551.553.21 : 551.521.32

OBJECTIVE CRITERIA FOR WITHDRAWAL OF SOUTHWEST MONSOON BASED ON OLR DATA

1. It is well known that perceptible changes occur in circulation and humidity fields at the time of onset of monsoon. These changes are reflected in the OLR fields as well, which has been studied extensively (Morrisey 1986, Rao *et al.* 1989 and Shyamala 1997). Objective criteria for declaring onset of southwest monsoon based on OLR data have been identified by Shyamala (1997). It is quite logical to anticipate the reversal of all these changes during monsoon withdrawal phase to get reflected in the OLR field which infact is the basis of this study.

1.1. Not many studies are available on withdrawal of southwest monsoon, though some efforts are on in this direction based on changes in circulation pattern and decrease in humidity field. Establishment of anticyclonic flow pattern over Northwest India, reduction in moisture content in the atmosphere and cessation of rainfall are at present considered for declaring withdrawal of southwest monsoon by I.M.D. With this subjective criteria, during certain years monsoon withdrawal over the country is very gradual while in other years the monsoon withdrawal takes places abruptly.

1.2. In this attempt, efforts are made to develop objective criteria for withdrawal of monsoon based on OLR data which infact includes all the changes in circulation and moisture in quantitative manner.

2. INSAT VHRR (Very High Resolution Radiometer) channel 10.5 micron to 12.5 micron data has been used in this study. The spectral response characteristic of this window channel has been considered for obtaining the OLR flux and is given by

$$T_f = T_\gamma (a + bT_\gamma)$$

T_f = Equivalent temperature in °K

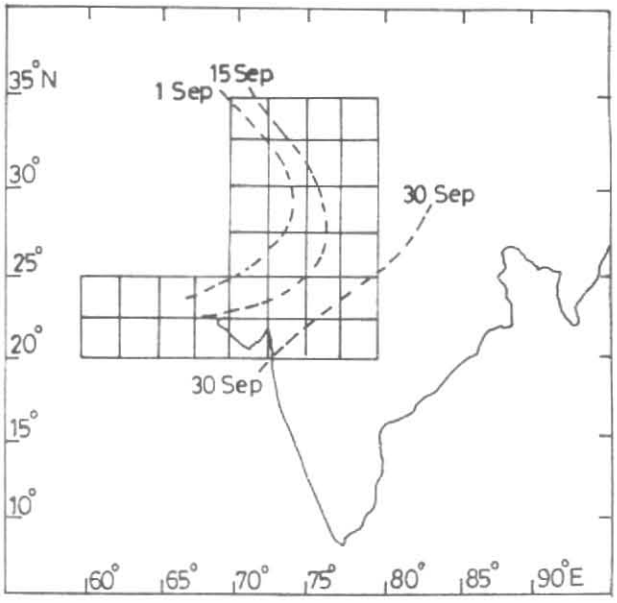

Fig. 1. Area of study and normal dates of withdrawal in N/NW India and Arabian Sea north of 17.5° N

T_γ = Brightness temperature in °K measured by satellite and 'a' and 'b' are constants.

2.1. The quadratic form of equation has been used because of better accuracy at extreme values. OLR flux is then computed as σT^4 where σ is the Stefan's Boltzman constant. The 2.5 degree grid values for the season 1987 to 1989 and 1993 for the month of September computed by I. M.D. as per above equation forms the basic data of the study. The data for period 1990-92 could not be included because of gaps in data.

3. Since the data received from I.M.D. extended upto 30 September, the areas where normal withdrawal is upto 30 September *i.e.* North/Northwest India, Saurashtra, Kutch

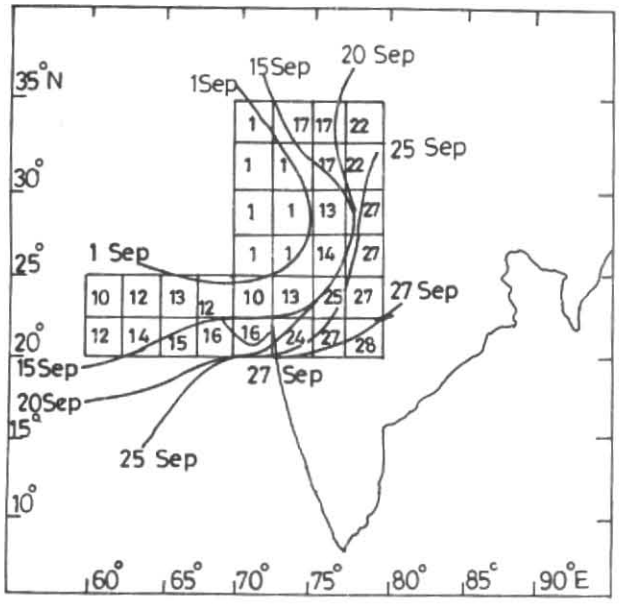

Fig.2. Monsoon withdrawal based on OLR criteria 1987

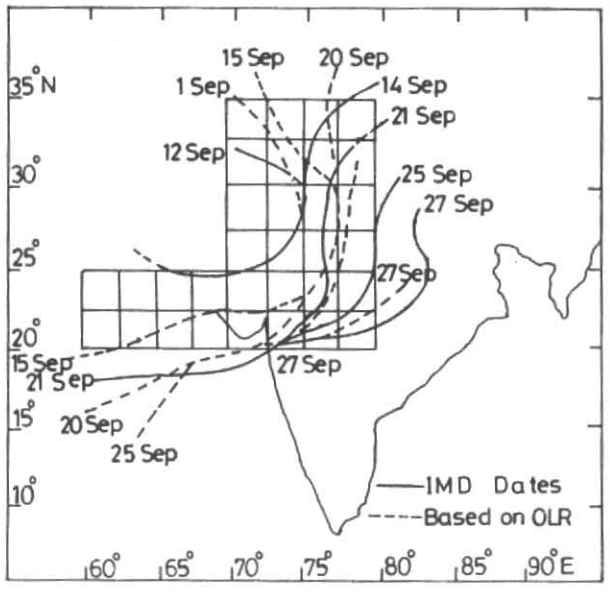

Fig.3. Monsoon withdrawal 1987

and Arabian Sea North of Lat.17.5° N were selected for this study and is shown in Fig. 1. The daily OLR values for 2.5°x2.5° grid points in this area are averaged for 5 day period so as to filter out day to day fluctuations. These average OLR values were examined for the period 1 September to 30 September.

3.1. It is seen that OLR values start increasing and reach a value 260 Watts/Sqm at the time of withdrawal. Persistence of decreased convection for 3 days with OLR>260 Watts/Sqm indicates withdrawal of monsoon air mass from an area. Thus preliminary criteria for withdrawal of monsoon is found to be

(*i*) OLR >260 Watts/Sqm and persisting for 3 days.

(*ii*) The third day when OLR >260 Watts/Sqm is the date of withdrawal of monsoon.

In order to eliminate temporary phases in increase in OLR due to weak or break monsoon condition during the monsoon season, following additional criteria are proposed.

(*iii*) OLR >260 Watts/Sqm should be considered only from the period one week prior to the normal date of withdrawal for the area.

Further because of the orientation of the normal withdrawal line in Northeast-Southwest direction.

(*iv*) For the areas Southwest of Lat. 27.5° N, prior withdrawal of monsoon in North/Northwest sector is necessary, *e.g* For withdrawal of monsoon from Southwest of M.P., withdrawal from Southeast Rajasthan is essential.

(*v*) For the areas North of Lat. 27.5° N, prior withdrawal of monsoon in West/Southwest sector is necessary *e.g.* For withdrawal of monsoon from Haryana, withdrawal of monsoon from Punjab and Northeast Rajasthan is essential.

3.2. Fig.2 gives the withdrawal dates based on all above criteria Fig. 3 is a comparison between withdrawal map based on OLR criteria and the I.M.D.'s withdrawal map for 1987 as illustration which show good agreement. Analysis of 88-89 and 93 shows similar results.

4. Objective criteria for withdrawal of monsoon over ocean and land based on OLR data are given below :

(*i*) OLR values increasing to 260 Watts/Sqm and persisting for 3 days. The third day can be taken as the withdrawal date provided.

(*ii*) The dates are considered from one week prior to normal date of withdrawal for the region.

(*iii*) The prior withdrawal of monsoon in Northwest or North sector of the region for area South of Lat 27.5° N.

(*iv*) Prior withdrawal of monsoon in the areas west or Southwest sector of the region for the areas to the North of Lat. 27.5°N.

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