Precipitation

By

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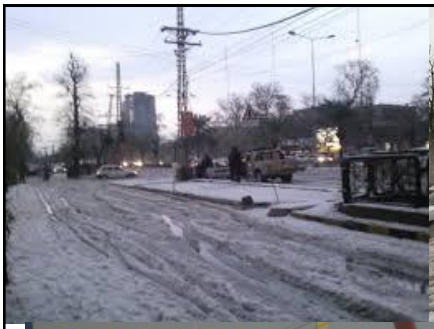
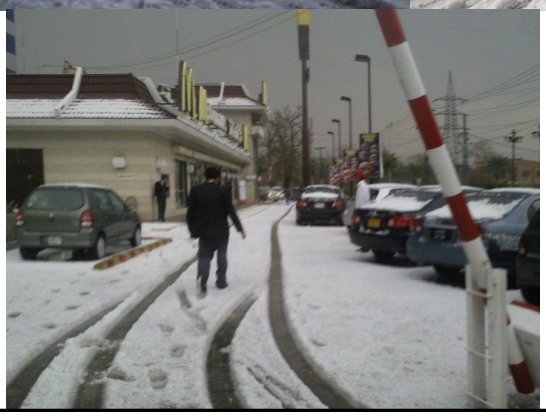
Topics

1. Precipitation
2. Forms of precipitation
3. Mechanism for precipitation
4. Classification of precipitation
5. Measurement of precipitation

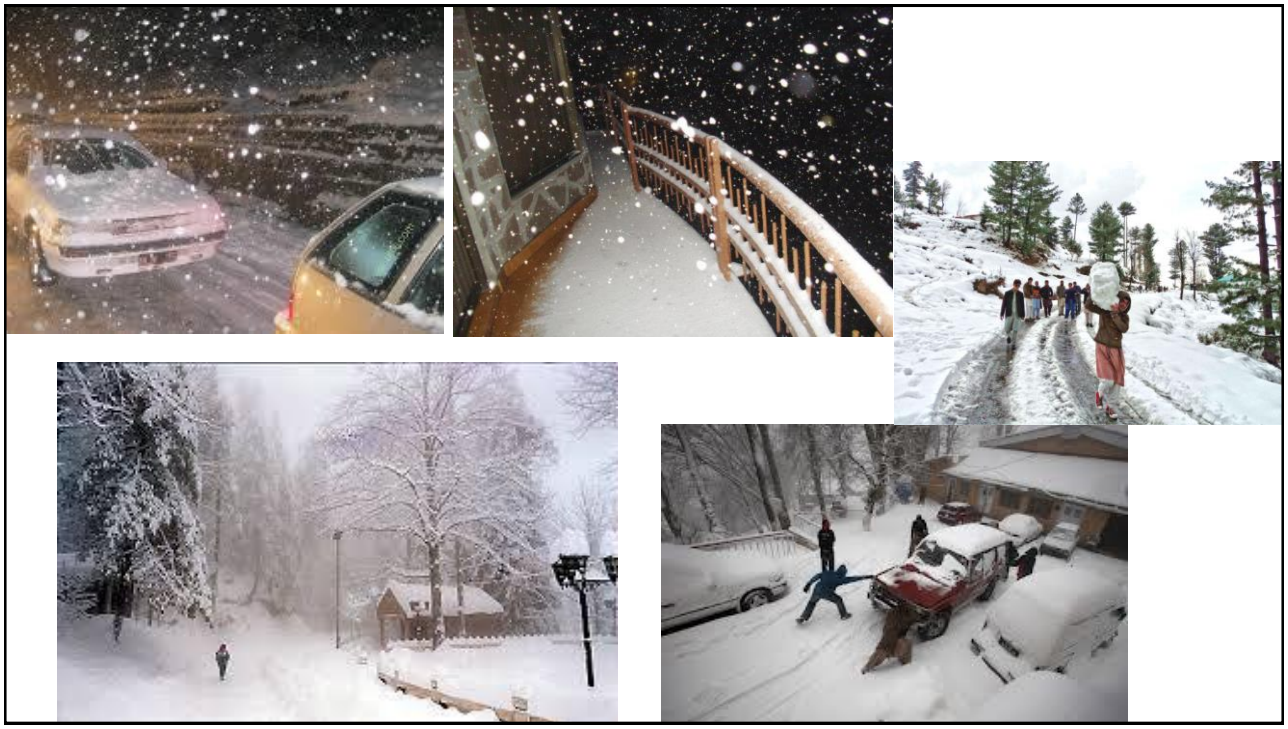



SAMSUNG
DAEWOO


Cakes & Bakes




McDonald's



What is precipitation? …
What are its forms? …
How it occurs? …
How can we measure it?

Precipitation

Precipitation can be defined as all types of moisture or liquid deposits that occurs on ground from the troposphere/hydrosphere *(First 12 km layer above earth)***.**

1. **Amount of precipitation (AOP)**
2. **Intensity of precipitation (IOP)**

1. **Amount of precipitation (AOP)**

The depth of precipitated water on the ground surface is known as amount of precipitation. It is measured in ***mm*** or ***Inches***.

2. **Intensity of precipitation (IOP)**

- Intensity of precipitation is the amount or depth of precipitation per unit time. It is measured in ***mm/hour*** or ***Inches/Day***.

Forms of precipitation

1. Drizzle
2. Rain/Mist
3. Snow
4. Hail
5. Sleet
6. Fogs
7. Frost/Glaze

1. Drizzle

They are the tiny water droplets having dimensions less than 0.5 mm.
Normally the diameter of water droplets ranges from 0.1 mm to 0.5 mm.
In case of drizzle or mist the moisture, *intensity of precipitation* is less than 1 mm/hrs

2. Rain/Mist

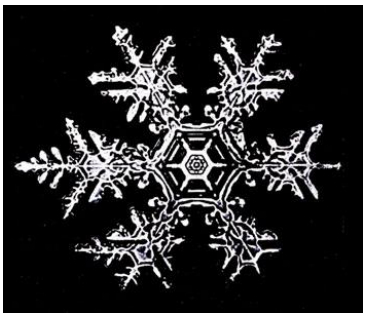
The type of precipitation in which the diameter of water droplets are greater than ***0.5 mm.***

- **According to US specifications rain can be classified in following three categories depending on the** *intensity of precipitation.*

1. ***Light rain IOP < 3mm/hrs***
2. ***Moderate rain IOP ≈ 3 mm/hrs to 8 mm/hrs***
3. ***Heavy rain IOP > 8mm/hrs***

3. Snow

- It is the form of precipitation in form of ice crystals (Hexagonal shape)
- The diameter of these crystals ranges from ***2 mm to 6 mm***.
- Freshly fallen snow fall density is approximately 10% of water.
- With the passage of time snow density increases.



4. Hail

- It is the form of precipitation in form of ice balls and they produced by the convective clouds.
- Diameter of hail is ***5 mm to 125 mm***.
- Density of hail is approximately equals to water.

5. Sleet

- It is the form of precipitation in form of mixture of water droplets and ice crystals.

6. Fogs

- It is the form of precipitation as a layer of moisture in form of weak clouds.

7. Frost/Glaze

- It is the form of precipitation in form of dew drops on the exposed surfaces.

Mechanism for precipitation

For the occurrence of precipitation following four processes are necessary.

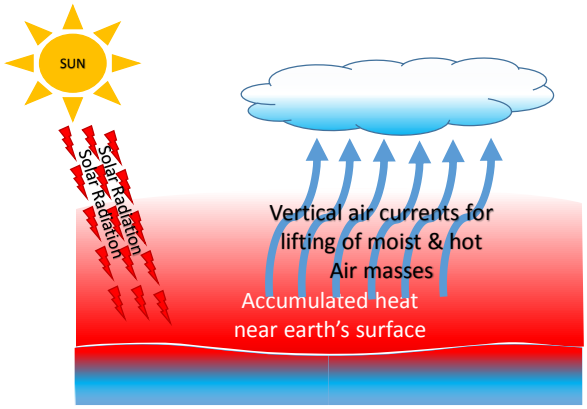
1. **Lifting mechanism for cooling the air mass**
2. **Condensation of water vapors to form clouds, droplets and ice crystals**
3. **Growth of cloud droplets**
4. **Sufficient accumulation of moisture for rainfall**

Water droplets and ***ice crystals*** of clouds when transformed into heavier particles they tends to fall out of clouds in form of precipitation.

Lifting mechanism for cooling the air mass

- For the large scale cooling of air masses some lifting mechanism is necessary for bring them to near saturation state.
- Nature has arranged the large scale cooling by the following different means.

1. **Convection**
2. **Orographic barriers**
3. **Cyclones**



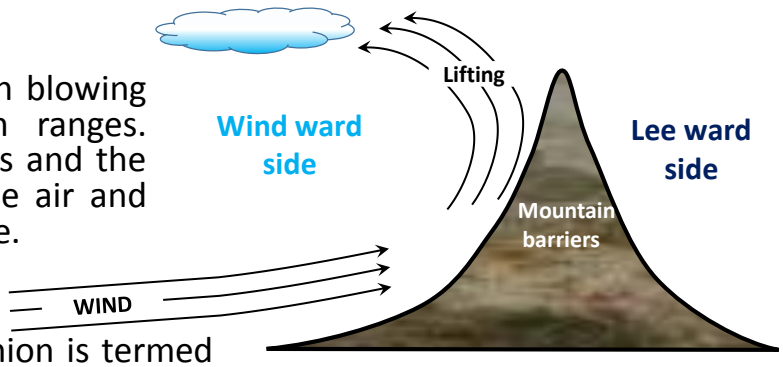
1. **<u>Convection</u>**

- Sun (Solar radiation) is the only source of heat. Major portion of solar radiation is utilized in heating the earth surface. The thermal conductivity of earth is a slow and heat accumulates near the earth's surface. The air masses near earth then get, lapse rate near earth increases rapidly and the vertical currents are setup which finally carry the heat and moisture laden air to high altitudes and form clouds.

Lifting mechanism for cooling the air mass

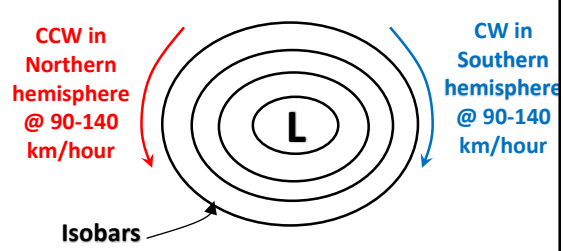
2. Orographic barriers

The moist air lifted up when blowing near/through the mountain ranges. The mountain acts as barriers and the sloppy surface gently lifts the air and return it on the windward side.



3. Cyclones

Wind moving in circular fashion is termed as cyclone. A cyclone can be represented as a group of nearly circular isobars. Cyclones formed in low latitude areas. A low pressure area exists in the center (Eye) of cyclone. By the circular motion wind lifted up and reaches in the cooler zones.



2. Condensation of water vapors to form clouds, droplets and ice crystals

- Condensation of **water vapors** in to **clouds droplets** can takes place on the following two types of **nuclei.**

1. **Hygroscopic or Condensation nuclei**
2. **Freezing nuclei**

1. Hygroscopic or Condensation nuclei

- The source/origin of Hygroscopic or Condensation nuclei is the **sea salts** or product of combustion such as **sulfurous** and **nitrous acids**.
- They are tiny particles and their diameter ranges from **0.1 to 10 µm** and always present in atmosphere in sufficient quantity.
- In presence of these nuclei, condensation takes place if air in low atmosphere is cool down to saturation level.

2. Freezing nuclei

- They consists of **clay minerals** like **Keolinite** [$Al_2Si_2O_5(OH)_4$]. Freezing nuclei initiate the growth of ice crystals.

3. Growth of cloud droplets

Growth of cloud droplets is necessary if is to reach the ground. For the growth of cloud droplets following two process are very effective.

1. **Coalescence through collision**
2. **Co-existence of ice crystals and water droplets**

1. Coalescence through collision

7 collision/km

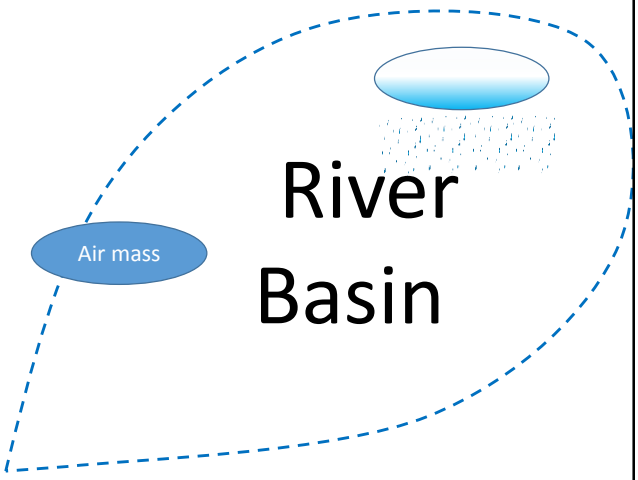
Coalescence through collision of droplets happens due to the difference of speed of falling water droplets. Larger droplets adhere the smaller ones comes in their way and grow in size. It is observed that normally **7 collisions per kilometer** occurs.

2. Co-existence of ice crystals and water droplets

When both the ice crystals and water droplets are present in clouds the saturation vapor pressure around the ice crystals will be low and the water droplets surrounding the ice crystals will condense and ice crystals will grow in size and may fall. This phenomenon occurs in the temp range of **10°F to 20°F** and known as **Bergeron's effect**.

4. Sufficient accumulation of moisture for heavy rainfall

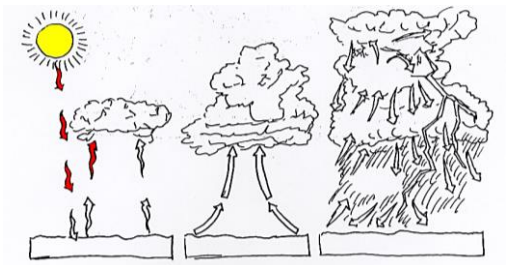
- Heavy rainfall occurs when the when there is large horizontal net inflow of water vapors. Tis net influx of moist air per unit area is known as **convergence**.
- In a river basin the convergence can be continuous through large distances however, when this moist air mass reaches a zone of active vertical motion it can rise through thousands of feet and looses its maximum moisture load in just few hours.



Classification of precipitation

Based on the lifting mechanism the precipitation can be classified in to following three (03) types.

1. **Convective precipitation**
2. **Orographic precipitation**
3. **Cyclonic precipitation**

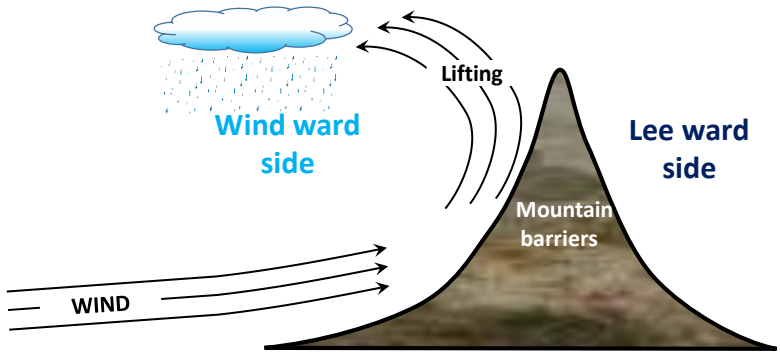


1. Convective precipitation

Because of convection and vertical currents, the hot and moist air masses travels from the earth surface to higher levels where condensation level meets. At this stage cumulus clouds develop and with further convection these clouds grow in to cumunimbus clouds. Thunderstorm, Lightning, gusty surface winds, showers and sometimes hail accompanying a thunderstorm occurs. Each thunderstorm is a form of a cell which updraft and downdraft turbulence etc. these cells are known as **understrom cells** having area from 2.5 to 5 km^2 .

2. Orographic precipitation

- Precipitation that occurs by lifting of moist air due to orographic barriers (Mountain) is known as orographic precipitation.
- In case of orographic precipitation most of the rain occurs on the windward side and very less precipitation occurs on the leeward side.



3. Cyclonic precipitation

- Precipitation in plain areas is cyclonic in character. cyclones can be of two types.
- Tropical (Near tropic)
- Extra-tropical (Away from tropic)
- All cyclones occurs in subcontinents are tropical cyclones. Tropical cyclones are the violent storms which formed by warm air masses in low latitude (Near tropic/equator)
- The wind around a tropical cyclone is parallel to isobars. The average diameter of a tropical cyclone is approximately 500 to 600 kms.
- In Bangladesh the cyclonic precipitation occurs from April to June which originated in the bay of Bengal and reaches in the northern areas of Pakistan in July and August (Moonsoon).
- The precipitation time over an area (On the way of cyclone) can be predicted by estimating its moving velocity.

Measurement of precipitation

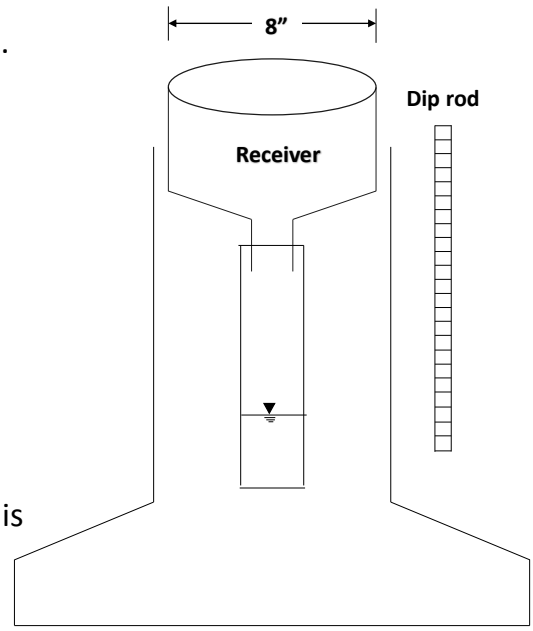
- Precipitation is measured by the following means.

1. **By rain gauge**
2. **By radar measurements**
3. **By satellite measurement (GIS data) (Geographical Information System)**

- Rain gages
- These measurement devices are fixed on ground and are of two types.

1. **Non recording rain gages**
2. **Recording rain gages**

- Non recording type rain gages do not record the temporal data of rain but the instantaneous data is measured. National Bauru for rain gage set the standard rain gages.



Design of precipitation measurement network

- It mainly depends on the purpose for which precipitation data is required. There are two principle purposes.

1. **Development and management of water resources**
2. **Operational purposes like floods forecasting, reservoir operation research**

- In order to meet the above purposes three types of station are designed.

1. **Principle stations**
2. **Secondary stations**
3. **Special stations**

- The principle stations are fixed and observations are made continuously. They are also called bench mark stations.
- Secondary stations are established to take observations for short period and they can be transferred from one place to other. The main objective of such stations is to develop a good correlation with the principle stations.

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Measurement net work consists of recording gages.

- **Network density (Gage density)**

Network density is the area of basin in km² that is being covered by one recording gage. **WMO** (World Metrological Agency) recommended the following minimum densities.

Minimum densities of precipitation network - WMO (World Metrological agency)

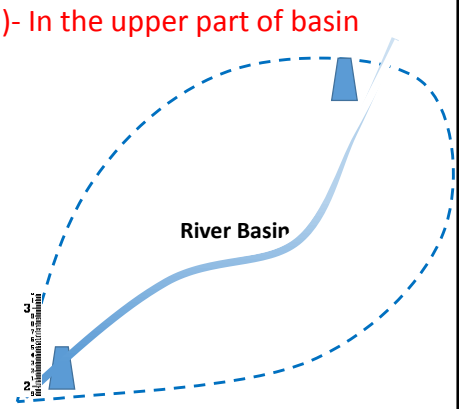
Sr. No.	Type of region	Network density (Km²/Station)	Tolerable range for difficult conditions (Km²/Station)
1	Flat region and tropical zones	600-900	900-3,000
2	Mountainous region and tropical zones	100-250	250-1,000
3	Arid and polar zones	1,500 – 10,000	-

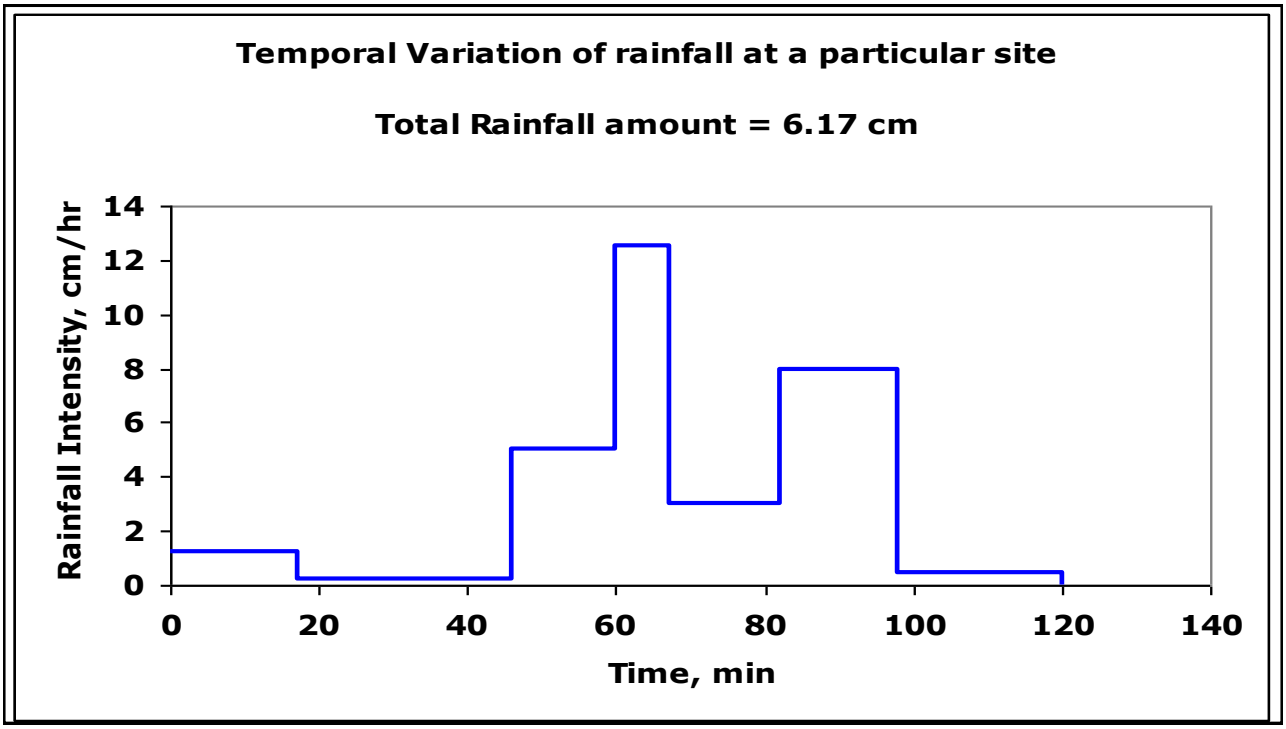
Minimum number of precipitation gages for a gaging station

There should be at least two gages for each gaging station.

1)- Near the stream gage

2)- In the upper part of basin





Types of clouds

They can be of following four types depending on their Size, shape, height of occurrence, weather and rainfall.

1. **Cumulus Clouds**
2. **Cumulonimbus Clouds**
3. **Altocumulus Clouds**
4. **Stratocumulus Clouds**

Cumulus Clouds

Cumulus clouds are probably the most recognized clouds out of all of the cloud types. Cumulus clouds form below 6,000 feet, but in some extreme cases they can be in altitudes as high as 39,000 feet. They are white puffy clouds that look like cotton balls. They have a lifetime of five to forty minutes, and are known for their flat bases and lumpy outlines. Cumulus clouds appear so fluffy because bubbles of air, called thermals, linger in the cloud making it have this kind of look. Fair weather is usually associated with cumulus clouds, but they can cause short and heavy rainfall. These clouds are also partly responsible for creating cold front systems. Cumulus clouds are formed by frontal lifting or convection, which is simply the rising of warm air, which then cools and condenses to form a cumulus cloud.

Cumulonimbus Clouds

Cumulonimbus clouds are larger and are more like tall towers than regular cumulus clouds. Cumulonimbus clouds exist from near ground to 50,000 feet up in the air. The clouds can exist as individual towers of clouds, or there can be a squall line. A squall line is a line of tower cumulonimbus clouds. The tops of this type of cloud often spread out in a shape of an anvil or plume. Fast-moving convective updrafts fuel these clouds to reach such great heights, and these, like other clouds, can be made of ice crystals as their main component in cold temperatures. Sometimes the cloud can contain both liquid water droplets and ice crystals when the freezing point is in the middle of the cloud. Fair weather cumulus clouds can form into cumulonimbus clouds in the right conditions. Cumulonimbus clouds are associated with powerful thunderstorms. Snow, rain, hail, lightning, thunder, and sometimes tornadoes can accompany cumulonimbus clouds.

Altocumulus Clouds

Altocumulus clouds lie at a range from 6,000 to 20,000 feet. Altocumulus clouds are usually made of water droplets but can be composed of ice crystals at higher elevations. Parallel bands of cloud or rounded cotton balls, like in this picture, usually signify altocumulus clouds. One part of the cloud is darker than the rest of the cloud, which makes it easy for one to tell the difference between these clouds and different types of cirrus clouds.
The slow uplift of warm air from a cold front pushing its way through near the ground causes altocumulus clouds to form. Thunderstorms can follow a warm and humid summer morning in the presence of this particular type of cloud.

Stratocumulus Clouds

Stratocumulus clouds form in altitudes below 6,000 feet. They do not significantly change the weather, and they appear in layers, rows, or patches. A low layer of stratocumulus clouds appear near sunset and are the spreading remains of larger cumulus clouds. Precipitation does not usually fall from stratocumulus clouds even though their color may be from dark to light gray. They are different from altocumulus clouds because they are slightly larger. One neat way to determine the difference between altocumulus and stratocumulus clouds is that standing on Earth, altocumulus clouds are about the size of a human thumb nail while stratocumulus clouds are the size of a fist.

Thanks