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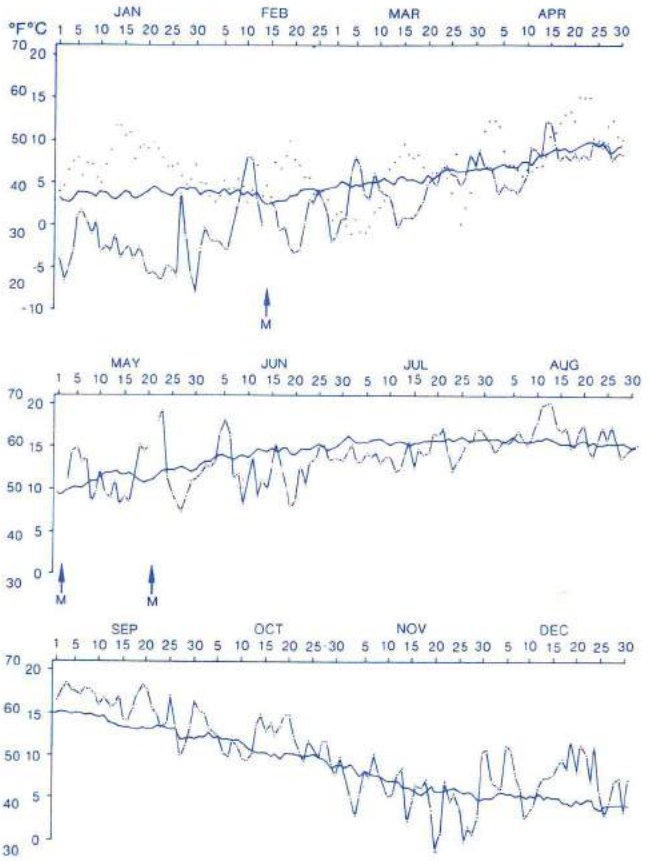


*BIRMINGHAM DAILY TEMPERATURES,*
*JANUARY 1795 - APRIL 1796*

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Telephone: National. 02216.2482; international +44.2216.2482

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# JOURNAL OF METEOROLOGY

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## DESCRIPTIVE DEFINITIONS OF TEMPERATURE

By PAUL R. BROWN.

*11 Wytherlies Drive, Stapleton, Bristol, BS16 1HX.*

*Abstract:* The problems of describing temperature in weather forecasts in terms of how warm or cold it actually feels are discussed.

Descriptive definitions of temperature are complicated, firstly, by the impossibility of allowing for variable non-meteorological factors, such as age and fitness of the person, degree of physical activity, and level of clothing being worn; and secondly by the fact that the meteorological parameters themselves are not easy to define objectively.

### ACCLIMATIZATION TO TEMPERATURES

To begin with, our bodies make certain adjustments in line with the seasonal changes, so that the same temperature feels different at different times of the year. For example, (other things being equal) 15°C in England feels pleasantly warm in early March, indifferent in May, and decidedly chilly in July. We do not, of course, adjust completely, otherwise a temperature equal to the seasonal average (or of equal departure therefrom) would feel the same at all seasons, which it obviously does not: e.g. 6°C in January does not feel the same as 21°C in July, albeit both are about the norm for their respective months. (6°C in January feels colder than 21 in July, but less cold than 6 would feel in July.)

We also adjust to spells of unseasonably warm or cold weather within a season. Thus a temperature of 8°C in January, coming suddenly after a week or two of freezing weather, can feel positively warm for a short while. We do, however, re-adjust rather quickly, so that within a couple of days the same temperature of 8 reverts to its normal winter feel of being rather cool.

It is possible that we get used to the average diurnal changes of temperature, for the same temperature appears to feel warmer at night than it does by day. For example, a July night with a minimum of 18°C is remarked upon for its warmth, but a *day maximum* of 18 in the same month excites no interest at all. But this may have more to do with the fact that minima and maxima are not directly comparable in this respect. The point is, that those values represent only the extremes reached during the period. On a night with a minimum of 18°C the temperature for the greater part of that night will have been higher than that - around 19-21; while on a day with a maximum of 18°C the temperature for much of the time will have been only 16 or 17. It is these prevailing values that should be compared, rather than the extremes. The day with a maximum of 18°C then turns out to be 3 or 4 degrees

cooler than the night with a minimum of the same.

By tradition, it is the two extremes of temperature - the maxima and the minima - that are offered to us in the forecasts. While there is good reason for this in respect of night minimum temperatures, it could be argued that a more useful indicator for the daytime would be the prevailing level of temperature during the day (the mean value from about 10am-5pm), in preference to the day maximum; though I suspect the latter is too firmly established now to be supplanted by such a radical notion.

## EFFECTS OF WIND

The cooling effect of a wind is well-established but is not always taken into account. Wind-chill is often mentioned when below-average temperatures (especially freezing temperatures) are accompanied by a strong wind, but it tends to be overlooked when temperatures are higher. Yet a strong wind is capable of making any temperature with which it is likely to occur in this country (i.e. up to about 21°C) feel cold, no matter whether that temperature is below average or not. Conversely, very light winds of less than force 2 can allow a low temperature, which would normally feel distinctly cold, to be quite tolerable.

Wind-chill equivalent temperatures, when given, are related to how low the screen temperature would have to be in still air to feel the same as the current temperature does with x knots of wind. I question whether this is the most useful figure to give. A dead calm is not all that common, and might not therefore be the most representative value with which to make comparison. It could be more meaningful, when equivalent temperatures are given, to relate them to the commonest observed wind speed, which for most stations would be force 3. In other words, tell us what temperature would be required to produce the same degree of cooling with a *light* wind, not with a calm.

There is a second effect produced by the wind on a person out in the open: that is the discomfort of being buffeted by the wind. At speeds up to force 4 this effect is negligible; at force 5-6 it becomes noticeable; and above force 6 it overtakes the cooling effect as the dominant impression made by the wind. This means that although the wind-chill continues to increase above force 6, the person exposed to it is no longer conscious of any worsening of the chill effect because their senses are pre-occupied by the physical difficulty of contending with the force of the wind.

## EFFECT OF DEPARTURES FROM AVERAGE

It sometimes seems to be wrongly assumed that in the absence of a significant wind-chill any temperature below the average feels cold, and any temperature above average feels warm. In fact, most winter temperatures in the British Isles feel more or less cold, even when they are above the seasonal normal. Only if it is much above average, or if the wind is near calm, or if there has been a sudden rise after a much colder spell, does it sometimes feel mild or warm in winter. Under normal circumstances a temperature of, say, 8°C in January (i.e. 2 or 3 degrees above average) actually feels cold, although officially it is 'rather mild'. Even with values as high as 11 or 12°C in winter any feeling of mildness is often nullified by the strength of the wind.



It may be of interest to relate the following instance. On a mid-January afternoon earlier this year I was taking a constitutional walk of about an hour's duration. The day was dry, anticyclonic, with rather a lot of layered cloud and occasional sunny intervals. There was a moderate breeze of force 4, and the temperature, at around 10°C, was well above the January average, as indeed it had been for some time. The forecast had said "mild". And yet, try as I might, I could not persuade myself that the weather that afternoon was anything other than cool.

On the other hand, most summer temperatures in this country feel somewhat warm, even if they are a few degrees below normal. For example, 18°C in July (when the average is, say, 20-22) only really feels cool if there is a brisk breeze blowing, or if the previous few days have been particularly warm; otherwise it feels, at worst, indifferent; and if the sun is out and the wind light there is very little cause for complaint. Summer temperatures in the British Isles need to be well below normal (15°C or lower) before they can automatically be assigned to a 'cool' category.

## INFLUENCE OF WET-BULB TEMPERATURES

Evaporation of perspiration from the skin is the way in which the body strives to maintain a comfortable temperature when either (a) a person is engaged in strenuous physical exertion, or (b) the weather is very warm. Evaporation causes the skin to register the wet-bulb temperature rather than the dry bulb, and so feel cooler. (This is in addition to any cooling there may be from a breeze.) If, however, the wet-bulb temperature itself is abnormally high, and the wind very light, the cooling may not be enough to prevent a person becoming uncomfortably, or even dangerously, hot.

This is when we begin to assign to the weather the adjective 'humid'; but it is, in fact, high wet-bulb temperatures rather than high relative humidities that create this impression - R.H. values in the British Isles are seldom above 70% when air temperatures are at their highest.

In this way the wet-bulb temperature plays a role in influencing how warm we feel.

No method of describing temperatures can be wholly satisfactory because the meteorological factors only make up half the story. The rest depends on physiological factors to do with the person experiencing the temperature. The best that can be done is to relate the meteorological effects, as described above, to the average person in a typical outdoor situation. That is: a person of proper fitness and health (not too old), walking along steadily but not hurrying, unencumbered with heavy baggage, and dressed according to the season (though this last point has become something of an anachronism with the modern tendency, induced by car travel and central heating, to wear the same level of clothing year-round!).

# LATE EIGHTEENTH CENTURY TEMPERATURES IN BIRMINGHAM, ENGLAND

By BRIAN D GILES

*School of Geography, University of Birmingham, B15 2TT.*

*Abstract:* A sixteen-month series of daily temperature observations taken near Birmingham, England, in 1795 and 1796 provide mean monthly values which are compared with the Central England Temperatures calculated by Manley. The daily values are used to describe a series of warm and cold spells in 1795 and 1796; they are also compared with mean date values based on the 1951-80 period.

In 1766 the Lunar Society (Bolton, 1889) was founded in Birmingham and consisted of about a dozen individuals, half of whom were Fellows of the Royal Society. They included such well-known names as Joseph Priestley (philosopher and pure scientist), Samuel Galton (gunmaker and scientist), John Baskerville (printer), Erasmus Darwin (medicine and natural science), Matthew Boulton and James Watt (steam engine), and William Withering (physician, botanist and chemist). The last of these is best remembered both as a caring physician and for his work on digitalis and the foxglove (Peck and Wilkinson, 1950). Allied to these, but much less known, was his interest in the weather. Born in Wellington, Shropshire, in 1741 and trained in Edinburgh he came to Birmingham via Stafford in 1775 and was elected F.R.S. in 1785. He moved 3 1/2 miles from the centre of Birmingham to the then rural countryside southwest of the town when he took up the lease on Edgbaston Hall in April 1786 where he lived almost continuously until his death in 1799. During his stay there he kept notes on the weather and a series of thrice daily temperature readings. A set of the latter from 1st January 1795 to 30th April 1796 was printed by his son (Withering, 1822) as part of a collection of papers which also included some of his father's comments on the weather. Unfortunately this collection does not contain any information on either the type or exposure of the thermometer, apart from the comment "the thermometrical observations... are according to the scale of Fahrenheit, taken out of doors, and in the shade". One can surmise that it was probably placed just outside a north window since this was a preferred position at the time and was specifically mentioned as a location for a thermometer used to provide some data for the Isle of Wight in the 1796/97 winter and also included in the same collection. Indeed, the collection contains several appendices of weather data collected by Withering Senior from various other contemporary weather observers whom he met during his travels in southern England and on his trips, for health reasons, to Portugal. These will form the basis of another article. However a short series of 9.30am readings were also made at Yoxall Lodge near Lichfield by the Rev. Thomas Gisborne. They were from 1 November 1794 until 27 June 1795 with 8 days missing in April (19-26) and are also considered here.

Withering's temperatures were recorded at 9am, 2pm and 9pm each day and there are only three readings missing in the whole set - those at 2pm on the 14th February, 2 and 21 May 1975. Thus it is possible to calculate mean daily temperatures for all sixteen months (Fig. 1). Giles and Kings (1987) calculated date mean temperatures for the five winter months using a twenty-seven year



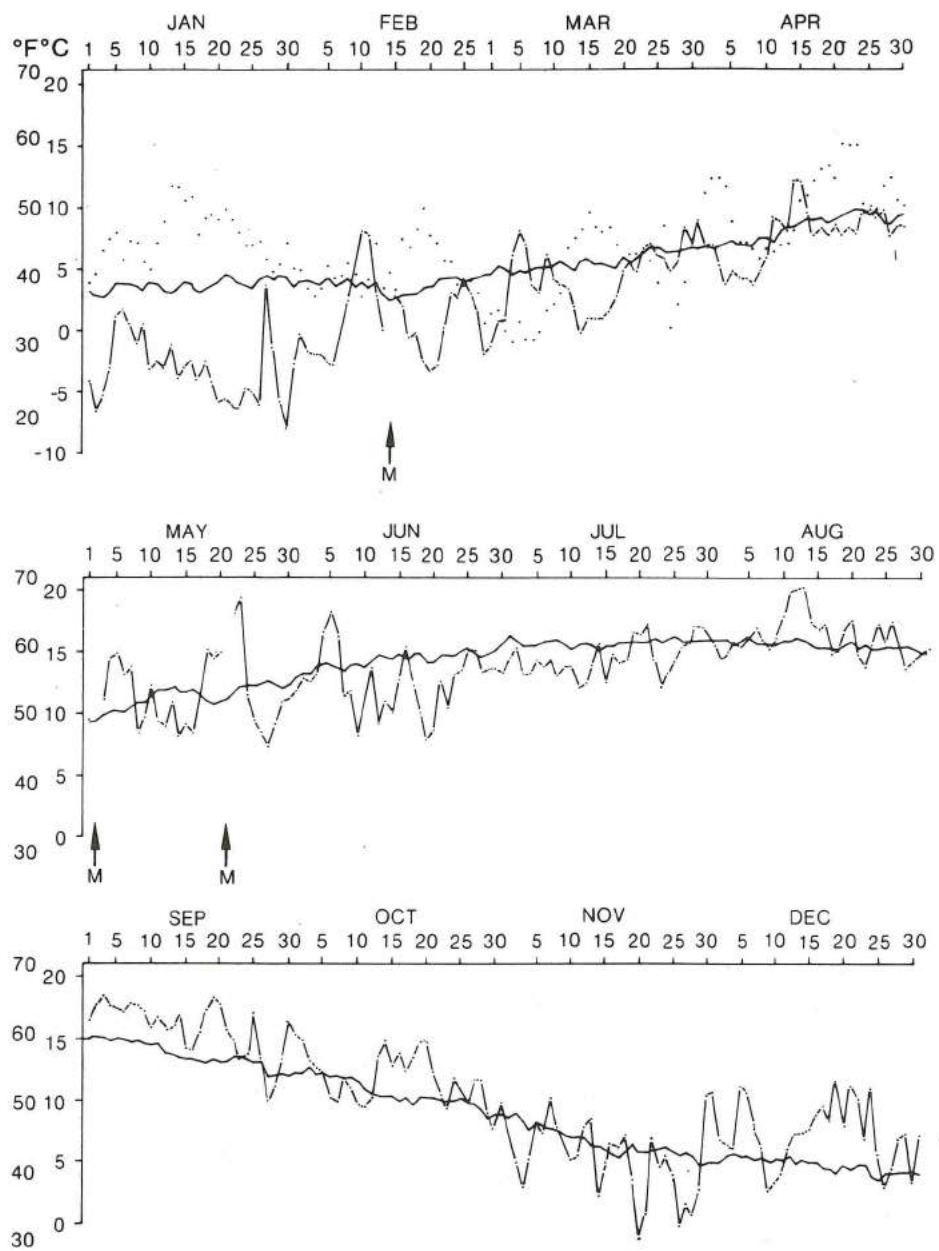


Fig. 1. Mean daily values for the period 1 January 1795 until 30 April 1796 based on thrice daily recordings made by William Withering (Withering, 1882) and mean date values calculated for the period 1951-1980. [M = missing data].
---1951-80; - - -17952 • • • 1796;

period. This has now been extended (but unpublished) to all twelve months based on the 1951-1980 period. These date values are also plotted on Fig. 1 to allow a comparison between recent means and two hundred year old actual daily temperatures. Remembering that the Withering data contain no low night time temperatures the coldness of the early months of 1795 is remarkable. It is not until July that the 1795 data straddle the mean data. September and mid October 1795 were warmer as was December, with a cold November separating them. Yet the first four months of 1796 show much warmer values than twelve months earlier and, apart from early March, are generally at or above the mean values.

Table 1: Monthly and Seasonal Mean Temperatures; Withering (1822) Manley (1953) Italic indicates some days were missing.

| Year | J | F | M | A | M | J | J | A | S | O | N | D | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1794 | | | | | | | | | | | | | |
| a) | | | | | | | | | | | 42.9 | 38.7 | |
| b) | | | | | | | | | | | | | |
| c) | | | | | | | | | | | 45.8 | 38.9 | |
| 1795 | | | | | | | | | | | | | |
| a) | 26.5 | 33.4 | 39.0 | 45.9 | 51.6 | 55.7 | 59.3 | 61.8 | 60.8 | 53.0 | 40.1 | 43.9 | 47.6 |
| b) | 26.2 | 33.5 | 39.3 | 45.8 | 53.0 | 54.7 | 58.4 | 60.9 | 60.4 | 53.3 | 41.2 | 45.2 | 47.7 |
| c) | 24.6 | 32.7 | 36.8 | *42.7* | 47.6 | *50.1* | | | | | | | |
| 1796 | | | | | | | | | | | | | |
| a) | 45.2 | 40.5 | 39.5 | 50.4 | | | | | | | | | |
| b) | 45.5 | 40.3 | 39.7 | 50.5 | | | | | | | | | |

| | Wint DJF 1795 | Spr MAM | Sum JJA | Aut SON | Wint DJF 1796 |
|---|---|---|---|---|---|
| a) | 32.9 | 45.5 | 58.9 | 51.3 | 43.2 |
| b) | | 46.0 | 58.0 | 51.6 | 43.7 |

a) Central England, °F; b) Edgbaston, °F; c) Yoxall, °F.

Mean monthly temperatures were also calculated for both the Edgbaston and the Yoxall series and compared with the Central England Temperatures published by Manley (1953, 1974) in Table 1. Differences between the three sets may be due to a variety of causes including peculiarities of the thermometers, regional differences (since Manley's figures are calculated from a variety of sources), to the fact that Withering's data does not include any night time temperatures, or that Gisborne's data was 9.30am. If averages of Gisborne and Withering data are based on comparable days in each month they are in reasonably close accord: +0.2, +0.3, -0.9, -0.7, -3.6, -2.6 January to June respectively, with + indicating that Yoxall was warmer. Withering recorded somewhat warmer temperatures than Manley in May, November and December 1795, while the reverse was true for June, July and August. While the differences are only of the order of 1°F or 1/2°C and so may be considered within experimental error one should look at them in the light of Fig. 1. May, June, November and December, with clear warm and cold spells, were months which showed quite marked differences in daily values, whereas July and August 1795 were much more equitable. In Table 2 mean monthly values for the three observation hours are given. They add flesh to the mean monthly figures by



Table.2: Mean Hourly Temperatures; Withering (1822).

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1795 | | | | | | | | | | | | |
| 9am | 24.4 | 32.4 | 37.7 | 44.1 | 51.2 | 53.0 | 57.0 | 60.1 | 58.5 | 52.2 | 40.2 | 44.0 |
| 2pm | 28.5 | 35.5 | 42.1 | 48.8 | 57.1 | 58.1 | 61.9 | 62.8 | 64.5 | 56.3 | 43.4 | 46.8 |
| 9pm | 25.8 | 32.6 | 38.2 | 44.4 | 50.6 | 53.1 | 56.3 | 59.5 | 58.3 | 51.4 | 40.1 | 44.8 |
| Mean | 26.2 | 33.5 | 39.3 | 45.8 | 53.0 | 54.7 | 58.4 | 60.9 | 60.4 | 53.3 | 41.2 | 45.2 |
| 1796 | | | | | | | | | | | | |
| 9am | 44.0 | 39.1 | 37.6 | 48.8 | | | | | | | | |
| 2pm | 47.5 | 42.8 | 43.2 | 54.6 | | | | | | | | |
| 9pm | 44.9 | 39.1 | 38.3 | 48.0 | | | | | | | | |
| Mean | 45.5 | 40.3 | 39.7 | 50.5 | | | | | | | | |

indicating the daytime temperature variations experienced at the time.

Some simple frequency analyses were also carried out. Temperatures below 32°F (0°C) at the observation hours were used to indicate the frequency of air frost (Table 3) and at the same time the number of days when all three temperatures were below this level (air frost days) were noted. On this criterion there were 24 air frost days in January, 9 in February and 1 in November 1795 and none in the four

Table.3: Frequency of Air Frost (<32°F)

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1795 | | | | | | | | | | | | |
| 9am | 27 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 2pm | 24 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 9pm | 26 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 1796 | | | | | | | | | | | | |
| 9am | 0 | 1 | 4 | 0 | | | | | | | | |
| 2pm | 0 | 0 | 0 | 0 | | | | | | | | |
| 9pm | 0 | 1 | 5 | 0 | | | | | | | | |

months of 1796. An alternative definition of a cold day being one when the daily average was below 32°F yielded 26 in January, 12 in February, 2 in March, 2 in November 1795, 1 in February and 2 in March 1796. Spells of three or more air frost days occurred as follows in 1795: Jan 1-4, 10-12, 14-26, 29-31 and Feb 2-6, 19-21; there were none during the 1795/96 winter. Spells of three or more cold days were: Jan 1-4, 10-26, Jan 28-Feb 6 and Feb 17-21. This kind of detail helps to flesh out the rather crude statistic that the 1794/95 winter was very cold according to Manley.

In contrast the summer of 1795 does not appear to have been extremely warm. If 'warm' is defined in terms of temperatures of 60°F or above then there are two ways to define a warm day: 1) those when the average of the three observations is 60°F or more, and 2) those on which all three observations were 60°F or over. As can be seen from Table 4 the former produces nearly twice as many days as the latter. Spells of warm days, using the criterion, were: May 21-23, Jun 4-6, Jul 19-21, and 26-31, Aug 3-7 & 9-16 & 23-26, Sep 1-14, and 17-21; using the stricter second criterion there were only three warm spells: Aug 9-16 & 24-26, Sep 2-8.

Similarly 'hot' may be specified by temperatures >67°F in the same two ways. There was not a single day when all three observations exceeded this threshold but there were three days (Aug 11-13) which had an average temperature about it.

Table 4: Warm days. (a) Average of three observations above 60°F;
(b) all three observations. above 60°F

| | | | | | | |
|---|---|---|---|---|---|---|
| (a) | 1795 | May 3 | Jun 3 | Jul 10 | Aug 19 | Sep 21 |
| (b) | 1795 | May 3 | Jun 2 | Jul 4 | Aug 12 | Sep 11 |

In addition to the tabulation of the daily data for the sixteen months Withering also quotes from a variety of his father's letters and notes. The following extracts are given together with relevant comments based on Manley's tabulation.

*from the 8th of January to the 23rd May [1785] no rain fell at Birmingham; some snow, but no great quantity*

*the protracted winter of 1785-6* - yet, according to Manley it was several degrees (F) warmer than the two previous winters.

*cold winds in March and April* [1790]

*1789-90 was a mild winter since the thermometer did not drop below 26°F and that only on two nights and the little snow that fell was not lying* - indeed it was and the average from Manley was 42.2°F.

*on the 22nd June [1790] there was a great storm: 4-5 inches of hail near Solihull with hail stones 2 1/2" in circumference ... the breadth of the storm (shown by damage to crops etc) length one mile, temperature was 79°30' [sic] in the shade at 2pm*

*on 18th November 1795 there was a tempest of wind which tore up 9 oak trees and lime trees at Edgbaston ... barometer was low*

*1796 - The early part of the winter was so unusually mild that during the greater part of January the thermometer indicated fifty-five, and was seldom lower than forty-five degrees* - this seems to be wishful thinking as far as the degree of warmth because his own observations produce an average of 45.5°F (see Table 2) and a range from 36° to 51°F.

*on Christmas Eve [1795] the temperature of the air was actually higher than it had been at the same hour on the preceding Midsummer-day* - again not strictly true since his own data give 60° at 2pm on June 21 and only 54° at the same time on December 24.

*the winter of 1796/7 was not remarkable for its severity yet at sunrise on Christmas Day the thermometer at Edgbaston was 7 1/2°F, at the same time in Croydon 5 1/2°F below zero which was a greater cold than any ... registered in the southern part of this island.*



It seems that Dr. Withering's comments were far more impressionistic than his recordings and he probably had the common failing with regard to the weather of thinking that the extremes were a little worse than the instruments suggested. Nevertheless, there is sufficiently close agreement between both his and Gisborne's data and that calculated by Manley for us to accept them as a valid set for the West Midlands at the end of the eighteenth century.

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# THE CHRISTMAS DAY TORNADO AT KEEVIL, WILTSHIRE


By CHRISTOPHER VERNON

*Keevil Manor, Keevil, Trowbridge, Wiltshire.*


Since the early hours of Christmas morning, 1990, there had been strong winds and sporadic heavy rain at my village of Keevil which is east of Trowbridge in Wiltshire. At about 0915 GMT I left the house to collect logs from the cow-shed. I noticed that the wind had increased, blowing from the south, to around 30 knots, and had become very gusty; indeed, some of the gusts were severe. Having suffered severe expensive damage from last winter's storms, I became rather concerned. However, I knew that a cold front or occlusion was near at hand, and I fully expected a rapid drop in windspeed in the rear of the front. Having filled my vast wheelbarrow with logs, I wheeled it outside the shed, lit a cigarette and indulged in my favourite pastime of weather-watching. I noticed that the wind had dropped and veered to a direction west of south. The rain had stopped and patches of blue sky had appeared overhead.

The feel of the air was soft and warm - a narrow warm sector, I surmised - and I continued to indulge my hobby! A few minutes later large, warm raindrops began to fall and the blue sky vanished. To the south-west I noticed the typical rugged rollcloud of an approaching cold front with the familiar lighter, whiter sky beyond.

I ventured forth and began to wheel my logs towards the manor. The time was 0940. As the rugged cloud passed overhead, a tremendous gust of wind lifted the wheelbarrow from my grasp. Logs and barrow disappeared from view in a cloud of falling 'white' rain and cloudwater vapour. For the next 90 seconds or so the wind became a roaring chaos. I tried to bury myself in the ground. Visibility became nil. A few large hailstones bounced off my forehead. The cow-shed roof was damaged. Soon, these extreme conditions moderated. It became cold and the sun came out. The wind fell away to nothing. By ten o'clock it was a bright, crisp Christmas Day. I returned to my wheelbarrow and filled it with the scattered logs.

When the tornadic squall hit, there was a feeling of utter helplessness, so extreme was the event. Later in the day, talking to villagers nearer to the centre of the track of the tornado - for that is what it was - there was a great sense of shock in their accounts of the event. It was lucky that the tornado rampaged through Keevil on Christmas morning. Few people were outside. Everyone I spoke to remarked on its rapidity and extreme violence, using terms like 'bomb', 'explosion', etc. At the Elms, 200 yards to my north in the path of the tornado, a witness saw the revolving cloud at ground level. Westwood Farm 200 yards further on suffered maximum damage. The farmer, Mr Banfield, said that "no-one could have lived in the yard with all the debris flying about!". The house between Westwood and The Elms, known as Highfield, had roof damage and was hit by debris from Westwood which led to a fire in the house. The tornado track was from W.S.W to E.N.E. over Westwood Farm, across the Trowbridge-Devizes road, and thence through chestnut trees beyond.

My own gut feeling, gleaned from years of weather-watching, agree with Keith Mortimore's and yours that our part of Wiltshire was near to a triple point - that warm, tropical air was over Keevil for a very short time prior to the event.

## NOTE REGARDING THE TROWBRIDGE TORNADO OF CHRISTMAS DAY 1990

By G. T. MEADEN

The editor was in France during Christmas week and could only begin his inquiry upon his return, namely 1st January 1991. He tracked tornadic damage through the southern housing estates of Trowbridge along a line from W.S.W. to E.N.E. Approaching 200 houses were damaged, mostly at T1 - T2 level but a few more severely at the T3 level. The main track was easily identifiable over a width of 300 metres and length of 1 1/2 kilometres ending at Elm Grove Farm, Drynham, beyond which there is a high railway embankment and open country until Keevil is reached six kilometres distant (Fig. 1). At its closest approach the Trowbridge tornado passed only 200 metres from the editor's former home where he lived from 1938-1953, 1 1/2 km from Cockhill House where he lived 1974-1983, and 5 km from Bradford-on-Avon (1983 to date) where reported weather conditions were exceptionally squally ("white rain being blown horizontally in different directions about 0930" (Mr R.T. Sadd)).



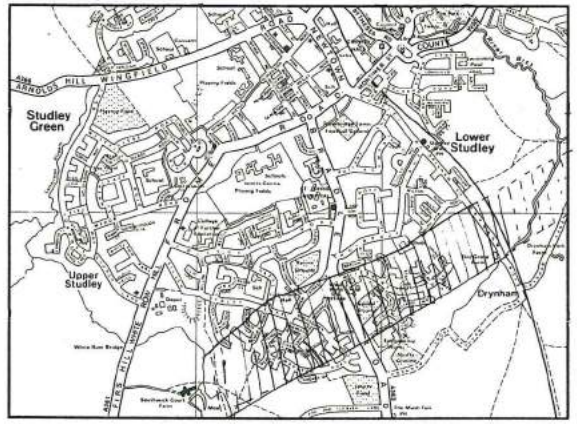



Fig. 1: Tornado track across Trowbridge, Wiltshire, 25 December 1990.

Further to the W.S.W. of Trowbridge the editor found tornado damage in the village of Southwick, but the moated farm known as Southwick Court between Southwick and the south of Trowbridge just escaped, the tornado brushing by on its south-eastern side. An eye-witness, Mrs Hazel Neathey, who was walking nearby, saw the huge spinning funnel cloud crossing the fields at ground level to hit the trees south of Sandringham Road and Balmoral Road and throw a vast amount of tree-debris at the first of the houses. Of the many dozens of incidents

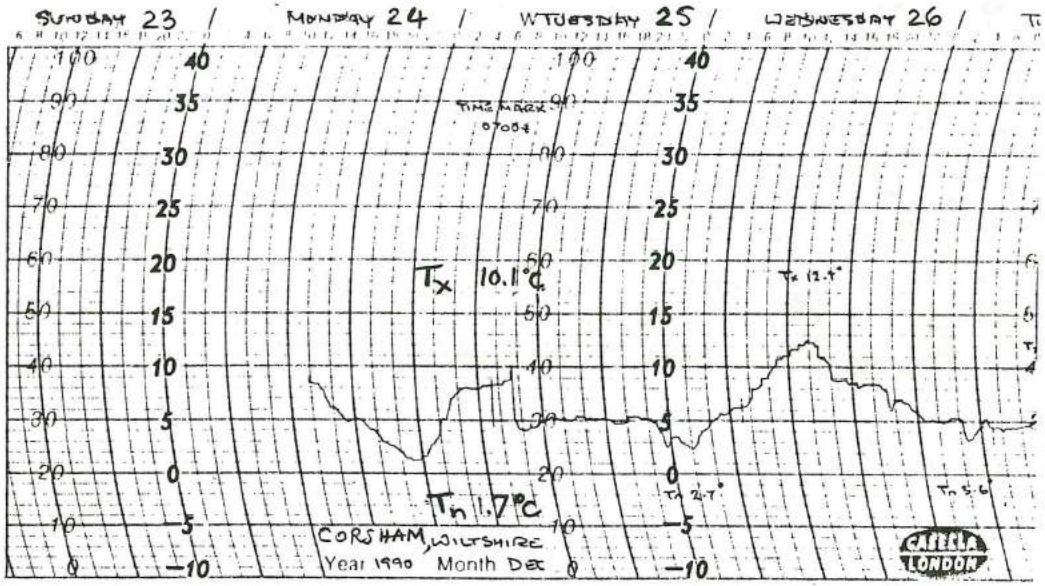



Figure 2: Thermograph from Keith Mortimore's weather station at Corsham, Wiltshire, showing the abrupt frontal passage (at about 0920 on the chart) the trace flowed smartly upwards to peak at 10.1°C, and fell as quickly to 5°C and below.

reported in this area of Trowbridge, a great many involved roof and wall damage to well-built stone houses (including a sucked-out gable-end which fell on to a garage in Heddington Close). There were a number of tile damaged cars (one car at 12 Balmoral Road was lifted a few centimetres off the ground and carried five metres) and a caravan in Sandringham Road was smashed. In Westmead Crescent a medium-sized fir tree was sucked upwards, and fell across a garage and a car. On the corner of Holyrood Close and Balmoral Road a tile sliced through the metal door of an up-and-over garage leaving a horizontal, letter-box type opening in it, and in Balmoral Road another tile passed through a W.C. from window to door shortly after it had been used.

Study of the tornado tracks in relation to Ordnance Survey maps suggests that the Southwick-Trowbridge tornado is not to be classed as precisely the same as the Keevil one, there being a track misalignment besides a somewhat lengthy lift-off section. These events were caused by tornadoes on a cold front close to the triple-point of an occlusion, the triple-point instability contributing to the gyratory inflow at ground level as the narrowing region of naturally-buoyant warm air was

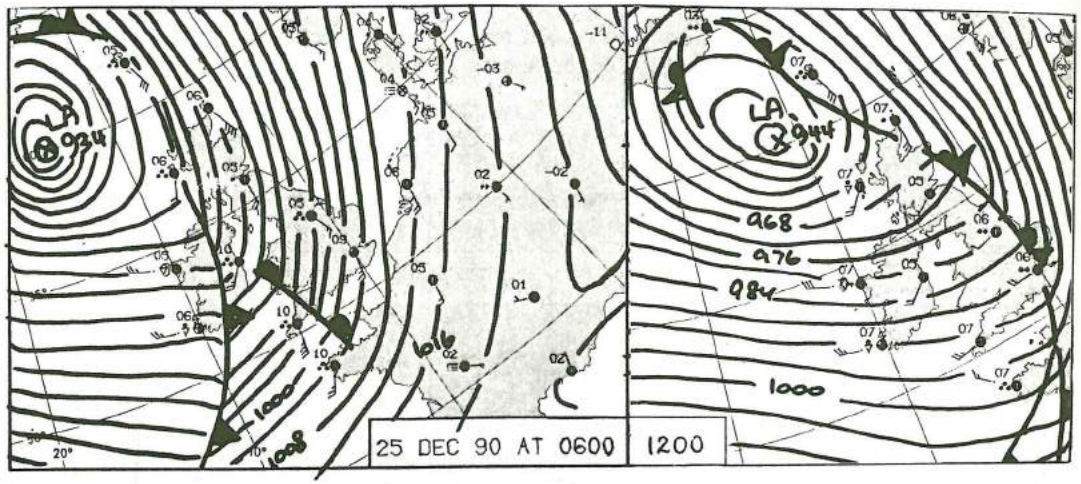



Figure 3: 0600 and 1200 GMT charts, courtesy *Daily Weather Summary* (London Weather Centre).

squeezed away upwards. Neither at Trowbridge nor Keevil did lightning and thunder occur. Ten or more other tornadoes are believed to have occurred that morning in Somerset, Avon and Wiltshire, some at the T4 level. Reports from other counties have been received too, including Oxfordshire (Goring-on-Thames) and Northamptonshire (Oundle). Details will be reported later.



Figure 4: Nine days after the Trowbridge tornado builders have arrived to replace the gable end of this house in Heddington Close which fell through the adjoining garage roof on to a car. Many buildings in this street lost edging tiles and television aerials.

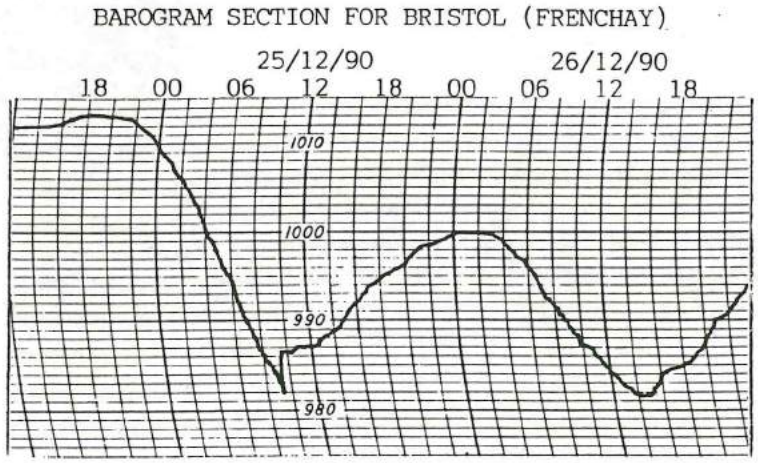
Figure 5: One of the many tiles stripped from the roof of the house opposite (in Holywood Close, Trowbridge) created a letter-box effect in the metal door of the garage of this house on the corner of Balmoral Road. The wide hole is shown plugged up with newspapers. The tile landed in the middle of the garage floor.

Figure 6: One of the many houses in Balmoral Road, Trowbridge, which lost edging tiles, ridge tiles and television aerials. This is number 10. Some damage to central parts of the roof also occurred due to the fall of levitated tiles. The rear side of the main roof was half-stripped of its tiles.

## PRESURE JUMP AT FRONTAL PASSAGE

This is a copy of my barograph chart covering 25-26 December, 1990, showing a remarkable almost-instantaneous rise of 4 1/2 millibars on the morning of 25th, at the passage of a vigorous occluding frontal system, which was accompanied by heavy rain, hail, thunder, squally winds and falling trees.

*11 Wytherlies Drive, Stapleton, Bristol* PAUL BROWN






# THE MAJOR DEVELOPMENTS IN CROP-CIRCLES RESEARCH IN 1990: PART 1

By G.T. MEADEN

*CERES, The Circles Effect Research Group, TORRO.*

*Abstract:* The latest research into crop-circles undertaken between April 1990 and March 1991 is summarised in a three-part paper to be published between now and the summer. Besides reporting a considerable amount of observational work some preliminary analytical results are reviewed too. It is important to emphasise that all the fresh evidence continues to support the generalised atmospheric vortex theory as the cause of the circles in the crops; that is to say, the circles owe their origin to nothing more than natural aerial vortices interacting with crops on the ground. However, the details of these vortices, the vortex-crop interaction and the resulting crop-circles display many amazing features *which denote an extraordinary phenomenon at work* - one which will be shown to have very considerable consequences for physics, meteorology, and other research disciplines in the coming years. This paper is restricted to considering the main advances relating to meteorology and physics.

Among the circle features not previously recorded in field-observation work are double-circle systems joined by a spur or 'corridor', sometimes accompanied by rectangular marks and rings or semi-circular arcs. Many of these systems were found aligned exactly along or parallel to tractor marks or 'tram lines'. At Alton Barnes and Stanton Saint Bernard, Wiltshire (Part 2) were linear arrays of this type consisting of twin pairs of double-circles with further single circles in the same line. A discussion is held in Part 3 on why the implied vortex sheet should seemingly be attracted to tractor lines in this way. Also this year reports were forthcoming on acoustic and optical effects associated with circle-making vortices, and there were newly-reported accounts from eye-witnesses who had actually watched circles forming from the effect of atmospheric vortices.

## INTRODUCTION

1990 proved to be the most exciting season for circles research since studies began ten years ago. So many discoveries were made, and in such diverse and wholly unexpected ways, that the present three-part report on the season's work is to be regarded as no more than a provisional, condensed summary of some of the highlights and major observations. Work is currently being carried out by professional scientists in Britain, Japan and America in collaboration with CERES. This includes experimental and theoretical studies, much of which will be published in other journals and books. In addition, a polytechnic student, Andrew Hewitt, has been making an analytical study of CERES's 1990 British database as his thesis project, regarding which papers will appear in due course. Further details of other work by CERES's membership together with some preliminary analyses can be found in issues of the *Journal of Meteorology* from October 1990 onwards. Finally I take the opportunity to acknowledge the help of so many investigators ranging from enthusiastic amateurs, whether trained scientists or not, to research workers at the professional level who have so willingly and usefully co-operated with CERES. It is by such collaboration and teamwork that we shall eventually arrive at amassing the precise data concerning circle types and surveys, places of occurrence, exact times and dates of formation, video and photographic sequences of circles and vortices happening by night and by day, that are needed in order to resolve this challenging and endlessly fascinating problem.

## THE SEASON'S TOTALS

Over seven hundred circles were found in Britain in 1990, the earliest in April,

the latest towards the end of August. They were spread across thirty counties, including Wales and Scotland, besides which there were numerous good reports of circles from Ireland, Holland, Bulgaria, Japan (at least twenty), Canada (over twenty), the U.S.A. and some other countries. The large British total was made possible because of the co-operation of so many enthusiasts via the nationwide CERES organisation.

As usual for Britain most circles were found in wheatfields, but there were some report from fields of barley, rapeseed, linseed, and long grass grown for silage. In 1990, as in 1989, Wiltshire dominated the British scene with about 70% of the year's total. This year the leading counties were Wiltshire: over 400; Hampshire: over 50; Norfolk: 18; Devon: 17; Sussex: 16; Oxfordshire: 13; Buckinghamshire: 12, and so on.

## THE FIRST CIRCLES

Britain's first circle of the year was spotted on 28 April in rapeseed south-west of Windmill Hill near Avebury, Wiltshire. This field formed part of R.A.F. Yatesbury until the station and airfield closed down in the 1960's and the fields reverted to farmland. Another circle of apparently similar age was found by Mr Busty Taylor a few days later. Judging by the age of the circles a formation date of 20-24 April may be surmised, the wind being approximately north-east in this period. The next circles, seven in all with one of them ringed, were found on Beckhampton Down in Wiltshire on 3rd May only a few kilometres from Yatesbury. Their slightly aged appearance suggested they had formed in April like the others.

Next, on 13th May, Mr Taylor found a new formation: a triple-ringed quintuplet - main circle diameter 31 metres, satellites about 4.2m, ring diameters 36m, 47m and 61 metres (or 200 feet). Within the group lay a 1/2 metre baby while a seventh circle lay a little to the north. Three more lay to the east further down the slope and seven were randomly dispersed in a neighbouring field. Thus by 13th May we knew of 26 circles for Wiltshire.

The first Hampshire case of the season came from the famous Cheesefoot Punchbowl. Formed overnight on 17th-18th May it was strictly a new variety and could be described as a circle surrounded by a 'doughnut ring'. Beyond the perimeter of a 12-metre solid circle was a narrow undamaged band and then a ring some 12 metres in width.

After the next happening we were back at Bishop's Cannings. On 19th May Mr Taylor had found the biggest circle so far known to circles investigators: a 61-metre diameter giant. Three rings were noted to surround it at the time, their diameters 68, 79 and 85 metres. Also in this big field were the circles of a *vortex shower* (defined below) numbering 28. Then between 22nd and 27th May another vortex shower added 35 to the fast-escalating total. The new circles were tiny, many about a metre across, the biggest two-three metres, and they were peppered about the field seemingly at random. It was on 27th May that a fourth, larger ring - diameter 92 metres - was spotted around the three-ringed circle. Its authenticity is admittedly a puzzle. It could have been engineered by two people working together, one walking round at a constant distance from the second who followed



either ring 2 or ring 3 holding the end of a tape six or twelve metres long. Alternatively, and perhaps more likely, the stalks may have been weakened at the bending point a few centimetres from the ground at the time of the first incident by a force circulating in 'ring 4', although the crop did not topple 'domino-fashion' until vibrated by general gusty winds a few days later.

Circle reports rolled in steadily from Wiltshire, Hampshire and Oxfordshire. By 1st June the 1990 total was 160 and CERES's overall databank total had passed the 1000 mark. The May total had escalated rapidly because circles formed by a large number of 'vortex showers' had been spotted from aircraft. This new term 'vortex shower', appropriately recognises the role behind the meaning of multiple occurrences, which either happen in a widely-dispersed fashion across one or more fields, or sometimes in a more limited, quasi-linear fashion.

Short, quasi-linear rows were found on several occasions, as on the curving summit of Furze Knoll, a part of Morgan's Hill between Bishop's Cannings and Calstone-Wellington. This place was visited the day before the Oxford conference by the visiting professors, and was identified as an example of marks made by boundary-line vortices. (Spinning vortices along such boundaries have been described by Professor Sir Richard Scorer in his *Clouds of the World* although vortices involving descent were not then recognised). A similar example had been noted the previous August beneath Beckhampton Hill in a wheatfield (of which one is shown in Fig.2 of Snow and Kikuchi's conference paper and another in Fig. 5 of Meaden's opening article - see *Circles from the Sky*). This is a vital observation, as Professor Snow stressed in his lecture, because each row plainly points to a line of separation of a fundamental kind crossing the hilltop and continuing downwind. Other vortex-lines turned up during May-June 1990, notably at Yatesbury in the lee of Windmill Hill, on the slopes of Overton Hill (east of Avebury), and further away in Oxfordshire (towards Childrey), and vortex showers were quite widespread later in the summer too.

Fig: 1. Upton Scudamore, West Wiltshire, showing the three-ringed middle circle of a triplet. Nearby is a doublet of which one circle has a single ring.

## QUADRUPLE-RINGED AND TRIPLE-RINGED QUINTUPLETS

Early on 1st June a *four-ringed quintuplet* system appeared in the parish of Bishop's Cannings along the Calne Road. Some time after midnight the occupant of the nearby farmhouse, farmhand Andrew Woolley, was awoken by a screaming, whistling sound. This was probably the moment, half a kilometre away, when the circles appeared, as we have plenty of evidence from other occasions to indicate that circle-making vortices are accompanied by whirlwind-sounding acoustics. In fact, a similar statement was made seven weeks later to Jenny Randles who was investigating the 22-metre diameter Cheshire circle at Preston Brook. She was told of "a high-pitched screeching wail coming from the direction of the field" at 1 to 2 a.m. on 28 July. In Pyecombe, Sussex, a local woman was "woken up by noises the night the crop circles turned up". These were the circles of a "classic triplet" which appeared in the first week of August.

Quintuplet sets with a faint ring connecting the satellites have been known since 1983 (Bratton, Wiltshire - cf *Circles Effect and its Mysteries* Fig. 33, p. 65). Early study of the satellite-ring overlap at Bishops Cannings showed that ring formation had preceded every one of the satellite circles. Close study of the westernmost satellite further revealed the peculiarity that the ring (diameter 58m) had entered this circle from opposite directions, and that the anti-clockwise part of the ring became the swirling anti-clockwise flow of the satellite. For this circle at least one may conclude that the air or ionised air flowing in the 58-metre narrow ring was constrained to recirculate as the 7-metre diameter satellite circle. On 6 July a single-ringed quintuplet (ring diameter 33m) affected the same field, overlapping the 92m fourth ring of the four-ringed quintuplet.

Another *four-ringed quintuplet* appeared at Upton Scudamore 20 km to the south-west in West Wiltshire near Warminster at the end of June. This one had a very small satellite on its outermost or fourth ring (not visible in this angled photograph) in addition to four big satellites on the second ring. Two fields away was a *three-ringed quintuplet*, formed the same day. This system could even be named a *septuplet* because the outermost ring entertained two small opposite clockwise satellites in addition to the four big anti-clockwise satellites on the first ring. An eighth circle lay on the second ring but this one may have descended as

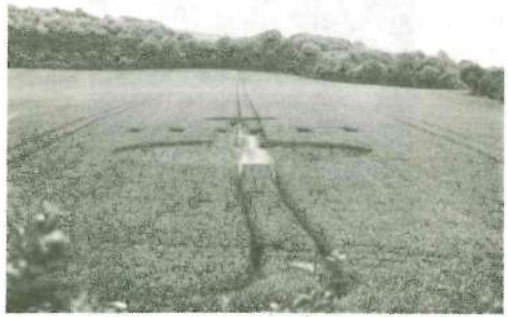


Fig: 2. 'Dumb-bell arrangement with spur and rectangular markings. Chilcomb, Hampshire, 23 May 1990. In 1989 when this field was planted with rape a single circle was formed (to the right of the picture). In 1987 a huge ringed circle with radial blast centre formed in the middle distance of this wheatfield.



part of a vortex shower rather than as an integral part of the main system. Another array of circles formed the same day at Upton Scudamore was a linear triplet in which the middle circle was triple ringed (Figure 1) and a doublet of which one of the circles was singly ringed.

## THE FIRST HAMPSHIRE-AREA DUMB-BELL SET WITH RECTANGULAR FEATURES

On 23 May a circle pair appeared in the county parish of Chilcomb and near to Cheesefoot Punchbowl (Figure 2). Its unusual features were: (1) the spur from the bigger circle which in effect became an avenue uniting the circles, and (2) the four rectangular trenches which were variously called troughs, squares, boxes, coffins and other names during the course of the season.

The wind that night fell calm having been from an easterly quarter, and became westerly after the passage of a ridge. The corridor linking the circles lay east-west.

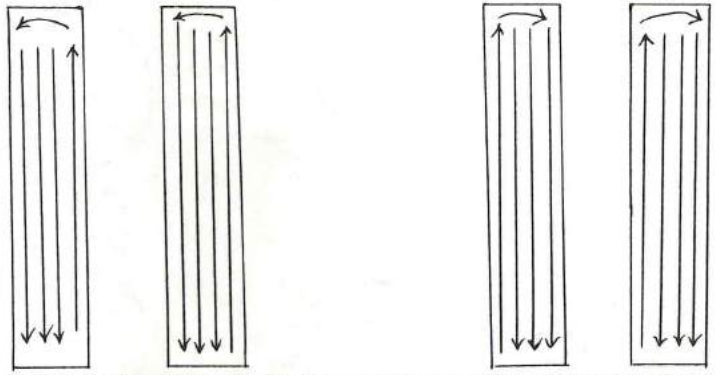


Fig. 3: Detail of the lie of the fallen wheat in the rectangular areas of the Chilcomb dumb-bell (number 1 of Figure 4).

This was also the direction of the tramlines, the lower field-boundary a hundred metres away, and the orientation with respect to a hill close to the east.

While an understanding of such a pattern will not be possible for some time, it may nevertheless be suggested that the pattern is the result of instability, a consequence of an unstable and complex vortex (or double vortex) making a powerful impact with the crop and the ground. The mirror-image symmetry noted within the trenches is remarkable. Each trench from a pair on one side is mirrored by its opposite number with regard to the internal lie of the crop (Figure 3). In fact, despite the rectangularity of shape the quintessence of vorticity is present within the beds of these trenches. Because a rectangular mark in the crop is what would result from the translatory motion of a 'rainbow arc' or semi-circular arc across the field, trenches do in any event retain the quality of the vorticity which drives the system.

## DUMB-BELLS WITH TRENCHES, AVENUE AND RING

A related circle system appeared a few days later on high ground a kilometre from the top of Cheesefoot Head. In this the smaller circle was surrounded by a

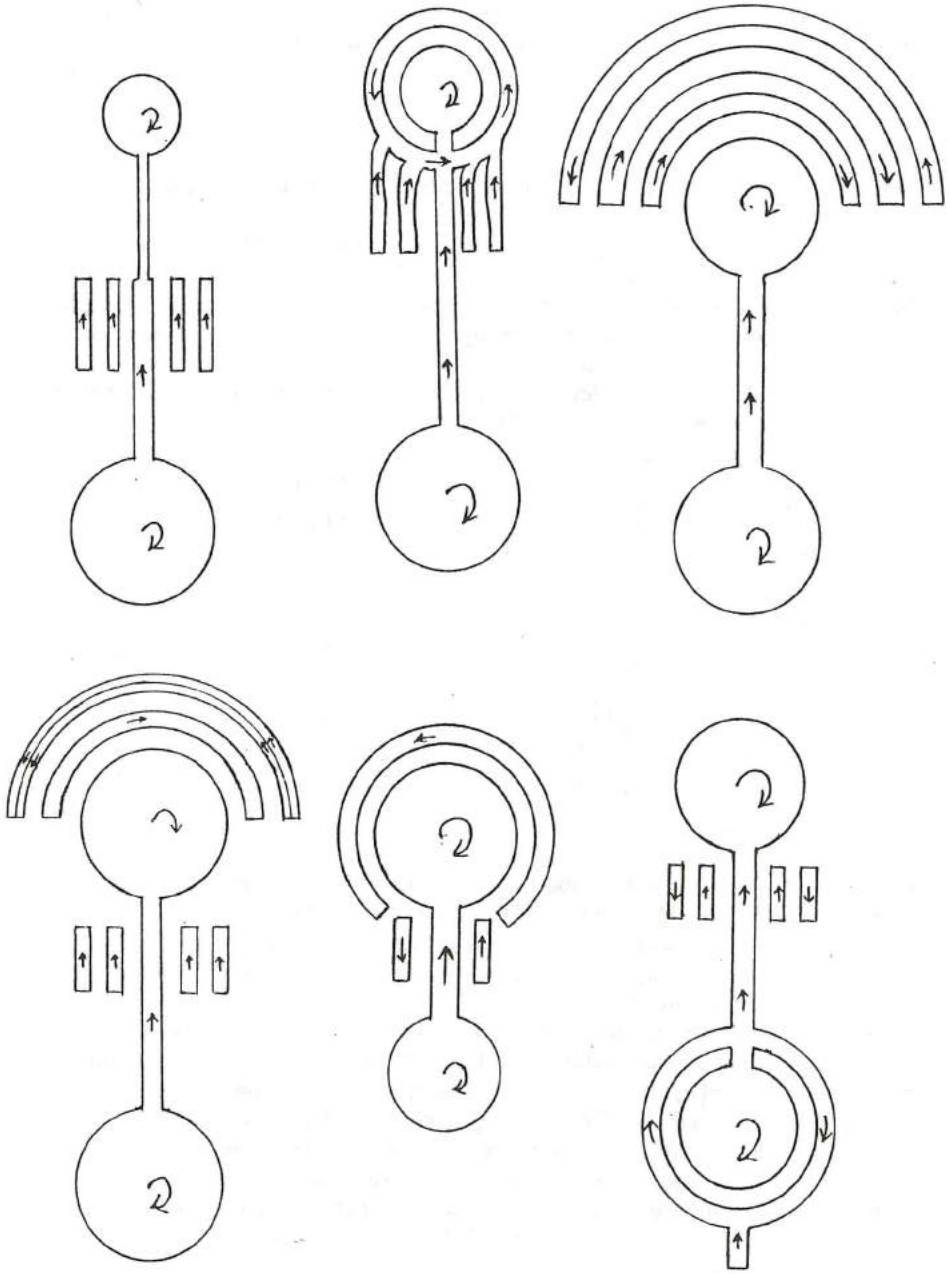


Fig. 4: Some of the Hampshire 'dumb-bells' of May-June 1990 (not to scale). 1. Chilcomb, lower field; 2. On high ground near Cheesefoot Head; 3. Chilcomb, upper field; 4. Near Litchfield/Seven Barrows; 5. Near Morestead; 6. Near Cheesefoot Head.



ring, the spur being so long as to constitute a complete avenue or corridor uniting the circles. In the trenches the felled corn displayed the same mirror-image tendencies as in the previous case but the trenches were elongated towards the ring, turning slightly on the approach to the ring so as to follow the direction of motion of the ring. This shows that the ring formed first, even if only by milliseconds, with a resulting distortion to the proximal ends of the lengthening trenches. The corridor too was slightly skewed in relation to the second circle.

Dumb-bell alignment was this time from west-east, at an acute angle of about 45 deg with the tramlines and also angled with regard to the downslope direction. The weather that night (May 31st-June 1st) had fallen calm, after which the wind picked up from a westerly direction.

Another system which attracted much attention was a triple-ringed circle in which the two innermost rings were composed of interrupted arcs. Each arc subtended an angle of 90 degrees and was followed by a 90 degree gap. The positions of the gaps of the innermost ring matched the arcs of the second ring and vice versa. The lie of the wheat in the discontinuous arcs of these rings was clockwise in both parts of the inner ring and counter-clockwise in the two parts of the middle ring. The character of these discontinuities reminds us that the rings form at the moment of impact because of the impact, the result of a short-lived

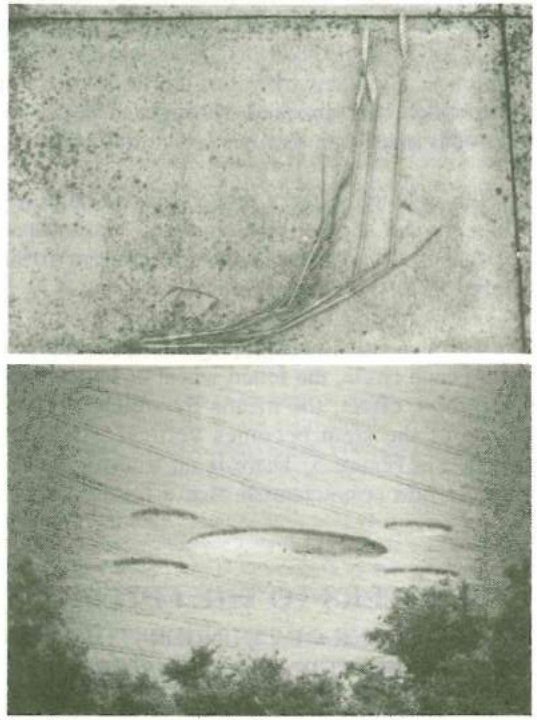


Fig. 5: Within three days of the appearance of the Exton quituplet the wheat was straightening up again by the normal process of nodal bending. A few plants were removed in order to be displayed more clearly in the second photograph. Whereas the lower part of the stem is horizontal to the ground, the upper part has turned through 90 degrees by bending at two nodes.

boundary interaction. Although the rings are found interrupted at the surface, they were not necessarily incomplete a short distance above the crop canopy.

The formation appeared in Dog Leg Field on the Longwood Estate on 6th June and presented an interesting contrast with a conventional triple-ringed circle which had manifested itself 700 metres to the east a week earlier.

VARIOUS HAMPSHIRE DUMB-BELLS, JUNE - JULY 1990

In Figure 4 which is not a scale drawing we summarise some of the complex shapes known for Hampshire in 1990. Whereas they differ from one another, they have the basic dumb-bell base as a common feature. Some people have been calling such shapes pictograms but this is a grave error, typical of intelligence/origin believers, because it implies picture-making symbolism that is other than natural.

The shape with three 170-degree arcs appeared at the upper end of the same field of wheat as the first Chilcomb circles of May but it arrived $3\frac{1}{2}$ weeks later on steeply-sloping ground near the top of the hill. A section of this system is shown in Figure 4.

The next system (see Figure 4) was at Seven Barrows, north of Litchfield, Hampshire near the A34 highway to Newbury. On the evening of 22 June I pointed out this featureless field to conference members as we drove past following our circles tour, saying that this was a 'repeater' region for circles events (circles are known for these fields for 1976, 1978, 1981, 1982 and 1985). The next morning, the day of the conference, attendees travelling north from Hampshire to Oxford spotted the formation which had appeared overnight. The circles were a hundred metres from a group of Bronze Age barrows which had been there for over three thousand years.

At Morestead, south of Winchester, a related dumb-bell combination appeared before the end of June, as did another on Longwood Warren in a field not distant from the eminence that is Cheesefoot Head. Yet another formed on Chilcomb Down on land belonging to the Bruce Family, near the A31 junction with the B3404.

In southern England the crops remained green until the middle of June. As always happens within each circle, the felled wheat or barley, being green, quickly responded to the geotropic effect, the means by which the youngest nodes turn upwards until the top of the stem becomes vertical. An example from Exton (Hampshire) is provided in Figure 5. There is no truth in the rash statements put out in 1989-1990 by certain non-scientists that a fallen crop continues to grow sideways.

## LETTERS TO THE EDITOR

### HIGH NUMBER OF THUNDERSTORMS IN WESTERN EIRE IN 1990

At my South Limerick station at Mount Russell, 640 feet (200 metres) above sea level in the northern foothills of the Ballyhoura Mountains which straddle the Cork-Limerick county boundaries, I logged 18 days with thunderstorms and lightning seen in 1990. Winter thunderstorms played a big feature. During the stormy January and February and again in December huge cumulo-nimbus



frequently came up the Shannon estuary from the Atlantic over whose warm waters they were spawned in unstable westerlies. In the cold darkness these anvils flickered with electric blue-yellow flashes, occasionally giving distant thunder that I heard at my station which is 70 to 80 kilometres from the outer Shannon Estuary to my north-west. Sometimes lightning damage was inflicted in these western counties to electricity, telegraph or radio/television masts.

With the onset of summer the main triggering force for thunderstorms is the heat off land surfaces following increased insolation amounts, yet while summer 1990 was not especially hot much of Ireland's summer thunder came from incursions of a cooler, unstable, westerly type of air. The summer storms logged at my station were mainly developing storms in the forenoon of some days; these storms gave only a few claps locally but went on to produce heavier storm activity in eastern Ireland during the afternoons. Only on 24th August did I record a heavy afternoon storm forming in a hot Continental airmass advected northwards ahead of colder Atlantic air which crossed Ireland during the late evening in the last of the summer's heatwaves.

I logged thundery activity in eight months, only March, May, September and November being thunder-free. January, June and December saw three days each, August had two, and the others one each except for February which was very thundery over all Western Ireland and Britain (K.O. Mortimore, TORRO Thunderstorm Report, *J. Meteorology*, vol. 15, pp 366-369) and I recorded four days that month.

*Mount Russell, Ardpatrick, County Limerick, Ireland.* DAVID MESKILL

## UNDERLYING TRENDS

The current striking example of the Northerly weather type (this letter is written on 10 December 1990) has prompted me to compare long-term trends in the amount of the Southerly type (illustrated in my letter to *J. Meteorology*, vol. 15, no 146, pp 56-58) with corresponding trends in this Northerly type.

The comparison shows that, together with the steady rise in S-type from a minimum reached about 1950 (28 days per year) to its present 1990 value of sixty days per year, there has been a much smaller rise in N-type from 53 days per year in 1950 to 55 in 1990 (a peak of 66 days having been reached in 1963). The incidence of N-type is thus at present below, but not far below, that of S-type.

Although these figures apply to Scotland alone, reconnaissance has shown that similar trends can be expected elsewhere in Britain.

*Whitewater House, Budleigh Salterton, Devon.* R.B.M. LEVICK

## JAKARTA'S RAINFALL IN 1990

Readers may be interested in a follow-up to my letter in the November 1990 issue concerning the record August rainfall in Jakarta, Indonesia. In the eight months to the end of August, Jakarta had already received 118% of its 126-year annual mean rainfall. Following the heavy falls at the end of that month, September to November were dry months, with about 50% of the mean or less, but a total of 277 mm in December (140% of the mean) raised the year's total to 2578 mm, 146% of the annual mean of 1770 mm (after 13 years in Jakarta, it was satisfying to achieve 100 inches of rain). December's high total was a result of the early arrival of the west "monsoon", Jakarta's wettest season. A week's retreat of the west wind mid-month caused a reversion to thundery weather, but on five days in succession, tremendous thunderstorms over Bogor just failed to reach my gauge by about one kilometre; otherwise our total might have been much higher.

This has been the second wettest year since records began in 1864, exceeded only in 1977 which achieved 2830 mm. It should be emphasized, however, that my raingauge is in South Jakarta, which is normally wetter than Central/North Jakarta from whence the long term records derive.

*Hunting Technical Services Ltd., P.O Box 236/JKSMG, Jakarta, Indonesia.* DEREK HOLMES

# LITERATURE REVIEWS AND LISTINGS

*Book Reviews*

**THE DYNAMICS OF THE COUPLED ATMOSPHERE AND OCEAN.** Proceedings of a Royal Society Discussion Meeting. Edited by H Charnock and S G H Philander, Royal Society, London, ISBN 0 85403 392 0, vii + 161 pp., £37.50.

The interaction between the oceans and the atmosphere presents complex physical problems in fluid dynamics the answers to which are vital to our understanding of the course of future changes in global climate. While empirical studies are, in themselves, valuable, it is our ability to construct reliable dynamic ocean-atmosphere models which is essential to achieving this objective. The papers presented at this Royal Society meeting held in December 1988 all have a strong modelling focus which requires the reader to have a good understanding of mathematics and physics. While most deal directly with coupled global atmosphere-ocean circulation models, there are regional treatments relating specifically to tropical latitudes and a final paper on momentum, heat and vapour fluxes. The Southern Oscillation and El Nino appear in the titles of three of the twelve papers but also figure prominently in several of the others. The editorial selection of papers is generally very good and the package tends to hang together moderately well. The last two papers, on the interaction of wind and waves and on surface fluxes are, however, a significant departure in scale from the other papers and despite their obvious academic quality they have a make-weight feel to them. Discussion points raised after some of the papers are included in the publication and are, on the whole, helpful. If there's anything missing from this collection of papers it is a summary, or overview, which I feel would have pulled the contributions together for the less specialised reader. I found the inconsistency in referencing and the utter lack of correspondence in page numbers between the contents page and the actual text very irritating. This is not a volume I would recommend to the general reader but it is certainly a very useful collection of papers on a topic vital to furthering our understanding of global climate.

S. J. HARRISON.

*Book Listings*

**DYNAMICS IN ATMOSPHERIC PHYSICS: LECTURE NOTES FOR AN INTRODUCTORY GRADUATE-LEVEL COURSE.** By Richard S. Lindzen. Cambridge University Press 1990, 310pp., £25.00.

Although designed as an introduction to atmospheric dynamics, this book is full of mathematical equations. Its author, nevertheless, feels that the reader does not require a particularly advanced knowledge of mathematics. He admits, however, that students who were given the course on which this book is based "usually had good backgrounds in undergraduate physics and applied mathematics" and had normally experienced "some earlier introduction to fluid mechanics". He also concedes that "the material...is in many instances



conceptually demanding" and that "Some topics may require considerable effort". Furthermore, the book is "not meant to be a comprehensive text or reference". It also has no index or glossary, but does indicate sources for further reading.

**PHYSICAL PRINCIPLES OF REMOTE SENSING** (Topics in Remote Sensing 1). By W.G. Rees. Cambridge University Press 1990, 247pp., £35.00 (H/b), £13.95 (P/b).

The author points out that many books on remote sensing have been directed towards readers "whose backgrounds are primarily in the environmental sciences". However, there is also a need to cater for those who wish to know how remote sensing systems work. In trying to meet that need, this book is aimed at "physical scientists, engineers and mathematicians", who are moving into environmental remote sensing in increasing numbers. The author expects that such people will have "a remarkable standard (although not necessarily to first degree level) in physics, with a commensurate level of mathematical ability".

LT

## WORLD WEATHER DISASTERS: July 1990.

1: Lightning hit tin roof of pavilion during storm at Kingwood, West Virginia, U.S.A., 24 people slightly injured. *Birmingham Evening Mail.*

1-9: Monsoon rains and floods in northern and western India, more than 100 deaths reported, in Rajasthan state, unprecedented rains flooded railways and roads; the monsoon has so far been heavier than average in most states. *Lloyds List.*

1-31: Worst drought in 50 years reported from Greece; forest fires reported from a number of locations. *L.L., Daily Telegraph.*

2(reported): From Jan 1st to June 30th 1990, 726 tornadoes reported in the U.S.A., this figure has only been exceeded twice since 1950, also widespread flooding has hit the South and Midwest of country. *International Herald Tribune.*

3: Lightning hit a fishing boat 800 metres off shore at Sentolokawat, near Cilacap, central Java, Indonesia, leaving one dead and four others injured, the boat broke up when the lightning struck. *Jakarta Post.*

3: A British Airways Boeing 747 hit severe air turbulence for between 30 and 60 seconds about two hours out from Orlando, Florida, U.S.A., while on a flight from Orlando to Manchester, England, nine of at least 336 people on board injured. *L.L.*

3-8: Heavy rains and floods in many areas of Bangladesh, between the 3rd and the 6th, 300 mm of rain in Chittagong and Cox's Bazaar regions, in these regions 150,000 acres of crops buried under sand washed down from the local hills, some one million people virtually marooned in the Chittagong region, roads washed away by floods, nearly 3000 homes destroyed, at least eight persons reported dead, including two in a landslide in south-east of country on the 7th. *L.L.*

5-13: Up to 50 forest fires reported from south and south-east France, around 8650 acres of forest and woodland, in the worst fire, 4950 acres of forest was burned

around the village of Coudoux, near Marseilles, fires around Toulon on the 6th and 7th injured 17 persons. *L.L.*

7-16: Severe weather in many areas of China, brief details below:-

7th-8th: Storms hit northern province of Shaanxi, leaving at least 27 people dead, almost 200 mm of rain fell in one area, eighteen cities and countries hit by floods; it was reported on the 9th that 10,000 people had been made homeless in the last five days in the Guangyuan area of the southern province of Sichuan.

12th: Renewed floods in Shaanxi province left 14 dead, nearly 75 mm of rain fell in less than an hour in some areas of province, meanwhile, in Liangshan prefecture of Sichuan province heavy rains touched off mudslides that left seven people dead and 26 others missing.

15th-16th: Severe hailstorms, torrential rain and winds gusting to 145 km/h hit much of Hebei province, leaving 33 people dead and 488 seriously injured, at least 18,000 'rooms' destroyed, with 300,000 homes damaged in 75 counties and municipalities, agricultural damage was reported over 2.5 million acres of cropland. Total damage put at $210 million. *L.L.*

9: Heavy snowfalls in New South Wales, Australia, in Sydney 2.75 metres of snow fell, vehicles buried by snowdrifts. *B.E.M.*

11: Thunderstorm in Virginia Beach area of Virginia, U.S.A., almost 230 mm of rain fell in some areas; minor flooding reported, lightning damaged a number of buildings. Floods up to 1.2 metres deep in some areas, many vehicles abandoned, in Virginia Beach and eastern Chesapeake area 2400 lightning strikes an hour recorded. *L.L.*

11(reported): Cyclone, followed by heavy rain and floods, hit area around Chita, eastern Siberia, U.S.S.R., dozens of homes, several factories and an electricity power station flooded when rivers rose by nearly six metres, about 100 bridges and sections of roads washed out and tens of thousands of acres of farmland submerged, damage put at nearly 100 million roubles, a number of deaths reported. *L.L.*

15: Lightning strike during thunderstorm on Mt. Whitney, California, U.S.A., left one climber dead and injured 15 others. *I.H.T.*

17: Two tornadoes reported from villages outside Manilla, in the Philippines, one hit village near Binangonan town, just east of Manila, left 1000 people homeless as tornado swept away houses in the afternoon. In the evening a tornado hit a village in Malolos, just north of Manila, destroying 52 houses and injuring four people. *L.L.*

18: Heavy rainstorm in and around Seoul, South Korea, at least six people reported dead and 20 injured, four of the dead in Seoul by mudslides triggered by heavy rains that began about 0100 hours, more than 168 mm of rain fell in Seoul during the early morning hours. Many nearby provincial areas also had more than 100 mm of rain. *L.L.*

19-23: Heatwave in Spain and France, brief details below:-

SPAIN: Temperatures on some days above 40°C, it was reported on the 21st that 25,000 chickens had died because of the heat in the north-west province of Lugo; on the 22nd the heat in north-east of country buckled a rail line, derailing a train, injuring 13 people.

FRANCE: On the 21st the temperature reached 39.2°C at Nerac, near Toulouse and Paris reported 34°C. Five people died in southern France when they got into cold water after prolonged exposure to heat. *I.H.T., D.T., B.E.M.*



22: Brush and forest fires in a number of acres of Italy, one firefighter died near Grosseto in Tuscany, three others injured, fires also reported from the slopes of Mt Vesuvius, in the hills north and south of Roma as well as southern Puglia, Sardinia and near Ventimiglia, on the French border, on the 25th it was reported that brush and forest fires have destroyed more than 1400 hectares of forest and brush since the beginning of July in drought hit Italy. *L.L.*

22-3 Aug: Monsoon rains and floods in many areas of Bangladesh left at least 75 dead and left thousands homeless in the north of the country, the floods, along, amongst others, the Jamuna and Brahmaputra rivers have affected up to three million people, crops on at least 200,000 acres were completely destroyed in the Sirajganj district when the river Jamuna overflowed its banks, on the 28th lightning killed 10 people and injured eight others. *L.L., D.T.*

24(reported): Floods caused by heavy rains have made thousands homeless west of Lake Baikal in Siberia, U.S.S.R., rivers overflowed sweeping away more than 400 bridges and causing damage estimated at 400 million roubles. An undetermined number of people reported dead. *L.L.*

25: Tropical storm "Arthur" hit Tobago and Grenada, causing "millions" of $'s worth of damage, in Tobago heavy rains caused floods and landslides, bridges were washed away, winds gusted to 80 km/h, in Grenada widespread flooding reported in south of the island, several hotels damaged and collapsed walls blocked roads, no fatalities reported from either islands. *L.L.*

30: Minibus ran into back of lorry in dense fog east of Johannesburg, South Africa, leaving 12 dead and 3 injured, more than 70 people were injured in another pile-up in fog between Johannesburg and Soweto. *D.T.*

31-Aug 2: Tropical Storm "Bertha" hit between Atlantic Ocean off the Florida, U.S.A., coast, and Newfoundland, brief details below:-

OFF FLORIDA: On the 31st riptides off the coast left two people dead, the heavy seas punched through sand bars off the coast.

ATLANTIC OCEAN: *M.V. Corazon* sank in heavy seas some 550 km off Cape Cod early on the 2nd, leaving six crew dead, 21 others rescued.

NEWFOUNDLAND: Hit on the 2nd with winds gusting to 113 km/h, no major damage reported. *L.L.*

31-Aug 2: Typhoon "Tasha" hit provinces of Fujian and Guangdong, southern China, on 31st and moved inland touching off serious floods which left 108 dead, 335 injured. In Fujian 60,000 homes destroyed and 135,000 hectares of crops damaged, 69 people died in province. In Guangdong, 25,200 homes destroyed and 143,000 hectares of farm-land damaged, 39 people died in province. *L.L.*

ALBERT J. THOMAS

# TORRO THUNDERSTORM REPORT: July 1990

By KEITH O. MORTIMORE.

*Thunderstorm Division, Tornado and Storm Research Organisation,*

*77 Dicketts Road, Corsham, Wiltshire, SN13 9JS.*

July was a dry, sunny and warm month with much below normal thunder activity in all parts of the United Kingdom and Ireland. Many parts of the country were totally thunder-free and the almost total absence of thunder throughout southern England was remarkable for a summer month. Apart from an isolated day with thunder-heard the only stations that reported more than a single day were situated in East Anglia where a small number of observers reported two days and with three in the Norwich area of Norfolk.

Thunder-days in July 1990 were as follows: (averages refer to the period 1951-80)

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

On 1st an occluded depression drifted slowly north-east across Scotland. In the early hours heavy rain was accompanied by thunder in Avon and in the Northern Isles of Scotland, and following morning sunshine a number of thundery showers were set off in the cold airmass over Lincolnshire and East Anglia. With cold air still covering the British Isles on 2nd showers, some accompanied by hail, affected various parts of the country, set off by prolonged spells of sunshine. Conditions were suitable for the development of thundery activity but as the showers were so isolated the only confirmed report of thunder came from east Yorkshire. The 15th was a hot day over England and Wales with temperatures as high as 31°C in some central areas. A cold front crossed north-western parts during the day and as it progressed further south-east a fall in pressure over the midlands and northern England, and associated convergence, set off scattered thunderstorms in parts of Wales and particularly over the high ground of the north Midlands and southern-most parts of northern England. The storms later drifted south-east across Lincolnshire and northern counties of East Anglia. The cold front also marked the boundary of some much cooler air. At Ruddington (Nottinghamshire) the temperature fell from 27° to 19° in the 30 minutes to 1900 GMT and at Elmdon, Birmingham, there was a 10 degree fall from 27° to 17°C between 1800 and 1900 GMT. By the end of the evening much of the activity had moved away, but with the warm air slow to clear from East Anglia, a few brief thunderstorms lingered into the early hours of 16th. On 19th a slow-moving cold front was responsible for



some thundery outbreaks in north-west Ireland. Another cold front moved north-eastwards across England and Wales on 27th, giving a spell of rain in most parts, and with a few heavier bursts in the west thunder was heard in Shropshire and over the southern Pennines. A few showers developed behind the front and thunder was heard in Gloucestershire in the afternoon. A showery trough was responsible for some thunder in parts of western Eire on 28th and lightning caused a power-surge that cut telephone services to parts of Co. Limerick for a time. Later, as the trough moved north-eastwards, there was thunder in Orkney and in Oxfordshire and possibly Essex. A cold front made very erratic progress south-eastwards across the British Isles on 29th and 30th as minor ripples ran along it. On 29th thunderstorms accompanied these bursts of frontal activity over Ireland and Scotland, and on the latter day, as the front transferred further south-east, parts of Wales and western England were similarly affected.

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

*New Products*

## (1) DIDCOT NOW MANUFACTURES SATELLITE RECEIVERS AND TRANSMITTERS

The Didcot Instrument Company, in conjunction with Bradford University Research Ltd has developed a new link to transmit data by satellite from remote weather stations. The new satellite receiver/transmitter system can be fitted to any Didcot weather station as an optional extra. In use, as data on atmospheric parameters are collected by the mast, it is passed to the collection platform to be transmitted to wherever required via Meteosat - a geostationary satellite, permanently sited over Africa. The satellite link has been developed by Paul Izzard of Didcot in conjunction with Professor J Stephenson. The Company claims to be one of the leaders in primary digital data systems for Meteosat, including the software to estimate rainfall from cloud temperatures.

Satellite transmitter/receiver systems are very popular on weather stations for remote locations. A recent £96,000 order from the Institute of Hydrology is for eight 'Budget' stations to be used in the Brazilian rainforest. This is the first time that Didcot has been able to supply the whole system; previously, the satellite links would have had to be bought in.

## (2)POLLUTION MONITORING PROBLEMS, POLLUTION MONITORING SOLUTIONS.

Weather-Data of 51/53 Albert Street, Rugby have announced the launch of their new low-cost Winscope 400M. This instrument displays wind speed and wind direction on a continuous basis from a remotely located, combined wind-speed and direction sensor. The sensor is made from high-density polyethylene, which is

capable of withstanding the most severe environment. The display shows windspeed from 0-99 miles per hour, or other ranges to order, and the sixteen major compass points. The Windscape 400M also has a battery-backed memory which will record the maximum and minimum windspeed. Housed in a robust grey ABS case the instrument operates on 240 volts AC, and is supplied complete, with sensor and mains plug for £475.00 + carriage and VAT.

For further information contact, Peter Ritchings, at WEATHER-DATA, 51-53 Albert Street, Rugby, Warwickshire CV21 2SG. Tel. (0788) 537575, Fax. (0788) 537511.

### (3) WINDY - DIGITAL WINDSPEED AT A REASONABLE PRICE

Incastec Associates Ltd., best known as marine electronics manufacturers and distributors, now distribute the "Windy" hand-held anemometer. This compact instrument, running on a PP3 battery, gives an accurate digital readout of windspeed in knots or metres/sec. (switchable) with comparison scales for Beaufort or kmh.

Meteorologists have shown a great deal of interest in the Windy, as its size and ease of operation makes it ideal for the keen amateur. These qualities, along with its very competitive price, make it an attractive proposition for anyone requiring precise windspeed measurement without bulky equipment.

The "Windy" retails at £75 inc. VAT, for further details contact the UK distributors, Incastec Associates Ltd., 75 Christchurch Road, Ringwood, Hampshire BH24 1DH (Tel. 0425 476211).

## WORLD WEATHER REVIEW: July 1990

**United States**. *Temperature:* warm from W. coast to W. Montana and C. Arizona; E. coast to West Virginia and E. Alabama; marginally in Hawaii; +2degC in W. Oregon. Cold elsewhere; -2degC in W. Texas. *Rainfall:* complex pattern, but mainly wet; over 200% in N.E. Washington, N. Idaho, extreme N.W. Montana, N. California, extreme N.W Nevada, S. Arizona, interior Wyoming, E.C. Colorado, S. Texas, S.E. Nebraska, S. Minnesota, N. Iowa, C. Ohio. Dry in W. Washington, Oregon, S. California; E. Nevada and extreme N. Arizona to most of Montana; in and near E. New Mexico; W. Nebraska through E. Dakotas to N. Minnesota, Wisconsin and N.W. Michigan; much of E. coast and S.E. quarter to E. Texas, S.E. Kansas and parts of Oklahoma. Under 50% at least locally in all these areas.

**Canada and Arctic**. *Temperature:* mostly warm; +3degC in W. Alaska. Cold from S.E. Alberta to S.W. Quebec then N. to Southampton Island; Newfoundland, S. Labrador, S.E. Greenland; -2degC in E. Newfoundland. *Rainfall:* wet in much of Alaska; S.E. British Columbia to parts of Manitoba; round Hudson Bay, Maritime Provinces, S. Iceland, Jan Mayen; much of Greenland. Over 200% locally but widely in Alaska and from S.E. British Columbia to S. Saskatchewan; Southampton Island, N. Ellesmere Island and near Prince Edward Island. Dry elsewhere; under 50% from coastal British Columbia through upper Mackenzie basin to L. Winnipeg; N. Quebec, S. Baffin Island, S.W. Greenland, N. Iceland, Spitzbergen, Bjornoya; parts of Franz Josef Land; locally in N. and S. Alaska.

**South and Central America.** *Temperature:* warm from N. Chile to E. Argentina; E. Brazil; C. Mexico to Honduras; extreme N.W. Mexico; +2degC from E. Yucatan to N. Honduras. Cold from Bolivia to La Plata estuary and S. Brazil; most of N. Mexico; -3degC in and near Paraguay. *Rainfall:* wet in N.C. Argentina, S.E. Brazil, N. and C. Mexico, N.E. Yucatan, E. Honduras; much of Paraguay; over 200% widely in first three areas and locally in N.E. Yucatan and S.E. Paraguay. Dry in most of Bolivia and N. and C. Argentina; N. and C. Chile, Uruguay, C. Paraguay, extreme S. Brazil; S. Mexico to W. Honduras. Under 50% in W. Bolivia, N. and C. Chile, C. and extreme N.W. Argentina, Uruguay, extreme S. Brazil, S. Yucatan, Gulf of Fonseca.



**Europe.** *Temperature:* warm from British Isles of Spain, Portugal, Switzerland and W. Italy; N.E. European Russia, extreme N. Norway; +2degC in W. and parts of S. France, Portugal, W. Spain; +5degC near N. Urals. Cold elsewhere; -2degC in W. European Russia and lower Volga basin. *Rainfall:* wet in S.E. Spain; most of Sweden and Finland; much of European Russia; parts of Norway and Ireland. Over 200% in parts of E. Sweden, W. Finland and S.E. Spain; S.E. of Moscow. Dry elsewhere; under 50% from E. Scotland and most of England to Spain, Portugal, W. Poland, W. Czechoslovakia and most of Italy; Greece to W. and S. Jugoslavia, C. Romania, most of Ukraine and Caucasus. Provisional sunspot number 147.

**Africa.** *Temperature:* warm near Mediterranean coast, in Canary Islands and from much of Namibia through Transvaal to Natal and extreme S.E. Cape Province; +3degC near Botswana-Transvaal border. Cold in most of Cape Province; W. Orange Free State; rarely -1degC. *Rainfall:* wet locally from W. Morocco to N. Tunisia and in W. Cape Province; over 200% locally near coast of Algeria and Tunisia. Generally dry (under 50%) in and near South Africa; generally dry or rainless from Canary Islands to Egypt.

**Asian U.S.S.R.** *Temperature:* mostly warm; +4degC S. of Gulf of Ob. Cold in and near Lena basin (-4degC locally); N. Caspian Sea through S. Urals nearly to L. Balkhash. *Rainfall:* mainly wet; over 200% in N. Kazakhstan, Kirgizia, upper Ob basin and generally E. and R. Lena. Dry from S. Caspian Sea to Aral Sea; N. Urals almost to R. Lena; under 50% widespread in both areas.

**Asia (excluding U.S.S.R.).** *Temperature:* warm in Turkey, S.E. India, E. China, W. Mongolia, S. Korea, Japan, Philippines; most of Thailand; +1degC at least locally in all these areas. Cold in E. Pakistan, W. and parts of N.E. China, N. Korea, extreme N. Thailand; most of India; -1degC in N.E. Pakistan, N. India, W. China; very locally in N. Korea. *Rainfall:* wet in Turkey, N. India, Bangladesh, C. Philippines; most of Korea; much of W., N. and N.E. China and Mongolia; locally in N.E. and S. Malaya; over 200% locally in N.W. Korea. Dry from S. Turkey to Pakistan and most of India; Japan, N. and S. Philippines; most of Thailand and Malaya; much of E. China and E. coastal Korea. Under 50% from S. Turkey to W. and parts of S. India; widely in Japan; parts of S.E. China; locally in Thailand.

**Australia.** *Temperature:* mostly warm; +2degC in Northern Territory. Cold (-1degC) in S.W. *Rainfall:* wet in S.E. quarter (over 200% in interior), in N.E. (over 200% in Cape York Peninsula) and in extreme S.W. Dry elsewhere; under 50% except in much of S.W.

M.W.R.

## WEATHER SUMMARY: October 1990

October was a warm month in all parts of the United Kingdom with generally more rain and less sunshine than normal. Some places in southern England were between one and a half and two degrees Celsius above the normal decreasing to nearer half a degree above in northern Scotland. Highest maxima were recorded just before mid month, reaching 24.3° at Northolt (London) and Ely (Cambridgeshire) on 12th and at Valley (Anglesey), Wyton and Ely (Cambridgeshire) on 13th. On the latter day 22°C was reached at Kinloss on the Moray Firth and 24.2° at Sidcup (Kent). High minima included 14.8° at Derby and Buxton (Norfolk) on 6th, 16.2° at the London Weather Centre on 13th, 17° at Eastbourne (East Sussex) on 14th and 16.4° at Guernsey (Channel Islands) on 15th. In Scotland 13.5° was recorded at Edinburgh on 14th. Cold weather spread south to much of the country at the end of the month. On 27th the temperature rose to just 7.8°C at Fylingdales (North Yorkshire) and on 28th Buxton (Derbyshire) recorded 6.4°, but lowest values were reported in central Scotland on 30th with 2.6° at Rannoch School, Dall, 3.3° at Tummel Bridge (both Tayside) and 4.3° at

Braemar. Over England and Wales the 8th was the coldest night of the month with many stations recording their first air frost of the season. Sandhurst (Berkshire) recorded -2.2°, Romsey (Hampshire) -2.0° and Gurney Slade (Somerset) -1.6°. In Scotland,the 30th saw minima as low as -4.0° at Glenlivet, -3.2° at Dyce Airport, Aberdeen and -2.6° at Inverdruie (Highland). On the grass -7.0° was recorded at East Hoathly (East Sussex) on 8th and -8.0°C at Lossiemouth on the Moray Firth on 30th. Rainfall totals were above average in most regions and in southern Scotland, Northern Ireland and locally in south-east England it was wet with more than twice the normal in places. Wettest days included 65.0mm at Fort William on 2nd, 50.0mm at Loch Ranza (Arran) on 17th, 59.9mm at Worthing on 26th and 56.2mm at Portland Bill (Dorset) on 27th. At Dover (Kent) 73.2mm fell on 26th followed by a further 44.5mm on 27th giving a 48-hour total of 117.7mm. October was a dull month in southern counties of England, in western counties and in northern England and southern Scotland. Elsewhere, sunshine was a little above normal, especially in central counties of England.

The month opened with an anticyclone to the south of Britain and a cold front over the north-western sea-board of Ireland and Scotland. Over the next two days the cold front advanced slowly south-east across the U.K. giving a spell of rain in all parts of the country, heavy at times in the north and west. A south-westerly airflow covered Britain on 4th and 5th and further frontal systems spread rain to most parts, while as a deepening depression cross Scotland on 6th there were considerable falls of rain and widespread flooding in the central-lowlands with lesser falls over England and Wales during the passage of the associated cold front. Pressure rose over the British Isles on 7th, as an anticyclone moved from the Atlantic towards northern France, and with light winds there was a widespread frost over southern Britain early on 8th. Over the next few days winds gradually backed towards the south around a low pressure area developing to the south-west of the U.K., and on 12th and 13th warm air advected northwards across the British Isles pushing temperatures into the low twenties as far north as the Moray Firth. Although a cold front crossed the British Isles during the night of 13th/14th it remained quite warm in most places and as pressure fell from the south-west scattered thunderstorms broke out on 15th and early on 16th. The 16th was a sunny day but as a depression approached the English Channel further thundery outbreaks developed in parts of the U.K. on 17th and 18th and there were spells of very heavy rain in East Anglia on the latter day, near to a slow-moving frontal system. Between 20th and 23rd an anticyclone over southern Scandinavia fed chilly easterly winds across the country but on 24th a depression to the west of Ireland pushed fronts and rain north-eastwards across the country, the rain being particularly heavy in the west. Over the next few days depressions tracked north-eastwards into the U.K. giving most places further spells of rain and on 27th and 28th as colder unstable air flowed over the relatively warm seas around the south and south-east heavy rain and thunderstorms fell as a result of intense convection near English Channel coasts. On 30th and 31st much colder north-westerly winds covered all parts of the British Isles. Showers fell widely and snow fell over mountain in the north.

K.O.M.



## WEATHER SUMMARY: November 1990

November 1990 was a rather warm month with mean temperatures generally close to one half a degree celsius above the normal over most of the United Kingdom. Highest maxima occurred around mid-month. At Tivington (Somerset): a high of 18.2° was recorded on 12th with 16.5° at Hurn Airport, Bournemouth (Dorset), 16.4° at Exeter (Devon) and 16.3°C at Velindre (Powys). On 13th 16.3° was recorded at the London Weather Centre and at Finningley (South Yorkshire) and 16.5° was reached on Guernsey in the Channel Islands. On 16th the temperature reached 16.5° at Sunderland (Tyne and Wear) and on 17th 16.5° was recorded at Madley (Hereford and Worcester). Temperatures were not as high over Scotland, reaching 14.4° at Edinburgh and 15° around the shores of the Moray Firth on 13th. Highest minima included 11.6° at Stornoway on 13th and 14.7° at Exeter on 17th. Under a blanket of often freezing fog Inverness recorded a maximum of only 0.9°C on 9th but generally it was the last week of the month before low maxima were reported anything like widely. On 23rd the temperature struggled to 2.5° at Carlton-in-Coverdale (North Yorkshire) and to 3.4° at Leeming (West Yorkshire), and on 24th 1.9° was the highest reached at Cilfynydd (Mid Glamorgan). On 27th 0.3° was recorded at Braemar (Grampian) and 1.0°C at Rannoch School, Dall (Tayside) and on 28th Belfast in Northern Ireland remained below freezing throughout with a maximum of -0.7°C. The morning of 8th was very cold in central Scotland with minima of-6.1° at Inverdruie and -5.4° at Aviemore (Highland). On 22nd lowest minima included -7.2° at Braemar, -7.1° at Rannoch School, Dall and -4.6° at Birmingham, and on 23rd -7.0° was recorded at St. Harmon (Powys) and -5.2° at Gurney Slade (Somerset). On 28th Tummel Bridge (Tayside) recorded -6.5° and on 29th Carrigans (Co. Tyrone) reported -5.8°. On the grass -10.1° was recorded at Inverdruie on 9th, -10.0° at Velindre on 23rd and -8.1°C at South Farnborough (Hampshire) on 6th. Although rainfall totals were rather above the average over parts of East Anglia and Kent, generally it was a dry or very dry month and in some central parts of England and over southern Scotland less than one half the normal was recorded. Wettest days included 57.8mm at Thirlmere and 55.1mm at Ambleside (Cumbria) on 16th, 33.2mm at Nantmore (Gwynedd) on 19th and 36.1mm at Aviemore on 20th. On 23rd 48.3mm fell at Cilfynydd (Mid Glamorgan), 37.7mm at Belfast and 45.3mm at Stithians (Cornwall), and on 24th 29.4mm was recorded at Eastbourne and 24.9mm at Brighton (East Sussex). On 25th Dover recorded 24.8mm and Charing (Kent) 24.0mm while 27.3mm fell at Lowestoft (Suffolk) on 26th. With winds frequently blowing from the north-east it was a dull month in northern and eastern regions of the U.K. while above average totals were reported in the south and west. The south-west peninsula was particularly sunny with more than 150 percent of the normal in places.

With a slow-moving and filling depression over southern Scandinavia northerly winds covered the whole country at the beginning of the month and it was quite cold with sunny spells and showers, some of them wintry in the north. Pressure rose over the country on 3rd and as an anticyclone settled over Scotland all parts became dry for several days, although with a lot of cloud trapped in its circulation

significant amounts of sunshine were confined to southern counties of England and Wales. Nights were cool but frost was confined to those parts having overnight cloud breaks. The anticyclone drifted away to the east on 8th and on 9th frontal systems pushed north-eastwards into the British Isles, but not before some northern and eastern parts had enjoyed a sunny day. All areas had rain on 10th and mild, muggy conditions followed a warm front across the country on 11th and 12th. The weather was very unsettled between 13th and 17th with frequent spells of rain and it was also very windy in the west and north, while, following the passage of a cold front the 18th was a much brighter, colder day. For much of the following week low pressure over the North Sea swept cold air southwards across all parts and showers were widespread and heavy with wintry precipitation in places, notably over the hills of Scotland where snowfalls were particularly heavy over the Cairngorms on 20th and 21st. Southerly winds strengthened over the U.K. on 23rd, ahead of a frontal trough approaching from the west, and by 24th a large and deep depression had formed over southern England giving many central and southern parts substantial falls of rain. The low drifted into France on 25th and after further rain in the south-east and a brief spell of north-easterly winds an anticyclone developed over the British Isles to give all parts a dry and quite frosty end to the month, although persistent cloud again reduced sunshine totals away from the south and west at times.

## TEMPERATURE AND RAINFALL: OCTOBER 1990

| | *Mean* | | | | *Grass* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Max* | *Min* | *Max* | *Min* | *Min* | *Rain* | *%* | *Wettest* | *TD* | *Th* |
| BELGIUM:Uccle | 16.5 | 9.0 | 25.7(12) | 4.4(8) | -1.0(23) | 80.0 | 113 | 34.4(28) | 13 | - |
| " Rochefort | 16.4 | 5.8 | 25.4(12) | -0.8(9) | | 65.2 | 69 | 24.8(28) | 11 | - |
| " Liege | 17.4 | 9.8 | 26.6(12) | 4.2(23) | | 48.0 | 77 | 18.1(28) | 12 | - |
| DENMARK:Fanø | 13.3 | 8.0 | 19.7(15) | 2.5(25) | | 99.3 | 103 | 33.6(29) | 14 | 0 |
| " Frederikssund | 12.8 | 6.9 | 18.2(16) | -2.7(21) | -3.0(21) | 76.7 | 138 | 21.1(12) | 12 | 0 |
| GERMANY:Berlin | 15.3 | 6.7 | 23.1(15) | 0.3(24) | -2.9(24) | 9.8 | 24 | 4.3(28) | 9 | 1 |
| " Hamburg | 14.9 | 7.6 | 22.9(14) | 0.2(25) | -2.1(25) | 50.8 | 88 | 16.1(5) | 8 | 1 |
| " Frankfurt | 16.4 | 6.8 | 23.3(14) | -1.9(24) | -4.9(24) | 52.7 | 108 | 28.5(28) | 12 | 0 |
| " Munchen | 15.6 | 5.3 | 24.0(15) | -3.6(23) | -7.1(23) | 87.5 | 151 | 16.6(29) | 14 | 0 |
| ITALY:Casalecchio | 18.0 | 12.3 | 25.0(v) | 4.0(23) | 3.0(23) | 170.5 | 208 | 71.2(5) | 14 | 1 |
| MALTA:Luqa | 27.3 | 20.0 | 33.6(9) | 15.6(23) | 11.8(23) | 63.1 | | 34.0(24) | 8 | 3 |
| NETHERLANDS:Ten Post | 15.1 | 8.2 | 22.1(15) | -0.1(24) | -1.9(24) | 55.0 | 79 | 13.9(30) | 10 | 1 |
| SWEDEN:Valla | 10.0 | 3.7 | 15.8(17) | -3.6(22) | | 64.1 | | 18.8(7) | 14 | 1 |
| SWITZERLAND:Basel | 18.2 | 8.2 | 26.0(14) | 0.3(9) | | 74.1 | 122 | 22.1(29) | 13 | 1 |
| EIRE:Straide | 13.6 | 8.1 | 18.4(13) | 2.7(29) | -3.2(29) | 234.6 | 194 | 33.4(5) | 25 | 2 |
| " *Mt.Russel,Co.Lim* | 12.9 | 8.2 | 17.5(5) | 3.7(29) | 0.6(8) | 190.8 | | 38.7(2) | 27 | 2 |
| SHETLAND:Whalsay | 10.7 | 7.6 | 14.2(14) | 3.1(1) | -1.9(31) | 123.3 | 82 | 17.6(8) | 21 | 1 |
| " Fair Isle | 10.8 | 8.5 | 13.6(14) | 3.1(31) | -1.4(31) | 119.5 | 107 | 28.9(28) | 22 | 0 |
| SCOTLAND:Braemar | 10.9 | 5.4 | 19.1(13) | -1.8(30) | -2.7(30) | 123.6 | 142 | 26.9(6) | 21 | 0 |
| " Inverdruie | 11.6 | 4.2 | 18.7(13) | -2.6(30) | -5.7(30) | 94.5 | 104 | 23.1(28) | 19 | 0 |
| " Rannoch | 11.4 | 4.6 | 17.4(13) | -0.9(30) | -1.1(30) | 160.9 | | 24.8(15) | 25 | 0 |
| WALES:Velindre | 14.6 | 8.7 | 21.4(12) | 0.6(8) | -3.2(8) | 93.3 | 114 | 20.8(25) | 21 | 2 |
| " Carmarthen | 14.5 | 9.2 | 20.1(12) | 3.0(8) | -0.0(8) | 135.0 | 104 | 24.7(25) | 20 | 2 |
| " Gower | 15.1 | 10.2 | 20.3(12) | 4.8(29) | 0.2(29) | 136.6 | 101 | 30.0(25) | 21 | 2 |
| GUERSEY:Airport | 16.0 | 11.5 | 21.0(12) | 7.5(29) | | 97.6 | | 24.1(27) | 14 | 2 |
| JERSEY:Carrefour/Clq | 17.7 | 10.7 | 24.4(12) | 4.1(9) | | 105.0 | | 29.8(27) | 14 | 1 |
| ENGLAND: | | | | | | | | | | |
| Denbury,*Devon* | 15.2 | 9.4 | 20.4(12) | 2.5(8) | 0.4(8) | 87.7 | 77 | 22.4(27) | 24 | 2 |
| Gurney Slade,*Somerset* | 14.5 | 7.9 | 21.2(12) | -1.6(8) | -2.0(8) | 138.5 | 105 | 23.2(27) | 18 | 0 |
| Yatton,*Avon* | 16.4 | 9.8 | 23.0(12) | -0.2(8) | -1.4(8) | 85.2 | 84 | 17.1(29) | 18 | 2 |



| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reading Univ,*Berkshire* | 15.9 | 9.2 | 22.9(12) | 0.4(8) | -5.6(8) | 33.4 | 61 | 10.2(27) | 11 | 1 |
| Sandhurst,*Berkshire* | 16.4 | 8.2 | 23.3(12) | -2.2(8) | -4.4(8) | 48.1 | 73 | 12.5(27) | 14 | 1 |
| Romsey,*Hampshire* | 16.3 | 8.3 | 23.3(12) | -2.0(8) | -3.5(8) | 85.0 | 107 | 26.2(27) | 13 | 4 |
| Brighton,*Sussex* | 15.7 | 9.6 | 20.6(3) | 1.0(8) | 0.5(8) | 122.3 | 95 | 35.4(27) | 17 | 5 |
| Hastings,*Sussex* | 14.8 | 8.9 | 21.2(v) | 3.6(29) | 0.8(8) | 126.4 | 142 | 39.4(27) | - | 3 |
| Dover,*Kent* | 15.9 | 9.4 | 22.7(13) | 2.3(9) | 1.5(8) | 156.0 | 164 | 73.2(26) | 14 | 5 |
| East Malling,*Kent* | 16.3 | 9.0 | 23.7(13) | 1.5(8) | -3.4(8) | 67.6 | 105 | 27.5(27) | 13 | 4 |
| Epsom Downs,*Surrey* | 15.7 | 8.9 | 22.7(12) | -1.5(8) | -4.0(8) | 70.9 | | 18.7(27) | 13 | 2 |
| Reigate,*Surrey* | 15.8 | 8.4 | 22.6(12) | -0.2(8) | -0.5(8) | 64.9 | 65 | 23.9(27) | 16 | 1 |
| Guildford,*Surrey* | 15.9 | 9.6 | 22.6(12) | 1.7(8) | -1.0(8) | 73.7 | 103 | 23.9(27) | 15 | 2 |
| Sidcup,*London* | 16.5 | 9.5 | 24.2(13) | 1.4(8) | -3.4(8) | 53.1 | | 16.7(27) | 14 | 4 |
| Hayes,*London* | 16.1 | 8.7 | 23.5(12) | -0.2(8) | -1.0(8) | 56.6 | 75 | 14.5(17) | 14 | 2 |
| Hampstead,*London* | 15.7 | 9.0 | 23.5(12) | 2.0(8) | -3.5(8) | 48.9 | 83 | 9.8(26) | 13 | 0 |
| Royston,*Hertfordshire* | 16.2 | 9.5 | 24.0(13) | 2.1(8) | -2.0(8) | 38.2 | 77 | 10.4(26) | 12 | 1 |
| Loughton,*Essex* | 16.0 | 8.9 | 23.1(13) | 2.0(8) | -3.0(8) | 44.7 | 75 | 10.9(27) | 11 | 3 |
| Buxton,*Norfolk* | 16.3 | 9.0 | 23.2(13) | 2.8(30) | 0.2(30) | 65.3 | 121 | 11.7(26) | 13 | 2 |
| Ely,*Cambridgeshire* | 16.3 | 7.0 | 24.3(12) | -1.1(8) | -1.9(8) | 38.2 | 73 | 8.8(18) | 12 | 2 |
| Luton,*Bedfordshire* | 15.8 | 9.0 | 23.6(13) | -0.4(8) | -4.4(8) | 60.4 | 104 | 24.8(18) | 14 | 2 |
| Buckingham,*Buckinghamshire* | 16.0 | 8.1 | 23.8(13) | -0.1(8) | -5.5(8) | 53.9 | 86 | 15.1(17) | 14 | 0 |
| Oxford University | 15.8 | 9.2 | 22.3(12) | 4.1(29) | -2.2(8) | 45.9 | 69 | 13.6(25) | 13 | - |
| Wolverhampton,*West Midlands* | 14.3 | 8.3 | 21.3(12) | 3.0(29) | -3.0(8) | 90.4 | | 22.0(25) | 14 | 1 |
| Louth,*Lincolnshire* | 15.1 | 8.2 | 22.1(13) | 2.3(23) | | 37.3 | | 15.4(27) | 10 | 0 |
| Keyworth,*Nottinghamshire* | 15.1 | 9.0 | 22.7(13) | 0.8(8) | -3.3(8) | 73.3 | | 18.6(17) | 13 | 3 |
| Nottingham,*Nottinghamshire* | 15.7 | 8.3 | 23.6(12) | 1.5(8) | -1.0(8) | 63.1 | 143 | 14.4(17) | 14 | 2 |
| Derby,*Derbyshire* | 15.5 | 9.4 | 22.7(12) | 1.6(8) | 0.9(8) | 90.1 | 168 | 22.3(17) | 15 | 2 |
| Middleton,*Derbyshire* | 12.3 | 7.4 | 19.0(12) | 1.4(29) | | 142.5 | 146 | 18.7(17) | 18 | 2 |
| Keele University,*Staffordshire* | 13.5 | 8.4 | 20.7(12) | 2.0(29) | -1.8(8) | 91.6 | 131 | 20.0(31) | 15 | 0 |
| Liverpool,*Merseyside* | 15.2 | 9.4 | 21.4(13) | 3.7(29) | | 142.2 | 192 | 36.2(31) | 17 | |
| Lathom,*Merseyside* | 14.2 | 8.8 | 20.0(13) | 3.2(8) | | 131.8 | | 26.1(10) | 20 | |
| High Bradfield,*South Yorkshire* | 11.9 | 6.8 | 19.7(12) | 1.6(8) | | 148.7 | | 36.4(17) | 19 | |
| Cottingham,*Humberside* | 15.2 | 8.6 | 21.8(13) | 3.2(8) | -0.6(30) | 45.0 | 86 | 14.5(18) | 15 | |
| Carlton-in-Cleveland | 13.9 | 8.9 | 20.0(13) | 2.0(8) | -2.1(8) | 67.0 | | 10.3(18) | 16 | |
| Durham University,*Durham* | 13.8 | 7.8 | 20.2(5) | 1.5(8) | -1.1(8) | 78.7 | 122 | 17.4(19) | 21 | |
| Sunderland,*Tyne & Wear* | 14.2 | 9.4 | 19.6(5) | 4.0(30) | | 66.1 | 118 | 13.9(19) | 16 | |
| CANADA:Halifax,NS | 13.4 | 7.4 | 24.0(7) | -1.5(28) | | 156.6 | | 45.6(29) | 15 | |
| U.S.: Bergenfield,NJ | 21.6 | 10.1 | 30.6(6) | -1.7(30) | -4.4(30) | 200.9 | | 56.9(9) | 10 | |
| JAMAICA:Kingston | 32.7 | 25.4 | 34.6(19) | 23.4(9) | | 188.3 | 112 | 47.2(8) | 18 | |
| " Montego Bay | 31.1 | 24.6 | 33.2(9) | 22.7(6) | | 127.7 | 76 | 25.5(28) | 21 | |
| AUSTRALIA:Leopold, Vic | 19.3 | 8.9 | 33.8(29) | 3.6(13) | | 102.1 | 176 | 42.2(10) | 13 | |

CUMBRIA RAINFALL:

Carlisle RAF 120.5mm, (143%); Grange-over-Sands 167.6mm (119%); Windermere, Whasdykee 222.1mm (124%); Hawkshead 253.9mm (129%); The Nook, Thirlmere, 361.7mm (125%); Consiton 383.8mm (140).

## TEMPERATURE AND RAINFALL: NOVEMBER 1990

| | *Mean* | | | *Grass* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Max* | *Min* | *Max* | *Min* | *Min* | *Rain* | *%* | *Wettest* | *RD* | *Th* |
| BELGIUM:Uccle | | | | | | | | | | |
| " Rochefort | | | | | | | | | | |
| " Liege | | | | | | | | | | |
| DENMARK:Fanø | 7.1 | 2.0 | 11.7(14) | -3.7(28) | | 77.7 | 83 | 17.2(19) | 12 | 1 |
| " Frederikssund | 6.8 | 1.8 | 12.2(16) | -5.5(22) | -8.0(30) | 47.7 | 78 | 13.3(27) | 13 | 0 |
| GERMANY:Berlin | 7.4 | 3.2 | 12.1(17) | -2.4(30) | -3.2(30) | 56.6 | 123 | 16.4(17) | 16 | 0 |
| " Hamburg | 7.4 | 3.1 | 12.9(16)) | -2.1(30) | -4.6(6) | 133.3 | 208 | 29.9(16) | 22 | 1 |
| " Frankfurt | 8.4 | 3.8 | 14.0(18)) | -2.4(10) | -5.0(10 | 87.2 | 155 | 16.8(17) | 18 | 0 |
| " Munchen | 6.9 | 0.6 | 14.3(17) | -5.6(9) | -9.3(9) | 78.3 | 137 | 13.1(19) | 20 | 0 |
| ITALY:Casalecchio | 11.0 | 5.0 | 20.0(22) | 0.0(V) | -1.0(9) | 55.2 | 76 | 35.0(25) | 6 | 0 |
| MALTA:Luqa | 21.2 | 15.4 | 27.1(1) | 11.0(29) | 5.9(28) | 129.3 | | 39.4(11) | 10 | 7 |
| NETHERLANDS:Ten Post | 8.4 | 3.2 | 13.6(29) | -2.1(29 | -4.9(6) | 125.4 | 161 | 20.5(21) | 22 | 0 |
| SWEDEN:Valla | 3.6 | -1.2 | 10.6(8) | -10.9(22) | -14.2(22) | 52.5 | | 16.5(17) | 16 | 0 |
| SWITZERLAND:Basel | 8.8 | 2.7 | 16.8(20) | -2.4(9) | | 116.6 | 208 | 18.6(22) | 21 | 1 |
| EIRE:Straide | 9.8 | 3.7 | 15.7(12) | -5.0(29) | -10.0(29) | 101.1 | 84 | 21.6(23) | 20 | 0 |
| " *Mt.Russel,Co.Lim* | 9.5 | 4.3 | 14.8(11) | -0.8(22) | -6.3(28) | 70.1 | | 13.3(22) | 17 | 0 |
| SHETLAND:Whalsay | 8.1 | 5.6107(13) | | 1.8(22) | -2.8(22) | 85.1 | 70 | 12.0(19) | 26 | 0 |
| " Fair Isle | 8.1 | 0.0 | 10.9(13) | 2.6(22) | -1.8(22) | 78.0 | 88 | 11.1(16) | 23 | 0 |
| SCOTLAND:Braemar | 6.4 | 0.6 | 13.3(13) | -7.2(22) | -7.8(22) | 52.5 | 59 | 14.0(24) | 17 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| " Inverdruie | 6.4 | 1.0 | 12.8(13) | -6.1(8) | -10.1(9) | 77.6 | 89 | 27.3(20) | 21 | 0 |
| " Rannoch | 6.8 | 1.3 | 12.5(13) | -7.1(22) | -7.1(22) | 67.7 | | 18.0(17) | 11 | 0 |
| WALES:Velindre | 9.0 | 3.3 | 16.3(12) | -4.6(23) | -10.0(23) | 65.6 | 69 | 16.6(23) | 18 | 0 |
| " Carmarthen | 9.6 | 3.9 | 14.0(17) | -1.0(23) | -5.1(23) | 91.8 | 65 | 30.5(23) | 18 | 0 |
| " Gower | 10.3 | 4.9 | 14.1(100 | 0.4(22) | -3.2(23) | 113.8 | 83 | 44.5(23) | 17 | 0 |
| GUERSEY:Airport | 11.1 | 7.6 | 14.69130 | 3.(26) | | 104.1 | | 14.9(26) | 22 | 3 |
| JERSEY:Carrefour/Clq | 11.8 | 7.0 | 15.4(13) | 1.7(26) | | 82.3 | | 12.3(2) | 22 | 2 |
| ENGLAND: | | | | | | | | | | |
| Denbury,*Devon* | 10.7 | 5.3 | 16.7(12) | -3.7(23) | -4.6(23) | 79.0 | 73 | 21.0(23) | 14 | 0 |
| Gurney Slade,*Somerset* | 9.0 | 3.5 | 14.3(12) | -5.2(23) | -6.0(23) | 92.8 | 80 | 16.3(11) | 18 | 0 |
| Yatton,*Avon* | 10.6 | 4.8 | 16.0(13) | -2.3(23) | -3.9(28) | 55.2 | 67 | 15.9(11) | 17 | 0 |
| Reading Univ,*Berkshire* | 10.2 | 4.7 | -1.0(6) | -1.0(6) | -7.0(6) | 24.7 | 42 | 8.2(25) | 12 | 1 |
| Sandhurst,*Berkshire* | 10.1 | 3.8 | 15.5(13) | -2.2(28) | -5.0(28) | 35.1 | 48 | 11.3(25) | 17 | 0 |
| Romsey,*Hampshire* | 10.6 | 4.1 | 15.5(16) | -2.0(21) | -4.8(28) | 41.1 | 56 | 14.1(23) | 14 | 0 |
| Brighton,*Sussex* | 9.9 | 5.0 | 13.7(12) | 0.9(21) | -0.3(28) | 72.7 | 92 | 24.9(24) | 14 | 1 |
| Hastings,*Sussex* | 10.3 | 5.6 | 14.0(-) | 0.2(21) | -2.1(-) | 74.4 | 85 | | | 1 |
| Dover,*Kent* | 10.3 | 5.4 | 15.3(17) | -1.8(21)) | | 98.4 | 98 | 24.8(25) | 18 | 3 |
| East Malling,*Kent* | 10.4 | 4.9 | 16.0(17) | -0.7(9) | -6.2(9) | 53.2 | 71 | 12.1(26) | 18 | 0 |
| Epsom Downs,*Surrey* | 9.7 | 4.1 | 14.8(16) | -2.8(28) | -6.4(28) | 46.4 | 67 | 14.8(23) | 18 | 0 |
| Reigate,*Surrey* | 9.4 | 4.5 | 14.8(17) | -1.7(21) | | 43.0 | 59 | 11.3(29) | 15 | 0 |
| Guildford,*Surrey* | 9.8 | 4.8 | 15.4(16) | -0.5(8) | -3.4(8) | 35.7 | 53 | 9.8(23) | 13 | 0 |
| Sidcup,*London* | 10.2 | 5.1 | 15.8(16) | -0.8(21) | -5.8(22) | 33.0 | 56 | 6.7(26) | 17 | 0 |
| Hayes,*London* | 10.1 | 4.4 | 15.3(16) | 0.2(6) | -1.6(5) | 30.9 | 62 | 6.3(25) | 15 | 0 |
| Hampstead,*London* | | | | | | | | | | |
| Royston,*Hertfordshire* | 9.4 | 4.9 | 15.7(17) | 0.4(6) | -5.0(6) | 36.6 | 63 | 7.4(25) | 17 | 0 |
| Loughton,*Essex* | 9.4 | 4.7 | 15.4(17) | -0.9(21) | -6.9(21) | 42.0 | 77 | 7.1(25) | 17 | 0 |
| Buxton,*Norfolk* | 9.9 | 4.3 | 15.7(16) | -2.3(21) | -3.4(21) | 90.4 | | 12.6(19) | 22 | 0 |
| Ely,*Cambridgeshire* | 9.6 | 2.7 | 15.2(16) | -2.1(6) | -3.1(6) | 42.9 | 82 | 10.0(19) | 20 | 0 |
| Luton,*Bedfordshire* | 9.3 | 4.4 | 15.2(17) | -2.4(6) | | 50.2 | | 13.0(25) | 17 | 1 |
| Buckingham,*Buckinghamshire* | 9.4 | 4.1 | 16.1(17) | -0.5(21) | -6.6(6) | 25.7 | 39 | 5.6(19) | 16 | 0 |
| Oxford University | 9.8 | 4.2 | 15.4(17) | -0.6(6) | -5.0(28) | 20.0 | 33 | 4.5(23) | 12 | - |
| Wolverhampton,*West Midlands* | 8.7 | 4.1 | 14.5(13) | -0.5(22) | -6.0(22) | 50.8 | | 17.8(19) | 16 | 0 |
| Louth,*Lincolnshire* | 9.3 | 4.5 | 15.2(16) | -0.7(25) | | 49.1 | 81 | 12.2(16) | 26 | 0 |
| Keyworth,*Nottinghamshire* | 9.1 | 4.5 | 15.0(13) | -2.5(22) | -6.4(22) | 45.3 | | 11.2(19) | 17 | 0 |
| Nottingham,*Nottinghamshire* | 9.3 | 4.8 | 15.3(16) | -1.7(22) | -4.5(22) | 38.4 | 70 | 7.0(19) | 17 | 0 |
| Derby,*Derbyshire* | 9.0 | 5.0 | 15.3(13) | -1.3(22) | -2.1(22) | 53.0 | 89 | 11.3(19) | 18 | 0 |
| Middleton,*Derbyshire* | | | | | | | | | | |
| Keele University,*Staffordshire* | 8.5 | 3.7 | 14.3(12) | -1.8(29) | -3.8(29) | 59.4 | | 14.8(19) | 14 | 0 |
| Liverpool,*Merseyside* | 9.7 | 4.4 | 15.1(16) | -1.7(29) | | 72.5 | 85 | 20.5(16) | 17 | 1 |
| Lathom,*Merseyside* | 9.4 | 4.1 | 15.0(16) | -1.9(29) | | 68.4 | | 15.7(16) | 14 | - |
| High Bradfield,*South Yorkshire* | 6.9 | 3.1 | 12.4(16) | -1.0(23) | | 66.6 | | 9.5(17) | 21 | - |
| Cottingham,*Humberside* | 10.1 | 4.6 | 15.8(16) | -0.9(22) | -5.8(22) | 55.7 | 88 | 8.8(24) | 21 | 0 |
| Carlton-in-Cleveland | 8.5 | 4.0 | 15.0(16) | -1.5(21) | -5.5(20) | 47.3 | | 9.0(3) | 21 | 0 |
| Durham University,*Durham* | 9.2 | 3.5 | 14.9(16) | -2.5(23) | -5.1(21) | 53.1 | 93 | 18.1(24) | 22 | - |
| Sunderland,*Tyne & Wear* | 16.5 | 5.5 | 16.5(16) | 0.7(23) | | 57.4 | 101 | 13.0(21) | 17 | 0 |
| CANADA:Halifax,NS | 8.3 | 0.6 | 15.3(28 | -4.0(30) | | 132.4 | 109 | 57.4(18) | 17 | 2 |
| U.S.: Bergenfield,NJ | 14.7 | 2.7 | 26.7(3) | -3.9(9) | -6.1(19) | 75.2 | | 49.5(10) | 7 | 1 |
| JAMAICA:Kingston | 31.6 | 24.3 | 33.2(26) | 23.0(28) | | 152.3 | 249 | 30.5(2) | 16 | 10 |
| " Montego Bay | 29.6 | 23.9 | 31.4(9) | 22.4(27) | | 132.3 | 120 | 18.1(1) | 20 | 7 |

CUMBRIA RAINFALL:
Carlisle 23.9mm, (30%); Seathwaite, 217.0mm (62%) The Nook, Thirlmere, 166.7mm (58%); Consiton156.0mm (57%),Hawkshead 119.0mm (60%);.

CONTENTS



*FRONT COVER*

Birmingham daily temperatures for 16 months, January 1795 to April 1796 compared with mean-date values calculated for 1951-1980 (see paper by Dr Brian Giles).

*EDITORIAL OFFICE:*

Journal of Meteorology, 54 Frome Road, Bradford-on-Avon, Wiltshire
BA15 1LD, U.K. (telephone 02216 2482; fax 02216 5601)