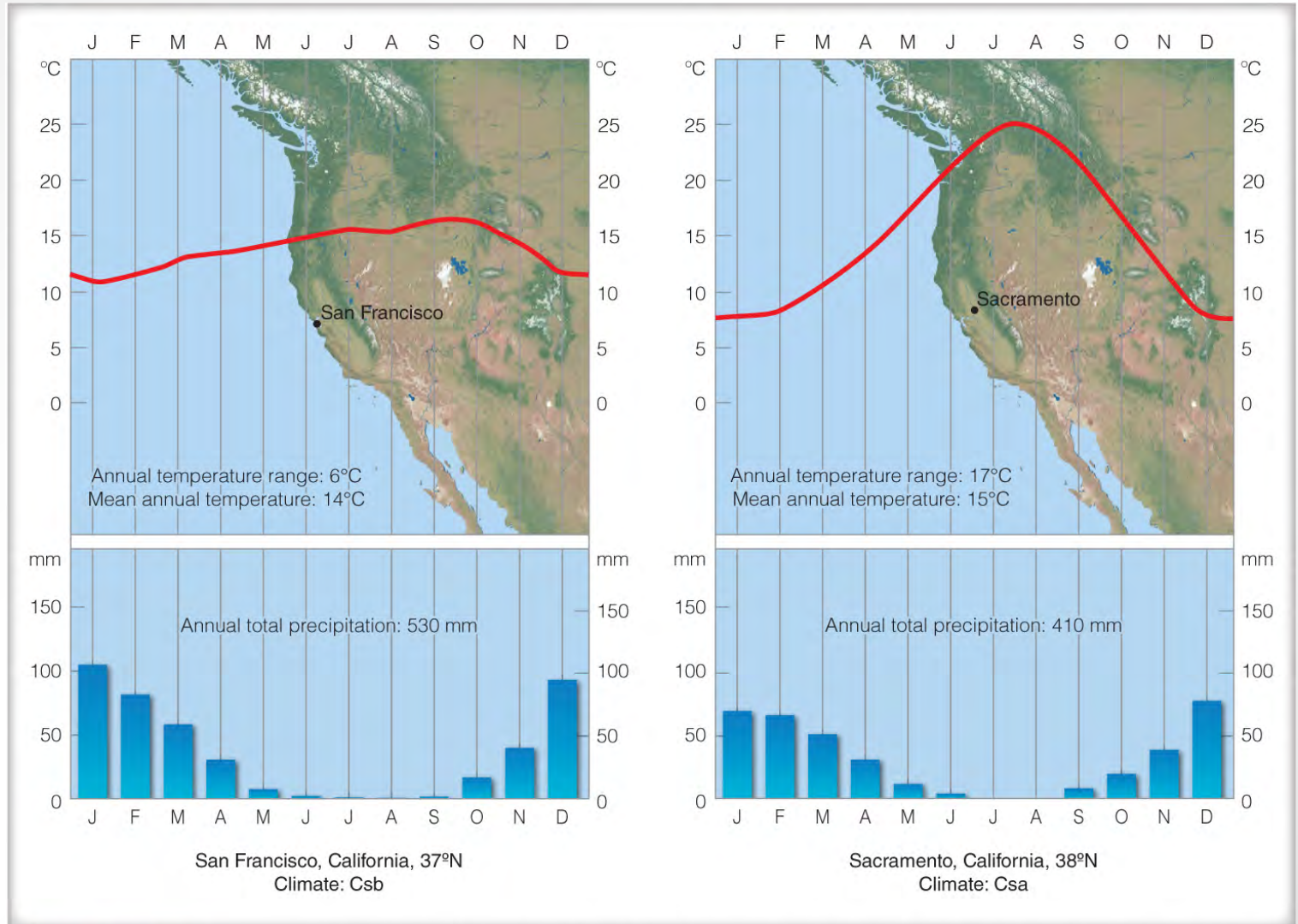
✚ Frequent fog and low clouds

Ahrens: Fig. 16.21

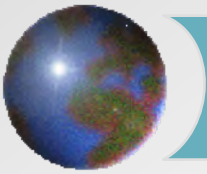




## *Csb, Csa – Mediterranean climates*

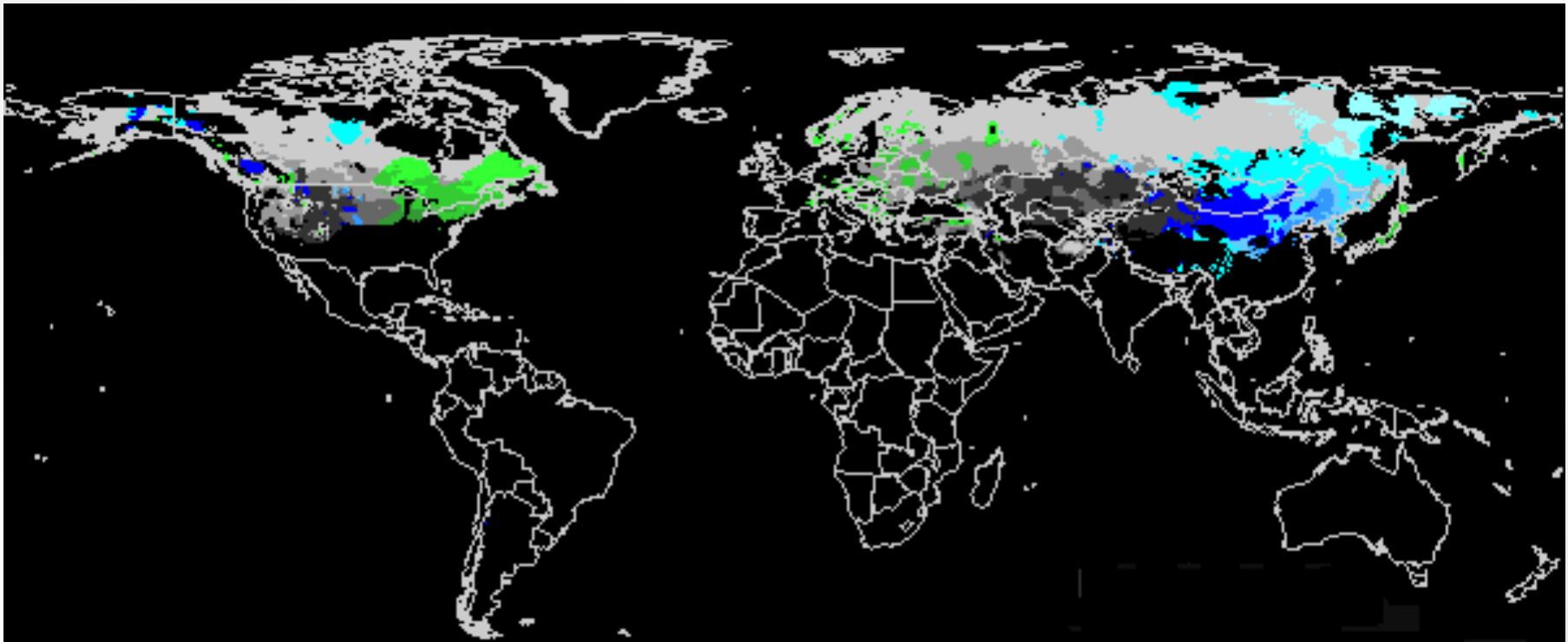


Ahrens:  
Fig. 16.22



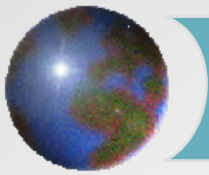
## *D – Cold Climates*

- Common between 40° and 70°
- Cold enough for snow but warm enough for trees

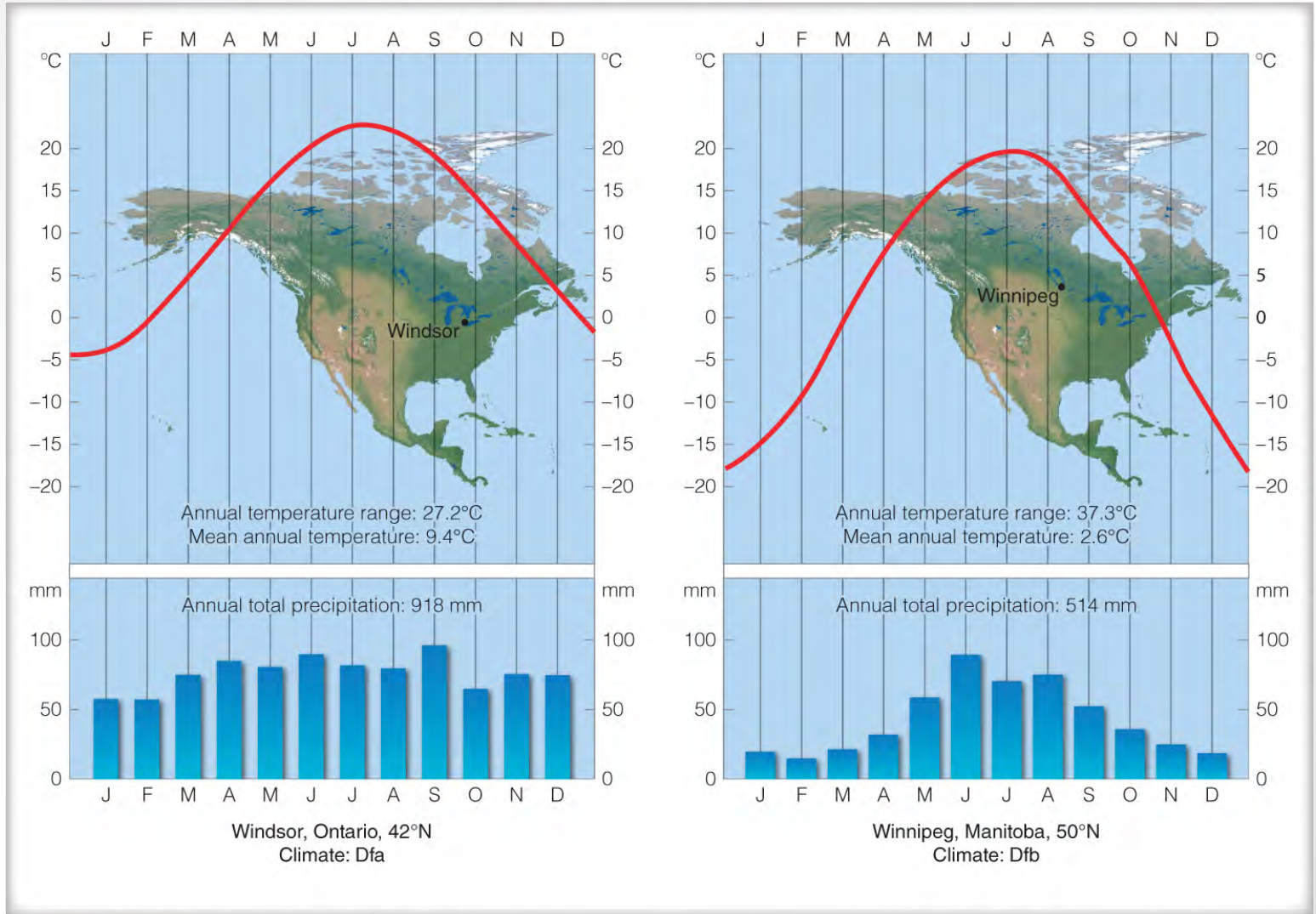


**Koeppen's Climate Classification: Class D: Cold**  
by FAO - SDRN - Agrometeorology Group - 1997



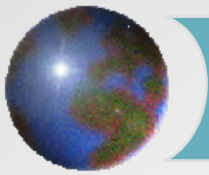


# *Dfa, Dfb, Dwa, Dwb – Humid continental climates*



Ahrens:  
Fig. 16.25





# *Dfc, Dfd, Dwc, Dwd – Subpolar climates*

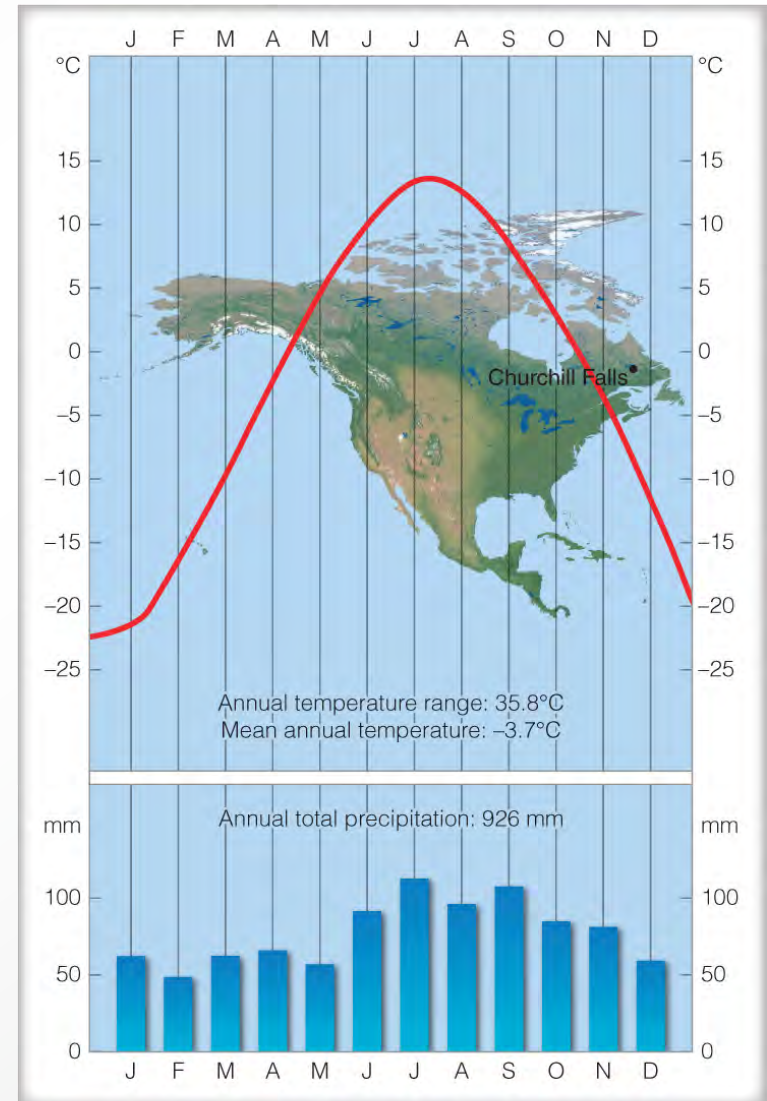
✚ Churchill Falls, NL (Dfc)

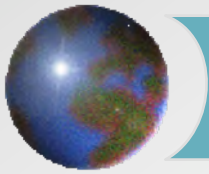
✚ 47°N, 53°W

✚ Poleward of humid continental

✚ Summers warm but short

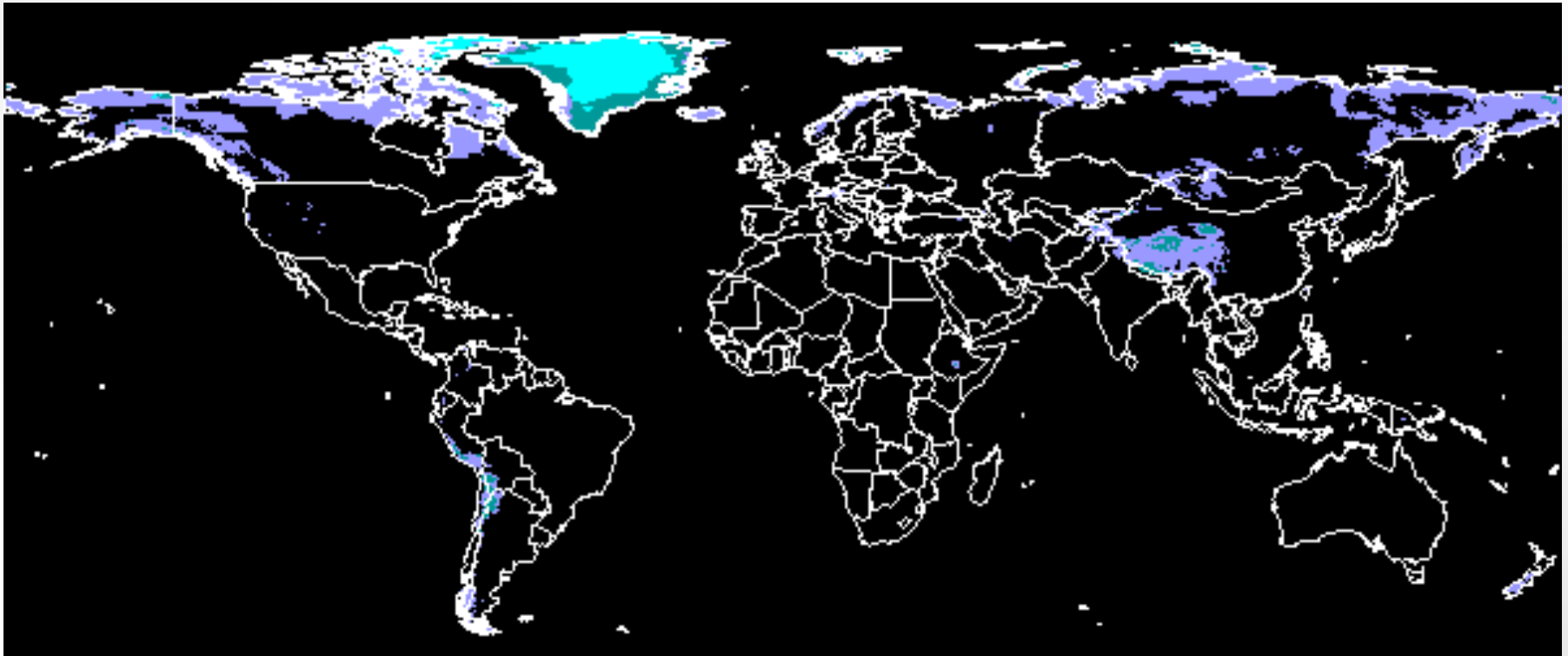
✚ Ahrens: Fig. 16.26





## *E – Polar Climates*

- Typically poleward of 70°
- Treeless terrain and very cold temperatures



**Koeppen's Climate Classification: Class E: Polar**

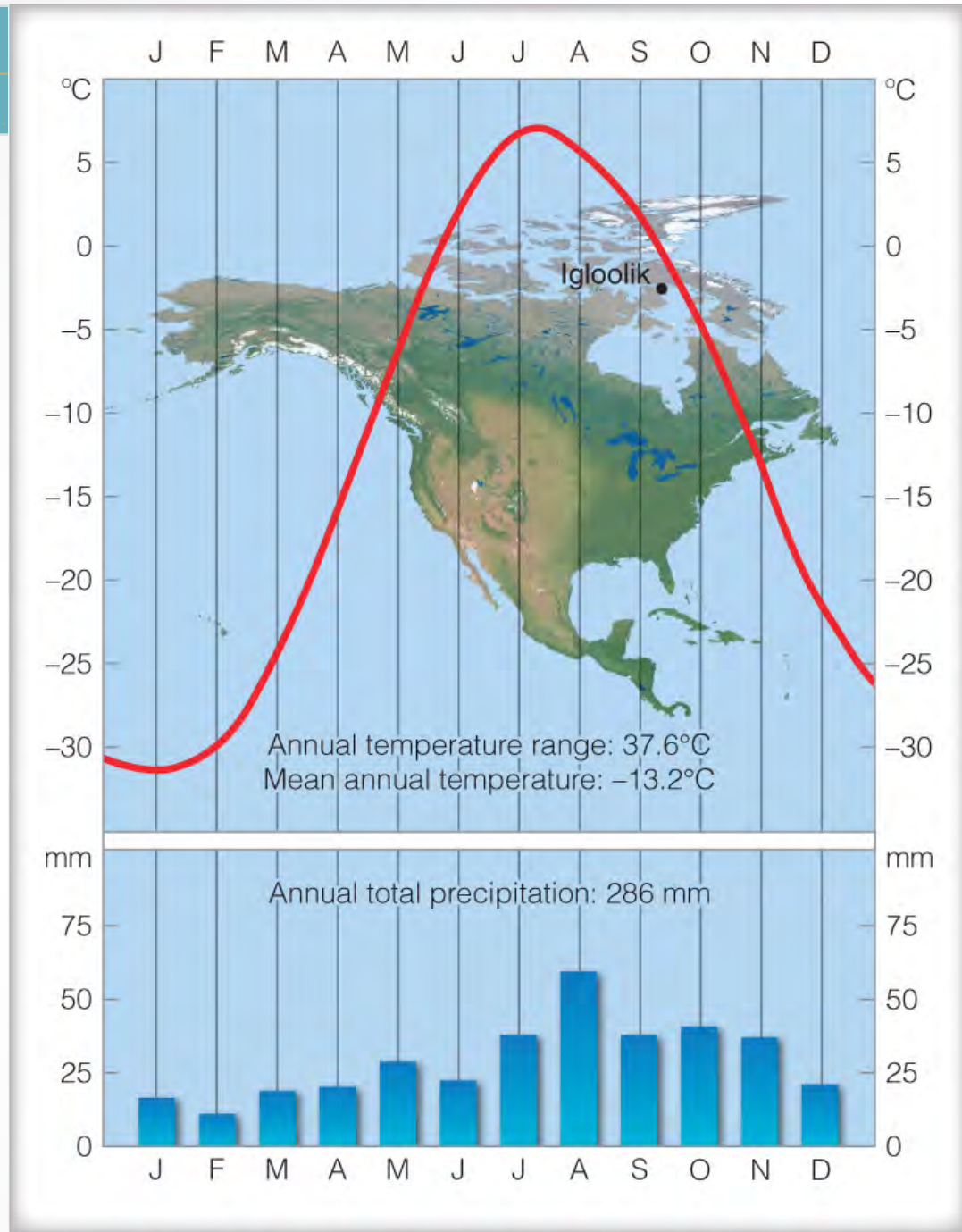
by FAO - SDRN - Agrometeorology Group - 1997

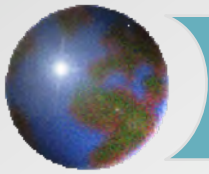


# *ET – Polar tundra climates*

- ✚ Igloolik, Nunavut
- ✚ 69°N, 82°W
- ✚ Harsh winters
- ✚ High annual *T* range
- ✚ Very low precipitation

Ahrens: Fig. 16.28





# *Polar tundra climates*

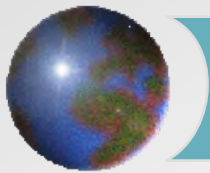
- ✚ Named for tundra  
vegetation: low-growing  
mosses, lichens, shrubs
- ✚ Permafrost is a constant  
feature



© Lonely Planet Images/Alamy

Ahrens: Fig. 16.29

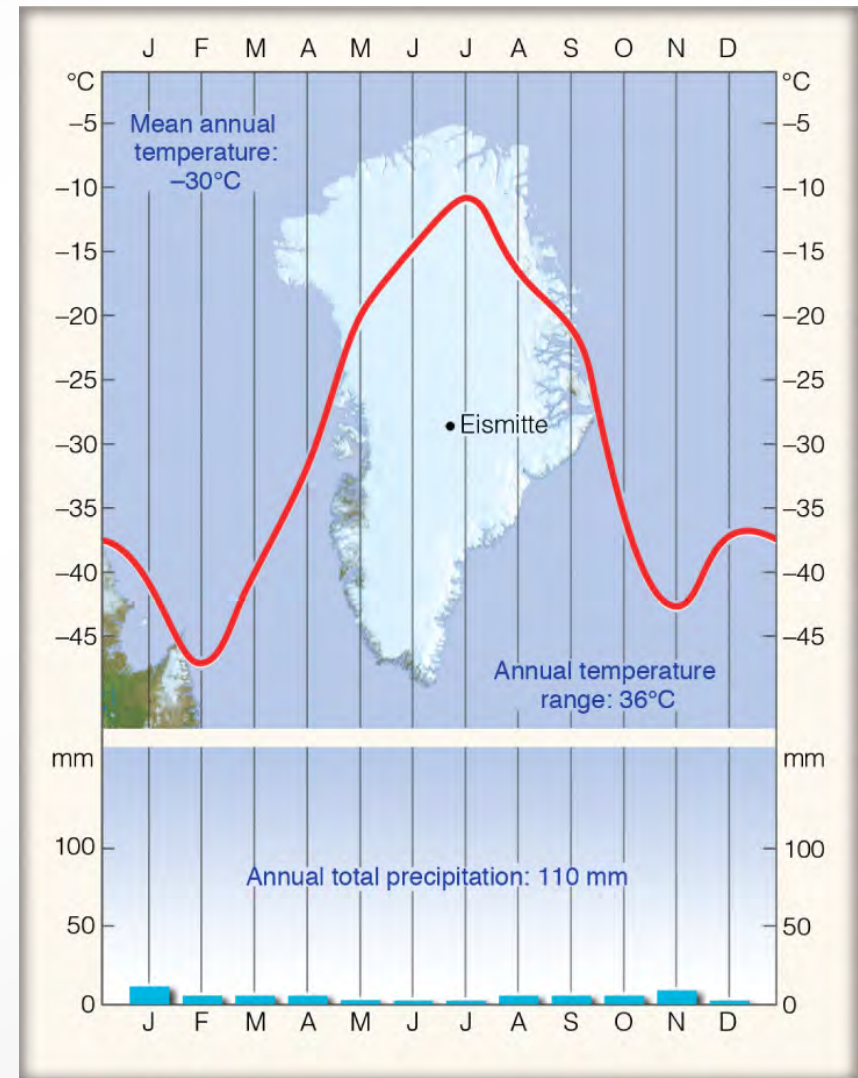


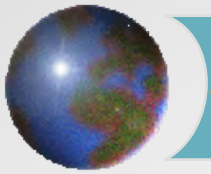


# *EF – Polar ice cap climates*

- ✦ Eismitte, Greenland
- ✦ 71°N, 3000 m above sea level
- ✦ Areas of constant ice cover found in Greenland and Antarctica

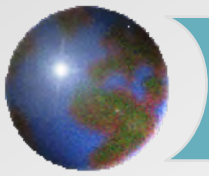
✦ Ahrens: Fig. 16.30



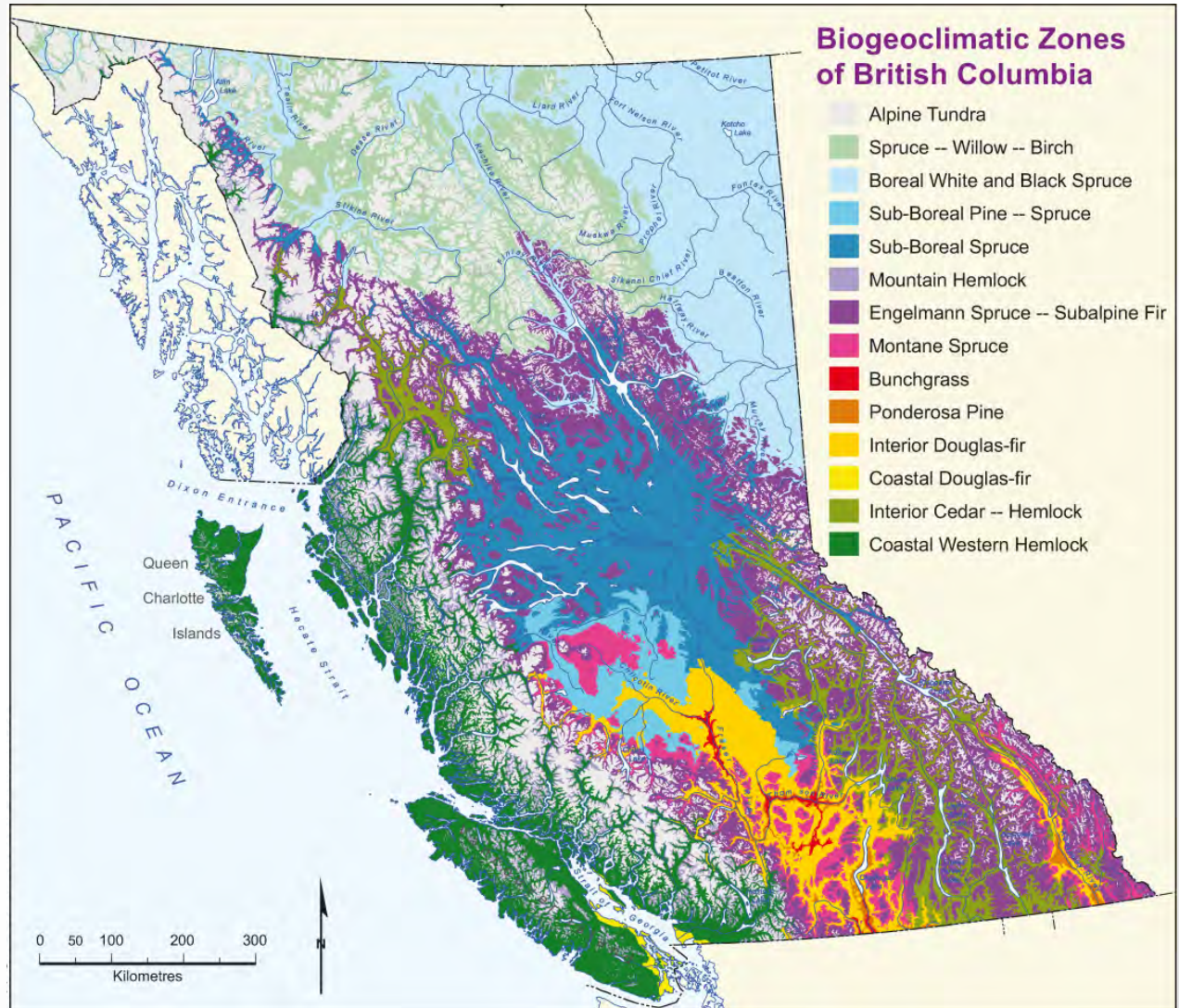


# *H – Highland Climates*

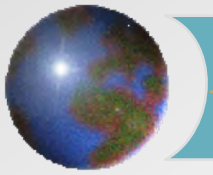
- ❖ Mountainous regions experience rapid temperature variations over short distances as a result of elevation changes
  
- ❖ Slope and aspect play a role in energy and water balances
  - Enhanced precipitation versus rain shadows
  
- ❖ Vertical changes become analogous to latitude changes, eventually leading to ice cap conditions in lofty elevation areas
  
- ❖ This *vertical zonation* leads to highly variable local climates, all classified within H climate designation



# H – British Columbia



Ahrens: Fig. 16.10



## *Next lecture*

📍 Global Climatic change