

## Analysis on the Spatio-temporal Distribution Characteristic of Cloud-to-ground Lightning in Hubei Province

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**Abstract:** Based on the cloud-to-ground (CG) lightning location data observed by ADTD lightning location network in Hubei province during 2006-2009 (there is a lack of the data from September to December in 2006), it is analyzed about the spatio-temporal distribution characteristics of the CG lightning in five districts in Hubei Province. The results indicate that: (1) There is significant difference in the number of CG during these years. Extreme process (day flash 10000 and above) causes more than half of the difference. (2) The monthly distribution features of the cloud-to-ground lightning in Hubei province are: Few lightning appear from January to March, then the amount increases at first during April to June and it reaches to maximum during July to August, at last the frequency decreases sharply during September to December. The CG lightning from April to August accounts for about 97.86% of the annual total CG lightning. (3) The temporal distribution of CG lightning displays single peak characteristic, the main peak value occurs during 14:00-20:00 (local time) with the most CG lightning appearing at 16:00. (4) The day distribution of CG lightning changes during April to August, and the variation is thought to be related to the season conversion. (5) According to the spatial distribution of the lightning, the lightning density is relatively large in the border area of west part of Jiangnan Plain and east Hubei province (it is also the border area of plain and mountain).

### Introduction:

Lightning is the phenomenon of strong discharge in the atmosphere[1]. According to spatial location, the lightning type can be divided into categories as: cloud-ground lightning, inside cloud lightning, lightning within clouds and skies cloud. Cloud-ground lightning has closest relations with human activities. Based on the CG lightning data, Guili Feng studied the lightning distribution characteristics of Shandong statistical, and the result shows that the spatial distribution of lightning relates to terrain and underlying. Mingyan Yi analyzed

the local spatio-temporal distribution characteristics of Guangzhou, and came to a conclusion that the spatial distribution of lightning density is obvious regional. This paper dis the analysis according to different time and location based on the CG lightning location data in Hubei province with a view to provide some available reference to the lightning disaster protection services.

## **DATA:**

The cloud-to-ground (CG) lightning location data analyzed was observed by ADTD lightning location network in Hubei province. The system detects the time, location, polarity, intensity of CG lightning in Hubei province. The data is between Jun 1st. 2006 in Dec 5th 2009 (there is a lack of the data from September to December in 2006). Both of the distribution character of day and month, and the density character of CG lightning in Hubei and all the five natural areas within the province are studied.

## **2 The analysis of spatio-temporal distribution characteristic**

### **2.1 The monthly distribution analysis**

#### **2.1.1 The monthly distribution of Hubei province**

The ADTD lightning location network has detected 2499984 CG lightning and 849 lightning days during 2006-2009, and positive lightning is 3.75%. As Fig1 shows: the monthly distribution features of the cloud-to-ground lightning in Hubei province are: Few lightning appear from January to March, then the amount increases at first during April to June and it reaches to maximum during July to August, at last the frequency decreases sharply during September to December. The CG lightning from April to August accounts for about 97.86% of the annual total CG lightning.

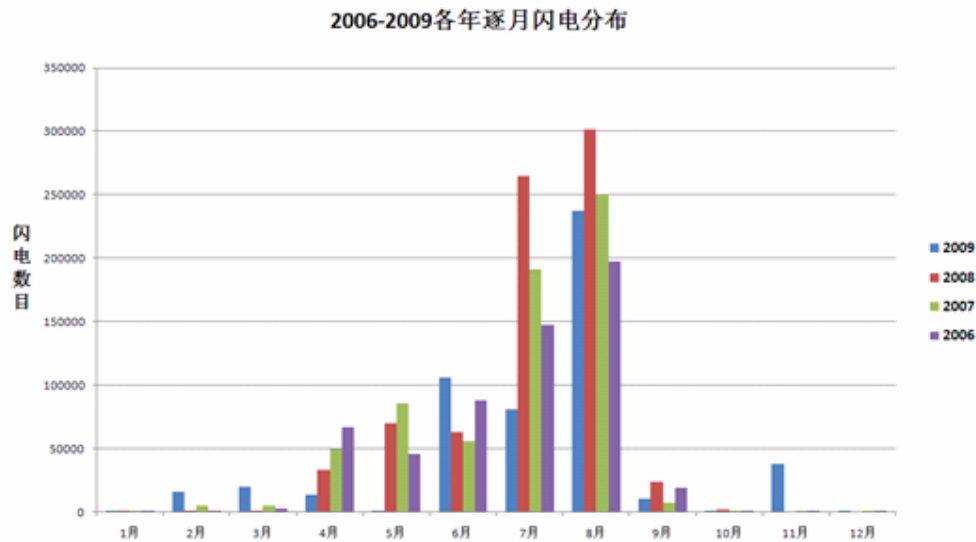


Fig1 the monthly distribution features of the CG lightning in Hubei province during 2006-2009

By comparing the CG lightning in these years, it is found that, frequencies of the CG lightning during 2006-2008 increased year by year while the frequency in the summer of 2009 was obviously less than that in the preceding three years. Fig1 also shows that July and August have the major differences in the number of CG lightning. The CG lightning distribution in July and August during 2006-2009 are analyzed, and it is found that there are at least 3 reasons for the significant differences in the number of CG lightning in July and August: (1) there are more lightning days in July and August in 2007 and 2008; (2) there are a lot more extreme process (day flash 10000 and above) in July and August in 2007 and 2008; (3) in July and August there are more lightning in almost every lightning day in 2007 and 2008 than 2006. Extreme process causes more than half of the difference of the number of CG lightning during 2006-2008; while the other two reasons cause considerable differences as well. The number of lightning day is close to regular years, while the number of CG lightning is obviously higher in January to march, June and November; lower in April, May, July and August. In June and November, there are significant less extreme process.

### 2.1.2 The monthly distribution of the five natural areas in Hubei province

Fig2 shows the monthly distribution of the five natural areas in Hubei province, and it tells that:

- 1、 The northeast part has the most lightning; while least in Southeast, and the rest are similar.

2、There are less lightnings in the southwest part in July which leads to the main peak occurs in August, while the other four occurs in both July and August.

3、In the southeast of Hubei province, the CG lightning activity from April to June is obviously weaker than that in other areas, which may be related to the less convective weather during the season conversion from spring to summer in this area.

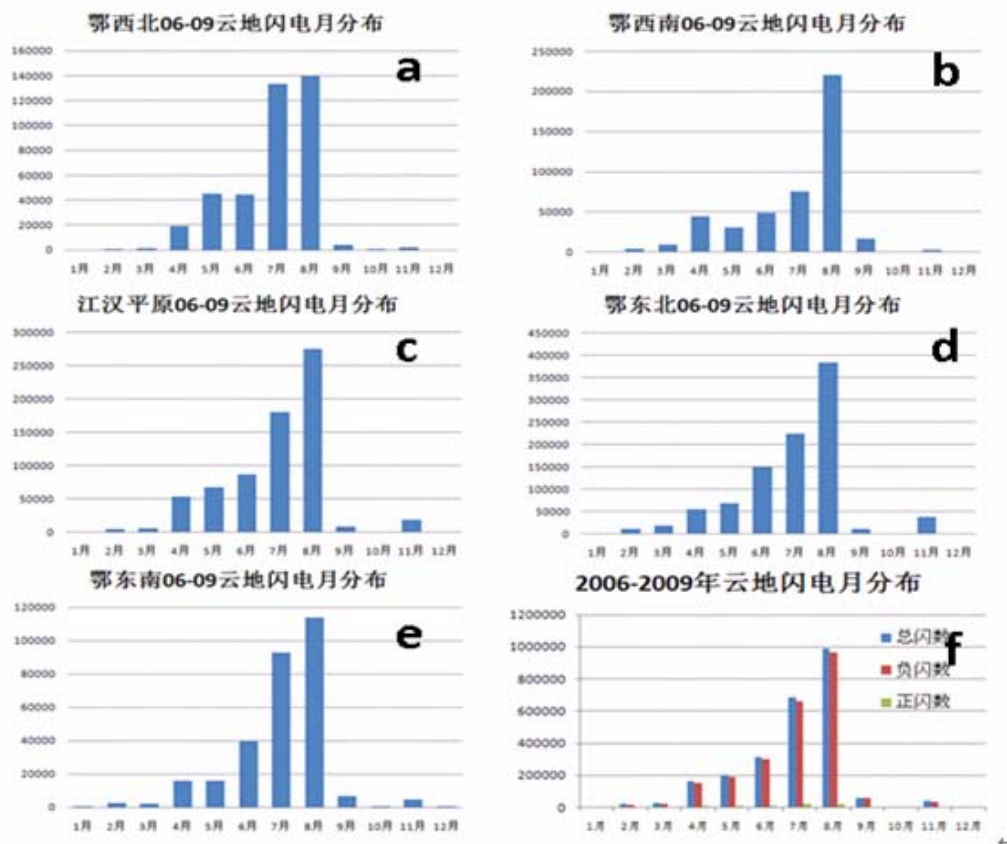


Fig2. The monthly distribution of five natural areas during 2006-2009. (a. the northwest; b. the southwest; c. the central plain; d. the northeast; e. the southeast; f. Hubei province)

## 2.2 The daily distribution analysis

As it is showed in Fig3, the temporal distribution of CG lightning displays single peak characteristic, the main peak value occurs during 14:00-20:00 (local time) with the most CG lightning appearing at 16:00. After the noon the frequency of CG lightning begins to increase sharply and as soon as reaching to the main peak, it decreased gradually and the valley appears at 10:00.

The temporal distributions of CG lightning in the five natural areas and the whole province show similar characters: the main peak is during the afternoon, while it decreases more faster after the main peak in the northwest and

southeast part.

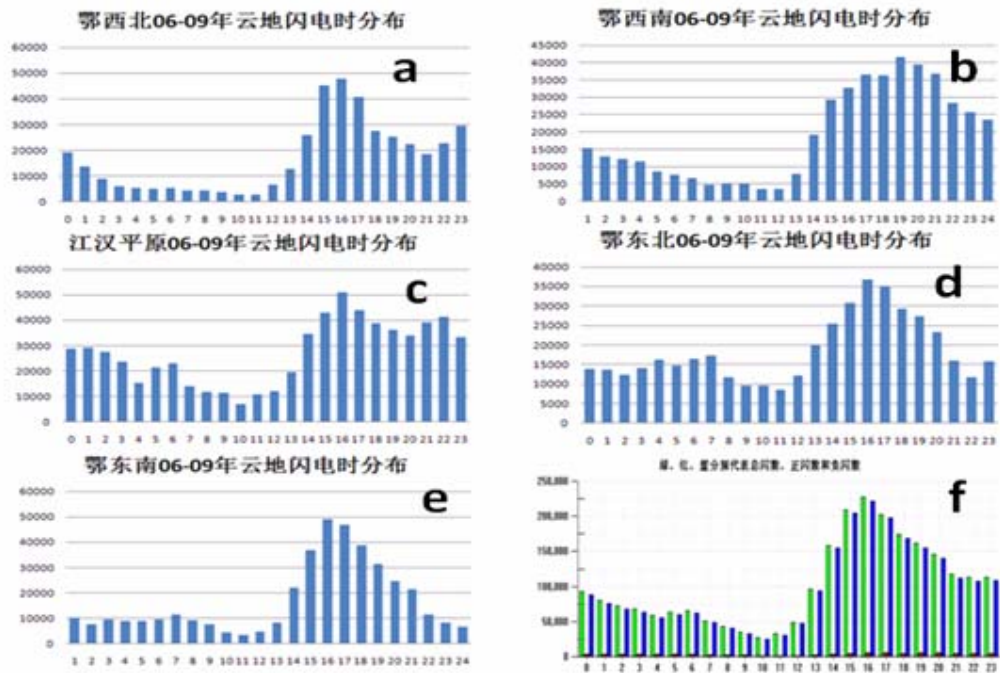


Fig3. . . . The daily distribution of the five natural areas and Hubei province during 2006-2009 (a-northwest; b-southwest; c-central plain; d-northeast; e-southeast; f-Hubei province)

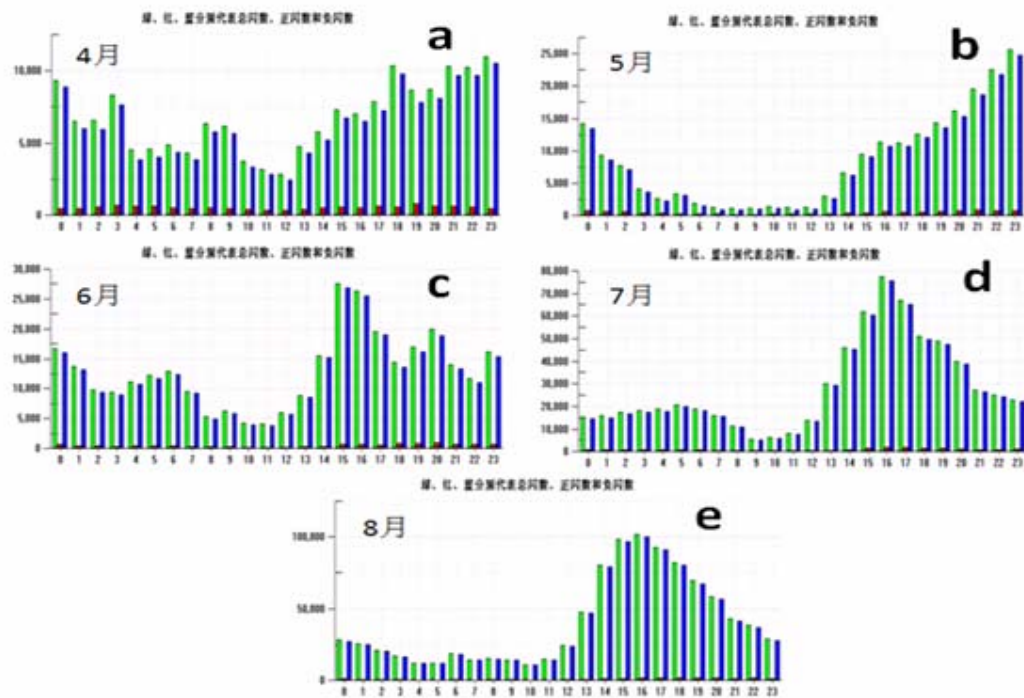


Fig4. . . . The daily distribution of Hubei province from April to August during 2006-2009 (a-April; b-May; c-June; d-July; e-August)

By analyzing the CG lightning during April, it was found that the main peak appears during 21:00-24:00 and there are some minor peaks at the same time. In May, the CG lightning shows obvious single peak feature and the main peak still appear in the evening. The main peak changes to be from 14:00 to 17:00 during June to August. Furthermore, some minor peaks are also found in the temporal change of CG lightning in June. It is thought to be related to the season conversion.(Fig 4.)

### 2.3 The density distribution of the lightning

Fig 5 is the average density distribution map of CG lightning during 2006-2009. Compared to the topographic drawing of Hubei, it could be found that the lightning density is relatively large in the border area of west part of central plain and east Hubei province (it is also the border area of plain and mountain). Although the situation varies from year to year, the CG lightning always concentrates in the border area of plain and mountain.

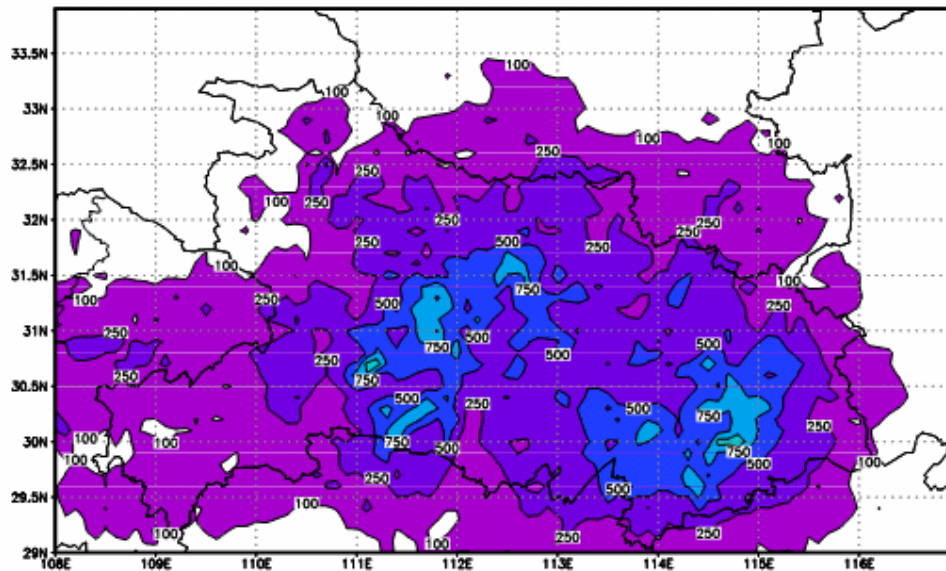


Fig5 . . . The . . . average density distribution of the CG lightning during 2006-2009年↵

### 3 Conclusions

Based on the cloud-to-ground (CG) lightning location data observed by ADTD lightning location network in Hubei province during 2006-2009 (there is a lack of the data from September to December in 2006), the spatio-temporal distribution characteristics of the CG lightning in five districts in Hubei Province is analyzed, and the conclusions are:

- (1) The monthly distribution features of the cloud-to-ground lightning in

Hubei province are: Few lightning appear from January to March, then the amount increases at first during April to June and it reaches to maximum during July to August, at last the frequency decreases sharply during September to December. The CG lightning from April to August accounts for about 97.86% of the annual total CG lightning.

(2) There is significant difference in the number of CG during these years. Extreme process (day flash 10000 and above) causes more than half of the difference.

(3) According to the spatial distribution of the lightning, the lightning density is relatively large in the border area of west part of the central plain and northeast Hubei province. In the southeast of Hubei province, the CG lightning activity from April to June is obviously weaker than that in other areas, which may be related to the less convective weather during the season conversion from spring to summer in this area.

(4) The temporal distribution of CG lightning displays single peak characteristic, the main peak value occurs during 14:00-20:00 (local time) with the most CG lightning appearing at 16:00. After the noon the frequency of CG lightning begins to increase sharply and as soon as reaching to the main peak, it decreased gradually and the valley appears at 10:00.

(5) By analyzing the CG lightning during April, it was found that the main peak appears during 21:00-24:00 and there are some minor peaks at the same time. In May, the CG lightning shows obvious single peak feature and the main peak still appear in the evening. The main peak changes to be from 14:00 to 17:00 during June to August. Furthermore, some minor peaks are also found in the temporal change of CG lightning in June. It is thought to be related to the season conversion.

(6) The lightning density is relatively large in the border area of west part of central plain and east Hubei province (it is also the border area of plain and mountain). Although the situation varies from year to year, the CG lightning always concentrates in the border area of plain and mountain.

### **References:**

[1] Yanyan Kong, Jianguo Shen. Strong thunderstorms forecast (M). Beijing: Meteorological Press, 2001: 128-141.

[2] Guili Feng, Wenxuan Chen, Shijun Liu, Analysis on the characters of lightning in Shandong (J). Quarterly Journal of Applied Meteorology, 2002, 13 (3): 347-355.

[3] Mingyan Yi, Zhaoli yang, Qiin Wan. Analysis of Lightning Density in Guangzhou City (J). Resources Science, 2006, 28 (1): 151-156.