

COST-P18 STSM Reference 01759

The Physics of a Lightning Flash and its Effects

Mission Report: Assisting the Sprite observation campaign in Israel

- **Applicant:** Oscar van der Velde, Ph.D. student, Laboratoire d'Aérodynamique, Toulouse, France
- **Host Institution:** Tel Aviv University and Open University (Profs. Colin Price and Yoav Yair)
- **Duration of STSM:** 1 week
- **Date of mission:** 13-19 December 2005

1. Background of the mission

Electrical discharges between the top of a thunderstorm and the ionosphere (40-90 km above ground) have only been discovered 16 years ago, by low-light television cameras in the United States. After observational campaigns conducted from Colorado, these transient luminous events (TLE) appeared to be common over large thunderstorm complexes and have been named "red sprites". Several other similar phenomena with different characteristics have been discovered as well, most notably, "blue jets" and "elves".

The subject has seen a strong growth of interest by research groups in widely different fields. The causes and effects of sprites on the global system have started to become explored, by a variety of techniques, such as optical earth- and space-based observations, lightning detection systems, and very long range radio signal receivers.

The sprite research groups at Tel Aviv University and the Open University in Israel have set up an observational campaign that should provide an optical basis for sprite research in this region. The region typically sees most precipitation and thunderstorms in the fall and winter season. The ultimate goal of the short-term scientific mission is to document sprites for the first time in this area, which will be investigated by the research team with additional means afterwards.

The applicant has experience in conducting sprite observations in France by remotely controlled camera systems, analysis of data, and knowledge of the meteorology of thunderstorms and storm electrification.

2. Methods and Results

During this one week in December 2005, which was flexibly chosen by the applicant to enhance the chance of doing observations in conditions with thunderstorms, the applicant has worked closely together with Michal Ganot, a student in charge of the operations.

The main work consisted of testing the combination of the camera setup and video software to maximize the opportunity of catching transient luminous events like sprites, jets and elves. The tasks depended upon availability of technical equipment – e.g. there was no housing for the cameras available at the time, so cameras could not be mounted and left alone (rain!) and operated remotely.

Effectively, we had three nights with thunderstorms, from which two nights of observations conducted over thunderstorms. During one night with thunderstorms around Tel Aviv, observations could have been conducted from Mitzpe-Ramon in the Negev Desert but there were technical problems at that site, so we missed one opportunity. The night of 15-16 December featured far thunderstorms in the north, and we figured out the best settings on the lenses and in the UFOCapture software, that detects thresholds of noise and signals in the incoming video stream, and saves video files of the event once triggered. No sprites were caught (storms too weak, supposedly), but more than 10 small meteors (and birds) were recorded this way, so that we can be sure that a sprite would have triggered the software as well. During the evening/early night of 17-18 December, a thunderstorm came close to Tel Aviv in the north – its lightning flashes triggered the software, but no sprites were recorded.

Besides the observations, the applicant showed Michal and Colin during the last night how to import a video image into the astronomical program Sky Charts, which settings are important and how to determine the true field of view of the lenses, and how to match stars in the image to that of the program in order to accurately determine the direction of a sprite in the image.

The applicant participated in a group discussion about the operational aspects of the campaign on Thursday 15 December, and gave a presentation of about an hour for the group about his research conducted in Toulouse on Sunday 18 December with the results of the EuroSprite 2003 campaign, including aspects of thunderstorm evolution and lightning signal properties related to sprite-producing discharges.

With one student he exchanged thoughts about automatic camera operation based on lightning detected by the Boltek system that yields directions and polarities of lightning from Tel Aviv. We concluded this is best done by aiming at a centroid of positive discharges rather than total activity, because the negative discharges would not be relevant to sprites and could cause a bias. It would, however, still be desirable to aim at the most totally active storm, if a choice has to be made between several storms.

With Michal Ganot, the applicant discussed about vertical wind profiles from soundings in determining the structure of an MCS – useful to determine in which

direction the anvil will blow relative to the core region of a storm system, this can be of help to predict in which direction sprites may appear if for example the Boltek system shows a cluster of lightning strikes. Several sources of weather forecasting models and their useful output fields (e.g. the NMM model at www.meteoblue.ch) were discussed, and some additional sites with satellite loops and observational data, to aid in nowcasting thunderstorms.

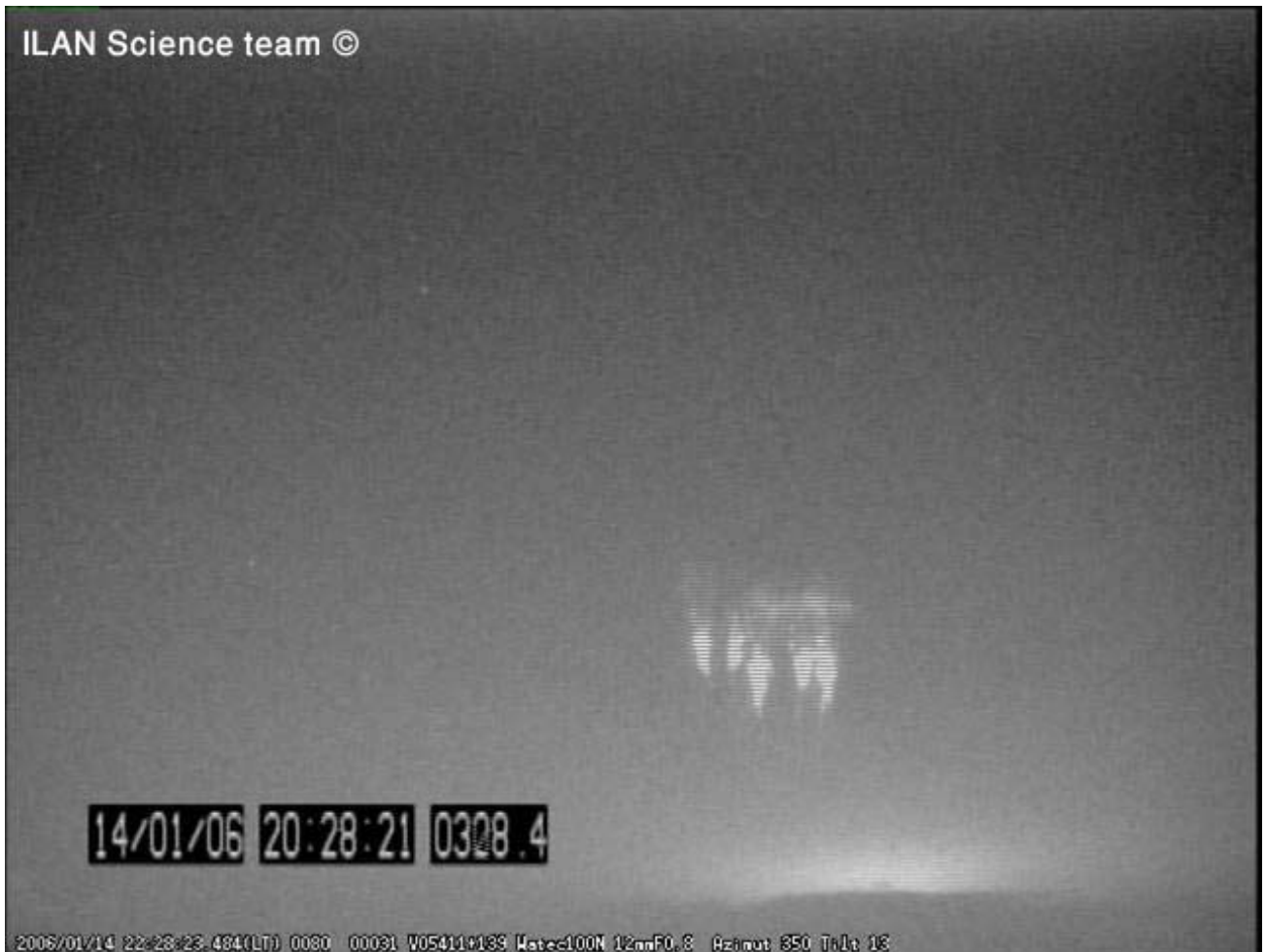


Figure 1. Image of a cluster of carrot sprites recorded from Mitzpe-Ramon on January 14th 2006, using hardware and software settings tuned during the STSM. In the bottom of the frame, the causative lightning flash in the thunderstorm is seen.



Figure 2. Image of the first elve (contrast enhanced), taken on January 13th 2006, using hardware and software settings tuned during the STSM. This ionospheric phenomenon is caused by excitation of the ions by an electromagnetic pulse of a strong lightning flash.

Although we did not have the luck of recording any TLE's during this short-term mission, the team has captured their first sprites just a few weeks later, on January 13 and 14 2006, to a total of 20 sprites, including 2 elves. The same settings were used as those saved during the STSM nights. The directions can be inferred from the stars in these images with the Sky Charts software.

Concluding, the applicant and the research team in Tel Aviv have established a good basis for cooperation, and with the help of the applicant the team has become successful in capturing TLE's in the eastern Mediterranean area to provide a good start of multi-method TLE research.