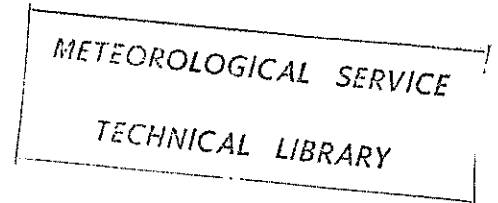


DEPARTMENT OF TRANSPORT AND POWER
METEOROLOGICAL SERVICE



AGROMETEOROLOGICAL MEMORANDUM No. 3

SOIL TEMPERATURES IN IRELAND

BY

M. J. CONNAUGHTON, M. Sc.

U. D. C.
551.525 (417)

DUBLIN
NOVEMBER 1970

SOIL TEMPERATURE IN IRELAND

The purpose of this Memorandum is to provide agriculturists with information on the monthly distribution of soil temperatures at various sites throughout the country.

Temperatures in the ground are usually measured at standard depths below the surface of 5, 10, 20, 30, 60 and 120 cm (2 inches to 4 feet). Temperatures at the three shallower depths are measured under a bare soil surface and are termed soil temperatures; temperatures at lower levels are measured under a grass-covered surface and are called earth temperatures. This publication is concerned only with soil temperatures; information on earth temperatures will be published separately.

The measurement of soil temperatures on a regular, standardised basis was begun in Ireland in late 1953; at present, readings of soil temperatures are taken at 29 meteorological stations throughout the country. At 14 of these stations (A stations) soil temperatures are measured four times each day, at 0300, 0900, 1500 and 2100 G.M.T. while at the remaining 15 stations (B stations) only one measurement is made daily, at 0900 G.M.T. For the purposes of this Memorandum, the soil temperature records of 18 stations, 11 A stations and 7 B stations, were examined and analysed. Records from stations of less than six years standing (up to January 1969) and records which were considered unreliable because of site changes or instrumental difficulties over long periods have not been included in the final analysis.

Fifteen-year (1954-1968) averages of monthly mean soil temperature at each of the three depths, 5 cm, 10 cm and 20 cm, were computed for each of the 18 stations. These averages are given in Table 1 on pages 4 to 17; the methods used in their computation are described in the Appendix (page 19). In the case of A stations, Table 1 also shows the highest and lowest monthly mean soil temperatures at each of the three depths. For those A stations for which records are available over the full fifteen years, the standard deviations from average are also included in Table 1. In order to provide a measure of the variability of soil temperatures at other sites, values of the average standard deviations over the country generally for each month at each of the three depths are given in Table 2 on page 18.

Using the Tables

The stations for which soil temperature data are provided in Table 1 are listed on page 3.

The location and height (above sea-level) of each station are shown in Table 1, together with a short description of the soil at the thermometer sites. The soil descriptions are based on surveys carried out by the Soils Division of An Foras Taluntais.

If estimates of average soil temperature are required for sites not included in Table 1, reference should be made to the nearest available station with similar soil and topography rather than just to the nearest available station irrespective of soil or physical features.

The values of the standard deviations may be used to determine the ranges of soil temperatures which are likely to occur. As a general rule, the soil temperature for any month will be within a standard deviation of the average value for that month in two years out of three and only rarely will it be more than two standard deviations above or below the average. For example, where the fifteen-year average soil temperature at 10 cm. in March is 6.0°C and the standard deviation is 1.4°C then, in two years out of three, the mean temperature at 10 cm. in March will be within the range 4.6°C to 7.4°C ; only on rare occasions will it be above 8.8°C or below 3.2°C . In Table 1, the values of the standard deviations are given for the first six stations. The values of the standard deviations given in Table 2 represent a reasonable approximation to the variability of temperature over a wide range of soils; they are not, however, appropriate to soils of extreme thermal characteristics such as peat, sand or heavy, badly-drained clay.

It should be remembered that the information on soil temperature given in this Memorandum is based on temperatures measured under a bare soil surface. The effect of surface vegetation on soil temperatures is complex, depending on the colour, height and density of the vegetation, on the time of year and on meteorological factors such as rainfall and sunshine. Broadly-speaking, the presence of vegetation on the ground surface leads to slightly higher soil temperatures in Winter and lower soil temperatures in Summer; in Spring and Autumn, temperatures under bare and vegetation-covered surfaces are generally quite similar.

TABLE 1.

Averages of Monthly Mean Soil Temperatures

Fifteen-year averages, over the period 1954-1968, of soil temperatures at depths of 5, 10, 20 cm. at 18 meteorological stations are given in the following pages. Extreme values of monthly mean temperatures are given for all A stations and in addition, the standard deviations from average are also included for the A stations on pages 4 to 9. All temperatures are in degrees Celsius ($^{\circ}\text{C}$).

List of Stations in Table 1

<u>Station</u>	<u>Type of Station</u>	<u>Page</u>
Claremorris, Co. Mayo.	A	4
Clones, Co. Monaghan.	A	5
Dublin Airport, Co. Dublin.	A	6
Mullingar, Co. Westmeath.	A	7
Shannon Airport, Co. Clare.	A	8
Valentia Observatory, Co. Kerry.	A	9
Beimullet, Co. Mayo.	A	10
Birr, Co. Offaly.	A	11
Kilkenny, Co. Kilkenny.	A	12
Roche's Point, Co. Cork.	A	13
Rosslare, Co. Wexford.	A	14
Carlow, Co. Carlow.	B	15
Kinsealy, Co. Dublin.	B	15
Tuam, Co. Galway.	B	15
Mallow, Co. Cork.	B	16
Thurles, Co. Tipperary.	B	16
Johnstown Castle, Co. Wexford.	B	16
Ballinamore, Co. Leitrim.	B	17

Claremorris, Co. Mayo

53° 43'N 8° 59'W - Grid Ref.M346738 - Height 69 m

Period of Record: 1954-68

Soil Type: Free-draining loam

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.2	1.49	5.0	-1.2
Feb.	3.8	1.56	6.4	0.5
Mar.	6.1	1.38	8.9	4.1
Apr.	8.8	0.73	10.1	7.3
May	12.1	1.15	14.0	10.3
June	15.2	1.06	17.3	14.1
July	16.0	1.16	19.2	14.1
Aug.	15.3	1.27	18.8	13.8
Sept.	13.0	0.84	14.2	11.6
Oct.	9.9	0.88	11.7	8.5
Nov.	6.0	0.97	7.9	4.1
Dec.	4.3	1.16	6.3	2.4

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.4	1.42	5.1	-0.8
Feb.	3.9	1.49	6.4	0.5
Mar.	6.1	1.36	8.9	4.2
Apr.	8.8	0.71	10.0	7.3
May	12.0	1.09	13.8	10.3
June	15.1	1.02	17.0	13.8
July	16.0	1.05	18.7	14.0
Aug.	15.4	1.23	18.7	13.9
Sept.	13.2	0.81	14.3	11.7
Oct.	10.2	0.78	11.9	9.1
Nov.	6.3	0.90	8.2	4.6
Dec.	4.5	1.10	6.4	2.8

20 cm.

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	4.0	1.23	5.4	0.4
Feb.	4.3	1.36	6.4	0.9
Mar.	6.2	1.19	8.6	4.5
Apr.	8.7	0.70	9.9	7.3
May	11.6	0.98	13.2	10.2
June	14.5	0.85	16.0	13.4
July	15.6	0.87	17.7	13.8
Aug.	15.3	1.04	18.0	14.1
Sept.	13.5	0.72	14.5	12.3
Oct.	10.8	0.67	12.2	9.9
Nov.	7.1	0.84	8.8	5.8
Dec.	5.2	0.88	6.6	3.9

Clones, Co. Monaghan

54°11'N 7°14'W - Grid Ref. H498263 - Height 87 m

Period of Record: 1954-68

Soil Type: Well-drained loam

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	2.9	1.41	4.3	-1.1
Feb.	3.4	1.49	6.0	0.2
Mar.	5.8	1.40	8.4	3.7
Apr.	9.0	0.96	10.3	6.7
May	12.7	1.33	14.9	10.5
June	16.0	1.08	18.4	14.3
July	16.8	1.41	21.0	14.7
Aug.	15.9	1.33	19.4	14.6
Sept.	13.3	1.02	14.8	11.6
Oct.	9.8	0.85	11.7	8.7
Nov.	5.7	1.00	7.7	3.7
Dec.	3.9	1.07	5.7	2.4

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.0	1.34	4.4	-0.7
Feb.	3.5	1.45	5.9	0.2
Mar.	5.8	1.36	8.3	3.7
Apr.	8.8	0.94	10.2	6.7
May	12.4	1.32	14.7	10.4
June	15.8	1.19	18.0	14.0
July	16.5	1.28	20.3	14.6
Aug.	15.7	1.29	19.1	14.3
Sept.	13.3	0.92	14.9	11.8
Oct.	10.1	0.82	11.9	9.0
Nov.	6.1	0.92	7.9	4.4
Dec.	4.2	1.00	5.8	2.6

20 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.5	1.22	4.8	0.2
Feb.	3.9	1.36	6.1	0.5
Mar.	5.8	1.29	8.2	4.0
Apr.	8.6	0.88	10.1	6.8
May	12.0	1.23	14.1	10.1
June	15.3	1.04	17.3	13.7
July	16.1	1.15	19.3	14.3
Aug.	15.6	1.15	18.6	14.3
Sept.	13.5	0.84	15.0	12.1
Oct.	10.5	0.69	12.3	9.8
Nov.	6.8	0.76	8.2	5.5
Dec.	4.8	0.87	5.9	3.2

Dublin Airport, Co. Dublin

53°26'N 6°15'W - Grid Ref. 0167437-Height 68m

Period of Record: 1954-68

Soil Type: Moderately well-drained loam

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.5	1.16	5.1	0.4
Feb.	3.9	1.39	6.4	1.6
Mar.	6.2	1.42	8.9	4.0
Apr.	9.3	0.86	10.7	7.6
May	12.9	1.24	14.8	10.5
June	16.6	1.17	18.6	14.8
July	17.4	1.55	21.9	15.4
Aug.	16.4	1.40	19.8	14.5
Sept.	13.8	1.03	15.8	12.2
Oct.	10.3	0.94	12.0	8.7
Nov.	6.3	0.87	7.8	4.9
Dec.	4.5	0.82	5.9	3.1

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.6	1.16	5.1	0.5
Feb.	4.0	1.33	6.4	1.5
Mar.	6.2	1.39	8.8	4.0
Apr.	9.3	0.83	10.7	7.6
May	12.8	1.24	14.6	10.4
June	16.5	1.13	18.6	14.8
July	17.3	1.46	21.5	15.4
Aug.	16.4	1.32	19.7	14.7
Sept.	18.9	0.96	15.7	12.4
Oct.	10.6	0.86	12.1	9.2
Nov.	6.6	0.80	7.9	5.3
Dec.	4.6	0.82	5.9	3.3

20 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.9	1.05	5.4	1.1
Feb.	4.3	1.25	6.4	1.8
Mar.	6.3	1.30	8.8	4.2
Apr.	9.2	0.80	10.6	7.5
May	12.5	1.11	14.1	10.4
June	16.1	1.03	17.9	14.6
July	17.0	1.33	20.8	15.3
Aug.	16.3	1.26	19.6	14.9
Sept.	14.1	0.87	15.8	12.7
Oct.	10.9	0.73	12.2	9.9
Nov.	7.1	0.75	8.3	5.8
Dec.	5.1	0.67	6.1	4.2

Mullingar, Co. Westmeath

53° 31' N 7° 21' W - Grid Ref. N428529 - Height 108 m

Period of Record 1954-68

Soil Type: Well-drained sandy clay loam

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.0	1.40	4.3	-1.1
Feb.	3.5	1.57	6.3	0.1
Mar.	5.8	1.52	8.9	3.4
Apr.	9.0	0.82	10.6	7.2
May.	12.5	1.32	14.6	10.3
June	16.0	1.27	18.0	14.1
July	16.7	1.20	19.4	14.8
Aug.	16.0	1.28	19.0	14.4
Sept.	13.4	0.93	14.9	11.9
Oct.	10.0	0.85	11.6	8.9
Nov.	5.8	1.02	7.7	3.8
Dec.	3.9	1.14	5.8	2.3

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.2	1.30	4.5	-0.5
Feb.	3.7	1.48	6.2	0.4
Mar.	5.9	1.44	8.3	3.8
Apr.	8.9	0.79	10.4	7.2
May.	12.4	1.19	14.3	10.3
June	15.9	1.20	17.8	13.9
July	16.6	1.15	19.3	14.8
Aug.	16.0	1.20	18.0	14.4
Sept.	13.5	0.87	14.9	12.1
Oct.	10.2	0.83	11.8	9.1
Nov.	6.1	1.01	8.1	4.2
Dec.	4.2	1.05	5.8	2.6

20 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	3.5	1.20	4.3	0.2
Feb.	3.9	1.39	6.1	0.6
Mar.	5.9	1.35	8.6	3.9
Apr.	8.7	0.77	10.2	7.1
May.	12.0	1.13	13.7	10.2
June.	15.4	1.04	17.2	13.7
July.	16.3	1.06	18.8	14.6
Aug.	15.9	1.10	18.6	14.5
Sept.	13.7	0.84	15.1	12.3
Oct.	10.6	0.72	12.1	9.8
Nov.	6.7	0.94	8.6	5.1
Dec.	4.7	0.96	6.2	3.2

Shannon Airport, Co. Clare

52° 41' N 8° 55' W - Grid Ref. R379604 - Height 2 m

Period of Record 1954-68

Soil Type: Poorly-drained gley soil of clay loam texture

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	4.1	1.48	5.7	-0.5
Feb.	4.5	1.82	7.3	1.3
Mar.	7.0	1.45	9.9	4.5
Apr.	10.0	0.64	11.1	8.9
May	13.3	0.98	14.9	11.7
June	16.6	0.91	17.9	15.2
July	17.6	1.38	21.3	15.1
Aug.	16.8	1.24	19.7	15.0
Sept.	14.4	0.87	16.1	12.9
Oct.	11.1	0.95	12.8	9.9
Nov.	7.0	0.98	8.9	5.3
Dec.	5.4	1.02	7.0	3.7

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	4.3	1.36	5.9	0.1
Feb.	4.7	1.73	7.3	1.3
Mar.	7.0	1.39	9.8	4.7
Apr.	9.8	0.67	10.9	8.8
May	13.1	0.99	14.8	11.5
June	16.3	0.87	17.6	15.1
July	17.4	1.24	20.9	15.3
Aug.	16.7	1.24	19.8	15.1
Sept.	14.5	0.85	16.2	13.1
Oct.	11.3	0.84	13.0	10.2
Nov.	7.3	0.93	9.1	5.8
Dec.	5.7	0.97	7.1	4.1

20 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	4.6	1.27	6.1	0.7
Feb.	4.8	1.63	7.2	1.4
Mar.	6.9	1.26	9.4	4.9
Apr.	9.5	0.69	10.8	8.5
May	12.6	0.93	14.2	11.3
June	15.8	0.83	17.4	14.8
July	16.9	1.05	19.8	15.1
Aug.	16.4	1.18	19.4	14.9
Sept.	14.6	0.81	16.4	13.6
Oct.	11.6	0.70	13.0	10.7
Nov.	7.8	0.86	9.4	6.3
Dec.	6.1	0.81	7.2	4.6

Valentia, Co. Kerry

51°56'N 10°15'W - Grid Ref. V456788 - Height 9 m

Period of Record: 1954-68

Soil Type. Well-drained gravelly clay loam

5 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	5.3	1.52	7.2	0.5
Feb.	5.6	1.78	8.2	2.9
Mar.	7.9	1.32	10.5	5.6
Apr.	10.5	0.72	11.8	9.4
May	13.5	1.14	15.3	11.5
June	16.4	1.04	18.7	15.3
July	17.4	1.24	21.1	15.4
Aug.	16.7	1.29	20.0	15.0
Sept.	14.3	0.80	15.6	13.1
Oct.	11.4	0.97	13.1	9.9
Nov.	7.8	0.81	9.2	6.6
Dec.	6.5	1.10	8.1	4.6

10 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	5.6	1.44	7.3	1.0
Feb.	5.8	1.72	8.3	3.2
Mar.	8.0	1.25	10.4	5.9
Apr.	10.5	0.69	11.7	9.4
May	13.3	1.08	15.0	11.4
June	16.1	0.95	18.2	15.1
July	17.2	1.17	20.8	15.4
Aug.	16.6	1.23	19.9	15.1
Sept.	14.4	0.75	15.7	13.2
Oct.	11.7	0.83	13.0	10.4
Nov.	8.2	0.83	9.6	6.8
Dec.	6.8	0.99	8.2	4.9

20 cm

Month	Average 1954-68	Standard Deviation from Average	Extreme monthly mean values 1954-68	
			Maximum	Minimum
Jan.	6.0	1.26	7.7	2.1
Feb.	6.1	1.52	8.3	3.6
Mar.	8.1	1.17	10.3	6.1
Apr.	10.4	0.63	11.5	9.3
May	13.0	0.95	14.3	11.4
June	15.7	0.80	17.6	14.9
July	16.9	1.02	20.0	15.3
Aug.	16.5	1.08	19.4	15.2
Sept.	14.7	0.74	16.0	13.5
Oct.	12.0	0.73	13.3	10.9
Nov.	8.7	0.79	10.1	7.4
Dec.	7.3	0.90	8.6	5.5

Belmullet, Co. Mayo

54°14'N 10°00'W - Grid Ref. F692327 - Height 9 m

Period of Record: 1956-68

Soil Type: Black humose loamy sand

5 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	4.4	6.1	0.2
Feb.	5.0	7.2	2.3
Mar.	6.8	9.4	5.2
Apr.	9.8	10.9	8.0
May	12.9	14.3	11.4
June	15.9	18.3	15.2
July	16.7	17.6	15.4
Aug.	15.9	17.4	14.6
Sept.	13.6	15.3	12.2
Oct.	10.8	12.3	9.6
Nov.	7.3	8.6	5.4
Dec.	5.8	6.9	3.8

10 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	4.7	6.3	0.9
Feb.	5.1	7.2	2.4
Mar.	7.0	9.5	5.4
Apr.	9.6	10.8	8.1
May	12.6	13.9	11.1
June	15.6	17.8	14.7
July	16.5	17.6	15.2
Aug.	15.9	17.3	14.6
Sept.	13.8	15.5	12.4
Oct.	11.1	12.4	9.9
Nov.	7.7	9.1	5.9
Dec.	6.1	7.1	4.4

20 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	5.2	6.6	2.2
Feb.	5.5	7.3	2.9
Mar.	7.1	9.2	5.9
Apr.	9.6	10.8	8.0
May	12.3	13.5	11.0
June	15.1	17.1	14.2
July	16.2	16.7	15.0
Aug.	15.8	17.1	14.7
Sept.	14.1	15.6	12.8
Oct.	11.6	12.8	10.6
Nov.	8.3	9.7	6.8
Dec.	6.8	7.6	5.4

Birr, Co. Offaly

53°05'N 7°53'W - Grid Ref. N073044 - Height 70 m

Period of Record: 1955-68

Soil Type: Sandy clay loam

5 cm

Month	Average 1954-68	Extreme monthly mean values 1955-68	
		Maximum	Minimum
Jan.	3.6	5.1	-1.1
Feb.	4.1	6.8	1.0
Mar.	6.5	9.7	4.4
Apr.	9.6	11.1	8.1
May	13.2	15.4	10.9
June	16.6	19.2	14.8
July	17.5	21.7	16.3
Aug.	16.5	20.4	15.1
Sept.	13.9	16.3	12.5
Oct.	10.4	12.1	9.2
Nov.	6.3	8.2	4.5
Dec.	4.6	7.2	2.6

10 cm

Month	Average 1954-68	Extreme monthly mean values 1955-68	
		Maximum	Minimum
Jan.	3.6	5.1	-0.6
Feb.	4.1	6.7	1.1
Mar.	6.5	9.4	4.2
Apr.	9.4	10.9	8.1
May	12.9	15.3	10.9
June	16.3	18.8	14.7
July	17.3	21.1	16.3
Aug.	16.4	19.8	14.7
Sept.	13.8	15.9	12.6
Oct.	10.5	12.1	9.4
Nov.	6.4	8.1	4.6
Dec.	4.7	7.1	3.0

20 cm

Month	Average 1954-68	Extreme monthly mean values 1955-68	
		Maximum	Minimum
Jan.	4.0	5.3	-0.2
Feb.	4.4	6.9	1.3
Mar.	6.6	9.2	4.9
Apr.	9.2	11.0	8.1
May	12.5	14.7	10.8
June	15.8	17.6	14.3
July	16.8	20.0	15.9
Aug.	16.1	19.3	14.7
Sept.	13.9	15.4	12.7
Oct.	10.8	12.3	9.9
Nov.	6.9	8.6	5.4
Dec.	5.2	7.4	3.4

Kilkenny, Co. Kilkenny

52°40'N 7°16'W - Grid Ref. 3495573 - Height 63 m

Period of Record: 1957-68

Soil Type: Well-drained gravelly sandy loam

5 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	3.5	4.8	-0.8
Feb.	4.1	6.7	1.3
Mar.	6.3	8.6	3.9
Apr.	9.7	11.3	8.2
May	13.2	16.0	10.6
June	17.1	19.7	15.6
July	18.1	20.1	16.4
Aug.	16.9	19.9	15.3
Sept.	13.8	16.2	12.6
Oct.	10.4	12.3	8.8
Nov.	6.3	8.3	4.2
Dec.	4.4	5.1	2.6

10 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	3.5	4.9	-0.5
Feb.	4.2	6.7	1.2
Mar.	6.3	8.5	4.1
Apr.	9.5	11.2	8.2
May	13.1	15.6	10.6
June	16.8	19.1	15.3
July	18.0	20.1	16.4
Aug.	16.8	19.8	15.3
Sept.	13.9	16.2	12.8
Oct.	10.5	12.4	9.1
Nov.	6.5	8.5	4.5
Dec.	4.6	5.1	2.8

20 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	4.0	5.2	0.3
Feb.	4.5	6.7	1.2
Mar.	6.4	8.5	4.3
Apr.	9.4	11.1	8.0
May	12.7	15.0	10.5
June	16.2	18.3	15.1
July	17.5	19.6	16.0
Aug.	16.7	19.4	15.2
Sept.	14.3	16.4	13.2
Oct.	11.0	12.6	9.9
Nov.	7.0	8.8	5.2
Dec.	5.0	5.5	3.6

Roche's Point, Co. Cork

51°48'N 8°15'W - Grid Ref. W828601 - Height 40 m

Period of Record: 1956-68

Soil Type: Well-drained gravelly loam

5 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	5.3	6.7	1.8
Feb.	5.6	7.7	3.4
Mar.	7.4	9.8	5.5
Apr.	10.1	11.2	8.9
May	13.1	15.2	11.4
June	16.3	18.2	15.2
July	17.3	18.5	16.2
Aug.	16.6	18.3	14.7
Sept.	14.4	16.7	13.1
Oct.	11.5	13.0	10.2
Nov.	7.9	9.8	6.2
Dec.	6.4	7.6	5.0

10 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	5.5	6.3	2.2
Feb.	5.8	7.8	3.5
Mar.	7.5	9.8	5.6
Apr.	10.2	11.3	8.9
May	13.0	15.2	11.3
June	16.1	18.1	14.9
July	17.1	18.4	16.2
Aug.	16.5	18.3	14.9
Sept.	14.5	16.6	13.4
Oct.	11.8	13.1	10.5
Nov.	8.2	10.0	6.7
Dec.	6.7	7.8	5.2

20 cm

Month	Average 1954-68	Extreme monthly mean values 1956-68	
		Maximum	Minimum
Jan.	5.9	7.1	2.7
Feb.	6.0	7.9	3.7
Mar.	7.5	9.7	5.7
Apr.	9.8	10.8	8.6
May	12.5	14.4	11.1
June	15.2	17.2	14.2
July	16.5	17.2	15.5
Aug.	16.1	17.3	14.8
Sept.	14.5	16.1	13.4
Oct.	12.0	13.2	11.0
Nov.	8.7	10.3	7.3
Dec.	7.2	8.2	5.7

Rosslare, Co. Wexford

52°15'N 6°20'W - Grid Ref. T137123 - Height 23 m

Period of Record: 1957-68

Soil Type: Poorly-drained loam to clay loam

5 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	4.6	6.3	0.7
Feb.	5.0	7.2	2.5
Mar.	7.0	9.8	5.0
Apr.	10.3	11.4	9.2
May	13.6	15.7	11.4
June	17.2	19.0	16.2
July	18.4	19.7	17.1
Aug.	17.2	19.8	16.2
Sept.	14.7	17.7	13.0
Oct.	11.3	12.9	10.2
Nov.	7.4	8.9	5.8
Dec.	5.7	6.1	4.3

10 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	4.9	6.6	1.2
Feb.	5.3	7.4	2.7
Mar.	7.1	9.7	5.4
Apr.	10.2	11.3	9.1
May	13.5	15.6	11.4
June	17.1	18.8	16.0
July	18.4	19.7	17.0
Aug.	17.3	19.8	16.4
Sept.	14.9	17.9	13.3
Oct.	11.6	13.1	10.5
Nov.	7.9	9.3	6.2
Dec.	6.0	6.4	4.7

20 cm

Month	Average 1954-68	Extreme monthly mean values 1957-68	
		Maximum	Minimum
Jan.	5.2	6.8	1.8
Feb.	5.5	7.4	3.0
Mar.	7.2	9.6	5.6
Apr.	10.1	11.2	9.1
May	13.3	15.3	11.3
June	16.7	18.3	15.4
July	18.1	19.3	16.6
Aug.	17.4	19.6	16.5
Sept.	15.3	18.0	13.7
Oct.	12.1	13.7	11.1
Nov.	8.4	9.8	6.8
Dec.	6.4	7.0	5.4

Carlow, Co. Carlow

52°51'N 06°56'W - Grid Ref. S721785 - Height 55 m

Soil Type: Well-drained sandy loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	3.6	3.5	3.8
Feb.	4.2	4.2	4.3
Mar.	6.6	6.6	6.5
Apr.	9.4	9.4	9.1
May	13.1	13.1	12.6
June	17.3	17.0	16.4
July	18.2	18.2	17.5
Aug.	17.2	17.2	17.0
Sept.	14.2	14.5	14.8
Oct.	10.9	10.9	11.1
Nov.	6.9	7.0	7.3
Dec.	5.1	5.0	5.2

Kinsealy, Co. Dublin

53°25'N 06°10'W - Grid Ref. 0213430 - Height 17 m

Soil Type: Moderately well-drained loam to clay loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	3.9	3.9	4.3
Feb.	4.3	4.3	4.6
Mar.	6.4	6.4	6.5
Apr.	9.4	9.3	9.1
May	12.7	12.7	12.3
June	16.3	16.3	15.6
July	17.2	17.1	16.6
Aug.	16.3	16.5	15.9
Sept.	14.0	14.0	14.0
Oct.	10.7	10.8	11.1
Nov.	6.6	7.0	7.5
Dec.	5.0	5.1	5.7

Tuam, Co. Galway

53°31'N 08°52'W - Grid Ref. M421531 - Height 31 m

Soil Type: Well-drained loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	3.5	3.8	4.1
Feb.	4.1	4.2	4.5
Mar.	6.4	6.4	6.4
Apr.	8.9	9.1	9.0
May	12.0	12.2	11.9
June	15.1	15.3	14.8
July	16.2	16.3	15.9
Aug.	15.4	15.7	15.5
Sept.	13.3	13.4	13.5
Oct.	10.1	10.3	10.9
Nov.	6.5	6.7	7.3
Dec.	4.8	4.9	5.4

Mallow, Co. Cork

52°08'N 08°42'W - Grid Ref. W510972 - Height 53 m

Soil Type: Free-draining sandy loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	4.3	4.5	5.0
Feb.	4.8	4.9	5.3
Mar.	7.3	7.3	7.3
Apr.	10.2	10.1	10.0
May	13.5	13.3	13.0
June	16.6	16.6	16.5
July	17.9	17.8	17.3
Aug.	16.9	16.6	16.6
Sept.	14.5	14.4	14.8
Oct.	11.3	11.3	11.9
Nov.	7.2	7.6	8.1
Dec.	5.5	5.8	6.2

Thurles, Co. Tipperary

52°39'N 07°50'W - Grid Ref. S119560 - Height 98 m

Soil Type: Well-drained loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	3.9	3.8	4.4
Feb.	4.3	4.4	4.7
Mar.	6.6	6.6	6.6
Apr.	9.6	9.4	9.4
May	13.0	13.0	12.6
June	16.6	16.3	15.8
July	17.7	17.5	17.1
Aug.	16.6	16.5	16.5
Sept.	14.2	14.3	14.6
Oct.	10.9	10.9	11.4
Nov.	6.8	7.0	7.5
Dec.	5.0	5.2	5.6

Johnstown Castle, Co. Wexford

52°28'N 6°30'W - Grid Ref. T022167 - Height 46 m

Soil Type: Well-drained sandy loam

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	4.1	4.2	4.6
Feb.	4.7	5.0	5.1
Mar.	6.8	6.8	6.8
Apr.	9.9	9.7	9.6
May	13.2	13.2	12.9
June	17.0	16.6	16.2
July	17.8	17.7	17.3
Aug.	16.8	16.8	16.8
Sept.	14.3	14.5	15.0
Oct.	11.3	11.4	11.7
Nov.	7.5	7.7	8.3
Dec.	5.3	5.7	6.1

Ballinamore, Co. Leitrim

54°04'N 07°46'W - Grid Ref. H148134 - Height 80 m

Soil Type: Poorly-drained gley of clay loam texture

Month	Average 1954-68		
	5 cm	10 cm	20 cm
Jan.	3.1	3.4	3.8
Feb.	3.6	3.7	4.1
Mar.	6.0	6.0	6.0
Apr.	8.6	8.6	8.5
May	12.2	12.1	11.8
June	15.5	15.4	14.8
July	15.9	16.0	15.7
Aug.	15.6	15.6	15.4
Sept.	13.1	13.3	13.4
Oct.	9.8	10.2	10.5
Nov.	5.9	6.2	6.8
Dec.	4.1	4.3	4.9

Table 2 Average values of standard deviations of soil temperatures (°C)

Depth \ Month	5 cm	10 cm	20 cm
January	1.50	1.41	1.28
February	1.64	1.58	1.48
March	1.44	1.39	1.28
April	0.85	0.82	0.80
May	1.30	1.26	1.15
June	1.14	1.12	0.98
July	1.23	1.15	1.01
August	1.26	1.20	1.09
September	1.01	0.95	0.87
October	0.97	0.89	0.77
November	1.03	0.99	0.92
December	1.03	0.96	0.83

NOTE: The values of the standard deviations of soil temperature shown in the Table above were obtained by taking the square roots of the pooled variances of soil temperatures at the 11 A stations. The pooling of variances was considered to be valid since a test for heterogeneity of variance (Biometrika Tables for Statisticians, Volume 1, Pearson and Hartley, Cambridge 1956, page 60) showed that the variances of soil temperatures at the 11 stations were homogeneous.

The rule, given on page 2, for assessing the variability of soil temperatures is based on the fact that monthly means of soil temperature are normally distributed. The normality of the monthly mean soil temperature was established using the tests for skewness and kurtosis described in Pearson and Hartley's Tables, pages 61 to 63.

APPENDIX

The Computation of Averages of Monthly Mean Soil Temperatures

Soil temperature records from two types of meteorological stations were analysed, 11 A stations, at which four measurements of soil temperatures are made daily, at 0300, 0900, 1500 and 2100 G.M.T. and 7 B stations, at which soil temperature is measured once daily, at 0900 G.M.T.

The monthly mean soil temperatures (t_m) at A stations were computed by taking the simple average of monthly means of the four daily readings, i.e.

$$t_m = \frac{1}{4} (t_3 + t_9 + t_{15} + t_{21})$$

where t_3 is the monthly mean soil temperature at 0300 G.M.T. etc.

For each of the 11 A stations, fifteen-year (1954-1968) averages of monthly mean soil temperatures (\bar{t}_m) were computed for each month of the year. Where a station's records did not extend over the full term, the fifteen-year averages were estimated by weighting available records against those of the nearest long-term stations.

The computation of \bar{t}_m for B stations presented some difficulty since a single reading of soil temperature at 0900 G.M.T. on any particular day is not representative of the mean soil temperature during that day - it is in fact, fairly close to the daily minimum soil temperature at depths of 10 cm to 20 cm during the greater part of the year. An examination of the records of A stations, for which fifteen-year averages of both monthly mean soil temperature (\bar{t}_m) and monthly soil temperature at 0900 G.M.T. (\bar{t}_9) were available, showed that at these stations, the differences ($\bar{t}_m - \bar{t}_9$) at the various depths were practically constant for all stations in any particular month. On the assumption that the quasi-constancy of ($\bar{t}_m - \bar{t}_9$) applies to B stations at which the soil was broadly similar to that at A stations, estimates of \bar{t}_m at B stations were obtained by applying a correction factor d_1 to values of \bar{t}_9 at these stations. Thus, for B stations,

$$\bar{t}_m = \bar{t}_9 + d_1 \dots\dots\dots(1)$$

where d_1 was obtained from monthly values of ($\bar{t}_m - \bar{t}_9$) at A stations.

A second estimate of \bar{t}_m at B stations was obtained by using the same technique with the differences between fifteen-year averages of monthly mean soil temperatures (\bar{t}_m) and of monthly mean air temperatures (\bar{t}_a). In the colder months, October^m to March, the differences ($\bar{t}_m - \bar{t}_a$) at A^a stations were found to be negative and small (-0.3°C to -0.7°C) and in any particular month, they varied little from station to station. During the warmer months the differences ($\bar{t}_m - \bar{t}_a$) were larger and were positive (2.0°C to 3.5°C) and they tended to be greatest at stations of greatest insolation. Estimates of \bar{t}_m for B stations were obtained by means of the equation

$$\bar{t}_m = \bar{t}_a + d_2 \dots\dots\dots(2)$$

d_2 being deduced from the distribution of ($\bar{t}_m - \bar{t}_a$) at A stations.

The two estimates of \bar{t}_m at B stations provided by equations (1) and (2) proved to be remarkably similar - in 90% of cases they differed by not more than 0.5°C, the greatest difference was 1.0°C. The values of \bar{t}_m shown in Table 1 for B stations are the simple averages of the two estimates.

It is considered that the above methods of estimating \bar{t}_m at B stations are valid only when applied to sites at which the soil has the same (approximately) thermal characteristics as that at the A stations. It is worthy of mention that attempts to apply these methods to soil temperature data at the peat stations at Glenamoy, Co. Mayo and Lullymore, Co. Kildare resulted in widely varying estimates of \bar{t}_m . The thermal conductivity and thermal capacity of peat are quite different from those of mineral soil and hence the relationships between \bar{t}_m , \bar{t}_9 and \bar{t}_a in mineral soils could not be expected to hold good for peat sites. It is hoped to provide information of the temperature distribution in peat soils at a later date.