Ground Based Observations of Optical Emissions from Transient Luminous Events above Thunderstorms

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In this presentation we give the opportunity for young scientist to learn how to use ground based systems to perform Transient Luminous Event observations assisted by lightning and satellite data. The first part of the presentation will be theoretical with an introduction of TLEs and of systems one can use to perform observations. The second part will be dedicated to a training session where student can perform their own observations on real or artificial data.

1. Transient Luminous Events.

During the last 25 years interest in atmospheric electricity has increased because of the discovery of electric discharges in the atmosphere and mesosphere above thunderstorms, the so-called sprites, first observed in 1989 [1].

The sprite is a large streamer discharge in the mesosphere made up of either single streamers or clusters of streamers that together can measure several tens of km horizontally and reaching from 50-80 km altitude. It is now known as the sprite: a giant discharges in the mesosphere at 50-80 km altitude. Following this evidence many other transient luminous events had been observed, they include elves, a 300-400 km wide pancake-shaped glow that occurs in the ionosphere at an altitude of 100 km, sprite halos, a 50 km wide ellipsoidal glow that occurs in the mesosphere at an altitude of 70 km, blue jets, a narrow cone of light emerging from the top of a thundercloud and reaching the lowest part of the ionosphere at 40 km altitude, and the biggest TLE: the gigantic jet. (e.g. [1-6]).

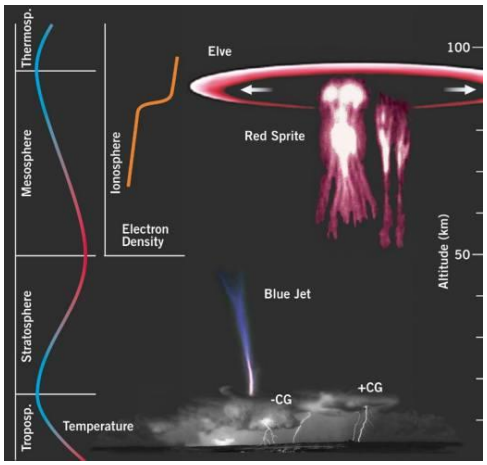

Figure 1: Diagram illustrating TLEs, reprinted from Science [7].

2. Ground based systems.

2.1. Instruments.

In this section, we will address only the measurements of optical emissions from TLEs. A TLE optical ground based system is usually built up around low-light cameras and/or photometers that measure the light coming from the atmosphere after it has been excited by the TLE. The instruments can be installed still or be mounted on a pointing system motorized or not.

2.2. Computer.

Usually, a standard PC is used to control the instruments and trigger the interesting data for storage and further analysis. The operating system can be either Linux or Windows which can use home-made triggering software (Spritewatch) or the popular UFOCapture.

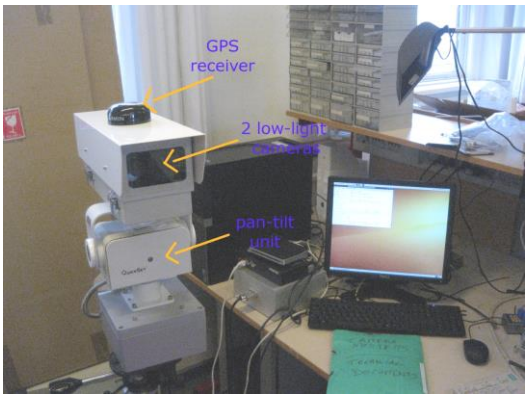

Figure 2: A camera system.

It is crucial to have good time stamping of the data, which is usually achieved by the use of a GPS. The most advanced systems can be entirely controlled remotely over the Internet to allow their operation

from home or a regular office desk and even be entirely automated.

2.3. Power and Internet access.

The system has to be powered by either standard electricity network or battery charged by solar panels. Systems installed far from standard internet access can use BGAN satellite access or mobile network.

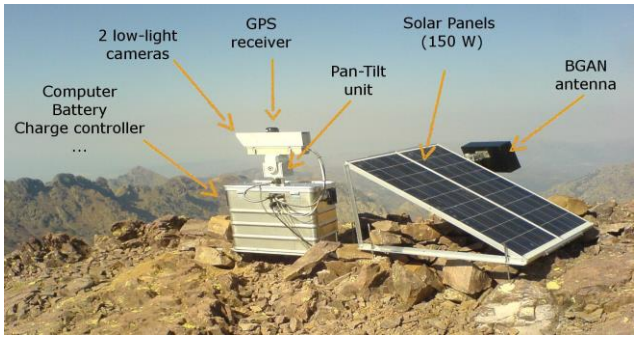

Figure 3: An autonomous camera system.

2.4. Support for observations.

In order to decide if it is worth performing observations, an operator or a software algorithm has to decide if there is some chance of thunderstorm in the field of view of the instruments. It is also good to know with a relative precision where to point at. It can be done using meteorological data from satellite like Meteosat, or lightning data from lightning detection network like EUCLID, LINET or WWWLN.

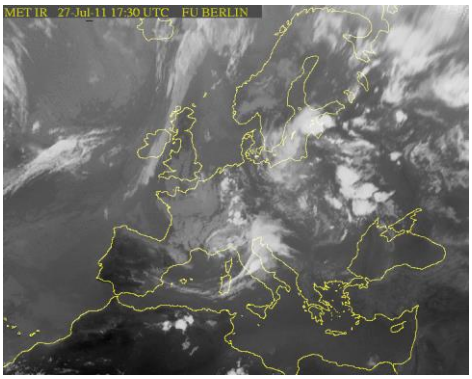

Figure 4: A meteosat image.

3. Coordinated observations.

For a complete analysis of the observations, it is usually interesting to have concurrent observations of the same event. For instance, one can obtain the exact position of the event by triangulation if other cameras had observed it. It can also be interesting to have other sort of measurements of the event simultaneously, like for instance radio wave measurements from ground or space. (eg. [8-11]).

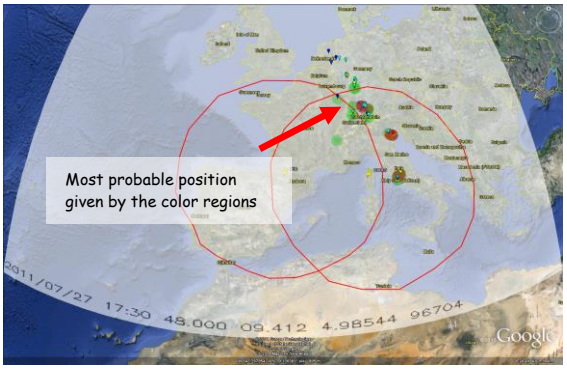

Figure 5: A lightning map computed for automated camera pointing.

4. Training session

During the training session the interested students will have the opportunity to perform observations on their own. Students will work by small groups on a computer and have access to a remote ground base system. The training will start with the analysis of Meteosat and Meteorage data and ends on an observation period based on realtime or simulated data.

5. References.

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