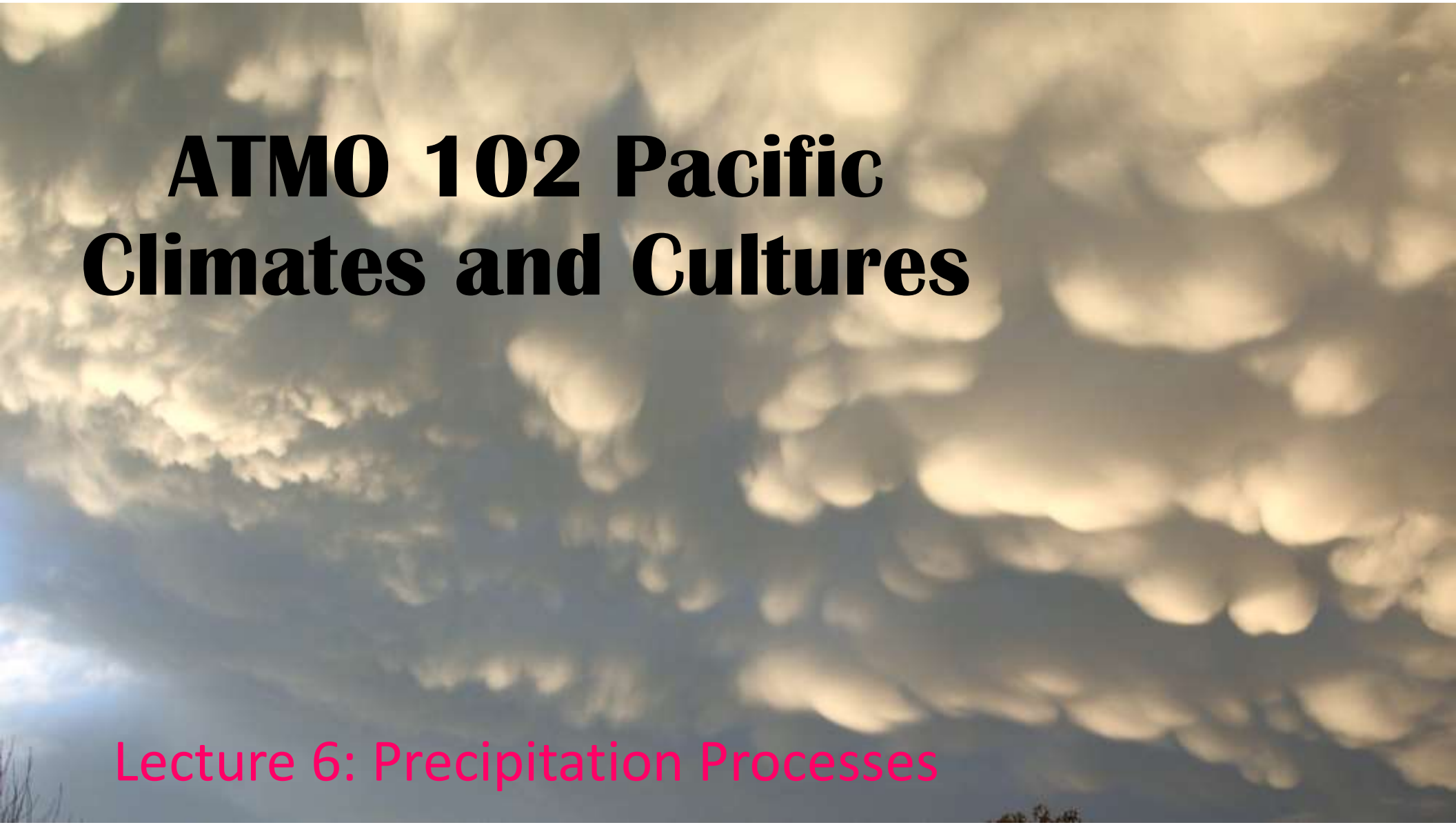
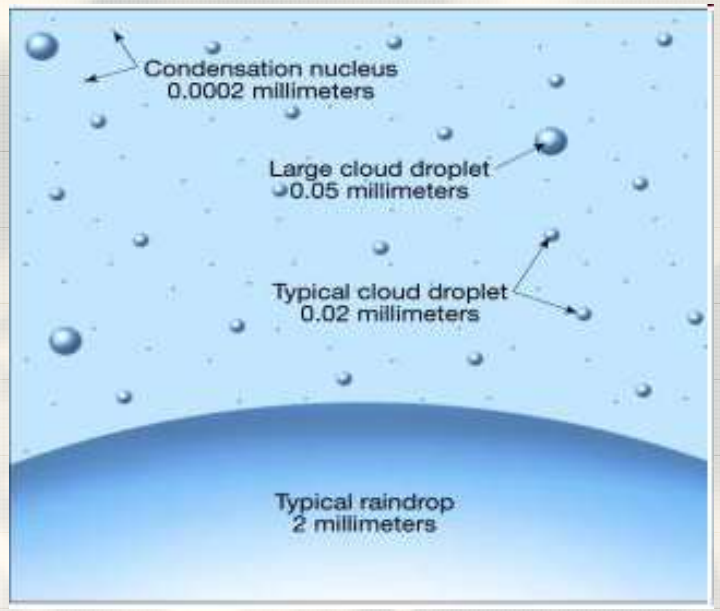
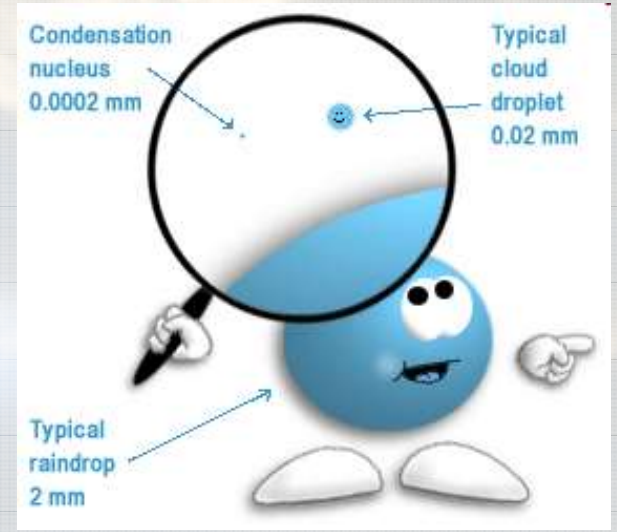


ATMO 102 Pacific Climates and Cultures

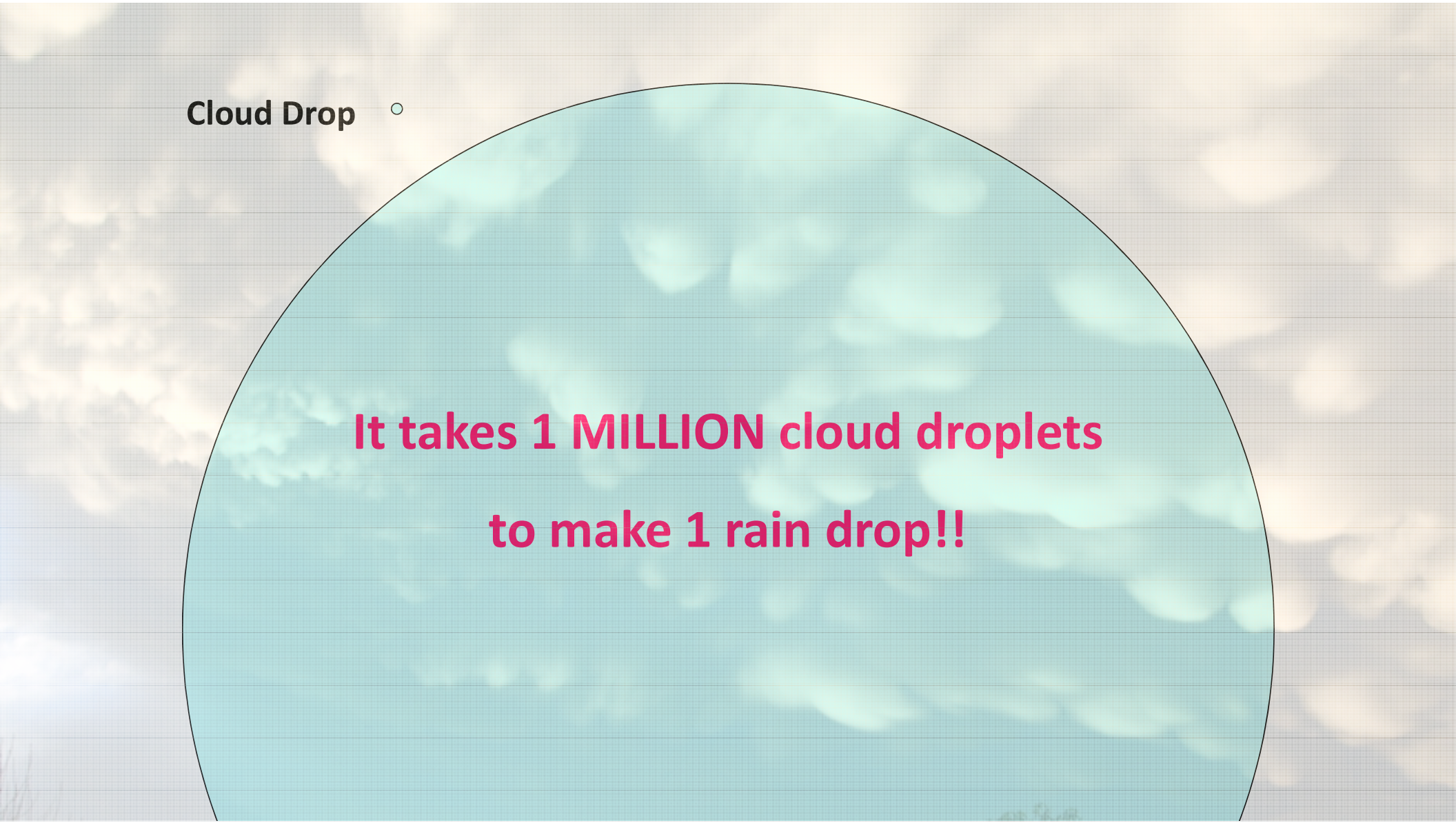
Lecture 6: Precipitation Processes



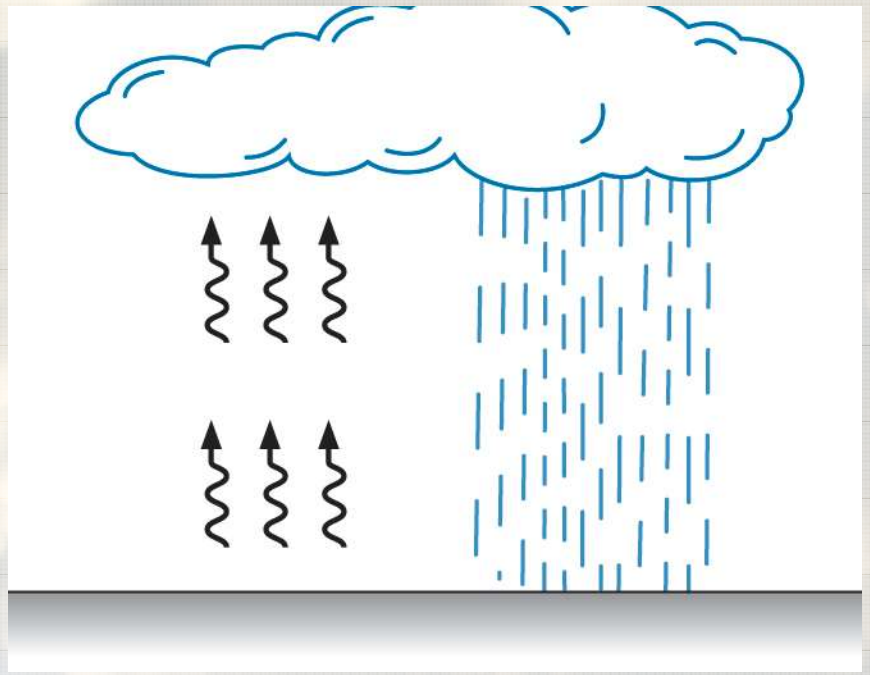


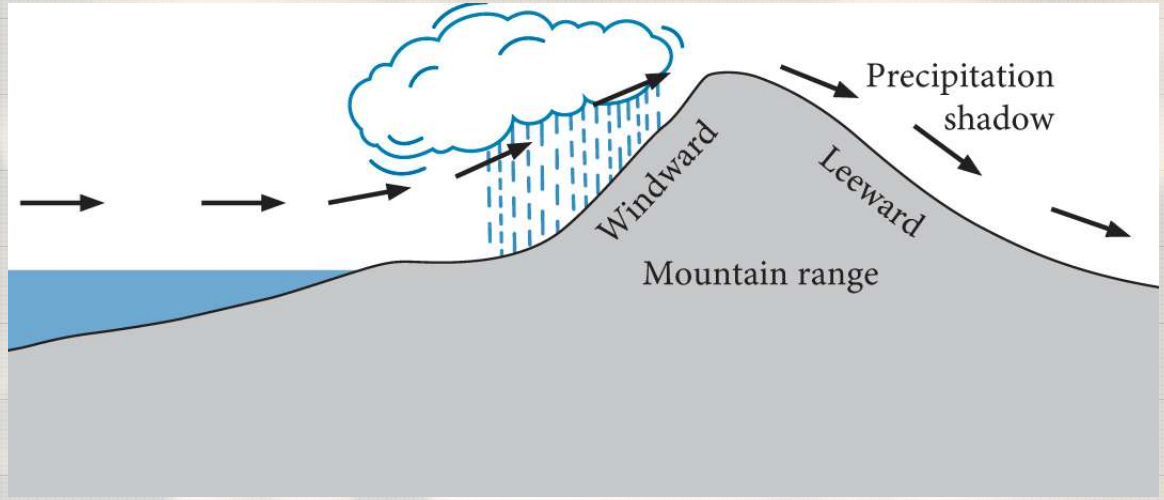
How Precipitation Forms

- It's actually really hard to make a rain drop
  - Cloud drops are **VERY TINY (0.02 mm)**
  - Rain drops are **VERY BIG (2 mm)**
  - **There has to be a mechanism for cloud drops to join together to form rain droplets.**
    - **100 times larger in diameter…. but it's more than that…. it's VOLUME!!!**


Cloud Drop
It takes 1 MILLION cloud droplets
to make 1 rain drop!!

Precipitation Types



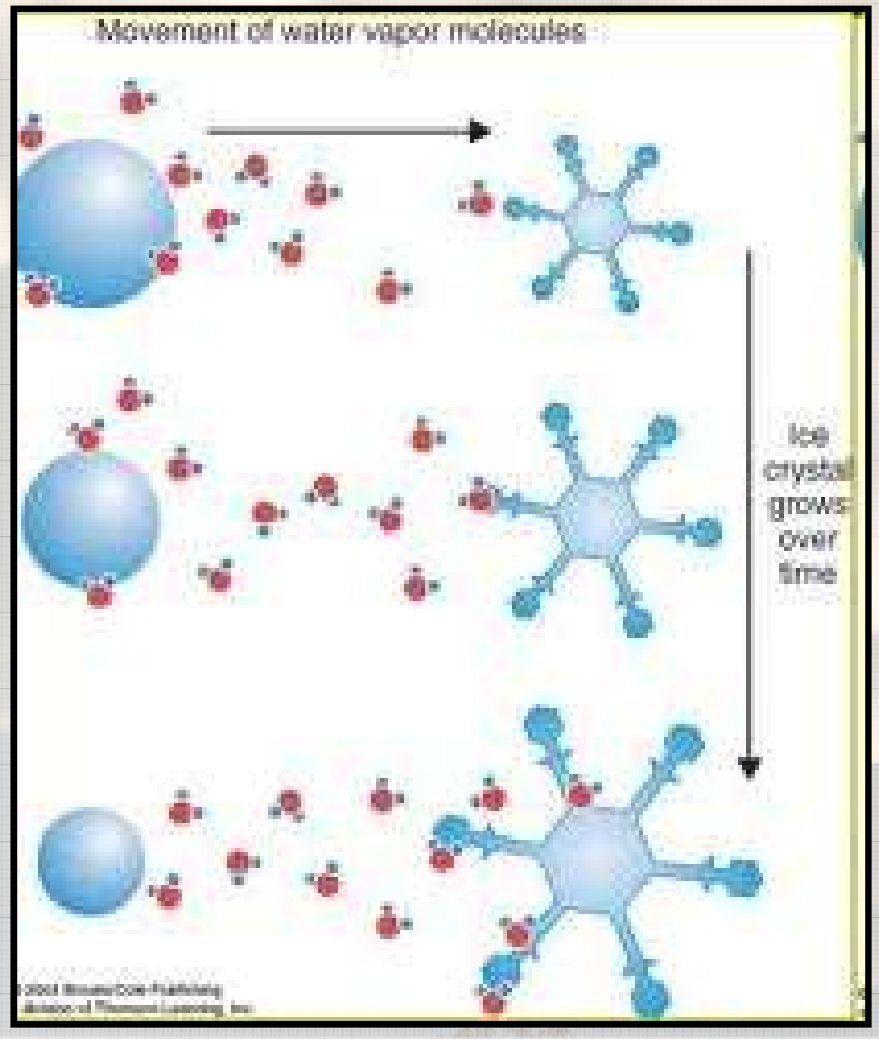


- Precipitation as a result of **local heating** of air at the earth's surface is called **convective precipitation**
- Active in **tropical areas** and **interiors** of continents
- Precipitation is **often local** and **intense** (thunderstorms)

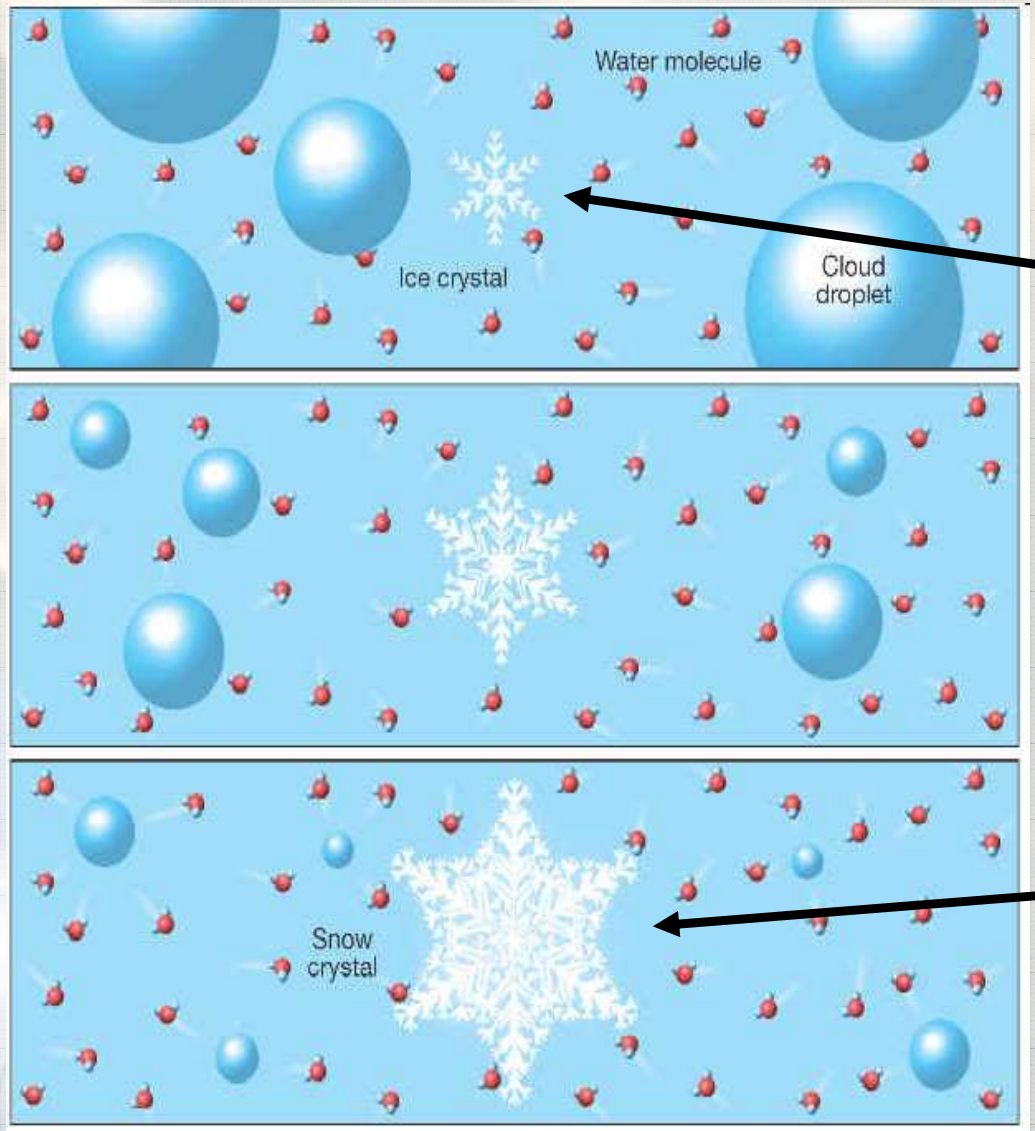
- When **horizontal air currents** are forced to rise over natural **barriers** such as mountains, **orographic precipitation** occurs
- Precipitation **falls** on the **windward** side
- **Leeward side** is the other side which is a **precipitation shadow** area

Precipitation in Cold Clouds

- Ice, water and water vapor exist at the same time.
- Cloud drops **DON'T FREEZE** at 0C!!
- Liquid water won't freeze until -40C
  - **SUPERCOOLED**
- Supercooled water freezes when it touches a **Freezing Nuclei**
  - **FN are rare**



The Bergeron Process

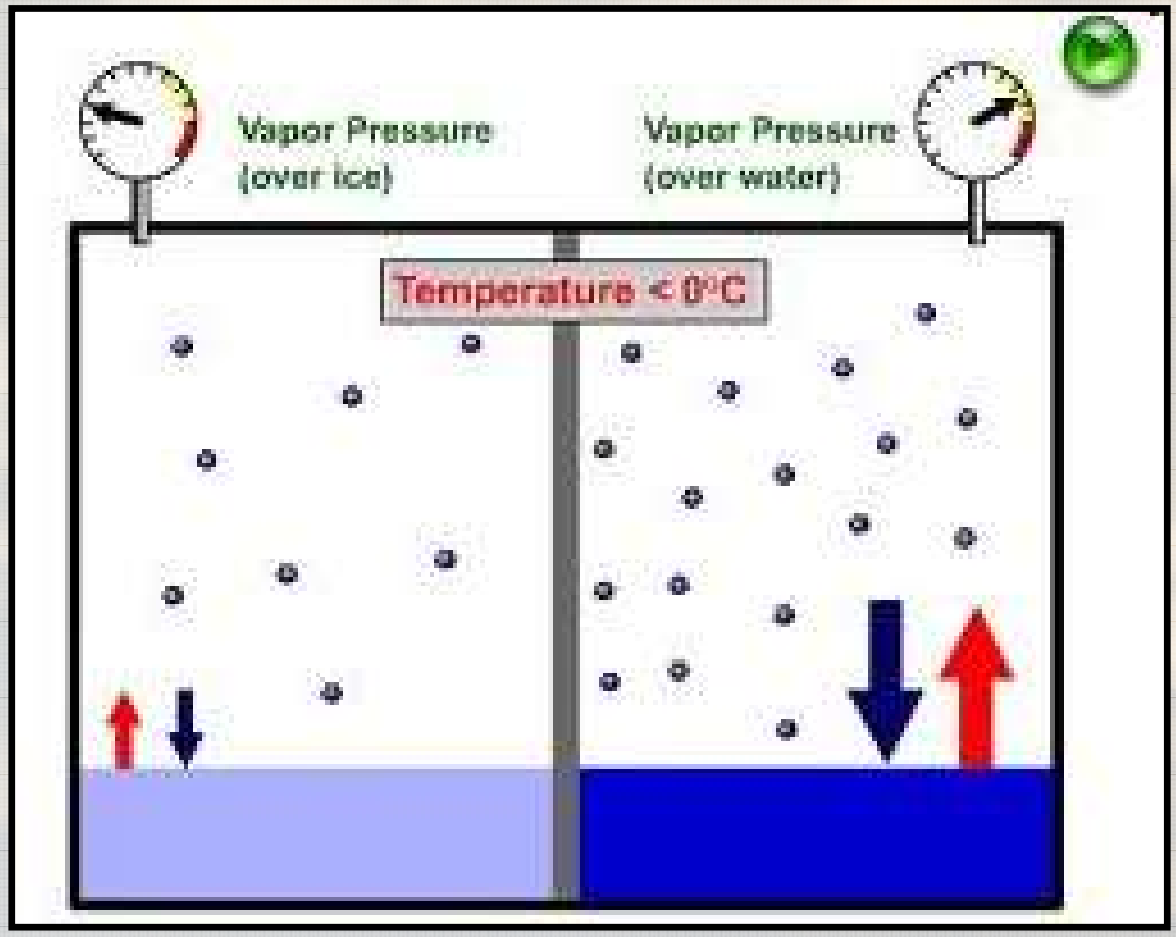


One little ice crystal and lots of water droplets

Grows Bigger by "Stealing" moisture from the Cloud droplets

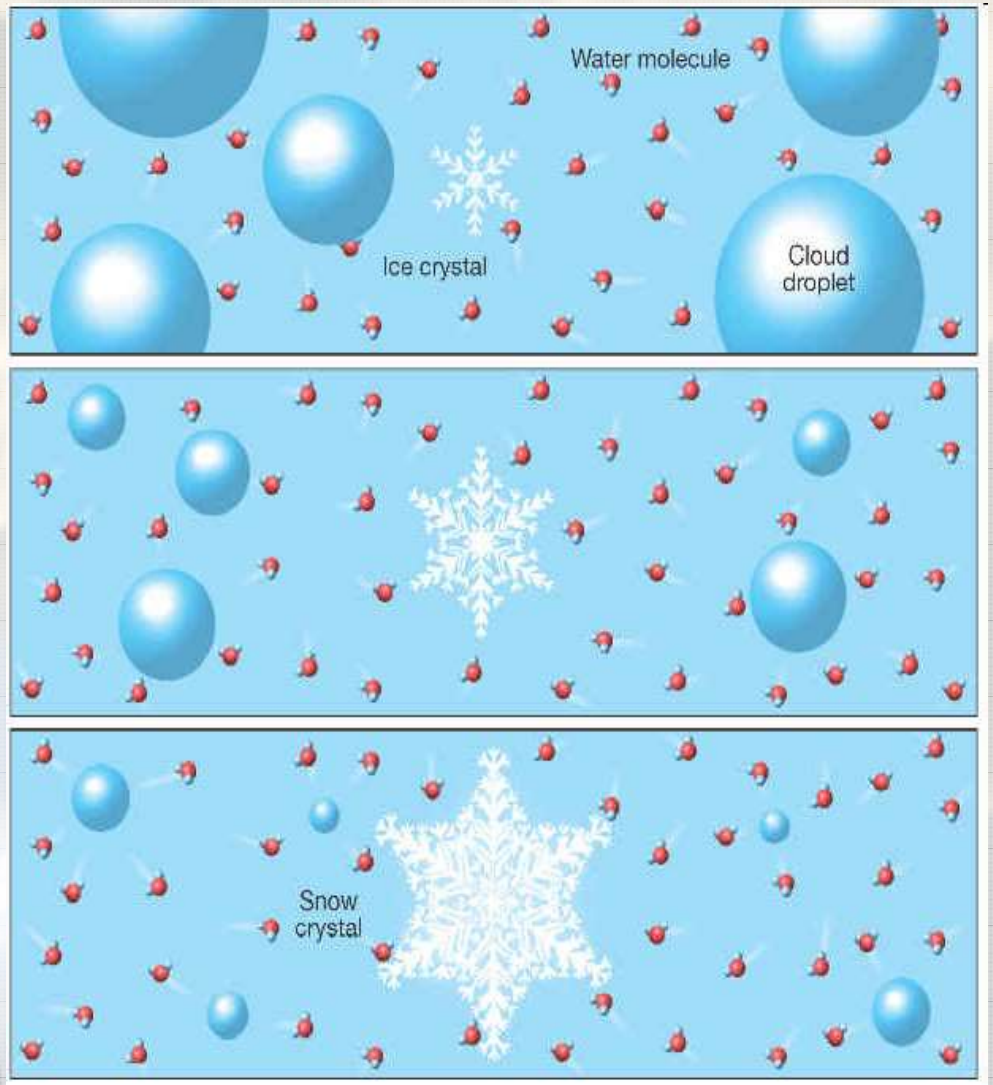
Precipitation in Cold Clouds

- Saturation vapor pressure above ice crystals is somewhat lower than above supercooled liquid droplets
  - **It's easier for water vapor to escape from the supercooled liquid**



Bergeron Process

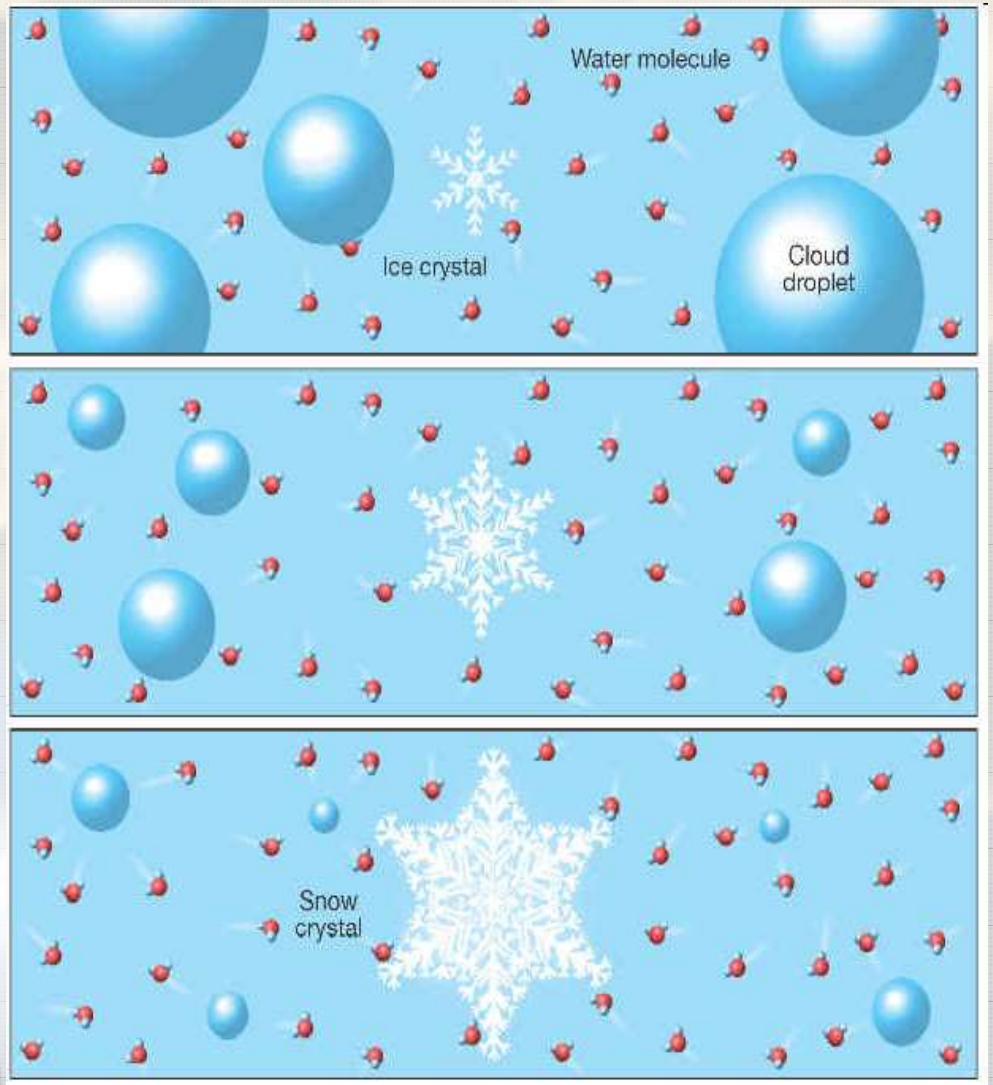
- Eventually the ice crystals will grow **large enough** to fall.
- The Bergeron Process often results in **liquid precipitation**.
  - As the crystals grow and fall, they pass through the base of the cloud, which may be above freezing.
  - This causes the crystals to melt and fall as rain.



The Bergeron Process Summary - 1

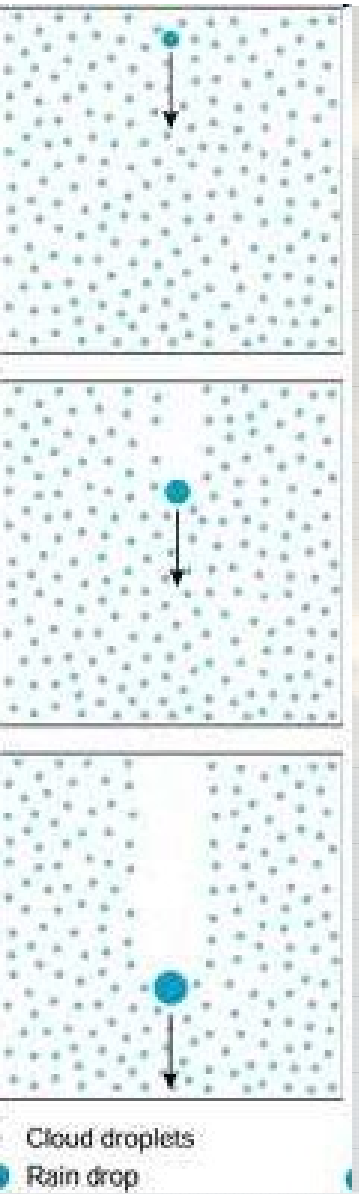
- The air reaches **saturation** and some of the resulting droplets will come in contact with **freezing nuclei** (assuming they have reached the activation temperature).
- There is then a combination of **ice crystals** and **supercooled water droplets**.
- From the perspective of the supercooled droplets, the air is in equilibrium at saturation, but from the perspective of the ice crystals, the air is supersaturated.

The Bergeron Process Summary - 2



- Therefore, **water vapor will sublimate on the ice crystals**. Since the amount of water vapor in the air has decreased, and from the perspective of the supercooled water droplet, the air is subsaturated, the supercooled water will evaporate until the air once again reaches saturation.

- The process then continues. In short summary**, the ice crystal grows through sublimation at the expense of the supercooled water droplet**.



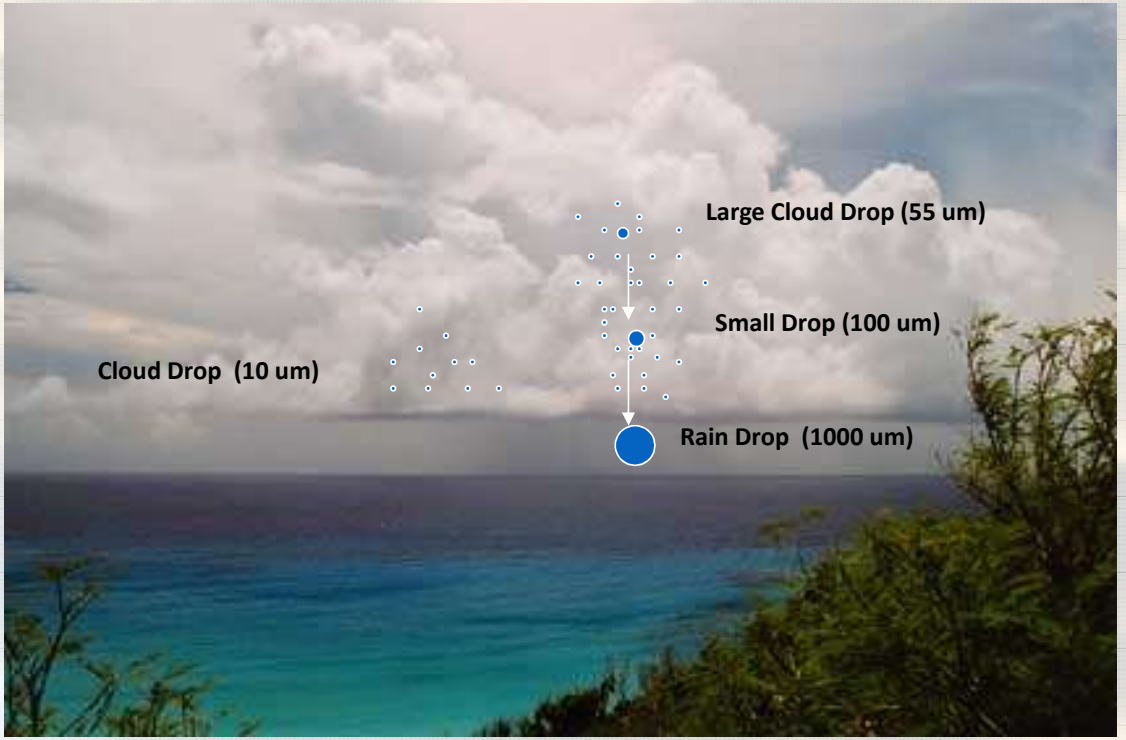
Precipitation in Warm Clouds

- In warm clouds there are no Ice Crystals so the Bergeron Process can't operate

- **Collision-Coalescence** a.k.a. Bump and Stick

- Need **one BIGGER** than average Cloud Drop
  - Really large aerosol (CCN) → Start Big…. End Big
  - Entrainment Mixing (evaporation and redistribution)
  - Turbulence (smashing together of droplets)

Collision-Coalescence

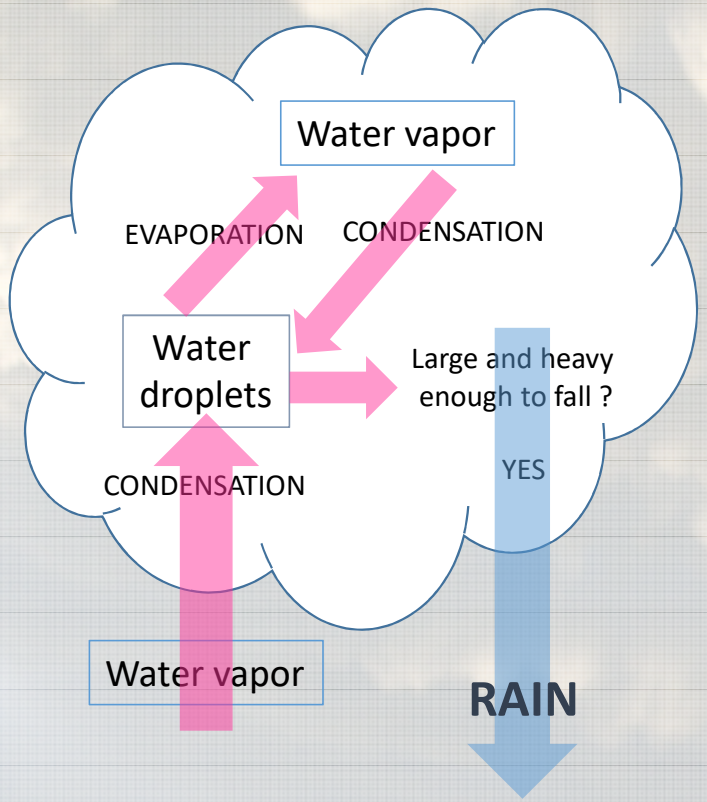


- **Terminal Velocity** matters
  - the highest velocity attainable by an object as it falls through the air.
  - Sum of the **drag force** and **buoyancy** equals the downward force of **gravity**.
  - If cloud drops were all the same size could they bump into each other?
    - **NO**

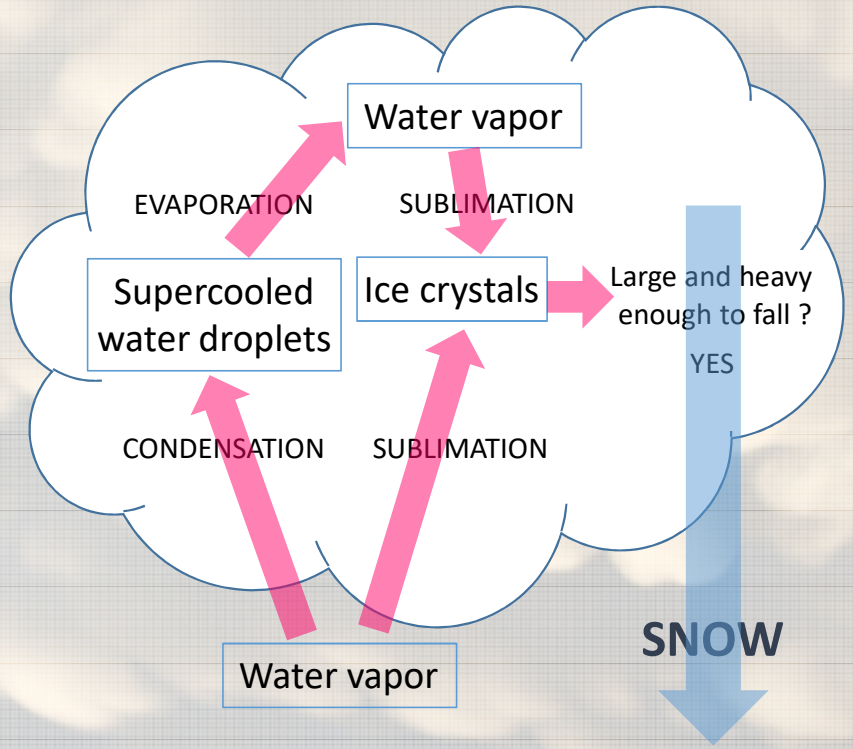
BIG drops fall FASTER than SMALL drops!!!!

Precipitation Summary

Warm cloud

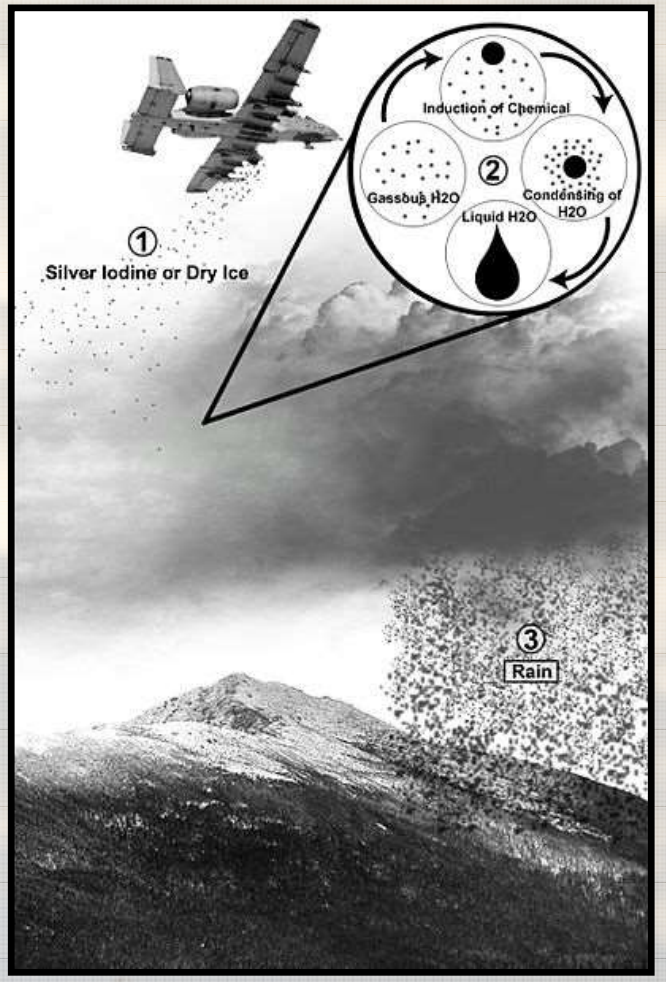


Cold cloud



Cloud Seeding and Precipitation

- Weather Modification is Termed "**WX-Mod**"
- "**Fake Ice**" to simulate the Bergeron Process
  - Dry Ice or Silver Iodide
- Hard to "**prove**" that it actually worked.
- Need the **right ratio of cloud droplets to ice crystals**.
- Concern over toxicity of **silver iodide**.
- You can "**overseed**" a cloud and too many ice crystals are formed so it doesn't rain
  - You can also "overseed" cold fog with dry ice to dissipate it.

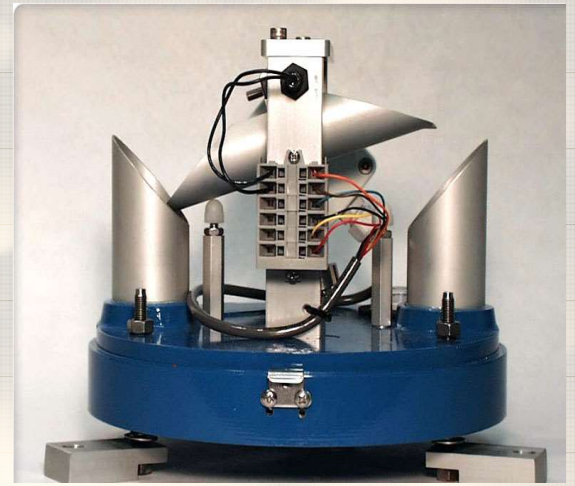


Precipitation Measurement

A **rain gauge** (also known as an **udometer, pluviometer, ombrometer**) is a type of instrument used by meteorologists and hydrologists to gather and measure the amount of liquid precipitation over a set period of time.

The standard NWS rain gauge, developed around the start of the 20th century, consists of a funnel emptying into a graduated cylinder, 2 cm in diameter, that fits inside a larger container which is 20 cm in diameter and 50 cm tall.

A **weighing-type precipitation** gauge consists of a storage bin, which is weighed to record the mass.



The **tipping bucket rain gauge** consists of a funnel that collects and channels the precipitation into a small seesaw-like container. After a pre-set amount of precipitation falls, the lever tips, dumping the collected water and sending an electrical signal.