SOME ASPECTS OF THE CLIMATE OF CENTRAL SCOTLAND

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SUMMARY

Climatological data from a selection of stations in Central Scotland are quoted to show the variations in climate which can exist over quite small distances. Two long-term records of summer sunshine are presented to illustrate year-to-year variations and to emphasise the difficulties of identifying trends in climate from limited information.

DIFFERENCES IN SPACE

Table 1 shows a selection of summarised data from climatological stations in Central Scotland. These data can be used to demonstrate some of the complexities of local climate, and the consequent problems which have to be faced by the climatologist when he is asked to estimate climate characteristics at sites where no data exist.

Most of the stations in Table 1 have full records of daily temperature extremes over the 10 year period 1968-77, but values have been enclosed in brackets to indicate that estimation of one or two years' values has been necessary to complete the decade. Three of the stations are maintained by the Meteorological Office, and the remainder by other organisations who co-operate by sending their data to the Meteorological Office each month. Stations are inspected regularly by Meteorological Office staff and their data are subjected to rigorous quality-control checks to ensure that standards are maintained.

The mean annual maximum (and minimum) temperature shown is the average of the highest (and lowest) air temperatures attained in each of the 10 years, and the number of days of air frost is the number of occasions on which the daily minimum air temperature was below 0°C.

Looking first at the mean annual maximum temperatures, it can be seen that stations with the highest values (Stirling, Paisley, Coatbridge, etc.) are all some distance from the coast and so in general do not experience the moderating influence which sea breezes can have on summer daytime temperatures. The lowest value (Earl's Hill) demonstrates the altitude effect on maximum temperatures, and comparison with the Stirling value implies a decrease of over 1°C per 100m increase in altitude.

Annual minimum temperatures are much more geographically complex. Lowest temperatures are achieved with light winds under clear skies, when heat can be lost readily by long-wave radiation from the earth's surface to space. Cold air is denser than warm air, so as the surface layer of air cools by radiation loss, it tends to flow down into any low-lying area, which accordingly experiences much lower temperatures than nearby elevated sites. Thus, the climatological station in the valley of the River Almond at Livingston experiences lower temperatures than other stations in Central Scotland, as does Kinross which is surrounded by hills.

It will be noted that the observing site at Paisley usually does not experience very low temperatures, largely because it is in the centre of an urban area. The urban fabric has a greater capacity than rural surroundings for heat absorption during the day and subsequent release at night and, also, the contribution of domestic and industrial heat in a densely-populated area is significant in keeping night-time temperatures up. It should be mentioned, however, that in weather conditions which are extremely favourable for night-time heat loss, temperatures can fall appreciably; a minimum temperature of -13.9°C was recorded at Paisley on the morning of 13th January 1979 — the lowest recorded there since 1895.

Surprisingly, the mean annual minimum temperature at Earl's Hill is of the same order as that measured at the two Stirling stations. In general, stronger winds at the hill-top level ensure that the surface layers of air are kept well-mixed with air from above, and so the persistent cooling of air near the surface is avoided. Also, when calm and clear conditions prevail, cold air can readily drain away down the hill, and so very low temperatures are unable to develop.

Coming now to the number of days of frost experienced at these stations, it can be seen at once that Earl's Hill has the highest frequency, as might be expected from its altitude, and Kinross also returns a high value, on account of its low-lying position relative to surrounding hills. The site at Paisley has only 35 days of frost on average, as a consequence of its urban surroundings.

It should be clear from the above discussion that variations of climate can occur on any space scale. Proximity to the coast and topography determine the basic pattern of spatial variation, which can be depicted on a small scale map in a reasonably coherent way, but then there is a superimposed variation due to immediately-local topography and nature of terrain, which cannot be so depicted, even on a large-scale map, because of the sparse nature of the observing network. In a country as topographically complex as Scotland, the precision with which we can formulate a numerical description of the climate at any point is less than we would wish. To meet the continuing demand for advice on climate because of its relevance to agriculture, the construction industry and energy consumption, there is a continuing need for high quality data to be gathered from as wide a range of sites as possible, so that in time a better quantitative understanding can be achieved of the relationships between a site's climate and its geographical and physical characteristics.

DIFFERENCES IN TIME

Turning now to differences in weather experienced from year to year, sunshine records taken from Paisley and Edinburgh for the popular holiday months of June to August illustrate the nature of the data. These stations began to record durations of bright sunshine in 1885 and 1900 respectively, and so show well the year-to-year variability which is a characteristic of a mid-latitude maritime climate. Other weather elements, such as temperature and rainfall, exhibit similar year-to-year variations.

Given the large variability evident in Figure 1, it is clearly very difficult to identify 'trends' in the record. A limited study of the summer sunshine values at Paisley over the 4 year period 1974-77 (or at Edinburgh during the period 1973-76) might have led to the injudicious conclusion that the summer climate of Central Scotland was subject to a rapid year by year improvement, but a glance at the climatic history since the beginning of the century surely emphasises the impossibility of identifying trends possessing any predictive potential. For most planning purposes, it is valid to consider the values as a statistical sample conforming closely to a normal distribution. This distribution predicts that 4.6% of values can be expected to lie more than 2 standard deviations away from the mean; in the period 1901-79, 5 such values at Edinburgh (1911, 1955, 1976 sunny and 1912, 1931 dull) and 3 at Paisley (1919, 1955 sunny and 1912 dull) were observed compared with the 'expected' number of 3.6.

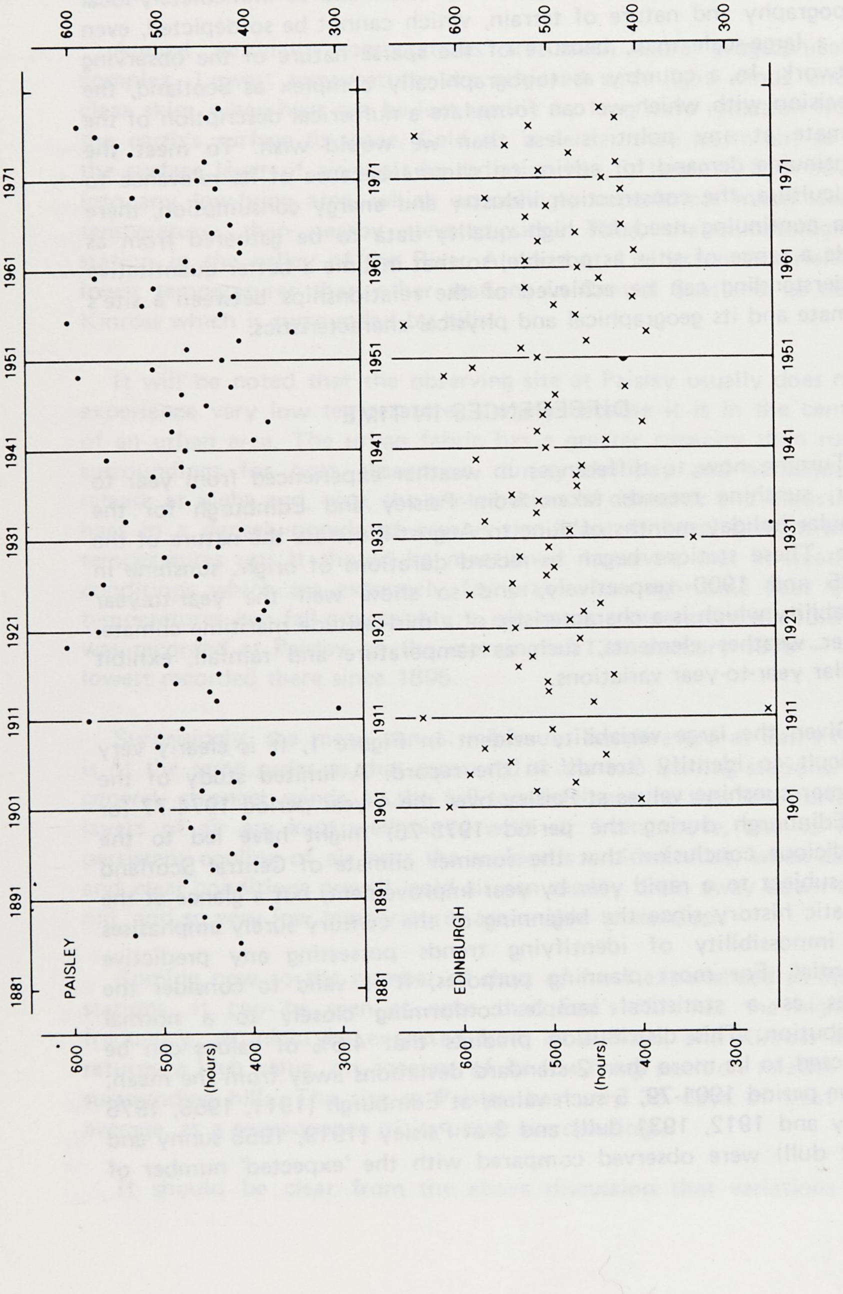

Figure 1 Durations of bright sunshire (hours) in the summer months (June to August) measured at Paisley (Coats Observatory) and Edinburgh (Royal Observatory, Blackford Hill).

Station	National Grid Reference	Altitude (metres)	Temperature (°C) mean annual: maximum	Temperature (°C) mean annual: minimum	Annual mean no. of days with air frost
*Abbotsinch (Glasgow Airport)	NS 480 667	5	27.4	−8.9	59
Ardtalnaig	NN 702 394	130	27.5	−6.8	54
Callander	NN 634 080	107	26.8	−8.5	73
Coatbridge	NS 712 643	78	(27.6)	−8.8	54
Drummond Castle	NN 841 177	113	(25.8)	(−9.1)	(76)
Earl's Hill	NS 725 882	335	24.7	−7.5	84
Falkirk	NS 902 820	3	26.5	−7.8	52
Glasgow (Springburn Park)	NS 608 686	107	27.1	−7.0	48
Kinross	NO 125 033	116	25.8	−10.5	82
Livingston	NT 035 659	125	(26.8)	(−11.0)	(74)
Paisley	NS 478 642	32	27.9	(−6.1)	35
Parkhead (Stirling University)	NS 812 972	107	(27.6)	(−7.5)	(53)
*Pitreavie	NT 117 848	40	25.9	−6.2	43
Perth	NO 101 239	23	27.1	−9.1	65
Sloy	NN 321 098	12	26.2	−7.1	41
Strathallan	NO 090 185	41	26.7	−8.4	61
Stirling	NS 786 925	38	28.1	(−8.0)	62
*Turnhouse (Edinburgh Airport)	NT 159 739	35	26.4	−9.3	58

*denotes Meteorological Office stations

TABLE 1 Temperature Data from Climatological Stations in Central Scotland

The reasonably high correlation between the two series (correlation coefficient of 0.78 over the period 1901-79) implies that the principal factor determining summer sunshine is a large-scale one affecting both Paisley and Edinburgh simultaneously. This can be identified as the presence or absence of persistent anticyclonic conditions giving clear skies over central Scotland. In the few years when conditions in the east and west are not similar (e.g. 1905, 1936, 1960, 1964, 1977), a secondary local factor can usually be recognised as overriding the primary one. For example, easterly winds from a cool North Sea may bring persistent seafog or *haar* to Edinburgh while Paisley experiences cloudless conditions.

A spell of a few years' weather particularly favourable for a specific activity may, paradoxically, result in economic loss in the longer term. It is clear from the nature of enquiries coming to the Meteorological Office that a series of mild winters or 'good' summers, for example, can lead to changes in procedure in practical fields such as the building industry and agriculture. It would seem that experience of a sequence of several mild winters in the early 1970s led to a relaxation by builders of precautions against frost damage to materials. Consequently, when winters became rather more severe again (1976/7 and subsequently), considerable losses were sustained because the relaxed protective measures proved inadequate. In agriculture, a run of sunny summers may perhaps lead farmers to expand grass/hay production in the expectation that the crop can easily be dried before storage. A subsequent return to average or dull summers may result in difficulties over crop drying and some consequent financial loss. In other words, the viability of a weather-sensitive enterprise may be dependent not only on the average conditions likely to be experienced but also on the variability from year to year.