

Modeling the stepping mechanism in negative lightning leaders

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It is well-known that the negative leaders develop in a step manner using a mechanism of the so-called space leaders in contrary to positive ones, which propagate continuously. Despite this fact has been known for about a hundred years till now no one had developed any plausible model explaining this asymmetry. In this study we suggest a model of the stepped development of the negative lightning leader which for the first time allows carrying out the numerical simulation of its evolution. The model is based on the probability approach and description of temporal evolution of the discharge channels. One of the key features of our model is accounting for the presence of so called space streamers/leaders which play a fundamental role in the formation of negative leader's steps. Their appearance becomes possible due to the accounting of potential influence of the space charge injected into the discharge gap by the streamer corona. The model takes into account an asymmetry of properties of negative and positive streamers which is based on well-known from numerous laboratory measurements fact that positive streamers need about twice weaker electric field to appear and propagate as compared to negative ones. An extinction of the conducting channel as a possible way of its evolution is also taken into account. This allows us to describe the leader channel's sheath formation. To verify the morphology and characteristics of the model discharge, we use the results of the high-speed video observations of natural negative stepped leaders. We can conclude that the key properties of the model and natural negative leaders are very similar.