Fundamentals of synoptic meteorology

Lecture 19

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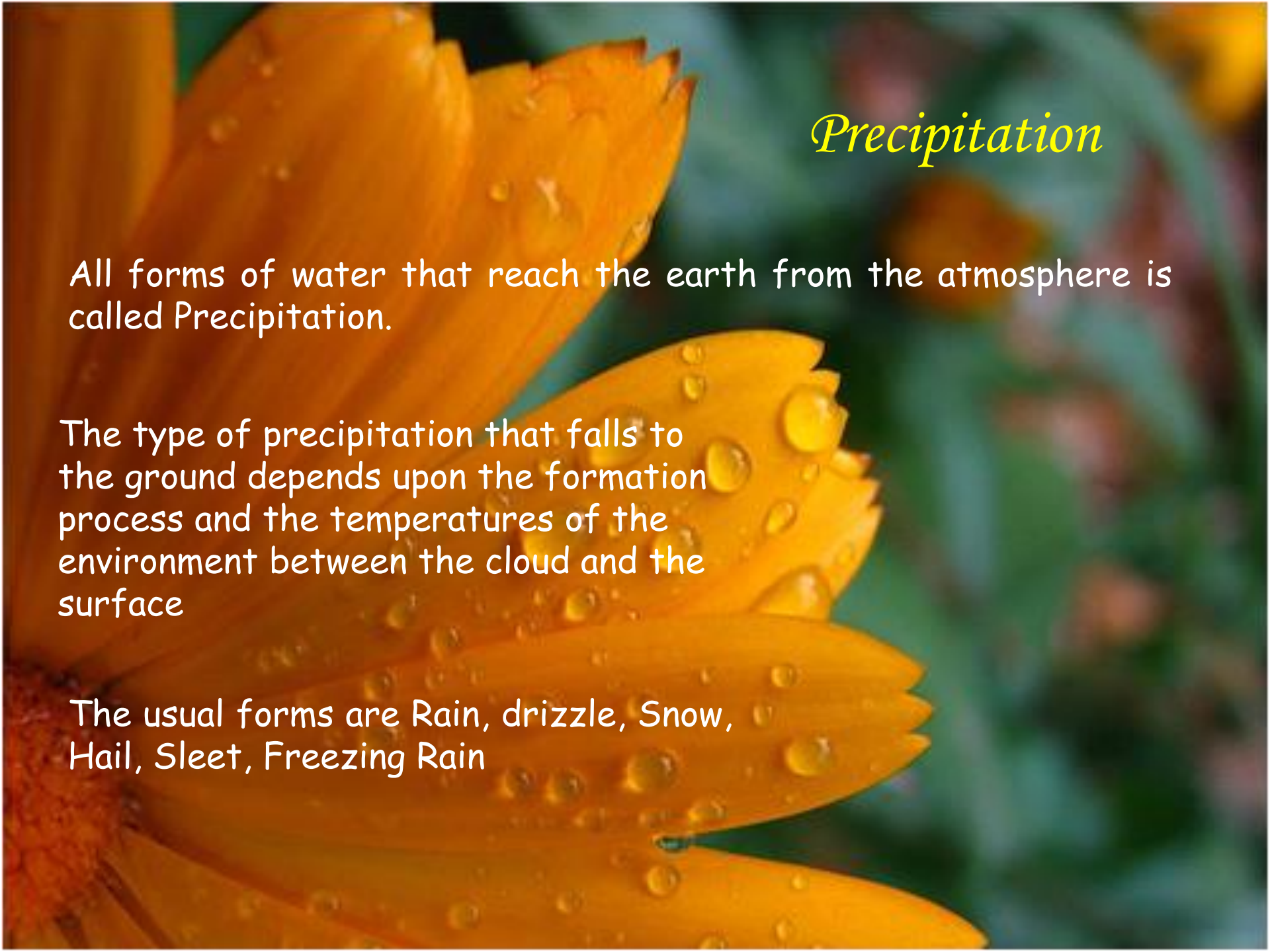


Precipitation

All forms of water that reach the earth from the atmosphere is called Precipitation.

The type of precipitation that falls to the ground depends upon the formation process and the temperatures of the environment between the cloud and the surface

The usual forms are Rain, drizzle, Snow, Hail, Sleet, Freezing Rain

Precipitation

Cloud droplets require a **condensation nuclei** on which to form; growth then occurs by deposition of water molecules from vapour.

Cloud droplets are typically 10 to 30 μm in diameter. Growth/evaporation can occur within a few 10s of seconds.

Rain drops growth from the vapour would take several hours.

Saturation vapour pressure over ice is less than that over water ⇒ ice crystals grow at expense of water droplets

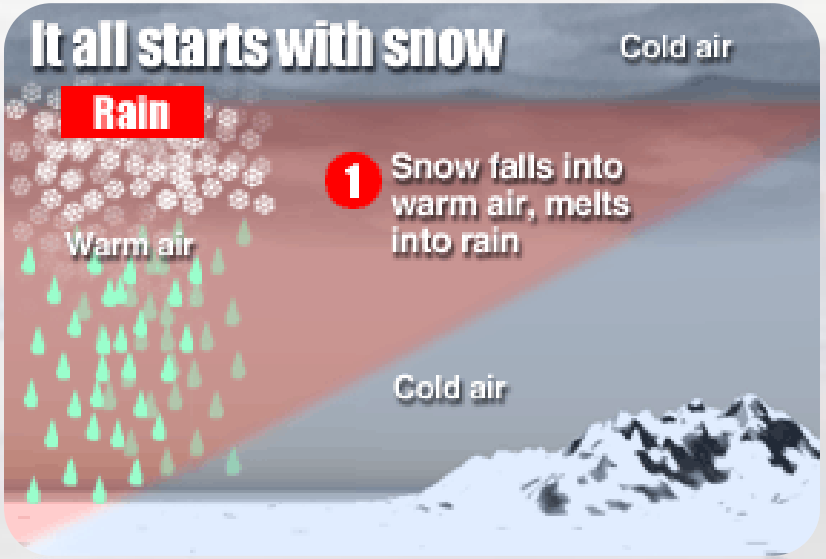
If ice crystal touches a droplet, the droplet freezes

Necessary conditions?

When clouds form in the atmosphere, they are non-precipitating in 99% of cases.

Rain

Is precipitation in the form of water drops of size larger than 0.5 mm to 6 mm in diameter.



drizzle < 0.5 mm

The rainfall is classified in to:

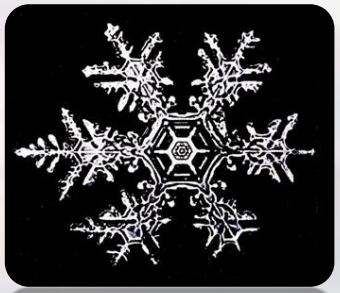
Light rain – if intensity is trace to 2.5 mm/h

Moderate – if intensity is 2.5 mm/hr to 7.5 mm/hr

Heavy rain – above 7.5 mm/hr

Snow

Snow is formed from ice crystal masses, which usually combine to form flakes.



snow is usually associated frontal uplifting with mid-latitude cyclones

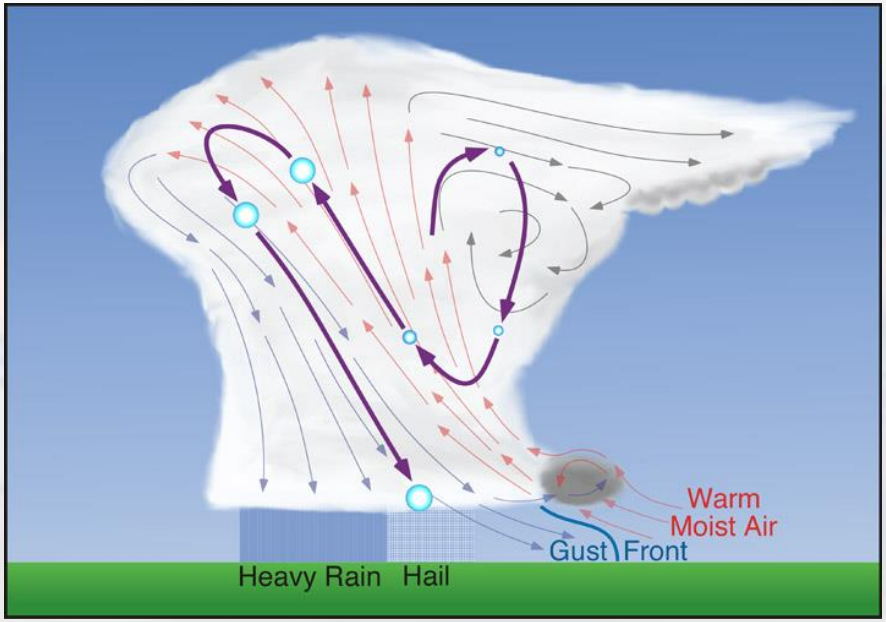
Hail

Hail is formed when updrafts carry raindrops upwards into extremely cold areas of the atmosphere

Strong uprising currents in thunderstorm clouds provide the mechanism for forming hail

Hail varies from 0.5 to 5 cm in diameter and can be damaging crops and small buildings.

The updrafts move hailstone embryos (e.g. Large frozen raindrops) upward through the storm cloud



where they encounter layers of ice crystals, snow & supercooled rain.

each encounter causes the hailstone to grow larger

hailstones can grow very large in size with repeated updrafts.

until being too heavy to by supported by updrafts, it begins falling under gravity

on descending, it can lose great mass due to melting

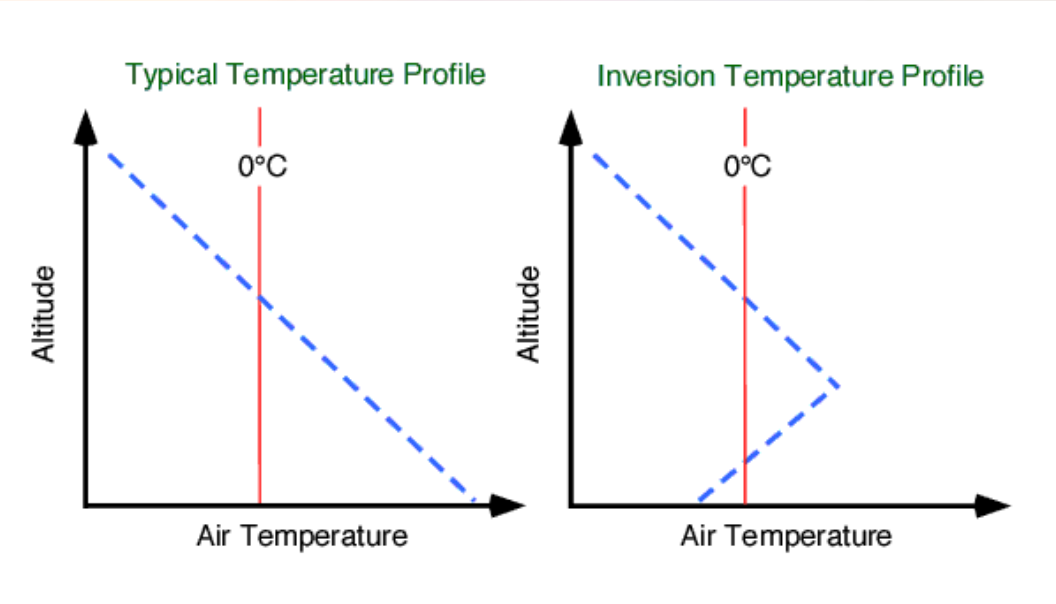
Freezing Rain

Freezing rain is falling rain that cools below 0°C, but does not turn to ice in the air.

The water is "supercooled"

When the drops hit anything they instantly turn to ice!

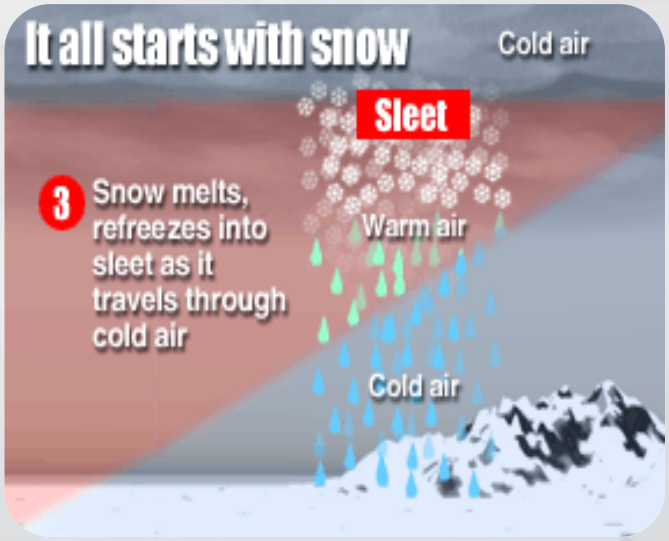
an air temperature inversion is required



Sleet

Sleet is frozen raindrops. Sleet begins as rain or snow and falls through a deep layer of cold air that contains temperatures below freezing that exist near the surface.

Rain that falls through this extremely cold layer has time to freeze into small pieces of ice



transparent / translucent spheres of frozen water with a diameter > 5 mm

develop first as raindrops in relatively warm atmosphere (Temp > freezing),

then raindrops descend into a colder layer of the atmosphere
(Temp < 0°C)

causing the freezing into ice pellets while reaching the ground surface

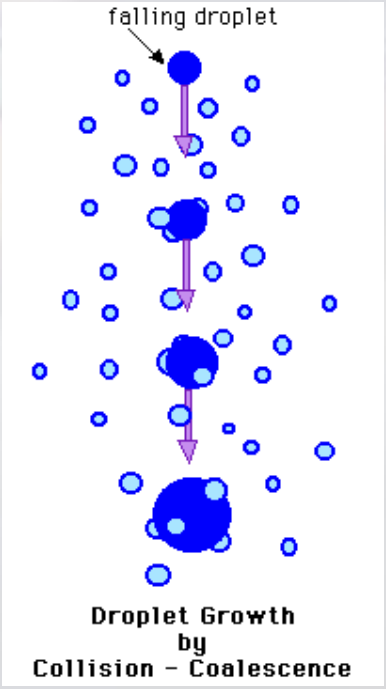
like freezing rain, an air temperature inversion is required

Mechanism of Precipitation Development

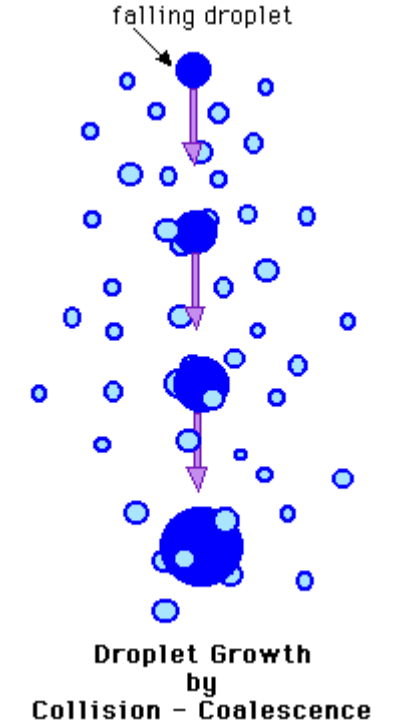
1. Coalescence theory

A droplet may continue to grow by diffusion beyond 20 micrometers in diameter, however, once a droplet attains this size, growth is slow and inefficient.

Droplets this large begin to collide and coalesce with other droplets as they fall through the cloud, meaning they will bump into and bond to one another and form larger drops.



Updrafts in a cloud can transport a droplet upward repeatedly allowing it many opportunities to fall back down through the cloud and collide and coalesce with other droplets.



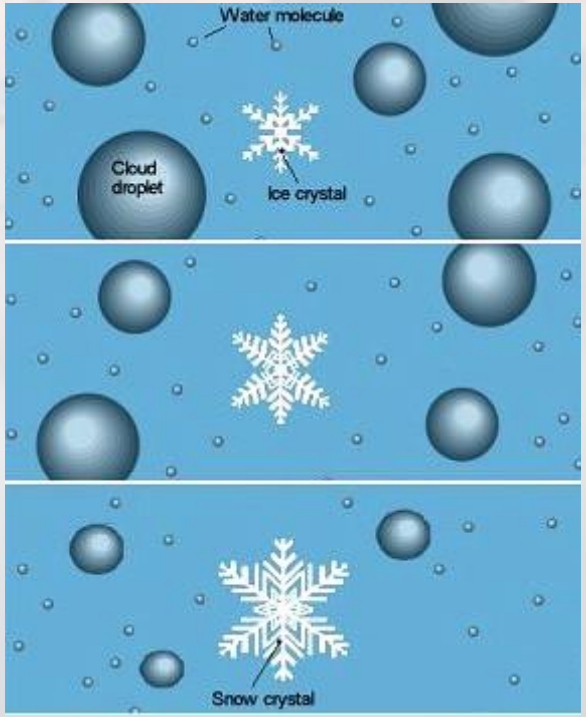
Tiny aerosol nuclei grow into large water droplets more than 10,000 times their initial size.

2. Bergeron-Findeisen process

also known as the cold rain or ice crystal process

As the formation of precipitation in the cold clouds of the mid and upper latitudes by ice crystal growth.

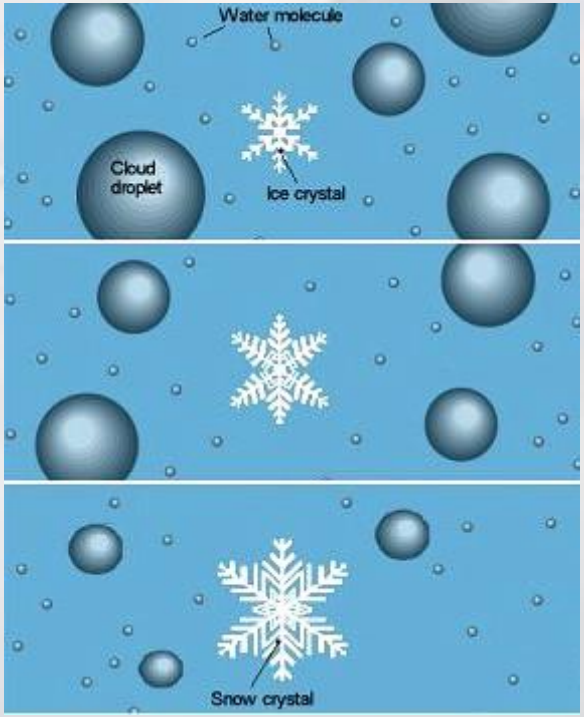
The equilibrium vapor pressure over water is greater than the saturation vapor pressure over ice, at the same temperature.



Therefore in a mixed phase cloud, the liquid water will be out of vapor pressure equilibrium and will evaporate to reach equilibrium.

The water droplets will move toward the lower pressure over the ice and diffuse onto the ice crystals.

The vapour will be condensed and freeze onto the ice crystal, causing it to grow larger.




Thanks
For your
Attention