EGU21-3141, updated on 18 May 2021
https://doi.org/10.5194/egusphere-egu21-3141
EGU General Assembly 2021

First observation of significant long-lasting Thunderstorm Ground Enhancements on the Milešovka peak (altitude 837 m) in Czechia

Ivana Kolmašová[1,2], Ondřej Santolík[1,2], Ondřej Ploc[3], Ronald Langer[3,4], Jana Popová[5], Zbyněk Sokol[5], Petr Zacharov[5], Jakub Šlegl[3], Gerhard Diendorfer[6], Igor Strhárský[4], Radek Lán[1], and Martin Kákona[3]

[1]Institute of Atmospheric Physics CAS, department of Space Physics, Prague, Czechia (iko@ufa.cas.cz)
[2]Charles University, Faculty of Mathematics and Physics, Prague, Czechia
[3]Nuclear Physics Institute, Czech Academy of Sciences, Prague, Czechia
[4]Institute of Experimental Physics, Slovak Academy of Sciences, Kosice, Slovakia
[5]Institute of Atmospheric Physics CAS, department of Meteorology, Prague, Czechia
[6]OVE Service GmbH, Dept. ALDIS, Vienna, Austria

Bursts of gamma rays observed on the Earth's surface – so called Thunderstorm Ground Enhancements (TGE) were detected by a plastic scintillator (disassembled from the particle detector SEVAN) located in the observatory building on the Milešovka peak (50.6N, 13.9E, altitude 837 m) in Czechia. The TGEs observed during two thunderstorms on 23 April 2018 respectively lasted 65 and 15 minutes and exceeded the background radiation levels by 30 and 40 percent.

The first storm was a part of an evolving squall line which crossed the Milešovka peak. The second storm was probably a supercell, which moved near Milešovka but did not hit its top. Both storms caused heavy precipitation and strong wind gusts. The onset of the TGEs preceded the onset of precipitation by approximately 8 minutes. During the increases of TGE radiation, the European lightning detection network EUCLID detected numerous predominantly negative intracloud lightning discharges at distances closer than 5 km from the particle detector.

To understand the conditions for the TGE observation we investigated the data collected during the enhancements by a Ka-band cloud radar, an electric field mill, and a broadband electromagnetic receiver installed in the Milešovka peak observatory. Using the cloud radar measurements, we estimated the vertical extent of the thunderclouds. The cloud base was found at about 500 m above the observatory. Estimated heights of the cloud tops for the two storms were 12 and 8 km, respectively, indicating that the storm center of the second storm was not directly above the cloud radar. The updraft velocities reached 10 m/s. A composition of hydrometeors suggested good conditions for cloud electrification.

We have found that the increases of TGE radiation corresponded to the large negative electric fields (up to – 20 kV/m) measured by the electric field mill rather than to individual discharges. We also identified numerous microsecond-scale pulses in the broadband magnetic field records, which can be attributed to corona-type discharges occurring near the receiving antenna in high

local electric fields below the thunderstorm.

Based on our analysis we assume that observed TGEs corresponded to the bremsstrahlung generated during collisions of electrons accelerated in the thunderstorm electric field with the air molecules. Because of a very small number of cloud-to-ground lighting discharges we hypothesize that the electrons might have been accelerated by a strong lower positive charge center at the bottom of the thundercloud. As the TGE radiation increases were unusually long, we speculate that their later part might have been assigned to the radon progeny which was lifted to the atmosphere by a near-surface electric field and returned back to the ground with the rain precipitation.