WHAT IS METEOROLOGY?

Meteorology is the science of weather. It is essentially an inter-disciplinary science because the atmosphere, land and ocean constitute an integrated system. The three basic aspects of meteorology are observation, understanding and prediction of weather. There are many kinds of routine meteorological observations. Some of them are made with simple instruments like the thermometer for measuring temperature or the anemometer for recording wind speed. The observing techniques have become increasingly complex in recent years and satellites have now made it possible to monitor the weather globally. Countries around the world exchange the weather observations through fast telecommunications channels. These are plotted on weather charts and analysed by professional meteorologists at forecasting centres. Weather forecasts are then made with the help of modern computers and supercomputers. Weather information and forecasts are of vital importance to many activities like agriculture, aviation, shipping, fisheries, tourism, defence, industrial projects, water management and disaster mitigation. Recent advances in satellite and computer technology have led to significant progress in meteorology. Our knowledge of the weather is, however, still incomplete.

WHAT IS SYNOPTIC METEOROLOGY?

Weather observations, taken on the ground or on ships, and in the upper atmosphere with the help of balloon soundings, represent the state of the atmosphere at a given time. When the data are plotted on a weather map, we get a synoptic view of the worlds weather. Hence day-to-day analysis and forecasting of weather has come to be known as synoptic meteorology. It is the study of the movement of low pressure areas, air masses, fronts, and other weather systems like depressions and tropical cyclones.

WHAT IS CLIMATOLOGY

Climatology is a study of the climate of a place or region on the basis of weather records accumulated over long periods of time. The average values of meteorological parameters derived from a data base that extends over several decades are called climatological normals. Different regions of the world have different characteristic climates. However, it is now recognized that climate is not static and issues such as climate change and global warming are receiving increasing attention.

DYNAMIC METEOROLOGY

This particular branch of meteorology attempts to describe the atmospheric processes through mathematical equations which together are called a numerical model. After defining the initial state of the atmosphere and ocean, the equations are solved to derive a final state, thus enabling a weather prediction to be made. Dynamic meteorology deals with a wide range of hydrodynamical equations from a global scale to small turbulent eddies. The process of solving the equations is very complicated and requires powerful computers to accomplish.

PHYSICAL METEOROLOGY

In physical meteorology we study the physical processes of the atmosphere, such as solar radiation, its absorption and scattering in the earth-atmosphere system, the radiation back to space and the transformation of solar energy into kinetic energy of air. Cloud physics and the study of rain processes are a part of physical meteorology.

AGRICULTURE METEOROLOGY

In simple terms, agricultural meteorology is the application of meteorological information and data for the enhancement of crop yields and reduction of crop losses because of adverse weather. This has linkages with forestry, horticulture and animal husbandry. The agrometeorologist requires not only a sound knowledge of meteorology, but also of agronomy, plant physiology and plant and animal pathology, in addition to common agricultural practices. This branch of meteorology is of particular relevance to India because of the high dependence of our agriculture on monsoon rainfall which has its own vagaries.

APPLIED METEOROLOGY

Like agriculture, there are many human activities which are affected by weather and for which meteorologists can provide valuable inputs. Applied meteorologists use weather information and adopt the findings of theoretical research to suit a specific application; for example, design of aircraft, control of air pollution, architectural design, urban planning, exploitation of solar and wind energy, air-conditioning, development of tour.

WHAT IS A CLOUD BURST?

A **cloudburst** is an extreme amount of precipitation in a short period of time,[1] sometimes accompanied by hail and thunder, which is capable of creating flood conditions. Cloudbursts can quickly dump large amounts of water, e.g. 25 mm of precipitation corresponds to 25,000 metric tons per square kilometre (1 inch corresponds to 72,300 short tons over one square mile). However, cloudbursts are infrequent as they occur only via orographic lift or occasionally when a warm air parcel mixes with cooler air, resulting in sudden condensation. At times, a large amount of runoff from higher elevations is mistakenly conflated with a cloudburst. The term "cloudburst" arose from the notion that clouds were akin to water balloons and could burst, resulting in rapid precipitation. Though this idea has since been disproven, the term remains in use.

WHAT IS A THUNDERSTORM?

A thunderstorm, also known as an **electrical storm** or a **lightning storm**, is a storm characterized by the presence of lightning[1] and its acoustic effect on the Earth's atmosphere, known as thunder. Relatively weak thunderstorms are sometimes called **thundershowers**. Thunderstorms occur in a type of cloud known as a cumulonimbus. They are usually accompanied by strong winds and often produce heavy rain and sometimes snow, sleet, or hail, but some thunderstorms produce little precipitation or no precipitation at all. Thunderstorms may line up in a series or become a rainband, known as a squall line. Strong or severe thunderstorms include some of the most dangerous weather phenomena, including large hail, strong winds, and tornadoes. Some of the most persistent severe thunderstorms, known as supercells, rotate as do cyclones. While most thunderstorms move with the mean wind flow through the layer of the troposphere that they occupy, vertical wind shear sometimes causes a deviation in their course at a right angle to the wind shear direction.

Thunderstorms can form and develop in any geographic location but most frequently within the mid-latitude, where warm, moist air from tropical latitudes collides with cooler air from polar latitudes. Thunderstorms are responsible for the development and formation of many severe weather phenomena. Thunderstorms, and the phenomena that occur along with them, pose great hazards. Damage that results from thunderstorms is mainly inflicted by downburst winds, large

hailstones, and flash flooding caused by heavy precipitation. Stronger thunderstorm cells are capable of producing tornadoes and waterspouts.

There are four types of thunderstorms: single-cell, multi-cell cluster, multi-cell lines and supercells. Supercell thunderstorms are the strongest and most severe.

WHAT IS FLASH FLOOD

Flash flooding is the process where a landscape, most notably an urban environment, is subjected to rapid floods. These rapid floods occur more quickly and are more localized than seasonal river flooding or areal flooding and are frequently (though not always) associated with intense rainfall. Flash flooding can frequently occur in slow-moving thunderstorms and is usually caused by the heavy liquid precipitation that accompanies it. Flash floods are most common in densely populated urban environments, where few plants and bodies of water are present to absorb and contain the extra water. Flash flooding can be hazardous to small infrastructure, such as bridges, and weakly constructed buildings. Plants and crops in agricultural areas can be destroyed and devastated by the force of raging water. Automobiles parked within affected areas can also be displaced. Soil erosion can occur as well, exposing risks of landslide phenomenon.

EXPLAIN WESTERN DISTURBANCES

The extratropical storm that originates in the Mediterranean region which brings sudden winter rain to the north-western parts of the Indian sub-continent is known as Western Disturbance. It is a non-monsoonal precipitation pattern which is driven by the westerlies. This may happen during any season, not necessarily in monsoon. These extratropical storms are a global phenomenon. This phenomenon usually carries moisture in the upper layer of the atmosphere, unlike their tropical counterparts where the moisture is carried in the lower layer of atmosphere. In the case of the Indian subcontinent, moisture is sometimes shed as rain when the storm system encounters the Himalayas or Himalayan region.

HOW DOES WESTERN DISTURBANCES FORMS

Western Disturbance has its origin in the Mediterranean Sea as extra-tropical cyclones. A high-pressure is exhibited area over the areas like Ukraine and neighbourhood countries causes the intrusion of cold air from Polar Regions towards an area of relatively warmer air with high moisture. This change in pressure from cold air to warm air generates favourable conditions for cyclogenesis in the upper layer of the atmosphere, that promotes the formation of an eastward-

moving extratropical depression in the sea. Then these gradually travel across the middle-east from Iran, Afghanistan and Pakistan to finally enter the Indian sub-continent.

WHERE DO WESTERN DISTURBANCES ORIGINATE FROM

WDs originate in the Caspian Sea or the Mediterranean Sea as extra-tropical cyclones. They gradually travel across the middle-east from Iran, Afghanistan and Pakistan to enter the Indian sub-continent.

WHAT ARE IMPACT OF WESTERN DISTURBANCES

- It plays a significant role in bringing moderate to heavy rain in low-lying areas and huge quantity of snow to mountainous areas of the Indian Subcontinent.
- This disturbance usually occurs with a cloudy sky, higher night temperatures and unusual rain.
- The precipitation formed has great impact in agriculture, particularly for the Rabi crops.
- The excessive precipitation formed due to this disturbance can cause crop damage, landslides, floods and avalanches.
- In the areas of Indo-Gangetic plains, it occasionally bring cold wave conditions and dense fog.
- These climatic conditions remain stable until disturbed by another western disturbance.
- When these western disturbances travel across northwest India earlier to the onset of monsoon, a set of temporary advancement of monsoon current appears over the affected region.

WHAT IS A WEATHER FRONT?

A weather front is a boundary separating air masses of several characteristics such as air density, wind, and humidity. Disturbed weather often arises from these differences. For instance, cold fronts can bring bands of thunderstorms or be preceded by squall lines, while warm fronts are usually preceded by stratiform precipitation and fog. In summer, subtler humidity gradients known as or dry lines can trigger severe weather. Some fronts produce no precipitation and little cloudiness, although there is invariably a wind shif

Cold front

A cold front is located along the warm side of a tightly packed temperature gradient. On surface analysis charts, this temperature gradient is visible in isotherms and can sometimes be identified using isobars since cold fronts often align with a surface trough. On weather maps, the surface position of the cold front is marked by a blue line with triangles pointing in the direction of cold air travel and it is placed at the leading edge of the cooler air mass. Cold fronts often bring rain,

and sometimes heavy thunderstorms as well. Cold fronts can produce sharper changes in weather and move at a rate that is up to twice as fast as warm fronts, since cold air is more dense than warm air, lifting as well as pushing the warm air preceding the boundary. The lifting motion often creates a narrow line of showers and thunderstorms if enough humidity is present. The concept of colder, dense air "wedging" under the less dense warmer air is too simplistic, as the upward motion is really part of a maintenance process for geostrophic balance on the rotating Earth in response to frontogenesis.

Warm front

Warm fronts are at the leading edge of a homogeneous warm air mass, which is located on the equatorward edge of the gradient in isotherms, and lie within broader troughs of low pressure than cold fronts. A warm front moves more slowly than the cold front which usually follows because cold air is denser and harder to remove from the Earth's surface.[2]

This also forces temperature differences across warm fronts to be broader in scale. Clouds ahead of the warm front are mostly stratiform, and rainfall gradually increases as the front approaches. Fog can also occur preceding a warm frontal passage. Clearing and warming is usually rapid after frontal passage. If the warm air mass is unstable, thunderstorms may be embedded among the stratiform clouds ahead of the front, and after frontal passage thundershowers may continue. On weather maps, the surface location of a warm front is marked with a red line of semicircles pointing in the direction of travel.

Occluded front

An occluded front is formed when a cold front overtakes a warm front, and usually forms around mature low-pressure areas. The cold and warm fronts curve naturally poleward into the point of occlusion, which is also known as the triple point. It lies within a sharp trough, but the air mass behind the boundary can be either warm or cold. In a cold occlusion, the air mass overtaking the warm front is cooler than the cool air ahead of the warm front and plows under both air masses. In a warm occlusion, the air mass overtaking the warm front is warmer than the cold air ahead of the warm front and rides over the colder air mass while lifting the warm air.

A wide variety of weather can be found along an occluded front, with thunderstorms possible, but usually their passage is associated with a drying of the air mass. Within the occlusion of the front, a circulation of air brings warm air upward and sends drafts of cold air downward, or vice versa depending on the occlusion the front is experiencing. Precipitations and clouds are

associated with the *trowal*, the projection on the Earth's surface of the tongue of warm air aloft formed during the occlusion process of the depression.

Occluded fronts are indicated on a weather map by a purple line with alternating half-circles and triangles pointing in direction of travel. The trowal is indicated by a series of blue and red junction lines.

Warm sector

The warm sector is a near-surface air mass in between the warm front and the cold front, on the equatorward side of an extratropical cyclone. With its warm and humid characteristics, this air is susceptive to convective instability and can sustain thunderstorms, especially if lifted by the advancing cold front.

Stationary front

A stationary front is a non-moving (or stalled) boundary between two air masses, neither of which is strong enough to replace the other. They tend to remain essentially in the same area for extended periods of time, usually moving in waves. There is normally a broad temperature gradient behind the boundary with more widely spaced isotherm packing.

A wide variety of weather can be found along a stationary front, but usually clouds and prolonged precipitation are found there. Stationary fronts either dissipate after several days or devolve into shear lines, but they can transform into a cold or warm front if conditions aloft change. Stationary fronts are marked on weather maps with alternating red half-circles and blue spikes pointing in opposite directions, indicating no significant movement.

When stationary fronts become smaller in scale, degenerating to a narrow zone where wind direction changes significantly over a relatively short distance, they become known as shearlines. A shearline is depicted as a line of red dots and dashes. Stationary fronts may bring snow or rain for a long period of time.