ORIGINAL RESEARCH PAPER

Environmental Science

KEY WORDS: Nor'wester, Pentad mean, Squall, Nowcast, Meso low, Wake low, Coriolis force, Meso high.

MESO ANALYSIS AND NOWCASTING OF SEVERE LOCAL STORMS WITH SQUALL AT KOLKATA (ALIPORE) THAT OCCURRED IN 2013.

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ABSTRACT

Fujita, Johnson and others at different times studied meso high, meso low and wake low with respect to passage of thunderstorms. In the present study, meso analysis of related atmospheric processes, i.e., surface meso highs, meso lows, and wake lows, with respect to severe local thunderstorms with Squall encountered at Alipore Observatory, occurred in pre-monsoon of 2013, has been analyzed. This has been done to improve nowcasting with respect to severe local storms. A suitable computer programme associated with departure from pentad mean may give a continuous pictorial record towards more accurate identification of meso lows ahead of the system.

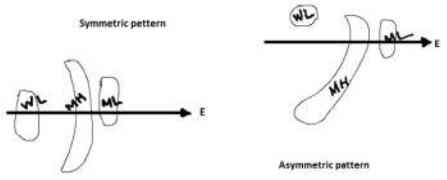
INTRODUCTION:- In late 1940s Fujita carried out detailéd analysis of surface weather system. Accordingly, he developed insights into atmospheric processes in respect of passages of thunderstorms in early 1950s. In the middle of 2000, Johnson elaborately studied surface meso highs, meso lows and wake lows in this aspect. Nor'wester thunderstorms are regular features during pre-monsoon period in the eastern India. In the present study, meso analysis of related atmospheric process i.e. surface meso highs, meso lows and wake lows in respect of the severe local thunder storms (with squall) encountered at Alipore observatory that occurred in pre-monsoon of 2013, has been exercised. Aim of the present study is to improve nowcasting in respect of severe local storms.

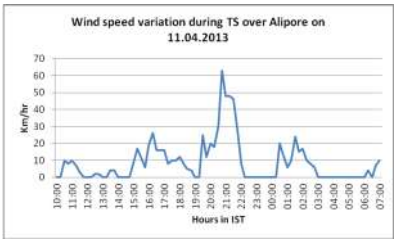
SOURCE OF DATA:- Meteorological data has been collected from the Regional Meteorological Centre, Kolkata (India Meteorological Department), as well as from the free access website (www.imd.gov.in).

Methodology:- Pressure, departure of pressure from pentad mean (preceeding 5 days) and wind speed have been plotted against time at 15 minutes interval around the time of occurrence of thunderstorm (with squall). Amounts of Rainfall that occurred at Alipore and neighbourhood (in meso scale) have been taken into consideration in connection with passage of thunderstorm and squall. Relevant Radar pictures have also been considered in this connection.

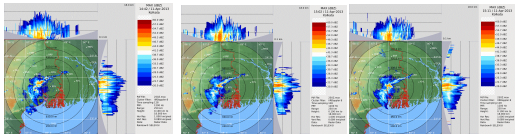
RESULTS OF THE STUDY:- It is found that the meso scale Convective Systems (MCSs) exhibit symmetric structure so far as Alipore observatory is concerned. Asymmetry is caused due to action of Coriolis force. Coriolis force depends on latitude and wind speed. Latitude of Alipore (22°32´N) is such that Coriolis force is insignificant whatsoever may be the wind speed, to create any asymmetry.

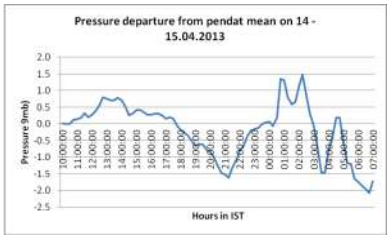
CONCLUSION:- Rainfall values and supporting Radar pictures are consistent with the symmetric nature of MCSs. Pinpoint nowcast may be issued with the aid of identification of meso lows etc. and nowcast may be issued for more specified area, with expected time of occurrence over the observing station. However, observation for every minute will give better results to identify meso low and wake low. Identification of wake low will be an aid in respect of post scenario precipitation and clearing of sky. A suitable computer programme in respect of pressure departure from pentad mean may give a continuous pictorial record towards more accurate identification of meso low ahead of the system, etc.

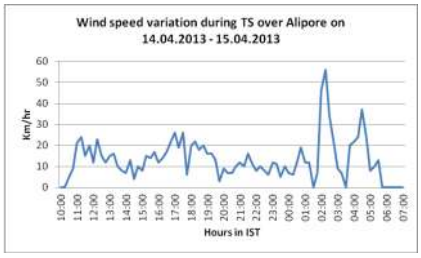




12.04.2013
Rainfall:
Alipore – 000.3mm
(2050 – 2200, 2201 – 2210 IST) (Thunder 2050 -2200 IST)
Dum Dum – 017.4mm
Saltlake (PAC) – 002.6mm
Diamond Harbour – 000.5mm
Thunder Squall: Alipore: 2055 – 2056 hrs IST on 11.04.2013/ dir- NWly/ speed 63Kmph.

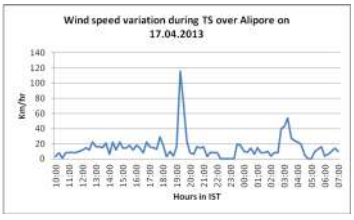


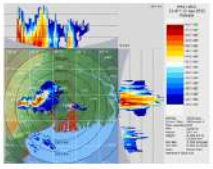


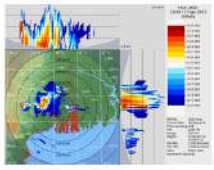


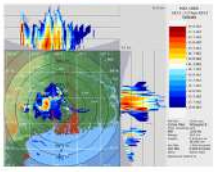
15.04.2013
Rainfall:
Alipore – Trace.
(Dz 0215 – 0345 IST) (Lightning 0200 – 0400 IST)
Canning – Trace.
Diamond Harbour – 000.8mm

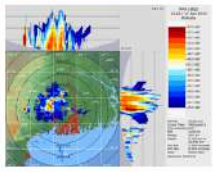
Barrackpur – Trace.
Thunder Squall: Alipore: 0215 – 0216 hrs IST on 15.04.2013/ dir- NNWly/ speed 56Kmph.











18.04.2013

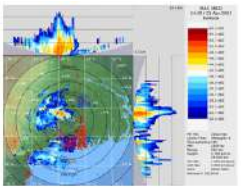
Rainfall:
Alipore – 010.8mm (1900 – 2100, 0300 – 0600 IST) (Thunder 1835 – 2200, 0300 – 0630 IST)
Canning – 013.6mm
Dum Dum – 021.7mm
Salt Lake – 024.0mm
Diamond Harbour – 039.4mm
Barrackpur – 005.8mm
Uluberia – 008.4mm

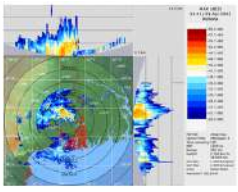
Thunder Squall:

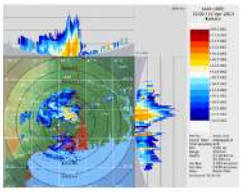
Alipore: 1915 – 1920 hrs IST on 17.04.2013/ dir- NWly/ speed 116Kmph.

Dum Dum: 1939 – 1940 hrs IST on 17.04.2013/ dir- Sly/ speed 68Kmph.

Diamond Harbour: 1945 – 1946 hrs IST on 17.04.2013/ dir- NWly/ speed 116Kmph

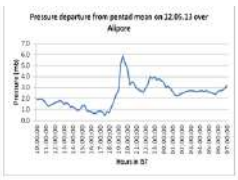


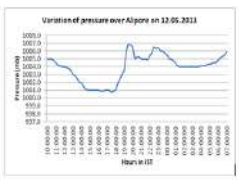


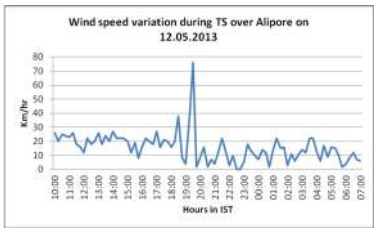


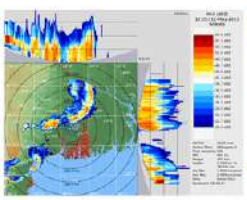
22.04.2013

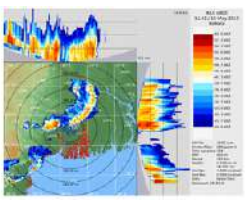
Rainfall:
Alipore – 000.1mm
Canning – 001.0mm
DumDum – 007.8mm
Diamond Harbour – 000.5mm
Barrackpur – 056.0mm
Thunder Squall:
Alipore: 2026 – 2027 hrs IST on 21.04.2013/ dir- NWly/ speed 56Kmph.

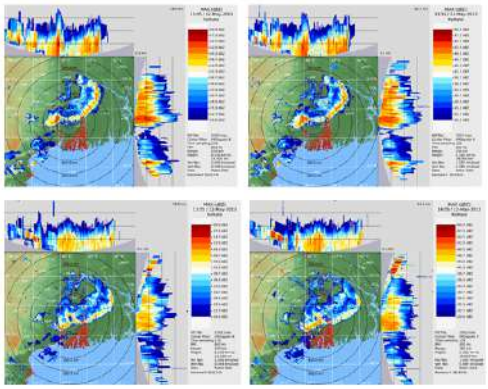






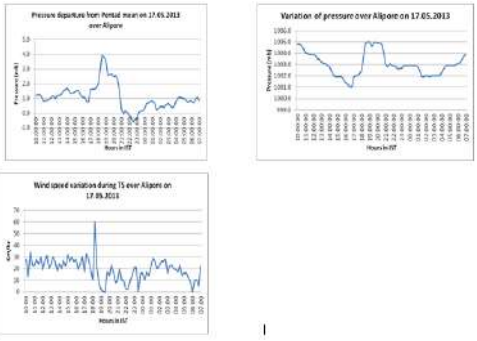






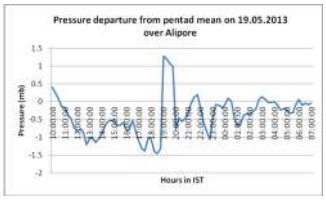
13.05.2013
Rainfall:
Alipore – 046.9mm (1900 – 2115IST) (Thunder 1845 – 2145IST)
Salt Lake – 071.8mm
DumDum – 033.8mm
Canning – 025.2mm
(1945 – 2030IST)
Diamond Harbour – 031.6mm
1935 – 2120IST) (1925 – 1935IST)
Barrackpur – 003.0mm
Thunder Squall:

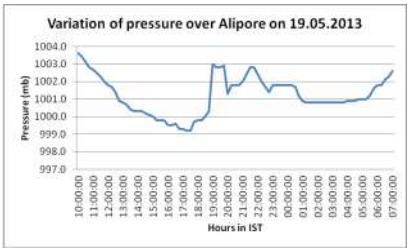
Alipore: 1930 – 1931 hrs IST on 12.05.2013/ dir- Nly/ speed 76Kmph.
Sriniketan: 1615 – 1616 hrs IST on 12.05.2013/ dir – Wly/ speed 44Kmph.

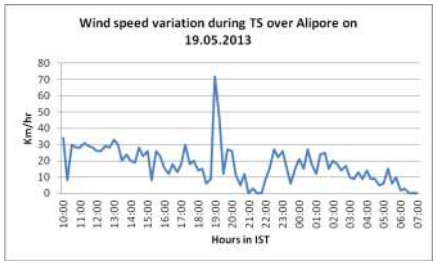


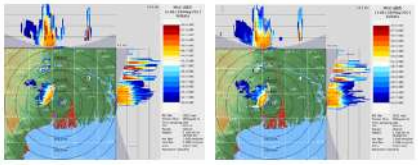
18.05.2013
Rainfall:
Alipore – 002.3mm
(1825 – 1840, 1850 – 1945, 1945 – 2115IST) (Thunder 1850 – 1945IST)
Canning – 009.2mm
DumDum – 008.0mm
Salt Lake – 012.8mm
Diamond Harbour – 016.2mm
(1834 – 2028IST) (Thunder 1920 – 2028IST)
Barrackpur – 007.6mm

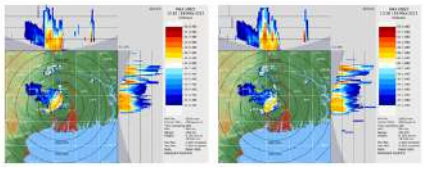
Thunder Squall:
DumDum: 1815 – 1816 hrs IST on 17.05.2013/ dir- Wly/ speed 56Kmph.
Alipore: 1818 – 1821 hrs IST on 17.05.2013/ dir- NWly/ speed 60Kmph.



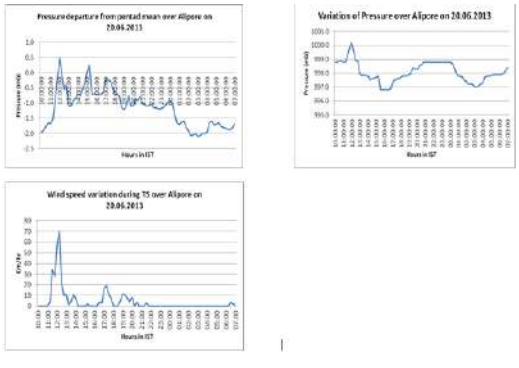




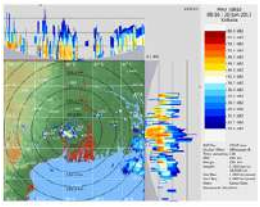
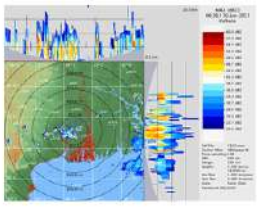
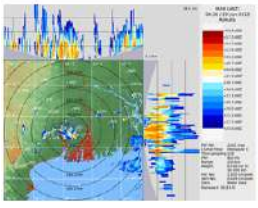
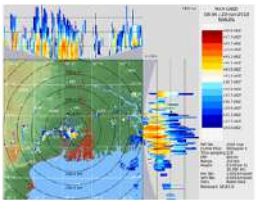




20.05.2013
Rainfall:
Alipore – 016.4mm
(1900 – 2115IST) (1930 – 2105IST)
Canning – 011.6mm
DumDum – 029.0mm
Salt Lake – 013.4mm
Diamond Harbour – 004.8mm
(1930 – 2000IST) (Thunder 1900 – 2000IST)
Barrackpur – 018.0mm
Thunder Squall:
DumDum: 1914 – 1915 hrs IST on 19.05.2013/ dir- Wly/ speed 52Kmph.
Alipore: 1900 – 1901 hrs IST on 19.05.2013/ dir- NWly/ speed 72Kmph.
Bankura: 1638 – 1640 hrs IST on 19.05.2013/ dir- SWly/ speed 65Kmph.



21.06.2013
Rainfall:
DumDum7.0 mm
Barrackpur Trace mm
Uluberia0.0 mm
Alipore110.6 mm
Diamond Harbour0.3 mm
Canning3.2 mm

$$f_c = 2\,\Omega \cdot \sin(\Phi),$$

where: $2\Omega = 1.458 \times 10^{-4} s^{-1}$

$$\frac{F_{y\,CF}}{m} = -f_c \cdot U$$

Date	Force (meter / sec²)	Wind Speed (kmph)	Wind speed (m/sec)
11.04.13	-0.001309	63	17.5
15.04.13	-0.001160	56	15.5
17.04.13	-0.002409	116	32.2
21.04.13	-0.001160	56	15.5
12.05.13	-0.001579	36	21.11
17.05.13	-0.001242	60	16.6
19.05.13	-0.001496	72	20.0
20.06.13	-0.001451	70	19.4

Table - II

Date	Meso low (hpa)	Meso high (hpa)	Wake low (hpa)	Time gap between meso low & meso high (min)	Mean time gap between meso low & meso high with range (min)	Time gap between meso high & wake low (min)	Mean time gap between meso high & wake low with range (min)
11/04	1005.0	1009.9	1004.5	105	Mean – 101 Range - 90	240	Mean – 169 Range - 215
15/04	1005.7	1006.7	1003.7	45		75	
17/04	1000.2	1008.0	1002.7	105		195	
21/04	1007.4	1011.4	1008.0	135		285	
12/05	1000.7	1006.9	1004.9	120		135	
17/05	1001.0	1005.0	1002.6	135		225	
19/05	999.2	1003.0	1001.3	105		60	
20/06	998.8	1000.2	997.5	60		135	

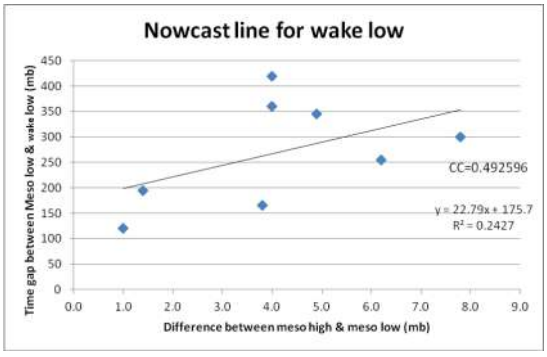
Table - III

Date	Difference between meso high & meso low (hpa)	Time gap between Meso high & meso low (min)	Difference between meso high & wake low (hpa)	Time gap between Meso high & wake low (min)
11/04	4.9	105	5.4	240
15/04	1.0	45	3.0	75
17/04	7.8	105	5.3	195

21/04	4.0	135	3.4	285
12/05	6.2	120	2.0	135
17/05	4.0	135	2.4	225
19/05	3.8	105	1.7	60
20/06	1.4	60	2.7	135

Table - IV

Date	Difference between meso high & meso low (hpa)	Time gap between Meso low & wake low (min)
11/04	4.9	345
15/04	1.0	120
17/04	7.8	300
21/04	4.0	420
12/05	6.2	255
17/05	4.0	360
19/05	3.8	165
20/06	1.4	195



Additional conclusion: Difference between meso high & meso low and Time gap between meso high & meso low, difference between meso high & wake low and Time gap between meso high & wake low – both are positively correlated. The linear trend line between difference between meso high & meso low and Time gap between meso low & wake low stands for an important tool to express the expected passage of wake low i.e expected duration of the MCS.

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