

Tropical cyclone activity in the Bay of Bengal during ENSO-IOD events

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1. Introduction:

The North Indian Ocean (NIO) is one of the important basins contributing about 7% of total tropical cyclones (TCs) over the world. El-Niño-Southern Oscillation (ENSO) a genuine ocean-atmospheric phenomenon born out of active interaction between the two components of the climate system and is considered as the most dominant inter-annual mode of tropical coupled ocean-atmosphere system (McPhaden 2002). ENSO events last approximately 12-18 months and occur every two to seven years with large variation in strengths (Chang et al. 2006). The co-occurrence of ENSO and Indian Ocean Dipole (IOD) events make it difficult to reach a clear conclusion of complex IOD-ENSO interaction on TC activity in the Bay of Bengal (BoB). In the present study, we use long term tropical cyclone climatology (1891-2007) to study the impacts of ENSO and IOD on intensity, frequency, genesis location, average lifetime of TC in BoB.

2. Data and Methodology:

The domain for the present study covers the entire BoB region. Niño3.4 and ONI values were employed for the period 1891-1949 and 1950-2007 respectively to determine the El Niño, La Niña and neutral ENSO years for the study period 1891-2007. DMI was used to classify the years as +ve IOD, -ve IOD and no IOD. In the present study, TC includes Cyclonic storms (CS (with maximum sustained wind (MSW) 34–47 knots) and Severe cyclonic storms (SCS) (with MSW ≥ 48 knots). An El Niño (La Niña) year is identified if the 5-month running-average of the Niño3.4 Index exceeds $+0.4^{\circ}\text{C}$ (-0.4°C) for at least 6 consecutive months. When the DMI is positive then, the phenomenon is referred as the +ve IOD and when it is negative, it is referred as -ve IOD. In this study we have computed the mean of the DMI from June-November of every year and assigned the value to represent the DMI of that particular year.

3. Results and Discussion:

Out of 502 TCs over BoB during 117-year study period (1891–2007), 178,169 and 155 TCs were observed during El Niño, neutral ENSO and La Niña years. The average frequency of TC per year during El Niño, neutral ENSO and La Niña years are computed as 4.23, 4.02 and 4.69 respectively. In this study, 33 years were identified as La Niña years while El Niño and neutral ENSO years were 42 each. Out of the 117 years of study period, number of +ve IOD, -ve IOD and no IOD years were identified as 18, 17 and 82 respectively. As a means to investigate the most probable period for TC formation in the BoB, the TC season from first one third of April to December 31 was divided into 10-day or one-third monthly intervals for the 117 years study period. Table 1 shows the TC season divided into 10-day intervals, the total number of TC formations, and the average number of TC that occurred for the 10-day intervals during the 117-year period of study. A close inspection of the data in the Table 1 for the months of April through December shows maximum peaks in TC development (primary TC peak period) during first third of November and is considered as the most favoured period of TC formation followed by during second one third of November and last one third of October. Genesis location decides the track length which plays an important role on life time and intensity of TC (Camargo et al. 2007). Therefore, to get detailed information on the genesis location and its consequent role on TC cycle, we divided the BoB into four quadrants; R₁ (15-26°N, 88.3°-100°E), R₂ (15-26°N, 76.3-88.3°E), R₃ (5-15°N, 76.3-88.3°E) and R₄ (5-15°N, 88.3-100°E) and computed the TCs formed in each quadrant (Fig. 1) for different ENSO and IOD years. During El Niño years total no of TCs formed are more than those during La Niña and neutral ENSO years. During El Niño years maximum (minimum) number of TCs are formed in R₃ (R₂) while during La Niña and neutral ENSO years, maximum (minimum) numbers of TCs are formed in R₄ (R₂). During +ve IOD, -ve IOD and no IOD years maximum (minimum) TCs are formed in R₄ (R₂). Comparison of frequency of formation of TCs in a particular quadrant under different IOD conditions reveals that maximum TCs are formed in R₁, R₂ during -ve IOD years and in R₃, R₄ during +ve IOD years. Life time of TCs has important implications on the intensity of TC and damage. During El Niño years, average life time of TCs is relatively shorter as compared to those during La Niña and neutral ENSO years (Table 2). The results corroborate with our observation made earlier regarding the genesis location of TCs; i.e. during El Niño years, TCs mostly form in R₃ followed by R₁ and hence have shorter life time than the TCs in R₄ during La Niña and neutral ENSO years which are away from the coast. The results also agree with the observations of Girishkumar and Ravichandran (2012), albeit with a longer life time. Further, it is observed that TCs formed over R₄ have longer life time followed by over R₁ during El Niño years while during La Niña and neutral ENSO years; TCs formed over R₁ have longer life time followed by over R₂. Life time of TCs formed over R₃ is however shorter in all types of ENSO events. Average life time of TCs is relatively longer (shorter) during +ve (-ve and no IOD) IOD years. The study shows that, TCs formed over R₁ have longer life time in all types of IOD events.

4. References:

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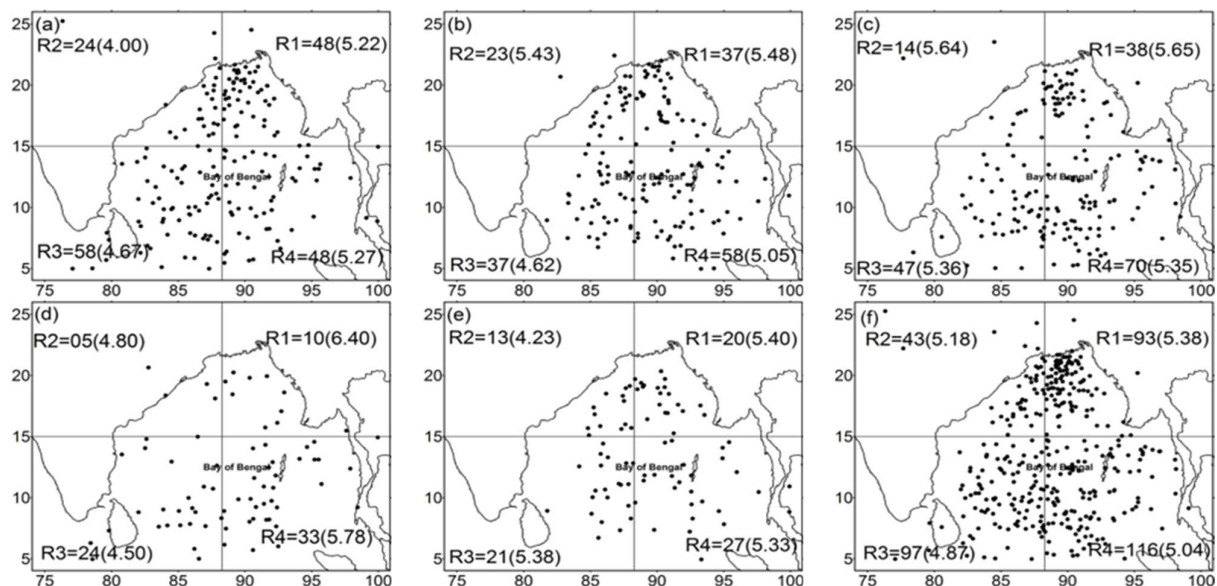


Fig 1 Genesis location of TCs during the ENSO/IOD events during 1891-2007 (a) El Niño years, (b) La Niña years, (c) Neutral ENSO years, (d) +ve IOD years, (e) -ve IOD years, (f) No IOD years.

Table 1 TCs formed over BoB during 1891-2007 for one-third monthly intervals

MONTH	Date (1/3 rd of a month)	TOTAL	Average per year
APRIL	1-10	2	0.017
APRIL	11-20	6	0.051
APRIL	21-30	16	0.136
MAY	1-10	18	0.153
MAY	11-20	20	0.170
MAY	21-31	17	0.145
JUNE	1-10	14	0.119
JUNE	11-20	10	0.085
JUNE	21-30	17	0.145
JULY	1-10	10	0.085
JULY	11-20	13	0.111
JULY	21-31	20	0.170
AUGUST	1-10	12	0.102
AUGUST	11-20	12	0.102
AUGUST	21-31	7	0.059
SEPTEMBER	1-10	8	0.068
SEPTEMBER	11-20	14	0.119
SEPTEMBER	21-30	22	0.188
OCTOBER	1-10	16	0.136
OCTOBER	11-20	32	0.273
OCTOBER	21-31	38	0.324
NOVEMBER	1-10	46	0.393
NOVEMBER	11-20	42	0.358
NOVEMBER	21-30	28	0.239
DECEMBER	1-10	19	0.162
DECEMBER	11-20	12	0.102
DECEMBER	21-31	16	0.136

Table 2 Life time (in days) of TCs during ENSO/IOD events

Event	El Niño	La Niña	Neutral ENSO	Positive IOD	Negative IOD	No IOD
Days	4.89	5.13	5.44	5.37	5.18	5.1