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A physics-based model of the electric field pulses occurring during the lightning initiation

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We investigate properties of the electric field pulses observed during the lightning initiation using a generalization of electrostatic and transmission-line models. In the model, the initial leader has a finite conductivity, the current in the channel is inducted owing to an ambient field generated by charge structure inside a thundercloud, and the electric field is computed by a formula derived from exact solution of the Maxwell's equations for a given inducted current. We show how the shape of electric field waveform of individual pulses depends on various parameters of the model with an emphasis on the thundercloud charge structure. We generalize the model to include sequences of several electric field pulses. We show how the peak current pulse is related to the preliminary breakdown electric field peak pulse and we compare this estimation with observations.