Correspondence between the Land Surface Temperatures and the Precipitation in various homogenous regions India

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Abstract **Precipitation at global and regional levels in India is an important socio-economical factor affecting the lives of millions. Among many factors affecting the precipitation at regional levels is the Land Surface Temperature (LST). The maximum and minimum average temperature over a time period is instrumental in determining the amount of precipitation. But is this association same throughout all homogeneous regions or is the effect more dominant over some regions than over other regions of India? In order to look into the question we have done a correlation analysis between the maximum land surface temperature and precipitation over four homogeneous regions of India- North East (NE), North West (NW), Peninsular India (PI) and West Central (WC) regions as well as over the All India Average at various lag values. It is observed that for most of the regions a high correlation is observed at lag values ranging from 0-24. The methodology is discussed, results are summarized and as a future aspect it is stated how a statistical model can be used to forecast precipitation using these correlations.**

Keywords - Land Surface, Temperatures, Precipitation, homogenous regions India.

I. INTRODUCTION

The interdependence between rainfall and air temperature (Cong and Brady, 2012; Hary et al., 2007) has a complex nature and is usually difficult to simulate. Off late the global warming effect has affected the trend of the mean, maximum and minimum Land Surface Temperature (LST) over India with an estimated increase of 0.055K per decade (Basha et al, 2017). However, the factors responsible for this growth have not been ascertained till yet.

Owing to the importance of the LST at various temporal scales in India, studies have been carried out for the historical constructions and future projections of these (Basha et al, 2017; Dash and Hunt, 2007; Ross et al, 2018). Data from 395 Indian stations (Ross et al, 2018) reveal that there is a rapid rise in surface temperature during the pre-monsoon, monsoon, post-monsoon, winter and annual records. The LST has also been analyzed at regional levels. Analysis of 37 year data set of 7 districts of Kashmir valley indicated heat and cold waves of moderate to severe intensity (Ahmad and Kanth, 2018). Long term climatology of heat and cold waves over Bihar was analyzed (Mahdi and Dhekale, 2016) and it was concluded that high frequency temperature extremes are decreasing. The temperature (maximum, minimum and mean) trends analysis over North Eastern region of India has shown a rising trend (Jain et al, 2013). The scenario is a little different when we consider the Diurnal Temperature Range (DTR). Here the Indian climate does not toe the world feature.

Although most of the studies reveal increase in the land temperature at all scales there is a deviation observed at some local levels. Northeastern Indian region has witnessed a cooling across decades in the maximum, minimum and mean LST (Ross et al, 2018). Further, in some cases it is also observed that the All-India surface air temperature during the drier part of the year has also witnessed a relative cooling (Krishnan, R. & Ramanathan, 2002). Jain and Kumar (Jain and Kumar, 2012) have also revealed that some stations located in the north and north eastern India have witnessed a falling trend in the annual mean temperature.

Unlike the LST which depicts an increasing trend over the globe, the India as a whole and India divided in climatic regions, the rainfall over India does not show a clear trend

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(Kumar et al, 2012). The importance of rainfall at various spatial and temporal scales over India is not disputed.

The association between precipitation and temperature (P-T) is important and indispensable for the researchers in meteorology. This association was evaluated in 17 climatic models involved in Coupled Model Intercomparison Project Phase 5 (CMIP5) for the IPCC Assessment Report version 5 (Wu et al, 2013). The impact of European (Kakade and Kulkarni, 2012) and Australian (Lee and Koh, 2012) temperatures on the Indian Summer Monsoon Rainfall (ISMR) has also investigated

Indirect methods of correlation (P-T) estimation have also figured. Ramchandra and others (Ramchandra et al., 2008) have studied the correspondence between the Normalized Difference Vegetation Index (NDVI) with LST and NDVI with rainfall in the Central Western Ghats. NDVI-LST correlation was found to be weak negative and the NDVI-rainfall correlation was found to be strong positive during 2003-2012. It was concluded that there is little correspondence between the LST and the west central rainfall. However, this is not universally true.

The present study is a statistical analysis of the effect of Land surface temperature on All India rainfall. The study also provides an analysis of the effect of LST over four homogeneous rainfall regions of India- North East (NE), North West (NW), Peninsular India (PI) and West Central (WC)..

II. PROCEDURES FOR PAPER SUBMISSION

Monthly rainfall data from 1871-2016 and temperature data from 1901 to 2007 were obtained from IITM website https://tropmet.res.in. The common time period data (1901 to 2007) has been used for the present analysis.

Correlation analysis has been done to find the regions having a direct association between the LST and the precipitation.

III. MATH

Fig. 1 shows the variation of the correlation between the All India Rainfall (AIR) and the max surface temperature for lag values ranging from 1 to 24 months. It can be seen that the correlation fluctuates from -0.9 to about 0.8. for different lag values. Fig. 2(a-d) shows similar plot for the North East (NE), North West (NW), Peninsular India (PI) and West Central (WC) regions.

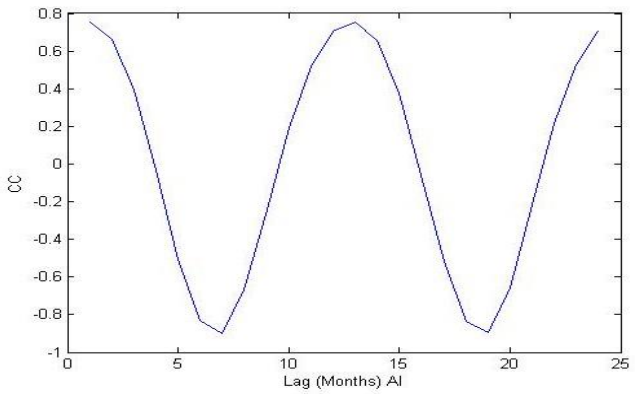
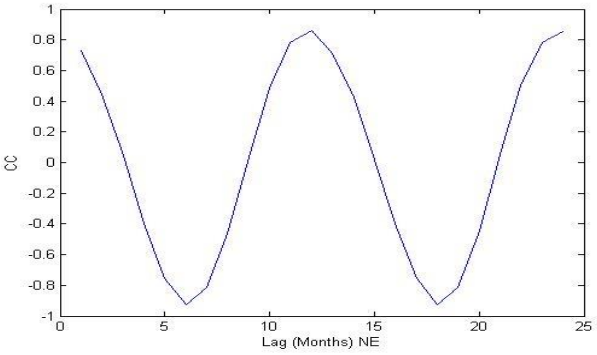
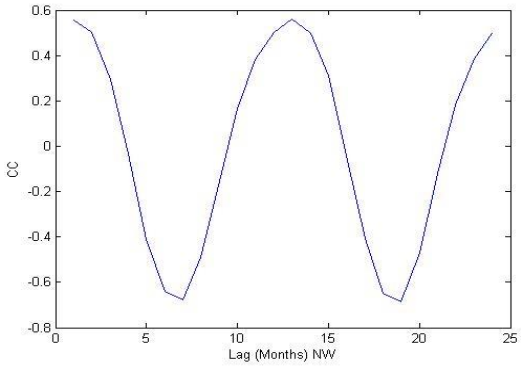


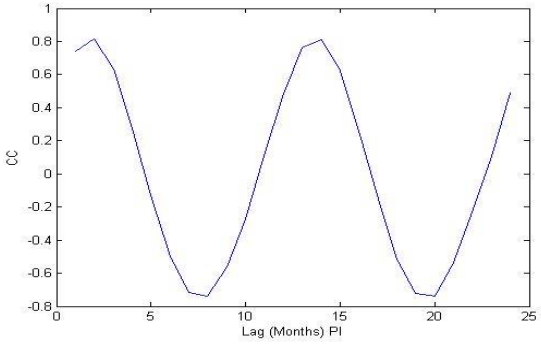
Figure 1: CC of All India Rainfall with Max Surface Temp



(a)



(b)



(c)

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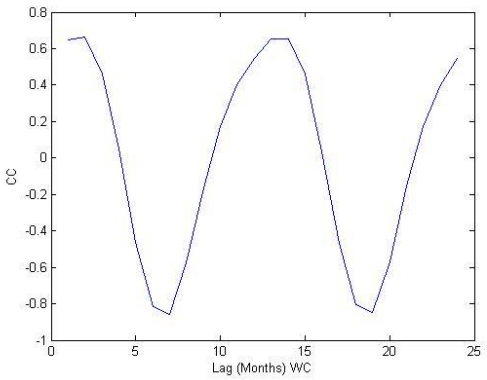

(d)

Figure 2: Correlation between the maximum temperature and AIR for different lag values (a) NE Region Rainfall, (b) NW Region Rainfall, (c) PI Region Rainfall, (d) WC Region Rainfall, with respective Max Surface Tempreature

Table 1 shows the best two correlations between the maximum temperature and AIR for different lag values for all the five regions considered. The numbers in brackets indicate the lag value for the corresponding correlation. It can be seen the two quantities are highly correlated in most of the cases except for the following – in the NW region a best correlation of 0.56 us observed and in the WC region the second best correlation obtained is 0.46. In most cases a correlation value greater than 0.7 is observed. However, a large lag value may be because of the cycles in the climatology.

Table 1: Best CC with Lag for Different Regions

	AI	NE	NW	PI	WC
Best CC1(Lag)	0.7567 (13)	0.8612 (12)	0.5611 (13)	0.8164 (2)	0.6612 (2)
Best CC2(Lag)	0.7553 (1)	0.8559 (24)	0.557 (1)	0.8126 (14)	0.6539 (13)

IV. CONCLUSION

The importance of Land Surface Temperature in determining the precipitation is well settled. Various studies have been done across the globe to study this impact at various levels. Important aspects of the analysis of LST over a region are the trends of heat and cold waves and the impact on the precipitation. This study was carried out over four homogeneous regions of India i.e. North East (NE), North West (NW), Peninsular India (PI) and West Central (WC) regions and also at the All India level. A correlation analysis of the maximum temperatures over these regions with the corresponding precipitation indicates that except for the North West region, the maximum temperature shows a high correlation with the precipitation. A further aspect of predictability of the precipitation using this correlation, as the lag in correlation was found to be significant, may be explored using statistical models such as the neural network.

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