Investigating the frequency distribution of lightning and its relation with elevation in Southeast of Iran

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Date of receive:94.11.28 **Date of accept:95.11.25**

Extended Abstract

Introduction

Lightning is one of the most fascinating climatic phenomena, which has not yet been fully understood. This phenomenon usually occurs during thunderstorms and at the times of electrical field failure in a variety of cloud-to-ground, cloud-to-cloud, and in-cloud or intra-cloud. The cloud-to-ground lightning which strikes the ground is one of the most important causes of mortality due to weather conditions. Lightning can also cause many financial losses such as damaging power lines and causing fire. Therefore, spatial distribution of lightning is essential in terms of energy and safety management. Furthermore, our community, which increasingly relies on information networks, helps to identify the areas prone to lightning in order to protect the information systems. Lightning activities vary widely on the spatial and temporal scales, and depend on local convectional activities to some extent. The knowledge of lightening activities was usually based on surface measurements over time, prior to the arrival of the satellites. But, the activity of these storms is not measured in places where there are no synoptic stations. Therefore, it is necessary to predict the exact location and the severity of convective storms based on the development and monitoring of the route for timely notification. This is because all measurements related to thunderstorms in Iran are recorded with a three hour interval in various codes and only at synoptic stations.

Materials and Methods

This study was carried out using lightning data recorded in space by LIS sensor in a period from January 1998 to December 2013 (16 years). Lightning imaging sensor (LIS) is installed on the TRMM satellite. The LIS sensor is an optical detector that measures light-induced and light-intensity variations in clouds in the range of 777 nm/s and is capable of observing thunderstorms with a scale of 3 to 6 km on a 600x600-km while the effective LIS efficiency is 90% at night and 70% at local noon time.

At the first stage of data analysis, it should be determined that the data are randomly distributed or have a certain spatial trend. Some of geographic processing functions were applied to data in the GIS software to compute the statistical values and to determine the locations having significant lightning levels. These calculations are done based on the Euclidean distance between the points (thunder and lightning) and the spatial concept of that weighting method based on the inverse distance. Other indices also compute the spatial distribution of the data. The nearest neighbor

index (NNI) and the Kernel density function are among these indices. The NNI is expressed as a proportion of the observed distance to the expected distance, assuming the random distribution of the images. To generalize the geographic location of a phenomenon (lightning occurrence) to the whole area, the Kernel density interpolation estimator has been used throughout the region. In fact, the Kernel density function in the GIS software calculates the density of the features in their neighborhood and can be used for linear and point features (lightning).

Results and Discussion

The results of this research showed that the maximum frequency of lightning occurs in the southeast of Iran in the months of March to August (warm period of the year). Its highest frequency is in August and its lowest frequency is in December. In the study of daily changes it was also found that from the early afternoon until late afternoon (from 1300 to 1600 hours local time), the lightning activities significantly increase, which seems to be related to local convectional activities which are along with the surface heat created by daily radiation of the sun. The nearest neighbor index results showed that the data distribution follows the cluster pattern. In other words, some regions have more favorable conditions for lightning. The results of the Kernel density index indicated that these areas are in the southern slopes of the region and its maximum is located before the main peak. The maximum frequency of lightning lies between 26° and 27° N, and is on the same orbital direction. Given the maximum lightning occurrence time which is during the warm period of the year, it seems that the southern currents created by the monsoons of the Southeast Asia along with local topography, is the exacerbating factor for the lightning activities in the southeast of Iran, and in particular, the region with a maximum lightning activities.

Conclusion

The use of satellite data to illustrate the distribution of some climatic phenomena can be very useful, since the frequency of some phenomena (especially lightning) is not recorded on ground stations. On the other hand, the distribution and density of ground stations are not appropriate, because the density of synoptic stations is particularly in low mountainous regions and the shape of the land in these areas is complex, and the distribution of thunderstorms is affected by this form of land. As it was observed in the results, one of the most important factors of the frequency distribution of lightning is the roughness, and these results indicate that remote sensing technology can be used to calculate the distribution of the phenomena of interest with high precision.

Keywords: Lightning, LIS, Kernel Density Functions, Southeast of Iran.