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The First Sprite Observation from Moscow in the Direction of Tver Region Associated with Repetitive Lightning Discharge

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Abstract. The summer thunderstorms 2016 in the central part of Russia produced heavy precipitations and were accompanied by huge amount of lightning. During these events we provide the Sprite observation from Moscow. On the 18 August we caught two Sprites on the distance from 260 km to 290 km in the Tver region. It is important to underline that both Sprites occurred after the rare repetitive lightning discharge and the multiple lightning discharge. These types of lightning are rare in the Moscow region and more habitual for the tropical thunderstorms in Equator area. Due to the Climate Change and Global Warming the Sprites are common for the Russian Federation now..

1. INTRODUCTION

The first Sprite observation was done by Low-light Television (LLTV) camera in 1989 by Franz et al. (1990). The detailed research follow from ground observation (Lyons, 1994a,b, 1996a) and aircraft campaign (Sentman et al., 1995). From these remarkable events Sprites, Blue jets, Elves and other kinds of high altitude lightning become widely known as Transient Luminous Events (TLE).

INSTRUMENT

For the TLE observation we use the CCD camera WATEC WAT-902H3 ULTIMATE with the lens BOSCH 3-8 mm (f 1:1.0). This is a good solution for the low light observation. Video capture device CANOPUS ADVC-110 is compatible with all Widows computers with DV interface.

The video capture software UFOCaptureV2 (V2.24 2013/06/09) provides the 2.4 sec video record (60 frames) and the JPEG image of the trigger event.

The time synchronization was done over Time Server "time.windows.com" before starting the observation. It looks like the difference between the computer time and the UTC was +400±140 msec. But it was possible to identify the exact lightning in the video record due to specific time interval between them. Each frame has duration of 40 msec and consists from even and odd half-frames. So we compare the UTC time stamp providing WorldWide Lightning Location Network together with the lightning location data for synchronization of the video record with accuracy of ±40 msec.

The Blitzortung.org contributors lightning map is very useful for the estimation of the lightning activity in the real time all over the World. In the day time the high resolution satellite images and infrared images are available from Sat24.com and during the night they provide the infrared images of the clouds. With the help of these visualization maps together with Radar maps it is possible to target the camera on the thunderstorm and make a good image of TLE.

2. SPRITE OBSERVATION

During the EuroSprite-2008 Campaign providing by DTU Space and National Space Institute in the period from 1 to 8 September 2008 we participate in the observation from Pic du Midi and Corsican systems. During the heavy thunderstorm lasted from 2 till 5 September 2008 the Corsican systems observed 84 Sprites, two Elves and one meteor (Sorokin, 2009). The observed Sprites (Sorokin, 2009) associated with the space-time coupling between seismic waves from earthquakes and triggered lightning (Sorokin, 2002, 2005, 2006, 2007b). This was a very successful experiment done during the period of high rate of seismic events.

The next successful Sprite observation was done 10 years later in the Russian Federation from Moscow. During the whole night 18 August 2016 only two Sprites were detected and the seismic activity was very weak in the period of observation. This was the first Sprite detection from the Moscow region, but it was not the first campaign in the Russian Federation, during the 2016 we provide the observations in July 17, 18, 30 and August 11, 12, 18, 19. The previous observations were not successful due to the bad visibility, experiments with the different cameras and lens, together with the software problems.

During the Conference Thunderstorms and elementary particle acceleration (TEPA – 2016) in Armenia with the help of Hripsime Mkrtchyan and Tigran Karapetyan the Sprite observation system was installed in the conference venue Nor Amberd, October 3-7, 2016. Due to the clear sky and absence of the thunderstorms in the range more then 600 km the Sprites in Armenia were not detected.

3. SPRITE OBSERVATION OVER TVER REGION ON 18 AUGUST 2016

At 18 August 2016 the Moscow weather was fine with clear sky and perfect visibility. This fact is seen from the Figure 1 and the red pointer demonstrates the destination from the place of observation (Moscow) to the Sprite location. In the evening the heavy thunderstorm was passing near Moscow over Tver region (Figure 1) and it was possible to target the camera in the direction of the most intensive lightning activity of the thunderstorm (Figure 2). From the Blitzortung.org contributors lightning data we can see that the maximum of the lightning activity in Europe produced the 3265 flashes within 20 minutes, just before the Sprites were detected. The Sprites occurred when the lightning activity reduced two times.

The observation was done from Moscow and the camera was situated in the place with coordinates: Latitude 55.6451 and Longitude 37.5176 with Elevation 36 m under the ground. From this direction we have a nice view on the North from Moscow

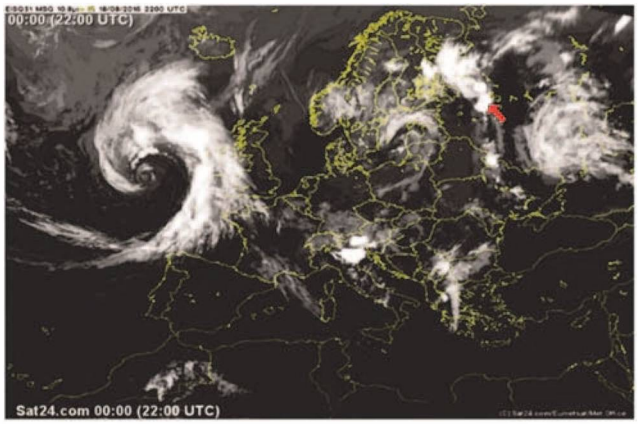

Figure 1. The Sat24.com infrared image of the clouds over Europe at 22:00 UTC, 18 August 2016. The red pointer demonstrates the destination from the place of observation (Moscow) to the Sprite location.

Source: Weather Europe Sat24.com – http://en.sat24.com/en

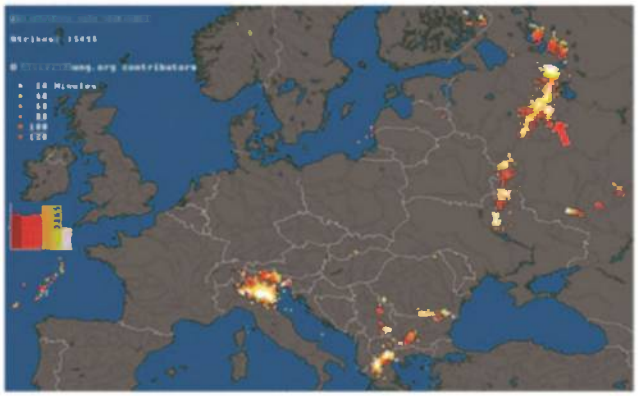

Figure 2. The crop image of the Blitzortung.org contributors lightning map of Europe. The red pointer demonstrates the destination from the place of observation (Moscow) to the Sprite location.

Source: Blitzortung.org contributors lightning map – http://blitzortung.org

Figure 3. The first Sprite was follow after the repetitive lightning discharge and can be seen together with the lightning flash halo.

Figure 4. The second Sprite occurs after the multiple lightning discharge.

Table 1. WorldWide Lightning Location Network Data associated with the first Sprite.

Date UTC Year/M/Day	Time UTC Hour:Min:Sec	Latitude Degrees	Longitude Degrees	Error µs	Stat. Num.	Event Type
2016/08/18	22:09:10.066566	56.2453	34.2695	6.9	5	Lightning
2016/08/18	**22:09:11.235464**	**57.7133**	**35.5068**	**15.6**	**6**	**Lightning**
2016/08/18	**22:09:11.235475**	**57.7487**	**35.5481**	**15.1**	**6**	**Lightning + Sprite**
2016/08/18	22:09:11.698913	58.0151	35.0644	16.0	8	Lightning

Table 2. WorldWide Lightning Location Network Data associated with the second Sprite.

Date UTC Year/M/Day	Time UTC Hour:Min:Sec	Latitude Degrees	Longitude Degrees	Error µs	Stat. Num.	Event Type
2016/08/18	22:18:19.898741	60.0752	36.5959	5.6	5	Lightning
2016/08/18	22:18:20.048457	60.1294	36.6468	12.9	7	Lightning
2016/08/18	**22:18:20.714342**	**58.0644**	**35.7196**	**11.8**	**5**	**Lightning**
2016/08/18	**22:18:20.744765**	**58.0306**	**35.6983**	**9.4**	**5**	**Lightning**
2016/08/18	**22:18:20.766665**	**58.0576**	**35.7276**	**7.6**	**5**	**Lightning + Sprite**
2016/08/18	22:18:21.426445	58.1337	35.1113	21.4	13	Lightning
2016/08/18	22:18:21.513607	58.2094	34.8091	17.0	5	Lightning

In Figure 3 we can see the frame with the Sprite event from UFO video capture software. The first Sprite was observed in between of repetitive lightning discharge and the delayed lightning (Table 1). It looks like the first Sprite was follow after the repetitive lightning discharge and can be seen on the next frame together with the lightning flash halo. The distance from the place of observation to the repetitive lightning discharge was 260 km. Usually the Sprite occur close to the lightning discharge so we can consider this distance as the characteristic for this event.

This thunderstorm lasted from the evening up to the midnight and produces only two Sprites. The next Sprite image we can see on the Figure 4. A group of three lightning was observed just before the second Sprite occurs (Table 2). This three lightning's ware visible in two different frames and the second Sprite happened the next frame after them.

This Sprite is slightly visible one frame more and has a longer duration then the first one. The distance from the place of observation to the multiple lightning discharge was 290 km, but the second Sprite was shifted to the direction of the first Sprite.

With the help of only one Sprite observations system we could not make the triangulation. But we can estimate the distance of 40 km between the repetitive lightning discharge (the first event) and the multiple lightning discharge (the second event). In the both cases (Figure 3 and Figure 4) we can see that the Sprites were localized in the compact area in comparison with their dimension.

CONCLUSION

On 18 August 2016, two Sprites ware detected in the central part of the Russian Federation, Tver region. So the Sprites are common for Russia now. It is important to underline that both Sprites occurred after the rare repetitive lightning discharge and the multiple lightning discharge. These types of lightning are rare in the Moscow region and more habitual for the tropical thunderstorms in Equator area. The repetitive lightning discharge due to the pinch effect can produce the high energy radiation on the altitude of 4-5 km (Sorokin, 2012). The source of the high energy radiation inside the cloud can launch the particle acceleration (Chilingarian et al., 2010), (Chilingarian et al., 2011) and nuclear reactions (Sorokin, 2012) these can cause the conditions for Upward lightning, Blue jets and Sprites.

The heavy thunderstorm (18 August 2016) over Tver region produce about 10000 lightning discharges within 3 hours and only two Sprites. Probably the Sprites were detected in the central part of the Russian Federation due to the Global Warming and the climate became more tropical. From the other side the top of the tropical thunderstorms can reach the higher altitudes of 16 – 18 km and produce more upward lightning that can initiate the Sprites.

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Blitzortung.org contributors lightning map – http://blitzortung.org

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