

# Occurrence Mechanism of the Sprites due to the 2015 Kanto-Tohoku Heavy Rainfall

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Our club has been observing TLEs (Transient Luminous Events) over the Sea of Japan from our school building (Iwata City, Shizuoka) since 2007. And in August 2015, we installed a camera aimed at the Kanto region. On September 9, 2015, 10:16 PM, an event of five sprites (a type of TLEs) was simultaneously observed by our club and Mr. Shimoda in Asahi Village, Nagano (Image : The sprites observed by our camera). Analyzing the data from the two observation points, it we determined that the sprites occurred over Utsunomiya City, Tochigi at an altitude of 75km. This occurred during the 2015 Kanto-Tohoku Heavy Rainfall.

Because there were masses of precipitation, we hypothesized that Mr. Masashi Kamogawa of Tokyo Gakugei University's occurrence mechanism (private note) of sprites during summer would apply. The purpose of this research is to verify this claim.

The hypothesis is as follows:

1. Heavy rainfall and -CG (thunderbolt having negative polarity) cause negative charge to leak from the bottom part of the cumulonimbus, leaving positive charge in the upper part of the cumulonimbus.
2. A +CG (thunderbolt having positive polarity) will occur between the positive charge of the cloud and the negative charge of the ground generating sprites.

The data acquired for this research is as follows:

- a) Altitude around Utsunomiya City (Released from the Geographical Information Authority of Japan)
- b) Wind direction and speed from September 8 to 10 at each Local Weather Observation Points of the Meteorological Agency in Tochigi
- c) Precipitation from September 8 to 10 at each Local Weather Observation Points of the Meteorological Agency in Tochigi
- d) Thermal satellite images around the Kanto region from September 8 to 10
- e) Radar images around the Kanto region from September 8 to 10 ( b)-e) acquired from the Japan Weather Association)
- f) Thunderbolt observation data in the 200km square area around the occurrence point from an hour before to an hour after (Observed by FRANKLIN JAPAN Inc.)

We superimposed the data on a Google Earth map to make comparisons.

The results are as follows.

1. There was wind from the East near the ground in Tochigi.
2. An arm-shaped cluster of spikes stretched along the plateau that runs from Takanezawa Town, Shioya Country, Tochigi to Kameyama, Mooka City, Tochigi from the thundercloud covered the south half of Tochigi and only one +CG arose there at the same time the sprites took place. The sprites occurred in a pentagon-shape which extended a little east and west of the +CG center.
3. On the squall line, the cloud from which the sprites arose generated both +CG and -CG heavily. However, no thunderbolts were observed from the cloud north of it.

Considering the above, the formation process of the sprites can be estimated as follows:

1. Interaction between the extratropical cyclone over the Sea of Japan (Changed from the Typhoon No.18) and Typhoon No.17 provided the Kanto district with humid air from the Pacific Ocean. The squall line was formed on the afternoon of September 8, 2015 and rain clouds passed from south to north one after the other.
2. Around September 9, 06:00 PM, a cumulonimbus appeared over Tokyo Bay and moved northward growing and polarizing, then moved north. The northernmost point of it reached Chikusei City, Ibaraki at 09:00 PM and Utsunomiya City, Tochigi at 10:00 PM. Incidentally, the cloud which went ahead of it did not become a thundercloud.
3. Easterly wind which ran up the plateau that runs from Takanezawa Town, Shioya Country, Tochigi to Kameyama, Mooka City, Tochigi made a partial ascending air current along the plateau. Effected by this, an arm-shaped cluster of spikes stretched from the northernmost point (over Utsunomiya City) of the cumulonimbus to the north-west.
4. The upper part of the cumulonimbus which had positive charge got over the plateau and induced negative charge to the ground underneath. The space above was negatively charged as well.
5. At 10:16:20 PM, over Higashi-machi, Utsunomiya City, a 28kA +CG occurred between the positive charge of the upper part of the cumulonimbus and the negative charge of the ground.
6. The negative charge of the upper part of the cumulonimbus that was left induced positive charge further above. Dielectric breaks down between the two charges and five routes of electric current surrounding the +CG run as sprites from the altitude of 70km to 80km.

The assignments for the future include:

1. To clarify the reason why there are both thunderclouds and normal rain clouds on the squall line.
2. To clarify the reason why the distribution of five sprites was a pentagon which extended east and west surrounding the +CG.

Keywords: Ionosphere, Transient Luminous Events, Sprites, 2015 Kanto-Tohoku Heavy Rainfall



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