

## THE WEATHER OF 1994

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History will probably record 1994 as a wet year as floods were an all too familiar feature, particularly in March which, for much of Scotland, was the wettest since records began. Local rivers overtopped their banks no less than four times within the month. The year finished with two wet months and over the weekend of 10th/11th December the Scottish football programme was largely washed out, and there was severe flooding in Glasgow. However, the VIMI was not entirely saturated, May being remarkably dry. As far as temperatures were concerned, spring and summer were generally rather cool and the growing season was late in getting under way. In sharp contrast, November and December were remarkably mild, the former being 3°C warmer than average.

*Temperature and rainfall values in the following refer to Parkhead unless otherwise indicated.*

**January.** Unsettled and wet.

Cold Arctic air affected Scotland over the first five days bringing snow to high ground. There was a spell of generally wet and windy weather until the 14th when the clouds cleared. Night temperatures fell below freezing and there were moderate frosts on the 15th, 16th and 17th, the air temperature falling to -4.5°C in Bridge of Allan by the morning of the 16th. There was a dramatic rise in temperature on the 18th and a persistent, and often very strong, westerly wind blew for the next six days. Blustery showers fell as snow, although none accumulated on ground below 500ft (152m). There was a brief respite on the 24th but gales and rain returned on the 25th. The wind veered towards the north on the 27th and temperatures were low in the Arctic air. Snow fell overnight but this lay to a depth of only 10mm in the Forth valley by the morning of the 29th. The wind backed to a milder south-westerly direction over the 29th and temperatures recovered a little by the end of the month.

**February.** Cold and dull.

Unsettled wet weather continued into February and 24.1mm of rainfall was recorded in Bridge of Allan over the first two days. By the 2nd, the Allan had overtopped its banks. There was a very strong easterly wind in central Scotland on the 3rd. The 9th and 10th were brighter but cloud and rain returned again on the 11th. After the 11th most of the British Isles was affected by a strong and bitterly cold easterly airstream, which persisted until the 18th. There were snow flurries on the 14th, but on the 15th the snow had become heavy and continuous, and the daytime temperature reached only 2.3°C. However, by the evening of the 15th the depth of snow was little more than 20mm on low

ground. No further snow fell but, as the clouds cleared, night temperatures fell very sharply and reached  $-9.5^{\circ}\text{C}$  by the morning of the 17th ( $-10.4^{\circ}\text{C}$  Bridge of Allan). The snow cover froze and lasted until the 18th when the cloud cover returned and improved night temperatures. Daytime temperatures, however, remained low, rising to only  $0.6^{\circ}\text{C}$  on the 20th. A cold continental easterly airstream became re-established from the 20th and snow began to fall again. However, central Scotland escaped the worst of the snow, which affected mainly northern England and southern Scotland. By the 25th, the Met Office was issuing severe weather warnings for Scotland and on the 26th several main roads were impassable in Grampian and Highland Regions. By the end of the month it was the wettest and dullest February since 1923 in parts of eastern and southern Scotland.

**March.** An exceptionally wet month.

The first two days were relatively calm but from the 2nd there was a protracted period of unsettled and exceptionally wet weather. After 18.2mm of rain had fallen on the 4th (20.8mm Bridge of Allan) the Allan was in flood by the 5th. The weather remained windy and very wet until the 8th by which time the Allan was in flood again for the second time within a week. While the wind remained in the south-west, temperatures remained relatively high and the night temperature only fell to  $7.7^{\circ}\text{C}$  in Bridge of Allan on the 7th/8th. Rain occasionally turned to sleet or snow in blustery showers but the snowline remained above 1000ft (305m) on the Ochil Hills. Rain fell again on the 12th and 13th (27.7mm) and the Allan was again in flood by the 14th. The wind veered westerly then north-westerly from the 15th bringing much colder weather with snow. The snowline on the Ochil Hills dropped to 100ft (31m) on the 16th but had retreated to 1500ft (457m) by the 19th, which was a bright and sunny day. There were moderate overnight air frosts between the 18th and 21st and the grass minimum temperature in Bridge of Allan fell below  $-5^{\circ}\text{C}$ . Heavy continuous rain fell from the late afternoon of the 22nd to mid-day on the 23rd, by which time the Allan was in flood for the fourth time in three weeks. The 25th and 26th were sunny and pleasantly warm days, reaching  $13.1^{\circ}\text{C}$  in Bridge of Allan. The interlude was, however, brief as wind and rain returned during the afternoon of the 27th. By the end of the month this had been the wettest March of the century in western Scotland.

**April.** Cool and unsettled.

Winds were generally fresh west to north-west for the first nine days. The weather was cold and rather unsettled during this period and heavy snow fell on the 4th. Rain on the 8th fell as snow above 500ft (152m). The 12th to 15th were sunny but the 16th and 17th were rather dull with some light drizzle at times. Between the 18th and 21st there were showers which fell as snow over the Grampians. After the following few days were mild with a fresh south westerly breeze and occasional rain. The end of the month was sunny and warm ( $16.0^{\circ}\text{C}$  Parkhead,  $17.6^{\circ}\text{C}$  Bridge of Allan).

**May.** Very dry and sunny.

The first day was sunny and warm but clouds in a mild south-easterly airstream deposited small quantities of orange dust in the Stirling area on the 2nd. The weather then remained unsettled until the 6th. There were heavy showers on the 8th with thunder in the late afternoon. The wind settled in the east from the 10th and temperatures rose in the relatively dry continental air, reaching 20.7°C in Bridge of Allan on the 14th. However, visibility was generally rather poor. The wind backed to north-easterly after the 18th resulting in a moderate ground frost (-3.2°C Bridge of Allan). The dry but fresh north-easterly persisted until the 24th. After this the remainder of the month was bright and sunny, but cool, in polar air. The wind freshened westerly towards the end of the month by which time there had been a continuous spell of 22 rainless days.

**June.** Mostly cool and cloudy.

A very warm southerly airstream affected the British Isles and on the 1st and 2nd, dust was deposited in light rain. There were spells of very heavy rain accompanied by thunder on the 3rd (19.8mm Bridge of Allan). The wind freshened westerly on the 4th which improved the visibility but occasional light rain fell over the next few days, with lengthy sunny spells. After the 10th there were three warm and sunny days, the air temperature reaching 25.0°C on the 13th. The daytime temperature fell to 17.6°C on the 14th and by the 16th the weather had reverted to an unsettled westerly pattern with mainly west to south-westerly winds and intermittent rain. Warm air from the south raised temperatures from the 27th when the temperature managed to reach 22.3°C but by the end of the month the daytime temperature had exceeded 20.0°C on only five occasions.

**July.** Warm but cloudy.

The weather was dominated by a warm but rather unsettled south-easterly airstream over the first eight days. The temperature reached 23.0°C on the 8th (24.0°C Bridge of Allan). There was intermittent rain in Scotland until the 15th, which saw the start of a spell of more settled weather. Although the temperature rose, reaching 24.5°C on the 20th (27.0°C Bridge of Allan), the relative humidity remained high, so the air was unpleasantly oppressive at times. There was cloud and rain on the 21st but the warm weather returned on the 22nd and persisted until the end of the month, although there were substantial falls of rain on the 25th (16.2mm) and 31st (9.6mm).

**August.** Cool and changeable.

Warm and humid weather continued over the first five days, but there were clearer fresher spells from the 6th. The overnight temperature fell to 3.8°C in Bridge of Allan by the morning of the 14th in a light north-westerly breeze. After the 16th the weather became cloudy with spells of light rain, but the skies cleared on the 20th. By the morning of the 24th 31.5mm of rain had fallen (27.0mm Bridge of Allan). The weather remained unsettled for the next three days, with occasional showers, but more protracted spells of heavy rain brought a further 27.9mm on the 27th/28th. Much of this fell in a torrential

downpour in the latter part of the morning of the 28th. This rain was very localised, which is indicated by the respective daily totals for Parkhead (21.6mm) and Bridge of Allan (11.2mm) for the 28th.

**September.** Cool and relatively dry.

The 1st and 2nd were bright sunny days but the 3rd was a dull and wet day (9.1mm). Between the 5th and 11th the weather was cloudy with heavy showers, which were accompanied by thunder on the 7th and 8th. By the 15th there were fresh to strong northerly winds and on the 17th and 18th night temperatures fell to 4.5°C (2.1°C Bridge of Allan). There were three warm sunny days from the 21st, the daytime temperature reaching 18.7°C. Aboyne on Deeside registered a remarkable 23.4°C on the 23rd.

**October.** Generally cloudy and cool.

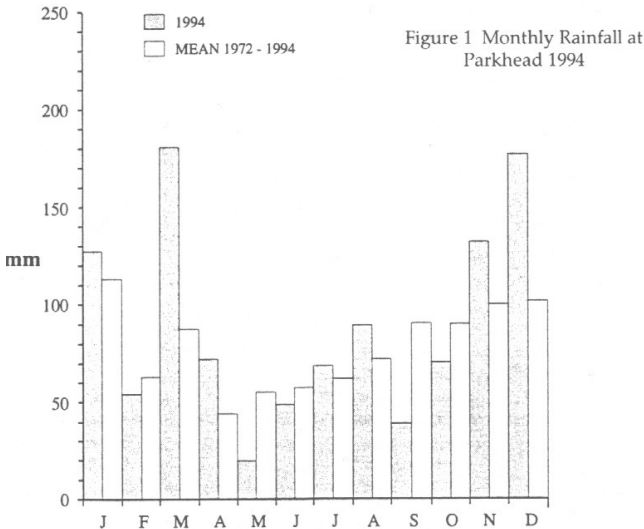
Over the first two days there were spells of heavy rain, then temperatures fell quickly on the 3rd in a strengthening northerly airstream. Under clearer skies the minimum temperature fell to -0.7°C by the morning of the 4th (-1.8°C Bridge of Allan), the first of the autumn frosts. The wind then backed to westerly which gusted to force 6 overnight on the 6th/7th. There was early morning fog every day between the 10th and 15th but this often cleared during the morning. The 11th and 12th were particularly warm and sunny (16.0°C). Scotland experienced a cool easterly run of air over the next three days and the daytime temperature reached only 8.8°C on the 17th. Wetter and windier weather dominated the remainder of the month and there was a 72hr rainfall total of 43.4mm (32.9mm Bridge of Allan) between the 20th and 22nd. As the sky cleared briefly a frost was recorded in Bridge of Allan on the morning of the 28th (Air -1.3°C, Ground -2.1°C).

**November.** Exceptionally warm and very wet at first.

The weather was dull with occasional rain from the 2nd to 4th and the daytime temperature reached an unseasonal 13.8°C in Bridge of Allan. A brief incursion of cold northerly air on the 5th reduced the temperature but by the 6th the warm but wet southerly airstream had returned. Heavy continuous rain began on the 11th and continued almost unabated until the afternoon of the 13th. This was replaced by heavy showers in a south-westerly wind which gusted to gale force overnight 13th/14th. The 4-day rainfall total (11th - 14th) was 54.5mm (45.8mm Bridge of Allan). A fresh showery westerly persisted until late on the 17th bringing yet more rain. A further 24.5mm was recorded on the 17th/18th. Scotland experienced an exceptionally mild south-westerly airstream until the 26th. The daytime temperature rose to 14.4°C on the 23rd having fallen to a remarkable overnight minimum of 12.0°C. The air then became calm and freezing fog formed during the evening of the 29th. The average air temperature over the month was more than 3.0°C higher than the long-term average and in most places it was the warmest November ever recorded.

**December.** Mostly mild and very wet.

A strong southerly airstream maintained mild but dull weather for two days. There was dense fog on the morning of the 5th but this gave way to rain, which became heavy in a blustery west wind by evening. Overnight rain had turned to snow by the morning of the 8th. The wind backed south-westerly on the 9th and the temperature increased very quickly early on the 10th. However, this was associated with very heavy and continuous rain which persisted until late on the 11th. The weekend's total rainfall amounted to 58.1mm in the Forth Valley but exceeded 115mm in Strathclyde Region. The Allan overtopped its banks, there was severe flooding in the Glasgow area, and the Scottish football programme was almost totally washed out. Temperatures fell very quickly in calm clear air after the 13th and there were moderate to severe frosts on the 14th and 15th. The daytime temperature reached only 3.7°C (1.7°C Bridge of Allan) on the 14th and freezing fog formed in the evening. Rain turned to sleet on low ground by the evening of the 18th. The snowline on the 19th was down to 400ft (122m) on the Ochil Hills. The minimum temperature on the 21st was -5.0°C (-6.0°C Bridge of Allan) after which the daytime temperature struggled to reach only 1.5°C. There was a lengthy spell of unsettled wet weather over the Christmas period. The 25th and 28th were particularly wet days (11.0mm; 13.5mm). However, the 27th was cold with persistent freezing fog all day. The air temperature was relatively low for much of the last ten days of the month in cold unstable Arctic air and hail fell in a thundery shower early on the 29th.



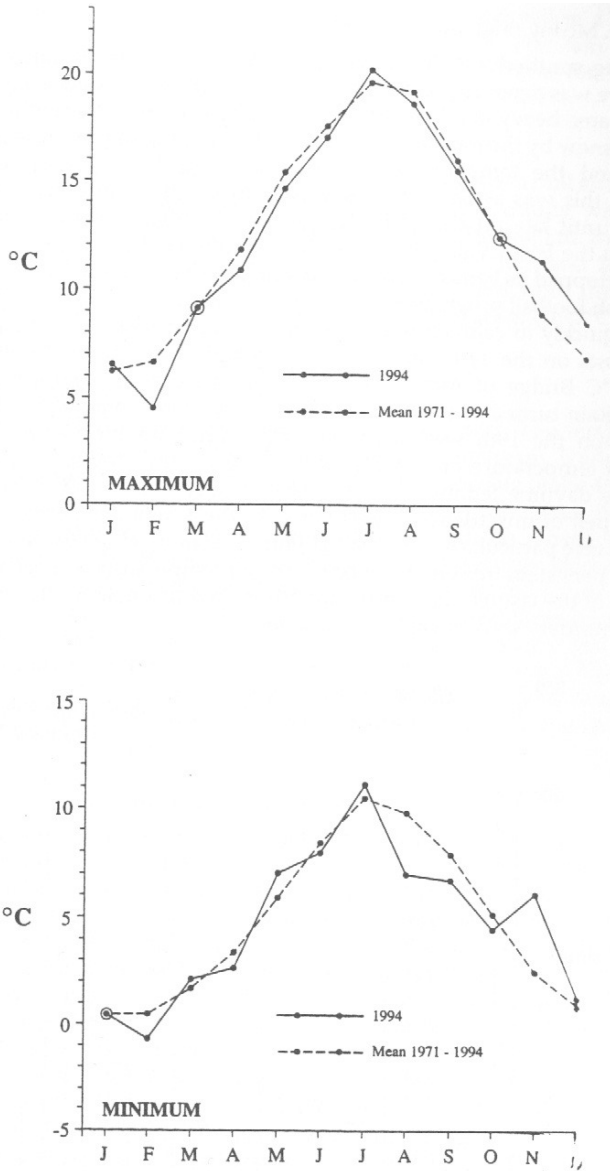


Figure 2. Air

Temperatures at Parkhead 1994

## NOTES

### Gales in Scotland January 23-27th

Severe gales affected Scotland on the 23rd, 24th and 26th of January as deep depressions moved quickly eastwards between Scotland and Iceland. On the 23rd the mean wind speed reached hurricane force (>33ms<sup>-1</sup>) on Shetland, and gusted to 60ms<sup>-1</sup> on the 24th when there was widespread damage to buildings and power lines. Gales returned on the 26th, when the wind gusted to 31ms<sup>-1</sup>. Trees were uprooted and there was some damage to buildings.

Wheeler, D., 1994. 23rd January - a stormy night on Fair Isle. *Climatology Observers Link Bulletin* 285 40.

### Dust falls in Bridge of Allan May 2nd and June 1st/2nd

Fine dust, which often originates in the Saharan area of Africa, frequently reaches the British Isles in Tropical continental air and is deposited in rainfall as a red or orange washout. The air is drawn in from the south or south-east as a depression and associated fronts approach the British Isles from the west and when there is a well-developed anticyclone over continental Europe. As rain falls from the advancing fronts it washes out the dust from the atmosphere. On May 2nd and June 1st the amount of dust deposited was relatively small.

### Exceptionally mild November

Many climatological stations throughout the British Isles registered the mildest November since their records began, with mean maximum and minimum temperatures 3.0°C above the long-term average. The indications from the Central England Temperature series are that it is necessary to go back to 1818 to find the next warmest November. Places as far north as Cumbria recorded no air frosts during the month. As a result of the mildness there was widespread out-of-season flowering of plants, and early spring growth, and midges seemed to enjoy the warmth. With the prospect of the damaging frosts of January and February yet to come, much of this early leaf growth would be lost, which could lead to eventual delays in spring leaf emergence and blossoming in spring 1995.

	Mean max	Diff.	Mean min	Diff.
Stornoway	11.0	+2.2	6.6	+3.3
Aviemore	10.5	+3.8	4.2	+3.4
Dyce	11.4	+3.1	4.7	+2.9
Leuchars	11.6	+2.9	5.3	+3.0
Abbotsinch	11.9	+3.0	6.7	+4.4
Eskdalemuir	9.8	+2.5	4.8	+3.8
Parkhead	11.7	+2.7	6.2	+3.7

Table 1: Monthly mean temperature for stations in Scotland and difference from the long-term average (Diff.). Temperatures are in degrees Celsius. From *Weather Log* November 1994 Royal Meteorological Society.

The underlying cause of the exceptional mildness was the persistence of a cloudy south-westerly airstream from the Azores. Not only was this relatively warm but the persistence of a cloud cover restricted heat loss from the ground at night. It is tempting to attribute this anomalous weather, together with the severe floods in western Europe early in 1995, to global warming but the case for this remains 'not proven'. What is clear is that recent winters have been associated with a more vigorous westerly airflow with its attendant mildness, cloudiness and variability, while cold continental easterly airflow has become a rarer visitor. While this could well be due to a global change in atmospheric pressure systems resulting from global warming, it could also be a part of the natural variability inherent in the complex relationship between atmosphere and ocean.

### Floods in Strathclyde Region December 10-13th

Rain entered Strathclyde Region from the south-west by 22.00 on Friday 9 December and over the following 54hrs up to 120mm had fallen over tl Glasgow area, of which more than 70mm fell on the 10th, which was a record 24hr total for Glasgow Airport. A warm front approached Scotland in the early hours of the 10th and by 06.00 heavy continuous rain was falling in freshening south-westerly wind, a cocktail which persisted unabated until the early hours of the 12th. The band of rain remained almost stationary over Strathclyde and was maintained by a supply of warm and very moist air from the south-west. The rain-shadow effect in the south-westerly wind was very marked, the Forth Valley receiving a little over 50% of the total received by Glasgow, although even this was sufficient to cause flooding.

The heavy rain hit an area with a long history of flooding, and warnings were issued by the police late on the 10th. By the early hours of the 11th, the Cart, Kelvin and Irvine had overflowed their banks and there was widespread flooding in Kirkintilloch, Irvine, Paisley, Johnstone and Beith. Many residents were forced to seek temporary accommodation in church halls and schools and more than 600 were homeless for at least two nights. Early estimates claims on insurance policies appear to suggest that the cost of the flood may run into many millions of pounds, added to which are the personal losses incurred by those residents who were not covered by insurance.

Date	Time	Rainfall (mm)	Total (mm)
9th	0900 - 2100	X	X
	2100 - 0900	9	9
10th	0900 - 2100	35	44
	2100 - 0900	37	81
11th	0900 - 2100	30	111
	2100 - 0900	7	118
12th	0900 - 2100	2	120
	2100 - 0900	X	120

Table 2: Rainfall recorded at Glasgow Airport between December 9th and 12th 1994  
From *Daily Weather Summary*, London Weather Centre .

Thousands of homes were left without electricity and many major roads were blocked by flood water. Parts of the tunnel carrying ScotRail's Argyle Line



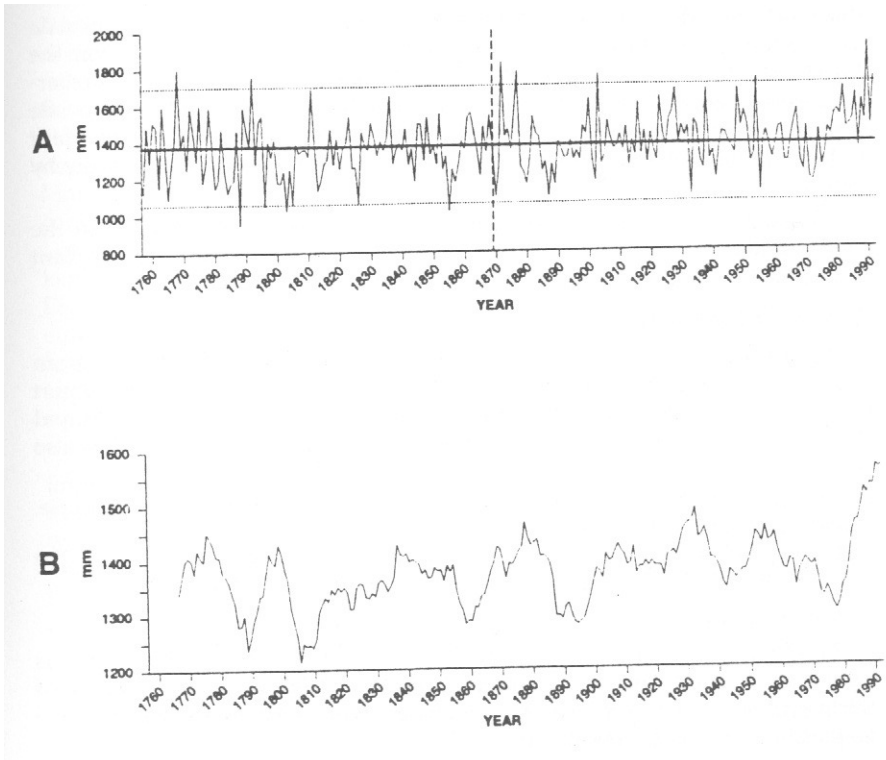
beneath Glasgow city centre were under 10ft of water (*Railnews* February 1995) and it would be several months before services were restored. An early-morning commuter train was abandoned by its passengers at Glasgow Central Low Level as the flood waters rose. Hundreds of tons of silt, sludge and debris were washed into the tunnel. As was the case with the Chichester flood in January, the expansion of the urban area of Glasgow was considered to have made a major contribution to the severity of the flooding.

Material for this brief report has been drawn from accounts published in the *Herald* and the *Scotsman*.

Figure 3 Annual precipitation (mm) over Scotland 1757-1992 (A) Individual values (B) ten-year running mean. (From Smith K Precipitation over Scotland, 1757-1992: some aspects of temporal variability *International Journal of Climatology* 15, 543-556).

**Temporal variability in precipitation in Scotland**

A 236-year time series (1757-1992) of monthly areal average precipitation



for Scotland (Figure 3) has been produced using records compiled by the Met Office. The series has been examined for fluctuations and extreme values, with particular reference to observed precipitation increases over the last two decades. There has been a recent trend towards higher winter precipitation. Spatial and temporal variation in snow-cover in the Scottish uplands

The distribution of snow-cover in the Scottish uplands has a considerable bearing on the ecology of these areas in addition to being a major influence on the viability of the skiing industry. Recent winters have shown a change from continental easterly to milder and more variable westerly weather patterns which affects the amount, duration, and character of snowfall. The spatial distribution of snowfall in upland areas is a result of the operation of several factors including altitude and topographic shelter, in addition to the direction of movement of snow-bearing weather systems. The relationship between snow accumulation and altitude is difficult to define because of a basic shortage of data. Values for the frequency of days on which snow is seen to be lying are available for most climatological stations but the majority of these lie at elevations below 400m. Estimates of snow cover duration for higher altitudes must, therefore, use some form of predictive model based on data from much lower altitudes. Topographic variation operates directly on the spatial variability of snow accumulation through its effect on the shelter-windspeed relationship. The location of persistent snow patches into late spring and early summer is a result of a complex balance between antecedent accumulations and ablation rates, the latter being affected in large measure by aspect.

Harrison, S. J., Sydes, C, Mordaunt, C. and Dawber, M. Changes in the snow climate of the Scottish mountains and their effect on alpine plant communities (in preparation).

### **Climate of Central Scotland**

An analysis of available climatological data for Central Region has been published as a contribution to a wider study of Central Scotland. The report considers air temperature, rainfall, sunshine, frost, fog and wind speed and direction. A brief description of climatic conditions in the Ochil Hills has also been published.

Harrison, S. J. 1994. Climate in: Corbett L. (Ed) Central Scotland - land, wildlife, people.

Forth Naturalist & Historian. Harrison, S. J. 1994. Climate/Weather In: Corbett L, Roy E. K. and Snaddon, R. C. The Ochil Hills. Forth Naturalist & Historian/Clackmannanshire Field Studies Society.

### **Acknowledgment**

This paper is a summary of the more comprehensive report which is published in the Annual Climatological Bulletin No.16 of the University of Stirling, copies of which can be purchased from Climate Services in the Department of Environmental Science.