

Manual weather measurements



Observing – whatever the weather

Introduction

This leaflet is designed primarily to assist anyone who is contemplating setting up a weather station to make climatological observations as a voluntary station co-operating with the Met Office. However, it will also be of help to others who wish to record the weather under standard conditions for their own purposes.

A further leaflet entitled *Automatic weather measurements* is available for those who are interested in automating their observing site.

General requirements

The most important requirements for stations to be accepted into the Met Office's co-operating observing network are as follows.

- Observations are to be made each day of the year by a competent observer at the fixed time of 0900 Universal Time Co-ordinated (UTC) — 9 a.m. clock time in the winter, 10 a.m. clock time during British Summer Time.
- The instruments should be of a standard design and, where possible, must be certified by an appropriate body.
- The instruments should be correctly set up on generally level ground away from the immediate influence of close obstructions such as fences, plants, trees or buildings.
- The proposed site should be representative of its general location and should not duplicate data from existing sites in the network.
- The site should have a planned lifespan of more than five years.

The *minimum* weather elements measured at a climatological station in the United Kingdom are daily maximum air temperature, daily minimum air temperature and daily rainfall amount, recorded over the period 09–09 UTC.

Details of the Met Office's co-operating observing networks are given in Met Office leaflet, *Making weather observations*.

Instruments

Where an authority maintains its own equipment prior to recruitment into the climatological network, it may be used for observations, as long as it meets Met Office specification. Where the Met Office has a need for a station in a particular area, or where existing equipment does not meet Met Office specification, equipment may be provided on loan. As long as official stocks permit, the Met Office will sell standard equipment at special rates to co-operating stations.

Essential equipment

The following instruments and equipment are essential to a basic climatological station if it is to meet the minimum requirement for daily measurements of maximum and minimum air temperature and rainfall amount.

- Maximum thermometer (mercury-in-glass)
- Minimum thermometer (spirit-in-glass)
- Thermometer screen and stand
- Rain gauge and rain measure



A voluntarily operated climatological station at Lambourn, Berks

Other equipment

Other weather elements may be measured depending on the resources available or interest at the station. Elements which may be reported on the Metform 3208B include:

- air temperature (dry bulb) using a thermometer (mercury-in-glass);
- wet-bulb temperature using a thermometer (mercury-in-glass);
- grass-minimum temperature using a thermometer (spirit-in-glass with radiation shield);
- concrete minimum temperature using a thermometer (spirit-in-glass with radiation shield);
- 10 and 20 cm soil temperatures using a right-angled thermometer (mercury-in-glass);
- 30, 50 and 100 cm soil temperatures using soil thermometers (mercury-in-glass, with the bulb set in wax, suspended in an iron or plastic tube driven into the ground);
- duration of bright sunshine using a Campbell–Stokes sunshine recorder;
- wind direction using a wind vane;
- wind speed using a cup anemometer;
- run of wind using a cup-counter anemometer.

No attempt is made in this leaflet to go into detail about the design of the meteorological instruments that might be used. Useful information can be obtained from the *Observer's handbook*.

Measurement of air temperatures

The thermometers used for the measurement of air temperatures (dry-bulb, wet-bulb, maximum and minimum temperatures) should be exposed in a Stevenson-pattern wooden thermometer screen, which has double-louved sides (i.e. slatted walls on four sides, the cross-section of the slats being an inverted V), a double roof and a floor made of three partially overlapping boards separated by an air space. The screen must be painted white inside and out, and must be set on a stand so that the bulbs of the dry-bulb and wet-bulb thermometers are 1.25 m above the ground (for most standard screens this means that the base of the screen is 1.10 m above the ground). The screen door should face north (or slightly east of north).

Thermometers should be graduated in degrees Celsius, be made in accordance with British Standards Specification BS692 and be identifiable by an engraved serial number. Thermometers issued by the Met Office will bear the monogram (MO) followed by a serial number.

Thermometers must be certified by either the Met Office or a recognised calibration laboratory (such as the British Standards Institution), and the observer must be in possession of a valid calibration certificate so that any necessary corrections can be applied.

The maximum thermometer records the highest temperature reached since the thermometer was last reset. A constriction in the bore of the thermometer holds the mercury in its highest position. The minimum thermometer records the lowest temperature reached since the thermometer was last reset. An index in the bore of the thermometer marks the minimum temperature. Once read, the thermometers should be reset.



A Campbell–Stokes sunshine recorder

Measurement of soil temperatures

Soil temperatures are measured at a number of depths — 10, 20, 30, 50 and 100 cm. Thermometers for the 10 and 20 cm depth temperatures are right-angled mercury-in-glass and are placed in the bare patch (see page 6). The bulb of the instrument is sunk to the appropriate depth but the stem of the thermometer remains on the surface. A different technique is used for the deeper measurements. The thermometer is suspended inside a tube with the bulb at the appropriate depth. The tube itself is sunk in the grass of the enclosure rather than the bare patch. The thermometer, housed in an extra protective glass sheath, has its bulb set in wax to slow its response enough to allow it to be removed and read.

Measurement of relative humidity

The humidity of the air is not normally measured directly. Instead, dry-bulb and wet-bulb thermometers are used and the humidity is calculated from the readings using tables or a humidity slide rule. The wet-bulb thermometer is a similar thermometer to the dry bulb, but its bulb is surrounded by a muslin wick which is kept wet from a reservoir of distilled water nearby. The wet bulb cools by evaporation and should normally read lower than the dry bulb, although in some conditions it can read the same. The wick should be replaced regularly and care must be taken to ensure that the reservoir is kept topped up to prevent the wick drying out. The interior of the reservoir container should also be cleaned and the water changed completely about every three months to prevent the growth of algae in the water reservoir.

Measurement of rainfall amount

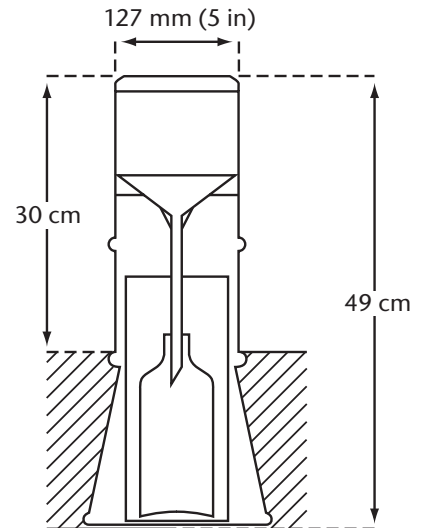
The rain gauge is usually made of copper with a knife-edged brass rim of 127 mm (5") diameter and has a deep funnel, as in the Met Office standard rain gauge or the Snowdon-pattern rain gauge. The rim should be set exactly level and at a height of 30 cm above the ground. The Snowdon-pattern rain gauge may need special attention to ensure stability because the depth of the gauge available to be buried in the ground while maintaining the rim at 30 cm is very limited.

A diagram of a standard rain gauge is shown right, along with a tapered rain measure. It will be seen that the rainwater is collected in a bottle standing within a removable inner (overflow) can. Rainfall is measured in millimetres (to the nearest tenth of a millimetre). The rain measure should be of the tapered pattern, graduated to discriminate between amounts of rain above or below 0.05 mm.

Information about the methods and instruments used for the measurement of rainfall can be found in Met Office leaflet, *Rules for rainfall observers*.



Measuring soil temperature



Met Office standard rain gauge

Measurement of sunshine duration

The duration of bright sunshine is normally recorded using a Campbell–Stokes pattern sunshine recorder. When the sun shines, a trace is burned into a record card.

A sunshine recorder requires a clear horizon between north-east and south-east and between south-west and north-west (ideally no obstruction in these directions should present an elevation in excess of three degrees). A rooftop location of a sunshine recorder often offers the best available exposure and maximum security from vandalism, as long as concerns over Health and Safety are considered.

The permissible height of obstructions between south-east and south-west depends on the latitude. The Met Office will complete a special obstruction diagram for the position where it is proposed to install a sunshine recorder, and, from this, the amount of obstruction will be computed in terms of the percentage loss of possible sunshine in each month. Up to five per cent loss in any month is normally considered acceptable.

When obtaining a sunshine recorder, stations should ensure that the glass sphere is certified by the Met Office.

Measurement of wind direction

Some means of assessing the wind direction is useful. This may be a wind vane, or a streamer attached to the top of a mast, or the drift of smoke from nearby chimneys — reference being made to fixed marks, the bearings of which are known. In a very open situation, a wind vane may be installed on a 6 m mast within the enclosure. If the site is obstructed, the vane should be erected on a building or mast so that it is at least 3 m higher than any obstacles in the immediate vicinity.

Measurement of wind speed

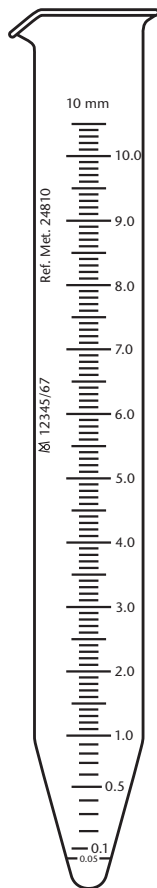
Wind speed is usually measured using a cup anemometer. The standard exposure for anemometers is at a height of 10 m above ground level in an open situation, but the effects of obstruction need to be considered in every case and advice should be sought from the Met Office. A cup-counter anemometer can also be used for calculating a mean wind speed by noting the difference in readings over a known short period and making a correction to the standard 10 m height. Details on how to do this may be found in Metform 3100A. If a station has no anemometer, the observer will be asked to estimate wind speed using the Beaufort Scale criteria as a guide.

Measurement of run of wind

When a cup-counter anemometer is used for run-of-wind recordings, for example at Agromet stations, the instrument should be exposed at a height of 2 m and the instructions given in the *Observer's handbook* for correction of wind to the standard height of 10 m should be ignored.

Visual observations

Some observations are normally made without the use of instruments. The Metform 3208B and DISCS (Data Input System for Climatological Stations) program have entries for total cloud amount, present weather, state of ground and visibility. Guidance on the codes used for making these observations can be found in the *Supplement to the Pocket Register*, Metform 3100A. Met Office booklet *Aide-mémoire for climatological observers* gives additional information about making these visual observations, with a large section on the present weather codes. It also contains helpful advice about observing the other elements at climatological stations.



Met Office tapered rain measure

Site and exposure

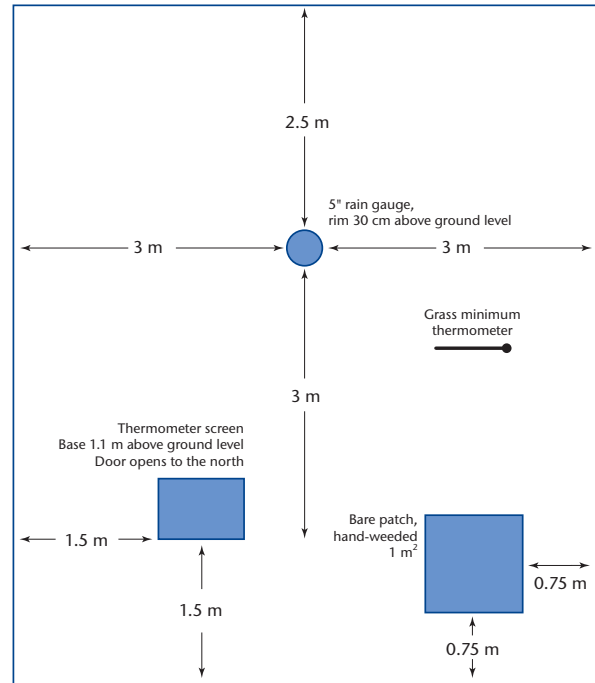
Readings of temperature and rainfall depend, to some extent, on the exposure of the instruments and, if observations made at different stations are to be comparable, it is necessary to ensure that instruments are set up under as uniform conditions as possible. The site of the instruments installed outside, known generally as the instrument enclosure, should ideally be on level ground covered with short grass or, where grass does not grow, the natural surface of the area.

The enclosure, which may be surrounded by open fencing or palings to exclude animals or unauthorised persons, should measure about 10 m by 7 m, but 7 m by 6 m for a basic climatological station, and should be away from the immediate influence of trees, buildings, hedges, fences and other obstacles. No obstruction should be nearer to the rain gauge than a distance equal to twice the height of the obstruction above the rim of the gauge. The screen and any thermometers on or in the ground should not be unduly shaded by trees or buildings. Conversely, the site, particularly that of the rain gauge, should not be unduly exposed to the sweep of the wind, although unavoidably exposed sites, such as on moorland or near the coast, can often be made acceptable by the construction of a turf wall around the rain gauge or by use of a ground-level pit gauge. (Details of how to build a turf wall are set out in Met Office leaflet, *Rules for rainfall observers*.) In general, a site should be representative of the surrounding area; when in a town, a site near the centre (if an acceptable exposure can be found) is preferred. A station should not be on, or close to, steep slopes, ridges, cliffs or hollows, although it is realised that such conditions will be difficult to avoid altogether in mountainous and hilly areas.

The instrument enclosure should include a patch of un-grassed, weed-free soil (the 'bare patch') at least 1 m square. This patch is used to determine the state of ground, and the soil should not be disturbed at any time. It should be kept free of vegetation by hand weeding or judicious use of a suitable weed-killing system. The bare plot should not be dug over, hoed or raked, etc. to keep it vegetation-free, as this will disturb the surface layer.

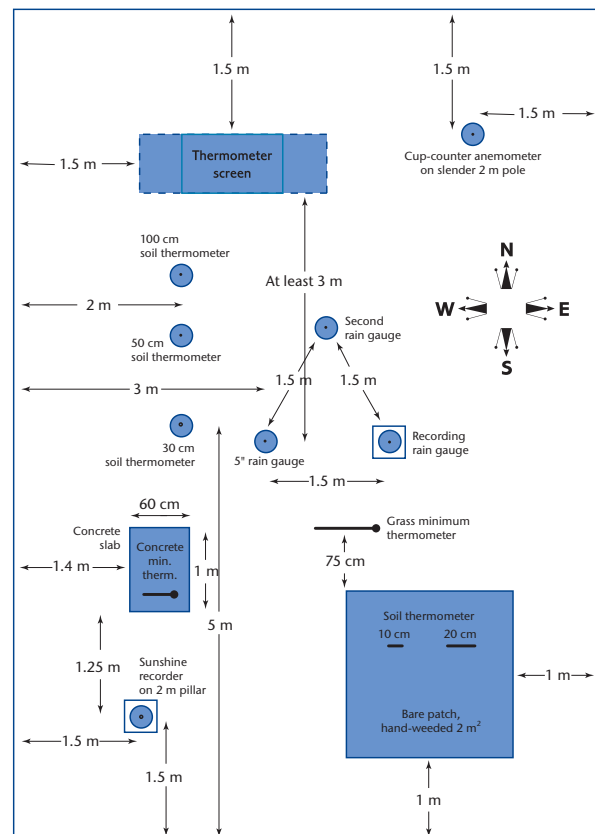
Right-angled thermometers (for 10 cm and 20 cm depths) are normally exposed over loose bare soil, but soil thermometer tubes (for 30, 50, and 100 cm depths) are set in ground covered with short grass.

A diagram showing the recommended layout of a climatological station is shown (right).



Suggested layout of basic met. enclosure for climate stations

Recommended layout of meteorological enclosure





A few additional tasks, such as cleaning the thermometer screen, are required periodically

Caretaking

In addition to the normal daily visits to make the observations, some additional work is required from time to time. Routine tasks include keeping the grass cut short in the enclosure, cleaning and painting the screen and keeping the bare patch free from weeds. At stations where wet-bulb temperatures are recorded, the muslin wick should be replaced regularly and the reservoir of water should be kept topped-up. The interior of the reservoir container should also be cleaned and the water changed completely about every three months to prevent the growth of algae in the water reservoir.

Bibliography

- *Rules for rainfall observers* (Met Office leaflet)
- *Making weather observations* (Met Office leaflet)
- *Automatic weather measurements* (Met Office leaflet)
- *The Health Resort Scheme* (Met Office leaflet)
- *An automatic weather station approved by the Met Office* (Met Office leaflet)
- *Aide-mémoire for climatological observers* (Met Office booklet)
- Metform 1091 — *Register of daily rainfall for a year (mm)*
- Metform 1122 — *Pocket register of rainfall*
- *Observer's handbook* (Met.O.1028)
- *Meteorological glossary* (Met.O.985)



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