Chapter 8

Weather Instruments, Maps and Charts

Weather denotes the atmospheric conditions of weather elements at a particular place and time. The weather elements include temperature, pressure, wind, humidity and cloudiness. Each day weather maps are prepared for that day by the Meteorological Department from the data obtained from observations made at various weather stations across the world. In India, weather-related information is collected and published under the auspices of the Indian Meteorological Department, New Delhi, which is also responsible for weather forecasting.

Indian Meteorological Department
The Indian Meteorological Department (IMD) was established in 1875, with its headquarters at Calcutta. The IMD headquarters are presently located at New Delhi.

Weather forecasts help in taking safety measures in advance in case of the likelihood of bad weather. Predicting weather a few days in advance may prove very useful to farmers and to the crew of ships, pilots, fishermen, defence personnel, etc.

Glossary

1. **Weather :** The condition of the atmosphere at a given place and time with respect to atmospheric pressure, temperature, humidity, precipitation, cloudiness and wind. These factors are known as weather elements.
2. **Weather Forecast :** Prediction with a reasonable amount of certainty about the conditions of weather that would prevail in the coming 12 to 48 hours in a certain area.

Weather Observations

Globally, meteorological observations are recorded at three levels, viz. surface observatories, upper air observatories and space-based observation platforms. The World Meteorological Organization (WMO), a

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specialised agency of the United Nations, coordinates these observations.

Surface Observatories

A typical surface observatory has instruments for measuring and recording weather elements like temperature (maximum and minimum), air pressure, humidity, clouds, wind and rainfall. Specialised observatories also record elements like radiation, ozone atmospheric trace gases, pollution and atmospheric electricity. These observations are taken all over the globe at fixed times of the day as decided by the WMO and the use of instruments are made conforming to international standards, thus making observations globally compatible.

In India, meteorological observations are normally classified into five categories depending upon their instruments and the number of daily observations taken. The highest category is Class-I. Typical instrumental facility available in a Class-I observatory consists of the following:

- Maximum and minimum thermometers
- Anemometer and wind vane
- Dry and Wet bulb thermometer
- Rain gauge
- Barometer

Observations are taken in these observatories normally at 00,03,06,09,12,15,18,21 hours (Greenwich Mean Time) around the globe. However, for logistic reasons, some of the observatories take limited number of daily observations upper air observation during daytime only.

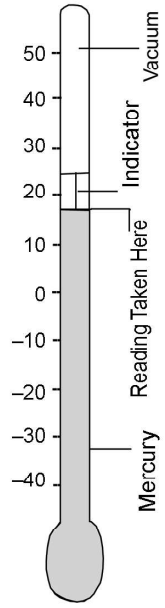


Figure 8.1 Maximum Thermometer

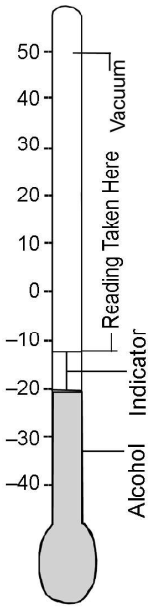


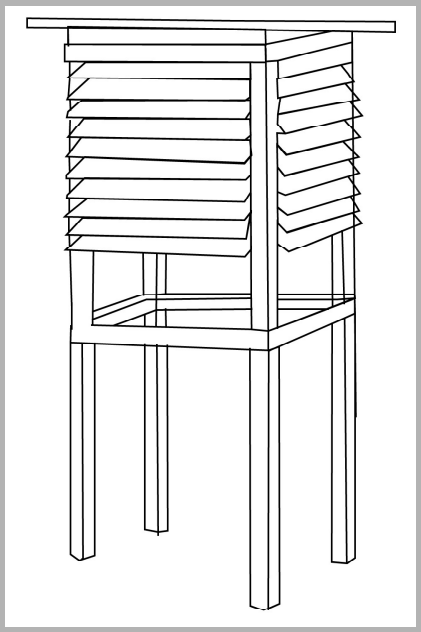
Figure 8.2 Minimum Thermometer

Space-based Observations

Weather satellites make comprehensive and large-scale observations of different meteorological elements at the ground level as well in the upper layers of the atmosphere. The geo-stationary satellites provide space-based observations about weather conditions (refer to Chapter 7). For example, The Indian National Satellite (INSAT)

Stevenson Screen

The Stevenson screen is designed to protect thermometers from precipitation and direct sunlight while allowing air to circulate freely around them. It is made from wood with louvered sides to allow free and even flow of air. It is provided valuable observations of temperature, cloud cover, wind and associated weather phenomena.



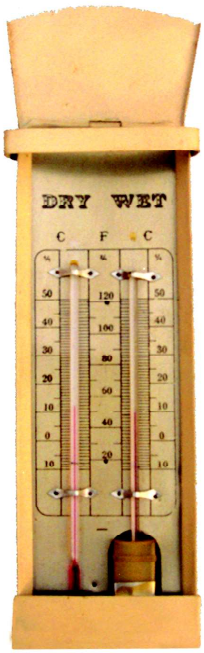


Figure 8.3 Wet and Dry Bulb Thermometer

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Weather Instruments

Various instruments are used for measuring different weather phenomena. Some of the common but important weather instruments are listed below.

Thermometer

Thermometer is used to measure air temperature. Most thermometers are in the form of a narrow closed glass tube with an expanded bulb at one end. The bulb and the lower part of the tube are filled with liquid such as mercury or alcohol. Before the other end is sealed off, the air in the tube is released by heating it. The bulb of the thermometer in contact with the air gets heated or cooled, as the case may be, as a result of which the mercury in the bulb rises or falls. A scale is marked on the glass tube and readings are taken from there.

The two most common scales used in thermometers are Centigrade and the Fahrenheit. On the Centigrade thermometer, the temperature of melting ice is marked 0^0C and that of boiling water as 100^0C, and the interval between the two is divided into 100 equal parts. On the Fahrenheit thermometer, the freezing and boiling points of water are graduated as 32^0F and 212^0F respectively.

While the maximum thermometer and minimum thermometer are used to measure the air temperature, the dry bulb and the wet bulb thermometers are used to determine the humidity in the air. A set of these thermometers is kept in the Stevenson Screen (Box 8.2).

The maximum thermometer is designed to record the highest temperature during a day. As the

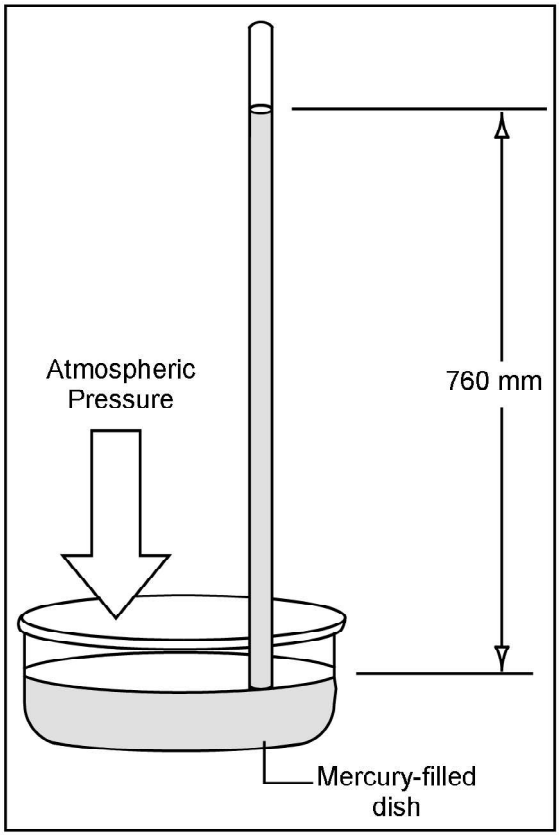

Figure 8.4 Mercury Barometer



Figure 8.5 Aneroid Barometer

temperature increases, the mercury moves up into the tube; however, as the mercury cools, it cannot move downwards because of a constriction in the tube. It must be reset again to bring it down. The minimum thermometer records the lowest reading in a day. In this thermometer, alcohol is used in place of mercury. When the temperature decreases, the metal pin in the tube goes down and strikes at the minimum temperature. (Fig. 8.1 Maximum and Fig. 8.2 Minimum Thermometers).

The dry bulb and wet bulb thermometers are used for measuring humidity

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Figure 8.6 Wind Vane

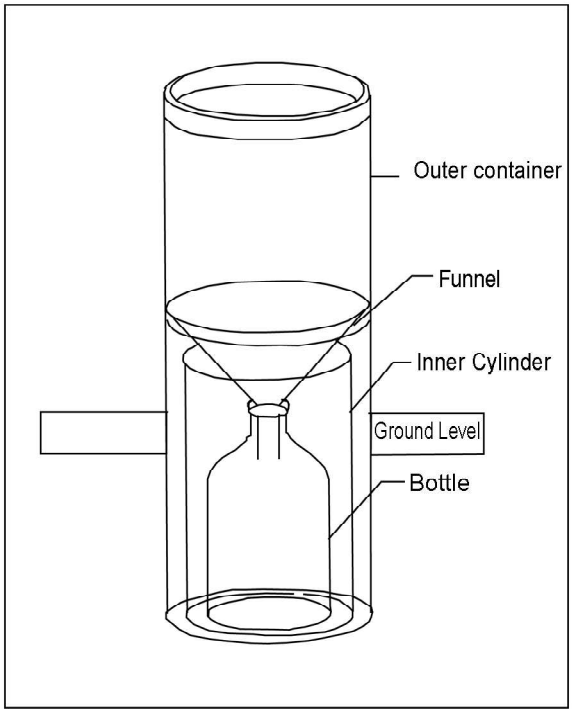

Figure 8.7 Rain Gauge

in the air (Fig. 8.3). The dry bulb and wet bulb thermometers are two identical thermometers fixed to a wooden frame. The bulb of the dry thermometer is kept uncovered and is exposed to the air while the bulb of the wet bulb thermometer is wrapped up with a piece of wet muslin, which is kept continuously moist by dipping a strand of it into a small vessel of distilled water. The evaporation from the wet bulb lowers its temperature.

Dry bulb readings are not affected by the amount of water vapour present in the air, but the wet bulb readings vary with it since the rate of

bulb will be small. On the other hand, when the air is dry, the evaporation from the surface of the wet bulb is rapid, which would lower its temperature and the difference between the two readings would be larger. Hence, the difference of the readings of the dry bulb and the wet bulb

thermometers determines the state of the atmosphere with regard to its humidity. The larger the difference, the more arid is the air.

Barometer

The air around us has weight, and it exerts great pressure on the earth's

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surface. At the sea level, under normal conditions, the pressure of air is 1.03 kg per square centimetre. Due to constant movement of air, change in temperature and variation in its vapour content, the weight

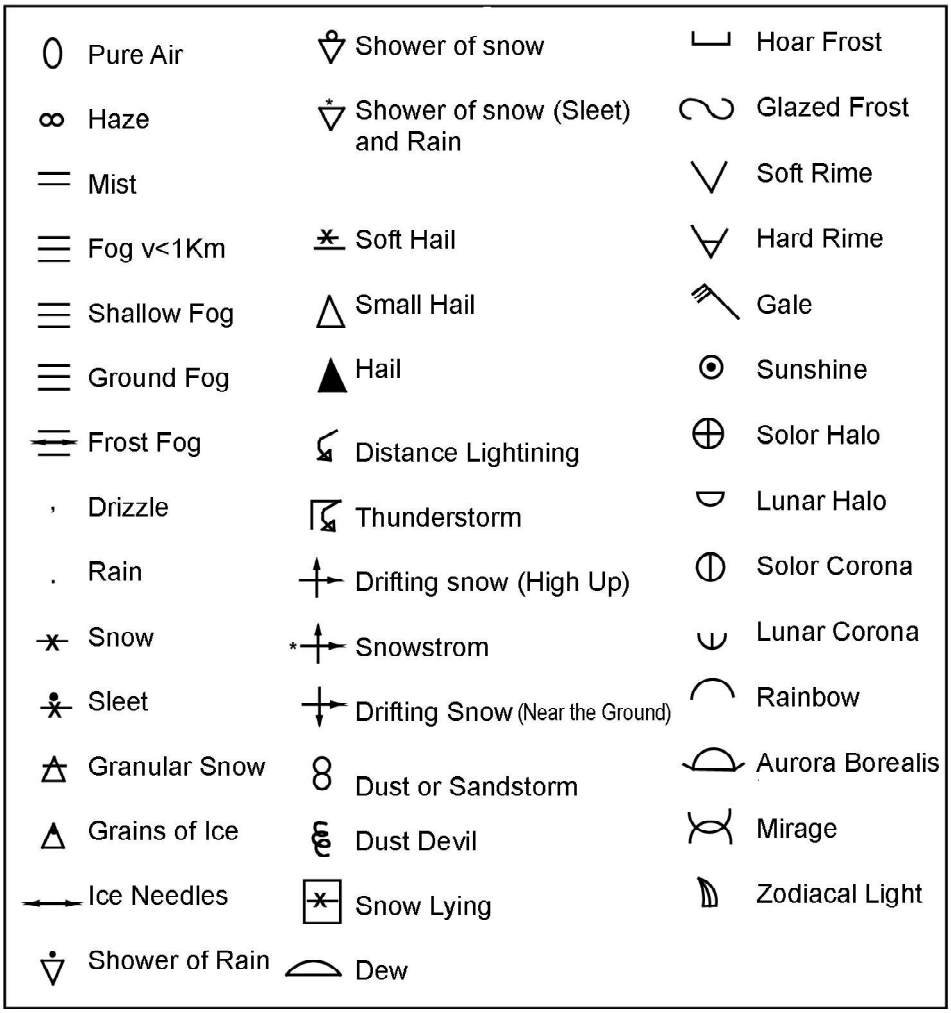

Figure 8.8 Meteorological Symbols (Approved by the International Meteorological Organisation, Warsaw, 1935)

Beaufort No.	Wind Arrow	Speed km/hr	Common effects
0 Calm		0	Calm, Smoke rise vertically.
1 Light air		1-5	Direction of wind shown by smoke drift, but not wind vanes.
		6-11	
2 Light breeze		12-19	Wind felt on face; leaves rustle; ordinary vane move by winds.
		20-28	
3 Gentle breeze		29-38	Leaves and small twigs in constant motion, wind extends light flag.
		39-49	
4 Moderate breeze		50-61	Raises dust and loose papers, small branches are moved.
		62-74	
5 Fresh breeze		75-88	Small tree in leaf begin to sway, crested wavelets from an inland waters.
		89-102	
6 Strong breeze		103-117	Large branches in motion; whistling heard in telegraph wires umbrellas used with diffiuclty.
		118 plus	
7 Moderate gale			Whole tree in motion, inconvenience felt when walking against wind.
8	Fresh gale		Breaks twigs off trees; generally impedes

Figure 8.9 Wind Speed and Common Effects

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of the air changes continuously with time and place.

The instrument used to measure atmospheric pressure is called a barometer. The most commonly used barometers are the mercury barometer, aneroid barometer and barographs. The unit of measurement is the millibar. Mercury barometer is an accurate instrument and is used as a standard. In it the atmospheric pressure of any place is balanced against the weight of a column of mercury in an inverted glass tube. The principle of a mercurial barometer can be explained by a simple experiment (Fig. 8.4). Take a thick glass tube of uniform strength about a meter long and fill it with mercury. Close the mouth of the tube with a finger, then invert and immerse its open end in a cup of mercury without allowing air to enter into the tube and then remove the finger.

The mercury will flow out of the tube into the cup and stand at a definite height above the level of the liquid in the cup. This is because the weight of the column of the mercury in the tube, above the surface of the mercury in the cup, is balanced by the weight of the air column of an indefinite height exerted as pressure upon an equal cross-section of the liquid surface. The height of the column of mercury in the tube, therefore, becomes the measure of the pressure of air.

Aneroid barometer gets its name from the Greek work, aneros (a- 'not', neros – 'moisture', meaning without liquid). It is a compact and portable instrument. It consists of a corrugated metal box made up of a thin alloy, sealed completely and made airtight after partial exhaustion of air. It has a thin flexible lid, which is sensitive to changes of pressure. (Fig. 8.5)

As the pressure increases, the lid is pressed inward, and this, in turn, moves a system of levers connected to a pointer, which moves clockwise over the graduated dial and gives higher reading. When the pressure decreases, the lid is pushed outward and the pointer moves counter clockwise, indicating lower pressure.

Barograph works on the principle of aneroid barometer. There are a number of vacuum boxes placed one above the other so that the displacement is large. A system of levers magnifies this movement which is recorded by a pen on a paper attached to a rotating drum. The

progress.
9 Strong gale — Slight structural damage occurs (chimney pots and slates removed.)
10 Whole gale — Seldom experienced inland; trees uprooted, considerable structural damage occurs.
11 Storm — Very rarely experienced, accompanied by widespread damage.
12 Hurricane — Most destructive.

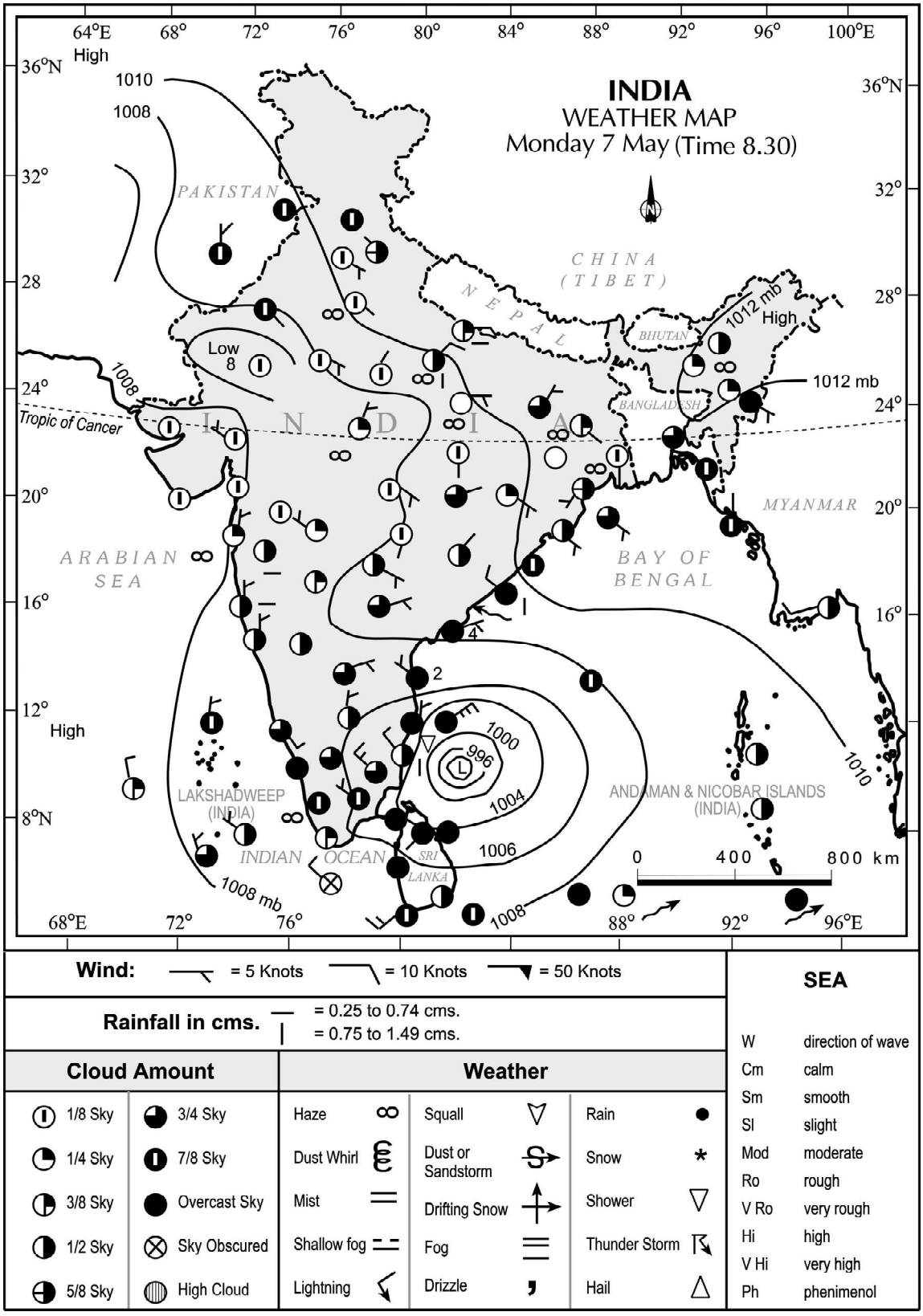

Figure 8.10 Indian Weather Map (for the month of May)

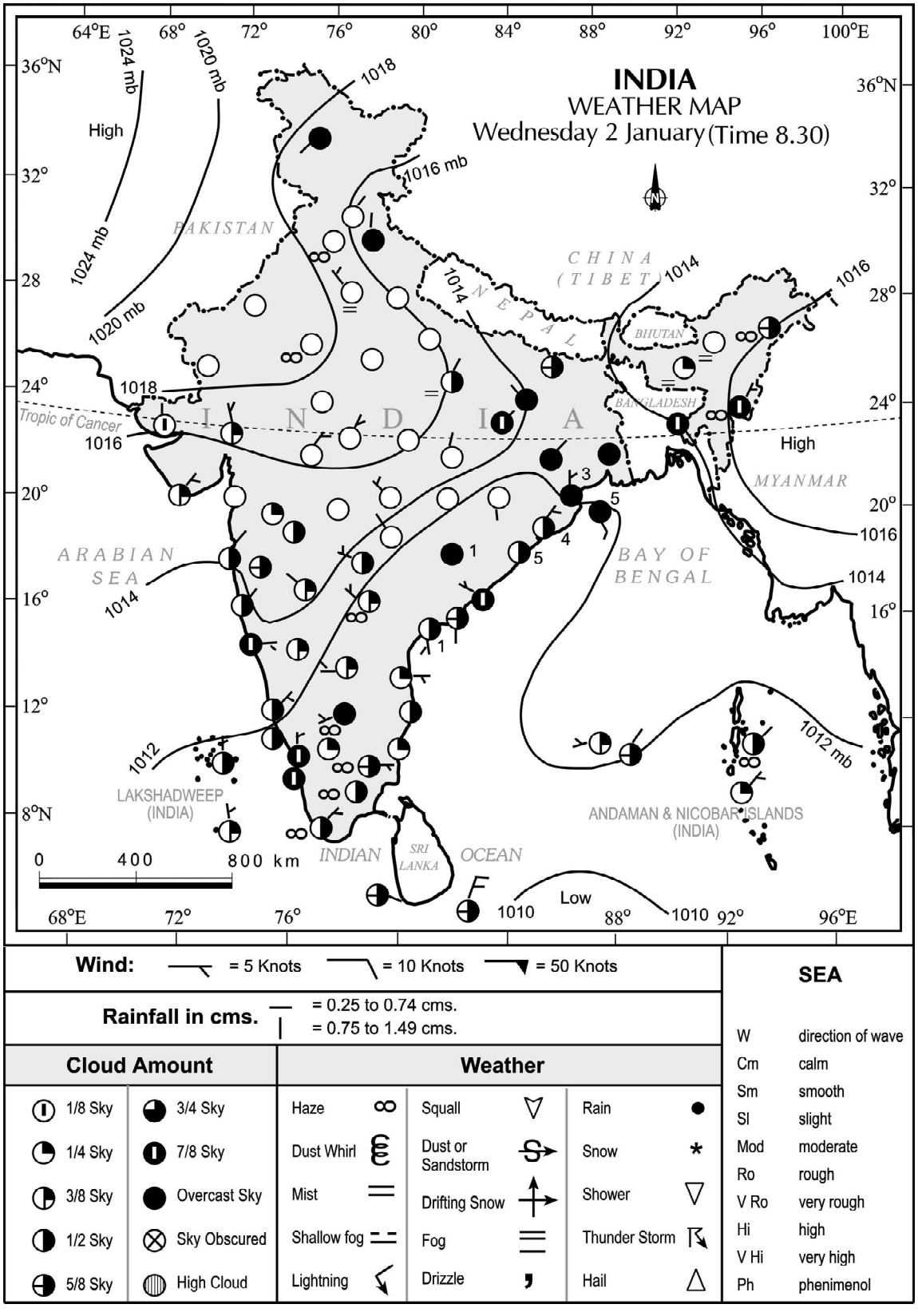

Figure 8.11 Indian Weather Map (for the month of January)

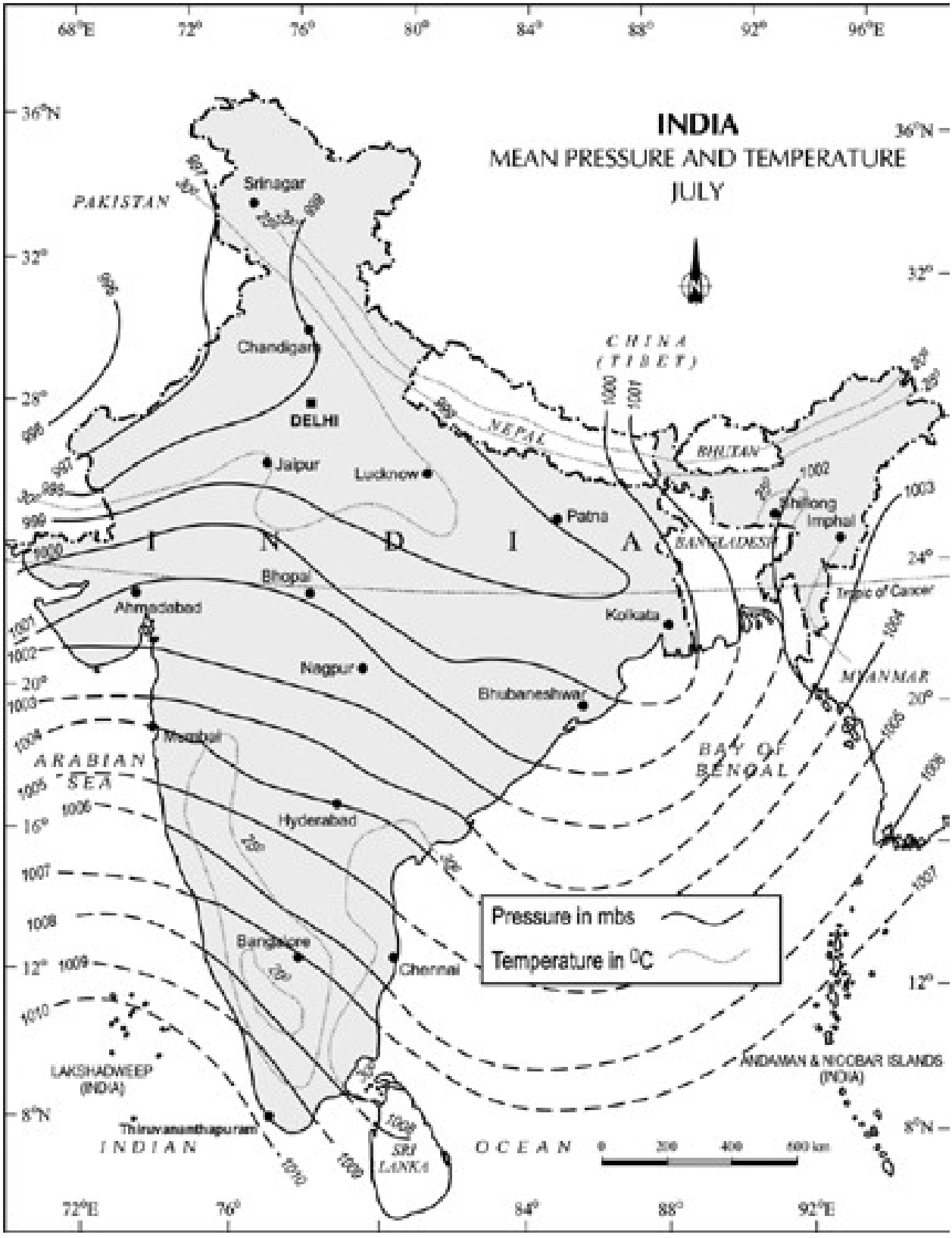

Figure 8.12 India - Mean Pressure and Temperature (January)

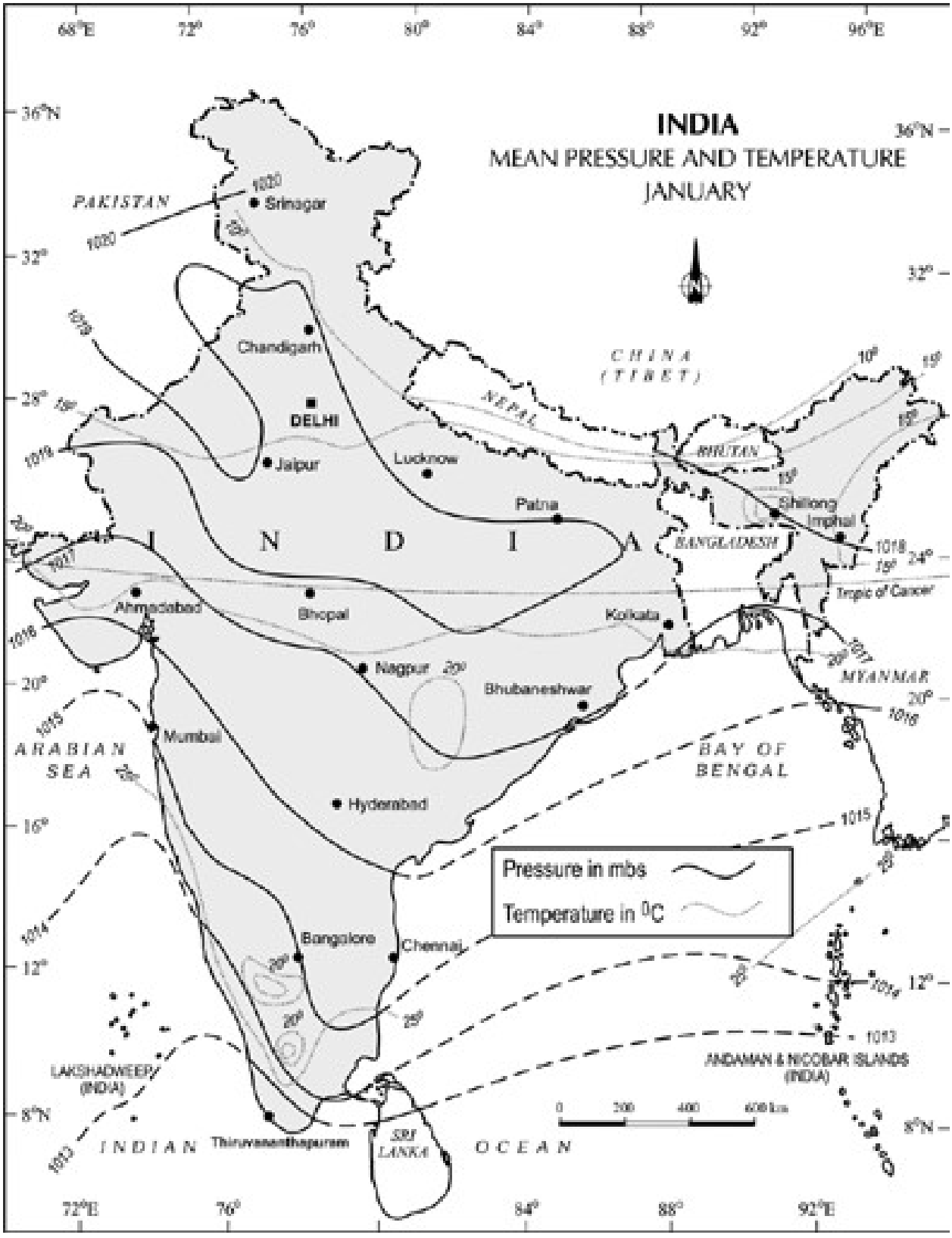

Figure 8.13 Mean Pressure and Temperature (July)

readings of a barograph are not always accurate, and therefore, they are standardised by comparing them with a mercury barometer reading.

(d) *Wind Vane*

Wind vane is a device used to measure the direction of the wind. The wind vane is a lightweight revolving plate with an arrowhead on one end and two metal plates attached to the other end at the same angle. This revolving plate is mounted on a rod in such a manner that it is free to rotate on a horizontal plane. It responds even to a slight blow of

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wind. The arrow always points towards the direction from which the wind blows. (Fig. 8.6)

Rain Gauge

The amount of rainfall is measured with the help of a rain gauge. The rain gauge consists of a metal cylinder on which a circular funnel is fitted. The diameter of the funnel's rim is normally 20 cm. The rain drops are collected and measured in a measuring glass. Normally, rainfall is measured in the units of millimetres or centimetres. Snow is also measured in a similar manner by turning it into liquid form (Fig. 8.7).

1	Temperature	Thermometer	°C/°F
2	Atmospheric Pressure	Barometer	Millibars
3	Wind (Direction)	Wind Vane	Cardinal points
4	Wind (Velocity)	Anemometer	Km/hr
5	Rainfall	Rain Gauge	mm/cm

Weather Maps and Charts

Weather Maps: A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface. It depicts conditions associated with different weather elements such as temperature, rainfall, sunshine and cloudiness, direction and velocity of winds, etc. on a particular day. Such observations being taken at fixed hours are transmitted by code to the forecasting stations. The central office keeps a record of the observations, which forms the basis for making a weather map. The upper air observations which are procured from hill stations, aeroplanes, pilot balloons, etc. are plotted separately. Since the inception of the Indian Meteorological Department, the weather maps and charts are prepared regularly.

Meteorological observatories transmit the data to the Central Observatory at Pune twice a day. Data is also collected on ships plying on the Indian seas. A good progress has been made in the field of weather forecasting and observation with the establishment of weather observatories in Antarctica, the International Indian Ocean Expedition, and the launching of rockets and weather satellites.