Geophysical Research Abstracts
Vol. 15, EGU2013-6130, 2013
EGU General Assembly 2013

Energy and density of low-energy electrons produced by high-energy cosmic particles in the troposphere

Christoph Koehn and Ute Ebert
Centrum Wiskunde en Informatica (CWI), Amsterdam

When high-energetic cosmic particles reach the atmosphere, they create showers of elementary particles and then ionization avalanches at lower energies. The Low Frequency Array (LOFAR) in Europe and the Pierre Auger Observatory in Argentina measure the energy and direction of the secondary shower electrons. The electric fields of thunderstorms certainly influence these measurements, but how much? And the created ionization might play a role in lightning inception, but how precisely? To model the particle showers and ionization avalanches, a Monte Carlo code has to cover an energy range from 10ˆ20 eV to fractions of eV. However, the Monte Carlo codes for the particle showers typically cover an energy range from 10ˆ20 eV to 1 MeV where the production of electron positron pairs stops. As a first step, we here update the models for the ionization avalanches at energies less than 1 MeV, in the absence of an electric field; thus there is no external energy source and the energy of the electrons dissipates due to ionization and excitations. We calculate electron number, spatial distribution and lifetime of the electron swarm, and discuss the influence of air pressure. We also present the mean energy and the energy spectrum of the electrons as a function of time. To do so, we use a particle model developed for the ignition and motion of streamers and extend it to electron energies up to 100 MeV. We use the screened Rutherford cross section for elastic scattering for energies above 1 keV and implement the relativistic binary-encounter Bethe (RBEB) ionization model for energies above 10 keV. We also take into account 36 different excitations for the constituents of air, attachment of electrons to oxygen, and charge recombination. While air is ionized by shower electrons, the number of electrons increases up to a maximum. Then it declines because electrons attach to oxygen through dissociative or three body attachment. It is remarkable that thermal air motion had to be introduced into the model to ultimately remove all free electrons.