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RED WHARF BAY, ANGLESEY,
IN CLEAR AND IN FOGGY CONDITIONS

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CLIMATOLOGICAL STATIONS AT COASTAL RESORTS: A Cautionary Note

By S. J. HARRISON

University of Stirling, Stirling, Scotland

Abstract: Data from British stations should be treated with caution when investigating change through time over protracted periods. Major siting changes are not infrequent and surrounding shelter conditions change according to local park management practices.

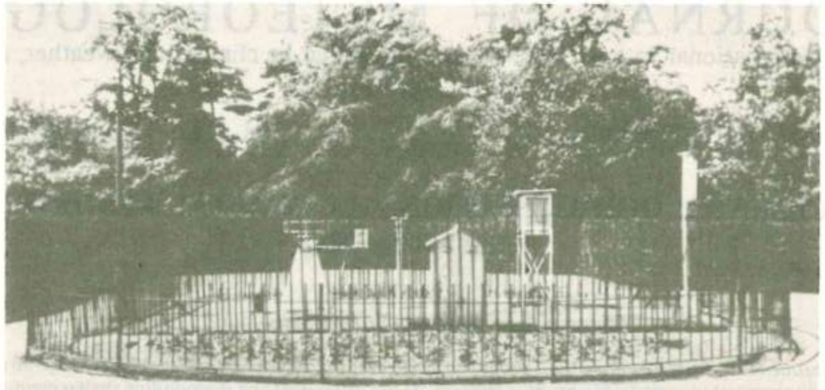
The recent closure of Kew Observatory attracted much public attention and was viewed with some sadness by meteorologists and climatologists. Data from Kew have, over the years, provided fuel for discussions of climatic changes of both natural and man-made origins. Great though this contribution is, attention should also be turned to those stations which have a more humble history but which have, nevertheless, provided the essential brush-strokes in the overall picture of the British climate. Those who have delved into climatic records have often come across long forgotten stations or have found data of some antiquity for stations which are still in operation.

TABLE 1: A sample of coastal stations submitting returns for publication in the *Monthly Weather Report* before 1910. Dates when first published.

Aberdeen	1884	Folkestone	1905	Scilly Isles	1884
Aberystwyth	1904	Lowestoft	1899	Skegness	1904
Bexhill-on-Sea	1908	Margate	1898	Southampton	1884
Bournemouth	1902	Newquay		Southend	1906
Clacton-on-Sea	1902	(Cornwall)	1891	Southport	1897
Colwyn Bay	1897	Penzance	1908	Stornoway	1884
Cromer	1902	Plymouth	1884	Torquay	1891
Douglas (I-o-M)	1884	Rhyl	1899	Weymouth	1908
Dover	1884	Rothesay	1908	Wick	1884
Eastbourne	1891	Sandown (I-o-W)	1908	Worthing	1899
Falmouth	1884	Scarborough	1884		

Many coastals climatological stations have particularly long records (Table 1). Douglas (Isle of Man), Plymouth and Scarborough, for example, have been submitting monthly summaries of observations to the *Monthly Weather Report* since it was first published in 1884. The image of the coastal resort station is of an enclosure surrounded by iron railings around which there may be ornamental hedges and flower borders to carry the eye outwards from the stark geometric installation. For example, the station in East Park, Southampton, although not a resort, was surrounded by a magnificent holly hedge and flower beds (Fig.1).

The Southsea station, formerly sited in Victoria Park Gardens near Portsmouth's city centre, now stands in isolation on Southsea Common (Fig.2), where it has been since 1953. Observations began in the 1860's at a site well inland at the infectious



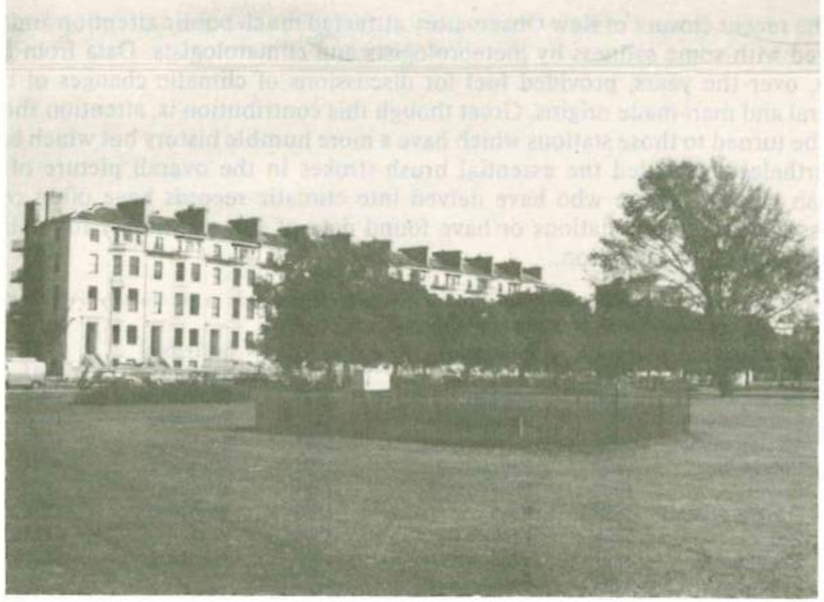


Fig.1: *(Upper photograph).* Climatological station (now closed) at Southampton (East Park).
Fig.2: *(Lower photograph).* Climatological station at Southsea Common in 1973.

diseases hospital in Milton (Fig.3). Data from this station were published as part of the Portsmouth Medical Officer of Health's Annual Report, and in 1888 observations were being made of maximum and minimum air temperature, black-bulb *in vacuo* temperature, grass surface and earth temperature, hours of sunshine (Jordan) and daily rainfall. By 1890 these were being submitted to the Meteorological Office but were not published until the station was moved in 1900 to a new site in the south-east corner of Victoria Park, near Portsmouth's city centre. The range of observations remained largely unchanged in the new station which was surrounded by 1.5 m high railings in a circle of diameter 4 m (Fig.4). The

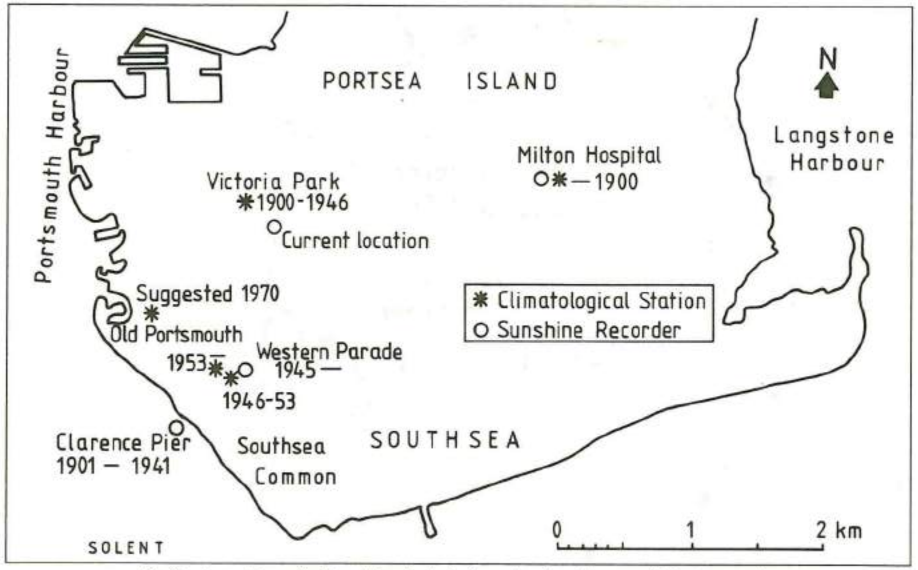


Fig.3: Location of climatological stations in Southsea and Portsmouth.

sunshine recorder was mounted on the roof of Clarence Pier, well away from potential shading.

The design of the station was typical of its period, and other fine examples still remain in many British coastal resorts. At stations of this type the demand for standardisation of site exposure has often conflicted with the aesthetic ideals of head gardeners. By the early 1920's general dissatisfaction with the exposure of the Victoria Park site was being expressed by Meteorological Office inspectors, and by 1930, the surrounding trees had become a persistent problem. Throughout most of the 1930's and 1940's the 1:2 exposure rule was not complied with, and in 1939 small trees were planted in the immediate vicinity of the station which would, in due course, affect the accuracy of observations.

On 18 January 1941, as a result of a heavy bombing raid over the city, Clarence Pier and its sunshine recorder were destroyed together with Portsmouth's Guildhall. The new recorder was later moved, with the Medical Officer of Health, to Western Parade in May 1945 (Fig.3). Victoria Park station was, by this time, totally unsatisfactory and was eventually moved to Southsea Common in 1946. Unfortunately, the circular enclosure was not only cramped but still suffered from excessive shelter.

In 1953 the present rectangular enclosure was constructed, in a more exposed position. The standard of the station furniture declined over the years, which was not surprising as some of it was of considerable age. In 1961, the NPL certificate on the dry-bulb thermometer was reported to date from 1889! The site also suffered flooding on 29 November 1954 when the station remained under water for several days. The old equipment was replaced by Portsmouth Polytechnic in 1972 and the station continues to operate in the 1953 enclosure despite attempts, in 1970, to move it to Old Portsmouth.

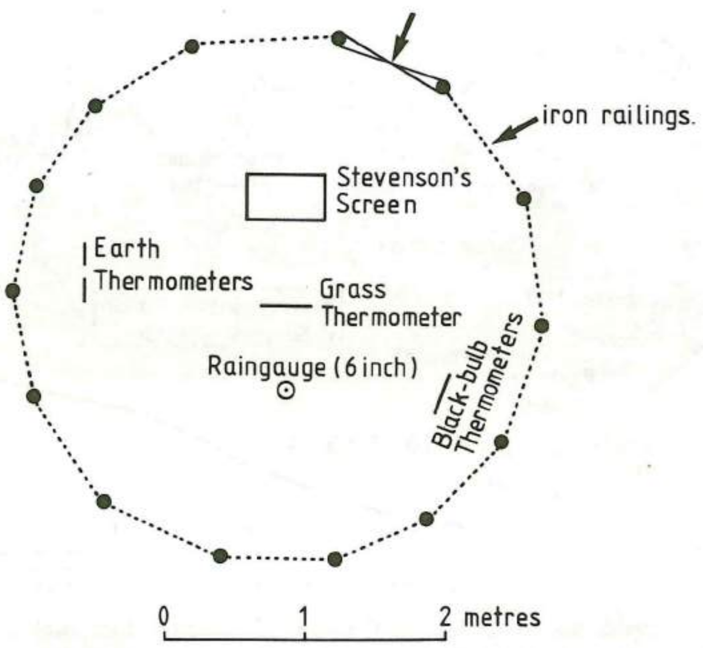


Fig.4: Climatological station at Portsmouth (Victoria Park) in 1900.

Coastal climatological stations such as Southsea have, over the years, provided much needed sources of data. Many continue to be supervised by local health authorities, a relic of their original function, although the data now are more likely to be used for publicity purposes. As observers and head gardeners have changed over the years, so perhaps, has the quality of the data collected, although circumstances have varied widely from resort to resort. The case of Southsea is hopefully one of the more unfortunate examples of lack of homogeneity in a body of climatological data, but the problems can be seen in other locations. The station at East Park, Southampton, for example, suffered fewer site shifts but was subject to varying degrees of shelter from the vegetation around it. Indeed, in 1957, it was suggested that the surrounding holly hedge could be inflating air temperatures.

Local site changes occur at many climatological stations but these may be particularly severe at seaside resort sites where they are associated with heavy recreational use of surrounding areas and ever-changing management of park settings. As to their value in the search for climatic changes, caution and a thorough familiarisation with siting changes, where these are notified, are essential preludes to analysis.

THE WEATHER AND BUTTERFLIES IN AVON COUNTY, 1982

By A. H. WEEKS

In the penultimate sentence of my note on this subject for 1981 (*J. Meteorology,* vol.7 (March 1982), p.83), I suggested that a recipe for the happiness of British

lepidopterists would be a slight rise in mean temperatures. If this was not intended as a prayer, it was, to a large extent, answered as one. All the monthly mean temperatures from February to October 1982 were above average at Yatton by, respectively, 1.8, 0.4, 0.5, 0.8, 1.8, 1.1, 1.0, 1.3 and 0.6 degrees C. Maximum temperatures climbed "into the eighties" (26 °C plus) at some time in every month from May to September inclusive. The effects on the butterfly population were marvellous.

The two cold spells of the 1981/82 winter (both of short duration here) seem not to have affected the hibernating butterflies at all, the first brimstone and small tortoiseshell being seen on the wing on 9 February. Then, the warmer spring and hot start to summer performed miracles for the local populations. Only the usually-plentiful speckled-wood seemed to be less frequent than normal in the spring, but they had largely recovered by autumn, not to disappear entirely until the last week of October.

Those eye-catching immigrants, red admirals and painted ladies, reached the English south coast in late May and arrived in Avon County right at the beginning of June, four or five weeks earlier than in 1981. The former species came in the greater numbers, but both produced good new broods, mint-condition specimens appearing on the wing from late July and flying right into October. The fresh brood of small tortoiseshells was very large and it emerged 6-7 weeks ahead of the comparable emergence in 1981, with subsequent broods filling our gardens for the remainder of the summer and well into autumn. Those summer browns which are usually first seen in July emerged early, before the end of June, in considerable numbers, with marbled whites so plentiful in places that (as it was described to me) "they were fighting to get on to a flower". From further afield, I heard reports of clouded yellows in the south-east of England in June. So, "Butterfly Year 1981-82" ended on a high note.

Despite its very wet second half, June, and then July, continued the splendid display. We saw that the big fritillaries, so scarce in 1981, had made at least a partial recovery. But if the season had been early for some species, it also ended early, aided by a disastrous occurrence at the beginning of August. In the late evening of 3rd, a severe thunderstorm struck this area: 36 mm of rain fell from 21.35, most of it by 22.15. In the days following, not a marbled white, nor a grayling was to be seen and very few skippers and meadow browns. In normal circumstances, they would probably have continued flying well into the month. It appears that these species, roosting in the grass, were washed into the ground and hammered out of existence: this single, sudden and severe, but short, weather event may have curtailed their breeding season by two or three weeks and therefore may cause a reduction in the 1983 populations. In partial compensation, the hot sun in mid-September and some beautiful days in October kept the nymphalids active, but while our gardens were alive with tortoiseshells, commas, painted ladies, and red admirals, only a few peacocks remained with us - most seem to have gone into hibernation early. One wonders what this might portend. The sighting of two Camberwell beauties in August, one in a main shopping street in Bristol, probably has no climatic significance; they may have hitched a lift on a timber ship from Scandinavia or have been bred locally and released.

Lastly, if I may, I step outside my normal territory. After many years in which we asked ourselves what had happened to the cuckoo, 1982 was the year when we hardly ceased to hear him from dawn to dusk throughout May and early June. And to judge from my sightings in the spring and early summer, it was a good year for adders.

SUNDERLAND'S METEOROLOGICAL RECORD: THE INSTRUMENTAL PERIOD 1856-1982

By DENNIS A. WHEELER

Geography Department, Sunderland Polytechnic, Sunderland, Tyne and Wear.

Professor Lamb's (1982) most recent book has probably reinforced the view of many amateur meteorologists that, despite the undoubted progress acheived by using sophisticated mathematics, meteorology has much in common with history. This is true from many points of view, as Lamb so admirably demonstrates, not the least of which is that of data sources. Making due allowance for errors and vagueness, both historians and meteorologists find contemporary documents of past events invaluable. Indeed a fine example of this appeared recently in the pages of this journal (Oldschool, 1982) and prompted this note. The Editor's warning attached to Oldschool's letter stresses the need to preserve meteorological documents and data collections, and is timely in view of an apparently declining number of active observers whose wealth of accumulated data should not be overlooked.

Recent searches in Sunderland have brought to light a notably rich legacy of meteorological studies. However, these discoveries are marred by the realisation that in one case the original daily observations appear to have long-since vanished and in another are incomplete. The manner of both losses highlights the difficulties that confront the meteorological archivist. What does remain should, nevertheless, be sufficiently impressive to persuade others to search for similar material in their own localities before it, too, suffers the fate of what has been lost in Sunderland.

In the case of one of the Sunderland data sources the worst effects of the losses have been diminished by the foresight of the observer, Thomas William Backhouse. Backhouse was a member of an important Sunderland Quaker family, and from 1856, when he was 14, until 1915, just four years before his death, he amassed a wealth of meteorological data. The data were collected on a daily, and on occasions hourly basis, when he was resident in Sunderland. However, both business and his first passion, astronomy, often took him away, although he appears to have made provision for the maintenance of his observations during his absences. These observations were kept in what Backhouse termed his 'journals'. In his later life Backhouse took the precaution of publishing, at his own expense, a quite astonishingly detailed summary and analysis of his findings (Backhouse, 1915). Anyone who has the opportunity to study a copy of this book is strongly urged to do so; the effort will repay handsome dividends. Sadly, of the original 'journals', with what must have been a wealth of daily data and notes on everything from rainfall and wind to haloes and aurorae, nothing can be found. Backhouse, although married (to a distant relative of L. F. Richardson the famous meteorological mathematician), did not have any children. This was possibly

critical for the survival of his documents for whereas his will makes specific provision for his astronomical papers there is no mention of his meteorological work. A search of local and national archives and the wills of his nearest relatives has failed to yield up any clues. The most recent, very tentative, contact with them can be dated to 1948 when the family home, by then the property of his niece, and many of the household effects including "books and sundry items" went for auction. The local auctioneers who conducted the sale are still in business but have long since diposed of their records. At that point, as they say, the trail goes 'cold'. It is the cherished, although forlorn, hope of the author that these valuable documents may yet materialise.

Sunderland's second major meteorological record also dates from the nineteenth century but has only very recently come to light. In 1875 the Sunderland Public Health Department started to take meteorological observations in the grounds of their offices. This work continued until 1974 when, just short of a notable century, the station was closed due to repeated vandalism. The then newly-founded Sunderland Polytechnic took over the task on a more secure site and thereby perpetuated a tradition that now dates back over 100 years. Quite why the Public Health Department should start such work is not clear but may well have been a response to the growing evidence linking weather patterns with contagious diseases. Sunderland had already experienced some severe outbreaks of cholera in the decades before 1875 and these, combined with the recently-passed Government Health Act (1871), may have given the final prompting.

The first page of the 13 bound volumes of observations is copied in Fig.1 from which we see the variety of data collected. Observations were made daily including weekends and bank holidays until 1964 when weekend observations ceased. In addition to the phenomena recorded in Fig.1 the observers were also in the fortunate habit of entering notes in the margins when snow, hail or sleet occurred (although how accurate and consistent these notes are is not easy to determine). From July 1888 soil temperatures at one and four feet were included and from January 1923 rainfall duration was also entered. However, and as with so much of this type of data, the precise methods of data-collection are uncertain. Unfortunately, there are gaps in the record. Abstracts from this data source made at an earlier time and now in possession of the author indicate that the observations continued uninterrupted and the gaps resulted from a general lack of awareness of the documents importance. Their current condition certainly suggests that they were not always looked after in the best manner before being finally deposited in the vaults of the local library. Consequently detailed data for the periods January 1886 - January 1888, November 1892 - November 1910, August 1914 - July 1918 and November 1932 - December 1939, may now be irretrievably lost. Only monthly rainfall totals for these periods remain.

During the course of the search for the Backhouse and Public Health Department records other data of similar antiquity and interest were also discovered. Sunderland has a centuries-old tradition of maritime trade based on the area around the estuary of the River Wear. The River Wear Commission was responsible for the administration of the Port of Sunderland during the nineteenth century and it is not surprising that they should have some interest in local weather conditions. That so much of their effort in this direction should have survived is

METEOROLOGICAL OBSERVATIONS

Made at Health Offices, 17, East Cross Street, Sunderland,

During the Week ending January 2nd 1876

AT TEN A.M. DAILY.

Month. Dec/74 & Jany	Days of Month.	Barometer at 32° Fahrenheit.	Hygrometer. Dry Bulb.	Hygrometer. Wet Bulb.	Dew Point.	Direction of Wind.	Velocity of Wind.	Force of Wind.	Amount of Cloud.	Character of Cloud.	Maximum and Minimum Thermometer in Shade. Highest.	Maximum and Minimum Thermometer in Shade. Lowest.	Rain in Inches.	
Sunday	27	30.144	31.0	30.0	27.3	NW		.05	0	0	39.0	27.0	0.01	
Monday	28	30.212	31.0	29.0	23.6	NW		.05	0	0	32.0	24.0	0.00	
Tuesday	29	30.228	26.0	15.0	–	WNW		.05	0	0	26.0	15.0	0.00	
Wednesday	30	30.291	23.0	23.0	–	NW		.05	10	Stratus	31.0	11.0	0.06	
Thursday	31	30.163	31.0	30.0	–	W.N.W		.05	10	Stratus	30.0	21.0	0.22	
Friday	1	30.147	23.0	23.0	15.7	[illegible]W		.1	0	0	45.0	15.0	0.0	Violent Storm of Snow & hail in evening
Saturday	2	29.668	37.0	36.0	34.6	SW		.05	0	0	49.0	22.0	0.06	Thaw set in rapidly

Mean of Highest Temperature in Week ... ... = 36.0°

Mean of Lowest " " ... ... = 19.2°

Mean Daily Range of Temperature ... ... = 16.7°

Absolute Highest Temperature in Week ... ... = 49.0° on Jany. 2. 1875

Absolute Lowest " " ... ... = 11.0° on Dec. 30th 1874

Extreme Range of Temperature in Week ... ... = 30.0°

Adopted Mean Temperature of Week ... ... = 27.6°

Fall of Rain in Week ... ... = 0.35 inches

(Signed) Henry [illegible] M.D.

Fig.1: The first page of observations in the 99-year records of the Sunderland Public Health Department.

more unexpected. The records consist of fog charts and barographs that were compiled at the Roker Pier lighthouse on the north side of the Wear's estuary. These charts found their way into the Tyne and Wear County Archives where they may now be consulted (see bibliography). Again, they appear to be incomplete but nevertheless are valuable, particularly when used in conjunction with the more complete meteorological coverage offered by the above two sources. The barographs are perhaps the more interesting and date from 1880 to 1962 with gaps from 1916-1919 and 1921-1930. Until 1907 the barographs were hand-drawn and based on hourly observations throughout the day, but it must be added that some of the curiously abrupt changes in air pressure so recorded cast some doubt on the accuracy of this method and the manner of data collection. From 1907 the trace is a continuous one of the type more familiar to present-day observers. The fog charts are rather a grand title for daily charts which simply record the times during which the fog warning system was operating from the lighthouse. The local reference points used by the keeper to determine the critical visibilities suggest that 'fog' is present when visibility drops below two miles. This record period runs from 1906 to 1960 with gaps for both World Wars and also 1923-1925. With the conversion of the lighthouse to a fully automated system in the early 1970's all such meteorological work came to an abrupt halt.

That these data, with all their inherent problems, can still be of considerable practical use has already been indicated (Wheeler, 1982). Work is also proceeding at present to attempt to reconstruct weather patterns in the Sunderland area over an instrumental period of over 120 years. But, bearing in mind what has been said in these paragraphs, it is unlikely that Sunderland's fortunate heritage is unique. Other ports and Victorian boroughs had identical problems and needs; do they too possess this form of record, or is it already too late?

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LAMB, H. H. (1982): *Climate, History and the Modern World.* London.

OLDSCHOOL, S. R. (1982): Epsom's Derby weather *J. Meteorology, 7,* 271.

WHEELER, D. A. (1982): Six months unusual weather in N.E. England *J. Meteorology, 7,* 182-187.

Sunderland Public Health Department's meteorological observations are currently in the care of the Sunderland Museum and Library.

River Wear Commission: barographs - Tyne and Wear Archives accession no.202/3643-3651.

River Wear Commission: fog charts - Tyne and Wear Archives accession no.202/3652.

MYSTERY SPIRALS IN CORNFIELDS: Further cases and discussion

By G. T. MEADEN

Tornado and Storm Research Organisation, Trowbridge.

In previous issues of this journal we have described and discussed the origins of nearly circular, flattened areas which had been found in various Wiltshire and Hampshire cereal-fields in recent summers (*J. Meteorology,* vol.6 (issue 57), 76-80; vol.7 (issue 66), 45-49; see also vol.6, page 155). The explanation was put forward that these nearly-cicrcular areas, with their beautiful spiral damage-patterns in the crops, were caused by quasi 'standing' fair-weather whirlwinds, and a theory was proposed to account for the occurrence of many of these close to the bases of concave hill-sides or escarpments (as in the 'Westbury' and 'Winchester' examples). These papers have provoked useful correspondence with the editor, some of which is reproduced below, and have led to the discovery of certain older cases (Charlton, South Wiltshire, 1963, and Tully, Australia, 1966, for example). Moreover, and very importantly, some new examples turned up in 1982 which were formed below Cley Hill, Warminster in West Wiltshire. The latter will be dealt with in some detail, as they take us towards the solution of the mystery.

LETTERS FROM MR. JOHN M. HEIGHES

First Letter. I was intrigued to learn of another case of near-symmetrical cornfield damage patterns (Meaden, 'Mystery spirals in a Hampshire cornfield', *J. Meteorology,* vol.7, 45-49, 1982) but I am not convinced that their cause is a natural meteorological one.

Dr. Meaden states that 'helicopters could never damage the cereal crops in this way with their blasting downdraught'. Although I earlier suggested the whirlwind as a possible explanation for some cornfield damage that I once investigated in August 1963 at Charlton, South Wiltshire (see Oakley-Hill, C.D.: 'Hard fact', *Gemini, London,* vol.1, 43-45), I have also witnessed a helicopter making a single cyclonic pattern with sharp edge cut-off in a field of tall grass by diving and climbing quickly over a fixed point. It is not difficult, therefore, to imagine the effect of one large helicopter flanked by two smaller craft making a formation landing/take-off manoeuvre in a general training area especially when the site resembles a runway, although I suspect there would be few pilots willing to admit it for fear of crop-damage implications.

Since I understand that French helicopter blades rotate in the opposite sense to those of British manufacture, one might expect to find both clockwise and anti-clockwise patterns, and I endorse the Editor's hope that readers will note details of any such markings they may come across in the future.

Whilst there may be other natural explanations, I would not entirely rule out the human one. For example, after I agreed to my comments being reproduced in *Gemini,* I was contacted by many U.F.O. enthusiasts, a few of whom it emerged were actively engaged in making a variety of ingenious 'earth markings' in the hope that some alien civilisation would spot them from above and be encouraged to make a landing nearby.

Note by the Editor. In the *Gemini* U.F.O. magazine, cited above, Mr. Oakley-Hill quoted the following extracts from a letter which Mr. Heighes had written to him.

'At the time of the Charlton affair I visited the cornfield where a U.F.O. was supposed to have landed. Although I recall that three hoaxers claimed to have been responsible, the markings which I examined were consistent with those expected from a vortex circulation which became narrower towards the end of its existence [this is a reference to possible vortex formation by aircraft - Ed.]. In the absence of reliable observations, however, this type of damage could equally well have occurred under entirely natural circumstances, in a manner similar to that which I have described in 1971 in *Weather* ('Observations of a rotating cloud') [namely, a tornadic funnel cloud - Ed.].

Second Letter. Thanks for your letter regarding the mystery spirals. I hope you will include your comments in *J. Meteorology* also.

As I see the situation there are three possible explanations:

(a) That three independent vortices formed and dissipated *in situ* with no lateral movement and that they just happened to occur not only almost equidistant from each other but also in perfect symmetry with respect to the narrow parallel lines of no corn growth.

(b) A formation of three helicopters descended, then ascended, over fixed points in the cornfield without landing. This would require quite precise teamwork owing to their close proximity not only to each other but also surface obstacles such as wire fences.

(c) One or more persons deliberately felled the corn-stalks in circular spiral patterns without leaving footprints by using one of the narrow fallow channels to make their entry/exit as was done in the Charlton (Wiltshire) case of August 1963 which was fully described by international press and TV at the time.

Because there are objections to each of these theories, it may be that a fourth explanation is the correct one, although it is rather difficult to imagine what this might be without involving a high level of speculation and a low degree of plausability. The patterns appear to be a not-uncommon occurrence (Michael Hunt claims to have observed at least five cases, *J. Meteorology,* vol.6, no.59, p.155), and there may be an animal or bio-chemical agricultural explanation.

LETTER FROM MR. STEUART CAMPBELL

The next letter is from Mr. Steuart Campbell, an architect, of 4 Dovecoat Loan, Edinburgh.

I accept that whirlwinds are a physical reality; I have seen one myself. What I question is whether or not we may conclude that the mystery circles were necessarily caused by whirlwinds. Surely what is needed is an observational connection between the two phenomena? Has anyone seen whirlwinds cause such circles? If the answer is no, I think there is a need for caution in concluding, as you appear to do, that there is a connection. The plan of airflow in a tornado indicates that air speeds do not suddenly drop at a particular radius point. Surely such a mechanism would not cut 'clean' circles in corn; the corn would be flattened progressively? By what mechanism would such a phenomenon flatten one stalk and leave its neighbour standing?

I do not have any alternative explanation available at this time; I merely want to understand the one you propose.

If you have not seen details of the Australian 'saucer nests', you may be interested in the enclosed copy of pages from *The Encyclopaedia of U.F.O's.* (ed. D. Ronald, published by Doubleday, New York, 1980). I do not believe in alien spacecraft, but clearly some natural mechansim was responsible. How does it compare with the Wiltshire circle?

TULLY (AUSTRALIA) 'SAUCER' NESTS

On the night of January 19, 1966, at around 9 p.m., George Pedley, a banana grower, was driving his tractor through a neighboring property (a cane farm owned by Albert Pennisi) on his way home.

He was startled by a loud hissing noise, which he could hear over the sound of the tractor engine, "like air escaping from a tire". Since the tractor tires seemed okay, Pedley continued driving, when he suddenly saw a "spaceship" rise at great speed out of a swamp (called Horseshoe Lagoon) about twenty-six yards in front of him. The object was described as bluish-gray in color and about twenty-five feet across and nine feet high. Pedley said, "It spun at a terrific rate as it rose vertically to about sixty feet, then made a shallow dive and rose sharply. Travelling at a fantastic speed, it headed off in a southwesterly direction. It was out of sight in seconds".

Pedley made his way to the spot from where he had observed the UFO rising. Although he had noticed nothing when he had passed the area during the previous evening, he now found a circular area thirty feet in diameter. The reeds "were without exception bent below water level, dead and swirled around in a clockwise manner, as if they had been subjected to some terrific rotary force". Only reeds within the perimeter of the circle were dead. Pedley subsequently indicated that he had noticed a "sulphur" smell in the area around the "nest" after the UFO had departed. His tractor engine had started to miss and subsequently stopped in the close vicinity of the unknown object. Pedley himself thought he may have stalled the tractor.

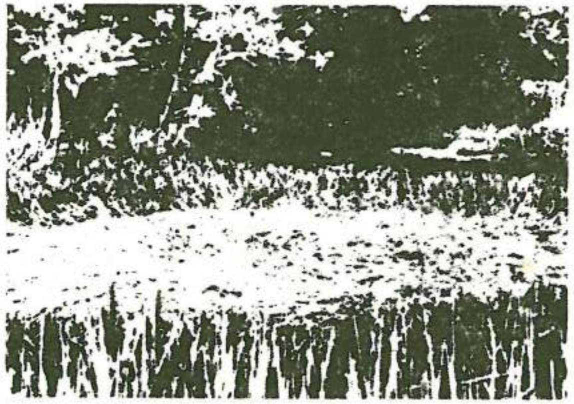

Fig.1: Bed of reeds, flattened over a circular area, in Tully, Australia.

The circular area consisted of a nine-inch layer of reeds, torn out by the roots. It was floating on top of five feet of water. Three large holes, suggestive of "landing indentations", were found beneath the nest (see Fig.1).

Another two nests were subsequently discovered by Mr. T. Warren and Mr. H. Penning, only twenty-five yards from the first one. These were a few feet apart, being about a third of the diameter of the original nest. The reeds were flattened, one clockwise and the other counterclockwise. About six feet from the perimeter of the "main" nest, a rectangular patch of the swamp couch grass, approximately five feet by six feet, had been clipped off at water level and removed.

A week after the original find, a cane farmer and his nephew found another two nests both apparently much older than those found earlier. One was about twelve feet in diameter and the other, eight feet, and they showed distinct signs of burning, in the shape of a circular patch of scorched reeds situated in the center. A few days later, again on Mr. Pennisi's property, an identical "new" nest with scorched center was found. It was situated among the earlier nests.

Although originally denied, "footprints" strongly suggestive of animal tracks were found in the vicinity of the nests on Pennisi's farm. They were found among the banana crop and also in the center of the small half-acre lagoon. The imprints were about ninety millimetres in length and were arranged in a single line with a spacing of about ten inches between each. Similar "tracks" were discovered on the outskirts of the nearby Mossop farm at about the same time.

The traces found subsequent to the discovery of the main nest, although interesting, are somewhat less probative, mainly because of the lack of a direct UFO connection, other than a high level of UFO activity in the local area.

UFOlogist Stan Seers, arranged for samples from the main trace to be studied at Brisbane University. The Royal Australian Air Force (RAAF) requested that other samples be sent to their base at Garbutt, Townsville.

Radioactivity tests for alpha, beta, and gamma radiation proved negative, and a low beta count found in one sample was regarded as background radiation by physicist G. Taylor. Dr. R. Langdon reported after botanical examination that the grass spparently died from submersion in swamp water. No evidence for parasitic infestation or burning was found. The submersion theory seems untenable when the following is considered. When Pedley had passed the area the evening before, the site "was smothered in green grasslike reeds protruding up to three feet above the surface [of the swamp water]". Thus it appears the reeds were uprooted and turned brown in about twelve hours, whereas comparative tests (where reeds were torn out and submerged) revealed that the reeds turned brown after about three days. I would suggest natural submersion with the reeds not being ripped out of the soil would probably take much longer. Indeed circumstantial evidence suggests that the observed unknown aerial object may have landed in the swamp at about 5:30 A.M. This fact may be supported by the fact that Pennisi's dog suddenly went mad at that time and bounded off towards the lagoon.

The RAAF made no statement at the time but later the Department of Air notified CAPIO (now defunct), in an official communication dated February 11, 1966, that testing "failed to reveal anything of significance". It was further suggested that the nests could have been "the results of severe turbulence, which normally accompany line squalls and thunderstorms prevalent in North Queensland at that time of the year". The observed visual phenomena are suggested to have been associated with, or have been the result of, "down draughts", "willy-willys" or "water spouts", "that are known to occur in the area". These explanations seem quite unsatisfactory since the weather was fine and sunny at the time, and there was no apparent debris scattered about. The reeds within the circle had been ripped out, roots and all, and were floating on the water's surface. An underwater inspection revealed that the soil underneath was smooth and clear of roots within the circle. Other less likely explanations, such as nesting birds, crocodiles, and a helicopter landing, were considered but disregarded. The case remains a mystery.

THE CLEY HILL, WARMINSTER, SPIRALS

In the foregoing pages several questions have been raised by Mr. Heighes, Mr. Campbell and Mr. Ronald (the writer of the Tully 'saucer' nest story). Some of these questions are answered by this next report – the discovery of more spirals in cornfields below Cley Hill near Warminster in West Wiltshire last summer. For a change these new spirals appear to solve more problems than they create. For the first time witnesses have been found who have seen the crops being flattened in spiral fashion. This report has been compiled by using extracts and photographs from an article by Ian Mrzyglod, previously published in vol.3, no,2 (October 1982) of *Probe* (16 Marigold Walk, Ashton, Bristol).

During 1980 and 1981, in the summers of both those years, *Probe* investigated the strange appearance of large flattened circles that were discovered in west country cornfields. At first, we were at a loss to find a rational and realistic explanation for their occurrence, but eventually help came from Dr. G. T. Meaden of the Tornado and Storm Research Organisation based in Trowbridge, Wiltshire. Dr. Meaden studied photographs supplied by ourselves, and together with this information, site measurements, general topographical details and prevailing weather conditions, arrived at the theory that whirlwinds were responsible for creating them. This explanation was treated with some scepticism, especially by members of the *Probe* team who actually stood in the centres of these circles. It seemed inconceivable that mere weather could cause such precise and massive damage, and not affect the corn stalks standing only inches away from the perimeters of the circles. Yet, this theory at least had foundations whereas the hope that UFOs had been the culprits remained *only* as a hope. The pieces fitted, and the whirlwind explanation seemed most logical, and was perhaps the only real explanation that could be put forward without delving off into the realms of the ridiculous. So we printed the reports and articles as they materialised, and they attracted criticism which was helpful in the sense that it opened the topic further for debate. Many of the critics refused to accept the natural phenomenon theory and stuck by their beliefs that UFOs (and in this sense we *are* talking about flying saucers) had touched down in these fields, spinning in a clockwise direction and thus flattening the corn. In the case of the Winchester circles, some 'ufologists' even managed to find witnesses who saw silvery suited beings walking about various fields. Sadly, further information on these vital visions was never forthcoming, so we politely ignored those testimonies and stuck to the hard facts. They were basically that we had hard, physical traces plumb in the middle of cornfields with no tracks leading to or from them, and that in each case, the circles were in fields that were at the base of a hill. This detail became very important in preparing the theory, because it was this hill that was trapping winds and causing the fair-weather whirlwind to remain stationary for a very short time - yet long enough to flatten a circular area. The circles themselves were never perfectly circular (usually about 90%) and it was always a feature that the centres of the spirals were never in the centres of the circles overall.

Understandably, many people voiced the argument that if natural phenomena are creating these circles, why is nobody seeing this happen or producing photographs of such events? Fair questions, but it has to be stressed that we were discussing a rare phenomenon. Equally, no photographs exist (that have been accepted as anything other than fakes) that show a UFO (or anything else) hovering above a cornfield flattening the stalks. Thus it was that we said in *Probe* "The next obvious step to take, as we ourselves shall take, is to look out next August for further appearances of such circles".

Fig.2: Two views of a circular area in a cornfield below Cley Hill; Warminster can be seen in the distance in the upper photograph (photographs by Ian Mrzyglod).

Not forgetting that line, periodical scans were made of various cornfields while driving through the countryside. Unfortunately, no circles were discovered by us. But (and now the pièce de résistance) the *Unexplained* office telephoned to say that one of their readers had spotted and photographed a strange circle of flattened corn and had written asking what might have caused it. What is more, the circle was also found in Wiltshire, in a cornfield, and the date that he saw it was 10 August 1982. But the most interesting thing about this particular circle was its precise location. It was situated at the foot of Cley Hill, one of the most famous skywatching spots of all Wiltshire, close to Warminster.

I visited Cley Hill on Friday 27 August to try and photograph the circle for myself, and to determine its exact location with regard to Cley Hill. The circle was easily found and photographed, and was situated at the foot of Cley Hill, which was in accordance with all the other mystery circles. In an effort to obtain a better bird's-eye view of the circle, I climbed up the face of the hill and was pleasantly surprised to see the remains of an even larger circle in an adjacent field, although this one had been harvested. Nevertheless, because the corn becomes flattened when the circle is created, the harvesting machinery cannot cut these stalks and they remain easily visible against the background of harvested crop. The second circle was again at the foot of Cley Hill, and was in even more of a wind-trap, thus perhaps accounting for its larger diameter. This circle measured, based upon previous measurements, at least 60 feet across in diameter. The first one was smaller, probably around 50 feet. These measurements could not be verified in the short time allowed, as no farmers were nearby to obtain permission from for entry into the fields. The second circle, being situated in a more enclosed area, could possibly have been the result of a fair-weather whirlwind being retained in position for a slightly longer spell.

Finally, another visit was paid to Cley Hill on 8 September to obtain some more photographs, but sadly, nearly all traces of the circles has been erased due to stubble-burning in the fields. In adjacent fields were farmers harvesting the last of the crop, and when approached on the subject of the circles were in one mind as to the cause. They nominated whirlwinds purely because they had seen them on many occasions causing similar damage, in some cases ripping the corn out from the ground and carrying it hundreds of feet into the air, only to return several minutes later floating slowly down. They also informed the author that four smaller circles were seen dotted about the field we were standing in, and luckily the remains of one, measuring roughly 15 feet, were still visible. But this circle was not quite the same as the others; the corn had not been totally flattened, just angled over, giving the impression that a lesser force had been responsible. When looking closer at this circle, which incidentally was placed several hundred yards away from the base of Cley Hill and thus was not in a position to suffer the full effects of a stationary whirlwind, it was not really circular, but oval in shape. This indicated that the whirl was moving as it flattened the corn until it died seconds after its birth. The presence of this last circle added to Dr. Meaden's theory by the very nature of its make-up and its location, that whirlwinds are varied in their ferocity and size depending on the weather conditions and the local topography.

I therefore feel that I have to state that the mystery circles that have been appearing in this area, *are* as a result of meteorological phenomena. Fair-weather whirlwinds, under normal conditions in open countryside, will travel across fields

and cause messy areas of damage. In fact, ordinary strong winds are enough to collapse long stalks of corn that are dry and brittle. Once bent over, they very often stay flattened. But the circles are all found at bases of hills where advancing wind can be trapped, and should a whirlwind form, it could very likely, when close to the hill, remain stationary for a very short period – perhaps only seconds. These seconds are long enough to flatten a large area, after which the corn will remain in such a position indefinitely. It is now time that the word 'mystery' be dropped from the description of these circles, which are now no more mysterious than other meteorological phenomena, and perhaps too they can be forgotten with regard to the UFO phenomenon.

A MYSTERY NO LONGER

So there we are. Witnesses have been found who have seen whirlwinds flattening mature crops over circular areas with their characteristic spiral damage patterns and sharply-cut perimeters. The perimeter edge is sharply defined because dry stalks, when bent beyond a critical limit, are irreversibly damaged; the perimeter merely indicates the boundary of this critical region. The spiral pattern is the simple consequence of the stalks following the wind inflow into a whirlwind (and thence upwards) (*J. Meteorology*, vol.6, 76-80). The high frequency of near-circular patterns close to hillsides seems to be linked to the proximity of the latter (*J. Meteorology*, vol.7, 45-49). The frequency of such circles in July and August in southern England is due to the brittleness of cereal crops at this time of the season; earlier, permanent damage is less likely. As for the Australian banana grower at Tully who saw a bluish-gray "spaceship" rising from a circular flattened reed-bed when he was going home in the evening (tired? poor eyesight?), it seems possible that he was observing a whirlwind rising and then literally 'disappearing into thin air' as it moved off in a south-westerly direction.

Doubtless there are many farmers who have seen their crops damaged in the way described in these articles. Many more are likely to have seen the probably-commoner, elongated, winding trails made by the translational motion of mobile, summer whirlwinds. If so, we would be pleased to hear from them. We are also hoping that meteorological readers of this magazine will be on the alert for whirlwind formation, and for their damage tracks, whenever they are out in the countryside, particularly in July and August, because we would welcome eye-witness reports of such whirlwinds in action from readers.

THE FORMATION OF HALOS IN THE ATMOSPHERE BY PYRAMIDAL ICE CRYSTALS

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Abstract: It is shown that equilibrium surface energy considerations predict that, if an ice crystal has pyramid faces at all, they correspond to a semi-vertical angle of 28 degrees. However, this theory predicts, at most, bi-pyramidal cystals, without truncation or an intervening hexagonal column, and it may be that absorption of impurities is more relevant to actual occurrences of pyramid faces. This suggestion may go towards explaining the observed angular radii of some halos of which pyramidal ice crystals have been held to be the cause.

INTRODUCTION

There are, occasionally, circular solar or lunar halos of which the angular radii are not the well-known ones of 22 or 46 degrees. Often halos of several such unusual radii are present simultaneously, typically one of about 8-9 degrees radius, several close to the halo of 22 degrees, and, perhaps rather more rarely, one of 32-35 degrees.

Earlier authors have considered the cause of such displays to be crystallisation of ice into pyramidal, rather that the normal prismatic, forms. They have not, however, been able to agree on the semi-vertical angle *d* of the pyramid, values of 25 degrees or 28 degrees being most frequently quoted.

In a previous paper[1] I stated that I am now more inclined to the view of the late Mr. E. C. W. Goldie that *d* is likely to be close to 28 degrees, rather than other possibilities such as the value close to 25 degrees suggested by Humphreys[2], or that of 26 degrees 17 minutes recently suggested by Dr. Meaden[3]. I should now like to explain more fully the reasons why I have changed my mind.

It is not clear that the advice Mr. Goldie was given on ice-crystal structure, which was used in the paper published under our three names[4], was based on an understanding of the forces that control the manner of stacking of units cells in crystal formation. A crystal adopts a particular shape to obtain a thermo-dynamic advantage, that is, in the equilibrium case, the minimisation of its total free surface energy for a given crystal volume.

CRYSTAL STRUCTURE

All crystals can be regarded as made up of "building blocks" called "unit cells", which have the property that they can be put together so as to fill space completely without leaving any voids between them. All unit cells for a given crystal are the same shape, and within each of these unit cells there are atoms of the same chemical elements in the same positions. A two-dimensional analogy, the building up of a wall-paper pattern by repetition of identical units, has been suggested. Note that the unit cell is merely a concept in terms of which we describe the crystal structure, not something that really exists - just as the equator is a purely imaginary line on the earth's surface.

There is more than one kind of unit cell (each kind being distinguished by shape, size, orientation and the position of atoms within it) possible for any crystal structure. One simple way in which, given one kind of cell for a particular structure, we can generate a new kind, is by setting every point on the new unit cell a fixed distance in a fixed direction from a corresponding point on the old one. The old and new unit cells are the same size, shape, and orientation relative to the structure but for most values of the "fixed distance", the atoms within them are in different positions. This is the non-uniqueness with respect to the translation of the unit cell. It can be understood in terms of the wallpaper analogy.

The choice of the unit cell of ice[5] most useful for subsequent discussion takes the form of a right rhombic prism, the acute angles of the rhombus being 60 degrees: we shall call the side of this cross-section *"a"*. Humphreys[2] calculated the value of *d* as 25 degrees on the assumption that the unit cells had their rectangular faces at 30 degrees to the rectangular faces of hexagonal prismatic ice crystals. Goldie et al.[4] calculated it as 28 degrees on the assumption that the rectangular faces of unit cells

are parallel to those of the crystal.

To look at this another way, we observe that, because each corner of the unit cell is a lattice point[6], the lattice (in the sense of Urch[6], as a three-dimensional network of the lattice points) has parallel six-fold axes of rotational symmetry, mirror planes normal to them, and a further six systems of parallel mirror planes mutually inclined at 30 degrees, such that the six-fold axes are the intersections of members of the six systems. In other words, ice crystallises in the hexagonal system. Looking in the direction of the six-fold axes, we see a honeycomb-like pattern of hexagons whose sides are chemical bonds joining oxygen atoms via hydrogen atoms. The hypothesis of Humphreys corresponds to the hexagons of the honeycomb having their sides parallel to those of the crystal cross-section.

Consequent upon the non-uniqueness with respect to translation of the unit cell, we have non-uniqueness with respect to translation of the lattice. The concept of lattice points enables us to understand another kind of non-uniqueness of the unit cell, most easily by another two-dimensional analogy. Let us consider the intersections of the lines on a piece of graph paper to be our lattice points. The squares on the paper are the most obvious choice of unit cell, but it is also possible to choose various kinds of parallelograms, each having a lattice point at each corner, as unit cells.

CRYSTAL MORPHOLOGY

At equillibrium, that is, for infinitely slow growth, bodies take on such a shape that the free surface energy (note that Tabor[7] uses this term where we use "free surface energy per unit area", and Burton et al.[13] "Surface free energy per unit area"), or briefly "the surface energy", for a given volume, is a minimum. This surface energy exists because the molecules inside the crystal are chemically bonded to others on all sides, whereas those on the surface are bonded on one side only, and hence are in a less stable, that is, more energetic, condition. We can say that there are broken bonds at the surface.

Where the surface energy per unit area is independent of surface orientation, as in an isotropic solid or a liquid, the equilibrium shape is spherical. The fact that the equilibrium shape is not attained for such solids (except perhaps for very minute bodies[7]) indicates the limitations of this static theory, but let us pursue it further for crystals. We let the *x, y* and *z* axes (not necessarily orthogonal) be directed parallel to the edges of unit cells, and let the area of the projection of a face of the crystal along the *z-axis* into the *x-y* plane be nC, where C is the area of the face of the unit cell parallel to the *x-y* plane, which defines n. We similarly define the symbols l, m, A, B by simultaneous cyclic permutation within each of the triads (x,y,z), (l,m,n), (A,B,C). Then we make the bond-counting hypothesis that the total surface energy of that face equals

$$lE + mF + nG \qquad (1)$$

where E is the total energy per unit cell of bonds broken by a cut parallel to the *y-z* plane, and F, G are similarly defined by simultaneous cyclic permutation in each of (x,y,z) and $(E.F.G)$. Because neither the unit cells nor the precise positions at which the cuts are made are uniquely defined, we cannot necessarily claim that equation *(1)* gives a unique value for the surface energy of a given face, and indeed, it often does not. We overcome this by introducing the further hypothesis that we select the unit cell, the cuts and hence the axes such that the values of equation *(1)* is minimised. This choice of unit cell will have its faces parallel to singular surfaces[8] of the crystal structure. These hypotheses are equivalent to treating a non-singular surface as microscopically not plane, but as a "three-dimensional staircase" with the treads and risers forming small parallelograms, every such parallelogram being parallel to the *x-y*, the *x-z* or the *y-z* plane.

Given such a hypothesis allowing us to calculate the surface energy of any face whose orientation relative to the lattice (usually given in terms of the "Miller Indices"[10]) is known, there are two methods to proceed. The first is by means of the general relation on the shapes of crystals generally known as "Wulff's theorem", which states that there is a point from which the perpendicular distances of the faces of the crystal are proportional to their surface energies per unit area. This was first enunciated by Wulff[11], and the first correct proof was given by Hilton[12]. Proofs have been given for the two-dimensional case by Burton et al.[13], without any *a priori* assumption of rectilinear polygonal form (that is, the possibility of continuously curving faces is admitted, and there need not even be any vertices), and by Herring[9] for the three-dimensional case, without *a priori* assumption that the crystal is a polyhedron with plane faces.

The second approach, suggested by Hilton, is to examine the variation of total surface energy of a crystal of fixed volume with a parameter or parameters determining the shape, the minimum being found by differential calculus.

THE CROSS-SECTION OF A BIPYRAMIDAL CRYSTAL

Let us apply the second method to a general right rectangular hexagonal bipyramidal ice crystal, with its axis parallel to the six-fold axes of the lattice, the height of each pyramid being h, and the side of the hexagonal base b. We shall take the *z-axis* parallel to the six-fold axes of the lattice, which gives, by bond counting from Evans' representation of the unit cell, and our principle of choosing the cuts to minimise equation *(1)*,

$$E = F = 2G \qquad (2)$$

since there are twice as many broken bonds on a face of the unit cell parallel to the *z-axis* as there are on one normal to that axis, and all such bonds are identical. For each face of the hexagonal bipyramid, and one of the possible choices of the x and y axes we have

$$A = 3^{-0.5} hb \sin t, \quad Bm = hb3^{-0.5} \sin(60-t), \quad Cn = 3^{0.5}b^2/4. \qquad (3)$$

The angle t is measured between the intersection of the face of the crystal being considered with the *x-y* plane and the *x*-axis corresponding to that face. It varies as the hexagonal cross-section is rotated relative to the lattice. All angles are measured in degrees in this paper. When we recognise that the crystal structure of ice possesses the three alternate systems of the six systems of mirror planes parallel to six-fold axes possessed by its lattice, we see that t has the same value for all faces of the crystal. The x and y axes can be chosen for each face such that we may take t as varying continuously from 0 to 60 degrees, then reverting discontinuously to zero, this cycle being repeated six times for a single complete revolution of the hexagonal cross-section relative to the lattice.

Let c be the dimension of the unit cell parallel to the *z*-axis: then we have $A = B = ac$, $C = \frac{1}{2}3^{0.5}a^2$, and so by *(1)*, *(2)* and *(3)* we have for the total surface energy of the crystal

$$hb(\sin t + \sin[60-t)]/[3^{0.5}a\, c] + \tfrac{1}{4}b^2/a^2 \qquad (4)$$

to within a factor that is "constant" in the sense that it is determined only by the substance we are considering (ice) and by the hexagonal bipyramidal form we have assumed. Variation of t does not alter the total volume or surface area of the crystal, and hence, this expression is proportional, as t varies, to the surface energy per unit area. It is readily found that the plot of total surface energy as the hexagonal cross-section is rotated relative to the lattice has minimal tacs (strictly these are not cusps, though this term is often used for them in the crystallographic literature), at 60-degrees intervals, corresponding to $t = 0$, where the value of *(4)* is

$$\tfrac{1}{2}\, hb/(ac) + \tfrac{1}{4}\, b^2/a^2. \qquad (5)$$

At the latter points there are singular surfaces, elsewhere vicinal or diffuse surfaces[8].

A particularly important special case is the limit of h very much greater than b, in which d tends to zero, that is, we have a hexagonal prism rather than a bipyramid, and the second term in each of *(4)* and *(5)* becomes negligible compared with the respective first terms.

We see that the result is in accord with the hypothesis of Goldie et al., not with that of Humphreys.

To obtain our result, we started from the assumption that the cross-section was a regular hexagon, but we can obtain the result quite easily starting from the assumption of arbitrary cross-section, by means of Wulff's theorem, so long as we retain the form of a right bipyramid with its axis parallel to the six-fold axes of the lattice. Under the latter hypothesis, the contribution from bonds broken by cuts parallel to the *x-y* plane remains constant so long as h and the total volume remain fixed, and we face merely a two-dimensional problem related to bonds broken by cuts perpendicular to these, in any "slice" of the crystal normal to the six-fold axes and the prism axis. Under our hypotheses, all such slices are the same shape, so we only consider one of them. We take the v-axis as the axis of the prism, the u-axis perpendicular to this and to a side of the cross-section predicted by Goldie et al., and the w-axis to form a mutually perpendicular set (u,v,w). Then we find that the equations of edges predicted by Wulff's therorem ate of the form

$$v = -\,w \tan t + [\sin t + \sin(60-t)] \sec t$$

with such a scale of length that the cross-section predicted by Goldie et al., is of unit side. The Wulff shape is given by any interior envelope of these lines that may exist, and we see that since they all intersect at $w = \frac{1}{2}$, $v = \frac{1}{2}3^{0.5}$, it is that predicted by Goldie et al. The generalisation to the limiting case of a prism again follows, and indeed both methods may be applied to show that the result holds for a crystal in the form of an arbitrary sequence of frustra and prismatic sections. We can pass to the continuous limit, and obtain the result starting with a shape as general as $r = f(p) \times g(v)$, where r, p, v are cylindrical polar co-ordinates, and g denotes an arbitrary continuous functional dependence, as does f for the Wulff method.

It is easy to check from Evans' representation of the unit cell that our bond-counting hypothesis is correct for $t = 30$, but Herring[9] states that the surface energy per unit area is mathematically pathological, with a tac at every rational Miller index.

THE POSSIBILITY OF PYRAMID FACES

We assume we have already selected the cross-section to minimise the total free surface energy as far as possible, and so the latter is given by twelve times *(5)*, multiplied by a quantity we shall call Q, a constant for hexagonal bipyramidal ice crystals. Let us examine whether Wulff's theorem predicts pyramid faces. After some labour, noting that $Q/(3^{0.5}a^2)$ depends only on constants of the crystal structure, and hence we may measure u and v in units of this quantity, we obtain for the equation of the intersection of the face with the u-v plane

$$v = 1 + 2\,h\,a/(bc) - 2\,h\,u/(3^{0.5}b).$$

These lines all intersect at $v = 1$, $u = 3^{0.5}a/c$. The Wulff shape is a hexagonal prism, the ratio of whose axial length to its maximum transverse dimension is $c/(2a) = 0.81\text{-}0.82$.

It is evident that, not only can the Wulff theory not predict pyramid faces, it cannot begin to predict the wide variety of columns, plates, dendrites etc. produced under variable temperature/humidity conditions. We can, however, obtain a more interesting result if we constrain the crystal to have pyramid faces by Hilton's method, and determine d for minimal surface energy for given volume. Writing $M = h/c$, $N = b/a$, we have by *(5)* that the total surface energy is proportional to

$$N\,(N + \tfrac{1}{2}\,M) \quad (6)$$

and for constant volume

$$M = k\,N^{-2} \quad (7)$$

with k a constant. Writing *(6)* as a function of N by *(7)*, we find, by differentiation, minimal total surface energy at $-kn^{-2} + N = 0$, that is, by *(7)*, $N = M$, the hypothesis of Goldie et al. that d is 28 degrees.

If we give the crystal sufficient freedom to avoid the formation of pyramid faces, it does so. For instance, if we introduce a hexagonal column between the pyramidal caps, we find $d = 90$, or if we allow the pyramids to be truncated, we find $d = 0$, both corresponding to a hexagonal prism with no pyramid faces.

CONCLUDING REMARKS

A suitable impurity absorbed on pyramid faces might form chemical linkages with the broken bonds, lowering the surface energy per unit area of these faces. However, to take up all broken bonds thereon, the impurity would have to have a different molecular structure, that is, be a different chemical substance from impurities required to take up all broken bonds on the basal and lateral faces. Thus it would stabilise pyramid faces as compared with basal and lateral faces. This is clearly possible for a $M{:}N = 1$ stacking ratio as in the hypothesis of Goldie at al., but for any other ratio a more complex molecular structure of the impurity is required for equally efficient stabilisation. Many observers of the 1974 solar halo display[4] commented on the presence of contrails, and it was suggested to the author by the late Professor F. H. Ludlam that impurities from aircraft exhaust were responsible for the pyramidal crystals. On the other hand, it should be recognised that halos of unusual radii were seen long prior to the aircraft age.

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TORRO THUNDERSTORM REPORT: July 1982

By KEITH O. MORTIMORE

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Over the whole of Great Britain and Ireland thunder was heard on 15 days, six below the normal for July. The following days were affected; 2nd-4th, 8th-15th, 21st, 22nd, 30th and 31st. Thunder was most frequent in southern counties of England and Wales with most stations reporting four or five days, but with six in places and seven locally in Greater London. Although most northern and western areas of Britain had only one or two days, if any at all, Whalsay in Shetland had five days.

On 2nd, northern areas of Britain lay in the circulation of a depression off north-west Scotland which gave most of these parts sunny periods and scattered showers. There were thunderstorms in places, particularly in Northern Ireland, north-east Scotland and Northern Isles. In the south a weak, slow-moving cold front lying along the English Channel became more active during the day and returned northwards into central England as a warm front. This development, together with the movement of a small low from north-west France to the Netherlands, set off some scattered outbreaks of thunderstorms, particularly in East Anglia in the evening. Scotland had further heavy showers and very scattered thunderstorms on 3rd, but in southern England some very heavy showers and thunderstorms developed in the Bristol and downland areas of Wiltshire and moved east across southern counties during the afternoon. The writer personally observed the development of thunderstorms over the Marlborough Downs near Avebury. A thundery shower or two also developed in south Wales during the morning of 4th. A thundery low developed to the west of Iberia on 8th and moved north-north-east towards western Eire. Upper instability in the form of altocumulus castellanus was observed in west Cornwall in the morning and there was some mostly light rain in this area by early evening. By mid-evening thunderstorms had broken out over western Eire and Cornwall and by midnight these had become widespread over Ireland and Cornwall and had spread to south and west Wales and Devon. At Ballyglass in Co. Mayo, a woman and her two children were fortunate to escape injury when lightning struck a barn in which they were standing, killing a cow, while at Hollymount, a farmer suffered heavier losses when five of his cattle were killed by lightning. There was a fair amount of rain in places, particularly in Cornwall, Devon, west Somerset and south Wales, and storms continued until after midnight in places. At Dawlish in south Devon an early morning thunderstorm was accompanied by a severe hailfall. Hailstones lying some five hours after the event still measured 1.3 cm in diameter and drifts to one metre remained well into the 9th. During 9th the low continued to move north to the west of Scotland and a surface trough gave some further thundery outbreaks in Wiltshire and the Channel Islands in the morning. Later in the afternoon an upper trough was responsible for further thunderstorm development over southern England from Salisbury Plain to Berkshire and Surrey, and there were some more widespread outbreaks in East Anglia and Lincolnshire in the evening. Thunderstorms also moved north up the North Sea to affect the Northern Isles during the morning of 10th. With very high temperatures over France and eastern Spain on 11th another thundery low developed over this area and moved slowly north, spreading thunderstorms into parts of south-west England later in the day. Thunder was first reported in the Scilly Isles early in the afternoon and there was a storm at Plymouth a few hours later. During the evening storms spread across the whole of Cornwall and into Devon, Somerset, Dorset and south Wales, and in many areas there was considerable activity throughout the night, particularly over Devon. During the morning of 12th a major outbreak of thunderstorms moved north into Dorset and continued north to affect a large area from the Isle of Wight and parts of Hampshire westwards to Devon and northwards to south Wales, Gloucestershire and Oxfordshire. Many of these storms were severe and long lasting and there were some 12 hours of virtually continuous activity in places. Rainfall was also very heavy with much flooding, particularly in south Somerset where, at the village of Bruton, severe flash flooding followed a rainfall of 110 mm in 24 hours. A bridge was partly demolished and cars were picked up in the swirling torrent and carried considerable distances before being dumped, many smashed beyond repair. One eye-witness reported floodwater . . . "roaring through the town like an express train" . . . "the sky was black and it was like midnight at midday". This 'day darkness' was widespread over the whole 'Wessex' area (see *J. Meteorology,* vol.7, p.269). Lightning damage was reported in many areas. At Yeovil a school caretaker was given the kiss of life when lightning struck the building in which he was working, and a family of four escaped injury when their home was struck at Preston near Weymouth, setting the roof on fire. Houses were also damaged at Blandford Forum, at Butleigh near Glastonbury, where a woman using a telephone was thrown across the room, and at Chilcompton, where a house was partly destroyed. Lightning also caused damage in Avon and Gloucestershire and power supplies were disrupted throughout the affected area. After a brief respite further scattered storms spread across Dorset and Devon in the late evening, and in the early hours of 13th there were thunderstorms in parts of south Wales and the Channel Islands. Some of these storms lingered into the morning, spreading to south Wales in the afternoon with further outbreaks in the Channel Islands in the evening. Widespread and often severe thunderstorms reached southern coasts of England around dawn on 14th and spread during the day to much of Great Britain, except Cornwall, Northern Ireland and western Scotland. Flooding and lightning damage occurred widely. In central London a man and a woman were seriously hurt when struck by lightning in St. James' Park, and at Maidenhead in Berkshire a woman was treated for shock after lightning struck a tea-strainer she was holding. At Exeter a workman had an amazing escape when lightning hit the scaffolding on a church roof where he was carrying out repairs; he suffered shock and burns to his hands, and two large pieces of stone were removed by the lightning. Lightning also struck the Weston-super-Mare General Hospital, setting off all the fire alarms, and at Sheffield, bricks and guttering were thrown some 20 metres when an office building was hit. A workman on the roof had an extremely lucky escape as the discharge demolished the chimney stack and gable-end only metres from where he was working. In his own words . . . "it looked like a ball of fire, like the sun coming out, then all of a sudden it turned blue". Lightning also damaged another building only 100 metres away. Again, electricity supplies and telephone services were widely disrupted. Although drier weather followed from the south during the day, scattered storms were reported again in the evening, mostly in Kent and in the West Country. During the morning of 15th some thunderstorms moved north across north-east England and eastern and northern Scotland, and some heavy thundery showers developed in parts of eastern and south-eastern England. In the afternoon thunderstorms also broke out from south Wales to Exeter with heavy rain locally (e.g. 12 mm in five minutes at Loughton in Essex). Storms that developed widely over France on 21st spread to the Channel Islands from the evening of 21st to morning of 22nd. Early in the evening of 24th there was a heavy downpour and minor tornado at Eskdalemuir, but no reported thunder. As a low drifted north-west from France thundery rain spread north into southern England around midday on 30th, spreading further north during the afternoon and evening to most southern counties with thunderstorms becoming quite heavy and widespread for a time before dying out by, or soon after, midnight. On 31st some scattered storms broke out in the late afternoon and evening in the north Midlands.

On the continent the Netherlands had thunder on 1st-4th, 7th, 10th, 14th-16th, 21st and 26th-31st, one day less than the normal. Belgium reported thunder on 2nd, 3rd, 5th, 14th, 15th, 21st, 22nd, 27th, 28th, 30th and 31st, which equals the July normal of 11 days, and in West Germany there was thunder on 3rd-5th, 15th, 16th, 21st-25th and 31st.

TORRO TORNADO REPORT: July 1982

By G. T. MEADEN

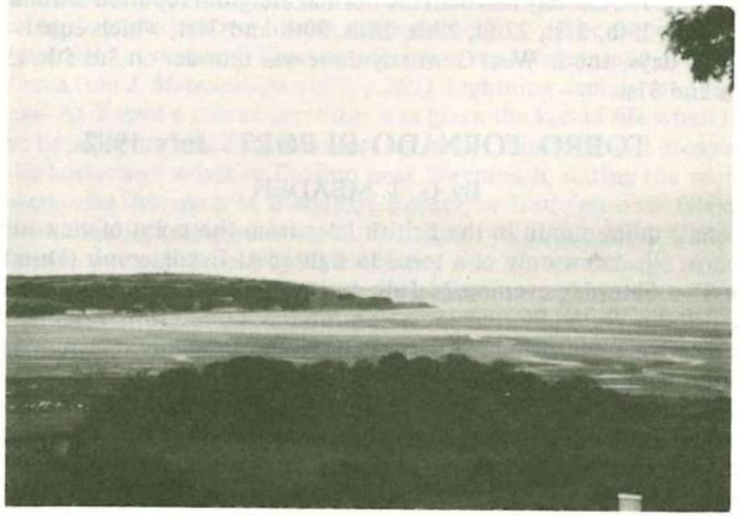
July was a quiet month in the British Isles from the point of view of tornadic phenomena. We know only of a tornado sighted at Eskdalemuir (Dumfries and Galloway) on Saturday evening 24 July during a fall of heavy rain because of its mention in the *Daily Weather Summary* of the London Weather Cemtre. In addition, there is a whirlwind report for Paisley (Renfrewshire) given in the *Paisley Daily Express* of 26 July, but this appears to be a reference to a land devil on the previous Thursday (i.e. 22nd). The report goes: 'A freak whirlwind tore through the north end of Paisley during the heatwave. It was so savage that the whirling gust took part of the roof from an Abercorn Street engineering works, Robert Livingstone Ltd. But a spokesman at Coats Observatory said that wind speeds on Thursday at the observatory never went over 15 miles an hour'.

In Holland funnel clouds were seen at Den Hoorn (Zuid-Holland) at 0900 U.T. and also in Friesland (*Weerspiegel,* p.399).

RED WHARF BAY, ANGLESEY

The photographs of Red Wharf Bay on the Island of Anglesey (north Wales) were taken by Mr. Keith Ledson from his cottage on the south-east side of the bay.

The upper photograph was taken on a bright winter's day in February 1982 with sea-fog rolling in. This sea-fog did not obtain any great depth as sea-fogs in May and June do; then, a height of 150 metres is not uncommon, but in February the fogs seldom reach the height of the cottage, about 65 metres above mean sea-level.



The lower photograph was taken on what Mr. Ledson described as a typical mid-summer day in 1981 - quiet conditions as frontal rain approaches.

Book Review

CLOUD DYNAMICS. Edited by E. M. Agee and T. Asai. D. Reidel Publishing Co., P.O. Box 17, 3300 AA Dordrecht, Holland. 1982. 423 pp. U.S. $49.50; 115 D.fl.

This book is the published proceedings of a symposium on cloud dynamics held at the Third General Assembly of the International Association of Meteorology and Atmospheric Physics in August 1981. Cloud dynamics is now an important area of modern dynamic meteorology, and in recent years, due to considerable technological developments, the rather wide gap between observational and theoretical studies has been reduced somewhat. In this volume primary attention has been given to studies of convective clouds, both shallow and deep. Thus, there are papers on convective cloud streets, precipitation cells in stratiform clouds, lake-effect snow-storms, thunderstorms, development of cumulonimbus clouds which move along a valley, radar techniques, hailstorms and tornadoes. This is undoubtedly a useful book for the specialists, and should be in any meteorological library which serves active meteorological research teams.

G. T. M.

WORLD WEATHER REVIEW: SEPTEMBER 1982

United States. *Temperatures:* mainly cold, −2 deg. in Oregon, N.E. California, E. Kentucky. Warm in extreme N.W. and in band from New Mexico and Texas to Minnesota through Great Lakes to Maine; +1 deg. in W. Washington, in and around Vermont, in and near Texas. *Rainfall:* wet W. of 105°W. except most of Arizona; over 150% generally, over 500% widely from S.W. California to S.W. Wyoming. Wet also from W. Kentucky to S. Illinois (over 200%); S. Louisiana; W. Iowa to L. Superior to N. Maine; N. Florida. Dry in most C. and E. states; under 50% in C. North Dakota; S. Wisconsin to N. Illinois to W. North Carolina to near New Orleans; S. Texas to S.E. Kansas.

Canada and Arctic. *Temperatures:* warm in N.W. Canada, most of Alaska; +3 deg. in C.E. Alaska. Cold in S. Alaska, N.E. and most of E. Canada, Greenland, Iceland; −3 deg. from S. Greenland to N. Iceland. *Rainfall:* wet from British Columbia to S. Baffin Island; Great Lakes to S.W. Quebec and Nova Scotia; most of Alaska; over 200% in N. British Columbia and N.W. of Hudson Bay. Dry elsewhere, under 50% from S. Saskatchewan to N.E. Manitoba; most of Greenland.

South and Central America. *Temperatures:* warm in Chile, Argentina, S. Paraguay, extreme S. Brazil, Venezuela, Mexico, West Indies; +2 deg. in N.E. Argentina, extreme S. Brazil, Jamaica, locally in N. Mexico. Cold in Bolivia (−2 deg. in E.), much of Brazil. *Rainfall:* wet in N.W. Argentina, W. Bolivia, much of Brazil (especially N.), Guianas, S.E. Venezuela, locally in N. Mexico; over 200% in N.W. Argentina. Dry in much of S. Brazil, E. Bolivia, most of Mexico; all under 50%.

Europe. *Temperatures:* mainly warm: +3 deg. from E. Germany through Czechoslovakia to N. Jugoslavia and N. Romania. Cold from N.W. Ireland to Norway, N. Sweden and White Sea; E. Spain; −1 deg. in N. Norway, E. Spain. *Rainfall:* mainly dry; wet from Scotland to Norway and W. and N. Sweden; C. France; Leningrad to N. Caspian Sea; E. Bulgaria; E. Czechoslovakia and E. Hungary; much of Italy; Portugal and N. and W. Spain. Over 200% in E. Czechoslovakia, N.E. Bulgaria, E. Sicily, N.E. Portugal, N.W. Spain. Under 50% over a large area from S. Finland through S. Denmark, Netherlands, Germany and Poland to Ukraine and Greece; S.E. Spain to S.E. France; under 25% in many of these areas. Provisional sunspot number 119.

Africa. *Temperatures:* warm from S. Morocco and Sierra Leone to N.E. Nigeria; N.W. Libya; S. Ethiopia to N. Tanzania; South Africa; +3 deg. in N. Cape Province; +2 deg. from E. Mauritania to C. Niger. Cold on coast from Spanish Sahara to N.W. Algeria then S.E. to Nile Valley and Gulf of Aden; round Gulf of Guinea; Zambia. *Rainfall:* wet from Cameroon to Central African Republic; N. Kenya; S. Namibia to near Port Elizabeth; in and near Orange Free State. Over 200% in N. Kenya, C. Namibia, C. Cape Province. Dry in most other areas, mostly under 50% N. of Sahara and in Sahel, Botswana, Transvaal, S. Mozambique.

U.S.S.R. *Temperatures:* warm from E. Taimyr Peninsula to Kamchatka; European Russia to Mongolian borders; +2 deg. in S. Ukraine. Cold elsewhere, −2 deg. in C. Yenisey and upper Lena Basins.

Temperatures: wet from Leningrad to Kazakhstan to Taimyr Peninsula; over 200% in Kazakhstan and W. Lena Basin. Dry elsewhere, under 50% in C. Ob Basin, near Mongolian border, New Siberian Islands to near Bering Sea.

Middle and Far East. *Temperatures:* warm from Turkey, Lebanon and Syria to Saudi Arabia and India; extreme S. and N.E. China; Borneo; +2 deg. in interior Saudi Arabia. Cold from S. Caspian Sea to most of China, N. Pakistan, Japan, parts of Korea; N.E. India; −4 deg. near S.E. Caspian Sea and N.W. of Peking; −2 deg. in C. China. S.E. Asia near norma. *Rainfall:* wet in S. China, S. Japan; over 200% locally in both. Dry in Turkey, India, Bangladesh, N. China, Mongolia, Korea, N. Japan; under 25% in W. Turkey (almost rainless), N.W. and extreme S. India, N.E. China, most of Korea. Rainless from Saudi Arabia to N.W. India.

Australia. *Temperatures:* mostly warm, +2 deg. in S.W. Queensland; cold in Northern Territory and from Brisbane to Melbourne. *Rainfall:* wet from Western Australia (except N.E. and S.) to S.W. Queensland, over 200% 25° to 30°S.; much of E. coast, over 200% near Townsville and in N.E. New South Wales. Dry elsewhere, rainless round Gulf of Carpentaria.

WORLD WEATHER REVIEW: OCTOBER 1982

United States. *Temperatures:* mostly cold, −3 deg. in Utah; rather warm on W. coast and from Alabama to Great Lakes. *Rainfall:* wet N.W. of a line from C. California to Chicago (except N.W. Montana); also a narrow band from S.E. Texas to N. Carolina; over 200% from N. California to S. Idaho, E. Montana to Minnesota, S.E. Texas to N. Mississippi. Dry elsewhere, under 50% in S.W., Indiana to New York state, N.E. Maine, W. Florida.

Canada and Arctic. *Temperatures:* warm in much of Canada (except extreme N.W. and E.), +2 deg. N.W. of Hudson Bay; also E. Greenland; Iceland near normal. Cold elsewhere, −2 deg. in Labrador, −5 deg. in N. Alaska. *Rainfall:* wet from most of Alaska, especially interior, to N.W. Baffin Island; S. Saskatchewan and Manitoba, E. Greenland, E. Iceland, Faeroes. Over 200% in interior Alaska and N.W. of Hudson Bay. Dry elsewhere, under 50% in S. Canadian Rockies, near Great Slave Lake, St. Lawrence Basin to W. Greenland, Spitzbergen, Franz Josef Land.

South and Central America. *Temperatures:* warm in N. Chile, N. Argentina, S.E. Paraguay, much of Brazil, probably much of West Indies; +2 deg. in N. Chile and very locally in N. Argentina. Cold in C. Argentina, N.E. Uruguay, N.W. Paraguay, Bolivia, W. Colombia, much of Mexico; −2 deg. in C. Argentina and S. Bolivia. *Rainfall:* wet in C. Chile, C. Bolivia,Buenos Aires to S. Brazil, locally in C. Mexico; over 200% locally in Bolivia. Dry in N. Chile (rainless as usual) and N. Argentina, W. and E. Bolivia, Paraguay, N Brazil, Guianas to Colombia, much of Mexico, most of West Indies. Under 50% in N.W. Argentina, interior N.E. Brazil, much of West Indies and Mexico.

Europe. *Temperatures:* mostly rather warm, +2 deg. locally from Germany to Jugoslavia and Romania. Cold in E. of European Russia, −5 deg. near N. Urals; rather cold in Iberia, parts of France, N.Italy, Switzerland; −1 deg. in much of Iberia, N.W. Italy. *Rainfall:* wet from British Isles and S. Sweden through Germany and Low Countries to France, N. and N.E. Spain, W. Switzerland, E. Austria, N. Jugoslavia and much of Italy; also coastal Bulgaria, N. Greece, White Sea to C. Urals, large area N. of Black Sea. Over 200% in S. Eire, S. England, N. and W. France, N.E. Spain, several areas in Italy and N. Jugoslavia, S.E. Austria, S.W. Germany, much of Low Countries, coastal Bulgaria, N. of Black Sea. Dry elsewhere, under 50% from N.C. Norway and Sweden through Baltic States and Poland to Romania and W. Bulgaria; S. Spain and Portugal. Provisional sunspot number 94.

Africa. *Temperatures:* mainly warm N. of 10°N. except Nile valley, Morocco, N.W. Algeria, Spanish Sahara (−2 deg. in last area); +3 deg. in E. Libya. Generally cold elsewhere, especially S. of 10°S. (−2 deg. in Zimbabwe), but warm in much of South Africa. *Rainfall:* wet from Somali Republic to South Africa, over 200% widespread, over 400% in coastal Kenya, Zimbabwe, C. Cape Province. Also wet in N. Tunisia and Algeria, in and around Upper Volta. Otherwise mainly dry N. of Equator, under 50% in coastal Libya and Egypt, most N.W. and W. coasts and Sahel.

U.S.S.R. *Temperatures:* cold in most parts, −7 deg. in large area near Gulf of Ob. Warm in and N. of Kamchatka (+3 deg.), Kazakhstan (+3 deg. E. of L. Balkhash), W. European Russia. *Rainfall:* generally wet: over 200% W. of Sea of Okhotsk, Kazakhstan to Omsk area, N. of Black Sea. Dry elsewhere (N.E. Siberia, Taimyr Peninsula, Gulf of Ob, round L. Baikal, most of European Russia); under 50% round Gulf of Ob, N. of L. Baikal, Baltic to W. Black Sea, N.E. of Black Sea.

Middle and Far East. *Temperatures:* warm from S. Saudi Arabia to S. Pakistan and India; China (except Tibet), Mongolia, Korea, Japan, most of S.E. Asia, Borneo; +2 deg. in S. Saudi Arabia, N.W. India, much of N. and E. China and Korea; +3 deg. in W. Mongolia. Cold from Jordan to N.W. Iran and Turkey. *Rainfall:* wet from S. Turkey, Israel and Saudi Arabia through C. Pakistan to C. India; scattered areas of S.E. and N.E. China; Mongolia, S. Thailand, Philippines, probably Kampuchea and Borneo. Dry in N. Turkey, S. and N. Pakistan, most of India, Bangladesh, Burma, China, Japan, Korea, N. Laos, N. Thailand; under 50% in parts of all these areas.

Australia. *Temperatures:* warm in W. and S. and in S.W. Queensland; +2 deg. round N.W. Cape and in S.W. Queensland. Cold elsewhere, −2 deg. in Northern Territory. *Rainfall:* over 200% in interior Western Australia, otherwise very dry; under 25% away from S.E.

WORLD WEATHER DISASTERS: October 1982

3 (reported): Drought, described as worst in 100 years, in north-east Brazil; drought zone lies just south of equator. *Sunday Telegraph.*

4: Boy, aged 6, swept away by a rain-swollen stream at Beetly near Dereham, Norfolk, England. *Daily Telegraph.*

5: F.v. *Eyupler* sank off Giresun, Turkey, in heavy storm, one dead, three missing. *Lloyds List.*

5-6: Heavy snowfall forced the closing of seven major Swiss Alpine passes. Snowfall, up to 300 mm, fell as low as 700 metre level. *International Herald Tribune.*

6: High tides, elevated by Sirrocco winds, flooded wide areas of Venice, Italy, tide rose 1.4 metres above normal sea-level. Sirrocco wind also hit other areas of Italy. *D.T., I.H.T.*

7: Vessel *Xi Jiang* sank off south-east Kyushu, Japan, during typhoon 'Mac', leaving three missing. *L.L.*

7 (reported): Heavy flooding in Azerbeijan S.S.R. has ruined crops, halted factories, flooded homes, cut rail and road links and ruined crops. *D.T.*

9-10: Brush fire whipped along by winds gusting to 100 km/h burned through 67,000 acres in southern California, U.S.A., 41 houses and 50 mobile homes destroyed, damage put at over $20 million in Los Angeles, Orange and Ventura counties, there were two major fires and several smaller ones, one of major fires believed started by arsonist, no deaths, but 146 people injured, mostly firemen. *I.H.T., L.L.*

11: Winds up to 72 knots, described as worst ever recorded, hit Malta, leaving four dead, 20 injured, walls blown down and buildings damaged. *L.L.*

12 (reported): Drought, described as worst for 30 years, in wide areas of central and southern Africa, widespread stock and game losses, millions of acres of crops threatened, several deaths reported in central Botswana as a result of malnutrition, drought extends through Angola, Zambia, Mozambique, Zimbabwe's Matabeleland region, Botswana, South-west Africa (Namibia) and areas of South Africa. *D.T.*

14-19: Typhoon "Nancy" hit northern Philippines and northern Vietnam.

Philippines: For six hours typhoon hit in ten provinces on Luzon Island, winds reached 185 km/h with heavy rains, although forward movement of storm, at 25 km/h, prevented major floods and landslides; heavy losses to rice, tobacco and cotton planations; some 50,000 people homeless, at least 66 dead, storm hit on 14/15.

Vietnam: Hit on 18th/19th for 12 hours, with winds up to 140 km/h and a storm wave; a 80 sq.km. area in Thanh Hoa and Nghe Tinh provinces on Gulf of Tonkin devastated; thousands of hectares of crops destroyed. In Vinh, capital of Nghe Tinh, 20,000 homes, schools, factories, hospitals and warehouses flattened, making 125,000 homeless, with 32 dead *L.L., D.T.*

15: Heavy snow in Switzerland blocked five Alpine passes, the Furka, Grimsel, Klausen, Nufenen and Great St. Bernard. *L.L.*

16-17: Gales and heavy rains in western and southern areas of Great Britain, on 16th a yacht grounded at Sidmouth, Devon in gale and high seas leaving two dead; on 17th heavy seas washed van off jetty at Port Talbot, south Wales, one died, three others saved themselves; the same day, a wave, between 15 and 22 metres high, hit drilling platform Western Apollo II in Beatrice oil field in North Sea, injuring seven. Widespread flooding in Devon, Cornwall, Sussex, Kent and also Dorset. *D.T., L.L.*

17: Winds up to 100 km/h in Uruguay, damage in cities of Colonia, Paysandu and Salto, where three were injured. *L.L.*

18-19: Cyclone, with heavy rain, hit Andrha Pradesh state, eastern India, leaving 10 dead and 50,000 homeless, hundreds of trees uprooted, five of deaths occurred during heavy rains in city of Visakhapatnam. *L.L.*

19: Ferry *Ciudad de Sevilla* grounded at Palma, Majorca, in high winds and heavy seas, vessel became unmanoeuvrable after on board power failure unrelated to weather, all on board rescued. *L.L.*

20-21: Torrential rains and serious floods in south-east Spain, worst hit areas around Valencia, huge losses to citrus crops, road, rail links cut, floodwaters in mountainous areas reached 9 metres deep, 100,000 people evacuated from below Tous dam, which was damaged by floods. Many houses flooded and some totally destroyed, at least 23 dead, 16 missing. *L.L.*

Fig.1: The Spanish town of Elche (Alicante Province) following the floods of 20-21 October 1982.

20: Blizzard hit Moscow and many areas of European part of Russia, traffic halted in Moscow and temperature there fell to 5 °C. *I.H.T.*

23-26: Bush fire in San Diego county, California, U.S.A., burned some 5,000 acres of bush north of Mexico. *I.H.T.*

25 (reported): Drought, described as worst in 50 years, in ten states in India, nearly 100,000,000 people affected by drought, which has dried up wells and irrigation ditches; worst hit state in West Bengal where 30 million people are affected and where drought has lasted one year. *I.H.T.*

26 (reported): Drought in Ethiopia threatens between 4.5 million and 5 million people in 13 of the country's 14 provinces. *I.H.T.*

28: M.v. *Star River* capsized and sank in very bad weather about 10 nautical miles north of the Faroe Islands, leaving one missing. *L.L.*

30-31: Torrential rains and floods in Sfax region of Tunisia, 1,369 dwellings destroyed, 3,228 dwellings and 551 shops damaged, with thousands of cattle and sheep drowned, rail and road communications cut; some 200 mm of rain fell in 36 hours, at least 46 dead and 50 missing. *L.L.*

30 (reported): Dry weather has caused the level of the River Danube to drop in some parts to its lowest level since 1954, the level in Austria and Czechoslovakia has fallen to about 1.5 metres. *I.H.T.*

31 (reported): Severe drought in eastern Mali, some 800,000 people under threat in Timbuctoo area, along with three million animals. *S.T.*

ALBERT J. THOMAS

OCTOBER 1982 WEATHER SUMMARY

October was a very disturbed and rather cold month with mean temperatures around one degree below normal in the south and 0.5 degree below in the north, the deficit being mostly the result of low maxima rather than low minima which were generally near to the October average. Over much of England the warmest day was 1st when the temperature rose to 19 °C in Jersey (Channel Islands) and parts of Kent, while in Scotland the 3rd was generally the warmest with 16 or 17 °C over many central and eastern areas. The 3rd was also the warmest in Wales and western England with 17 or 18 °C in a number of places. Throughout the rest of October maxima were mostly within the range 10 to 15 °C and occasionally up to 16 or 17 °C, locally, mostly in southern Britain. Maxima below 10 °C were infrequent over England and Wales, the coldest days being 21st and 22nd with 9 °C in places and with 8 °C in east Cornwall on 21st. Over Scotland and the Northern Isles 8 °C maxima occurred on 8th, 9th, 13th-15th, 22nd and 25th while 7 °C was recorded in Grampian on 14th. Highest minima over England and Wales included 15 °C locally on the coast of East Anglia and southern England on 1st, 14 °C in the south on 1st and more widely on 2nd, and 13 °C, mostly in the south, on 4th, 20th, 26th, 30th and 31st. In Scotland 13 °C was recorded on 1st and 29th and 12 °C on 6th and 31st. There was air frost on several nights during the second half of the month. Over England and Wales the coldest night was 23rd/24th when the temperature fell to -1^{0} or -2 °C quite widely over the country, and to -8.2 °C on the grass at Cwmbargoed in mid-Glamorgan, whereas -0.9 °C was recorded at Gatwick on 28th and -0.5 °C at Bournemouth Airport on 27th. In Scotland there was a -4.4 °C minimum at Glenlivet (Grampian) on 25th and -2.5 °C at the same station the following morning. Glenlivet also reported -3.0 °C on 23rd on which night there was a grass minimum of -7.5 °C at Glenlee (Dumfries and Galloway). Local slight air frosts were also reported in various parts of Britain on 15th, 21st and 22nd. October was a wet month in most areas, particularly in south-eastern counties of

England where two slow-moving cold fronts helped to produce between 250 and 300 percent of the normal rainfall. Parts of northern England and north-east Scotland on the other hand were less wet, and locally drier, than the average. There was virtually no let-up during the month with 25 mm or more recorded somewhere on 19 days and with only one day producing less than 10 mm. Heavy falls in England included 50.3 mm at Lowestoft on 4th, 48.7 mm at Bastreet (Cornwall) on 1st, 41.0 mm at Manston (Kent), again on 4th, and 40.8 mm at Honington on 2nd. In Wales there were 36.1 mm at Brynmman (Dyfed) on 16th, 35.8 mm at Cilfynydd (mid-Glamorgan) on 19th, and 32.1 mm, again at Cilfynydd, on 31st. Heavy falls were less widespread in Scotland but included 40.5 mm at Leuchars on 12th, 38.2 mm at Dumfries on 17th, and 33.8 mm at Glenlivet on 6th. Apart from the Western Isles of Scotland where sunshine was near or a little above the normal, all areas of Britain had a dull month with generally between 60 and 80 percent of the October normal and locally 50 to 60 percent. There were few sunny days and those that did occur were isolated features and associated with transient ridges of high pressures.

October was unsettled throughout with low pressure frequently near to or over the British Isles. The month opened with a very deep depression in mid Atlantic and frontal systems pushing eastwards into the U.K. The south-east was quite sunny and warm on 1st but western areas were wet as a cold front moved in from the west. The 2nd was drier and colder in western areas but eastern parts soon became cloudy with rain, and falls were prolonged in south-eastern counties as the front became slow-moving over the area. Apart from early rain in the far south-east the 3rd was a mostly dry day but, as a low moved north-east into Ireland, further rain, heavy at times, spread into the west in the evening and to all parts of the country on 4th followed in the west by showers, some of which were thundery. On 5th as the low became slow-moving over southern Britain, there was further heavy rain or showers in all areas with any sunshine confined to the south and west, but after a wet night in northern and western England the 6th became a little brighter and drier, but rather cold. Northerly or north-easterly winds became established over the country on 7th giving most areas a cloudy day with rain or drizzle at times but with sunny intervals and showers in the west, while on 8th, as a cold front moved from the north-east across the U.K., there was further rain or showers in all areas. With the European low over the North Sea and filling, the 9th and 10th were less wet, although still with some light rain in places, and there were some heavy showers and local thunderstorms in the south later on 10th. On 11th a depression moved eastwards across southern England and the Channel with heavy rain in places while there were showers further north. Another deep Atlantic depression crossed the British Isles between 12th and 14th accompanied by heavy rain or showers and thunderstorms, and with gales around coasts, but on 15th a temporary ridge gave most areas a dry day with much sunshine although still with showers in places. With a deep low close to north-west Britain and with frontal systems and small lows circulating around it, all parts of Great Britain were affected by spells of rain or showers between 16th and 19th, much of it heavy, and it was very windy at times with severe gales on exposed coasts. A cold front that crossed much of Great Britain on 20th slowed down considerably as it came south and became slow-moving over south-eastern areas where it remained until 22nd. In these parts the rain was continuous for some 60 hours in places while elsewhere it was brighter

with sunshine and showers. The 23rd was much brighter everywhere under a ridge of high pressure but Atlantic fronts carried further rain across the country from 24th to 26th with severe gales in the north-west. During the final days of the month, as an anticyclone developed over Europe, all parts became quite warm and in the south and east much drier with some sunshine at times and with widespread fog night and morning, particularly on 28th and 29th. North-western Britain continued to have spells of rain, and some light rain spread south-east to all areas on 31st, although southerly winds kept it very mild.

TEMPERATURE AND RAINFALL: OCTOBER 1982

	Mean				Grass					
	Max	Min	Max	Min	Min	Rain	%	Wettest	D	T
BELGIUM: Uccle	14.8	8.3	20.4(23)	4.5(6)		134.4	190	51.1(7)	21	1
„ Brugge	14.3	7.9	18.4(1)	3.2(28)		159.5	197	41.0(7)		1
„ Houwaart	15.2	6.7	20.8(22)	1.1(6)	0.7(6)	145.0	196	50.0(7)	17	0
DENMARK: Fanø	13.4	8.4	17.4(3)	4.3(29)		103.8		19.0(14)	19	2
„ Frederikssund	12.8	7.8	19.7(1)	2.1(29)	-4.0(28)	74.3	142	10.0(26)	18	1
FRANCE: Nice	19.9	13.1	23.0(1)	10.0(8)		121.0		43.0(18)	12	
„ Montpellier	20.0	10.7	26.0(3)	5.0(16)		53.0		17.0(23)	15	
„ Campistrous	16.7	10.9	28.5(13)	7.5(9)		164.8	172	27.2(6)	23	
GERMANY: Berlin	14.3	7.1	21.2(2)	1.5(26)	-0.4(26)	37.6	80	8.0(15)	11	1
„ Hamburg	13.7	7.0	19.2(3)	0.1(28)	-2.3(28)	81.5	138	34.1(23)	17	0
„ Frankfurt	13.1	7.9	18.1(1)	1.5(25)	-0.9(16)	128.5	257	27.8(23)	18	0
„ Munchen	13.3	5.3	19.2(21)	-0.4(17)	-5.0(17)	48.6	73	9.4(1)	20	0
ITALY: Casalecchio	17.1	11.7	22.0(v)	7.0(16)						
MALLORCA: Palma	23.1	13.1	28.0(3)	6.0(25)		94.0		76.0(21)	15	
MALTA: Luqa	25.2	17.9	29.3(1)	12.4(27)	8.2(27)	140.3		85.4(21)	10	7
NETHER'DS: De Bilt	14.4	7.9	19.2(2)	3.6(24)	0.0(28)	104.0	151	26.1(10)	16	3
„ Schettens	13.9	8.4	18.6(1)	0.5(28)	-0.7(28)	75.4	101	10.2(9)	19	4
„ Ten Post	14.0	8.4	19.1(2)	1.8(28)	-1.5(28)	82.6	118	12.4(16)	19	1
SPAIN: Valencia	23.6	13.8	30.0(2)	8.0(25)		90.0		29.0(21)	7	
SWITZER'ND: Basel	14.9	7.8	20.4(13)	1.0(30)		110.3	181	20.2(6)	16	1
EIRE: Straide	13.1	7.0	15.9(1)	-0.9(23)		141.5	119	23.0(16)	30	1
„ Galway	13.4	8.0	16.2(15)	3.0(23)		158.2	133	25.5(29)	24	0
N.IRE'ND: Bessbrook	12.9	6.3	16.7(2)	1.7(21)		140.8	150	28.5(3)	25	0
SHETLAND: Whalsay	10.8	7.4	13.2(2)	2.1(26)	-1.9(16)	109.7	109	25.2(1)	25	1
„ Fair Isle	10.6	8.5	12.8(2)	5.4(25)	-1.6(26)	85.2	103	19.5(1)	21	1
SCOTLAND: Keiss	11.6	6.6	13.8(3)	0.4(25)	-1.7(25)	65.5		10.3(4)	20	0
„ Braemar	10.0	4.2	13.9(3)	-4.6(25)		251.6		29.9(4)	23	0
WALES: Moel-y-Crio	12.3	6.0	15.7(3)	1.7(23)	-4.1(23)	82.6	115	24.9(5)	20	0
„ Lampeter	12.9	6.7	25.6(2)	-2.0(24)	-5.7(24)	170.2		32.2(1)	23	1
„ Penmaen	14.2	8.7	16.9(3)	4.5(24)	0.0(24)	160.2	131	23.2(31)	25	3
ENGLAND:										
Denbury, *Devon*	13.6	7.0	16.2(3)	0.5(24)	-4.5(24)	135.5	118	19.1(20)	24	0
Gurney Slade, *Somerset*	13.3	5.4	15.8(3)	-2.2(24)	-3.5(24)	100.0	116	20.8(16)	23	0
Yatton, *Avon*	14.5	8.3	17.8(3)	-0.6(24)	-2.0(24)	75.9	81	17.3(16)	21	0
Congresbury, *Avon*	14.7	8.7	18.4(3)	3.4(24)	-0.9(24)	73.4		12.3(17)	21	1
Codford, *Wiltshire*	13.8	5.4	17.0(3)	-2.6(24)	-6.5(24)	126.3	189	29.8(3)	22	–
Trowbridge, *Wiltshire*	13.8	6.9	16.4(3)	-1.3(24)	-4.4(24)	87.7	129	17.6(16)	21	1
Corsham, *Wiltshire*	13.2	7.5	16.2(3)	0.3(24)	-2.1(24)	93.7		18.4(16)	24	1
Marlborough, *Wiltshire*	13.3	6.2	15.9(3)	-1.9(24)		108.8		23.4(3)	23	0
Reading, *Berkshire*	13.5	6.9	17.0(1)	0.2(24)	-4.8(24)	130.5	206	33.0(21)	17	0
Sandhurst, *Berkshire*	14.0	6.4	17.8(1)	-1.1(24)	-2.8(24)	124.8	191	32.3(21)	17	0
Newport, *Isle of Wight*	14.1	8.1	17.5(1)	1.2(24)	-1.5(24)	165.9	218	26.7(21)	21	1
Horsham, *Sussex*	14.1	7.4	19.9(2)	1.0(24)	-1.9(28)	193.6	269	34.0(2)	21	2
Brighton, *Sussex*	13.7	8.1	17.8(1)	2.8(24)	2.0(24)	221.3		43.7(2)	23	1

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	D	T
Hastings, *Sussex*	13.8	8.8	17.5(2)	5.1(24)	1.1(24)	142.0	212	26.5(4)	20	1
East Malling, *Kent*	13.8	7.4	17.4(1)	-0.2(28)	-4.5(28)	142.0	221	24.2(2)	19	0
Gillingham, *Kent*	13.4	8.4	17.8(1)	2.8(28)		161.0	345	22.6(18)	18	0
Epsom Downs, *Surrey*	13.4	7.5	17.8(1)	0.0(24)	-0.5(28)	164.6	183	26.9(2)	20	1
Reigate, *Surrey*	13.2	7.3	17.7(1)	0.4(24)	0.4(24)	171.3	288	31.2(2)	22	1
Guildford, *Surrey*	13.6	8.2	17.5(1)	1.8(28)	-1.1(28)	137.5	221	27.0(21)	18	1
Worplesdon, *Surrey*	13.4	6.5	17.6(1)	0.6(28)	-4.0(28)	121.8		25.1(2)		
Sidcup, *London*	13.9	7.3	18.7(1)	0.3(24)	-0.7(24)	154.5	337	37.3(2)	20	0
Hayes, *London*	13.5	6.9	17.4(1)	1.0(28)	-1.4(28)	111.2	179	28.0(2)	19	1
Hampstead, *London*	13.4	6.7	17.4(1)	3.4(24)	-1.2(24)	123.0	197	30.2(2)	19	0
Royston, *Hertfordshire*	13.3	8.1	17.5(1)	3.9(24)	-1.5(24)	121.1	255	38.1(2)	16	1
Loughton, *Essex*	12.2	6.2	16.8(1)	-0.5(24)	-3.8(24)	132.8	175	34.4(2)	21	0
Leigh-on-Sea, *Essex*	13.8	8.1	18.3(1)	0.5(28)	-2.4(28)	147.8	305	31.0(2)	23	1
Pulham St.Mary, *N'folk*	13.7	7.1	17.0(1)	-0.8(28)	-3.3(28)	108.6	206	26.5(4)	21	0
Scole, *Norfolk*	13.6	6.6	17.5(1)	-0.1(24)	-3.6(28)	122.3	231	27.0(2)	20	0
Buxton, *Norfolk*	13.6	7.0	16.9(1)	0.0(24)	-6.7(28)	133.5	254	31.0(4)	23	0
Ely, *Cambridgeshire*	13.3	6.5	17.7(1)	0.9(24)	-1.8(24)	124.4	275	41.5(2)	19	1
Luton, *Bedfordshire*	13.2	7.1	17.1(1)	-1.3(24)	-2.8(24)	125.0	212	27.9(21)	19	0
Buckingham,*Bucks*	13.2	6.5	17.1(1)	-0.4(24)	-4.4(28)	91.0	144	18.1(2)	15	1
Oxford University	13.6	7.8	16.3(1)	2.0(24)	-1.5(27)	83.4	129	14.7(2)	18	0
Birmingham Univ'sity	12.7	6.7	15.4(3)	-1.0(24)	-3.5(28)	69.1	105	9.3(16)	18	1
Kettering, *Northants*	13.8	6.3	17.8(1)	-2.2(24)	-5.2(24)	72.9	152		15	0
Hinckley, *Leicestershire*	13.2	7.1	16.4(3)	0.5(24)	-2.6(24)	55.4	106	12.0(3)	16	0
Cosby, *Leicestershire*	12.8	6.8	15.8(3)	-1.1(24)	-3.0(24)	59.8	125	8.6(2)	20	0
Louth, *Lincolnshire*	13.2	7.3	17.0(1)	2.6(24)		93.3		28.0(2)	21	0
Deeping St James, *Lincs*	13.7	6.4	17.5(3)	-0.9(28)	-3.4(28)	75.7	129	20.7(2)	15	2
Newark, *Notts*	13.9	6.9	18.2(1)	-0.8(24)	-2.9(24)	44.4	96	9.9(2)	15	0
Nottingham, *Notts*	13.6	6.3	17.2(3)	-0.2(24)	-1.2(24)	43.8	99	8.7(5)	16	0
Middleton, *Derbyshire*	11.4	5.9	14.7(3)	0.8(23)	-1.7(24)	72.7		15.0(3)	18	0
Burton-on-Trent, *Staffs*	13.6	6.6	17.2(3)	-0.5(24)	-1.8(28)	58.2	100	11.8(5)	21	0
Keele University, *Staffs*	12.1	6.3	15.0(6)	-1.1(24)	-4.9(24)	72.9	104	17.4(19)	19	0
Meir-Heath, *Staffs*	11.9	6.3	14.7(3)	2.1(24)	-2.2(24)	71.8	95	17.0(19)	17	0
Sefton Park, *Merseyside*	13.4	7.6	17.8(6)	1.1(23)		67.3	91	15.5(5)	21	0
Latham, *Merseyside*	13.2	7.1	15.7(3)	2.1(24)		109.6		42.9(4)	19	0
Southport, *Merseyside*	13.6	7.6	16.8(3)	2.1(v)		103.6		21.8(4)	21	0
Sheffield, *S.Yorkshire*	12.7	6.8	16.0(3)	2.4(23)	-4.1(24)	59.8	91	15.7(5)	15	0
Cottingham, *Humber*	13.5	6.8	17.4(3)	0.4(24)	-2.9(24)	57.3	109	8.0(5)	20	0
Pickering, *N.Yorkshire*	12.0	5.6	16.7(3)	-2.6(24)	-5.1(24)	85.8	136	19.1(5)	17	0
Durham University	12.2	6.3	15.0(4)	-0.4(23)	-3.7(24)	89.9	139	19.6(5)	24	0
Sunderland, *Tyne/Wear*	14.5	7.9	17.0(3)	3.0(23)		65.9	116	8.3(5)	22	1
CANADA: Halifax	13.5	4.5	20.8(1)	-1.6(23)		31.9	26	23.4(14)	8	0
U.S.: Phoenix	30.9	16.3	36.0(16)	10.0(30)		0.2		0.2(27)	1	
„ Los Angeles	26.1	15.7	33.0(23)	13.0(29)		3.0		2.0(26)	3	
JAMAICA: Montego	30.5	23.2	32.8(13)	20.4(8)		162.4		74.5(16)	13	7
CANARIES: L.Palmas	25.1	19.8	30.0(13)	17.0(29)		19.0		10.0(18)	8	
TAHITI	29.5	21.9	31.0(21)	18.0(26)		11.0		9.0(14)	7	

ADDITIONAL RAINFALL, U.K.:

Cumbria: Coniston, 254.3 mm (101%); Kendal (Kirkbie S.), 147.1 mm; Appleby Castle, 78.1 mm (96%); Thirlmere, 351.7 mm (135%); Seathwaite, 413.0 mm; Honister, 421.0 mm.
Powys: Pembroke, 168.4 mm (150%).
Surrey: New Malden, 134.9 mm.
Gloucestershire: Stroud, 104.9 mm.
Lancashire: Leigh, 50.6 mm.
North Yorkshire: Northallerton, 48.3 mm; Cawood, 52.2 mm.

DAILY WEATHER SUMMARY

The London Weather Centre publishes a *Daily Weather Summary* comprising the following:

Surface isobaric charts for 0600, 1200, 1800, 2400 GMT, including frontal analysis and a simple weather description for various places on the chart.
Selected plotted observations from UK stations for 0600, 1200, 1800, 2400 with full coverage of 'significant weather' (eg thunder, snow, fog, gales).
Maps of daily minimum and maximum temperatures, rainfall and sunshine for places throughtout the UK.
A plain-language weather summary (about 100 words) of each day's weather, and a list of the daily 'extremes'.
An upper-air chart for 1200 (500 mb, and 1000-500 mb thickness).
A copy of a satellite picture showing cloud patterns around the UK for each day.

There is also a monthly weather summary, based on the daily summary, and this includes mean pressure maps for the three ten (or eleven) day periods in the month, and tables and maps of the mean monthly weather.

Sample copies and subscription rates, which are especially favourable for customers taking out annual subscriptions, are available on application to the London Weather Centre, 284 High Holborn, London WC1V 7HX.

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FRONT COVER:

Views of Red Wharf Bay, Anglesey, in clear and foggy conditions, as seen from Mr. Keith G. Ledson's cottage and weather station.