PAGASA Synoptic Station

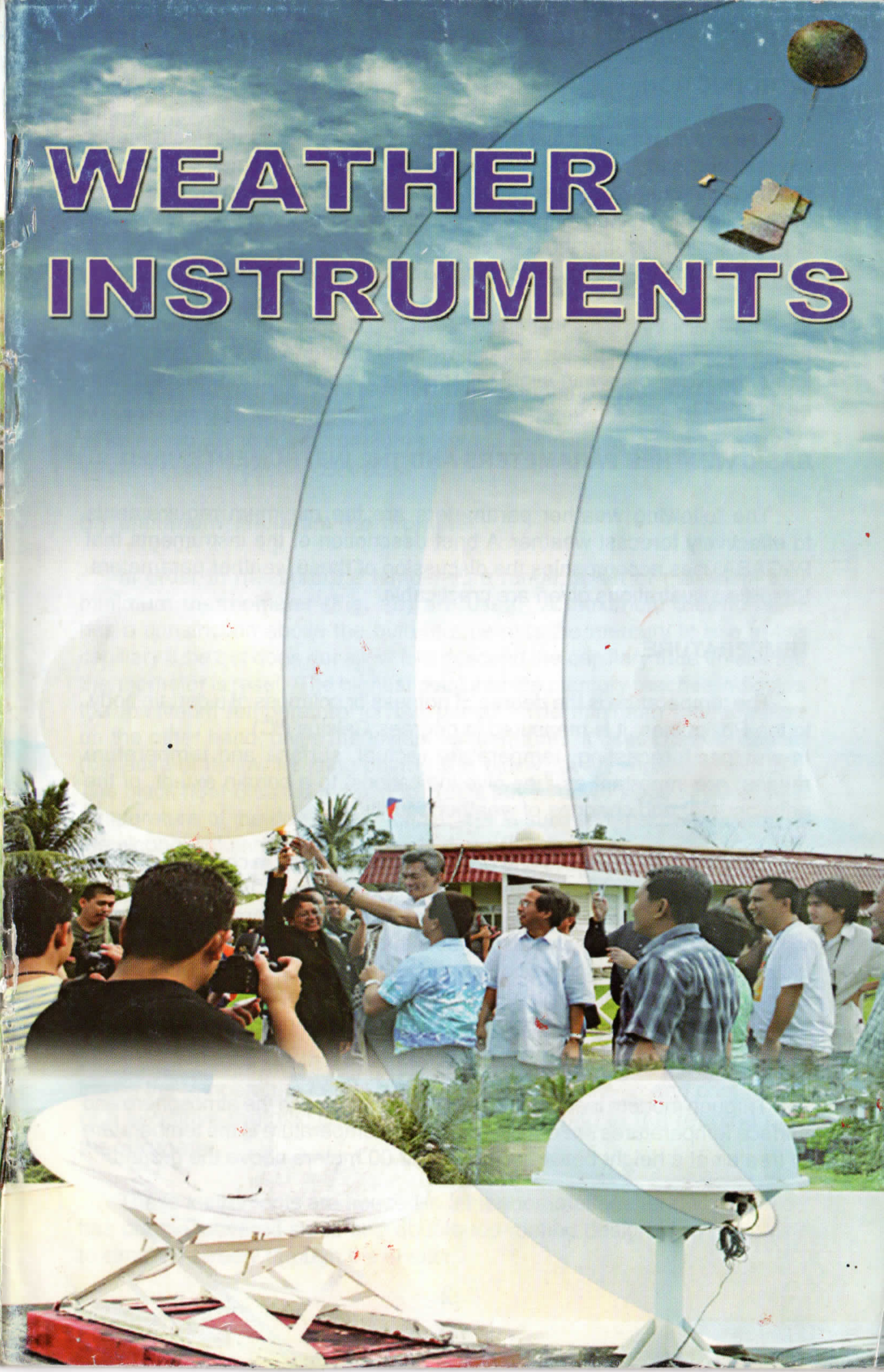
Department of Science and Technology

PHILIPPINE ATMOSPHERIC, GEOPHYSICAL AND ASTRONOMICAL SERVICES ADMINISTRATION (PAGASA)

Public Information and International Affairs Staff

Revised 2007

WEATHER INSTRUMENTS



INTRODUCTION

The weatherman just like any professional requires certain instruments to assist him in the conduct of his calling. He uses sophisticated instruments developed through the years. Little by little, due to advances in the science of meteorology and the advent of more sophisticated instruments, a forecaster is approaching the threshold where he can forecasts with confidence the weather for the following day and optimistically, a year later.

The Philippines is not far behind developed countries in instrumentations, specially when one speaks of basic weather instruments. They are all the same the world over with slight differences in construction and gradation as dictated by geographical requirements.

BASIC WEATHER PARAMETERS AND THE INSTRUMENTS USED

The following weather parameters are the minimum requirements to effectively forecast weather. A brief description of the instruments that PAGASA uses accompanies the discussion of these weather parameters. Simplified illustrations given are practicable.

TEMPERATURE

The temperature is the degree of hotness or coldness of a certain body. In the Philippines, it is measured in degrees Celsius (^{0}C).
In weather forecasting, temperature (actual, surface and temperature ranges) are important as they give indications, to a certain extent, of the development and changes of weather conditions.

Temperature change is one of the principal causes in changes of other basic weather elements. Temperature variations over lands and ocean result to a range of weather conditions from the gentlest breeze to the most violent storms. Temperature also affects the development and formation of clouds, the source of our precious water, when these clouds eventually fall as rain. It is, then, imperative that variations in temperature be considered in weather forecasting as they play an important part in the improvement or deterioration of weather conditions.

Through modern instruments, actual temperature in the atmosphere and surface temperatures are obtained. Surface temperature is the temperature of free air at a height between 1.25 and 2.00 meters above the ground.

The following instruments that measure temperature are commonly used:

a.) Thermometer

A thermometer (Fig. 1a) measures the degree of hotness or coldness of a given substance.

It operates on the principle of thermal expansion of the material used, e.g. liquids like mercury and alcohol, metallic materials etc. Mercury is one of the liquids very sensitive to changes of temperature. When the substance to be measures is warm, mercury expands and rises in the capillary tube. When it cools, mercury contracts.

b.) Maximum Minimum thermometer

In order to measure the temperature range, a set of maximum and minimum thermometer (Fig. 1b) are used. A maximum thermometer has a constriction above the bulb that permits the mercury to rise in the capillary tube but does not allow it to descend the capillary tube unless the thermometer is reset. The highest point that the mercury reaches indicates the maximum temperature for the period. The minimum thermometer, on the other hand, gives the lowest temperature. It uses colored alcohol (because of its low freezing point). It is placed at an angle of about 20$^{0.}$ The black float B called index (Fig. 1c) is pulled down slope to the lowest temperature of the day by two forces; a) the surface tension at the top of the alcohol column and b) the force of gravity.

c.) Thermograph

A thermograph (Fig 2) is an instrument that records air temperature continuously on graphing paper. It usually consists of a cylinder made to revolve once each week by means of clockworks inside. A sheet of graph paper is fastened on the outside. A pen point that rests on the paper traces the temperature curve, according to the expansion and contraction of a sensitive metallic coil or strip corresponding to the reading of a thermometer.

These instruments are housed in a thermometer shelter (Fig. 3) which has double-louvered sides and double-top roofing designed to permit air to circulated freely through the shelter.

TEMPERATURE MEASURING DEVICES

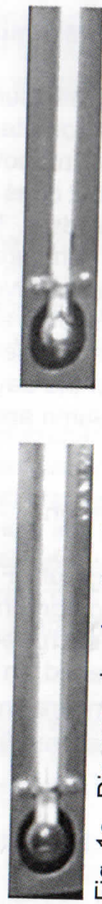


Fig. 1c. Diagram showing the distinctive characteristics of the maximum-minimum thermometer

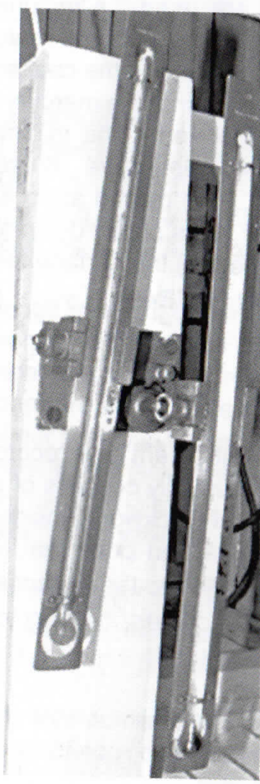


Fig. 1b. Maximum-Minimum thermometer mounted on a Townsend Support which clamps these in the proper position and allows for their setting

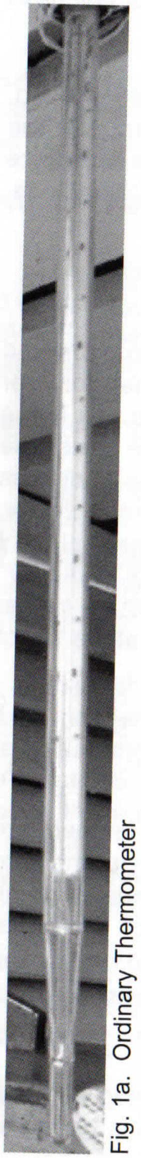


Fig. 1a. Ordinary Thermometer

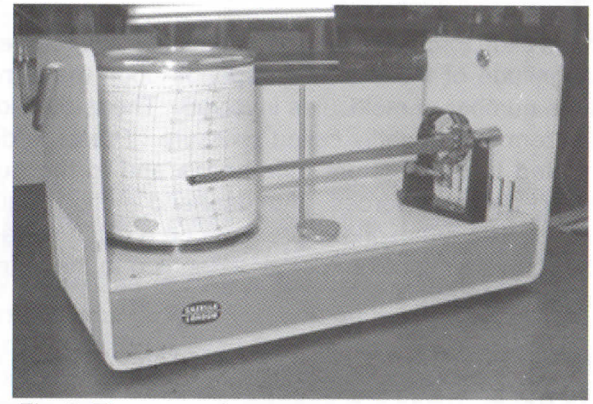


Fig. 2. Thermograph

Fig. 3. Thermometer Shelter or Screen. In the Northern Hemisphere its door faces north to prevent the sun's rays from directly affecting the intrument readings whenever it is opened

ATMOSPHERIC PRESSURE

Gas molecules exert forces on each other and their environmental they collide. The magnitude of these forces depends upon the temperature of the gas and the number of molecules involved. These collision forces are expressed in terms of quantity called pressure. Pressure difference is principally related to temperature differences and to the number of molecules exerting pressure forces. Atmospheric motion results from pressure variations. The atmospheric pressure on a given surface is the force exerted by an overlying column of air extending to the outer limit of the atmosphere per unit area.

To measure atmospheric pressure, a barometer is used, which is commonly of two types. These are:

a.) Mercurial Barometer

A mercury barometer (Fig.4a) is a simple barometer made by filling a glass tube 32 inches long with mercury and inverting it so that the open end of the tube is below the surface of mercury in a cistern. The height of the mercury column is measured by sliding a vernier attached on a scale. To obtain accurate measurements, corrections are made for temperature expansion of the instruments, gravity and latitude. Values are read in millibars, millimeter or inches of mercury.

b.) Aneroid Barometer

An aneroid barometer (Fig. 4b) is made by exhausting the air from a thin, circular, metallic box, with practically no air on the inside and an air pressure of 14.6 pounds per square inch on the outside, the box would collapse except for a strong spring inside. If one side of the box is fixed, the other side will move due to changes in atmospheric pressure. The surface of the metallic box is corrugated to increase the area exposed to the air. The movement of the spring causes a pointer to move over a scale of figures corresponding to the readings of a mercury barometer. Since air pressure decreases with increase in altitude, the aneroid is used to make altimeters (Fig. 5) On the altimeter, the scales is marked off in hundred and thousands of feet or meters above sea level. The altimeter is a basic instrument in aeronautical stations and on board an aircraft.

c.) Barograph

A barometer (Fig. 5a), on the other hand, is a recording barometer. The pen point that traces the pressure curve on the paper is made to move up

or down by means of a series of levers attached to the aneroid cells in tandem. The aneroid cells in tandem provide a more pronounced response to changes in atmospheric pressure than would be indicated by a single aneroid of the same size.

WIND

Wind is measured in terms of its velocity. Wind velocity has a vectorial notation and (usually) refers to both the speed and direction. Speed is the distance to which an object travels at a certain instant. Wind speed is usually expressed in meters per second (mps) and the more popular kilometers per hour (kph). On the other hand, wind direction refers to the direction of the compass point *from where the wind is coming.* Thus, when we say southwest winds, the wind is coming from the southwest and blowing towards the northwest.

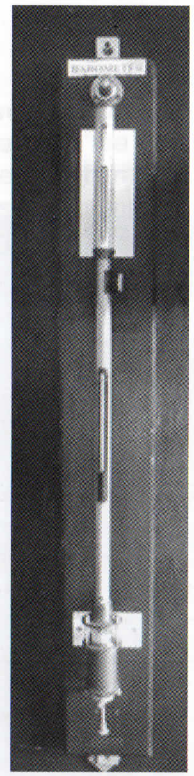


Fig. 4a. Mercurial Barometer

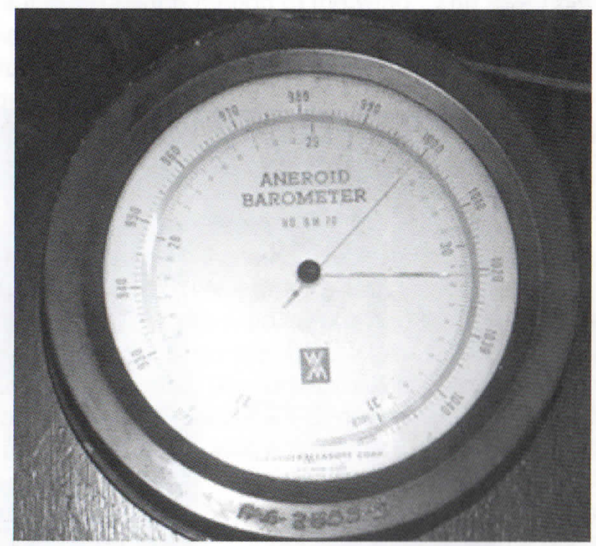


Fig. 4b. Aneroid Barometer

ATMOSPHERIC PRESSURE MEASURING DEVICES

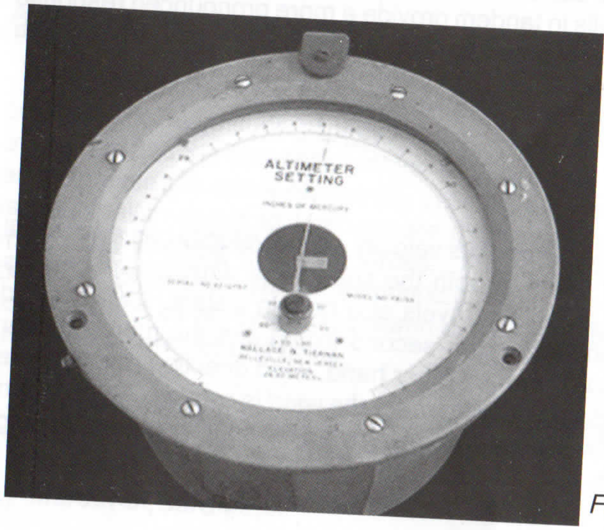


Fig. 5. Altimeter

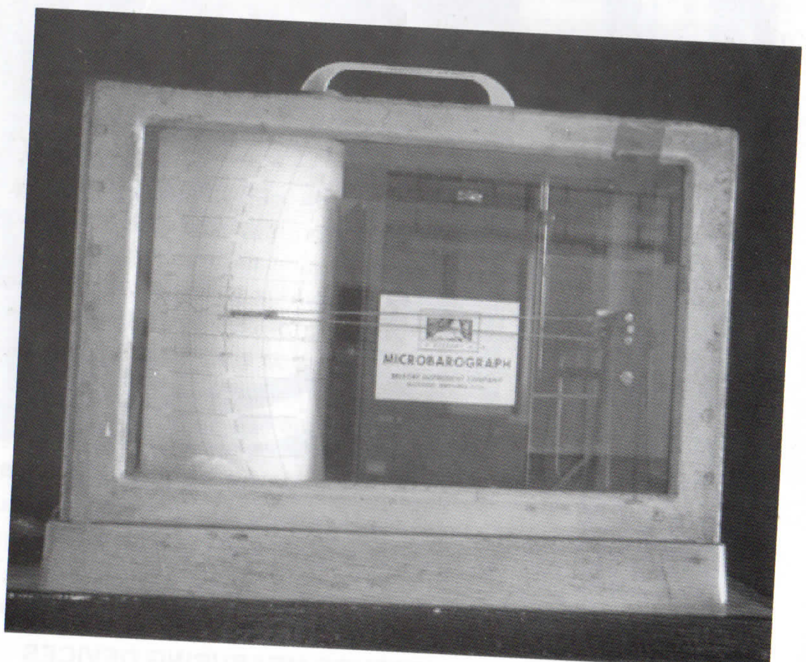


Fig. 5a. Barograph

SURFACE WIND VELOCITY AND DIRECTION

To accurately measure the wind speed and direction PAGASA uses several instruments: These are:

a. Wind Vane

A wind vane (Fig.6) is used to indicate wind direction. It consists basically of an asymmetrically shaped object with its center of gravity about a vertical axis. The front end of this object (in most cases as arrow) which officers the greater resistance to the motion of the air points to the direction from where the winds comes. The direction of the wind is determined by reference to an attached oriented compass rose.

b. Anemometer

An anemometer (fig. 6a) measures the wind speed and is made of propeller cups which are rotated by the motion of the wind. The essential parts of the cup anemometer are the cup wheel, a vertical shaft, the necessary mechanism for counting the revolution of the shaft or indicating its instantaneous speed of rotation.

c. Aerovane

An aerovane (Fig. 6b) indicates both the wind direction and wind speed or simply the wind velocity. It is shaped like an airplane. The nose of the plane ports to the direction from which the wind comes and the two-bladed propeller measures the wind speed. The propeller shaft is coupled to a small dynamo which generates current. The amount of current generated depends on the rate of rotation of the propeller which depends on the speed of the wind. The generated current activates a dial which gives the direct reading of the wind speed.

d. Anemographs

Anemograph gives direct record of the variations of wind velocity.

Fig. 6a. Rotating Cup Anemograph

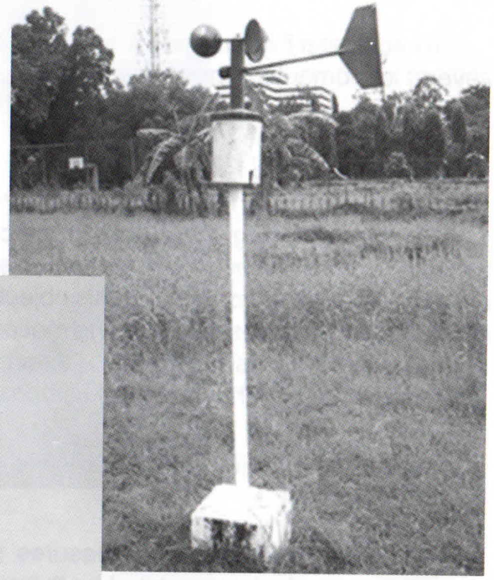


Fig. 6. Windvane

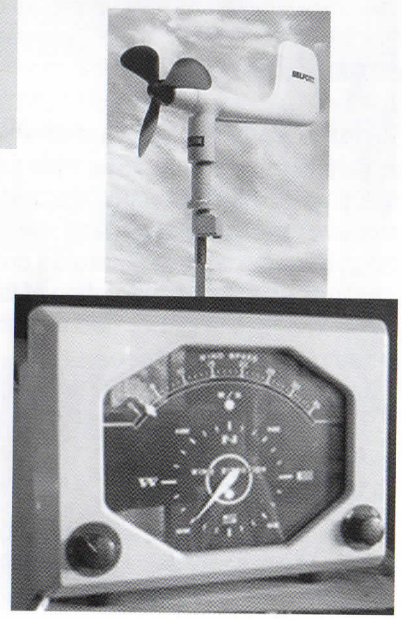


Fig.6b. An aerovane with its component, a wind indicator.

ATMOSPHERIC HUMIDITY

Humidity is the amount of water vapor or moisture content of the air. The amount of water vapor in the air affects human comfort. When the air is very moist or has high humidity, evaporation is very slow so much so that perspiration remains on the surface of the skin. This makes a person feel warm and uncomfortable. Humidity measurement is a useful parameter for weather forecasting in determining whether or not it will rain.

To measure humidity, the following instruments are used:

a. Sling Psychrometer

The sling psychrometer (Fig. 7a) consists of a dry and wet-bulb thermometer. The term bulb refers to that portion of the glass tube where the mercury is stored. The dry and wet bulbs are exactly alike in construction. The only difference is that the wet-bulb has a piece of muslin cloth or wick wrapped around its bulb and which is dipped in water shortly before the psychrometer is read.

This is how it is done. The weather observer first wets the cloth cladding the wet-bulb, whirls the psychrometer a few times, then reads the wet bulb. He reads the dry-bulb last. Normally, the wet-bulb reading will be lower than the dry-bulb's. The dry-bulb reading is the air temperature. The difference between the dry and wet-bulb reading will give, with the aid of psychrometric table, the dew point temperature and the relative humidity. (Dew point temperature at which the water will condense while relative humidity is the ratios of the amount of water vapor actually present in the air to the maximum amount of water vapor the air can hold at a given temperature.

b. Hygrometer

The other instrument used to measure humidity is the hygrometer (Fig. 7b). The hygrometer is less accurate than the psychrometer. It uses human air from which the oil has been removed by using ether. The hair becomes longer as the relative humidity of the air increases. This change can be made to move an indicator needle which moves over a scale, the graduations of which reads from 0% to 100%.

HUMIDITY MEASURING DEVICES

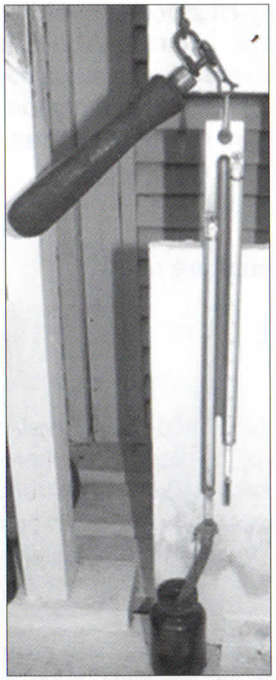


Fig. 7a. Sling Psychometer

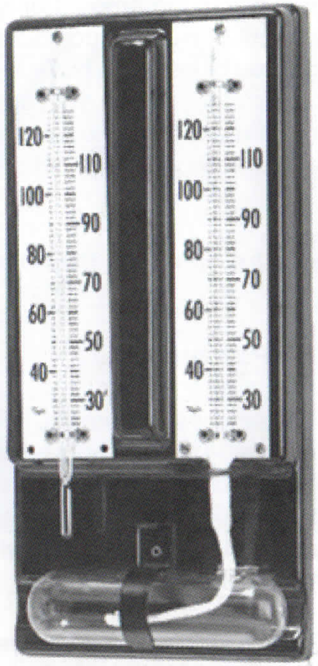


Fig. 7b. Hygrometer

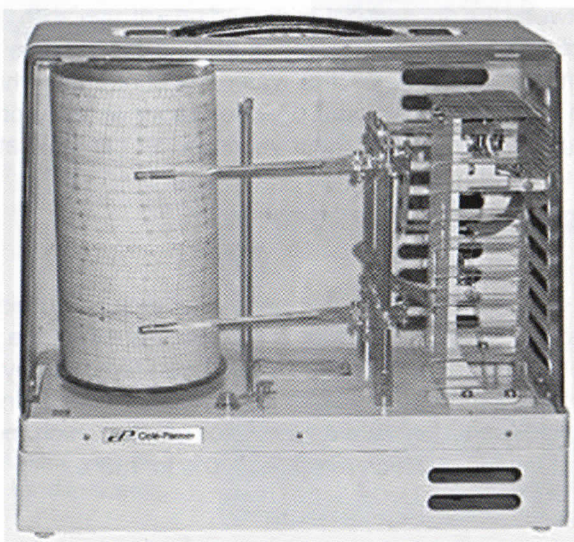


Fig. 7b. Hygrothermograph

c. Hygrothermograph

The hygrothermograph (Fig. 7c) measures and records relative humidity and temperature on graph paper in the same manner as the thermograph and barograph do.

PRECIPITATION

When the water vapor in the air aloft cools, it is transformed into water droplets that form the cloud we see in the sky. When these water droplets become large and heavy enough that the air could no longer support them, the water droplets eventually fall as rain, snow, sleet or hail. Rainfall is one such results of precipitation process.

a.) measuring stick

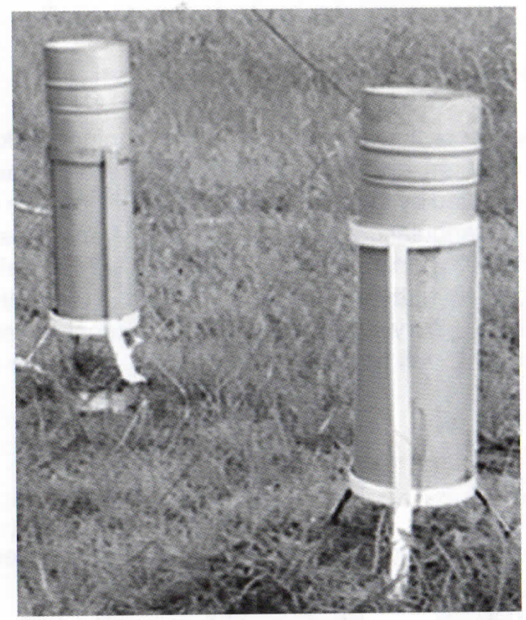


Fig. 8. An 8-inch raingauge and its parts. a.) measuring stick; b.) tube; c.) receiver and d.) overflow can.

PRECIPITATION MEASURING DEVICES