



The contribution of citizen observers to the UHU lightning and TLE observation campaign on the International Space Station in 2025

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Acknowledgements

The Authors are grateful to Dr. Burcu Kosar for endorsing the UHU project on Spritacular.org. The contribution of all academic and citizen observers is greatly appreciated. This work was supported by the National Research, Development and Innovation Office, Hungary – NKFIH, K138824.



Introduction

The UHU experiment (uhu.epss.hu/en/) was conducted on the International Space Station (ISS) from 26 June to 14 July, 2025, in the framework of Axiom Space's Ax-4 mission, to observe lightning activity and transient luminous events (TLE) from space using a commercial color video camera [1].

A large community of citizen as well as academic observers have been alerted to increase the chance of capturing one or more TLE from space and from the ground simultaneously to quantify the effect of the atmosphere on the recorded color and brightness distribution of the events.

Target thunderstorms and space-borne observations

The ground science team of the UHU experiment offered observational targets for the Ax-4 crew in the 27 June – 14 July time period by forecasting potential TLE-producing storms 24-36 hours ahead of the observational time windows [2]. The available astronaut time was rather limited, and constant strong sunlight in the cupola of the space station in roughly half of the mission time further reduced the number of space-borne observation possibilities. Eventually, 15 of the suggested targets were observed by the astronauts and TLE have been recorded in 7 of these sessions: ELVES over the maritime continent, blue events above China and the USA, and a single red sprite in Africa.

References

- [1] Yair et al., 2023, Acta Astronautica, <https://doi.org/10.1016/j.actaastro.2023.06.051>
- [2] Ziv et al, 2004, <https://doi.org/10.1175/2097.1>

Facebook group of TLE observers: <https://www.facebook.com/groups/376355972487572>

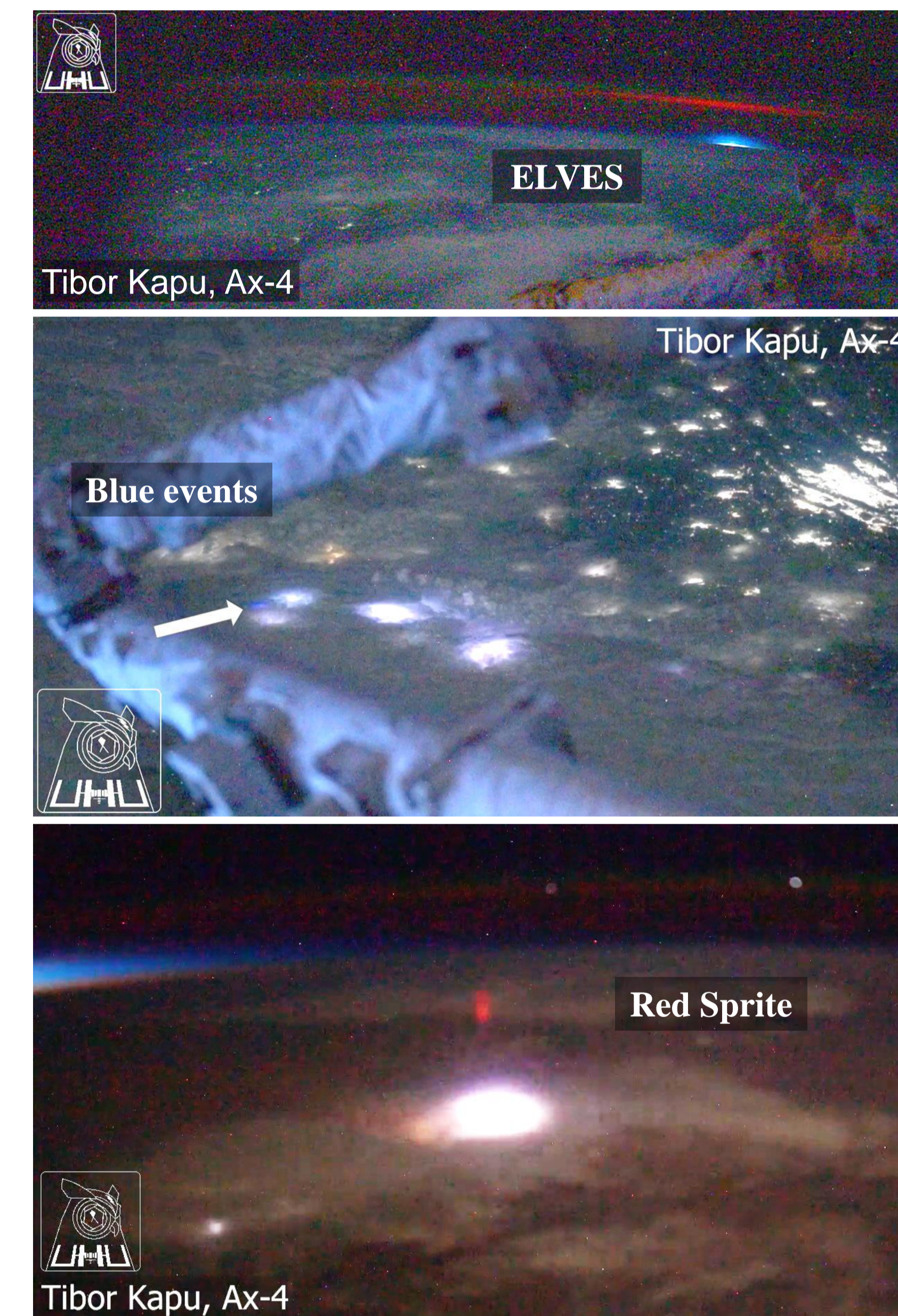
Organization-related experiences

Several practical lessons have been learned in the citizen science part of the observation campaign.

- Enough time must be allocated for the preparation of such campaigns. The background, the motivation, and the goals of the campaign as well as the activities requested from the contributors must be clearly communicated. Having a well-designed website is a great advantage.
- The call for participation should be posted in different communication channels and social media platforms to be effective. Interested applicants must be welcomed and supported, which does require significant efforts.
- Informing ground-based observers on the targets scheduled for observation from the ISS, if possible, helps concentrating the ground-based efforts and greatly increases the chance for success.
- Collecting the observations and the necessary metadata from different observers can be challenging. It also requires a sustained effort.
- The quality of the observation material varies much.
- Keeping the contributing people and communities updated on the progress of the research work carries a positive message and helps maintaining the intention for further joint activities.

Areal coverage

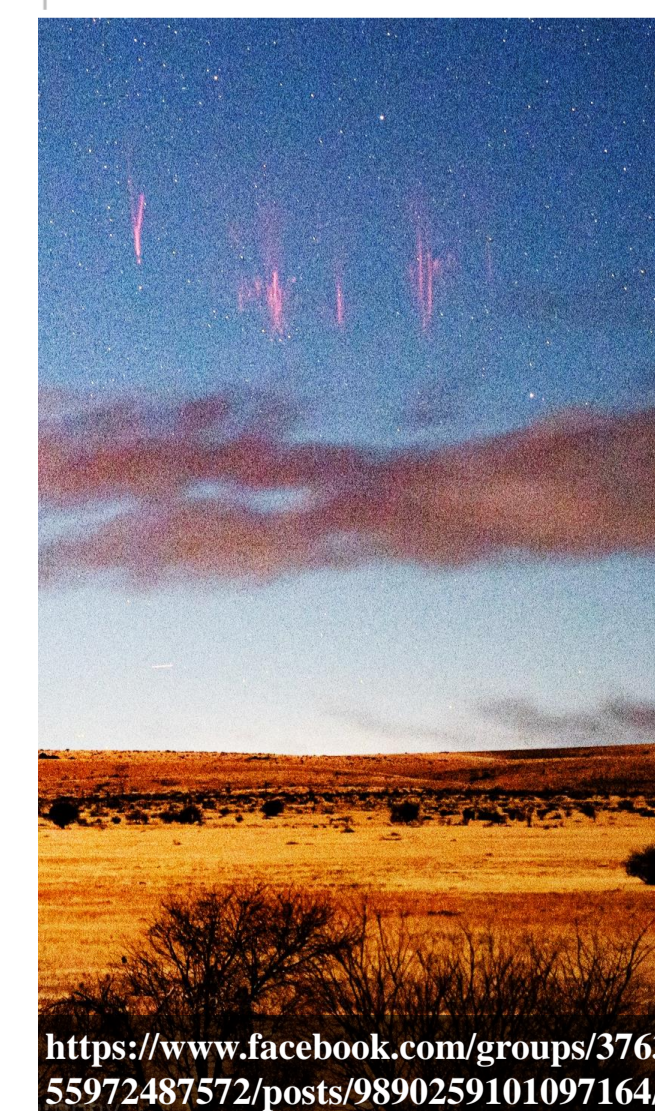
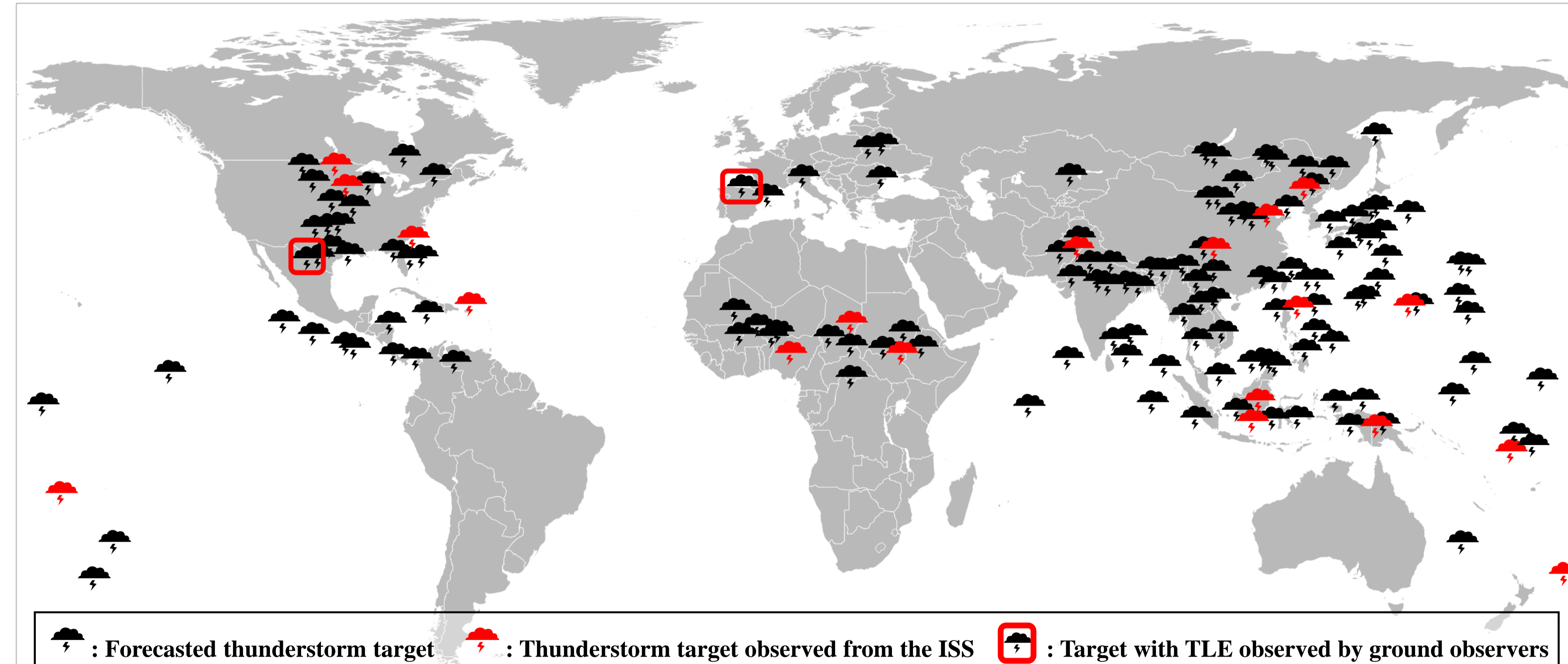
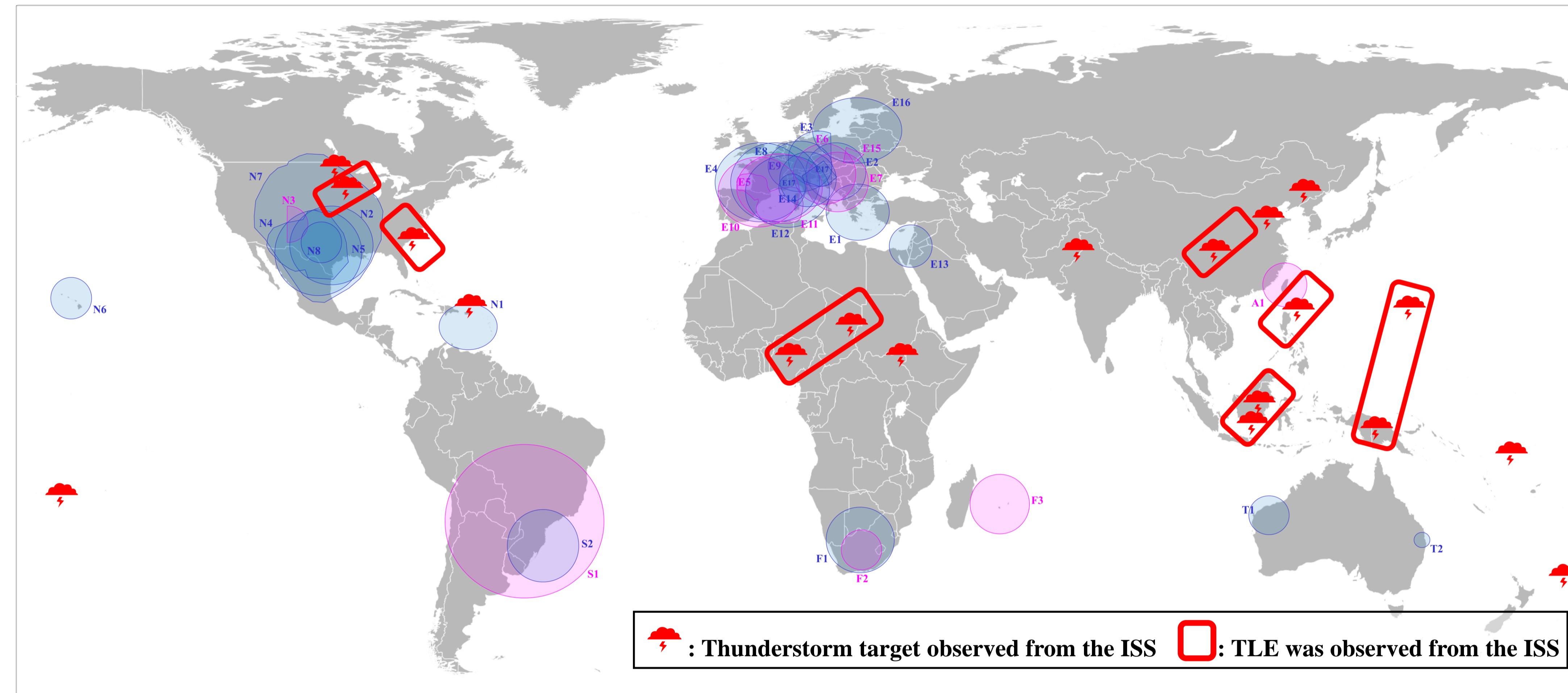
The known coverage of ground-based observations is highly uneven. The most covered regions are Europe, the central-southern USA, and the mid-latitudes in South America. The timing of the experiment (June-July) greatly increased the chances of capturing TLE from ground locations because it was in the middle of the thunderstorms season at mid-latitudes in the northern hemisphere.



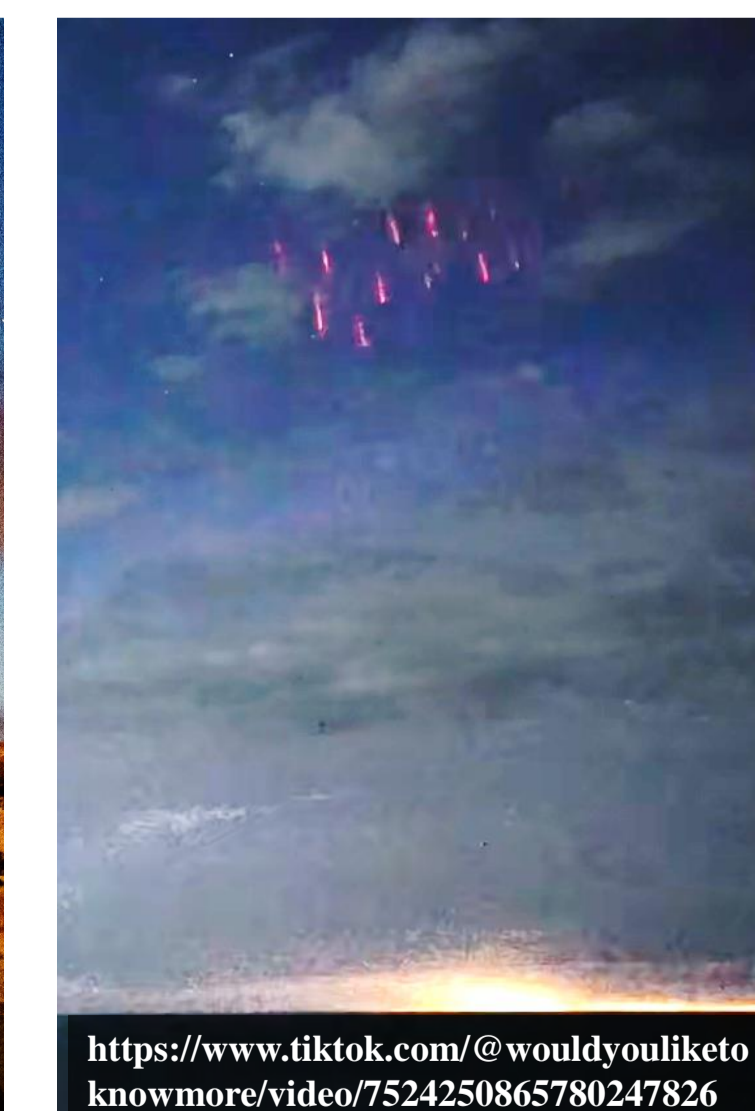
Ground-based observations

All ground-based observers agreed on that the mission time period was utterly weak in terms of the occurrence of sprite-producing thunderstorms and good observation conditions. Nevertheless, the observation of a few dozens of TLE, predominantly red sprites, have been reported. The observations included winter sprites in South Africa and Australia by observers Albertus Horn and David Finlay, respectively.

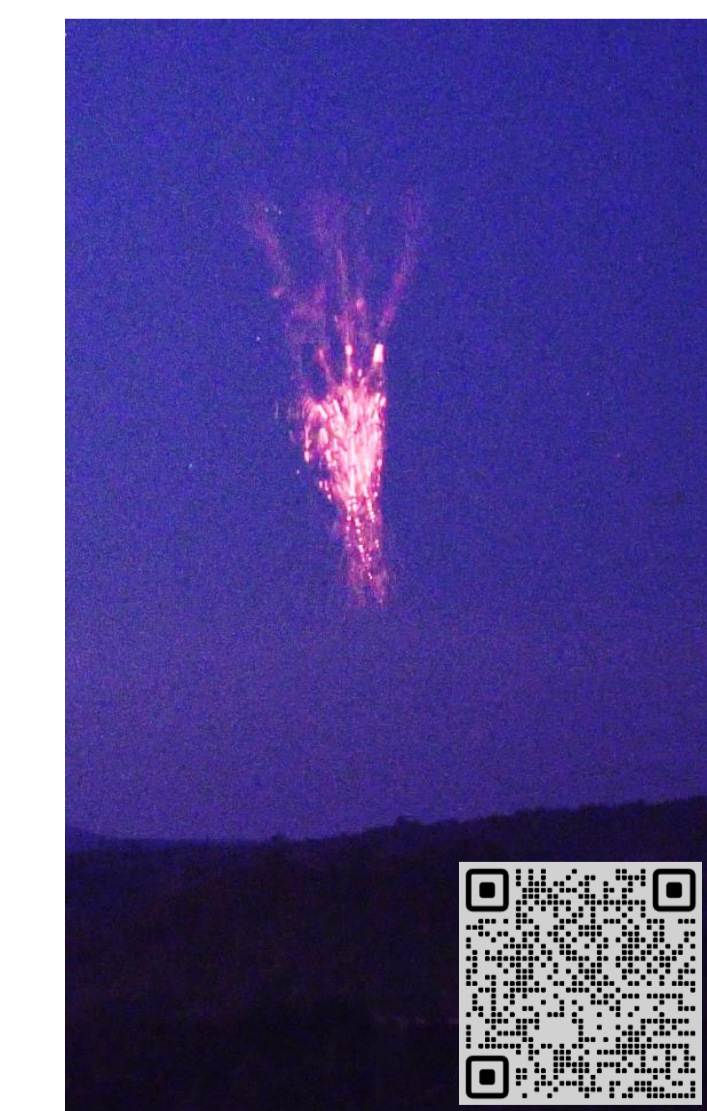
Furthermore, red sprites were observed above two thunderstorms, which were forecasted and offered as observational target for the astronauts on the ISS. Nicolas Escurat captured sprites above a storm in North-Spain/Bay of Biscay, and Stephen Hummel recorded them in Texas, USA. Unfortunately, these targets have not been scheduled for observation in the ISS, so simultaneous recording was not achieved. Nevertheless, these events directly justify the validity of the concept that making simultaneous ground-based and space-borne TLE observations is in fact feasible. This is yet another evidence for the very high potential of citizen contributors in supporting and facilitating academic research efforts in the field of atmospheric electricity, too.



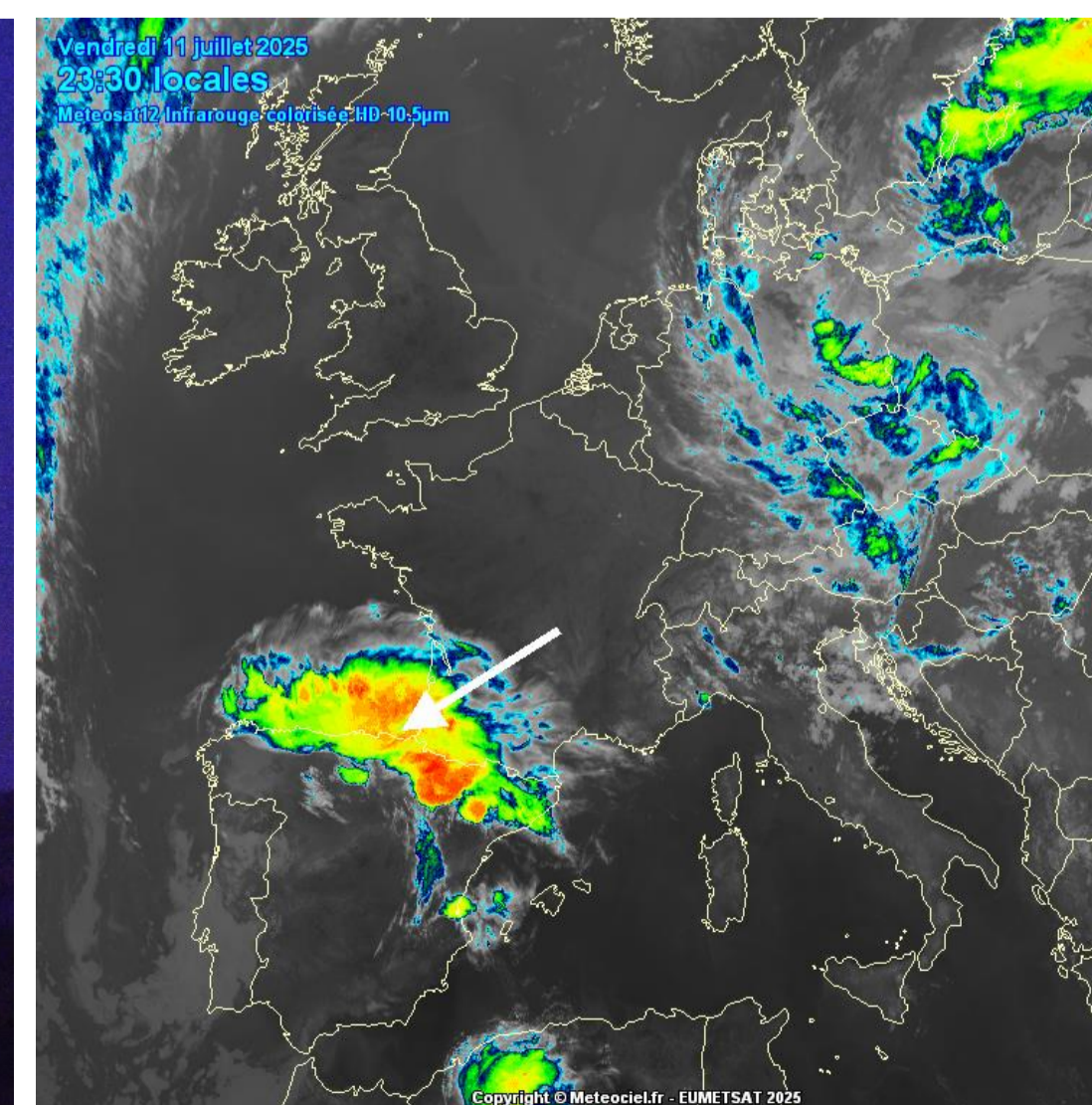
Albertus Horn
South Africa
winter sprites
2 July, 2025



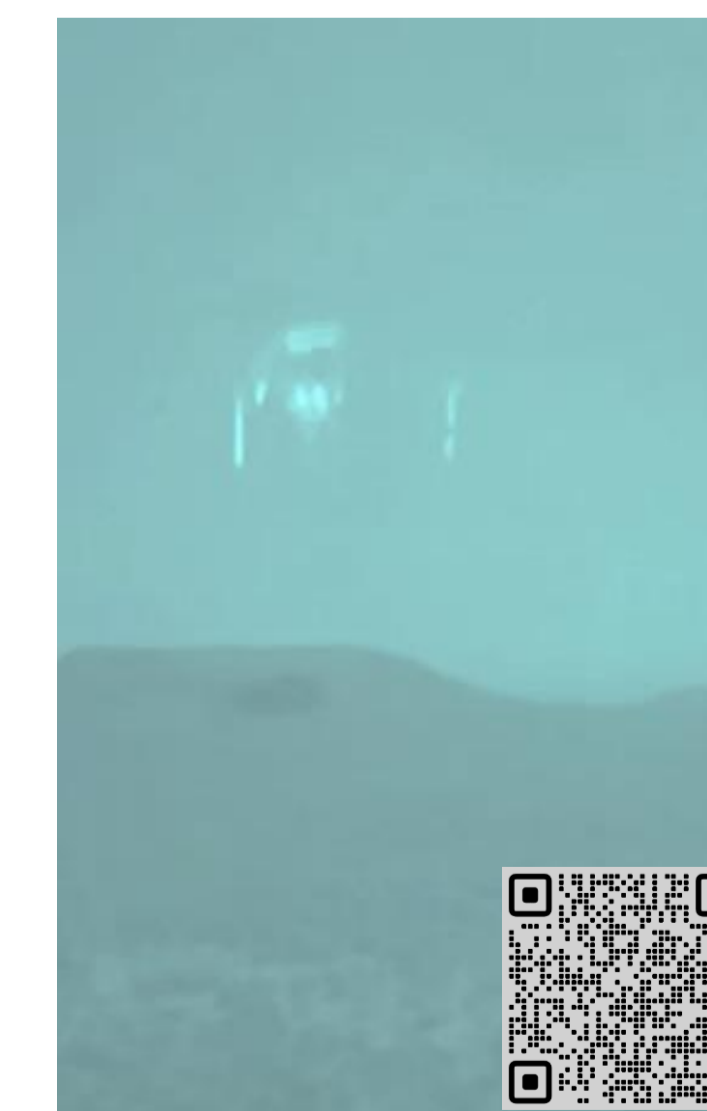
David Finlay
NSW Australia
winter sprites
early July, 2025



Nicolas Escurat, France
North Spain –
Bay of Biscay
red sprites
11 July, 2025



The thunderstorm
over North Spain –
Bay of Biscay
11 July, 2025



Stephen Hummel
Texas, USA
red sprites
13 July, 2025

Ground-based observers

underlined: captured TLE were during the mission
magenta: academic observations

- E1. The Greek community of observers: Christos Doudoulakis, Panagiotis Tsouras, Dimitris Sagiakos, Thanasis Papatthasiou; and Nikos Sioulas with the Global Meteor Network.
- E2. David Kacs, Hungary
- E3. Martin Popek, Czech Republic
- E4. Nicolas Escurat, France
- E5. Oscar van der Velde, UPC, Spain
- E6-E7. Jozsef Bor, HUN-REN EPSS, Hungary
- E8. Quentin Rey, France
- E9. Radoslav Zboran, Slovakia
- E10-E11. Serge Soula, Laboratoire d'Aérodologie, France
- E12. Sylvain Reybaut, France
- E13. Yoav Yair, Roy Yaniv, RUNI, Israel
- E14. Valter Binotto, Italy
- E15. Anna Odzimek, IGF, Poland
- E16. Tadas Janusonis and the Sky Chasers, Lithuania
- E17. Jose de Quierioz, Switzerland
- Others (coverage missing): Daniel Scerba, Stephane Vetter, Christophe Suarez, Laurent Richard, Remi Leroy, Bence Gucsik, Christian Carmona, Mary McIntire and the UK Meteor Network, Sirko Molau and the AllSky7 meteor Network, Italian Meteor Network, George Paraskevaides

- N1. Frankie Lucena, Puerto Rico
- N2. Will Young, USA
- N3. Elijah de Maria de Sao Sabbas, LEONA network
- N4. Stephen Hummel, USA
- N5. Levi Riggins, USA
- N6. Chaim Scowcroft, USA (Hawaii)
- N7. Paul Smith, USA
- N8. Kevin Palivec, USA
- Others (coverage missing): Thomas Ashcraft, Hank Schyma, observers reporting to Spritacular.org

- S1. Elijah de Maria de Sao Sabbas, LEONA network
- S2. Gabriel Zapparoli, Brasil
- Others (coverage missing): Carlos Fernando Jung

- F1. Albertus Horn, South Africa
- F2. Michael Kosch, SANS
- F3. Serge Soula, Laboratoire d'Aérodologie, France

- T1. Jeff Miles, Australia
- T2. Tell Lekatsas, Australia
- Others (coverage missing): JJ, Danny Welgama, David Finlay

- A1. Cheng-Ling Kuo, National Central University, Taiwan

- Others (coverage missing): Angel An, Xiaoyang Zhang, Jing Jiang, Xin Wang, Xiao Xiangyao Lulin Observatory, Taiwan, citizen observers in Japan