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Transient electric field in the mesosphere above a gamma-shape lightning stroke

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We describe the space-time distribution of the pulsed electric field in the middle atmosphere above a positive gamma?shaped lightning stroke. The channel of such a discharge contains a vertical and a horizontal section. The current wave moves initially vertically and turns horizontally then, so that radiation appears from the vertical electric dipole followed by that from the horizontal dipole. Combined with reflection from the perfectly conducting ground, the source provides the three subsequent pulses in the atmosphere, with the lag being originated owing to the finite velocity of the current wave in the gamma?shaped stroke. The pulses are reproduced by reflections from the air-ground and the air-ionosphere interfaces and the waveform resembles the M-component, which is often noted in the negative strokes [e.g. Yashunin, et al., 2007]. The non-stationary fine structure appears in the spatial distribution of electric field, which persists for 2 ms or even more and exceeds the runaway electron threshold. Estimates support the idea of free electron bunching in the mesosphere by the pulsed electric field. Focusing may occur about 10 km away from the point of electron- field interaction; it is delayed by a few ms from the moment of interaction. Data presented might be helpful in realistic modeling of the red sprite formation.

Keywords: lightning, electric field