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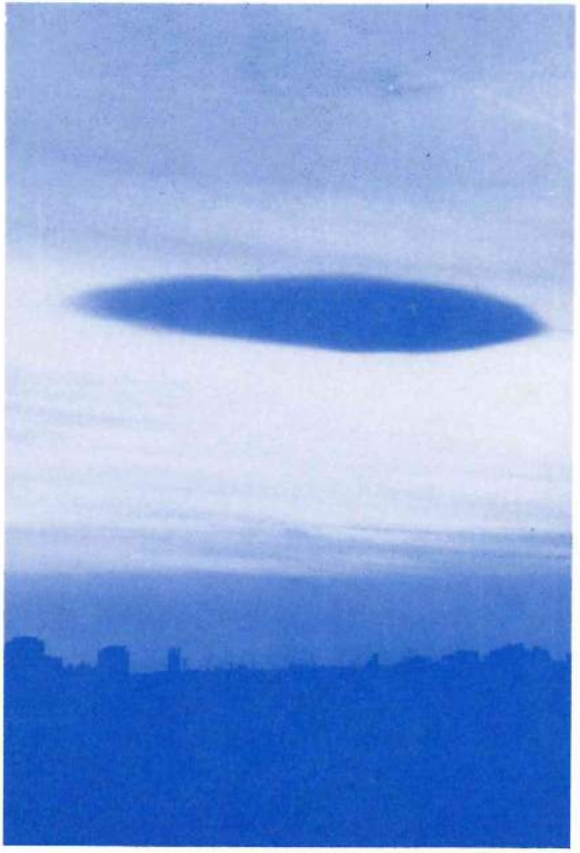

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PREDICTING FROST AT YOUR HOUSE

By DAVID R COOK
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Abstract: The occurrence, amount, and hardness of frost can be predicted reasonably well using meteorological information readily available to the homeowners. A set of equations is presented that is more than 90% accurate for predicting frost occurrence, and 74% and 58% accurate for predicting frost amount for clear sky and partly cloudy sky conditions, respectively. The meteorological quantities used in the equations are sunset temperature, predicted average night-time wind speed, and predicted night-time sky conditions. This simple scheme applies to unforested non-urban areas and lends itself well to use on a computer or programmable calculator. It allows the homeowner to take proper precautions in picking or protecting fruits, flowers, and vegetables the evening before a hard frost, and enables one to predict the occurrence, amount, and hardness of frost on automobile windshields, as well as other similarly exposed surfaces above ground level.

INTRODUCTION

Being able to predict the occurrence, amount, and hardness of frost at your house provides several potential benefits. A heavy or hard frost prediction may justify rising earlier in the morning to allow sufficient time to scrape the automobile windows (an occasional cause for me to be late to work), or provide the warning needed to justify picking or protecting frost susceptible fruits, flowers, and vegetables the evening before. A large number of theoretical, as well as empirical, techniques have been developed to predict frost occurrence. These techniques range from the fairly simple to the rather complex and have varying degrees of success for a variety of conditions. Frost forecasts are valuable for agriculturalists, particularly citrus fruit orchardists, although, as evidenced in the citrus areas of the very southern United States, frost prediction ability often exceeds the ability of the agriculturalist to protect adequately his crop from hard frosts, an unfortunate situation for both the agriculturalist and the consumer. Most frost prediction schemes do not predict the amount of frost (heavy - thick like a hoarfrost, moderate - complete surface coverage but not thick, light - incomplete surface coverage) and many do not predict whether the frost will be soft (easy to scrape from an automobile window) or hard (difficult to scrape). Furthermore, evening television and radio forecasts of frost tend to be fairly general, since the viewing or listening area often encompasses a large variety of topographic and land use conditions. Therefore, a frost prediction technique that takes advantage of weather information readily available to the homeowner was developed to provide reasonably accurate predictions of frost occurrence, amount, and hardness for a locale.

MEASUREMENTS

Meteorological and frost measurements made over one frost season in

northern Illinois, USA, were used to develop frost prediction equations.The meteorological quantities measured were sunset temperature (Ts), average wind speed (u) during the night, minimum temperature (Tmin), dewpoint temperature (Td) at the time of minimum temperature, relative humidity (RH) at the time of minimum temperature, average cloud cover during the night (overcast, partly cloudy - 2 to 8 tenths, clear - only thin cirrus permitted), and frost amount (w). Td serves as a measure of the amount of water vapour in the air per unit volume and therefore is important when considering the moisture available for frost formation. A recording meteorological data system provided u, Tmin, and Td. For the homeowner's prediction purposes, average cloudiness and u can be obtained from the evening television weather forecast and Ts can be measured. All other quantities are calculated. Cloudiness observations were made in the evening and morning to verify television cloudiness forecasts. In most cases, evening cloudiness amount persisted through the night, although occasional exceptions make television cloudiness forecasts useful.

Frost amount was measured with a petri dish placed upside-down on a piece of thick wood, which in turn sat on an overturned plastic bucket in the middle of my side yard. A petri dish is obviously not a perfect model of vegetables, fruit, flowers, or even automobile windows, yet it closely replicated the frosting observed on those items in my yard. The petri dish surface was regularly cleaned with distilled water to prevent enhanced frost formation on soil and other particles that might have fallen on the dish the previous night. Each evening, at sunset, the dish was put out in the yard and Ts was measured at about two meters (window thermometer height). Each morning, at sunrise, the dish sides were carefully scraped of frost so as to measure only the frost on the dish top. A scale accurate to a thousandth of a gram was used to weigh the dish and the frost on it, after which the dish weight was subtracted to obtain w, in grams.

RESULTS

Not all cloudless nights produced a heavy frost nor did all partly cloudy nights give a light frost, since w is predominantly a result of four factors: cloudiness, RH, Td, and u. Overcast nights inevitably gave no frost or so light a one as to be inconsequential, a result of efficient suppression of surface cooling by clouds, which radiate to the surface and air about equally as well as the surface radiates to the clouds and air. Clear and partly cloudy nights usually gave frost; the amount of frost is qualitatively related to water vapour content of the air in the table below. Later in this article the qualitative amounts below are related to a quantitative measure (w). Td is in degrees Celsius, with wind speeds less then three metres per second for the information in the table.

Cloudiness	RH	Td	Frost Amount	Comments
partly	<90%	<-5	light	
		= 0	moderate	
	= 95%	<-5	moderate	
		= 0	heavy	
	>98%	<-8	moderate	fog sometimes
		>-8	heavy	fog often
clear	= 85%	< - 11	light	
		> -11	moderate	
	= 95%	< -20	light	
		= -20	moderate	
		> -12	heavy	
	= 98%	< -22	light	
		= -22	moderate	fog sometimes
		> -14	heavy	fog often

Note how low the dewpoint temperature can be under clear sky conditions and still produce a heavy frost. On nights with higher wind speeds, mixings of warmer air from aloft down to the surface occurred, resulting in light or no frost. Very calm nights gave somewhat greater frost amounts than nights with light wind speeds.

As seen above, frost amount is controlled primarily by RH and Td, whereas hardness is controlled primarily by air temperature. Irregardless of the frost amount, Tmin within a few degrees of zero will normally produce a soft frost, whereas Tmin a dozen degrees or more below zero will usually produce a hard frost. So, w will indicate frost occurrence and amount, and Tmin will give us a measure of frost hardness.

Frost amount is affected by a few factors that have not been considered here. Surface wetness can affect frost amount, in that night time surface evaporation, although less than during the day, contributes to the moisture available for frost formation. Also, since a windshield, flower, fruit, or plant leaf can cool to a temperature slightly below that of the air, the measurements of Tmin were probably slight overestimates of surface minimum temperature, resulting in slight underestimates of RH. Other factors include whether there is snow on the ground, the age (and therefore the emissivity) of snow cover, and the temperature of a snowless surface. These will affect how quickly the surface, and therefore to some extent the air, will cool. During the measurement period for this study, snow cover did not produce greatly different results from bare ground in determining the equations for the prediction technique.

Frost occurrence and amount are fairly well predicted for clear nights, whereas predictions for partly cloudy nights are less accurate because of the difficulty of predicting partial cloud cover amount. The following predictive relations were determined from the measurements. Tmin and Td were well correlated with sunset temperature, Ts, for clear skies and moderately well correlated for partly cloudy skies, yielding the following:

Clear Sky:	Tmin = -5.23 + 0.85Ts
	Td = -6.83 + 0.99Ts
Partly Cloudy Sky:	Tmin = -4.44 + 0.64Ts
	Td = -5.31 + 0.84Ts,

where the temperatures are in degrees Celsius. RH for Tmin and Td calculated above is computed from the following equation, which is accurate to 1% for

Tmin slightly above zero through below -30 degrees Celsius:

$RH = 100.0 - 7.359Tmin + 7.388Td + 0.3424Tmin^2 + 0.2764Td^2 - 0.6157TminTd - 0.000001891Tmin^2Td^2.$

Frost amount w is then found, using the forecasted evening wind speed, from:

Clear Sky: $w = -1.48 - 0.237u + 0.063Td + 0.0556RH$

Partly Cloudy Sky: $w = -7.33 - 0.044 + 0.098Td + 0.108RH,$

where u is in units of meters per second. These equations are easily used in a home computer program or with a programmable calculator. A w greater than zero predicts frost occurrence. The equations predict frost occurrence properly more than 90% of the time; very light frost occurrence is not particularly well predicted. A w larger than 2.1 predicts a heavier frost or hoarfrost, whereas a w less than 2.1 predicts a lighter frost; in the data, values of w around 2.1 were associated with moderate frosts. Values of 3 or above usually indicate very heavy frost and values of 1 or less usually indicate very light frost. However, because of accumulated errors in the correlations performed with the data, the w equation is only 74% accurate for clear and 58% accurate for partly cloudy skies in predicting w above or below 2.1. Therefore, w must be cautiously used for predicting frost amount quantitatively; it is safer to use the predictive equations to determine frost amount on a qualitative basis (heavy, moderate, light). The equations above have not been verified at another similar location or for other years, but they would work reasonably well for a suburban or rural yard of decent size and exposure to the sky (not many trees).

Caution must be applied when using the equations in predicting frost amount on automobile windows. Sloping front and back windshields approximate the horizontal orientation of the petri dish. However, most people do not regularly clean their automobile windows with distilled water, as I did the petri dishes. The frost amount on automobile windows may exceed what might occur on a petri dish because of accumulated dirt, which can present more sites for frost formation. Side windows, which are nearly vertical, cool more slowly and therefore normally frost less than the windshields; an exception is a fog-produced hoarfrost, where things with any orientation tend to be heavily frosted. The equations also apply to an automobile which has, like the petri dish, sat completely exposed to the sky from sunset to sunrise. If one stays out late in the evening and returns home in a warmed automobile, the onset of frost formation may be delayed and the total amount of nighttime frost may be reduced.

How can the frost prediction technique be applied to your vegetable garden, flowers, and fruit trees? It is not the frost amount which is of primary concern to the agriculturalist. The hardness (controlled by Tmin) and length of time of the freeze will determine the extent of damage to the crop. A damaging 'frost' can still occur if Tmin is low enough long enough, even though w may be small because Td (a measure of the amount of water vapour in the air) is far below zero. Wind speed can play an important role in the modification of Tmin, since higher wind speeds can mix warmer air from above the surface. Therefore, the prediction of Tmin and u are more useful to the agriculturalist

than the prediction of w. Many fruits, flowers, and vegetables are not badly affected by soft frosts, except perhaps some leafy vegetables. However, only a few hardy fruits and vegetables can tolerate more than one hard frost. Some cannot tolerate even one.

The information in this article should help you to estimate morning frost occurrence, amount, and hardness, despite the limitations of the prediction technique. Then you'll know whether to use the flimsy or sturdy ice scraper on your automobile windows in the morning (and how much time it may take to do the scraping) and whether you will need to pick or protect susceptible flowers, fruits, and vegetables the evening before a killing, frost. The author has experienced the uncertainty of both situations!

THE EFFECT OF CONSISTENT ABOVE-AVERAGE TEMPERATURES AND SUMMER DROUGHT CONDITIONS ON BRITAIN'S BREEDING BIRDS DURING 1990

By DAVID E GLUE

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Abstract. Record breaking sunshine totals and high temperatures combined with widespread summer drought conditions during 1990 resulted in a nesting season of strikingly mixed fortunes for Britain's breeding birds. As in previous years it was a remarkably early nesting season and generally highly productive one for many birds - but again there were some notable exceptions, and seemingly more than in 1989. For species such as Starling, Wheatear, Robin, Hobby and Nightjar it was a very successful season, to be placed against widespread nesting losses amongst others including Rook, Moorhen, Dipper and House Martin.

The New Year started with exceptionally mild mid-winter conditions and before late January the British Trust for Ornithology had received details of a scattering of early nesting attempts. The birds involved ranged from Great Crested Grebe and Tawny Owl to Blackbird, Mistle Thrush, Woodpigeon and Collared Dove with clutches or young reported from London west to Dorset, across to Gwent and north to Glasgow. Sadly the Great Storm of 25 January put paid to all but the very tightest of sitting birds.

The severe storm-force winds of that fateful, memorable, January day physically destroyed the contents of virtually all of these early nests. Of greater significance, perhaps, it blew out many large sticknests traditionally used by corvids, Heron, Buzzard, Goshawk, Long-eared Owl and others, and destroyed many tree cavities regularly used by owls, woodpeckers and smaller passerines. Around four million trees were lost on January 25th with Devon, Hampshire and Dyfed the chief counties affected. This total is a little less than one quarter of those flattened during the Great Storm of October 1987 (when trees were generally in full leaf) but this year considerably more of the country was affected. Not all the storm damage was negative. This summer ornithologists have found Greater and Lesser Spotted Woodpeckers using snapped off trunks, Coal Tit, Wren, Robin and thrushes, even Kingfisher occupying cavities

amoung the root plates of upturned trees.

One disturbing aspect of the Great Storm was the number of exotic cage birds liberated from damaged aviaries in zoos, large bird collections and many private gardens. Collections from Padstow and Chester to Cardigan and Cobham saw expensive foreign stock liberated. These included such exotics as Eagle Owl, Sacred Ibis, Great Flamingo, Carolina Duck, Glossy Starling and Zebra Finches. Some wildfowl, parakeets and smaller grassland finches have survived well in the generally favourable conditions this summer to baffle birdwatchers in the field.

Over the key spring months for nesting birds, March to May 1990, the country as a whole received a third less rainfall and a quarter extra ration of sunshine than usual. Indeed, the first five-month spell of the year was the warmest since records began over 330 years ago. The immediate impact on Britain's birds was to prompt a spate of early spring nesting, for many species a fortnight or more ahead of schedule. Contributors to the BTO's Nest Records Scheme reported clutches started by Starling and Robin in mid February, Magpie and Moorhen in early March, Chaffinch and Buzzard in early April, Wheatear and Swallow during the last week of the month. The timing of egg laying is usually determined by a combination of interacting factors - increased day length, temperature and food.

Cuckoo were equally early with the first egg deposited in the Chew Valley Lake reedbeds, Avon County on 8th May. One marked Cuckoo returned to its Oxford reedbed site for an eighth season so equalling the European longevity record for Blaise in France. Egg laying started on 15th May but after depositing eight eggs (this Cuckoo had previously laid a world record of 25 eggs in one season) it sadly went 'missing' presumed dead.

Nestbox operators in lowland sites especially describe how titmice generally got off to a flying start. Oxford University's famous nestbox programme in Wytham Woods saw the first Great Tit egg laid on 1st April, by several days the earliest ever since the project started over 40 years ago. Blue Tit broods fledged as early as 26th April on the periphery of the New Forest. As in 1989, though, it proved only a moderate season success-wise with a poor hatch of the main caterpillar crop and developing young titmice, and late May frosts killing important larval invertebrate foods widely. As a result there have been many reports of partial and complete brood losses with successful Blue Tit families ranging from 3-15 young in size.

The mild winter helped to swell the populations of small rodents such as field vole and wood mouse which in turn helped Tawny Owls in many regions to a far better year than the disastrous 1988. Large clutches and regular broods of three and four young owlets were reared from the Kielder Forest, Chiltern Woodlands and the Forest of Dean. Kestrels began egg laying very early in the first week of April in the south with regular rural nest sites holding five and six young, and up to five in inner city London where the continuing abundance of immature rats provided the staple diet.

Further encouraging news came from many of Britain's scarce birds of prey. Raptors in general are averse to damp conditions on the nest. The relict Welsh

population of Red Kites topped 63 pairs with 70 young raised. Osprey and Marsh Harrier also took over fresh sites and exceeded their highest numbers of breeding pairs since re-establishment. The fragile Montagu's Harrier population involved 11 known nests and despite including several secondary females, some 20 young were reared. The Hobby, which eats large aerial insects and hirundines chiefly, enjoyed a fine year.

The populations of many small tender and early nesting residents such as Wren, Robin, Goldcrest, Long-tailed Tit and Grey Wagtail are already standing at unusually high levels after successive mild winters. Most are reliant on aerial insect foods and the signs are that the sunniest May on record helped them to another very productive year.

For many common migrants the patterns of performance revolved around staggered arrival dates and the influences of a cool period in June. Early migrants such as Chiffchaff, Wheatear, Ring Ouzel and Sand Martin returned prematurely from late February to early April, and nesting operations were often quickly underway. Fine weather persisted in Britain in April but a three week spell of stormy conditions in the Mediterranean area and beyond contrived to hold back mid and late migrants. Early May saw the floodgates open and mass arrivals with Whitethroat and House Martin appearing alongside Swift and Spotted Flycatcher.

As drought conditions intensified and temperature soared into the 90s during July and August the weather took its toll. Earlier, nest building corvids, thrushes and martins, had struggled. Rook were reduced to scavenging for scraps along major roads, in campsites and town gardens with inevitable casualities. Their normal soil invertebrate prey were safe in the rock hard ground.

Receding water levels along many rivers and lake margins contrived to expose nests and increase predation rates of many breeding ducks, rails, Dipper and others. Parched marshes, meadows and moors were generally unsuitable for some nesting waders including Lapwing and Golden Plover. Exposed substrates, though, of many inland pits and reservoirs appear to have favoured other waders including Little Ringed and Ringed Plovers.

Continuing warmth and dryness did encourage many species to make extra nesting attempts. Some irregular or only occasionally double brooded species such as Ringed Plover, Stone Curlew, Nightjar, Wheatear, Starling and Chaffinch consistently reared twin sets of young. For others, ornithologists in late July and August reported late broods reared by Little Grebe, Moorhen, Bullfinch, Linnet and Song Thrush - all contributing towards an above average breeding season for Britain's birds

IONIZATION, AND ITS POSSIBLE EFFECT ON CORN CIRCLES

By Gordon W C GARROULD

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As the study of the 'Corn Circle Phenomena' unavoidably involves the thinking of several different disciplines, the possible involvement of ionization is worth investigating, as Terence Meaden has pointed out in *The Circles Effect and its Mysteries*.

To start with some of the earliest demonstrations, the Faraday Dark Cloud Test is worth recalling. Faraday slowly evacuated a tube into which were fixed anode and cathode conductors, charged just enough to provide a faint crackle of discharge as the pressure fell. As the atmospheric pressure fell in the tube, the crackling quietened to a light streamer effect, and by the time the pressure had fallen to a half a light pink (for air) was noticeable at the cathode, ie. the beginning of a sort of aura, noticeable as the ionization increases. Evacuating the tube further to one-third atmospheric pressure greatly increased these effects and the colour, if anything, became more bluish.

This would not seem to be particularly relevant to our consideration until one realizes that one only has to travel in a high-altitude aeroplane to physically experience this little Faraday experiment. The atmosphere at 18,000 feet is already halved in pressure, and before the top of Mount Everest is reached the pressure has dropped to one third of that at sea level. Thus one quickly realizes that an ionized atmosphere is not particularly rare, in fact it is only at cloud level above our heads, and the really vast 'thunder clouds' can tower right up to 30,000 feet and above.

"Why cornfields?" is the question so often asked in the Press, and then "Why are these circles so much more frequent in recent years?"

The answer to both questions may to a great extent lie in the modern farming of grain crops. No longer do we see, as was so common in pre-war years, the farm cart toiling up the field with the animal manure being forked out of the back. Nor do we see the small patch-work fields, surrounded with hedge and ditch and often tall mature trees.

The present day farming of corn, 'prairie-farming' as it is sometimes described, presents the clouds above with a wide sea of regularly spaced corn ears, crowded together far nearer than before, and of remarkably even height due to careful seed selection and much more accurate spread of fertilizer. As the ear ripens it is heavier and larger, with the well-developed vertical bristles peculiar to ripening corn. These bristles in themselves need careful thought, for they are needle sharp and ideal for the discharge of static electricity. In fact we have in the cornfield a vast sea of tiny 'lightning conductors', each with its classic sharp-pointed form above, held above the ground by a dry hollow cornstalk but sufficiently damp inside to provide the conductor from ear to root.

Looking at the whole cornfield, as it were in 'cross section', we have in fact a form of 'double condenser'. The clouds slowly passing overhead provide more than likely a light negative charge or negative plate. The corn bristles below discharge through their bristles a continuous stream of electro-static charge ie. the typical lightning conductor situation. Yet approximately 80 cm below the ear we have the earth carrying equal and opposite charge, making a third plate to our condenser system.

For those who like a simple experiment, thread 12 to 15 cottons through a sheet of corrugated cardboard, and cut them off say 7 cm long. A sheet of ordinary window glass is now placed with a neat pile of books at each end to hold it say 12 cm above the 'cornfield'. Choose a bright dry sunny day.

Nothing happens in the damp. See that the 'cornfield' and glass are bone dry, and then rub vigorously the top of the glass with a *dry* silk cloth (not art-silk), and very soon the first of the 'corn-stalk' cottons will start to move and then stand up.

If the silk is now balled up and brought near the surface of the glass as if it were a mini-cloud, the cotton corn-stalks will duct away, i.e. they are electrostatically repelled. If a Malvern-water-type *plastic* bottle is now rubbed hard with the silk cloth, and brought near the glass surface, this mini-cloud, being of opposite polarity will attract the corn-stalk cottons instead of repelling them.

This simple experiment shows how easily an ionized condition can be established in very dry air, but as the books are only at each end, a light breeze from door or window will soon dissipate this tiny ionized zone and the cottons will sink back again. Thus in the real cornfield a steady breeze over even dry corn will keep ionization to minimal level, and it must be a still dry atmosphere above the corn to allow ionization to accumulate.

Below the corn ear of course, the forest of tiny corn stalks make such ventilation almost impossible because light breezes merely wave the corn into ripples without ever penetrating to the roots some 80 cm below. In this still dry atmosphere trapped amongst the corn stalks, we must consider another ionizing condition, all too often overlooked, and yet perhaps throwing light on the perplexing way in which these circles seem to be more prevalent in our Wiltshire area and often near ancient sites.

The fact is that in Cornwall the various granite formations have been weathered down and exposed, but as one moves east the granites dip down under broken alluvial rock formations, with in many cases overlaying chalk, and so many of our Wiltshire cornfields are on chalky soil. The 'prairie farming' of corn goes on just the same in East Anglia, but here the many fields starting from Hertfordshire into Essex and beyond are on deep clay.

As it is well known but often forgotten, granites the world over are slightly radioactive, and it is only when one reads HMSO publications recommending the proper ventilation of buildings to prevent the accumulations of radon gas, that one realizes how widespread this situation extends. There is little fear under normal circumstances, as the breezes blow the heavy gas away and dilute it, but in the still atmosphere around the corn roots it can accumulate for several weeks during growth and ripening.

Radon gas is itself radioactive, and continuously decays although slowly, to polonium which is itself radioactive. So the rays given off at each decay generate ionization in the atmosphere around. Here, however, the atmosphere cannot be ventilated, and so for several weeks on land with granites below them this accumulation is unavoidable.

There is little health risk, as the whole field is swept with dusty winds as soon as the corn is cut, but the Meaden Effect relies on static charge as well as vortices, and so by the reasoning above, one is led to the conclusion that the prairie farming of corn in Wiltshire is setting up quite naturally, if unintentionally, the ideal circumstances for corn-circle phenomena to occur

regularly.

A SEVENTEENTH-CENTURY REPORT OF AN ENCOUNTER WITH AN IONIZED VORTEX?

By R M SKINNER

The following is an excerpt from John Aubrey's *Natural History of Wiltshire* with annotations

"In the year 1633-4, soon after I had entered into my grammar at the Latin School at Yatton Keynal, our curate, Mr Hart, was annoyed one night by these elves or fairies coming over the downes, it being nearly darke and approaching one of the fairy dances as the common people call them in these parts, viz. the greene circles made by those spirites on the grasse, he all at once sawe an innumerable quantitie of pigmies or very small people dancing rounde and rounde, and singing and making all manner of small odd noyses. So being very greatly amaz'd, and yet not being able, as he says, to run away from them, being as he supposes kepte there in a kinde of enchantment. They no sooner perceave him but they surrounde him on all sides, and what betwixt feare and amazement, he fell downe scarcely knowing what he did; and thereupon these little creatures pinch'd him all over, and made a sorte of quick humming noyse all the time; but at length they left him, and when the sun rose he found himself exactly in the midst of one of these faery dances. This relation I had from him myselfe a few dayes after he was so tormented; but when I and my bedfellow Stump wente soon afterwards at night time to the dances on the downes, we sawe none of the elves or fairies. But indeed it is said they seldom appeare to any persons who go to seeke for them."

It is interesting to note the number of parallels in this account to the circumstances of crop circle formation, and witness statements of close contact with vortices:

1. *The topographical location* - on the downs, and in Wiltshire, where there have been numerous crop circles.
2. *The time of day* - dawn, "it being nearly dark" ("the sun rose" later).
3. *Observation of vortex* "Dancing round and round" - the rotary movement of dust and vegetable matter in the vortex? Perhaps the witness' perception of the vortex could have been altered by electromagnetic effects, leading to a visionary aspect to report?
4. *The sounds* - "singing, and making all manner of small noyses", "a sort of quick humming noise all the time" - perhaps a combination of sound of vortex and electromagnetic sound.
5. *Changed state of consciousness?* The witness was "kept in a kinde of enchantment" - changed state of consciousness due to electromagnetic effect? - leading to collapse.
6. *Physiological effect?* - The witness was "pinch'd him all over" - perhaps describing hairs standing on end, or another electromagnetic effect. Compare with the statement that "something stung my hands and cheeks" and of a "prickling feeling" in Mr Payne's account, (G T Meaden, *The Circles Effect and its Mysteries*, p. 83), and of witnesses describing sensation of hair standing on end when near supposed vortices (J Randles and P Fuller, *Crop Circles : A Mystery Solved*, pp 146, 147, 148).
7. *Evidence of vortex in grass around him?* - Is this perhaps stretching things too far! Aubrey uses the phrase "Fairy dance" - the local name for fairy ring or circle, and this cannot be equated with the 'crop circle' phenomenon. However, is it possible that the ring Mr Hart found around him at dawn was not the usual fairy ring, but the swirled ring or circle effect caused by the vortex?

NB The elements of a buzzing sound and pricking sensation also appear in other folklore accounts of encounters with fairies. (see *Popular Romances of the West of England* - Robert Hunt (1881, 1908) pp. 101, 119). Whirlwinds themselves were in some places regarded as being fairies, or indicating the passage of fairies.

POSSIBILITY OF A CROP CIRCLE FROM 1590

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I found this account by accident rather than design when looking for the original transcript describing a tornado at Offlehey, near Eccleshall, Staffordshire, which Mike Rowe said was known from Dr Robert Plott's *"The Natural History of Stafford-Shire"* (Plott, 1686). Having found the tornado description (pp 27-28) my interest was then attracted to several pages of text which described lightning events, damaging hail, haloes, comets/meteors, and rings in grass. Of the thirty-one pages in the first chapter which primarily describe atmospheric phenomena, Plott devotes as many as eleven pages to rings in grass. My impressions of this section when I first skimmed through it in September 1987 was that it was brimming with 17th century crop circles, but after a closer inspection over the next few months it became clear that Plott was describing little more than 'fairy rings' caused by fungus.

After the discovery and subsequent publication in November 1989 of the 'Mowing Devil' relating to a crop circle from 1678 in Hertfordshire (Randles (1989), Skinner (1989) and Evans (1898) (reprinted in *J Meteorology* p 389, vol. 14), I checked Plott's work again and was reminded of one of the accounts which described a whirlwind associated with a circle. At this stage I sent a copy of the whirlwind account to Paul Fuller (Terence Meaden having already been sent a copy of the chapter in 1987, his attention being drawn to the storm events only). I carefully re-read the account and realised that the circle pre-dated the Hertfordshire case by nearly 100 years. Publication of the 1590 event was delayed as the location of the circle could not be identified, but as I have been unable to make little progress on this front I write this now in the hope that some readers might be able to determine its location (see later).

GRASS RINGS AND FAIRY CIRCLES - RED HERRINGS

Almost all of the discussion that Plott enters into on the rings and circles may prove to be very misleading to the less-cautious, for he describes nothing more than fairy rings of fungal origin. Not knowing their true nature, Plott nevertheless takes the scientific stance and personally investigates some rings, attempting to dismiss the popular beliefs of the time that they were caused by those little *pygmy Spirits* they call *Elves* or *Fairys*", the "*Rendezvouzes* of *Witches*", wizards and/or devils.

Plott says that some believe their cause to be "*dung* and *urin* of *Cattle* fed in the winter time at the same pout of hay", and mentions a Mr Lister as suggesting that they are caused by the underground excrement of moles. For the modern researcher, all the necessary evidence indicating their true nature is in Plott's work - the "strange fertility of these green *Circles*" and the occurrence of some rings "running through *hedge* and *ditch*". At Handsworth Church (Birmingham), the "Reverend Mr *Ange* Rector of the place... seriously told me that when he first knew (of a nearby ring) it exceeded not 4 yards *diameter* at most, whereas when I measured it *Anon* 1680 it was increased almost to 40. haveing run through the *hedg* into another field". Another at Perry Hall (near Handsworth) ("*Purry-Hall*") also "increased from a *smaller* to a *larger* extent, till at length it came to be of near 50 yards *diameter*, and to run into the *water*". On digging up several, Plott found that parts of the rings were "interspersed with a white hoar or vinew much like that in mouldy bread, of a musty rancid smell". Below "six inches ... the earth again ... being of its due consistence and genuine smell, agreeable to the rest of the soils thereabout".

In preference to the supernatural origins of the rings held by the less well-educated, Plott suggests that their cause is a "*circular explosion* of *lightening*",

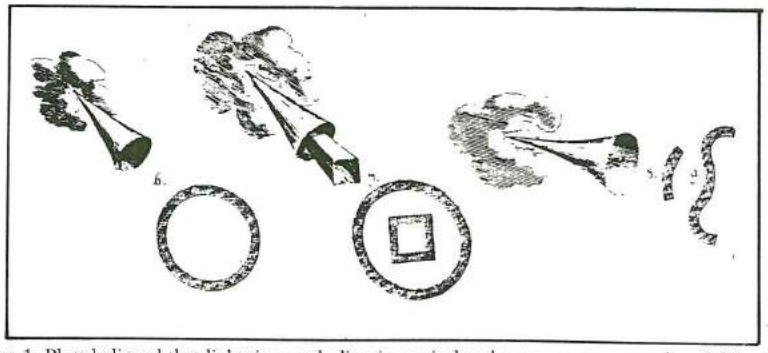

Figure 1: Plott believed that lightning exploding in conical and square patterns produced fairy rings, infecting the soil in such a way as to allow the ring to continue growing.

"possibly too infecting the *Earth* (for I look on them as a disease) ... that creeps on in the out parts, the middle growing well; these *Circles* I say being infected thus at first from the *Clouds* which something of this nature, may continually perhaps extend themselves in the like manner". He explains the existence of "imperfect segments", rings within rings, squares (?!), "*Semicircles*, *Quadrants* and *Sextants*" being formed by combinations of multiple strokes, differing angles of

21 But to come close to the buſineſs, let us return again to the forecited *Remigius*, who was a *Judg* in *Lorrain*, and perhaps the beſt skill'd in matters of this nature that the *world* has yet known (having had the Examinations, Confeſſions and Condemnations of no leſs than nine hundred *Wizards* and *Witches* in fifteen years time) who, to omit many others of the like kind, gives us a moſt remarkable relation of ſuch a *Conventicle*, and no leſs ſuitable (if true) to our preſent purpoſe. On the eighth of the *Calends* of *Auguſt* (ſays He) An. 1590. one *Nicolæa Lang-Bernhard* having been grinding at a *Quern* not far from *Aſſenuncuria*, and returning about noon, as ſhe walked by a hedg ſide, ſaw in an adjoyning field, an aſſembly of *Men* and *Women* dancing in a *Ring*, but in a quite different manner from the uſual practice of others; for ſays my author, *averſi terga oſtendentes id faciebant*, i.e. that they did it turning their *backs* upon one another; but at length viewing them more attentively, *ſhe* perceived ſome amongſt them to have *cloven* feet like *Oxen* and *Goats*, at which being ſore aſtoniſhed, and almoſt dead with fear, and calling upon the auxiliary name of *Jeſus* to help her well home, they forthwith all *vaniſht* except one *Petter Groſs-Petter*, whom quickly after *ſhe* ſaw ſnatcht up into the Air, and to let fall his *Maulkin* (a ſtick they make clean *Ovens* withal before they ſet in their bread) and *Her ſelf* was alſo driven ſo forcibly with the *wind*, that it made her almoſt loſe her breath, and when ſhe was got home to keep her bed no leſs than three days.

22. The fame of which matter being quickly ſpread by *her ſelf* and *Relations* through the whole *Village*, this *Petter* at firſt brought an action of ſlander againſt *Nicolæa*, but knowing his own guilt, and fearing to proceed too far, he deſiſted again; which breeding ſuſpition in the *Judg*, upon enquiry into his *life* and *manners*, he was at length apprehended, and at laſt freely confeſt the whole matter, and diſcovered others of his *Companions*, as *Barbelia* the wife of *Johannes Latomus*, *Mayetta* the wife of *Laurence Super Major*, both which though examined a part, yet confeſt expreſly in the ſame words, *de ſaltato à ſe averſis una cum intermediis Cornupedibus choro*, &c. *i.e.* that they had *danced* intermixt with thoſe cloven footed creatures at what time *Petter* was amongſt them.

23. And for further evidence of the buſineſs *John Michael* Herdſman did alſo confeſs that while they thus *danced*, he plaid upon his *crooked* ſtaff moving his fingers upon it, as if it had been a *Pipe*, ſitting upon a high bough of an *Oak*; and that as ſoon as *Nicolæa* called upon the name of *Jeſus*, he tumbled down headlong to the ground but was preſently catcht up again with a *whirlwind* and carryed to *Weiller* Meddows, where he had left his *herds* a little before: Add hereunto (which is moſt of all to the purpoſe) that there was found in the place where they danced a *round circle*, wherein there were the manifeſt marks of the treading of *Cloven* feet, as plain as are made by *Horſes* that run the *Ring*, as was teſtifyed by *Nickel Clein*, *Deſiderius Vervex*, *Gaſper Sutor*, and divers others that had been to ſee it, and were examined by the *Judg* as Witneſſes upon it: which *circle* remained from the day after *Nicolæa* had diſcover'd the buſineſs, till the next winter when the Plow cut it out[b].

Figure 2: The text describing the formation of the 1590 crop circle, attributed to evil spirits.

descent and variations in lightning strength *across* a stroke (Figure 1). To confuse matters, Plott also seems to be describing some approximately circular scorched areas resulting from a genuine lightning strike (it is on this "evidence" that he bases his theory of lightning creating fairy rings): "... Mr *Walker* a man eminant not only for his skill in Geometry but in all other *accomplishments*, who by chance one day walking in a *Meddow* amongst *Mowers* (with whom he had been but a little before) after such a storme of *Lightening* presently espyed one of these *Rings* about five yards *diameter*, the Rim whereof was about a foot broad, newly burnt bare as the colour and brittleness of the grass roots did plainly testify, which the year following became more fresh and *verdant* in the place burnt, than in the middle, and at mowing time was much taller and ranker grass than any in the Meddow", although this may have also been confused with a fairy ring.

THE CROP CIRCLE OF 8 AUGUST 1590 - WAS ITS FORMATION OBSERVED?

Not only does Plott possibly confuse a lightning earthing point with a fairy ring, but fortunately for our purposes he also includes a crop circle of the vortex-breakdown variety (see Figure 2). Plott includes the account of a Judge in Lorrain, who has "had the Examinations, Confessions and Condemnations of no less than nine hundred *Wizards* and *Witches* in fifteen year time".

At about noon on 8 August 1590 (18 August, modern calendar), Nicolaea Lang-Bernhard returned from grinding at a millstone ("*Queern*") and saw in an adjacent field men and women dancing around a ring. On carefully observing them, she "perceived some amongst them to have *cloven* feet like *Oxen* and *Goats*", which sufficiently frightened her to call on Jesus to protect her. At this point, all present vanished except Petter-Gross-Petter, "whom quickly after *she* saw snatcht up into the Air, and to let fall his *Maulkin* (a stick they make clean Ovens withal before they set in their bread) and *Herself* was also driven so forcibly with the *wind*, that it made her almost lose her breath, and when she was got home to keep her bed no less than three days". At the same time, John Michael, a herdsman who was sitting in an oak tree, fell (frightened and slipped or blown?) but was "presently catcht up again with a *whirlwind* and carried to *Weiller* Meddows, where he had left his herds a little before" (Plott's italics). "Add here unto (which is most of all the purpose) that there was found in the place where they danced a round circle ...". Many people, including the judge, went to see the circle, and it remained "till the next winter when the Plow cut it out"

The judge's involvement was to consider the case of slander that Petter brought against Nicolaea for spreading word of Petter's antics with cloven-footed creatures, claims that he clearly denied. However, upon withdrawing his claim of slander, the judge became suspicious, and eventually Petter "confessed", along with two other women, to dancing with such creatures.

In reality, events were probably much simpler. Petter may have been caught in or witnessed at very close quarters the formation of a crop circle by vortex breakdown, the (presumably) parent vortex then moving away, or descended again to create another (un-reported) crop circle. This motion is believed to

create some doublets and spurs, the luminous equivalent of descent and re-ascent being well-represented in UFO literature. A recent eye-witness observation of crop circle formation in daylight (Pearson, 1990) describes a similar motion by the whirlwinds. Nicolaea may have been recalling a sub-conscious desire to see one thing and yet report another - if there were cloven-footed creatures, they could have been cows or goats etc. that were greatly disturbed by the electrified whirlwind (cf Jones (1977) for a probable illuminated vortex), which would explain the judge's report of hoof-marks in the circle, with the beasts immediate disappearance a distortion of the truth. Alternatively, there were no beasts and the hoof-marks originally not present, added later (deliberately/coincidentally - remember John had a herd close by) or never existed. Despite two women later confessing that they danced with Petter and cloven-footed creatures, neither Nicolaea nor John identify any people other than Petter. Thus there are strong indications a of witch-hunt to satisfy the thirst of locals, whether Petter and the two women were "in league with the devil" or not - any excuse, concocted if necessary, would be deemed sufficient for conviction of witchcraft in the past.

However, it is possible that other dancers were present, who were engaged in a witchcraft ritual (perhaps wearing special shoes (clogs?) prompted by their discovery of a crop circle. If so, the whirlwind - probably a land devil in this scenario - was almost certainly unconnected with the circle. From a very critical approach, the circle may have been created by the dancers, with the whirlwind being a mere coincidence. Finally if the circle was genuine, it may have been a ringed circle as the dancer(s) moved around in a ring, with a circle then being found at the same place.

EVENT LOCATION - THE NETHERLANDS?

All we learn of the event location is that it is close to Weiller Meadows "not far from *Assenuncuria*". The names of people mentioned indicate a German or French site; Lorrain which is mentioned by Plott being the modern day region Lorraine in France, bordering with Luxembourg and Germany. A check in a standard world atlas gives a town called Assen in the north-east Netherlands, not far from the German boarder, so it would seem that this is the most likely site. It would be very interesting if any Dutch readers know if Assen was called Assenuncuria in the late 1500's, and if so, the location of Weiller Meadows and the topographical setting of the area.

ILLUMINATED PLASMA-VORTEX IN STAFFORDSHIRE 1676.

In addition to the 1590 eye-witness account, Plott also describes what he terms a meteor (paras. 40-41) at Broadheath, near Stafford (SJ 8525), observed by vicar John Nash, at seven p.m. "near *Michaelmass* time *Anno* 1675". At a distance the object appeared as a "great fire", but when closer it was described as a "*globular figure*, moving by jerks and making short *rests*, at every one of them letting all drops of *fire*, which were part of its body, for it decreased in magnitude the farther it went, and the oftner if dropt, so that it wholly disappeared at about 3 quarters of a mile's distance". At Seighford (SJ 880 250), about 3 km to the east, it was also described as being globular and making short

pauses. From the "computation of *time*, and other *circumstances*", Plott believes it was the same object described in the *Philosophical Transactions* (135, 863-864) which was observed over another eleven counties on 20 September 1676 (30 September modern calerdar), from Devon to Kent and into the south (but not the north) Midlands.

The motion of the object at Broadheath is not consistent with a meteor, but the wide area that it was seen over would be expected. Perhaps more likely is that the Broadheath event was on a different day, with the object(s) over southern counties being a true meteor(s). The possibility of a 'multiple outbreak' of illuminated plasma vortices over several regions along a weak front remains, although such an event would seem unparalleled in recent times, certainly in numbers and area affected

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GREAT CITIES OF THE WORLD THREATENED BY SEA-LEVEL RISE

London is one of the world's cities at risk from a flood catastrophe due to the sea level rise expected to result from global warming. A study carried out by the University of East Anglia's School of Environmental Sciences warns that the protection afforded by the Thames Barrier would be seriously eroded if the worst case predictions of sea level rise prove accurate. In any event, the report concludes that the designed safety margins of the barrier are likely to be exceeded around the year 2030.

In the study *Cities at Risk*, commissioned by London-based environmental information publishers BNA International Inc., co -authors Dr Mick Kelly, Kerry Turner and Dr Robert Kay carried out a detailed review of London's position its flood defences, including the barrier, are widely regarded as a model by other threatened cities around the world.

The report says: "It is clear that there is a significant chance that the allowances incorporated into the design level of the Thames Barrier, to take account of past trends in high-water level, could be surpassed as soon as the early decades of the 21st Century. In the worst case scenario, this point would be reached shortly after the turn of the century."

Other large cities facing severe flooding and other hazards as a result of sea level rise are considered in the report. The cities are:

Alexandria, Egypt: The loss of the delta plain surrounding Alexandria would be devastating. The report says a sea-level rise of even 10-20cm would accelerate significantly the retreat of the coastline. It adds: "Ultimately, the city could become a peninsula surrounded by the Mediterranean, to be approached by bridges and causeways."

Bangkok, Thailand: One of the world's fastest sinking cities – much of the city is only one metre above sea level. Mangrove swamps, the city's vital natural defence against storm surge, are at risk from sea level rise.

Dhaka, Bangladesh: Threatened indirectly. The city is at less risk than the Ganges–Brahmaputra flood plain – home for 100 million people. However, rising sea level could see Dhaka overwhelmed by refugeees and its drinking water contaminated by salt water.

Hamburg, Germany: Over 300 people died in a 1962 storm surge in the Elbe estuary. Problems are exacerbated by geological subsidence. A flood barrier is under consideration, but the project poses considerable technical probelms.

Leningrad, USSR: The "Amsterdam of the North", Leningrad, the Soviet Union's largest sea port, is located on a low, marshy site and is at risk from storm surges. A 25km flood barrier is due for completion next year. Rising sea level will decrease the barrier's ability to hold back storm tides.

Miami, USA: Miami Beach is built on a low sand barrier island, separated from the mainland by a shallow lagoon. This city is particularly vulnerable to sea level rise, as the whole island will want to move landwards. It cannot do this, as it is fixed in place by seawalls. The risk is that it may "drown in place."

New Orleans, USA: This city's present problems are a foretaste of things to come for delta cities such as Dhaka and Shanghai. Rapid land subsidence and loss of natural salt marsh defences against hurricanes has massively increased the risk of catastrophic flooding.

Shanghai, China: The country's largest industrial city and creator of one seventh of the national wealth. It is located on the Yangtze Delta and is one of Chin's most vulnerable cities.

Sydney, Austrailia: At risk due to the possibility that the cyclone belt may shift south, aggravating the difficulties of a city already facing river flooding problems.

Thessaloniki, Greece" Sited in a low-lying area of reclaimed land. A rise in sea level of one metre would cause extensive damage. A barrier protection scheme has been proposed.

"Over half the world's population live in coatsal cities and towns and over 40 of the largest cities are in coastal zones," says Dr Kelly. "City authorities, as well as governments, need to prepare for sea level rise in the wake of global warming. Prompt response is important, due to the long lead-times required for flood defence projects and other precautionary measures. Rotterdam, Hamburg and other cities already accept the need for urgent action. They want a new, international body to guide research and policymaking, for effective defence of the world's vulnerable coastal cities. Our report supports this view, as it is vital to set up new systems for the transmission of information, expertise and, possibly, financial aid from the developed to the developing world. This is the only way to avoid a future nightmare, in which millions of environmental refugees are forced into chaotic retreat from the low-lying coastal cities of nations lacking the resources to defend them."

Unles governments get to grips with the problem of reducing greenhouse emissions, global mean sea-level could rise between 3cm and 10cm every decade for the next 100 years, according to the Intergovernmenatl Panel on Climate Change (IPCC). IPCC scientists have warned that the consequences of sea-level rise include serious inundation of many coastal areas – possibly aggravated by more frequent and more violent storms and hurricanes as a product of rapid climatic change. They have also drawn attention to a range of other problems, including salt contamination of cities' freshwater supplies.

The University of East Anglia authors, Dr Kelly, environmental economist Kerry Turner and Dr Robert Kay, have produced a report which highlights the key areas of concern for policy makers and evaluates the response options.

Dr Kay says: "IPCC identified three main options: retreat, accommodation – accepting the risk and taking limited and relatively low-cost precautions – and, of course, protection. However, protection is extremely expensive and many of the world's poorer nations will be unable to muster the necessary resources without massive assistance from the developed world. Basic protection for the cities at greatest risk would cost over $100 billion, while a total expenditure of around $500 billion may be required for coastal defence and flood protection works worldwide."

The BNAI-sponsored report cautions against wholesale construction of "hard engineering" defence works, such as barriers, walls and dykes. Some cities, including London and Osaka, have flood barriers already in place; Hamburg and Rotterdam are considering this option while Leningrad has a 25km barrier under construction. However, Dr Kelly warns: "There is a growing body of opinion which argues that the hard engineering offers only a short-term respite, merely serving to delay the inevitable – or even aggravate – the ultimate losses that will occur during an infrequent but catastrophic event."

The study team points to the benefits of "soft-engineering" – from beach replenishment and large-scale sand pumping to techniques based on the protection and enhancement of natural coastline forms – sand dunes, coral reefs, salt marshes and shingle banks. As natural solutions, these coastal features "adapt" to changing sea levels, with relatively minor impact on human activities and the environment as a whole.

Copies of the report, *Cities at Risk*, are available from: BNA International Inc., 17 Dartmouth Street, London SW1H 9BL, United Kingdom. Telephone: UK +71 +222 8831. Fax: UK +71 =222 0294.

WORLD WEATHER DISASTERS: JANUARY 1990

1-4: Cold wave continued in northern India and Bangladesh; on the 3rd a further 22 died in Bangladesh, bringing the death toll in that country alone to at least 260. *Daily Telegraph*.

1-25: Lack of snow affecting many ski resorts from the Pyrenees to the Swiss and Austrian Alps; in western Switzerland precipitation reached record low levels; on the 25th snow fell in the Swiss Alps. *International Herald Tribune*.

2: Cyclone "Alibera" hit Madagascar, the south-eastern town of Nosy-Varika was 75% destroyed - several thousand people made homeless throughout

Madagascar and 12 deaths reported; floods reported, especially in south of the island. *Lloyds List*

3: Landslide destroyed 30 homes and damaged 20 others in a village on Nias island, off west coast of north Sumatra, Indonesia, over 300 people made homeless, 115 hectares of rice fields buried. *Jakarta Post*

3-5: Heat wave and bush fires in states of New South Wales, Victoria and South Australia, Australia, 'thousands' of animals burnt and a number of buildings destroyed, at least three injuries reported. On the 3rd temperature reached 48.2°C at Ivanhoe, in the outback, making it the hottest day since 1945, in Sydney, temperature reached 40°C. In Victoria, temperature reached 47.2°C at Mildura, the highest since 1938. *DT LL*

3-8: Heavy rains, floods and landslips in many areas of Sri Lanka, earth slips in central highlands left six people dead, over 100,000 people made homeless throughout island. *LL*

7-9: Three consecutive Pacific storms hit the north-west coast of USA, on the 7th, 8th and 9th, with winds up to 145 km/h and heavy rains, floods in Oregon and Washington states left 3 people dead, many roads flooded and road and rail links cut by floods and landslides and uprooted trees. *LL IHT*

7(reported): Rain has fallen for the first time in seven years in desert town of Erfoud, Morocco. *DT*

8: 45 vehicles piled up in dense fog on the M25 near Uxbridge, Middlesex, England, leaving five people dead and 12 others injured *DT BEM*

10: Boat capsized in rough weather off Trengganu state, Malaysia, leaving 14 people dead. *LL*

10: The *mv Minasa Mulya* sank in stormy weather off Madura, east Java, Indonesia, leaving seven crew dead, nine others rescued. *JP*

13-14: Storms sweeping northern Norway blew seven buses off icy roads, about 20 passengers slightly injured, thick snow cushioned affects of accidents *DT BEM*

14: Gulf island state of Bahrain had wettest January day in 20 years with 25 mm of rain in 24 hours causing more than 100 car accidents. *BEM*

14: Heavy rain in eastern province of Saudi Arabia caused some flooding in local areas. *LL*

14-15: Typhoon "Koryn" hit Guam and Saipan with winds gusting to 185 km/h near Saipan, winds of 145 km/h hit Guam for 15 hours on the 14th/15th, no major damage reported, crops damaged and power supplies disrupted *LL*

16: Mudslide engulfed a number of buildings at naval base in Baku, Azerbaijan SSR, leaving nine people dead, with another 11 missing. *LL*

18: Bus swept off bridge in north-eastern Zimbabwe by flood waters, eight people dead, with 27 others missing, some 38,000 homes destroyed or damaged, 307 schools damaged along with bridges, railways and roads badly damaged, also agricultural and livestock losses reported. Total damage put at $222 million. Some areas in south of country received more than 300 mm of rain between the 20th and the 24th this being more than the average for the whole year. *LL*

21-31: Monsoon rains, with floods and landslides, in Java, Indonesia, central areas of island worst hit; on the 21st 6 died in flood in northern central region; on the 24th landslide in hills of West Java, left two people dead; on the 26th flood at Semarang left 77 dead and a landslip south of Semaran left 33 dead, 215 mm of rain fell in a few days causing worst floods for 20 years. Total death toll in central Java later put at 128.

On the 23rd heavy rains and floods in Jakarta, Java, left one person dead and flooded thousands of homes; floods followed a 100 mm downpour of rain.

On the 27th floods and landslides hit Jayapura, Irian Jaya, eastern Indonesia, during monsoon rains left 17 people dead and 15 others injured.

Floods and landslides demolished or damaged some 10,722 houses. A total of 30,444 acres of rice fields and sugar plantations flooded and 3,800 acres of shrimp ponds destroyed. Damage in central Java put at 4.8 million. *JP LL*

23-31: Severe weather in many areas of Great Britain, brief details below:-

23rd: Gales in many areas of Great Britain, a gust of 185 km/h recorded in the Cairngorms, Scotland, and gusts up to 130 km/h recorded in western and northern Scotland, snow showers in Scotland. Floods in areas of Wales, high winds and heavy rains in southern England three died in sinking of small fishing vessels, two in Devon and one in Dorset.

24th: helicopter crashed during violent snowshower in Glasgow, Scotland, left one person dead and three others injured.

25th: Fierce gales over many areas of England and Wales, winds gusted to 167.5 km/h in Cornwall, 36 direct deaths reported, along with 10 indirect deaths and one maritime death, huge property losses reported; for more details see *J Meteorology* Vol 15, no 149 pp 201, 202.

28th Strong winds in southern England. Roads blocked by snow in Wales and the north of England, floods reported in West Country.

29th: Gales reach speeds of 150 km/h in western parts of England, floods in Wales, in Dyfed a flock of 120 sheep died after 30 acres of pastureland flooded near Haverfordwest. MV the *Flag heofana* sank in stormy seas, with winds gusting to 97 km/h, off Hayling Island, Hampshire, leaving all 19 crew dead.

29-31st: Heavy rains and floods in Midlands, floods along river Severn in Hereford and Worcester described as worst since 1968.

25-26: Fierce gales in western Europe, brief details below:

France: Eight deaths reported, mostly in Brittany and Normandy, with dozens injured, winds up to 174 km/h reported

Belgium: 10 deaths reported, with widespread damage, winds gusted to 160 km/h.

Netherlands: 19 deaths reported, storm described as worst for 10 years, with winds gusting to 130 km/h, many trees unprotected.

West Germany: Winds gusted to 170 km/h in northern and western areas of country, causing widespread damage and leaving at least seven dead and hundreds injured.

Denmark: Winds gusted to 137 km/h, trees uprooted, power lines cut, a freighter the *Jotun* sank in the Baltic, leaving one dead and three others missing, high seas caused floods in Jutland region and some islands.

Spain: MV *Boqueron* driven aground during gale on the 26th near Santander, no casualties reported. It was reported later that a vessel the *La Fayette*, with a crew of 5 was unaccounted for off the coast of Brittany, France, since the 25th *DT LL BEM IHT*

26: Heavy rains flooded streets in Cairo, Egypt *IHT*

27-31: Heavy rains and floods in Lesotho, South Africa, have left 22 people dead and made 250 people homeless, many farms around mountain villages have been devastated and 92 houses destroyed. At least 17 people died in the south-western town of Quthing and five others at Qacha's Nek, along the south eastern boarder. *LL*

29: Cargo vessel, the *Galiga*, capsized in storm in Timor Sea, Indonesia, leaving 15 crew dead, one other survived. *LL*

30: Vessel *Nuestra Senora de Gardotz* driven aground during the high winds and heavy seas on the eastern end of Bere Island, off the coast of Bantry, Co Cork, Eire, all crew air lifted to safety, but one Irish Navy seaman drowned during the rescue operation. *LL*

30: Bus skidded off icy road and fell into river 26 km east of Seoul, South Korea, leaving five passengers dead. *DT*

30(reported): Cyclone "Tina" hit northern coast of western Australia, Australia, with high winds, heavy rain and seas in coastal areas, no major damage reported. *LL*

WORLD WEATHER DISASTERS: FEBRUARY 1990.

1: Snowfall, up to 109mm., in Tokyo, Japan disrupted rail, road and air transportation, snowfalls in both Japan and South Korea left 27 people dead and hundreds injured in traffic accidents and falls. *International Herald Tribune*

1-3: Avalanches in the Swiss and French Alps left at least six people dead, five of them in France, at least 15 avalanches in the French Alps also reported from the Pyrenees. *Daily Telegraph.*

1-3: Floods in both West and East Java, Indonesia, in the West Java regency of Bandung, floods left three people dead along the Citarum river on the 3rd, while on the 2nd a landslide in the Lembang district of the same regency left another three dead, on the 2nd floods in Bojonegoro, East Java, forced thousands from their homes, the floods in Java flooded at least 6,600 homes along with nearly 70 mosques and 25 school buildings. *Jakarta Post.*

1-5: Cyclone "Ofa" hit a number of islands in the South Pacific, brief details below:- WESTERN SAMOA: hit from the 1st to the 4th with winds of 185 km/h, heavy rains and huge seas up to 15 metres high, 11 deaths reported, with 30,000 people homeless and damage put at $120 million. The nations entire food crops of taro, banana and breadfruit were virtually wiped out in storm, "hundreds" of people injured on Upolu and Savaii islands, the last island being worst hit, some villages being 90% to 100% destroyed.

AMERICAN SAMOA: hit on 3rd and 4th with high winds, which caused damage of at least $20 million.

TONGA ISLANDS: Cyclone "Ofa" hit islands of Niuafo'ou, Niuatoputapu and Tafahi, causing widespread damage and leaving one person dead.

WALLIS AND FORTUNA: also hit by storm.

NIUE: hit on the 5th for 18 hours with winds of up to 160 km/h and heavy seas, scores of houses unroofed and many other buildings damaged, no casualties reported. *Lloyds List. I.H.T. O.T.*

2-4: Cyclone "Nancy" hit eastern Australia, bringing heavy rains and floods which caused widespread damage and leaving three people dead, with two others missing. In a 24 hour period ending on the 3rd nearly 250mm of rain fell in Sydney, New South Wales and by the 4th 400mm of rain had fell on the city. *L.L. B.E.M.*

3-4: Fierce gales in areas of Europe, brief details below:-

FRANCE: Winds gusted to 168 km/h in northern areas of country, widespread damage reported, with damage put at Fr4 billion, at least 23 people reported dead, of which at least nine died in the Paris region, most of them hit by falling trees or flying debris, 'dozens' of others reported injured.

WEST GERMANY: Winds gusting to 110 km/h caused widespread damage leaving seven people dead, with 50 others injured, thousands of trees uprooted and hundreds of houses had their roofs torn off.

BELGIUM: Strong winds caused widespread damage in south of the country, three people seriously injured, several others slighlty injured. *L.L. I.H.T.*

3-4: Avalanches in the Dolomite mountains in northern Italy left four people dead, three on Mt. Spico, the other on Mt. Muro. *I.H.T*

9: Fierce winds, gusting to 130 km/h, hit Cape Town, South Africa, roofs ripped off houses and shop fronts blown in, also a double decker bus was blown over, no casualties in bus incident as passengers had got off, a number of minor injuries reported. *L.L.*

10: Storms, including tornadoes, hit Alabama and Georgia, USA, worst of tornadoes around Atlanta, Georgia, where seven tornadoes reported, the storms hit the Atlanta area about one hour before dawn, uprooting and splintering trees, many of which toppled on to or were hurled into houses or vehicles. Three deaths reported. Hardest hit was south Cobb County, a few kilometres north of Atlanta, where six houses were destroyed, with another 44 damaged. Some 30 homes were damaged or destroyed in a Douglas County mobile home park south-west of Atlanta. *L.L*

11: Hailstones hit five districts in northern Bangladesh injuring at least 500 people, 10 seriously and destroying about 1000 houses, most of the injuries were caused by flying tree branches and corrugated roof covers. The storm disrupted telephone and power lines in wide areas. *L.L.*

11-12: Gales in Eire, coatsal sea areas of Europe and Spain, details below:-

11th: Gales, with winds up to 128 km/h, in County Cork, woman died when uprooted tree brought a gate pillar onto her car at Rochestown College, floods along River Barrow at Carlow town reported to be highest since 1947.

11th: Gales in Finisterre, France, gusted to 160 km/h.

12th: Two vessels sank in stormy seas one the Scantrader, sank in the Bay of Biscay, with 12 crew aboard, no survivors found, the other, the MV *Sea Carrier*, sank off Almeria, Spain, leaving one person dead and seven others missing.

12th: Winds of 100 km/h hit Basque region of Spain, leaving one person dead in San Sebastian, flooding reported from northern coastal areas.

12th: Ro-ro MV *Railship III* heeled badly after manoeuvre in gale force winds in the German Bight, two people died and 15 were injured when they were thrown about as ship was hit by waves and wind. *L.L.*

12-19: Rain in Baluchistan, Pakistan, disrupted rail services by washing out embankments. On the 17th fierce thunderstorm hit Karachi ripping out telephone wires and toppling hoardings, 14mm of rain fell in storm was accompanied by north westerly winds of 25 knots *L.L.*

13-17: Heavy snow, rain, avalanches and floods reported from France, Switzerland and Italy, brief details below:

FRANCE: Avalanches and floods in many areas of the country left 15 people dead, with two others missing, many skiers stranded by the avalanches and mudslides, floods caused widespread damage in Alsace and Normandy. Gusting winds in Corsica cut electricity supplies to hundreds of homes.

SWITZERLAND: Heavy snowfalls, up to 889mm in places and high winds in Alps caused avalanches and landslides throughout Switzerland, the snow was followed by torrential rains, roads cut, villages isolated, one death reported.

ITALY: Warm winds with gusts to 96 km/h hit Alpine areas of country, avalanches blocked roads and winds blew roofs off houses and damaged electricity pylons. Near Bellune, in the extreme north east of country, a sudden *tornado* ripped roofs off buildings on the 15th. On the 16th about 90 forest fires broke out in the countryside near Torino and Cuneo in north west of country, several homes and farm buildings destroyed along with thousands of acres of forest. *L.L, I.H.T., D.T.*

11-15: Heavy snowfall closed airports in Chicago, Illinois, USA, disrupting airline schedules for a number of hours. Up to 305mm of snow fell in some areas as part of a widespread storm which hit the middle of the country with freezing rain, sleet as well as snow. Snow fell from Colorado and the Great Plains eastward to New York State. *L.L*

17: Avalanche near Sar Dasht, western Iran, killed at least 21 people and trapped 110 others. *B.E.M.*

18: Blizzards in eastern Turkey, hundreds of villages cut off, four mud brick homes caved in in the town of Karliova, Bingol province, leaving 10 people dead and 16 others injured after snow piled up on flat roofs, power supplies cut to 305 villages. *L.L.*

18: This winter period ten metres of snow had fallen to date on Valdez, Alaska, USA, a record, there are still two months to go till end of winter. *I.H.T.*

21: Thunderstorms and strong winds with possible tornado in Stoke-on-Trent in areas of English Midlands, trees and chimney pots blown down. *B.E.M.*

23: Violent storm front, with *tornadoes* in US states of Alabama and Georgia, near town of Opp, Alabama, serious damage and injuries reported. One tornado hit Columbus, Georgia. In both states trees uprooted, power lines brought down, at least three people seriously injured. *L.L.*

24: About 100 vehicles piled up in thick fog on A3 autobahn between Frankfurt and Wuerrzburg, West Germany, five deaths and 20 serious injuries reported. *B.E.M.*

25-28: Fierce gales in Britain, Eire, France, Belgium, Netherlands, West Germany, East Germany, Denmark and Italy, some details below:-

EIRE: hit on the 25th and 26th with gusts up to 160 km/h and heavy rains, buildings damaged, trees uprooted and power lines brought down.

FRANCE: hit on the 25th and 26th with winds gusting to 130 km/h, buildings damaged, trees uprooted and transportation disrupted, 11 deaths reported, with many injured. On island of Corsica winds gusted to 145 km/h, fierce forest and bush fires broke out on the 27th and 28th and were fanned by the winds, 800 people evacuated. In Atlantic Ocean off western coast wind gusts of 110 km/h and waves more than six metres high reported. Villages in north of country flooded by heavy rains and tidal flooding, village of Mers-le-Bains flooded by one metre deep floods when dyke broke.

BELGIUM: hit on the 26th by 135 km/h winds and torrential rains, five deaths reported, widespread damage reported.

NETHERLANDS: hit on 25th and 26th, by high winds, one death reported.

WEST GERMANY: hit on 26th by winds exceeding 145 km/h, widespread damage reported, thousands of trees uprooted, 15 deaths reported.

EAST GERMANY: three deaths reported from strong winds which hit on the 26th.

DENMARK: hit on the 26th to 28th by high winds and heavy coastal flooding caused by tidal surges, west Jutland coast worst affected, the winds uprooted trees and cut off power supplies, two died when fishing boat capsized off the western coast.

ITALY: hit on the 28th by winds gusting to 145 km/h in the north of the country, trees and power lines brought down, roofs ripped off houses, six deaths reported.

SWITZERLAND: On the 27th fierce winds blew two trains off the tracks through the Alps, several people injured, winds of 230 km/h recorded near the Jungfrau mountain in west of country, three deaths reported in gales throughout the country.

NORWAY: High seas caused coastal flooding on 26th.

Most of the deaths were caused by falling trees or debris. *L.L., D.T., I.H.T.*

27: Avalanche of mud and rock burried village of San Miguel de Rio Mayo, Peru, more than 120 people feared dead. D.T.

ALBERT J THOMAS

LITERATURE REVIEWS AND LISTINGS

Sundry Listings

THE GLOBAL CLIMATE. Wall chart compiled by M.Tanke and J.v.Gulik. Mirage Publishing, Herengracht 570, 1017 CH Amsterdam, The Netherlands 1989, Dfl. 35.00.

The top 60% of this full-colour, English language wall chart is occupied predominantly by climatic data in the form of a table and a histogram for each of more than 40 stations throughout the world. In the centre of this spread is a map of global climatic zones divided into 11 categories. The bottom section of the chart is arRanged into two tiers, the upper of which consists of 5 world maps showing temperature distribution (January and July), annual precipitation, and air pressure and winds (January and July). Of the 9 boxes which make up the lower tier, 4 deal with climatic change, another 4 are concerned with global atmospheric influences, and the remaining one consists of a brief reference list. Some of the illustrations in this lower tier have previously appeared in a wall chart entitled *The Atmosphere* (Mirage Publishing 1987) (Listed in *The Journal of Meteorology*, Vol. 13 (133), November 1988).

THEORETICAL GEOPHYSICAL FLUID DYNAMICS. By A.S. Monin (Translated from the Russian by Ron Hardin). Kluwer Academic Publishers 1990, 399pp., £99.00.

An indication of the level of this book is given in the preface where itis pointed out that "the author has not shied away from new mathematical techniques" and that since it was never the "intention to provide material for light reading, thc book is replete with problems for students". The contents are arranged in 3 parts: I) General concepts, II) Processes, and III) Global problems. Each is divided into chapters which number 10 in all. Some of these have titles which may seem tempting (eg. Ch.8 – General circulation of the atmosphere and ocean: Ch.9 – Theory of Climate). In reality, their content will be fully accessible only to the few. The book has numerous diagrams and a selected, multilingual reference list.

RAINBOWS, HALOS, AND GLORIES. By Robert Greenler. Cambridge University Press 1989, 195pp., £12.95.

This is the first paperback edition of a book which appeared in 1980. It consists of a straightforward reprint, without revisions or updating. The many beautiful full-colour photographs, which were such a notable feature of the original book have been retained.

SATELLITE AS MICROSCOPE. By R.S. Scorer. Ellis Horwood 1990, 266pp., £37.50.

This well-illustrated book presents a systematic and detailed interpretation of the reflectivity of different kinds of clouds and air pollution, deducing from their appearance in various satellite wavelengths basic facts about their particular composition. The results of eleven years of pictures from the Dundee archive were used in this comprehensive work.

LT

LETTERS TO THE EDITOR

RECORD AUGUST RAINFALL IN JAKARTA

While Europe was experiencing extremes of heat and drought during August 1990, Jakarta received its highest August rainfall on record. I registered 396mm in South Jakarta, 70% of which fell in the five days of 24-28 August. The highest total was 113mm on 27 August, most of which fell in just two hours. Although August is the peak of the dry season, I have recorded only four wetter months in 13 years, and these were all in the wet season month of January.

I have access to Central Jakarta rainfall records going back to 1864 (126 years), and it is apparent that this has been the wettest month on record during the period May to November inclusive. The monthly mean rainfall totals and extremes (1864-1989) are listed below (in mm.):

	J	F	M	A	M	J	J	A	S	O	N	D	YEAR
Mean	332	295	205	127	109	88	56	46	72	107	137	197	1770
Highest	825	746	453	406	341	288	253	369	233	327	359	569	2830
Lowest	67	80	5	19	5	0	0	0	0	0	6	59	936

These figures are based on Central Jakarta, which is marginally drier than South Jakarta. It is interesting to note that the previous extreme in August (369mm) was in 1986 (although my South Jakarta gauge recorded only 183mm in that month), and the second highest was 195mm in 1980.

Tropical rainfall is inherently variable, as illustrated by the extremes listed above. A cursory evaluation of months receiving less that 50% or over 150% of the monthly mean rainfall illustrates that variability is greatest in the dry season (73% of years in August, but only 28% in February and March). In nearly half the years, the August rainfall was less than 50% of the mean, which reflects the nature of dry season rainfall - droughts interspersed with a few heavy but often localized thunderstorms.

The first eight months of 1990 have produced 2088 mm (in South Jakarta), which is already 118% of the long-term annual mean (for Central Jakarta). If the remaining four months of 1990 produce only average rainfall, it will be the second wettest year on record. However, September has so far (18 Sept) proved to be very dry. A feature of this year has been the frequency of individual storms producing over 75 mm. I recorded a total of 18 such storms in the 12 years from 1978 to 1989, but the first eight months of 1990 have already produced 6 such events.

The records show that drought is commonplace in Jakarta, and that the drought during the 'El Nino' years of 1982-83 was far from unusual, as there have been some 18 droughts of at least this intensity since 1864. Rainfall was effectively nil for four consecutive months in 1877, 1914, 1953, 1961 and 1967. By contrast, in the wet season (December to March), the occasional dry months have generally been preceded or followed by months with at least average rainfall.

Jakarta, Java DEREK A. HOLMES

THE RAY CAHILL VIDEO FILM OF POSSIBLE BALL LIGHTNING

I would like to draw your attention to some of the comments in Mark Stenhoff's article about the possible ball lightning event at Ashford and his examination of the tapes here at TVS (*J Meteorology*, Vol 15, 141-143).

He implies that the limited experiments conducted with water drops and defocussed TV camera gave an effect that remotely duplicated what appears on the original tape. There was absolutely no correlation between the apparent movement of the features in the image and the position of the image within the camera field. All my colleagues who assisted in the attempts to reproduce the effect agree with me that it was only in the "eye of the beholder" that these were apparently seen. The senior lighting engineer and senior cameraman plus studio hands who were present strongly support me in this. The water drops when viewed looked exactly like what they were water drops and had not the closest resemblance to what appeared on the video tape.

This is not to say that ultimately it may be proved to be shown that the image thought to be ball lightning was caused by a water droplet. I merely wish to make it clear that Mark Stenhoff alone drew the highly dubious conclusions stated in his article and he is wrong to imply that any other person then present agrees with him.

I would be grateful if you would publish this fact.

Weather Department, TVS, Vintners Park, Maidstone, Kent RON LOBECK

TORRO TORNADO DIVISION REPORT:

January and February 1990

January and *February* 1990 were both unusually unsettled and often stormy months, and there was a considerable amount of tornado activity: in January three definite and two probable tornadoes, and one waterspout, were reported, while February is known to have had three definite, four probable and two possible tornadoes.

tnl990January 23. *Hawkesbury Upton, Avon (ST 7886)*

Force T2 damage was caused when a "freak whirlwind" struck Hawkesbury Upton at 0930 GMT. Tiles, guttering and gable ends were removed and windows smashed. Mr. John Bleaken said: "There was a flash of light and then the wind. It was all over in around 30 seconds" (*Dursley Gazette*, 26th January).

The tornado was probably on a cold front which crossed the area at about the right time, associated with an exceptionally deep low which was 936mbar west of the Faeroes at 0600. It was a cloudy morning in southern counties with rain, heavy in the south-west at first. At 500mbar there was a south-westerly airflow.

TNl990January 25/I. *Numphra, near S4. Just, Cornwall (c SW 384295)*

At the height of the storm which caused widespread damage in southern England a "whirlwind" lifted a 48-foot (15-metre) caravan and threw it "a quarter of a mile" (about 400 metres) N.N.E. across the fields to Dowran (SW 385301). Two girls in the caravan got out just in time, and took shelter in a farm cottage which their parents had been rebuilding. The wind sucked out and shattered virtually all the family's possessions". A second caravan was up-ended against buildings (*The Cornishman*, 1st February, sent by Rev. Alan Rowell). Force: uncertain, but presumably at least T3.

A very deep low crossed the country during the day, reaching 951mbar over Northumberland during the afternoon before deepening to 948mbar over the North Sea at 1800. At 500mbar a trough covered Britain. For a detailed account of this storm see *J. Meteorology*, 15, 197-206, May/June 1990).

TN1990January 25/II. *Dyfed*

A tornado pulled up a roof and scattered hay on a farm. Apparently the tornado was actually observed (BBC Wales News, reported to TORRO by David Reynolds).

tnl990January 25? *Langore, Cornwall (SX 2986)*

A "whirlwind" lifted a 120 by 40 foot (37 by 12 metre) shed 18 inches (46 centimetres) from its concrete base and dropped it on the side of a neighbouring shed, pushing it off its blocks. Thousands of pullets in the sheds

panicked and piled into the corners of the sheds; over 2000 were suffocated, very few being killed by the collapse of the sheds (*Cornish Post*, 3rd February). No date is given, but as the report occurs in an article about "the worst storms to hit the region in living memory" it is thought that the date was probably 25th January.

WS1990January 26. *Porlock Bay, Somerset (SS 8748)*

A waterspout was seen off Porlock Bay under a large cumulonimbus at 1600 GMT (*COL*, January 1990, p.14). A showery westerly airstream covered all areas. Many of the showers were of hail and snow even in the south, and thunderstorms were reported from north Devon and the Channel Islands during the afternoon.

TN1990January 31. *Breightmet to Walshaw, Greater Manchester (SD 7409-7711)*

A "freak thunderbolt" ripped off tiles during a thunderstorm at Breightmet, Bolton. Three houses were badly damaged, one losing nearly half its roof; six others, a caravan and car windscreens were damaged by flying tiles. Some tiles were embedded several inches in lawns. Mr. Walery Kulczycki attributed the damage to "a 'twister' wind". Another witness, Mr. Frank Kirkham, told TORRO that the tornado, which made a roaring sound, occurred at 0040 GMT; he lost almost the whole of one side of his roof, the damage amounting to over £2000. Tiles were also removed at Walshaw, 4km to the north-east, presumably by the same tornado. A witness, Mr. Paul Shaw, "saw the whirling wind coming towards him carrying bricks and all sorts" (*Bolton Evening News*, 31st January, sent by Mr. Philip Buller). Force: T3.

At 0000 a complex low lay to the west of Scotland and Ireland, with centres 952mbar. A cold front had crossed almost the whole of Great Britain very rapidly during the previous six hours. Thunderstorms occurred during the night in Wales and northern England. At 500mbar the country was in a southwesterly airstream.

TN1990 February ll/I. *Mousehole, Cornwall (SW 469263)*

"A whirlwind and thunderbolt brought devastation to the harbour area" of Mousehole. "Roofs all along the harbour front were damaged...Slates whirled down and...one chimney had to be taken down". The roof of a hotel was ripped off at Sidmouth, Devon (SY 1287), but there is no suggestion that a tornado was responsible (*Western Morning News*, 12th February). The *Cornishman* of 15th February talks of a "spiralling mass of air" at Mousehole, but it is not clear whether the tornado was actually seen or whether this is journalistic licence. The tornado "ripped through roofs, greenhouses and garden sheds, leaving a trail of devastation in its wake"; 20 roofs were damaged near the harbour, and some people experienced "doors, cupboards and drawers mysteriously being wrenched open and slammed as the whirlwind spent itself".

A vigorous low deepened as it crossed Ireland and Scotland; at 1800 its centre was 957mbar over the southern Hebrides. It was a very windy, very wet day in the south-west. At 500mbar there was a broad trough near western Ireland.

ql990 February ll. *Achill Island, Co. Mayo.*

Mr. David Meskill reported a possible tornado at Achill Island in which "a bus was blown around a number of times before being overturned" (information sent to Mr. Meskill by Mr. Martin Sweeney). More details are needed before this can be regarded as more than a possible tornado.

The depression centre mentioned in the previous entry was near Achill Island, 961mbar, at 1200.

TN1990 February 21/I. *Hull, North Humberside (TA 0928)*

Mr. Glenn Edson saw a whirlwind at Askew Avenue, Hull, at 0825 GMT. Light litter such as paper was lifted to over 10 metres with a spiralling movement. Force: TO. It became very black, with a violent wind, followed at 0838 by a sudden calm (Peter R. Jennings, *J. Meteorology*, 15, 163-164, April 1990).

The tornadoes of this date formed in an area of heavy showers with hail and thunder that crossed the country during the early morning, probably on a trough, as a cold front that had been crossing the country had reached the east coast by 0600. At 500mbar there was a slight trough near the east coast at 1200.

tnl990 February 21/II. *Stoke-on-Trent, Staffordshire (SJ 8747)*

Various BBC weather forecasts on this date mentioned that one or more tornadoes had occurred earlier in the day. The most specific information was that at Stoke-on-Trent "a sound like thunder, but which was not thunder, was heard" (Jennings, *ibid.*, p.164).

tnl990 February 21/III. *New Invention, Walsall, West Midlands (SJ 972013)*

A caravan was overturned, tiles were removed and aerials dislocated. Force: T1-2. The time was exactly 0700 GMT. The damage to the house of Mrs. S.A. Hill cost £1970 to repair. Mrs. Hill said that the tornado occurred during a burst of extremely heavy rain, with no thunder or lightning. The wind, which made a roaring noise, followed a definite path. This and the Darlaston case, reported in the Wolverhampton *Express and Star* of 21st February, were also investigated by David Reynolds.

tnl990 February 21/IV. *Oldbury, West Midlands (SO 9888)*

Two tiles were removed, a 10 by 6-foot (3 by 2-metre) shed thrown across a garden, a conifer blown down and a fencing panel removed (information from Mrs. Sylvia Redmore). The tornado made "a very unusual loud noise", and there was "severe damage" to other roofs in the area. Force: possibly T2. There was heavy rain at the time.

tnl990 February 21/V. *Swansea, West Glamorgan (SS 6494)*

A "freak whirlwind" caused considerable minor damage on an industrial estate, probably at about 0600 GMT (BBC Wales News, reported to TORRO by David Reynolds).

ql990 February 21. *Darlaston, West Midlands (SO 970974)*

Aerials were dislocated and a few tiles removed. Force: Tl. The site is 4km south of the probable tornado at New Invention. At his weather station in Wolverhampton David Reynolds recorded a violent squall just before 0700, with rain and slight hail about 0705 to 0707 GMT. At 0800 the wind was S.W. force 4, temperature 4.1°C, and the sky was clearing.

TNl990February 28. *Thurton, Norfolk (TG 3200)*

A tornado left a trail of damage 50 metres wide in Hall Road, Thurton. Roofs were partly stripped, a chicken coop picked up and smashed to pieces, and straw bales scattered about. The top of a large pine tree was carried 50 metres. The tornado was accompanied by hailstones the size of a fingernail (*Eastern Daily Press,* 1st March, sent by Dr. Charles Briscoe).

Mrs. Joan Stevens sent an excellent description of this event to TORRO. At about 1530 GMT there was "an uncanny stillness" (a feature often reported by tornado witnesses). This was followed by "a far-off sound, something akin to a distant train approaching at high speed. The sky darkened rapidly and the rushing, train-like noise, coming from the south-west, increased until it was a crescendo...The bungalow juddered violently. There was a terrible wrenching sound and the bedroom ceiling began to lift, the sky visible through it. My husband, meanwhile, had opened the door to the bathroom and was astonished to see the flat, tar-sealed roof there was gone completely, the plaster ceiling in chunks all over the floor and the contents of the bathroom...being whirled around and around in mid air... Hailstones of considerable size were now adding to the confusion". The conservatory was also demolished and some of the debris was found about 500 metres away. Most interestingly, Mrs. Stevens's adult daughter saw the tornado and described it as "a weird, smoky-grey shape (looking like a Michelin man and spinning like a top), with lightning-like bolts flashing within it". An old bedspread, found draped over a fence, was *"riddled with scorched holes, as if it had been burned all over by a hot poker"*. Force T3.

A vigorous low was crossing the country rapidly, and at 1800 GMT was off the Norfolk coast, 978mbar. The tornado may have been on the cold front, which crossed Norfolk at about 1600. There were thunderstorms in and near Norfolk during the afternoon. At 500mbar there was a strong westerly flow.

TORRO THUNDERSTORM REPORT:

February 1990

By KEITH 0. MORTIMORE

Thunderstorm Division, Tornado and Storm Research Organisation, 77 Dicketts Road, Corsham, Wiltshire, SN13 9JS

Low pressure dominated the weather during February with only a few brief anticyclonic spells. It was also very windy wlth frequent gales and everywhere it was wet. All countries of Great Britain and Ireland reported around twice the normal number of days with thunder heard while Scotland and Ireland both

approached three times the normal. With 21 days, Great Britain and Ireland as a whole reported more February thunder-days than any other since continuous records began in 1936, although England and Wales both noted more days with thunder in February 1977.

The following is a selection of other high February thunder-day totals:

Year	Engalnd	Wales	Scotland	Ireland	Great Britain and Ireland
1990	15	6	13	13	21
1977	16	11	4	7	19
1951	16	1	6	7	19
1989	10	3	12	9	18
1966	15	6	2	6	17
1960	14	3	8	7	17
1957	13	3	5	7	17
1955	15	9	2	8	17
1937	12	4	7	10	17
1988	13	5	6	5	16
1975	12	6	9	8	16
1970	11	5	10	10	16

Many places had at least one day with thunder and in western parts thunder was heard on three or four days quite widely. Southern counties east of the Isle of Wight also heard thunder on two or three days. Generally midland counties heard the least thunder, only a few observers hearing one day, and north-eastern counties, which were continuously in the shelter of the peristent westerly winds.

Thunder-days in February 1990 were as follows: (averages refer to the period 1951-1980).

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

In early hours of 1st hail showers affected parts of south-west England and south Wales and thunder was heard in north Devon, while following the passage of vigorous frontal systems, thunder accompanied evening showers in exposed parts of south-west England, Anglesey and locally in Northern Ireland.

Although England and Wales had quite a lot of sunshine on 2nd showers developed in many places and they were occasionally heavy with thunder in places, mainly around western and southern coasts, and in the Bristol Channel where activity was carried inland into the Black Mountains and the Cotswolds. During pre-dawn showers at Cardiff a sudden thunderstorm produced a powerful stroke of lightning that caused severe structural damage to a block of flats. The roof was ripped open and huge chunks of masonry were thrown to the ground, narrowly missing a milkman on his early morning round. Television sets were blown up and electricity cables burned out. An eye-witness spoke of the building being enveloped in a 'red glow'. An intense low moved northeastwards along the north coast of France on 3rd and heavy rain, with snow in places, fell over southern counties of England. Within the rain area a number of thundery cells developed along a sharp frontal trough from the Isle of Wight to Kent and south Essex. In morning of 8th there was an isolated thundery shower at St. Leonards-on-Sea (East Sussex) and in the afternoon and evening thunder accompanied showers in parts of north and west Scotland. Thunder again accompanied showers in the Western and Northern Isles of Scotland on 9th. The 10th was a wet day, as frontal systems crossed the U.K., and following the passage of a cold front showers developed widely in the afternoon and evening with thunder over coasts and hills in the west and north. Heavy rain and strong winds crossed southern Britain on 11th and the general rain area was followed by squally showers that developed into thunderstorms in a number of places in southern counties of England and Wales, in the Channel Islands and in parts of Ireland. Thundery showers continued to affect south-western counties of England and Wales into the early hours of 12th and later in the day local thunder was heard in parts of northern England and Scotland as squally wintry showers continued to develop. Thunder was heard much less widely over the next few days, affecting parts of western Scotland and the coast of Lancashire on 13th, in parts of Lancashire and Cumbria on 15th, locally in the Western Isles of Scotland on 17th and on the north coast of Northern Ireland on 18th. On 19th and 20th exposed parts of Ireland and Scotland had some thundery showers. On the latter day large hail fell at Ballina (Co. Mayo) and an R.T.E. television mast was struck by lightning to the west of Castlebar, putting it off the air for two days.

Activity was rather more widespread on 21st. Parts of western Ireland and the Western Isles of Scotland had isolated thundery showers in the early hours while later in the night and during the morning a more organised area of thundery showers accompanied a trough line eastwards across all parts of the country. Thunder was heard most widely in western parts of England and Wales and in some places the storms were accompanied by hail and quite violent squalls. On 23rd an area of thunderstorms tracked from south-west Ireland to north Wales and parts of northern England and southern Scotland. In the Short Strand area of Belfast a bolt of lightning ripped the roof off a house, thankfully without injury to the occupants and during a storm at Ardpatrick (Co. Limerick) a spectacular bolt of horizontal lightning was reported. A woman living near Kilfinane (Co. Limerick) received 8 slight shocks when

using the telephone as the lightning passed and an old-age pensioner a short distance away observed a ball of light jump between his TV set and the window. In early afternoon of 24th there were reports of thunder from near Hereford and in north Cheshire. A band of heavy rain with hail and some thunder accompanied the passage of a frontal system across the country on 25th, the thunder occurring mostly in Powys, parts of Cheshire, Lancashire and West Yorkshire and in central-southern and south-east England. There were also thundery showers in Co. Mayo in the clearer air behind the system. The 26th was an extremely windy day with severe gales right across the U.K. and Ireland. All parts had heavy, blustery showers and in some central and eastern counties thunderstorms developed in places and many were accompanied by snow and hail. There were also storms in parts of Ireland and the Northern Isles of Scotland. Some of the storms were quite active and a few continued well into the evening. Although much of the shower activity died down during the night some further thunder was reported in the early hours of 27th, especially in western and northern parts of the U.K. and Ireland. Later in the day thunder returned to parts of northern England and southern Scotland as showers again became frequent and heavy. A depression tracked eastwards across central Britain on 28th. Thunderstorms developed along a cold front as it crossed eastern counties of England in the afternoon and thundery showers affected many western parts of Ireland and Great Britain later in the day.

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

TORRO THUNDERSTORM REPORT:

March 1990

By KEITH 0. MORTIMORE

Thunderstorm Division, Tornado and Storm Research Organisation, 77 Dicketts Road, Corsham, Wiltshire, SN13 9JS.

After the very disturbed weather that predominated throughout the winter March saw a return to much quieter conditions over much of the U.K. and Ireland. High pressure was never far from southern Britain and persistent south-westerly winds resulted in significantly higher than average temperatures. However, north-west Scotland remained very unsettled and wet. Thunder-day totals reflected the overall weather pattern with much below average activity over England, Wales and Ireland and above average totals over Scotland, although it must be added that most parts of Scotland were equally quiet and five of the six days saw thunder confined to the Northern and Western Isles.

Northerly winds covered the British Isles on 1st and snow or hail showers developed widely. Snow showers were particularly heavy in the late afternoon and evening and some quite sharp thunderstorms affected the north-east of England, especially over hills and moors near the coast with good exposure to the northerly winds. During a storm at Gateshead lightning damaged a

Thunder-days in March 1990 were as follows: (averages refer to the period 1951-1980).

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

switchboard at a local radio station. Isolated thunder was also heard in Cambridgeshire, over the Mendip hills in Somerset and at Falmouth (Cornwall) and in the Channel Islands. Thundery, wintry showers affected the Northern Isles of Scotland on 5th and 11th and an advancing cold front set off a thunderstorm in Co. Antrim in the evening. On 19th thunder was again heard in the Shetland Isles, on 21st there was thunder in Skye and on the north coast of Scotland and on 22nd the Northern Isles were again affected.

A cold front crossed all parts of the U.K. and Ireland on 24th followed by much colder weather with wintry showers. The Northern and Western Isles heard thunder in showers very early in the day, parts of western Scotland were affected in the morning,there was thunder in Clwyd in the afternoon and there were thundery showers in the Manchester area and at Gatwick in the evening. With a cold upper trough lying just to the east of Britain eastern counties were affected by their first significant thunderstorm outbreak of the month on 25th. Hail also fell widely during thunderstorms that affected the counties of Greater London, Essex, Kent and Sussex throughout the morning and into the early afternoon.

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

WORLD WEATHER REVIEW: February 1990

United States. *Temperature:* mostly warm (January and February combined were the warmest since before 1895); +5degC in Tennessee and Kentucky. Cold from Pacific coast to S.W. Idaho, Utah and W. New Mexico; N. Maine, Hawaii; in and near E. Colorado; -3degC in S.E. Oregion and N.W. Nevada. *Rainfall:* generally wet S.E. of a line from Arizona to Michigan (except S. New Mexico, extreme W. Texas and much of E. coast); also parts of Nevada, Utah and Wyoming; coastal Washington and Oregon. Over 200% across a very large area from C. Texas and S.E. Colorado to L. Erie and W. North Carolina; S.E. Wyoming, N Arizona, S.W. Utah. Dry elsewhere; under 50% in extrme W. Texas, S. New Mexico, in near S. California; N. California to parts of Dakotas, E. Nebraska and W. Iowa; N.W. Hawaii; round Delaware Bay.

Canada and Arctic. *Temperature*: warm in extreme S. Canada (except British Columbia); N.E. Greenland and Jan Mayen to Franz Josef Land;+3degC in Spitzbergen adn Franz Josef Land. Cold elsewhre; -3degC from Alaska through most of Canada to W. Greenland; -7degC in S. Baffin Land and S. Labrador; -11degC in W. Alaska. *Rainfall*: wet in S. and C. Alaska; Great Lakes to Montreal; Newfoundland, N. Iceland, extreme N. Greenland; Melville Island to E. coast of Hudson Bay; much of area from S. British Columbia to N. Manitoba. Over 200% in S. Alaska, Melville Land, Baker Lake, extreme N. Iceland. Dry elsewhere; under 50% from exterme N. Alaska to N. British Columnis; S.E. British Columbia to S.W. Manitoba; S. end of Hudson Bay; Spitzbergen and W. Iceland through most of Greenland to Baffin Island and adjacent mainland.

South and Central America. *Temperature*: warm in S Brazil, C. and most of N. Chile, C Argentina, La Plata estuary, Bermuda, Bahamas; most of Mexico to W Honduras; most of West Indies; +2degC in N.E. Mexico, Bahamas, Cuba; locally in E. Brazil, C. Chile. Cold from Bolivia and extreme N. Chile to N. Argentina, N.W. Uruguay and extreme S. Brazil; N.W. Mexico, Barbados; -2degC from E. Bolivia to E. Paraguay. *Rainfall:* wet in Uruguay, extreme S. Brazil, E. Yucatan to E Honduras; Cuba; most of N. and C. Argentina; parts of S. coastal and C. Mexico and S.W. and N.E. Bolivia. Over 200% in and near Uruguay; S. coastal and C. Mexico; locally in N.W. and C. Argentina and E. Yucatan. Dry in W. and S. Bolivia, N. and C. Chile, S. Brazil, Paraguay, in and near Buenos Aires province (Argentina), Bermuda, Bahamas; most of Mexico to W. Honduras; most of West Indies. Under 50% in N. Chile, interior S. Brazil, round Rio de Janeiro, Bahamas; much of Mexico and West Indies; locally in W. Buenos Aires province.

Europe. *Temperature:* warm everywhere, exceptionally so in may areas; +3degC everywhere except Ireland, Scotland, Portugal, S Spain, S. Italy, in and near Greece; +6degC from N.E. Germany to Kola Peninsula and C. Urals; +10degC from White Sea to Moscow. *Rainfall:* mainly wet; over 200% across a very wide area from W. Austria and Switzerland through W. Germany, N. France and Low Countries to much of British Isles, then through S. Norway and S. Sweden to Finland and much of N. European Russia; C. Czechoslovakia. Dry in Portugal, Spain, S. coastal France, Italy, Jugoslavia, Greece, Bulgaria, Romainia, Hungary, S.E. European Russia, C. Norway, E. Poland. Under 50% widely in all these areas except perhaps last two. Provisional sunspot number 128.

Africa. *Temperature:* warm from Madeira and Canary Islands to Libya; W. Namibia, W. and S. Cape Province; +2degC from W. Morocco to Tunisia. Cold in Egypt, Botswana; most of South Africa; -1degC locally from E. Botswana to C. Cape Province. *Rainfall:* wet in N. Egypt; S.W. Cape Province to S.W. Transvaal. Over 200% locally in N. Egypt and W. Cape Province. Dry and Madeira and Canary Islands to Libya (mostly rainless); Namibia, Botswana, N. and E Transval, Natal, S.E. and extreme N. Cape Province (all under 50% at least locally).

Asian U.S.S.R. *Temperature:* mostly warm; +7degC in C. Urals and E. of L. Baikal. Cold from Lower Yenisey basin to W. Lena basin, and in N.E.; -10degC near Bering Sea. *Rainfall:* mostly wet; over 200% in upper Ob and upper Yenisey basin; lower Amur basin almost to L. Baikal. Dry in N.E. (except Bering Sea Coast), S.of Taimyr Peninsula, near W. Mongolian border, N. Caspian Sea to Aral Sea; under 50% in all these areas.

Asia (excluding U.S.S.R.). *Temperature:* warm in S.Arabia, S. and E. India, Mongolia, Japan, Korea, Thailand, Cambodia, Malaya, Borneo, Philippines; much of China; +4 deg C in N.E. China, Mongolia, N.Korea, S.Japan and much of Mongolia. Cold from Turkey to N.Arabia; Pakistan, N. and C. India; parts of S.China; -2 deg C in interior E.Turkey; Israel to N.Arabia. *Rainfall:* wet in S.Turkey, in and near extreme N.Arabia; S.Arabia, Pakistan, N.India, Korea, N.E. Thailand, Laos, S.Malaya, N. and S. Sumatra; most of China and Japan. Over 200% fairly widely in all these areas except perhaps S.Turkey, S.Malaya and N.Sumatra. Dry in N.Turkey, C. and N.W. Arabia, S.India, N.China. Mongolia, W. coastal Japan, N.Malaya, C.Sumatra, Philippines; most of Thailand. Under 50% widely in all these areas except perhaps Japan.

Austraila, *Temperature:* warm in N. half; +2 deg C in parts of Queensland. Cold elsewhere; -2 deg C in interior S.W. Rainfall: wet on and near S. and S.E. coasts from Perth to Brisbane; over 200% in S.E. and extreme S.W. Dry elsewhere mostly under 50%.

M.W.R.

WORLD WEATHER REVIEW: March 1990

United States. *Temperature:* warm almost everywhere (10th warmest March since 1895); +4degC from N.E. Montana to E. South Dakota. Cold in C. Hawaii and locally in S.W. Texas, but rarely by 1degC. *Rainfall:* wet from W. Montana and N. Michigan to S.E. New Mexico and Louisiana (except E. Montana to E. South Dakota); over 200% widespread; also Louisiana to S. Virginia (over 200% in S. Alabama). Dry elsewhere; under 50% in E. Montana, S.W. North Dakota, N. and W Florida, S Georgia, N. Kentucky to Pennsylvania; coastal Maine to Boston; much of area from California to E. New Mexico; Honolulu. Tornado total 130, second highest March total since good records began in 1953.

Canada and Arctic. *Temperature:* mostly warm; +6degC from N. Manitoba and E. British

Columbia to Mackenzie estuary. Cold from Quebec and Nova Scotia to Iceland, S. half of Greenland, Sptizbergen and W. Jan Mayen; -3degC in Newfoundland and W Iceland. *Rainfall:* wet in W Alaska; S. Alberta to Ontario then N. to Canadian Arctic islands, Greenland and most of Iceland. Over 200% in W. Alaska; S.E. Saskatchewan to W Ontario; much of Canadian Arctic. Dry elsewhere; under 50% from E. Alaska to N. Saskatchewan; S. Quebec, S. Labrador, Maritime Provinces.

South and Central America. *Temperature:* warm in E. Bolivia, S. Brazil, Paraguay, parts of N.W. Argentina; Mexico to W. Honduras; West Indies, Bermuda, Bahamas; +2degC in E. Brazil, W. and N.W. Mexico, Bermuda. Cold in S.W. Bolivia, C. and N.E. Argentina, Uruguay, extreme S. Brazil, parts of S. Mexico (all - 1degC). *Rainfall:* wet in N.E. Paraguay, S. and S.W. Brazil, Uruguay, Puerto Rico, E. Mexico to Honduras; much of N. and C. Argentina. Over 200% rather widely from N.E. Mexico to Honduras and in N. Uruguay; locally in the other areas, except perhaps Paraguay and Puerto Rico. Dry in E. Brazil, Bolivia, N and C. Chile into Argentina; Buenos Aires province (Argentina), S. and N.W. Paraguay, N.W. Mexico to S.W. Honduras; Bermuda, Bahamas; much of West Indies. Under 50% locally in E.Brazil, N.W. Paraguay and Buenos Aires province; widely in W. and N.W. Mexico and other areas.

Europe. *Temperature:* warm or very warm everywhere +5deg C from S. Sweden, Poland and Romania to all of European Russia except parts of extreme N. and S.; +7degC from S. Urals almost to Polish boarder. *Rainfall:* wet in W. Scotland, W. Ireland, Finland, N.E. Poland; most of Norway and European Russia; parts of N. Sweden. Over 200% in W. Scotland, S.W. Norway, S. Finland to S Urals; N. Urals to White Sea. Dry elsewhere; under 50% in E. Scotland; S.E. Ireland and S. England to most of Spain, Portugal and France; C. Italy, S Yugoslavia, Greece, Bulgaria, Romania, E. Czechoslovakia, E. Hungary, S Ukraine, lower Volga bain; locally in Germany, S. Poland, W. Switzerland. Provisional sunspot number 141.

Africa. *Temperature:* warm from Madeira and Canary Islands to Tunisia; N. of South Africa and adjoining areas: +2degC from Madeira and Canary Islands to N.W. Algeria. Cold in Egypt; S. Cape Province to Natal (-1degC locally in both areas). *Rainfall:* wet from S.E. Cape Province and S. Natal to Transvaal and W. Botswana; locally in S.W. Morocco; rarely over 200%. Dry from most of Morocco to Egypt; S Namibia, W. Cape Province.

Asian U.S.S.R. *Temperature:* warm or very warm everywhere; +8degC generally away from coasts and borders; +12degC from C. Siberian Plateau to C. Lena and upper Amur basins. *Rainfall:* mostly wet; over 200% from S. Urals to W. Lena basin. Dry from S. Caspian Sea to L. Balkhash; N.E. (except Bering Sea coast) to Sakhalin then W. to Mongolian border; under 50% widespread.

Asia (excluding U.S.S.R.) *Temperature:* warm generally from Turkey to Middle East; S.E. India, Korea, Japan, S. Thailand, Cambodia, S. Vietnam, Malaya, Philippines, most of China; +5degC in E. Arabia; +6degC in E. Mongolia and N.E. China. Cold from Cyprus to N.W. Arabia; Pakistan, Bangladesh, S.W. China. Cold from Cyprus to N.W. Arabia; Pakistan, Bangladesh, S.W. China, N. Thailand to N. Vietnam; most of India; -2degC in N. and N.E. India, Bangladesh; locally in Pakistan. *Rainfall:* wet from S. Turkey to Jordan; C. Arabia, E. coastal India, Bangladesh, W. Cambodia, N.E. Thailand, N . Laos, N. Vietnam; most of China, Korea and Japan; locally in Pakistan. Over 200% in C. Arabia, E. coastal India, Bangladesh, N. and S.E. China, W. Cambodia, N.E. Thailand. Dry in N. Arabia, extreme N.E. and S.E. China, E. Cambodia, S. Laos, S. Vietnam, Philippines; most of Turkey, India, Thailand, Malaya, Sumatra and Borneo; parts of Japan and Pakistan. Under 50% in all these areas except perhaps Japan; widely in Turkey, W. and N. India and Philippines.

Australia. *Temperature:* warm everywhere except marginally in S.E. Queensland and N.E. New South Wales; +2degC in N. *Rainfall:* wet in N.E. and extreme S.W. (over 200% in both); elsewhere mainly under 50%

New products

"WIND TRACKER 500"

Weather-Data of Rugby have announced the launch of the "Wind Tracker 500", a revolutionary new product to be used for the accurate tracking of airborne pollution. Based on the popular Windscope 500 range the Wind Tracker 500 is a completely self-contained, portable, battery or mains operated,

wind-analysis instrument. Using the new WD401 high density Polyethylene sensor, information is sent to the Wind Tracker 500. This information is recorded in the memory section of the instrument together with the date and time. The Wind Tracker 500 will store these data for over 35 days.

If the instrument is connected to a dot matrix printer, it will create and print a continuous chart record of the wind functions. Several powerful options make this instrument stand out, one is the option to chart records direct to the printer and to produce a wind plot which gives the direction of the wind and the distance it has travelled during a user set period. Unique to this instrument is the ability to plot the wind direction against time, so that the user may know when the wind was in a certain direction. This will save many previously wasted man hours waiting for a pollution problem to occur. If a printer is not connected, the instrument may be used in the logger mode and data can be downloaded to a PSION organiser or any IBM compatible PC. This information can be stored in a file on disc. There is a powerful graphics package supplied with the instrument which allows one to chart records or draw graphs or plot the wind vectors. It will be an invaluable tool for effective policing of the new pollution-control regulations which are coming into effect this year.

The Wind Tracker 500 is available from Weather-Data, c/o Peter Ritchings, 51/53 Albert St, Rugby, Warks, CV21 2SG. Tel. 0788 537575; Fax 0788 537511.

WEATHER SUMMARY: July 1990

July 1990 was a sunny and very dry month, and after a cool and unsettled start it became fine and very warm in all parts. Mean temperatures were in the region of one and a half degrees Celsius above the normal in central areas of Britain but much closer to the normal near coasts. By 11th temperatures were quite widely rising into the mid-twenties and 27.0° was recorded at Galway (Eire) on 13th. On 19th 27.7° was recorded at Dyce Airport, Aberdeen and 26.1° at Edinburgh, on 25th Glasgow reached 26.1° and on 26th 27.9° was recorded at Inverdruie (Highland). Over England and Wales the warmest day was generally the 21st with 33.0° at Epsom Downs (Surrey), 32.8° at Romsey (Hants) and 32.4° at Guildford and Reigate (Surrey). In the Channel Islands the temperature rose to 33.9°C at St. Helier (Jersey). The London Weather Centre was credited with the month s highest minimum, 19.7° on 20th, while on 21st Hastings (East Sussex) recorded 19.4°. In Scotland Glasgow recorded a minimum of 16.0° on 30th. Maxima were at their lowest early in the month and included 9.4° at Cape Wrath, 11.5° at Inverdruie, 14.3° at Aspatria (Cumbria) and 14.6° at Lyneham (Wiltshire) on 1st, 9.9° at Lerwick and 13.9° at Aberporth (Dyfed) on 2nd and 12.6° at High Bradfield (South Yorkshire) on 9th. Surprisingly the lowest temperature of the month closely followed the highest when, on 23rd, the temperature fell to 0.9°C at Glenlivet (Grampian) and 1.4° at Inverdruie, while as the cooler air spread south Buxton (Norfolk) recorded 3.3°C on 25th. The 3rd saw the most widespread low minima with 1.4° at Eskdalemuir, 2.1° at Aberdeen, 3.6° at Epsom Downs and 4.3° at Hurn Airport, Bournemouth (Dorset). Lowest grass minima included -2.6° at Buckingham and -2.4° at Straide (Co.Mayo) on 3rd, -4.0° at Inverdruie and -

2.0 at Glenlivet on 23rd and -1.8° at East Hoathly (East Sussex) on 25th. Rainfall totals were widely below 50 percent of the July normal and in the south-east it was particularly dry with less than 15 percent in places and as little as 8 percent at Eastbourne (East Sussex). Some places in the west were not as dry and monthly totals exceeded the normal in a few spots. Daily falls of note were 34.1 mm at Stornoway on 3rd, 37.3 mm at Kilmory (South-west Highland) on 7th and 35.2 mm at Stithians (Cornwall) on 29th. On 4th central Lakeland (Cumbria) received copious amounts of rain. Coniston recorded 57.4 mm and some 60-70 mm fell in the fells. All parts of the U.K. had a very sunny month and there were few places with less than 150 percent of the normal.

A depression tracked across Scotland early on 1st, giving all parts a cool, windy day with showers, but on 2nd and 3rd, as the low moved away into Scandinavia, the weather became drier and quite sunny. During 4th and 5th, as a deep depression and associated frontal systems crossed the U.K., all parts had a spell of wet and windy weather with a lot of rain in the north and west. A warm front spread some warm and very humid air across Britain on 6th accompanied by spells of rain in the west but on 8th and 9th cooler, showery conditions followed a cold front across the country. Pressure rose across Britain on 10th and by 11th it had become sunny and very warm, particularly in the south. Over the next few days an anticyclone was the dominating feature of the weather and sunny hot weather affected much of the country. By 15th temperatures were rising into the thirties in the west midlands but northern districts became temporarily cooler with some rain, and thunderstorms developed in parts of the south. Between 16th and 26th the weather was generally fine, sunny and very warm and it was hot between 19th and 21st with temperatures into the low thirties. However, it became less hot from 22nd and in the fresher air there were some chilly nights in the north and east from 23rd to 25th. Frontal systems pushed into the south-west on 27th, giving rain in places, and on 28th and 29th further fronts gave some rain in the west, heavy in places. High pressure over Europe kept eastern counties drier with some sunshine and it remained warm in all parts. On 30th a cold front crossed the British Isles from the west but sunny very warm weather returned on 31st as a new anticyclone developed over the country.

K.O.M.

NOTICE TO ALL TORRO OBSERVERS RE STORM CHASING

Observers are requested to report all occurences of tornadoes and damaging hail as soon as possible in order that site investigations may be made before damage is repaired/cleared up. Reports of severe squalls on cold fronts, heavy or violent thunderstorms, tornadoes, waterspouts and damaging hail actually occurring or just after their occurrences are particularly valuable because a storm-chasing team could be dispatched.

Observers should make reports to me on (0792) 205678 Ext 4229 between 09.30 - 12.30 and 13.30 - 16.30 hours clock time, weekdays only until further notice.

David Reynolds (TORRO), Dept of Geography, University College of Swansea, Singleton Park, Swansea, West Glamorgan SA2 8PP.

DAVID REYNOLDS

TEMPERATURE AND RAINFALL: JULY 1990

	Mean				Grass					
	Max	*Min*	*Max*	*Min*	*Min*	*Rain*	*%*	*Wettest*	*RD*	*Th*
BELGIUM: Uccle	23.0	12.5	30.5(27)	7.7(4)	2.7(4)	30.4	41	11.1(7)	11	–
" Rochefort	23.2	8.4	30.0(31)	3.6(4)		36.9	45	9.1(5)	10	–
" Liège	23.6	12.9	31.6(27)	9.2(24)		42.4	54	10.0(5)	11	–
DENMARK: Fanø	19.1	13.1	28.3(28)	9.8(14)		43.5	68	20.0(5)	12	1
" Frederikssund	21.1	13.7	27.4(28)	9.9(2)	7.3(3)	50.7	77	14.6(6)	10	1
GERMANY: Berlin	22.7	12.4	31.5(29)	8.5(14)	7.0(14)	21.3	34	7.5(3)	9	2
" Hamburg	20.8	12.0	30.9(28)	6.3(4)	2.0(4)	47.8	55	19.8(6)	11	4
" Frankfurt	25.0	12.9	34.6(28)	8.4(24)	6.1(24)	21.5	33	8.1(5)	9	1
" Munchen	23.4	11.1	30.9(29)	6.9(12)	3.6(12)	76.7	60	25.7(3)	11	3
ITALY: Casalecchio	29.4	18.2	34.0(v)	14.0(13)	13.0(13)	78.5	238	42.0(18)	5	3
MALTA: Luqa	31.6	21.7	35.2(25)	19.1(14)	15.2(23)	1.9		1.9(13)	1	1
NETHERLANDS: Ten Post	20.0	12.2	27.9(28)	7.2(2)	3.7(14)	59.1	66	12.0(6)	11	3
SWEDEN: Valla	21.2	11.4	29.0(28)	6.0(v)		77.2		13.6(9)	20	4
SWITZ'LAND: Basel	25.8	13.0	35.0(28)	7.2(7)		95.7	112	31.6(29)	9	3
EIRE: Straide	20.0	11.4	25.6(3)	5.2(3)	−2.4(3)	61.0	81	14.5(27)	15	0
" Mt. Russell,	19.8	11.7	24.8(13)	7.1(3)	0.9(3)	56.7		12.2(26)	10	1
Lim'k	14.3	9.9	20.0(30)	6.2(7)	0.0(7)	49.2	84	9.2(10)	17	0
SHETLAND: Whalsay	13.1	10.0	16.7(30)	7.9(2)	4.4(23)	43.2	81	11.8(15)	17	1
" Fair Isle										
SCOTLAND: Braemar	18.1	8.3	24.7(19)	3.3(24)	2.6(24)	51.7	85	21.1(1)	15	0
" Inverdruie	20.0	8.4	27.9(26)	1.4(13)	−4.0(23)	30.7	41	7.1(8)	13	0
" Rannoch	18.4	4.6	24.5(26)	0.1(14)	0.1(14)	52.6		18.2(6)	13	0
WALES: Velindre	22.3	10.8	29.0(20)	5.2(3)	1.8(3)	21.4	38	7.0(29)	7	0
" Carmarthen	21.2	12.1	26.8(13)	7.4(2)	5.0(2)	64.6	74	24.7(3)	8	0
" Gower	21.2	12.9	27.5(20)	8.7(2)	5.4(2)	42.1	55	16.3(3)	8	0
GUERNSEY: Airport	20.5	13.9	29.4(21)	10.0(3)		17.3		6.8(3)	6	0
JERSEY: Carrefour/Clq	22.9	13.2	32.6(21)	9.0(11)		20.4		5.0(6)	7	0
ENGLAND:										
Denbury, *Devon*	22.8	12.3	31.5(21)	6.9(11)	3.8(3)	48.7	120	28.9(29)	9	0
Gurney Slade, *Som*	22.8	10.6	29.8(20)	4.0(3)	2.5(3)	81.3		33.2(29)	10	0
Yatton, *Avon*	23.9	11.8	29.4(13)	4.0(3)	1.9(3)	40.9	77	16.9(29)	9	0
Mortimer, *Berks*	24.5	11.2	34.0(21)	5.4(3)	1.9(3)	12.0	25	6.8(4)	6	0
Reading Univ, *Berks*	23.8	12.0	32.0(21)	7.0(3)	−1.8(3)	9.5	23	6.2(4)	4	0
Sandhurst, *Berks*	24.1	10.8	32.8(21)	4.4(3)	−0.5(3)	7.6	12	3.1(4)	4	0
Romsey, *Hants*	24.5	10.7	32.8(21)	5.9(11)	2.2(2)	11.3	25	8.8(4)	3	0
Brighton, *Sussex*	22.5	12.8	31.1(21)	8.5(3)	7.3(3)	12.3	21	6.4(4)	7	0
Hastings, *Sussex*	21.5	12.9	28.9(21)	9.0(6)	5.8(6)	18.1	36	7.9(1)	4	0
Dover, *Kent*	22.0	11.7	28.2(20)	5.8(25)		15.4	22	6.4(6)	5	0
East Malling, *Kent*	23.4	11.2	30.0(20)	5.4(25)	1.0(25)	7.7	14	3.4(6)	8	0
Epsom Downs, *Surrey*	24.2	10.7	33.0(21)	3.6(3)	0.9(3)	10.4	24	6.0(4)	7	0
Reigate, *Surrey*	24.3	11.1	32.4(21)	6.2(2)	5.1(24)	11.2	21	5.4(4)	5	0
Guildford, *Surrey*	23.8	12.1	32.4(21)	7.7(3)	5.5(3)	8.5	18	4.5(4)	5	0
Sidcup, *London*	23.9	12.5	31.5(20)	8.0(25)	3.5(25)	9.4	18	4.0(6)	5	0
Hayes, *London*	24.3	12.3	31.3(20)	6.4(3)	4.6(3)	9.2	20	5.2(4)	5	0
Hampstead, *London*	23.0	12.5	30.2(20)	8.1(3)	1.5(25)	15.2	27	5.6(6)	6	0
Royston, *Herts*	23.8	12.0	30.5(20)	6.9(3)	2.9(3)	12.6	24	5.2(4)	6	1
Loughton, *Essex*	23.9	11.5	30.5(20)	7.2(25)	3.1(11)	22.4	45		8	0
Buxton, *Norfolk*	22.0	10.4	30.4(20)	3.3(25)	1.5(25)	23.2	42	8.2(4)	8	0
Ely, *Cambs*	23.7	10.3	32.0(20)	4.0(3)		21.7		6.5(4)	9	0
Luton, *Beds*	23.9	11.7	31.1(21)	3.4(3)	−0.5(3)	19.6	35	8.6(6)	6	0
Buckingham, *Bucks*	24.2	10.4	32.1(20)	2.4(3)	−2.6(3)	18.6	31	8.1(4)	4	0
Oxford University	23.8	12.2	31.1(21)	6.3(3)	−0.1(3)	17.7	29	8.1(29)	6	–
Birmingham Univ	22.6	11.3	29.8(20)	4.5(3)		27.1		6.6(4)	10	1
Wolverhampton, *W. Mid*	22.8	11.9	30.1(20)	7.9(2)	2.0(3)	32.0		7.5(4)	7	1
Louth, *Lincs*	21.5	10.9	29.3(30)	5.7(24)		15.4		12.1(4)	7	0

Keyworth, *Notts*	22.5	11.4	30.0(20)	6.4(24)	1.9(24)	28.3		7.0(4)	9	1
Nottingham, *Notts*	23.0	11.9	30.6(20)	7.4(3)	5.0(3)	27.2	55	10.7(4)	9	0
Derby, *Derbys*	–	–	29.6(20)	8.5(2)		29.8	54	9.4(4)	–	1
Middleton, *Derbys*	19.2	10.7	26.1(20)	6.5(3)		39.3	78	20.4(4)	10	1
Keele Univ, *Staffs*	20.7	11.3	28.0(20)	5.9(3)	1.5(3)	32.1	43	9.4(6)	10	1
Liverpool, *Mersey*	22.2	12.9	28.6(19)	9.0(3)		26.5	36	10.3(3)	9	0
Lathom, *Mersey*	20.4	11.6	26.8(19)	2.1(3)		31.7		10.7(3)	8	–
High Bradfield, *S. Yorks*	18.3	9.2	27.1(20)	5.3(2)		32.5		7.8(4)	11	–
Cottingham, *H'side*	22.4	11.2	30.1(20)	6.7(24)	4.0(24)	19.5	40	9.3(4)	8	0
Carlton-in-Cleveland	21.1	10.8	28.1(20)	4.8(24)	2.2(24)	25.5		9.6(4)	9	0
Durham Univ, *Durham*	20.6	9.7	28.0(20)	3.1(24)	1.3(24)	30.9	62	11.7(4)	7	–
Sunderland, *Tyne & Wear*	19.2	12.3	28.5(19)	8.3(3)		21.8	44	8.6(4)	6	1
CANADA: Halifax, *NS*	23.7	14.3	31.2(18)	9.5(2)		61.8	64	20.6(23)	12	0
U.S: Bergenfield, *NJ*	28.8	19.1	34.4(4)	13.3(13)	13.3(13)	112.0		31.2(1)	9	5
JAMAICA: Kingston	33.2	25.5	34.6(3)	22.9(17)		29.9	173	19.8(28)	5	–
" Montego Bay	32.0	24.1	33.7(3)	22.3(12)		38.6	72	13.5(7)	9	11
AUSTRALIA: Leopold, *Vic*	14.3	7.3	18.0(24)	3.0(6)		69.3	133	30.5(18)	14	1

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FRONT COVER

Wave cloud over Manchester, looking north-west, 2040 B.S.T. on 10 May 1987; photograph by Nigel Chatfield.

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