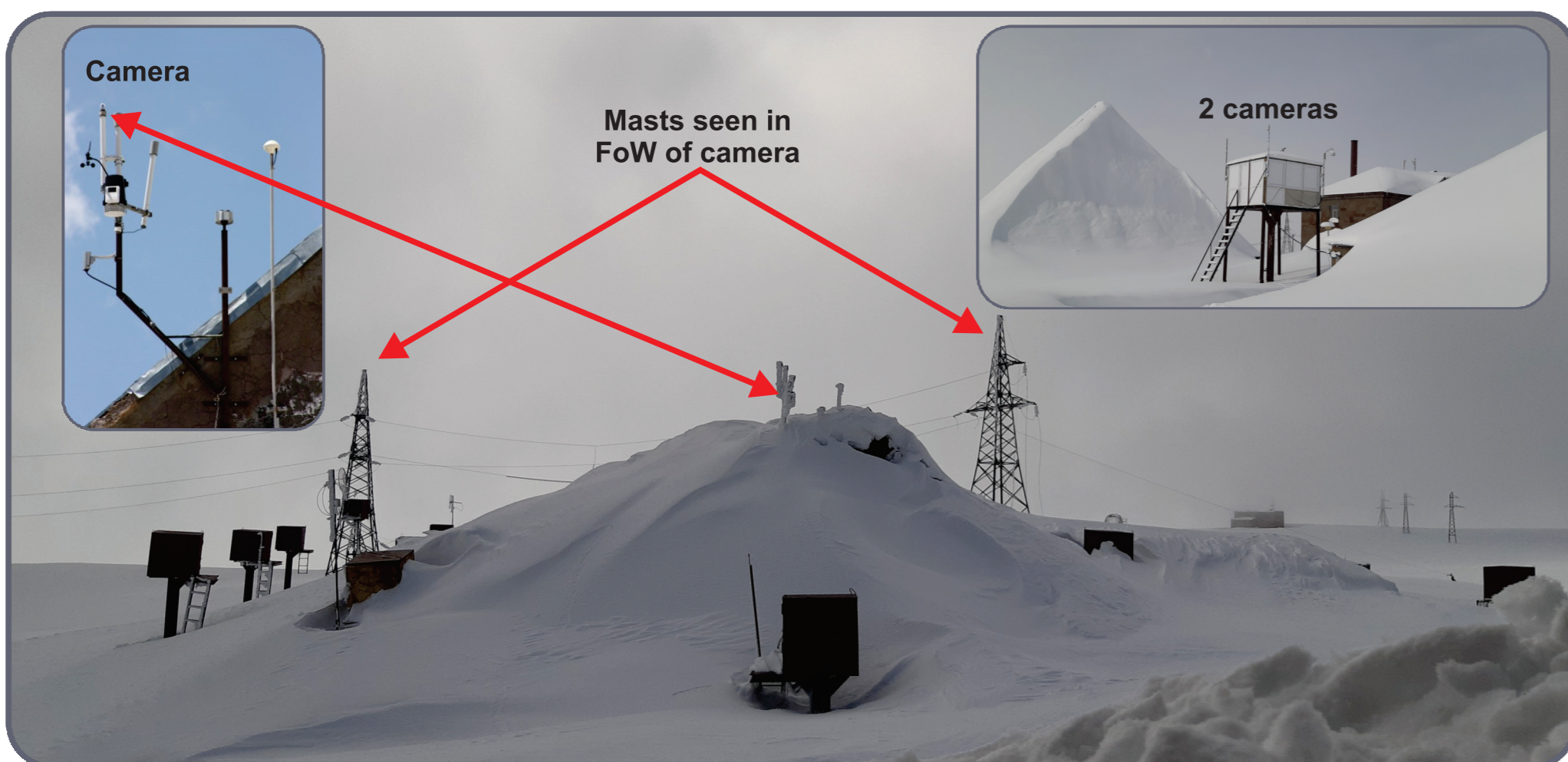
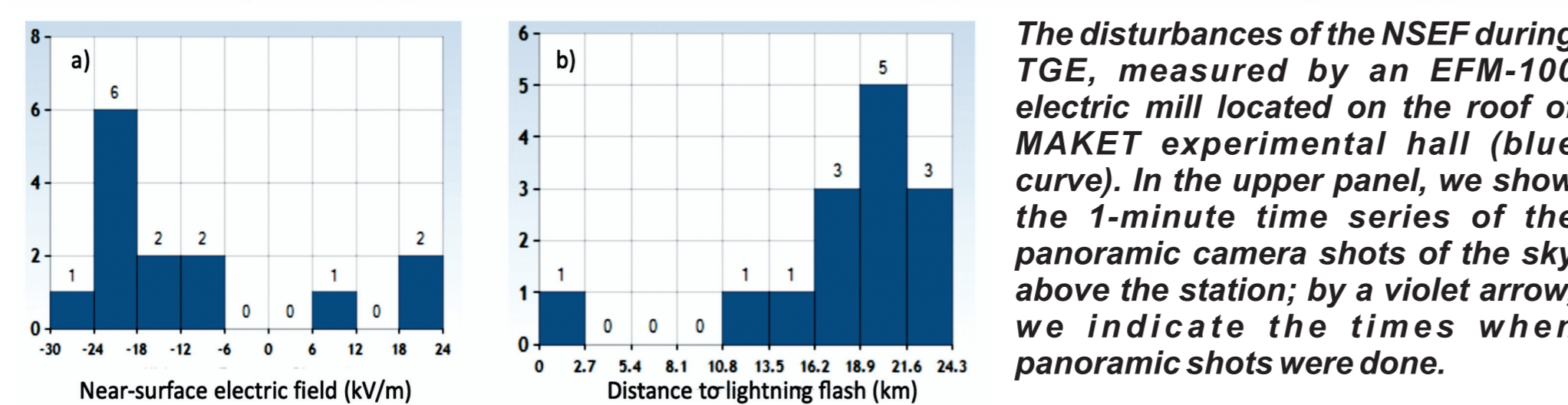
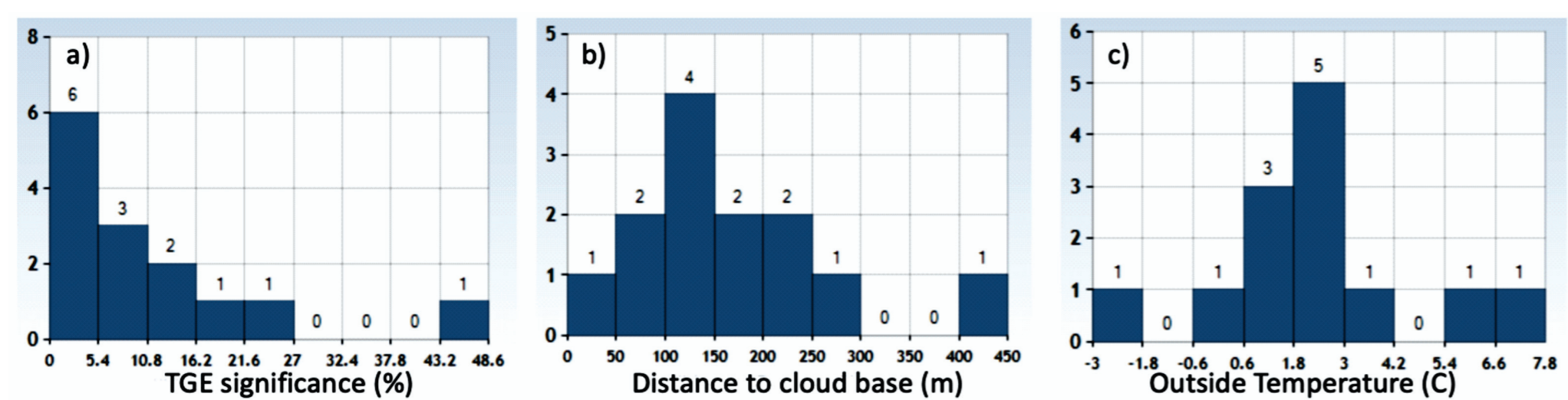
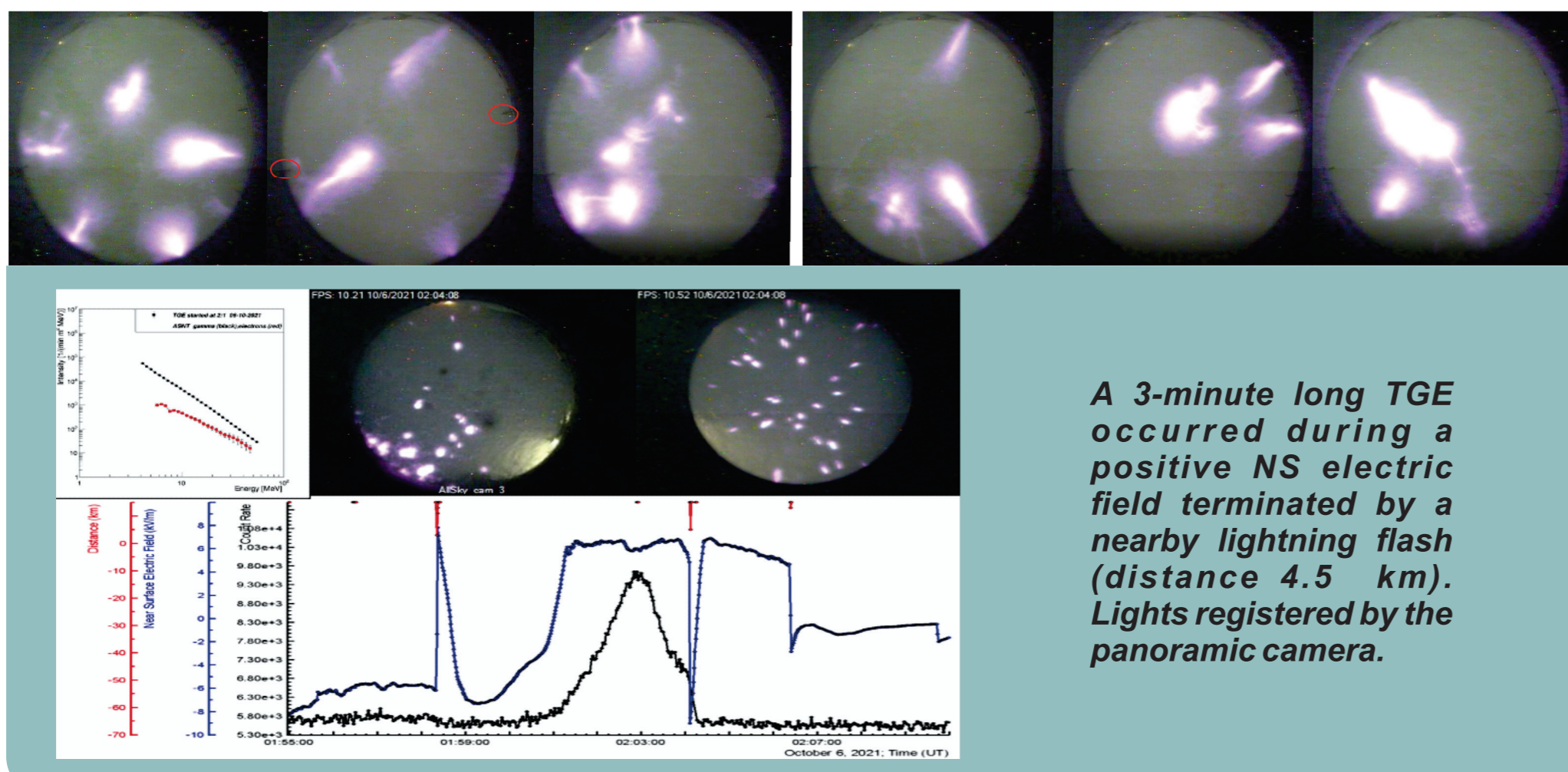


ABSTRACT

- Starting in 2014, we performed 24/7 monitoring of the skies above Aragats with panoramic cameras which have high sensitivity in the visible wavelength band of 300-700 nm.
- We present and discuss Transient Luminous Events (TLEs) in the lower atmosphere, observed during large disturbances of the near-surface electric fields (NSEF) and coinciding with large enhancements of the particle fluxes (thunderstorm ground enhancements – TGEs). In spite of large distances from the strongest electric field region the maximum energy of TGE particles on 22 and 25 May 2018 reaches 40 MeV. Thus, the accelerating electric field reaches 2.0 keV/cm even far from the zone of the strong lightning activity on the periphery of the storm.
- The light glows appearing at the same time in the skies can be due to the local charge rearrangement generating a small illuminating discharge without initiating the lightning flash.
- These unusual luminous phenomena are suggested that an electrical discharge much weaker than a lightning flash, could only partially neutralize the charge aloft, and hence, only partially lower the corresponding potential difference, allowing the electron accelerator to operate and send particle fluxes in the direction to the earth's surface. Simultaneously, these types of discharges initiate light glows in the thunderous atmosphere inside and below thunderclouds.



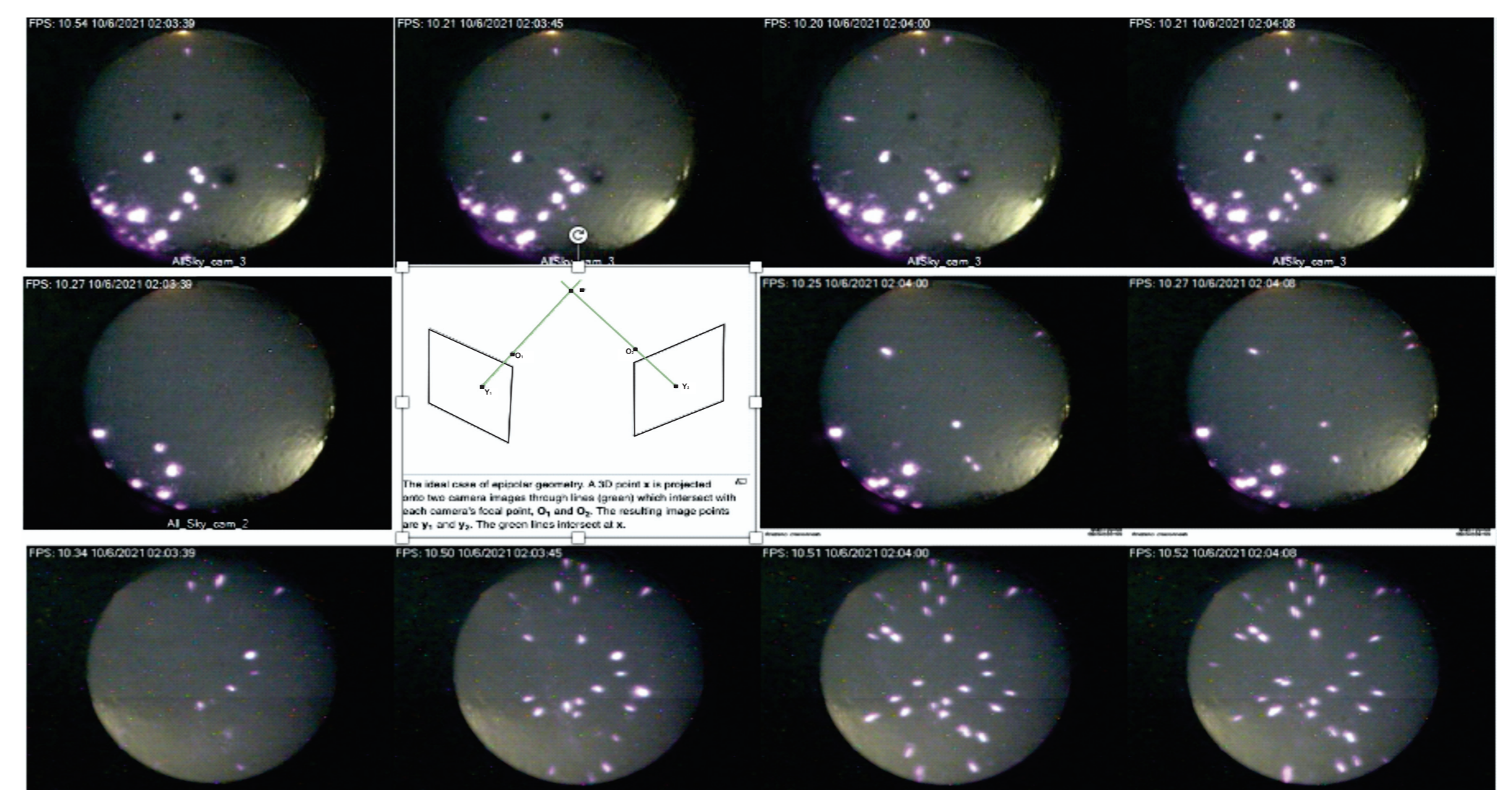
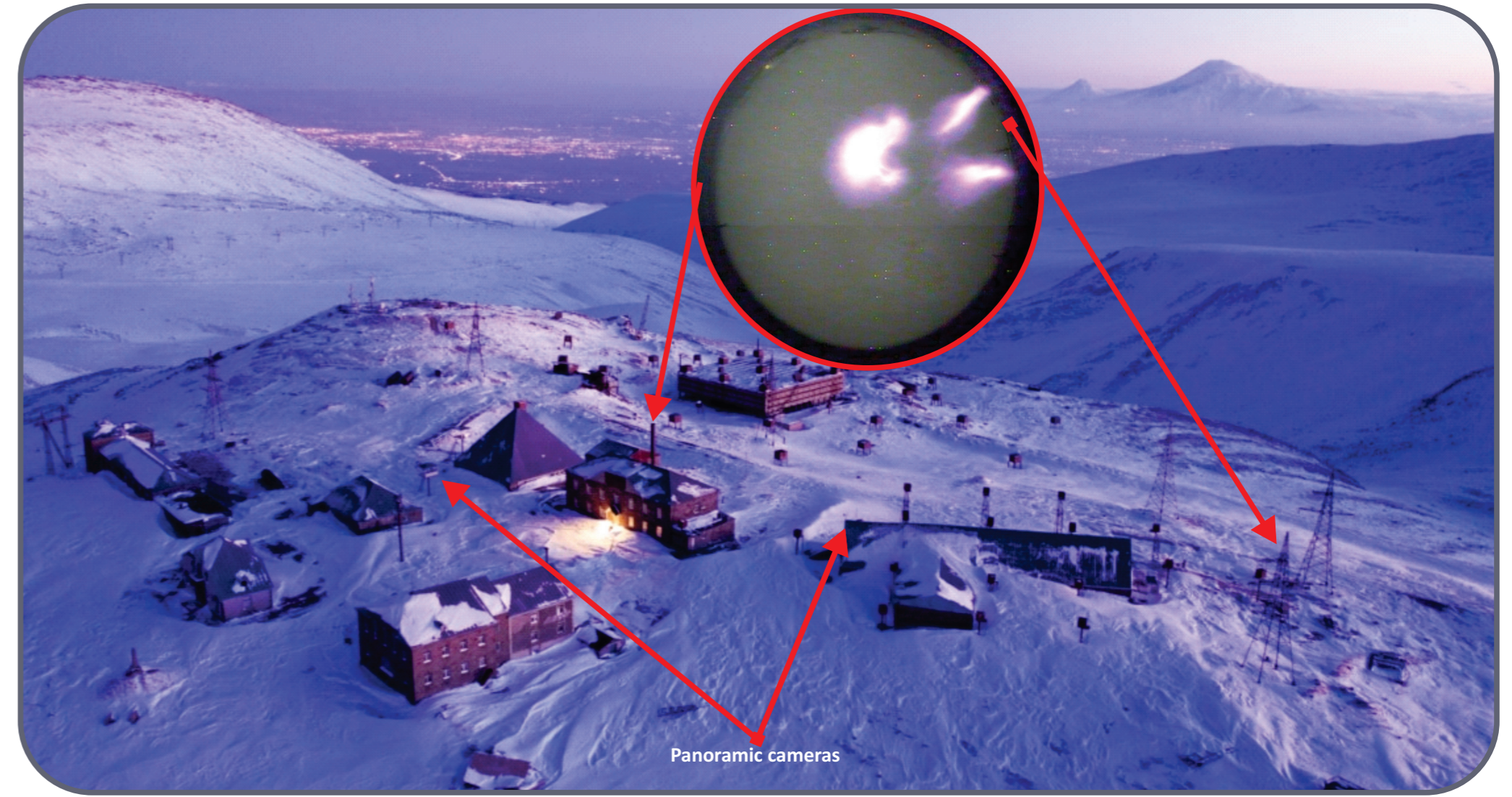
Starting in 2014, we performed continuously (24/7) monitoring of the sky with the "All Sky Cam" panoramic camera, from 2020 with 3 cameras. The camera employs the Color 1/3" Sony Super HAD CCD II image sensor which has high sensitivity in the visible wavelength band of 300-700 nm, pixel array – 446 x 457, exposure range 10-5 - 4 s (automatic).
<http://www.moonglowtech.com/products/AllSkyCam/Weather.shtml>.



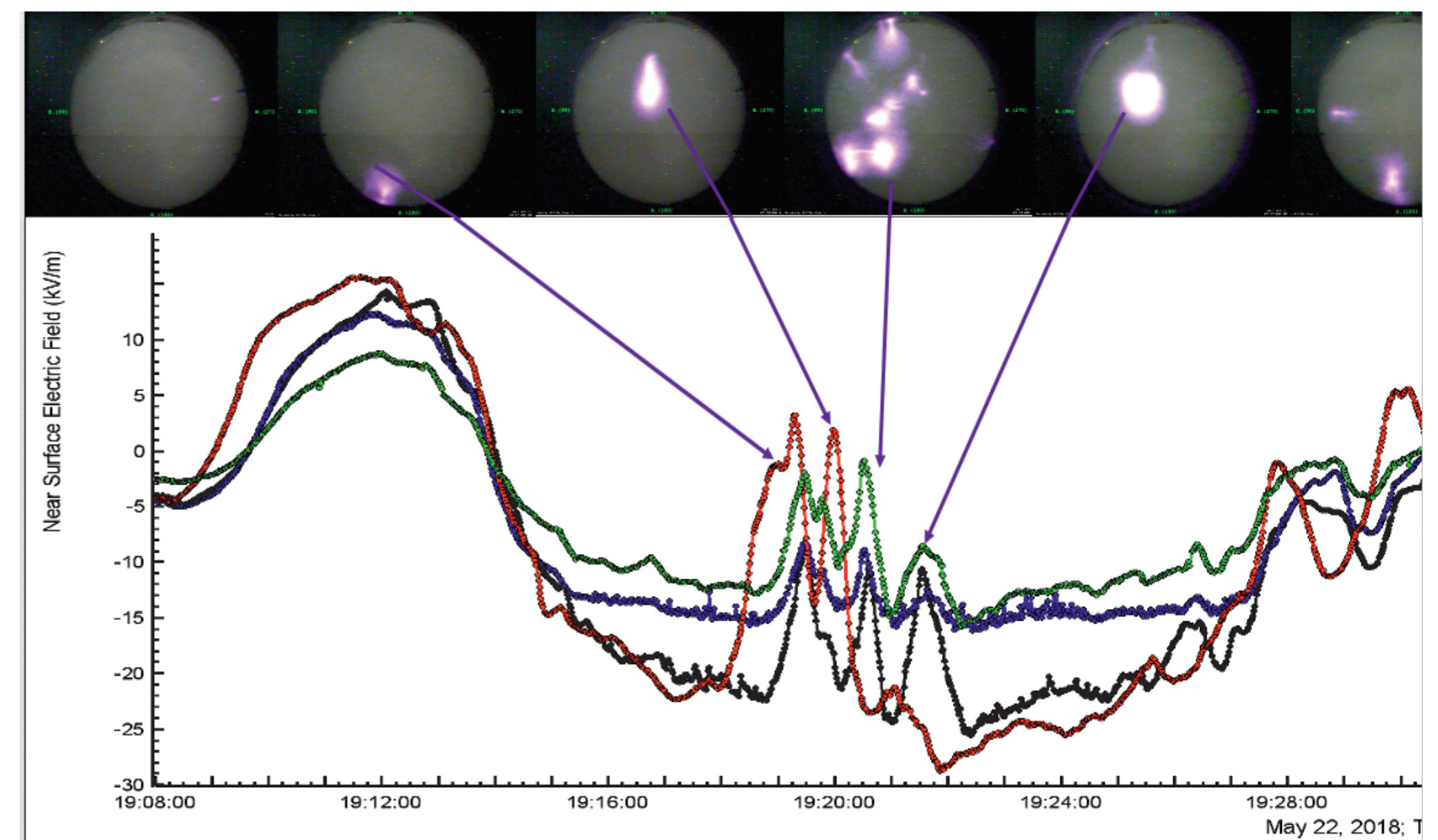
The disturbances of the NSEF during TGE, measured by an EFM-100 electric mill located on the roof of MAKET experimental hall (blue curve). In the upper panel, we show the 1-minute time series of the panoramic camera shots of the sky above the station; by a violet arrow, we indicate the times when panoramic shots were done.

CONCLUSIONS AND REFERENCES

- TGEs described in this paper are very different from TGEs terminated by lightning flash. Centers of the storm lightning activity were ≈ 10 km apart from the detectors and lightning flashes do not catastrophically lower the potential difference and abruptly terminate the RREA process in the thunderous atmosphere above the particle detectors. Particle fluxes that continued for 14 and 18 minutes and originate light glows during maximum flux of TGE. These considerably weak electrical discharges do not trigger the Aragats system of electromagnetic pulse detection, which is triggered only by strong nearby lightning flashes.
- Observed light glows are not local corona discharges on the camera mast but a discharge in the atmosphere above the Aragats station influencing all electric sensors. These discharges do not initiate lightning flash, only large disturbances of the NSEF and, light glows in the sky above the station.



Large TGE occurred on 6 October 2021 was accompanied with intense multiple light spots remaining in skies tens of seconds. Each row represents shots of one from 3 cameras at the same second. Not blue starters not ball lightning, what it can be?



The disturbances of the NSEF during TGE, measured by an EFM-100 electric mill located on the roof of MAKET experimental hall (blue curve). In the upper panel, we show the 1-minute time series of the panoramic camera shots of the sky above the station; by a violet arrow, we indicate the times when panoramic shots were done.

During the most of "glow" events, the NSEF was in the deep negative domain, only 3 from 14 were in the positive domain, see Fig. 20. The origin of light glows is under discussion, the possible explanations are intense fluxes of TGE electrons [1, 2], ball lightning [3,4], St. Elmo's fires, and geomagnetic disturbances [5]. However, after examining luminous TGE events, along with lightning location maps and NSEF time series, we think that these unusual luminous phenomena below thunderclouds are a new optical phenomenon. An electrical discharge much weaker than a lightning flash could only partially neutralize the charge above, and hence, only partially lowers the corresponding potential difference, allowing the electron accelerator to operate and send particle fluxes in the direction to the earth's surface. Simultaneously, these types of discharges initiate light glows in the thunderous atmosphere inside and below thunderclouds. Collection of thousands of glows and videos are posted in [6].

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