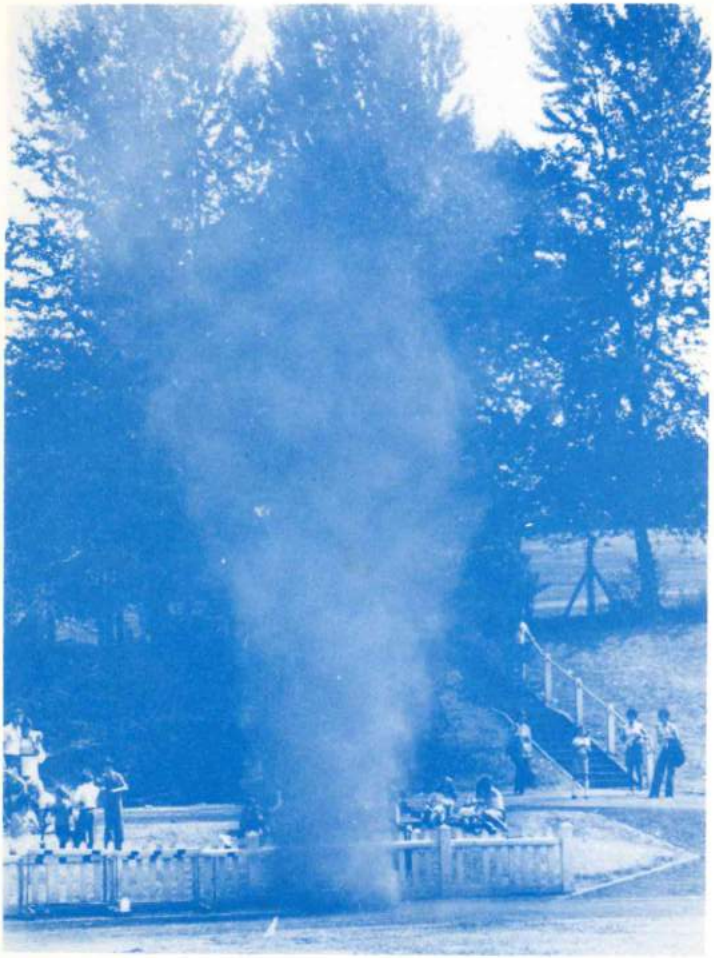
The JOURNAL of METEOROLOGY



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"An international journal for everyone interested in climate and weather, and in their influence on man."

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THE STORMS OF SUMMER 1980 IN THE SOUTH-EAST MIDLANDS

By G. P. EDEN

Clive Court, Havelock Rise, Luton, Bedfordshire

Abstract. This article illustrates the rainfall distribution during the series of major storms which affected the south-east Midlands and northern Home Counties in the summer half-year of 1980.

INTRODUCTION

Much was made in the press of the inclement nature of the summer of 1980, an impression not borne out by figures (Brown 1980), but the most abiding memory of the season for many people, particularly in parts of the Midlands and south-east England, was of a series of heavy thunderstorms. A descriptive account of the storms of 26th and 29th July and 14th August has already been given by the writer in the pages of this journal (Eden 1980); the purpose of this article is to present some quantitative information about the most important rainfall events of the season in an area covering the greater part of the counties of Greater London, Hertfordshire, Bedfordshire, Buckinghamshire, Northamptonshire, and adjacent parts of Cambridgeshire and Leicestershire (Figure 1).

It is well known that, in lowland Britain, individual daily falls exceeding 25 mm are much more frequent in the summer half of the year (i.e. May to October inclusive) than in the winter half, and that such falls are frequently associated with thunderstorms. For example, between 1940 and 1980 inclusive at Tothamsted, Herts, there were 52 such events distributed as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	2	1	1	2	11	9	6	4	7	5	4

Surprisingly, Rothamsted registered only one such fall in 1980 and that was on 15th October, although 24.9 mm was measured on 14th August. By contrast, 25 mm was exceeded somewhere in the area under consideration on no fewer than twelve rainfall days (a rainfall day is the 24-hour period commencing 0900 GMT on the date in question) and on several other days also in neighbouring districts. All these twelve occasions were between the end of May and the middle of October. In the Upper Nene Catchment near Long Buckby, better known by motorists as Watford Gap, there were seven such days.

The contrast across the area in June, July and August is exemplified by the monthly totals for Northampton (Moulton Park) and Sandy (Stratford Road), stations less than 60 km apart. The totals are rounded to the nearest whole millimetre:

	May	June	July	August	September	October
Sandy	22	42	78	34	16	74
Northampton	15	98	185	109	23	76

Furthermore, during the three-week period 25th July to 14th August inclu-

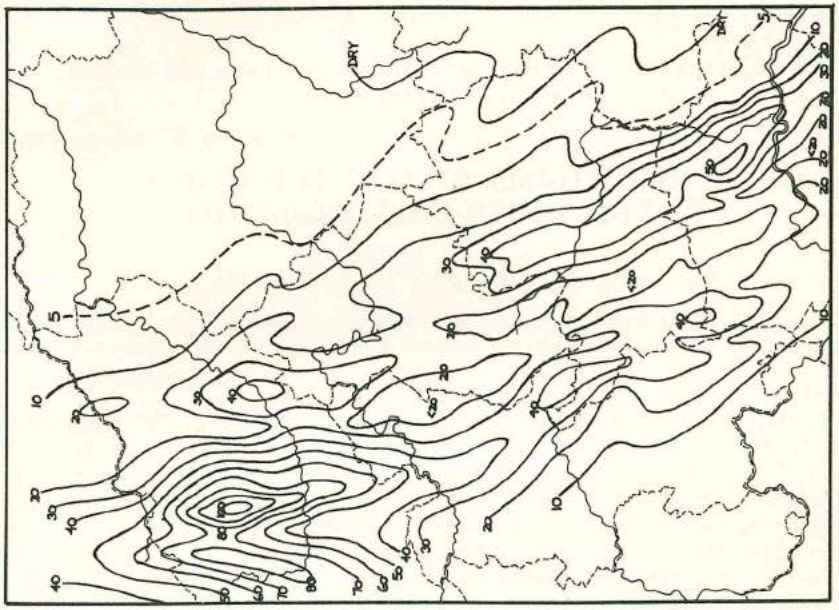

Fig. 2. Distribution of rainfall on 25-26 July 1980.

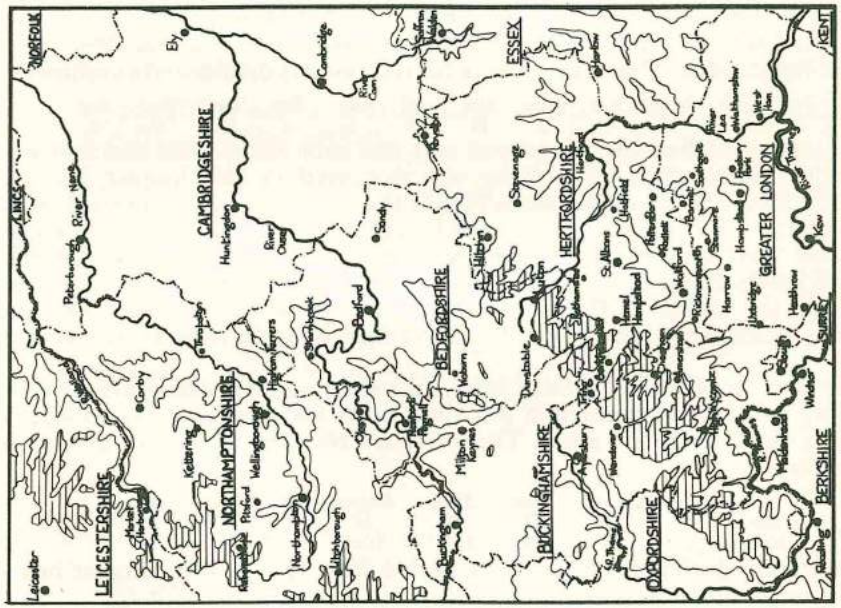

Fig. 1. Geographical Setting of the Study Area, showing major towns and other places mentioned in the text. (Contours at 75 and 150 metres).

sive, 191.3 mm fell at Northampton (West Bridge), 503% of the 1941-70 mean, as against 26.9 mm (some 75%) at Redericks Lane, just north of Harlow.

31 MAY 1980

April and May were dry months throughout the United Kingdom. Cardington, for example, measured 33.2 mm in the two-month period, and just 18.1 mm between 2nd April and 30th May. Rainfall on 31st, then, was welcome from agricultural, horticultural and hydrological viewpoints, but less than 10 mm fell north of a line from Harlow to Northampton. The heaviest falls were confined to bands aligned eastsoutheast-westnorthwest some 10 to 20 kilometres wide, one extending from Barnet across north Watford and Hemel Hempstead to Tring and north Aylesbury, the other from north-east London across Hampstead and Harrow to High Wycombe and beyond. Rain began around dawn on 31st and largely died out during the early hours of 1st June, so the event was spread over two rainfall days although by far the greater part of the total was credited to 31st. Largest totals for 30th/31st May were:—

Tring (Cowroast Lock)	31.5
Tring (Bulbourne)	29.9
Radlett (Aldenham School)	29.6
Watford (Garston)	29.4
Berkhamsted Sewage Works	28.2
Radlett (Blackbirds Sewage Works)	28.0
Hampstead Observatory	27.6

14 JUNE 1980

The rainfall event of 14th June was associated with the northward passage of a thundery cold front concluding a short spell of warm, humid weather. Embedded thunderstorms were neither severe nor prolonged, but torrential rain caused local flooding, chiefly in urban areas where drains could not cope with the rapid build-up of surface water. Although the event again encompassed two rainfall days, all the precipitation fell between 0300 and 1200 GMT and much of it within an hour: around 0600 in London and nearer 0900 in Northamptonshire. Less than 10 mm fell east of a line from Southgate to Corby, but 25 mm or more occurred in a broad band some 30 kilometres wide stretching through west London and Slough northnorthwestwards across most of Buckinghamshire to Northampton and beyond. Heaviest falls were as follows:—

Heathrow	41.7
Gt. Missenden (near Amersham)	38.8
Aylesbury (Hampden Hall)	37.6
Amersham	37.2
Chesham Sewage Works	37.0
Wendover	36.7
Uxbridge (West Drayton)	36.5
Rickmansworth (Maple Lodge)	34.9

30 JUNE — 1 JULY 1980

The south-east Midlands and northern Home Counties did not experience the exceptional rainfall which affected other parts of southern Britain during the very thundery fourth week of June (see, for example, Rogers 1980). A deepening depression tracked south-eastwards from south-west Scotland on the morning of 30th June across northern England and Lincolnshire to reach

the southern North Sea early on 1st July. Rain which affected the whole of England and Wales was heavy in many districts, particularly near the coast of East Anglia (Hunt 1980). Rainfall began during the afternoon, but became intermittent by midnight. There were, however, further outbreaks of rain until the afternoon of 1st Juky and these were heavy in Cambridgeshire, east Hertfordshire, and adjacent parts of Essex, and it was in this area that 25 mm was exceeded over the two-day period:

Cambridge (Chesterfield Park)	40.6
Thaxted (North-west Essex)	33.3
Maze Green	33.2
Wendens Ambo	30.4
Therfield 8 km SSW of Royston	29.0
Royston	26.0

13 JULY 1980

A depression tracked eastwards over southern Ireland and Wales during 13th, and crossed the south Midlands and East Anglia early on 14th. Rain began during the early evening on 13th, and had cleared most of the area by 0900 GMT on 14th although lingering until midday in parts of Hertfordshire and London. Falls of 25 mm or more were confined to north Buckinghamshire and south Northamptonshire, nowhere significantly exceeding 30 mm.

25-26 JULY 1980

These storms will be remembered for the frequency of electrical activity, abnormal daytime darkness which affected certain parts of London triggering street-lighting, and the watery scenes at The Oval cricket ground which many will have seen on television. The rainfall pattern is illustrated in figure two, and its complexity is indicative of the number of separate storm-cell clusters which constituted the event. Once again rain fell on both rainfall days but in the eastern half of the area under consideration all the rain fell after 0900 GMT. The first two storms to develop were the most severe and both affected the Northampton area, one between 0530 and 0600 when 30 mm fell at Ravensthorpe, and the second between 0645 and 0715 when 22 mm fell at Northampton. The largest precipitation totals to hand are as follows:

Northampton Area		*East London — mid-Herts*	
Pitsford Reservoir	100.1	Finsbury Park	53.1
Northampton (West Bridge)	85.0	St. Albans (Tyttenhanger)	47.6
Ravensthorpe Reservoir	83.5	Hatfield	46.8
Northampton (Centre)	74.4	Potters Bar (North Mimms)	46.7
Litchborough	69.6	Breachwood Green (east of Luton)	46.4
Northampton (Westone)	66.5	Walthamstow	45.9
Northampton (Moulton Park)	61.7	Barnet (Tudor Park)	44.0
Market Harborough	46.1	West Ham	43.8
Castle Ashby (nr. Wellingborough)	45.9	Southgate	43.7
Elsewhere			
Rickmansworth (Batchworth)	44.2		

Urban flooding occurred widely, notably in Northampton; there was also extensive flooding of agricultural land in the flood-plains of the Nene and Welland rivers.

29 JULY 1980

The storm of 29th developed on a northward-moving cold front at the end of a warm, very humid day. There appears to have been at least four distinct rainfall cells, and it is interesting to note that rain in the Northampton area began less than one hour after it started in Luton and Stevenage. At the Water

Research Centre, Stevenage, 38.0 mm was recorded by the autographic gauge (40.8 mm in the check-gauge), of which 37 mm fell in 50 minutes, 35 mm in 38 minutes and 20 mm in 14 minutes. The heaviest falls were:—

Breachwood Green (6 km east of Luton)	50.4
Hitchin (Queen Street)	41.8
Stevenage (Water Research Centre)	40.8
Stevenage (Broomin Green)	40.4
Pulloxhill Waterworks (13 km north of Luton)	40.7
Northampton (Centre)	38.6
Great Offley (near Hitchin)	37.2

This storm will be remembered for the suddenness of its arrival, the frequency and intensity of electrical activity, and for the torrential rain. The distribution of rainfall is shown in figure three, an interesting feature of which is the steepness of the isohyetal gradient east of Luton, where Luton Airport recorded 23.8 mm, 26.6 mm less than Breachwood Green just three kilometres distant.

7 AUGUST 1980

An isolated thunderstorm in the Bedford district on 1st August was described as the most severe of the summer by local inhabitants but no falls exceeding 25 mm were reported.

On 7th a complex thundery trough was slow-moving over the Midlands and East Anglia, and produced widespread thundery rain and some thunderstorms. Over 100 mm fell over a small area of Norfolk (Lyall 1980). In the south-east Midlands, over 25 mm occurred widely in the northern half of Northamptonshire and adjacent parts of Leicestershire, with over 50 mm affecting a small area between Leicester and Corby.

14-15 AUGUST 1980

Although electrical activity was frequent over a prolonged period, most lightning discharges were within the cloud mass, so that, as a series of thunderstorms, this event was probably less memorable than its predecessors. On the other hand, as a rainfall event this was undoubtedly the culmination of a particularly wet early and mid-summer.

The distribution of rainfall on 14th August (although rain continued after midnight, it had died out well before 0900 GMT on 15th, hence the whole fall was credited to 14th) is illustrated in figure four. Sporadic outbreaks of moderate rain were noted during the late afternoon and early evening, but nearly all the fall was the result of a series of northward-moving rain cells between 1930 and 0500 GMT. In west Hertfordshire and south Bedfordshire the period 2100 to 2300 GMT was the wettest with further relatively small additions between 0230 and 0330 GMT. At Luton, for example, 2 mm fell before 2100, 50 mm between 2100 and 2245, and 2 mm later in the night. A similar regime was recorded by automatic gauges in Cambridgeshire, east Bedfordshire and east Northamptonshire; for example at Peterborough 39.5 mm fell between 2050 and 2350 GMT and 8.5 mm between 0250 and 0540 GMT. By contrast, west of the belt of heaviest precipitation, a much larger proportion of the total fell after 0200 GMT. At Northampton (West Bridge) for instance 21.5 mm was recorded in three distinct outbreaks between 1915 and 2340 GMT and 32 mm between 0200 and 0400 GMT. As might be expected, the wettest areas had appreciable falls both before and after midnight: at Corby 32.5 mm fell between 1920 and 2350 GMT and 34 mm between 0250 and 0445 GMT.

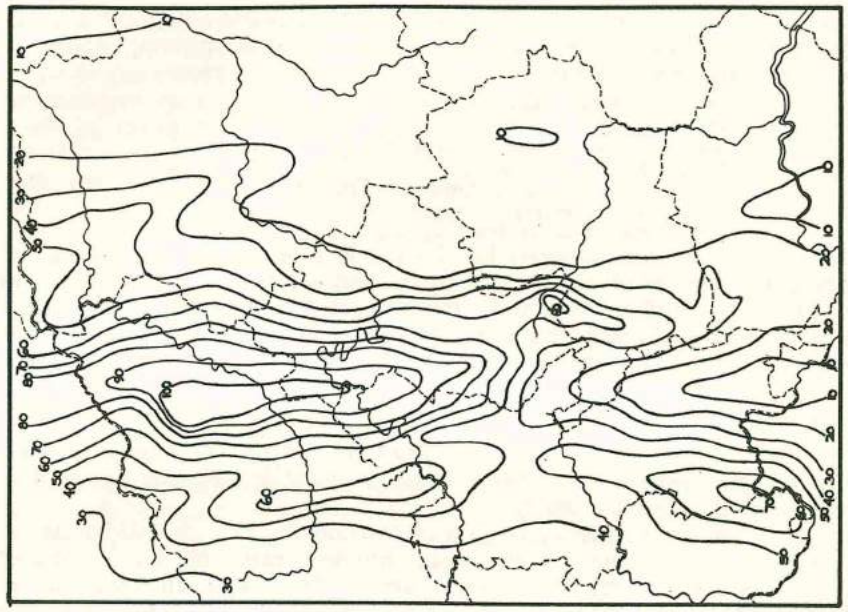

Fig. 4. Distribution of rainfall on 14 August 1980.

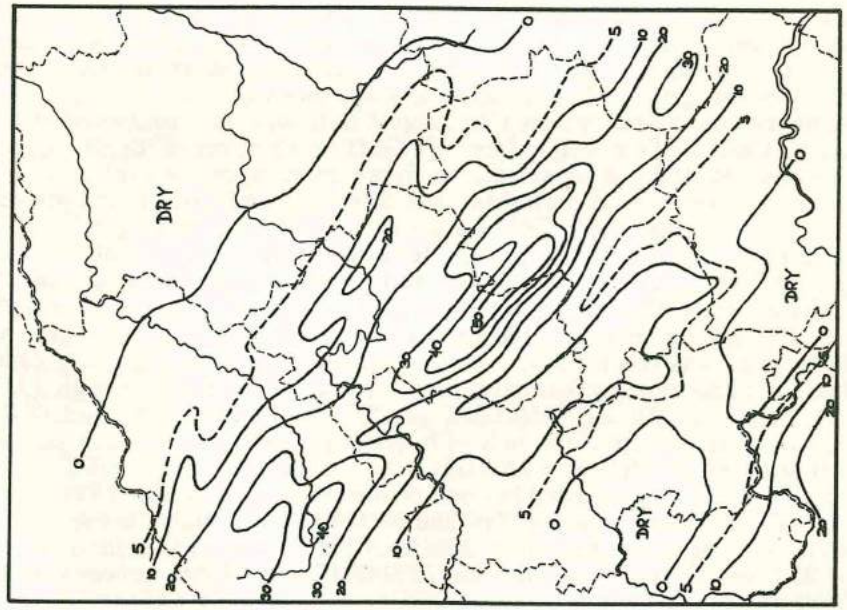

Fig. 3. Distribution of rainfall on 29 July 1980.

As well as urban flooding in such widely separated towns as High Wycombe, Luton, Northampton and Grantham, there was again extensive inundation of the flood-plains of the Ouse, Nene and Welland rivers. According to the Welland and Nene Rivers Division of the Anglian Water Authority, river discharges in the Nene catchment reached the highest summer levels on record, and indeed were only significantly exceeded in March 1947 when heavy rain and excessive snowmelt combined to produce the disastrous floods which affected many different parts of England. That the flooding did not this time seriously affect the downstream Fenland district was a result of both complex river-flow regulation developed over relatively recent years by the water authority and also the coincidence of maximum river flows with low tidal levels in The Wash.

The largest rainfall totals on both 26th July and 14th August fall beyond the limits of reliable calculation of return periods by either the Bilham formula or the Flood Studies Report method; suffice it to say that such falls are likely to occur once in more than one thousand years. 80 mm was exceeded at the following stations:

Weekley (near Kettering)	101.7
Higham Ferrers	98.7
Olney (Brayfield House)	97.1
Wellingborough (Nene Wharf)	95.2
Sharnbrook (Colworth House)	88.3
Woburn Experimental Farm	85.8
Rutland Water	85.2
Kettering	84.8
Thrapston (Islip Sewage Works)	82.7
Wellingborough (Wollaston)	81.3
Sherington (near Newport Pagnell)	80.0

20 SEPTEMBER 1980

Heavy thunderstorms affected many parts of England between 19th and 22nd September, and on the evening of 20th intense rainfall affected a band extending from the western Home Counties to the west Midlands. In the south-east corner of the study area Slough recorded 34.2 mm, High Wycombe 27.3 mm, nearby Hughenden 26.2 mm and Datchet 25.4 mm, indicating much heavier falls across the Thames in Berkshire and Surrey.

15-16 OCTOBER 1980

A prolonged frontal rainfall affected all of southern, central and eastern England on 15th and 16th October. An active depression crossed south-east England, the centre tracking northnortheastwards across London, Hertfordshire and Cambridgeshire, with warm, moist air aloft having been advected northwards from the west Mediterranean. 25 mm fell over a very extensive area including almost the whole of the area under study. 40 mm was exceeded over much of Greater London and some peripheral parts of Hertfordshire and Buckinghamshire:

Hampstead Observatory	51.7
Kew Observatory	45.8
Heathrow Airport	45.4
Stanmore (Canons Park)	45.4

Rain began during the evening of 15th, and largely died out between 0900 and 1200 GMT on 16th, but most of the total is credited to the rainfall day of 15th.

Acknowledgements. The data used in the compilation of this study were acquired from the relevant river divisions of the Anglian and Thames Water Authorities and from many schools, colleges and private individuals too numerous to mention but to whom the writer's appreciation is extended. A few data were also obtained from the Bulletin of the Climatological Observers Link and from the Meteorological Office.

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MYSTERY SPIRALS IN A WILTSHIRE CEREAL-FIELD

By G. T. MEADEN
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Last summer three nearly-circular, flattened areas were noted in adjacent cereal fields in west Wiltshire below the famous Westbury White Horse landmark. The first appeared in mid-May, probably during the third week, and was destroyed in July, when the grain was harvested before an investigation could be made. The others were formed in the last part of July in another field about 400 metres from the first, and were seen by thousands of visitors to the White Horse and ancient British fortifications known as Bratton Castle. These two slightly-eccentric circles, referred to here as number 2 and number 3, were about 120 metres apart, at a position 2 km ENE of Westbury town-centre and 8 km SE of Cockhill House, Trowbridge, their approximate grid reference being ST 895518. A photograph of no. 2, and a press report, appeared in *The Wiltshire Times* on Friday 15 August 1980. Next day, Ian Mrzyglod and Mike Seager of NUFOR (South-west) visited the depressions, with the consent of the farmer Mr. Scull, and took numerous measurements and photographs, besides interviewing Mr. Scull on this and later occasions. Technical details were published in the magazine *Probe*, vol. 1, issues 2 and 3 (published at 16 Marigold Walk, Ashton, Bristol, 60 pence each). A summary of the main points, with photographs and drawings, here follows, with acknowledgement to Mr. Mrzyglod for the basic information, drawings and photographs.

No. 2 was discovered on the morning of 21st July and no. 3 on the morning of 31st July according to Farmer Scull (Fig. 1). The depressions were slightly different in size and had slight differences with regards to shape and 'bed'. Number 2 was the larger of the two, measuring 64 feet 6 inches (19.35 metres) across its greatest diameter, whereas number 3 measured 58 feet 6 inches (17.5 metres). As can be seen from Figure 2, neither depression was a true circle, the eccentricities being 80 and 93%. The beds consisted of flattened oats, although number 2 had small patches where the oats were still standing at heights between 45 and 105 cm. In both cases, the oats were flattened at ground level in such a way as to create a spiral effect extending *away from* a centre in a clockwise direction. The centres of these spirals were not at the centres of the flattened areas. The stalks, although bent, appeared otherwise undamaged, as if the flattening had been caused by air pressure. There were

Fig. 1. (Lower). Taken from the centre of the second spiral, 28 days after its discovery (in the foreground some oat stalks can be seen which have attempted to stand up).
(Upper). Close-up showing the centre of the third spiral (photographs by I. Mrzyglod).

no scorch or burn marks, nor any tracks except for the small tracks made by the investigators and a few sight-seeing tourists. Samples of the stalks were sent to British University for spectroscopic analysis and radioactivity checks, but all tests proved negative. A notable aspect of both flattened areas was that the perimeters were formed without tapering; that is, the oats were flattened to a mean level of 7 cm (3 inches) right to the perimeter where they stood at an average height of 105 cm(3 feet 6 inches). The transition was abrupt; one stalk was bent to the ground, the next was upright. As late as 16th September I returned to the sites to photograph the two areas in relation to the nearby steep hillside in which the White Horse is cut. The oats had been harvested a long time before, and a part of the field had even been stubble-burnt. Yet, site no. 2 was easily visible, the remaining stalks being parallel to the ground and several centimetres in length. The clockwise spiral and its centre showed up well, and the whole diameter could still be paced out.

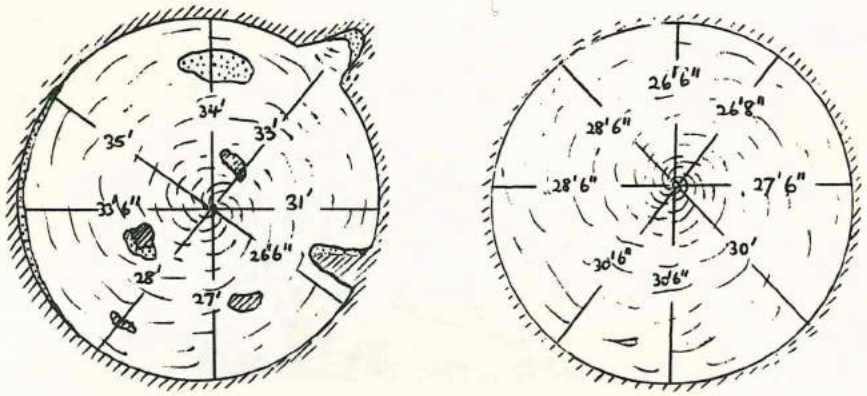

Fig. 2. Measurements by I. Mrzyglod of spiral areas number 2 (left drawing) and number 3 (right), (not to scale). Hatched area: oats at 3 feet 6 inches (105 cm); dotted area: oats at 1 feet 6 inches (45 cm).

INTERPRETATION

As we know of no eye-witnesses who were present at the time that the phenomena were occurring, it is necessary to interpret foregoing evidence as best we can. Firstly, there is the question of the days and the times of occurrence. The dates were worked out during two or three interviews conducted in the second half of August. While there could be some possibility of a slight error in the dates, it is certain that the first occurrence was in May, and probable that the second and third occurrences were on different dates a few days apart and close to 21st and 31st July, which were the dates of discovery.

The most natural explanation which comes to mind is that the near-circular flattening of the oats was caused by whirlwinds. Suitable atmospheric conditions for the formation of fair-weather whirlwinds occur quite frequently in the spring and summer months in England. There were many such days in 1980, especially in the third week of May and the last half of July. Included among such days were certainly 30th and 31st July.

Many fair-weather whirlwinds have their origins in an invisible column of rising warm air called a 'thermal' which, for some reason or other, acquires the additional characteristic of rotation. In a typical thermal, air rises upwards as a column without significant rotation, and it does this in the presence of the horizontal wind-of-the-day. The transition from thermal to whirlwind happens in the presence of a wind-shear régime. The latter commonly occurs when one air mass is being overrun and displaced by a new air mass having a different wind direction, temperature and humidity. For a short while there is a local wind-shear which rotates the thermal and triggers the whirlwind. Often, the whirlwind becomes mobile, travelling either in the same direction as the new wind or along the frontal boundary. Less often, the whirlwind's position remains almost, if not completely, stationary during its short life which is usually less than a minute, and it would appear probable that this is what took place below the Westbury Hills. In fact, there is a possibility that the proximity of the very steep hill immediately to the east and south helped to stabilise the axis of rotation of each of the whirlwinds. Whirlwinds typically have life-times ranging from a few seconds up to a minute or so. During their

Fig. 3. Airflow in a tornado (from A. Wegener, after Sandström).

life they grow in diameter up to some maximum point, and then lessen in diameter again. The streamlines of the airflow in a tornado, which usually has cyclonic, anti-clockwise rotation, are indicated in Figure 3 (taken from A. Wegener's *Wind- und Wasser-hosen*). The windflow in a fair-weather whirlwind would be similar to this, and either clockwise or anticlockwise. Diameters commonly range from one metre to 20 metres or more. A small one is shown in the photograph in Figure 4, taken at Woodside, Hertfordshire, on 10 July 1976. One may judge by the behaviour of the spectators in the photograph that the whirlwind had been nearly stationary for some time, and that when the picture was taken the whirlwind may have been moving very slowly towards the right. Whirlwinds of 20 metres diameter have been seen and photographed by the present author (*Weather*, vol. 36, pp 47-48, 1981), and on that occasion one was as large as 40-50 metres diameter (q.v.). Descriptions of still larger, more powerful whirlwinds abound in the literature, and TORRO has descriptions of a great many on file.

Reference to the *Daily Weather Report* and to my own station records indicate that the weather in the third week of May and the last part of July was frequently suitable for the formation of whirlwinds. TORRO has whirlwind reports for May 16th and 18th and July 24th and 31st from parts of southern Britain (and would be glad to be told by readers about any other whirlwind days of which they know). We would certainly expect 30th and 31st July to be potentially suitable days for whirlwinds in the Westbury region, and also 20-24th and 27-28th July.

Two other suggestions have been made concerning possible origins of the circularly-damaged areas in the cereal fields: the effect of a tornado funnel cloud or of a hovering helicopter. However, it is usual for a tornado funnel to rotate anticlockwise and to leave a winding trail; they are much rarer phenomena than summer whirlwinds and are unlikely to recur so soon three times in the same area, as are common whirlwinds. Helicopters cause an intense downdraught which would damage the crops, especially in the perimeter region, in quite a different and more drastic fashion.

Fig. 4. A fair-weather whirlwind (land-devil) at Woodside, Hertfordshire, on Saturday, 10 July 1976.

TORNADOES AND GIANT HAIL IN QUEENSLAND 15 AND 16 DECEMBER 1980

On successive days severe storms struck the Brisbane area of south-east Queensland. The damage in Brisbane, Ipswich, Archerfield and other towns on the second day approached 10 million Australian dollars. The following accounts are from the *Brisbane Telegraph*, sent by L. S. Laskey.

MONDAY, 15 DECEMBER 1980

People in areas of south-east Queensland were cleaning up today after the largest and most severe storm of the season hit the region late yesterday (15 December) and early today. The Brisbane Weather Bureau had forecast more

storms later today and tonight.

The storm developed late yesterday on the southern Darling Downs, and moved north-east with severe lightning, strong winds and heavy rain. Many houses and buildings were damaged, trees uprooted and power lines brought down. The South-East Electricity Board reported at least 40,000 homes were blacked out and some areas were unlikely to have power restored before midday today.

The worst affected area was at Warra near Dalby, where residents described the storm as a tornado. Mrs. Norma Wunsch, of Warra, said the storm winds lifted a 65-year-old Roman Catholic church two metres off its stumps and smashed it to the ground.

Hail was reported to be up to 8 cm in diameter in some areas. A State Emergency Service spokesman said the storm damaged many buildings from Minden and Marburg through Ipswich to Redbank Plains. A school is believed unroofed at Mount Walker, near Rosewood.

In Brisbane, a man was struck and killed by an electric train. Police said the man had crossed the railway line in heavy rain at Grovely station when he was struck.

Maximum wind gust recorded at the Bureau was 70 km/h at 6.30 p.m. Eagle Farm recorded a maximum wind gust of 55 km/h. Brisbane received 49.8 mm of rain. Highest suburban rainfall total following the storm was 84 mm at Browns Plains. The highest recorded rainfall in the metropolitan area during the 24 hours until 9 a.m. today was 84 mm at Acacia Ridge.

6800 lightning strikes to ground.

A total of 6800 lightning strikes were tracked to ground in south-east Queensland between noon and 9.30 p.m. yesterday. The strikes were in the area from the New South Wales border to about Dalby and north-east to Gympie. They were tracked by the new $70,000 lightning strike location equipment set up by Queensland University.

A world expert on lightning, Professor Mat Darveniza said: 'It was not as severe as some storms we have had, but it was the first severe storm we were able to plot.'

The equipment, an extension of radio direction finder units used during World War II, allows accurate location of storm cells by reading lightning as short radio transmissions. Directional finders set up at Redbank Plains, Oakey Airport and an area just north of Maleny were used to pin-point accurately each lightning strike.

Professor Darveniza said that the unit would be operated 24 hours a day and would be of great use to electricity and telecommunication authorities. The unit again would be tracking any possible lightning from forecast storms in the area later today and tonight.

TUESDAY, 16 DECEMBER 1980

The first rays of sunshine today played on a picture of desolation in the Brisbane northern bayside suburb of Brighton. Yesterday's (i.e. Tuesday's) fierce storms and hail had stripped foliage from trees, torn paint from houses, shattered windows, twisted iron awnings, and holed roofs. About 860 houses in Brighton were damaged, and 70 in Inala. Many residents spent the night mopping water from their homes.

State Emergency Service volunteers today were helping repair the damage. An SES official said tarpulins were available from the Brighton State School.

Mrs. Florence Martin, of Craig Street, said she was still in shock today following the storm. "I was sitting in the loungeroom when it started," she said. "The hail was small at first, then it just grew and grew. One lump about the size of a cricket ball smashed through the front plate-glass window. When the hail started pouring through the shattered window into the lounge, I ran into the bedroom."

She shut herself in the bedroom, but the hail was bouncing about 5 m across the lounge and pounding on the bedroom door.

Most residents have turned off the power supply to their houses because ceilings are saturated. Many have freezers packed with food for Christmas.

Insurance companies estimated storm damage in Brisbane and Ipswich at $7.5 million. And Insurance Council of Australia regional manager, Mr. Tony Carter, said a check in Ipswich, Inala, Archerfield and Brighton indicated the damage was likely to reach $10 million.

"Never before have we witnessed such a concentrated path of destruction as was left by the storms yesterday," he said.

An SGIO spokesman said that because of the extent of damage in the Brighton area his company had decided to send a "task force" there. They would work from an office in Brighton Road, Sandgate, to handle the flood of claims. A State Emergency Service official said today more than 900 houses had been damaged yesterday.

Light planes were smashed, cars damaged and houses left with windows and roofs shattered and holed. For the second night in succession, about 40,000 homes were blacked out.

Path of the Storm

At Archerfield, where two tornadoes hit in succession just after 3.30 p.m., 25 planes were destroyed and another 14 damaged.

The first tornado struck Archerfield aerodrome at about 3.30 p.m. First warning of the storm was given when meteorologists sighted a funnel-shaped cloud south of the Air Force base at Amberley.

A second funnel-shaped cloud was sighted north-west of the base and a warning issued of storms and tornadoes. It was the second tornado which did most damage. The aircraft had been tied down and only a few planes had been overturned by the first blow.

"We had just come out to clean up when the second one hit," a man at the aerodrome said. He said the planes were tossed about "like a pack of cards." Winds were estimated at 150 km/h during the second tornado. A man was injured trying to hold down a light aircraft. He was Mr. Don Martinez, of Rocklea, who was taken to Princess Alexandra Hospital with a cracked

vertebrae, abrasions and bruising. Damage to the aircraft was estimated to be at least $1 million.

Brisbane Weather Bureau officials said last night's storms and tornadoes developed in a band of unsettled atmosphere over the Darling Downs.

PREVIOUS QUEENSLAND TORNADOES

Yesterday (16 December) was the 24th recorded occasion in the past 28 years that tornadoes had struck Queensland. And according to Brisbane Weather Bureau records, south-east Queensland is the prime target.

Recorded Queensland tornadoes in south-east Queensland included Yuleba, east of Roma in 1973; Toowoomba, Bundaberg and Irvingdale near Dalby in 1972; Noosa, Kin Kin and Maroochydore in 1971; Buderim in 1964; Redlands in 1963 and Rosewood in 1961.

The Brisbane area had a tornado in 1973 which ripped through Brookfield, Saint Lucia, Mount Gravatt and MacGregor causing hundreds of thousands of dollars damage and one at Redcliffe in 1977.

A weather bureau spokesman said that tornadoes usually were associated with severe thunderstorms. "That's why south-east Queensland is more likely to get them. The area generally is susceptible to severe storms." He said that where there was an area of widespread storms an isolated area of low pressure could develop. This area then could begin rotating and the typical tornado funnel could develop. Last night's storm cell was about 17,000 metres high.

MONTHLY FREQUENCIES OF OUTDOOR SKATING CONDITIONS IN SOUTH HUMBERSIDE 1947-1980

By P. C. SPINK
Thornton Hall. Ulceby, South Humberside

Abstract. An analysis of monthly skating frequencies since and including 1947 has revealed a steady decline over the three decades, a tendency which is continuing up to the end of 1980. Any month during which skating was possible, even if only for one day, qualifies for inclusion.

When looking at my rusting skates the other day, it occurred to me that it is some time since there was an opportunity to use them. So, while investigating my weather records over the period 1947-1980 in order to check on C. R. Finch's 37-degree (F) minus Rule for determining the likelihood of a subsequent cold winter from December's temperature (*C.O.L.*, no. 128, December 1980), I noted the months during which skating was possible during this period. These were as follows:

November 1; December 7; January 14; February 8; March 3.

When analysis of decadal frequencies is made, an interesting trend emerges.

1946/57 to 1955/56	13 months
1956/57 to 1965/66	10 months
1966/67 to 1975/76	8 months
1976/77 to 1979/80	2 months

It will be seen that the trend is consistently downwards. The best skating winters occurred in the first decade. In 1946/47 there were three successive months, the thaw not occurring until 15th March. The 1952/53 winter was notable for the only occasion when rare November ice was available. This ice

was of lovely quality because there had been no snow to spoil it. There was also skating in December 1952 for a short period, but January and February were negative.

Perhaps the most memorable winter was 1955/56 which covered January and February. The month of February was particularly cold with a mean temperature below —1 °C. Skating became a habit every weekend; so much so, that the Sunday car-load of children that I took to a large lake on a neighbouring estate became known as the 'Skating Special'.

Notable too was the 1962/63 winter, which began early in December with perfect ice before the snow arrived and after a short thaw resumed, allowing the rarity of a pre-prandial skate on Christmas Day (as also occurred in 1961). January was a very snowy month, the dormitory factor being the Greenland High, and we witnessed the unusual sight of the Humber estuary full of large ice-floes carried forth and back by the tides. The banks were covered with large deposits of ice. The final skating in 1962/63 was on 4th March which marked the end of a 12-week frost.

There were no outstanding frosts during the next eighteen years, and only a short period of February 1978 with its heavy snowfall approached in severity some of the winters of the period 1946/47 to 1962/63.

It is of interest that all the good skating winters were well prognosticated by Finch's Winter Rule.

SOME RAILWAY ACCIDENTS CAUSED BY THE WIND

The following is from a letter by Mr. Nigel Pennick, of the I.G.R., 142 Pheasant Rise, Bar Hill, Cambridge.

One of the strangest railway accidents on record in Britain took place on Friday, October 30, 1863. At about 3.30 p.m., the engine shed of the London, Brighton and South Coast Railway at New Cross in South London was struck by a blast of wind. The doors were open at the time, and the wind, unable to escape from the confined space, lifted the roof bodily, and blasted open the walls. The roof then fell back upon the debris. The adjacent running line was blocked with debris, and the engine of a passing train was slightly damaged.

The building was 145 feet long by 42 feet wide. It was strongly built of brick work 14 inches thick, strengthened by 23 inch buttresses every 21 feet, yet the sudden blast of wind reduced it to a pile of smashed bricks. The seven locomotives stabled in the shed were covered with rubble. One, number 111, was derailed and severely damaged, being overturned into the ash pit between the rails. The driver and fireman escaped by scrambling into the pit beneath the engine as the roof came in, but a cleaner was crushed to death between the wrecked locomotive and the rubble.

The survivors were dug out of the debris, having been completely trapped. Details of the accident, an eye witness account of the scene an hour after the disaster, can be found in *Historic Locomotives and Moving Accidents by Steam and Rail*, written by Alfred Rosling Bennett, 1906. A photograph of the wrecked shed and locomotive appeared in *The Railway Magazine*, Jan/Feb. 1945. If any reader has any further information on wind accidents to railway premises or vehicles, I would be interested in hearing about them.

The grid reference of New Cross railway station is TQ 366772, just south of the River Thames, near Greenwich. It appears that a tornado of approximate TORRO force 5 was the cause of the incident.

There have been numerous occasions during the last 150 years when tornadoes have damaged railway property, more or less severely. An article summarising them may be prepared for a future issue of this journal. The latest occasion was on 3 January 1978 when a signal box at Newmarket was damaged beyond repair. On 8 December 1954 a tornado damaged property along a 20 kilometre track through west and north-west London (Brentford, Chiswick, Gunnersbury, Acton, Willesden, Golders Green, Hampstead, and Southgate). Houses, shops, and factories were badly damaged or destroyed by the TORRO 7 tornado. Six passengers who were on the platform of Gunnersbury station were injured when a part of the canopy roof was blown on to the track causing a short-circuit. They were taken to hospital, as was a pedestrian crushed by a falling 50 yard brick wall nearby. In the Chiswick area twelve houses had their roofs blown off, and in others walls were blown out. Over 40 homes were badly damaged in Acton and twelve people injured. In Acton Vale the side of a house fell into the main Uxbridge Road (*The Times*). In Acton a motor-car was seen 'floating' some five metres in the air.

The worst wind-related accident in British railway history was certainly the Tay Bridge disaster of 28 December 1879. As indicated elsewhere (see *J. Meteorology*, vol. 2, p. 57, 1976-77), it is believed that two tornado/waterspout columns destroyed the 3.5 km bridge at 1915 while the train, and its 75 passengers, was crossing it.

G. T. M.

EFFECT OF RECENT CLIMATIC CHANGE ON FARMING PRACTICE IN NEW ZEALAND

I would like to draw your attention to an interesting paper by R. G. Vines and A. I. Tomlinson which discusses New Zealands rainfall in relation to sun-spot activity(An analysis of New Zealand's rainfall 1894-1975. *N.Z. Journal of Science*, vol. 23, 205-216, 1980).

It has been my contention for a very long time that the simple airflow patterns of the Southern Hemisphere should make it relatively easy to make long-term forecasts. In this paper we have Tomlinson predicting quite strongly that 1983-6 may be a period of generally dry weather based on sun-spot activity and past records.

In 1979 I attended the ANZAAS Symposium on Food Production and Climatic Change at Auckland and was impressed by Professor P. D. Tyson who presented a very interesting paper on, "The Nature of Recent Climatic Changes over Southern Africa". He also felt that there was sufficient evidence available to make long-term preparations for periods likely to experience greater or lesser periods of rainfall or drought. Such predictions do of course have very large practical and political significance. In New Zealand at present there is a great debate about the establishment of a second aluminium smelter in New Zealand based on our so-called *cheap* and plentiful natural resource. hydro-power. Should this smelter go ahead it is likely that demand for power will be somewhat ahead of hydro development projects to service it and the

critical years of power supply could well be in 1983-6 just when hydro inputs could well be very low.

Agriculture also responds to these oscillations of rainfall and influences considerably farming practice in the form of stocking numbers and fodder production or conservation. As an area changes to more intensive land use such as horticulture, so cultural requirements become more demanding, irrigation development can be influenced, and research carried out over a five or six-year period can become irrelevant as the rainfall regime and possibly-related phenomena also change.

The following is an example based on Lincoln College, Canterbury, records for two consecutive seven-year periods during which time I conducted research in the field.

	Mean Total	Long Term Mean	% Normal
1967-73	574 mm	662	85%
1974-80	778 mm	662	117%

We can make these totals more interesting by dividing the months into: (a) Very dry — less than 50% of the mean; (b) Very wet — double the mean.

	Wet Months over 100 mm	Dry Months under 25 mm	Total Extreme Months
1967-73	5	20	25
1974-80	14	13	27

The number of extreme months is very similar. The first seven years show a preponderance of dry extremes whereas the second seven years show a much greater degree of extremes. In fact, the 1974-80 period will be remembered for the worst floods and the worst short-term droughts on the record. Can we look forward now to more settled conditions?

Looking more closely at the record, it is found that the real drought years were only of five years in length whereas the unsettled period has extended to the present time, and become increasingly unsettled, thus:

		Wet Months over 100 mm	Dry Months under 25 mm	Total
1969-73	5 yrs	2	18	20 months
1974-78	5 yrs	8	6	14 months
1979-80	2 yrs	6	7	13 months

During this last two-year exceptional period all the wet months occurred prior to March 1980 and all the dry months since March 1980. It was the driest May on record, the driest September on record and very close to one of the driest Octobers on record, making it certainly the driest spring on record. Since then there has been a return to the cooler, wetter weather with above average rainfall, thankfully, in November, and this is continuing in December.

If we can believe the figures of Tomlinson et al. then the "rains" are over and we can increasingly expect months to be drier rather than wetter.

In April 1968 a great tropical hurricane swept through New Zealand and became known as the "Wahine Storm" because it sank the interisland ferry with the loss of over 60 lives and brought over 200 mm of rain to Canterbury. This was the last memorable rainfall until February 1974 when I photographed the first north-east rain front I had ever seen moving into Canterbury (I moved to Canterbury in 1966). The great Christchurch flood of April 1974 followed

and has been repeated with regular monotony during the last seven years, the most recent being January 1980.

Horticultural clients of mine had never seen *blight* on potatoes, tomatoes, etc., until 1974 and since have had to invest in expensive spraying equipment to combat this new cultural challenge. Black spot or scab on apples, previously easily controlled, became a real problem due to lack of experience with the disease. On the credit side grass growth exploded and pasture pests have been relatively unimportant as a result over the last five or so years.

My own message to potential horticulturists has had to be changed from: There is no possibility of reliably growing horticultural crops in Canterbury *without* irrigation, to: Make sure your soil has good drainage characteristics, no soil pan, etc.

Perhaps farming practice over the years gives a truer reflection of climatic change than actual climatic records.

Certainly many farmers in Canterbury have spoken of rainfall patterns, harder winters, etc., over many years. Now it appears they may have been right.

Dept. of Horticulture,
Lincoln College, Canterbury.

R. A. CROWDER

SEA-FLOODS CLAIMED LINCOLNSHIRE CHURCHES

From an article last year in the *Louth Standard* we learn that the Lincolnshire town of Sutton-on-Sea was for many centuries (until about 1890 in fact) known as Sutton-in-the-Marsh or Sutton-le-Marsh. The Domesday Book name was Sudtune. This parish, like its sister parishes of Trusthorpe and Mablethorpe, has suffered greatly from the ravages of North Sea storms.

The *Chronicles of Louth Park Abbey* relate the great disaster of January 1287.

"On the night of the Circumcision, a great storm arose, the heavens opened and mountainous seas descended upon the coast, rending asunder the Church of St. Peter's, Mablethorpe and flooding over the land."

They go on to speak of extensive flooding in the Fens and it must be assumed that the churches of Druistorp (Trusthorpe)and Sudtune were also lost, as it is recorded that a great quantity of land was permanently lost to the sea.

Trusthorpe Church, so far as we know, was never seen again. Mablethorpe St. Peter's remained in a state of ruin for many years and there is a record in 1502 that the tenth Lord Willoughby d'Eresby ordered the lead to be stripped from its roof.

In the year 1800, Sutton received a visit from the great naturalist, Sir John Banks, who lived at Revesby Abbey. Of his visit he writes of having seen small islets or mud banks off shore in this village, the locals giving them the peculiar name of Hutts. Some of the village "ancients" told Sir Joseph that the foundations of the old church had been visible at low tide until about 1750.

"There is a deep water channel off the coast at Sutton, which possibly accounts for the sea striking harder in the Sandilands area. If you take a course out to sea from here, running slightly nor-nor-east, keeping the Inner Dowsing Light to your right and the large area of the Protector Overfalls on your left, you will be in an area of reasonably deep water, almost half-a-mile wide and six or seven fathoms deep.

In mid-Victorian days, it had been planned to build a very extensive harbour and deep water dock at Sutton.''

METEOROLOGICAL STAMPS REPORT: Part 2

By R. A. AUSTIN
Trident House, Hatfield Town Centre, Hertfordshire

The continually-growing demand for energy throughout the world has resulted over the past few years in research into 'alternative sources' of energy. Among these sources are those based on the workings of the weather and atmosphere. Several recent stamp issues reflect this awareness of the use of wind, sun and waves, and a few such items are illustrated here.

Windmills have, of course, a long history, appearing in Europe by the thirteenth century for pumping or grinding applications. Modern windmill prototypes are being used to harness electricity with projects already underway in the United States and in Holland. Figure 1 shows a stamp issued by

1.

2.

3.

4.

5.

Sweden in 1980 featuring a wind blade and weather map symbols, while Figure 4 depicts an Irish stamp of 1979 marking International Energy Conservation Month.

Solar energy is already being put to a wide variety of uses, from satellite power to domestic heating. Solar panels are shown on an Italian stamp issued in 1980 to promote energy conservation (Figure 5), and solar energy is also the subject of Figure 2.

Wave power is another energy source with largely untapped potential and is the subject of Figure 3. The three Swedish stamps illustrated are part of a set of five featuring 'renewable energy resources'.

Stamps such as those mentioned form an interesting sideline collection to a general meteorological theme, and seem likely to become more plentiful as programmes of energy research and conservation grow in importance.

VARIOUS HAPPENINGS

NEW ZEALAND TORNADOES

On 16 August 1980 a major cold front passed eastwards across New Zealand with rain falling over most of the country. A tornado in Onehunga (Auckland) caused considerable damage and resulted in the death of a woman.

During the early hours of 10 September, violent thunderstorms occurred in western North Island areas. In north Taranaki a tornado extensively damaged farm buildings, and caused power blackouts and loss of stock. *New Zealand Gazette.*

SEPTEMBER STORMS IN ONTARIO

A sharp cold front on 2 September 1980 brought heavy showers and high winds to the Toronto area, and several buildings under construction in the eastern suburbs were lifted from their foundations resulting in the death of three construction workers. Another cold wave on the 17th produced a number of waterspouts on Lake Ontario. Five days later, tornado funnel clouds touched down in the Stratford and Woodbridge areas.

COLDEST CHRISTMAS THIS CENTURY

Christmas Day 1980 was the coldest of the century for all of Ontario as temperatures plunged to —25 to —40 °C. Toronto City had not recorded a colder Christmas since 1872. Record minima for December were set at Dorval (—32 °C), Sherbrooke (—38 °C), and Maniwaki (—38 °C) as well as at several other locations in Quebec. Several places set new record December mean temperatures. Canada's lowest temperatures of all was at Mayo in the Yukon, —52.6 °C on 27th (December mean temperature —38.8 °C, 15 degrees below normal). *Canadian Weather Review.*

ANOTHER ICE-BLOCK FALL

A lump of ice twice the size of a person's head fell down from the sky into the vegetable garden of Mrs. Elizabeth Cross, of Scaberia, Bodmin Road, Truro, on Tuesday, 10th February, 1981. The ice fragments, which have unusual air hole patterns, were taken to St. Mawgan for analysis. (From the *West Briton*, sent by P. Richards).

PINK DUSTFALL

Mr. J. S. W. Richardson of Bessbrook, Newry, Northern Ireland, reported

that pink dust like flour was visible on motor cars on Thursday, 29 January 1981. The L.W.C. *Daily Weather Summary* added that similar dust fell in frontal rain along a track about 40 km wide from Northern Ireland to central Scotland.

4-14 JULY AS A PREDICTOR . . .

On p. 318, December 1980 issue, there is a printer's error in the ninth line of the section entitled 'Brumpton's Analysis'. The correct ninth line should read '. . . the chi-squared distribution with nine degrees of freedom, there is no evidence of statistical . . .'

WORLD-WIDE WEATHER DISASTERS: January 1981

1-4: Gales, rain, snow, floods in Scotland and northern England, Scotland worst hit with at least two dead, one on 2nd when blown off rope bridge at head of Loch Nevis, Inverness-shire, the other, on the 3rd, died of exposure at Auldhouse, East Kilbride, near Glasgow. Winds gusted to 113 km/h on 1st, rain and melting snow caused widespread floods in Scotland, worst hit being Ayrshire and north of Inverness, rail-line between Tyndnum and Oban in Argyll cloased by landslides, more snow in Scotland on 4th. *Daily Telegraph, Sunday Telegraph.*

1-8: Bush and forest fires in Alpine valleys of north Italy and along Ligurian coast, large tracts of woodlands and forest destroyed together with a number of holiday villas; since Dec. 20 at least 480 fires in coastal mountain region alone. *Lloyds List.*

1-28: Cold wave, with snow in Kashmir Valley, in many areas of northern India, leaving at least 300 dead. *D.T.*

1-31: Torrential rains, floods and landslides in southern Philippines over the whole month; by 10th 80% of Agusan del Norte province inundated, other provinces seriously affected being Agusan del Sur, Surigao del Norte, Surigao del Sur, Davao del Norte and Misamis Oriental; on 15th floods were reported up to 15 metres deep, with 165,000 homeless; by 20th death toll stood at 103, with 650,000 homeless; at months end death toll over 200, with 700,000 homeless, death toll includes about 100 who died when ferry boat sank off Suirgao del Norte in storms accompanying floods. *L.L.*

1-1 Feb.: Worst blizzard in northern Japan for 18 years left at least 70, possibly 83 dead, thousands homeless, and damage to crops, forest and fishery interest which amounted to $490 million; up to 4 metres of snow fell in some storms, most of deaths caused by avalanches, at least 696 people injured, widespread disruption to road, rail and air communications. *D.T., L.L.*

2: M. bulk carrier *Golden Pine* sank in rough seas, generated by 25 knot winds and waves 5 metres high, in position 32 22N lat, 136 36E long, 25 dead. *L.L.*

2-14: Severe cold spell in north-east U.S.A. caused widespread hardship, some 50 dead from cold or over exertion while shovelling snow, on 12th/13th cold wave hit Florida, causing damage to 20% of state's citrus crop. *L.L., D.T.*

3: Fierce wind storm hit Melbourne, Australia, with gusts up to 83 km/h, buildings unroofed, damaged cars, uprooted trees and caused widespread power blackouts, mainly due to tree branches falling across power lines, although one substation put out of action by lightning strike, at Tullamarine airport wind reached 137 km/h. no casualties. *L.L.*

3: S. bulk carrier *Antiparos* sank in heavy seas off eastern Japan; 35 dead. *L.L.*

3 (reported): Hundreds of forest fires in drought parched state of Louisiana, U.S.A., some 20,000 acres destroyed since fires began at beginning of December 1980, on 2nd/3rd 400 fires burnt 6,500 acres alone. Some 75% of fires set deliberately. *l.L.*

4: Avalanche swept over cross-country ski track between Zuers and Lech, Austria, leaving 3 dead and 2 injured. *International Herald Tribune.*

6-7: Heavy snowfalls stranded hundreds of holidaymakers in Austrian Alps. *D.T.*

6-10: High winds, rain and snowstorms, with sub zero temperatures, in many areas of Greece, many villages isolated in northern and central Greece, widespread crop damage, at least six dead in cold. *L.L.*

7 (reported): Three climbers died on Mt. Cook, New Zealand, two blown off ridge, third died of exposure.

8-16: Bad weather over many areas of Europe; brief review below:—

FRANCE: hit between 12th and 15th, with heavy snows which blocked roads and rail-lines, many people trapped in cars and trains, regions of Aude and Pyrenees Orientales, near Spanish border declared disaster area, damage put at $22 million to power lines, at least one dead.

SPAIN: hit on 11th, when snowstorms hit north and central areas, at least 20 villages isolated and roads blocked.

ITALY: hit by blizzards on 8th, villages in central Italy cut off, snow in Sicily, where Palermo had first heavy snow for 30 years; in north Italy, five missing in Alps, and ten injured in 50 car crash on Firenze-Roma highway, snow also in Sardinia. Severe weather returned on 12th, when winds up to 116 km/h accompanied by rain and snow swept from Sicily to Tuscany, hundreds of buildings damaged and many power lines bought down, blizzards in Sicily described as worst in 19 years, on northern and eastern coasts of Sicily high seas flooded low-lying areas; landslide touched off by rains derailed an express train near Cetraro, south Italy, five cars plunged down embankment leaving 3 dead and 16 injured. On the 16th winds gusting to 100 km/h hit southern Italy and Sicily again accompanied by rain and snow, again power lines bought down, and seas invaded north-east coast of Sicily.

SWITZERLAND: Snow blocked roads in central, west and southern areas.

SWEDEN-DENMARK: Snow blocked many roads and brought down power lines.

WEST GERMANY: On 10th/11th, 170 weather-related road accidents, which left 3 dead and 20 injured. temperatures in Bavaria fell to —13 °C.

AUSTRIA: heavy snow in many areas, avalanches claimed another four dead.

TURKEY: High winds, heavy rain in west, snow and sub-zero temperatures in eastern regions, villages cut off, at least one dead.

10-13: Violent snowstorms in Tunisia, described as worst for 25 years, hurricane-force winds uprooted trees and battered cypress plantations, many areas of country blanketed by snow and roads blocked. *D.T.*

11 (reported): Mississippi river reported to be at its lowest level since at least 1870, due to drought last summer and autumn. *L.L.*

12: Railway embankment subsided near San Sebastian, Spain, after heavy rains; inter-city train derailed leaving 3 dead and 20-25 injured. *D.T., I.H.T.*

13-23: Heavy rain and floods in Sabah state, east Malaysia, described as worst in 10 years, at least 8 dead; thousands homeless and widespread damage to thousands of acres of cocoa, palm oil and other crops. *L.L.*

14: Bus skidded off ice-covered road and plunged into ravine during snowstorm at Serij, Yugoslavia, leaving 3 dead, 6 injured. *D.T.*

14-15: Cyclone 'Arthur' hit Fiji islands, mainly west side of Viti Levu and smaller islands, at least 1,500 houses destroyed and another 1,200 partially destroyed, also widespread damage to sugar crops, no deaths reported, altho' three fishermen missing. *L.L.*

14-31: Torrential rains and widespread floods in many areas of Queensland, Australia, worst-hit areas being in north of state, towns of Townsville, Normantown and Burketown isolated, rivers in flood include the Burdekin, Herbert, Tully and Houghton, many roads cut and motorists stranded, widespread damage to sugar crops. Floods, which followed wettest monsoon season for 10 years, affected area stretching from Gulf of Carpentaria to eastern seaboard and south of Longreach. *L.L.*

17: Mv. *Deniz Sonmez* sank in heavy seas off Crete, leaving 34 dead. L.L.

17: Snow, ice, rain in many areas of U.K. leaving at least four dead in traffic accidents attributed to the weather. *S.T.*

18-20: Snowstorms and avalanches isolated countless Alpine villages and ski resorts in Switzerland, Zermatt one town cut off by avalanches. *B.E.M.*

20-23: Severe weather again returned to many areas of southern Italy, with winds gusting to 100 km/h on Sicily, where high seas again caused widespread damage to coastal areas, high winds also damaged many buildings and whole citrus plantations on the island. On southern Italian mainland blizzards blocked roads and cut off hundreds of mountain villages; in Milzano, raging seas smashed a jetty, broke through tidal barrier and flooded waterfront area. Ferry and phone links cut off to islands such as Stromboli, Ustica and the Lipan Islands. Recent bad weather in Italy described as worst for 19 years, in some regions temperatures down to —27 °C. *L.L.*

21-29: Gales, blizzards hit many areas of northern Greece, many villages cut off with many roads blocked, snow up to 5 metres deep with temperatures as low as —15 °C; gales raging in Ionian and Aegean seas, disrupted shipping; first estimates show that snow in Peloponnese and Crete had destroyed 25% of 1981 citrus crops, in central areas of Greece torrential rains fell in low-lying areas. *L.L.*

21 (reported): Drought emergency declared in New York City, U.S.A. as reservoirs serving city fell to 31% of capacity; normally at this time of year they are 80% full. *I.H.T.*

25: Iron ore carrier *Deifovos* sank in heavy seas, waves 10-12 metres high, some 40 nautical miles off Norwegian coast leaving nine dead, 29 rescued. *L.L.*

25-27: Gales, with winds gusting to 100 km/h and torrential rains hit Cape Province and Karoo region of South Africa; worst-hit area in a rough triangle between Laingsburg and the towns of Robertson to the south-west and Oudtshcorn to the south-east. In town of Laingsburg the Buffels river burst its banks and sent a two metre wall of water through town causing widespread damage, leaving 35 dead, 90 missing, many areas of country received more than 150 mm of rain in 24-hour period, widespread crop damage and many railway bridges washed away, also many roads blocked, although damage occurred in other towns and villages there were no further casualties, disaster described as worst natural disaster in South Africa's history. *L.L.*

25-1 Feb.: Serious forest fire in Aberdare mountain range north of Nairobi, Kenya, herds of wildlife threatened. *I.H.T.*

27 (reported): Serious famine threatens wide areas of Vietnam after eight months of natural disasters. *D.T.*

30 (reported): Snow-covered caravan found at Waidring, ski resort in Austrian Tyrol with four dead inside apparently after accidentally inhaling carbon monoxide gas from heater. *D.T.*

30-31: Fog over many southern areas of England and Wales causing widespread disruption to road and air transportation; on 30th two ship collisions took place, one involved two ro-ro cargoships, the *Undine* and *Ems*, which sank in North Sea, off the Norfolk coast, leaving four dead. The other collision was on the Thames at Blackwell Reach and involved Mv. *Blackthorn* and Mv. *Frederika 1* which sank, no casualties. *L.L., S.T.*

ALBERT J. THOMAS

LETTERS TO THE EDITOR

BALL LIGHTNING OBSERVATION IN THE SUMMER OF 1911

The recent TV programme 'Arthur C. Clarke's Mysterious World' showed several items of meteorological interest. One described the incident in which a large lump of ice fell from the sky nine minutes after a single violent stroke of lightning, just missing the observer R. F. Griffiths. Also missing was any reference in the TV programme to the lightning and to the explanations of this incident published in several journals[1], one of which is now in the astronomical literature[2].

Another item was the ball lightning described by R. C. Jennison and recently discussed in this journal[3]. This prompted a viewer, J. Baggs, Member of the Institution of Electrical Engineers, to describe his sighting of ball lightning many years ago, in a letter published in the *Journal of the IEE* . This incident happened on a very sultry day in the summer of 1911, near Newport, Shropshire. Mr. Baggs was then aged 12, and on his way home from school he met his father when a most violent thunderstorm developed. They ran for shelter to a pumping station near the railway. The building was about 50 yards long by 20 yards wide, with two large horizontal hot-tube oil engines, not then operating.

In Mr. Baggs' own words, "We had been there perhaps ten minutes when we saw through the windows a blinding flash of lightning and almost at once a bright green fluorescent ball floated in through the wooden door. We were paralysed with fright as it floated about: it must have had hardly any weight but it moved over the engines which stood about 4 feet from the floor and then floated out of the door. Possibly a minute later there was another flash and the storm passed away after a quarter of an hour.

On our way we passed a large mountain-ash tree which had been split down the middle, but whether the lightning ball had anything to do with it I cannot say.

So far as I remember it made no noise, but left behind a smell something like one gets from the sparks of high-voltage machines and sparking commutators that we had in the school lab."

I wrote to ask Mr. Baggs for more information and he replied as follows: ". . . the ball was about the size of a football. We did not see it before it floated, as though wafted, in through the door and its movements when inside the building were quite slow as might be due to draughts . . . When the ball floated out again it dropped from our line of vision, so whether the lightning flash that followed almost at once had anything to do with it I do not know.

I have sometimes thought the ball itself was perhaps not lightning at all, but a ball of luminous gas produced by lightning ionising atmospheric particles."

To make the last reference clearer, it suggests that the lightning or thunderstorm conditions caused atmospheric particles to be ionised, and the subsequent discharge produced a ball of luminous gas. I fully agree with this view, and I consider this account shows close similarities with the reported incident of ball lightning seen inside aircraft, in which it seems likely that the ball formed and moved entirely within the enclosure[3].

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26 St. David's Drive, Broxbourne, Herts. E. W. CREW

SUMMER 1980 AND THE PERIOD 4 TO 13 JULY

I refer to Mr. I. T. Lyall's letter in Vol. 6, number 55, and to my own contribution in Vol. 4, number 38 for April 1979 covering the summers at Ryde from 1918 to 1978.

Last summer at Ryde there were no days between July 4th and August 31st when the maximum reached the 75 °F level used as the criteria for a 'very warm' day, the highest reading being 74.7 °F on July 23rd. The mean maximum between July 4th and 13th was only 62.9 °F and the mean maximum between July 14th and August 31st was 68.0 °F.

In the summer of 1979, the number of 'very warm days' between 14th July was *two*, and the number between 14th July and 31st August was *four*.

26 Kings Road, Binstead, Ryde. K. J. HOSKING

THE GREAT STORM OF 1 AUGUST 1846

Perhaps one of Britain's greatest thunderstorms of the last 145 years was the one which traversed a greater part of England on 1 August 1846. It is possible that in London a tornado may have occurred in the region of Westminster, because it was reported that *every* pane of glass of the newly-completed Houses of Parliament was broken by hail. Such an occurrence suggests a rapid circulation of vortical nature, and, indeed, a sea-captain living nearer the City stated that the wind "boxed the compass". The fall of hail, in which the glass arcade over Regent Street was also shattered, was certainly a memorable one.

In Leicester the sexton of St. George's Church bravely went out to ring the curfew at about 20 hrs. During the ringing he noted that the clapper occasionally stuck to the bell, and just after he had left the building the spire was seriously damaged by a 'fireball'.

30 Molyneux Park Road, Tunbridge Wells, Kent. CICELY M. BOTLEY

ORKNEY GALES AND SNOW

On pp. 42, 43 of David and Charles' book in the Islands series, *Orkneys*, by Patrick Bailey, 1971, there is the following interesting weather information:

Unfortunately, Orkney gales can occur in any month of the year. Gales at harvest-time are rare, but have been disastrous, and that of August 1778 practically destroyed the whole food supply for the year, so that the enormous sum of £15,000 had to be spent on food imports.

Most of the great twentieth-century gales have come in mid-winter, those of 1952, 1953, 1962 and 1969 being especially memorable. The gale of January 1952 is always spoken of as the worst in living memory. A wind-speed of 135 m.p.h. was recorded. This was exceeded by 1 m.p.h. at Kirkwall airport on 7 February 1969, and on that occasion the gale, which came form the north-east, was accompanied by a very heavy snowfall.

It remains to be seen whether this unusually heavy snowfall is the prelude to a series of colder winters. Evidence from Iceland, where the pack-ice returned to the north coast in 1965 after an absence of forty years, rather suggests a general cooling of the North Atlantic winter climate, but such evidence is inconclusive at yet. Meanwhile prophets of a new ice age may note that, when Murdoch Mackenzie made his great survey of Orkney in the 1750s he measured his base-line on the frozen water of the Loch of Stennes."

Whalsay, Shetland. S. G. IRVINE

WHO CAN HELP?

On behalf of the Friends of the Earth (Greater Manchester Group) I am researching the possible climatic effects which may be manifest after the diversion of the Ob River in Soviet Central Asia. Anyone who may be able to assist me in this project is cordially invited to write to me for further details.

88 Oldham Street, Manchester M4. K. R. NICHOLAS

WORLD WEATHER REVIEW: November 1980

United States. *Temperature:* warm in most states, +3 deg. in Northern Plains. Cold in Gulf Coast states and in N.E., —3 deg. in W. Texas and locally in New England. *Rainfall:* wet in Florida; in patches from W. Texas (over 300%) N.W. to Washington, and in a band from Louisiana N.E. to New York state. Dry elsewhere; under 50% from desert S.W. to Oregon, under 25% in most of C. and N. Plains.

Canada and Arctic. *Temperature:* warm in Alaska, most of Canada, S.W. half of Greenland; +4 deg. in Rockies and Baffin Island. Cold from Manitoba to W. Quebec and extremely cold in Polar Basin: —2 deg. in E. Iceland, —5 deg. in N.E. Greenland, —8 deg. in Spitzbergen, —12 deg. in Franz Josef Land. *Rainfall:* wet on W. coast of Canada, N. to Mackenzie estuary and along N. and E. coast of Canada, S.W. half of Greenland. Dry in interior Canada, W. Alaska, N.E. half of Greenland, Iceland; under 50% just E. of Rockies, W. Alaska, N.E. Greenland, S.E. Iceland, Polar Basin.

South and Central America. *Temperature:* warm in E. and S.E. Brazil; cold in Paraguay, Uruguay, N. and C. Agrentina, round Amazon estuary, Mexico (—4 deg. in N.). *Rainfall:* wet in Guianas, N.E., S.W. and extreme S. Brazil, Paraguay, Uruguay, most of N. and C. Argentina, Cuba, N.E. and parts of S.E. Mexico; over 200% in N. Argentina, Uruguay, extreme S. and N.E. Brazil, N. Mexico. Dry in Bolivia, N.W. and C. Mexico.

Europe. *Temperature:* generally cold; warm only S.E. of a line from Albania to C. Urals; mostly —1 deg. from France to Poland but —5 to —7 deg. in N. Sweden and N. Finland. *Rainfall:* mainly wet; dry only in Norway, N. Sweden, from Poland W. through S. Germany to S. England, most of France and Switzerland and parts of Iberia; also in Greece and Bulgaria; under 50% in W. France, S. Switzerland, N. Italy and S. Germany. Over 200% near North Cape and in a broken band from C. Italy through Hungary and Ukraine to C. Urals. Sunshine in Germany high near N. coast and 48°-50°N., otherwise low.

Africa. *Temperature:* warm from Mali through Niger to E. Algeria then E. to Red Sea; +2 deg. in N. Libya; rather warm from Kenya to Natal. Cold in Morocco, W. Algeria, Liberia to S. Ethiopia, most areas S. of Equator except E. coast; —2 deg. in S. Morocco, S. Namibia, W. Cape Province. *Rainfall:* wet in N. Algeria (over 500%), locally near Gulf of Guinea, Somali Republic to Tanzania (over 400% in coastal Kenya), coastal and northern South Africa (over 200% widely). Dry on coast of Libya and Egypt, much of Sahel, Mozambique, locally in interior of South Africa.

U.S.S.R. *Temperature:* warm S. of a line from Odessa to C. Urals to S. Kamchatka; +8 deg. near L. Balkhash, +6 deg. near L. Baikal. Very cold in N.; —6 deg. near Finnish border, —7 deg. in N. Taimyr Peninsula, —10 deg. in N.E. Siberia. *Rainfall:* mainly wet: dry only on E. Caucasus, in and near Sakhalin and from Kara Sea nearly to Kamchatka; under 25% round Laptev Sea. Over 200% from Ukraine to C. Urals, most of Kazakhstan, locally elsewhere.

Middle and Far East. *Temperature:* warm from Turkey through most of Middle East, India and China to Korea, Japan, S.E. Asia, Borneo, Sumatra, Philippines, Java; +4 deg. in N. China, +2 deg. in C. India. Cold only in S. Pakistan, Bhutan, Assam, locally elsewhere. *Rainfall:* wet in N. Turkey.

locally on W. coast of India, N.E. China, S.W. and E. Japan; S.E. Asia rather mixed. Dry from S. Turkey through Middle East, most of India, Pakistan, Bangladesh and Burma to China, Korea and most of Japan; under 25% widely in China, rainless in N. India.

Australia. *Temperature:* warm everywhere except extreme W., +2 deg. in large area round middle. *Rainfall:* dry except 120°-133°E.; under 25% from Gulf of Carpentaria to N. New South Wales.

M. W. ROWE

WORLD WEATHER REVIEW: December 1980

United States. *Temperature:* mainly warm, especially in W., +5 deg. from Arizona to Wyoming. Cold from Minnesota to New England and from Coastal Texas to N. Carolina; —4 deg. in extreme N.E. *Rainfall:* a dry month: wet only in a well-marked band from S.W. Texas to L. Huron (over 200% in places); also W. Oregon to W. Dakota, and locally in coastal N. Caroloina and E. Florida. Most remaining areas had under 50%, and under 25% was widespread from Arizona to Minnesota and from E. Texas and N. Florida to New Hampshire.

Canada and Arctic. *Temperature:* a very cold month: warm only in British Columbia, round Baffin Bay and Davis Strait and N.W. of Hudson Bay. In contrast negative anomaly centres reached —6 deg. in Franz Josef Land, S.W. Quebec and E. Greenland, —9 deg. in Spitzbergen, —10 deg. in W. and —11 deg. on E. Alaska. *Rainfall:* wet in E. Alaska, most of Canada, W. Greenland; over 200% in N. Canadian Rockies, near Hudson Bay, N. Baffin Island. Dry in most of Alaska, Mackenzie Basin, S. Canada from Alberta to Ontario, most of Greenland and Iceland, Spitzbergen; under 50% N. of Great Bear Lake, locally on S. Prairies, S. Baffin Island, Spitzbergen, most of W. Alaska.

Europe. *Temperature:* warm from British Isles to C. Urals and Black Sea, but rarely above +1 deg. outside U.S.S.R. Cold from Faeroes to White Sea (—6 deg. in N. Sweden) and from Iberia to S. Poland and W. Romania; —2 deg. from S. France to Jugolavia. *Rainfall:* wet from N.E. France through Low Countries and W. Germany to Denmark, Norway, W. Sweden and most of European Russia, then S.W. to Romania, Bulgaria and N. Jugoslavia; also S. Italy and W. Eire; over 200% locally in Romania and parts of European Russia. Dry elsewhere, under 50% in most of Iberia, S.E. France, N.W. Italy and locally in Hungary and S. Poland. Severe drought in Iberia: under 10 mm (25%) except in extreme N.; rainless in S. quarter. Sunshine in Germany low in C., high elsewhere.

Africa. *Temperature:* cold N. of a line Cameroon to N. Ethiopia, except locally in W. Mauritania and W. Mali; also N. Cape Province to E. Tanzania; —3 deg. in N. Algeria. Warm elsewhere, +2 deg. in C. Kenya and S. Mozambique. *Rainfall:* wet from E. Morocco to Tunisia (over 200% widely), N. Egypt, from S. Cape Province through W. Natal and Transvaal into Zimbabwe and probably N. to L. Victoria. Dry nearly everywhere N. of Equator, S. Namibia to Orange Free State, coast of Natal and Mozambique.

U.S.S.R. *Temperature:* warm generally, +5 deg. from Caspian Sea to C. Siberian Plateau, +8 deg. near Okhotsk. Cold from White Sea to Taimyr Peninsula, extreme N.E. Siberia, large area N.E. of L. Baikal. *Rainfall:* wet generally, over 200% in Ukraine, E. of Baltic, White Sea to N. Urals, C. Yenisey Basin, L. Baikal to Sea of Okhotsk. Dry from S. Caspian Sea to Novosibirsk, Taimyr Peninsula to N. Kamchatka, often under 50%.

Middle and Far East. *Temperature:* warm from Turkey through Iraq to India, W. China, S.E. Asia, Indonesia, Philippines, N. Japan. Cold from Israel to Red Sea and Persian Gulf, W. coast of India, E. China, Korea, S. Japan; —2 deg. in the last two areas. *Rainfall:* wet from Jordan to Iraq, N.W. and N. India, extreme S. and N.E. China, N. Japan, Korea; over 500% in N. India, over 200% in N. Japan. Dry elsewhere, under 25% in S. and N.E. India, Bangladesh, Burma, Thailand, E. China; rainless locally in all these areas and everywhere from Red Sea to W. Pakistan.

Australia. *Temperature:* mainly warm, except locally in N. near Brisbane and in extreme S.W., +2 deg. from Western Australia to Victoria. *Rainfall:* dry from Western Australia to Alice Springs, from N.E. Queensland to Victoria and Adelaide, and round Sydney (under 50% in all these areas). West elsewhere; over 200% in S.E. Queensland and parts of New South Wales.

M. W. ROWE

JANUARY 1981 WEATHER SUMMARY

January was mild over the British Isles, the anomaly approaching +2 °C in places, and in the east and south of England and Scotland it was sunnier than average too. Less than half the normal rain fell over southern England and parts of north-east England and eastern Scotland, while more than average rain was limited to north-west England and north-east Scotland.

As the year began, low-pressure centres lay over Scandinavia, with further depressions in the North Atlantic approaching Iceland and high pressure to the west of the Bay of Biscay. A warm front reached western Britain during the night of the 1st/2nd and crossed to central Germany by the following midnight. In the wide warm sector rain was heavy in parts of Scotland and the English Lake District. 48-hour totals included 176 mm at Honiston, 135 at Coniston, and 101 at Ulpha. The 2nd and 3rd were mild days with maxima approaching 12-13 °C (East Malling 12.7 °C), and the intervening night very mild (Guildford 9.6 °C). For the next few days the weather was changeable, with alternating cooler and milder spells and some rain or snow. The weather then became influenced by anticyclones, firstly to the south-east of Britain and France (7th-8th) and then to the west of Ireland (10th-12th). During this period the continent was cold, with minima such as —18 °C at Stockholm (6th), —11.1 °C Frederikssund (8th), —14 °C Belgrade (8th), —16.9 °C Munchen (9th), and —4.6 °C Thessaloniki (10th). In Scotland Braemar registered —11.3 °C on the 7th, and in Wiltshire there was a grass minimum of —14.1 °C on the 12th.

A cold front crossing Britain southwards on the 12th became thundery in the east, and tornadoes developed in north Buckinghamshire and in Cam-

bridgeshire (at Ely). Further fronts followed in the ensuing days, giving on the 14th 17.3 mm at Keele (Staffordshire) and 33.5 mm at Uccle (Belgium). Minima on the night of 15th/16th included —7 °C at Pickering and —13 °C at Glenlivet (Highland). During the 16th a deep depression approached Scotland from the west, but filled rapidly on the 17th as it continued to the North Sea. Heavy snow preceded the rain in Scotland. The period of unsettled weather ended on the 20th/21st with the passing of a major warm front. The 21st-23rd were the warmest in Britain, e.g. 12.1 °C at Oxford (21st), 12.1 °C Cottingham, Hull (22nd), and 12.6 °C Luton (23rd). 18 °C was recorded at Montpellier on the 20th, and 21 °C at Madrid and 27 °C at Malaga next day; by contrast, the temperature on the 21st fell to —21.4 °C at Valla and on 23rd —7 °C at Bologna (Casalecchio). During the rest of the month, high pressure dominated the weather of western Europe, with conditions mainly mild in the west but cold in the centre and east of Europe. Fog was widespread in Southern Britain on the 30th and 31st, causing low day temperatures.

TEMPERATURE TABLES: JANUARY 1981

	MEAN		HIGHEST		LOWEST		GRASS	A	G
	Max	Min	Max	Min	Max	Min	Min	F	F
AUSTRIA: Graz	3.0	—5.9	9.7(1)			—13.6(10)	—15.0(10)	30	30
,, Innsbruck	—0.0	—7.5	7.4(1)		—4.2(8)	—16.5(9)		30	
BELGIUM: H'waart	5.1	0.4	10.3(3)	5.5(28)	0.0(12)	—7.3(12)	—10.0(12)		
,, Uccle	5.9	0.4	10.7(4)	6.0(28)	0.4(13)	—4.8(12)		13	
,, Brugge	6.9	1.9	11.0(4)	6.4(3)	3.4(13)	—3.6(12)		8	
DENMARK: Fano	3.0	—1.5	7.5(1)	3.5(2)	—3.0(18)	—9.5(21)		19	
,, Fred'k'sd	1.2	—3.5	5.2(3)	2.4(31)	—6.3(6)	—11.1(8)	—17.5(8)	22	28
FRANCE: Paris	6.3	1.8	11.0(3)	8.0(3)	1.0(12)	—5.0(12)		11	
,, Campistrous	8.6	3.6	13.0(31)	9.5(22)	2.5(13)	—1.0(v)			
,, Lyon	2.8	—1.8	11.0(4)	5.0(4)	—3.0(24)	—8.0(9)		23	
,, Montpellier	11.5	1.7	18.0(20)	10.0(4)	4.0(10)	—5.0(10)		10	
,, Nice	13.1	3.8	19.0(1)	8.0(18)	8.0(8)	—1.0(8)		2	
GERMANY: Berlin	1.1	—3.2	8.2(3)	3.3(3)	—5.9(8)	—11.7(8)	—14.1(8)	25	27
,, Hamburg	2.1	—3.2	9.0(3)	3.3(3)	—3.1(7)	—11.8(21)	—16.7(19)	21	20
,, Frankfurt	1.8	—3.5	9.6(3)	4.1(3)	—3.8(31)	—10.7(24)	—16.1(7)	27	28
,, Munchen	—0.5	—7.4	6.8(3)	0.6(3)	—6.4(24)	—16.9(9)	—21.8(23)	28	29
,, Sonthofen	0.0	—7.8	6.6(3)	1.5(3)	—4.9(29)	—16.8(9)	—23.2(9)	30	28
GREECE: Corfu	11.4	4.0	16.0(31)	11.0(v)	6.0(8)	—2.0(10)		7	
,, Thessaloniki	5.9	—0.2	12.4(3)	3.2(14)	—0.3(8)	—4.6(10)	—8.2(11)		
ITALY: Rome	10.5	0.9	16.0(4)	9.0(5)	2.0(8)	—4.0(10)		15	
,, Casalecchio	4.4	—2.1	9.0(3)	0.0(v)	3.0(5)	—7.0(23)		27	
MAJORCA: Palma	13.9	3.5	18.0(20)	13.0(16)	8.0(13)	—2.0(13)		9	
MALTA: Luqa	12.7	7.5	15.6(13)	12.9(5)	7.2(8)	1.4(29)	—3.5(29)	0	4
NETH'DS: Schettens	4.5	0.5	8.6(3)	5.6(3)	1.0(21)	—5.0(7)	—9.0(7)	14	21
,, Ten Post	4.0	—1.0	8.8(3)	4.9(3)	0.0(21)	—8.1(8)	—12.0(8)	16	21
,, Mon'kendam	5.0	1.3	9.4(3)	7.9(3)	1.6(21)	—3.4(7)	—5.2(7)	12	18
SPAIN: Madrid	12.6	—2.4	18.0(21)	11.0(21)	3.0(12)	—7.0(1)		26	
,, Malaga	17.0	6.2	27.0(21)	15.0(21)	11.0(11)	—1.0(12)		1	
SWEDEN: S'holm	—1.3	—5.8	7.0(31)	3.0(30)	—11.0(5)	—18.0(6)		24	
,, Valla	—0.6	—7.4	8.3(31)		—11.9(6)	—21.4(21)	—2.41(21)	27	31
SWITZ'D: Basel	3.0	—3.2	9.8(3)	4.6(3)	—0.9(8)	—9.6(23)		24	
,, Geneve	2.1	—3.5	8.1(4)	4.3(4)	—2.6(24)	—10.2(24)		7	
TURKEY: Istanbul	7.1	3.4	13.0(16)	9.0(5)	1.0(9)	—3.0(11)		1	
YUG'VIA: Belgrade	0.7	—4.9	8.0(3)	4.0(4)	—8.0(9)	—14.0(8)		28	
EIRE: Straide	9.3	4.4	11.4(31)	9.5(22)	5.9(5)	—2.5(5)			
,, Galway	8.9	4.8	10.9(21)	8.5(23)	6.0(4)	1.0(5)		0	4
N.IRE.: Armagh	7.8	2.6	11.2(22)	9.4(22)	2.9(4)	—2.1(5)	—6.7(5)	6	22
,, Bessbrook	7.9	2.9	11.4(23)	9.4(22)	2.8(12)	—1.7(5)		5	

	MEAN		HIGHEST		LOWEST		GRASS	A	G
	Max	Min	Max	Min	Max	Min	Min	F	F
SHT'D: Whalsay	5.3	0.6	9.8(23)	7.5(23)	—1.0(5)	—4.0(26)	—11.7(7)	14	19
,, Fair Isle	5.5	1.9	9.5(8)	7.1(27)	—0.2(15)	—4.5(15)	—9.1(26)	14	15
SCOT'D: Braemar	4.9	—1.9	9.7(29)	6.3(31)	—1.2(15)	—11.3(7)	—13.8(7)	20	23
WALES: Lampeter	8.1	1.2	11.0(21)	8.0(21)	3.8(31)	—4.2(10)	—6.4(10)	10	17
,, Pembroke	8.7	2.8	11.8(21)	8.6(3)	5.0(10)	—2.9(18)	—6.5(11)	5	9
,, Gower	8.1	3.3	10.7(21)	8.5(22)	4.1(31)	—1.8(13)	—6.8(13)	2	11
GUERNSEY: A'port	9.0	4.9	11.0(3)			0.9(13)		0	7
ENGLAND:									
Penryn, *Cornwall*	9.8	5.2	12.1(3)	9.1(3)	5.0(11)	0.6(12)		0	
Denbury, *Devon*	8.5	2.9	12.4(22)	8.2(3)	4.9(10)	—3.8(13)	—7.5(5)	5	20
Gurney Slade, *Som*	6.6	1.0	10.0(22)	6.7(22)	1.6(13)	—4.8(11)	—5.7(30)	9	14
Yatton, *Avon*	7.9	3.4	10.6(22)	9.0(3)	2.8(30)	—4.5(30)	—6.6(13)	6	13
Corsham, *Wilts*	7.6	2.3	10.7(2)	8.2(3)	2.3(31)	—2.9(31)	—5.2(13)	9	13
Trowbridge, *Wilts*	7.9	2.3	11.4(2)	8.7(3)	2.8(30)	—2.6(12)	—9.1(5)	11	18
Codford, *Wilts*	8.1	1.6	11.8(2)	3.2(10)	7.8(3)	—5.0(12)	—14.1(12)	9	23
Reading, *Berks*	7.8	1.8	11.5(2)	8.5(3)	2.4(30)	—2.3(13)	—7.5(5)	12	19
Sandhurst, *Berks*	7.7	1.6	11.7(3)	2.2(3)	2.2(7)	—.4.4(5)	—8.3(5)	13	25
Newport, *Wight*	8.4	2.9	11.7(3)	8.9(3)	4.4(10)	—3.5(12)	—6.1(12)	8	18
Horsham, *Sussex*	9.9	2.1	12.0(3)	9.6(22)		—4.8(12)		9	18
Brighton, *Sussex*	7.6	1.9	11.7(3)	7.8(23)	3.3(31)	—2.8(12)	—4.5(12)	9	18
Hastings, *Sussex*	7.8	2.3	12.0(3)	7.9(23)	4.3(11)	—2.1(31)	—4.6(31)	8	17
E.Malling, *Kent*	8.0	2.1	12.7(3)	8.8(3)	4.0(7)	—3.1(31)	—7.6(12)	10	21
Gillinham, *Kent*	7.1	2.8	12.2(3)	9.4(3)	1.1(13)	—2.8(12)		7	
Epsom Downs, *S'rey*	7.1	2.2	11.0(23)	9.5(3)	1.0(13)	—4.0(30)	—9.0(31)	9	15
Reigate, *Surrey*	7.3	2.3	11.9(3)	9.9(22)	1.3(13)	—4.2(30)	—6.1(12)	9	16
Guildford, *Surrey*	7.4	2.8	12.2(27)	9.6(3)	1.7(13)	—4.5(31)	—5.7(31)	9	13
Sidcup, *London*	7.9	2.2	12.0(2)	8.8(3)	3.8(11)	—3.2(30)	—7.2(30)	11	20
Hampstead, *London*	7.1	1.4	11.0(2)	8.3(23)	3.0(11)	—3.2(14)	—8.0(30)	13	17
Royston, *Herts*	7.1	2.8	11.5(3)	8.8(3)	2.0(15)	—2.9(13)	—8.2(16)	6	12
Loughton, *Essex*	6.0	1.5	10.8(23)	8.4(3)	0.3(16)	—3.9(16)	—6.3(18)	11	18
Leigh-on-Sea, *Essex*	7.3	2.6	12.1(3)	9.3(22)	1.0(13)	—3.2(31)	—7.8(12)	9	17
Buxton, *Norfolk*	6.3	2.3	11.0(2)	8.3(3)	0.3(13)	—3.2(16)	—5.8(16)	8	18
Ely, *Cambs*	6.7	1.2	11.1(2)	7.6(23)	1.2(31)	—4.0(16)	—6.8(16)	12	14
Luton, *Beds*	6.8	2.2	12.6(23)	8.9(22)	1.8(13)	—4.2(31)	—8.0(16)	9	19
Oxford (Radcliffe)	7.3	2.4	12.1(21)	8.2(3)	2.3(31)	—2.6(31)	—6.5(5)	8	17
Buckingham, *Bucks*	6.7	2.0	11.1(2)	9.0(3)	1.2(31)	—3.1(5)		9	12
Birmingham Univ	6.6	2.7	11.6(3)	8.8(22)	1.6(31)	—2.2(13)	—6.9(5)	10	15
Edgbaston Obs	7.3	1.9	11.2(2)			—2.6(13)	—9.0(5)	11	17
Kettering, *North*	6.7	1.6	11.1(22)	8.3(21)	1.8(13)	—4.4(16)	—9.0(16)	8	17
Hinckley, *Leics*	7.1	1.7	11.3(2)	7.9(23)	2.4(31)	—3.3(13)	—9.1(16)	11	14
Cosby, *Leics*	6.7	1.9	11.1(2)	8.3(3)	2.2(11)	—3.3(13)	—7.5(16)	8	14
Newark, *Notts*	6.5	2.2	10.8(23)	7.8(3)	1.6(7)	—3.8(16)	—7.9(16)	7	20
Nottingham, *Notts*	7.3	1.8	11.2(21)	7.1(9)	3.1(15)	—4.0(16)	—7.0(16)	9	12
Burton, *Staffs*	6.9	2.4	11.5(21)	8.5(3)	2.0(13)	—4.9(16)	—10.1(16)	6	14
Keele Univ	6.4	1.0	10.3(21)	6.2(3)	2.4(15)	—3.8(13)	—9.0(16)	13	18
Meir-Heath, *Staffs*	5.7	0.9	9.7(21)	5.6(23)	2.1(10)	—4.9(13)	—7.7(5)	11	19
Liverpool, Sefton	8.0	2.6	11.1(21)	9.4(23)	3.9(10)	—2.8(11)		5	
St.Helens, *M'side*	7.2	1.5	11.0(2)	8.2(22)	2.7(11)	—3.0(11)		10	
Southport, *M'side*	6.9	3.4	9.7(22)	7.1(3)	3.5(7)	—3.5(7)	—6.5(11)	3	10
Sheffield, *S.Yorks*	7.3	1.7	11.5(8)	8.2(22)	2.0(15)	—2.8(7)	—7.6(7)	8	16
Cottingham, *H'side*	7.4	1.9	12.1(22)	7.5(23)	3.1(6)	—4.1(16)	—6.4(16)	9	15
H.Bradfield, *S.Yorks*	5.2	0.4	10.0(22)	6.0(22)	—0.4(15)	—4.8(13)		19	
Pickering, *N.Yorks*	6.3	—0.2	11.1(2)	5.0(3)	1.8(6)	—7.0(16)	—9.1(16)	14	20
Durham Univ	7.1	0.4	11.0(2)			—4.8(16)	—8.4(7)		25
CANADA: Halifax	—2.5	—11.0	6.5(10)	0.6(27)	—13.9(4)	—23.5(5)		30	31
U.S.: San Francisco	15.2	7.0	19.5(15)	12.0(22)	9.0(2)	2.0(10)		0	
MADEIRA: Funchal	18.1	14.1	22.0(28)	17.0(v)	16.0(v)	12.0(v)		0	
ALGERIA: Algiers	14.9	4.7	19.0(17)	11.0(21)	8.0(13)	0.0(13)		0	
BAHRAIN: Airport	21.6	16.5	25.4(11)	19.0(22)	17.5(16)	12.6(16)		0	
JAPAN: Tokyo	8.5	0.8	12.0(10)	4.0(25)	5.0(18)	—2.0(14)		11	

RAINFALL TABLES: JANUARY 1981

	Total	%	Wettest Day	Days pptn	Snow/Sleet	Hail	Thunder
Graz	8.3	27	4.5(13)	5	5	0	0
Houwaart	103.8	167	17.7(3)	25	9	4	2
Uccle	119.4	185	33.5(14)	25	5	0	2
Brugge	84.5	145	14.9(14)	26	6	1	1
Fano	53.7	95	11.2(3)	24	11	8	1
Frederik'd	72.9	185	21.4(5)	19	13	0	0
Campistrous	79.1	70	20.8(15)	12			
Nice	12.5		12.0(13)	3	0	0	0
Berlin	51.5	120	10.0(14)	19	9	2	1
Hamburg	82.6	145	16.2(2)	20	7	0	1
Frankfurt	51.0	89	8.3(2)	19	8	1	2
Munchen	83.0	141	11.3(3)	20	9	0	2
Sonthofen	200.4	123	25.3(3)	20	19	0	3
Thessaloniki	36.0		15.7(21)	17	10	0	0
Casalecchio	31.8	72	21.8(13)		3	0	0
Moltrasio	0.9		0.5(12)	2	2	0	0
Luqa	120.4		27.4(7)	19	0	4	3
Monnick'dam	82.8	127	18.8(14)	22	11	7	3
Schettens	65.8	113	10.8(3)	24	12	9	0
Ten Post	92.0	151	18.0(15)	25	15	11	0
Valla	18.2		3.7(15)	16	15	0	0
Genève	125.8	198	32.9(5)	17	11	0	3
Basel	68.4	130	13.2(4)	18	14	0	0
Galway	64.7	52	11.8(15)	20	0	0	0
Straide	80.4	67	9.9(15)	21	5	6	0
Bessbrook	53.8	41	9.5(17)	17	5	0	0
Whalsay	133.3	131	14.1(2)	28	19	17	0
Fair Isle	90.4	79	12.2(2)	27	18	16	0
Braemar	80.1		8.0(1)	25	17	0	0
Lampeter	83.0		11.0(20)	22	6	3	0
Pembroke	47.0	57	8.1(18)	17	0	0	0
Gower	57.1	48	8.5(18)	22	3	1	0
Guernsey	54.9		10.1(14)	15	0	4	0
Penryn	73.7		14.3(18)	16	0	4	0
Denbury	40.2		10.2(14)	14	4	0	0
Gurney Slade	68.2	63	12.5(16)	16	4	1	1
Yatton	29.2	35	5.3(14)	16	2	0	0
Long Ashton	32.7		5.3(16)	16	1	0	0
Tytherington	25.6		5.1(9)	14			
Marshfield	42.0		8.2(14)	18			
Lyneham	28.6		4.8(14)	11			
Corsham	38.8	55	8.0(14)	18	4	3	0
Bradford/Avon	35.6	49	5.6(14)	13	6	1	0
Trowbridge	33.1	50	5.3(14)	11	6	1	0
Codford	43.6		8.1(14)	12			
Reading	34.5	56	6.9(6)	14	5	1	0
Maidenhead	50.5		12.5(6)	14	5	2	1
Sandhurst	33.0	48	6.8(6)	13	2	0	1
Romsey	30.4		4.5(19)	11	1	0	0
Newport	38.3	41	7.6(18)	13	2	1	1
Horsham	34.9		6.7(6)	17	7	4	0
Brighton	37.9		5.9(6)	16	4	2	1
Hastings	34.6	41	6.4(9)	21	5	2	1
E. Malling	25.2	42	4.0(21)	15	6	1	0

	Total	%	Wettest Day	Days pptn	Snow/Sleet	Hail	Thunder
Gillingham	22.9	30	4.3(9)	15	6	1	0
Coulsdon	30.3		6.7(9)	12	6	3	1
Epsom Downs	28.7		5.3(9)	14	7	2	1
Reigate	33.8		5.1(6)	13	6	3	1
Guildford	29.4		6.8(6)	15	9	2	0
New Malden	29.5	53	5.1(9)	13	3	2	1
Hayes	35.6	72	6.6(21)	17	8	2	1
Heathrow	31.3	61	6.0(12)	12	8	1	1
Sidcup	25.3		5.9(9)	11	6	3	1
Hampstead	29.6	61	5.0(16)	10	—	—	1
Royston	37.5	77	6.2(9)	17	6	4	0
Loughton	31.9	50	5.3(16)	14	7	2	1
Leigh-on-Sea	27.6	53	6.1(9)	17	6	0	0
Pulham St.M.	52.2	98	9.2(12)	16	8	0	0
Buxton	60.8		12.0(20)	19	7	5	0
Ely	35.3		5.6(9)	19	10	2	0
Luton	36.2	60	6.3(20)	15	9	3	0
Stroud	25.9	30	5.1(9)	11	3	0	0
Oxford	39.3	74	6.8(9)	16	6	1	1
Buckingham	38.8		7.1(v)	13	6	2	0
Birmingham U	58.6		10.3(6)	18	8	1	1
Edgbaston O	52.8	80	9.6(6)	17			1
Hall Green	47.7	62	9.4(6)	15	7	1	0
Northampton	37.4	66	9.7(20)	14	7	1	0
Kettering	62.2	70	10.4(20)	17	5	0	1
Cosby	35¦3	62	5.1(14)	19	6	0	1
Hinckley	37.2	66	6.9(14)	18	2	0	1
Boston							
Newark	32.4	63	11.7(20)	20	6	1	0
Nottingham	33.1	65	12.0(20)	15	6	2	0
Markeaton P	45.5		7.3(14)	17			
Hulland	56.7	70	9.7(14)	22	14	4	1
Middleton	78.3		13.9(16)	25	15	5	1
Burton/Trent	45.0	75	7.4(14)	23	7	1	0
Keele	81.4	121	17.3(14)	22	8	3	0
Meir-Heath	84.5		14.0(14)		14	7	0
Sefton Park	77.4		8.9(13)	21	3	4	0
Southport	82.2		11.7(14)	23	7	4	0
St. Helens	98.9		11.8(13)	23	3	2	1
Leigh	94.3	113	15.6(13)	24	3	—	1
Sheffield	57.5	71	11.0(16)	20	11	0	1
High Bradfield	80.2		13.3(14)	20			
Cottingham	34.5	63	6.9(16)	19	6	7	0
Cawood	38.8	71	8.6(20)	20	5	1	0
Northallerton	33.3		6.3(20)	19	7	0	0
Pickering	40.0	55	6.2(16)	21	12	2	0
Durham	28.3	57	7.6(16)	16			
Carlisle	67.4	96					
Kendal	128.2	107					
Hawkshead	190.6	98					
Coniston	342.5	132					
Seathwaite	325.0	101					
Honister	416.0						

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