Humidity and Precipitation: Objectives, Water Vapour in the Atmosphere, Humidity, Evaporation

In the composition of the atmosphere, water vapour, though a minor component is a very important constituent of the atmosphere. In this lesson, we will study the role of water vapour in producing day to day weather changes.

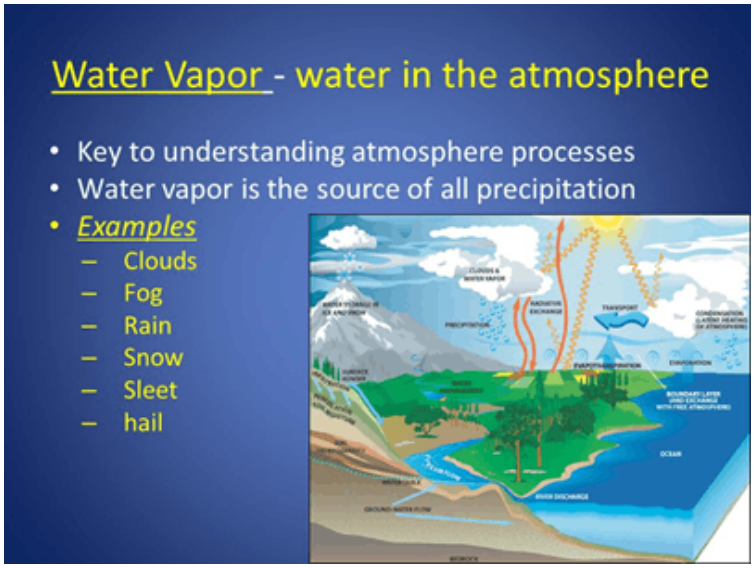
Objectives

The major objectives of this chapter are:

- To explain the significance of water vapour in the atmosphere
- To distinguish between absolute and relative humidity
- To establish relationship between temperature (absolute and relative humidity)
- To infer conditions in which the relative humidity of a given sample of air increases or decreases
- To distinguish between saturated and unsaturated air
- To identify the factors affecting the rate of evaporation
- To explain the latent heat and its importance
- To describe the various forms of condensation
- To explain conditions conducive to precipitation
- To distinguish among the three types of rainfall with the help of diagrams
- To describe the salient features of distribution of precipitation in the world with reference to regional and seasonal variations
- To identify factors affecting rainfall distribution

Water Vapour in the Atmosphere

Water vapour is a highly variable component of the atmosphere. Its proportion varies from 0 - 4% by volume of the atmosphere. Water can exist in the air in all the three states of matter i.e.. solid or ice-crystals, liquid or droplets of water, and gaseous or water vapour. Most commonly water exists in air as tasteless, colourless, and transparent gas known as water vapour. The presence of water in the atmosphere has made life possible on the earth. Its significance for life on the earth can be seen as follows:



- Water vapour in the atmosphere absorbs a significant portion of both incoming solar energy and outgoing earth radiation. In this way, it prevents great losses of heat from the earth's surface and helps to maintain suitable temperatures on the earth.
- The amount of water vapour present in the air affects the rate of evaporation.
- The amount of water vapour present in a volume of air decides the quality of latent heat or energy stored in it for producing atmospheric changes.
- The amount of water vapour present in the air of a place or in a region indicates the potential capacity of that air for precipitation.
- The amount of water vapour present in the air affects standing crops favourably. On the other hand, hot dry winds damage standing crops as in the case of Rabi crops of north-western India.
- Air that is poor in water vapour content makes our body skin dry and rough.

Humidity

The heat energy radiated from the sun changes water into water vapour. This invisible water vapour present in gaseous form in the atmosphere at any time and place is termed as humidity. It indicates the degree of dampness or wetness of the air. Humidity of the air is mainly expressed in the following ways:

Absolute Humidity

- Absolute humidity is the ratio of the mass of water vapour actually in the air to a unit mass of air, including the water vapour. It is expressed in gram per cubic metre of air. For example, if the absolute humidity of air is 10 grams it means that one cubic metre of that air holds 10 grams of moisture in the form of water vapour. Absolute humidity is variable and changes from place to place and with change in time.
- The ability of an air to hold water vapour depends entirely on its temperature. The capacity of holding water vapour of an air increases with the increase in its temperature. For example, at 10°C, one cubic metre of an air can hold 11.4 grams of water vapour. If the temperature of the same air increases to 21°C, the same volume of air can hold 22.2 grams of water vapour. Change in temperature and pressure conditions of an air results in the change of its volume and consequently there is change in its absolute humidity.

Relative Humidity

- Relative humidity is the ratio of the amount of water vapor actually in a volume occupied by air to the amount the space could contain at saturation.
- $$\text{Relative Humidity} = \frac{\text{Vapour} p\,\text{res sure in the air}}{\text{Saturation vapour} p\,\text{res} sure}$$
- Air can hold a definite maximum quantity of water vapour at a given temperature. When this situation is attained, the air is fully saturated. The temperature at which a given sample of air becomes fully saturated is called the dew point or saturation point. The relative humidity of an air at saturation point is 100% . Let us illustrate the concept of relative humidity with the help of an example. It is clear that an air can hold 22.2 grams of water vapour at 21°C temperature. If this air is holding 11.1 grams of water vapour at the same temperature i.e.. 21°C, the relative humidity of the air will be 11.1/22.2x100 or 50% . If the same air is actually holding 22.2 grams of water vapour at 210C, the relative humidity of air will be 22.2/22.2x100 or 100% . If the relative humidity of air is less than 100 percent, the air is said to be unsaturated.
- The relative humidity increases when the temperature of the air goes down or when more moist air is added to it. The relative humidity decreases when the temperature of the air increases or when less moist air is added to it.

Evaporation

Evaporation is the process of change of water from its liquid state to gaseous form. This process takes place at all places, at all times and at all temperatures except at dew point or when the air is saturated. The rate of evaporation is affected by several factors, such as:

Accessibility of Water Bodies: The rate of evaporation is higher over the oceans than on the continents.

Temperature: Hot air holds more moisture than cold air. When the temperature of an air is high, it is capable of holding more moisture in its body than at a low temperature. It is because of this that the rate of evaporation is more in summers than in winters. That is why wet clothes dry faster in summers than in winters.

Air Moisture: If the relative humidity of a sample of air is high, it is capable of holding less moisture. On the other hand, if the relative humidity is less, it can take more moisture. Hence, the rate of

evaporation will be high. Aridity or dryness of the air also increases the rate of evaporation. During rainy days, wet clothes take more time to dry owing to the high percentage of moisture content in the air, than on dry days.

Wind: If there is no wind, the air which overlies a water surface will get saturated through evaporation. This evaporation will cease once saturation point is reached. However, if there is wind, it will blow that saturated or nearly saturated air away from the evaporating surface and replace it with air of lower humidity. This allows evaporation to continue as long as the wind keep blowing saturated air away and bring drier air.

Cloud Cover: The cloud cover prevents solar radiation and thus influences the air temperatures at a place. Thus, it indirectly controls the process of evaporation.

- About 600 calories of heat is used for converting each gram of water into water vapour. A calorie is unit of heat energy spent in raising temperature of one gram of water by 10°C. The heat energy used for changing the state of water or a body from liquid to gaseous state or from solid to liquid state without changing its temperature is called latent heat. The latent heat consumed in changing water into gaseous form is released when water vapour changes into water or ice. The release of latent heat in the air is an important source of energy for causing changes in weather.
- A special case of evaporation is transpiration, which entails a loss of water from leaf and stem tissues of growing vegetation. The combined losses of moisture by evaporation and transpiration from a given areas are known as evapotranspiration.