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RADIATION SHIELD FOR MICROCLIMATOLOGICAL MEASURING OF TEMPERATURE

by

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A network of microclimatological stations was established in the northern part of Sodankylä, Finnish Lapland, in spring 1958, for investigation of the microclimate in various types of bog and forest. For air temperature measurements these stations used ordinary maximum and minimum thermometers furnished with a radiation shield. The accuracy of these measurements is discussed in this article.

The construction of the radiation shield is shown in the illustration (Fig. 1). The thermometers are protected against radiation from above and below in the same way as in Thornthwait's shield by means of two horizontal plates 1 cm apart. The plate surface towards the thermometers is painted dull black, the surface directed outward glossy white. The dimensions of the upper plate are 19 cm × 21 cm, of the middle plates 11 cm × 14 cm and of the lowest plate 8 cm × 12 cm. The east, west and north edge of the topmost plate, as the figure makes clear, is bent slightly downwards to prevent direct solar radiation on the thermometer bulb.

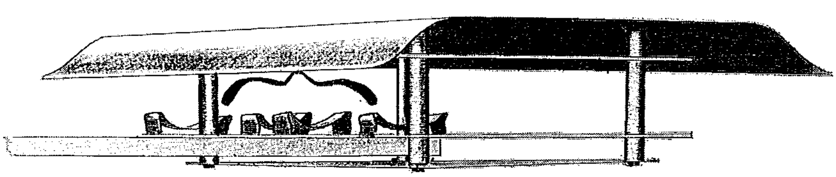

Fig. 1.

To find out how much the radiation shield reduced the radiation error, a mercury thermometer furnished with this shield was compared with ASSMANN's aspiration thermometer, both in natural conditions in the open and in the laboratory.

The comparison was made at Vuotso ($\varphi = 68.1$; $\lambda = 27.2$°E) in clear weather when the angle of elevation of the sun was c. 40°. The result appears from the table, which gives the radiation error at different wind velocities assuming that the aspiration thermometer is free from radiation errors.

Wind velocity (m/sec.)	1.2	1.4	1.6	2.0	2.2	2.6	3.2
Radiation error (°C)	0.48	0.40	0.22	0.23	0.14	0.22	0.10

The values given in the table are 10 min. averages. They vary slightly with the microvariations of the temperature. The radiation error is approximately 0.5° for a wind velocity of 1 m/sec and 0.2° for a wind velocity of 2 m/sec.

In the laboratory, the radiation error was determined at different wind velocities for radiation from above and below. The intensity of the radiation on a horizontal surface was 1 cal/sq.cm. per minute. The results are given in the following table.

Direction of radiation	Wind velocity (m/sec.)				
	0.25	0.4	0.8	1.1	1.8
	Radiation error (°C)				
downwards	1.2	0.4	0.2	0.2	0.1
upwards	3.0	0.9	0.5	0.4	0.2

It will be seen from the table that upward radiation causes a radiation error which is c. 2.5 times as great as an equally intense downward radiation. The radiation shield thus protects the thermometer against direct solar radiation and diffuse sky radiation considerably better than against radiation reflected from the earth's surface.

If it is assumed that the intensity of radiation from above is 1 cal/sq.cm. per minute and that of radiation from below 0.25 cal/sq.cm. per minute, which corresponds roughly with natural conditions on sandy surfaces when the sun's elevation angle is 40°, the following values are obtained for the radiation error, using the data given in the above table.

Wind velocity (m/sec)	0.25	0.4	0.8	1.1	1.8
Radiation error (°C)	2.0	0.6	0.4	0.3	0.2

These values are somewhat lower than the corresponding values calculated from observations made outdoors. The difference is probably due to the fact that the shield protects the thermometer better against the directed radiation used in the laboratory than against the diffuse radiation occurring out in the open air (diffuse sky radiation and radiation reflected from the earth's surface).

The thermometer with radiation shield was also compared with a thermometer encased in an English screen. The result will be seen in the table below, which gives the difference, $t_s - t_k$, between the temperature measured by the shielded thermometer (t_s) and the screen temperature (t_k). The measurements were made at Ilmala ($\varphi = 60.2°$; $\lambda = 25.0°$E) and at Korvanen ($\varphi = 68.0°$; $\lambda = 27.8°$E).

Month	Ilmala			Korvanen		
	Observation period					
	08	14	20	08	14	20
July	0.22	0.22	0.00	0.15	0.32	−0.06
August	0.17	0.13	−0.04	0.12	0.20	−0.04

According to the table, the shielded thermometer gives day temperatures an average of 0.2° higher than the screen thermometer. In clear weather the average difference was c. 0.3°, in cloudy weather less than 0.1°.

The following table gives the temperature differences Max t_s — Max t_k and Min t_s — Min t_k, in which Max t_s and Min t_s denote the monthly averages of the daily extreme values of the temperature according to a shielded thermometer, and Max t_k and Min t_k stand for the corresponding values according to a screen thermometer.

Extreme thermometers with radiation shield thus give on average c. 0.3° higher maximum temperatures and 0.2 — 0.3° lower minimum temperatures than thermometers encased in the screen. Comparison of

Month	Ilmala		Korvanen	
	Max t_s — Max t_k	Min t_s — Min t_k	Max t_s — Max t_k	Min t_s — Min t_k
July	0.26	−0.32	0.37	−0.20
August	0.36	−0.32	0.15	−0.11

the differences Max t_s — Max t_k with the $t_s - t_k$ values measured at 1 400 hours shows that the former are slightly higher. This is due to the fact that the lag of the radiation shield is considerably smaller than the lag of the screen. Owing to the smaller lag, shielded thermometers follow the temperature microvariations more rapidly and therefore give higher maximum temperatures than screen thermometers. The significance of the microvariations emerges clearly from the fact that the difference Max t_s — Max t_k was greatest in cumulus weather when rapid changes in cloudiness cause great microvariations in the temperature.