THE CLIMATE OF GREAT BRITAIN

PENNINES AND LAKE DISTRICT

Climatological Memorandum 128

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The front cover shows a view of England and Wales from satellite Tiros N taken at 1518 GMT on Wednesday 2 April 1980 – photograph by courtesy of the Department of Electrical Engineering and Electronics, University of Dundee.

An anticyclone was situated to the south-west of the British Isles and a showery north-westerly airstream covered Britain. The alignment of the clouds with the surface wind is clearly seen. The Pennines and Lake District had a few rain or hail showers with isolated thunderstorms. Most places had around 8 hours of sunshine and maximum temperatures of about 10 °C but with lower values over the high-ground areas.

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INTRODUCTION

This memorandum is one of a series which will cover the whole of Great Britain and seeks to present the main features of the climate of the area in a form suitable for use in schools and by members of the general public.

There is an Introduction to the series (Climatological Memorandum 113) which explains how the various weather elements are measured and defines some of the more common terms.

Industrial and commercial interests who are concerned with meteorological information for planning and design will probably require more complex analyses of the available data, and details of the services offered by the Meteorological Office to meet those needs are given on page 18.

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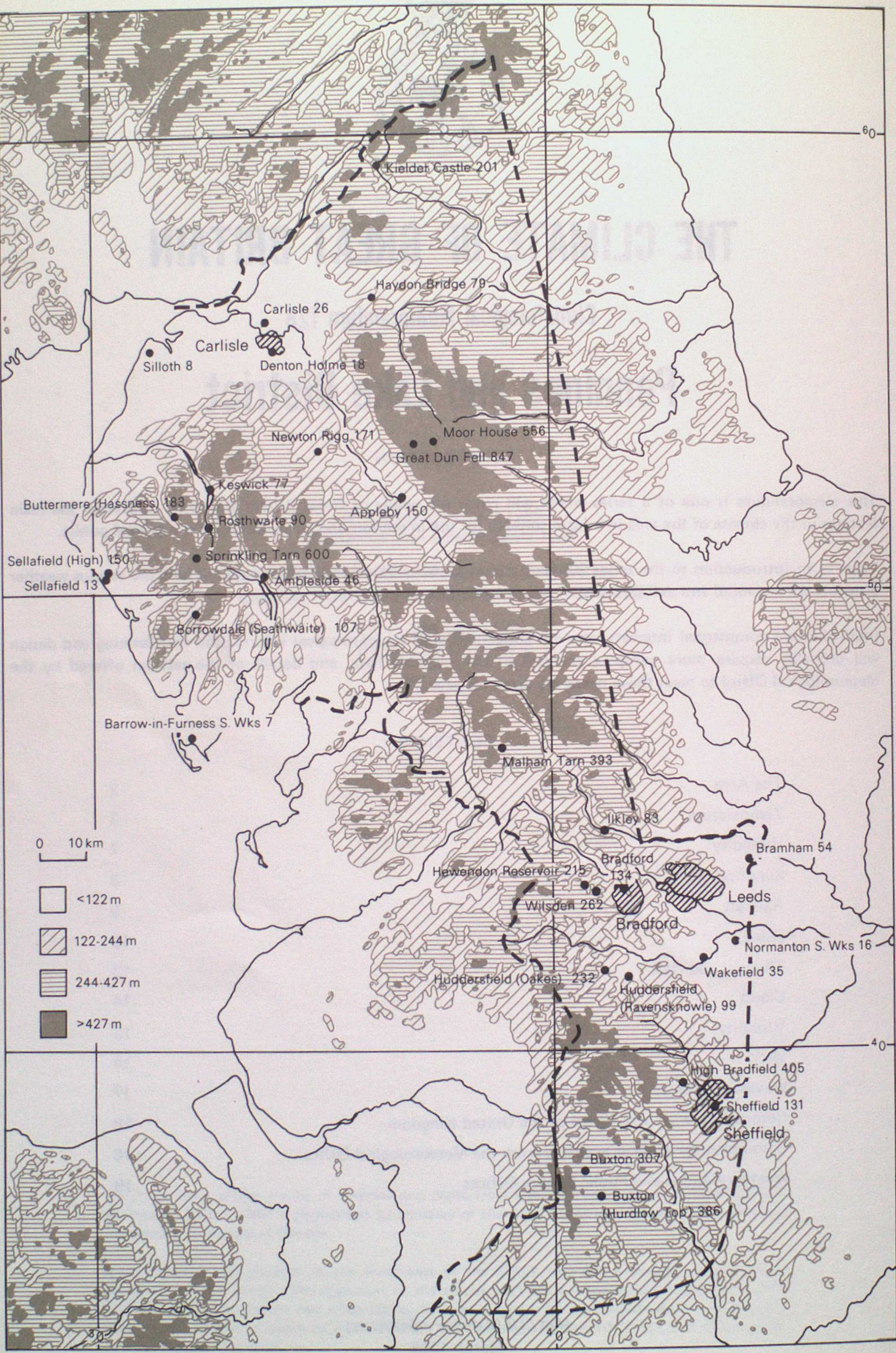
Met O 3 (Advisory Services)
March 1988

Topography of the area giving locations and altitudes (in metres) of the stations. Co-ordinates are national grid references.



THE AREA

This memorandum describes the main features of the climate of the Pennines and the Lake District. The area consists of Cumbria, West Yorkshire and parts of Northumberland, Durham, North Yorkshire, South Yorkshire, Derbyshire and Staffordshire.

The Pennines are a chain of plateaux which extend from the Tyne Valley to the Peak District, varying in width from around 30 to 65 kilometres. They rise to well over 600 metres, reaching their highest point at Cross Fell, 801 metres, in the northern Pennines. Scafell, 979 metres, in the Lake District, is the highest mountain in England. The Lake District is joined in the south-east to the Pennines at Shap Fell. To the north of the Pennines are the Cheviot Hills with peaks over 600 metres. The only low-ground areas, below 60 metres, are the Solway Plain and the Vale of Eden around Carlisle, coastal areas of Cumbria and an area east of the Pennines from Leeds southwards to the Sheffield area.

The Pennines form a natural barrier to east-west communications, but there are two important valley routes. In the north of the area is the Tyne gap which links Newcastle to Carlisle, and roughly central is the Aire gap which links the industrial areas of Yorkshire and Lancashire. There are also railway links through the Pennines and the M62 motorway linking West Yorkshire and the Greater Manchester area. In the lowland areas there is mixed farming and on the lower hill slopes stock raising and hill sheep farming. The higher ground is of little agricultural value.

The part of the area to the east of the Pennines lies on the western flank of the Yorkshire, Nottinghamshire and Derbyshire coalfield, which is the largest coalfield in Britain. Sheffield's importance stems from the growth of the iron and steel industry. With the presence of local ironstone as well as coal, a thriving cutlery industry developed. Today the raw materials are imported and the steel is made in electrical furnaces. Leeds, situated on the River Aire, is the largest centre for the ready-made clothing industry in the world.

The map shows the topography of the area and the locations of the climatological and rainfall stations for which data are given in this memorandum.

Carlisle is the only 24-hour reporting station in this area. Consequently, for a number of weather elements it is the only location for which data are available.

TEMPERATURE

The mean annual temperature over the area depends very much on the altitude of the location. Over the lower-lying parts the mean annual temperature is around 9.5 °C with an approximate decrease of 0.5 °C for each 100-metre increase in altitude. Over the British Isles mean annual temperatures over low ground range from about 7 °C in Shetland to over 11 °C in the extreme south-west of England and the Channel Islands.

Temperature shows both seasonal and diurnal variations. January is on average the coldest month with mean daily minimum temperatures ranging from about 1.5 °C around the coasts of Cumbria to zero or just below at some inland locations. These figures compare with −1.0 °C in parts of Tayside and Grampian to over 5.5 °C in the Isles of Scilly. Mean daily minimum temperatures also decrease by approximately 0.5 °C for each 100-metre increase in altitude.

Minimum temperatures normally occur around sunrise and extreme minimum temperatures usually occur in January or February, though some locations in the Pennines and the Lake District have recorded extremes in December or March. The lowest known temperature recorded in the area was −21.1 °C at Ambleside on 21 January 1940. For England and Wales the lowest temperature was −26.1 °C recorded at Newport, Shropshire on 10 January 1982.

Mean daily maximum temperatures are highest in July and range from about 18 °C around the Cumbrian coasts to 20 °C at some inland locations. Once again there is an approximate decrease of 0.5 °C for each 100-metre increase in altitude. The highest mean daily temperatures in the British Isles of 22.5 °C occur in the London area and the lowest of 15 °C in Shetland.

Maximum temperatures normally occur two to three hours after midday and extreme maximum temperatures usually occur in July or August but occasionally in June or September. The highest known temperature recorded in the Pennines and the Lake District is 33.3 °C, which has occurred on several occasions — see Table 10 for details.

The variation of mean maximum and mean minimum temperatures, together with extreme temperatures recorded at four locations in the area, are shown in Figure 1. There is a marked similarity between the curves of mean values but more variation in the extremes, which reflects the differing topographical features of the locations as well as the periods over which the data have been recorded. A comparison of the data for Buxton, 307 metres, and Kielder Castle, 201 metres, shows that Buxton has lower mean maximum temperatures but higher mean minimum temperatures. This is because Buxton is situated on a hillside and Kielder Castle at the bottom of a valley, and cold air tends to drain away from high ground and collect in valleys and hollows.

FIGURE 1 Annual variation of maximum and minimum temperature over the period 1951–80 with extreme temperatures for periods up to 1983

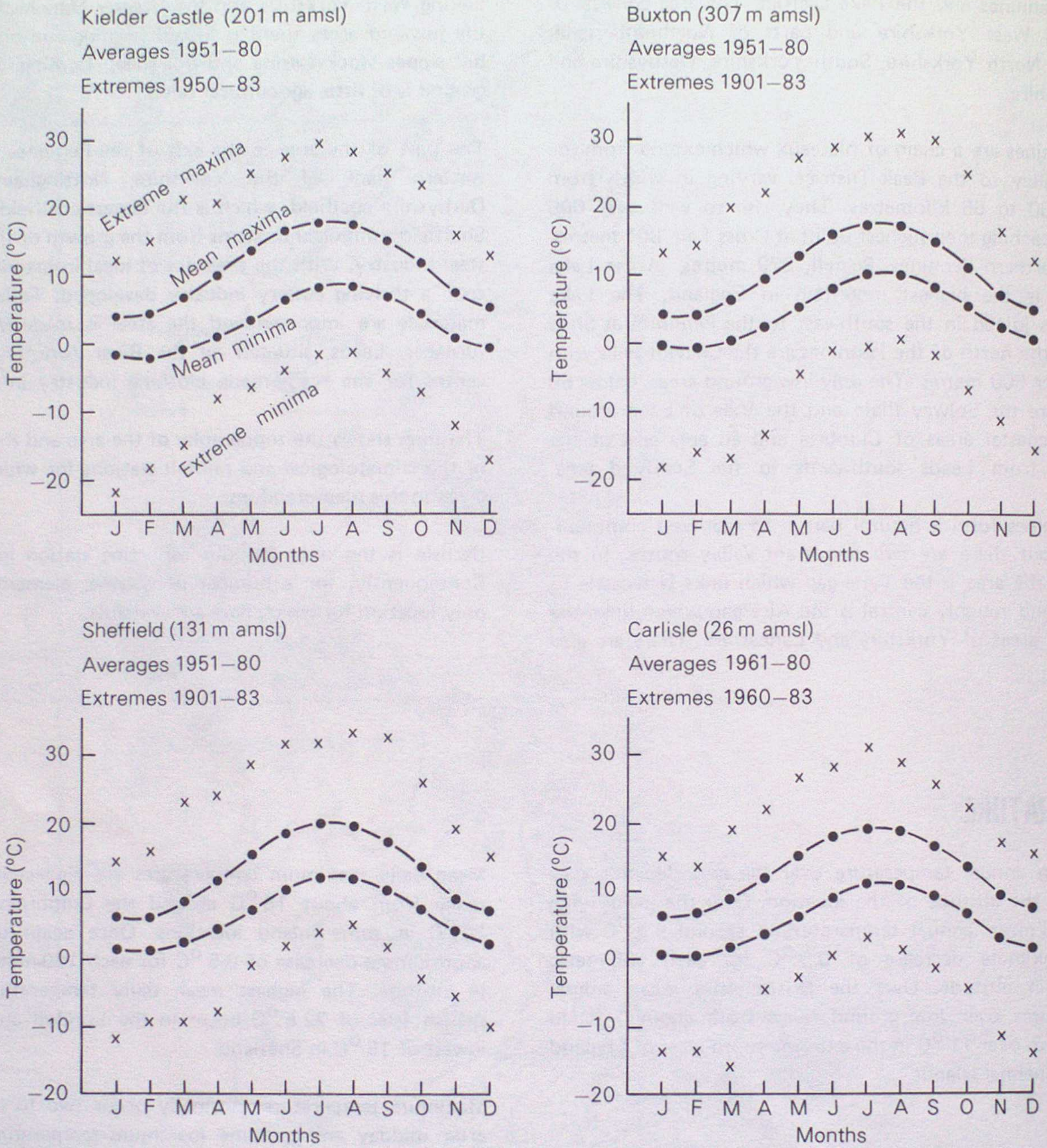


Table 1 gives the average number of days during 1961–80 that maximum and minimum temperatures at Moor House and Bradford occurred in the ranges specified. The most striking feature of the table is the wide range of maximum and minimum temperatures that can occur at any time of the year. Moor House has significantly lower temperatures than Bradford, due to its much greater altitude.

The great range of heights in the Pennines and the Lake District means that there is a wide range in the number of days on which frost occurs. The average number of days of air frost varies from about 40 along the Cumbrian coasts to over 150 on the higher peaks. For ground frost the average number of days varies from around 80 to over 170. Figure 2 gives the average number of days of air and ground frosts for four locations in the area. The data show the general increase in the incidence of frost with height. See also the Introduction to the series.

Days of frost vary widely from year to year; for example, Bradford recorded only 18 air frosts during the whole of 1974 but 28 in January 1979 alone.

Table 2 gives the average number of days temperatures exceeded certain limits at five locations in the Pennines and the Lake District. The variations between the five sites are due to their different altitudes and geographical locations.

TABLE 1 **Average number of days with maximum and minimum temperatures in the ranges specified for the period 1961–80**

Moor House

Maximum temperatures

Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
−3.1 or less	1.5	1.9	0.5								0.2	0.7	4.8
−3.0 to −0.1	6.1	6.1	4.1	0.5							2.0	4.3	23.1
0.0 to 2.9	11.2	10.1	9.1	4.1	0.2	0.1				0.4	7.3	11.5	54.0
3.0 to 5.9	8.2	6.8	9.9	7.9	2.0	0.2			0.2	3.1	8.8	7.5	54.6
6.0 to 8.9	3.8	3.3	5.9	9.7	10.1	2.1	0.3	0.1	3.5	10.9	8.7	6.4	64.8
9.0 to 11.9	0.1	0.2	1.3	5.1	10.1	8.1	5.2	5.8	11.2	10.8	2.9	0.6	61.4
12.0 to 14.9			0.1	2.0	5.5	8.7	12.2	13.3	10.4	4.4	0.1		56.7
15.0 to 17.9			0.1	0.5	2.1	6.2	9.3	7.4	3.8	1.2			30.6
18.0 to 20.9					1.0	3.7	2.6	3.0	0.8	0.3			11.4
21.0 to 23.9					0.1	0.9	1.2	1.1	0.1				3.4
24.0 to 26.9						0.1	0.2	0.3					0.5

Minimum temperatures

Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
−15.1 or less	0.3	0.3	0.1										0.7
−15.0 to −12.1	0.5	0.7	0.3									0.5	1.9
−12.0 to −9.1	1.9	1.8	0.7	0.1							0.4	1.2	6.0
−9.0 to −6.1	3.5	3.7	2.5	1.4	0.1						2.2	3.7	17.1
−6.0 to −3.1	5.2	5.2	5.0	3.5	1.3	0.2			0.1	0.9	4.1	4.8	30.3
−3.0 to −0.1	10.6	9.5	13.2	10.2	5.3	0.9	0.3	0.3	1.6	2.8	8.4	10.1	73.2
0.0 to 2.9	7.3	6.1	7.7	10.3	10.8	4.7	2.5	2.1	3.9	7.1	9.4	8.3	80.2
3.0 to 5.9	1.6	0.9	1.6	3.9	10.3	9.5	6.9	5.9	7.1	11.5	4.3	2.3	65.7
6.0 to 8.9	0.1		0.1	0.5	3.1	12.0	14.3	14.6	12.8	7.1	1.3	0.2	65.9
9.0 to 11.9					0.2	2.6	6.0	7.1	4.5	1.6			22.0
12.0 to 14.9						0.1	0.9	1.0	0.1				2.1
15.0 to 17.9							0.1						0.1

Bradford

Maximum temperatures

Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
−6.0 to −3.1												0.1	0.1
−3.0 to −0.1	1.1	1.1	0.1								0.1	0.9	3.1
0.0 to 2.9	7.3	5.9	2.5	0.3							1.5	4.9	22.3
3.0 to 5.9	8.7	8.1	6.5	1.9	0.1					0.1	4.9	9.1	39.3
6.0 to 8.9	8.7	8.4	9.9	8.0	1.2				0.1	2.3	11.1	8.4	58.1
9.0 to 11.9	4.9	4.3	9.6	10.0	6.3	1.1			1.5	9.3	8.7	6.3	61.9
12.0 to 14.9	0.3	0.5	1.8	6.5	11.5	5.5	2.4	1.6	7.6	11.8	3.1	1.3	53.8
15.0 to 17.9			0.5	2.7	7.5	10.9	12.1	13.3	13.3	6.7	0.6	0.1	67.7
18.0 to 20.9			0.1	0.7	2.7	6.9	9.5	9.8	6.0	0.7			36.4
21.0 to 23.9			0.1	0.1	1.5	4.0	5.1	4.1	1.4	0.3			16.6
24.0 to 26.9					0.1	1.5	1.5	1.6	0.2				4.9
27.0 to 29.9						0.2	0.3	0.5					1.0
30.0 to 32.9								0.1					0.1

Minimum temperatures

Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
−12.0 to −9.1	0.3	0.1											0.5
−9.0 to −6.1	1.3	0.8	0.3								0.1	1.1	3.6
−6.0 to −3.1	3.1	2.7	0.8	0.1							0.9	2.7	10.4
−3.0 to −0.1	7.1	7.1	6.8	2.7	0.3					0.5	4.9	6.3	35.8
0.0 to 2.9	11.2	10.1	12.9	8.7	2.6	0.2			0.6	3.3	8.9	10.2	68.7
3.0 to 5.9	6.0	5.9	7.9	12.3	9.2	2.3	0.2	0.7	2.6	7.1	8.7	6.9	69.8
6.0 to 8.9	1.9	1.3	2.1	5.3	14.9	10.5	5.2	4.8	8.7	12.1	5.1	3.7	75.8
9.0 to 11.9	0.1	0.1	0.1	0.8	3.7	12.4	14.4	14.7	12.5	6.7	1.5	0.2	66.9
12.0 to 14.9					0.3	4.3	9.7	9.4	5.3	1.3			30.4
15.0 to 17.9						0.2	1.5	1.5	0.2				3.5

FIGURE 2 **Average number of days with air frost (hatched areas) and ground frost (whole columns) for the period 1961–80**

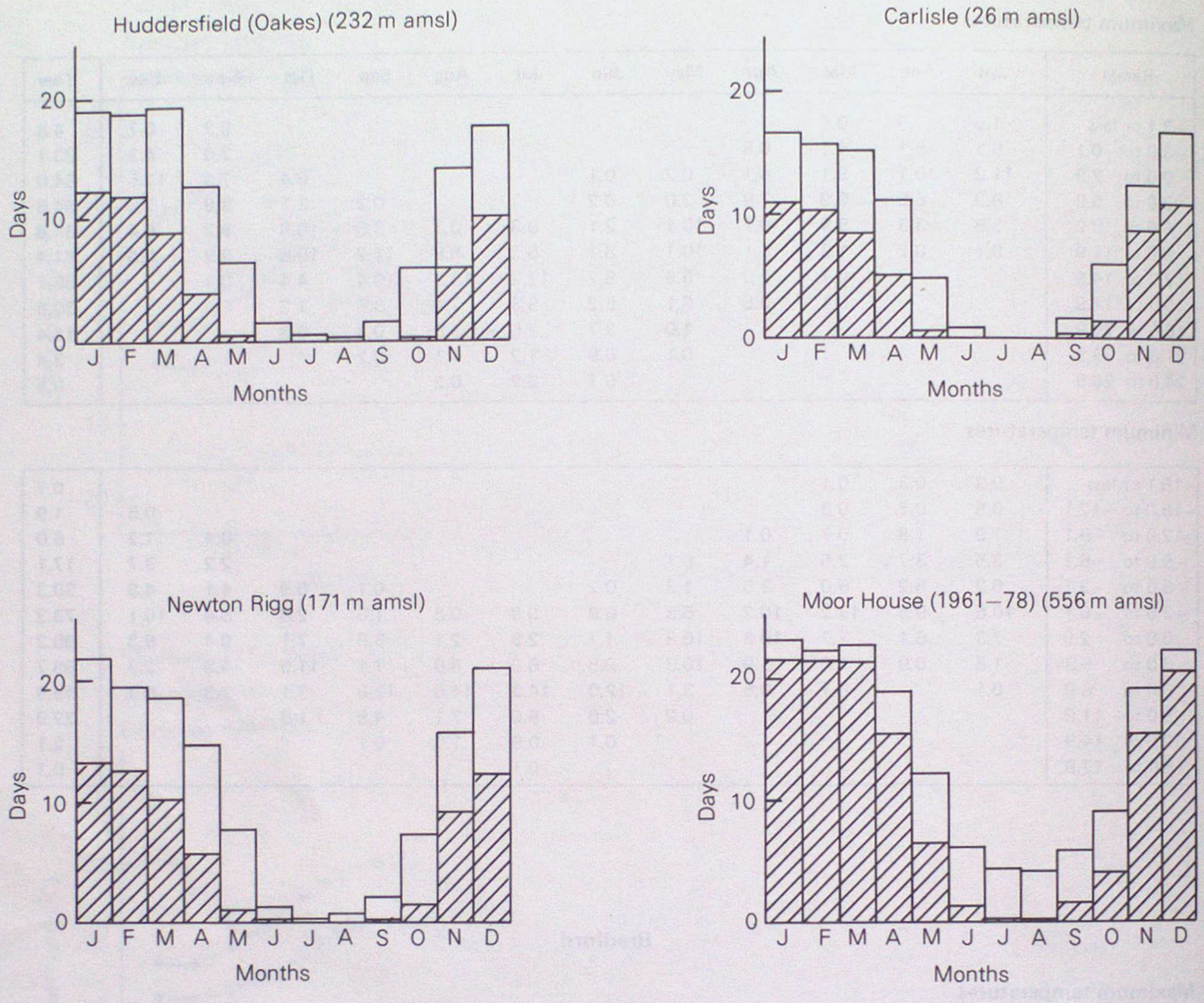


TABLE 2 **Average number of days (1961–80) with maximum and minimum temperatures exceeding the specified limits at selected sites**

Maximum temperature	**25 °C or more**						**30 °C or more**		
	May	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Jun**	**Jul**	**Aug**
Carlisle	0.1	1.7	1.3	1.3	0.1			0.1	
Sheffield	0.3	2.3	2.5	3.0	0.3	0.1	0.1	0.1	0.3
Ilkley	0.2	1.7	1.9	1.9					0.1
Malham Tarn		0.1	0.3	0.3					
Kielder Castle	0.1	0.5	0.9	0.7	0.1				

Minimum temperature	**–5 °C or less**								**–10 °C or less**				
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Carlisle		1.0	2.3	2.9	2.4	0.7			0.1	0.1	0.5	0.1	0.1
Sheffield		0.1	0.8	1.3	1.1	0.3	0.1						
Ilkley		0.3	2.2	3.0	1.8	0.7	0.1			0.1	0.3	0.1	0.1
Malham Tarn		1.1	2.7	3.9	3.5	1.5	0.5				0.1	0.1	0.1
Kielder Castle	0.1	2.9	4.8	5.7	5.7	3.2	1.3	0.1	0.1	1.0	1.6	1.2	0.6

HUMIDITY

Relative humidity is a measure of the amount of water vapour in the air compared with the maximum amount which could be contained by air at the same temperature, expressed as a percentage. If the amount of water vapour in the air remains constant then as the temperature rises (or falls) the relative humidity decreases (or increases).

Relative humidity averages about 85 per cent over the year in the Pennines and the Lake District with higher values occurring in the winter and by night. This is primarily a reflection of the seasonal and diurnal temperature changes. Relative humidity equals or exceeds 95 per cent for around 15 per cent of the time on the Solway Plain to over one-third of the time over the higher-ground areas. One hundred per cent can be reached in fog and persistent rain, snow or drizzle. Low humidities are less common as Figure 3 shows; this gives the percentage of time in the period 1971–80 that relative humidities in the stated 5 per cent ranges occurred at Carlisle. The lowest relative humidity ever recorded in Great Britain was 4 per cent at both Great Dun Fell and Manchester Airport on 29 March 1965.

Figure 4 shows the diurnal variation of relative humidity and temperature at Carlisle for the months of January and July over the period 1971–80; this illustrates a number of points made in the text.

FIGURE 3 **Percentage of the time humidity in specified ranges occurred at Carlisle over the period 1971–80**

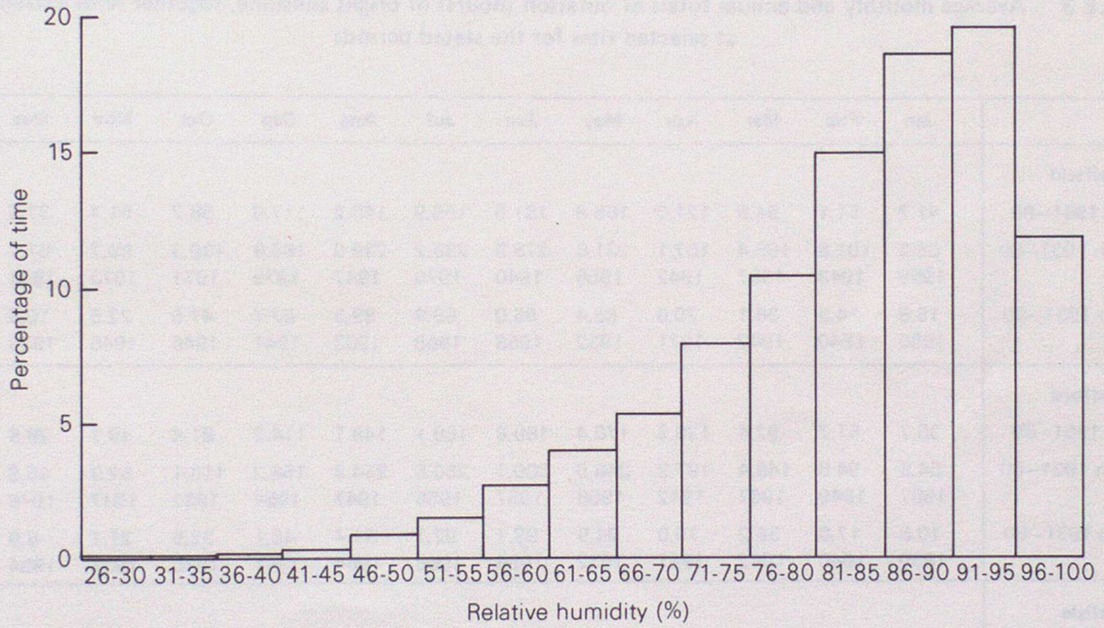
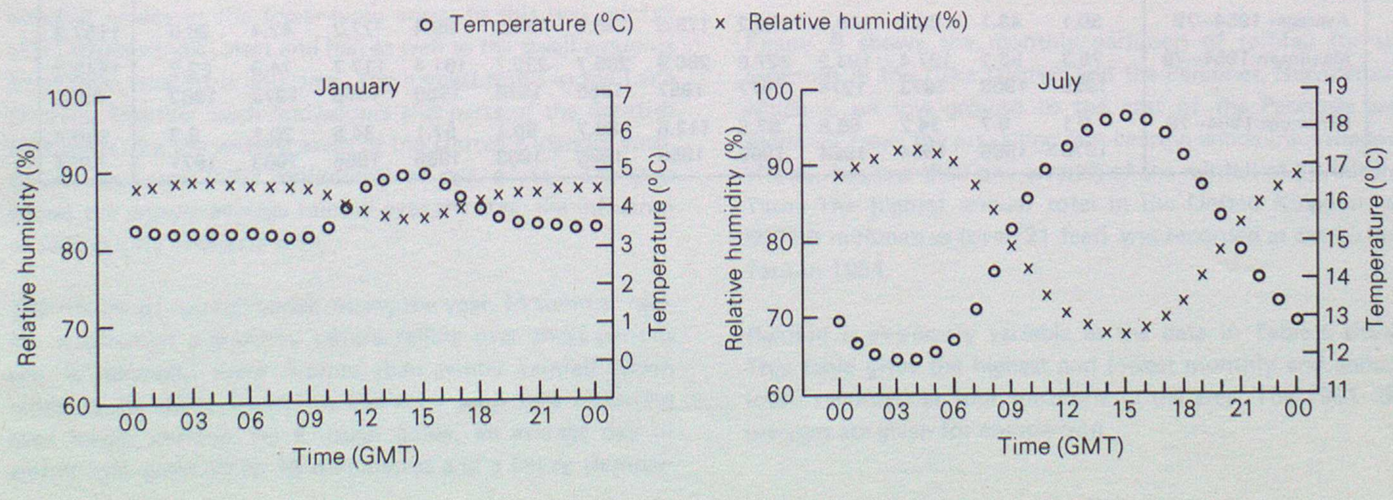


FIGURE 4 **Average diurnal variation of temperature and relative humidity at Carlisle for January and July over the period 1971–80**



SUNSHINE

The variation in length of day throughout the year means that the duration of sunshine shows a marked annual variation. On average December is the month with least sunshine and June is the sunniest. In general, sunshine amounts decrease with increasing latitude and altitude though aspect plays an important role, for example, the difference between north and south facing locations. Industrial pollution and smoke haze can reduce sunshine amounts.

Over the Pennines and the Lake District the average annual sunshine totals vary from 1500 hours or more along Cumbrian coasts to less than 1000 hours over the higher ground. Locations to the east of the Pennines average around 1250 hours per year. The sunniest place in Great Britain is St. Helier, Jersey with an annual average over the period 1951–80 of 1928 hours, and the least sunniest, at low altitudes, is Shetland, with less than 1100 hours.

Table 3 lists the average monthly and annual sunshine totals for four locations in the area plus the extreme values recorded. The highest and lowest monthly totals recorded in the area are 312.8 hours at Sellafield in July 1955 and 1.7 hours at Great Dun Fell in December 1971. This latter figure is not the lowest for Great Britain, for in December 1890 at Westminster no sunshine at all was recorded.

The average numbers of days each month that sunshine durations occurred in the ranges specified at Carlisle and Moor House are given in Table 4. The high altitude of Moor House means that it has fewer sunny days and more sunless days than Carlisle throughout the year.

TABLE 3 Average monthly and annual totals of duration (hours) of bright sunshine, together with extreme values, at selected sites for the stated periods

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Sheffield													
Averages 1951–80	41.7	51.1	94.5	121.0	165.8	181.5	159.9	148.2	117.8	88.2	51.4	37.6	1258.8
Maximum 1931–80	68.2	101.8	165.4	182.1	231.6	278.9	285.2	239.0	166.9	139.3	89.7	61.3	1487.7
	1959	1943	1967	1942	1956	1940	1976	1947	1979	1971	1973	1964	1949
Minimum 1931–80	15.8	14.3	36.1	70.0	86.4	95.0	69.9	88.5	62.7	47.5	22.5	10.9	987.7
	1950	1940	1942	1971	1932	1958	1968	1963	1941	1946	1946	1933	1968
Bradford													
Averages 1951–80	35.7	51.7	92.4	129.3	170.4	180.8	158.1	148.1	114.2	81.4	49.7	28.6	1240.3
Maximum 1931–80	54.5	94.6	146.4	197.2	248.5	300.1	250.6	254.8	158.2	115.1	82.9	45.8	1527.4
	1967	1949	1967	1942	1956	1957	1955	1947	1954	1931	1947	1976	1949
Minimum 1931–80	10.6	17.0	35.2	75.0	94.9	98.1	92.7	91.4	46.1	32.5	21.1	8.8	1020.4
	1950	1940	1942	1941	1932	1958	1968	1954	1941	1976	1931	1934	1937
Carlisle													
Averages 1961–80	48.4	74.3	101.6	148.4	183.8	191.7	163.5	164.4	113.7	93.5	62.8	47.4	1393.6
Maximum 1961–80	66.7	125.7	129.0	204.9	250.8	278.3	242.4	255.4	160.8	125.9	89.3	64.9	1666.9
	1963	1975	1965	1974	1975	1975	1976	1976	1963	1972	1965	1967	1975
Minimum 1961–80	26.9	28.6	58.2	105.1	119.2	140.5	120.9	117.6	74.5	59.8	35.3	25.4	1258.1
	1966	1980	1964	1967	1976	1980	1979	1963	1965	1974	1963	1969	1978
Moor House													
Averages 1954–79	30.1	48.1	82.2	118.3	164.2	178.9	148.7	139.0	99.4	77.2	42.4	28.6	1157.2
Maximum 1954–79	75.3	83.2	127.4	193.2	227.8	286.9	285.7	239.7	161.4	117.7	74.9	62.2	1543.7
	1959	1968	1973	1974	1977	1957	1955	1976	1959	1956	1973	1962	1955
Minimum 1954–79	9.1	9.7	34.2	65.8	97.5	112.6	85.7	80.1	57.1	34.5	20.1	9.3	990.3
	1975	1966	1964	1964	1969	1958	1968	1963	1965	1968	1963	1971	1954

TABLE 4 Average number of days of sunshine duration at Carlisle and Moor House during the stated periods

(Frequency of occurrence in each 3-hour band in each month)

Duration (Hours per day)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Carlisle 1961–80													
Nil	12.5	7.7	6.3	3.3	2.3	2.3	2.4	3.1	3.7	6.5	9.1	11.3	70.5
0.1 to 3.0	11.5	10.2	10.7	8.9	8.1	6.7	10.1	8.5	11.3	11.4	11.5	12.8	121.5
3.1 to 6.0	5.2	5.7	6.9	5.7	6.9	6.7	6.9	6.5	6.3	6.9	7.3	5.9	76.9
6.1 to 9.0	1.8	4.3	5.4	6.5	5.0	5.5	5.1	6.5	5.7	5.5	2.2	0.9	54.5
9.1 to 12.0		0.4	1.7	4.6	4.8	3.7	3.2	3.8	2.9	0.7			25.6
12.1 or more				1.0	3.9	5.1	3.3	2.8	0.1				16.3
Moor House 1961–79													
Nil	17.5	12.1	7.8	4.9	3.4	2.2	2.8	3.8	5.5	7.5	11.6	17.3	96.4
0.1 to 3.0	9.5	9.9	12.5	11.0	9.2	8.3	11.4	9.8	12.1	12.9	12.7	9.4	129.0
3.1 to 6.0	2.9	3.9	5.2	6.3	7.2	7.6	7.2	7.5	6.6	6.7	4.0	3.8	69.0
6.1 to 9.0	0.9	2.1	4.2	4.1	4.7	4.0	3.4	4.3	3.3	3.2	1.7	0.4	36.5
9.1 to 12.0		0.3	1.3	2.9	3.4	3.2	2.8	3.9	2.4	0.7			20.8
12.1 or more				0.7	3.2	4.7	3.3	1.7	0.1				13.5

RAINFALL

The distribution of rainfall over the United Kingdom is very much influenced by topography with the largest values occurring over the more mountainous regions and the smallest values in the lower-lying areas. In this text rainfall also includes snow, sleet and hail as well as the small amounts from dew, hoar-frost and rime. The highest peaks in the Lake District, together with Snowdonia and parts of the Scottish Highlands, are the wettest areas of the United Kingdom with, on average, over 3200 millimetres of rain a year. The map shows the annual average rainfall over the area; the influence of topography is clearly seen.

The nature of rainfall varies during the year. In summer rainfall is often of a showery nature falling over short periods and is normally more intense than winter rainfall which tends to be more frontal in character with falls occurring over longer periods. As a rough guide, an average day of steady rain gives 10 to 15 millimetres and a heavy thunderstorm lasting an hour or so 25 to 50 millimetres: 25 millimetres are equivalent to about 200 tonnes of water on a football pitch.

Figure 5 shows the monthly variation of rainfall for six locations in the Lake District and the Pennines. Normanton, which is on low ground to the east of the Pennines and sheltered from the prevailing rain-bearing winds (rain-shadow effect), has less than one-seventh of the rainfall of Sprinkling Tarn. The highest annual total in the United Kingdom of 6527.8 millimetres (over 21 feet) was recorded at Sprinkling Tarn in 1954.

Rainfall is extremely variable as the data in Table 5 show. This table gives the highest and lowest monthly and annual totals recorded at four locations in the area. The 1951–80 averages are given for comparison.

Average annual rainfall (mm) over the period 1941–70. Co-ordinates are national grid references.

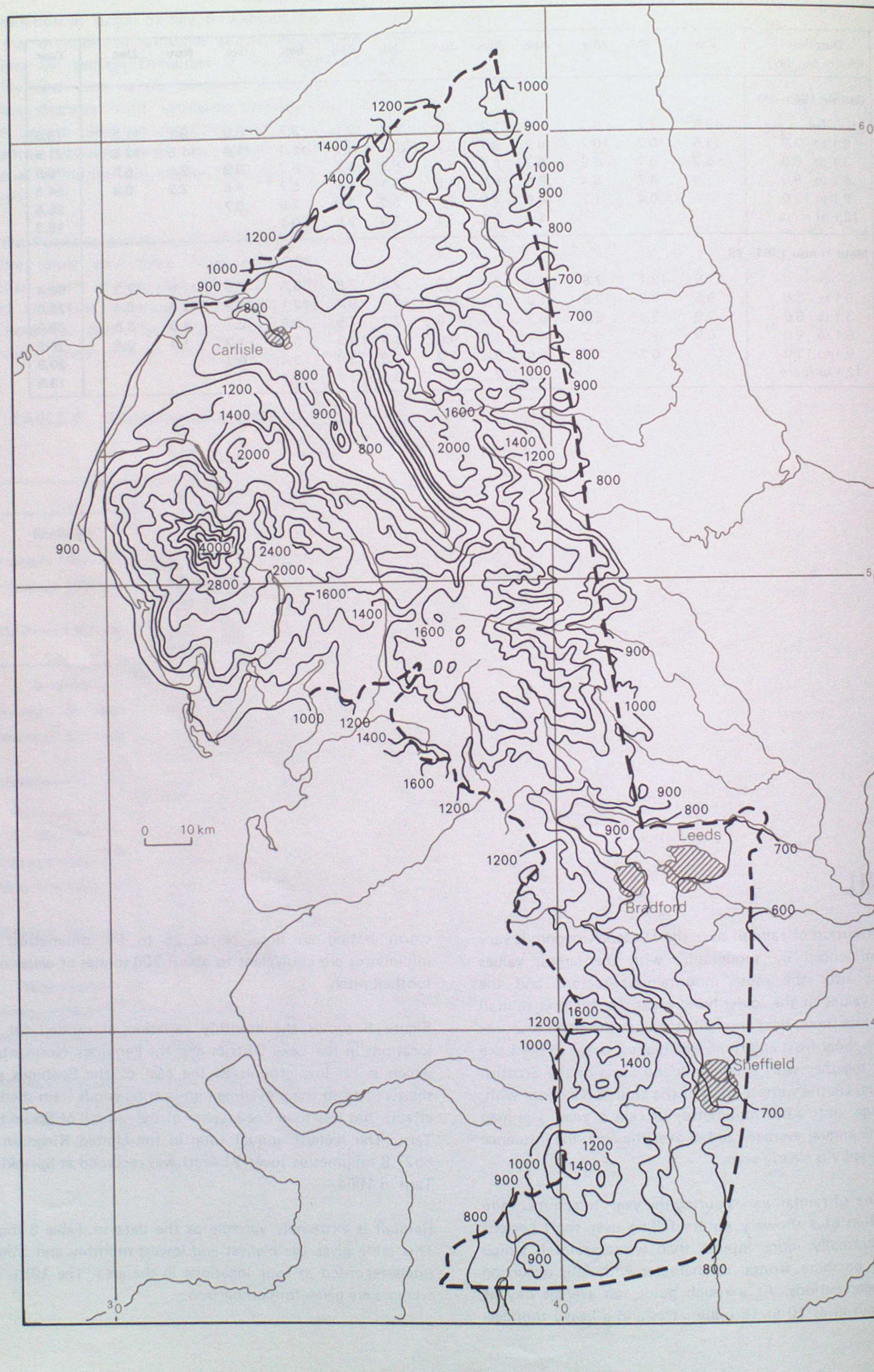


FIGURE 5 Average monthly rainfall (mm) over the period 1941–70

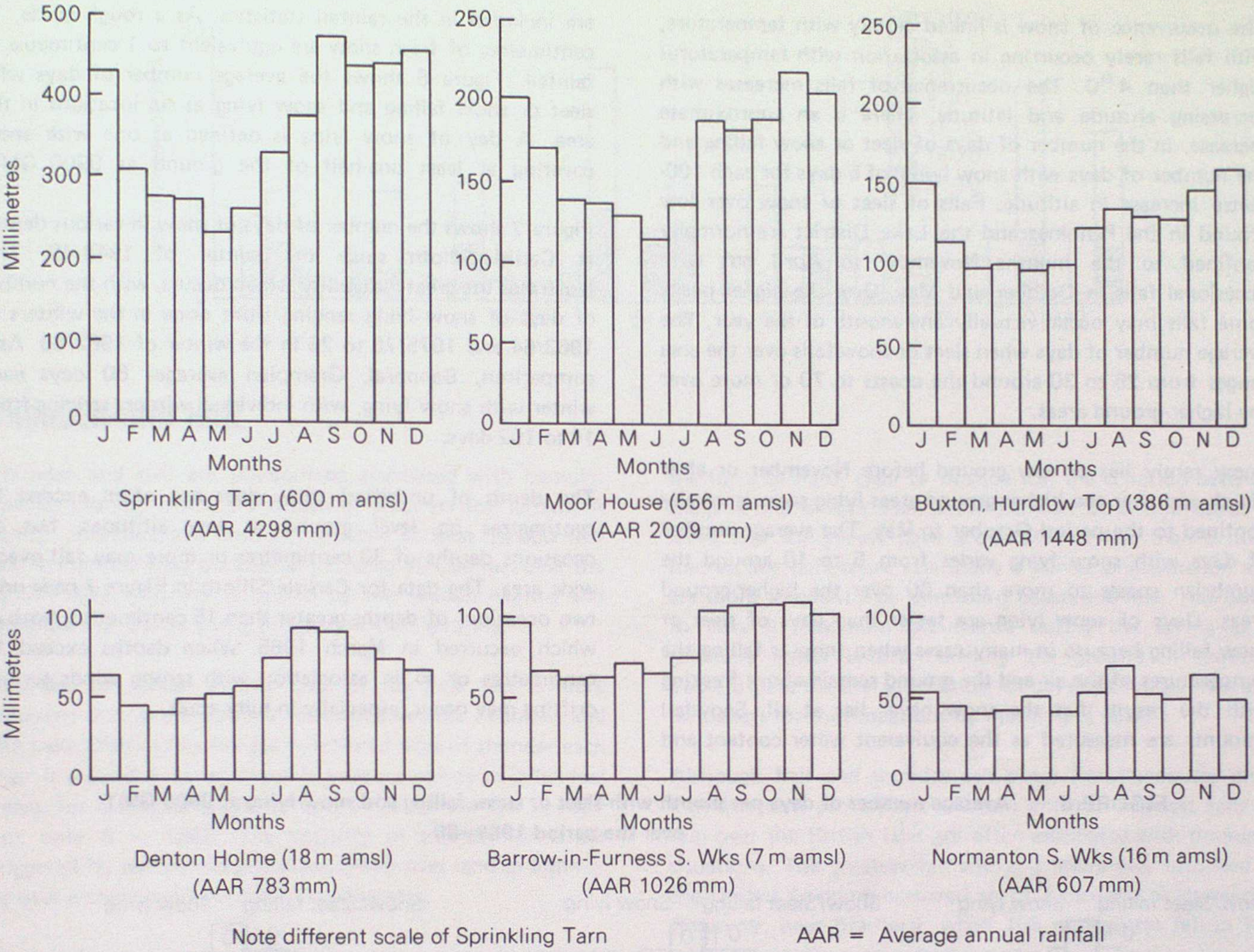


TABLE 5 Average monthly and annual rainfall (mm), with daily, monthly and annual extremes, at selected sites for the period 1951–80

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kielder Castle													
Average	123	83	85	74	78	73	89	108	103	109	127	136	1188
Wettest	241.3	150.5	216.4	139.7	187.1	153.7	174.8	209.8	169.6	292.0	274.0	242.8	1598.9
Driest	47.5	19.3	28.4	10.0	20.3	32.8	28.2	19.1	26.5	22.7	24.1	41.3	875.0
Most in a day	59.9	39.6	69.8	50.8	30.7	33.3	42.4	56.0	45.2	50.1	47.8	59.2	
Buxton													
Average	130	100	98	84	87	82	100	110	110	112	132	144	1289
Wettest	229.2	263.8	213.8	166.4	189.0	178.1	163.1	271.0	256.3	241.6	288.7	325.0	1630.7
Driest	56.6	19.5	39.7	9.3	18.0	19.0	23.8	22.7	4.2	30.4	45.6	23.0	961.6
Most in a day	44.2	169.2	42.4	44.2	37.6	37.1	87.5	45.3	56.6	50.7	43.7	71.4	
Pontefract													
Average	46	40	39	39	52	46	59	66	52	48	56	51	594
Wettest	112.4	116.8	109.7	106.3	143.9	109.5	126.7	129.3	177.1	171.7	128.9	146.5	831.9
Driest	11.4	2.1	8.9	3.3	12.2	4.3	14.8	19.8	1.9	7.8	13.2	17.7	420.4
Most in a day	22.0	28.2	31.5	44.6	44.7	37.6	60.7	38.6	47.5	43.9	30.5	37.4	
Sellafield													
Average	95	59	62	58	63	67	86	99	108	104	111	104	1016
Wettest	246.1	136.7	136.8	108.1	155.7	143.8	185.1	229.0	186.9	207.4	211.6	165.6	1424.4
Driest	26.2	5.3	11.2	5.1	6.4	24.0	23.8	5.0	15.0	24.1	33.4	28.0	809.1
Most in a day	45.1	34.0	32.5	30.7	25.7	31.2	54.6	57.7	50.3	64.4	65.0	35.1	

SNOW

The occurrence of snow is linked closely with temperature, with falls rarely occurring in association with temperatures higher than 4 °C. The occurrence of falls increases with increasing altitude and latitude. There is an approximate increase, in the number of days of sleet or snow falling and the number of days with snow lying, of 5 days for each 100-metre increase in altitude. Falls of sleet or snow over low ground in the Pennines and the Lake District are normally confined to the months November to April but with occasional falls in October and May. Over the higher peaks some falls may occur virtually any month of the year. The average number of days when sleet or snow falls over the area ranges from 25 to 30 around the coasts to 70 or more over the higher-ground areas.

Snow rarely lies on low ground before November or after March and over the higher-ground areas lying snow is usually confined to the period October to May. The average number of days with snow lying varies from 5 to 10 around the Cumbrian coasts to more than 60 over the higher-ground areas. Days of snow lying are fewer than days of sleet or snow falling because in many cases when snow is falling the temperatures of the air and the ground remain above freezing with the result that the snow never lies at all. Snowfall amounts are measured as the equivalent water content and are included in the rainfall statistics. As a rough guide, 10 centimetres of fresh snow are equivalent to 1 centimetre of rainfall. Figure 6 shows the average number of days with sleet or snow falling and snow lying at six locations in the area. A day of snow lying is defined as one with snow covering at least one-half of the ground at 0900 GMT.

Figure 7 shows the number of days of snow in various depths at Carlisle/Silloth since the winter of 1948/49. This illustrates the great variability which occurs, with the number of days of snow lying ranging from none in the winters of 1963/64 and 1975/76 to 26 in the winter of 1962/63. As a comparison, Balmoral, Grampian averages 60 days each winter with snow lying, with individual winters ranging from 14 to 102 days.

The depth of undrifted snow does not often exceed 15 centimetres on level ground at low altitudes, but on occasions depths of 30 centimetres or more may fall over a wide area. The data for Carlisle/Silloth in Figure 7 have only two occasions of depths greater than 15 centimetres, both of which occurred in March 1965. When depths exceed 15 centimetres or so in association with strong winds serious drifting may occur, especially in hilly areas.

FIGURE 6 Average number of days per month with sleet or snow falling and snow lying at 0900 GMT over the period 1961–80

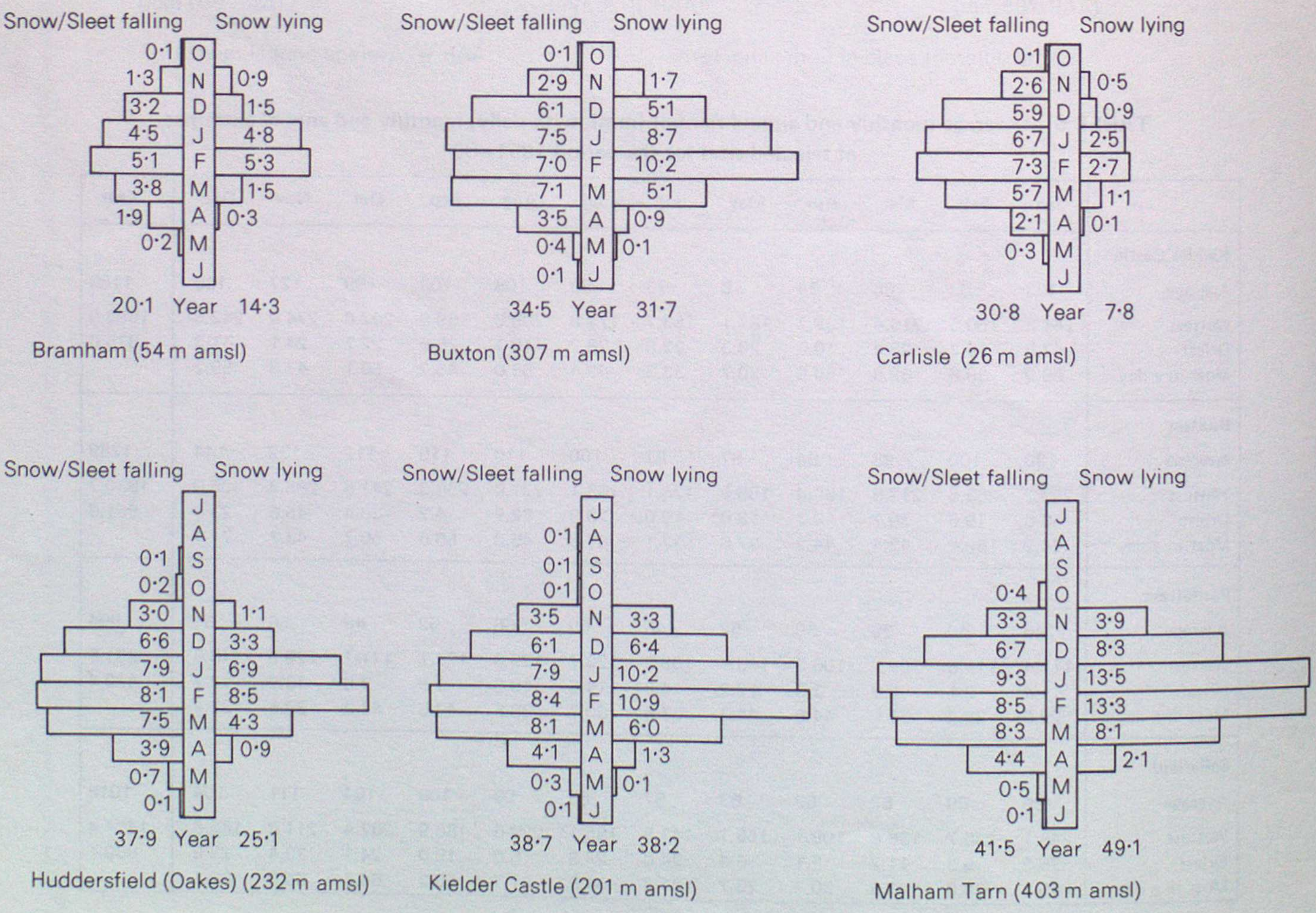
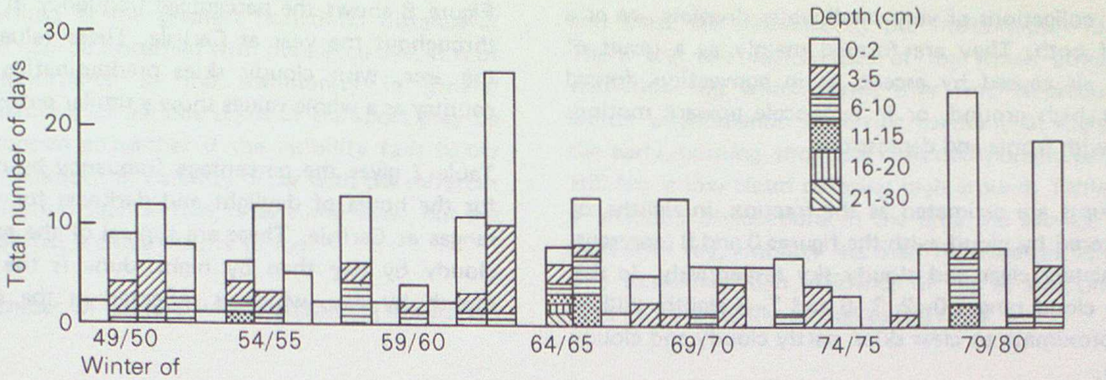


FIGURE 7 Number of days with total snow depth at 0900 GMT in stated ranges at Carlisle/Silloth



THUNDER AND HAIL

Thunder and hail are phenomena associated with cumulonimbus clouds, which are clouds of great vertical extent. A typical thundercloud normally reaches at least 18 000 feet and in summer may occasionally exceed 40 000 feet over the British Isles. Thunder is caused by the sudden heating and expansion of the air along the path of the lightning.

Thunder can occur at any time of the year but is more frequent during the summer months. Over the Pennines and the Lake District the average number of days of thunder each year is around 5 to 10. There is great variability in individual years; for example, Bradford had 21 days of thunder in 1967 but only 6 in 1965. The majority of thunderstorms are triggered by convective processes, either over land in summer or over a comparatively warm sea in winter.

In thunderstorms or heavy showers at any time of the year the precipitation may be of hail or ice pellets. Both are in the form of hard, clear or opaque ice; the criterion between them is one of size. Hail has a diameter of 5 millimetres or more and ice pellets have a diameter of less than 5 millimetres. Ice pellets are essentially a winter phenomenon and are more frequent over windward coasts and hills. Hail tends to have a maximum occurrence during the spring as it generally melts before reaching the ground in summer. Table 6 gives the average number of days of thunder, hail and ice pellets for four locations by month and year.

Although hail and thunder can occur simultaneously most thunderstorm precipitation is rain and the heaviest falls of rain over the British Isles are often associated with thundery situations. The greatest fall within 2 hours ever recorded in the United Kingdom occurred on 11 June 1956 at Hewenden Reservoir, near Bradford, when 155 millimetres fell in 105 minutes in a severe thunderstorm.

TABLE 6 Average number of days of thunder and hail over the periods stated

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Carlisle (1961–81)													
Thunder			0.3	0.3	1.2	1.3	1.3	1.6	0.9	0.6	0.1	0.1	7.9
Hail	1.1	0.7	1.7	1.4	1.0	0.4		0.1	0.1	0.7	1.4	1.0	9.5
Ice pellets	1.5	0.9	0.6	0.6	0.1				0.1			0.3	4.3
Moor House (1959–79)													
Thunder	0.1				1.4	0.9	0.1	1.4	0.1	0.1	0.4	0.1	4.7
Hail	1.5	1.0	3.0	3.5	3.1	1.1	0.4	0.3	0.9	1.0	1.0	1.3	18.1
Ice pellets	1.3	2.3	2.9	1.8	0.3	0.4		0.1	0.3	0.1	1.6	1.1	12.1
Great Dun Fell (1963–70)													
Thunder	0.3	0.3	0.1	0.3	0.7	0.9	1.3	4.6	0.4	0.3			9.0
Hail	0.3		0.8	1.1	1.4	0.1	0.6	4.7	0.1	0.1			9.3
Ice pellets		0.6	0.3		0.1				0.1	0.1	0.3	0.1	1.7
Bradford (1971–80)													
Thunder	0.3	0.1	0.4		1.7	1.7	1.4	1.1	0.7	0.5		0.3	8.2
Hail	0.4	0.7	0.8	1.0	0.9	0.6	0.3	0.1	0.3	0.2	0.9	1.2	7.4
Ice pellets	0.6	0.7	1.2	0.9							0.2	0.9	4.5

CLOUD

Clouds are collections of very small water droplets, ice or a mixture of both. They are formed mainly as a result of cooling of air caused by ascent, as in convection, forced lifting over high ground, or in large-scale upward motions associated with fronts and depressions.

Cloud amounts are estimated as the fraction, in eighths, of the sky covered by cloud, with the figures 0 and 8 representing a completely clear and cloudy sky respectively. In this section the cloud ranges 0–2, 3–6 and 7–8 eighths will be used to approximate to clear skies, partly cloudy and cloudy respectively.

Figure 8 shows the percentage frequency of cloud amounts throughout the year at Carlisle. These values are typical of the area, with cloudy skies predominating, and over the country as a whole values show a similar pattern.

Table 7 gives the percentage frequency by month and year for the hours of daylight and darkness for the three cloud ranges at Carlisle. These are typical of the area, being more cloudy by day than by night. June is the least cloudiest month by day, which is reflected in the sunshine totals.

FIGURE 8 Frequency of total cloud amount at Carlisle over the period 1957–76

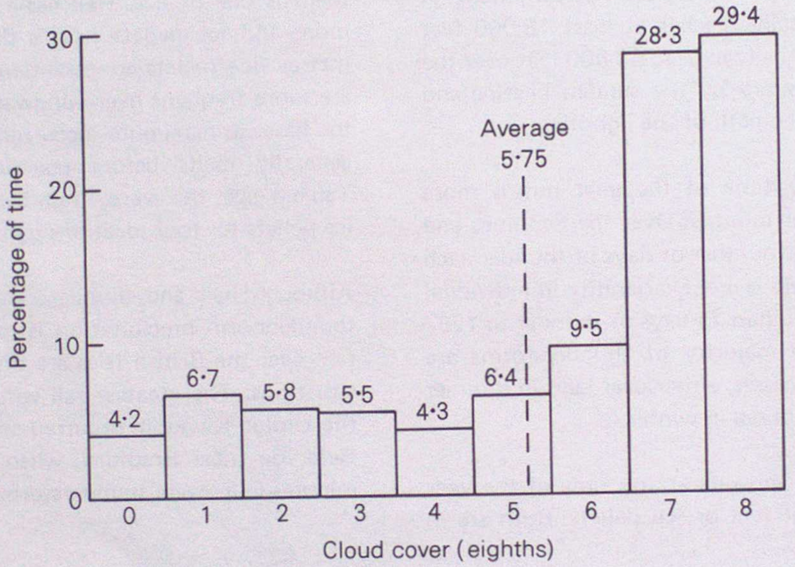


TABLE 7 Percentage frequency of hours with total cloud amount in selected ranges at Carlisle over the period 1957–76

Eighths	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
	Daylight hours												
0–2	11.0	13.7	9.9	12.2	11.3	13.8	8.7	9.7	11.2	11.6	10.9	13.1	11.4
3–6	22.9	25.9	27.6	29.7	31.6	31.9	28.5	32.4	30.2	27.6	27.1	27.2	28.9
7–8	66.2	60.4	62.5	58.2	57.2	54.3	62.8	58.0	58.5	60.8	62.0	59.7	59.6
	Hours of darkness												
0–2	19.9	23.7	23.7	25.8	22.3	20.6	17.1	22.0	24.0	22.6	22.3	22.1	22.1
3–6	17.8	20.0	20.7	22.6	27.0	29.9	24.5	26.2	22.9	21.3	20.4	21.5	22.3
7–8	62.4	56.3	55.4	51.7	50.8	49.5	58.3	51.9	53.0	56.0	57.4	56.5	55.6

VISIBILITY

Visibility is defined as the greatest horizontal distance at which an object can be discerned with the naked eye. It is of considerable importance to the community in general because the operation of various types of transport may be disrupted or stopped altogether if the visibility falls below certain limits. Variations in visibility occur with the different types of precipitation such as rain, drizzle and snow, but the really poor visibilities are due mainly to fog.

There are a number of factors which affect fog formation and these are discussed in the Introduction to the series. There are two main types of fog which affect the area. Radiation fog which forms over land is predominantly a winter phenomenon occurring generally at night or during the early morning, though it does occasionally persist all day. Hill fog is low cloud covering high ground. Table 8 gives for a selection of locations in the area the average number of days with fog, visibility less than 1000 metres, at 0900 GMT. The extremely high incidence of fog at this time at Great Dun Fell is virtually all due to hill fogs.

TABLE 8 Average number of days of fog, visibility less than 1000 metres at 0900 GMT

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Great Dun Fell (847 m)	23.5	19.1	22.8	19.8	16.4	14.0	17.6	20.4	21.7	20.6	22.4	20.7	239.0
Moor House (556 m)	7.9	9.0	5.7	2.3	2.3	1.9	1.8	1.6	2.2	4.0	4.0	7.3	50.0
Buxton (307 m)	7.7	7.8	4.8	3.2	1.1	0.7	0.2	1.2	1.8	4.7	3.2	6.3	42.7
Malham Tarn (393 m)	6.6	7.0	3.7	2.0	1.5	0.4	1.5	1.3	1.5	3.4	3.3	5.4	37.4
Kielder Castle (201 m)	3.7	4.7	2.6	1.5	1.0	0.3	0.8	0.4	1.7	2.4	3.2	3.2	25.5
Haydon Bridge (79 m)	2.3	2.5	1.8	1.6	0.3	0.3	0.2	0.2	1.1	2.5	1.7	1.8	16.1
Carlisle (26 m)	1.6	0.7	0.8	0.2				0.2	0.4	0.6	1.1	0.8	6.4

WIND

The wind direction is that from which the wind blows recorded either as a compass point or degrees from true north. Wind speeds are measured in knots (1 knot = 1.15 miles per hour; 1 metre per second = 1.94 knots) and are closely related to the pressure distribution. The strongest winds are associated with the passage of deep depressions across or close to the United Kingdom. The frequency of depressions is greatest during the winter months so this is when the strongest winds normally occur.

Wind seldom occurs as a smooth-flowing airstream and eddies give variations both in direction and speed. Winds are usually stronger by day because temperature rise causes increased turbulence making average speeds higher and the wind more gusty.

A day of gale is defined as a day on which the wind speed attains a mean value of 34 knots or more over any period of ten consecutive minutes. At low altitudes over the Pennines and the Lake District gales are most frequent along the Cumbrian coasts with an average of 20 days of gale a year. Away from the coast the number of days of gale decreases so that inland at low altitudes there are on average fewer than 5 days of gale a year.

Wind speeds increase with height and the majority of the strongest winds recorded in the United Kingdom have been at high-level stations (above 200 metres). Great Dun Fell, 847 metres, averages 100 days of gale a year and on 12 January 1974 recorded an hourly mean wind speed of 92 knots, which is the highest ever recorded in the United Kingdom.

Table 9 gives the annual percentage frequency of hourly mean wind speeds and directions for Wilsden for the period 1972–80. Although Wilsden is at 262 metres it is situated to the east of the Pennines and sheltered from the prevailing south-westerly winds, so the data are reasonably representative of the area in general.

In certain weather situations the presence of a range of hills can give rise to local enhancements of wind, known as lee waves. Such an occasion occurred on 16 February 1962 in a gale which was notable for the concentration of damage in some areas to the lee of the Pennines, notably Sheffield. See also the Introduction to the series which discusses some other local winds.

The wind-roses for Carlisle illustrate how the wind varies throughout the year. In January, although south-westerly winds predominate there is a relatively high percentage of south-easterly winds due to funnelling along the Eden Valley. In April there is a high incidence of winds from east to north-east which is due to the weather patterns which predominate during this month.

TABLE 9 Annual percentage frequencies of hourly mean wind speed and direction at Wilsden over the period 1972–80

Knots	Beaufort force equivalent	30° sectors centred on 360°	030°	060°	090°	120°	150°	180°	210°	240°	270°	300°	330°	All directions
Calm	0													0.5
1–3	1	0.4	0.5	0.9	0.9	1.4	1.4	1.1	1.1	0.8	1.2	1.1	0.6	12.8
4–10	2–3	1.8	3.3	3.9	3.4	5.1	3.4	2.5	5.2	4.4	7.0	5.7	2.5	48.2
11–21	4–5	1.0	1.8	2.0	1.0	0.9	0.8	1.3	5.1	6.8	9.0	3.5	1.3	34.8
22–33	6–7	+	+	+	+	+	+	+	0.3	1.2	1.4	0.3	+	3.5
≥34	≥8								+	+	0.1	+		0.1
Total ≥22	≥4	2.9	5.1	5.9	4.4	6.0	4.2	3.8	10.7	12.4	17.6	9.7	3.8	86.6

1–3 knots total includes a percentage light and variable

\+ Observations recorded in these categories but for less than 0.05 per cent of the time

FIGURE 9 Wind-roses for Carlisle

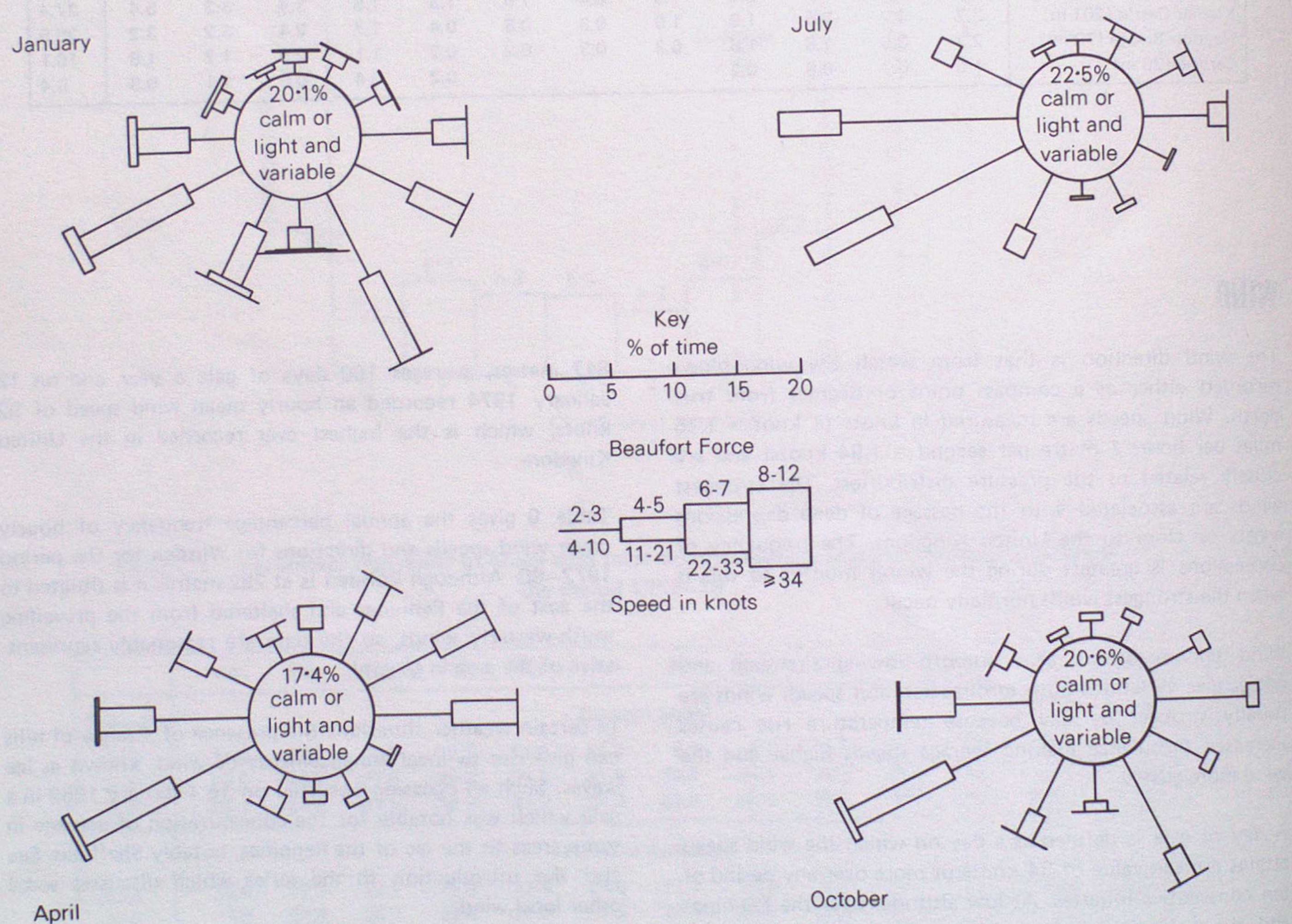


TABLE 10 Weather extremes

TEMPERATURE	Date records began and ceased where stated	Maximum daily temperature (^{o}C)	Date	Minimum daily temperature (^{o}C)	Date
Pennines and Lake District					
Newton Rigg	1901	33.3	20 July 1901	−20.0	16 February 1969
Huddersfield (Ravensknowle)	1907[1]	33.3	22 June 1941 9 August 1911	−13.9	21 January 1940
Wakefield	1901[2]	33.3	1 September 1906	−15.0	21 January 1940
Ambleside	1931[3]	31.7	6 June 1950 9 July 1934	−21.1	21 January 1940
Appleby	1901[4]	30.7	1 September 1906	−20.0	21 January 1940
United Kingdom					
Raunds Epsom Canterbury	–	36.7	9 August 1911		
Braemar	–			−27.2	11 February 1895 10 January 1982
SUNSHINE	**Date records began and ceased where stated**	**Maximum monthly duration (hours)**	**Date**	**Minimum monthly duration (hours)**	**Date**
Pennines and Lake District					
Sellafield	1950	312.8	July 1955	20.0	December 1978
Silloth	1951	308.9	July 1955	18.9	December 1954
Newton Rigg	1931	307.4	June 1975	11.7	December 1954
Great Dun Fell	1955[5]	243.5	June 1957	1.7	December 1971
Buxton	1931[6]	273.5	June 1940	3.2	December 1947
Keswick	1921[7]	294.9	May 1935	5.5	December 1922
United Kingdom					
Eastbourne	–	383.9	July 1911		
London (Westminster)	–			0	December 1890
WIND	**Date records began**	**Maximum mean wind speed (knots)**	**Date**	**Maximum gust speed (knots)**	**Date**
Pennines and Lake District					
Great Dun Fell	1963	92	12 January 1974	116	15 January 1968
Sellafield (High)	1963	76	12 January 1974	99	2 January 1976
High Bradfield	1975	60	18 November 1980	94	18 November 1980
United Kingdom (Low level sites)					
South Gare (Cleveland)	–	70	2 January 1976		
Kirkwall (Orkney)	–			118	7 February 1969
RAINFALL	**Date records began and ceased where stated**	**Maximum daily fall (mm)**			**Date**
Pennines and Lake District					
Borrowdale (Seathwaite)	1888[8]	204 178			12 November 1955 29 October 1911
Buttermere (Hassness)	–	181			29 July 1938
Rosthwaite	–	176			12 November 1897
United Kingdom					
Martinstown (Dorset)	–	279			18 July 1955

Records ceased: [1] 1977 [2] 1965 [3] 1971 [4] 1947 [5] 1972 [6] 1973 [7] 1960 [8] 1938

TABLE 11 Climatological data for places in the United Kingdom based on the period 1941–70 except where indicated

	Altitude (metres)	Average annual rainfall (mm)	Average daily temperatures (°C) # Minimum		Maximum		Average annual duration of bright sunshine (hours)	Average annual no. of days with*	
			Jan.	July	Jan.	July		Air frost	Snow lying
England									
Abingdon (Oxfordshire)	69	605	0.3	11.6	6.3	21.6	1544	57	13
Acklington (Northumberland)	42	644	0.0	10.3	5.5	17.9	1429	60	20
Birmingham Airport (W. Midlands)	96	679	0.1	11.2	5.7	20.5	1385	62	15
London (Kensington Palace)	25	640	1.7	13.3	6.6	22.2	1384[×]	35	7
Manchester Airport (Gr. Manchester)	75	819	0.5	11.7	5.8	19.6	1334	47	10
Plymouth/Mount Batten (Devon)	27	990	3.1	12.7	8.3	19.0	1678	25	3
Shawbury (Shropshire)	72	670	0.0	11.2	6.0	20.2	1368	63	17
Southsea (Hampshire)	2	702	2.4	13.9	7.1	20.7	1748	25	6
Waddington (Lincolnshire)	68	598	0.1	11.6	5.2	20.3	1503	54	18
Wales									
Cardiff/Wales Airport (S. Glamorgan)	67	947	1.3	11.9	6.6	19.3	1571	36	8
Valley (Gwynedd)	10	871	2.5	12.0	7.5	18.1	1612	27	3
Northern Ireland									
Belfast Airport (Antrim)	68	912	0.6	10.7	6.1	18.1	1281	53	9
Scotland									
Aberdeen Airport (Grampian)	58	872	−0.9	9.6	5.0	17.5	1341	75	30
Balmoral (Grampian)	283	834	−2.8	8.1	3.7	17.4	1120[†]	116	63
Edinburgh Airport (Lothian)	35	677	−0.6	10.3	5.7	18.5	1294	66	14
Lerwick (Shetland)	82	1172	0.6	9.3	5.0	14.0	1067	53	32
Stornoway (Western Isles)	3	1094	1.3	10.1	6.4	15.7	1244	49	11
Glasgow Airport (Strathclyde)	5	991	0.1	10.8	5.8	18.6	1266	58	6

* Based on 1956–70 only.
× For Regents Park.
† For Braemar.

\# Referring to 24-hour (09–09 GMT) extremes. Adjustments have been made to those stations normally recording night minimum (21–09 GMT) and day maximum (09–21 GMT). See Introduction to the series.

CLIMATOLOGICAL SERVICES AVAILABLE FROM THE METEOROLOGICAL OFFICE

The Meteorological Office collects and archives regular weather reports from a national network of observing stations, consisting of both Meteorological Offices manned by professional staff and co-operating stations operated by interested organizations or individuals. All these data are subjected to close scrutiny before being archived, to ensure consistency of standards, and are then available to meet the needs of the community.

Any undertaking which is at all weather-sensitive can benefit from a prior knowledge of the climate within which it is expected to operate. The building industry can use past weather statistics to estimate likely delays on contracts, architects and civil engineers need to know the likely extremes of weather which a design must withstand, and many industrial processes are dependent on atmospheric conditions for their success. The agricultural industry uses such information for a variety of purposes, many relating to the viability of new crops and the weather-related incidence and spread of pests and diseases.

In addition to special analyses of weather data for these purposes, the Meteorological Office can supply factual statements on weather conditions for legal or insurance purposes.

Enquiries related to aspects of past weather data should be directed to the appropriate address given on the back cover or, if more convenient, initially to your local weather centre (see opposite). Charges for the supply of information depend mainly on the staff time taken to meet the request.

Further information
Information leaflets and brochures describing in more detail the range of specialized services available from the Meteorological Office are available free from the same addresses. These leaflets and brochures also indicate the range of complex analyses that the Meteorological Office can undertake.

Forecasting services
For the day-to-day planning of outdoor work, special weather forecasts and warnings can be arranged to cover specific weather elements at agreed sites. Details may be obtained from:

The Director-General
Meteorological Office (Met O 7)
London Road
Bracknell
Berkshire RG12 2SZ

or from your local weather centre.

WEATHER CENTRES AND PUBLIC SERVICE OFFICES

Weather Centres

Bristol
The Gaunts House
Denmark Street
Bristol BS1 5DH

Bristol (0272) 279272

Cardiff
Southgate House
Wood Street
Cardiff CF1 1EW

Cardiff (0222) 390420

Glasgow
33 Bothwell Street
Glasgow G2 6TS

041—248 7272

Leeds
Oak House
Park Lane
Leeds LS3 1EL

Leeds (0532) 457703

London
284–286 High Holborn
London WC1V 7HX

01—430 5627

Manchester
Exchange Street
Stockport SK3 0ER

061—477 1017

Newcastle
7th Floor
Newgate House
Newgate Street
Newcastle-upon-Tyne NE1 5UQ

Tyneside 091—232 3808

Norwich
Rouen House
Rouen Road
Norwich NR1 1RB

Norwich (0603) 630164

Nottingham
Main Road
Watnall
Nottingham NG16 1HT

Nottingham (0602) 384094

Plymouth
Royal Air Force Mount Batten
Plymouth
Devon PL9 9SH

Plymouth (0752) 493377

Southampton
160 High Street-below-bar
Southampton SO1 0BT

Southampton (0703) 220646

Public Service Offices

Meteorological offices at:

Aberdeen (Dyce) Airport
Aberdeen, Grampian AB2 0DU

Aberdeen (0224) 724986

Belfast (Aldergrove) Airport
Belfast
Northern Ireland BT29 4AB

Crumlin (084 94) 22804

Birmingham Airport
Birmingham B26 3QN

021—743 6240

Kirkwall Airport
Kirkwall
Orkney KW15 1TH

Kirkwall (0856) 3802

Sella Ness
Port Admin Area
Craven, Mossbank
Shetland ZE2 9QR
(0806) 242069

THE CLIMATE OF GREAT BRITAIN

This memorandum is one of a series which will cover the whole of Great Britain in due course, published in the Climatological Memoranda range. The Introduction (CM 113) to the series explains how various weather elements are measured. The areas to be covered are:

SCOTLAND

114 Borders Region
115 Edinburgh, Lothian Region and Stirling
116 Fife, Dundee and Perth
117 Aberdeen and Buchan
118 Moray Firth coastal Region
119 Northern Isles
120 Western Isles
121 Skye and the North-west
122 Argyll and the Inner Hebrides
123 The Grampians and Perthshire Highlands
124 Glasgow and the Clyde valley
125 Ayrshire and the Firth of Clyde
126 Dumfries and Galloway Region

ENGLAND

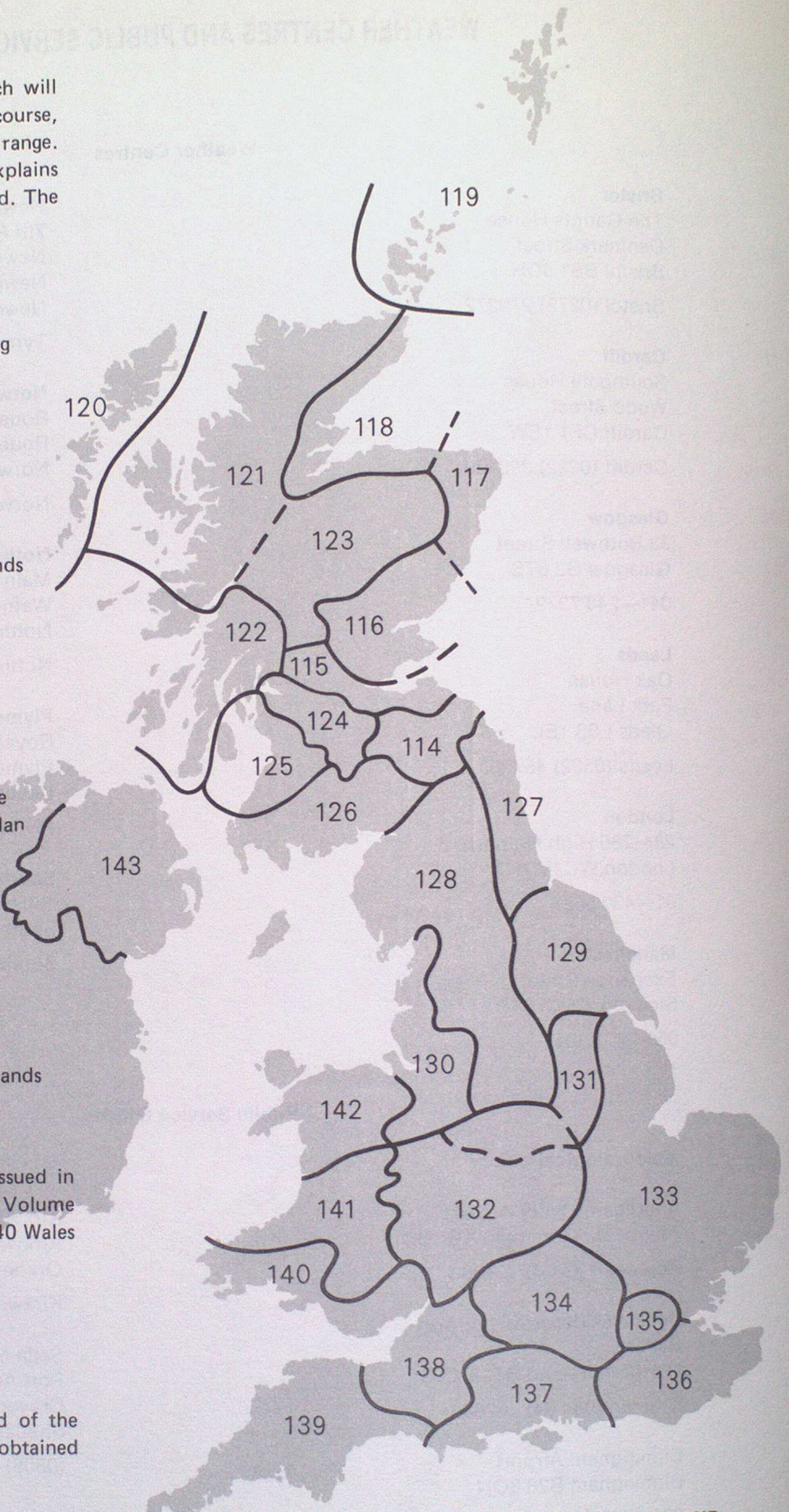
127 North-east England
128 Pennines and Lake District
129 East Yorkshire and North Humberside
130 Lancashire and Cheshire and Isle of Man
131 Trent Valley
132 Midlands
133 East Anglia and Lincolnshire
134 Thames Valley
135 London
136 South-east England
137 South England
138 Somerset and Avon
139 South-west Peninsula and Channel Islands

WALES

140 South Wales
141 Mid Wales
142 North Wales and Anglesey

} Now issued in one Volume No. 140 Wales

Also available
143 The Climate of Northern Ireland



Further details of these memoranda and of the services mentioned on page 18 can be obtained from:

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