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The Frequency of Lightning Activity in Hokkaido as Observed by the JLDN from 2000 to the Present

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***Abstract*— The Japanese Lightning Detection Network (JLDN) started observing lightning discharges in 1998 and covered the four main islands of Japan in 2000. The authors analyzed lightning frequency in Hokkaido. They observed a tendency toward an increase in the number of lightning strokes beginning in 2004. Not only the lightning activity but also the probability of lightning occurrence is higher in Hokkaido than it was in the past.**

Keywords—LLS; lightning frequency; thunderstorm days;

I. INTRODUCTION

The Japanese Lightning Detection Network (JLDN), operated by Franklin Japan Corporation, began operation in 1998 and has covered the four main islands of Japan (Hokkaido, Honshu, Shikoku and Kyushu) since 2000. Currently, the JLDN consists of 10 IMPACT-ESP, 9 LPATS-IV and 11 LS7001 sensors. The sensor locations of the JLDN in 2013 are shown in Figure 1.

The authors reported the lightning characteristics in Japan observed by the JLDN for the 10 year period from 2001 to 2010 at the 2012 ILMC and concluded there was no clear tendency showing that the number of lightning strokes in Japan had increased year after year [Sugita and Matsui, 2012]. However, although we know lightning characteristics can vary greatly from year to year, we feel lightning activity in Hokkaido has been increasing in recent years.

Hokkaido is the northernmost island of Japan. Unlike the rest of Japan, the weather pattern of Hokkaido is a cool-temperature climate. It is cold enough that drifting sea ice reaches its northeastern coast in winter. Unlike the other three main islands, it is said that there is no “Baiu” rainy season in Hokkaido in early summer. The authors analyzed the lightning characteristics in Hokkaido as compared to the lightning characteristics in the entire country with a focus on the changes in the frequency of lightning activity.

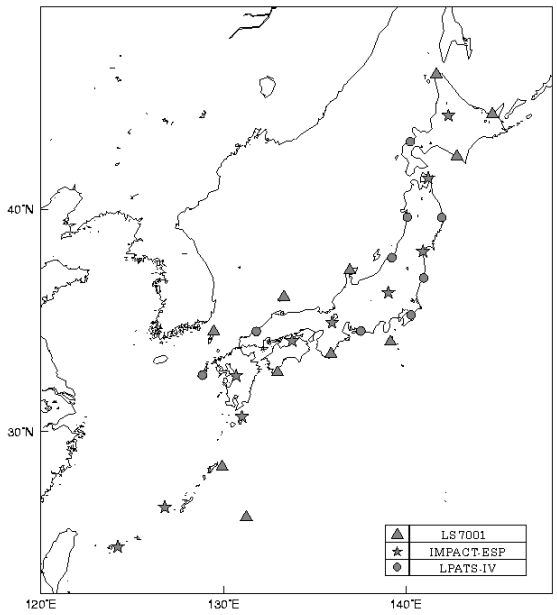

Fig. 1. JLDN Sensor Map in 2013. The circles are LPATS-IV sensors, the stars are IMPACT-ESP sensors and the triangles are LS7001 sensors.

II. DATA

The authors analyzed lightning stroke data observed by the JLDN from 2000 to 2013. Small discharges with peak currents ranging from -2kA to 5kA are not counted in this paper.

All analyses were done in the region from 41.1N to 46.1N in latitude and from 139E to 147E in longitude, and the geographical plots in this paper were created with a spatial resolution of 0.2 degrees. All the lightning data analyzed in this paper are not flashes but strokes, because the JLDN outputs only stroke data.

III. RESULTS

A. The Number of Lightning Strokes

The total number of lightning strokes in the analyzed area for the 14 years from 2000 to 2013 was 1,781,572. Figure 2 shows the annual number of lightning strokes from 2000 to 2013. The annual number of lighting strokes ranged from a low of 29,615 in 2003 to a high of 240,641 in 2012. The pattern of fluctuation in the annual number of lightning strokes in Hokkaido was clearly quite different from the pattern of increases and decreases across the entire country as a whole [Sugita and Matsui, 2012]. The annual number of lightning strokes in Hokkaido was around 50,000 from 2000 to 2003, but it increased by approximately 100,000 strokes beginning in 2004. It seems that the minimum level of the annual number of lightning strokes increased after 2003.

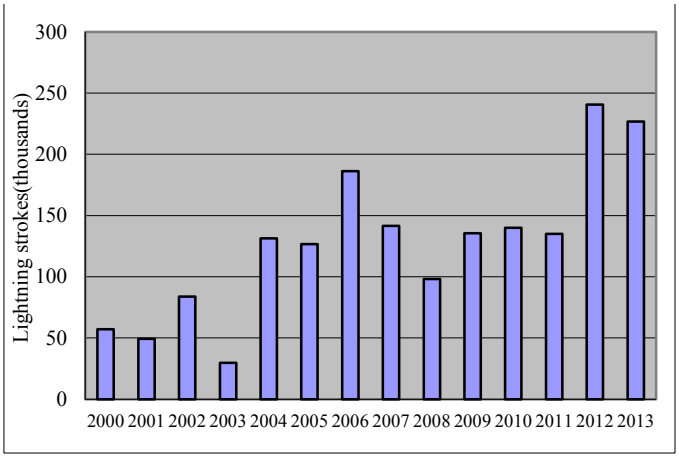

Fig. 2. The annual number of lightning strokes in the analyzed area from 2000 to 2013.

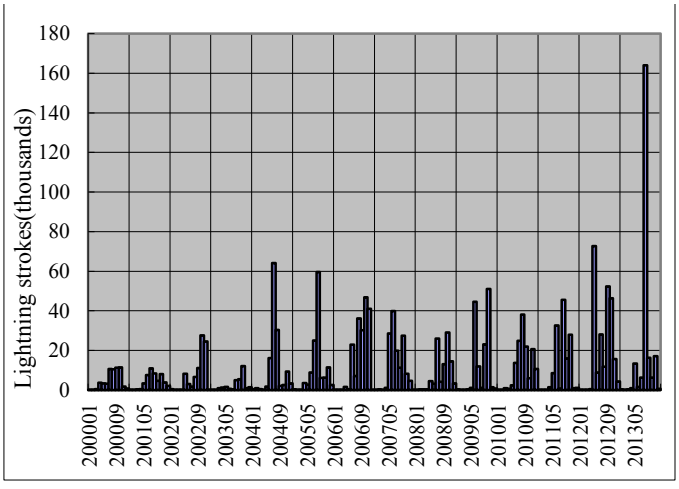

Fig. 3. The monthly distribution of lightning strokes in the analyzed area from 2000 to 2013.

To see the seasonal characteristics of lightning occurrence in Hokkaido, the number of lightning strokes was counted month by month. Figure 3 shows the monthly distribution of the number of lightning strokes from 2000 to 2013.

In Hokkaido, the number of lightning strokes is high in September, October and November when the season changes from autumn to winter. The number of lightning strokes also becomes high in summer in 2004 and in subsequent years.

In 2013, there were extremely numerous lightning strokes in August, but not so many lightning strokes in other months. The number of lightning strokes in August 2013 was 164,059 and that is higher than the annual number of lightning strokes in Hokkaido in every other year except 2006 and 2012. It was abnormal weather.

B. Lightning Frequency

Figure 4 shows the annual lightning stroke frequency from 2000 to 2013. It is important to note that, unlike flash density maps, each map is a plot of the number of lightning strokes on a 0.2 degree grid.

It is clear that the green region where the number of lightning strokes was over 100 has spread widely since 2004. Indeed, the white and blue regions where the number of lightning strokes was less than 100 occupied about 77% to 95% of the analyzed area from 2000 to 2003, but that percentage decreased to a range from 39% to 66% beginning in 2004.

The number of lightning strokes was high mainly in the southwestern part of Hokkaido up until 2003, but from 2004 onward, the number of lightning strokes was also high in the mountainous regions where solar heat caused convective thunderstorms to occur frequently in summer. In addition, the number of lightning strokes over the sea has increased. This is an indication that thunderstorms with high lightning activity now come more frequently to Hokkaido.

C. Thunderstorm Days

Figure 5 shows the annual thunderstorm days in the 0.2 degree grid from 2000 to 2013.

In the same way as lightning Frequency, it is also clear that the regions where there are ten or more thunderstorm days have become larger since 2004. The white and light blue regions where there were less than 10 thunderstorm days occupied about 90 to 95 % of the analyzed area from 2000 to 2003, but those percentages decreased to a range from 57% to 86% after 2003. Lightning occurred more frequently from 2004 on.

Thunderstorm days are highest only in southwestern Hokkaido up until 2003, but starting in 2004, thunderstorm days are higher not only on the coast of the Sea of Japan but also in the mountainous regions. In addition, the number of thunderstorm days itself becomes higher across a wide area of the analyzed region. This means the probability of lightning occurrence in Hokkaido is higher than before.

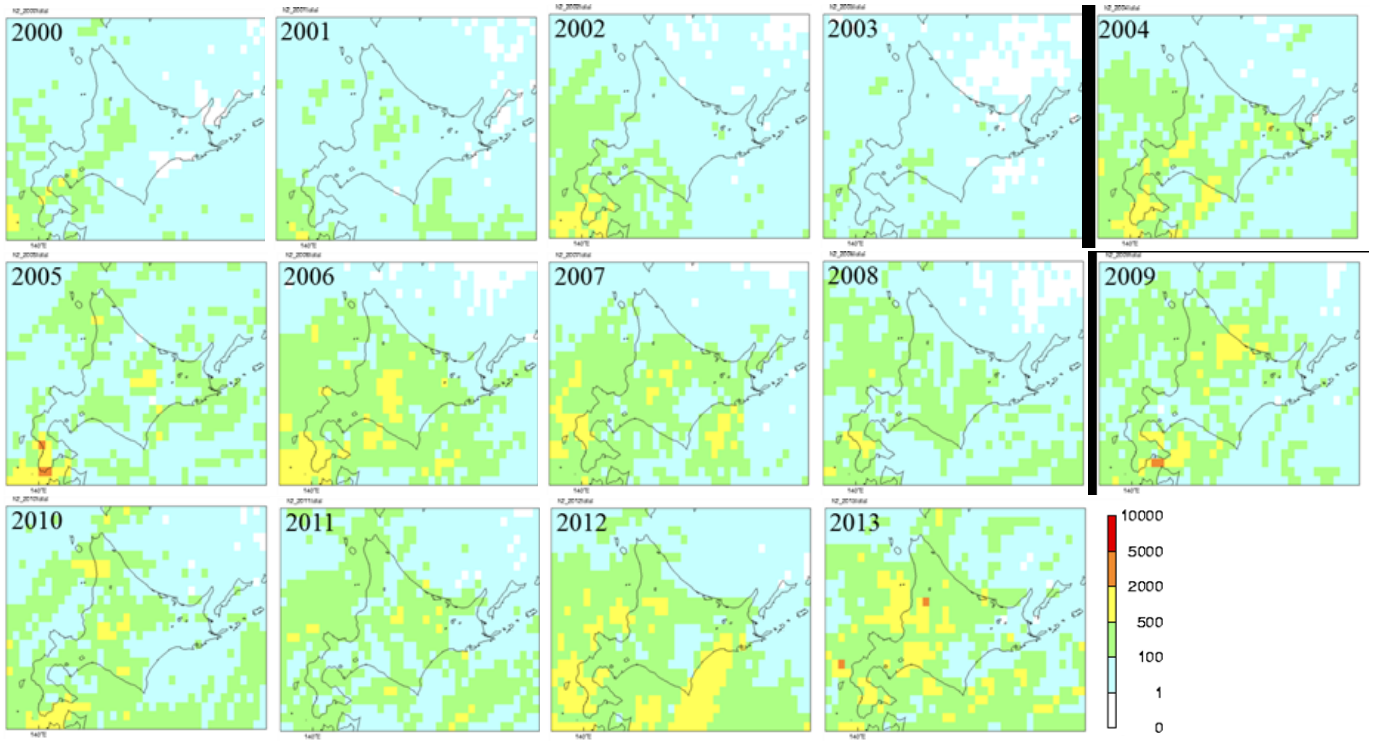

Fig. 4. The distribution of annual lightning strokes in a 0.2 degree grid from 2000 to 2013.

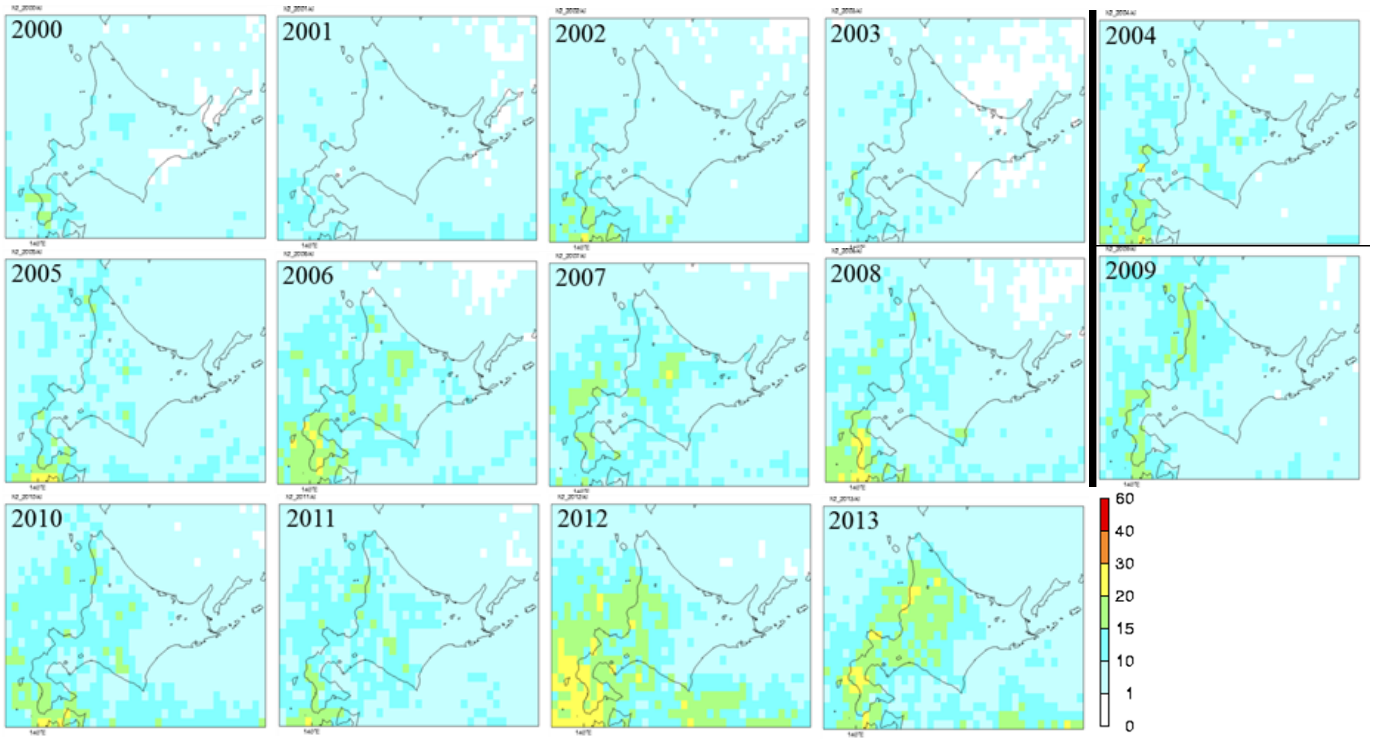

Fig. 5. The distribution of annual thunderstorm days in a 0.2 degree grid from 2000 to 2013.

IV. CONCLUSIONS

There has been a tendency toward an increase in the number of lightning strokes in Hokkaido since 2004. Hokkaido previously had a lot of lightning strokes in September, October and November. From 2004 onward, the number of lightning strokes has also been high in summer. Not only lightning frequency but also the number of thunderstorm days has gone up across wide regions of Hokkaido.

The authors would like to continue to introduce the lightning characteristics of Japan in future papers.

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REFERENCES

Sugita, A., M. Matsui (2012), Lightning characteristics in Japan observed by the JLDN from 2001 to 2010, paper presented at 4th International Lightning Meteorology Conference, Broomfield, Colorado, USA