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Time series trend analysis of rainfall and temperature over Kolkata and surrounding region

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RESUMEN

Los estudios de la variabilidad a largo plazo de la temperatura y las precipitaciones en el contexto del cambio climático son importantes, especialmente en las regiones donde predomina la agricultura de temporal. Se han determinado las tendencias a largo plazo de la temperatura y la lluvia para Kolkata, India (una región tropical), utilizando datos mensuales reticulados del Centro Mundial de Climatología de las Precipitaciones (GPCC v. 7) con una resolución de 0.5º × 0.5º para el periodo 1901-2014. Se han calculado el índice de concentración de precipitación, el coeficiente de variación y la anomalía de las precipitaciones, y se ha analizado el índice de severidad de la sequía de Palmer. Además, se han utilizado la prueba de Mann-Kendall y la estimación de la pendiente de Sen para detectar la tendencia de las series de tiempo. La temperatura y las precipitaciones anuales han aumentado a un ritmo de 0.0082 ºC y 0.03 mm por año, respectivamente. La mayoría de los meses muestran tendencias crecientes estadísticamente significativas para la temperatura y las precipitaciones. Se han observado precipitaciones con alto índice de concentración (16-20) para los periodos 1951-1975 y 1976-2000. Se ha incrementado el número de años con condiciones secas. Sin embargo, la intensidad de la sequía es cercana a cero. La información de este estudio será útil para que los agricultores planifiquen una agricultura resiliente.

ABSTRACT

Studies of temperature and rainfall long-term variability in the context of climate change are important, particularly in regions where rainfed agriculture is predominant. Long-term trends of temperature and rainfall have been determined for Kolkata, India (a tropical region) using gridded monthly data from the Global Precipitation and Climate Centre (GPCC v. 7) with 0.5º × 0.5º resolution for the period 1901 to 2014. Precipitation concentration index, coefficient of variation, and rainfall anomaly have been calculated and Palmer drought severity index has been analyzed. Furthermore, the Mann-Kendall test and Sen's slope estimate have been used to detect time series trend. Annual temperature and rainfall have increased at a rate of 0.0082ºC yr^{-1} and 0.03 mm yr^{-1}, respectively. Most months show statistically significant increasing trends for temperature and rainfall. Rainfall with high precipitation concentration index (16-20) has been observed for the period 1951-1975 and 1976-2000. The number of years with dry conditions has increased. However, the intensity of dryness is very close to zero. The information from this study will be helpful for farmers to plan for resilient farming.

Keywords: cloud attenuation, radiometer, elevation angle, exceedance probability, worst month statistics, liquid water content.

1. Introduction

Climate change is one of the most important global environmental challenges, which has an impact on food production, water supply and health. Rapid urbanization and industrialization affect climate change (Krockenberger et al., 2004; Matyssek et al., 2013; Da Costa and Barbi, 2016). Temperature and precipitation are the two most important parameters which characterize the climate change. It has been reported that the average temperature of the earth has been increased by 0.74 ºC for a decade (UNFCCC, 2007). As a result of deforestation and urbanization, the emission of greenhouse gases has increased. The highest warming has been experienced in the Antarctic over the last 50 years (Hughes et al., 2006). Nowadays, global warming is the most important issue worldwide. The variability of rainfall is of high interest for the countries where agricultural activities are mainly dependent on rainfall (Cheung et al., 2008). Changes in temperature and rainfall influence the natural ecosystem and socioeconomical condition of a country. Both parameters have an impact on the agricultural sector, food security and human health (Sari et al., 2007). The effect of climate change has also been observed on sea-level rise and warmer ocean temperatures (Zikra et al., 2015). This will be alarming for frequent floods and tsunamis. For the above reasons, it is necessary to investigate long-term variability of temperature and rainfall. Based on the information, adaptation strategies may be adopted.

A significant increasing trend of temperature has been revealed over the Nile river basin of Ethiopia, while for precipitation the trend was mixed (Mengitsu et al., 2014). An increasing trend in the number of drought years has been observed over Ethiopia (Asfaw et al., 2018). An increasing trend of temperature has been observed over the Chand basin of Africa (Mahmood et al., 2019). It has been observed that temperature has increased by 1.5 ºC in eastern China over the last 100 years (Zhao et al., 2014). An increasing trend of temperature has been reported in the summer season over Sweden for the period 1959-008 (Ceppi et al., 2012). A similar increasing trend has been reported in Spain (Rio et al., 2011), the USA (Degaetano and Allen, 2002), and Florida (Martínez et al., 2012). However, no significant trend of temperature has been reported in the USA (Karmeshu, 2012). Using the CMIP5 model, it has been observed that temperature will rise significantly over nine climatic zones in India (Yaduvanshi et al., 2021). It has been reported that precipitation has increased by 7-12% over the northern hemisphere in the 20th century (Xu et al., 2005). The long-term trend of precipitation shows a negative tendency over the Mediterranean region for the period 1901-2009 (Philandras et al., 2011). No significant trend has been observed in long-term rainfall over Bulgaria (Bocheva et al., 2008). A negative trend of precipitation has been reported in southern Italy (Longobardi and Villani, 2009).

Some studies have been made in India quantifying the long-term variability of the above two parameters and the relation between them. A positive trend of annual rainfall has been observed over central India for the period 1901-1960 (Parthasarathy and Dhar, 1974; Goswami et al., 2006; Rajeevan et al., 2008). Monsoon rainfall over the western Indo Gangetic Plain (IGP) has increased significantly since 1900 (Singh and Sontakke, 2002). Pal and al-Tabbaa (2009) have found that extreme post-monsoon and winter rainfall have increased over Kerala. No significant trend has been observed in average annual rainfall over India (Mooley and Parthasarthy, 1984; Sarker and Thapliyal, 1988; Thapliyal and Kulshreshtha, 1991; Lal, 2001; Sinha and de Us, 2003; Kumar et al., 2010). Rainfall shows an increasing trend for the period 1980-2017 over Odisha (Panda and Sahu, 2019). A significant increase in mean annual temperature has been observed over the north-central and northeastern regions, as well as the west coast of India (Hingane et al., 1985; Pant and Kumar, 1997) and also over the Mahanadi river basin (Rao, 1993). However, a decreasing trend has been reported over the northwest Indian region for the period 1901-1982 (Pant and Hingane, 1988). An increasing trend of temperature has been evident at 121 stations in India for the period 1901-1987 (Kumar et al., 1994).

Studies on long-term variability of temperature and rainfall are sparse over Kolkata and the surrounding region. Very few observations of long-term variation of temperature and rainfall have been reported over Kolkata and West Bengal. Temporal variability of monthly temperature has been observed over Kolkata for 70 years (Khan et al., 2015). In this study, a decreasing trend of temperature has been observed for December-March. For the remaining months, an increasing trend of temperature has been observed. Bisai et al. (2014) analyzed long-term change of temperature over Krishnanagar observatory, West Bengal, for the period 1941-2010; they reported that major temperature changes occurred after 2000. Nandargi and Barman (2018) analyzed rainfall anomalies, coefficient of variation (CV) and precipitation concentration index (PCI) over West Bengal using monthly rainfall data for the period 1901-2016; they showed an increase in the percentage of dry years after 1990.

Kolkata is a densely populated and highly polluted city in India. It is one of the important regions of India and contributes significantly to the gross domestic production (GDP) of the country. It is located near the land-ocean boundary and substantial rainfall occur over this region. Convective rainfall occurs over Kolkata in the pre-monsoon season and mainly stratiform and mixed rainfall occurs in the monsoon period. During all seasons, namely summer, winter, monsoon, and pre-monsoon rainfall can be clearly distinguished over this region. Different temperature and rainfall characteristics can be observed for different periods over this region. Rainfall mainly occurs during the monsoon (June-September) and pre-monsoon (March-May). However, localized post-monsoon and winter rainfall have also been observed. It is necessary to investigate the long-term trend of temperature and rainfall over this region to analyze the effect of climate change.

In this paper, a descriptive analysis of long-term variation of temperature and precipitation has been observed using gridded monthly data obtained from the Global Precipitation and Climate Centre (GPCC) for 114 years. The yearly box plot and trend analysis of the above parameters have been studied for the period 1901-2014 for four different seasons: December-February (DJF), March-May (MAM), June-September (JJAS) and October-November (ON). The CV, precipitation anomalies, and PCI have been calculated for statistical analysis (Oliver, 1980; Hare, 2003; Asfaw et al., 2018; Zhang et al., 2019). Furthermore, non-parametric tests (Man-Kendall and Sen's slope estimator) have been used to detect the trend of rainfall and temperature. The Palmer Drought Severity Index (PDSI) has been observed to examine the extent of meteorological drought (Agnew and Chappel, 1999; Szép et al., 2005; Dai, 2011; Diodato et al., 2019).

2. Experimental data and methodology

Gridded monthly precipitation and mean temperature data from the Global Precipitation and Climate Centre (GPCC v. 7) with 0.5º × 0.5º resolution for the period 1901 to 2014, downloaded from the KNMI Climate Change Atlas (https://climexp.knmi.nl/plot_atlas_form.py) (Becker et al., 2013; Schneider et al., 2017) are utilized to observe the trend analysis and the variability of the two parameters over Kolkata and the surrounding region. In addition, PDSI data for the period 1901-2005 was obtained from the same source. Several methods have been applied to observe the trend and anomalies of rainfall and temperature: CV, percentage deviation from the mean, PCI and Sen's slope (Asfaw et al., 2018). CV is used to classify the degree of variability of rainfall. It can be represented as

$$CV = \frac{\sigma * 100}{\mu} \tag{1}$$

where σ denotes standard deviation and μ is the mean precipitation. According to Hare (2003), CV is used to classify the degree of variability of rainfall events as low (CV < 20), moderate (20 < CV < 30), and high (CV > 30). PCI is used to provide information on seasonal or annual rainfall variability to examine whether the monthly rainfall is equally distributed or not. Mathematically, it is represented as (Oliver, 1980; Zhang et al., 2019):

$$PCI_{annual} = \frac{\sum_1^{12} P_i^2}{(\sum_1^{12} P_i)^2} X100 \tag{2}$$

It has been observed that PCI values less than 10 indicate low precipitation concentration, values between 11 and 15 denote moderate concentration, values from 16 to 20 indicate high concentration, and values above 21 indicate very high concentration of precipitation (Oliver, 1980). Rainfall anomalies have been evaluated to determine dry and wet years in the record (Agnew and Chappel, 1999; Viste et al., 2012; Hadgu et al., 2013). Mathematically, the anomalies defined as:

$$Z = (X_i - X_i') / S \tag{3}$$

where Z denotes standardized anomaly, X_i denotes annual rainfall of a particular year, X_i' represents long-term mean annual rainfall, and S is the standard deviation of annual rainfall. The drought severity classes can be divided as extreme drought ($Z <$ 1.65), severe drought (1.28 > Z > 1.65), moderate drought (0.84 > Z > 1.28, and no drought (Z > 0.84) (Agnew and Chappel, 1999). The Mann-Kendall test and Sen's slope estimator are used to detecting the trend of temperature and rainfall (Mann, 1945; Kendall, 1975; Yue et al., 2002; Karmeshu, 2012). The PDSI is an indicator of meteorological drought index that quantifies abnormally dry or abnormally wet weather conditions (Agnew and Chappel, 1999; Szép et al., 2005; Dai, 2011; Diodato et al., 2019). It is sensitive to soil moisture conditions and mostly used in agricultural applications.

3. Results

3.1 Long-term variation of temperature and rainfall

Temperature and rainfall monthly data obtained from GPCC was analyzed for the period 1901-2014 for different seasons, namely, winter (December-February, DJF), pre-monsoon (March-May, MAM), monsoon (June-September, JJAS) and post-monsoon (October-November, ON). Figures 1 and 2 show the boxplots of temperature and rainfall for four different seasons and periods (1901-1930, 1931-1960, 1961-1990, and 1991-2014). The climate change trend can be identified for 25-30 years. So, the total data period obtained from GPCC can be divided into four time spans of 30 years.

The average temperature and rainfall of the first and last five years of the above 30-year time span have also been shown for different seasons. It is evident from Figure 1 that the average temperature value for DJF, indicated by the red line in the box plot of temperature lies in the middle of the upper and lower bound of this parameter for the periods 1901-1930, 1931-1960, and 1961-1990; however, for the period 1991-2014 the average value is nearer to the lower limit. For MAM, the average value is closer to the lower and upper bounds for the periods

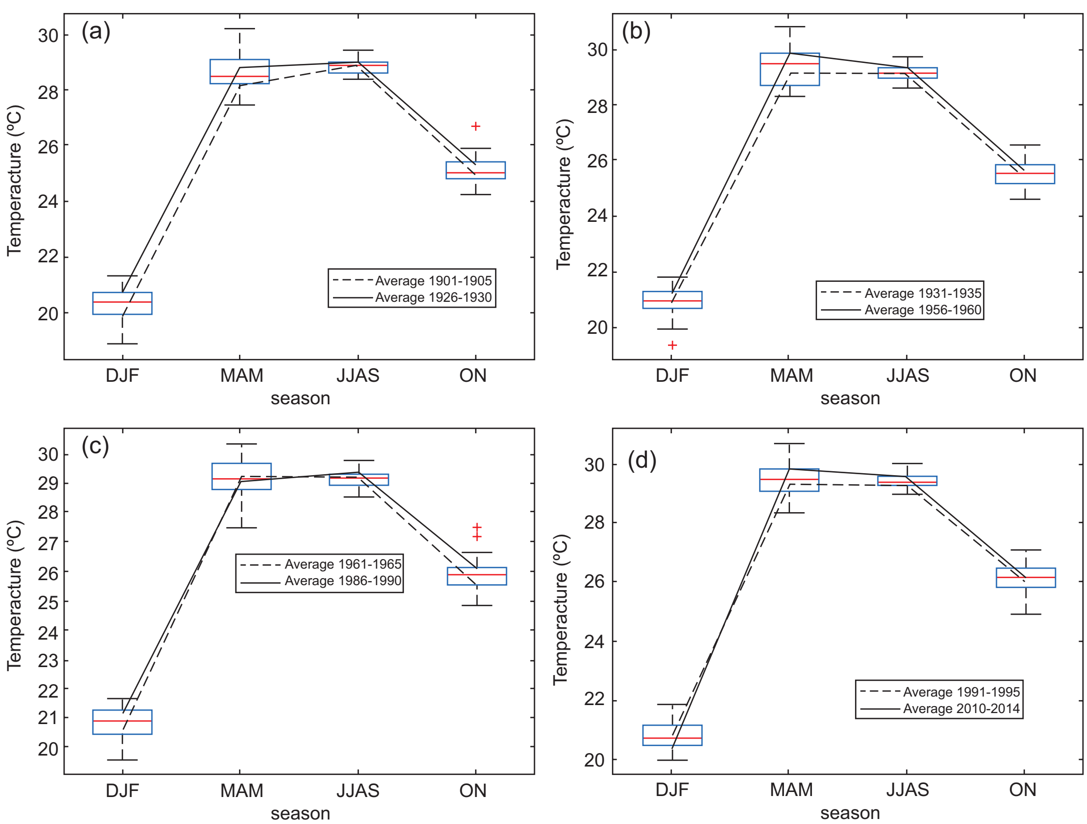

Fig. 1. Boxplot of temperature for the periods (a) 1901-1930, (b) 1931-1960, (c) 1961-1990, and (d) 1991-2014.

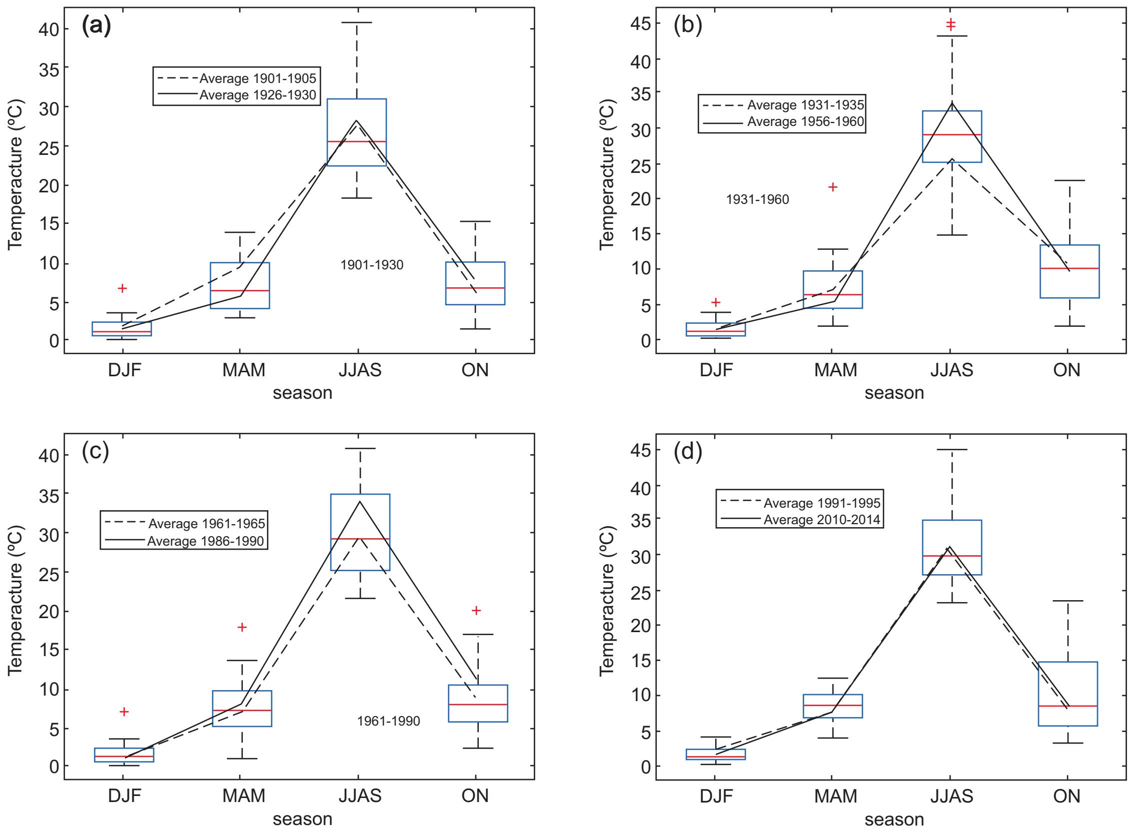

Fig. 2. Boxplot of rainfall for the periods (a) 1901-1930, (b) 1931-1960, (c) 1961-1990, and (d) 1991-2014.

1901-1930 and 1931-1960, respectively. For JJAS, the average value is closer to the upper limit for the periods 1901-1930 and 1961-1990, and to the lower limit for the period 1991-2014.

For DJF, the average value of rainfall lies closer to the lower limit for the periods 1901-1930, 1961-1990, and 1991-2014. For MAM, the average value is closer to the lower limit for the periods 1901-1930 and 1931-1960. For JJAS, the average value of rainfall is closer to the lower limit for the periods 1901-1930, 1961-1990, and 1991-2014, and to the upper limit for the period 1931-1960. For ON, the average value of rainfall is closer to the lower limit for the periods 1901-1930 and 1991-2014, and closer to the upper limit for the period 1931-1960. It is quite clear from the line plot, that the average temperature shows a higher value for the last five years with respect to the first five years of each period and season. The average value of rainfall for the last five years shows higher values with respect to the first five years for JJAS during periods 1931-1960 and 1961-1990.

Table I shows the number of years with higher or lower values of temperature and rainfall with respect to the average value. It can be seen from this table that, for DJF, MAM, and JJAS the number of years with temperature higher than the average has increased for the period 1991-2014 with respect to the other three periods. However, for rainfall, the situation is not clear, which shows the uncertainty of tropical rain over this region. For rainfall, most years show lower values than the average for the periods 1901-1930 and 1961-1990. Total rainfall for the period 1991-2014 is higher with respect to the other three periods.

3.2 Trend analysis of temperature and rainfall

Figures 3 and 4 show the trend analysis of temperature and rainfall for the period 1901-2014, respectively. The annual average temperature for this location is 20.7, 29.11, 29.13, and 25.64 ºC for the DJF, MAM, JJAS, and ON, respectively. A linear regression model has been used to define the slope, which in this case

Table I. Number of years of temperature and rainfall exceeding the average values.

Period		1901-1930		1931-1960		1961-1990		1991-2014	
		Number of years							
Season	Average value	T	R	T	R	T	R	T	R
DJF	>	14	11	13	13	15	11	16	9
	<	16	19	17	17	15	19	8	14
MAM	>	13	12	17	13	15	14	23	13
	<	17	18	13	17	15	16	1	10
JJAS	>	15	10	14	15	14	13	13	10
	<	15	20	16	15	16	17	11	14
ON	>	14	13	16	15	13	13	12	9
	<	16	17	14	15	17	17	12	15

T: temperature; R: rainfall; DJF: December-January-February; MAM: March-April-May; JJAS: June-July-August-September; ON: October-November.

is about 0.0053, 0.0086, 0.0064, 0.012, and 0.0082 ºC year^{-1} for DJF, MAM, JJAS, ON and the annual average, respectively. The average rainfall for this location is 5.15, 22.73, 117.27, 18.23, and 163.4 mm for DJF, MAM, JJAS, ON and the annual average, respectively. The slope of rainfall is 0.04, 0.03, 0.219, 0.04, and 0.3 mm year^{-1} for DJF, MAM, JJAS, ON and the annual avergae, respectively. The average percentage change of temperature and rainfall for the periods 1931-1960, 1961-1990, and 1991-2014 with respect to the previous period (i.e, 1901-1930, 1931-1960, and 1960-1990, respectively) is shown in Table II. In recent decades, temperature in all seasons has increased with respect to the previous year, except during winter. When the rainfall amount of recent decades (1991-2014) is compared with the previous years, a significant increase in rainfall is observed in the pre-monsoon period, which is indicative of the increased frequency of convective events over this region. However, in the case of the monsoon season, average rainfall increased 12.39% in the period 1931-1960 with respect to the previous period (1901-1930). For winter and post-monsoon seasons, significant interannual variability has been observed. This phenomenon reveals significant non-monsoon rainfall over this region. The Man-Kendall test and Sen's slope estimator has been applied to the time series data of temperature and rainfall for the period 1901-2014. Man-Kendall *Z* statistics value has been derived for 5% significance level and shown in Tables SI and SII (in the supplementary material) for temperature and rainfall, respectively. A statistically significant increasing trend ($p < 0.05$) of temperature is observed for all months except January. A statistically significant increasing trend is observed for rainfall during most of the months.

3.3 Descriptive statistics of rainfall

Mean annual rainfall in the area during the study period was 163 mm with 182.44 mm standard deviation and 86.38 CV. Over this region, maximum rainfall occurs in the monsoon season, mainly in July, and minimum during winter. The Indian Summer Monsoon (ISM) contributes about 61% of the total rainfall. The pre-monsoon and post-monsoon periods also contribute with a substantial amount of rainfall (around 15.88 and 19.1% of the total rainfall, respectively). This reveals that a significant amount of non-monsoon rainfall occurs over this region, which is mainly originated from local convective activities. The highest and lowest CV was recorded in December and July, respectively. DJF shows the highest CV compared to the other three seasons, which implies more interannual variability for this season. JJAS

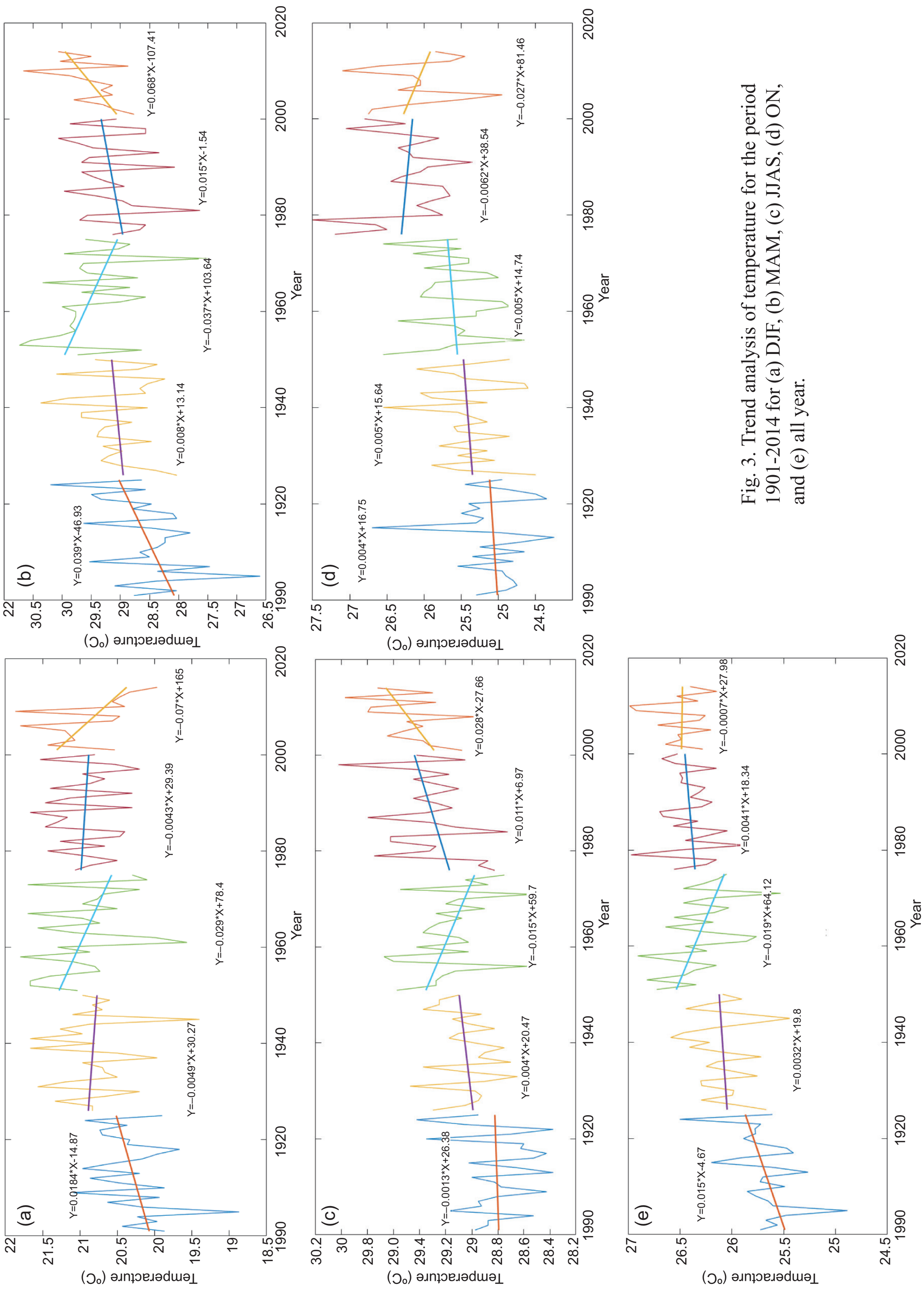

Fig. 3. Trend analysis of temperature for the period 1901-2014 for (a) DJF, (b) MAM, (c) JJAS, (d) ON, and (e) all year.

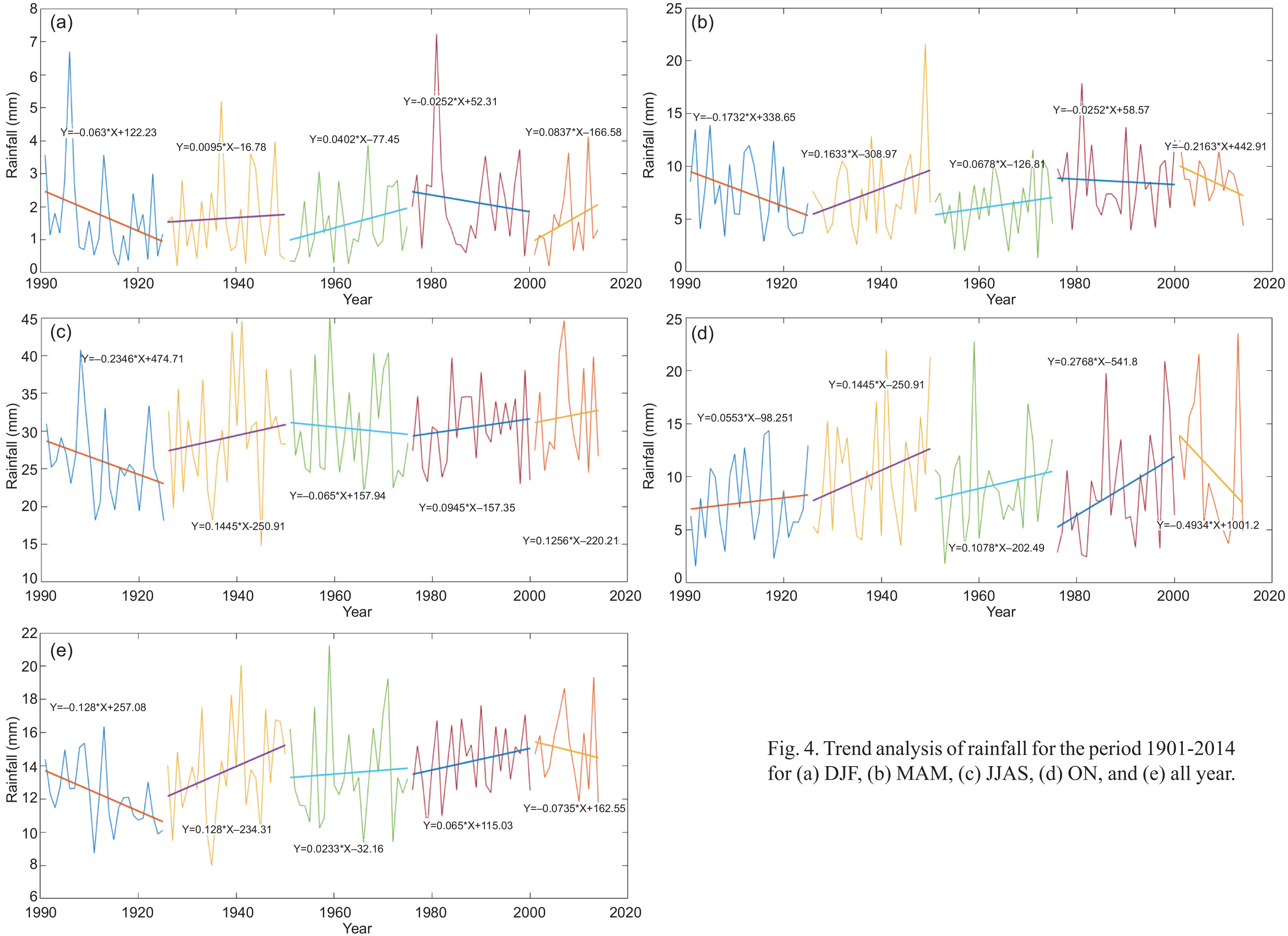

Fig. 4. Trend analysis of rainfall for the period 1901-2014 for (a) DJF, (b) MAM, (c) JJAS, (d) ON, and (e) all year.

Table II. Changes in temperature and rainfall in a 30 years span with respect to the previous 30 years.

Season	Changes in temperature			Changes in rainfall		
	1931-1960 wrt 1901-1930	1961-1990 wrt 1931-1960	1991-2014 wrt 1961-1990	1931-1960 wrt 1901-1930	1961-1990 wrt 1931-1960	1991-2014 wrt 1961-1990
DJF	2.87	–0.55	–0.08	–8.99	19.95	–4.92
MAM	2.63	–0.71	0.88	0.43	7.52	8.65
JJAS	0.95	0.19	0.85	12.39	0.50	3.83
ON	1.52	1.64	0.89	24.62	–18.17	17.03

DJF: December-January-February; MAM: March-April-May; JJAS: June-July-August-September; ON: October-November; wrt: with respect to.

shows the lowest inter-annual variability. Rainfall anomalies also show large interannual variability (Fig. 5), with low values indicating extreme drought conditions. Over this location, lower values of *Z* have decreased since 1975. High values of PCI (16-20), shown in Figure 6, have been observed for the periods 1951-1975 and 1976-2000.

PDSI data have been utilized to investigate the extent of meteorological drought for the period 1901-2005. The yearly variation of PDSI data over this location is shown in Figure 7. PDSI values fluctuate between –5 and +5. Negative (positive) values represent dry (wet) conditions, while the value indicates the intensity. The number of years with dry conditions have increased. However, the intensity of dryness is very near zero. A clear difference between 1901-1950 with respect to 1951-2000 is observed in Figure 7, which reveals that the value of PDSI decreased for the period 1951-2000 indicating a decreased intensity of dryness in Kolkata.

4. Conclusions

Kolkata, located near the land-ocean boundary of the Bay of Bengal, is one of the important cities of India and contributes significantly to the GDP of the country, together with its surrounding region, in which significant agricultural activities take place. Long-term variations of temperature and precipitation over this region are analyzed in this paper, using gridded monthly data obtained from the GPCC for the period 1901-2014. The trend

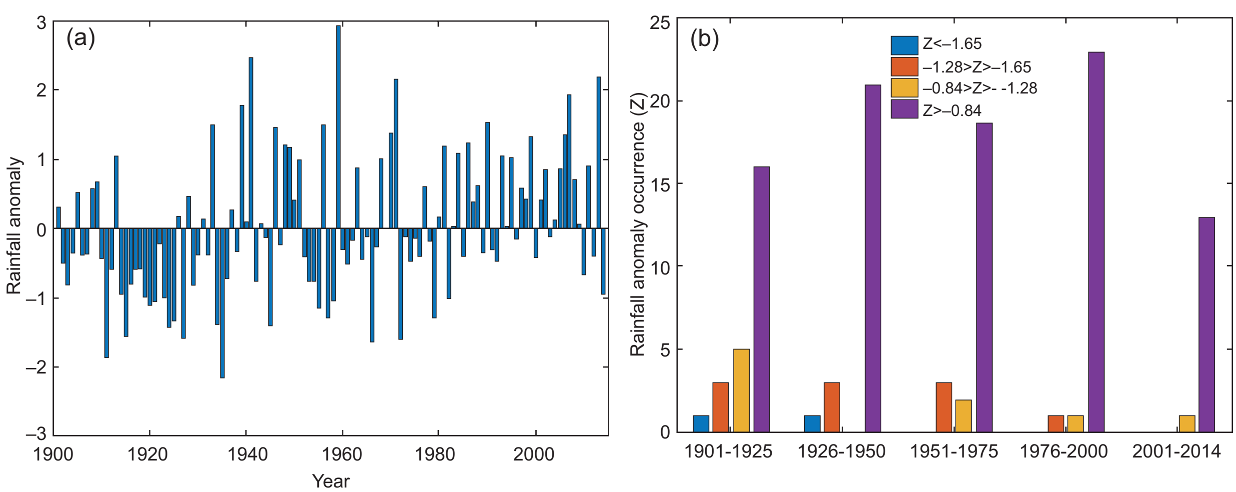

Fig. 5. (a) Yearly variation of rainfall anomalies, (b) rainfall anomalies occurrence for the different periods from 1901 to 2014.

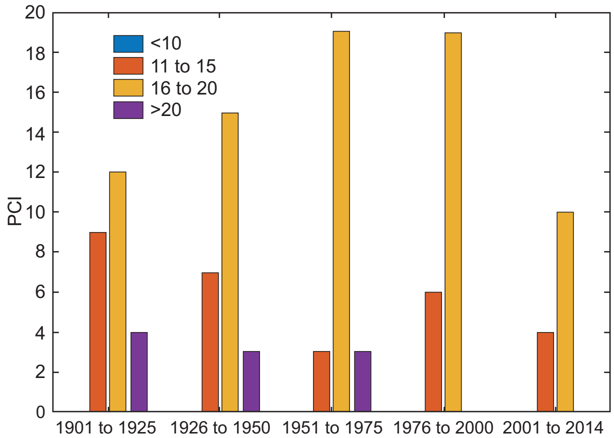

Fig. 6. Precipitation concentration index (PCI) for the different periods of this study.

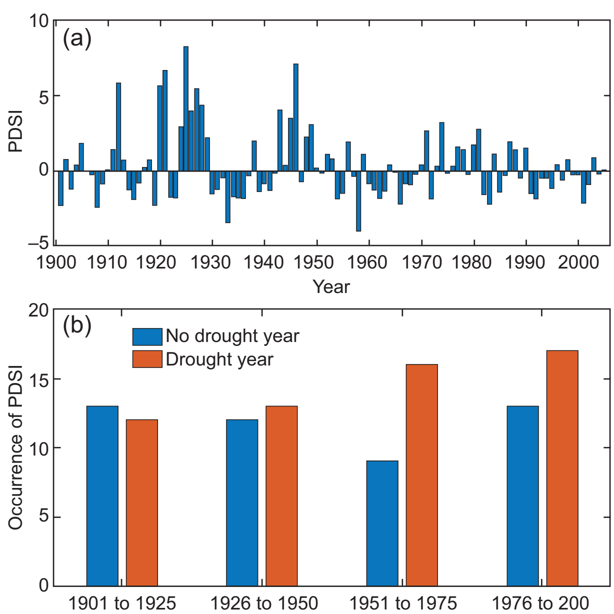

Fig. 7. (a) Yearly variations of the Palmer Drought Severity Index (PDSI), (b) PDSI for the different periods of this study.

analysis is performed for four different seasons: December-February (DJF), March-May (MAM), June-September (JJAS), and October- November (ON). Statistical parameters, namely, CV, precipitation anomalies, and PCI were calculated to characterize the climate of the region. Furthermore, non-parametric tests (Man-Kendall and Sen's slope estimator) were used to detect changes in trends of rainfall and temperature. The PDSI has also been observed to examine the extent of meteorological drought. The main conclusions are listed below:

The number of years greater than the average temperature value for DJF, MAM, and JJAS has increased for the period 1991-2014 with respect to the previous period. For rainfall, a greater number of years lower than average value has been observed for the periods 1901-1930 and 1961-1990. However, total rainfall for the period 1991-2014 shows a higher value with respect to the other three periods.

A detailed analysis of seasonal temperature and rainfall values has been done and the numerical figures have been calculated. The average temperature for DJF, MAM, JJAS, and ON over this location is 20.7, 29.11, 29.13, and 25.64 ºC, respectively. The average rainfall is highest during the monsoon season (117 mm) due to the ISM. The annual slope of temperature is 0.0082 ºC year^{-1} and rainfall is 0.03 mm year^{-1}. Significant increases in non-monsoon rainfall have been observed in recent decades, which is an indicator of an increase in local convective activities over this region. Average rainfall has also increased during the monsoon season. Interannual variability of rainfall has been observed in winter and the post-monsoon season, which reveals the uncertainty of non-monsoon rainfall over this region. A statistically significant increasing trend has been observed for most of the months for temperature and rainfall.

Winter shows the highest CV compared to the other three seasons, which implies more interannual variability for this season. The monsoon season shows the lowest inter-annual variability, as every year a significant amount of rain occurs during this period due to the ISM. Rainfall with high PCI (16-20) has been observed for the periods 1951-1975 and 1976-2000.

As an indicator of meteorological drought over this region, analysis of the PDSI indicates that though the number of years with dry conditions has increased, the intensity of dryness has decreased.

This long-term study of temperature and rainfall based on GPCC observations over Kolkata and the surrounding region will be helpful to understand the climate change over this location. It will also help the smallholder farmers for resilient farming and designing adaptation strategies for agricultural activities in climate change conditions.

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Supplementary Material

Table SI. Statistics of temperature.

	Min (ºC)	Max (ºC)	Average (ºC)	Standard deviation	Slope	Man-Kendall test	Sen's slope
January	17.9	21.6	19.68	0.87	–0.0045	–1.68	–0.004
February	18.3	25.2	22.57	1.017	0.019	4.05	0.01
March	24.3	29.5	27.04	1.025	0.01	3.38	0.01
April	26.8	32.2	29.76	1.057	0.008	2.64	0.007
May	28.7	33.1	30.55	0.91	0.0069	2.55	0.006
June	27.7	31.7	29.93	0.86	0.0075	3.13	0.007
July	28	30.3	28.94	0.41	0.0057	4.85	0.005
August	27.6	29.7	28.83	0.43	0.0073	6.27	0.007
September	27.9	29.7	28.81	0.38	0.0051	4.77	0.005
October	26	28.9	27.5	0.58	0.0088	5.56	0.009
November	22.1	26.7	23.79	0.91	0.015	6.51	0.015
December	17.7	21.6	20.02	0.76	0.0095	4.55	0.009
DJF	18.8	21.8	20.7	0.5	0.0053	3.09	0.005
MAM	26.6	30.7	29.11	0.74	0.0086	4.23	0.008
JJAS	28.4	30	29.13	0.35	0.0064	6.71	0.006
ON	24.2	27.5	25.64	0.66	0.012	7.17	0.013
Annual	24.9	26.9	26.16	0.39	0.0082	7.58	0.007

DJF: December-January-February; MAM: March-April-May; JJAS: June-July-August-September; ON: October-November.

Table SII. Statistics of rainfall.

	Min (mm)	Max (mm)	Mean (mm)	Standard deviation	%	CV	Slope	Man-Kendall test	Sen's slope
January	0.1	9.7	1.63	1.96	0.99	120.17	0.002	0.73	–0.007
February	0.2	16.3	2.96	2.81	1.81	94.83	–0.005	1.60	0.025
March	0.1	21.1	3.79	3.87	2.32	101.92	–0.0018	1.048	–0.007
April	0	20	5.60	4.21	3.42	75.10	0.005	1.02	–0.083
May	0.9	47.8	13.33	7.78	8.16	58.30	0.032	1.81	–0.013
June	3.5	63.8	26.48	12.69	16.20	47.92	0.027	1.24	–0.05
July	9.2	70.9	33.07	11.51	20.24	34.81	0.0431	1.56	0.03
August	12.7	58.1	31.79	11.29	19.46	35.51	0.064	1.82	–0.07
September	11.3	56	25.92	10.38	15.86	40.05	0.083	2.38	0.076
October	0	43.4	13.43	8.69	8.22	64.72	0.032	0.88	–0.11
November	0	26.1	4.80	4.30	2.94	89.51	0.008	0.95	–0.015
December	0	11.6	0.55	1.53	0.34	273.70	0.0026	–0.49	0
DJF	0.2	7.23	1.77	1.28	3.59	162.90	0.0014	0.76	–0.17
MAM	1.3	21.57	7.58	3.38	15.88	78.45	0.0122	1.66	–0.17
JJAS	14.8	44.92	29.32	6.39	61.42	39.585	0.054	2.89	–0.13
ON	1.55	23.5	9.12	4.96	19.10	77.193	0.023	0.97	–0.007
Annual	7.98	21.26	13.62	2.61	–	86.38	0.025	3.50	–0.48

DJF: December-January-February; MAM: March-April-May; JJAS: June-July-August-September; ON: October-November.