

VARIATION OF GLOBAL TEMPERATURE AND LIGHTNING ACTIVITIES WITH EARTHQUAKES

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Abstract

A critical study of variations of global temperature for the period 1880-2021 and lightning strikes per sq. km per day for the period 2010-2020 have been made and its close association with major earthquakes (magnitude ≥ 6 in Richter scale) is presented. From statistical analysis it is confirmed that global temperature and lightning strikes increases with the increase of number. of major Earthquakes occurred. Association of the lightning activity with medium range earthquake 4-5.9 in Richter scale is also taken into consideration. Possible explanation is also presented.

Keywords: *Variation of global temperature, Lightning strike, Variation of the lightning activity, Geomagnetic disturbance, Earthquake*

1. Introduction

An earthquake happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The location below the earth's surface where the earthquake starts is called the hypocenter, and the location directly above it on the surface of the earth is called the epicenter.

In earth science, global surface temperature (GST; sometimes referred to as global mean surface temperature, GMST) is determined by averaging the temperature at the surface of the sea and air temperature over land. In the recent years, potential impacts of climate change and variability have received a lot of attention from researchers. A comprehensive review of the potential impacts of climatic change was provided in Intergovernmental Panel on Climate Change (IPCC) reports (1998, 2001). According to IPCC (2001), increases in greenhouse gas concentrations increased the annual mean global temperature by $0.6 \pm 0.2^\circ\text{C}$ since the late 19th

century. Available records show that the 1990s have been the warmest decade of the millennium in the Northern Hemisphere and 1998 was the warmest year. Some of the largest changes have occurred in the high-latitude Northern Hemisphere land areas, where winter temperatures have increased at rates greater than 0.8°C .

A lightning is a flash of bright light in the sky that is produced by electricity moving between clouds or from clouds to the ground. The seasonal distribution of lightning flash activity over the globe is studied using yearly lightning flash data obtained from Lightning Imaging Sensor (LIS) on board the Tropical Rainfall Measuring Mission (TRMM) satellite. This paper presents the results of annual variation of the lightning activity all over world and its variations with earthquakes. As maximum thunderstorms activity occurs during late afternoon to evening hours, seasonal total flash counts during monsoon season are more

compared to pre-monsoon season. We can see an increasing trend of lightning over years.

Surface temperatures over a region show variation in seasonal and annual patterns, and are dependent on altitude, location in relation to the sea coast and other such geographical features. Throughout our globe various studies have been done to determine the effects of earthquakes with temperatures. Fagan (2003) stated that the global warming is the result of natural events and human activities. If the trend of global warming keeps on going then, it will be harmful for the survival of the mankind. Maslin (2007) gave the first indications that the diurnal asymmetry of temperature trends over globe and it is quite different. He found that maximum temperatures show larger increasing trends than the minimum temperatures, over a major part of the country. A decreasing trend in temperature over most of the northern parts of the country (north of 23°N), coupled with an increasing trend over southern parts (south of 23°N), and an overall slightly increasing trend of the order of 0.35°C was observed during the last 100 years. IPCC (2007) report has highlighted that the temperature of the world has been increased by 0.6°C in the 20th century which is greater than in any other century during the past 1000 years. This report has also indicated that Himalaya region are very sensitive to climate changes due to its geographical pattern. World's glaciers and changes in the snowfall pattern were observed during the 20th century. This report has showed if this trend remains same 80% of Himalayan glaciers will be gone in 30 years and nearly two billion people will be affected by the glacier retreats in the Himalayas. As the people of this region are dependent on natural resources, the changing climate has affected their livelihood. NASA (2013) mentioned that climate change is a natural and slow process. Midya and Panda (2013) found the relation of major earthquakes (Magnitude ≥ 6 Richter Scale) with Cp index during the period 2001-2007.

Midya and Gole (2014) analyzed trend of major earthquakes during the period 1900-2011 and its association with some solar and geomagnetic parameters. Midya et al. (2011) found the association of major Earthquakes (magnitude ≥ 6 Richter Scale) with geomagnetic disturbance index Kp during the period 2001-2007 shows variations of Kp index. Midya and Ghosh (2014) have associated an ionospheric parameter with major earthquake occurrence throughout the world gives us a clear view about various ionospheric parameters and their effects on earthquakes. Simpson (1967-1968) reported that solar and geomagnetic indices plays significant role in triggering of earthquakes.

In the present study, a nonparametric Mann-Kendall (MK) statistical test was applied to annual average temperature, annual average maximum temperature, annual average minimum temperature and average seasonal temperatures of 125 stations distributed throughout India. Annual and seasonal temperature anomalies were analyzed on a country scale as well as a regional scale. The main purpose of this study is to identify the trends in the temperature over India during the last century (period from 1901-2007). The Mann-Kendall, non-parametric statistical analysis is implemented to observe the trend in the data.

2. Materials and Methods

2.1 Data sources

The website

<https://earthquake.usgs.gov/earthquakes/search> is used to collect data (magnitude ≥ 6 Richter scale) and

<https://ourworldindata.org/grapher/temperature-anomaly?country=~Global> is used for global temperature data.

WGLC global gridded lightning climatology and time series data (Kaplan and Lau, 2021) is used for lightning strokes per unit sq. km per day.

2.2 Methodology

Graphical presentation of global temperature, major earthquakes and lightning strikes throughout the world is done. Their variations are also shown with data table and graphs.

3. Results and Discussion

At first, variation of global temperature with the year is shown and we can see an increasing trend of this curve. During the years 1880-1961 we can see an increasing trend of the graph (Fig. 1). Then from the 1961- 2021 we can see a sharp increase

of global temperature (Fig. 2). Thus, if we conclude the whole years from 1880- 2021 an increasing trend of the global temperature is seen (Fig. 3). As we have seen only the major earthquakes of magnitude greater than equal to 6 in Richter scale a sharp increasing trend is seen throughout the years of 1880- 2021 (Fig. 4a-c).

From figure 5, we have seen an increasing trend of lightning over the years. As mid-range earthquakes occur frequently rather than major earthquakes thus ionization occurs huge numbers throughout the globe. As a result, numbers of earthquakes are increasing during the periods. As the Radon emission increases in the lower region of ionosphere and troposphere, so it quite expected that lightning activity increases with the increase of earthquake.

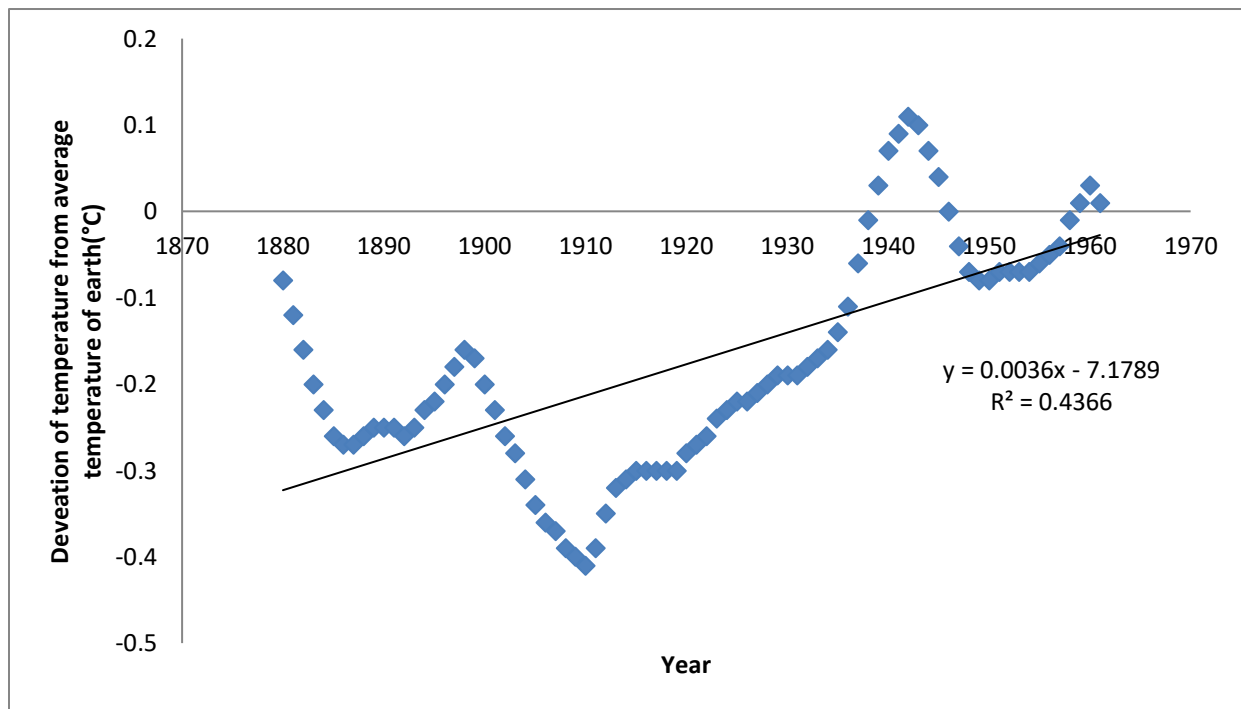


Figure 1 Deviation from Earth's average temperature from 1880 to 1961

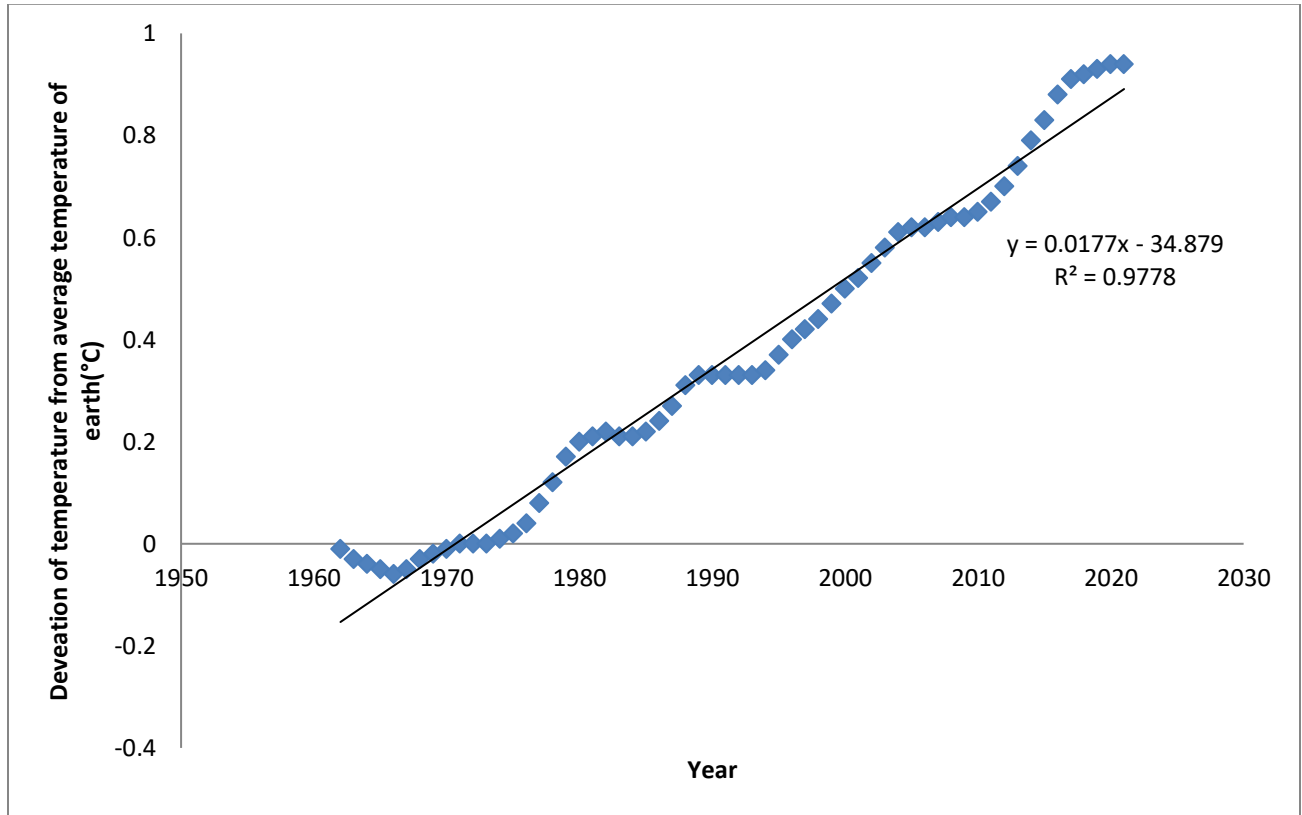


Figure 2 Deviation from Earth's average temperature from 1962 to 2021

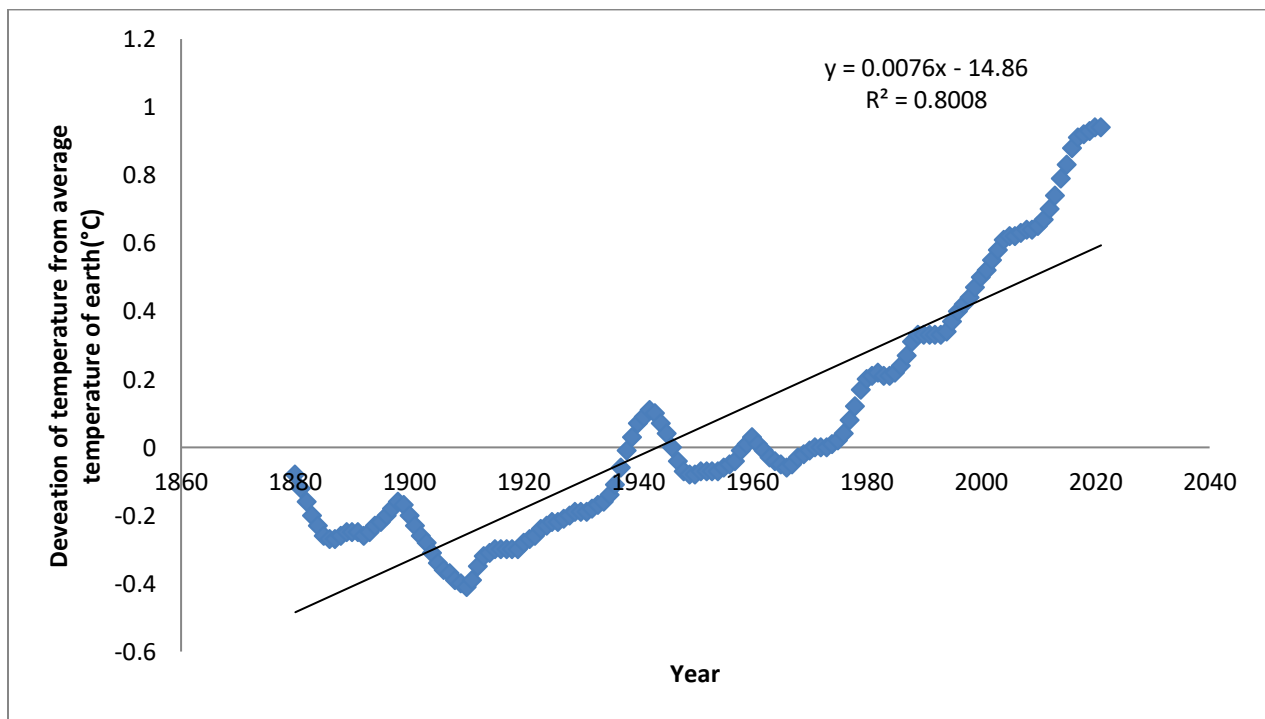


Figure 3 Deviation from Earth's average temperature from 1880 to 2021

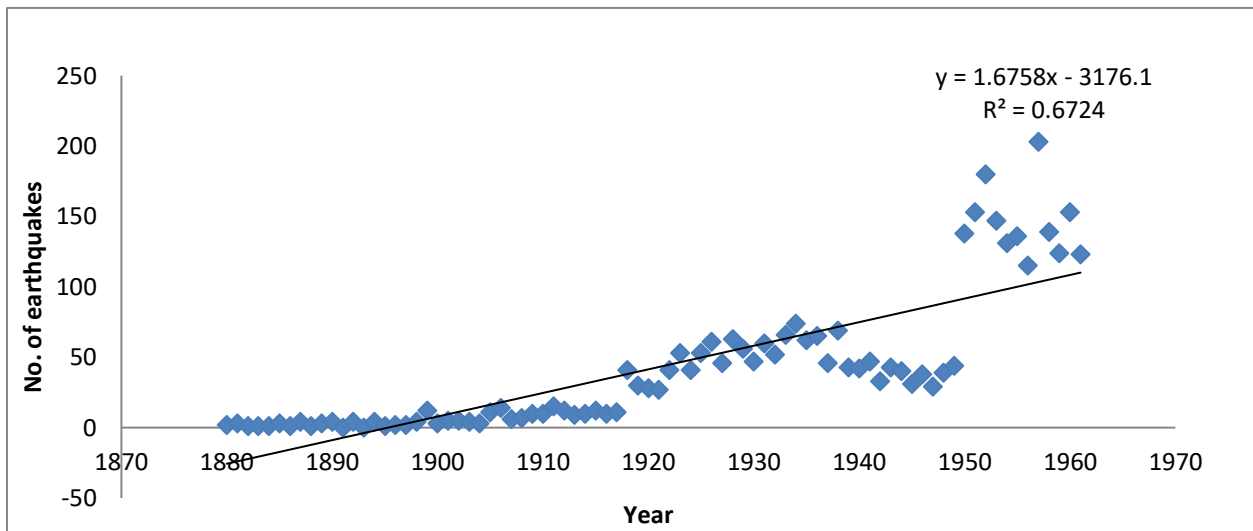


Figure 4a No. of Earthquakes(magnitude ≥ 6 in Richter scale) during 1880-1961

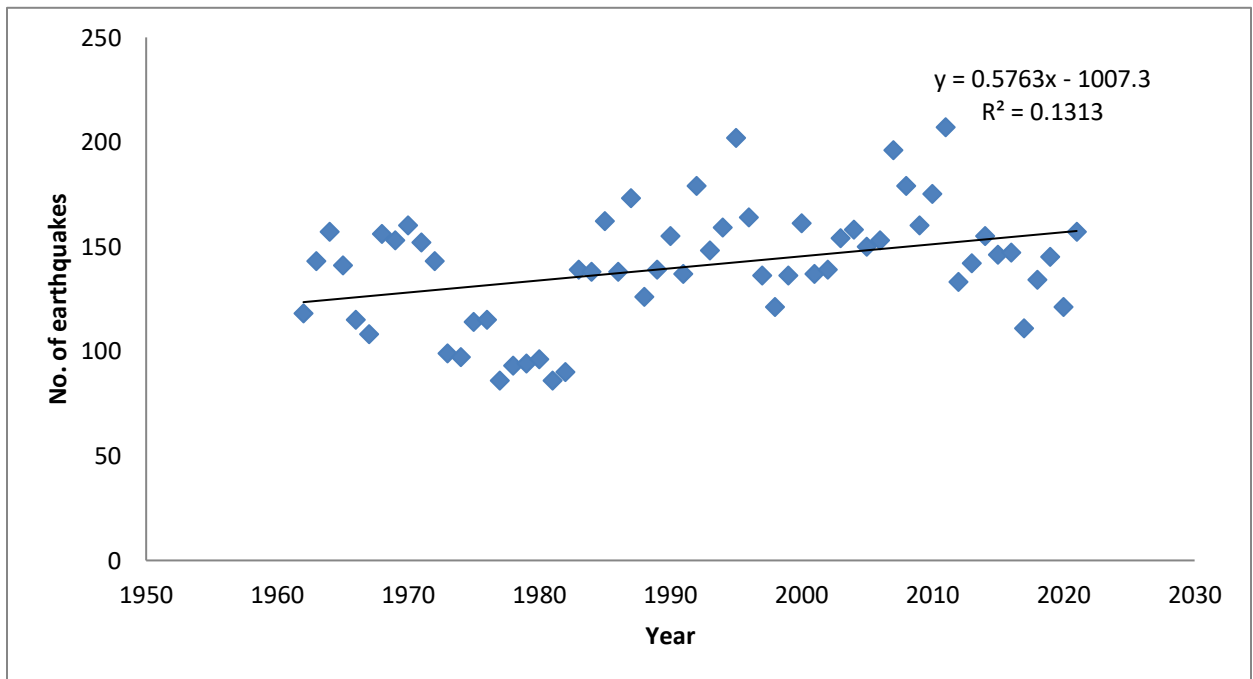


Figure 4b No. of Earthquakes(magnitude ≥ 6 in Richter scale) during 1962-2021

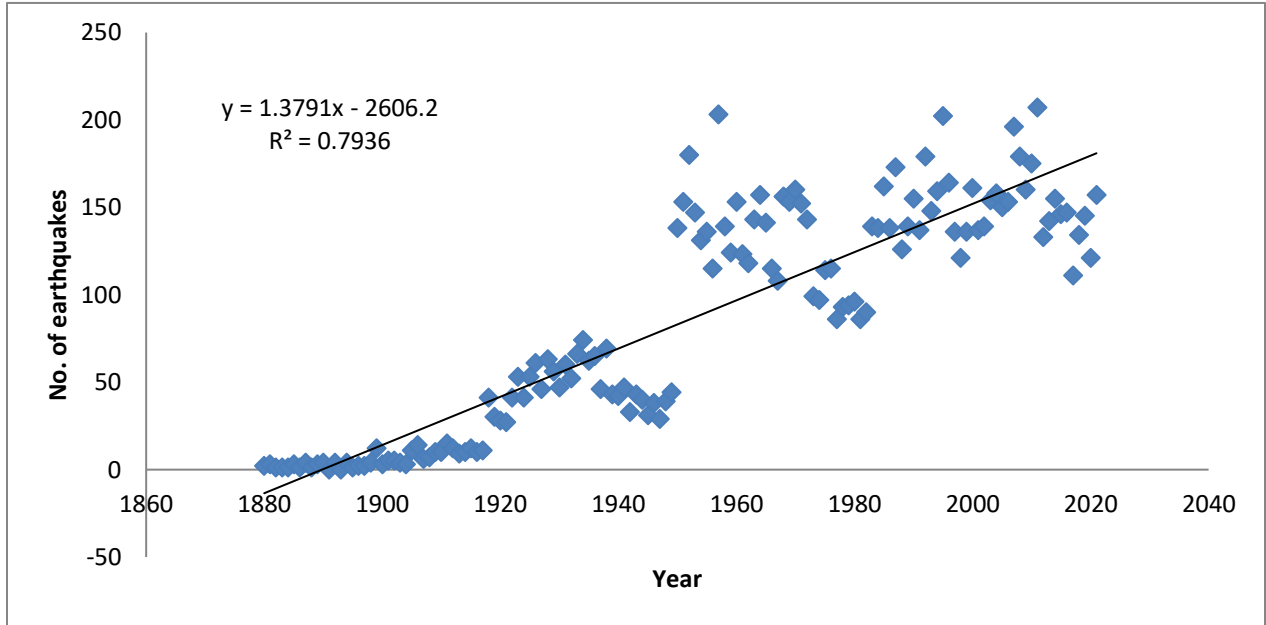


Figure 4c No. of Earthquakes (magnitude ≥ 6 in Richter scale) during the whole period 1880-2021

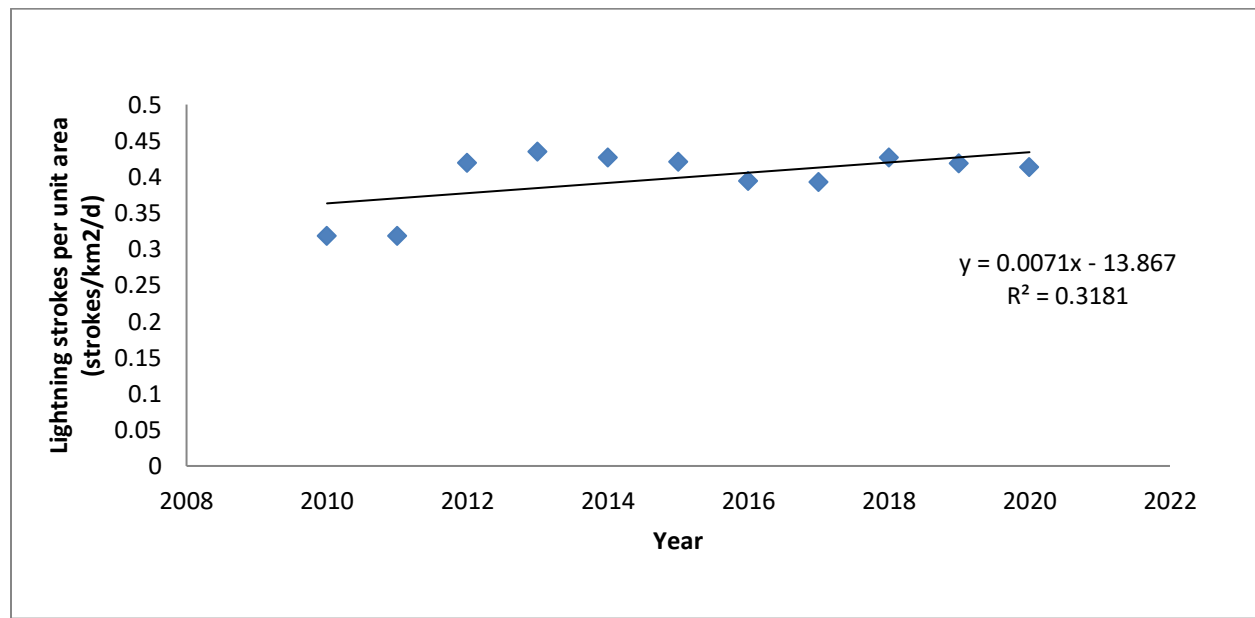


Figure 5 Global lightning strokes per sq. km per day (2010-2021)

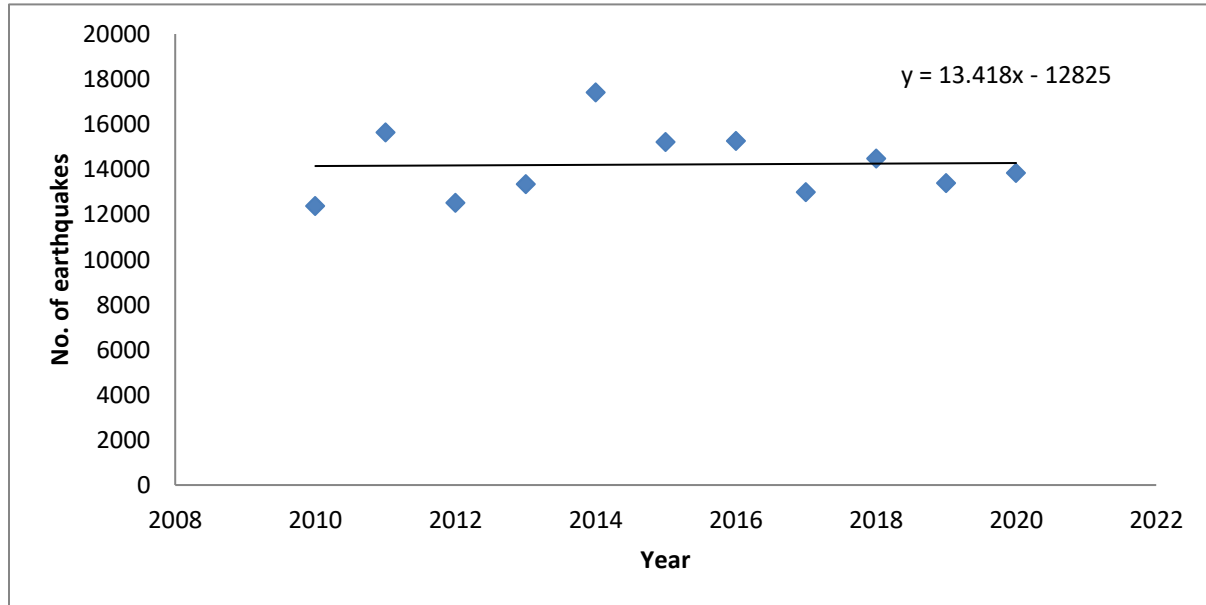


Figure 6 Trend of mid-range Earthquakes (4-5.9 in Richter scale)

4. Conclusions

The surface of earth is always moving with the rotation of earth. The plate in contact with outer crust of our earth is also moving. Whenever there is a differential movement between plates there is a disturbance in the lithosphere and earthquakes occurred. As we see a certain increase in the global temperature, the movement of these plates goes abnormal. As a result, earthquakes are increasing over years.

Lightning activities cause more ionization in the atmosphere which favours earthquakes. As lightning are increasing over years, earthquakes are also increasing.

As the frequency of mid-range earthquakes of magnitude 4-5.9 in Richter scale is high, lightning activities are also increasing accordingly.

According to LAIC(Lithosphere-Atmosphere-Ionosphere Coupling) before occurrence of the earthquake radon emitted in the fault zone. As a result, lower atmospheric particles are also

ionized and it is quite expected that lightning activity increases with the increase of tectonic activity.

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