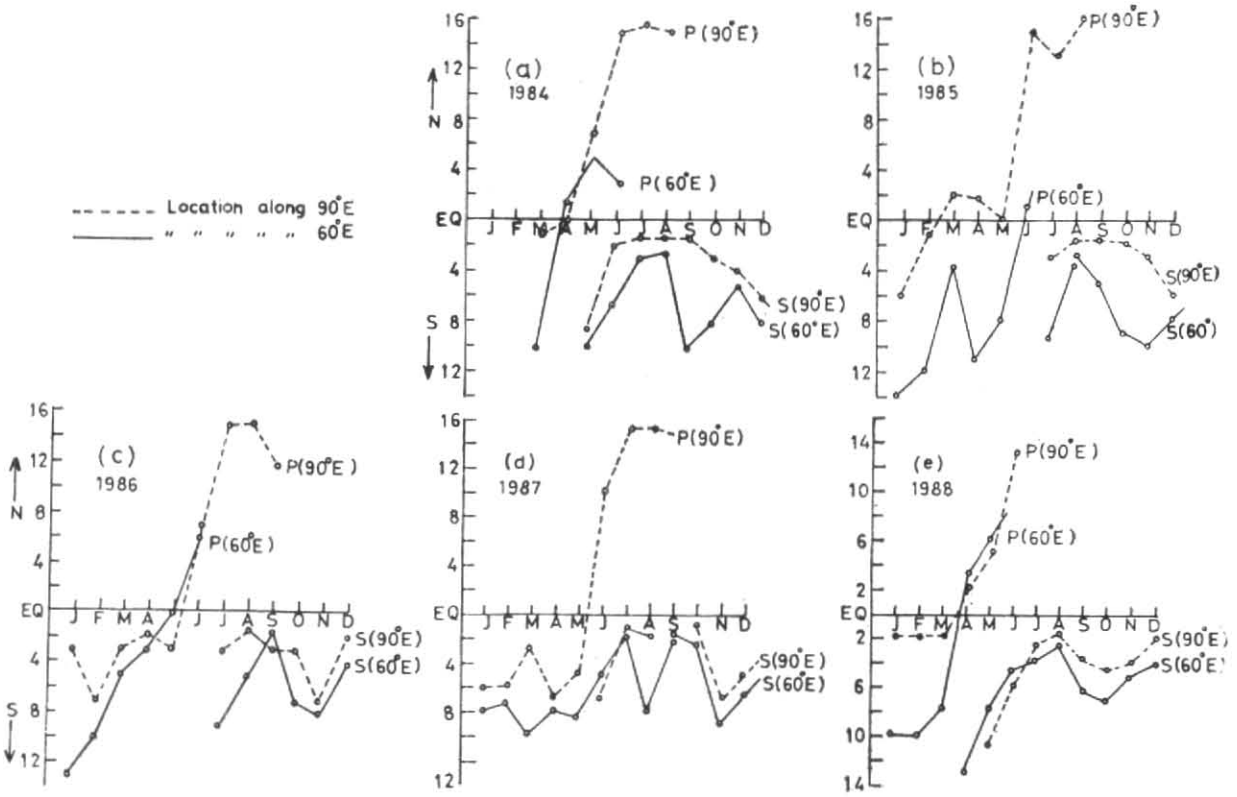
551.513.5:551.507.362.2:551.553.21 (267)

STUDY OF DOUBLE ITCZ OVER INDIAN OCEAN AS REVEALED BY INSAT CLOUD IMAGERY AND ITS ROLE FOR SOUTHWEST MONSOON

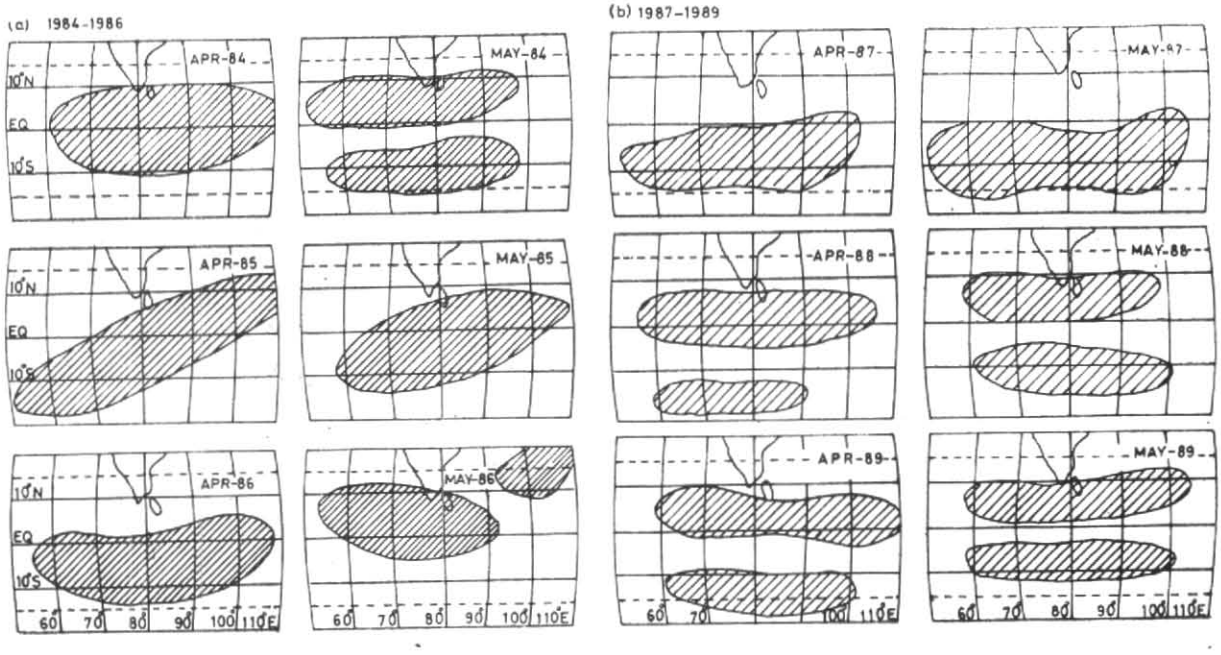
1. Indian economy depends on the behaviour of summer monsoon. The most striking aspect of monsoon is the Inter-Tropical Convergence Zone (ITCZ). This has been studied and defined by number of workers. Holton (1971) defined ITCZ as a narrow E/W band of vigorous cumulonimbus convection and area of heavy precipitation which forms alongwith equatorial boundary of trade wind region. Sikka & Gadgil (1980) and Gadgil (1988) reviewed the monsoon research and concluded that the onset of monsoon over peninsula and central India occur with the northward movement of the rainfall belt which is associated with the northward propagation of the Tropical Convergence Zone (TCZ) which moves onto the continent in response to the radiative heat source generated there in the summer, from the equatorial Indian Ocean.

In this study INSAT cloud pictures for the period 1984-89 are analysed to ascertain whether double ITCZ exist over Indian Ocean and if so how it influences the behaviour of southwest monsoon. INSAT cloud imageries received at Meteorological Data Utilisation Centre (MDUC), New Delhi between March 1984 to December 1988 and April-May 1989 have been made use of. In this work 0600 UTC full disk visible cloud pictures having resolution 2.75 km at sub-satellite point were used to extract the cloud cover extent over Indian Ocean and around Indian sub-continent between 40° E and 110° E longitudes and 20° N and 20° S latitudes to study the development, formation and movement of intertropical convergence zone (ITCZ) and its role in the Indian monsoon.

2. *Methodology* — Based on daily cloud data, weekly composite cloud extent was worked out as daily analysis could not lead to any conclusion. Weekly analysis was further extended to find out the most averaged cloud extent locations for the month. The analysis was carried out on weekly basis for all the weeks between March 1984-December 1988 and April-May 1989 and



Figs. 1 (a-e). ITCZ location during : (a) 1984, (b) 1985, (c) 1986, (d) 1987, and (e) 1988



Figs. 2(a & b). Monthly averaged cloud extent during April-May : (a) 1984-1986, and (b) 1987-1989

averaged monthly cloud extent for all the months for each year were prepared. Likewise composite monthly cloud extent for whole period under study was also worked out to find out the averaged cloud extent on monthly basis during the period under study. From the averaged cloud extent composite, the preferred cloud axis was worked out which corresponds to large convective cloud clusters.

3. *Analysis* — Fig. 1 shows the graphical representation of ITCZ movement with time at 60° E (Arabian branch) and 90°E (Bay branch) location. These graphs have been prepared separately for all these years under study to see the behaviour of ITCZ which is indirectly inferred as the axis (averaged central location) of convective cloud clusters having E/W orientation.

Fig. 3(a). 0600 UTC/26 May 1987 INSAT-1B visible

Fig. 3(b) 0600 UTC/26 May 1988 INSAT-1B visible

The primary ITCZ crosses the equator in all the years in the pre-monsoon season. The secondary ITCZ develops south of the equator mostly around June at both the locations. It first propagates equatorward, comes close to it sometime during July-September and then shifts southward.

The advance in the Bay of Bengal is seen propagating northward up to 15°N but it does not go beyond 8°N in the Arabian Sea. This shows predominant sinking in the western and adjoining central parts of the Arabian Sea. Important variations are seen in the position and time of appearance of secondary ITCZ in the period under consideration. During a good monsoon year like 1988, secondary ITCZ develops earlier in April. For a drought year 1987, there is no distinction between primary and secondary ITCZ along 60°E. The secondary ITCZ along 90°E appears later in June.

Figs. 2(a & b) show the monthly averaged cloud extent for the month of April-May during 1984 to 1989. In 1984 it was between 10°S and 10°N while in 1986 it was observed between equator and 10°S latitude in eastwest orientation. In 1985 cloud extent was from southwest to northeast confining between 10° S and 10° N latitudes. During May only one cloud convergence zone was observed with slight northward movement and having northeast to southwest orientation in 1985 and 1986. In May 1984, two separate cloud convergence zones were observed on either side of the equator which showed that the cloud extent pattern of April 1984 has just split up into two separate cells with a clear area around equator suggesting thereby that two low level convergence zones on either side of the equator are separated by low level divergence zone which results in setting anti-Hadley type of secondary circulation. Fig. 2(b) depicts monthly averaged cloud extent during April-May of 1987 to 1989. This shows that there was only one zone of convergence cloud between equator and 10°S during 1987 but two distinct zones during 1988 and 1989 on either side of the equator. The inspection of April and May cloud extent showed a northward propagation of both the convergence zones with time.

Figs. 3(a & b) show an example of cloud picture indicating clearly the presence of two convergence zones on either side of the equator separated by a cloud-free area around equator.

4. *Conclusions* — This study showed the presence of double ITCZ on either side of the equator during April-July. Early formation of secondary ITCZ along 10°S latitude has been observed during good monsoon year and absence or late formation during worst monsoon year. Northward propagation of primary ITCZ along 90°E is identified with advance of southwest monsoon in the Bay of Bengal. This study is based on five years data which can further be extended to find out much more detail.

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