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Letters to the Editor

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STUDY OF SEA BREEZE AT MADRAS

Sea and land breezes are one of the important local circulations and occur in most tropical coastal areas.

The sea breeze is of considerable interest to general public as its onset mitigates the afternoon heat. It is also of interest for aircraft operations as the sudden changes in wind direction and temperature can affect landing and take off operations at aerodrome in coastal areas.

With a view to gather observational data on the structure of the sea breeze circulations at Madras, a pilot project was operated in April and May of 1980 and the chief results obtained by analysing this project data are presented in this brief report. A detailed paper is being published elsewhere.

2. Madras has two 1st class observatories, one at Regional Meteorological Centre at Nungambakkam which occupies a central position in the city of Madras and the other at Meenambakkam Airport which lies in the southwestern outskirts of the city. In addition to these, 2 more U.A. observatories were specially set up; one at Avadi, which is 13.75 km from the city to the west, and the other at Tiruvallore 35.0 km from the city, also to the west.

3. The Nungambakkam and Meenambakkam observatories take all 8 surface observations per day. The project observatories at Avadi and Tiruvallore were manned from 1000 to 2400 IST.

Thermographs and hygrographs were installed at Avadi and Tiruvallore. A Dynes P. T. Anemograph is available at Meenambakkam. Hourly surface observations were taken at Avadi and Tiruvallore. Meenambakkam observatory takes two RS/RW observations at 0000 GMT and 1200 GMT. It also takes pilot balloon observations at 0600 GMT and 1800 GMT. Pilot balloon ascents were taken at Avadi and Tiruvallore stations at 06, 09, 12, 15 and 18 GMT, daily during the project days.

The special observations programme was conducted for 2 periods, one in April from 11th to 30th and the other in May for the same dates in the year 1980. The data from the two regular observatories as well as the data collected from the two project stations were utilised in this study.

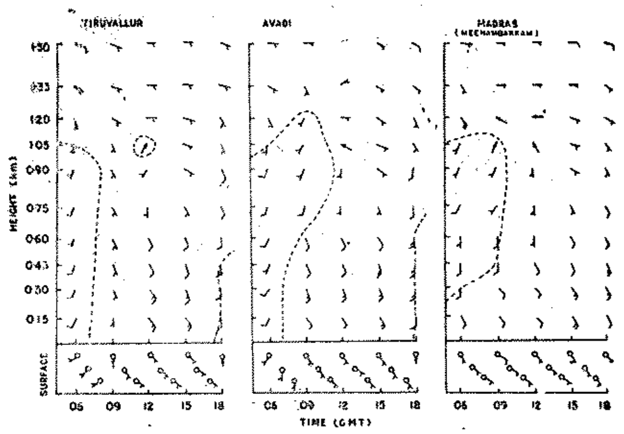

Fig. 1. Upper wind mean profile for each hour of April

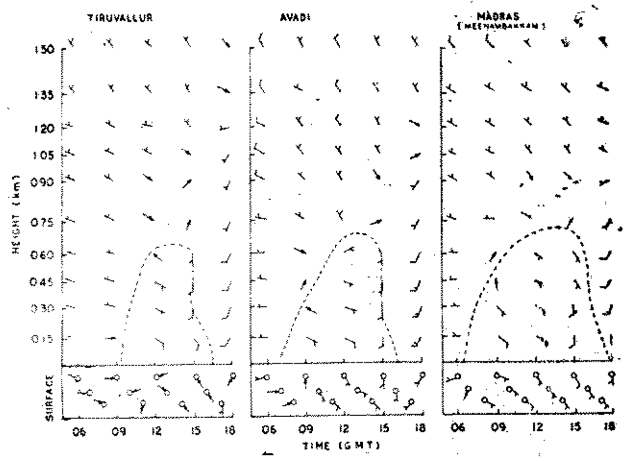

Fig. 2. Upper wind mean profile for each hour of May

4. The statistics of the time of occurrence of the sea breeze and the associated changes in temperature, humidity have been worked out. The changes in surface winds brought about by the sea breeze circulation have also been studied. In order to obtain the vertical structure of the sea breeze circulation, the data from the three upper air stations were analysed. The variations caused by the sea and land breeze circulation were studied by obtaining the anomalies of wind at different hours from the mean wind of the day. In order to get an idea of the average sea breeze circulation and its variation at different levels, the average winds at each hour for all the days in April and May separately for

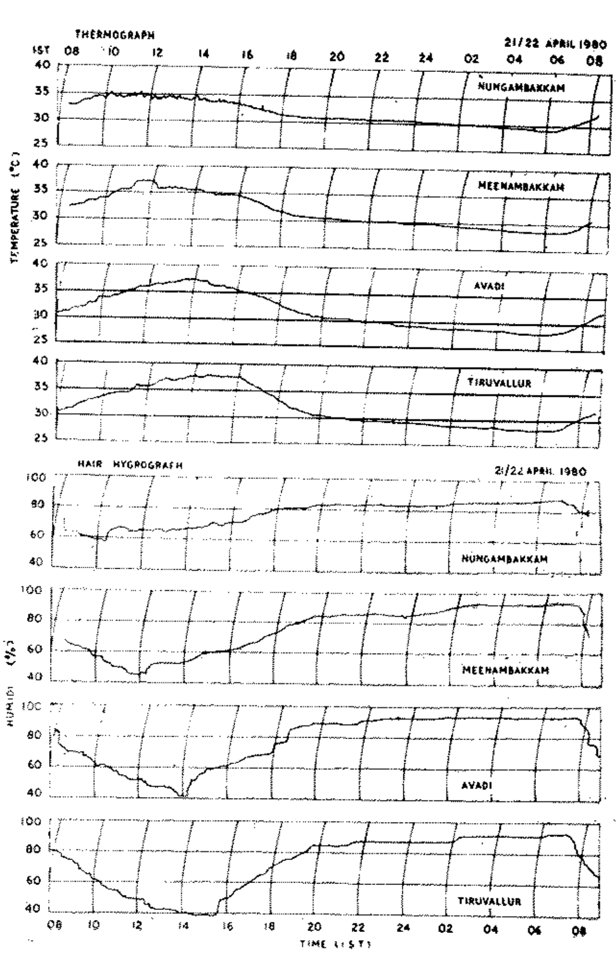

Fig. 3. Thermographs and hygrographs showing the progress of sea breeze inland

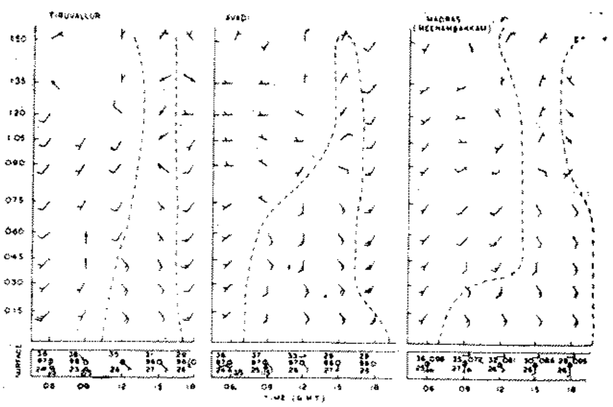

Fig. 4. Upper wind and surface observations of 21 April 1980

the 3 stations were calculated. These are shown in Figs. 1 and 2.

5. The main conclusions obtained from the above studies of sea breeze at Madras are :

(*i*) The prevailing winds which are easterly in April help the onset of the sea breeze while they being westerly in May oppose it. So, the sea breeze sets in earlier in April than in May.

(*ii*) The mean speed of propagation of the sea breeze front from sea to inland works out to be 4.5 km/hour in April and 6.5 km/hour in May.

(*iii*) The case studies of individual days indicate that the speed of the advance of the sea breeze cell is usually small in initial stages, but later increases. For example, on 21 April 1980 the sea breeze front advanced at the rate of 1.7 km/hour from Nungambakkam to Meenambakkam and at 3.8 km/hour from Meenambakkam to Avadi and then accelerated suddenly to move at the rate of 14 km/hour from Avadi to Tiruvallore (Fig. 3).

(*iv*) The temperature drop immediately following the onset of the sea breeze is usually small, being less than 1.5 deg. C in almost all cases in the month of April and less than 2 deg. C in 85% of the cases in month of May. Sometime, they can be as small as 0.2 deg. C. Though the temperature drop at the onset of sea breeze is not so marked, the heat mitigating effect of the same is considerable in view of the fact that it prevents further rise of temperature for that day.

(*v*) The rise in relative humidity at the onset is only 3 to 10% in April while it is of the order of 30% in May.

(*vi*) It is seen from the project data that the winds that come as sea breeze at Madras are due to a local circulation of the prevailing continental air which moves outwards to sea at upper levels and returns as sea breeze after picking up some moisture from the underlying sea surface as the humidity in this current is also low. It is also noticed that there is a horizontal expansion of sea breeze cell during afternoon period, which results in a longer sea travel of the air and consequently (slight) increase in the moisture with time after the onset (Fig. 4).

(*vii*) In April and May as the sea breeze sets in, the surface wind generally backs, rapidly to southeast, while remaining light and picking up speed gradually with time.

(*viii*) Generally, in the month of May, the sea breeze sets, in later, lives for shorter time and easterly component of the sea breeze cell extends to lesser heights, than in April (Fig. 2).

(*ix*) While the easterly component of the flow terminates at about 15 GMT in April, it does so after 18 GMT in May.

(*x*) The upper air profiles indicate, that the component of sea breeze cell extends upto 1.05 km above sea level in April and to less than 0.5 km in May.

(*xi*) The diurnal components of the wind speed are small, the effect extends to 1.5 km with a definite lag from lower level to upper levels.

N. S. BHASKARA RAO
S. D. WILLIAMS
MARY CHANDY
USHA DEVI

Regional Meteorological Centre,
Madras
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