The TLE observation site in Sopron, Hungary – an overview

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Transient luminous events (TLEs) are brief optical emissions which accompany tropospheric and/or upper atmospheric (20-100 km) electric discharges. An optical observation site has been installed in Sopron (46.7N, 16.6E), Hungary to capture and study TLEs in Central Europe. In this contribution, the methodology of observing TLEs is overviewed and the performance of original and upgraded hardware components of the observation system is evaluated on the basis of work experience. The summary of optical observations from Sopron since 2007 up to the present year is given and relevant findings originating from these detections are presented. Some research objectives to be studied in the future are suggested and the corresponding technical challenges are discussed.

1. Introduction

The observation site in Sopron was one of the first stations which were deployed in Central Europe (CE) in 2007 specifically to detect TLEs in the region [1]. Although Sopron lies in a valley, the target height range of 50-90 km above a large area of CE can be monitored from there (Fig. 1). Since 2008, the observation system can be remotely controlled from a web browser through the internet. Thunderstorm activity in CE is followed quasi real-time by data from the LINET lightning detection network [2]. Additionally, infra-red (IR) satellite images indicating cloud top temperatures are used to find the actual area of interest.

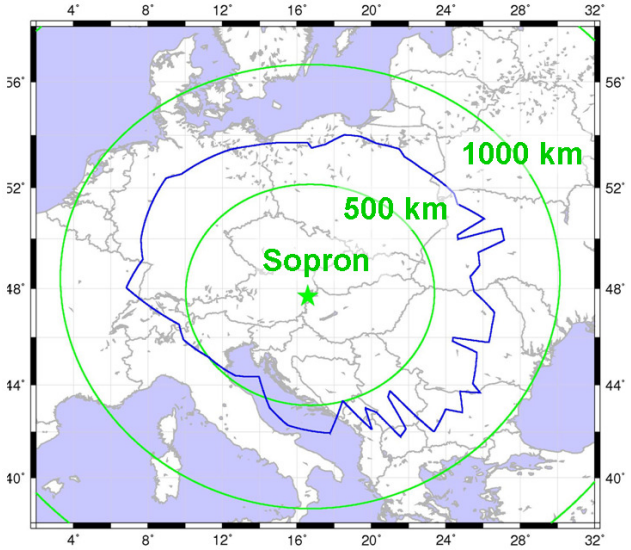

Fig.1. Blue line borders the area in CE above which the 50-90 km height range can be observed from Sopron.

2. Experiences of operation

2.1. Hardware performance

Advantages of the Watec 902H2 Ultimate CCIR camera: high sensitivity; 3 selectable level of gamma gain; manually adjustable linear gain. Drawbacks: analogue output; moderated (TV frame rate) time resolution.

Advantages of Computar HG0808FCS-L lens: high light throughput; good compromise between image resolution and the size of field of view; DC auto-iris function to protect the camera CCD. Drawbacks: not IR corrected; has focusing issues.

Advantages of UFO Capture recording program: real-time event detection; complete software package for event analysis. Drawbacks: pre-recorded video cannot be analyzed; unknown detection efficiency.

Advantage of EQ3-2+SynScan Goto pan-tilt solution: cheap; very accurate. Disadvantages: vulnerable; originally designed for equatorial movements; operation requires constant supervision.

2.2. TLE producing storms in Central Europe

The thunderstorm season in CE lasts practically from mid-May to late September. Not only very active multi-cell mesoscale convective systems produce TLEs (in particular sprites) in CE. Sprites have been captured above elongated squall lines and in some cases also above smaller, single cell thunderstorms with apparently lower flash rate. The sprite productivity of thunderstorms can be very different. The highest number of sprites observed

from Sopron above a thunderstorm in CE was 162, while the least was 1.

3. Summary of optical observations

3.1. Summary of detections

In the period of 2007-2011, more than 700 TLEs have been captured only from Sopron in CE. The vast majority of these events (>95%) were sprites, which appeared in various shapes and numbers in different cases. Either accompanying sprites or as standalone events, sprite halos have been captured, too. ELVES have been observed the least frequently. This experience can be (at least partly) due to system sensitivity issues [1]. From the group of more exotic TLEs, one blue jet-like event and a TROLL [3] was filmed, too.

3.2. Some relevant findings

Sprites in Central Europe generally do not differ from sprites observed on other parts of the world [4]. On conventional frame rate records, sprite events can be sorted into characteristic categories by the shape of their body (column, wishbone, tree, angel, and carrot) while several occasionally appearing morphological features can be recognized, too (e.g. tendrils, beads, puffs, diffuse glows, etc.). Sprites tend to occur in clusters, the majority of which contains sprites of different shapes. As detected by the optical system in Sopron, sprite emissions (afterglows) lasted most frequently for 40-80 ms. Events showing a single sprite type tend to have shorter optical life time, especially columns appearing with tendrils and glow emissions. Such emissions are generally very strong and are often referred to as jellyfish sprites (Fig. 2.).

4. Suggested research objectives

Meteorological factors characterizing the production rate of various TLEs in specific thunderstorms need to be identified and quantified. Relations of the optically perceptible characteristics (morphology, size, height range, brightness) of different TLEs to the properties of the parent lightning flash and the lower ionosphere as well as the mesospheric medium are to be revealed. In order to find the existing correspondences, simultaneous observations of the optical properties of TLEs and electromagnetic properties of both the TLE related upper atmospheric electric discharges and tropospheric, TLE producing lightning flashes are needed. Therefore, the importance of such observations are emphasized.

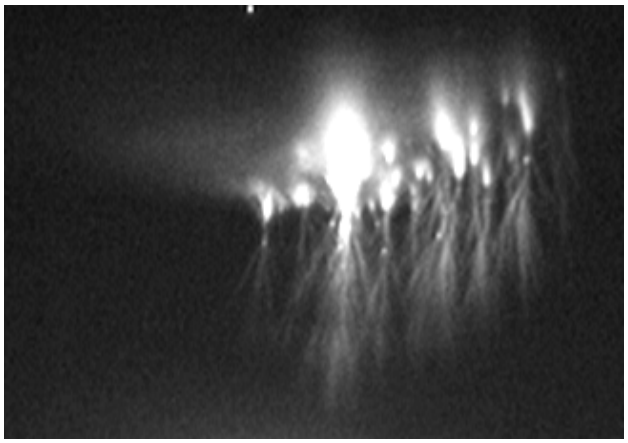

Fig.2. Jellyfish sprites accompanied by a sprite halo; observed in Central Europe from Sopron at 21:23:30.860 UTC, on 7th Aug, 2008.

5. References

[1] Bór, J., Sátori, G., Betz, H-D., (2009) Proceedings of the Workshop Corte (France), 23-27 June 2008, p.73, doi:10.1063/1.3137716.

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[4] Bór, J., Optically perceptible characteristics of sprites observed in Central Europe in 2007-2009, submitted to J. Atmos. Sol. Terr. Phys. in 2012.