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Analysis of electromagnetic measurements and meteorological observations linked to two Thunderstorm Ground Enhancements registered at the stormiest place in Czechia

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Two significant long-lasting Thunderstorm Ground Enhancement (TGE) events were registered on 23 April 2018 at the Milešovka Mt. observatory, the stormiest place in Czechia (50.55N, 13.93E, altitude 837 m), during two linearly organized thunderstorms. The increases of photon counts detected by a plastic scintillator lasted 70 and 25 minutes, respectively, and reached 31 % and 48 % above the background radiation levels during reported events. Using simulations, we verified that the observed increases of count rates are consistent with the energy spectrum of previously observed TGEs.

We investigated the relevant data from a suite of meteorological instruments, a Ka-band cloud radar, an electric field mill, a broadband electromagnetic receiver, all placed at the Milešovka Mt. observatory, with an aim to reveal the conditions for this unique continental TGE observation at an exceptionally low altitude. The onset of the TGEs preceded the onset of precipitation by 10 and 3 minutes, respectively, during the events. This delayed rain arrival and an energy threshold of 6.5 MeV for registered particles in the scintillator clearly excluded the presence of the radon progeny washout and its subsequent decay. During the increases of the 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 while the occurrence of cloud-to-ground discharges was suppressed. The cloud radar recorded presence of graupel below the melting level. The composition of hydrometeors suggested good conditions for the cloud electrification. The variations of the near surface electric field were unusual, exhibiting very brief negative electric field excursions reaching -20 kV in a quick succession. The sub-microsecond unipolar pulses emitted by close corona discharges saturated the broadband magnetic loop antenna.

All these measurements indicate presence of a strong lower positive charge region inside the thundercloud. The bottom thundercloud dipole was probably responsible for acceleration of the seed electrons in the air and subsequent bremsstrahlung registered at Milešovka observatory. These seed electrons might have had originated not only in the secondary cosmic ray particles but could also come from a high concentration of radon in the air collected during the propagation of the convective system above the uranium-rich soils before the thunderstorms overpassed the Milešovka Mt.