

## Letter to the Editor

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### A NOTE ON POST SUNSET SEA BREEZE AND ASSOCIATED ANGEL ECHOES AT BOMBAY AIRPORT

Delay in the onset of sea breeze to the extent of after sunset is possible on rare occasions in winter. Natarajan (1964) and Rao (1955) have reported post sunset sea breeze in Madras. The delay in the onset is caused mainly by the opposing gradient flow which has a strong tendency to drive against the sea breeze.

Instances of post sunset sea breeze at Santacruz during winter season, given in Table 1, were obtained from the autographic charts for the years 1960-1965. The total number of cases with more than 30 per cent change in R. H. were only four, of which the last one which occurred on 12 January 1965 is worth noting for its well-marked change in relative humidity of the order of 50 per cent. It is significant that the maximum temperature on that date was higher by 2-3°C than the other cases.

A well-marked wave pattern of dotted echoes as shown in Fig. 1 was noticed on the radarscope of Dacca type 41 storm detection radar installed at Santacruz airport, at 2015 IST when the above

cited sharp change in humidity was taking place. On a closer examination, the echo pattern, was found to consist of two distinct rows of dotted echoes. There were super-refraction echoes also along the coast line north of Bombay.

The autographic charts (Figs. 2 and 3) show that the sea-breeze was set at 1630 and 2015 IST at Colaba and Santacruz respectively. Weather was clear and fine in the region surrounding Bombay during the above interval. There was no significant change in surface pressure and no rainfall. The hygrograph of Santacruz was defective and hence not shown. There was haze at 2015 IST and visibility reduced from 10 to 5 km at the time of the onset of sea breeze and lasted for an hour and half.

The upper winds on 12 January 1965 at Santacruz were stronger than the normal (see Table 2) showing a strong gradient flow which was responsible for the late onset of sea breeze at Santacruz and produced frontal characteristics. The frontal activity depends on the strength of the opposing gradient flow and a flow of 15-20 kt can hinder penetration of the sea breeze inland.

Late onset of sea breeze is always possible, but post sunset sea breeze occurs very rarely,

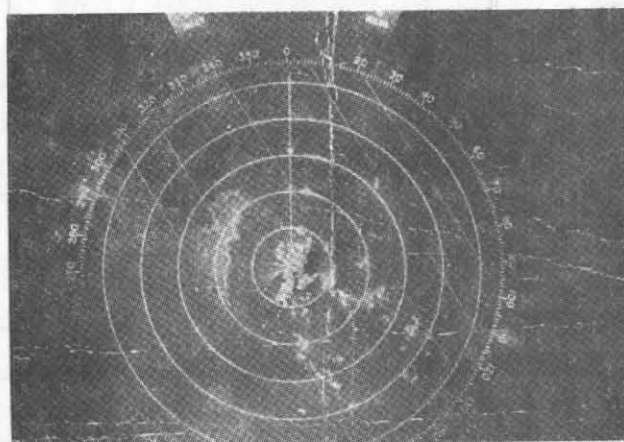


Fig. 1. Radarscope photograph of wavy-layer type angel echoes

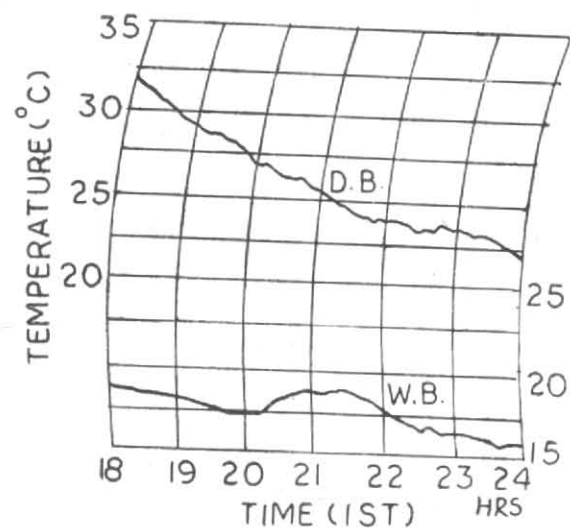
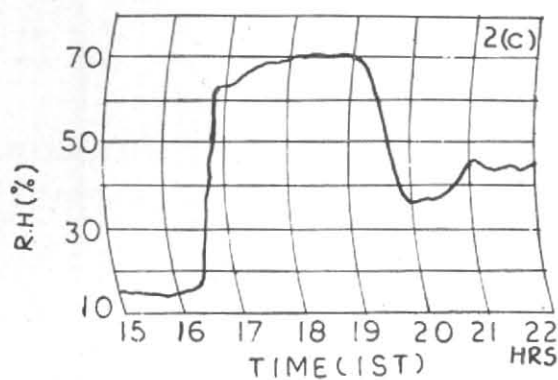
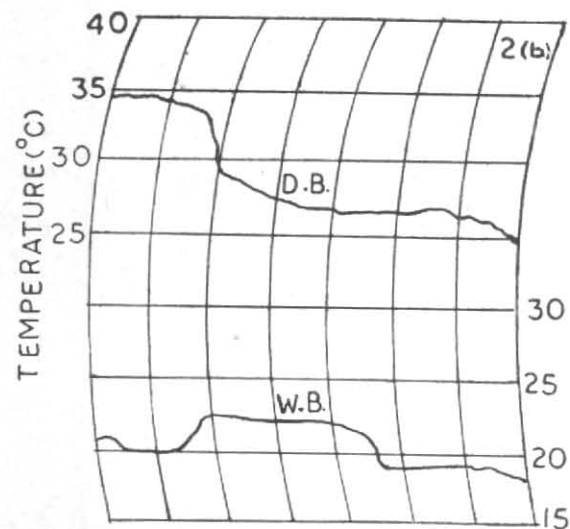
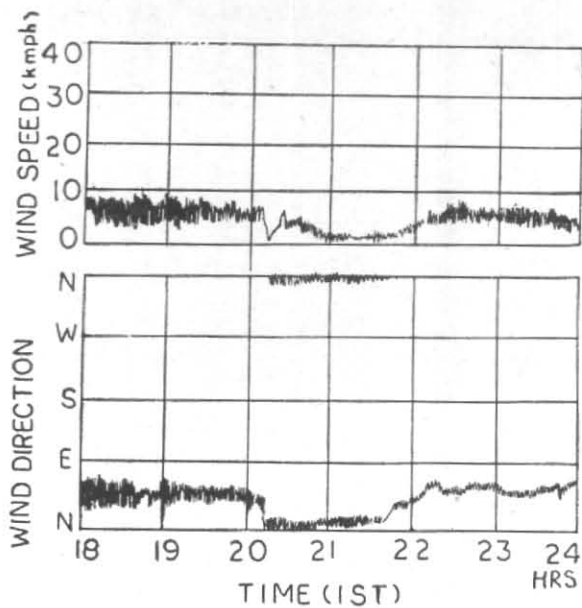
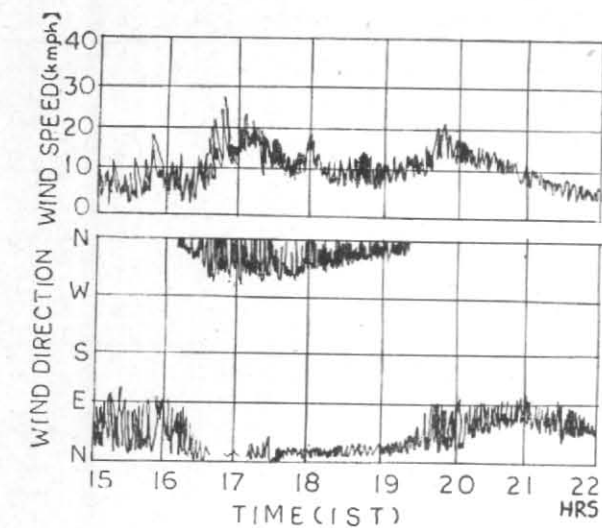


Fig. 2. Autographic charts of Colaba on 12 January 1965

Fig. 3. Autographic charts of Santaacruz on 12 January 1965

TABLE 1

Instances of post sunset sea breeze at Santacruz during winter seasons for the year 1960-1965

Date	Time (IST)	R. H. values (%)				Max. temp. (°C)
		Before	During sea breeze	After	Max. change	
23 Jan 1963	1830	29	66	55	37	32
6 Feb 1963	1910	39	70	45	31	33
4 Jan 1964	2230	48	78	48	30	32
12 Jan 1965	2015	15	63	45	48	35

Note — No instances observed during 1960-62

TABLE 2

Normal upper winds (degrees/knot) during January and the observed winds on 12 January 1965 at Santacruz

Height (km)	Normal wind			Observed wind				
	00Z	12Z	D	00Z	06Z	12Z	18Z	D
0.3	038/7.0 (4.5)	326/10.3 (-5.9)	-10.4	060/18 (15.6)	070/13 (12.2)	040/11 (7.1)	080/13 (12.8)	8.5
0.6	044/5.0 (3.5)	320/4.9 (-3.2)	-6.7	070/17 (16.0)	070/19 (17.9)	050/10 (7.7)	080/16 (15.8)	8.3
0.9	047/1.5 (1.1)	302/1.6 (-1.2)	-2.3	060/19 (16.5)	070/22 (20.7)	030/13 (11.3)	060/18 (17.7)	5.2
1.5	204/4.2 (-1.7)	180/3.9 (0.0)	-1.7	020/11 (3.8)	080/22 (21.7)	069/19 (16.5)	070/16 (15.0)	-12.7
2.1	196/8.6 (-2.2)	185/5.7 (-0.5)	-1.7	010/09 (1.6)	040/13 (8.4)	070/19 (17.9)	070/22 (20.7)	-16.5
3.0	240/9.6 (-8.2)	242/5.8 (-5.2)	-3.0	010/17 (3.0)	040/24 (15.4)	070/19 (17.9)	070/17 (16.0)	-14.9

Note — 1. Figures in brackets indicate E-ly component (kt) of the wind

2. D—Difference of E-ly component of 00 and 12 GMT winds

3. 06 and 18 GMT winds are from Pilot Balloon whereas 00 and 12 GMT are Rawin winds

that too in the winter season mainly in the month of January on comparatively warmer days exhibiting dotted angel echoes on the radarscope and reduction in visibility due to haze. The

exact mechanism by which this angel echoes appear is yet to be established by actual observations over the region when and where they are observed.

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## REFERENCES

Natarajan, K. K.  
Rao, D. V.

1964 *Indian J. Met. Geophys.* 15, 3, p. 431.  
1955 *Ibid.*, 6, p. 233