Meteorology instruments

The barometer

The most precise and accurate instrument to measure pressure is the mercury barometer, on the model of E. Torricelli's barometer invented in 1643. The aneroid barometer is less precise, however it is smaller and easier to use. It consists of a metal container in which a forced vacuum is created and sealed with a light flexible metal cover that rises and falls with variations in the external pressure. The movements of the cover are transformed by a mechanism into movements of a needle along a measuring scale that indicates the value of the atmospheric pressure.
By changing the values on the reference scale, aneroid barometers can be used as altimeters, to measure the height above sea level.
In a weather station, barographs are utilized. These are barometers coupled with a system to indicate the variations in the pressure graphically on a strip of paper. At present electronic instruments are able to transmit data directly to the processing stations and to record them on a computer.

The thermometer

The most commonly used thermometer is the mercury thermometer in which the temperature is measured on the basis of the expansion of liquid mercury in a bulb, however also ethyl alcohol thermometers are used. The thermograph that enables the recording of temperatures over a period of time is more complex: generally it consists of a bimetallic lamina, in which two different metals, that are welded together expand differently with the same variation in temperature.

The hygrometer

Relative humidity is measured with instruments called hygrometers. The most widespread are the hair type hygrometer, that exploit the unique property of human hair to stretch proportionally with the relative humidity (as those who have curly hair well know, when the air is humid, hair becomes more curly and knotted).
In meteorology more precise instruments called psychrometers (from the Greek word psycros, cold) are used. These consist of a couple of thermometers positioned side by side, one of which has a bulb covered with a cloth soaked with water. So long as the relative humidity is less than 100%, the thermometer with the wet bulb shows a lower temperature than the dry one, and the difference increases when the relative humidity decreases. By means of special tables it is therefore possible to calculate the relative humidity from the difference in the temperatures measured by the two thermometers. In fact, in order to make the water of the wet bulb evaporate, energy is necessary, which is subtracted from the bulb, which cools. The speed of evaporation, and therefore of the bulb cooling, is greater when the relative humidity is lower (i.e. when the air is dryer). When relative humidity is equal to 100% and the air is saturated with water vapour, instead, evaporation on the wet bulb stops and the two thermometers show the same temperature.

The rain gauge

The amount of water that falls on the ground is expressed in millimetres, i.e. the height the water would have reached had it fallen on a horizontal impermeable surface. One millimetre of rain that falls on a surface of 1 m2 is equivalent to one litre of water collected.
The amount of rain that falls is measured with pluviographs. These consist of a cylinder shaped container, positioned in a special weather cabin, above which is a collection funnel that has standard characteristics. The water that is collected is weighed and the data are recorded automatically and forwarded to a processing unit. Snowfall is collected on special tables, and the height is measured with measuring rods. Electric heating elements positioned on the funnel of the rain gauge melt the snow and thus the millimetres of rain, equivalent to the snowfall are obtained.

The anemometer

Wind speed is expressed in km/h or knots (1 knot = 1.852 km/h), or, more rarely in meteorology, with the Beaufort scale (proposed in 1805 by the English Admiral Francis Beaufort, to classify the winds according to their intensity).
Anemoscopes measure the direction of the wind and consist of simple metal vanes that rotate on a pivot and align with

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the direction of the wind (like the weathercocks on the roofs of houses or windsocks in the airports, that also provide an estimate of the speed of the wind depending on how the sock expands). A special instrumentation allows automatic recording of the data. Anemometers instead enable measurement of the wind speed with a small “pinwheel” that spins at a speed that is proportional to the speed of the wind. Generally, anemoscopes and anemometers are coupled in the same instrument. The more modern models are electric and special transmitters enable the transmission of data in real time to the processing station.

The heliograph

Insolation is when the Sun shines above the horizon on a given point of the Earth. This is measured by means of a helio-phano-graph, which consists of a spherical lens that concentrates the Sun’s rays on to a strip of special thermal paper that blackens when hit by the Sun’s rays that have been concentrated by the lens.
The energy received from a given surface, instead, is called global radiation, and is measured with an instrument called pyranometer or solarimeter, and is expressed in calories per unit of time per surface unit.

The weather station

The weather station is a small construction in which all the instruments used to measure the principal atmospheric parameters are set up. It is a wood cabin, painted white in order to reflect the Sun’s rays in the best possible manner, the sides are louvered shutters in order to guarantee air circulation. The cabin must be placed 1 m above ground so that it is not affected by direct heating from the ground. Many instruments are lodged in the cabin: a thermometer to measure the temperature, usually the maximum and minimum temperature type, a barograph and, on the outside, an anemometer and an anemoscope and a pluviograph are the minimum standard instrumentation.
The weather station must operate even if an operator is not present on the site, therefore all the instruments must be able to record data. Once, recordings were made on paper supports, and the operators periodically replaced the rolls of paper and collected the data, but now most of the instruments are electronic and are able to record data continuously, transfer them to a computer, and transmit them in real time to the recording stations, usually by means of radio signals.