## 5.2. **A new method for declaring NE Monsoon Onset**

In this section, a new method is proposed for objective declaring the NE monsoon onset. In this objective method, in addition to information on spatial distribution of rainfall, information of large-scale convection and wind patterns are also considered.

In the previous section, we have noted that the monsoon onset is associated with the presence of ITCZ as an east-west trough in the lower levels across south peninsula (Fig. 25 b-d) along $10^0$N. Large scale easterly wind flow is observed north of the trough. The emergence of this trough and easterlies are primary indications of the NE monsoon onset over south Peninsula. The monsoon onset is also associated with large scale convection over the region (Fig. 26 a), in which OLR values over the east coast of Tamil Nadu are less than 220 $Wm^{-2}$. Therefore, in the new method of declaration of the NE monsoon onset, information about easterly zonal winds, OLR and spatial distribution of rainfall are considered.

For deriving information about these parameters, the following methodology is adopted. For calculating zonal wind, an area of 12-16$^0$N, 85-90$^0$E is considered to calculate zonal winds at 850 hPa. For calculating OLR, an area of 09-14$^0$N, 79-82$^0$E is considered. For spatial distribution of rainfall, following 25 rain-gauge stations of IMD are considered:

1) Adiramapatnam 2) Chengalpattu 3) Chidambaram 4) Cuddalore 5) Kodavasal 6) Madurabthagam 7) Minambakkam 8) Muthupet 9) Nagapattinam 10) Needamangalam 11) Nungambakkam 12) Pamban 13) Ponneri 14) Ramanathapuram 15) Srimushnam 16) Sriperumudur 17) Thiruvallur 18) Thirvararur 19) Thondi 20) Thoothukudi 21) Thiruchendur 22) Vanur 23) Vedaranniyam 24) Sulurpet and 25) Nellore

After analyzing the data for all the years from 1981-2020, the following objective criteria are proposed as a new method for identifying/declaring the monsoon onset.

1) The NE monsoon Onset is declared on any date after 10 October, provided the Southwest monsoon is completely withdrawn from the country.

2) Easterly trade winds should prevail north of $12^0$N up to $20^0$N (approx) and extending from surface up to at least 700 hPa level. The zonal wind at 850 hPa, averaged over the box (12-$16^0$N, 85-$90^0$E) should be moderately negative at least for three consecutive days. Due to its large variability, a quantitative measure of the strength of easterlies could not be identified.

3) There is large scale convection over the south eastern peninsula region as seen in satellite pictures, with OLR value less than 210 $Wm^{-2}$, averaged over the box (09-$14^0$N, 79-$82^0$E).

4) At least 50 per cent of the above mentioned 25 IMD rain-gauge stations should report rainfall of 2.5 mm or more. This is equivalent to at least fairly widespread rainfall activity over the region.

5) The first day is taken as the monsoon onset date, provided conditions (1) to (4) are satisfied.

With these objective criteria, a new onset date has been fixed for each year and the new onset dates thus estimated are given in Table-6 below.

The mean onset date of IMD is 22 October with a standard deviation of 6.6 days and the mean onset date from this new method is 24 October with a standard deviation of 8.5 days. The correlation coefficient between the IMD onset date and the new onset date is 0.60, which is statistically significant at the 99% significance level.

**Table 5.2**

New Onset Dates along with the IMD Onset Date and

Onset Dates identified by Raj (2012).

| Year | IMD Onset Date | Onset Date by Raj (2012) | New Onset Date | Difference between the IMD date and new date |
|---|---|---|---|---|
| 1981 | 23-Oct | 23-Oct | 23-Oct | 0 |
| 1982 | 19-Oct | 18-Oct | 18-Oct | 1 |
| 1983 | 24-Oct | 24-Oct | 25-Oct | -1 |
| 1984 | 05-Oct | 03-Nov | 06-Nov | -32 |
| 1985 | 25-Oct | 25-Oct | 25-Oct | 0 |
| 1986 | 27-Oct | 26-Oct | 26-Oct | 1 |
| 1987 | 30-Oct | 20-Oct | 20-Oct | 10 |
| 1988 | 02-Nov | 03-Nov | 03-Nov | -1 |
| 1989 | 27-Oct | 29-Oct | 29-Oct | -2 |
| 1990 | 19-Oct | 18-Oct | 19-Oct | 0 |
| 1991 | 20-Oct | 19-Oct | 27-Oct | -7 |
| 1992 | 02-Nov | 02-Nov | 03-Nov | -1 |
| 1993 | 20-Oct | 13-Oct | 12-Oct | 8 |
| 1994 | 18-Oct | 18-Oct | 18-Oct | 0 |
| 1995 | 23-Oct | 23-Oct | 28-Oct | -5 |
| 1996 | 11-Oct | 10-Oct | 10-Oct | 1 |
| 1997 | 13-Oct | 13-Oct | 13-Oct | 0 |
| 1998 | 28-Oct | 28-Oct | 28-Oct | 0 |
| 1999 | 21-Oct | 04-Oct | 15-Oct | 6 |
| 2000 | 02-Nov | 05-Nov | 19-Nov | -17 |
| 2001 | 16-Oct | | 26-Oct | -10 |

| | | | | |
|---|---|---|---|---|
| 2002 | 25-Oct | | 30-Oct | -5 |
| 2003 | 19-Oct | | 19-Oct | 0 |
| 2004 | 18-Oct | | 26-Oct | -8 |
| 2005 | 12-Oct | | 11-Oct | 1 |
| 2006 | 19-Oct | | 19-Oct | 0 |
| 2007 | 22-Oct | | 20-Oct | 2 |
| 2008 | 15-Oct | | 12-Oct | 3 |
| 2009 | 29-Oct | | 29-Oct | 0 |
| 2010 | 29-Oct | | 29-Oct | 0 |
| 2011 | 24-Oct | | 25-Oct | -1 |
| 2012 | 19-Oct | | 19-Oct | 0 |
| 2013 | 21-Oct | | 21-Oct | 0 |
| 2014 | 18-Oct | | 18-Oct | 0 |
| 2015 | 28-Oct | | 28-Oct | 0 |
| 2016 | 30-Oct | | 01-Nov | -2 |
| 2017 | 27-Oct | | 30-Oct | -3 |
| 2018 | 01-Nov | | 02-Nov | -1 |
| 2019 | 16-Oct | | 20-Oct | -4 |
| 2020 | 28-Oct | | 13-Nov | -16 |
| | | | Difference | -2.0 days |
| | | | Correlation | 0.607 |
| Mean | 22-Oct | 21-Oct | 24-Oct | |
| Std. Dev | 6.65 | 8.57 | 8.65 | |

In general, the new onset dates and IMD onset dates are closer in most of the years. Both the onset dates are exactly the same in 14 years. However, there are

differences too. The largest difference for 10 days or more is found in years like 1984, 1987, 2000, 2001, and 2020. The mean difference between IMD onset date and New Onset date is about 2 days.

The new method of fixing the onset date is further discussed using a case study of the 1986 monsoon onset. Fig. 5.11 shows the time series of percent of stations reporting 2.5 mm or more, Outgoing longwave radiation (OLR) in $Wm^{-2}$ and the zonal wind at 850 hPa. As per the new method, the onset date in 1986 is 26 Oct. On this day, 63 percent stations reported 2.5mm or more rainfall, thus indicating fairly widespread rainfall activity. Enhanced rainfall activity continued for almost 10 days. OLR, which is a proxy for convection, started reducing a couple of days before the onset date. This suggests starting of large-scale convection over South peninsula associated with the monsoon onset. OLR values near the onset were less than 200 $Wm^{-2}$, which persisted for almost one week. By $16^{th}$ itself, easterlies were set in and strong easterly zonal winds were prevailing during the onset date and subsequent 10 days. But the zonal wind component has shown large day to day variations.

The NE monsoon onset of 2020 is now discussed with a similar time series plot. Fig. 5.12 shows the similar variation of parameters (as in 1986) from 24 Oct to 20 Nov. The IMD onset date in 2020 was 28 Oct and the new onset date as per the revised criteria was 13 Nov. On $28^{th}$ October, only 14% of IMD stations reported rainfall and OLR values were more than 240 $Wm^{-2}$, suggesting not enough convection over the region. Weaker easterly winds had just set in. Thereafter, there was not much rainfall activity over the region. Rainfall activity again picked up on 12 November. Easterly winds started strengthening and OLR values started dipping below 210 $Wm^{-2}$. The new criteria with the inputs on easterly winds and OLR values were completely satisfied on 13 Nov, which is the new monsoon onset date. Therefore, the new objective criteria could identify the real onset date which is associated with large scale convective activity over the region.

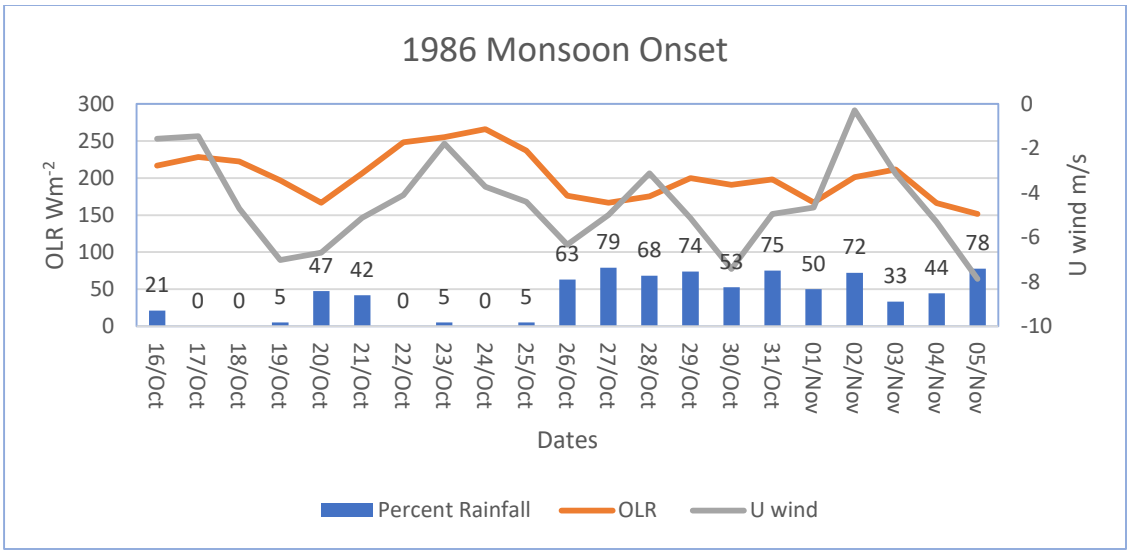


Fig. 5.11. Monsoon Onset in 1986. Time series of percent of stations reporting rainfall of 2.5 mm or more (Vertical bars in blue), OLR value (Orange colour) and zonal wind at 850 hPa during 16 Oct to 05 Nov, 1986.

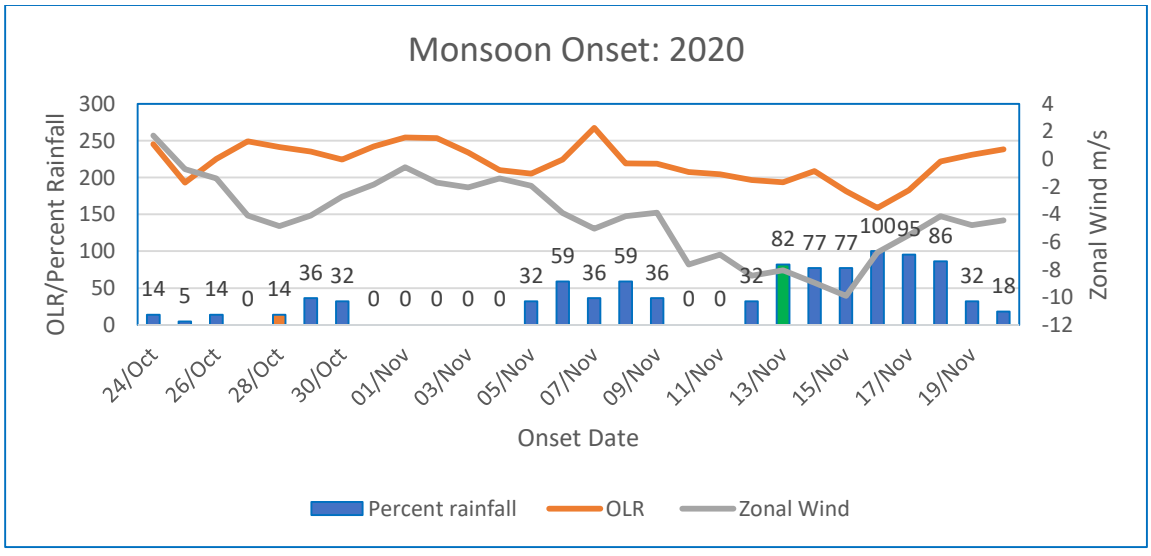


Fig. 5.12. Monsoon Onset in 2020. Time series of percent of stations reporting rainfall of 2.5 mm or more (Vertical bars in blue), OLR value (Orange colour) and zonal wind at 850 hPa during 24 Oct to 20 Nov 2020. The IMD Onset date, 28 Oct is shown as red vertical bar and the new Onset date is shown as green vertical bar.