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COMMENTS ON "PERIODICITIES IN THE FREQUENCY OF INDIAN MONSOONAL CYCLONIC DISTURBANCES AND STORMS" – MAUSAM, 54, 2 (APRIL 2003)

1. Monsoon disturbances such as low pressure areas (lows), depressions and cyclonic storms (CS) which generally form over the Bay of Bengal and move westwards or westnorthwestwards along monsoon trough over Indian region, produce large amounts of rainfall (Rao, 1976; Mooley and Shukla, 1989; Jenamani and Dash, 1999 and Jenamani and Desai, 1999). Meteorologists have been trying to look into various aspects of these monsoon disturbances such as their intensification, structure, associated instabilities, westwards movement, dissipation and their relation to the Indian summer monsoon rainfall (ISMR). Latest review of these studies are available in Jenamani (2001). However, during recent years, one of the important findings is by Jenamani and Dash (2001) and Singh (2001), who have shown that seasonal frequencies of intense monsoon disturbances *i.e.*, CS and depressions have decreased at the rate of -6.6 disturbances per year per hundred years with consistence downward trend in their frequency from 1970s till 2002 (Fig. 1). This decreasing trend reached to its worst stage recently in sever drought year of 2002 when not a single depression and CS formed over the Indian region including the Bay of Bengal and the Arabian sea during the monsoon season of 2002 (Fig. 1).

2. In the present era when there is a world wide concern about the global warming and its impacts on climate change, the diminishing frequency of CS and depressions over the Indian region with other regional and global parameters including rainfall variation over India is an important area of investigation. Among such attempts, studies on "the effect of such decreasing trend on total seasonal rainfall and sub-divisional rainfall over India" by Jenamani and Dash (2001), Jenamani (2002) studies on "change of dynamical parameters over Bay of Bengal associated with such decreasing trend CS and depressions" by Dash *et al.* (2003) are worth mentioning.

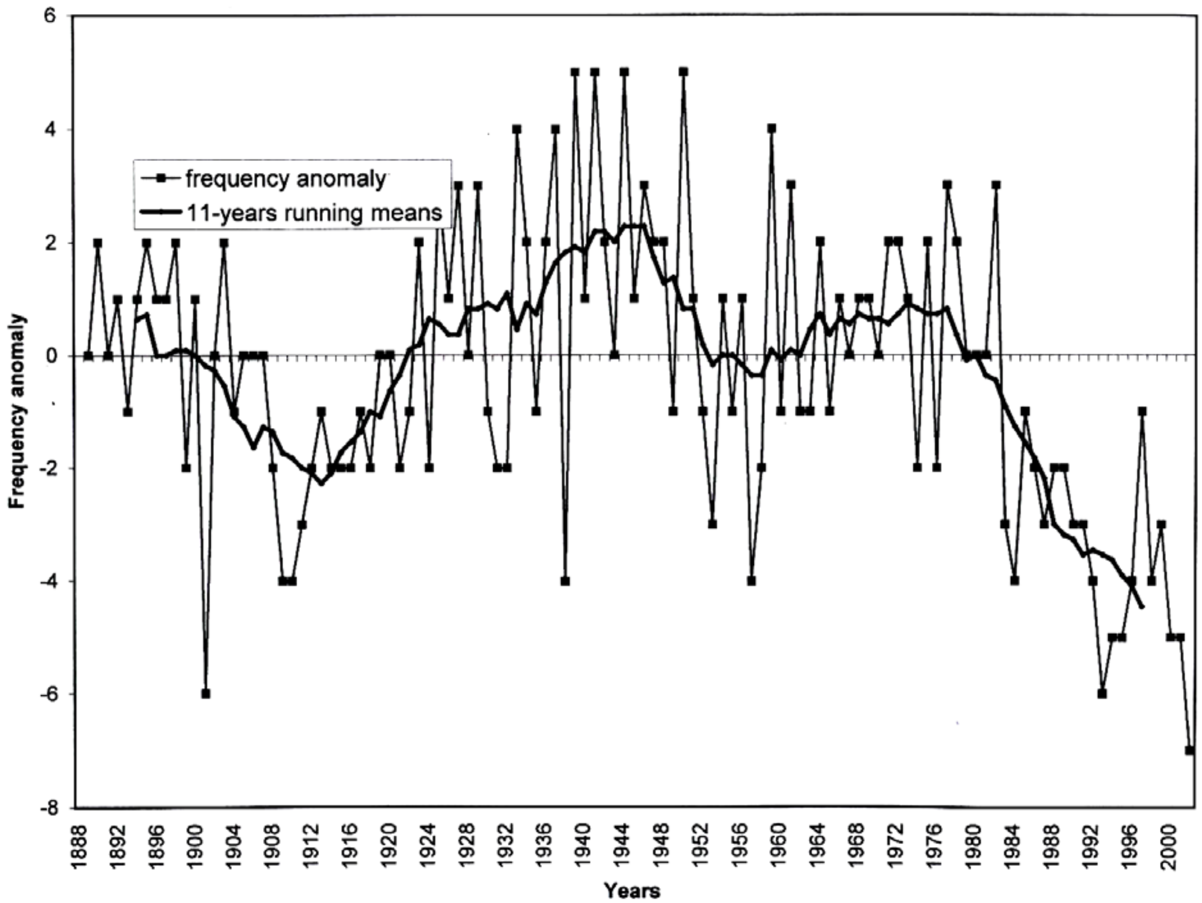

Fig. 1. Seasonal frequency anomaly of CS and depressions and their 11 years running means for the period 1889-2002

The main objective of these studies is to address systematically following two important questions

(*i*) Do day-to-day characteristics *e.g.* intensity, duration, tracks etc. of different monsoon disturbances *e.g.* CS and depressions, lows explain significant interannual and spatial variation of monsoon rainfall over India?

(*ii*) Is there any epochal variation on interdecadal time scale or 30-years time scale in the characteristics of these monsoon disturbances and their relationships with ISMR?

These questions are raised because of the relationship of ISMR with some of the characteristics of monsoon disturbances on different spatial and temporal scales. It may be noted here that the characteristics of intense monsoon disturbances such as depressions and CS and their relationship with rainfall have been studied earlier extensively by many authors (Jenamani and Dash, 2001 for references), for which tracks and frequencies, are regularly available from various publications of IMD year to year. However, characteristics of lows and their relationships with rainfall over India in different spatial and temporal scales have not been studied much.

Sikka (1980), first examined low pressure areas along with depressions over India in July and August for 5 good and 5 bad monsoon years and found no difference between good and bad monsoon years in respect of number of depressions and their duration. But he found a significant difference in their total duration.

3. Mooley and Shukla (1989) have studied 96 years of data (1888-1983) and found that their total duration have good positive correlation with ISMR. Jenamani and Desai (1999) have studied importance of these monsoon disturbances in ISMR for recent years of 1987-96 and also found that years of good ISMR are having higher number of such disturbance days compared with other years. However a recent paper of Kane (2003)

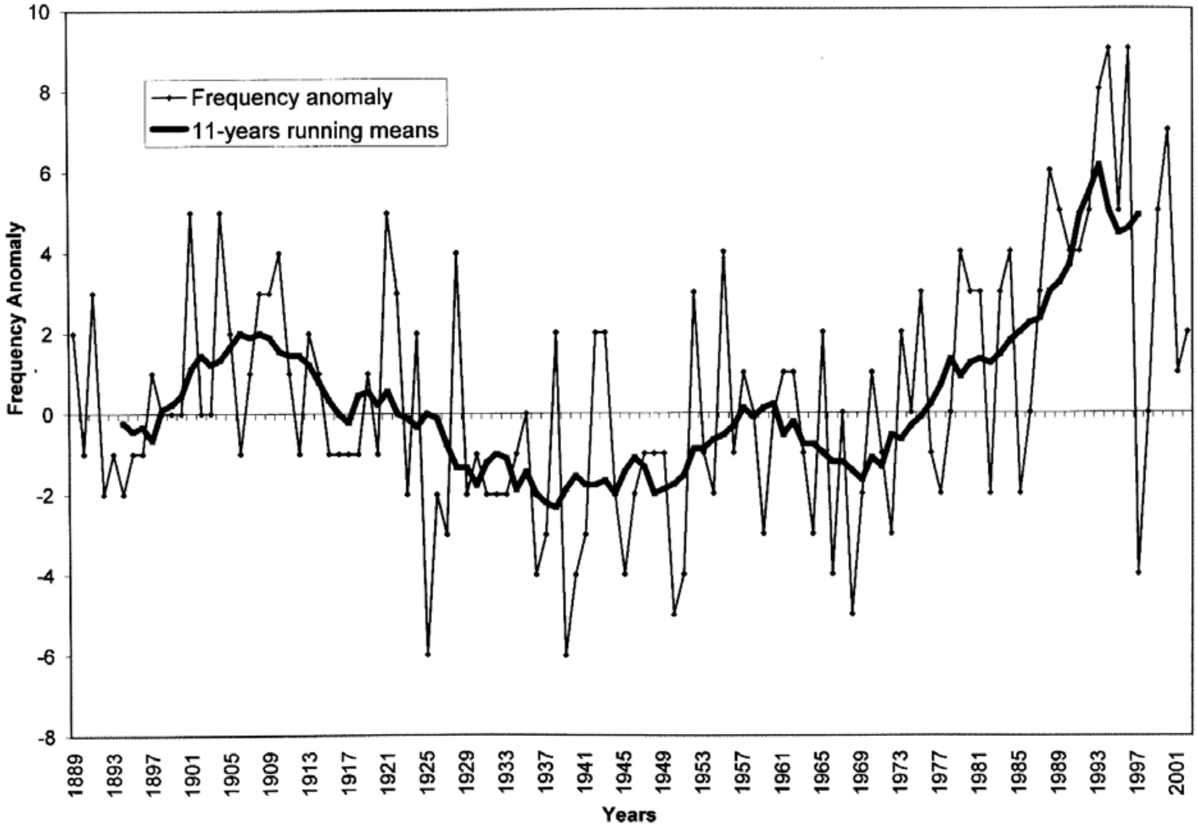

Fig. 2. Seasonal frequency anomaly of low pressure areas and their 11 years running means for the period 1889-2002

[here after (K03)] has attempted to directly relate the downward trends of CS and depressions with rainfall over central India. This observation has raised many logical and scientific points, which are needed to be addressed carefully by the meteorologists working in this field. By considering already established results from various studies including results of the present author, the remarks in K(03) that "The downward trend of CS and depressions should have affected the central India rainfall or ISMR considerably" merely add any new finding to this subject. Because, as commented by Singh (2003) thereafter and considering the results of Jenamani and Dash (2001), it is not CS and depressions or low pressure areas or even CS and depressions and lows by taking all together, whose seasonal frequencies affect interannual variation of ISMR. Rather, it is their total duration or total number of disturbance days in the season, which has strong relationship with ISMR.

Further according to K(03), though seasonal frequencies of CS and depressions have decreased considerably, ISMR follows roughly below normal or above normal of 30-40 years epochs (Kripalani and Kulkarni (1997) while rainfall over central India changed little in 1980-1995 (Kane, 2003) and hence he observed a dilemma in such relationship. However, "Downward trend in seasonal frequencies of CS and depressions has not affected the central or whole India rainfall" is not a dilemma if one will see the above-published works of the present author. Subsequent immediate comments by Singh (2003) are very useful related to the results of K(03).

4. To substantiate the present author's claim, few figures with latest data up to 2002 from IMD (by updating data used in Jenamani and Dash, 2001) are presented here. Fig. 2 shows decadal variation of the total number of lows anomalies. One to one comparison of 11-years running means of both the curves of lows of Fig. 2 and frequencies of CS and depressions of Fig. 1, confirm that number of lows and number of CS and monsoon depressions are mutually exclusive during most of the period and lows are significantly increasing from 1970s when continuous decreasing trend of CS and depression has started. Further, it may be noted that in the recent 15 years, record highest number of lows with lowest number of CS and depressions are observed. But these years have nearly the same number of systems, if total number of lows, depressions and CS are considered. Hence even though

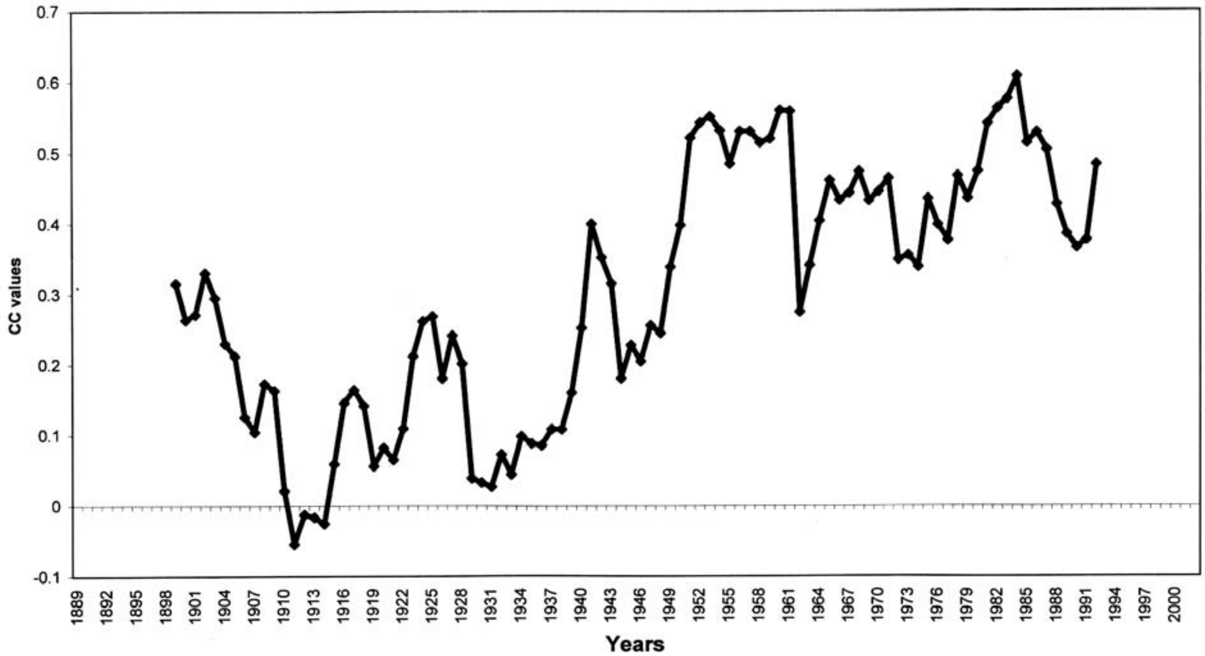

Fig. 3. Correlation Coefficients (CC) in a 21 - year moving window between seasonal anomaly of ISMR and monsoon disturbance days for the period 1889-2002

during the last 15-years, a record lowest number of depressions and CS are formed, the good rainfall was occurred as a result of formation of record highest number of lows over the region during these years.

As discussed earlier, since monsoon disturbance days have a good relation with ISMR, 21-years running mean of correlation coefficients (CC) between ISMR anomalies (data from Thapliyal, 1997) and season wise total monsoon disturbances days anomalies(data from Jenamani and Dash, 2001) are calculated and given in Fig. 3. One can observe from Fig. 3 that the CC between ISMR and monsoon disturbance days clearly undergoes epochal variations throughout the period like CC of SOI and NINO 3 SST with ISMR in Krishnamurthy and Goswami(1998). While the interannual fluctuations of both ISMR and monsoon disturbance days indices are strongly modulated by the interdecadal mode, the CC between monsoon disturbance days and ISMR in the interannual time scale are not so strongly modulated. The figure also shows high variation of all of their CC in magnitude with a very small but rare period having change of sign out of the whole period of data. Further, it is interesting to note from Fig. 3 that from 1950 onwards, both parameters continued to have very high CC of around 0.5 while before they had very weak CC. To find the possible cause of this anomalous relationship, total numbers of disturbance days have also been analysed for these two periods separately, which also shows presence of very higher number of total disturbances days during latter period particularly after 1970s. Since life period of lows are normally higher than CS and depressions and their movement are slow, presence of such high CC in recent years may be due to the formation of very less number of CS and depressions in most of these recent years, with very high number lows which is finally resulting such higher number of total monsoon disturbance days over Indian region and hence have resulted very high CC with ISMR.

5. Existence of interdecadal variation is studied in different basic parameters of tropical atmosphere and ocean along with their relationships with ISMR *e.g.* SST of east Pacific (Oceanic features), Eurasia snowfall etc. (see review by Jenamani and Dash, 2001). In the present comment, a decadal variation is also observed in

characteristics of monsoon disturbance, which is main synoptic system of ISMR. Such epochal variations of relationship also exists in various predictors used for long range forecasting of ISMR (Thapliyal, 1997). It is needed to find whether such epochal variations also exist in relationships of ISMR with other synoptic and semi-permanent components of Indian summer monsoon *e.g.* monsoon trough, Tibetan anticyclone etc. defined in Rao (1976), which have good relation with ISMR (Jenamani and Desai, 1999). But, it may finally be inferred that ISMR, its various lag parameters which are developed before the season and used in its long range forecast and its main synoptic component which control day to day rainfall distribution over India and form in the season, undergo epochal fluctuations of above normal and below normal epochs in the interdecadal time scale together with magnitudes of their correlation with ISMR.

It is beyond our doubt that the epochal variations of relationships of ISMR with its predictors for last many years, have not produced any effect on the spatial variation of ISMR. The monsoon disturbances are main rainfall producing systems, which also control the spatial distribution of ISMR. So with the establishment of existence of strong epochal variations in both characteristics (particularly intensity) of monsoon disturbances and its relationships with ISMR in the present study, one can not totally deny the possible significant climatic effect of such epochal variations on number of heavy rainfall events over India and on spatial variation of ISMR. Hence the cause of such interdecadal shifting of characteristics of monsoon disturbances, epochal variation of such relationships with ISMR and climatic effect of such variation on spatial variation of ISMR and frequencies of heavy rainfall events, are required to be further studied. Results of recent studies by Jenamani (2002), and Dash *et al*. (2003) brings further interesting findings on this subject.

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