
DEPARTMENT OF THE INTERIOR, U. S. GEOLOGICAL SURVEY.

INSTRUCTIONS

FOR

OBSERVING AIR TEMPERATURE, HUMIDITY, AND THE
DIRECTION AND FORCE OF WIND.

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AIR TEMPERATURE AND HUMIDITY.

Description of instruments.—The temperature and humidity of the air are obtained from the simultaneous observation of a pair of mercurial thermometers termed the dry and the wet bulb. The air temperature is given by the dry-bulb thermometer, and the humidity is obtained from the combined readings of both. The wet-bulb thermometer differs from the dry-bulb thermometer only in having its bulb covered with thin muslin, which is wetted in pure water at each observation. The two thermometers are fastened in a light metal or wooden frame. To this frame is to be attached a stout cord for the whirling of the thermometers, which is an essential part of every observation.

The proper observation of the wet thermometer requires especial attention, and the detailed instructions to be given concerning the application of the bulb covering, the wetting of the bulb with selected water, and the subsequent tests for a proper reading, all indicate the care considered necessary to be exercised in using this instrument.

Muslin for wet bulb; how applied.—For cylindrical bulbs, cut the muslin to a rectangular shape, in length about three-quarters of an inch greater than the length of the bulb, and in width a trifle greater than its circumference, so that when wrapped about it will cover the bulb completely; overlap the edges only enough to insure perfect covering. After cutting, wet the cover and attach it smoothly and tightly to the bulb, making sure that it is covered completely with one thickness of cloth. While the cloth is wet tie it tightly both above and below the bulb with fine thread. The muslin on the bulb should always be kept clean, and to this end should be renewed when necessary. A slight coating of any substance on the muslin seriously retards evaporation and thereby impairs the accuracy of the observations.

Place of observation.—The thermometers, while being whirled or read, should not be exposed to the direct rays of the sun, but should be held in the shade of a tree or other small object. The shade of a *large* building is to be avoided, because there the air on hot days may have a temperature considerably lower than the average of the surrounding temperatures.

Method of observing.—At each observation the muslin of the wet bulb is to be thoroughly wetted by immersing it in a tube or cup of pure water, preferably rain-water or melted snow. When properly ventilated, the temperature of the wet bulb will fall to the *temperature of evaporation*—the temperature which the instrument is designed to indicate, and which it is the object of the observation to determine. But in order to secure it considerable skill in manipulation is requisite.

The necessary ventilation is obtained by whirling the thermometers with the cord attached to the frame, whereby the evaporation is accelerated and the complete reduction of the temperature of the wet bulb secured. In order, however, that the evaporation shall not proceed more rapidly than the temperature can follow, and the muslin thereby become dry before the lowest temperature is secured, it is desirable, after wetting the muslin, to wait one or two minutes before whirling. This is especially necessary in warm, dry weather. During the interval the temperature falls nearly to its lowest point, while only so much moisture as is necessary to attain it is evaporated. The process is then completed by whirling the thermometers fifteen or twenty times and noting the temperature of the wet bulb; then by whirling again and again noting the temperature. If the temperature has not been changed by the second whirling it may be considered as the correct value. If there has been a change to a lower reading, the alternate whirling and reading should be continued until no further falling is observed. The lowest reading of the wet bulb together with the temperature of the dry bulb taken at the same time will be the readings to be recorded. Care should be taken not to allow the muslin to become dry, or even partly so, before the lowest reading has been secured; and in case it is suspected that such drying has occurred, it is necessary to rewet the bulb and repeat the observation.

If a strong wind is blowing, the thermometers when held up to the wind may receive sufficient ventilation to render the whirling unnecessary. The best results are attainable under these circumstances.

In very cold, still weather it is necessary to walk about while whirling, to prevent the air brought in contact with the thermometers from being warmed by the heat of the body.

In taking thermometric readings the line of sight should be perpendicular to the stem, and the readings should be taken as rapidly as accuracy will permit, to avoid affecting the temperature by heat from the body or lantern.

The cord used in swinging the thermometers should be frequently examined, and when found to be worn should be replaced by a new piece as a precaution against breakage.

MAXIMUM AND MINIMUM TEMPERATURES.

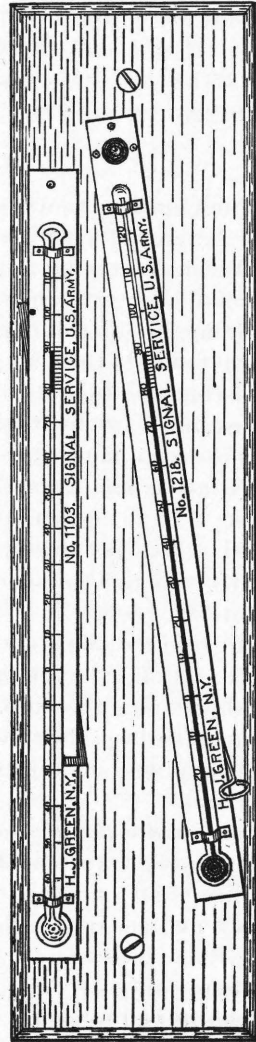
The highest and lowest temperatures occurring in each day are obtained from self-registering maximum and minimum thermometers exposed in a thermometer shelter.

The *thermometer shelter* is a cubical box whose sides are of open lattice work and the top and bottom of tightly matched boards. It should be placed upon and firmly bolted to a stout frame-work support, at a height such that the bottom of the shelter shall be 5 feet above the surface of the ground. The shelter should not be located within 25 feet of any building of the same or greater height, and, if the ground is not level, should be placed on a knoll rather than in a depression.

Mounting of thermometers.—Maximum and minimum thermometers are usually mounted together upon a board which is furnished with the instruments. This should be fastened in a horizontal position to a vertical or horizontal cross-piece erected in the middle of the shelter.

For the support of the maximum thermometer the long brass swing-pin, with a nut, must be screwed into the board, in the hole to the extreme right. The nut must be taken off and the pin slipped through the hole in the upper end of the thermometer frame, and then secured by replacing the nut and screwing it tightly. The plain brass set-pin must then be inserted in the hole on the left of the board, and the thermometer placed upon it so as to incline 1 inch in its length. The end of the swing-pin must be occasionally oiled to prevent friction.

The minimum thermometer is fastened to a long, thin, narrow piece of curved brass. This piece of brass is attached at its center by two screws to the board support, and is so placed as to bring the notched end about 3 inches above the maximum thermometer, and then fastened in the middle by one of the screws. The upper end of the thermometer scale is attached to the brass support by a milled-head screw, and the lower end of the scale is laid in the notch of the brass support. The thermometer is then carefully leveled to a position exactly horizontal, and the second center screw is then inserted to fasten the brass support to the board. The accompanying diagram shows the thermometers mounted as just described.



THE MAXIMUM THERMOMETER.

The maximum thermometer used by the Geological Survey is a mercurial thermometer whose bore is partly closed by a constriction just

above the bulb. By a rise of temperature a portion of the mercury in the bulb is forced through this constriction; and when the temperature falls the mercury does not return to the bulb, but remains above the contraction, and the top of the mercurial column indicates the highest temperature that has been reached since the thermometer was last set.

To set the maximum thermometer.—To set the maximum thermometer, remove the set-pin and whirl the thermometer on the swing-pin, thus forcing the mercury back into the bulb until the top of the column indicates the current temperature of the air. Before swinging the thermometer see that the nut on the swing-pin is tight so as to avoid the danger of accident. After swinging, slowly raise the thermometer to its proper position and insert the set-pin.

THE MINIMUM THERMOMETER.

The minimum thermometer used by the Geological Survey is an alcohol thermometer with a small glass index introduced into the tube.

When the temperature falls, the index which is within the alcohol column is drawn down by the surface tension at the end of the contracting liquid column. After the top of the spirit column ceases to move towards the bulb, and, by reason of a rising temperature, begins to ascend the tube again, the liquid does not disturb the position of the index, but flows by it leaving it at the point of lowest temperature that has occurred since the index was set.

To set the minimum thermometer.—To set the minimum thermometer, raise it to a vertical position and allow the index to run up the stem until it reaches the upper end of the spirit column. Then lower the bulb until the thermometer rests in the notch in its proper horizontal position.

To read the minimum thermometer.—Ascertain by inspection the nearest tenth of a degree on the scale coinciding with the end of the index farthest from the bulb. This will be the lowest temperature since the instrument was last set unless some displacement has occurred. The jarring of the shelter during high winds is frequently found to displace the index.

To reunite the alcohol column when detached.—It frequently happens that during transportation the column of alcohol is broken by the entrance of air bubbles. To reunite the detached column when it is only a few degrees in length, heat the bulb in warm water until the column is driven into the enlargement at the top of the tube and the main column joins it. The thermometer, placed in a vertical position, is then allowed to cool.

Minimum thermometer to be compared with dry-bulb thermometer.—In order to detect any error in the minimum thermometer, it is desirable to make occasional comparisons to determine whether the top of the alcohol column agrees with the readings of the dry-bulb thermometer hung beside it. This comparison should be made at a time of day

when the temperature is practically stationary, as in the early morning. Every monthly report of observations should contain at least one such comparison.

TIME OF OBSERVATION.

The maximum and minimum temperatures should be observed and the thermometers reset in the evening after the highest temperature of the day has been reached. If the thermometer shelter is subject to jarring by high winds, it is advisable to observe and record the reading of the minimum thermometer in the morning soon after the lowest temperature has been reached. But in this case, also, the minimum thermometer should always be reset in the evening.

WIND.

The highest force of the wind occurring each day, together with its direction and the time of its occurrence, is a part of the data needed for an elementary knowledge of climate.

Wind direction.—The first essential for observing the direction of the wind is to know the direction of the true north and south line. To this end it is desirable to have a fixed horizontal pointer or cross-piece to indicate the true meridian. The direction from which the wind blows may be shown by a wind-vane properly exposed, or, in the absence of a wind-vane, by the direction of moving smoke, or the observer may determine it from his own sensations. The record of direction should be given to the nearest eight points, viz: N., NE., E., SE., S., SW., W., NW.

Wind force.—Without instruments for accurate measures, the force of the wind must be estimated on an arbitrary scale. The following scale of ten numbers is to be used in making these estimates:

No.	Designation.	Suggested interpretation.
1	Light air	Just sensible, giving direction to smoke.
2	Gentle breeze.....	Setting in motion leaves of trees.
3	Moderate breeze.....	Swaying small twigs; starting dust.
4	Fresh breeze	Swaying small branches; blowing up dust.
5	Strong wind	Swaying large branches.
6	High wind	Blowing away all loose, unsecured material.
7	Gale	Damaging standing grain.
8	Strong gale.....	Ruining crops; breaking small branches.
9	Violent gale	Breaking large branches of trees.
10	Tornado wind	Destroying buildings; uprooting trees.

Instructions for recording the observations are contained in the blank forms furnished for preparing the reports.