The JOURNAL of METEOROLOGY

STRANGE ATTRACTOR: CIRCLE COMPLEX ALIGNED WITH TRACTOR LINES, CRAWLEY DOWN, HAMPSHIRE

Volume 15, number 152 **October 1990**

THE JOURNAL OF METEOROLOGY
LE JOURNAL DE MÉTÉOROLOGIE
Published in association with
The Tornado and Storm Research Organisation
a privately-supported research body, serving the national public interest
Edited by Dr. G. T. Meaden, 54 Frome Road,
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Published by The Artetech Publishing Co., 54 Frome Road, Bradford-on-Avon, Wiltshire, BA15 1LD.

Printed by The Dowland Press Ltd., Frome, Somerset.

 ISSN 0307-5966

JOURNAL OF METEOROLOGY
"An international journal for everyone interested in climate and weather, and in their influence on man."
Editor: Dr. G. T. Meaden Vol. 15, no. 152, October 1990

THE HAILSTORMS AND THUNDERSTORMS OF 22 AUGUST 1987 IN ESSEX AND SUFFOLK

By JONATHAN D. C. WEBB
T.O.R.R.O., Oxford

Abstract: Severe thunderstorms developed in a south-west/north-east swath across Essex and south Suffolk on the afternoon of 22 August 1987. Flash flooding disrupted transport and communications, while hailstones up to 38 mm diameter caused extensive damage to crops, glasshouses, and motor vehicles. The event was not unprecedented in the context of recent historical research which suggests that this region experiences a relatively high incidence of severe convective storms.

INTRODUCTION

A classical displacement of very warm humid conditions by cooler Atlantic air provided the background for some exceptionally heavy thunder/rainfall in England and Wales during the weekend of 21 to 23 August 1987. 86 mm of rain fell on Anglesey overnight on 21st to 22nd, while 114 mm fell in just over nine hours in Staffordshire on the 23rd (Stanier 1987). However the most spectacular thunderstorms, aspects of which are discussed in this paper, affected Essex and Suffolk during the afternoon of the 22nd. Features of these storms included violent rainfall, squalls, and hailstones typically of walnut size and occasionally up to golf-ball size.

SYNOPTIC BACKGROUND

On 19th August 1987 an anticyclone was situated over the English Channel; this moved north-east to the Southern Baltic on the 20th while a cold front edged into western Britain, its progress in the south being very slow as it came up against a developing upper ridge. Hot humid air was advected northwards into Southern England; the 20th and 21st were among the warmest days of the year with temperatures rising to 29 to 30°C in places. At 1800 on the 21st the cold front lay from the Irish Sea across Wales and the north Midlands to the Humber. Previous thunderstorms during the summer of 1987 had been almost exclusively associated with deep unstable Polar air (e.g. between 6th and 17th June). However, developments on 21st August correctly suggested that widespread thundery activity would extend from France and Biscay into southern and eastern England.

Two organized waves of thunderstorms drifted north-east across south-east England and East Anglia during the evening and earlier part of the night of 21st–22nd (Fig. 1). The storms were especially active over Kent where

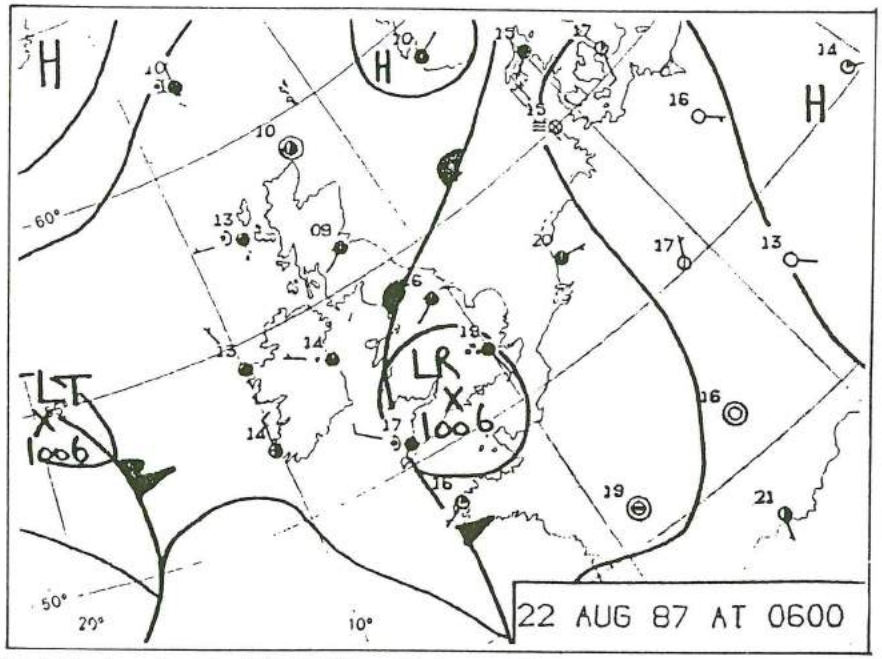

Fig.1: Surface chart for 0600 GMT on 22 August 1987.

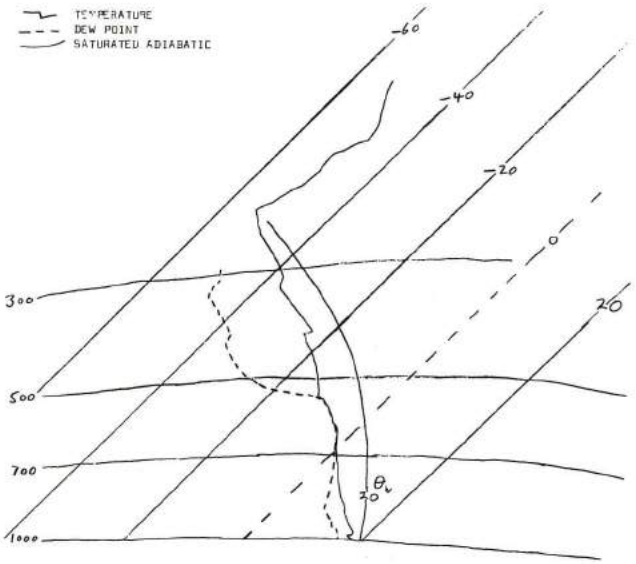

Fig.2: Upper-air temperatures and dewpoints. Hemsby, 22 August 1987 at 1200.

overnight rainfall exceeded 40 mm in places (e.g. 43 mm at Charing). Some hail was also reported and hailstones were observed up to 13 mm diameter in the Gillingham area. As the upper winds continued to back ahead of the approaching upper trough, the third wave of thundery outbreaks was carried on a more northerly track across central southern England and into the south Midlands between 0500 and 0900; activity from these overnight storms had largely subsided by mid-morning.

The 1200 upper air ascent at Hemsby (Fig. 2) indicated strong potential instability with a deep layer of moist air from the surface up to 550 millibars (especially between 750mb and 550mb), capped by much drier air above 550mb. The forecast afternoon surface temperatures of 23 to 25°C would be expected to launch deep convection extending right up to the tropopause. The tephigram predicted cumulonimbus tops in the region of 11 kilometres, and this agrees closely with subsequent observations of cloud heights made by aircraft in the Ipswich area in the afternoon.

The vertical wind profile (Table 1) shows strong speed shear throughout the entire depth of the troposphere, velocities increasing from 5 knots at the surface to 85 knots at 250 millibars (anvil level). There was also substantial wind veer between 850mb and 500mb. Significant wind shear is believed to be a critical factor favouring the development of the organized convective storms that are associated with large hail (Ludlam 1980, Dent and Monk 1984).

TABLE 1: Upper Winds, 22 August August 1987, 1200Z. Hemsby. 52.7°N. 1.7°E

Height (mb)	*Direction*	*Speed (knots)*
Surface	160	5
850	150	26
700	195	26
500	200	46
300	175	80
250	170	85
200	195	50

THE FORMATION AND PROGRESS OF THE STORMS

Cloud broke up in the late morning to allow surface temperatures to climb above 23°C in places, especially in the London area (25.5°C at Northolt). Isolated showers developed soon after 1200 but the widespread eruption of deep convection from the surface was triggered around 1330 over and to the south-west of London; these thunderstorms drifted north-eastwards in the upper wind flow to reach south-west Essex between 1330 and 1400. A series of storms affected the Loughton (Prichard 1987) and Chigwell areas from 1330 onwards, and by 1400 one of these storm cells had spread as far north-east as the Ongar area where radar pictures indicated precipitation intensities of over 40mm per hour. This cell declined rapidly after 1400 but between

1415 and 1445 two very intense cumulonimbus cells exploded over Essex. The first involved the intensification of another thundery shower which had moved north-east from London; this storm was approaching Chelmsford from the west by 1445. The second major cell shot up a few kilometres west-south-west of Colchester; these two major cells rapidly became part of a band of thundery rain, 30 to 50 kilometres wide, extending north-eastwards right across Essex to the Suffolk border. (Fig. 3a)

A severe thunderstorm crossed the Chelmsford area between 1445 and 1530. The onset of the storm was heralded by a violent squall which tore branches up to four feet long off trees. 41mm of rain was recorded in 30 minutes and the western and northern districts of the town were subjected to intense hail of 6 to 10mm diameter which caused considerable damage to gardens.

Meanwhile, by 1500, rainfall intensities associated with the other major cell were exceeding 90mm per hour west of Colchester, suggesting the presence of large hailstones. Both these severe thunderstorm cells passed over the Colchester area between 1500 and 1600 with peak rainfall intensities soaring to over 100mm an hour (Fig. 3a). At West Bergholt hail the size of walnuts fell almost continuously for up to half an hour from 1515 covering the ground for up to three hours. The full ferocity of the storms was experienced across the Stour Valley where there were two bursts of hail up to 38mm diameter in places. One motorist, observing his windscreen bulge with the impact of the hailstones, described the storm as resembling "100 hammers hitting the car simultaneously". At Dedham the hail lay up to 150mm deep, reminding older residents of a similar storm in June 1942.

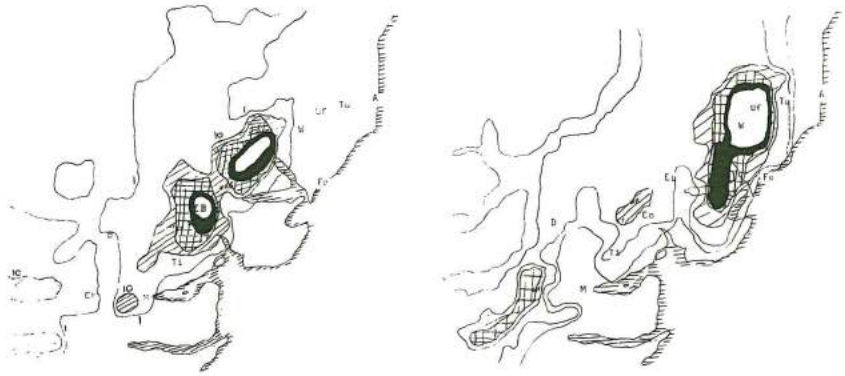

Fig.3a: Radar pictures for 1545 GMT on 22 August 1987. Precipitation intensities are represented by isolines of 1, 10, 25, 50, 75mm/hour. A Aldeburgh, B Braintree, Co Colchester, Ch Chelmsford, Fe Felixstowe, M Maldon, T Tiptree, Tu Tunstall, Uf Ufford, W Woodbridge.

Fig.3b: Radar picture for 1615 GMT on 22 August 1987.

Radar pictures (Fig. 3b) suggest that the two intense storm cells had merged into a single large system by 1530. However the 5km × 5km radar resolution may not have been fine enough to identify separate cells. There is therefore insufficient evidence to confirm that the storm had achieved true "supercell" status.

Near total darkness was reported from Ipswich as the storm commenced there around 1530; intense precipitation fell for 20 to 30 minutes, the deluge of hailstones being so severe that ice covered the ground to a depth of 150 to 200mm in the east of the town. Further north-east, Saturday afternoon shoppers in Woodbridge were sent running for cover by the barrage of hailstones which accumulated ankle deep in places. 33mm of rain fell in just 20 minutes at nearby Melton. The swath of large hail continued its course across Ufford and into Tunstall forest. This storm's final onslaught, before moving out over the North Sea, occurred when a violent squall struck the quayside at Aldeburgh; two catamarans were lifted, one being hurled over four yachts; several other craft ran aground. Torrential rain followed with 27mm falling in less than half an hour.

Radar pictures indicate that another very severe storm cell moved from the Chelmsford area towards Tiptree between 1630 and 1700 with peak precipitation intensities exceeding 100mm per hour. This cell contributed towards the widespread flooding in Tiptree (where quite large hail was reported) and the Heybridge basin.

However, by 1730 the whole band of thundery rain had declined and begun to recede north-eastwards.

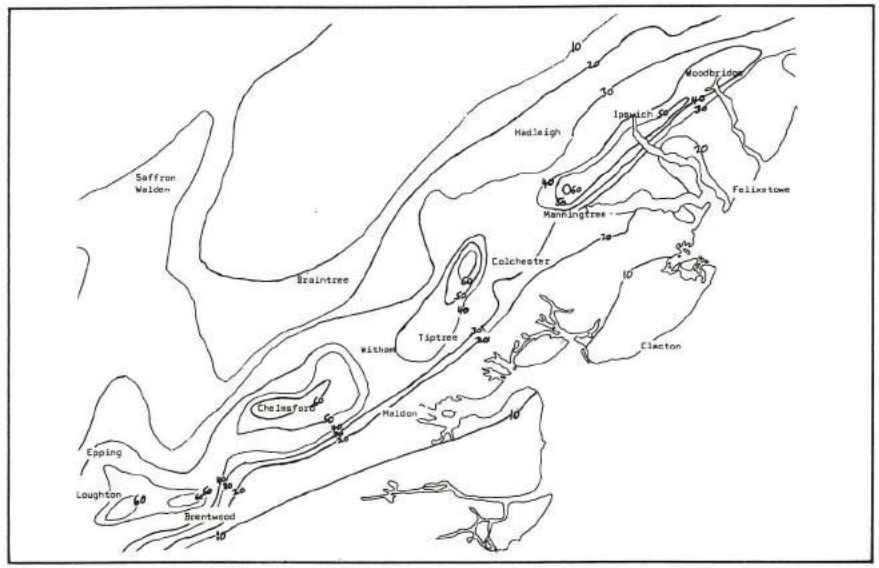

Fig.4: Total rainfall (mm) for 24 hours from 0900 GMT on 22 August 1987.

TABLE 2: Hourly Rainfall Totals, 22nd August 1987

Time	*Writtle* TL 677069	*Chantry* TM 149414
0900 – 1100	–	8.5
1100 – 1300	2.7	–
1300 – 1400	–	–
1400 – 1500	8.9	–
1500 – 1600	35.6	11.5
1600 – 1700	19.4	33.5
1700 – 1900	1.4	1.5
1900 – 2100	–	–
12 Hour Totals	68.0	55.0

THE DISTRIBUTION OF PRECIPITATION

Fig. 4 plots rainfall totals for the 24 hours commencing 0900 on 22 August 1987, while Table 2 presents hourly rainfall data (0900–2100) for two representative recording raingauge sites, Writtle, near Chelmsford, and Chantry, near Ipswich. The highest official 'daily' rainfall was 77.2mm at Chigwell Row in the extreme south-west of Essex where thunderstorms, which began by 1400, continued throughout the afternoon. The severe flooding reported in such riverside towns as Romford, Chelmsford, Colchester and Manningtree can be partly attributed to very heavy rainfall occurring slightly upstream (e.g. to the north-west of Romford). It must also be noted that some 10–15mm of rain had already fallen over much of Essex during the storms of the previous night.

Hail exceeding 20mm diameter fell in a swath extending from a few miles south-west of Colchester to Tunstall Forest in Suffolk (Fig. 5). Hailstones up to 38mm diameter were reported from villages just west and north of Colchester, in the Dedham Vale, and from Woodbridge and Ufford in Suffolk.

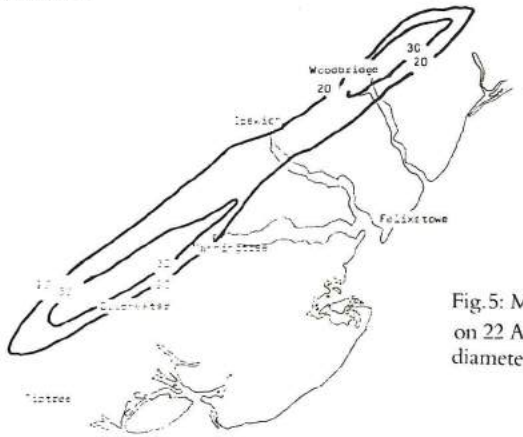

Fig. 5: Map showing principal hail-swath on 22 August 1987. Isolines are of hailstone diameters at 20mm and 30mm.

FLOODING

Romford Police used dinghies to rescue four people who were trapped in their flooded homes. One hundred houses were flooded and people were forced to sleep in pubs and church halls. The River Rom overflowed, blocking the main A12 road.

Chelmsford Several High Street stores were flooded when the River Chelmer burst its banks causing floods up to seven feet deep. Policemen had to swim across Westway to check whether anyone was trapped in two submerged cars. Telephone systems were damaged disrupting emergency ambulance services. The town was reported to be completely cut off for a time in the evening with floodwater blocking major roads including the main A414 to Harlow (at Roxwell) and the A12 at Widford. Firemen, inundated with calls, had to restrict these to life-threatening emergencies for a while. Collapsed embankments interrupted railway services.

Braintree The swollen River Brain blocked the Braintree-Faulkbourne road for a time.

Colchester district Dogs had to swim to safety when kennels in School Road, Copford, were flooded. Many houses in the village were also inundated. Houses were also flooded in West Bergholt and at Stanway where the A12 was restricted to single lane traffic. Over 15 homes were flooded in Tiptree, while further south, Heybridge on the Blackwater, was partly cut off by flooding.

Stour Valley A 33cm thick wall in Manningtree was washed away by raging floodwaters. A landslide blocked Colchester Road, Lawford, while three feet deep floods stranded cars in Dovercourt. The main Ipswich to London railway line was blocked by a landslide at Brantham.

Ipswich The Strand, Whersted, sustained thousands of pounds worth of damage through flooding; vehicles became marooned in three feet of water. The main A45 road to Felixstowe was blocked, and severe flooding also affected the A12 at Copdock Mill.

Woodbridge The matinee performance at the Riverside Theatre was suspended when the underside of the stage became flooded. Pubs and stores were also inundated, while cars parked on a hill were actually shifted by the force of the floodwaters.

HAIL DAMAGE

Glass Hundreds of glasshouses were broken, localities severely affected included West Bergholt, Langham, Dedham, Woodbridge, Melton and Ufford. Golf ball size hailstones caused £100,000 damage to one nursery in Ufford.

Glass roofs and skylight windows also experienced widespread breakages, causing additional flooding to both domestic and commercial premises. St. Audry's hospital, Melton, sustained very severe damage; every skylight was at least partially smashed, while an average of twenty panes of glass were broken in each of the wards, many of which suffered flooding.

One glass covered corridor was completely wrecked.

PVC roofing including carports and conservatories, was damaged over a large area. Hailstones punctured hundreds of small holes in one conservatory roof in Bixley Road, Ipswich.

Motor vehicles Many cars had the bodywork of their roofs, bonnets and tailgates pitted, some with hundreds of dents. Windscreens were cracked or shattered, especially west of Colchester and between Woodbridge and Ufford. Repair shops and insurance companies were overwhelmed with claims following the storms. Repair costs often amounted to between £1,000 and £2,000, typically including the replacement of bonnet, roof, tailgate, and top panels, while even vertical door panels required respraying. The widespread damage to vehicles may reflect the uncanny manner in which the storms followed the course of the main A12 trunk road! However some 'upmarket' cars claimed a sales publicity boost during the storms. Powerful Porsches displayed on a forecourt near Colchester were reported to have ridden the storm unscathed!

Caravans on a site in West Bergholt looked as if they had been "machine gunned".

Crops and Vegetation The storms cut a swath through one of East Anglia's principal apple growing areas. Most fruit affected was scarred with deep pock marks. Some apples were actually split in half by the force of the hailstones. At a farm near Ardleigh, Colchester, 80 acres of orchards were virtually destroyed. Standing wheat was also damaged (though of course some had already been harvested), while some sugar beet and dwarf beans were reduced to stems.

It was reported that nearly every garden in Woodbridge was flattened. "Woodbridge in Bloom" displays of basket flowers were ruined. Foliage stripped off trees combined with ankle deep accumulations of hail to block drains and aggravate flooding.

FACTORS INFLUENCING THE FORMATION AND EXTENT OF THE STORMS

Prichard (1987) remarked that the synoptic background on 22nd August 1987 closely resembled other occasions when severe thunderstorms caused flooding in south-west Essex. It seems likely that the relatively strong upper south-westerlies present in this case created the additional conditions favourable for the production of large hail, and also provided the steering wind which propagated the storms north-eastwards across Essex and into South Suffolk.

The surface synoptic chart for 1500 GMT (Fig. 6) indicates that a trough extending east from the shallow depression centred over the Midlands was crossing eastern England at the time; however that would not explain the south-west/north-east orientation of storms which persisted for several hours. The tendency for this corridor of storms to persist roughly parallel with the coast suggests that a sea breeze convergence zone, several kilometres inland, may have contributed to their development and persistence.

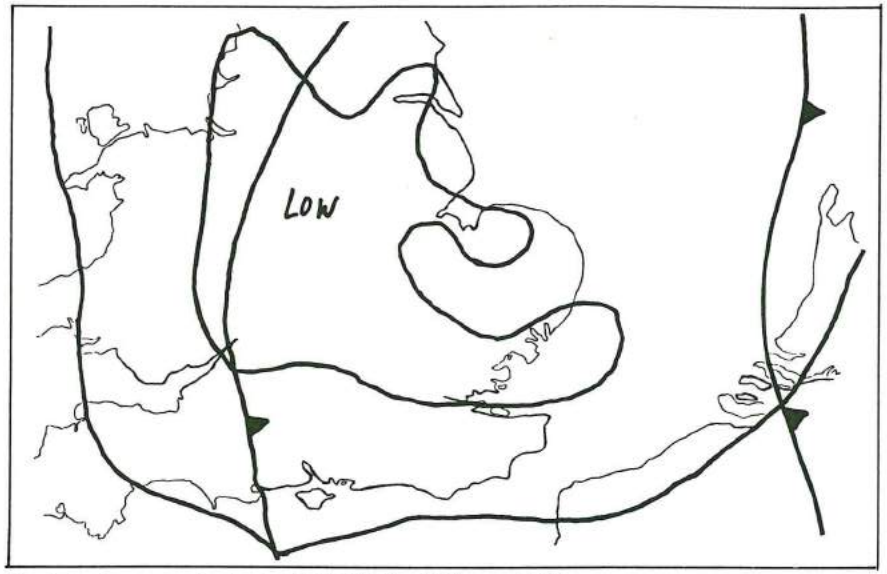

Fig.6: Surface synoptic chart at 1500 GMT on 22 August 1987.

PREVIOUS SEVERE CONVECTIVE STORMS IN THE AREA

Provisional TORRO research does suggest that Essex and Suffolk experience a relatively higher incidence of seriously damaging hailstorms than other parts of the British Isles (Webb 1988). Another recent outbreak on 26th May 1985 affected a larger area than in 1987; an estimated £1,500,000 damage to crops was reported from farms around Great Dunmow, Essex and a relief fund was organized by the local NFU.

Some press reports described the 1987 storms as the worst of their kind to hit the Colchester and Ipswich areas this century. In order to place this even in historical perspective other damaging hail events in north-east Essex and south-east Suffolk over the previous 100 years have been extracted from TORRO's files and are reviewed below.

7th June 1889. Hail of 18 to 25mm diameter fell at Ipswich. It was reported that 100,000 panes of glass were broken.

26th May 1892. Hail up to 25mm diameter fell in Ipswich. Much glass was broken in the east of the town, and also at Colchester.

26th April 1894. Large hail was reported at Woodbridge.

20th July 1900. Severe hailstorm in Ipswich. Much glass broken in the Bishop Hill area.

8th February 1906. Hail the size of marbles fell in the Ipswich area.

14th June 1942. A severe hailstorm affected the Stour Valley, including East Bergholt, Stratford St. Mary, Langham, Dedham and Ardleigh. The hail lay 60mm deep with 300mm drifts. Roof slates and tiles were

broken, fruit and vegetable crops seriously damaged, and birds were reported killed.

5th August 1956. Hailstones lay 40mm deep in Ipswich following a severe storm. The main Ipswich to Harwich road was blocked after torrential rain caused a landslide at Brantham.

10th July 1959. A severe hailstorm was reported from Felixstowe in the early hours.

Those storms in 1889, 1892, 1900 and 1942 appear comparable in severity with the 1987 storms. Although its impact was felt outside the immediate area of interest, mention must be made of the historic Essex hailstorm of 24th June 1897 which inflicted damage at the *H7* level in the Chelmsford area. At least 13,000 hectares of crops in Essex were wiped out by that storm (Essex Field Club 1897). Destructive hailstorms caused disastrous crop losses over a wide area of West Suffolk on 2nd–3rd July 1946, and in a swath across mid Suffolk on 16th July 1947.

The intensity of the rainfall on 22 August 1987 has certainly been surpassed in the region; indeed barely three weeks before on 29 July 1987, 53mm of rain fell in only 21 minutes near Epping, south-west Essex. Writtle, near Chelmsford, recorded 99mm in two hours on 26 July 1941, while 75mm fell in one hour at Ipswich on 21 July 1897. However the rainfall event of 22 August 1987 was outstanding for the relatively large area affected. It must be unusual for Chelmsford, Colchester and Ipswich, three major East Anglian towns, to be affected by "flash flooding" during the course of the same afternoon.

Acknowledgements. Special thanks are due to the Meteorological Office, Anglian Water Authority, and Mr. T. Mayes (Rainfall Organisation of Essex and Suffolk) for the supply of rainfall data, and to Mr. A. Waters of Met.0.15 and Mr. B. Hems of Met.0.3 for the supply of and discussions on radar data. Sincere thanks are also due to numerous other correspondents who contributed information on these storms.

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OPERATION HIGH HILL – CERES'S CIRCLES WATCH OF 1990

Lights and noises in the atmosphere

Operation High Hill, organized by CERES, took place from Friday 13 July to Saturday 11 August 1990, chiefly on the Beckhampton Downs in mid-north Wiltshire, but with additional watching at Bratton and Upton Scudamore (West Wiltshire) in the period 13 July to 20 July. The hope was to obtain eyewitness and photographic evidence of either circles forming or their associated light-forms appearing, together with instrumental data regarding the condition of the atmosphere as a function of time. Alas, we were out of luck this year, as also last year (Operation Green Hill), but one of our observers did at least have a sighting of a luminous form above a field in which circles were found when daybreak came.

The key to our operation was mobility. Instead of setting up the entire team in front of a single field for the whole operation, the team was split in order that different zones could be monitored simultaneously, the choice of zone depending upon recent developments and present and predicted weather variations. On Friday nights, when observer numbers were at a maximum, as many as five or six hillside or hilltop observation posts were each manned by one or two carloads of circles watchers.

The whole operation was intended to be a quiet affair without sought-for publicity. However on the first night, the 13th July, the meeting of some thirty observers at Silbury Hill car-park was attended by several press reporters and ABC television of the U.S.A. who were making a documentary programme on the circles effect. Among the scientists present were Dr John Graham (chief agronomist at Shuttleworth College, Cranfield Institute of Technology), Dr Robin Allen (Department of Physics, Southampton University), Dr Chris Nash (Southampton University), David Reynolds (Lancaster University), George Bathurst, Maxwell Woosnam, and Gordon Garrould. Other keen circle watchers included Paul Fuller, Busty Taylor, Peter Rendall, Roger Davis, Jacqui Pearson, Richard Flaherty, Michael Dimmock, Stanley Morcom, Una Dawood, and Alan Rayner.

The ABC television crew assisted that night by filming with their infrared night-vision camera at Bishops Cannings and Alton Barnes. At Bishops Cannings adjoining the Calne Road a four-ringed quintuplet had appeared on 1st June. Its arrival had been heard in the darkness of the night by farmhand Andrew Woolley as an extraordinary whistling sound which woke him up before stopping soon afterwards. A further quintuplet hit the same field on 6th July, partially overlapping the first quintuplet. At Alton Barnes the now-famous circles complex appeared on Thursday 12th July and was still very fresh when the CERES team inspected it on the evening of the next day and the following morning. The night of Wednesday–Thursday had been calm except of course for the 'vortex sheet' where the descending

vortices struck, but the night of Friday–Saturday (the first crop-watch night) was unfortunately rather windy and no circles appeared anywhere that night. However the next night when only one witness was present (and he was an unsuspecting but observant member of the public, not an intended circles watcher, who was on the road near the top of Walkers Hill, Alton Barnes) a marvellous orange-yellow light form manifested itself by hovering close to the hilltop. In the morning wheatfield circles were found close by (details to be published later).

One of the circles observers working with the CERES team was Richard Flaherty, an experienced wildlife photographer. He spent three weeks camped on the downs, and was out watching practically every night, choosing sites according to the wind conditions. One cold, calm, starlit night at 2.30 in the morning (BST) he was walking along a track at SU 076095. This was slightly below the ridge along which the A4 passes, and was between the A4 and Windmill Hill, Avebury. Richard was moving westwards when he saw in the distance to the south-east a single column of light coming from high in the sky into what he realised must have been Stephen Horton's wheatfield the other side of the A361 around 1.25 km away (SU 083685). Unfortunately he could not see the lower end of the column because the ridge intervened and there was no quick way of attaining the ridge. The column seemed to be the result of weak self-illumination and in particular was entirely different from car headlights in character, brightness and direction. In fact the luminous column, which was near vertical, had furthermore definitely nothing to do with aircraft, there being none about anyway. He watched the unusual light for six or seven seconds not fully aware of its importance, but nevertheless decided that in the morning he should look to see whether any circles had appeared below – which he did. The date was Wednesday 25th July, the morning when Stephen Horton, like Richard Flaherty, found that the field contained circles linked by curving paths (the so-called 'scrolls'). This observation of a luminous column or tube is very important being the third time in three years that such a report has come to our attention. The other occurrences were at Silbury Hill (June 1988) and Bratton (July 1988) when the witnesses were able to specify that they definitely saw *tubes*, not beams, of light.

During the four weeks of Operation High Hill several circles appeared on the Beckhampton Downs but not within sight of our observers. In the end the circles season terminated, as always, by the disappearance of the cereal crops. In a mainly rainless, warm July–August, as this summer, harvesting starts early and is completed early. We hope for better luck on next year's circles watch when we plan to return to the same general area for a more detailed and persistent monitoring programme of the Beckhampton Down-Pewsey Vale circles region. The starting date is likely to be Friday 21 June 1991 or the Friday before.

G.T.M.

THE BECKHAMPTON 'SCROLL-TYPE' CIRCLES, THE BECKHAMPTON 'TRIANGLE', AND STRANGE ATTRACTORS

By G. T. MEADEN
CERES, Bradford-on-Avon, Wiltshire

At Beckhampton, Wiltshire, the night of Tuesday–Wednesday 24–25th July 1990 produced some amazing circle patterns in a wheatfield owned by Stephen Horton. As indicated in the preceding article, it is possible that the appearance of one or more of the patterns was related to the occurrence of a self-luminous column or tube of light seen pointing into that field at 2.30 a.m. on the 25th.

A general view of the field is given in Figure 1. Altogether there are thirteen circles (some joined to each other by curving corridors) together with one of quasi-triangular shape and some other but smaller geometrical elements of interest in themselves.

Figure 2 provides a sketch, not to scale, of two of the circles with just a few survey points showing. The circles are joined by a curving path thirty metres long. The bigger circle was clockwise outwards and the smaller circle clockwise inwards. Both circles had tufts at their centres. These elementary

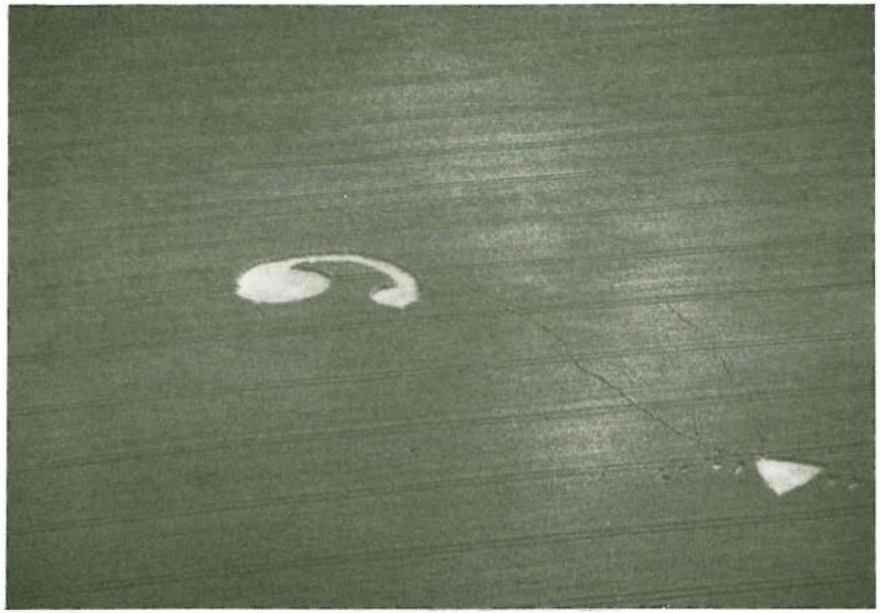

Figure 1. Aerial view over the Beckhampton field with its scroll-like, curving features and the concave-sided triangle.

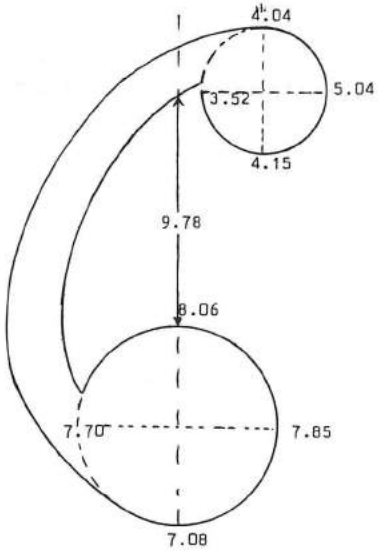

Figure 2. Plan of the circle-pair linked by a curving corridor.

observations accord with vortex theory in which a ring vortex is envisaged as descending into a field before 'spinning up' again. This is not the first time that a curving arc has been seen. Last July there was a long curving path into a single circle in a field close to Cheesefoot Head, Hampshire, and on a smaller scale entry paths of a related type have been spotted elsewhere (1987 Bratton, 1988 Firs Farm, Beckhampton).

Also visible in the photograph (Figure 1) is a series of three linked circles. All were anticlockwise, each with a central tuft, and were joined by a four-metre broad curving corridor. In order, the circle diameters were 14, 7½ and 7 metres. It was in the biggest of these circles that Paul Ferguson and Terence Meaden performed various proton magnetometer tests, parts of which were also filmed for an ITV farming programme and a BBC children's programme.

Next we mention the tuft-centred quasi-triangular shape, with sides 10–11 metres long, shown in Figure 3. This was likely produced by the descent of a ring vortex which expanded in the usual circular fashion up to a diameter of eight metres. Beyond this a distortion of the circulating forces set in which led to a quasi-triangular shape with two rounded corners. However, formation of the third corner seems to have been affected by the presence of the tractor lanes. The flattening of the corn within these 'corners' was regular, being no more than an extension of the outward flattening initiated by the primary spiral-circle. Some non-scientists have tended to regard non-circular shapes like the quasi-triangle as wholly anomalous, but the triangle is nothing other than an imperfect circle. It is only to be expected that non-

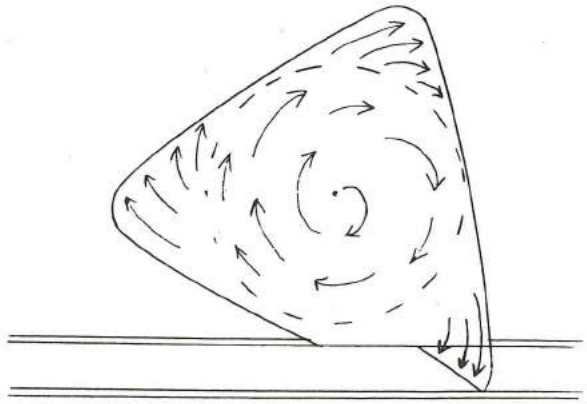

Figure 3. The Beckhampton 'triangle' which is no more than a deformed vortex-circle.

circles and curving paths should occasionally result from the vicissitudes of wandering vortices – that not all of the short-lived vortices are perfectly quasi-stationary during their brief moment of impact with the crop and ground.

Of the other unusual patterns noted in this field there was a mini-triangle with sides 4–4½ metres long and a rectangle four metres by one metre which displayed the characteristic 'combing' effect into the corn at its remote end in the way commonly noted for natural rectangles. The origin of these and some other small cropmarks in the vicinity seem to be linked to the presence of a tractor lane from which they exit. This serves to emphasise the role that

Figure 4. Complex circle set on Crawley Down in Hampshire, July 1990.

tractor marks can play in modifying the earth's local electric field possibly by acting as 'strange attractors' for vortex descent and hence aligned circle-patterning on some occasions at least. We shall go into this in more detail in another paper, but for the present it is enough to say that multiple-circle alignment with tractor marks, where it occurs (cf Figure 4), is likely to have a perfectly intelligible, scientific explanation without recourse to the absurd 'alien intelligence' ideas being aired by certain anti-scientists.

SPONTANEOUS COMBUSTION –

An eye-witness case from Hungary

Spontaneous combustion has long been an enigmatic problem for connoisseurs of the curious. Mystifying examples include the discovery of unfortunate individuals burnt, or partly burnt, to death in closed rooms, sometimes with little or no evidence of ignition to the rest of the room's contents. The main hypothesis advanced in the past – although without acceptable proof – has been that ball lightning somehow intruded into the room. Now at least we have a rather well-documented case because of the presence of an eyewitness. The investigation was made by ball-lightning expert Dr George Egely of the Central Institute of Physics, Budapest, and was reported at the Second Ball Lightning Conference held in Budapest in June 1990 the week following the Oxford Circles Effect Conference.

The date was 25 May 1989, and the place a field by the roadside near Kerecseud, a village 109 kilometres from Budapest. The victim was a 27-year old engineer within whose body, it is conjectured, ball lightning formed. The man had stopped his car and walked to the edge of a field about ten metres distant to urinate. Suddenly his wife who had remained behind in the car saw that the young man was surrounded by a blue light. He opened his arms wide and fell to the ground. His wife ran to him, noticing that one of his tennis shoes had been torn off. Although it looked hopeless she tried to help him but soon after she was able to stop a passing bus. Amazingly, the bus was filled with medical doctors returning from a meeting; unhappily they immediately pronounced that the man was dead.

At the autopsy a hole was found in the man's heel where the shoe had been. The lungs were torn and damaged, and the stomach and belly were carbonized! This is indicative of internal combustion, just as the blue light is proof of atmospheric electricity while the damaged heel and shoe are indicative of electrical earthing. No other effects of local atmospheric electricity were noticed. The sky was overcast and conditions possibly suitable for a thunderstorm. The couple had earlier passed through a thunderstorm when 50 kilometres away, but at the site of the tragedy it was dry and rainless.

G.T.M.

TORNADIC EVENT OF 26 MAY 1990

By DANA MACK

436, East Linden, Mustang, OK 73064, U.S.A.

The morning and afternoon preceding the outbreak of severe storms this day had been exceedingly hot and sultry, with temperatures in the mid-90's. As I watered the garden, I felt stifled, as I attempted to breathe in the moist, oppressive airmass. Earlier in the day, the NWS had felt that the cap-an layer of warm air in mid-levels was too strong to allow thunderstorms to develop. However, changes occurred in the synoptic conditions to prove this contention incorrect.

Earlier that morning, in the pre-dawn hours, severe thunderstorms had formed complexes in south-eastern Kansas, and north-eastern Oklahoma, pounding those areas with torrential rains, and large hail. These storms produced regions of rain-cooled outflow that moved south and west with time, and by five o'clock had reached Oklahoma City. Towering cumulus began building north and west of Oklahoma City as the outflow boundary moved west of the city. I could see convection trying to overcome the cap, as it billowed upwards, but then to be sheared off to the northeast, and collapse as the cap held. Each tower, with time, began to show signs of increasing intense convection, and by five-thirty or so, one tower broke through the cap near Enid, Oklahoma, and quickly became severe.

It was at this time, that the Oklahoma County Civil Defense was requested by the National Weather Service Forecast Office in Norman, Oklahoma (south of Oklahoma City by 17 miles – about 25 to our south-south-east) to send two members of its organization to relay radar reports and warnings via two-way radio to field crews. I, being a recent recruit into the organization, and known as spotter number 953, was eager to participate in the night's festivities. Our chase leader, number 912 – Bryan D. – put out a message to me over the radio, hoping I would hear on my scanner – "953, if you copy this, please go to Norman now . . .".

I threw note-pad, pencils and maps into the car, and headed towards Norman, with some urgency, being careful to watch for law enforcement personnel along the way, because my speed was not within lawfully prescribed limits. To my west, gigantic anvils from storms building southward into Kingfisher County and Canadian County (my home county just west of Oklahoma City) overspread the sky, and a dark blue – almost black – presented a foreboding appearance.

I reached the forecast office in Norman about 6.30pm and strode into the darkened radar room with brightly coloured radar scopes showing several areas of red in the counties to our north and west – storms were building southward along the outflow boundary in western Canadian and Kingfisher county.

By 6.42pm, severe thunderstorms were located south of Waukomis, and near Kingfisher, while storms were developing near El Reno and Okarache. A few minutes passed by, and reports of a wall cloud WNW of Kingfisher were received from a storm spotter – number 954 reported a hail shaft to his west, with a sickly green colour to the sky. (If you have never seen this effect, it is one to make the hairs stand up on your back, I can assure you!)

This wall cloud strengthened, and exhibited rotation at cloud base, with scud rising vertically into the structure – definitely not a good sign for any inhabitants directly underneath. At one point, this wall cloud lowered to approximately 600 feet off the ground. 954 kept feeding reports to the forecast office – two miles south of Kingfisher, he received golf-ball sized hail, with the emerald hue of the sky still in evidence. Apparently these observations, along with Doppler Radar indications of a mesocyclone, prompted the issue of a Tornado Warning at 7.13pm CDT for Kingfisher County.

The storms to the south of this tornadic storm continued their intensification and at 7.23pm, storm spotters were advising that the southern cell, in west-central Canadian County appeared to be taking over from the Kingfisher storm.

However, the Kingfisher storm still had a punch, as witnessed by the report from number 954 of "hail larger than baseballs southwest of Okarche . . ." Another wall cloud was forming in northern Canadian County, just north of El Reno, and produced a funnel that reached half-way to the ground, prompting one spotter rather excitedly to report: "a tornado is imminent – it's going to ground . . .!!!" Even though the funnel did not, it merely signalled what was to come.

While all of this was going on, the storm of the day was developing in extreme northeast Caddo County, and southwestern Canadian County, near the town of Hinton. Spotter 912 was just north of Hinton on Highway 281 when he reported "explosive development" over Hinton as cumulus boiled up into the hazy blue sky. Shortly thereafter, the tornado sirens were reported to be going off in Hinton – 8.33pm.

The rationale for this action quickly became apparent when 912 called in and reported a large rope-like tornado on the ground in a wheat field just east of the grain elevators in Hinton. As 912 moved further east of town on Highway 37 damage became evident, and rather extensive damage at that. "912 to Norman Weather . . . go ahead 912 . . . 912 reports numerous trees down, heavy damage – house damage – heavy damage . . ." More intensive damage than this was given by 912 when, at 8.53pm, he reported, "There are vehicles all over the place . . . total devastation . . . houses completely sheared off at the foundation . . ." It was apparent that a major tornado – F3 to F4 on the Fujita scale – had occurred. The only question now was whether there were any casualties.

As the storms moved southeastward into Oklahoma City, they produced heavy rains, small hail and some limited wind damage. In addition, lightning was almost continuous, as I could see when I looked out the windows

of the outer room at the forecast office. Great fantails of pink, and steel-blue rippled and burnt their way through the clouds, illuminating the swelling folds in the cumulus rising into the dark humid night.

By 11.30pm, the line had cleared the metro area, and I headed for home, observing vast amounts of fan-tail lightning rippling through the mammoth storms to our south and east. As it turned out, the storm at Hinton produced two tornadoes – the smaller one 912 saw, and a monster F4 about a half mile wide or so at its greatest extent. Fortunately, no one was injured, thanks to the warnings from the NWS and local media. My wife and saner half – Jo Anne – told me that we received heavy rain and small hail for about an hour, and checking the raingauge, I measured 1.50 inches (38 mm) – not a bad haul.

My involvement with the Civil Defence has given me a sense of accomplishment to add to my enjoyment of the weather. Storm chasers are a unique breed, lending weight to my argument that the Almighty has a definite sense of humour.

WORLD WEATHER DISASTERS: November 1989

2–10: Typhoon "Gay" swept from Gulf of Thailand to India, details below:–

Gulf of Thailand: Affected on the 2nd and 3rd with winds of over 120 km/h and ten metre high waves, at least 101 fishing vessels sunk, with at least 30 others missing, but the biggest loss was the drilling vessel, the *Seacrest* which capsized and sank with the loss of 91 of the 97 people aboard, at least 100 dead at sea, with at least 433 fishermen reported missing.

Thailand: Hit on the 3rd and 4th with 185 km/h winds, heavy rains, floods and heavy seas, eight provinces in south of country hit, with provinces of Chumphon and Prachuap Khiri Khan being worst hit. In area affected 29,536 houses destroyed or damaged, 42 Government buildings, 253 schools and 114 temples also destroyed or damaged, crop losses also reported, damage put at more than $280 million, 529 deaths reported, with an undetermined number of others missing, at least 440 died in Chumphon province alone.

Andaman Islands: Hit on 4th and 5th, widespread damage reported.

Bay of Bengal: Winds of up to 233 km/h reported on the 8th.

India: Andhra Pradesh state hit on the 9th by winds of 120 km/h, heavy rains and 4.88 metre high waves in coastal areas, 39 deaths reported, 20,000 homes destroyed or damaged, leaving 100,000 people homeless, the storm crossed coast near Kavali, 200 km north of Madras. *Lloyds List, Daily Telegraph, Jakarta Post.*

7–8: Winds, gusting to 100 km/h, covered much of town of Mobridge,

South Dakota, U.S.A., in prairie tumbleweed, blocking streets and completely burying some houses. *I.H.T.*

8: Gales in England and Wales and adjacent North Sea, winds gusting to 138 km/h reported in England and Wales, a self elevating drilling platform, the *Interocean I* capsized and sank in the North Sea some 113 km north east of Great Yarmouth, Norfolk, during gale, all 51 aboard rescued. *L.L. D.T.*

10: Barge, the *Nereus*, capsized in rough seas, about 56 km south west of Esbjerg, Denmark, three crew dead. *L.L.*

10: Heavy rain caused collapse of house in eastern Turkey, leaving 13 people dead. *Birmingham Evening Mail*

13: Fog in area of Austria and Italy, near Vienna, a tour bus went off road and down embankment in thick fog leaving four dead and 27 injured, meanwhile in Italy a 100 vehicle pile-up on the Milano-Brescia highway in fog left 23 injured. *B.E.M.*

13–30: Torrential rains and floods in southern and eastern Spain, province of Malaga amongst worst hit areas, on the 14th heavy storm hit Malaga city around midday for about one hour, storm ended with a hailstorm, floods up to one metre deep reported in the Andalucian region on the 14th/15th, storms returned to Malaga province on the 20th, cutting rail, road and air links, again storms hit province from the 24th till end of month, on the 27th the Guadalhorce river burst its banks for the third time in two weeks, by month's end death toll in storms and floods put at ten. *L.L.*

15–16: Thunderstorms, tornadoes, hail, rain and snow in many areas of U.S.A., and into Canada, details below:–

U.S.A.: Sixteen states hit by inclement weather, on the 15th tornadoes hit seven states in an arc stretching from Mississippi to Kentucky to the Carolinas, worst of tornadoes hit Huntsville, Alabama, where a tornado hit at dusk, leaving 17 people dead, 463 injured and 1000 homeless, and insured losses of $95.4 million, tornado accompanied by rain and hail. Another tornado demolished a caravan park about 48 km south west of Atlanta, Georgia, injuring 12 people. In southern Illinois, winds caused destruction at an airport and were blamed for one death. On the 16th six children were killed and 19 others injured when hurricane force gust of wind demolished wall of school cafeteria at Newburgh, New York state, in New York city itself one died in Manhattan when wind blew pipe off building. Winds gusting to 113 km/h hit north east states of New York and New Jersey, ripping roofs off houses and uprooting trees. Snow fell in Michigan, north-Indiana and north eastern Ohio. The storm system cost a total of $225 million in insured losses.

Canada: On the 16th a tornado hit town of Mont St. Hilare 40 km east of Montreal, Quebec, leaving a ten square block path of devastation, at least 20 families left homeless, one person injured; tornado lasted 30 seconds, damaged at least 60 houses, 16 stores and 100 vehicles, meanwhile, thunderstorms, with winds gusting to 150 km/h hit Montreal uprooting trees and damaging roofs. *L.L. I.H.T.*

16: Hailstorm with golf-ball sized hail, hit town of Ballarak, Victoria, Australia, damage put at $15 million, mainly due to hail damage to cars. *L.L.*

19–22: Typhoon "Hunt" in vicinity of the Philippine islands, on the 19th the mv *Ampon* capsized in high seas whipped up by typhoon off coast of Quezon province, leaving six people dead, on the 22nd, typhoon "Hunt" went inland over Quezon province on Luzon island, with winds of 160 km/h and heavy rains, storm lost strength rapidly after making landfall, 1500 reported homeless, big waves induced by "Hunt" washed away 60 houses in Catarman and Biri, in northern Samar, leaving 948 homeless. *L.L.*

20: Mv *Kao Hwa 3* sank in stormy seas about 290 km west of the Philippines, leaving two crewmen dead, 19 others rescued, one of whom was seriously injured. *L.L.*

25: Heavy rains touched off landslide in village of Peuteuysayak, west Java, Indonesia, 17 houses buried, leaving ten people dead, heavy rains also set off landslide which destroyed five houses in village of Sianipar Dua, north Tapanuli, northern Sumatra, Indonesia, leaving 13 persons dead. *J.P.*

28 (reported): Drought has ruined crops in northern Ethiopia, fears are mounting of a serious famine, which could affect between two and six million. *L.L., D.T.*

ALBERT J. THOMAS

WORLD WEATHER DISASTERS: December 1989

1: Tropical storm "Karen" brought at least 381mm of rain to Isle of Youth, off Cuba, and 178mm of rain to Havana, Cuba. *Lloyds List.*

1: Series of multi-vehicle pile-ups on fog bound roads reported from a number of areas of Great Britain. A 30 vehicle pile-up on M6 just south of Sandbach, Cheshire, left two dead and ten injured, earlier, a 40 vehicle accident on the M56 near Hapsford, also in Cheshire, left 11 injured, other accidents in various parts of the country in fog and/or ice, left at least ten others injured.

Later in the month, on the 11th, 60 vehicles piled-up in fog on the M4 near Hungerford, Berkshire, leaving 13 injured and on the 27th 19 people were injured in a 20 vehicle pile-up in fog on the M57 near Liverpool. *Daily Telegraph.*

1–9: Continuing rain and floods in south and east Spain, on the 2nd the Rivers Jucar, Magro and Turia burst their banks around the city of Valencia. On the 8th/9th the city of Malaga flooded for the fourth time in less

than one month. Since floods began in November 11 deaths reported, with three others missing. *L.L.*

3: Gales and torrential rains swept the Algarve coast of Portugal, a fishing boat sank off Faro, leaving four men missing, the town centre of Tavira was under one metre of water after the Gilao river overflowed, no casualties reported. *L.L.*

3: High seas washed car off sea wall in Sicily, leaving two dead. *Birmingham Evening Mail.*

3: Lightning hit cafe at Serpong, west Java, Indonesia, left three people dead, with another four injured. *Jakarta Post.*

4: Heavy snow in Erzurum province, eastern Turkey, a house collapsed under weight of snow near city of Erzurum leaving five people dead, temperatures in area fell to −20°F (−29°C). *B.E.M.*

5: Violent hailstorm hit town of Moe, Victoria, Australia, damage put as high as $A2 million, between 1800 hours and 2100 hours 36mm of rain fell on town. *L.L.*

8: Three vessels, the m.v.'s *Capitaine Torres* and *Johanna B* and the f.v. *Johnny and Sisters II*, sank in the violent storms off eastern Canada, the two motor vessels sank in the Gulf of St. Lawrence in winds gusting to 113 km/h and waves up to nine metres high, all 39 crew aboard both vessels died, the fishing vessel sank about 200 km off Cape Race, Newfoundland, all eight crew believed dead. *L.L.*

13–25: Adverse weather conditions in many areas of Great Britain, brief details below:–

13th: Strong winds, rain and high tides resulted in floods at Cowes, Isle of Wight and Hythe, near Southampton.

14th: Storm, with a tornado, hit village of Long Stratton, Norfolk, damaging 100 houses, no casualties reported; storms and high tides brought flooding to more southern coastal towns, snow in north-west England closed six trans-Pennine routes and 305 mm of snow fell in north Wales, heavy rains caused localised flooding in some areas.

16th–17th: Gales, torrential rains and high seas in many areas of Great Britain, on the 16th the f.v. *Destiny* sank in stormy seas off Gourock, in the Clyde estuary, Scotland, leaving six people dead; the gales also hit Eire on the 16th causing widespread damage on the south-east coastline, especially in Co. Wexford, winds gusted to 185 km/h in Cornwall, a lighthouse in the Scilly Isles washed away. Floods up to 1.5 metres deep reported from Lymington, Hampshire. At least two deaths reported, both of youths swept away by heavy seas, one at Castletown, Isle of Man, the other at Folkestone, Kent; the m.v. *Arklow Victor* sank in the Bay of Biscay, leaving one person dead.

20th: Thunderstorms caused widespread flooding in south-west England, up to 50 mm of rain reported in areas of south Somerset, floods up to one metre deep reported in some areas.

21st: Thunderstorms, heavy rains and high winds in many areas of Great Britain, houses damaged by lightning in Midlands and flooding reported from some areas.

15: Motor vessel sank in stormy seas in the Seribu islands, north of Jakarta, Java, Indonesia, 88 people rescued, 15 others feared dead. *J.P.*

15–24: Gales, high seas and heavy rains in many areas of Western Europe, a number of marine casualties reported in addition to incidents on land:–

15th: Gales hit west coast of Portugal, a barge sank in the river Tagus, four men missing. Floodwater and debris cut the main coast road in a number of places.

16th-17th: Fierce gales in France and Spain, winds gusted to 130 km/h, at least four deaths reported in northern Spain and a further four reported missing when the m.v. *Baitin* sank 1.6 km from Punta Insula near Camotta on the west coast. In France at least three deaths reported on the 17th, one died when car swept off road at Le-Conquet, Brittany, another death, and nine injuries reported when a golf clubhouse collapsed at Villennes-sur-Seine, 48 km west of Paris, the other death reported at St. Pierre-en-Port when swept away by high seas. One death reported in northern Portugal when house collapsed in gale at Guarda. F.v. *Velasco Segundo* sank in storm about 480 nautical miles north east of St. Michaels, Azores, all 11 crew feared dead.

19th: M.f.v. *Panchita Reina del Mar* missing in storm off southern Spanish coast, seven crew aboard.

24th: M.v. *Topoloveni* sank in storm off Cape Finisterre, Spain, one crewman dead, 13 others missing, another 14 crew rescued. *L.L. D.T. I.H.T.*

15–31: Heavy rains, floods and mudslides in central and north east Brazil left at least 40 dead and 200,000 others homeless, worst hit was state of Bahia, where at least 26 died, the states of Maranhao, Piaui, Minas Gerais, Goias, Espirito Santo and Tocantins also reported floods, rail and road communications disrupted, hundreds of plantations destroyed. *L.L.*

16–26: Severe cold and snow in many areas of U.S.A.

21st–26th: Extreme cold in 21 of US States, from northern states to Florida and other southern states, especially Texas, widespread losses to citrus crops in Texas and Florida. Record low temperatures recorded in 112 locations. On the 25th snow drifts up to 2.4 metres deep reported in South Carolina and a record breaking 381 mm of snow fell at Wilmington, North Carolina. Damage to vegetable and citrus crops in Texas put at $200 million, in the 21 states affected insured property losses put at $500 million, $240 million of which occurred in Texas. At least 73 direct or indirect deaths reported from the cold. *L.L. I.H.T.*

24–25: Severe storms in the Brisbane area, Queensland, Australia, left two people dead and damaged 800 homes; winds up to 100 km/h reported, more than 25 mm of rain fell. Electricity and telephone lines cut. *L.L.*

26–31: Cold wave in northern India and Bangladesh, temperatures as low as

2°C recorded in Delhi, other locations even colder, also in India dense fog in northern areas disrupted transport, 80 deaths reported in India, including over 40 in Bihar, the worst affected state. Meanwhile in Bangladesh temperatures fell as low as 4°C, at least 44 deaths reported from Bangladesh. Most of deaths among the poor and homeless. *D.T. I.H.T. B.E.M.*

29: Avalanche near the Simeli pass in southern Switzerland left six skiers dead. *Sunday Express.*

30–31: Storms, associated with cyclone "Alibera", struck Dar es Salaam, Tanzania, leaving seven people dead and 600 families homeless. Gales and heavy rains destroyed houses, churches and schools in Dar es Salaam's main suburbs of Temeke, Ilala and Kinondoni, also bridges washed away. *L.L.*

30 (reported): Drought in northern Ethiopia, but heavy rain caused some crop damage in the central province of Shewa and the south-west provinces of Welega and Ilubabor. *L.L.*

30 (reported): Lightning hit hut in rice field 50 km north of Ujung Pandang, south Sula-Wesi, Indonesia, four people dead, two others escaped unhurt. *J.P.*

ALBERT J. THOMAS

LETTERS TO THE EDITOR

SO-CALLED 'CHARRED AND SCORCHED' STEMS FOUND IN CROP CIRCLES

During 1990, my colleagues and I have visited many circles formed by circles-effect vortices. We have recently become aware of articles in some esoteric magazines, in which it is claimed that 'charred and scorched stems are often found in circles'. I should like to make genuine researchers aware of what we discovered in the circles at Beckhampton this year, in order to prevent this, too, becoming part of the myth which has arisen around the circles.

With my colleague, Roger Davis, I visited the Beckhampton 'S' shaped formations, in July of this year. Whilst photographing the formations, we found what appeared to be stems apparently affected by heat (blackened, charred, etc). Closer investigation revealed these stems to be tick beans (cattle feed) and not wheat. The plants had died, possibly by use of a selective weed-killer, and had turned black.

Realising that the 'charred by unknown energy forces' theory might be applied by many of the people finding these stems, we decided that we should look for one, still in the ground, and well away from any circles-effect traces. Eventually, at length, we did indeed find plants, still in the ground (but dead) and no-where near any circle or other shape. We photographed the plants for future reference.

This will, I hope, effectively put paid to any stories that may arise concerning 'charred and scorched crops found in circles'.

46 Partridge Road, Pucklechurch, Bristol P. D. RENDALL

[The previous year this field had been planted with tick beans which blacken as they ripen and die. – Ed]

SHEEP CIRCLES AND FAIRY RINGS

An account of an observation of mysterious rings of grazing sheep observed by Mr. J. C. Belcher near Leeds in 1988 has been published (*J. Meteorology*, Vol.14, No.135, p.54), followed by another report of the phenomenon by Mr. C. Andrews (*J. Meteorology*, Vol.14;140, p.287). Paul Spink has suggested that circular formations of grazing sheep might be explained by a preference for the darker green grass of the perimeter of fairy rings in the field, which might be more palatable than the grass elsewhere. Whilst discounting the theory as an explanation for Mr Andrews' observation (which occurred on arable land, rather than pasture) Dr Meaden has stated that it may be relevant in the Leeds case, but noted that "the ring diameters seem rather huge". (*J. Meteorology* Vol.14:144 p.431).

Readers may be interested in further information relevant to Paul Spink's theory, and Mr Belcher's observation, which I have uncovered whilst researching older sources on fairy rings (in the hope of coming across old accounts of crop circles). Despite Dr. Meaden's reservation, it appears that fairy rings are "sometimes of immense size . . . thirty yards or more in diameter" (M.C. Cooke, *Science Gossip* 1st October 1866). One modern source speaks of a somewhat irregular "ring" several hundred feet in diameter having been found.

Do sheep prefer the grass of fairy rings, as suggested by Spink, or do they actually *avoid* eating it? Most writers seem to support the latter view, quoting as their authority William Shakespeare, who wrote of the "green sour ringlets . . . whereof the ewe bites not" (*The Tempest*). The Victorian botanist Edwin Lees added his own observation. In a meadow close to Stratford-on-Avon, he had noticed that the sheep had closely grazed the grass apart from the dense growth of coarse grass on the outer circle of fairy rings, which had been left untouched. (*Woolhope Field Club Transactions* 1867 p.168).

The matter is not so easily settled, however. Another reliable countryman and botanist described observations that are clearly contrary. John Knapp recorded that although some "rank" grass in fields was avoided by cattle, his sheep ate "with a marked preference" the dark-coloured grasses of fairy rings, "manifesting that it possesses an agreeable flavour, derived immediately from the soil, or communicated by atmospheric influence." (*Journal of a Naturalist* (1829) p.378).

Such clear, but contradictory observations may indicate that whether or not sheep enjoy eating the grass of the fairy rings may be determined by variables such as the type of grass growing in the ring, the breed of sheep, or the particular species of fungi associated with the fairy ring. It is possible, therefore, that Knapp's observation of the "marked preference" of his sheep for the grass of fairy rings in his fields may, after all, explain the sheep-circles observed by Mr. Belcher. At this late date, over two years following the original observation, the conclusive evidence may still remain in the fields. Fairy circles often persist for many years, and may still be visible at the sites of the mysterious "sheep circles".

16 Hillside Lane, Heath End, R.M. SKINNER
Farnham, Surrey.

OUR CRAZY WEATHER

A few days before Saturday and Sunday, April 21/22 1990, westerly winds (usually mild) were very chilly giving maxima as low as 11°C at Rushmere St. Andrew (2 miles NE of Ipswich and only 10 miles from the North Sea), with snow being reported in some parts of the country.

The forecasters were unanimous in predicting brisk NE winds over the weekend bringing, understandably, *even colder* weather. The northeasters arrived as expected but maxima on Saturday and Sunday, April 21/22, were a balmy (spelt both ways) 17°C and 18°C respectively.

85 Playford Road, Rushmere St. Andrew ALFRED GLENN
Near Ipswich, Suffolk.

TORRO THUNDERSTORM REPORT: January 1990

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The month of January can be conveniently divided into two contrasting parts. The first 15 days were mostly of an anticyclonic westerly type, influenced by a persistent high pressure area over western Europe, and although there was a lot of rain in north-western Britain, central and southern parts were mostly dry and sunny, often remarkably spring-like, and thunder was almost totally absent. However, from 16th the weather turned much more disturbed, as the high slowly gave way and intense lows began to control the weather in all parts. With polar-maritime airstreams frequently flowing over the U.K. thunder was heard somewhere in the British Isles or Eire on all but one of the last 16 days and on that day lightning was observed in southern Ireland. As is quite normal in very mobile westerly regimes at this time of the year thunder most frequently affected the more exposed coasts and hills of the north and west with some activity along parts of the English Channel coast and in some more inland areas where topographical influences allow thundery showers to penetrate into some central areas of the country, such as through the Cheshire gap and into the Thames and Severn valleys from the Bristol Channel. Many western and northern areas heard thunder on two or more days and as many as five days were reported in parts of west Cornwall.

Thunder-days in January 1990 were as follows: (averages refer to the period 1951–1980)

	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						×																×	×	×	×	×	×			×	×	9	8.3
Wales																						×				×	×	×		×	×	6	4.9
Scotland																×	×	×	×	×		×	×	×	×	×		×			×	12	6.4
Ireland																×	×					×	×		×	×			×	×	×	9	7.1
Total						×										×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	16	12.1
Netherlands																								×	×	×	×	×	×	×		7	4.0
Belgium																								×	×	×	×	×				5	

The only thunder report in the first half of the month came from west Cornwall when, early in afternoon of 6th thunder was heard to the south of Constantine, near Falmouth. A cold front was lying north-south across the area at the time. Between 16th and 20th thundery showers affected parts of northern and western Scotland, and exposed parts of Ireland were similarly affected on 16th and 17th. Late in the evening of 21st lightning was observed over south-west Eire. On 22nd, after thundery outbreaks in parts of Eire in the early hours, thunderstorms affected parts of north Wales, Merseyside and Greater Manchester soon after dawn and thundery showers developed in parts of western Scotland in the afternoon. The 23rd was a very showery

day in many parts of the country and there were further thundery outbreaks from time-to-time throughout the day over exposed parts of western Scotland, and over Cumbria and the Pennines in the evening. Wintry showers developed widely on 24th and some were accompanied by thunder in the early hours in parts of Scotland, the Channel Islands and locally along the coastline of southern England. Storm-force winds battered many parts of the country on 25th, as an intense low crossed southern Scotland, and in its wake heavy showers developed in many places. Showers were most active in the evening with thunder in exposed parts of Scotland, Ireland and south-west England and south Wales continued to be affected by thundery showers during early hours of 26th, with hail and snow in many places, and isolated thunder was also heard in western Scotland and along parts of the south coast of England. Lightning damage was reported from a number of localities. In south-west Ireland telephone services to Ennis hospitals were put out of action, lightning struck a transformer near Gort, and a PAN-AM jet was struck by lightning as it approached Shannon Airport. There were also reports of cattle deaths in the area. Shortly after midnight Guernsey in the Channel Islands was hit by a severe hailstorm, accompanied by a spectacular display of lightning. Hailstones measured 2 to 3.5cm diameter over a wide area of the south and south-west of the island. Damage was sustained to crops and to the bodywork of motor vehicles and, driven by strong winds, some house windows were broken. In south Wales the TV transmitter on Kilvey Hill, near Swansea, was struck by lightning blacking out TV pictures and disrupting local radio transmissions in the area.

WORLD WEATHER REVIEW: December 1989

United States. *Temperature:* fourth coldest December since 1895. Warm from most of Pacific coast to N.W. Montana, C. Oregon, W. Colorado and W. New Mexico; +2degC locally from N.E. Washington to C. Nevada. Cold elsewhere; −5degC in whole N.E. quarter and in coastal Texas; −8degC in N. New York and N. Vermont. *Rainfall:* third driest December since 1895. Wet only from N. Montana to parts of Colorado and N. Nebraska; S. Louisiana to most of North Carolina (except S.E. Florida); extreme S. Texas. Over 200% locally in N. and S.E. Montana, C. Georgia, W. Florida and extreme S. Texas. Dry elsewhere; under 50% very general; under 25% from Pacific coast to S. Idaho, S.W. Wyoming and N.W. New Mexico; E. Texas to S. Missouri; locally from North Dakota to N. Illinois.

Canada and Arctic. *Temperature:* warm from Alaska to British Columbia and S. Alberta; Greenland; +6degC from interior Alaska to C. British Columbia. Cold elsewhere; −4degC in Franz Josef Land; −6degC from Winnipeg to W. Quebec; −9degC at Montreal. *Rainfall:* wet in W. and S. Alaska, N. Quebec, Newfoundland, Franz Josef Land; locally in N.E. and S.E. Greenland. Over 200% in W. and S. Alaska; locally in N. Quebec. Dry elsewhere; under 50% in E. Saskatchewan, W. Manitoba, Canadian Arctic coast, Spitzbergen, Greenland new 70°N.; locally in S. British Columbia, S. Alberta and S. Iceland.

South and Central America. *Temperature:* warm in most of South America 15–40°S.; W. coastal Mexico to El Salvador; E. Honduras; most of West Indies; +2degC locally in N. Argentina, Uruguay and extreme S. Brazil; more widely in E. Argentina. Cold in E. Bolivia; E.

Mexico to W. Honduras; much of Paraguay; round Sao Paulo (Brazil); −2degC in N. Paraguay and much of N.E. Mexico (−4degC in extreme N.E.). *Rainfall:* wet in parts of E. Bolivia; N. Paraguay, C. Chile, C. Brazil, Uruguay, N. and C. Argentina, N.E. and C. Mexico, S. Belize, N. Guatemala, N. Honduras, Bermuda, Cuba. Over 200% at least locally except perhaps in Bolivia, Uruguay, Bermuda and Cuba; widely in C. Brazil, N. and C. Argentina, N.E. and C. Mexico. Dry in W. Bolivia, N. Chile, S.C. and extreme W. Argentina, C. Paraguay, extreme S. Brazil, N.W. Mexico, S. Mexico and S. Honduras; Bahamas; most of West Indies. Under 50% at least locally in all these areas; widely except in Paraguay.

Europe. *Temperature:* mainly warm; +4degC in N. Spain, S.W. France. Cold from Ireland, Scotand and Faeroes to N. Urals; S. Italy, S. Yugoslavia, Greece, S. Bulgaria, N. Romania; −2degC locally in Scotland and N. Romania; −3degC from C. Sweden to N. Urals. *Rainfall:* mostly wet; over 200% widely in N. and C. European Russia away from Urals; S. England, N.W. France, Portugal; most of Spain; locally in W. Germany. Over 400% in S. Portugal and much of S. Spain. Dry in N. Ireland, Scotland, Faeroes, extreme S. Norway, S.W. Finland; extreme N.E. Spain through S. France and Italy to S. Poland and most of Balkans, Ukraine and Caucasus; most of Sweden. Under 50% at least locally except possibly in Faeroes, Norway, Finland; widely from Pyrenees to S.W. Ukraine, including most of Italy and Balkans. Provisional sunspot number 165.

Africa. *Temperature:* warm from Madeira to W. Egypt; in and near South Africa; +3degC widely from Morocco to W. Libya. Cold (−1degC) in parts of Egypt and extreme S.W. Namibia. *Rainfall:* wet in Madeira, Canary Islands, N.W. and S. Morocco, extreme N. Tunisia, N. Natal; most of Transvaal. Over 200% in Madeira, Canary Islands and N.W. and S. Morocco. Dry from C. Morocco to Egypt; most of south Africa into Namibia and Botswana; under 50% general.

Asian U.S.S.R. *Temperature:* warm almost everywhere; +4degC from S. Urals almost to Lena basin; +9degC near L. Balkhash. Cold only from N. Urals to N. Taimyr Peninsula (−2degC). *Rainfall:* wet from Turkmenistan and Uzbekistan through Ob basin to C. Yenisey basin and almost to Lena basin; Amur basin. Over 200% from Turkmenistan and Uzbekistan through Kirgizia to C. Ob basin; lower Amur basin. Dry elsewhere; under 50% fairly widely from East Siberian Sea to Sea of Okhotsk then S.W. to L. Baikal; also near Aral Sea.

Asia (excluding U.S.S.R.). *Temperature:* warm in N.W. and S. India, Mongolia, Korea, Japan, Malaysia, extreme S. Philippines: most of Pakistan and China; +3degC in N. Korea and a vast area of N. and W. China and Mongolia; +8degC in N.W. China. Cold in Turkey, N. Arabia, interior S. China, N. Thailand; most of N. India and Philippines; −2degC in interior Turkey. Near normal in Cambodia and Vietnam. *Rainfall:* wet in N. and E. Arabia, N. Pakistan, N.E. and interior China, E. coastal Korea; parts of N. India and N.W. Japan. Over 200% locally in coastal E. Korea; fairly widely in the other areas except perhaps Japan. Dry in Thailand, Cambodia, Laos, Vietnam, Malaysia, Philippines; most of Turkey, E. coastal and W. China, Korea, Japan; part of S. Arabia, S. Pakistan, W., S. and E. India. Under 50% widely in all these areas.

Australia. *Temperature:* mostly warm; +2degC on Nullarbor Plain. Cold in N.E., N.W. and near W. coast; −2degC round Perth. *Rainfall:* wet from Nullarbor Plain to Northern Territory; over 200% in S. half of this area. Dry elsewhere; under 50% fairly generally. M.W.R.

WORLD WEATHER REVIEW: January 1990

United States. *Temperature:* warmest January since before 1895; warm virtually everywhere; +5degC over a very large area from E. Washington to E. Oklahoma and Vermont; +9degC in Dakotas and S. Minnesota. *Rainfall:* wet from E. Wyoming through E. New Mexico and most of Texas to Georgia; much of area from N.E. coast to S. Wisconsin and N. Illinois; about half the area from W. Washington to S.W. Arizona; Hawaii. Over 200% from S.E. Colorado

through N. and E. Texas to S.W. Missouri and C. Alabama; Hilo (Hawaii). Dry elsewhere; under 50% in E. Oregon, N. Montana to N.E. Utah; N.E. Arizona to W. Texas; Dakotas to N. Kansas and N.W. Wisconsin; S. Florida.

Canada and Arctic. *Temperature:* warm in extreme S. Alaska, S. Canada south of a line through Great Slave Lake to Gulf of St. Lawrence; N.E. half of Greenland, Iceland; probably Spitzbergen; +4degC from S. Quebec to S. British Columbia; N.E. Greeland; +8degC in S. Saskatchewan. Cold elsewhere; −4degC in parts of N. Alaska and Baffin Island. *Rainfall:* wet near Pacific coast of Canada and Alaska; Keewatin District and Saskatchewan to W. Quebec and Newfoundland; N.E. Greenland, Iceland; locally in W. Alaska; over 200% very locally in last two areas. Dry elsewhere; under 50% in N. Alaska, S. Alberta, Baffin Island, W. Greenland.

South and Central America. *Temperature:* generally warm in South America 15–40°S.; Mexico to Honduras; Bermuda, Bahamas, West Indies; +2degC in Bermuda, Bahamas; locally in N. and C. Argentina, N. Uruguay, S. Brazil, N.E. Mexico, Gulf of Honduras, West Indies. Cold in S.W. Bolivia, Paraguay, near Bahía Blanca (E. Argentina) (all locally −1degC). *Rainfall:* wet from Buenos Aires to Bahía Blanca (over 200% widely); interior N.W. Argentina, much of S. Brazil and scattered areas in Mexico (locally over 200%). Dry in most of South America 15–40°S.; most of Mexico to W. Honduras; Bermuda, Bahamas, West Indies. Under 50% in N. and C. Chile, S.C. and locally in N. Argentina, E. Brazil; much of Mexico to W. Honduras; Bermuda, Bahamas; much of West Indies.

Europe. *Temperature:* mainly warm; +3degC from England through Netherlands, S. Sweden and Poland to lower Volga basin; +6degC around Minsk. Cold from N. Norway to C. Urals (−6degC round Pechora Gulf); Greece, Bulgaria, S. Yugoslavia and parts of Italy; −2degC in parts of Greece. *Rainfall:* wet from most of British Isles (except E. Coasts) through Faeroes and Scandinavia to most of European Russia except S.; parts of E. Spain. Over 200% in Scottish Highlands, in and E. of Estonia, in and near C. Urals, near Valencia (E. Spain); much of Finland. Dry elsewhere; under 50% over a very large area from N.E. Spain and S. France through most of Italy to Balkans and W. Ukraine and N. to S.E. Germany and much of Poland. Provisional sunspot number 179.

Africa. *Temperature:* warm from N. Algeria to W. Egypt; in and near South Africa; +2degC in N.E. Algeria and S. Tunisia. Cold in Morocco (−1degC) and Canary Islands. *Rainfall:* wet from N. Algeria to N. Egypt; S. Botswana, N. Transvaal, narrow band across Cape Province. Over 200% widely in Tunisia and interior N. Algeria; coastal Egypt; locally in N. Transvaal. Dry in Madeira; most of Morocco and South Africa. Under 50% in Madeira, S. Morocco, N.W. and S. Cape Province; locally in Orange Free State, Transvaal and S. Natal.

Asian U.S.S.R. *Temperature:* warm from Caspian Sea to L. Baikal and N. to C. Ob basin (except part of E. Kazakhstan); New Siberian Islands almost to Sea of Okhotsk; +3degC in upper Ob basin. Cold elsewhere; −7degC from Gulf of Ob to C. Yenisey basin. *Rainfall:* wet from Caspian and Aral Seas to L. Balkhash, Urals, upper Ob basin and Central Siberian Plateau; in and N. of Kamchatka. Over 200% in upper Ob basin; locally in Kazakhstan and Kamchatka. Dry elsewhere; under 50% from lower Ob basin to S. Taimyr Peninsula; Mongolian border to Sea of Okhotsk; lower Kolyma basin.

Asia (excluding U.S.S.R.). *Temperature:* warm on S. and W. coasts of Arabia; Pakistan, W. Mongolia, W. Korea, Japan; Thailand and Malaysia to Philippines; nearly all of India; most of China; +2degC in N.W. India; much of Pakistan, Thailand, Laos and Vietnam; +3degC in W. China. Cold from Turkey to C. Arabia; N.E. India, N.E. and parts of E. China, E. Mongolia, E. Korea; −2degC from much of Turkey to C. Arabia; N.E. China, E. Mongolia. *Rainfall:* wet from Israel to E. Arabia; W. Pakistan, extreme S.E. India, S. Japan, E. Laos; most of Korea; much of China; parts of Malaya and E. Philippines. Over 200% in W. Pakistan, extreme S.E. India, C. Korea; widely in E. and C. China (very locally also in extreme W.); parts of S. Japan; locally in E. Saudi Arabia and Oman. Dry in Turkey, Cyprus, W. Arabia, E. Pakistan, Bangladesh, N. and W. China, Mongolia and nearly all of India (under 50% widely in these

areas); N.E. Korea, N. Japan (locally under 50%); most of the area from Thailand and Malaysia to W. Philippines (under 50% fairly widely).

Australia. *Temperature:* mostly warm; +3degC in S. Queensland. Cold in W.; −2degC round Perth. *Rainfalls:* wet in most of Western and South Australia (over 200% widespread, especially in W.); dry elsewhere; under 50% widely in E.

M.W.R.

WEATHER SUMMARY: June 1990

June was a rather cool month over the whole of the U.K. with mean temperatures widely around half a degree Celsius below the normal. The negative anomaly was generally the result of low day-time values while because of cloudy nights mean minima were a shade above the normal. Maxima rarely reached significant heights anywhere and after 25.0° at Cromer
(Norfolk) on 1st it was 26th before this temperature was attained again. However, on 9th, central parts of Scotland had a warm day with 23.3° at Glasgow and 23.3° at Rannoch School, Dall (Tayside). On 26th Lincolnshire reported the highest temperatures of the month with 26.8° at Louth and 26.0° at Waddington, while on the same day 25.7° was reached at Carlton in Nottingham, 25.4° at Derby and 25.0° at Buckingham, Royston (Hertfordshire), Sidcup (Kent) and Reigate (Surrey). On 27th Margate and Dover, with 25.8° and 25.6° respectively, made Kent the warmest part of the country. On 30th Cromer ended the month as it began with a maximum of 25.0°C. Parts of Scotland had minimum temperatures around 13°C on 1st, 18th and 27th but over much of the British Isles the warmest night of the month was 27th. Highest minima included 17.5° at the London Weather Centre, 17.1° at Royston, 17.0° at Sidcup, 16.7° at Wyton (Cambridgeshire) and 16.5° at Stansted (Essex). Maxima on 10th were as low as 9.7° at Cape Wrath, 10.2° at Whalsay and 10.3° at Lerwick and Wick but generally the 11th to 13th saw the coolest weather over much of England and Wales. On 11th Newcastle reached 11.4° and on 12th the temperature failed to exceed 8.3°C at High Bradfield (South Yorkshire), 8.9° at Fylingdales (North Yorkshire) and 10.4° at Middleton (Derbyshire). The only report of an air frost during June came from Achnasheen (Highland) with −0.5° on 5th. Elsewhere, 0.5° was recorded at Tummel Bridge (Tayside) and 1.2° at Inverdruie (Highland) on 6th, 1.0° at Inchmarlo, near Aberdeen, on 8th, 0.6° at St. Harmon (Powys) on 15th and 1.2°, again at Inverdruie, on 20th. In southern Britain Gt. Gaddesden recorded 2.1° on 5th and Rickmansworth 2.7° on 7th (both stations in Hertfordshire) and Stithians (Cornwall) 2.7° on 15th. Lowest grass minima included −4.1° at Inverdruie on 6th, −3.6° at Beaufort Park (Berkshire) on 12th and −3.2°C at south Farnborough on 5th. Although parts of the south-east had below average rainfall most places had a wet month, particularly in central and eastern Scotland where totals were around 150 to 250 per cent of the normal. Central parts of Scotland were very wet on 6th with 65.8 mm at Aviemore (Highland), 43.7 mm at Inverdruie and 34.7 mm at Dall. On 7th 37.6 mm fell at Rothesay, on 20th 38.8 mm was recorded at Cilfynydd (mid Glamorgan) and on 30th Leuchars (Fife) had a fall of 40.6 mm. The 21st was generally the wettest day over England and Wales producing 39.3 mm at Fylingdales, 29.4 mm at Carlton Nottingham, 28.0 mm at Leeming (North Yorkshire) and 26.2 mm at Gatwick. June was also a disappointing month for sunshine. Few places had more than 80 per cent of their normal and some in the English midlands failed to achieve 60 per cent. Fewer than 100 hours were recorded in places.

The first week of June was mostly unsettled and with low pressure never far from northern Scotland a series of frontal systems gave all parts spells of rain or showers. The rain was particularly heavy during the night of 6th/7th as a depression crossed the northern mainland of Scotland and as the low tracked south-eastwards down the east coast of England on 8th many parts had showers and local thunderstorms. The second week of the month was dry and very cloudy, as an anticyclone settled down to the west of Ireland, and it also became very cool in the persistent northerly or north-easterly winds. However, temperatures recovered from 14th, as the high crossed to the east of the U.K., but although coastal areas became much brighter with a good deal of sunshine central counties remained very cloudy. The weather turned much more cyclonic on 17th and for several days depressions and associated frontal systems gave all parts spells of rain, especially on 21st when a depression crossed England and Wales and produced strong winds near Channel coasts. Although the weather remained unsettled with rain from time-to-time throughout the rest of the month an incursion of warm, humid air gave south-eastern parts their warmest weather of the month on 26th and 27th before a cold front brought a sharp drop in temperature on 28th. The month ended on a very disturbed note and as a depression crossed Ireland and central areas of Great Britain rain and strong winds spread to much of the country with hail and thunder in places.

K.O.M.

TEMPERATURE AND RAINFALL: JUNE 1990

	Mean									
	Max	*Min*	*Max*	*Min*	*Grass*	*Rain*	*%*	*Wettest*	*RD*	*Th*
BELGIUM: Uccle	19.6	11.4	29.2(26)	7.8(5)	3.4(10)	95.5	143	18.8(26)	16	–
" Rochefort	19.0	9.2	29.6(26)	1.4(5)		108.0	140	16.0(29)	18	–
" Liège	20.1	13.0	30.4(26)	8.6(5)		88.6	125	16.7(30)	17	–
DENMARK: Fano	17.3	12.1	22.7(30)	5.8(6)		109.3	224	26.2(30)	16	1
" Frederikssund	20.8	12.4	23.9(9)	9.1(2)	4.2(2)	85.5	164	32.5(21)	13	2
GERMANY: Berlin	21.0	12.3	29.4(27)	8.3(18)	6.5(6)	157.5	215	49.2(9)	18	7
" Hamburg	18.9	11.4	26.0(26)	6.4(1)	1.5(1)	112.4	161	26.0(4)	18	2
" Frankfurt	21.3	11.8	31.0(26)	5.3(5)	3.0(5)	85.7	116	33.1(27)	19	6
" Munchen	20.4	10.1	29.2(30)	5.2(10)	1.0(1)	238.2	113	35.3(12)	23	9
ITALY: Casalecchio	26.9	15.9	35.0(30)	10.0(1)	8.0(1)	9.0	21	5.0(6)	5	4
MALTA: Luqa	28.6	19.2	33.2(24)	13.1(1)	8.5(1)	0.5	–	0.5(18)	1	1
NETH'NDS: Ten Post	18.8	11.4	25.9(27)	6.1(9)	2.3(16)	82.3	132	17.2(5)	15	6
SWEDEN: Valla	20.6	8.6	25.9(11)	3.2(9)		55.3		26.1(23)	12	4
SWITZ'D: Basel	22.3	11.5	31.2(26)	7.2(5)		165.6	180	26.7(19)	20	8

EIRE: Straide	15.9	8.6	19.2(17)	3.0(19)	−2.3(19)	110.2	149	28.8(20)	23	2
" Mt. Russell	15.7	9.1	19.1(14)	6.4(19)	1.0(11)	91.6		17.4(21)	20	3
SHETLAND: Whalsay	12.8	9.0	15.5(19)	5.5(27)	−1.1(27)	121.2	342	26.1(27)	18	0
" Fair Isle	11.5	8.8	13.8(26)	7.9(10)	3.9(27)	101.5	273	31.7(30)	19	0
SCOTLAND: Braemar	15.1	6.8	21.7(9)	1.1(12)	0.9(12)	70.6	128	22.8(6)	17	0
" Inverdruie	16.4	6.9	23.7(15)	1.2(6)	−4.1(6)	106.2	174	43.7(6)	17	0
" Rannoch		6.0	23.4(9)	1.4(12)	0.0(2)	94.9		34.7(6)	19	0
WALES: Velindre	17.1	9.5	22.8(25)	5.0(29)	1.5(7)	77.4	136	12.1(21)	17	2
" Carmarthen	16.2	9.7	20.4(16)	5.4(15)	1.8(15)	97.5	126	14.5(29)	19	0
" Gower	16.6	10.4	20.3(16)	8.0(15)	4.0(15)	94.1	124	16.9(21)	18	1
GUERNSEY: Airport	16.5	11.1	21.4(29)	8.9(14)		50.8		10.0(18)	15	0
JERSEY: Carrefour/Clq	18.8	10.8	24.0(1)	7.7(24)		67.1		11.1(20)	16	2
ENGLAND:										
Denbury: *Devon*	18.0	10.2	24.8(10)	6.0(15)	3.2(15)	58.7	111	12.1(21)	17	0
Yatton, *Avon*	18.4	10.8	24.1(26)	7.7(17)	5.7(17)	75.4	126	18.1(30)	18	2
Mortimer, *Berks*	18.9	9.5	25.3(26)	4.9(5)	1.1(5)	30.4	58	8.7(21)	13	1
Reading Univ, *Berks*	18.5	10.2	24.0(26)	5.9(7)	−1.4(7)	28.0	102	8.8(21)	12	0
Sandhurst, *Berks*	18.8	9.3	23.9(27)	3.3(8)	−0.5(7)	39.2	95	13.3(21)	11	0
Romsey, *Hants*	18.5	9.1	23.3(10)	3.3(5)	−0.3(8)	45.3	69	13.5(21)	12	1
Brighton, *Sussex*	17.9	10.3	22.1(29)	5.4(5)	4.5(5)	57.4	102	19.2(21)	14	1
Hastings, *Sussex*	–	–	21.7(1)	7.9(18)	3.2(–)	53.7	105	19.1(21)	–	0
Dover, *Kent*	18.5	10.2	25.6(27)	5.0(17)		58.3	137	13.1(21)	12	0
East Malling, *Kent*	18.8	9.5	23.9(27)	5.5(16)	1.0(5)	54.7	118	13.7(21)	12	4
Epsom Down, *Surrey*	18.7	9.4	23.8(26)	4.2(5)	−0.4(12)	59.1	109	20.0(21)	21	3
Reigate, *Surrey*	18.9	9.2	25.0(26)	4.4(5)	4.1(5)	57.8	105	17.4(21)	13	0
Guildford, *Surrey*	18.3	10.6	23.4(17)	6.6(12)	5.2(12)	42.8	86	23.0(21)	11	0
Sidcup, *London*	19.3	10.5	25.0(26)	6.4(7)		45.8	92	11.3(21)	12	3
Hayes, *London*	18.8	10.2	24.2(27)	5.8(7)	3.8(7)	43.9	87	10.9(21)	12	1
Royston, *Herts*	18.7	10.4	25.0(26)	7.0(8)	2.1(5)	28.7	55	6.9(30)	13	2
Loughton, *Essex*	19.1	9.8	24.9(26)	5.9(7)	0.9(7)	49.8	90	15.6(21)	12	3
Buxton, *Norfolk*	18.7	9.1	25.3(27)	2.9(16)	2.1(16)	46.1	85	8.4(20)	14	1
Ely, *Cambs*	19.0	8.3	24.9(27)	4.1(5)		41.2		6.2(23)	16	2
Luton, *Beds*	18.4	9.7	25.5(26)	3.9(12)		42.7		6.8(21)	15	2
Buckingham, *Bucks*	18.4	8.8	25.0(26)	3.8(5)	−2.2(5)	41.9	99	10.3(30)	15	1
Oxford University	18.3	7.9	23.7(26)	6.2(12)	0.3(7)	48.8	90	13.7(30)	12	–
Birmingham Univ.	17.3	10.0	24.0(26)	5.6(7)		65.8		13.9(21)	18	3
Wolver'pton, *W.Mid.*	17.4	10.7	25.0(26)	8.4(12)	4.0(v)	70.0		11.7(21)	21	4
Louth, *Lincs*	18.3	9.5	26.8(26)	4.0(5)		61.0		12.2(21)	20	5
Keyworth, *Notts*	17.7	10.1	24.5(26)	7.0(7)	1.4(7)	61.6		19.5(21)	17	4
Nottingham, *Notts*	18.2	10.4	25.7(26)	7.1(5)	3.9(7)	77.2	142	29.4(21)	17	3
Derby, *Derbys*	17.4	10.5	25.4(26)	7.0(7)	5.9(12)	81.5	147	23.8(21)	20	4
Middleton, *Derbys*	15.2	9.0	22.4(26)	4.4(7)		103.4	116	16.2(21)	21	6
Keele Univ, *Staffs*	16.1	9.4	22.9(26)	5.8(7)	1.2(7)	73.7	111	16.6(21)	19	2
Liverpool, *Mersey*	17.8	11.2	22.9(26)	5.4(9)		89.6	163	14.2(21)	18	2
Lathom, *Mersey*	16.3	10.1	21.0(26)	6.1(14)		100.0		16.0(2)	21	
High Bradfield, *S.York*	14.5	7.9	22.7(26)	5.1(5)		56.6		17.4(21)	22	–
Cottingham, H'side	18.7	9.9	25.1(27)	5.9(5)	2.7(5)	73.5		16.5(21)	18	5
Carlton-in-Cleveland	17.0	9.6	21.4(27)	6.0(8)	3.3(8)	86.3		24.2(21)	21	6
Durham Univ, *Durham*	17.3	8.1	21.6(27)	4.0(20)	1.4(13)	46.3	92	11.1(30)	19	–
Sunderland, *Tyne Wear*	16.8	10.4	22.3(27)	7.7(8)		39.0	65	9.7(30)	18	5
CANADA: Halifax *NS*	19.2	10.1	24.6(2)	6.1(13)		106.6	127	25.8(30)	13	1
U.S.: Bergenfield *NJ*	27.1	15.4	32.2(22)	7.2(5)	6.1(5)	71.4		20.3(19)	10	6
JAMAICA: Kingston	33.2	25.9	34.8(30)	24.5(5)		69.9		51.6(17)	4	4
" Montego Bay	30.9	24.3	32.8(25)	23.0(11)		59.1	39	47.6(18)	10	5
AUSTRALIA: Leopold,	14.7	7.5	17.5(12)	3.0(28)		44.4	86	16.0(10)	13	1

CUMBRIA RAINFALL:

Seathwaite, 270 mm (148%); The Nook, Thirlmere, 178.8 mm (143%); Coniston, 183.5 mm (141%); Hawkshead, 129.1 mm (128%); Windermere, Whasdyke, 128.5 mm (132%).

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FRONT COVER:
Strange attractor: Circle complex aligned with tractor lines on Crawley Down, Hampshire, July 1990.

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