Vol : 12, Issue: 1
June 2025

International Journal of Electronics and Applied Research (IJEAR)

Climatic Temperature: An Approach to measure Its Change

Dhritikesh Chakrabarty*
Independent Researcher
Associate Professor (Retd.) of Statistics, Handique Girls' College, Guwahati-781001, India
dhritikesh.c@rediffmail.com , dhritikeshchakrabarty@gmail.com

Article History : 1st received: February 14, 2025, Final :March 2, 2025

Abstract

Temperature, termed in this article as climatic temperature, is the most important factor that determines the climate of a place or region. Climatic temperature changes continuously over time. Testing of significance of change, whose methods are available in standard literature of statistics, is necessary but not sufficient since it can only identify whether the change is significant but cannot measure the amount of change. Attempt has here been made on developing an approach to measure overall change in a group of variables in general and to measure overall change in climatic temperature in particular. This article describes this measure along with its numerical application in the context of climatic temperature in Assam.

Key Words: *Climatic Temperature, Measure of Change, Temperature Index, Climatic Change in Assam*

* *A part of the work of the MS was presented by the author at the IConEAST-24 held at Gauhati University in November 2024*

1. Introduction:

Temperature, termed in this article as **climatic temperature** (abbreviated as **CT**), is the most important factor that determines the climate of a place or region and also the globe. It changes continuously over time and its change occurs basically due to two types of causes namely :

(1) Assignable Cause (that contains not only a single one cause but many causes that are imposed and accordingly are controllable).

& (2) Chance Cause (that contains the cause which occurs accidently and accordingly is not controllable)

and the change can be regarded as significant if & only if it occurs due to both the causes and as insignificant if & only if it occurs due to chance cause only [Chakrabarty (2005 , 2011 , 2014*a* , 2014*b*)].

There is necessity of testing/examining the significance of change, whose methods are available in standard literature of statistics [Lehmann & Romano (2023) ; Michael & Erica (2022)], in order to determine whether the change occurs due to both the causes or due to the chance cause only, because, the task of controlling the change arises only when the change occurs due to assignable cause (or causes). However, testing of significance of change is necessary but not sufficient since it can only identify whether the change is significant but cannot measure the amount of change

There had been several studies on identifying the significance of change of **CT** at a place as well as on its central tendency [Bordoloi & Chakrabarty (2015 , 2015 – 16 , 2018) ; Bordoloi , Chakrabarty & Kashyap (2021) ; Chakrabarty (2005 , 2015*a* , 2015*b* , 2020*b*] and its confidence interval (also natural extremum) within a temperature periodic year [Bordoloi & Chakrabarty (2016 , 2017) ; Bordoloi , Chakrabarty & Kashyap (2017) ; Chakrabarty (2005 , 2011 , 2014*a* , 2014*b* , 2015 – 16)]. On the other hand, it is also essential to know the degree or amount of change in climatic temperature at a location or at the glove over time.

Attempt has here been made on developing a measure, based on the philosophy of **average** [Bakker (2003) ; Miguel (2016)], of change of **CT** over different situations in general and over time in particular. This article describes this measure along with its numerical application in the context of climatic temperature in Assam.

The measure developed here, has been derived by applying the philosophy/concept introduced by Pythagoras [Huffman (2014) ; Kahn (2001)] in developing three basic measures of averages namely arithmetic mean, geometric mean and harmonic mean known as Pythagorean means [Chakrabarty (2016 , 2019*a* , 2021*a* , 2021*b* , 2024*c*) ; Coggeshall (1886)] from which a number of definitions / formulations of average had been derived some of them are quadratic mean or root mean square of which are square root mean , cubic mean, cube root mean, generalized *p mean* & generalized p^{th} root mean etc. [Chakrabarty (2016 , 2017 , 2018 , 2019*b* , 2020*a*)] and also from which four formulations of average have recently been derived which are Arithmetic-Geometric Mean, Arithmetic-Harmonic Mean, Geometric-Harmonic Mean and Arithmetic-Geometric-Harmonic respectively [Chakrabarty (20201*a*)].

In statistics, Pythagorean means are used in measuring the central tendency of data [Ali, Bhaskar, & Sudheesh (2019) ; Argyrous (1997) ; Herbert (1992) ; Jain Sharad & Vijay (2019) ; Kelly & Beamer (1986); Malakar (2023) ; Manikandan (2011) ; Weisberg (1992) ; Williams (1984)]. Recently, it has been established that in addition to the three Pythagorean means, the four formulations of average derived from them can also be used as mathematical measures of central tendency of data. [Chakrabarty (2021*c* , 2022)] which implies that average is a basis of mathematical measures of central tendency of data. Moreover, Pythagorean means can be hypothesized as a tool of constructing measures of various characteristics of data [Chakrabarty (2016)]. One common characteristic of data in addition to central is dispersion [Anderson & Finn (1996) ; John (2024) ; Kelly & James (1986) ; Malakar (2023) ; Moore (2010) ; Murray & Larry (2018)]. Recently, it has been shown that average is also a basis of mathematical measures of dispersion of data [Chakrabarty (2024*b*)]. In another study, an art was shown on how to apply Pythagorean geometric mean, which carries a beautiful multiplicative property [Chakrabarty (2024*a*)] in finding a suitable measure of overall change in a group of variables [Chakrabarty (2019*a*)]. This art has here been applied in deriving a measure/formulation of overall change of **CT** over two different situations, in this study. The formulation has been applied in estimating **climatic temperature index** (abbreviated as **CTI**) at the five cities Dhubri, Dibrugarh , Guwahati , Silchar & Tezpur in order to obtain estimate of its change over the last fifty years at these five cities.

2. Climatic Temperature and Data:

CT is a continuous function of time. But data are collectable at time points only and hence discrete in nature. The meteorological department, after collecting observations, keeps record of daily data on maximum temperature, minimum temperature, average temperature etc. of **CT** at different time points. Thus :

Daily Maximum, Daily Minimum & Daily Average data on **CT** can be made available.

Moreover, data on daily median of **CT** are also obtainable from daily maximum & daily minimum.

From daily data as mentioned above, data on

Monthly Maximum, Monthly Minimum, Monthly Average & Monthly Median as well as on Annual Maximum, Annual Minimum, Annual Average & Annual Median are obtainable.

Thus, the total number of observations, in a year, on any of the above measures of **CT** is to be 365 for daily data in a normal year (366 for daily data in a leap year), 12 for monthly data, & 1 for annual data.

Changes in the 365 observations for daily data and/or 12 observations for monthly data, on any measure, over years may not be monotonic. Changes in some observations may not be found in the same direction of the overall change of the measure over two different situations (years, locations etc.).

The overall change in the set of observations, over two different situations, is usually regarded/accepted as the behavioral change of the measure.

3. Climatic Temperature – A Measure of Change:

Let us consider some characteristic T T of **CT** at a place.

Suppose,

$$T_1 , T_1 , T_2 , T_2 , \ldots\ldots\ldots , T_n \; T_n$$

are n variables representing the characteristic corresponding to the situations (which may be different days, different months, different years, different places etc.)

$$1 , 2, \ldots\ldots\ldots , n$$

respectively.

Then $T_1 , T_1 , T_2 , T_2 , \ldots\ldots\ldots , T_n \; T_n$ form a group of n variables.

Suppose,

$$T_{1b} \, T_{1b} , T_{2b} \, T_{2b} , \ldots\ldots\ldots , T_{nb} \, T_{nb}$$

are the values of the respective variables in the situation 'b'

and

$$T_{1c} \, T_{1c} , T_{2c} \, T_{2c} , \ldots\ldots\ldots , T_{nc} \, T_{nc}$$

are the values of the respective variables in the situation 'c'.

Let the values in the situation ‘c’ be respectively

$$k_1 k_1 \, , \, k_2 k_2 \, , \ldots\ldots\ldots\ldots , \, k_n k_n$$

times of the corresponding values in a situation ‘b’.

Then

$$T_{1c} T_{1c} = k_1 T_{1b} k_1 T_{1b} \, , \, T_{2c} T_{2c} = k_2 T_{2b} k_2 T_{2b} \, , \ldots\ldots\ldots\ldots , \, T_{nc} T_{nc} = k_n k_n T_{nb} T_{nb}$$

This means,

$$k_1 k_1 \, , \, k_2 k_2 \, , \ldots\ldots\ldots\ldots , \, k_n k_n$$

are the respective multiples of

$$T_{1b} T_{1b} \, , \, T_{2b} T_{2b} \, , \ldots\ldots\ldots\ldots , \, T_{nb} T_{nb}$$

such that $(k_1 k_1 x_{1b} T_{1b} T_{1b})(k_2 k_2 T_{2b} T_{2b}) \ldots\ldots\ldots (k_n k_n T_{nb} T_{nb}) = T_{1c} T_{1c} \, . \, T_{2c} T_{2c} \, . \ldots\ldots\ldots\ldots . \, T_{nc} T_{nc}$

Now, if k is the overall multiple, equivalently overall relative change, which makes the values

$$T_{1b} T_{1b} \, , \, T_{2b} T_{2b} \, , \ldots\ldots\ldots\ldots , \, T_{nb} T_{nb}$$

changed to to the respective values

$$T_{1c} T_{1c} \, , \, T_{2c} T_{2c} \, , \ldots\ldots\ldots\ldots , \, T_{nc} T_{nc}$$

then $(k \, x_{1b} T_{1b} T_{1b}).(k \, x_{2b} T_{2b}). \ldots\ldots\ldots\ldots .(k \, x_{nb} T_{nb}) = (T_{1c} T_{1c} \, . \, T_{2c} T_{2c} \, . \ldots\ldots\ldots\ldots . \, T_{nc} T_{nc})$

or equivalently, $k^n \, (T_{1b} T_{1b} \, . \, T_{2b} T_{2b} \, . \ldots\ldots\ldots . \, T_{nb} T_{nb}) = (T_{1c} T_{1c} \, . \, T_{2c} T_{2c} \, . \ldots\ldots\ldots\ldots . \, T_{nc} T_{nc})$

which implies,

$$k = \left\{ \frac{(T_{1c} \, .T_{2c} \ldots\ldots\ldots\ldots T_{nc})}{(T_{1b} \, .T_{2b} \, . \ldots\ldots\ldots .T_{nb})} \frac{(T_{1c} \, .T_{2c} \ldots\ldots\ldots\ldots T_{nc})}{(T_{1b} \, .T_{2b} \, . \ldots\ldots\ldots .T_{nb})} \right\}^{1/n}$$

(3.1)

International Journal of Electronics
and Applied Research (IJEAR)

Here,

$$k_1\, k_1 = \frac{T_{1c}}{T_{1b}}\,\frac{T_{1c}}{T_{1b}}\ ,\quad k_2\, k_2 = \frac{T_{2c}}{T_{2b}}\,\frac{T_{2c}}{T_{2b}}\ ,\ \ldots\ldots\ldots\ldots ,\quad k_n\, k_n = \frac{T_{nc}}{T_{nb}}\,\frac{T_{nc}}{T_{nb}}$$

can be interpreted as the relative changes (or change relative) of the respectively variables

$$T_1\,, T_1\,,\ T_2\,, T_2\,,\ \ldots\ldots\ldots\ ,\ T_n\ T_n$$

in the situation 'c' with respect to the situation 'b'.

Therefore, the overall relative change k of the variables in the situation 'c' with respect to the situation 'b' can be defined as the geometric mean of the ratios

$$\frac{x_{1c}}{x_{1b}}\,\frac{T_{1c}}{T_{1b}}\,\frac{T_{1c}}{T_{1b}}\ ,\quad \frac{x_{2c}}{x_{2b}}\,\frac{T_{2c}}{T_{2b}}\,\frac{T_{2c}}{T_{2b}}\ ,\ \ldots\ldots\ldots\ldots ,\quad \frac{x_{nc}}{x_{nb}}\,\frac{T_{nc}}{T_{nb}}$$

Note:

(1) The overall relative change k of the variables $T_1\,, T_1\,,\ T_2\,, T_2\,,\ \ldots\ldots\ldots\ ,\ T_n\ T_n$ in the situation 'c' with respect to the situation 'b' can be termed as the **Change Index** of the variables in the situation 'c' with respect to the situation 'b' .

Usually, the index is expressed as a percentage. Thus, 100 times k can usually be used as a change index of the variables.

Therefore, **CTI** of $T\ T$ in the situation 'c' with respect to the situation 'b', denoted here by $I_{bc}(T)\ I_{bc}(T)$, can usually be defined by

$$I_{bc}(T)\ I_{bc}(T) = \left\{ \frac{(T_{1c}\,.T_{2c}\cdots\cdots\cdots T_{nc})}{(T_{1b}\,.T_{2b}\ .\ \cdots\cdots\cdots .T_{nb})}\,\frac{(T_{1c}\,.T_{2c}\cdots\cdots\cdots T_{nc})}{(T_{1b}\,.T_{2b}\ .\ \cdots\cdots\cdots .T_{nb})} \right\}^{1/n} \times 100 \qquad (3.2)$$

Overall change in the variables $T_1, T_1, T_2, T_2, \ldots\ldots\ldots, T_n\ T_n$ can be interpreted as increasing or decreasing according to the value of $I_{bc}(T)\ I_{bc}(T)$ is greater than 100 or less than 100.

4. Change of Climatic Temperature in Assam:

Temperature Index at Five Cities in Assam

The formulation of **CTI**, **described** above, has been applied in estimating the **CTI** at the five cities Dhubri, Dibrugarh , Guwahati , Silchar & Tezpur in order to obtain estimate of change of **CTI** over the last 50 years at these five cities.

Maximum, Mean Maximum, Minimum, Mean Minimum & Median of **CT** during a period of time can respectively describe/explain the highest level, the lowest level & the tendency of warm in the period. Accordingly, monthly data on these measures of **CT** have been used in the study. **Tables (Nos: 4.1 – 4.5)** show the values Maximum, Mean Maximum, Minimum, Mean Minimum & Median of **CT** at the above five cities. Values of these measures have been calculated from the corresponding primary data collected from Indian Meteorological Department for the year 1973 and from the website

AccuWeather https://www.accuweather.com › january-weather for the year 2023.

Values of **CTI** of each of Monthly Maximum, Monthly Mean Maximum, Monthly Minimum, Mean Minimum, Monthly Mean Minimum & Monthly Median obtained by the application of the formula of **CTI** given by equation (3.2) have been shown in **Table – 4.6**

Moreover, percentage (%) of change of each of these monthly measures in the year 2023 from that in the year 1973 have been computed which have been shown in **Table – 4.7**.

In the table, the symbols "↑" and "↓" have been used to denote increase and decrease respectively.

From the values of Monthly Measures of **CT**, available in **Tables (Nos: 4.1 – 4.5)**, values of the corresponding Annual Measures have been calculated for the years 1973 & 2023. These values have been shown in **Table – 4.8**. Finally, for comparing the changes described by

International Journal of Electronics and Applied Research (IJEAR)

Monthly Measures and Annual Measures, values of percentage (%) of the respective changes have been computed which have been shown in Table – 4.9.

Table – 4.1

CT (in Degree Celsius) at Dhubri in the years 1973 & 2023

Month	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
January	25.2	30.0	22.8	26.16	9.2	9.0	12.0	11.1	17.2	19.5
February	30.3	32.0	27.5	28.25	11.4	9.0	14.1	15.0	20.85	20.5
March	35.6	35.0	30.3	30.48	13.9	15.0	17.0	20.52	24.75	25.0
April	39.6	38.0	33.8	32.87	19.4	17.0	21.4	20.0	29.5	27.5
May	32.8	37.0	30.9	33.52	20.6	20.0	23.4	22.13	26.7	28.5
June	33.2	39.0	30.5	33.43	22.5	23.0	24.4	24.77	27.85	31.0
July	35.6	38.0	32.5	34.65	24.5	25.0	26.4	26.16	30.05	31.5
August	37.0	38.0	32.6	34.26	23.5	24.0	25.9	25.97	30.25	31.0
September	38.8	38.0	31.3	35.17	22.9	23.0	25.0	25.47	30.85	25.0
October	33.8	34.0	29.8	32.19	19.8	20.0	23.1	22.67	26.8	27.0
November	29.6	33.0	26.3	29.4	15.8	14.0	18.5	17.53	22.7	23.5
December	25.1	29.0	23.3	23.77	12.6	11.0	14.1	14.1	18.85	20.0

Table – 4.2

CT (in Degree Celsius) at Dibrugar in the years 1973 & 2023

Month	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
January	25.9	28.33	22.3	24.08	5.7	9.44	10.4	11.74	15.80	18.89
February	28.6	29.44	24.1	24.51	9.1	11.66	12.8	15.26	18.85	20.55
March	34.5	32.22	28.7	26.31	13.0	15.0	15.6	17.54	23.75	23.61
April	34.3	35.0	29.4	28.29	16.8	12.22	19.7	20.11	25.55	23.61
May	34.2	36.11	29.9	28.87	20.1	20.55	22.2	22.21	27.15	28.33
June	35.9	37.22	30.1	30.94	21.3	22.22	23.8	25.54	28.60	29.72
July	30.6	36.66	32.8	31.08	22.9	25.0	25.3	26.29	26.75	30.83
August	36.6	36.66	31.9	31.04	22.5	24.44	25.0	25.09	29.55	30.55
September	35.6	37.22	31.2	33.59	21.1	24.44	23.7	26.79	28.35	30.83

October	34.9	33.88	30.6	30.45	16.1	18.88	20.9	22.91	25.50	26.38
November	29.5	31.66	26.8	28.87	9.6	13.33	14.3	17.22	19.55	22.50
December	25.9	28.33	23.6	25.71	7.3	10.55	9.7	14.23	16.60	19.44

Table – 4.3

CT (in Degree Celsius) at **Guwahati** in the years 1973 & 2023

Month	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
January	26.1	30.0	24.0	25.09	7.0	9.0	11.5	12.12	16.55	19.5
February	31.4	32.0	27.4	27.04	5.0	9.0	11.4	14.72	18.2	20.5
March	35.7	35.0	30.3	29.59	12.0	14.0	16.1	18.32	23.85	24.5
April	39.0	38.0	33.2	31.89	17.0	17.0	19.4	19.57	28.0	27.5
May	33.5	38.0	31.2	32.4	20.3	20.0	22.4	21.56	26.9	29.0
June	35.2	39.0	31.0	32.32	23.4	22.0	24.4	25.54	29.3	30.5
July	36.7	38.0	33.4	33.35	23.5	25.0	25.5	27.17	30.1	31.5
August	36.3	38.0	32.4	32.74	23.9	25.0	24.7	26.97	30.1	31.5
September	34.6	38.0	31.4	34.24	23.3	23.0	24.1	26.48	28.95	30.5
October	33.7	34.0	30.5	31.08	17.8	19.0	21.3	23.44	25.75	26.5
November	29.8	33.0	26.9	29.29	12.4	14.0	16.1	18.74	21.1	23.5
December	26.2	30.0	24.0	25.57	9.5	10.0	11.1	15.33	17.85	20.0

Table – 4.4

CT (in Degree Celsius) at **Silchar** in the years 1973 & 2023

Month	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
January	27.1	30.0	22.1	26.16	9.5	9.0	12.2	11.1	18.3	19.5
February	28.2	31.0	25.4	28.25	11.4	9.0	15.1	15.0	19.8	20.0
March	34.5	35.0	28.1	30.48	14.0	15.0	18.0	17.45	24.25	25.0
April	35.0	38.0	30.4	32.53	18.9	17.0	22.1	20.0	26.95	27.5
May	32.5	37.0	28.4	31.77	20.9	20.0	23.6	22.13	26.7	28.5
June	32.3	39.0	28.2	33.43	22.3	23.0	24.9	24.87	27.3	31.0
July	35.5	38.0	30.4	34.65	24.4	25.0	25.9	26.16	29.95	31.5
August	33.6	38.0	30.0	31.68	23.7	24.0	25.6	25.97	28.65	31.0

September	33.1	38.0	30.0	29.97	23.9	23.0	25.2	25.47	28.5	30.5
October	32.1	34.0	29.5	32.19	19.9	19.0	24.1	22.68	26.0	26.5
November	28.3	33.0	25.2	30.43	14.9	14.0	19.0	17.53	21.6	23.5
December	23.1	23.0	21.5	27.0	11.9	10.0	13.5	14.1	17.5	16.5

Table – 4.5

CT (in Degree Celsius) at **Tezpur** in the years 1973 & 2023

Month	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
January	25.2	28.0	23.9	26.48	10.0	9.0	12.0	11.1	17.6	18.5
February	29.7	31.0	27.7	28.25	11.7	9.0	14.5	13.89	20.7	20.0
March	34.7	35.0	31.3	30.48	14.9	15.0	16.7	17.52	24.8	25.0
April	37.0	38.0	33.2	32.87	19.5	17.0	21.3	20.0	28.25	27.5
May	34.4	37.0	31.1	32.55	20.3	20.0	22.7	22.13	27.35	28.5
June	34.9	39.0	31.9	33.43	22.7	23.0	24.4	24.87	28.8	31.0
July	37.2	38.0	34.0	34.65	23.2	25.0	25.7	26.12	30.2	31.5
August	36.5	38.0	32.9	33.9	23.3	24.0	25.0	25.97	29.9	31.0
September	36.0	38.0	32.3	35.17	22.9	23.0	24.5	23.13	29.45	30.5
October	33.6	34.0	31.7	32.19	17.9	19.0	21.6	26.45	25.75	26.5
November	31.6	33.0	28.8	30.43	13.1	16.0	16.8	17.53	22.35	24.5
December	29.6	29.0	25.0	27.0	10.5	10.0	12.6	14.1	20.05	19.5

Table – 4.6

CTI in the year 2023 with respect to the year 1973

Measure	Temperature Index at				
	Dhubri	Dibrugarh	Guwahati	Silchar	Tezpur
Maximum	106.74	104.41	106.55	110.03	104.41
Mean Maximum	106.49	100.91	102.61	112.32	103.90
Minimum	95.74	116.33	110.96	94.93	99.00
Mean Minimum	100.03	111.73	111.16	97.04	101.78
Median	101.54	107.36	106.90	104.76	102.68

Table – 4.7

Percentage (%) of Change of Monthly Measures of **CT**

Measure	% of Change at				
	Dhubri	Dibrugarh	Guwahati	Silchar	Tezpur
Maximum	6.74 ↑	4.41 ↑	6.55 ↑	10.03 ↑	4.41 ↑
Mean Maximum	6.49 ↑	0.91 ↑	2.61 ↑	12.32 ↑	3.90 ↑
Minimum	4.26 ↓	16.33 ↑	10.96 ↑	5.07 ↓	1.00 ↓
Mean Minimum	0.03 ↑	11.73 ↑	11.16 ↑	2.96 ↓	1.78 ↑
Median	1.54 ↑	7.36 ↑	6.90 ↑	4.76 ↑	2.68 ↑

Table – 4.8
Annual measure of **CT** (in Degree Celsius)

Station	Measure									
	Maximum		Mean Maximum		Minimum		Mean Minimum		Median	
	1973	2023	1973	2023	1973	2023	1973	2023	1973	2023
Dhubri	39.60	39.00	29.30	31.19	9.20	9.00	20.47	20.48	24.40	24.00
Dibrugarh	36.60	37.22	28.48	28.67	5.70	9.44	18.65	20.43	21.15	23.33
Guwahati	39.00	39.00	29.65	30.39	5.00	9.00	19.04	22.39	22.00	24.00
Silchar	35.50	39.00	27.44	30.72	9.50	9.00	20.79	20.23	22.50	24.00
Tezpur	37.20	39.00	30.32	31.46	10.50	9.00	19.84	20.27	23.85	24.00

Table – 4.9
Percentage (%) of Change of Monthly & Annual Measures of **CT**

Measure	% of Change at				
	Dhubri	Dibrugarh	Guwahati	Silchar	Tezpur
Maximum (Monthly) Maximum (Annual)	6.74 ↑ 0	4.41 ↑ 1.69 ↑	6.55 ↑ 0	10.03 ↑ 9.86 ↑	4.41 ↑ 4.84 ↑
Mean Maximum (Monthly) Mean Maximum (Annual)	6.49 ↑ 6.48 ↑	0.91 ↑ 0.77 ↓	2.61 ↑ 2.36 ↑	12.33 ↑ 12.04 ↑	3.90 ↑ 3.76 ↑
Minimum (Monthly) Minimum (Annual)	4.26 ↓ 2.22 ↓	16.33 ↑ 65.61 ↓	10.96 ↑ 80.0 ↑	5.07 ↓ 5.26 ↓	1.00 ↓ 14.29 ↓
Mean Minimum (Monthly) Mean Minimum (Annual)	0.03↑ 0.50 ↑	11.73 ↑ 9.54 ↑	11.16 ↑ 17.89 ↑	2.96 ↓ 2.88 ↓	1.78 ↑ 2.02 ↑

Median (Monthly) Median (Annual)	1.54 ↑ 1.64 ↑	7.36 ↑ 10.31 ↑	6.90 ↑ 9.09 ↑	4.76 ↑ 6.67 ↑	2.68 ↑ 0.63 ↑

4. Conclusion:

The following are some notable observations obtained in the study:

(1) Annual measure of temperature (like Annual Maximum, Annual Minimum etc.) which are based on a single observation may be likely to be affected by random fluctuation and hence its value may be an outlier. Accordingly, findings on the overall change of temperature based on such annual measures may not be accurate. This has been observed in a few cases in this study.

(2) The probability that the 12 variables associated with a monthly measure are affected simultaneously by random fluctuations is less than the probability that the only variable associated with the respective annual measure is affected by random fluctuation. Hence, the accuracy of the findings on the overall change based on the corresponding monthly measure is more than that based on the respective annual measure.

(3) The probability that the 365 variables associated with a daily measure are affected simultaneously by random fluctuations is least among the three such probabilities corresponding to the respective daily measure, monthly measure and annual measure. Hence, the accuracy of the findings on the overall change based on the corresponding daily measure is highest among the three accuracies of the respective findings yielded by the respective three measures.

(4) If the chain index is calculated in every year with respect to the just preceding year and recorded then the index in any year with respect to some past year, though long, can be calculated even if the past primary data on daily, monthly & annual measures are found missing.

Based on the findings of the study, it can be reasonable to pass the following recommendations:

(1) The formula for measuring temperature index, described above, is a valid measure of overall change of climatic temperature.

(2) The chain property of the formula of the measure can reduce the computational load when overall relative changes in the same group of variables are to be computed for many situations.

(3) The similar technique, which has here been applied in measuring the overall change in climatic temperature, can be applied in measuring the overall change in other variables also.

(4) The overall discomfort due to maximum climatic temperature has increased by up to 6.7% at Dhubri, 4.4% at Dibrugarh , 6.5% at Guwahati, 10.0% at Silchar & at 4.4% Tezpur.
while the overall discomfort due to minimum climatic temperature has increased by up to 4.2% at Dhubri, 5.9% at silchar & at 1.0% Tezpur

and

has decreased by 16.3% at Dibrugarh & 10.9% at Guwahati, 10.0% at Silchar & at 4.4% Tezpur over the last 50 years (1973 − 2023) .

References:

Ali Zulfiqar; Bhaskar, S Bala & Sudheesh K (2019), Descriptive Statistics: Measures of Central Tendency, Dispersion, Correlation and Regression, *Airway*, 2(3), 120 – 125. DOI: 10.4103/ARWY.ARWY_37_19 .

Anderson T. W. & Finn J. D. (1996), Measures of Variability. In: The New Statistical Analysis of Data, Springer, New York, NY. https://doi.org/10.1007/978-1-4612-4000-6_4 .

Argyrous G. (1997), Measures of Central Tendency and Measures of Dispersion, *In: Statistics for Social Research*, Palgrave, London. https://doi.org/10.1007/978-1-349-14777-9_4 .

Bakker Arthur (2003), The Early History of Average Values and Implications for Education", *Journal of Statistics Education*, 11(1), 17 – 26.

Bordoloi R. S. & Chakrabarty D. (2015), Central Tendency of Annual Extremum of Ambient Air Temperature at Tezpur Based on Midrange and Median, *J. Chem. Bio. Phy. Sci.*, Sec. C, 5(4), 4397 – 4410. www.jcbsc.org .

Bordoloi R. S. & Chakrabarty D. (2015 – 16), Annual Extremum of Ambient Air Temperature at Dibrugarh: Determination of Central Tendency, *J. Chem. Bio. Phy. Sci.*, Sec. C, 6(1), 212 – 233. www.jcbsc.org .

Bordoloi R. S. & Chakrabarty D. (2016), Confidence Interval of Annual Extremum of Ambient Air Temperature at Guwahati, *Journal of Mathematics and Systems*, 12(1–2), 55 – 62. www.abjni.com .

Bordoloi R. S. & Chakrabarty D. (2017), Confidence Interval of Annual Extremum of Ambient Air Temperature at Dibrugarh, *Aryabhatta Journal of Mathematics & Informatics*, 9(1), 85 – 94. www.abjni.com .

Bordoloi R. S. , Chakrabarty D. & Kashyap M. P. (2017), Confidence Interval of Annual Extremum of Ambient Air Temperature at Silchar, *International Journal of Advanced Research in Science, Engineering and Technology*, 4(11), 4868 – 4875. www.ijarset.com .

International Journal of Electronics
and Applied Research (IJEAR)

Bordoloi R. S. & Chakrabarty D. (2018), Central Tendency of Annual Extremum of Ambient Air Temperature at Dhubri, *Aryabhatta Journal of Mathematics & Informatics*, 10(1), 115 – 124. www.abjni.com .

Bordoloi R. S. , Chakrabarty D. & Kashyap M. P. (2021), Central Tendency of Annual Extremum of Ambient Air Temperature at Silchar, *Kalyan Bharati*, 37(IX), 32 – 45. https://www.researchgate.net/publication/351618003_CENTRAL_TENDENCY_OF_ANNUAL_EXTREMUM_OF_AMBIENT_AIR_TEMPERATURE_AT_SILCHAR .

Chakrabarty D. (2005), Probabilistic Forecasting of Time Series, *Report of the UGC Awarded Post Doctoral Research Project* (2003 – 2005). DOI: 10.13140/RG.2.2.12952.98569.

Chakrabarty D. (2011), Determination of Natural Extrema of Temperature in the contest of Assam, *Report of the UGC Awarded Research Project* (2010 – 2011). DOI: 10.13140/RG.2.2.26374.75840 .

Chakrabarty D. (2014*a*), Temperature in Assam: Natural Extreme Value, *J. Chem. Bio. Phy. Sci.*, Sec. C, 4 (2), 1479 –1488. www.jcbsc.org .

Chakrabarty D. (2014*b*), Natural Interval of Monthly Extreme Temperature in the Context of Assam, *J. Chem. Bio. Phy. Sci.* Sec. C, 4 (3), 2424 –2433. www.jcbsc.org .

Chakrabarty D. (2015*a*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati, *J. Chem. Bio. Phy. Sci.*, Sec. C, 5(3), 2863 – 2877. www.jcbsc.org .

Chakrabarty D. (2015*b*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati Based on Midrange and Median, *J. Chem. Bio. Phy. Sci.*, Sec. D, 5(3), 3193 – 3204. www.jcbsc.org .

Chakrabarty D. (2015 – 16), Confidence Interval of Annual Extremum of Ambient Air Temperature at Guwahati, *J. Chem. Bio. Phy. Sci.*, Sec. C, 6(1), 192 – 203. www.jcbsc.org .

Chakrabarty D. (2016): "Pythagorean Mean: Concept behind the Averages and Lot of Measures of Characteristics of Data", NaSAEAST- 2016, *Abstract ID: CMAST_NaSAEAST (Inv)-1601)*, 2016. DOI: 10.13140/RG.2.2.27022.57920 .

Chakrabarty D. (2017), Objectives and Philosophy behind the Construction of Different Types of Measures of Average, NaSAEAST- 2017, *Abstract ID: CMAST_NaSAEAST (Inv)- 1701.* DOI: 10.13140/RG.2.2.23858.17606 .

Chakrabarty D. (2018), General Technique of Defining Average, NaSAEAST- 2018, *Abstract ID: CMAST_NaSAEAST -1801 (I)*. DOI: 10.13140/RG.2.2.22599.88481 .

Chakrabarty D. (2019*a*), Pythagorean Geometric Mean: Measure of Relative Change in a Group of Variables, NaSAEAST- 2019, *Abstract ID: CMAST_NaSAEAST-1902 (I).* DOI: 10.13140/RG.2.2.29310.77124 .

Chakrabarty D. (2019*b*), One General Method of Defining Average: Derivation of Definitions/Formulations of Various Means, *Journal of Environmental Science, Computer Science and Engineering & Technology*, Sec. C, 8(4), 327 – 338, www.jecet.org .

Chakrabarty D. (2019*c*), A General Method of Defining Average of Function of a Set of Values, *Aryabhatta Journal of Mathematics & Informatics*, 11(2), 269 – 284. www.abjni.com .

Chakrabarty D. (2020*a*), Definition / Formulation of Average from First Principle, *Journal of Environmental Science, Computer Science and Engineering & Technology*, Sec C, 9(2), 151 – 163. www.jecet.org . DOI: 10.24214/jecet.C.9.2.15163.

Chakrabarty D. (2020*b*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati by AGHM, *International Journal of Advanced Research in Science, Engineering and Technology*, 7(12), 16088 – 16098. www.ijarset.com .

Chakrabarty D. (2021*a*), Four Formulations of Average Derived from Pythagorean Means, *International Journal of Mathematics Trends and Technology*, 67(6), 97 – 118. http://www.ijmttjournal.org . doi:10.14445/22315373/IJMTT-V67I6P512 .

Chakrabarty D. (2021*b*), Recent Development on General Method of Defining Average: A Brief Outline, *International Journal of Advanced Research in Science, Engineering and Technology*, 8(8), 17947 – 17955. www.ijarset.com.

Chakrabarty D. (2021*c*), Measuremental Data: Seven Measures of Central Tendency, *International Journal of Electronics and Applied Research*, 8(1), 15 – 24. www.eses.net.in .

Chakrabarty D. (2022), AGM, AHM, GHM & AGH: Measures of Central Tendency of Data, *International Journal of Electronics and Applied Research*, 9(1), 1 – 26. http://eses.net.in/online_journal.html .

Chakrabarty D. (2024*a*), Beautiful Multiplicative Property of Geometric Expectation, *Partners Universal International Innovation Journal*, 02(02), 92 – 98. www.puiij.com . DOI: 10.5281/zenodo.10999414 .

Chakrabarty D. (2024*b*), Average: A Basis of Measures of Dispersion of Data, *International Journal of Advanced Research in Science, Engineering and Technology*, 11(7), 22053 – 22061. www.ijarset.com .

Chakrabarty D. (2024*c*): "Extended Inequality Satisfied by Pythagorean Classical means", *Partners Universal International Innovation Journal*, 02(04), 15 – 18. www.puiij.com . DOI: 10.5281/zenodo.13621318 .

Coggeshall F. (1886), The Arithmetic, Geometric, and Harmonic Means, *The Quarterly Journal of Economics*, 1(1), 83−86. https://doi.org/10.2307/1883111 . https://www.jstor.org/stable/1883111 .

Herbert F. Weisberg (1992), Central Tendency and Variability, Series: Quantitative Applications in the Social Sciences", Issue 83, ", Chapter- 4, 46 − 75, Sage Publication, London.

Huffman, Carl (2014), *A History of Pythagoreanism*, Cambridge University Press. p. 168. ISBN 978-1139915984.

Kahn Charles H. (2001), *Pythagoras and the Pythagoreans: A Brief History*, Indianapolis, Indiana and Cambridge, England: Hackett Publishing Company. ISBN 978-0-87220-575-8. OCLC 46394974 – via Internet Archive.

Jain Sharad K. & Vijay P. Singh (2019), Key Statistical Measures of Data, Chap. 18.2 in *Engineering Hydrology: An Introduction to Processes, Analysis, and Modeling*, McGraw-Hill Education, New York. https://www.accessengineeringlibrary.com/content/book/9781259641978/toc-chapter/chapter18/section/section6 .

John H. Mc Donald (2024), Statistics of Dispersion, Sec 3.2, Statistics LibreTexts , https://stats.libretexts.org .

Kelly Ivan W. & Beamer James E. (1986), Central Tendency and Dispersion: The Essential Union, *The Mathematics Teacher*, 79(1), 59 – 65. *JSTOR*, http://www.jstor.org/stable/27964757.

Lehmann E. L. & Romano Joseph P. (2023), *Testing Statistical Hypotheses*, Springer Cham. DOI: https://doi.org/10.1007/978-3-030-70578-7. Softcover ISBN: 978-3-030-70580-0.

Malakar I. M. (2023), Conceptualizing Central Tendency and Dispersion in Applied Statistics, *Cognition*, 5(1), 50 – 62. https://doi.org/10.3126/cognition.v5i1.55408 .

Manikandan S. (2011), Measures of Central Tendency: Median and mode, *Journal of Pharmacology and Pharmacotherapeutics*, 2(3), 214 – 215, 2011. DOI: 10.4103/0976-500X.83300 .

Michael P. Fay & Erica H. Brittain (2022), *Statistical Hypothesis Testing in Context Reproducibility, Inference & Science*, Cambridge University Press. Online ISBN: 9781108528825. DOI: https://doi.org/10.1017/9781108528825.

Miguel de Carvalho (2016), Mean, what do you mean?, *The American Statistician*, , 70, 764 – 776.

Moore P. G. (2010), Principles of Statistical Techniques - Measures of Dispersion, Chapter-7, Cambridge University Press.

Murray R. Spiegel & Larry J. Stephens (2018), The Standard Deviation and Other Measures of Dispersion, In the book "*Schaum's Outline of Statistics*" Chapter-4, ISBN: 9781260011463, McGraw Hill. https://www.accessscience.com › chapter › chapter4.

Weisberg H. F. (1992), Central Tendency and Variability, *Sage University Paper Series on Quantitative Applications in the Social Sciences*, ISBN 0-8039-4007-6 pp.2.

Williams R. B. G.(1984), Measures of Central Tendency, *Introduction to Statistics for Geographers and Earth Scientist*, Soft cover ISBN978-0-333-35275-5, eBook ISBN978-1-349-06815-9 , Palgrave, London, 51 – 60.

.

International Journal of Electronics
and Applied Research (IJEAR)