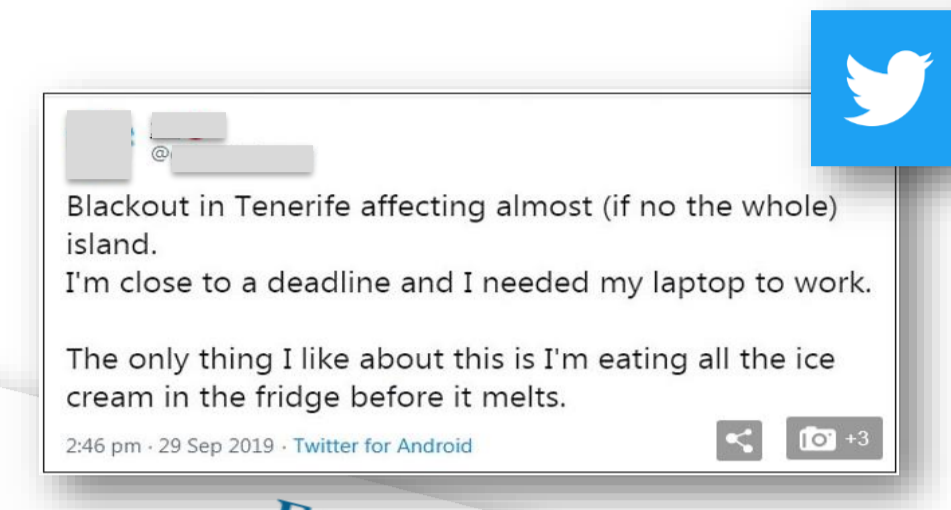
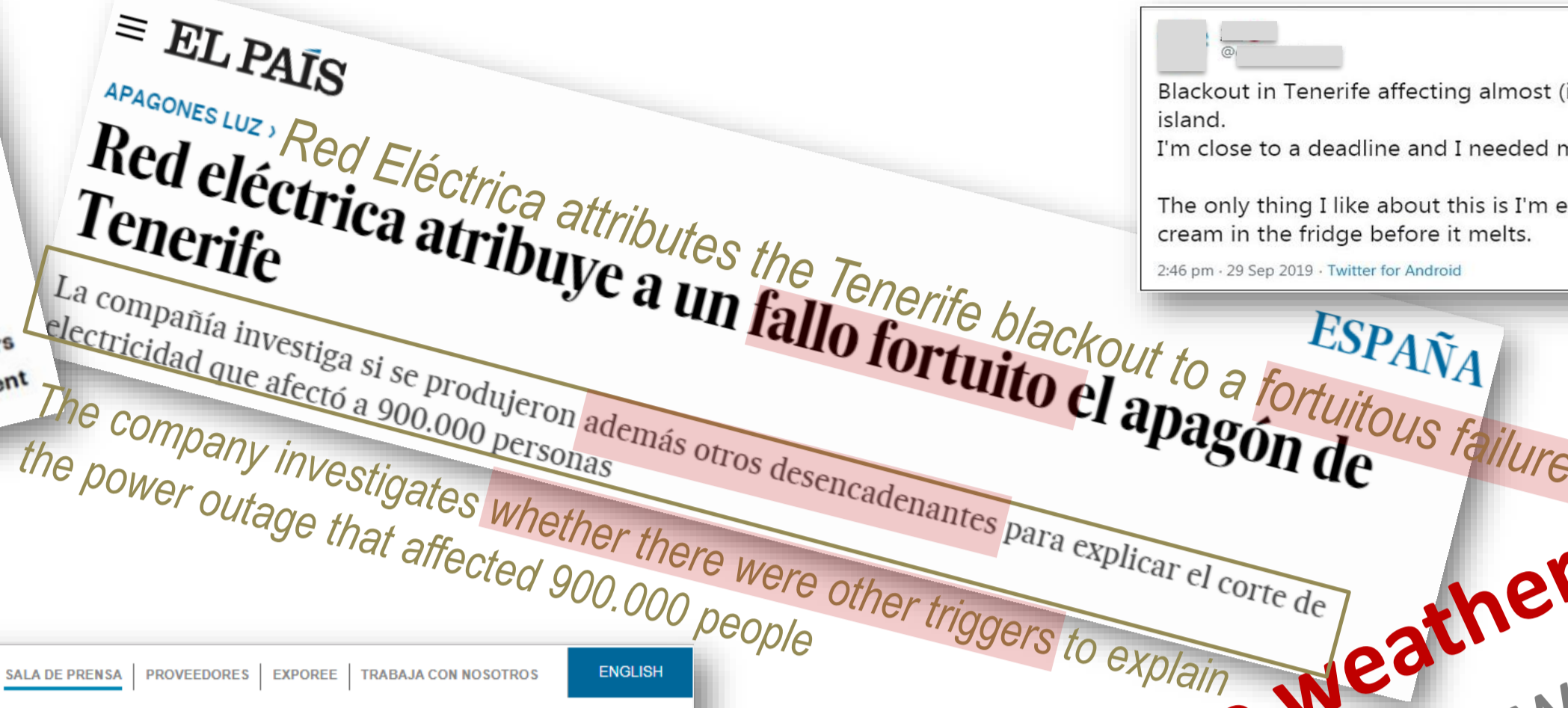




The space weather environment before the Tenerife blackout

Consuelo Cid, Elena Saiz, Antonio Guerrero
Space Weather Group, University of Alcalá, Spain

The 29th of September 2019 the Canary Island of Tenerife was hit by a major blackout. Almost 1 million people were left without power. The entire Atlantic island was affected by the power outage, which took about 9 hours to completely recover. This presentation analyses the space weather environment before the blackout to evaluate if solar activity may have played any role in this blackout.



Might space weather have played any role in this blackout?
At least the space weather conditions before the blackout should be analyzed

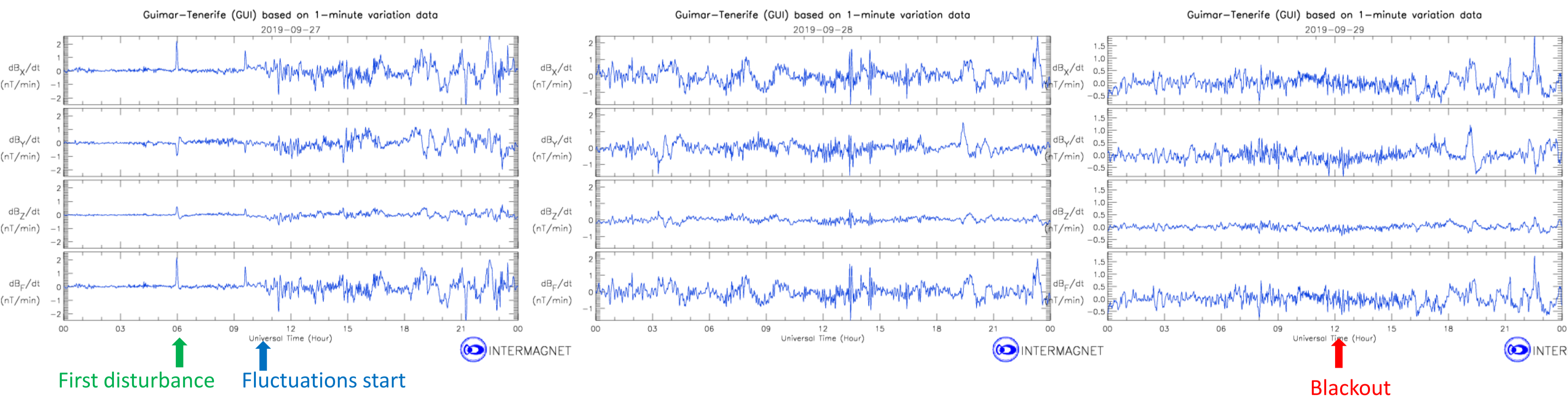


The power incident in Tenerife, starting at 13:11h and causing a power outage, was due to a technical failure in the Granadilla substation, on the South of the island.

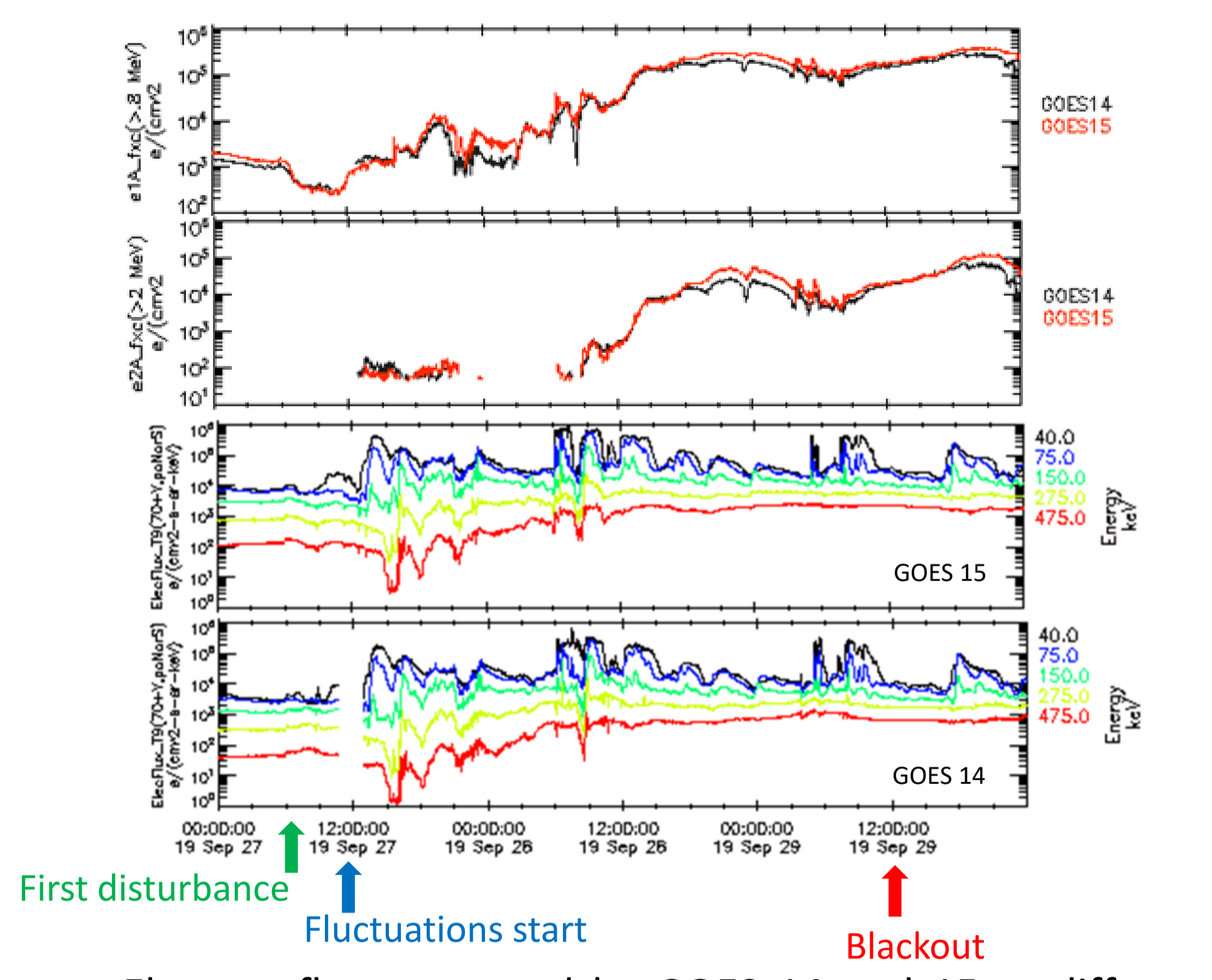
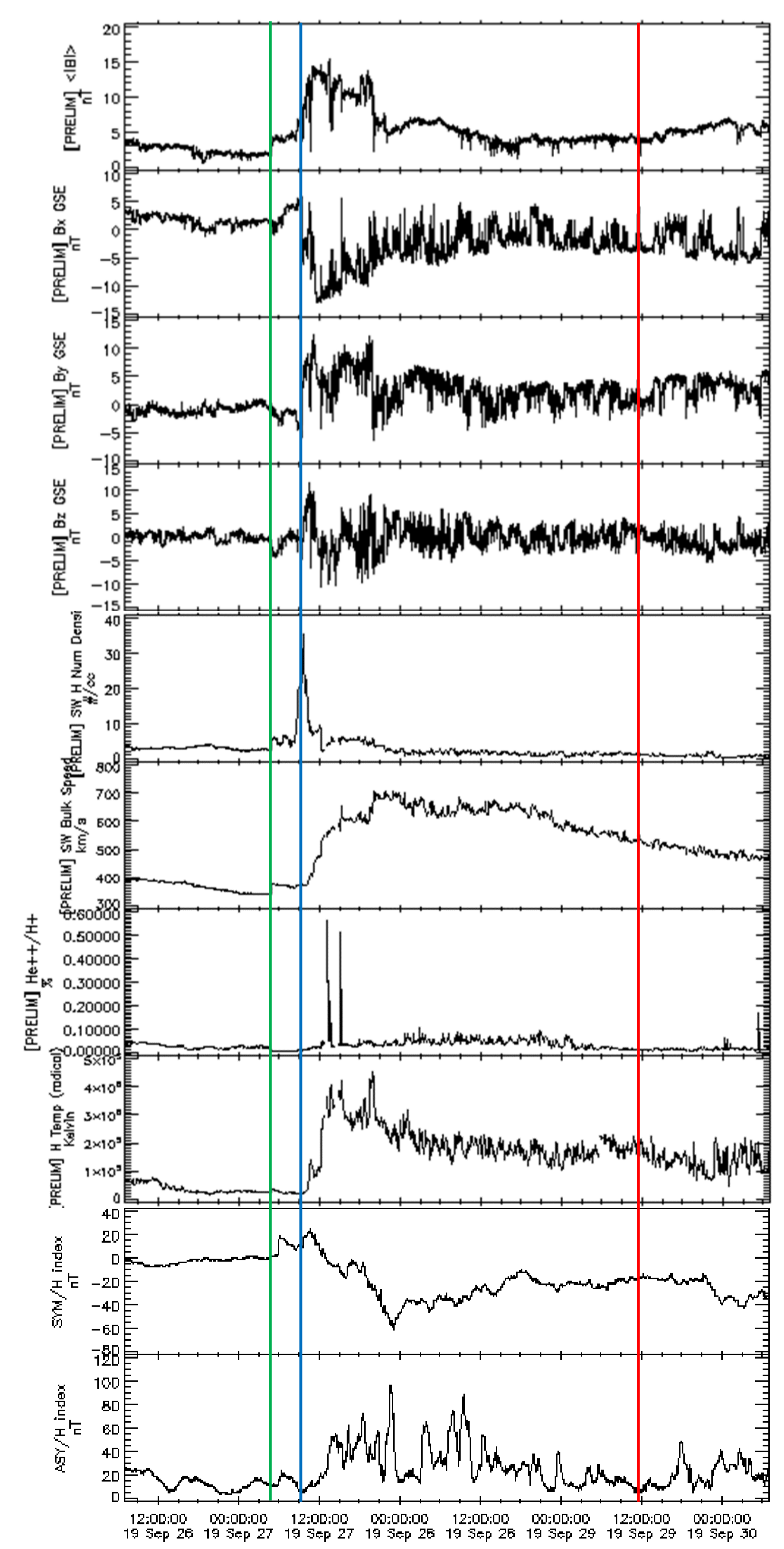


High-power electricity network in Tenerife island shows isolated loop topology (source REE)

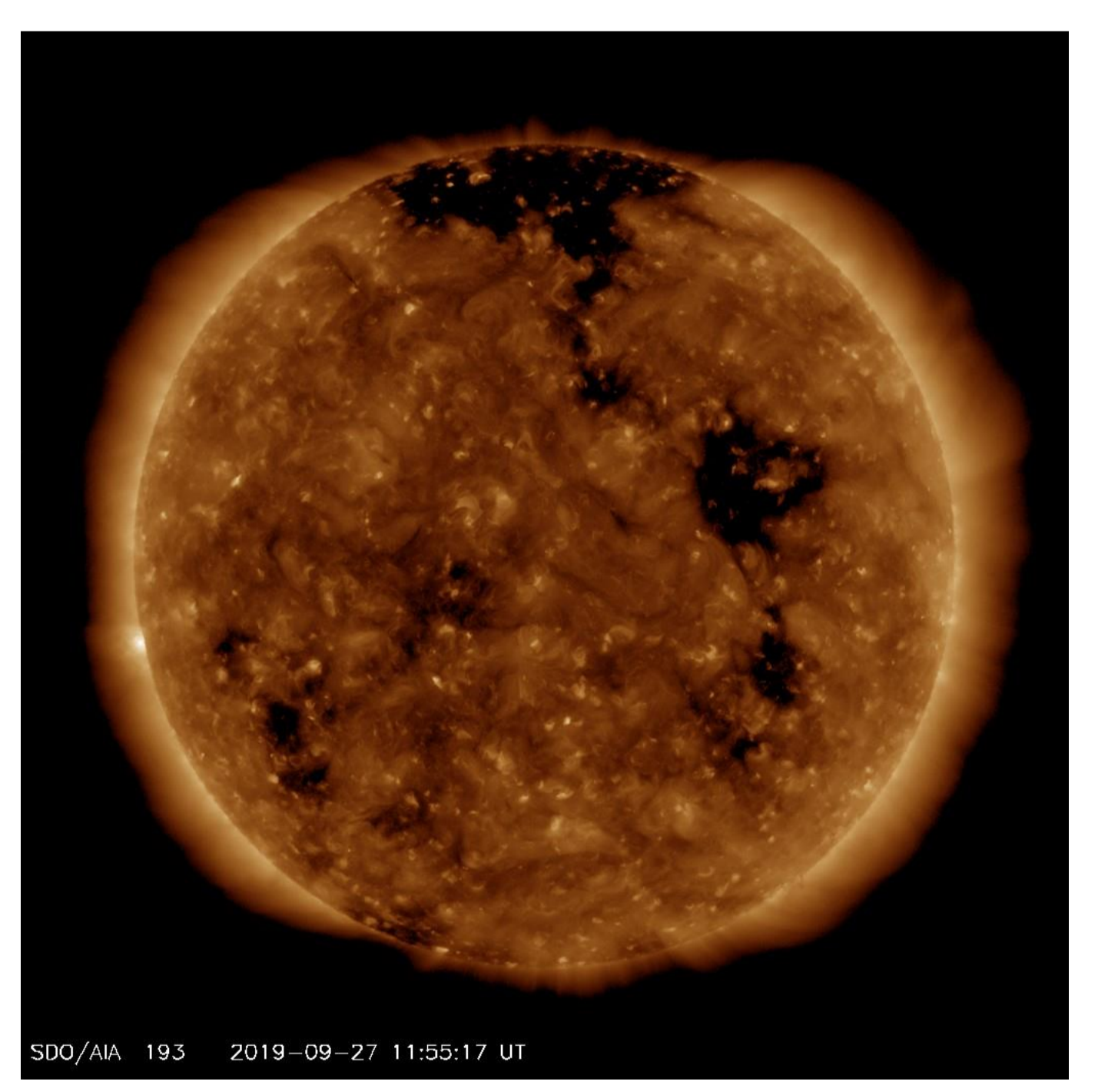
We will analyse the causes of this failure which has produced a power outage



- The rate of change of magnetic field at Guimar-Tenerife observatory shows a first disturbance on 27 September at 6 UT with $dB/dt > 2nT/min$
- From that day at ~10 UT ground magnetic field was highly fluctuating.
- dB/dt is related to GICs [see for example Viljanen 1997, Viljanen et al. 2001, Fiori et al., 2013, Myllys et al., 2014]



Electron flux measured by GOES 14 and 15 at different energy channels. Note the gap in GOES 14 data when the magnetic field fluctuation begins in GUI



A huge solar coronal hole close to the solar equator on the west side is present in the AIA/SDO Fe XII image

- The blackout in Tenerife took place when the Earth was under the influence of (at least) a fast stream from a solar coronal hole
- Not too high but continuous long duration geomagnetic activity was recorded from two days before up to the time of the blackout in ground local magnetometer records and in global geomagnetic indices
- GOES data shows enhanced and injected particle fluxes indicating that the magnetosphere was disturbed by substorm activity during this time interval. Fluctuations start coincides with a disruption (data gaps) in all instruments of GOES 14
- Solar wind key parameters show an interplanetary shock at the time of the first disturbance at GUI, followed by a fast stream from a coronal hole. The large value of proton density, joint to the spikes in alpha-to-proton ratio, suggest a more complex solar event (definitive data will clarify this issue)

Hazardous Space Weather environment, joint to a vulnerable power grid (isolated loop topology), may be the answer to explain the technical failure in the Granadilla substation, which cut electricity in the whole Tenerife island

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