Lecture Ch. 4b

- Homework Problem Ch. 4 Prob. 5
- Hydrostatic equilibrium
  - Special cases
  - Pressure altitude dependence
- More Midterm Review problems
  - Terminology review

Curry and Webster, Ch. 4 (pp. 96-115; skip 4.5, 4.6)
For Thursday: Read Ch. 5
Tuesday: Study for midterm, extra problems at end of each chapter

More Reminders

- **Virtual Temperature:** The temperature air would have at the given pressure and density if there were no water vapor in it.
- **Potential Temperature:** The temperature a parcel would have if it were brought adiabatically and reversibly to p_0 (usually 1 atm)
- **Virtual Potential Temperature:** The temperature a parcel would have if there were no water vapor in it (only condensed water) and if it were brought adiabatically and reversibly to p_0 (usually 1 atm)
- **Equivalent Temperature:** The temperature that an air parcel would have if all of the water vapor were to condense in an adiabatic isobaric process.
- **Equivalent Potential Temperature:** The temperature a parcel would have if all of the water were condensed in an adiabatic isobaric process and if it were brought adiabatically and reversibly to p_0 (usually 1 atm)

Ch. 4: Problem 5

Consider moist air at a temperature of 20°C, a pressure of 1,000 hPa, and a relative humidity of 50%. Find the values of the following quantities:
a) vapor pressure
b) mixing ratio
c) specific humidity
d) specific heat at constant pressure
e) virtual temperature

Hydrostatic Equilibrium Example

Consider a planet with an atmosphere in hydrostatic equilibrium. Assume that the atmosphere is an ideal gas. Also assume that the temperature is a maximum at the surface of the planet, and, as height increases, the temperature in the atmosphere decreases linearly (in other words, temperature decreases with height at a constant rate). Derive a formula for atmospheric density as a function of height in this atmosphere.

Special Cases of Hydrostatic Equilibrium

- 1. rho=constant (homogeneous)
  - H=8 km =RT/g=scale height eq. 1.39
  - DT/dz=-g/R=-34/deg/km
- 2. constant lapse rate
  - -dT/dz=constant
- 3. isothermal T=constant
  - p=p_0*exp(-z/H)

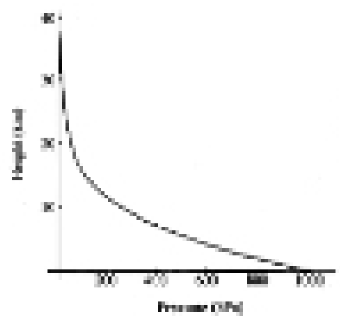
Pressure Altitude Calculator

Let's compare the hydrostatic equation to the atmosphere

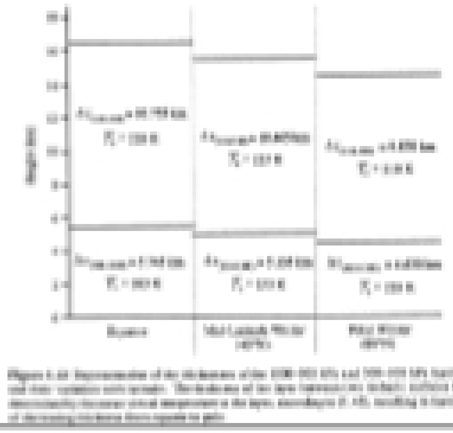
$$p = p_0\left(\frac{T}{T_0}\right)^{g/R\Gamma},\ T = T_0 - \Gamma z \rightarrow p = p_0\left(\frac{T_0 - \Gamma z}{T_0}\right)^{g/R\Gamma}$$

http://www.csgnetwork.com/pressurealtcalc.html

Pressure-Altitude Dependence



Latitudinal and Seasonal Variability of Pressure-Altitude



Definition Example

Define the following terms, briefly and clearly, in light of their use in the kinetic theory of gases and the first and second laws of thermodynamics:

a) an ideal gas
b) temperature
c) entropy
d) exact differential
e) enthalpy

Terminology Review

- Synoptic
  - large phenomena, hundreds of kilometers in length
- Isentropic
  - Adiabatic+reversible
- For adiabatic, ideal:
  - p determines T and vice versa
- Potential temperature
  - temperature that air would have if raised/lowered to a reference pressure.