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A BRIEF NOTE ON THE INTENSE DEPRESSIONS OF LATE DECEMBER 1999 OVER WESTERN EUROPE

By PAUL R. BROWN

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In a statistical survey of depression depths (Brown 1996) I found there to be on average about five days a year with centres below 950 mb in the North Atlantic/European region, all of them between September and April, and most of them in the zone between Newfoundland and the Norwegian Sea (although as this study used only one chart per day the results may err slightly on the low side). It is rare for a depression of that depth to cross the British Isles. As far as can be estimated from a few occurrences, the frequency seems to be about once in 10-15 years. The main dates of occurrence in the last 30-odd years have been 1 December 1966, 20 December 1982, and 16/17 December 1989, together with a few other borderline cases when the pressure was within a millibar or two of 950. On the night of 24/25 December 1999 a depression deepened below 950 mb while crossing the British Isles into the North Sea. By coincidence this was the third year in a row with an intense depression over the British Isles at Christmas time - 1997/8 having had such an occurrence on 24 December, and 1998 on 26th; but while the 1999 one was ultimately the deepest of the three, the gales associated with it seem to have been not quite as severe as with the other two.

The system developed in the southwest approaches as a secondary depression on a vigorous cold front which had crossed the British Isles from the west during 23/24 December. At midday on 24th it was about 976 mb just off Valentia (southwest Ireland), where pressure was falling 81 (8.1 millibars in 3 hours) with heavy rain. Deepening rapidly and moving quickly northeast across Ireland it reached Dundalk Bay on the east coast by 1800 GMT, central pressure by then down to 957 mb (pressure falling 163 at Long Kesh in northeast Ireland, with heavy rain). By midnight it had crossed to the east coast of Scotland near Montrose, with centre 946 mb (pressure at Dyce 948.0 mb and falling 172, with heavy rain). It deepened a further few millibars as it turned north through the northern North Sea during the morning of 25th (at 0600 GMT Lerwick had a force 9 northwesterly gale with heavy rain, and pressure 945.9 mb), until at midday on 25th Central Forecasting Office, Bracknell, analysed it down to 938 mb midway between Shetland and Norway, supported by several actual reports of pressures around 940 mb from out over the sea.
Twelve hours later, at 0000 GMT on 26th, another deepening secondary, of 981 mb, was in the southwest approaches, but this time heading due east along 49°N (pressure falling 104 at Ushant, northwest France). Travelling at over 70 knots, the centre (969 mb) was north of Paris at 0600 GMT, where Orly reported pressure falling 190. By midday it was just past Frankfurt (972 mb), whence it continued east northeast across Poland, slowly filling. Following close behind this low, but unconnected with it, a vigorous squally trough moved quickly east across France during the afternoon of that same day.

At 1200 GMT the next day (27th) yet another secondary was pursuing the same course through the southwest approaches, with central pressure around 972 mb, giving a pressure fall of 113 at Brest. Six hours later it had moved into northwest France between Nantes and Rennes, and deepened to 963 mb (pressure falling 150 at Tours). By 0000 GMT on 28th it was in eastern France approaching Dijon, but by then having filled a few millibars to 967. Behind it, pressure was now rising 206 (7 millibars per hour) at Tours. As they passed their points of greatest depth, when the rates of pressure change at the centres, both these French lows developed ferocious pressure gradients on their western flanks, with theoretical geostrophic winds of at least 150 knots (over a small area). At one stage there was a pressure difference of 48 millibars from northeast to southwest across the Bay of Biscay. Taking a slightly more southerly track than its predecessor, this latest depression ran up against the barrier of the Alps, at which point it split, so that by 0600 GMT on 28th the original was near Munich (980 mb) while a new centre of 975 mb had formed in the Gulf of Venice. Subsequently this new one moved east northeast across northern Yugoslavia to the Ukraine, while the other continued to fill.

These two intense secondaries of 26 and 27 December barely affected the British Isles, other than to give some rain in the far south; but they wreaked havoc on the continent, where the intensity and the speed of movement of the systems combined to produce widespread gusts of 60-90 knots in a broad swath between 43 and 49°N from the coasts of Biscay right through France and upper Germany and down to the Mediterranean coasts. Some of the reported gusts from the synoptic stations between 24 and 28 December are listed below.

<table>
<thead>
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<th>DATE/TIME (GMT)</th>
<th>24/1800</th>
<th>25/0000</th>
<th>25/0600</th>
<th>25/1200</th>
<th>26/0600</th>
<th>26/1200</th>
<th>26/1800</th>
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Fig. 1 Synoptic charts for midnight 25 and 28 December 1999 (from Daily Weather Summary of the London Weather Centre, by permission of the Meteorological Office).
around 80 knots in Shetland, Orkney, and Lewis.

REFERENCE


AN ANALYSIS OF HEAVY SNOWFALLS/BLIZZARDS/ SNOWSTORMS AND SNOWFALLS GREATER THAN 13 CM ACROSS GREAT BRITAIN BETWEEN 1861 AND 1996

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the Geography Department, University of Derby, Kedleston Road, Derby, DE22 1GB

and TORRÓ (Director of Blizzards and Heavy Snowfalls Division) and
GREG O’HARE and ROBERT WILBY

Geography Department, University of Derby, Kedleston Road, Derby, DE22 1GB

Abstract: As pointed out in our previous article (Wild et al. 1996), further research was in progress to update information that was presented in that paper. Some of that research has now been updated. The previous paper showed occurrences of blizzard/major snow events over the British Isles, covering the period 1880-1989. This new research has covered the period and the area covered to be changed. This now just covers Great Britain and the period has been lengthened to 1861-1996.

INTRODUCTION

After reviewing Met Office Daily, Monthly and Annual Weather Reports, publications like British Rainfall, the Snow Survey of Great Britain, most academic and meteorological journals, and miscellaneous material such as personal conversations, newspaper cuttings and letters, 1107 days have been found where a heavy snowfall/blizzard/snowstorm or snowfalls greater than 13cm occurred over Great Britain between 1861 and 1996 (Wild 1996).

The year 1861 was chosen as the first year of this study, to coincide with the start of Lamb’s day classification. For dates to be included in this new research, the following criteria have been set:

1. 13 cm (5 inches) or more of snow must have freshly fallen somewhere in Great Britain in 24 hours (not accumulated depths).

2. A particular snow event has been described as a blizzard or a snowstorm.

3. The snow event has been described as heavy (for a date to be included the term ‘heavy’ describing a snow event is only used where the other two criteria above are not known, especially on dates in the early part of this study where the word blizzard was not officially used to describe a snowstorm and/or where snow depth

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**Table:**

<table>
<thead>
<tr>
<th>Location</th>
<th>Snowfall (cm)</th>
<th>Wind Speed (knots)</th>
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<tbody>
<tr>
<td>Chassiron</td>
<td>99</td>
<td>60</td>
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<tr>
<td>Limoges</td>
<td>68</td>
<td>80</td>
</tr>
<tr>
<td>Clermont-Ferrand</td>
<td>60</td>
<td>86</td>
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<td>Bordeaux</td>
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<td>Millau</td>
<td>62</td>
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<td>Tarbes</td>
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<td>Toulouse</td>
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<td>72</td>
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<tr>
<td>Oviedo</td>
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<td>79</td>
</tr>
<tr>
<td>Santander</td>
<td>93</td>
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<tr>
<td>San Sebastián</td>
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<td>60</td>
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<tr>
<td>Stuttgart</td>
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<td>Straubing</td>
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<td>Augsburg</td>
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<td>Switzerland</td>
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<td>Zurich</td>
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<td>Austria</td>
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<tr>
<td>Czechoslovakia</td>
<td>60**</td>
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</tr>
</tbody>
</table>

*Station unmanned at time of report
**Converted from metres per second by doubling

The 99-knot gust reported from Chassiron at 1800 on 27th requires comment. It is by no means impossible - this station was within the very tightest part of the pressure gradient - but shamefully the station was unmanned at this most crucial hour, and the current mean wind was given, obviously wrongly, as calm. Also, for stations reporting in knots, 99 is the highest speed that the synoptic code allows for, so anything above this value can only be reported as 99.

A week later a new family of depressions was active on the North Atlantic, and the passage of one of these across the Faeroes on 3 January 2000 produced gusts of...
measurements were not undertaken).

4. The heavy snowfall must have affected a populated area and/or must have occurred below two hundred metres above mean sea level.

Again, as with our previous paper (Wild et al. 1996), this may not be a definitive list. Some dates where the above criteria could have been met, may have been excluded due to insufficient information about them.

![Image of weather map]

**Fig. 1** Principal weather types leading to blizzards: (a) Mid-latitude Atlantic depressions, as for 14 February 1979 (0600 chart); (b) Polar low pressure system, as for 4 March 1970 (0600 chart); (c) Low-pressure system, as on 12 January 1987 (1200 GMT chart).

AN UPDATE ON CURRENT RESEARCH

In our previous paper (Wild et al. 1996), Table 1 indicated the number of blizzards/major snow events at all altitudes in the British Isles, 1880-1989. This table showed the number of blizzards, and number of blizzard days, and the dates themselves portrayed every decade. The updated version of this, in the same format, is shown below (Table 1).

<table>
<thead>
<tr>
<th>Decade</th>
<th>Snowfalls/Blizzards/Snowstorms/Snowfalls Greater than 13 cm Dates</th>
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</thead>
<tbody>
<tr>
<td>1861-1869</td>
<td>88</td>
</tr>
<tr>
<td>1870-1879</td>
<td>53</td>
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<td>1880-1889</td>
<td>34</td>
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<tr>
<td>1890-1899</td>
<td>27</td>
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<tr>
<td>1900-1909</td>
<td>28</td>
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</tbody>
</table>

**TABLE 1.** Heavy snowfalls/blizzards/snowstorms/snowfalls greater than 13 cm in Great Britain, 1861-1996

<table>
<thead>
<tr>
<th>Number of heavy snowfalls</th>
<th>Number of days of heavy snowfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-1909</td>
<td>28</td>
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</tbody>
</table>
The updated literature search suggests that there have been at least 591 events with separate heavy snowfalls/blizzards/snowstorms or snowfalls greater than 13 cm between 1861-1996, covering a duration of 1107 days.

HEAVY SNOWFALL FREQUENCIES

In our previous paper (Wild et al., 1996), five graphs were portrayed showing the breakdown of information in Table 1. Fig. 2(a) showed blizzard frequency by decade; Fig. 2(b) gave the number of blizzard days by decade; while Fig. 2(c) showed the average length of blizzards per decade, between 1880-1989 over the British Isles. The other two graphs showed frequency and duration relationship of blizzards (Fig. 3), while Fig. 4 showed the frequency of blizzards by occurrence of month during the period 1880-1989 in the British Isles. These graphs have now been updated showing the information supplied in the new Table 1.

Analysis of Table 1 indicates that there is considerable decadal variation in the occurrences of heavy snow and heavy snowfall days. As shown in Fig. 2(a) the decade 1860-1869 shows the highest frequency of heavy snow with 58 occurrences, while the decade 1900-1909 shows the lowest frequency with just 28. Other significant heavy snowfall decades were the 1950s and the 1870s with 53 occurrences. As each heavy snowfall occurrence varies with each decade, the number of heavy snowfall days also fluctuates between decades over the period. For instance, only 35 days were identified for the decade 1900-1909, while as many as 109, 102 and 101 occurred in the decades 1970-1979, 1860-1869 and 1870-1879 (see Fig. 2(b)).

Fig. 2(c) illustrates that the decade 1890-1899 experienced heavy snowfalls with an average duration of around two-and-a-half days, while 1910-1919 had a shorter period with an average duration of just over one and half days. Over the entire period 1861-1996 the approximate durational trend shows that an episode of heavy snow usually lasts around two days.

Fig. 3 shows the frequency and duration relationship of heavy snow from 1861-1996. The majority of heavy snowfalls (264) lasted one day or less, which was closely followed by 213 heavy snowfall days, which lasted over a two-day period. No heavy snowfalls were recorded which were longer than seven days duration.

The season or month when each heavy snowfall event occurs is also important. As might be expected, heavy snowfalls are largely but not entirely winter events. Fig. 4 indicates that 64.5% (387 occurrences) of the heavy snowfalls happened during the winter (December, January, February), but 27% (162 occurrences) happened in spring (March, April, May). Two occurrences (both in June) occurred in summer (0.3%) (June, July, August), with 49 occurrences (8.2%) in autumn (September, October, November). On a monthly basis, January is the dominant heavy snowfall month (162 occurrences, covering 287 days), while February (125 occurrences, covering 235 days), and March (241 occurrences, covering 229 days) are a close second. At the other extreme, no heavy snowfalls occurred in the months July to September.
CONCLUSION

After reviewing the literature and using the criteria stated, we have identified 591 heavy snowfalls covering 1107 days over Great Britain between 1861 and 1996. An examination of the heavy snowfall series also reveals that there is a variation in seasonality, frequency and duration. As expected nearly 65% of them occur in the winter period (December, January, February), with January the most dominant month. The relationship between heavy snowfall frequency and duration shows that nearly 81% of them (477 occurrences out of 591) last two days or less. There is also decadal variation in the occurrences and frequency of events. The beginning of the period (1860s and 1870s) shows a high frequency of heavy snowfall days and duration, while the 1900s and 1910s shows a lower frequency, before rising again towards a peak in the 1970s before falling again. The high numbers of heavy snowfalls recorded during the most recent decades could be a reflection of not only greater frequency, but also improved data collection and monitoring.

ACKNOWLEDGEMENTS

The author wishes to thank Miss Marina Manning and the staff of the National Meteorological Library and Archive for their help in the research and writing of this paper.

REFERENCES


MORE ON A TURUS BALL-LIGHTNING CASE

By ALEXANDER G. KEUL

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Abstract. The field investigation results of a long time toroidal ball lightning case from Gmunden, Austria, are reported. First-case data have been published in J. Meteorology, volume 24, 178-179.

An exceptional Austrian BL case of 1996, reported in 1998, was field investigated in the summer of 1999. On August 21, 1999, the author together with Viennese researcher Oliver Stummer drove to the site at Gmunden, northern Lower Austria, interviewed the witness, Aurelia Reisinger (born 1911), and took measurements.

The location is a housing settlement of the early 1950s between Great Harlbruck Pond, the town centre, and the railroad station. Gmunden lies on a flat granite plateau with scattered boulders, swamps and lakes, an almost Scandinavian landscape. Among a tree garden and 10 metres north of the old one-family-house, the summer apple-tree involved in the BL episode was planted around 1930. With 3.5 metres, it is not the tallest tree in the garden. Before the incident, Mrs. Reisinger was working in a garden shed 10 metres from the apple tree. The tree-top, seen from the shed, is exactly in the west (270°). The house has no lightning protection. No electrical cables cross the garden.
When the BL appeared suddenly from behind the tree, it caught the attention of the witness who said it looked like it “sat down on to the tree”. It had the proportions of a small truck tyre, not a large tractor one”, and it had a definite torus shape. What made the dark object an even stranger sight was a considerable number of “Xmas candies”, all hanging down from its underside 15 to 20 centimetres long and “sparkling”, which means changing brightness with an emission of sparks at the same time. A humming and sizzling sound was associated with this optical effect, but there was no static electricity. The strange light was not blinding, but irritated the eyes of the witness who looked at it only intermittently.

Mrs Reisinger continued her work in the shed, not moving closer to the object and getting more nervous over the 10 minutes that the phenomenon lasted. Her eyes started to water towards the end of the observation. Another phenomenon that she remembers was the irregular extinction of the “candies” which went out by piece by piece. When half of the torus’s underside had become dark, the rest went out quickly. After the observation, she heard from her sister, 91, who died in 1999, that a cat had been getting nervous inside the house. The witness had eye complications for about a day, seeing “stars” that night, and remaining nervous for two or three days so she received a sedative. The apple tree, according to Mrs. Reisinger, not only showed no visible damage or loss of leaves, but even seemed to grow better afterwards. The observer profile of the old lady was excellent. Despite her age of 88 (87 in 1998, not 85 as previously reported), she was articulate and motivated. Coming from a forester family with eight siblings, she always took an interest in natural phenomena. She did not give her observation a non-ordinary meaning.

Radioactivity measured in the garden and near the apple tree was not above the local level (an increased one due to the granite). The only problem remaining is that the Austrian lightning detection system ALDIS plots no cloud-to-ground strokes at Gmuend for June 6, 1996, which renders the case date unsure.

Torsional BL is unknown in the first German monograph (Brand, 1923), but torus-shaped BLs glow distributions (“ring”, “doughnut”) were noticed in 14.3 percent of the US cases collected by Dewan (1954). Barry (1980) does not mention torsional BL. The Austrian BL Data Bank contains a second torus case from Salzburg Province, where a “tyre”-shape rolled downhill.

REFERENCES
The morning of 20 May dawned partly cloudy and very humid, temperatures in the high 70's by 11 a.m. with dew-points nudging 20/21 C (70 F), the air having a real "storm" feel to it. We departed NSSL in Norman around 11 a.m., following Probe 4 of Vortex with David Reynolds in it. The destination was Childress in the far South East of the Texas panhandle. This drive of around 220 miles took about four hours, but as we arrived near Childress, towering cumulus was being reported North East of Amarillo towards Pampa in the Texas panhandle, so we headed with more urgency that way. On route towards Pampa from the South, large cumulus was punching up through the gap that had been suppressing convection for the previous three days. Within half-an-hour of our arrival on the scene, it had developed into a fully fledged storm, and the SPC had already issued a Tornado Watch for the area in response to this convection, noting: "Winds likely to gust over 70 mph with these storms, with hail up to three inches in diameter likely."

The adrenaline was now pumping, as the chase was on. Dave informed us that the storm just North of Pampa already had a developing mesocyclone. Cautiously we followed Probe 4 towards the storm, keeping a wary eye on the rain-free base to our North East. As we headed North out of Pampa, a notable 'thwack' hit the roof, quickly followed by several more, alerting us to the fact that big hail was falling. Remembering the SPC's earlier forecast and not wishing to bring back a rental car full of tents, we turned round and headed south, winning with each hail impact. The largest stone was probably just smaller than golf ball size, but the noise on the car made them seem much bigger! After finding an awning in Pampa to hide under, the storm, which was unusually moving from north to south, roared into town, with torrential rains and sporadic outbreaks of marble to golf ball hail. After sheltering for 45 minutes we headed out into the unknown! To get a view of the mesocyclone and its attendant wall cloud --- which did produce a tornado north of Pampa --- we had to get around the storm, because core-punching was certainly not an option. As we headed back south along the western side of the storm, tornado warnings were being issued on local radio for this cell. At about 6 p.m. a tornado warning was issued for Clarendon, Texas, 40 km (25 miles) to our south, for this beast approaching from the north.

Heading for Clarendon at a speed not normally tolerated by the Texas law enforcement, we arrived at Clarendon ahead of the storm and awaited our prey. This storm got wise though, and turned away, now heading S.S.E., so we moved along south-east towards Memphis, all the while observing a huge wall cloud to the north which looked very menacing as it spat out CG's across the Texas scrubland. On arrival in Memphis, tornado sirens were wailing, and the winds from the RFD were creating a dust storm, obscuring the setting sun. All this, combined with the storm, gave it an eerie appearance.

And still the storm tried to outwit us as it veered left again, now moving SE-ESE. Heading east out of Memphis, we were now on the road the mesocyclone would cross in the next 15 minutes. Trying to stay a safe distance was the main aim now, but this was proving slightly difficult with torrential rain reducing visibility, and the fact that it was going dark anyway. Moving further eastwards, bigger hail started falling, so we pulled on to the shoulder, unaware whether bigger hail lay ahead. The wind here started to pick up violently, rocking the car, and slinging the hail at us almost horizontally. We crawled forward at 10 mph or so, observing furious motion on the next rise, rain being almost lifted into the grey tumult ahead. Suddenly, sheets of rain hit the car from the north, and large wind gusts of 60-70 mph started up. Hail began to impact, and a car farther up the road quickly turned round. The situation deteriorated rapidly, with furious wind gusts and hail slamming our now less-than-pristine rental car. Quickly turning to get out, visibility became literally nil as torrential rain blew in horizontal sheets across the road. It became quickly clear that we had driven into the edge of the mesocyclone, causing a minor panic in the car, as Paul shouted loudly: "We're right in it. We're right in it, Mark."

Slowly driving out of the maelstrom and regaining breath, we let the monster mesocyclone take its path across the road and away to our south-east, before following once more. We later learned that a rain-wrapped tornado had formed and crossed the road just three kilometres (two miles) to our east. We had almost opened the 'bear's cage' and shaken hands with the tornado!

For the next two hours, we followed this storm as it slowly took its reign of terror north of Childress and then into South-West Oklahoma. It was heading for Vernon, Texas --- accompanied all the time with a tornado warning --- before suddenly dying out, about 10.45 p.m. CDT, after six hours of terrorising the Texas panhandle over a distance of about 250 kilometres (150 miles). Over the course of six hours, we had twice encountered large hail, one stone giving us a rental car a good dent, and we had a close, personal meeting with its furious mesocyclone. We later learned that Probe 4 of Vortex encountered soft-ball size hail just north of Pampa, and that one stone had completely shattered their back windshield, and showered Dave with glass! They had to limp 400 kilometres (250 miles) back to Norman in that state. It had been a splendid day, and our first real storm of the 1999 trip!

The following week or so was much quieter, with little in the way of convective activity, barring an impressive and potentially tornadic storm about 65 kilometres (40 miles) east of Lubbock, Texas during our last week. The 1999 trip contained storms far more severe than for much of our 1998 trip, and we felt that it had been much more like a chase trip should be. Having so many British chasers in Mustang made it feel almost like home from home, four at once being almost a record I should imagine! It was rather disappointing that while we were in the U.S., Western Europe had managed three Biscay storm events in about 10 days!
A NEW-MEXICAN SUPERCELL
SATURDAY, JUNE 6, 1998

By DANA C. MACK
436, East Linden Lane, Mustang, Oklahoma 73064-4142, U.S.A.

Abstract: Although May 1998 on the Southern Plains of the U.S.A. was dominated by drought and heat, those who opted to take a later chase vacation in June were rewarded with a two to three week period of activity. This article recounts one of the first chases of this active period, with the chase team of one American (Dana Mack) and two British (Paul Knightley and Mark Lowe) taking a long trip out westwards on I-40 from central Oklahoma, through the Texas Panhandle and on to the border of New Mexico to reach the day's storms.

After the previous bout of severe weather affecting Oklahoma in late May, the storm track moved over the northern U.S., leaving us with blazing sun, soaring temperatures and soupy-haze. However, by the first week of June a potent severe weather pattern was beginning to evolve in what continued to be a 'Jekyll and Hyde' type year - extreme drought or a plague of severe storms. Two storm chasers, out on the Southern Plains for their first American storm season, had made it back to Oklahoma City the night before. Having packed-up an impressive accumulation of miles on their rental car and having called me, I was invited to go over to wherever the storms would entice them.

Dave Reynolds and Janine were riding with a friend of Pat Burke's, so as arranged I hitched a ride with Paul Knightley and Mark Lowe. We met up with the N.S.S.L. (National Severe Storms Laboratory) V.O.R.T.E.X. (Verification of the Origins of Rotation in Tornadoes EXperiment) convoy just east of El Reno, in which Pat was a participant. As the convoy sped past, it was obvious that several others had appended themselves to the train of cars - a chase from Vermont, Virginia and others with out-state plates. We now added our two vehicles to this motley collection racing down the interstate, having just heard the latest Oklahoma Thunderstorm Outlook: "... a Slight Risk for severe thunderstorms ... for western Oklahoma ... a strong upper level disturbance over northern Arizona will move east into eastern Colorado. Strong south-easterly surface winds will rapidly transport Gulf moisture north-westwards into the Texas Panhandle and western Oklahoma ... A dry-line will become established over eastern New Mexico and move east ... Thunderstorms over eastern New Mexico and western Texas will become more numerous and intense, moving north-eastwards into western Oklahoma tonight ..."

Since the storms were forecast to start way out in New Mexico during the afternoon, we had a protracted drive ahead in order to reach the dry-line - the boundary between saturation and desiccation, hovering out along the Llano-Estacado of eastern New Mexico. Here in Oklahoma, it certainly didn't look encouraging, as a smothering grayish blanket of stratuscumulus kept solar insulation at low values and conditions relatively cool. Our trip westward along I-40 was like experiencing a rush hour, except most of the participants were 18-wheelers - some of whose drivers seemed to have little concern for those vehicles driving a lesser speed than they were. Often Paul would be looking over his shoulder, worrying about the proximity of a very large bumper to our cars' rear.

As we were experiencing our high speed rush-hour, a Tornado Watch was being posted covering much of the north-western Texas Panhandle, north-eastern New Mexico down to Clovis and south-eastern Colorado. We could already rule out this area for our chase, for any cells here would move north-eastwards and away from central Oklahoma. There was also greater heating just ahead of the dry-line, now positioned 20 miles or so west of Clovis - hence our target area was south-west of Amarillo, just the other side of Clovis. As we were still under overcast skies at Amarillo (at 1400 Central Daylight Time), we still had some 80 miles to go to reach the dry-line.

We reached the border between Texas and New Mexico, bouncing over the uneven two-track crossing of the BNSF RR (Burlington-Northern/Santa Fe Railroad) at Farwell, Texas, and into Texico, New Mexico. This was just as the overcast began to exhibit breaks and the scuds on the medium wave were cracking with frequent bursts - something was breaking down lightning onto the scrub with great regularity. We couldn't see it, nor hear, although we were able to hear the electrical footsteps. Just past the entry gates of Cannon Air Force Base on the west side of Clovis (at 1747 CDT), there were enough breaks to throw off a bit of hazy-turquoise sky, amidst a clutter of scud, cumulus and other scattered 'garbage' clouds. Then we saw it - the source of the lightning: from its appearance, it meant business - of that there was no doubt!

I exclaimed: "... A very circular anvil - right over us! Explosive anvil! The southern edge of the anvil is to our south-south-west ..." "Thick anvil, that is!", Paul added, glancing up over the steering-wheel. I noted the clouds' impressive aspect "Yeah ... and it's shooting out! We probably need to get south ..."

In the 'Land Of Enchantment', there weren't a lot of road options - unless one was a road-runner or a coyote - so we had to continue west on U.S. 60 and towards a wall of deepening black that seemed to swallow the distant horizon. Our first southbound highway proved to be at Melrose, 20 miles west, a wind-blown crossed comprised of a gas station, a cluster of adobe-walled dwellings stained with red dust impregnating their exteriors and several rusting hulks that had been motor vehicles in decades past.

I made a note of our race to this south road, saying "Probably still well west of us ... westbound on U.S. 60 - look how far the anvil is shooting out! You can see the hazy-blue sky with the anvil backlit by a cream merging into its bluish-gray base ... and it's streaming miles and miles out-it's being thrown out like a sheet blown in a hurricane! Look how smooth that top anvil is - 5:52 PM!"

Drawing closer to this tempest of such evidently-incredible proportions, I documented my observations into the recorder. "This is a monster New Mexican storm - but the problem with a New Mexican monster is that if you're road-screwed, you're dead. All you can do is retreat or gut it through. As we proceeded, above the scrub and barbed-wire bounded slightly-rolling plains, it was impossible to miss the
wallowing feeder band being drawn into the thunderstorms' charcoal-hued body. I described it as "a very large beavers' tail" and I don't mean a sliver. A humongous beavers' tail! Sferics are very pokey......

A few miles south of Melrose, we halted to peruse a high-based but impressive and well-sculptured wall cloud wrapping up to our west. Standing proved a bit difficult, as a south-easterly gale was drawn into the circulation of the mesocyclone. With inflow racing in, I wondered what sort of tornado might be possible with this. My concentration on the wall cloud was rudely interrupted by a sharp crack, like a marble on tile, right at my feet. Glancing around, I saw an orb of ice the size of a dime roll to a stop a couple of feet away. With this kind of storm, hail much larger than this was possible - even probable - so we couldn't risk remaining where we were.

"Hail! Dime-sized hail! A dime-sized hailstone in the field - there it comes! I think we'd better go!" I yelled.

Haste was the order of the day as we moved south to a ridge line about a mile away, where we pulled on to the verge to check out what the storm was doing. The wall cloud was there - still large - but cloaked a bit by chaotic patterns of scud moving here and there. Dave advised us that Doppler radar was indicating a very strong "gate-to-gate" signature just north-west of our current position, where there was a wall cloud black enough to rival a raven's plumage and with an eastern side that was vertical - a sign of intense rising motion. I made note of this, commencing. "Look at the side of it, look at it rise straight up! Like a lift.....and the inflow is increasing. This is what an inflow jet feels like! Time is 6:27 PM and we're being buffeted. It's tracking over the yuccas and dried plains of eastern New Mexico. Look at the dust going across the highway - getting a broad concavity - the precipitation core's coming around the back side!"

We drove north, cautiously, towards Melrose and U.S. 60. We remained behind the precipitation area, just beyond a creamy-white shaft of what we knew was hail. Just south of town, wispy, opaque-white tendrils of vapor swirled up into the sultry atmosphere as a half of great accumulation covered the ground - the interface between the opposing contrasts of ice and tropical air creating the condensation thus. "...This is ice fog! Will you look over here? This is hail fog! Hail fog here, just south of Melrose...any ice in your drinks?!", I excitedly exclaimed.

Most of these chunks of ice were golfball size, lying in the tufts of parched grass. However as we neared town, the diameter increased to that of almost tennis-ball size. Obviously, more than a few roots in this dirt-blown New Mexican town would now be needing the services of roofing contractors!

Reaching the hail-assaulted town of Melrose, we moved eastwards on U.S. 60 towards Clovis, passing a multitude of automobiles clustered beneath underpasses. This wasn't a sign of tranquility; at 1822 CDT, our weather radio informed us that "The National Weather Service has issued a Tornado Warning for Curry County. Doppler radar had indicated a tornado in the vicinity of Clovis, moving east..." Looking ahead to our east, it was obvious that the core of the blackness containing the circulation was directly ahead - along the eastern skyline, embedded in a cloak of vilet-ebony. It was black over black, threat over throughway and, for us, prudence over pursuit! We decided not to penetrate the storm - a view of what was concealed wasn't worth the life after, revealed!

Passing groups of anxious wide-eyed residents, huddled in groups in their water-logged yards and casting wary-glares towards the retiring wall of sooty-shaded cloud, Paul commented... "These people they must be quite happy that it has gone past them - can't be very nice when, suddenly, your weather radio squeals and sirens start going......" Driving through Clovis, we could see the water sluicing through the gutters, the ragged silvery-scud swirling and scooting against the massive, smothering wall of gloom to the east - and a family emerging from beneath a timber bower of the railroad. Obviously something furious and ferocious had assaulted Clovis from the heavens, as the storm rained down its dangerous mix of cloudburst, conflagration and currents.

Next, we rolled into Texico, a town clustered along the New Mexican side of the tracks and just four miles distant from the Lone Star state and Farwell, Texas - essentially a continuation of the same community, only in a different state. A haunting wail - a ghostly warning to those below the storm - was sounding, announcing the alert that possible tornado activity was nearby.

"Tornado sirens have blown!" I exclaimed, as a boiling jet-black sky threatened to vacuum the table-flat, chocolate-colored fields. Against the midnight sullenness, the twin white elevators were made to seem immaculate shrines.

At this point, I preferred to stay behind the cloud, out of reach of any ebony, twisting strands it might loose on the prairie. This was not a storm to be trifled with. Before leaving Texico, we stopped at a convenience store - a Quick-Stop - where we met a jean-clad, boot-shorn western-hut who told us of his close encounter with the mesocyclone as it churned eastward over his town. He said "It just... it just...... Lookin' on top of this building [a grain elevator to the west] and it kinda looked like it camin' down - we couldn't see if it was down on the ground - yeah! It was a funnel and we've seen a couple of lightning bolts there - and then it started liftin' back up...... Right towards the north of where I'm standin' right now - it started circulating real bad! And then it came down - it got down about halfway....."

As we bounced over the well-worn rail crossing into Texas, we could see another thunderstorm looming up from the flat western horizon; spitting the occasional bolt of lightning, it thundered out of Curry County. Like the predecessor, this cell was also potentially tornadic. Ours was still tornadic, still boiling away over the flat, dry dirt fields of western Texas and still depositing its reservoir of liquid on to the table-like terrain.

Continuing eastward another 20 miles to the first major north-south road we intersected, I nervously advised "This is starting to form another meso in here, south east of the other! We're in a meso-sandwich...... junction with Farm-Market Road 214..... I'd go straight... I wouldn't go up there [north]...... There's something goin' on that's not wholesome in appearance - 8:21 PM - grain elevators, a yellowish-cream to the north...... Looks like there's another RFD comin' in to our north-west...... See how
that's going straight up a little bit?" (the southern edge of the wall cloud).

Ever since Melrose, the mesocyclone had been pulling sustained 60 mile-an-hour south-easterly winds into its vortex. This liberated vast quantities of black dirt resembling smoke off plowed and parched fields - and which made driving in a straight line extremely challenging. Still, on we went to another junction with another north-south road, where we decided to try to move northwards 10 miles to the next eastbound road.

As we pulled up to the stop sign, my verbal deliberations set the scene as I said 

"...8:29 PM This is not terribly good news; the winds are more southerly, right? When it's doing this, it's pulling into somewhere! Go north! The meso's north!"

This was not an intelligent move, as it turned out that the meso was where we shouldn't have been - in the same place! Not a few miles northwards, we were enveloped in a blinding-veil of ink-black dust which was skimming across the road and hurled by a raging inflow jet - like the black, viscous ink a squid uses to defend itself. The eerie shadow quickly reduced what light was left and the duststorm diminished visibility. The driving was becoming far less safe and, as self-preservation demanded, we pulled off onto the roads' shoulders to reconsider our intention to proceed northwards. At the same time, the ominous darkening and flares of lightning were barely perceptible within the bank of rolling dust while the screaming inflow was sweeping towards us.

Personally, I had seen enough so I urged my friends. "Turn around - THIS is not a good choice! Go back to the cross-roads... That other guy [another chaser] may go north but I wouldn't go north into something like this! The dust is just screaming north-westwards into this meso!" As we turned around, the Storm Prediction Center was issuing a Tornado Watch for the eastern two-thirds of the Texas and Oklahoma Panhandles, valid until 0200 CDT the next morning. The skies immediately to our west were assuming a most unpleasant cast of ochre, ochre and grape. Just as we were getting into the vehicle, as if to reinforce our decision, something round, hard and icy cracked onto the asphalt and bounced several short hops before skittering to a stop at our feet.

I asked "What size is it?". "It's golfball...". Paul quickly glanced down at the road. "Time to go, I thought, saying "Uh we need to get south right now!"

BANG!! A pristine rock of ice a bit larger than a golfball slammed onto our cars' steel roof, which was itself not as pristine as it had been before the impact. It wasn't the last impact either, as another THWACK, quickly followed by another, convinced us of the error of my ways - the way north, which we now abandoned. I was mightily thankful my name wasn't on the rental agreement! Fortunately, despite our worst fears, we escaped out of the large hail and back into the dust and wind, where we found Pat's N.S.S.L. chase vehicle parked alongside the highway. We pulled up next to him and learned that it was a good thing we hadn't continued on, for at least one N.S.S.L. unit got caught in the large hail in Dimmitt and had three and a half-inch hail crack the windshield!

Now it was a sprint east to 1-27, where we turned again northward towards Tulia

and where it was our goal to intercept the still-tornadic cell we'd been chasing all afternoon. It was a tense contest - a toss-up between success and failure, between glass-intact and glass-shattered. Our conversation betrayed our unease:

Paul: "We're at mile post 150, so 6 miles to 'ground-zero' - you can tell it's flashing to our left!"

Dana: "It's gonna be a very close shave!!". Paul: "Cars are still on the road in front of us!". [minutes pass]

Paul: "We don't want to be going into baseballs at great speed!"

We did make it to an underpass just south of Tulia, just after the first hailstone bounded down to the highway and as we skidded beneath the bridge. After a brief though lively hailfall and heavy rain, the storm swept past with not much visible of our meso - although it was still there, the radio said. Darkness makes everything look sinister - every cloud a potential tornado! So, it was time to head home - now the hard part - five hours of hard driving and a late-hour before I could collapse into bed. Next time, I said to myself, someone remind me of this last bit of a long chase - as I got older, it was becoming progressively less tolerable!

Comment from Pat Burke of N.S.S.L., who was in one of the V.O.R.T.EX. vehicles: The Clovis supercell was observed by experienced storm chasers and meteorologists through most of its lifetime. The environmental shear and instability profiles were thought to be favorable for tornadoes and the storm did rotate strongly. Radar sampling of the storm revealed strong characteristics of a tornadic mesocyclone and the storm was visually impressive - especially as moved over the city of Clovis. Tornado reports, however, were limited to a few isolated instances, none of which could be confirmed. Some or all of these may have resulted from a combination of low, rotating cloud bases, sculpt and the dust and sand that was kicked into the air by storm-scale features. Two members of the National Severe Storms Laboratory V.O.R.T.EX. research team did witness what they classified as an extremely weak, short-lived tornado. Upon passing Clovis, the storm became shrouded in fog, making visual observations of the supercell cloud base difficult to impossible. Despite this, the V.O.R.T.EX. team continued to sample the storm. Several V.O.R.T.EX. vehicles received damage from hailstones up to 3 inches (7.5 cm) in diameter. Quality data were gathered, however, and the Clovis supercell will be studied as a most interesting but effectively null tornado case.

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THE WEATHER AT OXFORD IN 1999

RADCLIFFE METEOREOLOGICAL STATION
UNIVERSITY OF OXFORD

In 1998, we reported that the year was generally warmer than expected from past records. This trend has continued into 1999. In fact, this year was a record breaker in
terms of temperature. Most notably it was the joint warmest year on record in terms of mean air temperature (11.1°C) since 1815. The other years to have such a high mean air temperature are 1889 and 1990.

January followed on from December 1998 as a warm and wet month with most of the temperature recordings being above the long-term averages. Rainfall was in excess of the long-period mean; however, wet periods never lasted longer than six days. The highest daily rainfall of 13.1 mm came on the 15th as a result of a storm that also brought strong winds (maximum gust of 46 knots). The month concluded with a renewed period of light rainfall and light winds. Unlike January, February was generally dry, with the total monthly precipitation (32.9 mm) below the long-term average. However, the warm trend of January continued with temperatures being well above the long-term means. This was despite a cold period between the 7th and the 14th, during which time snowfall occurred (on the evening of the 8th). The persistence of warm conditions during these months resulted in a winter season that was also warm (the 15th hottest on record with mean air temperatures of 5.8°C) and mainly dry with total rainfall being 20 mm less than expected.

March continued the trend set by February, generally being dry, with the total monthly precipitation well below the long-term average. Additionally, mild conditions persisted, only briefly interrupted by a cold period between the 4th and the 11th. Although temperatures were around 2 degrees above average, the total sunshine hours (97.4) were below the long-term average, obviously a result of the numerous warm, overcast, rain-free days during the month. Warmer than average conditions persisted into April. This warmth was accompanied by wet conditions, with the total monthly precipitation well above the long-term average at 57.6 mm. This increased rainfall and associated cloudiness was reflected in reduced hours of sunshine (147.9). May was again a warmer than average yet cloudy month. The mean monthly air temperature was the 9th highest on record whilst the monthly mean minimum temperature (9.7°C) was the highest on record in 115 years. The generally cloudy conditions were reflected in the substantially reduced hours of sunshine (153.6). Although rainfall was average for the time of year, notable storms (accompanied by thunder and lightning) occurred on the evening of the 19th and afternoon of the 29th. Warm conditions each month resulted in spring being a record breacker in terms of mean air temperature. With an average of 10.5°C, it became the warmest on record since 1815 surpassing 1893 and 1945 when the average was 10.4°C.

June was notable as the only month this year where measures of temperature fell below the long-period averages. This coolness was despite many sunny days. Although the total monthly precipitation was higher than expected (65.3 mm), this was mainly accounted for by two significant rainfall events on the 1st and 28th. On each day around 18.5 mm of rain fell in only a few hours. There were 4 days with morning mists, well up on average and generally related to the bright weather with cloudless nights. Continuing the trend begun in May, July was a very hot and dry month. In fact the mean air temperature of 18.5°C was the 15th highest recorded in the last 180 years. Accompanying the warm conditions, this month was very dry with only 7.2 mm of rain falling (7th driest July in the last 220 years). This resulted from predominantly anticyclonic conditions which enabled us to enjoy an extra 44 hours of sunshine. The long periods of high pressure were interrupted briefly by the passage of frontal systems which brought limited rain showers (on the 2nd and 20th) however these were more than 1 to 2 hours. The very hot and dry conditions continued during the first two days of August the dry spell was ended by the arrival of much needed rain. Before the rain cooled down, maximum temperatures reached 31.2°C (just outside the top 10 for the hottest August day in the last 150 years). The rainfall was manifested as heavy showers with over 10 mm falling on the 4th, 6th and 9th. These contributed to the monthly rainfall total (98.9 mm) being 40 mm higher than the long-term average. For the summer as a whole, there was little difference from the long-term mean conditions. However, during July and August, we basked in an extra 30 hours of sunshine (compared to the long-term average) when temperatures regularly climbed to over 30°C.

Hot conditions were still evident in September with all measures of temperature being above the long-term average by about 2°C. In fact the mean air temperature of 16.2°C was the 4th warmest on record. As well as being very warm, the month was also wet with an extra 40 mm of rain falling during a number of storms (accompanied by thunder and lightning). The most significant of these events occurred over the evening of the 19th/20th when 30 mm fell in less than 24 hours. These storms were brought about by the passage of frontal systems over southern England. As well as being mild, October was notable for being the 4th sunniest on record (in the last 119 years) with 144.8 hours of bright sunshine on offer. This was as a result of generally anticyclonic conditions which also accounted for there being little rainfall from the 4th to the 19th. Despite this long dry period, the total monthly rainfall (70.5 mm) exceeded the long-term average by about 6 mm. November was again a generally mild month despite a cold snap between the 17th and the 21st. Conditions were also generally sunny with above average total bright sunshine hours (81.1). This welcome warmth was as a result of predominantly anticyclonic conditions. Although it rained on most days, falls were very light (rarely exceeding 3 mm each day) and resulted from weak frontal systems penetrating the anticyclone. November was generally a calm month, however it became windy at the end of the month (26th, 28th and 30th). The warm conditions each month resulted in the autumn season being the 5th warmest since 1815 with a mean air temperature of 11.6°C. The warmest autumn on record was in 1818 when the temperature was 12°C. A predominance of anticyclonic conditions meant that we were able to enjoy an extra 80 hours of sunshine (compared to the long-term average) however the heavy rainstorms in the latter half of September left their mark, with above average rainfall for the season.

With most measures of temperature again above the long-term averages, December completed a year when most months were warmer than expected from previous
experience. The month was also wet as rain fell on 22 out of the 31 days although these falls were relatively small. There was a notable storm during Christmas Eve

Radcliffe Meteorological Station
School of Geography, University of Oxford
Annual Summary of Weather at Oxford for 1999

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which was accompanied by the strongest winds of the year (peaking at 62 knots). Also of note was the 3cm of snow which fell during the night of the 18th/19th and lasted for 3 days bringing with it hazardous conditions as temperatures fell to a minimum of -7.5°C.

As noted in the introduction, 1999 was joint the warmest on record in terms of mean air temperature with 1989 and 1990. It was also record breaking by having the highest mean minimum air temperature (tying with 1994 on 7.5°C) and the highest mean minimum grass temperature (4.7°C) on record. As mean air temperatures have increased proportionally less, it is suggested that the average diurnal

range of temperatures in Oxford appears to be decreasing. This evidence seems in line with research by Easterling et al. published in Science in 1997 (Vol. 277, p. 364-367). In annual terms, 1999 was also generally wetter (95mm above the long term mean) and sunnier (an extra 75 hours) than expected.

Anthony Preston, Alexander Shaw and Norman Cheung

Book Reviews:


This is the story of the hurricane, which with its associated tidal wave, hit the Texas port of Galveston on 8 September 1900, causing between 6,000 and 10,000 deaths, making it easily the worst natural disaster to affect the USA this century. The story is woven round Isaac Cline the Weather Bureau’s local forecaster, his younger brother Joseph and a complacent and dogmatic Weather Bureau. Like other reviewers, I was, at first disappointed that the book contains no photographs, because photographs undoubtedly exist and were used to illustrate the extract that appeared in one of the newspaper colour supplements. However, the author’s vivid prose soon banishes any disappointment. The following quotation, taken at random, makes the point:

“A serene peace settled over the city. People bore their losses quietly. John W. Harris was seven when the storm struck, but remembered vividly how the mayor himself paid his father, John Junior, a visit on Sunday morning at their home in Tremont Street. One of the finest houses in the city, it had weathered the storm so well that the Harrises had no conception of the devastation elsewhere in town. They were eating breakfast when the mayor arrived. ‘John’, the mayor told the elder Harris, ‘your whole family is destroyed’.

Harris had lost his sisters and their families. Eleven men, women and children. His son saw him cry for the very first time’.

This book is extremely well-researched, as the list of sources at the end makes clear. It reads almost like a thriller, even though the outcome is known. The author really makes turn of the century small town America come to life. It is a poignant tale, for Isaac Cline loses his wife and some of his children, yet goes on to become a successful observer in other parts of the South. I can unreservedly recommend this absorbing and fascinating book as an ideal Christmas present for anyone with the smallest interest in severe weather and its effects on people and places.


The Guinness stable of books surely needs no introduction, with the annual Guinness Book of Records regularly appearing in the autumn best-seller lists. The list
of publications has expanded over the years, and this volume as its title suggests, covers Nature's more extreme events. There are seven sections, with a further section entitled "Earth Extremes", an Index and List of Credits. The section on Global Forces has subsections on hurricanes, floods, lightning, tornadoes, typhoons, monsoons, snowstorms, etc., while another section, entitled Strange Phenomena has subsections on Flash Floods, Strange Skies and Freak Events. Each "sub-section" is in fact two facing pages, with one large, striking colour photograph and some text and other illustrations. Although hurricanes and tornadoes are allocated two sub-sections each, the book is, inevitably, superficial, because it has many topics to cover in a relatively short space, but it might well whet the appetite of a teenager wanting to know more about the world's extremes. The colour illustrations are stunning, but, in reality this is a coffee table book with some additional information. Its value would have been enhanced had it contained a list of further reading.


This is a truly remarkable book. John Thorne, who is a Reader in Applied Meteorology and Director of Atmospheric Impacts Research Group within the University of Birmingham, has obviously devoted years of research into the scientific accuracy of the skies that John Constable painted, and has produced what must clearly become a classic in its field. After a short Introduction, Dr Thorne sets the scene with a long but fascinating chapter entitled Landscape meteorology, which deals with Luke Howard's cloud classification, cloud perspective, light, the sun, the rainbow and other optical effects, etc. and also draws together the details of the volcanic eruptions of the period, the dust from which doubtless affected the skies which Constable painted. The second chapter is entitled John Constable's Meteorological Understanding, after which we have the longest chapter, Evolution of the Skies in Constable's Art. Next comes another long chapter entitled The Influence of Art and Science on Constable's skies in which Dr Thorne reviews the influence that earlier artists' portrayals of weather phenomena had on Constable's own paintings. The last chapter, A Fusion of Art and Science brings the strands together. Appendix 1, which extends to 75 pages, analyses 54 of Constable's paintings by reference to contemporaneous weather observations, in each case ending with a line indicating how good a comparison there is between the painted scene and the synoptic analysis, because Constable, unlike some artists, kept accurate records of when and where he painted the scene. This analysis enables the author to date some of Constable's previously undated paintings. Each chapter has an extensive bibliography, but the real glory of the book is the superb colour reproduction of no less than 125 of Constable's paintings. These are reproduced extremely well, and it is a real pleasure to note that, unlike so many art books, it has been wholly produced and printed in this country. Inevitably with the feast of colour prints, the book cannot be cheap, but, to my mind, it is extremely good value when you realise how many reproductions you get. But, unlike the coffee table books of paintings that regularly appear, this volume has the inestimable advantage of a scholarly and well written text. Meteorologists and art lovers alike can only benefit from this volume. I can think of no better use to which book tokens received for Christmas can be put. Buy this classic if you have the least interest in the subject.


Even though the Met Office is gradually loosening its ties with the Ministry of Defence (it became an Executive Agency in April 1990, and started operating as a Trading Fund six years later), it is right that taxpayers should have this annual opportunity to see how it is performing. The Annual Report and Accounts, eight pages longer and £1.55 more expensive than last year, concentrates on the Met Office's commercial performance. We are reminded that five out of the six key performance targets were met, the one that was narrowly missed being the Global NWP Index. The Chief Executive in his annual review tells readers that a separate Commercial Division has been set up with effect from 1 April 1999, to concentrate on services to commerce industry and the private sector generally. The chance to take the lead in European weather research is clearly going to be grasped. If the tone of this volume is a little self-congratulatory, this is perhaps understandable because the Met Office does seem to turning into a commercial success, though, inevitably, this is putting their services increasingly out of the reach of individuals as opposed to companies, industry etc.

Many readers of Journal of Meteorology will, I suspect be more interested in the companion volume, The Scientific and Technical Review. This has short sections devoted to Observations; Forecasting; Business; Atmospheric Process Research; Climate Research and Ocean Applications. Each year, two topics are selected for consideration in greater depth, this year's topics being Information Technology and Numerical Weather Production. I found the section on Climate Research the most interesting, but it is clear that the Met Office is advancing on all fronts, and is a self-confident and pioneering organisation, which is borne out by the extensive list of papers published by employees during the year under review.

Both volumes are well produced in the modern fashion, which seems to assume that readers will not be willing to absorb more than a couple of pages on each topic, and even then, illustrations are necessary to "break up" the text. This gives a rather staccato effect, which seems a pity especially in the Scientific and Technical review. This volume contains two pages of ACRONYMS, ranging from ones familiar to most readers such as ENSO to less familiar ones such as MIDAS (Met Office Integrated Data System). Taken together, these are a useful barometer of how the Met Office is faring. Looking back over previous years' editions it is obvious that the Met Office is
benefitting from its increasing freedom from direct government control, though it is
perhaps to be hoped that complete privatisation is a little way ahead.

PETER ROGERS.

BRITISH THUNDERSTORM SUMMARY: SEPTEMBER 1999
By BOB PRICHARD

There was little thundery activity during the first half of the month, but a fair
number of thunderstorms occurred later, especially from the 22nd to the 29th. There
was, though, rather a patchy distribution of storms; large areas of Scotland and Ireland
had no thunder at all, whilst in parts of east and southeast England thunder was heard
on at least five days - and it was reported on ten days at Eastbourne. Elsewhere, totals
were mostly around three days.

September began with much very warm, sunny weather. However, by the 5th,
pressure had fallen, as a block of colder air aloft drifted northwest into southeast
England - hence moving away northeastwards on the 6th. Thundery outbreaks
accompanied it; the first of these edging northwest from France into southeast Kent
and the East Sussex coast in mid-afternoon on the 5th, but then died out. An active
thunderstorm system developed over the North Downs near Biggin Hill around 4pm,
and drifted west-northwest; it was at its most severe over north Surrey around 5pm,
when large hailstones broke windows in the Surbiton area. 33.5 millimetres fell here
in forty-five minutes and over forty houses were flooded. The outbreak then became
rather disorganised, with some extension both to the north and south as it left the
generating region of the North Downs - eventually to die out over Wiltshire around
9pm. Another thunderstorm broke out in the Biggin Hill area near midnight,
and continued for around ninety minutes, with a slight drift to the east northeast.
On the afternoon of the 6th, sharp thunderstorms broke out briefly in the Ipswich, Colchester,
Thanet and mid-Kent regions. Meanwhile, an active cold front over northwest Britain
and Ireland gave isolated thunder here from the evening of the 5th to the middle of
the 6th.

A showery southwestern airflow gave isolated thunder near northwestern coasts
on the 8th and 9th, but cold fronts displacing very hot air over England into the
Continent over the weekend of 11th/12th failed to produce much thunder; it broke
out briefly around Leeds in mid-afternoon of the 11th, and there were some storms
over southern and western Ireland on the 12th in the cooler, showery air behind
the fronts. On the 13th, a minor wave running north along the cold front, now off
the southeastern coast of England, gave thunder briefly to parts of east Kent and Suffolk
in the morning. The same day also saw isolated thundery showers again in the cooler
air over northwest Scotland. Thunder was reported from Penzance in showers early
on the 14th.

The second half of the month was very unsettled, and thunder was reported
somewhere in the country on most days. From the early hours of the 17th through to
around midnight on the 18th, a scattering of thundery showers occurred in a showery
southwesterly airflow; night-time activity was mainly near the south coast, whilst it
migrated inland (mainly over England) in response to rising daytime temperatures -
there was quite a fierce storm in Oxford in mid-afternoon. A very deep depression
edged eastwards towards the British Isles over the weekend 18th/19th. Its cold front
moved crenatae northeast, accompanied by outbreaks of very heavy rain and isolated
thunderstorms; lively thunderstorms moved from Devon to south Wales on the
afternoon of the 18th. At Ermington (Devon), visibility was reduced to about fifty
metres as a "wall of rain" moved up the valley. By the 20th, the slowly filling depression
was over the Irish Sea, and heavy frontal rain - now heading slowly for Scotland -
was followed by numerous heavy showers. Thunder was not widespread, but affected
scattered localities, mainly over east and southeast England. On the 21st, the depression
drifted away to the northwest, and there was just isolated thunder in the south on a
less showery day.

The 22nd was the most thundery day of the month; indeed, it was one of the most
active of the year. Another deep depression drifted northeast into Ireland during the
day; a fairly weak occlusion moved north over the British Isles, but a much more
active secondary cold front swung northeast across England and Wales during the
afternoon, bringing an outbreak of thunderstorms, whilst others followed in the
vigorous showery airflow behind it. The first storms were noted over the Channel
Islands in the late morning; around forty millimetres of rain fell in fifty minutes at
Rocquaine on Guernsey. Most southern coastal counties were affected in the afternoon,
when there were also storms over north Wales and northwest England. The evening
saw the southerly outbreak move up across the east Midlands to North Yorkshire,
later reaching southern Scotland, whilst another outbreak moved from Hampshire to
East Anglia; later in the night, thunder again affected parts of southern England.
Several of the storms were severe, with resulting lightning damage, mainly to buildings;
there was flooding in parts of the London area in the late afternoon storm, when two
women were killed by lightning in Hyde Park as they sheltered under a tree. At Bulphan
(Essex), a man was flung nine feet across a room and suffered brief numbness when
lightning struck his Victorian cottage as he was on the telephone; his son, in an upstairs
room had his hand burnt when flames shot out of a stereo system he was tuning.
Similarly, at North Hykeham (Lincolnshire), a man was thrown across a room when
lightning struck his cottage. There were a few tornadoes as well during this series of
storms, notably at Pagham (West Sussex) and Ruislip (west London) around dawn on
the 23rd. Isolated thunder also occurred in widely separated areas of the British Isles
later on the 23rd as the showery weather continued.

Another secondary cold front gave some thunder on the 24th, as it brought a few
hours of rain in its slow eastward passage across southeast England from late morning
to late afternoon; behind it, there was also thunder in some of the showers around a
depression over Scotland, mainly over southern Britain. Lightning struck a car at Birdlip (Gloucestershire) shattering the windscreen; the driver commented "there was a terrific bang and flash and the windscreen turned white ... I could not see a thing...just managed to steer the car out of the way of oncoming traffic" (so much for the 'Faraday cage' protecting occupants of cars in thunderstorms). Hall accompanied some of the thundery showers, whilst a waterspout was observed off Lancing (West Sussex). There were further thundery showers on the 25th, especially over the Midlands in the evening as a small discrete depression within the southwest to westerly airflow drifted across the area. Lightning struck the roof of the sun and wind sensor units at Weston Coyney (Staffordshire), knocking out the data logger; this is the second such report in three months (the other was at Calthorpe (Norfolk) on the 3rd July). There was a little more thunder over eastern England in showers on the 26th, when a house was damaged by lightning at Cleaden (Tyneside). A showery westerly airflow followed another rainband into southern Britain on the 27th, and there were a few more reports of thunder, mainly near southeastern coasts in the evening. A more vigorous westerly airflow gave a very showery day to England and Wales on the 29th, with thunder in various districts. Lightning damaged two houses at Stoke-on-Trent, and there was some flooding in the area. A church was damaged by lightning at Cambridge, and the vicar had the telephone she was holding blown out of her hand. The final report of thunder for the month comes from the Ipswich area in a shower in the early evening of the 30th.

TORRO THUNDERSTORM REPORT: OCTOBER 1999
By BOB PRICHARD

After the thundery August and September, things quietened down this month; there were several days with thunder, but it was mostly isolated.

A deep depression drifted east southeast off our northern shores during the first three days of the month, and there was some thunder in the showers around it; it was reported from parts of Ireland and western and northern Scotland late on the 1st, from isolated widely scattered localities during the afternoon and night of the 2nd, and from, chiefly, a few parts of eastern England on the afternoon of the 3rd. Isolated thunder also affected parts of Norfolk and Cornwall early on the 4th. The next report of thunder is not until late evening on the 21st, from Aldeburgh (Suffolk); a northward-drifting occlusion was in the vicinity. A showery airflow around a depression near Ireland brought several incidents on the 22nd, mainly over England during the afternoon and evening; there was a little more thunder around southern coasts on the 24th and 25th, and the month ended with isolated thunder in the circulation of a very deep depression that drifted northeast off northwest Scotland during the 30th and 31st.
and E. of Crimea. Dry elsewhere; under 50% from S. and N. Norway to N.W. Russia; S.E. France, N. Italy; most of Portugal and Spain; locally in C. Latvia. Provisional sunspot number 74.

**Africa. Temperature:** mostly warm N. of 10° N.; KwaZulu Natal to Mozambique and N. Zimbabwe; N. Namibia; +2degC in Canary Islands, N.E. Morocco, Egypt. Cold in E. Algeria, Tunisia, S. Namibia, S. Zimbabwe; most of Libya and South Africa; -2degC in S.E. Algeria. **Rainfall:** wet in extreme N.E. Algeria, N.W. Tunisia, Zimbabwe, S. Mozambique; most of South Africa. Over 200% locally in all these areas; rather more widely in South Africa and S. Mozambique. Dry generally from Canary Islands to Egypt; in and near Namibia; under 50% widely in both these areas.

**Asia. Temperature:** warm in Turkey, S.E. Uzbekistan, Kyrgyzstan, S.E. Kazakhstan, Taiwan, Sri Lanka, Bangladesh, Nepal; Thailand to most of Indonesia and Philippines; most of Mongolia, Japan, Korea, China, Pakistan, India; +4degC in E. Turkey; fairly widely from W. Mongolia to S.E. China; locally +5degC near China-Mongolia border.

Cold in N.W. Uzbekistan, Ob basin, N.E. Mongolia, N.E. China, extreme N.E. Korea, N. Japan, extreme S.E. Pakistan into India; most of Kazakhstan; -12degC in N. Ob basin. **Rainfall:** wet in W. Turkey, N.W. and S.E. Kazakhstan, N.E., N.W. and C. China, E. Taiwan, N.E. and part of W. Korea, N. Japan, N. Thailand, S. Vietnam, N. Sumatra, S. Philippines, Sulawesi; most of Mongolia, India, Nepal, Bangladesh. Over 200% locally in W. Turkey, N.W. and S.E. Kazakhstan, C. and N.W. China, Korea, S. Philippines; widely in the other areas except perhaps E. Taiwan, N. Japan and N. Sumatra. Dry in C. and S.E. Turkey, Uzbekistan, S.W. Mongolia, N.W. and most of S. Korea, W. Taiwan, S. Japan, N. Vietnam, C. Sumatra, N. Philippines, Pakistan, N.W., C.S. and N.E. India, N.E. Nepal, most of Kazakhstan, Kyrgyzstan; much of China. Under 50% locally in S.E. Turkey, Kazakhstan, N. Vietnam, N. Philippines, C.S. India; widely in the other areas except possibly C. Turkey and N.E. Nepal. Borneo mostly near normal; Java variable but mainly dry.

**Australia. Temperature:** warm in Western Australia (-2degC locally in W.); marginally in S. Northern Territory and W. Queensland. Cold elsewhere; -2degC locally from E.C. Queensland to C. New South Wales. Tasmania uncertain. **Rainfall:** mostly wet; over 200% in E. Western Australia, S.W. and N.E. Northern Territory, N. Queensland, W. and N.E. South Australia, W. New South Wales, C.N. Victoria. Dry in N.W. Western Australia, in and near Victoria (both under 50% at least locally); S.W. Tasmania.

M.W. ROWE

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**BRITISH WEATHER SUMMARY: OCTOBER 1999**

Although there were intervals of disturbed weather, for the most part this was a placid October with a lot of sunshine. Mean temperatures were mostly rather above normal; it was often quite warm, but there were cold nights around the 5th and 13th and cold days around the 20th. Rainfall totals were generally below normal, although two or three very wet days conspired to make it a wet month in scattered localities.

September’s unsettled weather did not linger long into October, but there was a boisterous start to the month as a deep depression drifted east southeast off northern Scotland during the first three days. Its cold front was particularly active as it crossed Wales, northern and central England on the night of the 1st/2nd, giving 30 to 50 millimetres of rain in quite a few districts. Rather cold, bright but showery weather followed. Pressure then rose strongly in the cold air, killing off most of the showers, but leading to early season frosts in several places on the 5th and 6th. A much milder westerly airflow became established by the 8th, and fronts brought rain or drizzle to many areas, but more especially to the west and north. The temperature rose to 21 degrees in parts of eastern England on the 10th after overnight minima of 14 or 15. Renewed high pressure brought sunny weather to much of the country in mid-month, with quite warm days but cold nights. It was not completely settled, though; 40 millimetres of rain fell at Teignmouth (Devon) on the 15th and 16th, the greater part of the fall being very localised.

Strengthening easterly winds turned it much colder by the 20th, and the sunnier skies retreated northwards; the temperature only reached 7 degrees at Buxton (Derbyshire) on both the 20th and 21st. The next few days were very unsettled, under the influence of deep low pressure drifting across the country from Ireland. Around forty millimetres of rain fell in several regions of England (including Teignmouth again) and Wales on the 24th, when there were severe gales near southeastern coasts; there was a fair amount of flooding and wind damage on this day. It then became more settled again for a while in the south - even with fog for a few hours on the 29th - but a very rapid fall in pressure ensured that the month ended in rather similar vein to how it began.
### TEMPERATURE AND RAINFALL TABLES: OCTOBER 1999

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### Tornado Research Organization Spring Meeting

**TORREY SPRING MEETING**
Saturday, 18 March 2000
12.00 - 4.15 pm
Oxford Brooks University

The TORRO Directors invite you to participate in their Review of 1999. Speakers will look back at last year's thunderstorm, lightning, hailstorm, tornado, waterspout and snowfall activity and ask 'was it an average or an exceptional year' and what were the highlights of 1999?

Attention will be given to the violent thunderstorms and flash floods in late May and early July, the damaging golfball-sized hail in Hampshire in May, the tornado outbreaks of 5 July and 5 November, the numerous funnel cloud sightings, the record ball lightning sightings on 26 January, the severe thunder squall line of 29 May, the fatal lightning strikes in August and September, the 'whiteout' in Surrey in September, and the disruptive heavy snowfalls in early February and December.

Other presentations will explore forecasting of severe storms and the use of upper air charts and tephigrams (or, alternatively, 'what everyone wants to know about tephigrams but is afraid to ask'). The tornado outbreak of 5 November will be used to discuss how to conduct a tornado damage site investigation and how to deal with the demands made by the news media.

Your comments and Insights concerning the storm events of 1999 will be especially welcomed. Lunchtime provides the opportunity to make new contacts and discuss your meteorological interests.

Advance booking is essential as the number of participants is restricted to a maximum of 20. If you would like to attend please contact Professor D. J. Elson for a booking form by post (TORRO Headquarters: Geography Department, Oxford University, Headington, Oxford, OX3 0BP) or by e-mail (torro@brookes.ac.uk). Preference for places will be given to full members of the organization. A small registration fee is payable (£5 for full members, £8 for others).

All full members of TORRO receive the Journal of Meteorology. Membership details can be obtained from the Oxford Brooks University website at http://www.oxfordbrooks.ac.uk/
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FRONT COVER PICTURE
Waterspout in the solent near the Isle of Wight, 6 July 1996,
photographed by S. L. Lodge

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