Fundamentals of Physical Geography 2e

Humidity, Condensation, and Precipitation

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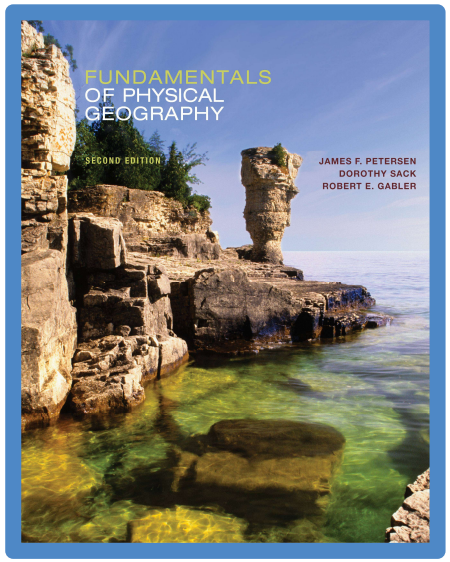
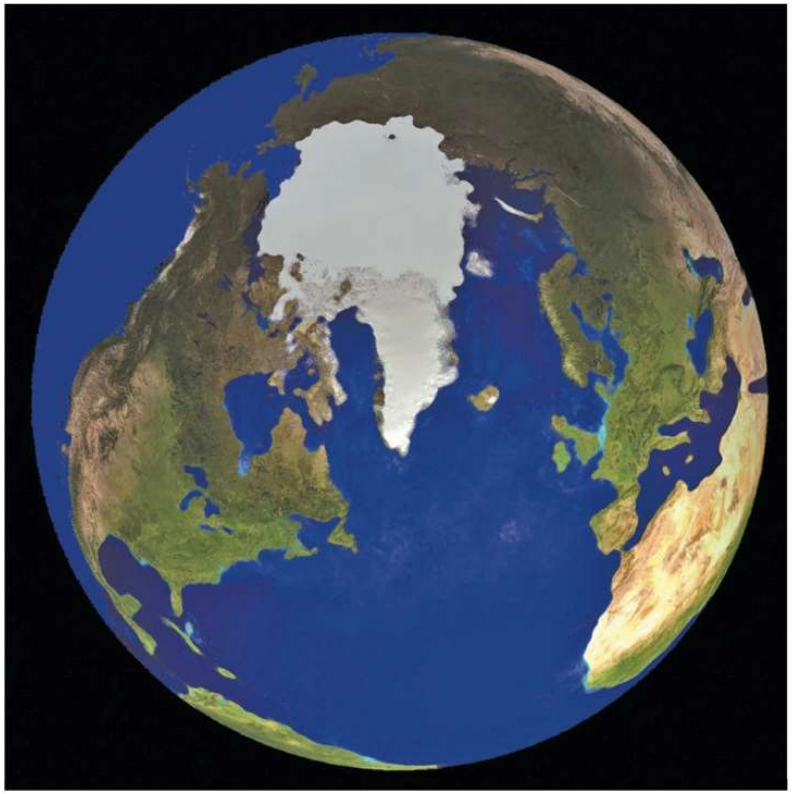


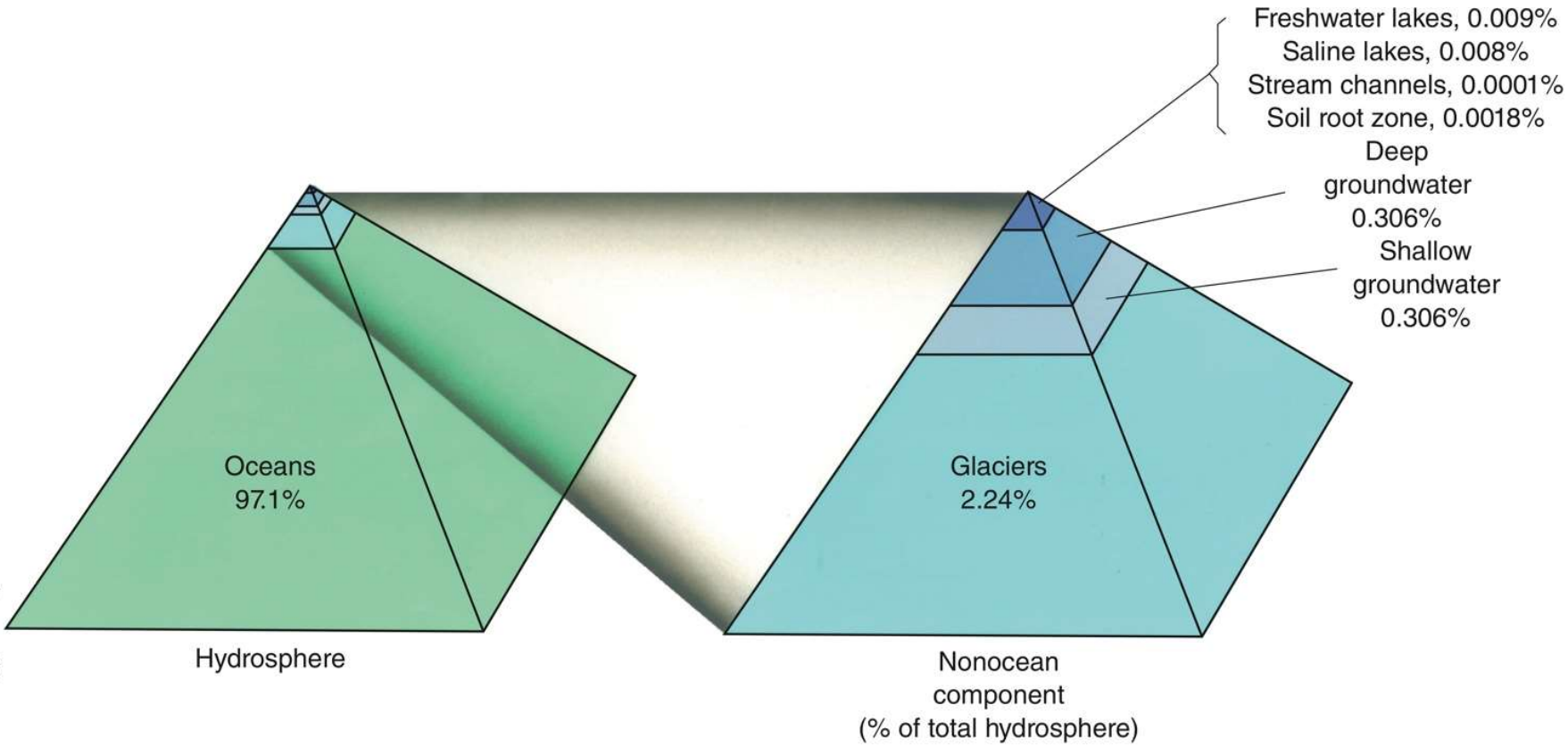
- Peterson
  - Sack
    - Gabler

Introduction

- Water: necessary for photosynthesis, soil formation, and the absorption of nutrients by animals and plants
- Properties of water
  - Universal solvent
  - Capillary action
  - Expands when it freezes
- Earth's water (hydrosphere): three states
  - Liquid, solid, and gas



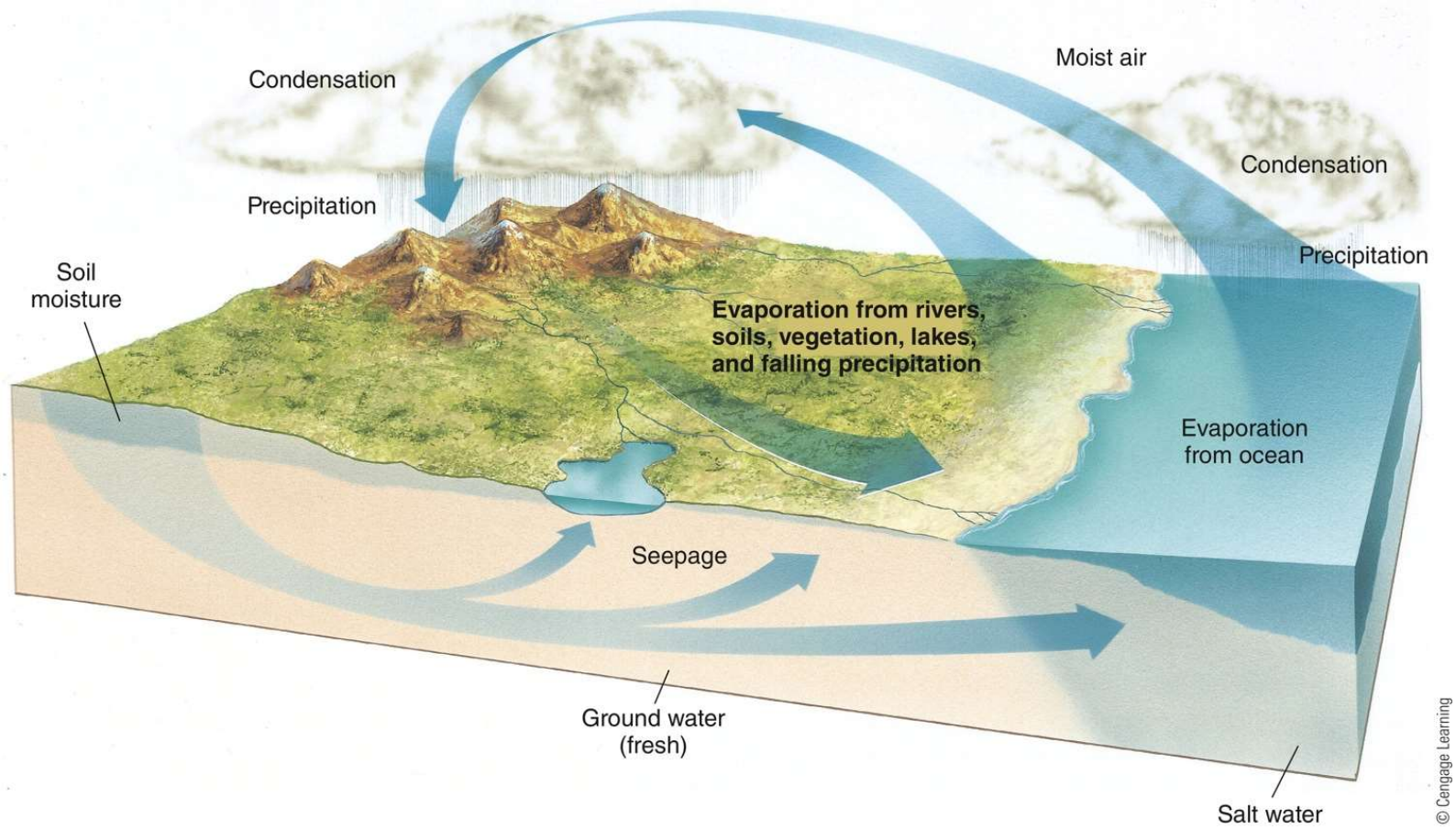
Can you distinguish between the Greenland and Antarctic ice sheets and the seasonal pack ice that has formed on the oceans' surface?



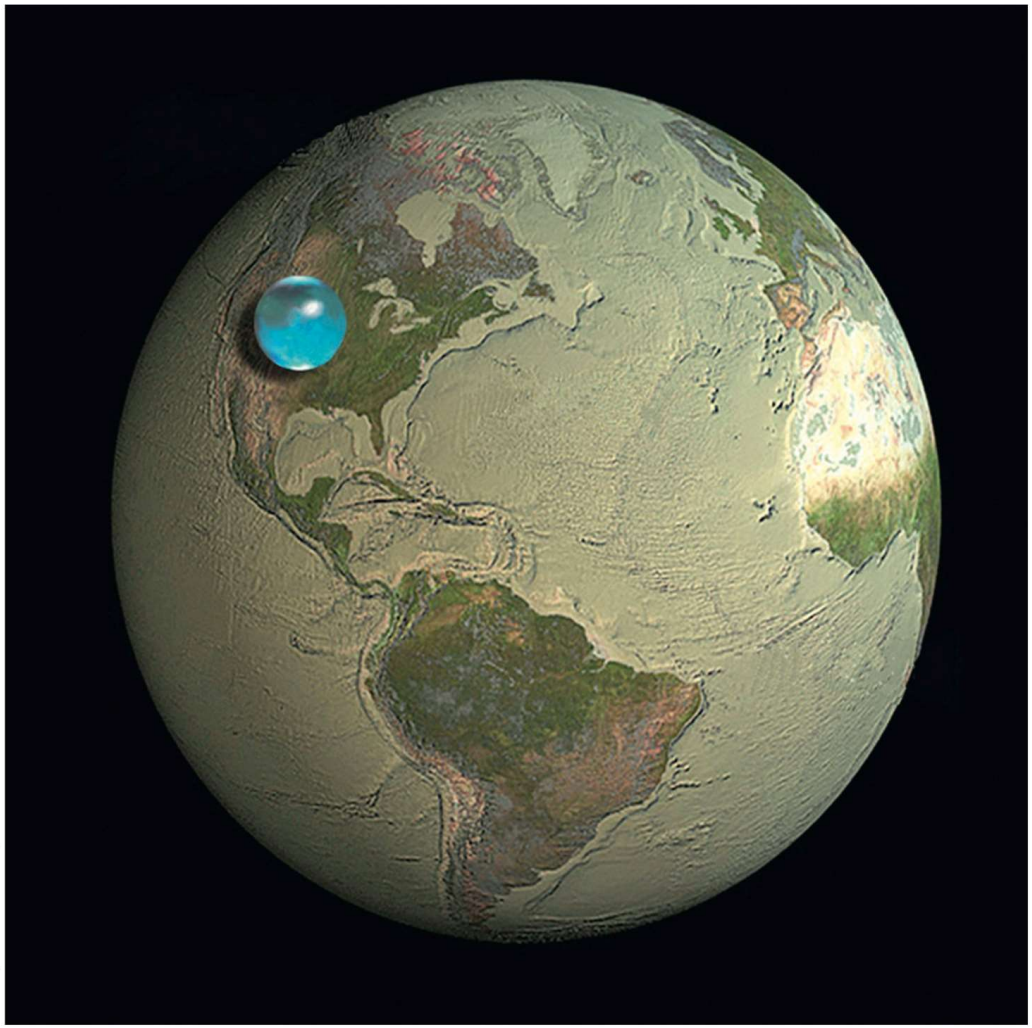
How might global warming or cooling alter this distribution of water on Earth?

The Hydrologic Cycle

- Circulation of water from one of Earth's systems to another
  - Evaporation, condensation, precipitation, and transportation of water over the land, in water bodies, and in the ground
- The water budget
  - Total quantity of water in Earth's hydrosphere remains the same



Is the hydrologic cycle as shown here a closed system or an open system? Why?

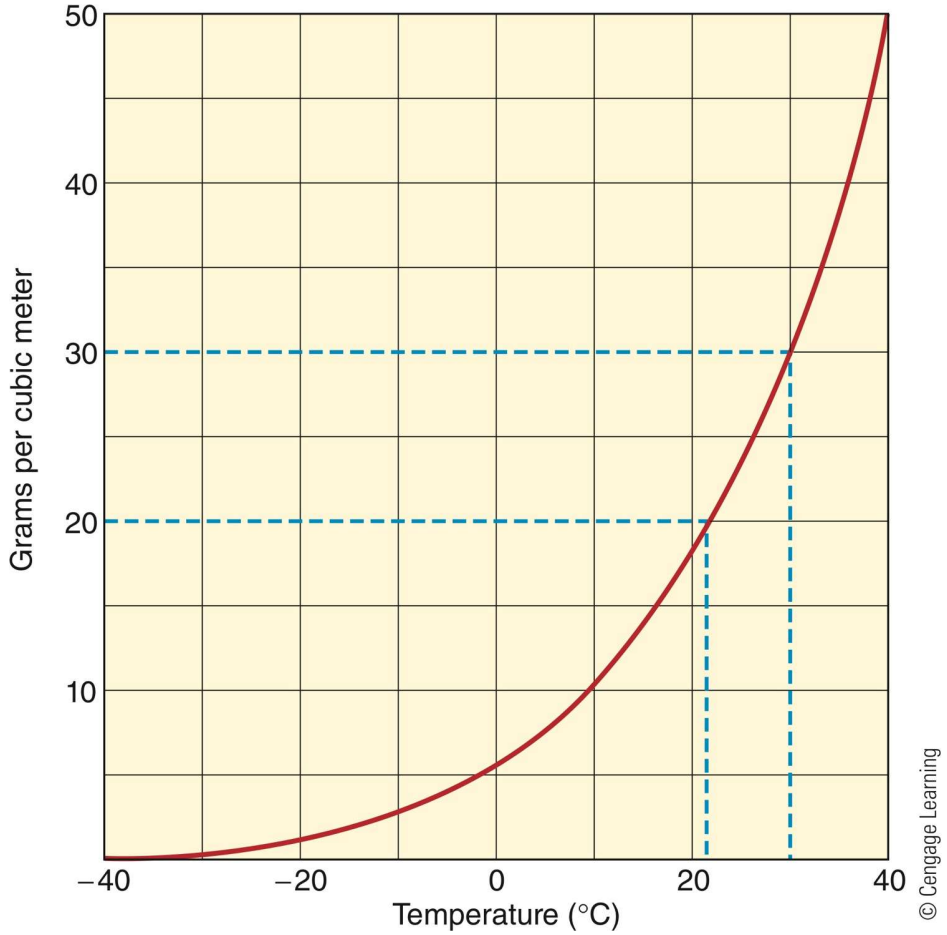


USGS; WHOI-USGS/Jack Cook

What does this relationship mean in terms of water as a resource on Earth?

Water in the Atmosphere

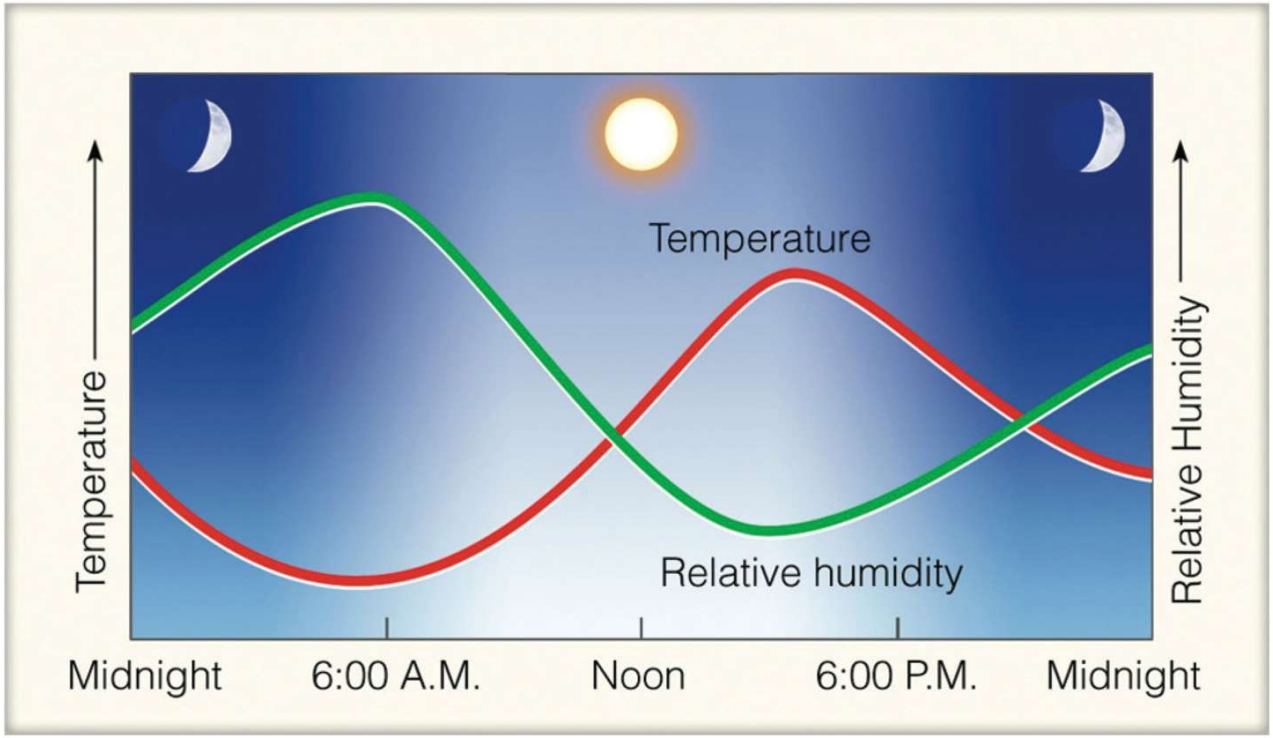
- Forms: ice (snow, hail), tiny liquid droplets (clouds, fog), and gas (water vapor)
- Troposphere: contains 99% of the water vapor in the atmosphere
- What is the significance of water vapor in the atmosphere?



Compare the changes in capacity if the air temperatures rise from 0°C to 10°C, and also from 20°C to 30°C. What is the relationship between temperature changes and capacity?

Water in the Atmosphere (cont'd.)

- Saturation and the dew point
  - State of saturation: air of a given temperature has reached its moisture capacity
  - Dew point temperature: condensation occurs
- Humidity: amount of water vapor in the air at any one time and place
  - Absolute
  - Specific
  - Relative



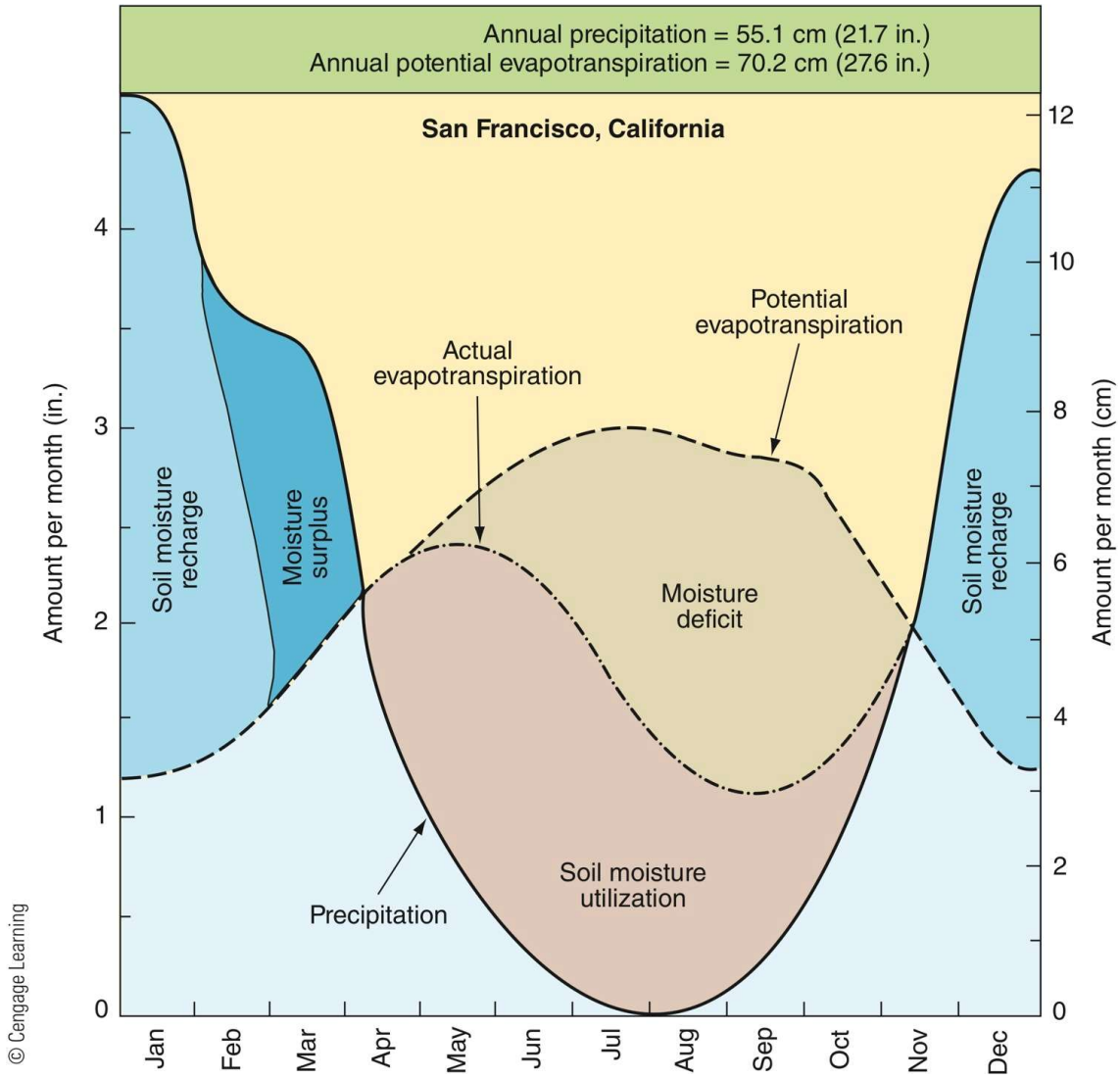
How is the relationship between air temperature and relative humidity applied when using a hair dryer?

Atmospheric Moisture Sources

- Water in the atmosphere
  - Evaporation from many different sources
  - Transpiration from plants
  - What is evapotranspiration?
- Evaporation rates
  - Affected by the amount and temperature of accessible water
  - Refer to Table 5.1

Atmospheric Moisture Sources (cont'd.)

- Potential evapotranspiration
  - Estimated using formulas
  - Refer to "Understanding Map Content 5.1"



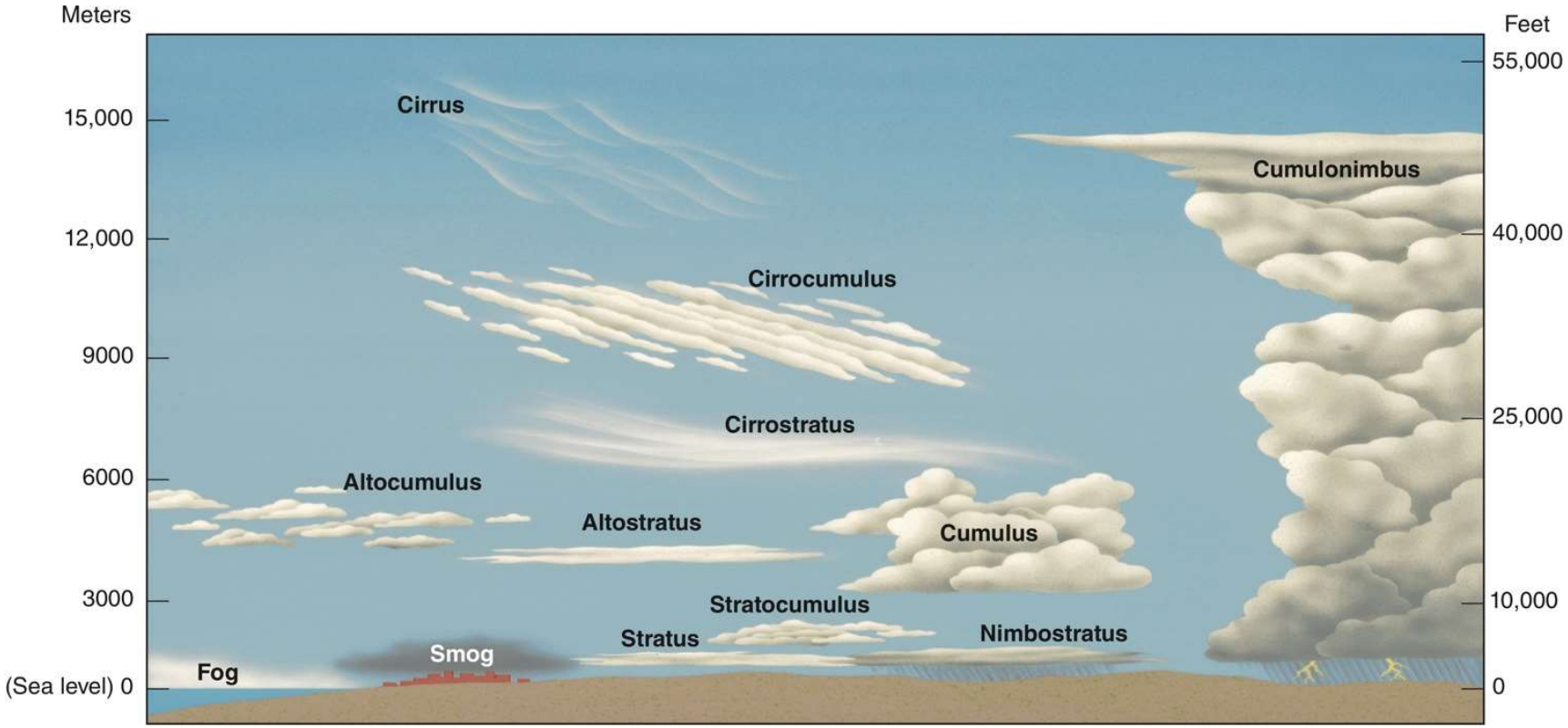
When would irrigation be necessary at this site?

Condensation, Fog, and Clouds

- Condensation: depends on the relative humidity of the air and the degree of cooling
- What are examples of condensation nuclei?
- Fog
  - Types: radiation, advection, and upslope
  - Refer to Figure 5.9)

Condensation, Fog, and Clouds (cont'd.)

- Dew
  - Collects on surfaces that are good radiators of heat
- Frost
  - Results from sublimation process
- Clouds
  - Source of all precipitation
  - Role in heat energy budget
  - Cloud forms: named based on their height and form



Observe these cloud types and Figure 5.11; what cloud type is present in your area today?

J. Petersen

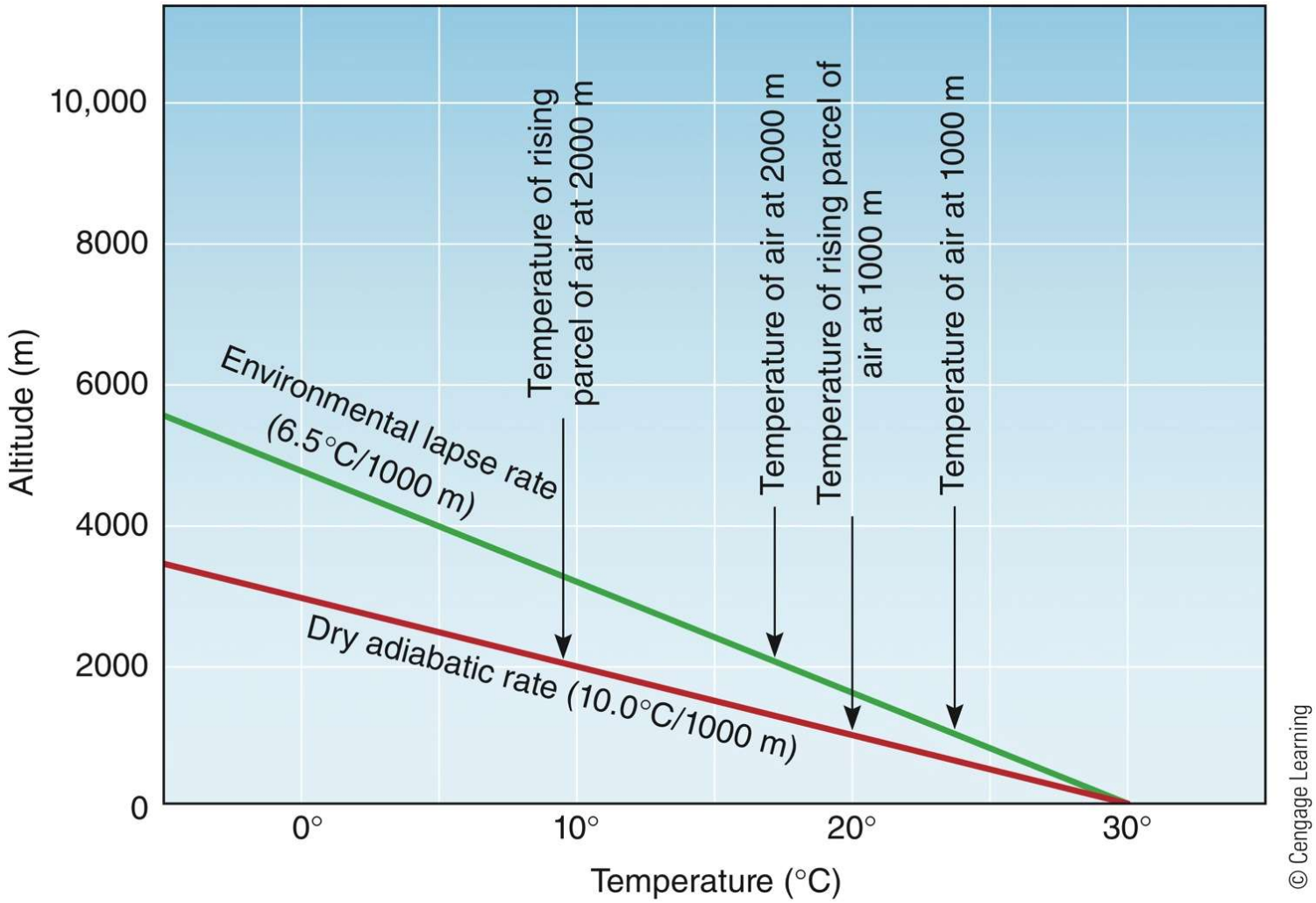
NOAA/NWS

John Cunningham/Visuals Unlimited

J. Petersen

Adiabatic Heating and Cooling

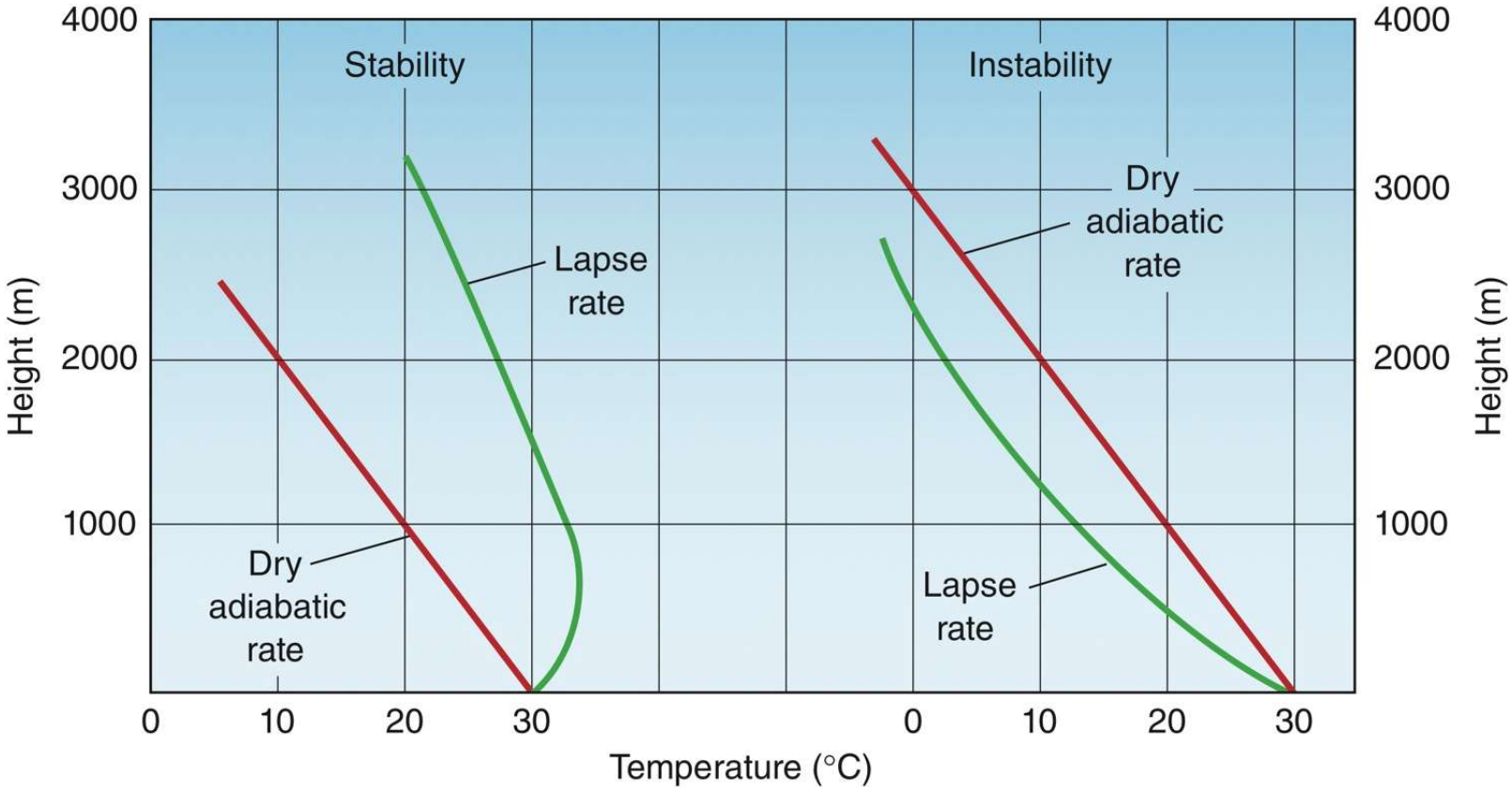
- Adiabatic cooling: occurs as air molecules rise and spread out
- Adiabatic cooling: air temperature increases as air descends and compresses
  - Dry adiabatic lapse rate
  - Wet adiabatic lapse rate
- What do environmental lapse rates and adiabatic lapse rates differ?



In this example, using the environmental lapse rate, what is the air temperature at 2,000 meters?

Adiabatic Heating and Cooling (cont'd.)

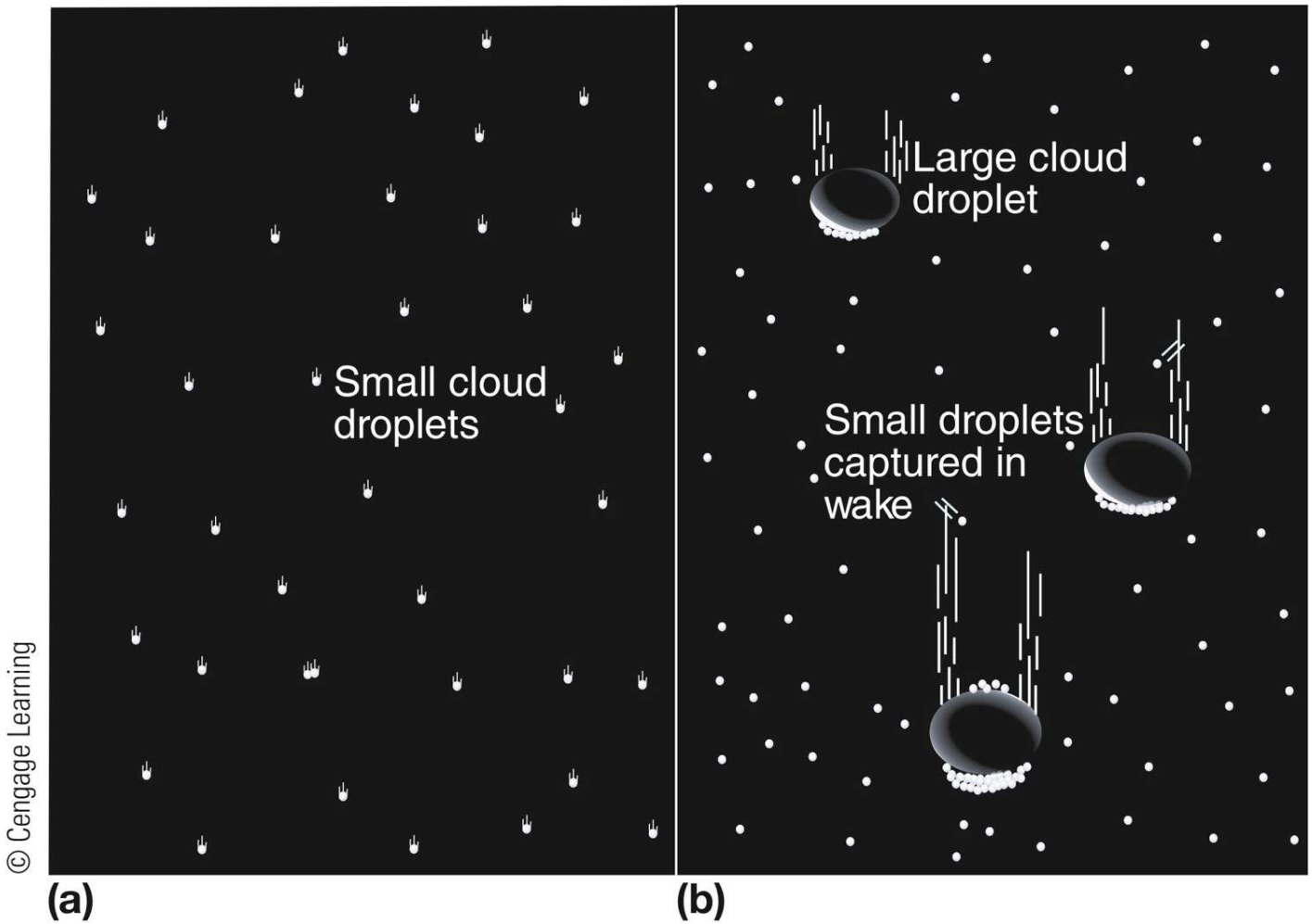
- Instability and stability
  - Unstable: air parcel that is warmer than surrounding air
  - Stable: sinking air
  - Related to the cooling and heating of air at Earth's surface



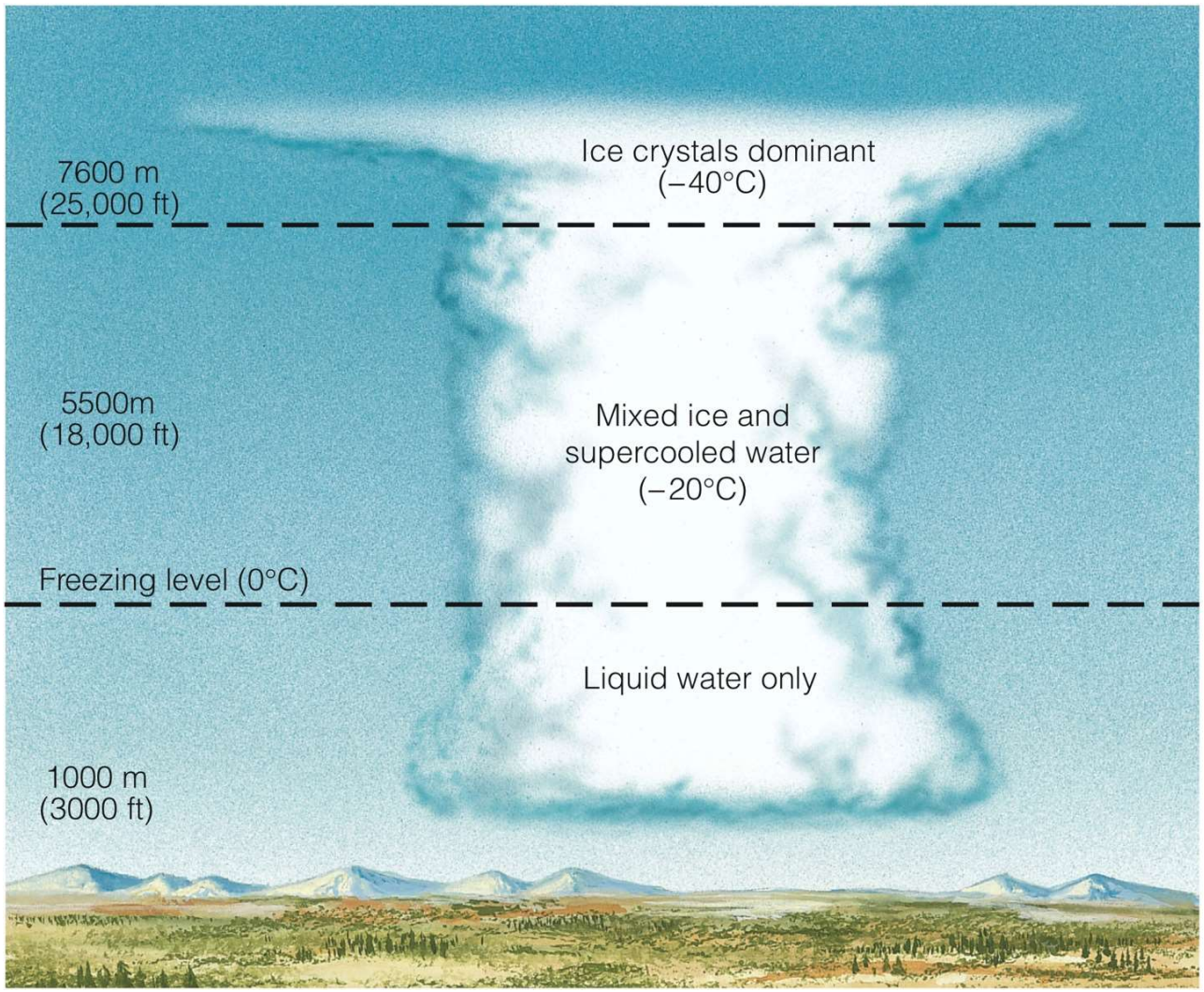
In these examples, what would the air temperature be at 2,000 meters if the air at the surface rose to this level?

Precipitation Processes

- Precipitation: occurs when droplets of water or ice crystals become too large and heavy to be held aloft
- Precipitation development theories
  - Collision–coalescence process
  - Bergeron (ice crystal) process



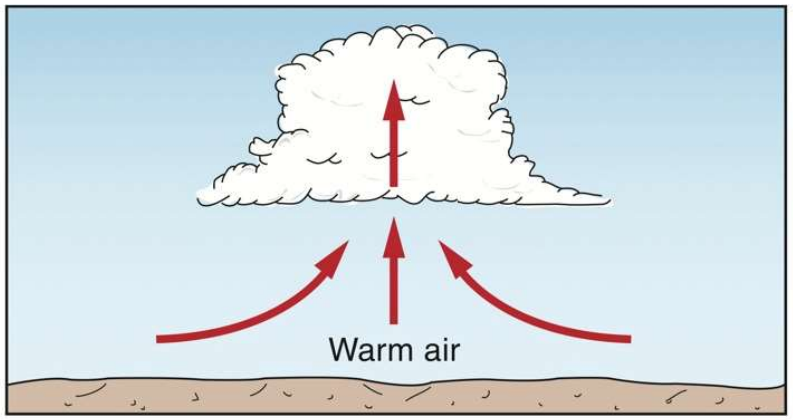
Why do these tiny droplets fall at different speeds?



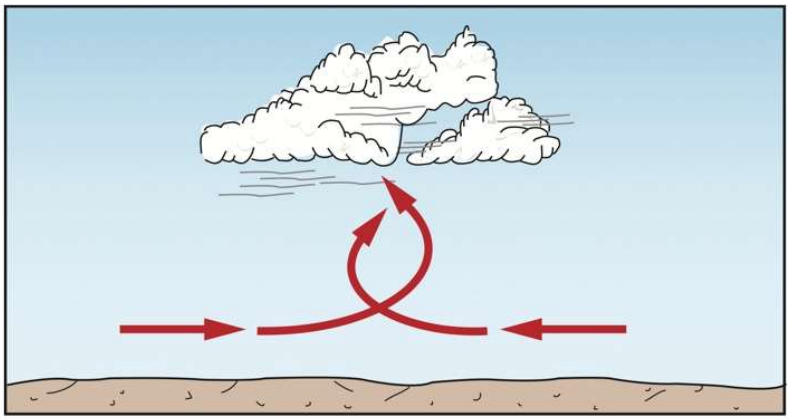
What is the difference between water and supercooled water?

Precipitation Processes (cont'd.)

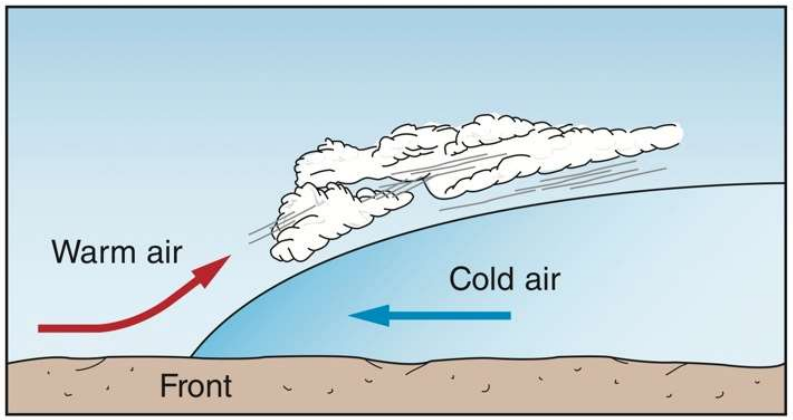
- Forms of precipitation: rain and drizzle, snow, sleet, hail, and freezing rain
- Factors necessary for precipitation
  - Moist air
  - Condensation nuclei
  - Uplift mechanism



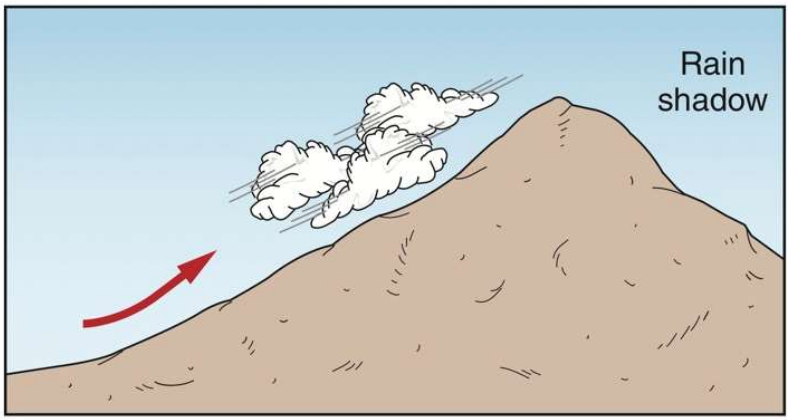
Convectional



Cyclonic (Convergence)



Frontal



Orographic

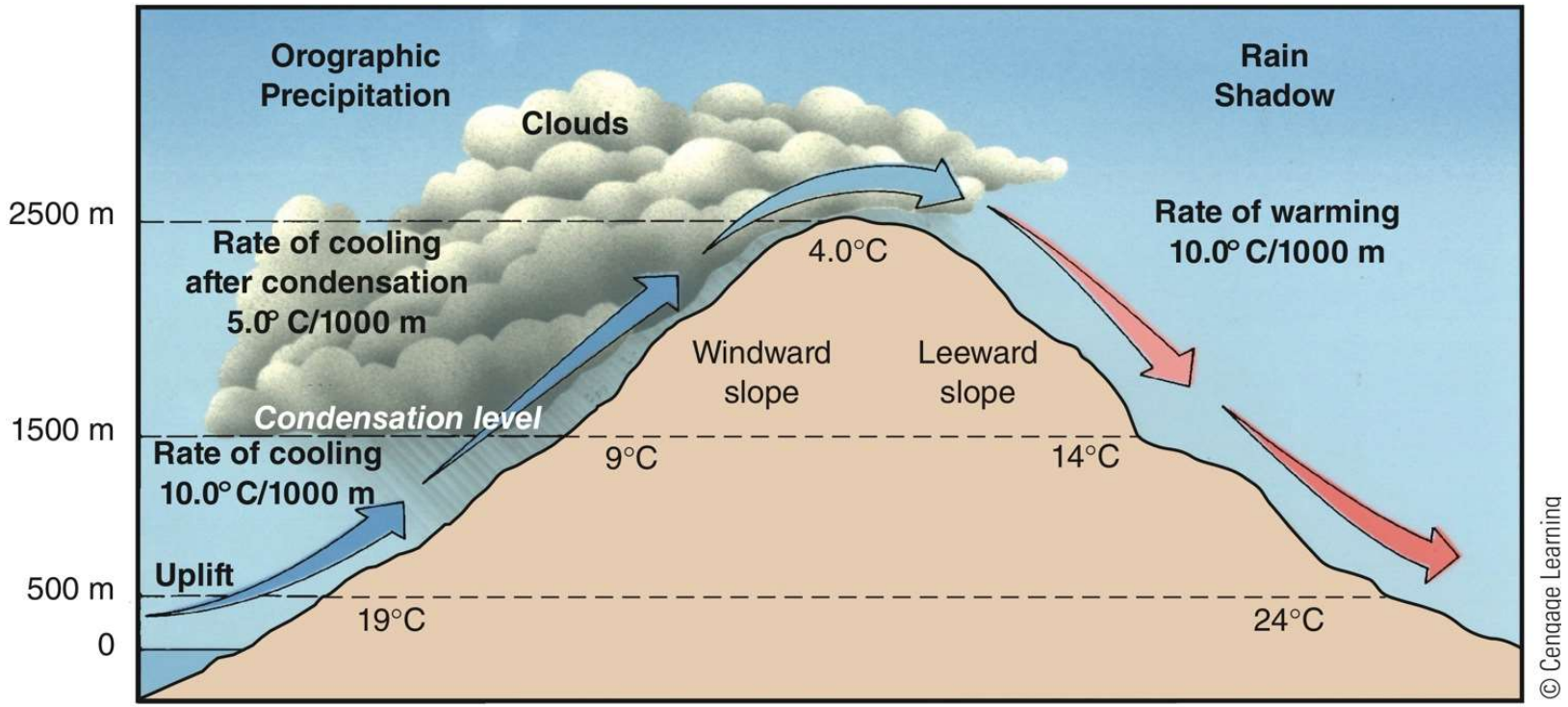
What kind of air movement is common to the depictions in all four diagrams?

Precipitation Processes (cont'd.)

- The lifting condensation level (LCL)

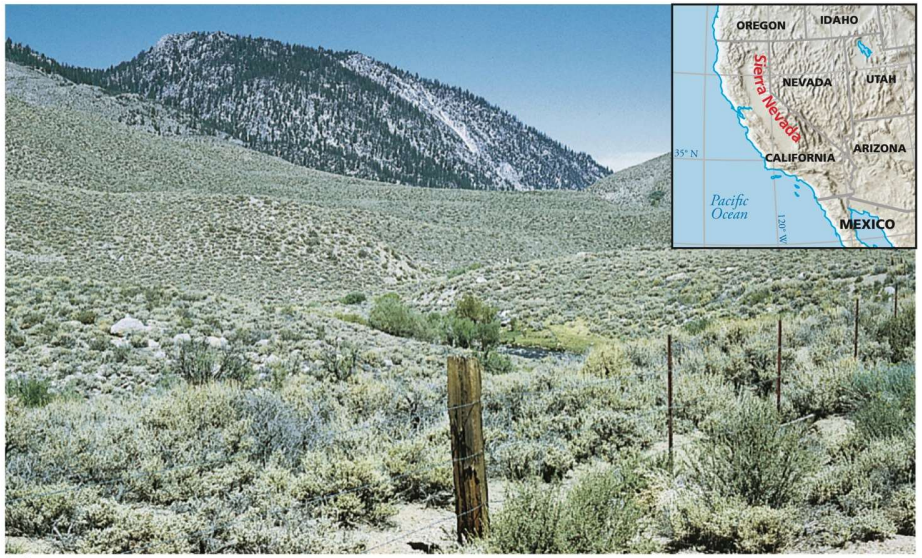
  LCL (in meters) = 125 meters × (Celsius temperature – Celsius dew point)

- Note: formula is best used with the lowest level of cloud cover that appears overhead



R. Gabler

(b)



R. Gabler

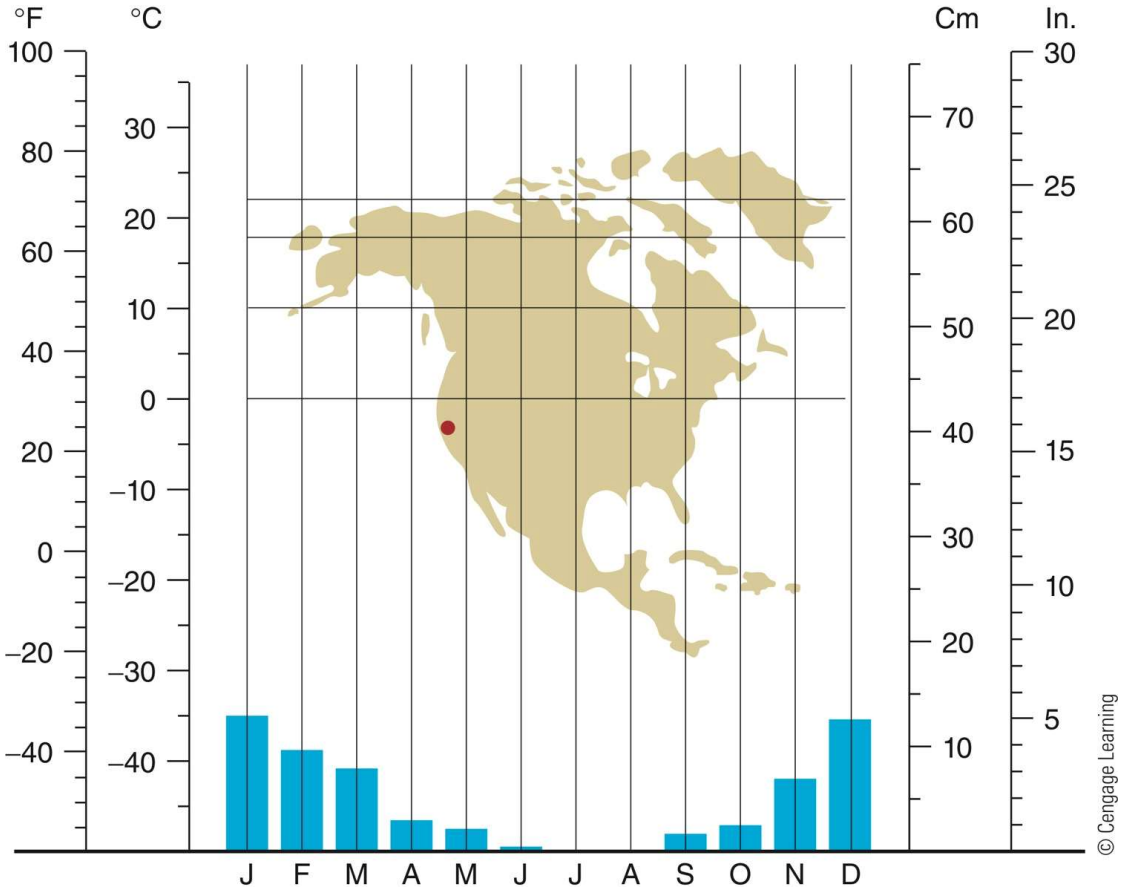
(c)

Can you identify a mountain range in Eurasia in which the leeward side of that range is in the rain shadow?

Precipitation Distributions

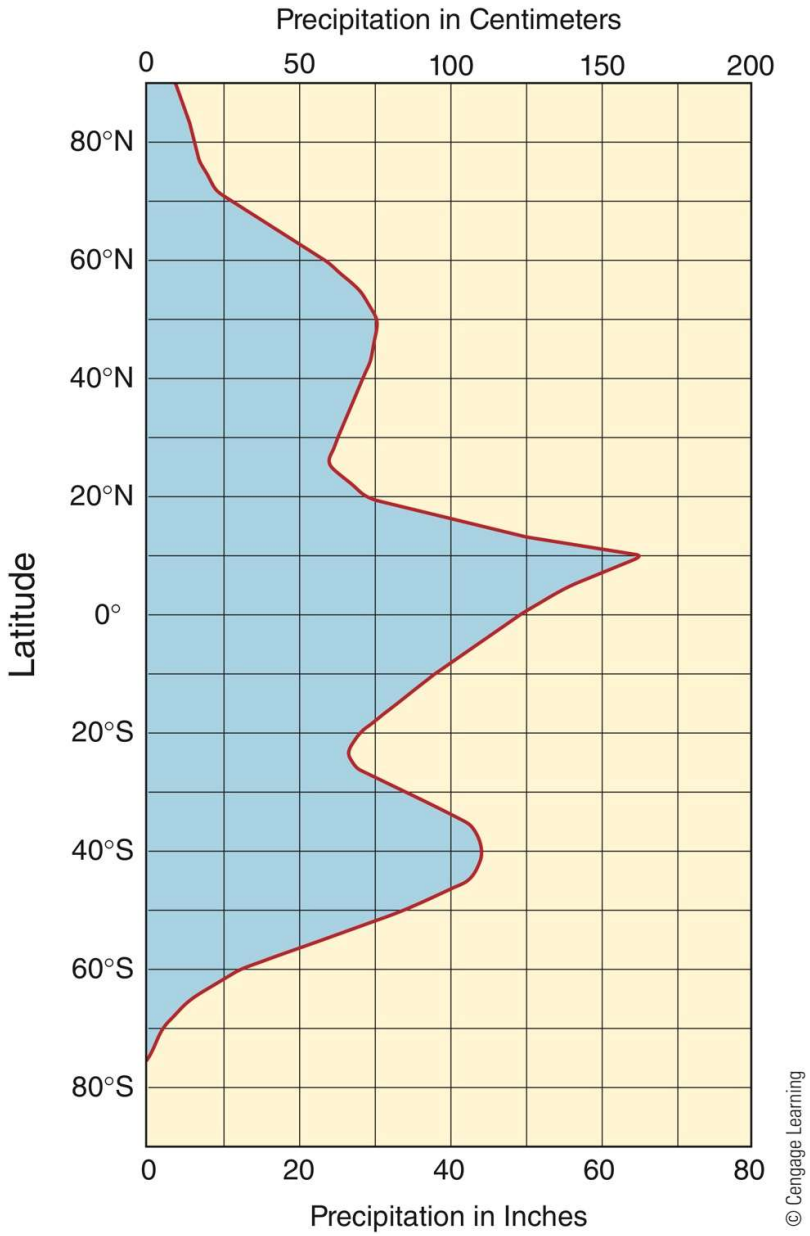
- Distribution over time
  - Average annual precipitation
  - Number of rain days: annually or monthly
  - Average monthly precipitation
- Latitudinal distribution
  - Refer to Figure 5.21: average annual precipitation of Earth's land areas
    - In general, where on Earth's surface does the heaviest rainfall occur? Why?

Station:	San Francisco	Mean annual temp.:	12.8°C (55°F)
Latitude:	38°N	Average annual prec.:	55 cm (21.7 in.)
Longitude:	122°W	Annual temp. range:	7.2°C (13°F)



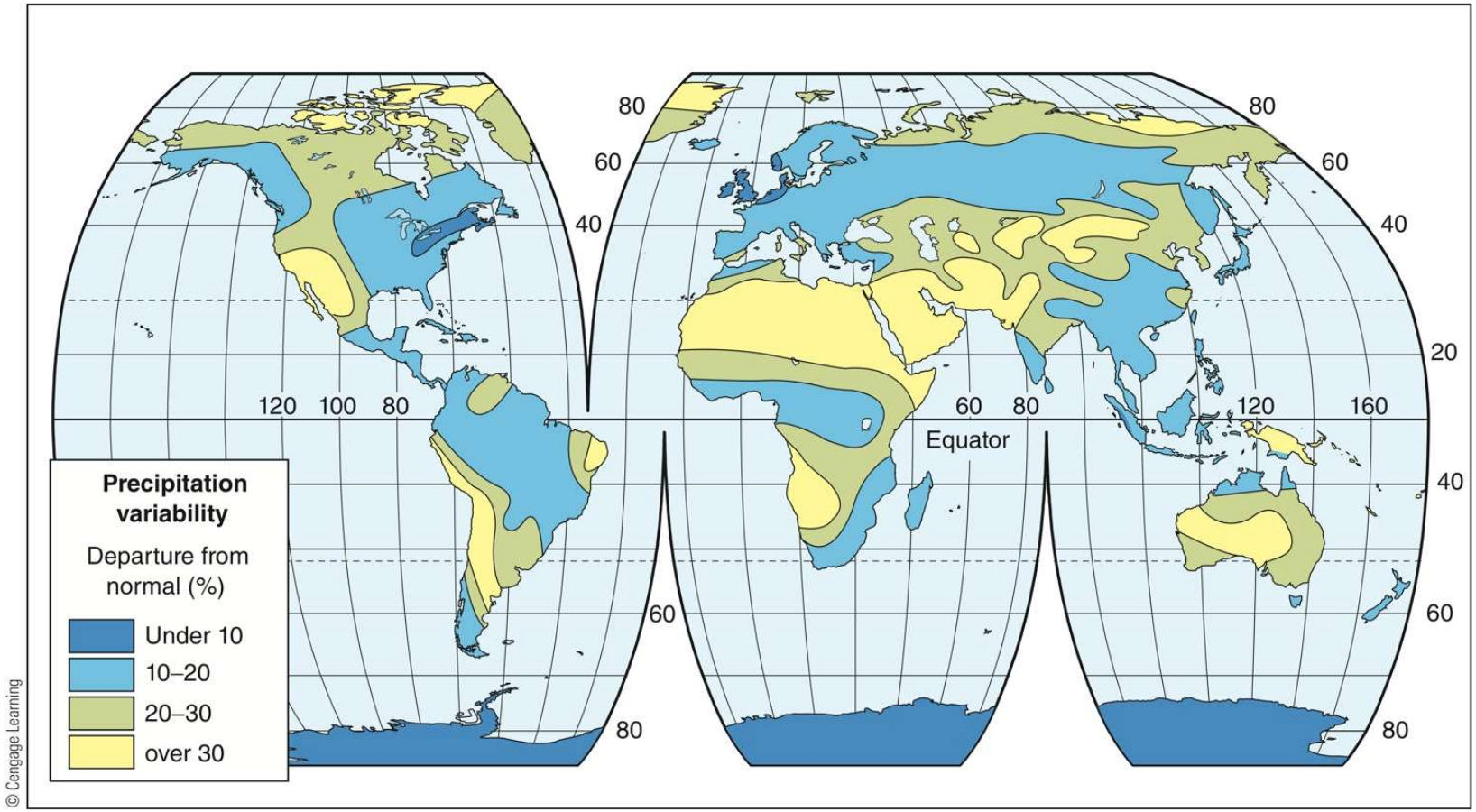
How would this kind of rainfall pattern affect agriculture?

Compare this graph with Figure 4.10. What is the relationship between world rainfall patterns and world pressure distribution?



Precipitation Variability

- Varying rainfall amounts
  - Within any single year
  - From year to year
  - Conditions of drought and flooding
  - Interaction of multiple factors in producing precipitation



Compare this map with Figure 5.22. What are some of the similarities and differences?

Fundamentals of Physical Geography 2e

Humidity, Condensation, and Precipitation

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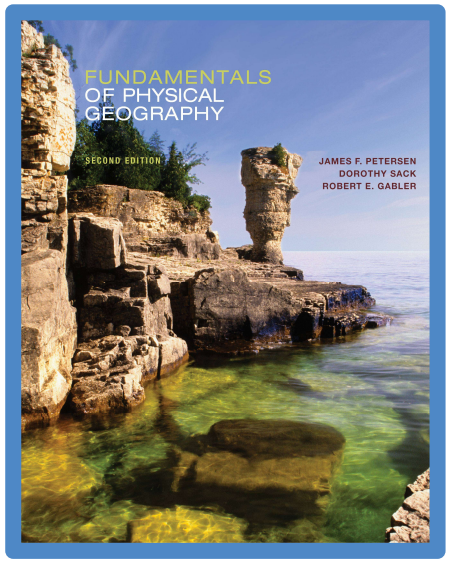

- Peterson
  - Sack
    - Gabler