Lecture Ch. 7b

- Effects of Meteorology on Pollution
  - Stability (review)
  - Atmospheric structure (review)
  - Water vapor structure (review)
  - Inversions (review)

Curry and Webster, Ch. 7, 8
For Thursday: Ch. 12
Saturated Stability Criteria

i) the saturated layer will be stable if $\frac{d\theta}{dz} > 0$;
ii) the saturated layer will be neutral if $\frac{d\theta}{dz} = 0$;
iii) the saturated layer will be unstable if $\frac{d\theta}{dz} < 0$.

Figure 8.21. Typical temperature profiles in a convective environment. The solid profile represents the environmental temperature; the dashed profile corresponds to the temperature within the cloud. The cloud base forms near the lifting condensation level $z_c$. Near the cloud base, the temperature increases more rapidly with height in the cloud than in the surroundings, resulting in a relatively large temperature difference between the environmental temperature and the cloud's liquid temperature. A cloud that reaches the level of free convection (LFC) will ascend upwards until it reaches the level of neutral buoyancy (LNB), where the environmental temperature is equal to the interior cloud temperature.

Figure 7.4 Destabilizing an initially stable atmospheric layer. The initially stable and unsaturated inversion layer $A_1B_1$ is lifted adiabatically. If the bottom of the layer reaches saturation before the top of the layer (e.g., as in an inversion layer in which the mixing ratio decreases with height), further lifting will destabilize the layer. This occurs because the bottom of the layer cools at the much slower saturated adiabatic lapse rate, while the top of the layer continues to cool at the faster dry adiabatic lapse rate.

Figure 6.2 Dew-point depression. As the relative humidity increases, the difference between the ambient temperature and the dew-point temperature (i.e., the dew-point depression) decreases. As the ambient temperature decreases, the dew-point depression becomes less sensitive to changes in the relative humidity.
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

Maximum Mixing Depth

- Maximum Mixing Depth (MMD): the limit of the convective mixing layer where $T_{\text{parcel}} = T_{\text{surrounding environment}}.$

Effects of Meteorology on Pollution

- $T$ is not constant as $z$ increases in the troposphere!

Assume

- there exists a mass of air that may deform as it moves upward
- exchange of air molecules across boundary $<<$ size of air parcel
- as $z$ increases, expansion occurs adiabatically (no heat exchange)
- as $z$ increases, $T$ decreases

Atmospheric Structure

- Structure of the atmosphere
  - Decreasing temperature with altitude
  - Decreasing pressure with altitude
  - Changes in water vapor (“mixing ratio”) with altitude
- Temperatures in meteorology
  - Potential temperature (meteorologists’ entropy)
  - Virtual (potential) temperature
  - Equivalent (potential) temperature

- Describing the atmospheric structure
  - Example: Skew-T log P plot
  - Example: Tephigram

Updrafts

- $T$, $w$, $p$
How do Aerosols cool?

Aerosol **direct** effects cause cooling by reflecting more light (e.g. smog).

Aerosol **indirect** effects cause cooling by clouds that reflect more light (e.g. tracks).
Simulated annual global mean surface temperatures