Proceedings of 33rd Annual European Meeting on Atmospheric Studies by Optical Methods.
IRF Sci. Rep., 292, 29–40, 2008
http://www.irf.se/publications/proc33AM/eurosprite2005-team.pdf
ISSN 0284-1703, ISBN 978-91-977255-1-4,

The Eurosprite 2005 campaign

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Abstract.

In this report we give an overview of the Eurosprite observation programme and present the results of the Eurosprite 2005 campaign. These campaigns search for occurrences of transient luminous events, such as red sprites, above thunderstorms in France, Spain, northern Italy, Switzerland and southwestern Germany. Low-light video cameras are used to register the events. Simultaneously, meteorological observations and continuous recordings of electromagnetic emissions in the VLF-ELF-ULF range and of infrasound are carried out. During the Eurosprite 2005 campaign, two camera systems were operated at two locations in southern France. In total 64 sprite events were captured. Due to unfavourable conditions, none of these were captured simultaneously at both stations.

The campaigns constitute a long-term effort but have already provided several new results, mainly concerning the correlation between optical and non-optical means of sprite detection. The campaigns will be extended into a global sprite-watch partnership and in addition space-borne instruments will be deployed.

1 Introduction

Transient luminous events (henceforth TLEs) occur in the middle atmosphere above thunderclouds. The family of TLEs includes red sprites, blue jets and elves. The latter are associated with heating of lower-ionospheric electrons by the electromagnetic pulses from the lightning currents (Fukunishi et al., 1996) whereas sprites and jets are discharges in the electric field between the thunderclouds and the ionosphere. See Neubert (2003) for a further description of these phenomena.

Sprites are the most easily observed TLEs and tend to occur over strong positive cloud-to-ground (+CG) discharges. Their rate of occurrence is on the order of one per 1000 lightning flashes (Ignaccolo et al., 2006). In the last few years, a number of studies have investigated the physical nature of sprites (see Füllekrug et al., 2006, and references therein). However, the most recent high-speed camera observations (Cummer et al., 2006) have shown that their variety and complex microphysics is still far from being understood. Long-term and more effective observations are therefore needed.

To study TLEs and their relation to thunderstorms, the European sprite observation campaigns (Eurosprite) have been organised since 2000. The Eurosprite 2003, 2005 and 2006 campaigns were part of the activities of the European FP6 research training network CAL (Coupling of Atmospheric Layers). The main objective of the campaigns is to detect transient luminous events above thunderstorms using ground-based observing facilities and create the expertise

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Published by the Swedish Institute of Space Physics.

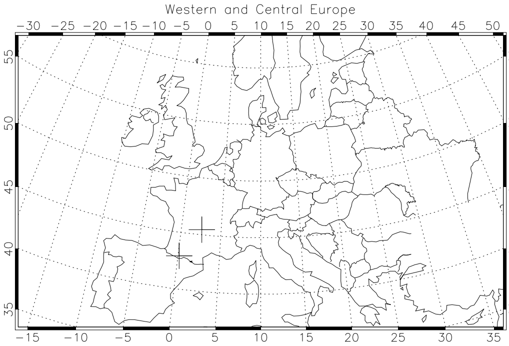

Fig. 1. Map of central and western Europe showing the locations of the two remote-controlled cameras on Pic du Midi (42.94° N, 0.14° E) and Puy de Dôme (45.46° N, 2.57° E) in France.

and long-term observations needed for the space-borne observational missions that are now under development.

During the Eurosprite 2005 campaign, which is the topic of this report, two remote-controlled cameras were installed in France. One system was located at Pic du Midi in the French Pyrénées and the other one at Puy de Dôme in the Massif Central. The campaign was originally planned for July 15–September 18, but because of unfavourable weather conditions and technical problems at the the Puy de Dôme station in the beginning of the period, the campaign was extended until November 21. Images of 64 sprite events, in 19 storms during 14 nights, were obtained. During the whole period of the campaign, a large number of supporting non-optical observations were run, involving many research groups.

2 Optical observations

The optical observations were performed with two similar video camera systems located at the Observatoire de Midi-Pyrénées on Pic du Midi de Bigorre (42.94° N, 0.14° E), southern France, and on Puy de Dôme (45.46° N, 2.57° E) in the Massif Central. The camera locations are shown on a map in Fig. 1. The systems were found capable of observing sprites up to a distance of about 800 km, thus covering Spain, France, northern Italy, Switzerland and the westernmost part of Germany. The two systems have been described in detail by Allin et al. (2006), and are designed to be fully remotely controlled via the Internet.

2.1 The Pic du Midi camera system

The Pic du Midi setup consisted of two JAI CV-M4+ cameras with Sony ICX285AL 2/3-inch ExView HAD CCD sensors. One was equipped with a 16 mm F/1.4 lens for event detection, and the other with a 50 mm F/0.95 lens for high-resolution recording of sprite structures. The video stream was digitised at 24 full frames per second using a CameraLink frame grabber. The cameras were mounted in a housing containing heaters and sensors for temperature, pressure and humidity (Fig. 2). This system also included a photometer. The whole setup was mounted on a QuickSet 20 remote-controlled pan-tilt unit. A Blackbox TCP/IP-controlled power switch was used to switch the system on for operation and off during daytime.

Fig. 2. The Pic du Midi camera system. Upper picture: The mounting of the two JAI cameras. Lower picture: View of the setup, cameras mounted on the pan-tilt unit.

2.2 The Puy de Dôme system

The system on Puy de Dôme used two JAI CV-S3200 cameras, each fitted with a Sony ICX249AL 1/2-inch ExView HAD sensor. These cameras have a lower resolution than the ones at Pic du Midi. The event detection camera had a 16 mm F/1.4 lens whereas the detail camera had a 25 mm F/0.95 lens. This system operated at 50 interlaced half-frames per second with a BT878 frame grabber accessed through the standard Video4Linux2 (V4L2) interface. The mounting was similar to that of the Pic du Midi system, except that no photometer was included.

2.3 Event detection and data storage

Both systems were based on a PC running a Linux distribution with kernel 2.4.20. Since there was no external time stamping of the video frames, the kernel was patched to support high-resolution timing and the 1 PPS GPS signal. Therefore the time-stamp of each saved event data file will be within the GPS accuracy, but the event timing will still suffer from variable delays between the actual video frame grabbing and the data file dumps (due to the varying latency that is always present in a multitasking system).

The video frames were analysed by the Spritewatch event detection software described by Allin et al. (2006). Spritewatch stores the most recent video frames in a circular input buffer and sums the differences of the pixel values of two subsequent frames over each row and column. A frame is classified as a sprite event if the integrated intensity differences of more than M rows or N columns exceed a threshold value, usually a percentage of the average image intensity. The values of M, N and the triggering threshold can be adjusted by the operator to avoid false triggering on clouds, stars or image noise.

When the event classification threshold is exceeded, the video frames close to the trigger frame are dumped to data storage. Since a typical sprite may be visible for several tenths of a millisecond, it will appear in several subsequent video frames. In the setups used during Eurosprite 2005, data were saved for at least 200 ms. The event images were automatically backed up to the central Eurosprite server at the Danish National Space Institute during daytime.

In addition to the event detection, the Spritewatch software was configured to save low-resolution overview (quick-look) images every two minutes. These were uploaded to the Eurosprite web server in near real time for monitoring the local weather conditions at the stations.

2.4 User interface

To guide the Eurosprite system operators, the following data were presented in near real time on password-protected web pages, one for each station:

- The quick-look overview images
- Meteosat images
- Maps of the most recent cloud-to-ground discharges from the French national lightning detection network Météorage, which is similar to NLDN (Cummins et al., 1998) in the United States
- Computer system logs

The two stations were operated by running command-line shell scripts on the station PCs via secure shell (ssh) login. A program that converts the desired target latitude, longitude and altitude into line-of-sight pan and tilt angles was used to point the cameras above the thunderstorms of interest. The operation and data flow are given schematically in Fig. 3.

3 Meteorological observations

Thunderstorms tend to occur in humid low-level air, often leading to situations in which the cameras are inside or below a deck of low clouds when this air is lifted over the mountains. On several occasions the lines of sight towards the sky above a large thunderstorm were obscured by the extensive anvil clouds of the storms themselves. Weather radar and lightning detection data for research of the relations between thunderstorm systems and sprite production have been obtained for only 4 occasions, and only for one of these were a reasonable number of sprites (10) recorded. Other thunderstorms with many sprites occurred over the Mediterranean Sea, where lightning detection is more limited and the storms were out of range of land-based radar. However, a comprehensive set of data was obtained for a case of one sprite in northern Spain displaced by 30 km from its parent lightning. This includes data from the SAFIR interferometric lightning detection system (Richard and Lojou, 1996), weather radar, and VLF broadband data from Nançay, France (paper submitted to GRL, 02/2007). Similar data from the meteorologically more fortunate 2003 campaign have been combined into a paper investigating sprite types and lightning sferic characteristics (van der Velde et al., 2006). Thunderstorm characteristics (such as radar reflectivity distributions near lightning strikes) related to sprites, containing also the best cases of 2005 and 2006, are currently being summarised statistically and case by case.

4 Infrasound observations

Liszka (2004) first assumed that infrasound spectrograms show a specific signature (a chirp) when a sprite occurs. Unfortunately, during Eurosprite 2005 no simultaneous sprite images were recorded when infrasound chirps were measured. However, during the Eurosprite 2003 campaign, this relation was confirmed (Farges et al., 2005). The correlation between sprite infrasound and sprite images was realised by calculating the propagation time with a model. A clear relation between the infrasound duration and the sprite size was also found. Ignaccolo et al. (2007) designed an algorithm to detect sprites automatically in the infrasound data. For the Eurosprite 2005 campaign, in addition to the permanent infrasound station of Flers (48.8° N, 0.5° W), a supplementary station was set up in St Just (45.3° N, 0.5° E) about 400 km southwest of Flers (Fig.4). This additional station provided data from August 30 to October 31. The two main objectives for this infrasound campaign were:

1. to measure the same sprite with two stations and, if possible, locate it
2. to evaluate the attenuation with distance of the infrasound produced by lightning.

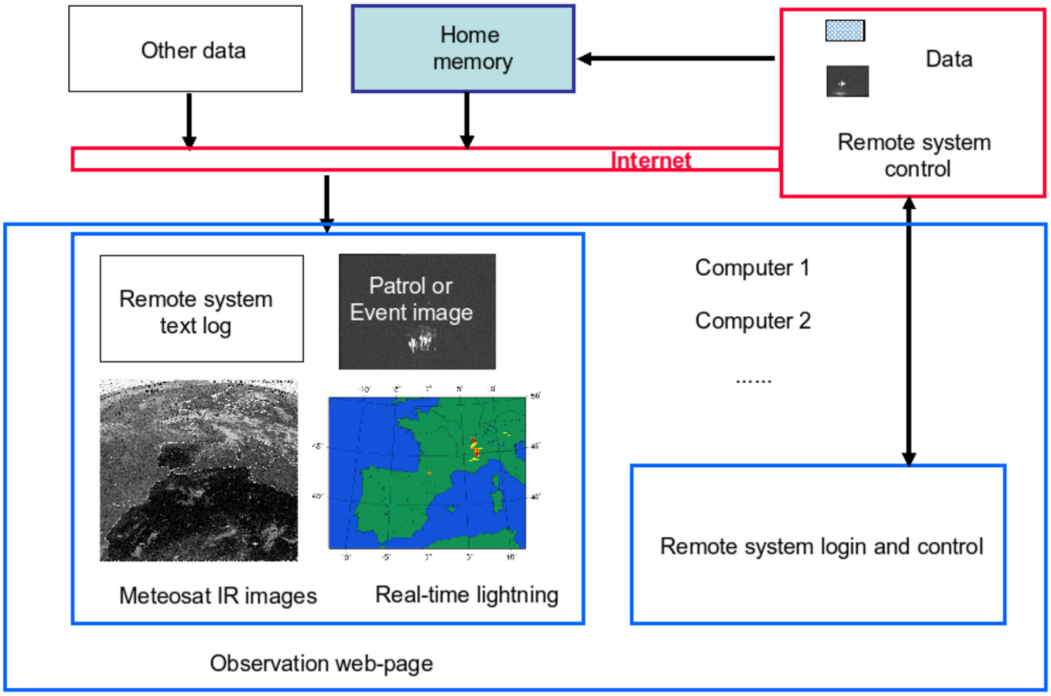

Fig. 3. Operation of the Eurosprite camera systems: Data flow and web output.

The expected result of the second objective was a confirmation that the chirp signature is due to the sprite alone and not to the sprite and its parent lightning.

On September 9, 3 sprites were observed from 20:30 to 21:30 UTC over south-western France. The thunderstorm moved north-eastward from the Bay of Biscay, passing just over the St Just station at around 23:00 UTC (Fig. 4, left panel). The right panel of Fig. 4 shows the overpressure signals recorded at the two stations from 18:00 to 03:00 UTC. In St Just, the overpressure reached 20 Pa peak-to-peak when the storm was just over the sensors whereas it never exceeded 1 Pa peak-to-peak in the sensors at Flers. The amplitude of the infrasound produced by lightning exceeds the noise level when lightning is close (distance less than 50 km) to the station, and when lightning is above the station the amplitude at 1 Hz reaches 40 dB above the noise level. These measurements show clearly that the infrasound produced by lightning and measured at St Just is not detectable in Flers. The chirp signature is therefore only a sprite property. Furthermore, several sprite infrasound signals were detected, particularly during the large storm of September 26.

5 Electromagnetic observations

During the campaign, many collaborating institutions were running electromagnetic observations covering the range from ULF to VLF. The following partners were involved, in addition to members of the CAL groups:

5.1 ULF measurements (<10 Hz)

Measurements of geomagnetic pulsations in the ultra low frequency (ULF) range were performed at Hylaty, Poland (49.19° N, 22.56° E) by A. Kułak, Schumann Resonances Laboratory, Jagiellonian University of Kraków, and in Crete and all other stations of the Finnish pulsation magnetometer network by T. Bösinger, University of Oulu. See Bösinger et al. (2006) and Shalimov and Bösinger (2006) for a discussion of these results.

5.2 ELF measurements (3–30 Hz)

Lightnings excite Schumann resonances in the Earth-ionosphere cavity. These are close to multiples of 8 Hz (Sentman, 1995; Nickolaenko and Hayakawa, 2002), i.e. extremely low frequency (ELF) waves. Measurements were performed in Poland (Hylaty), in Finland by Sodankylä Geophysical Observatory, at the Tel Aviv University astronomical observatory near the town of Mitzpe-Ramon in the Negev Desert (by E. Greenberg and C. Price), and at the Nagycenk (NCK) station (16.7° E, 47.6° N) of the Geodetic and Geophysical Research Institute in Sopron, Hungary.

The NCK station records three components of the atmospheric electromagnetic field in the 5-30Hz frequency band:

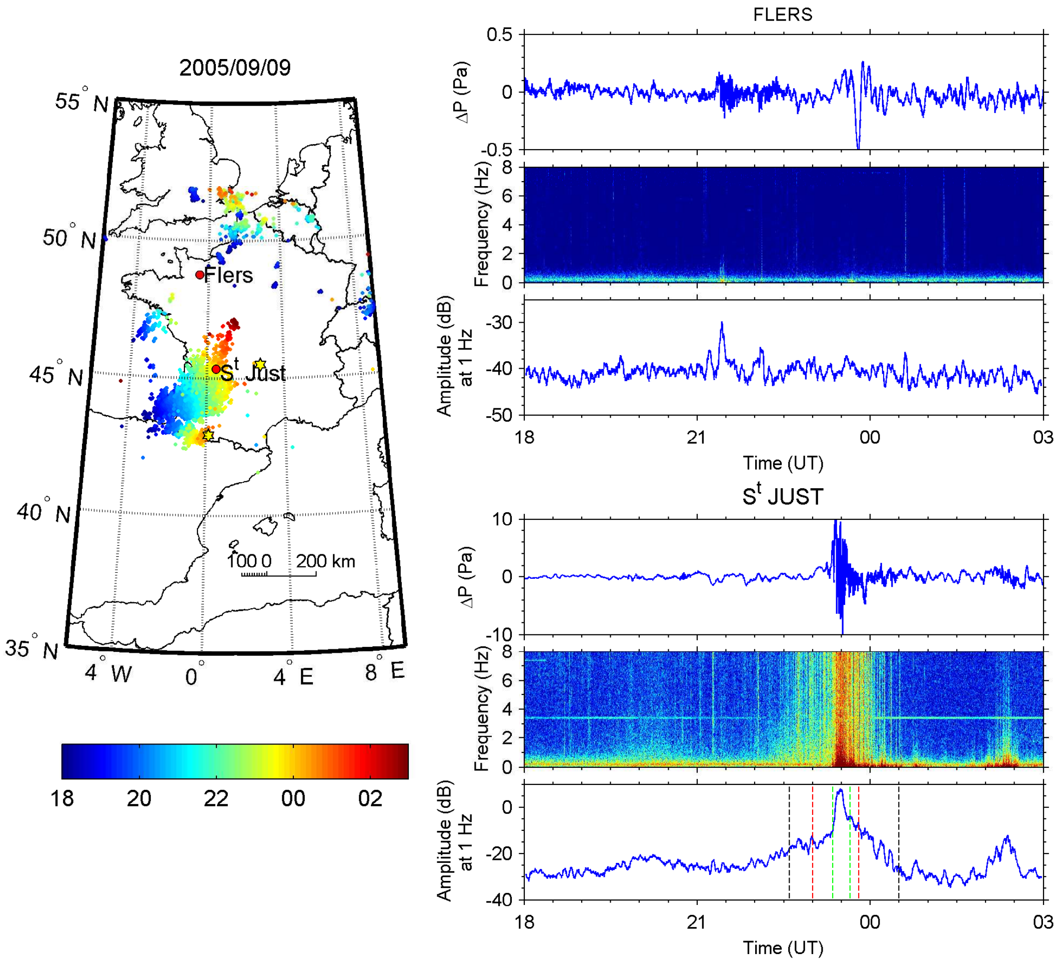

Fig. 4. Left: Lightning map recorded on September 9 and 10 from 18 to 03 UTC, with the locations of Flers (48.8° N, 0.5° W) and St Just (45.3° N, 0.5° E) infrasound stations (red circles) and of camera sites (yellow stars). Right: Overpressure signal, its spectrogram and the amplitude at 1 Hz recorded at Flers (top) and at St Just (bottom). On the latter plot, the vertical dashed lines indicate the mean distance of the storm: less than 50 km in black, 20 km in red and 10 km in green.

the horizontal components of the magnetic field and the vertical electric component (Sátori et al., 1996). For 59 out of the 64 sprite events, coherent transient signals could be observed in both the electric and the magnetic components. Records from NCK have millisecond accuracy time stamps due to a GPS clock, which worked continuously during the observation campaign. Most ELF transients set on very accurately around the time when the +CG was observed according to Table 1. In some cases the transient was shifted from the given time of the optical observation. The magnitude and sign of these time shifts were characteristic for certain periods of the campaign, so they indicate the uncertainties due to failing GPS timing of the optical observations. In 9 cases, transient signals were recorded also when no cloud-to-ground lightning could be associated with the sprite event. The analysis of the records suggests that the parent lightnings of those transients occurred in the observed thunderstorm. When the observation time of the event is not exactly known, these transients cannot be unambiguously associated with the corresponding event. In other cases, however, the possibility cannot be excluded that Météorage either missed or misclassified the corresponding discharges. The sources of those transients could be intense vertical intra-cloud flashes as well.

Out of the 59 observed transients, 43 were suitable for further analysis. The charge moment change (CMC) of the source was estimated for each transient. The methods applied are described in Neubert et al. (2005). The histogram of the CMCs (Fig. 5) shows no significant difference when compared to the histogram of CMCs observed during the Eurosprite 2003 campaign (Neubert et al., 2005). CMCs were observed in the range of 300–4600 Ckm and the distribution

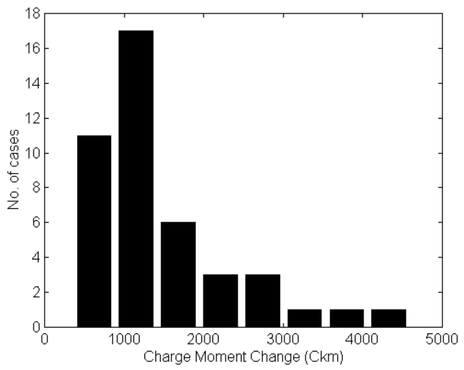

Fig. 5. Histogram of charge moment changes deduced from 43 sprite-related Schumann resonance transient events observed at Nagycenk, Hungary (16.7° E, 47.6° N), during the Eurosprite 2005 campaign.

has a peak around 1200 Ckm.

5.3 VLF measurements (3–30 kHz)

Very low frequency (VLF) waves provide a powerful technique for remote sensing using both natural and artificial VLF sources. Measurements of broad-band VLF transients (usually called sferics) can be used in thunderstorm location. Narrow-band VLF receivers monitor signals from VLF communication and navigation transmitters. Conductivity changes along the upper plate of the earth-ionosphere waveguide can be detected as perturbations in the amplitude and/or phase of these signals (see Strangeways, 1996).

The following measurements were operated during the campaign:

Nançay, France:. One narrow-band system (U. Inan and R. Marshall, Stanford University) and one wide-band receiver (M. Parrot and F. Lefeuvre, CNRS/LPCE, Orléans; Stanford University).

Sde Boker, Israel:. (E. Greenberg and C. Price, Tel Aviv University) VLF data were recorded from mid-July till mid-September (until event no. 21 in Table 1, 2005-09-09).

Sodankylä, Finland:. One station of the World-Wide Lightning Location (WWLLN) network (R. Holzworth, University of Washington, Seattle, USA; R. Dowden and C. Rodger, University of Otago, New Zealand) and one AARDDVARK receiver (British Antarctic Survey, Cambridge, UK). In addition the SGO EUV2300 ELF-ULF-VLF receiver, covering the whole range of 0–8 kHz, was operated between 2005-09-26 and 2005-10-09 (by T. Turunen and coworkers) but unfortunately no sprites were captured in this period.

A near one-to-one relationship between TLEs and early VLF perturbations has been found by Haldoupis et al. (2004) and reinforced by Mika et al. (2005). In the Eurosprite observations a new type of disturbance, the early/slow event, was observed for the first time by Haldoupis et al. (2004) and studied in more detail by Haldoupis et al. (2006). Events of this type set on early but build up slowly, signifying continuing lower-ionospheric ionisation either through direct effects of the lightning or through an indirect magnetospheric mechanism.

6 Summary of optical observations

In total 64 sprite events were captured with the cameras during the 2005 campaign. No events were captured simultaneously by both cameras mainly because the weather rarely allowed both stations to view the same area. The Puy de Dôme station also suffered severely from local light pollution and technical problems (such as unreliable network communication). The full optical campaign data sets are available to the operators through a password-protected website. Public resources are also available online (see Sect. 9). Table 1 lists the sprite events captured during the 2005 observations from Pic du Midi (Pic) and Puy de Dôme (Puy), showing the UTC times of the events, the locations and peak currents of their causative +CG discharges (if identifiable), the time delays between the +CG and the sprite event, identified within the possible accuracy of the event timing, and the charge moment changes calculated from the ELF recordings at Nagycenk. Sometimes failing GPS synchronisation caused timing errors, which is also noted.

7 Conclusions

Using the results from the Eurosprite campaigns, Ignaccolo et al. (2006, 2007) have designed automatic systems for sprite detection and estimated the global rate of sprite events to be around three per minute, i.e. about one sprite for every 1000 lightning flashes. The previous campaigns have also given new results: Haldoupis et al. (2004) and Mika et al. (2005) confirmed the relation between sprites and early VLF propagation disturbances. VLF events of a new kind, the early/slow events, were also observed and studied in more detail by Haldoupis et al. (2006). The Eurosprite observations also support the use of infrasonic detection (Farges et al., 2005) as a regular sprite detection tool, as applied by Liszka and Hobara (2006).

8 Future

The Eurosprite campaigns will be extended into a Global Sprite-Watch Partnership. Fielding of semi-autonomous stations is planned for Cuba and Corsica in 2007. New observers are also invited to join the partnership and to take part in observations with the current systems (operation manuals are available). An extended ground-based observational infrastructure is essential to two complementary space-borne missions, ASIM and TARANIS, planned for 2010 and beyond. The long-term coverage of the same locations will also provide an important set of data for statistical studies.

8.1 ASIM

The Atmosphere-Space Interactions Monitor (ASIM) is designed to fly for at least one year on the Columbus external platform of the International Space Station (ISS), which has a low Earth orbit (about 360 km height) suitable for observing TLEs. The objective of the mission is simultaneous limb and nadir monitoring of optical and X-ray emissions associated with thunderstorm activity, as well as studying the relation between lightning, TLEs and terrestrial gamma-ray flashes (Smith et al., 2005). ASIM is led by the Danish National Space Institute, has completed the ESA Phase A study and entered Phase B during early 2007.

8.2 TARANIS

TARANIS (Tool for the Analysis of RAdiations from lightNIngs and Sprites, named after the ancient Gallic god of lightning and thunder) is a 2-year micro-satellite mission developed with objectives similar to those of ASIM, and with the additional capability of detecting ELF and VLF electromagnetic waves. TARANIS is developed by the Centre National d'Études Spatiales (CNES), France and is also expected to enter ESA Phase B in 2007.

9 Online resources

Overview. General information on the campaigns and the future projects is available via
`http://www.space.dtu.dk/research/solarphysics`

Blog. Forecasts, planning and examples of results (as low-resolution overview images) are found in the Eurosprite operator blog at `http://eurosprite.blogspot.com`

Acknowledgements. We acknowledge funding through the European Community's Human Potential Programme under contract HPRN-CT-2002-00216, Coupling of Atmospheric Layers (CAL).

The contribution of Gabriella Sátori and József Bór was supported by the Hungarian Scientific Research Fund (OTKA), N161013.

The supporting ULF-ELF-VLF registrations were possible thanks to the collective effort of a large number of research groups. We thank these groups for making the data available.

The model names of the equipment used at the sites of observation are registered trademarks of their respective manufacturers.

The editors thank one referee for assistance in evaluating this paper.

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Table 1. Summary of optical sprite observations during Eurosprite 2005, also showing the corresponding locations and peak currents of the associated Météorage +CG lightnings, the time delays between the +CGs and the events (for values in parentheses the onset of the associated ELF transient was considered), and the charge moment change (CMC) calculated from Nagycenk (NCK) Schumann resonance data. For some cases more than one +CG lightning preceded the sprite event within a reasonable spatial and temporal interval; such cases cannot be distinguished without triangulation of the sprites. In a few cases no +CG lightnings could be unambiguously attributed to the sprites. For many of these cases, but not all, the timing was out of GPS synchronisation.

Event	Station	Time (UTC)	Timing	+CG location (lat, long)	+CG peak current (kA)	Δt +CG-event (ms)	NCK CMC (Ckm)
1	Pic	2005-07-19 00:46:12.51	OK	45°3626; 9°9975	70.7	76	1042
2	Pic	2005-07-29 01:28:59.14	No GPS	45°0439; 2°2686 or 45°0349; 2°2981	197.4 or 38.7	75 63	1387
3a	Pic	2005-07-29 01:32:51.33	No GPS	44°9256; 2°4655	24.6	85	
3b	Pic	2005-07-29 01:32:51.41	No GPS	44°9824; 2°2419	35.5	46	1460
4	Pic	2005-07-29 01:36:09.46	No GPS	45°2527; 2°6821 or 45°2544; 2°6796	66.7 or 29.4	103 67	
5	Pic	2005-07-29 01:40:50.28	No GPS	44°9953; 2°6827 or 45°0610; 2°1906	61.4 or 115.6	85 -98	1020
6a	Pic	2005-07-29 01:43:52.66	No GPS	45°2205; 2°5627	8.1	136 or 290	
6b	Pic	2005-07-29 01:43:52.70	No GPS	45°3520; 2°0880	25.5	-36	
7	Pic	2005-07-29 01:46:04.82	No GPS	45°2653; 2°7139	63.1	81	446
8a	Pic	2005-07-29 01:48:08.39	No GPS	45°3333; 2°7731 or 45°2719; 2°6210	129.9 or 75.2	123 7	2239
8b	Pic	2005-07-29 01:48:08.52	No GPS	45°3221; 2°6180 or 45°2976; 2°0029	16.2 or 27.8	102 -31	
9	Pic	2005-07-29 01:54:35.20	No GPS	46°2103; 3°0672	49.8	43 or -103 – -105	761
10a	Pic	2005-07-29 01:54:38.16	No GPS	45°0637; 2°8356	71.9	82	1106
10b	Pic	2005-07-29 01:54:38.53	No GPS	45°4945; 2°6584	31.0	86	
11a	Pic	2005-07-29 02:04:10.30	No GPS	45°3311; 2°7704	99.7	44	
11b	Pic	2005-07-29 02:04:10.39	No GPS	45°5442; 2°5895 or	66.2 or	48	

Continuing

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Event	Station	Time (UTC)	Timing	+CG location (lat, long)	+CG current (kA)	Δt +CG-event (ms)	NCK CMC (Ckm)
				45°4436; 2°5321 or 45°2514; 2°5886	32.9 or 53.6	47 22	
12	Puy	2005-08-11 22:44:15.63	No GPS	43°9625; 6°8845	43.0	49033	945
13	Puy	2005-08-11 23:02:21.01	No GPS	43°5969; 6°7493 or 43°8537; 7°0086	80.6 or 31.6	49034 48940	1171
14	Puy	2005-08-11 23:12:39.23	No GPS	43°7520; 6°7169	50.7	49033	680
15	Pic	2005-08-16 23:06:42.26	OK	41°9948; 0°8384	24.5	78	
16	Pic	2005-09-07 02:14:08.37	OK	43°8377; 6°2490	57.6	33	1483
17a	Puy	2005-09-09 01:08:10.96	No GPS	43°8410; 5°4698 or 43°8933; 5°4027	47.4 or 25.6	2047 1968	
17b	Puy	2005-09-09 01:08:11.12	No GPS	43°7617; 6°1867	114.4	2036	563
18	Puy	2005-09-09 03:02:14.68	No GPS	43°6843; 5°8300	177.9	2039	1282
19	Puy	2005-09-09 03:45:44.37	No GPS	43°8566; 7°1371 or 43°9189; 7°0820	170.3 or 81.2	2020 1982	
20	Pic	2005-09-09 20:35:42.35	OK	44°6450; -1°4153	37.2	58	582
21	Puy	2005-09-09 20:52:26.49	No GPS	44°8078; -0°8396 or 44°8404; -1°0773	98.0 or 43.7	2028 1948	 520
22	Pic	2005-09-09 21:18:39.33	OK	45°0097; -1°0484	74.5	110	
23	Pic	2005-09-26 01:06:35.68	OK	40°3565; 3°2920	77.4	62	1228
24	Pic	2005-09-26 01:09:43.60	OK	40°5905; 3°2933	89.5	50	3673
25	Pic	2005-09-26 01:14:39.76	OK	40°4105; 3°8076 or 40°5277; 3°6858	41.2 or 3.6	290 26	507
26a	Pic	2005-09-26 01:22:03.92	OK	40°5682; 3°9882	70.7	98	
26b	Pic	2005-09-26 01:22:04.	OK	40°6368; 3°3994	19.2	31	973
27	Pic	2005-09-26 01:25:39.01	OK	40°4839; 4°0563 or	28.4 or	116	

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Event	Station	Time (UTC)	Timing	+CG location (lat, long)	+CG current (kA)	Δt +CG-event (ms)	NCK CMC (Ckm)
				40°5396; 3°4241 or	56.1 or	14	
				40°5677; 3°0873	76.5	14	
28a	Pic	2005-09-26 01:33:43.30	OK	40°5257; 4°0132	138.4	53	
28b	Pic	2005-09-26 01:33:43.42	OK	40°8745; 3°4924 or	60.6 or	72	2578
				40°5765; 3°3765	84.0	61	
29a	Pic	2005-09-26 01:39:09.72	OK	40°4881; 3°9481	12.9	107	358
29b	Pic	2005-09-26 01:39:09.93	OK	40°6594; 3°6072 or	26.4 or	107	
				40°7859; 3°6114	8.2	82	
30	Pic	2005-09-26 01:49:15.37	OK	40°5616; 3°6740	112.9	77	1677
31	Pic	2005-09-26 01:54:17.49	OK	40°5265; 3°9523	126.8	47	2389
32	Pic	2005-09-26 01:59:32.98	OK	No +CG found	No +CG found	(39)	1704
33	Pic	2005-09-26 02:41:43.74	OK	No +CG found	No +CG found	? (-1640)	
34	Pic	2005-09-26 02:49:52.24	OK	40°4284; 3°9302	10.4	12	801
35	Pic	2005-09-26 02:53:58.02	OK	40°2957; 4°0049	10.7	103	
36a	Pic	2005-09-26 03:00:42.57	OK	40°3054; 3°7981	60.8	42	1413
36b	Pic	2005-09-26 03:00:42.78	OK	40°5265; 3°5147 or	97.1 or	62	
				41°0074; 3°9667	5.0	35	
37a	Pic	2005-09-26 03:06:19.41	OK	40°4541; 4°1782	26.4	77	506
37b	Pic	2005-09-26 03:06:19.87	OK	40°8201; 3°3885	85.8	73	936
38	Pic	2005-09-26 03:10:29.26	OK	40°3902; 3°9138	105.5	65	1346
39a	Pic	2005-09-26 03:12:41.59	OK	40°6580; 3°9072	25.0	64	
39b	Pic	2005-09-26 03:12:41.71	OK	40°4573; 3°6664	27.7	72	1135
40	Pic	2005-09-26 03:23:03.99	OK	40°8010; 3°8467	274.5	67	
41	Pic	2005-09-26 03:27:22.73	OK	40°5872; 4°0318	64.3	52	1101
42	Pic	2005-09-26 03:38:57.32	OK	40°1432; 5°8353	4.5	84	4591
43	Puy	2005-10-06 23:51:07.77	No GPS	No +CG found	No +CG found	?	
44	Puy	2005-10-06 23:53:27.25	No GPS	No +CG found	No +CG found	?	
45	Puy	2005-10-06 23:55:50.89	No GPS	No +CG found	No +CG found	?	

Continuing

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Event	Station	Time (UTC)	Timing	+CG location (lat, long)	+CG current (kA)	Δt +CG-event (ms)	NCK CMC (Ckm)
46	Pic	2005-10-23 18:59:24.01	OK	40°6406; 3°7546	41.5	68	1233
47	Pic	2005-11-11 00:56:46.61	No GPS	40°0550; 3°1835 or 39°9641; 2°9490	26.8 or 97.0	56 55	
48	Pic	2005-11-11 01:11:31.24	No GPS	40°1907; 2°8985	28.3	101 or -20	522
49	Pic	2005-11-11 02:34:13.66	No GPS	40°6097; 4°6513	7.1	162 81	
50a	Pic	2005-11-11 02:43:46.68	No GPS	40°4398; 3°8508	10.1	68	
50b	Pic	2005-11-11 02:43:46.85	No GPS	40°5305; 3°4553 or 40°3586; 3°4009	30.4 or 45.3	74 32	1281
50c	Pic	2005-11-11 02:43:47.10	No GPS	40°3830; 2°9583	89.0	59	1258
51a	Pic	2005-11-11 02:56:13.78	No GPS	40°7560; 3°6362	41.0	-47	
51b	Pic	2005-11-11 02:56:13.95	No GPS	40°5668; 3°3505	17.5	104	
51c	Pic	2005-11-11 02:56:14.03	No GPS	40°6070; 2°9842	30.1	70	
52	Pic	2005-11-12 02:21:38.81	No GPS	37°8038; -0°1312	13.2	437	3421
53	Pic	2005-11-12 02:27:57.24	No GPS	No +CG found	No +CG found	? (662)	
54	Pic	2005-11-12 03:36:29.44	No GPS	No +CG found	No +CG found	? (683)	
55	Pic	2005-11-12 04:27:54.47	No GPS	38°5832; 0°4316	27.1	564	2043
56	Pic	2005-11-12 04:31:19.98	No GPS	38°5189; 0°6066	108.0	672	1448
57	Pic	2005-11-12 04:46:05.50	No GPS	No +CG found	No +CG found	? (719 or 680)	
58	Pic	2005-11-12 05:02:02.99	No GPS	38°5522; 1°5099 or 38°3828; 1°2003	13.8 or 72.4	134 73	2821
59	Pic	2005-11-15 01:47:31.99	OK	No +CG found	No +CG found	? (648)	2484
60	Pic	2005-11-15 02:01:25.24	OK	No +CG found	No +CG found	? (671)	
61	Pic	2005-11-15 22:12:43.56	OK	40°6283; 2°0396	2.8	115	1635
62	Pic	2005-11-15 22:47:36.88	OK	No +CG found	No +CG found	? (146)	
63	Pic	2005-11-15 22:51:18.06	OK	No +CG found	No +CG found	? (106)	
64	Pic	2005-11-15 23:15:31.30	OK	No +CG found	No +CG found	? (101)	