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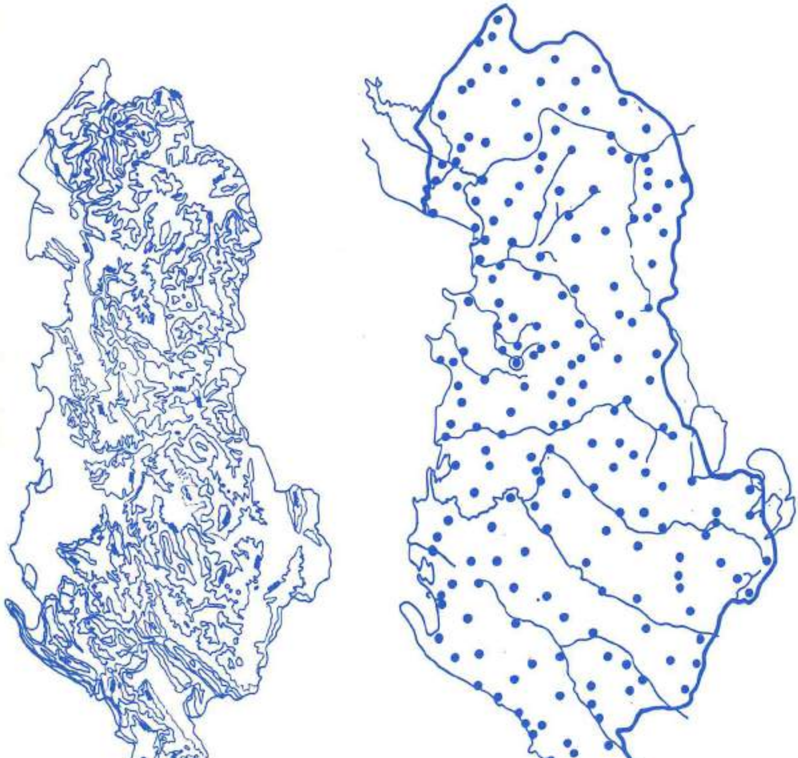

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TOPOGRAPHICAL MAP OF ALBANIA (A) AND THE NETWORK OF THE STATIONS (B)

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BRITAIN'S HIGHEST TEMPERATURES FOR EVERY DATE OF THE YEAR, 1 JANUARY TO 31 DECEMBER

By J.D.C. WEBB and G.T. MEADEN

Abstract: **A table of amendments is supplied to update the British maximum temperature to every date of the year, based on over a hundred years of temperature records (1875-1900). The original table was given in volume 9, 169-176 *J. Meteorology*.**

A table of Britains' highest recorded temperatures for every date of the year was first published in this journal in the issue for July-August 1984. In view of the numerous new daily 'highs' that have been recorded in the last few years, especially in 1989-90, we consider it appropriate to present a revised table. We have also taken the opportunity to incorporate the corrections that were first published in *Journal of Meteorology* number 96, pages 50-51, plus a few other omissions from the original table which have subsequently come to light. A revised table of UK County maxima will also be published when all the new temperature records set during the heatwave of 1st to 4th August 1990 are known.

While the warmth of 1989 and 1990 has clearly been outstanding, it is interesting to observe that less than a decade ago numerous county and daily temperature minima were recorded during December 1981 and January 1982. These and several other very cold spells in the 1980's should caution the inevitable speculation that the recent warm period is a symptom of longer term climate change, rather than a short period fluctuation.

The closest parallel to the recent warm spell during this century occurred between April 1947 and March 1950, (including the record warm year of 1949). During this 36 month period 31 of the daily maximum temperature records in the table were set, this compares favourably withe the 20 new daily 'highs' which have been recorded in the 24 months from December 1988 to November 1990. Two of the most remarkably warm days, relative to the time of year, were recorded during the former period: 23.9°C (75°F), in London on 9th March 1948, and 29.4°C (85°F), also in London, on 16th April 1949.

The exceptional summer of 1976 also features prominently in the table. During the sixteen day heatwave from 23 June to 8 July 1976 national daily highs were recorded on no less than ten occasions.

The table highlights the tendency for very high winter temperatures to be recorded to the lee of high ground in the west and north of Great Britain: East Devon, the Welsh borders, North Wales, and north and north-east Scotland have all experienced temperatures above 16°C in December or January as a result of such a south or south-westerly Fohn.

BRITAINS HIGHEST DAILY TEMPERATURES 1991 AMENDMENTS

JANUARY	08	14.9	58.8	Aber (Gwynedd) 1988
	15	16.0	60.8	Colwyn Bay (Clwyd) 1990
	25	13.6	56.5	Innsworth (Gloucestershire) 1977
FEBRUARY	06	15.9	60.6	East Bergholt (Suffolk) 1989
	15	16.6	61.9	Betwys-y-Coed, Prestatyn (Clwyd) 1988
	23	19.2	66.6	March (Cambridgeshire) 1990
	26	16.7	62	Leeming (North Yorkshire) 1953
MARCH	14	20.6	69.1	Gatwick Airport (West Sussex) 1961
	17	22.2	72.0	Enfield (Greater London) 1990
	18	22.3	72.1	Cambridge, Botanical Gardens 1990
APRIL	28	25.5	77.9	Kinlochewe (Highland) 1984
MAY	01	27.4	81.3	Lossiemouth (Grampian) 1990
	02	28.3	82.9	Rothes (Grampian) 1990
	03	28.6	83.5	Barbourne (Worcesterl) 1990
	04	28.3	82.9	Cheltenham (Glos) 1990
	06	26.4	79.5	Goudhurst (Kent) 1990
	08	28.0	82.4	Plumpton (East Sussex) 1976
	09	27.8	82.0	Southampton, Mayflower Park 1976
	30	31.7	89	Kensington Palace (London) 1947
JUNE	30	33.3	92	East Malling, Swanley (Kent) 1957
JULY	23	33.4	92.1	North Heath (West Sussex) 1989
AUGUST	01	33.3	91.9	Jersey, St. Helier 1990
	02	36.2	97.2	Barbourne, Worcester 1990
	03	37.1	98.8	Cheltenham (Gloucestershire) 1990
	04	34.7	94.5	Ulcombe (Kent) 1990
	24	32.5	90.5	Bramley (Hampshire) 1899
SEPTEMBER	21	27.2	81.0	Jersey, St. Helier 1989
OCTOBER	01	29.5	85.1	Waddon (Greater London) 1985
	02	28.1	82.6	Whitby (North Yorks) 1908
	03	28.3	83	Rugby (Warwicks) Faversham (Kent); Mickleham (Surrey) 1959; Whitby 1908
	04	28.3	82.9	Whitby (North Yorks) 1908
	13	24.8	76.6	Pen-y-Fridd (Gwynedd) 1990
	14	22.3	72.1	Jersey, St. Helier 1990
	23	20.6	69.1	Heathrow (London) 1971
	27	20.3	68.5	Old Street (London) 1888
	29	19.2	66.6	Coltishall (Norfolk) 1984
NOVEMBER	01	19.7	67.5	Hawarden Bridge (Clwyd) 1971
	13	18.9	66.0	Nantmor (Gwynedd) 1989
	14	17.7	63.9	Cwmbargoed (Mid Glamorgan) 1989
DECEMBER	01	16.0	60.8	Harrowgate (North Yorks) 1985
	12	17.4	63.3	Cape Wrath (Highland) 1984
	13	16.5	61.7	Eilanreach (Highland) 1984
	21	15.5	59.9	Mackworth (Derbyshire) 1971; Bastreet (Cornwall) 1989

The revised table covers the period from 1875 to 1990 inclusive, and, as before, entries have been restricted to temperatures recorded at weather stations equipped and operated to Meteorological Office standards. The principal sources have been the *Monthly Weather Report*, the *Daily Weather Report* and the *Daily Weather Summary* of the Meteorological Office, the *Meteorological Record* and the *Quarterly Journal of the Royal Meteorological Society*, the *Journal of the Scottish Meteorological Society*, the *Meteorological Magazine*, and the *Journal of Meteorology*. Compared with the original table there have been about 12 per cent changes.

Once again we thank readers who drew our attention to errors in the initial table. Thanks are also due to Mr. Mike Wood and his colleagues at the National Meteorological archives for assistance in locating some original observers' returns for scrutiny. Finally it must be noted that several new daily temperature minima have also been recorded since a table of daily 'lows' was first published in *Journal of Meteorology* number 96 (1985), and a revised list of these will be published in due course.

DAMAGING HAIL IN GREAT BRITAIN AND IRELAND 1989 TORRO HAILSTORM DIVISION: SIXTH ANNUAL SUMMARY

By JONATHON D.C. WEBB
TORRO, OXFORD

All reports of large or intense hail that have been received by TORRO for 1989 are summarised in this report. Damaging hail events (TORRO intensity H1 or more) are listed in Table 1. There were thirteen days with reports of damaging hail in 1989 contributing to a total of 19 such storms. The most severe events were associated with the two outstanding thundery outbreaks of 1989, on 24th May and 6th July (Fig. 1, 2). Table 1 gives an estimate for the length of each storms' track. Several winter hailstorms were observed at places a few miles inland from windward coasts: the hailswath has only been extended to the coast where the observer has been able to closely monitor the approach of the storm. In the absence of a well-defined trough, warm seas are likely to have been the source of such vigorous winter cumulonimbus; however topographical features a few kilometres in land can still contribute to such a storm's intensification.

During *January* and *early February* persistent high pressure, extending from Biscay into Europe, repeatedly steered deep Atlantic depressions to the north of the British isles which remained in a zone of very mild south-westerly winds. While Southern Britain had an uneventful spell of weather, Northern Scotland was very stormy at times (Roy 1989). During the latter half of February the belt of high pressure across Europe collapsed and the final week of the month was outstanding for the extremely low pressure in the vicinity of the British Isles, with attendant deep polar air.

A deep depression was situated to the north of Scotland on February 23rd with an unstable westerly airstream of Polar origin covering the British Isles; during the day winds backed towards the south-west as a newly developing depression moved towards the south-west approaches. Frequent showers, some accompanied by hail and thunder, affected southern and western coastal areas; during a squally thundery shower over Bournemouth hailstones of up to 20mm diameter fell around 1025.

A very deep and complex area of low pressure covered the British Isles on the 26th, to the south of which a strong westerly airstream fed polar air across Biscay and into Europe. At 500mb a deep upper low was also evident across the British Isles. Showers or longer

TABLE 1: Occasions of 'Damaging' Hail in Great Britain and Ireland, 1989

Date		*Weather Type*	*Counties*	*Length of Hailswath*		*TORRO Intensity*
Feb	23	CSW	Dorset		10	H1
Feb	26	C	Somerset		7	H1
Feb	27	CW	Cornwall	over	5	H1
Feb	28	CW	Devon		5-25*	H2
Apr	13	C	Essex	under	5	H1
May	23	E	Ireland (Cork)		15	H2+
May	24	E	Surrey	under	5	H1
May	24		Berkshire	over	5	H2
May	24		Oxfordshire		10-20	H2
May	24		Dorset/Wiltshire		10	H2
May	24		Somerset	over	10	H4
June	1	N	Somerset/Devon		2	H2
June	6	CN	Kent		5-10	H1
June	7	N	West Yorkshire	under	5	H1
July	6	CE	Hampshire/Berkshire		10	H2/3
July	6		Warwickshire/ West Midlands	over	70	H3
Dec	21	CSW	Dorset		5	H2/3
Dec	25	SW	Dyfed	over	10	H1
Dec	25		Cornwall		1-20*	H1

* The upper limit assumes that the hailswath extended from the coast

outbreaks of rain, turning to wet snow at times, affected southern counties of England. Considerable thundery activity was reported in the Bristol Channel area, where hailstones up to 16mm diameter fell during a thunderstorm at Tivington, near Minehead.

The very deep low pressure area had drifted into the northern North Sea on the 27th, leaving most of the British Isles in the zone of strong unstable westerly winds. Squally and locally thundery showers affected the south and west. A noon thunderstorm at Helston, Cornwall, was accompanied by hailstones up to 20mm diameter, while a heavy evening hailstorm whitened gardens and roads at Bunledon Green, Hampshire. The vigorous west to north-westerly airflow persisted on the 28th and further thundery showers affected south-west England. A particularly sharp thunderstorm was observed at Broadwoodwidger, near Lifton, in north-west Devon, during the early afternoon. Hailstones, which were at least the size of marbles fell for five minutes, causing damage to foliage on shrubs and early flowering tulips.

March was another mild westerly-type month. Once again western Scotland was extremely wet (over 200% of average rainfall). Although thunder was reported on numerous days, especially in Scotland, occurrences were mostly very isolated and confined to windward coasts.

In marked contrast *April* was a cold month with frequent northerly and north-easterly winds. Rainfall exceeded 200% of normal in parts of Eastern England.

Hail and thunder accompanied widespread showers across Southern England on the 7th in an unstable westerly airstream south of a filling depression over Scotland. On the 12th a broad trough of low pressure extended south-eastwards into England and Wales from a complex depression near Iceland, while an upper trough was moving slowly eastwards towards Biscay and Western Europe. During widespread showers and thunderstorms which developed across central and southern England, hail averaging 10mm. diameter fell at Bromham, Bedfordshire.

The shallow trough of low pressure persisted across England on the 13th, gradually becoming absorbed by a developing depression over the Alps. Further thundery showers developed in central and eastern counties. A prolonged thunderstorm affected Halstead, Essex, between 1830 and 2015, and was accompanied by intense hail which lay 50mm deep for a time. Hail was also quite widespread on the 20th during thundery showers which developed over south-east England in an unstable north-easterly airstream; and again on the 25th during wintry showers which broke out in a very cold arctic airstream.

Anticyclonic weather predominated in *May 1989* which was an exceptionally warm, dry and sunny month. A short spell of cooler, unsettled weather occurred during the second week. A depression moved south-east across Scotland on the 11th followed by a rather cool, showery, north-westerly airstream. Following heavy showers on Anglesey, North Wales, hail lay at least 30mm deep in places at Red Wharf Bay. Some severe thunderstorms broke out between the 19th and 24th during an especially warm period of south-easterly winds. Thunderstorms formed across the Pennines on the 19th, just to the south of a weak front laying across the England/Scotland border. Extreme flash flooding affected the Halifax/ Calderdale area where a point rainfall of 193.2mm was recorded at Walshaw Dean reservoir (Acreman 1989, Collinge, etc. 1990). Despite the possibility of insplashing there is evidence (of run off, etc) which suggests that this total was very close to the truth. Some intense hail also accompanied the storm with the observer at Walshaw Dean reporting hailstones covering the yard.

Pressure was high over the Baltic on the 22nd and 23rd while a trough extended north into Biscay from a shallow depression over Spain. Scattered thundery outbreaks moved northwards across southern England early on the 22nd with large hail reported in a few places (Mortimore 1990). Upper southerlies on the eastward flank of a shallow 500mb trough over Biscay carried a large area of thundery rain northwards across western parts of England and east Wales during the morning of the 23rd, while high surface temperatures (up to 29°C) initiated thundery afternoon showers in central England. Meanwhile intense thunderstorms occurred in southern Ireland during the late afternoon, ahead of a slow-moving cold front. Local surface convergence was enhanced by a shallow heat low inland where temperatures exceeded 25°C. A cloudburst at Mallow, County Cork, flooded the racecourse and greyhound track. Some of the hailstones accompanying the storm were reported to be as 'large as a fist'. Large hailstones also fell in the Castletown Roche area, north-west of Mallow.

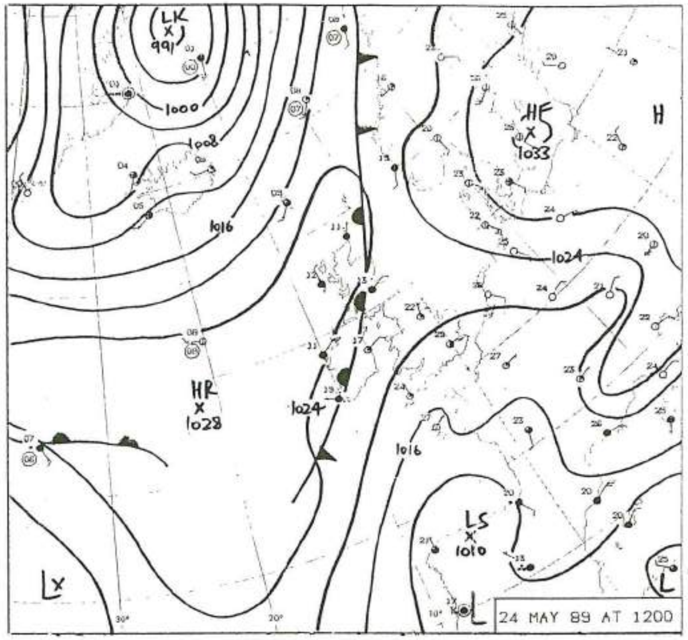

FIG. 1

The most outstanding outbreak of thunderstorms during the year occurred on the 24th May (Fig. 1) A diffuse trough extended northwards into England from a slack area of low pressure over Spain and south-west France, while a cold front was moving slowly south-east across Scotland. At 500 mb a shallow trough was evident over Biscay and Spain on the left flank of an upper ridge covering much of Europe. As on the 23rd thundery outbreaks moved north-north-westwards across central southern England, the West Midlands, and East Wales during the early morning. There is evidence of higher dewpoints in these areas resulting from the precipitation on the mornings of the 23rd and 24th; in contrast, drier air was encroaching to the east of the surface trough, reinforcing the tendency for the latter to act as a convergence zone. A remarkable feature of the Crawley and Larkhill 1200 ascents was the exceptionally light windflow at medium and upper levels. Both tephigrams indicated the likelihood of vigorous convection accompanying afternoon surface temperatures of 25 - 29°C. Conditions were ideal for the development of slow moving severe thunderstorms.

The first afternoon storms developed over the North Downs in Surrey; a 'domino effect' followed with waves of cumulonimbus development expanding westwards and north-westwards during the next few hours. Storm development propagated south-westwards along the Downland ridges of Southern England (possibly adjacent to a sea breeze convergence zone), and also in a broad swath northwards into the East Midlands and northern home counties (broadly along the axis of the surface trough). Additional storms broke out over the hills of Wales and the southern Pennines as the earlier medium level storm clouds began to break up. Intense downpours of rain and hail were numerous. 62mm of rain fell in one hour at Mickleham, between Dorking and Leatherhead, during the first major storm, when large hailstones halted traffic on the nearby M25 Motorway. A large area of storms affected north Surrey, east Berkshire, and north-west Hampshire in the early afternoon, with particularly intense falls of rain (exceeding 60mm) near Woking, Farnborough and Basingstoke. Very heavy hail fell for about 15 minutes in the Woking area, while hailstones of up to 23mm diameter were observed during the storms at Beaufort Park, near Bracknell. At Tilehurst, near Reading, a deluge of rain and hailstones up to 13mm diameter brought traffic to a temporary standstill around 1500. 13mm diameter hail was also reported in the Hatfield area of Hertfordshire. Severe thunderstorms extended in a swath northwards through Oxfordshire during mid-afternoon to affect Wiltshire, north Dorset, Somerset and east Devon.

A severe storm in North Dorset flooded premises in Gillingham and Shaftesbury; 61.1mm of rain fell in 100 minutes at East Stour (Brown 1989). Hailstones the size of marbles fell in Shaftesbury, puncturing plastic sheeting, while surrounding hills were observed to be covered in 150mm of hail. Further north heavy thunderstorms also developed across Salisbury Plain; at Porton, near Amesbury, 22mm of rain fell in 20 minutes accompanied by hail up to 10mm diameter. One of the most severe thunderstorms of the day affected the Taunton district during the early evening. The affected area extended from Churchingford on the Blackdown Hills to villages just north of Taunton. Hailstones as large as 38 to 50mm diameter fell at Blagdon Hill where plastic roofing was penetrated and solar panels were smashed. Gardens in the village were ruined by hailstones, floodwater and associated debris. Considerable accumulations of hail were deposited in East Taunton;

guttering was smashed by the hailstones in the Holway area, while golfers at Vivary Park lost their balls amongst the carpet of hailstones! Hailstones as large as marbles also thickly covered the ground at Creech St. Michael. Finally during the violent late afternoon thunderstorms in north-west England, 13mm diameter hailstones were reported from Blackburn, Lancashire, and Heywood, near Manchester.

Further very warm anticyclonic weather occurred for two weeks from *June* 11th to 25th. However very unsettled periods occurred early and late in the month. During the first week of June surface winds were predominantly northerly and the British Isles were under the influence of unusually cold upper air. A showery trough moved slowly southwards over Southern England on the 1st within a slack northerly airstream. A very deep upper trough extended from Scandinavia across the British Isles to Biscay and over most of England and Wales 500mb thicknesses fell below 534mb. Brize Norton (Oxon) and Bedford recorded day maximum temperatures of only 10°C. Widespread showers and thunderstorms were accompanied by hail across southern counties. During a storm at Wansted, north-east of London, hail completely covered the ground. A severe hailstorm affected the Chard area of Somerset in the early afternoon. Hailstones of 6 to 13mm diameter caused severe damage to gardens and orchards in the village of Tatworth. 34 acres of orchards were affected. Trees were stripped of leaves, and apples were pitted with large holes. Bedding plants and beans also sustained damage.

A depression was slow moving over south-east England on the 6th, while a very cool northerly airstream affected most of the British Isles. A large upper trough extended from the Norwegian Sea into western Europe. Thunderstorms broke out widely in south-east England from late morning with hail reported in several areas of Kent and south-east London. East Malling, near Maidstone, reported 15 minutes of hail during a thunderstorm around noon, while an unusually prolonged and intense hailstorm affected the Gillingham and Chatham areas shortly afterwards. Hail fell for a duration of 17 minutes in Chatham, but this was far exceeded in Gillingham where hailstones, the largest about 13mm diameter, fell continuously for around 50 minutes in the south of the town. Hailstones accumulated to an average depth of 125mm in the Hempstead area, the white blanket being fairly even owing to the light surface winds. Some reports, however, spoke of ice being heaped over 300mm deep in places. The intense rain and hail caused atrocious driving conditions and many streets were blocked by stranded vehicles. At Wigmore 35mm of rain fell in 30 minutes at the height of the storm.

An unstable northerly airstream was maintained on the the 7th when a local council reported that a hailstorm had damaged allotment vegetables at Knottingley, West Yorkshire; however local residents attributed the damage to atmospheric pollutants! A trough moved south-east across southern England on the 8th setting off further thunderstorms, especially in Kent. Lightning caused damage in Canterbury (Mortimore 1990) and hailstones up to 13mm diameter fell at Sheperdswell, north-west of Dover. The very warm period in mid-June was interrupted by scattered thunderstorms in the north-west on the *12th - 13th* as a cold front moved slowly eastwards across the British Isles. Large hailstones were reported from Rusherkin, County Antrim, Northern Ireland.

Anticyclonic weather was predominant during *July* which was, like May, an unusually sunny and warm month. Much of the month's rainfall was attributable to

thunderstorms between the 6th and 8th. A shallow, complex, depression covering Biscay, Spain, and Western France drifted northwards towards Southern England on the *6th:* high pressure was situated over Southern Scandinavia.(Fig 2) The 500mb chart shows an upper trough over Biscay and a strong ridge across central Europe. The 1100 upper air ascent at Larkhill, Wiltshire, indicated moderate vertical wind shear; the surface winds of 095/8 knots veered and increased to 140/21 knots at 600mb and 165/26 knots at 250mb. Temperatures rose to 25° to 30°C (31°C at Heathrow) in the light surface easterly airflow generating deep convection by afternoon. Thunderstorms were particularly widespread and severe in central southern England and the Midlands. A slow moving storm affected the Hampshire/ Berkshire border region between 1600 and 1900; during this period 82mm of rain was recorded at Tadley, just north of Basingstoke. Large hailstones fell between 1700 and 1800, a typical hailstone at Aldermaston Soke measuring 22mm in diameter. One hailstone of 30mm diameter was measured near Tadley. The impact of the hailstones was overshadowed by exceptionally severe flooding. Floodwaters pouring off the Berkshire Downs turned miles of the A4 near Woolhampton into a complete river. A decoy pond at Aldermaston Court overflowed surging a torrent of floodwater through the village which inundated homes up to four feet deep, ripped up tarmac and flattened an eight foot wall. The storm, which extended northwards about as far as Hermitage on the Berkshire Downs, appears to have been maintained for about three hours as a series of cells developing over the ridge of the Hampshire Downs near Basingstoke moved slowly north-westwards.

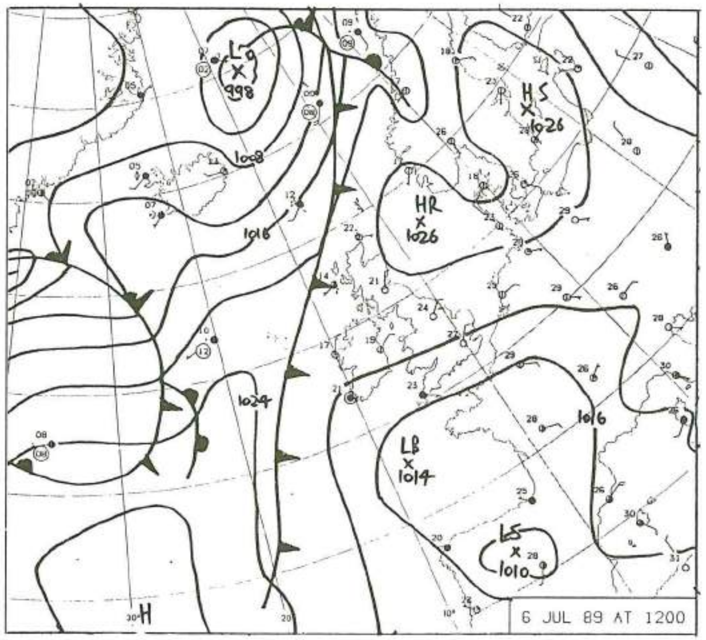

FIG. 2

A more mobile, but equally vigorous thunderstorm system affected the West Midlands. this appeared to originate as a cluster of cumulonimbus which erupted close to high ground on the Northaptonshire/Leicestershire border. The complex storm moved west-north-westwards to affect Rugby, Coventry, much of Birmingham, Wolverhampton and later West Shropshire and Clwyd.

Hailstones up to 12mm diameter accompanied intense rainfall along the A45 west of Rugby between 1616 and 1625. The storm was extremely violent over Coventry from 1622 to 1655; lightning strikes to ground were observed every 30 seconds at one time. Intense hail of up to 10mm diameter fell across much of the south and west of the city, accompanied by severe squalls around 1745. Hailstones of 18 to 20mm diameter were reported from Allesley on the north-western outskirts of the city, where a greenhouse was smashed. The thunderstorms hit Birmingham airport around 1740 where squall winds of up to 54 knots were recorded. A large branch torn off an oak tree narrowly missed a golfer. Squally winds gusting to 50 to 60 knots and hailstones up to 13 to 19mm diameter were reported from several places in the southern half of Birmingham, where the hailstones locally choked roof drains and covered the ground 'like snow'. The largest hailstones reported in the region fell at Oakham, near Dudley, where some measured 25mm diameter. PVC roofing was holed and gardens were devastated, some plants being described as 'pulped'. Sedgeley and Wolverhampton were also affected by the storm with reports of hail up to 15mm across (Reynolds 1991). The storms later caused widespread flooding in West Shropshire.

During afternoon thunderstorms in west Oxfordshire motorists driving on the A40 near Burford swerved off the road under a barrage of large hailstones around 1600. Further heavy thunderstorms spread north from France into southern England during the following night and hail was again reported in a few places. Thunderstorms were infrequent during the rest of July, although locally heavy storms occurred in Eastern England on the 8th, 22nd and 29th.

August was a predominantly anticyclonic westerly month, dry and very sunny in central and southern England, but wet in the north-west. The most disturbed weather occurred in mid-month. Thunderstorms were quite widespread as very active cold fronts crossed the British Isles on the 13th and 14th. A tornado caused considerable damage at Pwllheli, North Wales on the latter date and hail over 10mm diameter fell at Ballywatticock, County Down, Northern Ireland.

September was another warm and predominantly dry month, although thunderstorms were responsible for some heavy local downpours in the south between the 10th and 13th and some more widespread heavy rain affected the Midlands on the 16th.

A shallow depression located over northern France on the 11th drifted northwards into southern England on the 12th. The British Isles were also under the influence of an upper trough. Heavy thunderstorms affected south-west England from the afternoon of the 11th through to the early hours of the 12th. Hail completely whitened the ground at Weymouth, where 30mm of rain fell. During severe thunderstorms over south-east England on the afternoon of the 12th hail fell for more than an hour in the Gillingham area; 68mm of rain was recorded there in two hours, easily exceeding that during the earlier storm of 6th June.

After a quiet first half of the month, very disturbed weather prevailed from 19th to 31st *October*. Thunder was heard on eleven of these last 13 days but no reports of significant hail have been received.

November. The unsettled weather of late October persisted until the 10th, following which a long spell of dry, anticyclonic weather prevailed, continuing well into December. A showery westerly airstream affected Southern Britain on the 1st; Towy Castle near Carmarthen experienced a sharp thunderstorm with hail up to 14mm diameter.

December. The first ten days were anticyclonic while settled weather returned after Christmas. However the period 11th to 25th was extremely cyclonic and often stormy; monthly rainfall exceeded 200% of normal across most of southern England, the Midlands and East Wales. Thundery activity was unusually widespread and severe for the season on the 14th, 20th, 21st, 23rd and 25th; some places in the south-east Midlands reported up to six thunder days (Mortimore 1990c). A depression was situated north-west of Ireland on the 21st. This fed a very mild, strong and unstable returning maritime Polar airstream across England and Wales which also lay on the eastern flank of an upper trough. Thunderstorms were widespread during the morning in association with a showery through. A tornado caused considerable damage (*See J. Meteorology 15*, 296-297) at West Stour, Dorset, around 0630. During the associated thunderstorm hail the size of marbles also damaged a skylight window. A surface occlusion and an associated upper trough moved quickly eastwards across southern and central England on the 23rd. Thunderstorms were accompanied by hail in many parts of South Wales and Southern England, hailstones of up to 12mm across falling to the south-east of Carmarthen, Dyfed.

A very deep depression was situated south of Iceland on Christmas Day and, as on the 21st, the British Isles were under the influence of a very unstable south-westerly airstream of distant polar origin. Thunderstorms were quite widespread near western coasts with a few penetrating well inland. Large hail again accompanied a storm near Carmarthen where Towy Castle reported hail of up to 18mm diameter. During an early morning storm at Stithians, Cornwall, hail with an average diameter of 10mm completely carpeted the ground.

ACKNOWLEDGEMENTS. The TORRO directors wish to thank all observers of the Tornado and Storm Research Organisation, Thunderstorm Census Organisation and Climatological Observers Link whose invaluable reports have provided the basis for this summary. Useful information has also been reported in the *Daily Weather Summary* and *Monthly Weather Report* of the Meteorological Office. The two weather charts are reproduced with permission of the London Weather Centre. Particular thanks are due to A. Waters, W.S. Pike, and D.J. Reynolds for discussions concerning the thunderstorms of 24th May and 6th July. Sincere thanks are also due to members of the general public who have responded to press appeals and other enquiries concerning severe storms.

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DAMAGING TORNADO AT OVERBURY IN THE COUNTY OF HEREFORD AND WORCESTER: 2 FEBRUARY 1990

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Abstract At 1530 GMT on 2 February 1990 a damaging tornado passed through the village of Overbury in the county of Hereford and Worcester, which is situated just to the south of the 293 metre Bredon Hill. This short paper describes the incident and also refers to earlier possible tornado damage that was noticed by Mr. F.E. Wood on the southern slopes of Bredon Hill on 26 January 1990.

INTRODUCTION

A deep depression that had moved north-east close to north-west Ireland on 1st lay just to the north of Scotland by the afternoon of 2nd and the whole of the United Kingdom was covered by a vigorous west to south-westerly airstream. At Overbury the weather of the day was very stormy with squally showers and the west-south-west winds gusted to severe gale force at times. Rainfall for the 2nd amounted to 9mm.

THE TORNADO

Events leading up to the occurrence of the tornado were witnessed from a position on Bredon Hill about 1.2km above the village of Overbury in a northerly direction. Attention was initially drawn to a black cloud formation, resembling a possible thunderstorm, approaching from the west. No funnel-cloud, as such, was seen but part of the cloud base was seen to be hanging down in ragged fashion. The immediate area, including the point of observation, was subjected to a hailstorm which lasted for some five minutes and hailstones accumulated to approximately 2.5cm in depth. The largest hailstones, which must easily have been in the region of 8 to 13mm in diameter, accompanied the onset of the storm and was of such severity that the observer had to kneel down to avoid being cut about the face, such was the force of the assault. The hailfall was marked by a sudden drop in temperature and the accumulated hailstones still lay thick on the ground some 30 minutes later. Just before the onset and during the hailstorm a roaring sound could be heard in the direction of Overbury village, sometimes increasing in intensity. No thunder or lightning was observed.

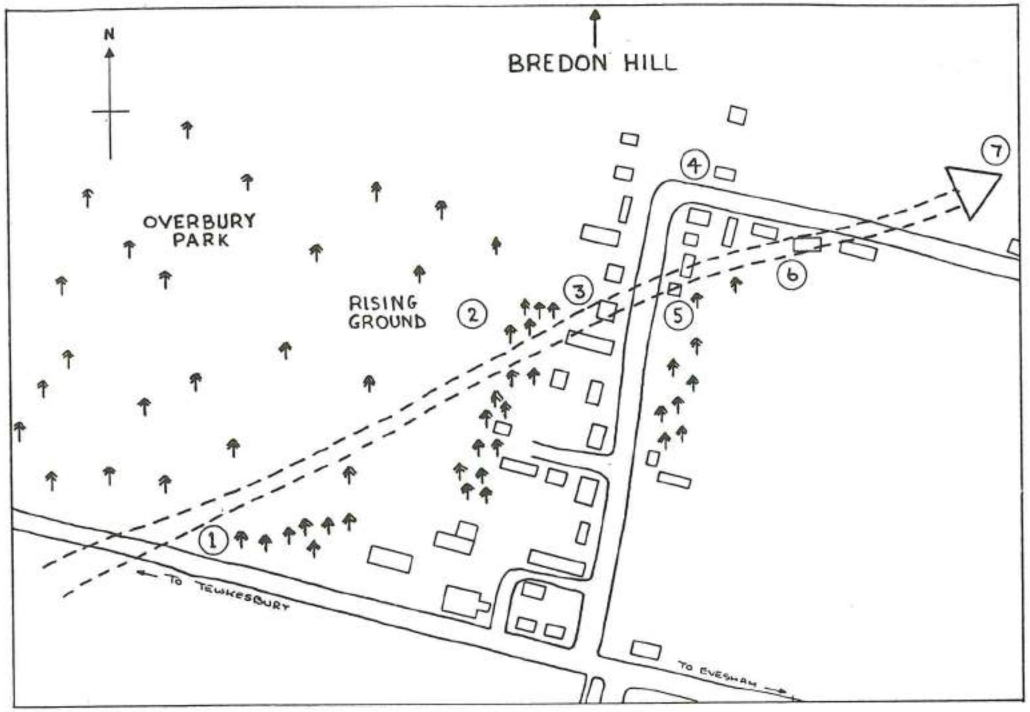

FIG. 1

Figure 1 clearly shows the track of the tornado through the village. The tornado approached from the south-west, crossing the Tewkesbury road at position 1 where the width of damage was approximately 30 metres. At this point a 21 metre cedar tree was lifted clean out of the ground and limbs 'twisted' from other trees were carried some 100 metres before being dropped. The tornado continued to track through Overbury Park but as it approached rising ground at position 2 the funnel would seem to have temporarily lifted off the surface only to make contact again at position 3. Damage beyond position 3 was considerable. A metal greenhouse was twisted beyond recognition, a car was rendered a complete write-off, tiles were stripped from houses, windows were shattered and brickwork was disloged. At position 5 a massive horse chestnut tree was rent assunder, half of it falling in the road just five minutes after a group of school children had passed beneath it. A witness at position 4 observed small fruit trees, sundry garden debris, parts of smashed chicken pens and branches, etc., ascending and spiralling upwards in a narrow column before being dropped further along the tornado track at position 6.

The tornado would seem to have finally lifted or dispersed at position 7 having been in contact with the ground for the greater part of 2.5 km through Overbury from the initial point of contact 1.2 km to the south-west of the village. After the 30 metre swathe of damage at position 1 the width from position 3 was nearer to 15 or 20 metres. An estimate of the cost of damage to property was in the region of £60,000.

A REPORT OF POSSIBLE EARLIER TORNADO DAMAGE ON BREDON HILL

On 26 January 1990 attention was drawn to a belt of mature beech trees about 800 metres below the summit of Bredon Hill, on the south side, above Overbury village. A complete group of 33 trees had been up-rooted and left lying at all angles. It is more normal for felled trees to lie in a common direction but in this incident the group of trees had been subjected to a tremendous force of a twisting nature. No other damage was visible adjacent to the 40 metre wide damage swathe on either side, or in front of or behind the tree belt which is largely open ground. It is not possible to accurately date this visitation but as the damage was observed on 26 January there is a strong possibility that it may have happened on 25 January when storm-force winds swept right across the British Isles. Considerable straight-wind damage occurred on this day but parts of the west-country were hit by tornadoes and it is quite likely that the above damage may well have been the result of a short-lived tornadic development associated with a storm cell moving up the valley of the river Severn from the Bristol Channel.

THE WEATHER AT OXFORD DURING 1990

By T.P. BURT and ROSEMARY MUNRO

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Like 1989, 1990 has been an exceptional year: as warm as 1989, with some exceptionally high temperatures in July and August; sunnier even than 1989 though somewhat less so in the summer; strong winds on repeated occasions in January and February; and, a prolonged drought after a very wet start to the year.

January was a record-breaking month with remarkably mild temperatures punctuated by a powerful gale on the 25th. January was, in fact warmer than December (1989), the fourth warmest in 176 years of record; only 1983 has equalled this in the last 78 years. A single day of air frost has been equalled only five times since 1882 and the accompanying absolute minimum air temperature (-0.2°C) was the third warmest on record; the mean minimum air temperature (4.5°C) was sixth highest on record. Not surprisingly, the mean soil temperature of 6.3°C at 30cm was the warmest ever recorded, beating January 1989 by a small margin. January was a wet month, receiving 75mm rainfall. On the 25th, winds gusting to 74 knots over a period of two hours from 13:30 GMT caused widespread damage. The windspeeds easily exceeded those of 16th October 1987 when Oxford missed the worst of the storm; the maximum gust then was only 62 knots. The storm of 25th January 1990 was more comparable, though probably a little less severe, than that of 2nd January 1976 for the Oxford region. The sustained impact of high windspeeds may have been particularly important in relation to the large amount of damage done, compounded by its daytime occurrence. 74 knots is not the strongest gust ever recorded at Oxford by the current anemometer (installed in summer 1976). In March 1987 there was a gust of 76 kt; however, that seems to have been an isolated event and there was generally little damage in the area. The anemometer is at a height of 44m; however, its urban location may mean that its performance is little different from an anemometer at 10m in open country.

February was also a remarkably warm month with mean air temperature (8.0 C) the warmest on record, a full four degrees above normal. February was also wet and windy, with 94.2mm rainfall, the eighth wettest February since 1767. Nevertheless it was sunnier than normal, the 9th sunniest since 1881. Since both December (1989) and January were also mild, January notably so, the very high temperatures in February ensured that the *winter of 1990* (including December 1989 by convention) was the warmest since records began in 1815, equalling that in 1869 (6.9°C; 2.9°C above average). This is particularly interesting since the 1989 winter was also remarkably warm (fourth highest) and the 1988 winter was also well above average (thirtieth on record): three very mild winters in a row may give some

TABLE 1: Summary of observations made at the Radcliffe observatory, Oxford University during 1990.

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
T	7.1	8.0	8.5	8.1	13.2	14.3	17.7	19.0	13.6	12.3	6.8	4.3	11.1
Diff	+3.5	+4.0	+2.9	-0.1	+1.7	-0.5	+1.3	+3.0	0.0	+2.3	+0.5	-0.2	+1.6
Max	12.6	15.6	20.9	22.2	25.9	23.7	31.1	35.1	24.2	22.3	15.4	11.8	35.1
Mean	10.0	11.3	12.7	13.7	19.0	18.2	23.8	24.8	18.6	15.8	9.8	7.0	15.4
Diff	+3.4	+4.1	+2.8	+0.8	+2.4	-1.5	+4.1	+3.8	+0.1	+1.7	+0.1	-0.3	1.6
Min	-0.2	0.4	-1.6	-2.4	3.6	6.2	6.3	10.2	3.8	4.1	-0.6	-4.9	-4.9
Mean	4.5	5.2	5.0	3.2	7.9	10.7	12.2	14.0	9.4	9.3	4.2	1.7	7.3
Diff	+3.2	+4.0	+2.8	-0.9	+0.8	+0.6	+0.1	+2.1	-0.3	+2.7	+0.5	-0.4	+1.3
Grass	-4.5	-6.0	-7.8	-9.5	-2.4	0.3	-0.1	4.4	-2.4	-2.2	-5.0	-5.6	-9.5
Wet	11.9	18.0	12.0	5.5	7.3	13.7	8.1	10.4	24.4	13.6	4.5	8.0	24.4
Day/ Rain	75.0	94.2	18.4	20.4	8.7	48.8	17.7	26.5	41.1	45.9	20.0	56.3	473.0
Diff	+23.1	+53.6	-22.9	-22.5	-42.1	-5.1	-42.7	-32.1	-19.2	-18.7	-41.1	+1.1	-168.8
Sun	58.3	95.7	144.1	234.4	285.1	121.1	268.5	236.6	165.0	124.4	83.7	58.8	1875.7
Diff	+4.9	+26.9	+30.8	+83.9	+94.7	-76.3	+79.4	+60.1	+26.7	+23.4	+20.0	+10.7	+385.2
A.F.	1	0	2	5	0	0	0	0	0	0	1	4	13

T = mean temperature (°C); Max = extreme maximum; Diff = difference of mean long-term mean, etc; grass = grass minimum; A.F. = air frosts cause for suspicion! The 1990 winter was also remarkably wet, unlike the previous winter, with a total of 311mm making it the wettest since records began in 1767. It was also one of the stormiest winters on record, with a whole series of intense gales, notably on 25th January (74 knot maximum gust), 7th February (57kt), 26th February (71kt) and 28th February (58kt).

March was one of the warmest recorded since 1815, third equal with 1822 and only exceeded by 1938 and 1957. The maximum temperature of 20.9C on the 17th was the warmest March day since 1968. The mean maximum temperature was the ninth highest on record and the mean minimum was the third highest on record, exceeded only by 1957 and 1981. March was a dry month, with less than half the average rainfall; from now on all months were below average rainfall with the exception of December which just struggled above the mean value. *April* was a mixture of dry, warm and sunny days, and cold nights. A maximum of 22.2 C was recorded on the 30th, welcomely warm if not exceptional! The nights were generally cold with the grass minimum dropping to -9.5C on the 5th, equal coldest on record for April; the mean grass minimum temperature (-0.6C) was equal sixth lowest on record. It was the fifth sunniest April since 1881. Like April, *May* was warm, sunny and dry. 1989 was an exceptional month, but May 1990 came close to it; it was the third sunniest on record (beaten only by 1909 and 1989) and the eighth driest on record, least rain in May since 1956. Like 1989, the warm winter led to very high soil temperatures in the spring with temperatures at 30cm in May being the second highest on record since 1925 (again beaten only by 1989). Despite all this, nights were cool and the grass minium temperature (2.9°C) was the fifth lowest since 1881, with six ground frosts but no air frosts.

ture (18.2°C) was equal eighteenth lowest on record since 1881 and the absolute maximum of 23.7 °C was equal thirteenth lowest on record. Minimum temperatures were, however, above average and there were no ground frosts. Rainfall was just below average. Most notable was the lack of sunshine: only 121.1 hours, the second lowest June total on record, only 190 9 with 109.4 being worse. In 1989 Oxford received almost double this amount — eight hours sunshine a day instead of four this year! *July* was characterised by clear skies, giving warm days, cool nights, low rainfall and more sunshine than usual for the time of year. Daytime temperatures were consistently higher than average with the eighteenth highest maximum air temperature (31.1°C) and the fifteenth highest mean maximum air temperature (23.8°C) since 1881. Conversely, the first ever ground frost for July was recorded on the 3rd; indeed the ground was consistently cool with the lowest recorded mean minimum grass temperature equalling 1922 and 1924. Rainfall was again substantially below average: less than a third of the expected rainfall. Sunshine was well above average, the seventh highest total since 1881. *August* was the third warmest on record since 1815, bettered only in 1947 and 1975. The maximum temperature of 35.1C on the 3rd equalled the highest ever recorded in Oxford (19th August 1932). As expected all measures of temperature were exceptionally high, in particular at night: the lowest temperature recorded all month was 10.2°C! August was a sunny month, though not remarkably so, ranking only thirteenth since 1881. Once again, rainfall was below average.

Following on from the exceptionally fine summer of 1989 at Oxford, it was perhaps something of a surprise to experience the *summer of 1990* which like its predecessor was noticeably drier, warmer and sunnier than average. However, both in terms of the three summer months (June to August) and the extended summer (May to September) it was not quite so remarkable as it first seemed. The mean temperature for June to August 1990 was 17.0 C, only twentieth out of 176 in rank; total rainfall was 93mm, twentyfourth lowest. There were 626 hours of bright sunshine in 1990 as compared to 794 hours in 1989; it was not very much sunnier than average. In terms of Poulter's Index, a measure of the common perception of fine summers, 1990 was fourteenth in rank out of 110 years with an index of 711 as compared with 745 in 1989. The four finest summers by this index were 1976, 1911, 1975 and 1989 in that order. The mean temperature for the extended summer (May to September) was 15.6°C. Most memorable for many people was the dryness of the (extended) summer: all five months had below average rainfall, the total (142.8mm) being the fourth lowest in 220 years, after 1929 (115.2mm) and close to the values for 1921 and 1940. There were 1076 hours of bright sunshine which makes 1990 the sixth sunniest extended summer in 110 years. The sunniest extended summer was 1989 with 1237 hours, well above the second sunniest (1959).

After such an exceptional August, September proved to be somewhat mundane. Temperatures were average, but it was sunnier than normal. October was also a warm month sixth equal warmest since 1815 and the warmest since 1969. Mean minimum temperature was the fourth highest since 1881 and mean maximum temperature (15.8°C) tenth highest on record. November too was somewhat warmer than average. A warm spell in the middle of the month was followed by a cold snap with a maximum temperature of only 3.3°C on the 22nd. There were more ground frosts than normal but fewer air frosts. For the ninth month in a row rainfall was below average. December was a little cooler than average. Rainfall exceeded the monthly average for the first time since February, although an excess of 1.1mm was hardly cause for celebration! Some snow fell on the 8th, a rare sight these days.

Mean air temperature in 1990 was 11.1°C (1.6°C above average), identical to that in 1989, the second year in a row that mean temperature has exceeded 11C: to experience two such record-breaking years in a row is remarkable. The mean maximum temperature was 15.4°C, 1.6°C above average, equal second with 1949 and only beaten by 1921; only the December value was below normal. Mean minimum temperature was well above average (7.3C; +1.3°C), second only to 1989. Soil temperatures too were very high, again second only to 1989. There were only 13 air frosts, 33 fewer than expected, the lowest total on record; on the other hand, the number of ground frosts was nearly normal and the first ground frost in July was recorded. 1990 was a dry year, with a deficit of 169mm, the twelfth driest calendar year since 1767; the deficit would have been even greater without heavy rain in January and February. The sequence of nine months with rainfall below average was the longest since the 11-month period: October 1975 to August 1976. The combined total for 1989 and 1990 is 1068mm, a deficit of 214mm. There have been 11 periods since 1767 when 24-month rainfall totals have been below 1000mm, so the current drought is less than a one in 20-year event. However, many of these eleven occurred in the 18th and 19th centuries when demand for water was much less. Accordingly the impact of this drought may be somewhat more extreme than the statistics would imply; the rainfall in December, continuing into January 1991, is therefore most welcome with respect to recharge of soil and ground water. 1990 was also the sunniest year on record at Oxford, beating the 1989 total by almost eight hours! Although the summer of 1990 was less sunny than that of 1989, all months with the exception of June were more sunny than normal.

In summary, 1990 was the warmest year in record in Oxford, equalling the record established in 1989. It was the sunniest year on record, and one of the driest. It may, too, have been one of the windiest, with notable gales in late January and February.

Notes: 1. We are grateful to Mr. C G Smith, former Director of the Radcliffe Meteorological Station for providing the analysis of the 1990 summer.

2. Some figures listed on the 1990 summary table attached differ from those given previously on individual monthly summary sheets; we apologise for any inconvenience these corrections may cause.

PRINCIPAL COMPONENT ANALYSIS OF ALBANIAN RAINFALL

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ABSTRACT Principal Component Analysis has been used to establish some characteristics of the precipitation for Albania. The data of mean monthly precipitation amounts for a 35 year period (1931-1965) from 154 meteorological stations were used. The first two principal components (PC's), which describe 87.2 per cent of the total variance, are considered. It is shown statistically that PC1 is related to the frequency of the cyclones crossing the area and PC2 to the anticyclonic and non-gradient surface weather types and cold pools aloft. This means that the PC1 explains the annual amounts of precipitation and PC2 the summer thundery rainfalls. Using the PC's scores, homogeneous precipitation sectors are determined over the territory of which the annual pattern of precipitation is discussed.

INTRODUCTION

The Mediterranean precipitation climatic types of Cs and Cf— according to the Koeppen classification— are dominant over Albania, where the precipitation maximum comes in winter and the minimum in summer (less than 30mm/month in Cs and more than 30mm/month in Cf type). The influence of both the atmospheric circulation and geographical factors on this type of precipitation was studied for a number of Mediterranean stations by Maheras (1985) and by Goossens (1985) in relevant papers, by using the principal component analysis technique (PCA), but these papers only use Albanian stations.

In this study the method of Principal Component Analysis has been used to describe the mean monthly precipitation total sover Albania, an area where a very complicated relief dominates and an intense network of meteorological stations exists (Figure 1A and B).

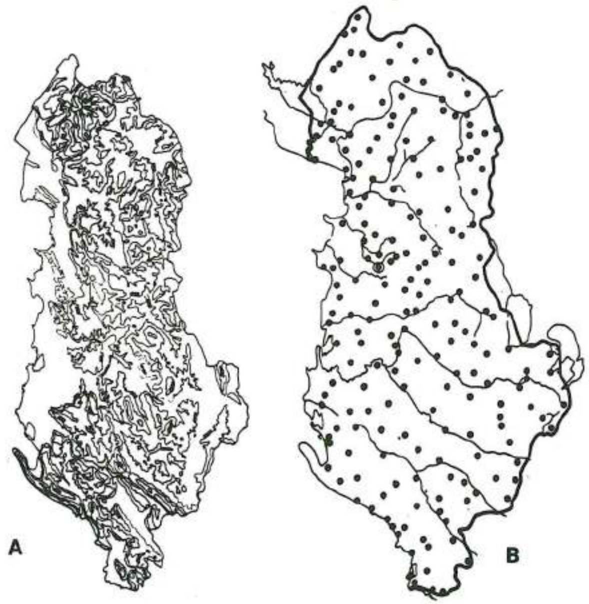

FIG 1. The topographical map of Albania (A) and the network of the meteorological stations (B)

The 35 year dataset (1931-1965) consists of mean monthly precipitation amounts for 154 meteorological stations. The stations used are almost evenly distributed over the country (Figure 1B) and their data have been published in "Le climat del' Albanie, tableaux, precipitations atmospheriques, Volume I, Tirane, 1978". Hence the initial matrix was M=154x12.

METHOD AND ANALYSIS

This rainfall matrix was subjected to the principal component analysis by generating a 12x12 correlation matrix between the set of stations and the set of months. This method has been described extensively in the literature. (Sneyers and Goossens, 1988).

In order to determine those principal components (PC's) which have a variation significantly different from a random evolution, Kaiser's criterion (Kaiser, 1959) was used. These components (PC's) were further subjected to the orthogonal varimax rotation. Rotation of these hypothetical vectors often removes certain ambiguities that are sometime evident in the direct solutions.

From Table 1, Kaiser's criterion indicates that the cut-off value for the eigenvalues is at the eigenvalue number two. These two first components account for 87.2 per cent of the total variance of the rainfall of which 74.5% was extracted for the first component and 12.7% for the second.

Table 1. Results of the principal component analysis

Factor	*Eigenvalue*	*Percent var*	*Cumul. percent*
1	8.94	74.5	74.5
2	1.52	12.7	87.2
3	0.42	3.5	90.6
4	0.33	2.8	93.4
5	0.21	1.7	95.1
6	0.15	1.2	96.3
7	0.13	1.1	97.4
8	0.09	0.8	98.2
9	0.08	0.7	98.8
10	0.06	0.5	99.3
11	0.05	0.4	99.7
12	0.04	0.3	100.0

PHYSICAL EXPLANATION

a) *Component Loading*

The results of the analysis indicated that the colder months (September to April) were highly correlated with the first principal component which explains 74.5% of the total variance, while the warmer months (May to August) were significantly correlated to the second principal component (Figure 2A and B, continuous lines). Thus a close correlation exists between the Mediterranean weather types and the rotated PC's. This can be supported by the simultaneous presentation, in Figure 2 (A and B), of the frequencies of the annual course of the cyclonic, anticyclonic and non-gradient weather types over the southern Balkans, determined by Maheras (Maheras, 1983).

The annual course of the cyclonic frequencies compared with the annual course of the first PC's loadings (Figure 2A) shows a good agreement and supported by the high correlation coefficient (r=0.98). Hence the first component can be related to the cyclonic precipitation type, which falls during the colder period over the country. This relation means that the PC1 explains the annual amounts of precipitation. The annual course of the frequencies of anticyclonic and non-gradient weather types compared with the annual course of the second PC's loadings (Figure 2B) also shows a good agreement (r=0.95). Thus the second component, which explains 12.7% of the total variance, is related to summer thunderstorm activity which is intensified by the presence of a cold pool aloft.

A study of the European upper air daily weather charts, reveals that a cold pool very frequently appears over the Balkans mainly during the warm months May to July. This pool well-recognized in the 1000-500 Hpa thickness chart, usually extends to the south as far as the 39th parallel and is one of the main factors controlling the summer thunderstorm activity over an extensive part of Balkans.

b) *Component scores*

The first component presents positive scores mainly in the northern and southern parts of Albania and a smaller one in the middle (Figure 3) and negative scores in the rest of the country. Higher positive values mean higher amounts of annual precipitation and

smaller negative scores mean lower annual rainfall amounts. Thus the first PC's scores divide the country in sectors with high annual rainfall amounts (positive areas) and low amounts (negative areas). Comparing this map (Fig. 3) with the map of Figure 1A it is obvious that the stations with high scores are located in the high mountainous areas. Thus a link between the atmospheric circulation and the topography is established.

The second component (Figure 4) presents negative scores in most the coastal area and the east part of Albania, and positive scores mainly in the central areas, where the higher mountains appear (see Fig. 1A). The high positive scores denote that these areas have high amounts of precipitation during the summer compared with the areas of negative scores, where a longer dry period is established. This distribution of the scores seems to be linked to the thundery showers during the warm period, as the summer rainfall mainly comes from thunderstorm action which is reinforced by the topography.

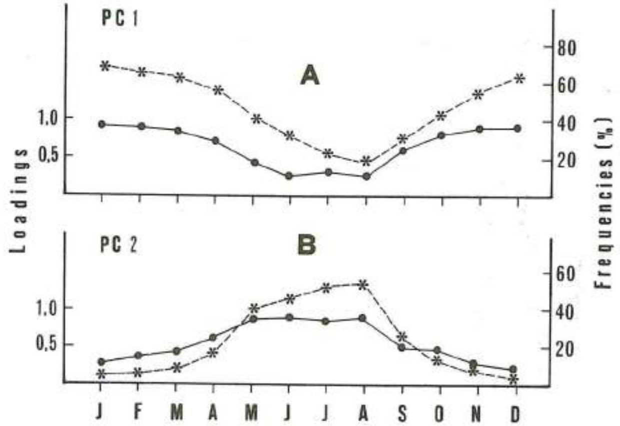

FIG 2. Presentation of the 35-year monthly averages of the first two standardized precipitation field varimax rotated PC's (---) in comparison with (-*--*-) a: The annual course of cyclone frequencies, and b: the anticyclonic and non-gradient weather types with cold pool aloft according to Maheras 1983.

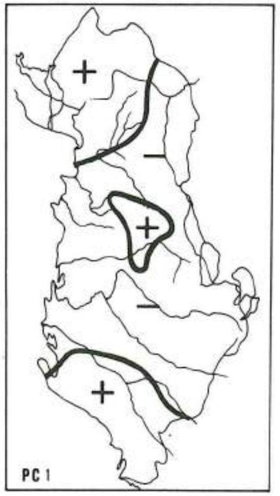

FIG 3. First principal component of mean monthly rainfall in 171 Albanian stations. PC1 explains 74.5 percent of the variance.

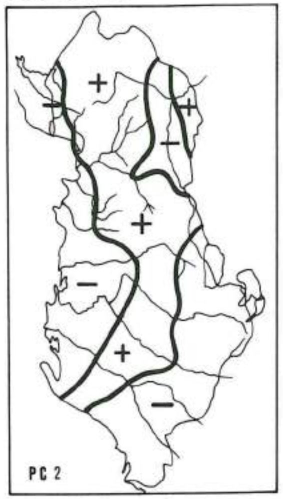

FIG 4. Second principal component of mean monthly rainfall in 171 Albanian stations. PC2 explains 12.7 percent of the total variance.

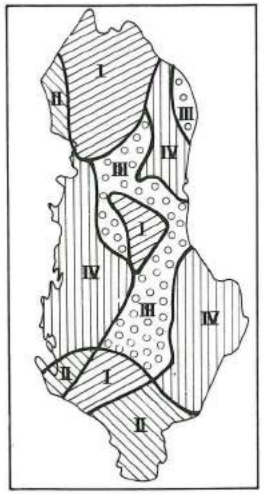

FIG 5. The homogeneous precipitation groups in Albania.

HOMOGENEOUS PRECIPITATION SECTORS

In order to determine the homogeneous precipitation groups of the stations in Albania, an algorithm was applied together with the first two PC's scores. The result is illustrated in Figure 5. Albania is divided into eleven sectors which make up four homogeneous groups:

Group I: This group presents high annual amounts of precipitation almost without dry season. It appears in the highest mountainous areas with altitudes over 1800 metres.

Group II: As group 1, characterized by high annual rainfall amounts with a dry period during summer. This group covers a variety of complex topographical areas which seem to result in forced ascent.

Group III: This group appears mainly in central areas with small amounts of precipitation and a very limited summer dry period due to thundery rainfall.

Group IV: This group is characterized by lower annual rainfall amounts in comparison with the previous groups, and presents a pronounced dry summer period. It appears in the east part of the country (far from the sea) with mountain heights less than 1200 metres. These low amounts can be attributed first to depression tracks which usually follow a SW or NW path (Maheras 1983, Flocas 1988). Thus the rain systems meet near the Adriatic coast high mountain ranges (Fig. 1A) resulting in heavy orographic rains over these ranges. Then the drier air moves east giving a rain shadow affecting this part of the country.

Secondly, during the summer, the air flow from the Adriatic Sea is slow over the country and thus a topographically-induced instability appears over the main mountain axis from north to south. East of this range the atmospheric humidity is too low to give high rainfall amounts from thunderstorm activities.

A representative course of the annual precipitation separately for each group is given in the histograms of Figure 6. The values are the monthly arithmetic means of the stations found in each group. These histograms illustrate very well the dominating annual rainfall regime of each group of stations.

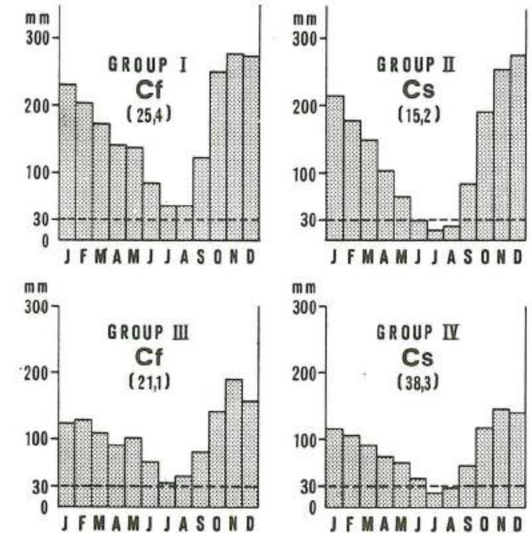

FIG 6. Annual course of the mean precipitation amounts for each group of the stations. The number of the brackets denote the percent of the stations belonging to the groups.

LITERATURE REVIEWS AND LISTINGS

Book Reviews

FORTY YEARS OF PROGRESS AND ACHIEVEMENT: A HISTORICAL REVIEW OF WMO. Edited by Sir Arthur Davies. WMO-No. 721, Geneva 1990, 205pp. 90 Sw.fr.

Few books are as well produced at this, which befits the celebratory aims of its authors. Moreover, the text succeeds well in the stated objective of being accessible to other interested parties, as well as meteorologists. Especially for those who know little about the World Meteorological Organization, chapter 1 ('In the beginning') will serve a double purpose. First, and most obviously, it will tell them how the organization came into being: it also, however, gives some useful data on earlier achievements in meteorology, going back to the time of Aristotle and beyond. In the absence of a detailed and comprehensive account of the history of developments in meteorology, this chapter will prove an important source of data for those wishing to improve their knowledge of the subject. Equally, the final chapter (No. XVIII - 'Further outlook') offers an insight into possible directions of future progress, with the outline of the WMO's so-called 'Third Long-term Plan (1992-2001)' likely to be of particular interest to many readers. Between these first and last chapters are a number of accounts whose generally more specialised nature probably means their appeal will be less widespread. Some of these cover the programmes undertaken in areas of long-standing meteorological interest, such as aviation, shipping and agriculture. Others, however, deal with more recent concerns, stemming from man-induced changes in the natural environment (e.g. No.XI - 'Protection of the environment'). There are also accounts of educational, technical/instrumental and organizational/collaborational aspects of the WMO's work. This is not a book which is likely to be near the top of most peoples' list of spending priorities. On the other hand, every atmospheric scientist should know something about the aims,

CONCLUSIONS

Principal component analysis has been applied to the monthly mean values of observed rainfall in Albania for the period 1931-1965. The first component represents the annual cycle of precipitation and may be linked to depression frequencies. The second shows the maximum during the summer and seems to be linked to thundery activity during the summer. The resulting scores indicate that the method was able to classify Albanian rainfall stations into four homogeneous groups which are described in the text.

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achievements and plans of the WMO. Therefore, at least the first and last chapters of this book should be regarded by all as essential reading.

ECONOMIC AND SOCIAL BENEFITS OF METEOROLOGICAL AND HYDROLOGICAL SERVICES Anon. WMO-No.733, Geneva 1990, xxx+461pp., 50 Sw. Fr.

This is a set of conference papers, which offers a selection of topics, rather than a comprehensive overview of its subject. The venue for this 'Technical Conference' was Geneva on 26-30 March 1990. Authorship of the 61 papers reproduced is multinational, though some countries (e.g. France) are more poorly represented than one would have expected. All papers are in English, as is a high proportion of the references they quote. The organization of this large amount of material displays both strengths and weaknesses. Of particular assistance to the reader is the way most papers are grouped under one of four topic headings, which discuss: 1) Methodologies for assessing the economic and social benefits of meteorological and hydrological services, 2) User requirements for specific weather and climate services and related economic studies, 3) User requirements for hydrological services and related economic studies, and 4) Role and status of meteorological and hydrological services in economic and social development. Within each topic group there is an introductory overview and a number of keynote papers. The whole is prefaced by an opening address and by W.J. Maunder's introductory, though longish overview statement whose title is the same as that of the book. In addition, there are 12 further contributions grouped under the heading "Papers presented at the poster session". Finally, and most important of all, there is a useful section entitled "Summary report of the conference with conclusions and recommendations". On the other hand, the extra assistance which would have come from an index is not provided. This omission is doubtless the result of the book having received no editorial oversight or revision. Equally, there has been no attempt to homogenise the appearance of the typeface, some of which is distinctly unpleasant. More significantly, the contributions to this publication vary considerably in length, and in the value and level of their contents. This therefore is a book which contains much interesting data, though people are more likely to borrow it from a library for selective reading than to buy it for their personal collection.

LT

CROP CIRCLES: A MYSTERY SOLVED By Jenny Randles and Paul Fuller. Robert Hale Limited, Clerkenwell House, Clerkenwell Green, London, EC1R 0HT, 1990, 250pp., £13.95 (Hardback).

The authors of this work, both council members of the British UFO Research Association (BUFORA), became involved 'by accident' with the mystery of crop circles in the early 1980's when some people were promoting the neatly-flattened areas of crop as proof that the 'aliens had landed'. As an association that promotes a rational and objective investigation of aerial phenomena of uncertain nature, neither Jenny Randles nor Paul Fuller could see any connection between the high-quality reports of unidentified lights and crop circles - they were two unrelated mysteries. However, within the span of a decade, their view has completely changed, a view which is clear and well articulated in their commendable book *Crop Circles: a mystery solved*. In the opinion of the authors, not only are UFOs creating the circles, they have been relegated to the category of IFOs - identified flying objects - and in the process, explaining most of the outstanding UFO reports. But there are still no aliens in sight - the IFO responsible is not a spaceship, but an electrified vortex. Too often, and for too many people - scientists included - the term UFO means alien spacecraft, and therefore anyone who researches UFOs are automatically avoided by the scientific community. This is regrettable because there are dedicated ufologists, like Jenny Randles and Paul Fuller, who are continually battling against mystics and fantasisers who promote quite incredible claims. Randles and Fuller unequivocally point out that in the thousands of UFO reports, most are explainable (mis-identifications and hoaxes) but not one of those remaining unexplained suggests any hint of alien life. The universe might be buzzing with intelligent life, but the fact remains that there is no proof whatever that Earth has been visited. This is brought out in no uncertain terms in the second chapter of the book, after detailing the dawn of modem circles research in 1980 in the first chapter.

Chapter three introduces the nature of the circles, and is sub-divided into two sections, 'characteristics of the affected zones' and 'characteristics of the circles' locations'. At this stage some errors creep in, for example during the description of the precise definition of the circle. Sharp cut-offs do not exist at all circle edges, and no mention is made of circles in which the crop has only been lightly kimmed. On p. 49, tramlines are considered as areas of weakness; however some circles suggest that in certain circumstances at least, tram lines can act as areas of strength in that the damaged area avoids or is poorly defined around the tramlines (e.g. King's Bromley (1989), a satellite of the June 1989 Silbury Hill quintuplet, and general wind damage).

Various suggestions that have been forwarded for circle-genesis are considered in chapter four, from tethered model aeroplanes to planetary poltergeists! All are rejected as creating the circles of interest to us, although mention could have been made under the 'Hercules transport plane' section (better titled 'aircraft trailing vortices that come to earth' (see *J. Meteorology*, January 1989). A photograph of a jet showing the trailing vortices emanating from the wing tips would have been helpful. A misprint is evident on p. 66, where we are told that the 'hole in the ozone layer is positioned above the Arctic'. The hoax option is considered in detail in the following chapter, since proven hoaxes have been identified and therefore constitute a percentage of crop circles that are reported. A useful table of differences between the hoaxed version and the genuine article is produced.

Entitled 'unknown forces', chapter six is quite revealing in that it examines some of the claims made in the book *Circular Evidence* by Pat Delgado and Colin Andrews (reviewed in *J. Meteorology*, October 1989). Randles and Fuller are surprised that Delgado and Andrews omit eye-witness accounts of crop circles actually forming, the strong topographic link to circle distribution and the correlation of circle formation with the overhead passage of weak fronts. A number of inconsistences in that book are also identified, and claims in the media are also critically examined, including the alleged crop contamination and the "involvement of the Queen".

The vortex theory is first introduced in chapter seven, 100 pages into the book. Neither of the authors has a background in meteorology, and this is evident with their confusion of vortex terminology, for instance describing atmospheric vortices as tornadoes, whirlwinds and waterspouts (p. 100), while on p. 116 waterspouts are termed minor vortices, and on p. 132, the Pucklechurch land-devil is described as a tornado. The term whirlwind is the generic name for atmospheric vortices, which is then sub-divided into major ones (e.g. tornadoes and waterspouts) and minor ones (e.g. land-devils). More confusion could occur when we are told on p. 101 that 'ordinary whirlwinds ascend'. The airflow in a vertical vortex is always upwards. However, while a land-devil develops at ground-level, rises up, and then normally lifts off from the ground before decaying, a tornado (or waterspout) develops downwards and retracts upwards - even though the airflow remains upwards. It would appear that in most cases an eddy or a trailing vortex is the necessary pre-requisite for circle formation, although the Pucklechurch circle may indicate that in some instances a land-devil can also produce a crop circle. It is surprising that the eddy vortex at Carron Reservoir in Scotland is given scant treatment because this appears to be a type of vortex that can go on to produce circles. The mechanism of actual circle formation is believed to lie in the complex area of vortex breakdown in fluid dynamics, in which a ring vortex is ejected from the eddy or trailing vortex and hits the ground to produce the circle (although Randles and Fuller did not know of the mechanism until the majority of the book was written). Emphasis is placed on eye-witness accounts of stationary vortices, although this may not be essential - the main requirement for a circle to be formed is that there is little horizontal displacement of the ring vortex. A contradiction appears on

p.114 where on the subject of fair-weather whirlwinds, Randles and Fuller correctly say airflow spirals up, but then say 'these spiral ground traces clearly mimic the patterns found inside corn circles' - a circle bed shows the results of air divergence, not convergence. On multiple vortices, a photograph might have been helpful, such as of the 10 April 1979 Wichita falls tornado, Texas, USA.

In chapter eight, the authors consider evidence in support of the vortex theory. Claims of evidence undermining the vortex theory are rejected up to the point where linear features are considered. The authors are not 'fully convinced by Meaden's explanation of linear spurs', and believe that there is good devidence that spurs were hoaxed on to genuine circles. Concern is also voiced at the apparently-increasing complexity of formations with time, although many historical (pre-1980) analogues have now been discovered from literature searches and discussions with farmers. It should be remembered that the book was written before the 1990 formations, appendices excepted, with their great suspicions also being voiced about the "new" formations of May 1990 (which are mentioned in appendix 3). Spurs have been reported more frequently in 1990, and rectangles and keys have been first documented. This escalation has an entirely natural explanation, which the reviewer is currently considering. An undamaged bed crop is justifiably considered as supporting a natural mechanism rather than hoaxing (which damages the crop), although some plants are removed from genuine circles and are then deposited on to the neighbouring, undamaged crop canopy, where they remain until wind rustles them into the crop. Plants lying on the canopy are another hall-mark of a genuine circle, if investigators reach the site quickly enough. It is helpful to see a map of Britain showing the distribution of circle sites, but as such a map would initially need considerable revision every year, the month and year to which the map was compiled up to should have been included. The reviewer was amused to read that all the researchers actively looking for circles prior to 1989 lived in the south of England (presumably and more specifically Wessex and adjacent areas), when this circles researcher was looking before 1989 and lives in the West Midlands region!

Accounts of vortices given in chapter nine often emphasise the stationary nature of the whirlwind; however, it has already been pointed out that the vertical vortex need not be stationary to produce a crop circle, it is the ring vortex that needs to remain stationary in the horizontal plane. In an account of a ship meeting an electrified vortex off the east coast of the USA in 1904, the authors say that "... a peculiar calmness descended, possibly suggestigng that the crew entered an altered state of conciousness". It is much more probable that the ship entered the centre of the vortex where the winds are calm - or not even that, since tornado reports frequently include accounts from eye-witnesses who report an eerie calmness just before and/or just after the tornado strikes. An illuminated whirlwind is described on pp. 152-153, but the ring subsequently discovered where the light descended sounds suspiciously like a fairy ring ('the ring itself was about one foot wide, was of a much lusher green than the central grass and was also growing taller than the centre'). It would appear that the eddy or trailing vortex did descend to ground level, but did not undergo vortex breakdown (or breakdown did occur, but the circle imprint was not held by the grass).

Chapter ten is really an updated consideration of theories to explain UFO reports. It was interesting to learn that it was as early as 1974 when G. Burrows suspected that a link existed between electrified whirlwinds and some UFO reports. Ball lightning is mentioned too, but it is now being realised that most, if not all, reports of gaint ball lightning are nothing more than illuminated whirlwinds, whether occurring in thundery conditions or not. The questions are now just how applicable is the electrified vortex theory in helping to understand the nature of the more typical reports of ball lightning (with diameters of 30cm or so) and where to draw the dividing line between giant ball lightning (or illuminated vortices) and 'normal' ball lightining of uncertain nature. Geological aspects of ufology are touched upon, with reference to research into piezo-electrical and electro-chemical mechanisms. Having read *Earthlights Revelation* by Paul Devereux, this reviewer is inclined to believe that many of the lights that Devereux believes have a geological origin actually have a vortex origin, such as in the Pennine foothills, where the presence of the Craven Fault might be nothing more than co-incidence. This chapter concludes with neurology.

The final chapter is boldly entitled 'The death of the UFO', for Randles and Fuller not only believe that a vortex can account for crop circles, but the illuminated form can explain away the rare but high-quality reports of glowing lights appearing in the sky, usually being reported as descending to road level and often causing engine failure in petrol-driven vehicles. Combined with strong rotating winds, electrical fields and 'smells' (nitrogen oxides and ozone), it is quite easy to imagine the petrified state of a lone driver at night. With no other credible explanation, the witness would report it (if at all) as a spaceship, grafting on to the featureless light details of fins, windows, ramps, etc. Regression hypnosis may be employed to obtain additional information, but this may also recall fantasy rather than reality. Believing that it really was a spacecraft, it is little wonder that under hypnosis the witness recalls being 'floated' into the 'craft' and meeting aliens, fuelling the claims of mystics that extra-terrestirals have landed. We even learn of a descending illuminated whirlwind from Australia that not only produced a ringed circle (?) in grass, but also six outwardly-radiating spokes - sounding identical to the formation (less the lone ring) reported from Etchilhampton, near Devizes in Wiltshire in 1990.

Appendix one is composed of comments by meteorologists, and includes a mention of vortex breakdown in the postscript. Appendix two describes the earliest known crop circle, occurring in 1678 (which has since been pre-dated by the discovery in literature of a possible circle in 1590 by the reviewer - see *J. Meteorology*, November 1990). Appendix three updates the reader with a brief mention of the start of the 1990 season. Many of the new formations are considered the result of hoaxing, but are now known to be mostly genuine. The largest circle found - to May 1990 - was not 60m in diameter, but 80m (and another at 70m) at King's Bromley, although the authors were unaware of this formation at the time. Appendix four gives a crop circle code for budding spotters.

The book is non-technical, so is suited for the layman who wants an objective introduction to crop circles, without all the unnecessary mystery too often promoted by the media. The most disapointing aspect of the book is the lack of photographs, only eight pages in all. Some photographs are lucid, but a few are not sharp and a very few are quite poor. It was, however, pleasing to see a picture of one of the original circles at Westbury in 1980. A photograph of a UFO now believed to be an illuminated vortex - form Hessdalen (Norway) ~~is~~ included, but looks nothing more than a white blotch on a black background. There have been some quite good evening photographs taken which pick out a glowing globe and its relation to the surrounding mountains it is a pity that such a photograph was not used here. The use of monochrome illustrations, aside from the dust jacket, is also disappointing. As an introductory book, especially at a non-technical level, the use of numerous and good quality photographs is a must - crop circles are very photogenic phenomena. The price is also a little high, and would probably deter the casually-interested from a purchase.

However, this book deserves to be purchased by all interested in crop circles, from the slightly interested to the serious researcher. It offers the layman the best introduction to crop circles by far, and also for the scientist as an introduction to objective ufology and the high quality UFO reports - reports that have finally succombed to meteorology. Consideration of a second edition is strongly recommended to include a greater range of photographs so that the novice has a better feel for the characteristics of an individual circle and of circle formations, to update the reader with the latest formations and research into the meteorological conditions responsible, and to iron out the occasional errors.

D.J. REYNOLDS

WORLD WEATHER DISASTERS: AUGUST 1990

1-3: High winds and heavy rains, with widespread flooding in eastern Australia, some 264,500 square km of New South Wales inundated, leaving two people dead and one missing. Rainfall in Sydney totalled 191mm in the first three days of the month. The high winds blew roofs off houses and uprooted trees. *Lloyds List.*

3-5: Torrential rains, floods and mudslides in northeastern Brazil, 27 deaths reported. *Birminham Evening Mail*

5-8: Hurricane "Diana" hit Yucatan penisula and eastern Gulf coast of Mexico. The storm hit the Yucatan peninsula with 73km/h winds and moderately heavy rains on the 5th/6th; the storm then hit the states of Veracruz and Hidalgo around midday on the 7th with winds of up to 160km/h and heavy rains which caused flooding; more than 300 houses and a number of public buildings and churches were destroyed or severely damaged by the hurricane, at least 38 deaths reported with 60 injured and 11 others missing.

6 (reported): Monsoon floods in northern India have left over 500 dead in the last few weeks.

10: Tropical storm "Winona" hit island of Honshu, Japan, with winds of 108km/h and torrential rains; up to 200mm of rain fell in the mountains north of Tokyo; rail, road and air transportation disrupted, some landslides reported: waves up to 8 metres high reported from the Cape Omaezaki area, about 200km south-west of Tokyo where the storm came ashore about 0700 hours. *L.L.*

11-12: Forest fire destroyed up to 30 houses, along with a camping park; dozens of cars and part of a textile factory, destroyed by the fire, which left one person dead and 40 injured; other fires reported to be burning in parts of central and northern Portugal. *L.L.*

11 (reported): Flooding in 24 of 29 provinces of China by end of July had left over (reported) 2000 people dead and caused damage estimated at £1.3 billion, 21.4 million acres of farmland flooded. *B.E.M.*

13: Violent storm, accompanied by torrential rain, strong winds and hailstones hit large areas of south-west France, one person killed by lighning in Montauban, roofs of more than 80% of homes in Damazan, 19km from Agen, were either blown off or destroyed by tennis-ball-sized hailstones; a "mini-tornado" hit town of Agen and surrounding areas, leaving two persons injured and destroying homes, vineyards, orchard s and cutivated fields in its path; the storm, which hit in the afternoon, lasted for well over two hours, with the damage largely confined to the areas around Damazan, Port Ste. Marie and Buzet-sur-Blaise. *L.L.*

14: Tropical storm "Fran", blowing at 36 knots, passed through Trinidad and Tobago blowing off roofs, uprooting trees and cutting and cutting electricity supplies, no reported. *L.L.*

16-23: Typhoon "Yancy" hit from the Philippines to China, brief details below-:*Philippines:* hit by fringe winds between the 16th-18th, sinking two ships leaving three people dead and four others missing, heavy rains inLuzon.

Taiwan: hit on the 19th with high winds and heavy rains, leaving three people dead and disrupting air, rail and road traffic. Landslides blocked highways and rail lines in several north-eastern cities.

China: hit on the 20th with strong winds and heavy rains in provinces Fujian, Zhejiang and Guangdong, at least 216 people died, 59 missing and 400,000 homeless, up to 550mm of rain fell in some areas, in Fujian province almost 6000 homes destroyed and 100 000 tonnes of grain lost, in Zhejian province 6500 hectares of rice paddy fields completely destroyed. *L.L., I.H.T.*

16: So far this year 20338 forest fires reported in the Soviet Union. *I.H.T.*

19: Mudslide buried part of hamlet in Oaxaca state, Mexico, leaving ten dead and five others injured. B.E.M.

19: Torrential rains caused serious flooding in Ambon, capital of Maluku, Indonesia, thousands of people fled their homes in floods, which reached a depth of two metres in areas, no casualties reported. *Jakarta Post.*

20: About 50 vessels reported missing off Cox's Bazar, Bangladesh, in storm in Bay of Bengal; at least 500 fishermen aboard boats reported missing. *L.L.*

20-21: Floating oil rig, the West Gamma, damaged by heavy seas whipped up by 130km/h winds in the north sea off Denmark on the 20th, the rig capsized and sank on the 21st after all 49 aboard rescued. *L.L. D.T.*

21: Frigate, the Andaman, sank in heavy seas in the Bay of Bengal about 240 km off the coast of Andhra Pradesh state in southern India leaving 14 of 132 crew missing. *L.L.*

21-26: Serious forest fires burned through the Calanques region of southern France, some of the fires reached outskirts of Marseilles; some 12000 hectares of forest and brush burned; serious fires also reported from the Var region, the fires described as worst since 1964; in Cassis, a fishing port near Marseilles, one fire destroyed 12 villas, cars and some boats, onefirefighter died and at least four others injured in vehicle accidents whilst fighting fires. *L.L.D.T.*

24-28: Monsoon rains caused floods and landslides on Luzon Island, the Philippines, leaving 32 people dead in the provinces of Benguet, Nueva Viscaya and Nueva Ecija, other flooding caused widespread disruption in Manila, some 14000 families fled their homes in Manila and surrounding areas as floods rose to a depth of two metres in places. *L.L.*

24: Snowfall, described as worst in many years, in the Falkland Islands, some (reported) roads blocked by drifts up to two metres deep. *D.T.*

28: Tornadoes in north-east Illinois, U.S.A., left at least 24 dead, nearly 350 injured, 19 of them seriously, dozens of homes destroyed, the tornadoes left a 11km long trail of destruction. *L.L. I.H.T.*

31-3 Sept: Typhoon "Abe" hit provinces of Zhejiang, Jiangsu and Anhui, eastern China, bringing high winds, heavy rains and widespread flooding which left 108 dead and 850 injured. In Zhejiang province 2.46 million acres of rice crops and 820,000 acres of cotton had been seriously damaged, about 88000 houses collapsed and 120 000 other damaged, typhoon described as one of the worst in the area in decades. *L.L.*

ALBERT J. THOMAS

TORRO THUNDERSTORM REPORT: August 1990

By KEITH O. MORTIMORE

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Over the whole of Great Britain and Ireland thunder was heard on fewer than half the normal number of days in August. Thundery activity most frequently affected those parts of England to the south-east of a line from the Wash to the Isle of Wight. Within this area quite a few observers heard thunder on two days and three were reported locally. At Loughton (Essex) thunder was heard on four days. In other parts of England and Wales many observers heard no thunder at all, some reported a single day and a few observers in north-east England heard thunder on two days. Scotland and Ireland were unusually quiet with only a single day being reported very locally.

Thunder-days in August 1990 were as follows: (averages refer to the priod 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	Tot	Ave
England												X			X	X			X		-----	-----		X	X	X			X			8	17
Wales																X					-----	-----		X								2	19
Scotland														X							-----	-----				X			X			3	9
Ireland																X					-----	-----	X	X								3	8
Total												X		X		X					-----	-----	X	X	X	X			X			9	19
Netherlands				X	X	X	X		X		X	X	X	X	X	X	X	X			X				X		X		X	X		18	16
Belgium						X							X	X	X										X	X	X		X	X			10

First activity of the month occurred on 12th when scattered thundery outbreaks accompanied periods of heavy rain in parts of North Yorkshire in association with a cold front approaching from the north-west and on 14th scattered thundery showers developed in the Shetlands and over the north-east mainland of Scotland. On 15th a few thunderstorms developed on a cold front as it crossed central England, East Anglia and the London area. In the afternoon and evening of 16th heavy showers and thunderstorms developed over south Wales and in central-southern and south-east England. There were also local outbreaks in southern Ireland. These storms developed in a very dry environment and a number of observers remarked on the restricted nature of cumulonimbus development with many storms occurring in 'streets' with high bases and glaciation virtually down to base level. Large temperature falls accompanied some of these storms with brief but heavy rainfall and with local hail. Most activity had died out by late evening but lightning was still being observed to the east of Herstmonceux (East Sussex) in the very early hours of 17th. A small but active depression cross the north Midlands and northern East Anglia with thunderstorms in places in central parts of England on 19th giving widespread heavy rain in many parts of the U.K.

In afternoon of 23rd there were scattered thunderstorms in central Ireland and this heralded the movement of an area of very humid air into central areas of Britain. A shallow region of low pressure developed over England on 24th and coupled with rising dew-points, up to 20°C in places, the stage was set for the development of thunderstorms over Ireland, Wales and over western and northern counties of England. Some local thundery outbreaks affected north-west England soon after dawn and during the morning thunderstorms broke out in the Channel Islands and over the North York Moors, while in the afternoon there were widespread thunderstorms in many western and northern counties. Storm damage was widely reported in Yorkshire, particularly as a result of flooding that followed the torrential rainfall and at Dishforth windows were cracked by large hailstones. Some lightning damage was reported, mostly to power supply equipment, but at Haslingden (Lancashire) a bungalow was struck and destroyed by a fire that followed the incident. Thundery conditions transferred to south-east England on 25th and apart from a few outbreaks in the north most activity occurred over East Anglia and the counties of East Sussex, Kent, Hertfordshire and Bedfordshire. After a sunny and very warm morning active thunderstorms developed quite widely with torrential rain and widespread flooding. Essex was particularly badly hit, especially the Brentwood area where many homes were inundated as floodwater flowed off higher ground into the properties. At Malden a house was set alight and the roof badly damaged following a lightning strike and at Norton Heath farm, near Hutton, two barns, a combine harvester, 400 tonnes of hay, a car and a caravan were destroyed in another fire started by lightning. In Kent a house at Ditton was set alight, but although fire damage was confined to the roof space, extensive damage was caused by water. At Folkestone three houses were struck by lightning including a building society office whose chimney crashed through the roof. Much of the activity had died out by late evening to be followed by a quiet night and on 26th thunderstorms were confined to Surrey, the London area and very locally in Dorset and the Northern Isles of Scotland. A cold front pushed eastwards across the British Isles on 29th. There was thunder at Flamborough Head in the late afternoon, during the passage of the weakening cold front, but an area of very unstable air advecting northwards from France re-activated the cold front and initiated the development of a large area of thunderstorms over the east midlands, East Anglia and the south-eastern counties of England with some quite intense storms in places. Among reported damage incidents a car-parts factory at Maidstone (Kent) was destroyed by lightning causing £65 000 worth of damage and electricity supplies were cut in many parts of the Cambridge area. There were also thundery showers in the evening over Ireland and eastern Scotland.

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Product News

A.G.I. ACQUIRES DISTRIBUTORSHIP OF OBSERMET METEOROLOGICAL PRODUCTS AND SYSTEMS

To promote this expansion AGI have created a wholly owned subsidiary AGI Obsermet Ltd. which will also take over from Obsermet's previous marketing organisation, Obsermet (UK) Ltd. AGI Obsermet are pleased to welcome Chris Stock, formerly Obsermet's UK Sales Manager, who now join the team at Verwood. The combination of the resources of the two organisations is a logical one. AGI are established UK Defence and Public Sector contractors specialising in the design, manufacture and support of high-technology sensing equipment for naval and civil aviation markets. AGI's ship's speed and distance measuring systems are in service with over 30 navies worldwide, while their AGIVIS runway visibility systems are operational in all Category II and III airports in the U.K. Obsermet B.V., member of the Transmark Group in Holland, design and manufacture wide range of high quality sensors for meteorological and hydrological applications. Their equipment has a high reputation and is in service in over 25 countries worldwide.

AGI-Obsermet Ltd., will continue to handle the sales and service of all products previously dealt with by Obsermet (UK) and will cover both the UK and Commonwealth countries. Following a tradition of technical and product enhancement, AGI-Obsermet will continue to add to its range of meteorological and hydrological sensors, while offering extended product support, design consultancy and manufacturing services to new and existing customers.

Present market areas include civil and military airport weather stations, meteorological weather stations, instrumented runway visual range systems, environmental monitory, agronomic weather stations, wind alarm systems (cranes, ports, harbours), water management systems and lightning warning systems and stations.

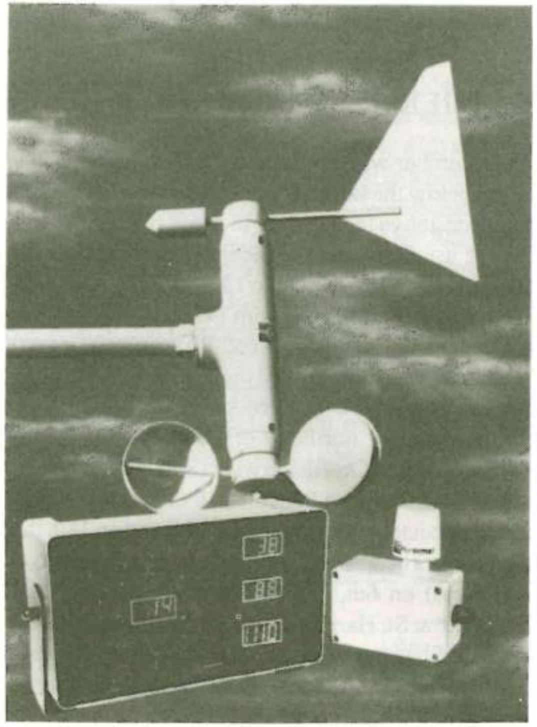

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FIG. 2 AGI's IRVR System

WEATHER SUMMARY: December 1990

In most places December was a rather cold month with mean temperatures around one half a degree Celsius below the normal, while there were a few spots with mean values very close to or even a shade above the normal. In many places it was the coldest December since 1981, reflecting the usual mildness of recent Decembers. On 22nd the temperature rose to 14.2° at Tummel Bridge (Tayside) and to 13.8° at Dyce Airport, Aberdeen while over southern Britain the 26th was the mildest day with 14.2°C at Madley, Worcester and Colwyn Bay in north Wales. On the latter day Exeter and Ilfracombe (Devon) reported 13.8° and 13.4° respectively. The 22nd was the warmest night with minima of 11.0° at Belfast, 10.5° at the London Weather Centre and 10.0° at Abbotsinch, Glasgow. With much of the country subjected to frequent outbreaks of northerly or north-easterly winds low maxima were recorded on a number of occasions. On 7th Lerwick (Shetland) reported a maximum of -1.4° at Tummel Bridge and -3.0° at Rannoch School, Dall (Tayside). Beaufort Park (Berkshire) recorded just -0.1° during persistent freezing fog on 14th and on 18th the Derbyshire stations of Buxton and Middleton recorded -0.2°. Lowest minima included -5.4° at Lyneham and -6.5° at St. Harmon (Powys) on 6th, -7.7° at Rannoch School, Dall on 10th, -6.4°C at Abbotsinch on 13th and -7.0° at St. Harmon in central Wales on 15th. On the grass Velindre (Powys) recorded -8.8° and Shawbury (Salop) -9.6° on 6thy, -9.1° was recorded at Bastreet (Cornwall) on 14th, -9.6° at Belfast on 15th and -9.0° at East Hoathly (East Sussex) on 20th. Many parts of the west and north had a wet month with up to 150 percent of the normal rainfall in some places while a few central parts of England and east Wales had high totals as a result of the heavy snowfalls on 8th. High daily totals included 73.0mm at Fylingdales (North Yorkshire) on 8th, 43.5mm at Bastreet on 20th, 39.5mm at Eskdalemuir (Dumfries and Galloway) on 22nd and 39.7mm at Nantmor (Gwynedd) on Christmas Day. On 28th Nantmor was again wet with 37.6mm. Sunshine totals were rather variable with above

average totals over most southern and central counties of England, south Wales and Northern Ireland. However, it was a dull month in eastern England, north Wales and over much of Scotland.

A slow-moving anticyclone over south-western Britain dominated the weather over the U.K. during the first few days but prior to the passage of a weak cold front on 3rd it was very cloudy with little sunshine. The 4th and 5th, however, were much brighter days with long sunny spells over England and Wales. The 6th was another sunny day in the south-east but as the high moved away into Europe a cold front made progress into the north-west of Britain. On 7th and 8th the cold front moved slowly across England and Wales but as it did so a large and deep depression developed on it and remained slow-moving for some hours over south-east England. Many northern and western counties of England and east Wales and the midlands were subjected to prolonged heavy snowfalls with considerable drifting in the gale-force northerly winds. With temperatures generally a little above freezing accumulating wet snow brought down many power lines and cut supplies over a wide area. Some consumers were without electricity for a number of days. A general thaw set in on 9th with slowly rising temperatures and by 10th the depression had moved well away to the south-east. On 11th and 12th, as a depression moved south-east into the Baltic, frontal systems crossed the British Isles followed by a developing ridge of high pressure. By 13th an anticyclone had built over the British Isles and over the next few days it drifted slowly north-east allowing south-easterly winds to cover all parts with some sunshine, particularly in the south, and with frost and fog at night. There was also a little light wintry precipitation in places. A cold front crossed all parts from the west on 18th and 19th, giving many places a little rain or snow, but south-westerly winds had set in by 20th and thereafter it was wet and at times very stormy as active frontal systems repeatedly crossed the country. Christmas Day was particularly stormy and violent squalls accompanied an occluding frontal system as it crossed the country. Hail and thunderstorms were reported in a number of places and several tornadoes damaged property, particularly in the west country. The final week of the month saw a continuation of the wet and stormy weather as deep depressions continued to track north-eastwards between Scotland and Iceland, and as the air became increasingly cold a good deal of snow fell over northern hills and mountains with blizzard conditions at times over the Scottish Highlands.

K.O.M.

TEMPERATURE AND RAINFALL: DECEMBER 1990

	Mean		Max	Min	Grass	Rain	%	Wettest	RD	TL
	Max	Min								
DENMARK: Fano	5.3	1.2	9.3(2)	-5.6(14)		79.8	184	19.0(27)	20	0
" Frederikssund	4.3	0.5	8.5(3)	-5.6(3)	-8.5(13)	36.9	66	7.4(27)	16	1
GERMANY: Berlin	2.8	-1.1	9.0(29)	-5.8(8)	-7.0(9)	73.0	149	23.3(10)	10	0
" Hamburg	4.6	0.2	9.2(29)	-5.1(9)	-7.4(9)	63.4	89	10.7(28)	8	1
" Frankfurt	3.8	-0.7	13.4(29)	-8.0(8)	-10.0(8)	58.1	109	11.0(31)	5	0
" Munchen	1.5	-4.4	13.6(30)	-13.8(8)	-20.8(8)	50.0	96	9.7(30)	6	1
MALTA: Luqa	15.7	10.3	20.0(10)	6.3(4)	1.4(18)	152.6	136	28.3(21)	22	8
NETHERLANDS:Ten Post	5.4	1.6	9.3(29)	-2.8(9)	-4.3(9)	78.3	105	17.1(17)	15	0
SWEDEN: Valla	2.3	-2.2	9.0(3)	-16.0(22)		32.0		10.1(23)	18	0

December 1990	Mean		Max	Min	Grass	Rain	%	Wettest	RD	TL
	Max	Min								
SWITZ'D: Basel	4.1	-1.4	16.4(29)	-6.7(8)		55.3	125	14.9(10)	15	0
EIRE: Straide	8.0	1.6	12.2(25)	-5.0(10)	-10.7(10)	195.8	134	24.2(20)	20	3
" Mt. Russell, *Limerick*	7.6	1.9	12.5(25)	-3.8(8)	-7.5(10)	123.7		23.4(22)	20	3
SHETLAND: Whalsay	6.4	2.9	11.9(2)	-3.1(7)	-6.3(8)	109.0	82	13.5(25)	29	0
" Fair Isle	6.7	3.9	10.6(2)	-3.5(7)	-5.2(30)	85.6	80	13.7(6)	26	0
SCOTLAND: Braemar	4.6	-1.2	11.7(22)	-6.2(11)	-7.7(11)	133.9	136	22.5(30)	22	0
" Inverdruie	5.0	-0.0	11.6(21)	-4.4(13)	-8.2(28)	137.0	157	29.3(30)	21	0
" Rannoch	5.2	-1.4	11.7(21)	-7.7(10)	-7.8(10)	182.6		26.3(24)	17	0
WALES: Velindre	6.8	1.2	12.0(26)	-4.4(6)	-8.8(6)	109.2	106	21.0(24)	16	0
" Gower	7.9	2.7	11.9(26)	-1.8(15)	-5.0(15)	109.8	82	21.2(24)	17	0
GUERSEY: Airport	8.5	5.0	12.2(26)	1.4(v)		77.3		14.9(8)	16	2
JERSEY: Carrefour/Clq	9.0	4.0	12.3(26)	-0.5(15)		109.9		18.6(28)	17	2
ENGLAND:										
Denbury, *Devon*	7.6	2.6	12.8(26)	-3.6(15)	-5.0(15)	87.2	53	17.5(24)	16	0
Gurney Slade, *Som*	6.1	0.9	11.5(26	-5.9(15)	-6.5(15)	119.8	87	27.0(20)	18	1
Yatton, *Avon*	7.8	2.6	12.9(26)	-4.4(6)	-5.8(6)	63.5	65	10.2(29)	18	1
Reading Univ, *Berks*	7.1	2.1	13.2(26)	-3.0(15)	-6.8(6)	60.6	93	11.4(25)	15	0
Sandhurst, *Berks*	6.8	1.5	11.7(26)	-3.9(20)	-7.2(20)	71.6	104	16.9(25)	14	0
Romsey, *Hants*	7.3	1.7	12.4(26)	-5.2(6)	-7.3(15)	64.5	53	14.3(25)	14	0
Brighton, *Sussex*	6.9	2.4	10.5(26)	-1.3(19)	-2.9(19)	60.8	68	13.8(25)	16	1
Hastings, *Sussex*	7.0	3.2	11.4(26)	-1.1(17)	-3.0(v)	70.5	87	10.8(26)	17	0
Dover, *Kent*	7.2	2.7	11.5(26)	-1.5(17)		79.1	86	14.6(9)	22	1
East Malling, *Kent*	7.4	2.4	12.4(26)	-2.6(6)	-8.0(17)	54.5	87	10.8(25)	15	0
Epsom Downs, *Surrey*	6.5	2.4	11.7(26)	-4.7(15)	-7.1(17)	74.8	94	23.4(25)	16	1
Reigate, *Surrey*	6.2	1.8	11.0(26)	-3.5(v)		70.8	107	18.2(25)	16	1
Guildford, *Surrey*	6.6	2.7	12.1(26)	-3.3(15)	-4.7(15)	63.2	87	14.6(25)	15	0
Sidcup, *London*	7.3	2.7	12.5(26)	-2.1(15)	-6.3(15)	62.1	105	17.7(25)	13	1
Hayes, *London*	7.1	2.0	12.3(26)	-4.2(15)	-6.5(15)	55.8	85	14.19250	15	0
Hampstead, *London*	6.8	2.5	11.8(26)	-1.3(6)	-9.2(9)	63.3	102	12.1(25)	16	0
Royston, *Herts*	6.4	2.7	12.5(26)	-2.0(9)	-4.3(5)	56.7	105	13.4(8)	15	0
Loughton, *Essex*	6.6	2.4	11.3(26)	-2.7(6)	-7.7(17)	63.0	99	14.5(25)	14	0
Buxton, *Norfolk*	6.3	1.6	11.6(26)	-4.7(15)	-9.3(15)	62.3	108	8.8(9)	18.	0
Ely, *Cambs*	6.6	0.6	12.0(26)	-4.4(6)	-4.9(14)	29.9	60	5.7(25)	14	0
Luton, *Beds*	6.3	2.1	11.7(26)	-3.9(6)	-6.8(6)	68.5		14.8(25)	16	0
Buckinghm, *Bucks*	6.3	1.6	11.6(26)	-4.7(15)	-9.3(15)	62.3	108	8.8(9)	18	0
Oxford University	7.0	1.7	11.8(22)	-4.9(16)	-5.6(6)	56.3	102	8.0(7)	17	-
Wolverhampton, *W.Mid*	5.9	1.8	12.1(26)	-4.0(15)	-7(14)	93.8		17.5(7)	18	2
Louth, *Lincs*	6.9	2.6	11.5(26)	-0.6(15)		47.6		9.7(25)	21	0
Keyworth, *Notts*	6.7	1.8	13.0(26)	-3.3(15)	-5.2(15)	56.5		13.0(7)	18	2
Nottingham, *Notts*	6.9	2.4	11.8(26)	-2.8(15)	-5.3(15)	85.7	157	23.7(7)	18	2
Derby, *Derbys*	6.5	2.7	11.4(22)	-3.4(15)	-4.1(15)	83.2	123	17.8(18)	18	2
Middleton, *Derbys*	4.9	1.2	9.6(26)	-2.0(19)		151.0	127	26.9(8)	21	1
Keele Univ, *Staffs*	5.8	1.0	11.1(26)	-5.8(15)	-6.0(6)	75.6	109	12.3(8)	21	0
Liverpool, *Mersey*	7.6	2.1	12.3(21)	-2.5(15)		76.9	104	12.8(25)	15	0
Lathom, *Mersey*	7.0	2.2	11.9(22)	-1.4(14)	-3.3(14)	93.3	152	27.4(7)	22	-
Sunderland, *Tyne&Wear*	8.1	3.1	12.8(22)	-0.7(8)		59.0	135	19.4(8)	17	0
Canada: Halifax, NS										
U.S.: Beigerheld, N.J.	9.3	-0.3	18.3(23)	-7.8(27)	-11.1(27)	138.9		48.8(-)	13	0
JAMAICA: Kingston	31.5	22.1	33.4(14)	21.2(24)		20.1	65	17.5(6)	4	0
" Montego Bay	28.4	22.9	29.7(21)	21.2(19)		145.5	141	40.0(3)	17	-
Australia: Leopold	25.2	12.8	37.8(31)	8.7(24)		26.3	53	9.0(10)	5	2

CUMBRIA RAINFALL:

Coniston 315.1mm (115%); Hawkshead 231.9mm (113%);
Windermere (Whasdyke) 200.4mm (108%); The Nook, Thirlmere 378.7mm (131%); Honister 491mm.

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FRONT COVER:

Albania, topographical map (A) and the network of meteorological stations (B).

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