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http://www.humboldt.edu/~geology/courses/geology531/531_handouts/lapse_rates.pdf

LAPSE RATES AND AIR-MASS STABILITY

DEFINITIONS:

LAPSE RATE: The variation (usually a decrease) in air temperature with increasing elevation in the atmosphere.

ACTUAL LAPSE RATE: The lapse rate of an air mass, as determined by temperature measurements at various elevations.

ADIABATIC LAPSE RATE: If air is uplifted for any reason, it expands because the pressure on it is reduced. This expansion causes cooling of the air. This rate of cooling due to expansion is fixed by the thermodynamic properties of air and the pressure structure of the atmosphere. (This expansion due to decrease in pressure is called ADIABATIC EXPANSION, and the associated cooling is ADIABATIC COOLING.) The term adiabatic means that no heat energy is gained or lost in the process. The decrease in temperature that a parcel of air experiences due to expansion as it is forced upwards is the ADIABATIC LAPSE RATE.

DRY ADIABATIC LAPSE RATE: For air without any condensation of moisture. It is equal to 1.0°C/100 m (5.6°F/1000 ft).

WET ADIABATIC LAPSE RATE: For air which has reached saturation and from which moisture is condensing. This rate depends in part upon the total water content of the air. The average value is 0.7°C/100 m (3°F/1000 ft). This is less than the dry rate because as moisture condenses it releases its latent heat of vaporization (540-590 cal/gram) and thus warms the air.

AIR MASS STABILITY:

An AIR MASS is a vast body of air (e.g., 1000 sq. mi. and up) with more or less horizontally uniform moisture and temperature conditions; it will usually have a distinctive actual lapse rate.

An air mass is STABLE if air which is lifted by any means is cooler (and thus denser) than the surrounding air. In such circumstances it will not continue to rise and is incapable of rising spontaneously.

The stability of an air mass depends upon the relation of the actual lapse rate to the wet and dry adiabatic rates. (see diagrams on next page.)

1. ABSOLUTELY STABLE: dry rate > moist rate > actual rate

   air uplifted is always cooler than surrounding air and will settle back down

2. ABSOLUTELY UNSTABLE: actual rate > dry rate > moist rate

   air uplifted is always warmer than surrounding air; any slight uplift will start air rising, and it will continue to rise.

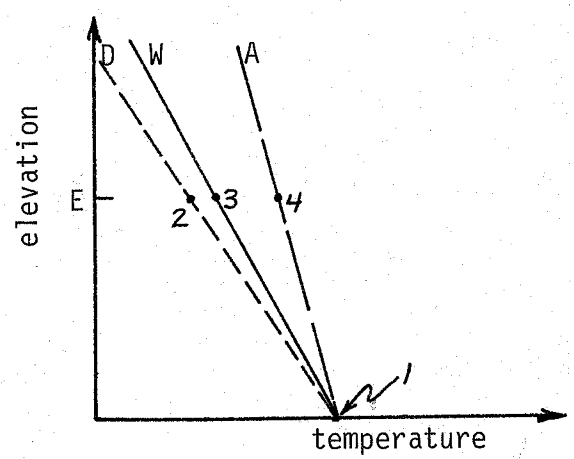
3. CONDITIONALLY STABLE (convectively unstable): dry rate > actual rate > wet rate

   air is stable until itis lifted high enough for moisture to start condensing; then it becomes unstable

It is convenient to express the lapse rates pictorially, as graphs of temperature vs. elevation. The slope of the line is the value of the lapse rate.

A= actual rate D= dry adiabatic rate W= wet adiabatic rate

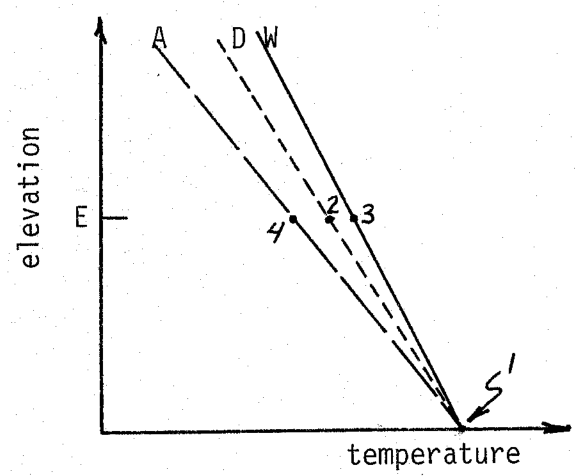
1. ABSOLUTELY STABLE



$T_2 < T_3 < T_4$

If air rises from 1 to elevation E, along either wet or dry curves its T will be < T of the surrounding air and it will sink back down.

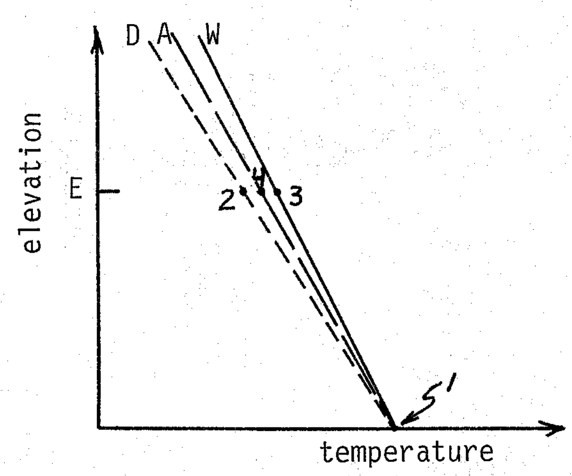
2. ABSOLUTELY UNSTABLE



$T_4 < T_2 < T_3$

If air rises from 1 to elevation E along either wet or dry curves, its T will always be > T of the surrounding air and it will continue to rise.

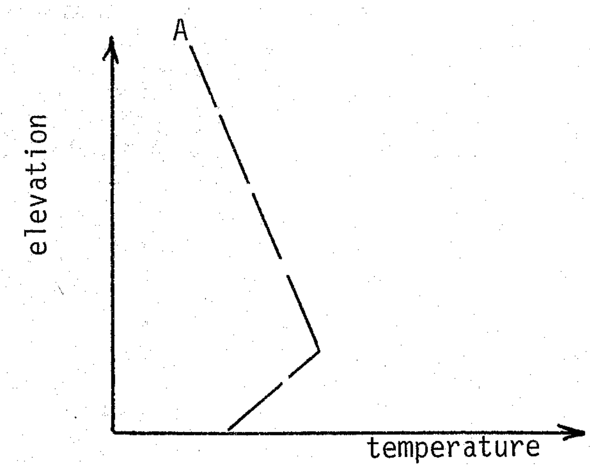
3. CONVECTIVELY UNSTABLE



$T_2 < T_4 < T_3$

If air rises from 1 to elevation E and is dry, its T will be < T of surrounding air and it will sink back down. If air condenses moisture as it rises, it will follow the wet rate and at elevation E will be warmer than surrounding air and so will continue to rise.

4. TEMPERATURE INVERSION



An inversion occurs when T increases with elevation. This may occur if the bottom of an air mass is greatly cooled by contact with cool water, land, etc. The air in the inversion is extremely stable and the inversion acts as a "lid" to keep air from mixing upwards. The most dangerous air pollution builds up during an inversion.