Statistical Analysis of Long Term Surface Temperature: A Case Study of Malda District, West Bengal, India

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ABSTRACT *Global warming is the rise of the average temperature of Earth's surface. Several studies shown that the temperature of the Earth is rising. In the last century, global temperature increased by 0.6 to 0.8ºC where the temperature of India has increased by 1 to 1.1ºC. In this study the researcher observed the surface temperature change at Malda district by analysing GHCN CAMS gridded monthly surface temperature data. This study shows that the rate of increment of surface temperature of Malda district (0.139ºC per decade) is lower than the rate of increment of global surface temperature (0.179ºC per decade).*

Key Words*: Global Warming; Temperature Trend; Malda; Temperature Anomalies*

1. Introduction

One of the major issues in the present day is global warming due to anthropogenic activity. Several research works have been conducted on global warming and its impact on climate change. Over the past million years, the natural climate of earth has oscillated between warm period and ice ages. But over the past 50 years, the rate of increment of temperate is highest in the recorded history (Hansen et. al., 2010). The average global temperate has increased by 0.6 to 0.8ºC over the last century (Hansen and Lebedeff, 1987, Hansen et. al., 2010). Earth's rising temperature leading to extreme weather like frequent droughts, heavier rainfall and cyclones (Bender et. al., 2010).

Malda is a district of the state West Bengal of India. Malda district is low lying basin and it is prone to flood. The river Ganges passes over Malda and erosion of the Ganges river bank is a serious issue at Malda (Das et. al., 2012, Rudra K.,2000). The income source of peoples of this district are mainly from cultivation. Extreme weather affects on cultivation of this district and hence it affects on the people's life. Higher surface temperature increases the more water requirements of crops. The International Food Policy Research Institute (IFPRI) report on Climate Change, Impact on Agriculture and Costs of Adaptation, forecasts that by 2050 rice prices will increase between 32% and 37% as a result of climate change.

In the last century, the atmospheric surface temperature of India has increased by 1 to 1.1ºC (Das et. al., 2007) where the global surface temperature increased about 0.8ºC. Annual Climate Summary – 2015, Indian Meteorological Department, has computed annual mean temperature trend of India and the temperature trend is different for different region of India. The temperature trend at Malda district is positive. Here the researcher investigating the change of surface temperature at Malda district using GHCN CAMS gridded monthly surface temperature data (Fan and Dool, 2008). The rate of change of surface temperature at Malda relative to global surface temperature change have been computed here. This manuscript will help to study the climate of Malda district. The manuscript arranged in the following way – Section 2 describes data and methodology. Results have given in the section 3 and discussion in section 4.

2. Data and Methodology

Goddard Institute for space Studies (GISS), National Aeronautics and Space Administration (NASA) has produced global monthly combined land-surface air and sea surface water temperature anomaly. Gridded Monthly GISS temperature anomaly (GISTEMP Team, 2017 and Hansen et. al., 2010) and the global mean monthly temperature anomaly data were downloaded from GISS's website (URL: *data.giss.nasa.gov/gistemp*). The spatial resolution of the gridded data is 2ºx2º. The boundary of Malda district has shown by red curve in Figure 1. The nearest grid points in the data set are (87ºE, 25ºN) and (89ºE, 25ºN) (shown by purple asterisk in Figure 1). The grid point of this data set is not available inside Malda district. Also the grid points are far away from the boundary of the Malda district.

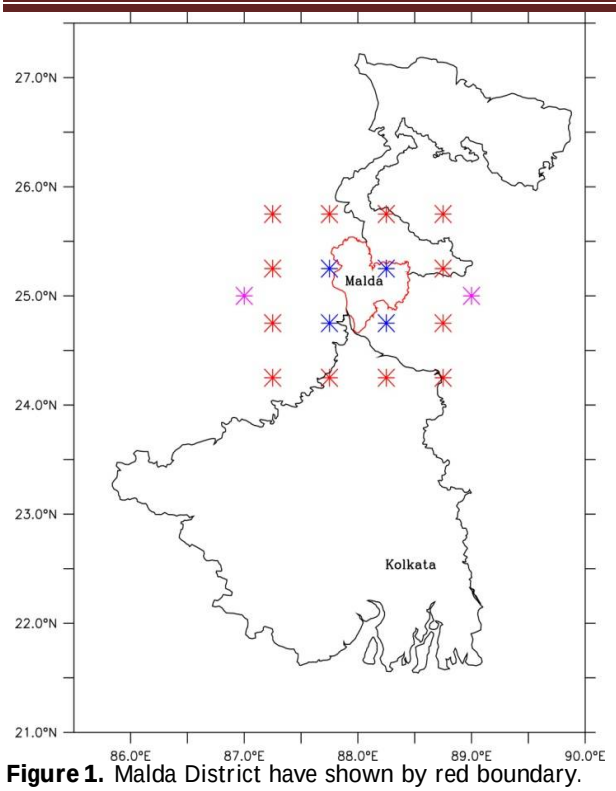

Figure 1. Malda District have shown by red boundary. The grid points of GHCN CAMS Temperature data have shown in red and blue asterisk marks. GISS Temp grid points have shown by purple asterisk marks. Average temperature of the blue asterisk grid points considered as the mean temperature of Malda district.

GHCN Gridded V2 data, provided by NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at *http://www.esrl.noaa.gov/psd/*, has been used in this study. Temporal resolution of this data is monthly and spatial resolution of this data is 0.5ºx0.5º. The spatial grid points have shown by red and blue asterisk mark in Figure 1. Only one grid point is available inside the Malda district boundary. The average of the temperature of the grid points inside the boundary and within 20km away from the boundary (blue asterisk marks in Figure 1) of Malda district has been considered as the temperature of Malda district. Temperature anomalies computed by subtracting the long-term average temperature.

The annual mean temperature of India downloaded from Open Government Data (OGD) Platform India (data.gov.in). The temperature data is available from the year 1901 to 2015. The temperature anomaly has been computed by taking difference between the long-term average temperature and the temperature that is actually occurring. The source of all the data and web addresses are given in Table 1. The temperature anomalies of all the data sets have shown in the Figure 2. Temperature anomalies has been replotted from the year 1975 and shown in the Figure 3. Standard deviation of the temperature anomalies for all the data sets have been computed. The standard deviations for the Global, India and Malda's temperature anomalies are 0.33, 0.34 and 0.31 respectively.

Data Source	Resolution	Data Availability	URL
GISS Combined Land and Ocean Surface Mean Temperature Anomalies	Monthly and Seasonal	January, 1880 – July, 2017	https://data.giss.nasa.gov/gistemp/
Annual Mean Temperature of India	Monthly, Seasonal and Annual	January, 1901 - December, 2015	https://data.gov.in/catalog/all-india-seasonal-andannual-mean-temperatureseries
GHCN CAMS Temperature (NOAA Earth System Research Laboratory)	0.5ºx0.5º and Monthly	January, 1948 – June, 2017	https://www.esrl.noaa.gov/psd/data/gridded/data.ghcncams.html

Table 1. Data sets and their sources. The first column lists the data source, second column the resolution of the data and the third column the Internet source from which the data were downloaded.

3. Result

Figure 2 and 3 shows the annual temperature anomaly of the global average temperature and anomalies of averaged temperature of India and Malda. Clearly the change of temperature is not linear. A fairly linear upward trend is observed since 1970s. Temperature anomalies are replotted from the year 1975 in Figure 3. The trend lines have been fitted for all the anomalies in Figure 3. All the trend lines are showing the rise

of temperature. The equations of the trend lines of the global, India and Malda's data sets are respectively as the followings:

$$f(x) = 0.0179x + 0.0341 \quad (1)$$
$$f(x) = 0.0204x - 0.1400 \quad (2)$$
$$f(x) = 0.0139x - 0.3218 \quad (3)$$

The value of the regression coefficient (R^2) for the global anomaly is 0.8375, for India it is 0.5137 and the value of the regression coefficient (R^2) for the Malda's anomaly is 0.2682. The slope of the trend lines is 0.179, 0.0204 and 0.0139 for the global, India and Malda's temperature anomalies respectively. This implies that the rate of increment of global temperature is 0.0179ºC per year or 0.179 ºC per decade since 1975. Also, the rate of increment of temperature of India and Malda district are 0.204 ºC per decade and 0.139ºC per decade respectively since 1975.

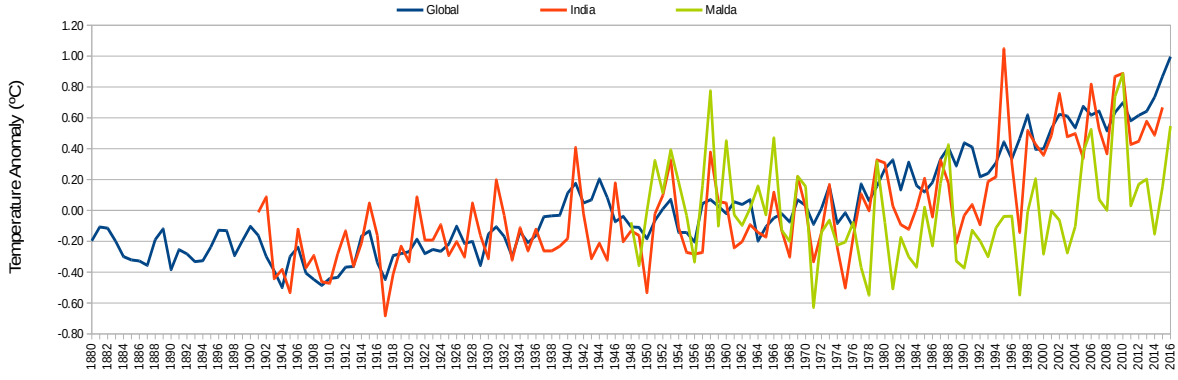

Figure 2. Annual temperature anomalies of Global (blue carve), India (red curve) and Malda (green curve).

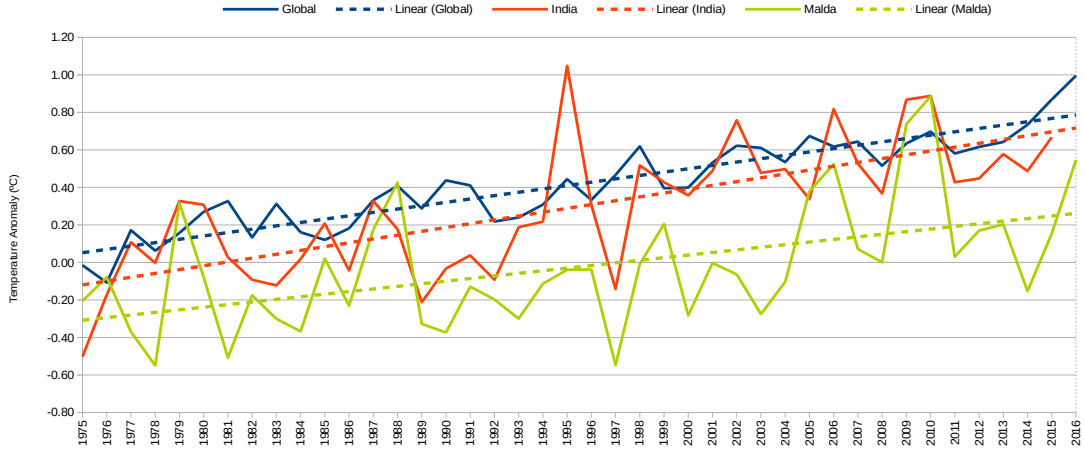

Figure 3. Post 1975 temperature anomaly of Global (blue carve), India (red curve) and Malda (green curve). Trend lines (dashed lines) have been plotted for all the anomalies. All the trend lines are showing the trend of increasing temperature.

Slope of the all trend lines are positive. This indicates that the temperature is rising in all the anomalies. Rate of increment of the temperature is proportional to the slope of the trend line. Slope of the trend line (2) is higher than the slope of the trend line (1) and (3). This means that the rate of increment of temperature in India is higher than the rate of increment of Global and Malda's temperature. It therefore follows that global annual mean temperature has been increased by 0.75ºC in the last 42 years while the annual mean temperature of India and Malda have been increased by 0.86ºC and 0.58ºC respectively.

Hence, it can be concluded that the rate of increase of mean temperature of Malda district is less than the rate of increase of global mean temperature.

4. Discussion

The detailed analysis shows that the temperature has been increasing at Malda and also in India. However, the rate of increment of temperature is not the same. The rate of increment of temperature at Malda is lower than the rate of increment of Global as well as India's mean temperature. Although the rate of increment of temperature of India is higher than the rate of increment of Global and Malda's temperature.

The reasons for the different rate of increment of temperature has not been investigated in this study. It is very difficult to arrive in a conclusion that the changes observed are due to anthropogenic activities or due to natural climate changes. Modeling study is needed to be undertaken in future to bring out the actual reason of the changes.

5. Acknowledgement

Data used in this study have been obtained from Goddard Institute for space Studies (GISS) surface temperature analysis (GISTEMP) and GHCN Gridded V2 data provided by NOAA. The author thanks Dr. K. Somasundar, Ministry of Earth Sciences, India for publishing the data in the data.gov.in.

6. References

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