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Model of first return stroke based on a bidirectional leader concept

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We have developed a new return stroke model belonging to the category of electromagnetic models. The lightning channel is modeled to have a finite conductivity. The model includes a corona sheath, a realistic cloud charge distribution, and an arc model for the evolution of the return stroke channel conductivity. The contact of the lightning channel with ground is modeled by connecting one segment with a fixed zero potential to the bottom of a channel. Streamer to leader transition occurs close to a ground contact by the increase of streamer's conductivity. The induced charges and the leader potentials before and after the contact with the ground agree with an electrostatic modeling of bidirectional leader followed by a return stroke. The channel base current is not assumed to have a predefined form but it is predicted by the model. We show the current waveform profile along the return stroke channel. We show that the current rise time increases and the current propagation speed decreases with the height. We compare modeled magnetic field waveforms with our observations. The peak currents and distances from the receiver for return stroke pulses used for this comparison were provided by the METEORAGE lightning detection network.