

# Statistics of TLE-causing lightning strokes at high latitudes – FinSprite results 2009-2011

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The Finnish Meteorological Institute (FMI) together with fireball and storm chasing divisions of the Finnish Astronomical Association Ursa, have coordinated observation campaign of Transient Luminous Events (TLE) in Finland and surroundings since 2009. This paper summarizes the results. The motivation is to present statistics of the parent strokes causing the TLEs, including peak current and polarity, which are obtained from the Nordic Lightning Information System (NORDLIS). The results indicate that the typical parent stroke is a positive stroke with an average peak current of 33.5 kiloamperes. All of the TLE observations are from 19-03 UTC (22-06 LT) from the late-summer or autumn.

## 1. Introduction

The first observed TLE near Finland was observed in 2009 ([1]). Apparently the event was the highest northern latitude TLE ever captured. The observation led to the establishment of the Finnish observation campaign, FinSprite, which is aimed to observe routinely TLEs occurring in Finland and the surrounding areas (including Estonia, western Russia, Sweden, and Norway). The basis of FinSprite, including the instrumentation, are very similar to those in EuroSprite [2].

During 2009-2011 it has been found out that to routinely observe TLEs at high latitudes is possible, but contains some unique difficulties:

- the main thunderstorm season is situated in the midsummer, which is also the brightest time of the year, hampering the observations;
- the most suitable time of the year for observing TLEs is the late summer, but thunderstorms are rare at that time of the year.

According to the two points above, the TLE observations in Finland are more random than for example in the southern Europe, and the number of observations is highly dependent on the arrival of suitable storms in the late summer or autumn. For example, in 2010 about 20 TLEs were observed, but only one in 2011.

In 2009-2011, a total of 25 TLEs have been captured in FinSprite, and for 21 of these there is an unambiguous match in the lightning location system (LLS) data. This paper summarizes these 21 confirmed observations, and shows especially the statistics of the parent strokes causing the TLEs.

## 2. Data and methods

The basis of the TLE observations is the ground-based camera network of the Finnish Astronomical

Association (Ursa). A detailed description is found in [3] (in this conference).

Besides the camera network, large contribution for the campaign comes from the NORDLIS lightning location system ([4]): the real time lightning locations are used for pinpointing candidate lightning strokes for the camera users. When a thunderstorm arrives to the FinSprite observation area, cameras can be pointed towards the storm, which increases the likelihood to capture a TLE. Furthermore, archived LLS data can be used to confirm whether a captured event has occurred at the same time as a located lightning stroke.

Besides time and location of the strokes, NORDLIS shows also the peak current and polarity.

## 3. Results

Table I shows the statistics of the parent strokes. The major part of the TLEs have been Sprites. Also, the data set includes one confirmed Blue jet and ELVES. About 68 % of parent strokes are of positive polarity, including one extremely high-peak current stroke (207 kA). The average peak current of the parent strokes is 33.5 kA, which is almost twice greater than the annual average of all strokes in Finland ([4]).

*Table 1: Statistics of parent strokes of the observed TLEs.*

Avg. peak current	33.5 kA
Median peak current	14.6 kA
Max. peak current	207.2 kA
Positive strokes	68 %
Avg. distance to the camera	514 km

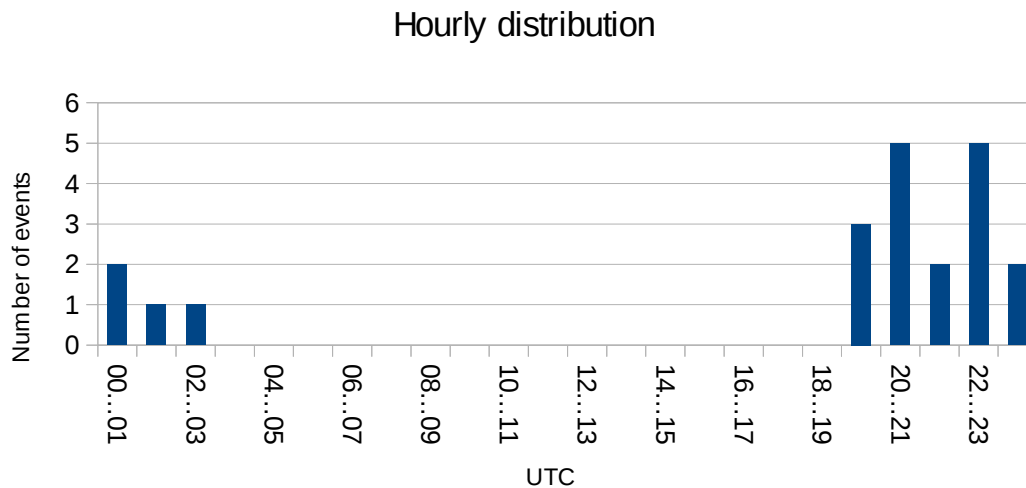


Fig. 1: Distribution of the TLE occurrence times (local time is UTC+3 hours).

The hourly distribution of TLEs during FinSprite is shown in Fig. 1. The evening and night hours (19-03 UTC, i.e. 22-06 LT) include all of the observations. The monthly distribution (not shown) indicates that August is the most numerous month; a few observations are also in late-July and October. Surprisingly, there are no TLE observations in September.

In Figure 2 we have plotted the locations of the parent strokes. A concentration of events is over the Baltic Countries. The northernmost observed TLE has occurred at 62.2778°N, 21.8727°E, which, to our knowledge, is the northernmost observed TLE globally.



Fig. 2: The located parent strokes (red) of TLEs during FinSprite.

#### 4. Conclusions

The statistics of FinSprite in 2009-2011 indicate that TLEs can be observed also at high latitudes, but the observation period is limited to the late-summer or autumn. All of the observations have been made during the evening or night (19-03 UTC). Cameras pointing towards the south or southeast seem to be the most favourable directions (i.e., away from the setting sun).

The lightning location system data indicates that the most common parent stroke is a positive stroke with an average peak current of 33.5 kA; this value is about twice the average of all annual strokes in Finland.

#### 5. References

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