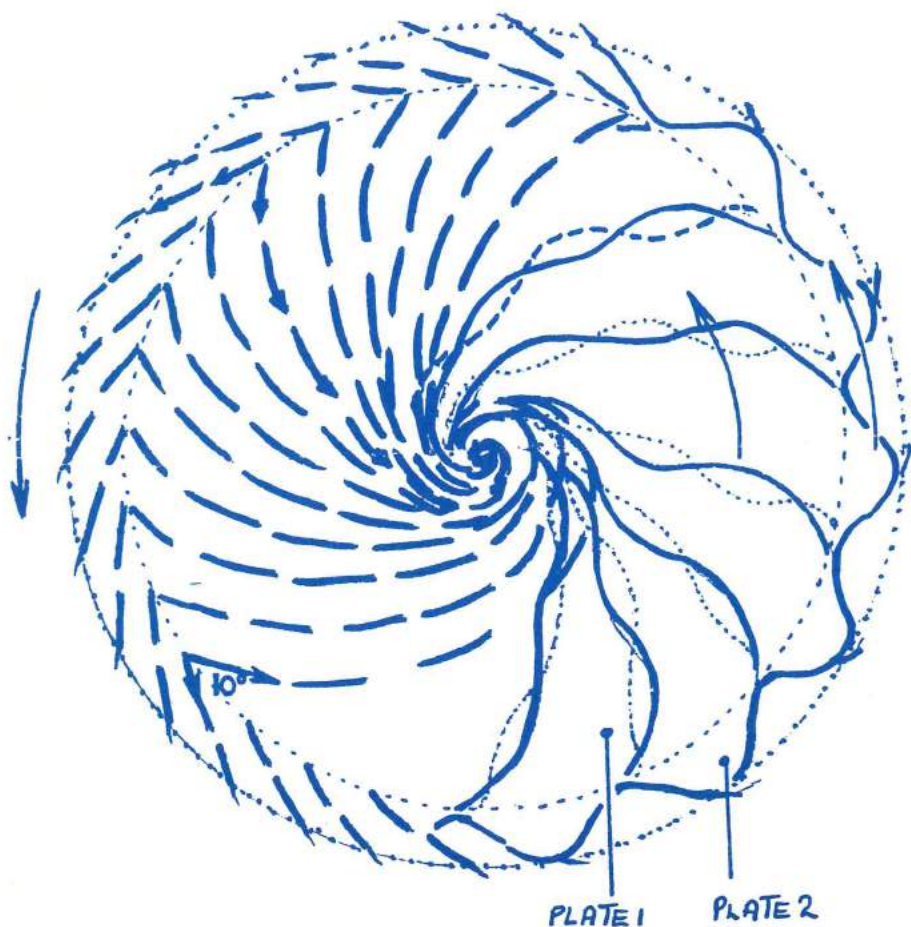


The
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AN ANTICLOCKWISE SPIRAL-CIRCLE
FORMED IN A CEREAL CROP IN HAMPSHIRE

JOURNAL OF METEOROLOGY

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THE WEATHER OF PEPYS, 1660-1669: PART 2

By the late D. J. SCHOVE
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Abstract: The second part of this series of four articles covers the period from spring 1664 to December 1666, and includes the Great Plague of 1665 and the Great Fire of London in the autumn 1666. Part 1 was published in *J. Meteorology*, vol.11, no.107, March 1986 (pp.73-88). The references cited in these articles will be given with the concluding paper.

SPRING 1664: DRY BUT THUNDERY

In 1664 Pepys begins to record not only the cold and wet days but also the warm and fine days, and these were indeed becoming more frequent. His weather notes (e.g. 20th, 24th, 28th February; 1st March) refer to 'pleasant weather' and 'brave moonshine' and to Hyde Park 'dust' (22nd April), but our knowledge of the dryness of the season as a whole comes from other writers. Josselin on 28th February, after a month when farmers expect the ditches to be full of water, reports 'a very clearly time many days, promising a drou't' and by 15th May states 'The season very dry, the drought great. God hath yet visited our fields with rain beyond the portion of others' and the dryness continued until the end of May, his comment on the 22nd being 'yet the season very dry, some little dewes Lord satisfie the earth'.

The abnormal thunder and hail showers (reported this year in Scotland, England, France and Russia) brought local relief, as had evidently occurred in Essex before 15th May: indeed Pepys has, as usual, some references to rain (12th, 13th, 26th March; 12th, 13th April; 13th, 19th May). His rainbow 'the first ever in the morning I saw' (13th February) belongs to a spell when there were some very severe local hailstorms (see Schove, 1951).

The aurorae of the period 1660-64 have been discussed elsewhere, but the only reference in Pepys (26th April) relates to Amsterdam and he did not mention the displays some other Londoners have described (cf. Schove 1952).

SUMMER 1664: FAIRLY WARM, THUNDERY, FAIRLY WET

In Norfolk Clarke records 20 days between 5th April and 31st August with thunder, and the frequent London storms are noted by Pepys. On 1st June when he was at the theatre in the pit watching *The Silent Woman*, suddenly 'it fell such a storm of hayle that we in the middle of the pit were fain to rise' (see iv, 166, n.1) 'and disorder followed'. Pepys refers to thunderstorms again on the 19th and 26th; on 3rd July he comments, 'this yeare have had the most of thunder and lightning they say of any in man's memory, and, so it is, it seems, in France and everywhere else'. (In Oxford hail like that of 15th May had 'not been knowne in the memory of man or at least for 60 yeares', Wood, 1892). Pepys, not without apprehension, left



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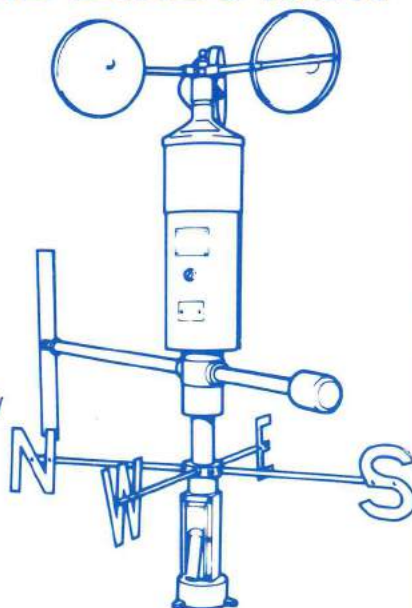
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off his 'linnen waistcoat' on the 7th July but it was still cool, and the worst storm was yet to come, the thunderstorm of 16th August (cf. iv, 243, n.3).

Plague had meanwhile reached Amsterdam, probably from Algiers, as Pepys noted on 25th July, and on 3rd August he adds that it has got into their fleet.

AUTUMN 1664: WET

In this season both Pepys and Josselin record the rainy periods but the first month (except for about the 1st September) must have been dry, and Josselin, who like Pepys noted the rain on 25th September, added 'a mercy after much dry weather'. In a letter to the Earl of Sandwich he had noted that the wind for some days had been N.E., and, as is usual then, in Scotland the autumn was considered dry. Nevertheless, in S.E. England the mid-season was very wet; already on 1st September Pepys had noted 'A sad rainy night'. Josselin mentioned also 'the wayes for dirt and water like the depth of winter', and a further 'wonderfull floud' on 30th October.

Ground frosts were often seen on the grass in seventeenth-century London and Goad records once again a 'Sharp Frost (in the) morning' on 3rd/13th September. He had also noted frosts earlier (24th-26th August). Ground frosts are not uncommon in the grass-covered areas of London to-day, but air frosts do not occur until the second half of the month (Brazell, 1968, p.54).

DECEMBER 1664: COMET

The unsettled weather of autumn continued until about 10th December after which the weather became cold. It was also often clear, and then a comet could be observed. This comet (v 346 n.3) had been seen on 5th December, on which day Josselin wrote 'this morning a blazing starre seen in Earles Court as several said . . .' but Evelyn did not refer to its being seen before about 13th December, one of those days when Pepys 'lay long in bed' perhaps because of the change in the weather (cf. 10th December). Pepys found much talk about it at the Coffee House on the 15th, but did not see it himself until 24th December (cf. also 23rd and 26th December) and indeed in the 'hard frosts' at the end of the year (e.g. 30th December according to Goad) Pepys once again tells us: 'Lay long in bed . . . my wife very full of a resolution to keepe within doors'.

The positions of the comet among the stars are given in ed. Hall, A. R. and Hall, M. B., 'The Correspondence of Henry Oldenburg', 3, p.5 and p.357.

The comet was later regarded as a portent of the cold weather, the plague and the Dutch War and 'Some said that when faithful (nonconformist) ministers were discharged (from) preaching, God set a preacher in the heavens, which no bishop could dispose'. (M. Crawford of Renfrewshire, MS History of the Church of Scotland. In the Old Statistical Account, 18, 212).

YEAR 1664: DRY, MUCH HAIL AND THUNDER

The dryness was noted particularly in Scotland, the hail and thunder over much of Europe.

WINTER 1664-5: LONG, VERY COLD, DRY WINTER

The long, cold winter that preceded the plague was rated by Pepys 'as hard a winter as any hath been these many years'. It had begun in early December and was

to last until the beginning of April; the cold was particularly severe in January and February. In Europe as a whole the winter was less extreme than 1658, but unusual cold was reported from the Orkneys off N.E. Scotland to southern Italy.

On 3rd January Pepys had noted that because of 'a great frost' there was little horse traffic and he found 'the street full of footballs'. On the 4th he noted 'a very hard frost' and on the 5th Goad recorded 'Ice on Thames'. On January 27th in Old Style dating (February 6th New Style) the thermometer readings at Paris have been interpreted as -21°C or -6°F , and although London would not have been as cold as this, a few days later the cold there became severe.

In this month Hooke's scale had just been developed but London readings of this date do not survive (cf. Patterson, 1953).

On 5th February Pepys 'lay in bed most of the morning', the 6th 'being one of the coldest days, all say, they ever felt in England' and Pepys apprehensively donned a suit that had not been aired in his efforts to keep warm. For eight weeks, according to Josselin, from 21st December to 9th February, 'it was wonderfull sharpe beyond what known for so long in my memory'.

The winter was also very dry, although this we infer only from the almost complete absence of references to rain and snow in the diaries.

The plague, which had already been present in London in 1664, did not spread. In his 'Loimologia or an Historical Account of the Plague in London in 1665' Nathaniel Hodges wrote '. . . a very hard frost set in on December, which continued three months and seemed greatly to deaden the contagion and very few died during that season . . .'

SPRING 1665: COLD, VERY DRY, NEW COMET

The very cold weather continued. On 22nd February (4th March N.S.) the reason Pepys gave for being 'cold all night' was that he and his wife were in separate beds, but Goad tells us that it was trying to snow ('Offering snow'). On 5th March Josselin says 'my inkhorn frosne . . .' and on the 7th 'my pump frozen . . .'. On 6th March Goad, a good observer, wrote 'not such frost known in March'. On 8th March Pepys still recorded 'A bitter cold day' but he makes almost no comments about the rest of the season.

Other diarists tell us how the rain came on 12th March but the weather generally continued dry and cold with 'nights almost continually cold frosts' as late as 16th April (26th April N.S.) according to Josselin. On the 25th he regretted taking off his periwig. On 13th May Pepys was still wearing winter clothes but 'the weather being hot' Pepys was uncomfortable. On the 14th Josselin complained 'the drought doth not only continue but the heat groweth very much' but Pepys proudly writes that his wife went to church 'very fine in a new yellow bird's eye hood'. The dryness had already by 11th April led to a warning by Charles II about the risk of fire (see below p.44).

The new comet has already been discussed (vi 75 n.1); the plague was mentioned by Pepys on 30th April (vi, 93, n.2).

SUMMER 1665: HOT, DRY, PLAGUE, GOOD HARVEST

Pepys now begins to make more observations about the weather and the hot spells of this season are well described. However, the diary refers to rain six times, (8th, 25th June; 19th July; 5th, 6th, 13th August) although in general the season

was dry in S.E. England. The summer was regarded as wet in Scotland, and wet spells in London were limited to early July (not noted by Pepys) and early August.

The 7th June Pepys termed 'The hottest day that ever I felt in my life . . .'. His wife and mother, in order to refresh themselves, got up at 2 a.m. and took a boat to Gravesend. Pepys himself 'weary with . . . the mighty heat of the weather . . . stayed walking in the garden to 12 at night' awaiting his wife's return. (Locke in Boyle, 1692).

The cold winter, followed by the dry Spring and hot Summer, can be shown to be the standard pattern of those years in this century in which plague epidemics developed in N.W. Europe; it was on this hot day that Pepys saw houses marked with the Red Cross to indicate that they were isolated because of the plague. As Nathaniel Hodges put it ' . . . upon the frost breaking the contagion got ground, and gradually got out of its confinements like a flame that for some time seems smothered and suddenly breaks out with aggravated fury'.

Again in mid-July it became very hot. On the 11th 'sweaty it being very hot beyond bearing; Goad at Waltham Cross reported that it was 'Excessive hot' on the 15th, and on the 16th Pepys says 'it was most extraordinary hot that ever I knew it'.

The sound of the gunfire off Lowestoft between the Dutch and the British on 3rd June were heard in London, 200km to the S.W. and the same day in Cambridge. This phenomenon, effective in the range 200/300km, is known as abnormal audibility and occurs notably in summer because a warm layer 50km up in the stratosphere reflects the sounds (cf. vi, 116, n.1 and cf. C. M. G. Dobson, 'Exploring the Atmosphere' 2nd ed. 1968, Oxford). Ozone in that layer absorbs the ultra-violet light and incidentally protects us from its harmful effects.

Pepys did not mention the sun-pillar described by Evelyn on 9th March or the English earthquake of January/March but his talk of 'a new comet' on 17th August (cf. vi, 194, n.1) is not confirmed by other writers.

AUTUMN: 1665: COOL, WITH GALES. FAIRLY DRY, PLAGUE

Plague, it was supposed, would spread less if fires were lit in the streets, and fires were deliberately so lit on 6th September (cf. vi, 213, n.5); smart showers soon extinguished them, Pepys reporting 'A most cursed rainy afternoon, having had none a great while before'. Despite the fires, and even the cooler weather that followed, the plague continued to be very bad. N.W. gales followed in N.W. Europe on the 10th and 11th, Pepys reporting how the wind caused damage on the 13th *inside* the mansion of Captain Cocke! Marine phosphorescence, or bioluminescence, was noted by Pepys at sea on 25th September (vi, 241, n.3). Some (ground) frosts were noted by Goad on the 16th, but plague deaths that week increased unexpectedly, as Pepys pointed out (vi, 234, n.1).

The 'looseness' that affected Pepys on 28th September, ascribed by him to 'damp linen', was a normal concomitant of dry seasons even in the nineteenth century; water-supplies were often infected.

The gales of 24th/27th October that 'drove the Dutch off the coast' were associated with a very low barometer, as Beal and Wallis recorded. Further gales are also described by Pepys including a 'hideous wind' on 7th November; on 5th November Josselin observed 'few leaves left on the trees, except those withered on

the oaks'. The gales of mid-November were associated with a tidal surge (cf. Gottschalk, 1975) and Pepys was relieved he was no longer at sea on November 13th/14th (cf. vi, 298, n.2), when there was 'as great a storme as was ever remembered'. Damage was done in various parts of England, Holland and Flanders by the gales of this month, but, despite the references in the diary, even November was not wet and October had certainly been dry.

DECEMBER 1665: COLD, DRY

Colder weather brought the plague deaths down to below a thousand, the statistics being quoted by Pepys on 22nd November (2nd December N.S.) when he reports 'a very exceeding hard frost'. On the 26th it was too cold for him to go by water and it was hard and slippery but 'with a lanthorn' he managed to walk to Greenwich.

The weather was mild in the early part of December and Pepys noted: 'The plague is increased again this week, notwithstanding there hath been a day or two great frosts (i.e. after the 9th DJS); but we hope it is only the effects of the late close warm weather and if the frosts continue the next week, may fall again'. Pepys was right. The frosts did continue and the plague did decrease. By the 18th 'the river beginning to be very full of ice' Pepys was 'a little frightened' and going to Lambeth Pepys found it 'troublesome' on the 20th crossing over the River by boat. On the 21st his beef was 'frost-bitten' and eaten unroast. On the 22nd the 'river was frozen'. On the 31st Josselin wrote 'the frost continues' and Pepys recorded 'now the plague is abated almost to nothing'. In the false belief that cold *winters* stopped the plague (February had actually been cold in the plague years of 1603 and 1625) everybody was hoping for a second cold winter, although it now seems that the plague increases with warmth only in summer.

The month was very dry there being no references to rain in either Josselin or Pepys; snow was mentioned only on the 18th.

YEAR 1665: COLD, DRY, CONTINENTAL-TYPE

The coldness of the plague year as a whole is well brought out by Pepys. The cold of winter and the dryness of spring and summer were all conducive to its spread, which was encouraged by what is termed a continental type climate.

The change to dry weather in this year is discussed on p.39, and the region of dryness in the years 1665/6 extended through S.E. Europe (there were two fires in the Seraglio of Constantinople) to Arabia, where the drought was regarded as exceptional and caused famine.

WINTER 1665-1666: DRY, COLD AT FIRST

The very cold weather of the first part of the winter has already been described. The first half of January was as warm as early December had been whereas the rest of the season was mixed.

Pepys, with his professional Naval interests, paid special attention to the gales of January (cf. vii, 21, n.5): on the 24th he noticed houses 'blowed down' and, with no palings left on either side of London Bridge, he had to take special care when crossing it. On 11th February he refers to 'all the storms we have had' since the middle of December, but his anxiety about these gales arose from his fear that Smith's fleet had been lost – perhaps, he thought, in the Biscay region (cf. vii, 9, n.5).

The snow that covered the graves on 4th February made Pepys 'less afeared for going through the churchyard'. But the snow did not last: the next day it rained. This was typical of the winter.

Pepys had not yet noticed the outstanding meteorological character of the season – dryness. On 14th January Josselin reported '... no rain or litle and so ever since Nov: 64, no water in ponds they drive their catle to water in the hundreds' and again on the 21st, when a wet week set in, 'our ponds empty and almost without water'. This dryness was significant as it preceded the Fire of London (cf. below p.44).

SPRING 1666: DRY, WARM

In this season Pepys himself now begins to talk of drought: he has several references to dry or pleasant weather (cf. 23rd, 26th, 28th February) and on 18th March he states 'Very fine, fair dry weather, but all cry out for lack of rain'. Josselin already on 11th March had termed the season 'excessive dry'. At Oxford there was no rain from 10th February to 19th March, according to Wood (1972 ed). A wet spell followed but on 1st April when Pepys has merely 'a most pleasant warm day' Josselin, referring to the whole week, say 'Wonderfull dry' and two days later when showers came added 'very refreshing to our dusty lands'.

On 7th March Boyle wrote to Oldenburg (see Hall and Hall, 3, 54) about the persistently high barometric pressure and the dry seasons (although his explanation of the connection was incorrect); he referred also to the drying up of springs near Weymouth.

The second half of the season was not particularly dry but it was warm, and this aspect comes over well in Pepys. 21st April he described as 'A mighty hot and pleasant day' and on the 29th he wrote 'To bed having my haire of my head cut shorter, even close to my skull'. On 5th May in 'fine moonshine' he sang in the garden till about 12 at night with mighty pleasure to ourselves and neighbours, by the Casements opening'. In our own day, with television, such a response from neighbours would not be considered complimentary.

On the 10th of May 'it being wonderous hot all the day (and) night'. Pepys spent the evening 'for the ayre', going by coach to what was then the country. The plague meanwhile had increased again as Pepys had noted on 12th May, and indeed it was active in Flanders; however, on 13th May Josselin reported 'the aire very cold and very much rain' and the month as a whole was described by him as 'cold' (27th May). The plague continued to spread into the Rhineland but only local outbreaks occurred in England in 1666 (cf. J-N. Biraben, 'Les hommes et la peste', 1975, Paris, Mouton, pp.125-7 and appendices).

SUMMER 1666: HOT, DRY

The warmth of the summer of 1666 is clearly conveyed in the diary. Sometimes Pepys is too brief: on 17th June he wrote merely 'fine', whereas Josselin, referring to the week as a whole and no doubt thinking of the hay, is more revealing with 'God good in the season very hot and dry'. Small details in Pepys at other times tell us much; on 20th June, Pepys had 'of late' worn a thin silke waistcoate, without any other coats over it and open-breasted '... ' and in the evening he was once again singing in the garden 'it having been these three or four days mighty hot weather'. On 25th June, the day when in Lord Brooke's garden he pulled off a little orange



Fig.1: Harvesting fruit from a Dorset garden in mediaeval times.

'by stealth and eat it', he says 'the weather being extremely hot. So home and to bed, and this night the first night of my lying without a waistcoat ... '

The good wine made this year from Sir W. Batten's English grapes was appreciated by Pepys the next (1667, 17th July), when 'the whole company said they never drank better foreign wine in their lives'.

The next hot spell is noted on 7th July 'the hottest night that ever I was in my life, ... ' but again on the 15th 'it being mighty hot' he fell asleep in the Park on a Sunday, a day when Josselin confirmed that it was 'a very hot season'. These words were repeated the following Sunday, when Pepys reported merely that the Navy were awaiting a wind before they left the Thames to fight the Dutch. On the 25th, dining on the food that came from the king's table, Pepys described the 'most brave drink cooled in ice' at this hot time as most welcome. August was nevertheless destined to be cooler.

The dryness of the season, notably in June, is also well conveyed by Pepys on the 26th when he states 'after a long drowth, we had a good shower of rain, but it will not signify much if no more come' and again on the 27th when the shower was 'a great and welcome one after so much dry weather'. The heat and dryness extended even to Scotland and the Chronicle of the Frasers notes 'Hot drought' from May to mid-July. On the Continent the summer was noted as dry from the French Riviera to Poland, and in S.E. Europe the drought led to emigration and famine.

There were again thunderstorms and hail in England in this summer, notably in late July. On the 16th Pepys reports that Harwich had hailstones 'as big as walnuts' although London had only a shower of rain. East Anglia in this season may have had more rain than London, and on the same day Josselin in Essex wrote 'the greatest hailstones fell I ever saw as big as hen's eggs and some round and flatt with strange pictures as some say'. On the next day (17th July) in Suffolk at Aldborough hailstones as big as Turkey's eggs were said to have fallen (see *Phil. Trans. Roy. Soc.*, 2 and cf. Schove, 1951, p.20). No storms were mentioned this summer by Pepys for

London, although Lambeth Parish Register reports on 6th July the burial of John Ward 'who was killed with a thunderbolt'. On May 31st Portslade Church in Sussex had been damaged by lightning.

Abnormal audibility of gunfire was again reported this summer by Pepys e.g. on 4th June, when the English and Dutch fleet were engaged in battle off the Belgian coast. The sound waves from the guns passed high above the Kent coast but were reflected down to London by the warm 'ozone' layer. The sounds were noted by Pepys also on 2nd June and 25th July.

AUTUMN 1666: DRY UNTIL THE FIRE THEN MAINLY WET AND WINDY

The dryness, so persistent since the winter of 1664-5, enabled the Fire to spread rapidly, the part played by the weather being discussed separately below. The general wind direction during the Fire was Easterly – and our table suggests that such spells were frequent from 1663-1667 – but Pepys supplied interesting evidence with his entry on the 3rd February following when it is put on record that pieces of burnt paper were carried by the wind as far as Cranbourne near Windsor.

The long dryness was interrupted on 9th September by wind and rain. This rain, as Pepys put it, was 'good for the fire', which had not been completely extinguished, Rugge informing us later that the fire continued burning for four months, though it rained in the month of October for ten days without ceasing (cf. viii, 393, n.1). By 18th October the posts were delayed by the flooded roads, and on 12th November, when Josselin reports 'wett dirty' weather, Pepys was upset because he 'did get such a splash and spots of dirt' on his new vest.

DECEMBER 1666: WET THEN COLD WITH SNOW

The rain and wind continued until about 10th December, described as 'a cold day'. By the 23rd both Pepys and Josselin report frost and snow and this was to continue until the thaw on 9th January 1667.

1666: DRY, WARM

The year of the Fire of London was dry in Europe as a whole, although floods were reported in Italy. The weather for Pepys had become more important since the Plague of 1665 and his interest was maintained so that his references correctly portray the year as warm and dry. Dendrochronology of Stuart furniture in S.E. England (Schove 1966, 1985b) confirms that the pair of rings in 1666/67 (like 1674/5 and 1684/5) are characteristically narrow.

(to be continued)

AN ANTICLOCKWISE SPIRAL-CIRCLE IN A CEREAL CROP

Part 1: Results of the Studies made Before Harvesting

By G. T. MEADEN
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Abstract: For the first time it has been possible to make a scientific study of a cereal-crop circle in which the spiral flattening was anti-clockwise. The circle's mean diameter was 17.65 metres. Circle

centre and spiral centre did not coincide, the distance apart being 0.67m. Because the evidence shows that the initial flattening occurred by air pressure from above, the spiral flow at ground level must originally have been outwards, so it is noteworthy that the upper, or final, layering of the stalks was on an *inward-flowing* spiral. Interpretations of this and some other characteristics are given briefly.

INTRODUCTION

It is only since 1980 that the attention of scientists has been drawn to the phenomenon of spiral circles flattened in fields by 'mysterious', unseen, forces. Since then, we have visited and photographed a couple of dozen sets of circles, including triplet and quintuplet sets besides the single type. All of the circles that we investigated displayed clockwise rotation and a severe flattening of the corn which plainly indicated strong downward air-pressure. In the summer of 1986 there occurred several cases of clockwise circles within which was incorporated an anticlockwise ring. We also examined most of these, and a report on these studies is forthcoming. Nevertheless, examination of a fully anticlockwise circle was still lacking, so it was with considerable interest that we learnt of the discovery of an anticlockwise circle early in August, and with haste set off with Mr. Colin Andrews to view it.



Fig.1: A westerly view of the anticlockwise circle at Headbourne Worthy.

The site was a field one kilometre west of the village of Headbourne Worthy, not far north of Winchester, Hampshire. The national grid reference was SU 475335. The field on Down Farm sloped gently to the south and had nearly ripe barley at the time of the spiral manifestation (Fig.1, this view is looking west). Interviews with the farmer Mr. Simon Brown and with farmhands indicated that the date of formation was either the evening of Thursday 31st July or during the night of 31st July/1st August 1986. Consultation of weather diaries and study of the synoptic charts of the Meteorological Office showed that the weather was fairly cloudy over central-southern England in the evening of 31st with a force 3-4 W. to S.W. wind, but skies cleared by midnight and the wind strength decreased.

DESCRIPTION

The author and Colin Andrews visited the site only after obtaining permission from the farmer to enter his field to take photographs and measurements.

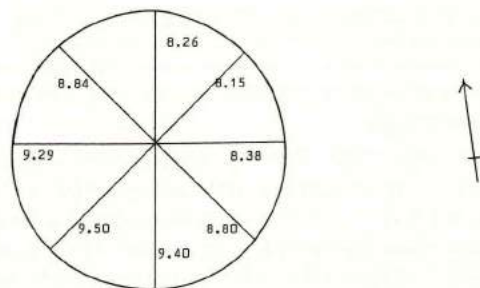


Fig.2: The principal measurements were the eight 'radii' shown on this diagram. Notice that the four diameters which result from these measurements are, respectively, 17.66, 17.65, 17.67 and 17.64 metres.

Eight radii were measured at 45 degree intervals, the measurements being taken to the spiral centre (Fig.2). Although the radii varied considerably from 8.15 to 9.50 metres, the variation was systematic and gave rise to a remarkable concordance between the four resulting diameters each of which differed from 17.65 metres (57 feet 4 inches) by less than 2cm. Allowing for small but inevitable uncertainties in measurement, this approximates well enough to a true circle. The position of the spiral centre, shown in close-up in Fig.3, proved to be 0.67 metre from the centre of the circle in a direction approximately to the north-east. The photograph shows that the straws nearest the centre are so tightly spiralled inwards that some of them are sharply kinked but not snapped through.



Fig.3: Close-up photograph of the spiral centre.

Close study of the lying straws showed that, despite the simplicity suggested by a circular perimeter, the details of the way in which the flattening had occurred were extremely complex.

Firstly, although, as is usual with this phenomenon, none of the straws were broken; the straws had been forced down with such intensity that some heads were even pressed firmly against the surface of the soil. A photograph (not reproduced here) was taken showing that a few heads had been totally stripped of

their grains by the pressure. There is no doubt that the primary agent was a force which had a strong vertical component downwards, and yet it must have been coupled with a spiralling horizontal component which, logically, could only have been outflowing. But as can be seen from the photographs reproduced in this article, the visible flow direction, although it is definitely anticlockwise, is, on the upper surface at any rate, inwards and not outwards. At first sight this looks like the perfect paradox, but it is readily reconciled because, upon close inspection, it is found that directional changes occur in the layering beneath the uppermost one. This will be explained later.

The second observation which merits careful study is what we are calling tangential ejections. This appears as a striated effect at the perimeter and represents an extension of the lying straws into the standing corn. The result is that straws, in bunches, have fallen beyond the circumference at intervals of some 15-25cm around the perimeter. They are easily seen in Figs.4 and 5. We had witnessed these effects on some previous occasions, and they are clearly seen on air photographs of the Goodworth Clatford quintuplet of 1985. We regard this



Fig.4: The northern perimeter of the circle.

effect as demonstrating the manner by which the spinning circle expands its diameter during its period of growth. The effect is interrelated with the bunched growth pattern of the crop. At the time of planting, the seeds fall in groups so that a slight bunching effect is inevitable as the stalks grow – and as they fall in the airflow. Nor do they all fall at right angles to the radius, for some are angled at 80-85 degrees, as can be seen in Fig.5 and is clarified in Colin Andrews' drawing (Fig.1 of the next article).

Thirdly there is a noticeable twisting effect to be considered. This is also a consequence of the bunching during growth and a twisting during the fall. It is further evidence of the torsional forces present in the airflow that flattened the crop. The direction of the twisting is anticlockwise when viewed from the head to root, or clockwise when regarded from root to head.

Of various other features present in this complex situation (cf. article by Colin Andrews which follows) one other effect could be studied in the time available,

although only partially. This was a layering effect noted to be present over part of the surface area of the flattened crop. By 'layering' we mean that stalks beneath the surface were lying at different angles from those above, giving an impression that the barley was lying as if on two layers. Because the directions of some of the lower-layer straws could be evaluated, this provided the final clue as to the sequence of events by which the circle had been formed.

DEDUCTIONS REGARDING THE MANNER OF FORMATION OF THE CIRCLE

From the foregoing evidence we conclude that the first stage was the descent of a spiralling vortex which upon reaching the level of the crop began flattening it anticlockwise. The affected area was circular with its spiral centre at the centre of the original expanding circle. Vestiges of this primary anticlockwise flow, directed as an outflowing spiral, remained in parts of the lower levels of the crop at the time of our investigation. The circle continued to expand by steadily increasing its diameter until the maximum figure of 17.65 metres was reached. Throughout this period the tangential component of the airflow was combined vectorially with a smaller radial component, the net result of which was an anticlockwise flow directed slightly outwards. The surface remnants of this outflow were still to be seen in the outer 50cm of the flattened crop and at the circumference itself. This is clearly visible in the photographs of Fig.5 and in the drawings of Colin Andrews.



Fig.5: Close-up view showing the 'outward flow' effect near and at the circumference of the circle.

Then began the stage of retraction and dissipation which was to end with total withdrawal of the spinning vortex from ground level. Still turning anticlockwise, the diameter began contracting, thereby causing the majority of the previously flattened stalks to adopt the modified direction of the airflow. This meant that they took up the direction of inward anticlockwise flow. But not all stalks were able to move, at least not completely, some of those lying deepest being protected by others above. This explains the layering effect found in some parts of the circle. As the diameter of that part of the spinning vortex which was in contact with the

surface of the field shrank, the spiral centre drifted very slowly, pushed along by the general wind of the day which was from the west-south-west, south-west or west. Slowly, as a vectorial result of the imposed forces, the spiral centre moved approximately north-eastwards, and was at a point 0.67 metre from its original position by the time the vortex left the ground. The fact that the barley had been obliged to suffer consecutive anticlockwise motions, the first possessing an outward component, the second an inward component, may explain Mr. Andrews' conclusion that there had been "two separate plates rotating anticlockwise" (see his article, *infra*).

The last visit to the circle site at Headbourne Worthy was made on 11th October following Mr. Andrews' telephone call of 8th October, and further photographs were taken. Certain aspects of the structure were more readily seen than before, including the circumferential 'sine-wave' effect which may indicate that there were one or more peripheral mini-vortices travelling around the outermost annulus.

CONCLUSIONS

The main features of the anticlockwise flow-fields in the flattened circle of barley at Headbourne Worthy have been described and an explanation proposed in terms of a two-stage process involving a descending vortex which first intensifies at ground level and then weakens before ascending again. What we have not done is to examine the origin of the vortex. Work on this is continuing and will be published in due course.

AN ANTICLOCKWISE SPIRAL-CIRCLE IN A CEREAL CROP:

Part 2: Results of Studies made After Harvesting

By COLIN ANDREWS
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Abstract: Some weeks after harvesting a further visit to the anticlockwise spiral-circle at Headbourne Worthy was made. This revealed additional details, and clarified others, concerning the character of the flattened crop.

On 8th October I returned to the anti-clockwise circle, north of Winchester, to investigate further the major features still clearly evident. Very heavy germination had taken place within the circle making it more easily seen from the outskirts of Winchester than had been the case back in early August when I visited the site with Dr. Terence Meaden.

On this latest visit I noticed that the remaining stems of barley were laid down positively in their primary contours, in such a way as to resemble its own skeleton. Now that all the surface stems had been combined off only the bones, as it were, remained. More information was available now than before. I noticed how a sine-wave formation ran around the outer edge of the circle, also the veining into the centre, which we are now so used to seeing, similarly consisted of sine waves. Each vein was made up of two sine waves, each overlaying the other, causing plaiting to be formed.

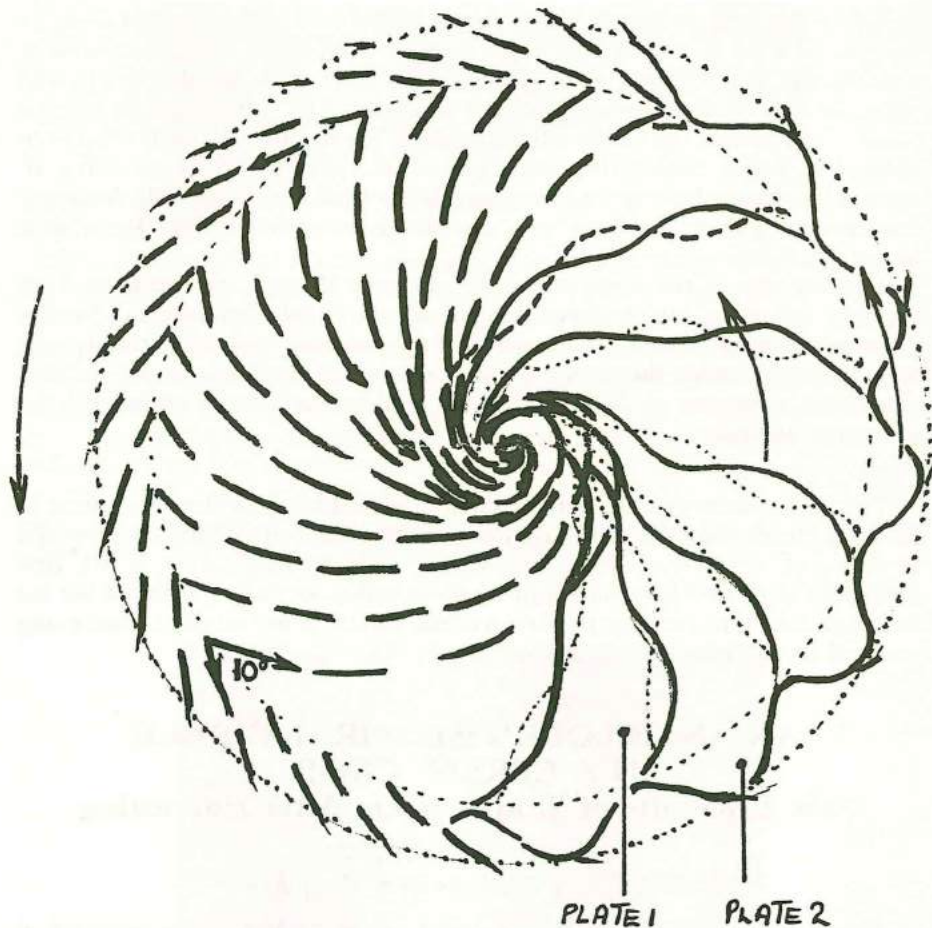


Fig.1: Analysis of the patterns in the flattened crop at Headbourne Worthy as viewed after harvesting.

For many weeks I had been troubled by what I had seen. Each time I placed an aerial photograph under the magnifier I saw a flecking into the standing crop on the outer rim of this anti-clockwise swirl, and yet the veining from the centre was clockwise as had occurred before in many of the clockwise circles. This just did not seem to make sense. But on site there was the answer: at about twenty-five inches in from the circumference the angle of swirl diverged. To the outside it split some five degrees tangential to the circumference, and to the inside five degrees towards the centre.

I asked Mr. Pat Delgado, who has considerable experience of this phenomenon, to join me on site and witness my observations. The whole structure appeared to be formed as if by two separate plates rotating anti-clockwise, and, while in motion, oscillating in a spiral-like wave-form.

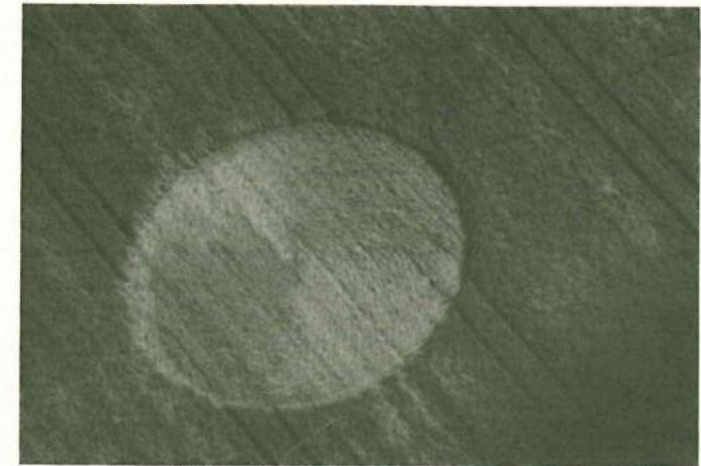


Fig.2: An aerial photograph taken by the author.

I have on file other very significant evidence which indicates that this phenomenon is worthy of continued detailed investigation. Other important features I have noticed in pictures taken during 1978 match the mysteries photographed this year. My own investigations have led me to conclude one thing – *and that is we are not looking at a hoax.*

WEATHER AND BUTTERFLIES IN AVON COUNTY, 1986

By A. H. WEEKS
Yatton, near Bristol

As was the case in 1985, we are left with impressions of consistently poor weather in 1986, which agree reasonably well with the picture suggested by statistics, except for the summer which was better than we thought. Indeed, the professionals were at pains to tell us, at the end of August, that the summer had not been a bad one, but had simply reverted to near-normal after a succession of better-than-average ones. Our impressions might have been different had that summer followed a normal spring. However, there is no doubt that the weather in the six months from March to August, covering the greater part of the butterfly season, was a disaster for most butterflies. Only June had anything to commend it.

As in previous articles in this series, Table 1 sets out the monthly and seasonal differences from normal of day-time maximum temperatures and percentages of rainfall and sunshine for this area. The figures speak for themselves. The cold and wet winter was followed by an appalling spring which, as we shall see, severely affected butterflies, at whatever stages of their life-cycles they were in. In addition, for the second year in succession, high maxima in the summer were few, with 80°F (26.6°C) being exceeded on only four days, all in June. The best that July achieved was 78.2°F (25.6°C) during a warm but cloudy spell in mid-month.

Table 1.

	Monthly Differences			Seasonal Differences	
	Max Temp.	% Rainfall	Approx. % Sun	Max. Temp.	% Rainfall
December 85	+1.8	173	95	Winter -1.2	113
January 86	-0.3	123	95		
February	-5.3	12	85		
March	-0.8	117	95	Spring -1.3	135
April	-2.8	113	87		
May	-0.5	168	86		
June	+1.6	70	95	Summer 0.0	85
July	+0.1	78	90		
August	-1.7	100	75		
September	-1.6	34	110	Autumn +0.3	102
October	+0.9	120	100		

August had a mere three days with temperatures over 21.1°C (70°F) and even one below 15°C (59°F). It was another summer with a high incidence of strong winds.

No note on wildlife in 1986 would be complete without some comment on the broader effects of the winter. There was very little snow cover in this area and the ground became solid for a long time. The first signs of trouble to come were when, in December 1985, fieldfares worked systematically along the hedgerows removing every single berry. They had moved on by the end of the year. So, when ground-feeding in the fields became impossible, the flocks of redwings were forced to move into gardens. It was not long before the crops of berries there were exhausted too. There would have been no crisis had February's cold spell lasted only the usual week to ten days instead of being protracted as well as severe. Sadly, numbers of redwings fell by the wayside and once again, it was a battle for us humans to help as many of the birds as possible – a daily (at least) manufacture of "bird pie" of bread, fats, nuts, currants, apples and birdseed. In a few days, we saw more siskins and blackcaps than ever before in our lives. Even snipe (usually resident on the North Somerset levels about two kilometres north of here) were driven in near to habitation, although I doubt whether we would have become aware of the fact if two had not fallen foul of one of the neighbourhood cats (both rescued alive and released at a safe distance). With this sort of activity going on, there could be no thought of insect life stirring, so although it remained cold, it was with relief that we turned the calendar to March – spring had arrived (at least on paper).

The conditions needed before hibernating butterflies take wing seem to be an air temperature approaching 15°C and a solar radiation temperature of around 30°C, together with a light wind. 5th March provided the first two of these requirements, but there was a fresh, blustery W.N.W. breeze and only short sunny periods. Two days later, the screen maximum reached only 11.5°C, but the black bulb in vacuo rose to 31°C, there was a clear sky and a light S.W. breeze. These were enough to coax the first Small Tortoiseshell into the garden, together with a variety of bees. There were sightings on only two other days in March, followed by six days in April (a very thin showing), then none until July. The Peacocks needed a little more persuasion, first appearing on 19th March, a day which offered no

better conditions (max. 10.6°C, black bulb 31°C) than several earlier days. They put in appearances on seven days in April, three in early May, then none until early August. The other two common hibernators were even more reluctant to rouse. There was no stranger day than 19th April for me, for during a look round a local nature reserve, I came upon lizard and adder before I had seen a Brimstone or a Comma butterfly. (Oddly, the date for the adder was the same as in 1985). Down amongst the grass and scrub on a south-facing slope sheltered from the N.W. breeze, these reptiles were happy in their micro-climates, but the sight made me wonder just what sort of spring this was. However, I did not have to wait long: all four hibernators came into my garden on 26th April (max. 14.5°C/37°F).

One could only marvel at the sight of the Commas, looking as fresh and bright as though they had just emerged from their pupae, although they had of course spent six months or more out in the open, braving all winds and weathers. I have remarked before on the fact that severe cold hardly seems to affect them, although mildness and excessive damp do. On the following day, 27th April, Small White, Green-veined White and Speckled Wood flew and two days later, the Large White. Spring was now here in fact but in view of the date, there could be no euphoria.

Towards the end of April, our minds had switched back to birds. Insect life was still so scarce that we willed our martins not to arrive yet. It was not to be. The first swallows darted over the fields on 25th April, swifts wheeled overhead on 5th May and martins arrived at the nest on 11th. They eked out an existence somehow and went on to produce their usual two broods.

Refreshing though the sight of the first butterflies had been, conditions for flight, mating, egg-laying and caterpillar growth were still far from ideal. The intense cold of winter and the coolness of spring held back growth of food-plants – nettles in the case of the three nymphalids. We could not expect early or large summer broods of any of them. Yet the gloom was lifted a little by two successes. The Orange Tip enjoyed a good, if somewhat late, season from mid-May to mid-June and a large colony of the Marsh Fritillary was discovered – flying right on time.

The miserable spring also did great damage to nearly all species in the larval stage then. The numbers of Common Blue and Brown Argus in the summer of 1985 were poor (*J. Meteorology*, vol.11, page 57) which meant that they were even more so in the spring of 1986. These two were present, but not plentiful, in June and the absence of warmth and sun in August resulted in their remaining scarce later in that month. Worse, I have received a *single* report of a Holly Blue in the whole of the county this year. The populations of all four common summer browns were reduced drastically, with the Marbled White and Ringlet marginally least affected on "my" nature reserve, with reasonable numbers in mid-July. On the other hand, an appreciation of how bad things were came during an hour spent walking over a common on the edge of the Mendips on 9th August. I would normally have expected to see Meadow Browns and Gatekeepers in their hundreds; in fact, I recorded twelve different species, eight of which (including Meadow Brown) were single specimens – and there were only five Gatekeepers. As well as the browns, the numbers of the four common skippers were further reduced for the second year in succession. My counts in 1986 of Green Hairstreak,

Wall Brown and Small Copper were all extremely small, but Graylings and Small Heaths were reasonable. There were also fair numbers of Dark Green Fritillary, no apparent reduction of the Silver-washed Fritillary and White Admiral and I sighted two specimens of that rarity (nowadays), the White Letter Hairstreak.

The immigrants fared no better than the indigenous species this year. I was surprised to see a Red Admiral near York in mid-May and they were present on the Scillies in June, but the first to grace my garden buddleias appeared on 1st July. About a month elapsed before fresh ones arrived. The first local report of a Painted Lady came in late May and they too were on the Scillies, but otherwise activity locally was confined to August. The Clouded Yellow was scarce, one being seen in August near Bath and one on the Western Mendips in early September. In mid-July, the Pale Clouded Yellow was recorded at several places along the South Coast and several days later, one was observed in a wildlife garden in central Bristol. Meanwhile, the new broods of Tortoiseshells, Peacocks and Commas appeared in fair numbers. Large Whites reached almost plague proportions in mid-late August but curiously, there were comparatively few caterpillars on cabbages. The season in my garden peaked on 24th August, when twelve species visited – but by then, swallows were lining up on the wires and the end of summer was in sight.

It almost goes without saying that opportunities for the observer seemed fewer even than in 1985. Several planned longer runs had to be called off, but some quick sorties were made in desperate attempts to see things that were just not there to see: so, although I took an extra six walks in the pursuit of recording, the total of species logged personally in the season fell to 30. Missing from my list were Holly Blue, Small Blue, Chalk Hill Blue, Marsh Fritillary, High Brown Fritillary and Duke of Burgundy Fritillary – all except the first, largely through my inability to get to the sites on which they occur in good weather.

The cool September put a brake on activity. In particular, the numbers of Peacocks in flight dropped rapidly as they went into hibernation. Conversely, the warm sunny start to October, together with the continuing supply of nectar available from the still-plentiful garden flowers, kept things going for other species until the very wet spell commenced in mid-month. The season was then virtually over. I had recorded seventeen species in the garden – the same number as in 1985 – but the late dates stretched over a much longer period. Painted Lady and Common Blue last appeared on 31st August. September saw the last Gatekeeper on 14th, Brimstone and Peacock on 20th, Green-veined White on 26th. In October, there were Large White on 11th, Red Admiral on 13th, Small White on 14th, Speckled Wood 15th, Silver 'Y' moth, 16th and Small Tortoiseshell, 17th. Lastly there was a Comma on 12th and 15th November. I consider the Comma to be "Butterfly of the Year". From the first appearance of the summer form in mid-July, there was hardly a day, when butterflies flew at all, on which a Comma was not among them. It was appropriate that this was the last species that I saw alive – one sitting on the garden path which I collected and put in what I considered to be a safe place for hibernation. It thought otherwise, for three days later, it was back on the lawn and I had to try again in another place.

Overall, it has been the worst year since I resumed butterfly-watching in the Bristol area in 1979, and probably the worst since 1977, when the effects of the

1976 drought were felt. Butterflies were not alone of course. Bee-keepers were even harder hit than in 1985 and because of the dearth of insect life, I understand that bat populations have taken a nose-dive – ironically, during the "Year of the Bat". It will no doubt take several seasons of favourable conditions for some species to recover to their former numbers – especially the blues. Let us hope that 1987 will provide the first of these.

WORLD WEATHER DISASTERS: August 1986

1-28: Drought in Spain, especially in north-eastern areas, empty reservoirs in Catalonia, Aragon and Navarre, water rationed in 60 Catalan towns and villages, some 66% of grain crop destroyed in some areas, brush and forest fires in many areas; on the 1st and 2nd a fire burned through 2,000 hectares of pine forest and scrubland in the Huesca region, strong winds spread a fire over a 15km wide front along the Guarga river. From the 15th to the 28th a series of fires reported, one on the 15th till the 18th near Logrono, another near Burgos burned 1,200 hectares of forest, causing \$3,000,000 damage, from the 18th to 20th a fire threatened the monastery of Monserrat, near Barcelona. On the 21st/22nd seven fires broke out in the Valencia region destroying more than 500 hectares of forest and scrubland. Up to August 21st, forest fires in Spain since January 1st had destroyed 177,000 hectares of forest and scrubland, some 5,000 fires reported. A fire on the 24th/25th burned 180 hectares of pine and scrub near Benalmadena, meanwhile in central-western region of Las Hurdes a 2,500 hectare fire still burned. Fires reported on the 25th to 28th from provinces of Zaragoza and Huesca, near city of Cordoba, and from southern city of Granada. *Lloyds List, Daily Telegraph*.

1-26: Drought in many areas of France, some 75% of agricultural areas of country seriously affected, as with Spain, serious forest and bush fires reported, from 1st to 3rd fires reported from south and south-eastern areas, seven fires broke out on the 2nd/3rd, four of them in the Ardeche area, two other fires in the Pyrenees near the Spanish border. On the 7th fires broke out in the upper Loire valley and in the Alpine region of Provence, a fire in the Loire valley near Le Puy burned 200 hectares. The most serious fires burned from the 23rd to the 26th in south-eastern areas leaving four dead, 200 injured, and destroying 10,000 hectares of forest along with many homes. The fires stretched from Tanneron, in the Var region, east to the resort towns of Grasse and Mandelieu, in the Alps-Maritime region, villages of Auribeau and Pegomas 80% destroyed, fires spread by high winds. *L.L., D.T.*

1-21: Drought continued in U.S.A. south-eastern states; from July 1st to August 1st 81 deaths reported from extreme heat; storms on 3rd and 4th, on the 3rd lightning left three dead, one injured in Ocean City, Maryland, on the 4th lightning hit oak tree in Mobile, Alabama, leaving two dead, moderate rainfall eased drought conditions, which on the 5th extended from Mississippi to southern Pennsylvania and included northern Florida and much of eastern Tennessee. On the 11th it was reported that the drought had halted barge traffic on the river Chattahoochee, Flint and Apalachicola. More rain fell in several

days prior to the 21st but although the situation eased, the drought was not yet over. *L.L., International Herald Tribune.*

- 1-15: Widespread storms and floods in China, weeks of heavy rains in Heilongjiang, Jilin and Liaoning provinces in north-east of country. In Jilin province 800,000 people made homeless and damage put at \$1,200,000,000, by middle of month 44% of province's farmland under water, 400,000 homes estimated to have been destroyed, floods described as worst in area for nearly 40 years. The floods in Jilin and Liaoning left at least 80 dead. In Heilongjiang province 300 oil wells flooded, cutting oil production, 150,000 hectares of farmland flooded, 380 bridges destroyed, 3,300 homes damaged and more than 588,000 people affected in 30 counties in the province. Floods in north-eastern Inner Mongolia swept through four counties in Kezuohougi County, floods destroyed more than 30,000 houses, floods followed a month of heavy rains. Meanwhile, floods hit southern Chinese provinces of Hubei, Guangdong, Guangxi and Yunnan province worst affected being Yunnan where 233 deaths reported, floods began after heavy rains from early July onwards, over half of 128 counties in province affected by the floods, which destroyed 7,090 homes, 80,000 hectares of crops, 130 bridges and 530km of river embankments. Since January 1st at least 1,061 deaths reported, along with 19,100 injuries in floods, typhoons and hailstorms in China, 2,200,000 homes destroyed. *L.L.*
- 1-11: Heavy rains and floods in Pakistan, on the 4th serious floods in the Sialkot district, some 400 villages affected, no casualties, the floods destroyed 7,350 acres of crops. On the 11th Quetta cut off from rest of country, rains and floods in Baluchistan, Sind, Punjab and Frontier provinces. *L.L.*
- 1-9: Monsoon floods in Bangladesh, rivers Padma, Mahananda and Pagla rivers overflowed, flooding at least 20 villages in the Chapainawabgary district, leaving 26 dead and 10,000 homeless, 500,000 people affected, with 60,000 hectares of crops submerged. *L.L.*
- 1: Vessel, the *Beatriz* sank in heavy seas 25km off San Francisco, Camotes Islands, between Cebu and Leyte, Philippines, leaving 3 dead, 7 missing, a further 152 people rescued. *L.L.*
- 1: Sudden gale blew up around south-west Eire, gusting to force 10 at times, the f.v. *Contessa Viv* sank in stormy seas after hitting rocks in Berehaven Sound, off Cork, leaving five dead. *L.L.*
- 2: Ferry boat the *Uska*, sank in rough seas off the north-east coast of Kalimantan, Indonesia, leaving 16 dead, and dozens missing. *L.L.*
- 2: Gales in north Wales overturned 14 caravans on the Morfa caravan site at Conway, nine people injured. *Birmingham Evening Mail.*
- 2-4: Forest fires in eight areas of Greece; on the 3rd a forest fire broke out near Loutraki, 85km south-west of Athens, destroying two houses and an open-air restaurant along with 400 hectares of woodland.
- 2-24: Bush and forest fires in western U.S.A., by the 13th fires in Washington, Oregon, Idaho, Montana, Utah and Nevada had burned 560,000 acres, including 151,000 acres in Idaho, 158,000 in Oregon, 25,000 in Utah, 13,500 in Nevada and at least 8,000 in Washington. In Idaho, since August 2nd, 6,724 fires had started, most of fires in six-state area started by lightning. *L.L., D.T., I.H.T.*
- 3 (reported): High wind blew car off road and into a ravine in Val Vigezzo, north

- of Milano, Italy, driver scratched and bruised; however, when motorist reached top of the ravine, the wind blew over a tree which killed the man. *Sunday Express.*
- 4: A de Havilland Twin Otter aircraft crashed into the sea off St. Vincent, West Indies, during heavy rain squalls, all 13 aboard dead. *L.L.*
 - 4-5: Tropical storm "Sarah" hit central Japan, cutting across main island of Honshu before heading into the Pacific off northern Japan, "Sarah" brought torrential rains, floods and landslides which left 17 dead, flooded 81,000 houses, caused 1,270 landslides and damage in 16 out of 47 prefectures. In Miyagi prefecture, northern Japan, 368mm of rain fell in a 24-hour period, floods and landslides disrupted rail services. *L.L., B.E.M., I.H.T.*
 - 4-7: Torrential rains in New South Wales, Australia; in the 24 hours ending at 0900 hours on the 6th, 332.7mm of rain fell in Sydney and from the 4th until 2100 hours on the 6th the total was 508mm, the rainfalls were the heaviest ever recorded and ended the driest six-month period in 98 years. In Sydney widespread flooding left six dead, thousands of homes flooded and widespread traffic disruption, winds gusting upto 121 km/h accompanied the rains, insurance companies estimated the storm caused damage of more than A\$100,000,000 in Sydney and surrounding areas. *L.L., B.E.M.*
 - 4-7: Floods in Jammu and Kashmir, India, left at least 39 dead. *I.H.T.*
 - 5-6: Torrential rains in Eire, especially in south-west areas, on Valentia Island, Co. Kerry, 89mm of rain fell, worst floods were in Tralee, Co. Kerry, and Bantry and Macroom, Co. Cork where streets were submerged by up to two metres of water, many people rescued from homes and cars. Flood along river Lee in Co. Cork described as the kind of flood that occurs once every 500 years. *L.L.*
 - 5-10: Storm raged around peak of K2 mountain in Himalayas, at least three dead. *D.T.*
 - 6: Gales around Cornwall, England, huge waves swept youth into sea at Mullion, on the Lizard peninsula; although rescued, he later died in hospital. *B.E.M.*
 - 6-31: Monsoon floods in several areas of India, on the 6th it was reported that since June floods in northern India had left 250 dead and displaced more than 3,000,000 people, 105 of dead occurred in Uttar Pradesh state. River Ganges overran its banks at several places and inundated vast tracts of land in Uttar Pradesh and Bihar states. From the 7th to the 9th heavy rains lashed Bombay. Floods in Andhra Pradesh state left over 200 dead, by the 22nd over 350 villages flooded, nearly 3,000,000 people displaced, crop damage put at \$100,000,000, worst of floods along river Godavari. *L.L., D.T.*
 - 8-18: Torrential rains in Uruguay caused widespread flooding of rivers in the central and southern regions of country, some rivers rose 7 to 10 metres above normal levels, flooding wide areas, 2,000 people made homeless, three deaths reported, hundreds of head of cattle dead. Hailstorms were reported in Department of Colonia on 8th August. *L.L.*
 - 10: Thunderstorms ended heatwave in Switzerland, three people including two French climbers, killed by lightning. *B.E.M.*
 - 13-15: Heavy rains in west Java and Lampung province of south Sumatra, Indonesia. From 7.00 p.m. on the 13th to 9.30 a.m. on the 14th 198mm of rain fell in east Jakarta, causing widespread floods in city. The floods in Lampung

province flooded 28 villages, destroying scores of houses, at least two dead in floods when Ngarip river overflowed, another five died in mudslide at village of Tarahan Panjang on the 13th. *Jakarta Post*.

16: Vessel *Maysuri* listed and sank in heavy seas 93km off Nogas Island near Panay, central Philippines, leaving seven crew missing. *L.L.*

17: Tornado hit campsite at Charité-sur-Loire, central France, during evening, leaving one dead, over a dozen injured. *I.H.T.*

18: Tornado hit northern Italy in evening. In the village of Casorezzo 90% of homes damaged, in area affected tornado ripped roofs off hundreds of buildings, injuring dozens of people, the tornado was accompanied by hailstones the size of apples on outskirts of Milano, entire fields of corn and maize destroyed and dozens of vineyards wrecked. *L.L.*

18: Hailstorm hit the Lake Geneva and Lake Lucerne regions of Switzerland; in Geneva hail the size of ping-pong balls dented 40,000 cars and smashed windows and skylights, damage in city put at £40,000,000. Storm lasted ten minutes, in area around Geneva many hectares of crops and vineyards destroyed, scores of ducks died on Lake Geneva and the Lake of the Four Cantons near Lucerne, the storm was described as the worst in years. *D.T.*

18: Hailstorms in western Czechoslovakia, in one area only 600 out of 6,500 acres of hop fields survived relatively intact. Five students injured by falling hop poles in storms. *D.T.*

18-26: Hurricane "Charley" swept from eastern seaboard of U.S.A. over to Great Britain:

Eastern U.S.A.: Hit on the 18th, the storm, with winds up to 121 km/h, side swiped states of North Carolina and Virginia, Maryland also affected, damage put at \$7,000,000, \$3,000,000 each in North Carolina and Virginia, \$1,000,000 in Maryland and four deaths, all indirect, reported in storms on the 17th, three when a small plane fell into Chesapeake Bay during rain and thunder squalls, the other was a motorist whose car slipped off Outer Banks causeway into canal. Storm damaged some 200 homes, thousands of people evacuated from coastal areas.

Eire: Hit on 25th and 26th, with 97 km/h winds and torrential rains, worst-hit areas being Bray, Co. Wicklow and eastern areas of country, in the 24 hours ending 10.00 hours 26th August nearly 200mm of rain fell at Castle Kelly, in the Glenasmole valley above Tallaght, Co. Dublin. Cereal growers suffered severely, particularly in Co's. Kilkenny, Waterford, Tipperary and Dublin, ports from Wexford to Drogheda reported widespread losses to small boats, many being completely destroyed, the rainstorms brought widespread flooding and many thousands of people had to leave homes temporarily, losses could run into 'tens' of millions of £'s. At least two direct deaths reported, a woman and child were blown into river Liffey and drowned, a second child was missing, three indirect deaths reported.

Northern Ireland: Hit on 25th by high winds and heavy rains, one indirect death reported.

Great Britain: Hit on 25th and 26th by high winds and heavy rains, on the 25th 75mm of rain fell in east Devon and the river Axe reached one of its highest ever recorded levels, the river rose 1.3 metres above normal, gales and rain



Fig.1: The harbour at Bray, Co. Wicklow, covered with debris following the passage of hurricane Charley, 26th August 1986.

throughout country uprooted trees, flooded roads and caused widespread damage. The North Yorkshire floods on the 26th centred in Swaledale, many people evacuated from campsites as river Swale overflowed, river rose 3 metres above normal, scores of villages cut off. Thousands of homes without power in Cumbria as winds brought down power lines. One direct death reported, near Coldstream, Scotland, when a vehicle swept into Bowmont Water, which had swelled from being 1.25 metres wide to 90 metres wide, one indirect death when boat sank on flooded river Tees at Yarm, Cleveland. Two maritime deaths reported, a raft lost in heavy seas off South Stack Beach, Anglesey, north Wales. *L.L., D.T., B.E.M., Irish Times, Irish Independent.*

21: M.v. *Santa Fe* capsized and sank between Butuan City and Camiguin Island after encountering strong winds and heavy seas, leaving three dead and 13 missing. *L.L.*

22-24: Torrential rain that fell for 30 hours caused Los Jabalines river to overflow in Sinaloa state, northern Mexico, 15 communities flooded, leaving nine missing and 3,000 people evacuated, scores of homes destroyed in Mazatlan. *L.L.*

22-31: Typhoon "Wayne" moved erratically around the Pacific Ocean, details below:

Taiwan: Hit on the 22nd with 137 km/h winds and heavy rains mainly in southern and central areas of island, storm described as worst in 27 years. Damage included 464 houses destroyed, another 2,760 heavily damaged, 515 fishing vessels destroyed, another 574 heavily damaged, two small military vessels also lost, thousands of hectares of farmland flooded by seawater. At least 52 dead, 126 injured. Property damage put at \$100,000,000, the typhoon then moved out into the Pacific Ocean, on the 24th "Wayne" again passed Taiwan, the centre being about 50km south-east of Taiwan's southern tip, winds in southern Taiwan reached from 72 km/h to 108 km/h, no major damage from second strike. *L.L.*

- 23: Tornado hit Penza region of the central Soviet Union uprooting trees and power lines and demolishing homes, one death and several serious injuries reported. Over 200 structures, mostly homes, destroyed, as the tornado swept through three districts of the Penza region. The worst hit area was the village of Belinskiy, about 65km south-west of Penza. Roofs on many homes were blown off, schools, a factory and a dairy were destroyed and tens of kilometres of high-voltage power lines were brought down. The tornado was followed by storms that dumped 'egg-sized' hailstones on the Penza district, compounding the damage. *L.L.*
- 23-24: Sudden cold and blizzards in Austrian Alps left eight hikers and climbers dead, and four more climbers died just over the border in West Germany in same storms. *B.E.M., D.T.*
- 23-24: Gales and torrential rains caused damage estimated at more than £16,500,000 in the republic of Slovenia, Yugoslavia. *D.T.*
- 26: Thunderstorms in N.E. Ohio, U.S.A., a tornado hit city of Lorain, the tornado touched down near S. Broadway Avenue and Cooper-Foster Park Road and moved north-east across the south-eastern portion of Lorain. It lifted off the ground near Homewood Elementary School. About 193 families had their homes damaged in the tornado; 10 homes and 87 apartment units in Lorain with major damage, about 87 apartment units in Sheffield township suffered major damage. Another 96 residences received minor damage in the two communities, the storm then moved into Cuyahoga County, where it began to weaken, 25mm of rain fell in 15 minutes in town of Westlake. *L.L.*
- 26-30: Typhoon "Vera" swept from Okinawa to North Korea, details below:
Okinawa: Hit on 26th with winds up to 160 km/h disrupting transport and cutting power to 30,000 homes, typhoon passed over Okinawa at 0600 hours, one fisherman reported dead.
East China Sea: Vessel *New Genshine* sank in heavy seas in lat. 29°47'N, long. 125°16'E on the 27th, leaving 25 dead.
China: Hit on the 27th, typhoon hit Shanghai, destroying more than 500 homes, leaving seven dead and 20 injured, power supplies cut in many parts of city.
Japan: Hit by fringe winds on the 27th, leaving one dead.
South Korea: Hit on 27th/28th, winds up to 145 km/h on the 27th hit island of Cheju along with up to 340mm of rain, trees and power line poles uprooted, on the 28th "Vera" hit South Korea proper with winds of 110 km/h and heavy rains, around noon, damage put at \$2,720,000. At least 115 houses and buildings were flooded or damaged, six ships wrecked or aground, farms flooded and road transportation disrupted. At least 8 dead, 81 injured and 12 missing.
North Korea: Hit on 28th to 30th, the north-east of country worst hit, whole villages washed away by floods causing losses of at least \$35,000,000, only a few lives were lost as authorities evacuated threatened areas. *I.H.T., L.L.*
- 29 (reported): High winds destroyed over 1,000 homes and brought down power lines in the Ryazan region, south-east of Moscow, U.S.S.R. The storm, with winds up to 108 km/h, caused no casualties. *D.T.*

ALBERT J. THOMAS

LITERATURE REVIEWS AND LISTINGS

Book Reviews

BASIC METEOROLOGY: A PHYSICAL OUTLINE. By Robin McIlveen. Van Nostrand Reinhold (UK) Co. Ltd., Molly Millars Lane, Wokingham, Berkshire, 1986, xxii + 457pp. £15.95.

The aim of this book is to marry an account of the behaviour of the lower atmosphere with an explanation of the physical mechanisms responsible. Despite the value of such an approach, the text which has resulted poses two major difficulties. The first is to reconcile how a book exceeding 450 pages can justifiably claim to be no more than a physical *outline* of *basic* meteorology. Given that the words italicised imply brevity and conciseness, it is difficult to see how a book of this length can persistently achieve such attributes unless its subject matter is very wide-ranging. As it is, McIlveen's book has a somewhat limited range when compared with other general texts on the atmosphere. Subjects to which it gives scant treatment include various types of atmospheric hazard, pollution, and climatic change.

A second, related problem concerns the level of reader for which the book is intended. According to remarks on the back cover, it is meant as an "introduction to meteorology for students, whatever their academic background" and it "covers the material needed for meteorology courses in the first two years of a degree in environmental sciences or geography. It also provides the ideal introduction to the subject for students of physics, geophysics and atmospheric physics". Additionally, the preface mentions that the book was written for "serious amateurs seeking introductory information about the behaviour of the lower atmosphere". However, the disappointingly low attraction which meteorology seems to have for many students (at least in Britain) and limitations in the scope of this text suggest that it may have difficulties in appealing to a wide audience. Furthermore, there is the problem that the longer and more detailed texts become, the less likely they are to be purchased and read extensively by all but a few students and amateurs. In fact, sound reasons can be given for suggesting that, whatever the topic, the length of books should often not exceed 200 pages. The mathematics in this text, although not particularly advanced, may also deter some people.

A number of interesting points emerge when a comparison is made between McIlveen's book and two recent general texts on the atmosphere, viz. Barry and Chorley's *Atmosphere, weather and climate* (fourth edition, 1982) and Henderson-Sellers and Robinson's *Contemporary climatology* (1986). All three perhaps err on the long side, though admittedly Barry and Chorley is 50 pages shorter than McIlveen. Despite this, when randomly-chosen topics (local winds, tornadoes, snow, albedo, etc.) were looked up in the three books, Barry and Chorley generally proved the most informative. Although such an approach obviously has limitations, it is hard to avoid the feeling that many undergraduates and amateurs will judge Barry and Chorley as being the most appropriate for their needs, with Henderson-Seller and Robinson a close second. McIlveen's book will therefore be seen as one which is chiefly useful for occasional consultation. It will be a pity if this happens, because it will mean that the book is being undervalued.

L. T.

THE PHYSICS OF ATMOSPHERES. By J. T. Houghton. Cambridge University Press, 1986. Second edition. £9.95.

John Houghton has both updated and extended the first edition of this well-thumbed reference text. The book is, in general, well structured, clearly explained and, in parts, interesting. The author clearly, and quite rightly, assumes that his readers have a basic familiarity with mathematical concepts, but he skillfully leads them into deeper mathematical waters without any real fear of drowning. The chapters, thirteen in all, are relatively short digestible chunks and each is followed by a large number of related problems, solutions to which are to be found at the back of the book. Chapters 1 and 2 deal with basic physics while 3 to 6 lead the reader into more complex thermodynamics, radiant energy transfers, physics of middle and upper atmosphere and cloud physics. This last chapter is surprisingly very short. The reader is then plunged into deeper water in a consideration of equations of motion, atmospheric waves and turbulence. The final chapters deal with numerical modelling, global observation, and long term changes. There is a tendency to go overboard with the problems which occupy more than 20 per cent of the book, although I suspect that teachers of advanced meteorology may find these very useful.

Although the text is, in general, digestible, a little more flesh would make the meal a little more palatable in places. The Appendices are extensive, occupying approximately 10 per cent of the book, and on the whole I found them to be very useful. The references are up to date but I must admit to disliking the absence of article titles in journal references.

On the whole I feel that this is a book for the committed meteorologist but it should have a place on library shelves where meteorology or climatology are taught. As for the general reader, I suspect that all but the most tenacious will be deterred by the strong mathematical flavour.

S. J. HARRISON

LETTER TO THE EDITOR

NUCLEAR WINTER

The Literature Review section of the November issue referred to my letter to *Weather* on the subject of the 'nuclear winter'. However, I did *not* argue that it was pointless to study the subject on the grounds that "such an event might leave few or no survivors". What I wrote was that such study "lends credence to the idea that such an event is survivable – and as soon as such thought gains currency the likelihood of the event increases". I do not believe that "politicians and the military" would take heed of climatological research on the subject; even if rational thought went into a decision to wage such a war, they could easily conclude that climatologists have a very poor track record in the field of forecasting anyway.

My point really was – and still is – that on humanitarian grounds, a nuclear war on *any* scale just must not be fought. Climatological research is a red herring, at best. If scientists are going to become involved in political issues, they must do so seriously and responsibly, and not play games. For too long the natural sciences have been considered a "higher discipline than the social sciences, with the result that vast sums of money have been spent on too much pointless research. Much of this research is harmless, but where it attempts to impinge on the real world, questions have to be asked. The major issues facing us today are moral rather than scientific; basically, twentieth-century civilisation is clever but immoral. The scientific revolution has not led to happiness, and faith in science as the means of resolving the problems of the world is no longer credible.

Loughton, Essex.

R. J. PRICHARD

TORRO TORNADO REPORT: May and June 1986

May 1986, a rather unsettled month, produced the first undoubted tornadoes of the year – two, both on 21st. There was a funnel cloud over the Bristol Channel on 28th.

TN1986May21/I. *Cubbington, Warwickshire (SP 3468)*

This tornado struck Cubbington, on the northern outskirts of Leamington Spa, about 1245 GMT "after a torrential downpour of rain". Overhead electricity wires were torn away from homes and tree branches removed. A corrugated garage roof was lifted over houses and crashed in pieces through the roof of a conservatory. A one-tonne caravan was blown over. Mr. Ernest Lester said: "It looked exactly like a whirlwind. It just came up in a straight line from the Lillington direction" (i.e. from the S.W.) (*Leamington Spa Courier*, 23rd May). Force: T2.

A cold front had just passed through the area, associated with a very deep low (971mb) to the south of Iceland. A strong westerly flow covered Britain. At 500mb a marked trough lay over the country.

TN1986May21/II. *Leven, Humberside (TA 1045)*

The village of Leven was hit by a force T1 "whirlwind" during the afternoon. Mrs. Vivien Tindall heard "a terrific noise, like a spaceship lifting off" and saw the wind rushing up the street, doubling over trees in its path, while trees on either side were completely untouched. The tornado smashed greenhouses, damaged roofs and broke guttering. Tiles were "lifted off as if in unison" (*Hull Daily Mail*, 22nd May).

FC1986May28. *Weston-super-Mare, Avon (ST 3161)*

Mr. Marc Becker saw a funnel cloud over the Bristol Channel near Weston at 0755 GMT on 28th May. The funnel passed over the coast and decayed rapidly, in less than one minute, at 0803. At its maximum the funnel reached about two-thirds of the way to the sea surface. Mr. Becker remarked that the cumulus which produced the funnel cloud was relatively small compared with some that were visible, though it did produce a sharp shower as it crossed Weston. The wind was W.N.W., force 3, and the funnel cloud also moved from the W.N.W. A north-westerly airstream covered the whole of Britain. There was a broad trough at 500mb.

Land devils in May 1986

LD1986May27. *Levers Water, Cumbria (SD 2799)*

Mr. Paul Bohan saw about 15 to 20 small whirlwinds over a period of an hour at Levers Water, N.W. of Coniston. Most of the whirlwinds were single, but some came in twos. They travelled from N.W. to S.E. at about running speed, and nearly all followed the same path. They were about two feet (60cm) wide and lifted debris about one foot off the ground. They were strong enough to knock Mr. Bohan over. The weather was cold, extremely windy and damp, but not raining.

On 27th May a very strong westerly or north-westerly airstream covered Britain, in the circulation of a deep low which was over northern Scotland at 1200. Gusts of over 50kn were recorded at many places in S.W. Scotland and northern England (*Monthly Weather Report*, May 1986). In view of the mountainous terrain, the repetitive nature of the whirlwinds and the weather conditions, these were almost certainly eddy whirlwinds rather than true land devils.

LD1986May29? *Pendle Hill, Lancashire (SD 7941)*

A hang glider pilot, Mr. Nigel Sumpter, was caught in a "mini tornado" on Pendle Hill and plunged 40 feet (12 metres) to the ground. The hang glider was completely wrecked, and Mr. Sumpter suffered back injuries (*Manchester Evening News*, 30th May). The date of the accident is not given in the press report. 28th and 29th May had a north-westerly airstream, rather anticyclonic on 29th; 30th May was anticyclonic and westerly in character.

June 1986 was unsettled up to 12th, and then became anticyclonic and very warm. No tornadoes were reported, with the possible exception of the following incident.

q1986June29. *Sidmouth, Devon (ST 1287)*

Miss E. M. Preston was struck by a "whirlwind" on the sea front at Sidmouth just after 1100 GMT. "Everything was whirling around . . . The wind was roaring around me and the noise was terrific". Miss Preston saw a wooden chair flying at least six feet off the ground; a large board was also carried away. A woman was blown down and taken to hospital with a broken wrist. The violent wind was very local.

There was a good deal of thundery activity in S.W. England on 29th June, and Jersey had hailstones up to 26mm in diameter (*Weather Log*, June 1986). The thunderstorms were associated with a warm front in a col.

LD1986June7. *Watch Water, Borders (NT 632561)*

A land devil about 20 metres in diameter was observed by Mr. Frank Brady in the valley of Watch Water in the Lammermuir Hills. Leaves, twigs and grit were lifted in a spiral to a height of a few metres. The time was 1200 GMT. The weather was warm, dry and rather cloudy, with little wind. The airstream over Scotland was north-westerly; a low was centred over Denmark at 1200.

Additions to previous reports:

FC1983? *Dry Drayton, Cambridgeshire (TL 3862)*

Mrs. L. Michell saw a whirlwind "quite high in the clouds" over Dry Drayton, near Cambridge. No further details are known.

WS1984October2/3. *Chesil Beach, Dorset (c SY 5882)*

This waterspout appeared about midday (1100 GMT). Mrs. Mary Donaldson and her husband watched it "until it parted in the middle. The seaward end disappeared first; the sky end hung for a longer time".

M. W. ROWE; G. T. MEADEN

TORRO THUNDERSTORM REPORT: May 1986

*Thunderstorm Division, Tornado and Storm Research Organisation,
77 Dicketts Road, Corsham, Wiltshire*

Thunder was heard in Scotland on ten days and in Ireland on nine, the normal being exceeded by a single day in both cases. England and Wales with 14 and seven days failed to reach the May normal by three and two days respectively. On only three days could thunderstorms be considered as widespread, 3rd, 20th and 28th, but of the three the 20th saw the most widespread and damaging outbreaks of the month. During much of the month thunder was most frequently associated with showery outbreaks and was therefore of an isolated nature. Station totals were highest over central and eastern counties of England, thunder being heard on two to four days quite widely. In East Anglia there were some reports of five or six days, and seven or eight days were very locally reported in Lincolnshire and south of the Humber. There were few, if any, storms in the far south-west of England and towards the south and west of Wales. One factor becomes apparent when looking at the overall pattern, namely the wide variation of totals in all parts between stations in relatively close proximity, a situation frequently encountered in basically showery months. This may be confidently attributed, at least to a large extent, to the fact that showers turn thundery for only brief periods and are of only limited horizontal development. In such cases few observers actually report overhead activity and the odd distant thunder-clap can invariably pass unnoticed by persons otherwise engaged in their day-to-day employment, frequently in noisy environments and often indoors.

Thunder-days in May 1986 were as follows:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Ave.
England		X	X		X	X	X	X					X	X	X					X	X	X							X	X		14	16.9
Wales			X					X	X					X						X	X								X			7	8.6
Scotland		X	X	X	X			X												X	X	X							X			10	9.1
Ireland			X	X			X			X			X	X							X	X							X			9	8.0
Total		X	X	X	X	X	X	X		X			X	X	X					X	X	X	X					X	X			17	18.7
Netherlands		X	X	X	X	X	X	X	X				X	X	X						X	X							X	X	X	16	14
Belgium		X	X	X	X	X	X	X					X	X							X	X							X	X	X	14	

On 2nd, as warm air moved north across northern England and north Wales, showers developed in many places and thunderstorms broke out in parts of Greater Manchester and Lancashire in the afternoon and in parts of southern and western Scotland in the evening. In early hours of 3rd thunderstorms moved north from the continent into south-eastern counties of England, and during the course of the day to many parts of the U.K. and Ireland followed by a change to much cooler, fresher conditions. Reports of damage by lightning were received from some parts of the country but most were concentrated in south-west Scotland and included an incident at Glenluce in Dumfries and Galloway where 19 cows, valued at around £10,000 were killed. Scattered thunderstorms affected parts of Scotland, northern England and the Irish Republic on 4th and 5th but on 6th activity was confined to eastern coastal areas of East Anglia and, to a lesser extent,

south-east England. Showers turned thundery in various parts of England, Wales and Ireland on 7th, although generally activity was confined to Northern Ireland and northern England. Belfast had a particularly bad storm in the early evening and lightning damage was reported from Co. Durham. Ireland was the only country not to hear thunder on 8th but much of the activity was concentrated over central and eastern counties of England. Hail fell locally and lightning damage was reported in places. On 10th a few pre-dawn storms affected Northern Ireland and south-west Scotland. Heavy showers were accompanied by thunder and hail in parts of England, Wales and Ireland from 13th to 15th, although on the latter day activity was confined to northern and eastern parts of England. On 14th a Roman Catholic Church at Ampleforth in Yorkshire was damaged by lightning.

The 19th was a sunny and warm day apart from scattered showers in Scotland and local thunder in the Grampians in the afternoon. In the evening scattered thunderstorms transferred northwards from the Channel Islands across south-west England and south Wales, and widespread, often severe, storms moved quickly north across central-southern Scotland overnight and during the morning of 20th. After a temporary lull further storms swept north over central and eastern counties of England in the afternoon and evening. Clearer, much fresher weather followed an eastward moving cold front across all parts by the end of the day. Lightning damage was reported widely and very heavy rain accompanied many storms. Rainfall was particularly heavy and widespread in the north Midlands, where 40 to 50mm fell in a number of places, and at Littleover, a suburb of Derby, 55.3mm fell in two storms within a five-hour period. Flash flooding inundated homes in the south Derbyshire area. The 21st was a cooler, blustery day with spells of sunshine but also with showers, and, locally in northern England, Scotland and in eastern Eire, there was the occasional thunderstorm. The 22nd saw thunderstorms confined to Co. Mayo in the north-west of the Irish Republic. Thunder was heard widely on the 28th with many storms accompanied by hailstones, but the most concentrated activity affected southern Britain. At Donaghee, Co. Down, Northern Ireland our observer saw a 'nuclear mushroom cloud' rise into the air from an electricity transformer after it was struck by lightning. The smoke from the explosion was seen to be drawn into the thundercloud. The months' activity ceased on 29th with scattered afternoon activity in Lincolnshire, the east Midlands, East Anglia and locally in the south-eastern counties of England.

Acknowledgements. The Directors would like to thank all TORRO observers who have contributed to the compiling of this monthly report. Sincere thanks are also offered to observers of the Thunderstorm Census Organisation, the Climatological Observers Link, and also to the London Weather Centre for information published in the *Daily Weather Summary*.

K. O. M.

WORLD WEATHER REVIEW: September 1986

United States. *Temperature:* warm E. of a line from New Mexico through Nebraska and Michigan to Pennsylvania; +2 deg. widely from S. Texas to Indiana. Cold elsewhere; -4 deg. in N.E. California. *Rainfall:* mostly wet; 200% exceeded over a very large area; generally from California to Michigan, S. Oklahoma and W. Texas (except S.E. California, S. Nevada, S. Montana to N. Texas). Dry in the three areas just mentioned; also E. coastal states, most of Gulf Coast and Mexican border; lower Mississippi

basin. Under 50% in S.E. California, S. Nevada, C. Colorado to S.W. Nebraska; much of E. coast; Mississippi delta, S. and extreme N. Texas, S. Arizona to W. New Mexico; C. Arkansas to W. Tennessee.

Canada and Arctic. *Temperature:* warm from Alaska to Great Slave Lake; most of Greenland; +3 deg. at Barrow (Alaska) and Coppermine (N.W. Canada). Cold in most of Canada; S.E. Alaska, Iceland, Jan Mayen, Spitzbergen, Franz Josef Land; -3 deg. in Newfoundland and Franz Josef Land; -4 deg. locally in S. British Columbia, S. Alberta and W. Ellesmere Island. *Rainfall:* wet in W. Alaska, most of Canada, part of W. Greenland; over 200% in N.W. Alaska, S.E. British Columbia to S.W. Saskatchewan; near L. Superior; N.W. Quebec to S. Baffin Island. Dry in E. Alaska, most of Northwest Territories; N. Alberta to N. Manitoba; parts of Quebec, most of Greenland; Iceland, Spitzbergen. Under 50% in Alaska, N. Alberta and N. Manitoba to N. Baffin Island; E. Iceland, Spitzbergen

South and Central America. *Temperature:* warm in N.E. Argentina, Uruguay, extreme S. Brazil, most of Mexico, Bahamas; +2 deg. in N. Uruguay and adjacent part of Argentina. Cold in Chile, W. Argentina, Bolivia, Paraguay, S. Brazil, N.W. and extreme S. Mexico; -2 deg. locally in Chile, W. Argentina, Paraguay, S. Brazil, N.W. Mexico. *Rainfall:* wet in N. Argentina, N. and E. Bolivia, W. Uruguay, most of Paraguay, N.C. Mexico; over 200% locally in all these areas, except perhaps Uruguay; widely in N.C. Mexico. Dry in and near Chile, C. Paraguay, E. Uruguay, S.E. Brazil (except extreme S.), N.W. and S. Mexico, Bahamas. Under 50% in and near Chile, S.E. Brazil, N.W. and locally in S. Mexico; Bahamas.

Europe. *Temperature:* warm from Iberian Peninsula and S. France through Italy to Balkans (except N. Yugoslavia and W. Romania), Ukraine and Caucasus; +2 deg. in N. Portugal, S.E. Spain, C. Bulgaria, N. Romania, Caucasus. Cold elsewhere; -2 deg. in most of N. half of Europe; -3 deg. in N.E. France, S. Norway to White Sea. *Rainfall:* wet from S. Norway and C. Sweden through S. Finland to much of European Russia, the W. through N. Poland and C. Germany to N. and W. France and much of Belgium; much of Iberian Peninsula; Crete. Over 200% round Bergen (Norway), S. of Leningrad, S.E. of Moscow, near Strasbourg, most of Portugal and W. Spain; Crete. Dry elsewhere; under 50% in most of British Isles and Netherlands; N. Denmark, S. and extreme N. Sweden, N. Urals, Switzerland to most of Balkans, S. Ukraine and Caucasus; C. Italy, locally in S. Spain. Under 10% round Irish Sea and from N.E. Yugoslavia to E. Hungary and extreme S.W. Ukraine. Provisional sunspot number 4.

Africa. *Temperature:* mostly warm in and near South Africa and N. of Sahara; +2 deg. locally in N. Algeria. Cold in most of Tunisia. *Rainfall:* wet from S.W. Morocco to N.W. Algeria to N. Tunisia; from N. Cape Province through W. Transvaal into Botswana and Namibia; over 200% locally in all these areas. Otherwise dry N. of Sahara and in South Africa; under 50% widespread.

Asiatic U.S.S.R. *Temperature:* warm in S. half; +3 deg. near L. Baikal; cold in N.; -2 deg. in Lower Ob Basin and near Laptev Sea; -3 deg. in N.E. Siberia. *Rainfall:* wet from Ob and Yenisey Basins S. to Afghan border and E. to Upper Lena Basin and S. to Afghan border and E. to Upper Lena Basin and S. Kamchatka; N.E. Siberia. Over 200% near Tashkent. Dry elsewhere; under 50% in N. Urals, Lower Lena Basin, Bering Sea, Upper Yenisey to Amur Basins; N. Caspian Sea to Aral Sea.

Middle and Far East. *Temperature:* warm from Turkey to Arabia; most of India; parts of E. China; Mongolia, Japan, Philippines, most of S.E. Asia; +3 deg. in and near N. Iraq; +2 deg. in C. India. Cold in S. Iran, Pakistan, N.E. India, most of China; Korea, parts of S. Thailand; -3 deg. in S. Iran; -2 deg. in S. Pakistan. *Rainfall:* wet in much of Turkey; N.E. coastal and part of S.W. India, Bangladesh, S. and N.E. China, S. Mongolia, N. Japan, parts of S. Thailand. Over 200% locally in all these areas except perhaps N. Japan. Dry in N.W. and S.E. Turkey, Middle East, Pakistan, most of India; W. and S.E. China, most of Korea and Japan; N. Thailand. Under 50% locally in N. Thailand; fairly widely in the other areas except perhaps Korea. Malaya and Philippines variable, no great extremes. Middle East mostly rainless.

Australia. *Temperature:* warm, except locally in W. and extreme S.; +2 deg. N.E. of centre. *Rainfall:* wet near N.E. coast and in interior S.E., S., W. and N.W. Dry elsewhere; under 50% near centre, on N.W. and N. coast and locally on S.E. coast

WORLD WEATHER REVIEW: October 1986

United States. *Temperature:* warm in N.W. (coastal California to Washington state and N. Dakota) and E. (except near Canadian border); +2 deg. in N. Washington, E. Virginia and E. North Carolina. Cold elsewhere; -2 deg. from N.W. Oklahoma to E. Nevada. *Rainfall:* mostly wet; over 200% very

widely in area from Texas to E. Wyoming and W. Iowa; also N. Louisiana, S.E. Arkansas, S.E. Missouri to W. Ohio; N. Georgia to coastal S. Carolina; locally in W. and N.W. Florida, S.W. Alabama, extreme S.W. California. Dry in W., N. and N.E.; under 50% from most of California to E. Montana; E. Dakotas and N. Minnesota; E. Maine, N.E. North Carolina, extreme S. Florida, S. Arizona.

Canada and Arctic. *Temperature:* warm from S.E. Alaska through Canadian Rockies to L. Winnipeg; +2 deg. from S.E. Alaska to W. Alberta. Cold elsewhere; -2 deg. from Iceland and W. Greenland to E. Ontario and Victoria Island; -7 deg. in E. Baffin Island. *Rainfall:* wet in most of Alaska, much of Canada, Spitzbergen, Bear Island, Jan Mayen. Over 200% in E. Alaska, N. British Columbia, Bear Island. Dry in W. Alaska, S. British Columbia to L. Superior to Mackenzie Estuary; Gulf of St. Lawrence; most of Greenland, Baffin Island and adjacent area; most of Iceland. Under 50% in W. Alaska, locally from S. British Columbia to L. Superior; near Great Slave Lake; New Brunswick; S. Baffin Island to S.W. Greenland.

South and Central America. *Temperature:* warm in N. and C. Chile, N. and C. Argentina, much of S. Brazil, S. Mexico to Honduras; +2 deg. locally in Chile and inland from Sao Paulo (Brazil). Cold in Bolivia, Paraguay and adjacent area of Brazil; N. Mexico; -1 deg. widespread. Uruguay near normal. *Rainfall:* wet in extreme W. and N. and much of E. Argentina; E. Bolivia, N.W. Paraguay, C.S. Uruguay, much of Mexico to Guatemala. Over 200% locally in all these areas, especially in N. Mexico. Dry in N. and C. Chile, interior Argentina, W. Bolivia, S.E. Paraguay, N. Uruguay, S. Brazil, N.W. and parts of S. Mexico. Under 50% locally in all these areas (except perhaps Uruguay) and widely in Chile and Brazil.

Europe. *Temperature:* warm from N. European Russia through most of Scandinavia and British Isles to W. Poland, Italy and Spain; +2 deg. in N. Finland, C. and S. France, E. Switzerland, S.W. Italy. Cold in S. European Russia, Balkans, Faeroes; -1 deg. in Ukraine, N. Romania, E. Bulgaria. *Rainfall:* wet in much of European Russia, Finland, N. Sweden, N. and S.W. Norway, Faeroes, much of British Isles, N.E. France, Low Countries, N.W. Switzerland, Germany, W. Czechoslovakia, much of Bulgaria, coastal Romania, S. Greece, E. Spain. Over 200% in E. Ukraine, N.E. France, S. Germany, E. Spain. Dry elsewhere; under 50% in C. Sweden, White Russia to N. and W. Romania, E. Hungary and E. Yugoslavia; S.W. Bulgaria to Albania and N. Greece; N.W. Yugoslavia to N. Italy and S.E. Switzerland; S. Italy, C. Austria, C. and S.W. France, Portugal, N.W. Spain. Provisional sunspot number 36.

Africa. *Temperature:* warm in Morocco, N.E. Algeria, most of Tunisia, most of South Africa; +2 deg. in N.E. Algeria. Cold in S. Morocco, Egypt (both -1 deg.), much of Transvaal. *Rainfall:* wet in Morocco, N. Algeria, N. Tunisia, coastal Libya, most of South Africa into Namibia and Botswana. Over 200% locally in all areas, and very widely in S.E. and N. Cape Province, W. Transvaal and into Namibia and Botswana. Dry in Canary Islands, Madeira, most of Morocco and Tunisia, E. Algeria, Egypt, W. Cape Province. E. Transvaal, N.E. Natal, S. Mozambique; under 50% widespread in all these areas.

Arctic U.S.S.R. *Temperature:* mostly warm; +4 deg. W. of Lena Basin. Cold in S. and N.E.; -3 deg. on N.E. coast. *Rainfall:* wet from N. Urals and Gulf of Ob to L. Balkhash; L. Baikal to Upper Amur Basin; parts of N.E. Over 200% round L. Balkhash, Upper Amur, E. of Lena Estuary, Bering Sea coast. Dry elsewhere; under 50% in Caucasus, N. Caspian Sea to Afghan border; W. Mongolian border to Upper Lena and Lower Amur Basins; Lower Kolyma Basin.

Middle and Far East. *Temperature:* warm in Middle East, N.W. and S. Pakistan, W. and S. India, W. China, Thailand, S. Philippines; +2 deg. in and near Kuwait, S.W. Pakistan, C. India, W. China. Cold in Turkey, N.E. Pakistan, N. and N.E. India, most of China; Mongolia, Korea, Japan; -2 deg. in N. Turkey, N.E. China, extreme N.W. Japan. *Rainfall:* wet in S.E. Turkey, Syria, Lebanon, N.E. India, E. and S. China, Korea, W. coastal Japan. Over 200% in S.E. Turkey, locally in E. and S. China, widely in Korea. Dry in W. and N. Turkey, most of Middle East, Pakistan and India; W. and N.E. China, most of Japan. Under 50% widespread in all these areas. Philippines mixed and no large anomalies in Thailand.

Australia. *Temperature:* warm in N. and N.E.; mainly +1 deg. Cold elsewhere; -2 deg. in W. and interior S.E. *Rainfall:* mostly wet; over 200% from Arnhem Land almost to Spencer Gulf, and in Eucla Basin. Dry in N.W. (under 50%) and in N.E. New South Wales.

M. W. ROWE

WEATHER SUMMARY: November 1986

November was a mild month in all parts of the U.K., mean temperatures varying on either side of one degree celsius above the normal in most parts. The unsettled and mobile nature of the month resulted in a predominance of mild days, and cold snaps were brief except for a colder anticyclonic end when frost and fog put in a belated appearance. Lossiemouth on the Moray Firth recorded the month's highest temperature with 16.6°C on 7th, the result of a foehn effect to the lee of the Grampians. Elsewhere, 16.5°C was reached at Northolt (London) and at Poole (Dorset) on 10th, 16.3°C at Royston (Hertfordshire) on 11th, and 16.0°C at Colwyn (Clwyd) on 24th, the latter also a foehn effect. At night the temperature failed to drop below 12.8°C at Birdham (West Sussex) on 10th and at Leeming (North Yorkshire) on 25th. Other high minima included 12.6°C in Central London and 12.4°C at Plymouth on 11th, and 10.5°C at Turnhouse (Edinburgh) on 25th. Apart from a short chilly spell in Scotland from 19th to 21st low maxima were confined to the end of the month. On 29th Honington (Suffolk) recorded a maximum of only 1.9°C with 2.2°C at Wattisham and 2.3°C at Stansted. On 30th the temperature rose to only 2.6°C at Fylingdales (North Yorkshire). Lowest night-time temperatures included -7.7°C at Dall (Rannoch School) on 1st and -6.5°C at Tummel Bridge, -4.0°C at Aldergrove (Northern Ireland) and -3.0°C at Velindre (Powys), all on 2nd. On 21st the temperature fell to -7.2°C at Braemar and to -6.5°C at Galashields (borders) and on 30th, to -2.6°C at Denbury (Devon) and -2.0°C at Manston (Kent). On the grass -12.3°C was recorded at Dall (Rannoch School) on 1st, -11.6°C at Glenlee (Dumfries and Galloway), -7.7°C at Velindre (Powys) and -7.0°C at Stourbridge (West Midlands) on 2nd. Rainfall totals in most places ranged between 100 and 150 percent of the normal but with wide variations across the country. Eastern Scotland and north-east England as far south as Lincolnshire were surprisingly dry with less than 50 percent of the normal locally. There were a number of heavy 24-hour falls, the highest figure so far received being 68.2mm at Okehampton (Devon) on 18th, this station already having recorded 48.3mm on 9th.

In other parts of the country 49.2mm fell at Eskdalemuir on 24th, 45.8mm at Ardnamurchan on 17th and 44.4mm at Denbury (Devon) on 18th. In complete contrast Wick in the far north-east of Scotland recorded only 6.3mm on 5th, the monthly total of 42.5mm being only 47 percent of the normal. Despite the totally unsettled nature of the month, sunshine totals were widely above the November normal, and in central and northern parts of England some 130 to 140 percent were reported quite widely. Northern Scotland proved the exception with around 60 percent in some places.

After a wet start to the month over England and Wales a ridge of high pressure moved south-east across the country on 2nd followed on 3rd by a cold front that gave some heavy rain for a time. The weather continued very changeable for several days as a series of fronts crossed all parts and after a coolish start temperatures slowly recovered to above normal values. The 9th was a particularly wet and windy day, especially in the west as a waving cold front took its time crossing the area, and low pressure close to northern Scotland kept it equally unsettled on 10th and 11th. After a brief drier interlude, further fronts from the

Atlantic spread wet and windy weather to most parts on 13th and 14th and rainfall was particularly heavy near to a low-pressure area that moved north-east across northern Britain. With frontal systems continuing their seemingly relentless progress across the country, all parts had rain or showers at times, and on 18th it became generally wet and very windy as a depression moved rapidly east-north-east across Ireland and northern England. South-western areas were especially badly hit with winds reaching 79 knots at Gwennap Head (Cornwall). After a very showery spell, during which a small low and associated squall-line spread sharp thunderstorms and a number of tornadoes across southern counties in the evening of 20th, a very deep depression passed close to northern Scotland on 22nd and kept the stormy pattern of weather going until 27th. With an anticyclone developing close to the south-east the final few days, at least over England and Wales, were much more settled with cold and often foggy nights, the fog persisting all day in a number of places.

K. O. M.

TEMPERATURE AND RAINFALL: NOVEMBER 1986

	Mean		Max	Min	Grass		Rain	%	Wettest	D	T
	Max	Min			Min	Max					
AUSTRIA: Innsbruck	10.2	0.5	16.7(15)	-5.5(30)	-11.9(30)	24.6			14.8(23)	9	0
BELGIUM: Uccle	10.8	5.2	15.2(11)	-0.6(29)		75.5	111		14.1(1)	21	1
" Rochefort	10.2	2.2	15.6(15)	-7.0(29)		50.5	74		12.6(19)	15	-
" Houwaart	11.5	2.8	17.6(13)	-6.1(30)	-8.2(30)	69.8	97		17.0(19)	18	0
DENMARK: Fanø	10.3	5.9	12.9(10)	2.9(13)		105.3	111		22.2(19)	25	0
" Frederikssund	9.1	4.6	11.7(11)	-1.4(3)	-4.0(3)	47.9	76		9.3(6)	16	0
GERMANY: Berlin	9.5	3.7	13.7(17)	-3.2(30)	-4.5(30)	25.2	54		7.5(5)	15	0
" Hamburg	10.1	4.5	16.3(11)	-1.6(3)	-4.0(3)	66.6	104		17.2(1)	16	0
" Frankfurt	9.6	2.5	14.6(16)	-4.7(30)	-6.1(v)	37.1	61		9.7(1)	17	0
" Munchen	10.0	-0.2	17.8(8)	-5.3(28)	-9.6(v)	33.9	60		7.2(20)	11	0
GREECE: Thessaloniki	14.8	6.5	18.8(26)	1.0(30)		36.5			33.0(5)	5	0
ITALY: Casalecchio	12.7	7.5	15.0(v)	3.0(v)	0.0(v)	76.7	106		60.2(3)	6	1
MALTA: Luqa	19.2	13.8	21.6(v)	10.2(6)	5.6(10)	204.4			62.3(25)	19	12
NETH'RD'S: Ten Post	10.2	5.0	14.5(15)	-1.8(30)	-2.5(30)	80.2	103		15.6(19)	21	0
" Schettens	10.2	5.8	13.0(13)	-0.2(30)	-1.4(30)	68.0	80		11.1(21)	21	1
" De Bilt	10.8	4.9	15.2(13)	-3.3(30)	-3.2(30)	88.0	118		28.0(20)	16	1
NORWAY: Donski	6.3	0.4	11.5(10)	-4.0(20)	-6.5(20)	88.8			15.3(23)	20	0
SWEDEN: Valla	7.5	2.2	11.9(26)	-3.8(13)	-6.8(13)	41.8			13.7(6)	23	0
SWITZ'LAND: Basel	11.0	2.6	17.7(16)	-3.0(30)		35.5	63		7.1(21)	11	0
EIRE: Galway	11.4	5.5	13.7(24)	0.4(21)		155.0	127		22.1(18)	25	2
" Straide	10.5	4.2	13.5(24)	-1.8(2)	-7.2(21)	208.5	174		26.4(24)	26	0
SHETL'ND: Whalsay	7.9	4.4	10.1(7)	0.0(12)	-5.4(21)	163.3	157		15.4(30)	29	1
" Fair Isle	8.5	5.4	11.6(7)	0.8(12)	-2.9(21)	139.1	111		15.8(10)	30	0
SCOT'ND: Braemar	7.9	1.2	13.1(7)	-7.2(21)	-9.1(21)	98.8	111		28.5(9)	22	0
" Inverduie	7.9	2.0	15.3(7)	-4.9(2)	-9.1(21)	69.1	79		10.1(9)	25	0
" Rannoch	8.7	1.9	13.8(7)	-7.7(1)	-12.3(1)	193.2			36.1(9)	27	0
" Edinburgh	9.5	4.7	14.6(7)	-4.2(21)	-8.5(21)	41.6			7.3(7)	17	0
WALES: Moel-y-Crio	9.9	3.8	13.6(7)	-1.2(2)	-6.5(2)	81.1			12.1(7)	22	0
" Pembroke	11.4	6.0	13.3(10)	0.6(2)	-2.7(2)	174.9	126		23.5(18)	25	1
" Lampeter	11.6	4.8	14.9(7)	-1.7(1)	-0.9(1)	218.0			28.5(9)	22	-
" Velindre	10.9	3.7	14.3(7)	-3.0(2)	-7.7(2)	156.4	165		24.1(3)	20	0
" Carmarthen	10.8	4.3	13.0(9)	-0.8(2)	-5.9(2)	277.2	198		37.6(18)	24	1
" Gower	11.4	6.0	13.9(10)	1.1(2)	-3.6(2)	225.8	165		31.9(18)	20	1
GUERNSEY: Airport	12.1	7.8	14.3(10)	3.2(23)		105.7			16.4(14)	20	1

	Mean		Max	Min	Grass		Rain	%	Wettest	D	T
	Max	Min			Min	Max					
ENGLAND:											
Denbury, Devon	10.8	4.2	13.3(24)	-2.6(30)	-6.8(29)	205.3	191		44.4(18)	19	0
Bournemouth, Dorset	12.2	5.9	14.7(10)	0.3(29)	-3.0(29)	131.9	140		25.1(18)	17	2
Gurney Slade, Somerset	10.4	4.2	13.3(10)	-1.1(4)	-4.5(6)	183.8	164		25.7(18)	22	3
Yatton, Avon	11.9	5.7	16.0(7)	-1.2(29)	-3.4(29)	133.9	144		23.7(18)	20	2
Congresbury, Avon	11.7	5.9	16.0(7)	-0.2(3)		126.6			19.7(18)	19	2
Bradford-o-Avon, Wilts	11.4	3.4	14.7(10)	-1.1(29)		114.7	147		15.3(20)	22	1
Corsham, Wiltshire	11.2	4.5	13.9(7)	0.1(4)	-3.6(29)	129.0	152		20.7(18)	20	1
Reading, Berkshire	11.6	4.7	15.4(10)	0.9(12)	-2.6(v)	71.5	121		10.8(14)	18	0
Sandhurst, Berkshire	11.1	4.0	15.6(10)	-0.5(4)	-4.4(4)	86.9	126		12.5(14)	18	0
Romsey, Hampshire	11.7	4.4	15.6(10)	-1.0(29)	-4.3(2)	127.2			19.8(18)	20	1
Newport, Isle of Wight	12.4	6.1	14.6(1)	0.1(29)		155.2	143		31.0(18)	22	1
Horsham, Sussex	10.9	4.8	12.8(10)	0.9(28)	-2.1(27)	120.6	140		24.1(20)		0
Brighton, Sussex	11.3	5.6	14.3(10)	0.6(29)	-0.6(29)	135.5			29.3(20)	22	1
Hastings, Sussex	11.4	6.2	13.8(12)	0.0(29)	-3.2(v)	140.4	163		29.6(20)	19	0
Dover, Kent	11.6	4.6	14.9(1)	-1.4(29)		126.0	129		32.9(20)	21	0
East Malling, Kent	11.8	5.0	15.5(10)	0.5(7)	-1.7(7)	91.1	121		25.3(20)	22	0
Epsom Downs, Surrey	10.8	5.0	14.2(10)	0.0(4)	-2.6(2)	107.6	140		14.5(17)	21	0
Reigate, Surrey	10.5	4.3	14.1(10)	-0.2(27)		122.4	169		20.8(18)	20	0
Guildford, Surrey	10.9	5.7	15.2(10)	1.3(2)	-1.4(2)	96.0	137		15.4(14)	20	0
Sidcup, London	11.8	5.2	15.3(10)	0.8(28)	-2.8(28)	88.1	149		11.3(14)	22	0
Hayes, London	11.5	4.5	16.1(10)	0.6(12)	-1.5(28)	76.3	149		13.2(14)	22	0
Hampstead, London	11.2	5.5	15.4(10)	1.8(23)	-2.2(29)	86.9	122		13.5(14)	21	0
Royston, Hertfordshire	10.7	5.4	16.3(11)	0.1(29)	-2.5(29)	56.6	98		9.1(14)	19	0
Loughton, Essex	10.6	4.5	15.4(10)	0.8(12)	-3.2(29)	76.4	140		12.0(14)	21	0
Leigh-on-Sea, Essex	11.3	5.4	15.4(10)	1.6(29)	-0.5(28)	57.5	101		9.5(14)	18	0
Needham Market, S'lk	10.8	5.3	15.4(10)	0.2(29)		55.2			10.9(20)	19	0
Pulham St. Mary, N'folk	10.7	4.5	15.6(10)	-0.3(30)	-2.6(12)	48.3	76		9.1(20)	18	0
Buxton, Norfolk	11.1	4.4	15.6(10)	-0.5(12)	-2.2(7)	57.9	84		11.2(20)	17	0
Ely, Cambridgeshire	10.8	3.3	14.8(10)	-1.0(29)	-1.5(4)	64.6	121		12.0(20)	20	0
Luton, Bedfordshire	10.4	4.7	14.1(10)	-0.2(4)	-2.3(4)	76.3	111		10.9(14)	19	0
Oxford University	11.4	5.4	14.8(7)	1.8(2)	-4.1(29)	78.4	128		14.3(20)	18	0
Buckingham, Bucks'shire	10.6	4.1	13.8(10)	-0.1(29)	-4.4(7)	81.9	124		11.8(20)	19	0
Stourbridge, W.Mid'nds	9.6	4.4	14.4(7)	-0.8(2)	-7.0(2)	79.4			12.5(13)	19	0
Birmingham Univ'sity	9.9	4.6	14.7(7)	0.0(29)	-4.5(29)	98.1	135		15.7(13)	20	0
Kettering, Northants	10.4	3.8	14.4(7)	-1.1(29)	-3.9(v)	66.3	132		18.0(20)	18	0
Hinckley, Leicestershire	10.4	4.2	13.8(25)	0.4(2)	-1.4(2)	77.9	129		12.2(20)	19	0
Cosby, Leicestershire	10.0	3.9	14.2(25)	-0.8(2)	-4.0(2)	69.4	121		13.2(20)	19	0
Louth, Lincolnshire	10.7	4.5	15.1(7)	0.8(30)		75.3			23.0(20)	18	0
Newark, Nottingham'shire	10.6	4.3	16.2(7)	0.4(29)	-2.2(6)	57.4	128		13.5(20)	15	0
Nottingham, Nott'shire	10.8	3.9	15.1(7)	0.2(12)	-3.1(29)	60.3	109		12.1(20)	16	0
Middleton, Derbyshire	8.2	3.0	12.4(7)	-0.9(30)		135.2			26.1(25)	23	0
Burton-on-Trent, Staffs	10.9	3.5	15.0(7)	-1.0(2)	-3.4(29)	73.0	122		15.0(22)	21	0
Keele University, Staffs	9.9	3.3	14.1(7)	-0.7(2)	-4.9(2)	92.9	127		17.1(25)	13	0
Liverpool, Merseyside	11.3	4.4	15.2(7)	0.2(2)		71.0			20.2(18)	21	0
Lathom, Merseyside	10.7	4.4	14.9(7)	-1.1(2)		106.0			21.0(18)	21	0
Huddersfield, W.Yorks	9.9	2.0	13.4(5)	-2.2(2)	-2.2(2)	108.7	124		20.9(18)	21	1
Sheffield, S.Yorkshire	10.5	4.1	13.8(v)	0.0(30)	-2.0(29)	92.4	111		17.5(20)	21	0
High Bradfield, S.Yorks	7.7	3.0	11.7(7)	-0.8(21)		112.6			18.8(18)	20	-
Cottingham, Hum'b'side	11.1	4.6	15.1(25)	1.7(30)	-2.8(17)	58.5	89		17.9(25)	16	0
Carlton-in-Cleveland	10.3	4.8	14.2(7)	1.2(21)	-1.3(20)	47.3			9.7(14)	17	0
Durham University	10.5	4.3	14.2(7)	-0.4(21)	-6.0(21)	36.2	64		6.8(18)	17	0
Sunderland, Tyne/Wear	10.8	5.4	14.6(7)	1.0(21)		33.2	48		6.0(18)	17	0
Carlisle, Cumbria	10.3	5.1	13.9(7)	-3.0(2)		97.4			14.1(24)	-	-
CAN'DA: Vanderhoof	-0.4	-8.9	11.7(3)	-22.8(9)		86.9			0.8(10)	-	-
" Wolseley, Sask	-3.9	-13.7	8.9(4)	-25.0(17)		6.1			2.0(9)	-	-

	Mean		Max	Min	Grass		%	Wettest	D	T
	Max	Min			Min	Rain				
U.S.: Bergenfield, N.J.	11.3	0.7	21.1(9)	-7.8(14)	-11.1(14)	154.2		43.2(26)	14	1
" San Diego, Ca.	22.9	9.9	27.8(12)	6.1(30)		37.1		36.1(18)	-	-
" Colorado Spr.	10.4	-3.4	20.0(29)	-11.1(11)		18.3		17.3(1)	-	-
" Jennings, L.A.	21.7	12.7	28.9(9)	0.6(14)		214.8		45.5(25)	-	-
" Bath, Maine	7.7	-2.8	13.9(26)	-12.8(20)		104.9		40.4(21)	-	-
" New York C'y	11.7	3.4	22.8(9)	-5.6(14)		146.8		36.1(11)	-	-
" Dayton, Ohio	8.4	0.9	21.7(1)	-11.7(14)		73.2		17.0(12)	-	-
" Galveston, Tx.	20.8	15.6	27.8(20)	4.4(14)		102.1		51.3(24)	-	-
" Virginia B'ch	18.1	10.9	28.9(9)	2.2(14)		76.5		19.6(12)	-	-
A'ALIA: Mt. Waverley	20.7	10.5	33.4(5)	5.6(21)		31.3		12.2(18)	12	0

ASSOCIATION OF BRITISH CLIMATOLOGY: Meetings

Saturday 14th March *Acid Rain*
A one-day meeting at U.M.I.S.T.
(telephone local organiser, Leslie Musk, 061.273.3333, ext. 3243)

Saturday 9th May *Climatological Research*
A one-day meeting at Dept. of Geography, Loughborough University
(telephone, Mr. Keith Boucher, 0509.263171, ext. 2745)

INTERNATIONAL SYMPOSIUM: 'NEW DEVELOPMENTS IN BUILDING CLIMATOLOGY'

MOSCOW - MAY 12th-15th, 1987

The Symposium will address many aspects of building and urban climatology, including settlement and facilities planning in various climates, wind effects, internal conditions in buildings, effects on building materials and ways of computing and presenting climatic data for various applications in planning, design and construction.

While participants will need to make detailed arrangements direct with the organisers in Moscow, further information may also be obtained from the UK Co-ordinator, Professor V. B. Torrance, Department of Building, Heriot-Watt University Edinburgh (tel: 031.225.8432), or from Mr. E. J. Keeble, Building Research Establishment, Garston, Watford (tel: 0923.674.040), or from Mr. M. J. Prior, Meteorological Office, Bracknell, Berkshire (tel: 0344.420.242).

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An anticlockwise spiral-circle in a cereal crop, Hampshire 1986.

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