



## **Characteristics of Central European Transient Luminous Events and Their Parent Lightning Discharges**

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Transient luminous events (TLEs) are large-scale optical emissions directly connected to lightning discharges. We analyze a dataset of transient luminous events which occurred over the central part of Europe in 2017 and were detected optically by the station in Nydek, Czech Republic (49.668N, 18.769E) in 2017. We combine this dataset with measurements of electromagnetic signals emitted in the very low frequency range by lightning return strokes which occurred during TLE-producing thunderstorms. We use three-component VLF measurements of sferics, which we have recorded in a favorable electromagnetic environment on the summit of La Grande Montagne (1028 m, 43.9410N, 5.4836E), Plateau d'Albion, France. The measurement of the vertical electric field and two perpendicular components of magnetic field of lightning related signals allows us to estimate the arrival direction of recorded return stroke pulses and the polarity of causative lightning strokes. As this VLF measurement is not continuous (2 minutes of recordings, 5 minutes-long gap), we also use a list of lightning discharges provided by the World Wide Location Network (WWLLN) in order to identify all lightning stroke detected during analyzed thunderstorms including their locations and energy estimates. Then we compare electromagnetic signatures of lightning discharges which generated TLEs with those which occurred during the same thunderstorm but with which no TLEs were associated. We investigate recorded VLF waveforms focusing on shapes of recorded return stroke pulses and intensity of their ionospheric reflections with the aim to find differences in characteristics of lightning discharges parent and non-parent to TLEs.