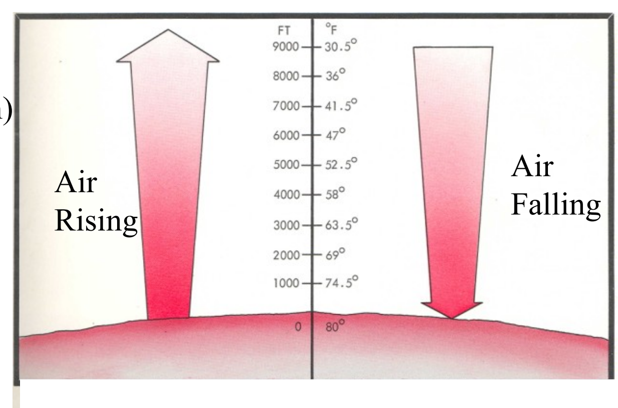
Temperature

Temperature can be defined as degree of hotness of any matter, while heat is the total energy of the object / matter. In other words temperature is the intensity of heat of an object or matter. Temperature is also defined as the mean kinetic energy of the molecules of the matter. The energy is transfered from higher temperature to lower temperature object. Atmospheric temperature can be defined as temperature of air.

Adiabatic process

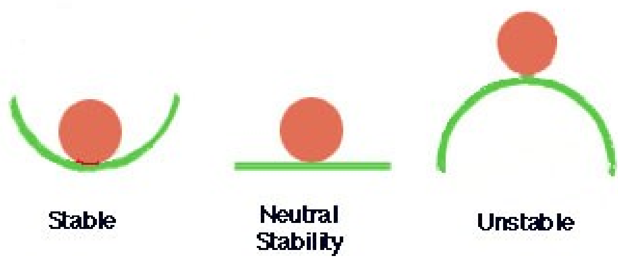
↓ pressure
(expansion)
↑ volume
= cooling



↑ pressure
(compression)
↓ volume
= warming

Adiabatic process: - No heat is gained or lost by mixing with the surrounding air ("parcels of air")

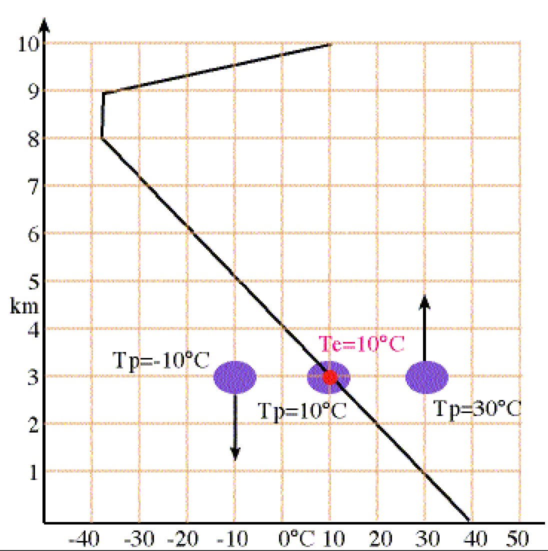
Atmospheric Stability



Stability refers to a condition of equilibrium
If we apply some perturbation /push to a system, how will that system be affected?

Stable: System returns to original state
Unstable: System continues to move away from original state
Neutral: System remains steady after perturbed

Vertical Profile of Atmospheric Temperature



Lapse Rates

Lapse Rate: The rate at which temperature decreases with height (Remember the inherent negative wording to it). This is the average lapse rate of atmosphere

Environmental Lapse Rate: Lapse rates associated with an observed atmospheric sounding (negative for an inversion layer). This is the measured lapse rate of any location or point.

Parcel Lapse Rate: Lapse rate of a parcel of air as it rises or falls (either saturated or not)

MALR - **Moist Adiabatic Lapse Rate**: Saturated air parcel

DALR - **Dry Adiabatic Lapse Rate**: Dry air parcel

DALR

- Air in parcel must be unsaturated
- (RH < 100%)
- Rate of adiabatic heating or cooling = 9.8°C for every 1000 meter (1 kilometer) change in elevation

Parcel temperature decreases by about 10° if parcel is raised by 1km, and increases about 10° if it is lowered by 1km

The adiabatic lapse rate for ***DRY*** air on Earth is

$$\Gamma_d = g/c_p$$

$$\Gamma_d = 9.81\ m\ s^{-2} / 1004\ J\ kg^{-1}\ K^{-1}$$

$$\Gamma_d = 0.00977\ K\ m^{-1}$$

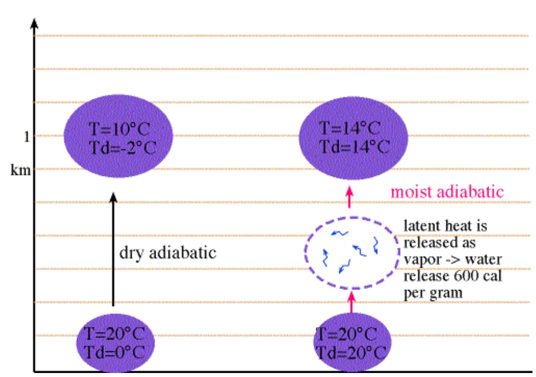
$$\Gamma_d = 9.77\ K\ km^{-1}$$

MALR (or SALR)

- As rising air cools, its RH increases because the temperature approaches the dew point temperature, Td
- If T = Td at some elevation, the air in the parcel will be saturated (RH = 100%)
- If parcel is raised further, condensation will occur and the temperature of the parcel will cool at the rate of about 6°C per 1km in the mid-latitudes

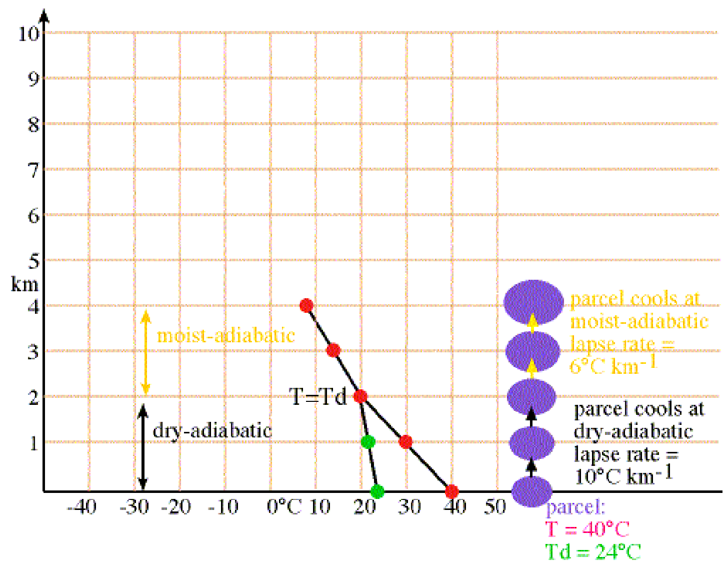
DALR vs. MALR

- The MALR is less than the DALR because of latent heating
  - As water vapor condenses into liquid water for a saturated parcel, LH is released, lessening the adiabatic cooling



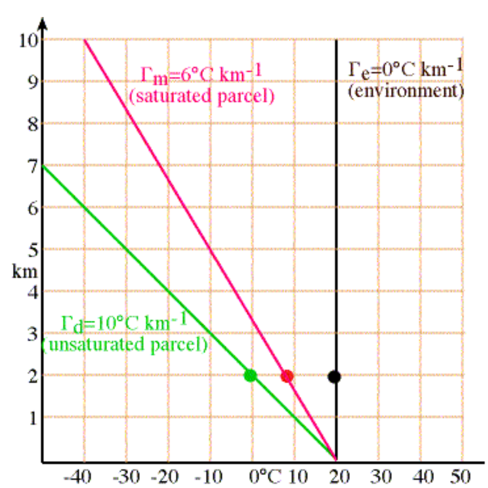
Remember no heat exchanged with environment

DALR vs. MALR



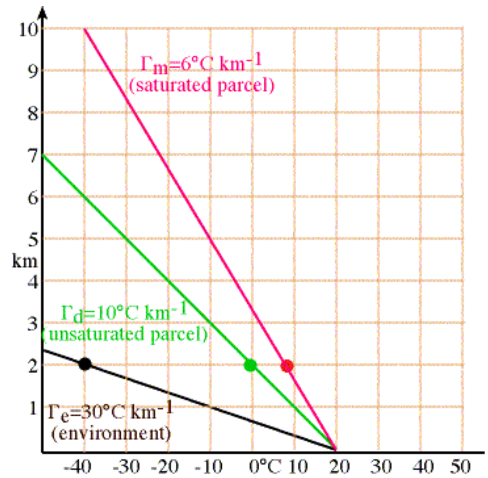
Absolute Stability

- The atmosphere is *absolutely stable* when the environmental lapse rate (ELR) is less than the MLR
  - ELR < MALR < DALR
  - A saturated OR unsaturated parcel will be cooler than the surrounding environment and will sink, if raised



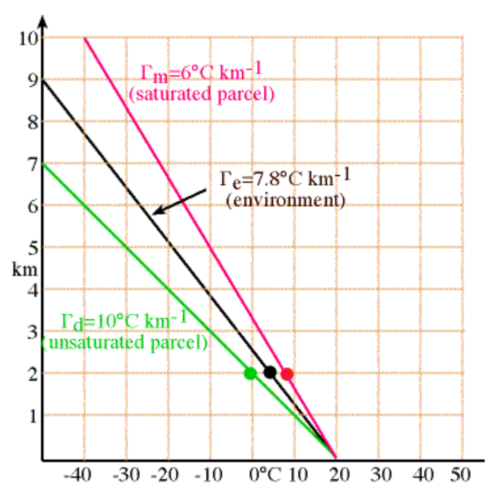
Absolute Instability

- The atmosphere is *absolutely unstable* when the ELR is greater than the DALR
  - ELR > DALR > MALR
  - An unsaturated OR saturated parcel will always be warmer than the surrounding environment and will continue to ascend, if raised

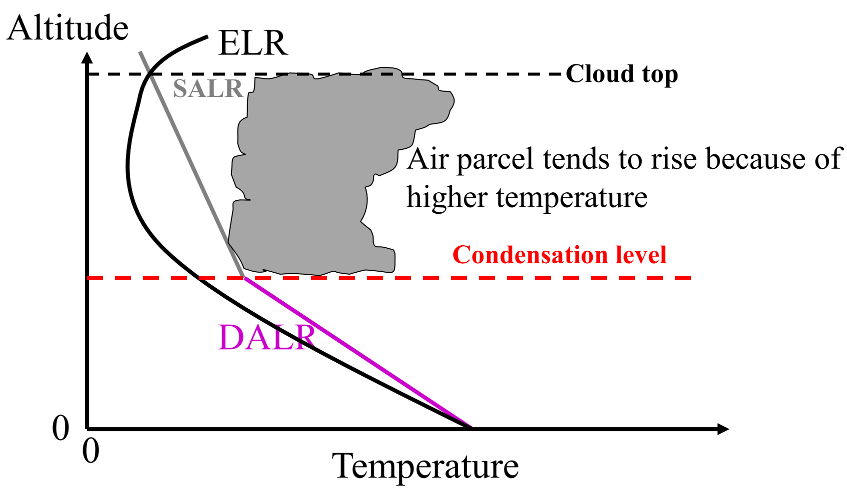


Conditional Instability

- The atmosphere is *conditionally unstable* when the ELR is greater than the MALR but less than the DALR
  - MALR < ELR < DALR
  - An unsaturated parcel will be cooler and will sink, if raised
  - A saturated parcel will be warmer and will continue to ascend, if raised

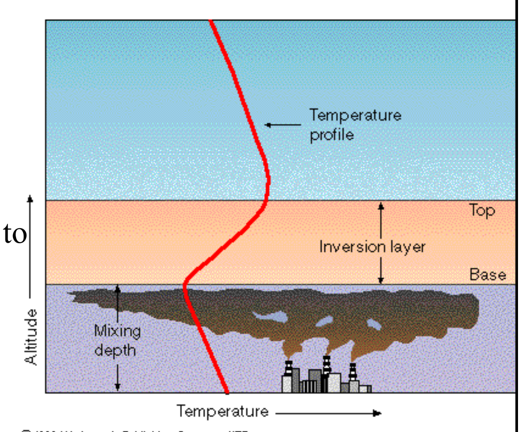


Atmospheric stability and cloud development

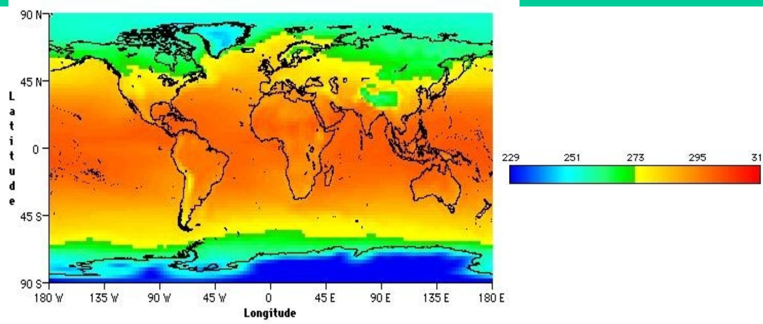


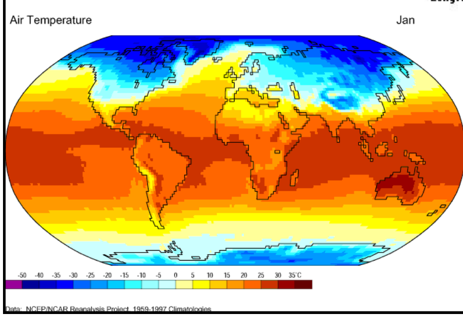
Temperature Inversion

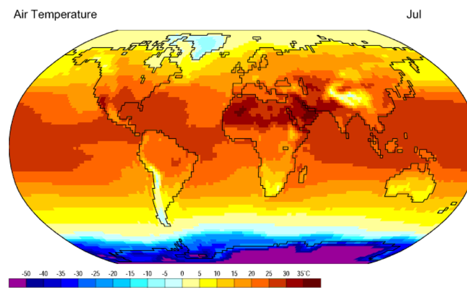
Temperature inversion is a condition in which the **temperature** of the atmosphere increases with altitude in contrast to the normal decrease with altitude. When **temperature inversion** occurs, cold air underlies warmer air at higher altitudes.



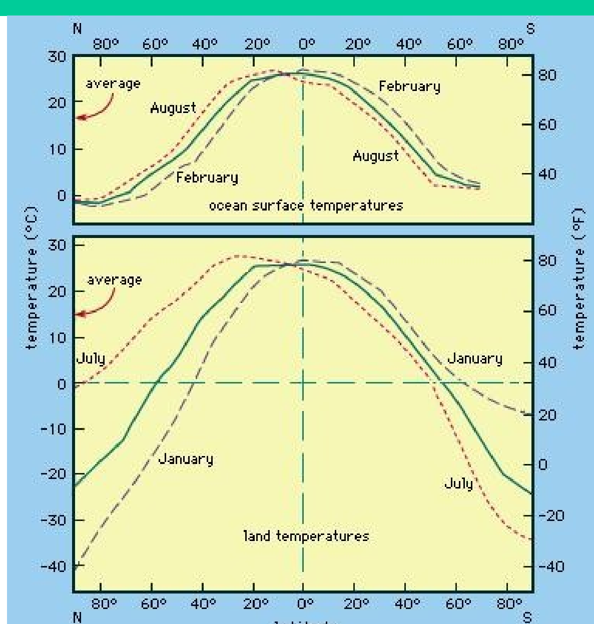
Horizontal Temperature Distribution







Horizontal Temperature Distribution

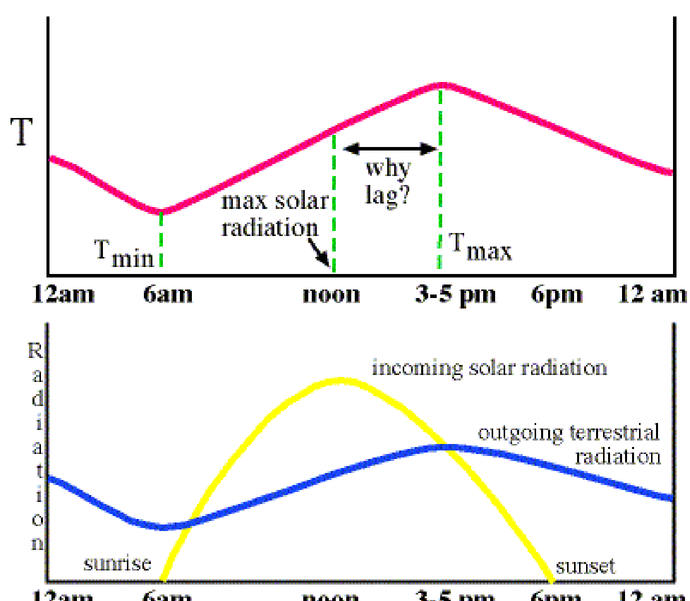


Factors affecting Temperature

Factors affecting Temperature distribution

1. Latitude
2. Differential heating
3. Land & Water Distribution
4. Distance from water bodies
5. Ocean Currents
6. Air mass movements (advection process)
7. Elevation
8. Local Relief (Physical obstacles)
9. Precipitation and cloudiness
10. Atmospheric compositions (global warming gasses)
11. Anthropogenic activities
12. Colour of the soil
13. Slope and aspect of the land
14. Forest and vegetation
15. Season
16. Sun-earth distance

Diurnal Temperature Variation



Seasonal Temperature Variation