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UNUSUAL THUNDER SQUALL OVER KOLKATA

1. A rare thunder squall occurred in the post monsoon season of 2010 over Kolkata. Synoptic and thermodynamic conditions favourable for the development of that event have been analysed using autographic chart data of both Dumdum airport and Alipore observatory, analysed 0300/0000 UTC surface and upper air charts and satellite and radar pictures.

Thunderstorm activity is very common during the month of March, April and May of pre-monsoon season in Gangetic West Bengal and neighbourhood which is locally known as Nor'wester. These norwesters are strong northwesternly winds from the thunder clouds and severe thunderstorms are accompanied with squalls and hails. A squall is a sudden increase of wind speed by at least 8 metre per second (16 knots or 28 km per hour) speed rising to 11 m/s (22 knots or 40 kmph) or more lasting for at least one minute (WMO, 1962). The thunderstorm accompanied with squall is very rare in the month of October of post-monsoon season in West Bengal. Manohar and Kesarkar (2004) opined that most part of India except Southern portion of East coast and extreme South India are free from thunderstorm activity during October and November of post monsoon season and 2-4 storms are seen along some parts of East coast and region of Bay of Bengal during the season. An unusual squall event with gust wind speed reaching 35 knots (64 kmph) and 31 knots (58 kmph) recorded at Dumdum and Alipore observatory, respectively in Kolkata on 5th October 2010.

Many Scientists and researchers have studied the various aspects of thunderstorm for several stations of India during last few decades. Basu and Mondal (2002) made the forecasting aspect of thunder squall over Kolkata and its parameterization. Chakraborty *et al.* (2007) described the positive aspect of thunderstorm over West Bengal. Das *et al*. (2010) described the climatological and synoptic aspect of hail storm and squall over Guwahati airport during pre-monsoon season.

2. Kolkata (Lat. 22° 33′ N / Long. 88° 30′ E, 7 metre above MSL) is located in the eastern part of the river Ganges and the topography of the land is from west to east. The Bay of Bengal is only 100 km from the city and mainly southerly wind is blowing in most of the season except winter over the city. The data pertaining to autographic charts of temperature, pressure, relative humidity, rainfall and wind speed/direction of Dumdum airport and Alipore observatory of Kolkata on 5 October, 2010 have been studied and the analysed surface (0300 UTC) and upper air (0000 UTC) charts of the same day along with satellite (0500 / 0900 UTC) and Doppler radar picture (0600 / 0900 UTC) during the same day have been considered for the study.

3. The comparative analysis of autographic charts of both observatories during squall period presented in Table 1.

The Autographic Chart in Fig. 1 revealed that wind from south east direction started strengthening from 1235 hrs (IST) with maximum gust of 64 kmph (35 kts) recorded at Dumdum at 1240 hrs (IST) changing to northwest direction after the passage of TS squall and in case of Alipore, it was reported as 58 kmph (31kts) around 1245 hrs (IST), *i.e*., the squall approached from SE direction reducing the wind speed gradually during the movement of the cell. Observation showed that pressure dipped about 0.7 hPa between 1223 and 1240 hrs (IST) at Dumdum airport and the pressure drop was around 1 hPa at Alipore between 1212 and 1238 hrs (IST) just prior to the commencement of squall. The fall of pressure first and then rise of pressure during passage of thunderstorm cell accompanied by a squall is due to bringing of cold air mass from the downdraft of thunderstorm cell creating a ridge of high pressure, as observed by Asnani (2005) and Chakraborty *et al*. (2007).

The thermograph record of both stations indicated that the temperature started falling before commencement of rain at 1235 hrs (IST) both at Dumdum and Alipore and 9 °C fall recorded from 1235 to 1305 hrs at Dumdum airport and same was 6.4 °C between 1235 and 1320 hrs (IST) at Alipore observatory. Basu & Mondal (2002) & Chakraborty *et al*. (2007) also reported the significant pressure and temperature change in Gangetic West Bengal during passing of thunder squall.

TABLE 1

Variation of autographic chart values during the passage of Squall

Name of station	Pressure (hPa) / Time (IST)	Temperature (°C) / Time (IST)	R.H. (%) / Time (IST)	Rainfall (mm) / Time (IST)
Dumdum	1003.2/1223 - 1002.5/1240	35/1235 - 26/1305	55/1230 - 90/1310	12.8/(1245 - 1420)
Alipore	1006.0/1212 - 1005.0/1238	33.8/1235 - 27.4/1320	61/1240 - 88/1315	1.3/(1252 - 1315)

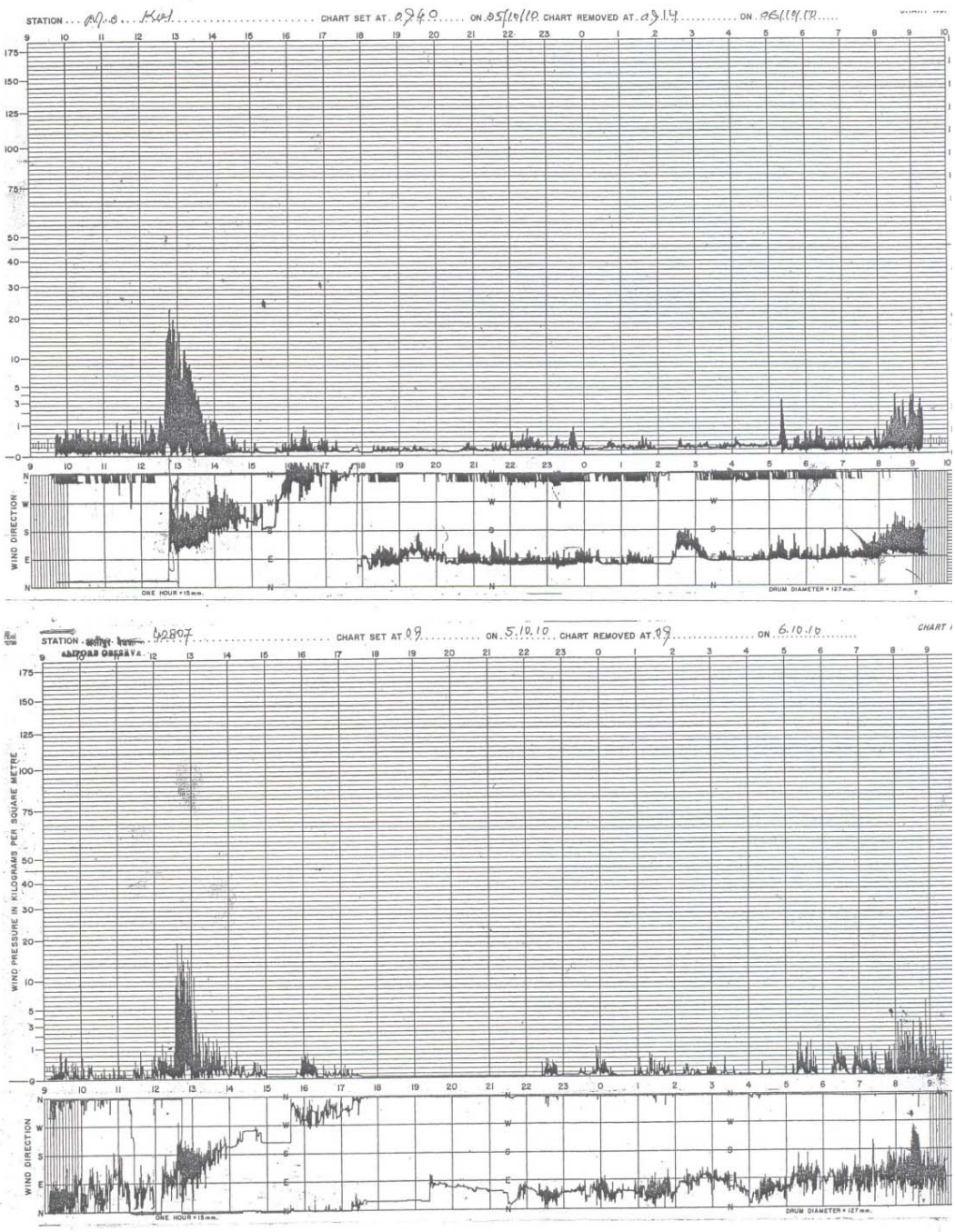

Fig. 1. Relevant portion of Anemograph charts of Dumdum airport & Alipore observatory on 5th October, 2010 during squall period

Hair hygrograph showed increase of Relative humidity from 55% at 1230 to 90% at 1310 hrs (IST) at Dumdum airport and the same was ranging from 61% to 88% between 1240 to 1315 hrs (IST) at Alipore. The rainfall started in Dumdum at 1245 and it was at 1252 hrs (IST) at Alipore after passing of the squall and the rainfall amount recorded 12.8 mm within 1 hour 45 minutes at Dum Dum and the same was only 1.3 mm between 1252 and 1315 hrs (IST) (Table 1). The increase of Relative Humidity about 35% (from 55% to 90%) at Dumdum

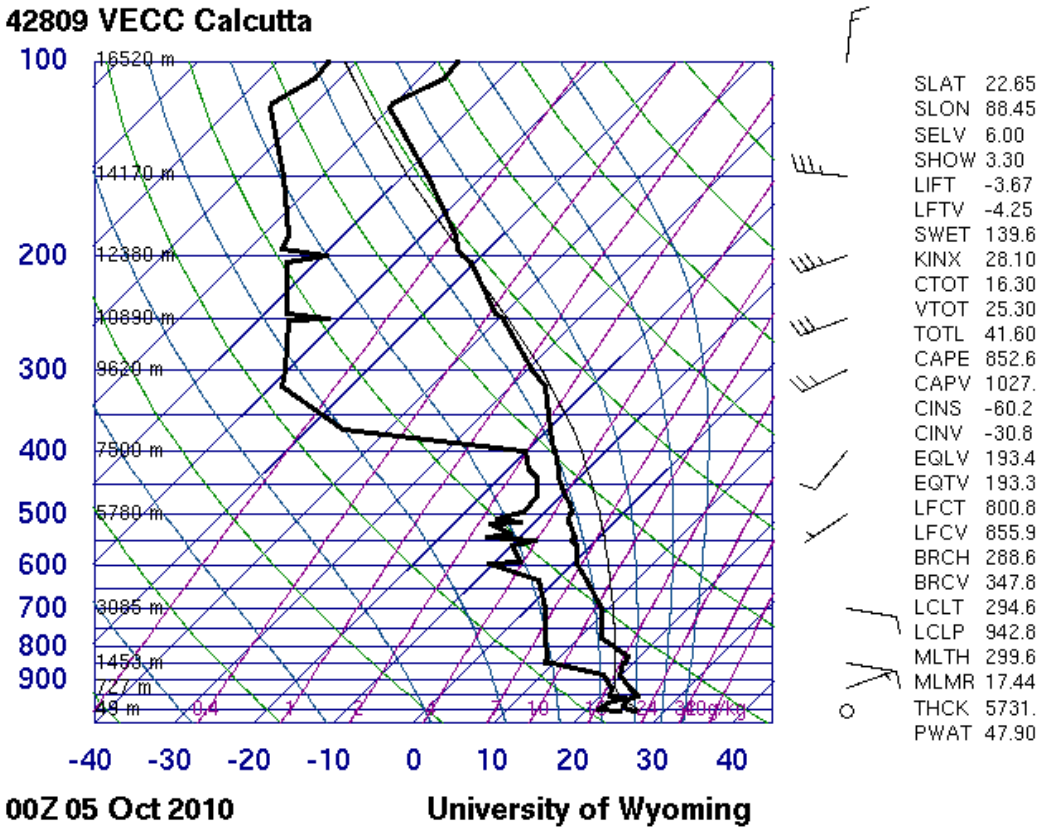

Fig. 2. Sounding diagram of Dumdum airport (Kolkata) on 5 October 2010 (*Courtesy* : University of Wyoming website at http:// weather.uwyo.edu/upperair/sounding.html)

and 27% (from 61% to 88%) at Alipore may be attributed to the commencement of rainfall after passing of squall.

Weather observations of 0300, 0600, 0900 UTC of 5 October, 2010 of coastal and interior observatories neighbouring Kolkata in GWB, *viz*., Digha, Haldia, Dimond Harbour, Canning, Bankura and Srinikaton have been presented in Table 2. No significant change of pressure, temperature and wind speed / direction recorded in all these stations, except Haldia and Diamond Harbour where temperature dropped markedly from 0600 to 0900 UTC by 7.4 °C and 9 °C respectively. However, variation of different weather elements in the synoptic hours of these observatories are attributed to the prevailing seasonal weather conditions of the region.

Satellite picture observation of 0500 and 0900 UTC revealed that long convective cloud bands is seen from a large area extending all along east coast including Gangetic West Bengal and is moving towards west in association with Low pressure area (LOPAR) over west central & adjoining east central Bay of Bengal with circulation extending upto middle troposphere. The Doppler weather radar, Kolkata observed thunder squall at 0600 UTC along and off West Bengal coast and it moved over Gangetic West Bengal and neighbourhood afterwards. A cluster of echoes of reflectivity 44-49 dBZ were observed at 0600 UTC at DWR, Kolkata and the cell moved westward over the land & crossed Kolkata. The echo intensity was increasing while passing over Gangetic West Bengal and neighbourhood. The sounding diagram (Skew-T) of Dumdum at 0000 UTC of 5 October, 2010 is presented in Fig. 2 which shows prevalence of moderate instability.

4. It is inferred from the current study that thunder squall may also occur in post-monsoon season with low value of convective available potential energy (CAPE). The thunder squall on 5 October, 2010 occurred due to thermodynamic instability with non-homogenous temperature field and high moisture incursion in association with LOPAR with associated cyclonic circulation extending upto middle troposphere. Sudden

TABLE 2

Weather observations of different observatories in the neighbourhood of Kolkata on 5 October, 2010

Name of the station	Synoptic hrs. (UTC)	Pressure (hPa)	Air Temp (°C)	Dew Point Temp (°C)	Wind Direction / Speed (kts)	Rainfall (mm)
Bankura	0300	1007.2	26.8	24.8	000/00	19.0
	0600	1006.3	31.0	26.8	000/00	-
	0900	1003.9	31.4	27.6	000/00	-
Digha	0300	1006.5	29.0	25.0	N/04	0.9
	0600	1006.4	26.6	25.5	S/02	3.0
	0900	1004.7	26.0	25.4	NE/02	10.0
Haldia	0300	1007.2	31.0	26.6	NNE/02	-
	0600	1006.4	33.4	27.1	SE/02	-
	0900	1005.1	26.0	24.6	SSW/01	-
Dimond Harbour	0300	1007.5	30.0	26.7	000/00	2.0
	0600	1006.7	35.0	26.7	000/00	-
	0900	1005.6	26.0	25.1	S/01	14.0
Srinikaton	0300	1008.6	29.6	25.4	NNE/02	-
	0600	1007.5	33.0	26.7	NE/02	-
	0900	1003.9	34.6	28.1	ENE/01	-
Canning	0300	1006.8	30.8	28.1	E/03	-
	0600	Not Available	Not Available	Not Available	Not Available	Not Available
	0900	Not Available	Not Available	Not Available	Not Available	Not Available

rise of relative humidity (35% & 27%) and drop of temperature (9 & 6.4 °C) have been recorded in Dumdum airport and Alipore observatory, respectively during the passage of squall. More study is needed by real time co-ordination and integration of all the relevant data of autographic charts as well as Doppler weather radar and upper air / synoptic for nowcasting of the squalls.

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