Using a short-range quasi-electrostatic thunderstorm detector for lightning safety and research
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1. Method
The BTD-300 sensor uses a system of 3 co-located stainless steel passive antennas of approximately 0.1 m². Each antenna generates a displacement current, flowing from the surface of the conductor to the ground, in response to the rate of change of the local electric field, which is measured using an electrometer current amplifier, embedded within the supporting PTFE insulator. The signal measured is suitably digitized and filtered to remove the DC currents and the minute-scale variability associated with the passage of charged clouds and to suppress the RF components above 200 Hz. It is then sampled continuously at 100 Hz to resolve the total electric field change from distant lightning flashes.

Lightning flashes are not the only source of transient changes in the atmospheric electric field. Charged particles, fast moving near and/or impacting the detector surface, such as charged hydrometeors and wind blown ions, produce also large and rapid changes to the electric field. The BTD-300 separates lightning flash signals from non-lightning sources by a unique method which compares the signal characteristics on the three antennas. Due to the special geometry of the detector and antennas, only lightning produces the correct combination of relative signal amplitudes and antennas correlation compared with local, non-lightning sources of electric field change.

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2. 2 Lightning activity
Data from the Météogazette lightning network suggest that the flashes started around 23 UTC. The peak lightning activity was between 05 and 0130 UTC on the 27th May, after which the storm moved northwards into Wales and gradually dissipated. It is possible that the storm moved northwards over the steep slopes of the moors, present on the South West peninsula, caused the updrafts to grow stronger and the storm to intensify. During the peak lightning activity, 23 strokes were also captured by one of the UKMON cameras located in Wiltshire, nearly 200 km away from the storm.

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3. BTD signature of elves over Europe
The almost one-to-one correspondence found between the large amplitude quasi-static current transients and distant optical elves, up to more than 1,000 km away from the BTD sensors, suggests a further link to TLE and extremely large peak-current strokes (i.e. when the CMC is below the threshold for halos/spires initiation). The following example shows the case of a large storm across the Netherlands on the 10th April 2018 which produced several powerful strokes and subsequent elves, as observed by an amateur observer in France. For a later stage of the storm, the occurrence of elves is inferred indirectly from the BTD measurements and the step-like LORE events on a VLF transmission path.

4. Conclusions and future work
- Innovative and unique single site sensor for nowcasting of hazards related to thunderstorms around a specific area.
- Further capability to detect transient signals originating from powerful lightning strokes located hundreds of kilometres away, offering a potentially new complementary method for TLE research.
- Quasi-static current onsets appear as a clear signature of remote CG strokes producing electron density enhancements and quasi-electrostatic heating at mesospheric altitudes.
- Planned fieldwork in southern France during the summer 2019, supported by high resolution imaging of TLE and electromagnetic simulations will assess if the observed signatures can be used to evaluate the European regional rate of TLE-producing strokes by means of a BTD mini-array.
- Release of a BTD upgraded version for research purposes.

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