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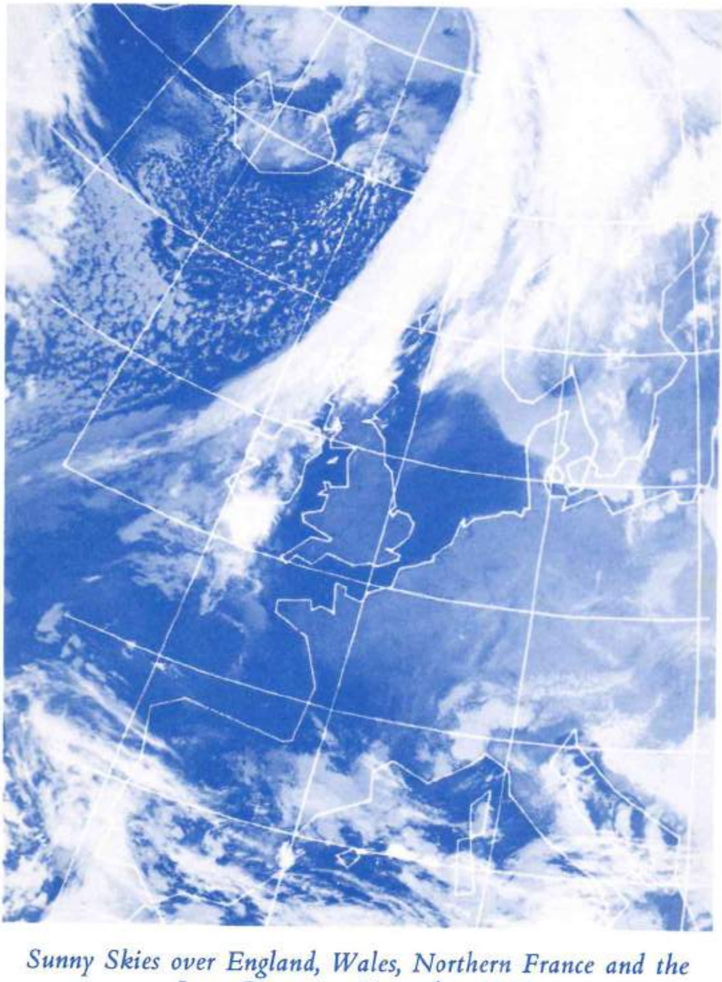

Sunny Skies over England, Wales, Northern France and the Low Countries, November 1988.

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JOURNAL OF METEOROLOGY

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SUNSHINE IN NORTH-EAST ENGLAND NOVEMBER 1988

By DENNIS A. WHEELER

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Abstract: The North-east region of England, in common with most of Britain, experienced prolonged sunshine in November of last year. This paper looks at the meteorological background to the events of the month.

The Climatological Observer's Link (COL) newsletter for November 1988 drew attention to the usually sunny conditions that prevailed over the greater part of the country that month with most areas experiencing above average totals (Figure 1). Extraordinary sunshine totals were noted from some locations; Birmingham University's 97.9 hours was the century's second highest for the site, while at Penmaen the total of 103.3 hours went one better as the best since 1900. Ryde (IOW) was top of the COL list with no less than 115.8 hours! These bright conditions reached as far as north-east England where monthly totals contradicted the region's undeserved reputation for hill

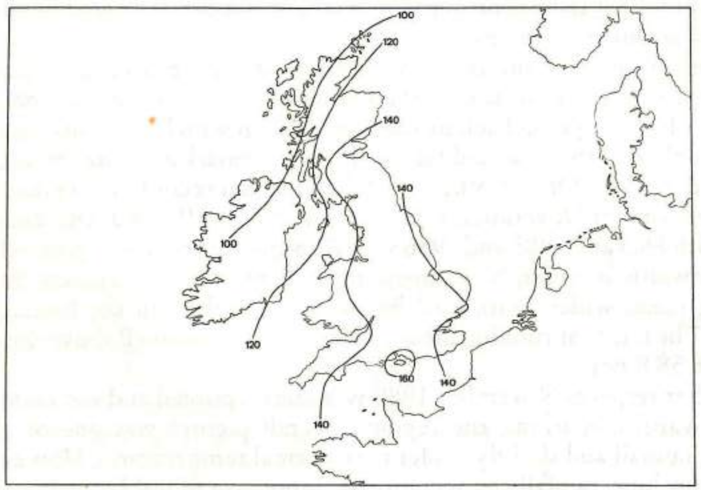

Fig.1: Map showing sunshine anomalies over the British Isles for November 1988. The map is based on the November COL report and is reproduced by the kind permission of the organisation.

TABLE 1. Summary of sunshine statistics for the north-east of England, November 1988.

station	*total (hours)*	*difference/% of mean*	*sunniest day*	*previous record*
Boulmer	97.4	+25.9/136	8.2 (3rd)	97.4 (1986)
Tynemouth	98.6	+49.6/201	7.8 (3rd)	97.8 (1986)
Durham	87.8	+25.8/142	7.6 (4th)	120.0 (1947)
Hartburn	78.4	+15.2/124	7.1 (4th)	90.6 (1973)
Widdybank	93.6	+43.5/186	8.8 (3rd)	62.7 (1976)
Redesdale	84.3	+14.4/121	7.3 (4th)	94.5 (1973)
Sunderland	98.9	+28.2/140	8.0 (4th)	100.6 (1986)
Newcastle	100.9	+27.4/137	8.0 (3rd)	100.4 (1986)
Redcar	78.4	+19.9/134	7.1 (4th)	90.7 (1973)
Region	90.9	+27.8/147	7.7 (4th)	n/a

mists and sea fogs. Absolute totals and differences from the means for the region's sunshine stations are listed in Table 1. Records were set or equalled at Newcastle, Tynemouth and Boulmer. Most remarkable of all was the 93.6 hours recorded at Widdybank Fell; the figure is noteworthy by any November standard, but when it is recalled that the station is one of Britain's highest at 580m ASL such a figure becomes all the more unusual; indeed the previous November record for the site was a mere 62.7 hours. Sunderland's figure fell short of the recently set 1986 record by only 1.8 hours. Many of the absolute totals may not appear high, only Newcastle exceeded 100 hours during a month when several southern stations enjoyed this privilege, but it must not be forgotten that the opportunity for daylight is more restricted in northerly latitudes at this time of year.

However, most of the region's sunshine sites have been operational for thirty years or less. Fortunately, the Durham University record is one of the country's longest, going back to 1886, and one in which the November 1988 total is only eighth equal and far short of the remarkable total of 120 hours observed in 1947. On the other hand the Durham record does reveal four of the seven sunnier Novembers to have been since 1969; 1969 with 94.3 hours, 1973 with 89.3 and 1985 and 1986 with 87.8 and 89.6 hours respectively. This trend towards brighter Novembers is confirmed by the current five-year running mean which, with 75.2 hours, is the highest in the hundred year record. The ten-year running mean of 69.0 hours is also well above the overall mean of 58.8 hours.

In other respects November 1988 was unexceptional and not matched by dry or warm conditions; the region's overall picture was one of close to average rainfall and slightly cooler than normal temperatures. However, and unlike sunshine, rainfall can accumulate impressive monthly totals as a result of one or two events. Such was the case in November when 60% of the precipitation (20.9mm of rain at the very close of the month, and 18.4mm

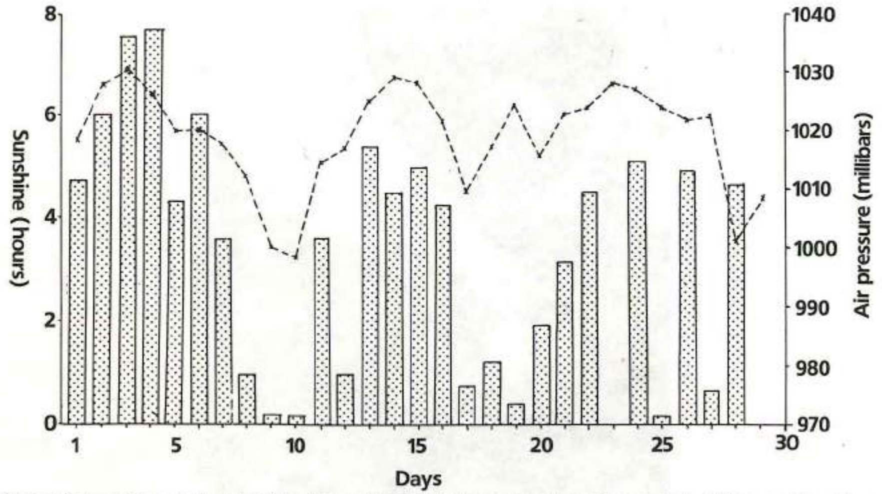

Fig.2: Composite graph showing the relationship between air pressure and daily sunshine for Sunderland during November 1988. The bars represent daily sunshine and the broken line the trend of air pressure. The three spells of anticyclonic weather are clearly distinguishable, together with the associated spells of sunny weather. Only at the close of the month did anticyclonic gloom and fogs play any significant role in limiting sunshine.

equivalent water depth of snow on 19th) was recorded during a month otherwise dominated by the anticyclonic activity that was itself so important in creating such sunny conditions. Figure 2 shows the link between air pressure and daily sunshine totals as recorded in Sunderland. The three distinct phases of high pressure activity occurred as systems drifted eastwards over Britain and Europe, often lying to the south or east of the region with consequent light south-westerlies. Only in the few days between the three spells were cloud and rain or snow able to exercise any authority over the region's weather. The snow of the 19th fell from cold northerlies in advance of the month's final 'high' which was moving in from the north-west at the time. The region is notably exposed to such winds which on this occasion provided the region's heaviest November snowfall for several years. These marked, however, only brief interruptions to the generally settled conditions. Otherwise only the anticyclonic gloom and fogs on 23rd and 25th limited the sunshine total over final anticyclonic phase of the month. For the most part, depressions were steered well to the north of Britain and their trailing fronts exerted little influence on eastern and southern districts where the anticyclonic hold was firmer. Figure 3 is a good example of such a situation.

It is interesting to compare these conditions with those of November 1986 when several of the region's sunshine records were set. On that occasion Sunderland's 103.3 hours was the best British site on the COL list. But that was a month of dominantly low-pressure activity marked by the frequent passage of systems to the immediate north of England and the absence of any

Fig.3: NOAA-11 infra-red image taken at 13.01 GMT on 4th November 1988. This was the region's sunniest day. England and Wales lie firmly in the grip of an anticyclone centred over Poland. The low to the north of Iceland was moving away north-eastwards, its trailing cold front bringing much cloud to Scotland and Ireland but weakening southwards. Other features to note are the classic instability of the cold sector to the south of Iceland and the thick fog banks between Norway and Denmark. Photo courtesy of Dundee University.

nearby anticyclones. By the time the resulting west and south-west air streams had negotiated the high Pennines ridge on the western side of County Durham and reached the north-east coast they had lost much of their moisture leaving skies clear of all cloud save some scattered cumulus and although Sunderland, on that occasion, recorded 17 rain days the total rainfall depth was less than 50% of the average, most of it resulting from the frequent, but light, showers. Such a pattern certainly agrees well with Manley's (1935) observations that ". . . the disturbed southerly to westerly weather so characteristic of the autumn months means that sunshine is more likely to be found, for example, in Northumberland . . .". The general 'sunniness' of November in Sunderland (with an average of 72 hours) stands in contrast with February's 65 hours average. This distinction between months either side of the solstice reflects the frequent dominance of cyclonic westerlies in

November while February is more notable for anticyclonic easterlies, which in this region betokens prolonged gloom.

The wind regimes were dominated by westerlies and south-westerlies in both 1986 and 1988 (480 and 411 hours respectively in Sunderland) but were of contrastingly cyclonic nature in the former year and anticyclonic in the latter. Westerly cyclonic winds are, along the north-east coast, dry and clear by virtue of the desiccating effects of the Pennines and high ground further west. The similarly dry character of anticyclonic westerlies is, on the other hand, due principally to large scale subsidence. In both cases, though it has been little studied, additional local warming results from the Föhn effect which operates as air descends the 800 metres from the Pennines ridge. But whatever the driving force behind them, westerly winds are peculiarly favourable to the region's climate.

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CIRCLE FORMATION IN A WILTSHIRE CEREAL-CROP - AN EYE-WITNESS ACCOUNT AND ANALYSIS OF A CIRCLES-EFFECT EVENT AT WESTBURY

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Abstract: A rare sighting of a circle being flattened naturally in a cereal-crop is described. The circumstances of the event, which is exactly dated, are consistent with circle-formation by a vortex of atmospheric origin.

INTRODUCTION

On Saturday 3 July 1982 at 1650 G.M.T. Mr Ray A. Barnes was fortunate to witness the formation of a large circle in a cornfield at Westbury, a parish in Wiltshire on the north-western edge of Salisbury Plain. Mr Barnes's clear account confirms the vortex character of the agency responsible for making this circle and permits us to reconstruct the manner in which the corn was laid down. This constitutes a major advance in our quest to unravel the complex processes behind the circles effect, for which we believe there is more than one species of crop-flattening mechanism.

EYEWITNESS ACCOUNT AND SITE DETAILS

It was on 14th January 1989 that I received this letter from Mr Barnes.

"I have been meaning to write to you for some time on the subject of corn circles. About six or seven years ago I was fortunate to see one of these form in a field at Westbury. It happened on a Saturday in early July just before six in the evening after a thunderstorm earlier that afternoon; in fact it was still raining slightly.

My attention was first drawn to a 'wave' coming through the heads of the cereal crop in a straight line at steady speed; I have since worked this out to be about fifty miles per hour.

The agency, though invisible, behaved like a solid object throughout and did not show any fluid tendencies, i.e. no variation in speed, line or strength. There was no visual aberration either in front, above or below the advancing line.

After crossing the field on a shallow arc the 'line' dropped to a position about 1 o'clock and radially described a circle 75ft radius in about 4 seconds. The agency then disappeared".

I interviewed Mr Barnes the day after receiving his letter. He added that the corn went down with a 'hiss and a rustle'. The rustle came from the falling stalks while the sound of hissing emanated from the agency responsible for making the effect in the corn. The corn was either winter barley or oats and was nearly ripe.

Mr Barnes was out walking his two dogs along Wellhead Drove, an unmetalled lane running northwest-southeast below and parallel to the scarp of Salisbury Plain a few hundred metres south-east of Westbury Town. The

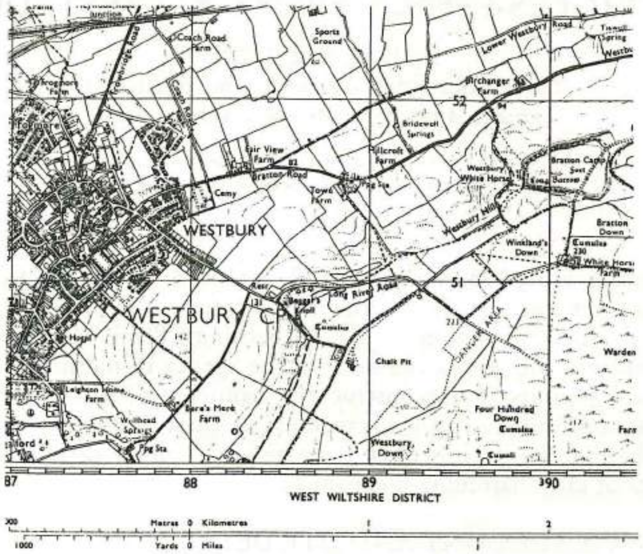

Fig.1: Map of Westbury and the hills to its south-east showing the place where Mr Barnes witnessed the formation of a crop-circle (near Bere's Mere Farm). *Reproduced with permission of the Ordnance Survey.*

afternoon had been sunny with thunder and rain showers, and the sky was clearing to give a sunny evening. When Mr Barnes reached National Grid Reference ST 880504 (see Ordnance Survey map, Figure 1), the time was 1750 B.S.T./1650 G.M.T. As the last cumulonimbus moved away over the plain and the final raindrops were falling, the sky was clearing from the north-west and the wind where the observer was standing, some 250 metres from the site, had 'fallen still'. On looking south-east across the field, Mr Barnes noticed a linear effect that was moving transversely from right to left across the crop – from ST 882501 to 883503. This effect progressed for about 250 yards (230 metres) in a direction from approximately S.S.W. to N.N.E., following an arc that was convex to the hillside along descending ground (cf the sketch supplied by Mr Barnes in Figure 2). The corn as it fell left a seemingly circular pattern in the crop, easily visible despite the distance because the crop-mark on the hillside was angled at some 20 degrees to the horizontal.

RETROSPECTIVE SURVEY

A check through the author's weather diaries proved conclusively that Mr Barnes's observations must have been made on Saturday 3rd July 1982. From 1974 to 1983 the author maintained a full weather diary at Trowbridge eight kilometres N.N.W. of Westbury (and this has been continued at nearby

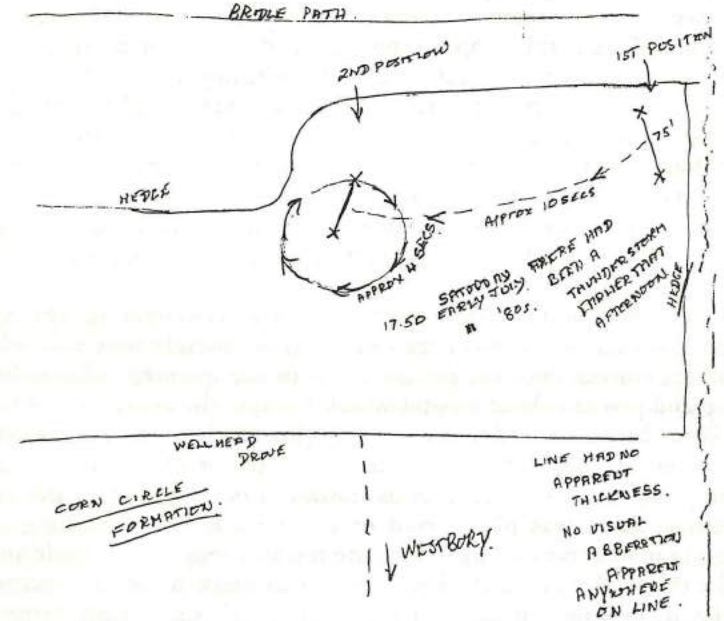

Fig.2: Diagrammatic sketch supplied by Mr Barnes (not to scale).

Bradford-on-Avon). The wind was W.N.W. in the morning and veered to N.W. later. After a cloudy morning the temperature reached 20.4°C in the afternoon, and the sunshine totalled seven hours by the end of the day. The thunderstorm at Trowbridge was not accompanied by rain as it was at Westbury for the cumulo-nimbus passed right over the latter town.

The field in question occupied the bottom and sides of a dry valley along the foot of the scarp adjoining Bere's Mere Farm. The witness was on the north-west side of the field and the circle on the far, south-eastern side, so the observer had an unobstructed view of the opposite side of the sloping field. Higher up, the slope of the hill increased sharply, and became greater than 45 degrees at its maximum steepness.

From the known topographical details and the direction of cloud movement it is plain that the motion of the cumulo-nimbus was more or less perpendicular to this part of the escarpment. Together with the facts of Mr Barnes's lucid account, enough information is available for us to reconstruct the method by which a running vortex was able to mark out the circle which Mr Barnes observed with such critical precision.

HOW THE CIRCLE WAS FORMED

The major issues to explain are: (1) the origin of the transverse motion of what was seen as a 'line' and (2) the laying down of a circle of corn in a manner that resembled 'the opening of a lady's fan'.

First we note the remark that 'the agency behaved like a solid object throughout'. This is the property possessed of a mass of air or ionized air spinning rapidly like a top – rather like the whirling vortices mentioned by Humphreys whose cores were said to rotate as a solid mass (Humphreys 1940). From the behaviour and motion of the 'line' that crossed the top of the cornfield we may deduce that the axis of the vortex was angled so far from the vertical that it was literally flying parallel to the surface of the hillside. Rotation in either sense would produce a line element in the manner described, but as we shall see only a vortex having cyclonic spin could produce the clockwise circle witnessed.

Without seeking to establish precisely the character of the vortex-supporting system at this moment (see later) we merely note that what we may call for convenience the proximal end of the spinning column dug into the crop and pivoted about a point which became the centre of the naissant circle. What had been until then a vanishing line on the surface of the corn was instantly transformed into the radius of the sector of a circle of rapidly-increasing angle. This instantaneous transition between linear and circular geometrical states was plain proof of the presence of a pivoting vortex, resembling in its action a child's spinning top as it topples on its side and rolls around a circle. Because a clockwise trace was marked out, the vortex must have been cyclonic because its direction of spin must have been counterclockwise as seen from above. What can be the origin of this

astounding vortex? How can any vortex originate on what seems to be the windward side of the hill?

POSSIBLE ORIGIN OF THE VORTEX

We know from the studies of Jenkins et al (1981) that a quasi-conical hill like Ailsa Craig (an island off the coast of south-west Scotland) can produce a long trailing vortex downstream of an obstacle to geostrophic airflow. Our own work and suggestions by John Snow have led us to conclude that bluff scarps may act similarly in producing trailing-vortex systems whose positions, durations and senses of rotation are determined by local topographical details and the wind velocity of the airflow. We believe that a short-lived breakdown situation can arise in which elements of the vortex descend briefly to ground level. This happens quite definitely in the lee of the obstruction, but conditions can be envisaged in which the vortex can bend over to, or lower to, windward. A particularly good example is afforded by the present situation.

It is well-known that winds at ground level beneath cumulonimbus clouds are often the reverse of the direction of the unhindered geostrophic or gradient wind. The storm on 3rd July 1982 was travelling from north-west to south-east, steered by the upper winds, but the surface windflow from the downdraught at the back of the storm would have been in the opposite sense until a region is reached where the air falls calm (as noted by Mr Barnes) before picking up again with the return of the prevailing north-westerly. This situation, together with uncertain complexities determined by the topographical vicissitudes of scarp, concave hillside, and valley, combined to produce a trailing vortex whose freed and tilted tip led to the 'dying-top' effect observed in the cornfield. That the trailing vortex was angled downwards from the upper reaches of the hill is further indicated by the curvature of the arc across the field. In what follows we must take account of the axiom that vortices cannot terminate except on a boundary; that is, they can never end in mid-air. (If a spinning column, for example, should get severed from its source or sink, either the vortex immediately collapses or the new ends instantly seek boundaries upon which to terminate).

The upper or source end of the trailing vortex is effectively a small area or point associated with the hill/scarp. Similarly, with an aerofoil it is the wing-tip (in this case the source of energy is leakage of the pressure-differentials around the wing edges). The far end of a vortex trailing from an aerofoil is not 'free' either; it may appear to be 'lost' in the turbulent flow far behind the aircraft but in reality it is bound to some part of the turbulent wind-structure. The same may be true of the trailing end of a hilltop trailing-vortex system unless, or until, for some reason atmospheric conditions cause the channel of the trailing-vortex system to bend towards ground level. What had been until then a dynamically-satisfied dissipating 'free' end senses the proximity of the land surface via the influence of surface-frictional effects which modify the spin vectors of the gyrating channel; this encourages a tilting towards the nearest available boundary, and in our case it was the field.

Nonetheless, it is odd that the identity of a vortex rolling on its side should be maintained so well that a good circle gets marked out. We propose that the reason for this is that the air constituting the vortex was in a plasma state. The evidence for this from other case-studies is considerable, and has been summarised elsewhere (Meaden 1989). Between the boundaries of the spinning plasma and the supporting atmosphere a kind of surface tension may be thought to act, as suggested for ball lightning by the Swedish physicist Carl Benedicks (1954). This skin effect helps to delimit the boundaries of the wind system within the vortex besides reducing plasma losses by leakage. The hissing noise heard by Mr Barnes is typically the sound of electrical discharges.

CONCLUSIONS

An eye-witness account of a circle being flattened in a cornfield is a rare event whose interpretation has considerable importance for meteorological vortex dynamics. Due to the perspicacity of an astute observer local general weather conditions pertaining on 3rd July 1982 at Westbury could be reconstructed. Vortex tilting and rolling may explain the observed twin phenomena of line motion and radial crop-flattening, while known thundercloud dynamics could account for a windflow capable of organizing a trailing vortex on the windward side of the escarpment.

The author has visited hundreds of crop-circles but has not yet seen one as large as the circle described by Mr Barnes. The Westbury circle was reportedly some 45 metres (150ft) in diameter whereas the biggest plain circle so far measured by the author was 22-25 metres in diameter. These differences help to emphasize the uniqueness of the synoptic-topographical combination at Westbury, and suggests that the situation was a decidedly uncommon one considering that such a large-diameter circle came to be formed. Nevertheless it is likely that reverse airflow conditions are similarly involved in some, perhaps many, of the other cases where circle-forming vortices have reached the ground on the windward sides of hill-ranges. There were several such cases at nearby Bratton (2-3 kilometres distant) and elsewhere in Wessex in 1987 and 1988.

Acknowledgement. I wish to express my gratitude to Mr R. A. Barnes for reporting this extra-ordinary event to me, that it may be set in the scientific record for proper examination by serious researchers in atmospheric dynamics.

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EXTREMELY LOW RELATIVE HUMIDITIES ON MOUNT OLYMPUS, GREECE

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Abstract: A special phenomenon concerning extremely low relative humidities (from less than 20% to almost zero) on the famous summit of Mount Olympus during the summer period is examined. The monthly and hourly distribution of the phenomenon, and its beginning, ending and duration are tabulated. The change of air temperature, the role of the wind direction and speed, the topography of the area and the role of the nearby sea are examined to explain the abrupt fall of the relative humidity. One example is analysed in detail.

INTRODUCTION

Research on the daily course of relative humidity and phenomena related to it are almost non-existent for high-altitude stations. There are only infrequent references to the high daily variability of values of this meteorological element along with the minimum values of humidity which can possibly be observed in stations of high altitude, (Livadas 1976, Maheras 1976). However, studies referred to the annual course of the same meteorological element at highland stations are very few (Calinescou, 1976). The present study was based on the thorough observation of daily readings from hygrographs for the summer period 1966-1973, i.e. June 25th to October 10th.

The study was effected at two meteorological stations on Mount Olympus: at OSC (Olympus Scientific Center) (elevation = 2817 metres) and at the Iatrio (elevation 2400 metres) for the period 1965-1970. From the entire set of daily records we have only chosen those cases in which the course of relative humidity shows an abrupt decrease in value, i.e. below 20% to 0%; this decrease lasts for at least a few hours.

FREQUENCY OF THE PHENOMENON

The phenomenon was observed 73 times at the station of OSC and 38 times at the station of Iatrio for which the study period was shorter (Table 1).

From the distribution of cases, during the time that the stations functioned in the summer time, it is obvious that the phenomenon is most frequent in the month of September: 40% at the OSC station and 45% at the Iatrio station. In August, the second most favourable month, the values are 26% to 29%

TABLE 1. The absolute and relative frequency of the phenomenon according to month of the year

Station	*June*	*July*	*Aug.*	*Sep.*	*Oct.*	*Total*
OSC	1	17	19	29	7	73
	1.4%	23%	26%	40%	9.6%	
Iatrio	0	4	11	17	6	38
	0	10%	29%	45%	16%	

Table 2. Beginning, ending and duration time of the phenomenon.

	Beginning		*Ending*		*Duration*	
	OSC	*IATRIO*	*OSC*	*IATRIO*	*OSC*	*IATRIO*
00-22	20	2	2	1	2	2
02-04	15	9	7	4	17	9
04-06	8	4	13	4	11	9
06-08	7	3	12	9	15	6
08-10	3	2	17	9	7	3
10-12	0	0	9	7	3	3
12-14	1	0	5	1	5	4
14-16	2	0	3	0	2	0
16-18	3	2	1	0	2	1
18-20	3	4	2	1	2	0
20-22	10	8	2	2	0	0
22-24	1	4	0	2	5	0
Above 24					5	1
Total	73	38	73	38	73	38

correspondingly for the stations of OSC and Iatrio. Finally the phenomenon is non-existent in June for the time that the stations did function.

The maximum frequency in September can be explained by the high frequency of anticyclonic types of circulation which occur during this month in the East Mediterranean (Maheras, 1979) resulting in conditions of high stability in the air in relation to the N.W. direction of the prevailing winds.

BEGINNING, ENDING AND DURATION OF THE PHENOMENON

From Table 2 the existence of a very favourable period related to the beginning of the phenomenon for both stations and for the entire observed time from 2000 to 0900 can be ascertained, there being a distinct preference for the time between 0100 to 0400 for the OSC station and between 0300 to 0400 for the Iatrio station.

The phenomenon most frequently ends between 0300 and 1400 for the OSC station with the highest value between 0900 to 1000 local time, i.e. the very time that ascending motions begin at the summit and slopes of Olympus and between 0300 to 1200 for the Iatrio station with the maximum value between 0700 to 1000.

From the same table it is obvious that the highest frequency of the phenomenon lasts 3 to 4 hours (17 cases) up to 7-8 hours (15 cases). Generally, 64% of the cases of the OSC station and the 71% of the cases at Iatrio last 3 to 10 hours.

THE COURSE OF TEMPERATURE DURING THE PHENOMENON

The course of temperature was observed in 65 cases for which there are the relevant temperature charts. The results are in Table 3. For only 4 cases was a drop of temperature observed while in 11 cases there was no observed change of temperature.

Table 3. Absolute frequencies of temperature variation during the phenomenon.

Decrease		4
Unchanged		11
Increase	0.1-1 deg.C	12
Increase	1.1-2 deg.C	14
Increase	2.1-3 deg.C	12
Increase	above +3 deg.C	12
TOTAL		65

There were 12 occasions in which the temperature rose to 0.1 to 1.0 degrees, 14 cases with a change of 1.1 to 2°C, 12 cases in which the temperature was raised up to 2.1 to 3°C, and finally 12 cases with an increase of temperature above 3°C. It is to be mentioned that the change of temperature is mainly observed in the course of the first 2 or 3 hours at the beginning of the phenomenon and it is not taken into consideration the increase of temperature which is due to the influence of the diurnal cycle, in the cases where the phenomenon continues during the day. The increase of temperature in these cases is up to 6 degrees C.

DIRECTION AND SPEED OF WIND AND RELATED PHENOMENA

As can be seen in Figure 1, the predominant direction of the wind, with a frequency of 39%, is north-west followed by north with a frequency of 24%. On the whole winds from the northern sector have a frequency of 72% whereas calms are almost zero (2%). Winds from the eastern and southern sectors are also of zero frequency.

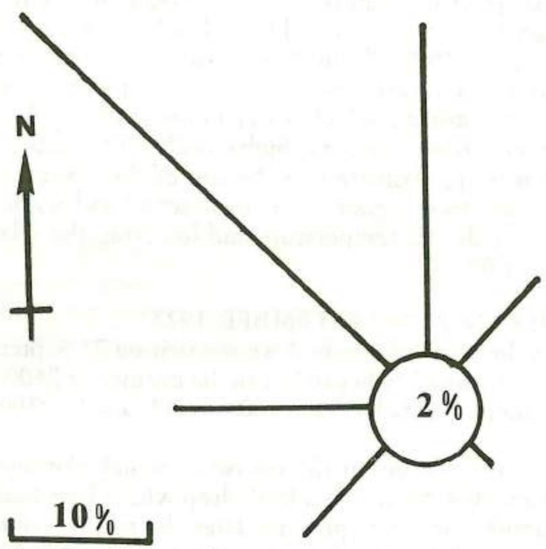

Fig.1: Prevailing wind directions during the phenomenon.

As far as the speed of the wind is concerned, there are moderate to strong or extremely strong winds, the speed of which, at the time of the phenomenon, can reach or even exceed 60km/h. 80% of the cases have an average speed ranging from 20 to 50km/h and in some cases wind speed can exceed storm velocity within the first 12 hours of the actual observation of the phenomenon.

RELATED PHENOMENA

The sudden decrease of relative humidity usually takes place in cloudless weather. In fact, when the phenomenon happens during the day-time, the absence of clouds is total. When it takes place at night, both at 2000 and 0800 no substantial cloudiness is noted. However, in many cases there was observed a continuous stratiform cloud layer, usually from east and north-east, i.e. to the direction of the sea and above it. The top is estimated at 1500 metres up to 2000 metres, while the height of bases it is impossible to estimate.

The continuous stratiform cloud layer is possibly due to the existence of an intense temperature inversion, not very deep, in combination with the heating of the lower layers of air above the sea. There are two more phenomena related to the decrease of humidity: (a) in certain cases (after heavy rains or thunderstorms) exceptional visibility was noted. On these occasions the summits of mountains at a distance of 150 or 200km could be distinguished. This indicates an intense instability of the air from a height of 2000 up to 3500 metres approximately, which results in a thorough mixing of air at these levels and a general decrease of humidity. These are usually the cases which are related to a decrease of temperature. It is characteristic that sometimes even in Thessaloniki exceptional visibility is simultaneously noted. It is well known that this phenomenon in Thessaloniki is related to the existence of Mount Olympus (Arseni et al 1980). (b) In the majority of cases the opposite is noted, i.e. there is the characteristic existence of the peplopause (the top of the mixing layer) in the horizon, which is well known as being due to the intense temperature inversion because of the high stability of the atmosphere. In these cases the station is approximately at the top of the inversion layer. These situations force air from higher levels to descend and warm adiabatically, thereby increasing the air temperature and lowering the relative humidity towards values of 0%.

THE EXAMPLE OF 21-22 SEPTEMBER 1973

Referring to the chart of Figure 2 we see that on 21 September 1973 the sudden decrease of humidity began late in the evening at 2100 hours. Within an hour the humidity had fallen from 100% to 20% and by 2300 had reached a value of 4%.

After a slight fluctuation, in the course of which the humidity did not exceed 10%, from 0030 there was a fresh drop which lasted until 0800 when the relative humidity was zero percent. Then the relative humidity began to increase from 1000 while the value did not exceed the 20%. At the same time

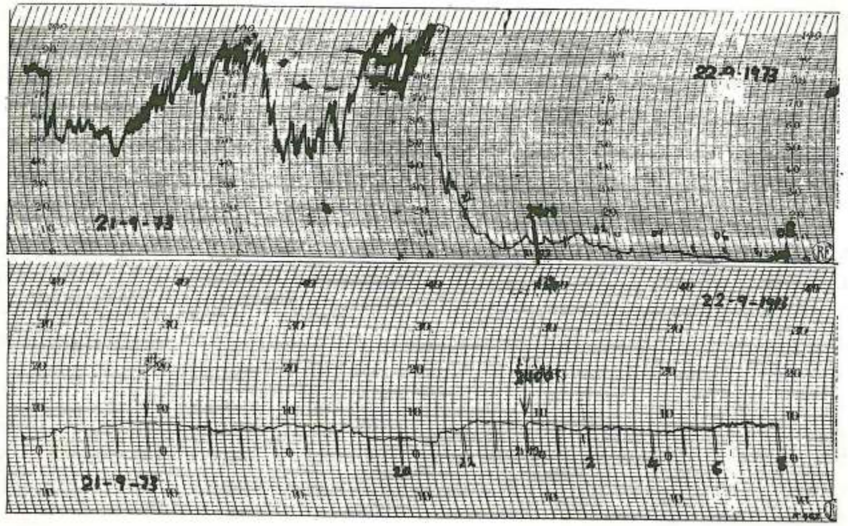

Fig.2: Thermo-hygrograph chart for 21-22/9/73.

the temperature of the air had exactly opposite movements.

The thermograph chart shows that the temperature began to increase at exactly the same moment that the drop in the humidity began, i.e. at 2100. So we note that within a few minutes (ten) there is a sudden increase of 2.5 degrees, followed by a second increase, this time (until 2300) a progressive one of 3.0 degrees. That is to say, in the space of two hours in the middle of the night the temperature had risen from 2.5°C to 8°C. Turning to the surface synoptic situation we see that in the course of September 21st and 22nd 1973 there existed an indiginous anticyclonic type of circulation with its centre in the Balkans which showed a great stability of the atmosphere. At the 500 Hpa level above the central Mediterranean Sea a secondary anticyclonic ridge covered the Greek area with its right side. For this reason, the winds are orientated from NNW which is the predominant direction towards this level for the entire period of September.

In fact in the entire period of the phenomenon in the area of Olympus NNW winds predominated, and were often very strong and sometimes exceeded 25m/sec.

CONCLUSIONS

The phenomenon of a sudden drop of relative humidity below 20%, resulting in almost totally dry air (R.H. = 0%), caused by various weather and synoptic conditions has been studied. The main reason seems to be an increase of temperature (apart from the factors that cause high visibility) and it is in this direction that we should look for the main factors of the presence of the phenomenon. From this point of view the main roles seem to be the following: (1) the stability of the atmosphere and the presence of an intense temperature inversion; (2) topographical relief together with the proximity of the sea. In fact, the frictional difference of the lower atmospheric layers at the height of Olympus (2900 metres), because the air is abruptly above the sea, causes the increase of speed. This reinforces the presence of the inversion (at the height of Olympus) due to subsidence of air from higher levels. On the other hand the presence of continuous stratiform cloud layer to the north-east above the sea is directly related to the appearance of a second inversion at the lower layers and smaller thickness in comparison to the first; (3) the high speed of north-west winds in relation to their dryness; (4) the high radiation of the conical summit where the station is. This favours the subsidence of the cooler air masses towards the slopes and their subsidence in relation to the presence of the inversion layer and its reinforcement due to adiabatic heat. In conclusion we find that the explanation of the phenomenon is multilateral because the various factors influence each other. The processing of new elements and their application will possibly contribute to a more complete explanation.

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AIR POLLUTION ALERT IN MADRID

One of the unwelcome consequences of the persistent high pressure over continental Europe last winter was the severe air pollution episode, the worst for four years, which occurred in Madrid during the early days of January 1989. The rapidly-expanding capital of Spain, situated at a height of 650m on the Meseta and flanked to the north-west by the Sierra de Guadarrama which rises to a height of 2430m, is no stranger to air pollution as high pressure situations occur frequently during the winter months. To the air pollution caused by vehicle exhausts and industry must be added that due to space heating as Madrid experiences a cold winter with a January mean temperature of only 5°C.

During the 1988-89 winter the circulation within the anticyclone, which dominated European weather for unusually long periods, encompassed most of the Iberian peninsula, allowing the air pollution to build up to an unusual

degree. The Centro de Control Atmosférico operates 19 air monitoring stations (to be increased to 21 in 1989), distributed throughout the areas of greatest pollution in Madrid and every hour computer terminals indicate the current pollution level in the areas of high risk such as the Plaza de Espana.

Under a strong subsidence inversion and with no wind or rain (in December 1988 Madrid received only a trace of rainfall; the December mean is 48mm) to disperse the pollutants, a thick layer of SO_2 and smoke built up during the first few days of 1989. On 2 January SO_2 level climbed to 280 x $10^{-6}g/m^3$ and smoke to 149 x $10^{-6}g/m^3$, reaching the European Community health protection air-quality standard ('limit values') of 250 x $10^{-6}g/m^3$ for SO_2 with an associated value of 150 x $10^{-6}g/m^3$ for smoke, which is not to be exceeded on more than three consecutive days, thus requiring the issuing of an atmospheric alert. The highly polluted air caused severe problems for people suffering from respiratory ailments, asthma and other allergies and the hospitals were hard pressed to deal with the situation.

The main contributors to the air pollution were vehicles, industry and coal-fired heating appliances and the mayor of Madrid brought in measures, which had been on the point of being introduced on 22 December, to reduce traffic in 43 streets, to order industry to use special fuel for a 15 day period and to limit the lighting of coal fires to the period between 11am and 7pm. Penalties for offenders included a 15,000 peseta (£75) fine for drivers whose vehicles emitted excessive exhaust gases or who even parked badly, obliging others to manoeuvre unnecessarily. Industries which did not use fuel low in contaminanats risked a 300,000 peseta (£1500) fine and the municipal authorities could order their closure while the alert remained in force. Lighting coal-fired boilers during prohibited hours risked a fine of 75,000 pesetas (£375) and the sealing of the appliance.

Largely due to the restrictions imposed, the SO_2 level had dropped to 201 x $10^{-6}g/m^3$ by 4 January but the smoke level remained high and there was talk of the need for further measures to be taken if the meteorological situation did not improve. The range of measures taken by the authorities was not sufficient for a group of ecologists, who wanted more drastic action against traffic, especially in the centre of Madrid, because more toxic and carcinogenic elements like nitrogen oxide were not being monitored.

Although the measures taken helped to alleviate the situation, only a change in meteorological conditions could ensure a fresher, less polluted atmosphere for the Madrilenos. The advection of colder air aloft would give rise to greater vertical instability and the possibility of convective showers. More general frontal rainfall coming from the west would, in the presence of such a polluted atmosphere, initially produce acid rain but the change in air mass and the post frontal north-westerly winds would eventually sweep away the pollutants, at least for a while.

Hope for improved air quality for the capital lies in the results of a study now being conducted into the problem of air pollution in Madrid. The study is due to be completed this year and the report will certainly call for additional measures to combat the pollution problem.

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THE WORST STORM IN THE EASTERN CANARY ISLANDS FOR 35 YEARS

The severe storm which affected the Canary Islands of Gran Canaria, Fuerteventura and Lanzarote on 16-17 February, 1989, was reported to be the worst in that area for 35 years. The exceptionally heavy rainfall and strong winds caused extensive flooding in the principal towns, particularly in the largest city in the Canary Islands, Las Palmas on Gran Canaria, which suffered a total collapse of public services and a closing of schools after a rainfall of 115mm between 1800 GMT on 16 February and 0600 GMT the following day. This fall represents 83 per cent of the mean total *annual* rainfall at Las Palmas of 139mm.

Traffic light failure, caused by the widespread electricity power cuts, and flooded roads caused traffic chaos. Flood waters were reported to be more than a metre deep in the streets of Telde, Gran Canaria, which received 178mm of rainfall.

As the rain continued to fall on 17 February, and with the threat of more flooding, the Governor of the Canary Islands declared a 'red alert' in Gran Canaria, Fuerteventura and Lanzarote, causing some people who lived in ground or first floor dwellings in Las Palmas to leave their homes with their treasured possessions. The rainfall, although light, continued on 18 and 19 February and the red alert was not revoked until 1900 hours on the latter day. As the floods receded, many urban streets on Gran Canaria were filled with mud, deposited from the eroding flood waters, and the help of the Armed Forces was requested for the clear up operation.

Whereas urban dwellers suffered greatly from the storm, farmers rejoiced at the spectacular increase of more than 2 million cubic metres in the water stored in the reservoirs, the largest since 1954.

The spell of rough weather in these sub-tropical islands was caused by a cut-off cold low, the type of upper air disturbance which, from time to time, results in very heavy rainfall in the Canary Islands. The upper tropospheric instability associated with these systems is in direct contrast to the normal stability associated with the north-east trade wind circulation which dominates the climate of the islands. On this occasion the cut-off cold low was situated just to the west of the Canary Islands on 16-17 February, with a 500mbar temperature below -20°C at its centre and with a circulation extending from the surface up to 200mbar. The disturbance later moved eastwards as an upper cold trough and by 21 February was situated over Iberia and north-west Africa.

The anomalous nature of the storm can be gauged by a comparison of the rainfall recorded between 1800 GMT on 15 February and 0600 GMT on 20

February, 1989, and the mean total annual rainfall:

	15-20 February	*Annual*
Las Palmas Airport (Gando), Gran Canaria	143mm	134mm
Arrecife, Lanzarote	99mm	130mm

Due to the inadequate rainfall of many of the Canary Islands, there is a long history of attempts to increase that rainfall by cloud seeding and therefore it is not surprising that one newspaper report quoted a complaint by some residents that the storm was partly caused by a light aircraft belonging to the Comisión de Servicios Hidráulicos' rain enhancement programme which seeded the clouds on that very day. The fact that the authorities refused that idea probably did not convince everyone living on the three islands most affected by the deluge.

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WINTER WARMTH IN CONTEXT

1988/89 was the second warmest winter in Manley's (1974) Central England temperature record with a mean temperature for the three months December, January, February of 6.6°C. This compares with the previous mildest winters of: 1868/9 – 6.76°C, 1834/5 – 6.53°C, 1795/6 and 1974/5 6.30°C.

It was the consistent mildness throughout the winter that was perhaps the most notable feature of this last winter. December, the first month of winter, had a monthly mean of 7.6°C, a figure which has only been beaten in 1974 (7.9°C) and 1934 (8.1°C). The mean for January was 6.2°C. This was considerably below the all-time record of 7.5°C in 1916, and was also exceeded in 1921 (7.3°C) and 1834 (7.1°C). In Scotland, however, January was particularly extreme with Glasgow having its mildest January since 1868. Many stations as far apart as Lerwick, Newcastle, London and Ilfracombe failed to record a single air frost all month. February was the least extreme month of the three and there was a higher incidence of frost and snow in the second half of the month than at any other time of the winter. Nevertheless with a Central England mean of 6.0°C temperatures were 2.2 degrees above the long-period period average.

Since 1700 there have only been five winters (1948/9, 1942/3, 1876/7, 1868/9 and 1862/3) which have had three winter months in Quartile 5.

Another characteristic of the winter was the persistent anticyclone over Europe and the almost complete absence for most of the winter of an Azores anticyclone. Not only did this lead to a disastrous lack of snow in the skiing areas of the Alps and to worries about water supply in future months in Southern England, but it diverted depressions towards Iceland, so while western and northern Scotland were persistently wet on the fringes of these lows, most of eastern Scotland and England and Wales was very dry. This regime broke down in the latter part of February as depressions tracked further southwards including, on the 25th February, one of the deepest depressions on record over southern England, with central pressure below 950mb. As a result, February redressed some of the rainfall deficit of the previous months, especially in western areas. Not since the winter of 1973/74 has a European anticyclone so dominated the winter months. Over most of the winter prevailing weather types were anticyclonic south-westerly and southerly and at times air from the sub-tropical Atlantic was convected northwards on the western flank of the high for several consecutive days. During these episodes the highest temperatures were often to be found in sheltered parts of eastern Scotland, aided by a fohn effect. A maximum of 15.6°C on 28th December 1988 at Lossiemouth, and 15.1°C at Kinloss on 27th January 1989 were examples. The largest positive temperature anomalies for the winter as a whole occurred over southern and eastern Scotland and in the Bristol area.

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(*Note by the editor:* The Central England temperature for March 1989 was about 7.3°C, another very high figure. The four-month period December 1988 to March 1989 appears to have been the warmest in the whole Central England series stretching back 300 years).

WORLD WEATHER DISASTERS: OCTOBER 1988

1-15: Monsoon floods in eastern Pakistan from late September left at least 196 dead, four million people affected. Floods along rivers Ravi, Chenab and Sutlej inundated large areas of the Punjab plain and have been described as worst since 1955. The floods destroyed 14 bridges, 28 hospitals and 6,500 schools along with 200,000 acres of rice and 300,000 acres of cotton, along with 35,000 acres of the sugar cane crop. Fifty thousand cattle and buffaloes drowned. Total losses, excluding industry, put at $360 million. *Lloyds List.*

1-7: Floods continued to recede in Bangladesh, death toll put at 3000 on the 6th, with 45 million made homeless. *L.L.*

1-2: Tropical storm "Isaac" hit Trinidad with heavy rains, floods and mudslides which caused extensive damage, leaving two dead and 20 injured, at least three homes flattened by landslides at Morvant and Laventille. *L.L.*

2: Landslide buried ten farms near small town of Fredonia, Western Colombia, leaving between 40 and 60 dead. *L.L., Daily Telegraph.*

2-3: Torrential rains, floods and mudslides in and around Nimes, France, left eight dead, 200mm of rain fell on Nimes in three hours, some 45,000 people made homeless, most only temporarily. Damage put at $634 million, a further two people died when a helicopter carrying relief workers crashed near Nimes. *L.L.*

3: Torrential rains in Maharashtra state, India, left 20 dead; the people died in floods, landslides and collapsing homes in and around Bombay, at least 13 people seriously injured and train services disrupted in Bombay. *D.T.*

4(reported): Severe flooding has devastated the largest refugee camp in Ethiopia. *L.L.*

6(reported): Snowstorms in Ladakh, Kashmir, India left 14 people dead, many others rescued. *D.T.*

7-11: Forest fire destroyed more than 2000 hectares of pine and oak forest in western Spain, the fire started in the mountain region of Las Hurdes. *L.L.*

7-12: Gales, rains, thunderstorms and floods in areas of Great Britain, brief details below:-

7th: High winds in many parts of country, gusting to 113km/h in places, two people injured by falling scaffolding and debris.

8th: Over 25mm of rain fell in southern England during evening, up to 0.3 metres of floodwater on roads in Kent and Sussex, one indirect death, at Blackpool, Lancashire, in high winds and heavy seas.

9th: Yacht capsized in heavy seas near the Chichester Bar off Sussex leaving one person dead.

11th: Up to 50mm of rain in Devon and Cornwall, widespread flooding, the A39 near Truro under two metres of water, floods in Truro itself reported to be 1.25 metres deep, many shops and houses flooded, gales also in Devon and Somerset, huge seas hit seafront at Torquay, roads closed.

12th: Thunderstorm in and around Quarry Bank, Cradeley and parts of Halesowen, the Black Country, several houses hit by lightning, worst of storm around 0400 hours, floods subsided in West Country, but not before one died in collision between two vehicles on flooded road near St. Mewan, Cornwall. *L.L., D.T., Birmingham Evening Mail.*

10: Heavy rains touched off flash flood which swept through three villages in Lampung province south Sumatra, Indonesia, leaving two dead and three missing, a number of houses swept away, with others flooded. *Jakarta Post.*

10-13: At least three brush fires burned 2000 hectares of bushland and parkland near Sydney, New South Wales, Australia, no casualties. *L.L.*

11: Torrential rains and floods in south-east France; three deaths reported, two when mudslide hit houses in Teil in the Ardeche region, the third death was at Egeze, in the Gard region when the floods washed away a bridge. The floods were reported in the regions of Gard, Savoie, Haute-Savoie, Isere, Drome and Ardeche. *L.L.*

12: Lightning hit hut in Gazankulu, South Africa, leaving eight children dead. *D.T.*

13: Monsoon rains on Luzon Island, Philippines, a landslide buried homes in village of Mabitak, Laguna province, leaving seven dead and seven others injured. The storm was also blamed for a power failure which blacked out all of Luzon, lightning hit a power post south of Manila and triggered a "cascade" effect across Luzon. *L.L.*

13(reported): One of largest bushfires in Australia's history burned through three million hectares of pastoral and crown land in Kimberley region of Western Australia; blaze, which began as four or five separate blazes, had been burning for three months, some farm losses reported. *L.L., D.T.*

14: Two ferry boats sank in stormy seas around the Philippines:
The *Balangiga* capsized in San Pedro Bay, in the Leyte Gulf, in the centre of the country, leaving at least 51 dead, 78 others rescued.
The *Lady Aurora* capsized in heavy seas off town of Dinalungan, north east of Manila, Luzon island, leaving at least 22 dead, several others reported missing. *L.L.*

15: Two motor vessels collided in thick fog on river Rhine near Karlsruhe, Germany, both vessels badly damaged, some people suffered shock.

15-24: Hurricane "Joan" hit from Barbados to Nicaragua, brief details below:-
15th: "Joan" brushed passed Barbados, light damage, such as uprooted trees, from winds of 45km/h.
16th: "Joan", still in tropical storm stage, hit island of Curacao with winds of 65km/h, uprooting trees and damaging roofs of 100 homes, six people injured.
17-20th: Heavy rains accompanying "Joan" caused floods and mudslides in Venezuela, on the 20th landslides in the shanty towns around Caracas left at least 12 dead.
18th: The storm, now of hurricane intensity, hit the Guajira Peninsula and other areas of northern Colombia, with torrential rains, floods and landslides, which left 17 dead, 50 missing and 100,000 people homeless, river Alferez overflowed after two days of heavy rains. Up to 305mm of rain fell in 72 hours in the La Guajira desert, along the Carribean coast 740km north of Bogota. Winds and rain destroyed 100 houses in Uribia and another 150 buildings in city of Maicao.
21st: Island of Isla San Andres, to east of Nicaragua, hit by winds gusting to 200km/h, destroying houses and uprooting trees, 'dozens' of people reported injured. Heavy rains began to fall in Panama, causing floods and landslides.
22nd: "Joan" hit Corn Island and Nicaragua, with winds gusting to 217km/h, some 99% of coastal town of Bluefields, Nicaragua, destroyed, along with 90% of town of Rama and 70% of Nueva Guinea. The death toll in Nicaragua was at least 79, with 300,000 people reported homeless, damage was put at $900 million. 5284 square kilometres of forest, crops and fields swept away in east of the country, on the 22nd/23rd, "Joan", now downgraded to a tropical storm, hit Managua, the capital, with 75km/h winds and 75mm of rain in six hours.
22nd: Heavy rains caused floods in Costa Rica which left at least 23 dead, with 50 others reported missing and 175 injured, floods, along with high winds destroyed 1500 homes, leaving 7,500 people homeless, many roads cut, widespread agricultural damage.
22nd: Hurricane "Joan" hit Panama with high winds, heavy rains and floods which left seven people dead and 23 others missing, damage put at $60 million, including eight bridges destroyed, 60km of national highways destroyed, and 67 schools destroyed or damaged.
22nd: Floods due to "Joan" in Honduras left at least 12 dead.
23rd: Tropical storm "Joan" hit El Salvador with winds of 90km/h and heavy rains, no major damage or casualties reported.
24th: "Joan", now renamed "Miriam", moved into the Pacific Ocean after leaving at least 150 dead and 73 others missing in the areas affected. *L.L., D.T., International Herald Tribune.*

circa 15: High winds and torrential rains in central Vietnam left 100 dead, 28 missing and destroyed thousands of homes, nearly 600,000 people affected by storm, described as a typhoon. Provinces of Nghe Tinh, Nghia Binh and Quang Nam-Danang worst affected, between 196mm and 1118mm of rain reported from some areas. Some 350,000 tons of grain destroyed, along with 1257 head of livestock.

16: Floods in northern Guatemala isolated 16 villages and made 6000 people homeless, persistent rains swelled the river Chioxy in El Quiche province causing it to overflow its banks. *L.L.*

18: Floods touched off by heavy rains in south east Turkey left nine people dead and damaged at least 150 houses. *L.L.*

19: Thunderstorms caused flooding in widely separated locations from Scotland to Kent, several main roads in Scotland closed, in Liverpool 25mm of rain fell in a few hours, causing minor flooding, 13mm of rain fell on Essex, floods reported from Ipswich, Suffolk and Herne Bay, Kent. *B.E.M.*

19: Cyclone hit southern Bangladesh with winds up to 121km/h and 4.5m high waves along the coast. In the Bay of Bengal at least 25 fishing vessels capsized leaving 31 dead, altogether 100 people were injured in storm. *L.L., B.E.M., D.T.*

21: Typhoon "Pat" hit Luzon island, Philippines, wrecking the homes of 9000 people. *L.L.*

21(reported): Floods in Thailand, at least six provinces seriously affected, in the south east province of Rayong two people reportedly swept away, floods in Bangkok disrupted road traffic. *L.L.*

22–25: Typhoon "Ruby" hit the Philippines, brief details below:–
22nd: As "Ruby" approached Mindanao torrential rains, floods and a tornado left 15 people dead, the tornado reportedly killed 10 on the island, five dead in floods in three villages around Cagayan de Oro.
23rd: "Ruby" headed for Luzon with winds gusting to 165km/h.
24th: "Ruby" hit Samar island at about 0800 hours, the typhoon blew bus off bridge and into a river in the central province of Antique, leaving 26 people dead, 10 provinces affected by "Ruby" by this day, but the worst incident was the sinking of the M.V. *'Dona Marilyn'* between Samar and Masbate islands which left at least 150 dead, 263 others were rescued, but many others were missing, also a ferry, the *'Zanaida'* went missing off Quezon province, Luzon island, with 20 people aboard.

25th: Typhoon hit Manila with high winds and heavy rains which caused widespread flooding in and around city, leaving 100,000 homeless.
Throughout country at least 331 people died in "Ruby", including 181 in drowning and other accidents unrelated to the *'Dona Marilyn'* incident, 78 others reported missing, the homes of 2.3 million people were washed away or flooded by storm, with some 300,000 people made homeless. *L.L., D.T., I.H.T.*

24: Flash floods after rainstorm swept through the Samaria gorge on Crete, left one person dead, with one other missing. *D.T.*

27-28: Heavy rains and floods in Thailand, parts of Bangkok flooded, more than 100mm of rain fell on the northern areas of Bangkok on the 27th, the Chao Phraya river overflowed its banks into city when floods along river met high tides moving in from coast. *L.L.*

30: Mv *Maria Pilar* sank in heavy seas off Cabugao, Ilocos Sur province, Luzon island, Philippines, all 21 crew rescued. *L.L.*

31: Avalanche hit camp at foot of mount Medvezhya in the Ural mountains, U.S.S.R., 13 people killed. *I.H.T.*

31:Fv *Sang Young No. 35* sank in heavy seas in lat. 39° 40N, long. 154° 35E, some 885km off northern Japan, all 27 crew unaccounted for. *L.L.*

ALBERT J. THOMAS

LITERATURE REVIEWS AND LISTINGS

Book Review

CLOUDS IN A GLASS OF BEER: SIMPLE EXPERIMENTS IN ATMOSPHERIC PHYSICS. By Craig F. Bohren., J. Wiley & Sons 1987, 195pp., £9.95.

On first seeing this book the reader would be wise to direct attention towards the wording of its subtitle. The term 'simple experiments' is meant to indicate that the text contains numerous suggestions for laboratory work of a basic type which requires only inexpensive materials. No-one should therefore be deterred by the term 'atmospheric physics'. The writer has an easy-going style and introduces many personal touches (e.g. by frequently recounting his own experience). Nowhere are there mathematical equations, specialised terminology or difficult concepts. An attempt has been made to intrigue as well as to enlighten. the book therefore has several chapters with fascinating titles, which will allure the reader into probing their contents more deeply (e.g. Chapter 3: "Happy ducks, like happy people, perform best with cool heads"). It also has many quotable remarks (e.g. "a glass of beer is a cloud inside out"). Another of the book's objectives is to attack "the legends and blatent falsehoods that have crept into our casual descriptions of the physical world". Thus, it explains, for example, the real reasons why frost can fail to develop on the grass beneath a tree. The explanation of this and other everyday atmospheric phenomena make the book valuable for teachers and laymen alike. Certainly, the former could raise the interest of classwork by demonstrating to pupils some of the experiments which the author describes.

THE WEATHER JOURNALS OF A RUTLAND SQUIRE. Introduced and edited by John Kington. Rutland Record Series, Volume 2. Published by the Rutland Record Society, Rutland County Museum, Oakham 1988, 217pp., £15.00

This is a book of exceptional quality, owing to the fascinating nature of its subject, the interesting and thorough way that subject is presented and the high standard of its production. Moreover, the price makes it a bargain compared with much meteorological literature being published today.

The subject of this book is Thomas Barker, who was brother-in-law of the famous naturalist, Gilbert White, and who lived at Lyndon Hall in what used to be Rutland. His principal achievement was to have observed methodically and to have commented on the weather for around two-thirds of the 18th century. As Kington (quoting Manley) remarks, Barker's efforts have, among other things, bequeathed to us "one of the best thermometric series made before 1800". An account of this achievement forms the core of the present book (i.e. chapter 4 – "The meteorological journals"; chapter 5 – "Miscellaneous records"; chapter 6 – "Articles on meteorology published in the *Philosophical Transactions* of the Royal Society"). There is also an account of Barker's life and family background (chapter 1) and of his broader interests (beekeeping, astronomy, etc.) (chapter 2). The remaining chapters discuss how Barker carried out meteorological observations (chapter 3) and give a list of his published and extant unpublished works (chapter 7). There are over 30 illustrations in the book, its typeface is clear and the paper quality is good. It is most heartening that a local society can issue such an excellent publication. The standard is comparable to that of the volumes in the marvellous and long series of transactions from the Cumberland and Westmorland Antiquarian and Archaeological Society.

L.T.

LETTERS TO THE EDITOR

BUTTERFLIES IN MIDWINTER

Further to Mr Weeks's sighting of a Small Tortoiseshell(*J. Meteorology*, vol.14, no.136), may I report a sighting even closer to the winter solstice?

On 27th December 1988 while walking along the southern edge of Upton Wood (SP 385624) near Southam, Warwickshire, I was surprised to see a Small Tortoiseshell butterfly basking in the sunshine on a twig on the wood-edge. I have never seen a butterfly during the winter months prior to this.

The day was mild and sunny with a light south-westerly breeze (force 2). I recorded a maximum temperature of 11.5°C, not exceptional at all, but the continuous sunshine was enough to tempt this butterfly to arouse.

Wyken, Coventry A. C. HERRON

TROPICAL AIR OVER ENGLAND IN EARLY FEBRUARY

I refer to Mr Oldschool's letter in the April issue of *J. Meteorology*. My exposed station some 290 kilometres north of London recorded maxima of 14.7°C on 6th February, 13.3 on 8th, and 11.1 on 9th.

I should mention that on the 6th my solar black-bulb thermometer surprised me by registering 35.6°C, the highest February temperature recorded so early in the month since my station was founded in 1947.

Regarding the sudden access of drier air mentioned by Mr Oldschool, I consulted the monthly *Weather Log* included in *Weather* which clearly shows on the 8th the replacement of the tropical maritime airflow from the south-west by a south-easterly flow direct from the Continent advecting over the London area.

Thornton Hall, Ulceby, Humberside PAUL C. SPINK

THE WEATHER OF 1988 IN JAKARTA

Readers may be interested in a summary of the weather in 1988. The year's rainfall in my South Jakarta garden of 76.6 inches (1947mm) was very close to the average but this hides some marked variations. January, May, October and December had above average rainfall, with the wettest May and December that I have recorded in 11 years here (11.8 inches, 300mm in both). Whereas April and June to September were dry, the expected drought failed to materialize, at least in Jakarta, with sufficient isolated storms in the dry season to replenish the soil which had been well watered in May. There were no extreme rainfall events, the wettest days being 23 January (3.3 inches, 84mm) and 4 March (3.0 inches), but the wettest week of the year was 13-21 December with 10.2 inches, including three falls of over 2.0 inches, which caused floods in northern Java.

The year was marked by warm nights, with the temperature not once falling below 70°F (21°C). 28 April had the warmest night I have recorded here, with a minimum of 80°F (26.7°C). The hottest days were 1 and 6 October which attained my previous record of 98°F (36.7°C) (1 November 1987). The low frequency of severe thunderstorms was notable – in the latter part of the year, this was caused by the early arrival of westerly winds, which were established in the first week of November, at least six weeks early. Jakarta's big storms very rarely come on a west wind.

By the time you read this, we will know whether or not the December floods in Java were a foretaste of a very wet January, heralded by the southward progress of severe monsoon rains through Bangladesh, Thailand, Malaya and western Sumatra.

Jakarta, Indonesia DEREK HOLMES

LIVERPOOL'S HOLE IN THE CLOUDS

What a winter! Merseyside had 81 hours of sun in January and over a hundred hours in February. We get good shelter by the Welsh mountains in a south-westerly airstream. In Anglesey, February, with 146.9mm rain, was much wetter and windier than here. Over 25mm fell on 7th which was a dry day here. The 7th was an unusual day with south-west winds reaching gale force and a top temperature of 13.0°C. A hole persisted in the cloud cover over South Liverpool all day, or rather from dawn till 16 hrs. The sky over Sefton Park was cloudless. The 'hole' had the sharpest and best-defined edge that I have ever seen; this phenomenon only appears when the south-west wind blows strongly. I reckon we had a good six hours of brilliant sunshine. The sky is always a dazzling blue, and the cloud surrounding the hole to the west and north-west is especially dark. Patches of cloud, as I have mentioned before (*J. Meteorology*, Vol.4., 51-52, 1979), race up to the edge of the hole and speed around it but never across. It is a great pity that the Meteorological Office at Liverpool Airport closed down and that Riversdale Technical College at Aigburth has no sunshine recorder; they are in a ideal position. At about 16 hrs the hole just closed over swiftly, but this is typical. Bidston Observatory was outside the hole and had only 0.2 hours of sunshine. Blackpool had 18mm rain. Colwyn Bay had no sunshine that day either.

Sefton Park, Liverpool KEITH G. LEDSON

SHEEP CIRCLES

I was particularly interested in the report of sheep circles published in *J. Meteorology*, Vol.14, no.136, as I was one of a team of seven researchers from this country and abroad who observed a similar occurrence at Cheesefoot Head, Hampshire, on 15th January 1989.

We were driving east along the A272 Winchester-to-Petersfield road and approaching the punchbowl on our left when one of my passengers caught the first sighting of this most unusual formation. Approximately sixty sheep were grazing quite peacefully but forming a very clear circular form. Ten minutes later we walked back from the car park on the top of the hill and noted from a different angle (south) that the well-defined circle was being maintained. The spot concerned was where the circle and ring were formed in 1987. I took a video film of this at 1558 hours. Close scrutiny of the film shows only one sheep outside the circle perimeter. I have also checked with a number of farmers who have all stated that this behaviour is not associated with sheep. We may be looking at a very unusual coincidence or perhaps something of note.

Andover, Hampshire COLIN A. ANDREWS

(*Note by the editor:* Whereas the cause of this phenomenon remains obscure, one may remark that the matter of primary concern from the sheep's point of view was most probably food. Were the sheep, in fact, grazing where the pasture tasted the best?).

TORRO THUNDERSTORM REPORT: August 1988

By KEITH O. MORTIMORE
Thunderstorm Division, Tornado and Storm Research Organisation, 77 Dicketts Road, Corsham, Wiltshire, SN3 9JS.

In all parts of the United Kingdom and Ireland August 1988 was a quiet month. Only nine days with thunder were reported over England, eight days below the normal, and two days in Wales, six days below the normal. The deficit over Scotland and Ireland was not so large, being approximately two and one below the August normal respectively. Station totals in eastern and south-eastern counties of England were very variable with two or three days with thunder, generally not far from the normal, while a few had four and quite a number none at all. In the north and west there was very little, if any thunder. A significant feature of the month was the almost total lack of any continental outbreaks that are often a major contributor to the August totals. This played a large part in the almost total absence of thunder in the west and south-west.

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

August 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	9	17.0
Wales	X	X																														2	8.9
Scotland	X	X										X		X				X	X					X								7	9.3
Ireland		X										X	X	X			X		X									X				7	7.8
Total	X	X										X	X	X			X	X	X	X				X				X	X		X	13	18.8
Netherlands	X							X		X	X	X		X				X	X	X	X			X	X			X	X	X	X	16	16
Belgium	X									X	X									X	X							X	X		X	8	

Although a large area of thunderstorms developed over northern France on 1st storms in the U.K. were confined to parts of south-east Scotland, north-east England, Merseyside and locally in north Wales. At Coldstream (Berwickshire) an hour-long hailstorm left the ground completely covered with ice. With an upper cold pool sitting over the country the 2nd saw much more widespread activity over central and eastern areas of England with just a few thundery showers in southern Scotland, in south Wales and in south-east Eire. Some of the storms over England were particularly active with torrential rain and local lightning damage. At Stannington, near Sheffield (South Yorkshire) a 31-year-old woman received a burned ear and thigh when lightning struck the telephone she was using. Several houses were struck by lightning in Sheffield causing damage to electrical appliances and, in some cases, some structural damage. Flooding also affected large parts of the area. At Mablethorpe (Lincolnshire) lightning struck two 33 metre gas vent stacks at the Conoco Viking gas terminal. Strong downbursts resulted in reports of sudden and appreciable temperature falls in the Chelmsford area of Essex. Following this outbreak there was no further activity until 11th when lightning and possible very distant thunder was reported at Straide in Co. Mayo very late in the evening, close to the centre of a small depression. The 12th saw more scattered activity in Northern Ireland, southern Scotland and north-east England and there was a little evening thunder in Co's Mayo and Monaghan. There were further scattered thundery outbreaks in Scotland and Eire on 14th and on 17th the Co. Down area of Ulster was subjected to a few thundery showers in the evening. During the early hours of 18th thunderstorms developed through central regions of Scotland, mainly in the Glasgow and Edinburgh areas and in the early hours of 19th some medium-level thunderstorms moved north-east from France into parts of south-east England. Later in the day scattered storms developed over northern and western counties of England, in central Scotland and in Northern Ireland. The Bristol area was subjected to some thundery developments in the small hours of 20th and a report of 63mm of rain at Weston-super-Mare has still not been confirmed. In the afternoon and evening some thundery showers broke out in parts of south-east England. Cumbria and parts of eastern Scotland were affected by thundery outbreaks in the afternoon of 24th and late in the evening lightning was seen from east Kent as a thundery trough moved away into the Low Countries. Before dawn on 28th thunderstorms moved from France into extreme counties of England and some thundery outbreaks moved north as far as Lincolnshire before dying out around mid-morning. In the afternoon there was some thunder at Mullinger (Eire). The 29th was a showery day and one such shower was accompanied by thunder on Humberside in the afternoon. Late in the evening lightning was observed over the North Sea from the coast of Cleveland. The 31st produced the most interesting outbreaks of the month over south-east England. The sharpening of an upper trough intensified an already active cold front over East Anglia and particularly near to the tip of a wave that ran north-east along it. A house at Cheam (Surrey) was almost completely destroyed by lightning and large hail fell in the Sutton and Surbiton areas. Squall-lines were reported at Leatherhead (Surrey) and at Loughton (Essex). There was a tornado near Norwich (Norfolk) and a waterspout was observed off Lowestoft (Suffolk). Rainfall totals for the 24-hours commencing 0900 GMT on 31st included 45.3mm at Royston (Hertfordshire) and 44.7mm at Ely (Cambridgeshire). Although the severe storms were confined to the south-east of England heavy rain fell over a large part of southern England and thunder was heard as far west as Wiltshire.

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

WORLD WEATHER REVIEW: October 1988

United States. *Temperature:* warm W. of a line from Montana to Texas; S. Florida; Hawaii; +3degC from W. Arizona to W. Montana. Cold elsewhere; -3degC from L. Superior to Kentucky and
Maryland. *Rainfall:* a very dry month; wet only from interior N. Carolina to Mississippi and N. Louisiana then N. to Great Lakes; S. Arizona; over 200% in C. Mississippi, N. Indiana, S.W. Michigan, S. Arizona. Dry elsewhere (including Hawaii)); under 50% generally W. of R. Mississippi; Florida, N.W. Virginia to S. Pennsylvania; E. New York to S. New Hampshire; N.W. Hawaii. Under 35% general from California and S. Washington to Dakotas, N.W. Missouri and C. Texas; Honolulu.

Canada and Arctic. *Temperature:* warm in most of British Columbia, Alberta, Northwest Territories and Greenland; N. Quebec; +5degC in Ellesmere Island. Cold in Alaska, Yukon, Saskatchewan to Maritime Provinces; extreme S. Greenland through Iceland to Spitzbergen and Franz Josef Land; -2degC in much of Alaska; S. Manitoba, S. Ontario, Spitzbergen, Franz Josef Land; -8degC at Barrow (Alaska) and in Franz Josef Land. *Rainfall:* wet in E. Alaska, N. British Columbia, parts of Yukon and W. Greenland, S.W. Iceland; most of E. Canada. Over 200% in N. British Columbia, S. Quebec, Nova Scotia; locally in Canadian Arctic. Dry in W. Alaska, S. British Columbia to W. Ontario and Victoria Island; Spitzbergen, N. Iceland, E. Greenland. Under 50% in all these areas.

South and Central America. *Temperature:* warm in interior S. Brazil, N.W. Argentina; most of N. Mexico; Bahamas; +2degC in N.W. Mexico and near Córdoba (Argentina). Cold in Bolivia, Paraguay, C. and much of N. Chile, C. and N.E. Argentina, Uruguay, E. coastal Brazil, S. Mexico to Honduras; part of N.W. Mexico; -2degC in S. Bolivia. *Rainfall:* wet in S.E. Brazil, N. Paraguay, round La Plata estuary, N.W. Mexico; parts of S. Mexico to Belize. Over 200% in N.W. Mexico. Dry in most of South America 15-40°S.; most of Mexico to S. Guatemala; Bahamas. Under 50% in N. and C. Chile, W. Argentina, N. Uruguay, extreme S. Brazil, E. Paraguay, W. and interior N. Mexico to S. Guatemala; N.W. Yucatan.

Europe. *Temperature:* mostly warm; +2degC in N.E. Spain, S. France, S. Germany, E. Switzerland, W. Austria, N. and C. Italy; near C. Urals. Cold from S. Norway and S. Sweden to Greece and W. Ukraine; marginally in W. and N. of British Isles -2degC locally in S. Romania and E. Bulgaria. *Rainfall:* wet from Urals to N. Norway then through E. Sweden and Denmark to many parts of British Isles; E. France, Switzerland, S.W. Germany, extreme N. Italy, Portugal and most of Spain; much of Black Sea coast. Over 200% in Urals; locally in E. France, S.W. Germany, W. Switzerland, extreme N. Italy, N.E. Spain, S. Ukraine. Dry elsewhere; under 50% from S. Urals to

E. Germany, E. Austria and E. Italy; C. Norway, S.W. France; most of N. Spain. Provisional sunspot number 124.

Africa. *Temperature:* mostly warm from Morocco to Libya; +3degC in N. Algeria and N.W. Libya. Cold in N. Morocco, Egypt and in and near South Africa; -2degC locally in first two areas, more widely from W. Cape Province to N. Transvaal. *Rainfall:* wet in parts of Morocco and Algeria (locally over 200%); N.E. Cape Province into Zimbabwe and Mozambique (over 200% widespread). Dry generally into Namibia; under 50% widespread in both these areas.

Asiatic U.S.S.R. *Temperature:* mostly warm; +3degC in C. Lena basin and near Sea of Okhotsk. Cold near most of Arctic coast (-5degC in N. Taimyr Peninsula); locally in upper Ob basin. *Rainfall:* wet in most of Urals; E. Kazakhstan to Taimyr Peninsula to Sea of Okhotsk; over 200% in Taimyr Peninsula and Lena basin. Dry elsewhere; under 50% from S. Urals southwards, near Mongolian border and in N.E.

Asia (excluding U.S.S.R.). *Temperature:* warm in Arabia, S. Pakistan, N.W. and S. India, N. Bangladesh, S. Japan, Korea, Malaya, Sumatra, Sarawak, Philippines (rest of S.E. Asia near normal); much of China; +2degC in C. Arabia, N.E. China. Cold from Turkey; N. India, C. China; most of Japan (all -1degC at least locally). *Rainfall:* wet from Turkey to Jordan and W. Iraq; extreme S.E. and parts of N.E. China, N. Thailand, Laos, N. Kampuchea; most of Philippines; locally in N.W. India; over 200% at least locally in all these areas (except perhaps Kampuchea), especially from E. Turkey to Iraq and in N. Laos. Dry in Arabia, Pakistan, W. Bangladesh, Korea, Japan, Mongolia, S. Thailand, Malaya; most of India and China; under 50% widespread in all these areas.

Australia. *Temperature:* warm everywhere; +3degC in much if interior. *Rainfall:* dry almost everywhere (mostly under 25%), but wet near Darwin (over 200%) and in N.E. Queensland.

M.W.R.

WEATHER SUMMARY: February 1989

February was another very mild month everywhere with mean temperatures ranging from three degrees Celsius above the normal in parts of the south to around one degree above in the north of Scotland. It was especially mild at times and on 6th there were maxima of 15.8° at the London Weather Centre, 15.0° at Heathrow and Sidcup (Kent) and 15.4°C at Dyce Airport, Aberdeen. On 18th Finningley (South Yorkshire) recorded 15.3°, and at Cottingham (North Humberside) 15.3° was reached on both 6th and 18th. The 6th was also a mild night with minima of 11.3° at Newcastle and 11.0° at Dyce and on 19th the temperature failed to fall below 11.4° in central London and 11.3°C at Sidcup. There were a few brief cold spells early in the month and it became more generally colder towards the close of the month. Low maxima included -0.2° at High Bradfield (South Yorkshire), 1.8° at Edinburgh and 3.5°C at Rhoose Airport, Cardiff, all on 25th, 0.8° at Lerwick on 16th, 1.0° at Aviemore (Highland) on 23rd and 1.1°C at Cromer (Norfolk) on 2nd. On 27th the air temperature fell to -9.7° at Braemar (Grampian) and to -7.1° at Aviemore, on 11th Shawbury recorded -5.9° and Hurn Airport, Bournemouth, -5.1° and on 17th -5.8°C was the Finningley minimum. On the grass the temperature at Aviemore fell to -12.5° on 16th and -11.3°C was recorded at Finningley on 17th and Edinburgh on 26th. Rainfall was much above the February normal over northern and western parts of Scotland with

more than twice the normal widely and five times the normal at Fort William. Over the rest of Great Britain it was very dry for two weeks but the second half of the south saw much more rain and by the end of the month, although some eastern areas were still rather dry, the normal had been exceeded by as much as 50 percent in places. Daily totals were particularly high in north-west Scotland. At Kinlochewe (Western Ross) 170.4mm fell on 5th and at Fort William 131.5mm were recorded on 6th. Fort William also recorded 68.7mm on 14th. At Rannoch School, Dall (Tayside) 80.0mm fell on 6th. South of the border 37.9mm were recorded at Penmaen (West Glamorgan) on 23rd, 36.5mm at Cellarhead (Staffordshire) on 24th and at Cilfynydd (Mid Glamorgan) 42.4mm fell on 17th and 40.1mm on 18th. Away from the north-west of Scotland and Cumbria it was a very sunny month with 125 percent of the normal sunshine quite widely over England and Wales and greatly in excess of 150 percent in quite a few places.

The strong anticyclone over western Europe, a persistent feature so far this winter, continued to control the weather over much of Britain for the first two weeks of February and pressure exceeded 1040mbars over south-west England on 12th. Throughout this period most parts of the country were dry with generally small amounts of rain as weakening frontal systems periodically pushed into the high pressure area. In northern and western Scotland the weather was frequently wet and windy as active weather systems repeatedly crossed these parts and rainfall was particularly heavy on both 5th and 6th resulting in considerable flooding, especially around Inverness. On 7th heavy rain moved south into Cumbria and other parts of northern England. On 13th the main feature of the weather was the wind and in the circulation of a depression moving east just to the north of Scotland the wind gusted to 128 knots at Fraserburgh (north-east Grampian) and to almost 110 knots on Cairngorm. Further very heavy rain fell over western Scotland on 14th as an active warm front crossed the area and the cold front of this system spread rain to all parts of Britain on 15th. After a bright but chilly day on 16th more rain spread north-east across England and Wales on 17th, preceded by snow in places which produced a few centimetres on the ground for a time over the Midlands and north. Western and northern parts of England and Wales had heavy rain on 18th, with heavy falls over the Welsh mountains, and on 19th there was heavy snow over the mountains of Scotland. There was a good deal of sunshine over much of the U.K. on 20th and 21st though rain, with snow in the north, reached the west later on 21st. A cold front spread heavy rain across all parts of the U.K. early on 22nd followed by widespread wintry showers on 22nd and again on 23rd. On 24th a deep depression moved north-east across central counties of England into the North Sea. Heavy rain fell widely over England and Wales and snow caused problems on higher ground, particularly over the southern Pennines where Buxton in the Peak District was cut-off for a time. On 25th a very deep depression traversed the Channel coast of England with a central pressure of 948mbars, the lowest sea-level pressure over southern England since at least 1870. Rain was again very heavy in the southern parts and snow fell over high ground throughout the country. Most places had sunshine and wintry showers from 26th to 28th and as small lows circulated around the British Isles there were spells of heavy rain at first, again with snow over high ground. Southern and eastern counties of England had fewer showers and good spells of sunshine.

WEATHER SUMMARY: March 1989

March was the fourth month in succession with above average temperatures. In the north and north-west of Scotland mean values were marginally on the mild side but it was appreciably milder further south with mean temperatures over much of south and south-east England between two and two and a half degrees Celsius above the normal. It was especially warm and spring-like during the last week of the month with temperatures rising to 19.9° at East Hoathly (East Sussex) on 28th and at the London Weather Centre on 31st. The London Weather Centre also recorded 19.8°C on 30th and maxima were widely above 18° over England between 26th and 28th. In Scotland the temperature reached 16°C at Leuchars and Kinloss on 27th. Many stations recorded their highest March temperatures for 21 years and the 18.9° maximum at Dover (Kent) on 28th was the highest since records began there 32 years ago. Highest minima included 12.1° at the London Weather Centre and 10.8° at Guernsey on 28th and 10.7°C at both Yatton (Avon) and Exeter (Devon) on 5th. In Scotland 9.2° was recorded at Glasgow and Edinburgh on 6th. The coldest weather occurred during the third week of the month. On 16th there was a maximum of 1.9° at Lerwick (Shetland) and on 17th High Bradfield (South Yorkshire) recorded only 2.0°C. On 20th the temperature rose to only 2.0° at Aviemore and 2.7° at Inverdruie (Highland). In the south the temperature on 16th rose to just 3.3° at Corsham (Wiltshire) and 3.4° at Bath (Avon). The 17th was the coldest night of the month in Scotland with temperatures as low as –7.6° at Inverdruie and Tummel Bridge (Tayside). On 18th temperatures further south fell to –6.1° at Kettering (Northamptonshire), –5.9° at Hurn Airport, Bournemouth (Dorset), –5.5° at Sandhurst and –5.1°C at Mortimer (Berkshire). On the grass –14.2° was recorded at Glenlee (Dumfries and Galloway) and –11.2° at Inverdruie on 17th and on 18th –11.9°C was recorded at Shawbury (Shropshire), –11.5° at Low Etherley (Durham) and –10.5° at Velindre (Powys). Some eastern counties of England and Scotland had a dry month, particularly close to the Scottish borders where around 30 percent of the normal was recorded. Elsewhere it was a wet month with around 250 percent in parts of western Scotland. On 8th 65mm of rain fell at Nantmor (Gwynedd) and on 9th a site at Thirlmere (Cumbria) reported 112.5mm, with a 48-hour total (8th and 9th) of 164.6mm. Ambleside recorded 87.9mm on 9th and on the same day 50.2mm fell at Manchester and 52.7mm at Eskdalemuir (Dumfries and Galloway). At Okehampton (Devon) 45.2mm fell on 14th. Many central and eastern parts of the U.K. had a sunny month, more especially in the drier parts of north-east England and eastern Scotland. In south-western counties totals were around 55 percent below the normal in places. During the night of 13th/14th a spectacular display of the Aurora Borealis was observed over many parts of the U.K. as far south as the Channel Islands.

During the opening days of the month, as a depression tracked slowly east across central areas of England and Wales, most places had rain or showers at times and on 2nd some northern parts had a little snow. Mild southerly winds spread to all parts of the U.K. on 5th and 6th, the latter day being one of the mildest early March days this century, but on 7th colder, showery weather followed a cold front from the west. A very deep depression to the south of Iceland pushed wet and windy weather to all parts on 8th and 9th with substantial falls of rain in the west and north while on 10th and 11th most parts were brighter with showers, particularly in the north-west. Between 12th and 15th two depressions took similar tracks across Northern Ireland and the English/Scottish borders. This was a stormy period with a lot of rain, and gales were severe at times in the south-west. The following two or three days were much colder with rain turning to snow in places in the south-west on 16th and wintry showers occurred in many places on 17th. The morning of 18th was the coldest of the month in the south but the weather was again on the change as frontal systems pushed rain and milder air across the country from the west during the day preceded by a period of snow in parts of the north. A clearance followed the rain to all parts on 19th and the next few days were cold with wintry showers in most places although southern parts of Britain became milder for a time on 21st. The 23rd and 24th were further cold days with widespread wintry showers interrupted from time-to-time by longer spells of rain as frontal systems crossed the country. Milder south-westerly winds pushed north-eastwards across southern counties of England and Wales on 25th followed by some warm and spring-like weather on 26th and 27th. The 28th was again warm and sunny in the south-east but a cold front brought a marked drop in temperature during the day and at one time there was a ten degree Celsius contrast in temperature between the Midlands and the London area. The south-east became warm again during the closing days of the month and with high pressure in control to the south it was generally dry in all parts with good spells of sunshine.

K.O.M.

TEMPERATURE AND RAINFALL: FEBRUARY 1989

	Mean				*Grass*					
	Max	*Min*	*Max*	*Min*	*Min*	*Rain*	*%*	*Wettest*	*RD*	*Th*
BELGIUM: Uccle	8.3	1.9	13.6(19)	–1.2(1)	–7.4(13)	56.2	106	8.2(19)	16	–
„ Rochefort	8.4	–1.9	14.2(9)	–7.7(5)		71.1	135	7.8(22)	19	–
„ Houwaart	9.6	–0.1	15.9(9)	–4.2(22)	–6.8(13)	55.5	107	10.2(27)	14	0
DENMARK: Fanø	7.3	3.5	11.8(7)	–0.4(17)		61.9	158	10.1(24)	20	1
„ Frederikssund	7.3	3.3	11.0(19)	–1.9(18)	–7.3(18)	32.0	125	5.7(26)	18	0
GERMANY: Berlin	7.8	1.4	13.4(19)	–2.3(22)	–4.3(22)	40.6	117	11.5(19)	16	2
„ Hamburg	7.7	2.0	12.6(19)	–1.4(17)	–4.1(22)	40.9	103	8.8(18)	16	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
„ Frankfurt	6.2	1.2	14.4(20)	-2.9(4)	-3.8(22)	42.1	105	12.3(18)	21	1
„ Munchen	6.7	-0.8	12.9(20)	-7.4(2)	-9.6(2)	45.9	84	13.3(18)	15	1
MALTA: Luqa	15.9	8.9	19.8(26)	4.9(1)	-1.0(1)	57.1		19.6(15)	9	2
NETH'NDS: Ten Post	7.8	2.1	11.9(19)	-3.6(17)	-7.5(17)	54.3	124	9.5(19)	17	1
„ Schettens	7.5	2.5	10.7(18)	-2.5(17)	-6.6(17)	52.7	110	8.1(19)	16	0
„ De Bilt	8.6	2.0	12.9(19)	-3.9(17)	-7.5(17)	46.7	93	8.8(18)	17	0
SWEDEN: Valla	6.1	0.6	10.5(6)	-8.3(18)		34.7		12.0(27)	17	0
SWITZ'LAND: Basel	8.7	0.6	16.1(19)	-4.8(3)		66.4	166	17.5(21)	14	1
EIRE: Straide	9.1	3.3	13.2(5)	-3.8(25)	-8.5(25)	154.2	188	15.3(2)	27	3
SHET'AND: Whalsay	6.5	2.3	10.3(6)	-4.8(17)	-7.0(17)	186.7	229	27.6(14)	28	12
„ Fair Isle	6.6	3.3	10.3(6)	-1.2(16)	-4.1(17)	139.1	269	18.3(14)	27	2
SCOT'AND: Braemar	5.5	-0.6	11.3(3)	-9.7(27)	-10.8(27)	125.1	187	29.5(28)	22	0
„ Inverdruie	6.2	-0.1	11.9(3)	-8.0(27)	-13.9(17)	173.0	309	24.5(6)	23	0
„ Rannoch	6.6	-0.6	12.0(5)	-6.2(10)	-6.4(10)	298.3		80.0(6)	26	0
WALES: Pembroke	9.8	4.2	12.6(6)	0.0(21)	-4.4(11)	113.0	151	22.9(23)	20	0
„ Velindre	9.1	2.3	12.7(6)	-3.9(11)	-9.8(11)	99.8	143	17.9(24)	18	0
„ Carmarthen	9.0	3.2	12.6(7)	-2.3(21)	-7.9(21)	134.5	158	21.2(23)	20	0
„ Gower	9.6	4.5	11.8(7)	0.6(25)	-3.8(21)	145.5	174	37.9(23)	18	1
GUERNSEY: Airport	9.6	5.8	12.0(6)	2.0(23)		54.8		9.0(17)	18	3
ENGLAND:										
Denbury, *Devon*	10.3	3.9	12.5(5)	-2.2(11)	-5.2(11)	135.9	118	24.7(23)	18	2
Gurney Slade, *Somerset*	9.2	2.3	13.0(6)	-4.7(17)	-5.0(17)	134.8	152	21.2(14)	18	–
Yatton, *Avon*	10.6	4.0	15.0(6)	-3.5(2)	-5.8(2)	85.6	184	14.9(25)	17	1
Corsham, *Wiltshire*	9.7	3.0	14.1(6)	-2.7(2)	-7.3(2)	80.9	153	17.9(25)	17	1
Mortimer, *Berkshire*	9.7	2.0	14.2(6)	-2.8(2)	-9.4(11)	57.8	118	10.4(25)	18	0
Reading Univ., *Berks*	10.0	2.6	14.4(6)	-2.6(2)	-6.2(2)	45.2	113	7.4(25)	16	0
Sandhurst, *Berkshire*	10.1	2.4	14.4(6)	-4.4(11)	-6.7(11)	59.8	123	12.2(25)	15	0
Romsey, *Hampshire*	10.3	2.4	13.6(9)	-4.0(11)	-7.8(11)	99.8	187	24.8(24)	18	0
Horsham, *Sussex*	9.7	3.0	14.1(6)	-3.1(11)	-6.5(11)	70.9	133	17.4(24)	15	0
Brighton, *Sussex*	9.3	3.9	11.0(6)	-0.1(23)	-1.6(16)	69.2	153	12.7(17)	21	1
Hastings, *Sussex*	9.2	3.9	11.2(5)	0.6(v)	-2.7(23)	56.8	112	14.7(25)	12	2
Dover, *Kent*	9.8	3.2	13.2(6)	-1.3(11)		60.6	108	9.2(22)	13	0
East Malling, *Kent*	9.8	3.0	14.6(6)	-2.5(11)	-6.4(17)	46.0	99	15.1(25)	14	0
Epsom Downs, *Surrey*	9.3	3.3	13.9(6)	-2.0(11)	-5.6(11)	60.2	136	17.3(25)	14	0
Reigate, *Surrey*	9.2	2.8	13.6(6)	-2.9(11)		64.9	135	19.4(25)	16	0
Guildford, *Surrey*	9.6	3.8	13.8(6)	-0.5(11)	-2.9(2)	60.6	142	12.5(24)	16	0
Sidcup, *London*	10.2	3.0	15.0(6)	-2.6(7)	-6.2(17)	41.4	121	14.5(25)	14	0
Hayes, *London*	10.2	2.2	15.3(6)	-3.9(11)	-6.3(11)	44.9	117	9.4(17)	15	0
Hampstead, *London*	9.7	2.6	14.4(6)	-0.8(17)	-8.9(17)	48.3	101	12.9(25)	15	0
Royston, *Hertfordshire*	9.0	3.4	14.0(6)	-0.5(2)	-5.0(17)	46.9	126	13.5(25)	11	0
Loughton, *Essex*	9.4	1.9	14.4(6)	-3.5(11)	-9.0(11)	43.4	125	13.5(25)	14	0
Buxton, *Norfolk*	9.0	2.5	14.8(12)	-4.5(17)	-6.2(17)	37.7	103	12.9(25)	11	0
Ely, *Cambridgeshire*	9.2	1.1	14.5(6)	-2.7(2)	-5.7(17)	29.3	91	11.2(25)	10	0
Luton, *Bedfordshire*	9.1	2.8	13.9(6)	-3.6(11)	-8.7(11)	60.3	75	17.5(25)	18	0
Buckingham, *Buck'shire*	9.2	1.8	13.4(6)	-3.7(2)	-8.8(17)	60.6	104	18.2(25)	17	0
Oxford University	9.9	3.0	14.6(6)	-3.2(2)	-7.5(2)	55.1	136	14.5(26)	16	0
Stourbridge, *W.Midla'ds*	8.7	3.2	13.3(6)	-1.1(23)	-6.9(21)	59.0	135	28.9(24)	13	0
Birmingham Univ'sity	8.4	3.1	13.1(18)	-2.0(11)	-8.2(17)	56.4	101	24.9(24)	14	0
Wolverhampton	8.4	2.5	12.4(18)	-1.1(17)	-5.1(17)	60.5		25.1(24)	13	0
Kettering, *Northants*	9.0	1.7	13.9(6)	-5.1(17)	-8.5(17)	37.7		8.0(24)	17	0
Louth, *Lincolnshire*	9.0	2.1	14.0(18)	-2.6(17)		32.2		8.3(24)	14	0
Keyworth, *Nott'shire*	9.2	2.2	14.3(6)	-2.1(17)	-8.5(17)	35.9		15.1(24)	14	0
Nottingham *Nott'shire*	9.6	2.2	14.3(18)	-3.1(17)	-7.2(17)	40.5	91	15.1(24)	14	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
Derby, *Derbyshire*	9.0	3.1	13.8(6)	-1.2(17)	-3.9(17)	49.1	99	19.7(24)	14	0
Middleton, *Derbyshire*	6.5	1.6	11.1(6)	-2.4(23)		102.1	148	33.7(24)	16	0
Keele University, *Staffs*	8.3	1.7	12.7(6)	-1.5(21)	-6.8(21)	62.0	129	26.9(24)	17	0
Liverpool, *Merseyside*	9.9	3.2	13.5(18)	-1.9(21)		65.6	128	22.6(24)	16	0
Lathom, *Merseyside*	9.1	3.0	13.1(18)	-1.0(11)		84.5		18.3(24)	18	1
High Bradfield, *S.Yorks*	6.4	1.5	11.0(18)	-2.3(23)		88.7		16.1(24)	18	–
Cottingham, *Humb'side*	10.3	2.3	15.3(6)	-4.1(17)	-7.1(17)	31.1		13.4(24)	13	0
Carlton-in-Cleveland	8.6	2.7	12.8(6)	-2.3(17)	-6.1(17)	53.8		34.4(24)	9	0
Durham University	8.6	2.1	12.2(18)	-3.7(17)	-6.6(17)	47.1	125	20.4(24)	14	–
Sunderland, *Tyne/Wear*	9.5	3.1	13.4(18)	-0.6(17)		39.1	144	21.8(24)	10	0
Carlisle, *Cumbria*	8.4	3.9				100.9	224			
CANADA: Halifax	-1.0	-9.4	9.2(21)	-17.4(17)		152.1	124	37.1(22)	17	0
U.S.: Bergenfield, *NJ*	5.3	-3.6	20.0(1)	-9.4(10)	-12.8(10)	63.5		33.5(21)	9	0
JAMAICA: Kingston	30.9	21.7	33.5(14)	20.2(26)		18.1		10.4(18)	5	0
AUST'IA: Mt. Wav'ley	27.5	14.9	37.0(18)	8.9(26)		30.3		18.3(15)	5	3
„ Leopold, *Vic*	26.7	14.0	38.5(18)	10.4(20)		30.1	68	25.3(15)	4	3

CUMBRIA RAINFALL:

The Nook, Thirlmere, 385.2mm (235%); Coniston, 352.9mm (222%); Hawkshead, 250.3mm (202%); Honister, 409.0mm.

TEMPERATURE AND RAINFALL: MARCH 1989

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
BELGIUM: Uccle	12.9	5.0	21.7(27)	-1.3(18)	-7.2(18)	87.3	160	26.6(7)	17	–
„ Houwaart	14.4	3.0	25.3(28)	-5.4(18)	-7.6(18)	86.5	147	27.9(7)	19	1
„ Rochefort	13.2	2.2	22.8(27)	-3.2(19)		66.4	121	13.5(7)	19	0
DENMARK: Fanø	8.4	3.9	15.9(27)	-0.6(18)		110.0	237	18.0(8)	22	1
„ Frederikssund	9.4	3.7	19.2(28)	0.6(3)	-4.9(18)	57.1	157	6.9(22)	18	1
GERMANY: Berlin	12.0	3.0	22.0(28)	-1.0(18)	-2.5(18)	25.7	81	5.3(1)	17	0
„ Hamburg	11.0	3.7	23.0(18)	-2.3(18)	-5.5(18)	77.6	176	10.5(24)	19	2
„ Frankfurt	13.7	3.6	24.2(28)	-1.9(19)	-5.2(19)	52.1	120	10.3(2)	17	1
„ Munchen	13.4	2.4	23.3(30)	-3.7(24)	-7.5(24)	34.0	64	9.5(18)	14	1
ITALY: Casalecchio	15.2	7.2	21.0(v)	4.0(v)	3.0(6)	49.4	100	16.5(19)	6	1
MALTA: Luqa	18.2	10.8	21.7(14)	5.9(10)	1.4(10)	16.8		11.3(8)	3	0
NETH'NDS: Ten Post	11.1	4.0	22.1(28)	-1.1(16)	-4.9(16)	102.2	225	22.7(8)	20	0
„ Schettens	10.5	4.3	19.2(28)	-2.0(16)	-5.8(18)	84.8	188	21.7(8)	20	0
„ De Bilt	12.1	4.0	21.8(28)	-2.8(18)	-6.9(18)	114.4	223	18.4(7)	19	1
SWEDEN: Valla	6.5	0.5	12.4(29)	-2.6(18)	-6.8(18)	51.9		7.6(24)	21	0
SWITZ'LAND: Basel	15.2	4.3	26.3(30)	-1.7(19)		34.2	69	9.1(15)	10	3
EIRE: Straide	10.2	3.1	13.8(31)	-4.0(17)	-10.5(17)	165.4	197		31	3
SHET'AND: Whalsay	7.4	2.8	10.7(30)	-1.0(16)	-2.1(24)	128.7	107	12.3(12)	28	3
„ Fair Isle										
SCOT'AND: Braemar	6.7	0.2	12.2(30)	-4.8(17)	-6.8(17)	127.0	244	25.5(23)	27	0
„ Inverdruie	8.3	0.3	14.9(31)	-7.6(17)	-11.2(17)	108.3	193	20.3(23)	25	0
„ Rannoch	7.6	1.8	12.9(31)	-7.0(17)	-6.2(17)	208.8		28.6(23)	29	0
WALES: Pembroke	11.2	4.6	14.4(29)	-0.8(18)	-4.0(18)	144.4	121	23.5(14)	24	0
„ Velindre	11.0	3.6	18.0(27)	-5.0(18)	-10.5(18)	82.5	144	15.1(14)	18	0
„ Carmarthen	10.3	4.1	14.4(26)	-2.3(18)	-7.0(18)	178.3	215	38.5(8)	25	0
„ Gower	10.6	4.7	14.3(26)	-0.2(17)	-5.5(18)	152.2	173	27.2(14)	22	0
GUERNSEY: Airport	11.1	6.7	17.0(27)	3.0(18)		65.5		13.1(15)	23	1
ENGLAND:										

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
Denbury, *Devon*	11.4	5.1	17.3(27)	–2.7(18)	–6.0(18)	121.6	98	25.9(14)	22	0
Gurney Slade, *Somerset*	10.8	3.8	18.7(27)	–4.7(18)	–5.8(18)	162.5	137	37.0(8)	23	0
Yatton, *Avon*	12.0	5.4	19.2(27)	–2.3(8)	–4.5(18)	94.3	114	23.6(14)	19	0
Corsham, *Wiltshire*	11.7	4.0	18.8(27)	–2.8(18)	–7.6(18)	79.9	151	21.1(14)	19	0
Mortimer, *Berkshire*	12.0	3.7	18.4(27)	–5.1(18)	–10.0(18)	71.0		13.5(20)	18	0
Reading Univ., *Berks*	12.2	4.3	18.4(27)	–4.4(18)	–7.1(18)	58.5	102	11.2(20)	17	0
Sandhurst, *Berkshire*	12.6	4.2	20.0(27)	–5.5(18)	–6.7(18)	73.5	169	17.3(2)	19	0
Romsey, *Hampshire*	12.3	4.0	19.1(28)	–6.3(18)		90.9		17.9(14)	19	0
Horsham, *Sussex*	12.4	4.7	19.7(28)	–3.1(18)	–6.7(18)	76.5	156	14.3(14)	18	0
Brighton, *Sussex*	11.7	5.3	17.7(28)	–1.0(18)	–2.2(18)	74.9	90	15.1(14)	16	0
Hastings, *Sussex*	11.1	4.8	17.6(28)	–0.1(18)		66.2	95	17.4(16)	12	0
Dover, *Kent*	12.2	4.8	18.9(28)	–3.0(18)		75.4	163	27.9(16)	15	1
East Malling, *Kent*	12.3	4.6	18.7(18)	–2.4(18)	–9.0(18)	59.4	138	19.1(16)	17	0
Epsom Downs, *Surrey*	12.3	5.0	19.2(31)	–2.9(18)	–5.3(18)	68.6	98	13.6(16)	18	0
Reigate, *Surrey*	12.4	4.2	20.0(31)	–3.2(18)		79.9	153	12.3(16)	20	0
Guildford, *Surrey*	12.2	5.4	19.0(31)	–1.7(18)	–4.0(18)	72.0	118	14.4(16)	17	0
Sidcup, *London*	13.0	4.7	19.8(31)	–4.4(18)	–6.8(18)	54.6	119	14.4(16)	16	0
Hayes, *London*	12.6	4.2	19.3(31)	–4.3(18)	–5.3(18)	62.6	101	10.9(16)	15	0
Hampstead, *London*	12.1	4.0	18.5(30)	–1.1(18)		71.1	141	18.4(16)	18	0
Royston, *Hertfordshire*	11.9	5.1	18.1(31)	–0.6(18)	–5.7(18)	41.8	95	15.2(16)	14	0
Loughton, *Essex*	12.6	3.8	18.7(28)	–4.7(18)	–10.0(18)	70.6	105	23.5(16)	17	0
Buxton, *Norfolk*	11.7	3.6	18.7(30)	–4.1(18)	–6.1(18)	43.7	88	8.1(2)	15	0
Ely, *Cambridgeshire*	11.8	2.9	18.8(27)	–3.3(18)	–5.2(18)	43.8	87	13.5(16)	17	0
Luton, *Bedfordshire*	11.5	4.6	18.4(31)	–2.6(8)	–7.6(18)	61.2	118	14.5(16)	19	0
Buckingham, *Buck'shire*	11.5	3.7	17.8(27)	–3.2(18)	–9.4(18)	55.9	129	12.5(14)	19	0
Oxford University	12.0	4.6	17.7(27)	–0.6(18)	–7.7(18)	47.0	145	7.9(2)	19	–
Stourbridge, *W.Mid'nds*	10.9	4.1	17.1(27)	–1.3(18)	–8.4(18)	44.5	56	11.2(14)	17	0
Birmingham Unv'sity	10.6	4.1	17.6(27)	–3.0(18)	–9.5(18)	60.5	101	13.2(14)	20	0
Wolverhampton	10.6	3.3	15.9(27)	–1.0(18)	–5.7(18)	57.3		11.3(14)	19	0
Kettering, *Northants*	11.3	3.4	18.3(31)	–6.1(18)		43.2	66	11.4(14)	21	0
Louth, *Lincolnshire*	11.2	2.7	17.0(30)	–0.8(9)		59.6		10.9(2)	16	0
Keyworth, *Nott'shire*	11.2	3.8	16.8(30)	–1.5(18)	–7.7(18)	49.8		8.5(14)	16	0
Nottingham, *Nott'shire*	12.0	3.6	17.7(27)	–1.7(8)	–6.1(8)	53.7	123	10.5(23)	20	0
Derby, *Derbyshire*	11.1	4.6	17.0(27)	–1.2(18)	–3.6(18)	55.8	112	9.0(14)	22	0
Middleton, *Derbyshire*	8.6	2.5	14.6(27)	–2.2(18)		124.2		22.8(14)	21	0
Keele University, *Staffs*	10.0	2.6	15.7(27)	–3.1(18)	–8.0(8)	51.0	106	7.9(14)	17	0
Liverpool, *Merseyside*	11.3	3.7	15.8(30)	–2.1(18)		49.5		9.0(20)	21	2
Lathom, *Merseyside*	10.3	3.7	14.6(27)	–1.5(17)		93.1		17.0(18)	18	0
High Bradfield, *S.Yorks*	7.7	1.5	13.9(27)	–3.5(18)		90.3		23.1(23)	–	–
Cottingham, *Humb'side*	12.0	3.2	18.6(27)	–2.2(8)	–6.1(8)	51.3	93	8.7(20)	21	0
Carlton-in-Cleveland	10.3	3.1	16.8(27)	–2.4(8)	–6.4(8)	47.9		7.6(27)	18	0
Durham University	10.5	2.8	16.5(27)	–3.2(18)	–7.9(18)	20.7	46	3.5(23)	17	0
Sunderland, *Tyne/Wear*	11.0	3.6	17.2(31)	–3.8(17)		17.3	38	5.2(16)	13	0
Carlisle, *Cumbria*	9.8	3.4				72.6	127			
CANADA: Halifax	1.9	–7.4	17.5(28)	–20.8(7)		113.8	97	31.8(21)	13	0
U.S.: Bergenfield, *NJ*	11.4	0.0	28.3(28)	–12.2(8)	–15.0(8)	92.5		20.8(24)	8	3
JAMAICA: Kingston	30.5	22.0	31.9(25)	19.6(14)		57.7		26.5(8)	6	1
AUST'IA: Mt. Wav'ley	25.3	14.6	38.6(2)	7.6(v)		103.5		31.5(21)	14	4

CUMBRIA RAINFALL:

The Nook, Thirlmere 498.4mm (258%); Coniston, 419.7mm (227%); Hawkshead 334.1mm (239%); Grange-over-Sands 170.8mm (203%).

Corrigendum: **In the article on the Irish tornado of 1054, by M. Rowe, Vol.14, p.90, the first sentence of the conclusion should read: 'The Rosdalla tornado is certainly one of the most interesting of the known mediaeval cases . . .'.**

JOURNAL OF METEOROLOGY Vol. 14, no. 140, July/August, 1989

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FRONT COVER:

Sunny skies over England and Wales, November 1988, one of the sunniest Novembers of the century (article by D. A. Wheeler).

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