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Electromagnetic model of M-component processes in Lightning

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In cloud-to-ground lightning flashes, M-components are transient enhancements of the luminosity occurring between the return stroke processes and are related to the transfer of additional charge from cloud to ground. They occur during a background flow of a continuing current in the return stroke channel. M-components are typically associated with characteristic features of the electric/magnetic fields at different distances from the lightning discharge. We model M-components as a connection between the return stroke channel and a vertical channel of an upward in-cloud leader. In order to describe these processes, we numerically solve Maxwell's equations by the method of moments for both channels including their interactions. Ambient electric potential related to a realistic thunderstorm charge structure is computed by the successive over-relaxation method. We obtain simulated electric field changes and compare them together with time-correlated electromagnetic and optical measurements obtained in Florida in 2011. Waveshapes of simulated current waveforms at different heights above the perfectly conducting ground are compared with luminosity measurements. We also determine a time evolution of the electric potential and the line charge density along the lightning channel.