Lecture Outlines
PowerPoint

Chapter 20

Earth Science 11e

Tarbuck/Lutgens

Earth Science, 11e

Climate
Chapter 20

The climate system

- Climate is an aggregate of weather
- Involves the exchanges of energy and moisture that occur among the
  - Atmosphere
  - Hydrosphere
  - Solid Earth
  - Biosphere, and
  - Cryosphere (ice and snow)

World climates

- Every location has a distinctive climate
- The most important elements in a climatic description are
  - Temperature, and
  - Precipitation

Climate classification

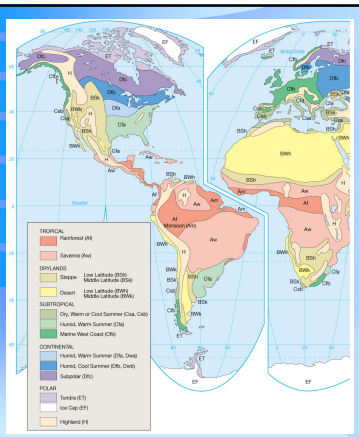
- Brings order to large quantities of information
- Many climatic-classification systems have been devised
- Köppen classification of climates
  - Best known and most used system
  - Uses mean monthly and annual values of temperature and precipitation

Climate classification

- Köppen classification of climates
  - Divides the world into climatic regions in a realistic way
  - Boundaries Köppen chose were largely based on the limits of certain plant associations
  - Five principal climate groups
    - Humid tropical (A)
    - Dry (B)
    - Humid middle-latitude with mild winters (C)

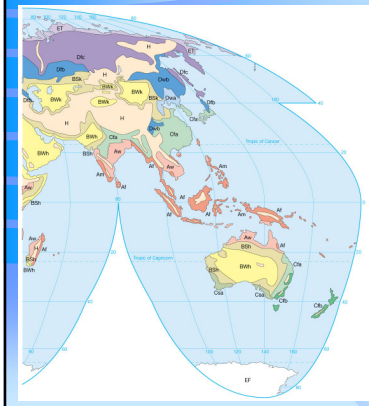
Climate classification

- Köppen classification of climates
  - Five principal climate groups
    - Humid middle-latitude with severe winters (D)
    - Polar (E)
  - A, C, D, and E climates are defined on the basis of temperature characteristics
  - Precipitation is the primary criterion for the B group



Climates of the world based on the Köppen classification

Figure 20.2



Climates of the world based on the Köppen classification (continued)

Figure 20.2

Köppen climates

- Humid tropical (A) climates
  - Winterless climates, with all months having a mean temperature above 18ºC
  - Two main types
    - Wet tropics
      - High temperatures and year-round rainfall
      - Luxuriant vegetation (tropical rain forest)
      - Discontinuous belt astride the equator
      - Strongly influenced by the equatorial low pressures

Köppen climates

- Humid tropical (A) climates
  - Two main types
    - Tropical wet and dry
      - Poleward of wet tropics and equatorward of the tropical deserts
      - Tropical grassland (savanna)
      - Seasonal rainfall

Comparison of A-type climates

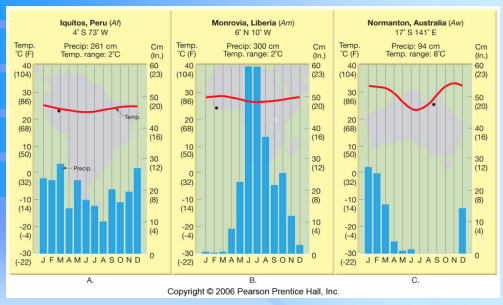


Figure 20.4

Köppen climates

- Dry (B) climates
  - Evaporation exceeds precipitation and there is a constant water deficiency
  - Boundary determined by formulas involving the three variables
    - Average annual precipitation
    - Average annual temperature
    - Seasonal distribution of precipitation

Köppen climates

- Dry (B) climates
  - Two climatic types
    - Arid or desert (BW)
    - Semiarid or steppe (BS)
      - More humid than arid climate
      - Surrounds desert
  - Causes of deserts and steppes
    - In the low latitudes
      - e.g., North Africa to northwestern India, northern Mexico, southwestern U.S.

Arid and semiarid climates of the world

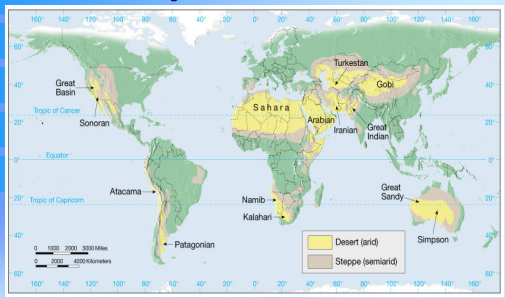


Figure 20.6

Köppen climates

- Dry (B) climates
  - Causes of deserts and steppes
    - In the low latitudes
      - Coincide with the dry, stable, subsiding air of the sub-tropical high-pressure belts
    - Middle-latitude deserts and steppes
      - Due to their position in the deep interiors of large landmasses and/or the presence of high mountains
      - Most are located in the Northern Hemisphere

Comparison of B-type climates

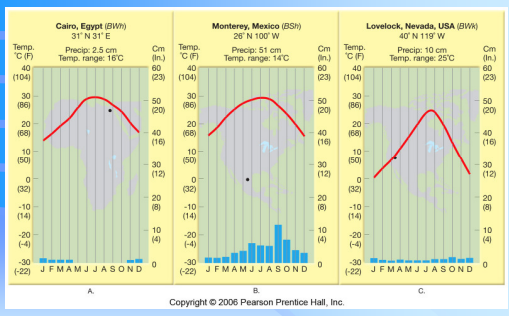


Figure 20.7

Köppen climates

- Humid middle-latitude climates with mild winters (C climates)
  - Average temperature of the coldest month is below 18˚C but above -3˚C
  - Subgroups
    - Humid subtropics
      - Eastern sides of continents
      - 25 to 40 degree latitude range
      - Hot, sultry summers
      - Mild winters
      - Winter precipitation is generated along fronts

Köppen climates

- ❖Humid middle-latitude climates with mild winters (C climates)
  - Subgroups
    - Marine west coast
      - Western (windward) side of continents
      - 40 to 65 degrees north and south latitude
      - Onshore flow of ocean air
      - Mild winters and cool summers

Köppen climates

- ❖Humid middle-latitude climates with mild winters (C climates)
  - Subgroups
    - Dry-summer subtropics
      - West sides of continents between latitudes 30 and 45˚
      - Strong winter rainfall maximum
      - Often called a Mediterranean climate

Comparison of C-type climates

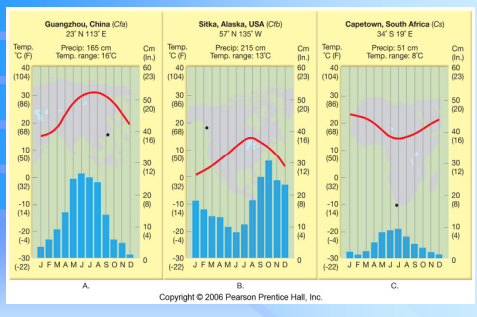


Figure 20.8

Köppen climates

- ❖Humid middle-latitude climates with severe winters (D climates)
  - Average temperature of the coldest month is below -3˚C and the warmest monthly mean exceeds 10˚C
  - Land-controlled climates
  - Absent in the Southern Hemisphere

Köppen climates

- ❖Humid middle-latitude climates with severe winters (D climates)
  - Subgroups
    - Humid continental
      - Confined to the central and eastern portions of North America and Eurasia between 40 and 50 degrees north latitude
      - Severe winter and summer temperatures
      - High annual temperature ranges
      - Precipitation is generally greater in the summer than in the winter
      - Snow remains on the ground for extended periods

Köppen climates

- ❖Humid middle-latitude climates with severe winters (D climates)
  - Subgroups
    - Subarctic
      - North of the humid continental climate
      - Often referred to as the taiga climate
      - Largest stretch of continuous forests on Earth
      - Source regions of cP air masses
      - Frigid winters, remarkably warm but short summers

Comparison of D-type climates

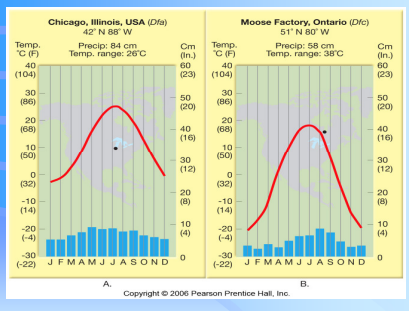


Figure 20.9

Köppen climates

- Polar (E) climates
  - Mean temperature of the warmest month is below 10ºC
  - Enduring cold
  - Meager precipitation
  - Two types of polar climates
    - Tundra climate (ET)
      - Treeless climate
      - Almost exclusively in the Northern Hemisphere
      - Severe winters, cool summers
      - High annual temperature range

Köppen climates

- Polar (E) climates
  - Two types of polar climates
    - Ice cap climate (EF)
      - No monthly mean above 0ºC
      - Permanent ice and snow
- Highland climates
  - Usually cooler and wetter than adjacent lowlands
  - Great diversity of climatic conditions
  - Best described by the terms *variety* and *changeability*

Comparison of E-type climates

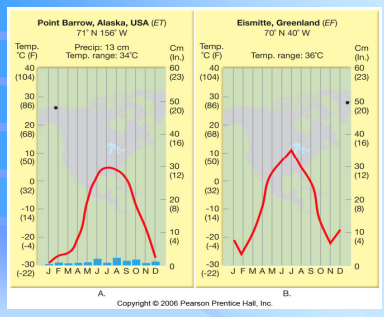


Figure 20.12

Human impact on global climate

- Humans have been modifying the environment over extensive areas for thousands of years
  - By using fire
  - By overgrazing of marginal lands
- Most hypotheses of climatic change are to some degree controversial

Human impact on global climate

- Global warming
  - Water vapor and carbon dioxide absorb heat and are largely responsible for the greenhouse effect of the atmosphere
  - Burning fossil fuels has added great quantities of carbon dioxide to the atmosphere

Energy consumption in the United States, 2001

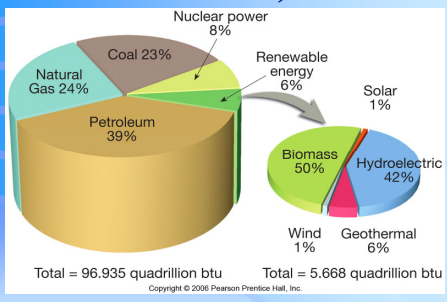


Figure 20.15

Human impact on global climate

- The atmosphere response
  - Global temperatures have increased
    - Balance of evidence suggests a human influence on global climate
    - Globally averaged surface temperature is projected to increase by 1.4 to 5.8ºC by the year 2100
  - The role of trace gases
    - Atmospheric trace gasses
      - Methane
      - Nitrous oxide
      - Certain chlorofluorocarbons

Annual average global temperatures variations for the period 1860-2001

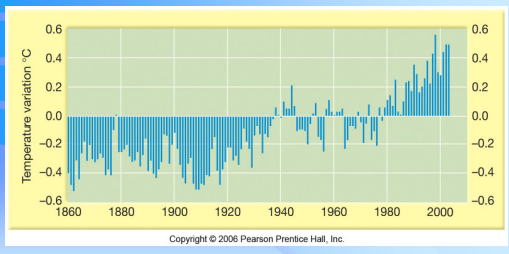


Figure 20.17

Human impact on global climate

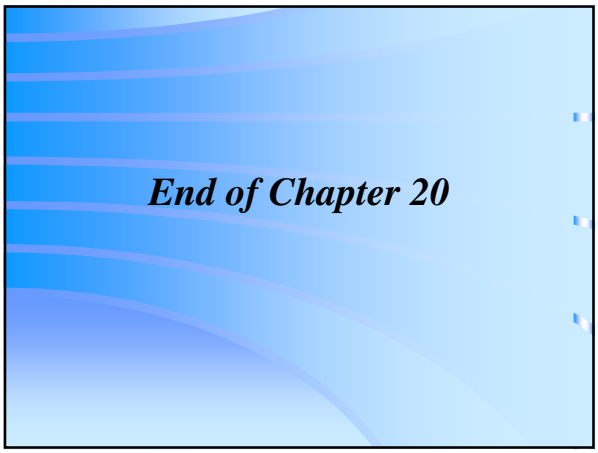
- The atmosphere response
  - The role of trace gases
    - Absorb wavelengths of outgoing Earth radiation
    - Taken together, their warming effects may be nearly as great as carbon dioxide

Climate feed-back mechanisms

- Possible outcomes of altering the climate-system
- Two types
  - Positive -feedback mechanisms reinforce the initial change
  - Negative-feedback mechanisms produce results that are just the opposite of the initial change and tend to offset it

Some possible consequences of global warming

- Altered distribution of the world's water resources and the affect on the productivity of agricultural regions
- Rise in global mean sea level
- Changing weather patterns
  - Higher frequency and intensity of hurricanes
  - Shifts in the paths of large-scale cyclonic storms
  - Changes in frequency and intensity of heat waves and droughts


End of Chapter 20