551.524.3 (42)

The mean temperature of central England, 1698-1952

By GORDON MANLEY
Bedford College, University of London

(Manuscript received 24 November 1952, in revised form 23 February 1953)

SUMMARY

A table of monthly mean temperatures representative of the English Midlands has been constructed for the period 1698-1952. From 1815 it is derived from the average of the 'Radcliffe' (Oxford) and 'Lancashire' monthly means. From 1771-1815 it has been built up by averaging the departures, or anomalies, for each month at a number of inland stations whose records are long enough to be bridged into the years 1815-1840; from 1771-1798 the values thus obtained are reinforced by direct values based on the long Midland record at Lyndon. Before 1771 the existing Edinburgh, Greenwich and Lancashire means are supplemented by further direct values based on Lyndon and Exeter. For all years previous to 1752 the Old Style calendar months have been rectified to the New Style, and the direct values derived from early MS. journals in London, Plymouth, and the Midlands have been carefully collated back to 1728, and extended by means of other short records from Halifax, London and elsewhere back to November 1722. Finally, a direct reduction of Derham's Upminster record, 1699-1706, has been used as a basis for the earliest years. For the intervening years estimates are provided from a consideration of the Utrecht reductions, supplemented for 1713-1722 by non-instrumental observations of wind and weather in England. Some corroboration of the values so obtained during the eighteenth century is provided; it is hoped that the table can serve as a general standard for studies of English temperature variations until such time as something better can be provided.

1. INTRODUCTION

Long-period tables illustrating the vicissitudes of a temperate climate have an evident value. In recent years investigations of the glaciers of north-west Europe go to show that the maximum postglacial advance of the remaining glaciers began at some time after 1300 and culminated within the last 200 years. The minor retreats and advances of the past century or thereabouts can be correlated with the fluctuations of the climatic elements since the time of establishment of standardized meteorological observations under national auspices. Botanical evidence moreover indicates that the north-west European climate has undergone several minor recessions and ameliorations since the Climatic Optimum, with recession on the whole predominant. Yet the amplitude of the temperature fluctuations indicated by the vegetation is little greater than that which may prevail from decade to decade at the present day. It thus becomes evident that further study of the reasons for the minor fluctuations of the past three centuries may provide the key to many of the events of the postglacial period, and by extension, to those of the Ice Age itself.

Further extension in time of our knowledge of yearly, seasonal and monthly variations is indeed desirable but with the diminishing precision of instruments and technique the difficulties become very great. Methods of approximation must be resorted to, most notably in England where, despite our very long scientific tradition, almost all our observation before 1841 was dependent on amateur effort, so that widely scattered records of diverse length and accuracy provide endless problems. It is the purpose of this paper to attempt to lay down a table of monthly means comparable with that provided by the late Dr. Labrijn for Utrecht in Holland which goes back to 1706, and indeed to provide some slight extension. Labrijn (1945), however, was able to assemble by straightforward methods a succession of overlapping records kept by different observers, not very far apart, and in a country of uniform relief. The English records offer a more formidable problem.

Figure 1. Location of the principal stations referred to in the text.

LIST OF PRINCIPAL RECORDS, USED IN COMPILING A 'CENTRAL ENGLAND' TABLE

(A)	1815-1952.	Monthly means directly derived from Oxford (Radcliffe) and Lancashire; the latter based on 4 to 7 north-western stations reduced to a common standard.
(B)	1799-1814.	London (Royal Society), London (Strand), Salford (1807 on), Stroud, Derby, South Kyme with Lancashire and Edinburgh, all bridged into (A).
(C)	1793-1798.	Above; supplemented by Lyndon (Rutland) directly reduced to 'outdoors.'
(D)	1786-1792.	Above; lacking Derby and Stroud.
(E)	1771-1785.	The same, together with Stroud, also Greenwich reductions.
(F)	1764-1770.	Direct numerical values based on Edinburgh, Greenwich, Lancashire and Exeter, appropriately corrected to the Oxford-Lancashire means (called here "RL").
(G)	1754-1763.	Lyndon (Rutland) monthly means from cool-room readings; Exeter (1755 onward) and Lancashire, corrected to RL and given less weight.
(H)	1753.	Lyndon only; chance of gross errors diminished by rough Lancs. and London data.
(K)	1748-1752.	Lyndon; Plymouth reduced to probable outdoor values and to RL; London (St. John's Gate) for 1751-52 : London (Jurin) to 1750. All adjusted to the New Style calendar months.
(L)	1745-1747.	London (Jurin); Plymouth; Lyndon (mean of extremes only).
(M)	1728-1744.	London (Jurin's earlier location, reduced to outdoor rural exposure and to RL); Plymouth; Lyndon (mean of extremes) 1736 onward; Southwick (Northants), outhouse observations from 1727-1739 reduced to outdoors, New Style and RL. Edinburgh 1731-1736 as partial check.
(N)	1723-1728.	MS. records as described : London (Hauksbee), Halifax, Plymouth and others, overlapping into (M).
(P)	1707-1722.	Estimated from Utrecht, except for a few months in 1707 and 1722.
(Q)	1699-1706.	Upminster; outdoor shade readings at fixed hours reduced to °F., New Style, monthly means for the Midlands. Estimates for 1698 added based on Upminster and Shropshire journals.

2. THE CHOICE OF LONG-TERM RECORDS ON WHICH TO BUILD; SOME EXISTING TABLES

Two major sets of monthly means for London back to 1763 and for Edinburgh back to 1764 are well known. Some comment on these is necessary.

The London data were standardized by normal 'bridging' through overlapping series on to the Greenwich hourly observations which began in 1841. These have now

come to an end. While they are said (Jones 1939) to be not absolutely impeccable on account of slight variations in radiation effects from buildings which probably affected the ' Glaisher stand ' on which the readings were taken, they have provided, nevertheless, a longer and more satisfactory basis on which to build than any other London station. They were carried back to 1771, principally by means of the Royal Society observations (1774-1780, 1787-1843) which were carefully reduced by Glaisher (1849, 1850) and supplemented from 1814 onward by additional Greenwich observations and others from Epping, until the official Observatory station began recording late in 1840. A second reduction of the London data, back to 1763, is available (Buchan 1893); the chief component before 1822 being derived from Thomas Hoy's observations, which from August 1782 onward were made at Sion House. The two series differed appreciably in the earlier years and were integrated by Dr. C. E. P. Brooks to form the well-known table printed by Sir David Brunt (1925) in his early paper on periodicity; the standard being that of the Greenwich hourly means. This will henceforth be referred to as ' Greenwich.' Hoy's journals at Sion House have also been used by Drummond (1943) who has essayed the problem of carrying back a table of monthly means representative of Kew Observatory.

I have been led to doubt the validity of those parts of the early ' London ' tables which are dependent on Hoy, on account of the phenomenally high figures given during the years 1782-1786 and here and there elsewhere; for example, the quite extraordinary mean temperature of 48·1°F or thereabouts given in the ' Greenwich,' ' Kew ' and ' Buchan ' tables for January 1796, as well as the mean of 73·7°F given for July 1783. These values are meteorologically impossible if we accept the published means for other NW. European stations in those months. Moreover, the trend of the annual means shown by ' Greenwich ' about 1782-1807, does not accord well with that of Edinburgh or Utrecht. Scrutiny of Hoy's published means gives the impression that at times the mercury column in his thermometer became broken and there is evidence that this occurred elsewhere, for example, in the irregularities of the Derby record (1793-1838) during the earlier years. On the whole therefore I have felt that, before 1820, greater confidence should be placed in the trend, if not the actual reduction, shown by the ' Royal Society ' observations. These were kept at Somerset House and the best instruments may be presumed to have been used. It must be agreed that some criticism of the way the observations were then kept was made by John Dalton (1819) but soon afterwards this appears to have been put right (Dalton 1840) and, as the observations appear to have been maintained in the same circumstances from 1787 to 1843 there is a valuable overlap with the existing Oxford (Radcliffe Observatory) record which began in 1815.

The exceedingly thorough reduction of the more distant Edinburgh series by Mossman (1897, 1900) remains a landmark in British climatology and it is with diffidence that one may point to some slight likelihood of error which might possibly arise on account of the uncertainty of early thermometer corrections; Mossman's careful integration of different overlapping records is, however, very reassuring.

The more recent Lancashire table, standardized by the present writer (Manley 1946) is quite independent of the others, and is based on overlapping series of observations together with direct reduction with allowances for site, from never less than two north-western stations, back to 1784. For still earlier years back to 1753, the monthly means should be regarded with greater reserve.

The Radcliffe Observatory series at Oxford (Knox-Shaw and Balk, 1932) beginning in 1815, appears to be more reliable than any other in southern England, on account of the methods of reduction, the relative lack of the urban effects associated with London, and the careful nature of the observations throughout.

3. Some later 18th century records: reasons for adoption of a 'central England' standard

Before 1800 one of the best series of daily observations of temperature was kept from 1736-1798 at a very representative site in the East Midlands, by Thomas Barker at Lyndon in Rutland, and the part from 1748-1763 has recently been discussed and reduced by the present writer (Manley 1952a). His extant manuscript diaries give daily observations from Mar. 1748 to Aug. 1763, and Jan. 1777 to June 1789. Monthly summaries from 1771-1798 were published in the *Philosophical Transactions*, and they include the results of both indoor ' cool-room ' observations and outdoor ' shade ' observations, twice daily. A scanty summary of Barker's earlier observations (1736-1748), giving monthly extremes, was published by Short (1750). In the Society's Library there is also an Exeter diary (S. Milward, 1755-1774) giving daily readings at noon of a thermometer indoors in a 'cool-room' following the prevailing earlier eighteenth-century fashion. While it is capable of rough reduction to outdoor means by the same method as that for Barker, it is not very satisfactory; careful comparison with other stations points either to minor changes of location, or of the thermometer; one cannot be certain. Nevertheless, these two records appear to be the only surviving sources of daily observations for the year 1762 in England. It should be added that valuable introductory notes and summaries for several of these early MS. series were made by Mr. C. E. Britton and are available in typescript in the Society's Library.

A later Midland record kept in or close to Stroud by a Dr. Hughes, covers Jan. 1771-Jan. 1774 and Jan. 1775 to Mar. 1813 (MS., three volumes, in the Society's Library). The figures have never been reduced, and I have with some labour taken out the approximate monthly means for thirty-five years. Three changes of exposure, rather variable observing hours from month to month, and the prevailing omission of one or two days each month do not render this a very congenial series, but the morning observations for 1775-1785 are nearly complete, and also twice-daily readings from 1803-1812. From these one can compare the means for successive months of the same name. Derby (1793-1838) with, as a rule, thrice-daily outdoor readings was kept and beautifully tabulated by T. Swanwick in an MS. volume now in the Society's Library, but the results are unfortunately subject at intervals to large and persistent thermometer errors, easily detected against other contemporary observers.

The existence of these four, and notably the long Barker series in the East Midlands, led me to think that the best method of standardizing any of the scattered earlier English records would be to try to bring them all to a comparable standard, namely a ' Central England mean ' represented nowadays by ' Radcliffe ' (i.e. Oxford) plus ' Lancashire ' divided by two. Let us call this, henceforth, ' RL.' For it will be evident that a direct extension of the Oxford tables could not well be effected as no reliable adjacent stations existed. Similarly, a direct extension of the ' Lancashire ' tables by interpolation from places as far distant as Lyndon would be far more likely to error.

For if we study the normal pattern of the isotherms we soon observe that, whether the month be excessively cold or extremely warm, the departure of the mean temperatures from the normal throughout the Midlands is likely to be well represented by the departures of RL, i.e., $\frac{1}{2}$ (Oxford + Lancashire). It must be emphasized that ' Oxford ' implies the corrected Radcliffe monthly mean which differs a little from the average of the maxima and minima; the corrections are discussed (Knox-Shaw and Balk 1932) in the Appendix to the ' Radcliffe Observations ' for that year.

Inasmuch as they are all Midland stations, better use of Lyndon (1736-1798), Stroud (1771-1813) and Derby (1793-1838) could be made by relating them to RL than to any of the other long series. In order to be sure of the merits of RL as a central England

mean, I have taken out the means for every month from 1931-1950 for a number of stations, e.g., Cheltenham, Rugby, Oundle; the results are very reassuring. On inspection it also appears that the monthly means for RL for 1906-1935 bear a close resemblance to those at Shrewsbury and to Giggleswick + 2·0, Buxton + 3·2, Welshpool + 0·3, Marlborough + 0·8, Huddersfield + 0·9, Cullompton − 1·2, Hereford − 0·2, Macclesfield + 1·4. The Meteorological Office mean for District 4 ('Midland Counties') is 0·4 lower in December-January and 0·4 higher in July-August; over the year it is nearly 0·1 below RL for the same period. RL therefore represents the probable 24-hour mean which would derive from observations at a site of intermediate character between 100-150 ft above sea level in Shropshire, south Cheshire or Worcestershire, i.e., the west Midlands. More easterly Midland stations such as Nottingham, Worksop, Wakefield and Cambridge, and even Copdock near Ipswich, were slightly warmer in summer and cooler in winter. All this, of course, is to be expected; nevertheless the consistency is agreeable and leads to the conclusion that the average of the anomalies presented by the monthly means at any pair of Midland stations, lying respectively towards the north and towards the south, should be quite close to that presented by RL. Incidentally the monthly means at London stations present anomalies in good general agreement, considering the miscellaneous urban effects, with other south Midland stations such as Oxford. Further, the interesting fact emerges that, after test over a number of years, the mean of ' Edinburgh ' and ' Greenwich ' lies close to that of RL, taking ' Edinburgh ' to be the location at 250 ft altitude to which Mossman's reductions apply, while ' Greenwich ' is the mean hourly value to which the long tables of London data have been standardized by Dr. C. E. P. Brooks. Hence the departure of (E + G)/2 from normal in any given month, i.e., the mean of the E and G anomalies, appears to give a fair approximation to the ' Midland anomaly,' that is the departure of RL from normal in the same month.

Hence the problem has been, to derive a ' central England mean ' for each month from one or more records, sometimes well within the Midlands, sometimes towards the periphery. The further towards the periphery, the greater the chance of error, unless the record in question could be bracketed with one on the opposite side. If, to quote an extreme case, one estimates the ' Midland anomaly ' for any given month from that prevailing at Plymouth Hoe far to the south-west, errors of up to 2°F may be expected. For in any case the anomalies at a coastal station tend to be less, in extreme months, than those inland. Hence the Cullompton (Exeter) anomalies accord considerably better with those of the Midlands, than do those at Plymouth Hoe.

In view of the fact that records of various sorts in London go back to 1723 with only minor gaps about 1753-4 and in 1762, it may be asked why the existing London tables should not be extended without further ado. Unfortunately, really good ' bridges ' or overlaps are lacking; and further, the varying size of London makes it extremely difficult to decide how to standardize the earlier records; thirdly, the imperfections about 1783 previously mentioned should be eliminated.

4. Compilation of a ' Midland ' mean before the Oxford tables begin

The assemblage of the monthly means for RL back to 1815 thus presents no difficulty. But the backward extension of Midland means through the Napoleonic wars in order to overlap the Barker (Lyndon) means, which end in 1798, is much more tricky. It has involved the careful scrutiny and test of the following records :

(1) Braithwaite near Keighley, 1799-1857 (Shackleton). 8 hr readings, indoors before 1809. Reluctantly discarded owing to early irregularities and doubtful exposure (MS., Keighley Library).

(2) York, 1800-1824. 8 hr readings. Very large thermometer errors at intervals especially about 1807-1808. Of little utility. (Gray's record; Meteorological Office Library).

(3) Stroud, 1803-1812 twice daily; tolerably complete, quite useful, consistent exposure. Also 1793-1812, morning observations only. (Hughes, R. Met. Soc. Library).

(4) Salford, 1807-1818; extremely urban, but consistent (Hanson, scattered in contemporary journals).

(5) Derby, 1793-1838. Earlier period subject to long spells of erroneous readings of constant magnitude, when compared against others, but tolerably useful (Swanwick's record, R. Met. Soc. Library).

(6) South Kyme (near Sleaford, Lincs.). 1800-1869 (summary at Meteorological Office Library). Apparently 8 hr; many details lacking, but after test against Royal Society, 'Oxford and Lancashire' for 1815-1824, the figures appear to agree very well, allowing for exposure and early hour of reading; hence the departures of the monthly means back to 1800 from that of 1815-1824 are reasonably trustworthy. Although relatively close to the East coast, this record is quite fairly representative of the 'East Midlands.'

(7) Mongewell (near Wallingford) 1773-1823. Presents great difficulty owing to irregular hours, but useful as an independent check for individual months. (Royal Society Library MS.).

(8) Strand, London (Cary's record, 1786-1846, *Gentleman's Magazine*). Discussed below. In addition, the other London series (notably the 'Royal Society') already mentioned, also 'Edinburgh' and 'Lancashire.'

The primary assumption made is that the overall Oxford (Radcliffe) means for 1821-1840, and the overall Lancashire mean for the same twenty years, are acceptable. The 'Royal Society' means, reduced by Glaisher, provide one of the overlaps; and the departure of the mean for every month back to 1787 from the mean for 1821-1840 was taken out and entered. Similarly, the departure of every month at Edinburgh from the mean of 1821-1840 was taken out and entered and compared with that of London. The Stroud means, 1803-1812, were standardized on to Oxford 1821-1840, through the Royal Society overlap, thus providing a further series of Midland anomalies for each month. A second Stroud set of means, 1793-1812, was calculated out using the morning observation only, and by the like bridging process a second series of anomalies for each month was carried back to 1793. The Derby anomalies for each month back to 1793 were taken out by overlapping against RL for 1815-1824. The Salford anomalies, back to 1807, were taken out against RL for 1815-1818, a relatively short but useful series covering the gap between the end of the Stroud record (February 1813) and 1815 when the Oxford observations began.

Nevertheless, a further check appeared desirable in view of certain apparent inconsistencies in the Royal Society and Greenwich reductions and the doubtful features attached to both Stroud and Derby. A completely independent series of observations in London was kept by Cary, the well-known instrument maker, in the Strand. It is extremely urban, with two observations daily (8 hr and noon) but agreeably long and apparently very consistent from 1786-1846; there may be a slight error for a few months in 1818. It has never been reduced as a whole to monthly means. With much labour, and aided by several friends I have taken out the means for the 40 years 1786-1825. In order to diminish the evident radiation effects, I have given treble weight to the 8-hr observation in comparison with that at noon. I then took out the departures for each month, 1800-1814, from the mean for 1815-1824 for the three stations : Cary, South Kyme and Lancashire; the mean of the three anomalies has been regarded as representative

of the Midlands. For each month it provides a nearly independent check on the anomaly derived from Royal Society plus Stroud plus Salford plus Edinburgh plus Derby plus Lancashire described earlier. For the period 1786-1799 the mean of the two anomalies (Cary and Lancashire) has been used as a check on the Midland anomaly otherwise obtained.

For 1771-1798 we have the Lyndon (Rutland) record kept by Barker. Throughout this period he maintained indoor (i.e. cool-room) and outdoor readings; but in 1786 he broke his outdoor thermometer, and after replacement the outdoor means differ from those indoors by an average of 1·7°F less than they previously did. Comparison with overlapping series elsewhere leads me to the conclusion that his outdoor thermometer read too low before 1787 and hence that the mean temperatures derived from the indoor readings are more likely to be correct, and accordingly I have reduced them all on the assumption made in my previous short paper on Barker's records (Manley 1952a). For the years 1771-1798, therefore, we have a series of approximate monthly means for Lyndon which is quite independent of any other series. Having obtained them it was agreeable to find that the departures from normal (based on the probable value, derived from Oxford, for Lyndon, 1821-1840) agreed very well with those provided by means of the above bridging, that is by averaging the Royal Society, Edinburgh, Lancashire and Stroud anomalies previously derived and checked with the aid of Cary back to 1786. With the aid of Lyndon, Lancashire, and to some extent Stroud as a check on Lancashire, I have thus calculated the probable value of the Midland anomaly for each month back to 1771; and for the year 1774-1781 it was also possible to use the Royal Society observations again, and to check the approximate value for each month of the Midland anomaly by working out that resulting from ½ (Edinburgh plus Greenwich) for the same month.

Lyndon, being well in the Midlands, provides a good index of the probable value of the monthly mean temperature in the region represented by RL for the years 1748-1763; the corrections, Lyndon to RL, are quite small. For the intervening period 1764-1770 I have taken out the direct mean temperature, rather than the anomalies, from a consideration of the values given by Lancashire, Greenwich, and Edinburgh in conjunction with the rather approximate means resulting from the reduction of the Exeter record kept by Milward, 1755-1774. For 1753-1759 the Lancashire values supplement those derived from Lyndon but I have given them less weight. This means that the value of RL for each month is principally dependent on the stations lying eastward and northward; far to the south-west, however, the Exeter record provides at least a minor check back to 1755. We have seen already that over a thirty-year period, the monthly mean temperatures at Cullompton, near Exeter, differ from those of the Midlands by a remarkably constant amount; so that for individual months the estimates of the departures of the Midland mean from normal are not likely to be too bad, even from so distant a region as Devonshire.

It may be mentioned in passing that Gilbert White kept records at Selborne from 1768-1793; I have examined his MS. as a south-country inland set for that period would have provided useful reinforcement; but there are far too many gaps due to absence. There is, however, a very long and hitherto unreduced set of observations at Mongewell, 13 mi SE. of Oxford, among the MS. in the Royal Society's Library; daily observations of a well-shaded thermometer are almost complete from 1773-1823. It is, however, a very difficult set to reduce owing to a great lack of consistency in the hours of observation and possible variations in the exposure. I have, however, taken out a number of ' sample ' months for comparison, more particularly the very hot or cold months such as July 1783, 1794, 1808 and 1818, and January 1776, 1780, 1795, 1814. The resultant check on the general reductions otherwise made has proved remarkably reassuring.

Reduction of the monthly means is necessarily complex owing to the need to allow for both distance and reliability of the several sources of data. Illustrations are given below :

TABLE 1. ILLUSTRATION OF THE REDUCTION FOR TYPICAL MONTHS

January 1797

Departures of the Monthly Mean (°F) from that of 1821-1840 :

(A) Royal Society = − 0·7
(B) Greenwich = + 3·7 (i) $\frac{A+C}{2} = +1{\cdot}9$ (' Rough Midland anomaly ')
(C) Edinburgh = + 4·4

(D) Lyndon = + 0·8
(E) Lancashire = + 1·7 (ii) $\frac{1}{2}\left(\frac{A+C}{2}+D\right) = +1{\cdot}3$ (' Average of above with Lyndon ')

(F) Derby = (+ 2·2)
(G) Stroud = (+ 2·4) (iii) $\frac{1}{2}\left[\frac{1}{2}\left(\frac{A+C}{2}+D\right)+E\right] = +1{\cdot}5$ (' Average of S. and E. Midlands and Lancashire')

Greenwich (B) above not used as it is persistently high about this period.
Mean value of RL for 1821-1840 for January = 36·7
∴ Probable value for January 1797 (using (iii)) = **38·2**

Check on the above value

Departures of the Monthly Mean from that of 1815-1824 :

(H) ' Cary ' (London) = + 1·4
(K) Lancashire = + 1·2
(H + K)/2 = 1·3

Mean value of RL for 1815-1824 for January = 37·1
∴ Probable value for January 1797 = **38·4**
Adopted value, taking account of the more doubtful (F) and (G) above = **38·3**

July 1776

The above stations give the following departures :

(A) = + 1·4, (B) = + 0·9, (C) = + 0·3, (D) = + 0·3, (E) = + 1·0, (G) = + 0·4

Greenwich is here used, with the result :

Probable anomaly for S. Midlands $= \frac{1}{2}\left(A+\frac{B+C}{2}\right) = +1{\cdot}0 = Y$
Probable anomaly for S. and E. Midlands $= \frac{1}{2}[Y+D] = +0{\cdot}7 = Z$
Probable anomaly for W. Midlands applicable to RL $= \frac{1}{2}[Z+E] = +0{\cdot}8$
Mean RL for 1821-1840 for July = 60·6
∴ Probable value for July 1776 = **61·4**
The Stroud value, although doubtful, is in sufficient agreement as a check.

5. SOME FURTHER PROBLEMS PRESENTED BY OBSERVATIONS BEFORE 1753

In England daily readings of thermometers exposed to the air were first maintained, as far as is known, by Robert Hooke in 1664. Following his advocacy of the need for such studies, during the later part of the seventeenth century daily observations of pressure, temperature, rainfall and wind direction were begun in a number of places and some of the resultant ' registers of the weather ' have been preserved. Unfortunately the surviving records of temperature are not only scattered but much interrupted. Some of these early manuscript records were sent to the Royal Society; among these the first really useful set of daily observations covers the years from 1699-1706. They were kept by William Derham at Upminster, whose rainfall measurements (1697-1716) are already well-known. As yet I have not devised a way of incorporating any observations of earlier date.

In 1723 Jurin, who was then Secretary of the Royal Society, published a short paper

in which he advocated the maintenance of regular daily observations and invited contributions. As a result he received quite a spate of tables of carefully maintained daily readings, sometimes reduced to monthly means, from various parts of the country. For our knowledge of eighteenth century weather we are particularly indebted to Jurin's medical colleagues with whom he entered into correspondence; of these, perhaps the most noteworthy was Huxham of Plymouth. In his subsequent *Essay on Fevers*, which went through several editions, Huxham added careful summaries of the weather of each month, and in particular he gave means and extremes of his temperature readings which cover the period 1728-1752, and were kept by 'Jurin's method.'

Jurin himself, while in practice in London, kept a daily register of his observations following the general method which he had advocated in his 1723 paper. The thermometer he says 'should preferably be one made by Francis Hauksbee and should be exposed in a fireless room where no sun can penetrate.' As a result of this the majority of English records of temperature before 1755 are kept under circumstances which are not easy to interpret or standardize. The so called 'Royal Society' thermometers made by Hauksbee and copied by others used a scale on which, according to Martine (1740), zero was equal to 88°F while 'between 78 and 79' gave freezing-point. How the upper point was established on these spirit thermometers is not clear, neither is it evident that they were strictly comparable. For Barker used a 'Royal Society's pattern' thermometer made by Patrick on which freezing point lay at 76·5. On one occasion Jurin put his own instrument out with its bulb in the snow where it read 78°; it is not quite clear that the snow was melting at the time. The bulbs were spherical and frequently upwards of an inch in diameter, so that we may agree that they would not be at all responsive by modern standards; moreover, there is some evidence that the scale reading of the freezing point might change with age. Lastly, while readings twice daily were thought desirable, and the time of observation was often noted, the actual time of reading varied a good deal. With indoor cool-room observations, however, the effects are not too serious (late editions of Martine also give slightly different conversions).

Nevertheless, continuity of daily recording in cool rooms was maintained by several observers for long periods, so that with suitable methods of interpretation an index of the vicissitudes of the monthly mean temperature can undoubtedly be produced. The problem is, how to standardize such scattered individual records and how to build them into a temperature series which can be brought down to the present day.

6. Before 1753: the rectification of the calendar months

There is a further problem with regard to all English records before September 1752; existing monthly means refer to the Old Style or Julian Calendar and as the stagger amounts to eleven days they are far from comparable with those of the New Style or Gregorian months. It so happens that from 1729 to 1747 there is only one set of daily observations in manuscript; from March 1747 to September 1751 there is a second incomplete daily record; from March 1748 onward to the calendar change in September 1752 there is a third but with a nine months' interruption. Hence for the intervals Mar. 1729-Feb. 1747 and Oct. 1751-Aug. 1752 we are oddly enough dependent on a single set of daily observations, in order to make the translation of Old Style to New Style monthly means. However, so long as we are dealing with English Midland stations the relationship between Old Style and New Style means for any given month is probably very closely represented by that registered at any other inland station. There is no way of avoiding such an assumption if we are to devise New Style monthly means for England for comparison with Holland, where the New-Style calendar was adopted in 1700, or with our present-day monthly means.

Barker's extant MS. journal begins in March 1748 and a straightforward series of monthly means for the Old and New Style months was soon compiled. There is, however, a gap Oct. 1751-Aug. 1752, but during these months daily readings of a thermometer at noon, at St. John's Gate in London, were published in the *Gentleman's Magazine*; unfortunately, excluding the Sundays. Nevertheless, the relationship between the Old and New Style means can be closely estimated for that period.

To carry back the rectification further, we have a simple MS. journal kept by Jurin, Aug. 1728-Mar. 1750, giving daily readings on his own system, that is within a cool room in London. Still further back we have full tables of Hauksbee's daily observations in London at Crane Court (July 1723-Dec. 1728); Nettleton's at Halifax, 1724-1727; and Stukeley's in London (Nov. 1722-Feb. 1725). Lastly, the daily observations kept by Derham cover the years 1699-1706; his non-instrumental data for 1698 enable estimates for that year to be added. These are the principal MS. sources and, together with some minor MSS. are all preserved in the Library of the Royal Society. None of them have hitherto been reduced to modern standards.

It must of course be agreed that the difference between the monthly means for any one New Style and Old Style month, if derived from observations in London, is not likely to be precisely the same for other parts of the country; but from a few comparisons the difference does not appear to be at all serious so far as the Midlands are concerned. In general, of course the New Style months are cooler in spring and warmer in autumn than those of the Old Style. Casting up the two sets of means from these numerous manuscripts over a period of 38 years has been a very prolonged task.

7. The derivation of central England means from these early records

Barker's MS. takes us back to March 1748. We now have to make use of Huxham's fine series of monthly means of temperature based on twice-daily observations of a Hauksbee thermometer ' on Jurin's method ' at a house in the sheltered older part of Plymouth (Huxham 1752, 1770). Nearly three earlier years with his daily readings are available in MS. (Mar. 1724 to Dec. 1726). Although the 1724 readings are of little use, as he used another pattern of thermometer, Huxham provides us with the monthly extremes, and careful notes of the frequency of snow and sleet enable us to judge very well the overall mean temperature of the winter half-year, November-April, during the decades in question; compare my earlier notes on the subject (Manley 1948, 1952a). Huxham's rather elegant Latinity is also not unamusing. Comparison of the ranges shown by morning and afternoon temperatures and monthly extremes leaves no doubt that the place of exposure was quite well ventilated.

I have reduced Huxham's indoor monthly mean temperatures from the Old to the New Style using the comparison provided by the Jurin observations in London. I have then reduced these New Style indoor means directly to outdoor equivalents on the Fahrenheit scale, on the same general principles as I adopted for Barker's observations (Manley 1952a). The resultant overall annual mean for Plymouth for 1748-1752 can be compared against the Barker Midland mean for the same years. Huxham's overall mean temperature for the winter months, 1728-1752, must be very close to that of the present day to judge by his overall frequency of snow (Manley 1948); the temperatures of his extreme months, e.g., July 1733 can be placed close to the highest means likely to be observed today; and the temperatures he reports for extreme days, hot or cold, can likewise be plotted against today's extreme values. Some allowance has been made for the fact that Plymouth town is more sheltered than the Hoe.

Having thus estimated the Plymouth outdoor means for the New Style months for the years in question, the normal differences, ' Plymouth-RL,' have been applied, giving

a series of values for RL. These, however, are not likely to be at all accurate, as Plymouth lies a long way south-west and the temperature gradient to the Midlands varies a good deal especially in cold winter months (compare Jan. 1744, in Table 2).

Accordingly, I have derived a similar series of outdoor means, by similar methods, from Jurin's London observations between 1728 and March 1745. In that month he removed and the characteristics of his cool-room became appreciably different, in Lincoln's Inn Fields, from those at his previous house in Garlick Hill. One can compare the two London locations by reference to the overall sums of the monthly means at Plymouth. With regard to the later part of Jurin's record, May 1745 to March 1750, differences between successive months of the same name can be carried backwards from the Barker record which begins in March 1748.

We also know the mean of the monthly extremes of Barker's indoor thermometer for the months May 1736 onward; these were given by Short (1750). These provide a rough value for the monthly mean, and a check on that derived from the more distant London and Plymouth observations.

Midland observations of a more useful type were kept at Southwick, near Oundle, by George Lynn. He read a Hauksbee thermometer twice daily in an outhouse and published the means, for the Old Style months, for 1726-1739 (Lynn 1741). The range of Lynn's readings, daily, monthly and annual, indicates a well-aired outbuilding in which the thermometer responded well to outdoor variations. I reduced all these to *approximate* Fahrenheit equivalents (freezing point = 78° Hauksbee and 1·4°H = 1°F), which evidently differed but little from outdoor means; and also through Jurin to the New Style. Taking the years 1728-1739, an overall mean of all Lynn's observations could be compared with Huxham at Plymouth, and with Jurin at London; the approximate outdoor Fahrenheit equivalents of the means given for his warmest and coldest months could similarly be estimated. From these, a curve relating the means of his outhouse reading to outdoor equivalents could be drawn. Thus it became possible to eliminate error in the scale reading of the freezing point, to which Martine refers.

From 1728-1739, therefore, actual Midland observations reinforce those elsewhere; and the difference between these Southwick monthly means, and those representative of RL, has been considered to be 0°·2 greater than that between Oundle and RL at the present day, based on the difference in altitude.

At this stage, having derived a series of approximate values of RL for every month back to 1728, it was recalled that Mossman (1900) reduced an independent Edinburgh set of observations, 1731-1736, to modern standards by the best methods he could think of. Knowing the mean difference, Edinburgh − RL, it was agreeable to find that the differences between Mossman's reduced values and my own for the years 1733-5 were reasonably accordant with those prevailing in more modern times. Secondly, as the series of monthly means was steadily lengthened, very pleasing general agreement has been found with the Utrecht tables (Labrijn 1945). For example, the phenomenally warm September 1729, the hot July of 1733, the severely cold October of 1740 and the warm November of 1743 are all in admirable accord.

For the earlier years we have Hauksbee's own readings, twice daily, at Crane Court in London, July 1723-Dec. 1728. These provide a means of adjusting Lynn's Southwick means for 1727 to the New Style and carrying back the results of actual Midland observations for a further year (Lynn for 1726 is unreliable). For 1724-1727 Nettleton's observations from Halifax, again using Hauksbee's thermometer and the method advocated by Jurin, are exquisitely tabulated and averaged, but as indoor readings they appear to suffer more than most from lag; it is tempting to recall the solidity as well as the chill of the older stone houses of Yorkshire. Hence I have taken back the means to 1723

largely by repeated differencing of months of the same name, both in northern and southern England, from the values of RL derived for the years 1727 and 1728. Stukeley's MS. observations indeed take us back to November 1722, but here the problem arose of a different thermometer scale of unknown derivation; fortunately it could be bridged with Hauksbee's observations, and supplemented with a brief series of monthly means from Northumberland. All these MS. records have been gone through in detail, but regard for the exigencies of space and the likelihood of tolerance of complex arguments about remote events, suggests curtailment.

TABLE 2. ILLUSTRATION OF THE REDUCTION FOR TYPICAL MONTHS

		RL Adopted Mean
January 1756		
RL, based on Lyndon reduced to 'outdoors'	39·9	
RL, based on Lancashire	40·3	40·0
RL, estimated from Exeter	39·9	
January 1744		
RL, based on London (Jurin) reduced to °F, New Style and outdoors	35·8	
RL, based on Plymouth similarly treated	33·2	34·5
RL, based on departure of Plymouth from mean of Plymouth 1748-1752, applied to Lyndon's mean for those years	33·7	
RL, based on mean of Lyndon monthly extremes	35·5	
January 1730		
RL, based on London (Jurin) as above	37·6	
RL, based on Plymouth (Huxham) as above	39·3	
RL, based on Southwick (Lynn)	39·0	38·5
RL, based on departures of Plymouth from mean of Plymouth 1748-1752, applied to Lyndon's mean for those years	39·6	

Finally, we go back to the beautifully tabulated annual MS. summaries for Upminster, east of London, which were sent to the Royal Society by William Derham; the first of these, for 1699, was printed (Derham 1700). His thermometer, nearly three feet long, was exposed on a north wall and read thrice daily at stated hours. He records the freezing point on his scale as 82·2° (his 'degrees' were scaled in linear inches and tenths); the extreme values over eight years are 58 and 186. From a consideration of the probable extreme values over a series of years on a north wall at Upminster, which undoubtedly would bear a close relation to those in the old North Wall screen at Kew, I have interpreted Derham's scale. I have then reduced his observations, adjusted them for intermittent omissions, and corrected them for the hours of observation which vary from month to month, using the Kew corrections to a twenty-four hour mean. The result certainly looks very well. But it is finely supported by the fact that the annual mean thus derived for 1706 for Upminster differs from that at Utrecht by very much the same amount as we should expect today. No other test whatever is available, other than the frequency of snow in relation to the winter mean temperature over this period. This is also satisfactory. As the fluctuations of the monthly means at inland stations near London are in fair agreement with those in the Midlands, I have extended the RL means from the Upminster values using the normal monthly differences between RL and the average of six Essex and nearby stations today. The values so derived for RL however are smoothed to the nearest half-degree. Estimates for the year 1698 have been added, based on Derham's earlier non-instrumental record and on notes by a Shropshire farmer (abstract of T. Like's journal by C. E. Britton, R. Met. Soc. Library); as there is evidence that May 1698 was colder than any subsequent month of that name.

Unfortunately, no other English records exist, so far as is known, which allow us to bridge the gap 1707-1722, except for a few months in 1707 when some sketchy MS.

observations (Beighton's) from Coventry permit a very rough reduction. I have accordingly made estimates of the mean temperature of the Midlands, to the nearest degree, based on the Utrecht table in Holland. These, especially in cold winters, must be very approximate; in summer they are likely to be better. My estimates for each month during the years 1713-1722 have also been supplemented and adjusted from a consideration of the daily wind and weather, observed by G. Smith at Richmond near London (MS. summary, R. Met. Soc.). From these one can to some extent judge the probable incidence of the air masses in England by comparison with Holland. There is always the possibility that further observations of temperature may be found; but at present there seems little hope, and those who are curious about the trend during the early years of the eighteenth century must therefore be satisfied by the interpolated estimates below. The Northern Ireland diary (1711-1725) kept by Le Neve only contains temperatures from June 1722 onward, so that it too proves rather a disappointment.

8. Conclusion

This paper is long, and would be far longer if all the stages of a compilation which has taken nearly five years to complete were argued in detail. The principal link is through Oxford and Lancashire for 1821-1840; should these reductions be found to err, the earlier tables will need corresponding adjustment. But the reductions of still earlier MS. series through a consideration of the probable outdoor equivalent of indoor means seem to lead to good results. For in the first place the effects of varying readings of the freezing point on different thermometers are eliminated. Moreover, we have a useful test of the overall average of the winter mean temperatures for long periods in the eighteenth century through a critical study of the observations of snow frequency. To provide some confirmation of the resultant values of mean temperature, we may quote :

TABLE 3. Comparison of past and present snow-frequencies and winter mean temperatures

	Period	Average annual number of days with snow or sleet observed	Mean temperature °F, (RL) for November-April
Tonbridge and NW. Kent (Source of data: Hooker's MS Journal, R.S. Library)	1729-1765	13·0	41·1
North-west Kent at similar levels and by similar standards	1912-1938	(12·5)*	41·7
	1931-1950	12·0	42·0
Upminster (West Essex)	1698-1706	13·8	40·6
West Essex at similar levels and by similar standards	1912-1938	(12·0)*	41·7
	1931-1950	(11·7)*	42·0

* Approximate, based on available 'good-standard' stations.

Although the Upminster data cover only nine years, which is a short period from the standpoint of a snow-frequency average, they do conform well with the expectation based on temperatures. Snowfall frequencies for London (1728-1749), Plymouth (1725-1752), Lyndon (1748-1763, 1777-1789) and Liverpool (1768-1793) are also satisfactorily accordant.

Scattered notes also exist in Barker's journals and elsewhere with regard to the thickness of ice on ponds and rivers, which confirm the remarkable intensity and length of the frost of 1740 by comparison with other severe winters. In that year, for example, the ice on the River Eden was reported to have attained 22 in. in thickness, and Hardraw

Force is said to have been completely frozen. Phenological records also have some value, e.g., for the springs of 1740 and 1750.

Moreover, the general pattern of evidence of extreme months, the range of variation they show, and the accordance with other NW. European records, all make for confidence in the reality of the values shown; and, while they must not be regarded as more than representative of the English W. or NW. Midlands and not precisely appertaining to any single location, particularly in winter anticyclonic months, it is doubtful whether any longer series, integrating our scattered observations, could be constructed which would at the same time be free from urban effects. Such tables of standardized monthly means provide also a basis for the discussion of the incidence of extremes, for the extraction of ' singularities,' and for the integration of minor scattered records. Before 1750 however statisticians should view the table with caution.

Discussion and illustration of the trends revealed by this table of monthly means and their relationship with other phenomena will be reserved for a later paper. In the light of current studies, the establishment of the comprehensive Table 4 has appeared to be a primary need. The January and July running means are however shown elsewhere on p. 193 of this issue of the *Journal*. A short table of extreme values is given below (Table 5), and decadal means are added in Table 6.

9. Acknowledgments

I have to express my very grateful acknowledgments to the Officers of the Royal Society for allowing me generous opportunities to consult the MSS. and other works in the Society's Library; and to Mr. Kaye, the Society's Librarian, and his staff for their help. I have also to thank the authorities of Lancing College for the loan of the early Barker journals, and the Librarians of the Royal Meteorological Society, of the Meteorological Office, and of the Keighley Municipal Library for further opportunities of consultation. I have to thank Mr. J. G. Balk of the Radcliffe Observatory for very kindly providing data for 1931-50 in continuation of his earlier published table. Lastly, I am most grateful to several friends for assistance, notably in reducing the Cary monthly means over the 40 years 1786-1825. To this the late Mrs. Margaret Anderson of Cambridge, with Miss Audrey Ashworth and Miss Mavis Rodgers, recent graduates from the Department of Geography at Bedford College, have generously contributed much time. The whole of the remaining calculations and reductions from the available material have been carried out by myself, and I shall be very ready to give details to those who may desire them, with regard to particular records or reductions.

TABLE 4. Reduced values (°F) of the monthly mean temperature representative of central England, 1698-1952

New Style or Gregorian Calendar throughout
(Figures in brackets must be regarded with reserve, for 1698 and 1707-1722)

	J	F	M	A	M	J	J	A	S	O	N	D
1698	(35)	(35)	(40)	(45)	(47)	(57)	(60)	(60)	(55)	(49)	(39)	(40)
1699	38·0	38·5	39·0	42·5	49·5	58·5	63·0	58·0	56·0	50·0	42·0	39·0
1700	40·5	37·0	38·0	48·5	53·0	55·5	59·0	59·0	55·0	48·0	42·0	39·0
1701	37·5	37·0	36·5	40·5	51·0	57·5	64·5	60·5	57·0	46·0	43·5	39·0
1702	40·0	44·0	43·5	41·0	51·0	56·0	59·0	61·0	57·5	49·5	40·5	38·0
1703	36·5	38·5	42·0	47·0	49·5	55·0	59·5	60·0	52·0	46·5	45·0	41·0
1704	36·0	38·0	41·5	47·5	51·5	57·0	62·0	61·5	53·0	47·5	43·5	39·5
1705	37·0	38·0	39·0	45·5	50·0	54·0	59·5	62·5	53·5	48·0	38·5	40·5

	J	F	M	A	M	J	J	A	S	O	N	D
1706	37·0	39·5	43·0	47·5	53·5	60·5	60·0	60·5	53·0	51·0	43·0	41·0
1707	(38)	(37)	(41)	(47)	(52)	(61)	(63)	(61)	(57)	(47)	(44)	(38)
1708	(43)	(39)	(44)	(49)	(51)	(57)	(58)	(64)	(59)	(47)	(45)	(37)
1709	(29)	(35)	(37)	(48)	(54)	(58)	(60)	(60)	(56)	(50)	(48)	(41)
1710	(37)	(38)	(43)	(44)	(53)	(58)	(58)	(60)	(56)	(49)	(46)	(46)
1711	(41)	(36)	(42)	(49)	(52)	(60)	(59)	(59)	(55)	(49)	(45)	(38)
1712	(37)	(40)	(41)	(46)	(52)	(59)	(61)	(58)	(55)	(49)	(43)	(42)
1713	(37)	(42)	(38)	(41)	(50)	(56)	(57)	(59)	(57)	(49)	(40)	(39)
1714	(39)	(42)	(41)	(45)	(50)	(58)	(64)	(58)	(55)	(51)	(43)	(39)
1715	(39)	(41)	(44)	(49)	(52)	(57)	(59)	(59)	(57)	(51)	(44)	(34)
1716	(28)	(37)	(40)	(48)	(51)	(57)	(60)	(59)	(54)	(49)	(42)	(37)
1717	(40)	(37)	(40)	(45)	(50)	(57)	(59)	(59)	(56)	(49)	(42)	(41)
1718	(34)	(37)	(42)	(46)	(52)	(58)	(63)	(63)	(58)	(49)	(43)	(40)
1719	(38)	(40)	(41)	(44)	(53)	(58)	(64)	(63)	(57)	(48)	(43)	(38)
1720	(40)	(39)	(39)	(45)	(52)	(55)	(61)	(57)	(56)	(47)	(43)	(42)
1721	(41)	(35)	(37)	(47)	(49)	(57)	(58)	(60)	(57)	(48)	(43)	(40)
1722	(39)	(41)	(43)	(46)	(51)	(57)	(59)	(59)	(56)	(50)	46·0	39·0
1723	34·0	40·0	45·5	48·0	53·0	59·0	59·5	60·0	56·0	52·0	45·5	42·5
1724	42·0	39·5	40·5	45·0	52·5	59·5	59·0	61·2	58·0	47·5	41·5	38·0
1725	40·0	38·0	41·0	46·5	51·5	54·0	56·8	56·0	55·0	49·0	44·5	39·0
1726	34·0	39·5	39·5	47·2	56·2	61·5	60·8	60·0	58·5	50·3	43·0	35·2
1727	39·5	41·0	41·2	48·5	56·5	58·8	62·5	62·5	58·0	51·5	40·5	38·5
1728	39·0	36·3	44·7	46·9	54·5	61·5	62·5	60·8	55·1	48·4	45·0	34·8
1729	34·2	36·1	37·0	44·8	50·6	59·2	62·3	60·2	61·8	50·1	46·6	41·0
1730	39·3	40·4	43·1	47·7	54·3	57·2	59·5	61·4	59·5	51·6	48·5	38·1
1731	35·5	35·9	42·8	44·2	53·7	60·0	61·3	62·0	59·5	54·2	46·0	41·4
1732	36·3	43·5	43·0	48·0	52·6	58·3	60·8	61·9	58·1	51·7	43·3	36·0
1733	44·5	42·8	42·7	50·0	52·1	59·3	65·0	61·0	55·0	48·3	43·7	45·7
1734	39·7	43·5	46·6	48·7	52·0	57·3	61·1	61·1	56·0	47·1	43·1	39·2
1735	40·0	39·2	42·4	48·0	51·7	56·0	58·6	61·1	57·6	50·5	43·4	41·8
1736	43·5	37·5	44·5	47·5	51·0	60·3	61·5	64·0	58·0	50·8	44·4	43·5
1737	43·2	39·6	43·0	47·8	54·5	60·7	63·3	56·8	57·5	48·1	43·0	40·9
1738	40·2	40·3	41·9	49·9	52·5	57·5	61·5	60·8	54·5	50·3	43·4	43·0
1739	39·2	44·2	42·5	44·0	52·8	59·3	60·8	58·5	55·5	49·3	38·6	37·7
1740	27·0	29·2	39·0	43·5	47·5	55·0	59·5	58·5	57·2	41·5	38·0	36·0
1741	35·0	40·0	39·5	44·7	48·7	59·3	60·0	62·0	58·5	51·8	46·0	39·0
1742	35·5	38·5	39·4	43·8	51·0	59·0	60·5	60·5	54·0	48·5	40·0	34·0
1743	38·5	41·7	41·6	41·7	56·0	60·0	58·8	62·5	57·5	48·0	48·8	40·8
1744	34·5	37·2	40·7	44·0	51·5	58·0	61·5	59·8	55·0	49·0	44·5	38·3
1745	38·8	36·2	40·0	45·5	52·5	54·0	61·0	59·0	57·5	50·5	42·5	36·8
1746	36·5	34·5	37·5	44·5	55·0	57·7	60·5	60·6	57·5	46·0	38·0	41·5
1747	38·0	42·5	36·5	46·5	54·0	58·5	62·5	65·0	58·0	49·0	44·5	41·5
1748	36·5	35·3	35·3	43·3	50·8	58·7	59·8	60·5	57·5	48·5	44·8	42·8
1749	41·6	38·5	41·6	44·2	54·2	53·4	63·0	60·0	56·8	50·2	44·0	40·5
1750	39·2	44·0	46·8	45·8	51·3	57·6	63·0	59·0	59·3	48·6	39·2	39·5
1751	39·2	34·7	43·2	44·8	48·8	58·9	59·6	58·2	54·6	47·0	39·8	37·4
1752	37·8	37·5	42·0	44·3	50·5	58·7	60·0	60·2	57·0	51·0	43·7	39·6
1753	36·0	38·5	42·8	45·5	53·8	58·3	59·4	60·2	55·5	50·0	40·3	40·0
1754	38·0	37·0	38·2	44·0	54·0	56·5	58·5	60·2	57·0	50·8	42·3	38·5
1755	36·0	34·2	39·0	50·0	49·0	60·3	59·0	58·2	56·3	47·2	40·5	39·0
1756	40·0	40·2	42·8	44·0	48·3	56·8	61·0	58·4	56·5	49·0	39·0	37·3
1757	32·5	39·2	40·8	46·5	51·3	57·2	65·1	59·4	56·0	46·7	44·8	37·8
1758	36·7	38·8	41·4	45·0	56·8	58·2	57·5	61·5	53·5	46·5	42·3	39·0
1759	42·6	42·4	43·0	47·5	53·7	59·0	64·8	61·3	56·3	51·7	41·2	36·5
1760	35·5	38·8	43·8	49·0	53·0	59·3	62·5	60·5	60·3	48·5	42·3	43·0

	J	F	M	A	M	J	J	A	S	O	N	D
1761	41·7	42·5	44·3	49·0	53·5	57·7	60·4	61·5	57·5	49·0	43·2	40·0
1762	40·5	39·2	38·7	50·0	55·3	62·5	64·0	59·5	56·5	46·2	40·3	38·5
1763	30·5	40·8	41·8	48·0	50·3	58·3	59·5	59·5	55·5	47·0	42·5	43·2
1764	38·7	38·8	39·0	45·0	54·0	57·0	61·0	59·3	54·5	48·0	40·0	37·0
1765	40·7	32·7	41·0	45·5	52·5	56·8	60·2	59·5	56·0	48·5	39·0	35·0
1766	33·2	35·0	39·5	46·5	49·5	56·6	60·3	61·8	56·0	48·8	45·0	38·0
1767	32·2	41·7	40·5	45·2	50·0	55·0	58·0	61·0	57·3	48·6	44·5	38·0
1768	33·5	40·7	40·5	46·5	54·0	57·0	60·0	60·8	53·0	48·6	42·0	40·2
1769	36·5	36·9	41·0	46·0	52·3	55·5	61·5	59·0	55·0	46·8	42·2	40·6
1770	38·6	40·3	36·5	41·8	50·0	55·5	59·5	60·5	57·0	48·0	41·5	38·5
1771	33·8	37·7	37·6	41·9	54·0	57·7	60·3	57·8	53·9	48·6	43·3	42·0
1772	34·2	35·5	40·0	43·5	50·1	60·9	62·5	61·0	55·4	53·1	44·9	40·6
1773	39·2	36·6	43·7	46·9	50·5	58·4	60·6	62·9	54·3	49·8	41·6	38·8
1774	33·0	39·7	43·5	47·4	51·7	58·4	60·9	61·0	54·5	50·6	40·7	38·3
1775	40·3	42·9	42·8	49·7	54·6	61·8	62·1	60·5	57·8	48·8	40·7	40·1
1776	29·2	38·8	43·6	48·9	51·5	57·4	61·4	59·3	55·3	50·4	43·1	40·0
1777	35·4	36·1	44·2	44·9	53·0	56·5	59·6	60·7	58·3	50·3	44·5	36·6
1778	35·5	37·7	40·3	46·7	51·1	59·8	63·2	62·2	54·0	45·4	44·1	43·0
1779	37·2	46·3	46·2	49·0	53·4	57·9	64·2	63·7	59·4	51·6	42·3	37·5
1780	30·3	35·7	46·3	43·4	55·1	57·6	62·2	63·6	60·0	48·4	40·0	37·7
1781	35·8	40·6	43·9	48·6	53·7	61·1	63·3	63·1	57·6	51·1	43·7	41·7
1782	41·4	35·4	39·3	41·4	48·2	58·9	60·0	57·5	56·0	45·6	36·2	37·0
1783	38·1	37·9	38·0	50·2	50·7	58·7	65·8	60·4	55·1	49·6	43·1	36·8
1784	31·0	34·5	36·8	42·3	56·3	56·7	59·3	57·2	58·6	46·0	41·9	32·5
1785	38·2	32·7	34·2	47·1	54·2	60·9	61·0	57·1	56·5	47·7	42·1	37·0
1786	36·8	38·1	35·8	46·6	52·1	61·0	59·0	59·1	53·0	45·5	38·0	37·1
1787	38·5	42·7	44·3	45·4	52·7	57·0	60·4	60·0	55·0	49·7	40·1	38·9
1788	39·1	38·8	38·5	49·0	56·8	59·7	60·5	60·4	56·2	49·6	43·0	31·5
1789	34·7	41·0	35·8	45·3	54·5	57·2	59·8	61·8	55·6	47·5	40·3	43·0
1790	39·8	43·8	43·6	42·9	53·5	58·2	58·8	60·1	53·9	50·5	43·0	39·8
1791	39·8	40·5	43·7	49·2	51·1	58·5	59·5	60·6	56·9	48·0	42·6	34·0
1792	36·2	40·1	42·6	50·0	50·3	55·8	59·5	62·5	53·3	47·9	44·7	39·7
1793	37·1	40·3	39·6	43·1	51·6	56·3	63·6	59·0	53·0	52·4	42·8	41·6
1794	35·2	44·9	44·6	50·3	52·3	60·3	64·6	59·9	54·5	49·2	42·9	38·7
1795	26·5	33·4	39·0	45·9	51·6	55·7	59·3	61·8	60·8	53·0	40·1	43·9
1796	45·2	40·5	39·5	50·4	50·6	57·1	58·4	60·6	58·2	46·6	40·2	31·4
1797	38·3	40·2	39·8	45·4	52·3	56·5	63·2	60·4	54·5	46·8	40·5	40·7
1798	38·5	39·2	41·2	50·8	55·3	62·4	61·3	61·5	56·5	49·9	40·5	34·7
1799	35·0	37·0	38·1	41·7	49·3	57·3	59·4	57·9	55·3	47·0	42·1	34·4
1800	37·1	36·0	39·2	48·7	54·2	57·0	63·8	62·3	57·1	48·6	41·8	38·0
1801	40·3	40·7	44·0	47·0	53·7	58·7	60·9	62·7	57·5	50·4	40·7	34·7
1802	34·9	38·7	42·0	48·0	51·0	56·6	56·3	62·9	56·9	50·2	41·1	38·5
1803	35·2	38·2	43·3	48·3	50·9	56·6	63·7	60·9	52·6	48·8	41·0	39·9
1804	42·5	37·2	40·4	44·4	55·9	60·9	60·7	60·0	57·5	51·2	43·8	35·8
1805	35·8	39·3	43·1	46·9	50·3	55·7	60·8	61·6	58·2	46·7	40·7	38·4
1806	39·6	39·8	41·1	44·2	53·7	58·8	59·8	61·2	56·1	51·0	46·1	44·3
1807	37·0	38·6	37·3	45·9	53·3	57·5	62·8	62·5	50·9	52·5	37·3	35·5
1808	36·7	37·0	37·8	42·5	56·7	58·6	65·1	62·0	54·8	45·0	42·8	36·0
1809	35·6	42·3	42·8	41·3	55·6	56·7	59·2	58·7	54·9	50·4	40·3	39·4
1810	35·9	38·3	40·9	46·8	48·6	58·3	59·4	58·3	57·0	49·7	41·8	38·4
1811	34·1	40·3	44·7	48·0	55·0	57·4	60·9	58·0	56·7	54·2	45·8	37·6
1812	36·6	41·5	38·3	41·9	51·7	55·4	57·6	57·8	55·7	48·8	40·8	35·0
1813	35·4	42·5	44·2	45·7	52·9	56·5	59·0	58·1	54·5	46·6	39·7	37·0
1814	26·7	34·6	37·3	49·2	48·6	53·9	60·8	58·4	55·1	46·5	40·5	39·7
1815	32·6	43·7	45·1	46·5	54·7	57·7	58·9	59·5	56·1	50·5	38·1	36·1

	J	F	M	A	M	J	J	A	S	O	N	D
1816	36·8	35·7	39·1	43·9	49·9	55·0	56·1	57·1	53·2	50·5	39·0	37·6
1817	40·1	43·5	41·9	45·7	47·7	59·1	57·4	56·4	55·7	43·5	48·3	36·5
1818	39·9	36·8	40·1	44·5	52·3	61·5	64·7	59·5	55·9	53·6	49·1	38·4
1819	39·9	39·7	44·3	47·5	52·7	56·1	61·6	63·4	56·1	48·4	39·3	34·6
1820	31·5	37·8	40·4	48·1	52·5	56·5	60·3	58·5	54·1	46·6	42·0	40·5
1821	38·5	35·7	42·3	49·1	48·9	54·2	58·7	61·5	58·9	50·8	47·5	43·5
1822	40·5	43·4	46·1	46·9	54·8	62·7	60·1	59·4	54·3	51·3	46·7	34·9
1823	31·9	37·5	41·0	44·1	53·9	54·1	57·3	57·9	54·5	47·1	44·7	40·7
1824	39·7	40·5	40·3	45·3	51·2	56·2	60·8	59·2	56·7	49·1	44·9	41·1
1825	38·9	39·1	41·0	48·3	52·8	57·3	62·9	61·3	59·1	51·5	41·3	40·3
1826	32·7	43·5	43·3	47·8	52·2	63·1	64·3	63·6	56·5	51·9	39·9	42·5
1827	35·1	33·3	42·7	48·1	53·5	57·6	61·7	58·6	56·7	52·5	44·5	44·4
1828	41·2	41·3	43·9	47·0	54·3	59·7	60·8	59·5	57·7	50·3	45·4	45·3
1829	32·5	39·7	39·7	44·0	54·5	58·9	59·1	57·7	52·3	46·9	40·1	34·5
1830	31·7	35·9	45·9	48·1	53·6	54·9	61·1	56·7	53·4	50·7	44·5	35·3
1831	34·9	40·7	44·9	48·5	52·7	59·7	62·1	62·5	56·7	54·9	42·1	42·5
1832	37·5	38·1	42·5	47·4	51·7	59·3	60·7	59·7	56·5	51·2	42·6	41·4
1833	34·2	42·0	39·1	45·9	59·1	58·2	60·5	57·7	53·7	50·1	43·9	44·5
1834	44·7	42·0	44·7	45·9	55·4	59·7	62·5	61·1	56·9	51·1	44·0	42·1
1835	37·3	42·3	42·5	47·4	52·3	59·0	61·5	62·5	56·1	48·1	43·9	37·5
1836	38·7	38·3	42·4	44·9	52·0	59·5	59·7	58·3	53·0	47·5	41·5	39·3
1837	36·9	40·5	36·1	40·4	49·9	59·9	62·5	60·3	54·5	50·9	41·4	41·5
1838	29·3	32·7	40·9	42·9	50·9	58·0	60·1	59·1	54·9	49·7	40·2	39·2
1839	37·1	39·3	39·5	43·5	50·3	57·7	58·9	58·3	54·3	48·7	45·1	38·6
1840	39·3	38·4	38·9	49·5	52·5	57·3	56·9	60·7	51·9	45·5	42·5	34·3
1841	34·0	36·4	45·5	46·1	54·9	55·3	56·9	58·3	56·2	47·6	41·3	40·0
1842	33·0	39·5	43·5	46·1	52·6	60·0	58·1	62·7	55·7	44·9	41·9	44·9
1843	39·2	35·5	42·1	47·3	50·7	55·0	58·7	59·5	58·0	46·2	42·2	45·3
1844	38·8	34·9	40·4	49·6	51·5	58·5	59·7	56·3	55·9	48·5	42·7	32·7
1845	37·8	33·7	35·6	47·5	49·1	58·9	57·7	56·3	52·6	49·1	44·1	40·3
1846	43·3	43·5	42·9	46·1	54·1	64·7	61·7	61·9	58·5	49·1	44·5	32·9
1847	35·9	36·3	42·1	43·9	54·1	57·1	63·5	59·3	52·7	51·2	46·2	40·7
1848	34·3	42·9	42·7	46·7	57·1	58·1	60·1	56·5	55·1	49·5	42·4	42·1
1849	39·1	42·3	43·0	43·5	53·7	57·1	59·7	60·1	55·9	48·5	43·9	38·1
1850	33·3	43·5	40·5	48·2	50·2	59·7	61·1	58·1	54·1	46·2	45·3	40·3
1851	42·1	40·4	42·5	45·3	50·7	57·8	58·3	59·9	54·9	51·4	37·5	40·7
1852	40·8	40·5	41·3	46·8	51·1	55·7	65·6	60·5	55·2	46·0	46·2	45·8
1853	41·1	33·0	38·2	45·7	51·6	57·7	58·9	58·5	54·1	50·1	41·3	34·3
1854	38·5	39·7	44·1	48·5	50·6	55·7	59·7	59·4	57·9	48·9	40·9	41·1
1855	36·3	28·9	37·9	44·7	47·8	55·9	62·3	60·2	55·7	49·5	41·5	36·3
1856	38·7	41·5	39·9	46·5	48·9	56·3	59·5	62·5	54·5	51·3	40·7	39·9
1857	36·7	39·7	41·5	45·5	52·3	60·5	61·5	63·4	58·1	52·3	44·9	45·2
1858	38·2	35·3	40·9	45·9	51·5	62·3	58·7	60·5	58·5	49·2	39·8	40·7
1859	40·8	42·3	45·1	45·5	53·1	58·7	64·9	61·1	55·3	49·2	40·7	34·9
1860	38·3	35·1	40·5	42·7	52·7	54·2	58·1	56·5	52·1	49·7	40·1	34·7
1861	35·0	40·9	43·3	45·5	50·8	58·7	59·0	60·6	55·6	53·2	39·5	39·1
1862	39·1	41·1	41·9	47·9	54·2	54·9	57·5	58·3	55·4	50·6	37·7	43·7
1863	40·8	42·4	43·7	47·9	51·1	56·4	59·3	59·9	52·9	49·9	45·2	43·3
1864	36·3	36·1	40·5	47·9	54·3	56·5	59·9	57·5	55·9	49·6	41·9	38·6
1865	35·7	36·1	37·3	51·1	54·7	60·0	61·9	59·1	61·3	49·5	44·0	42·5
1866	42·5	39·9	40·6	47·5	50·0	59·9	59·9	58·5	55·1	51·3	44·5	42·9
1867	34·1	44·5	37·5	48·7	52·5	57·3	58·8	61·3	56·5	48·8	40·7	38·1
1868	39·0	43·4	44·3	47·7	56·3	59·9	64·9	62·3	57·8	47·2	40·9	44·9
1869	42·1	45·5	38·9	50·1	49·2	55·7	63·1	59·9	57·9	49·4	42·5	37·3
1870	38·0	37·0	40·4	48·5	53·0	59·3	63·5	60·3	55·2	49·1	40·5	33·0

	J	F	M	A	M	J	J	A	S	O	N	D
1871	32·9	42·9	45·1	47·7	52·3	55·0	59·4	62·9	54·9	49·7	38·1	38·5
1872	41·0	44·5	44·3	46·8	49·5	57·3	62·7	59·5	55·7	47·1	44·6	41·5
1873	41·3	35·3	41·7	45·9	49·9	57·6	61·1	59·7	53·3	47·4	43·3	41·5
1874	41·9	39·1	44·1	49·7	50·0	57·1	63·1	59·1	56·5	50·8	42·1	31·7
1875	43·5	36·1	41·1	47·4	54·1	57·5	58·7	61·0	58·9	48·1	41·7	39·5
1876	37·7	40·6	40·1	46·3	49·3	57·7	62·9	61·7	54·9	52·3	43·0	42·8
1877	41·9	43·1	40·9	44·6	48·3	59·4	58·5	59·3	52·1	48·7	44·8	40·5
1878	40·3	42·0	41·7	48·1	53·3	59·1	61·9	61·2	55·9	50·3	38·3	31·5
1879	30·7	37·5	40·5	42·3	48·1	55·3	56·5	58·1	54·7	48·0	39·4	33·2
1880	33·7	42·5	43·1	46·3	50·7	56·9	59·9	61·6	58·3	44·7	41·7	41·1
1881	29·3	37·7	41·5	45·1	53·3	56·6	61·1	57·1	54·9	45·1	48·0	39·1
1882	41·3	43·0	45·3	47·2	52·7	55·5	59·3	58·8	53·7	49·9	42·3	39·1
1883	40·4	42·6	35·5	46·5	51·1	57·1	58·1	59·5	55·9	49·5	42·5	40·3
1884	43·7	41·5	43·7	44·9	52·3	57·3	61·3	62·9	58·1	49·0	41·5	39·9
1885	37·3	42·5	40·1	45·9	48·1	57·1	61·3	56·5	53·9	45·5	42·7	38·7
1886	35·7	34·7	39·6	45·7	50·6	56·5	60·7	60·5	56·5	52·3	43·8	35·5
1887	36 3	38·8	37·9	43·1	49·0	59·5	63·1	60·2	53·2	44·7	40·0	36·7
1888	37·8	35·3	37·6	43·1	51·2	55·7	56·7	57·3	54·0	46·3	45·9	40·9
1889	38·2	37·3	40·5	44·7	55·2	59·6	59·5	58·5	55·1	47·5	44·5	37·9
1890	42·3	37·5	43·1	44·7	53·1	56·3	58·1	57·3	58·3	48·9	42·3	30·5
1891	34·4	39·1	38·9	43·2	49·1	58·4	59·1	57·3	57·5	48·9	42·1	39·3
1892	36·1	38·5	36·9	45·1	52·8	56·1	57·7	59·3	54·3	44·7	43·5	35·2
1893	36·0	40·5	44·9	50·5	55·5	60·1	61·5	63·3	55·3	49·8	41·3	40·6
1894	38·2	41·1	44·1	49·4	48·5	56·3	60·6	57·5	52·9	48·7	46·2	41·2
1895	32·3	28·7	41·1	46·7	54·4	58·7	59·4	60·5	59·8	44·8	45·5	39·1
1896	40·7	40·2	44·1	48·4	53·5	61·1	61·1	57·7	55·6	44·5	39·8	39·1
1897	34·8	42·5	43·7	44·7	50·0	59·1	61·7	61·2	53·8	49·9	45·7	40·5
1898	43·9	40·6	39·7	47·3	50·3	56·5	59·5	61·7	59·3	52·3	44·9	45·1
1899	40·9	41·1	41·1	46·1	49·8	60·3	63·1	64·1	55·7	47·9	47·3	35·9
1900	39·9	36·6	38·6	46·9	50·5	58·4	63·9	59·1	56·5	49·7	45·2	44·9
1901	38·3	36·1	39·3	47·5	52·7	57·0	64·4	60·1	57·1	49·4	40·7	38·1
1902	40·5	34·7	44·0	45·5	48·0	57·1	58·5	57·7	55·1	49·3	44·3	40·3
1903	39·5	44·7	44·7	43·5	51·9	55·4	59·6	57·7	55·5	50·9	43·5	38·0
1904	39·3	38·2	39·8	47·7	51·6	56·0	62·7	59·1	54·5	49·5	41·4	38·6
1905	38·4	41·3	44·3	45·1	51·5	58·5	62·9	58·5	54·3	44·7	40·8	40·8
1906	41·5	37·6	41·1	45·1	50·9	57·7	60·4	62·1	57·1	51·6	45·2	37·4
1907	38·5	37·0	43·3	45·6	50·9	54·4	57·4	57·7	56·5	49·7	43·7	40·3
1908	36·5	41·5	39·7	42·8	54·3	57·8	60·4	58·3	55·3	53·3	45·3	39·1
1909	38·3	37·3	38·7	47·7	51·8	53·3	58·2	59·7	53·5	50·8	40·7	39·1
1910	38·3	41·1	42·9	45·1	52·1	58·5	57·5	59·3	54·5	51·1	37·7	43·5
1911	38·9	40·7	41·3	45·5	55·2	58·1	64·7	64·7	57·1	48·8	42·9	43·1
1912	38·5	41·8	44·9	47·9	53·7	57·1	60·9	55·3	52·0	46·7	43·3	44·1
1913	40·1	40·6	43·1	46·5	52·5	57·7	58·3	59·3	57·3	51·7	47·1	41·1
1914	38·6	44·3	42·9	49·7	51·5	58·1	60·5	60·9	55·9	50·6	44·2	40·3
1915	39·3	39·8	41·3	46·3	51·5	57·9	58·3	59·5	56·1	48·3	37·0	41·5
1916	45·5	38·9	37·9	46·7	52·9	53·3	59·5	61·5	55·4	51·1	44·2	35·5
1917	34·9	33·7	37·7	41·7	55·0	59·4	60·9	59·5	57·2	45·5	46·1	36·1
1918	38·9	43·7	42·3	44·1	55·4	55·9	59·7	61·0	53·5	48·7	41·9	44·5
1919	37·3	35·4	38·5	44·8	56·3	57·7	57·1	60·3	54·9	45·3	37·9	41·9
1920	41·3	42·8	44·9	46·8	53·3	57·9	57·3	56·5	55·4	50·7	44·3	39·6
1921	45·2	40·7	45·3	46·4	52·7	58·5	65·3	59·7	57·3	55·0	40·2	43·7
1922	38·7	40·0	40·3	41·9	54·9	56·9	56·6	56·4	53·9	46·7	42·6	42·5
1923	42·0	42·0	43·7	45·7	48·5	54·5	63·5	59·4	54·5	49·4	37·9	38·8
1924	40·5	37·9	39·3	44·5	52·9	57·1	59·5	57·4	55·9	50·2	44·7	44·3
1925	41·6	41·4	40·9	45·5	52·9	59·0	62·3	59·8	52·7	50·8	38·5	37·1

	J	F	M	A	M	J	J	A	S	O	N	D
1926	40·2	44·3	43·4	48·8	50·3	56·5	62·7	61·1	57·9	46·5	42·7	39·5
1927	40·2	39·1	45·1	46·3	52·1	54·6	60·7	60·3	54·5	50·9	43·1	35·7
1928	41·3	42·5	43·3	47·3	51·7	55·3	60·9	59·6	55·0	50·2	45·7	38·2
1929	34·4	32·7	43·1	44·2	52·3	55·9	60·8	59·7	59·5	49·2	44·1	42·5
1930	42·0	36·5	41·5	46·9	51·3	59·5	59·3	60·3	56·5	50·9	43·2	39·7
1931	37·7	39·0	39·5	45·9	52·5	57·9	59·5	57·9	52·7	47·9	46·1	41·6
1932	43·3	37·3	40·5	44·4	50·9	57·3	61·0	62·7	55·3	47·8	43·9	42·3
1933	36·0	39·7	45·1	47·9	54·0	60·0	64·1	63·7	58·9	50·1	42·0	34·9
1934	39·4	38·8	40·7	46·4	52·3	58·9	64·8	59·7	58·2	51·1	42·9	46·5
1935	40·1	42·4	43·9	46·7	49·9	59·2	62·7	61·9	56·5	49·1	44·5	37·1
1936	38·7	36·7	44·7	43·3	52·7	58·4	59·6	60·9	57·9	48·9	41·9	41·5
1937	41·3	42·1	38·5	48·5	53·9	57·4	61·0	62·5	56·1	50·7	41·1	37·4
1938	42·3	41·1	48·3	45·6	51·3	57·9	59·4	61·3	56·8	50·9	48·9	39·9
1939	39·5	42·0	42·5	47·8	52·5	57·5	59·9	61·6	57·6	46·7	47·7	37·7
1940	29·5	36·7	42·8	47·7	54·5	61·5	59·1	60·0	55·1	49·3	44·5	38·9
1941	32·9	38·3	41·1	43·6	48·9	59·1	63·2	58·5	58·1	50·8	43·9	42·0
1942	33·7	32·1	41·3	48·5	51·9	58·0	59·9	61·8	56·5	50·8	40·9	44·1
1943	40·8	42·9	43·7	50·9	53·3	58·0	61·5	60·9	55·9	51·1	43·3	38·3
1944	42·4	38·5	41·3	50·3	52·5	56·3	61·7	62·6	54·5	48·8	43·1	38·5
1945	32·7	44·7	46·3	50·1	53·9	58·3	62·1	60·6	57·9	53·5	45·0	40·9
1946	36·9	42·7	41·2	49·9	51·3	55·5	61·3	58·5	57·2	49·6	46·6	37·5
1947	35·9	28·6	38·5	47·4	56·3	59·9	62·6	65·5	58·9	51·1	44·9	41·1
1948	41·7	40·5	46·9	48·2	52·5	56·3	60·5	59·1	56·9	50·1	45·1	42·3
1949	41·9	42·2	41·1	50·0	52·1	59·5	63·4	62·3	61·3	53·1	43·9	42·4
1950	39·5	41·6	45·3	45·7	52·3	61·1	60·7	60·1	55·2	49·3	42·2	34·1
1951	39·1	38·6	39·3	44·3	50·1	57·2	61·3	58·7	57·4	49·0	47·3	41·9
1952	36·9	38·1	43·9	49·3	56·2	57·9	62·3	60·4	51·3	47·8	39·3	37·1

TABLE 5. EXTREME VALUES FOR PURPOSES OF REFERENCE

	J	F	M	A	M	J	J	A	S	O	N	D
Warmest												
	1916	1779	1938	1865	1833	1846	1783	1947	1729	1921	1818	1934
	45·5	46·3	48·3	51·1	59·1	64·7	65·8	65·5	61·8	55·0	49·1	46·5
	1796	1869	1948	1943	1848	1826	1852	1747	1865, 1949	1831	1938	(1710)
	45·2	45·5	46·9	50·9	57·1	63·1	65·6	65·0	61·3	54·9	48·9	(46)
	1921	1794	1750	1798	1758, 1788	1822	1921	1911	1795	1731, 1811	1743	1852
	45·2	44·9	46·8	50·8	56·8	62·7	65·3	64·7	60·8	54·2	48·8	45·8
Coldest												
	1795	1947	1785	1837	(1698)	1909, 1916	1816	1912	1807	1740	1782	1890
	26·5	28·6	34·2	40·4	(47)	53·3	56·1	55·3	50·9	41·5	36·2	30·5
	1814	1895	1748	(1701)	1740	1749	1802	1725	1952	1817	1915	1796
	26·7	28·7	35·3	(40·5)	47·5	53·4	56·3	56·0	51·3	43·5	37·0	31·4
	1740	1855	1883	1809, (1713)	1817	1814, (1705)	1879	1844, 1845	1840, (1703)	1896	1807	1788, 1878
	27·0	28·9	35·5	41·3	47·7	53·9	56·5	56·3	51·9	44·5	37·3	31·5

Warmest year 1949, 51·1°. Coldest year 1740, 44·3°.

TABLE 6

DECADAL MEANS

	J	F	M	A	M	J	J	A	S	O	N	D	Year
1701-10	37·1	38·4	41·1	45·7	51·7	57·4	60·3	61·1	55·4	48·1	43·7	40·1	48·3
1711-20	37·3	39·1	40·8	45·8	51·4	57·5	60·7	59·4	56·0	49·1	42·8	39·0	48·2
1721-30	38·2	38·7	41·3	46·5	52·9	58·5	60·0	60·1	57·5	49·8	44·1	38·5	48·8
1731-40	38·9	39·5	42·8	47·2	52·0	58·4	61·3	60·6	56·9	49·2	42·7	40·5	49·2
1741-50	37·4	38·8	39·9	44·0	52·5	57·6	61·1	60·9	57·1	49·0	43·2	39·5	48·4
1751-60	37·4	38·1	41·7	46·1	51·9	58·3	60·7	59·8	56·3	48·8	41·2	38·8	48·3
1761-70	36·6	38·9	40·3	46·3	52·1	57·2	60·5	60·2	55·8	47·9	42·0	38·9	48·1
1771-80	34·8	38·7	42·8	46·3	52·5	58·6	61·7	61·3	56·3	49·7	42·5	39·5	48·7
1781-90	37·3	38·5	39·0	45·9	53·3	58·9	60·8	59·7	55·7	48·3	41·1	37·5	48·0
1791-1800	36·9	39·0	40·7	47·5	51·9	57·7	61·3	60·7	56·0	48·9	41·8	37·7	48·3
1801-10	37·3	39·0	41·3	45·5	53·0	57·8	60·9	61·1	55·6	49·6	41·6	38·1	48·4
1811-20	35·4	39·6	41·5	46·1	51·8	56·9	59·7	58·7	55·3	48·9	42·3	37·3	47·8
1821-30	36·3	39·0	42·6	46·9	53·0	57·9	60·7	59·5	56·0	50·2	43·9	40·3	48·9
1831-40	37·0	39·4	41·1	45·6	52·7	58·8	60·5	60·0	54·9	49·8	42·7	40·1	48·5
1841-50	37·0	38·9	41·8	46·5	52·8	58·4	59·7	58·9	55·5	48·1	43·5	39·7	48·4
1851-60	39·2	37·6	41·2	45·7	51·0	57·5	60·7	60·3	55·6	49·8	41·4	39·4	48·3
1861-70	38·3	40·7	40·8	48·3	52·6	57·9	60·8	59·8	56·4	49·9	41·7	40·3	49·0
1871-80	38·5	40·4	42·3	46·5	50·5	57·3	60·5	60·4	55·5	48·7	41·7	38·2	48·3
1881-90	38·2	39·1	40·5	45·1	51·7	57·1	59·9	58·7	55·4	47·9	43·3	37·9	47·9
1891-1900	37·7	38·9	41·3	46·8	51·4	58·5	60·8	60·2	56·1	48·1	44·1	40·1	48·7
1901-10	38·9	38·9	41·8	45·6	51·6	56·6	60·2	59·0	55·3	50·0	42·3	39·5	48·3
1911-20	39·3	40·2	41·5	46·0	53·7	57·3	59·7	59·9	55·5	48·7	42·9	40·8	48·8
1921-30	40·6	39·7	42·6	45·7	51·9	56·8	61·2	59·3	55·8	50·0	42·3	40·2	48·8
1931-40	38·8	39·6	42·7	46·4	52·5	58·6	61·1	61·2	56·5	49·3	44·3	39·8	49·2
1941-50	37·8	39·2	42·7	48·5	52·5	58·2	61·7	61·0	57·2	50·8	43·9	40·1	49·5
MEANS													
1701-1950	37·7	39·1	41·4	46·3	52·2	57·8	60·7	60·1	56·0	49·1	42·7	39·3	48·5
1901-1930	39·6	39·6	42·0	45·8	52·4	56·9	60·4	59·4	55·5	49·6	42·5	40·2	48·7
1931-1950	38·3	39·4	42·7	47·5	52·5	58·4	61·4	61·1	56·9	50·1	44·1	39·9	49·4

REFERENCES

Barker, T.	1772-1800	*Phil. Trans.*, **62** to **91**, *passim*; also MS. journals, R. Met. Soc. and Lancing College.
Brunt, Sir D.	1925	*Phil. Trans.*, **225** A, p. **247**.
Buchan, A.	1893	*J. Scot. Met. Soc.*, 3rd Ser., **9**, p. 213.
Dalton, J.	1819	*Mem. Manc. Lit. Phil. Soc.*, 2nd Ser., **3**, p. 490
	1840	*Ibid.*, **6**, p. 561.
Derham, W.	1699	*Phil. Trans.*, **21**, p. 45.
	1700	*Ibid.*, **22**, p. 527.
	1709	*Ibid.*, **26**, p. 454, also MSS. in Library, Royal Society.
Drummond, A. J.	1943	*Quart. J. R. Met. Soc.*, **69**, p. 17.
Glaisher, J.	1849	*Phil. Trans.*, **138**, p. 307.
	1850	*Ibid.*, **139**, p. 569.
Huxham, J.	1752, 1770	*Observationes de Aere et Morbis Epidemicis*, 3rd and 4th editions, London. Also MS., Library Royal Society.
Jones, Sir H. Spencer	1939	*Quart. J. R. Met. Soc.*, **65**, p. 535.
Jurin, J.	1723	*Phil. Trans.*, **32**, p. 422. Also MS., Library Royal Society.
Knox-Shaw, H. and Balk, J. G.	1932	*Radcliffe Observations*, **55**, Appendix.
Labrijn, A.	1945	*Med. en Verh.*, K.N.M.I., **49**, No. 102.
Lynn, G.	1741	*Phil. Trans.*, **41**, p. 686.
Manley, G.	1946	*Quart. J. R. Met. Soc.*, **72**, p. 1.
	1948	*Ibid.*, **74**, p. 119.
	1952a	*Ibid.*, **78**, p. 255.
	1952b	*R. S. Notes and Records*, **9**, p. 300.
Martine, G.	1740	*Essays* . . . . (on thermometers, etc.), London.
Meteorological Office	1936	*Averages of Temperature*, 1906-35, London (H.M.S.O.).
Mossman, R.	1897, 1900	'The climate of Edinburgh,' *Trans. R. S. Edinb.*, **38**, **39**.
Short, T.	1750	*New observations* . . . . , London.