

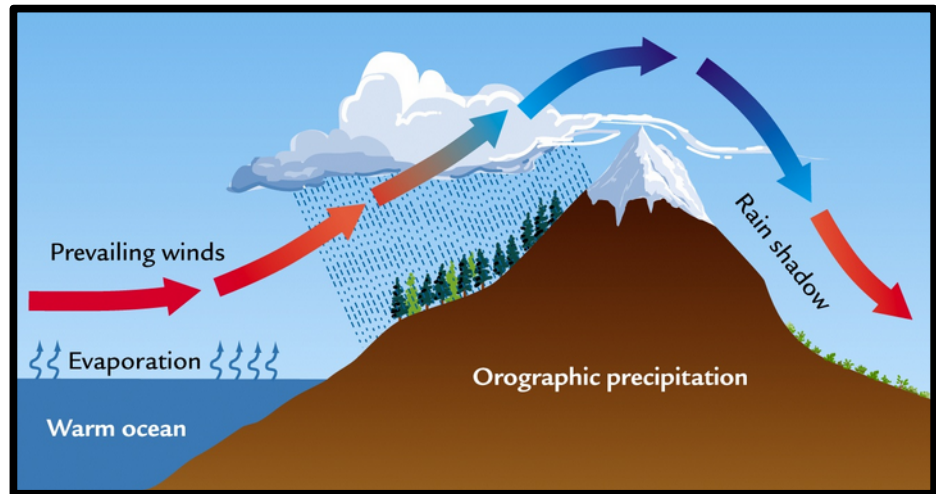
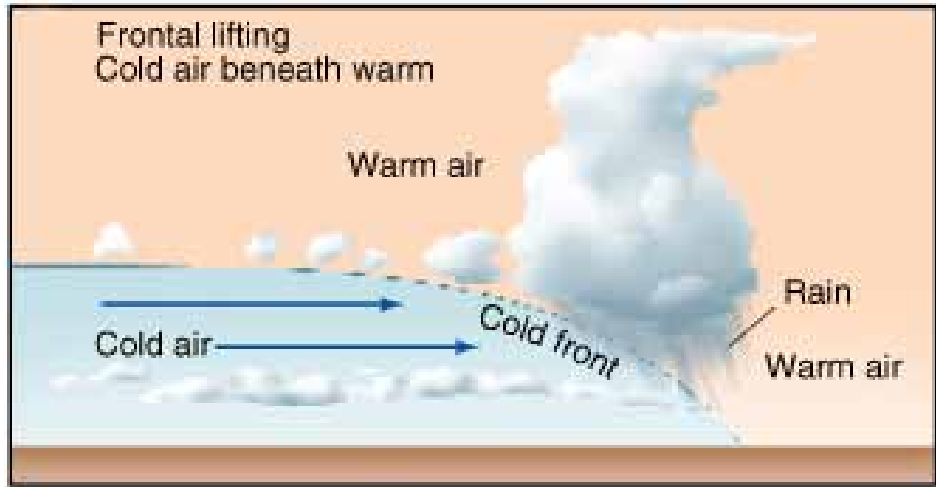
Cloud Dynamics



Thermals Rising Upward

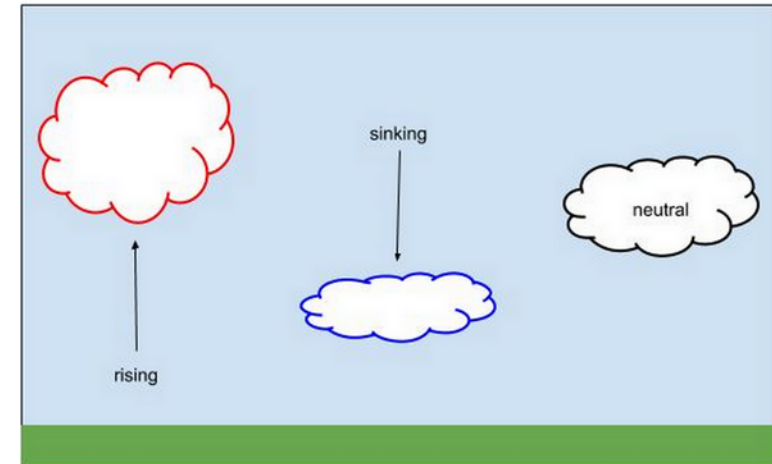
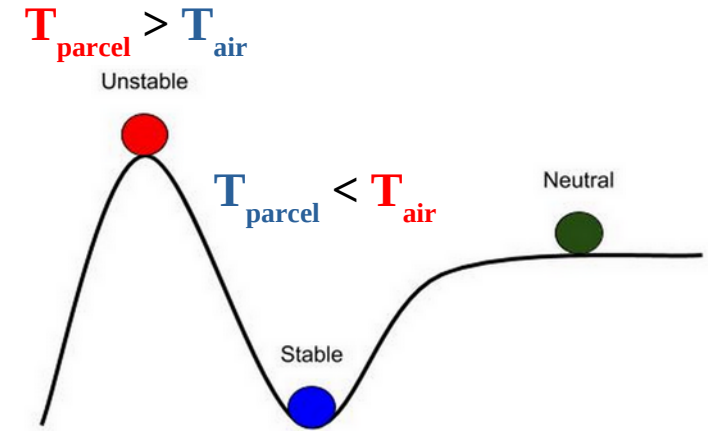
Cloud Formation Processes

- Rising Air Due to:
 - Synoptic Lifting
 - (Low Pressure)
 - Mesoscale Lifting
 - (Jet Streaks)
 - Thermals
 - Fronts
 - Terrain



Atmospheric Stability and Vertical Motion

- Stability: Resistance of the atmosphere to vertical motion.
- Air motions are governed by atmospheric stability.
- **Unstable: Rapid Vertical Motion**
- **Stable: Limited Vertical Motion**
- **Neutral: No Change**



How does the parcel and air temperature (T) compare for neutral stability?

Effects of Latent Heating on Vertical Motion

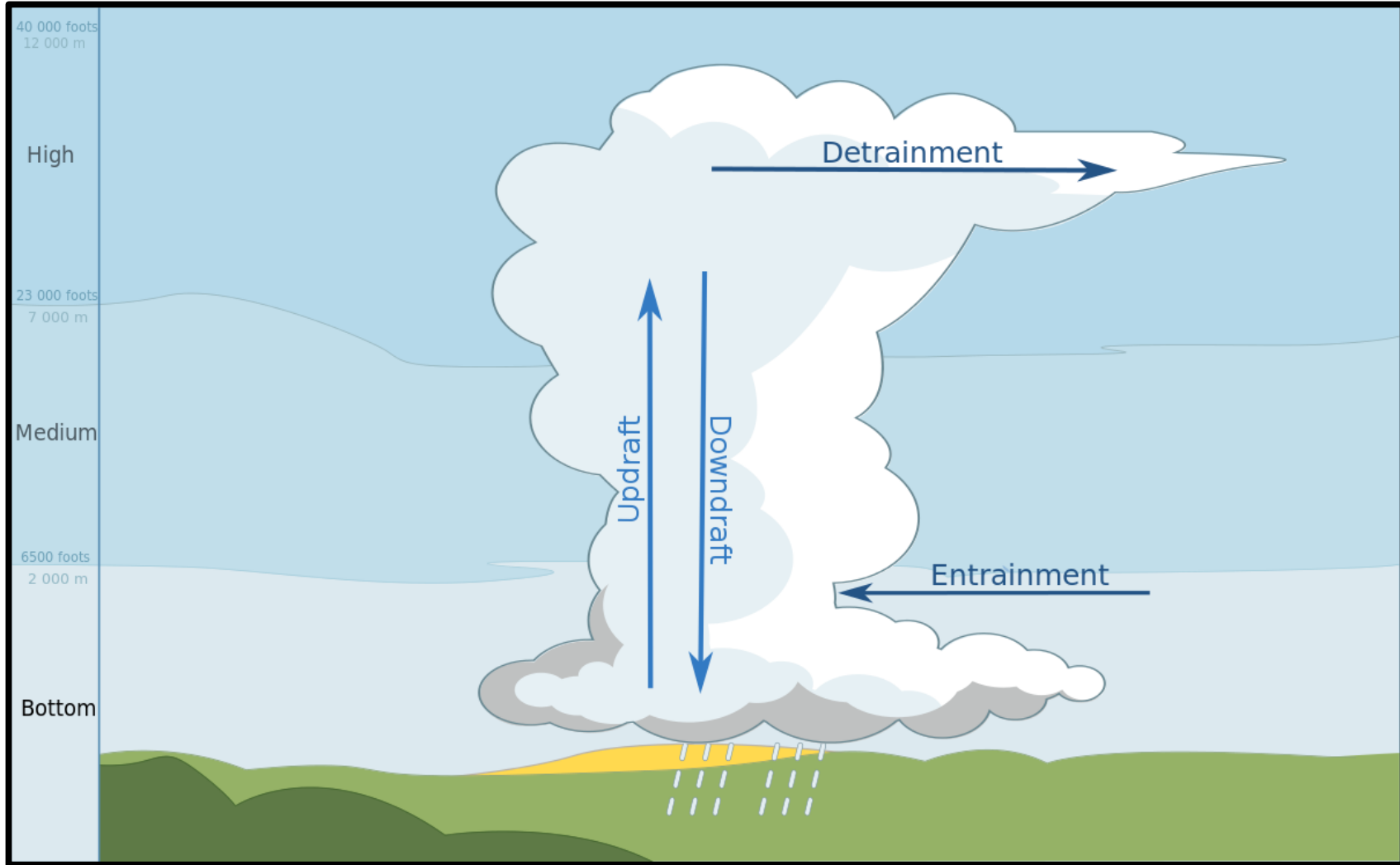
- Condensation and freezing release latent heat.
- Cloud Air Warms Slightly
- Warming Produces Buoyancy
- Buoyancy Causes the Air to Rise



Cloud Entrainment and Detrainment

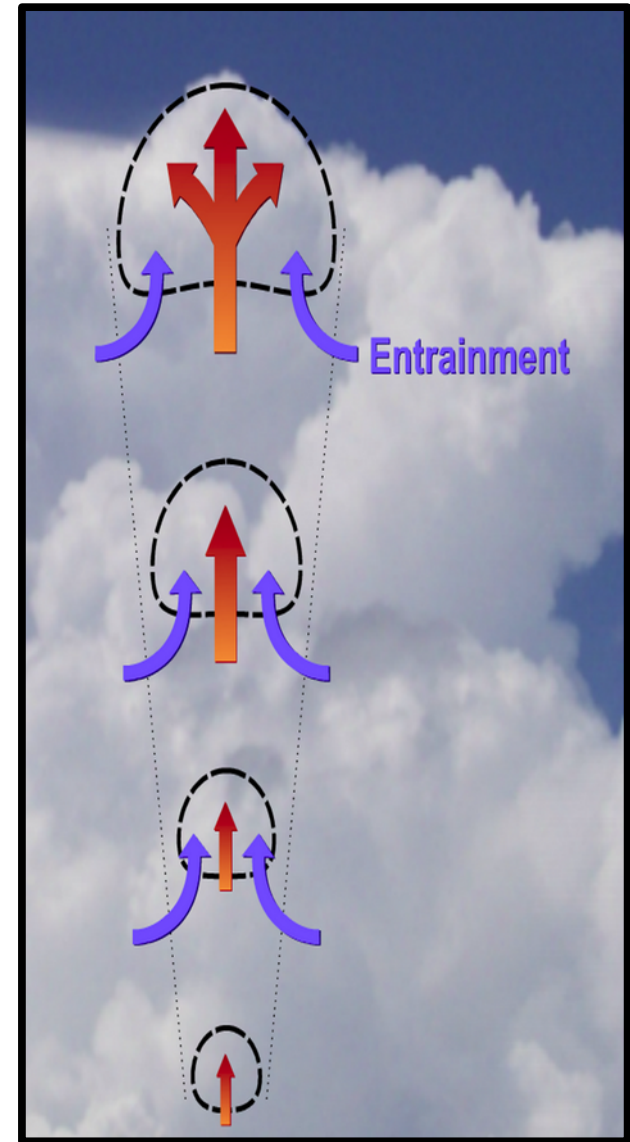
- Air within the cloud mixes with air around the cloud because of turbulent air motions due to the cloud air going up through the environment.
- Entrainment is outside air entering the cloud.
- Detrainment is cloudy air leaving the cloud.
- Cloud air is saturated, surrounding air is unsaturated.
- Mixed air is unsaturated, so cloud particles evaporate.

Entrainment and Detrainment Location



Effects of Cloud Entrainment

- Mixing at the cloud boundary results in evaporation, which is a cooling process.
- Cooling increases air density, causing it to sink.
- The sinking offsets some of the cloud rising motion.
- Drier air works its way toward the interior of the cloud and will eventually stop the updraft.



Precipitation Loading of Clouds

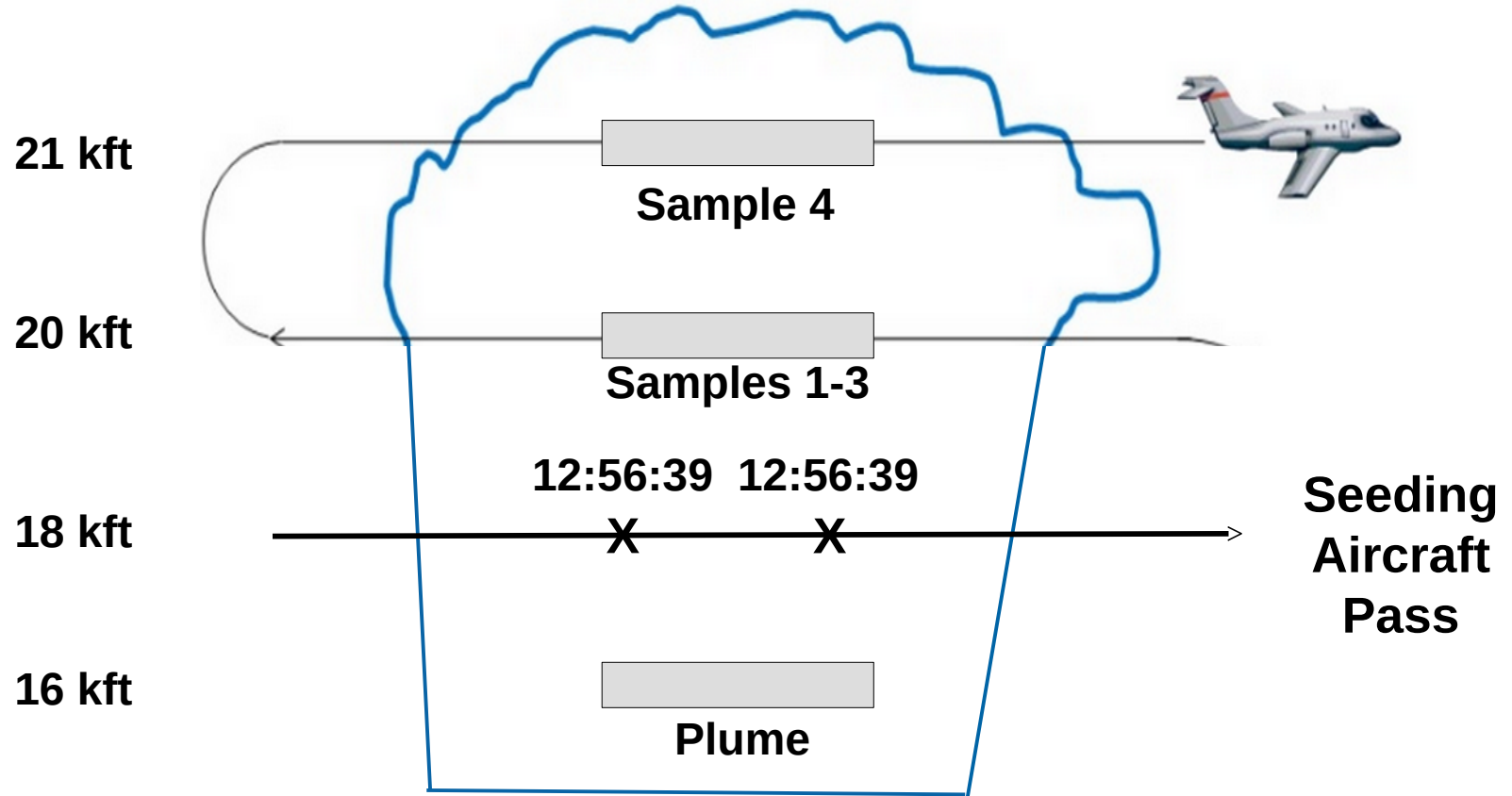
- Precipitation loading refers to the effect of condensed water in the updraft.
- Cloud particles are pulled downward by gravity.
- Particles have increasing drag as they grow.
- Combined drag of all particles slows the upward moving air in the cloud (“updraft”) and reverses the flow from upward to downward (“downdraft”).

Downdraft Effects on Clouds

- As downdraft air moves through sub-saturated air more evaporation cooling occurs.
- Cooling causes the air to accelerate downward.
- Downdraft spreads out horizontally as it nears the ground.
- Leading edge of spreading air (“gust front”) lifts air ahead of it, which may cause new clouds to form.

Sampling Seeded Plumes: Saudi 2023/2024

31 March 2024



MedEd Convection Module

- Principles of Convection I: Buoyancy and CAPE
(<http://www.meted.ucar.edu/mesoprim/cape/>)
- Likely need to create account using University email address.