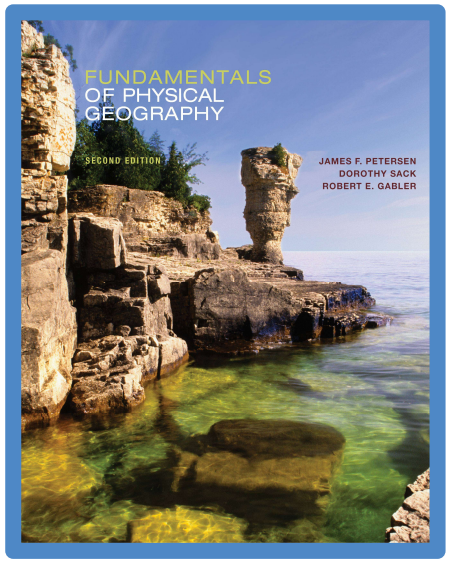
Fundamentals of Physical Geography 2e

Microthermal, Polar, and Highland Climate Regions: Climate Change

8



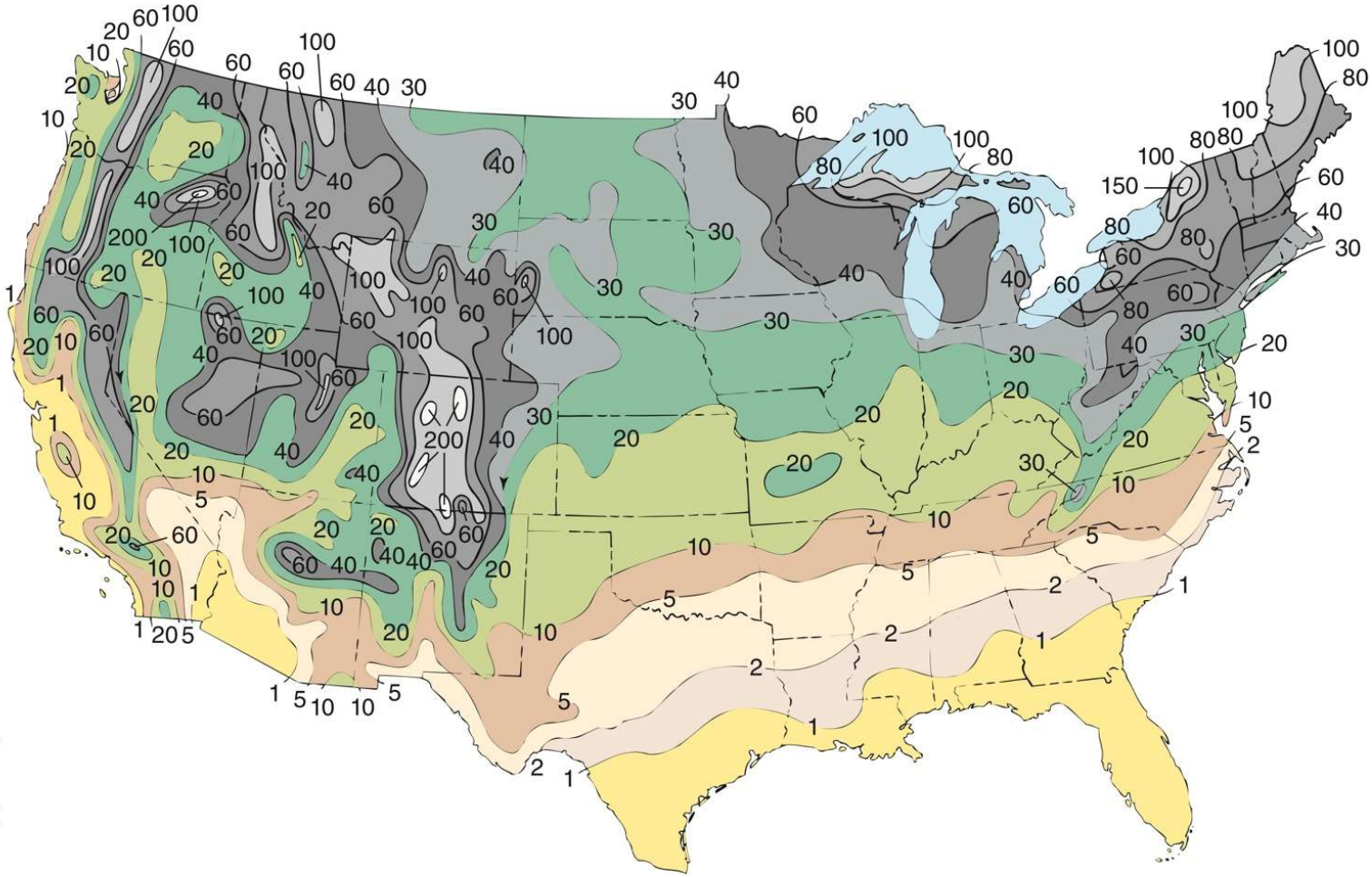
- Peterson
  - Sack
    - Gabler

Microthermal Climate Regions

- Characterized by:
  - Recognizable summer with at least one month averaging more than 10°C (50°F)
  - Distinct winter with the coldest month averaging less than 0°C (32°F)
- Microthermal climates
  - Humid continental, hot summer
  - Humid continental, mild summer
  - Subarctic

Microthermal Climate Regions

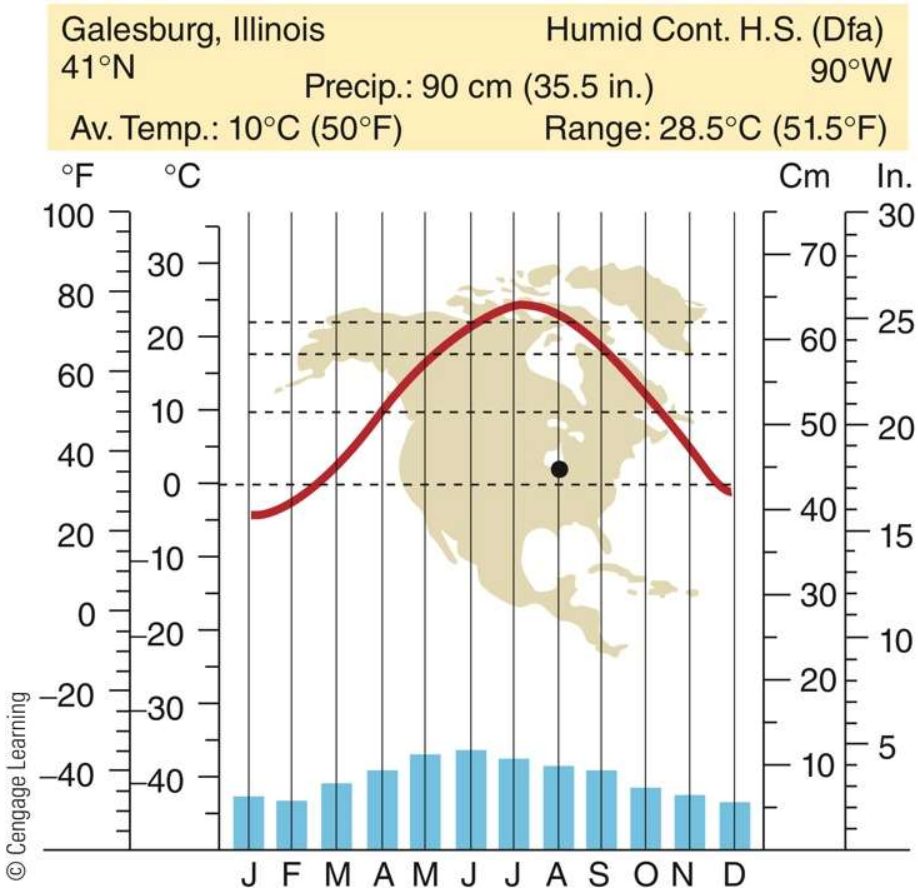
- Humid microthermal generalizations
  - Year-round precipitation except subarctic
  - Maximum precipitation in summer
  - Significant snow
  - Unpredictable and variable weather
- Humid continental climates
  - Humid continental hot-summer climate: most productive agriculturally
  - Humid continental mild summer climate

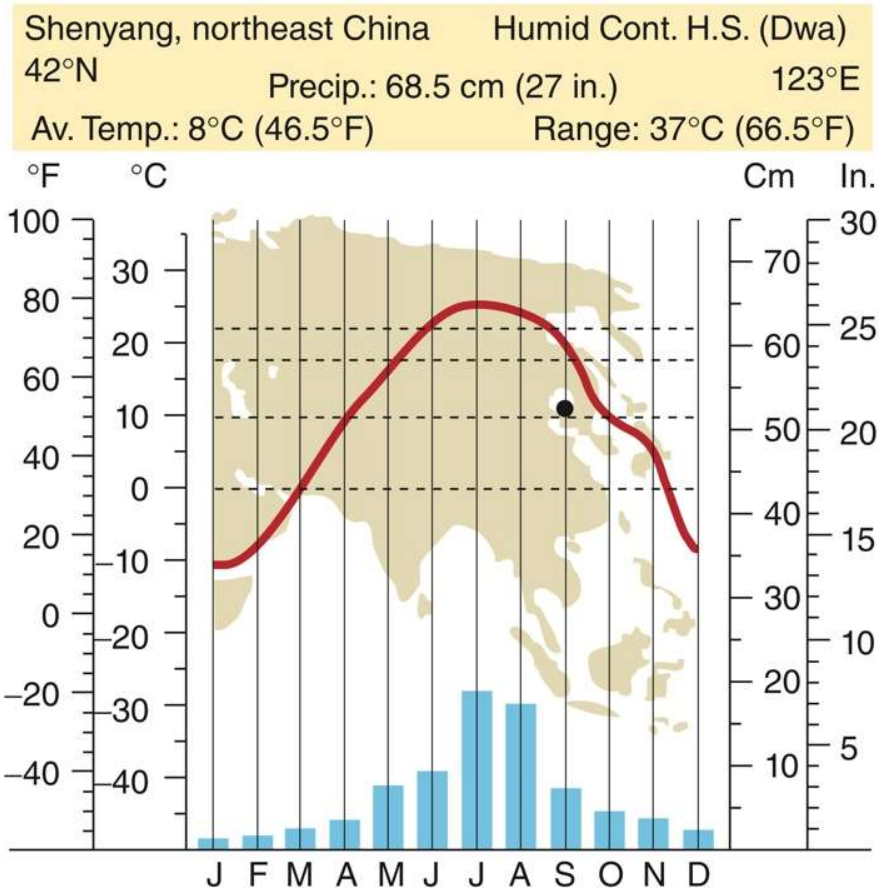


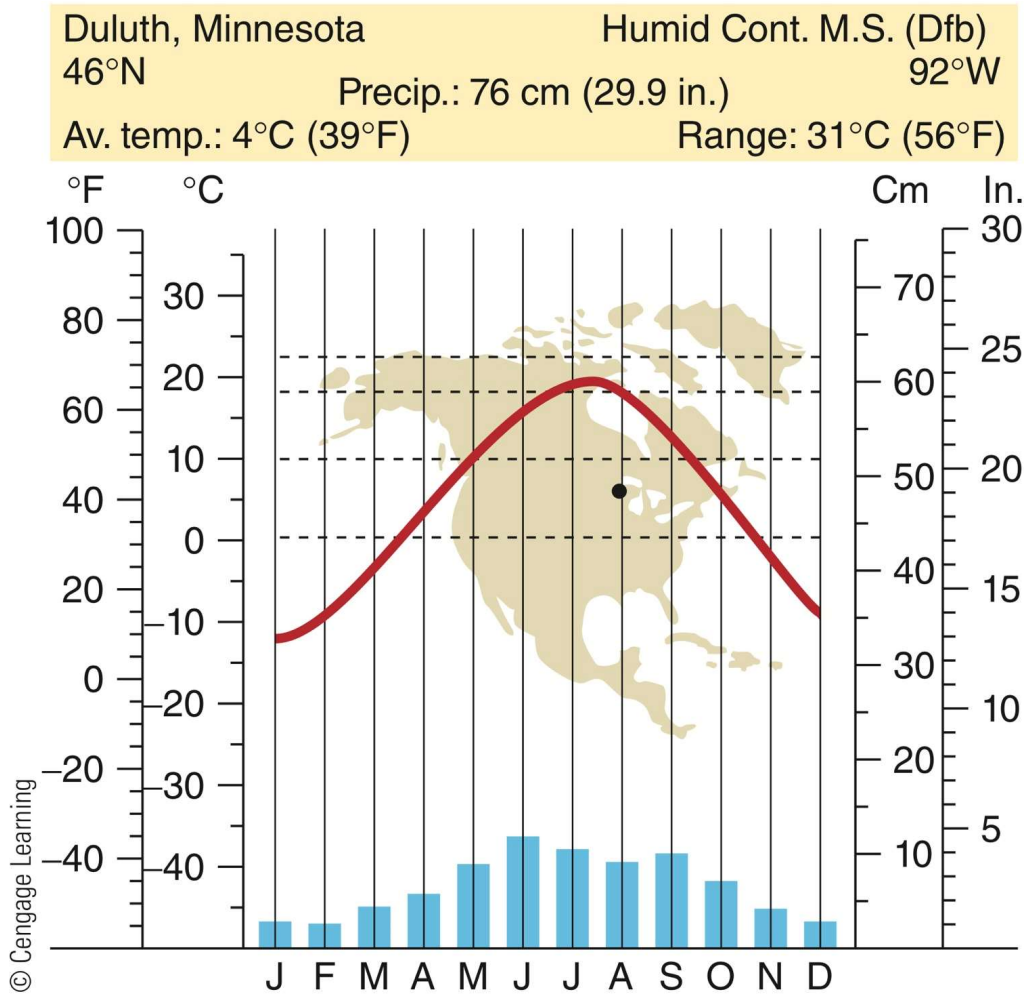
What areas of the United States average the greatest number of days with snow cover?

Microthermal Climate Regions (cont'd.)

- Comparison of hot-summer and mild-summer climates
  - Hot-summer regions: long, hot summers
  - Mild-summer regions: more-severe winters and shorter summers
  - Amount and distribution of precipitation varies
  - Differences in vegetation and soil types







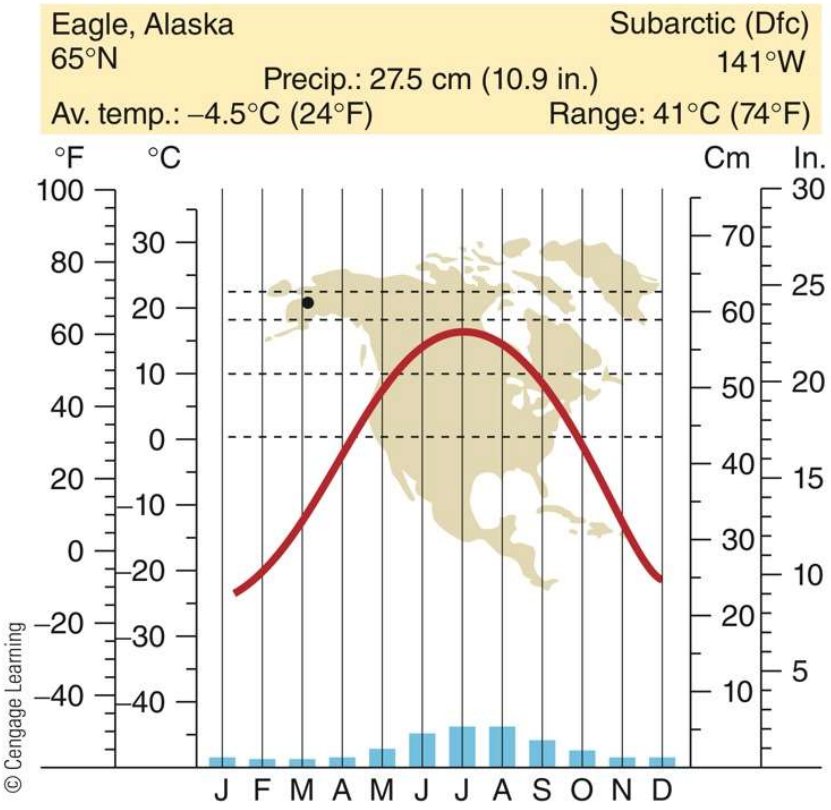
How do you explain the differences in temperature and precipitation between Duluth and Galesburg, Illinois (in Fig. 8.3)?

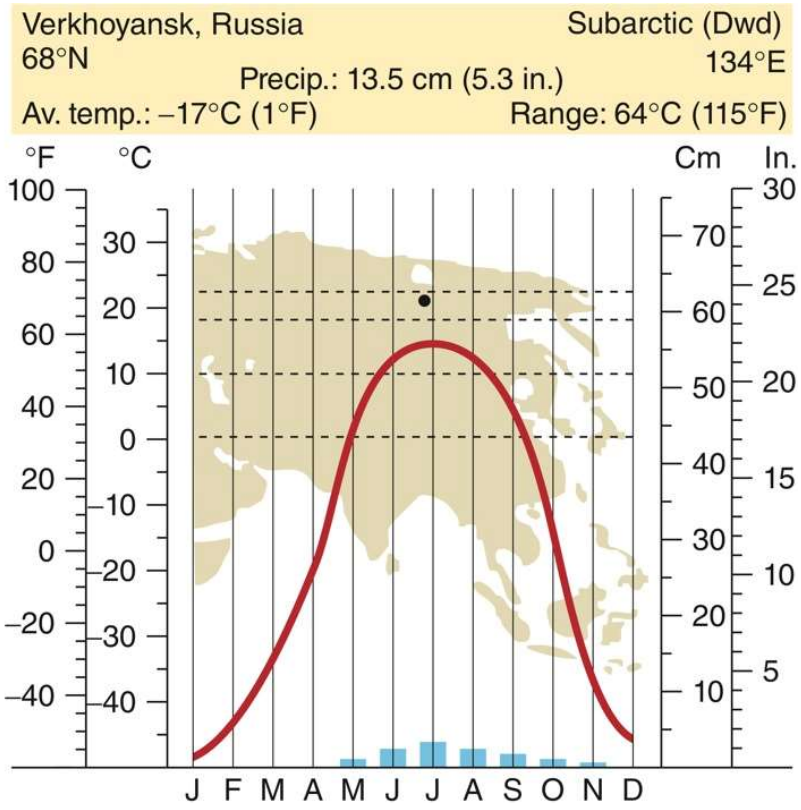
Microthermal Climate Regions (cont'd.)

- Seasonal changes
  - Four distinct seasons in humid continental climates
  - Atmospheric changes within seasons
    - Humid continental climates: classic examples of variable middle-latitude weather
- Land use in humid continental regions
  - Impacted by growing season length, rainfall amount, and soil characteristics due to glacial effects

Microthermal Climate Regions (cont'd.)

- Subarctic climate
  - Farthest poleward and most extreme of the microthermal climates
  - Poleward boundary: latitudinal limit of forest growth
  - Exclusively in Northern Hemisphere
  - High latitude and continentality
    - Short, cool summers and long, bitterly cold winters
    - Rapid heating and cooling associated with continental interiors





Why would people live in such severe-winter climate regions?

Microthermal Climate Regions (cont'd.)

- Subarctic climate
  - A limiting environment
    - Boreal forest: taiga
    - What is permafrost?
    - Patterned ground or frost polygons

Why are these kinds of forests currently of little economic value?

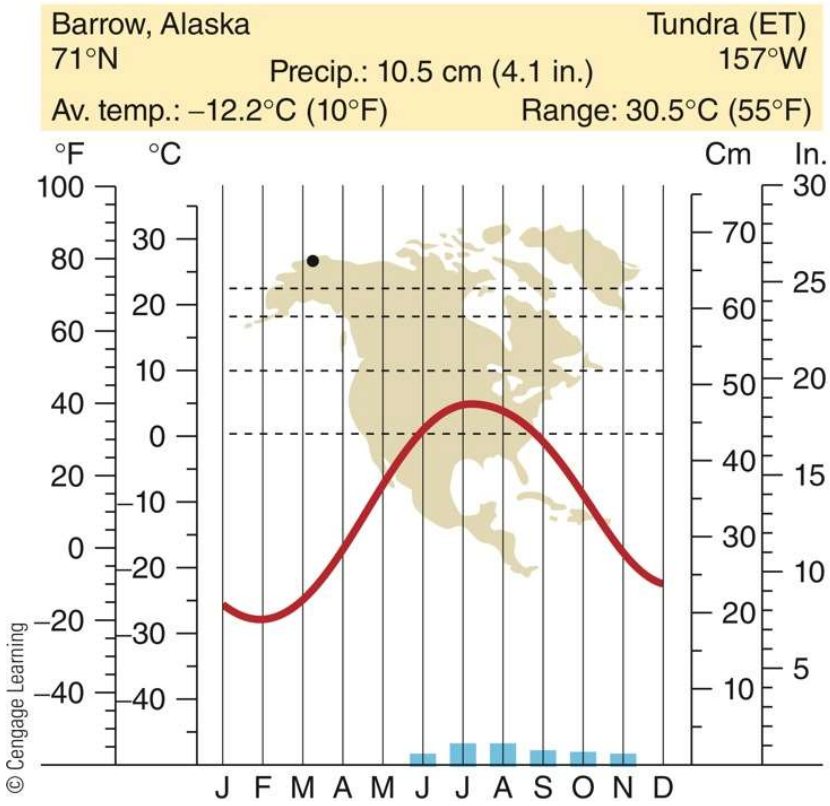
Melissa Gabrielson/US Fish and Wildlife Service, Alaska

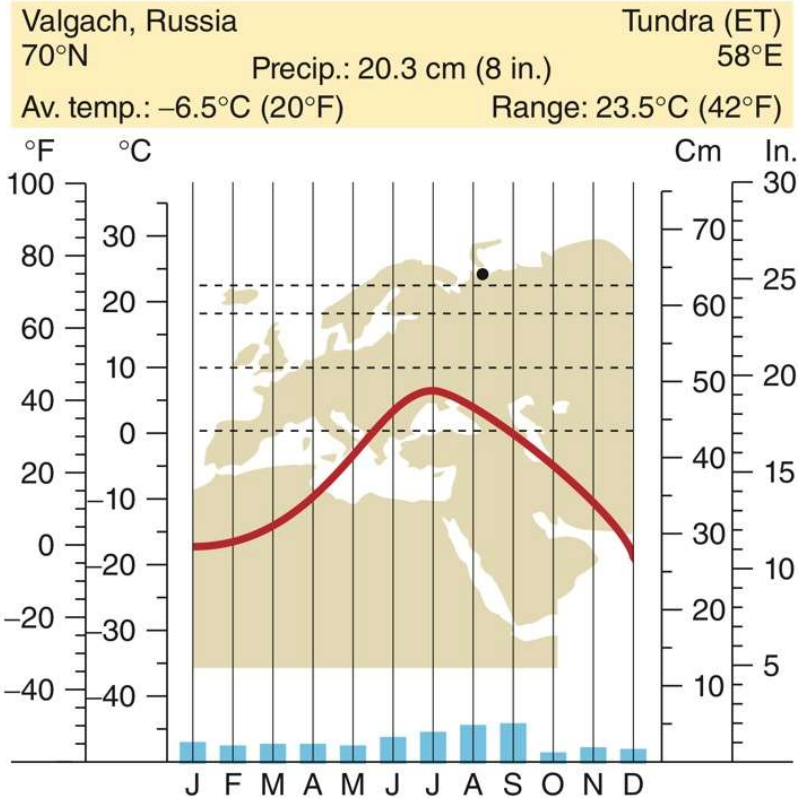
Polar Climate Regions

- Characteristics
  - Low amounts of annual insolation
  - Unique pattern of daylight and darkness
- Polar climate types
  - Tundra climate
  - Ice-sheet climate

NAME AND DESCRIPTION	CONTROLLING FACTORS
Tundra	
Warmest month between 0°C (32°F) and 10°C (50°F); precipitation exceeds potential evapotranspiration	Location in the high latitudes; subsidence and divergence of the polar anticyclone; proximity to coasts
Ice Sheet	
Warmest month below 0°C (32°F); precipitation exceeds potential evaporation	Location in the high latitudes and interior of landmasses; year round influence of the polar anticyclone; ice cover; elevation

GEOGRAPHIC DISTRIBUTION	DISTINGUISHING CHARACTERISTICS
Tundra	
Arctic Ocean borderlands of North America, Greenland, and Eurasia; Antarctic Peninsula; some polar islands	At least 9 months average below freezing; low evaporation; precipitation usually below 25.5 cm (10 in.); coastal fog; strong winds
Ice Sheet	
Antarctica; interior Greenland; permanently frozen portions of the Arctic Ocean and associated islands	Summerless; all months average below freezing; world's coldest temperature; extremely meager precipitation in the form of snow, evaporation even less; gale force winds

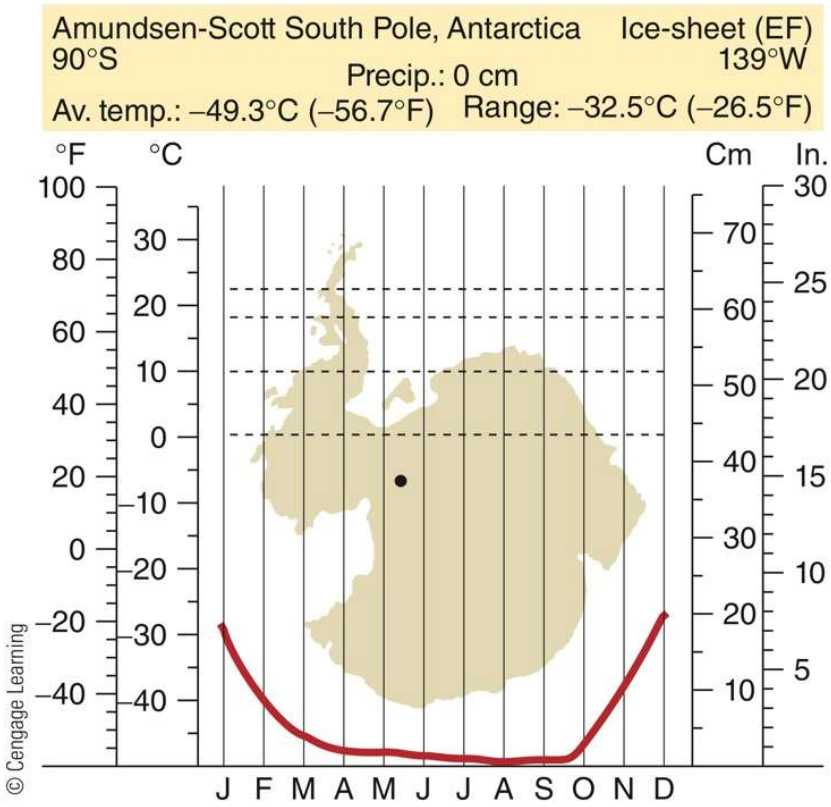


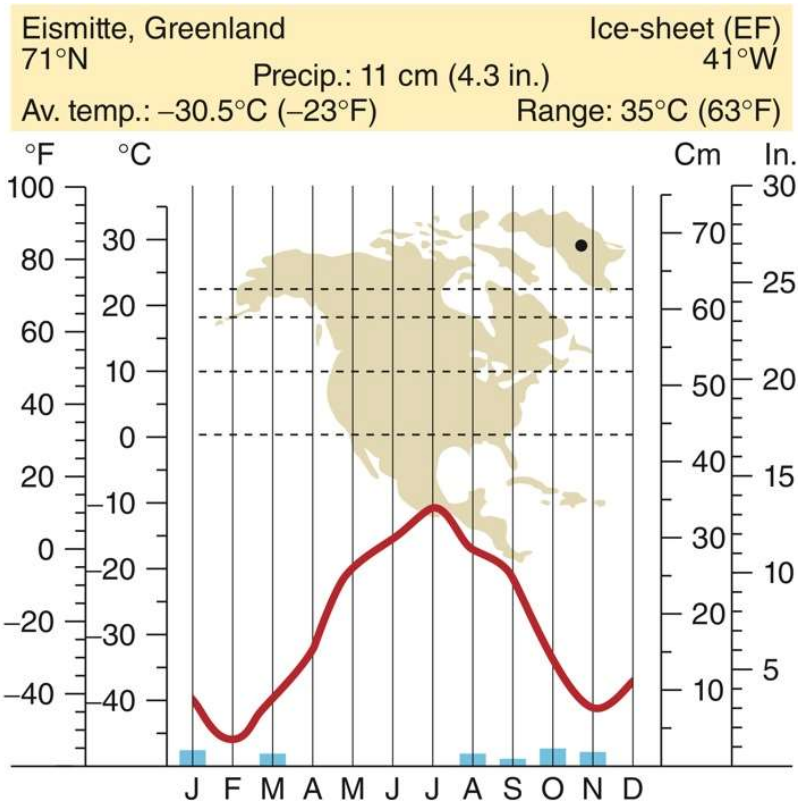


Why is it not surprising that both stations are located in the Northern Hemisphere?

Jason Neely/Polar Field Service

What climate controls help to form a tundra landscape?





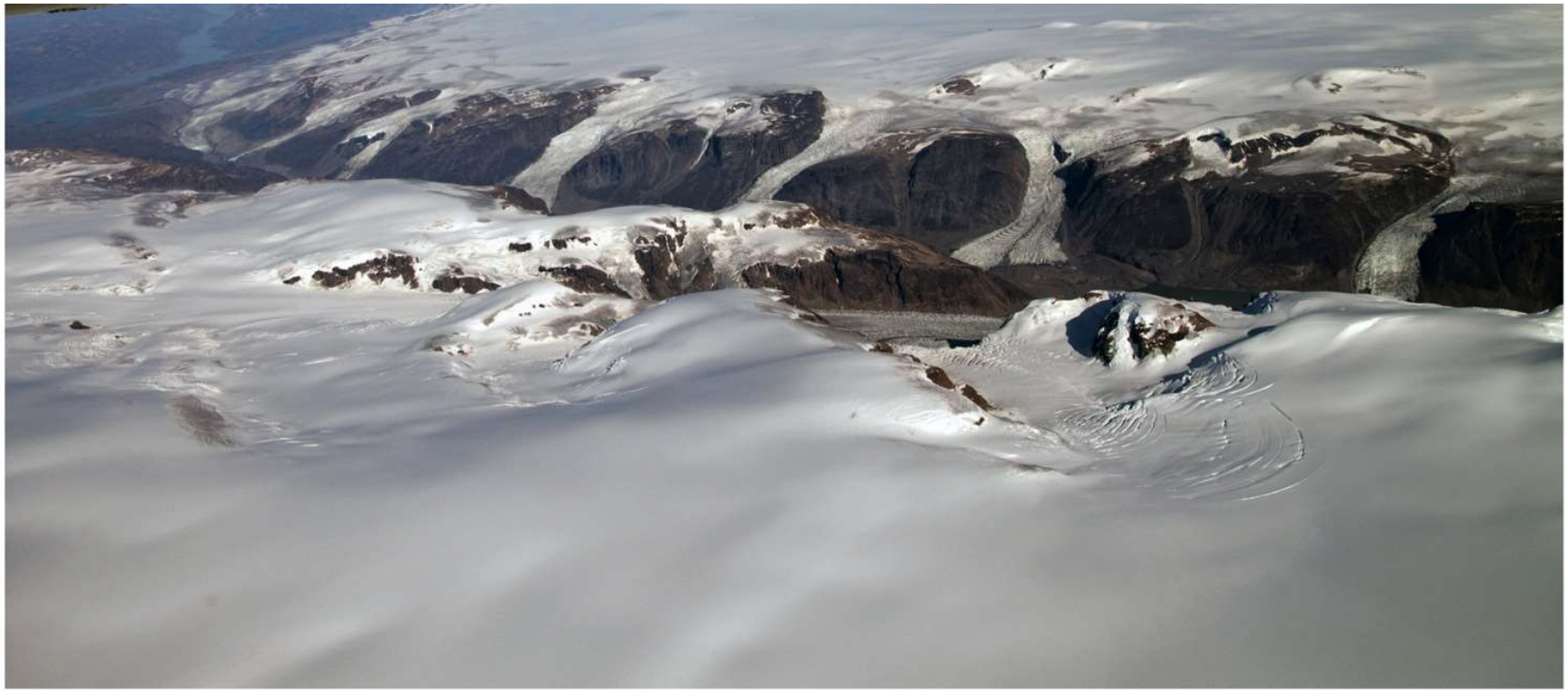
If you were offered an all expense-paid trip to either Greenland or Antarctica, which would you choose, and why?

Polar Climate Regions (cont'd.)

- Human activity in polar regions
  - Limited animal life and human settlement
  - Tundra region: workers depend on other regions for support; often inhabit only temporarily
  - Ice-sheet climate: cannot serve as a home for humans or other animals

Dave Houseknecht/US Geological Survey

Considering the vulnerability of Alaska's physical environment, should development of the North Slope oil fields have been permitted?



Courtesy of Dan Satterfield

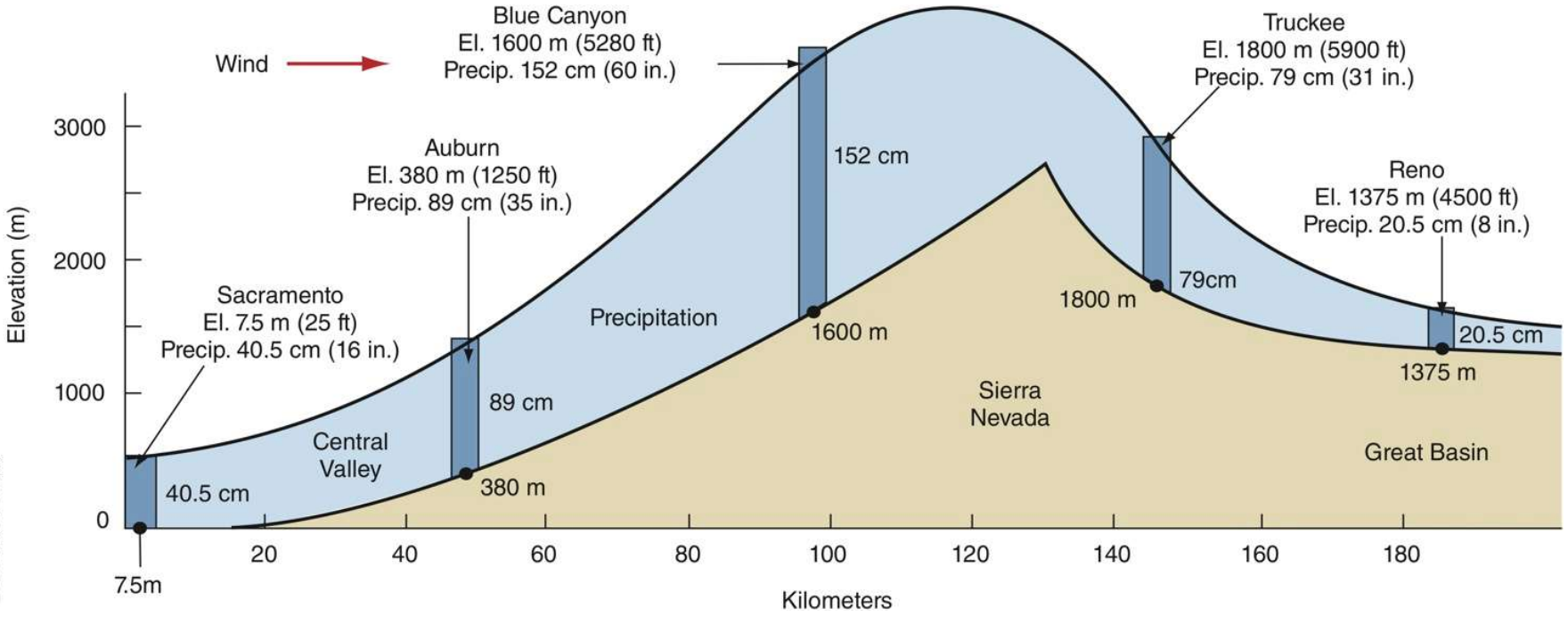
What kind of activities might bring individuals from other regions to an ice-sheet climate?

Highland Climate Regions

- Exhibit vertical zones of climate based on changes in temperature with elevation
  - Seasons only exist if also present in nearby lowland regions
- How does exposure affect highland climates?
  - Slope aspect: west-facing and east-facing slopes

NPS/Great Basin National Park

In what ways might high latitudes be similar to high elevations?



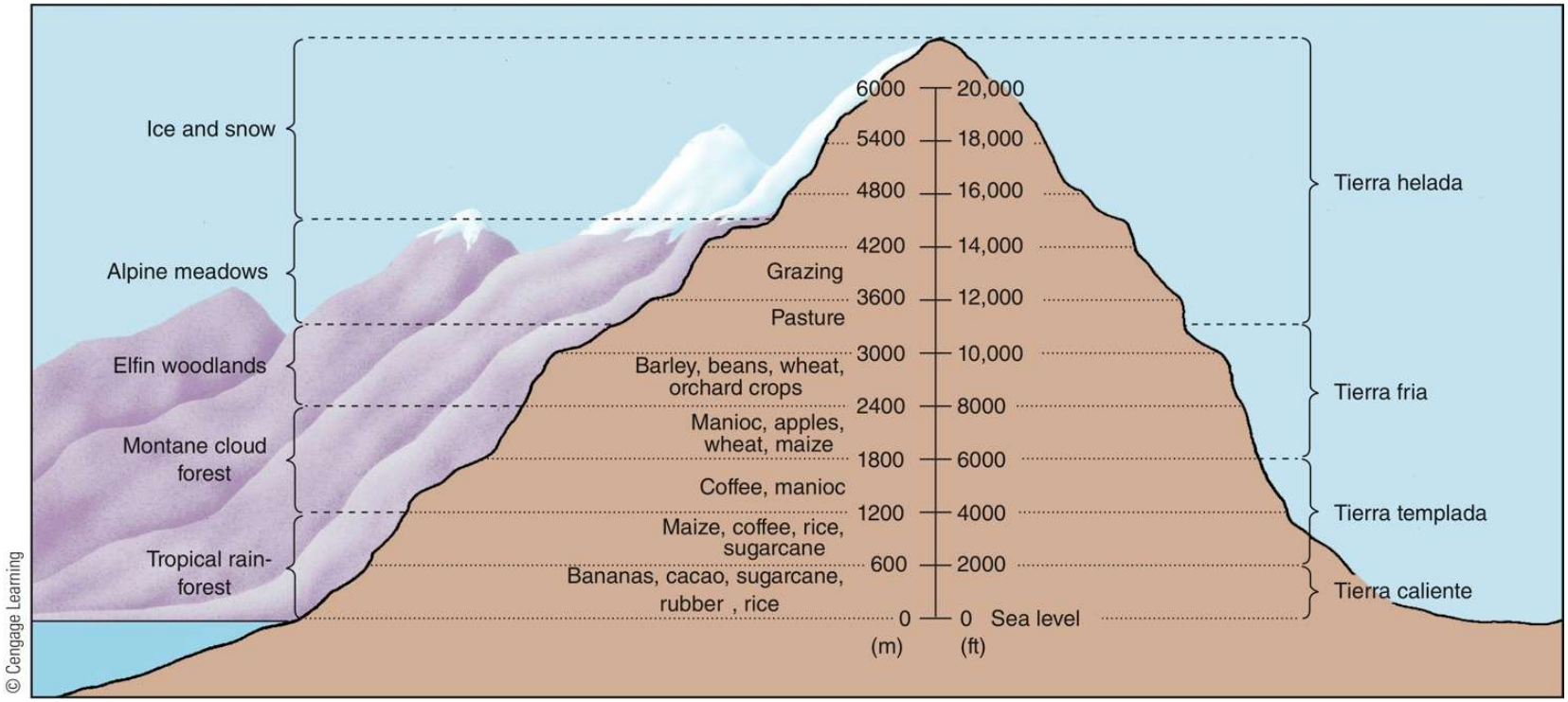
Given the locations of the recording stations shown here, during what season does the maximum precipitation on the windward slope occur?

Highland Climate Regions (cont'd.)

- The nature of mountain climates
  - High variability from hour to hour as well as place to place
  - Tree line: only forms of vegetation are those that grow low to the ground
  - Equilibrium line: some preceding winter's snowfall remains through summer

R. Gabler

What do you see in the photograph that indicates the prevailing wind direction?



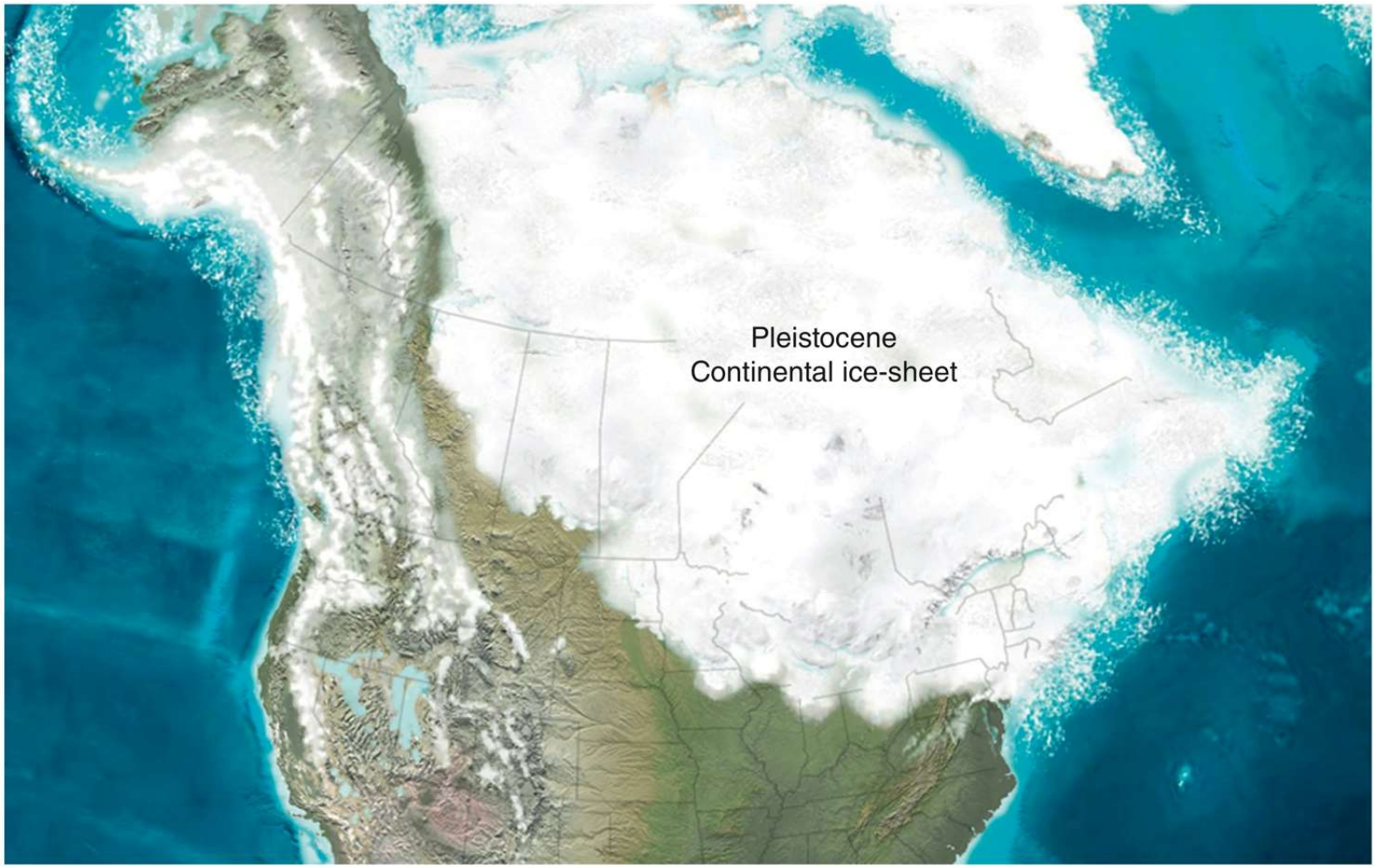
When Europeans first settled in the highlands of tropical South America, in which vertical climate zone did they prefer to live?

Highland Climate Regions (cont'd.)

- Adaptation to highland climates
  - Transhumance: seasonal movement of herds and herders between alpine pastures and villages in the valleys
  - Middle-latitude highlands: primarily sources of timber and minerals and areas for recreation
  - Tropical highlands: greater human settlement

Climate Change

- Global warming: recent and ongoing rise in Earth's average atmospheric temperatures
- Past climates: Ice Ages
- The recent Ice Age: the Pleistocene
  - Began about 2.6 million years ago and ended 12,000 years ago
  - Glaciations: periods of glacial advance
  - Interglacials: times of glacial retreat



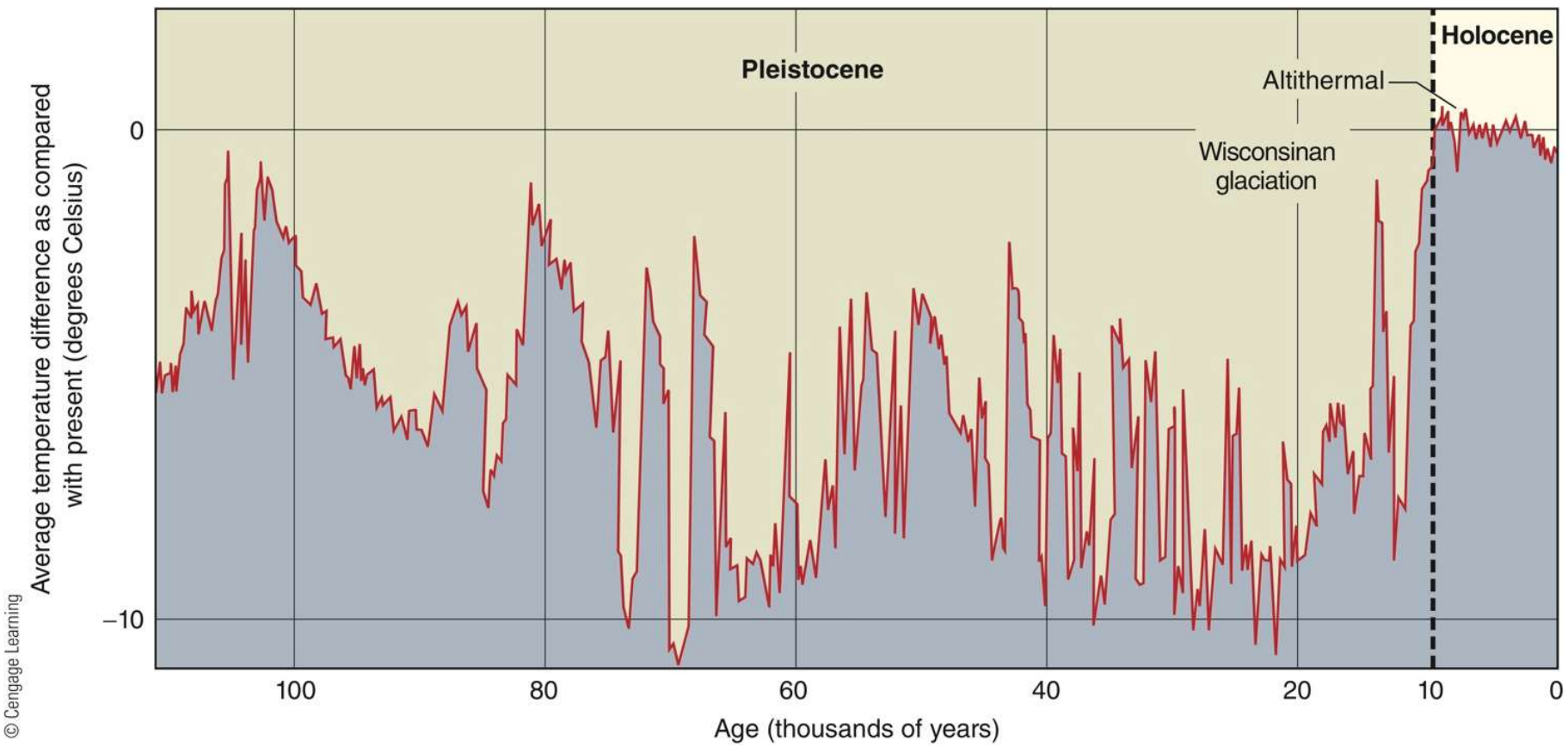
Why did the sea level drop enough for people to cross from Asia to North America on foot?

Climate Change (cont'd.)

- Methods for revealing past climates
  - Radiocarbon dating of organic materials in glacial deposits
  - Detailed evidence within sediments deposited on the ocean floor
  - Oxygen-isotope analysis: relation of ratios of ^{18}O and ^{16}O to ocean temperatures

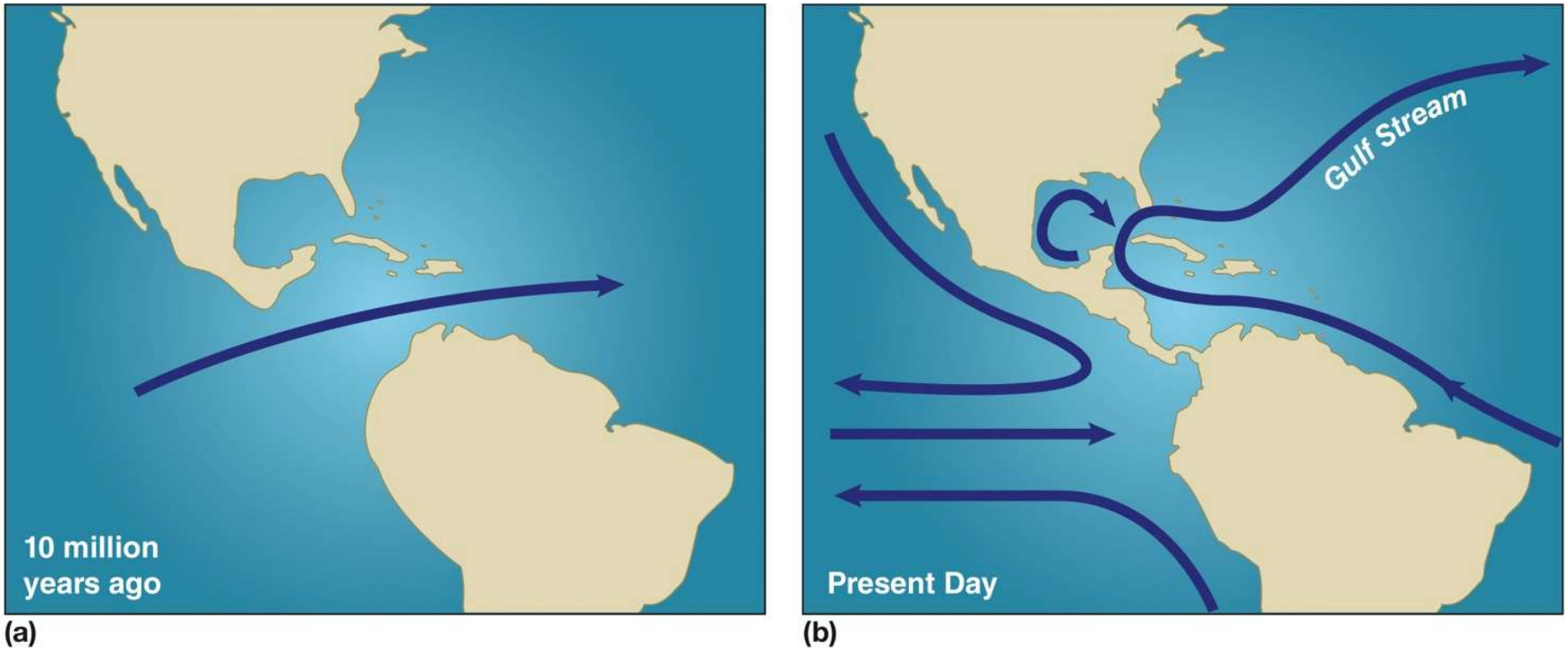
Climate Change

- Study of glacial ice cores: Antarctica and Greenland
  - Yearly snowfall accumulations in ice layers that can provide short-term evidence of climate changes



Climate Change (cont'd.)

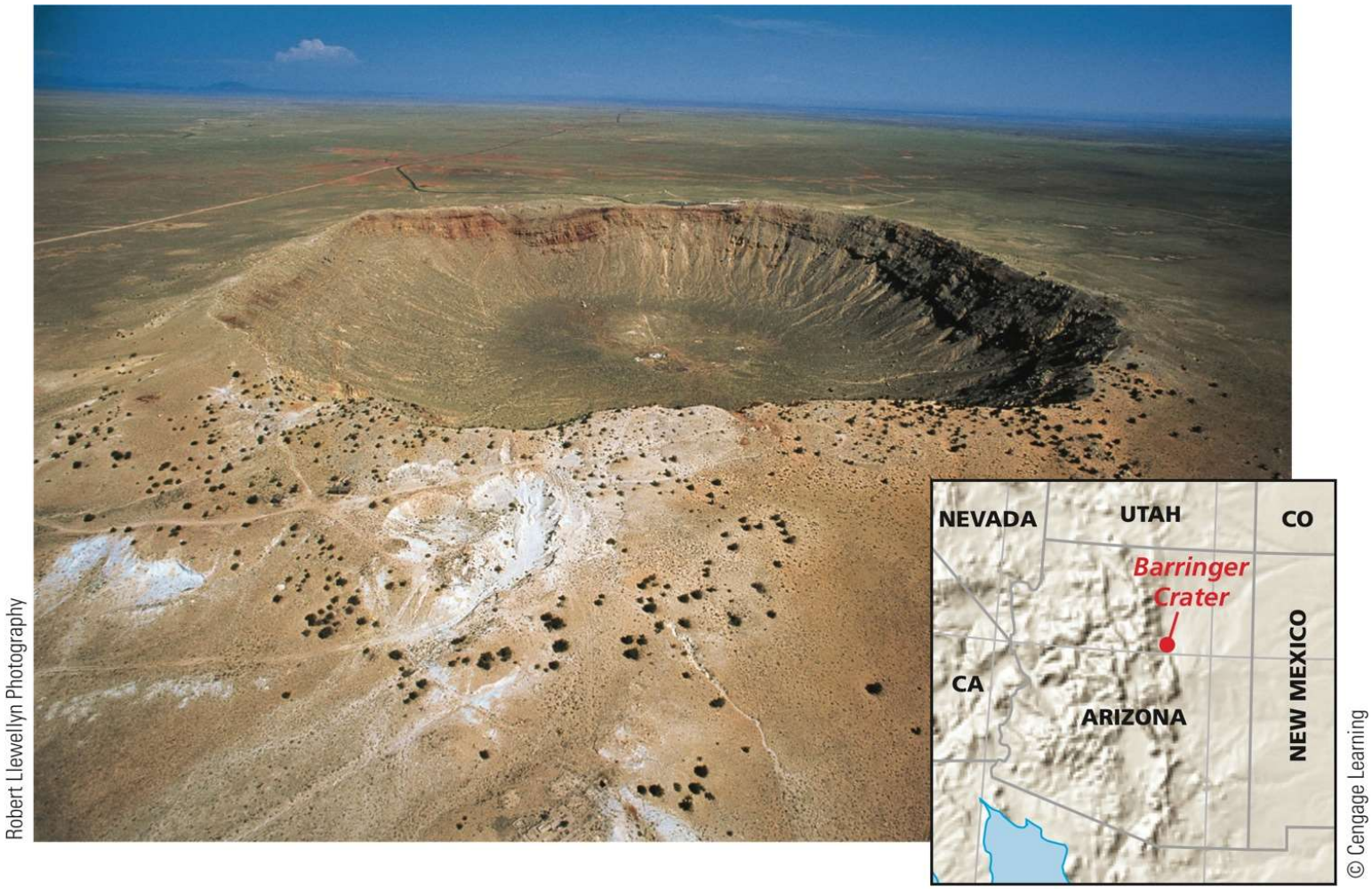
- Causes of climate change
  - Astronomical variations in Earth's orbit
    - Milankovitch theory or astronomical theory: eccentricity cycle, obliquity cycle, and precession cycle
    - Refer to Figure 8.20: What effect should these changes in receipt of insolation have on global climates?
  - Changes in oceanic circulation
    - Affected by variations in water buoyancy caused by salinity differences



How do ocean currents along east and west coasts outside the tropics affect climate?

Climate Change (cont'd.)

- Causes of climate change
  - Changes in the distribution of landmasses
    - Presence of a continent in polar latitudes
    - Formation, disappearance, or movement of a landmass: alters oceanic circulation, atmospheric circulation, or the composition of the atmosphere
    - Albedo changes
  - Impact events: asteroids, meteoroids, and comets



Robert Llewellyn Photography

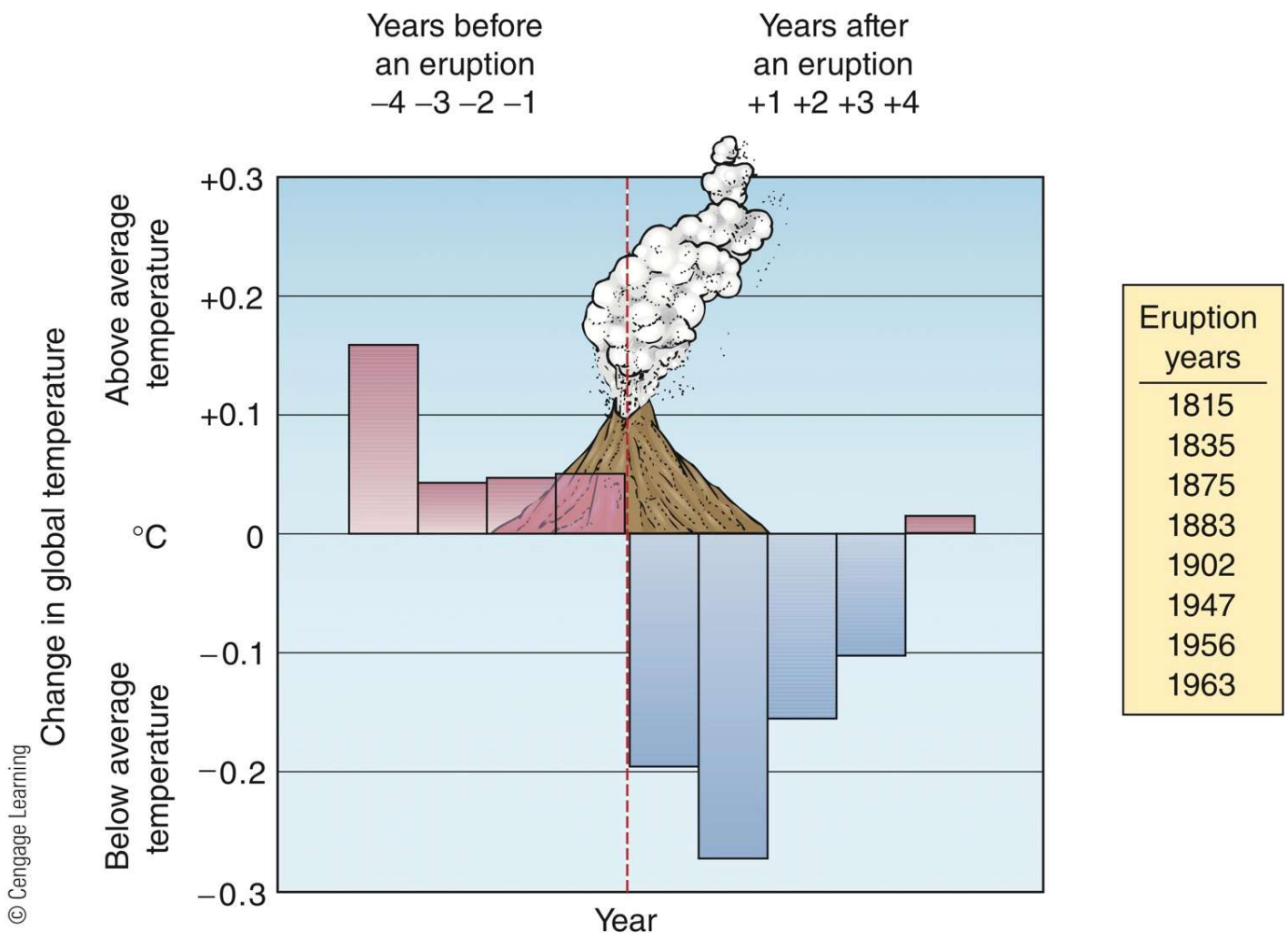
Can you conceive of the damage that would occur if a similar meteorite impacted an urban area?

Climate Change (cont'd.)

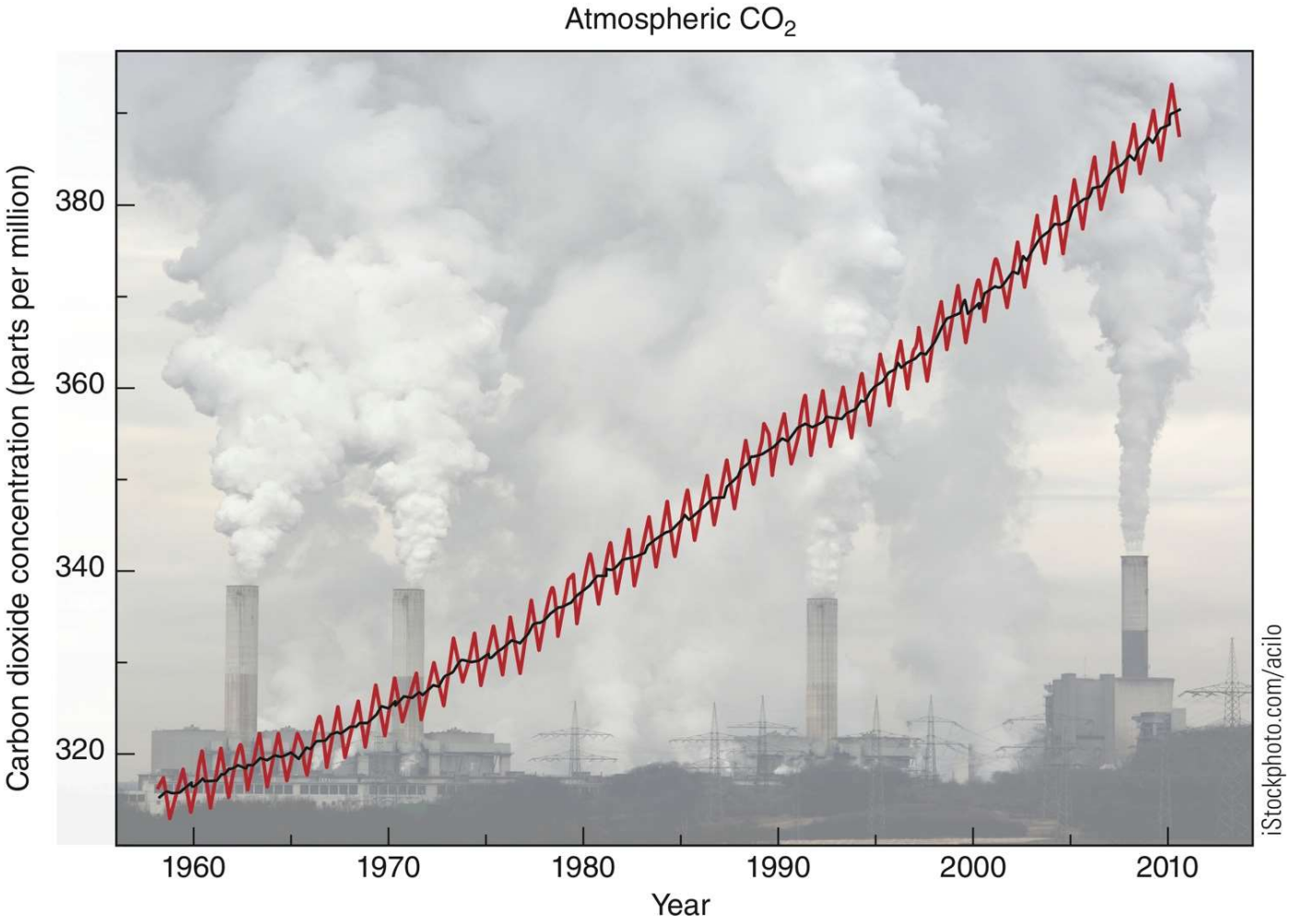
- Causes of climate change
  - Changes in the atmosphere
    - Volcanic activity
  - Atmospheric gases
    - Greenhouse gases: carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), and nitrous oxide (N_2O)

In addition to affecting the climate, what other hazards result from volcanic explosions?

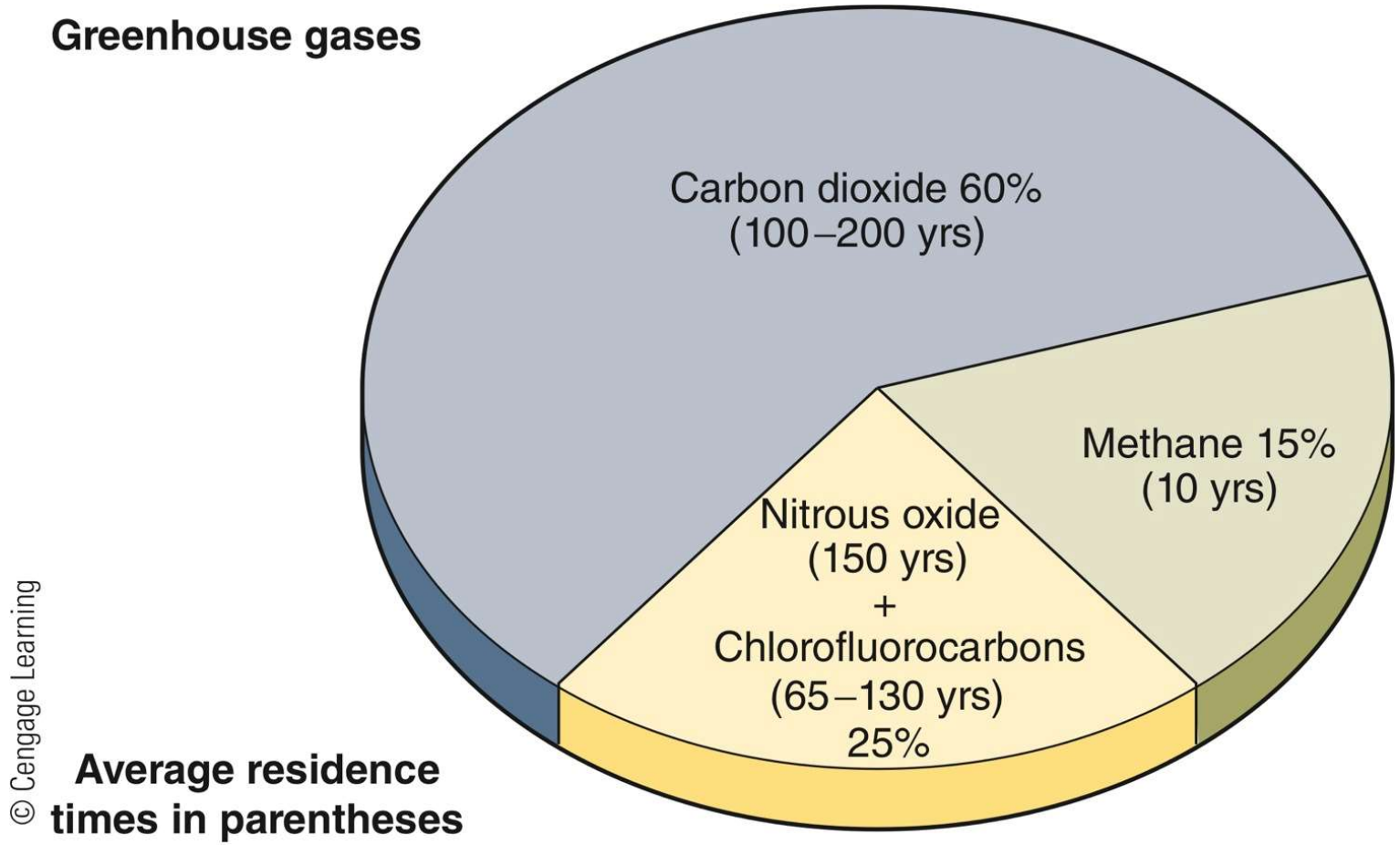
USGS/Richard P. Moblitt



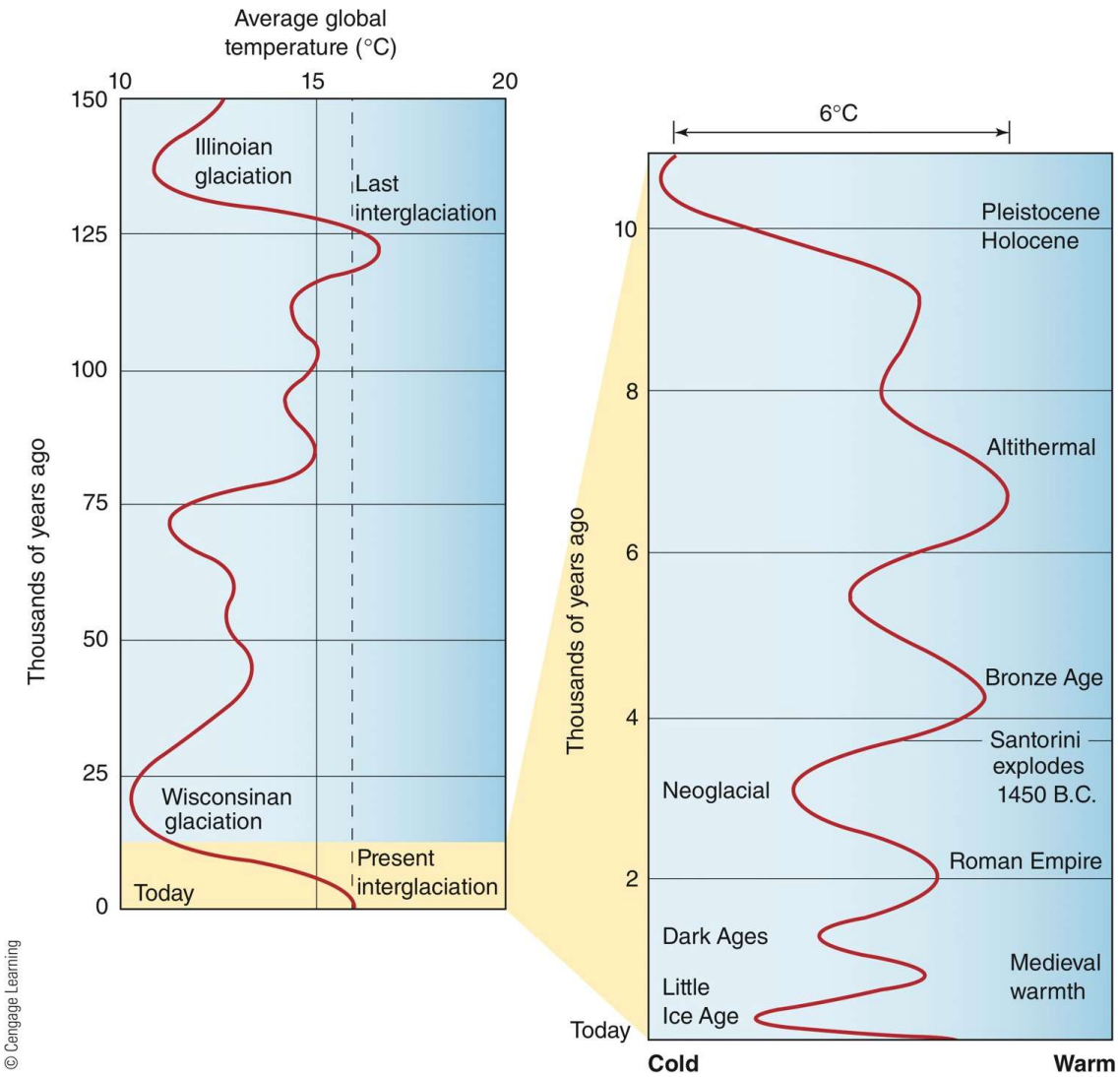
At what period after an eruption year does the effect seem the greatest?



What can you do personally to help reduce the amount of greenhouse gases going into the atmosphere?



Which gas has the longest residence time?



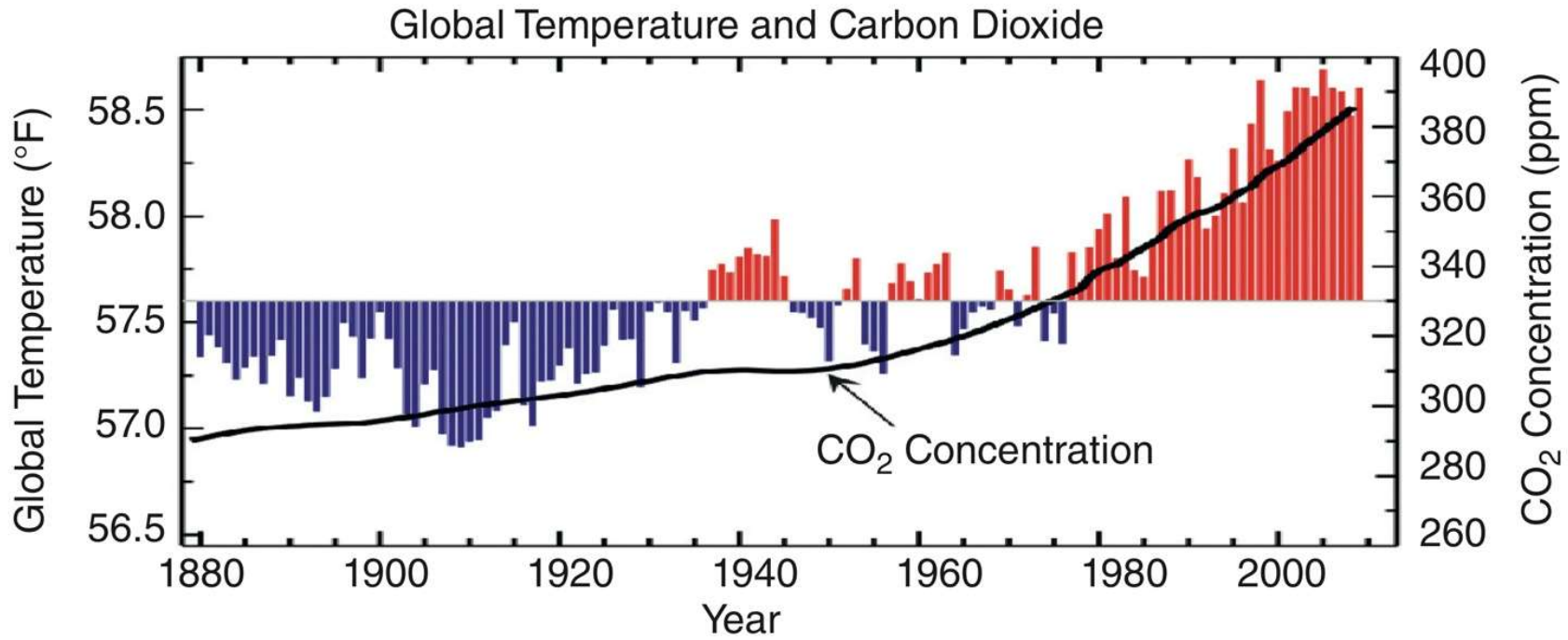
What is some of the evidence for past climates that can be studied directly?

Climate Change (cont'd.)

- Climate change and its impact on coastlines
  - More glacial ice: sea level falls
  - Warming tendency of world climates: sea level rises
    - Concerns for low-lying coastal areas
  - World map coastlines: shift over time

Global Warming

- Unusual increase in the rate of rising global temperatures
  - Attributed to expanding industrialization and growing emissions of greenhouse gases
  - Controversy: extent caused by natural processes vs. anthropogenic (human-induced) activities
  - Intergovernmental Panel on Climate Change (IPCC): global warming reports



Global Warming (cont'd.)

- Refer to Figure 8.29:
  - On what continent has the observed temperature fluctuated the most during this time period, and which one the least?
- Future climates
  - Global climate models (GCMs): predict warming of 1°C to 3.5°C (2°F to 6°F) in the 21st century

Bruce Molnia, U.S. Geological Survey

In what ways do melting glaciers become a problem?

Global Warming (cont'd.)

- Recommendations for the future – on a personal scale
  - Use carpools and mass transportation, drive smaller cars, and drive less often and at reduced speed
  - Use more energy-efficient lighting and appliances and turn them off when they are not in use

Global Warming (cont'd.)

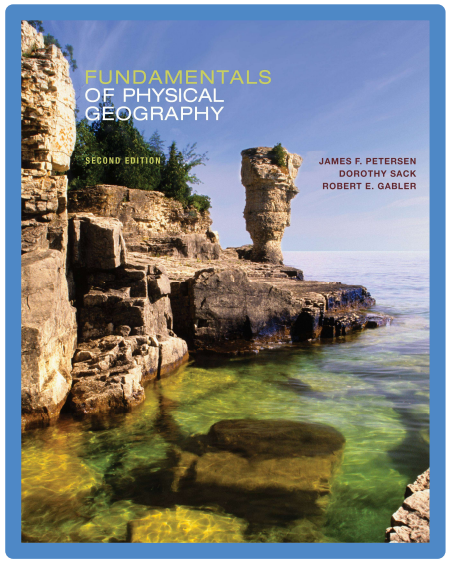
- Recommendations for the future – on a personal scale
  - Set thermostats to use less energy to cool your home in summer and warm it in the winter
  - Recycle materials (metals, glass, plastic, paper, etc.)
  - Consciously protect your own physical environment

Fundamentals of Physical Geography 2e

Microthermal, Polar, and Highland Climate Regions: Climate Change

8

<end of chapter>



- Peterson
  - Sack
    - Gabler