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Cloud to ground lightning strikes, northern France, August 2000 and 2001

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Machhe Purche peak, Nepal (6993m)

As seen from Pokhara town, Plate 1 (page 377)

Picture: O.N. Dhar

Hole in altocumulus made by an aircraft

Shenley, Herts, UK, October 2002, Plate 2 (Letters to the Editor, page 394)

Pictures: Burl Solomons

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THE WINTER OF 1962-63 PART II: THE BLIZZARDS AND ICE STORMS OF 3-5 JANUARY and 19-20 JANUARY 1963

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Abstract: The two blizzards and ice storms occurring over (1) 3-5 January and (2) 19-20 January 1963 in southern Britain are assessed and described as part two of a 40-year retrospective look at the famous 1962-63 winter.

INTRODUCTION:

After the late-December 1962 snowfalls had blanketed much of England from Birmingham southward (*J. Meteorology, 27, no. 272, pp285*), continuing snow cover and persistent easterly winds produced the coldest January for nearly 150 years (actually since 1814; Manley, 1974) in central England. A brief summary of the conditions appeared in *Weather* (*Vol. 18, p96*) and this described January 1963 as, "Dry and exceptionally cold with frequent blizzards and widespread snow cover". The rather longer *Historical Weather Log* (*Weather, Vol. 47, pp. 15-18*) provided a sequence of North Atlantic charts dominated by anticyclones over Scandinavia and to the north of Britain. This log also reproduced statistics that illustrated how comparatively dry January 1963 was, and how some western British stations had their sunniest January of the 20th Century. However, statistics fail to convey what was felt by many as complete 'cheerlessness' after the festive season as they struggled to return to work through deep snow and ice early in January 1963. And, to make matters worse, the Met. Office were expecting another blizzard, similar to the paralysing one of 29-30 December 1962, as another deep depression was developing to the south of the country.

3-5 JANUARY 1963

After a depressingly dull, 'sub-freezing' day with light drizzle on January 2nd; snow accompanied by strong north-easterly winds reached southern coastal counties of England during the evening, and spread quite rapidly north-westwards.

Typical snow 'onset' times (GMT) were 2150 at Torre, Somerset; 2200 at Boscombe Down, Wiltshire; 2245 at Cardiff (Rhoose) Airport; 2300 at Abingdon and Lyneham; 2350 at Pershore Little Rissington and Bristol (Filton) Airport, by which time (as a sign of things to come) heavy freezing rain was reported at Bournemouth (Hurn) Airport. The snowfall reached Exeter Airport by 0100 on the 3rd, and Birmingham (Elmdon) Airport by 0130, commencing at Aberporth (Cardigan Bay) by 0200 and at Shawbury in Shropshire by 0300 GMT.

By contrast, progress of the snow was relatively slow north eastwards into East Anglia, where after reaching RAF stations at Wyton and Bassingbourn in Cambridgeshire by 0145, only a few flurries were observed at Mildenhall before 0530 GMT. Notably, Norfolk did not have appreciable snowfall before the 4th. Figure 1 shows the synoptic situation was already a complex one by 1800 GMT on 3 January. A small depression (Low 'X') was in evidence over Somerset, drifting slowly westwards over the Bristol Channel with the leading warm occlusion. Warmer air aloft behind these features had turned the precipitation over many south-eastern districts to freezing rain, with temperatures (at last) lifting above 0°C over London and Kent as Low 'Z' and its warm front began to cross the English Channel.

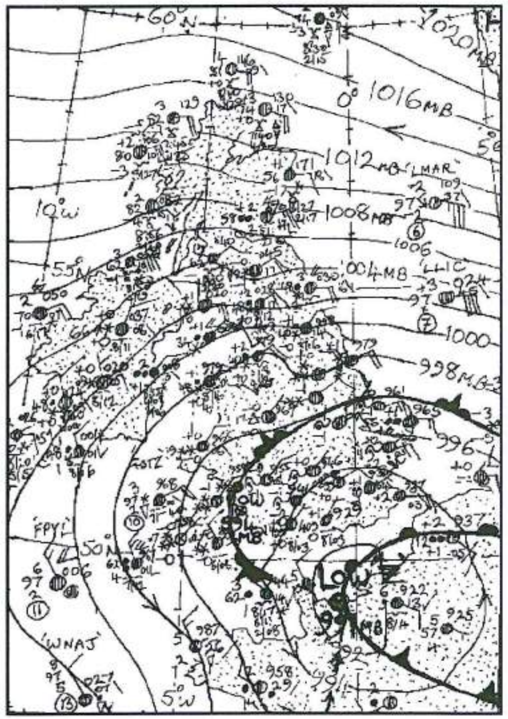

Fig.1 Surface synoptic chart for 1800 GMT on Thursday 3 January 1963. Drawn by the author, based on information supplied by the Met. Office.

Figure 2 presents depths of new snow over 3-4 January, with (as best as could be determined in the strong winds) total depths (new plus old cover) given in brackets (in centimetres). It shows that, far from being a 'repeat performance' of 29-30 December 1962, the main areas to be affected were in the west country, Worcestershire, and eastern Wales where over 10 cm fell. The 3rd was reported as being the snowiest day of the winter in much of Devon, Somerset and west Dorset (the 29-30 December blizzard had occurred overnight).

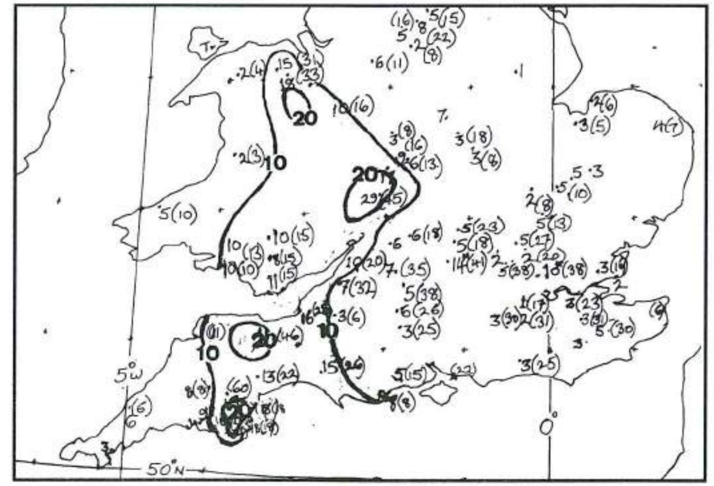

Fig. 2. Chart of maximum falls of new snow over 3-4 January 1963 (undrifted) in cms. Total depths (fresh and old cover combined, but undrifted) given in brackets, also in cms. Based on Met. Office and Snow Survey Observer Information

The 'Snow Survey' observer at Torre, Washford, Somerset (155ft/ 47m asl) reported a "heavy blizzard" from 2nd/2150 to 3rd/2245hrs resulting in a 20cm increase in snow depth to 46 cm in total. This was probably influenced by the development and slow passage north-westward of Low 'X', which eventually became slow-moving feature off south-western Wales (see Figure 3). In fact, Pershore in Worcestershire (not far from Tewkesbury) was one of the snowiest places in England that Thursday. The snowfall lasted 18 hours until eventually turning to freezing drizzle in the evening. The observers gave the continuous snowfall as being of "moderate" intensity on twelve of the eighteen regular hourly observations, with bursts of "heavy" snow between 1215 and 1510 in the afternoon, sufficient to reduce visibility to 400yds at 1310. An hourly measurement of water equivalent, yielded 7.2mm from melted snow between 1200 and 1300 GMT. The day total (24 hrs to 2100 GMT on the 3rd) was 34.8 mm, although this included 3mm of freezing precipitation, from 1800 to 2100 hrs; so, the fall of new snow was 29 cm, producing 31.8 mm water equivalent, with a total snow depth of 45cms.

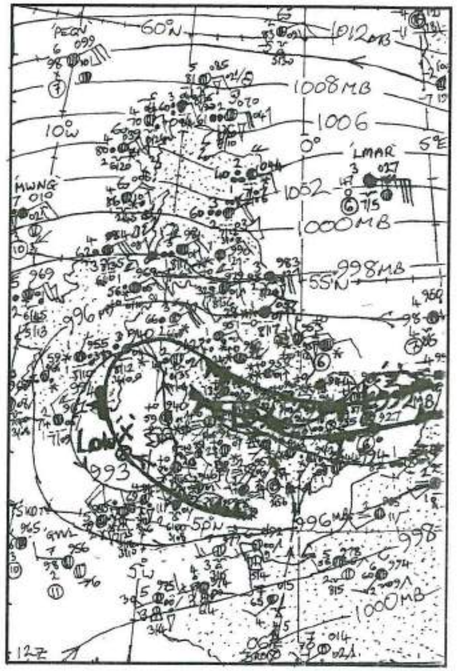

Fig.3. Surface synoptic chart for 1200 GMT on Friday 4 January 1963. Plotted and analysed by the author; based on information supplied by the Met. Office.

The problem of blowing snow made estimates of new falls difficult. It could be suggested that the 11cm of new snow measured at Cardiff (Rhoose) corresponded to their 35.7 water equivalent at 1800 GMT, could have been a result of drifting snow entering the gauge. Similarly, over-estimates of depth (marked '*' on Figure 2) were probably made at Abingdon (14cms) and Hampstead (10cms), where the snowfall lasted less than 9 hours before turning to freezing rain. Maximum reported winds were generally northeasterly 20-25kts gusting 30-35kts.

The freezing precipitation over south-eastern parts of England was in itself memorable for producing a 1cm thick 'crust' of clear glazed ice over the snow by the end of the afternoon on Thursday the 3rd. The author recalls his fourteen stone father being able to walk on top of the 3-4ft snowdrifts in the garden at Beacon Farm, near Newmarket in Suffolk. The nearby professional observer at RAF Bassingbourn noted that the moderate freezing rain lasted for 4 hours 10mins from 0950 to 1400, with the glaze accumulating at 2mm per hour, giving 8mm by 1700 GMT, then with freezing drizzle from 14 to 1800 GMT.

Over high ground, such as the Chilterns, Cotswolds, Downs, and Salisbury Plain, the temperature remained below O°C for longer, and freezing precipitation alternated with ice pellets (frozen rain) or even reverted to snow or sleet at times, especially where the upper air was that bit colder, further to the west. At RAF Colerne (just north of Bath) where, after spells of either freezing or frozen precipitation, the wind direction indicator became "frozen up" by 2200 GMT on the 3rd. Maximum temperatures had remained below 0°C all day, with -1.3°C recorded at 1800 hrs, and -1.0°C overnight to 0600 hrs on the 4th. However, in most places to the south-east of a line from Hull to Birmingham to Bristol to Bournemouth, there was a slight rise in temperature to just above O°C later on the 3rd or during the early hours of the 4th, and a slow thaw set in, albeit temporarily.

By 1200 GMT on 4th January 1963 (see Figure 3), the situation had become quite complex with Low 'Z' moving slowly eastwards towards Holland, Low 'X' was slow moving, if anything, returning southwards again towards the south-west peninsula, and a third small depression over Warwickshire and edging eastwards towards Norfolk. The relatively mild air with rain was sandwiched in a narrowing band from Suffolk to Shropshire between the two occlusions. The main zone of snowfall was now lying from the West Midlands to Norfolk, and beginning to push southwards again.

Snowfalls in this area over 4-5 January 1963 were somewhat gentler than those further south-west the previous day. Coltishall in Norfolk reported continuous slight or moderate snow from 0925hrs on the 4th to 1230hrs on the 5th, with an increase in depth only from 2cm to 7cm over those 15 hours. Similarly at Birmingham (Elmdon) Airport, there was only a 2cm increment (from 11cm to 13cm lying) during the renewed snowfall from 1400hrs on the 4th to 0400 on the 5th. Most places in Norfolk (even Hunstanton nearer sea level) saw two inches by early on the 5th. Rising pressure was weakening the frontal activity, and freezing fog became the next hazard in south central England.

Although this paper concentrates on snowfalls in the south, it should be mentioned that Northumberland and Durham had persistent showers or longer periods of snow coming off of the North Sea during the period 1-5 January 1963. Eggleston Snow Survey observer (NGR, NY 900027 at 1,025ft /312m up in Teesdale, Co. Durham) reported 15cm new snow (41cm in total) with considerable drifting at 0900 hrs on a fresh the 3rd; another 10cm new snow (51 cm total) by the 4th, and a fresh 5cm (56 cm total) by 0900 hrs on the 5th. This was comparable with the 60 cm reported depth at Dartmoor Prison, where water equivalents for the 24hr periods were 16.3mm on the 3rd and 10.4mm on the 4th. Even at low levels, Gosforth (170ft/52 m asl in Northumberland) reported "heavy snow showers" producing 10cms on 1st and 2nd, with further periods of snow giving 18cms total cover by 0900 by the 5th. The higher east facing slopes of the Pennines and North York Moors also received 20-25cms during the first five days of the month.

As a result of these extensive snowfalls and severe frosts, virtually all of the third round F.A. Cup football matches scheduled for Saturday 5th January in England and Wales were postponed, and the 'Pools Panel' were then formed to invent the probable results! One notable exception was Leicester City, whose fixtures could be played on a pitch with underground heating.

19-20 JANUARY 1963.

This particular blizzard occurred in the middle of an extremely cold period of weather when the authors Six's maximum/minimum thermometer did not climb above 0°C at Newmarket (NGR TL 593618) for 10 days, between 15-25 January 1963. January 19th started crystal clear in much of England and Wales, before the first small cumulus appeared at around 1100 GMT. The wind was increasing from the east throughout the morning, to reach its maximum strength just as the snow began, reaching Manston in Kent by 1400 GMT, then spreading rapidly across many southern districts as far west as Pershore and Cardiff by 1800 GMT. Figure 4 presents the synoptic situation, with a trough lying from Norwich to the Isle of Wight by that time.

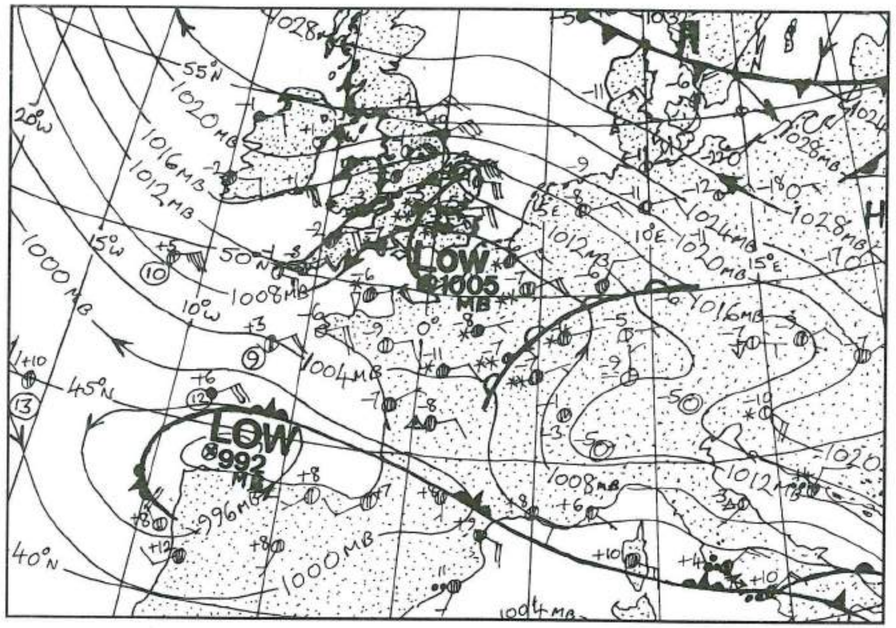

Fig.4 Surface synoptic chart for North-Western Europe at 1800 GMT on Saturday 19th January 1963. Analysed by the author, and based on information supplied by the Met. Office.

Several soccer matches were abandoned that Saturday afternoon at or soon after half-time in south-east England, due to the windchill and snow. The Carl Giles cartoon in the *Daily Express* on January 22nd depicted what appeared to be Ipswich Town (or other football team) trying to thaw themselves and the football out at half-time, with what appears to be a snowman in the goalmouth! The caption read, 'I bet Charlie's cold in goal today. By the way- where is Charlie?' as the snow falls thickly outside.

Ex-Met Office Archivist, Mick Wood, was on duty at Shoeburyness, Essex, that afternoon, and at 1600GMT, his observation gave an easterly wind of 30kts (corrected) gusting 56kts (uncorrected at 100ft exposure height) with continuous slight snow and a dry bulb temperature of -5.5°C! There had been an uncorrected gust of 68kts earlier at 1430GMT, when the snow was just starting to fall. Using Dr Paul Siple's formula to calculate windchill, which is explained in George (1984), we find that given 'V' = 15m/s and 'T'= -5.5°C in the formula:

Windchill, $'C' = (\sqrt{100xV} + 10.45 - V)x(33 - T)$

We find that 'C'= 1331 (kilogramme calories of heat lost, per square metre of skin, per hour). This figure is midway between the 'bitterly cold' (1200) and the 'exposed flesh freezes' (1400) category lines on the Wind Chill Index graph (George, 1984). No wonder the footballers were cold!

At Mildenhall Airfield, the observer reported 'blowing dust to the west' (present weather code figure 'ww =07') for three hours before the snow began, in east-north-easterly winds of 25-30kts gusting 42-53kts that afternoon. These conditions were reminiscent of the Canadian Prairies, but here giving a wintertime 'Fenland Blow'. Relatively sheltered locations, such as Kew Observatory also recorded strong gusts (58kts) as the snow began, and their 4cm cover had increased to 13cm by 0900 GMT on the 20th. Special water equivalents of the snowfall were taken at hourly intervals, and of the total 16mm overnight, 2.5mm fell between 1800 and 1900 GMT and 8.8mm between 1900 and 2000 GMT, a very high hourly figure for snow, indicating that heavy showers were embedded in the system. Although the wind strength diminished during the evening, considerable drifting was remarked on in both town and country. At Kew, maximum temperature had only risen to -1.7°C on the 19th.

Generally speaking, fresh snowfalls of some 8-10cm were common, but 15cm with 1-2m drifts were reported from snow survey stations at Framlingham in Suffolk; Boxstead Lodge in Essex (16-17cm); and Ware in Hertfordshire. The author remembers noting the 10cm fall on Newmarket Racecourse the next morning, and a fair proportion (some 20%) appeared to consist of quite large snow grains of 1-2 mm diameter, indicating the showery nature of the embedded heavier precipitation.

Figure 5 shows the movement of the responsible 1000-500mb 'cold pool' centre as it travelled westwards, albeit warming all the time, from 18-20 January 1963. This 'continuity chart' shows that the snow band was closely associated with the cold pool as it passed over the English Channel between 1200 GMT on the 19th and midnight on the 20th, when close to Devon. Two snow survey stations in that county also reported six-inch snowfall (15cm) later that evening, namely Dartmoor Prison (1,650ft/502m alt) and Bala Brook (770ft/234m.).

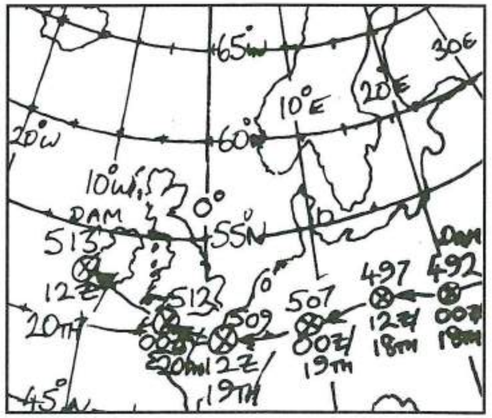

Fig.5. Continuity chart of 1000-500mb Thickness 'Cold Pool' centre, drawn by the author from successive charts over 18-20 January 1963. Based on information supplied by the Met. Office

Another feature which should be remarked upon in Figure 4 is the 'upper level' warm front heading north-westwards over the Alps. This front was bringing something of a temporary Fohn Effect (a warming of the air as it is forced to rise and then sink again in passing over a mountain range), which is best shown by radiosonde profiles, such as those from Crawley in West Sussex (Figure 6). It can be seen that the air had warmed considerably from about 960mb to 430mb, during the 24 hours from midday on the 19th to the 20th, and is just above O°C from 920 to 900mb (i.e. in a 600ft-deep layer just below 3,000ft) which is sufficient to melt falling precipitation and cause freezing rain or freezing drizzle to be reported at the surface.

This freezing precipitation was not as heavy as had been observed on 3-4 January, but nevertheless caused some problems for travellers during the course of 20th January 1963, because it continued for spells of 6 hours or so in many southern districts, and fell with temperatures generally in the range of -2 to -5°C. Only in the extreme south-west did temperatures rise above O°C during the evening of the 20th, (e.g. Plymouth, Mountbatten noted a steady rise in temperature during the drizzle from -2.4°c at 1800 GMT to +1.4°C at 2200 GMT).

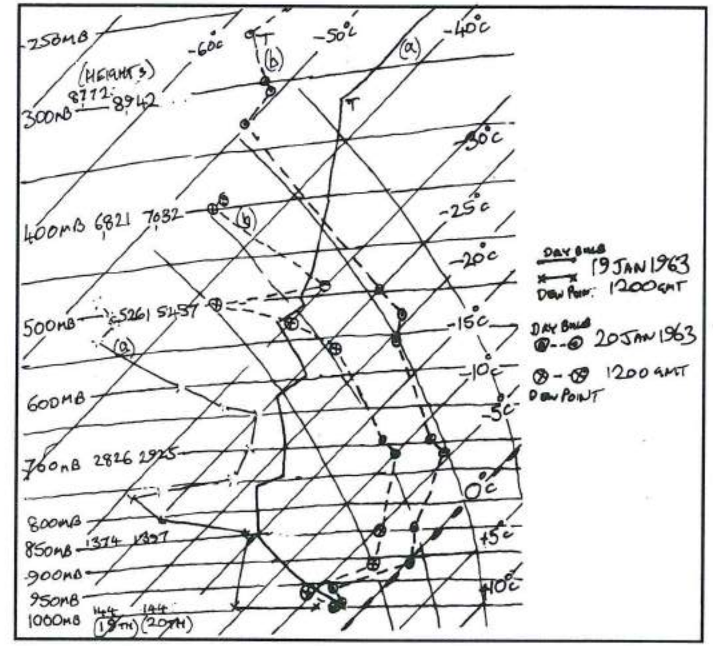

Fig.6. Radiosonde profiles from Crawley, West Sussex, for (a) 1200 GMT on 19 January 1963 (solid lines) and (b) 1200 GMT on 20 January 1963 (pecked lines). The dots represent dry bulb temperatures; the crosses give dew point soundings. Drawn from information supplied by the Met. Office.

BRIEF CONCLUDING REMARKS

Some of the snowfalls and freezing precipitation events seen during the 1962-3 winter are comparable to anything since the proverbial 1946-7 and 1940 winters respectively. The freezing rain may not have produced such thick glaze as in January 1940 (Brooks & Douglas, 1946) and the 29cm of snow falling at Pershore on January 1963 making a total 45cm, may not have been quite as deep as some of the West Midlands accumulations in the winter of 1946-7. However, the 1962-3 cold spell lasted longer, and in many respects represented the worst winter in many peoples' memories.

ACKNOWLEDGEMENTS

Special thanks are due to Ian MacGregor and Marion James at Met. Office Archives, Bracknell, where synoptic charts, upper air information, snow survey and climatological reports were studied; enabling this article to be written and the figures to be drawn. I am grateful also to Mick Wood and Jonathan Webb (TORRO) for their own personal memories of the 1962-3 winter season.

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THUNDERSTORM DAYS IN POLAND, 2000

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Abstract: This research is based on daily meteorological data for 2000, and concerns the occurrence thunderstorm in 43 Polish synoptic stations.

INTRODUCTION

Data for this research was collected from the Institute of Meteorology and Water Management (IMGW) meteorological stations (Figure 1). Analysis of the distribution map of number of thunderstorm days in 2000 has shown that the frequency of thunderstorms increased from the north to the southeast of the country. On the Baltic Coast there were fewer than 20 thunderstorm days, around 25 days in the center of Poland and over 35 days in the Carpathians. The Bieszczady region produced the most thunderstorm days with over 40 days per year (Figure 2). On average there were 26.7 thunderstorm days per station in Poland in 2000.

SPRING / SUMMER

The frequency of thunderstorm days in the spring and summer are similar to the annual distribution. In these seasons the number of thunderstorm days increased from the north to the south of Poland. In the spring there were fewer than 10 days in the north and middle-east of the country.

Fig.1 Location of meteorological stations

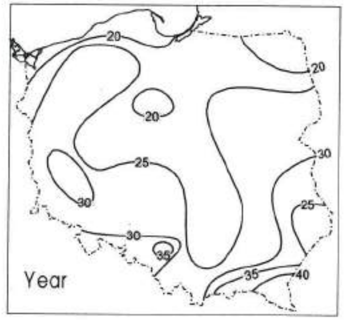

Fig.2 The number of days with thunderstorm in Poland

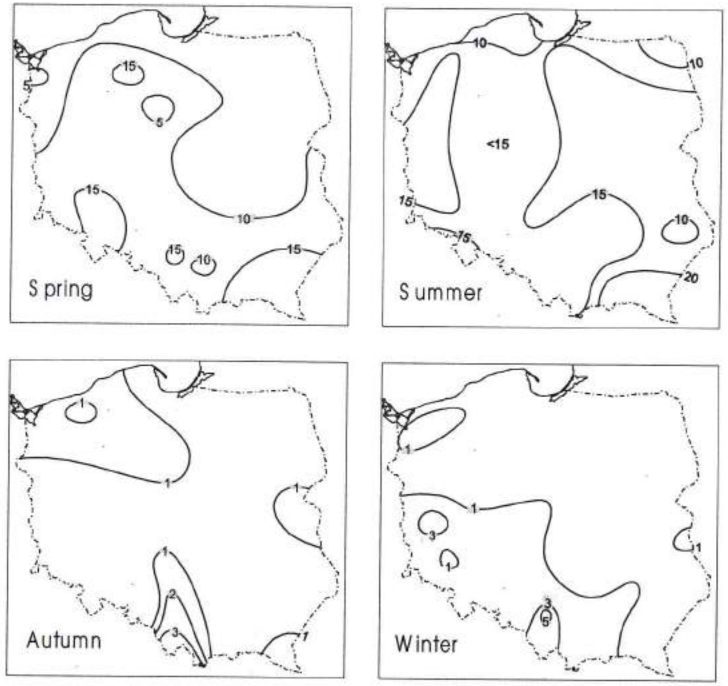

Fig.3 The number of days with thunderstorm in Poland in particular sesons of the year 2000

More than 15 days occurred in the Carpathians, eastern part of the Sudety and eastern part of the Silesian Lowland and also in the region of Katowice and Chojnice. On the average there were 11.2 thunderstorm days per station in the spring. In the summer, days with thunderstorms occurred slightly more often. They occurred less often (below 10 days) in the north of the country, in the middle part of the coast. In the centre of Poland there were approximately 15 thunderstorm days and in the Carpathians over 20. On the average there are 14.3 thunderstorm days per station in the summer.

	Bielsko-Biała	Białystok	Chojnice	Elbląg	Gdańsk	Gorzów Wlkp.	Jelenia Góra	Kalisz	Kasprowy Wierch	Katowice	Kielce	Kłodzko	Koło	Koszalin	Kraków	Legnica	Lesko	Leszno	Lublin	Łódź	Mława	Nowy Sącz
JAN	1	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0
FEB	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
MAR	2	0	0	0	0	0	1	0	1	3	1	1	0	2	2	0	3	1	0	0	0	3
APR	4	2	6	0	2	4	3	2	1	2	2	6	0	2	1	3	6	3	3	1	3	2
MAY	5	3	6	5	3	3	6	10	7	7	2	6	6	5	2	9	2	5	2	3	5	6
JUN	4	4	5	4	4	4	6	5	8	6	7	5	5	5	5	6	7	4	6	5	3	9
JUL	5	6	0	4	0	5	3	4	4	7	6	7	4	4	4	4	13	4	10	6	5	9
AUG	4	10	8	5	5	8	5	6	7	4	5	6	5	4	6	6	8	5	9	6	5	10
SEPT	0	1	3	4	2	3	2	1	2	2	1	1	2	4	0	2	0	2	2	2	4	0
OCT	3	0	1	0	0	0	0	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0
NOV	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Olsztyn	Opole	Płock	Poznań	Racibórz	Rzeszów	Sandomierz	Siedlce	Suwałki	Szczecin	Śnieżka	Świnoujście	Toruń	Ustka	Warszawa	Wieluń	Włodawa	Wrocław	Zakopane	Zamość	Zielona Góra	
JAN	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	
FEB	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	3	
MAR	0	0	0	0	1	2	2	0	0	0	0	1	0	1	0	2	0	0	1	1	1	
APR	1	5	0	2	3	2	4	1	0	1	3	2	1	4	3	2	2	5	1	2	3	
MAY	5	7	5	5	7	5	4	3	4	2	6	3	3	3	3	5	5	6	6	5	6	
JUN	3	3	4	5	6	9	5	4	3	5	6	4	0	3	4	5	7	7	8	7	5	
JULI	4	3	4	4	7	10	7	7	6	4	4	2	4	1	7	5	9	3	4	6	5	
AUG	9	6	7	6	5	4	4	7	2	4	6	2	6	4	9	8	5	5	6	0	6	
SEPT	2	1	3	1	1	2	1	4	1	3	3	5	3	2	4	1	2	1	1	0	2	
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	
NOV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
DEC	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	

Table 1. The frequency of thunderstorm days in Polish meteorological stations each months for 2000.

AUTUMN / WINTER

The frequency of thunderstorm days is very small in the autumn and winter. On the average there were 0.4 and 0.8 days per station respectively. Thus, in the winter of 2000 there were more days with thunderstorm than in the autumn. At the synoptic stations located in the northwest Poland and also in Polesie Lubelskie and Sidlecka Upland, Krakowsko Czêstochowska Upland, the Podhale and in the Bieszczady there was only one day with thunderstorm recorded in the autumn. Two thunderstorm days occurred within this period in the region of Katowice and three days near Bielsko Biala.

ANALYSIS

Comparison of the year 2000 with the mean multi-annual period of 1969-1998 (Kolendowicz 2002) showed that the frequency of occurrence of thunderstorm days is larger than the mean value. Table 1 illustrates thunderstorm days in particular months for 2000. The frequency of thunderstorm days increased slightly from January to April. In this period the maximal number of thunderstorm days reached 6. In May, thunderstorm days occurred more often than in the preceding period, however not at all stations. Thunderstorm days occurred most often between May and August. In this period, 10 or more days per month were recorded at six stations. In September, the number of thunderstorm days fell considerably in comparison with that of August, which, to some extent, resembles the situation of April and May. From October the number of thunderstorm days decreased considerably. In December thunderstorms were not recorded at any synoptic station.

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PRECIPITATION DISTRIBUTION AROUND THE ANNAPURNA RANGE OF NEPAL HIMALAYAS: A BRIEF APPRAISAL

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Abstract: Precipitation around Annapurna range of the Nepal Himalayas has been studied in this research. There are a few precipitation stations both to the south as well as to the north of this 7 to 8 km high Himalayan range. It has been seen that in this sector of the Himalayas, moist winds on crossing the range from south to north lose about 95% of their moisture which appears to be the highest for any section of the Himalayas.

INTRODUCTION

In Nepal Kingdom before 1947, there was only one meteorological observatory at its capital city, Katmandu. In connection with the Kosi High Dam Project and Flood Control Projects of the Government of India, more than 100 meteorological stations were started by India Meteorological Department (IMD) throughout the Kingdom with the permission of the Nepal Government. From the early 1960's Nepal Meteorological Service augmented this network by adding more stations and at present there are about 264 meteorological stations.

Their data are available for varying periods, ranging between 10 to 50 years. Using this data International Centre for Integrated Mountain Development (ICIMOD), Katmandu, Nepal, prepared generalised maps of precipitation distribution over the entire Nepal region (Chalise et al., 1996). These precipitation maps form the basic input to study the precipitation distribution on the north and south of the 7 to 8 km high Annapurna range of the Himalayas in Central Nepal. Before studying the precipitation distribution, a brief review of the study region was undertaken.

ANNAPURNA RANGE

Annapurna range of the Central Himalayas extends from 83°45'E to 84°15'E from west to east (Figure 1). It is bound in the east by the Marsyandi River and in the west by the Kalii Gandaki River which is known for having cut the deepest gorge in the Himalayas. Annapurna range is unique, because it has twelve different Himalayan peaks of higher than 7000m and many other peaks higher than 6000m.

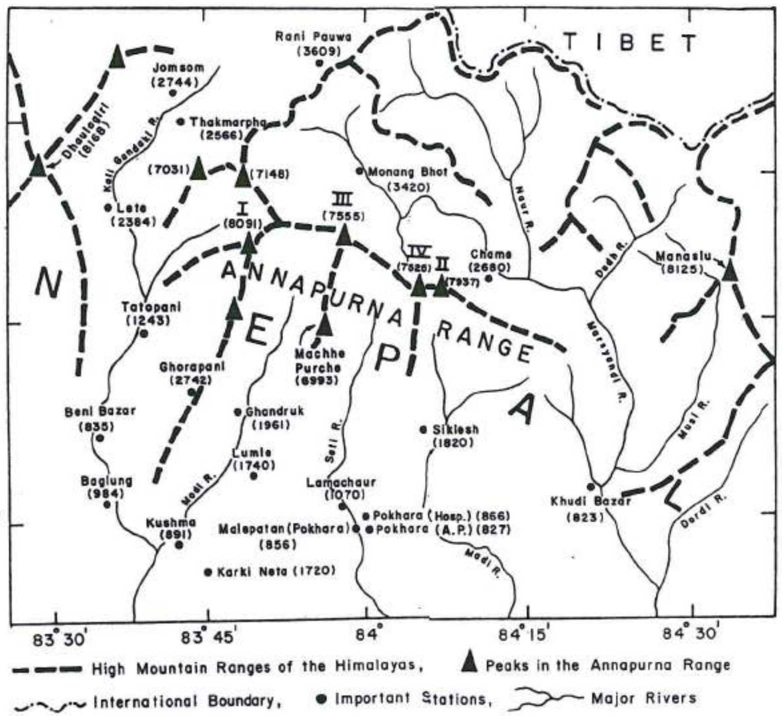

Fig 1. Annapurna range of the Nepal Himalayas and other adjacent mountain peaks

Annapurna-I (8091 m) is located on the Annapurna massif in the northwest and it is considered as the 13th highest mountain peak in the world. It was first climbed in 1950 by the French expedition lead by Maurice Herzog on June 3rd, 1950. On the west of the Annapurna range is the giant peak of Dhaulagiri (8168 m) and on its eastern side is the giant peak of Manaslu (8125 m) (Figure 1). The Annapurna range is thus sandwiched between these two Himalayan giants. The major peaks on the Annapurna range are Annapurna-I (8091 m), Annapurna-II (7937 m), Annapurna-III (7555 m), Annapurna-IV (7525 m), Gangapurna (7455 m) and Annapurna South (7219 m).

Annapurna, literally means *"the Goddess of Abundant Harvest"*, it lies at a horizontal distance of 40 to 50 km from the broad valley of Pokhara which is at an elevation of about 900m. The most imposing pyramidal peak in the central foreground is that of Mt. Machhe Purche (Plate 1 *inside front cover*). At the back of this peak lies the entire Annapurna range.

POKHARA VALLEY

Pokhara Valley occupies a central location in Nepal and is dominated by the peaks of the Annapurna range. The uniqueness of Pokhara town (931 m) is that it is about 50 kms south of the Annapurna range. There is a decline of about six thousand metres in altitude within a distance of about 30 kms from the Annapurna range, thereby providing with a drastic contrast in precipitation distribution. The Seti River originates in the glaciers of Machhe Purche Peak (6993 m), which is a satellite peak south of the Annapurna range. This river flows through the heart of the Pokhara town (Figure 1) and carves a deep course through the city of Pokhara.

PRECIPITATION DISTRIBUTION AROUND ANNAPURNA RANGE

Examination of the precipitation charts of the ICIMOD Atlas (Chalise et al., 1996), showed, just to the northwest of Pokhara town, there is a prominent pocket of high precipitation whose magnitude varies from 5000 mm to 6000 mm annually. This fact was also discovered by Dhar and Mandal (1986) while studying precipitation distribution over the Nepal Himalayas. They found that the two stations, Lumle and Lamachure just to the northwest of Pokhara town recorded high magnitudes of precipitation annually, which were of the order of 5000 mm to 6000 mm. The ICIMOD Atlas has also confirmed this observation of Dhar and Mandal (1986).

Lang and Barros (2002) in their recent study on the onset of monsoon in Central Nepal Marsyandi basin, located to the east of Annapurna range, also found that stations to the north of Annapurna range received far less precipitation during the monsoon period when compared to stations to the south. Figure 2 shows the mean annual precipitation around the Annapurna range.

The geographical location of high Himalayan mountains and valleys in this region of Nepal is responsible for causing a pocket of high precipitation which is not experienced in such a magnitude in any other part of the Himalayas. A possible explanation for this high precipitation pocket appears to be that the northern part of Pokhara Valley is box / bowl like. On three sides are high mountain ranges (Figure 1) which trap the moist winds from the south and make them rise high up in the atmosphere, nearly 40 kms south of the Annapurna range, making them precipitate practically all the moisture within them. Since there is no network of precipitation stations north of Lumle and Lamachure stations, it cannot be said with confidence whether there is any other higher pocket of precipitation nearer the Annapurna range. This fact can only be confirmed by installing a few more precipitation stations in the upper Pokhara Valley.

On the lee side, viz. Northern side of Annapurna range in Nepal, there are 5 to 6 precipitation stations whose mean annual precipitation decreases to 200 mm (Figure 2). Stations near the Annapurna ridge on its northern slopes may be receiving higher precipitation due to spillover effect and as one moves further to the north towards Nepal-Tibet border, precipitation decrease rapidly to about 200 mm or even less.

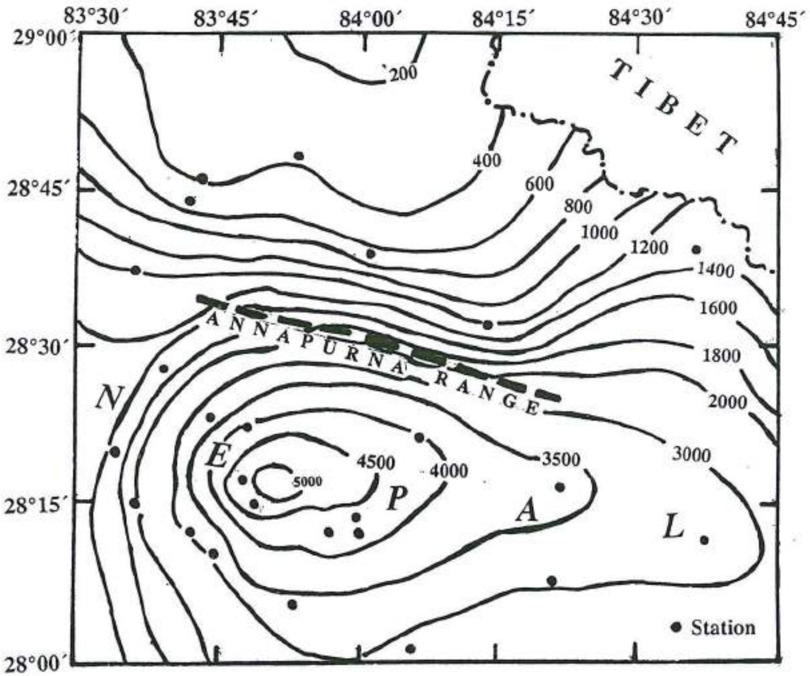

Fig. 2 Mean annual precipitation distribution around Annapurna range

The entire area to the north of the Annapurna ridge is semi-arid like the Tibetan region or Ladakh region in Kashmir which are located on the leeward side of the Great Himalayan range. In Table 1 mean annual precipitation of a few prominent stations located on both sides of the Himalayas from west to east is given here by way of information.

No.	*Station name*	*Location*	*Height (asl m)*	*Mean annual precipitation (mm)*
1.	Gilgit	36°55' N / 74°23' E	490	132
2.	Skardu	35°16' N / 75°37' E	2288	160
3.	Dras	34°26' N / 75°46' E	3066	648
4.	Kargil	34°34' N / 76°08' E	2682	240
5.	Leh	34°09' N / 77°34' E	3514	83
6.	Srinagar	34°05' N / 74°50' E	1586	660
7.	Jammu	32°45' N / 74°55' E	366	1069
8.	Yatung	27°29' N / 88°55' E	2987	967
9.	Katmandu	27°42' N / 85°12' E	1337	1417
10.	Darjeeling	27°03' N / 88°16' E	2265	3211
11.	Kalimpong	27°04' N / 88°28' E	1208	2189
12.	Lhasa	29°40' N / 91°07' E	3685	406

Table 1: Mean annual precipitation of some important Himalayan and trans-Himalayan stations (from west to east). Note: Mean annual precipitation shown in the Table may not exactly tally with the figures based upon the latest normals of these stations.

Recently, Dhar and Nandargi (2002) on the basis of available data studied the precipitation distribution on the windward and leeward sides of the Everest-Kanchenjunga Himalayan range in the longitude belt of 87° to 89°E. They found that the precipitation decreased roughly at the rate of 70% on crossing the Great Himalayan range from south to north. In the case of Annapurna range the decrease of precipitation was about 95%. Perhaps, this is the highest decrease of precipitation that occurs while crossing the great Himalayan range due to the large altitudinal difference between the valley floor and the mountain ridge, a height of about 7000 m or so.

CONCLUDING REMARKS

Using the precipitation data given in the ICIMOD Atlas (Chalise et al, 1996), it has been confirmed that there is a high pocket of precipitation located in the south Pokhara valley. The high pocket of precipitation is just northwest of Pokhara town. Other stations in and near Pokhara town also record high precipitation amounts when compared to stations in and near their neighbouring areas. It has also been found that rate of decrease of precipitation on crossing the Annapurna range is about 95% which appears to be the highest for any region of the Himalayas, based upon the precipitation data of existing network of stations.

ACKNOWLEDGEMENT

Authors are grateful to Dr. Rupa Kumar Kolli, Dy. Director and Dr. G.B. Pant, Director for giving all the facilities to the authors for undertaking this research.

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CORRIGENDA

J. Meteorology, vol.27, no. 272, October 2002

pp285, Abstract, line 3, should read, "A Col Low was found to be a *hitherto-unmentioned* cause of exacerbating the first snowfall...."

pp289, para , line 8, should read "...the rise in temperature for a time indicates it was a '*warm-cored*' feature."

Additions to TORRO Tornado Division Report for Britain and Ireland: August 2000 TN c 1994. Lyme Regis, Dorset (c SY 3392)

Mr. Ron Bailey, in his account of the funnel cloud near Charmouth on 19 or 20 August 2000, said that he had seen a tornado at Lyme Regis about six years earlier. "I watched it come down, pick [up] a load of rubbish, carry it along and then throw it away" (Western Gazette, 31 August 2000).

WS 1998? Penmaenmawr, Gwynedd (c SH 7176)

Ms. Christine Candlin, in reporting the Llandudno waterspout of 28 August, mentioned that she had seen a waterspout off Penmaenmawr "a couple of years ago"; she was watching from Llandudno.

LD 1999 July 31/I. Detling, Kent (c TQ 7958)

This was reported as a land devil in J. Meteorology, 26: 228, July/August 2001. However Bob Prichard has pointed out that there were thunderstorms in Kent that afternoon, including Maidstone, which is close to Detling, so the event could well have been a tornado.

Welcome new members of The Tornado and Storm Research Organisation and readers of The Journal of Meteorology:

K. Leszke (Perthshire, Scotland), I. Marcinonine (Vilnius, Lithuania) J. O'Neill (Victoria, Australia), Z. Sokol (Praha, Czech Republic)

JOURNAL OF METEOROLOGY

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SUBJECT – KEYWORD INDEX

VOLUME 27, issues 265 – 274

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EUROPEAN RAINFALL TOTALS AT THE TIME OF THE AUGUST 2002 FLOODS

By PAUL R. BROWN

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Abstract. A map of rainfall totals over Central and Eastern Europe is presented for the time of the great floods of August 2002.

On 10 August 2002 a depression of 998 mb formed near the Gulf of Genoa. During the next seven days it transferred to the Gulf of Venice, deepened to 995 mb, absorbed a pre-existing shallow low over Austria, moved north into Poland (see Figure 2), and transferred into Russia, where it stagnated near the Black Sea for a few days before eventually losing its identity. (When we talk of a pressure centre 'transferring' from A to B, we mean that a new centre forms downwind of, and then absorbs, the original one. The centre, as it were, jumps from A to B without traversing the distance in between.)

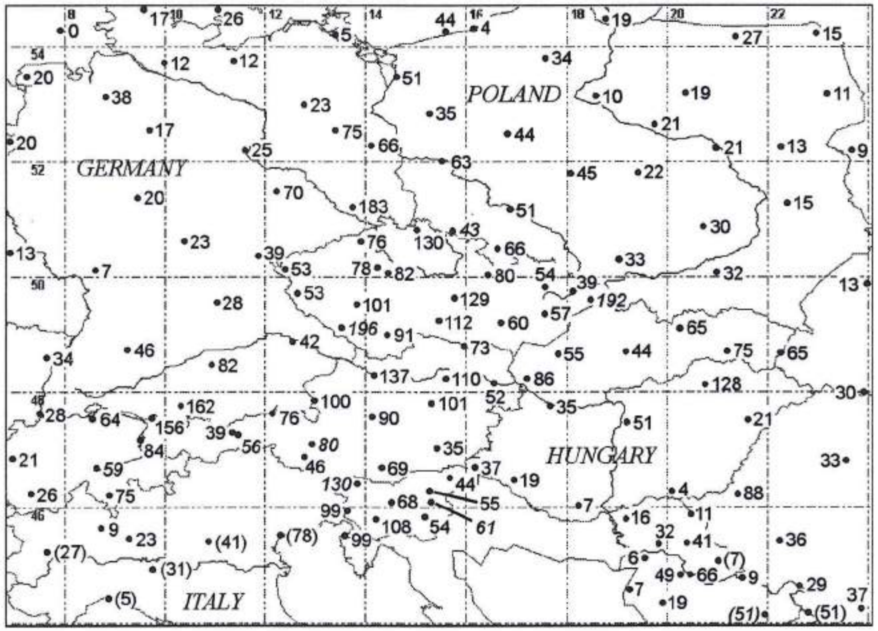

Fig. 1. Rainfall totals in millimetres over Central and Eastern Europe from 9-15 August 2002.

A prolonged deluge accompanied this centre as it crossed Central Europe; and over the ensuing days, as an incalculable mass of water began to pour out of the mountains, many of the rivers burst their banks, leading to extensive inundations of the flood plains. Figure 1 gives the point rainfall totals reported by the main synoptic stations at this time.

Values in italics are from mountain stations; bracketed entries indicate that some data were missing. Isohyets were not drawn on the map because of the largely unknown totals over the extensive mountain ranges in the area of greatest rainfall (on the tops of which, incidentally, it fell as snow); but it is clear that much of this region had over 50 mm, and large areas in the middle had between 100 and 200 mm. Although the amounts here are for the seven days from 9-15 August, the bulk of these totals fell within a 36-48-hour period. The timing of this period varied from station to station, but the 12^{th} was one of the wettest days, e.g. Dresden 116 mm between 0600 and 1800 GMT.

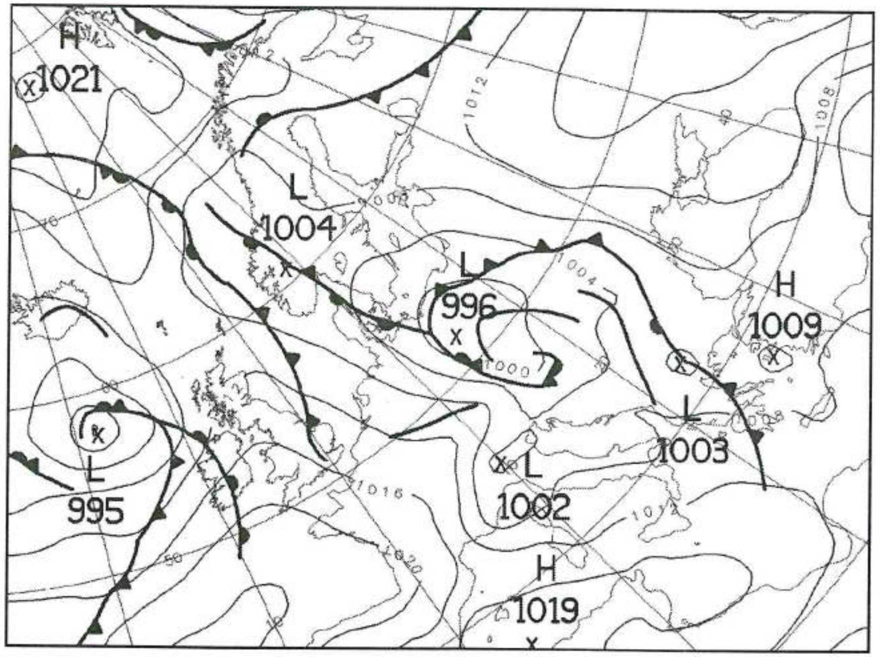

Fig. 2. Synoptic situation over Europe at 1200 GMT 12 August 2002 (from the chart issued by the Meteorological Office, Bracknell).

COMPARATIVE ANALYSIS OF 405 CENTRAL EUROPEAN BALL LIGHTNING CASES

By ALEXANDER G. KEUL* and OLIVER STUMMER°

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° Student of mineralogy, Vienna University, Austria

Abstract: Two Austrian ball lightning (BL) data banks (ABLD 1 - 150 cases, and ABLD 2 - 103 cases) and a Central European BL data bank (CEBLD, 152 cases, mostly German) were analysed and compared[1]. The first author has used the same field investigation and questionnaire scheme since 1974, which has produced high documentary consistency. The analysis found unexpectedly constant statistical patterns with regard to reporter populations, witness reactions, time cycles and durations, meteorological conditions, distance, size, motion data and phenomenological details of BL (form, colour, surface, luminosity). The data were compared with the old European BL data bank of Brand (1923) and other sources. An extreme group test showed stability of the patterns over time within the 20^{th} century. The three data bank profiles indicate one time-constant, space-invariant set of BL phenomena all over Central Europe.

INTRODUCTION

In 27 years (1974-2000), the first author as meteorologist and psychologist has collected and investigated 650 ball lightning (BL) reports. Several outstanding cases have already been published (Keul, 1992, 1994, 1997, 1999a, 2000; Keul, Gugenbauer & Diendorfer, 1993). 150 Austrian BL cases were put in a first BL data bank called ABLD 1, statistically evaluated for ISBL 1 at Tokyo (Keul & Schwarzenbacher, 1989) and with the Russian Stakhanov-Grigoriev data bank (Bychkov, Smirnov & Stridjev, 1993). 134 more cases, 103 already coded, make up a second Austrian BL data bank called ABLD 2. From German-speaking witnesses around Austria, 152 BL cases have been collected and coded as data bank CEBLD. Cases with insufficient information, under investigation, not fully coded or outside Central Europe are not presented here.

The documented BL report density for Austria (8 million inhabitants, population density 95, 284 cases on file) of one case per 28.000 inhabitants is two times higher than for densely populated Japan (126 million inhabitants, population density 333, 2.060 cases according to Ohtsuki & Ofuruton, 1989) with one case per 61.000 inhabitants.

[1] The comparative evaluation of ABLD 1, 2 and CEBLD was supported by Verbund (Austria's main power company) and Siemens in 2000 and 2001 by the research grant "Verbund Forschungsinitiative MBE 25.11.1999". Our thanks go to director Alfred Geiswinkler, BEWAG, and Dr.Gerhard Diendorfer, ALDIS.

State and industry research funds made it possible in 2000/2001 to code, statistically evaluate ABLD 2 and CEBLD, and match them with ABLD 1. Although the European data sets are smaller than the collection of Stakhanov/ Grigoriev by the factor ten, they are very homogenous: 85% of the cases were documented systematically by the same questionnaire type following first reports. The two parallel Austrian data banks enable a split-half stability test.

METHODOLOGY

A series of calls for BL reports started in 1974 in Austrian newspapers and magazines. Besides, several existing BL records at the Central Meteorological Station at Vienna were used, plus a number of reports travelling through meteorological or astronomical channels. Most German reports were triggered by a 1981 BL article in the science magazine "Bild der Wissenschaft" and by extensive press coverage on the Salzburg BL congress Vizotum (Keul, 1993). Of 650 raw reports, 11% were eliminated as non-BL, 14% had insufficient data for coding, 2% were under investigation, 10% still uncoded and 1% outside Central Europe. 405 cases from Central Europe - 62% of the raw data - were coded/re-checked and evaluated in this research project.

Most first contacts were written reports. All reporters were sent a standard questionnaire made up of 54 questions to be filled in and returned by the witness. Other forms were filled in by the first author during phone interviews. Field investigations used the same instrument. With only minor variations in the questionnaire over the years, 84-89% of the BL cases were documented in the same data format.The coding scheme used 46 variables. 11 variables had absolute values, 5 were ordinals and 12 nominals. 18 other (nominal) phenomena were coded binary (existent/non-existent) and added as a data string. 150 cases of ABLD 1 had been coded by the first author and a colleague (1989), the 103 cases of ABLD 2 and the 152 cases of CEBLD were freshly coded by the second author and control-read by the first. The 28 non-binary variables were transferred to a SPSS file for statistical analysis. After the descriptive statistics (see Table 1 for the main results), hypothesis-based correlations were computed.

RESULTS AND DISCUSSION

The results of three different BL data banks from Central Europe gave the opportunity for a statistical comparison of data collected in countries with a common language, and documented in a continuous format. Thus, major differences between ABLD 1, 2, and CEBLD should be due to variations in the BL phenomenon or reporting behaviour in time and space. Comparing the three data banks, the following structures were noticed:

Location: The data form a *report* distribution, not a clear *occurrence* statistics of BL phenomena. Media calls-for-reports had certain social and age impacts. The *potential* for BL reports appears as a superposition of thunderstorm frequency and population density (Keul & Schwarzenbacher, 1989).

Variables	*Austria ABLD 1 (n=150)*	*Austria ABLD 2 (n=103)*	*mostly Germany CEBLD (n=152)*
Location (Federal Province or country) *CEBLD: German-speaking population	25% Styria 21% Lower Austria 14% Vienna 13% Salzburg 11% Upper Austria 6% Vorarlberg 5% Carinthia 3% Tyrol 2% Burgenland	21% Lower Austria 18% Upper Austria 15% Styria 15% Salzburg 9% Vorarlberg 7% Vienna 6% Carinthia 5% Tyrol 4% Burgenland	16% Saxony 15% Bavaria 10% Baden-Württemberg 8% Thuringia 7% Switzerland 6% Czechia* 6% Schleswig-Holstein 32% rest 1-4% each
Witness gender	52% female 48% male	63% male 37% female	56% male 44% female
Witness age at time of observation	Mean 33,6 Range 5-83	Mean 32,7 Range 6-81	Mean 26,7 Range 4-82
Witness age at time of report	Mean 60,4 Range 16-91	Mean 67,9 Range 28-93	Mean 64,0 Range 23-93
Delta (time to report)	Mean 26,7 Range 0-78	Mean 35,3 Range 0-77	Mean 37,1 Range 0-81
Witness profession (at observation time)	26% employed 25% in training 10% academic 9% farmer, worker 9% housewife 9% self-employed 9% pensioner 3% pre-school	28% in training 22% employed 14% housewife 12% self-employed 8% pensioner 7% academic 3%: unemployed/farmer 2% pre-school	50% in training 16% employed 10% housewife 6% academic 6% pensioner 5% farmer, worker 3%: self-empl./pre-sch. 1% unemployed
Witness reaction	45% fascinated 35% frightened 15% calm 5% flight, panic 1% ambivalent	51% frightened 34% fascinated 11% calm 4% ambivalent no flight, panic	46% frightened 33% fascinated 15% calm 5% ambivalent 1% flight, panic
Number of persons	Mean 2,2 Mode 1 Range 1-8 Peaks: 1 49% 2 28%	Mean 2,1 Mode 1 Range 1-30 Peaks: 1 53% 2 39%	Mean 2,2 Mode 1 Range 1-35 Peaks: 1 53% 2 26%
Year [range] All peaks >3% each	Range 1909-86 [78 yrs] Peaks 50, 72, 76, 77	Range 1911-98 [88 yrs] Peaks 33, 35, 57	Range 1900-92 [93 yrs] Peaks 38, 43, 52, 53, 63
Month	Peaks: July 30% Aug 27% June 22% all cases summer 87%	Peaks: July 37% Aug 32% June 13% all cases summer 84%	Peaks: July 35% Aug 29% June 13% all cases summer 87%
Hour (Peaks >3%)	Peak 2:30-5:00 P.M.	Peak 2:30-5:00 P.M.	Peak 2:00-6:00 P.M.
Thunderstorm * damp, oppressive	72% simultaneously 10% after thunderstorm 7% before thunderstorm 6% no thunderstorm 5% thundery*	68% simultaneously 14% no thunderstorm 10% after thunderstorm 7% thundery* 1% before thunderstorm	64% simultaneously 15% thundery* 10% no thunderstorm 7% before thunderstorm 4% after thunderstorm
Precipitation	55% simultaneously 39% no precipitation 6% prec. after BL	56% simultaneously 25% no precipitation 16% prec. after BL 3% prec. before BL	56% simultaneously 24% no precipitation 14% prec. after BL 6% prec. before BL
Lightning flash	57% no lightning flash 22% simultaneously 17% lightning before BL	35% lightning before BL 33% no lightning 24% simultaneously	40% no lightning flash 34% lightning before BL 24% simultaneously

Table 1. Descriptive statistics of the three central European data banks

Variables (continued)	*ABLD 1 (n=150)*	*ABLD 2 (n=103)*	*CEBLD (n=152)*
Number of objects	Mean 1,3 [range 1-8] 92% 1 object 2% 2 objects 1% 3 objects	Mean 1,0 [range 1-2] 99% 1 object 1% 2 objects	Mean 1,1 [range 1-5] 94% 1 object 3% 2 objects 3% 3 objects
Duration	Mean 7,7 sec. Median 3, Mode 2 Range 1-180 sec.	Mean 28,2 sec. Median 5, Modes 2, 4 Range 1-900 sec.	Mean 15,4 sec. Median 5, Mode 5 Range 1-600 sec.
Shape	91% round 6% oval, elliptical 2% oblong 1% other, variable	88% round 6% other 4% oval, elliptical 2% oblong	96% round 2% variable 2% other 1% oblong
Distance object-observer	Median 5 m Range 0-8 km 50% < 5 m	Median 10 m Range 0-5 km 50% ≤ 6 m	Median 6 m Range 0-10 km 50% ≤ 5 m
Object size	Mean 30,1 cm Median 25, Mode 30 Range 1-150 cm	Mean 68,8 cm Median 30, Mode 30 Range 1-1.000 cm	Mean 41,6 cm Median 30, Mode 30 Range 1-500 cm
Object surface	74% sharply defined 18% fuzzy 7% core+halo 1% transparent	74% sharply defined 17% fuzzy 7% non homogenous 2% core+halo	77% sharply defined 10% fuzzy 7% core+halo 6% non homogenous etc.
Colour	32% yellow 17% orange 14% white 11% red 8% blue-white 8% blue, violet 7% variable 3% green	29% yellow 24% orange 15% white, grey 12% fiery 9% red 6% green, variable 3% blue-white 2% blue, black	43% yellow 12% orange 10% white, grey 10% variable 10% fiery 8% red 5% green, blue, violet 2% blue-white
Brightness	82% not blinding 15% blinding 3% flickering	68% not blinding 21% blinding 8% flickering 3% other	73% not blinding 21% blinding 4% flickering 2% other
Primary motion	50% horizontal 25% downwards 12% complex 11% stationary 1% upwards	46% horizontal 33% downwards 10% stationary 9% complex 2% upwards	53% horizontal 23% downwards 13% complex 10% stationary 1% upwards
Secondary motion	86% none 6% hopping 4% oscillating 2% circling 2% irregular, jerky	82% none 13% hopping 2% circling 2% irregular 1% oscillating	85% none 9% hopping 3% circling 2% irregular, jerky 1% oscillating
Other details Individual phenomena, no sum-up to 100%	35% inside buildings 14% smell 15% sound 14% sparks 4% tail 22% residue 24% formation seen 80% end seen (38% explosive)	27% inside buildings 14% smell 14% sound 11% sparks 9% tail 23% residue 23% formation seen 71% end seen (36% terminal bang)	33% inside buildings 11% smell 18% sound 9% sparks 6% tail 26% residue 28% formation seen 76% end seen (53% terminal bang)

Table 1. Descriptive statistics of the three central European data banks

Reporter population/behaviour: With the exception of ABLD 2, the gender ratio male:female was balanced. Long time-to-report deltas (27-34 years) occurred. All observer age distributions are skewed to the left, all reporter age distributions skewed to the right. Thus, BL was more readily observed by young people active in open countryside, and reported by interested old newspaper readers who had time and motivation to write a message. ABLD 1 showed shorter report delays (delta/yrs 0-1 15%, -5 21%, -10 34%, cumulative) than ABLD 2 (delta/yrs 0-1 5%, -4 11%, -11 17%, -20 26%, cumulative) or CEBLD (delta/yrs 0-1 6%, -4 10%, -10 14%, -20 24%, cumulative). This means ABLD 1 contains more "fresh" reports, ABLD 2 and CEBLD more "old" reports.

The profession statistics gives a high percentage of young people in training (school, apprenticeship, army) and of academics (a reporter self-selection effect).

35 to 50% became frightened by BL, 45 to 60% stayed calm or were fascinated. Only up to 5% showed flight and/or panic.

Every second case was a one-witness case. About 25 to 40% of the cases had two observers, 10 to 25% happened with more than two people.

Years: With ranges of 80 to over 90 years, all three data banks cover most of the 20th century. The peaks are different in the three data sets.

Month and time of day: Summer is European thunderstorm and BL season with a peak in July. The afternoon BL peak (Austria 2:30 – 5:00) overlaps with the local thunderstorm maximum.

Coincidence with thunderstorms/precipitation/lightning: With 60 to 70%, the thunderstorm connection is prominent. Precipitation, often strong, occurs simultaneously in over 50%. A cloud-to-ground flash precedes/goes with BL in 30-60% of the cases, according to the witness, i.e. with some false attributions.

Object number: With well over 90%, the typical case is a single object event. However, up to five or even eight objects may appear on rare occasions.

Duration: No BL cases were eliminated due to long durations reported. Anyway, 50% of the cases last less than 3 to 5 seconds. Medians and modes are all in the area of 2 to 5 seconds.

Shape: Around 90% (Austria) to 95% (Europe) of the objects are reportedly globular. In Austria, 6 to 8% other round shapes are seen, outside Austria less.

Distance: In 50% of all cases, the minimum distance observer-phenomenon was under 5 or 6 meters. This means descriptions of close-up phenomena. Objects are discerned to a maximum distance of 10 kilometres.

Object size: No BL cases were eliminated due to large sizes reported. The median and modal sizes lie between 25 and 30 centimetres. Very large objects are rare.

Surface/colour/brightness: Around 75% were sharply defined objects, 10 to 20% had fuzzy outlines, a small but consistent percentage had a central core with halo. The main colour ranks were highly similar in all data banks: yellow-orange-white-fiery/red. 70-80% were non-blinding objects, i.e. easy to look at.

Motion: About 50% showed horizontal motion, 20-30% moved downwards. A steady proportion of 20-25% in all data sets moved erratically or not at all. Around 85% had no secondary motion pattern. The rest showed consistent secondary patterns described as circling, bouncing, oscillations or jerks.
Other details: Every fourth to third BL phenomenon happened inside a building. The percentages for smell, sound, and sparks are similar. One report out of four includes residue – big damage is rare. In about 25% of the cases, BL formation was visible, and in 70-80%, the final stage was seen (40-50% of it explosive).
Investigation quality: 84-89% of the data bank cases had been investigated in direct interaction of the first author with the reporting witness (field trip, phone, by mail), the rest of 14-16% consists of "handwritten" (10%) or secondary reports with sufficient details given.

Austrian split-half statistics (ABLD 1 and 2)

To perform a split-half test, Austrian cases forthcoming after 1988 were put into a second data bank. Looking at the main witness, object and location variables in Table 1, the data sets are remarkably similar except for some differences. Location ranks differ after the first author had moved from Vienna to Salzburg in 1980. Also, the property of "fresh" cases (report max. 1 year later) dropped from 15% (ABLD 1) to 5% (ABLD 2). ABLD 1 data were collected until 1988, thus stop with observation year 1986, ABLD 2 data - collected later on - with year 1998. The reported occurrence of lightning flashes is different for ABLD 1 and 2, but similar between ABLD 1 and CEBLD. Reported durations range much higher in ABLD 2, also in CEBLD. The same effect is noticeable for object sizes.

Variable	*ABLD 1*	*ABLD 2*	*CEBLD*	*Brand, Egely, Russia, USA*
Month	max.: 30% July	37% July	35% July	max. July: 23% (B,E), 39% (R)
Hour (PM)	2:30-5:00	2:30-5:00	2:00-6:00	4:00-6:00 (B), 12:00-3:00 (R)
Thunderstorm	72% simult.	68% simult.	64% simult.	>50% (B)
Lightning	57% none 22% simult.	33% none 24% simult.	40% none 24% simult.	K=0,8 (R), 85% (U)
Duration (sec)	50% <3	50% <5	50% <5	>50% 1-5 (B), 43% 1-5 (E), 10±3 (R), 61% 1-4 (U)
Distance (m)	50% <5	50% <6	50% ? 5	49% 1-5 (E), 33% 1-5 (R)
Size (cm)	50% <25	50% <30	50% <30	10-20 (B), 23% 20-30 (E), 64% 10-50 (R), 55% 13-40 (U)
Colour	49% yellow- orange, 11% red	53% y-o, 9% r	55% y-o, 8% r	26% y-o, 43% r (B), 24% y-o, 27% r (E), 35% y.o, 19% r (R),
Explosion	31 %	26 %	38 %	29 % (B), >50% (R)

Table 2. Comparison with four other BL data banks

COMPARISON WITH FOUR PUBLISHED BL DATA BANKS

Stenhoff (1999, 12) recently listed nine national BL data sets with 5,700 reports. Details of an early, mostly Central European archive (n=215, Brand, 1923), of an US survey (n=513, Dewey, 1954), of the Russian Stakhanov-Grigoriev data bank (n=2.500, Smirnov, 1993; Bychkov, Smirnov & Stridjev, 1993) and from Hungary (n=278, Egely, 1987) were accessible to the authors.

Table 2 gives a phenomenological data comparison of the three data sets evaluated above with the four sources listed. It is apparent that the case distribution by month has a uniform maximum in July. The diurnal case maximum is earlier for Brand and later in Russia. Brand lists over 50% heavy thunderstorms associated with his cases. The US lightning connection is much stronger than in Central Europe. Here, Smirnov computed a correlation coefficient of 0,8. The duration data show a high consistency in the region of 1 to 5 seconds. Smirnov gets a lifetime of 10±3 seconds. The distance data in Hungary are similar with every second case under 5 metres, in Russia every third case. All size curves peak in the area under 50 centimetres with a maximum region between 10 and 30 centimetres. The three Central European data banks presented here list every second object in the yellow-orange colour range. Other data banks contain less (24-35%) objects in this range, but more objects described as red (except Russia). Nevertheless, the yellow-orange-red sector is most dominant. The old Brand data collection records a similar frequency of exploding objects; the percentage is even higher in Russia.

HYPOTHESIS TESTING BY NONPARAMETRIC CORRELATIONS

Systematic testing as in experimental design is not encouraged by the relative paucity of absolute-scaled data (11 variables) compared to ordinal (5) and nominal/binary data (30 variables). Kolmogorov-Smirnov tests done in SPSS with all three data banks indicated that only the witness age and report year data did not deviate significantly from a normal distribution. Therefore, nonparametric tests were run in SPSS: A hypothesis-bound search for a possible dependency of reported physical and psychosocial data detected and tested three strong correlations with Kendall's tau and Spearman's rho.

Phenomenon	*Data bank*	*Kendall's tau τ*	*Spearman's rho ρ*	*Significance*
Gender - reaction	ABLD 1	τ -,252 p<,006	ρ -,268 p<,005	**
	ABLD 2	τ -,164 p<,093	ρ -,172 p<,095	n.s.
	CEBLD	τ -,211 p<,009	ρ -,224 p<,008	**
Reaction - distance	ABLD 1	τ -,308 p<,000	ρ -,374 p<,000	***
	ABLD 2	τ -,317 p<,000	ρ -,404 p<,000	***
	CEBLD	τ -,358 p<,000	ρ -,450 p<,000	***
Distance - size	ABLD 1	τ ,323 p<,000	ρ ,421 p<,000	***
	ABLD 2	τ ,247 p<,002	ρ ,334 p<,000	***
	CEBLD	τ ,283 p<,000	ρ ,383 p<,000	***

Table 3. Significant and stable non-parametric correlations

Table 3 gives the details on stable relations, i.e. occurring in all three data banks: A significant (**) correlation witness gender - reaction in ABLD 1 and CEBLD means that women either displayed or reported more fear than men. ABLD 2 (no gender - reaction correlation) contains only 37% female observers, ABLD 1 and CEBLD each over 50%. Short distances observer-object have a highly significant (***) correlation with fear reactions in all three data banks. This makes sense from a psychological point of view. A highly positive correlation (***) distance - object size means that objects further away are only seen when they are considerably bigger than BL usually seen nearby. Aerial perspective takes its toll.

Further results not shown in Table 3 are: Observation age is not related to object size or duration in all three data banks. The same is true for witness gender and object size/duration. A significant (p<,003) correlation between observation age and witness reaction in ABLD 1 does not hold for ABLD 2 or CEBLD. A significant (p<,010) correlation for number of persons and witness reactions only appeared in CEBLD, not in the Austrian data banks. Witness reaction and object size is not related in all three data sets. Witness reaction and object duration is significantly correlated (p<0,15) in CEBLD, but not in Austrian cases. Object size and object duration is not related in all three data collections.

TEMPORAL STABILITY TEST OF THE PATTERNS

Are the reported BL patterns stable over the decades of the 20th century? ABLD 1 and 2 cover the century from 1900 to 1998. Two extreme groups - 1900-1935 and 1970-1990 - were extracted from the data sets and analysed.

The results are shown in Table 4. Month data were mostly missing in the old report group. The distance observer-object was twice bigger for the old case group. However, a good match indicating stability of patterns was obtained for time of day, duration and size.

Variable	*1900-1935 (n=23)*	*1970-1990 (n=50)*
Month	3x July, rest: missing data	30% August, 27% July, 24% June
Time of day	Peak 2:30 - 3 P.M. (25%)	Peak 2:30 - 4 P.M. (26%)
Object distance	Median 12,5 m; 50% <10 m	Median 5 m; 55% <5 m
Duration	Median 3 sec; 81% <5 sec.	Median 3 sec; 77% <5 sec.
Size	Median 30 cm; 47% <25 cm	Median 30 cm; 49% <25 cm

Table 4. Temporal stability of reported BL patterns from Austria

CONCLUSION

The statistical analysis of three Central European data banks found unexpectedly constant patterns across the files with regard to reporter populations, witness reactions, time cycles and durations, meteorological conditions, distance, size, motion data and phenomenological details of BL (form, colour, surface, luminosity).

The percentages of emotional reactions are nearly identical. Time-of-year (July) and daytime (2-5 P.M. CET) coincide. 70% are thunderstorm-, 50% rainshower-, about 50% cloud-ground-flash-related. Median durations are 3-5 seconds, median sizes 25-30 centimeters, 50% of the distances fall below 5 meters. 75% show a sharp outline, all colour rankings start with yellow, orange, white, 70-80% have non-blinding brightness. Comparisons with the old Central European data bank by Brand and other archives place the new Central European data statistically into the mainstream.Summing up the results, the three data profiles obtained indicate one time-constant, space-invariant set of BL phenomena all over Central Europe.Further evaluations of the three data banks are to follow. Recently, the growth of high-precision electronic lightning detection networks in Europe enabled detection checks for lightning strokes associated with BL reports (Keul, 1999b). Technical innovation has also changed BL reporting. Now, first reports are often send as e-mails via the internet. The first author offers a BL homepage which can be reached via alexander.keul@sbg.ac.at.

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LETTERS TO THE EDITOR

The Editor invites comments and questions on all aspects of weather and climate. Letters addressed to the Editor should be typed or clearly written and sent to the Editorial Office, editorial@journalofmeteorology.com. The Editor reserves the right to edit any correspondence as appropriate.

Dear Sir,
I am sure that those of us who subscribed to the Journal of Meteorology since it's inception, will find it hard to credit that 27 years have elapsed since the first issue in the heat wave year of 1975. The success of the Journal is proved by it's longevity, due jointly to it's content being authoritative and to the sheer energy, both intellectual and physical, of it's founder. Over the years most readers will have contacted Terence Meaden and thereby become friends and contributors to the Journal. As is widely known, *The Journal of Meteorology* is quoted by most of the learned publications and the general press, and is foremost in the field of tornado research and reportage. I am confident that the entire readership will join me in thanking Terence for the herculean task in launching and maintaining a periodical that has become like a trusted and knowledgeable friend that one meets each month!
Norman Brooks
Norwich, UK

Cloud formation over Shenley, Herts, UK

Whilst driving near Sheley, Herts (October 2002) I came across this interesting cloud formation (*Plate 2 inside cover*). I was wondering whether someone could explain its formation.
Burl Solomons
Herts, UK

Re. Cloud formation over Shenley, Herts, UK

The picture in question looks like a 'fall-streak hole'. This is where an aircraft flies through a cloud which is mainly comprised of water droplets, but at temperatures well below freezing. As the aircraft flies through the cloud, particles from its exhaust emissions 'seed' the cloud, resulting in the water droplets, because of their increase in size, turning more readily to ice. Then the Bergeron-Findeisson process takes over. Here the cloudy air becomes sub-saturated with respect to water, but super-saturated with respect to ice. Therefore, ice crystals then grow at the expense of the surrounding water droplets. Once the ice crystals become large enough, they fall out of the cloud as snow. The surrounding cloud, losing its moisture, then evaporates leaving a hole in an otherwise overcast. This appears to be well advanced and the fall of snow appears to have finished. Newly formed 'fall-streak holes' frequently have wispy edges, these patterns being formed by the falling snow.
Nigel Bolton
Met. Office,
Bracknell, UK

WORLD WEATHER DISASTERS : AUGUST 2002

In Prague, 50,000 residents were evacuated after the worst flooding since 1954. Many of the historic parts of the city were threatened and by the 19th, it was estimated that more than 100 people in Central Europe had lost their lives. Stagnant water in parts of Austria led to fears of mosquitoes breeding on a large scale. Bangladesh experienced an exceptionally heavy monsoon, affecting 3.5 million people in half of the country's 64 districts, with floods also affecting the east and north-east of India. Weather can often provide interesting contrasts however, and other parts of India have been hit by severe drought, as have parts of the Mid-West in the USA where more than 600,000 acres were scorched by fires during the first half of the month. Intense heat and humidity affected the Eastern seaboard mid-month and the 14th saw the inhabitants of Boston gasping in a maximum temperature of 38°C. Other events included:

3: Lightning strikes kill 3 as fierce storms leave thousands without power in N. E. U.S.A. *Lloyds List (L.L.)*

4: Flash floods in W. Kameng district of Arunachal Pradesh, India, kill 8. *L. L.*

4: Floods sweep bus from bridge in Gansu province, China, killing 28. *L. L.*

4-8: More than 10,000 homes damaged amidst rain in S. Korea. Scores dead, injured or missing in heavy rains in North and South Korea. *L. L.*

5: Dramatic hail storms in N. Italy injure about 20 people. Padua, Venice and Treviso worst hit. *L. L.*

5: Tropical storm Bertha comes ashore on Gulf Coast of U. S. A. with heavy rain and flash floods in parts of Mississippi. *L. L.*

5: Flash floods kill at least 10 in N. Vietnam. *L. L.*

6: Nine killed in Guangdong city of Meizhou, China due to rain and flooding from tropical storm " Beimian". *L. L.*

8: Heavy rains inundate Austrian villages, flood London Underground and batter vineyards and olive groves in N. Italy. *L. L.*

8: Worst drought in most of India for 15 years. NOAA web site.

8-9 : At least 21 killed and 100 missing after floods near Novorosiysk, Russia. *L. L.*

8-13: Landslides caused by monsoon rains in E .Nepal kill at least 422. *L. L.*

9: Landslides and flooding in several cities and regions of Hunan province, China kill 47. *L. L.*

10: Severe drought over last three months in Ethiopia kills 180,000 cattle in districts of Afar, Oromiya and Somali. *L. L.*

10: Floods and storms kill 7 in Romania, Bulgaria and the Czech Republic *L. L.*

11: At least 33 killed in torrential rains that trigger landslides and flatten homes in N. Indian mountainous state of Uttaranchal. *L. L*

11: Fifty eight bodies recovered around Novorosiysk, Russia after flooding. *L. L.*

12: Fresh rainfall feeds swollen rivers in S. Germany. Rain affects roads and homes in states of Bavaria and Baden-Wuerttemberg. Possibly the worst flood in 100 years in Prague, Czech Republic, 50,000 evacuated from homes in Prague. Seven dead. Danube close to breaking banks in Vienna, Austria. *Guardian, L .L. B.B.C. teletext.*

13: Eighty seven killed as rivers overflow in Czech Republic, Germany, Russia and Romania. Salzburg and Vienna threatened by rising Danube. Rainfall in some areas highest since records began. *Guardian, BBC teletext.*

13: Massive landslide due to heavy rain buries 39 in a village in Yunnan province, China. *L.L.*

13: Floods in Bihar and Assam states, India kill 295 since June, 15,000,000 displaced or trapped in both states. *L.L.*

13-14: Tropical depression causes heavy flooding in Manila, Philippines. Twenty two killed. *L.L.*

13-19: Floods in southern Tay Nguyen claim 1 life in Cat Tien district Lam Dong province, Vietnam. *L.L.*

14: At least 35 people drown in flash floods that wash away roads and swamp farm land in N.E. Iran. *L.L.*

14: Twenty-five die from heat stroke in Sudan after temperatures rise to 46C in E. Sudan *L. L.*

14-15: Severe flooding in Dresden and Prague as rivers Elbe and Vltava burst banks. Highest water level in Bratislava, Slovakia, for 500 years. Worst flooding in Dresden since 1845. Death toll from European rainfall is now 94. Nearly 100 animals die in Prague zoo. Total damage in Europe could cost $20 billion. *Guardian, BBC teletext, Channel 4 news. NOAA web site.*

15: Two dams in Mexico burst after heavy rains killing at least 8. *L.L.*

15: Hot summer brings drought conditions to many states in U.S.A. *L.L.*

16: Continued flooding in Dresden as Elbe reaches highest level since records began. Death toll from two weeks of flooding across Europe is 104. Guardian.

16: Wall of mud and rock kills 67 in landslide in Xinping county, 200km south of Kunming, Yunnan province, China. *L.L.*

17: Seven drown when boat capsizes in floodwaters in E. India. Swollen river bursts banks and swamps dozens of villages in Bangladesh, 911 weather related deaths in Nepal, India and Bangladesh since June. *L. L.*

17: Sixteen missing in floods in E. London, S. Africa. Second heaviest rainfall in E. London's history: 32cm in 24 hours *L.L.*

18: Twenty nine lives lost in floods in north and central highlands, Vietnam. *L.L.*

18-19 : Continued flooding in various parts of Germany, tens of thousands evacuated from homes. More than 200,000 people displaced in Czech Republic. Guardian

19: Thousands evacuated after several days of heavy rain cause Moei river to overflow in Burma. *L.L.*

19: Heavy rainstorm floods parts of Athens and Piraeus, Greece. *L. L.*

19: Further monsoon rains threaten to engulf fresh areas of Bangladesh. At least 5 killed by collapsing homes in Nepal. *L. L.*

19: High water levels on Red River, Vietnam, swamp 13,000 homes in Hanoi. *L.L.*

21: Landslide after heavy rains in village in E. Nepal kills at least 65. *L. L.*

21: State of emergency declared in central China's Hunan province, where Dongting lake threatens to burst banks. *L. L.*

24-26: Flooding Mekong river, Cambodia, causes at least 8 to go missing, forces around 20,000 to evacuate and damages much crops. *L. L.*

25: About 12,000 evacuated from vicinity of leaking dam in central Indian state of Madhya Pradesh after heavy monsoon rains. *L. L.*

26: Flooding and loss of crops in parts of Laos due to rising Mekong river. *L. L.*

26: Eight inches of rain across east N. Carolina, causing widespread flash flooding. *L.L.*

27: Ten killed and 6 missing after storm in E. Algeria causes flash floods in Mila region. *L.L.*

28: At least 9 dead and 26 missing after heavy rains in S.E. Afghanistan triggered mud slide. *L.L.*

28: Flash flood causes extensive damage to many buildings and homes in Wyoming, U.S.A. *L.L.*

29: Late night hail storm in Cheyenne, U. S. A. causes $28 million in damage. *L.L.*

31: Typhoon Rusa (Malaysian word for deer) causes floods and land slides across S. Korea, killing at least 3. *L.L. NOAA web site.*

BOOK REVIEW

MEGA BITES: TORNADOES AND OTHER DRAMATIC WEATHER SYSTEMS. by Michael Allaby, Dorling Kindersley 2001 p.b. pp 96 £4.99 ISBN 24681097531

Dorling Kindersley, have produced a very attractive slim paperback, crammed with colour illustrations, covering tornadoes, hurricanes, snow, ice, drought and pollution. The crediting of Philip Eden as a consultant ensures that the material is scientifically sound. Each chapter has appropriate references to websites, and there is a useful section at the end that includes a page of weather records, the (old) Beaufort Wind Scale, the Saffir-Simpson Hurricane Scale, a tornado glossary and the assigned names of North Atlantic hurricanes for 2002 - 2004. This book should attract young weather enthusiasts, and could well encourage a lasting interest in the weather. The price makes it an ideal Christmas stocking filler. (PR)

BRITISH WEATHER SUMMARY: AUGUST 2002

A complex thundery low pressure area covered the country until the 10th. Pressure was mostly rather higher for the rest of the month, although the centre of the anticyclone was generally to the southwest of Britain and it was never very settled. Fronts from the Atlantic crossed the country in the closing days. Mean monthly temperatures were generally a degree or so above normal, but once again it was rather a dull month (for the fourth consecutive month) - with the result that mean minima were higher, relative to the normal, than mean maxima. The thundery nature of much of the rain meant that monthly totals were very variable, with parts of the northwest and south distinctly dry but many central regions wet.

Much of the month's rain in central regions came in the first three days, as the late July thundery low drifted very slowly east from southern England into the low countries. A large rain area (and low daytime temperatures) edged slowly north from the northern half of England and Wales into Scotland and Northern Ireland - after a hot and sunny start to the month in the northwest. 81 millimetres of rain fell in twelve hours early on the 2nd at Leeming in North Yorkshire; parts of the same county had around 150 millimetres of rain in the five days from 29th July, and there was severe flooding. Southern Britain was quite bright and warm at the beginning of the month, but thundery showers became fairly widespread by the 3rd, and a week of thundery weather followed over much of the country as further lows drifted in from the Atlantic. 60 millimetres fell in an hour in north London and near Milton Keynes on the 7th, and flash floods were reported from various districts during this spell. The temperature reached 27 degrees in parts of the south on the 6th and 7th, but few places got above 21C on the 9th.

There was much less thunder after the 10th, and the southeast had a mid-month heat wave (31 degrees in places on the 17th). But it was often wet in the north and west, and weak low pressure developed in response to the heat to bring a brief renewal of thundery weather in many places around the 18th - whilst non-thundery frontal rain gave 64 millimetres in twelve hours at Milford Haven (southwest Wales). Rather stronger ridging northeastwards from the anticyclone to the southwest in the last ten days did not completely settle the weather, but there were some warm, sunny spots; most days saw 24 or 25 degrees somewhere, but it was only 17 under grey skies in the southeast on Bank Holiday Monday (26th).

EXTREMES: AUGUST 2002

Hottest:	33.3C	Cambridge, Cambs, 17th	Warmest:	19.2°C Cambridge, Cambs
Coldest:	3.1°C	Culford, Suffolk, 20th	Coolest:	14.7°C Darvel, Strathclyde
Most Rain:	66.5mm	Normanby, North Yorks, 2nd	Wettest:	153.4mm Normanby, North Yorks
Most Sun:	15.4hrs	Haselbury, Somerset, 15th	Driest:	11mm Torquay, Devon
Windiest:	69mph	Sconser, Highland, 15th	Sunniest:	217.6hrs Bournemouth, Dorset
			Dullest:	105.1hrs Sconser, Highland

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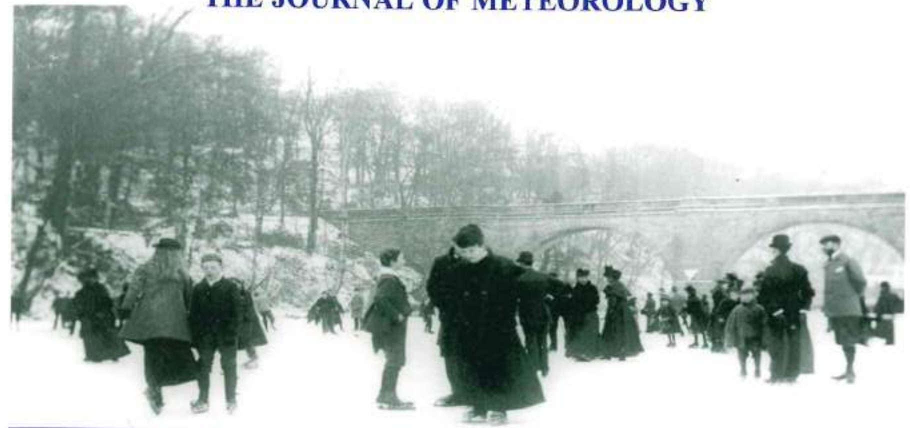

Frozen River Wear, Durham, UK, winter 1895

The winter of 1895 was the third coldest (0.6C) on record at Durham since 1850. Only 1879 (-0.1C) and 1963 (-0.13C) were colder.

Picture courtesy Michael Richardson / Professor Tim Burt

CONTENTS

FRONT COVER:
Cloud to ground lightning strikes
northern France
Top: Thursday 2 August 2001
Cassel, Flandres, France
Bottom: Sunday 13 August 2000
Wormhout, Flandres, France

Photographs: Philippe Talleu

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