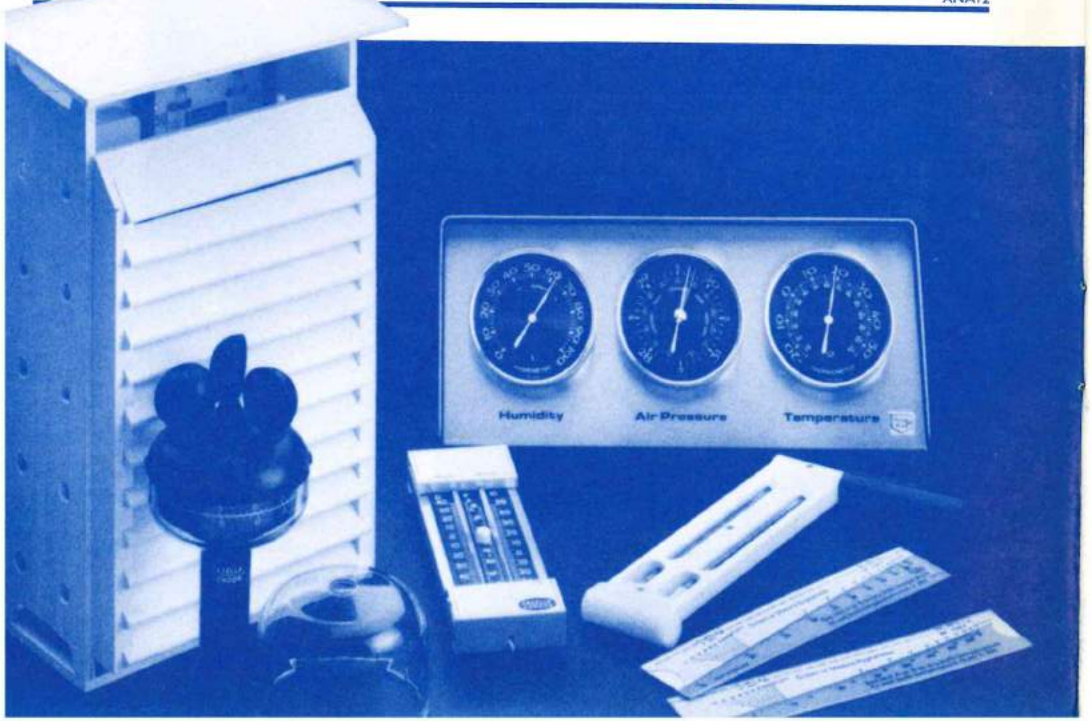
The
JOURNAL of METEOROLOGY

THE SECRET OF THE MYSTERY SPIRALS

WHIRLWIND CIRCLE WITH SPIRAL PATTERN OVER 14 METRES IN DIAMETER.

Volume 10, number 97 **March 1985**



JOURNAL OF METEOROLOGY

"An international journal for everyone interested in climate and weather, and in their influence on man."

Editor: Dr. G. T. Meaden — Vol. 10, no. 97, March 1985

ADVANCES IN THE UNDERSTANDING OF WHIRLWIND SPIRAL PATTERNS IN CEREAL FIELDS

By G. T. MEADEN
Tornado and Storm Research Organisation

Abstract: Important new evidence, including eye-witness observations, is provided which proves that the flattened circular areas occasionally found in cereal-fields in the summer are caused by standing whirlwinds. They occur under special conditions of wind and weather, often towards night-fall, on fine summer evenings. It appears that they form in crops or grass upon *any* terrain, provided that the necessary atmospheric stimuli are present.

INTRODUCTION

The summer of 1984 was the fifth season in which attention has been given to probing the origin of the mysterious quasi-circular, flattened areas which are sometimes to be found in English cereal fields in the summer months. These flattened areas are circular or nearly circular in outline. Within them, the stalks of the growing cereal crops are laid down clockwise, following a spiral pattern outwards from a central point. Often there is just a single circle. On one occasion (at Cheesefoot Head, near Winchester, in 1981) there were triplets (one large circle flanked by two smaller ones), and on eight known occasions, 1980 to 1984, there have been quintuplets (a large circle attended by four evenly-spaced small satellite ones).

Our previous accounts are to be found in *J. Meteorology,* vol.6, 76-80; vol.7, 45-49; vol.8, 11-19, 216-217; and vol.9, 137-146). The accumulated evidence has led us to conclude that standing whirlwinds are responsible for these puzzling events, but it has not been possible to specify the precise conditions of formation because of a lack of eye-witness reports and considerable doubt about the dates and times of formation. Nevertheless, it had begun to seem that the unseen standing whirlwinds responsible for the circles may have the peculiar predeliction for forming in the evenings (*loc. cit.,* vol.9, 143).

Thus, for the 1984 season it was decided (*loc. cit.,* 145-146) to visit the West Wiltshire sites of most likely interest a few times a week from early May to late August in the hope of arriving within 24 hours of a whirlwind event, or of even being present at the time of occurrence of one. In fact, this dedication proved worthwhile because in two cases it proved possible to be specific about formation dates, with their approximate times, and so be certain about the prevailing weather conditions. These cases are the Cley Hill and White Horse cases, described as sets 1 and 4 below. In addition, we discovered, and interviewed, an observant eye-witness who had watched a circle in the process of formation one evening in 1983.

Fig.1: The main circle of the quintuplet set of circles formed in green wheat near Cley Hill and photographed by the author on 24th June 1984.

THE CIRCLE SETS OF 1984

SET 1. Quintuplet circles in a field of green wheat at ST 845450, 400 metres from the eastern base of Cley Hill, near Warminster and Longleat; found by the author on 24th June and considered definitely to have been formed on Thursday 21st June between 1500 GMT (when Terry Chivers departed from Cley Hill) and dusk (about 2200 GMT). [Note, 22nd June was an overcast windy day, and 23rd June was also windy with increasing cloud which gave a cloudy-overcast afternoon and evening, both these days being quite unsuitable for whirlwinds.].

The main circle had a diameter of 14.5 metres (Fig.1), satellites 1 and 3 were about 4.2 metres in diameter, and satellites 4 and 2 (Fig.2) about 3.75 metres in diameter. Satellite 1, the main circle, and satellite 3 were in alignment with Cley Hill, and almost due east from it (Fig.3). On 21st June the wind was westerly and light, the weather was very sunny, and thermals were abundant. Therefore, we may conclude that the whirlwind set was formed from a convective thermal plume in the air-mass in the lee of the hill. The region is evidently a favoured one for standing whirlwinds, because singlet and quintuplet circles have formed in the vicinity in previous years as well (*vide* 1982 and 1983).

SET 3. This was a similar quintuplet set of circles, formed in a field of barley near Cheesefoot Head, not far from Winchester in Hampshire; first reported by Maurice Botting of Payne, Owslebury, when thought to be three or four weeks old; considered to have been formed 'about 24th June', according to Chris Wood of Southampton.

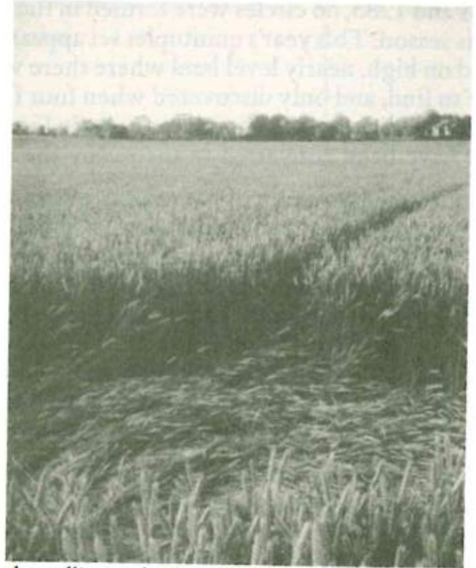


Fig.2: The north satellite circle, diameter 3.8m, of the Cley Hill quintuplet set.

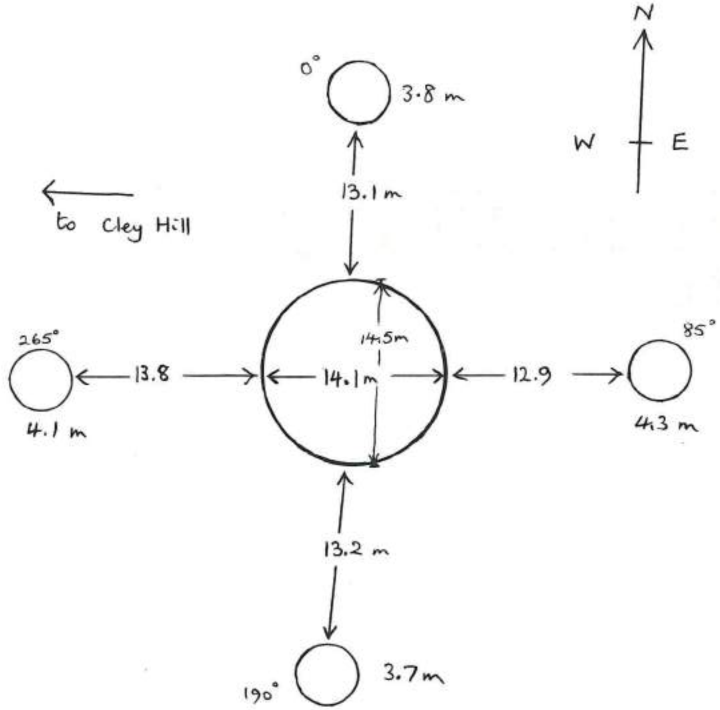


Fig.3: The quintuplet circles near Cley Hill, with measurements by the author.

In contrast to 1981 and 1983, no circles were formed in the punch-bowl area of Cheesefoot Head this season. This year's quintuplet set appeared over a kilometre away in a distant field on high, nearly level land where there was a low knoll. The circles were difficult to find, and only discovered when four farm managers were inspecting their crops by helicopter. The measurements in Fig.4 are based on those by Chris Wood, but have been converted to metres by the author.

SET 3. The third known quintuplet of the season was in a cereal-field below Cradle Hill which faces north-west and is near the road from Seaford to Alfriston in Sussex (TQ 508014). Chris Wood suggests the date of formation as the evening of 26th July 1984, the discovery having been made the next day. The diameter of the biggest circle was about 10-11 metres, and the smaller ones about 3 metres (the photograph in Fig.5 is by Mr. Alan Smith). Mr. D. Cliff runs a weather station 1½km from the site. His diary shows that the 26th was a clear sunny day with a maximum temperature of 19.3°C. At 1800 GMT the dry bulb was 17.0°C, wet bulb 14.5°C, visibility moderate, and the wind west-by-north, force 2-3.

SET 4. This was a single circle, 11 metres in diameter, formed in a field of ripe oats, below the White Horse at Bratton, near Westbury, Wiltshire (ST 895517), at the same place (to within 10 metres) as the multiplet set of August 1980 photographed and discussed in *J. Meteorology,* vol.9, 144-145. The White Horse escarpment faces south-west at this point, and then turns to face north-west creating a punch-bowl effect. The circle was found by the author on 15th August. Discussions with local people and hang-glider pilots proved that the circle was formed in the evening of Thursday 9th August. On this day, and the next three as well, the wind was light north-easterly. The weather was warm, with good sunny periods, and undoubtedly good thermals were about.

OTHER KNOWN CIRCLES OF 1984

(i) The author saw a circle, about 10 metres in diameter, 40 metres into a wheat field on sloping ground on 30th June while travelling along the A4 trunk road, being then between Froxfield and Marlborough (Wiltshire) at SU 2568; the top of the hill beyond was about half a kilometre distant.

(ii) Circles were reported in the *Bath and West Evening Chronicle* of 26th July as being at The Common, Steeple Ashton, near Trowbridge (Wiltshire), but not found when subsequently searched for by the authors' friends.

(iii) A circle in a 'cornfield' (blé) two kilometres west of Vienne, Department of Isère, France, seen by Mme. I. Cheyroux on 5th June 1984, from the N502 just south-west of Pont-Evêque. The circle was approximately 10 metres in diameter, and 50 metres from the road. There was a hill parallel to the road, beyond the back of the field and 150 metres distant.

EYE-WITNESS DESCRIPTION OF A 1983 WHIRLWIND CIRCLE IN FORMATION

On 2nd July 1984 Mr. Melvyn Bell of Spiers Piece, Keevil, Wiltshire, who lives a couple of kilometres from Bratton village, recounted to the author his observation of a whirlwind which he watched flattening wheat into a circle towards dusk in the summer of 1983.

The date was late July or early August, and the place was a dry valley running

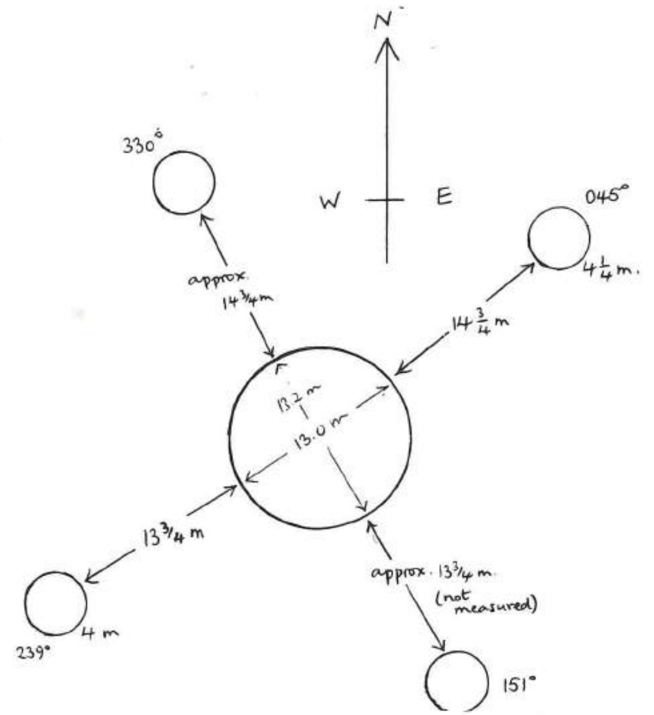


Fig.4: The quintuplet circles above Cheesefoot Head (measurements by Chris Wood).

Fig.5: The quintuplet circles below Cradle Hill, Seaford, photographed by Alan Smith.

from west to east on Littleton Down at ST 9752 which is below Great Cheverill Hill. Mr. Bell was horse-riding at the time, and stopped when he became aware of a whirlwind starting up below him in a field adjacent to the bridle-path. 50 to 60 metres away he could see dust, dirt and other light debris spiralling into the air, and in a matter of only a few seconds a 10-12 metre diameter circle was flattened out in the wheat as he watched. At that distance he was not aware of any accompanying noise. The sun was just setting after a good sunny day. He added that "the whirlwind happened just at the time of evening when the wind is changing with approaching nightfall." This is likely to mean that towards dusk 'the wind changes' for one or both of two reasons: (a) the net wind velocity decreases as the thermals disappear for want of a sufficient supply of fresh warm buoyant air, and (b) in valley or hillside locations a katabatic flow of cool air may become noticeable.

PRESENT STATUS OF THE WHIRLWIND THEORY OF CIRCLE FORMATION

The foregoing eye-witness description, together with the Cley Hill circles of 21st June 1984 and the White Horse circle of 8th August 1984, completes the basic evidence supporting a whirlwind theory for circle formation. Our present ideas may be summarised as follows.

A circle is the result of a standing whirlwind which exists for a few seconds only under critical circumstances when a convective thermal plume is weakening at the end of a sunny day (or perhaps sometimes earlier if increasing cloud cover begins cutting off the buoyant air supply).

The thermal is induced to rotate because of vorticity inherent in the air-mass in the locality. The example of Cley Hill on 21st June 1984 is a case where the regional horizontal wind of the day interacted with the dome-shaped hill to produce a downwind region of enhanced anticyclonic vorticity. As a summer evening progresses, the quantity of inflowing buoyant air which maintains the insolational plume decreases. The thermal plume consequently becomes increasingly sensitive to any converging air-flows which happen to be present, and these would be relatively common to the lee of a hill like Cley Hill. One may then suppose that just once or twice a year the critical conditions are exactly right to trigger the transition from thermal plume to thermal whirlwind.

A spinning vortex sucks in the fresh supply of buoyant air required to maintain it very efficiently – much more effectively, in fact, than the pre-existing and, until then, dynamically stable thermal plume. But because the available warm air supply is limited in quantity, especially at the time of day when insolation is weakening, the supply is quickly exhausted. Accordingly, the new-born whirlwind has a very short life amounting to only a few seconds. This compares with lifetimes of the order of minutes (or, exceptionally, hours) for typical whirlwind devils formed in the heat of the day in unobstructed situations with a smooth inflow of hot buoyant air.

Nevertheless, in its short lifetime the standing whirlwind consists of a cylindrical annulus of warm rising air which spirals dust and dirt upwards and whose expanding diameter transversely flattens the crop, aided by the weak downdraught, in anticyclonic spiral fashion. The situation may be compared inversely with that of bathwater exitting through the plug-hole, in which sometimes there is little noticeable vorticity until the final emptying stage when the last of the water rushes out with considerable speed, spin and noise. A diagram illustrating the manner in which a spiral pattern is formed in the crops or long grass was given in our last paper, *J. Meteorology*, vol.9, 137-146.

This explanation may also apply to the White Horse circle of 8th August 1984, the Seaford quintuplet of 26th July 1984, and the Great Cheverill Hill circle of 1983, the vorticity being naturally present on these occasions within an air mass being turned against the hillsides for particular wind directions and speeds. Alternatively, it is possible that a katabatic descent of cool air down the convoluted hillsides may have been involved too.

Lastly, there is the June 1984 multiplet pattern at Cheesefoot Head, in which the quintuple circles formed on a low knoll on otherwise nearly flat, high ground. In this case, the shape of the terrain favoured convective thermal plume formation at the knoll, and in some way local vorticity in the air-mass triggered the whirlwind. Such vorticity could have been engendered by a sea-breeze front in this and the Seaford events, but purely random vorticity seems unlikely because all of the 50 circles studied so far eschewed a non-random direction: they were all anticyclonic (i.e. clockwise). It does, however, now appear that whirlwind patterns, in crops or grass, may form on almost any terrain, provided that the necessary meteorological stimuli are present. Doubtless, more would be found on open terrain if suitable vantage points were available.

Here we might add that we have also seen, or had reports of, circle pairs, overlapping circle pairs, and triple circles at about 60 degrees to one another.

SUMMARY AND CONCLUSIONS

In this paper we report the first-known eye-witness account of a whirlwind flattening out a spiral-patterned circle in a wheat field; an important feature is that it happened close to sunset on a sunny evening (in an earlier paper we gave an eye-witness account of a whirlwind creating a spiral-pattern in grass). Two other circle formations, also in West Wiltshire, are described in the present paper for which the dates (21st June 1984 and 8th August 1984) and hence the local weather conditions can be exactly specified. Again, it seems likely that the times of formation were in the evening. Because we have other evidence from earlier years (1980-1983) indicating that several other circle sets were formed in the late evening, the whirlwinds responsible are being called sunset whirlwinds.

These various events have enabled us to deduce that such circles, with their neat spiral patterns, are caused by whirlwinds generated from thermal plumes by the triggering action of a wind-field possessing net angular momentum. This may be aided by a suitable quirk of the local topography (lee of a hill, or proximity of steep hillsides), perhaps sometimes coupled with a sea-breeze front or other micro-front. Some circles certainly form in quite open country.

Of the remaining problems, the most important must be to calculate how multiplet circle sets can develop, particularly the triplet and quintuplet states, and to elucidate the nature of the trigger responsible. One must also solve the question as to why all European circle sets found to date have anticyclonic (clockwise) patterns, whereas true heat whirlwinds appear to be roughly equally divided between the two spin directions, and most tornadoes have cyclonic spin. This would certainly make it appear that the net convergence of the overall wind-field cannot be due to entirely random forces.

We urge everyone who visits the countryside in the summer to be vigilant as to the occurrence of these phenomena, and to report any discoveries immediately to us.

Footnote. Certain aspects of this work on natural spiral circles have been carried further than we have related here. These extensions to the research will be described in later papers, details of which will appear in due course.

SUMMER THUNDERSTORMS OVER THE AREA OF MOUNT OLYMPUS IN GREECE

By CHRISTOS BALAFOUTIS and PANAGIOTIS MAHERAS
Meteorological and Climatological Institute, University of Thessalonki, Greece

Abstract. This study of thunderstorms is based upon a set of data obtained at the Olympus Meteorological Observatory (Mt. Olympus, elevation 2817m), during the warm season (July, August, September) of the period 1966-1973. A thunderstorm day was defined as the 24-hour period from midnight to midnight during which thunder was heard at least once. Firstly, we discuss the phenomenon of thunderstorms over the area of Mount Olympus during the warm season from the statistical point of view. We classify them into nocturnal and daily thunderstorms, we estimate their frequencies of occurrence, and we interpret the results. Secondly, we study the frequency distributions of the start and end times of the thunderstorms. The influence of the daily cycle on the formation of the phenomenon of thunderstorms leads to many useful conclusions relating the effects of the Olympus mountain passes to the thermal stratified layers of air; in other words, the interactions among the bare mountainous ground, the deep valleys, and the nearby sea, are drawn. Finally, we study those characteristic synoptic conditions which are responsible for vigorous thunderstorms with long duration. The role of the existence of cold air with height (in the form of pool of cold air) to the appearance of thunderstorms is emphasised.

INTRODUCTION

In the present paper, the study of thunderstorms is based on the examination of observations for the period 1966-1973 made at the Mount Olympus observation station (Agios Antonios, 2817m altitude).

Firstly, we present statistical data relating to the occurrence of thunderstorms in the Mount Olympus area. Secondly, we note the times of the onset and ending of thunderstorms and the influence of the diurnal cycle and the massif on the phenomenon.

Finally, for days on which thunderstorms occurred, four groups of synoptic situations are established for prevailing conditions on the surface and aloft.

DURATION OF THUNDERSTORMS

As Tables 1 and 2 show, thunderstorms of one to two hours' duration occur with the greatest frequency. Next most frequent are storms of 30 minutes to one hour's duration and those of two to three hours. The same distribution has been noted for Thessaloniki (Balafoutis and Maheras, 1982). Looking at the cumulative frequencies, it will be observed that 51% of the total last for less than two hours. The corresponding cumulative frequencies for Thessaloniki are 59%. Thus, warm season thunderstorms around Olympus are of short duration, but relatively longer than those of Thessaloniki.

TABLE 1. Duration of thunderstorms at Mount Olympus (July-September).

Hours	*July*	*Aug.*	*Sept.*	*Total*	*Cumulative Frequency*	
					Absolute	*Relative (%)*
01-15 mins.	3	3	3	9	9	5
16-30 mins.	4	4	9	17	26	16
31-60 mins.	14	7	8	29	55	33
01-02 hrs.	15	10	5	30	85	51
02-03	9	7	4	20	105	63
03-04	3	4	6	13	118	72
04-05	6	6	3	15	133	80
05-06	6	3	4	13	146	87
06-07	3	0	2	5	151	90
07-08	2	4	0	6	157	94
08-09	2	0	1	3	160	96
09-10	2	0	1	3	163	98
10-11	0	0	1	1	164	98
11-12	1	0	1	2	166	99
12	0	0	1	1	167	100
Total	70	48	49	167	167	100

Daytime thunderstorms are defined as those whose onset occurs between 08.00 and 20.00 local time. The maximum frequency is, as before, of storms with a duration of one to two hours. There is a high frequency of occurrence of storms with a duration of two to six hours.

Night-time storms are those with onset occurring between 20.00 and 08.00. In contrast to the day-time storms, the night-time thunderstorms of maximum frequency are those of 30 minutes to one hour duration and two to three hours duration. Storms lasting more than five hours are relatively infrequent. The ratio of night-time to day-time storms is 50 to 100, whereas for Thessaloniki the corresponding ratio is 73 to 100 (Maheras and Balafoutis, 1980).

TABLE 2. Daily (D) and Nocturnal (N) thunderstorms at Mount Olympus.

Hours	*July*		*August*		*September*		*Total*		*Rel. Cumul. Freq. (%)*	
Hours	*D*	*N*	*D*	*N*	*D*	*N*	*D*	*N*	*D*	*N*
01-15'	1	2	2	1	1	2	4	5	4	9
16-30'	2	2	3	1	4	5	9	8	12	23
30-60'	10	4	4	3	6	2	20	9	30	39
01-02	12	3	7	3	5	0	24	6	53	50
02-03	4	5	5	2	2	2	11	9	61	66
03-04	1	2	2	2	4	2	7	6	68	77
04-05	4	2	5	1	0	3	9	6	76	87
05-06	5	1	3	0	4	0	12	1	86	87
06-07	3	0	0	0	2	0	5	0	91	89
07-08	1	1	2	2	0	0	3	3	94	94
08-09	1	1	0	0	1	0	2	1	95	96
09-10	1	1	0	0	1	0	2	1	98	99
10-11	0	0	0	0	1	0	1	0	98	99
11-12	1	0	0	0	1	0	2	0	100	99
12	0	0	0	0	0	1	0	1		100
Total	46	24	33	15	32	17	111	56	100	100

TABLE 3. Beginning time and frequencies of thunderstorms.

Hours	*July*	*August*	*Sept.*	*Total*
00-02	3	1	2	4
02-04	1	1	2	4
04-06	0	0	1	1
06-08	1	1	1	3
08-10	3	1	1	5
10-12	4	3	1	8
12-14	7	4	7	18
14-16	10	7	1	18
16-18	17	12	6	35
18-20	5	6	16	27
20-22	15	10	6	31
22-24	4	2	5	11
Total	70	48	49	167

TIMES OF ONSET OF THUNDERSTORMS

Table 3 shows that the most favourable period for the occurrence of thunderstorms is from 12.00 to 22.00, with a clear preference for 16.00 to 22.00, and a peak between 16.00 and 18.00. A comparison with graphs of onsets in the Athens area (Michalopoulou, 1978) and Thessaloniki (Balafoutis and Maheras, 1982) shows that onsets for Olympus are approximately two to three hours later than for Athens, and three to four hours earlier than for Thessaloniki. Clearly, the topographical features of Mount Olympus bear no comparison with those of Athens or Thessaloniki. However, the intermediate onset times may assist us in the interpretation of the data.

The 14.00 peak onset for the Athens area has been attributed to the marked warming of the lower layers which occurs in the early afternoon hours (Michalopoulou, 1978). The effect of the sea in the Saronic Gulf may be ignored. In the Thessaloniki area, the occurrence of the peak immediately after sunset has been attributed to local topographical peculiarities. The principal factor here is the almost entirely closed Bay of Thessaloniki, which behaves like a shallow inland lake (Maheras and Balafoutis, 1980). It appears then that in the greater area of Mount Olympus, the development of thunderstorms is favoured by purely continental influences as well as by: (1) influences related to the transport of water vapour from the sea to the east, (2) influences related to the intense evapotranspiration of the wooded valleys to the north and east, and (3) influences related to the convecting and mixing of air masses above the mountain peaks after uplift along the slopes (Sachsamanoglou, 1977). If Sachsamanoglou's study were to be extended to cover more hourly observations than the 14.00 one, this would allow us to draw firmer conclusions for the role of Olympus as a source of warming for the lower troposphere (Sachsamanoglou, 1977). This would further show to what extent all the factors contribute to the daily course of the instability around Olympus.

The maximum frequency of termination of thunderstorms (Table 4) occurs in the same two-hour period as the onset, which reinforces the view that thunderstorms on Olympus are of short duration. Generally, the commonest termination times are between 16.00 and 02.00, with a peak in termination between 22.00 and 24.00.

TABLE 4. Ending time and frequencies of thunderstorms.

Hours	*July*	*August*	*Sept.*	*Total*
00-02	10	5	7	22
02-04	1	3	5	9
04-06	1	1	1	3
06-08	2	1	3	6
08-10	1	0	0	1
10-12	1	2	1	4
12-14	3	2	2	7
14-16	4	2	3	9
16-18	18	9	6	33
18-20	10	8	5	23
20-22	6	8	8	22
22-24	13	7	8	28
Total	70	48	49	167

STUDY OF THE SYNOPTIC SITUATIONS

From an examination of the synoptic situations prevailing over the central and eastern Mediterranean at the times of the 167 observations we may note the importance of the presence of cold air aloft in the formation of thunderstorms in the Mount Olympus region. Thus in 102 cases of thunderstorms (61% of the overall total), 52 (31%) are directly related to the existence of a cold pool aloft, whereas the other 50 (30%) correspond to the existence of a shallow trough and movement of cold air. There are a further 60 cases (36% of the overall total), of which 26 (16%) correspond to low-pressure systems on the surface, and the other 34 (20%) to surface cold fronts. For the remaining 5 (3%) thunderstorms, there are no apparent dynamic features.

The Influence of Cold Pools Aloft

Cold pools aloft are the most important factor not only for the frequency of occurrence, but also for the intensity of the thunderstorms over the area of study. Because the cold pools which create instability persist for days at a time, thunderstorms do not occur in isolation, but as series lasting for a number of consecutive days.

A noteworthy example occurred in July 1972, when there was a sequence of thirteen days of thunderstorms (12th-24th). On the first two days (12th and 13th) there was a combination of a depression and a cold pool aloft. On the other days, there was only a cold pool aloft.

In this sequence of thunderstorms, the most intense, both from the point of view of the phenomenon itself and from the quantities of rain or hail, occurred on the 15th. The thunderstorm on this day began at 18.10 hours with sheet lightning to the south. It then spread throughout the region and went on until 00.30 hours. The station was continually struck by lightning from 19.30 on, and it was impossible to carry out the 20.00 observation. Rain set in at 17.15 and continued intermittently until the termination of the thunderstorms, with occasional hail. The total of precipitation as measured at 08.00 the next day was 59.3mm. On account of the extremely severe winds during the thunderstorm, the 8-metre high mast of the weather station was blown down with the destruction of the instruments.

The thunderstorm continued over the following days but with reduced intensity, and generally appearing after mid-day. Significant amounts of rain fell on 16th (27.9mm), on 18th (9.3mm), on 19th (18.3mm), on 20th (9.5mm), and on 24th (18.8mm).

Surface situation conditions on 15th are characterised by the prevailance of low pressure resulting from the western displacement of the Asian thermal low. Aloft, the core of the cold pool, with a temperature of −18°C, was situated over southern Italy. The whole of Greece was under the influence of the eastern side of this pool, with temperatures ranging between −10° and −11°C.

Frontal Thunderstorms

In contrast to those in the previous category, frontal (cold front) thunderstorms usually form in isolated cases and last for one or, at most, two days. They arise as a result of the rapid movement of cold fronts over Greece (Maheras, 1983). In addition, with the disappearance or dispersal of the cold front at the surface, the instability of the cold air aloft may persist. This gives us a change in the categorisation of the thunderstorm type.

A characteristic example is given by the case of 3rd July 1972. The cold front, under the influence of the trough, moved very rapidly south-east, influencing the area around Mount Olympus from the evening of the 2nd. The thunderstorm in that area began at 12.05 and lasted until 20.30. Light intermittent rain began at 11.00 and hail at 12.10. The largest hailstones fell between 17.50 and 18.05 hours.

CONCLUSIONS

Cold air aloft, principally in the form of a cold pool, is the most important element in the appearance of thunderstorms. Both the duration (in hours and days) and intensity of the storms depend on the persistence of the cold air aloft. In this case, the influence of the diurnal cycle is evident.

The passage of cold fronts also influences the appearance of the phenomenon, although to a lesser extent. Cold front thunderstorms may occur at any hour of day or night, although their duration (principally in days) and their intensity are much reduced, compared to cold pool thunderstorms.

The effect of the mountain mass on the occurence of thunderstorms is evident. The intense warming of the slopes and the heat loss from the peaks, due to their shape, create large temperature lapse-rates between the slopes and the peaks. Continual inflow of water vapour from the nearby sea and intense evapotranspiration favours the formation of convective clouds where the upward-moving air-masses over the slopes converge at the peaks. Also, the fact that the maximum frequency of onset occurs between 16.00 and 18.00 appears to be related to the amounts of water-vapour flux from the nearby sea.

REFERENCES

BALAFOUTIS, Ch., and MAHERAS, P. (1982): Thunderstorms in the area of Thessaloniki, during the warm season-statistical contribution. *Proceedings of the First Hel.-Brit. Climat. Meeting in Athens,* Sept., 1980, pp.57-87.

MAHERAS, P. (1983): Les types de temps dépressionnaires perturbés au-dessus de la mer Egée. *Riv. Met. Aer.,* XLIII no.1/2, 1983, pp.13-22.

MAHERAS, P. et BALAFOUTIS, Ch., (1980): Essai d' interprétation du rythme diurne des orages durant la période chaude de l'année. *Rech. Géogr. à Strasbourg,* no.13-14, pp.161-168.

MICHALOPOULOU, C. (1978): Kataigides sten periokhe Athenon (Thunderstorms in the Athens area). Doctoral thesis, Athens.

SACHSAMANOGLOU, C., (1977): O oreinos ogkos tou Olympou san pege thermanses tes katoteres troposhaires (The Olympus massif as a source of warming of the lower troposphere). Doctoral thesis, Thessaloniki.

THE JANUARY 1985 COLD SPELL IN DOVER, KENT

By F. G. THOMAS

I give in Table 1 details of extreme temperatures measured at River, just inland from Dover in Kent. My thermometer screen is situated in a garden with a low hedge on three sides, so that the thermometers are above any cold air that accumulates. The road parallel to the garden falls gradually to the River Dour 7-8 metres below our site to which itself is about 30 metres above mean sea-level. The site therefore has the modified characteristics of a frost hollow, because night minima are appreciably below those of the surrounding uplands on clear nights and below those of the site of the former Dover meteorological station on the sea-front.

TABLE 1.

	Max.	*Min.*		*Max.*	*Min.*
5th	−2.6	−4.3	12th	2.7	−1.9
6th	2.2	−6.0	13th	−0.4	−3.1
7th	−2.7	−4.9	14th	−0.5	−1.4
8th	0.6	−11.1	15th	−3.3	−4.9
9th	1.3	−1.8	16th	−4.3	−12.4
10th	1.9	−3.7	17th	−1.2	−13.0
11th	2.2	−2.8	18th	0.6	−12.2

The night minimum of −12.4°C on Wednesday, 16th January, is significant because the night was overcast above 1.5 to 1.8cm of snow. The minimum of −13°C on the following night, which was clear, is the lowest recorded screen temperature here, because the figure of 30th January 1972 at River is a conversion to degrees Celsius from 9°F (i.e. −12.8°C). The Dover meteorological station minimum that night was −7.2°C.

Night minima at that station on 24th February 1947 was −11.1°C and on 9th February 1942 −10.6°C. Unfortunately, there are no figures available for River on those occasions, which would appear to be the coldest in these parts. With regard to 20th January 1940 when the county record of −20°C was established at Canterbury, the lowest temperature at Dover was −7.2°C (on the 19th).

During the recent cold spell −14°C was recorded in a screen at Canterbury when it was −13°C here. The observer considered that −16°C might have been reached at a lower altitude in that city.

RECORD COLD IN ITALY IN JANUARY 1985

By MARIO DELMONTE
Casalecchio di Reno, Bologna, Italy.

From the 4th January 1985 the Italian Peninsula was directly affected by a strong current of Arctic air which was feeding a deep depression in the Mediterranean Basin. This brought abundant and continuous snow, especially to southern parts. The situation was worsened by the arrival of another perturbation from northern Europe which brought bad weather as well to other regions including the north of Italy.

The zone most affected by the snowfall which lasted for 48-72 consecutive hours was Emilia-Romagna, where on the 8th-9th the situation became very difficult due to the snow depth which reached 30-40cm at Bologna, Forli, Ravenna, Rimini and Ferrara, and a depth of one metre in places in the Appennino Tosco-Emiliano. There was much snow too on the Marche, Abruzzo and Toscana; snow was 25-40cm deep in Ancona, Pescara and Firenze. The railway stations of Bologna and Firenze were semi-paralysed by the ice. 15cm of snow fell at Roma causing much disruption to an unprepared city.

Napoli suffered as well, and many villages in Calabria and Basilicata remained isolated for a time. S. Giovanni in Fiore had 100cm snow, as did Pollino and other places. Not for many years had snow fallen at Maratea, which that week had 10cm.

Heavy snow reached Sardinia on the 10th, and the snow at Cagliari, Sassari and Olbia paralysed the airports.

The snow and the cold were among the worst of this century. Lowest temperatures were registered in Emilia and in Toscana, in which regions seven deaths resulted. Here is a list of the temperature records on 6th January:

Capanna Margherita (Monte Rosa)	–35°C
Livigno	–31
Bormio	–31
Tarvisio	–31
Madonna di Campiglio	–23
Cortina d'Ampezzo	–21

On 7th January: –22°C at Parma.

On 10th January: Reggio Emilia –20°C; Firenze –15; Milano –17; Torino –14; and –8 Roma.

On 11th January: –27°C Finale Emilia (MO); –25 Parma; –20 Reggia Emilia; –22 Ferrara; –15 Ravenna; –16 Bologna; –23 Firenze; –18 Brescia; –14 Aquila; –11 Roma; –15 Pisa; –8 Positano; –14 Milano; and –10 Torino.

On 12th January: –20°C Reggio Emilia; –18 Parma; –20 Ravenna; –18 Ferrara; –25 Cavezzo (MO); –30 Altipiani Abruzzesi; and –20 Lucca.

On 14th January another vast depression in the Mediterranean, engaging the very cold air, led to a further three days of heavy snow in northern Italy. All transport was again paralysed, and many buildings collapsed under the weight of the snow. The snow reached exceptional depths:

Genova	50 cm
Torino	45
Milano	75
Piaceuza	80-100
Parma	60-70
Bologna	80
Trento	150
Novara	100

The snow was two to two-and-a-half metres deep on the Appenines. By contrast, central and southern Italy had heavy rain. The 43mm at Roma was a 22-

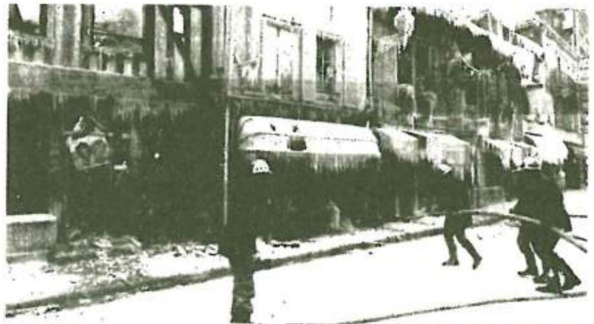
year record for the month of January. The heavy rain in Catania caused much damage. In the province of Regusa tornadoes (trombe d'aria) occurred. Heavy seas caused much damage on the coasts. There were four victims in Sicilia.

To illustrate the exceptional temperatures from the 5th to the 13th January, I shall give those for Casalecchio di Reno, which is near Bologna. The River Reno became almost covered over with ice floes.

	Min.	*Max.*		*Min.*	*Max.*		*Min.*	*Max.*
5th	–7	–3	8th	–11	–3	11th	–10	–2
6th	–10	–3	9th	–5	–2	12th	–10	–4
7th	–11	–4	10th	–7	–1	13th	–10	–1

THE COLD SPELL IN FRANCE

The piercing cold of January affected France and much of Spain, as it did the rest of western Europe. Record snowfalls occurred on Spain's Costa Brava, and in Italy as far south as Calabria and Sicily. The accompanying photographs are from France. The lower photograph shows a skier progressing along the Promenade des Anglais, Nice, using Nordic skis on 9th January 1985. The upper photograph is from Troyes in northern France, and shows firemen struggling with their equipment in front of a row of 14 ice-coated houses and shops which were all destroyed by fire during the night of 8th-9th January when the minimum temperature was –28°C.



MORE BALL LIGHTNING INCIDENTS

Mike Rowe's press appeal continues to bring in fresh examples of interesting ball lightning incidents which have never been previously published. In this issue we publish a few more examples.

GREAT BOWDEN, LEICESTERSHIRE, ABOUT 1882/84

In reply to your letter in the *Galloway Gazette* of 4th February asking for accounts of ball lightning, you might be interested in the following account of one such experience given to me by my mother many years ago, although it was not in Scotland.

The date of the occurrence was in the evening of a day in July, in the period 1882-1884. The place was on a country road between Great Bowden and Market Harborough (SP 7488), Leicestershire. My mother as a child of 7-9 years was travelling with her parents and other children of the family in a horse-drawn cab (commonly called a growler, I believe) from Great Bowden to Market Harborough, after visiting relatives, when there was a terrific thunderstorm. Suddenly there was an uncanny hush and the party saw a fireball (up to one foot in diameter) rolling towards the cab on the road, and, as it passed underneath the cab, there was an explosion and the cab was tipped partly into the ditch at the side of the road, the driver being thrown over the hedge. Fortunately on investigation it was found that he was only shaken by the experience and he managed to get the cab to Market Harborough by leading the horse, which had been blinded by the explosion, although it recovered after a few days.

Examination of the cab, which fortunately had a double bottom, revealed that the outer layer had been completely splintered to pieces, and the party could have been killed with only a single bottom in the cab.

I hope that this account, which I am sure is an accurate account of what happened, will prove useful to you.

10 Laigh Isle, Isle of Whithorn, Newton Stewart, Scotland. J. A. MARRIOTT

BALL LIGHTNING AT BLACKROCK, COUNTY CORK, 1915/16

It seems funny to be writing about something that happened in 1915/16 at class one day. It must have been June as the window was opened wide. The fireplace was right opposite the window and the class was sitting all to one side of the room. *Slowly* in through the window came this large red ball (about twice or three times the size of a football), and it passed in front of us and went up the chimney. Simultaneously, there was a huge crack of thunder, and as a matter of fact the building was split and a castle nearby was also struck. The building is the Ursuline Convent boarding school, Blackrock, County Cork.

This is the best my memory can do, and I hope it will be of use to you.

St. Gerards, Florence Road, Bray,
Co. Wicklow, Ireland. (Mrs.) M. E. COUGHLAN

UNUSUAL BALLS OF LIGHTNING, ABOUT 1927, IN KENT

With reference to your inquiries in today's issue of *Extra,* I had a tremendous experience of fireballs all around me some years ago.

The year was 1927 (as far as I can recollect). I was sleeping out in my bivouac in

the small meadow (then an orchard) which lays between Port Farm House and the main road, Upstreet.

I was awakened by a tearing gale which inflated the tent and threatened to blow it down. Looking out, I became aware of round globules of fire (about the size of coconuts) bouncing over the tops of the apple trees. Then it pelted with rain. Hurriedly, I stowed everything into a wrapped ground sheet and waited for the rain to ease off a bit, before rushing over to the shelter of the back-door boot shed. I well remember that just as I was about to jump over the back-lawn gate a globule danced over the top of it – all of which was exceedingly un-nerving. A bit of quick thinking and a boot knife led to entry through a sash window and thus into the house.

18 Walnut Tree Lane, Westbere,
Canterbury, Kent. JOHN LANGFORD-WEEKLEY

(Second letter). Glad to have been of interest.

Scene: Around late summer, about mid-night. Whole area lit as by day-light. Balls of lightning (?) glowing as bright as any magnesium flares (i.e. white) dancing over most of the trees in orchard. A tearing wind blowing and bending upper boughs and my bivouac inflated like a balloon. After dancing for say 3 to 4 seconds the balls just disappeared in a flash, their place being taken up by others.

Then a sudden downpour, but the display continued through this and was to carry on after raining ceased. There was no thunder or signs of any normal lightning that night.

JOHN LANGFORD-WEEKLEY

BOUNCING BALL OF FIRE, AT VALE, GUERNSEY, 1933

With reference to your recent letter in our local press, I would like to inform you of an incident which occurred in the Vale parish of Guernsey in 1933. It was late at night and I was cycling along Rue des Marais (lane) which is a marshy area; a mist was hanging low over the fields. Looking back before turning into my gateway. I saw to my fright, what could only be described as a ball of fire, bouncing along at a fast pace along the top of the hedge. I didn't wait but got quickly indoors, telling my father of this to which he replied, "That's the Willow-the-Wisp, Linda." He actually told me this in Patois (Guernsey French), Feu (fire) Boullangey which means Fireball.

St. Peter Port, Guernsey, Channel Islands. LINDA REGAN

Book Review

WEATHER AND BIRD BEHAVIOUR. By Norman Elkins; illustrated by Crispin Fisher. pp.239 (including 195 references and index). T. and A. D. Poyser Ltd., Town Head House, Calton, Waterhouses, Staffs. 1983. £12.60 clothbound.

This volume will delight all meteorologists who have any enthusiasm or interest in natural science but particularly of course in ornithology. This is because the book has been written by a professional meteorologist who knows how to write well for the two disciplines at once. I am in no doubt, too, that all professional ornithologists must have been glad to see this book appear. Despite the total dependence of the world's birds on the course of the weather, this book is apparently the first of its kind on the subject. Whereas "the ultimate motive for most of a bird's activities is the finding of sufficient food to ensure survival and successful reproduction", the effects of the weather on food availability, breeding, flight and migration are all crucial at different times of the day or in different seasons.

The book opens with a lucid chapter on weather and weather systems. The next chapter, entitled "flight", describes the type of airflow exploited by birds, principally convective flow and orographic flow. The upward gliding of birds in thermals (soaring) is well explained here, and again in chapter 10 in connection with long-distance cross-country travel when large birds may achieve a glide ratio of 12 to 1. The next two chapters concern ground feeding and aerial feeding, and chapter 5 on "breeding" demonstrates how all aspects of the reproduction cycle depend closely on the weather (song, display, nesting, laying, incubation and rearing). In chapter 6 the direct effects of the elements of the weather on individuals are considered: cold, heat, sunshine, wind and precipitation, and the importance of the choice of roosting site to provide best protection from the weather. The next four chapters treat various aspects of bird migration. Chapter 7 and 8 skilfully discuss the dynamics of migration for both successful migrants and for disorientated ones. A number of weather maps for north-western Europes are used to help explain some of the typical and some of the unusual cases. For example, we see how Pink-footed Geese wait in Iceland as a depression passes (Fig.22, 16th September 1978) and then fly down to Scotland in the clearing skies on north-west winds. Or we learn how a migrating flight goes wrong (Fig.28, 3rd September 1965) and half a million birds land exhausted on Britain's east coast, their navigation impaired by deep cloud, heavy rain, and progressively changing strong winds. Chapter 9 deals with "vagrants", i.e. those individuals carried enormous distances from their usual range by unusual weather situations. In this way, common birds of one continent arrive as a rare bird in another continent. Chapter 11 explores the mortality of birds due to truly extreme weather conditions, i.e. abnormally long or intense spells of snow and ice, and also fog, hail and tornadoes. The tornado case cited was the East Anglian event of 3rd January 1978 which we covered in *J. Meteorology* at the time (q.v., vol.3, 233-234; 4, 77-78 – 140 geese levitated by tornadoes on a squall line and deposited along a 50km corridor). The effects of an American hail and thunderstorm on a flight of ducks is worth repeating here: "In November 1973, ducks on a local feeding movement in Arkansas flew into a thunderstorm where they encountered hailstones up to 50mm in diameter; many were struck and grounded, suffering broken bones, gashes, cuts and bruises. Eighteen birds were found frozen and ice-encrusted; one female Mallard had pieces of ice 20mm in diameter frozen to the tips of feathers on the neck, breast and flanks. From the descriptions of the icing, it is clear that many birds must have been flung high into the sub-zero temperature region of a cumulonimbus, where they underwent the same process as a water droplet during its formation into a hailstone. Four dead birds were found with head feathers singed, possibly by lightning strikes." The final chapter is about sea-birds. It is amazing what severe storms many oceanic species can endure. This chapter, like its predecessors, contains much information about bird-life at which we can also marvel. Birds have adapted to the weather better than man has, and are much better suited to surviving its extremes. We can learn a lot yet by studying bird-life in detail, and this volume provides an excellent summary of the state of knowledge. I fully recommend the book to true weather-lovers.

G. T. M.

Book Announcement

CLIMATIC CHANGE IN CANADA 4: Annotated Bibliography of Quaternary Climatic Change in Canada. (*Syllogeus* No.51). Ed. by C. R. Harington and G. Rice. pp.368. 1984. Published by the National Museum of Natural Sciences, Ottawa, Canada, under its Climatic Change Project.

LETTERS TO THE EDITOR

WEATHER WATCHERS NETWORK IN SCOTLAND

During the winter of 1983/4 BBC Scotland launched a network of amateur weather observers to follow local developments in severe weather over Scotland. Linked mainly by telephone these so-called "Weather Watchers" were able to pass newsworthy items of weather information back to the Co-ordinator, Roland Chaplain, at the studios of the BBC in Glasgow. The BBC were already using regular road weather-conditions reports from the Automobile Association, and it was soon realised that consistency of reporting was best served by the Network's reports being cross-checked with the AA's own patrols' reports and with those which the AA relies on from local police forces, Highway Departments, etc.

Radio Scotland effectively funded this experiment in "weather broadcasting" for its first three months but it then fell victim of worries in the BBC about any form of new expenditure commitment pending decisions about the new TV licence fee. With this still remaining unresolved the Network has been forced to become an independent entity and the obvious direction for it to turn was to the Automobile Association's broadcasters for an outlet for its weather reports.

The AA cleared this with the BBC and with local commercial radio stations, and during the cold spells of January and February 1985 we have been providing the AA with regular weather reports for which we receive due credit 'on air'. The cost of phone calls severely limits the scale of the Network's internal phone-round for information but at least the experience of recent weeks has shown that the Network's capability for picking up on significant local weather developments continues both to grow and often to be slightly quicker than that of the Meteorological Office.

In effect, what is happening is that the "Weather Watchers Network" is developing as an Auxiliary Weather Service which can now make a serious claim to be able to complement Met Office weather-forecast services and pick up on occasions when the public presentation of these might be misleading or when it has been impossible in the time available to give all the significant local detail. With this emphasis on local detail, perhaps our most important consideration now is to fill gaps in a Network of some 400 main locations. It sounds a lot but it falls far short of what we really need if we are to fulfil the real potential of this kind of local Weather Nowcasting

Therefore the Network is now appealing for more Weather Watchers particularly in the following areas:

(1) Jura, Knapdale, Kyles of Bute, Kintyre.
(2) From Carlisle to Lockerbie and north-eastwards to Carter Bar, Hawick and Galashiels.
(3) From the Pentland Hills south and east to Blyth Bridge, Peebles, Galashiels, Greenlaw and the Lammermuir Hills.
(4) From Ardlui to Spean Bridge in the vicinity of the railway and A82, and along the A86 to Newtonmore.
(5) The A835 from Dingwall to Ullapool and anywhere north of there in N.W. Scotland.

Although these are the priority areas in which we need to find more people, the Network welcomes more members anywhere in Scotland. It is always valuable to have extra people to fall back on for quick checks on current weather conditions and a major aim of the Network is to improve popular meteorological education among people of all ages. To this end the Network is developing an internally organised "Learning Exchange" to put members in touch with one another who want to learn and/or teach about weather observing, nowcasting and the rudiments of local forecasting.

At one stage there was an interest in the Network developing into a federation of community businesses to provide low-level weather services on a subscription basis. This had a particular appeal to those of us who happened to be unemployed, ex-professional meteorologists, but it soon became evident at our Regional Meetings (another series of which takes place at the end of March) that most members of the Network wanted us to remain a strictly voluntary organisation relying on traditional methods of fund-raising.

However, telephone calls have to be paid for and each general mailing of the Network costs more than the last. So, even as a voluntary organisation the Network is being forced to go to funding bodies, e.g. the Highlands and Islands Development Board, the Manpower Services Commission – for Community Project workers – and local authorities for assistance and to ask users to cover the cost of weather telephone-rounds made on their behalf.

Those of us in the Weather Watchers Network in Scotland believe that it has a great potential not only to produce popular and useful weather broadcasting but also to help the emergency services in fine-tuning vulnerable operations where the timing of weather changes could be crucial.

Anyone wanting to know more about the Network, or who is considering offering their services, is asked to send a large 22p s.a.e. to the Co-ordinator, Roland Chaplain, 'Windhover', Laurieston, Castle Douglas, DG7 2PW, Scotland, tel: (064 45) 652.

Roland CHAPLAIN

THE REBELLIOUS WEATHER MACHINE

During the recent severe wintry weather of January 1985 when the Meteorological Office proudly brought into use a new radar weather computer which tracks more accurately areas of precipitation, severe local storms, etc., and thereby improves the forecasting of the intensity and quantity of rainfall, it was with some panache that the forecasters were confidently predicting a severe snowstorm across southern England, the worst since 1947. To their chagrin the forecast went awry, at least for south-east England. I felt for them as the offending depression misbehaved by steering off towards the Mediterranean instead of following its forecast track across northern France.

This embarassing upset for the forecasters of the day reminded me of my early childhood love and enthusiasm for the weather scene and the reasons why "the weather" excited my interest and curiosity.

Growing up in an increasingly scientific and technological world, the weather at least defied attempts to be strait-jacketted and controlled. It was an early and fervent hope of childhood that the weather in my lifetime would never be controlled or understood enough to predict in advance with 100% accuracy what the weather was going to be like next day and every day. Because if the weather behaved exactly as predicted, it would detract enormously from the enjoyment of 'unknowing' what the day had to offer weatherwise.

It seems to me that since 1945 our lives have been increasingly dominated by the specialist with his or her expert views on what is good or bad for us. British weather, fortunately, has a most endearing habit of cocking a snook at the expert by having a 'life' of its own and a distinctive poetry of its own.

Poetry does not fit into the pages of the specialists language and accompanying mind-boggling equations. Nor does it exactly inspire the bored reader with enthusiasm for the subject. We are in danger of emulating the gobbledegook of some civil service pamphlets. Sometimes, I believe the expert of this ilk would be better employed in drawing a snowflake!

To my untutored imaginary 'eye' the weather cannot be strait-jacketted and put into compartments. Science, art and poetry coexist in the weather scene. The late Professor Gordon Manley and L. C. W. Bonacina were rounded personalities and saw meteorology through the eyes of both artist and scientist. I still enjoy reading Gordon Manley's *Climate and the British Scene* as perhaps the most readable and informative book on the understanding of British weather. Both Manley and Bonacina had the power to communicate their love of the subject.

I am all for the understanding of the Global Weather Machine, but please keep it simple.

Ackhill, Presteigne, Powys. G. A. SOUTHERN

A SIMPLE INSTRUMENT FOR RAINFALL INTENSITIES

Having in position already two standard raingauges (one for daily readings and one for monthly checking) I could not at first see any reason for purchasing a plastic version selling for £4 in a local

Garden Centre; but further consideration brought to mind one very useful advantage over the standard type:

Placed in the garden a few feet from the window, the level of any rainfall can be clearly seen against the bold white-printed scales (1mm divisions on one side and 0.05in on the other). Thus weather observers who, like myself, do not possess more sophisticated equipment, can have the means to calculate rainfall intensities without even venturing outside!

For example, on 16th November 1984, the reading at 9.15 a.m. was nil as rain commenced to fall. Later readings, easily made between the day's other commitments, were 12.15 p.m. 8mm; 3.15 p.m. 9mm; 5.15 p.m. 12mm; 7.15 p.m. 16mm; and 10.00 p.m. 17mm. The standard gauge was read at 10.00 p.m. and the fall was confirmed as 17.0mm. These observations gave a lively thread of interest throughout an otherwise dreary day!

Enclosed is an illustration of the gauge, which is about 25cm long. The writer's own model has been positioned in the nearest flower border, about three metres from the bungalow window, with the mouth 40cm above ground level, but no doubt some appartment dwellers might find a position to fix it, e.g. on fire escapes, etc., to show meaningful readings, even if only approximate.

Observations during thunderstorms should prove of absorbing interest as the level of rain is moving up the scale, and any exceptional intensities will be reported to *J. Meteorology* while, of course, bearing in mind that the instrument is not officially approved.

69 Sandown Road, Thundersley, Benfleet, Essex. R. W. SELFE

Product News

PHILIPS METEOROLOGICAL SYSTEM FEATURING INDUSTRIAL DATA LOGGER

Working in close cooperation with Norwegian and German meteorological authorities, PHILIPS has developed a highly-flexible, computer-based, cost-effective meteorological system based on its well-proven and widely used PR 2011 Industrial Data Logger. Currently being used in a Norwegian offshore application, the system embodies many other notable features, including a truly standardised format for all uses. It will, for example, accept all types of parameter-sensing devices directly, without the need for intermediate amplifiers or converters, as designed for unattended operation, has automatic reporting facilities and a full range of interface equipment including computers, printers, etc., plus an automatic self-diagnosis capability. Meteo data can be presented in a variety of ways; multiple-display units, printers and recorders, or on tape.

Heart of the system is the PR 2011, a high-efficiency unit which can accept up to 256 sensors, and which also gives the system its extreme flexibility and capability. The PR 2011 is perhaps better known for its applications in areas like monitoring turbo-machinery, and where it is used in conjunction with the PHILIPS RMS 700 Machine-Monitoring System, and in process-control where it is used with the PCS 700 system.

In this Norwegian application all prevailing meteo data are presented on a VDU (remote VDU's can also be installed), and there is additional analog presentation of wind-dependent parameters. Optimal measuring conditions can be selected for dual-sensor operation, and there is an alarm-condition display facility for the complete system, plus a provision for individual meteo-sensing devices. Standard presentation covers wind velocity (mean velocity over last 15 seconds, maximum velocity over last 10 minutes, plus rate-of-change per unit time), wind direction (mean value over last 15 seconds, direction of maximum gust over preceding 10 minutes), air temperature, air pressure, dew point, cloud base and visibility.

Further information from: Philips GmbH, Paul Levitt, S&I Division, Meiendorfer Straße 205, P.O. Box 730 370, D-2000 Hamburg 73, West Germany, Telephone (040) 67 97-448.

NEW WIND MEASUREMENT SYSTEM FROM VAISALA

The new multi-channel Wind Measurement System from Vaisala (U.K.) Ltd., gives instant answers to wind speed and direction questions that are essential to airports, harbour authorities, marine, offshore and general industry.

The unique WAD21M system allows up to four three-cup anemometer and vane sensors, with opto-electronic transducers incorporated as wind speed and direction sensors, to be connected through central units to a two-wire line forming a current loop. These sensors can be remotely sited in order to cover a large area (up to 10km from display), to give representative specimens of wind conditions, at either ground level or from multi-level tower. The sensors are mounted on the cross-arm of a mast with the control unit at the base. Wind speed and direction samples are converted into digital display and transmitted from the control down the serial line.

Display units may be installed in a number of locations or at one central point. Each micro-processor-based display unit performs averaging minimum and maximum measurements and is shown in easy-to-read format. By simply turning a switch, variation of visual display can be given, including 5-second, 2-minute or 10-minute average wind-speeds, minimum and maximum wind speeds, average wind direction, or direction variation sector. As an additional feature, the WAD21M can format incoming data to compute 'wind shear' conditions.

The display unit possesses a built-in self-test system to ensure data quality and an optional range of accessories are available, for readout, interfacing with computers, or providing audible alarms.

The WAD21M Wind Measurement System is extremely cost-effective and its flexibility enables it to be expanded to fulfill all requirements. Please direct enquiries to Vaisala (U.K.) Ltd., Cambridge Science Park, Milton Road, Cambridge CB4 4BH.

WORLD WEATHER REVIEW: October 1984

United States. *Temperature:* warm in E. half, cold in W.; +4 deg. from E. Alabama to West Virginia; -4 deg. in E. Oregon, S. Wyoming, N. Colorado. *Rainfall:* mostly wet; over 200% over a remarkably large area: most of the Plains and Mississippi Basin; also C. California to Nevada and locally in W. Oregon; over 400% from E. Texas to S. Missouri. Dry in E. coast states; Wyoming, E. Montana, N.W. South Dakota, E. Washington to C. Idaho, S.E. California to S. Arizona. Under 50% in all these areas; under 25% in much of Florida.

Canada and Arctic. *Temperature:* warm in E. half of Canada (except near coast), N.W. Alaska, Franz Josef Land; mainly +1 deg. Cold in W. Canada, Iceland, most of Alaska, nearly all of Greenland; -3 deg. in Canadian Rockies; -2 deg. in S.W. Greenland. *Rainfall:* wet in W. Canada; over 200% from L. Winnipeg to Great Slave Lake and in far N. of Canadian Arctic Islands. Dry in Alaska; Ontario and N.E. Manitoba to Newfoundland; Iceland and most of Greenland to Spitzbergen and Franz Josef Land. Under 50% in S.W. Alaska; round Gulf of St. Lawrence; S.W. Greenland through E. Greenland to Spitzbergen and Franz Josef Land.

South and Central America. *Temperature:* warm in most of Argentina and Brazil; E. Bolivia, N. Chile, Paraguay, Uruguay, E. and S. Mexico to Honduras; +3 deg. in S. Brazil; +2 deg. locally in N. Argentina and N.E. Mexico. Cold in C. Chile, W. Bolivia, N. coastal Brazil to E. Venezuela; coastal Colombia, N.W. Mexico; -3 deg. in N.W. Mexico. *Rainfall:* wet in C. Chile, E. Argentina, Uruguay, S. Bolivia, N. coastal Brazil and lower Amazon Basin to Guianas and E. Venezuela; extreme N. Mexico. Over 200% in all these areas except Uruguay. Dry in N. Chile, W. Argentina, Paraguay, S. Brazil, W. and E. Bolivia, Colombia, interior Venezuela, West Indies (except Windward Islands), most of Mexico to Honduras; under 50% in all these areas.

Europe. *Temperature:* mostly warm; +3 deg. locally from Bulgaria to W. Ukraine; +2 deg. widely from N. Greece to E. Germany and S. Finland. Cold from White Sea to Urals (-3 deg. round N. Urals); rather cold from Corsica and Sardinia to most of Iberian Peninsula (-1 deg. locally). *Rainfall:* generally wet from N.W. Iberian Peninsula through France, Low Countries, British Isles and Scandinavia (except N. Norway) to S. Urals. Over 200% locally in N.W. Spain, C. France, S.E. Belgium, Luxembourg and N.W. Germany, and widely from N. Denmark to W. Finland and Leningrad; also near S. Urals. Dry in S. as far N. as C. Portugal, N.E. Spain, S. France, S. Germany, Poland, S. European Russia; under 50% widespread (also in N. Norway); under 25% in S. and E. Spain, Greece to S. Romania. Provisional sunspot number 13.

Africa. *Temperature:* warm in Libya, C. Morocco, Botswana to Natal; cold generally N. of Sahara and from Namibia to Cape Province; -2 deg. in Algeria and W. Cape Province. *Rainfall:* wet from N.E. Algeria to N.W. Libya; most of South Africa and adjacent areas; over 200% from N.E. Algeria to N.W. Libya; S. Namibia, W. Cape Province, S.W. Zimbabwe. Dry generally N. of Sahara; N.W. Botswana, S.E. Cape Province (under 50% widespread in all these areas).

U.S.S.R. *Temperature:* warm from most of European Russia through Kazakhstan to Mongolian border; E. Siberia, N. Taimyr Peninsula; +4 deg. N. of Kamchatka; +2 deg. in W. European Russia. Cold from White Sea through Urals to Lena Basin and Sakhalin; -3 deg. round N. Urals, -5 deg. on C. Siberian Plateau. *Rainfall:* wet from White Sea and Leningrad through S. Urals to upper Lena Basin; also New Siberian Islands to Sakhalin. Over 200% near Leningrad, S. Urals to upper Ob Basin; round Sea of Okhotsk. Dry elsewhere, under 50% in W. Ukraine, from S. Kazakhstan to S. border.

Middle and Far East. *Temperature:* warm in N.W. Turkey, E. India, W. and part of E. China, S.W. Japan; +2 deg. in W. China. Cold in most of Turkey; S. Arabia to Pakistan and W. India; S.E., C. and extreme N.E. China, N. Japan; -2deg. in S. Pakistan. Philippines and S.E. Asia close to normal. *Rainfall:* wet in S.W. India, N.E. Thailand, S. Laos; over 200% locally in all three areas. Dry from Turkey to Pakistan, most of India, Bangladesh; much of S.E. Asia; Korea, Japan, Mongolia. Under 50% in much of India; S. Japan, much of Korea; largely rainless from Turkey to N.W. India. Very mixed pattern in China and Philippines.

Australia. *Temperature:* mostly warm; +2 deg. in S.E. Western Australia and N.E. of L. Eyre. Cold in New South Wales and S. Queensland (-1 deg.). *Rainfall:* complex pattern; over 200% from N.W. Cape to Nullarbor Plain; N.W. of Alice Springs; under 50% from near L. Harris (South Australia) to N.W. coast to Cape York Peninsula; much of Victoria.

M. W. ROWE

WORLD WEATHER REVIEW: November 1984

United States. *Temperature:* warm in W. and N. (except N.W. Arizona to S. Oregon; parts of Washington state); +2 deg. from N. Wyoming to W. Dakotas and N.W. Kansas. Cold in S.E., –2 deg. locally from N.E. Arkansas to S.W. Pennsylvania; also W. Nevada to N. California. *Rainfall:* mostly wet; over 200% across wide areas: in and near W. coast states (except S.W. California and much of Washington); S.E. New Mexico and N.W. Texas; N.E. Nebraska, N.W. Arkansas, W. Illinois, S. Kentucky, E. Florida. Dry in most E. coast states, on coast of Gulf of Mexico, and from Utah and N.E. Arizona to E. Montana and L. Superior; under 50% widespread except on Gulf coast.

Canada and Arctic. *Temperature:* warm in S.W. Alaska, S. Manitoba to Quebec, in and near N. Baffin Island, E. Greenland, Spitzbergen; +2 deg. in Aleutian Islands and N. Baffin Island. Cold in most of Alaska, W. and C. Canada, N. and S. Greenland, Iceland, Franz Josef Land; –5 deg. in Mackenzie Basin. *Rainfall:* wet in Aleutian Islands; Victoria Island and N. Baffin Island to N. Manitoba and Labrador; N.E. Greenland, Spitzbergen, Franz Josef Land. Over 200% in Aleutians, Melville Peninsula (N. Canada), N.E. Greenland. Dry in most of Alaska, W. and extreme S. Canada, round Davis Strait; under 50% in all these areas.

South and Central America. *Temperature:* warm in N. Chile, round La Plata estuary, S. and C. Brazil, N.E. Mexico; +2 deg. in interior S. Brazil. Cold in C. Chile, Bolivia, most of Argentina, Paraguay, Uruguay, extreme S. Brazil, most of Mexico to Honduras; –2 deg. from S. Brazil to N. and C. Argentina; locally in N.W. and S. Mexico. *Rainfall:* wet in most of N. and C. Argentina, Bolivia, Paraguay, interior Uruguay, S. Brazil, extreme N. Mexico, N. coastal Honduras. Over 200% in interior C. Argentina, E. Bolivia, in and near Paraguay, extreme N.W. Mexico. Dry in Chile, N.W. Argentina, Rio de La Plata to S. coastal Brazil; part of E. Brazil, most of Mexico to El Salvador and Honduras. Under 50% in N.W. Argentina, round Rio de Janeiro, most of Mexico to El Salvador and S. Honduras.

Europe. *Temperature:* warm from S. Norway and S. Sweden through Germany, Great Britain and Low Countries to Iberian Peninsula, France, Italy, Czechoslovakia, Hungary and N.W. Romania; +3 deg. in W. Belgium and much of France. Cold elsewhere, –7 deg. in N. Urals. *Rainfall:* wet from British Isles to most of France and Iberian Peninsula; E. Bulgaria, E. Romania, S. Ukraine, W. of C. and S. Urals; locally in Germany, Low Countries and Czechoslovakia. Over 200% in W. France, N.W. Portugal, N. and E. Spain, W. of C. Urals. Dry elsewhere, under 50% in C. Finland, C. Poland, W. Austria, Albania, W. Bulgaria, N.W. Ukraine; locally in N. and E. Italy, N.W. Jugoslavia, E. Greece. Provisional sunspot number 22.

Africa. *Temperature:* warm from N.E. Morocco to N. Libya; S.E. Namibia, Cape Province; +2 deg. in N.W. Algeria, N.W. Cape Province. Cold in E. Egypt, much of Namibia, from Natal and Lesotho into Zimbabwe and Mozambique; –2 deg. in N.E. Egypt and S. Transvaal. *Rainfall:* wet in W. Morocco, N.W. Algeria, Nile Delta, S.E. Namibia to C. Botswana; S.E. Zimbabwe to S. Mozambique. Dry generally N. of Equator, much of Namibia, W. Cape Province, S. Orange Free State, Lesotho, W. Transvaal. Under 50% widely from Morocco to Egypt; extreme N. and S. Namibia, W. Cape Province, W. Transvaal.

U.S.S.R. *Temperature:* warm in extreme S. and N.E. Siberia; +5 deg. on coast of E. Siberian Sea. Cold elsewhere, –9 deg. near Gulf of Ob. *Rainfall:* wet from S. Ukraine to Kazakhstan, C. Urals and upper Yenisey Basin to L. Baikal; N.E. Siberia (except Gulf of Anadyr). Over 200% from Caucasus to Yenisey Basin; large area round L. Baikal, part of N.E. Siberia. Dry elsewhere, under 50% round Gulf of Ob and Sea of Okhotsk.

Middle and Far East. *Temperature:* warm from Saudi Arabia to W. Pakistan; extreme S. India, S.E. Asia, Philippines, China (except Tibet), Mongolia, Korea, S. Japan; +2 deg. from Persian Gulf to Afghanistan; E. and N. China, Mongolia, parts of Korea, S. Japan. Cold from S. Turkey to Sinai; E. Pakistan and most of India to Tibet; N. Japan; –2 deg. in N. India, Tibet. *Rainfall:* wet from S. Turkey to N. Arabia; S. Laos, C. Philippines, lower Hwang Ho Basin, S.E. Korea. Over 200% in all these areas except perhaps Philippines. Dry in N. Turkey, from S. Arabia through S. Pakistan, India and Bangladesh to Thailand; most of China, Mongolia, Korea and Japan. Under 50% in all these areas, especially from Arabia to India and China.

Australia. *Temperature:* warm nearly everywhere, +2 deg. locally in N. and S.E. *Rainfall:* wet on some coasts, over 200% in S.E. and S.W.; otherwise dry, under 25% widespread in interior.

M. W. ROWE

WORLD EATHER DISASTERS: December 1984

1-7: Floods in southern Thailand, province of Makhon Si Thammrat worst hit floods destroyed houses, bridges and rice crops, leaving 17 dead, 31 injured and forcing 34,540 people to abandon homes. *Daily Telegraph.*

2: Heavy snow and avalanches in Swiss Alps, road passes closed, one dead in an avalanche. *Birmingham Evening Mail.*

2: Mv. *Blue Angel* developed list in heavy seas some 64km south-east of southern tip of Taiwan, crew abandoned ship, which was believed to have sunk later, three missing. *Lloyds List.*

3-10: Heavy rains and floods in southern Bandung, West Java, Indonesia; river Citarum overflowed, flooding hundreds of homes in town of Bandung, some people driven from homes, rain also touched off floods in Bojonegoro area of east Java, no major damage reported. *Kakarta Post.*

6 (reported): Drought and famine in Uganda; since July, 300 people have died of starvation in the Nebbi district; in the north-west of the country, another 80,000 face starvation due to drought. *D.T.*

10-11: Fog and ice on roads in many areas of Great Britain, at least 14 deaths reported in road accidents, including nine on the M25 in a 22-vehicle pile-up near Westerham, Kent. *D.T., B.E.M.*

10-14: Cyclone in Indian Ocean brought heavy rains to drought-hit areas of Ethiopia, but drought remained unbroken, some crop damage feared from rain. *D.T.*

13: Series of tornadoes from Dallas to San Antonio, north-central Texas, U.S.A., scores of buildings destroyed, at least 40 people injured, worst-hit area was Dallas suburb of Mesquite, where 30 people injured and 200 buildings damaged or destroyed. *L.L., International Herald Tribune.*

15-16: Heavy rain and floods in Minas Gerais state, south-east Brazil, left 11 dead, 2,500 homeless. *D.T.*

18-31: Cold spell in northern India, worst-hit states being Bihar and Uttar Pradesh, by the 27th death toll had reached 179, at least 140 in Bihar. *D.T., B.E.M.*

21-28: Heavy rains and floods in north Sumatra, Indonesia, over 1,000 people evacuated from three villages along the Silau river, hundreds of hectares of rice paddies destroyed, hundreds of pigs and chickens drowned, no casualties. *J.P.*

22-23: Two multi-vehicle pile-ups in fog on the Zagreb-Beograd road, Yugoslavia, a total of 134 vehicles involved, injuring 37 people. *D.T.*

23-31: Heavy snowstorms in northern Japan, at least 12 deaths reported, most of victims, in Niigata, had fallen while clearing snow from house roofs; on the 30th thousands of travellers delayed when over 40 express trains in Niigata area cancelled because of the snow. *D.T.*

23-31: Heavy monsoon rains in Malaysia, eastern coastal states badly hit, especially states of Kelantan and Johore, at least 11 deaths reported and about 8,700 people driven from homes, nearly whole of Kota Bahru, capital of Kelantan, under water, floods ranged in depth from 0.2 metre to 0.4 metre, road and rail communications cut. *L.L., J.P.*

25: High seas swept child into sea near St. Oswald's Bay, Dorset, body later recovered. *D.T.*

25-31: Fog, snow, ice in many areas of Great Britain, at least 10 deaths reported in road accidents partially attributed to the weather. *D.T., B.E.M.*

26 (reported): Heavy snowfalls in Yugoslavia contributed to four different road accidents that left 11 dead. *D.T.*

27: Cyclone "Frank" crossed Western Australia coast without causing major damage, in Port Headland; several trees uprooted, roofs damaged and power cuts of up to three hours. *L.L.*

27-28: Floodwater from ice-jammed Yellow River inundated a huge section of the Shengli oilfield in Shendong province, China; water from one to two metres deep, covered an area about 50km in circumference, over 2,000 workers trapped on roofs of buildings, derricks and small hills, all rescued; river began to ice over on 25th December as temperature dropped sharply. *D.T.*

27 (reported): Thirty yachts have abandoned the Sydney-Hobart race after being dismasted or damaged in strong winds and rough seas. *B.E.M.*

29: Record high temperatures in areas of U.S.A., New York recorded temperature of 21°C, while in Grand Rapids, Michigan, 18.5°C recorded, many other towns recorded record highs for date. *D.T.*

29-31: Torrential rains and heavy snowfalls in eastern Algeria, nine deaths reported, 8 on 30th near port of Jijel and one on 31st in Collo, near Skikda; all deaths occurred when houses collapsed because of rain and snow, winds on coast gusted to 100 km/h and on 31st up to 130mm of rain fell in some areas, air and rail links cut, parts of city of Annaba flooded. *L.L.*

ALBERT J. THOMAS

DECEMBER 1984 WEATHER SUMMARY

December was a mild, unsettled month with a predominance of south-westerly winds over the whole of the U.K. Mean temperatures were above the average by between 0.5 and 1.0 deg. over much of England and Wales and by 1.5 to 2.0 deg. over Scotland, particularly in the east. Day-time temperatures were unseasonably high at times and at Cape Wrath on the northern coast of Scotland Fohn winds flowing off the mountains lifted the temperature to 17.1°C between 0600 and 0900 GMT on 13th, thus setting a new British high for 13th December (see *Journal of Meteorology,* vol.9, p.169). Elsewhere, 15.0°C was reached at Lossiemouth (Moray Firth) on 23rd, 14.4°C at Leigh-on-Sea and 14.3°C at the London Weather Centre on 1st, and 14.3°C at Finningley on 23rd. At night, the temperature remained above 11.3°C at Plymouth on 23rd, with 10.5°C at St. Mawgan, 10.3°C at Yatton and 10.2°C at Congresbury, all on the same night, and 10.6°C was recorded at Hurn and Guernsey on 5th. In Scotland, there were minima of 9.6°C at Abbotsinch and 9.5°C at Tiree, both on 23rd. There was little cold weather until shortly after Christmas when a brief incursion of continental air produced maxima of −3.8°C at Abbotsinch, −2.1°C at Leeming and −1.4°C at Finningley on 27th, and −1.1°C at Tummel Bridge and 0.1°C at High Bradfield (south Yorkshire) on 26th, mostly in association with persistent freezing fog. Apart from a minimum of −5.9°C at Carrigans (Co. Tyrone) on 2nd, night-time temperatures were also at their lowest between 27th and 29th. Lowest values

were −9.4°C at Abbotsinch, −8.6°C at Braemar and −8.1°C at Turnhouse Airport (Edinburgh) all on 27th, −6.5°C at Cranwell (Lincolnshire) and −5.0°C at Marham (Norfolk) on 28th, and −5.1°C at Hurn and −6.3°C at Coltishall on 29th. Lowest grass minima included −13.9°C at Turnhouse, −11.1°C at Aviemore and −10.0°C at Straide (Co. Mayo), all on 27th, and −9.7°C at Coltishall on 29th. Rainfall amounts were rather variable, being generally above normal in southern counties of England, west Wales, Northern Ireland and Scotland, away from the south-east, but below normal in other parts. At Newcastle, only 38 percent of the normal was recorded. Highest daily falls included 59.4mm at Fraserburgh (Grampian) on 17th, 55.8mm at Fort William on 7th, 49.8mm at Killin (Loch Tay) on 6th and 44.0mm at Ilfracombe (Devon) on 15th. In Wales 41.0mm fell at Nantmor (Gwynedd) on 22nd. December was generally a sunny month and totals exceeded the normal by some 50 percent in the Midlands and parts of East Anglia.

Much of England and Wales had rain on 1st and 2nd as a small depression moved north-east into the Midlands before filling, the rain being heaviest in western areas. On 3rd Atlantic fronts, associated with low pressure areas to the north-west of Great Britain, moved into western areas of the country and these spread rain to much of Britain on 4th and 5th. Drier conditions affected southern counties of the U.K. on 6th and 7th as a temporary ridge built northwards from France but at the same time heavy rain fell in many parts of Scotland. A cold front brought a little rain to most parts on 8th but rising pressure from the south-east gave a dry period in all parts of the country until 12th with frost in places at night and with widespread, dense and locally persistent fog over England and Wales. Unsettled weather returned on 12th, and as fronts and low pressure areas moved into the country from the Atlantic the next two weeks were very disturbed with widespread rain which turned to snow at times over northern hills, particularly on 17th. Although wintry showers continued to affect northern areas from time-to-time, southern Britain remained mostly mild and rainy. Wintry weather reached the north-west on 25th and by the evening of Christmas Day Straide (Co. Mayo, Eire) reported 2cm of lying snow. These colder conditions moved south to most parts by Boxing Day accompanied by quite widespread wintry showers, and as a ridge built across the country from Norway frost and freezing fog became a problem at night. The cold spell proved to be only short-lived, and the year ended on a milder, more unsettled note as slow-moving depressions near to north-west Scotland spread rain and drizzle to most parts.

K. O. M.

TEMPERATURE AND RAINFALL: DECEMBER 1984

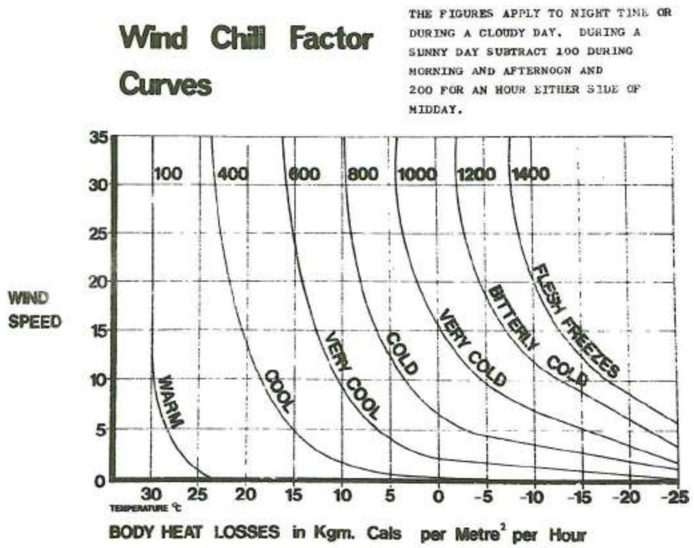
	Mean				*Grass*					
	Max	*Min*	*Max*	*Min*	*Min*	*Rain*	*%*	*Wettest*	*D*	*T*
AUSTRIA: Innsbruck	4.2	−2.2	16.5(2)	−8.5(31)	−11.5(28)	33.6	66	11.9(18)	13	0
BELGIUM: Uccle	5.5	0.8	14.0(1)	−2.6(29)	−7.7(29)	35.9	52	12.0(17)	17	
„ Rochefort	4.9	−2.4	11.0(1)	−5.4(30)		33.9	49	10.6(17)	17	
„ Houwaart	7.1	−0.2	12.3(1)	−6.4(29)	−9.0(29)	32.7	45	11.3(17)	14	0
DENMARK: Fanø	4.9	2.1	9.1(7)	−3.9(31)		49.2	66	10.8(24)	18	0
„ Frederikssund	3.6	0.6	8.5(10)	−6.3(30)	−11.5(18)	23.4	45	7.0(21)	13	0
GERMANY: Berlin	2.2	−1.3	8.6(11)	−6.1(16)	−6.5(16)	28.7	70	6.0(21)	15	0
„ Hamburg	3.6	−0.2	9.1(11)	−7.7(17)	−8.5(17)	45.5	78	15.5(20)	15	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	D	T
GERM'NY: Frankfurt	4.4	0.4	8.7(12)	−7.4(31)	−9.8(31)	45.6	86	14.1(18)	11	0
„ Munchen	2.9	−3.0	9.8(11)	−12.0(25)	−12.9(25)	45.7	91	15.5(16)	16	0
„ Sonthofen	3.5	−3.0	11.1(1)	−12.2(31)		83.6		31.4(16)	6	–
ITALY: Casalecchio	8.0	3.7	12.0(v)	−4.0(26)	−5.0(26)	92.6	161	29.7(3)	10	0
MALTA: Luqa	17.0	10.6	20.1(1)	6.8(27)	2.3(27)	171.0		34.8(23)	19	5
NETH'DS: Ten Post	5.0	1.4	9.2(11)	−3.0(31)	−3.6(30)	37.3	50	19.9(21)	17	0
„ Schettens	6.0	2.0	11.6(1)	−4.4(29)	−5.6(29)	47.5	62	22.2(21)	18	1
„ De Bilt	7.0	1.7	12.2(1)	−2.0(30)	−5.3(30)	30.2	38	9.1(21)	14	0
SWEDEN: Valla	2.3	−1.0	9.6(8)	−6.3(13)	−11.2(18)	43.4		8.9(7)	20	0
SWITZER'ND: Basel	5.2	−0.1	11.9(11)	−4.8(11)		45.8	104	21.0(16)	13	0
EIRE: Galway	9.5	4.3	12.6(30)	−2.0(27)		130.8	106	13.2(18)	25	1
„ Straide	8.8	2.8	12.2(30)	−4.0(27)	−10.0(27)	131.6	97	19.9(23)	23	1
N.IREL'D: Bessbrook	8.0	2.6	12.2(23)	−3.3(2)		104.7	102	14.7(13)	21	0
SHET'D: Whalsay	7.2	4.6	10.7(7)	1.6(21)	−4.2(30)	107.4	95	14.0(30)	27	1
„ Fair Isles	7.8	5.5	10.4(1)	0.6(18)	−2.3(19)	113.7	112	12.5(5)	26	1
SCOTL'D: Braemar	5.5	0.0	10.9(23)	−8.6(27)	−9.8(27)	76.8		12.5(23)	21	0
„ Inverdruie	6.4	0.7	13.0(23)	−6.7(27)	−11.1(27)	76.9	88	15.3(23)	23	0
„ Edinburgh	6.9	3.1	12.8(23)	−6.4(27)		42.6		12.6(1)		0
WALES: Moel-y-Crio	7.4	1.7	11.9(23)	−2.4(26)	−5.0(26)	67.1	71	19.5(1)	19	0
„ Lampeter	8.3	2.1	11.7(23)	−1.9(17)	−4.3(17)	156.6		27.7(23)	23	–
„ Pembroke	9.4	4.5	12.0(5)	−1.0(27)	−5.5(27)	182.8	141	24.7(13)	23	1
„ Gower	9.2	4.2	12.4(5)	−0.8(27)	−6.4(27)	207.6	159	37.7(1)	23	1
GUERNSEY: Airport	10.0	6.1	12.1(3)	2.7(v)		139.5		30.2(5)	22	2
ENGLAND:										
Denbury, *Devon*	9.5	2.8	12.9(30)	−2.9(26)	−8.0(26)	75.0	125	10.4(2)	18	1
Bournemouth, *Dorset*	9.9	3.4	12.2(20)	−2.2(26)	−5.4(26)	96.9	117	16.2(26)	21	1
Gurney Slade, *Somerset*	8.1	2.1	12.0(5)	−4.0(11)	−5.5(29)	140.1	128	14.1(16)	21	0
Yatton, *Avon*	9.4	3.9	13.5(5)	−2.9(11)	−6.2(29)	78.4	8.5	11.0(13)	20	0
Congresbury, *Avon*	9.6	4.0	13.9(23)	−0.9(11)		84.7		11.2(8)	21	0
Trowbridge, *Wiltshire*	8.6	0.8	12.7(5)	−4.6(29)	−9.8(18)	93.6	132	15.5(29)	19	0
Codford, *Wiltshire*	9.0	1.7	12.9(5)	−5.2(29)	−8.0(29)	100.3	106	14.4(26)	19	0
Corsham, *Wiltshire*	8.4	1.8	12.4(5)	−3.7(29)		98.2		14.5(26)	18	0
Marlborough, *Wiltshire*										
Reading Univ., *Berks.*	8.3	2.4	13.0(1)	−2.2(29)	−8.5(26)	60.3	102	8.9(15)	19	0
Sandhurst, *Berkshire*	8.4	1.8	13.3(1)	3.9(18)	−8.3(18)	70.9	103	12.3(15)	19	0
Newport, *Isle of Wight*	9.7	3.3	12.1(1)	−1.9(29)	−5.2(18)	118.9	127	16.3(5)	21	0
Horsham, *Sussex*	8.1	2.6	12.6(1)	−3.6(29)	−5.6(18)	96.3	125	21.0(5)	21	0
Brighton, *Sussex*	8.8	3.6	12.5(1)	−1.0(18)	−2.0(18)	125.3		21.8(5)	23	1
Hastings, *Sussex*	9.1	5.1	13.0(1)	0.6(25)	−5.0(25)	113.4	142	22.7(16)	16	1
Dover, *Kent*	8.3	3.1	11.3(20)	−2.1(27)		128.9	185	29.2(16)	22	2
East Malling, *Kent*	8.5	2.2	13.7(1)	−3.6(29)	−6.0(18)	70.1	112	16.5(5)	21	0
Epsom Downs, *Surrey*	7.4	2.8	12.0(1)	−3.1(28)	−4.4(18)	80.5	96	19.2(5)	22	0
Reigate, *Surrey*	7.4	2.4	12.8(1)	−4.2(29)		88.7		16.4(5)	21	0
Guildford, *Surrey*	7.8	3.3	12.7(1)	−4.4(29)	−5.7(29)	72.7	100	12.9(5)	20	0
Sidcup, *London*	8.4	2.4	14.0(1)	−2.8(29)	−6.8(27)	51.2	88	11.7(5)	19	0
Hayes, *London*	8.1	2.1	12.9(1)	−2.8(25)	−4.6(25)	67.9	126	11.4(2)	21	0
Hampstead, *London*	8.0	3.2	12.9(1)	−0.9(29)	−4.4(29)	58.3	97	11.5(5)	23	0
Royston, *Hertforshire*	7.6	3.6	12.5(1)	−1.6(28)	−5.6(28)	34.6	65	9.5(5)	18	0
Loughton, *Essex*	7.5	2.2	13.5(1)	−3.0(25)	−7.8(27)	55.3	95	12.6(5)	22	0
Leigh-on-Sea, *Essex*	8.7	3.6	14.4(1)	−1.9(28)	−4.1(29)	49.6	99	13.7(5)	18	0
Pulham St.Mary, *N'folk*	8.0	1.8	13.7(1)	−3.9(28)	−7.2(27)	48.8	92	9.3(5)	19	0
Buxton, *Norfolk*	7.7	2.0	13.7(1)	−5.0(29)	−6.7(27)	44.3	77	8.9(5)	15	0
Scole, *Norfolk*	8.1	2.2	13.9(1)	−3.3(29)	−7.7(29)	53.7	101	9.9(5)	16	0
Ely, *Cambridgeshire*	7.8	1.7	12.8(1)	−3.5(27)	−5.1(28)	40.7	87	5.2(19)	17	0
Luton, *Bedforshire*	7.6	2.8	12.6(1)	−3.0(28)	−6.1(28)	53.5	84	7.6(5)	20	0
Bedford, *Bedforshire*	8.4	2.2	13.5(1)	−4.1(28)	−7.9(27)	41.9		6.0(15)	17	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	D	T
Buckingham, *Bucks.*	7.6	1.9	12.1(1)	−5.0(28)	−8.8(28)	45.2	79	6.8(16)	17	0
Oxford University	8.3	2.7	12.9(5)	−2.6(28)	−7.0(29)	44.3	80	8.4(15)	18	0
Birmingham Univ'sity	7.1	2.7	13.2(5)	−2.0(26)	−7.1(26)	46.5	62	7.9(33)	21	0
Kettering, *Northant.*	7.7	2.0	12.2(23)	−4.8(28)		48.5	75	11.0(2)	19	0
Hinckley, *Leicestershire*	7.7	2.5	13.0(5)	−1.5(28)	−4.7(11)	38.4	62	5.4(15)	20	0
Cosby, *Leicestershire*	7.1	1.6	11.7(5)	−3.3(28)	−6.5(28)	35.0	54	4.8(15)	20	0
Louth, *Lincolnshire*	8.0	2.8	12.6(23)	−3.1(27)		45.8		10.4(24)	17	0
Newark, *Notts.*	7.0	2.6	13.0(23)	−1.3(27)	−6.0(27)	39.5	69	9.1(24)	16	0
Nottingham, *Notts.*	7.5	2.1	13.1(5)	−3.6(28)	−6.6(28)	32.3	59	4.9(23)	16	0
Middleton, *Derbyshire*	5.6	1.7	10.9(23)	−3.0(27)		62.0		7.1(3)	22	0
Burton-on-Trent, *Staffs*	7.6	1.9	13.5(5)	−3.0(28)	−4.5(25)	43.4	73	7.8(15)	22	0
Keele University, *Staffs*	6.8	1.7	12.3(5)	−2.2(26)	−5.0(26)	49.6	66	9.6(23)	17	0
Liverpool, *Merseyside*	8.1	3.0	13.4(23)	−1.1(27)		71.0	95	10.7(1)	22	0
Lathom, *Merseyside*	8.2	2.8	13.1(1)	−1.5(27)		64.5		12.5(17)	20	0
Sheffield, *S.Yorkshire*	6.9	2.5	12.6(23)	−3.4(27)	−8.9(27)	48.5		6.1(18)	19	0
High Bradfield, *S.Yorks*	4.3	1.2	9.4(23)	−4.6(27)		73.2		12.4(18)	24	–
Cottingham, *Hum'side.*	8.0	2.4	13.8(23)	−3.8(27)	−7.2(27)	37.5	61	5.1(17)	17	0
Carlton-in-Cleveland	7.4	2.1	12.7(23)	−4.4(27)	−8.9(27)	29.3		4.9(17)	14	0
Sunderland, *Tyne/Wear*	8.1	3.0	13.1(23)	−4.3(27)		24.3	47	5.5(23)	13	0
Carlisle, *Cumbria*	7.8	3.3	12.5(23)	−4.3(27)		76.8	116			
Kendal, *Cumbria*	7.6	1.3	12.0(5)	−7.0(27)		129.8	123			
CANADA: Halifax	4.7	−4.3	11.5(6)	−19.3(27)		138.5		33.4(23)	20	0
U.S.: Durham, Maine	2.8	−7.8	11.1(17)	−20.0(27)		79.5		23.9(6)	21	0
JAMAICA: Montego	28.4	21.1	29.8(5)	19.0(12)		55.1		18.5(4)	14	0
ANT'ICA: Neumeyer	−2.2	−8.2	0.5(19)	−13.5(15)						

CUMBRIA RAINFALL:

Appleby Castle, 79.7mm (92%); Hawkshead, 198.9mm (103%); The Nook, Thirlmere, 258.3mm (94%); Coniston, 271.2mm (106%); Seathwaite, 349.0mm (109%).



FIRST CONFERENCE ON TORNADOES, WATERSPOUTS, WIND DEVILS AND SEVERE STORM PHENOMENA

to be held on

SATURDAY 29th JUNE 1985

at

OXFORD POLYTECHNIC

The conference is co-sponsored by the Tornado and Storm Research Organisation and the *Journal of Meteorology;* it will be chaired by Michael Hunt of Anglia Television. The proceedings will be published in the hundredth issue of the *Journal of Meteorology.*

CONFERENCE PROGRAMME

10.15-11.00
Registration and tea/coffee.

11.00
Conference opened by Michael Hunt, Anglia Television, Norwich.

11.00-11.30
TORRO – The Tornado and Storm Research Organisation:

Part A:
The formation and expansion of TORRO
(Terence Meaden, TORRO, Bradford-on-Avon).

Part B:
Work of the Tornado Division
(Michael W. Rowe, TORRO, Southampton).

Part C:
Work of the Thunderstorm Division
(Keith O. Mortimore, TORRO, Corsham).

Part D:
Work of the Hailstorm Division
(Derek M. Elsom, TORRO, Oxford Polytechnic).

11.30-12.00
Spatial and temporal distribution of thunderstorms in Britain
(Bob Prichard, London Weather Centre).

12.00-12.30
The classification of whirlwind types and a discussion of their physical origins
(Terence Meaden, TORRO, Bradford-on-Avon).

12.30-1.00
Tornadoes in Britain: where, when and how often
(Derek M. Elsom, TORRO, Oxford Polytechnic).

1.00-2.15
LUNCH

2.15-2.45
Britain's greatest tornadoes and tornado outbreaks
(Michael W. Rowe, TORRO, Southampton).

2.45-3.15
Building damage caused by tornadoes
(Philip Buller, Building Research Establishment, Garston).

3.15-3.45
Ball lightning
(Mark Stenhoff, St. Dunstan's College, London).

3.45-4.25
Illustrated case studies of recent whirlwind phenomena in Britain including:

- ★ the Barmouth tornado-waterspout, 22nd September 1984 (John Smith, Wolverhampton Polytechnic).
- ★ the Severn Bridge tornado-waterspout.
- ★ Tornado at Smarden, Kent, 5th September 1980 (Christopher R. Chatfield).

4.25-4.30
Closing remarks: the future work and role of TORRO.

4.30-5.15
Tea available.

THE CONFERENCE WILL INCLUDE:

- ★ the first display of TORRO's extensive photographic collection of British tornadoes, waterspouts, wind devils and large hailstones and the damage they have caused.
- ★ the first exhibition in Britain of tornado paintings and drawings by Leonard Silverman of Cambridge, Massachusetts.
- ★ the showing of the film – THE TORNADO.
- ★ the display of slide sets and other teaching materials concerned with severe storms.

REGISTRATION

Attendance at the meeting is open to all. Amateur meteorologists are especially welcome as there will be opportunity for questions and discussion after each of the main talks.

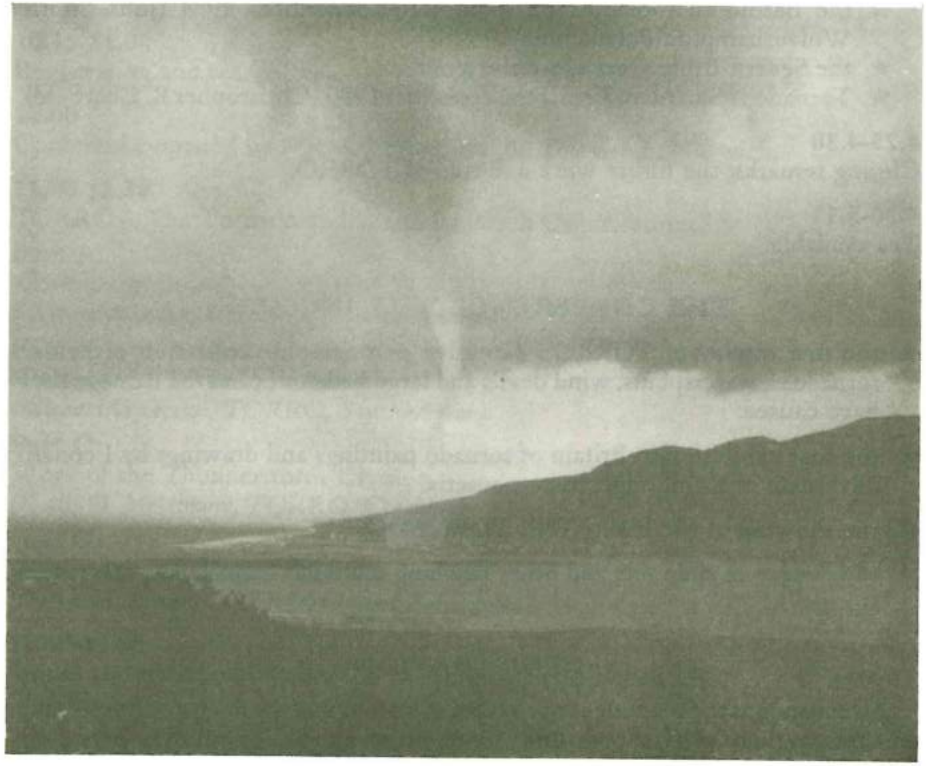
The registration fee is £3 for *Journal of Meteorology* subscribers (and students) or

£5 for non-subscribers (this will cover coffee, tea, biscuits, administration costs, TORRO literature, and a copy of the conference proceedings). A choice of lunches is available at an additional charge. Participants need to register in advance by obtaining a booking form from Dr. Derek Elsom, Geography Section, Oxford Polytechnic, Oxford (tel: 0865 64777).

AN INVITATION FOR SHORT CONTRIBUTIONS

TORRO recognises the important role that amateur meteorologists play in providing observations on whirlwind phenomena and their effects. During the afternoon session of this conference, an opportunity is being given to anyone willing to provide a 5-minute eye-witness account of a recent whirlwind event.

Interested persons should contact Derek Elsom or Terence Meaden. Preference will be given to those who can provide an *illustrated* case-study. Videos are welcome. TORRO will provide the facilities for the making of slides from any available photographs



Tornado waterspout raising spray and sinking boats in Barmouth harbour on 22nd September 1984, photographed by Mr. R. Vaugton.

THE JOURNAL OF METEOROLOGY
LE JOURNAL DE MÉTÉOROLOGIE

Published in association with
The Tornado and Storm Research Organisation
a privately-supported research body, serving the national public interest

Edited by Dr. G. T. Meaden, 54 Frome Road,
Bradford-on-Avon, Wiltshire, BA15 1LD, England.
Telephone: National, 02216.2482; international, +44.2216.2482

Research papers, letters, news items, conference information, books for review, and other communications on all aspects of meteorology and climatology are to be addressed to the Editor.

Contributions for publication should be typed, or neatly handwritten, with double spacing and 25 mm wide margins. In the case of typescripts, a duplicate copy would be appreciated. Every paper should commence with a short abstract summarising its significant and/or original content. Recent issues of the journal should be consulted as a guide to the layout of papers. Metric units are strongly recommended. Line drawings may be prepared up to 2 or 3 times oversize, but their quality should be good enough for direct reproduction. They should be drawn with a black pen on good-quality white paper, with lettering symbols large enough to be legible after reduction. Figure captions should be numbered and collected in sequence at the end of the paper. Each table should have a number and a short title, and be on a separate sheet at the end of the manuscript. In the text, references should be made by giving the author's name and year of publication, e.g. Manley (1976).

The usual language of the journal is English but a few contributions will be acceptable in French, Spanish, Italián and German. Correspondence with the Editor's office may be in any of these languages.

Responsibility for the opinions expressed in the signed articles rests with their respective authors, who should also obtain copyright permission where necessary. Please note that page charges may have to be imposed for some articles involving special artwork, complex equations, or numerous photographs or diagrams.

Kindly note that, for citation purposes, the recommended abbreviation for the title of this journal is *J. Meteorology, UK.*

Subscriptions for 1985, Volume 10, *including surface post,* U.K. £24.00; rest of world £26.00; *including airmail* £32.00. For personal subscriptions from individuals deduct £8.00 from each of these rates. Students and senior citizens £12.00 upon request.

Back issues are available for purchase either as complete volumes or singly. Volumes 1-6, £4.00 each; volume 7 or 8, £8.00; volume 9, £12.00. Single issues, *pro rata.* These prices include postage and packing.

Published by The Artetech Publishing Co., 54 Frome Road, Bradford-on-Avon, Wiltshire, BA15 1LD.

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

ISSN 0307-5966

JOURNAL OF METEOROLOGY Vol. 10, no. 97, March 1985

CONTENTS PAGE

FRONT COVER:

A whirlwind circle with perfect spiral pattern over 14 metres in diameter photographed on 24th June 1984 near Cley Hill (Warminster, Wiltshire, is in the distance). This one had four small satellite circles, each about 4 metres across.

JOURNAL OF METEOROLOGY EDITORIAL OFFICE:
54 Frome Road, Bradford-on-Avon, Wiltshire, BA15 1LD, U.K.