Precipitation
AOSC 200

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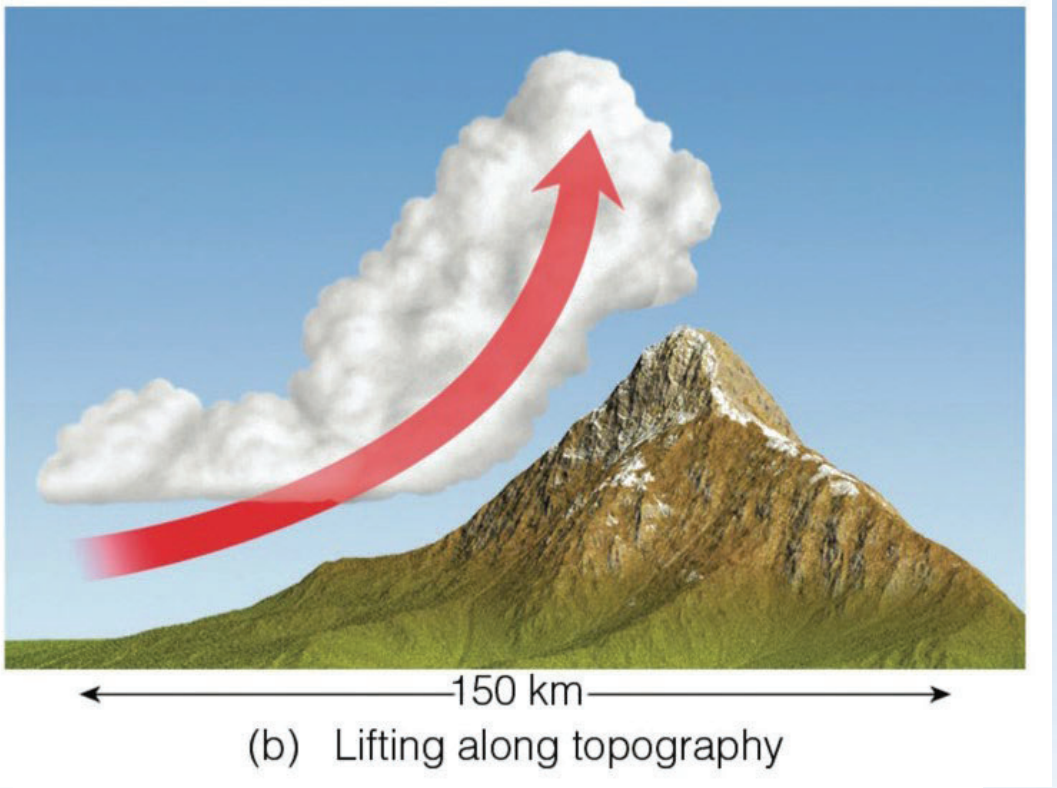
Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

Precipitation formation
Rain
Ice

Lecture 14
Oct 10 2019

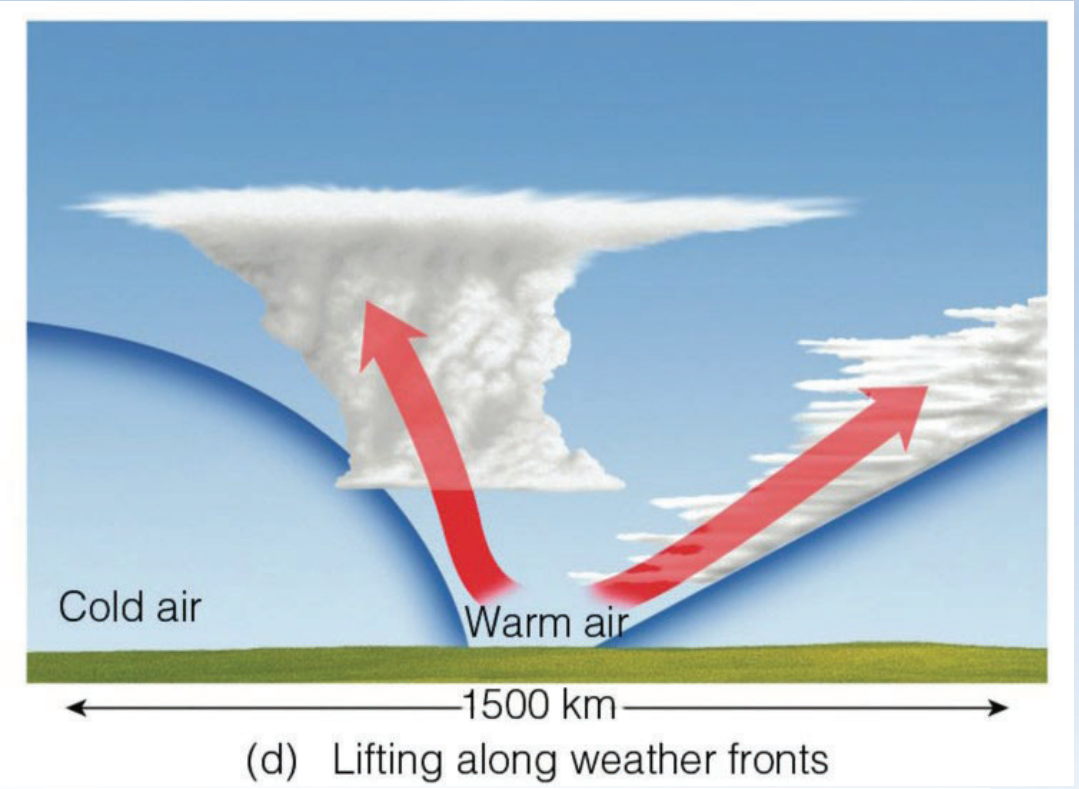
Cloud Development: Orographic Lifting



Air is forced up the side of a mountain and cools as it rises

Fig 5.10: ***Essentials of Meteorology***

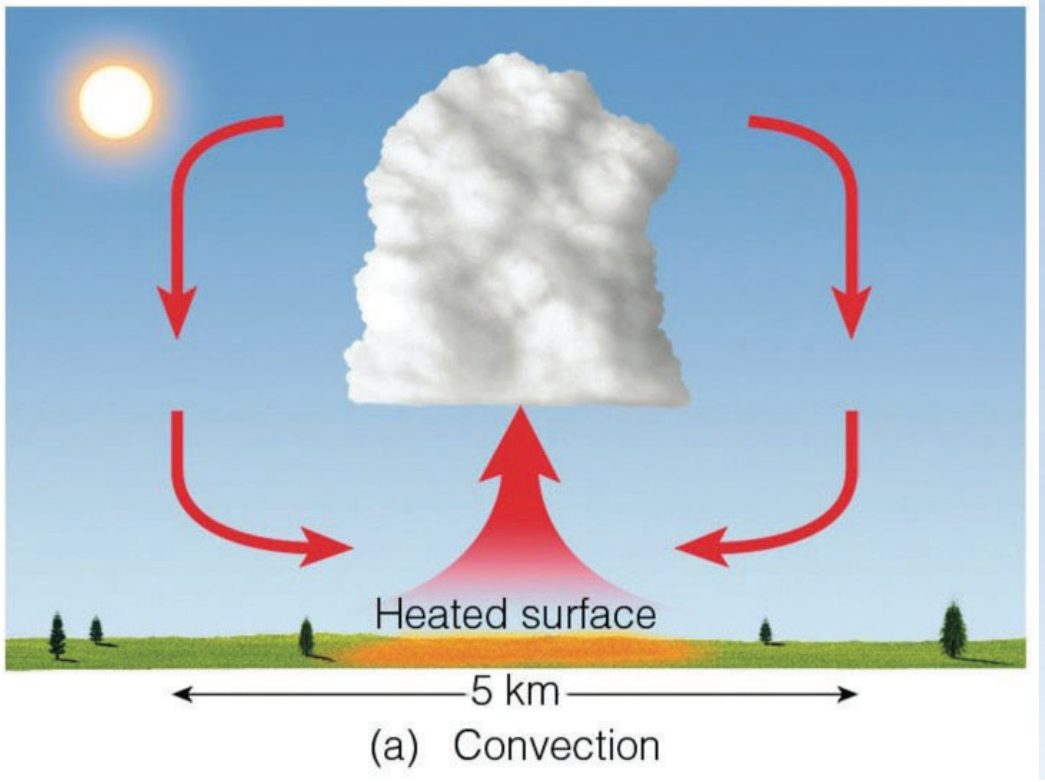
Cloud Development: Frontal Lifting



A cold front will lift warm air that it comes in contact with

Fig 5.10: ***Essentials of Meteorology***

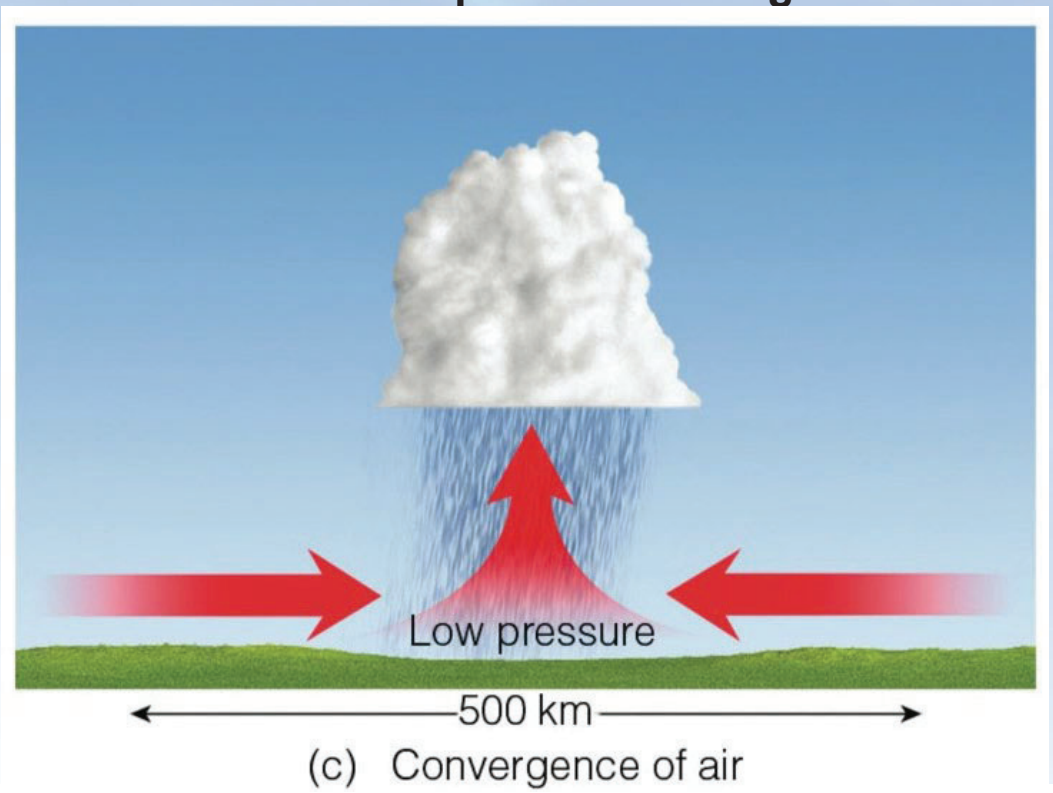
Cloud Development: Convection



As surface air is warmed by the sun, it becomes less dense and rises

Fig 5.10: ***Essentials of Meteorology***

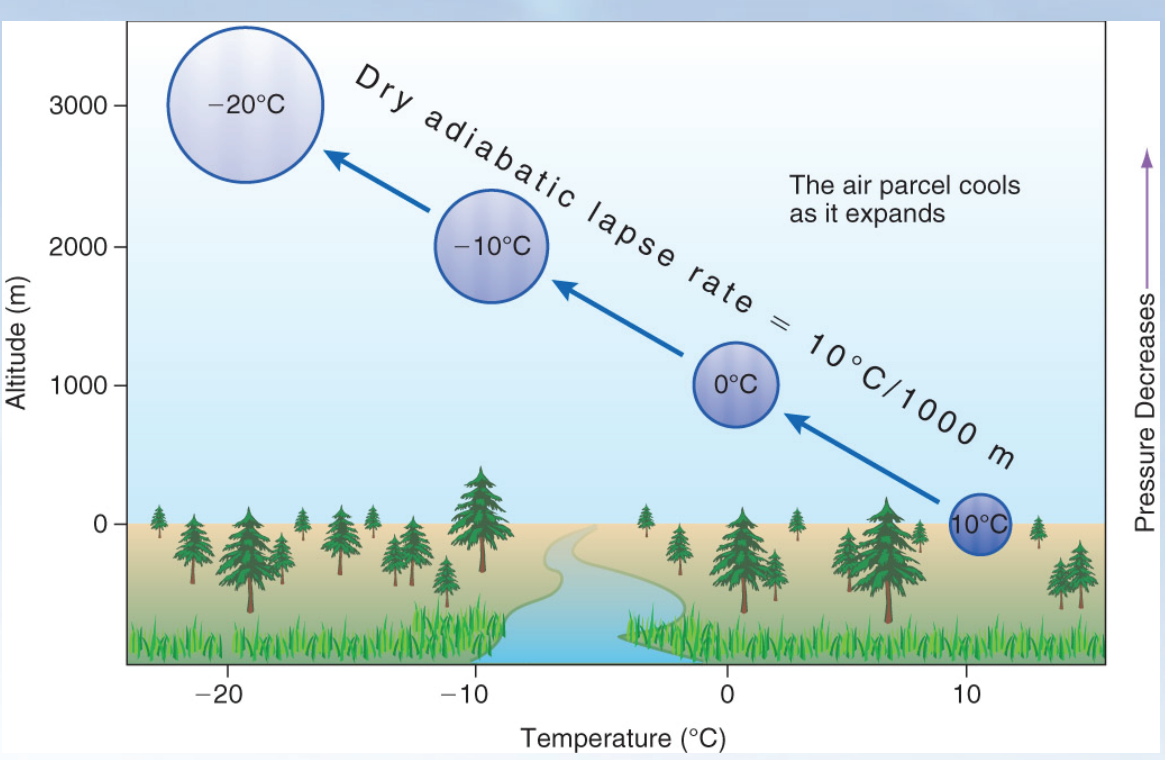
Cloud Development: Convergence



When wind meets from different directions, the air in between has no place to go but up

Fig 5.10: ***Essentials of Meteorology***

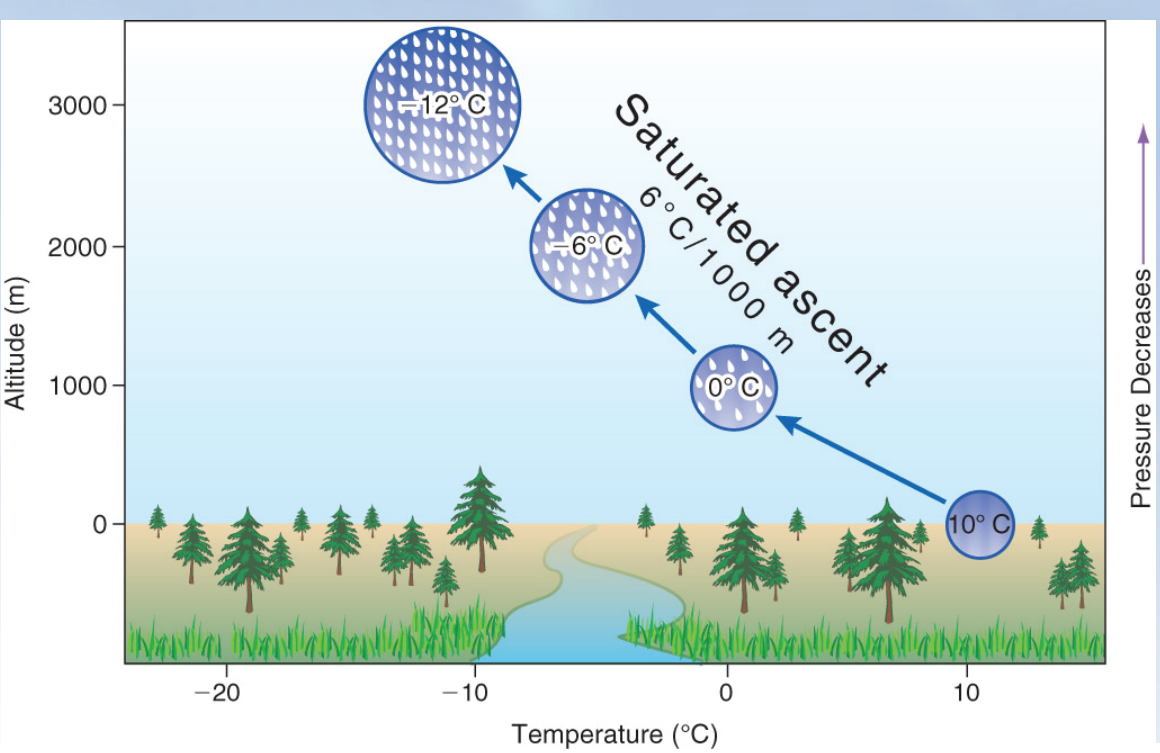
Lapse Rate



Dry adiabatic lapse rate: if no cloud forms, air will cool at 10°C per kilometer.

Fig 3-19 *Meteorology: Understanding the Atmosphere*

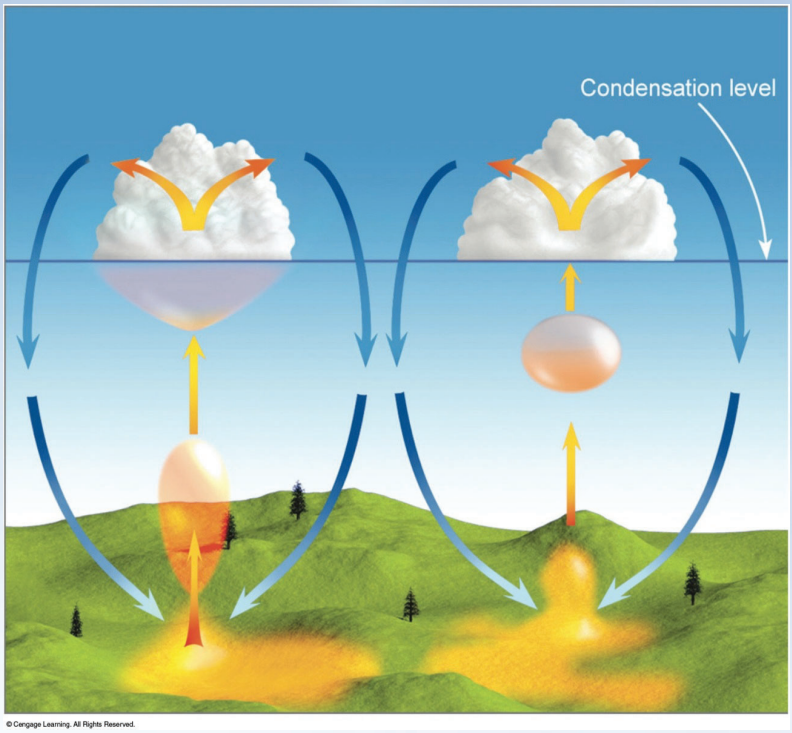
Saturated Adiabatic Lapse Rate



Once water begins to condense, latent heat is released. The air parcel cools at a slower rate than if the air parcel was dry

Fig 4-14 *Meteorology: Understanding the Atmosphere*

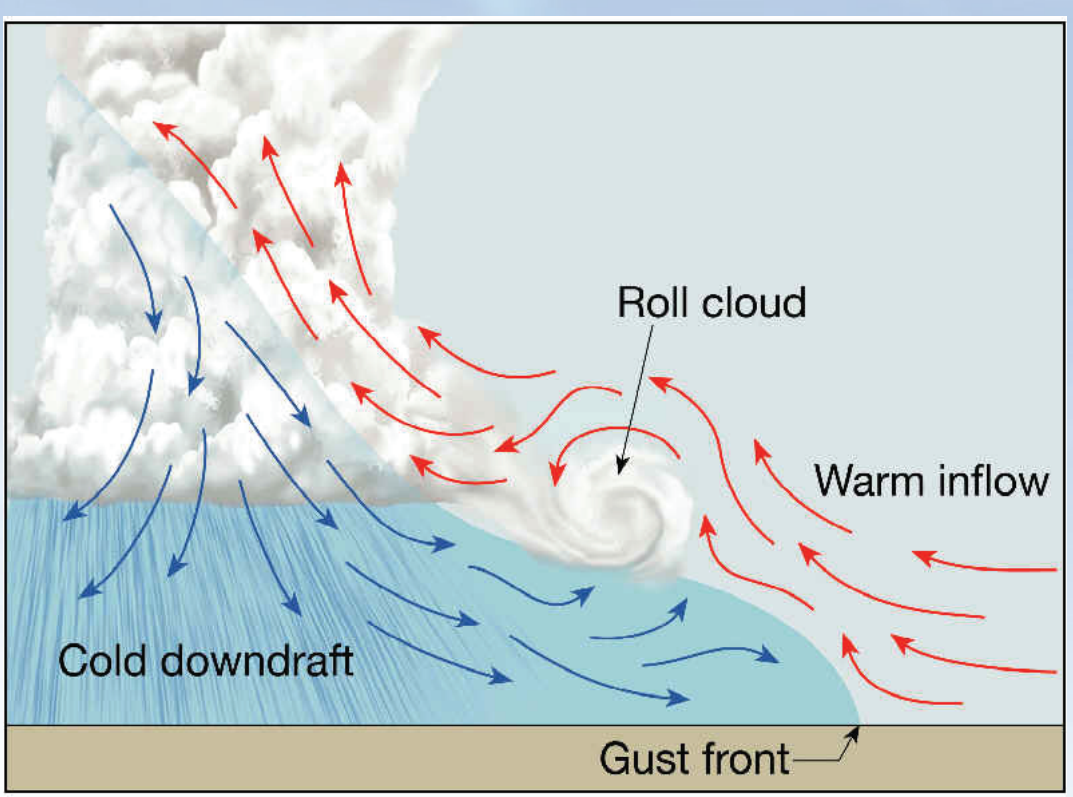
Cloud Development: Convection



Hot air rises. Some evaporation occurs outside of cloud
Cold air sinks, replaces the warm surface air, heats and rises

Fig 5.11: ***Essentials of Meteorology***

Roll Clouds



http://www.geography.hunter.cuny.edu/tbw/wc.notes/10.thunderstorms.tornadoes/roll_cloud_diagram.htm

How Does Precipitation Really Form: Collision and Coalescence: water

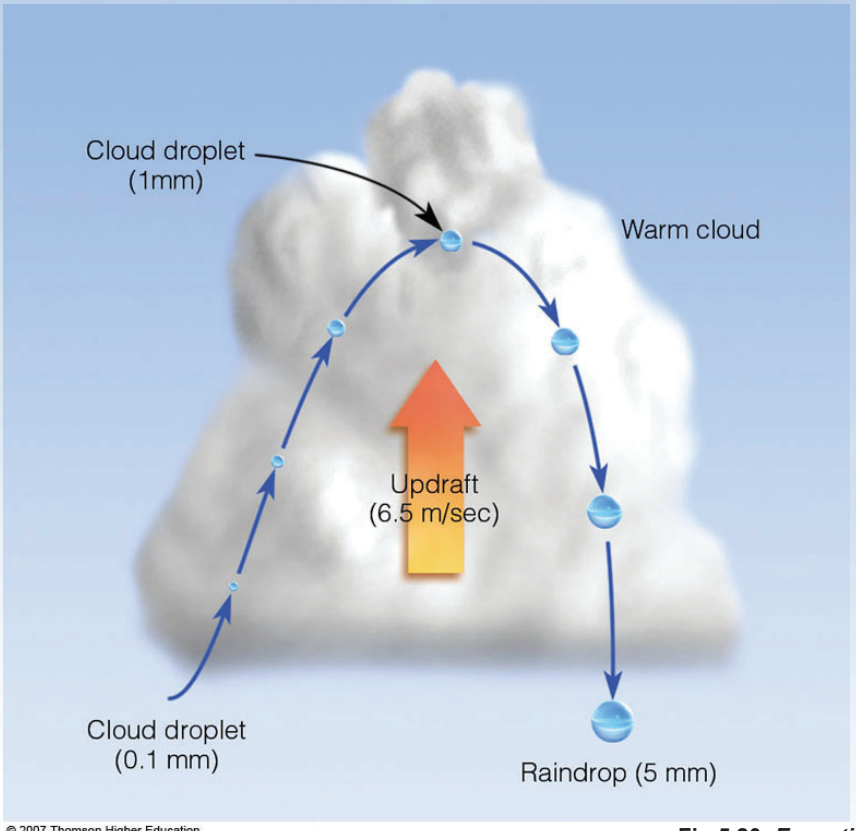
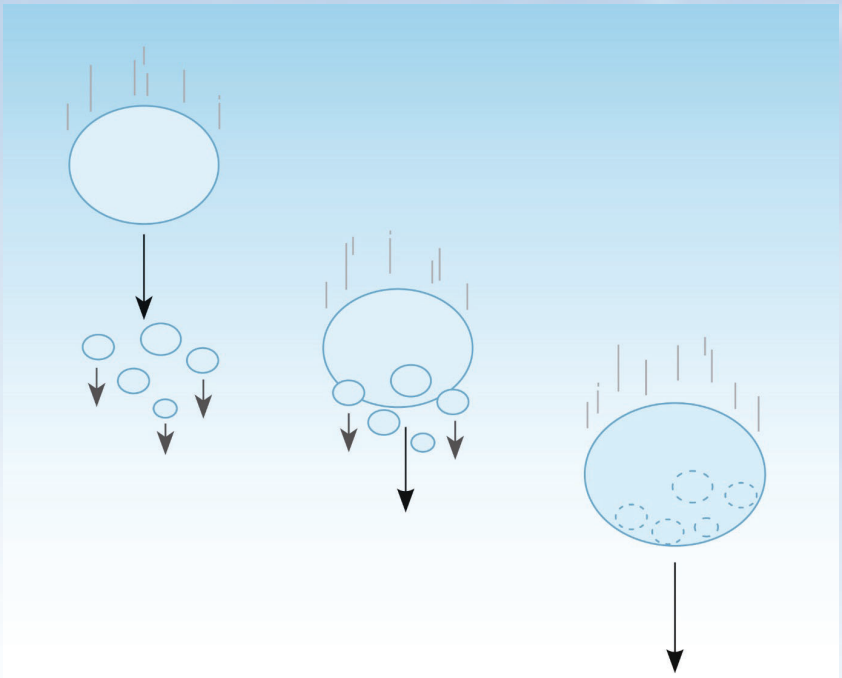


Fig 5.20: ***Essentials of Meteorology***

How Does Precipitation Really Form: Collision and Coalescence: water



When the large drops fall, they hit small drops

The big drops get even bigger.

Some small drops are moving upward when they get hit

Some small drops get trapped in the wake of the big drop

Fig 7.2 *Weather: A Concise Introduction*

Water Phases Within a Cloud

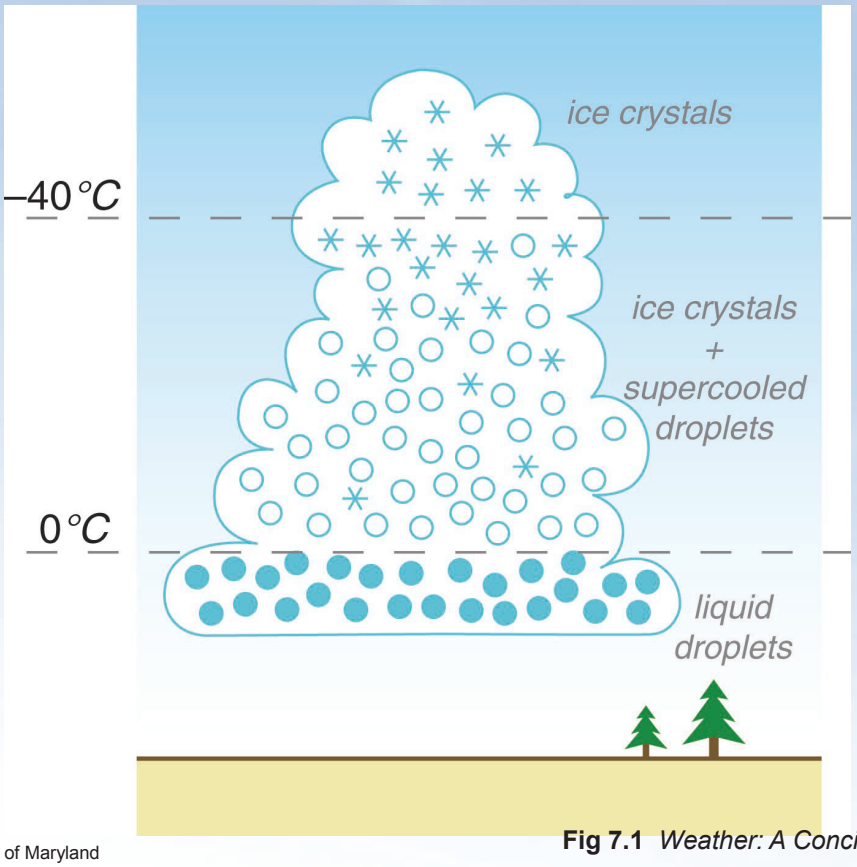
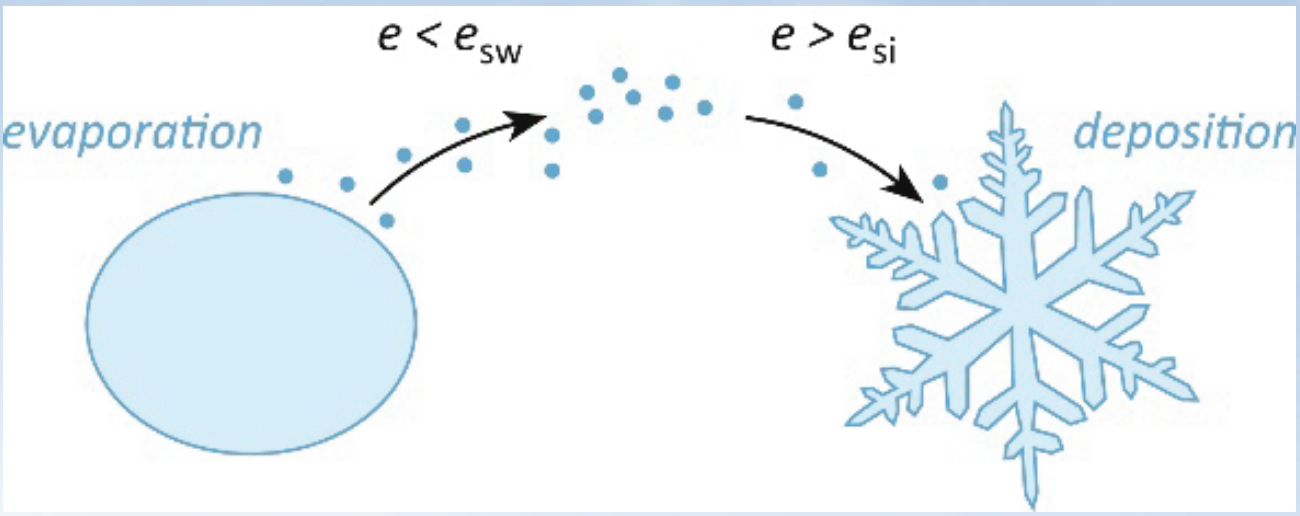


Fig 7.1 *Weather: A Concise Introduction*

How Does Precipitation Really Form: Accretion and Aggregation: Ice

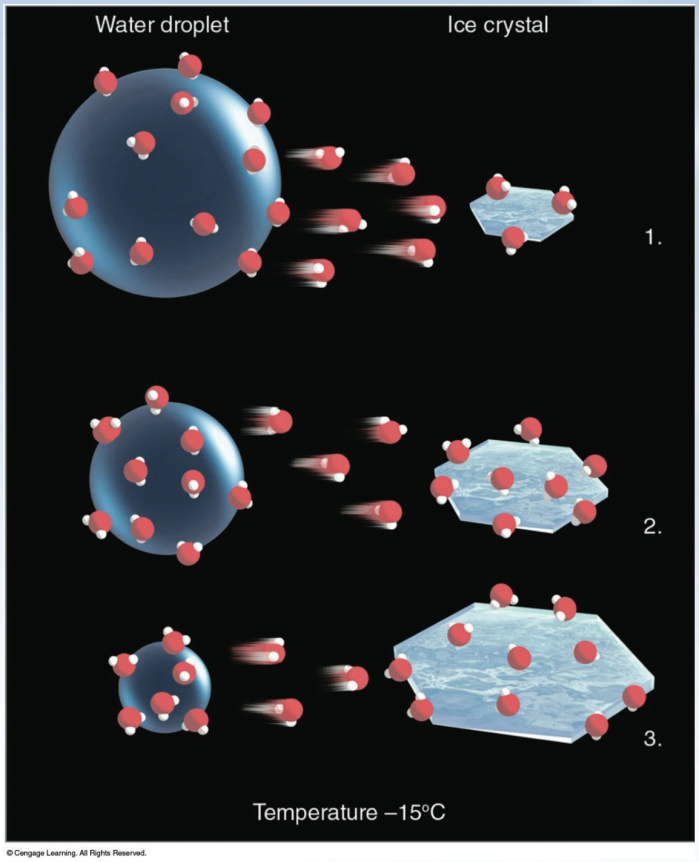


This is known as the Bergeron Process

It's harder for water vapor to exist over ice than water

Fig 7.5 *Weather: A Concise Introduction*

Water vs. Ice



It's easier for water molecules to leave the droplet than to leave the ice

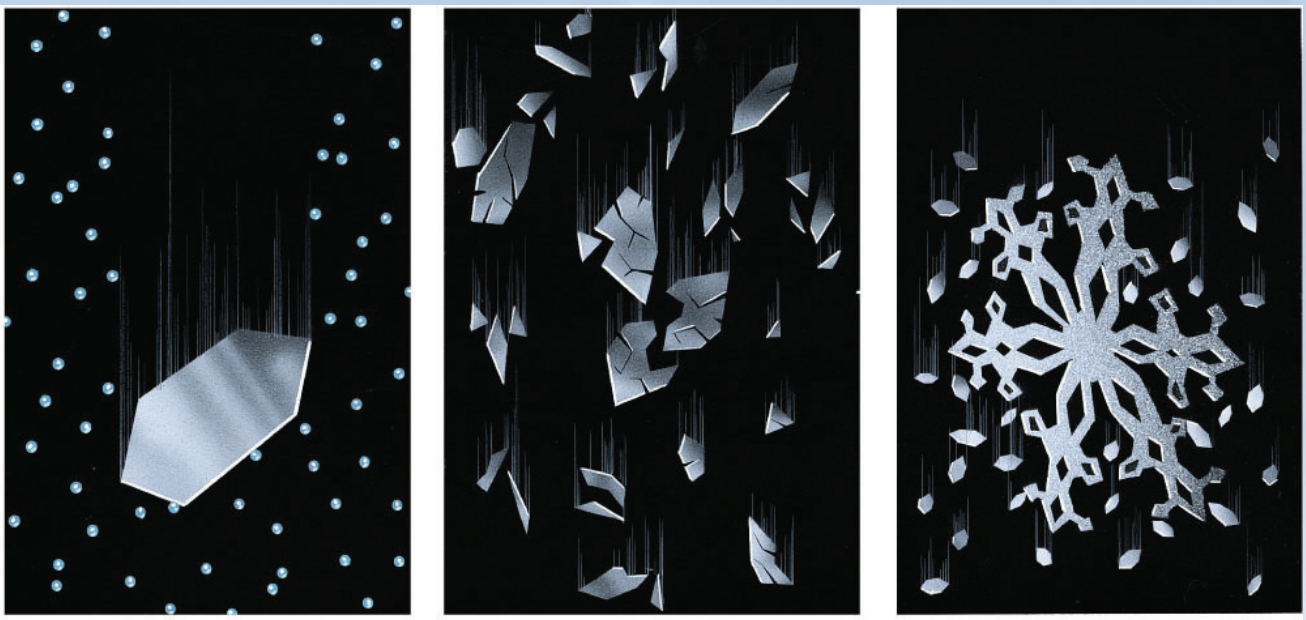
Water vapor leaves the droplet and sticks to the ice

The ice crystal grows while the droplet shrinks

Ice Wins!!!!

Fig 5.23: ***Essentials of Meteorology***

How Does Precipitation Really Form: Accretion and Aggregation: Ice



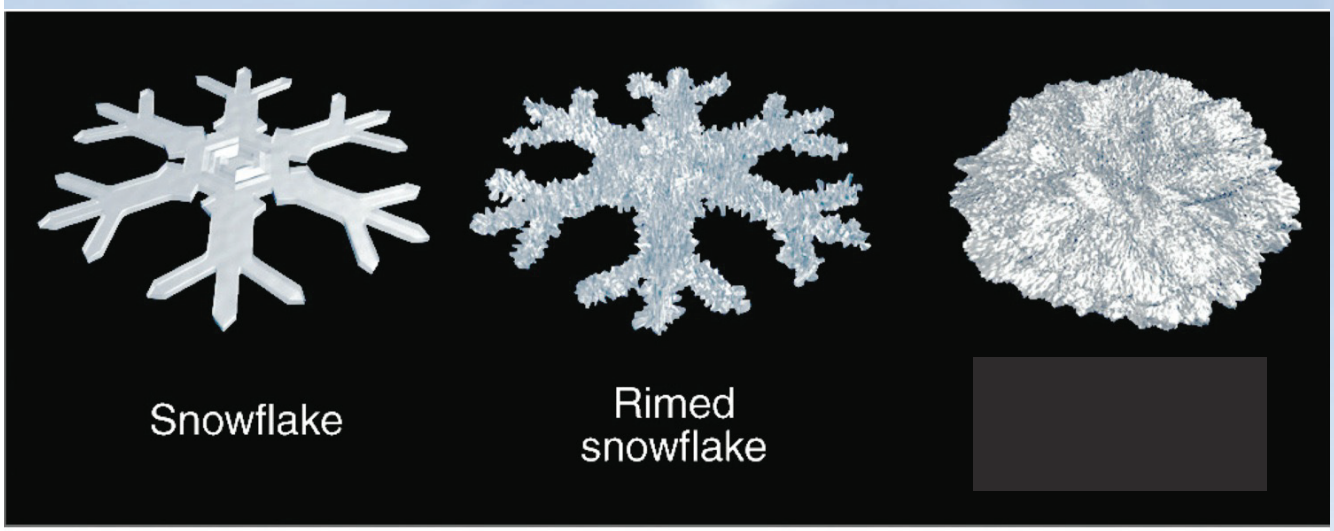
(a) Falling ice crystals may freeze supercooled droplets on contact (accretion), producing larger ice particles.

(b) Falling ice particles may collide and fracture into many tiny (secondary) ice particles.

(c) Falling ice crystals may collide and stick to other ice crystals (aggregation), producing snowflakes.

Fig 5.24: ***Essentials of Meteorology***

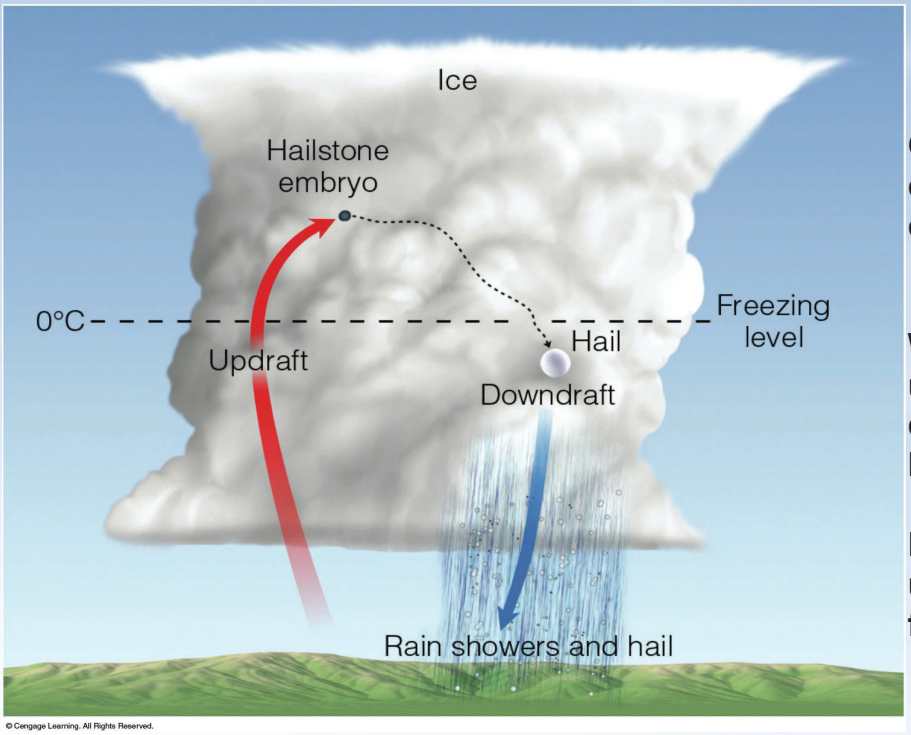
Best word in science coming up!!!!



wait for it…..

Fig 5.38: ***Essentials of Meteorology***

Hail



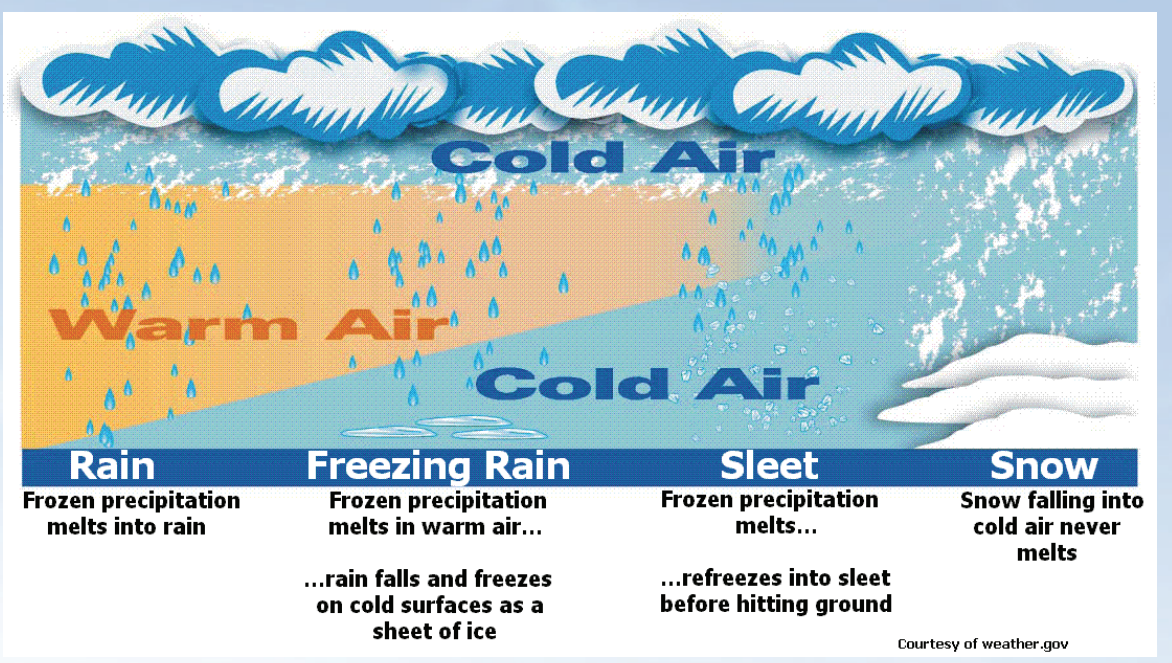
Cold water can freeze on contact to a cold condensation nuclei

While the ice is in the updraft it can cycle up and down or be moved horizontally

Layers of ice are added until eventually it falls from the cloud

Fig 5.41: ***Essentials of Meteorology***

Temperature determines the type of precipitation



The type of precipitation that reaches the ground depends on the temperature profile of the atmosphere

Updrafts and Downdrafts

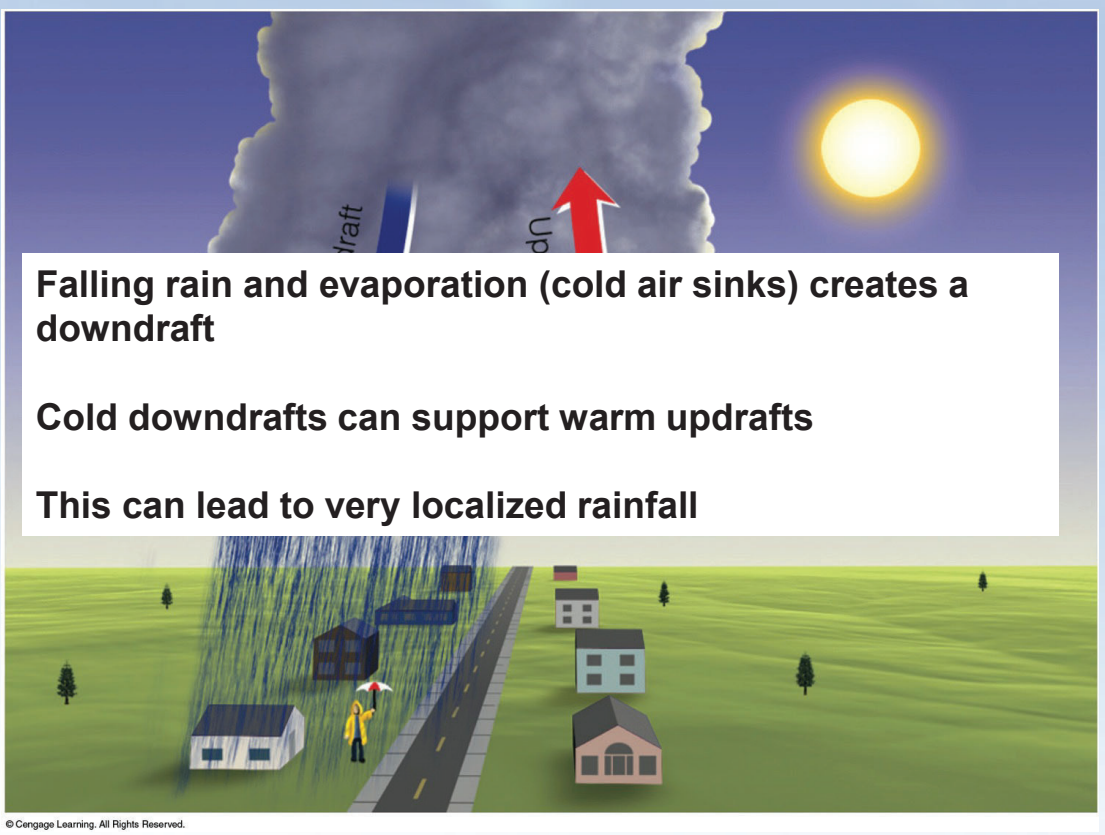


Fig 5.28: ***Essentials of Meteorology***

Rain: Falling drops of water larger than 0.02 inch in diameter. In forecasts, "rain" usually implies that the rain will fall steadily over a period of time. (See "showers" below).

Light rain: Falls at the rate of 0.10 inch or less an hour.

Moderate rain: Falls at the rate of 0.11 to 0.30 inch an hour.

Heavy rain: Falls at the rate of 0.30 inch an hour or more.

Drizzle: Falling drops of water smaller than 0.02 inch in diameter. They appear to float in air currents, but unlike fog, do fall to the ground.

Light drizzle: Drizzle with visibility of more than 5/8 of a mile.

Moderate drizzle: Drizzle with visibility from 5/16 to 5/8 of a mile.

Heavy drizzle: Drizzle with visibility of less than 5/16 of a mile.

Showers: Rain that falls intermittently over a small area. The rain from an individual shower can be heavy or light, but doesn't cover a large area or last more than an hour or so.

rain is steady and continuous, showers start and stop abruptly and can vary in intensity

Snow Flurries: light snow falling for short durations. Little to no accumulation. The most accumulation that can be expected is a light snow dusting.

Snow Showers: Snow falling at varying intensities for brief periods of time. Some accumulation is possible, but not guaranteed.

Snow Squalls: intense, but limited duration, period of moderate to heavy snowfall, accompanied by strong, gusty surface winds and possibly lightning (generally moderate to heavy snow showers). Snow accumulation may be significant.

Blizzards: Winds over 35 mph. Visibility is often near zero. Significant accumulations of snow likely

How are clouds REALLY formed?

To answer this… we should answer some other questions

Aerosols (really tiny!!!!)

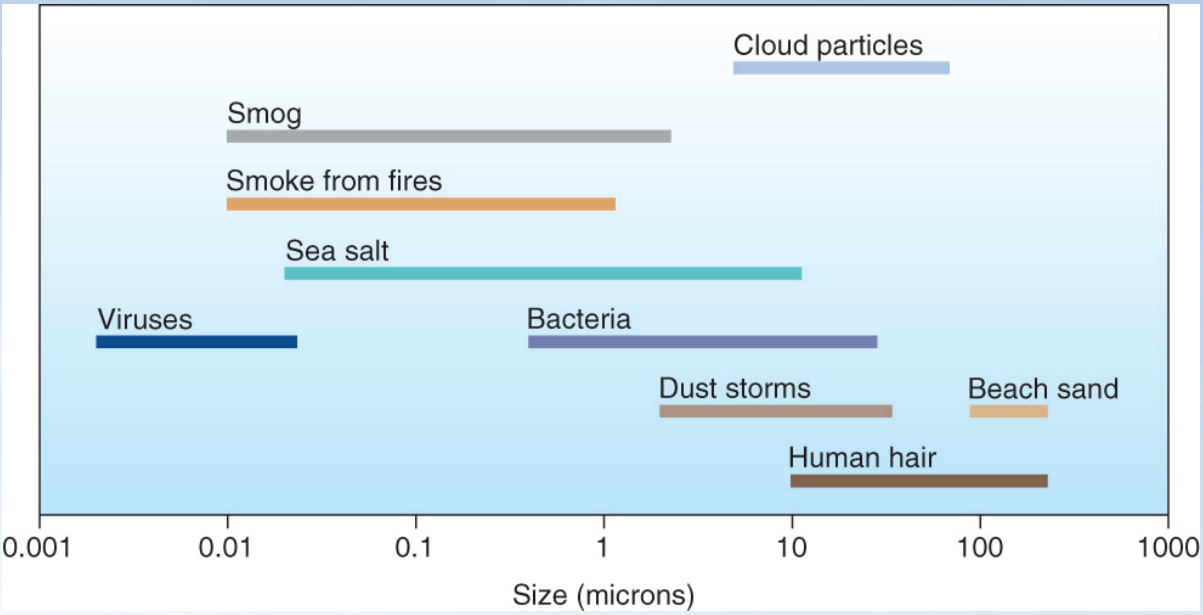


Fig 1-10 *Meteorology: Understanding the Atmosphere*

Condensation Nuclei

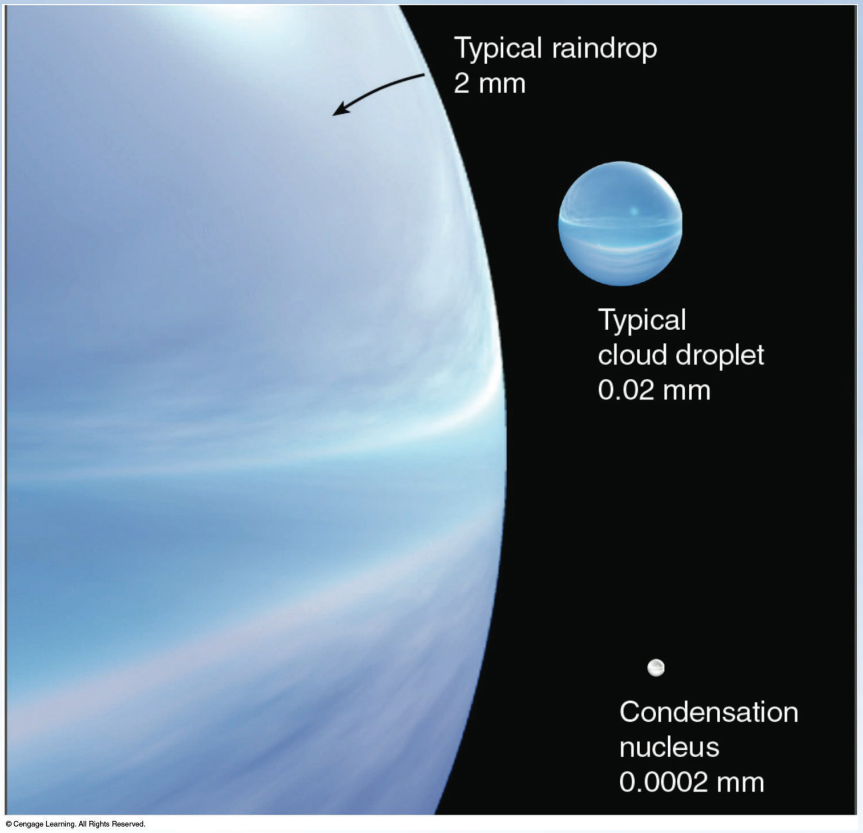


Fig 5.18: ***Essentials of Meteorology***