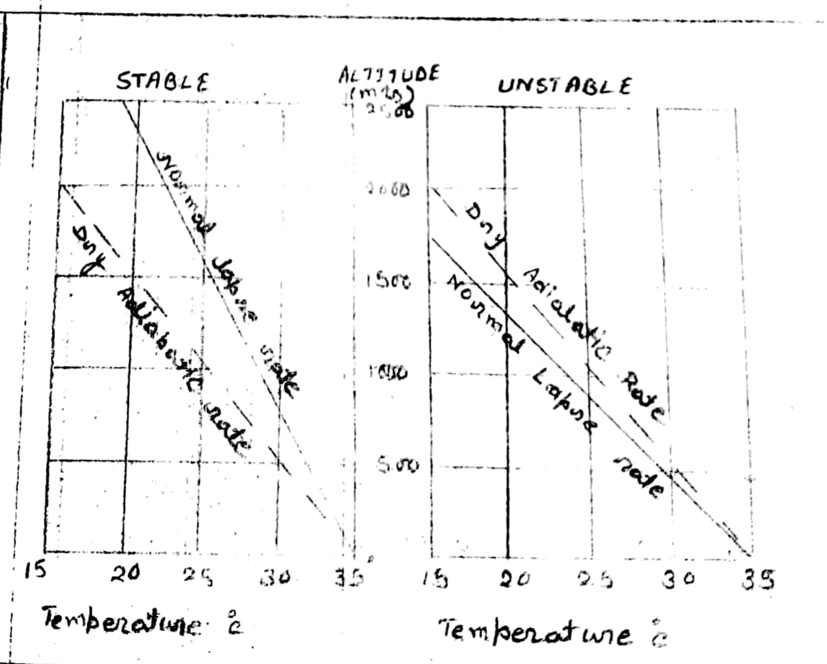
STABILITY AND INSTABILITY OF THE ATMOSPHERE

Air is said to be stable and consequently autogonistic to precipitstion, if is non buoyant and resists vertical displacement or if, following forced vertical displacement, it tends to return to its former position. Vertical moti are largely absent in stable air, On the hand, if displacement results in buoyancy and a teandency to further movement away from the original position, a condition of instability prevails. Under such conditions vertical movement is prevalent.

Wheather an air mass is stable or unstable depends upon a comparison of its lapse rate (about 3.3°F Per 1000 ft / 6°c per 1000m) with the dry adiabatic rate (5.54°F Per 1000 ft / 10°c per 1000m.). When the lapse rate exceeds the dry adiatatic rate, the surface air is unstable and inclined to rise. But when the lapse rate is less than the dry adiabatic rate, the air is stable, it resists displeement and tends to remain in its original position. It the lapse rate which is the variable. The dry adiabatic lapse rate is the lapse rate which is the same at all times and under all conditions.



In the left-hand diagram the surface air is at a temperatures of 35°c with a lapse rate of 6°c per 1000 m. When a parcel of air with 35°c temp. at the ground is forced upward and reaches a height of 1000 m.; its temperature comes down to 25°c, while the temperature of the surrounding air is about 29°c. In this case the existing lapse rate is less than the dry adiabatic rate. Therefore, the air is stable.

In the right hand diagram, on the other hand, the ascending air parcel at the height of 1000 m. has cooled down to 20°c, while the temperature of the surrounding air at the same height is only about 24°c. In this case the lapse rate exceeds the dry adiabatic rate, therefore, the air is unstable.

"Absolute stability":

When an air layer has a lapse rate that is less than the dry adiabatic, say 3.50 F per 1000 ft, a stable condition is present, and there is opposition to vertical movement. In the left hand diagram, the ascending air is cooler than the surrounding air at the same height and must sink down ward, this parcel of air would tend to come back to its original position unless some outside force is applied to it, because further ascent would cause it to become colder and heavier than the surrounding air.

If the lapse rate is less than about 2.5°F per 1000 ft, the air is said to be absolutely stable. this air resists vertical displacement even when condensation takes place. A common instance of absolute stability is the temperature inversion. An inversion is so stable that it acts as an aerial "lid" to halt ordinary rising currents. Rising columns of smoke or growing clouds are forced to spread out horizontally beneath the base of the inversion.

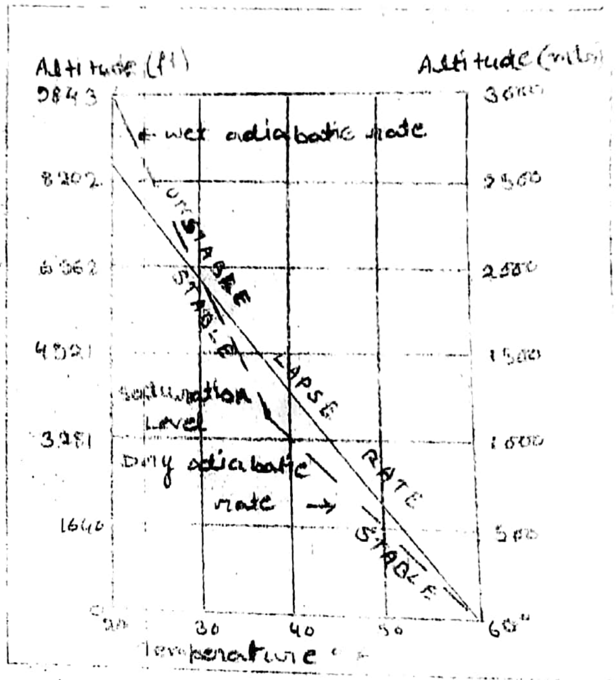
"Absolute Instability":

When the distribution of temperature is such that at every level the lapse rate is greater then the dry adiabatic rate of 5.54° per 1000 ft, the displaced parcel of air has a tendency to continuously move upward till its temperature is equal to that of the surrounding air. Such a state

absolute instability:

"Conditional instability":

The term "conditional instability" refers to the state of a column of air when its vertical distribution of temperature is such that the layer is stable for dry air but unstable for saturated air, this occurs when an air layer has an actual lapse rate between the dry adiabatic (5.54°F / 1000 ft) and the wet adiabatic (2.5°F / 1000 ft) rates of cooling, its instability being conditional upon the relative humidity of the air at all levels.



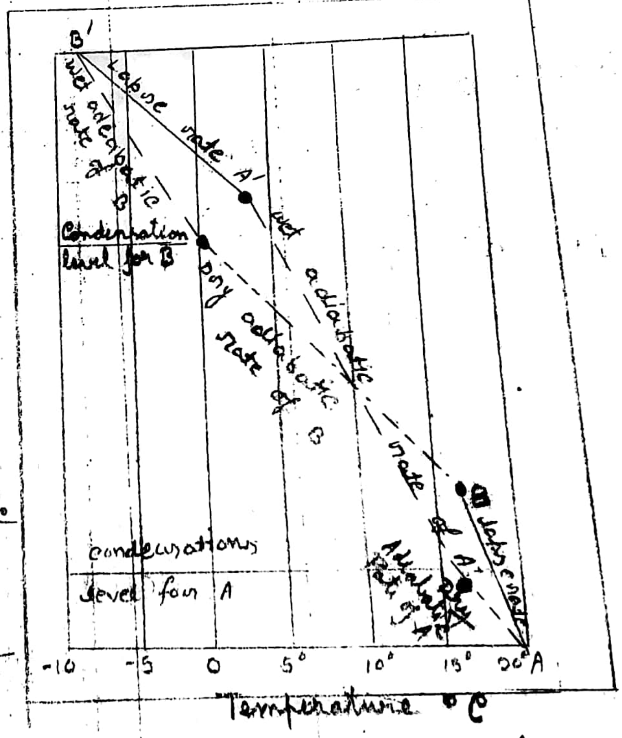
The lapse rate shown in the adjoining diagram represents a state of conditional instability. The rising air while still unsaturated follows the dry adiabatic rate of cooling. In this situation the lapse rate is less then the dry adiabatic rate; therefore it is stable. But, when the rising air reaches condensation level and latent heat is added, any further cooling takes place of the wet adiabatic rate which is less than the lapse rate. As a result, the lapse rate exceeds the wet adiabatic rate, so the air is unstable.

"Mechanical instability":

At times, there are abnormal situation when the lapse rate is too steep (19°F per 1000 ft / 35°C per 1000 m.) and the upper layers of the atmosphere become far more denser than the underlying layers. Under these special circumstances there is an automatic overturning of air any initial forced displacement. This condition as mechanical instability, is of rare occurrence in nature. It may play a part in ...lls or tornado weather.

Convective instability:

Convective (or potential) instability is characteristic of a layer of air several hundreds of metres thick and thousands of kilometres in areal extent, being moist in the lower part and dry in the upper part and ultimately forced to rise. It is explained graphically as follows:



"AB" is a deep layer of air, its lapse rate being indicated by the sloping line AB. Since air at A is more humid than at B, after being displaced it reaches the condensation level sooner than at B. The bottom of the layer cools at the dry adiabatic rate from 20°c at point A to 16.7°c at condensation point. Further cooling carries the bottom of the layer from the condensation level to A' at wet adiabatic rate at 3.7°c. On the other hand, the layer cools at the dry adiabatic rate from 17°c to 0°c at its condensation level. From this point upward the saturated top layer cools at the wet adiabatic rate. It arrives at B' at a temperature of -8.3°c, thus, after uplift the layer of air having the initial lapse rate AB has the new lapse rate "A'B'" which is steeper than before.