International Journal of Physics and Mathematical Sciences ISSN: 2277-2111 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jpms.htm
2020 Vol. 10, pp. 29-35/Satish
Research Article

ANALYSIS OF LIGHTNING OCCURRENCES OVER INDIAN REGION

***Satish Prakash**
Meerut College, Meerut-UP-250004
**Author for Correspondence*

ABSTRACT
The weather and climate scenario is changing globally. The accurate prediction of the weather events is a challenging job even after the enormous information's from satellite, radar and latest state of art instruments. Every year, extreme weather events drastically affect our economy and decisions. In the present work we have analysed three years (2016 to 2018) lightning occurrence monthly basis over Bihar (Gaya, Patna, Bhagalpur and Purnia) area. It has been observed that May to October the lightning occurrences are more (84.2 %) as compared to other months. There is a large variation in the lightning occurrences during 2016 -2018. It may be attributed to the influence of weather systems over Bihar during each season. It is seen that the coverage of lightning can also be monitored through space and with more datasets in future can help to identify the vulnerable area of lightning over Indian domain for each season and month or even daily scale.

Keywords: *Lightning, Model Analysis and lightning Network*

INTRODUCTION
Lightning activities with varying intensity and durations have observed throughout the year all over the India. It causes severe damage of life and property with a short span of time. There are sensitive weather pockets which enhance the severity of these events. In the Eastern parts we have Bihar, Jharkhand and Odisha and in north India Rajasthan and Uttar Pradesh are vulnerable to the fatal lightning strikes. Hilly areas both in north and northeast are also more sensitive areas of the country. Lightening activities are severe if the thunder clouds are of great height and large instabilities are prevailing over the area. Changes in local severe weather events under the warming climate are of great concern to the society[1-3] but there are great challenges in understanding the linkage and correlations between the local weather variations and the global climate change. The difficulty is at least in part because severe weather often occurs in spatial scales within tens of kilometers and periods within hours, which is in stark contrast with the scales of the global climate change that are in thousands of kilometers and over decades or longer. Normally, each and every thunderstorm is accompanied by lightning activities.
Lightning is hazardous to human health (*e.g.*, Elsom, 2001; Ashley and Gilson, 2009), can cause issues for aviation safety (*e.g.*, Mäkelä *et al.*, 2013; Wilkinson *et al.*, 2013b), and causes property damage (e.g., Curran *et al.*, 2000). Accurate forecasts of when and where lightning is likely to occur are useful in minimizing the risks to human life and property.
Near real time (NRT) monitoring of lightning from lightning Image Sensor (LIS) on the International space station since February -2017 have prime importance after lightning image sensor aboard NASA's Earth Observing System (EOS) Tropical Rainfall Measuring Mission (TRMM) satellite (up to 2015). NRT data is available within two minutes interval in non-quality controlled (NQC) and quality controlled (QC) data sets. He spatial coverage of the data sets from N: 54.0, S: -54.0, E: 180.0, W: -180.0 with 4-8 km spatial resolution. Algorithm Theoretical Basis Document (ATBD) of ISIS, LIS data sets is (Christian *et al.*, 1983, 2000).
Figure 3 represent a sample map of 7th February -2018 of lightning flashes and red dots over northeast India shows the lightning activity. The data has timing accuracy better than 2 milliseconds, horizontal location accuracy around 3 kilometers, and space coverage from the latitude of 55 degree N to 55 degree S and available in public domain globally. It was claimed that these resolutions and coverage have never been achieved before.

The real time data from International Space System, Lightning Image Sensor (ISS LIS) have enabled new applications for the benefit of the public, including weather forecasting and public safety. The instrument is also serving as a standard for comparison to other space borne lightning sensors such as the Geostationary Lightning Mapper.

MATERIALS AND METHODS

The lightning occurrence data of Bihar is taken from Meteorological Centre Patna, Bihar of India Meteorological Department (IMD). Near real time monitoring of lightning data from International Space System, Lightning Image Sensor is available over Indian domain from 2017 onward in Public domain. The coverage
(sky to ground flashes) is obtained from Indian Air Force & Indian Institute of Tropical Meteorology (IITM) lightning networks. This actual data is compared with the Satellite Lightning Mapping Imager LMI) estimated flashes and UK Met office Unified model derived forecasts.

RESULTS AND DISCUSSION

Figure 1 below shows the 3 x3 km resolution from Meteosat Second Generation (MSG) satellite with SEVIRI (Spinning Enhanced Visible and Infra-red Imager) payload. MSG is a joint project between ESA

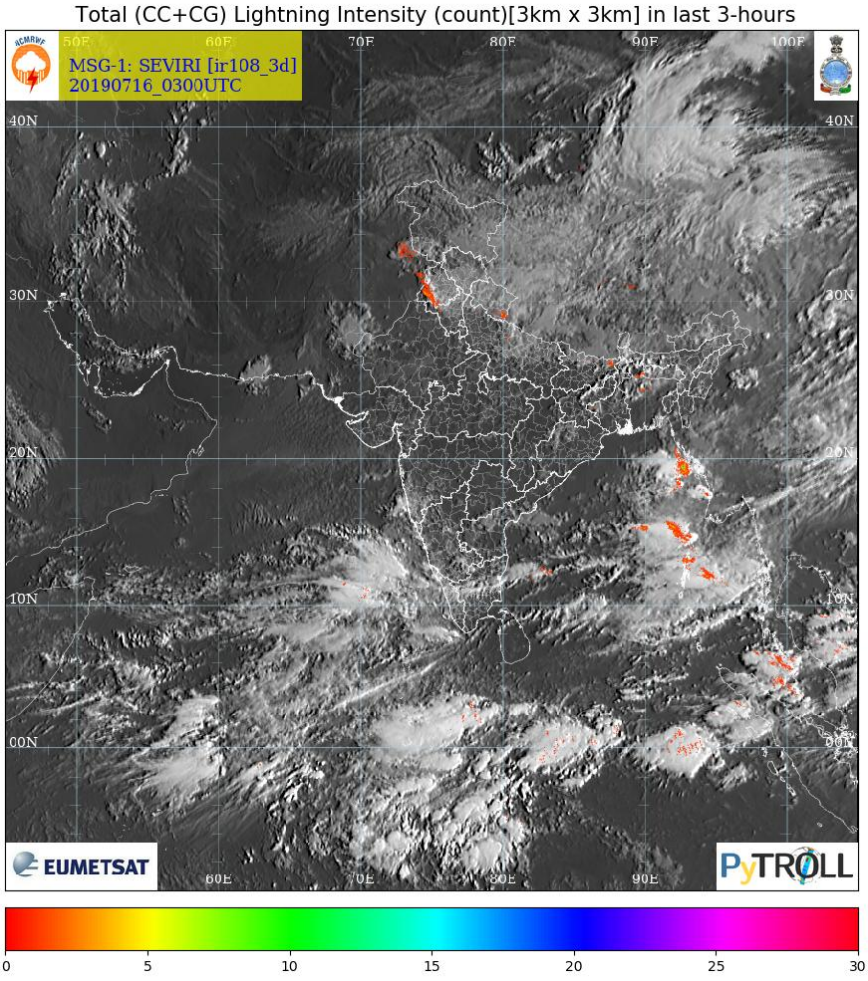

Figure 1: Cloud to cloud (CC) and Cloud to Ground (CG) lightning intensity count (3 x3 km resolution. Image by courtesy of Eumetsat.

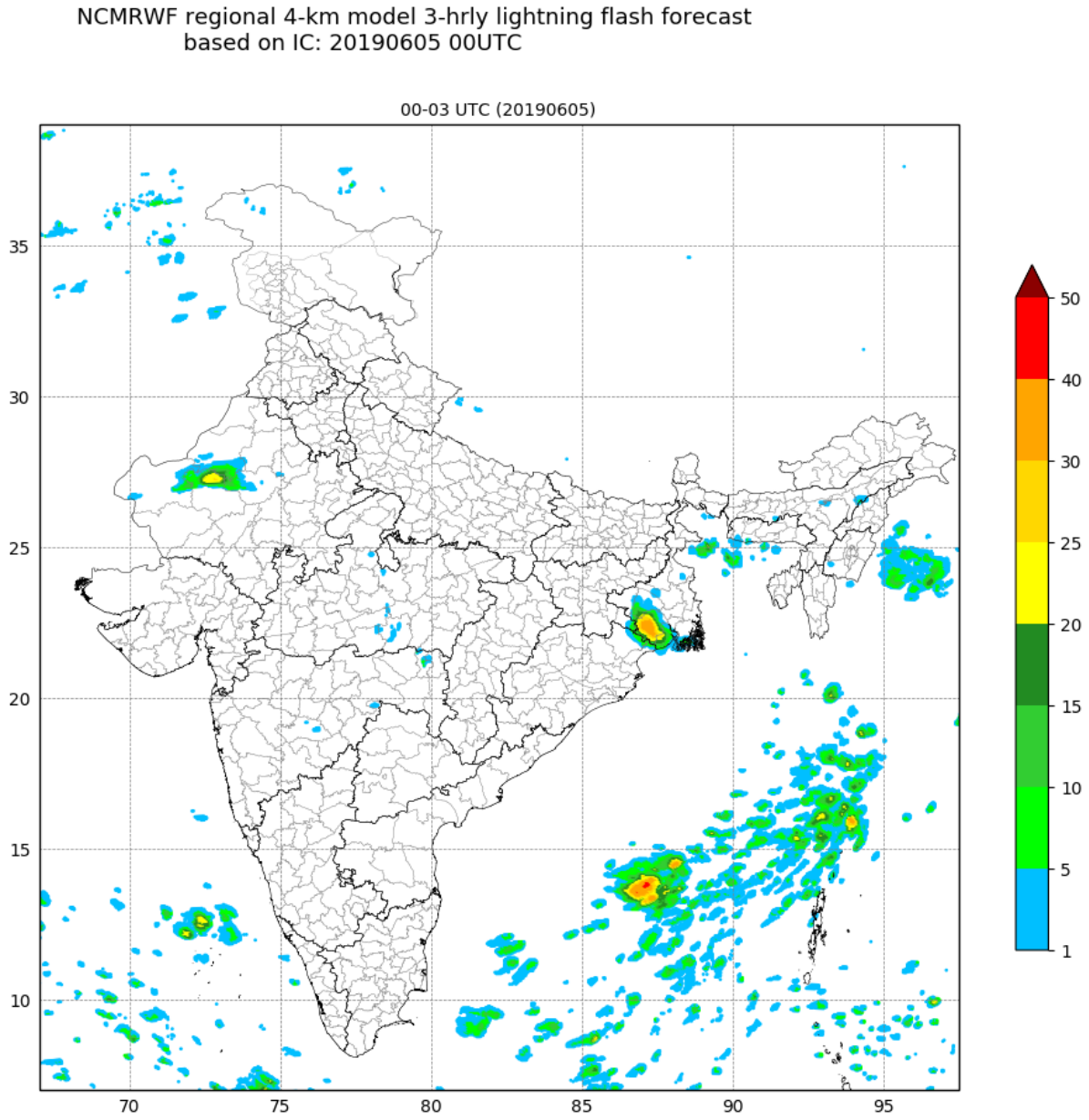

Figure 2: UK based unified model generated forecast of lightning flashes at the National Centre of Medium Range Weather Forecast (NCMRWF) Noida-UP.

and EUMETSAT to provide meteorological observations from geostationary orbit. Red colour shows the potential area lightning counts in three hours both cloud to cloud (CC) and cloud to ground (CG). This type of information is useful to issue the warnings over the area by judging the persistency of the clouds. If there is a chance of persistence of the similar type of clouds over the region then we can warn the public about the severity of the weather events. Figure 2 is the forecast generated by the UK based unified model running daily at the National Centre for Medium Range Weather Forecast (NCMRWF) Centre at Noida –UP. This information is generated at 4.0 km resolution in every three hour forecast and freely available at real time mode for public domain at NCMRWF web site.

This type of satellite based and model based information is compared with the actual information available from the lightning network data, This is essential to validate the model and satellite information to get the confidence in public and derived information.
This is a new area and we are in a process of statistical examining the severe weather events. These events have direct impact of human life and property, even sometimes whole crops are damaged due to lightning and this affects farmer's life very badly. Our country is mainly depends on agriculture and if we are able to provide the accurate or precise information of such type of events then it will be a great help to our country.

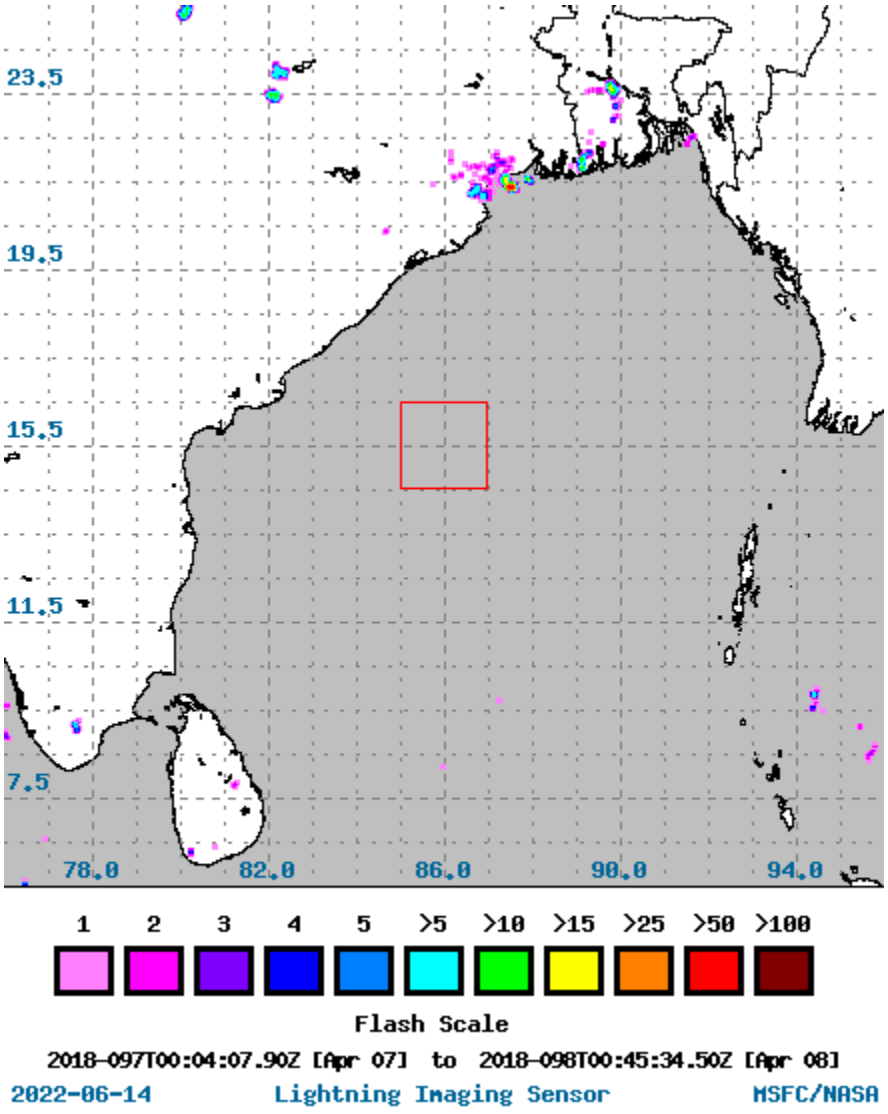

Figure 3: 7th April 2018 lightning map generated from the International Space Station Lightning Imaging Sensor (ISS LIS). Red dots (flashes) at North East (NE) region of India shows lightning activities.

Lightning is the global phenomenon and can be associated with mesoscale complex formation and its passage and it varied global, regional as well as local variations. Within the Central U.S. 25 % of total

annual lightning can be accounted for by the passage of but a single mesoscale convective complex (Goodman and MacGorman, 1986).

Three years (2016 to 2018) lightning occurrence has been examined at monthly basis over Bihar (Gaya, Patna, Bhagalpur and Purnia). It has been observed that May to October the lightning occurrences are more as compared to other months, figures 4 (a-d). It covers parts of pre-monsoon and entire monsoon season till its withdrawal from the country.

Monitoring through Space

The Tropical Rainfall Measuring Mission (TRMM) satellite has a semi-equatorial orbit that is inclined 35 degrees with respect to the equator. This was equipped with lightning image sensor (LIS). The satellite altitude was 350 km from 1997 until 2001, at which time it was raised to 403 km. The orbit gradually declined in the last year of operation from 2014 - 2015. In 2015, TRMM was removed from orbit. There was a gap of remote sensing data over Indian region after 2015. ISS LIS remote sensing data for public domain & can be a useful recourse for future.

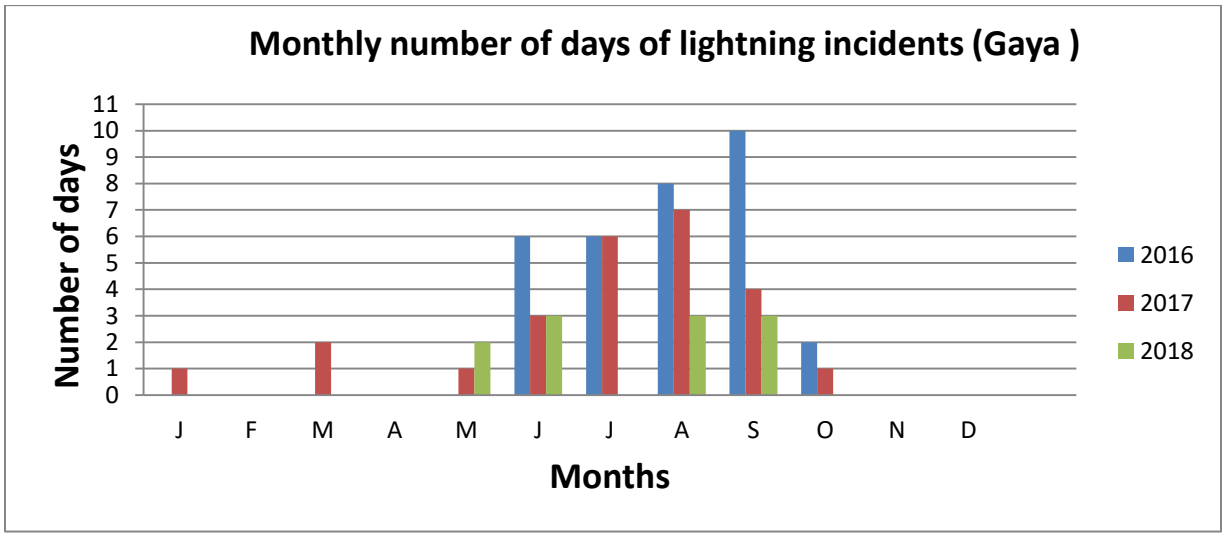

Figure 4 (a): Monthly number of incident reported at Gaya (Bihar) during the year 2016 to 2018.

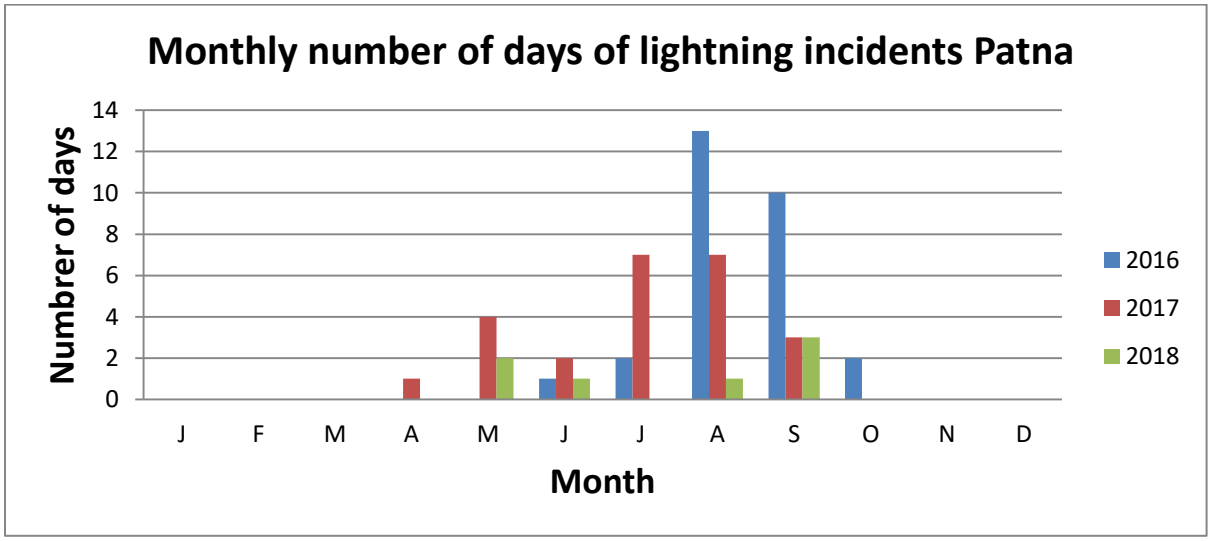

Figure 4 (b): Monthly number of incident reported at Patna (Bihar) during the year 2016 to 2018.

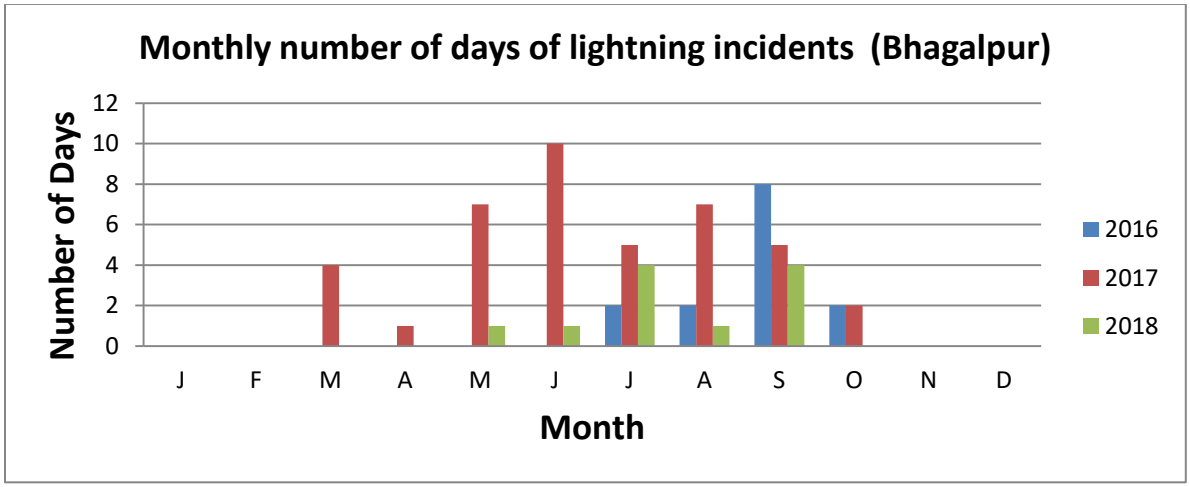

Figure 4 (c): Monthly number of incident reported at Bhagalpur (Bihar) during the year 2016 to 2018.

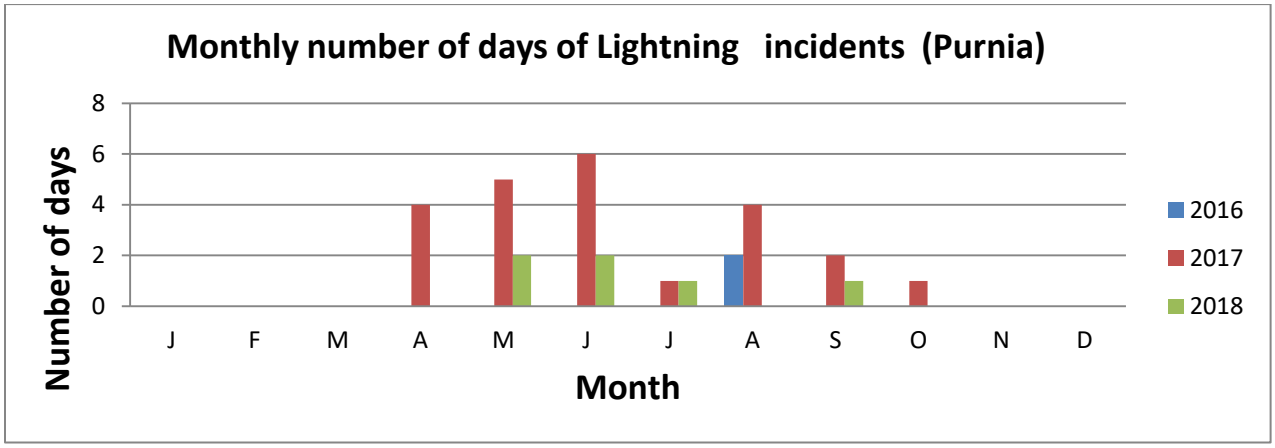

Figure 4 (d): Monthly number of incident reported at Bhagalpur (Bihar) during the year 2016 to 2018.

Conclusion

Weather events are increasing in intensity in the recent past. Lightning is the common weather hazard which affect the people throughout the globe. It precise prediction with sufficient lead time is a challenging task. Northeast region of India during pre-monsoon (March to May) and monsoon season frequently affected by thunderstorm and lightning activities. It is seen from the analysis that during three years (2016-2018) lightning occurrences over Bihar stations, Gaya, Patna, Bhagalpur and Purnia districts shows monthly variation and most of the lightning events (84.2 %) was occurred between May to October months. The findings of this study are important for further planning the preventive measures in advance. In this direction, the role of space based lightning data over Indian region will play an important role. In future, similar analysis with more number of observational occurrences along with the support of space based lightning data can help to identify the lightning vulnerable pockets in India.

ACKNOWLEDGEMENTS

The authors are grateful to the DGM of IMD for providing the lightning observation data. Authors acknowledge the support of EUMETSAT and NCMRWF centres are duly acknowledge for supporting

the real time satellite and model information of lightning activity. The ATBD information of lightning data from International Space Station data is duly acknowledged.

REFERENCES

Brooks HE, Carbin GW & Marsh PT (2014). Increased variability of tornado occurrence in the United States. Science. 346, 349–352.

Christian HJ, RL Frost, PH Gillaspy, SJ Goodman, OH Vaughn, M Brook, B Vonnegut, and RE Orville (1983). Observations of optical lightning emissions from above thunderstorms using U-2 aircraft, *Bulletin of American Meterological Society*, 64, 120.

Christian HJ, RJ Blakeslee, SJ Goodman and DM (2000). Algorithm Theoretical Basis Document ATBD) for the Lightning Imaging Sensor (LIS). *https://eospso.gsfc.nasa.gov/sites/default/files/atbd/atbd-lis-01.pdf*

Parry ML, Canziani OF, Palutikof JP, Linden PJ van der & Hanson CE IPCC, (2007). Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. (Cambridge University Press, 2007).

Field CB *et al.*, (2012). A special report of working groups I and II of the intergovernmental panel on climate change (Cambridge University Press, 2012).

Goodman SJ, and DR MacGorman (1986). Cloud-to-ground lightning activity in mesoscale convective complexes, *Monsoon Weather Review*, 114, 2320.

Elsom DM (2001). Deaths and injuries caused by lightning in the United Kingdom: Analyses of two databases. *Atmosphere Research*, **56**, 325–334.

Ashley WS and CW Gilson (2009). A reassessment of U.S. lightning mortality. *Bulletin of American Meteorological Society*, **90**, 1501–1518.

Mäkelä A, E Saltikoff, J Julkunen, I Juga, E Gregow and S Niemelä (2013). Cold-season thunderstorms in Finland and their effect on aviation safety. *Bulletin of American Meteorological Society*, **94**, 847–858.

Wilkinson JM, H Wells, PR Field and P Agnew (2013b). Investigation and prediction of helicopter-triggered lightning over the North Sea. *Meteorological Application*, **20**, 94–106.

Curran EB, RL Holle and RE López (2000). Lightning casualties and damages in the United States from 1959 to 1994. *Journal of Climate*, **13**, 3448–3464.