551.58

THUNDERSTORM ACTIVITY AND SEA SURFACE TEMPERATURE OVER THE ISLAND STATIONS AND ALONG THE EAST AND WEST COAST OF INDIA

1. The influence of subtle changes of sea surface temperature (SST) on the atmosphere was recognized about thirty years ago. Thereafter in many subsequent studies of the SST, related to the generation and the maintenance of the convective cloudiness and precipitation in the tropics were shown that the most important factor governing the cloudiness was the variability of the SST. Since thunderstorm is an important weather phenomenon to understand many issues related to weather, the authors have made an attempt to study whether SST have any influence on thunderstorm development. Thus the central focus of the present study is the issue of the sensitivity of SST to the occurrence of thunderstorm>over the two island stations each in Bay of Bengal and Arabian sea [Port Blair (PBL) and Minicoy (MNC)] and along the east and west coast of Indian Peninsula.

2. Monthly mean number af thunderstorm days for a period of 11 year from 1970-1980 forms the data sets for the present study. The number of stations considered in this study is shown in Fig. 1. Monthly mean value of SST at the points comprising the above mentioned stations are carefully extracted from the Global Oceanic Surface Temperature Atlas which provides global fields of width 5° latitude × 5° longitude resolution of monthly (1951-1980) SST averages and are used in the present study.

3. Monthly mean variation of SST at PBL and MNC and along the east and west coast of India are shown in Figs. 2(a-d). The vertical bars indicates the standard deviations in the monthly means. Some points of similarity in Figs. 2(a-d) are (*i*) all curves exhibit semi-annual oscillation, (*ii*) there is concurrence in the month of two maxima (May and October), (*iii*) the amplitude of first maximum (May) is higher than the second maximum (October) and (*iv*) large fluctuations in SST occurred in December, January and February months. These observations are in good agreement with the earlier studies made by Ray (1991). The point of dissimilarity in these curves is the annual average SST at PBL is higher (28.2° C) than at MNC (27.7° C) but the annual range of SST variation is observed to be in the opposite sense. Comparison of these two curves shows that SST's at PBL are warmer and steady than at MNC in the annual period. Figs. 2(c&d) shows the SST along the east and west coast. The comparison between these two curves shows that SST along the west coast are ~ 0.5° C higher than the east coast during March-May and August-October months. During rest of the period they are much alike. Although the magnitude of these difference in the SST appears to be modest it is of much significance in relation to the development of weather phenomenon such as thunderstorms.

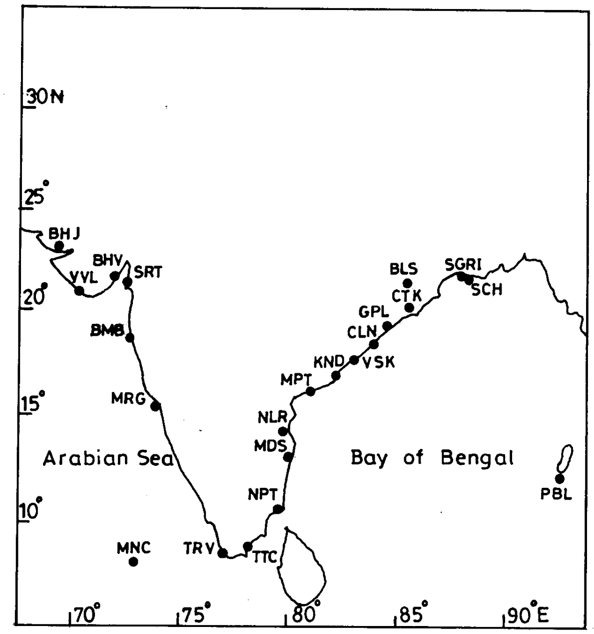
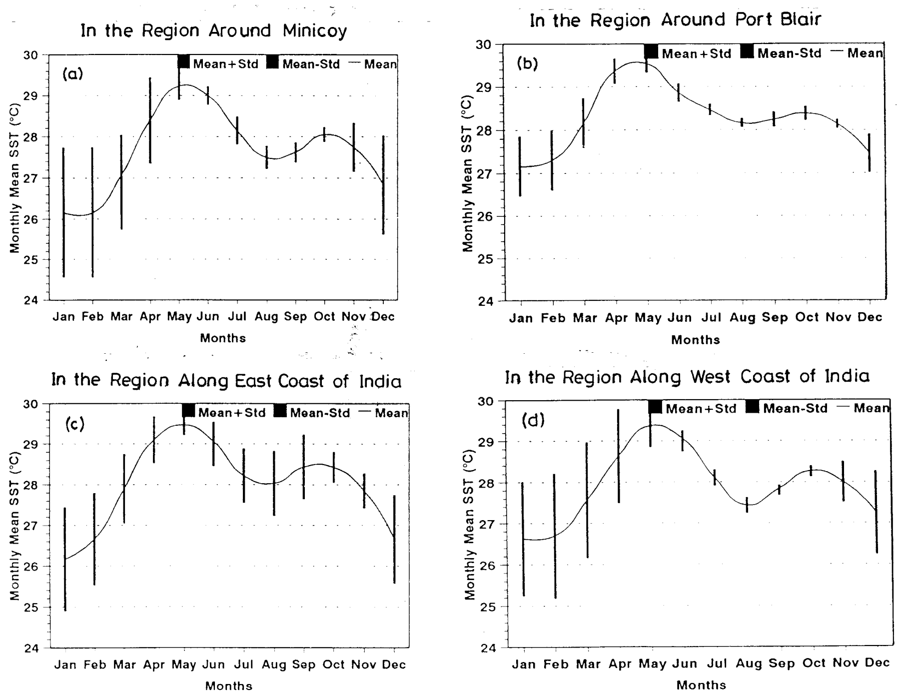


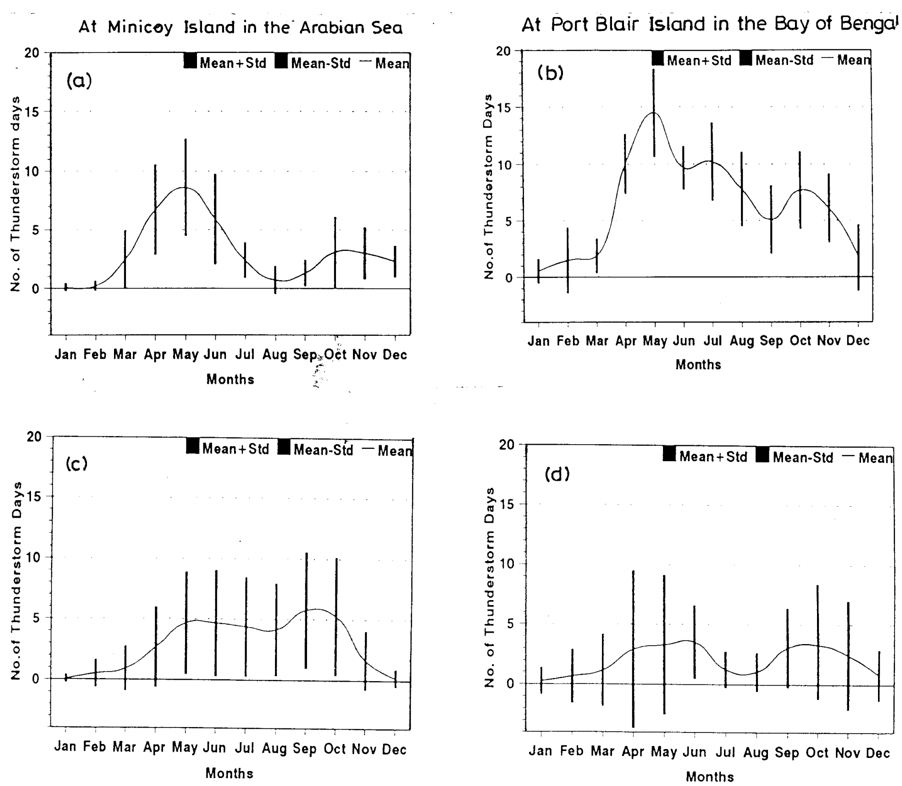
Fig. 1. Map of India showing locations of stations used in this study

4. Monthly mean number of thunderstorms days at these 4 locations are shown in Figs. 3 (a-d). The curve at PBL and MNC shows similar semi-annual oscillation but there also appears a feeble third maximum at PBL in the month of July which is the characteristic feature of the PBL curve. The comparison of these two curves shows that during the complete annual period the PBL curve well overlays the MNC curve. The lower most two curves of Fig. 3 shows the thunderstorm activity along the east and west coast. From these curves it is observed that the shape of both the curves are typically flat, but the west coast curve remains on the lower side of the east coast curve.

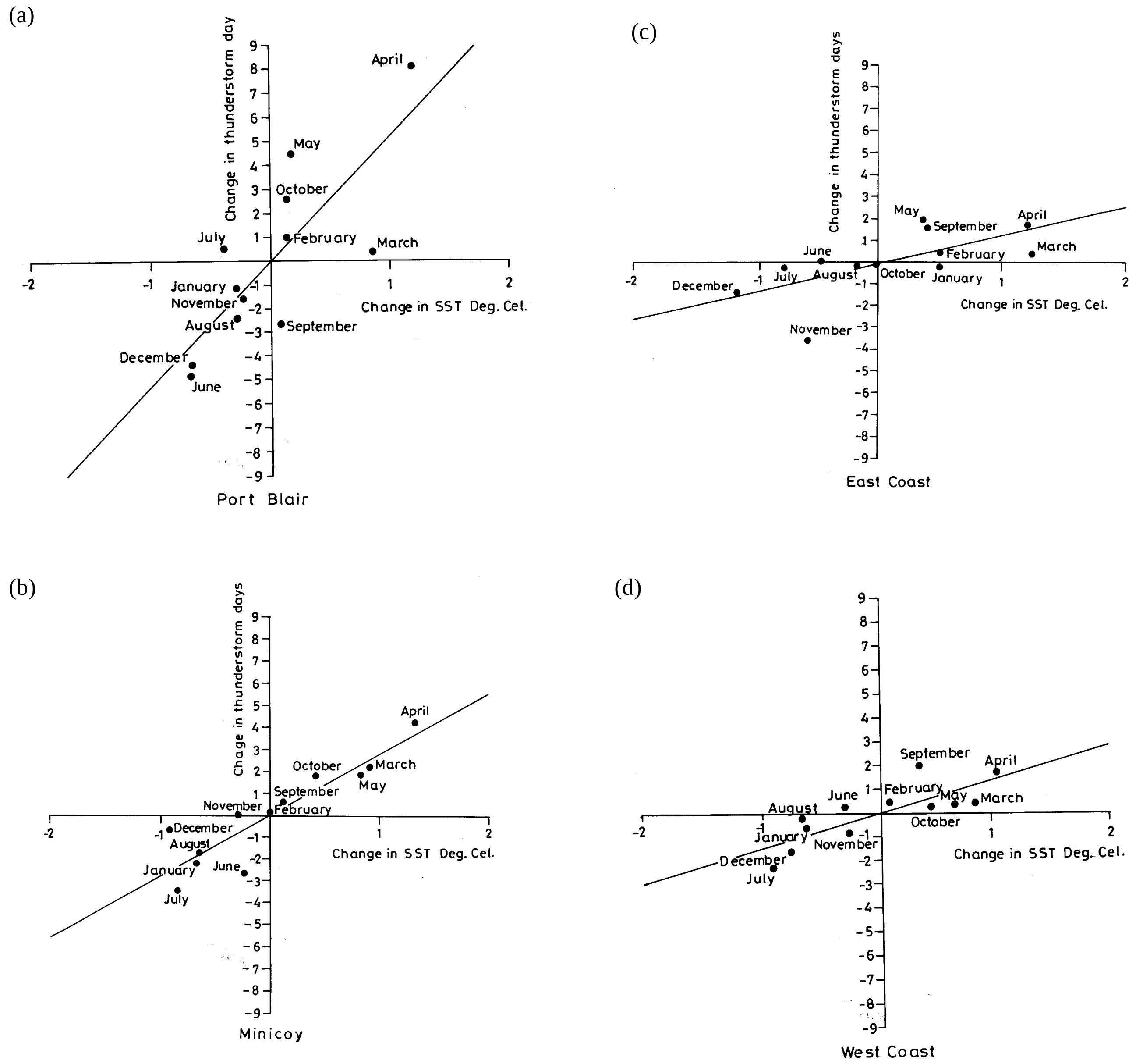
In short, comparison between Figs. 2(a-d) and Figs. 3(a-d) summarizes that all the curves show similar semi-annual oscillation and their trends are mutually comparable. The correlation coefficient between monthly SST and thunderstorm days at each location was worked out and it was significant at less than 0.1% level of significance.



Figs. 2(a-d). Monthly mean SST (1951-1980) at (a) Minicoy, (b) PortBlair, (c) Along East coast of Indian Peninsula and (d) Along West coast of Indian Peninsula



Figs. 3(a-d). Same as Fig. 2 but for monthly mean number of thunderstorm days during 1970-1980



Figs. 4(a-d). Monthly change in the SST *versus* change in the number of thunderstorm days at the four locations (a,b,c,d)

5. *Thunderstorm occurrence and monthly changes in SST* – In order to examine the monthly response of SST and occurrence of thunderstorm, month to month changes in SST and number of thunderstorm days at each location were worked out and these are plotted in the X- Y coordinate system and shown in Figs. 4 (a-d). It is seen from these figures that at each location most of the points lie in the Ist and IIIrd quadrant of the X-Y coordinate system and this point is of vital significance as it suggests that more or fewer occurrence of thunderstorm days is dependent on the warming and cooling of the SST and their mutual dependence bears a linear relationship. This result is analogous to our earlier result (Manohar *et al.*, 1999). A straight line of best fit is drawn through these data points and it is seen that at each location the straight line has positive but different slope. At PBL, the value of slope is observed to be highest (~5 thunderstorm per 1° C change in SST).

Also, the points in these figures are labelled with their months which gives the systematic picture of their monthly variation during their annual period. It is noted that at each location, the warming of SST begins from February and peak differential heating is observed in the month of April. Similarly, second cycle of peak heating starts in the months of September/ October. These two results indicate that the peak periods of warming of the SST in the month of April and September/ October in the two sea regions precede the onset of southwest and northeast monsoon seasons respectively by 30-40 days.

The observed similarity in the prime period of the heating of the SST before the onset of monsoon on both occasions is a consistent and important meteorological result. We thus note that the degree and period of warming of the SST and the activity of occurrence of the thunderstorm is closely associated with each other which in turn is also linked with the seasonal establishment of monsoon.

The authors are thankful to the Director General of Meteorology, IMD, New Delhi for supplying the data used in this study. They are also thankful to the Director, Indian Institute of Tropical Meteorology, Pune, for his constant support and encouragement during the research activity.

References

Global Oceanic Surface Temperature Atlas (GOSTA), produced jointly by Meteorological Office, Bracknell, (U.K.) and Department of Earth Atmospheric and Planetary Sciences, M.I.T., (U.S.A,)

Manohar, G.K., Kandalgaonkar, S.S. and Tinmaker, M.I.R., 1999, "Thunderstorm activity over Indian and the Indian southwest monsoon", *J. Geophys. Res*., **104**, 4162-4186.

Ray, T.K., 1991, "Sea surface temperature and southwest monsoon over India", *Mausam*, **42**, 1, 71-76.

S. S. KANDALGAONKAR
M. I. R. TINMAKER
M. K. KULKARNI
ASHA NATH

Indian Institute of Tropical Meteorology, Pune, India
24 April 2001, Modified 15 October 2001