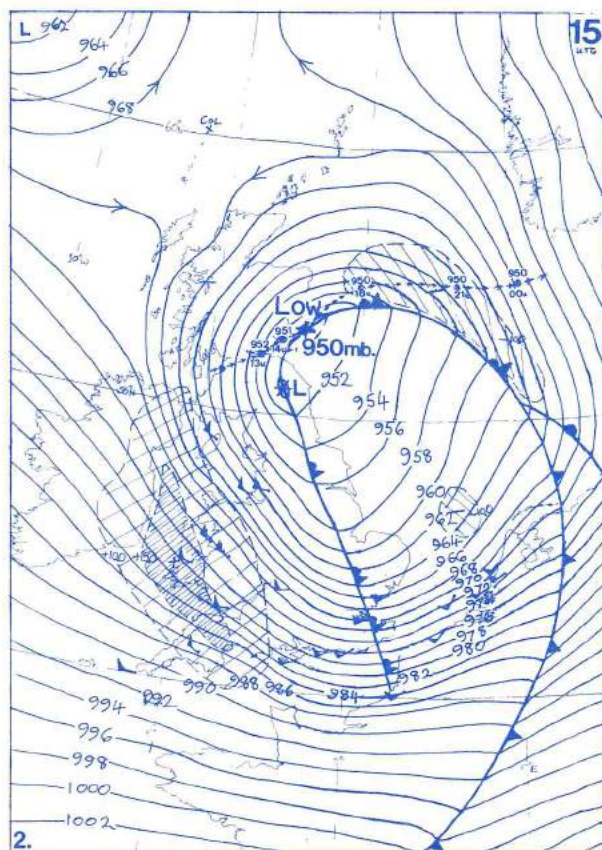


# *The* JOURNAL of METEOROLOGY



*The Storm of 25 January 1990 over Britain  
showing the fronts of the back-bent occlusion*



# THE JOURNAL OF METEOROLOGY

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Telephone: National, 02216.2482; international, +44.2216.2482

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# JOURNAL OF METEOROLOGY

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## THE STORM OF 25th JANUARY 1990

By MICHAEL ROWE

*Tornado and Storm Research Organisation, Lymington, Hampshire.*

### INTRODUCTION

On 25th January 1990, for the second time in 27 months, large areas of southern Britain suffered serious damage as a severe gale crossed the country. The gale was due to an intense depression which deepened explosively as it approached Britain. Several other deep depressions caused widespread damage over the next four weeks, and the winter as a whole was characterised by an unusually large number of very deep depressions over the Atlantic.

### DEVELOPMENT OF THE STORM

The depression responsible for the gale of 25th January 1990 "developed off the east coast of North America along a front which had earlier brought wintry weather to many sections of the United States. Indeed, this appears to be the same frontal system which brought heavy snow to New England on January 21, to Kansas on January 19, and to northern New Mexico on January 18" (Le Comte, 1990).

At 1200 GMT on 23rd January the previous major depression in the series lay east of Iceland with an exceptionally low central pressure of 938mbar. Its cold front lay through S.W. Norway and Kent, then trailed back across the Atlantic. In the western Atlantic, S.E. of Newfoundland, it was beginning to return north or north-east as a warm front. By 1200 on 24th the new low on this frontal system was over the central Atlantic at 48°N., 35°W., central pressure 992mbar. It moved E.N.E., deepening rapidly, and at 1800 was near 51°N., 24°W., 980mbar, with pressure starting to fall in the western parts of the British Isles. At 0000 on 25th the low lay at 51°N., 18°W., 968mbar (Figure 1). Pressure was now falling in all parts of the British Isles except the Northern Isles, and continuous moderate rain had reached south-western areas of Britain and Ireland, associated with the warm front, which lay just to the south-west of Valentia and Cornwall. Wind speeds over Britain were still low; Plymouth, Guernsey, Aberporth and Valley, with 20 knots, reported the highest speeds of the stations plotted in the *Daily Weather Summary* (apart from Lerwick, which was still in the circulation of the old low near Iceland).

At 0600 on 25th the new low, still deepening appreciably, was centred at 53.5°N., 10°W., on the west coast of Ireland, 955mbar. The warm front lay



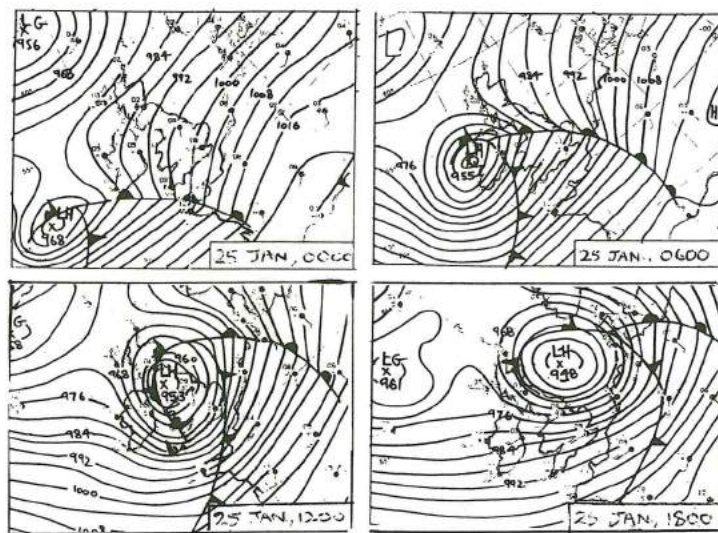


Fig. 1: Synoptic charts for 25th January 1990 (from the *Daily Weather Summary*, reproduced by permission of the London Weather Centre).

from about Blackpool to Great Yarmouth, and the cold front had crossed most of Ireland. Temperatures were 10–12°C in much of the warm sector, with south-west winds and rain or drizzle, but 4°C or less over Scotland. Wind speeds were still comparatively low in the east and inland (15 knots at Manston, Leeming and Elmdon), but at or near gale force on western coasts (Plymouth and Aberport 35 knots; Cardiff and Valley 30 knots).

At 1200 the low was centred south of Glasgow, 953mbar. The cold front had cleared the whole of Britain except the extreme coast of Kent, while an occlusion lay over the Irish Sea. Temperatures behind the cold front had dropped to 7–10°C, and most places in England and Wales were reporting showers or longer periods of rain. Wind speeds were now extremely high in the south and south-west (Plymouth 60 knots; Guernsey 50; Bournemouth 45; Manston 40), but decreased northwards along western coasts (Cardiff and Aberporth 35 knots; Valley 25; Ronaldsway 20).

At 1800 the low was over the North Sea, 56°N., 2°E., 948mbar, with winds moderating over southern districts but picking up to gale force in parts of northern England. During the afternoon 951mbar was reached in Northumberland, an exceptionally low pressure for the United Kingdom and the lowest recorded in the country during January 1990.

The storm was well predicted by the Meteorological Office forecasters, who had foreseen it as early as 21st. The forecast chart for 1200 on 25th, issued the previous day and published in the national press on 25th, has the position of the depression centre and the fronts generally correct, though the central

pressure was about 12mbar lower than expected. The Meteorological Office issued a storm warning to the Ministry of Defence at 1830 on 24th, and at 1845 a national warning of storm-force winds was issued; this was repeated on the BBC1 weather forecast at 2130.

## DAMAGE

The first damage occurred in Cornwall at about 0600 on 25th. At Trengwainton Gardens, a National Trust property in Penzance, about one third of the trees on the densely-wooded 25-acre (10-hectare) estate were blown down in the three hours beginning about 0600. Further east in Cornwall, at Launceston, a sudden gust lifted an entire 120-foot (37-metre) fibreglass chicken house and threw it 300 yards. Minutes later the remaining three chicken houses collapsed, crushing 10,000 birds. This damage sounds as though it could have been due to a tornado, but with a violent gale raging anyway it is impossible to be sure.

Further east still, at Cullompton, Devon, the storm became severe at about 0815, then subsided somewhat till 1200, when six acres (2.4 hectares) of greenhouses were shattered. "The glasshouses looked like polythene bags blowing up into the air and then exploding", said the owner, Mr. Ian Cummings (Caseby, Palmer and Lees, 1990).

Similar damage occurred throughout most of southern England. The damage was more widespread than in the storm of 16th October 1987, but was probably nowhere as severe as that which occurred in Kent and Sussex in the 1987 storm. In Lymington, Hampshire, which suffered in both storms, the more recent one caused more damage, but Lymington was near the edge of the damage area in the 1987 storm, and much less badly affected than areas in the east.

The death toll in Britain, 47, was extremely high; in the storm of 16th October 1987 18 people died, the much higher number in the recent storm being partly because it occurred during the daytime and partly because it affected a larger area.

The storm also caused damage in Belgium, France, West Germany and the Netherlands, and the total death toll throughout Europe was at least 94 (Le Comte gives "at least 91", but his figure for Britain is 44, whereas other sources tend to suggest 47).

## THE STORM IN CONTEXT

The storm of 25th January was one of a large number of very deep depressions over the North Atlantic during the winter of 1989–90. There seem to have been an unusually large number of very deep depressions in this area during the last ten years or so. Some of them were mentioned by Burt (1987) in his note on the depression that produced a new North Atlantic pressure record of 915–916mbar on 15th December 1986.

The sequence of deep depressions in the second half of 1989 and the early months of 1990 began with a number of deep lows between about 10th and



22nd August, mostly in the Faeroes-Iceland area, the deepest of which was 966mbar west of the Hebrides on 14th-15th August. (Its cold front produced a damaging tornado near Pwllheli in North Wales on the evening of 14th). On 15th-16th September ex-hurricane Gabrielle deepened to 948mbar south-west of the Faeroes, an exceptionally low pressure for mid-September; yet only two days later, at 0000 on 18th September, a low west of Ireland at 53°N., 20°W. reached 950mbar. A month later, on 20th October, 952mbar was the central pressure of a low centred at 57.5°N., 23°W. at 1200. At Valley, Anglesey, 969.3mbar was recorded on 28th October – unusual for the United Kingdom in October. The following day a low of 938mbar was centred at 57°N., 33°W. at 1200. A low at 49.5°N., 14°W. was 936mbar at 1200 on 16th December; another south-west of Iceland, at 62°N., 24°W., reached an extraordinary 925mbar at 1200 on Christmas Eve; and yet another reached 940mbar at 53°N., 37°W. at 1200 on 30th December.

In January 1990 at least six depressions reached 950mbar or below over the Atlantic, with 936mbar reached three times: 60°N., 28°W., at 1200 on 8th; 62.5°N., 11°W., at 0600 on 23rd; and 54.5°N., 38°W., at 1200 on 28th. February also saw at least six depressions reaching 950mbar or less, with 938mbar at 59°N., 17°W., at 0600 on 19th.

Mean January pressure over the North Atlantic was below normal north of 50°N., by as much as 16mbar in the Iceland-Faeroes area; it was 5mbar above normal just south of the Azores, and also over central and southern Europe. Mean pressure was as low as 980mbar at about 60°N., 30°W. Judging from maps given by Lamb and Johnson (1966) only four years between 1850 and 1962 had a similar or lower mean January pressure in this area (or anywhere else in the North Atlantic): 1851, 977.5mbar; 1869 and 1890, 980mbar; 1933, 978mbar). Mean pressure in February 1990 was even lower in the same general area, being below 976mbar north-west of the Faeroes according to the chart in the monthly summary of the *Daily Weather Summary*. This figure is probably even rarer in February than it would be in January, since the Icelandic low is on average beginning to become less deep by February.

There was a persistent tendency in 1989 for below-average pressure in the Iceland area and an equally persistent tendency for below-average temperature in the Iceland-Greenland area, contrasting with above-normal temperature over most of Europe. This enhanced temperature gradient appears also to have been present over the North Atlantic in most months and may have been partly responsible for the large number of deep depressions.

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## DETAILS OF CASUALTIES AND DAMAGE IN THE STORM OF 25th JANUARY 1990

The gale of January 25th 1990 left the largest number of weather-related deaths in a single British event for 37 years, with 47 direct or indirect deaths reported. We have to go back to 1st February 1953, when 307 people died during the East coast storm surge, to find a larger death toll.

Of the 47 deaths, 36 were due to direct causes, i.e. falling trees etc. and 10 died in indirect causes, i.e. road accidents where the weather played a part. There was also one maritime fatality.

The following is a breakdown of the direct fatalities by cause:-

14 died after being in vehicles hit by falling trees; 10 died after being hit by falling debris from buildings; 8 died after being hit by falling trees; 3 elderly people died after either being blown over or into the path of passing vehicles; 1 died when blown off a scooter and into a road sign.

Six of the ten indirect deaths were in road accidents where the weather was a contributory factor. Two others died in a house fire when a candle set a room on fire, the candle being used because of a power cut induced by the winds. The other two deaths occurred whilst repairing or removing storm damage.

There was one maritime death, a man was swept overboard from a ship about 320km W.S.W. of Lands End, Cornwall.

The following is a breakdown of the direct fatalities by county:-

Avon: 3; Buckinghamshire: 1; Cleveland: 1; Cornwall: 1; Devon: 2; Dorset: 2; Gloucestershire: 1; Hampshire: 6; Hereford and Worcester: 1; Hertfordshire: 3; Kent: 1; London: 4; Somerset: 1; Suffolk: 1; Surrey: 1; Sussex: 3; West Sussex: 1; Wiltshire: 1.

There were two deaths in Wales:-

Cardiff: 1; Clywd: 1.

Most of the direct deaths were single incidences. There were two incidents where two people died in each:-

- Lorry hit by tree near Hemel Hempstead, Hertfordshire.
- Scaffolding blown down at Uppark House, near Chichester, Sussex.

The following is a breakdown of the indirect fatalities by county:-

Bedfordshire: 1; Devon: 1; Essex: 2; Co. Antrim, N. Ireland: 2; Lincolnshire: 1; Oxfordshire: 2; Sussex: 1.

As can be expected, the damage caused by the gale was quite severe and widespread. It is estimated that at least 4 million trees were uprooted. By contrast in the October 1987 storm, some 15 million trees were uprooted, but then the trees were in leaf. It is still not known exactly what the total cost of property damage will be, but it is likely to exceed that of the estimated £1.1 billion damage caused in the October 1987 storm. Also this year subsequent



storms in January and especially on February 26th, caused additional damage. The total damage from the storms in January and February 1990 has been put at £2.5 billion. It is important to note that these figures are for insured losses only.

The following is a list of some of the wind-speeds recorded during the gale of January 25th:-

Lands End, Cornwall: 167.5km/h; Dover, Kent: 167km/h; Hinkley Point, Somerset: 158km/h; Plymouth, Devon: 156km/h; St. Mawgan, Cornwall: 156km/h; Great Gaddesden, Hertfordshire: 156km/h; Bidston, Merseyside: 153km/h; Guernsey Airport: 143km/h; Chelmsford, Essex: 138.5km/h; Dorchester, Dorset: 137km/h; Maidenhead, Berkshire: 137km/h; Welwyn Garden City, Hertfordshire: 132km/h; Northwood, London: 129km/h; Nottingham, Notts.: 127km/h; Bournemouth, Dorset: 124km/h; Edlesborough, Buckinghamshire: 114km/h.

A gust of 160km/h was recorded atop a crane 91.5 metres above Birmingham city centre. Times of some of the gusts are as follows:-

Chelmsford, Essex (138.5km/h) 1415 GMT  
Chelmsford, Essex (138.5km/h) 1500 GMT  
Edlesborough, Bucks. (114km/h) 1500 GMT  
Great Gaddesden, Herts. (156km/h) 1515 GMT.

Sources:- Casualty figures: *Daily Telegraph*, *Birmingham Evening Mail*.  
Wind speeds: C.O.L. January 1990.

ALBERT J. THOMAS

## 'BACK-BENT' OCCLUSIONS OF 25th JANUARY AND 3rd FEBRUARY 1990

By W. S. PIKE

19 Inholmes Common, Woodlands St Mary, Newbury,  
Berkshire RG16 7SX, UK.

*Abstract:* Two recent vigorous Atlantic Depressions are analysed and their effects described in the local area.

### INTRODUCTION

Two violent storms within ten days both featured an active "back-bent" occlusion, which was also common to the 'great storm' of 15th-16th October 1987 in south-east England. However, the associated weather conditions were also very unusual on these two subsequent occasions.

### SYNOPTIC SITUATION OF 25th JANUARY 1990

Figure 1, which is based on the Met. Office Bracknell CFO Analysis, shows the position of a deep and still-deepening depression at 1200 UTC. It was then

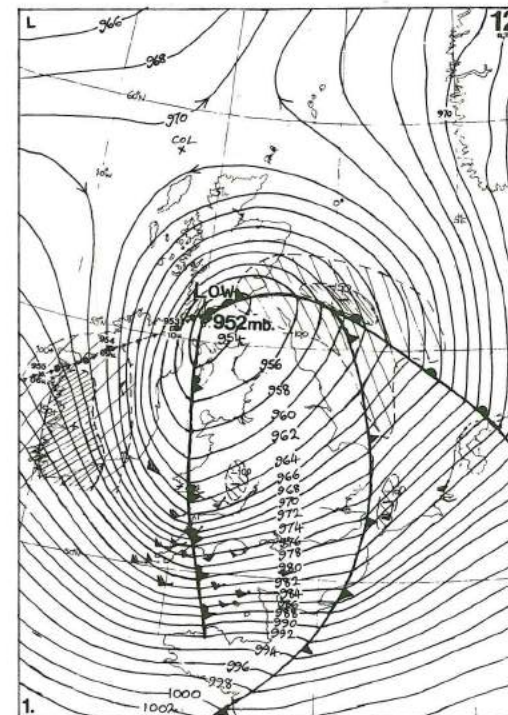


Fig.1: Surface synoptic chart for 1200 UTC on Thursday 25th January 1990, based on Bracknell CFO Analysis. See text for Legend. Isobars at 2mb-intervals, continuity of centre given at, primarily, 3-hourly intervals.

situated near Glasgow, and was producing some heavy snowfalls to the north over the Central Highlands of Scotland as it continued to move north-eastwards with a slowly-declining central pressure value (see continuity figures).

The depression's passage was marked by large 3-hourly pressure tendencies in its vicinity, showing falls of between 14.0 and 17.0 millibars(mb) ahead and rises from 16.0 to 18.0mb behind (20.2mb rise at Valentia in S. Eire at 1100 UTC). Although these large tendencies do happen from time to time in the UK some exceptional ones are listed in Burt, 1985, p.49; theoretically, North Atlantic frontal depressions usually begin to fill up soon after the 'occlusion process' has begun, but this one maintained its central pressure near 950mb for some hours over the North Sea (continuity of 950mb core value until at least 00 UTC on the 26th, in Figure 2), perhaps because it was being 'fed' by relatively warm, returning polar maritime air ahead of the 'back-bent'



occlusion, which was acting as a vigorous, second cold front.

Perhaps equally remarkable were the local pressure falls of 10.0mb 3-hr<sup>-1</sup> ahead of the 'back-bent' occlusion (over south-east Wales in Figure 1, and over the southern North Sea in Figure 2), because such features usually pass through after the main depression has passed by, and as already remarked, often after it has begun to fill. Regions with pressure tendency of  $\pm 10.0$  and  $\pm 15.0$ mb 3-hr<sup>-1</sup> or more are indicated by the hatched areas in Figures 1 and 2.

### STRONG WINDS AND DAMAGE

Strongest-reported mean winds of at least storm force 10 (synoptic stations observing this are marked on Figures 1 and 2, the 'flag' representing 50kt mean speed and each additional 'half feather' an increment of 5kt, as recorded at 1200 and 1500 UTC on the 25th) occurred (1) in a narrow band ahead of the cold front and (2) over a broader band representing an approximate six-hour period of time associated with the 'back-bent' occlusion (from about three hours ahead to three hours behind its passage). Highest gusts were very

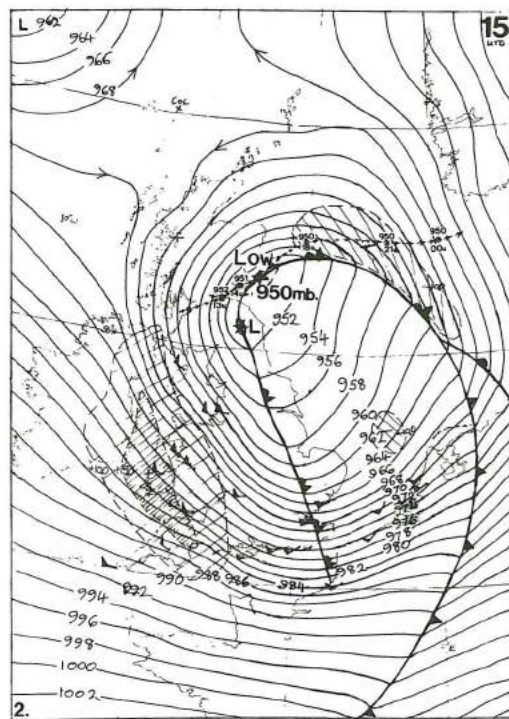


Fig.2: Surface synoptic chart for 1500 UTC on Thursday 25th January 1990. Legend as for Figure 1 and notes in the text.

variable according to location but several coastal stations recorded 90kt (or a little more) and exposed hilly areas were not far behind, most places having at least one gust in the range 70-85kt. This affected much of southern England and S. Wales, where the storm of 15-16 October 1987 had been confined more to south-east England.

Consequently, damage to trees and buildings in the author's local area of West Berkshire and Wiltshire was considerable. Particularly where wind 'funneling' occurred, whole stands of beech trees were felled, and perhaps one-in-ten to one-in-twenty of other species were broken, snapped off, or uprooted. This revealed that many had been either diseased or weakened by ivy, a reflection on the fact that quite a few large 'Estates' no longer employ their own Foresters, as was once the case to maintain healthy trees. Figure 3 shows a large beech, snapped-off near the roots, and showing clear signs of a fungal infection. This fell in the author's garden, at 1505 UTC demolishing a small shed together with its contents. Another view is given in Figure 6.

One result of the falling trees was widespread power cuts. The author was down to his last two candles when electricity was restored to Woodlands St Mary at 1905 UTC on Sunday 28th, some 79 hours after the power had failed at noon on the 25th. Some residents in the Pinchington Lane area of Newbury were still without electricity a week after the storm (*Newbury Weekly News* report) although they could see most of the rest of the town bathed in yellow sodium street-lights! A few isolated rural areas remained without power for up to a fortnight, despite the gallant efforts of local and East Midlands Electricity Board crews who had been drafted in.

Inspectors are to report on the structural strength of school roofs in Wiltshire following the death of one pupil at Grange School, Swindon. A small boy (sitting next to the girl who was killed) managed to avoid injury more serious than a crushed foot when he just managed to dive under a desk before large pieces of collapsing roof fell on them. At Inholmes Estate, a large Scots Pine demolished part of the wood storage barn. Mrs Bell (who readers may remember was visited by ball lightning, see *J. Meteorol., UK*, 7, pp.253-7) lost part of her thatched roof and west-facing wall as a small chimney collapsed in the storm. Thatched and tiled roofs were damaged quite widely in the area, and appear to have been particularly susceptible at gable ends, corners and ridges, where a reduction in pressure occurs in the strong airflow. Brick walls were also casualties of pressure effects, the sheer force of wind being sufficient to blow them down, quite literally.

### REMARKS AND COMPARISONS

The storm of 25th January 1990 was comparable to that of 15th-16th October 1987 in terms of the depression's central pressure (which was slightly lower, also lower for longer) and associated strong winds (which affected a larger area) than on the earlier occasion, which has been called 'the great storm' (see Burt and Mansfield, 1988).





Fig.3: Beech tree in excess of 1m diameter snapped off near the roots (which were undisturbed) in the author's garden on 25th January 1990. The collapse occurred at 1505 UTC, and followed the fall of an apple tree nearby in the same direction at 1330 UTC. Photo taken at 0900 UTC on 26th January 1990.

The storm of 25th January 1990 was well-forecast in all aspects other than perhaps the time-period for strongest winds associated with the 'back-bent' occlusion, which might have been slightly underestimated by up to two hours or so, perhaps due to the feature's rarely-attained vigour as it crossed the UK, from west to east, at about 50kt along the south coast of England.

#### SYNOPTIC SITUATION OF 3rd FEBRUARY 1990

Figure 4 shows another depression moving up from the south-west, but on this occasion it takes a much more southerly track and is, at its deepest by 09 UTC, some 35 millibars shallower than the storm of 25th January which crossed southern Scotland. Figure 4 shows precipitation in the form of heavy rain over southern England with temperatures near 5°C (generally  $\pm 2^\circ\text{C}$ ), however this has turned to sleet at Plymouth (first reported, 0800 UTC) and at Yeovilton, where previously only rain had been falling. Thunder was reported in the western English Channel with hail at Berry Head, S.E. Devon,

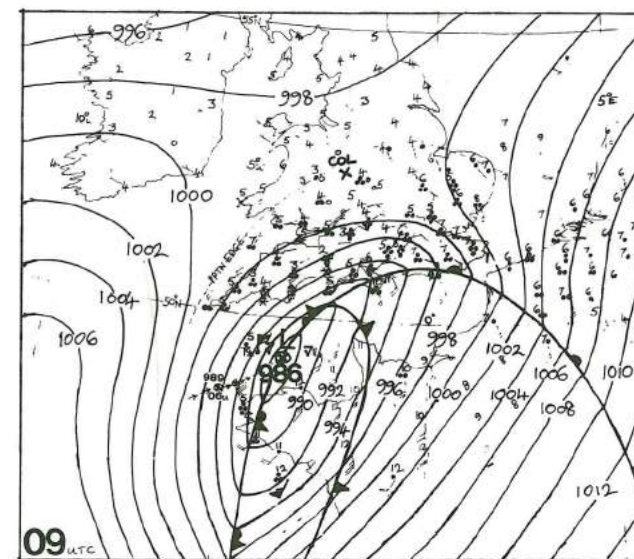


Fig.4: Surface Synoptic Chart for 0900 UTC on Saturday 3rd February 1990, based on Bracknell CFO Analysis. Legend as for Figure 1 and notes in the text.

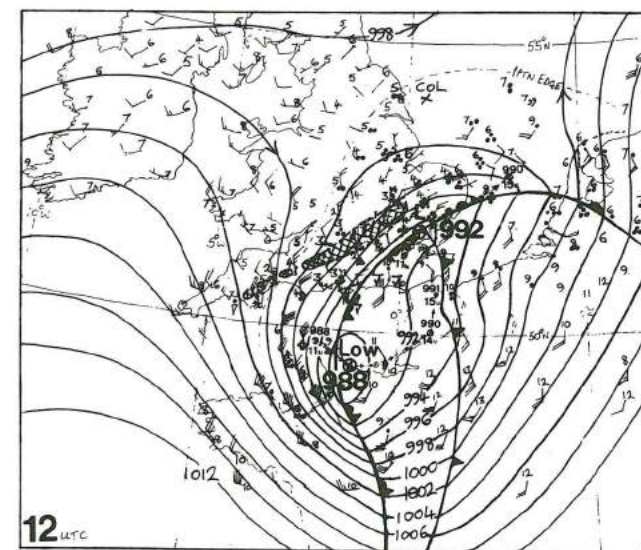


Fig.5: Surface Synoptic Chart for 1200 UTC on Saturday 3rd February 1990. Legend as for Figure 1 and notes in the text.



suggesting marked instability near the 'Low' centre. Only two reports of mean wind speeds of 50kt or more occur (near Brittany).

Figure 5 shows the situation three hours henceforward at 1200 UTC. A small 'breakaway' triple-point depression has formed, just south of London at around 1100 UTC, and is continuing north-eastwards. This becomes the deeper feature by 1500 UTC (with central pressure 990mb) in the southern North Sea, while the older centre, now associated with the 'back-bent' occlusion, follows the northern French coastline to lie over the Strait of Dover, filling slowly (see continuity figures) also by 1500 UTC.

Between the two centres, along the 'back-bent' occlusion, there is thunder-storm activity reported from London (Heathrow) Airport and St Catherine's Point (Isle of Wight) at 1200 UTC, and by London (Gatwick) Airport at 1300 UTC, as the feature moves eastwards.

### OBSERVATIONS OF SNOWFALL

Saturday 3rd February 1990 dawned very wet at Woodlands St Mary with 14.0mm (over half an inch) of rain falling between 0600 and 0830 UTC, at which time the first partly-melted snowflakes were observed in the rain. The village is 182m (600ft) a.m.s.l. and prone to snowfall when high ground is affected by precipitation at low temperatures in central southern England. By 0850 UTC the precipitation had quickly turned to snow with temperatures falling rapidly towards 0°C.

The snow continued at moderate to heavy intensity, and soon began settling on grass and concrete, with the postman leaving tracks in 2cm snow at 0956 UTC. By 1100 UTC 6cm lay on the grass and 5cm on concrete. Then, after a period of particularly heavy snow (flakes 3cm in diameter reducing visibility to 150m) between 1140 and 1150 UTC, there was a maximum depth of 6cm on concrete and 8cm on grass by the time that photographic Figures 6(a) and 6(b) were taken at 1215 UTC. Thereafter, thawing was quite rapid, but patches of undisturbed snow still could be seen at 09 UTC on 4th February. Temperature during the snowfall hovered near 0°C, and a further 15.0mm of rainfall (water yield from snow) was measured after precipitation had tapered off while still falling as snow, around 1230 UTC. The day total had been 29.0mm, which fell in 6½ hours.

With moderate to heavy precipitation falling at a rate between 3 and 5mm hr<sup>-1</sup>, this was sufficient to lower the height of the wet-bulb freezing level by 800 to 900m (it had been at 900mb at Hemsby, and 905mb at Camborne on the noon radiosonde ascents for 3 February 1990, so quite near 3,000ft above station levels), permitting the heavy precipitation to reach the ground as snow. (See Lumb, 1961, in which he mentions a 1500m-fall of the wet-bulb freezing level to produce a hilltop snowfall on the Cotswolds on 1st November 1942. A maximum-recorded 2,300m-fall has been known in Canada also, see Pike, 1988).

On 3rd February 1990, problems with snowfall were not expected; however up to 10cm accumulated in a narrow 'swathe' (outlined in Figure 5 as

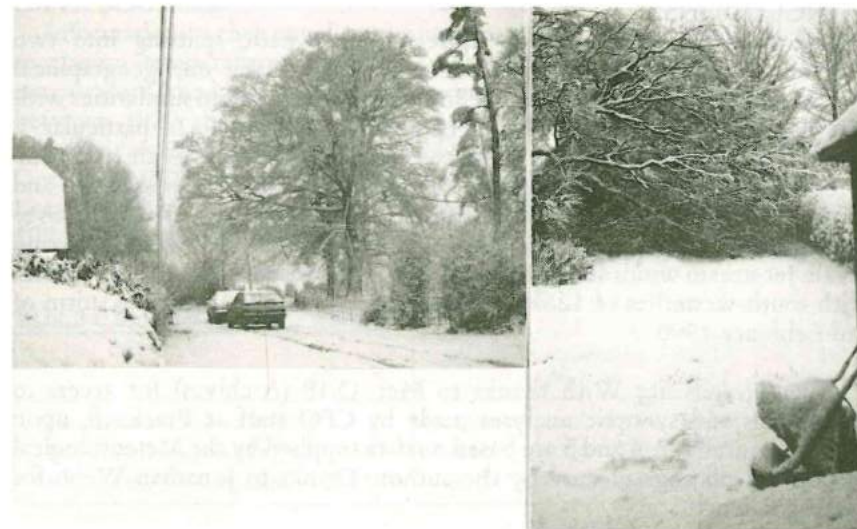


Fig.6(a): Snowfall of 6cm on road surfaces at 1215 UTC on 3rd February 1990. View to the south at Woodlands St Mary, West Berkshire.

Fig.6(b): Snowfall of up to 8cm at 1215 UTC on 3rd February 1990 on branches of the felled beech tree, shown in Figure 3. View to east at Woodlands St Mary, West Berkshire, in the Author's garden.

the cross-hatched areas) stretching from South Dartmoor through Somerset, South Wiltshire, Berkshire, South Oxfordshire, and on to the Chilterns in Bedfordshire Bucks. Snowploughs were called out after roads had been blocked, Warminster and Newbury being two examples of this. Roads closed including the A345 between Marlborough and Amesbury, and the B4494 Newbury to Wantage road. Some minor accidents occurred on snow-covered roads, the earlier rain having prevented pre-treatment of highways with salt.

Jonathan Webb, writing from Oxford, remarks that the snowfall was very heavy there between 1015 and 1130, giving a "temporary covering on the grass, roofs and pavements", even on lower ground in the City. A fall of 5-10cm was also reported from the Didcot area of southern Oxfordshire that morning.

Wind speeds were often quite light and never more than moderate to fresh during the snowfalls, however, speeds did increase at times later in the afternoon, as clearer weather spread down from the north west. The zone of strongest winds associated with the southern section of the 'back-bent' occlusion made 'News Headlines' as having affected northern France. Figure 5 shows a 70-kt north-westerly wind reported from the Pointe du Roc, when gusts between 60 and 85kt were being recorded throughout Brittany, and these were soon to move eastwards.



## CONCLUSIONS

Although following a much more-southerly path, splitting into two centres, and producing very different weather at any one geographical location, the more-shallow storm of 3rd February had certain similarities with the vigorous, deep Atlantic Storm of 25th January 1990. In particular, a marked 'back-bent' occlusion produced storm force winds with hurricane force gusts to the south of the main 'Low' centre as each passed by, and snowfalls occurred on the northern side of both depressions, particularly over high ground where sheer intensity of the precipitation lowered freezing levels. Jet stream winds above 100mph were also a feature of both depressions, with south-westerlies of 125kt at 250mb-level associated with the storm of 3rd February 1990.

*Acknowledgements:* With thanks to Met. O.18 (Archives) for access to tephigrams and synoptic analyses made by CFO staff at Bracknell, upon which, Figures 1, 2, 4 and 5 are based on data supplied by the Meteorological Office. All photographs are by the author. Thanks to Jonathan Webb for correspondence.

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## ANNUAL MAXIMUM AND MINIMUM TEMPERATURES IN THE UNITED KINGDOM 1920-1989

By D. G. TOUT

*Department of Geography, University of Manchester.*

*Abstract:* An investigation is carried out of the annual maximum and minimum air temperatures recorded in the UK between 1920 and 1989. The Lamb circulation types associated with these extremes are identified and possible temporal trends noted. The locations of the extremes are mapped.

## INTRODUCTION

In an earlier paper the author looked at the extremes of air temperature in the UK on a daily basis for 1984 and 1985, with an analysis of the spatial distribution of the stations recording these daily maximum and minimum temperatures (Tout, 1987). The current study investigates the annual maximum and minimum air temperatures recorded in the UK in the 70 years between 1920 and 1989, comments on the circulation types associated with the extremes and speculates on possible temporal trends.

## DATA SOURCES

Information on the annual maximum temperature (the highest of the 'daily maximum temperatures' observed in the UK) and the annual minimum temperature (the lowest of the 'daily minimum temperatures'), for each year between 1920 and 1988 and when and where they were recorded, was obtained from the Annual Summary of the *Monthly Weather Report* (HMSO). Details for 1989 were taken from the *UK Monthly Summary* publication of the London Weather Centre. Lamb (1972), for 1920-71, and *Climate Monitor*, for 1972-1988, were the sources for the daily classification of Lamb circulation types over the British Isles.

TABLE 1: Summary of the data analysis.

	Mean	Standard deviation	Highest/lowest	Lowest/highest
Annual max temperature (°C)	32.0	2.1	36.1	27.8
Annual min temperature (°C)	-18.0	3.9	-27.2	-10.2
Annual range of temperature (deg C)	50.0	3.8	57.9	38.2

## ANALYSIS OF THE DATA

The UK annual maximum temperatures and the Lamb circulation type for the day in question have been plotted in Figure 1 and the data have been summarised in Table 1. The highest temperature recorded over the 70-year period was 36.1°C (Circulation type (CT) U), recorded at Camden Square, Enfield, Regent's Park and Tottenham (Central London) and Halstead (Essex) on 19th August 1932, closely followed by the 35.9°C (CT:E) of the remarkable summer of 1976, recorded at Cheltenham on 3rd July. In 1989 the temperature rose to 34.2°C (CT:C) at Heathrow Airport on 22nd July, the highest annual maximum since 1976. The absolute maximum temperature for the UK is often quoted as 38.1°C (CT:A), at Tonbridge (Kent) on 22nd July 1868 (Lamb, 1958), although the authenticity of this observation has been disputed (Laing, 1977). This latter author instead recognises the 36.7°C (CT:A) recorded at Canterbury (Kent), Epsom (Surrey) and Raunds (Northants) on 9 August 1911 as the absolute maximum.

Although by intuition one would expect all annual maxima to occur during summer anticyclonic conditions, only 40 days are actually classified as anticyclonic (including anticyclonic hybrids), 19 as directional (covers all the directional circulation types (eg. W, NE)), 15, surprisingly, as cyclonic (including cyclonic hybrids) and 8 as unclassified. The aggregate is more than 70 as in some years the maximum was recorded on more than one day and all occurrences have been included in the circulation type analysis. Lyall (1974), investigating synoptic aspects of hot weather in Britain, in fact observed that his D1 (depression periphery or trough of low pressure) synoptic classification was the most frequently occurring single type, accounting for 40% of all days with a maximum exceeding or equal to 27°C.



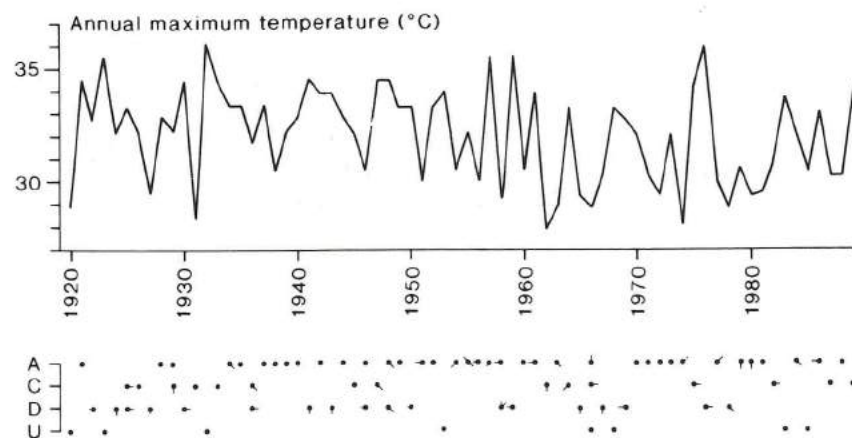


Fig.1: Annual maximum temperatures, and associated Lamb circulation type, recorded in the UK (1920-89). (Hybrid anticyclonic and cyclonic circulation types are indicated by the appropriate direction indicator).

The lowest UK annual maximum was  $27.8^{\circ}\text{C}$  (CT:CS), recorded at Writtle (Essex) in 1962 as late in the year as 3rd September. In 13 years the maximum failed to reach  $30^{\circ}\text{C}$ , ten of these being since 1957. Purely visual evidence indeed suggests a slight downward trend in the incidence of annual maximum temperatures over the 70-year period. The range of dates on which the annual maximum has been recorded is surprisingly large, the earliest being on 14th May 1965 (CT:S) and the latest on 19th September 1926 (CT:C).

The UK annual minimum temperatures and the corresponding Lamb circulation types have been plotted in Figure 2. The lowest UK temperature in the 70-years was  $-27.2^{\circ}\text{C}$  (CT:A), recorded at Braemar (Grampian) on 10th January 1982. This equals the absolute minimum for the UK, also recorded at Braemar, on 11th February 1895 (CT:E). It is interesting to note that three of the four lowest temperatures in the analysis period occurred between 1979-82. The events of the exceptionally cold period in mid-January 1982 have been extensively reported elsewhere (Meaden, 1982; Roach and Brownscombe, 1984). The highest annual minimum was  $-10.2^{\circ}\text{C}$  (CT:W), at Lagganlia (Highland) on 14th February 1974, followed by  $-11.4^{\circ}\text{C}$  (CT:E) at Balmoral (Grampian) on 8th February the next year.

As with the maxima, one would expect the annual minima to be recorded under quiet, cloudless, anticyclonic weather but in fact only 27 of the days were anticyclonic, 23 directional, 15 cyclonic and 8 unclassified. Visual evidence suggests a decreasing trend in the annual minimum temperatures from 1920 to about 1955, with a subsequent increase to 1976 and a very variable regime between 1977 and 1989. Table 1 shows that the standard deviation for the annual minimum is nearly twice as large as for the annual

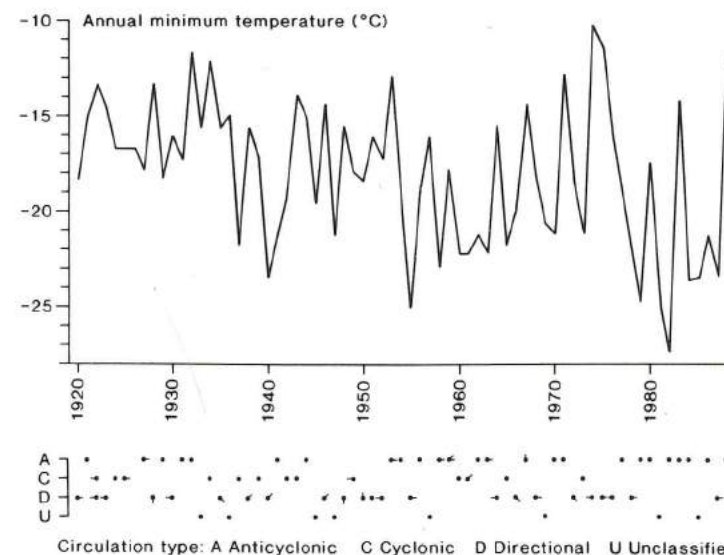


Fig.2: Annual minimum temperatures, and associated Lamb circulation type, recorded in the UK (1920-89). (See note to Figure 1).

maximum, indicating a much greater variation from year to year and clearly visible in Figures 1 and 2. The range of dates on which the annual minimum temperature has been recorded covers about four months; from 22nd November (1988) (CT:A) to 20th March (1930) (CT:W), but it must be remembered that these dates refer to the calendar year, not the winter period, which spans two years. In both 1988 and 1989 January to March periods were mild and the annual minimum temperature actually occurred in November in 1988 and in December in 1989.

The 63 stations recording the annual maximum temperature and the 31 stations recording the annual minimum temperature have been plotted in Figure 3. Each station which featured in the list, even in a year when the extreme was recorded at more than one station, has been included but no attempt has been made to depict frequency of occurrence of extremes at a particular station (eg. the annual minimum temperature was recorded at Braemar (Grampian) in no less than 25 of the 70 years). The annual maximum is usually recorded in southern or eastern England, south and east of a line from approximately Torquay to Scarborough (55 out of 63), while the annual minimum occurs in more than half the years in Scotland (17 out of 31). Wales features on only six occasions (two maxima, four minima) as the site of an extreme and Northern Ireland never.

The greatest range of temperature in a single year (1982) was  $57.9^{\circ}\text{C}$ , from  $30.7^{\circ}\text{C}$  to  $-27.2^{\circ}\text{C}$ . The most 'equable' year was 1974, with a range of  $38.2^{\circ}\text{C}$ , from  $28.0^{\circ}\text{C}$  to  $-10.2^{\circ}\text{C}$  (Table 1).



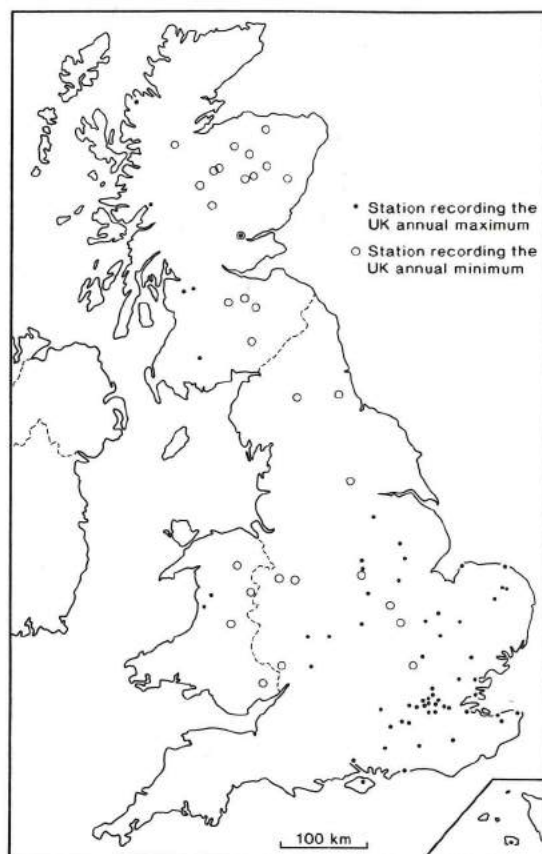


Fig.3: The location of stations recording the UK annual maximum and annual minimum temperatures, (1920-89).

## SUMMARY

The absolute range of temperature in the 70-year period was 63.3 deg C, from 36.1°C to -27.2°C. All the data refer, of course, to 'official' temperatures recorded at stations which are quoted in Meteorological Office publications. Although it is unlikely that substantially higher temperatures occur but are not recorded, even lower temperatures certainly do occur in isolated valleys which are susceptible to cold air drainage. Using NOAA-6 AVHRR satellite data, it has been estimated that the absolute minimum temperature of -27.2°C, recorded at Braemar (Grampian) on 10th January 1982, was exceeded on the same day by about 2 deg C at one or more locations in the Spey valley (Collier et al, 1989).

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## WORLD WEATHER DISASTERS: JUNE 1989

- 1: Thunderstorm in east London, Great Britain, one dead by lightning, storm in afternoon, accompanied by hail. *Birmingham Evening Post*.
- 1-3: Storm described as tornado accompanied by flash floods which swept through ten villages in the municipality of Malita, in Davao del Sur province, 1000km south-east of Manila, Philippines, leaving 11 dead, 4 missing and forcing 4000 from their homes, about 150 homes washed away. *Lloyds List*.
- 1-9: Storms, including wind, hail and tornadoes in six southern states of the U.S.A., including Texas and Oklahoma. On the 2nd insured losses from storms in Texas put at \$15 million, a storm in Texas 2nd Oklahoma on the 3rd caused insured losses of \$30 million, \$20 million in Texas, storms from the 6th to the 9th caused insured losses in six states of \$115 million, of which \$75 million occurred in Texas. *L.L.*
- 2: Two ships, one m. bulk carrier *Conch*, the other mv. *Taiyo Maru No.18*, collided in dense fog 26km north north east of Kinkasan lighthouse, Ojika Peninsula, Miyagi prefecture, Honshu, Japan, *Taiyo Maru No.18* sank, leaving two missing and a third injured. *L.L.*
- 2-7: Torrential rains, floods and landslides in south west Sri Lanka left at least 315 people dead, floods and mudslides reported from Kegalla, Kalutara and Ratapura areas in the south west and Nuwara Elija in the highlands, the Kegalla district worst hit, some areas under 9.15 metres of water, in addition to the dead, 1000 others injured and 200,000 made homeless, floods described as worst for 40 years. *L.L.*
- 3: Unseasonal heavy rains in central and east Java, Indonesia, floods in the Madiun regency in east Java along the Madiun river forced 29,000 people from their homes after flooding some 7,350 homes, the floods described as worst in 14 years, caused no casualties. *Jakarta Post*.



- 7: Mudslide hit bus in Kashmir, leaving 42 people dead. *Daily Telegraph*.
- 8: Lightning struck a number of huts in the coastal district of Thane, 80km from Bombay, India, the first day of the south west monsoon, leaving seven people dead and a further 12 injured. *D.T.*
- 8: Thunderstorms, rain, hail and tornadoes in U.S. states of Louisiana, Mississippi, Alabama and Florida. One tornado hit town of Grosse Tete, Louisiana, leaving two dead and 24 injured, at least 25 houses destroyed, the tornado was one of several in the Baton Rouge area. Another tornado hit Florida town of East Point, destroying a number of houses and leaving three people dead. *L.L.*
- 10: Typhoon "Dot" hit coastal regions of northern Vietnam, large areas of Ha Nam Ninh province, south of Hanoi, devastated, winds gusted to 120km/h and an average of 198mm of rain fell throughout the province. Nearly all houses in the coastal villages destroyed and more than 289,000 acres of rice, peanuts and sweet potatoes destroyed by wind and flooding, no immediate reports of casualties. *L.L.*
- 10-11: Tornadoes, wind and hail in New Mexico and Texas, U.S.A., caused insured losses estimated at \$25 million. *L.L.*
- 10-11: Heavy rains, floods and landslides in and around Rio de Janeiro, Brazil, left seven people dead, with a further five others missing, floods waist high in some streets, power supplies disrupted. *L.L.*
- 10-30: Serious forest fires around Vladivostok, Soviet far east and on island of Sakhalin. On Sakhalin two huge fires burned through more than 200,000 hectares of forest, in fires around Vladivostok one firefighter dead, with a further 12 injured. *L.L.*
- 13: Heavy rain touched off mudslide which flooded open-cut gold mine some 604km north east of Perth, Western Australia, six miners feared dead. *L.L.*
- 14-15: Thunderstorms, heavy rains and winds gusting to 130km/h hit Washington D.C. area, U.S.A., uprooting trees and cutting power supplies to 150,000 homes. On the 15th a tornado hit the central Manor area in Pennsylvania, injuring four people, tornado 16km long, seven houses destroyed. Storms swept from Florida to Pennsylvania on the 15th, trees uprooted and power lines brought down. *L.L.*
- 15-24: Heavy rains brought floods to Alabama, U.S.A., farms flooded. *D.T.*
- 16: A Delta Air Lines Inc L 1011 (Tristar) flew into severe air turbulence over state of Tennessee, U.S.A., 25 to 30 of the 282 passengers aboard the air liner injured. *L.L.*
- 16-20: Heavy rains, floods and landslides in India and Bangladesh:-  
*India:* Floods and landslides in the north east state of Arunachal Pradesh left 16 dead and thousands homeless.  
*Bangladesh:* Rains and floods along rivers in northern and eastern areas of country washed away hundreds of mud-and-straw houses, leaving at least 10,000 people homeless, the river Tista swept away at least 1,000 homes in the northern Rangpur and Lalmanirhat districts, on the 16th

- the river Gumti burst its banks at four places in the Comilla district sweeping away thousands of mud-and-straw houses in about 100 villages, leaving about 50,000 people homeless, no casualties reported. *L.L., International Herald Tribune.*
- 20: Heavy rains caused five rivers to overflow in the Purworejo regency, central Java, Indonesia, leaving two people dead, floods described as worst ever in the area. *J.P.*
  - 21: A coastal vessel sank in storm off the coast west of Palu, central Sulawesi, Indonesia, leaving 13 people dead, with up to 20 others believed missing. *J.P.*
  - 21-22: Hurricane "Cosme" hit Pacific coast of Mexico about 50km south east of Acapulco, with winds of up to 120km/h and heavy rains, no major damage reported, buildings damaged and trees uprooted, no casualties reported. *L.L.*
  - 21-22: Monsoon rain and floods in Ambon, Maluku, Indonesia, left eight dead and forced 32,500 people from their homes, floods up to two metres deep in areas, 160 houses destroyed by the floods. *J.P.*
  - 23: Two vessels, one the mv. *Melouia*, the other the mv. *Lady Rhoda* collided in dense fog about 11 nautical miles west of Cabo Silleiro, south entrance to Vigo Bay, Portugal, the *Lady Rhoda* sank, leaving one person dead and five others missing. *L.L.*
  - 23-30: Floods sweeping through Guangxi province, southern China after heavy rains have left 28 people dead in Tian'e county, in north west of province, where 108 houses were destroyed by floods and mudslides. *L.L.*
  - 24(reported): Floods along the Amazon river in Brazil described as third highest this century, 50,000 families forced from homes on the 23rd, five deaths reported in Manaus, capital of Amazonas state. *D.T.*
  - 25-27: Tropical storm "Allison" hit coast of Texas, U.S.A., with high winds, rain and flooding, no major damage, "Allison" went inland over north coastal area, some damage also reported from Louisiana. *L.L.*
  - 26: About 120 vehicles involved in a series of collisions on the autobahn between Augsburg and Munich, West Germany, in dense fog, leaving three people dead and 25 others injured. *I.H.T.*
  - 27-28: Brush fire burned through 4,000 acres in Riverside and Orange counties, southern California, U.S.A., 400 people evacuated, one firefighter injured, rainfall in area down by 50% this year. *L.L.*

ALBERT J. THOMAS

## LITERATURE REVIEWS AND LISTINGS

### Book Reviews

#### WINDS OF CHANGE: LIVING IN THE GLOBAL GREENHOUSE.

By John Gribbin and Mick Kelly. Hodder & Stoughton 1989, 162pp., £9.95.

This excellent book, written by two well-known scientists, deserves a wide readership for it examines a subject which is of great importance to everyone.



Moreover, it does so at an intellectual and financial level that is within most peoples' capabilities. It is also well produced (on non-chlorine bleached paper), with a clear typeface and over 130 attractive photographs, maps and diagrams in full colour, some of which are, however, less than essential. The inclusion of many interesting facts and some very useful diagrams (eg. 'Recent trends in climate', p.37; 'Sahel rainfall during the May-October season', p.69) mean that undergraduates and teachers, as well as the general public, will find things here that are of value. The authors underscore the importance of their subject by using evocative titles for some of their chapters (eg. 'The road to ruin' and 'Second only to nuclear war') and by demonstrating in their final pages how everyone is not only affected by this great problem, but must contribute towards its alleviation. This wide-ranging and comprehensive approach to the greenhouse problem is undoubtedly the best introduction to the subject currently available. Put it on your list of essential reading for 1990!

**THE WEATHER PROJECT BOOK.** By Francis Wilson. Hodder and Stoughton 1989, 32pp., £2.99.

Any book which attempts to stimulate the interest of the young does its subject a notable service. In producing such a book Francis Wilson has contrived to range widely within a small number of pages. He covers not only the nature and workings of the atmosphere, but also important topics such as forecasting, climatic change and atmospheric pollution. For each he suggests inexpensive and simple ideas to enable pupils (and perhaps some enquiring adults) to carry out their own observations and investigations. Clearly, there are weather topics which are not covered or are dealt with only briefly in this book. If, however, its aim of stimulating interest and enquiry is fulfilled, pupils and teachers should quickly find new projects and areas for investigation suggesting themselves (eg. visiting the local library to collect data about 19th century weather). Teachers may also find that the book covers many topics so briefly that pupils will ask for these to be expanded. They may even feel the need to challenge the occasional over-dogmatic statement (eg. that the next ice age "is due within 1000 years", p.21; or that "in fifty years time sea levels will have risen more than one metre", p.22). Overall, however, this book is good value for money.

L. T.

## LETTERS TO THE EDITOR

### A MOST UNEXPECTED SHOWER

On Saturday 3rd March 1990, after rising steeply for 2½ days my barograph was showing the unusually high value of 1045mb m.s.l. pressure (a guarantee, if ever there was one, of dry weather).

The day began cloudless, and although the usual convective cumulus began to appear after 10am, there was no reason to suppose anything amiss, except that the breeze had possibly become a bit gustier than one would have thought with such high pressure. Then, just after midday the sky became dull; and contrary, I am sure, to all expectations both official and amateur, there was a short but quite sharp shower of rain, sufficient briefly to wet the ground.

I do not know the reason. I can only suppose that there was a shallow freezing layer at cloud height – a well-renowned cause of upset to the forecasters.

Stapleton, Bristol

PAUL R. BROWN

### A BALMY, BARMY FEBRUARY

Not only was February 1990 the second mildest since records began in 1659 in the U.K., but many extreme maximum temperature records were broken in Europe as well. Among the most noteworthy were the following. Where existing records are known these are shown in brackets.

21st February – Las Palmas: 27 (29); Berlin: 16 (17); Warsaw: 16 (13)

15th February – Turin: 25°; Milan: 24° (20°); Nice: 25° (20°); Alicante: 26° (25°)

23rd February – Bordeaux: 25°; Biarritz: 26.2; Stockholm 16° (16.5); Rome: 21° (20°) – highest since 1782; London (Heathrow): 18.5 (19.4); Sundalsøra, S of Trondheim Norway 19; Leningrad: 8° (3°); Moscow: 7° (3°)

Over England and Wales winter 1989/90 had higher mean temperatures than winter 1988/89 south-east of a line from the Wash to Southampton with several individual stations being 0.5 deg C warmer in the most recent winter. Provisional figures suggest winter 1989-90 was the third warmest and the fourth wettest on record in the U.K.

University College of Swansea

ALLEN H. PERRY

### WHIRLWIND CIRCLES

I write with reference to the above phenomena and an article in the magazine *Me*, dated 30th October 1989, in which you were quoted as believing that the circles are caused by 'vortices' (columns) of air that can suck up or press down'. I came across the article quite by chance, as the magazine belonged to my auntie and had been relegated to the coffee table!

Last summer, on Monday 24th July, my mother, sister and I were visiting a place called Roundway Hill near Devizes, which is, as I'm sure you know, a picturesque, rather rugged spot that's quite off the beaten track. About 4 o'clock, we decided to head for home; it had been a blazing hot day, with very little, if any wind. Driving back along the beaten track, my sister suddenly exclaimed, "What's that?". We stopped the car, and watched, transfixed as a perfectly-shaped globe of wind swirled and spun before our eyes, picking up chaff from the freshly-cut corn. The chaff spun and floated about for about 10 seconds. Then the orb rose up, moved to the right, dropped down, the same thing happening again. It then moved up and fizzled away. We also noticed some litter, an apparently large piece of polythene, being picked up and spun in the same manner, only higher, further away, towards the tree line. I do not remember seeing it drop.

Although we could not gain access, my sister noticed round depressions in the field recalling the type that appear to have been the subject of much heated discussion during the last year. Seeing the article in the magazine refreshed our memory and I thought we should contact you in order to substantiate your theory about the circles. I hope that this letter is of some use to you in your research.

120 Harborne Road, Oldbury, Warley, West Midlands.

JACKIE F. PEARSON

### RINGED CIRCLE WITH THREE SATELLITES IN AUSTRALIA

In *J. Meteorology, UK*, Vol.15/no.146 (February 1990) Dr. Meaden reports on his survey of a rare cropfield circle formation which occurred near Oadby, Leicestershire, in June 1988: a ringed circle with three small satellites. This, as the report makes clear, was unique in the experience of researchers in the UK (and has not yet been seen again in this country). The paper refers however to a "trace similar to this one" which has recently been reported from Australia, albeit some years after its occurrence in 1982.

I assume that the Australian occurrence referred to is the one which was conveyed to me by one of my Australian correspondents and which seemed to me to be of sufficient interest to warrant my informing CERES about it in a memorandum to them dated 25th November 1989. I think it will



be relevant to further research into the cropfield circles phenomenon if I enlarge a little on the details of this Australian case.

My correspondent informs me that she was walking with a friend along a track, hemmed in by dense trees on either side, when they observed – in the bare earth – a succession of circular disturbances. “We followed the circles a long way down this pathway until we reached a large rocky ledge and then the track stopped, due to its edge being on the brink of a drop . . . On the rocky ledge was a 4-circle formation . . .” which my correspondent then describes in identical terms to the Oadby cropfield markings of 1988. (I have reproduced her emphasis in the above quotation from her letter).

We may well wish that this report had reached us more quickly and that it bore the stamp of a scientifically qualified observer (which I am clear that my correspondent would not wish to claim that she is). But if we take the report seriously as a possible counterpart to the Oadby cropfield occurrence (as Dr. Meaden’s paper is ready to consider) two points need stressing. First, the Australian event was in no sense a cropfield circle: there were no crops! Secondly, we have evidence of something which can leave a distinct and complex impression in hard earth.

Several questions arise. For example, can one and the same energy-form (Dr. Meaden’s plasma vortex is the leading contender) act with sufficient gentleness to make distinctive patterns in growing crops in England without killing them, yet also leave its impress in a “rocky ledge” in Australia? If so, what enables it to act so differentially in different circumstances? What factors determine the form which its manifestations seem able to take on different occasions: a ringed circle with small satellites in pliable grain at Oadby in 1988; a ringed circle with small satellites in a “rocky ledge” in Australia in 1982; the many other patterns of ground-disturbance – some in crops, many in other terrain – which have been observed world-wide in recent decades.

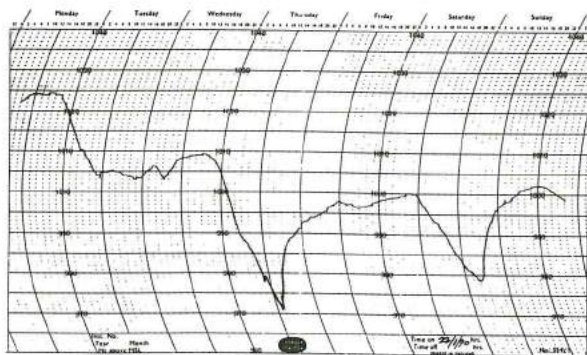
The questions might be multiplied; it is for field-researchers and the theoreticians to consider them. My sole concern is to ensure that the surprising details of my Australian correspondent’s report of 1982 are not lost to sight: they must either be dismissed as the misperception of an untrained observer, or account must be taken of them in framing a comprehensive hypothesis of the cropfield circles phenomenon.

9 Oakley Street, London.

RALPH NOYES

### PRESSURE CHART FOR THE WEEK OF THE 25th JANUARY 1990 STORM

I attach a barograph chart for the week commencing 22nd January 1990, which may be of interest.



I personally lost my greenhouse which was shattered beyond repair during the gales on Thursday 25th. January, despite the fact it stayed put during the 1987 storm.

42 Alpine Avenue, Tolworth, Surbiton, Surrey.

PETER M. ASHDOWN

## TORRO TORNADO DIVISION REPORT: July and August 1989

Both July and August 1989 were fine and settled for most of the time, though August was more unsettled in the north-west of Britain. For July TORRO has reports of one unconfirmed tornado, eleven land devils, four showers of hay or straw and one fire devil. For August we know of one definite tornado, nine or more land devils and two showers of straw. A water devil was also reported during the summer.

LD1989July5. *Bexleyheath, Greater London (TQ 4875)*

A land devil was observed at about 1000 GMT (COL, July 1989, p.15). The area was in a north-easterly airstream on the flank of a high centred off N.E. Scotland, 1032mbar, at 1200.

LD1989July11. *Wootton, Isle of Wight (SZ 5492)*

Mrs. Olga Watts sent a cutting from the *Isle of Wight County Press* of 14th July which described how a 40lb (18kg) pushchair was lifted six feet (two metres) by a land devil during the afternoon. Southern England was covered by a ridge from the Azores high.

Mr. Bernard Burton reports that analysis of his anemograms from Wokingham, Berkshire (SU 800699), suggests the passage of vortices resembling land devils at about 1215 GMT on 11th July and 1525 GMT on 16th July.

2LD1989July15. *Near Beauworth, Hampshire (SU 570247)*

Ms. Sue Saville, a BBC television reporter, saw a land devil between 1200 and 1300 GMT. It was at least 100 feet (30 metres) high and lasted for between five and ten seconds. A smaller land devil appeared ten minutes later. Both were in a field, and neither made any sound (information from Mr. Paul Fuller). A north-westerly airstream covered all areas, with a high (1034mbar) west of Ireland at 1200. The day was very warm (27°C inland in Hampshire), with almost unbroken sunshine.

RS1989July18. *Trowbridge, Wiltshire (ST 859575)*

Ms. Alexandra Woolner witnessed strands and clumps of hay falling at Trowbridge swimming baths (famous as the scene of a shower of small frogs on 14th June 1989; see G. T. Meaden, *J. Meteorology*, 7, 178-181, July/August 1982). The time was about 1230 GMT. The wind was northerly, light; maximum temperature about 28°C. A high covered all areas.

RS1989July19/I. *Penn, Wolverhampton, West Midlands (SO 8996)*

RS1989July19/II. *Perton, Staffordshire (SC 8598)*

Falls of hay during the afternoon were mentioned in a press report sent by Mr. David Reynolds, who at 1700 GMT recorded 27.0°C, wind calm, ½ cumulus and ½ altocumulus, at Wolverhampton. All areas were affected by a high centred off the coast of East Anglia, 1026mbar, at 1200.



LD1989July20/I. *Somerford Mill Farm, Brewood, Staffordshire (SJ 888094)*

This land devil, which formed at 1550 GMT, travelled rapidly from S.E. to N.W. "in a force 3 wind which pushed the land devil over to an angle of about 60° to the ground". It probably formed on a potato field, which was being harvested at the time; it crossed a field of rape straw and disappeared near a hedge. Its rotation was revealed by the soil and rape straw it raised to a height of about six metres (David Reynolds). There was  $\frac{5}{8}$  altocumulus castellanus at the time. At 1700 GMT Mr. Reynolds recorded 28.5°C, wind E. force 2,  $\frac{3}{8}$  cumulus, at Wolverhampton. Most areas were affected by a high centred over the North Sea.

LD1989July20/II. *Three Barrows, near Beckhampton, Wiltshire (SU 0567)*

At about 1330 GMT Mr. David Banks photographed a land devil which was lifting straw to a height of 15-20 feet (5-6 metres) as it travelled north or north-west at about walking speed. The weather was fine, sunny and very warm.

FD1989July21. *Cawthorpe Farm, near Bourne, Lincolnshire (TF 0922)*

Mr. John Lister was burning stubble when a "freak whirlwind" picked up burning straw and dropped it in the next field, where the fire spread and caused damage estimated at £4000 (*Stamford Mercury*, 28th July, sent by Mr. J. Tourtel). A trough crossed the area in the early afternoon, in a hot south-easterly airstream with maxima of 29°C in inland Lincolnshire.

tn1989July22. *Newport Pagnell, Buckinghamshire (SP 877432)*

During a thunderstorm that lasted from 1910 to 2005 GMT willow trees lost branches in a narrow band from S.S.E. to N.N.W.; 10-15 pear trees were also damaged. Pressure was very uniform across Britain for most of the day, with a shallow low, 1014mbar, forming over the south-east by midnight. There was a slack south-westerly flow at 500mbar. Thunderstorms broke out in eastern areas during the late evening, after a very hot day with maxima of 32-33°C widely in the south-east and Midlands.

RS1989July22. *Tong, Shropshire (SJ 7907)*

David Reynolds was told by a witness of a considerable and extensive shower of straw at Tong during the afternoon. At 1700 GMT he recorded 30.0°C, wind W. force 3,  $\frac{5}{8}$  altocumulus, at Wolverhampton.

2LD1989July23. *Somerford Mill Farm, Brewood, Staffordshire (SJ 893092)*

Mr. John Groves saw two land devils in a field of barley stubble during the afternoon. At 1700 GMT David Reynolds recorded 27.5°C, wind N. force 3,  $\frac{1}{8}$  cumulus,  $\frac{1}{8}$  altocumulus and  $\frac{5}{8}$  cirrus, at Wolverhampton. Britain lay in a col.

LD1989July24. *Chadderton, Greater Manchester (SD 9005)*

This land devil removed tiles from the house roof of Mrs. Nora Pimlott (*Oldham Chronicle*, 25th July, sent by Mrs. Audrey Crowe). Mrs. Crowe said

that about 35 tiles were displaced, and that the event happened during the afternoon. Much of Britain lay in a col; maxima were 27-29°C in the Manchester area.

LD1989July29. *Longwood Warren, near Winchester, Hampshire (SU 525268)*

At 1005 GMT Mr. Colin Andrews saw a land devil lifting dust and straw to a height of 15 metres. The land devil was five metres wide, and was observed for 15 seconds, passing roughly from S.W. to N.E. Southern England was in a south-westerly airstream.

LD1989July. *High House Farm, Beetley, Norfolk (TF 977179)*

Straw was lifted 40 feet (12 metres) by a land devil which resembled "an enormous upside-down ice cream cone", at High House Farm, Beetley (*Eastern Daily Press*, 22nd July, sent by Mr. Norman Brooks). No date is given in the press report, which probably means that the event happened several days earlier.

LD1989August4. *Keyworth, Nottinghamshire (SK 6231)*

During the afternoon "a column of spinning . . . dust and straw" was observed at the British Geological Survey office at Keyworth (information from Mr. Jerry Hodgson). A ridge affected most areas; Nottinghamshire was sunny with maxima around 21°C.

LD1989August5/I. *Pucklechurch, Avon (ST 695761)*

A land devil was seen by Miss Jacqui E. Griffiths at about 1220 GMT; the track was roughly from north to south. Later "swirled patches of flattened grass and straw" were found nearby (Peter D. Rendall, *J. Meteorology*, 14, 414-415, December 1989). A very flat pressure field covered England; the day was sunny in Avon with maxima around 26°C.

LD1989August5/II. *Near Bratton, Wiltshire (ST 9251)*

Several land devils were seen by Mr. Christopher Garbutt on the hills above Bratton. They showed up well in the recently burnt fields.

LD1989August6. *Keyworth, Nottinghamshire (SK 6231)*

RS1989August6. *Tollerton, Nottinghamshire (SK 6034)*

In the early afternoon a "rotating area of straw" was seen moving across a field at Keyworth. At the same time an observer at Tollerton saw pieces of straw drifting down out of the sky (Jerry Hodgson). A shallow low (1001mbar off western Scotland at 1200) affected many areas, but Nottinghamshire was very warm (maxima around 27°C) and fairly sunny.

RS1989August6/II. *Hempnall, Norfolk (TM 2494)*

Mrs. E. M. Chapman wrote to Derek Elsom to report that a shower of straw had fallen at lunchtime (probably about 1200 GMT).

2LD1989August8/I. *Somerford Mill Farm, Brewood, Staffordshire (SJ 893092)*

These two land devils formed in the field of barley stubble where two land



devils were observed on 23rd July. They were made clearly visible by raising lime dust. The first devil, which formed at 1209 GMT, had a diameter of about ten metres and a height of at least 20 metres. It travelled from S.W. to N.E. in the force 3 wind, but became stationary twice. It was in view for at least 15 seconds, during which time it split into two for two to three seconds. "As it split, the outer circulation decreased in velocity, whilst the circulation of the two vortices increased, and they were observed to make half a rotation around each other before dissipating, with the single vortex becoming established once again". The track length was at least 300 metres. The second land devil (1214 GMT) was seen for about ten seconds; it was about 15 metres high but little more than one metre in diameter; rotation was very fast. There was  $\frac{1}{8}$  cumulus and  $\frac{1}{8}$  cirrus at the time; the maximum temperature at Wolverhampton was 24.7°C (David Reynolds). Britain was in a south-westerly airstream.

LD1989August8/II. *Thruxton Aerodrome, Hampshire (SU 2745)*

At 1220 GMT Terence Meaden watched a land devil moving from west to east along a slightly dusty metalled track at perhaps 6-8 knots. The known path length was about 100 metres.

TN1989August14. *Near Pwllheil, Gwynedd (SH 4336)*

The Butlins Holidayworld Centre, five kilometres east of Pwllheli, was seriously damaged by this tornado, which struck just after 1830 GMT. The roofs were ripped off 150 timber-built chalets and extensive damage was caused to other buildings; 3500 people had to be evacuated and 13 suffered minor injuries. Trees were uprooted and ice cream kiosks blown into a lake. A witness, Mr. Fred Rudge, said: "Looking out we could see bins being thrown some 30 feet into the air" (*Cambrian News*, 18th August, sent by Mr. Robin Harper). The force was probably T4.

A deep low (966mbar) was centred west of Scotland at 1800, and its cold front crossed the Pwllheli area at about the time of the tornado. The front was accompanied by heavy rain, squalls and thunderstorms in many places. At 500mbar there was a large low well to the west of Scotland.

LD1989August28. *Somerford Mill Farm, Brewood, Staffordshire (SJ 8909)*

A land devil 15 metres in diameter raised straw as it moved from W.N.W. to E.S.E. (David Reynolds). Mr. Reynolds ran into the land devil, and estimated the wind speed there as force 5; rotation was anticyclonic. It was at least 30 metres high, and travelled at least 100 metres. There was  $\frac{1}{8}$  cumulus; wind was W.N.W. force 2. The maximum temperature at Wolverhampton was 19.7°C. Britain was under the influence of a high centred off S.W. England, 1026mbar, at 1200.

WD-LD1989summer. *Near St. Ives, Cambridgeshire (c TL 3071)*

Mr. Brian Neasham saw a water devil on the River Great Ouse near St. Ives on "a very hot Saturday morning, with absolutely no wind at all . . . This

vortex raised the water from the still river at least two to three feet with a diameter of at least three feet . . . After some three minutes it slowly disappeared to the bankside and across the field" (letter in unidentified issue of *Country*). The weather conditions suggest that the date was 22nd July.

#### *Waterspouts worldwide*

The following waterspouts have been reported to TORRO by Capt. M. L. M. Coombs of the Meteorological Office.

WS1989May30

35° 09.0'N., 8° 52.9'W.; observers J. Benson and J. C. Yates; ship *English Star*.

WS1989August25

57° 43'N., 19° 48'E.; Capt. R. Hemmings, L. Orsted, A. Devlin; *Baltic Link*.  
M. W. ROWE, G. T. MEADEN

## TORRO THUNDERSTORM REPORT: August 1989

By KEITH O. MORTIMORE

*Thunderstorm Division, Tornado and Storm Research Organisation,  
77 Dicketts Road, Corsham, Wiltshire SN13 9JS.*

Apart from the period 13th to 16th, when thunderstorms occurred fairly widely across the U.K., there was little activity of any consequence during August. Totals of thunder-days were below the normal in all countries, except Scotland where the normal was closely approached. Due to the almost total absence of thunderstorms of continental origin southern coastal counties of England were almost totally devoid of thunder, perhaps a single day being heard inland. Towards the midland counties of England thunder was heard more frequently with three days being reported by a few observers. In Northern Ireland thunder was heard on four days locally.

Thunder-days in August 1989 were as follows: (Averages refer to the period 1951-1980).

August 1989	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Ave.
England						X	X		X	X		X	X	X	X	X										X	X				11	17.0	
Wales												X	X		X																3	8.9	
Scotland					X	X	X					X	X	X	X				X	X											9	9.3	
Ireland					X	X						X		X	X																5	7.8	
Total					X	X	X		X	X		X	X	X	X	X		X	X							X	X				15	18.8	
Netherlands	X					X	X	X		X		X			X		X									X	X	X			11	16.0	
Belgium	X					X	X	X		X					X											X	X	X			9		

On 5th a cold front crossed Ireland and parts of Scotland; as it did so it produced a number of thunderstorms in Ireland and some very isolated activity in western Scotland, and on afternoon of 6th this slow-moving front set off further activity in east Scotland. In the south-east of England some



isolated thundery outbreaks developed late in the day ahead of the cold front out of an area of cloud moving north from France. In the early hours of 7th the thunderstorms in north-east Scotland moved to the Northern Isles and in the afternoon and evening some isolated storms were set off behind the front over East Anglia and Kent. Very late on 9th some thunder was heard in east Devon and during the early hours of 10th scattered thundery activity extended eastwards across southern counties of England, while slowly dying out. There was also thunder in the Channel Islands. During morning of 12th thundery showers affected parts of western Scotland. Thunderstorms occurred fairly widely on 13th and 14th as bands of showers crossed the U.K. from the west, the main areas of activity being associated with active cold fronts that crossed the country late on 13th and again late on 14th. During the storms of 14th lightning struck a house near Cardiff setting fire to the roof which in turn set a bedroom alight from which an eleven-month old baby was rescued unharmed. During the evening the Butlin's Holiday Camp at Pwllheli on the north Wales coast was hit by a strong tornado that inflicted considerable damage to the complex. Scattered showers affected many parts of Britain on 15th and these were heaviest in the north and west with thunder in parts of Ireland, southern Scotland and northern England. On 16th showers again developed widely and all parts of the U.K. and Eire reported scattered thundery activity, but more especially in the south-east where storms survived well into the evening. Heavy hail fell in some parts. Showers also turned thundery in parts of central and southern England on 17th. On 19th and 20th parts of southern and central Scotland reported scattered thunderstorms and on each occasion these were associated with cold fronts crossing the area. The final two thunder-days were very insignificant with isolated thunder in east Norfolk on 26th, in association with the passage of a low across the area, and in some eastern and south-eastern coastal areas on 27th as showers turned thundery over the North Sea in the cool northerly airflow. Lightning was observed over the North Sea from some inland stations in the late evening.

*Acknowledgements:* The Directors would like to thank all TORRO and TCO observers who have contributed to the compiling of this report. Sincere thanks are also offered to members of the *Climatological Observers Link* and also to the London Weather Centre for information published in the *Daily Weather Summary*.

## WEATHER SUMMARY: January 1990

January 1990 was a very mild and wet month and the final week was particularly stormy. Mean temperatures across the country ranged from one and a half degrees Celsius above the normal in northern Scotland to more than three and a half degrees above in central and southern England. Temperatures rose to 13° or 14° over parts of Scotland on 11th, reaching 14.4° at Kinloss on

the Moray Firth, and 14° or 15° was widely reported over northern parts of England and Wales on 15th. Highest values included 15.0° at Sunderland (Tyne and Wear), 15.2° at Sefton Park, Liverpool and 16.0° at Colwyn Bay to the lee of the Snowdonian mountains in north Wales. Highest minima occurred on the morning of 16th with 11.4° at Plymouth, 11.2° at Exeter and 11.0° at Sefton Park, Liverpool. Lowest maxima included 3.3° at Stansted (Essex) on 1st, 3.1° at Boulmer (Northumberland) on 2nd, -0.1° at Aviemore and 0.3° at Inverdrue (Highland) on 24th, 0.3° at Braemar (Grampian) on 25th and 0.5° at High Bradfield (South Yorkshire) on 26th. The lowest minimum of the month was only -5.3° at Shawbury (Shropshire) on 7th, with other unexceptional values being -3.9° at Inverdrue and -3.5° at Gatwick on 2nd and with -3.5° at Hurn airport, Bournemouth on 18th. On the grass -9.9° was recorded at Shawbury on 7th, -9.0° at Kinloss on 4th, -8.8° at Belfast on 28th and -8.2° at Belfast on 28th and -8.2° at East Hoathly (East Sussex) on 18th. Apart from some eastern coastal areas, where rainfall totals were rather below the normal, most other parts of the U.K. had a wet month and a number of places reported between 150 and 200 percent of the normal, especially in the west and north. The rain shadow effect was very pronounced over Scotland where more than 250 percent of the normal fell over the western highlands and just 61 percent at Aberdeen and 49 percent at Wick on the north-east mainland. The 27th saw the most widespread heavy falls across the country and some of this fell as snow in parts of Wales and the north of England. Rainfall totals for the 27th included 68.5mm at Milford Haven (Dyfed), 43.4mm at Velindre (Powys) and 35.4mm at Leeming (North Yorkshire). At Broadford (Skye) 62.9mm fell on 14th and a further 55.0mm fell on 15th. On 29th 45.9mm fell at Pencelli (Powys) and on 30th Brighton (East Sussex) received 34.8mm. Eastern parts of both England and Scotland had a very sunny month as did north Wales and the north-west Midlands down-wind from the mid Wales mountains. In these parts as much as 150 percent of the normal sunshine was recorded. In the west and in southern coastal counties of England sunshine totals were generally rather below normal.

Cold continental air covered the U.K. at the start of the month but during 1st a cold front crossed the country introducing air of more maritime origin and gave all parts a spell of quite heavy rain. Western areas had further rain on 2nd and 3rd but southern and eastern counties were dry, and although rather cold at first, it became very mild in all parts by 6th. The 6th was also quite wet over England and Wales, as a cold front crossed the country, and after an early frost on 7th frontal systems spread more rain to most places by the end of the day, followed in turn by a sunny day over England and Wales on 8th. The 9th to 11th was a very mild period with brisk south-westerly winds; most parts were dry but the north-west had a good deal of rain. Very mild south-westerly winds continued to blow over the U.K. during the next few days and although wet at times there was quite a lot of sunshine in the south and east. The moisture-laden airstream also produced copious amounts of rain in north-



western Britain, particularly over the mountains. After exceptionally mild conditions on 15th the following week saw less extreme temperatures and in the north it became rather cold at times. However, by the end of the period it was again very mild with 13° to 14° maximum in a number of spots. Wet spells continued to affect all parts but with high pressure over the continent the south and east had some good sunny spells, especially on 17th and 18th. After 22nd the weather became very disturbed, as the European anticyclone declined and very intense depressions began to take more southerly tracks over or very close to the British Isles. Winds reached severe gale force at times in many places and rainfall was widespread and often heavy. On 25th a particularly intense low of 951mbar crossed southern Scotland giving south Wales and central and southern England a spell of damaging winds that gusted to 90 knots in places and with mean values in the region of 40 to 50 knots over a wide area. Structural damage occurred widely and there was considerable loss of life. Active depressions continued to cross the country until the end of the month with frequent spells of heavy rain and as it turned colder snow fell over high ground from mid-Wales and the north midlands northwards. Snowfalls were quite considerable on 27th but the cold spell was short-lived and melting snow coupled with continuing heavy rain produced considerable flooding in western counties by the end of the month.

### WEATHER SUMMARY: February 1990

February 1990 was a very wet, stormy and exceptionally mild month and from long-term records for central England it would seem to have been the second mildest since 1659. Mean values ranged from four and a half degrees Celsius above the normal over parts of the south to around one degree above over north-west Scotland. Notably high temperatures were reported on a number of days. On 5th 15.1° was recorded at Saunton Sands (Devon), on 7th 15.1° was reached at Coltishall (Norfolk) and Bristol and on 20th the temperature rose to 16.0° on Guernsey. After 17.0° at Saunton Sands on 22nd and 23rd saw spring-like conditions over many parts of Great Britain. Highest maxima were 19.3°C at Buxton (Norfolk), 18.9° at Sidcup (Kent), 18.5° at the London Weather Centre and 14.5° at Aberdeen in Scotland. A temporary incursion of cold air just before mid-month produced rather low temperatures, particularly in the north, with maxima of 2.3° at Tummel Bridge (Tayside) and Glenlivet (Grampian) on 11th, 1.9° at Glenlivet on 12th and 1.8° at Aviemore on 13th. At Braemar (Grampian) 1.2° was recorded on both 11th and 13th. On 28th Emley Moor and Bingley (West Yorkshire) recorded just 1.6° and 1.1°C was reported at High Bradfield (South Yorkshire). High minima included 12.4° at Manchester, 12.3° at Wyton (Cambridgeshire) and 12.5° at Yatton (Avon) on 20th, Leeming (North Yorkshire) recorded 12.2° on 24th and in Scotland Aberdeen recorded a

minimum of 11.1°C on 5th. Lowest screen minima included -6.0° at Glenlivet on 15th, -5.0° at Belfast and -3.7° at Wattisham (Suffolk) on 16th. On the grass -8.8° was recorded at Marham (Norfolk) and -7.0° at East Malling (Kent) on 16th, -8.5° at Aviemore on 15th and -7.7° at Coltishall on 17th. Rainfall was quite exceptional during February, causing serious flooding in some western areas at times. Few areas received less than twice their normal while in Cumbria and western Scotland between 300 and 450 percent of the normal was widely recorded. High 24-hour totals include 49.5mm at Sloy (nr. Loch Lomond) on 1st, 72.3mm at Fort William on 4th, 61.8mm and 66.5mm at Pencelli (Powys) on 6th and 7th respectively, 44.6mm at Bastreet (Cornwall) on 13th and 49.4mm at the same station on 14th and 65.4mm at Trawsfynydd (Gwynedd) on 19th. Most western and northern parts of the U.K. had a dull month with many stations recording less than 80 percent of the normal. In central and south-eastern areas it was quite sunny and more than 150 percent of the normal sunshine was reported in parts of East Anglia and south-east England.

As a deep low tracked north-east to the west of Ireland heavy rain and gale-force winds crossed all parts of Britain on 1st, followed by showers and sunny spells on 2nd, while on 3rd a small depression spread heavy rain and some local thunderstorms across southern counties of England followed in turn by widespread wintry showers. Very mild south-westerly winds covered all parts from 4th to 6th, the very moist air producing considerable rainfall over north-west Britain, and on 7th stormy conditions and heavy rain accompanied the passage of an active low and cold front across southern Britain. Between 8th and 10th the weather was brighter with some sunny spells, apart from a little rain on a cold front that crossed the country on 10th, but on 11th, as a deep low crossed Scotland, much of the U.K. had heavy rain and severe gales followed by wintry showers. Heavy snowfalls affected the Scottish mountains. Over the next few days the colder weather spread south with wintry showers and sunny spells and also frosty nights, with frost being particularly widespread on 15th and 16th. Most parts turned milder from 17th, although wintry showers continued to affect the far north for a time and heavy rain accompanied a frontal wave across western counties on 19th. Temperatures rose to 14° and 15° quite widely on 20th, as tropical air moved north across the country, and on 22nd and 23rd temperatures reached 16° to 19° giving an early taste of spring. A depression tracked north-east across Scotland on 24th spreading cooler air to most parts and giving Scotland some heavy rain, and then on 25th all parts had spells of rain. Heavy rain crossed most areas early on 26th followed by a day of severe gales which reached storm-force in northern areas, where gusts in excess of 80 knots caused considerable structural damage. Much of the U.K. had wintry showers during the day and these colder conditions continued until the end of the month with snow falling over northern hills accompanied by drifting in the continuing strong to gale-force winds.



## TEMPERATURE AND RAINFALL: JANUARY 1990

	Mean		Grass									
	Max	Min	Max	Min								
BELGIUM: Uccle	7.4	3.0	13.4(25)	-1.8(4)	-6.3(4)	67.7	104	21.7(23)	20			
" Rochefort	6.6	0.2	12.4(25)	-7.4(5)		41.7	64	12.1(23)	14			
" Liège	8.1	3.3	13.6(25)	-1.8(4)		61.5	101	25.3(23)	16			
DENMARK: Fanø	6.2	3.3	8.5(31)	-1.7(5)		87.5	142	14.3(23)	28	3		
" Frederikssund	5.9	2.6	9.8(15)	-1.2(2)	-5.0(3)	56.5	124	21.0(26)	20	0		
GERMANY: Berlin	5.8	1.6	11.3(17)	-6.0(7)	-8.1(7)	33.8	83	10.9(25)	20	2		
" Hamburg	6.8	2.4	11.7(16)	-2.5(4)	-3.6(15)	47.6	51	9.9(25)	20	1		
" Frankfurt	5.5	1.1	13.6(31)	-2.6(2)	-4.0(18)	22.8	52	9.3(25)	9	2		
" Munchen	4.2	-5.7	14.5(28)	-17.2(12)	-20.2(12)	27.2	52	12.6(5)	10	0		
ITALY: Casalecchio	6.9	0.0	11.0(30)	-6.0(3)	-8.0(3)	0.6	1	0.5(28)	2	0		
MALTA: Luqa	15.8	10.6	18.3(1)	6.3(18)	1.7(19)	191.4		38.1(13)	18	4		
NETH'NDS: Ten Post	6.9	3.1	11.4(16)	-2.5(1)	-4.2(4)	54.2	88	16.4(26)	19	1		
SWEDEN: Valla	3.5	-0.5	8.0(11)	-4.8(3)	-8.0(27)	52.4		13.4(26)	23	0		
SWITZ'LAND: Basel	6.3	-1.4	14.7(25)	-7.3(11)		24.2	46	7.2(28)	10	0		
EIRE: Straide	9.1	3.8	13.8(15)	-0.7(8)	-7.9(8)	212.5	167	27.0(22)	29	5		
SHEET'AND: Whalsay	6.7	3.4	9.5(12)	0.2(28)	-4.1(28)	149.9	118	13.0(14)	31	3		
" Fair Isle	7.3	5.0	10.0(11)	0.8(24)	-3.0(20)	130.3	133	23.3(25)	28	2		
SCOT'AND: Braemar	5.6	0.1	10.8(21)	-2.9(26)	-4.5(26)	143.0	174	17.5(16)	31	0		
" Inverduie	6.5	1.0	11.7(21)	-3.9(2)	-9.1(26)	155.8	195	20.6(16)	29	0		
" Rannoch	6.7	0.6	12.1(21)	-5.0(26)	-5.2(26)	257.7		28.4(16)	26	0		
WALES: Velindre	9.7	4.0	12.6(15)	-2.9(7)	-9.3(7)	162.5	175	43.4(27)	25	1		
" Carmarthen	9.3	4.1	11.2(15)	-2.4(7)	-6.2(7)	222.6	178	34.2(27)	29	3		
" Gower	9.6	5.4	11.2(22)	1.7(27)	-4.0(13)	188.4	152	40.0(27)	29	1		
GUERNSEY: Airport	10.2	6.4	11.9(25)	2.6(26)		123.5		18.8(23)	20	3		
ENGLAND:												
Denbury, Devon	9.8	5.4	12.9(15)	-1.0(13)	-3.7(13)	203.4	170	20.1(31)	23	2		
Gurney Slade, Somerset	8.9	4.0	12.0(8)	-1.4(13)	-3.0(13)	152.0	122	20.8(27)	25	2		
Yatton, Avon	10.5	5.5	12.7(25)	-2.5(13)		120.7		17.9(27)	25	1		
Mortimer, Berkshire	9.4	3.6	12.7(15)	-1.4(18)	-7.4(18)	107.4	163	18.9(30)	21	1		
Reading Univ., Berks	9.9	4.0	12.9(15)	-1.2(2)	-6.2(2)	85.4	153	15.0(30)	19	1		
Sandhurst, Berkshire	9.6	3.5	12.8(15)	-2.2(18)	-3.9(18)	92.6	135	13.3(6)	19	0		
Romsey, Hampshire	9.8	3.9	12.7(15)	-3.0(18)	-5.6(18)	127.4	156	19.1(30)	22	0		
Brighton, Sussex	8.9	4.4	11.0(25)	0.5(14)	-1.2(18)	131.7	163	34.8(30)	25	0		
Hastings, Sussex	8.9	5.1	11.0(22)	1.9(14)	-2.9(-)	114.4	126	22.3(30)	20	0		
Dover, Kent	9.6	4.6	11.8(25)	-2.2(14)		99.1	124	22.0(30)	22	2		
East Malling, Kent	9.8	4.1	12.5(22)	-1.8(14)	-6.9(14)	92.3	150	20.4(30)	22	0		
Epsom Downs, Surrey	9.1	4.8	12.3(15)	-0.6(2)	-4.5(2)	110.8	138	18.3(30)	19	0		
Reigate, Surrey	8.8	3.6	11.9(22)	-1.2(18)	-4.1(18)	115.7	155	25.7(30)	19	1		
Guildford, Surrey	9.2	5.0	12.8(15)	1.0(14)	-1.7(27)	106.2	149	18.0(30)	20	1		
Sidcup, London	9.8	4.5	13.0(15)	-1.2(14)	-5.0(-)	64.3	128	11.2(30)	19	0		
Hayes, London	9.5	3.8	12.6(15)	-1.8(14)	-3.9(14)	75.8	130	12.6(6)	19	1		
Hampstead, London	9.3	4.3	12.2(15)	0.8(18)	-4.7(2)	74.6	136	13.5(6)	20	1		
Royston, Hertfordshire	9.0	4.8	12.0(15)	1.0(2)	-1.1(7)	60.2	122	11.0(6)	18	0		
Loughton, Essex	8.8	4.0	12.1(15)	-1.1(14)	-7.3(14)	74.2	125	11.1(30)	19	0		
Buxton, Norfolk	9.0	3.9	13.2(16)	-1.6(14)	-3.7(14)	42.6	79	6.6(24)	16	0		
Ely, Cambridgeshire	9.1	2.2	12.4(21)	-1.0(v)		53.7		9.3(25)	17	0		
Luton, Bedfordshire	8.8	4.1	12.1(11)	-0.4(13)	-5.6(13)	84.3	135	11.2(6)	21	0		
Buckingham, Bucks'shire	9.0	3.5	12.6(21)	-1.1(13)		78.0		11.1(6)	17	0		
Oxford University	10.0	3.2	12.6(21)	-0.2(1)	-4.5(2)	75.0	144	11.9(6)	20	0		
Stourbridge, W. Mid	8.7	4.2	12.5(15)	-1.1(7)		90.2		21.9(27)	22	0		
Wolverhampton,	8.7	3.6	12.2(15)	-0.3(28)	-4.0(7)	103.7		23.3(7)	19	0		
Louth, Lincolnshire	8.8	3.1	13.2(16)	0.3(13)		61.8		9.4(27)	13	0		
Keyworth, Nott'shire	9.4	3.7	12.9(14)	-0.6(7)	-5.2(13)	64.0		13.3(27)	19	0		
Nottingham Nott'shire	9.4	3.7	13.8(21)	-0.8(13)	-4.8(13)	63.6	121	10.6(27)	19	0		

	Mean		Grass									
	Max	Min	Max	Min								
Derby, Derbyshire	8.8	4.6	12.9(21)	-1.0(7)		77.1	132	17.8(27)	22	0		
Middleton, Derbyshire	6.8	2.4	10.8(15)	-0.7(27)		157.7	134	27.3(29)	23	0		
Keele University, Staffs	8.3	2.9	12.4(15)	-2.0(7)	-4.5(13)	111.6	166	32.0(27)	18	1		
Liverpool, Merseyside	9.9	4.2	15.2(15)	-1.6(7)		108.1	155	27.3(27)	24	2		
Lathom, Mersey	9.0	3.2	13.6(15)	-1.5(7)		145.4		27.2(27)	22	1		
High Bradfield, S.Yorks	6.7	2.6	10.6(15)	-1.4(1)		-		25.1(27)	-	-		
Cottingham, Humbside	9.4	3.8	13.6(15)	-0.7(7)	-5.8(7)	51.3	91	12.5(27)	19	0		
Carlton-in-Cleveland	8.5	3.5	13.5(15)	0.0(28)	-3.6(7)	81.7		38.0(27)	22	1		
Durham University	8.7	2.1	14.0(15)	-1.4(2)	-5.0(13)	72.6	147	22.3(27)	20	-		
Sunderland, Tyne/Wear	9.6	3.8	15.0(15)	0.4(30)		50.6	136	20.6(27)	12	0		
CANADA: Halifax NS	2.5	-6.1	10.2(26)	-15.4(22)		129.5		24.2(30)	19	0		
U.S.: Bergenfield, NJ	8.8	-0.2	18.3(18)	-5.0(13)	-8.9(7)	116.8		22.9(30)	11	0		
JAMAICA: Kingston	32.3	21.5	34.1(3)	20.1(12)		1.6	8	1.0(9)	3	0		
" Montego Bay	28.9	22.2	30.0(29)	21.0(12)		54.6	64	17.0(2)	11	1		

## CUMBRIA RAINFALL:

The Nook, Thirlmere, 507.9mm (189%); Coniston, 395.6mm (145%); Hawkshead, 316.8mm (157%); Windermere (Whasdyke), 300.7mm (169%).

## TEMPERATURE AND RAINFALL: FEBRUARY 1990

	Mean		Grass									
	Max	Min	Max	Min								
BELGIUM: Uccle	11.6	4.7	18.3(20)	-0.2(17)	-3.5(17)	111.5	210	14.8(25)	16	-		
" Rochefort	11.4	1.7	18.2(24)	-4.4(17)		100.2	189	29.3(14)	14	-		
" Liège	12.4	5.0	20.4(24)	0.2(17)		99.6	199	22.2(13)	14	-		
DENMARK: Fanø	7.6	3.9	9.6(7)	-1.4(14)		118.5	298	37.2(7)	21	1		
" Frederikssund	8.6	3.2	14.0(24)	-3.3(14)	-7.8(14)	49.9	194	20.6(8)	16	1		
GERMANY: Berlin	10.6	2.8	18.6(21)	-1.1(6)	-3.0(6)	65.6	189	13.0(28)	15	4		
" Hamburg	10.3	3.4	16.7(24)	-1.5(17)	-3.6(15)	76.7	192	11.1(26)	19	5		
" Frankfurt	11.6	2.0	17.5(20)	-4.2(17)	-6.4(17)	81.0	203	15.2(13)	14	4		
" Munchen	11.4	-0.3	20.8(25)	-5.8(6)	-8.5(6)	100.8	183	41.5(14)	13	4		
ITALY: Casalecchio	12.3	4.1	21.0(27)	-2.0(7)	-3.0(7)	12.1	23	11.0(12)	3	0		
MALTA: Luqa	17.6	10.5	19.4(28)	6.0(11)	1.0(11)	4.7		2.5(12)	4	1		
NETH'NDS: Ten Post	10.1	3.8	15.8(20)	-1.3(17)	-3.6(17)	78.7	179	20.6(4)	18	0		
SWEDEN: Valla	6.9	1.7	12.9(23)	-3.5(16)	-7.1(16)	68.4		23.5(8)	20	0		
SWITZ'LAND: Basel	13.8	2.8	21.7(25)	-2.1(6)		69.0	172	12.8(27)	14	2		
EIRE: Straide	9.1	3.2	12.8(22)	-2.3(16)	-7.0(16)	287.1	350	72.1(3)	28	4		
SHEET'AND: Whalsay	6.9	3.1	10.5(23)	-1.0(17)	-4.3(17)	162.5	213	23.4(6)	26	1		
" Fair Isle	6.9	4.1	10.5(5)	0.2(18)	-4.6(17)	138.5	242	23.9(6)	27	1		
SCOT'AND: Braemar	5.6	0.5	12.6(22)	-4.8(15)	-6.2(15)	208.5	311	24.5(6)	26	0		
" Inverduie	6.0	0.5	13.5(22)	-5.4(15)	-10.1(16)	172.3	265	17.5(-)	25	0		
" Rannoch	6.2	0.6	12.5(22)	-4.3(16)	-5.5(16)	389.6		45.0(3)	25	1		
WALES: Velindre	10.4	4.9	18.6(23)	-1.6(16)	-7.3(16)	148.9	213	21.1(11)	23	2		
" Carmarthen	10.3	5.1	17.4(23)	1.6(27)	-1.4(1)	169.2	199	23.2(7)	23	2		
" Gower	10.2	5.6	14.1(22)	2.2(16)	-2.3(16)	159.8	192	20.4(6)	21	1		
GUERNSEY: Airport	11.2	6.9	14.3(23)	2.9(16)		144.1		22.1(2)	21	2		
ENGLAND:												
Denbury, Devon	10.7	5.4	13.4(22)	1.5(3)	-1.7(1)	283.7	246	42.5(7)	23	0		
Gurney Slade, Somerset	9.9	4.3	14.7(23)	1.1(16)	-0.5(18)	155.2	141	19.5(13)	24	2		
Yatton, Avon	11.5	6.0	15.9(23)	1.9(16)	-0.7(16)	107.3	213	17.0(1)	20	0		
Mortimer, Berkshire	10.8	4.5	17.1(23)	0.5(4)	-2.5(16)	131.8	269	19.2(7)	18	1		
Reading Univ., Berks	11.1	5.1	17.0(23)	1.0(16)	-3.5(16)	108.5	273	15.2(1)	17	0		
Sandhurst, Berkshire	11.2	4.6	18.3(23)	-0.1(16)	-1.2(16)	121.4	249	27.1(3)	17	2		



	Mean				Grass				Wettest	RD	Th
	Max	Min	Max	Min	Min	Rain	%				
Romsey, Hampshire	11.1	5.1	16.3(23)	0.0(9)	-3.1(9)	166.5	312	24.8(1)	20	0	
Brighton, Sussex	10.5	5.7	14.4(23)	1.6(11)	0.1(13)	116.0	258	17.9(14)	20	0	
Hastings, Sussex	10.8	5.7	14.1(23)	2.3(16)	-1.2(16)	116.9	230	25.4(2)	15	3	
Dover, Kent	11.2	5.4	14.4(23)	-1.1(16)		96.4	162	13.8(3)	15	1	
East Malling, Kent	11.4	5.1	17.1(23)	-1.5(16)	-7.0(16)	93.9	203	11.8(3)	18		
Epsom Downs, Surrey	10.5	5.3	17.0(23)	-1.2(16)	-3.9(16)	144.5	288	24.3(1)	17	2	
Reigate, Surrey	10.7	4.7	16.8(23)	-0.4(16)	-2.6(16)	127.5	331	17.1(1)	19	3	
Guildford, Surrey	10.8	5.6	17.4(23)	1.6(11)	-1.5(16)	134.1	309	17.0(1)	18	1	
Sidcup, London	11.6	5.7	18.9(23)	-2.6(16)	-6.0(16)	100.2		17.7(3)	16	3	
Hayes, London	11.2	4.7	18.1(23)	-2.5(16)	-3.9(16)	101.4	276	16.3(3)	17	2	
Hampstead, London	10.7	5.2	17.6(23)	-0.3(16)	-8.4(16)	93.1	195	18.9(3)	18	0	
Royston, Hertfordshire	10.8	5.3	17.6(23)	1.0(27)	-2.4(17)	72.5	194	20.8(3)	15	0	
Loughton, Essex	10.6	4.7	16.8(23)	-1.9(16)	-9.0(16)	93.1	275	19.5(3)	16	1	
Buxton, Norfolk	10.9	4.8	19.3(23)	-2.1(17)	-3.9(17)	96.8		26.0(28)	13	0	
Ely, Cambridgeshire	10.9	2.7	18.2(23)	-2.5(16)		66.2		23.6(3)	14	1	
Luton, Bedfordshire	10.3	4.5	17.2(23)	-2.9(16)	-7.2(16)	114.1	255	24.0(3)	17	0	
Buckingham, Bucks'shire	10.5	4.0	16.1(23)	-2.0(16)	-8.2(16)	93.4	205	21.6(3)	17	0	
Oxford University	11.3	5.2	15.6(23)	0.4(16)	-6.0(16)	94.2	237	18.0(7)	18	-	
Wolverhampton	9.8	3.8	15.9(23)	-0.7(16)	-4.0(17)	119.6		21.5(7)	18	0	
Louth, Lincolnshire	10.2	3.7	17.8(23)	-0.6(16)		77.3		14.3(7)	14	2	
Keyworth, Nott'shire	10.4	4.4	17.7(23)	-1.0(16)	-6.5(16)	90.1		15.7(7)	17	1	
Nottingham Nott'shire	10.9	4.4	18.6(23)	-2.2(16)	-6.3(16)	108.7	244	24.9(28)	16	1	
Derby, Derbyshire	10.2	4.9	17.3(23)	-0.5(16)	-3.0(16)	109.6	220	28.8(7)	19	4	
Middleton, Derbyshire	7.7	2.4	14.8(23)	-2.0(16)		169.4	214	33.2(7)	23	1	
Keele University, Staffs	9.5	3.1	15.0(23)	-1.8(16)	-5.6(16)	87.7	183	18.1(7)	21	1	
Liverpool, Merseyside	10.9	4.7	15.7(5)	-1.7(16)		88.4	173	19.9(7)	23	1	
Lathom, Merseyside	10.1	3.9	14.4(5)	-1.5(16)		88.9		19.2(7)	22	-	
High Bradfield, S.Yorks	7.1	2.6	14.0(23)	-2.0(16)		126.1		26.3(7)	21	-	
Cottingham, Humb'side	10.3	4.2	17.3(23)	-0.9(16)	-4.3(17)	54.0	124	14.0(7)	18	0	
Carlton-in-Cleveland	9.3	4.1	14.7(23)	-0.4(27)	-3.4(16)	70.5		11.5(7)	19	0	
Durham University	9.5	3.1	13.9(5)	0.6(16)	-3.2(1)	60.4	159	15.4(7)	20	-	
Sunderland, Tyne/Wear	10.2	4.7	15.0(23)	0.9(15)		47.7	188	15.8(7)	12	0	
CANADA: Halifax NS	-0.1	-11.0	9.1(10)	-21.9(5)		131.9	107	56.4(10)	16	0	
U.S.: Bergenfield, NJ	9.5	-1.3	19.4(23)	-14.4(26)	-18.3(26)	55.4		12.5(24)	9	0	
JAMAICA: Kingston	31.0	21.5	32.3(20)	20.0(18)		28.2	176	12.4(27)	7	0	
" Montego Bay	28.9	21.5	29.9(1)	19.5(5)		68.2	98	37.1(19)	9	0	
AUSTR'LIA: Leopold	24.1	14.1	32.6(16)	10.6(1)		102.2	237	55.3(2)	11	2	

## Conference Announcement

SECOND INTERNATIONAL SYMPOSIUM ON  
BALL LIGHTNING

A three-day international symposium on the subject of ball lightning is to be held in Budapest, Hungary from 26th to 29th June 1990.

Delegates who are known to be offering papers include Y. H. Ohtsuki, H. Ofuruton, G. T. Meaden, E. Strand, G. Egely, You Sou-Zai, Ying Zhong-Lu, A. Z. Grigoriev, S. O. Shiryayeva, Hilary Evans, J. F. Corum, G. C. Dijkhuis, R. Struijs, P. H. Handel, P. Janhunnen, K. Nickel, B. M. Smirnov, Han Ming Wu, Bin Kun Xu, and A. P. Veduta. Subject areas covered are properties, observations, case studies, experimental investigations, and theories.

For further information contact: Dr George Egely

Central Institute for Physics,  
P.O. Box 49, Budapest 1525,  
Hungary.

## Conference Announcement

INTERNATIONAL CONFERENCE ON THE  
CIRCLES EFFECT

A one-day international conference on this important new research discipline has been organized for Saturday 23rd June 1990, at Oxford Polytechnic, Headington, Oxford, starting at 10.30 a.m. (registration from 9.30 a.m.).

The conference is intended for those who are genuinely interested by the meteorological aspects of the subject, and the proceedings will be published as a booklet entitled *Circles Research 1*.

People wishing to attend the conference are invited to request details from: Dr Derek Elsom

TORRO Research Centre, Oxford Polytechnic,  
Headington, Oxford OX3 0BP, England.



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*FRONT COVER:*

The storm of 25th January 1990 over Britain  
showing the front of the back-bent occlusion

*EDITORIAL OFFICE:*

Journal of Meteorology, 54 Frome Road, Bradford-on-Avon, Wiltshire,  
BA15 1LD, U.K. (telephone 02216 2482; fax 02216 5601).