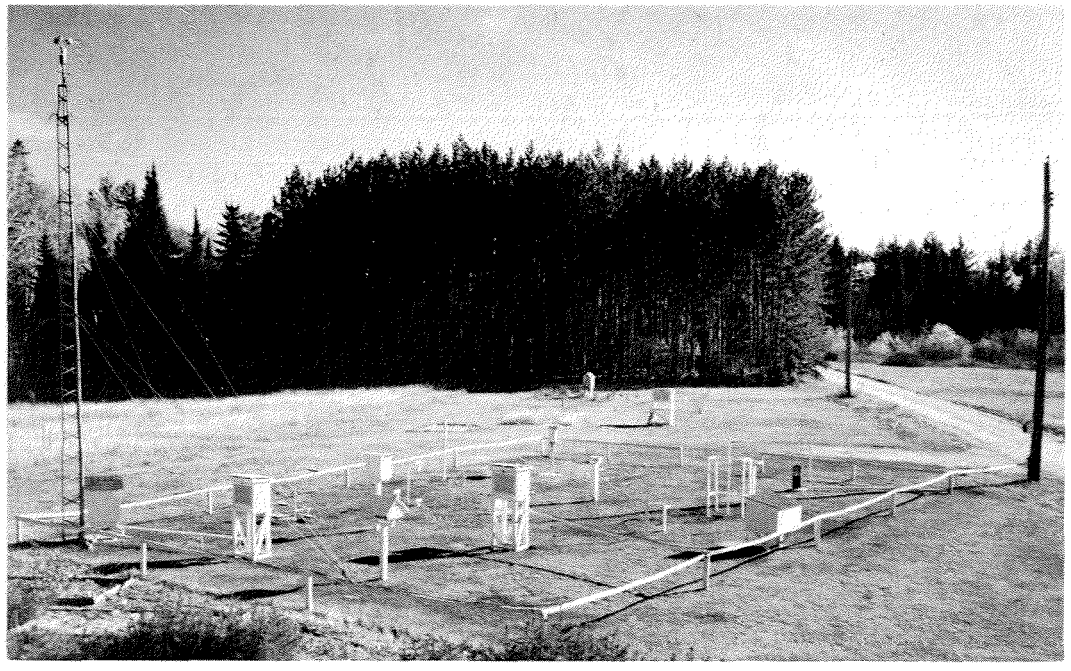
THE STANDARD WEATHER STATION
at the
PETAWAWA FOREST EXPERIMENT STATION
CHALK RIVER, ONTARIO

by

J. W. Fraser and C. R. C. Farr



Résumé en français

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Cover Picture

The standard weather station at the Petawawa Forest Experiment Station, Chalk River, Ontario.

Illustration de la couverture

La station météorologique de type classique de la Station d'expérimentation forestière de Petawawa, près de Chalk River (Ont.).

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Abstract

The standard weather station at the Petawawa Forest Experiment Station is described and details given of the instrumentation used to record soil temperature, precipitation, wind speed and direction, solar radiation, evaporation.

Résumé

L'on trouve, dans cette publication, la description de la station de météorologie de type classique située à la Station d'expérimentation forestière de Petawawa, près de Chalk River, (Ont.). On y trouve aussi la nomenclature des instruments qu'on y emploie, et des renseignements détaillés sur l'utilisation de ces instruments qui servent à enregistrer les températures de l'air et du sol, les précipitations, la vélocité et la direction des vents, la radiation solaire et les périodes d'ensoleillement et, enfin, l'évaporation.

CONTENTS

The Standard Weather Station at the Petawawa Forest Experiment Station Chalk River, Ontario

by

J. W. FRASER[1] and C. R. C. FARR[2]

INTRODUCTION

"The forester is interested in weather science insofar as the various processes are of significance for his forest" (Geiger, 1950). Climate influences the results of silvicultural operations which in their turn affect stand climate, hence the research forester should consider weather in describing his experimental areas or interpreting his results. Many foresters who have occasion to establish climatological stations, yet lack formal training in meteorology, may find helpful this description of the standard weather station established at the Petawawa Forest Experiment Station, Chalk River, Ontario.

A weather station can vary from a few relatively simple instruments for obtaining short term or even periodic measurements of temperature and precipitation, to a complex of sensitive instruments for measuring and recording many elements of weather in great detail on a long term basis.

Since accurate measurement of many meteorological elements depends on the correct exposure of the instruments, the choice of site is important. Ideally, the site should be representative of the forest conditions concerned, but should not be on or adjacent to steep slopes, cliffs or hollows. In practice many foresters accept a clearing in the forest as a standard site for a forest weather station. Department of Transport (DOT) regulations (Anon. 1952a) stipulate that instruments on meteorological stations must be located no closer to an obstruction than a distance equal to at least twice the height of the obstruction. MacHattie[3] suggests that forest clearings should be sufficiently large that instruments be as remote from the nearest trees as a distance equal to four times their height. The World Meteorological Organization (WMO) Guide (Anon. 1961a) recommends that weather stations be located at places and under arrangements that will provide for continued operation for at least 10 years and for the exposure to remain unchanged.

The weather station described here (Cover Picture and Figure 1) was established to obtain long-term representative data on temperature, precipitation,

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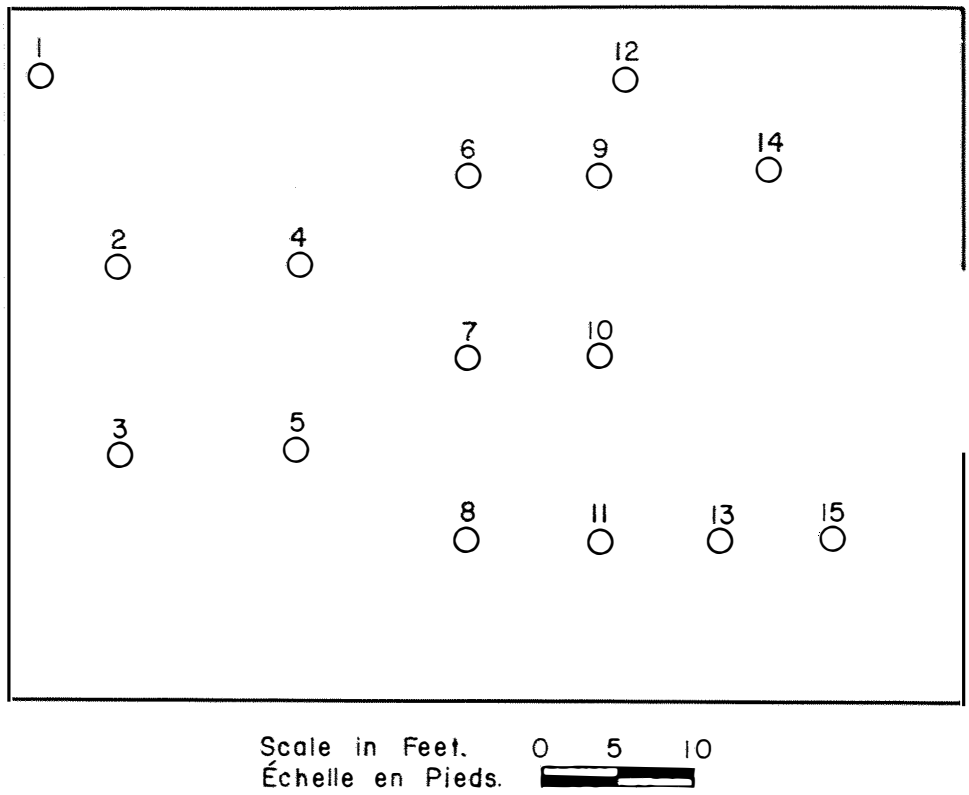
[3] MacHattie, L. B. Standard meteorological station for forest research area. Department of Forestry of Canada. Unpublished MS.



1. MSC Type C Anemometer. *Anémomètre MSC de type C.*
2. Hygrothermograph (MSC Standard Screen). *Hygro-thermographe (écran type MSC).*
3. Hygrothermograph (Birdhouse Shelter). *Hygro-thermographe (abri, genre maisonnette d'oiseaux).*
4. Recording Soil-Thermometer. *Géothermographe.*
5. MSC No. 5 Min. and Max. Thermometers in MSC Standard Screen. *Thermomètres à maximum et à minimum MSC n° 5 dans un abri de type MSC.*
6. S and M Min. Max. Six's Thermometers in Can Shelters at 6":12":45". *Thermomètres de Six à maximum et à minimum S et M, dans des abris métalliques à 6", 12" et 45" au-dessus du sol.*
7. MSC Ordinary Rain Gauge. *Pluviomètre ordinaire MSC.*
8. Piché Evaporimeters at 6":12":45". *Evaporomètres de Piché à 6", 12" et 45" au-dessus du sol.*
9. Grass Minimum Thermometer. *Thermomètre à minimum, de gazon.*
10. Wright Evaporimeter. *Evaporomètre de Wright.*
11. Bellani Pyranometer. *Pyranomètre de Bellani.*
12. Snow Depth Gauge. *Nivomètre.*
13. Casella Actinograph. *Actinographe de Casella.*
14. Nipher Snow Shield. *Abri contre la neige, de Nipher.*
15. MSC Type B Recording Rain Gauge. *Pluviographe MSC de type B.*

    Campbell-Stokes Sunshine Recorder — on Laboratory roof. *Héliographe de Campbell-Stokes, sur le toit du Laboratoire.*

Figure 1: Location of instruments on standard weather station at Petawawa Forest Experiment Station. *Disposition des appareils à la station météorologique de type classique de la station d'expérimentation forestière de Petawawa.*

evaporation, sunshine and wind for the Petawawa Forest Experiment Station area. It is situated on a well-turfed rectangle, 65 feet by 45 feet, at the approximate centre of a level 5-acre clearing representative of natural conditions in the area. The local climate is warm and dry by day; cool and dry by night.

The station exceeds the essential minimum requirements of WMO for climatological stations (Anon. 1961a), and is operated on a co-operative basis with DOT whose inspectors check it periodically.

INSTRUMENT REQUIREMENTS

The WMO guide (Anon. 1961a) lists the desirable characteristics of instruments as follows:

Reliability
Accuracy
Simplicity of design
Convenience of operation and maintenance
Strength of construction.

The guide states that "it is more important that an instrument should be able to maintain a known accuracy over a long period than have a very high precision initially without being able to retain it for long under operating conditions. Simplicity and convenience of operation and maintenance are important since most meteorological instruments are in continuous use year in and year out and may be situated far away from good repair facilities. Robust construction is especially desirable for those instruments which are wholly or partially exposed to the weather".

To facilitate comparisons with data from other meteorological stations, and particularly with those from official stations, the essential elements should be measured, when feasible, with instruments and methods approved by the meteorological authority of the country concerned. However, environmental conditions, financial, instrumental and man-power limitations often preclude strict adherence to meteorological practices and instrumentation by the forester. In such instances the forester is obliged to stipulate the specific purpose of his measurements, describe his instrumentation and acknowledge any recognized departure from accepted procedures. The resultant data should be evaluated accordingly.

Instrumentation at the Petawawa Forest Experiment Station weather station is described under two headings: "Essential Instrumentation" and "Additional Instrumentation". Under the former are listed those instruments declared by WMO and DOT standards as minimum requirements for a climatological station. Under the latter heading are described additional instruments which are considered very useful although not all are officially approved.

ESSENTIAL INSTRUMENTATION

Air temperature

Sheathless MSC[4] No. 5 spirit, and mercury thermometers (Anon. 1952a) in tubular aluminum frames are used to measure daily minimum and maximum air temperatures respectively; they are exposed one above the other in an MSC double-louvred standard screen with the sensors 45 inches above the surface of the ground. These thermometers are calibrated to tenths of one degree by the Meteorological Branch before they are distributed for field use, and are supplied with correction cards.

Wet and dry bulb temperatures are measured once daily with an MSC type D sling psychrometer (Anon. 1952b). Mechanically aspirated psychrometers such as the Bendix-Friez Psychron also satisfy DOT requirements and can be used in many situations where it is impossible to use a sling psychrometer.

Precipitation

Total rainfall is measured to hundredths of an inch with an MSC ordinary rain gauge. The rim of this gauge, which has a 10-square-inch opening, should be 12 inches above a level surface.

ADDITIONAL INSTRUMENTATION

Air temperature

Extremes of daily air temperature are also measured 6, 12 and 45 inches above the surface with Six's type thermometers in 'can' shelters. Fraser (1961b) recognized that this type of instrumentation was not acceptable on an official meteorological station but maintained that it served a useful purpose, when used as specified, in many forestry studies.

An unshielded MSC No. 5 spirit thermometer is used as a grass minimum or terrestrial thermometer to measure minimum air temperature 3 inches above the surface of the soil. In practice it is usually exposed horizontally over short grass with its bulb just touching the tips of the blades of grass. At Petawawa this instrument is removed when the first snowfall occurs. If used during the winter it should be supported immediately above, but not touching the snow.

Continuous traces of air temperature and relative humidity are obtained with two identical Fuess hygrothermographs; one of them is exposed in an approved double-louvred Stevenson screen, the other in a "Birdhouse" screen (Fraser 1961a) designed to eliminate the practical disadvantages of the standard screen for many forestry field studies. Measurements obtained in a "Birdhouse" screen are not

[4] Meteorological Service of Canada.

officially recognized by WMO or DOT, but when the screen is used as specified it is "a cheap, convenient and acceptable substitute for the standard shelter for obtaining acceptable approximations of mean air temperatures when financial or other considerations, such as inaccessibility of study areas preclude the use of standard Stevenson screens" (Fraser 1961a).

Soil temperature

Soil temperatures 4, 8 and 24 inches below the surface are recorded continuously by means of a Taylor, mercury-actuated, 3-sensor recording thermometer. Experience has shown that yearly calibration of such an instrument is advisable. The main disadvantages of this instrument are the large sensors which preclude its use to measure temperatures in the shallow horizon immediately below the surface where the steepest gradients occur, and the fact that the entire installation must be removed for calibration once each year.

Thermocouples afford an excellent means of measuring soil temperatures close to the surface as well as at depth. They can be left in the ground indefinitely and used with manually operated portable potentiometers to obtain single measurements, or with electric multipoint recording potentiometers to measure soil temperatures continuously. Fraser (1964) described a simple method of constructing and installing thermocouples in the soil for either purpose.

Single readings of soil temperatures are also obtained on the weather station with Weston dial-type bimetallic thermometers. The robust construction of this type of thermometer has obvious advantages over the mercury-in-glass bent-stem thermometer in general use as a soil thermometer on meteorological stations.

Precipitation

In addition to the standard measurement of total rainfall, a continuous record of its time, duration and intensity is obtained with an MSC type B1 10-inch tipping-bucket rain gauge receiver in combination with an MSC type B electric impulse rain gauge recorder (Anon. 1952c) operated on a 7-volt DC power supply.

A Nipher shield (Middleton and Spilhaus, 1953) was installed recently to measure snowfall. This is a more accurate method of measuring snowfall than either the snow board or snow box which were used formerly, although both methods are widely used and considered acceptable except on open areas exposed to high winds.

Snow depth throughout the winter is measured against a fixed vertical rod with ½-inch graduations.

Wind speed and direction

Wind speed and direction are measured by an MSC type 45B contact-type combined cup anemometer and wind vane (Anon. 1961b) mounted on a portable 35-foot television antenna tower. Continuous records of these data are obtained

with an MSC type B anemograph (Anon. 1961b). This equipment is operated by 7-9 volts DC rectified from 110 volts AC.

Wind speed and direction at 79 feet are measured and recorded by an earlier, battery-operated model of the same equipment mounted upon a hose-drying tower behind the main laboratory. This installation is the officially approved wind equipment for the experiment station. Differences in the data from the two anemometers indicate that whenever an environmental study area is at any considerable distance from the closest standard station it may be advisable to measure ventilation at the actual experiment site.

Solar radiation

Daily hours of sunshine are measured by a Campbell-Stokes sunshine recorder (Anon. 1956) mounted on the roof of the main laboratory, approximately a quarter of a mile northwest of the weather station. A Bellani pyranometer (Courvoisier and Wierzejewski, 1954) located at the weather station measures total daily radiation on a spherical surface. Incoming radiation throughout the day on a flat surface is measured and recorded by a Casella actinograph.

Evaporation

Relative measures of evaporation are obtained with a Wright evaporimeter at 45 inches, and with Piché evaporimeters suspended freely in the open 6, 12 and 45 inches above the surface. The Piché is particularly suitable for environmental studies and may be suspended freely, or rigidly either in the open or inside instrument screens. WMO emphasizes 'that comparable results are not obtained when different methods are used. They can only be obtained by using identical instruments and similar exposures and then can only be regarded as purely relative'.

READING AND RECORDS

The non-recording instruments are read daily throughout the year at 0800 hours Eastern Standard time. The data are recorded in weather station field books (2321)[5] and transferred to permanent ledgers from which weekly, monthly and annual summaries are prepared. Copies of the following reports and abstracts, which are forwarded each month to DOT as part of the co-operative agreement, are retained in the Petawawa weather files:

(a) Climatological station report: 2304
(b) Recording precipitation gauge monthly report: 2296
(c) Record of sunshine: 2307-1
(d) Abstract of wind: 2306

The data from the Petawawa weather station are available to any interested persons or agencies.

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[5] Meteorological Branch, Department of Transport form numbers.

REFERENCES

ANON. 1952a. Thermometers. Can. Dept. Transport, Meteorological Division. Instrument Manual 20.

——— 1952b. Wet and dry bulb psychrometers. Can. Dept. Transport, Meteorological Division. Instrument Manual 30.

——— 1952c. The tipping-bucket rain gauge. Can. Dept. Transport, Meteorological Division. Instrument Manual 41.

——— 1956. Sunshine recorders. Can. Dept. Transport, Meteorological Division. Instrument Manual 81.

——— 1961a. Guide to meteorological instruments and observing practices. 2nd. ed. Secretariat of the World Meteorological Organization, Geneva, Switzerland. WMO-No. 8 TP 3.

——— 1961b. Wind equipment. Can. Dept. Transport, Meteorological Division. Instrument Manual 51.

COURVOISIER, P., and H. WIERZEJEWSKI. 1954. Das Kugerpyranometer Bellani. V. Beitrage zur Strahlungsmess-methodik. Archiv für Meteorologie, Geophysik und Bioklimatologie, Serie B. 5(3/4): 413-446.

FRASER, J. W. 1961a. A simple instrument shelter for use in forest ecology studies. Dept. Forestry, Can., Forest Research Branch, Tech. Note No. 113.

——— 1961b. A simple intrument shelter for Six's thermometers. Forestry Chronicle, 37:4.

——— 1964. A method of constructing and installing thermocouples for measuring soil temperature. Submitted for publication in Forest Science.

GEIGER, R. 1950. The climate near the ground. 2nd ed. Harvard University Press.

MIDDLETON, W. E. K., and A. F. SPILHAUS. 1953. Meteorological Instruments. 3rd ed. University of Toronto Press.