Atmospheric Physics

Lecture 12

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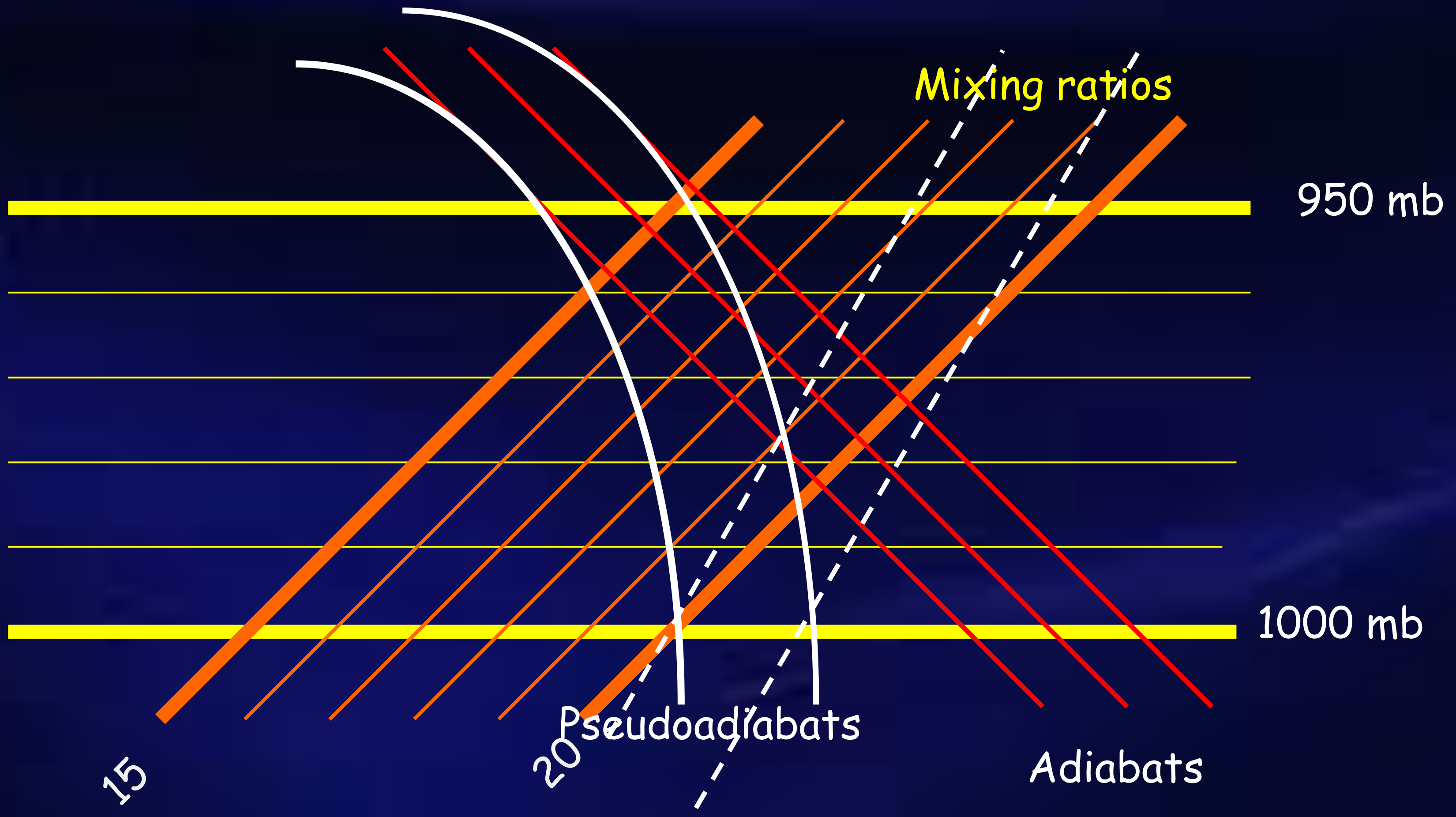
Skew-T Log-P Diagram



Basic Definitions

mixing ratio (r_v): mass of vapor to mass of dry air

saturation mixing ratio (r_{vs}): maximum for a given T and p

wet-bulb temperature (T_w): equilibrium T when water evaporates from a wetted-bulb thermometer at a rate where latent heat lost is balanced by flow of heat from surrounding warmer air

potential temperature (θ): temperature of air if brought dry-adiabatically to 1000 mb

vapor pressure (e): partial pressure of water vapor *virtual temperature* (T_v): temperature dry air at pressure P would have so its density equals that of a moist parcel at T and P

dew point temperature (T_d): temperature of a parcel cooled to saturation at constant P

relative humidity : 100 x (mixing ratio / saturation mixing ratio)

specific humidity (q): mass of vapor to mass of moist air (nearly the same as mixing ratio)

equivalent temperature (T_e): temperature air would have if all of its latent heat were released equivalent potential temperature (θ_e): temperature of a parcel if all moisture condensed out (latent heat released) then the parcel brought dry-adiabatically to 1000 mb

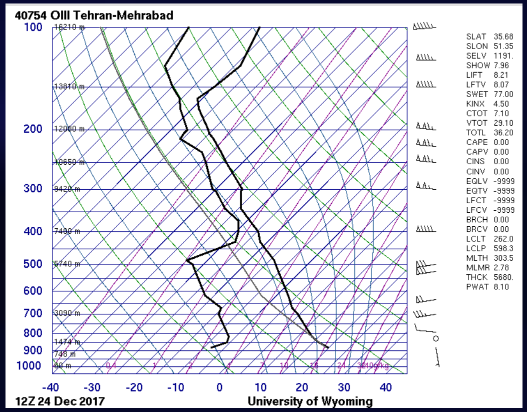
Convective condensation level (CCL): Height where rising parcel just becomes saturated (condensation starts)

Convective temperature (T_c): T that must be reached for a surface parcel to rise to CCL

Lifting condensation level (LCL) (or saturation point): Height where parcel becomes saturated by lifting dry-adiabatically

Level of free convection (LFC): Height where parcel lifted dry-adiabatically until saturated, then moist-adiabatically, first becomes warmer than the surrounding air

Sounding Station Parameters and Indices



SLAT	35.68
SLON	51.35
SELV	1191.
SHOW	**7.96**
LIFT	8.21
LFTV	8.07
SWET	77.00
KINX	4.50
CTOT	7.10
VTOT	29.10
TOTL	36.20
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	262.0
LCLP	598.3
MLTH	303.5
MLMR	2.78
THCK	5680.
PWAT	8.10

SLAT Station latitude in degrees

SLON Station longitude in degrees; West longitude is negative

SELV Station elevation in meters

SHOW Showalter index — Showalter stability index

$$SHOW = T_{500} - T_{parcel}$$

where T_{parcel} is the temperature (°C) of a parcel lifted from 850 to 500 mb, dry-adiabatically to saturation and moist-adiabatically above that.

As the index decreases to zero and below, the likelihood of showers and thunderstorms is considered to increase (Showalter 1947).

LIFT Lifted index

$$LIFT = T_{500} - T_{parcel}$$

T_{500}= temperature in Celsius of the environment at 500 mb

T_{parcel} = 500 mb temperature in Celsius of a lifted parcel with the average pressure, temperature, and dewpoint of the layer 500 m above the surface

LFTV LIFT computed by using virtual temperature

SLAT	35.68
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Atmospheric Stability

Adiabatic Processes

Parcel of air expands and cools, or compresses and warms, with no interchange of heat with the surrounding environment

An adiabatic process is reversible

If the parcel doesn't saturate, then cooling or warming occurs at the dry adiabatic lapse rate

Constant in our atmosphere 10 ^{o}C / km

Atmospheric Stability

If the parcel does saturate and ascent is occurring...

Condensation (RH = 100%), latent heat is released

Latent heating offsets some of the cooling

Cooling at slower rate: saturated adiabatic lapse rate

Not constant, varies with temperature and moisture

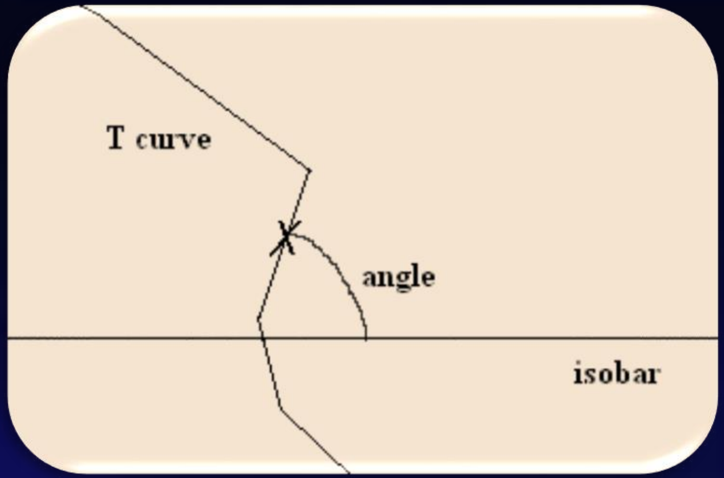
Average value ~ 6 ^{o}C / km

Not reversible (heat added, moisture probably removed)

Pseudo-adiabatic process

Stability

The term "slope" in reference to the Skew-T chart is the angle from the horizontal (the isobars) counter-clockwise to a section of the T curve.



For stability, the smaller the angle, the greater stability there will be.

The larger this angle, the more instability there will be.

The stability of air parcels in an atmospheric layer is indicated by comparing the slope of the virtual temperature to the slope of the dry or saturation adiabats.

Useful Parameters for Rising Air Parcels

Lifting Condensation Level (LCL):

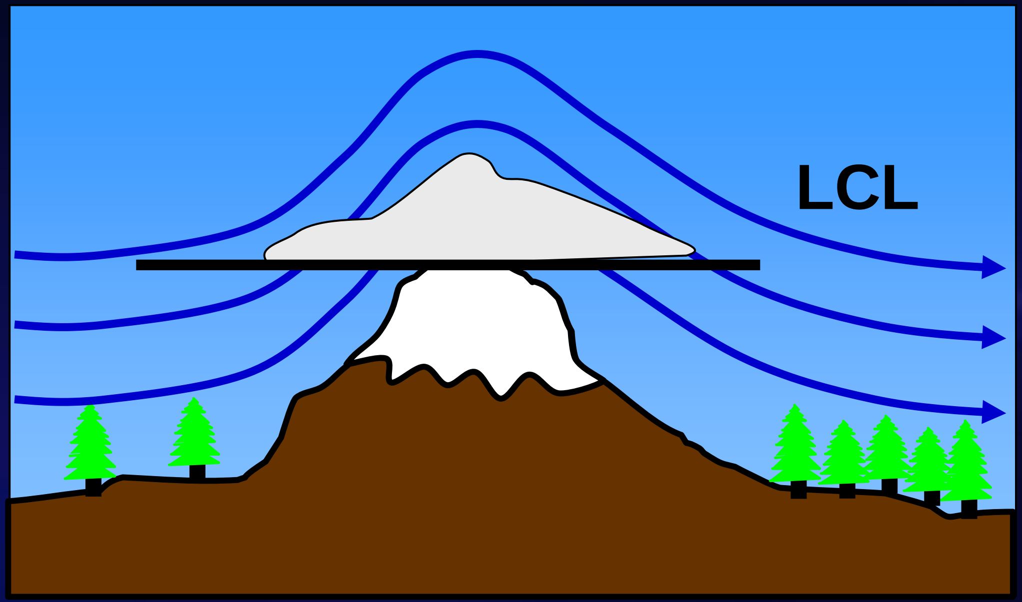
Definition: The level to which a parcel must be raised dry adiabatically, and at constant mixing ratio, in order to achieve saturation.

Lifting can result from:

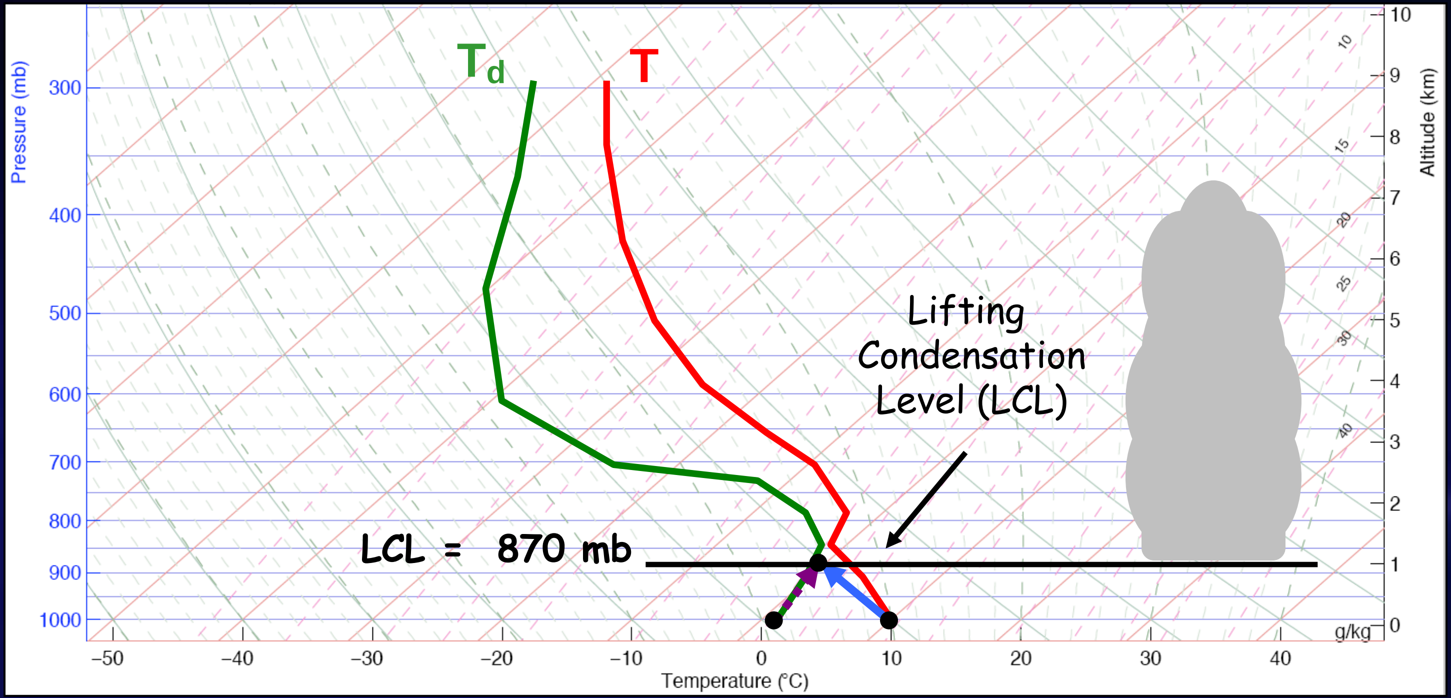
Convergence

Flow over topography

Fronts



Lifting Condensation Level (LCL):



CAPE	0.00
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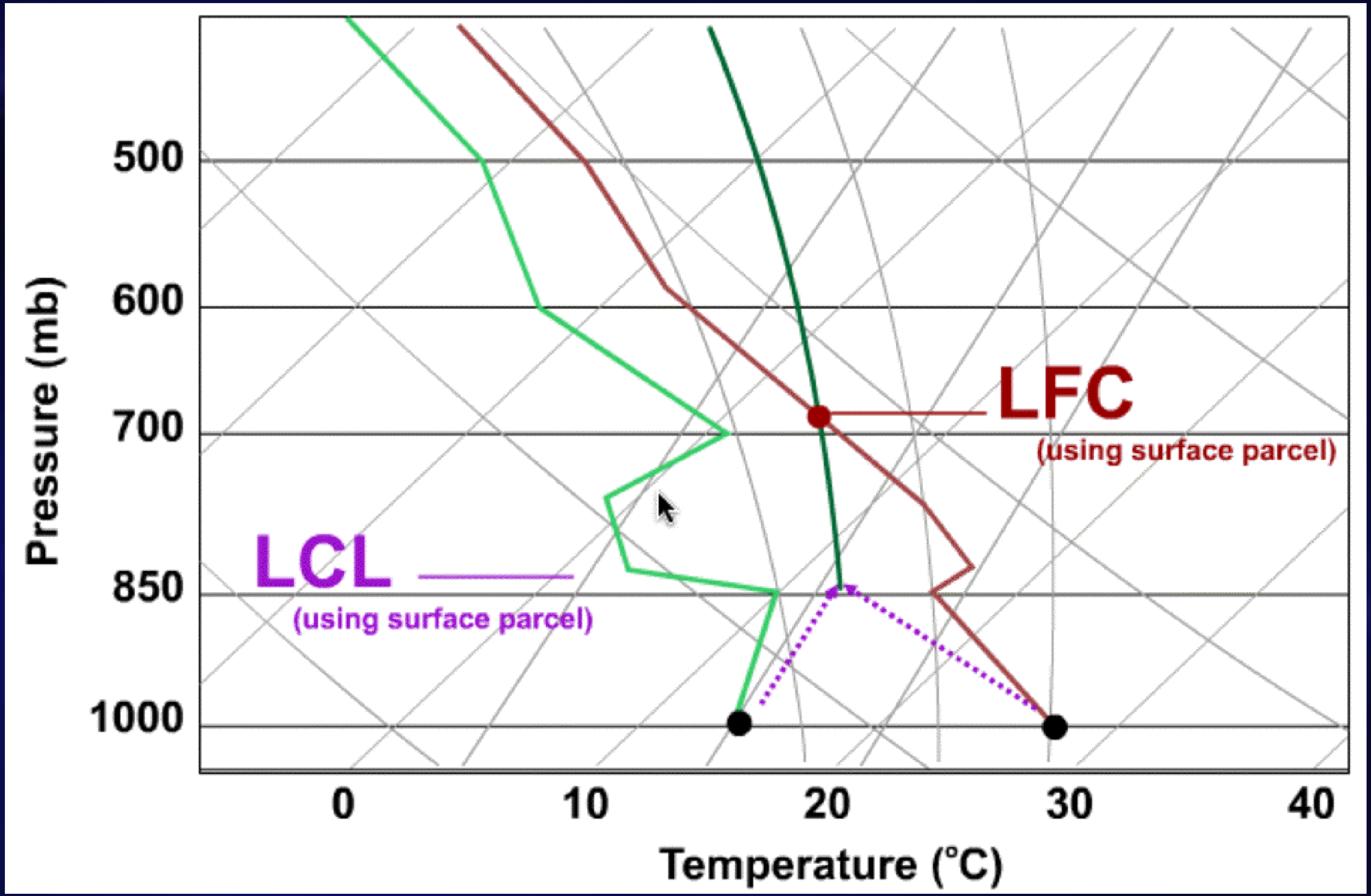
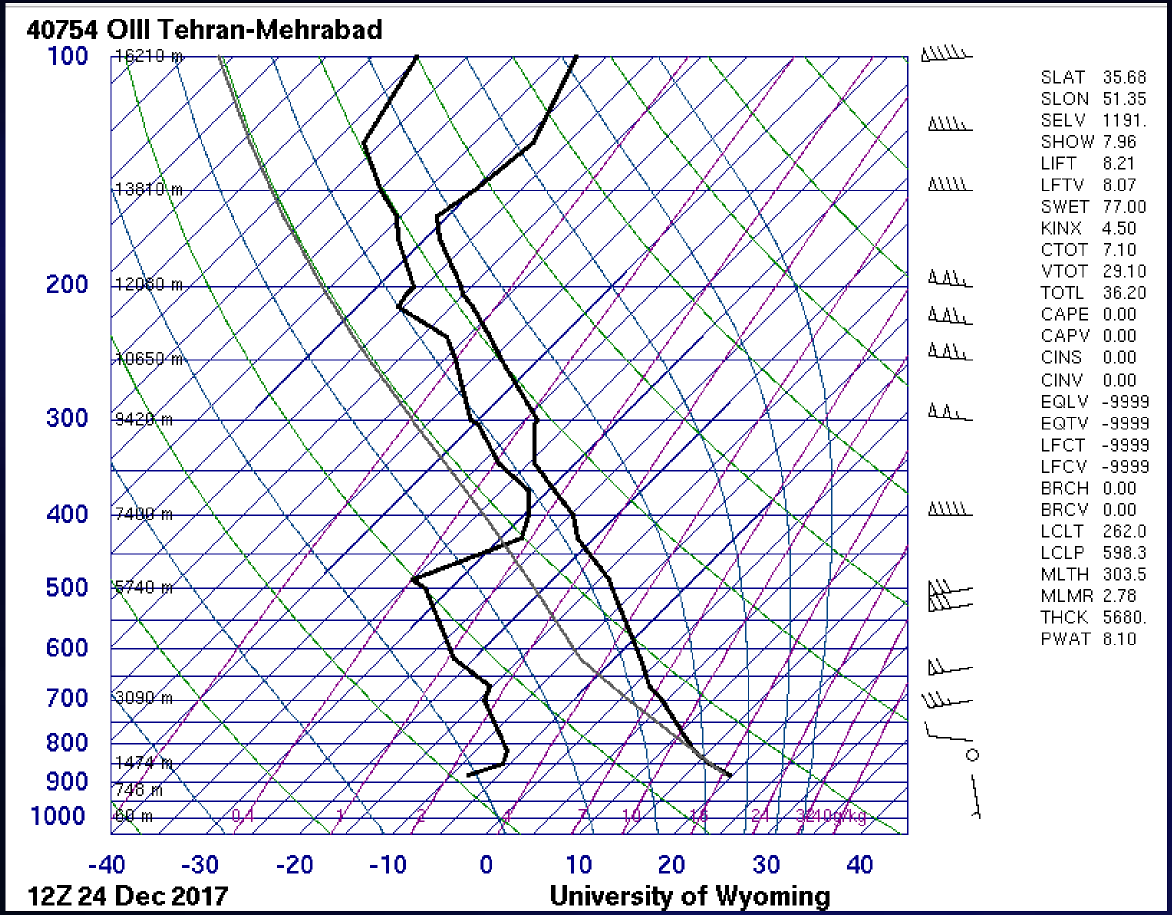


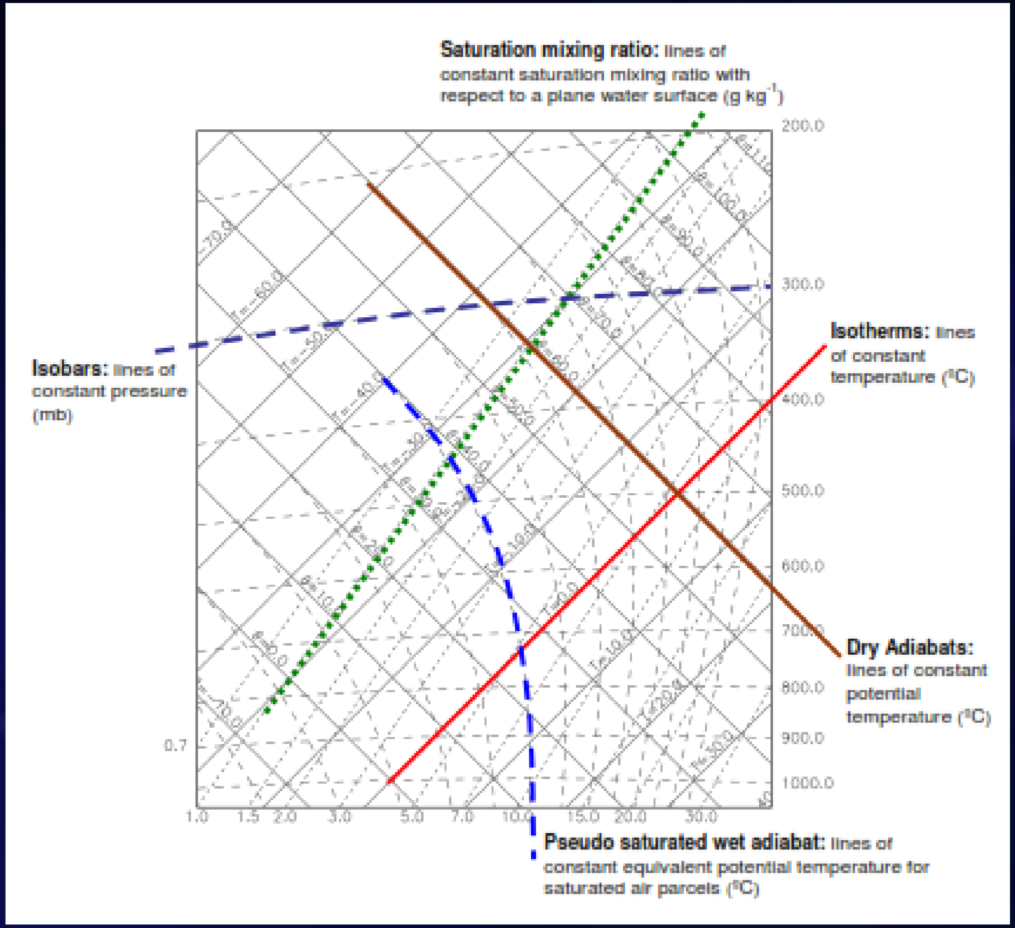
500
600
700
850
1000
Pressure (mb)
LFC
(using surface parcel)
LCL
(using surface parcel)
0
10
20
30
40
Temperature (°C)

Skew-T Log-P Diagram

Useful Parameters for Rising Air Parcels

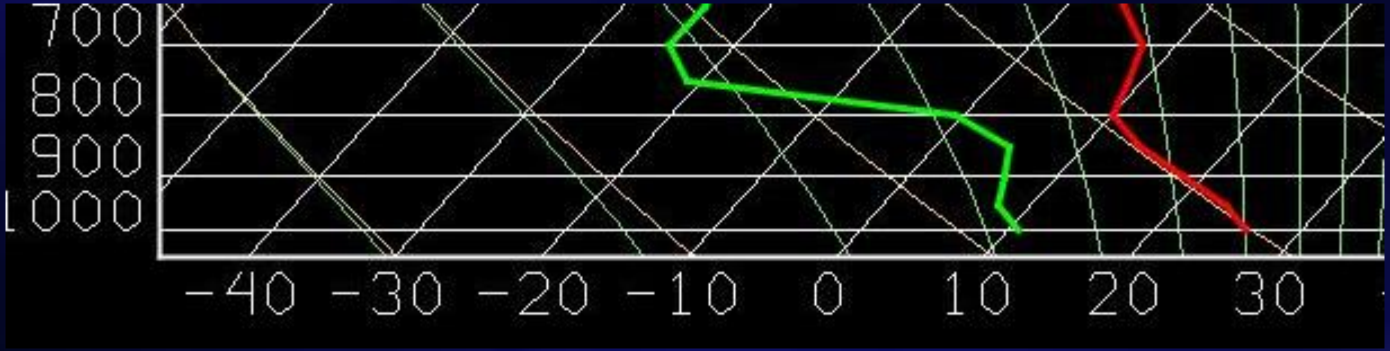
Atmospheric Soundings Plotted on Thermodynamic Diagrams

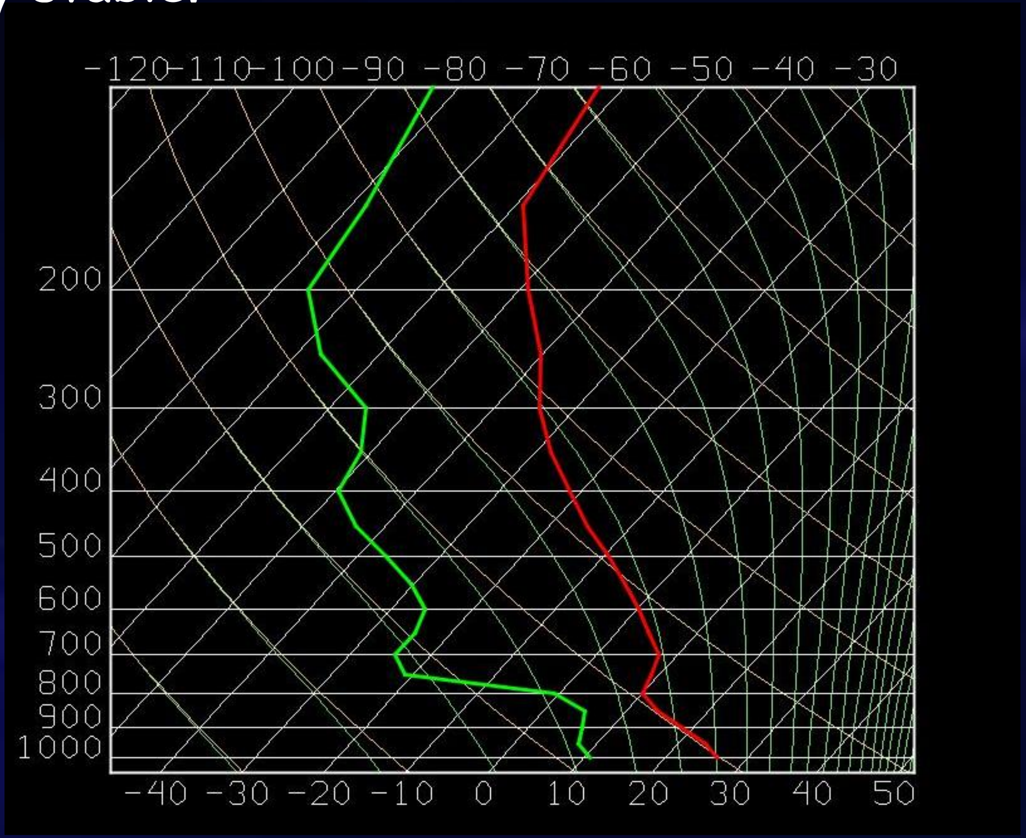




Absolutely Stable

If the slope of the T curve is less than the slope of the saturation adiabat and the slope of the dry adiabat then the layer is considered absolutely stable.





The area between 700 and 800mb is an example of an absolutely stable layer.

Absolutely Stable