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DEVELOPMENT, DECAY AND DURATION OF WINTER LAND BREEZE OVER CHENNAI

1. Chennai (Madras) city located at longitude 80.2° E, Latitude 13.0°N in the southeastern coast of India has two low level wind regimes, *viz.* the westerly regime during (mid) April to (mid) October and the easterly regime during (mid) October to (mid) April. During the westerly regime, sea breeze that sets in during forenoon or afternoon and blows upto night is an important meso scale event over Chennai. During the easterly regime land breeze (LB) that develops during late night is another significant weather event albeit in a less spectacular fashion compared to sea breeze. The LB is more prominent over Chennai after the retreat of northeast monsoon, when the speed of prevalent easterlies shows a slight decrease. In this note, we present the results of a study on the development and decay of LB over Chennai during the period January-March.

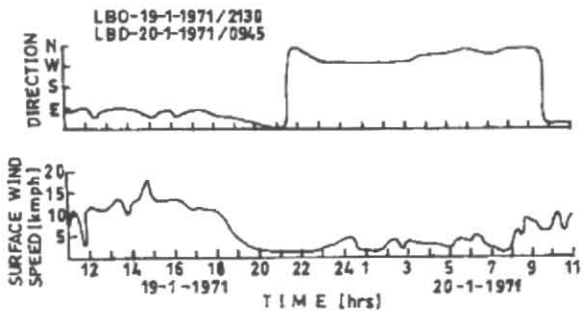

Fig. 1. Land breeze development and decay (LBO and LBD) over Chennai A.P. during 19-20 January 1971 as seen in the anemogram

2. During January-March the sea surface temperature (SST) over the Bay of Bengal off Chennai varies in the range of 27-28° C with negligible diurnal variation. The land surface temperature (LST) over Chennai has a normal minimum of 20-23° C with increasing LST from January to March. As such an SST-LST gradient of nearly 6° C gets developed during night

TABLE 1

Winter land breeze parameters for Chennai (Normal based on data of 1971-80)

Period	Jan	Feb	Mar	JFM	SD (JFM) (min)
Time of :					
Development	0035	0135	0150	0115	190
Decay	0950	0955	0930	0945	85
Maximum intensity	0525	0555	0540	0540	130
Duration	0915	0820	0735	0830	215
Maximum LB wind speed (kmph)	10	10	9	9	
No. of observation (days)	284	258	189	732	
Percentage of days of LB determination	92	92	61	81	
Normal wind direction :					
Before LB developmant	NNE	ESE	SE	E	
Regular LB flow	NW	WNW	W	WNW	
LB when at its maximum intensity	WNW	W	W	WNW	
LB when direction is closet to W	WNW	W	W	WNW	

(JFM - Jan, Feb and Mar, SD - Standard deviation, LB- Land breeze)

resulting in a solenoidal circulation from land to sea, which if stronger than the prevalent easterlies results into LB (Holton, 1979 & Asnani, 1993).

3. The study has been based on anemograms of Chennai A.P. for the period 1971-80 for 1 January-31 March. A typical winter anemogram of 19 January 1971 is presented in Fig. 1. The winds representing the larger low level flow pattern are easterlies, which prevail during daytime with speeds upto 15 kmph. The winds decrease in strength after 1800 hr and back to northerlies and then to northwesterlies at about 2130 hr in association with the development of land breeze. The westerly land breeze blows during 2300-0300 hr with a speed of 2-5 kmph where after it veers to northwesterlies and decays at about 0945 hr as evidenced by the restoration of the easterlies thereafter.

For the present study the anemograms of all the days for the period of study were analysed and the following details extracted;

(*i*) Time of LB development

(*ii*) Prevailing wind direction before LB development

(*iii*) Direction of LB during steady LB flow

(*iv*) Maximum intensity and time of occurrence thereof – LB during steady LB flow

(*v*) Wind direction closest to westerly during steady LB flow and

(*vi*) Time of LB decay

The days when LB did not develop or could not be clearly delineated were omitted. When the prevalent winds were westerlies, the development of land to sea solenoidal circulation would not generate an LB front and so such days were also not considered.

4. The following analysis was carried out based on the values of the parameters extracted:

(*i*) Normal time of development, maximum intensity, decay and duration of LB along with standard deviation (SD) were computed for each month – January, February and March and for the entire period January to March.

(*ii*) Frequency distribution of the wind direction for the categories defined in 3 (*ii*), (*iii*) and (*iv*) above were constructed and from this , mean (normal) wind direction was computed assuming constant wind speed against each class for a given frequency distribution. The results are discussed below.

5. Table 1 presents the normal time of LB development, decay, duration and magnitude of maximum intensity. As seen the development of land breeze which occurs at about 0035 hr during January gets delayed to 0135 hr in February and to 0150 hr in March. The time of decay of LB does not show such a sharp intra-seasonal variation and occurs during 0930-1000 hr in all the three months. The duration of LB which is 9hr 15 min. decreases to 8 hr 20 min. in February and then to 7 hr 35 min. in March. During all the three months, the maximum intensity of LB is obtained at about 0530 hr with a magnitude of nearly 10 kmph. With recourse to climatic data we could observe that that the time of maximum intensity of LB *viz.* 0530 hr is approximately the time of occurrence of minimum temperature and so the time of highest SST-LST contrast. Similarly the time of LB decay, which is 0930-1000 hr, is roughly the time of disappearance/reversal of the SST-LST gradient.

The standard deviation of the above parameters did not display much inter-month variation and the figures provided in Table 1 for January-March are representative of all the individual months as well. The time of development of LB and its duration have a large SD of over 3 hr. The time of decay of LB has SD of 85 minutes which is less than half of that of LB development. The time of maximum intensity of LB has an SD of more than 2 hr.

In the Table 1 the normal wind direction (s) associated with 2 (*ii*), (*iii*) and (*v*) are also presented. The normal wind before LB development, which is by and large from NNE in January, veers to ESE in February and to SE in March. The LB, which blows from NW in January backs to WNW in February and to W in March. At the time of maximum intensity the normal direction is WNW in January and W in the other two months. The normal wind direction closest to W is WNW during January-February and W in March. For the complete season of January, February and March, the normal wind before LB development is E with LB blowing from WNW while the LB of maximum intensity and LB closest to W blows from WNW. It is also evident that the winter LB front is sharply defined during February when the normal wind prior to the occurrence of LB is 180° opposite to the regular LB flow.

The development and decay of LB could be clearly detected on 92% of the days in January – February and 61% of the days in March. During March, on 35% of the days, prevalent winds were westerlies leading to day time sea breeze development (Raj *et al.*, 1998) and no discernible LB. Thus, it is evident that during January-March LB front develops almost on every day save for the days with westerlies as the prevailing wind.

6. The summer sea breeze of Chennai that brings cooler air into the shore during the daytime is a much sought after weather event for the general public. The onset of sea breeze is marked by sharp changes in temperature, humidity and wind direction. But due to various factors the sea breeze front develops only 67% of the days in April-May and 70% of the days during June-September. The land breeze on the other hand is not associated with any sharp change in temperature or humidity but only in surface wind. Unlike sea breeze, which can extend upto 2 km, the land breeze is shallow and hardly extends upto 500 m asl. However, the winter land breeze over Chennai is much more regular in its appearance than the summer sea breeze despite the later being more prominent and spectacular.

References

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Y.E.A. RAJ
P. NAGESHWARI

Regional Meteorological Centre,
Chennai-600006, India
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