Additional stability tidbits not in handout

Easy way to compute dewpoint temperature in a humid environment

- Only works if RH> 50%
- $T_D = T - \frac{(100-RH)}{5}$
- T and T_D must be in Celcius

AMS provided a nice source of definitive definitions:

http://glossary.ametsoc.org/wiki/Main_Page

Wet bulb temperature

1.Isobaric wet-bulb temperature: the temperature an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporation of water into it, all latent heat being supplied by the parcel.

2.Adiabatic wet-bulb temperature (*or* pseudo wet-bulb temperature): the temperature an air parcel would have if cooled adiabatically to saturation and then compressed adiabatically to the original pressure in a moist-adiabatic process.

This is the wet-bulb temperature as read off the thermodynamic diagram and is always less than the isobaric wet-bulb temperature, usually by a fraction of a degree centigrade.

Virtual temperature

(*Also called* density temperature.) The virtual temperature $T_v = T(1 + r_v/ \varepsilon)/(1 + r_v)$, where r_v is the mixing ratio and ε is the ratio of the gas constants of air and water vapor, ≈ 0.622.

The virtual temperature allows the use of the dry-air equation of state for moist air, except with T replaced by T_v. Hence the virtual temperature is the temperature that dry dry air would have if its pressure and density were equal to those of a given sample of moist air. For typical observed values of r_v, the virtual temperature may be approximated by $T_v = (1 + 0.61\, r_v)\, T$. Some authors incorporate the density increment due to liquid or solid water into virtual temperature, in which case the definition becomes $T_v = T(1 + r_v/\varepsilon)/(1 + r_v + r_l) \approx T(1 + 0.61r_v - r_l)$, where r_l is the liquid or liquid plus solid water mixing ratio.

Also see discussion at http://www.cimms.ou.edu/~doswell/virtual/virtual.html

Convective condensation level and convective temperature

(Abbreviated CCL.) On a thermodynamic diagram, the point of intersection of a sounding curve (representing the vertical distribution of temperature in an atmospheric column) with the saturation mixing ratio line corresponding to the average mixing ratio in the surface layer (i.e., approximately the lowest 1500 ft).

The dry adiabat through this point determines, approximately, the lowest temperature to which the surface air must be heated before a parcel can rise dry-adiabatically to its lifting condensation level without ever being colder than the environment. This temperature, the convective temperature, is a useful parameter in forecasting the onset of convection.

Layer instability

Also called convective instability or potential instability

The state of an unsaturated layer or column of air in the atmosphere with a wet-bulb potential temperature or equivalent potential temperature that decreases with elevation.

If such a column is lifted bodily until completely saturated, it will become unstable (i.e., its temperature lapse rate will exceed the saturation-adiabatic lapse rate) regardless of its initial stratification.

Mathematical requirement:

$$\frac{\partial \theta_e}{\partial z} < 0$$

Another mathematical requirement, but never used:

$$\frac{\partial \theta_w}{\partial z} < 0$$

Precipitable Water

(*Or* precipitable water vapor.) The total atmospheric water vapor contained in a vertical column of unit cross-sectional area extending between any two specified levels, commonly expressed in terms of the height to which that water substance would stand if completely condensed and collected in a vessel of the same unit cross section.

The total precipitable water is that contained in a column of unit cross section extending all of the way from the earth's surface to the "top" of the atmosphere. Mathematically, if $q(p)$ is the mixing ratio at the pressure level, p, then the precipitable water vapor, PW, contained in a layer bounded by pressures p_1 and p_2 is given by

$$PW = \frac{1}{\rho g} \int_{p_1}^{p_2} q \, dp = \int_{z_2}^{z_1} q \, dz$$

where ρ represents the density of water and g is the acceleration of gravity. Using the hydrostatic equation, its easily transformed for an expression for column of q between z_1 and z_2.

In actual rainstorms, particularly thunderstorms, amounts of rain very often exceed the total precipitable water vapor of the overlying atmosphere. This results from the action of convergence that brings into the rainstorm the water vapor from a surrounding area that is often quite large.

Nevertheless, there is a general correlation between precipitation amounts in given storms and the precipitable water vapor. Its also an important predictor for aerial coverage of air mass thunderstorms, an excellent visualization animation tool showing the evolution of he atmosphere, and where layered pockets of moist and dry air exist.

In addition to soundings, satellite radio occultation techniques provide high density measurements of PW, making large contributions to model improvements in the last decade.

Climatology of Precipitable Water

See:

http://www.srh.noaa.gov/lmrfc/?n=uac

Typical range on the northern Gulf Coast in the summer:

mm	inches
30	1.2
35	1.4
40	1.6
45	1.8
50	2.0
55	2.2

SkewT websites with calculations

http://www.wxcaster.com/etaskewts.htm

http://www.spc.noaa.gov/exper/soundings/

http://weather.unisys.com/upper_air/skew/