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AN ANTICLOCKWISE SPIRAL-CIRCLE BENEATH 11,000-VOLT HIGH TENSION CABLES, JUNE 1988

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FREAK HEAVY RAINFALL AND GALES IN MALTA IN NOVEMBER AND DECEMBER 1988

By A. H. PERRY and S. E. ASHTON
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INTRODUCTION

November 1988 was a disturbed and in many places wet month in the Mediterranean. Persistent blocking near the British Isles for most of the month allowed pulses of cold air on the eastern flank of the high to plunge southwards into the Mediterranean and trigger cyclogenesis. With the sea still comparatively warm, conditions were at times ideal for the generation of heavy convective rainfall. Among the places establishing new November rainfall records was Malta where the Meteorological Office at Luqa recorded a total of 297mm. This was more than three times the average fall for the month (75mm) and in the station record which commenced in 1947 the only notably wetter month was October 1951 when 476mm fell.

THE FLOODS AND DAMAGE OF 10-11TH NOVEMBER IN MALTA

From the larger composite records established by Bulmer and Stormonth (1960), it would appear that November was equally wet in 1920 and probably

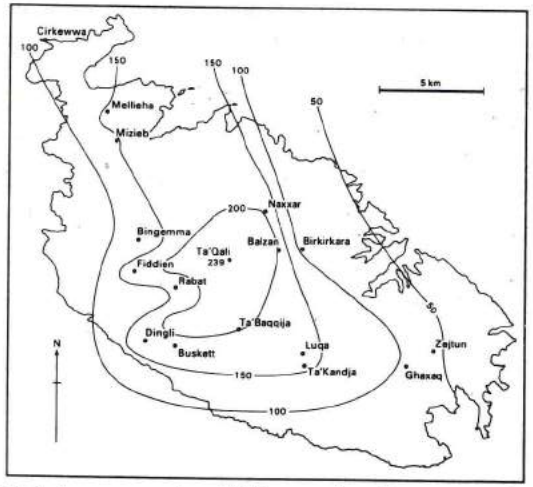

Fig.1: Average number of falls exceeding 10mm over 5-day periods 1968-1987.

rather wetter in 1859. The two previous wettest Novembers were 1983 with 257mm and 1958 with 237mm.

In many parts of Malta more than half the total month's precipitation fell in the rainfall day ending at 0900 hrs on the 11th. For example at Rabat 160mm of the monthly total of 293mm fell on this day. At Luqa, where 162.5mm was noted, the highest daily total since records began, 99mm fell in just three hours between 1900 and 2200 hrs on the evening of the 10th. The torrential rain appears to have been restricted to Malta, only 50mm being recorded on the island of Gozo. The heaviest falls occurred near the centre of the island, with Ta Qali noting 238mm while at the Government viticulture centre at Buskett there was 185mm.

In the large Valetta conurbation with its impermeable urban surfaces, rapid runoff led to flooding, particularly at Marsa and Qormi where shops were inundated and parked cars carried along by torrents of water rushing down sloping streets. Luckily no casualties occurred although many animals, which are traditionally kept in small enclosed spaces, were drowned. Thousands of pounds worth of damage was caused to private and personal property and insurance claims are expected to be very high.

THE SYNOPTIC SITUATION

On November 10th the European anticyclone was centred over Bulgaria with a ridge extending southwards across Greece to Egypt. Over Malta surface winds were south-easterly and the long track of the airflow over the Ionian Sea resulted in very humid conditions in the lower levels of the atmosphere. At 500mb the upper flow was highly amplified over Europe with a ridge over Scandinavia and a deep trough in the longitude of the Black Sea and extending south into the eastern Mediterranean. Over the central Mediterranean the upper flow was from the west bringing in relatively cold air from Spain. A well-marked cold pad was centred near the Canary Islands. Instability produced a slow moving cloud area with prolonged heavy rain and thunderstorms late on the evening of Thursday 10th.

THE STORM IS CONTEXT

Malta is a highly populated and urbanised island, and daily rainfalls of this magnitude inevitably cause damage and hardship. While this storm produced a new daily rainfall record at Luqa and was probably the most memorable storm of the last 40 years, there is long-term evidence of much larger falls in the past. Bulmer and Stormonth (1960) drew attention to a daily fall in October 1912 of 406mm with 152mm falling in just one hour and although very localized this storm is still recalled by some of the island's older inhabitants. More recently a storm in October 1979 left five persons dead.

On average, October is the wettest month in Malta, and November ranks as only the fourth wettest month. Based on a survey of heavy falls in the period 1968-87 there is a clear maximum frequency of falls over 10mm in late December, but the fall of 105mm in August 1964 emphasises that Malta is at risk from occasional heavy falls for more than half the year.

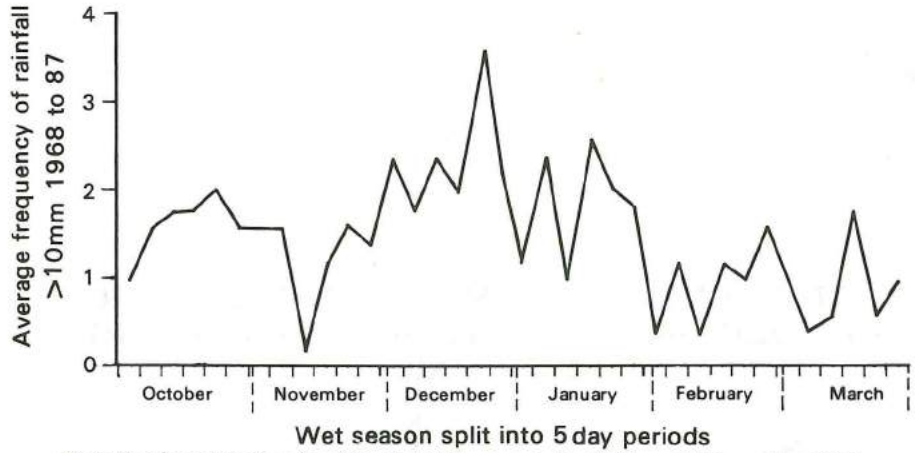

Fig.2: Total precipitation (mm) for the 24-hour period to 0900 on 11 November 1988.

THE GALE OF 8TH-9TH DECEMBER

Almost exactly a month after suffering from the floods, Malta was struck by a severe gale of an intensity that few inhabitants had experienced before. The highest gust at Luqa was 66 knots, a new record, and for a time Malta was isolated as the airport had to be closed and shipping could not enter Grand Harbour. Five incoming charter flights were diverted to Palermo or Tunis. The main damage was to fishing and leisure boats, many of which were dragged from their anchorages and swept to pieces. On land there were many cases of damage to buildings, and roads were strewn with rubble and fallen T.V. aerials. Hundreds of trees were uprooted, a major loss in an island with few wooded areas. Many localities were hit by power cuts and water supply was disrupted since electricity cuts prevented the operation of the reverse-osmosis plants which produce half of the island's water needs.

The depression responsible developed over Libya around midnight on the 8th. As it moved slowly northwards it deepened rapidly, and by 1200 hrs on the 9th central pressure was below 985mb with the centre about 300 miles east of Malta. 24-hour surface pressure falls exceeded 15mb near Malta. The severe N.-N.E. gales reached Force 10 for a time with very gusty conditions contributing to the damage. As the low drifted east towards Crete on the 10th it began to fill and winds quickly died down.

The surface low developed just ahead of a well-marked upper cold trough orientated N.E.-S.W. across the central Mediterranean. As this trough reached the vicinity of Malta by midnight on the 9th, a separate cut-off low formed, which was in evidence up to the 200mb level. Associated 1,000 – 500mb thickness values were exceptionally low at this time.

CONCLUSIONS

While the period from October to the end of the year can often bring unsettled, capricious weather conditions, Malta was particularly unfortunate in having to suffer two severe weather events with long return-periods in the same year. In a

small island economy a good deal of hardship was caused, perhaps one of the few benefits being that water supplies, especially for irrigation, and the tourist industry, will be adequate for the present growing season.

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BULMER, B. F. and STORMONTH, K. (1960): The rainfall of Malta, *Met. Office Scientific Paper No.3* H.M.S.O.

THE HEAVY LOCALISED SNOWFALL OVER CENTRAL SOUTHERN ENGLAND OVERNIGHT 18TH-19TH MARCH 1987

By W. S. PIKE

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Abstract: Discussion is made using satellite and radar data of title subject which is in part attributed to the formation and rapid development of a new 'Polar Low' off the West Sussex coast and partly to the movement of an associated mesoscale trough which advanced slowly north-eastwards over C. S. England, became stationary, and then returned south-westwards later in the night.

THE SYNOPTIC SITUATION

Figure 1a shows the UK was in a cold, unstable north-westerly airflow in which a substantial mesoscale 'Polar Low' had recently formed and was moving south-south-eastwards into N. W. Ireland by 18 GMT on 18 March 1987, in the circulation of a deep depression, central pressure 974mb but filling, as it moved eastwards into the Skagerrak. By 06 GMT on 19 March (Figure 1b) the two depressions had become a 'family' of five, including three 'Polar Lows', the original of which had travelled rapidly over Cornwall during the night and was losing identity near the Channel Islands. Meanwhile, another two had formed over the

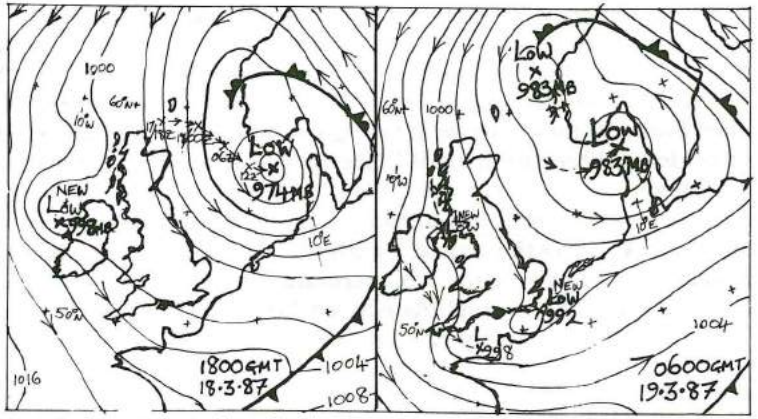

Fig.1: Surface Synoptic charts for (a) 18 GMT on 18 March 1987 and (b) 06 GMT on 19 March 1987, based on Meteorological Office (CFO Bracknell) analyses. Isobars at 4mb intervals.

relatively-warm waters of (1) the North Channel between Ireland and Scotland (2) the eastern English Channel. The latter had developed rapidly (at 1mb hr^{-1}) during the 'early hours' of 19 March, having first formed off Bognor Regis, central pressure 996mb at 0200 GMT, it then moved eastwards towards Cap Gris Nez.

SATELLITE AND RADAR DATA

Infra Red 'GOES' satellite data (Figure 2a) show the relatively-small but well-marked 'comma cloud' formation associated with the first 'Polar Low' moving south-south-eastwards over Co. Cork at 22 GMT on 18 March. Scattered higher-topped clouds, almost certainly cumulonimbus, are noticeable from Pembroke Bay through S. Wales to Avon and Wiltshire. Radar data for 22 GMT (Figure 3a) show well-scattered showers over the S. W. Peninsula, and also two distinct bands (which are probably 'wind-parallel') through Pembroke Bay and Wiltshire, indicating the presence of 'convergent flows' forming minor troughs in these areas.

By midnight (Figure 3b), a crescent-shaped area of precipitation associated with the first 'Polar Low' approaches Cornwall. While the belt of precipitation through Wales has diminished in width and length, that through Avon, Wiltshire and Dorset has lengthened considerably from Hereford through the Isle of Wight.

By 02 GMT (Figures 2b and 2c), this band of precipitation over 'Wessex' attained its maximum area, becoming a mesoscale belt 25-50km wide and extending along the W. Sussex coast at a time when the 'crescent' over Cornwall and West Devon was closest, thunder being reported from Plymouth, incidentally. A large area of cold-topped cloud had built up between Hereford and the Isle of Wight, and the heavy snow reported beneath suggests this was cumulonimbus in an active state.

At 04 GMT (Figure 3d), the snow belt had died out north of the River Severn and narrowed somewhat, while beginning to move south-westwards into Somerset and Dorset. Simultaneously, some movement occurs north-eastwards along the E. Sussex coast, but the belt is maintained near the coast of Hampshire and W. Sussex.

By 06 GMT (Figures 2c and 3e), only scattered remnants of the snowfall continue to affect 'South Coast Counties', although activity over Dorset appears to maintain a recognisable belt of cloud and precipitation, which continues to make some progress south-westwards. There are also larger cumulonimbus build-ups over the Strait of Dover and East Kent where the newly-developing 'Polar Low' was moving eastwards. Only 'anvil remnants' persist over E. Hants and Berkshire.

DISCUSSION OF THE SNOWFALLS

Meteorological Office manned network hourly observations (Figure 4) permit closer inspection of snowfall onset and cessation times (where automatic stations do not) and plots are made of five stations' observations where either moderate or heavy snow was reported during the night.

At Lyneham, Boscombe Down and Southampton, the snowfalls occurred in five hours commencing at midnight on 19 March. Heaviest accumulations took places between 01 and 03 GMT. This is corroborated by a 'C.O.L.' contact at Ryde, Isle of Wight, who reports ten inches (25cm) of snow falling there in the four

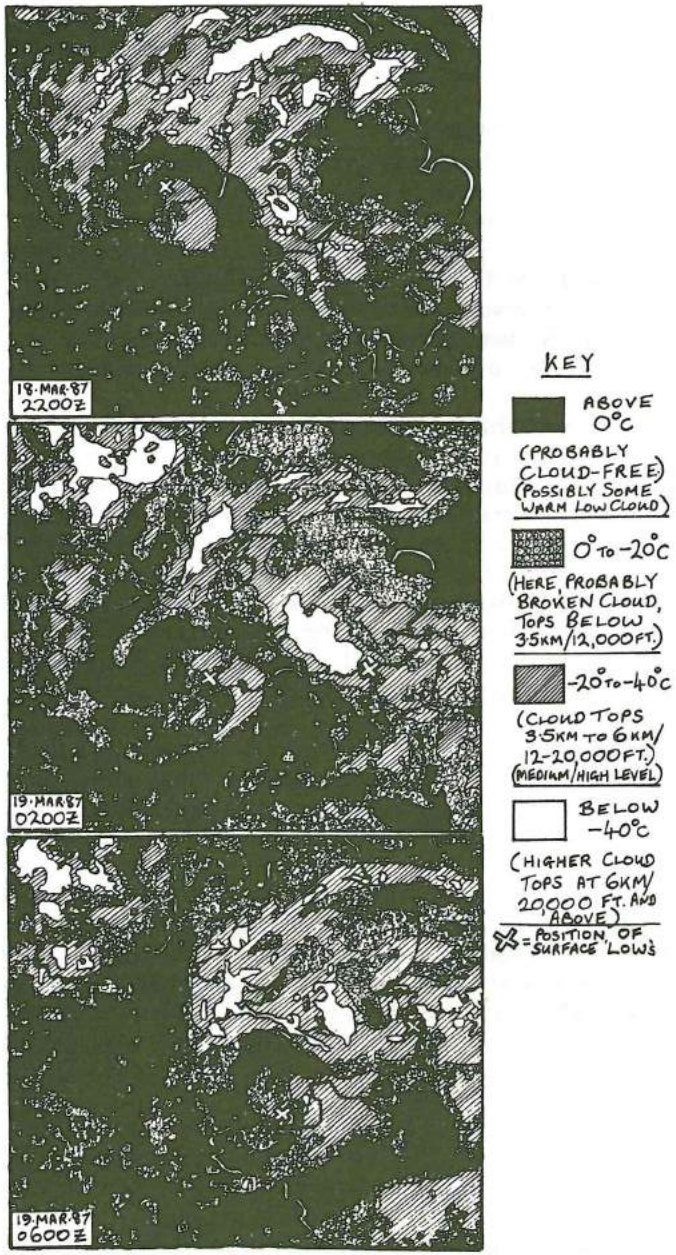

Fig.2: Geostationary ('GOES') 'METEOSAT' Infra-Red Imagery interpretations at four-hourly intervals for (a) 22 GMT on 18 March 1987 (b) 02 GMT and (c) 06 GMT on 19 March 1987. See Key for temperature representations.

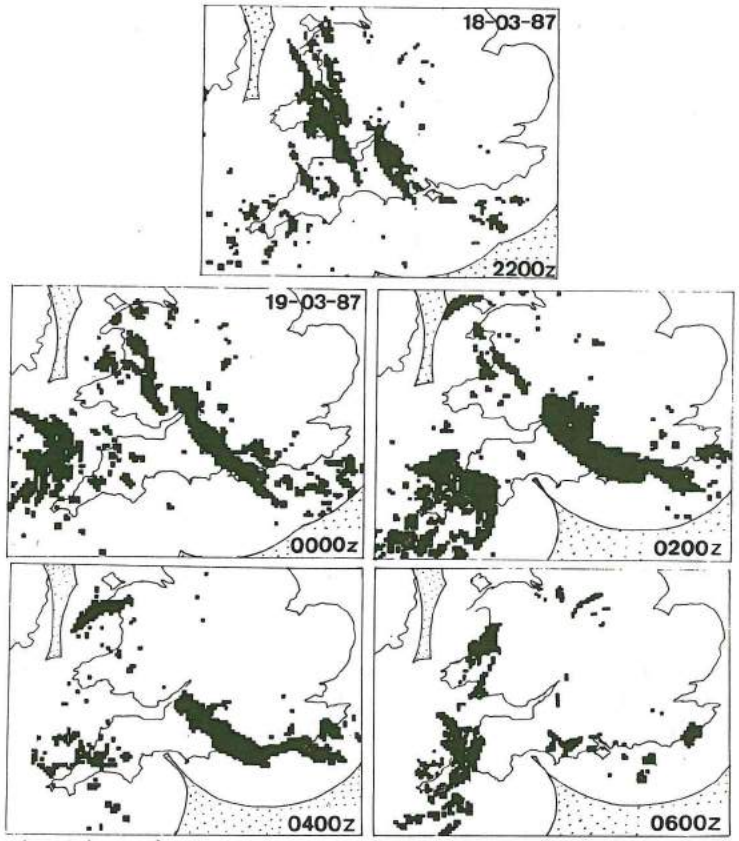

Fig.3: UK Weather Radar Network Precipitation charts at two-hourly intervals (one pixel approximate 5km x 5km area) for (a) 22 GMT on 18 March 1987, (b) 00 GMT, (c) 02 GMT, (d) 04 GMT, (e) 06 GMT on 19 March 1987.

hours up to 03 GMT on the 19th. At Bristol Weather Centre, only mostly-light snowfall was reported between 01 and 05 GMT.

Further to the south-west at St. Catherine's Point, Isle of Wight, and at Bournemouth (Hurn) Airport, two distinct periods of snow occurred (1) around 23 GMT on the 18th and (2) from 04 to 06 GMT on the 19th, suggesting that the trough which had pushed north-eastwards halted nearby, then returned south-westwards later in the night. This suspicion is corroborated by the medium-level cloud (reported as altostratus) not clearing Hurn during the 'early hours' of the 19th.

Figure 5 serves firstly as a 'continuity chart' which indicates movement of both surface depressions and that of a 'cut off low' 500mb contour height centre. Note that the heaviest precipitation occurs at, and from a few hours before, passage of the upper trough with 'cut off low' swinging east-south-eastwards nearby. As one surface vortex in its vicinity is 'shed' during the night near Cornwall, a new 'Polar Low' forms just off the Sussex coast, and over the relatively-warm sea deepens at a

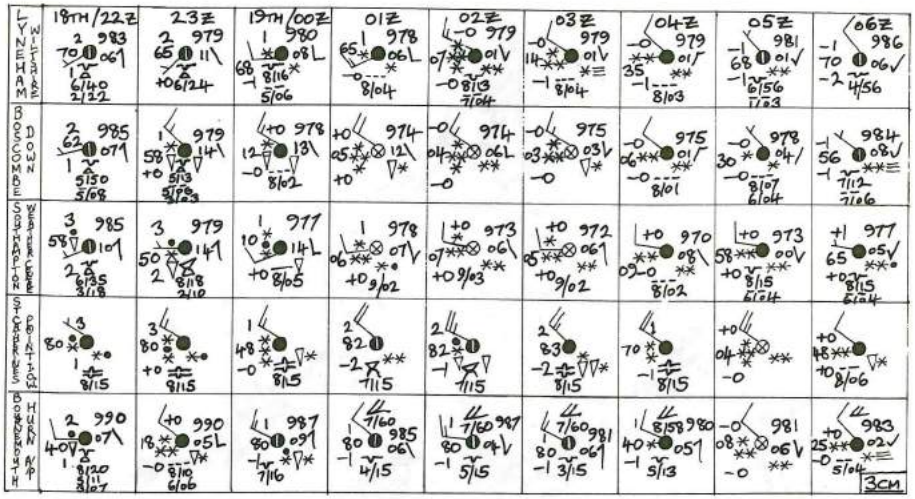

Fig.4: Hourly surface observations from Lyneham, Boscombe Down, Southampton W.C., St Catherine's Point (I.O.W.), and Bournemouth (Hurn) Airport, between 22 GMT on 18th, and 06 GMT on 19th March 1987, with symbols plotted in accordance with the International Synoptic Code.

rate of about 1mb hr^{-1} while moving eastwards over the Strait of Dover. It is probable that uplift associated with close proximity of the 500mb 'cut-off low', which by extrapolation, was passing over Devon between 01 and 03 GMT on the 19th, aided development of the area of cumulonimbus clouds over Wiltshire and Hampshire at this time.

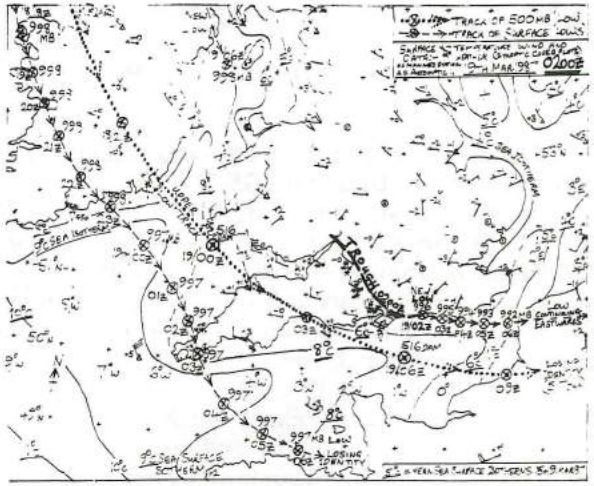

Fig.5: Composite Chart for (1) Continuity of surface and 500mb features over 18-19 March 1987 (2) surface temperature, wind and present weather data, plus mesoscale trough position for 02 GMT on 19 March 1987 (3) Five-Day-Mean Sea-Surfaces Isotherms over 15-19 March, issued 20 March 1987.

Secondarily, Figure 5 gives surface data for 02 GMT on 19 March to indicate the extent of a light north-easterly 'land breeze' blowing from the frosty Midlands and East Anglia, over the countries of Worcestershire, Oxon and Surrey, also as far as the South Downs. This can be interpreted as 'cold air inflow' to feed the newly-developing depression, and also as a 'land breeze' which could well have helped maintain the snow belt near to the Sussex Coast, because another 'C.O.L.' contact at Worthing remarked that the three to four inches (8cm) of snow "extended only one mile inland from the sea" *(Climatological Observers' Link March 1987 Bulletin)*. There was (from Figure 5) a difference of up to 6 deg C between sea and ground surface temperatures along the Sussex Coast, so a boundary layer phenomenon (i.e., a 'Coastal front' forming between slow-moving overland air and more-boisterous airflow over the English Channel) may well have helped maintain the snow belt along the Hampshire to East Sussex coastline from 02 to 04 GMT on the 19th Van den Berg (1987, p61) mentions there have been examples of 'Polar Lows' passing nearby (or moving over) the Dutch Coast, which have induced or activated a coastal front. A case investigated by Seaman et al (1982) is cited as an example.

Perhaps because of the trough becoming stationary, the northern edge of snow cover was very well-marked on the ground. On March 19, this author travelled into Marlborough, Wiltshire, from the north-east, finding no snow before Axford, 1cm at Mildenhall, deepening rapidly to 5cm just 2km distant in Marlborough, from where a totally-white landscape was visible to the south-west, with little traffic moving to clear the snow lying on roads.

Some routes across Salisbury Plain (even major roads) had been unexpectedly blocked, and heaviest falls were reported towards the centre of a 50km-wide 'swathe' (Figure 6), from the hills around Bradford-on-Avon (25cm) towards Salisbury and the Wiltshire-Hampshire border (30cm), then on to Cowes, I.O.W. (30cm also). Not surprisingly, commuters faced problems and delays negotiating the morning journey into Southampton, especially from the New Forest.

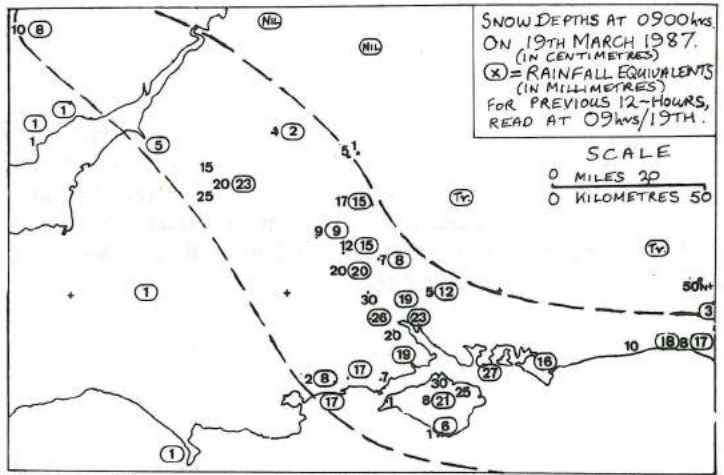

Fig.6: Chart of Snow Depths and Past-12-Hour rainfall equivalents, both read at 09 GMT on 19th March 1987.

Albeit this snowfall was experienced before the great storm of 15-16 October 1987, but Michael Rowe wrote to the author from Lymington on 9 April 1987:-

"The snow on 18-19 March caused more damage in the New Forest than I have ever seen done by a gale. We had only 6-7cm lying here on the morning of 19 March, but there was 20cm at Ashurst, near Lyndhurst . . . The snow was wet and extremely heavy, and between Lyndhurst and Ashurst 10-20 per cent of trees near the road suffered damage. The worst affected trees were tall but very spindly birches".

SUMMARY AND CONCLUSIONS

At first sight of the general synoptic situation (Figure 1) the locally-heavy snowfalls occurring overnight 18-19 March 1987 could be dismissed as merely 'chance' alignment of showers associated with passage southward of the trough lying along the English Channel and into the North Sea by 06 GMT on 19th. However, investigation of the complex 'mesoscale' situation indicates that a pre-existing convergence-line or 'trough', aligned N.W.-S.E. (see Figure 5) was already producing heavy snow when a new 'Polar Low' developed, perhaps as an 'eddy vortex' on its south-eastern end, where an area of strong surface thermal contrast existed near the Sussex Coast.

The mesoscale trough appeared to separate low level flow (1) slowly moving or stagnating over the Midlands from (2) the more boisterous west-north-westerly maritime airflow over the Bristol Channel and south-west Peninsula. Oscillation of this trough and possible interaction with the cold, 'land breeze' defined the northern limit of snow cover very sharply.

Intensity of the snowfall was greatest, and cyclogenesis off the Sussex Coast was most pronounced between 02 and 03 GMT on 19 March, just prior to the overhead passage of an upper level trough and 500mbar 'cut off low' whose centre was swinging east-south-eastwards over Devon at this time.

The snowfall was very 'wet', with surface temperatures near 0°C, and water equivalents largely agreed with snow depths (i.e. 1cm snow = 1mm rainfall, see Figure 6). Maximum depths of 30cm were reported.

Acknowledgements. Particular thanks to Met.0.24 for supplying satellite and radar data, and to 'C.O.L.' and 'T.O.R.R.O.' observers who supplement the declining number of Meteorological Office manned observing stations. The figures are by the author, and based on information supplied by the Meteorological Office. Additional rainfall data came from D. M. Giles, Resources Engineer, Southern Water Authority, Winchester.

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(Both references available at the National Meteorological Library, Bracknell).

THE CIRCLE-MAKING VORTEX THAT DESCENDED THROUGH 11,000-VOLT OVERHEAD CABLES IN SOUTHERN ENGLAND, AND A WIRE-TRAVERSING VORTEX CASE FROM FRANCE

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Tornado and Storm Research Organisation

Abstract: An anticlockwise vortex-circle in a wheatfield is described. On account of its situation the parent vortex must have passed through three high-tension electricity cables but without damaging the wires. A case from France dating from 25 years ago is also recounted.

LOCATION AND POSITION RELATIVE TO THE WIRES

The vortex crop-circle described in this paper was investigated at Beckhampton on Wednesday 29 June 1988, and again in July, with the kind permission of the farmer Mr Stephen Horton. It was an anticlockwise circle 9½-metres in diameter and was located towards the top of a north-facing slope (at national grid reference SU 080681) overlooking Beckhampton Downs south of Beckhampton village near Avebury. Some fifty metres to the west was a smaller circle, of opposite sense and average diameter 4.2 metres. A third circle, still smaller although anticlockwise like the first, lay in an adjoining wheatfield (at SU 077680); it is hoped to report and explain certain unusual features of this circle on another occasion.

Fig.1: Photograph taken on 29 June 1988 showing anticlockwise circle beneath overhead utility wires.

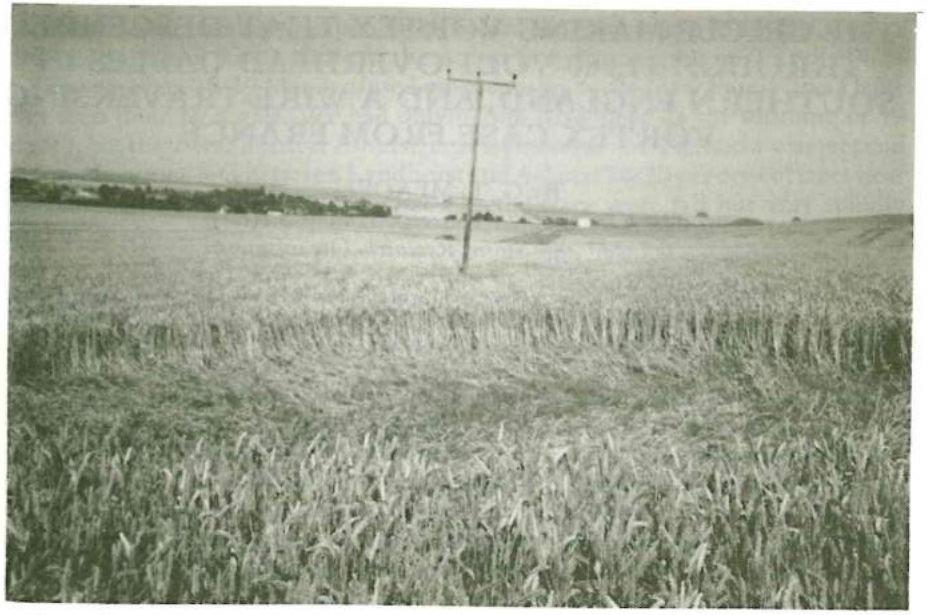

Fig.2: The same circle photographed a month later; grass is now growing in the flattened area.

The importance of the biggest circle was that it lay directly beneath overhead power lines consisting of three 11,000-volt cables (Figures 1 and 2). The spinning vortex which made the circle had evidently passed straight through the wires and had damaged neither the wires nor their supporting poles. This is the only occasion to date, out of some 350 vortex-circles *personally seen,* where an atmospheric vortex has passed through power lines – although several near-misses have been noted.

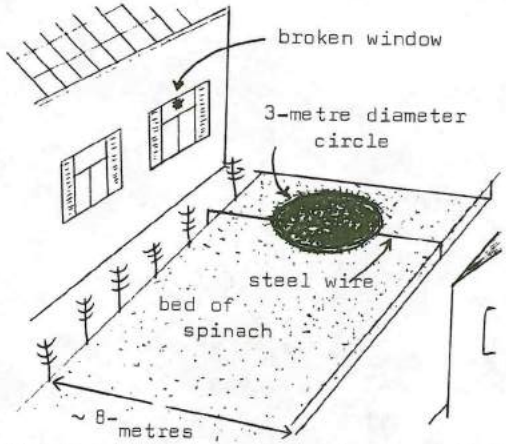

Fig.3: Sketch of the circle formed in a large bed of spinach at St Souplet in the north of France.

A PROBABLY SIMILAR EVENT IN FRANCE

There is however another case in the CERES-TORRO data bank, a French occurrence from St. Souplet (Département du Nord). This nocturnal event happened in the summer of 1963 or 1964 when a three-metre diameter circle was created in a crop of spinach across which a low steel wire was stretched (Figure 2). The incident was accompanied by a violent noise, described as a report like a door slamming sharply but much amplified, and a bright red light. At the same time the window of a house a few metres distant was broken by a projectile (a small stone) thrown from the crop-circle. The wire was neither broken nor stretched but the spinach suffered a mild sort of *flétrissement* (very slight wilting or withering) without breakage (details from *Lumiéres dans la nuit,* March 1976).

TRANSVERSE DIMENSIONS OF THE JUNE 1988 VORTEX WHICH TRAVERSED THE HIGH-TENSION WIRES

The flattened wheat in the base of the circle had two distinct layers. Examination of the lowest revealed a radially-striated or starburst pattern, the consequence of a strong downburst due to the high speed of descent of the initial vortex. The straws in the upper layer curved outwards from a final centre in an anticlockwise sense and displayed a spiral rotation which amounted to about half a revolution in all. To judge by the character of the underlying starburst effect we conclude that the initial strength of the descending vortex was very powerful and may have lasted only a second or two at ground level, but that in the ensuing few seconds while the 'attack' from the remainder of the vortex followed a partial anticlockwise twist imposed itself upon the crop structure.

Eight radii were measured at 45-degree intervals. They ranged from 4.3 metres to 5.3 metres, a broad spread which emphasised the eccentricity of the spiral centre. Despite this, the radii combined to produce a more limited range of diameters, lying approximately between 9.3 and 9.6 metres.

As with all crop circles which the author has investigated since 1980, the three circles showed no obvious indication of damage other than that which air pressure or wind would create; but on this occasion we have the additional evidence that the crop-damaging agaent is able to pass unhindered through overhead electricity cables, just as aircraft trailing vortices can pass through trees (*J. Meteorology, 14,* 2-10, 1989).

The age of the Beckhampton circles is unknown so one cannot turn to weather charts and anemograms in order to evaluate the meteorological conditions at the time of the circles' formation but because of their fresh appearance we know that the circles were not many days old. We may at least be sure that they were present on Sunday 26 June 1988, the day when Mr Fred Taylor flew above them in a light aircraft. Later, on different days in mid-July and only two kilometres distant, two quintuplet circle systems appeared close to Silbury Hill in a field that was also crossed by overhead electricity lines. Whereas none of the satellite vortices lay directly beneath utility lines on these other occasions, the first quintuplet circle system did straddle the power lines. The northernmost satellite of the first set of five lay to the north of the utility lines and the remaining four circles lay to the south.

THE EARLIEST DOCUMENTED TORNADO IN THE BRITISH ISLES: ROSDALLA, COUNTY WESTMEATH, EIRE, APRIL 1054

By MICHAEL ROWE
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Abstract: The *Chronicum Scotorum* gives an account of a "tower of fire" surrounded by "birds" which picked up objects from the ground. This undoubted tornado occurred 37 years before the famous London case of October 1091, which has hitherto been regarded as the earliest definite tornado on record in the British Isles.

INTRODUCTION

The earliest known British and Irish tornadoes have been discussed in this journal by Meaden (1975), who shows that the oldest undoubted case is the tornado which occurred in London on 17th October 1091 (23rd October, New Style). This tornado, which appears to have been extremely powerful, perhaps force T8 on the TORRO scale, has also been mentioned by such writers as Lane (1968, 1986) and Holford (1982) and is now probably one of the best-known historic British tornadoes.

In his 1975 article, before dealing with the tornado of 1091, Meaden discussed several earlier storms, mostly in Ireland, which could have been, or have included, tornadoes. Recently, however, I received an account of an unusual event at Rosdalla, in County Westmeath, Eire, in April 1054, which was without doubt a tornado. The account, which was sent by Squadron Leader John L. Alton, of Amesbury, Wiltshire, is taken from pages 32-33 of *The Wonders of Ireland,* by P. W. Joyce, a 19th-century Irish writer.

JOYCE'S VERSION

"In the year of our Lord 1055, on Sunday the feast day of St. George, the people of Rosdalla, near Kilbeggan in the present county of Westmeath, saw standing high up in the air, a great steeple of fire, in the exact shape of a circular belfry, or what we now call a round tower. For nine hours it remained there in sight of all: and during the whole time, flocks of large dark-coloured birds without number kept flying in and out through the door and windows. There was among them one great jet-black bird of vast size; and while he remained outside the others flew round him in flocks; but whenever he entered the tower they nestled in thousands under his wings, remaining there till he returned to the open air, when they again came forth and flew round him as before.

"Sometimes a number of them would swoop suddenly down, and snatch up in their talons dogs, cats, or any other small animals that happened to lie in their way; and when they had risen again to a great height they would drop them dead to the ground.

"At last they flew away towards a neighbouring wood; and the moment they left the tower it faded gradually from the people's view. The birds perched on the trees, the great bird choosing a large oak for himself; and so great were their numbers that the branches bent to the ground under their weight. There they remained for some time as if to rest; when suddenly they all rose into the air; and

when the great bird was rising he tore the oak tree by the roots from the earth, and carried it off in his talons. The birds then all flew away, no one could tell whither, for they were never seen or heard of afterwards".

On reading this I realised at once that a tornado was being described, but I was uncertain how much of the description was original and how much was later comment and explanation. (The words "in the present county of Westmeath" and "or what we now call a round tower" look like comments by Joyce). A search through the early Irish chronicles has brought to light an account of the tornado in the *Chronicum Scotorum,* and there is another (which I have not seen) in the *Annals of the Four Masters.* The *Chronicum Scotorum* describes the tornado as follows.

THE *CHRONICUM SCOTORUM* VERSION

"A tower of fire was seen at Ross-Deala, on the Sunday of the festival of George, during the space of five hours; black birds innumerable going into and out of it; and one large bird in the middle of it; and the little birds used to go under its wings when they went into the tower. They came out and lifted up, into the air, the greyhound which was in the middle of the town, and let it fall down again, so that it died immediately; and they lifted up three garments, and let them down again. The wood, moreover, on which the birds perched fell under them, and the oak whereon the birds alighted was shaking, together with its roots in the ground".

This version appears to be more original than Joyce's. In both, however, there are three features that clearly indicate that a tornado is being described. These are the "tower of fire", the "birds" around it and the lifting up of objects from the ground. The discussion that follows is based on the text in the *Chronicum Scotorum* unless otherwise stated.

THE "TOWER OF FIRE"

The "tower of fire" is a reference to the tornado funnel. The word fire in this context does not mean that flames were observed. It means either that the tornado resembled a column of smoke or that the swift motion of the vapour in the funnel resembled the motion of the smoke in a large fire. The TORRO data bank contains a large number of cases in which the funnel was described as looking like smoke, or sometimes fire; this description is particularly common in records from before about 1800, when eye witnesses were less likely to understand what they were seeing. Thus a Mrs. Dowsett, watching a tornado at Good Easter, Essex, on 18th August 1768, described it as "a great thick smoke", and thought that the accompanying wind came "out of the ground" (*Annual Register,* 1768). In August 1741, at Holkham, Norfolk, some of Lord Lovell's ploughmen saw "a Wind like a Whirlwind, come gradually towards them . . . like a great Flash or Ball of Fire". Another witness "saw no Fire, only a terrible Smoak, and heard such a Noise as Fire makes when a Barn is burning". There was also "a most terrible Smell of Sulphur" (Lovell, 1742). It is likely that in such cases the noise, and perhaps also the smell, contribute to the illusion of fire. The comparison continues to be made: writing of the Buckinghamshire tornado of 21st May 1950 Bonacina (1950) says: "Those who saw the vortex at close quarters likened its appearance to that of a fire, because of the dense masses of dust which were whisked aloft".

In a small number of cases it is difficult to avoid the conclusion that the witnesses really did see some sort of electrical discharge resembling fire in or near the funnel. When a severe tornado damaged Catgill Hall, near Egremont, Cumbria, on the night of 17 January 1962, Mr. John Braithwaite saw through the window "a great ball of fire" coming straight for the house (*Daily Telegraph,* 18th January 1962). Mr. William Marshall, who saw a tornado at Newbottle, Northamptonshire, on 30th November 1872, described it as "'a dark ball, as big as a carriage', and sending up 'a cloud of smoke' . . . He distinctly saw sparks of a red colour emitted from the ball about six feet from the ground, and this is confirmed by another man . . . Notwithstanding the natural tendency in uneducated observers to assume that 'where there is smoke there is fire', I am disposed to credit these observations, although not supported by the other spectators, who, however, had not so good a view as these men had" (Beesley 1873). Despite a careful examination of the site a few minutes later, no trace of combustion was found, and no smell of burning or sulphur was perceptible.

A very similar description was sent to TORRO recently by Mr. Joseph Cameron, who saw a waterspout about 10 miles (15 kilometres) off the Needles (Isle of Wight) in May 1944. "The strangest thing was that there was . . . a bright red fire burning inside and throwing out quite big red sparks".

There is thus no difficulty in accepting the Rosdalla "tower of fire" as a tornado funnel. The description of the funnel as a tower is reminiscent of the East Anglian tornado of 21st May 1646 (31st, New Style): "Betwixt *Newmarket* and the town of *Thetford* . . . there was observed a piller or a Cloud to ascend from the earth, with the bright hilts of a sword towards the bottom of it, which piller did ascend in pyramidall form, and fashioned it self into the forme of a Spire or broach steeple" (Blount 1979; see also Dewhirst 1980 a, b, Warren 1980, Rowe 1980; a shorter account is in Botley 1977).

THE "BIRDS"

The second piece of evidence that classes the Rosdalla event as a tornado is the "black birds innumerable going into and coming out of the "tower". These were either pieces of debris carried aloft and circling around the tornado, or portions of cloud detached from the funnel. The debris raised by a whirlwind has been mistaken for a flock of birds on a number of occasions. A land devil near Kirkstall Abbey, West Yorkshire, on 19th July 1858, raised large quantities of hay, so that "at first it had the appearance of being a flight of birds hovering above the Abbey in immense numbers" (*Illustrated London News,* 24th July 1858). Mrs. P. L. Flanagan, who experienced the very severe tornado that struck Birmingham on 14th June 1931, saw "what I thought was a large flight of pigeons sailing past my mother's bedroom window; but it was roof slates that had been caught up with the tornado". Mr. Ernest Buckmaster, of Leighton Buzzard, Bedfordshire, describing the tornado which caused great damage in that area on 21st May 1950, wrote: "I could see objects moving in the air over Linslade". Mrs. Muriel MacRobert had earlier seen the same tornado at Wendover, Buckinghamshire: "Around the top were spinning bits of buildings and trees and other debris". This is no doubt what Mr. J. E. Burke, a mile or two away at Halton, meant by "flying debris and crows around the 'trunk/core'".

Wisps of vapour moving rapidly around the funnel of a tornado have certainly been taken for a flock of birds. Mrs. Margaret Murphy, of Curracloe, County Wexford, Eire, saw a funnel cloud there on 30th October 1985 and watched it carefully through binoculars. When the funnel's parent cloud "came close to other small clouds they seemed to be very quickly drawn into it". Had Mrs. Murphy not had the benefit of binoculars she might have thought, as others did, that she was watching "just an odd-shaped cloud or a flock of birds". The following description of the Newbottle tornado of 1872 gives a good idea of what the people of Rosdalla may have seen! "Portions of the 'smoke as big as a wheelbarrow' were occasionally thrown off from the main column, and after circling around it for a time, were drawn into it again" (Beesley 1873).

THE LEVITATION OF OBJECTS

Lastly, the lifting of a dog high enough for it to be killed by the fall is conclusive evidence of a whirlwind of some kind; while the shaking or uprooting of trees also implies a localised strong wind (and a tornadic one at that, if Joyce's version is correct in saying that a tree was "carried off").

THE DURATION OF THE TORNADO

The only part of the account that could not apply to a tornado is the statement that the phenomenon lasted for five hours. This is not a serious objection. Figures in medieval chronicles are notoriously unreliable, partly because the chroniclers were not always concerned with mathematical or statistical accuracy, but mainly because the original figures were very liable to corruption by later copyists. Indeed, Joyce's text gives the tornado an even more impossible duration of nine hours. It is possible that these statements are corruptions of "at the fifth (or ninth) hour" – the time when the tornado occurred.

THE DATE

As with many early historical events, there are technical problems in ascertaining the date of the tornado, though near certainty can be achieved. Joyce's version has Sunday, the feast day of St. George, 1055, and this is plausible since the date in question (23rd April) was a Sunday in that year. The *Chronicum Scotorum,* on the other hand, though it also dates the event on Sunday the festival of St. George, enters it under 1052. However, the editor of this work, William Hennessy, states that from 969 to 1061 the chronology of the *Chronicum Scotorum* is two years in arrear, which would fix the tornado to the year 1054. Hennessy also notes that the *Annals of the Four Masters* record the event under 1054, and quotes the editor of that work as stating that its chronology is perfectly correct during the years under consideration. It is perhaps worth adding that the next item in the *Chronicum Scotorum* after the tornado – the mysterious draining away of Loch Suidhe Odhrain – is dated 1054 in the *Annals of Loch Cé* and also, according to Joyce, in the *Annals of the Four Masters.*

In 1054, however, St. George's Day was a Saturday, and this is almost certainly why Joyce (or his source) dates the tornado 1055, when the festival in question did fall on a Sunday. Hennessy quotes a note by Dr. O'Donovan, the editor of the *Annals of the Four Masters,* who observes: "In the year 1054 the feast of St. George

was on Saturday; the annalist must, therefore, mean the year 1055, unless by 'the Sunday of the festuval' he meant 'the Sunday next after the festival', which looks very probable, as the chronology of the Four Masters is at this period perfectly correct". We may therefore state with some confidence that the tornado occurred on the Sunday after the festival of St. George, that is 24th April, 1054. By the New Style (Gregorian) calendar this would be 30th April.

CONCLUSION

The Rosdalla tornado is certainly one of the most interesting of the known cases, and one whose tornadic character is particularly clear. Indeed, although the witnesses' and chroniclers' *explanation* of what was seen is understandably very confused, the actual *description* is remarkably accurate. The author and TORRO would be most grateful for any further references to the tornado which readers may come across, particularly original accounts in the Irish chronicles. We know that it is described in the *Annals of the Four Masters,* but we have not read this version. We also know that it is not mentioned in the *Annals of Loch Cé,* but there are several other contemporary chronicles which it had not yet been possible to examine.

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UNSEASONAL NESTING BY BIRDS DURING MILD MID-WINTER 1988-89

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The exceptionally mild weather of December and January, that continued over into February in many parts of Britain, triggered off a spate of interesting 'out-of-season' cases of breeding by birds. Several passerines, owls, pigeons and freshwater aquatic species surprisingly completed successful nesting attempts. It was all due

to a steady procession of north-east tracking depressions that mainly skirted northern Britain and drew mild, often moist, south-westerly air off the Atlantic. Daily average temperatures a full 3-4 degrees centigrade above the expected meant that frosts were a rarity, and gave the mildest mid-winter since 1974-75, and one of the five mildest this century.

A resulting problem for ornithologists will be to decide when 1988 finished and the fresh season started. For instance, well grown Barn Owlets at nesting sites in central southern England during November were clearly from second broods initially induced by high mice and rat population. Similarly, both Woodpigeon and Collared Dove found incubating clutches and feeding squabs during December in the Home Counties belonged to 1988. But these doves, and Feral Pigeons, continued to breed non-stop into the New Year in parts of both England and Scotland. BTO staff had watched developing late broods of Great Crested Grebes on Tring Reservoirs, Hertfordshire, during October 1988, so were surprised when adults began nest building on 11th January, more so when news arrived on the 26th of a pair feeding one week old young at Frimley gravel-pit in Surrey.

Even more remarkable was a brood of Ravens found close to fledging by an RSPB warden in SW Scotland on New Year's day. Not far away at Renfrew town hall the local Christmas tree had been taken over by Blackbirds who began incubating a full clutch of eggs in the first week of January. Precisely the same strange type of nesting place was occupied by Blackbirds in Cheltenham, Gloucestershire, and on the 18th interested onlookers watched parents feeding three ten day old young. Meanwhile, in Wigan, Lancashire, it was a set of traffic signals that provided a nest platform, amber light and heat, for Song Thrushes which hatched four young on the 19th. At the same time, suburban street lighting and a chicken coop gave home for a brood of Robins in Newton Abbott, south Devon. The last few days of January and early February then saw a scattering of breeding records including nest building by Heron, Dipper, Magpie, Jackdaw and Blue Tit, plus sightings of Mallard, Moorhen and Mistle Thrush with young.

The mild mid-winter certainly produced a wealth of unusual nature notes in January. They ranged from hawthorn in full leaf, mass flowering by lesser celandines, regular foraging by bumble bees and bats, widespread frog spawning, concerted coastal Lapwing display and regular drumming by the spotted woodpeckers. Most notable to the general public was the surge in bird song and advanced vegetation, with the possibility of an 'early' spring to rival 1948, 1957 or 1961.

THE WEATHER AT OXFORD DURING 1987

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After the memorable events of last year, 1988 has seemed rather dull by comparison. Nevertheless, a number of records have been broken during the year. Both the beginning and end of the year were remarkably mild, and the last five months were very dry. The Christmas period was one of the warmest on record.

The summer was cool and July notably wet.

January began much warmer than usual with a maximum temperature of 13.0 C on the 1st and 2nd. Apart from a brief cold spell (15th-17th), the remainder of the month was also much milder than normal, giving the warmest January since 1976, 1.9 C above the long-term mean. Both maximum and minimum temperatures were well above normal, with an absolute minimum of only –1.8 C, the 10th equal warmest since 1881. There were also some strong winds in January, particularly on the 6th when an active depression gave a gust of 59 knots. Th most remarkable feature of January's weather was the rain: total rainfall was 100.0mm, the 12th wettest January since 1767. The highest rainfall was 17.9mm on the 21st; the rain turned to snow in the early hours of the 22nd, giving a covering of about 20mm, the only significant snowfall of the month. There was extensive flooding in the Thames basin at the end of the month as a result of the high rainfall and snowmelt.

The first half of *February* continued very mild and showery. There was well above the average amount of rainfall, although between the showers there was a good deal of sunshine, with 8.2 hours on the 8th. An intense depression crossed Scotland on the 9th causing extensive damage; like the rest of the country, there were strong winds in Oxford on the 9th with a maximum gust of 61 knots. The second half of the month saw cold, northerly winds with temperatures nearer the average. Even so, the lowest air temperature (on the 26th) of –1.8 C was still 3 higher than the normal February absolute minimum. Only 0.8mm of precipitation fell in the second half of the month, to give a total for the month slightly down on the long-term mean. Only one day had snow lying at 0900 hours (26th). For February as a whole, temperatures were higher than normal, with only half the normal number of air frosts. Most remarkable was the total sunshine for the month: 103.7 hours – the sunniest February since 1970 and the 5th sunniest since 1881. By contrast, *March* was a rather gloomy month, with only 85.2 hours of sunshine; the sky was less than half obscured by clouds at 0900 hours on only 6 days, and on only 3 days could the state of the sky be described as "bright". Rainfall and temperature were both higher than normal. There were only 10 ground frosts, the least since 1881. Temperatures in *April* were close to the mean, although the maximum air temperature of 5.7 C on the 9th was unseasonably cool. There was a little less rainfall than usual, and also slightly less sunshine, although the 132 hours of bright sunshine was a welcome improvement on March's figure.

May was yet another warm month, though slightly drier and less sunny than normal. The air temperature was 0.6 C above the mean, though the highest temperature attained, 22.8 C on the 14th, was 1.2 C below the long-term mean maximum of 24.0 C. The last four ground frosts of the spring occurred in May, a normal number for the month. Sunshine was less than normal with 6 days having less than one hour of bright sunshine; the sunniest day was the 16th with 12.9 hours. With a total of 32mm, this was the driest May since 1974. 17 days had less than 0.1mm and only 2 days had more than 5mm. This still fell well short of record breaking, however; in May *1788* there was only 10.2mm rainfall, whilst in 1795 only a meagre 1.5mm fell! Like June 1987, *June* of this year also had unusually low sunshine, 142.3 hours, the 13th lowest since 1881. Persistent low cloud, carried on a raw north-east wind, meant that on only seven days was the sky at 0900 hours less than half obscured by cloud. Cloudy conditions led to maximum temperatures

being slightly less than normal and minimum temperatures being slightly higher; overall the mean temperature was 0.6 C below the long-term mean. On the 9th, the maximum temperature reached only an unseasonable 11.6 C, the coldest June day since 1974. Total rainfall was just above average despite two weeks of dry weather in the middle of the month when only 0.2mm was recorded. More than half the month's rainfall fell on just two days, the 8th and 26th.

July was a very cool and unusually wet month; a continuous procession of depressions passed over or near to the British Isles. Almost half of the rain fell in the first week (47.7mm) and the total of 96.5mm was the wettest July since 1968. Though only the 32nd wettest July since 1767, this means that such rainfall totals will recur on average about once every seven years in Oxford. There were 23 days with 0.2mm or more, the second highest total since 1881; only 1888 had more. On only 5 days was there less than 0.1mm rainfall. The wettest day was the 3rd with 20.8mm. Not surprisingly, temperatures and sunshine were lower than normal. The maximum temperature reached was only a dismal 23.5 C, the 11th lowest since 1881 and the lowest July maximum since 1965. The mean maximum air temperature was 2.6 C below normal, 9th lowest since 1881 and again the lowest since 1965. The mean air temperature too was last as low as 14.9 C in July in 1965 and was 1.5 C below average. There were 50 hours less bright sunshine than on average this July; 133.8 hours total was the least sunny since 1981, a July total as low as this occurring on average about once every 12 years. Overall, July was a very disappointing holiday month.

August marked the beginning of a period of below average rainfall which lasted throughout the rest of the year, though this did not necessarily mean high temperatures and plenty of sunshine! Mean air temperature in August was 0.3 C below average. Though the mean maximum air temperature was also below normal, the warmest day of the year, 28.2 on the 7th, was significantly warmer than the long-term mean, and only 1983 and 1984 have had warmer August days this decade. Total sunshine was also close to average; the brightest day, also the 7th, had 14.1 hours of bright sunshine. The dullest days were the 13th and 21st with only 0.1 hour each. The total rainfall of 38.8mm was some 20mm less than normal; had it not been for 15.3mm on the night of the 31st, this would have been the driest August since 1955. *September* was, like August, very much an average month. Although the maximum temperature of 25.4 C was more than a degree above the normal absolute maximum for the month, the mean temperature was barely different from usual, just 0.3 C higher. The first ground frost of the autumn was recorded on the morning of the 30th. In the first three weeks of the month only 3.5mm of rain were recorded. Over 36mm fell in the final week to give a total more than 20mm below normal (though this is still by no means unusual). The weather systems associated with the heavy rain also gave rise to the windiest weather, with a gust of 50 knots recorded on the 23rd.

The first half of *October* saw some warm, wet and occasionally windy weather, although there was nothing to match the "great gale" of 1987. A maximum gust of 48 knots was recorded on the 7th, the mean speed for the day being over 20 knots. The wettest day was the 8th with 9.6mm. By contrast, the second half of the month was cold, calm and often cloudless, with more than 7 hours of sunshine recorded on each of the last four days of the month. Indeed, the total sunshine of

120 hours was 19.3 hours above normal, the sunniest since 1975. The cold spell at the end of the month brought the first two air frosts of autumn on the 30th and 31st; the 30th was an unusually cold day, with a maximum of only 8.8 C. The absolute minimum of 0.7 C on the 30th was only slightly colder than the October mean absolute minimum. October was drier than normal, the total of 38.6mm being 25.9mm below normal.

The cold clear weather of late October continued into *November,* which was unusually cold, bright and dry. For much of the month the weather was dominated by slow-moving high pressure systems which gave cold nights, foggy mornings and sunny days. Thus the monthly sunshine was well up on normal, the sunniest since 1977; this helped keep daytime temperatures around normal. The clear skies gave much colder minimum temperatures than is usual for November, the mean minimum temperature being 2.1 C below average, the 9th equal lowest on record, and lowest since 1952. The mean grass minimum was also well below average and at –2.4 C was the 4th lowest on record, the lowest since 1923. The absolute minimum grass temperature of –10.0 C on the 22nd has been exceeded only twice since records began in 1881, the last occasion also being in 1923. The low overnight temperatures gave more fog than normal, with seven days when the visibility was less than one kilometre at 0900 hours GMT. Although snow falling in November is not unusual, "snow lying" (i.e. covering more than half the ground) at 0900 hours is: the snow cover on the 20th was the first in November since 1969. November continued the run of dry months. Despite the fall of 13.1mm on the 29th, the month's total of 29.5mm was less than half of the average.

The cool November weather continued into early *December,* but for most of the month the steady influence of the Azores High gave remarkably mild weather, with south westerly winds, much cloud, but little rain. Temperatures peaked over the Christmas period: Christmas Day was the 5th warmest on record; Christmas Day night was the warmest since records began in 1881; Boxing Day recorded both its highest maximum and minimum temperatures. The air temperature did not drop below freezing during December, and the mean air temperature of 7.6 C was more than 3 C above normal – only three years this century (1918, 1934 and 1974) have seen such a mild December. The mean minimum and maximum temperatures were similarly unusual. The mean minimum temperature of 5.4 C has been exceeded twice in 108 years. December 1988 had the lowest number of "raindays" (days with more than 0.2mm rainfall) since such records began in 1881. It was the 14th driest December on record since 1767, and the third driest this century – only 1926 and 1933 being drier. With every month since August having had rainfall well below average, this meant that only 53% of the normal rainfall occurred in the last 5 months of 1988.

Looking at the year as a whole, despite some unusual months, 1988 was an average year in most respects. The winter was slightly warmer and the summer slightly cooler than usual, giving a mean air temperature for the year just 0.4 C higher than normal – the unusually warm December being partly responsible for this also. The highest temperature of 28.2 C was 1.2 C lower than usual, but the mean of the maxima hardly differed from the long term average. The minimum values were, however, unusually high. The lowest temperature for the year (–3.8 C) was the third warmest since 1881, exceeded only by 1984 and 1986. The mean

minimum of 6.7 C was also remarkably high, having been exceeded just seven times since 1881. The number of air frosts was correspondingly low: 33 or fewer air frosts would be expected once every seven years or so. Similarly the number of days when visibility at 0900 GMT was less than 1000m was well below average, although in fact six years this decade have had even less fog recorded. Overall rainfall was 71mm less than the average annual total of 642mm, not in fact an unusually dry year as a whole; nine months had below average rainfall but January and July were both wet. The total sunshine was just 72 hours short of the average of 1473 hours. The dull months of June and July were partly compensated for by more than average sunshine in February, October and November.

TABLE 1. Summary of observations made at the Radcliffe Observatory, Oxford University, during 1987.

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year*
T	5.5	4.9	6.6	8.2	12.1	14.2	14.9	15.7	13.8	10.9	5.1	7.6	9.9
Diff	+1.9	+0.9	+1.0	0.0	+0.6	–0.6	–1.5	–0.3	+0.3	+0.9	–1.2	+3.1	+0.4
Max	13.0	13.8	13.7	17.7	22.8	24.1	23.5	28.2	25.4	17.4	15.3	14.1	28.2
Mean	8.1	8.1	10.2	12.6	17.1	18.9	18.9	20.4	17.9	14.5	9.1	10.1	13.8
Diff	+1.5	+0.9	+0.3	–0.3	+0.5	–1.0	–2.6	–0.6	–0.6	+0.5	–0.6	+2.8	+0.1
Min	–1.8	–1.8	–3.3	–0.8	3.0	6.9	7.8	7.6	3.3	–0.7	–3.8	0.0	–3.8
Mean	3.3	2.3	3.8	4.6	7.8	10.2	11.6	11.9	10.4	7.9	1.6	5.4	6.7
Diff	+2.0	+1.1	+2.6	+0.5	+0.7	+0.1	–0.5	+0.1	+0.7	+1.3	–2.1	+3.4	+0.7
G.M.	–7.5	–6.9	–8.1	–7.1	–1.6	2.3	5.5	3.7	–1.5	–6.0	–10.0	–5.9	–10.0
Rain	100.0	33.8	59.1	30.2	32.0	59.6	96.5	38.8	39.6	38.6	29.5	13.4	571.1
Diff	+48.1	–6.8	+17.9	–12.7	–19.0	+5.8	+36.0	–20.0	–21.1	–25.9	–31.9	–41.5	–71
Sun	47.7	103.7	85.2	132.0	178.1	142.3	138.8	178.8	136.9	120.0	91.4	46.7	1401.6
Diff	–5.0	+36.3	–28.9	–18.7	–11.7	–55.2	–50.0	+3.3	–1.3	+19.3	+28.1	–1.6	–71.8
A.F.	4	5	4	3	0	0	0	0	0	2	15	0	33

T = mean temperature (°C); Max = extreme maximum; Diff = difference of mean from long-term average, etc; G.M. = extreme grass minimum temperature; A.F. = air frosts.

WORLD WEATHER DISASTERS: AUGUST 1988

1-31: Heavy rains and floods in many areas of Sudan, rains began on the 1st, but worst of rain fell on the 4th and 5th when 210mm of rain fell in a 13 hour period in Khartoum; during 1987 38mm of rain fell during the whole year; many thousands of mud brick houses collapsed in the rains, making nearly two million homeless throughout country, over one million in Khartoum alone, more heavy rains fell on the 12th/13th in Khartoum, up to 50mm recorded. The floods in Sudan described as worst since 1946, at least 96 deaths reported, widespread damage to railways, roads, crops and livestock, in addition to the houses destroyed. *Lloyds List., Daily Telegraph.*

1-31: Heatwave and forest fires in many areas of U.S.A., worst of heat in the first 20 days or so of the month, some cities recorded the highest temperatures ever recorded on individual days, in week ending Aug 10th four deaths blamed on heat in Chicago, meanwhile it was reported on the 5th that persistent rain over the previous week had restored the river Mississippi to near its normal levels. Western States of the U.S.A. reported serious forest fires during the month, on

the 2nd fires reported from Wyoming, Idaho, Montana, Oregon, Utah and Washington, one fire in Idaho cost $9 million. On the 19th a fire that began ten days earlier reached outer suburbs of Helena, Montana, at least five homes destroyed. By the month's end over three million acres of forest had burned in the north west states, 385,000 of them in the Yellowstone National park. *L.L., D.T., International Herald Tribune.*

1-10: Monsoon rains and floods in many areas of Pakistan, on the 4th it was reported that 340 people had died in the floods in the past three weeks, on the 3rd, 24 people killed by lightning in the village of Chugarzai, 160km north west of Islamabad, some 2.6 million acres of land have been flooded, crops on 60,000 acres destroyed and 50,000 homes damaged. In Karachi 50mm of rain fell in two hours on the 4th, another 28mm fell between the 5th and 0600 on the 6th, bringing the aggregate for the season to 190mm. *L.L., D.T.*

2-3: Heavy rains and a hailstorm in the area around Infiesto, Spain, touched off mudslide which covered the Santander-Oviedo railway line on the 2nd, on the 3rd a two coach passenger train was derailed by the mudslide, leaving four dead and 16 injured. *L.L.*

2-4: Cyclone accompanied by torrential rains, hit an area east of Lake Baikal, central Siberia, U.S.S.R., many rivers burst their banks, flooding villages and over 75,000 hectares of farmland, electric power lines brought down. *L.L.*

2-25: Severe weather in many areas of China, brief details below:-

2nd reported: Hailstorm in north east province of Heilongjiang injured 424 people and caused damage estimated at $21 million.

5th reported: Heatwave in central China, temperature in city of Wuhan, Hubei province, reached 40°C, 38 people died in city due to heat, storms in Beijing destroyed 50 houses and up to 280mm of rain fell in counties to south west of capital.

6th: Heavy rains hit, Fenyang county in Shanxi for three-and-a-half hours, submerging 40 villages, leaving 49 dead and 10 others missing.

8th: Typhoon "Bill" hit eastern province of Zhejiang, destroying nearly 50,000 homes, leaving at least 117 dead and 1,184 injured, the typhoon described as worst in 32 years, hundreds of trees uprooted in Hangzhou, up to 100mm of rain fell across province, 100,000 acres of cotton damaged, on the river Quiantang 58 vessels sank, the typhoon moved across province at 29km/h and moved into Anhui province around noon, Zhejiang province was hit early in the morning.

8th: Torrential rains and floods across seven counties of Shaanxi province left seven dead and 19 others missing.

9th: Rains and floods in Henan province left 34 dead and inundated thousands of acres of farmland.

15th-17th: River Nen Jiang in Heilongjiang province reached its highest level since 1949, many thousands of people evacuated.

11th: Floods in Inner Mongolia left 10 dead and 100,000 stranded, 2000 homes destroyed when river Gan overflowed.

17th (reported): Fierce storm in Shaanxi province killed at least 163 people, destroyed 3000 homes and 16 bridges along with many kilometres of roads.

22nd-25th: River Nen Jiang broke its banks in Jilin province, on the 22nd Yellow River flooded 33 villages in Shangdong province, in east of country. *L.L.*

3-4: Brush fires on Sardinia, north-east of island worst affected, fires spread by warm winds in temperatures that rose above 40°C, two people died in fires, and at least 10 people injured. *L.L.*

3-4: Thunderstorms and high winds in northern Italy, winds gusting to 80km/h blew tiles off roofs, damaged chimneys and uprooted trees as far south as Genoa; on the 3rd roofs ripped off holiday chalets around the Dolomite mountain valley of Val Gardena, golf ball size hailstones damaged crops of apples, pears and grapes and dented cars, power cut off when electricity lines damaged. On the 4th storms caused floods in Torino and Milano and in other areas, a landslide blocked the rail line between Bardonecchia, Italy and Modane, France. Storms in Alto Adige region caused damage estimated at $7 million to fruit orchards and other crops. *L.L.*

3(reported): Hot, dry winds blowing from the south has brought drought to north Sumatra, south Sulawesi and Java, Indonesia. *Jakarta Post.*

4-5: Brush and forest fires have destroyed thousands of hectares in southern Italy. *L.L.*

4-5: Brush and forest fire near Sibenik, Yugoslavia, the fire passed through the suburb of Subisevac destroying vegetation and damaging several apartments, on the 7th another fire, less serious, broke out near town and burned for several hours. *L.L.*

4(reported): Forest fires in Khabarovsk region of U.S.S.R. have burned through 103,000 hectares in the past several days. *L.L.*

8-9: Tropical storm "Beryl" hit states of Louisiana, Mississippi and Alabama with winds gusting to 80km/h, high tides, as high as 2.14 metres and heavy rains, 152.4mm at Biloxi, Mississippi and 114mm at Mobile, Alabama, rains flooded roads and winds brought down power lines, on the 8th a vessel capsized in storm off the Alabama coast near Mobile Bay, leaving one person missing. *L.L.*

9: Heavy seas and high winds hit yachts off New South Wales, Australia, leaving one man missing, two yachts overturned and a police rescue launch sank. *L.L.*

10: Tour vessel the *Nubia* sank in violent wind and rainstorms 1.6km from Edfu, Upper Egypt, on the river Nile, leaving 12 dead and up to 19 others missing. *L.L.*

11: A tornado hit village of Sarbaktu, east of Lake Baikal, Siberia, U.S.S.R., tornado lasted 10 minutes, destroying houses and stores and injuring 8 people, the tornado, 152 metres high and 76 metres wide, was accompanied by hail. *L.L.*

12: Ten climbers were struck by lightning while climbing Mt. Breithorn, Switzerland, three taken to hospital. *D.T.*

13-15: Torrential rains in central and southern Taiwan, some areas receiving as much as 711mm of rain, some 2500 homes destroyed, nine people dead, with three others missing. *L.L.*

13-16: Twelve forest fires in Greece burned through 15,000 acres of woodlands, a farmer died of smoke inhalation on the 15th near the southern town of Kalamata. *B.E.M.*

15(reported): Prolonged heatwave and drought in Yugoslavia, temperatures in some areas of country up to 45°C, crops of maize, sugar beet and other crops could be halved in worst drought in 36 years, the situation was worst in the

republic of Macedonia. *L.L.*

16: Heaviest rains in decades hit Zurich, Switzerland, flooding streets. *I.H.T.*

17: Trawler, the *Rajiz* sank in bad weather in Bay of Bengal near Putuakhali, Bangladesh, leaving 12 people missing. *L.L.*

17-25: Heavy rains and floods in West Africa, brief details below:-

Nigeria: Adam, the Bagauda, gave way on the 17th, after the heaviest rains in 50 years, flooding wide areas of Kano state, 23 deaths reported from floods in Kano state in floods prior to dam burst, but no deaths reported from dam burst. Floods in Nigeria destroyed 18,000 homes and made 200,000 people homeless.

Niger: Heaviest rains in 20 years left 13 dead and 7000 homeless.

Chad: Heavy rains on the 23rd caused widespread floods and damage in N'djamena, the capital and town of Moundou, floods left 45 dead and 48,000 homeless, the rains in the capital lasted six hours and destroyed 1900 houses, 2500 houses destroyed in Moundou.

Cameroun: Storms hit north of country on the 25th, leaving at least 10 dead and more than 1000 homeless.

Burkina Faso: Storms and floods in 12 of country's 30 provinces left 10,000 homeless. *L.L., D.T., I.H.T., B.E.M.*

18-31: Monsoon rains and floods in Bangladesh, by the 20th floods in north-west of country left four dead and 50,000 homeless; it was reported on the 27th that scores of rivers, had burst their banks and by the month's end some 33% of country affected by floods, leaving 111 people dead. *L.L., I.H.T.*

19-24: Forest and scrub fire on island of Ibiza, Balearic islands, destroyed 300 hectares of pine and scrub. *L.L.*

20-24: Heavy rains and floods in many areas of Mexico driving thousands of people from their homes in six states, causing heavy damage to crops, roads and communications, a mudslide in an undetermined location left four dead and six others injured. In the town of Emiliano Zapata, Morelos state, floods and mudslides destroyed 50 homes and several thousand acres of rice, corn and sugar cane. *L.L., B.E.M.*

24-28: Tropical storm "Chris" moved from south of Puerto Rico to the U.S.A. details below:-

Puerto Rico: heavy rains fell on the 24th and high winds uprooted trees, at least three deaths reported, with 451 people made homeless, on the 24th and 25th 250mm of rain fell on Cabo Rojo, 18 injuries reported in Arecibo, 80km east of San Juan.

Dominican Republic: heavy rains caused floods and landslides which left at least seven dead and four others reported missing, six of dead in floods along the Haina and Duey rivers and the seventh died in a landslide. The homes of 180 families destroyed by floods.

U.S.A.: "Chris" came ashore at Charleston, South Carolina on the 28th with winds of 80km/h, storm dissipated rapidly after moving ashore, from 75mm to 125mm of rain fell along the Atlantic coast. The storm spawned 9 tornadoes in South Carolina which left one dead and destroyed 50 mobile homes, worst tornado hit Manning, 105km north west of Charleston, destroying 30 mobile homes and damaging 20 others, leaving one dead and one injured, the tornado path was 0.8km long and 0.4km wide, two tornadoes reported from North Carolina. *L.L.*

24-31: Monsoon rains and floods in India, on the 26th thousands of villages in north and east of the country flooded along the Ganges and Brahma putra rivers, states of Uttar Pradesh, West Bengal, Bihar and Assam worst affected, at least 24 deaths reported, raising to 466 the number of lives claimed by flooding since the monsoon rains began two months ago, many thousands of people moved from the flooded areas, where rail and road communications have been disrupted. *L.L., D.T.*

25-29: Tropical storm "Kristy" hit four countries of Central America, brief details below:-

El Salvador: This country was the worst affected, with at least 36 deaths reported, with 15,000 people made homeless, provinces of Usulutan, La Union, Ahuachapan, San Miguel and San Salvador worst hit.

Guatemala: Rains and floods left six people dead and 500 homeless, in Guatemala City, 119mm of rain fell in a 36 hour period.

Honduras: Rains and floods made 2500 people homeless in or near capital, Tegucigalpa, after at least 300 homes were destroyed.

Nicaragua: Floods left one person dead in city of Nandaime, 48km south of Managua. *L.L.*

26: Flash floods after heavy rains in mountains near Tehran, Iran, left 25 dead, 18 injured and seven others missing. Houses and roads were damaged in three towns and 30 villages. *D.T., I.H.T.*

27-30: Heavy rains and flash floods hit a number of villages in Tanah Laut regency, south Kalimantan, Indonesia, leaving one dead and damaging 250 houses, the floods from the river Riam, rose to a depth of two metres in areas. *J.P.*

31Aug-1Sep: Strong winds, heavy rains and thunderstorms in southern England and south Wales, hundreds of acres of low-lying farmland in Devon under water, 125mm of water on A30 between Exeter and Honiton, floods on roads in Hampshire. Two houses reported set on fire by lightning at unreported locations in southern England, one man swept overboard from trimaran in the western approaches, young girl fell into river Vyrnwy near Welshpool and swept away, power cuts reported along south coast when power lines brought down by the gales. *B.E.M., D.T.*

ALBERT J. THOMAS

LITERATURE REVIEWS AND LISTINGS

Book Reviews

TROPOSPHERIC OZONE: REGIONAL AND GLOBAL SCALE INTERACTIONS. Edited by I.S.A. Isaksen. D. Reidel Publishing Company, Dordrecht/Boston/Lancaster/Tokyo 1988, 425pp., £58.00.

The upsurge of concern about depletion of stratospheric ozone will for many have obscured the fact that around 10% of the gas occurs within the troposphere. It

is therefore timely that a book has appeared which discusses this part of the ozone profile, for it is a subject which needs examining just as carefully as events in the stratosphere.

An international workshop, held at Lillehammer (Norway) in 1987, had as its chief aim "to increase our knowledge of ozone formation and distribution in the troposphere, its relation to precursor (NOx and HC species) distribution, how it is affected by transport processes in the troposphere, and to show how the increasing levels of ozone can cause environmental problems". It is the 23 presentations and 4 working group summaries from this event that make up the contents of *Tropospheric Ozone*. The intention is that a similar workshop will be held "within a few years".

Almost inevitably, books of this sort do not offer a comprehensive treatment of their subject. In this case a long and useful paper by B. Prinz entitled 'Ozone effects on vegetation' is not matched by similarly thorough discussions of how the gas affects human health and materials. Likewise, references to American experiences, such as the well-known photochemical smogs of California, are not as numerous and detailed as one might expect. On the other hand, the book does contain a valuable article by P. J. Crutzen ('Tropospheric ozone: an overview') and has data on important topics like the origins, increase and transport of ozone within the troposphere. It is also good for illustrations and tables which can be used in lecturing/teaching (eg. the graphs showing estimated NOx emissions since 1900 in the US (p.15) and increasing ozone levels during the last 100 years (p.64): also, the tables which give an estimate of global sources and sinks of methane (p.11) and list the sensitivities of various plants to ozone (p.167). The standard of this book is quite advanced and there are papers which for some people will have an unacceptable amount of chemistry (eg. R. A. Cox 'Atmospheric chemistry of NOx and hydrocarbons influencing tropospheric ozone'). Even so, non-specialists are likely to derive much useful information by a careful reading of this text.

CHAMBERS SCIENCE AND TECHNOLOGY DICTIONARY. Edited by Peter M. B. Walker. Chambers/Cambridge University Press 1988, 1008pp., £30.00 (hardback), £16.95 (paperback).

A pointer to the scope of this dictionary is given by lists (pp.ix-xii) of its subject categories and contributors. Thus, although meteorology is among the categories listed, a number of weather-related subjects, such as hydrology, glaciology and geomorphology, are omitted. Then again, there is only a single contributor to the meteorological category, R. P. Waldo Lewis, former Head of Library and Publications Branch at the Meteorological Office. These facts will quickly arouse the suspicion of readers that this dictionary, though long, may be inadequate for those studying weather and related topics.

To test this suspicion it was decided to examine how competently the dictionary explains terms associated with cold climate phenomena. The first surprise was that key words like 'periglacial', 'cryopedology' and 'cryonival' are not defined. Similarly, no mention is made of terms like 'gelifraction', 'gelifluction' and 'geliturbation', nor of periglacial features such as 'patterned ground', 'pingos' and 'palsas'. Indeed, one of the few aspects of periglacial climates which receives a mention is 'permafrost', though alternative and associated terms (eg. 'pergelisol',

'permafrost table' and 'thermokarst') are omitted. Likewise, only a few glaciological terms are defined and there are some words (eg. 'ablation', 'mass balance') which are given only non-glacial definitions. Another inconsistency is that the dictionary defines 'crevasse', but fails to mention other glacier characteristics such as 'pressure folds', 'dirt cones' and 'glacier tables'.

Meteorologists are likely to find this dictionary disappointing. Even when people's interests range over the broader field of Environmental Science, they will continue to discover many shortcomings. Admittedly, its value may on occasion be extended somewhat by the need to look up words from quite different disciplines (eg. where these relate to medical conditions resulting from exposure to atmospheric pollution). The probability is, however, that the majority of weather enthusiasts would most of all welcome a good dictionary which is tailored to their specialist interests.

L.T.

LETTERS TO THE EDITOR

A STORMY DAY IN MALTA

Having optimistically travelled to Malta at the beginning of December in search of warmer weather for a week, my wife and I were pleasantly surprised with daytime temperatures in the upper teens°C, and night minima not much lower but with N.W. winds quite strong at times. The 7th December in particular was a gloriously sunny day with Ci slowly clearing from the N.W., but later in the afternoon dense Ci started to form quite low down in the atmosphere.

The following morning was quite a different story. Overnight the wind had backed E., Force 3-4, and as our hotel window at St. Anton faced E.S.E. I could see great banks of Cumulus starting to cover the sky. Soon after 9 a.m. rain set in but was mainly light and patchy, so ever hopeful we set off in our hire car on a previously arranged trip to the S.E. Coast, a journey of about seven miles. Towards noon, the rain which had almost ceased became heavier so we had an early lunch at a hotel overlooking a bay with the sea getting quite choppy. As the car hire was due to finish that afternoon anyway, we decided to return to our hotel. Roadside drainage is minimal in Malta and soon road surfaces were flooded making driving hazardous, especially as one has to contend with frequent potholes. The engine on the car started to cough and splutter but with a little nursing made it back to the hotel, where I then had a grandstand seat for what was to come.

During the afternoon the rain became heavy at times, but the most significant thing was the wind which steadily increased as time went on. By mid-afternoon the wind was howling and moaning around the hotel giving problems to staff trying to keep the swing doors shut. Palm trees and bushes started to sway violently, and the rain rattled against the hotel windows like bullets. As the wind increased so did my frustration at not having a barometer or anemometer to hand!

At 3.30 p.m. lightning started to flash and thunder rumbled intermittently. Still the wind increased and thoughts reverted to a certain storm last October here at home! Soon the noise was terrific as the building shook with ever more violent gusts, and even without an anemometer it was clear that the wind was blowing at a mean speed of force 9-10.

By late evening the storm reached its height with rain coming down in torrents and starting to encroach under balcony doors and into some of the bedrooms. At one point around midnight I thought that the glass would disintegrate in the more violent gusts.

Early in the night the storm eased and the worse was over, but the following morning a force 7-8 N. wind was still blowing with intermittent rain, and spray at Valetta was still reaching 20-30 feet. Damage in the islands was widespread with trees uprooted, telegraph poles toppled, sea walls breached, many small boats sunk or damaged, and some roofs blown off. At Sliema near Valetta on the E. Coast, waves smashed windows along the front.

Rainfall in the storm averaged 61.3mm over the islands from 12 p.m. on the 8th to 12 p.m. on the 9th when the majority of the rain fell. An individual total of 60mm was recorded at Victoria on Gozo which

is the northern most island and 72.4mm at Luqa. The Malta Met. Office confirmed mean wind speeds of force 10 with a gust of 66 knots being recorded at Luqa Airport. The storm was reported as being the worst in terms of wind since 1948.

The low responsible formed over N.W. Libya on 8th in response to an upper stream of cold air moving E. from Tunisia and by 1200 had deepened to 1003mb, the pressure at Luqa at the same time being 1006mb. A warm front moving slowly N.W. became slow moving over Malta by midnight with the low still deepening and moving E.N.E. By 1200 on 9th the low had reached its lowest pressure of 984mb and was now to the E. of the islands.

So ended an interesting day's weather, but my wife thinks I arranged it deliberately! My thanks to Colin Finch for providing information on the low.

Epsom Downs, Surrey. P. B. L. CLIFFORD

STORMS OF 8-9 DECEMBER 1988 IN MALTA

I have recently been to Malta for a short holiday, and can offer a few notes in respect of the severe storms which affected the island on the 8th/9th December 1988. Where appropriate, I quote from *The Times* published on 10 December 1988 in Valetta.

Many boats had been severely damaged at Xemxija. Fallen trees blocked the roads in this area. At Bugibba, a water-polo complex was completely demolished, and garages and houses flooded. Yachts were damaged at Gzira, and several were lost due to sinking. A tree fell on to a car and its occupant near San Pawltat-Targa. Roads were closed in some coastal areas due to debris or flooding, which entered homes in places such as Kalkara.

Winds achieved a maximum gust of 66kt at Luqa, from the north-east to north, at about midnight on the 8th/9th. Distress signals were received at Valetta from several vessels at sea, causing Sicilian helicopters to go out searching. Vessels entered Marsaxlokk for shelter. Valetta harbour was closed due to huge waves breaking over the defences at the seaward end of the harbour complex.

Tree damage occurred widely, with Addolorata Cemetery suffering broken tombstones and monuments. Buskett Gardens were strewn with fallen trees (seen by the writer, still fallen a month later). The island water supply was affected due to electricity power cuts – used in the reverse-osmosis process at various supply stations. The writer observed a good deal of damage to seafront structures and buildings around the northern and eastern part of Malta. According to the press report, rainfall at Luqa for 8th December was 72.4mm.

4 Arden Close, Derby. DAVID J. STANIER

TORRO THUNDERSTORM REPORT: July 1988

By KEITH O. MORTIMORE
Thunderstorm Division, Tornado and Storm Research Organisation, 77 Dicketts Road, Corsham, Wiltshire.

July was cool, wet and dull in most parts of the U.K. and as a result of the persistently disturbed nature of the month thunderstorms of a summer nature were entirely absent. Although the total number of thunder-days was above the normal throughout the British Isles and Eire all activity was the result of showery developments in the mobile westerly flow. As would be expected in such situations much of the thundery activity occurred in central and eastern counties of England and Scotland. In the north and west thunder was heard on one to three days with only a handful of stations failing to hear any thunder at all. Most central areas reported three to five days and in East Anglia some four to six were reported while eight occurred in a few spots in Essex, Norfolk and Lincolnshire.

Thunder-days in July 1988 were as follows:

July 1988	*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						X	X	X	X	X	X	X	X	X			21	15.8
Wales					X								X								X	X										4	7.8
Scotland	X				X	X	X															X	X	X	X		X				X	10	9.4
Ireland		X	X	X	X	X						X									X		X		X		X			X		11	7.4
Total	X	X	X	X	X	X	X	X				X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	23	17.8
Netherlands	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X		X		X	X	X	X		X	X	X	X			24	17
Belgium	X	X	X	X	X	X	X	X					X	X								X	X	X			X					14	

An occluding frontal system moved north-east across England and Wales on 1st, slowing down and becoming slow-moving over Scotland. Many areas had outbreaks of rain, and thunderstorms broke out over parts of England and Scotland. Initially storms developed in the frontal zone but later, some heavy showers, accompanied by hail and thunder, developed in the clearer air behind the front. Flooding was reported from North Yorkshire and at Pickering over 60mm of rain was reported in the press as having fallen in about 60 minutes. Thundery showers developed widely over England on 2nd and hail fell in a number of places. There was also isolated thunder in southern Eire. It was the turn of Ireland to be particularly affected by thunderstorms on 3rd with quite widespread activity in the afternoon and evening. Power was disrupted in many places and a door bell fitting was blown from a door at Ballyferope Glenroe in Co. Limerick. In England storms were confined to a few localities near to the east coast. There were a few storms around in Eire on 4th but activity on this day was generally confined to central and eastern counties of England. Lightning struck the chimney stack of a public house at Helmdon, nr. Wappenham (Northamptonshire) causing some structural damage to the building and some slight incidents were reported elsewhere in the area. Flooding was the result of heavy rain that accompanied some of the storms and at Skegness (Lincolnshire) many shops were inundated and stock damaged. At Gibraltar Point 23.5mm fell in only 30 minutes. A funnel cloud was observed over the city of Nottingham. On 5th a similar area of England and Eire was again affected and on this occasion there were thundery developments in parts of Wales and Scotland. Hail was a feature of some of these storms and some lightning damage was reported. At Maidstone (Kent) a serious factory fire could well have been started by lightning and in another Maidstone incident struck a tree in the garden of a house which also sustained fire damage. On the M5 near Cheltenham the electrics of a Renault 25 were burned out when lightning apparently struck the car. At Camborne (Cornwall) the Met. Office radar system was struck by lightning and put out of action. The worst flooding for a number of years followed torrential rain in east Co. Cork in the Republic of Ireland. The 6th saw heavy showers and thunderstorms over a wide area of England and Scotland, and to a lesser extent, Ireland, and again some of the storms were heavy with flooding and lightning damage. Activity began in the south-west in the early hours and moved progressively north-east during the course of the day. All storms had died out by early evening. On 7th showers turned thundery over parts of north-east England and northern Scotland. At Wetherby in Yorkshire a woman was struck by lightning on the local golf course. A club was knocked from her hand but luckily she escaped

serious injury. The lightning apparently struck the sixth fairway, travelled along the ground and across the fifth green and into the green-keeper's shed where three of the staff were eating their lunch. The greensman said . . . "the whole shed lit up, there was a huge bang on the roof and sandwiches went everywhere". At Scarborough the lighthouse was struck by lightning. A trough moving slowly east across northern and central England on 8th produced some heavy rain and local thunder in the Greater Manchester and Cheshire areas, and later in the north Midlands and north-east. During storms in Newcastle several houses were damaged by a lightning bolt that caused some structural damage and blew telephone equipment.

After a brief quiet spell a few storms affected southern Eire on 12th and on 13th southern Britain and parts of Wales saw some thundery outbreaks as a cold pool drifted east across England. Two short-lived funnel clouds were sighted at Fleet (Lincolnshire) and there was a possible tornado at Carmarthen (Dyfed). On 14th and 15th some eastern areas had a few thundery outbreaks as a showery northerly flow covered the North Sea and adjacent land areas. Minor waves developing on a slow-moving cold front lying across southern England were responsible for some thunderstorms from south-west England to East Anglia on 21st. Some of the rain was heavy and very humid air to the south of the front resulted in reports of dense fog accompanying some of the storms along the south coast. There were also scattered thundery showers in Northern Ireland. Heavy rain moved north across northern England and Scotland on 22nd, with scattered thunderstorms in places, and very humid conditions produced further outbreaks of heavy rain on 23rd, again with local thunder, mostly in the north. Parts of Northern Ireland were also affected by thundery outbreaks and hail fell locally. Scotland and the far north of England again saw thundery out-breaks on 24th, and on 25th strong winds and thundery showers affected Northern Ireland and southern Scotland. Heavy showers and thunderstorms developed widely over southern and central England on 26th and with much cold air aloft there were numerous reports of large temperature falls, squally winds and hailstorms. At Codsall, north-west of Wolverhampton (West Midlands) hail caused great damage to crops and lay 5cm deep on the ground. Hailstones also damaged garden produce at Fleet (Lincolnshire). Apart from isolated thunderstorms in Northern Ireland and south-west Scotland thundery developments were confined to southern counties of England on 27th where high ground would seem to have been responsible for setting off heavy showers and thunderstorms from Devon to Kent. On 28th thunder was heard in heavy rain in North Yorkshire and heavy showers and thunderstorms affected the south Midlands in the afternoon of 29th. On 30th a cold front lying from south-west Ireland to the northern English Midlands was responsible for thundery developments in Co. Limerick, Staffordshire and Lincolnshire and on 31st there were thundery showers over the Cairngorms and in the Fife area of eastern Scotland.

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

New Product

DELTA-T DEVICES ADDS 4-WIRE MEASUREMENT TO DELTA LOGGER

- User installable upgrade to enhance versatility of a modular, field data logger.
- Accurate, four-wire measurement from PRT sensors over –220 to +836 Celsius.
- Excitation for other bridge or potentiometric type transducers.

Delta-T Devices, Environmental measurement specialists of Cambridge, England, has introduced a 4-wire measurement input card, type LFWI, to upgrade the specification of its *Delta Logger* weatherproof (IP65), portable data collection unit. The new card is easily installed in the instrument by existing *Delta Logger* users, and is supplied with a disk containing the linearisation look up table to supplement the user's existing software.

The new 4 wire-card measures up to 12 channels of Platinum Resistance sensors to BA1904/DIN43760, with a linearisation look-up table covering –220 to +836 Celsius. Alternatively, the card can provide excitation and measurement for other bridge-connected sensors, such as Strain Gauges, Load Cells, and Pressure transducers, or potentiometric sensors such as windvanes or displacement transducers. 1 or 2 LFW1 cards may be installed in a Delta Logger, giving measurement of up to 24 4-wire sensor channels. The 4-wire card virtually eliminates measurement errors due to cable resistance, which can be significant even in 3-wire techniques.

LFW1 is designed for accurate operation over the full *Delta Logger* environmental range of –20 to +60 Celsius. The *Delta Logger* unit, with measurement cards installed, is lightweight, fully weatherproof (to IP65) and internally battery powered for field-based and unattended logging applications. It has an RS-232C serial interface to download collected data in a format compatible with many standard spreadsheet and statistical data processing packages. Delta-T Devices can supply configuration and data-collection software for a wide variety of MS-DOS and other microcomputers.

The *Delta Logger* is proving a popular and successful instrument. Applications range from *'straightforward' meteorological recording on remote Antarctic islands,* the monitoring of temperatures and other parameters in experimental vehicles and industrial processes, energy management studies on public buildings, and even to logging the growth rate of young birds in the wild – by weighing the entire nest with load cells!

Delta-T Devices Ltd. 128 Low Road, Burwell, Cambridge CB5 0EJ, England
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WEATHER SUMMARY: November 1988

November was a rather cold month over England, Wales Northern Ireland and southern and central Scotland. Most northern parts of Scotland had temperatures near to or a little above the average. Night-time temperatures showed the greatest negative anomaly over England and Wales where a number of stations reported mean minima some two or more degrees Celsius below the normal. Although 15.2° was recorded at Nantmor (Gwynedd) on 7th most places reported their highest

maximum values on 9th or 10th. On 9th 18°C was reached at Guernsey (Channel Islands), 16.1° in Central London and 15.8° at Sidcup (Kent), and on 10th 17.0° was recorded at Guernsey, 16.0° at Yatton (Avon) and 15°C around the Moray Firth in Scotland. Over England and Wales the 10th was widely the warmest night with minima of 13.7°C in Central London, 13.4° at Hurn Airport, Bournemouth (Dorset), and 13.3° at Exeter (Devon) while in Scotland parts of the Western Isles and western mainland recorded between 10° and 11°C on 14th, 15th and 16th. Lowest maxima were generally recorded between 19th and 22nd. Lowest values over England and Wales were 1.0° at Ringway Airport, Manchester, and Ely (Cambridge) on 20th and 21st respectively with 0.8°C on the latter day at High Bradfield (South Yorkshire) and −1.5° at Whin's Pond (Cumbria) on 22nd. In Scotland the 20th was the coldest day with −1.0° at Salsburgh (nr. Glasgow), −0.5° at Inverdruie (Highland) and −0.4°C at Rannoch School, Dall. Lowest minima included −11.4° and −11.6° at Carnwath (Strathclyde) on 21st and 22nd respectively, −8.9° at Churchdown, Gloucester on 22nd and −7.9° at St. Harmon (Powys) on 27th. On 22nd a number of stations in England reported minima below −6°. Lowest values on the grass included −13.8° at Carlton-in-Cleveland (North Yorkshire) on 22nd and −12.7°C at Glenlee and Eskdalemuir (Dumfries and Galloway) on 21st and 22nd. In Ireland −12.1° was recorded at Straide (Co. Mayo) on 21st and in Wales Velindre (Powys) reported −12.0° on 22nd. Many parts of the U.K. had a very dry November and parts of southern England were exceptionally so with percentages in the low twenties in places. Northern Britain was not quite so dry as further south and in parts of north-east England totals were somewhat above the normal. On 27th 45.5mm fell at Broadford (Skye) and on 28th 39.5mm fell at Whalsay (Shetland). The 29th saw between 20mm and 30mm over a wide area of England and Wales. Highest reported values were 38.7mm at Ilfracombe (Devon), 33.9mm at Penmaen (West Glamorgan), 27.1mm at Carmarthen (Dyfed) and 25.6mm at Stratton, Burton-on-Trent (Staffordshire). Snow fell quite widely on 20th and 21st and a number of stations reported their first lying snow in November for quite a few years. The greatest reported depth was 18.3cm at 09 GMT and 21 GMT on 21st at Carlton-in-Cleveland where there was lying snow at 09 GMT on eight consecutive mornings. Over the hills around Dover 12.5cm accumulated late on 21st which lay for several days. Away from the far north-west of Scotland most parts had a sunny November with between 120 and 160 percent of the normal in most places. At Glasgow it was the sunniest November since 1947, at Penmaen the sunniest this century, and at Ryde (Isle of Wight) since before 1915.

High pressure that covered much of Britain on 1st moved slowly eastwards into Europe during the first week. Most parts had good spells of autumnal sunshine with some frost and local fog at night and on 6th and 7th fog proved reluctant to clear in parts of the south-east. Some north-western areas were rather cloudy with rain at times. With strengthening southerly winds frontal systems and rain spread from the west to most parts from 8th to 10th and it became milder right across the country. By 13th an anticyclone had returned to cover southern Britain and as the centre of high pressure moved slowly east across southern counties and into Europe it again became dry and settled with overnight fog that persisted all day in places. A cold front crossed the country on 17th as a depression moved into Scotland, and on its western flank cold northerly winds spread south to most parts

of the country on 18th followed on 19th by further rain as frontal disturbances tracked south-east across northern and central counties of England and Wales. As these features crossed southern counties on 20th rain turned to snow in many parts and gave a snow cover in a number of places away from the west country with accumulations of 10 to 15cm in a few places. Snow showers added to what was already lying in some northern and eastern counties on 21st, particularly near exposed coasts. Over the next few days high pressure covered much of Britain and frost became quite severe at night. Fog also developed at times and persisted well into the daylight hours in some spots. By 27th the high had declined and moved away to the south-east allowing frontal systems to push in from the west, and over the final few days all parts had spells of rain, especially on 29th, and winds reached gale force for a while in the north. Southern areas also became very mild for a time.

K. O. M.

TEMPERATURE AND RAINFALL: NOVEMBER 1988

	Mean				*Grass*					
	Max	*Min*	*Max*	*Min*	*Min*	*Rain*	*%*	*Wettest*	*RD*	*Th*
BELGIUM: Uccle	8.9	2.4	14.6(10)	−5.9(22)	−12.5(22)	51.9	81	15.9(29)	17	–
„ Rochefort	8.2	−0.6	15.3(11)	−9.6(22)		60.4	89	12.6(30)	17	–
„ Houwaart	9.4	0.5	15.4(11)	10.1(22)	−13.5(22)	33.6	47	10.9(20)	11	1
DENMARK: Fanø	7.6	2.3	11.2(11)	−5.8(22)		48.0	50	11.4(29)	14	0
„ Frederikssund	5.9	0.7	10.5(11)	−7.1(21)	−12.6(22)	33.2	54	13.3(29)	14	0
GERMANY: Berlin	5.9	−0.1	13.2(12)	−10.7(22)	−12.1(22)	41.4	91	7.0(12)	18	0
„ Hamburg	7.0	1.3	12.0(11)	−11.0(22)	−12.6(22)	45.8	88	10.0(28)	22	0
„ Frankfurt	6.8	0.9	12.5(15)	−8.4(22)	−11.9(23)	44.5	75	18.9(30)	11	0
„ Munchen	5.3	−1.5	12.8(11)	−14.2(23)	−18.3(23)	69.4	121	17.1(21)	14	0
MALTA: Luqa	19.2	14.0	24.4(3)	7.3(18)	2.4(18)	297.0		162.5(10)	21	8
NETH'NDS: Ten Post	8.2	2.7	13.1(11)	−5.8(22)	−12.0(22)	58.4	75	15.2(10)	18	0
„ Schettens	8.6	3.2	12.9(11)	−6.0(21)	−8.6(22)	43.8	52	8.8(10)	20	0
„ De Bilt	9.6	2.6	14.1(10)	−6.3(22)	−9.7(22)	51.0	68	23.2(30)	13	0
SWEDEN: Valla	1.8	−5.1	7.1(13)	−17.1(30)	−23.9(30)	36.3		12.6(18)	8	0
SWITZ'LAND: Basel	8.3	0.3	18.5(11)	−9.8(23)		39.1	70	18.9(20)	9	0
EIRE: Galway	10.3	4.1	13.0(18)	−3.0(v)		73.7	61	14.7(2)	15	0
„ Straide	9.6	1.8	12.7(10)	−6.2(21)	−12.1(21)	70.7	59	15.7(4)	14	0
SHET'AND: Whalsay	7.7	4.6	10.5(10)	−0.5(19)	−2.8(3)	127.4	123	29.5(28)	26	1
„ Fair Isle	8.2	5.6	11.2(10)	−0.3(20)	−1.8(20)	93.2	78	10.3(27)	22	0
SCOT'AND: Braemar	6.7	0.3	12.1(10)	−5.2(3)	−6.8(3)	53.1	60	7.8(8)	17	0
„ Inverdruie	7.2	0.0	13.6(10	−6.7(22)	−12.1(21)	35.7	41	7.9(19)	14	0
„ Rannoch	6.7	−2.3	11.8(10)	−7.5(21)	−7.2(22)	72.9		14.5(12)	15	0
WALES: Pembroke	10.1	3.9	13.3(8)	−3.5(1)	−9.7(1)	50.7	37	15.3(29)	12	0
„ Velindre	9.0	0.2	14.4(9)	−6.8(22)	−12.0(22)	29.1	31	14.2(29)	11	0
„ Carmarthen	9.9	1.9	13.3(8)	−4.7(22)	−7.8(22)	75.7	54	27.1(29)	12	0
„ Gower	10.3	4.4	13.5(17)	−2.0(22)	−6.4(22)	70.6	52	33.3(29)	10	0
GUERNSEY: Airport	11.0	7.6	15.8(9)	2.1(22)		34.3	32	12.8(28)	9	0
ENGLAND:										
Denbury, *Devon*	10.9	4.5	14.7(18)	−5.0(22)	−6.6(22)	33.8	31	13.2(29)	12	0
Yatton, *Avon*	10.6	1.8	16.0(10)	−6.3(22)	−8.3(22)	35.5	40	21.7(29)	9	0
Corsham, *Wiltshire*	9.5	1.4	14.8(9)	−5.0(22)	−9.1(22)	35.0	41	17.2(29)	11	0
Mortimer, *Berks*	8.8	1.0	15.0(9)	−5.9(22)	−11.2(22)	26.8	36	13.8(29)	11	0
Reading Univ., *Berks*	9.5	1.5	15.4(9)	−4.8(22)	−8.1(22)	18.7	32	10.3(29)	7	0
Sandhurst, *Berkshire*	9.6	0.5	15.5(9)	−7.2(22)	−8.3(22)	17.8	24	11.1(29)	6	0
Romsey, *Hampshire*	10.2	0.8	15.4(10)	−6.9(25)	−10.9(22)	25.1	34	14.1(29)	9	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
Horsham, *Sussex*										
Brighton, *Sussex*	9.4	3.4	14.5(10)	-1.7(22)	-2.6(22)	34.4	44	16.6(29)	13	0
Hastings, *Sussex*	9.9	4.9	14.3(10)	-0.6(21)	-3.3(28)	32.2	37	14.8(29)	8	0
Dover, *Kent*	9.7	2.9	14.7(11)	-2.3(5)		67.3	69	19.0(21)	13	2
East Malling, *Kent*	9.8	2.0	15.2(10)	-4.5(5)	-9.2(5)	27.9	37	12.5(29)	8	0
Epsom Downs, *Surrey*	9.0	1.7	14.7(9)	-5.1(24)	-7.8(27)	23.4	32	12.2(29)	9	0
Reigate, *Surrey*	8.6	1.7	14.9(10)	-4.3(27)		26.1	36	13.6(29)	10	0
Guildford, *Surrey*	9.1	2.8	15.4(9)	-3.0(22)	-5.0(22)	21.5	30	12.1(29)	10	0
Sidcup, *London*	9.6	1.9	15.8(9)	-4.6(5)	-6.8(5)	25.9	44	12.8(29)	9	0
Hayes, *London*	9.6	1.3	15.5(9)	-4.2(24)	-6.2(24)	18.8	37	10.7(29)	9	0
Hampstead, *London*	9.5	3.0	15.1(9)	-3.2(22)	-8.4(22)	26.6	39	13.4(29)	12	0
Royston, *Hertfordshire*	8.2	2.7	15.1(9)	-2.6(22)	-7.8(5)	31.3	54	11.6(29)	10	0
Loughton, *Essex*	8.6	1.3	15.8(10)	-5.0(5)	-10.0(5)	28.8	60	12.9(29)	10	0
Buxton, *Norfolk*	9.3	1.6	15.1(10)	-5.5(5)	-5.0(5)	36.8	54	20.2(29)	8	0
Ely, *Cambridgeshire*	8.4	0.7	15.5(9)	-6.1(22)	-9.5(22)	42.4	79	22.3(29)	11	0
Luton, *Bedfordshire*	8.4	1.3	15.1(10)	-5.4(22)	-11.5(22)	28.0	41	11.9(29)	12	0
Buckingham, *Buck'shire*	8.5	0.9	15.0(10)	-5.3(5)	-10.0(5)	32.4	49	15.4(29)	11	0
Oxford University	9.1	1.6	15.3(9)	-3.8(22)	-10.0(22)	29.5	48	13.1(29)	10	0
Churchdown, *Glos*	10.0	0.0	13.3(17)	-8.9(22)		30.7	46	8.2(29)	9	0
Stourbridge, *W.Mid'nds*	8.3	1.6	14.7(10)	-4.8(22)	-11.1(22)	34.6	52	17.7(29)	8	0
Birmingham Unv'sity	8.5	1.4	14.5(10)	-5.0(22)	-10.5(22)	36.0	49	20.8(29)	7	0
Wolverampton *W.Mids*	7.9	1.8	13.3(10)	-2.9(22)	-6.7(4)	38.8		21.4(29)	5	0
Kettering, *Northants*	8.5	0.5	15.6(10)	-6.7(5)		31.7		19.1(29)	9	0
Louth, *Lincolnshire*	8.6	1.9	15.0(10)	-2.9(22)		55.1		12.5(30)	11	0
Keyworth, *Notts*	8.5	1.4	14.9(10)	-4.2(22)	-8.5(4)	30.3		18.1(29)	8	0
Nottingham, *Nott'shire*	8.9	1.4	14.8(10)	-5.0(22)	-8.4(22)	32.5	59	21.2(29)	8	0
Derby, *Derbyshire*	8.4	2.6	15.0(10)	-3.5(22)		37.8	70	23.6(29)	7	0
Middleton, *Derbyshire*	6.9	2.2	12.4(9)	-3.6(22)		53.4	53	22.6(29)	13	0
Keele University, *Staffs*	8.1	1.6	13.4(10)	-4.9(22)	-8.6(22)	43.1	56	24.3(29)	10	0
Liverpool, *Merseyside*	9.0	1.8	14.5(10)	-4.3(22)		58.2	68	23.7(29)	13	0
Lathom, *Merseyside*	9.1	2.5	14.2(10)	-4.4(22)		54.8		16.8(29)	10	-
High Bradfield, *S.Yorks*	7.2	2.4	12.3(10)	-4.1(22)						
Cottingham, *Humb'side*	9.4	1.9	14.7(10)	-2.7(2)	-4.9(27)	41.0		18.4(29)	9	0
Carlton-in-Cleveland	8.3	2.2	14.0(10)	-7.7(22)	-13.8(22)	64.7		18.6(20)	14	0
Durham University	9.0	2.0	14.2(10)	-4.0(3)	-7.5(27)	64.7	114	15.6(29)	15	-
Sunderland, *Tyne/Wear*	9.6	3.9	15.0(10)	-1.0(22)		54.4	78	20.9(29)	13	0
Carlisle, *Cumbria*	8.2	2.9	13.5(10)	-5.6(22)		48.6	53	19.8(29)	15	
CANADA: Halifax	8.6	1.4	15.0(6)	-6.0(24)		218.4	162	52.2(28)	18	1
U.S.: Bergenfield, *NJ*	13.4	2.5	18.9(6)	-3.9(23)		197.9		58.9(20)	10	2
AUSTR'LIA:										
„ Mt.Waverley	21.9	11.4	34.9(2)	5.3(6)		166.3		58.0(22)	14	3

CUMBRIA RAINFALL:

Seathwaite 184mm (53%); The Nook, Thirlmere, 140.8mm (48%); Coniston 177.9mm (64%); Hawkshead 114.9mm (57%); Sellafield 32.0mm (31%); Broadfield 22.6mm (28%).

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9½-metre diameter anticlockwise spiral-circle with three 11,000-volt electricity cables overhead, June 1988.

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