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SURGE OF HURRICANES AND FLOODS PERTURBS INSURANCE INDUSTRY

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A recent spate of natural disasters — many of them topping $1 billion in insured losses — has shaken the insurance industry in the U.S. and around the world. The $3 billion of insured loss from Hurricane Hugo in 1989 broke all records for losses, but only three years later losses from Hurricane Andrew hit $17 billion. There is the sobering thought that the staggering scope of losses could have been much worse if the storms had followed a different route, if the path of Andrew had veered directly over Miami instead of 10 miles away in southern Dade County. The Great Flood of 1993 on the Mississippi — although little of it was covered by private insurance — raises profound questions about future protection from disaster.

A small but growing number of insurance officials are speculating about the relationship of these disasters to climate change. Even without sufficient evidence to convince sceptics, these officials are unwilling to gamble on the chance that the disasters are a string of bad luck, unlikely to reappear in the future. They are examining alternatives for action to reduce future losses.

A sample listing of recent catastrophes includes:
- Typhoon Yancy, September 3-4, 1993, one of the strongest storms to hit Japan in nearly 50 years. More than 40 people died.
- The Great Flood of 1993 on the Mississippi, $12 billion in damage, $8 billion of it for crops. The U.S. Congress has voted $5.7 billion for flood relief of this 9-state disaster which cost 50 lives and displaced 50,000 people. At best only half the damage will be picked up by the Federal Government. Only about $650 million of total losses were privately insured, according to an early insurance association estimate, most of it for such things as business interruption and autos. A few large organisations carried all-risk insurance, and the City of Des Moines had a large policy.
- The unusual weather pattern, which dumped enormous amounts of rain in the Mid-West, brought drought to the East Coast. In South Carolina, 95 percent of the corn crop and 40 percent of the soya bean and cotton crop were depleted.
- March 13, 1993 storm along the U.S. East coast.
- Cyclone Kina on January 4, 1993, the strongest storm to hit Fiji in 20 years, leaving 10,000 homeless.
- Cyclone Nina hit the Solomono shortly afterward, leaving another 10,000 homeless.
• Hurricanes Andrew and Iniki in 1992 with gross insured losses of $17 billion.
• A cyclone in Bangladesh in 1991 in which 138,000 people died.
• Cyclone Val in December 1991 devastated homes and buildings on Samoa (the second year in succession that Samoa has been hit).
• Typhoon Mireille in Japan in September 1991.
• Hurricane Bob in August followed by another U.S. East Coast storm on Hallowe’en in 1991.
• Drought-related Oakland Fire in California in 1991 with insured losses of $1.2 billion.
• Cyclone Ofa in February 1990, one of the strongest ever Pacific cyclones.
• Severe windstorms in central and Western Europe. Eight storms within a 5-week period in 1990 caused more damage than any natural catastrophe experienced in Europe, costing $10 billion to the insurance industry.
• A storm in Colorado, U.S.A., caused one billion dollars in damage.
• A string of natural disasters in Australia which has left what Jeremy Leggett has described as “a trail of damaged companies, failed managers, spoilt insureds, angry shareholders”.
• Hurricane Hugo in the south-east U.S. coast caused the greatest amount of insured loss from hurricane winds in four decades, leaving in its aftermath till then the highest insured losses in history — $3 billion — in 1989.

The United Nations and the International Red Cross report that the annual number of disasters — events whose losses overwhelmed the restorative capacity of the affected area, requiring assistance from outside the region or from foreign countries — increased from three at the beginning of the century to about 20 today.

Skyrocketing losses are a relatively new phenomenon. From 1966-87 no losses from catastrophes topped $1 billion. From 1987-1992, there were 15 catastrophes whose insured losses exceeded $1 billion, 10 of them windstorms, accounting for 86 percent of the $53 billion losses. The insured loss from the 1960s to the 1980s increased 4.8 times.

“Physical risks are only one element — and sometimes not even the most important element — in the calculus of disaster”, according to Mitchell and Erickson in Irving Mintzer’s 1992 book, Confronting Climate Change. “Human-related factors . . . help to determine the scale of damage that results from weather events”. (See box).

The insurance industry currently has over $160 billion in disaster reserves. However, most would agree that a major disaster would hurt firms at all levels from local insurers to big international reinsurance companies. Forty-five American insurers went bankrupt in 1992, according to TIEPOLO (a publication of the International Institute for Environment and Development in London), at least a quarter of them because of Hurricane Andrew. After Iniki, Hawaii’s largest insurer announced it would not renew existing policies and other insurers issued a moratorium on writing new policies indefinitely. Following Cyclones Ofa and Val, two insurance companies withdrew all coverage. If the status quo continues, the reinsurance pool could start to disappear. Many people in the Virgin Islands have been left uninsured.

Some feel that Lloyd’s of London which carries about 30 percent of international catastrophe reinsurance, is overextended. Recently Lloyd’s capacity has contracted, and the price of reinsurance has risen steeply. A string of losses — more than $1 billion in 1988, $3.3 billion in 1989, an estimated $2.4 billion in 1990 and close to $2 billion in 1991 — has raised fears that the 300-year-old company rests on a shaky foundation.

### Human-Related Factors Contributing to Rising Disaster Costs

- Growth in world population.
- Growth in world property values.
- Improvement in living standards which include expensive appliances and equipment and increased value of personal belongings.
- Upward spiral of inflation.
- Increased concentration of people and property in huge urban conglomerations.
- Increasing spread of development and growth.
- Global migration of people and industries to particularly exposed regions, especially the coasts.
- Mismanagement of huge rivers which may have shifted the balance of human needs too far against those of the river environment. Logging and farming which cleared vegetation have resulted in eroded watersheds and silted river beds. Dams and levees have allowed people to live, work and build in paths of rivers. Huge levee systems may have constrained rivers too severely.
- Drainage of wetlands.
- Inappropriate building on floodplains.
- Introduction of less resistant building methods and more hazardous technologies.
- In factories, chemical plants and power stations, machines are more difficult to dismantle and repair, parts are more vulnerable, engineering requirements more stringent.
According to Jeremy Leggett, Director of Research for Greenpeace, Lloyd's List has no more than $250 to $300 million in catastrophe reinsurance available on a global basis for a single company. With losses greater than $1 billion for individual companies, catastrophe insurance is insufficient for large insurers, forcing the industry to rethink its basic practices.

Almost everywhere around the world the insurance industry is in trouble, and as Leggett remarks in a recent study of the insurance industry as a whole, the amount of capital is shrinking while the magnitude of catastrophes is increasing. The insurance and reinsurance industries are now looking to the future with some trepidation.

Historically the industry has not placed high priority on the threat of global warming. A spokesman for the American Insurance Association reported that he had not heard of any industry research being conducted on whether recent large disasters are climate-related. The person in charge of "natural disasters" for the American Insurance Services Group, a trade organization, replied, "No comment", to a question of whether there is any move by the industry to include the threat of more intense storms and drought in its calculations. Each company makes its own decisions, he noted. He did say there was an increase in tornado activity over the national average. The successor to Dr. Friedman at Travelers declared that with Hurricane Andrew and coastal management to worry about the company had a lot more pressing things on its agenda than long-term climate change. Only when there is new evidence or further confirmation of global warming would the company take the subject up again, he said.

Major insurance consortiums are now beginning to wonder how much of their current misfortune is due to human-induced climate change. How stable will the insurance market be if current climate models predicting global warming should prove accurate, or underestimates?

Research around the world is not reassuring. A group of atmospheric scientists in Australia has simulated changes in daily rainfall intensity due to an enhanced greenhouse effect. In the mid to high latitudes, the processes of convection tend to accelerate and intensify. The models revealed a regime of fewer days of rain and more intense rainfall of shorter duration, leading to more inundations. The scientists tested the models in four regions: Australia, Western Europe, Mid-western U.S. and India. The striking results, especially in mid-western U.S. and India, showed two to three times as many days of an inch or more of daily rainfall under doubled CO2 conditions.

A paper from Munich Re (a major international reinsurance firm), entitled "Windstorm", raised the danger of storm floods along the European Atlantic coast, the possibility of full-fledged hurricanes reaching the coast of Western Europe, and an "explosive development of low-pressure systems already observed time and again in the Mediterranean region, with features quite comparable to tropical cyclones, which might well result in full-scale hurricanes causing incredible damage in these densely populated regions". Entire countries, such as Bangladesh, are at risk from cyclones and storm surges.

Gerhard Berz of Munich Re warns: If feared climate change is confirmed, it will obviously stretch the insurance industry to its limit. Extending these limits will require equitable distribution of the added burden between policymakers, insurers and reinsurers based on their relative financial strengths. Burden sharing must go beyond the concept of the solidarity of the risk community upon which insurance is originally based. We must marshal our talents for innovation.

Local and international markets tend to react slowly to changing situations; if change takes place gradually, insurers can adjust more easily. However, they may not have that luxury. Previously, experience of past losses provided a basis for rating insurance coverage, but if environmental conditions change significantly, if the change is quick and the trend difficult to detect, or if positive and negative feedback leads to nonlinear or exponential change in the entire system, historical experience and data are uncertain guides. When the more favourable experience of the past enters into calculations adaptation is delayed and insurance rates are kept at an inappropriately low level. Slow deterioration of the environment is particularly worrying, Berz warns, as it is difficult to prove conditions are really changing. Accurate actuarial work on future losses is extremely difficult.

An exception to the general industry complacency about climate change has been Dr. Don G. Friedman, former Director of the Natural Hazards Program of the Travelers Insurance Company of Hartford, CT, U.S.A. In a 1990 study entitled, "Is Hugo a Forerunner of Future Great Hurricanes?" he developed computer simulations for three scenarios based on: 1) no temperature change in

Uneven impact of Disasters on Developing and Industrial Countries

The burden of climate and weather-related catastrophes does not fall equally on both industrialised and developing countries. "During a recent 20-year period, natural disasters resulted in 28 million deaths and adversely affected over 820 million people". Mintzer notes in his book, "Cost of Disaster, loss is not evenly distributed or equally felt by all the affected economies". Winds of 140 mph in Hurricane Andrew resulted in the loss of 20 lives; in the cyclone in Bangladesh one year earlier, winds of the same strength resulted in the death of 138,000 people.

Hong Kong lost 10,000 people, many of them living in boats, in typhoons in 1906 and 1937. The population has now grown, living standards are higher and many fewer people live in boats. The risk of loss of life from future typhoons has been reduced, but of property damage has greatly increased.

While 1989 losses of $7.6 billion (more than half from Hurricane Hugo) represented less than 0.1 percent of U.S. GNP, 1992-93 losses in Bolivia, Ecuador and Peru from El Nino were nearly 100 times as large, almost 10 percent of GNP, costing the three Latin American countries the equivalent of nearly half their annual tax revenues for those years.

Many small island states live with the threat of complete inundation if the sea level rises and a huge typhoon should strike. In the belief that industrial countries have contributed to the conditions that generate hurricanes and raise the sea level, the Alliance for Small Island States (AOSIS) has pressed as a legitimate issue, under the UN Framework Convention on Climate Change, the financing by industrialised countries of a disaster insurance pool for vulnerable developing countries.
a transitional climate period from 1990-2010, 2) a change of 2 degrees C by 2050, and 3) a change of 5 degrees C by 2050 under greenhouse-induced global warming. He calculated that if the minimum sea surface temperature (SST) of 27 degrees C considered necessary to generate a hurricane were to increase by 0.5 degrees, the number of land-falling hurricanes would increase by one-third near the end of the transitional period under scenario 2 and 45 percent under scenario 3. The hurricane season would also last longer, extending 10 days at each end under scenario 2 and 15 days at each end under scenario 3. The average annual loss expected would increase by 40 percent in scenario 2 and by 55 percent under scenario 3. Ominously, more intense storms hitting land during the warmest segment of the hurricane season (as measured by SST) strike farther north on the Atlantic Coast, where population is more dense and insured property values higher, Friedman warns.

Will strategic measures be sufficient?

Berz declares: “If the solvency and financial standing of reinsurers is appropriate, the insurance industry will be able to fulfill its obligations even in an increasingly hostile environment.”

Leggett argues that unless greenhouse gas concentrations are stabilised global average temperatures will rise, bringing threats to climate stability, the viability of ecosystems and the health of the world economy. If no efforts are made to limit greenhouse gas emissions, no matter how far-reaching the changes insurers make in their business practices, they will only be buying time, he believes.

How the insurance industry chooses to direct its resources can have enormous impact, contributing to the solution of its own difficulties as well as to the alleviation of the worldwide climate change threat.

There are clear signs an industry-wide upheaval is underway, motivated in some cases by the prospect of climate change. Unless the community adapts to changing circumstances, there will be a decrease in insurance capacity or an unwillingness to accept risks in geographical locations identified as at high risk. Insurance claims will rise, both in technologically advanced countries like Australia as well as the industrial regions of the Third World and South-East Asia. Unfortunately, it may take large catastrophes to convince markets, authorities and the public of the necessity of rate increases, Berz believes. The industry may not be able to wait for conclusive answers about possible connections between climate change and disasters. If the number and intensity of storms do rise, the risks could multiply exponentially and with gathering speed. Recent trends raise serious alarm.

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BALL LIGHTNING COLOUR PHOTOGRAPH FROM SENNING, LOWER AUSTRIA

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Abstract: As a result of the Vizotum '93 conference publicity, Christian Witz, head of Sankt Pölten, Lower Austria, weather station, reported a colour diastole of ball lightning which he had taken in 1989. A field investigation by the author confirmed the case report. The great experience of the observer and the simple object structure reported and visible on the photograph calls for no extensive hypothesis testing, as in the Vorarlberg 1978 photo case. The Senning phenomenon is outstanding because it was observed and photographed by a weatherman who also provided meteorological data from his climatological station nearby.

INTRODUCTION

High-quality material like the U.S. Prairie Network ball lightning (BL) photograph (Barry, 1980, 97-98) and especially BL cases with corresponding visual and photographic data are extremely rare. The controversy over the Vorarlberg colour photograph (e.g. Keul, 1992; White, 1993) again showed that alleged photographic BL cases easily collapse. Even to distinguish a "possible BL photograph" from a "non-BL photograph" is an epistemological problem of a special flavour (Keul, 1993). In any case, photographs stand and fall with the personality of the photographer and background facts about situation and intentions of his/her picture-taking. According to Occam's Razor, a question mark should be put on the file as long as the possibility exists that other phenomena offer plausible explanations.

As a result of the wave of publicity following Vizotum '93, the Salzburg BL congress (Keul and Bychkov, 1993), Christian Witz, a professional weather observer and amateur photographer, contacted the author in September 1993 and reported a colour photo case. First details sounded exciting, so the author started a field investigation in early October, and confirmed most case details. Report and slide are less controversial than the Vorarlberg photographs and are presented here for a possible discussion by J. Meteorology (U.K.) readers.

VISUAL OBSERVATION AND PHOTO-TAKING SITUATION

In the late evening of 4 July 1989, a front with heavy thunderstorms passed over the Sankt Pölten area at Lower Austria. Christian Witz, head of the Sankt Pölten weather station (a main station of the Austrian synoptic observation network), was off duty at his home in the village Fuchseberg 1.5km east of town. He has 15 years of experience in observing and photographing meteorological phenomena. The severe storm drew his attention, so he packed the camera equipment into his VW car and drove to a wooded hillside north of the village Senning (about 15°50'E longitude / 48°13'N latitude), 350 metres above sea level.

For dangerous photo tours (and this was to be one), the weatherman does not use a lightning- and rain-exposed tripod outside the car, but supports the reflex camera with wire-release by a wooden board plus blanket fixed inside his car. That night in 1989, he took photographs of the approaching thunderstorm front through a side window of the VW car (example: Figure 1).

The time was around 9 p.m. (Central European Time); it was already dark because of the heavy rain, and cloud-to-ground strokes hit around the car. The thunderstorm was unusually strong for the area. A few moments after a ground stroke to the north-east, approximately 200 metres away, Christian Witz watched a strange phenomenon: "Out of the blue, something formed like in a spiral, rotating movement. It was a white ball of light with fuzzy outlines, big as the full moon, very bright, almost blinding, a quiet, steady light. The ball formed 2 or 3 metres in the air, 200 to 300 metres right [south] of the ground stroke, stayed there and very slowly moved downward like a toy balloon. Then it went out like a candle flame in carbon dioxide".

When the phenomenon happened, Witz was taking another time exposure, and he released the shutter just after the light went out. The exposure time had been between 4 and 10 minutes. When asked to re-imagine the course of events on the site during the field investigation, the witness gave a time estimate of seven seconds total duration (stop watch readings). The observer remembers no sound from the BL. However, the car window was closed and Mr. Witz suffered after-effects of a heavy thunderclap following a cloud-to-ground flash nearby.

The developed film made clear that the camera angle had not included the initial cloud-to-ground flash, but the BL phenomenon in the lower left corner of the frame (Figure 2). The photographic data: Fujichrome 100 Professional diastole film (100 ASA, fine grain), Minolta SRT 303b reflex camera with
Tamron tele-zoom lens 60 to 300 mm (1:4.5 - 56; 52 mm front lens opening). For the BL photograph, the zoom lens stood at 60 mm, with the focus set to infinity, the exposure hand to “B” (time exposure), and open f stop (4; range 4-16) because of the weather-caused darkness. For all his weather photos, Mr. Witz uses a polarizing filter type “Zirkum”, so it was also in its position on 4 July 1989. Its exact orientation is unknown. Besides the BL slide, the photographer still keeps several other slides showing ground-to-ground strokes of that night (example: Figure 1).

LOCATION, OBJECT SIZE AND WEATHER

The geography of the area consists of partly-wooded rolling hills and small villages between the Vienna Woods (to the south) and the Tullner Feld basin (to the north, reaching up to the river Danube). The observation spot of Mr. Witz lies at the southern edge of Haspelwald forest with a highest hill called Frauenberg (378 m). The vantage point offers a view towards Neulengbach and its castle to the east and the Vienna Woods to the south. The view sweeps over cultivated fields with a narrow meadow strip called “Haag” in-between (Figure 3). A geological map shows Tertiary and Quaternary sands and gravel. No power line runs through the vicinity.

The town of Neulengbach (marker “1” in Figure 3) has an azimuth of 110° (N/ESW). There, or further to the north/left, the initial cloud-to-ground stroke hit, preceding the BL. From his recollection and the diaslide, the witness guessed that the BL position could have been above the “Haag” at an azimuth of about 120° (marker “2” in figure 3). With a measuring tape, the author

Figure 2: Paper print of the ball lightning colour slide taken by Christian Witz near Sankt Pöltten, Austria, 4 July 1989. © Christian Witz.

ascertained that the nearest field comes to an end 73 metres from the 1989 car position, which would place the BL phenomenon at about 100 metres from the observer, because the hill slopes down steeper at a greater distance. From eye level to ground level at that distance, at an angle of -2° was measured with a clinometer. The witness gave 8 mm (of an object held 57 cm from his eyes) as a raw size estimate, which gives a BL body of about 1.5 m diameter at 100 metres. It should have been smaller (1 metre) because of the irradiation effect caused by luminosity. The author found neither an object able to produce St. Elmo’s Fire nor metal possibly causing a flash-over in the critical area. The presence of such an object (e.g. a mower) cannot be ruled out definitely for 1989. The witness did not search the field after his observation.

The meteorological data on record are excellent for the Senning case as Christian Witz not only runs the Sankt Pöltten main station but also a smaller climatological station beneath his home at Fuchseberg, only 700 metres west of the observation and photo spot. At 7 p.m. CET on 4 July 1989, the air temperature at Fuchseberg was 23.1° Celsius. Heavy thunderstorms passed over the station from E.S.E. to W.N.W. between 8.30 and 9.50 p.m. CET. The relative humidity rose from 35% at 7 p.m. to nearly 90% at 9 p.m. CET. In the 24 hours between 7 p.m., 4 July and 7 p.m., 5 July, 27.7 mm precipitation fell at the Fuchseberg station with a mean pH-value of 5.0. Showers were registered at the St. Pöltten main station on 4 July from 3:40 to 3:50, 5:25 to 5:38 p.m. CET, and also later with interruptions. At 7:31 p.m. CET., a windspeed of about 35 km/h was measured at St. Pöltten. Other 7 p.m. CET. synoptic values at St.

Figure 3: Daylight view of ball lightning location near Senning, Lower Austria. The camera points to E.S.E. Square Marker “1” = Neulengbach, marker “2” = “Haag” between two fields. The BL position was north of marker “1” at 8 p.m. © Photo by the author. © A. G. Keul.
Pöllen were: clouds 5/8, visibility 10 kilometres, wind from NE, air pressure 84.7 hPa.

The 4/5 July night thunderstorms caused damage and floodings in the Vienna Woods. Destructions by severe thunderstorms were also reported from Styria, Carinthia and Salzburg, i.e. a very active front had crossed Austria.

WITNESS BACKGROUND

Christian Witz, born in 1956, is employed by the Austrian meteorological service (central office: "Hohe Warte", Vienna) as head of the Sankt Pöllen main station at the capital of Lower Austria. He joined the public service as weather observer and government official in 1976 and took roughly 25,000 weather-related diaslides during the years. Mr. Witz has normal eye-sight. He is married and apart from his sometimes dangerous photo-expeditions, leads a quiet life in a former farmhouse at Fuchsburg. He knew ball lightning from a story of his father who had seen one. Another BL report came from a woman of Fuchsburg.

FIRST INSPECTION OF THE PHOTOGRAPH, DISCUSSION

The BL diaslide has a 23 x 35 mm frame (enlarge to Figure 2) and belongs to a series of lightning photographs showing cloud-to-ground flashes in front of a gradually darkening landscape. Characteristic features (trees, streetlights) of the background present on the 1989 series could be identified as daylights at the vantage point near Senning. On the BL diaslide (Figure 2), dark fields seem to rise optically from left to right (N to S). There is no such rise in reality, but an almost horizontal line of hillside from north-east until azimuth 120°, where the next field optically falls/slopes towards the south (Figure 3). Therefore, the camera was not lying horizontally on the board and blanket, but with an inclination of a few degrees to the south. The BL landscape is not pitch black as on other (later) frames, but illuminated to twilight by lightning. The sky looks grey and overcast, and is more lit-up towards the left (north-east), where the initial cloud-to-ground stroke went down outside the camera field.

The salient detail of the frame is a source of light 5 mm from the left edge and about 3 mm above the bottom edge of the frame. It is an overexposed light source with an optical diameter of less than 1 mm on the slide. Light scattering in the car window and in raindrops on the screen is noticeable. Compared to cloud-to-ground flashes, the BL image is neither reddish nor bluish, but bright white, like a neon street light or a car headlight. The light source seems to come from a point higher than ground level. The horizon line between the dark foreground and the grey sky is formed by a silhouette of grass, grain or corn stubbles left and right of the BL position. A discrepancy between photo and report is the apparently sharp image (no blurring, track) of the bright light source, whereas the witness said it sank slowly. Maybe the slow downward motion was an optical illusion.

Are there any clues to confirm the BL position above the "Haag" (azimuth 120°)? Grass, grain or corn stubbles make up the dark horizon of the left half of the photo, whereas the right half looks like a full-grown corn field. The witness, when questioned about farming practices at Senning, said that local peasants have the habit of harvesting parts of their corn-fields early to be able to feed their animals even in case of a later drought. Therefore, the line between the left and right part of the foreground was not necessarily a division between two fields. As no further background is visible behind his silhouette, visibility could have been as low as 100 or 200 metres in the rainshower. Thus, the only position clue we have is the silhouette (and horizon line) of the field visible on the picture — which is straight. Compared to Figure 3, where the most southern field slopes considerably, the frame must have been taken of the even hillside north of the "Haag" (marker "2"), which places the BL at a point left of marker "1", i.e. between E.N.E. and E. An evaluation of 150 Austrian cases (Keul et al., 1989) yielded 14% white objects and 15% cases with blinding BL. In 1993, no prominent objects, metal fences etc. able to cause St. Elmo's Fire or a flash-over were found upon inspection of the location. However, the presence of such an object cannot be ruled out for 1989. All major problems encountered in the Vorarlberg BL colour photo case (Keul 1992) — luminosity discrepancy report-photograph, lack of terrestrial details on BL frame, strange details of the luminous track etc. — which led into long discussion about trick photography and case validity, are not present in this new material. Nevertheless, the J. Meteorology (U.K.) readership is again invited to forward empirically-testable additional hypotheses about the Senning case.

REFERENCES


BALL LIGHTNING AND ROCKET LIGHTNING

By D. ANDREW WHITE

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Abstract: Some reported ball lightnings behave more like rocket lightnings than discrete masses of air plasma. These ball lightnings have velocities that are too high, both upwards and downwards, to be masses of near air density. In several cases they travel against the wind, even accelerate. This behaviour is more like that of lightning leaders, except these "ball lightnings" are slower than normal lightning leaders.
Most reported ball lightning events seem to be discrete masses of some sort. However, some reported cases have characteristics that are incompatible with this idea.  

(1) Some fire balls reportedly fall, implying that they have a greater than air density, i.e. a non-zero terminal velocity. This is in contradiction of most plasma ball theories which usually imply a lighter than air density.  

(2) Some fire balls reportedly have a high velocity, sometimes approaching, or exceeding the sound barrier (340 m/sec). The sound barrier is usually the upper limit of terminal velocity.  

For example, in 1877, in France, M. Ed. Blanc reported several fire balls issuing from a cloud at an angular velocity of at least 1°/sec as seen from a 18 km distance. Assuming the time and distance estimates were accurate, the velocity of these “fire balls” was at least 314 m/sec.  

(3) Some ball lightnings reportedly rise up from the ground, or sea, and then accelerate to supersonic speeds.  

For example, in 1887 a Dr. J. W. Trippe reported three “fire balls” that rose slowly from the ground, and then virtually transformed into lightning, zigzag paths and all, as they headed off towards a cumulonimbus cloud.  

(4) Some ball lightnings travel against the wind. An air density mass would quickly lose its momentum to air resistance.  

For example, in 1887 a crew on a ship in the North Atlantic saw a fire ball rise from the sea, and travel against the wind.  

Many of these “ball lightning” reports could be explained as a type of slow lightning, or “rocket lightning”. However, this form of “ball lightning” is extremely slow (< 10 km/sec), compared to normal slow lightning leaders (10 to 260 km/sec). The ball-like appearance of some of the slower lightning leaders has been noted before. If these fire balls are actually lightning leaders, then their progression against the wind, supersonic velocity and seemingly rapid “fall” rates could be explained. The slowness of these leaders, not their speed, would then be the remaining mystery.  

The idea that ball lightning is a type of slow lightning leader was proposed in 1881 by British archaeologist Sir W. M. Flinders Petrie. Since that time other theorists have proposed that ball lightning is an electric discharge phenomenon. Perhaps in some cases, as in the examples here presented, this theory is correct.

REFERENCES


ROTORS, VORTICES AND AIRCRAFT CRASHES

Two reports are given here of aircraft crashes in which air turbulence appears to have been involved.

ROTORS?

A rare and severe form of turbulence could have caused the loss of a training aircraft over Deeside, a fatal accident inquiry heard yesterday.

Department of Transport air accidents investigator Bernard Forward (57) said this was the most likely cause of the air crash last year that killed flying instructor Mark Ives (34), New Croft, Hill of Ord, Aberchirder, and pupil Kenneth Ramsay (21), 410 Great Western Road, Aberdeen. They died when their Aberdeen Flying Club Grob 115 plunged into Loch Muick on April 3 1992 while on a training flight. Their bodies were recovered along with the wreckage of their plane by divers three-and-a-half weeks later.

The accident investigator described how winds hitting tops of hills swirled down one side in a circular motion, creating a type of turbulence known as rotor.

Mr. Forward said ensuing windspeeds and downdraughts “could fairly rapidly” have turned the aircraft upside down, a position from which recovery might not have been possible. He said the phenomenon was a relatively rare hazard that pilots like Mr. Ives would have known about. He told the second and last day of the inquiry at Stonehaven Sheriff Court that the aircraft struck the water with its right wing low and at high speed — consistent with a spiral dive.

Fiscal Brian Crookshanks asked: “Is the spiral dive a likely impact effect of rotor turbulence?”

“Yes” he replied.

Mr. Forward, a flier for 33 years — 28 with the RAF — said the aircraft would not have headed into the loch if the route was barred by bad weather.

He said: “I do not believe a pilot of Mr. Ives’ experience and temperament would enter Loch Muick, which is basically a closed canyon, if the weather was not clear. My only conclusion is that the aircraft suddenly encountered conditions that were totally unexpected. The only thing I can account for it is this rotor.”

Mr. Forward reached the crash scene the day after the two-seat plane was lost. Using radar plots taken from an RAF Awacs hi-tech spy plane, he traced the last minutes of the flight up to 10.50 am and the spot it crashed.

A colleague of Mr. Ives, instructor Peter van Wees (28), 47 Dishland Street, Arbroath, said flying along the loch was an acceptable option if conditions were right. He said he would have taken that route to hop over to Glen Clova and up the east coast to Aberdeen or down to Dundee.

Asked if he thought Mr. Ives would have ventured into the loch in adverse weather, he replied: “No”. Aberdeen Flying Club manager William Henderson (48) said Mr. Ives had been an ideal candidate when selected as the club’s chief
flying instructor not long before he died. Mr. Henderson, 9 Crawford Avenue, The Gauldry, Newport-on-Tay, said: “He made the right sort of decisions — when to fly and when not to fly”.

Sheriff Brian Murphy said he would issue his findings as soon as possible.

From the Press and Journal, 11 August 1993, sent by Mr. Stuart Campbell

LAND-DEVIL VORTEX

Aircraft type and registration: Piper PA-18-150 Super Cub, G-BHGC
Number and type of engines: 1 Lycoming O-320-A2B piston engine
Year of manufacture: 1969
Day and Time (UTC): 28 August 1993 at 1300 hrs
Location: Lee-on-Solent Airfield, Hampshire, U.K.
Type of flight: Glider towing
Persons on board: Crew - 1; passengers - none
Injuries: None
Nature of damage: Damage to propeller, engine cowling and left wing leading edge
Commander’s licence and age: Private Pilot’s Licence, 54 years
Commander’s flying experience: 4,200 hours (of which 1,200 hours were on type)
Information source: Aircraft Accident Report Form submitted by the pilot, and enquiries by the AAIB

The aircraft was approaching to land on the grass area adjacent to the east side of Runway 05 after a glider launch. The pilot reported that after a normal approach and landing, at a speed of approximately 20-30 mph, the aircraft became airborne in a “three point” attitude. The pilot instinctively applied some power to cushion the touchdown, but as the aircraft sank, a roll to the right rapidly developed. Despite the application of full power, full left aileron and rudder, the aircraft continued in the right turn with the right wingtip brushing the grass. When the aircraft had turned through approximately 150° without responding to control inputs, the pilot closed the throttle. However, the aircraft tipped on to its nose, and came to rest almost immediately on its nose and main landing gear. There was no fire and the pilot, who was wearing a full harness, was uninjured and vacated the aircraft by the normal means.

The pilot of another glider-tug aircraft on the airfield reported that shortly before the landing of the Super Cub a strong thermal, or dust devil vortex, was observed to originate from a nearby cut straw area and to cross the airfield close to the threshold of Runway 05, raising light debris from the ground to a great height. The same pilot also encountered similar handling difficulties on landing on two occasions later the same day, and subsequent flying operations were cancelled.

The weather conditions at the time were reported as surface wind 330°/5 kt, with gusts to 12 kt, good visibility with scattered cumulus cloud base 4,000 feet. The temperature was reported as being very high at the time of the accident.

(From the AAIB Bulletin, number 10/93)

A STUDY OF THREE TYPES OF WIND-BLOWN DUST IN KUWAIT: DUSTSTORMS, RISING DUST AND SUSPENDED DUST

By AL-OSTAD ABDULAZIZ
P.O. Box 687, 45707 Al-Sarja, State of Kuwait

Abstract: Dust and duststorms are natural phenomena of desert climates. In Kuwait, dust and duststorms occur in any month of the year, but they are more frequent during spring and summer. They are mainly due to the strong surface winds and a vertical movement of the air during these two seasons. Twenty-seven years of data from hourly reports of duststorms, rising dust and suspended dust for April, May, June, July and August of 1963-1989 have been divided into three periods, the first period from 1963-1971, the second period from 1972-1980, and the third period from 1981-1989. These data have been investigated to define and understand the rate of occurrence of these three types of dust in the state of Kuwait during spring and summer. This study concludes that the number of duststorms and rising dust are increasing, while suspended dust is still increasing.

INTRODUCTION

Kuwait lies at the north-west end of the Arabian Gulf between longitudes 46° and 48° 30’ east and latitudes 28° 30’ and 30° 08’ north.

The climate of Kuwait may be divided into two main parts: (1) a long dry hot summer (April-October) when mean daily maximum temperature is about 45°C in July and August and the mean daily maximum relative humidity within these two months is 31% and 32% respectively and mean daily minimum is 8% and 9% respectively and dust; (2) a short cold winter (November-March) when mean daily minimum temperature is about 8°C in December and January: the mean daily maximum relative humidity within these two months is 84% and 87% respectively and mean daily minimum is 38% and 40% respectively. The scanty rain begins in October and ends in May with a seasonal average of about 12 mm (Safar 1985). Prevailing winds are mostly from a north-westerly direction particularly in the summer (Safar 1985, Al-Kulaib 1984).

Dust and duststorms are common phenomena in arid and semi-arid lands because most of the region’s surface is covered by loose, mobile sediments. These phenomena occur almost throughout all seasons, and they are more frequent during spring and summer (Safar 1985). This is mainly due to, firstly, the dry fresh north-westerly winds blowing from Iraq and local lands. Secondly, Kuwait is surrounded by the Iraqi desert from the north and the north-west and the desert of Saudi Arabia from the west and south, and most of the surface of the area is covered by loose sediments (Khalaf 1984).

The purpose of this paper is to define and understand the rate of occurrence of the three types of dust (duststorms, rising dust and suspended dust) for the last 27 years (1963-1989) during spring and summer.

Definitions of the three types of dust:

Duststorms: These storms are accompanied by fresh or strong winds (about 18 knots or more). Horizontal visibility is less that 1,000 metres, but when visibility has deteriorated below
200 metres, the storm is regarded as a severe duststorm.

**Rising Dust:**
Winds are generally moderate. Horizontal visibility is equal to or more than 1000 metres.

**Suspended Dust:**
Horizontal visibility is less than 1000 metres with thick suspended dust, but when it is moderate the visibility ranges between 1 km and 5 km due to dust not raised by local winds. Winds are generally light or calm.

**LITERATURE REVIEW**

The problem of dust and duststorms has been investigated by many researchers and writers in Kuwait and the rest of the world. Al-Kulaib (1984) pointed out that during the cool season (November-April), these phenomena occur mainly within the summer (June-August) due to the effects of the eastward passage of the western depressions, and they occur with Indian Monsoon pressure.

Safar (1985) studied the percentages of hours of the three types of dust (duststorms, rising dust, suspended dust) for the period 1962-1984. He found that the percentage of hours averages 13% of time. This percentage increases to 27% during June and 24% during July, and decreases to 5% during November and December. Safar also studied the frequency of dust with concurrent wind speed and direction during day-time in the summer for a period of 10 years in Kuwait.

Gharib (1983) investigated the nature of dust and duststorm sediments as well as the recent deposits covering the surface of Kuwait.

**Table 1: Mean Number of Hours of Duststorms**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
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<tbody>
<tr>
<td>1963-71</td>
<td>15.3</td>
<td>17.1</td>
<td>30.8</td>
<td>34.7</td>
<td>12.7</td>
<td>17.1</td>
<td>30.8</td>
<td>34.7</td>
<td>12.7</td>
<td>17.1</td>
<td>30.8</td>
<td>34.7</td>
<td>110.6</td>
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<tr>
<td>1972-80</td>
<td>7.9</td>
<td>8.0</td>
<td>31.8</td>
<td>32.8</td>
<td>36.0</td>
<td>31.8</td>
<td>32.8</td>
<td>36.0</td>
<td>31.8</td>
<td>32.8</td>
<td>36.0</td>
<td>31.8</td>
<td>116.5</td>
</tr>
<tr>
<td>1981-89</td>
<td>4.1</td>
<td>10.5</td>
<td>25.9</td>
<td>21.9</td>
<td>15.8</td>
<td>25.9</td>
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<td>15.8</td>
<td>25.9</td>
<td>21.9</td>
<td>15.8</td>
<td>25.9</td>
<td>78.5</td>
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**Table 2: Mean Number of Hours of Rising Dust**

<table>
<thead>
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<th>Mar</th>
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<td>113.9</td>
<td>94.6</td>
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</tr>
<tr>
<td>1972-80</td>
<td>45.1</td>
<td>45.9</td>
<td>108.0</td>
<td>99.8</td>
<td>66.5</td>
<td>99.8</td>
<td>108.0</td>
<td>99.8</td>
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<tr>
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<td>47.6</td>
<td>117.0</td>
<td>86.8</td>
<td>77.7</td>
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<td>86.8</td>
<td>117.0</td>
<td>86.8</td>
<td>357.1</td>
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</table>

**Table 3: Mean Number of Hours of Suspended Dust**

<table>
<thead>
<tr>
<th>Year</th>
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<th>Feb</th>
<th>Mar</th>
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<td>27.2</td>
<td>47.8</td>
<td>47.6</td>
<td>50.9</td>
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</tr>
<tr>
<td>1972-80</td>
<td>38.3</td>
<td>41.6</td>
<td>57.4</td>
<td>54.1</td>
<td>41.4</td>
<td>54.1</td>
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<td>41.4</td>
<td>54.1</td>
<td>57.4</td>
<td>54.1</td>
<td>232.8</td>
</tr>
<tr>
<td>1981-89</td>
<td>48.3</td>
<td>59.7</td>
<td>58.9</td>
<td>50.1</td>
<td>37.3</td>
<td>50.1</td>
<td>37.3</td>
<td>50.1</td>
<td>37.3</td>
<td>50.1</td>
<td>37.3</td>
<td>50.1</td>
<td>254.3</td>
</tr>
</tbody>
</table>

**Figures 1-3:** Number of hours of dust-storms (1) 1963-71; (2) 1972-80; (3) 1981-89. Figures 4-6: Number of hours of rising dust (1) 1963-71; (2) 1972-80; (3) 1981-89.

Morales (1977) reviewed the North African climate with particular emphasis on the production of dust and transportation in the Sahara. He estimated that this area may consist annually from 60 to 200 million tons of soil dust compared to the tropospheric aerosols.

Hoddo and Hinds (1975) pointed out the damage caused by these phenomena to the military system (Operation and maintenance of mechanical and electrical equipment).
METHODOLOGY

Twenty-seven years of data from hourly reports (duststorms, rising dust and suspended dust) for April, May, June, July and August of 1963-1989 have been collected from Kuwait International Airport Station.

The data were divided into three periods, as set out in Tables 1-3.

From Table 1 it can be noticed that duststorms during the months of April to August of the first period (1963-1971) averaged a total of 110.6 hr, while those during the second period (1972-1980) averaged 116.5 hr, and the total hours of the third period (1981-1989) averaged 78.2 hr. That means that the dust-storms’ hours increased during the second period (1972-1980) and decreased during the third period (1981-1989) [Figs. 1-3].

Turning next to rising dust (Table 2), the number of rising-dust hours during the first period (1963-1971) reached 403.4 hr, while those in the second period (1972-1980) reached 365.3 hr and in the third period (1981-1989) 357.1 hr. In other words the total number of hours of rising dust decreases during the entire period [Figs. 4, 5, 6].

The total hours of suspended dust (Table 3) during the first period (1963-1971) reached 212.5 hr, during the second period (1972-1980) 232.8 hr, and during the third period (1981-1989) 254.3 hr. This means that suspended dust increased during the third period (1981-1989) [Figs. 7, 8, 9], while duststorm and rising-dust hours decreased during the past period (1981-1989).

From this it appears that duststorms and rising dust are decreasing, while the suspended dust is still increasing.

Acknowledgements: I greatly appreciate my superior Dr. J. Gerrard from the University of Birmingham, United Kingdom, for his recommendations. Special thanks are due to my wife Adeeba Al-Hurban, my friends in the climatology section in Kuwait International Airport, Faisal Al-Mutrouk for his help in preparing the illustrations and teacher Mohammed Abdulssalam for his review of the paper.

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LETTERS TO THE EDITOR

MORE ON GREENHOUSE COMPLEXITY

In response to Stuart Campbell’s letter (“Comment on Ball-lightning and ‘Greenhouse Effect’ Papers, Sept. 1993), I neglected to mention water vapour in my paper in the April issue because, as the title indicated, I was examining “The Methane Greenhouse”. However, Campbell’s assertion that “almost all (99%) of the ‘greenhouse effect’ is produced by water vapour” is not in agreement with Press and Siever (1986), who state that “nearly half the heat absorbed by the atmosphere comes from water vapour”.

Campbell has rather recklessly dismissed the contribution of carbon dioxide and methane in climatology with his statement that “the amounts [sic] of CO₂ and CH₄ in the atmosphere are too small to have much influence”. For openers, he fails to extend this to considering the highly varied heat-retaining potencies of each of these greenhouse gases on a molecular level (or indeed even noting that such differing heat-retaining potencies exist). CO₂ and CH₄ are much more heat-retentive than is water vapour on a molecular basis, and this fact, taken into consideration along with the atmospheric levels of these gases, yields a substantial climatological greenhouse contribution from CO₂ and CH₄ (Sulit, 1993).

Merely pointing to the level of a greenhouse gas to assess its greenhouse contribution is an overly simplistic assessment. Apart from that, a plethora of papers have expressed concern over the climatological threat posed by additional CO₂ and CH₄ being added to the atmosphere by human activities, with concerns in Nature that “continued increases, due to human activity, in concentrations of CO₂ and CH₄, and CFCs will lead to measurable, if not damaging environmental
parade, we had to be at the front and the Chaplain stood up and chanted "God Save the King", at which Wilson, poor man, reeled forward and bawled out, "Not the King, God save Ginger Wilson!" whereupon a horde of hairy hands took him away, weeping. I never saw him again, but I thought just for once I would tell his story. I can still "see" the "bubbling" moving stealthily downwards.

Winchburgh, Stockburn
Gatehouse of Fleet, Dumfries and Galloway

NORMAN GREEN
(This interesting, true story was sent in November 1993 by Norman Green to Bob Prichard who writes pieces on the weather for The Guardian newspaper. Bob kindly sent it to us for publication.)

SUMMER SNOW IN NORTHERN ENGLAND

With reference to the article in Issue No. 181 (September 1993) of The Journal of Meteorology the following events (reported in the Bulletin of Climatological Observers Link by Trevor Smith of Carlton-in-Cove Dale, North Yorkshire) may be of interest:

7.6.85: "At 7 pm the sleet ceased, the sky cleared revealing all the surrounding hills to be snow covered down to a level of about 1700 ft. The evening sunshine lit up the hills with a delightful "Alpine Glow"... the hills were still covered at daybreak".

3+6.6.91: "Sleet fell on two days with an inch of snow being reported on the higher hills on the night of 3rd/4th June; two cars slid on snow going over minor roads 1700ft above sea level".

REFERENCES

(1) COL BULLETIN No. 183, July 1985.
(2) COL BULLETIN No. 254, June 1991

High House Cottage, Wath, Pateley Bridge, Harrogate, HG3 5PL

D.W.M. WADE

MAURICE MATTHEWS: OBITUARY

Long-standing weather observer Maurice Matthews, of Littleover, Derby, died on 30th October 1993. He was 82, and had been unwell for a time. He was admitted to hospital with an acute illness only the previous day.

Maurice was born in Burton-on-Trent, appropriately enough on St. Swithin's Day (15th July) in 1911. A few days later Britain experienced one of the hottest days recorded this century! He was still at school when he obtained his first thermometer, and was certainly recording weather in some detail by 1929 (he furnished me with local data for the cold February that year, recalling the frozen River Trent in response to my enquiry). He contributed information to the Thunderstorm Census Organisation at an early stage of his observing career, and continued doing so right up to his death.

In 1940, Maurice was called up and was in service with the RAF in Egypt as a meteorological observer. After the war, he returned to his "home" area, moving from Burton-on-Trent to Littleover, Derby, in the early 1950s. It was at about this time that he became a Fellow of the Royal Meteorological Society. His observations continued from Littleover for about forty years, and of course, his notes were submitted to the Met. Office, C.O.I., and the Journal of Meteorology. His station also formed part of the East Midlands network which I set up in 1981 for the local section of the Royal Meteorological Society with data appearing in the seasonal report "Weather Front". BBC Radio Derby interviewed him on air to mark his 80th birthday in 1991. Sadly, declining health over the last two years or so prevented Maurice from maintaining a continuous record, but his enthusiasm for the subject continued. I was able to keep him abreast of latest developments for the last five years or so and our addresses were only about ten minutes walk apart.

I first "knew" Maurice via his regular contributions to the Derby Evening Telegraph, which I read with much interest during my early following of meteorological matters from c.1963 onwards. It was not until the mid-1970s that I met Maurice when he kindly supported my own application to the
Royal Meteorological Society and introduced me to the Journal of Meteorology etc., after I had experienced and reported upon the hailstorm of 14 July 1975 (coincidentally noted in J. Meteorology, vol. 18, no. 183).

Besides his interest in the weather, Maurice was a very active Church worker, both in Burton-on-Trent, and later, Littlington. His working career involved him in the world of insurance, especially Marine Insurance. He leaves a widow, Freda, a son and a daughter.  

DAVID STANIER

LITERATURE REVIEWS AND LISTINGS

Book Reviews


This is a surprising and some would say odd and rather eccentric, volume. Surely a book on mid-latitude weather systems might be expected to have quite a bit to say on anticyclones? Three pages out of a total of over 500 on blocking also seems more than a little brief. A more accurate title would have been along the lines of “Mid-Latitude Atmospheric Motion”.

The text is a relatively advanced one as it assumes that students are well acquainted with basic dynamics. There is no effort made to derive in detail fundamental equations of motion or thermodynamics for example. The general level is pitched at about the beginning of a postgraduate course for students with some background in physics and mathematics. Another bias in the book is in terms of area covered. Almost all the examples and maps cover the eastern two-thirds of the United States where the author is currently based.

Perhaps my favourite quote from this book is the Preface remark that “the synoptictrician faces an identity crisis. Except in some private enterprises the romance of the independent forecaster has vanished”. A pity, I suspect, many forecasters will feel. Meanwhile, providing one accepts the quirks of this volume, many students of synoptic meteorology will want to dip into it.

A. PERRY


This A4-format paperback has been prepared by the Institute for Atmospheric Physics, Oberpfaffenhofen, Germany, with the recent co-operation of (the late) Prof. Wally Wallington and proof-reading by Tom Bradbury. According to the Foreword, it is “expanded” to cater for the special needs of pilots now flying hang gliders, paragliders, hot-air balloons and microlight aircraft. Probably only the first section really succeeds in fulfilling this claim by outlining the technical aspects and needs of these various sports. While advances in satellite photographs, plus illustrations of numerical modelling (and lidar sensing) of thermal cross-section imagery have been incorporated, much remaining content seems essentially unchanged from the first edition, which appeared in 1978 and ran to 100 pages.

The first edition was largely inspired and written by the Austrian-American glider pilot, Joachim Kueutter; then later assisted by Tom Bradbury who additionally prepared a number of the hand-drawn illustrations in England. The handbook was originally intended for weather forecasters at airfields, working in support of gliding and soaring competitions. This second edition, while widening its intended scope, utilises space-saving typesetting and improved graphic techniques, allowing separate margins for headings and the reduced size illustrations, which enable a slimmed-down volume of 85 pages to be produced. The earlier five-language abstract is replaced by one in English only (saving four pages) and some early theory (e.g., Caswall’s method of forecasting lee-wave probability) has been omitted.

For the most part, illustration-legibility has been considerably improved since the first edition, with one or two exceptions. Fig. 7.3 (on p61) is jokingly printed on its side, for example. However, the advances in satellite imagery are very apparent through comparison, the better definition allowing sharper and smaller-size reproduction.

But have there been no advances in satellite photographic-analysis since Cruette (1973)? Her original map of wave-cloud formation over Europe in a North-westerly airstream (based on 2 years data) was better-presented in the first edition (through being related to causal topography) than is the over-simplified sketch here on p50. One suspects that ‘Soaring Climatology’ is in its infancy (the small, 2-page end section testifies to this). However, the excellent chart by Lindemann (1988) depicting the month in which maximum thermal convection can be expected (over N.W. Europe and Asia Minor) is a real step in the right direction... (this probably appears on p79, although the handbook’s pagination breaks down after p77 in my copy and I cannot be sure).

Although not specifically aimed at pilots, this book would increase its sales potential by being marketed at flying centres. The weather conditions in which altitude, distance and endurance records have been broken in various parts of the world are of great interest to competitive aviators, and this section could be expanded to include record flights in paragliders, hot-air balloons, etc., if a 3rd edition is considered. Perhaps by that time, ‘Global-scale’ charts might be prepared representing whole-hearted WMO co-operation. At present, there is no mention here of what pilots may expect in Africa (south of the Sahara), over much of Asia, and South America. Lindemann (1988) seems to be a good starting point.

W.S. PIKE
over southern England, with thunder reported from Dorchester just before midnight, and over parts of East Anglia around dawn. Behind the front, showers quickly developed in a brisk west to north-westerly airflow; thunder first appeared in mid-morning over Merseyside and north Wales, and hail covered the ground briefly at Blaenau Ffestiniog. Thunder showers then became widespread in a zone east-south-east from this source across much of the Midlands to East Anglia. Some of the storms were quite fierce; hail fell in places, and there were several reports of lightning damage to buildings. There were also squally winds and marked drop in temperature. Apart from a brief storm at Dover in mid-afternoon, there was a sharp southern edge to the storm area, with much of the south Midlands and southern England having a sunny, breezy afternoon; at 4 p.m., the temperature was 10°C at Wattisham, near Ipswich, and 21°C at Southend. There was also very little thunder north of Yorkshire, although isolated thunder was reported in central Scotland. The storms cleared away into the North Sea in the early evening.

The weekend did not remain quiet. The 14th/15th saw a potentially thunderous situation that never quite materialized. A cold front was moving slowly east into a warm southerly airflow which had minor areas of low pressure drifting northwards within it. A few pockets of thunder activity developed on the evening of the 14th, rumbling their way through the night as they drifted north-east across England and Wales. Where they did occur, the storms were often severe. One outbreak initially affected East Sussex and mid-Kent, then moved into the east of East Anglia; at around 5 am on the 15th, lightning set part of Lowestoft Hospital alight, and, later, it caused a fire which badly damaged a disused hospital at Roundhead near Yarmouth. Several other buildings in Norfolk were struck. A second area of storms broke out near the border of south Powys and Shropshire in the late evening of the 14th; it may have been triggered by the Brecon Beacons. This area of storms drifted across the Birmingham and Nottingham areas during the early hours of the 15th. Later in the day, there was a slow-moving storm around the Wash, which gave 56 mm of rain at Hunstanton, causing considerable flooding in the area.

Pressure then rose strongly across the British Isles, although there were isolated thunder showers over the north Yorkshire coast and the Grampians on the afternoon of the 16th before the anticyclone took hold.

A cold front moved slowly south over southern Britain on the 21st, whilst a depression moved north-east across France; heavy rain developed as a result of the sharpening temperature gradient along this front over the south on the night of the 21st/22nd, and there was a little thunder, chiefly along a track from Guernsey to East Sussex. In the cool northerly airflow behind the front, a cold pool of air aloft interacted with the warm seas off south-west Britain and an area of heavy rain developed under it during the night of the 22nd/23rd; thunder was reported from the south of the Isle of Wight, Brixham (Devon) and, especially, the Channel Islands. Guernsey had quite a severe storm around dawn, followed by several hours more rain, giving 79 mm in total; there was some lightning damage and flooding.

The last report of thunder for August 1993 was an isolated discharge on the Cleveland coast early on the 30th as a cool northerly airflow moved over the relatively warm North Sea.
WORLD WEATHER DISASTERS; September 1993

1-2: Hurricane "Jova" affected western Mexico. On the 1st rains fell on the states of Colima, Jalisco, Nayarit, Michoacan and Chiapas; in the Chiapas 200 people forced from their homes as the river Usamacinta burst its banks. On the 2nd "Jova" hit the island of Socorro, 500 km off the western coast of Mexico, no casualties reported from the storm. Lloyd's List.

1-3: Torrential rains in Bangladesh. On the 3rd traffic in Dhaka brought to a virtual standstill as half the city was flooded, with some areas knee deep in water. In the morning of the 3rd, 140 mm of rain fell on Dhaka, the most rain to have fallen on the capital in a single day in about five years. The rains also touched off floods in the north of the country and around Chittagong in the south; no casualties reported. L.L.

2-5: Typhoon "Yancy" hit the Ryukyu island chain and Japan, brief details below: 2nd: The island of Miyakojima, part of the Ryukyu island chain of islands, hit in the early morning with high winds and heavy rains, power cut to 10,000 homes. On the same day high winds and heavy rains also hit Okinawa, no casualties reported on either island, but a fisherman was missing off Okinawa.

3rd: "Yancy" came ashore at the Satsuma peninsula, on the southern tip of Kyushu, Japan, at 0700 G.M.T. with winds gusting to 180 km/h and torrential rains which touched off floods and landslides. The storm paralysed air, sea and road transport. At 1100 G.M.T. "Yancy" was located near Nobeoka, also on Kyushu, with winds of 162 km/h. A mudslide at Kikyo, in Kagoshima prefecture, destroyed several houses and a public building, leaving 10 people dead and four others missing; many homes were flooded in the city of Kagoshima. The storm continued on the 4th hitting the islands of Kyushu and Shikoku. Winds from "Yancy" uprooted trees and telephone poles, sign boards and ripped telephone lines off roofs. The typhoon demolished or badly damaged more than 572 homes, flooded 1500 other buildings, sank or damaged 15 ferries and fishing vessels, damaged highways at 64 locations and washed away 70 bridges. The rains accompanying "Yancy" set off 210 landslides. The typhoon caused extensive damage to farms producing rice, vegetables and fruit, damage to farms and produce in the Kagoshima area alone put at $129 million. Typhoon "Yancy" killed off the 5th, leaving 42 people dead, 40 of them on Kyushu, 155 others injured and five others missing. L.L.

5: Gale force winds and a 10-metre swell in the Cook Strait halted ferry services between New Zealand and two main islands. 3,000 people were stranded, the ferries ran between Wellington, North Island and Picton, South Island. The gales were still battering Wellington in the evening, no casualties reported. L.L.

7-9: Floods, following heavy rains, sweeping parts of Uttar Pradesh state, India. Left 17 people dead as houses collapsed in some eastern districts of the state near the town of Gorakhpur, about 2,500 villages either under water or have been washed away completely. Most of the deluged areas were declared drought zones only two weeks ago. L.L.

11-13: A storm in the Bay of Biscay; winds gusted to 160 km/h along the southern coast of Brittany, France. On the 12th, the five crew of a yacht abandoned ship on the 12th during the storm and are missing, another vessel, with one person on board, also missing. On the 13th the storm hit Finistere blowing off roofs and uprooting trees and telephone poles, some injuries reported. L.L.

12: Floods in southern England in evening, a motorist was killed when his camper van was blown off the A3082 near Wimborne, in Dorset, in force nine winds. Boats were ripped from their moorings along the south coast. Birmingham Evening Mail.

12-14: Typhoon "Abe" hit the Bataan islands, to the north of Luzon island, Philippines, early in the morning, no casualties reported, winds in "Abe" gusting up to 150 km/h. L.L.

12-13: Hurricane "Lidia" hit western Mexico, brief details below: 12th: Hurricane "Lidia" buried past the Baja California peninsula, the "eye" of the storm 100 km south-west of the peninsula in the evening, with sustained winds of 165 km/h, and gusts to 205 km/h, little damage reported, some roads affected by flooding and mudslides.

13th: "Lidia" hit the state of Sinaloa, accompanied by heavy rains, the "eye" moved inland 48 km south of the state capital, Culiacan, in the early day, with maximum sustained winds of 104 km/h and moving in a north-easterly direction at 24 km/h, shortly after moving inland "Lidia" was downgraded to a tropical storm. One person died when a power cable blew down, the storm brought down power and telephone poles, disrupted rail, road and air communications and destroyed fishing vessels. Later in the day "Lidia" near the village of Guaymas, in Durango state, moving north-east with sustained winds of 85 km/h and gusts of 100 km/h. L.L.

12-19: Heavy monsoon rains caused floods and landslides in Uttar Pradesh state, India, leaving nearly 200 dead. The rains caused landslides in the Almora, Pithorgarh and Pauri-garh districts, which are seated in the Himalayan foothills of the state. The Ramganga river was running one to 1.5 metres above danger level in the Farrakhabad district, villages and crops destroyed. Throughout the affected area hundreds of villages destroyed and thousands of people made homeless. On the 19th some of the flooding was beginning to recede. Damage to buildings, crops and livestock put at $84 million. L.L.

13: Wind, hail and tornadoes in Fort Worth, Texas, U.S.A., caused insured property losses estimated at $25 million. Strong winds caused severe damage in Johnson, Tarrant and Denton counties. L.L.

13(reg): No rain has fallen in Minas Gerais state, Brazil, since April, forest fires burning in areas of the state, one burned 400 hectares in the Rio Doce area of the Atlantic forest, no casualties reported. L.L.

14-15: Heavy rains touched off floods and landslides in western Nepal; on the 14th landslides buried five people in the Palpa district, while on the 15th floods in the district of Ramanpur after the Mahakali river overflowed left one person dead and one other missing. It was reported on the 15th that the dawn flood in the July floods had reached 1.157, but the final death toll was believed to be between 2,000 and 12,000. L.L.

14-22: Hurricane "Gert" swept from Nicaragua to Mexico, brief details below: Nicaragua: Hit on the 14th/15th whilst in the tropical storm phase, Atlantic coastal areas hit with 54 km/h winds and heavy rains, driving fishing vessels ashore; the storm moved N.W. and damaged an area of the country at 14.5 km/h. Gusting 36 km/h. On the 16th, the waves destroyed nine large fishing vessels on Corn island, 100 km off the port of Bluefields. Early on the 16th "Gert" downgraded to a tropical depression after moving inland; there was continuous rains for at least 24 hours on the 15th; the town of Rama partially destroyed as rivers in the area rose more than 12.2 metres above their normal levels, forcing the evacuation of 4,000 people. In central Nicaragua the storm brought torrential rains to Matagalpa, Jinotepe and Nueva Segovia provinces, the river Grande in Matagalpa in flood. Floods in the town of Rio Blanco washed away parked cars, in the town of Matiguas, 113 km north-east of Managua, the river Siquia in flood. At least six deaths reported, four died in floods near to the city of Chinandega, 106 km north-west of Managua and two others died in mudslide near to the northern city of Matagalpa.

Costa Rica: Hit on the 14th/15th with high winds and heavy rains, the rains caused floods and landslides along the south Pacific coast and in central parts of the country, forcing the evacuation of 600 people and driving as many as 3,000 others from their homes, railways and roads impassable, two bridges washed away, one death reported.

Honduras: Hit on the 16th/17th again whilst "Gert" in tropical depression mode, bringing heavy rains and flooding which left at least 21 people dead and forcing 7,000 people from their homes; of the dead seven died in village of Choloma, in the north of the country, while three homes were swept away, three others died in the Atlantida region, also in the north, and two others died in the south of the country.

Mexico: Hit on the 20th/21st; on the 20th "Gert" was of hurricane force when it hit the coast, the storm made landfall around Tuxpan, south of Tampico, with winds gusting to 193 km/h, villages along the coast destroyed. As "Gert" approached the coast, gale force winds and torrential rains hit the Gulf of Mexico states of Tamaulipas and Veracruz, the rains brought flooding to these states and five other eastern and central states. At midnight on the 20th/21st winds in San Luis Potosi state blowing at 97 km/h, gusting to 113 km/h. On the 21st "Gert", now downgraded to a tropical storm, hit north and central states of the country with 97 km/h winds and heavy rains. At least 20,000 people forced from their homes, the rains touched off
mudslides which blocked roads in the state of Veracruz and the central states of Hidalgo and San Luis Potosí, while power, telephone and water supplies cut to many areas. Up to 400 mm of rain fell in the eastern state of San Luis Potosí. On the 22nd it was reported that rivers and lakes in six states were in flood, the worst hit states being Veracruz, Tamaulipas, San Luis Potosí and Hidalgo, the Palmazúca river burst its banks in Veracruz state, leaving three people dead, in Tamaulipas state the Blanco and El Tigre rivers flooded, washing away at least 100 homes, at least 11 people died in Hidalgo state, with another eight people reported injured, more than 1300 homes affected by the flooding, while in San Luis Potosí state 10,000 people were forced from their homes and eight people were missing. In Nuevo León state, in the north-east of the country, flooding along the Blanco river closed roads, only limited damage reported from the state. More than 10,000 acres of crops ruined by the floods throughout the country. On the 29th it was reported that 35 people had died in the floods and that a total of 85,000 people had been made homeless, residual rains continuing after "Gerti" had dissipated continued until at least 28th, keeping flood levels high till at least October 2nd. L.L.

16: Brush fire in wooded hills around Mill Valley, 16 km north of San Francisco, California, U.S.A., ten acres and one house destroyed, the fire was fanned by winds gusting to between 40 and 48 km/h, no casualties reported. L.L.

17: Mr. Polese's sink in stormy seas about 322 km south-west of Gough Island in the South Atlantic, one crewman dead, 28 others missing, one survivor picked up. L.L.

17-18: Severe tropical storm "Becky" hit Hong Kong, Macao and Southern China, brief details below:

Hong Kong: Hit on the 17th. The eye of "Becky" passed 90 km to the south of the colony, air, ferry and road transport disrupted, one person was killed and 130 others injured, 8000 homes were damaged, the storm caused extensive damage to the city, the death toll in Hong Kong was 12, 21 missing, one rescued. L.L.

Mr. Lo Hai 112 sank 31 km south-east of Hong Kong, nine crew missing, three others rescued. L.L.

Mississippi: Also hit out he 17th with winds up to 160 km/h, buildings damaged, one death and 31 injuries reported, 1500 people made homeless, the "eye" of the storm passed within 30 km of the colony.

China: "Becky" hit Guangdong province, in the south of the country, on the 18th, leaving seven people dead and 1500 people injured and 130 people hospitalized. L.L.

19: Violent storms hit the city of Rivero, Uruguay, with winds up to 128 km/h and torrential rains. The storm blew off roofs, uprooted trees and a radio transmission tower, and cut power supplies as high tension lines were damaged, two injuries reported. L.L.

21-22: Wind, hail and tornadoes in the states of Kansas and Missouri, U.S.A., caused insured property losses estimated at $35 million. Thunderstorms associated with a frontal boundary resulted in the severe weather. The tornadoes caused only minor property damage. L.L.

22-23: Severe storms hit eastern France, 200 mm of rain fell in the Marseilles region between 1530 and 2000 hrs on the 22nd flooding many cellars and causing old houses to crumble in the rain. The worst hit town was Aix-en-Provence, where two people died in the floods. In the nearby town of Pertuis 246 houses destroyed, making approximately 1,000 people homeless, and a motorist had a fatal heart attack whilst being rescued from his flooded stranded car. A death was also reported from Rouen and a train driver died when the heavy rains derailed his train in the affected area. The Ardeche river rose two metres. The floods washed away hundreds of cars and cut and road links. On the 25th the torrential rains and mudslides forced the closure of the Mont Blanc and Frejus road tunnels, connecting France and Italy through the Alps; heavy rains continued in central and southern areas of the country, the death toll in the floods rose to four and a fifth death was reported in a mudslide near the village of Lansle-Billard in the Alps. The floods began to ease on the 26th. L.L.

23-26: Torrential rains and flooding in northern Italian provinces of Liguria, Piedmont, Lombardy and Valle d'Aosta; on the 23rd a violent storm in Genoa touched off floods which left two people dead, one of whom was swept away in a car, the floods forced the closure of schools and damaged power installations, cutting power to 30,000 people, up to three metres of water in some streets, damage in the city put at $625 million. At least six other deaths and 150 injuries were reported, three in a car accident on a flooded road near to the city of Udine, two others died when a car was swept away in Ivec, near Turin, the seventh death was in the Valle d'Aosta region when a stream burst its banks, the floods cut rail and road links. The water level of some large lakes in the north of the country rose by three metres in two days. On the 25th the river Dora Baltea overflowed in the Piedmont region, in the north-west of the country; on the 26th the floods and landslides cut rail and road links, swept away bridges and cut off towns. On the 26th the rain had mostly stopped in the provinces of Piedmont, Valle d'Aosta and Liguria, on this day Lake Maggiore overflowed into the valleys of Laveno and Port Vatriaglia, but the level of Lake Como had stopped rising, the main square of Como under 0.5 metres of water. The floods left eight people dead. L.L.

23-26: The port of Injai, Brazil, closed due to heavy rains causing the Itajai river to flood, with very strong currents in the port. L.L.

25: The river Salina burst its banks in the town of Brigg, Valais canton, Switzerland, leaving two persons dead, the town was declared a disaster area, the floods, which followed torrential rains, caused damage estimated at $70 million. L.L.

25-26: Heavy rains brought renewed flooding to areas of the U.S. mid-west; on the 25th 432 mm or rain fell in Pittsburgh, Kansas, touching off flash-flooding which forced 150 people from their homes; flooding along the James river forced hundreds from their homes in Galena, Missouri, the floods left at least 12 people dead and one missing. U.S.A. Today.

25-29: Brush and forest fires near Santa Barbara, California, U.S.A.; by the 30th 3200 acres had burned and the fire was still burning, no casualties reported. L.L.

26: Tropical storm "Dot" hit Hong Kong with winds gusting to 160 km/h and heavy rains; eleven landslides and 17 flood incidents reported, no major damage reported, neither were there any casualties. L.L.

27: Floods, following by heavy rains, in north-east Oklahoma, U.S.A., the floods threatened three bridges on the Burlington Northern railroad's St. Louis-Tulsa main line causing trains to be diverted. The heavy rains caused the Neosho river to rise 3.05 metres above flood stage, threatening two of the three bridges, the third bridge under threat spanned the Spring river at Wyandotte, where the river crested at 5.49 metres above flood stage in the morning. Floodwaters also affected the town of Miami, causing extensive flooding in low-lying areas, with 150-160 homes and businesses damaged, no casualties reported. L.L.

27: A powerful thunderstorm hit the Washington D.C. area in the afternoon, high winds accompanying the thunderstorm, uprooted trees, which damaged cars and buildings. A tornado touched down briefly in northern Prince William County, but no deaths or serious injuries were reported. The storm cut power to about 50,000 homes and businesses in the District and surrounding suburbs. Washington Post.

28: Heavy rains caused floods in northern Bangladesh, six deaths reported, hundreds were made homeless and thousands of others were moved from their homes. All of the dead were in the district of Chapai Nawabganj, two died when a hut was swept away and four died when they tried to cross the Mahampadia river in a small boat. Floods following heavy rains inundated parts of the district of Kurigram, where many residential areas were under 30 cm of water. The floods in the town of
Flash flooding also hit the district of Nekrokoa, most roads in the north-eastern town of Sylhet flooded after nearly 127 mm of rain fell in the 24 hours up to the morning of the 29th. L.L.

30: Wind, hail and tornadoes in eastern Pennsylvania, western New Jersey, Delaware, Maryland and Virginia, U.S.A., caused an estimated $20 million in insured property losses. Seven thunderstorms associated with a very strong cold front caused the damage in the affected area. Some dwellings destroyed and many other buildings suffered minor to moderate damage. There was scattered damage to vehicles from hail, tree limbs and wind-blown debris. L.L.

30-1 Oct: Violent storm in the Vauchien and Drome regions of south-east France, three people killed, two missing. The area was swept away by floods and the third was crushed by a falling wall. In the town of Bollene the floods were waist deep after the river Lez burst its banks. The floods destroyed bridges, cut roads and swept away cattle, power supplies cut to thousands of people. The floods followed just two hours of rain. L.L.

ALBERT J. THOMAS

WORLD WEATHER REVIEW: May 1993

United States: Temperature: mostly warm; +3 to +6°C in and near much of Idaho. Cold from Minnesota and N. Wisconsin to Texas and Louisiana then E. to N. and W. Florida; -1 to +5°C in C. Oklahoma and S.E. Louisiana. Rainfall: wet from N. California to Washington; W. Montana to N. Arizona; E. Dakotas and N. Michigan to S.E. Texas and Mississippi (except parts of N.E. Texas to Louisiana and E. Arkansas); Mississippi to N. Georgia; Chesapeake Bay. Over 200% from N. California to W. Washington; S.E. Idaho to S.E. Utah; parts of E. Dakotas, S. Iowa, S. Kansas, C. Oklahoma and S.E. Texas. Dry elsewhere; under 50% from S.E. California to extreme S. Oregon; extreme S. Montana; in and near N. Florida; E. Pennsylvania to S. Maine; C. Hawaii; locally from W. Dakotas through W. Nebraska to extreme W. Texas and S. Arizona; N.E. Texas and E. Louisiana; E. Illinois to extreme W. Pennsylvania.

Canada and Arctic: Temperature: mostly warm; +3 to +6°C in S. Alaska, Keelewayen Territory; much of British Columbia and Greenland and W. Iceland to S. Labrador. Rainfall: -1°C in parts of E. Canada; +1°C in parts of S.E. Canada; dry in parts of S.E. Canada. (1°C) marginally in S. Manitoba and S. Ontario. Rainfall: wet in S. British Columbia, Iceland, Spitsbergen, Quebec, Newfoundland; most of north-west Territories (except Baffin Island); over 200% in Canadian Arctic islands and W. Greenland. Dry elsewhere; under 50% from Baffin Island to S.E. Greenland; Franz Josef Land; locally from W. Alberta to W. Manitoba.

South and Central America: Temperature: warm in N. and parts of C. Chile, extreme S.W. Bolivia, extreme N. and parts of N.E. Argentina, coastal Uruguay, S.C. Brazil, N.W. Mexico, S. Mexico, C. Mexico to Honduras; Brazil, West Indies; +2 to +5°C in interior S.C. Brazil, extreme N.W. Mexico. Cold elsewhere in South America -10°C; N.E. and C. Mexico, Bahamas; -1°C locally in W. and S. Bolivia and C. Mexico. Rainfall: wet in S. Chile, N.E. Argentina, N. Uruguay, S. Brazil, N.E. coastal Mexico, E. Yucatan to Belize and N. Guatemala; Jamaica, Martinique. Over 200% in N. Uruguay and Jamaica; parts of Yucatan to Belize; locally in C. Chile, N.E. Argentina, S.E. Paraguay, extreme S. Brazil. Dry elsewhere in S. America -10°C; parts of Mexico to El Salvador and parts of Honduras; Bermuda, Bahamas; locally in S.C. Argentina.

Europe: Temperature: mostly warm; +3°C from S.E. Sweden to S. Finland, W. Belarusia and Baltic States and widely from there to E. Germany, N. Austria, E. Hungary. Cold only in Portugal, W. Spain, S. Greece, lower Volga basin (all -sc); Scotland; parts of Ireland. Rainfall: wet in Portugal, W. Spain, N. France, British Isles (except S.E. England, Hebrides and Shetlands), S. Italy, N. Norway, N. Sweden, N. and W. Greece, E. Bulgaria, S.E. Romania, S. Moldavia, S. Ukraine to Volga estuary; much of Low Countries and and W. and N. Germany, Over 200% in N.W. Greece; much of Portugal; parts of British Isles (especially near Irish Sea); locally in W. Spain and lower Volga basin. Dry elsewhere; under 50% in N.E. Spain, coastal S. France, N. Italy, S. Austria, Hungary, W. Romania, former Yugoslavia; extreme S. Norway, N. Denmark and S.W. and E. Sweden to Finland, White Sea and S. Urals; much of S. Sweden; locally in Poland. Provisional summer number 61.

Africa: Temperature: warm in Algeria, Tunisia; Senegal to Niger and Nigeria; S. of 20'N (except marginally in W. Cape Province); +2°C in interior Algeria; +3°C in interior N. Namibia to W. Zimbabwe and N.W. Transvaal. Cold in Morocco (-1°C). Rainfall: wet in extreme N. Morocco, N. Tunisia, Egypt, S.W. and N.E. Namibia, W. Cape Province, N.W. Boiswana; all over 200%. Dry

generally from Morocco to Tunisia; Senegal to Niger; S. of 20'N; all widely under 50%.

Asia: Temperature: warm in Pakistan, Bhutan, Mongolia, N.E. and parts of China, Korea, Thailand, S. Laos, Cambodia, S. Vietnam, Malaysia, Indonesia, Philippines; most of India; +2°C in N.W. Pakistan; locally in W. Mongolia. Cold in Turkey, Syria, Israel; Turkmenistan to Tajikistan and upper Ob basin; N.E. India, Bangladesh, Nepal, N. Laos, N. Vietnam; most of China; +2°C in E. Kazakhstan; locally in C. China. Rainfall: wet in Turkey, Syria, Israel, extreme S. Turkmenistan, and W. and E. Uzbekistan, Tajikistan, W. and S. Kazakhstan, N.E. India, E. Nepal, Bhutan, N. Mongolia, N.E. Cambodia, S. Myanmar, C. Sumatra; most of Bangladesh, Korea, Laos and Vietnam. Over 200% in parts of Turkey, Israel, Uzbekistan, Kazakhstan, Tajikistan; Bangladesh and Korea. Dry in C. Uzbekistan, Pakistan, W. Nepal, S. Mongolia, extreme N. Korea, S.W. Cambodia, N. Malaysia, Philippines; most of Turkmenistan, India, Japan, Thailand and Indonesia; parts of N. Kazakhstan. Under 50% at least locally in all these areas; widely in C. Turkmenistan, C. Uzbekistan, Pakistan, N.W. India, S. Mongolia, Philippines, China under 50% in N.

Australia: Temperature: warm; wet; +2°C in S. Queensland and locally in N.W. cold in S.W. (-1°C) and marginally in parts of S.E. Rainfall: wet from most of Western Australia to N.W. New South Wales; locally over 200%. Dry elsewhere; under 50% from N.W. coast clockwise to Victoria.

W. ROWE

BRITISH WEATHER SUMMAR: OCTOBER 1993

Few months produce quite such a contrast from one half to the next as did this one. A series of deep depressions drifting east into the country during the first thirteen days continued the very wet spell that began on September 7th. In that five-week spell around 250 mm of rain, or about four times the normal for the period, fell in many southern and eastern districts. Early October was also very thundery in the south, but cold, north-easterly winds were more frequent than the usual from northern Scotland, and the cold air eventually spread to all areas by the 14th, bringing to an end the wet spell in the process. It was then unusually cold for so early in the season for a few days, but sunny, with record low minima for October and very early snow in the north. High pressure became centred near or over the British Isles for most of the last fortnight, bringing mostly dry, but dull and cold weather.

Mean temperatures for the month were mostly around two degrees C below normal. Rainfall tables were in fact rather variable, because some western and far northern areas missed most of the early downpours. Much of the east and south, though, had at least 150% of normal — locally up to 250%. The mid-month sunny spell elevated sunshine totals above normal in many areas, but only the south-west peninsula saw much of the sun in the last ten days, so it would be misleading to describe it as a sunny month.

Amongst the most notable deluges in the first half was one of 79 mm at Gatwick, Surrey in the 36 hours to 2100 on the 2nd (this includes 11 mm that goes to September's total). Thunderstorms were particularly severe over parts of the Midland and south on the 5th, 6th and 8th, with widespread lightning damage. Around 75 mm fell in eastern Scotland on the 6th and 7th in prolonged rain, and serious flooding followed. A week later, much of the south was under floodwater.

The mid-month cold spell included a minimum of 0°F at Carnwath in south-west Scotland on the 17th, and many minima of -6°C between the 16th and 19th.
## TEMPERATURE AND RAINFALL: OCTOBER 1993

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### INFRA-RED METEOSAT AT 12:00 GMT

**Fig. 1**

**INFRA-RED METEOSAT AT 18:00 GMT**

**Fig. 2**

**Fig. 3**

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**CUMBERLAND RAINFAULS**

- **Broadford**: 45.2 mm (35%) - Appleby Boreas: 41.1 mm (28%) - Aurora: 26.7 mm (33%) - The Rock: 37.2 mm (22%) - Cumbria: 37.2 mm (22%) - Keswick: 37.2 mm (22%)
- **Lake District**: 37.2 mm (22%) - At the Lake District station, it was the driest October since 1951, and one of the driest October's since records started in 1910.
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**FRONT COVER:**

Ball lightning photograph by Christian Witz from Senning in Lower Austria; lower photograph by A. G. Keul shows the scene in daylight.

**EDITORIAL OFFICE:**

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