

EGU2020-699

<https://doi.org/10.5194/egusphere-egu2020-699>

EGU General Assembly 2020

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Meteorological Parameters of Thunderstorm Ground Enhancements

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Thunderstorm ground enhancements (TGEs) are events of energetic particle flux increases, discovered and observed at the Aragats Research Station (Armenia). Energetic particles are accelerated and multiplied in the electric field of clouds, and may be registered by ground-based detectors. Analysis of the structure of thunderclouds producing TGEs is crucial for clarifying the mechanism of particle acceleration.

In the present study the hydrometeor dynamics are analysed on the basis of the state of the atmosphere modeling by means of Weather Research and Forecasting Model. Meteorological characteristics typical of TGE occurrence in the mountainous region of Aragats are discovered. A technique has been developed for estimation of the charge distribution in a cloud on the basis of comparison of the simulations and experimental data. The retrieved cloud electrical structure is used to estimate the dependence of the electrification process on the temperature and liquid water content.

An unusually low concentration of ice particles leads to the great importance of snow particles in the process of charge separation. A typical charge distribution in a TGE-producing cloud is found to be well approximated by a two-layered charge structure with a lower positive charge region formed by graupel particles and an upper negative region formed by snow particles. Characteristic charge density is 0.01 C/km^3 for graupel cluster and 0.02 C/km^3 for snow cluster. A vertical distance of about 1-2 km between the lower positive and upper negative layers is sufficient for the development of an energetic particle avalanche.

The obtained estimation of the hydrometeor content and the electrical structure of a TGE-producing cloud provides new evidence on particle acceleration mechanisms in the atmosphere and processes of charge distribution in mountainous conditions.