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Determination of Parameter from Observation Containing Itself and Chance Error: Central Tendency of Annual Extremum of Ambient air Temperature at Tezpur

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ABSTRACT: An analytical method has been developed, by Chakrabarty in 2014, for determining the true value of the parameter from observed data in the situation where the observations consist of a single parameter chance error but any assignable error. The method has already been successfully applied in determining the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Guwahati. This paper deals with the determination of the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Tezpur by the same method. The study has carried out using the data since 1969 onwards.

KEYWORDS: Ambient air temperature at Tezpur, central tendency, data with chance error, analytical method of determination

I. INTRODUCTION

Observations or data collected from experiments or survey suffer from chance error (which is unavoidable or uncontrollable) even if all the assignable (or intentional) causes or the sources of errors are controlled or eliminated and consequently the findings obtained by analysing the observations or data which are free from the assignable errors are also subject to errors due to the presence of chance error in the observations [7]. Determination of parameters, in different situations, based on the observations is also subject to error due to the same reason. Searching for mathematical models describing the association of chance error with the observations is necessary for analysing the errors. There are innumerable situations/forms corresponding to the scientific experiments. The simplest one is that where observations are composed of some parameter and chance errors ([7], [8] & [9]). The existing methods of estimation namely least squares method, maximum likelihood method, minimum variance unbiased method, method of moment and method of minimum chi-square ([1], [2], [3], [4], [5] &, [6]) provide the estimator of the parameter which suffers from some error. In other words, none of these methods can provide the true value of the parameter. However, An analytical method has been developed, by Chakrabarty [8] for determining the true value of the parameter from observed data in the situation where the observations consist of a single parameter chance error but any assignable error. The method has already been successfully applied in determining the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Guwahati ([8] & [9]). This paper deals with the determination of the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Tezpur by the same method. The study has carried out using the data since 1969 onwards.

II. THE METHOD

Let

$$X_1 , X_2 , \ldots\ldots\ldots\ldots , X_n$$

be n observations on the annual maximum (or minimum) of the ambient air temperature at a location with central tendency μ.

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In this situation, each observation X_i is composed of μ and chance error ε_i [10].

The method determining the value of the central tendency μ, developed by Chakrabarty [8] consists of the following steps:

Step-1:

Arranged the observations in ascending order of magnitude as

$$X_{(1)} < X_{(2)} < \ldots\ldots\ldots\ldots < X_{(n)} \tag{2.1}$$

Step-2:

Construct the averages

$$\bar{X}_{(i)}(1) = (n-1)^{-1} \sum_{j=1, j\neq i}^{n} X_{(j)} \quad (i = 1, 2, \ldots\ldots\ldots, n) \tag{2.2}$$

Step-3:

Take the interval

$$\bar{X}_{(n)}(1) < \mu < \bar{X}_{(1)}(1) \tag{2.3}$$

as the first interval of μ.

Step-4:

Exclude the two extreme values namely $X_{(1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(2) = (n-3)^{-1} \sum_{j=2, j\neq i}^{n-1} X_{(j)} \quad (i = 2, \ldots\ldots\ldots, n-1). \tag{2.4}$$

Step-5:

Take the interval

$$\bar{X}_{(n-1)}(2) < \mu < \bar{X}_{(2)}(2) \tag{2.5}$$

as the second interval of μ.

Step-6:

Exclude the four extreme values namely $X_{(1)}, X_{(2)}, X_{(n-1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(3) = (n-5)^{-1} \sum_{j=3, j\neq i}^{n-2} X_{(j)} \quad (i = 3, \ldots\ldots\ldots, n-2), \tag{2.6}$$

Step-7:

Take the interval

$$\bar{X}_{(n-2)}(3) < \mu < \bar{X}_{(3)}(3) \tag{2.7}$$

as the third interval of μ.

Step-8:

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Exclude the six extreme values namely $X_{(1)}$, $X_{(2)}$, $X_{(3)}$, $X_{(n-2)}$, $X_{(n-1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(4) = (n-5)^{-1} \sum_{\substack{j=4,\, j\neq i \\ (i=4,\ \ldots\ldots,\ n-3)}}^{n-3} X_{(j)} \qquad (2.8)$$

Step-9:

Take the interval

$$\bar{X}_{(n-3)}(4) < \mu < \bar{X}_{(4)}(4) \qquad (2.9)$$

as the fourth interval of μ.

The process can be continued further if necessary.

From the intervals obtained, one can detect the point value of μ.

III. ANNUAL EXTREMUM OF AMBIENT AIR TEMPERATURE AT TEZPUR:

A. ANNUAL MAXIMUM

Data on annual maximum of the ambient air temperature at Tezpur, collected from the meteorological department of India, for the period from 1969 to 2010 have been presented in **Table – 1**. These have been arranged in ascending order of magnitude and presented in **Table – 2**.

TABLE – 1

Observed value of Annual Maximum Temperature at Tezpur (in Degree Celsius)

Year	Observed value	Year	Observed value	Year	Observed value	Year	Observed value
1969	36.5	1980	35.1	1991	36.1	2005	35.7
1970	35.8	1981	37.1	1992	36.4	2006	36.1
1971	35.9	1982	36.6	1993	35.9	2007	38.2
1972	45.7	1983	38.4	1994	37.1	2008	37.7
1973	37.2	1984	36.5	1995	36	2009	36.9
1974	36.6	1985	35.4	1996	36.9	2010	37.8
1975	39.5	1986	37.2	2000	36.4	2011	37.1
1976	35.1	1987	36.8	2001	37.5	2012	37.0
1977	38.2	1988	36.6	2002	36.4	2013	37.8
1978	36.4	1989	38.5	2003	35.7		

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1979	38.1	1990	35.7	2004	37.2		

.

TABLE – 2

Observed values of Annual Maximum Temperature at Tezpur in ascending order (in Degree Celsius)

Serial No	Observed value	Serial No	Observed value	Serial No	Observed value	Serial No	Observed value
1	35.1	7	36.1	13	37.0	19	38.1
2	35.4	8	36.4	14	37.1	20	38.2
3	35.7	9	36.5	15	37.2	21	38.4
4	35.8	10	36.6	16	37.5	22	38.5
5	35.9	11	36.8	17	37.7	23	39.5
6	36.0	12	36.9	18	37.8	24	45.7

Determination of the Central Tendency

1. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES

TABLE – 3

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1	37.4260	13	37.0	37.3435
2	35.4	37.4130	14	37.1	37.3391
3	35.7	37.4	15	37.2	37.3348
4	35.8	37.3957	16	37.5	37.3217
5	35.9	37.3913	17	37.7	37.3130
6	36.0	37.3870	18	37.8	37.3087
7	36.1	37.3826	19	38.1	37.2957
8	36.4	37.3696	20	38.2	37.2913
9	36.5	37.3652	21	38.4	37.2826
10	36.6	37.3607	22	38.5	37.2783

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11	36.8	37.3522	23	39.5	37.2348
12	36.9	37.3478	24	45.7	36.9652

From this table the interval value of the central tendency is found to be

(36.9652 Degree Celsius , 37.4260 Degree Celsius) (3.1)

2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE TWO EXTREME OBSERVATIONS NAMELY THE 1ST & THE 23RD ONES

TABLE – 4

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		13	37.0	37.0524
2	35.4	37.1286	14	37.1	37.0476
3	35.7	37.1143	15	37.2	37.0429
4	35.8	37.1095	16	37.5	37.0286
5	35.9	37.1048	17	37.7	37.0190
6	36.0	37.100	18	37.8	37.0143
7	36.1	37.0952	19	38.1	37.000
8	36.4	37.0810	20	38.2	36.9952
9	36.5	37.0762	21	38.4	36.9857
10	36.6	37.0714	22	38.5	36.9810
11	36.8	37.0619	23	39.5	36.9333
12	36.9	37.0571	24	45.7	

From this table the interval value of the central tendency is found to be

(36.9333 Degree Celsius , 37.1286 Degree Celsius) (3.2)

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3. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE 1ST, 2ND, 22ND & THE 23RD ONES

TABLE – 5

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		13	37.0	37.0105
2	35.4		14	37.1	37.0053
3	35.7	37.0789	15	37.2	37.0000
4	35.8	37.0737	16	37.5	36.9842
5	35.9	37.0684	17	37.7	36.9737
6	36.0	37.0632	18	37.8	36.9684
7	36.1	37.0579	19	38.1	36.9526
8	36.4	37.0421	20	38.2	36.9473
9	36.5	37.0368	21	38.4	36.9368
10	36.6	37.0316	22	38.5	36.9315
11	36.8	37.0211	23	39.5	
12	36.9	37.0158	24	45.7	

From this table the interval value of the central tendency is found to be

(36.9315 Degree Celsius , 37.0789 Degree Celsius) (3.3)

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4. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE SIX EXTREME OBSERVATIONS NAMELY THE FIRST THREE & THE LAST THREE

TABLE – 6

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		13	37.0	37.0000
2	35.4		14	37.1	36.9941
3	35.7		15	37.2	36.9882
4	35.8	37.0706	16	37.5	36.9706
5	35.9	37.0647	17	37.7	36.9588
6	36.0	37.0588	18	37.8	36.9529
7	36.1	37.0529	19	38.1	36.9353
8	36.4	37.0353	20	38.2	36.9294
9	36.5	37.0294	21	38.4	36.9176
10	36.6	37.0235	22	38.5	
11	36.8	37.0118	23	39.5	
12	36.9	37.0059	24	45.7	

From this table the interval value of the central tendency is found to be

(36.9176 Degree Celsius , 37.0706 Degree Celsius) (3.4)

POINT VALUE: The above four intervals yields the shortest interval as

(36.9652 Degree Celsius , 37.0706 Degree Celsius) (3.5)

which further implies that the value of the central tendency 37.0 Degree Celsius.

Thus the central tendency of annual maximum of the ambient air temperature at Tezpur, as the available data yield, is 37.0 Degree Celsius.

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B. ANNUAL MINIMUM

Data on annual minimum of the ambient air temperature at Tezpur, collected from the meteorological department of India, for the period from 1969 to 2010 have been presented in **Table – 1** from {[6] & [7]}. These have been arranged in ascending order of magnitude and presented in **Table – 2**

TABLE – 1

Observed value of Annual Minimum Temperature at Tezpur (in Degree Celsius)

Year no	Observed value	Calendar year, Month & Date of occurrence	Year no	Observed value	Calendar year ,Month & Date of occurrence
1	8.8	1970,January 6	23	7.6	1992, January 5 & February 9
2	8.5	1971, January31	24	8.1	1992, December 24
3	8.5	1972, February 10	25	9.5	1994, January 19
4	10.0	1973, January 20	26	8.5	1995, January 24
5	9.3	1974, January 20	27	9.8	1996, January 19
6	9.3	1974, December 31	28	NA	NA
7	10.5	1975, December 31	29	NA	NA
8	8.6	1977, February 9	30	NA	NA
9	8.2	1978, January 13	31	7.6	2000, January 8
10	8.5	1979, January 9	32	9.0	2001, January 7
11	9.2	1980, January 10	33	9.4	2002, January 8
12	9.6	1981, January 11	34	9.3	2003, January 16
13	10.2	1982, February 11	35	9.9	2004, January 6 & 30
14	8.1	1983, February 7	36	8.5	2004, December 29
15	8.6	1984, January 31	37	9.2	2006, January 8 & 16
16	8.6	1984, December 31	38	8.0	2007, January 18
17	9.3	1986, January 1	39	7.0	2008, February 3
18	8.5	1987, January 7	40	8.5	2009, January 7 & 8
19	9.1	1987, December 31	41	9.6	2010, February 7
20	7.5	1989, January 14	42	8.0	2011, January 21

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21	8.1	1989, December 31	43	6.8	2011, December 25
22	7.8	1991, January 23	44	7.4	2013, January 12

TABLE – 2

Observed value of Annual Minimum Temperature at Tezpur in ascending order (in Degree Celsius)

Serial No	Observed value	Serial No	Observed value	Serial No	Observed value	Serial No	Observed value
1	6.8	8	8.1	15	9.2	22	10.0
2	7.0	9	8.2	16	9.3	23	10.2
3	7.4	10	8.5	17	9.4	24	10.5
4	7.5	11	8.6	18	9.5		
5	7.6	12	8.8	19	9.6		
6	7.8	13	9.0	20	9.8		
7	8.0	14	9.1	21	9.9		

Determination of the Central Tendency

1. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES

TABLE – 3

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	6.8	8.8261	9	8.2	8.7652	17	9.4	8.7130
2	7.0	8.8174	10	8.5	8.7522	18	9.5	8.7087
3	7.4	8.8	11	8.6	8.7478	19	9.6	8.7043
4	7.5	8.7957	12	8.8	8.7391	20	9.8	8.6956
5	7.6	8.7913	13	9.0	8.7304	21	9.9	8.6913
6	7.8	8.7826	14	9.1	8.7261	22	10.0	8.6870

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7	8.0	8.7739	15	9.2	8.7217	23	10.2	8.6783
8	8.1	8.7696	16	9.3	8.7174	24	10.5	8.6652

From this table the interval value of the central tendency is found to be

(8.6652 Degree Celsius , 8.8261 Degree Celsius) (3.6)

1. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE TWO EXTREME OBSERVATIONS NAMELY THE 1ST & THE 28TH ONES

TABLE – 4

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	6.8		9	8.2	8.7762	17	9.4	8.7190
2	7.0	8.8333	10	8.5	8.7619	18	9.5	8.7143
3	7.4	8.8143	11	8.6	8.7571	19	9.6	8.7095
4	7.5	8.8095	12	8.8	8.7476	20	9.8	8.7000
5	7.6	8.8048	13	9.0	8.7381	21	9.9	8.6952
6	7.8	8.7952	14	9.1	8.7333	22	10.0	8.6905
7	8.0	8.7857	15	9.2	8.7286	23	10.2	8.6810
8	8.1	8.7809	16	9.3	8.7238	24	10.5	

From this table the interval value of the central tendency is found to be

(8.6810 Degree Celsius , 8.8333 Degree Celsius) (3.7)

2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE 1^{ST}, 2^{ND}, 27^{TH} & THE 28^{TH} ONES

TABLE – 5

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean

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1	6.8		9	8.2	8.7947	17	9.4	8.7315
2	7.0		10	8.5	8.7789	18	9.5	8.7263
3	7.4	8.8368	11	8.6	8.7737	19	9.6	8.7211
4	7.5	8.8316	12	8.8	8.7632	20	9.8	8.7105
5	7.6	8.8263	13	9.0	8.526	21	9.9	8.7053
6	7.8	8.8158	14	9.1	8.7474	22	10.0	8.7000
7	8.0	8.8053	15	9.2	8.7421	23	10.2	
8	8.1	8.8000	16	9.3	8.7368	24	10.5	

From this table the interval value of the central tendency is found to be

(8.7000 Degree Celsius , 8.8368 Degree Celsius) (3.8)

2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE FIRST THREE & THE LAST THREE

TABLE – 6

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	6.8		9	8.2	8.8059	17	9.4	8.7353
2	7.0		10	8.5	8.7882	18	9.5	8.7294
3	7.4		11	8.6	8.7824	19	9.6	8.7235
4	7.5	8.8471	12	8.8	8.7706	20	9.8	8.7118
5	7.6	8.8412	13	9.0	8.7588	21	9.9	8.7058
6	7.8	8.8294	14	9.1	8.7529	22	10.0	
7	8.0	8.8176	15	9.2	8.7471	23	10.2	
8	8.1	8.8118	16	9.3	8.7412	24	10.5	

From this table the interval value of the central tendency is found to be

(8.7058 Degree Celsius , 8.8471 Degree Celsius) (3.9)

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POINT VALUE: The above four intervals yields the shortest interval as

(8.7058 Degree Celsius , 8.8261 Degree Celsius) (3.10)

which further implies that the value of the central tendency 8.8 Degree Celsius.

Thus the central tendency of annual minimum of the ambient air temperature at Tezpur, as the available data yield, is 8.8 Degree Celsius.

IV. CONCLUSION

The existing statistical methods of estimation yield estimates which are not free from error.
However, the method developed by Chakrabarty [8] can yield the estimate which is free from error (i.e. exactly equal to the true value of the parameter). Thus the central tendency of annual minimum as well as annual minimum of the ambient air temperature at Tezpur, as the available data yield, can be taken as 37.0 Degree Celsius and 8.8 Degree Celsius respectively.
The determination of these two is based on the assumption that the data recorded by the Indian Meteorological Department have been recorded correctly. If there is any error in recording the data, the determined value(s) will not be accurate.
The determination of these two is based on another assumption that the change in temperature at Tezpur during the period whose data have been used in computation has not been influenced by any assignable cause(s). If in this period, some assignable cause has influenced significantly on the change in temperature at this location, the findings are bound to be inaccurate.

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