The JOURNAL of METEOROLOGY

THE PLACE IN KENT WHERE 'A VORTEX OF LIGHT' CAME DOWN INTO A CORNFIELD ON 10 AUGUST 1989

Volume 15, number 145 **January 1990**

THE JOURNAL OF METEOROLOGY
LE JOURNAL DE MÉTÉOROLOGIE
Published in association with
The Tornado and Storm Research Organisation
a privately-supported research body, serving the national public interest
Edited by Dr. G. T. Meaden, 54 Frome Road,
Bradford-on-Avon, Wiltshire, BA15 1LD, England.
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Published by The Artetech Publishing Co., 54 Frome Road, Bradford-on-Avon, Wiltshire, BA15 1LD.

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

ISSN 0307-5966

THE JOURNAL OF METEOROLOGY

Le journal de météorologie

Volume 15

1990, numbers 145 to 154

Edited by G. T. Meaden, M.A., D.Phil.(Oxon)

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

1990

ISSN 0307-5966

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

Editor: Dr. G. T. Meaden Vol. 15, no. 145, January 1990

NOCTURNAL EYE WITNESS OBSERVATION OF CIRCLES IN THE MAKING PART 1: EAST KENT, 10th AUGUST 1989

By PAUL HARRIS
Folkestone, Kent, England.

Early on the morning of 10th August 1989 just outside the Kentish seaside resort of Margate a remarkable event took place that may well add considerably to our understanding of the manner of crop circle formation.

At approximately 0130 BST (0030 GMT) on the morning in question Wilfred Gomez and a friend were driving north along the A256 towards Margate (see map in Figure 1). The friends noticed a strange object in a field to their left in the north-north-west which looked like a short column of light with a fuzzy indistinct top and more clearly defined base, glowing white with

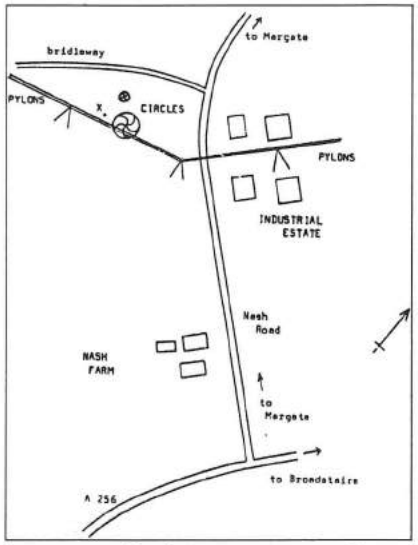


Fig.1: The area south of Margate, Kent, where the light phenomenon was seen and the circles found. The Photograph was taken at the point marked X.

a bluish tinge. Mr Gomez could detect a rapidly spinning motion, leading him to describe the phenomenon as resembling a 'solid hurricane of light' or 'vortex of light'. A low, even, humming sound could be heard through the open car window. The object remained in view for about 4 seconds before disappearing by 'blinking out to one side' as Mr Gomez describes it, both witnesses noticing that an after image momentarily remained in their eyes. The humming sound ceased when the object vanished. Mr Gomez took the first left turn and drove up onto a bridleway next to where the object appeared to have been. Walking into the standing corn the friends discovered a small circle of flattened crop some 5m in diameter, and about another 5m further in they found a 'massive' 20m circle. The half moon provided enough light to see by.

Initially Mr Gomez did not seek publicity but a friend feeling this was of some importance alerted the local free newspaper ADSCENE, reporters from which accompanied him to the site of the circle for a closer look. The corn proved to be bent over but not broken, and swirled around in an anticlockwise direction in common with many other crop circles found throughout England.

The circles appeared almost directly beneath power lines crossing a corn field about a quarter of a mile north of the A256 from where the ground slopes gently toward the site of circle formation, losing some 50ft in the process. The windflow at the time of the sighting was from just *east of south,* at a speed of 5 knots. The circles formed therefore within the lee of the slope, consistent with

Fig.2: The 20-metre circle partly underneath the high-tension wires. This is the exact place at which the light phenomenon was seen on 10th August 1989. (Reproduced with the permission of ADSCENE Publishing Ltd.).

current theory and observations. There are no other hills or significant elevations in the vicinity which is mostly quite flat until the low cliffs of Pegwell Bay not far to the south. The farmer owning this land, a Mr J. F. Lamont, reports that he did not see the circles in his field prior to the arrival of *Adscene* reporters with Mr Gomez. However he has noticed whirlwinds lifting corn 'hundreds of feet into the air' on several occasions and once sustained damage to an outbuilding from such a phenomenon. Mr Lamont stated that he has not previously seen any circles in his fields, only more unruly damage, but did believe that whirlwinds of some kind were responsible. The Meteorological Office at RAF Manston also confirmed that this area is prone to the appearance of 'dust devils' during late summer and early autumn. Unfortunately no-one at Manston could say that the radar screen was being observed during those crucial few seconds.

Some final thoughts on this case, the description of the vortex 'blinking out to one side', suggests a momentary movement in the focus of the phenomenon. Could this have started the formation of the second circle, its development ceasing with the disappearance of the vortex? Also with all the evidence that this spot may be prone to such occurrences can be added a further report of a similar glowing manifestation at virtually the same spot during August 1988. Summer 1990 should be interesting!

NOCTURNAL EYE WITNESS OBSERVATION OF CIRCLES IN THE MAKING
PART 2: NORTH WILTSHIRE, 29th JUNE 1989

By G. T. MEADEN
CERES, Bradford-on-Avon, Wiltshire.

This important observation took place in north-central Wiltshire near Silbury Hill in the middle of the night of 28th to 29th June 1989. Like the event in Kent recounted by Paul Harris in the preceding article, it concerns a self-luminous spinning ball of light which was seen descending into a cropfield and – it would appear – scouring out a broad circular impression in the crop. A brief résumé of the incident is set down herewith.

Soon after midnight the occupier of the roadside cottage by the path which leads to West Kennett Long Barrow noticed a large ball of light 400 metres distant in a wheatfield to the west. At the time of the observation he was walking from house to garage, and had a clear view to the illuminated part of the field through a gap in a hedge which borders his garden. He described the ball as orange in colour, adding that it was brighter around the periphery, and he guessed the diameter as 30 – 40 feet (say, 10 to 13 metres). When first seen, the ball was already low over the field and still descending. The witness watched the base of the ball 'go flat' as it made contact with the crop and/or the ground. The ball then gave 'a little bounce' and after a further 'seven or eight seconds' disappeared *in situ.*

Fig.1: The circles as photographed at 0900 on 30th June 1989. The nearest is the one associated with the orange ball of light.

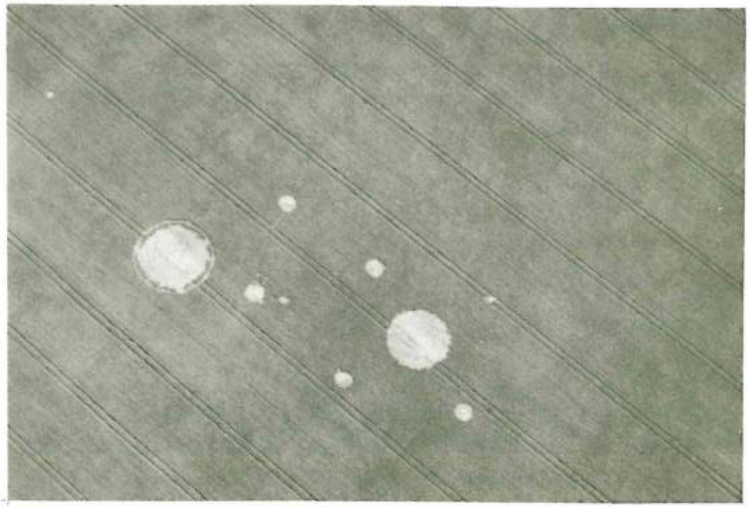


Fig.2: The same circles as seen by helicopter on 4th July.

Next morning on leaving the house the witness could see via the gap in the hedge a large circle at the place which corresponded to the position of the light source the previous night, and some smaller circles were evident as well.

CERES learnt of the new circles later that day after a fly-over by Mr F. C. Taylor who reported that the big circle had a ring around it.

The writer arrived on the morning of the 30th and found that overnight half-a-dozen additional circles had joined the first ones (Figure 1). The new circles included a quintuplet formation which was important in itself for the smallness of one of its satellites which had spun in the area of weakness provoked by the presence of tractor lines. The effect shows up well in the next photograph (Figure 2) taken by the author on 4th July during a helicopter reconnaissance. The adjacent ringed circle with its narrow clockwise ring is seen with its intervening wall lying in a partially collapsed condition. The diameter of the clockwise circle was found to be 15 metres while the ring width varied between 0.2 and 0.45 metre.

The observations of luminosity reported by the eye witness are highly significant for the theory of plasma vortices as proposed by the author in *The circles effect and its mysteries,* for one may conjecture that the peripheral brightness noted for the self-luminous ball accords with the position of the plasma-pause, the primary source of the electromagnetic and radio-frequency emissions postulated for the radiating vortex.

BUTTERFLIES AND THE WEATHER IN AVON COUNTY – 1989 AND THE 1980s

By A. H. WEEKS
13 Stowey Park, Yatton, Bristol.

Abstract: The author has watched and recorded butterflies throughout the 1980s. In his article, he looks at the weather of the decade and how it appears to have affected the fortunes of certain species.

INTRODUCTION

We should all be concerned about butterflies. When 'Butterfly Year 1981-82' was inaugurated, a leaflet published by the British Butterfly Conservation Society stated "Butterflies are indicative of the general health of the countryside . . .", now; eight years later, the environment is a matter which looms large in the media. So perhaps it would be appropriate to commence this last article in the series by repeating some material from the first (*J. Meteorology,* Vol. 7, no. 67, pp. 82-83), that is, by looking at the weather and other requirements of these sensitive insects.

As poikilotherms, the main source of their body and muscle heat is the external environment. In the adult stage, they need sunshine and warmth for flight and mating – mostly in spring and summer: they also need a good supply of nectar to provide the energy to keep them going. Warmth is also needed at

the caterpillar stage; this is the only growth stage in the life cycle and for many British species, it starts in spring, and, it follows, the appropriate food plant should be growing well and in season. Butterflies overwinter in various stages of the life cycle, and for all (except two borderline adult hibernators), a cold dry winter is probably more favourable than a warm wet one. The four common species that hibernate as adults appear to be able to withstand severe cold – even the Comma, which spends this season folded up, exposed in a hedge or bramble thicket. Others that come through the winter in the egg, caterpillar or chrysalis stage do so largely amongst grass or leaf litter, and a covering of snow protects them from predators, mainly birds: they are easier victims in warm winters when they also suffer more readily from virus diseases and mould. For butterflies, then, an ideal year would consist of a cold winter, a warm but not too wet spring, a hot summer with sufficient rain to keep vegetation growing and wildflowers in bloom, and a not over-wet autumn. As we shall see, in the 1980s, these criteria have been satisfied to varying extents. Even in good years, there have been 'rogue' months, and other unwelcome events such as the snowfall which occurred in some areas in late April 1981.

Butterflies are beset nowadays by a number of factors other than weather. Changes of habitat have had the most significant effects: there have been some improvements, unfortunately outweighed by deterioration. In particular, locally, changes in forestry practice have resulted in the disappearance, during the '80s, of the Pearl-Bordered and High Brown fritillaries. Both like open woodland and where this once existed, there are now conifer plantations. Neglect of other woodlands, e.g. open glades being allowed to become overgrown, has reduced the numbers of other species. In a review of the effects of weather on butterflies, therefore, these factors have to be ignored, except that where a species has been reduced to small numbers because of them, a poor season weather-wise can topple it into extinction (this is what happened to the Large Blue in the latter half of the 1970s). There are also imponderables which enter into the scene, as we shall see.

1989

Before embarking on a review of the 1980s, we should look briefly at progress in 1989. There is little need to describe in detail the weather in each month: by the time this article is published, enough will already have been written about this remarkable year. Suffice it to say that the only disappointing month from December 1988 to September 1989 was April, which was cool and had nearly double average rainfall. The warm winter resulted in some of the hibernating species having very disturbed sleep. Reports of Small Tortoiseshells taking advantage of the sun started from shortly after Christmas 1988 and a Peacock appeared as early as 10 February. Fortunately, there was nectar to sustain these early fliers – the number of different plants in flower in my garden on 15 February was 26 (three more than in 1988). The insects seemed to have a preference to settle on grape hyacinths. The Brimstone and

Comma, on the other hand, emerged no earlier than usual, but in early April, the Red Admiral appeared in this area in remarkable numbers, suggesting that some at least had successfully overwintered.

The summer rainfall total was well below average. In the three summer months, it mostly descended in the space of a few days around 26 June, 7 July and 9-14 August. With long hot sun between these falls, the countryside became parched, e.g. from 7 July to 8 August, the only day with measurable rain was 29 July with a mere 2mm. Nectar from wild flowers became scarce and once again, the domestic garden proved its worth. The total number of species visiting my own was the highest since 1984, and they included the Wall Brown, not recorded here since 1981. Most species seem to have had early but short seasons. The population sizes were still variable. On the positive side – despite the poor April – conditions for breeding of Small Tortoiseshell, Peacock, Brimstone and Red Admiral appear to have been good and the summer broods of the first two began to fly in early July. There were more widespread reports of the Holly Blue, and in greater numbers, than for several years. The Common Blue and Brown Argus too continued their improvement, especially in August, and the Chalk Hill Blue had another successful year. Slightly more Clouded Yellows were seen in August and September than in recent years, although total numbers were still small. There is more to report on the negative side. The Comma, despite sharing its early breeding season and main food plant with Small Tortoiseshell and Peacock, made a comparatively poor showing in July and an even worse one of the dark winter form in late August and September.

The dryness of July and August saw an early end to the browns and skippers, all of which seemed to have reduced populations. April may have been the reason for there being few reports of the Green Hairstreak (through reduced opportunities for observation) and the poor performance of the Green Veined White in August. The Painted Lady was scarce and appeared here only over a very short period near the beginning of August.

The most extraordinary event of the year commenced just after mid-July. The Small Copper is a species which has come into my garden every year, usually on a handful of occasions between late July and early October. In 1989, there was an invasion, the numbers increasing until on 7 September, I estimated upwards of 25 on one clump of Aaron's rod, while many others flitted about elsewhere. The phenomenon was general in this part of the county and in adjacent North Somerset. One wonders what ingredient was present in 1989's conditions to cause this population explosion, when nothing like it seems to have occurred in comparably warm summers like 1983 and 1984. The food plants of the caterpillar are common enough – dock and sorrel – and usually do not merit close inspection: I certainly did not notice that in May and June they must have been swarming with caterpillars. After the early September peak, numbers dropped rapidly and the last adult was seen on 30th. Thereafter, few species showed themselves in the garden, the latest in October being Peacock (9th), Small White and Large White (17th) and in

November, Red Admiral (4th) and Small Tortoiseshell (5th). Overall, 1989 showed a marked improvement on 1988 – indeed, it could hardly have failed to do so.

THE 1980s

Table 1 shows that the 6-month period March to August in the '80s was predominantly warm, but only 1984 and 1989 emerge as the years with warm, sunny and dry weather in both spring and summer. 1987's were warm and dry but somewhat less sunny. 1983 was marred by a cool wet spring (the adjectives apply particularly to April and May). 1982's summer was damp and short on sunshine. 1985, 1986 and 1988 were obviously the worst. But, as already suggested in the opening paragraph, a very dry summer is not necessarily the best for butterflies if it results in the supply of nectar ceasing. To judge from the Table, the best butterfly years of the decade should have been 1982, 1983 and 1984, with a slight recovery from the recessions of 1985 and 1986 in 1987 and a greater one in 1989. I now look at the information in my possession in more detail to see if this assessment is correct.

TABLE 1

	Mean max temp. Difference from LTA		*Rainfall % of LTA*		*Approx. % sunshine*	
	Spring	*Summer*	*Spring*	*Summer*	*Spring*	*Summer*
1980	+0.6	–0.2	88	85	98	83
1	+0.5	+0.5	165	49	70	90
2	+1.3	+1.4	87	114	115	86
3	–0.8	+3.5	143	45	80	120
4	+0.2	+2.8	78	47	100	125
5	–0.1	–0.6	100	160	105	92
6	–1.3	0.0	135	85	90	85
7	+0.4	+0.5	87	63	97	96
8	+0.8	–0.6	97	140	92	85
9	+1.5	+2.7	98	69	110	135

(Yatton temperatures and rainfall; LTA at Long Ashton Research Station).

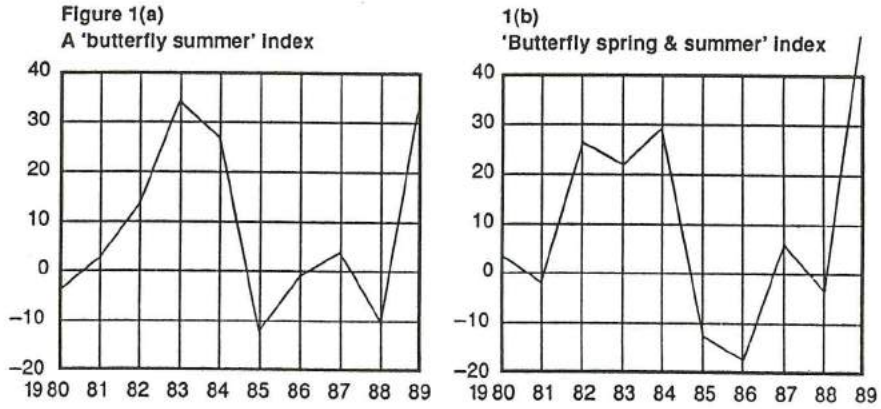
Over the ten years, the one habitat which has been maintained in a consistent state is my garden. Although there are no resident butterflies, the number of species which visits it each year is indicative of the populations in the vicinity. It is not unreasonable (but perhaps lazy) to make a quick comparison between the years by listing these numbers. (I do not, of course, spend *all* my time watching the comings and goings: my observations are casual, but as a good proportion of my day is spent out of the house, I claim not to miss much!) Table 2 suggests that my preliminary ranking of the years above may prove to be near the mark.

TABLE 2. Species recorded in garden

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
No. of species	n/a	15	20	18	20	17	17	16	15	19

The highest number of species seen on any one day was 13 on 23 July 1989.

It would be useful, in attempting to compare the merits of the individual years, to have a 'summer index' along the lines suggested some years ago in this Journal.[1][2] In the absence of my own sunshine records, I am unable to do this. However, I have devised an index, using the criteria for butterflies given earlier in this article, by taking a factor of temperature difference and adding or subtracting an element according to whether there was a surplus or deficit of sunshine. No adjustment has been made for near-normal rainfall, but the index has been reduced by an amount related to excessive wetness and (perhaps an unusual method of apply) excessive dryness. The result for summer is shown in Figure 1(a), and for combined spring and summer in Figure 1(b). These simply emphasise the superiority of 1983 and 1984 and show the poverty of 1985 and 1986. Of the two, 1(b) agrees more closely with my records of the butterfly populations.



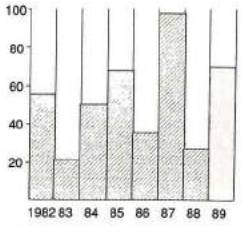
THE PERFORMANCES OF CERTAIN INDIVIDUAL SPECIES

The Holly Blue has been mentioned often in this series. It is a species which is inclined to fluctuations in numbers in different areas, whether through predation, parasitisation or weather is unclear. It was common around here in the early '80s, but went into decline in 1985 and by 1987 had all but disappeared. In 1988, it staged a partial recovery which continued in 1989, probably reaching something like its former numbers. Its decline and recovery matches roughly the curve of the combined index in Fig.1(b). Rather similar curves might apply also to the Common Blue and Brown Argus. But these are only impressions, for I know of no local statistics for these species. However, population figures exist for certain common species over the years 1982 to

1988 inclusive, when the Bristol Regional Environmental Records Centre (BRERC) carried out surveys. The numbers of observers contributing to these changed from year to year (as no doubt did the quality of the observations!) but in the absence of anything better, they can be used as a basis for making a year-by-year assessment of the performance of the selected species. In doing so, I have expressed the survey results as a ratio of total sightings to number of observations. The results for the four hibernating species are shown in Figure 2(a)–(d).

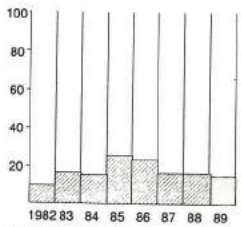
Figure 2. Records per observer of certain common species.

(a) Small Tortoiseshell



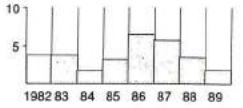
The best year was 1987. By far the most of the observations were made from July to September in that year, indicating a successful mating season in spring. Both spring and summer were warmer and drier than average. 1983's poor performance seems to be a reflection of the cool, damp spring. My off-the-cuff forecast for 1989 is that it will be similar to 1985, when most records were received for September and October.

(b) Peacock



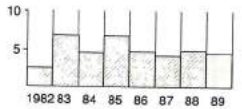
This insect is seen to be a more consistent performer. Since the life-cycle is similar to that of the Small Tortoiseshell and the larval food plant is the same, one would expect a similar variation in numbers, but this is not so. The Peacock tends to go into hibernation earlier which, of course, would make for a drastic drop in sightings from early September. My prediction for 1989 is that it will prove to have been a poor year – perhaps down to 1982 levels.

(c) Comma



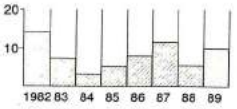
The best year was 1986 (when I chose this as 'butterfly of the year'). Spring numbers then were small but summer and autumn broods were good. This is strange, since the spring was cool and damp, and could have been expected to affect Comma, Small Tortoiseshell and Peacock alike. 1989 numbers are likely to be little better than 1984's.

(d) Brimstone

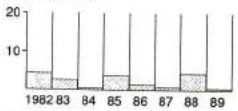


Best years 1983 and 1985. In the former year, the largest numbers were seen in mid-summer, suggesting a successful mating season in spring, despite the adverse weather. In 1985, the largest numbers were recorded in spring (April & May), i.e. those that had emerged in summer 1984 and overwintered. Why 1984 was not so good is not immediately apparent, in the light of their success in summer 1983: an explanation might lie in the adverse winter of 1983/84, which was the wettest of the decade (126% of average), when a fair proportion of the population may have fallen victim to disease. I think that 1989 will have turned out to be only an average year.

(e) Red Admiral



(f) Painted Lady

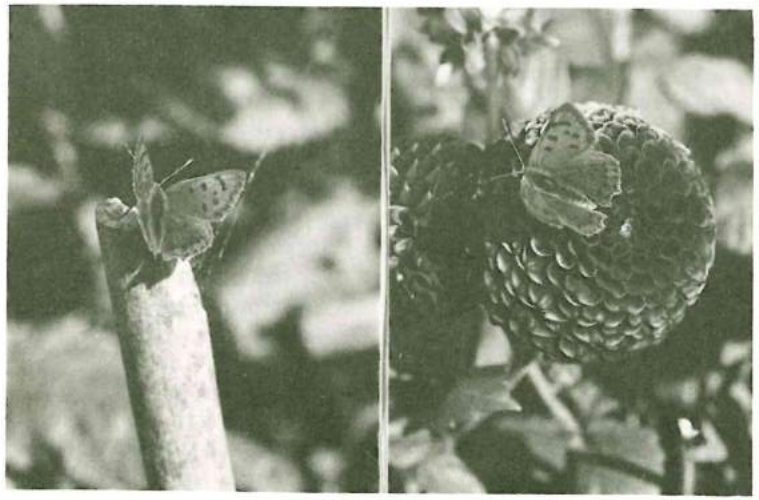


Note that the same scales have been used for Small Tortoiseshell and Peacock; Comma and Brimstone; Red Admiral and Painted Lady. Because of the widely varying numbers seen, it is not possible to use a common vertical scale. Entries in 1989 columns are author's estimates.

The Migrants

The commonest immigrant species to Avon are the Red Admiral and Painted Lady. Both usually arrive in late spring or early summer and produce late summer broods which fly on into autumn, with some evidence of a southward movement later in the season. Both have made appearances in every year but in varying numbers. The bulk of the records for both species were made from July to October, i.e. they cover the new arrivals and their descendants. One would expect, therefore, that the better the summer, the larger the records for late summer and autumn, but this is not so. Figures 2(e) and (f) show that there is no discernible correlation between weather and the populations of these two species. 1982 and 1987 turned out to be the most successful for the Red Admiral – years which were reasonably warm and moist. Surprisingly 1983 and 1984 were among the worst. 1989 may turn out to be a no-more-than-average year, similar to 1983 and 1986.

Painted Ladies were never as plentiful as Red Admirals: indeed they were a rare sight in 1984 and 1987, and 1989 can have been little better. Their better showing in 1988 was one of the best aspects of an otherwise dismal year. It does appear that in recent years, more individuals of both species have succeeded in overwintering as adults and have been seen in flight early in the year. They may have helped to swell numbers in summer and certainly, the Red Admirals seen here early in July '89 were mostly fresh, perfect, obviously newly-emerged specimens. If this is the greenhouse effect beginning to 'bite', maybe we shall see more of this happening. There, were too, unusual happenings, for example the early arrival here of migrants in April 1985; and an immigration, along the south coast, of Painted Ladies over Christmas and New Year 1987/88 (although I had no reports of them from Avon). It seems that almost anything can happen!



The Clouded Yellow has been seen in small numbers in almost every year except 1983, when it was plentiful. This was one of the good summers, but there were no migrations on a similar scale in 1982, 1984 or 1989. Mass arrivals, such as we witnessed in 1983, are very irregular, usually occur in a hot summer, e.g. 1947, and are possibly the result of population pressures in the homeland. Amongst the arrivals are usually some of the pale form of the female, *helice,* and some Pale Clouded Yellows. The 1984 records were unusual in that a quite high proportion of the small numbers seen consisted of *helice.*

There has been no report in the 1980s of the Camberwell Beauty, other than escapes from breeding cages, and only two of the Monarch, in 1981 and 1983.

Rarities

The close scrutiny given to lepidoptera in this area in the 1980s led to one or two surprises. In 1982, there were two separate unexpected reports of the Large Tortoiseshell in gardens, which were followed up by the BRERC and the sightings confirmed. Reports in succeeding years suggested the existence of a small colony of this rare, endangered species in a remote spot. Possibly they are still there; poorer weather in recent years has hindered observations.

No review of butterflies in Avon in the 1980s would be complete without a mention of what must be the success story of the decade. The Glanville Fritillary takes its name, according to local evidence, from one Mrs Glanville who lived at Tickenham Manor (then in Somerset, now in Avon) in the late 18th century and who identified the species flying on Tickenham Moor and Nailsea Moor, only 3½ miles (5kms) north of my station. It subsequently died out there and textbooks now give the south coast of the Isle of Wight and a small area of the Hampshire coast as its only British habitats. However, in 1984, a local amateur entomologist who was breeding this butterfly in captivity had such great success that he found himself with several hundred caterpillars surplus to his requirements and, rather than commit mass murder, he decided to distribute them over an area, not many miles from Tickenham, where there is a plentiful supply of the larval food-plant (some of the plantains). In common with the IOW habitats, the spot chosen has a steep, south-facing slope near the sea, and, I suspect, a very similar climate to that of the Island. The experiment – if that is the correct term – succeeded and there has been a good showing of the Glanville Fritillary there in every year since. I was somewhat saddened, when I walked over the site in early August '89 to find it scorched and the plantains withered. There may be a problem for 1990 here (1977, following the drought of 1976, was a poor year for lepidoptera).

Miscellaneous

Table 1 is concerned with spring and summer weather, but I mentioned in the opening paragraph some possible effects of winter on butterfly populations. So what *have* been the effects of winters in the 1980s? That of

1981/82 springs to mind as the coldest, with its deep-freeze December and January, but the intense cold then was short-lived. 1982 was one of the good years for butterflies. The coldest statistically was 1984/85, which preceded a poor year. The wettest winter was 1983/84, mentioned already as possibly connected with the lower numbers of Brimstone (Fig.2(d)). Runner-up was 1985/86 (113% of LTA), which was followed by a wet spring (135%), so it is no wonder that 1986 populations showed no improvement over 1985. The warmest winters were 1987/88 and 1988/89, the first preceding a bad year and the latter a good one. No consistent pattern emerges which would enable me to substantiate my claim that cold winters are beneficial and warm, wet ones detrimental.

Readers of earlier articles in this series will know that since I acquired a black-bulb in vacuo thermometer, I have watched insect activity in relation to 'sun power', especially early in the year. As already reported, I have concluded that the conditions needed to arouse any of the hibernators in late winter or early spring are screen temperatures of 55° to 60°F (13-16°C) and black-bulb readings of about 80°F (26°C), the latter arising from fairly constant, not fitful, sunshine. There must also be only a light breeze. Once aroused, it does not require these values to be reached for further flight. I have seen butterflies active with temperatures below 50°F and even bumble bees busy in the 30s!

Watching nature in this way never fails to produce fresh food for thought. In my article on 1988 (*J. Met.* Vol. 14, no. 135, pp. 18-21), I remarked on the extreme scarcity of ladybirds, yet in mid-March 1989, regiments of them were basking in the sun on nettlebeds, with temperatures at 8.4°C in the screen and a black-bulb maximum of 31.7°C. Where had they been last summer?

CONCLUSION

If buddleias are *covered* with Small Tortoiseshells in late summer, does that make a good butterfly year? Attractive though this sight may be, to me it merely signifies the success of one of the commonest species: I define a good year as one when it is possible to visit a site and see all the species known to be there, in good quantity and at the right time. Looking back, there have been good years and bad ones, by this yardstick, in the 1980s. The best years were undoubtedly 1982, 1983 and 1984. Until I came to pen this article, I had forgotten how very good 1982 was: it was the year when I logged 25 species in one locality on 24 and 29 July (22 on the earlier date, 23 on the later), out of a total of 32 seen there in the entire year, 1983 produced 20 on 28 July, total 32; and 1984, 20 on 6 August, total 29. In succeeding years, the figures dropped until in 1987, the last complete year during which I was able to make regular visits, they had fallen to 17 on 20 August, total 25. Similar trends have been observed at other sites visited regularly. It does seem that butterflies have suffered a decline over the decade, and this has not been wholly connected with loss of habitat. The one butterfly which I consider has maintained or perhaps even increased its numbers is the Speckled Wood. If 1990 is a poor

year, as 1977 was after the 1976 drought, the outlook is not encouraging.

If all my efforts have done little more than confirm that butterflies *are* creatures of sunshine and warmth, at least they have occupied me in the first ten years of retirement in a pleasant and harmless way! Throughout the series, I have used my own field observations mostly in South Avon but I am grateful to have had valuable supplementary information supplied by the BRERC and members of the Entomological Section of Bristol Naturalists' Society: also I must thank a few correspondents who have written to me about unusual sightings, and local residents who have called my attention to miscellaneous items of interest. I am indebted, on the weather side, to the Climatological Observers' Link and to Wessex Rivers, whose monthly bulletins and reports have provided me with the modicum of information on which I have based my approximate sunshine figures.

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(2) I. J. LYALL, *ibid.*, Vol. 1, no. 6, p. 183 and no. 8, p. 253.

Addendum

Since writing the above, I have read David Glue's article on Britain's Breeding Birds in 1989 (*J. Met.*, Vol. 14, no. 143). At the bottom of page 373, he mentions the relative failure of the Tit family as possibly caused by "a poor match of the main caterpillar crop and developing young". Here, surely, is the explanation for the spectacular success of the Small Copper to which I refer, with the birds getting off to an early start ahead of the caterpillars in late May and June, so that the latter suffered less predation.

Yet I have not noticed a decrease in Blue Tit population here. The real disaster in 1989 was in House Martin numbers. 'Our own' took up residence in early June and produced a single brood of three chicks, instead of the normal two broods of five or six. Several nests around here remained unoccupied and sadly have since been taken down.

THE WEATHER OF PEPYS, 1660-1669: PART 4

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Abstract: The final part of this series of four articles, published posthumously, covers the period from the summer 1668 to 1669.

SUMMER 1668 FAIRLY WET, HOT SPELLS

The wetness of the first week of the summer which in meteorological parlance began in N.W. Europe generally on May 22nd is well described by Pepys although he gives little information about the rest of the season. On the way to Cambridge on the 24th he writes 'Through the waters with very good success, though very deep almost all the way . . . all over Portholme and the meadows . . .' Josselin on the 23rd confirms the same pattern for Essex

'Wonderfull wett, flouding the meadows . . .' In Norfolk, as often happens in a south-westerly season, it was fairly dry, but the region of wetness extended from the British Isles to Germany and especially Muscovy. Frequent rain is mentioned by Josselin through the season, especially in the first half of August; this time, therefore, we cannot argue from the silence in the Diary that it was dry in London. The wetness at this time helps to explain the wide tree-rings found in Stuart furniture, and in the oak selected for Wren's churches.

Some hot spells are nevertheless mentioned by Pepys as on 30 June when he wrote 'Then home to dinner, where a stinking leg of mutton, the weather being very wet and hot to keep meat in'. Exactly four years earlier Pepys had referred to his mother losing some of her household who went elsewhere because the meat, although bought fresh, was stinking by the time it was served, and in the same thundery year 1664 on 3 July he and his wife had to eat 'the remains of yesterday's venison and a couple of brave green geese, which we were fain to eat alone, because they will not keep, which troubled us'. No wonder Fellows of the Royal Society had begun to think of the possibilities of refrigeration.

On July 15 it was hotter still Pepys writing 'Wonderful hot all day and night, and this the first night that I remember in my life that ever I could like with only a sheet and one rug'. He had forgotten the similar remark he had entered in his diary for 13 July, 1667! On July 17 he again made similar remarks and having found it excessively hot watching the play, adds that he and his wife were forced to lie in separate beds. The summer was generally warm in Scandinavia judging from the wide tree-rings found near the tree-line, whereas in Scotland the harvest was the best for sixty years.

The prolonged dryness over several years appears to have been responsible for a sandstorm – a phenomenon more usual in deserts than in European countries. Small lakes in the Breckland of East Anglia respond closely to the changes in the saturation level of the underlying chalk and when there is a drought the grass cover that prevents the sand from moving is easily stirred. The movement had started in the dry thirties when some sand had reached Downham. S.W. gales in 1668 carried the sand from Lakenheath Warren six miles away and blocked the Little Ouse at the place that until that time had been known as Downham (see *Phil. Trans. Roy. Soc.*, no. 37, pp. 722-725). To commemorate this event, the village has ever since been known as Santon Downham.

AUTUMN 1668 DRY, WARM

The dryness and warmth of the Autumn is well conveyed by combining the remarks of Pepys (who refers merely to individual days: 6, 20, 21, 27, 28 September; 11, 18 October) with those of Josselin. On 11 October Pepys had commented 'the season of the year as good as summer in all respects'.

The very dry weather in S.E. England in September and October is specifically indicated by Josselin's weekly summaries which start by saying (13 Sept) 'god wonderfull good in the drines of the season' and (20 Sept) 'god good

to us in a dry season' and continues with (11 Oct) 'no rain yet' (25 Oct) 'dewes but no rain to wett'. On 18 October Pepys noted a rainy morning, but he fails to indicate the wetness that did follow from the 28th when Josselin began to report 'daily showres so that the wayes are dirtie'. November was indeed to be wet, and there is an occasional reference in Pepys as on the 7th 'the way so bad' (in a week when Josselin wrote 'wett and wett through') but there are gaps. The gale of 12 November, recorded by Goad and Gadbury, was presumably left out when Pepys wrote up the events belatedly ('for six or seven days') on the 15th. The hard frosts that Goad and Gadbury recorded on 16/23 November are also omitted and were perhaps forgotten by Pepys on 7 December when he was to write 'The first frosty day we have had this winter'. Nevertheless the November weather was out of character with the season as a whole and Pepys' difficulties in keeping his diary up to date were no doubt explained by his other activities – both business and pleasure. Thus there were only two 'weather' entries between 18 October and 24 December. However, from 11 November we have Gadbury's continuous and reliable weather diary that is available in print.

DECEMBER 1668 MILD

There are only two comments on the weather in the diary this month: they are probably both untrue but they imply correctly that the very mild weather continued. On 7 December, as we have already mentioned, Pepys forgot the mid-November frosts when he wrote "The first frosty day we have had this winter'. On the 24th he tells us 'it being now very cold, and in hopes of a frost, I begin this night to put on a waistcoat, it being the first winter in my whole memory that ever I staid till this day before I did so'. On Christmas Day 'continued on my waistcoat' but the astrologer Gadbury says the frost broke in the morning.

December was also wet between the 16th and 20th, Gadbury mentioning 'thundery rain at night' on the 19th and the Essex floods of 18-22 December being described by Skippone (see C. M. Hood, *Norfolk Archaeology*, 22, 1925, p. 162). On the 20th Josselin, also in Essex, records 'Waters filling the dry heart of the earth' but Pepys did not even tell us the ways were dirty.

1668 WARM

Warmth is the obvious characteristic of the year as a whole; it was fairly wet but prices were still low.

Smallpox in this year is mentioned several times in the diary and the epidemic of 1667/8 killed about 10% of London's population; several epidemics of the seventeenth century developed in dry years (e.g.1652) and the dryness of 1666/7 may perhaps be one factor involved.

WINTER 1669 COLD

The frosty weather that set in intermittently on 22 December became more severe in the first three weeks of January and Pepys during this period makes various notes on the weather, all corroborated by Gadbury. Indeed, the cold

spell affected Oxford and Norfolk at the same time as our usual sources confirm. Josselin, but not Pepys, now omits all reference to the weather between 20 December and 14 February, 1669.

SPRING 1669 COLD, VERY DRY SPRING

The gradual onset of spring can be followed by some of the incidental remarks in the diary. On 1 February he had travelled by water instead of by coach from the Tower to Whitehall. On the 14th, still strictly winter, Josselin had written 'a good dry weather' and on the 15th there occurred the first of a group of reference to minor fires – at the Cloth Fair in London, another occurring on the 24th in Gray's Inn Lane. On 2 March Mrs. Pepys 'put on first her French gown', but on 5 March 'the first time out of town with our coach... the spring beginning a little now to appear, though the way be dirty . . .' On 14 March he walks with Mrs. Pepys in the garden, 'the first time this year, the weather being mighty temperate' and on the 18th he 'with mighty pride rode up and down' in Hyde Park.

A cold spell from 20 March to the 5th April is, however, reflected in a number of comments. On the 24th he walked over the fields to Chatham in the snow, which on that same day in Suffolk was foot deep (Skippon) but we learn from Josselin that by this time (4 April) 'it was droughty'. Pepys, however, confirms this for the drought was interrupted by what Gadbury calls 'some drops (of rain)' when on 18 April Pepys says 'This being the first day of rain we have had many a day, the streets being as dusty as in summer'. The weather was still 'very pleasant' on 25 April, the day of another minor fire in London at Durham Yard (see entry under 26 April).

On 1 and 2 May there was some rain but Josselin tells us that on the 2nd the season was cold and dry, and although it became warmer from the 6th 'a noble day' to the 10th when 'I first left off both my waistcoats by day, and my waistcoat by night, it being very hot weather'. A little rain is recorded in Pepys in mid-May, but Josselin on the 17th complains 'dews but no full rain'.

THE REST OF 1669. DRY SUMMER, AUTUMN AND DECEMBER

On 23rd May, when Mr. and Mrs. Pepys were 'taking the ayre . . . with great pleasure' Josselin tells us that it was 'dry burning weather' and Gadbury confirms. This was indeed to be typical of the summer although it is typical of Pepys that his only reference to the weather is to rain – this is on 30 May when Goad tells it was close but 'show(er)ing 6p'. This shower of Goad's, evidently at 6 p.m., must have been the rain that Pepys tells us 'sent us suddenly home'. By the end of the year (18 December) Josselin reports that 'waters low beyond whatever I knew . . . I was forced to water all my catle at Pitchers pond'. The year was indeed a typical high pressure year in western Europe, the estimate in our table suggesting a mean barometer about 0.06 inches or 2mb above normal.

Acknowledgements: Special thanks are due to the contributors to the Spectrum of Time project for sending me Xeroxed or TS references to

meteorological items. Thanks are thus due to Dr. C. E. Britton and Dr. J. N. L. Baker for their manuscript collections, Dr. F. E. Dixon for a chronology of Goad's items, Dr. Craddock for a chronology of Evelyn's items, Dr. A. Macfarlane for his chronology of extracts from Josselyn, and to many friends at the Institute of Historical Research.

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WORLD WEATHER DISASTERS: APRIL 1989

1-30: Flash floods that have struck central South Yemen since March 19th have left 53 dead, 50 injured and 100,000 homeless, thousands of cattle drowned, crops destroyed and roads and bridges swept away, floods, described as worst in 50 years. *Lloyds List., International Herald Tribune.*

1-4: Fierce storms hit coast of eastern Australia, causing serious floods in New South Wales and southern Queensland, worst floods along north coast of New South Wales, with the business districts in the cities of Lismore and Murwillumbah under one metre of water, some suburbs of Sydney were also flooded. Weather described as wettest for 15 years, in Sydney 108mm of rain fell in 24 hours ending dawn on April 2nd; five

people feared drowned, two in Queensland and three in New South Wales in the floods; it was reported on the 12th that a lake, 113km long and 4.8km wide, had formed on a usually dry tributary of the Murrumbidgee river in New South Wales. *L.L., Daily Telegraph.*

3: Captain of F.v., the *Batela,* swept overboard during storm in the Gulf of Gascogne, some 70 nautical miles off coast of northern Spain, near to French border, and drowned, 12 other crew members rescued. *L.L.*

4-5: Gales, sleet and snow in many areas of Great Britain, worst of gales in south east England, East Anglia and south Wales, on the 5th up to 125mm of snow fell in southern England, a number of roads in the Pennines blocked in north Derbyshire. Two dead in road accidents attributed to weather. *D.T.*

4-5: Cyclone, "Aivu" hit eastern Queensland, Australia, with winds up to 200km/h and torrential rains, one person killed, 'dozens' of others injured, 250 homes destroyed or severely damaged, damage to sugar cane crop put at $A6 million, whilst farm building losses put at another $A20 million; cyclone described as worst in area for 20 years. *L.L.*

4-18: Torrential rains and floods in Tanzania, rail and road links cut, bridges swept away, crops damaged and thousands of people made homeless, no casualties reported. *L.L.*

4(reported): Three-month drought in areas of Brazil, rice crop ruined and cattle killed. *L.L.*

5-12: Floods in eastern Iran swept away 250 villages in province of Sistan – Baluchestan as the river Hirmand, filled with flood waters from Afghanistan, burst its banks, flooding 20,000 hectares of farmland; damage put at 10 billion rials, no casualties reported in the floods, described as worst in area for several decades. *L.L.*

6-9: Heavy rains and floods in Djibouti, Africa, left eight people dead and 20,000 others homeless, the floods affected 150,000 people, floods up to one metre deep in places. Some 70% of capital, Djibouti, flooded, worst of floods along the Ambouli river, many animals from nomad herds drowned. *L.L.*

7: Up to 305mm of snow fell in parts of North Carolina, U.S.A. *I.H.T.*

7-9: Heavy rains and floods in Argentina, about 2,000 people evacuated from their homes in low-lying areas of Buenos Aires where more than 178mm of rain fell in less than 24 hours; the rains and floods caused power failures which affected hundreds of thousands of consumers; four deaths reported, including two who died when they were electrocuted when they touched power line brought down by storm at Rosairo, 306km north of Buenos Aire. *L.L.*

8-13: Torrential rains, floods and landslides in various parts of Brazil, the north-east state of Paraiba being the worst hit, where at least 28 people died with nearly 5,000 others made homeless, heavy rains and floods on the 11th left four dead in a mudslide in Recife, one person died in Sao Paulo when swept away by floods, heavy rains and winds destroyed 14 houses and uprooted trees in Rio de Janeiro. *L.L., D.T.*

10: M.v. *Deval* sank after collision with m.v. *Selin* in dense fog in the Adriatic Sea just off the Yugoslavian coast, near Palagruza island, leaving 14 crewmen missing. *L.L.*

10-11: Cyclone "Lili" hit New Caledonia islands, south Pacific, with winds up to 150km/h and heavy rains which uprooted trees, tore off roofs and flooded roads, no deaths reported, the east coast of the archipelago worst hit, along with the Loyalty Islands, Ouvea, Lifou and Mare. *L.L.*

10-17: Gales in Atlantic Ocean and on the 17th the m.v. *Star of Alexandria* capsized and sank in 64km/h winds and three metre high seas some 644km south east of Cape Cod, Massachusetts, U.S.A., leaving two missing, 23 other crewmen rescued. *L.L.*

11: Gales in many areas of Great Britain, winds gusted to 158km/h in Milford Haven, Wales, while gusts reached 129km/h at Swansea and Aberporth, also in Wales, in west Wales trees uprooted and tiles taken off roofs. Thousands of homes in south-west and mid Wales, Devon and Cornwall were without power as trees felled by winds, brought down power lines. Two people injured in Wales. A disused rail shed at Duddeston, Birmingham, collapsed during strong winds, no casualties. *L.L., D.T.*

12-13: Torrential rains and floods in northern Somalia, a large number of deaths reported along with material damages in northern coastal towns. *L.L.*

13-14: Snow in Swiss Alps, 400mm fell in canton of Wallis, hundreds of skiers stranded in mountain huts throughout the Alps, including Italian Alps, in Roma eight hours of rain and hail reported. *D.T., I.H.T.*

15: Landslide after heavy rains buried a house in Mandalo, north Sulawesi, Indonesia, leaving five dead and five others seriously injured. *Jakarta Post.*

15: M.v. *Super Star* sank in storm between islands of Ambon and Seram, Maluku, Indonesia, some 80 people unnacounted for, 62 other people rescued. *J.P.*

17-18: Floods in Uzbekistan S.S.R., over 2,000 people evacuated from houses when the rivers Mailisai, Tenktasai and Chirtaksai burst their banks, no loss of life reported, more than 300 homes destroyed and another 300 damaged, cotton fields, orchards and vineyards inundated in the Osh district. *L.L.*

19: Storm hit north-eastern Bangladesh, leaving three dead, 100 injured. At least 15,000 acres of crops destroyed by hail which followed blinding dust storm, hundreds of huts destroyed, trees uprooted and power supplies disrupted. The storm, with 97km/h winds, hit districts of Sylhet and Sunamgary, some of hailstones weighed 2lbs (1kg), it is possible that some of the casualties were caused by the hail. *L.L.*

19(reported): Drought fears re-emerging in some areas of U.S.A., the areas worst hit by lack of rain being eastern Nebraska, Iowa, north-western Illinois, southern Minnesota and Wisconsin. *L.L.*

20: Floods, avalanches and mudslides in the Adjarian region of the Georgian

S.S.R., at least 52 deaths reported, nearly 3000 residents evacuated, more than 500 homes destroyed or badly damaged near the village of Tsablana, where a bus carrying more than 20 people caught in flood, no survivors found. One landslide formed a 100 metre high dam across the Chorokh river, causing flooding. *L.L.*

20: Severe hailstorm, with hailstones weighing up to 8ozs (220g) hit 10 cities and districts in Sichuan province, south-west China, leaving at least 87 dead, 4200 injured and thousands of homes destroyed. The storm hit before dawn and lasted for five hours, the storm moved forward at a speed of about 28 metres per second. *L.L., Birmingham Evening Mail.*

20-24: Cyclone "Orson" in the Timor Sea where at least two fishing vessels sank, another 20 or so fishing vessels aground on and around Ashmore and Scott Reefs, north-west of Broome, Western Australia, on the 20th/21st, on the 23rd cyclone "Orson" hit the Western Australian coast, winds up to 200km/h hit port of Dampier, town of Pannawonica and Dampier worst hit, the storm hit coast 40km west of Karratha, some 80% of homes in Pannawonica damaged including over a dozen homes unroofed, other towns suffered less serious damage. Earlier, gusts of 300km/h and seas up to 30 metres high were recorded as the cyclone moved near to the North Rankin A gas platform. *L.L.*

20(reported): Rains destroyed crops in central and southern Zambia, more than one million people in fear of famine. *B.E.M.*

21(reported): Floods in province of Bengo, northern Angola, 40,000 people fled from homes. *I.H.T.*

22: Violent storms in Prince William Sound, Alaska, U.S.A., whipped up two metre high swells. *L.L.*

24(reported): Two-month drought in Bangladesh, rice crop damaged, seven deaths reported from sunstroke, water borne epidemics have left at least 273 dead. *L.L., D.T., I.H.T.*

25: Heavy rains collapsed walls of mines in Burundi, central Africa, at least 100 miners reported dead. *B.E.M.*

26: Tornado, with winds up to 169km/h, hit Manikgary district of Bangladesh, leaving at least 1100 dead, 10,000 injured, the tornado was 13km long and 1.6km wide and hit 50 villages, the tornado then lifted and moved for about 32km before touching down again in the Bhuapur district where it caused severe damage and some injuries in about 20 villages, about 100,000 people made homeless. Storms associated with the tornado capsized a ferry boat near Cox's Bazaar, leaving some 200 people dead. The tornado destroyed some 80,000 houses. *L.L., I.H.T.*

28-30: Continuing storms in Bangladesh, in the southern districts of Chittagong, Khulna and Rajbari eight villages destroyed, on the 29th nearly 20 boats sank on the Jamuna river with 40 fishermen on board. *L.L.*

28: Lightning hit bell tower in Urbana, Illinois, U.S.A., leaving one person dead. *Sunday Telegraph.*

30: Tornado near missile site in eastern India left 10 people dead. *D.T.*

30: Storms in Pacific Ocean to east of Japan, a number of ships in difficulty, 10 of 26 crew of m.v. *Yacu Maru* abandoned ship in a life raft which capsized, throwing all into the water, four saved, two others died and the other four missing, the vessel ran into difficulties some 925km east of Kinkassan, Honstu, Japan, in 73km/h winds and 10 metre high waves. *L.L.*

ALBERT J. THOMAS

LITERATURE REVIEWS AND LISTINGS

Book Reviews

THE ATMOSPHERE: AN INTRODUCTION TO METEOROLOGY. By Frederick K. Lutgens and Edward J. Tarbuck. Fourth Edition, Prentice Hall 1989, 491pp., £42.80.

A particularly difficult challenge for aspiring authors is that of writing a good introductory text to a major branch of science. In undertaking such a challenge, the authors of the present book have on balance emerged successful. The "special attention" they have paid "to the quality of the artwork and photographs" undoubtedly provides the book with one of its strongest and most attractive features. Of the numerous photographs, diagrams and maps, a good proportion is in full colour, which usually means an improved appearance and greater clarity. Furthermore, the authors have a pleasant written style and include several devices for assisting readers' understanding of the text (boldface type for keywords, both within the text and at its margins; a vocabulary review and set of review questions at the end of each chapter; a glossary of 21 pages at the end of the book; and an attempt to keep the individual sections of each chapter fairly short). As the book has been written "for an introductory audience", it is both "non-technical and non-mathematical".

Added to these virtues there are, however, a number of shortcomings. Thus, related topics are sometimes widely dispersed throughout the book (e.g. data on instruments for recording weather). Equally, the positioning of certain subjects within the text is rather curious (e.g. discussion of the ozone problem as early as page 7-10). Thirdly, the emphasis given to some topics is questionable. For example, there is, unusually for this sort of book, a fascinating chapter on atmospheric optical phenomena. One must nevertheless ask whether its 20 pages could not have been better used for discussing more important topics, like the nature and impact of climatic change during historical times, snow and associated phenomena or the various facets of microclimatology.

On balance, this is a nice introduction to atmospheric studies, which should find a place in many libraries where it will probably be well used. Its price is, however, likely to exclude it from the collection of most individuals, at least in the UK.

LOST LANDS AND SUNKEN CITIES. By Nigel Pennick. Fortean Tomes, 1 Shoebury Road, East Ham, London E6 2AQ, 176pp., £8.50 (paperback), £12.95 (hardback).

This is intended for an even wider readership than the previous book. It aims principally "to correct the lamentable ignorance about how the shape of Britain has changed within historical times". Despite this aim, the book's limits are poorly defined. For instance, the events mentioned in chapter 1 ('Coastal cataclysms') range throughout the world. Similarly, chapter 4 deals with the Atlantis legend, while chapter 14 (on Brittany) is longer than chapter 9 (on Scotland). Had the author restricted himself to Britain, he would have had space to provide a fuller account of coastal inundations around these islands. As it is, some interesting material has been omitted (e.g. there is no reference to the intriguing case of Skinburness on the Cumbrian coast, reputedly destroyed by the sea in 1304, while further details could easily have been found about events in and near Aldingham at the end of 1553). The book would also have gained from a more determined attempt to explain the processes and reasons behind coastal flooding and loss, rather than depending so heavily on straightforward recounting of historical events. The inclusion of many photographs of doubtful quality and the several illustrations of questionable value (e.g. on pages 39, 90, 100, etc.) also detract from the book's merits. Yet, this is an absorbing topic which makes a good read. Many people are therefore going to pick up this book out of sheer curiosity and will be fascinated by what they learn.

L. T.

THE CIRCLES EFFECT AND ITS MYSTERIES. By G. Terence Meaden. Artetech Publishing Co., Bradford-on-Avon, June 1989, 114pp., 45 photographs and other figures, 8 colour photographs on dust jacket. £9.95, U.S. $30.00.

Anyone who has had the pleasure of meeting Terence Meaden would be able to attest to his wholehearted dedication for a number of years to solving the mysteries of the crop circles. After several articles on the subject in such publications as the journal, and in *Weather* (Jan 89), Dr Meaden has now written this fascinating book in which he brings us up to date with his latest thinking on this intriguing subject.

No one can fail to be impressed and puzzled by the appearance of these circles, and the 114 pages of this interesting book are well peppered with 45 figures, 32 of which are photographs of the circles taken both from the air and ground. There is also a de-luxe dust jacket bearing eight colour photographs.

Chapter 1 of 7 introduces the reader to the circles mystery, with a brief history of the events which coloured Dr Meaden's thinking. The circles are described, and the possibility that they may be a hoax soundly discounted. The concept of the atmospheric vortex is introduced, and some of the puzzles which have appeared over the years, such as multi-ringed circles and outwardly-directed radial spurs, are reviewed.

Chapter 2 gives some examples of eye-witness evidence. I was particularly interested in this chapter, as I see this form of evidence as the most likely to be productive in leading towards the answer as to the causative agent, short of instrumental recordings, without which any solution is likely to remain theoretical. However, when deciding on the authenticity or relevance of a particular eye-witness account, it must be very difficult to separate the real from the imagined, and especially to isolate the tendency for the human brain to rationalize possibly unrelated events into a single event, if these events seem to have no rational explanation, in the experience of the observer, when considered on their own. In this chapter there are several eye-witness accounts of vortices, though only three relate directly to crop circles actually being formed. There is also an introduction to the optical and acoustic effects which may be related to atmospheric vortices.

In chapter 3 the author shows that topography seems to play an important part in the location of crop circles. In this context I am minded of some informative explanations on the formation of vortices and waves in the lower atmosphere related to quite modest slopes, when the lower atmosphere is stably stratified, which seems to be a common prerequisite for the crop circles vortices. These, and a comprehensive theoretical and mathematical treatment of the subject can be found in *Environmental Aerodynamics* by R. S. Scorer. My own experience as a meteorologist would support the view that night-time cooling can often lead to the establishment of very strong vertical wind shear in the lower layers of the atmosphere. This coupled with high static stability would create conditions favourable for the formation of waves over even modest hills. Tilting and bending of streamlines over irregularities in terrain or the interaction of some opposing flow such as a sea breeze or distant storm outflow, would be expected to result in vortex formation which could have its axis very far from the vertical.

Chapter 4 introduces the reader to the properties of electrically charged vortices, and points to possible links between the measured electric fields of dust devils and the observational evidence of some form of glow discharge associated with nocturnal vortices. The theory is further developed and the author introduces his concept of the plasma vortex. (The plasma in this context being a region of cold ionised gas, and, of course, not the type of hot plasma associated with nuclear fusion experiments). One observation cited, though, in which a self-luminous pipe was seen stretching from the ground up into the cloud base, is, to my mind, probably the least convincing of the visible manifestations which Dr Meaden links to nocturnal vortices. Living as I do near the flight path to Heathrow, I can only too well envisage just such a beam of light emanating from an aircraft, although in the case quoted in the book where the shaft of light was angled at about 45 degrees, and was presumably stationary, a helicopter would be a more likely candidate. Possibly, too, the beam could have been projected from the ground by the shining of a strong flashlight, perhaps of the type used by mountain rescue teams. Hopefully such run-of-the-hill explanations have been considered, but I would wish to be

further convinced before I could consider this observation as evidence of an electrified vortex channelling a charge from cloud to ground. I also have reservations about linking the type of glow envisaged by the author in relation to nocturnal vortices with those observed and photographed emanating from tornado columns, which are almost always beneath giant electrically-active clouds.

In chapter 5 the electrical-discharge theory is developed to explain the large number of observations of low level globular light forms. The author adopts a cautious approach, however, and stresses the need for more data, in particular a need for well-instrumented sitings, a sentiment with which I would wholly concur. Later in the chapter, problems posed by ringed systems are elucidated, and a possible solution which depends on charge-flow of opposite sign is presented. The plasma vortex hypothesis is also used to explain the appearance of satellite ring systems, some tri-symmetric and quadri-symmetric examples appear among the photographs in the book. The chapter concludes with discussion on further oddities, single rings not enclosing circles, incomplete circles, radial or star-burst patterns, and spurs.

Chapter 6 returns again to vortices and balls of light, and there are several fascinating eye-witness accounts of the latter, some producing other electro-magnetic effects. I was impressed by the similarity between the reported experiences of witnesses who had been close to the phenomenon. All the cases cited where there were additional physical effects would seem to strengthen the case for a link between the balls of light and the formation of crop circles, and lend weight to Dr Meaden's plasma vortex hypothesis.

In the final chapter, Dr Meaden discusses alternative explanations for the formation of crop circles put forward by various people in the past few years. In the space of some four pages, the author is able to show that these have been 'loosely-phrased suggestions and wild guesses'. My own view, after reading the book, is that the circles effect must have some physical explanation, and that most likely there is some hitherto unrecognised atmospheric phenomenon, which could quite possibly be of the plasma vortex type as envisaged by Dr Meaden. The chapter continues with a summary of the development of the author's ideas, and concludes with a look to the future, in which he stresses the need for more good visual descriptions of the circles being formed, backed up with photographic evidence. Personally, I feel that much might be learned by some simple field experiments, involving the release of smoke as an airflow tracer recorded on video, supported by other ground-based instrumentation, and possibly mini-sonde ascents, to measure the standard variables plus electro-magnetic effects. This is possibly a project suitable for academic research.

In conclusion, a very interesting book on a subject near the frontiers of atmospheric science, an exciting topic. One is left with the feeling that some vital discovery may be just around the corner.

B. J. BURTON

Note added by editor: This book has been translated into Japanese by Dr. Y. H. Ohtsuki, Professor of Physics at Waseda University, Tokyo. It will be published in Tokyo by the Maruzen Book Company in April 1990.

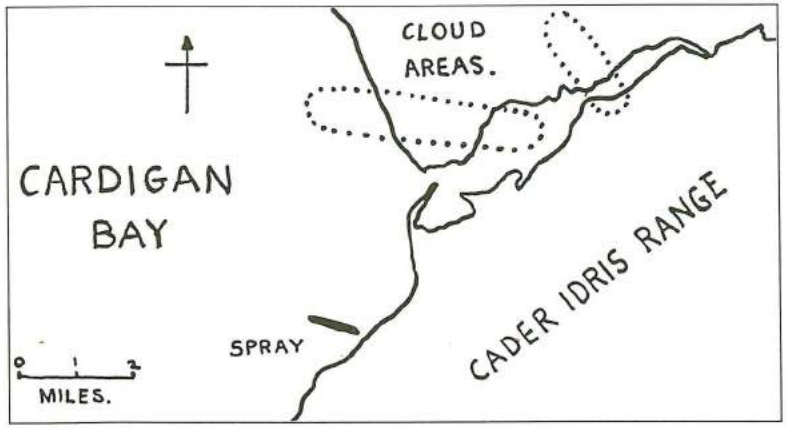
A second English edition is also in preparation, to be published by Artetech in Spring 1990. The book has been re-set and includes additions and minor amendments which take account of progress made in 1989. The page size has been increased by 20mm, the type face is bigger, and there is a new dust jacket, 116pp., ISBN 0 9510590 3 3, £11.95.

LETTERS TO THE EDITOR

LEE TURBULENCE BEHIND CADER IDRIS, WEST WALES

When an easterly wind blows around the flank of an anticyclone during the winter months, dramatic effects appear in the lee of the Cader Idris range, where the land drops from the ridge at over 2000 feet (over 620 metres altitude) to sea-level along the parallel estuary of the river Mawddach.

Conditions on 16 November 1989 provided a good example, with a strong ESE wind blowing at low level, while the cirro-stratus top cover hardly moved. The only low cloud locally was created by the rotor turbulence about three kilometres up the estuary, forming a street of extremely turbulent clouds at a height of 2000 to 3000 feet (600 to 900 metres). A new cloud formed every few minutes and drifted downwind while swirling in all directions and decaying before or soon after crossing the coastline (Figure 1). Similar clouds formed a few kilometres further up the estuary, but travelled in a more northerly direction, and had a shorter life.



After watching these clouds for an hour during the afternoon, while I was returning home and discussing the cloud activity with acquaintances they pointed out another remarkable phenomenon. At the base of steep cliffs on the coast near Llwyngwril (Figure 1) the surface of the sea, which had no more than a slight general swell, was affected by a very localised violent wind which whipped up spray to a height of perhaps 30 metres. The area involved appeared to be only 10 to 20 metres wide (as judged using binoculars at a distance of five kilometres) and stretched to

about one and a half kilometres out to sea. Most of the turbulence was random, but occasional vortices were noticed; each built up every half minute either at the coast or a little way from it and generally lasted 20 to 30 seconds. There is no significant topographical variation of the cliff face for half a mile or more on both sides of the origin of the disturbance.

Without yet knowing the details of the unfortunate fatal accident to a microlight aircraft near Porthmadog on the same day, one is tempted to blame these turbulent conditions. The location of this accident is about 25 kilometres north of here, and seven or eight kilometres to the lee of the Rhinog massif.

Y Wern, Bryn Mynach Road, Barmouth, Gwynedd, Wales R. D. M. HARPER

FLOODS AND GALES IN IRELAND 26-28 OCTOBER 1989

The three days before the Irish bank holiday weekend brought severe weather to Ireland. Water deficits which had accumulated because of the dry summer were quickly replenished in southern Ireland and exceeded three or fourfold in the west of the country, especially County Mayo.

On 25th a cold frontal wave crossed midland and southern Ireland and introduced a cold upper trough the next day with a slack surface ridge. In the south extensive tufted cirrus and cirrostratus were indicative of the cold air aloft. Towards 1800 Z on 26th, when observing from my south County Limerick station, I noticed that altostratus was thickening and lowering especially to the south over County Cork. There were already 6/8 altostratus with extensive undercloud mamma, and the force 2 easterly which had displaced the earlier calm was gaining strength in response to a sharpening warm front invading from the N.N.W. Rain was falling heavily over much of southern Ireland by 2400 Z and western and north-western Ireland had had several hours heavy rain by dawn. By 0900 many areas had received between 18 and 30mm. My own total of 26.8mm by 0900 was the highest of 1989 to date.

By this time the warm front was north-west of my station and was lying from the Shannon estuary to Drogheda with the heaviest rain on its N.W. flank. Radar echos showed that the heaviest rain was then over Counties Galway, East Mayo, Sligo and Donegal in Eire and Counties Fermanagh, Tyrone, Londonderry, and North Antrim in Northern Ireland. As the front remained almost stationary in this position throughout 27th and 28th the heavy prolonged rain continued. County Mayo and the north-west of Eire in particular saw intense falls. Straide (Co. Mayo) had 94.7mm in the 24 hour period to 0900 Z on 28th, and Belmullet 67.5mm. At Straide 139.9mm fell in 44 hours of more or less continuous rain, while Belmullet had 129mm in a similar period. 91mm was measured at Claremorris, 68mm at Malin Head, and 53mm at my station. Little thunderstorm activity was reported. I only know of a short-lived thunderstorm at Westport during 27th.

The rivers quickly rose to severe flood level. Floodwaters two to three metres deep surged through homes in Crossmouna. Hundreds of sheep in County Mayo and along the River Clare basin in east County Galway were drowned. The heavy rain continued overnight into 28th in the west and spread again into much of Ireland but this time with gales. The low-pressure centre which came northwards from west of Iberia on 26th and was south-west of Valentia on 27th had deepened significantly and on 28th was crossing Ireland with force 8-10 winds blowing across the south. Shannon and Cork airports were closed for a time. Trees, power lines and telephone lines came down. Near Dingle, County Kerry, a tragedy was averted by the quick action of a mother who rushed her six children to safety after a high-voltage line was blown from a pylon on to the roof of her house which was ignited and rapidly destroyed. By late on the 28th the worst of the weather was over, and power supplies were restored to most areas over the weekend. The worst flooding in County Mayo's living memory entered the annals of Irish weather history having cost over a million pounds in damage and losses.

The author wishes to thank Mr Martin Sweeney and the Irish Meteorological Service for information quoted in this letter.

Mount Russell, Ardpatrick, Kilmallock, Co. Limerick, Ireland. DAVID MESKILL

MY FRIEND-THE FLAKE!!!

My friend:
Is a devotee of the tempests –
Of all kinds, but especially those frozen;
Those which swirl flakes are best!
He's happy with one, but ecstatic with a dozen!
And though a flurry, his attention peaks,
His smile broadens with the fall of even more
Of those lacy, pristine crystals he seeks,
As he anticipates the blizzard yet in store!
It matters not whether he gets caught in a drift,
He'll shrug off frostbite and not at all care,
While red-faced suburbanites, shovel-loads lift,
As white mounds accumulate into frosty Arctic air.
His eyes grow wide in enthused amazement,
As hoary feathers descend in muffling waves,
Quieting softness from opaque firmament,
These memories for summer he will save!
And when the frigid storm is through,
And as the birds fly out to their dinner, find,
Those melting flakes will leave his blue –
That there aren't millions more of their kind.
Some may think him just a bit crazy,
Absurd, overwhelming – definitely not lazy!
Yet I – I think similar thoughts through spring –
This storm's gone, when will winds, the next one bring?

DANA MACK

New Products:

(1) INFRA-RED DEVICE FROM BIRAL WHICH DETECTS THE PRESENCE OF FOG OR LOW CLOUD

It was an identified need to activate sensor packages in foggy conditions, that led to the development of the Fog Sentinel by Associated Weather Services in the USA. This is an infra-red device which detects the presence of fog or low cloud and is a low cost optical instrument which works by detecting light forward-scattered by small droplets.

The Fog Sentinel has an adjustable detection threshold for different sized droplets and is designed as a controller for fog/cloud water collectors, and in warning signs for land, sea and air transportation. It is especially engineered for use in remote and rugged environments and has an optional fog-hours totalizer for continuous monitoring.

Further information on the Fog Sentinel is available from: Bristol Industrial and Research Associates Limited (BIRAL), PO Box 2, Portishead, Bristol, BS20 9JB. Tel: 0272 847787, Fax: 0272 847303.

(2) VENTUREPRISE DUAL-CHART WIND-SPEED AND DIRECTION PRINTER

Ventureprise announce the launch of a totally new concept in environmental air pollution monitoring.

This instrument, the 400D-P is a dual, chart-recording, wind-speed and direction analyser ideally suited to the measurement of airborne pollutants. It is supplied complete with lightweight yet robust wind speed and direction sensor combined as one unit for ease of installation. It will mount via two "U" bolts to a 25mm aluminium mast. The instrument can be mains or battery operated via a suitable inverter and will record the wind functions on a 24 hour basis. This information is stored on an inkless paper roll which will last for one month.

There are already a number of local authorities using this system to track airborne pollution and they are finding this equipment invaluable in monitoring spillage or indeed regulating the emission of pollutants. Environmental Officers with companies where pollution has traditionally been a problem have also used this equipment to show that certain complaints are unjustified as the wind has been shown to be in a totally different direction that day.

The 400D-P is available from VENTUREPRISE LTD., Kensington Court, Kensington Road, Coventry CV5 6GG. For further information contact: Peter Ritchings. (0203) 714160.

WORLD WEATHER REVIEW: June 1989

United States. *Temperature:* warm in E. coast states; from Pacific to W. Montana and W. New Mexico; extreme S. Texas, Hawaii; +2degC in C. Arizona and N.W. Nevada. Cold elsewhere; -3degC from S.W. Kansas to extreme N. Texas. *Rainfall:* second wettest June since 1895; only about half the country above average but much of this area over 200% (E. Colorado through E. Texas to N.W. Florida and western Virginia). Over 400% locally from extreme E. Texas to Alabama (Baton Rouge 589mm, normal 79mm). Hawaii also mostly wet, but Honolulu only 20%. Dry from Pacific to S.W. Texas, W. New Mexico, N. Nebraska and most of Michigan and Indiana (under 50% widespread); S.E. Florida (under 50% on E. coast).

Canada and Arctic. *Temperature:* mostly warm; +2degC in Mackenzie basin, S. Labrador. Cold in S. Quebec, Greenland (except N.), Franz Josef Land, parts of Iceland; -2degC in S.W. Greenland. *Rainfall:* wet in Alaska, coastal British Columbia, S. British Columbia to S.W. Manitoba; E. Quebec to Canadian Arctic islands and W. Greenland. Over 200% locally in W. and S. Alaska, Ellesmere Island. Dry in much of E. and N. Canada and Canadian Rockies; E. Greenland, Iceland, Spitzbergen. Under 50% in all these areas (except perhaps last), especially E. Canada.

South and Central America. *Temperature:* mostly warm in South America 15-40°S.; Mexico to Honduras; Bermuda, Bahamas, West Indies; +2degC in W. Argentina, N. Bolivia, Bermuda; locally in N.E. Mexico. Cold from C. Uruguay to C. Paraguay and S. Brazil; -1degC fairly widely. *Rainfall:* wet in C. Chile, N.E. Argentina, C. Mexico, S. Guatemala; much of Paraguay; parts of E. Bolivia. S. Brazil mixed. Over 200% in N.E. Argentina, C. Mexico; locally in S. Bolivia, S. Paraguay and E. Coastal Brazil. Dry in N. Chile, W. Bolivia, C. and N.W. Argentina, Uruguay, most of Mexico to Honduras; Bermuda, Bahamas, West Indies. Under 50% widely in all these areas.

Europe. *Temperature:* mostly warm; +2degC in most of Finland and European Russia; locally in N.W. Spain; +5degC in N.E. European Russia. Cold from E. France to Balkans, Poland and W. Ukraine; Faeroes; -2degC from S. Poland to S. Jugoslavia and parts of E. Italy; S. Greece, Crete. *Rainfall:* wet from N.E. Sweden to Kola Peninsula; most of Italy and Balkans to E. Poland and Moscow area; Faeroes, S.W. Norway; parts of E. Spain and N. and E. England. Over 200% in E.

Italy, S.W. European Russia; locally in E. Poland, E. Hungary, N.W. Romania, C. and S. Jugoslavia, N. Greece; very locally in E. Spain. Dry elsewhere; under 50% in much of Portugal, Spain and France; S.W. and E. Germany, W. Poland, W. Switzerland, extreme N.W. Italy, Corsica, Sardinia, S. Greece, Crete, W. Sweden, S. Finland; parts of N.E. European Russia, S. Romania and S. England. Provisional sunspot number 196.

Africa. *Temperature:* warm in Madeira, Canary Islands, Morocco; Natal through Transvaal into Botswana; +2degC in N. Transvaal. Cold in much of Algeria and Tunisia; Cape Province into Namibia (all -1degC). *Rainfall:* wet in interior Morocco, interior N. Algeria, in and around Transvaal (all over 200%). Dry in Canary Islands, coastal Morocco; most of Algeria and Tunisia; most of Cape Province into Namibia. Under 50% widely in all these areas.

Asian U.S.S.R. *Temperature:* warm from W. Turkmenistan to lower Ob basin and in N.E.; +3degC in N.E.; +5degC in N. Urals. Cold elsewhere; -5degC on C. Siberian Plateau. *Rainfall:* wet in E. Tadzhikistan; Yenisey Gulf and Lena basin to upper Amur basin; N. of Kamchatka; parts of upper Ob basin. Over 200% in E. Tadzhikistan; round Yenisey Gulf and Lena estuary; upper Lena basin to upper Amur basin. Dry elsewhere; under 50% in Ob basin, Taimyr Peninsula and much of N.E.

Asia (excluding U.S.S.R.). *Temperature:* warm in interior Turkey, N. Arabia, S. China, Malaya, Sumatra, Sarawak (all +1degC). Cold in N. and S. Turkey, Cyprus, Israel, S. Arabia, Pakistan, India, N. China, Mongolia, Japan (all -1degC except perhaps S. Arabia). Near normal in Korea, Thailand, Philippines. *Rainfall:* wet in parts of N. Pakistan, C. India and N. and E. Japan; S. Korea, E. Philippines; much of China. Over 200% in parts of S. China. Dry from most of Turkey through Middle East to most of Pakistan, India and Bangladesh; extreme S. and locally in N. China; N. Korea, W. Philippines; most of Japan. Under 50% at least locally in all these areas except possibly Bangladesh and N. Korea. Middle East largely rainless. Thailand, Malaya and Borneo mixed, with few large anomalies.

Australia. *Temperature:* cold except parts of N.W. (+2degC on coast); -2degC in C. area. *Rainfall:* wet in much of E. and S., extreme N. and part of W; over 200% in extreme N., in N.E. New South Wales and in part of W. Dry elsewhere; under 50% in C. and N.; also locally near Brisbane and Perth.

M. W. R.

WEATHER SUMMARY: September 1989

The long months with above average mean temperatures continued in September with main values over southern Britain more than one degree Celsius above average quite generally and approaching two degrees in parts of the south-east. Northern Britain saw values very close to the September normal. On 7th temperatures rose to 27.2° at Benson (Oxfordshire) and Reigate (Surrey) and on 21st St. Helier (Jersey) reached the same value. In Scotland 23° was recorded on the Moray Firth on 18th and 21°C was reached in the same area on 20th. The 17th was generally the warmest night of the month over England and Wales with minima of 18.1° at the London Weather Centre, 18° at Folkestone (Kent), 17.5° at Hurn Airport, Bournemouth and 17.4° at Guildford. On 25th Inverdruie (Highland) reported 13.9°C. Lerwick (Shetland) was credited with the month's lowest maximum, 10.0° on 30th, elsewhere 12.0° was recorded at Belfast on 22nd and on 14th 13.8° was recorded at Birmingham and 11.5° at Inverdruie. Chilly nights were relatively

infrequent and air frosts were restricted to the usual frost-prone locations. At Aviemore and Inverdruie (Highland) –3.1° was recorded on 11th and –2.0° was reached at St. Harmon (Powys) on 3rd and Tummel Bridge (Tayside) on 10th. Over England 2.1° was recorded at Hurn Airport on 3rd and 1.0°C at Bastreet (Cornwall) on 4th. On the grass –8.2° was recorded at Inverdruie and –6.6° at Aviemore on 11th and on 1st –3.0° was recorded at South Farnborough. September was yet another month with below normal rainfall and following the pattern of recent months, some stations were affected by heavy, locally thundery, rain around mid-month, especially in the parched south-western counties, and the average was reached or exceeded in these parts. Many parts of central and southern Britain registered less than 50 percent of the normal and some spots received less than 15 percent. Highest daily totals included 61.6mm at Culdrose (Cornwall), 58.2mm at Bastreet (Cornwall) and 41.6mm at Ilfracombe (Devon), all on 14th, 57.0mm at Bexley (Kent) on 12th, 52mm at Kettering (Northamptonshire) on 16th and 51.6mm at Eskdalemuir (Dumfries and Galloway) on 20th. Central parts of England reported sunshine totals slightly in excess of the normal, as did north-eastern parts of Scotland, but elsewhere totals were in the region of five to ten percent down on the average.

With an anticyclone to the south-west of the U.K. many places were dry during the opening days of the month with spells of sunshine. Frontal systems crossed all parts from time-to-time giving northern areas some rain at times but with the fronts weakening as they moved south-east across the country southern counties saw little if any rain. As the anticyclone ridged north-eastwards towards Scandinavia a north-easterly flow extended northwards across Britain from 7th and after some very warm weather cooler, cloudier conditions spread to most parts on 9th and 10th. Late on 10th there was some thunder in east Kent and between 11th and 13th thundery weather affected many parts of England but by end of 13th a cold front had spread fresher conditions to all parts of the country. A frontal wave tracked across southern counties of England on 14th accompanied by rain which was particularly heavy in the south-west, and on 15th an intense low moving north-east between Scotland and Iceland gave the north-west a stormy day and most parts of Britain had further rain. On 16th a slow-moving front over southern England produced further heavy rain in places and it was end of 18th before this front finally cleared the south-east. The 19th and 20th were windy days but pressure was already rising to the south-east and south-eastern Britain became dry, sunny and warm for a time. As a depression moved north across the U.K. the 22nd was a rainy day with thunderstorms in places and further heavy showers affected some southern counties on 23rd. With high pressure covering southern Britain the south became generally dry during the last week of the month, apart from a little rain as weak frontal systems crossed the country on 27th and from 28th to 30th a large anticyclone settled down to the west of Ireland and all parts became dry with spells of sunshine.

K. O. M.

TEMPERATURE AND RAINFALL: SEPTEMBER 1989

	Mean				*Grass*					
	Max	*Min*	*Max*	*Min*	*Min*	*Rain*	*%*	*Wettest*	*RD*	*Th*
BELGIUM: Uccle	20.1	11.8	27.3(18)	6.6(4)	1.0(4)	62.7	90	15.5(12)	11	–
„ Rochefort	20.0	7.8	27.2(18)	1.6(5)		96.9	137	23.8(12)	14	–
„ Houwaart	22.3	8.6	29.0(18)	1.6(4)	–0.8(4)	44.2	67	14.6(19)	13	3
DENMARK: Fanø	18.1	11.8	25.2(22)	5.5(26)		47.6	60	12.6(13)	10	0
„ Frederikssund	18.8	10.4	24.5(19)	5.7(27)	1.9(13)	40.0	72	13.0(18)	12	1
GERMANY: Berlin	21.3	11.6	28.3(19)	6.6(27)	4.9(30)	9.5	21	3.0(26)	5	1
„ Hamburg	19.8	10.8	26.7(18)	4.5(27)	0.6(3)	26.9	40	19.2(13)	9	2
„ Frankfurt	21.2	10.8	28.4(18)	2.5(28)	1.1(28)	28.9	57	10.3(14)	8	2
„ Munchen	18.4	9.3	27.5(19)	4.4(7)	0.1(1)	115.6	160	22.7(3)	14	3
ITALY: Casalecchio	22.0	13.9	27.0(18)	9.0(5)	7.0(5)	170.9	335	85.0(2)	9	3
MALTA: Luqa	28.5	20.8	31.9(12)	17.2(18)	12.9(21)	37.1		21.0(23)	5	1
NETH'NDS: Ten Post	19.6	11.6	26.6(18)	8.2(v)	3.1(27)	48.9	69	11.6(14)	14	1
SWEDEN: Valla	17.1	7.7	23.3(19)	–0.5(11)	–3.2(11)	20.0		4.2(9)	11	1
SWITZ'LAND: Basel	21.2	10.3	30.1(18)	2.4(30)		62.3	78	14.4(13)	10	6
EIRE: Straide	16.0	8.5	19.3(24)	1.5(11)	–3.8(11)	56.1	54	21.8(19)	17	0
SHET'AND: Whalsay	12.9	8.4	15.0(21)	3.1(26)	–2.7(10)	73.1	60	10.8(20)	21	0
„ Fair Isle	12.4	9.6	15.1(24)	5.3(26)	–2.0(11)	66.3	67	19.1(24)	23	0
SCOT'AND: Braemar	14.6	6.2	19.4(30)	–0.4(26)	–1.7(26)	69.0	85	22.2(22)	18	0
„ Inverdruie	15.4	5.5	20.0(18)	–3.1(11)	–8.2(11)	57.1	74	40.5(22)	15	0
„ Rannoch	14.3	4.6	17.8(18)	1.7(11)	1.8(11)	100.3		43.6(20)	19	0
WALES: Pembroke	18.5	10.4	21.9(6)	6.2(3)	2.2(3)	68.1	61	31.2(14)	12	0
„ Velindre	18.0	8.8	23.1(6)	2.2(3)	–2.1(3)	51.3	63	32.2(16)	12	0
„ Carmarthen	17.6	10.0	21.5(7)	4.1(3)	0.9(3)	67.3	54	20.2(14)	15	3
„ Gower	18.1	11.2	22.1(7)	7.3(3)	2.1(14)	73.5	65	35.5(14)	10	1
GUERNSEY: Airport	19.2	13.5	24.0(21)	10.9(4)		30.2		15.1(14)	10	1
ENGLAND:										
Denbury, *Devon*	19.0	10.7	24.0(6)	6.2(4)	–1.8(3)	100.5	125	38.4(11)	11	2
Gurney Slade, *Somerset*	18.7	9.1	26.0(7)	2.0(29)	1.5(29)	74.5	103	35.9(14)	9	0
Yatton, *Avon*	19.9	10.9	25.2(21)	3.5(29)	1.8(29)	45.6	55	21.5(16)	8	1
Corsham, *Wiltshire*	19.6	11.1	25.9(7)	4.9(29)	0.7(29)	69.7	98	29.1(12)	9	2
Mortimer, *Berkshire*	19.9	11.1	26.8(7)	5.5(29)	5.5(29)	29.8	48	10.4(12)	10	1
Reading Univ., *Berks*	19.3	11.3	26.1(7)	6.0(3)	–2.0(3)	42.5	78	22.2(12)	8	2
Sandhurst, *Berkshire*	20.3	9.8	26.7(7)	2.8(3)	–0.5(3)	16.2	31	6.4(14)	9	2
Romsey, *Hampshire*	20.7	10.2	27.0(7)	3.3(3)	–2.0(3)	26.4		15.3(14)	7	2
Horsham, *Sussex*	20.4	11.3	27.0(6)	5.8(25)	1.5(3)	23.0	33	10.6(14)	9	3
Brighton, *Sussex*	19.6	12.4	24.2(8)	7.3(29)	5.8(3)	45.2	73	15.7(4)	13	4
Dover, *Kent*	20.0	11.9	24.5(21)	6.2(4)		76.6	128	30.6(9)	11	5
East Malling, *Kent*	20.1	11.6	25.8(7)	7.5(5)	1.3(29)	44.9	75	22.5(12)	10	2
Epsom Downs, *Surrey*	20.1	10.8	26.7(7)	2.0(3)	–0.5(3)	14.5	29	7.4(14)	8	0
Reigate, *Surrey*	20.6	11.1	27.2(7)	5.6(3)	4.7(3)	25.1	38	11.2(14)	10	3
Guildford, *Surrey*	20.2	12.0	26.9(7)	6.1(3)	2.5(3)	39.1	59	23.3(12)	7	1
Sidcup, *London*	20.6	12.4	26.9(7)	8.0(3)	4.9(29)	48.9	79	35.7(12)	9	3
Hayes, *London*	20.3	11.5	26.6(7)	5.5(3)	3.4(3)	13.3	27	3.5(14)	9	1
Hampstead, *London*	19.9	12.5	25.6(7)	7.2(3)	2.0(3)	10.5	16	3.0(14)	10	1
Royston, *Hertfordshire*	19.9	12.3	26.0(7)	6.1(3)	2.0(29)	22.4	43	6.0(11)	10	1
Loughton, *Essex*	20.3	11.7	25.8(21)	7.2(3)	3.8(3)	17.9	40	9.8(12)	9	2
Buxton, *Norfolk*	19.1	11.1	26.6(6)	6.0(25)	5.2(29)	33.6	65	12.0(16)	13	1
Ely, *Cambridgeshire*	19.8	10.1	26.5(7)	4.2(29)	3.1(29)	34.8	81	16.7(16)	9	0
Luton, *Bedfordshire*	19.4	11.5	27.1(7)	4.1(29)	–1.6(3)	19.2	32	5.1(13)	10	1
Buckingham, *Buck'shire*	19.7	10.4	27.3(7)	3.2(3)	–2.5(3)	34.1	59	17.9(16)	9	2
Oxford University	20.1	11.9	26.2(7)	6.0(29)	–0.3(29)	23.8	39	9.6(16)	8	–
Stourbridge, *W.Midla'ds*	18.4	10.3	23.5(6)	6.0(29)	–0.2(3)	37.4	61	24.3(16)	12	0
Birmingham Univ'sity	18.6	9.9	24.8(6)	4.5(3)	–1.1(3)	36.8	54	20.7(16)	13	0
Wolverhampton	18.5	10.4	25.1(6)	5.9(3)	1.6(3)	35.4		18.4(16)	12	0

	Mean Max	Mean Min	Max	Min	Grass Min	Rain	%	Wettest	RD	Th
Kettering, *Northants*	19.6	10.3	26.1(7)	1.8(3)	−1.1(3)	58.6		52.0(16)	9	1
Louth, *Lincolnshire*	19.1	10.8	26.0(6)	7.3(29)		28.2		14.9(16)	10	1
Keyworth, *Nott'shire*	19.2	10.7	25.2(21)	4.3(3)	−1.5(3)	28.8		19.8(16)	9	2
Nottingham *Nott'shire*	19.7	10.4	26.5(21)	5.0(3)	2.6(3)	26.1		18.0(16)	9	1
Derby, *Derbyshire*	19.0	11.1	25.0(21)	5.1(3)	4.0(3)	31.1	54	16.1(16)	10	1
Middleton, *Derbyshire*	16.5	9.7	21.5(21)	6.4(3)		31.6	42	15.1(16)	13	0
Keele University, *Staffs*	17.1	10.0	22.7(21)	6.5(30)	−1.3(23)	31.9	42	13.5(16)	10	0
Liverpool, *Merseyside*	18.3	10.5	22.8(18)	7.6(3)		21.0	27	7.0(16)	10	1
Lathom, *Merseyside*	17.0	10.9	21.6(21)	10.9(29)		13.7		3.8(16)	9	1
High Bradfield, *S.Yorks*	16.2	9.1	21.9(21)	4.8(3)						
Cottingham, *Humb'side*	19.6	10.9	25.3(21)	7.1(3)	3.2(3)	31.6	56	10.7(11)	9	0
Carlton-in-Cleveland	18.0	9.7	23.2(21)	3.5(3)	−0.2(26)	13.2		4.9(12)	7	1
Durham University	18.0	8.7	23.3(6)	1.8(26)	−0.5(26)	11.7	23	7.1(12)	11	–
Sunderland, *Tyne/Wear*	17.3	11.2	22.2(18)	6.3(26)		8.1	12	3.6(12)	6	0
U.S.: Bergenfield, *NJ*	24.9	14.1	35.0(10)	3.3(28)	0.6(28)	130.1		35.1(19)	13	1
JAMAICA: Kingston	33.0	25.5	34.4(5)	23.4(27)		59.1	55	10.6(2)	11	12
AUSTR'LIA: Leopold	17.5	7.4	27.2(29)	4.1(7)		64.4	119	13.4( )	13	0

CUMBRIA RAINFALL:

Carlisle, 16.0mm; Broadfield 13.1mm (16%); Sellafield 18.9mm; The Nook, Thirlmere, 75.0mm (30%)

Corrections:

February 1989 (p. 294), Frankfurt, 17 days with rain; March 1989 (p. 295), Hamburg, highest maximum temperature, 23.0 (28th). Munchen: No thunder.

JOURNAL OF METEOROLOGY Vol. 15, no. 145, January, 1990

CONTENTS PAGE

FRONT COVER:

The place south of Margate, Kent, where a "vortex of light" came down into a cornfield on 10th August 1989. (© ADSCENE Publishing Ltd.).

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