Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic.
It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>

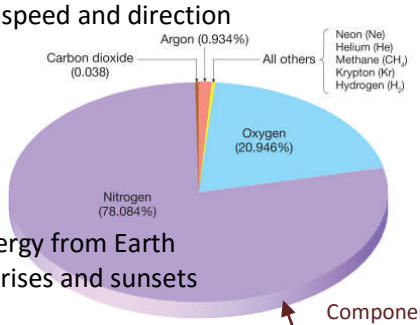
Earth's Atmosphere

I. Weather and climate

A. **Weather** - is what you see outside the window today
B. **Climate** - what you expect to see outside on any day based on records of past weather
C. Elements of weather and climate are the properties regularly measured including:
temperature; humidity; cloudiness; precipitation; air pressure; wind speed and direction

II. Composition of the atmosphere

A. Air is a mixture of gases
B. Major components of clean, dry air include:
Nitrogen (N_2) - 78%; Oxygen (O_2) - 21%; Argon and other gases < 1%
C. Variable components of air include:
1. **Water vapor** – up to 4% of the air's volume, forms clouds, absorbs heat energy from Earth
2. **Aerosols** - tiny solid and liquid particles, reflects sunlight, gives color to sunrises and sunsets
3. **Ozone** – molecules composed of three atoms of oxygen (O_3)…
concentrated between 10 and 50 km above the surface where it absorbs harmful UV radiation

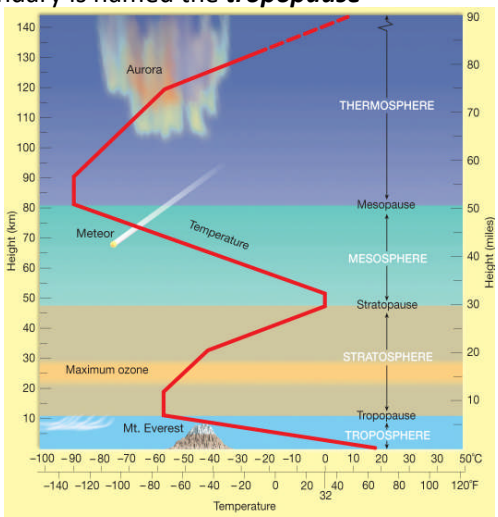


Components of Earth's atmosphere

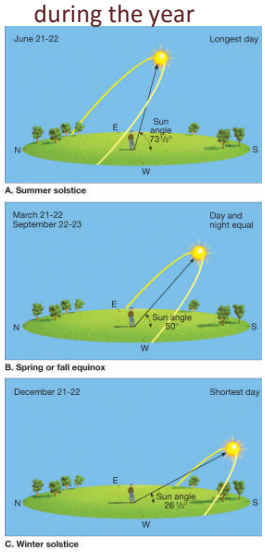
III. Structure of the atmosphere

A. Pressure changes - atmospheric pressure is the weight of the air above…
average sea level pressure is slightly more than 1000 millibars (≈14.7psi), and decreases with altitude
B. Atmospheric layers based on temperature include:
1. **Troposphere** – the bottom layer *(at Earth's surface)*
a. T° decreases with altitude (***environmental lapse rate***) at 6.5°C per km *(3.5°F per 1000 ft)*
b. Thickness varies—avg height is about 12 km, the upper boundary is named the ***tropopause***
2. **Stratosphere** – layer above the troposphere
a. About 12 km to 50 km above Earth's surface
b. T° increases with altitude
c. Outer boundary is named the ***stratopause***
3. **Mesosphere** – layer above the stratosphere
a. About 50 km to 80 km above Earth's surface
b. T° decreases with altitude
c. Outer boundary is named the ***mesopause***
4. **Thermosphere** – layer above the mesosphere
a. Just a small fraction of the atmosphere's mass with no well-defined upper limit
b. T° increases with altitude due to gas atoms moving at high speeds (*it would not 'feel' hot)*

Atmospheric layers by temperature →



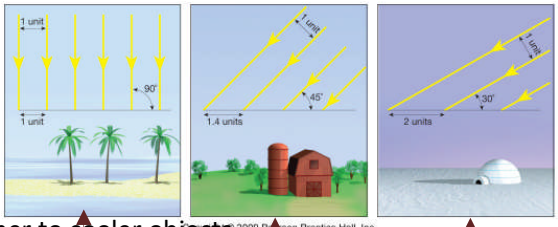
Sun's changing overhead position during the year



IV. Earth–Sun relations

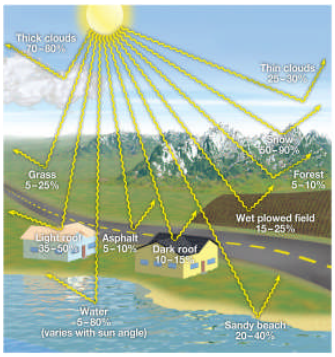
A. Earth's motions include rotating on its axis, and revolving around the Sun
B. Seasons - result of changing Sun angle and the resultant changing length of daylight
1. Caused by Earth's changing orientation to the Sun as it revolves around the Sun – the result of Earth's axis being inclined 23½° while maintaining *(in the short term)* its 'stellar' orientation
2. Special days *(in Northern Hemisphere)*
a. **Summer solstice** – 1st day of summer, June 21–22…
Sun's vertical rays are located at the Tropic of Cancer (23½°N latitude)
b. **Winter solstice** – 1st day of winter, December 21–22…
Sun's vertical rays are located at the Tropic of Capricorn (23½°S latitude)

c. **Autumnal equinox** – 1st day of fall, September 22–23…
Sun's vertical rays are located at the equator (0° latitude)
d. **Spring equinox** – 1st day of spring, March 21–22…
Sun's vertical rays are located at the equator (0° latitude)



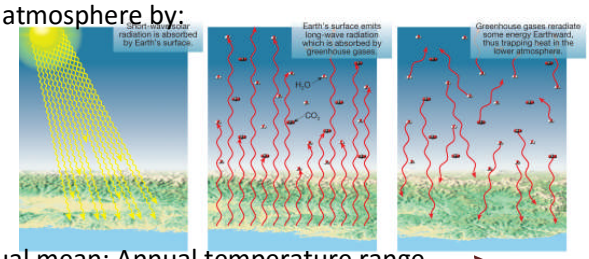
Low latitudes — Middle latitudes — High latitudes

V. Atmospheric heating - heat energy is always transferred from warmer to cooler objects
A. Mechanisms of heat transfer
1. **Conduction** - through molecular activity *(physical contact)*
2. **Convection** - mass movement within a substance *(a material flows)…*
Usually involves vertical motions *(convection currents)*
3. **Radiation** - electromagnetic radiation *(Velocity: 186,000 miles per second)*
a. Consists of different wavelengths including:
Gamma *(very short);* X-rays; Ultraviolet; Visible; Infrared; Microwaves; Radio *(longest)*
b. Governed by basic laws *(all objects, at whatever temperature, emit electromagnetic radiation)*
1. Hotter objects radiate more total energy per unit area than do cooler objects
2. The hotter the radiating body, the shorter the wavelength of maximum radiation
3. Objects that are good absorbers of radiation are also good emitters



The amounts of solar radiation absorbed by various objects

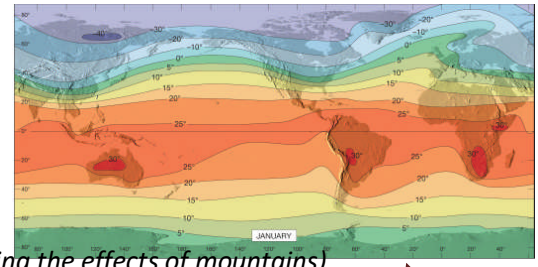
B. Incoming solar radiation to Earth
1. Atmosphere is largely 'transparent' to incoming solar radiation
2. Atmospheric effects include:
reflection/albedo *(% reflected)*; scattering; absorption
3. Most visible radiation reaches the surface, about 50% is absorbed at Earth's surface
C. Radiation emitted from Earth's surface *(back towards space)*
1. Earth re-radiates radiation *(terrestrial radiation)* but at the longer wavelengths
2. Longer-wavelength terrestrial radiation is absorbed in the atmosphere by:
carbon dioxide, water vapor, and other gases
3. The lower atmosphere is heated from Earth's surface
D. Heating of the atmosphere by Earth's radiation is termed the **'greenhouse effect'**



Radiation absorbed in the day, then re-radiated both during the day & during the night

VI. Temperature measurement
A. Daily maximum and minimum, from which can be calculated:
Daily mean temperature; Daily range; Monthly mean; Annual mean; Annual temperature range
B. Human perception of temperature is controlled by:
air temperature; relative humidity; wind speed; sunshine

VII. Controls of temperature – causes of temperature variations…
Receipt of solar radiation is the most important control. Others include:
1. Altitude; geographic position; cloud cover; albedo
2. Differential heating of land and water
a. Land heats more rapidly, and gets hotter, than water
b. Land cools faster, and gets cooler, than water



Generalized global T° patterns in January

VIII. World distribution of temperature
A. Temperature maps
1. **Isotherm**—a line connecting places of equal temperature
2. Often T° *(isotherms etc)* is adjusted to sea level *(thus ignoring the effects of mountains)*
3. January and July are used for analysis because they represent the temperature extremes
B. General global temperature patterns
1. Temperature decreases poleward from the tropics
2. Isotherms exhibit a latitudinal shift with the seasons
3. Warmest and coldest temperatures occur over land
4. In the Southern Hemisphere - Isotherms are straighter, and isotherms are more stable *(due largely to more ocean)*
5. Annual temperature range:
small near equator; increases with an increase in latitude; greatest over continental locations