## **Temperature Variation in Atmosphere**

#### LECTURE -3

## Thermal structure of the atmosphere



Copyright © 2006 Pearson Prentice Hall, Inc.

#### **Atmospheric Vertical Structure**

#### **Standard Atmosphere:**

• Mesosphere is the region where auroras are sometimes observed







**Fig. 1.9** Vertical temperature distribution in the earth's atmosphere with emphasis on the thermosphere. (After P. M. Banks and G. Kockarts, "Aeronomy," Academic Press, New York, 1973, Part A, p. 3.)

## Average distribution of incoming solar radiation



Copyright © 2006 Pearson Prentice Hall, Inc.

## Insulation and the Atmosphere

• Incoming solar radiation is called insulation

Earth receives only two-billionths of the suns rays

- Of 100 units of suns energy 30 reflected back into space, 19 Absorbed by the atmosphere, 51 absorbed by Earth's surface
- Unequal insulation caused temperature differences

## Local Temperature Variations

 Caused by insulation (energy) heats Earth's surface and atmosphere unequally

## Intensity of Insulation

- The angle at which the suns rays strike the earth, the more overhead (90°) the more energy.
- Time of day Suns rays are closest to vertical at noon. However, the highest temperature occur later in the day because of time needed for the surface to create heat using the insulation.
- Latitude and equator 90° more insulation where as high latitude sun rays strike at more of an angle less insulation

- <u>Time of year mid latitude locations have</u> <u>higher temperatures in summer because the</u> <u>rays are more direct than in winter</u>
  - Year's maximum insulation occurs in June but max temperate are in July, weakest sunlight in December but lowest temps are in January
- Cloud Cover more insulation on clear days because clouds reflect sunlight. However, they hold the heat in at night.

## Heating of Water and Land

- Water and land warm up and cool off at different rates. Water warms more slowly than land and cools more slowly.
  - Suns energy penetrates water deeper spreading it out
  - Some energy is used in evaporation
  - Water has a higher specific heat
- Different hard surfaces absorb radiation differently
  - light colored surfaces absorbs less than dark
    - e.g. blacktop gets warmer than grass

## Controls of temperature

Temperature variations

## Receipt of solar radiation is the most important control

### Differential heating of land and water

- Land heats more rapidly than water
- Land gets hotter than water
- Land cools faster than water
- Land gets cooler than water

## Controls of temperature

### Other important controls

- Altitude
- Geographic position
- Cloud cover
- Albedo





Clouds reduce the daily temperature range

Copyright © 2006 Pearson Prentice Hall, Inc.

В.

Conduction- transfer of heat through matter by molecular activity. Fast moving molecules transfer by speeding up the slugs.

Insulators- poor conductors. Air is a good insulator, therefore conductive heat transfer is not considered significant in meteorology. Most commercial insulators are made up of a substance with lots of small bubbles of trapped air.

Convection- transfer of heat by mass movement within a substance. This can only take place in fluids where the atoms and molecules are free to move about (boiling water). Because air is a poor conductor and poor radiator, most of the energy transfer is the result of convective transfer.

Convective circulation- turnover of the atmosphere because of relative density.

Example- boiling water is one of the best examples.

Advection- horizontal component of convective flow, also known as wind.

Example- go outside without a coat.

## World distribution of temperature

Temperature maps

- Isotherm a line connecting places of equal temperature
- Temperatures are adjusted to sea level
- January and July are used for analysis because they represent the temperature extremes

## World distribution of temperature

#### Global temperature patterns

- Temperature decreases poleward from the tropics
- Isotherms exhibit a latitudinal shift with the seasons
- Warmest and coldest temperatures occur over land

## World distribution of temperature

#### Global temperature patterns

- In the Southern Hemisphere
  - Isotherms are straighter
  - Isotherms are more stable
- Isotherms show ocean currents
- Annual temperature range
  - Small near equator
  - Increases with an increase in latitude
  - Greatest over continental locations

## World mean sea-level temperatures in January



## World mean sea-level temperatures in July



# Annual average global temperatures variations for the period 1860-2001



Copyright © 2006 Pearson Prentice Hall, Inc.

## 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 5.8°C by the year 2100
- The role of gases
  - Atmospheric gasses
    - Water vapor and
    - carbon dioxide
    - Methane
    - Nitrous oxide
    - Certain chlorofluorocarbons.

# 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

#### Atmospheric general circulation and climate

