

Transient Luminous Events Observations with FRIPON

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Transient Luminous Event (TLE)

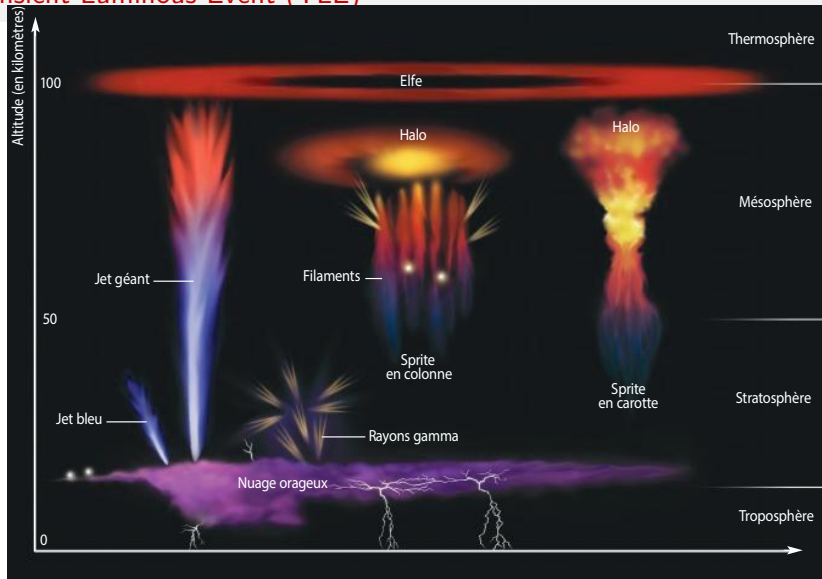


Figure adapted from [Blanc and Farges, Pour la Science, 416, 48, 2012].

Transient Luminous Event (TLE)

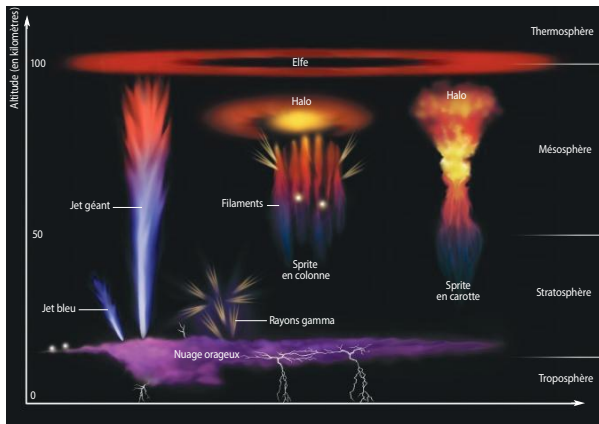


Figure adapted from [Blanc and Farges, Pour la Science, 416, 48, 2012].

- TLEs are optical phenomena of large dimensions in the stratosphere, mesosphere and thermosphere directly associated to the electrical activity in a thunderstorm.
- They are the optical demonstrations of an electrodynamic coupling between the atmospheric layers.

Transient Luminous Event (TLE)

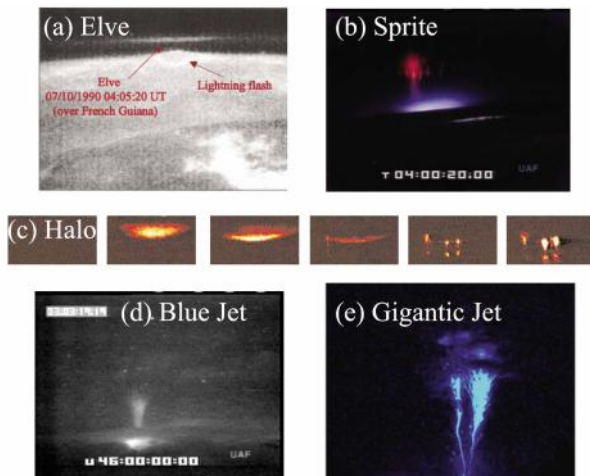
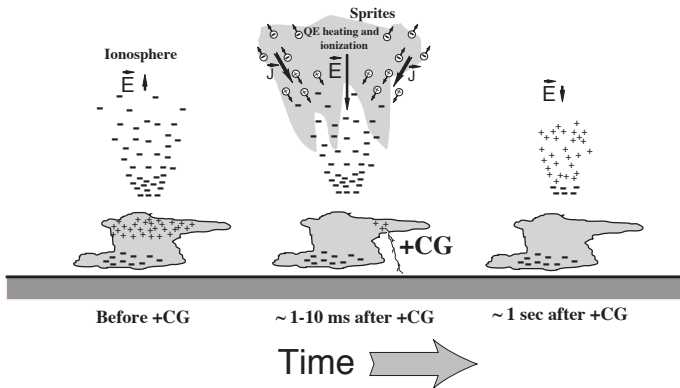


Figure reproduced from [Pasko et al., JGR, 115, A00E35, 2010, Figure 1].

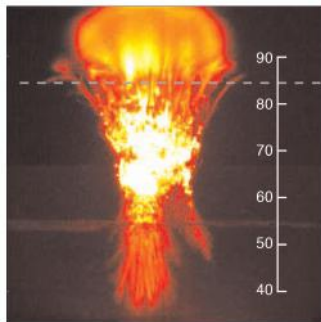
- Global occurrence of sprite : ~ 1 event/min [Chen et al., JGR, 113, A08306, 2008].
- Halos: ~ 1 events/min.
- Elves: ~ 35 events/min.

Production mechanism of a sprite

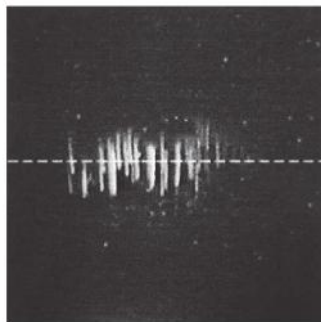


Reproduced from [Pasko et al., JGR, 102, 4529, 1997, Figure 2].

Sprite morphology



A carrot sprite
[Pasko and Stenbaek-Nielsen, GRL, 29,
1440, 2002]



Columniform sprites
[Wescott et al., JASTP, 60, 733, 1998]

Carrot and column sprites

- **Research** : Initiation mechanisms, role of ionospheric inhomogeneities (meteors?), propagation, morphology, spectroscopy, global effects (chemistry, GEC, ionospheric disturbances, influence on radio wave propagation)

Observation by space missions

- ISUAL [Chen et al., JGR, 113, 2008]
- GLIMS [Sato et al., JGR, 120, 2015]
- ASIM [Torsten and ASIM Instrument Team, AIP, 1118, 2009]
- TARANIS [Lefeuvre et al., Springer, 301, 2008]

Problem

Spacecrafts and ground-based observation campaigns give information on a small region of space for a limited duration → No continuous observation of the same area

FRIPON and TLEs

Problem

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Why is FRIPON useful

- Spread over a large area
- Some regions correspond to strong electric activity
- Continuous observations of the same area over long timescales
- Complementary to space mission



Figure: FRIPON map

Continuous observations of the same area over long timescales

FRIPON can help answer questions on :

- Occurrence variability
- role of the state of ionosphere
- Other large time and space scales phenomena

Complementary to space mission

FRIPON can act as a support of observations of TLEs by space missions, especially those with nadir-viewing strategies

TLEs observations with FRIPON

- TLEs are detected in parallel of meteors (threading)
- Failsafes are in place to avoid disruption of the meteor part

Overview of the algorithm

- 1 Difference between consecutive images
- 2 Masking
- 3 Thresholding against background
- 4 Filtering for enhancing
- 5 Thresholding for hardening
- 6 Rejector based on scattering

Challenges to be solved

- Moon and bright sources : Currently, threshold on a stack of 1 s
- Dynamic mask : Work in progress
- Triangulation : Work in progress

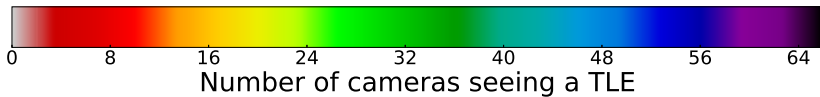
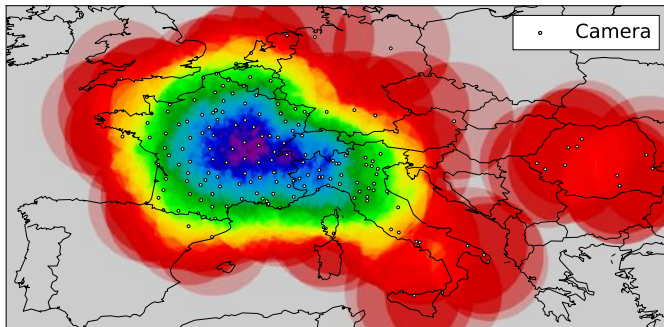


Figure: Potential efficiency of the FRIPON network

Extension of the Sprite mode

- Italy is a great place to detect sprites
- Italian meteor observing amateurs frequently observe sprites
- Could increase the probability to detect TLE



Figure: Lightning strikes over Italy. Source : blitzortung.org

Implication

- The Orleans team is engaged on the development of freeture
- It also manages the GitHub
- Upgrade Freeture for the future (new features, new cameras,etc.)

Processing sprite data

- Sprite data from stations are sent to Marseille
- rsync between Marseille and Orleans
- Local data processing and archiving
- Pipeline processing in progress



Figure: Pikachu, our server

Goal

FRIPON potentially allows statistical analysis of TLEs observed continuously over a large area.

Conclusions

Science

- Would strongly support space observations (ASIM, TARANIS)
- Bring answers to questions about TLEs
- Statistical approach of these events

FRIPON project

- Development and support of the software
- Contribution to Freeture through GitHub

Future for sprite detections?

We are interested in activating the sprite detection mode in other regions