Lecture Number	**5**
Lecture Title	**CLOUDS AND FOG**

Lecture Items

Lecture 5– CLOUDS AND FOG

5.1 CLOUDS

- Condensation above the earth's surface produces clouds
- Clouds are aesthetically appealing and add excitement to the atmosphere
- Without them, there would be no rain or snow, thunder or lightning, or rainbows
- A *cloud* is a visible aggregate of tiny water droplets or ice crystals suspended in the air
- Some are found only at high elevations, whereas others nearly touch the ground
- Clouds can be thick or thin, big or little—they exist in a seemingly endless variety of forms

5.2 FORMATION OF CLOUDS

- When air becomes saturated with water vapor, any excess water vapor condenses to form clouds
- The air can become saturated either by:
  - addition of water vapor
  - cooling the air
- A common way for air to become saturated is for it to be lifted and *adiabatically* cooled via one of the four methods of lifting as shown in figure (**5.1**)
  - Topographic lifting
  - Frontal lifting
  - Convergence lifting
  - Convective lifting

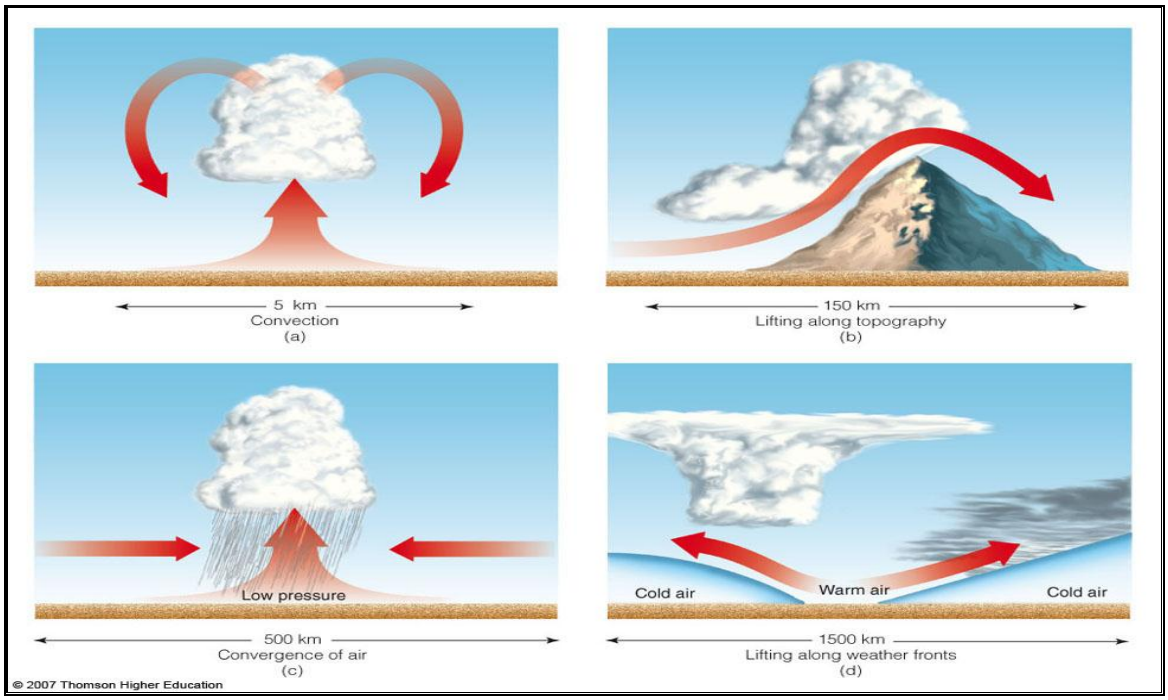

Fig . (5.1) : Methods of lifting air

- In order to condense, there must be a surface for the water to condense onto
- In the atmosphere, tiny dust, or smoke particles serve as these surfaces
- They are known as *condensation nuclei*
- In the absence of condensation nuclei the relative humidity can get up to **400%** without condensation occurring
- If the relative humidities over **100%** , the air is said to be *supersaturated*
- Not all particles in the atmosphere can be condensation nuclei
- Only those that have an affinity for water (called *hygroscopic* nuclei) are effective as condensation nuclei
  - Condensation can also occur on other surfaces, such as grass, cars, and windows, this is known as *dew*
- Clouds are composed of a large number of very small droplets of water
- The droplets are so small that they do not fall, but remain suspended in the air

5.3 CLOUDS CLASSIFICATION

- Clouds are classified in two ways, by *form* and by *height*

5.3.1 Clouds Classification by form

- ***Cirriform*** –
  - Cirriform clouds are very high, thin, and wispy
  - They are composed mostly of ice crystals

- ***Cumuliform*** –
  - These clouds are puffy, develop vertically
  - They generally have flat bottom
  - They are associated with unstable atmospheres

- ***Stratiform*** –
  - These clouds are generally spread out sheet like
  - These clouds are generally associated with stable atmospheres

5.3.2 Clouds Classification by height

- ***High clouds*** *: –*

- Bases of High clouds in middle and low latitudes generally form above **20,000** ft (or **6000** m)
- Because the air at these elevations is quite cold and "dry," high clouds are composed almost exclusively of ice crystals
- The types of high clouds are :

- Cirrus (**Ci**)
- Cirrostratus (**Cs**)
- Cirrocumulus (**Cc**)

- ***Middle clouds*** *: –*

- The middle clouds have bases between about **6500** and **23,000** ft (**2000** and **7000** m) in the middle latitudes
- These clouds are composed of water droplets and—when the temperature becomes low enough— some ice crystals
- The types of middle clouds are :

- Altocumulus (**Ac**)
- Altostratus (**As**)

- ***Low clouds :*** –

- Low clouds, with their bases lying below **6500** ft (or **2000** m)
- These clouds are almost always composed of water droplets; however, in cold weather, they may contain ice particles and snow
- The types of middle clouds are :

- Stratus (**St**)
- Stratocumulus (**Sc**)
- Nimbostratus (**Ns**)

- ***Clouds of vertical development***
- The types of clouds of vertical development are :
- Cumulus (**Cu**)
  - Dense clouds often characterized by flat bases
- Cumulonimbus (**Cb**)
  - Towering clouds , sometimes spreading out on top to form an anvil head
  - Associated with heavy rainfall , thunder , lightning and hail

- The approximate base height of each cloud group is given in Table (**5.1**)

Table (5.1) : Approximate height of Cloud base above the surface For various Regions

Cloud Group	Tropical Region	Middle Latitude Region	Polar Region
High Ci, Cs, Cc	20,000 to 60,000 ft (6000 to 18,000 m)	16,000 to 43,000 ft (5000 to 13,000 m)	10,000 to 26,000 ft (3000 to 8000 m)
Middle As, Ac	6500 to 26,000 ft (2000 to 8000 m)	6500 to 23,000 ft (2000 to 7000 m)	6500 to 13,000 ft (2000 to 4000 m)
Low St, Sc, Ns	surface to 6500 ft (0 to 2000 m)	surface to 6500 ft (0 to 2000 m)	surface to 6500 ft (0 to 2000 m)

- Note that the altitude separating the high and middle cloud groups overlaps and varies with latitude
- Large temperature changes cause most of this latitudinal variation
- For example, high cirri form clouds are composed almost entirely of ice crystals
- The precipitation and composition of clouds is given in Table (**5.2**) and the different types of clouds shown in figure (**5.2**)

Fig.(5.2) : Types of clouds

Table (5.2) : The precipitation and composition of clouds

CLOUD FAMILY	CLOUD TYPE	PRICIPITATION	COMPOSITION
HIGH CLOUDS	CIRRUS **Ci**	NONE THAT REACHES GROUND	ICE CRYSTALS
	CIRROSTRATUS **Cs**	NONE	ICE CRYSTALS
	CIRROCUMULUS **Cc**	NONE THAT REACHES GROUND	ICE CRYSTALS
MIDDLE CLOUDS	ALTOCUMULUS **Ac**	VERY OCCASIONAL LIGHT RAIN	MOSTLY LIQUID WATER, MAY ALSO CONTAIN ICE CRYSTALS
	ALTOSTRATUS **As**	OCCASIONAL LIGHT RAIN,SNOW	BOTH LIQUID WATER, AND ICE CRYSTALS
LOW CLOUDS	STRATUS **St**	NO MORE THAN LIGHT DRIZZLE	LIQUID WATER
	STRATOCUMULUS **Sc**	OCCASIONAL LIGHT RAIN,SNOW	LIQUID WATER
	NIMBOSTRSTUS **Ns**	MODERATE TO HEAVY RAIN OR SNOW,WHICH IS GENERALLY STEADY	LIQUID WATER,RAINDROPS,SNOWFLAKS AND ICE CRYSTALS
CLOUDS OF VERTICAL DEVELOPMENT	CUMULUS **Cu**	GENERALLY NONE , EXCEPT FOR BRIF SHOWERS	LIQUID WATER
	CUMULONIMBUS **Cb**	HEAVYRAIN, HAIL	LIQUID WATER THROUGHT , ICE CRYSTAL AT THE TOP

5.4 FOG

- Fog is a cloud with its base at or very near the ground
- Fog can be formed in one of two ways:
  - By cooling the air until it reaches saturation
  - By evaporating water into the air until it reaches saturation

5.5 TYPES OF FOG

- There are five types of fog as shown in figure (**5.3**)
- They all look similar, but are formed differently

5-5-1 Fogs formed by cooling

- ***Radiation fog*** –
- Results from radiation cooling of the ground and air next to the ground, the moist, lower layer quickly becomes saturated, and fog forms
- Occurs at night under clear skies, the longer the night, the longer the time of cooling and the greater the likelihood of fog
- Hence, radiation fogs are most common over land in late fall and winter
- Although radiation fog may form in calm air ,another factor promoting the formation of radiation fog is a light breeze
- Radiation fogs are normally deepest around sunrise
- Usually, however, a shallow fog layer will dissipate by afternoon
- Of course, rather, sunlight penetrates the fog and warms
- The ground, causing the temperature of the air in contact with the ground to increase, and soon the fog completely disappears

- ***Advection fog*** –
- Results When warm, moist air moves over a sufficiently colder surface, the moist air may cool to its saturation point, forming advection fog
- This type of fog, unlike radiation fog, always involves the movement of air

- ***Upslope fog*** –
- Results from air being lifted and cooled orographically
- Fog that forms as moist air flows up along an elevated plain, hill, or mountain is called upslope fog
- The air gradually rises, expands, becomes cooler, and—if sufficiently moist—a fog forms
- Upslope fogs that form over an extensive area may last for many days

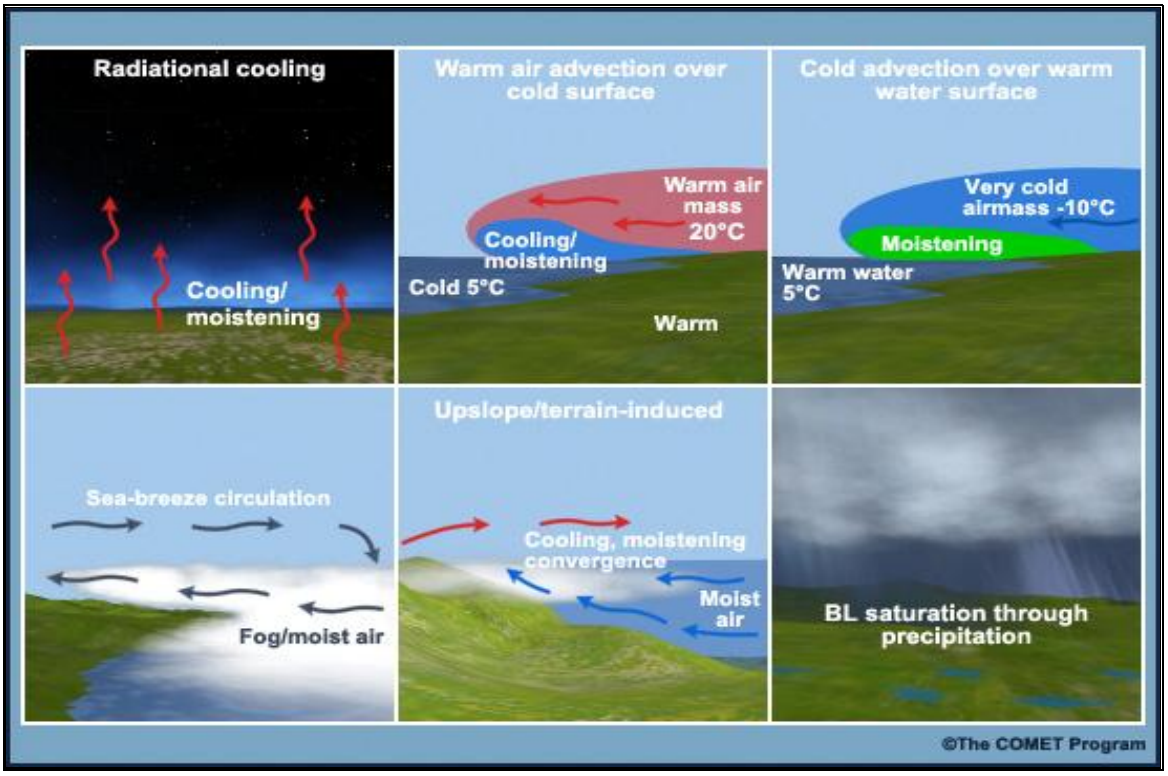

Fig.(5.3) : Types of Fog

5-5-2 Fogs formed by evaporation

- ***Steam fog*** –
- Results when cool air moves over warm water
- Sometimes called "sea smoke"
- It is common to see steam fog forming over lakes on autumn mornings

- ***Frontal fog*** –
- Formed from a warm rain falling through a layer of cold, moist air can produce fog (warm raindrops evaporate in a cool air mass)
- This type of evaporation fog is also known as *precipitation fog*