Mausam, (1989), **40**, 2, 221-224

551.551 : 551.515.4

A case study of possible occurrence of a microburst cell on 27 June 1985 over Palam airport

DAYA KISHAN and BHAJAN LAL

Meteorological Office, Palam Airport

(Received 13 January 1988)

सार — पालम हवाई अड्डे पर 27 जून 1985 को एक प्रचण्ड तड़ित् झंझा आई। पालम और सफदरजंग हवाई अड्डों पर रिकार्ड किए गए तड़ित् झंझा से सम्बद्ध सतह मौसम प्राचलों और रेडार प्रतिध्वनियों के आकार, गति तथा ऊँचाई का अध्ययन तथा विश्लेषण किया गया है। पालम हवाई अड्डे की दो हवाई पट्टियों के किनारों पर एक दूसरे से 3 कि. मी. की दूरी पर स्थापित पवन उपकरणों ने लगभग विपरीत दिशाओं से झोंकों में उसी समय में क्रमश: 78 और 25 नॉट की सतही पवनों को रिकार्ड किया।

गहन सतही वातप्रवाह और उससे सम्बद्ध मौसम सम्बन्धी अन्य प्राचलों तथा उनमें शामिल परिवर्तनों से यह पता चलता है कि वहां पर एक सूक्ष्म-प्रस्फोट (माइक्रोब्रस्ट) सेल था जोकि पालम हवाई अड्डे से गुजरा और उसके कारण 3 कि. मी. की दूरी पर 100 नॉट से भी अधिक पवन अपरूपण (विंड शियर) उत्पन्न हुआ।

ABSTRACT. A severe thunderstorm occurred on 27 June 1985 over Palam airport. The height, speed and shape of the radar echoes and the surface meteorologcial parameters associated with the thunderstorm, recorded at Palam and Safdarjung airports. have been studied and analysed. The wind instruments installed at Palam airport at the two runway ends, at a distance of 3 km from each other, recorded surface winds of 78 and 25 kt respectively at the same time in gusts from nearly opposite directions.

The intense surface draft and other associated meteorological parameters, including changes in them, suggest that there was a microburst cell which moved across Palam airport causing a wind shear of more than 100 kt over a distance of 3 km.

1. Introduction

The low level wind shear has come to be known as the most hazardous weather phenomenon which affects modern airliners during take-off and landing. In fact a number of fatal air accidents have been attributed to this phenomenon. Low level wind shear can be encountered under a number of meteorological situations : sea breeze circulation; ground layer inversions during winter months resulting in strong jet like winds aloft; air mass boundaries; sharp wind changes due to topographical features over an aerodrome or in association with thunderstorms. There has been even controversy about relative importance of hazard due to horizontal wind shear, vertical wind shear or shear of vertical winds.

Investigations since last decade, however, indicate that the wind shears associated with thunderstorms are, by far, the most dangerous because these are intense and complex, containing all the type of wind shears mentioned above. Downdrafts in thunderstorms encompassing horizontal gusts of large magnitude have been described as downbursts or microbursts.

1.1. *Downbursts and microbursts*

The existence of downdrafts in thunderstorms has been well known since long. However, Fujita and Byers (1977) while analysing meteorological conditions leading to the crash of an airliner at Kennedy airport, New York, found downdrafts much stronger than those measured and mentioned in 'Thunderstorm Project' by Byers and Braham (1949). These exceptional downdrafts were designated by Fujita and Byers (1977) as downbursts. A downburst has been defined as a localised intense downdraft with vertical currents exceeding a downward speed of 3.6 m/s (12 ft/sec) at 91 m (300 ft) above the surface. As shown by Fujita and Caracena (1977) this value is comparable to the normal descent rate of a jet aircraft during landing. A downburst of this threshold value tends to double the sinking speed of such an aircraft trimmed for normal approach near touchdown at usual 3° glide slope below 150 m (500 feet). A microburst is a smaller but rather more intense version of the downburst. The horizontal extent of these phenomena as proposed by McCarthy *et al.* (1982) are taken as 4-10 km and 1-4 km respectively. The downbursts or microbursts when reach the surface spread out horizontally giving rise to strong gusty surface winds with average maximum up to 50 to 60 m/s. If an aircraft encounters such downbursts or microbursts during approach and take-off, the extra power needed to compensate for the sudden reduction in the *angle of attack, airspeed* and *lift* can be beyond the capacity of the aircraft engines to prevent the aircraft from striking the ground. The encounter can, therefore, be lethal. A vertical cross-section of a microburst with the flight track of an aircraft penetrating it shortly after take-off is shown in Fig. 1.

2. Meteorological situation on 27 June 1985

A feeble cyclonic circulation was lying over Haryana and neighbourhood in the lower levels extending

TABLE 1

Squall data of Palam and Safdarjung airports of 27 June 1985

Max. speed in squall (kmph)	Dir. of squall (°)	Temp. fall (°C)	Dew point fall (°C)	Pressure change (mb)	Rainfall (mm)
Palam airport, 1535-1540 IST (5 min)					
100 with peak of 144 at 1540)	300	15.5 (39.5-24.0)	7.8 (25.8-18.0)	4.0 (966.2-970.2)	44.5
Safdarjung airport, 1536-1541 IST (5 min)					
66	270	13.6 (39.1-25.5)	1.1 (25.4-24.3)	0.8 (968.2-969.0)	5.3

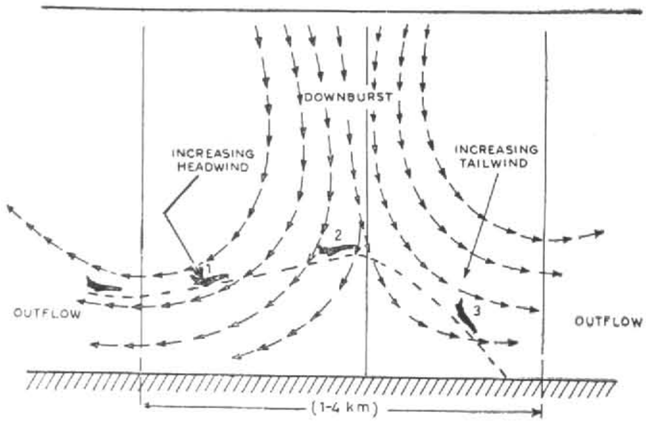

Fig. 1. Vertical cross-section of microburst and flight track of an aircraft passing through it. The aircraft encounters a head wind and experiences increasing performances (1). The headwind decreases and downdraft itself affect the aircraft by pitching resulting in decreasing performance (2). The aircraft encounters strong tail wind causing serious decrease in the performance resulting in ground impact (3)

upto 1.5 km a.s.l. at 00 GMT. The axis of the seasonal trough at 0.9 km a.s.l. was passing through Ganga Nagar, Hissar, Aligarh, Jhansi and thence further eastwards. Tephigram of 0000 GMT of the date for Delhi suggested well marked condional instability (maximum temperature recorded was 40°C). BEL storm warning radar installed at Palam airport reported at 0845 GMT a few cells of 8-10 km height in the NW sector as shown in Fig. 2. The cell K with top 8 km was located at 40 nm (74 km) in the northwest direction. Polar diagram of 0945 GMT radar observation (Fig. 2 b) shows a solid echo covering WNW-north sector at a distance of 20 nm (37 km). RHI indicated top of 17 km from 315° direction at 0940 GMT. Thus, it appears that the cell K moved from 40 nm at 0845 GMT to 20 nm at 0945 GMT and grew fast from 8 km to 17 km. The morning tephigram suggests that tropopause was lying at 90 mb (17.5 km). There was no radiosonde ascent in evening over Delhi, also the radar remained unserviceable from 0945 to 1245 GMT. As such, we have to make inference from the changes in surface meteorological parameters which took place during the period of unusually strong surface gusts at and about 1000 GMT.

The surface wind at airport changed from 0945 GMT onwards, when the cell was at 37 km from the airport, from E'ly/SE'ly to W'ly and picked speed very fast. Squalls were reported during 1005 to 1010 GMT at Palam and Safdarjung airports. Details of changes in surface meteorological parameters during the period of intense gusts, *i.e.*, squalls, at Palam and Safdarjung observatories are presented in Table 1. During the squally period an unusually strong gust of 78 kt from 300° direction was recorded by CWIS installed at runway 28, whille CWIS installed at runway 10 recorded wind of 25 kt from 090° at the same time. The wind records of the two runway ends of Palam airport are presented in Fig 3. A lot of damage was reported from the NW sector of airport due to intense gusty winds and heavy rain; a school wall in the area collapsed and a large number of trees were found uprooted in the area.

3. Analysis

On 27 June 1985, the prevailing surface wind over Delhi, at both Palam and Safdarjung airports was E' ly/SE'ly. However, the surface wind started changing after 0930 GMT to NW'ly direction at both ends of runway at Palam, the change in the direction occurred earlier at runway 10 then at runway 28 as anticipated, because the cell was moving from W'ly direction towards the station. The solid thunderstorm echo, under discussion, was at 20 nm (37 km) in the NW direction at that time as shown in Fig. 2. This shows that winds over the Palam airport came under the influence of combined downdrafts from a number of cells present in the echo, at various stages of their development. It is also noticed from Fig. 3 that changes in surface parameters such as rise in surface pressure, fall in surface temperature etc, all started simultaneously 15 to 20 minutes earlier than the occurrence of squall. The surface squall was recorded during the period 1005 to 1010 GMT at runway ends 10 and 28 at Palam and Safdarjung airports with maximum gusts reaching 35, 78 and 36 kt from 070°, 300° and 270° respectively. The amount of rainfall and rise in surface pressure at Safdarjung airport were very much less than those at Palam airport but the fall in surface temperature at both places was of the same order (14° C), however, the rate of fall of temperature at Safdarjung was not as fast as that at Palam (it took 45 minutes at Safdarjung against 15 minutes at Palam). It can also be seen that at Palam dew point decreased by 8° C while that at Safdarjung it was 1°C only.

4. Inference

The analysis suggests that a microburst cell moved across the Palam airport during the period 1005 to 1010 GMT. The directions and intensities of the gusts at the two ends of runway at Palam and Safdarjung airports suggest that microburst cell was located near to the runway end 28. The cell produced a headwind-tail wind shear of more than 100 kt over a distance of 3 km, an unusually strong low altitude wind shear. Fortunately, however, there was no aircraft movement over the airport.

4.1. *Microburst formation and growth*

McCarthy and Willson (1984) while discussing the structure and mechanism of microbursts have proposed five possible mechanism that may cause or contribute to

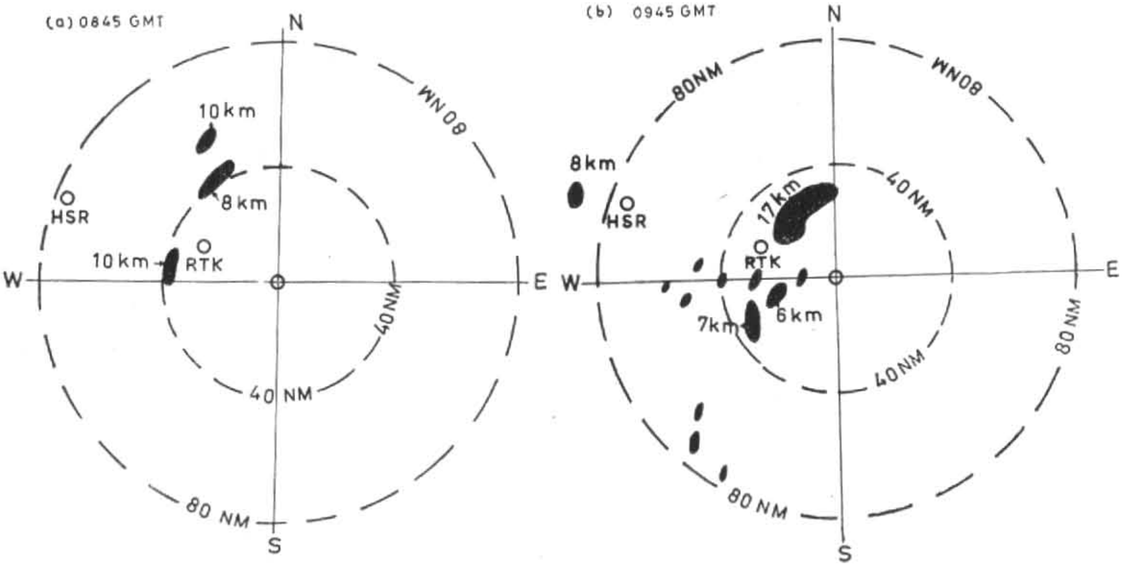

Fig. 2. BEL radar observation of Palam airport on 27 June 1985

the microburst downdraft. Of these, evaporation cooling/precipitation melting is thought to be most common. Fujita and Byers (1977) have associated downburst cells with radar echoes called spear-head echoes which move with unusual speed of 30-35 kt. The model involves tops overshooting the anvil, then collapsing into a downdraft with heavy precipitation. Entrainment at the top levels transports dry air and large horizontal momentum downward. In the subsaturated mixutre of cloud air with dry entrained air from stratospheric levels, sublimation/evaporation makes the downdraft cold and negatively bouyant. A successive rise and fall of the top may create a family of downburst cells that move away from the parent thunderstorm.

It is interesting to note that available features of the present case study closely resemble the model given by Fujita and Byers (1977) for the formation and growth of downbursts. The movement of thunder cells was very fast, *i.e.,* 40-48 kt (covering 20 nm between 0940 and 1005/1010 GMT). The tops of the thunderstorm echo reached 17 km, which was near the tropopause level, possibly allowing entraining the dry air into saturated cloud air to cause evaporation and thereby cooling of the downburst drafts. At surface there was very intense headwind to tail wind shear (more than 100 kt over a distance of 3 km) with associated heavy rain (44.5 mm) with very cold and comparatively dry air as expected in the model enunciated by Fujita and Byer and sharp rise in pressure. Thus, available evidence clearly suggests that a microburst cell moved across the Palam airport from west to east. In fact if we closely examine the windspeed record of CWIS of runway end 28, we can say, there was a family of four microbursts which passed through the airport area over a period of 22 minutes, the time difference between two microbursts being between 6 and 8 minutes. The damage reported around Military Base hospital at a distance of 3 km from airport also supports this view.

4.2. *Microburst visual characteristics*

McCarthy and Serafin (1984) have described the visual characteristics of the microbursts. Often microbursts may occur in association with heavy rain from a thunderstorm. However, at times, the air below the cloud base may be even rain-free with no visible clues to warn the presence of microbursts. Sometimes, however, there are tell-tale signs of the presence of a microburst that pilots or meteorologists can be trained to recognise. One of these is the localised blowing dust near the ground. It is also interesting that in the present case study both heavy rain, and prior to it, localised dust raising phenomenon was reported at Palam for a short period of 20 minutes. The phenomenon of dust raising wind was local as it was not reported by Safdarjung observatory. Similarly the heavy rain of 44.5 mm was reported at Palam while Safdarjung reported 5.3 mm rainfall only suggesting that the centre of the downburst cell was over or near the runway end 28 with a horizontal dimension of less then 3 km and, therefore, the cell could be characterised as microburst.

5. The existence of gust front

Fujita and Caracena (1977) have suggested the existence of two regions of strong wind shear associated with thunderstorms. The first region is located along the leading edge of the pressure dome generated by the cold outflow from the cell. This leading edge is called gust front. In the present case rise in pressure and fall in temperature along with change in surface wind started at the time when thunderstorm echo was 30 km away from the station suggesting that gust front zone extended upto 30 km from the parent thunderstorm. While shears exist in the gust front zone, but it should not be confused with microburst or downburst where shears of large magnitude occur over small area for a short period. The present study, having recorded a wind shear of more than 100 kt over a distance of 3 km supports the view.

6. Conclusion

(*i*) The study suggests that a close watch on the radar echoes, their heights, speed and shape coupled