

Lecture Ch. 8a

- Review of Ch. 7 Concepts
 - Homework Ch. 7, Prob. 3
- Cloud Classification
- Precipitation Processes

Curry and Webster, Ch. 8
For Tuesday: Finish reading Ch. 8

Atmospheric Structure

- Structure of the atmosphere
 - Decreasing temperature with altitude
 - Decreasing pressure with altitude
 - Change in mass layer with altitude
- Describing the atmospheric structure
 - Example: Skew-T log P plot
 - Example: Tephigram
- Temperature in meteorology
 - Potential temperature (meteorologist's concept)
 - Virtual (potential) temperature
 - Equivalent (potential) temperature

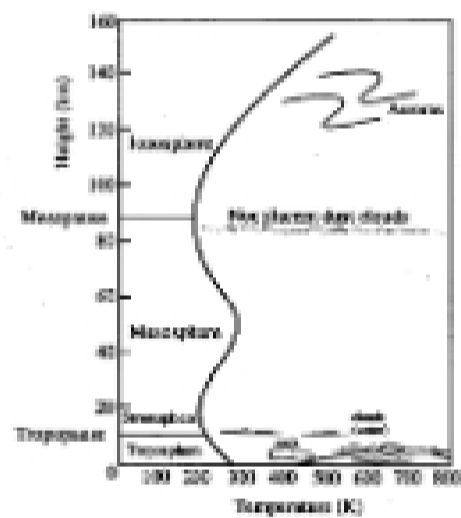


Figure 14.1 Vertical structure and features of Earth's atmosphere.

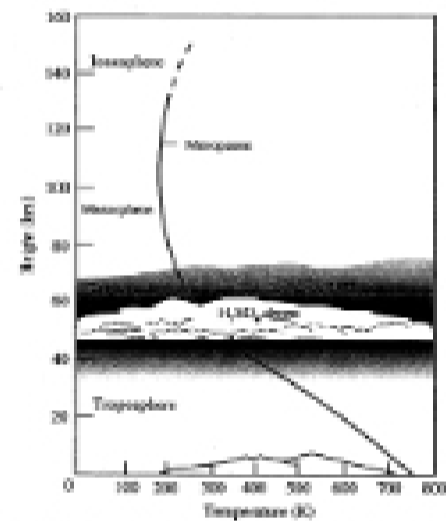


Figure 14.2 Vertical structure and features of Venus's atmosphere.

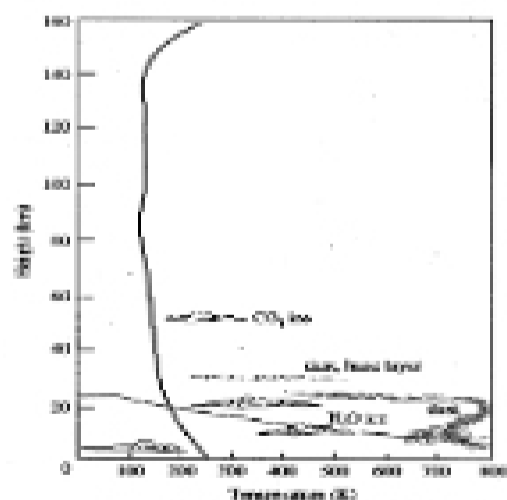


Figure 14.3 Vertical structure and features of the Martian atmosphere.

Inversions

- Inversion: A condition of strong stability characterized by a positive temperature gradient.

Subsidence Inversions

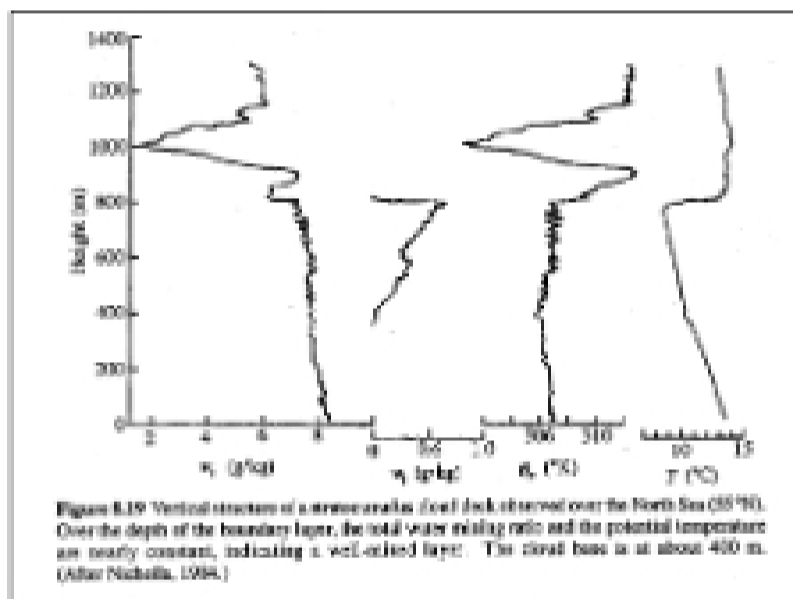
- Subsidence Inversion
 - Cause: adiabatic compression and warming of a large layer of earth as it sinks to lower altitude.
 - $dT/dP = 1/(C_p \rho)$, where C_p is essentially constant over T .

Because of a change in P with z , what can be said about p_{top} versus p_{bottom} ?

Which layer is warmer, top or bottom?

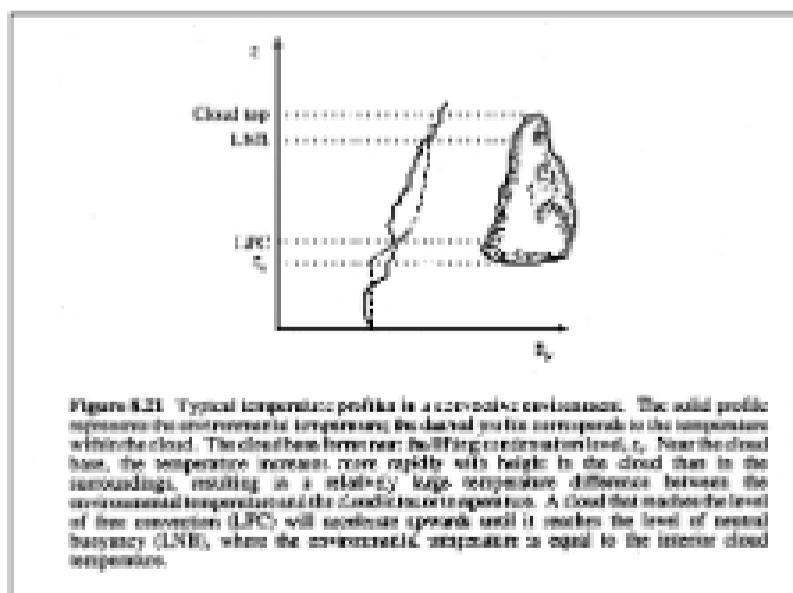
Radiation Inversions

- Radiation Inversion
 - Cause:
 - radiation of heat by the ground at night
 - air adjacent to the the surface has a $T <$ layer at higher elevations



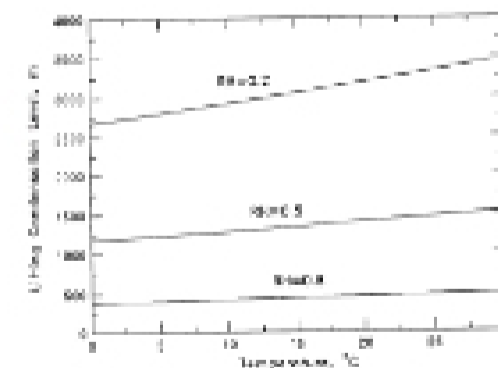
Water Vapor in the Atmosphere

- The Earth's surface is the primary source of water vapor for the atmosphere
- The amount of water vapor in the atmosphere depends on
 - (1) the amount which enters the atmosphere through evaporation and sublimation,
 - (2) its transport by means of various winds throughout the troposphere and the lower stratosphere,
 - (3) the amount which leaves the atmosphere (precipitation, rain, hail and snow)
- ρ_w the amount of water vapor in air at saturation on a mass-per-mass basis, decreases with decreasing temperature
 - the amount of water in an air parcel correspondingly decreases with altitude, reaching a minimum in the lower stratosphere a few kilometers above the tropopause
 - atmosphere has very low water content
- clouds and fog form by cooling of moist air
 - cloud formation is driven by the rise of moist air due to thermally-driven updrafts, which result in adiabatic cooling and expansion; in many cases the expansion is close to adiabatic
 - fog formation and some stratus cloud formation are caused by radiative cooling, caused by surface cooling
 - after a sufficient amount of cooling $q > q_s$ and a liquid condensation is formed, the process ceases when the droplet temperature (T_d) is reached



Lifting Condensation Level

- Lifting condensation level varies with initial relative humidity and is a weak function of initial temperature



Seinfeld and Pandis, Fig. 15.11

Cloud Classification

Clouds are also distinguished by the heights above ground level at which they form:

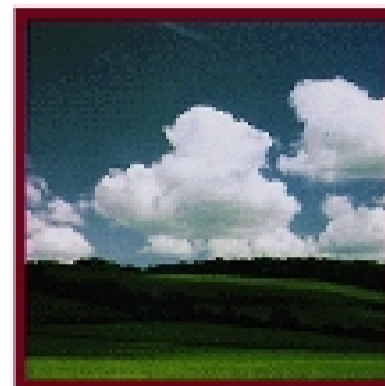
- 1) high clouds whose bases are higher than 6 km in the tropics and 3 km in the polar regions (prefix: cirri);
- 2) middle clouds whose bases lie between 2 and 8 km in the tropics and 2 and 4 km in the polar regions (prefix: alto);
- 3) low clouds whose bases lie below 2 km;
- 4) clouds of vertical development.

The prefix nimbo or the suffix nimbus indicates the presence of rain.
The cloud classification is based on ten main cloud

Cumulus Clouds

Swelling Cumulus

Active heaped-up cloud with flat bottom and growing cauliflower top.
[<http://www.fox3wghp.com/spacious.htm>]



Cumulonimbus Clouds

Cumulonimbus

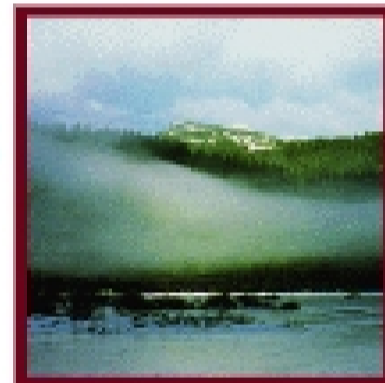
Massive cloud system producing heavy showers, sometimes with hail. Most active clouds may have lightning and thunder. A few spawn tornadoes.
[<http://www.fox3wghp.com/spacious.htm>]



Stratus Clouds

Stratus

Low lying layer of cloud (called fog if on the ground) with no structure.
[<http://www.fox3wghp.com/spacious.htm>]



Cirrus Clouds

Cirrus

An ice crystal cloud, wispy in appearance. May produce ice crystal snow in winter or in mountains.
[<http://www.fox3wghp.com/spacious.htm>]



Altostratus Clouds

Altostratus

Thickly layered water droplet cloud. Sun seen as through ground glass.
[<http://www.fox3wghp.com/spacious.htm>]

