Correspondence

The Greenwich temperature record

By G. S. Callendar

It was with regret that we learnt from the Astronomer Royal's article in the October 1951 *Journal*, p. 672, that the Greenwich Observatory Meteorological record has terminated. These observations, which include almost a million hourly temperature recordings taken under closely controlled conditions, have continued without a break since 1841, and, as they extend over a longer period than almost any others of comparable accuracy, it seems appropriate to put on record the fluctuations of mean temperature which they reveal.
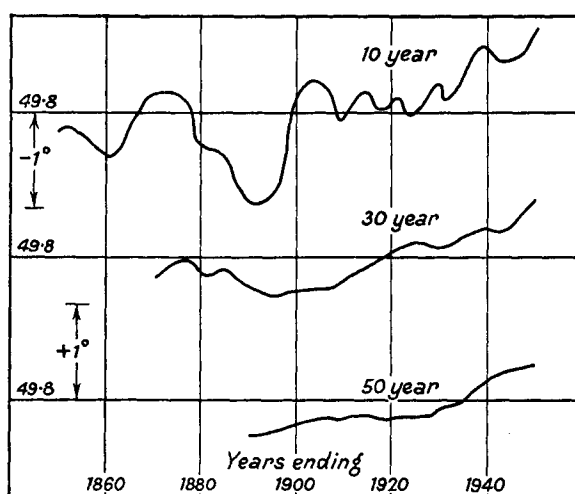

Figure 1. Temperature variations at Greenwich.

The accompanying diagram shows the moving average of annual temperature for several periods of years. The upper curve shows that fluctuations of the ten-year average have amounted to about 2°F during the period, and perhaps the most striking feature of this curve is the low values which occurred about 1890. It is known that similar cool periods had occurred previously about 1815 and 1840 (Manley 1946). More significant, however, than these temporary, and sometimes local, fluctuations is the small upward trend shown by the lower curve of 50-year averages, because it is known that this trend, in varying degree, is representative of a vast area of the north Atlantic region, and may extend over much of the earth's surface (Lysgaard 1949).

Because of the known accuracy of the Greenwich temperatures any definite trend which they reveal is a matter of considerable climatological interest. But, however accurate in themselves, instrumental indications of this kind are very vulnerable to local influences, and although the site of these observations is very favourable, being situated on high ground in Greenwich Park, the conditions at greater distances are by no means so propitious. In fact the general area within a few miles of the park has seen much building activity within the last two or three decades, and, because of the effect such activities can have on local air temperatures, it is necessary to check the trend shown by the Greenwich figures against that found in rural areas nearby. The more so as a glance at the middle curve of 30-year averages shows that the trend is mainly confined to recent decades. This has been done to cover the significant period of the last half-century, with the aid of temperature readings from some reliable rural stations in south-east England. As one of the senior British records Oxford is also included in the comparison.

The result is shown as the change of temperature between the successive 25-year periods 1900 to 1924, and 1925 to 1949, at the following meteorological stations:

Woburn	Agricultural Experimental Station	0·42°F
Wisley	Botanical Gardens	0·63°F
Ventnor	Hospital	0·56°F
Greenwich	Observatory	0·55°F
Oxford	Radcliffe	0·59°F

It is rather surprising to find that the two urban stations show no greater change of temperature than the others, in spite of a large increase in the local population at the former. This increase has been very large over the period at Oxford. In any case the comparison gives great confidence in the Greenwich figures, and indicates that their upward trend is fully significant.

Undoubtedly this fine series would make excellent material for a comprehensive memoir. Perhaps we may hope that some enthusiast will undertake this formidable but valuable task, and thus provide a change from the spate of mathematical papers which are so dreary to the non-specialist.

' Percuil,'
Parsonage Road, Horsham.
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THE QUASI-GEOSTROPHIC WIND APPROXIMATION

By N. P. SELLICK

I have recently been examining the tendencies in the thickness of a layer of air bounded above and below by isobaric surfaces determined to fit simple instantaneous flow patterns. The results obtained have been found to differ materially from the solution offered by Sutcliffe's Eq. 14 (1947) and I was led to examine the approximations on which this equation is based. Sutcliffe proceeds from Eq. 9, a version of the vorticity equation, by ingenious steps which involve the assumption of quasi-geostrophic motion, to his final Eq. 14. The assumptions of quasi-geostrophic motion made are examined below in a model which is intended to represent an instantaneous state of the atmosphere.

Consider a simple pattern of flow in an isobaric surface determined by the velocities

$$u = \frac{2\omega \cos \phi}{Rb^2} + c - a \sin by \; ; \quad v = a \sin b (x - ct)$$

in which a is the velocity of circulation, b determines the dimensions of the cells and c is the velocity of translation. The remaining symbols are traditional and the first term in ϕ is the ' Rossby ' term which satisfies the vorticity equation when treated as a constant.

The vorticity of this wind field is

$$\zeta = ab \{ \cos b (x - ct) + \cos by \} \qquad . \qquad . \qquad . \qquad . \qquad . \qquad (1)$$

and the divergence is zero. The field of contours to balance the wind field is

$$h = - a^2 \cos b (x - ct) \cos by - \frac{a}{b} l \{ \cos b (x - ct) + \cos by \} + h_0 \qquad . \qquad (2)$$

together with terms in ϕ which become small when differentiated.